2014-2018 Chevrolet Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Antenna Amplifier Fastener	3 N.m	27 lb in
Antenna Module Ground Bolt	10 N.m	89 lb in
Audio Amplifier Fasteners	2.5 N.m	22 lb in
Cellular Communication Antenna Base Fastener	9 N.m	80 lb in
Communication Interface Module Battery Fastener	2.5 N.m	22 lb in
Communication Interface Module Bracket to Body Fastener	3.5 N.m	27 lb in
Communication Interface Module to Mounting Bracket Fastener	5 N.m	44 lb in
Digital Radio Receiver Mounting Bracket to Body Fasteners	5 N.m	44 lb in
Digital Radio Receiver to Mounting Bracket Fasteners	5 N.m	44 lb in
Radio Fasteners	2 N.m	18 lb in
Speaker Grille Fasteners	2 N.m	18 lb in

SCHEMATIC WIRING DIAGRAMS

RADIO/NAVIGATION SYSTEM WIRING SCHEMATICS

Power, Ground, and References

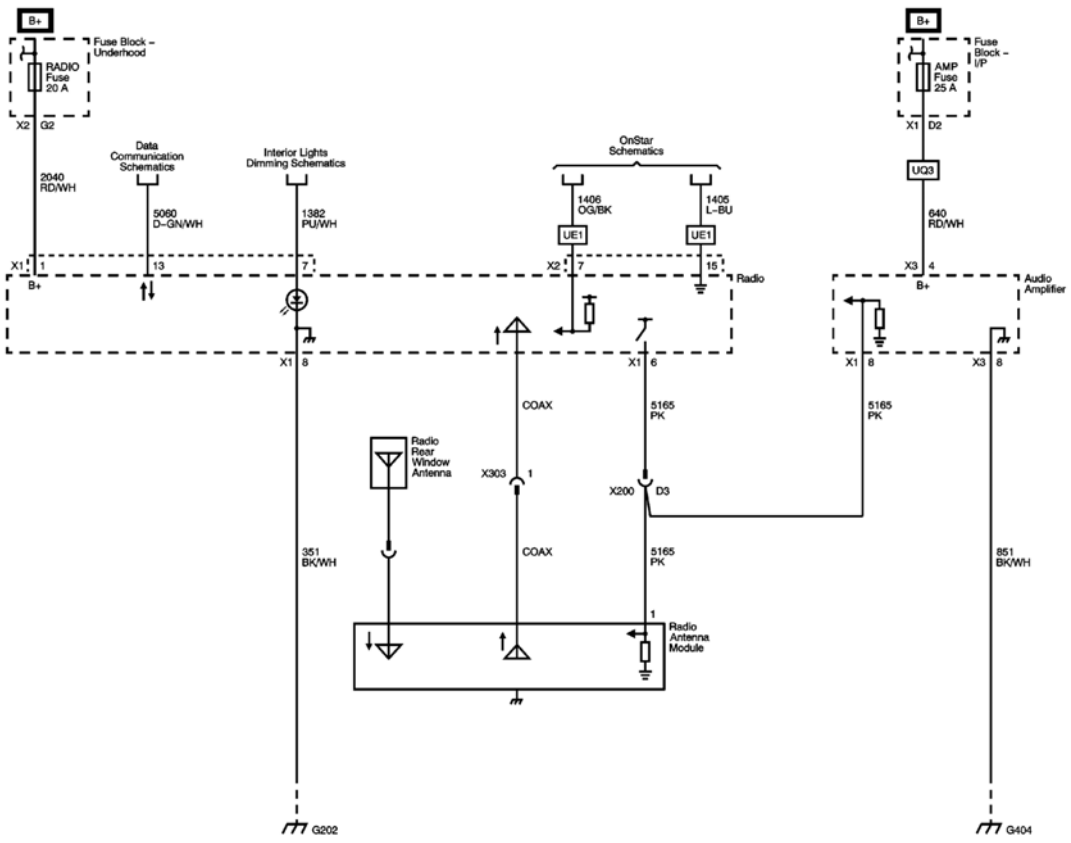


Fig. 1: Power, Ground, and References Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Radio to Speakers (UW6)

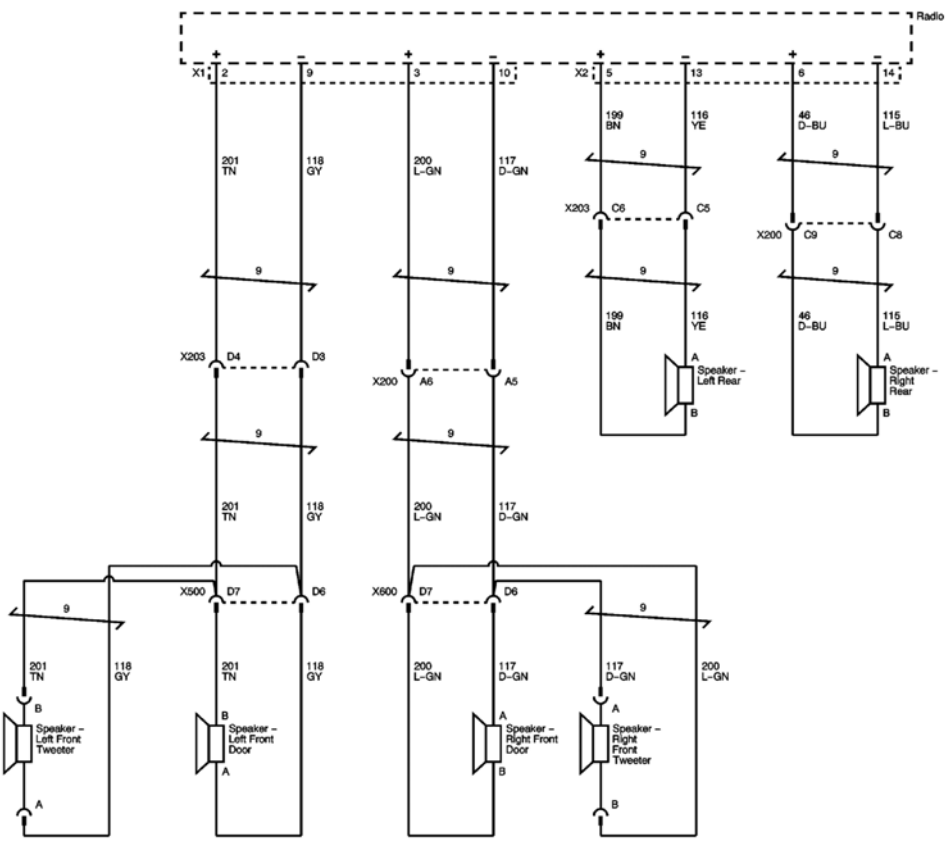


Fig. 2: Radio to Speakers Wiring Schematic (UW6)

Courtesy of GENERAL MOTORS COMPANY

Audio Signal Communications (UQ3)

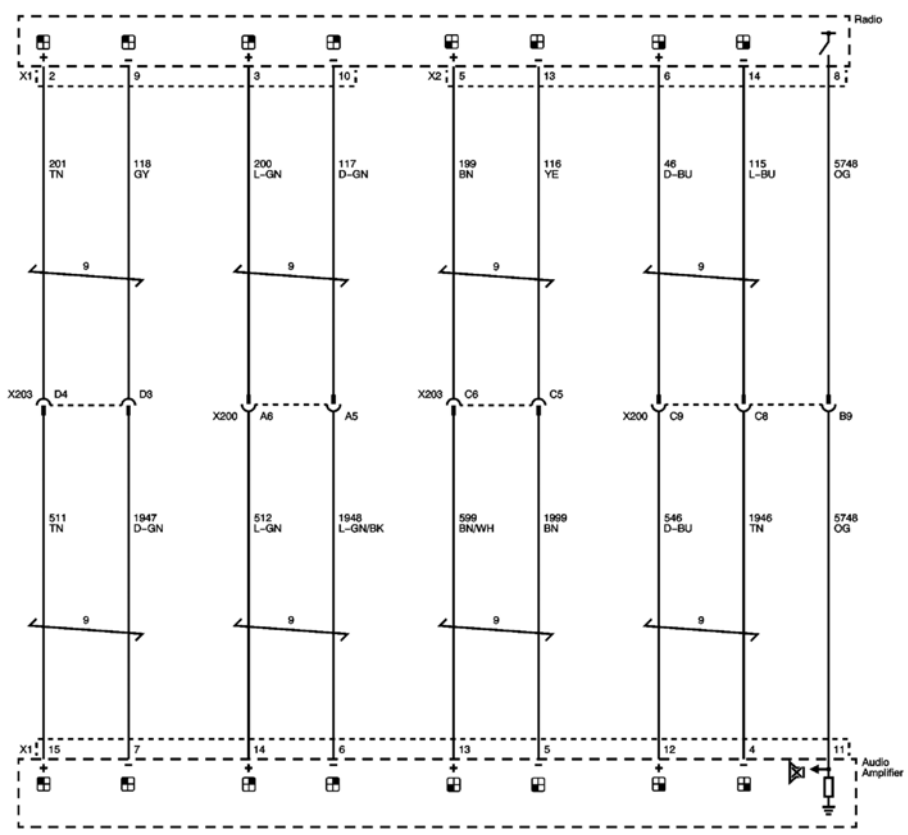


Fig. 3: Audio Signal Communications Wiring Schematic (UQ3)

Courtesy of GENERAL MOTORS COMPANY

Audio Amplifier to Speakers (UQ3)

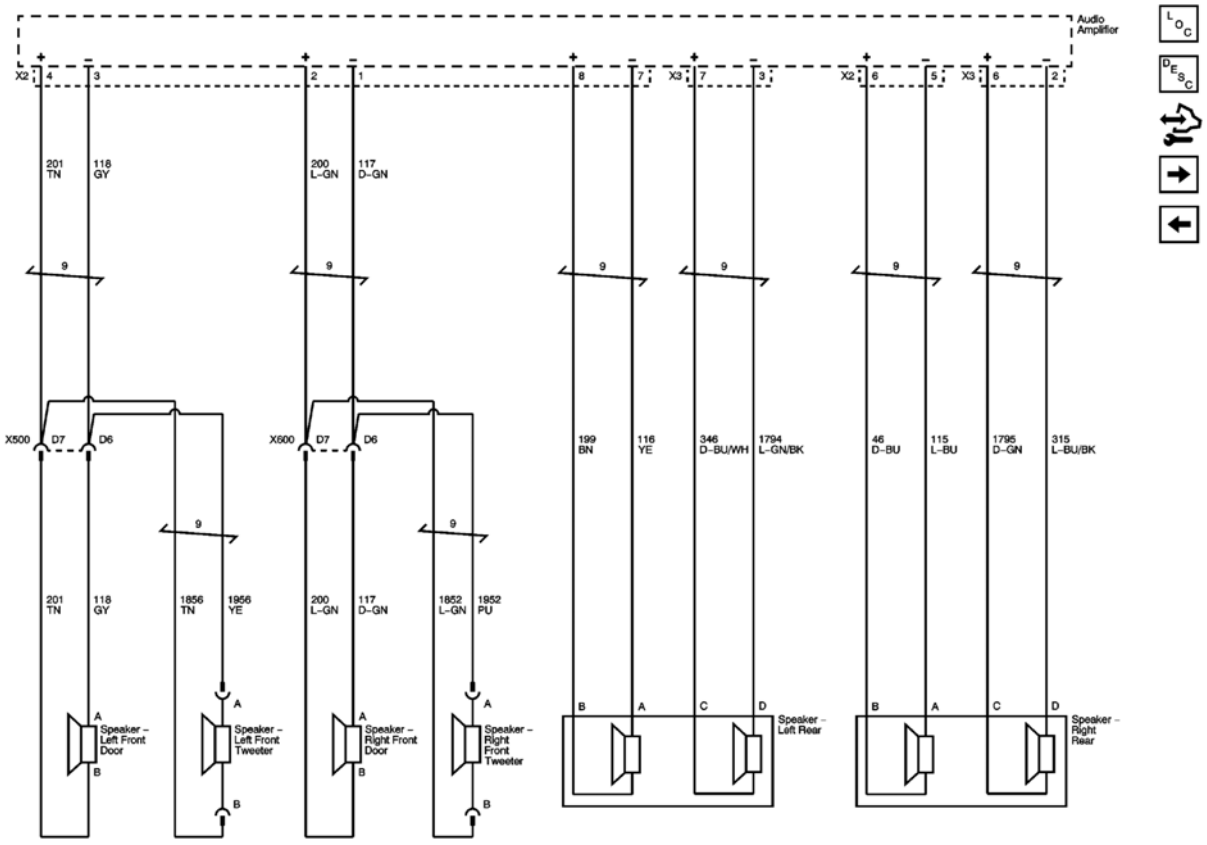


Fig. 4: Audio Amplifier to Speakers Wiring Schematic (UQ3)
Courtesy of GENERAL MOTORS COMPANY

Radio to Speakers (9C1 or 9C3 without WX7)

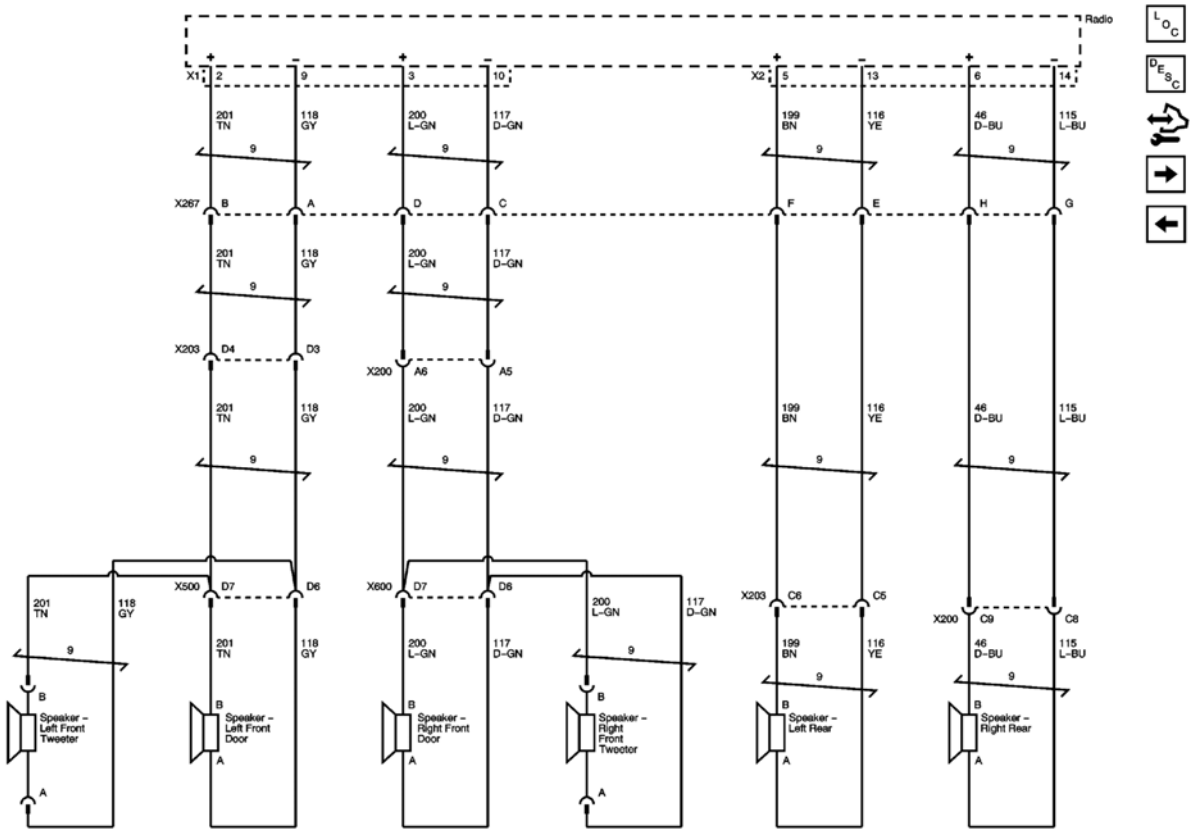


Fig. 5: Radio to Speakers Wiring Schematic (9C1 or 9C3 without WX7)

Courtesy of GENERAL MOTORS COMPANY

Radio to Speakers (9C1 or 9C3 with WX7)

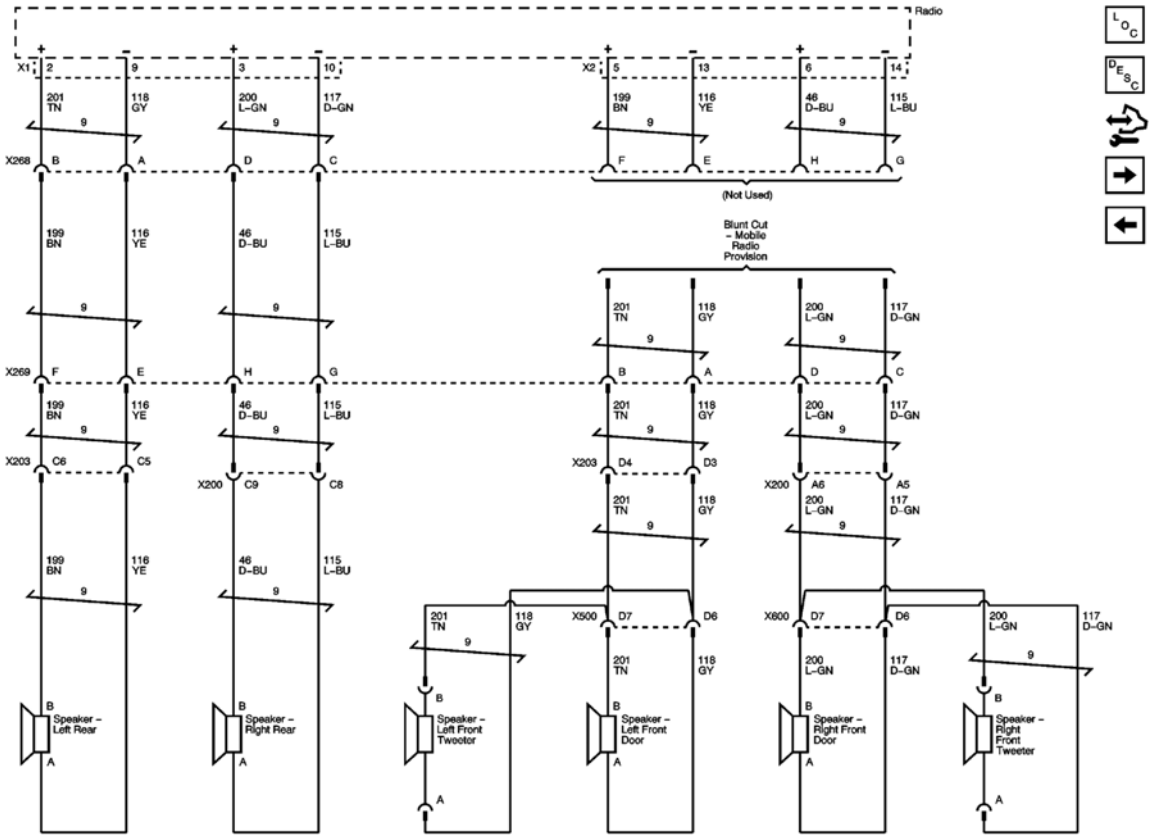


Fig. 6: Radio to Speakers Wiring Schematic (9C1 or 9C3 with WX7)

Courtesy of GENERAL MOTORS COMPANY

Satellite Radio (U2K)

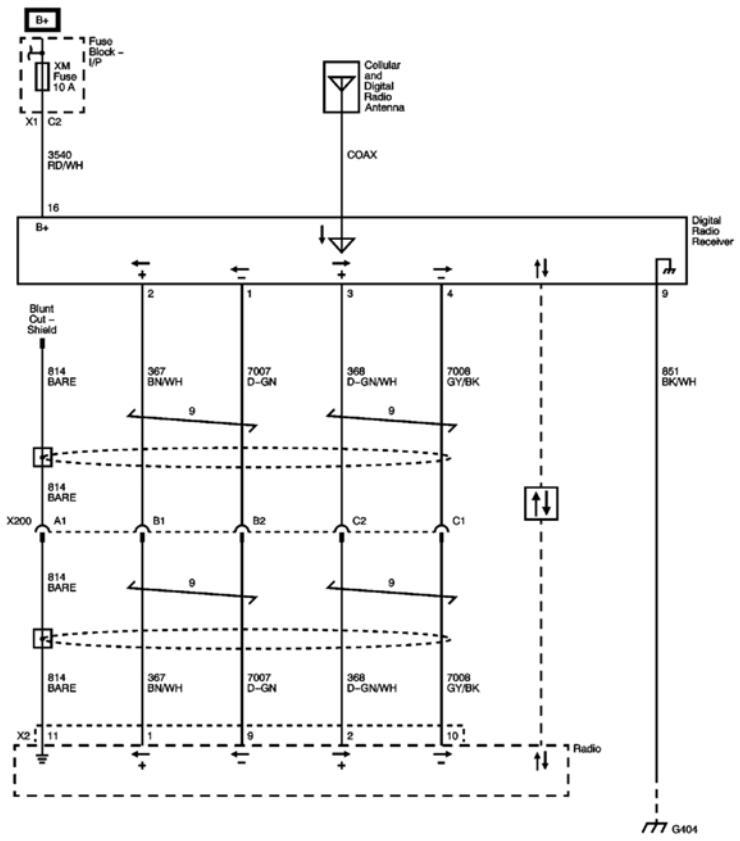


Fig. 7: Satellite Radio Wiring Schematic (U2K)
Courtesy of GENERAL MOTORS COMPANY

ONSTAR/TELEMATICS WIRING SCHEMATICS

OnStar

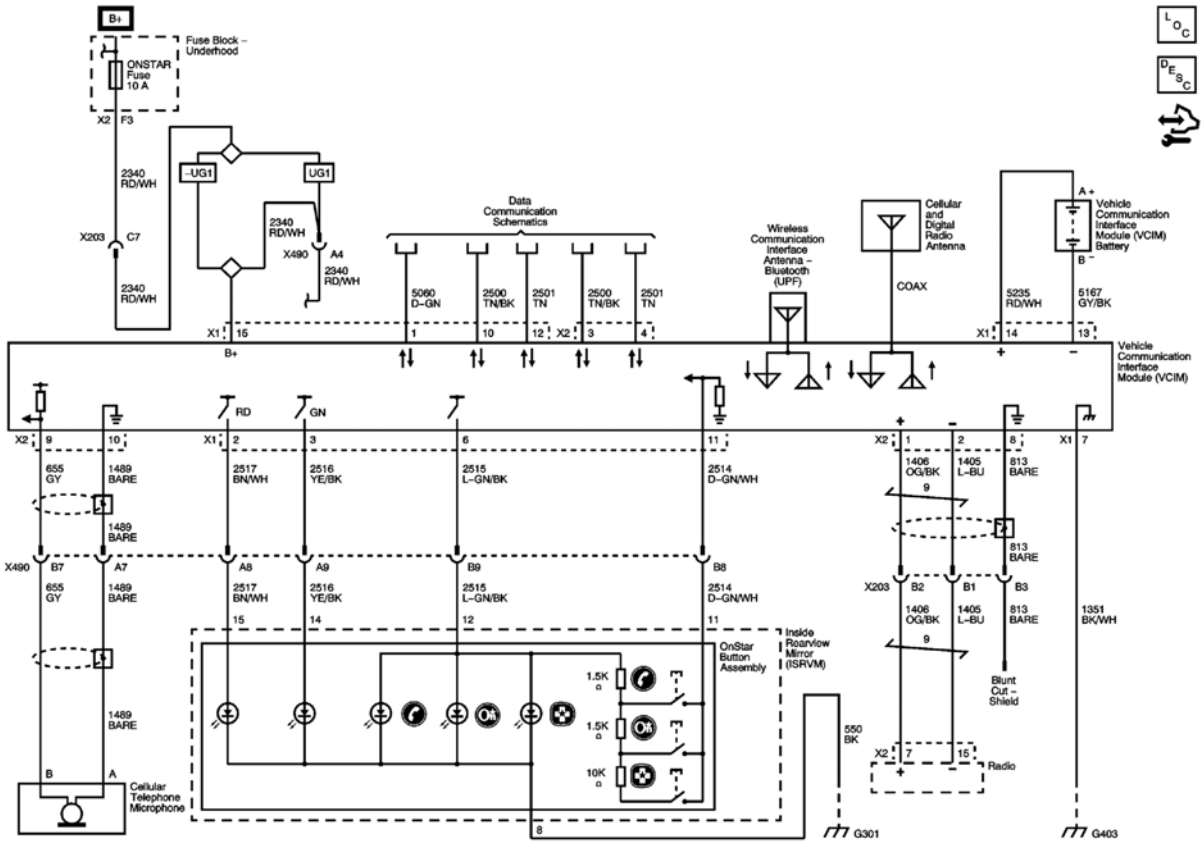


Fig. 8: OnStar Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B1025, B1035, B1045, OR B1055: AUDIO OUTPUT 1-4

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1025 01

Audio Output 1 Left Front Circuit Short to Battery

DTC B1025 02

Audio Output 1 Left Front Circuit Short to Ground

DTC B1035 01

Audio Output 2 Right Front Circuit Short to Battery

DTC B1035 02

Audio Output 2 Right Front Circuit Short to Ground

DTC B1045 01

Audio Output 3 Left Rear Circuit Short to Battery

DTC B1045 02

Audio Output 3 Left Rear Circuit Short to Ground

DTC B1055 01

Audio Output 4 Right Rear Circuit Short to Battery

DTC B1055 02

Audio Output 4 Right Rear Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Antenna 14V Switched Supply Voltage	2	2	-	-
Amplifier Battery Positive Voltage	2	2	-	-
Amplifier Ground	-	2	-	-
Left Front Speaker Output (+)/Left Front Low Level Audio Signal (+)	B1025 02*	1	B1025 01*	-
Left Front Speaker Output (-)/Left Front Low Level Audio Signal (-)	B1025 02*	1	B1025 01*	-
Right Front Speaker Output (+)/Right Front Low Level Audio Signal (+)	B1035 02*	1	B1035 01*	-
Right Front Speaker Output (-)/Right Front Low Level Audio Signal (-)	B1035 02*	1	B1035 01*	-
Left Rear Speaker Output (+)/Left Rear Low Level Audio Signal (+)	B1045 02*	1	B1045 01*	-
Left Rear Speaker Output (-)/Left Rear Low Level Audio Signal (-)	B1045 02*	1	B1045 01*	-
Right Rear Speaker Output (+)/Right Rear Low Level Audio Signal (+)	B1055 02*	1	B1055 01*	-
Right Rear Speaker Output (-)/Right Rear Low Level Audio Signal (-)	B1055 02*	1	B1055 01*	-
1. No or reduced sound from speaker 2. Amplifier inoperative/no sound from speakers * Noticeable audio distortion possible				

Circuit/System Description

Each of the audio output channel circuits (+) and (-), at the radio and at the amplifier (if equipped) have a DC bias voltage that is one half of the battery voltage. When using a DMM, each of the audio output channel circuits will measure approximately 6.5V DC. The audio being played on the system is produced by a varying AC voltage that is centered around the DC bias voltage on the same circuit. The AC voltage is what causes the speaker cone to move and produce sound. This voltage will vary depending on what type of audio is being listened to, talk or music, and type of music, as well as the volume setting of the system. Low volume and talk settings will measure around 1V AC and less, where constant music may measure 3V AC and slightly higher. In an amplified audio system, these similar AC voltage measurements may be slightly higher on the output of the amplifier, and the typical AC voltage readings at the output of the radio are less than 1V AC .

Conditions for Running the DTC

The radio is ON.

Conditions for Setting the DTC

B1025 01, B1035 01, B1045 01, B1055 01

A short to voltage is detected on the specified (+) or (-) signal circuit

B1025 02, B1035 02, B1045 02, B1055 02

A short to ground is detected on the specified (+) or (-) signal circuit

Action Taken When the DTC Sets

The radio disables audio output on the appropriate channel

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting are no longer seen
- A history DTC will clear after 100 malfunction free ignition cycles

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Radio ON, adjust the fade and balance controls on the radio to test all four channels individually. Each of the four channels should produce clear and even sound.

Circuit/System Testing

Without Amplifier

1. Ignition OFF, disconnect the harness connector at the appropriate speaker.
2. Radio ON, test for 5.0-7.5 volts between each signal circuit terminal A and terminal B and ground.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. If all circuits test normal, replace the speaker.

With Amplifier

1. Ignition OFF, disconnect the X1 connector at the amplifier.
2. Radio ON, test for 5.0-7.5 volts between the appropriate signal circuit terminal listed below and ground.
    - Left front low level audio signal (+) - terminal 15 X1
    - Left front low level audio signal (-) - terminal 7 X1
    - Right front low level audio signal (+) - terminal 14 X1
    - Right front low level audio signal (-) - terminal 6 X1
    - Left rear low level audio signal (+) - terminal 13 X1
    - Left rear low level audio signal (-) - terminal 5 X1
    - Right rear low level audio signal (+) - terminal 12 X1
    - Right rear low level audio signal (-) - terminal 4 X1
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. If all circuits test normal, replace the amplifier.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Speaker Replacement Reference**
- **Control Module References** for radio or amplifier replacement, setup, and programming

DTC B1259: ANTENNA GROUND

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1259 02

Antenna Ground Circuit Short to Ground

DTC B1259 05

Antenna Ground Circuit Short to Battery or Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Voltage	-	1	-	-
Left Audio Signal (+)	2	2	2	-
Left Audio Signal (-)	2	2	2	-
Right Audio Signal (+)	3	3	3	-
Right Audio Signal (-)	3	3	3	-
Digital Radio Antenna Coax	B1259 02	B1259 05	B1259 05	-
Ground	-	1	-	-
1. No communication with DRR/XM not available 2. No or distorted audio from left side speakers when listening to digital radio 3. No or distorted audio from right side speakers when listening to digital radio				

Circuit/System Description

The digital radio receiver (DRR) receives an XM satellite radio signal via the digital radio antenna. This signal is passed to the DRR through the digital radio antenna coax. The DRR sends a varying AC mV signal through separate left and right audio circuits (+ and -) to the radio. The voltage amount and rate of change is dependent upon the type of signal being received. The radio then processes these signals and passes the audio to the appropriate speakers or amplifier.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

B1259 02

The DRR detects a short to ground in the antenna circuit.

B1259 05

The DRR detects a short to voltage or an open in the antenna circuit.

Action Taken When the DTC Sets

The radio displays No XM Signal.

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting the DTC are no longer present.
- A history DTC clears after 100 malfunction-free ignition cycles.

Diagnostic Aids

When diagnosing digital radio concerns, the vehicle should be located outside with an unobstructed view of the southern sky to ensure proper reception of the satellite signal. Reception may limited, intermittent or not possible inside structures or under heavy cover.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48028 Digital Radio Test Antenna

Circuit System Verification

With the vehicle outside in an area with an unobstructed view of the southern sky, tune to XM. Verify XM reception is clear and the No XM Signal message is not displayed on the radio.

Circuit/System Testing

1. Ignition OFF, disconnect the antenna coax from the DRR. Connect the **EL-48028** antenna to the DRR.
2. Radio ON, tuned to XM, verify DTC B1259 is not set as current.
    - If the DTC is current, replace the DRR.
3. Ignition OFF, reconnect the antenna coax to the DRR, disconnect the digital radio antenna coax from the digital radio antenna.
4. Ignition ON, test for 4.5-5.5 volts between the antenna coax center terminal and the coax outer shield.
    - If not within the specified range, replace the antenna coax.
5. If all circuits test normal, replace the digital radio antenna.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Cellular Communications/Digital Radio Antenna Replacement**
- **Control Module References** for DRR replacement, setup, and programming

DTC B1287: AMPLIFIER CONTROL SIGNAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1287 01

Amplifier Control Signal Circuit Short to Battery

DTC B1287 02

Amplifier Control Signal Circuit Short to Ground

DTC B1287 04

Amplifier Control Signal Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Antenna 14V Switched Supply	B1287 02	B1287 04	B1287 01	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Voltage				

Circuit/System Description

The amplifier receives PWM signals on the antenna 14V switch supply voltage circuit at varying duty cycle percentages for controlling the ON and OFF functions of the amplifier. The radio outputs a low duty cycle signal to produce an ON condition at the amplifier. The radio outputs a high duty cycle signal to produce a OFF condition at the amplifier.

Conditions for Running the DTC

- Radio is ON
- The system voltage is at between 9 volts and 16 volts

Conditions for Setting the DTC

A short to voltage, short to ground, or an open is seen on the remote enable circuit

Action Taken When the DTC Sets

Amplifier functions are disabled

Conditions for Clearing the DTC

- A current DTC clears when the condition for setting the DTC is no longer present
- A history DTC clears after 100 malfunction- free ignition cycles

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Radio ON, adjust the fade and balance control to verify audio is present at each individual channel.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the amplifier.
2. Radio ON, test for B+ between the signal circuit terminal 8 and ground.
    - If less than the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.
3. If all circuits test normal, replace the amplifier.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for radio or amplifier replacement

DTC B1446 OR B1447: BACKUP POWER SOURCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1446

Replace Backup Power Source Below Minimum Threshold

DTC B1447

Backup Power Source Open Circuit

For symptom byte information refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Backup Battery B+	B1447 03	B1447 04	-	-
Backup Battery Low Reference	B1447 03	B1447 04	-	-

Circuit/System Description

The backup power source provides voltage to the telematics communication interface control module , to be able to successfully place a call in the event of a main battery disconnect during a collision event.

Conditions for Running the DTC

B1446 03

- Ignition On/Vehicle in Service Mode.
- System voltage is between 9.5 and 15.5 V.
- DTC B1447 is not set.

B1447 04

- Ignition On/Vehicle in Service Mode.
- System voltage is between 9.5 and 15.5 V.
- The above conditions are present for greater than 10 s.

Conditions for Setting the DTC

B1446 03

The telematics communication interface control module detects that the backup power source voltage has dropped below the minimum threshold value.

B1447 04

The telematics communication interface control module detects no voltage from the backup power source.

Action Taken When the DTC Sets

B1446 03

The OnStarÂ® status LED turns red.

B1447 04

- The OnStarÂ® status LED turns red.
- The telematics communication interface control module will be unable to place a call in the event of a main battery disconnect during a collision event.

Conditions for Clearing the DTC

- A current DTC B1446 will clear when the telematics communication interface control module detects the voltage of the backup power source is above the minimum threshold value.
- A current DTC B1447 will clear when the telematics communication interface control module detects voltage from the backup power source.
- A history DTC clears after 50 malfunction-free ignition cycles.

Diagnostic Aids

- Shorting the backup power source positive voltage circuit to the backup power source ground circuit or chassis ground will activate the internal circuit protection of the backup power source, rendering the backup power source inoperative.

- DTC B1447 may set if the K73 Telematics Communication Interface Control Module has been incorrectly disconnected or serviced. When disconnecting the K73 Telematics Communication Interface Control Module , disconnect the harness connector X1 at the K73 Telematics Communication Interface Control Module prior to disconnecting any other harness connectors. This will ensure the backup power source is preserved when voltage is removed from the K73 Telematics Communication Interface Control Module .

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Testing for Intermittent Conditions and Poor Connections**
- **Circuit Testing**
- **Wiring Repairs**
- **Connector Repairs**

Circuit/System Testing

1. Ignition OFF/Vehicle OFF and all vehicle systems OFF, disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for greater than 9.5 V between the B+ circuit terminal 14 and the low reference circuit terminal 13.
    - **If 9.5 V or less**

      Test or replace the C3 Telematics Communication Interface Control Module Battery.

    - **If greater than 9.5 V**
3. Replace the K73 Telematics Communication Interface Control Module .

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Communication Interface Module Battery Replacement**
- **Control Module References** for telematics communication interface control module replacement, programming and setup.

DTC B2455: CELLULAR PHONE MICROPHONE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC B2455 02

Cellular Phone Microphone Circuit Short to Ground

DTC B2455 04

Cellular Phone Microphone Circuit Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Microphone Signal Circuit	B2455 02	B2455 04	1	-
Low Reference Circuit	-	B2455 04	B2455 04	-
1. OnStar Microphone Inoperative - Caller Cannot Be Heard				

Circuit/System Description

The Telematics Communication Interface Control Module provides the Cellular Phone Microphone with a supplied voltage on the Cellular Phone Microphone signal circuit. When the microphone is in use, voice data from the user is sent back to the Telematics Communication Interface Control Module on the signal circuit. The Telematics Communication Interface Control Module provides a ground for the Cellular Phone Microphone via the low reference wire.

Conditions for Running the DTC

- The ignition must be in the RUN or ACC position.
- The system voltage is at least 9.5 V and no more than 15.5 V.
- All the above conditions are present for greater than 10 seconds.

Conditions for Setting the DTC

B2455 02

The Telematics Communication Interface Control Module detects a short to ground in the Cellular Phone Microphone signal circuit for 10 seconds or greater.

B2455 04

The following conditions will set this DTC:

- The Telematics Communication Interface Control Module detects an open/high resistance in the Cellular

Phone Microphone signal circuit for 10 seconds or greater.

- The Telematics Communication Interface Control Module detects an open/high resistance in the low reference circuit for 10 seconds or greater.

Action Taken When the DTC Sets

- The OnStarÂ® status LED turns red.
- The Telematics Communication Interface Control Module will not receive a signal from the Cellular Phone Microphone.
- Calls can be placed but the caller cannot be heard.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B24 Cellular Phone Microphone, ignition ON.
2. Test for 8-10.5 V between the microphone signal circuit terminal B and ground.
    - **If less than 8 V**
    1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module.
    2. Test for infinite resistance between the microphone signal circuit and ground.

- If less than infinite resistance, repair the short to ground in the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the microphone signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the vehicle K73 Telematics Communication Interface Control Module.

- **If greater than 10.5 V**

1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
2. Test for less than 1 V between the microphone signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K73 Telematics Communication Interface Control Module.

- **If between 8-10.5 V**

3. Test for less than 1 V between the low signal circuit terminal A and ground.
    - **If greater than 1 V**

    1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage in the circuit.
        - If less than 1 V, repair the K73 Telematics Communication Interface Control Module.

    - **If less than 1 V**

4. Test for greater than 8 V between the microphone signal circuit terminal B and the low reference circuit terminal A.
    - **If less than 8 V**

    1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the vehicle K73 Telematics Communication Interface Control Module.

    - **If greater than 9.5 V**

5. Test or replace the B24 Cellular Phone Microphone.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mobile Telephone Microphone Replacement**
- **Control Module References** for Telematics Communication Interface Control Module replacement, programming and setup.

DTC B2470: CELLULAR PHONE ANTENNA

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2470 02

Cellular Phone Antenna Circuit Malfunction Short to Ground

DTC B2470 04

Cellular Phone Antenna Circuit Malfunction Open Circuit

Circuit/System Description

The cellular antenna is connected to the vehicle communication interface module (VCIM) with a RG-58 coax cable. The VCIM polls the data from the cellular antenna once every second.

Conditions for Running the DTC

- Ignition in the RUN or ACC position.
- System voltage is between 9.5 volts and 15.5 volts.
- The above conditions are present for greater than 1 second.

Conditions for Setting the DTC

- The VCIM does not detect the presence of a cellular antenna.
- The above conditions are present for greater than 1 second.

Action Taken When the DTC Sets

- The vehicle is unable to connect to the OnStarÂ® Call Center.
- The OnStarÂ® status LED turns red.

Conditions for Clearing the DTC

- The VCIM detects the presence of a cellular antenna.
- A history DTC clears after 50 malfunction-free ignition cycles.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-49903 GM OnStar Antenna Diagnostic Tool Kit

Circuit/System Verification

Verify that the cellular antenna and cellular antenna coupling assembly are not damaged.

- If the antenna assembly is damaged, replace the cellular antenna.

Circuit/System Testing

NOTE: **The vehicle may be equipped with sectioned coax. Test each section and replace only the faulty section, not the entire length of coax.**

1. Ignition OFF, disconnect the GPS and cellular coax cable connector at the VCIM.
2. Using the EL-49903-3 kit (EL-49903-5 adapter and EL-49903-4 coax cable), connect the **EL-49903** kit to the VCIM.
3. Clear the DTCs and operate the vehicle within the conditions for running the DTC. Verify DTC B2470 does not set.
    - If the DTC sets, replace the VCIM.
4. Ignition OFF, disconnect the **EL-49903** kit from the VCIM and perform the coax cable test on the coax cable between the VCIM and the cellular phone antenna.
    - If the coax cable does not pass the test, replace the coax cable.
5. If all circuits test normal, replace the cellular phone antenna.

Component Testing

CAUTION: **Refer to Test Probe Caution .**

NOTE: **Before testing the coax cable, check the cable exterior for being pinched, cut, damaged, or having loose connections at the components, which can cause reception issues.**

To prevent false reading when testing the center coax terminals, use care not to ground the test probe on the outer housing/shield.

Coax Cable Test

1. Ignition OFF, disconnect the GPS and cellular phone coax cable at both components.
2. Test both for less than 5 Ω between both ends of the coax cables center terminals.
   - If greater than the specified range, replace the failed coax cable.
3. Test for greater than 10k Ω between the coax cable center wire and the outer coax shield.
   - If less than the specified range, replace the coax cable.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Cellular Communications/Digital Radio Antenna Replacement**
- **Control Module References** for VCIM replacement, setup, and programming

DTC B2476 OR B2482: CELLULAR PHONE SELECT SERVICE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2476 04

Cellular Phone Select Service Switch Open

DTC B2476 59

Cellular Phone Select Service Switch Protection Time-out

DTC B2482 00

Cellular Phone Select Service Switch Range/Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
10 V Reference	B2476 04	B2476 04	B2476 04	-
Signal Terminal 11	1	B2476 04	B2476 59	B2476 59, B2482 00
Ground	-	B2476 04	-	-
1. OnStarÂ® Buttons Inoperative				

Circuit/System Description

The OnStarÂ® button assembly consists of 3 buttons: Call/Answer, OnStarÂ® Call Center, and OnStarÂ® Emergency. The telematics communication interface control module supplies the OnStarÂ® button assembly with 10 V via the 10 V reference circuit . Each of the buttons, when pressed, completes the circuit across a resistor allowing a specific voltage to be returned to the telematics communication interface control module over the keypad signal circuit. Depending upon the voltage range returned, the telematics communication interface control module is able to identify which button has been pressed.

Conditions for Running the DTC

- Ignition ON.
- Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B2476 04

The telematics communication interface control module detects a short to voltage or an open/high resistance on the keypad 10 V reference circuit.

B2482 and B2476 59

The telematics communication interface control module detects a valid signal on the keypad signal circuit for longer than 15 seconds. If one of the OnStarÂ® buttons is held or stuck for 15 seconds or greater, the telematics communication interface control module will set this DTC.

Action Taken When the DTC Sets

- The OnStarÂ® status LED turns red.
- No calls can be placed.
- The telematics communication interface control module will ignore all inputs from the OnStarÂ® button assembly.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Contact the OnStarÂ® Call Center first before pressing the emergency button in order to notify them of the test.**

1. Ignition ON.
2. Verify that each button of the S51 Telematics Button Assembly operates normally by pressing each button individually.
   - **If none of the buttons operate normally**

     Refer to Circuit/System testing

   - **If some, but not all, of the buttons operate normally**

     Test or replace the A10 Inside Rearview Mirror

   - **If all of the buttons operate normally**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A10 Inside Rearview Mirror. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 8 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
3. Ignition ON.
4. Test for 8.0-10.5 V between the 10 V reference circuit terminal 12 and ground.
   - **If less than 8.0 V**

1. Ignition OFF, disconnect the harness connector at the K73 Telematics Communication Interface Control Module.
2. Test for infinite resistance between the 10 V reference circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the 10 V reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K73 Telematics Communication Interface Control Module.

- **If greater than 10.5 V**

1. Ignition OFF, disconnect the harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
2. Test for less than 1 V between the 10 V reference circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K73 Telematics Communication Interface Control Module.

- **If between 8.0-10.5 V**

5. Ignition OFF.
6. Test for 500-900 Ω between the signal circuit terminal 11 and ground.

- **If less than 500 Ω**

1. Disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module.
2. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K73 Telematics Communication Interface Control Module.

- **If greater than 900 Ω**

1. Disconnect the X1 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
3. Ignition OFF.
4. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K73 Telematics Communication Interface Control Module.

- **If between 500-900 Ω**

7. Test or replace the A10 Inside Rearview Mirror.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair procedure.

- **Inside Rearview Mirror Replacement**

- **Control Module References** for telematics communication interface control module replacement, programming, and setup.

DTC B2485: WIRELESS COMMUNICATION ANTENNA

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC B2485 02

Wireless Communication Antenna Circuit Short to Ground

DTC B2485 04

Wireless Communication Antenna Circuit Open Circuit

Circuit/System Description

The Bluetooth Â® antenna is a small fixed antenna connected directly to the communication interface module (CIM) and is used to send and receive signals from a Bluetooth Â® enabled cellular phone. The antenna utilizes no cabling and is not external to the vehicle.

Conditions for Running the DTC

- Ignition ON.
- Battery voltage must be between 9-16 V.
- The CIM tests the antenna once every second.

Conditions for Setting the DTC

B2485 02

The CIM detects a short to ground in the Bluetooth Â® antenna.

B2485 04

The CIM detects an open/high resistance in the Bluetooth Â® antenna.

Actions Taken When the DTC Sets

- The OnStar Â® status LED turns red.
- Bluetooth Â® functionality is disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 consecutive malfunction-free ignition cycles have occurred.

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Verify the Bluetooth Â® antenna is properly connected to the CIM and is not damaged.
    - If the antenna is disconnected or damaged, repair or replace as necessary.
2. Ignition ON, verify the DTC B2485 is not set .
    - If the DTC is set, replace the Bluetooth Â® antenna. Clear the DTC and cycle the ignition OFF then back ON. If the DTC resets as current, replace the CIM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Wireless Communication Interface Antenna Replacement**
- **Control Module References** for CIM replacement, setup, and programming

SYMPTOMS - CELLULAR COMMUNICATION

NOTE: **The following steps must be completed before using the symptom table.**

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
    - There are no DTCs set.
    - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **OnStar Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Radio/Audio System. Refer to **Checking Aftermarket Accessories** .
- Inspect for easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Bluetooth Malfunction**
- **OnStar Global Positioning System (GPS) Data Not Current or Inaccurate**
- **OnStar Microphone Malfunction**
- **OnStar Audio Malfunction**
- **OnStar Button LED Malfunction**
- **OnStar Call Center Remote Function Requests Malfunction**
- **OnStar Button Malfunction**
- **Unable to Contact OnStar Call Center**
- **OnStar Voice Recognition Malfunction**
- **OnStar Steering Wheel Control Functions Malfunction**

SYMPTOMS - ENTERTAINMENT

IMPORTANT: The following steps must be completed before using the symptom table.

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Radio/Audio System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Radio/Audio System. Refer to **Checking Aftermarket Accessories** .
- Inspect for easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Digital Radio Malfunction**
- **Radio Poor Reception**
- **Speaker Malfunction**

BLUETOOTH MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

Circuit/System Description

The Bluetooth Â® antenna is a small fixed antenna connected directly to the communication interface module (CIM) and is used to send and receive signals from a Bluetooth Â® enabled cellular phone. The antenna utilizes no cabling and is not external to the vehicle.

In order to use hands-free calling, the cellular phone must be paired to the vehicle. Up to five devices can be paired to the vehicle at one time, but only one can be connected at any given time. To pair a phone, the customer must know how to operate the Bluetooth Â® functionality of their phone. The pairing process must only be done one time for each phone, unless that phone's information is deleted. For safety reasons, the pairing process is disabled while the vehicle is moving.

Diagnostic Aids

- The purpose of this diagnostic is to verify the ability of the CIM to pair to a Bluetooth Â® device.
- Before performing this test, verify compatibility of the cellular phone(s) the customer is attempting to use with the vehicle. Based on the cellular phone's service provider and the manufacturer's implementation of Bluetooth Â®, not all phones support all available Bluetooth Â® functionality. A vehicle and feature compatibility list will be provided via the GM Bluetooth Â® website: http://www.onstar.com /web/Bluetooth/
- If the vehicle passes the following tests and a compatible device is being used, the concern may be due to a device malfunction or an incomplete/improper pairing attempt.
- A Bluetooth Â® test tool or equivalent can also be used to verify the ability of the customers cellular phone(s) to pair with another device.

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC B2485 is not set.
    - If DTC B2485 is set , refer to **DTC B2485**.
2. Set up a Bluetooth Â® test tool or equivalent.
3. Ignition ON, perform the discovery/search operation with the test tool. Verify the vehicle appears in the list of available devices.
    - If the vehicle is not in the list of available devices, repeat the discovery/search operation. If the vehicle is still not in the list of available devices, replace the CIM.
4. Follow the instructions provided in the Vehicle Owners Manual for pairing a device. Verify successful pairing with the test tool.
    - If pairing is not successful, repeat the pairing process. If pairing is still not successful, replace the CIM.
5. Refer to Diagnostic Aids.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for CIM replacement, programming and setup

DIGITAL RADIO MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Voltage	-	1	-	-
Left Audio Signal (+)	2	2	2	-
Left Audio Signal (-)	2	2	2	-
Right Audio Signal (+)	3	3	3	-
Right Audio Signal (-)	3	3	3	-
Digital Radio Antenna Coax	B1259 02	B1259 05	B1259 05	-
Ground	-	1	-	-
1. No communication with DRR/XM not available 2. No or distorted audio from left side speakers when listening to digital radio 3. No or distorted audio from right side speakers when listening to digital radio				

Circuit/System Description

The digital radio receiver (DRR) receives an XM satellite radio signal via the digital radio antenna. This signal is passed to the DRR through the digital radio antenna coax. The DRR sends a varying AC mV signal through separate left and right audio circuits (+ and -) to the radio. The voltage amount and rate of change is dependent upon the type of signal being received. The radio then processes these signals and passes the audio to the appropriate speakers or amplifier.

Diagnostic Aids

When diagnosing digital radio concerns, the vehicle should be located outside with an unobstructed view of the southern sky to ensure proper reception of the satellite signal. Reception may be limited, intermittent or not possible inside structures or under heavy cover.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48028 Digital Radio Test Antenna

Circuit/System Verification

1. Verify that the Check XM Receiver message is not displayed on the radio.
    - If a Check XM Receiver message is displayed, replace the DRR.
2. Tune to a strong AM or FM station and verify each speaker is producing clear and even sound, with no distortion.
    - If any speaker is not producing sound or the sound produced is distorted, refer to **Speaker Malfunction**.
3. With the vehicle outside in an area with an unobstructed view of the southern sky, tune to XM. Verify XM reception is clear and the No XM Signal message is not displayed on the radio.
    - If the No XM Signal message is displayed or XM reception is poor, refer to Digital Radio Antenna Circuit Malfunction.
4. Radio tuned to XM, use the radio balance function to transfer audio between the left and right side of the vehicle. Verify clear and even sound is heard from each side of the vehicle.
    - If either side of the vehicle is not producing sound or the sound produced is distorted, refer to Digital Radio Output Circuit Malfunction.
5. Verify if the XM band is receiving all channels (preview mode).
    - If no channels are displayed, advise the customer to refer to the owners manual for XM contact information in regards to an active account status and/or a refresh request.

Circuit/System Testing

Digital Radio Antenna Circuit Malfunction

1. Ignition OFF, disconnect the antenna coax from the DRR. Connect the **EL-48028** antenna to the DRR.
2. Ignition ON, radio tuned to XM, verify XM reception is clear and uninterrupted.
    - If reception is not clear, replace the DRR.
3. Ignition OFF, reconnect the antenna coax to the DRR, disconnect the digital radio antenna coax from the digital radio antenna.
4. Ignition ON, test for 4.5-5.5 volts between the antenna coax center terminal and the coax outer shield.
    - If not within the specified range, replace the antenna coax.
5. If all circuits test normal, replace the digital radio antenna.

Digital Radio Output Circuit Malfunction

1. Ignition OFF, disconnect the X2 harness connector at the radio.
2. Ignition ON, radio ON and tuned to XM, test for varying mV AC voltage between the following signal circuit terminals listed below and ground:
    - Left audio signal (+) - connector X2, terminal 1

- Right audio signal (+) - connector X2, terminal 2
- Left audio signal (-) - connector X2, terminal 9
- Right audio signal (-) - connector X2, terminal 10
- If the varying mV A/C voltage is not present, test the signal circuit for a short to voltage, short to ground, or an open/high resistance. If the circuit tests normal, replace the DRR.

3. If all circuits test normal, replace the radio.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Cellular Communications/Digital Radio Antenna Replacement**
- **Control Module References** for radio or DRR replacement, setup, and programming

ONSTAR GLOBAL POSITIONING SYSTEM (GPS) DATA NOT CURRENT OR INACCURATE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The vehicle communication interface module (VCIM) receives information from a specific navigation antenna located on the outside of the vehicle. The navigation antenna is connected to the vehicle communication interface module via a shielded coaxial cable. The antenna cable also provides a path for DC current for powering the antenna.

Diagnostic Aids

- The GPS signal title on the scan tool will display a Yes or No dependant upon whether or not the module sees an increment of the seconds transmitted by GPS signals to the vehicle communication interface module. Upon entering this screen, the GPS signal title will automatically display Yes, regardless of the presence of time increment, for at least 2 seconds, while the algorithm in the scan tool determines the status of the clock. If increment is found, Yes is continually displayed. If the clock remains static, No is displayed. The scan tool looks for increment every second, regardless of current display.
- Inaccurate or aged GPS position concerns which are no longer present may have been due to the temporary loss of GPS signal reception by the vehicle. Conditions such as driving through tunnels or parking structures while making an OnStarÂ® keypress will restrict the navigation antenna from a clear view of the satellites in the sky and may have caused this temporary data loss.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **OnStar Description and Operation**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-49903 GM OnStar Antenna Diagnostic Tool Kit

Circuit/System Verification

NOTE: **It is important to have the vehicle in an open outside area where a cellular call can be successfully placed and GPS data can be received from the satellites. It is also necessary to inform the OnStarÂ® Call Center advisor that this call is for vehicle diagnostic purposes.**

1. Ignition ON, observe the GPS signal status indicator for at least 10 seconds with a scan tool. The indicator should display Yes.
   - If the indicator does not display Yes, refer to Circuit/System Testing.
2. Call and verify the OnStar advisor has received the GPS data.
   - If the advisor did not receive the GPS data and the call was a "fail to voice", contact the GM Technical Assistance Center.
   - If the advisor did not receive the GPS data and the call was not a "fail to voice", refer to Circuit/System Testing.
3. Verify with the OnStar Call Center advisor that your actual position is within a reasonable distance from the actual location of the vehicle.
   - If your actual position is not within a reasonable distance from the actual location of the vehicle, replace the vehicle communication interface module.

Circuit/System Testing

1. Ignition OFF, disconnect the GPS and cell coax cable connector at the vehicle communication interface module.
2. Using the EL-49903-3 kit (EL-49903-5 adapter and EL-49903-4 coax cable), connect the **EL-49903** kit to the vehicle communication interface module, place the test antenna on the roof of the vehicle.

3. Ignition ON, wait 5 minutes, then contact the OnStar call center consultant by pressing the blue OnStar button. A call center consultant should answer the call, ask the consultant to verify the vehicle location to confirm the GPS system is functioning.
    - If the OnStar GPS does not function, replace the vehicle communication interface module.
4. Reconnect the coax cable to the vehicle communication interface module. Disconnect the coax cable from the navigation antenna.
5. Test for 4.5-5.5 V between the coax cable center conductor and the outer shield.
    - If not within the specified range, replace the coax cable.
6. If all circuits test normal, replace the navigation antenna.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Cellular Communications/Digital Radio Antenna Replacement**
- **Control Module References** for vehicle communication interface module replacement, setup, and programming

ONSTAR MICROPHONE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Microphone Signal	B2455 02	B2455 04	1	-
Microphone Low Reference	1	B2455 04	B2455 04	-
1. OnStar Microphone Inoperative - Caller Cannot Be Heard				

Circuit/System Description

The Telematics Communication Interface Control Module provides the Cellular Phone Microphone with a supplied voltage on the Cellular Phone Microphone signal circuit. When the Cellular Phone Microphone is in use, voice data from the user is sent back to the Telematics Communication Interface Control Module on the signal circuit.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **It is necessary to have the vehicle in a quiet, open outside area where a cellular call can be successfully placed and GPS data can be received from satellites.**

1. Ignition ON.
2. Verify that DTC B2455 is not set.
   - **If DTC B2455 is set**

     Refer to **DTC B2455**

   - **If DTC B2455 is not set**
3. Verify that a successful OnStar voice command can be made.
   - **If your voice can not be heard clearly**

     Refer to Circuit/System Testing.

   - **If your voice can be heard clearly**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B24 Cellular Phone Microphone, ignition ON.
2. Test for 9.5-10.5 V between the signal circuit terminal B and ground.
   - **If less than 9.5 V**
   1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground in the circuit.
      - If infinite resistance

3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the vehicle K73 Telematics Communication Interface Control Module.
- **If greater than 10.5 V**

1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K73 Telematics Communication Interface Control Module.
- **If between 9.5-10.5 V**

3. Test for 9.5-10.5 V between the signal circuit terminal B and the low reference circuit terminal A.
    - **If less than 9.5 V**

    1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the vehicle K73 Telematics Communication Interface Control Module.
    - **If greater than 10.5 V**

    1. Ignition OFF, disconnect the X2 harness connector at the K73 Telematics Communication Interface Control Module, ignition ON.
    2. Test for less than 1 V between the low reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K73 Telematics Communication Interface Control Module.
    - **If between 9.5-10.5 V**

4. Test or replace the B24 Cellular Phone Microphone.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mobile Telephone Microphone Replacement**
- **Control Module References** for Telematics Communication Interface Control Module replacement, programming and setup.

ONSTAR AUDIO MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Audio Signal	1	1	1	-
Audio Common Signal	-	1	-	-
1. No (or Noisy) OnStarÂ® Audio				

Circuit/System Description

When an OnStarÂ® keypress is made, a serial data message is sent to the audio system to mute all radio functions and output OnStarÂ® originated audio. After the audio system is muted, the vehicle communication interface control module transmits signals to the audio system on the audio signal and audio common circuits.

Reference Information

Schematic Reference

- **OnStar/Telematics Schematics**
- **Radio/Navigation System Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Tune radio to a known good station and verify the audio is heard clearly through all speaker channels.
   - If audio is not heard clearly, refer to **Speaker Malfunction**.
2. Ignition ON, radio ON, set volume to comfortable level and press OnStarÂ® Call Center button. Verify Connecting to OnStarÂ® message is heard clearly through the audio system.
   - If OnStarÂ® message is noisy or distorted, refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the radio.
2. Disconnect the X2 harness connector at the vehicle communication interface control module.
3. Ignition ON, test for less than 1 V between the vehicle communication interface control module cellular telephone voice signal circuit terminal 1 X2 and ground.
    - If not the specified value, test the cellular telephone voice signal circuit for a short to voltage.
4. Test for less than 1 V between the vehicle communication interface control module cellular telephone voice low reference circuit terminal 2 X2 and ground.
    - If not the specified value, test the cellular telephone voice low reference circuit for a short to voltage.
5. Ignition OFF, test for infinite resistance between the vehicle communication interface control module cellular telephone voice signal circuit terminal 1 X2 and ground.
    - If not the specified value, test the cellular telephone voice signal circuit for a short to ground.
6. Test for infinite resistance between the vehicle communication interface control module cellular telephone voice low reference circuit terminal 2 X2 and ground.
    - If not the specified value, test the cellular telephone voice low reference circuit for a short to ground.
7. Test for less than 2 Ω between the vehicle communication interface control module cellular telephone voice signal circuit terminal 1 X2 and the radio terminal 20 X1.
    - If not the specified value, test the cellular telephone voice signal circuit for a open/high resistance.
8. Test for less than 2 Ω between the vehicle communication interface control module cellular telephone voice low reference circuit terminal 2 X2 and the radio terminal 6 X1.
    - If not the specified value, test the cellular telephone voice low reference circuit for a open/high resistance.
9. If all circuits test normal, replace the vehicle communication interface control module.
10. If all circuits test normal, replace the radio.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for radio or vehicle communication interface control module replacement, setup, and programming.

ONSTAR BUTTON LED MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
10 V Reference	-	B24156 04	-	-
Control Terminal 14	1	1	2	-
Control Terminal 15	1	1	2	-
Signal Terminal 11	3	3	-	B24156 59, B248200
Ground	-	B24156 04	-	-
1. OnStarÂ® LED Inoperative 2. LED Illuminated At All Times 3. OnStarÂ® Buttons Inoperative				

Circuit Description

The OnStarÂ® status LEDs are located in the inside rearview mirror telematic button assembly. The green LED is illuminated when the system is ON and operating normally. When the green LED is green and flashing, it is an indication that a call is in progress. When the red LED is illuminated, a system malfunction is present. In the event there is a system malfunction and the OnStarÂ® system is still able to make a call, the LED will flash red during the call. The OnStarÂ® LEDs are controlled by the telematics communication interface control module via the keypad green LED control circuit and the keypad red LED control circuit.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **If the green LED is off with the ignition ON and the LED does not function when**

commanded with the scan tool, contact the OnStar Center to confirm the vehicle has a current subscription.

1. Ignition ON.
2. Verify that the green LED turns ON and OFF when commanding the K73 telematics communication interface control module green indicator ON and OFF with a scan tool.
   - **If the green LED does not turn ON and OFF**

     Refer to Circuit/System Testing - Green LED Test

   - **If the green LED turns ON and OFF**
3. Verify that the red LED turns ON and OFF when commanding the K73 telematics communication interface control module red indicator ON and OFF with a scan tool.
   - **If the red LED does not turn ON and OFF**

     Refer to Circuit/System Testing - Red LED Test

   - **If the red LED turns ON and OFF**
4. All OK.

Circuit/System Testing

Green LED Test

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at the A10 inside rearview mirror. It may take up to 2 minutes for all vehicle systems to power down. Doors closed, courtesy lamps OFF.
2. Test for less than 10 Ω between the ground circuit terminal 8 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
3. Ignition ON.
4. Test for less than 1 V between the control circuit terminal 14 and ground while commanding the K73 telematics communication interface control module green indicator OFF with a scan tool.
   - **If 1 V or greater**
   1. Ignition OFF, disconnect the X1 harness connector at the K73 telematics communication interface control module, ignition ON.
   2. Test for less than 1 V between the control circuit terminal 14 and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K73 telematics communication interface control module.
   - **If less than 1 V**

5. Test for greater than 8 V between the control circuit terminal 14 and ground while commanding the K73 telematics communication interface control module green indicator ON with a scan tool.
    - **If 8 V or less**
    1. Ignition OFF, disconnect the X1 harness connector at the K73 telematics communication interface control module.
    2. Test for infinite resistance between the control circuit terminal 14 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K73 telematics communication interface control module.
    - **If greater than 8 V**
6. Test or replace the A10 inside rearview mirror.

Red LED Test

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at the A10 inside rearview mirror. It may take up to 2 minutes for all vehicle systems to power down. Doors closed, courtesy lamps OFF.
2. Test for less than 10 Ω between the ground circuit terminal 8 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 10 Ω**
3. Ignition ON.
4. Test for less than 1 V between the control circuit terminal 15 and ground while commanding the K73 telematics communication interface control module red indicator OFF with a scan tool.
    - **If 1 V or greater**
    1. Ignition OFF, disconnect the X1 harness connector at the K73 telematics communication interface control module, ignition ON.
    2. Test for less than 1 V between the control circuit terminal 15 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K73 telematics communication interface control module.
    - **If less than 1 V**
5. Test for greater than 8 V between the control circuit terminal 15 and ground while commanding the K73 telematics communication interface control module red indicator ON with a scan tool.
    - **If 8 V or less**
    1. Ignition OFF, disconnect the X1 harness connector at the K73 telematics communication interface control module.

2. Test for infinite resistance between the control circuit terminal 15 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K73 telematics communication interface control module.

- **If greater than 8 V**

6. Test or replace the A10 inside rearview mirror.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Inside Rearview Mirror Replacement**
- **Control Module References** for telematics communication interface control module replacement, programming and setup.

ONSTAR CALL CENTER REMOTE FUNCTION REQUESTS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The telematics communication interface control module has the capability of commanding the horn, initiating door lock/unlock, or operating the exterior lamps using the serial data circuits. These functions are commanded by the OnStarÂ® Call Center per a customer request.

Diagnostic Aids

The customer concern may have been due to a lack of cellular service in a given area, or a failure in the National Cellular Network infrastructure that has since been corrected.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **It is necessary to inform the OnStarÂ® Call Center advisor that this call is for vehicle diagnostic purposes.**
- **It is necessary to have the vehicle in an open outside area where a cellular call can be successfully placed and GPS data can be received from satellites.**

1. Ignition ON/vehicle in Service Mode.
2. Verify that the horn, lights, and the door locks on the vehicle operate properly.
   - **If an applicable vehicle system does not operate properly**

     Refer to **Diagnostic System Check - Vehicle** .

   - **If all applicable vehicle systems operate properly**
3. Verify that a call can be successfully placed to the OnStar Call Center by pressing the blue OnStar button.
   - **If unable to contact the OnStarÂ® call center**

     Refer to **Unable to Contact OnStar Call Center**

   - **If able to contact the OnStar Call Center**
4. Verify with the OnStar advisor that all remote functions (door locks, lights, and horn) work.
   - **If the remote functions do not operate when requested**

     Replace the K73 Telematics Communication Interface Control Module

   - **If the remote functions operate when requested**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for telematics communication interface control module replacement, programming and setup.

ONSTAR BUTTON MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
10 V Reference	-	B2476 04	-	-
Control Terminal 14	1	1	2	-
Control Terminal 15	1	1	2	-
Signal Terminal 11	3	3	2	B2476 59, B2482 00
Ground	-	B2476 04	-	-
1. OnStarÂ® LED Inoperative 2. LED Illuminated At All Times 3. OnStarÂ® Buttons Inoperative				

Circuit/System Description

The OnStarÂ® button assembly consists of 3 buttons: Call/Answer, OnStarÂ® Call Center, and OnStarÂ® Emergency. The telematics communication interface control module supplies the OnStarÂ® button assembly with 10 V via the keypad supply voltage circuit . Each of the buttons, when pressed, completes the circuit across a resistor allowing a specific voltage to be returned to the telematics communication interface control module over the keypad signal circuit. Depending upon the voltage range returned, the telematics communication interface control module is able to identify which button has been activated.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Contact the OnStarÂ® Call Center first before pressing the emergency button in order to notify them of the test.**

1. Ignition ON.
2. Verify the buttons operate normally by pressing each button individually.
   - **If none of the buttons operate normally**

     Refer to Circuit/System Testing.

   - **If some, but not all, of the buttons operate normally**

     Test or replace the A10 inside rearview mirror.

   - **If all of the buttons operate normally**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A10 inside rearview mirror. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 15 Ω between the ground circuit terminal 8 and ground.
   - **If 15 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 15 Ω**
3. Ignition ON.
4. Test for 9.5-10.5 V between the 10 V reference circuit terminal 12 and ground.
   - **If less than 9.5 V**
   1. Ignition OFF, disconnect the harness connector at the K73 telematics communication interface control module.
   2. Test for infinite resistance between the 10 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 10 V reference circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K73 telematics communication interface control module.

- **If greater than 10.5 V**

1. Ignition OFF, disconnect the harness connector at the K73 telematics communication interface control module, ignition ON.
2. Test for less than 1 V between the 10 V reference circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K73 telematics communication interface control module.

- **If between 9.5-10.5 V**

5. Ignition OFF.
6. Test for 500-900 Ω between the signal circuit terminal 11 and ground.

- **If less than 500 Ω**

1. Disconnect the X1 harness connector at the K73 telematics communication interface control module.
2. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K73 telematics communication interface control module.

- **If greater than 900 Ω**

1. Disconnect the X1 harness connector at the K73 telematics communication interface control module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V
3. Ignition OFF.
4. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K73 telematics communication interface control module.

- **If between 500-900 Ω**

7. Test or replace the A10 inside rearview mirror.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Inside Rearview Mirror Replacement**
- **Control Module References** for telematics communication interface control module replacement, programming and setup.

ONSTAR STEERING WHEEL CONTROL FUNCTIONS MALFUNCTION

Some vehicles equipped with the OnStarÂ® system have the capability of accessing voice mailboxes and other automated phone systems by means of the steering wheel controls, while the OnStarÂ® Personal Calling

feature is in use. If the "Talk" or "Mute" button (depending upon the vehicle) on the steering wheel controls is depressed during an OnStarÂ® Personal Calling call, the telematics communication interface control module receives the message on the serial data bus from either the radio or body control module. This message is interpreted as a request to turn any spoken numbers into dual tone multi-frequency tones to be delivered over the airwaves to the phone system the user is communicating with. Complete instructions for operation of these features can be found in the information provided to the customer with the OnStarÂ® system.

The steering wheel controls are a resistor network that consist of multiple momentary contact switches and a series of resistors. The switches and resistor network are arranged so that each switch has a different resistance value. When a switch is pressed, a voltage drop occurs in the resistor network, which produces a specific voltage value unique to the switch selected, to be interpreted by either the radio or BCM. In the event the OnStarÂ® steering wheel control functions are inoperative, technicians should refer to **Steering Wheel Controls Malfunction** , to begin diagnosis of the steering wheel control concern.

RADIO POOR RECEPTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

AM and FM radio reception is dependent on the following components:

- Radio antenna - part of the rear glass
- Radio antenna module
- Coax cable between the radio antenna module and the radio
- Radio

Diagnostic Aids

NOTE: **Radio systems with the antenna(s) in the glass are subject to possible interference when an aftermarket window tint is applied, especially when there is a metallic present in the film.**

Poor AM and FM radio reception is dependent on multiple influences, some of which may not be vehicle related. Areas which have high RF traffic or block the signal path may cause a degradation in radio reception. Radio reception may also be influenced by items within the vehicle, but not part of the radio system. Such examples are aftermarket electrical accessories or other items which may generated noise in the vehicle electrical system.

AM reception is highly dependent on the antenna module receiving battery voltage from the radio and being properly grounded. The antenna module has a built in antenna amplifier that boosts both AM and FM reception. When the antenna module does not receive power, AM stations will not be received and FM reception will be limited. If the module is not properly grounded, excessive interference in the signal may occur, or reception may be limited.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio Rear Speaker Replacement (Impala w/UW6)Radio Rear Speaker Replacement (Impala w/UQ3)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Rear Glass Antenna Inspection

1. Ignition OFF, disconnect the coax from the antenna located at the rear glass.
2. Verify the coax connector at the back glass is properly secured and free of any damage.
    - If damage is found, repair or replace as necessary.
3. Inspect the antenna on the rear glass. Verify all branches of the antenna are intact, with no scratches or other damage.
    - If damage is found, repair or replace as necessary.

Antenna Coaxial Cable Testing

1. Disconnect the antenna coax from the radio and the radio antenna module.
2. Test for infinite resistance between the antenna coax center terminal and ground.
    - If less than the specified value, replace the antenna coax.
3. Test for less than 5 ohms of resistance on the antenna coax center terminal from end to end.
    - If greater than the specified range, replace the antenna coax.
4. Test for less than 5 ohms of resistance on the antenna coax outer shield from end to end.
    - If greater than the specified range, replace the antenna coax.
5. Test for infinite resistance between the coax center terminal and the outer shield.

- If less than the specified value, replace the antenna coax.

Radio Antenna Module Test

1. Inspect the radio antenna module grounding surfaces and the mounting hardware for any corrosion that may cause a poor ground.
   - If corrosion is noted, clean the grounding surfaces or hardware.
2. Ignition OFF, disconnect the harness connector at the radio antenna module.
3. Radio ON, verify a test lamp illuminates between the signal circuit terminal 1 and ground.
   - If the test lamp does not illuminate, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.
4. If all circuits test normal, replace the radio antenna module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Radio Antenna Module Replacement**
- **Antenna Cable Replacement**
- **Radio Antenna Cable Extension Cable Replacement**
- **Control Module References** for radio replacement, setup, and programming

SPEAKER REPLACEMENT REFERENCE

Component	Repair Instruction
Front Speaker (Tweeter)	Refer to **Front Upper Speaker Replacement**
Front Door Speaker	Refer to **Radio Front Side Door Speaker Replacement**
Rear Speaker (Rear Shelf)	Refer to **Radio Rear Speaker Replacement (Impala w/UW6)Radio Rear Speaker Replacement (Impala w/UQ3)**

SPEAKER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Antenna 14 V Switched Supply Voltage	2	2	-	-
Amplifier Battery Positive Voltage	2	2	-	-
Amplifier Ground	-	2	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Front Speaker Output (+)/Left Front Low Level Audio Signal (+)	B1025 02*	1	B1025 01*	-
Left Front Speaker Output (-)/Left Front Low Level Audio Signal (-)	B1025 02*	1	B1025 01*	-
Right Front Speaker Output (+)/Right Front Low Level Audio Signal (+)	B1035 02*	1	B1035 01*	-
Right Front Speaker Output (-)/Right Front Low Level Audio Signal (-)	B1035 02*	1	B1035 01*	-
Left Rear Speaker Output (+)/Left Rear Low Level Audio Signal (+)	B1045 02*	1	B1045 01*	-
Left Rear Speaker Output (-)/Left Rear Low Level Audio Signal (-)	B1045 02*	1	B1045 01*	-
Right Rear Speaker Output (+)/Right Rear Low Level Audio Signal (+)	B1055 02*	1	B1055 01*	-
Right Rear Speaker Output (-)/Right Rear Low Level Audio Signal (-)	B1055 02*	1	B1055 01*	-
1. No or reduced sound from speaker 2. Amplifier inoperative/no sound from speakers * Noticeable audio distortion possible				

Circuit/System Description

Each of the audio output channel circuits (+) and (-), at the radio and at the amplifier (if equipped) have a DC bias voltage that is one half of the battery voltage. When using a DMM, each of the audio output channel circuits will measure approximately 6.5 V DC. The audio being played on the system is produced by a varying AC voltage that is centered around the DC bias voltage on the same circuit. The AC voltage is what causes the speaker cone to move and produce sound. This voltage will vary depending on what type of audio is being listened to, talk or music, and type of music, as well as the volume setting of the system. Low volume and talk settings will measure around 1 V AC and less, where constant music may measure 3 V AC and slightly higher. In an amplified audio system, these similar AC voltage measurements may be slightly higher on the output of the amplifier, and the typical AC voltage readings at the output of the radio are less than 1V AC .

Diagnostic Aids

- Improper speaker mounting or loose trim may cause an audible buzz or distortion. Inspect the appropriate speaker and the surrounding interior trim for proper and secure mounting.

  The EL-50334-6 Audio System Diagnostic CD contains audio tracks that can be used to duplicate and isolate such concerns. Tracks 11 and 12 contain audio sweep tones for testing for speaker and grill rattles.

  If the speaker or surrounding interior trim is found to be loose or improperly secured, correctly secure the item.

- When equipped with an amplifier, it is possible for some individual circuit faults to affect more than one speakers operation. Perform diagnostic tests in the sequence listed to avoid misdiagnosis.

Reference Information

Schematic Reference

Radio/Navigation System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Radio/Audio System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Without Amplifier

Radio ON, verify clear audio is heard from each audio speaker.

- If audio is inoperative from all speakers, replace the radio.
- If audio is inoperative from one or more, but not all, speakers or the audio emitted from the speakers is not clear, refer to Speaker Circuit Malfunction - without Amplifier.

With Amplifier

Radio ON, verify clear audio is heard from each audio speaker.

- If audio is inoperative from all speakers, refer to Amplifier Circuit Malfunction.
- If audio is inoperative from one or more, but not all, speakers or the audio emitted from the speakers is not clear, refer to Speaker Circuit Malfunction - with Amplifier.

Circuit/System Testing

Speaker Circuit Malfunction - without Amplifier

1. Ignition OFF, disconnect the harness connector at the appropriate speaker.

2. Radio ON, test for 5.0-7.5 V between each signal circuit terminal A and terminal B and ground.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
3. If all circuits test normal, replace the speaker.

Amplifier Circuit Malfunction

1. Ignition OFF, disconnect the X3 harness connector at the amplifier.
2. Test for less than 10 Ω of resistance between the ground circuit terminal 8 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Test for B+ between the battery voltage circuit terminal 4 and ground.
    - If less than the specified value, test the circuit for a short to ground or an open/high resistance.
4. Disconnect the X1 harness connector at the amplifier.
5. Radio ON, test for B+ between the signal circuit terminal 8 and ground.
    - If less than the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.
6. If all circuits test normal, replace the amplifier.

Speaker Circuit Malfunction - with Amplifier

1. Ignition OFF, disconnect the X1 connector at the amplifier.
2. Radio ON, test for 5.0-7.5 V between the appropriate signal circuit terminal listed below and ground.
    - Left front low level audio signal (+) - terminal 15 X1
    - Left front low level audio signal (-) - terminal 7 X1
    - Right front low level audio signal (+) - terminal 14 X1
    - Right front low level audio signal (-) - terminal 6 X1
    - Left rear low level audio signal (+) - terminal 13 X1
    - Left rear low level audio signal (-) - terminal 5 X1
    - Right rear low level audio signal (+) - terminal 12 X1
    - Right rear low level audio signal (-) - terminal 4 X1
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the radio.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the radio.
3. Ignition OFF, disconnect the X2 and X3 harness connectors at the amplifier.
4. Ignition ON, test for less than 1 V between each of the signal circuit terminals listed below and ground.
    - Left front speaker output (-) - terminal 3 X2
    - Left front speaker output (+) - terminal 4 X2
    - Right front speaker output (-) - terminal 1 X2

- Right front speaker output (-) - terminal 2 X2
- Left rear speaker output (-) - terminal 7 X2
- Left rear speaker output (+) - terminal 8 X2
- Right rear speaker output (-) - terminal 5 X2
- Right rear speaker output (-) - terminal 6 X2
- Left subwoofer speaker output (-) - terminal 3 X3
- Left subwoofer speaker output (+) - terminal 7 X3
- Right subwoofer speaker output (-) - terminal 2 X3
- Right subwoofer speaker output (+) - terminal 6 X3
- If greater than the specified range, test both signal circuits of the affected speaker for a short to voltage.

5. Ignition OFF, test for infinite resistance between each of the signal circuit terminals listed below and ground.
    - Left front speaker output (-) - terminal 3 X2
    - Left front speaker output (+) - terminal 4 X2
    - Right front speaker output (-) - terminal 1 X2
    - Right front speaker output (+) - terminal 2 X2
    - Left rear speaker output (-) - terminal 7 X2
    - Left rear speaker output (+) - terminal 8 X2
    - Right rear speaker output (-) - terminal 5 X2
    - Right rear speaker output (+) - terminal 6 X2
    - Left subwoofer speaker output (-) - terminal 3 X3
    - Left subwoofer speaker output (+) - terminal 7 X3
    - Right subwoofer speaker output (-) - terminal 2 X3
    - Right subwoofer speaker output (+) - terminal 6 X3
    - If less than the specified range, test both signal circuits of the affected speaker for a short to ground.
6. Ignition OFF, reconnect all harness connectors at the amplifier. Disconnect the harness connector at the appropriate speaker.
7. Radio ON, test for 5.0-7.5 V between the appropriate signal circuit terminals listed below and ground.
    - Front door speakers - terminal A and B
    - Front A pillar speakers - terminal A and B
    - Rear tweeters - terminal A and B
    - Rear subwoofers - terminal C and D
    - If less than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the amplifier.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the amplifier.
8. If all circuits test normal, replace the speaker.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Speaker Replacement Reference**
- **Control Module References** for amplifier or radio replacement, programming and setup

UNABLE TO CONTACT ONSTAR CALL CENTER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The vehicle communication interface module (VCIM) is a cellular device that allows the user to communicate data and voice signals over the national cellular network. When an OnStar keypress is made, the VCIM activates and connects the system to the cellular carriers communication system by interacting with the national cellular infrastructure. The module sends and receives all cellular communications over the cellular phone and navigation antenna and cellular antenna coax.

Diagnostic Aids

- The customer concern may have been due to a lack of cellular service in a given area. A failure in the National Cellular Network infrastructure at the time of the customers failed connection that has since been repaired may also have been the cause.
- If an OnStarÂ® emergency call is able to successfully connect the vehicle to the OnStarÂ® Call Center when an OnStarÂ® Call Center button press is not, there may be a failure in the ability of the OnStarÂ® system in the vehicle to be recognized by the local cellular carrier.
- If the prompt "OnStarÂ® request ended" is heard, without pressing the white dot button at the end of the OnStarÂ® keypress, the OnStarÂ® system at one time has made a successful cellular connection, but was unable to complete the call.
- It is important to have the vehicle in an open outside area where a cellular call can be successfully placed and GPS data can be received from satellites.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-49903 GM OnStar Antenna Diagnostic Tool Kit

Circuit/System Verification

NOTE: **The following verification requires the vehicle to be outside with an unobstructed view of the southern sky. Allow 5 minutes after turning key on for the GPS satellites to acquire vehicle signal.**

Ignition ON, wait 5 minutes, then contact the OnStar call center consultant by pressing the blue OnStar button. A call center consultant should answer the call, verifying the vehicle OnStar system is functioning and the consultant can locate the vehicle.

- If the unit does not connect to the OnStar Call Center, use a scan tool to obtain and record the following information: Electronic Serial Number (ESN), Station Identifier (STID), GM 8-digit part number, Mobile Identification Number (MIN), Mobile Dialed Number (MDN), Transceiver ID (Trans ID) and call GM TAC to confirm a valid subscription.

Circuit/System Testing

NOTE: **The vehicle may be equipped with sectioned coax. Test each section and replace only the faulty section, not the entire length of coax.**

1. Ignition OFF, disconnect the GPS and cellular coax cable connector at the VCIM.
2. Using the EL-49903-3 kit (EL-49903-5 adapter and EL-49903-4 coax cable), connect the **EL-49903** kit to the VCIM.
3. Ignition ON, wait 5 minutes, and then contact the OnStar call center consultant by pressing the blue OnStar button. A call center consultant should answer the call.
    - If the unit does not connect to the OnStar Call Center, replace the VCIM.
4. Ignition OFF, disconnect the **EL-49903** kit from the VCIM and perform the coax cable test on the coax cable between the VCIM and the cellular antenna.
    - If the coax cable does not pass the test, replace the coax cable.
5. If all circuits test normal, replace the cellular antenna.

Component Testing

CAUTION: **Refer to Test Probe Caution .**

NOTE: **Before testing the coax cable, check the cable exterior for being pinched, cut, damaged, or having loose connections at the components, which can cause reception issues.**

To prevent false reading when testing the center coax terminals, use care not to ground the test probe on the outer housing/shield.

Coax Cable Test

1. Ignition OFF, disconnect the GPS and cellular phone coax cable at both components.
2. Test both for less than 5 Ω between both ends of the coax cables center terminals.
    - If greater than the specified range, replace the failed coax cable.
3. Test for greater than 10k Ω between the coax cable center wire and the outer coax shield.
    - If less than the specified range, replace the coax cable.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Cellular Communications/Digital Radio Antenna Replacement**
- **Control Module References** for VCIM replacement, setup, and programming

ONSTAR VOICE RECOGNITION MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The telematics communication interface control module is capable of interpreting voice commands received over the cellular microphone circuit. Speech recognition allows the user to speak to one computer in the vehicle, and one reached over the cellular communication network. The module attempts to understand the users command, and responds by speaking back, or by taking the appropriate action, e.g. dialing the phone.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

OnStar Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

NOTE:

- **It is necessary to have the vehicle in an open outside area where a cellular call can be successfully placed and GPS data can be received from satellites.**
- **The vehicle should be located in a quiet area.**

1. Ignition ON/vehicle in Service Mode, press the blue OnStar Call button.
2. Verify that your voice is heard clearly by the OnStar Call center.
   - **If your voice can not be heard clearly**

     Refer to **OnStar Microphone Malfunction**
   - **If your voice can be heard clearly**
3. Verify that the system responds appropriately to all voice commands by pressing the voice command button and attempting to operate the system using multiple voice commands.
   - **If the OnStar system does not respond to any voice commands**

     Replace the K73 Telematics Communication Interface Control Module
   - **If the OnStar system responds to some, but not all voice commands**

     Refer to **OnStar Description and Operation** for tips on proper pronunciation
   - **If the OnStar system responds to all voice commands**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair procedure.

Control Module References for telematics communication interface control module replacement, programming, and setup.

REPAIR INSTRUCTIONS

MOBILE TELEPHONE MICROPHONE REPLACEMENT

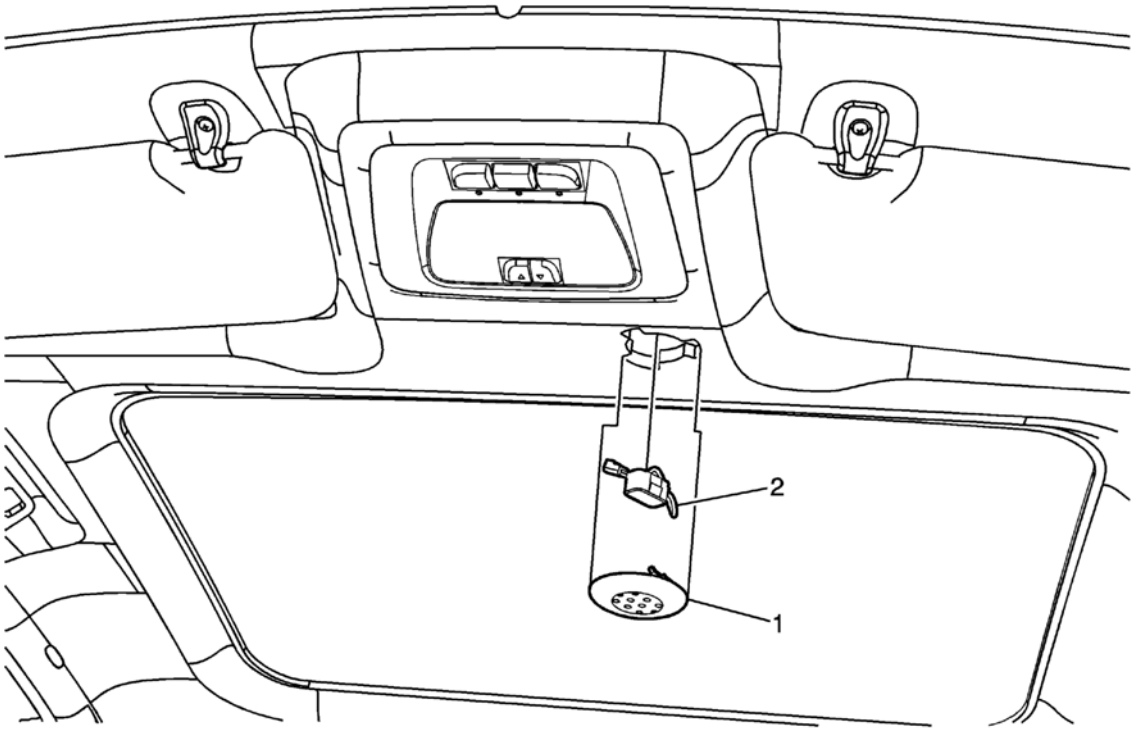


Fig. 9: Mobile Telephone Microphone
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Mobile Telephone Microphone Bezel **Procedure** Snap the bezel out of the headliner.
2	Mobile Telephone Microphone **Procedure** Disconnect the electrical connector.

COMMUNICATION INTERFACE MODULE REPLACEMENT

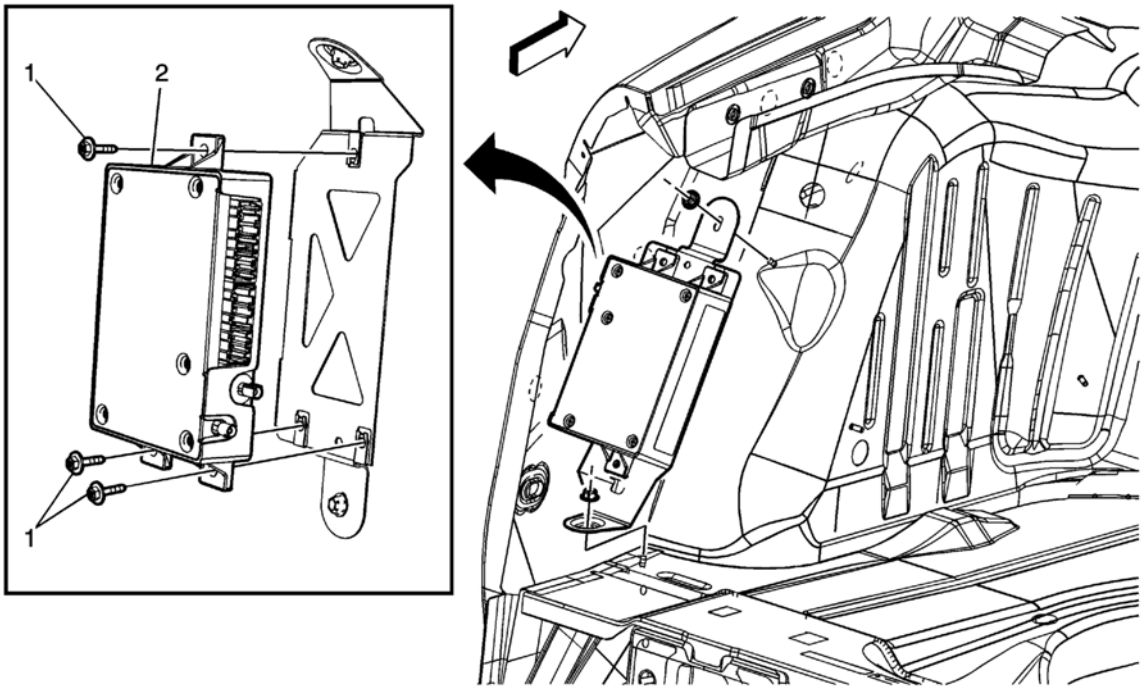


Fig. 10: Communication Interface Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** . 2. Pull back the left rear compartment trim panel in order to expose the communication interface module. 3. For programming and set up, Refer to **Control Module References** .	
1	Communication Interface Bolt/Screw (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** • The vehicle communication interface module (VCIM) has a specific set of unique numbers that tie the module to each vehicle. These numbers, the 10-digit station identification and the 11-digit electronic serial number, are used by the National Cellular Network and OnStarÂ® to identify the specific vehicle. Because these numbers are tied to the vehicle identification number of the vehicle, you must never exchange these parts with those of another vehicle. • After replacing the vehicle communication interface module, you must reconfigure the

Callout	Component Name
	OnStarÂ® system. Failure to reconfigure the system will result in an additional customer visit for repair. In addition, pressing and holding the white dot button on the keypad will NOT reset this version of the OnStarÂ® system. This action will cause a DTC to set. • When replacing the VCIM be sure to transfer Bluetooth Antenna, if equipped. **Tighten** 5 N.m (44 lb in)
2	Communication Interface Module **Procedure** For programming and set up information, refer to **Control Module References** .

COMMUNICATION INTERFACE MODULE BATTERY REPLACEMENT

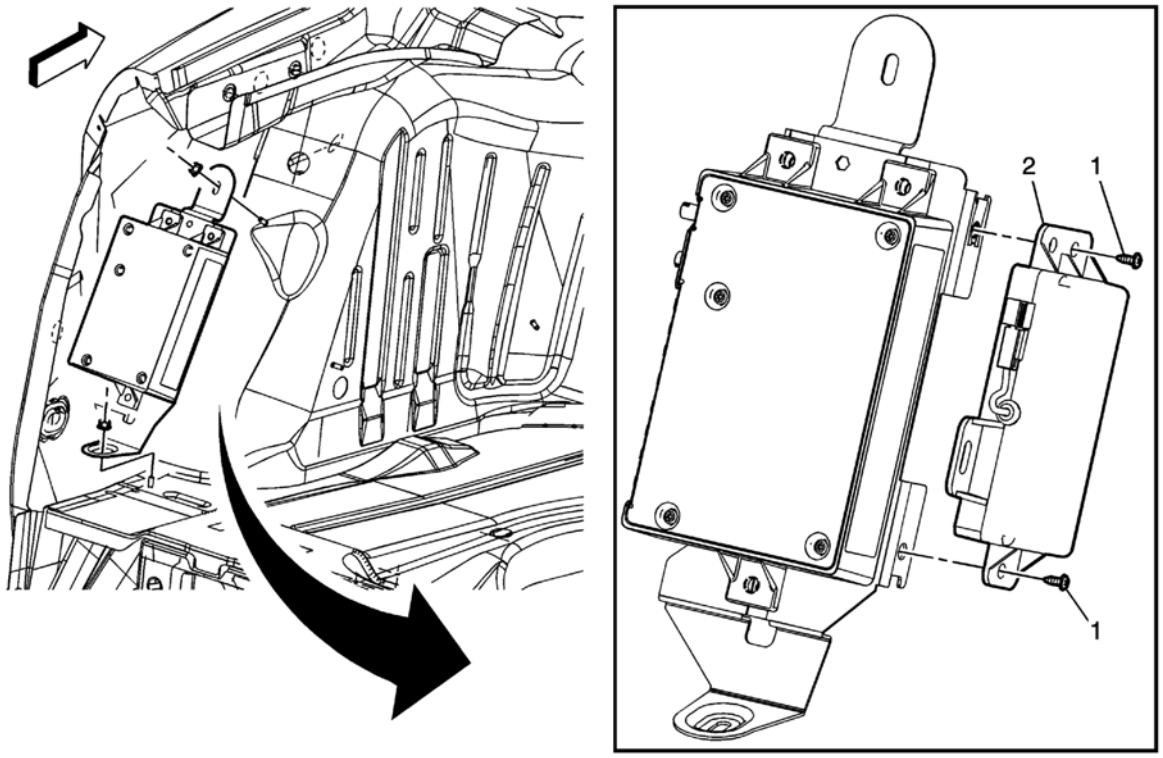


Fig. 11: Communication Interface Module Battery
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the left side rear compartment trim. 2. Program the communication interface module (OnStarÂ®) after replacement. Refer to **Control Module References** .	

Callout	Component Name
1	Communication Interface Module Battery Screw (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution** **.** **Tighten** 2.5 N.m (22 lb in)
2	Communication Interface Module Battery • The vehicle communication interface module (VCIM) has a specific set of unique numbers that tie the module to each vehicle. These numbers, the 10-digit station identification and the 11-digit electronic serial number, are used by the National Cellular Network and OnStarÂ® to identify the specific vehicle. Because these numbers are tied to the vehicle identification number of the vehicle, you must never exchange these parts with those of another vehicle. • Replacement of the back-up battery (BUB) does not require reconfiguration of the VCIM. If a trouble code is indicated before the battery is replaced, the DTC must be cleared following the installation of the new battery. The OnStarÂ® system does not need to be reconfigured unless the VCIM is replaced. • When the VCIM is replaced, the OnStarÂ® system must be reconfigured. Failure to reconfigure the system will result in an additional customer visit for repair. In addition, pressing and holding the white dot button on the keypad will NOT reset this version of the OnStarÂ® system. This action will cause a DTC to set.

WIRELESS COMMUNICATION INTERFACE ANTENNA REPLACEMENT

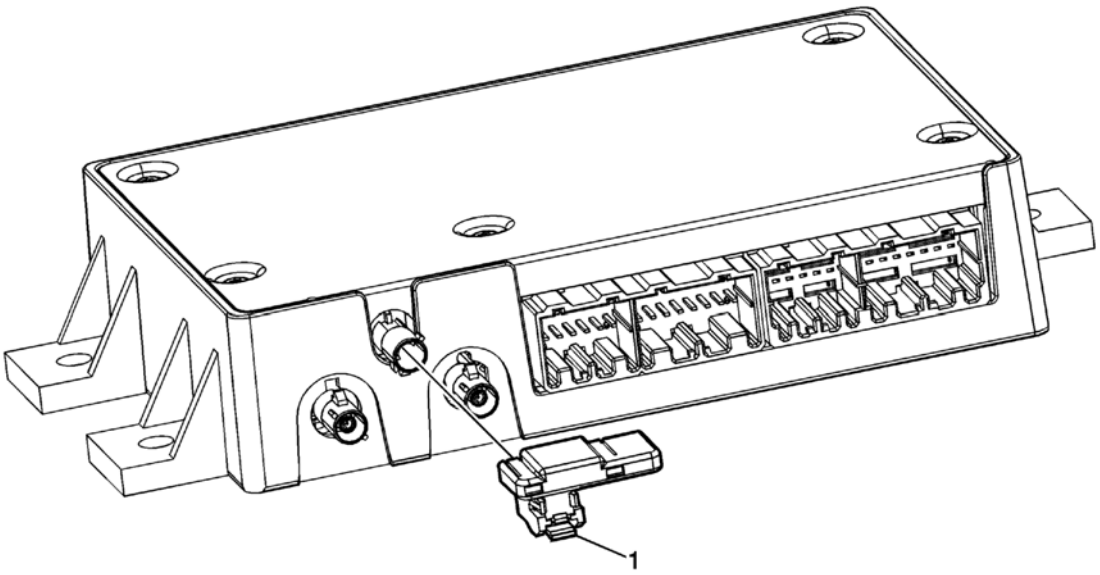


Fig. 12: Wireless Communication Interface Antenna
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the communication interface module. Refer to **Communication Interface Module Replacement**	
1	Wireless Communication Interface Antenna Bluetooth Module **Procedure** Unsnap the Antenna from Communication Module.

RADIO REPLACEMENT

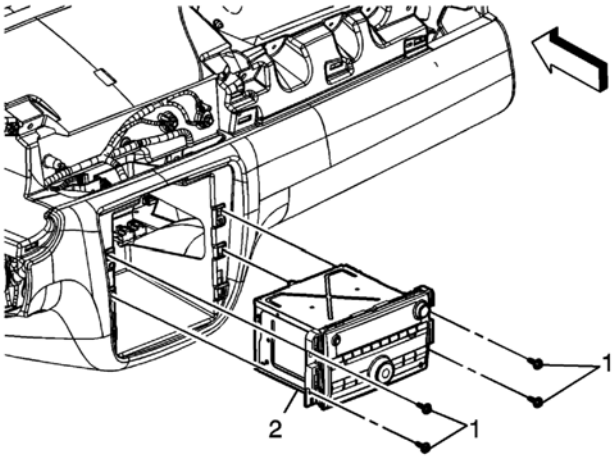


Fig. 13: Radio
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the instrument panel accessory trim plate. Refer to **Instrument Panel Accessory Trim Plate Replacement** 2. Remove the heating and air conditioning control module. Refer to **Heater and Air Conditioning Control Replacement** 3. Slightly push the antenna lead toward the radio to relieve tension on the internal fingers. Pull back on the spring-loaded locking ring and remove the connector from the radio. 4. To install the antenna lead, plug the antenna lead into the socket until it clicks. 5. Program the radio after replacement. Refer to **Control Module References**	
1	Radio Bolt/Screw (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	AM/FM Stereo Radio

DIGITAL RADIO RECEIVER REPLACEMENT

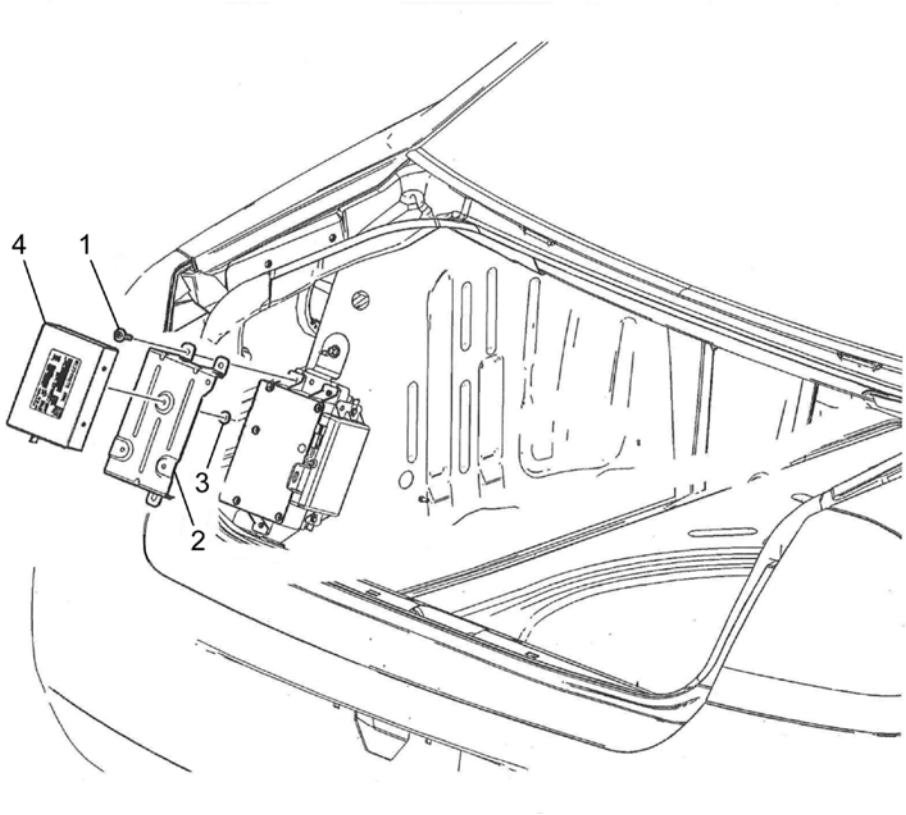


Fig. 14: Digital Radio Receiver
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the right rear compartment trim. Refer to **Rear Compartment Side Trim Replacement - Right Side** .	
1	Digital Radio Receiver Bracket Bolt (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution** **.**
2	Digital Radio Receiver Bracket
3	Digital Radio Receiver Nut (Qty: 3)
4	Digital Radio Receiver **Procedure** 1. Disconnect the electrical connectors. 2. Refer to **Control Module References** for programming and set up, if required.

RADIO SPEAKER AMPLIFIER REPLACEMENT

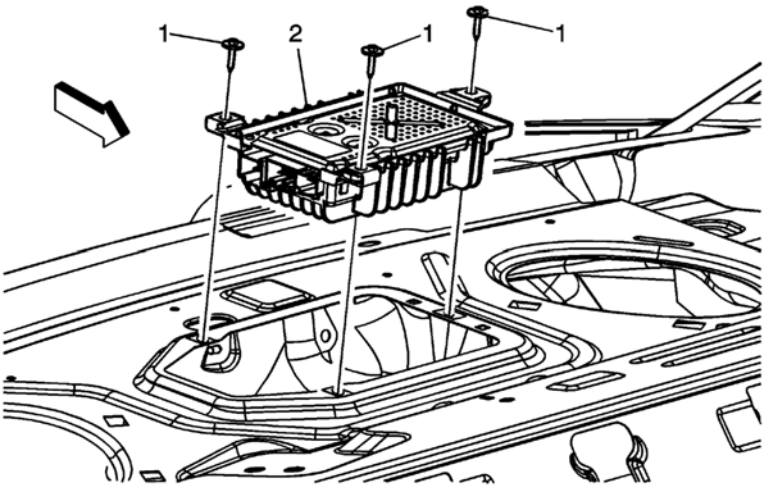


Fig. 15: Radio Speaker Amplifier
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear window shelf trim panel. Refer to **Rear Window Shelf Trim Panel Replacement** .	
1	Low Frequency Audio Amplifier Bolt (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 2.5 N.m (22 lb in)
2	Low Frequency Audio Amplifier Assembly Refer to **Control Module References** for programming and setup information.

MOBILE TELEPHONE DIGITAL ANTENNA REPLACEMENT

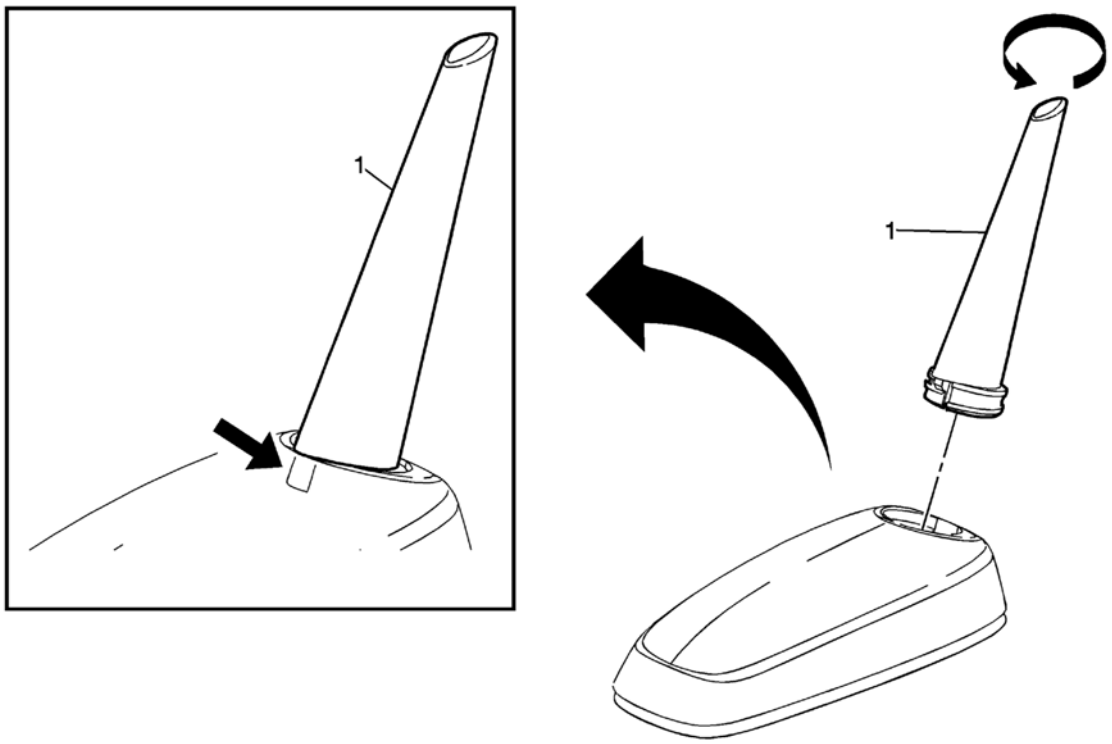


Fig. 16: Mobile Telephone Digital Antenna
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Mobile Telephone Digital Antenna Assembly • The release tab is not visible with the mast assembled to the antenna base. • Using a small flat-bladed tool, push in and hold the release tab, then rotate the mast counterclockwise in order to release the mast from the antenna base.

CELLULAR COMMUNICATIONS/DIGITAL RADIO ANTENNA REPLACEMENT

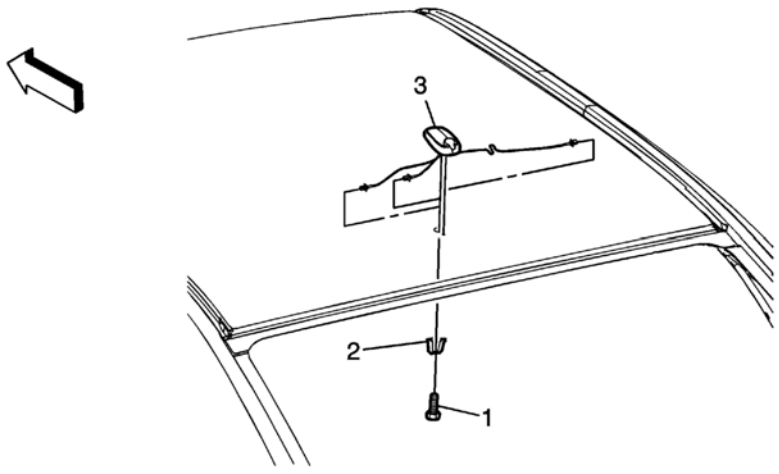


Fig. 17: Cellular Communications/Digital Radio Antenna

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Lower the rear of the headliner. Refer to **Headlining Trim Panel Replacement** .	
1	Mobile Telephone and Vehicle Location Antenna Base Bolt **CAUTION:** **Refer to** **Fastener Caution** . **TIP:** Disconnect the electrical connections. **Tighten** 9 N.m (80 lb in)
2	Mobile Telephone and Vehicle Location Antenna Base Expansion Sleeve
3	Mobile Telephone and Vehicle Location Antenna Base Assembly

RADIO ANTENNA MODULE REPLACEMENT

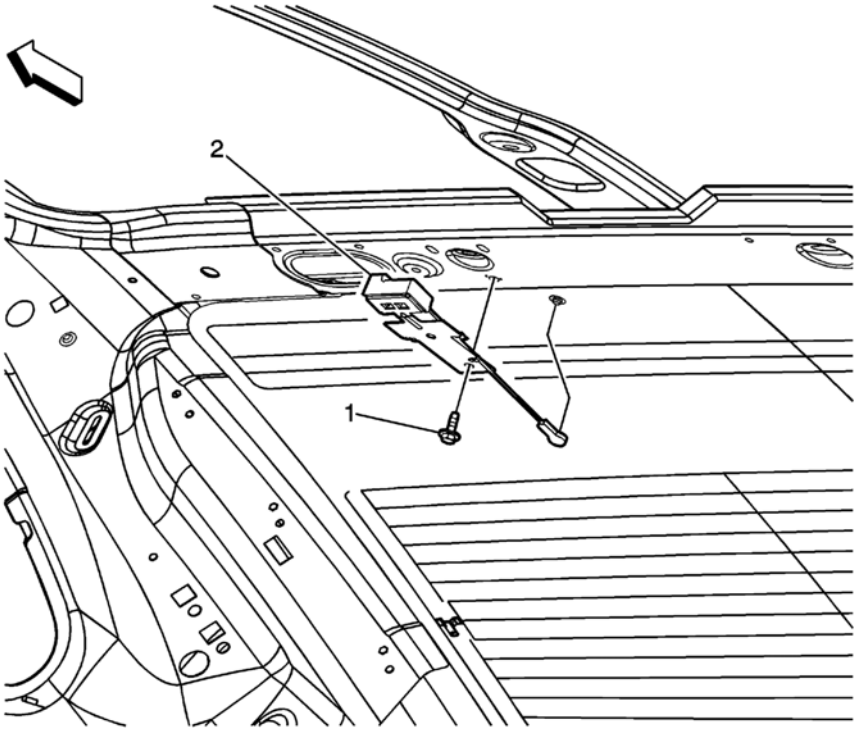


Fig. 18: Radio Antenna Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Lower the rear of the headliner. Refer to **Headlining Trim Panel Replacement** .	

Callout	Component Name
1	Radio Antenna Module Bolt (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 10 N.m (89 lb in)
2	Radio Antenna Module Assembly • Disconnect the antenna lead from the rear window. • Disconnect the electrical connector.

DIGITAL RADIO ANTENNA CABLE REPLACEMENT

Removal Procedure

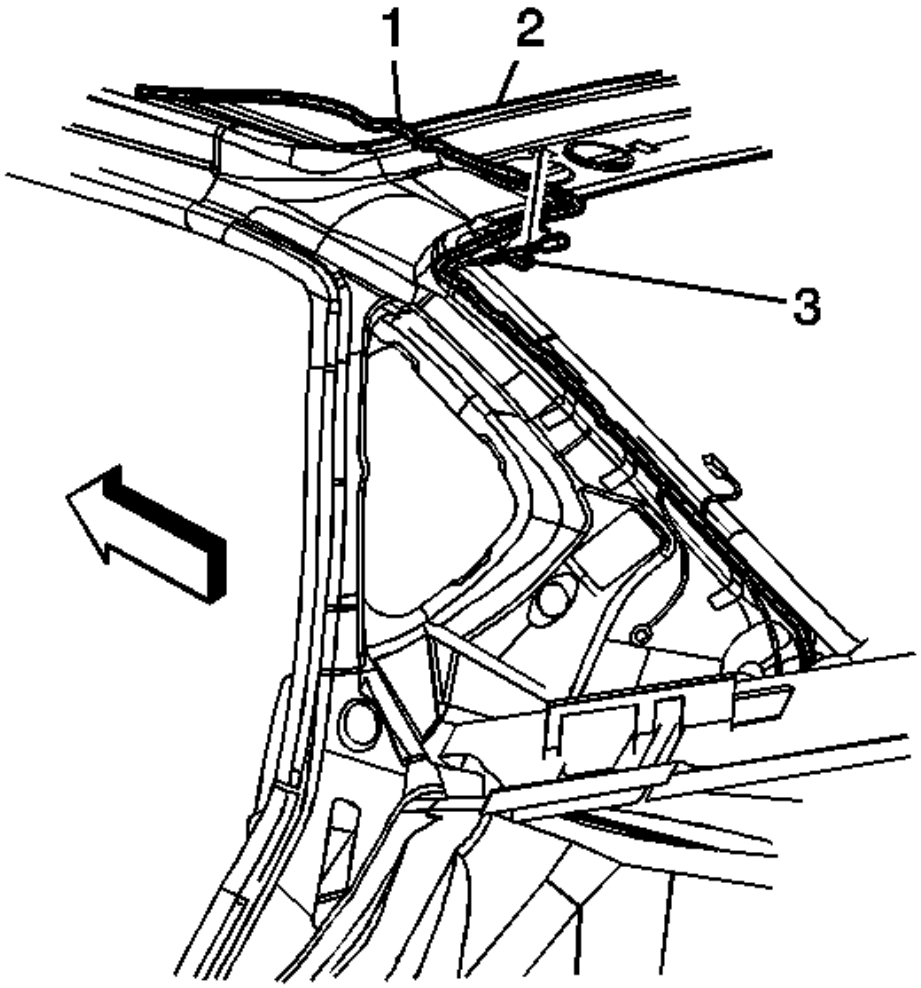


Fig. 19: Antenna Cable, Retainer & Rear Header
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right rear upper quarter trim panel. Refer to **Quarter Upper Trim Panel Replacement** .
2. Lower the rear of the headliner for access to the antenna/cable attachment. Refer to **Headlining Trim Panel Replacement** .
3. Adjust the antenna cable mastic patch/tape at the roof.
4. Disconnect the antenna cable from the antenna base cable connector.
5. Remove the antenna cable retainer (3) from the rear header (2).

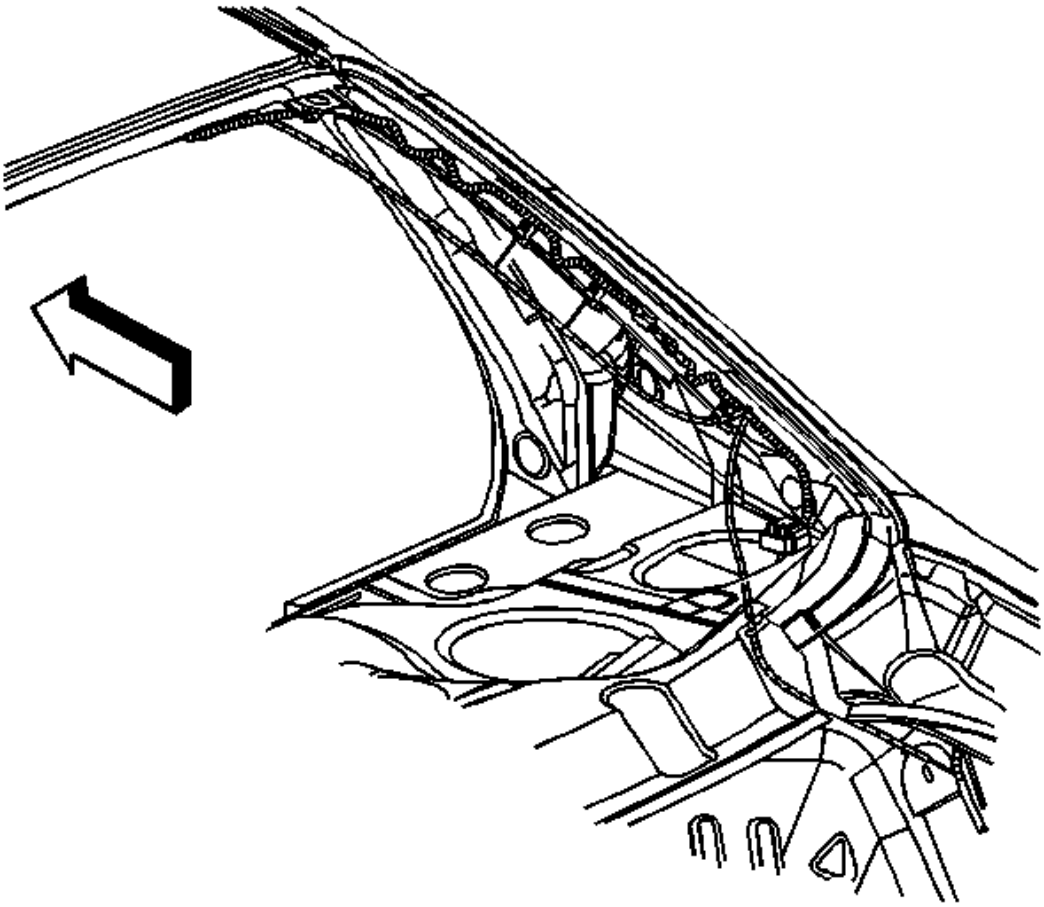


Fig. 20: Routing Antenna Cable
Courtesy of GENERAL MOTORS COMPANY

6. Remove the antenna cable from the dome lamp harness clips.
7. Remove the antenna cable from between the dome lamp harness and the upper quarter panel.
8. Attach a piece of wire or string to the end of the antenna cable.
9. Route the antenna cable through the rear shelf and along the rear wheel house.
10. Adjust the right rear compartment trim panel.

11. Disconnect the antenna cable from the digital radio receiver.
12. Remove the antenna cable retainers from the receiver bracket.
13. Remove the wire or string from the antenna cable.
14. Remove the antenna cable.

Installation Procedure

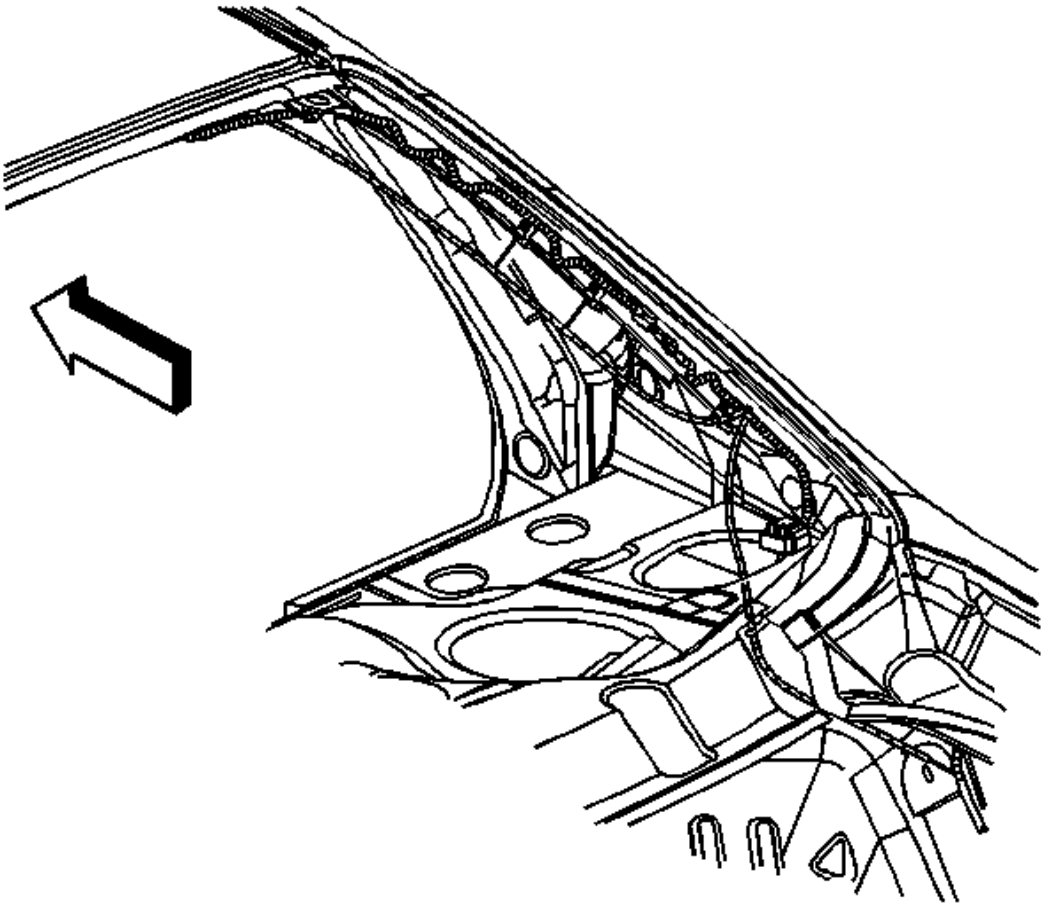


Fig. 21: Routing Antenna Cable
Courtesy of GENERAL MOTORS COMPANY

1. Install the antenna cable retainers to the receiver bracket.
2. Connect the antenna cable to the digital radio receiver.
3. Attach the wire or string used in the removal procedure to the cable being installed.
4. Carefully pull the antenna cable through the rear shelf into the passenger compartment.
5. Install the right rear compartment trim panel.
6. Remove the wire or string from the antenna cable.
7. Route the antenna cable between the dome lamp harness and the upper quarter panel.
8. Install the antenna cable to the dome lamp harness clips.

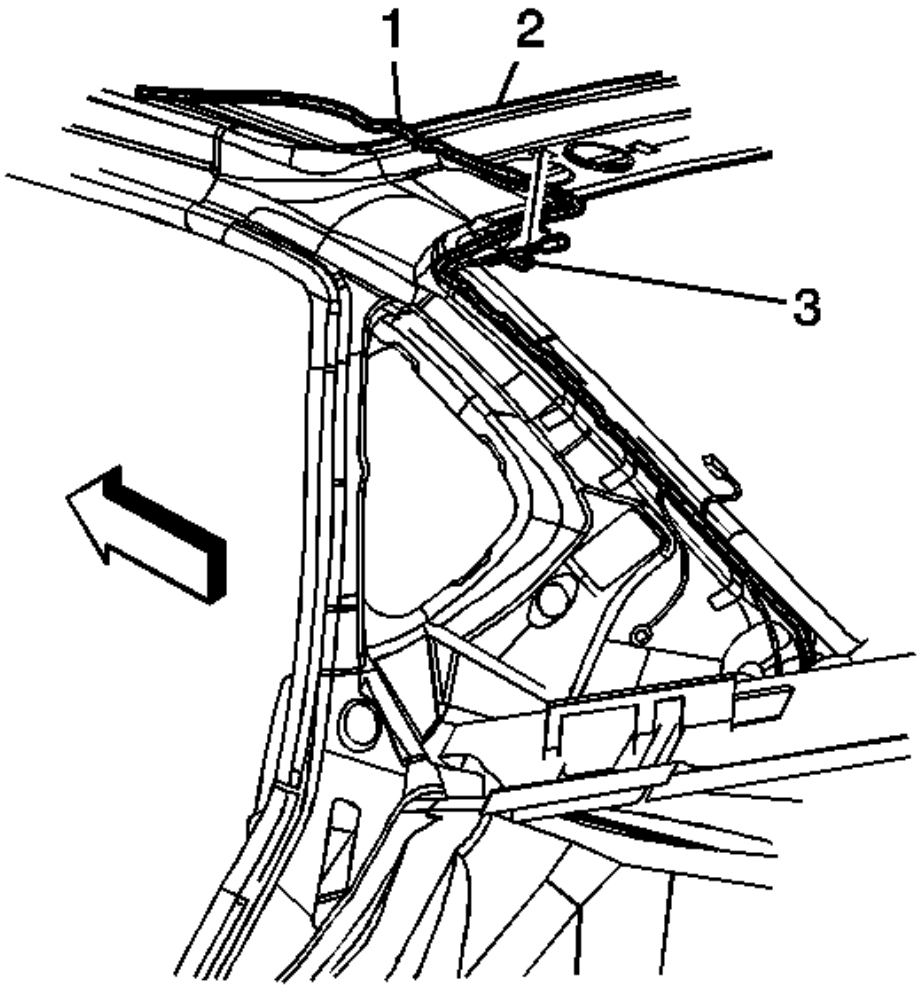


Fig. 22: Antenna Cable, Retainer & Rear Header
Courtesy of GENERAL MOTORS COMPANY

9. Install the antenna cable retainer (3) to the rear header (2).
10. Connect the antenna cable to the antenna base cable connector.
11. Install the antenna cable mastic patch/tape at the roof.
12. Install the rear of the headliner. Refer to **Headlining Trim Panel Replacement** .
13. Install the right rear upper quarter trim panel. Refer to **Quarter Upper Trim Panel Replacement** .

ANTENNA CABLE REPLACEMENT

Removal Procedure

1. Remove the rear upper quarter trim panel. Refer to **Quarter Upper Trim Panel Replacement** .

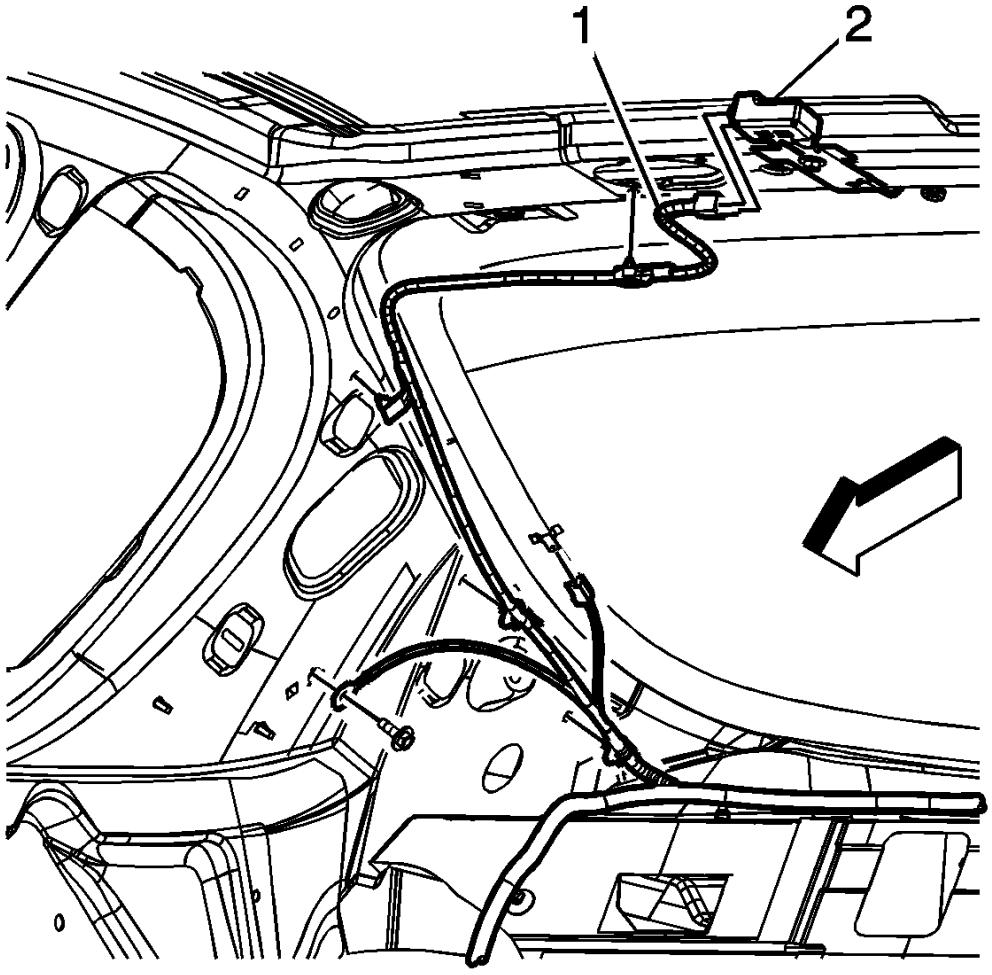


Fig. 23: Antenna Cable & Radio Antenna Module
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the antenna cable (1) from the radio antenna module (2).
3. Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala)** .
   Remove the rear seat back. Refer to **Rear Seat Back Cushion Removal and Installation (Impala)** .
4.

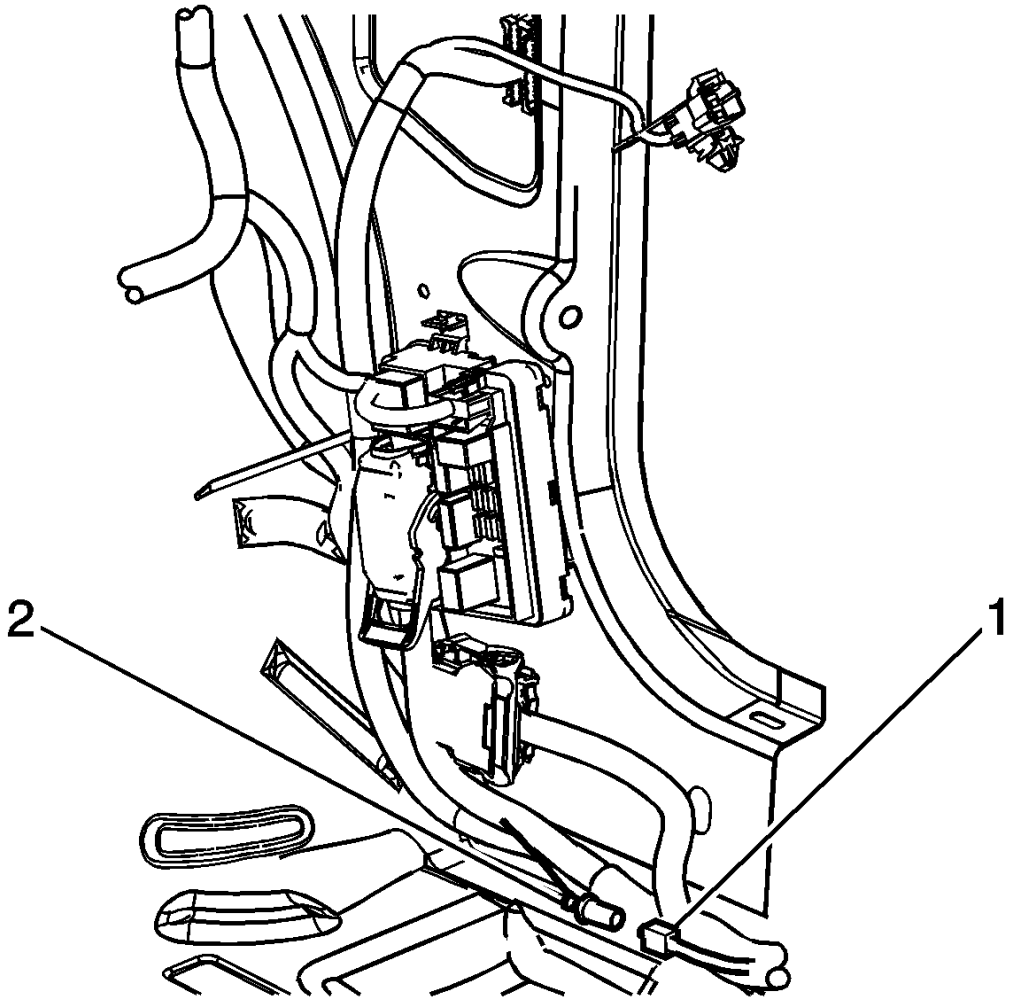


Fig. 24: Identifying Antenna Cable & Antenna Extension Cable
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right carpet retainers. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala)** .
6. Remove the right lower center pillar trim panel. Refer to **Center Pillar Lower Trim Panel Replacement** .
7. Adjust the carpet for access to the antenna cable as required.
8. Disconnect the antenna cable (1) from the antenna extension cable (2).
9. Cut off the visible end of the antenna cable from the wiring harness in the following locations:
   - The kick panel area
   - The rear shelf area

Installation Procedure

1. Install the antenna cable to the vehicle. Use electrical tape in order to secure the antenna extension cable to the top of the wiring harness. Secure the cable to the harness at least every 150 mm (6 in).

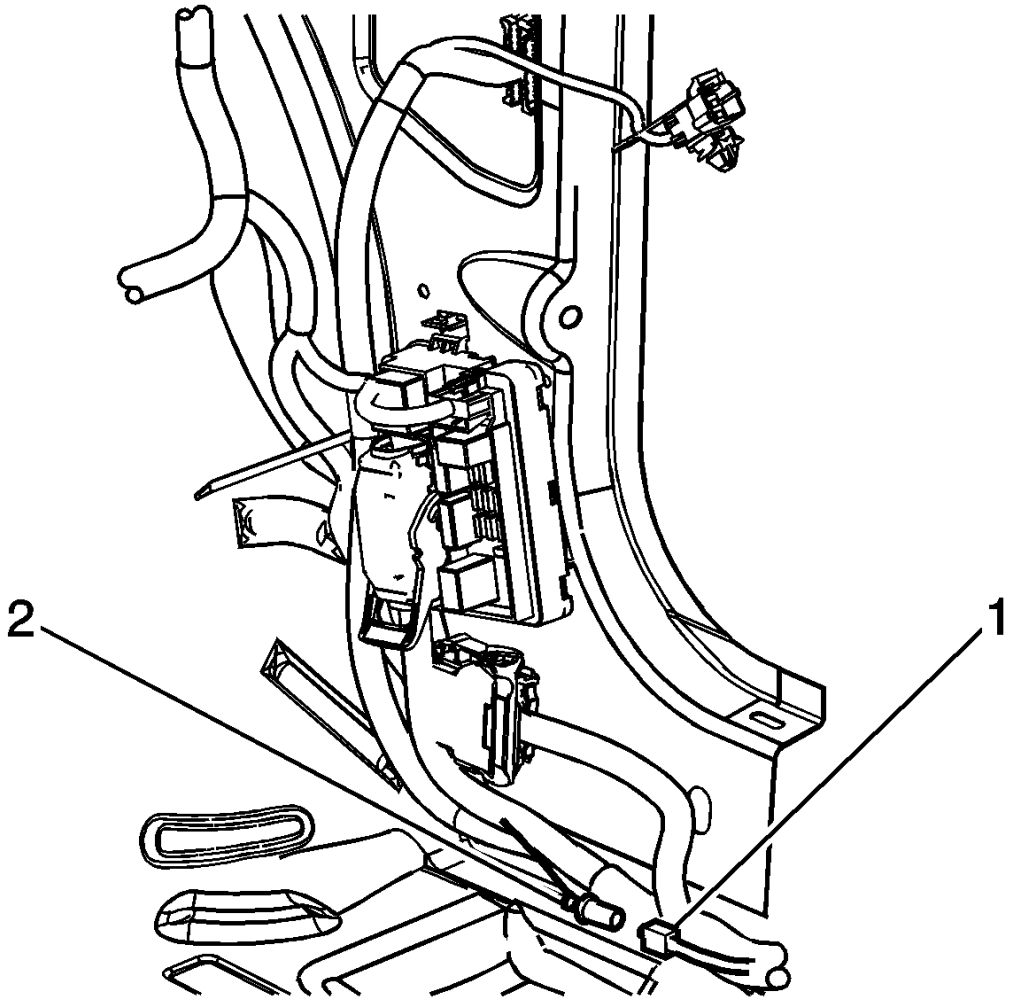


Fig. 25: Antenna Cable & Antenna Extension Cable
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: The antenna cable uses a sliding snap-lock. Holding the sliding lock feature will prevent installation.

2. Connect the antenna extension cable (2) from the radio to the antenna cable (1) near the kick panel:
    1. Position the antenna extension cable behind the sliding lock feature.
    2. Install the antenna extension cable to the sliding lock feature.
3. Install the carpet.
4. Install the right lower center pillar trim panel. Refer to **Center Pillar Lower Trim Panel Replacement** .
5. Install the right carpet retainers. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala)** .

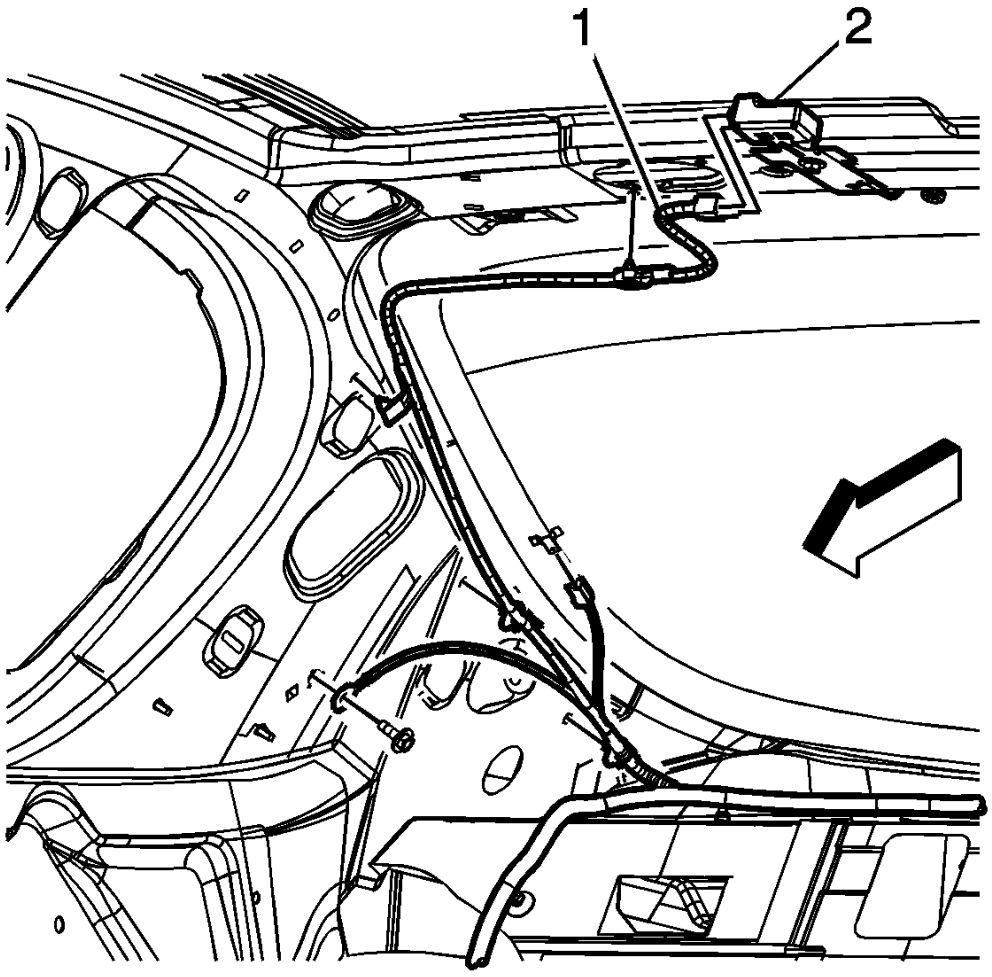


Fig. 26: Antenna Cable & Radio Antenna Module
Courtesy of GENERAL MOTORS COMPANY

6. Install the rear seat back. Refer to **Rear Seat Back Cushion Removal and Installation (Impala)** .
7. Install the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala)** .

IMPORTANT: The antenna cable uses a sliding snap-lock. Holding the sliding lock feature will prevent installation.

8. Connect the antenna cable (1) to the radio antenna module (2):
    1. Position the antenna cable behind the sliding lock feature.
    2. Install the antenna cable to the sliding lock feature.
9. Install the rear upper quarter trim panel. Refer to **Quarter Upper Trim Panel Replacement** .

RADIO ANTENNA CABLE EXTENSION CABLE REPLACEMENT

Removal Procedure

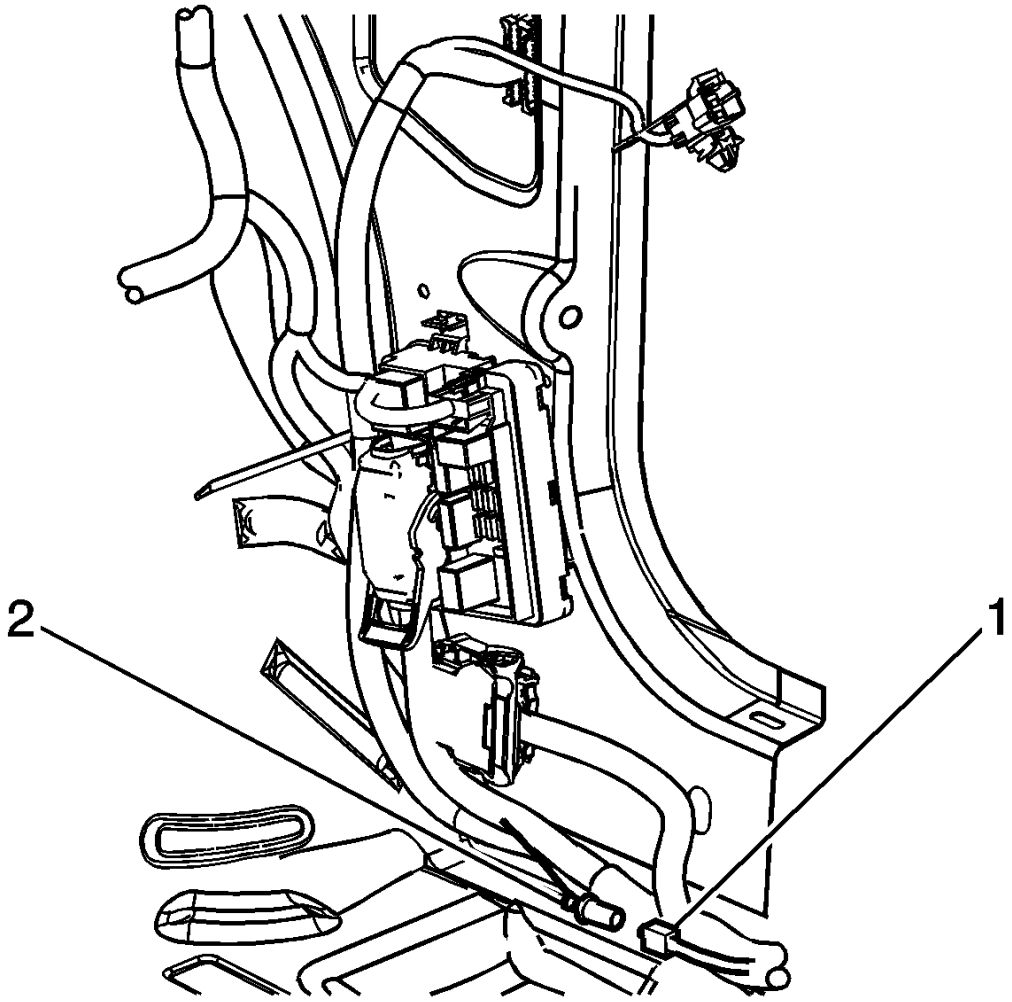


Fig. 27: Antenna Cable & Antenna Extension Cable
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right carpet retainer. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala)** .
2. Adjust the carpet for access.
3. Disconnect the antenna extension cable (2) from the antenna cable (1).
4. Remove the right instrument panel insulator. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** .

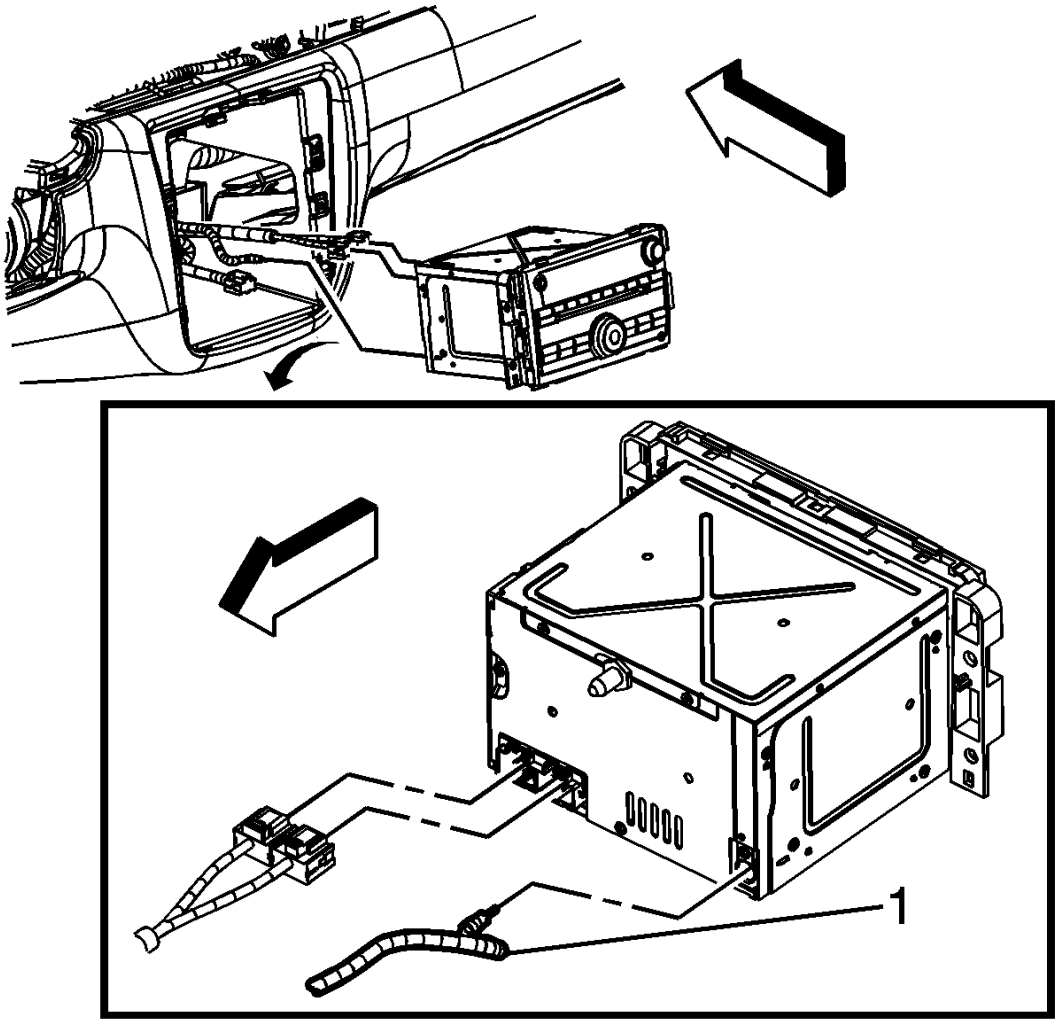


Fig. 28: Antenna Extension Cable & Radio
Courtesy of GENERAL MOTORS COMPANY

5. Adjust the radio for access. Disconnect the antenna extension cable (1) from the radio. Refer to **Radio Replacement**.
6. Cut off the visible ends of the antenna extension cable.

Installation Procedure

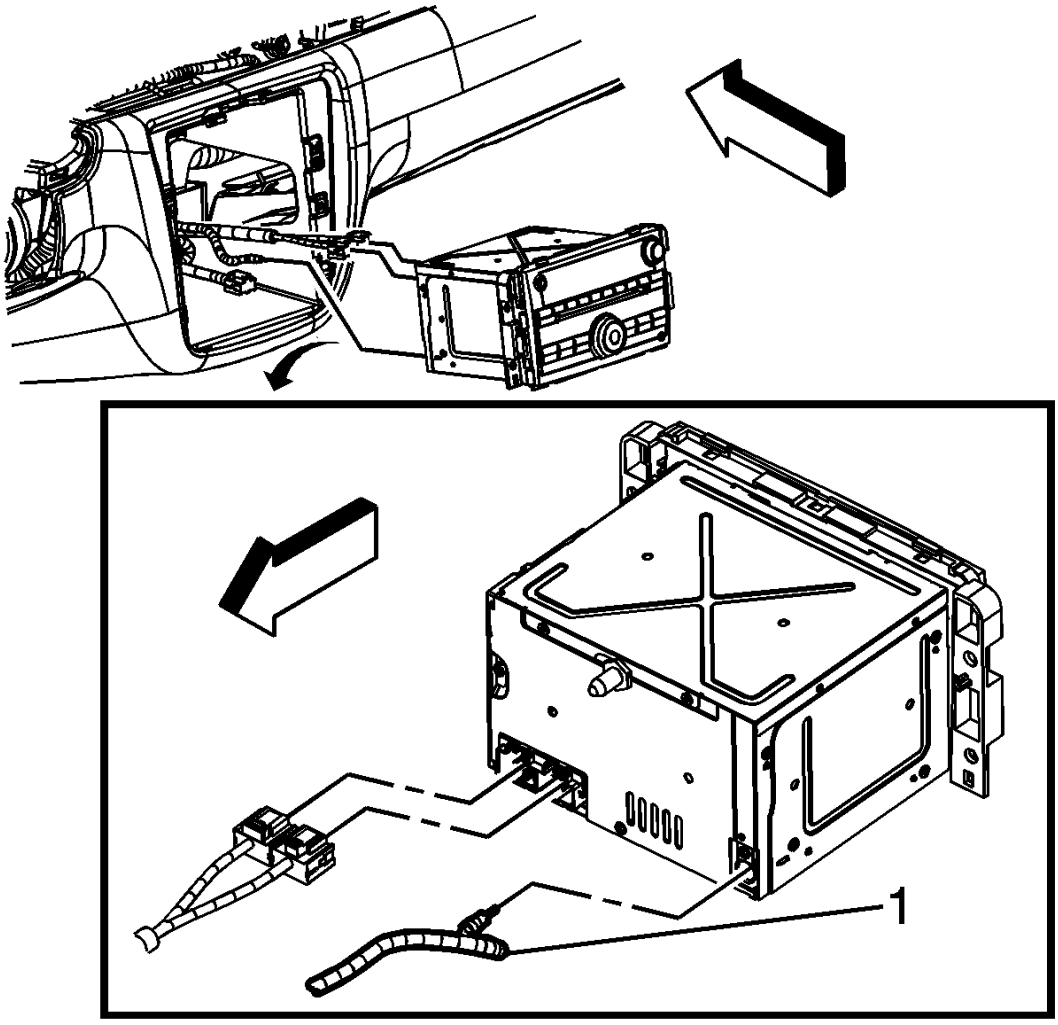


Fig. 29: Antenna Extension Cable & Radio
Courtesy of GENERAL MOTORS COMPANY

1. Route the antenna extension cable. Secure the cable.
2. Connect the antenna extension cable (1) to the radio. Install the radio. Refer to **Radio Replacement**.

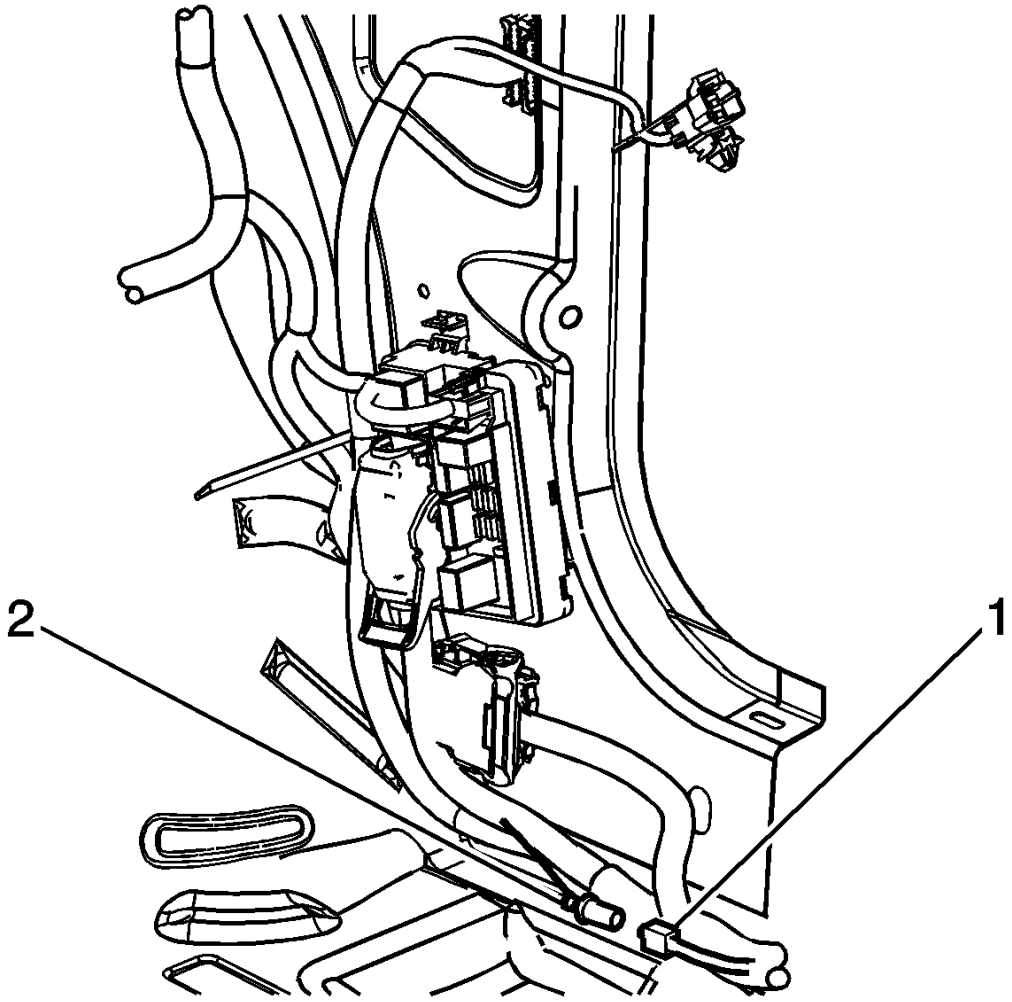


Fig. 30: Antenna Cable & Antenna Extension Cable
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: The antenna cable uses a sliding snap-lock. Holding the sliding lock feature will prevent installation.

3. Connect the antenna extension cable (2) from the radio to the antenna cable (1) near the kick panel:
    1. Position the antenna extension cable behind the sliding lock feature.
    2. Install the antenna extension cable to the sliding lock feature.
4. Install the right instrument panel insulator. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** .
5. Install the carpet.
6. Install the right carpet retainer. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala)** .

MOBILE TELEPHONE AND NAVIGATION ANTENNA COAXIAL CABLE REPLACEMENT (IMPALA)

Removal Procedure

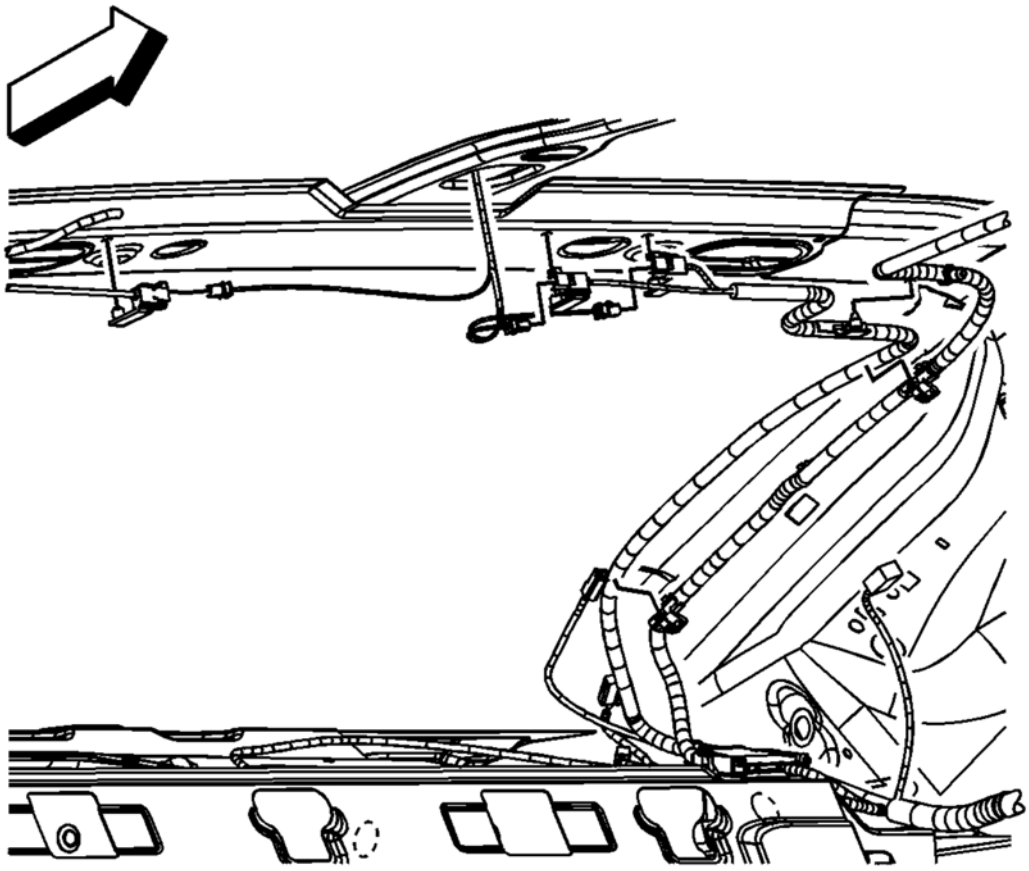


Fig. 31: Headliner & Digital Antenna
Courtesy of GENERAL MOTORS COMPANY

1. Lower the rear of the headliner to access the digital antenna connection. Refer to **Headlining Trim Panel Replacement** .
2. Disconnect the digital antenna connection and cut the connector on the harness side off.
3. Remove the left rear compartment side trim. Refer to **Rear Compartment Side Trim Replacement - Left Side** .

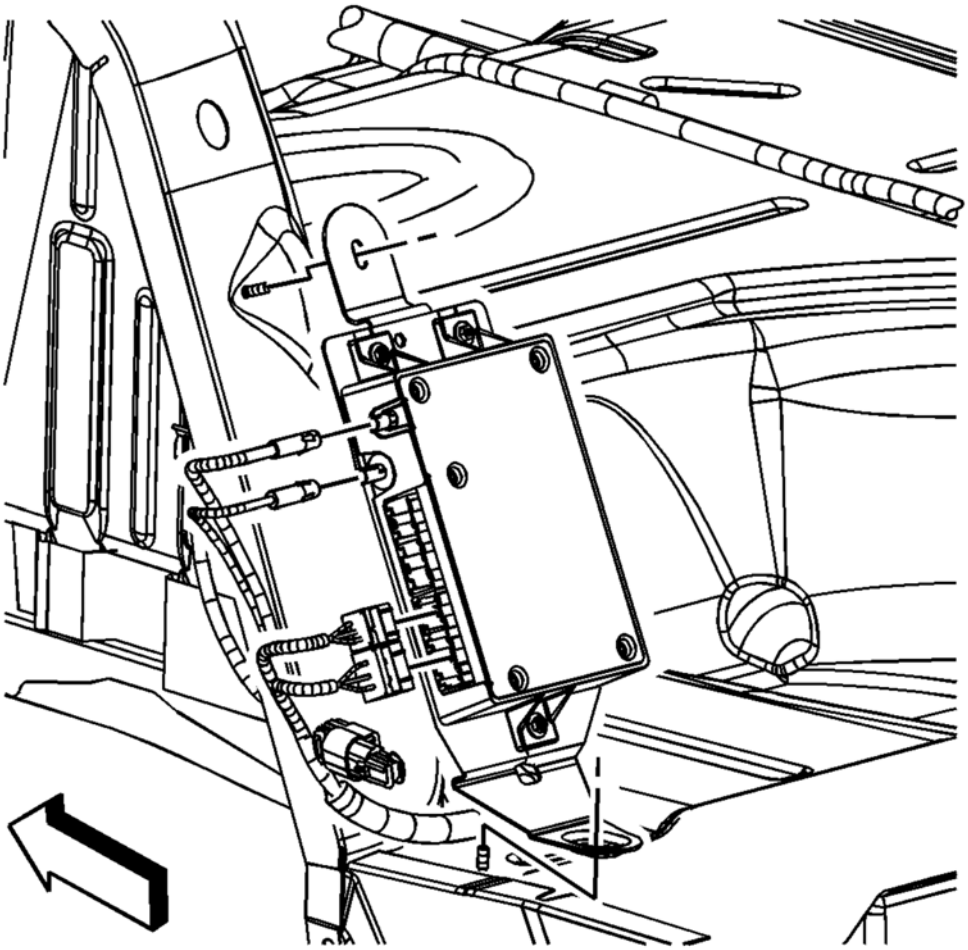


Fig. 32: Antenna Cable Connector & Harness Side
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the antenna cable connector and cut the end off on the harness side.

Installation Procedure

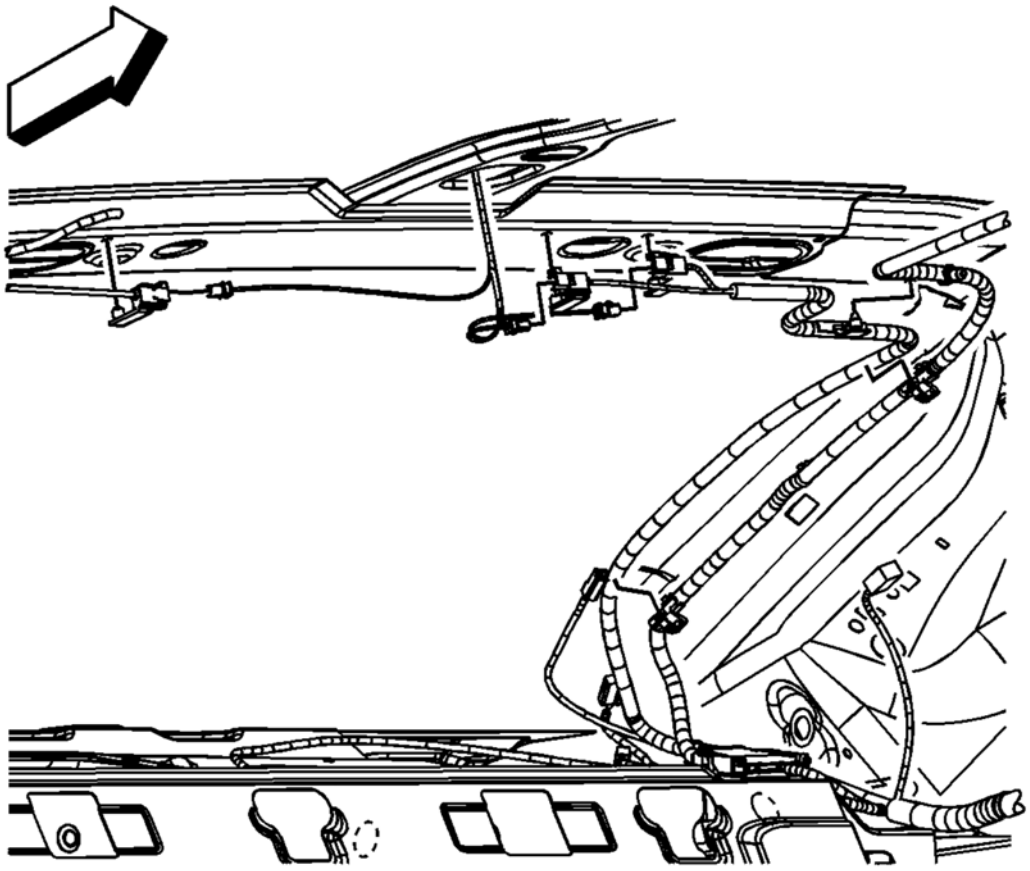


Fig. 33: Headliner & Digital Antenna
Courtesy of GENERAL MOTORS COMPANY

1. Route the new cellular antenna cable from the interior of the vehicle to the rear compartment area following the same path as the old cable. A piece of mechnic's wire may be used as needed to assist in the procedure. Secure the new cable as needed with tie straps.

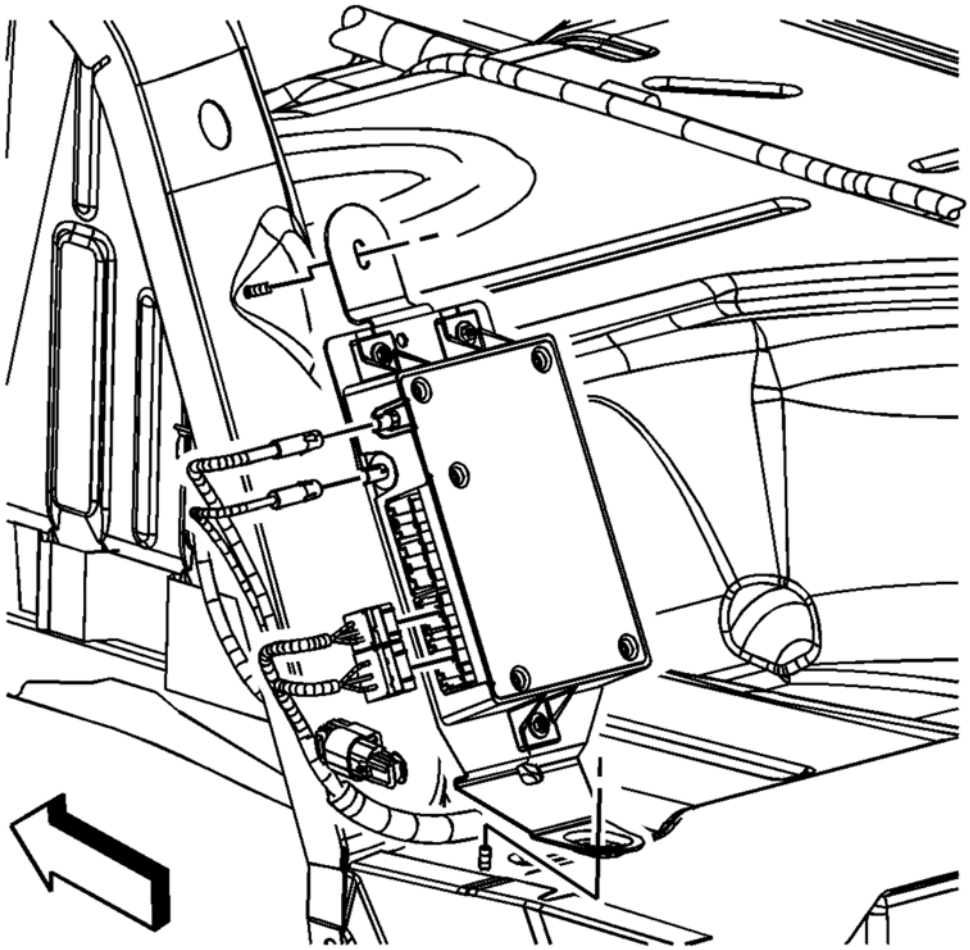


Fig. 34: Antenna Cable Connector & Harness Side
Courtesy of GENERAL MOTORS COMPANY

2. Connect the new cable to the ONSTAR module and install the left rear compartment side trim. Refer to **Rear Compartment Side Trim Replacement - Left Side** .
3. Connect the new cable to the digital antenna and secure the headliner. Refer to **Headlining Trim Panel Replacement** .

RADIO REAR SPEAKER GRILLE REPLACEMENT

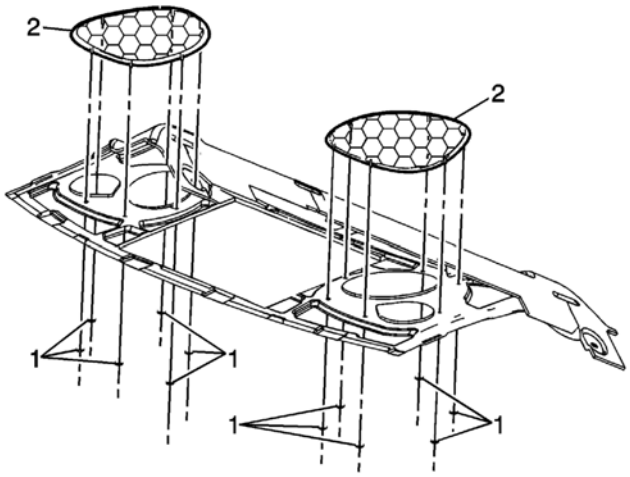


Fig. 35: Radio Rear Speaker Grille
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear window shelf trim panel. Refer to **Rear Window Shelf Trim Panel Replacement** .	
1	Radio Rear Speaker Grille Nut **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 2 N.m (18 lb in)
2	Radio Rear Speaker Grille

FRONT UPPER SPEAKER REPLACEMENT

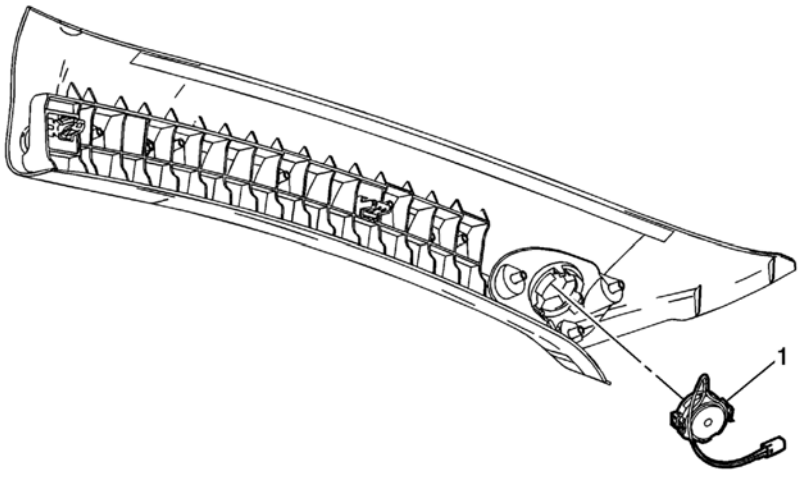


Fig. 36: Front Upper Speaker
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the instrument panel (I/P) outer trim cover. Refer to **Instrument Panel Outer Trim Cover Replacement - Right Side** , or **Instrument Panel Outer Trim Cover Replacement - Left Side** . 2. Remove the windshield pillar garnish molding. Refer to **Windshield Pillar Garnish Molding Replacement** .	
1	Radio Windshield Side Garnish Molding Speaker Assembly **TIP:** Release the tabs on the windshield pillar speaker carrier to remove the speaker from the molding.

RADIO FRONT SIDE DOOR SPEAKER REPLACEMENT

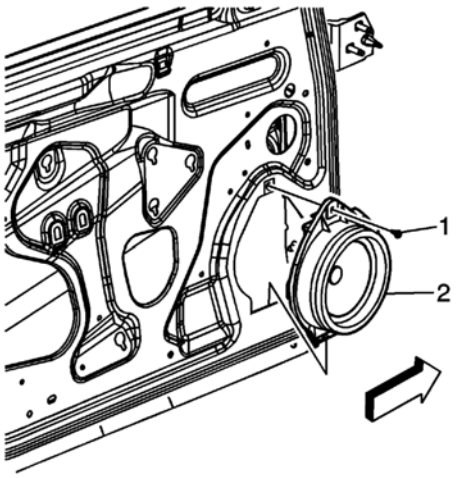


Fig. 37: Radio Front Side Door Lower Speaker
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front door trim panel. Refer to **Front Side Door Trim Panel Replacement**	
1	Radio Front Side Door Speaker Housing Bolt/Screw **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)

Callout	Component Name
2	Radio Front Side Door Speaker Assembly **Procedure** Disconnect electrical connections.

RADIO REAR SPEAKER REPLACEMENT (IMPALA W/UW6)

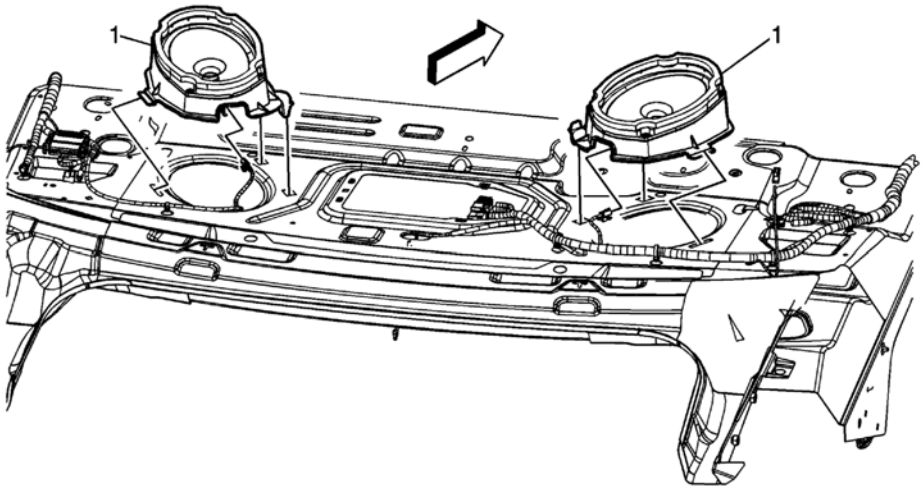


Fig. 38: Radio Rear Speaker (Impala w/UW6)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear window shelf trim panel. Refer to **Rear Window Shelf Trim Panel Replacement** .	
1	Radio Rear Speaker Assembly (Qty: 2) • Push in on the tabs on the speaker in order to release. • Disconnect the electrical connector.

RADIO REAR SPEAKER REPLACEMENT (IMPALA W/UQ3)

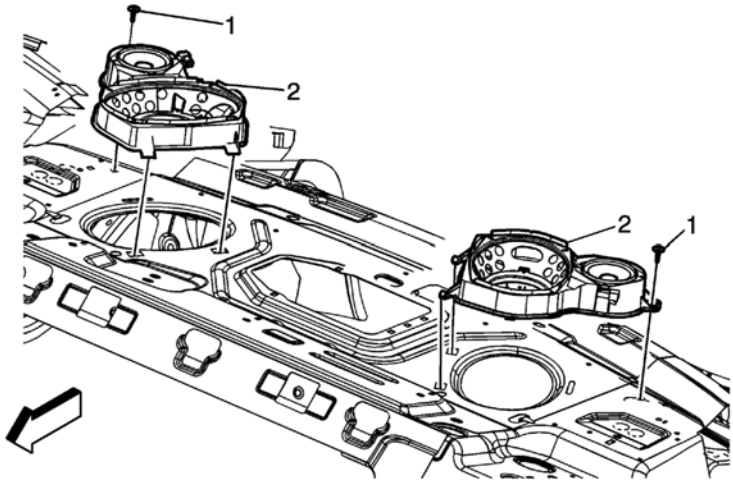


Fig. 39: Radio Rear Speaker (Impala w/UQ3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear window shelf trim panel. Refer to **Rear Window Shelf Trim Panel Replacement** .	
1	Radio Rear Speaker Bolt/Screw **CAUTION:** **Refer to** **Fastener** **Caution** . **TIP:** Disconnect the electrical connector. **Tighten** 2.5 N.m (22 lb in)
2	Radio Rear Speaker Assembly

DESCRIPTION AND OPERATION

ONSTAR DESCRIPTION AND OPERATION

This OnStarÂ® system consists of the following components:

- Telematics communication interface control module
- OnStarÂ® three button assembly
- Microphone
- Cellular antenna
- Navigation antenna
- BluetoothÂ® antenna (If equipped)
- Back up battery (If equipped)

This system also interfaces with the factory installed vehicle audio system.

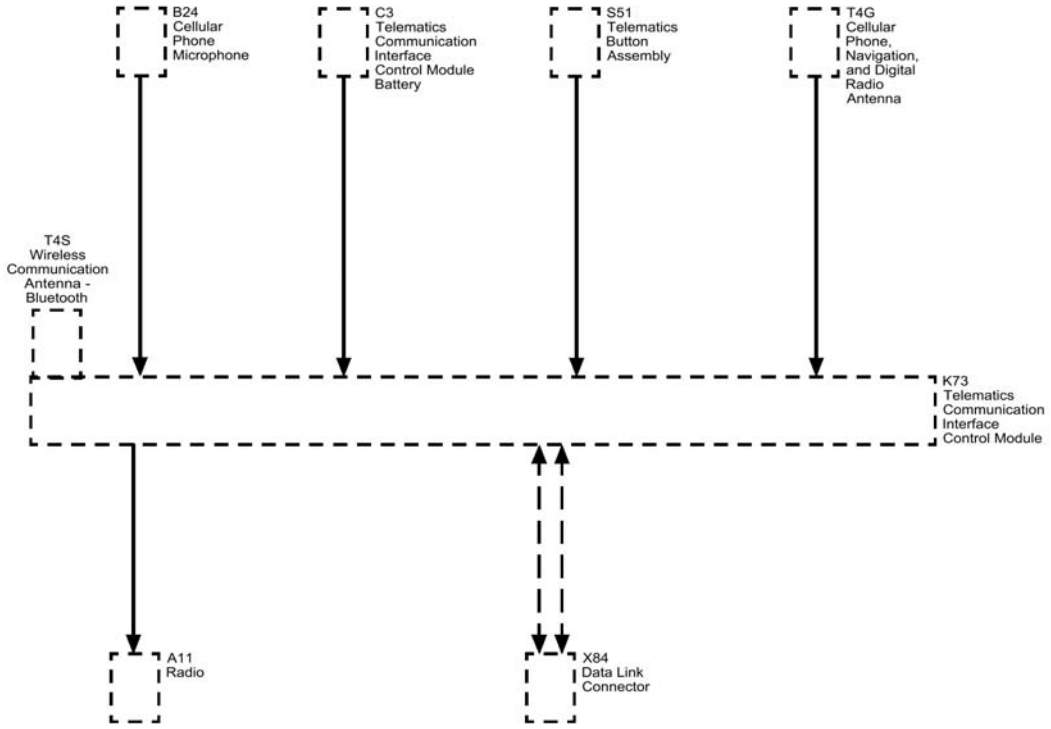


Fig. 40: Identifying Onstar Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
B24	B24 Cellular Phone Microphone
C3	C3 Telematics Communication Interface Control Module Battery
S51	S51 Telematics Button Assembly
T4G	T4G Cellular Phone, Navigation, and Digital Radio Antenna
T4S	T4S Wireless Communication Antenna - Bluetooth
K73	K73 Telematics Communication Interface Control Module
A11	A11 Radio
X84	X84 Data Link Connector

Telematics Communication Interface Control Module

The telematics communication interface control module is a cellular device that allows the user to communicate data and voice signals over the national cellular network. Power is provided by a dedicated, fused B+ circuit. Ground is provided through the vehicle wiring harness attached to the module. The ignition state is determined

by the telematics communication interface control module through serial data messaging.

Dedicated circuits are used to connect the telematics communication interface control module to a microphone, the button assembly, and to command the status LED. The telematics communication interface control module communicates with the rest of the vehicle over the serial data bus.

The module houses 2 technology systems, one to process GPS data, and another for cellular information. The cellular system connects the OnStarÂ® system to the cellular carrier's communication system by interacting with the national cellular infrastructure. The module sends and receives all cellular communications over the cellular antenna and cellular antenna coax. GPS satellites orbiting earth are constantly transmitting signals of their current location. The OnStarÂ® system uses the GPS signals to provide location on demand.

The module also has the capability of activating the horn, initiating door lock/unlock, or activating the exterior lamps using the serial data circuits. These functions can be commanded by the OnStarÂ® Call Center per a customer request.

OnStarÂ® Three Button Assembly

Base Mirror

- The OnStarÂ® button assembly may be part of the rearview mirror, or a separate, stand alone unit. The button assembly is comprised of 3 buttons and a status LED. The buttons are defined as follows:
  - The answer/end call button, which is black with a white phone icon, allows the user to answer and end calls or initiate speech recognition.
  - The blue OnStarÂ® call center button, which displays the OnStarÂ® logo, allows the user to connect to the OnStarÂ® call center.
  - The emergency button, which displays a white cross with a red background, sends a high priority emergency call to the OnStarÂ® call center when pressed.

The telematics communication interface control module supplies 10 volts to the OnStarÂ® button assembly on the keypad supply voltage circuit. When pressed, each button completes a circuit across a resistor allowing a specific voltage to be returned to the telematics communication interface control module on the keypad signal circuit. Depending upon the voltage range returned the telematics communication interface control module is able to identify which button has been pressed.

The OnStarÂ® status LED is located with the button assembly. The LED is green when the system is ON and operating normally. When the status LED is green and flashing, it is an indication that a call is in progress. When the LED is red, this indicates a system malfunction is present. In the event there is a system malfunction and the OnStarÂ® system is still able to make a call, the LED will flash red during the call.

If the mirror has the rear vision camera display in the mirror, the LED's are then interior to the mirror and controlled via data communication on the Low Speed GMLAN bus from the Telematics Communication Interface Control Module to the mirror.

If the LED does not illuminate, this may indicate that the customers OnStarÂ® subscription is not active or has expired. Push the blue OnStar button to connect to an advisor who can then verify the account status.

Each LED is controlled by the telematics communication interface control module over dedicated LED signal circuits. Ground for the LED is provided by the wiring harness attached to the button assembly.

Prismatic Mirror (If Equipped)

- The OnStarÂ® button assembly is apart of the rearview mirror. The button assembly is comprised of 3 capacitive touch buttons and a status LED. The buttons are defined as follows:
  - The answer/end call button, which is a white driver figure seated with voice signals near it's face, allows the user to answer and end calls or initiate speech recognition.
  - The blue OnStarÂ® call center button, which displays the blue OnStarÂ® logo, allows the user to connect to the OnStarÂ® call center.
  - The emergency button, which displays red letters "SOS" as an illuminated Indicator, sends a high priority emergency call to the OnStarÂ® call center when pressed.

The telematics communication interface control module supplies 10 volts to the OnStarÂ® button assembly on the keypad supply voltage circuit. When pressed, each button press is processed and completes a circuit across an internal resistor allowing a specific voltage to be returned to the telematics communication interface control module on the keypad signal circuit. Depending upon the voltage range returned the telematics communication interface control module is able to identify which button has been pressed.

The OnStarÂ® status LED is located within the mirror near the buttons. The LED is green when the system is ON and operating normally. When the status LED is green and flashing, it is an indication that a call is in progress. When the LED is red, this indicates a system malfunction is present. In the event there is a system malfunction and the OnStarÂ® system is still able to make a call, the LED will flash red during the call.

If the LED does not illuminate, this may indicate that the customers OnStarÂ® subscription is not active or has expired. Push the blue OnStar button to connect to an advisor who can then verify the account status.

Each LED is controlled by the telematics communication interface control module over dedicated LED signal circuits. Ground for the LED is provided by the wiring harness attached to the button assembly.

Electrochromic Mirror (If Equipped)

- The OnStarÂ® button assembly is apart of the rearview mirror. The button assembly is comprised of 3 capacitive touch buttons and an error indicator. The buttons are defined as follows:
  - The answer/end call button, which is a white driver figure seated with voice signals near it's face, allows the user to answer and end calls or initiate speech recognition.
  - The blue OnStarÂ® call center button, which displays the blue OnStarÂ® logo, allows the user to connect to the OnStarÂ® call center.
  - The emergency button, which displays red letters "SOS" as an illuminated Indicator, sends a high priority emergency call to the OnStarÂ® call center when pressed.

The telematics communication interface control module supplies 10 volts to the OnStarÂ® button assembly on the keypad supply voltage circuit. When pressed, each button press is processed and completes a circuit across an internal resistor allowing a specific voltage to be returned to the telematics communication interface control module on the keypad signal circuit. Depending upon the voltage range returned the telematics communication interface control module is able to identify which button has been pressed and illuminate associated indicator above each button.

The OnStarÂ® error indicator is located within the mirror above the buttons between the OnStarÂ® indicator and emergency "SOS" indicator. All three indicators associated with a button press are illuminated when the

system is ON and operating normally. When any indicator is illuminated and flashing, it is an indication that a call is in progress. When the OnStarÂ® error indicator is illuminated, this indicates a system malfunction is present. In the event there is a system malfunction and the OnStarÂ® system is still able to make a call, the OnStarÂ® error indicator will remain illuminated during the call.

If the indicators do not illuminate, this may indicate that the customers OnStarÂ® subscription is not active or has expired. Push the blue OnStar button to connect to an advisor who can then verify the account status.

Secondary OnStarÂ® Controls

Some vehicles may have an additional button that when pushed can engage the OnStarÂ® system. The button may be a symbol of a face with sound waves, or may say MUTE, or be a symbol of a radio speaker with a slash through it.

By engaging the OnStarÂ® system with this feature, the user can interact with the system by use of voice commands. A complete list of these commands is supplied in the information provided to the customer. If the information is not available for reference, at any command prompt the user can say "HELP" and the telematics communication interface control module will return an audible list of available commands.

OnStarÂ® Microphone

The OnStarÂ®, or cellular microphone, can be a part of the rearview mirror assembly, or on some vehicle lines, a separate, stand alone unit. In either case, the telematics communication interface control module supplies approximately 10 volts to the microphone on the cellular microphone signal circuit, and voice data from the user is sent back to the telematics communication interface control module over the same circuit. A cellular microphone low reference circuit or a drain wire provides a ground for the microphone.

Cellular and GPS Antennas

This vehicle will be equipped with one of the following types of antennas:

- A combination cellular and navigation antenna, which brings the functions of both into a single part
- A cellular, GPS, and digital radio receiver antenna, which also incorporates the functionality of the digital radio receiver satellite antenna (XM).
- A cellular, GPS, and digital radio receiver antenna, which also incorporates the AM/FM antenna.

The cellular antenna is the component that allows the OnStarÂ® system to send and receive data over airwaves by means of cellular technology. The antenna is connected at the base to a coax cable that plugs directly into the telematics communication interface control module.

The GPS antenna is used to collect the signals of the orbiting GPS satellites. Within the antenna is housed a low noise amplifier that allows for a more broad and precise reception of this data. The antenna is connected at the base to a coax cable that plugs directly into the telematics communication interface control module. The cable also provides a path for DC current for powering the antenna.

The OnStarÂ® Call Center also has the capability of communicating with the vehicle during an OnStarÂ® call to retrieve the latest GPS location and transmit it to the OnStarÂ® Call Center. A history location of the last recorded position of the vehicle is stored in the module and marked as aged, for as long as the module power is not removed. Actual GPS location may take up to 10 minutes to register in the event of a loss of power.

OnStarÂ® RemoteLink

OnStarÂ® RemoteLink is a mobile app to link mobile devices to a vehicle for diagnostics and feature controls. After downloading the app and registering the device, vehicle owners with an eligible vehicle can use their mobile devices to access real-time data from their vehicle and perform specific commands remotely.

All communication between the app and the vehicle is powered by OnStar'sÂ® advanced connected vehicle technology. An active OnStarÂ® account as well as a valid OnStarÂ® username and password are required to use the app. The remote commands must be enabled by logging into the user's OnStarÂ® account prior to using the app.

Vehicle Control Features

- Lock/Unlock doors
- Start vehicle remotely
- Activate your Horn & Lights
- Contact an OnStar Advisor, Roadside Assistance or your Preferred Dealer

Available Vehicle Data:

- Real-time fuel information, including fuel range, fuel remaining, and lifetime MPG
- Lifetime mileage
- Remaining oil life
- Current tire pressure information
- OnStarÂ® account information

Compass Heading

The telematics communication interface module has a compass feature to calculate vehicle direction which is displayed via the instrument panel cluster or designated display. The compass heading is determined by dead reckoning until the GPS 3d fix is established. The dead reckoning is accomplished by using the yaw rate sensors and wheel ticks to determine heading changes from a GPS known heading. The GPS 3d fix heading is determined by the deferential of two locations.

BluetoothÂ® (If Equipped)

BluetoothÂ® wireless technology is a short-range communications technology intended to replace the cables connecting portable and/or fixed devices while maintaining high levels of security. Only vehicles with steering wheel controls will have BluetoothÂ® functionality. In order to utilize the vehicle's BluetoothÂ® system, a BluetoothÂ® equipped cellular phone is required.

The BluetoothÂ® antenna is a small fixed antenna connected directly to the telematics communication interface control module and is used to send and receive signals from a BluetoothÂ® enabled cellular phone. The antenna utilizes no cabling and is not external to the vehicle. The available features and functions are determined by the software within the device being used and the telematics communication interface control module. The operating range of the signal from the vehicle is approximately 30 feet. Note that the operating range is dependent upon the cellular phone being used and battery level of the phone.

With BluetoothÂ® technology customers can experience hands-free calling as their BluetoothÂ® capable

cellular phones are wirelessly connected to the vehicle. It will allow customers to place and receive calls using the steering wheel controls and voice recognition. The vehicle audio system will allow you to listen to your call through the vehicle speakers and adjust volume through steering wheel or radio controls.

Not all BluetoothÂ® cellular phones are guaranteed to work with the vehicle's BluetoothÂ® system. Based on the cellular phone's service provider and the manufacturer's implementation of BluetoothÂ®, not all phones support all available BluetoothÂ® functionality. BluetoothÂ® enabled cellular phones will be tested for vehicle compatibility and a feature compatibility list will be provided via the GM BluetoothÂ® website: http://www.gm.com/vc/bluetooth/

BluetoothÂ® Features Supported

The following is a list of features supported by the BluetoothÂ® system. Note that not all devices will support all of the listed functions.

- Automatic reconnection - highest priority phone will automatically be connected to vehicle when vehicle ignition is on
- Hands-free dialing- via digits, redial, name tags (phone number saved to a nametag via voice recognition)
- Answering a call
- Ending a call
- Mute a Call
- Rejecting a call - ignore an incoming call
- Call Waiting
- Three-way Calling - initiated from hands-free system
- Send Number During a Call - this is used when calling a menu-driven phone system
- Transfer a Call - transfer call from vehicle to cellular phone and visa versa
- Voice Pass-Thru - allow access to the voice recognition commands on the cellular phone

Pairing a BluetoothÂ® Cellular Phone to the Vehicle

In order to use hands-free calling, the cellular phone must be paired to the vehicle. Up to five devices can be paired to the vehicle at one time, but only one can be connected at any given time. To pair a phone, the customer must know how to operate the BluetoothÂ® functionality of their phone. The pairing process must only be done one time for each phone, unless that phone's information is deleted. For safety reasons, the pairing process is disabled while the vehicle is moving.

Once the BluetoothÂ® cellular phone has been paired with vehicle, it will automatically connect to the vehicle when the ignition is on and the device is on. When more than one paired phone is in the vehicle, the phone with the highest priority will be connected. If the cellular phone is in use while getting into the vehicle, the phone can be switched to hands-free mode with the press of a button. In addition, a call in progress can be transferred from the vehicle hands-free mode to the phone to continue the call as the customer exits the vehicle.

Complete pairing instructions are provided in the Vehicle Owners Manual.

Back-up Battery (If Equipped)

IMPORTANT: Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key

in any position other than OFF. Disconnecting power to the OnStarÂ® module in any way while the ignition is ON or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery. This action is per design as the back-up battery is designed to provide power to the telematics communication interface control module so an emergency notification call can be made after an event where the main battery is disabled. Once the Back-Up Battery is activated it will stay on until the power is restored back to the telematics communication interface control module. The telematics communication interface control module naturally chooses the main supply voltage as it's default supply, but if the main supply is removed or lost for any reason the OnStarÂ® module will use the Back-Up Battery as a power supply as long as the default supply can not be detected. The back-up battery is not rechargeable and once discharged below 9.5 volts the back-up battery must be replaced.

Certain OnStarÂ® equipped vehicles may also be equipped with a back-up battery. The back-up battery is a non-rechargeable, lithium battery intended to provide an auxiliary power source for the telematics communication interface control module in the event where power from the main vehicle battery is lost.

The back-up battery is intended to have a life span of approximately 4 years and is designed to maintain an open circuit voltage between 16 V and 9 V throughout this period. This allows the battery to power the basic functions of the telematics communication interface control module for least one 200 second (5 minute) call at the end of the 4 year span, should the main vehicle battery be lost. In the case of a vehicle losing vehicle battery power, OnStar will switch over to the backup battery based on an internal algorithm. It will look for an air-bag deploy, or near-deploy, messages from the SDM. If there are no messages the OnStar module will stay wake for a few minutes longer and monitor the buttons in the mirror. If not pressed, the modules will power down and shut off completely.

The back-up battery is connected to the telematics communication interface control module through the back-up battery positive voltage circuit and back-up battery ground circuit and is protected from a short circuit by means of an internal fuse. In the event the back-up battery, battery positive voltage circuit is shorted to the back-up battery ground circuit or chassis ground, the fuse will open and render the back-up battery permanently inoperable. The status of the back-up battery and its associated wiring is monitored by the telematics communication interface control module.

Audio System Interface

When the OnStarÂ® requires audio output, a serial data message is sent to the audio system to mute all radio functions and transmit OnStarÂ® originated audio. The OnStarÂ® audio is transmitted to the vehicle audio system by a dedicated signal circuit and a low reference circuit.

The audio system will mute and an audible ring will be heard though the speakers if the vehicle receives a call with the radio ON.

On some vehicles, the HVAC blower speed may be reduced when the OnStarÂ® system is active to aid in reducing interior noise. When the system is no longer active, the blower speed will return to its previous setting.

OnStarÂ® Sleep Cycle

The OnStarÂ® system uses a unique sleep cycle to allow the system to receive cellular calls while the ignition is in the OFF position and retained accessory power mode has ended. This cycle enables the telematics communication interface control module to perform remote functions, such as door unlock, as commanded over

the air by the OnStarÂ® Call Center, and to continue to maintain an acceptable level of battery electrical drain.

The OnStarÂ® system uses 4 states of readiness, depending upon the type of cellular market the vehicle is in when the ignition is put into the OFF state:

- High power
- Low power
- Sleep
- Digital standby

The high power state is in effect whenever the ignition is in the ON or RUN position, or retained accessory power is enabled, and the OnStarÂ® system is sending or receiving calls or when the system is performing a remote function.

The low power state is in effect when the OnStarÂ® system is idle with the ignition in the ON or RUN position, or with retained accessory power enabled.

The sleep state is entered after the vehicle has been shut off and the retained accessory power has timed out while in an analog cellular area. At a predetermined time recorded within the telematics communication interface control module, the system re-enters the low power state to listen for a call from the OnStarÂ® Call Center for 1 minute. After this interval, the system will again return to the sleep state for 9 minutes. If a call is sent during the 1 minute interval, the OnStarÂ® system will receive the call and immediately go into the high power mode to perform any requested functions. If no call is received during the 1 minute interval, the system will go back into the sleep mode for another 9 minutes. This process will continue for up to 48 hours, after which the OnStarÂ® system will turn off until the ignition is turned to the ON or RUN position.

The digital standby power state is entered after the vehicle has been shut off and the retained accessory power has timed out while in a digital cellular area. When in digital standby mode, the OnStarÂ® module is able to perform all remote functions as commanded by an OnStarÂ® advisor at any time, for a continuous 120 hours. After 120 hours, the OnStarÂ® module will go into sleep mode until a wake up signal from the vehicle is seen by the telematics communication interface control module. If the OnStar module loses the digital cellular signal it will revert to analog mode and follow the standard sleep state (9 minutes OFF, 1 minute standby) based on the time of the GPS signals, this will continue until a digital cellular signal is again received.

If the OnStarÂ® system loses battery power while the system is in a standby or sleep mode, the system will remain OFF until battery power is restored and the ignition is turned to the ON or RUN position.

Features

OnStarÂ® Personal Calling

The hands free, OnStarÂ® personal calling cellular phone feature is an additional feature of the OnStarÂ® system. This feature is embedded within the telematics communication interface control module; however it must be activated by an OnStarÂ® advisor. OnStarÂ® personal calling operates similar to most hand held cellular phones in that the availability for its usage is based on minutes or units. The customer must have a current OnStarÂ® subscription, as this feature cannot be utilized without it. To use OnStarÂ® personal calling, the customer must also purchase units (minutes) as outlined in the owners guide provided with the OnStarÂ® system. Units begin to deplete, 1 unit is equal to 1 minute, as the customer makes outbound phone calls, answers inbound phone calls, or while connected to the OnStarÂ® virtual advisor. In addition, units may also

have an expiration date, depending upon the type of units purchased.

Customers have the ability to store telephone numbers within the module, referenced by a nametag for the convenience of frequently dialed numbers. After storing a nametag, the user can dial this number by initiating the OnStarÂ® personal calling feature, speaking the word "call," and repeating the nametag assigned.

Turn by Turn Navigation

Turn by Turn Navigation allows the driver to contact OnStarÂ® to obtain directions for driving from a current location to a desired location. The Turn by Turn Navigation system stores your planned route and continually checks your position along that route, when you deviate from the planned route, the system will recognize this and prompt the driver with verbal prompts for how to proceed. The driver then responds verbally to direct the system to continue the current routing or to recalculate the route because of a missed turn.

Advisor Record Feature

The Advisor Record Feature allows the user to store any information given during a call with an OnStarÂ® Advisor. Recording is activated by pressing the blue OnStar button during a call; pressing the button a second time stops the recording. The stored information can be played back by pressing the phone button on the three button assembly and using the voice command "Advisor Playback".

Deactivated OnStarÂ® Accounts

In the event a customer has not renewed their OnStarÂ® account after expiration or the account was never activated, OnStarÂ® will make a discrete cellular call to the vehicle to deactivate the OnStarÂ® system. Before taking this action, customers are notified that the OnStarÂ® system in their vehicle will be deactivated unless they elect to renew the account. After the OnStarÂ® account has been deactivated, customers will experience the following:

- The OnStarÂ® status LED will not illuminate.
- The OnStarÂ® system will NOT attempt to connect to the OnStarÂ® Call Center in the event of a collision or if the vehicle's front air bags deploy for any other reason.
- An emergency button press will play a demo message indicating the service has been deactivated.
- An OnStarÂ® Call Center button press will connect the customer with a dedicated sales team who can sell an OnStarÂ® subscription and reactivate the vehicle. Depending on the type of OnStarÂ® hardware in the vehicle, the customer may first hear a demonstration message stating there is no current OnStarÂ® subscription for the vehicle, and directing the customer what to do to activate services.
- OnStarÂ® personal calling will not be available, as this feature requires the customer to have a current OnStarÂ® account. Attempts to use this feature may result in cellular connection failure messages and the inability to connect to the number dialed.

Certain vehicles that have never had an active OnStarÂ® account, or that have been deactivated, may be unable to establish a connection with the OnStarÂ® Call Center. When normal published diagnostic procedures do not indicate a possible cause for the no connect concern, the vehicle may have been deactivated. For deactivated vehicles, a no connect response should be considered normal operation. Further diagnosis and subsequent repair is only necessary should the customer elect to become an active OnStarÂ® subscriber or renew the account subscription.

OnStarÂ® Cellular, GPS, and Diagnostic Limitations

The proper operation of the OnStarÂ® System is dependent on several elements outside the components integrated into the vehicle. These include the National Cellular Network Infrastructure, the cellular telephone carriers within the network, and the GPS.

The cellular operation of the OnStarÂ® system may be inhibited by factors such as the users range from an analog or digital cellular tower, the state of the cellular carrier's equipment, and the location where the call is placed. Making an OnStarÂ® key press in areas that lack sufficient cellular coverage or have a temporary equipment failure will result in either the inability of a call to complete with a data transfer or the complete inability to connect to the OnStarÂ® Call Center. The OnStarÂ® system may also experience connection issues if the identification numbers for the module, station identification number, electronic serial number or manufacturers electronic ID, are not recognized by the cellular carriers local signal receiving towers.

The satellites that orbit earth providing the OnStar system with GPS data have almost no failures associated with them. In the event of a no GPS concern, the failure will likely lie with the inability of the system to gain GPS signals because of its location, i.e. in a parking structure, hardware failure, or being mistaken with an OnStarÂ® call which has reached the Call Center without vehicle data.

During diagnostic testing of the OnStarÂ® system, the technician should ensure the vehicle is located in an area that has a clear unobstructed view of the open sky, and preferably, an area where analog or digital cellular calls have been successfully placed. These areas can be found by successfully making an OnStarÂ® keypress in a known good OnStarÂ® equipped vehicle and confirming success with the OnStarÂ® Call Center advisor. Such places can be used as a permanent reference for future OnStarÂ® testing.

Mobile Identification Number and Mobile Directory Number

The telematics communication interface control module utilizes 2 numbers for cellular device identification, call routing and connection, a mobile identification number and a mobile directory number. The mobile identification number represents the number used by the cellular carrier for call routing purposes while the mobile directory number represents the number dialed to reach the cellular device.

Operation of the OnStarÂ® Speech Recognition Systems

OnStarÂ® users communicate with 2 speech recognition systems. Speech recognition allows the user to speak to one computer in the vehicle, and one reached over a phone line. The computer tries to understand the users command, and responds by speaking back, or by taking the appropriate action, e.g. dialing the phone.

- Personal Calling uses a speech recognition system that resides in the vehicle. When the user presses the phone button, the system states, Ready, and listens for the user's command. The user can speak commands to control the hands-free phone.
- Virtual advisor is a remote speech recognition system that the caller can access by making a phone call. The user connects to virtual advisor by requesting it during personal calling use. The user is then transferred to the virtual advisor server and talks to it via a cellular connection.

The OnStarÂ® speech recognition systems use speech technology that is designed to understand a wide range of American English speakers. Although there is no one right way to speak English, the system will work best when users try to modify their pronunciation should they encounter difficulty. Users who do not obtain good results are advised to try the tips and workarounds found in this section.

General Tips for Better Speech Recognition

Concern	Tip for Better Result
Noise	Noise may confuse the speech recognition system. You usually get better performance from the system in quieter conditions: • The HVAC fan creates noise. Turn it down or OFF for better speech system performance. • Driving at high speeds creates louder engine noise and wind noise. You may get better results at lower speeds. • An open window or an open sunroof allows more noise to enter the vehicle. Close all windows for better results. • Noisy rainstorms can also reduce performance. • If passengers are talking while you use the speech system, it may be confused by their speech. You will get better results if all occupants of the vehicle are quiet while the system is listening for commands.
When to Speak	In Personal Calling, the system is only listening after it prompts you to speak with a beep. • When the system prompts you to speak, you have about 5 seconds to respond. If the system does not hear a response, it will prompt you again, or cancel the transaction. • If you begin to speak too soon, try pausing for a half second before speaking after the beep. • In the Virtual Advisor, the system is always listening for commands, even while it is speaking.
How to Speak	Speak forcefully, and clearly. • The noisier the environment, the louder you need to speak. If you are in the driver seat, speak facing the front of the car. If you are a passenger, speak facing the rearview mirror. • Speak calmly, and naturally. The system may sometimes fail your repeated attempts to give a command. If your speech is distorted by shouting or frustration, this may cause more errors. • People with high-pitched voices may have better results by speaking in a deeper, lower-pitched voice. However, do not lower the volume of the voice. • Avoid speaking with a rising intonation, like asking a question. Use a flat or falling intonation, like giving an answer.
What to Say	Personal Calling: One-word commands • The Personal Calling system listens for only one word at a time. There are some exceptions, 2-word phrases that are spoken and understood as a single word, e.g. "virtual advisor", "voice feedback", and "my number". You can enter phone numbers only one digit at a

Concern	Tip for Better Result
	time, and the system repeats each digit as it hears it. • Say "Help" at the Ready prompt to hear the list of Personal Calling commands. • Virtual Advisor can understand sentences with more than one word. It also expects to hear a 4-digit number all at once when it asks for your PIN. • Say, "What are my choices?" to hear a list of commands that the Virtual Advisor understands.
Entering a phone number	• If you have trouble getting numbers correctly into the system, store your frequently-called number in the directory, so the system will remember them. After you have stored a number with a nametag, then you simply say "call" and the nametag in order to call the number. • If the system cannot understand your numbers, ask another person to help you enter your frequently-called numbers. This person can speak the numbers, then you can speak the nametag.
Storing or dialing a number	When you have finished speaking your phone number, you do not need to say "store" or "dial" to indicate that you are done. If you pause and say nothing, the system will ask you if you want to store or dial. Say "yes".
Creating nametags	• Short nametags that are similar may be easily confused by the system. You may get better recognition of your nametags if you make them longer, for example "George Washington" without pause, instead of "George" only. • If you want to use nametags while driving, it is best to store the nametag with some vehicle noise in the background. If you are in park while you are storing nametags, you can turn the fan on low or open windows in order to create some background noise.
Virtual Advisor 4-digit PIN	Say the 4 digits in a natural way, without pausing between digits.
Interrupting	• When the Virtual Advisor is speaking, you can interrupt it with another command. The first word in your command helps to get its attention. • If the Virtual Advisor has trouble understanding your commands when you interrupt, try speaking the first word loudly and clearly, then pause for an instant, then continue with the rest of the command. For example: "Get ... my weather" or "Lookup... a quote for General Motors".

RADIO/AUDIO SYSTEM DESCRIPTION AND OPERATION

The entertainment system on this vehicle may have several different configurations available to it. To determine

the specific configuration of the vehicle, please see the Service Parts ID Label, and refer to **RPO Code List** .

The entertainment system on this vehicle is configured with either a base or an uplevel system. The base and uplevel systems each contain a radio, antenna, speakers, and on some systems an audio amplifier. The uplevel system differs from the base system by providing the customer with enhanced audio system features. Some of those features may include the radio data system (RDS), an audio amplifier, programmable equalizer (EQ), and digital satellite radio (U2K).

Each item in the list below represents topics covered in detail below.

- Radio Circuit Operation
- Antenna System
- AM/FM Reception
- Digital Radio Receiver
- Speaker Operation
- Audio Amplifier
- Radio Data System (RDS)
- Radio Data System (RDS) Messages
- MP3/CD Formatting Information for MP3/CD Radios (If equipped)
- Integral Multi Disc CD Changer (IMDX)
- Noise Compensation
- Radio Error Messages
- Theft Deterrent
- OnStar Â®
- Steering Wheel Controls
- Auxiliary Input Jack
- Noise Compensation

Radio Circuit Operation

Radio Power

The radio does not use a discrete ignition feed circuit for power moding. The power mode master (PMM) provides the system power mode to the radio via serial data messages. The PMM determines the system power mode by processing power mode information from ignition switch inputs. Serial data power modes supported by the radio are OFF, ACCESSORY, RUN, and CRANK REQUEST.

Radio Grounds

The vehicle harness provides a ground for the radio circuits. The radio may also be case grounded.

Radio Data Link Communication

The radio communicates with other modules via serial data.

Radio Outputs

At minimum volume, the plus (+) and minus (-) speaker outputs are approximately half battery voltage, measured to vehicle ground. As the volume increases, the plus and minus change to create a voltage difference between each other either driving the voice coil of the speaker, or being fed to an amplifier.

Radio Head Dimming

Dimming and backlighting levels are determined by the serial data messages the radio receives.

Antenna System

Backglass Antenna

The AM-FM antenna is on the backglass with the rear window defogger, at the top of the rear window.

Make sure that the inside surface of the rear window is not scratched and that the lines on the glass are not damaged. If the inside surface is damaged, it could interfere with radio reception. Using a razor blade or sharp object to clear or clean the inside rear window may damage the rear window antenna and/or the rear window defogger. Do not apply aftermarket glass tinting with metallic film. The metallic film in some tinting materials will interfere with the incoming radio reception.

Antenna Module

The radio antenna is connected to the antenna module. The antenna module is powered by a battery voltage circuit supplied by the radio. The antenna module boosts the received signal and transmits the signal to the radio via a coaxial cable.

Multi-Band Antenna

The multi-band antenna is located on the roof of the vehicle. This type of antenna may be used with the AM/FM radio, but is primarily for OnStarÂ® and the XM™ Satellite Radio Service System, if the vehicle has these features. Keep this antenna clear of snow and ice build up for clear reception. If the vehicle has a sunroof, the performance of the system may be affected if the sunroof is open. Loading items onto the roof of the vehicle can interfere with the performance of the system, ensure the multi-band antenna is not obstructed.

AM/FM Reception

Radio Signal

The radio signal is sent from a broadcast station and is then received by an antenna. The strength of the signal received depends on the following:

- The power output (wattage) of the broadcasting station
- The location of the vehicle (or receiver) relative to the broadcast tower.
- Obstacles between the tower and the receiver
- Atmospheric conditions
- What band (AM or FM) the station is broadcasting
- Type of antenna and the ground plane

AM Reception

The AM band has a lower frequency range than the FM band. These longer wavelengths:

- Bend around Obstacles
- Follow the curvature of the earth
- May reflect off the ionosphere (skip)

The AM frequencies have longer range due to the ground wave. The ground wave follows the curvature of the earth and is effected by its conductivity. Greater conductivity equates to less signal loss thus transmission over water is better than over land. The AM band has a range of 80-320 km (50-200 miles).

FM Reception

The shorter wavelengths of the higher frequency FM band:

- Reflect off obstacles
- Are absorbed by the ground
- Penetrate the ionosphere

Broadcasts in the FM band are to line of sight reception which is typically 40 km (25 miles). Even when out of a direct line of sight, the signal may be reflected into areas that would be in a shadow otherwise. Factors which affect the line of sight include:

- Height of the broadcast antenna
- Height of the receiving antenna
- Terrain and buildings in the broadcast path

Digital Radio Receiver (If equipped)

XM satellite radio provides digital radio reception. The XM signal is broadcast from two satellites and, where necessary, terrestrial repeaters. The high power satellites allow the antenna to receive the XM signal even when foliage and other partial obstructions block the antennas view of the satellite. Terrestrial repeaters are used in dense urban areas. These repeaters will receive the satellite signal and re-broadcast them at much higher power levels in order to ensure reception in areas with densely packed tall buildings. A service fee is required in order to receive the XM service.

The radio communicates with the digital radio receiver (DRR) via serial data. During XM operation the audio signals are sent over the left and right audio signal circuits from the DRR to the radio.

Speaker Operation

Speakers turn electrical energy into mechanical energy to move air, using a permanent magnet and an electromagnet. The electromagnet is energized when the radio or amplifier (if equipped) delivers current to the voice coil on the speaker. The voice coil will form a north and south pole that will cause the voice coil and the speaker cone to move in relation to the permanent magnet. The current delivered to the speaker is rapidly changing alternating current (A/C). This causes the speaker cone to move in two directions producing sound. When the speaker is at rest, such as when the volume at a minimum value, the voltage applied to each side of the speaker is 1/2 ignition system voltage. This way, the speaker cone can be moved in either direction.

Audio Amplifier (If equipped)

Amplifier Interface

A fused battery voltage circuit provides the main amplifier power. A switched 12-volt output from the radio is used to control the power-state of the amplifier. To respond quickly to audio input and control signals, the amplifier is ON in all vehicle power modes except OFF and CRANK Request. The internal amplifier bridges are fully powered and unmuted when the amplifier receives the switched 12-volt input. This type of amplifier does not have serial data communication capability, and can not set DTCs.

Amplifier Operation

The purpose of the amplifier is to increase the power of a voltage or current signal. The output signal of an amplifier may consist of the same frequencies as the input signal or it may consist of only a portion of the frequencies as in the case of a subwoofer or midrange speaker. The radio creates a low level stereo audio output signal, which is sent at the user-defined volume level to the audio amplifier. The audio amplifier amplifies the signal and sends it to the appropriate speakers.

Radio Data System (RDS) (If equipped)

The radio may be equipped with the Radio Data System (RDS). The RDS feature is available only on FM stations that broadcast RDS information. This system relies upon receiving specific information from these stations and only works when the information is available. While the radio is tuned to an FM-RDS station, the station name or call letters display.

RDS data is carried in what is known as a "subcarrier". A subcarrier is a frequency that the FM broadcaster is authorized to use to send data that is not audible in the main audio program.

- RDS functions will only work with FM broadcast stations that are broadcasting RDS data.
- Not all FM Broadcast stations broadcast RDS data or offer all of the RDS services.
- The information displayed is dependent upon the information broadcast by the particular station. The information may vary greatly between stations.
- RDS functions may not work properly when reception is weak, reception is of poor quality, or RDS is not implemented properly by the FM Broadcaster.
- In some cases, a radio station broadcasting incorrect information may cause the RDS features of the radio to appear to work improperly.

With RDS, the radio can do the following:

- Seek to stations broadcasting the selected type of programming
- Receive announcements concerning local and national emergencies
- Display messages from radio stations

RDS may display text information such as:

- The name of the station.
- The type of program.
- General information such as artist and song title, call in phone numbers, etc.

RDS Messages

- ALERT!: Alert warns of local or national emergencies. When an alert announcement comes on the current radio station, ALERT! displays. You will hear the announcement, even if the volume is low or a CD is playing. If a CD is playing, play stops during the announcement. Alert announcements cannot be turned off. ALERT! is not affected by tests of the emergency broadcast system. This feature is not supported by all RDS stations.
- INFO (Information): If the current station has a message, the information symbol or INFO displays. Press this button to see the message. The message can display the artist, song title, call in phone numbers, etc. If the entire message can not be displayed, parts of the message appear every three seconds. To scroll through the message, press and release the INFO button. A new group of words displays after every press of this button. Once the complete message has displayed, the information symbol or INFO disappears from the display until another new message is received. The last message is displayed by pressing the INFO button. View the last message until a new message is received or you tune to a different station.

MP3/CD Formatting Information for MP3/CD Radios

The MP3/CD equipped radios will play standard audio CDs, CD-Rs, and CD-RWs. The CD-R/RWs may contain either standard audio (*.cda) or compressed audio (*.mp3). Customers who record their own music CDs should be aware of the following:

- The files can be recorded on a CD-R/RW disc with a maximum capacity of 700 MB.
- The radio will play only compressed audio files recorded in the *.mp3 format. It also supports playlists that can be made and saved with popular MP3 software (in the *.m3u format). A playlist name must be no more than 32 characters in length. If the name of a playlist is longer than 32 characters, the radio will ignore the playlist.
- The radio will only play audio from a CD-R/RW, it cannot record audio.
- The radio will play a mixed mode CD-R/RW (one recorded with both *.cda and *.mp3 files). If a mixed mode CD is inserted in the radio, the radio will assign the standard CD audio to a directory which is listed as ROM audio directory.
- ID3 tag information is displayed by the radio, if available. The ID3 tag information can either be version 1 or 2. The radio will display the filename, song name, artist name, album name, directory name, and playlist name, etc.
- The radio supports multi-session discs, but only the files from the last session will be played.
- There are a total of 20 directories (folders) allowed on a disc. The file structure can be 0-4 directories deep (a folder within a folder, within a folder, etc.) Anything more than 20 directories will be ignored. Each directory may have up to 99 files contained within it. Files not having the *.mp3 extension will not be played, but still count toward the maximum. Anything more than the first 99 files within a directory will be ignored. A single disc may have up to 254 files and directories. Anything beyond the 254 limit will be ignored.
- MP3 files must be written to a CD-R/RW in one of the following industry-standard formats:
    - ISO 9660 Level 1
    - ISO 9660 Level 2
    - Joliet
    - Romeo

If the customer does not follow these guidelines when recording a CD-R/RW, the disc may not play in the MP3

Radio.

Integral Multi Disc CD Changer (IMDX) (If equipped)

The integral multi disc CD changer has the capability of storing and playing up to six (6) compact discs. The integral multi disc CD changer has a shock-absorbing system. Only under extreme operating temperatures or severe shock or vibration should the compact disc player skip or mute. If the customer travels an abnormally rough road, a skip condition may be normal. Test drive the vehicle on a normal road with a known good CD. If the condition is still present, replace the radio. The use of CD lens cleaner discs is not advised, due to the risk of contaminating the lens of the CD optics with lubricants internal to the CD mechanism.

The CD mechanism within the ICDX radio will begin an initialization routine after a battery connect (e.g., connecting radio connector C1). The initialization process takes approximately 25 seconds to complete. It is very critical that the initialization is completed before removing battery power from the radio, in order for the complex moving parts of the CD mechanism to be positioned properly before shipping and/or handling purposes. Damage may result to the moving parts of the CD mechanism if battery power is removed during the initialization routine. The damage occurs to the CD mechanism during subsequent shipping or handling operations. The extent of the damage causes the CD mechanism not to recover and the mechanism becomes inoperative.

Theft Deterrent

The radio theft deterrent system is intended to disable or limit radio functionality if incorrect vehicle information is received by the radio. The radio disables functionality if the VIN information received by the radio does not match the VIN information that has been learned by the radio. A VIN sequence is the last 6 digits of the VIN. The radio receives this information via serial data. A possible cause of incorrect VIN info could be the radio was originally installed in another vehicle.

The radio has the following theft operating modes as part of the theft deterrent system:

- Normal Mode-A radio has received a VIN sequence. The radio only learns the VIN sequence if the VIN sequence contained all 6 digits. In this mode the radio has full functionality.
- No VIN Mode-A radio that has not received or learned a VIN. In this mode the radio has functionality.
- Theft Detected Mode-A radio that had previously learned a VIN sequence and subsequently received a VIN sequence not matching the learned sequence. In this mode the radio has functionality.

Radio Error Messages

The Radio may display the following Error Messages (Not all messages may be applicable):

- ERR: This message is displayed when the radio is unable to play the inserted cassette or CD
- LOC: This message is displayed when the radio has entered Theft mode.
- CAL/CAL ERR: This message is displayed when the radio has detected an invalid calibration.
- CDX ERR: Displays if communication is lost with the remote CD changer.
- CHECK CD: Displays when the player encounters a focus or tracking error.
- CHK CDXX: Displays when the CD changer encounters a focus or tracking error .
- CHK TAPE: Displays if a tape has been inserted but is unable to be played due to an error.

- DOOR OPEN: Displays when the CD changer door has been left open.
- NO DISC: Displays when the radio expected a disc to be inserted.
- NONE: Displays when the radio is unable to detect the vehicle speed data information via the serial data circuit.

If an error message is displayed, perform the appropriate diagnostics.

OnStar Â® (If equipped)

When OnStar is activated, a serial data message is sent to the radio that activates a software program. When the software begins its process, the fade goes to the front, Bass and Treble are set to the mid range, the outputs are mono, and the audio source is OnStar. OnStar takes priority over any other audio source. All of these actions are preset values stored in the radio.

For additional OnStar information, refer to **OnStar Description and Operation**.

Steering Wheel Controls (If equipped)

Some audio functions are available using the steering wheel controls. The steering wheel controls duplicate the function of the primary controls available on the radio.

For additional information on steering wheel controls, refer to **Steering Wheel Controls Description and Operation** .

Using the Auxiliary Input Jack (If equipped)

The radio system may have a 3.5 mm auxiliary input jack located on the faceplate. An external audio device such as an MP3 player, CD changer, laptop computer, cassette tape player, etc. can be connected to the auxiliary input jack for use as another source for audio listening. This is not an audio output; do not plug a headphone set into the front auxiliary input jack.

To use a portable audio player, connect a 3.5 mm (1/8 inch) cable to the radio's front auxiliary input jack. While a device is connected, press the radio CD/AUX button to begin playing audio from the device over the vehicle speakers. If there is a CD in the player, pressing the button once will play the CD, pressing again will switch it to the AUX feature.

Noise Compensation (If equipped)

A microphone mounted in the vehicle passenger compartment monitors background noise (such as wind noise from a window being opened) and digitally modifies the system's volume and equalization to ensure optimal sound and performance. This replaces the conventional speed/volume compensation (SCV) adjustment, which automatically adjusted the audio system volume according to vehicle speed.

VIDEO ENTERTAINMENT SYSTEM DESCRIPTION AND OPERATION (DUAL HEADREST DVD SYSTEMS)

Each item in the list below represents topics covered in detail below.

- Dual Headrest DVD Circuit Operation
- Dual Headrest DVD System Components

- Dual Headrest DVD Player
- Playing a Disc
- DVD Messages
- Parental Control
- Video Screen
- Remote Control
- Wireless Headphones
- AUX Inputs
- Audio Outputs
- Wired Headphone Jacks

Dual Headrest DVD Circuit Operation

Dual Headrest DVD Power

The Dual Headrest DVD uses a switched battery voltage feed circuit for power moding.

Dual Headrest DVD Grounds

The vehicle harness provides a ground for the Dual Headrest DVD system.

Dual Headrest DVD Data Link Communication

The Dual Headrest DVD system does not communicate with serial data.

Dual Headrest DVD Outputs

The Dual Headrest DVD system can only output video to each screen and through the AV output for external devices such as a camcorder.

Dual Headrest DVD Components

The Dual Headrest DVD system includes:

- Two video display screens
- DVD Control Module
- A Digital Versatile Disc (DVD) player built into each monitor - If equipped with Dual Player
- Two sets of wireless infrared headphones
- A remote control
- Stereo audio and video inputs for playing an auxiliary device

Dual Headrest DVD Player

The DVD players are integrated the display screen. The DVD player can be controlled by both the buttons on the DVD player and by the buttons on the remote control. The DVD player power may be turned on when the ignition is in the run, accessory, or retained accessory power (RAP) power modes. DVDs are manufactured with different region codes based on the country in which they are sold. Therefore, the DVD player is only

compatible with the region code where the vehicle is sold. The DVD region code is printed on the jacket of most DVDs. Home recorded CDs, CD-R or CD-RW formats, may not play in the DVD player.

Playing a Disc

To play a disc, gently insert the disc with the label side facing the back of the vehicle, into the loading slot. The DVD player will continue to load the disc and the player will automatically start if the vehicle ignition is in an enabled power mode. If a disc is already in the player, press the play/pause button on the face of the DVD player or on the remote control. Some DVDs will not allow the user to fast forward or skip the copyright or previews. Some DVDs will automatically begin to play after the previews have finished. If the DVD does not begin to play the main title, refer to the on-screen instructions, and press play on the DVD player buttons or on the remote control.

DVD Messages

The following errors may be displayed on the video screen monitor.

Disc Format Error

This message will be displayed if a disc is inserted upside down, the disc is not able to be read, or if the disc format is not compatible with the DVD player.

Load / Eject Error

This message will be displayed if the disc is not able to properly load or eject.

Disc Play Error

This message will be displayed if the DVD player cannot play the disc. Severely damaged discs will cause this error.

Region Code Error

This message will be displayed if the region code of the DVD media is not compatible with the DVD player.

No Disc

This message will be displayed if the play button is pressed and there is no disc in the DVD player. If the disc is inserted wrong, the DVD player automatically ejects the disc and No Disc displays.

Parental Control

Part of the SETUP MENU lets users control the type of movie rating content (from G to Adult) that can be viewed and is only accessible when no disc is loaded. The parental control feature limits viewing to the selected preference. If a disc is inserted into the DVD compartment slot and it exceeds the Parental Setting, the following message appears on display: "The Parental Setting of this player prohibits play. Would you like to allow this disc to play?"

If yes if selected, the six digit password must be entered for the disc to play. If the wrong password is entered, the following message appears: " This movie will not play due to the Parental Setting of the player. To create a

six digit password, use the numeric keypad on the remote control. Press the ENTER button to confirm." The default password is 136900.

Video Screen

The rear display screen shows video from either DVD player, or an AUX input device, such as a video game console or camera. Each video screen has a dedicated video signal circuit to the DVD control. If the vehicle is equipped with rear seat entertainment, there is no way to source the movie from the rear seat entertainment to the Dual Headrest DVD screens.

DVD Control Module

The two video screens are linked together by the DVD Control Module. This module allows screen 1 to source the media being played on screen 2. Video, audio, power, and remote signals are sent from the DVD Control Module, to each of the video screens. Video and audio signals are sent from the screen to the control module, and then to both screens.

Remote Control

To use the remote control, aim it at the infrared window above the video screen and press the desired remote control button. Direct sunlight or very bright light may affect the ability of the entertainment system to receive signals from the remote control. If the remote control does not seem to be working, the batteries may need to be replaced. Objects blocking the line of sight may affect the function of the remote control.

If the remote control is to be stored for a long period of time, remove the batteries and keep them in a cool, dry place. Do not store the remote control in heat or direct sunlight. This could damage the remote control. Keep the remote control stored in a cool, dry place.

Wireless Headphones

Wireless headphones allow for rear seat passengers to use the Dual Headrest DVD player without disturbing the listening of front seat passengers. The wireless headphones receive audio signals from the infrared (IR) transmitters on the overhead console. This transmission is line of sight only, so audio quality will be degraded if anything blocks the transmitter signal from reaching the headphones, or if the headphones are placed in the front of the vehicle. On some models, the infrared transmitter will have red LEDs illuminated when activated.

The wireless headphones include 2 channels. This allows rear seat passengers to utilize both screens individually without disturbing one another.

Each set of headphones has a rotary volume control. To adjust the volume, adjust this control. The headphones may automatically turn OFF if they lose the infrared signal from the system for approximately 4 minutes in order to preserve their battery power. The signal may be lost if the system is turned off or if the headphones are out of range of the infrared signal transmitters that are located near the video display screen.

AUX Inputs

The AUX input jacks are standard color-coded RCA-style jacks. Video is yellow, right audio is red, and left audio is white. The jacks are located on the front of the monitor. A number of devices may be plugged into the AUX jacks, including, but not to video game consoles, digital cameras, camcorders, or other devices. Audio only sources can be played through the AUX jacks from portable audio devices.

Audio Outputs

Audio from the DVD player or auxiliary inputs may be heard through the following possible sources:

- Wireless infrared headphones
- Vehicle speakers - via the FM transmitter (if equipped)
- Wired headphone jacks on each monitor

The Dual Headrest DVD system will always transmit the audio signal by infrared to the wireless headphones, if there is audio available. The Dual Headrest DVD system may be capable of outputting audio to the vehicle speakers via the FM transmitter. Once the correct FM frequency is selected as an audio source on the radio you may adjust the speaker volume on the radio to control the volume of the audio to the speakers. Only one audio source can be heard through the vehicle's speakers at a time. The audio source being used is specified by the A/V (audio/video) source selected on the driver side head restraint monitor.

The Dual Headrest DVD system is capable of outputting audio through the wired headphone jacks on the monitors.

Wired Headphone Jacks

Each headrest monitor is equipped with a 2.5 mm jack for wired headphones. To use the wired headphones, plug the headphones into the jacks. The headphones can be used to listen to any source the Dual Headrest DVD system can source.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

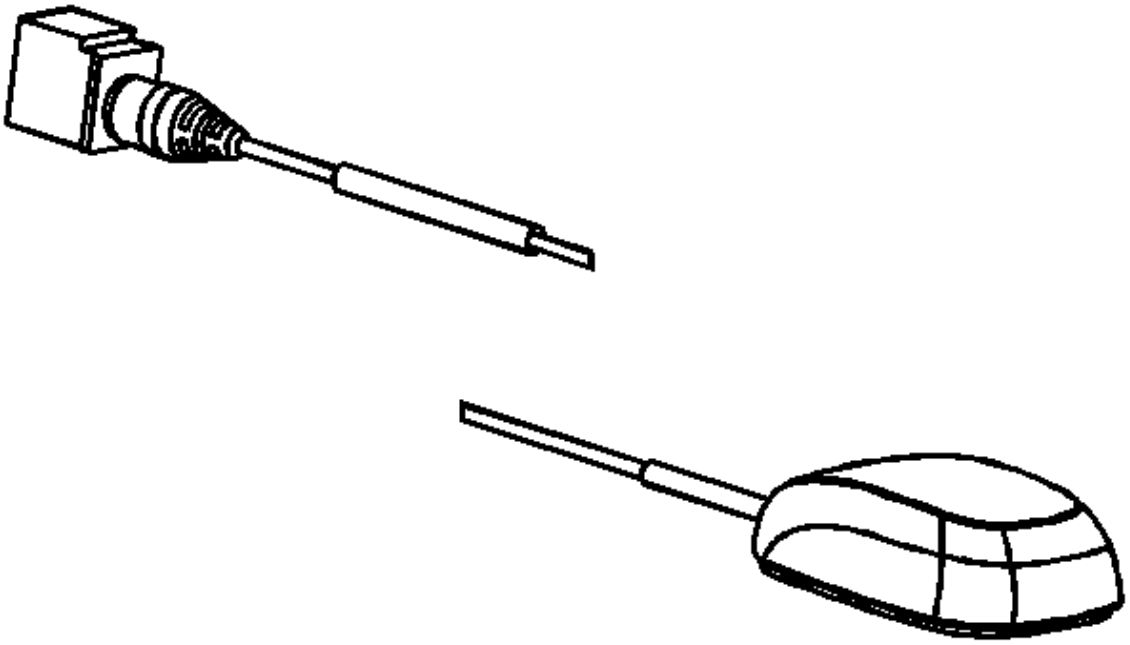
Illustration	Tool Number/ Description
	EL 48028 Digital Radio Test Antenna

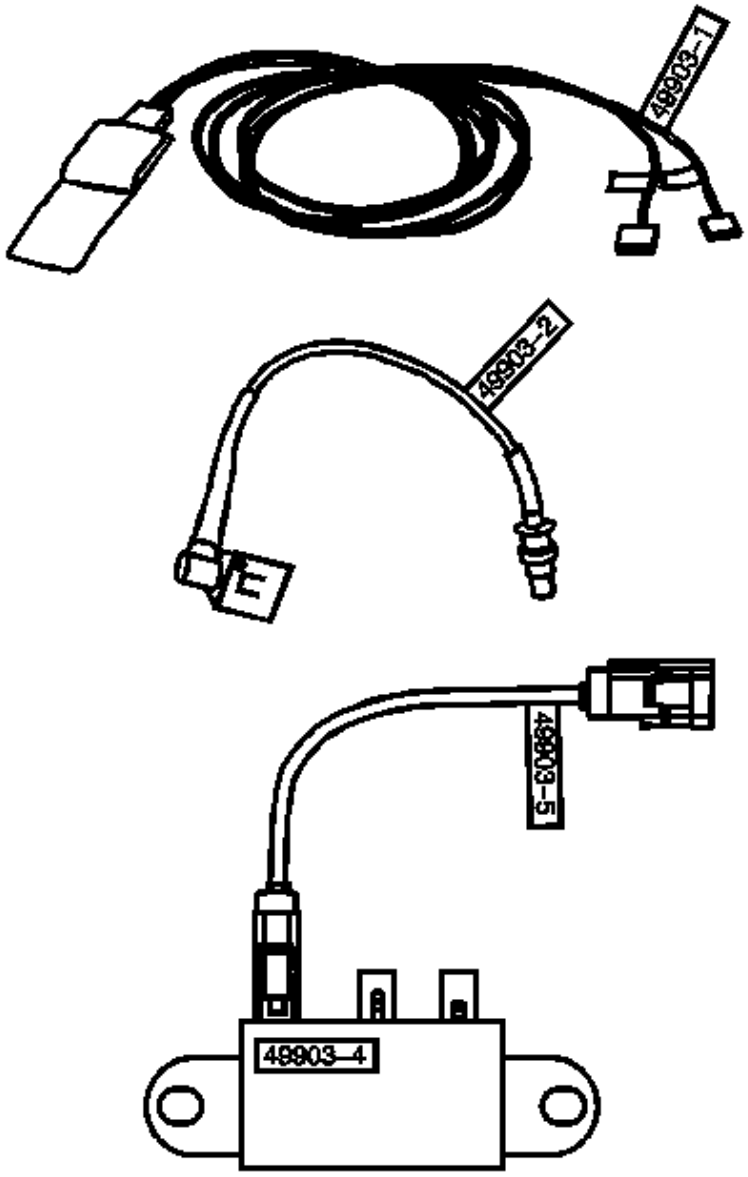
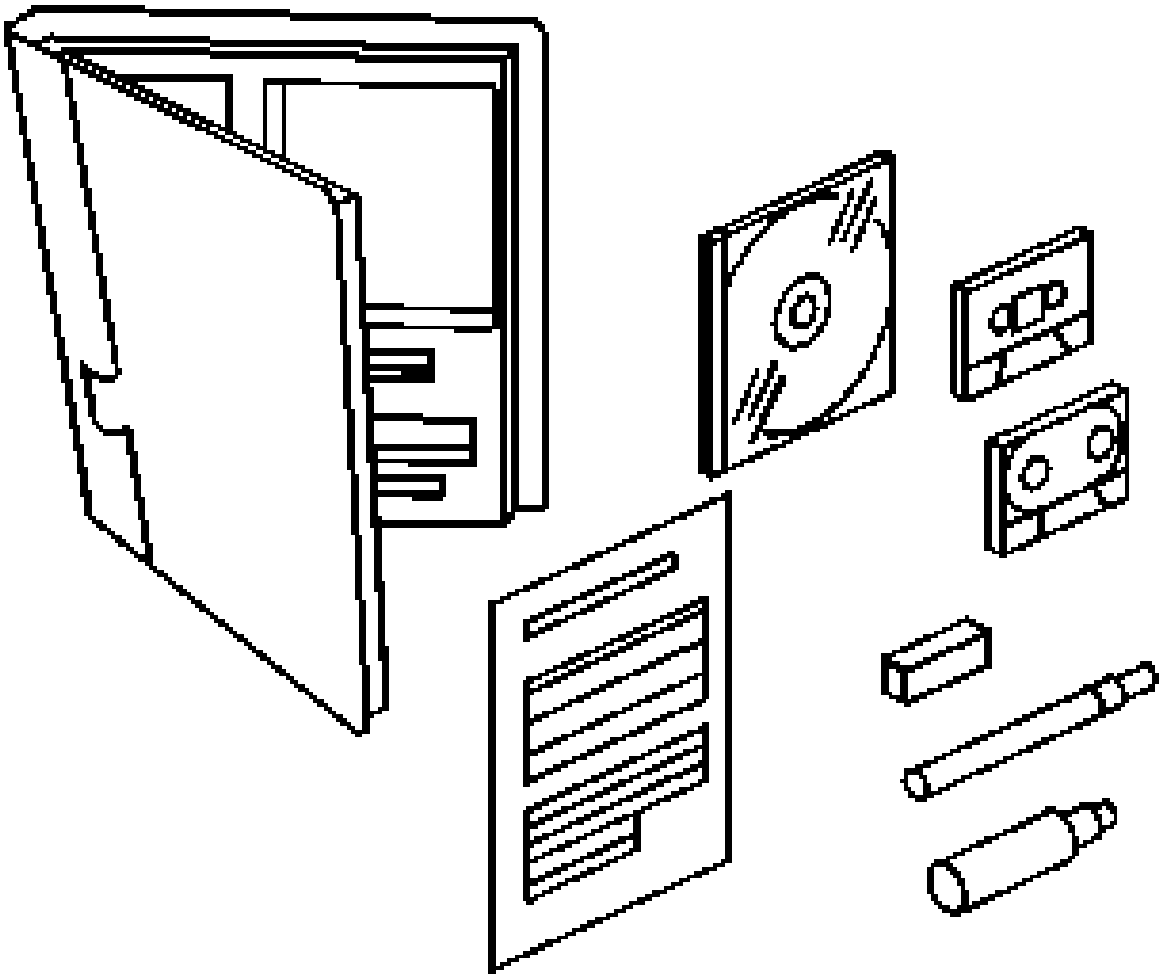
Illustration	Tool Number/ Description
	EL-49903 OnStar Antenna Diagnostic Tool Kit

Illustration	Tool Number/ Description
	J 39916 A CD and Cassette Diagnostic Audio Kit

Article GUID: A00737177

ACCESSORIES AND EQUIPMENT

Cruise Control - Impala

SCHEMATIC WIRING DIAGRAMS

CRUISE CONTROL WIRING SCHEMATICS

Cruise Control

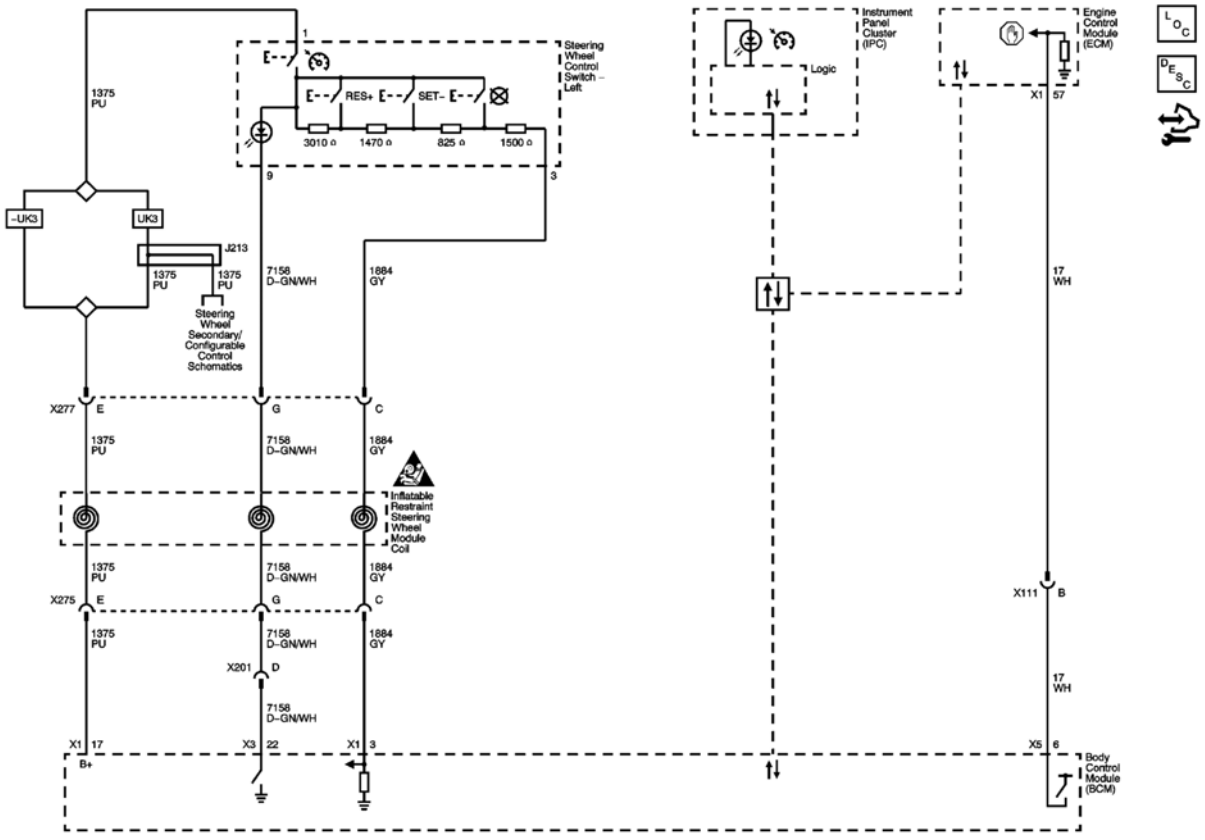


Fig. 1: Cruise Control Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, OR P162C: CRUISE CONTROL MALFUNCTION - CRUISE CONTROL SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3794 08

Cruise Control Function Request Circuit

DTC B3794 61

Cruise Control Function Request Circuit

DTC P0564

Cruise Control Multifunction Switch Circuit

DTC P0565

Cruise Control Switch Circuit

DTC P0567

Cruise Control Resume Switch Circuit

DTC P0568

Cruise Control Set Switch Circuit

DTC P056C

Cruise Control Cancel Switch Circuit

DTC P0580

Cruise Control Multifunction Switch Circuit Low Voltage

DTC P0581

Cruise Control Multifunction Switch Circuit High Voltage

DTC P155A

Cruise Control Switch State Undetermined

DTC P155B

Cruise Control Set/Coast Switch 2 Circuit

DTC P155C

Cruise Control Resume/Acceleration Switch 2 Circuit

DTC P162C

Vehicle Speed Limiting/Warning Switch Circuit

For symptom bite information, refer to **Symptom Byte List**

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-
Signal	1	P0564	B3794 08, P0567, P0568	B3794 61, P0564
1. Cruise Control Malfunction				

Circuit/System Description

The cruise control switch is an input to the body control module (BCM). The BCM monitors the cruise control on/off, set/coast, resume/accelerate and cancel switches via the cruise control switch signal circuit in order to detect when the driver has requested to perform a cruise control function. The BCM detects a specific voltage signal on the cruise control switch signal circuit when a switch is applied. The engine control module (ECM) receives the requested cruise control switch function from the BCM via a serial data message.

Conditions for Running the DTC

- The cruise switch is ON.
- The ignition is ON.

Conditions for Setting the DTC

B3794 08

The BCM detects an invalid voltage signal on the cruise control switch signal circuit for 1 second.

B3794 61

Stuck switch for either Resume/Accelerate or Set/Coast button for 60 seconds.

P0564, P0565, P0567, P0568, P056C

- The BCM detects an invalid voltage signal on the cruise control switch signal circuit for greater than 2 seconds and sends a serial data message to the ECM. The ECM sets these DTCs when the message is received.
- The ECM runs this diagnostic continuously.

P0580, P0581

- The ECM detects an invalid voltage signal on the cruise control switch signal circuit.
- The above condition is present for greater than 2 seconds.
- The ECM runs this diagnostic continuously.

P155A

The ECM is unable to determine the state of the cruise control switch.

P162C

The ECM is unable to determine the state of the vehicle speed limiting switch.

Actions Taken When the DTC Sets

B3794

- The malfunction indicator lamp (MIL) will not illuminate.
- The cruise control system is disabled.

P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A, P162C

DTCs P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A and P162C are type C DTCs

Conditions for Clearing the DTC

B3794

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A, P162C

DTCs P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A and P162C are type C DTCs.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that the stop lamps operate properly and that no B22 Brake Pedal Position Sensor related DTCs are

set.

- **If brake pedal position sensor related DTCs are set**

  Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

- **If no brake pedal position sensor related DTCs are set**

3. Verify the scan tool BCM Cruise Control Switch Status parameter changes between Off and On, Resume and Set when switching between each position on the cruise control switch.
   - **If the parameter does not change**

     Refer to Circuit/System Testing.

   - **If the parameter changes**
4. Verify that no conditions that may inhibit cruise control operation are present. Refer to the ECM scan tool data list Cruise Control Inhibit Reason parameter. Refer to the **Cruise Control Description and Operation**for a list of inhibit reasons.
   - **If the cruise control system has a reason why it is inhibited**

     Repair the condition that is causing the inhibit reason.

   - **If the cruise control system does not have any reasons why it may be inhibited**
5. Verify that no cruise control related DTCs are set.
   - **If any cruise control related DTCs are set**

     Refer to Circuit/System Testing.

   - **If no cruise control related DTCs are set**
6. All OK.

Circuit/System Testing

NOTE:

- **An open ignition circuit or fuse before the control module will cause communication DTCs or power mode mismatch DTCs to set against or in the control module. This failure mode will be diagnosed in the no communications diagnostic procedure or power mode mismatch.**
- **This test assumes the ignition circuit has a driver that will open under a high current condition before the fuse opens.**
- **The driver can open under normal conditions such as battery run down protection or a retained accessory power mode.**

1. Ignition OFF, disconnect the harness connector at the S70L Steering Wheel Controls Switch-Left, ignition ON.
2. Verify a test lamp illuminates between the ignition circuit terminal 1 and ground.
   - **If the test lamp does not illuminate**
   1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.

2. Test for greater than 100 Ω between the ignition circuit and ground.
    - If 100 Ω or less, repair the short to ground on the circuit.
    - If greater than 100 Ω
3. Test for less than 2 Ω in the ignition circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, test or replace the K9 Body Control Module.

- **If the test lamp illuminates**

3. Verify the scan tool ECM Cruise Control Switch Status parameter is Off.
    - **If not Off**

    1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal 3 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K9 Body Control Module.

    - **If Off**

4. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the ignition circuit terminal 1.
5. Verify the scan tool ECM Cruise Control parameter is Disabled.
    - **If not Error**

    1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
    2. Test for infinite resistance between the signal circuit terminal 9 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 Body Control Module.

    - **If Error**

6. Test or replace the S70L Steering Wheel Controls Switch-Left.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming and setup.

DTC P0571: CRUISE CONTROL BRAKE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0571

Cruise Control Brake Switch Circuit

Circuit/System Description

The engine control module (ECM) monitors the brake pedal position sensor. When the brake pedal is applied, the ECM detects a predetermined voltage signal. The ECM sends a serial data message to the body control module (BCM) indicating the status of the stop lamps.

This diagnostic test functions on the assumption that a sudden decrease in vehicle speed is caused by a brake pedal application. When the ECM detects that there is a 4.2 km/h (2.6 mph) or greater decrease in vehicle speed within 0.25 s without a transition of the stop lamp switch, the ECM sets DTC P0571.

Conditions for Running the DTC

- The engine speed is greater than 700 RPM.
- The traction control system or the antilock brake system are not active and have not malfunctioned.
- The vehicle speed is greater than 48 km/h (30 mph).
- The diagnostic will disable when the wheel speed is less than 16 km/h (10 mph).

Conditions for Setting the DTC

The BCM detects either a low voltage signal on the stop lamp switch signal circuit when the serial data message from the ECM indicates the brakes are applied, or a high voltage signal on the stop lamp switch signal circuit when the serial data message from the ECM indicates the brakes are not applied.

Actions Taken When the DTC Sets

- The cruise control system is disabled.
- The malfunction indicator lamp (MIL) will not illuminate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

- **Cruise Control Schematics**
- **Exterior Lights Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the stop lamps operate properly and that no B22 Brake Pedal Position Sensor related DTCs are set.
    - **If brake pedal position sensor related DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **If no brake pedal position sensor related DTCs are set**
2. Verify that no DTCs are set, except DTC P0571.
    - **If any other DTC is set, except DTC P0571**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **If only DTC P0571 is set**
3. Replace the K20 Engine Control Module.
4. Verify DTC P0571 does not set when operating the vehicle within the conditions for running the DTC.
    - **If the DTC sets**

      Replace the K9 Body Control Module.

    - **If the DTC does not set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM or ECM replacement, programming and setup.

DTC P0572 OR P0573: BRAKE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0572

Brake Switch Circuit 1 Low Voltage

DTC P0573

Brake Switch Circuit 1 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Stop Lamp Switch Signal	C0297 02, P0572	P0572	P0573	P0572, P0573

Circuit/System Description

The stop lamp switch signal circuit is a B+ input from the body control module (BCM) to the engine control module (ECM). The ECM monitors the stop lamp switch circuit to detect when the brake pedal has been applied. The BCM monitors the brake pedal position sensor to determine when the brake pedal is applied. When the brake pedal is applied, the BCM supplies B+ on the stop lamp switch signal circuit and also sends a serial data message to the ECM indicating that the brake pedal has been applied.

Conditions for Running the DTC

- The engine is running.
- Battery voltage is greater than 11.5 V.
- Brakes applied.

Conditions for Setting the DTC

P0572

This DTC will set when the ECM detects a short to ground or an open on the discrete brake signal circuit when the serial data message from the BCM indicates the brakes are applied. This diagnostic will run when the serial data message and the voltage signal on the brake switch signal circuit do not match for 8 out 10 times, and the condition is present for greater than 2 s.

P0573

This DTC will set when the ECM detects a short to voltage on the discrete brake signal circuit when the serial data message from the BCM indicates the brakes are not applied. This diagnostic will run when the serial data message and the voltage signal on the brake switch signal circuit do not match for 8 out 10 times, and the condition is present for greater than 2 s.

Actions Taken When the DTC Sets

- The malfunction indicator lamp (MIL) will not illuminate.
- The cruise control system is disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that the stop lamps operate properly and that no B22 Brake Pedal Position Sensor related DTCs are set.
    - **If brake pedal position sensor related DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

    - **If no brake pedal position sensor related DTCs are set**
3. Refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
2. Connect a test lamp between the signal circuit terminal 57 and ground.
3. Verify the test lamp turns ON and OFF when pressing and releasing the brake pedal.
    - **If the test lamp is always OFF**
    1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.

2. Test for infinite resistance between the signal circuit and ground.
    - If not infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance.
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K9 Body Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V replace the K9 Body Control Module.

- **If the test lamp turns ON and OFF**

4. Replace the K20 Engine Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM or ECM replacement, programming, and setup.

DTC P0575: CRUISE CONTROL SWITCH SIGNAL MESSAGE COUNTER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0575

Cruise Control Switch Signal Message Counter Incorrect

Circuit/System Description

When a cruise control function switch is activated, the body control module (BCM) detects a predetermined voltage. The BCM sends a serial data message to the engine control module (ECM) indicating the function that has been requested.

Conditions for Running the DTC

- The ignition is ON.
- The vehicle speed is greater than 40 km/h (25 MPH) and the cruise control is engaged.

Conditions for Setting the DTC

- The ECM receives an invalid cruise control switch status serial data message from the BCM.

- This diagnostic runs continuously.

Actions Taken When the DTC Sets

DTC P0575 is a type C DTC.

Conditions for Clearing the DTC

DTC P0575 is a type C DTC.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that no DTCs are set, except DTC P0575.
   - **If any other DTC is set, except DTC P0575**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If only DTC P0575 is set**
2. Replace the K9 Body Control Module.
3. Verify DTC P0575 does not set when operating the vehicle within the Conditions for Running the DTC.
   - **If the DTC sets**

Replace the K20 Engine Control Module.

- **If the DTC does not set**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM or ECM replacement, programming, and setup.

DTC P0703: BRAKE SWITCH SIGNAL MESSAGE COUNTER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0703

Brake Switch Signal Message Counter Incorrect

Circuit/System Description

The body control module (BCM) monitors the brake pedal position sensor. When the brake pedal is applied, the BCM detects a predetermined voltage signal. The BCM sends a serial data message to the engine control module (ECM) indicating the status of the stop lamps.

Conditions for Running the DTC

The engine is ON.

Conditions for Setting the DTC

- The ECM receives an invalid brake pedal status serial data message from the BCM.
- This diagnostic runs continuously.

Actions Taken When the DTC Sets

- The malfunction indicator lamp (MIL) will not illuminate.
- The cruise control system is disabled.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that no DTCs are set, except DTC P0703.
    - **If any other DTC is set, except DTC P0703**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **If only DTC P0703 is set**
2. Replace the K9 Body Control Module.
3. Verify DTC P0703 does not set when operating the vehicle within the conditions for running the DTC.
    - **If the DTC sets**

      Replace the K20 Engine Control Module.

    - **If the DTC does not set**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM or ECM replacement, programming, and setup.

SYMPTOMS - CRUISE CONTROL

NOTE: **The following steps must be completed before using the symptom tables.**

1. Before using the symptom diagnostic table, perform the **Diagnostic System Check - Vehicle** in order to verify the following conditions:
    - There are no DTCs set.
    - The module can communicate via the serial data.
2. Review the system operation in order to understand the system functions. Refer to **Cruise Control Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which can affect the operation of the Cruise Control System. Refer to **Checking Aftermarket Accessories** .
- Inspect the accessible system components or the visible system components for obvious damage or for obvious conditions which can cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
- **Cruise Control Indicator Malfunction**

CRUISE CONTROL INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The instrument cluster illuminates the cruise control engaged indicator based on serial data messages received from the engine control module (ECM). The indicator is commanded ON when the cruise control system is controlling vehicle speed, and turned OFF with the system disengaged.

Reference Information

Schematic Reference

Cruise Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Cruise Control Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the cruise control indicator turns ON and OFF when commanding the All Indicators ON and OFF with a scan tool.
    - **If the indicator does not turn ON and OFF**

      Replace the P16 Instrument Cluster.

    - **If the indicator turns ON and OFF**
2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for instrument cluster replacement, programming and setup.

DESCRIPTION AND OPERATION

CRUISE CONTROL DESCRIPTION AND OPERATION

Cruise Control System Block Diagram

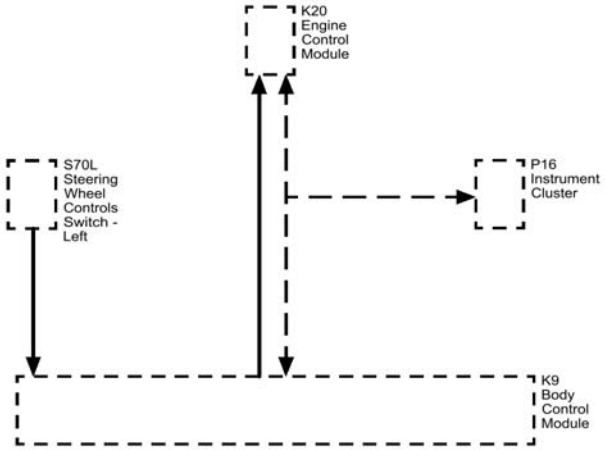


Fig. 2: Cruise Control System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
K20	K20 Engine Control Module
S70L	S70L Steering Wheel Controls Switch - Left
P16	P16 Instrument Cluster
K9	K9 Body Control Module

Cruise control is a speed control system that maintains a desired vehicle speed under normal driving conditions at speeds above 40 km/h (25 mph). Steep grades may cause variations in the selected vehicle speeds.

The following are the main components of the Cruise Control System:

- The accelerator pedal
- The brake pedal position (BPP) sensor
- The body control module (BCM)
- The cruise on/off switch
- The cruise control cancel switch
- The + RES switch (equivalent to resume/accelerate switch)
- The - SET switch (equivalent to set/coast switch)
- The engine control module (ECM)
- The throttle actuator control (TAC) motor (gasoline engines only)
- The vehicle speed sensor

The body control module (BCM) monitors the signal circuit of the cruise control switches, which are located on the steering wheel. The BCM relays the cruise control switch status to the engine control module (ECM) via the serial data circuit. The ECM uses the status of the cruise control switch to determine when to capture and maintain the vehicle speed. The ECM monitors the vehicle speed signal circuit in order to determine the desired vehicle speed.

Voltage is supplied to the cruise control switch via the steering wheel control switch reference voltage circuit supplied by the BCM. The cruise control function switches are arranged in a resistive ladder design, with each cruise control function switch having a different resistance value. The BCM detects a specific voltage value that is associated with the cruise control function switch being activated. The BCM sends a serial data message to the ECM indicating that the on/off switch is active. Similarly, when the normally open + RES switch or the normally open - SET switch are pressed, the switch closes and the BCM detects the predetermined voltage signal on the cruise control resume/accel and set/coast switch signal circuit. The BCM sends a serial data message to the ECM indicating that the + RES switch or the - SET switch is active.

Cruise Control Engaged

The Cruise Control System will engage and adjust vehicle speeds, based on the activation of the following cruise control switches, which are located on the steering wheel:

- On/Off
- + RES
- - SET

To engage the Cruise Control System, ensure that the vehicle speed is above 40.2 km/h (25 mph), turn the cruise On/Off switch ON and momentarily press the - SET switch. The ECM will engage the Cruise Control System and record the vehicle speed. The ECM sends a serial data message to the instrument panel cluster (IPC) in order to illuminate the Cruise Engaged indicator in the IPC. Refer to the vehicle owner's manual for the location and operation of the cruise control On/Off indicators and driver information center (DIC) messages.

Pressing the accelerator pedal while the Cruise Control System is engaged, allows the driver to override the Cruise Control System in order to accelerate the vehicle beyond the current set vehicle speed. When the accelerator pedal is released, the vehicle will decelerate and resume the current set vehicle speed.

The driver can also override the current set vehicle speed via the - SET switch and the + RES switch. When the Cruise Control System is engaged, pressing and holding the - SET switch will allow the vehicle to decelerate from the current set vehicle speed without deactivating the Cruise Control System. When the - SET switch is released, the ECM will record the vehicle speed and maintain the vehicle speed as the new set vehicle speed. When the Cruise Control System is engaged, momentarily pressing the - SET switch will allow the vehicle to decelerate at a vehicle specific calibratable increment, commonly 1.6 km/h (1 mph), each time that the - SET is momentarily pressed, with a minimum vehicle speed of 38 km/h (24 mph). Refer to the vehicle Owner's Manual for more information.

Pressing and holding the + RES switch, when the Cruise Control System is engaged, will allow the vehicle to accelerate to a greater vehicle speed than the current set vehicle speed. When the + RES switch is released, the ECM will record the vehicle speed and maintain the vehicle speed as the new set vehicle speed. When the Cruise Control System is engaged, momentarily pressing the + RES switch will allow the vehicle to accelerate at a vehicle specific calibratable increment, commonly 1.6 km/h (1 mph), each time that the + RES switch is momentarily pressed. Momentarily activating the + RES switch will recall the previous vehicle speed, after the

cruise control system has been disengaged by pressing the brake pedal, or CANCEL switch. Refer to the vehicle Owner's Manual for more information.

Cruise Control Disengaged

The engine control module (ECM) disengages the cruise control operation based on the signals from the following switches:

- The brake pedal position (BPP) sensor
- The On/Off switch
- The cruise control cancel switch

The Cruise Control System will disengage when the brake pedal is applied. The body control module (BCM) monitors the BPP sensor via the BPP sensor signal circuit as the voltage signal increases while the pedal is further applied. The ECM monitors the BPP signal through a discrete input and a serial data message signal from the BCM indicating the brake status. When either signal indicates the brake pedal is applied, the ECM will disengage the cruise control system.

The Cruise Control System will also disengage when the cruise control on/off switch is switched OFF, or the cruise control cancel switch is activated. The body control module (BCM) determines when the cruise control cancel switch is activated. When the normally open cancel switch is closed, the BCM detects the predetermined voltage signal on the cruise control function switch circuit. The vehicle speed stored in the memory of the engine control module will be erased when the cruise control On/Off switch is turned OFF, or the ignition switch is turned OFF. The BCM sends a serial data message to the ECM in order to disengage the cruise control system. When the Cruise Control System has been disengaged, the ECM sends a serial message to the instrument panel cluster (IPC) in order to turn OFF the Cruise Engaged indicator.

Every time the Cruise Control System is disengaged, the ECM will keep track of the reason for system disengagement. The last 8 disengagement reasons will be recorded within the ECM memory. The scan tool will display the last 8 Cruise Disengage History parameters, in which one out of approximately 50 possible reasons will be displayed in each of these 8 parameters. For the disengagement reason to be displayed within the scan tool parameter the Cruise Control System is active and disengagement is requested.

When engagement of the system is requested but an engagement inhibit is present, the most recent inhibit reason is recorded in the ECM history. The scan tool will display the most recent inhibit reason, in which one out of approximately 50 possible reasons will be displayed.

Cruise Control Inhibited

The engine control module (ECM) inhibits the cruise control operation when any of the following conditions exist:

- The ECM has not detected a brake pedal activation from the body control module (BCM) this ignition cycle.
- A Cruise Control System DTC has been set.
- The vehicle speed is less than 38.6 km/h (24 mph).
- The vehicle speed is too high.
- The vehicle is in PARK, REVERSE, NEUTRAL, or 1st gear.

- The engine RPM is low.
- The engine RPM is high.
- The system voltage is not between 9 volts and 16 volts.
- The Antilock Brake System (ABS)/Traction Control System (TCS) is active for more than a calibratable time (typically 0.3 to 0.7 seconds).

Cruise Control Inhibit Reasons

This is a general list of inhibit reasons. Not every inhibit reason is applicable to all vehicles. Refer to the scan tool inhibit reason list for the last 8 reasons that have been recorded during the current ignition cycle.

Scan Tool Name	Description	Long Description
ACC BRAKE INOP	Adaptive Cruise Control Automatic Braking Failed	Adaptive Cruise Control Automatic Braking Inoperative
ACC DATA	Serial data fault for Adaptive Cruise Control Throttle Control and Brake Control signals sent by Adaptive Cruise Control module	Adaptive Cruise Control Module serial data fault is active or communication has been lost between ACC module and ECM.
ACC INHIBIT	Adaptive Cruise Control Inhibited	Adaptive Cruise Control Inhibited
ACC OPTION	Adaptive Cruise Control option mismatch	Cruise control type (adaptive cruise or conventional cruise) mismatched between ECM and BCM.
ACCEL RATE	High acceleration	Vehicle acceleration rate is too high.
ACCEL Time	Rate Limiting Fault	Cruise torque request rate limiting active too long
APP OVERRIDE	Pedal greater than cruise (override)	Driver has overridden cruise control set speed with accelerator pedal for greater than an allowable time.
Auto Brk Data	Automatic Braking Engine Torque Request Signal Communication Malfunction	ECM to EBCM serial data fault is active or communication has been lost between ECM and EBCM.
AXLE RANGE	Rear Axle Low	Rear axle in low range
BPP DATA	DTC P0703 active or maximum time elapsed without receiving valid Brake Pedal Position signal.	Serial data fault is active or communication has been lost with module sending brake pedal apply state
BPP DTC	Brake Pedal Position signal invalid	Brake Pedal Apply Circuit fault has been detected.
BPP Not Learned	Brake Apply Sensor Home Position Not Learned	Brake Pedal Position Sensor Released Position Not Learned.
BRAKE	Brake pedal apply	Brake Pedal was applied.
Brk Ped Press	Brake Pedal Driver Applied Pressure Detected	A Brake Pedal Apply has been detected based on brake pedal pressure as measured by the EBCM.
Calc Eng Torque	Calculated Torque	Engine torque calculation is incorrect.
CANCEL	Cancel switch active	Cancel Switch was depressed.

Scan Tool Name	Description	Long Description
CLUTCH	Clutch switch active	Clutch Pedal was applied.
COAST DISENGAGE	Coast disengage	Cruise control is in coast mode with the Set/Coast switch depressed and is requesting no throttle
COAST SPEED LOW	Coast below low speed inhibit	Set / Coast switch was depressed. Vehicle slowed below minimum cruise operating speed.
Cruise Brk Inop	Brake System Malfunction	EBCM has detected a failure that does not allow automatic braking to be performed.
CRUISE S/W	Sequence of completion checks	Cruise control software execution error has occurred.
CRUISE SW DATA	Serial data fault (Cruise switch serial communication fault)	Cruise switch serial data fault is active or communication has been lost with module sending cruise switch states
CRUISE SW. OFF	On/Off switch in Off state	Cruise On/Off switch turned Off
DECEL RATE	High deceleration	Vehicle deceleration rate is too high.
DLC OVERRIDE	ALDL	Scan Tool plugged into ALDL connector
DTC SET	Malfunction in PCM/ECM (DTC active)	DTC is active or in history that inhibits cruise control operation.
D WHL SPD HI	Driven Whl Spd Greater (wheel slip detection)	Driven wheel speed greater than Non Driven wheel speed (slip detection)
D WHL SPD LOW	Un-driven Whl speed Greater	Non Driven wheel speed greater than driven wheel speed
ECM INHIBIT	PCM/ECM inhibit (RAM corruption)	ECM internal communication error
ECM RESET	ECM Running Reset	ECM Running Reset occurred
ECT OVERTEMP	Engine metal overtemp active	Engine over temperature. Overheated.
ENG RUN TIME	Engine run time not elapsed	Engine has not been running long enough, typically five seconds.
ENGINE SPEED	Engine speed too low or too high	Engine RPM too low (near stall) or too high (near engine RPM fuel shutoff).
FIRST GEAR	1st Gear	Transmission is engaged in 1st gear
HIGH SPEED	Vehicle speed exceeds high speed threshold	Vehicle speed has exceeded maximum cruise operating speed
HIGH VOLTAGE	Voltage above high voltage threshold	Ignition Voltage High at ECM (typically 18 volts)
ILLEGAL MODE	Illegal cruise mode	Cruise control mode is incorrect based on switch states.
LOST FWD GEAR	Transmission in neutral. Reverse or park	Gear selector not in forward gear

Scan Tool Name	Description	Long Description
LOW SPEED	Vehicle speed drops below low speed threshold	Vehicle speed dropped below the cruise control minimum operating speed. May be due to hilly terrain and low vehicle speed. Manual transmission gear selection and engine torque may contribute to this disengagement reason.
LOW VOLTAGE	Voltage below low voltage threshold	Ignition Voltage Low at ECM (typically 9 volts)
MEMORY DTC	Memory Failure	Control module memory failure detected.
MPH LIMIT	MPH Fuel (Vehicle overspeed fuel cut-off active)	Vehicle overspeed protection active with fuel cut off active
M/T Gear Changed	Manual transmission out of gear with no clutch pedal apply	Manual transmission shifted to Neutral without clutch pedal being applied.
NONE	None	This disengagement reason may be displayed after a dead battery repair or module replacement.
OVER SET SPEED	Over schedule	Vehicle speed has exceeded driver selected set speed by more than an allowable amount. This may occur while driving down a significant grade or driver overriding cruise while performing a passing maneuver.
PARK BRAKE	Park Brake Switch signal Active	Parking Brake Applied
PEDAL INITIALIZE	Brake before cruise	The brake pedal has not been seen as applied prior to driver request to engage cruise with set switch. A brake pedal apply must be seen before allowing cruise engagement during each key cycle. On a vehicle equipped with a manual transmission, a clutch pedal apply may satisfy the brake pedal apply criteria.
PTO ACTIVE	Power Take Off Active	Power Take Off is active.
Ram DTC	Processor Integrity Fault (Ram corruption)	ECM software error has occurred
RPM LIMIT	Injectors Disabled (Engine overspeed fuel cut-off active)	Engine RPM limiter active with fuel cut off active.
S/C ON SPEED HI	Over schedule tap-down	Set/Coast switch selected, vehicle speed is above set speed and does not decrease. May be due to traveling down hill

Scan Tool Name	Description	Long Description
SIMUL S/C-R/A	SET and RESUME switches simultaneously active	Set/Coast and Resume Accelerate switches pressed simultaneously
SL/W Sys On	Speed Limiter / Warning On/Off switch turned on	Driver has turned on the Speed Limiter/Warning on/off switch. Cruise is disabled / inhibited and cruise on/off switch will be set to OFF.
SW. INVALID	Analog cruise switch input out of range	Cruise switch voltage signal in invalid range
TAC INHIBIT	ETC prevents cruise operation	Electronic Throttle Control has detected a failure in the throttle control hardware
TCS	Traction control active	Traction Control was Active
TRANS DTC	Trans Gear Fault	Transmission DTC is active or in history that inhibits cruise control operation
UNDER SET SPEED	Under schedule	Vehicle speed is below cruise control set speed by more than an allowable amount
VSES	Vehicle stability active	Vehicle Stability Control was active
4WD Low	4WD Low	Transfer case in low range

Article GUID: A00737169

SCHEMATIC WIRING DIAGRAMS

DATA COMMUNICATION WIRING SCHEMATICS

Power, Ground, and Low Speed GMLAN Serial Data

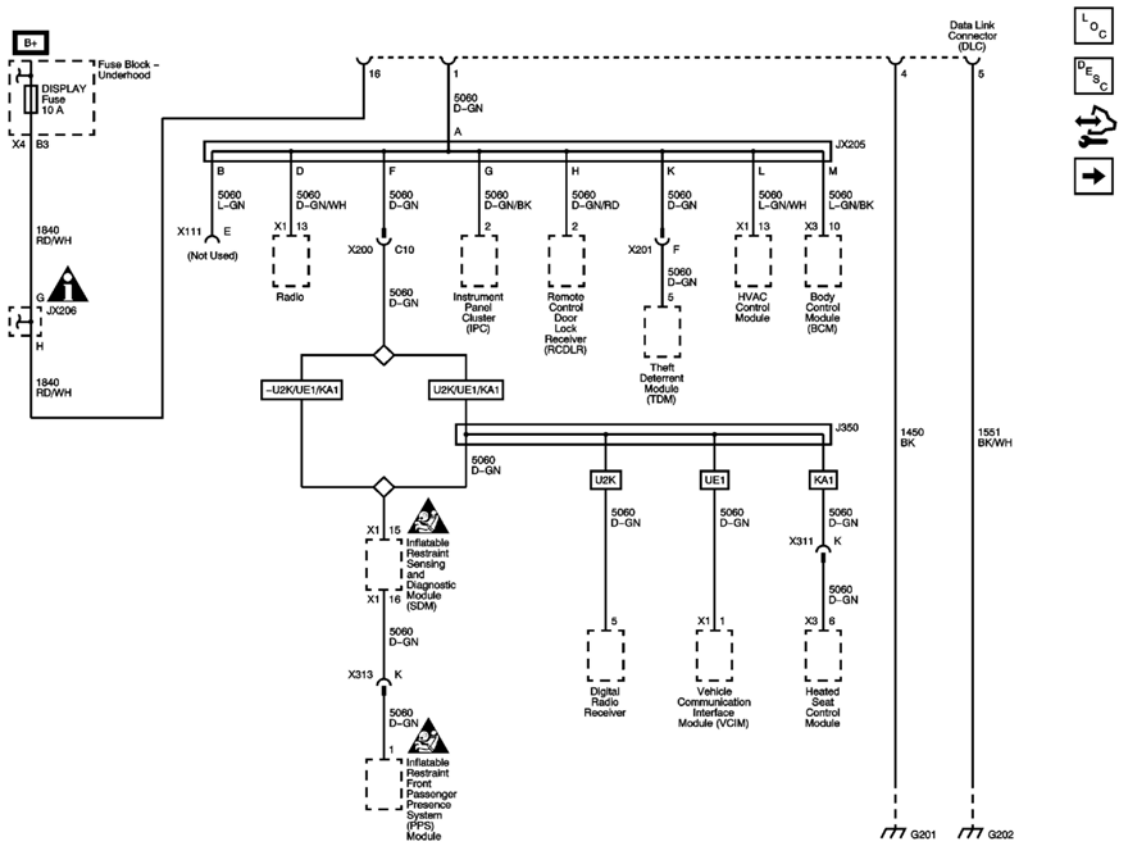


Fig. 1: Power, Ground, and Low Speed GMLAN Serial Data Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

High Speed GMLAN Serial Data

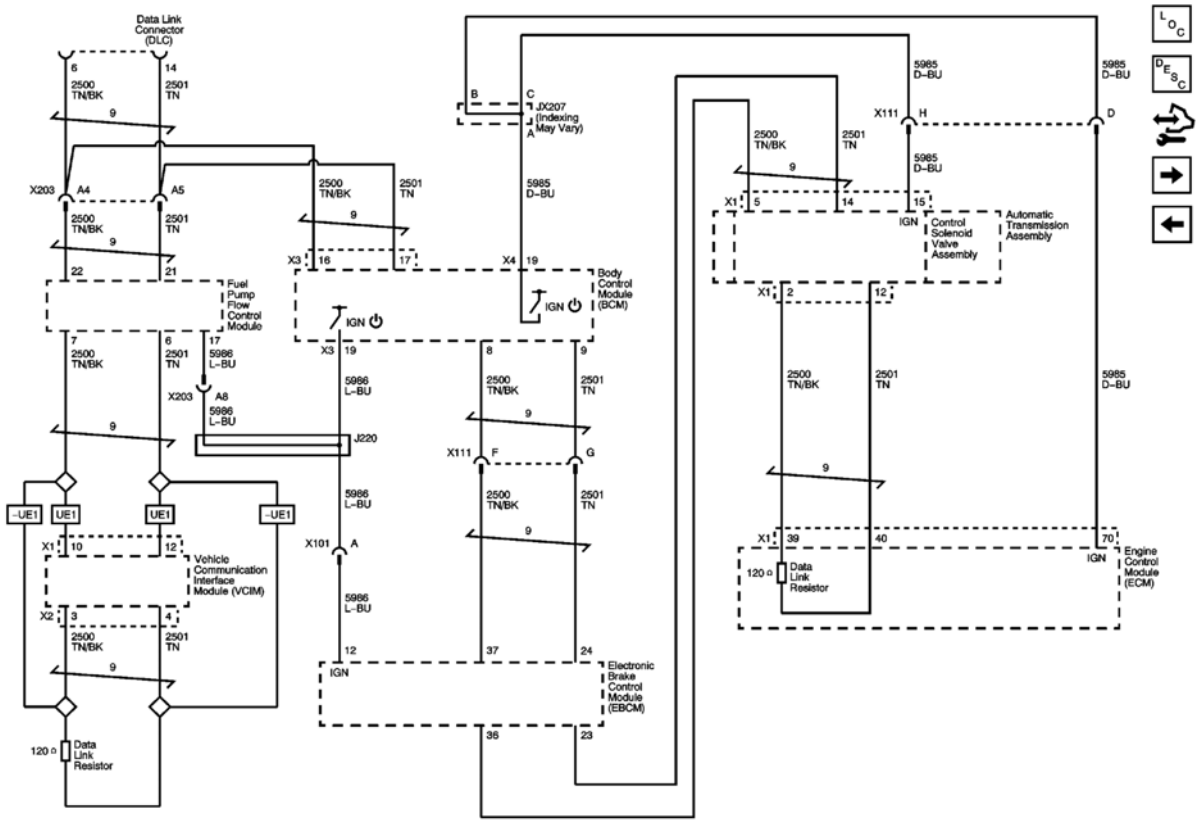


Fig. 2: High Speed GMLAN Serial Data Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

CAN Bus Serial Data

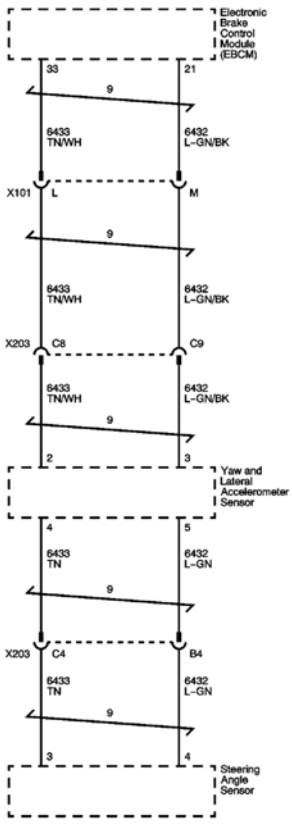


Fig. 3: CAN Bus Serial Data Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

BODY CONTROL SYSTEM WIRING SCHEMATICS

Power and Ground

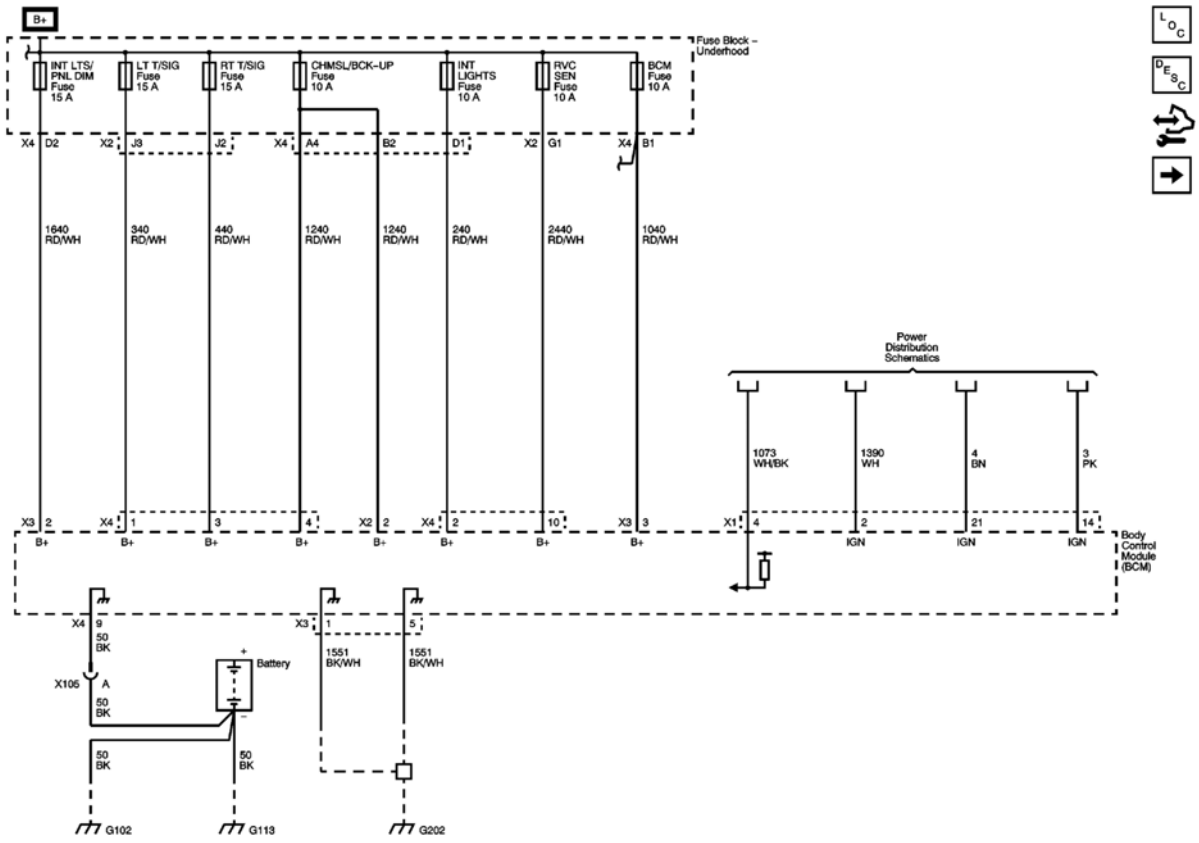


Fig. 4: Power and Ground Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Data Link, Starting and Charging, Engine Controls, AT Shift Lock Controls, Cruise Control, ABS, Brake Warning, Headlights/DRL and Fog Lights References

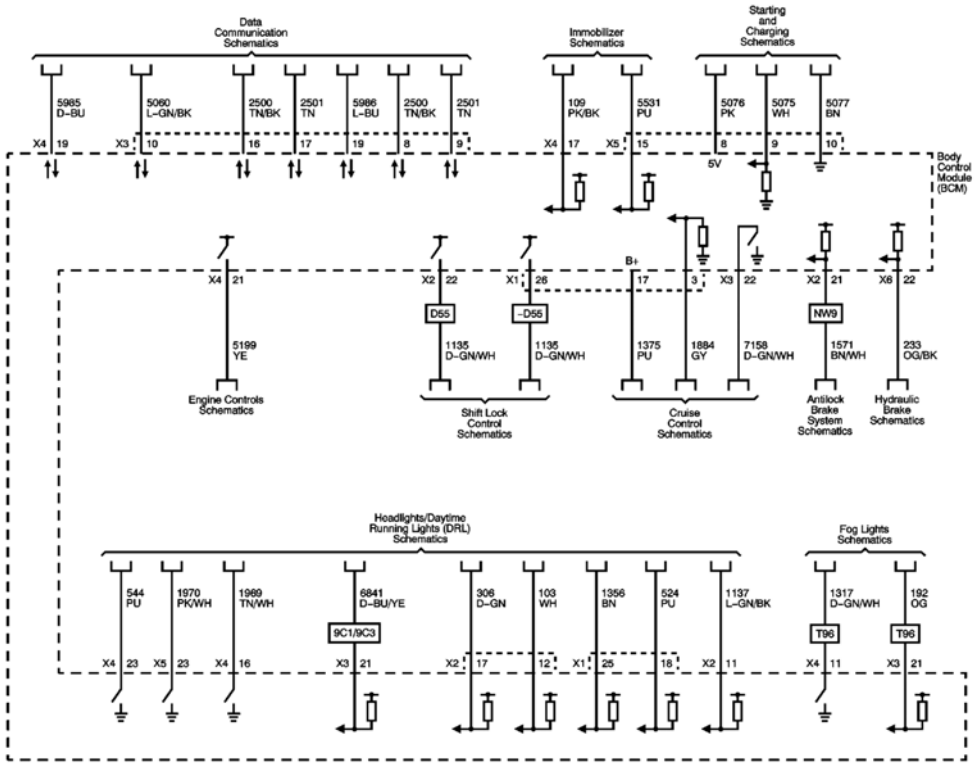


Fig. 5: Data Link, Starting and Charging, Engine Controls, AT Shift Lock Controls, Cruise Control, ABS, Brake Warning, Headlights/DRL and Fog Lights References Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Exterior Lights, Interior Lights, Interior Lights Dimming, Power Moding, and Door Lock/Indicator References

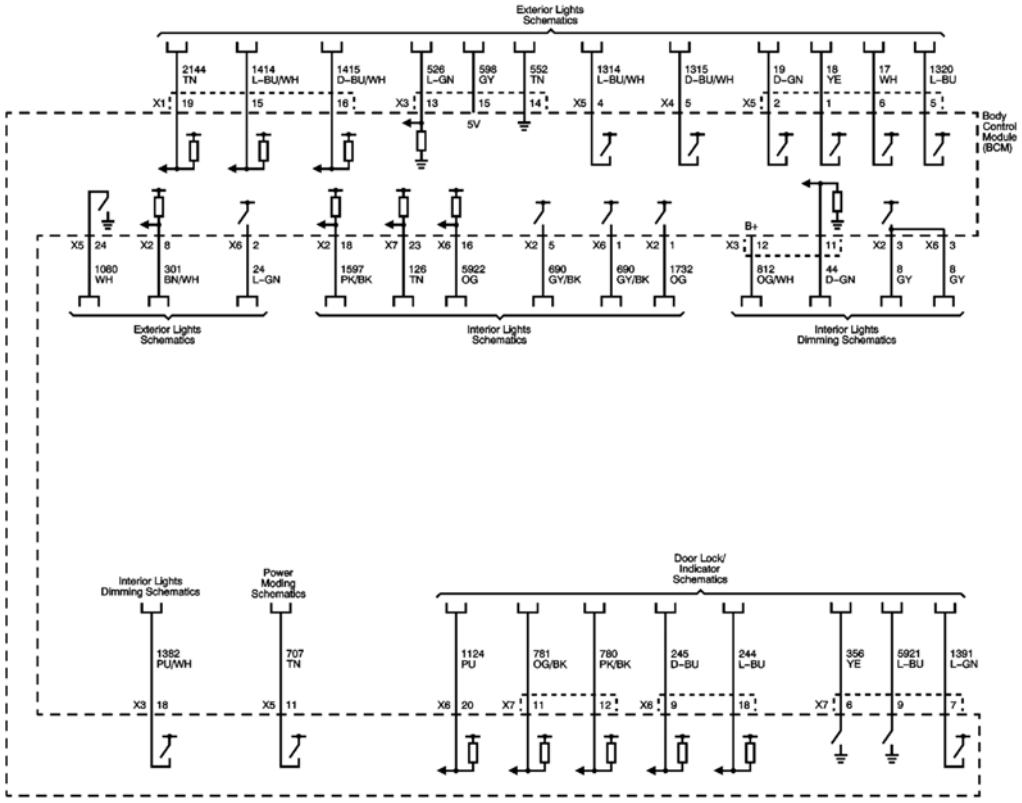


Fig. 6: Exterior Lights, Interior Lights, Interior Lights Dimming, Power Moding, and Door Lock/Indicator References Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

Door Lock/Indicator Cont, Theft Deterrent, Horns, Steering Wheel, Upfitter Provisions, Wiper/Washer, and Release System References

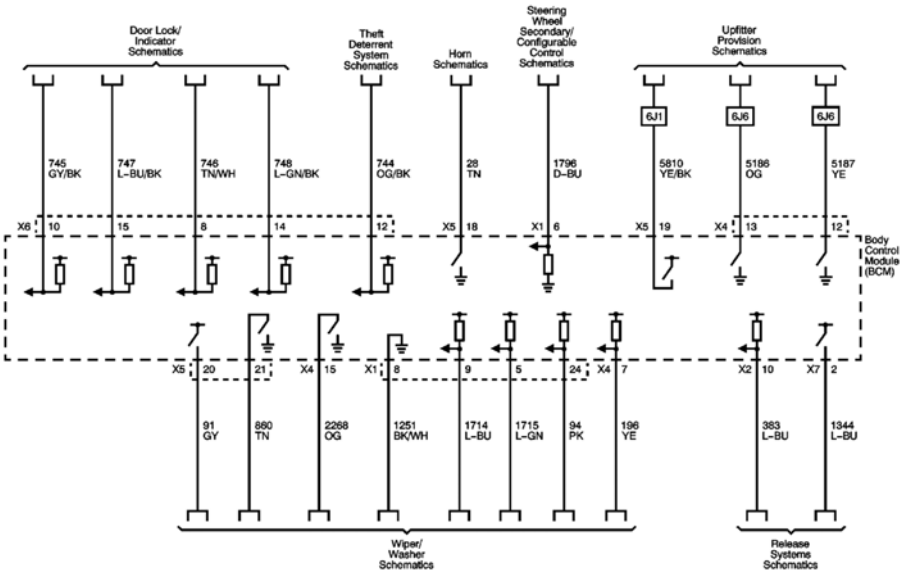


Fig. 7: Door Lock/Indicator Cont, Theft Deterrent, Horns, Steering Wheel, Upfitter Provisions, Wiper/Washer, and Release System References Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

CONTROL MODULE U CODE LIST

This list includes all Data Communications related U-code DTCs in alphanumeric order with descriptors for all modules. Not all DTCs listed will be applicable to all vehicles.

DTC	DTC Descriptor
U0001 00	High Speed CAN Bus Malfunction
U0002 00	High Speed CAN Bus
U0010 00	Medium Speed CAN Bus
U0020 00	Low Speed CAN Bus
U0073 00	Control Module Communication Bus A Off
U0073 71	ECU HS Bus Off
U0073 72	ECU LS Bus Off
U0074 00	Control Module Communication Bus B Off
U0075 00	Control Module Communication Bus C Off
U0100 00	Lost Communication with Engine/Powertrain Control Module (ECM/PCM)
U0100 75	Lost Communication with Engine/Powertrain Control Module (ECM)
U0100 7F	Lost Communication with Engine/Powertrain Control Module (ECM)

DTC	DTC Descriptor
U0101 00	Lost Communication with Transmission Control Module (TCM)
U0101 75	Lost Communication with Transmission Control Module (TCM)
U0102 00	Lost Communication with Transfer Case Control Module
U0104 00	Lost Communication with Cruise Control Module
U0104 7F	Lost Communication with Cruise Control Module
U0106 00	Lost Communication with Glow Plug Control Module
U0109 00	Lost Communication with Fuel Pump Control Module
	Lost Communication with CNG Control Module
U010E 00	Lost Communication with Reductant Sensor Module
U010F 00	Lost Communication with Air Conditioning Control Module
U0111 00	Lost Communication with Battery Energy Control Module
U0115 00	Lost Communication with ECM/PCM B
U0117 00	Lost Communication PTO Control Module
U0121 00	Lost Communication with Electronic Brake Control Module (EBCM)
U0122 00	Lost Communication with Vehicle Stability Control Module (ESCM)
U0123 00	Lost Communication with Yaw Rate Sensor Module
U0126 00	Lost Communication with Steering Wheel Angle Sensor Module
U0128 00	Lost Communication with Park Brake Control Module
U0129 00	Lost Communication with Brake System Control Module
U0131 00	Lost Communication with Power Steering Control Module
U0132 00	Lost Communication with Suspension Control Module
U0134 00	Lost Communication with Power Steering Control Module - Rear
U0136 00	Lost Communication with Differential Control Module - Rear
U0137 00	Lost Communication with Trailer Brake Control Module
U0140 00	Lost Communication with Body Control Module
U0141 00	Lost Communication with Body Control Module A
U0144 00	Lost Communication with Body Control Module D
U0146 00	Lost Communication with Gateway A
U0151 00	Lost Communication with Inflatable Restraint Sensing and Diagnostic Module (SDM)
U0151 71	Lost Communication with Inflatable Restraint Sensing and Diagnostic Module (SDM) Invalid Serial Data Received
U0151 7F	Lost Communication with Restraints Control Inflatable Restraint Sensing and Diagnostic Module (SDM) Erratic
U0155 00	Lost Communication with Instrument Panel Cluster (IPC) Control Module
U0156 00	Lost Communication with Information Center A (DIC)
U0157 00	Lost Communication with Information Center B (DID)
U0158 00	Lost Communication with Head Up Display
U0159 00	Lost Communication with Parking Assist Control Module (RPA)
U0160 00	Lost Communication with Chime Alarm Control Module
U0164 00	Lost Communication with HVAC Control Module

DTC	DTC Descriptor
U0165 00	Loss of Communication with HVAC Control Module - Rear
U0166 00	Lost Communication with Auxiliary Heater Control Module
U0168 00	Lost Communication with Vehicle Security Control Module
U0170 00	Lost Communication with Restraints System Sensor A (PPS)
U0172 00	Lost Communication with Restraints System Sensor C
U0173 00	Lost Communication with Restraints System Sensor D
U0181 00	Lost Communication with Headlamp Leveling Control Module
U0184 00	Lost Communication with Radio
U0186 00	Lost Communication with Audio Amplifier
U0191 00	Lost Communication with Television
U0194 00	Lost Communication with Digital Radio Receiver (DRR)
U0196 00	Lost Communication with Rear Audio Control Module
U0197 00	Lost Communication with Telephone Control Module
U0198 00	Lost Communication with Telematics Communication Interface Control Module
U0199 00	Lost Communication with Driver Door Control Module
U0200 00	Lost Communication with Door Control Module
U0208 00	Lost Communication with Seat Control Module A (DSM/MSM)
U0209 00	Lost Communication with Seat Control Module B (HVSM)
U0210 00	Lost Communication with Seat Control Module C (RHSM)
U0214 00	Lost Communication with Remote Function Actuation
U0230 00	Lost Communication with Rear Gate Module
U0232 00	Lost Communication with Side Object Detection (SOD) Module - Left
U0233 00	Lost Communication with Side Object Detection (SOD) Module - Right
U0236 00	Lost Communication with Column Locking Module (CLM)
U023A 00	Lost Communication with Vehicle Direction Camera Control Module (Lane Departure Warning)
U0241 00	Lost Communication with Headlamp Control Module A
U0249 00	Loss of Communication with Entertainment Control Module - Rear B
U0252 00	Lost Communication with Trailer Interface Module
U0254 00	Lost Communication with Remote Start Module
U0255 00	Loss of Communication with Front Display Interface Module
U0256 00	Loss of Communication with Front Controls Interface Module
U0257 00	Loss of Communication with Front Controls/Display Interface Module
U0293 00	Lost Communication with HP2 Powertrain Control Module
U029D 00	Lost Communication with NOX Sensor Module 1
U029E 00	Lost Communication with NOX Sensor Module 2
U0401 00	Invalid Data Received From ECM
U0401 72	Invalid Data Received From ECM Message Counter Incorrect
U0401 74	Invalid Data Received From ECM Bus Signal Checksum Error
U0402 72	Invalid Data Received From Transmission Control Module Message Counter Incorrect

DTC	DTC Descriptor
U0402 73	Invalid Data Received From Transmission Control Module Parity Error
U0402 74	Invalid Data Received From Transmission Control Module Bus Signal Checksum Error
U0405 00	Invalid Data Received From Cruise Module
U0405 71	Invalid Data Received From Cruise Control Module Invalid Data
U0405 72	Invalid Data Received From Cruise Control Module Message Counter Incorrect
U0405 74	Invalid Data Received From Cruise Control Module Bus Signal Checksum Error
U0415 00	Invalid Data Received From Electronic Brake Control Module
U0415 72	Invalid Data Received From Electronic Brake Control Module Message Counter Incorrect
U0415 74	Invalid Data Received From Electronic Brake Control Module Bus Signal Checksum Error
U0416 00	Invalid Data Received From Vehicle Dynamics Control Module
U0416 72	Invalid Data Received From Vehicle Dynamics Control Module Message Counter Incorrect
U0416 74	Invalid Data Received From Vehicle Dynamics Control Module Bus Signal Checksum Error
U0418 00	Invalid Data Received From Brake System Control Module
U0418 71	Invalid Data Received From Brake System Control Module Invalid Data
U0418 72	Invalid Data Received From Brake System Control Module Message Counter Incorrect
U0422 00	Invalid Data Received From Body Control Module
U0422 70	Invalid Data Received From Body Control Module
U0422 72	Invalid Data Received From Body Control Module Message Counter Incorrect
U0422 74	Invalid Data Received From Body Control Module Bus Signal Checksum Error
U0423 00	Invalid Data Received From Instrument Cluster
U0423 71	Invalid Data Received From Instrument Cluster Invalid Data
U0423 72	Invalid Data Received From Instrument Cluster Message Counter Incorrect
U0423 74	Invalid Data Received From Instrument Cluster Bus Signal Checksum Error
U0424 00	Invalid Data Received From HVAC Control Module
U0432 00	Invalid Data Received From Multi-Axis Acceleration Sensor Module
U0432 72	Invalid Data Received From Multi-Axis Acceleration Sensor Module Message Counter Incorrect
U0432 74	Invalid Data Received From Multi-Axis Acceleration Sensor Module Bus Signal Checksum Error
U0438 00	Invalid Data Received From Trailer Brake Control Module
U0438 71	Invalid Data Received From Trailer Brake Control Module Invalid Data
U0465 00	Invalid Data Received From Power Take-Off Control Module
U180F	Electronic Brake Control Module Communications Bus B OFF
U1000	Class 2 Data Link Malfunction
U1016	Lost Communication with ECM/PCM
U1017	Lost Communication with Engine Control System

DTC	DTC Descriptor
U1024	Lost Communication with Transmission Control Module
U1026	Lost Communication with Transfer Case Control Module
U1040	Lost Communication with Electronic Brake Control Module
U1041	Lost Communication with Electronic Brake Control Module
U1064	Lost Communication with Body Control Module/Dash Integration Module
U1088	Lost Communication with Inflatable Restraint Sensing and Diagnostic Module
U1096	Lost Communication with Instrument Panel Cluster
U1098	Lost Communication with Secondary Information Center
U1099	Lost Communication with Head Up Display
U1100	Lost Communication with Driver Information and Displays Control System
U1128	Lost Communication with Radio
U1129	Lost Communication with Amplifier
U1133	Lost Communication with Mini Disc Changer
U1137	Lost Communication with Satellite Digital Audio Reception System (DRR)
U1153	Lost Communication with Climate Control Panel
U1162	Lost Communication with Liftgate Module
U1164	Lost Communication with Driver Door Switch
U1165	Lost Communication with Passenger Door Switch
U1176	Lost Communication with Remote Function Actuation
U1177	Lost Communication with Folding Top Controller
U1192	Lost Communication with Immobilizer
U1193	Lost Communication with Remote Control Door Lock Receiver
U1255	Loss of Class 2 Communication
U1300	Class 2 Data Link Low
U1301	Class 2 Data Link High
U1305	Class 2 Data Link High or Low
U1500 00	Inter-Device Dedicated Bus
U1500 00	(EBCM) Inter Device Dedicated Bus (Lost Communication with Yaw and Lateral Accelerometer Sensor)
U1500 00	(DDM/PDM) Inter Device Dedicated Bus (Lost Communication with Front Window Motor)
U1500 01	Inter-Device Dedicated Bus Short to Battery
U1500 02	Inter-Device Dedicated Bus Short to Ground
U1501 00	Inter-Device Dedicated Bus 1
U1501 01	Inter-Device Dedicated Bus 1 Short to Battery
U1501 02	Inter-Device Dedicated Bus 1 Short to Ground
U1511 00	(BCM) Inter-device Dedicated Bus 1 Lost Communication with Device 1 (Electronic Compass Module)
U1511 00	(DDM/PDM) Inter-device Dedicated Bus 1 Lost Communication with Device 1 (Front Window Motor)

DTC	DTC Descriptor
U1511 00	(HCM) Inter-device Dedicated Bus 1 Lost Communication with Device 1 (AFL - Left)
U1512 00	(DDM) Inter-device Dedicated Bus 1 Lost Communication with Device 2 (Left Rear Window Motor)
U1513 00	(PDM) Inter-device Dedicated Bus 1 Lost Communication with Device 3 (Right Rear Window Motor)
U1521 00	(HCM) Inter-device Dedicated Bus 2 Lost Communication with Device 1 (AFL - Right)
U1650 00	Chassis System Dedicated Bus Controller
U1651 00	Chassis System Dedicated Bus Sensor
U180F 00	Control Module Communication Bus B Off
U1802 00	Lost Communication with Fuel Pump Control Module
U1812 00	Battery Energy Control Module Bus B High Speed Communication Enable Circuit Low
U1813 00	Battery Energy Control Module Bus B High Speed Communication Enable Circuit High
U1814 00	Powertrain High Speed Communication Enable Circuit
U1815 00	Lost Communication with Drive Motor Control Module A on Bus B
U1816 00	Lost Communication with Drive Motor Control Module B on Bus B
U1817 00	Lost Communication with Hybrid Powertrain Control Module on Bus B
U1818 00	Lost Communication with ECM/PCM A on Bus B
U1820 00	Lost Communication with Brake System Control Module on Bus B
U1821 00	Lost Communication with DC to DC Converter Control Module A on Bus B
U1822 00	Lost Communications with Power Steering Control Module on Bus B
U1823 00	Lost Communications with Cruise Control Module on Bus B
U1824 00	Lost Communications with Suspension Control Module
U1825 00	Lost Communications with Vehicle Dynamics Control Module
U1826 71	Lost Communication with Multi-Axis Acceleration Sensor Module on Bus B Invalid Serial Data Received
U1826 72	Lost Communication with Multi-Axis Acceleration Sensor Module on Bus B Alive Counter Incorrect/Not Updated
U1826 7F	Lost Communication with Multi-Axis Acceleration Sensor Module on Bus B Erratic
U1827 71	Lost Communication with Steering Angle Sensor Module on Bus B Invalid Serial Data
U1827 72	Lost Communication with Steering Angle Sensor Module on Bus B Alive Counter Incorrect/Not Updated
U1827 74	Lost Communication with Steering Angle Sensor Module on Bus B Value of Signal Protection Calculation Incorrect
U1827 7F	Lost Communication with Steering Angle Sensor Module on Bus B Erratic
U1829 00	Lost Communication with Gateway A on Bus B
U182A 00	Lost Communication with Battery Energy Control Module on Bus B

DTC	DTC Descriptor
U1842 00	Electronic Brake Control Module Lost Communication with Engine Control Module on Bus B
U1843 00	Electronic Brake Control Module Lost Communication with Hybrid Engine Control Module on Bus B
U1862 00	Battery Energy Control Module Lost Communication with Communications Gateway Module
U1863 00	Starter/Generator Control Module Lost Communication with Body Control Module
U1865 00	Fuel Operated Heater Lost Communication with Engine Control Module
U1866 00	Battery Energy Control Module Lost Communication with Body Control Module
U186A 00	Lost Communication with Transfer Case Control Module
U186B 00	Lost Communication with TCM
U1875 00	Drive Motor A Control Module Lost Communication with Battery Energy Control Module
U1876 00	Drive Motor A Control Module Lost Communication with Engine Control Module (ECM)/Powertrain Control Module (PCM)
U1878 00	Drive Motor B Control Module Lost Communication with Battery Energy Control Module
U1879 00	Drive Motor B Control Module Lost Communication with Engine Control Module (ECM)/Powertrain Control Module (PCM)
U1885 00	Battery Energy Control Module Lost Communication with HP2 Powertrain Control Module
U1886 00	Battery Energy Control Module Lost Communication with Engine Control Module (ECM)
U1888 00	Hybrid Powertrain Control Module Lost Communication With Starter/Generator Control Module
U1897 00	Starter/Generator Control Module Lost Communication with Battery Energy Control Module
U1899 00	Starter/Generator Control Module Lost Communication with Engine Control Module/Powertrain Control Module
U189A 00	DC to DC Converter Control Module A Lost Communication with HP2 Powertrain Control Module
U2099 00	High Speed Communication Enable Circuit
U209A 00	High Speed Communication Enable Circuit Low
U209D 00	Battery Energy Control Module High Speed Communication Enable Circuit High
U2100 00	Controller Area Network (CAN) Bus Communication
U2100 47	Controller Area Network (CAN) Bus Communication
U2102 00	More Controllers On Bus Than Programmed
U2103 00	Fewer Controllers On Bus Than Programmed
U2105 00	Lost Communication with Engine Control Module
U2106 00	Lost Communication with Transmission Control Module
U2107 00	Lost Communication with Body Control Module

DTC	DTC Descriptor
U2108 00	Lost Communication with ABS/TCS Control System
U2109 00	Lost Communication with Powertrain Control Module
U2110 00	Lost Communication with Chassis Multiple Control System
U2111 00	Lost Communication with Steering Control Module
U2112 00	Lost Communication with Electronic Suspension Control (ESC)
U2113 00	Lost Communication with Sensing and Diagnostic Module (SDM)
U2114 00	Lost Communication with PPS or CPS
U2115 00	Lost Communication with Restraints Control System
U2116 00	Lost Communication with Instrument Cluster
U2117 00	Lost Communication with Info Display
U2118 00	Lost Communication with Head Up Display (HUD)
U2119 00	Lost Communication with Daytime Running Lamps Control Module
U2120 00	Lost Communication with Automatic Headlamp Leveling Control Module
U2121 00	Lost Communication with Radio Display
U2122 00	Lost Communication with Radio
U2123 00	Lost Communication with Compact Disc Changer (CDX)
U2124 00	Lost Communication with Audio Amplifier
U2125 00	Lost Communication with Telematic Unit
U2126 00	Lost Communication with Mobile Communications Control System
U2127 00	Lost Communication with Front HVAC Control Module
U2128 00	Lost Communication with Rear HVAC Control Module
U2129 00	Lost Communication with Remote Function Actuator (RFA)
U2130 00	Lost Communication with Driver Door Module (DDM)
U2131 00	Lost Communication with Driver Seat Module (DSM)
U2132 00	Lost Communication with Passenger Door Module (PDM)
U2133 00	Lost Communication with Passenger Seat Module (PSM)
U2134 00	Lost Communication with Rear Door Module (RDM)
U2135 00	Lost Communication with Rear Integration Module (RIM)
U2136 00	Lost Communication with Memory Mirror Module (MMM)
U2137 00	Lost Communication with Vehicle Theft Deterrent (VTD)
U2138 00	Lost Communication with Column Locking Module (CLM)
U2139 00	Lost Communication with Column Integration Module (CIM)
U2140 00	Lost Communication with Underhood Electrical Center (UEC)
U2141 00	Lost Communication with Rear Electrical Center
U2142 00	Lost Communication with Yaw Rate Sensor (YRS)
U2143 00	Lost Communication with Steering Angle Sensor (SAS)
U2144 00	Lost Communication with Distance Sensing Cruise Control Module
U2145 00	Lost Communication with Parking Assistance System (PAS)
U2146 00	Lost Communication with Shift Lever Module (SLM)
U2147 00	Lost Communication with Auxiliary Heater System (AHS)
U2148 00	Lost Communication with Sun Roof Module (SRM)

DTC	DTC Descriptor
U2149 00	Lost Communication with Tire Pressure Monitor (TPM) System
U2150 00	Navigation Electronic Control Unit (ECU) Gateway Communications
U2151 00	Navigation Electronic Control Unit (ECU) Communications
U2152 00	Navigation Bus Request Line Circuit Low
U2153 00	Navigation Electronic Control Unit (ECU) - VICS Communication Circuit
U2160 00	Lost Communication with Steering Control System Sensor
U2161 00	Lost Communication with Dash Integration Module (DIM)
U2162 00	Lost Communication with Instrument Panel integration Module (IPM)
U2163 00	Lost Communication with Left Rear Door Module (LRDM)
U2164 00	Lost Communication with Right Rear Door Module (RRDM)
U2165 00	Lost Communication with Driver Door Switch (DDS)
U2166 00	Lost Communication with Driver Position Module (DPM)
U2167 00	Lost Communication with Remote Control Door Lock Receiver (RCDLR)
U2168 00	Lost Communication with Side Object Detection (SOD) Module - Left
U2169 00	Lost Communication with Side Object Detection (SOD) Module - Right
U2170 00	Lost Communication with Four Wheel Drive (4WD) Clutch
U2171 00	Lost Communication with Rear Seat Entertainment (RSE)
U2172 00	Lost Communication with Digital Radio Receiver (DRR)
U2173 00	Lost Communication with Passive Entry and Passive Start System
U2174 00	Lost Communication with Parking Heater System
U2175 00	Lost Communication with Special Vehicle Module
U2176 00	Lost Communication with Power Take Off (PTO) Control Module
U2177 00	Lost Communication with Cruise Control Module
U2178 00	Lost Communication with Trailer Interface Module
U2179 00	Lost Communication with Television Module
U2180 00	Lost Communication with Folding Top Control Module
U2181 00	Lost Communication with Moveable Roof Module

DTC B1000: ECU PERFORMANCE/SIDE OBJECT DETECTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1000 00

Electronic Control Unit (ECU) Performance No Additional Information Available

DTC B1000 04

Side Object Detection Performance - RAM Failure

DTC B1000 08

Electronic Control Unit (ECU) Performance Signal Invalid

DTC B1000 12

Electronic Control Unit (ECU) Performance Below Minimum Threshold

DTC B1000 31

Electronic Control Unit (ECU) General Checksum Problem

DTC B1000 32

Electronic Control Unit (ECU) General Memory Failure

DTC B1000 33

Electronic Control Unit (ECU) Performance Special Memory Failure

DTC B1000 34

Electronic Control Unit (ECU) Performance RAM Integrity

DTC B1000 35

Electronic Control Unit (ECU) Performance ROM Integrity

DTC B1000 36

Electronic Control Unit (ECU) Performance EEPROM Integrity

DTC B1000 37

Electronic Control Unit (ECU) Performance Watchdog / Safety Failure

DTC B1000 38

Electronic Control Unit (ECU) Performance Supervision Software Failure

DTC B1000 39

Electronic Control Unit (ECU) Performance Internal Electronic Failure

DTC B1000 43

Electronic Control Unit (ECU) Performance EEPROM Error

DTC B1000 46

Side Object Detection Performance - Invalid Configuration

DTC B1000 56

Electronic Control Unit (ECU) Performance Allowable Number of Transitions / Events Exceeded

DTC B1000 57

Electronic Control Unit (ECU) Performance

DTC B1000 73

Electronic Control Unit (ECU) Performance Parity Error

DTC B1000 0F

Electronic Control Unit (ECU) Performance Erratic

DTC B1000 2B

Electronic Control Unit (ECU) Performance Missing Reference

DTC B1000 2C

Electronic Control Unit Performance Reserved

DTC B1000 3B

Electronic Control Unit (ECU) Performance Internal Self Test Failed

DTC B1000 3C

Electronic Control Unit (ECU) Performance Internal Communications Failure

DTC B1000 4A

Side Object Detection Performance - PROM Checksum Error

DTC B1000 F0

Side Object Detection RF Transmit Chain Failed

DTC B1000 F1

Side Object Detection RF Receive Chain Failed

DTC B1000 F2

Side Object Detection Frequency Calibration Failure

DTC B1000 F3

Side Object Detection Inter-Processor Communication Failed

Circuit/System Description

The internal fault detection is handled inside the control module. No external circuits are involved.

Conditions for Running the DTC

The module runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

Conditions for Setting the DTC

The module has detected an internal malfunction.

Action Taken When the DTC Sets

The module refuses all additional inputs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 100, without a repeat of the malfunction.

Diagnostic Aids

- This DTC may be stored as a history DTC without affecting the operation of the control module.
- Do not replace a control module based only on DTC B1000 being set in history with the exception of the following control modules:
  - Sensing and Diagnostic Module (SDM)
  - Rollover Sensor
  - Passenger Presence System Module
- If DTC B1000 is set as current, replace the appropriate control module.

Circuit/System Verification

If the DTC is set, replace the appropriate control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for module replacement, setup, and programming

DTC B1001: OPTION CONFIGURATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1001 00

Option Configuration Error

DTC B1001 45

Option Configuration Error Variant Not Programmed

DTC B1001 46

Option Configuration Error

DTC B1001 4B

Option Configuration Error Calibration Not Learned

Circuit/System Description

Some control modules must be configured with serial numbers, vehicle options, or other information. If a control module was not properly configured after installation, that module may set DTC B1001.

Conditions for Running the DTC

Battery voltage is between 9-16 volts and data link communications operate normally.

Conditions for Setting the DTC

The control module is not configured properly.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Circuit/System Verification

1. Program or configure the module or related module that set DTC B1001. The module should successfully configure.
    - If the module will not configure, replace the module that set the DTC.
2. With a scan tool, clear the DTC.
3. Ignition OFF, remove the scan tool, open and close the drivers door.
4. Wait 60 seconds, then recheck for DTCs. DTC B1001 should not set.
    - If DTC B1001 sets, replace the module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control module replacement, setup, and programming

DTC B1016: VIN NOT PROGRAMMED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1016 00

VIN Not Programmed

Circuit/System Description

The internal fault detection is handled inside the control module. No external circuits are involved.

Conditions for Running the DTC

The only requirements are voltage and ground.

Conditions for Setting the DTC

The module has detected that the VIN is not programmed.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Circuit/System Verification

1. Program the VIN information to the module that set the DTC.
2. Turn the ignition OFF, wait several seconds and then turn the ignition ON.
3. Retrieve DTCs from the module that set the DTC. DTC B1016 should change to a history DTC.
    - If this DTC is retrieved as a current DTC, replace the module that set the DTC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, setup, and programming

DTC B101D: ELECTRONIC CONTROL UNIT HARDWARE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B101D 00

Electronic Control Unit Hardware Malfunction

DTC B101D 04

Electronic Control Unit Hardware Open

DTC B101D 08

Electronic Control Unit Hardware Performance - Signal Invalid

DTC B101D 0F

Electronic Control Unit Hardware Signal Erratic

DTC B101D 12

Electronic Control Unit Hardware Low Input

DTC B101D 13

Electronic Control Unit Hardware Low Voltage/High Temperature

DTC B101D 14

Electronic Control Unit Hardware High Voltage/Low Temperature

DTC B101D 1A

Electronic Control Unit Hardware Performance - Bias Level Out of Range

DTC B101D 2B

Electronic Control Unit Hardware Missing Reference

DTC B101D 2C

Electronic Control Unit Hardware

DTC B101D 31

Electronic Control Unit Hardware Internal Checksum Error

DTC B101D 32

Electronic Control Unit Hardware General Memory Malfunction

DTC B101D 34

Electronic Control Unit Hardware RAM Malfunction

DTC B101D 35

Electronic Control Unit Hardware ROM Malfunction

DTC B101D 36

Electronic Control Unit Hardware EEPROM Performance/Malfunction

DTC B101D 37

Electronic Control Unit Hardware Software Malfunction

DTC B101D 38

Electronic Control Unit Hardware Supervision Software Malfunction

DTC B101D 39

Electronic Control Unit Hardware Internal Malfunction

DTC B101D 3A

Electronic Control Unit Hardware Incorrect Component Installed

DTC B101D 3B

Electronic Control Unit Hardware Self-Test Malfunction

DTC B101D 3C

Electronic Control Unit Hardware Internal Communication Malfunction

DTC B101D 43

Electronic Control Unit Hardware EEPROM Incorrect Programming

DTC B101D 73

Electronic Control Unit Hardware Parity Error

DTC B101D F0

Electronic Control Unit Hardware

DTC B101D F1

Electronic Control Unit Hardware

Circuit/System Description

The internal fault detection is handled inside the control module. The symptom byte listed in the DTC

Descriptor is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

- The control module runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.
- The keyless entry control module will set this DTC with symptom byte 39 when the keyless entry control module antenna is activated.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Action Taken When the DTC Sets

The control module refuses all additional inputs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the control module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- If DTC B101D is set as history or current in the K36 Inflatable Restraint Sensing and Diagnostic Module (SDM) and there are Air Bag or Pretensioner DTC's with symptom byte 02, it is important to repair the deployment loop issue first prior to replacing the K36 SDM. Failure to repair the Air Bag or Pretensioner wiring concern first may cause B101D to reset in the replacement K36 SDM.
- This DTC may be stored as a history DTC without affecting the operation of the control module.
- Do not replace a control module based only on DTC B101D being set in history with the exception of the following control modules:
  - K36 Inflatable Restraint Sensing and Diagnostic Module (SDM)
  - K85 Passenger Presence Detection Module
- If DTC B101D is set as current, replace the appropriate control module.

Circuit/System Verification

Verify that DTC B101D is not set.

- If the DTC is set with symptom byte 43, program the control module that set the DTC. If the DTC resets, replace the control module that set the DTC.
- If the DTC is set with other symptom bytes, replace the control module that set the DTC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, setup, and programming

DTC B101E: ELECTRONIC CONTROL UNIT SOFTWARE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B101E 00

Electronic Control Unit Software Malfunction

DTC B101E 31

Electronic Control Unit Software Internal Checksum Error

DTC B101E 32

Electronic Control Unit Software General Memory Malfunction

DTC B101E 41

Electronic Control Unit Software Not Programmed

DTC B101E 42

Electronic Control Unit Software Calibration Not Programmed

DTC B101E 43

Electronic Control Unit Software EEPROM Incorrect Programming

DTC B101E 44

Electronic Control Unit Software Security Access Not Activated

DTC B101E 45

Electronic Control Unit Software Variant Not Programmed

DTC B101E 46

Electronic Control Unit Software Configuration Not Programmed

DTC B101E 47

Electronic Control Unit Software VIN Not Programmed

DTC B101E 48

Electronic Control Unit Software Security Code Not Programmed

DTC B101E 4A

Electronic Control Unit Software Programming Checksum Error

DTC B101E 4B

Electronic Control Unit Software Calibration Not Learned

DTC B101E 4C

Electronic Control Unit Software DTC Memory Full

Circuit/System Description

Some control modules must be configured with specific software, serial numbers, vehicle options, or other information. If a control module was not properly configured after installation that module may set DTC B101E. The symptom byte listed in the DTC Descriptor is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

Battery voltage is between 9-16 V and data link communications operate normally.

Conditions for Setting the DTC

The control module is not configured properly.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool References

Control Module References for scan tool information

Circuit/System Verification

Verify DTC B101E is not set.

- If the DTC is set, program the control module. If the DTC resets, replace the control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control module replacement, setup, and programming

DTC C0550: ELECTRONIC CONTROL UNIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0550 00

Electronic Control Unit Malfunction

DTC C0550 35

Electronic Control Unit ROM Malfunction

DTC C0550 39

Electronic Control Unit Internal Malfunction

DTC C0550 43

Electronic Control Unit EEPROM Incorrect Programming

Circuit/System Description

The internal fault detection is handled inside the control module. The symptom byte listed in the DTC Descriptor is for engineering reference only. No external circuit diagnosis is involved.

Conditions for Running the DTC

The module runs the program to detect an internal fault when power up is commanded. The only requirements are voltage and ground. This program runs even if the voltage is out of the valid operating range.

Conditions for Setting the DTC

The module has detected an internal malfunction.

Action Taken When the DTC Sets

The module refuses all additional inputs.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- This DTC may be stored as a history DTC without affecting the operation of the module.
- If stored only as a history DTC and not retrieved as a current DTC, do not replace the module.
- If this DTC is retrieved as both a current and history DTC, replace the module that set the DTC.

Circuit/System Verification

1. Verify that DTC B1325, B1330, B1370, B1380, B1424, B1440, B1441, B1517, C0800, C0899, C12E1, P0560, or P0562 is not set.
    - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Verify that DTC C0550 is not set.
    - If the DTC is set with symptom byte 39 or 43, program the control module that set the DTC. If the DTC resets, replace the control module that set the DTC.
    - If the DTC is set with other symptom bytes, replace the control module that set the DTC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for module replacement, setup, and programming

DTC U0020: LOW SPEED CAN COMMUNICATION BUS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U0020 00

Low Speed CAN Communication Bus Performance

Circuit/System Description

Modules connected to the GMLAN serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the modules. The modules have programmed information about what messages are needed to be exchanged on the serial data circuits. The messages are also supervised and some periodic messages are used by the receiver module as an availability indication of the transmitter module.

DTC U0020 will set when fewer modules are detected on the bus before the modules can learn the other modules IDs. If the communication bus is opened, or if the modules power supply is lost when the vehicle is in the OFF power mode, and then placed in the RUN power mode, U0020 will set in specific modules.

Conditions for Running the DTCs

- Voltage at the modules is in the normal operating voltage range.
- The vehicle power mode requires serial data communication to occur.
- The DTC U2100 does not have a current status.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter module availability has not been received.

Action Taken When the DTCs Sets

The module uses a default value for the missing parameter.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Circuit/System Verification

Diagnosis of this DTC is accomplished via the symptom, **DTC U0100-U02FF**.

DTC U0073 OR U2100: COMMUNICATION BUS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U0073 00

Control Module Communication Bus Off

DTC U0073 71

ECU HS Bus Off

DTC U0073 72

ECU LS Bus Off

DTC U2100 00

Controller Area Network (CAN) Bus Communication

DTC U2100 47

Controller Area Network (CAN) Bus Communication

Circuit/System Description

The serial data circuits are serial data buses are used to communicate information between the control modules. The serial data circuits also connect directly to the data link connector (DLC).

Conditions for Running the DTCs

- Supply voltage at the control modules are in the normal operating range.
- The vehicle power mode requires serial data communications.

Conditions for Setting the DTC

The control module setting the DTC has attempted to establish communications on the serial data circuits more than 3 times in 5 seconds.

Action Taken When the DTCs Sets

- The module suspends all message transmission.
- The module uses default values for all parameters received on the serial data circuits.
- In the TCM, DTC U0073 will cause the transmission to go into default gears.
- In the ECM and TCM, DTC U0073 will cause the malfunction indicator lamp (MIL) to illuminate.
- The module inhibits the setting of all other communication DTCs.

Conditions for Clearing the DTC

- The ECM/TCM modules turn OFF the MIL after 4 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the control module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Circuit/System Verification

1. Refer to **Data Link References** to determine which serial data system is used for a specific control module.

2. This DTC cannot be retrieved with a current status. Diagnosis is accomplished using the symptom **Scan Tool Does Not Communicate with High Speed GMLAN Device**, or **Scan Tool Does Not Communicate with Low Speed GMLAN Device**.

DTC U0100-U02FF: CONTROL MODULE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

Refer to **Control Module U Code List**.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U0100-U02FF	U0100-U02FF	-	-
Ignition	U0100-U02FF	U0100-U02FF	-	-
Accessory Wakeup Serial Data	U1814	U0100-U02FF	-	-
Serial Data Communication Enable	U2099	U0100-U02FF	-	-
Chassis High Speed GMLAN Serial Data (+)	U0074	U0074, U0100-U02FF	U0074	-
Chassis High Speed GMLAN Serial Data (-)	U0074	U0074, U0100-U02FF	U0074	-
Mid Speed GMLAN Serial Data (+)	U0074	U0074, U0100-U02FF	U0074	-
Mid Speed GMLAN Serial Data (-)	U0074	U0074, U0100-U02FF	U0074	-
High Speed GMLAN Serial Data (+)	2	U0073, U0100-U02FF	2	-
High Speed GMLAN Serial Data (-)	2	U0073, U0100-U02FF	2	-
Low Speed GMLAN Serial Data	1	U0100-U02FF	1	-
Ground	-	U0100-U02FF	-	-
1. Scan tool does not communicate with low speed GMLAN device 2. Scan tool does not communicate with high speed GMLAN device				

Circuit/System Description

The serial data circuit is the means by which the control modules in the vehicle communicate with each other. Once the scan tool is connected to the serial data circuit through the data link connector (DLC), the scan tool can be used to monitor each control module for diagnostic purposes and to check for diagnostic trouble codes (DTCs). When the ignition switch is in RUN, each control module communicating on the serial data circuit sends a state of health (SOH) message to ensure that the control module is operating properly. When a control

module stops communicating on the serial data circuit, for example if the control module loses power or ground, the SOH message it normally sends on the serial data circuit disappears. Other control modules on the serial data circuit, which expect to receive that SOH message, detect its absence; those control modules in turn set a DTC associated with the loss of SOH of the non-communicating control module. The DTC is unique to the control module which is not communicating and one or more control modules may set the same exact code. A loss of serial data communications DTC does not represent a failure of the control modules that contain the stored code.

Conditions for Running the DTC

The system voltage is between 9-16 V.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter module availability has not been received.

Action Taken When the DTC Sets

- Specific subsystems will not function.
- DTC U0100 in the TCM will cause the transmission to go into default gears.
- Both DTC U0100 in the TCM and DTC U0101 in the ECM will cause the malfunction indicator lamp (MIL) to illuminate.

Conditions for Clearing the DTC

- The ECM/TCM module turns OFF the MIL after 4 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the control module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of- communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
    - A control module on the data communication circuit was disconnected while the communication circuit is awake.
    - Power to one or more control modules was interrupted during diagnosis.
    - A low battery condition was present, so some control modules stop communicating when battery voltage drops below a certain threshold.
    - Battery power was restored to the vehicle and control modules on the communication circuit did not all re-initialize at the same time.
    - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be

interpreted as an intermittent fault, causing you to replace a part.

- A control module may have a U-code stored in history that does not require any repairs. Issues with late or corrupted messages between control modules can be temporary with no apparent symptom or complaint; this does not mean the control module is faulty. Do not replace a control module based only on a history U-code.
- Do not replace a control module reporting a U-code. The U-code identifies which control module needs to be diagnosed for a communication issue.
- Communication may be available between the BCM and the scan tool with either the low or high speed GMLAN serial data system inoperative. This condition is due to the BCM using both the low and high speed GMLAN systems.
- Use **Data Link References** to determine if the control module uses high or low speed GMLAN serial data communications.
- Some control modules may not have internal protection for specific control circuits and may open a B+ or ignition fuse. If a fuse is open and the B+ or ignition circuit is not shorted to ground, ensure none of the control circuits are shorted to ground before replacing the control module.
- Some intermittent communication concerns may be caused by fretting corrosion on the serial data circuit terminals. Inspect all connectors at the control module that set the communication DTC, the control module that the communication DTC was set against, and any inline harness connectors between the two control modules. Do not replace a control module based only on fretting corrosion. Refer to bulletin 09-06-03-004 for assistance with the diagnosis and repair of this condition.
- This diagnostic can be used for any control module that is not communicating, regardless of the type of serial data circuit it is connected to, providing the vehicle is equipped with the control module.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Determine the control module that is not communicating. Refer to **Control Module U Code List**.
2. Verify that DTC U0073, U2100, U0074, U0078, U1814, U2099, B1325, B1330, B1370, B1380, B1424, B1428, B1440, B1441, B1517, C0800, C0899, C12E1, P0560, or P0562 is not set.
   - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. Engine running for 10 seconds.
4. Ignition ON, engine OFF, verify that DTC U0100-U02FF is not set with symptom byte 00.
   - If the DTC U0100-U02FF is set with symptom byte 00, refer to Circuit/System Testing.
5. Verify that DTC U0100-U02FF is not set with symptom byte 71 or 72.
   - If the DTC U0100-U02FF is set with symptom byte 71 or 72 along with other DTCs set, diagnose all other codes first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - If the DTC U0100-U02FF is set with symptom byte 71 or 72 and without other DTCs set, reprogram the control module. If the DTC resets, replace the control module.

Circuit/System Testing

NOTE: **Use the schematic to identify the following:**

- **Control modules the vehicle is equipped with**
- **Control module locations on the low and high speed GMLAN serial data circuits**
- **The control modules B+, ignition, ground, communication enable and serial data circuit terminals**

1. Ignition OFF, disconnect the harness connector at of the control module that is not communicating.
2. Test for less than 10 Ω between each ground circuit terminal and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. If equipped, ignition ON, verify that a test lamp illuminates between each B+ circuit terminal and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit fuse is open, test the control circuits of the control module for a short to ground. If the circuits test normal, replace the control module.
4. If equipped, ignition ON, verify that a test lamp illuminates between each ignition circuit terminal and ground.
   - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit fuse is open, test the control circuits of the control module for a short to ground. If the circuits test normal, replace the control module.

NOTE: **Only the high speed GMLAN modules have a serial data communication enable circuit OR an accessory wakeup serial data circuit, and the K9 body control module is the output for these circuits. Refer to the control module schematics to identify which control modules have these circuits.**

5. If equipped, ignition ON, verify that a test lamp illuminates between the communication enable circuit terminal OR the accessory wakeup circuit terminal and ground.
    - If the test lamp does not illuminate, test the entire circuit, including the B+ circuit to the K9 Body Control Module, for an open/high resistance or short to ground. If the circuits test normal, replace the K9 Body Control Module.

NOTE: **The following test step is only applicable to low speed GMLAN modules.**

6. Test for less than 4.5 V between each low speed GMLAN serial data circuit terminal and ground.
    - If greater than the specified range, refer to **Scan Tool Does Not Communicate with Low Speed GMLAN Device** to test for a short to voltage in the serial data circuit.
7. Ignition OFF, all access doors closed, all vehicle systems OFF, and all keys at least 3 meters away from vehicle. It may take up to 2 minutes for all vehicle systems to power down. Test for less than 5 Ω between the serial data circuit terminals and the appropriate X84 data link connector (DLC) terminal listed below:
    - Class 2 serial data circuit terminal 2
    - Low speed GMLAN serial data terminal 1
    - High speed GMLAN serial data terminal 6 or 14
    - Mid speed GMLAN serial data terminal 3 or 11
    - Chassis high speed GMLAN serial data terminal 12 or 13
    - If greater than the specified range, test the serial data circuit for an open/high resistance between the non communicating control module and a module setting the DTC or a serial data splice pack.

NOTE: **The following test step is only applicable to high speed GMLAN modules.**

8. Test for less than 130 Ω between each pair of high speed GMLAN serial data circuits.
    - If greater than the specified range, refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** to test for an open/high resistance in the serial data circuit.
9. If all circuits test normal, replace the control module that is not communicating.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for control module replacement, setup, and programming.

DTC U1814: POWERTRAIN HIGH SPEED COMMUNICATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U1814 00

Powertrain High Speed Communication Enable Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Accessory Wake Up Signal Serial Data	U1814	U0100	-	-

Circuit/System Description

The accessory wake up serial data circuit is a voltage wake up signal from the body control module (BCM) to the engine control module (ECM) and the transmission control module (TCM). The signal is activated in 2 ways; any time the ignition switch is in the ACC or RUN position, or anytime the BCM determines that communication is needed from the powertrain. When the ignition switch is in the ACC or RUN position, the accessory voltage circuit input to the BCM is internally connected to the accessory wake up serial data circuit output, and voltage is supplied to the modules. The BCM also supplies voltage to the accessory wake up serial data circuit when it determines that communication is necessary with the powertrain and the ignition is not in the ACC or RUN position such as during remote start.

Conditions for Running the DTC

- The system voltage is between 9-16 volts.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

The BCM senses a short to ground on the accessory wake up serial data circuit.

Action Taken When the DTC Sets

- The modules use a default value for the missing parameters until the next ignition cycle.
- The modules is never signaled, therefore the specific subsystems will not function.
- The vehicle may not start.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Short to ground may open the fuse feeding the ignition switch.
- Short to ground may also set multiple no communication DTCs for GMLAN high speed modules.

Reference Information

Schematic Reference

- **Body Control System Schematics**

- **Data Communication Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the ECM and the TCM one at a time. After each disconnect, test for current DTCs. DTC U1814 should remain current.
    - If the DTC becomes history, replace the module disconnected when the DTC became history.
2. Ignition OFF, disconnect the X4 harness connector at the BCM.
3. Test for infinite resistance between the signal circuit terminal 19 and ground.
    - If less than the specified value, test the signal circuit for a short to ground.
4. If all circuits tests normal, replace the BCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for module replacement, setup, and programming
- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**

DTC U1826 OR U1827: LOST COMMUNICATION MODULE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC U1826 71

Lost Communication With Multi-Axis Acceleration Sensor Module on Bus "B" Invalid Serial Data Received

DTC U1826 72

Lost Communication With Multi-Axis Acceleration Sensor Module on Bus "B" Alive Counter Incorrect/Not Updated

DTC U1826 7F

Lost Communication With Multi-Axis Acceleration Sensor Module on Bus "B" Erratic

DTC U1827 71

Lost Communication With Steering Angle Sensor Module on Bus "B" Invalid Serial Data

DTC U1827 72

Lost Communication With Steering Angle Sensor Module on Bus "B" Alive Counter Incorrect/Not Updated

DTC U1827 74

Lost Communication With Steering Angle Sensor Module on Bus "B" Value of Signal Protection Calculation Incorrect

DTC U1827 7F

Lost Communication With Steering Angle Sensor Module on Bus "B" Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Steering Wheel Position Sensor Can Bus High Serial Data	-	U1827 71, U1827 72, U1827 7F	-	U1827 7F
Steering Wheel Position Sensor Can Bus Low Serial Data	-	U1827 71, U1827 72, 1827 7F	-	U1827 7F
Vehicle Yaw Sensor Can Bus High Serial Data	-	U1826 71, U1826 72, U1826 74, U1826 7F	-	U1826 7F
Vehicle Yaw Sensor Can Bus Low Serial Data	-	U1826 71, U1826 72, U1826 74, U1826 7F	-	U1826 7F
Vehicle Yaw Sensor	-	1	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Steering Wheel Position Sensor Ground	-	1	-	-
Vehicle Yaw Sensor 12 V Reference	1	1	-	-
Steering Wheel Position Sensor 12 V Reference	1	1	-	-
1. Circuit Inoperative				

Circuit/System Description

The electronic brake control module (EBCM) activates the other modules connected to the CAN serial data circuits by applying voltage when the ignition key is in ACC, ON or START. The EBCM, Yaw Rate Sensor, and the Steering Angle or Steering Wheel Position Sensor are the only modules connected to the CAN bus serial data circuits. For more information on CAN bus serial data refer to **Data Link Communications Description and Operation**.

Conditions for Running the DTC

- The system voltage is between 9-16 V.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter module availability has not been received.

Action Taken When the DTC Sets

- The vehicle stability enhancement system (VSES), if equipped, and traction control system (TCS) will not function.
- System OFF lamps will illuminate for these systems.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Use the DTC Descriptor list above to determine the module which is not communicating.
- If there are multiple non-communicating modules choose the one closest to the EBCM.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Antilock Brake System Schematics**

- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

Yaw Rate Sensor DTC U1826

1. Ignition OFF, disconnect the harness connector at the Yaw Rate Sensor.
2. Test for less than 10 Ω between the Yaw Rate Sensor ground circuit terminal 6 and ground.
    - If greater than the specified value, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the Yaw Rate Sensor voltage (12 V reference) circuit terminal 1 and ground.
    - If the test lamp does not illuminate, test the circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the EBCM.
4. Ignition OFF, disconnect the harness connector at the EBCM.
5. Test for less than 2 Ω in each pair of serial data circuits between the Yaw Rate Sensor and the EBCM:
    - Yaw Rate Sensor serial data circuit terminal 2 and EBCM serial data circuit terminal 33
    - Yaw Rate Sensor serial data circuit terminal 3 and EBCM serial data circuit terminal 21
    - If greater than 2 Ω, test the Yaw Rate Sensor serial data circuits terminals 2 and 3 for an open/high resistance.
6. If all circuits test normal, replace the Yaw Rate Sensor.

Steering Wheel Position Sensor (Steering Angle Sensor) DTC U1827

1. Ignition OFF, disconnect the harness connector at the Steering Wheel Position Sensor.
2. Test for less than 10 Ω between the Steering Wheel Position Sensor ground circuit terminal 1 and ground.
    - If greater than the specified value, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the Steering Wheel Position Sensor voltage (12

V reference) circuit terminal 2 and ground.

- If the test lamp does not illuminate, test the circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the EBCM.

4. Ignition OFF, disconnect the harness connector at the Yaw Rate Sensor.
5. Test for less than 2 Ω in each pair of serial data circuits between the Steering Wheel Position Sensor and the Yaw Rate Sensor:
   - Steering Wheel Position Sensor serial data circuit terminal 3 and Yaw Rate Sensor serial data circuit terminal 4
   - Steering Wheel Position Sensor serial data circuit terminal 4 and Yaw Rate Sensor serial data circuit terminal 5
   - If greater than 2 Ω, test the Steering Wheel Position Sensor serial data circuits terminals 3 and 4 for an open/high resistance.
6. If all circuits test normal, replace the Steering Wheel Position Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Vehicle Yaw Sensor with Vehicle Lateral Accelerometer Replacement**
- **Steering Angle Sensor Replacement**
- **Control Module References** for control module replacement, setup, and programming

DTC U2099: HIGH SPEED COMMUNICATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC U2099 00

High Speed Communication Enable Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Serial Data Communication Enable	U2099, U0100-U0299[1]	U0100-U0299	U0100-U0299[2]	-

[1] Vehicle will not start.
[2] History only. If cleared the DTC will return after several ignition cycles.

Circuit/System Description

The body control module (BCM) activates the serial data communication enable circuit, when the ignition key is in ACC, ON or START. The serial data communication enable circuit wakes up the electronic brake control module (EBCM) for buss communication.

Conditions for Running the DTC

- The system voltage is between 9-16 volts.
- The vehicle power mode master requires serial data communication to occur.

Conditions for Setting the DTC

The BCM senses a short to ground on the serial data communication enable circuit.

Action Taken When the DTC Sets

- The output command is turned off while the malfunction is present.
- The modules use a default value for the missing parameters until the next ignition cycle.
- The module(s) is never signaled, therefore the specific subsystem(s) will not function.
- The vehicle will not start while the circuit is shorted to ground.

Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Use the DMM MIN/MAX function to capture/locate intermittent conditions.
- Short to ground will also set multiple history no communication codes for GMLAN high speed modules.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the EBCM.
2. Retest for current DTCs. DTC U2099 should remain current.
    - If the DTC becomes history, replace the EBCM.
3. Ignition OFF, disconnect the X 3 harness connector at the BCM.
4. Test for infinite resistance between the serial data communication enable circuit terminal 19 and ground.
    - If less than infinite resistance, repair the enable circuit for a short to ground.
5. If all circuits tests normal, replace the BCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for module replacement, setup, and programming

SYMPTOMS - DATA COMMUNICATIONS

IMPORTANT: The following steps must be completed before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
    - There are no DTCs set.
    - The control modules can communicate via the serial data links.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to:
    - **Body Control System Description and Operation**
    - **Data Link Communications Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the systems. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Scan Tool Does Not Power Up**
- **Scan Tool Does Not Communicate with High Speed GMLAN Device**

- **Scan Tool Does Not Communicate with Low Speed GMLAN Device**

SCAN TOOL DOES NOT POWER UP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
DLC B+	1	1	-	-
DLC Ground	-	1	-	-
1. Scan Tool Does Not Power Up				

Circuit/System Description

The data link connector (DLC) is a standardized 16 cavity connector. Connector design and location is dictated by an industry wide standard, and is required to provide the following:

- Scan tool B+ voltage at terminal 16
- Scan tool ground at terminal 4
- Common ground at terminal 5

Diagnostic Aids

- The scan tool will power up with the ignition OFF. Some modules however, will not communicate unless the ignition is ON and the power mode master (PMM) module sends the appropriate power mode message.
- If the B+ circuit, ground circuits, and connections of the DLC are functioning properly, the malfunction must be due to the scan tool/CANdi module.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Testing

1. Test for less than 2.0 ohms between the ground circuits terminal 4 of the DLC and ground, and terminal 5 of the DLC and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
2. Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 16 at the DLC and ground.
   - If the test lamp does not illuminate, test the voltage supply circuit for a short to ground or an open/high resistance.
3. If all circuits test normal, refer to the scan tool/CANdi module user guide.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

SCAN TOOL DOES NOT COMMUNICATE WITH HIGH SPEED GMLAN DEVICE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Speed GMLAN Serial Data (+)	1	U0100-U02FF*	1	-
High Speed GMLAN Serial Data (-)	1	U0100-U02FF*	1	-
Ground (DLC, terminal 5)	-	1	-	-
* No communications with one or more high speed GMLAN modules. An open in only one high speed GMLAN serial data circuit may allow degraded communication between the control modules. An open between the data link connector (DLC) and the first splice will only effect the communication with the scan tool. The vehicle modules will still communicate. 1. No communication with any high speed GMLAN module				

Circuit/System Description

The serial data is transmitted on two twisted wires that allow speeds up to 500 Kb/s. The twisted pair is terminated with two 120 Ω resistors, one is internal to the engine control module (ECM) and the other can be a separate resistor in a connector assembly or in another control module. The resistors are used as the load for the high speed GMLAN bus during normal vehicle operation. The high speed GMLAN is a differential bus. The high speed GMLAN serial data bus (+) and high speed GMLAN serial data (-) are driven to opposite extremes from a rest or idle level of approximately 2.5 V. Driving the lines to their extremes, adds one volt to the high speed GMLAN serial data bus (+) circuit and subtracts one volt from the high speed GMLAN serial data bus (-) circuit. If serial data is lost, control modules will set a no communication code against the non-communicating control module. Note that a loss of serial data DTC does not represent a failure of the control module that set it.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they are transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
    - A control module on the data communication circuit was disconnected while the communication circuit is awake.
    - Power to one or more modules was interrupted during diagnosis
    - A low battery condition was present, so some control modules stop communicating when battery voltage drops below a certain threshold.
    - Battery power was restored to the vehicle and control modules on the communication circuit did not all re-initialize at the same time.
    - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- Do not replace a control module reporting a U-code. The U-code identifies which control module needs to be diagnosed for a communication issue.
- Communication may be available between the body control module (BCM) and the scan tool with the high speed GMLAN serial data system inoperative. This condition is due to the BCM using both the high and low speed GMLAN systems.
- An open in the DLC ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle. When the scan tool attempts to communicate with the vehicle a message "no CANdi module detected" will be displayed.
- The engine will not start when there is a total malfunction of the high speed GMLAN serial data bus.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC) and no low speed GMLAN communications with the scan tool.
- These conditions may be caused by the installation of an aftermarket navigation radio module (see bulletins). Some customers may comment of one or more of the following concerns:
    - Vehicle will not crank.
    - Vehicle cranks but will not start.
    - Vehicle stability enhancement system warning lights and messages.

- PRNDL gear indicator position errors.
- Tire Pressure Monitor (TPM) system warning lights.

Reference Information

Schematic Reference

- **Data Communication Schematics**
- **Control Module References**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: **Each control module may need to be disconnected to isolate a circuit fault. Use the schematic and component connector end views to identify the following:**

- **Control modules the vehicle is equipped with**
- **High speed GMLAN serial data circuit terminating resistors**
- **Control module locations on the high speed GMLAN serial data circuits**
- **Each control module's high speed GMLAN serial data circuit terminals**

1. Attempt to communicate with all control modules on the high speed GMLAN serial data circuit, refer to **Data Link References**. Communications should not be available with two or more control modules on the high speed GMLAN serial data circuit.
   - If only one control module is not communicating, diagnose that control module only; refer to **DTC U0100-U02FF**.
2. Disconnect the scan tool from the DLC. The following tests will be done at the DLC connector.
3. All access doors closed, ignition OFF for 60 seconds, test for less than 10 Ω between the ground circuit terminal 5 and ground.

- If greater than the specified range, test the ground circuit for an open/high resistance.

4. Ignition ON, test for less than 4.5 V between the serial data circuits listed below and ground:
    - Terminal 6
    - Terminal 14
    - If greater than the specified range, test the serial data circuit for a short to voltage; refer to Testing the Serial Data Circuits for a Short to Voltage.
5. Ignition OFF for 60 seconds, test for greater than 100 Ω between the serial data circuits listed below and ground:
    - Terminal 6
    - Terminal 14
    - If less than the specified range, test the serial data circuit for a short to ground; refer to Testing the Serial Data Circuits for a Short to Ground.
6. Test for 50-70 Ω between the serial data circuits terminal 6 and terminal 14.
    - If less than 35 Ω, test for a short between the serial data circuits; refer to Testing the Serial Data Circuits for a Short between the Circuits.
    - If 35-50 Ω there may be a third terminating resistor between the serial data circuits. This can happen if the incorrect control module is installed. Some control modules are available with and without the terminating resistors installed to reduce the need of terminating resistors in the wiring harness.
    - If greater than 70 Ω but less than infinite, test the serial data circuit for an open/high resistance; refer to Testing the Serial Data Circuits for an Open/High Resistance.
    - If infinite, test the serial data circuits between the DLC and the first connection to the serial data circuit for an open/high resistance.

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible control module.
2. Ignition ON, test for greater than 4.5 V between each serial data circuit at the control module connector that was just disconnected and ground. Verify that one or more serial data circuits are greater than 4.5 V.
    - If all serial data circuits are less than the specified range, replace the control module that was disconnected.
3. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at another control module, in the direction of the circuit shorted to voltage.
4. Ignition ON, test for greater than 4.5 V between the serial data circuits at the control module connector that was just disconnected and ground. Verify that one or more serial data circuits are greater than 4.5 V.
    - If all serial data circuits are less than the specified range, replace the control module that was just disconnected.
5. Repeat step 3 until one of the follow conditions are isolated:
    - A short to voltage on the serial data circuit between 2 control modules
    - A short to voltage on the serial data circuit between a control module and a terminating resistor.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible control module.
2. Ignition OFF for 60 seconds, test for less than 1k Ω between each serial data circuit at the control module connector that was just disconnected and ground. Verify that one or more serial data circuits are less than 1k Ω.
    - If all serial data circuits are greater than the specified range, replace the control module that was disconnected.
3. Disconnect the harness connectors with the high speed GMLAN serial data circuits at another control module, in the direction of the circuit shorted to ground.
4. Ignition OFF for 60 seconds, test for less than 1k Ω between the serial data circuits at the control module connector that was just disconnected and ground. Verify that one or more serial data circuits are less than 1k Ω.
    - If greater than the specified range for all serial data circuits, replace the control module that was just disconnected.
5. Repeat step 3 until one of the follow conditions are isolated:
    - A short to ground on the serial data circuit between 2 control modules
    - A short to ground on the serial data circuit between a control module and a terminating resistor

Testing the Serial Data Circuits for a Short between the Circuits

1. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible control module that is not communicating.
2. Ignition OFF for 60 seconds, test for less than 35 Ω between each pair of serial data circuits at the control module connector that was just disconnected. Verify that one pair of serial data circuits are less than 35 Ω.
    - If each pair of serial data circuits is greater than the specified range, replace the control module that was disconnected.
3. Connect the harness connectors at the control module that was disconnected.
4. Disconnect the harness connectors with the high speed GMLAN serial data circuits at another control module, in the direction of the circuits shorted together.
5. Ignition OFF for 60 seconds, test for less than 35 Ω between each pair of serial data circuits at the control module connector that was just disconnected. Verify that one pair of serial data circuits are less than 35 Ω.
    - If each pair of serial data circuits is within the specified range, replace the control module that was just disconnected.
6. Repeat step 3 until one of the following conditions are isolated:
    - Serial data circuits shorted together between 2 control modules
    - Serial data circuits shorted together between a control module and a terminating resistor
    - A shorted terminating resistor

Testing the Serial Data Circuits for an Open/High Resistance

1. Ignition OFF, disconnect the harness connectors with the high speed GMLAN serial data circuits at an easily accessible control module that is not communicating.
2. Ignition OFF for 60 seconds, test for greater than 130 Ω between each pair of serial data circuits at the control module connector that was just disconnected. Verify that one pair of serial data circuits are greater

than 130 Ω.

- If each pair of serial data circuits is less than the specified range, replace the control module that was disconnected.

3. Connect the harness connectors at the control module that was disconnected.
4. Disconnect the harness connectors with the high speed GMLAN serial data circuits at another control module, in the direction of the open circuit.
5. Ignition OFF for 60 seconds, test for greater than 130 Ω between each pair of serial data circuits at the control module connector that was just disconnected. Verify that one pair of serial data circuits are greater than 130 Ω.
   - If each pair of serial data circuits is less than the specified range, replace the control module that was just disconnected.
6. Repeat step 3 until one of the following conditions are isolated:
   - An open/high resistance on the serial data circuit between 2 control modules
   - An open/high resistance on the serial data circuit between a control module and a terminating resistor
   - An open/high resistance terminating resistor

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for control module replacement, setup, and programming

SCAN TOOL DOES NOT COMMUNICATE WITH LOW SPEED GMLAN DEVICE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Speed GMLAN Serial Data	1	U0100-U0299*	1	-
Ground (DLC, terminal 5)	-	1*	-	-
* An open between the data link connector serial data circuit terminal 1 or ground circuit terminal 5 and the BCM circuit will only effect the communication with the scan tool. 1. No communication on any low speed GMLAN module				

Circuit/System Description

The serial data is transmitted over a single wire to the appropriate control modules. The transmission speed for GMLAN low speed is up to 83.33 Kb/s. Under normal vehicle operating conditions, the speed of the buss is 33.33 Kb/s. The control modules toggle the serial data circuit between 0-5 V during normal communications.

To wake the control modules connected to the GMLAN low speed serial data circuit, a voltage wake up pulse of 10 V is sent out. If serial data is lost, control modules will set a no communication code against the non-communicating control module. Note: a loss of serial data communications DTC does not represent a failure of the module that set it.

Diagnostic Aids

- Sometimes, while diagnosing a specific customer concern or after a repair, you may notice a history U-code present. However, there is no associated "current" or "active" status. Loss-of-communication U-codes such as these can set for a variety of reasons. Many times, they're transparent to the vehicle operator and technician, and/or have no associated symptoms. Eventually, they will erase themselves automatically after a number of fault-free ignition cycles. This condition would most likely be attributed to one of these scenarios:
    - A control module on the data communication circuit was disconnected while the communication circuit is awake.
    - Power to one or more modules was interrupted during diagnosis
    - A low battery condition was present, so some control modules stop communicating when battery voltage drops below a certain threshold.
    - Battery power was restored to the vehicle and control modules on the communication circuit did not all re-initialize at the same time.
    - If a loss-of-communication U-code appears in history for no apparent reason, it is most likely associated with one of the scenarios above. These are all temporary conditions and should never be interpreted as an intermittent fault, causing you to replace a part.
- Do not replace a control module reporting a U-code. The U-code identifies which control module needs to be diagnosed for a communication issue.
- Communication may be available between the BCM and the scan tool with the low speed GMLAN serial data system inoperative. This condition is due to the BCM using both the high and low speed GMLAN systems.
- An open in the low speed GMLAN serial data circuit between the splice pack and a module will only affect that specific module. This type of failure will set a loss of communication DTC for each module effected, and the other modules will still communicate.
- An open in the DLC ground circuit terminal 5 will allow the scan tool to operate but not communicate with the vehicle. When the scan tool attempts to communicate with the vehicle a No CANdi Module Detected message will be displayed.
- An open between the DLC and JX 205 will only effect the communication with the scan tool. The vehicle modules will still communicate, and the vehicle will start.
- The engine will not start when there is a total malfunction of the low speed GMLAN serial data circuit.
- Technicians may find various Local Area Network (LAN) communication Diagnostic Trouble Codes (DTC) and no low speed LAN communications with the scan tool.

  These conditions may be caused by the installation of an aftermarket navigation radio module (see bulletins). Some customers may comment of one or more of the following concerns:

    - Vehicle will not crank.
    - Vehicle cranks but will not start.

- Vehicle stability enhancement system warning lights and messages.
- PRNDL gear indicator position errors.
- Tire Pressure Monitor (TPM) system warning light.

Reference Information

Schematic Reference

Data Communication Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Splice Pack Connector End Views**

Description and Operation

Data Link Communications Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Testing

NOTE: **Use the schematic to identify the following:**

- **Control modules the vehicle is equipped with**
- **Control module locations on the low speed GMLAN serial data circuit**
- **The low speed GMLAN serial data circuit terminals for each control module**

1. Attempt to communicate with all control modules on the low speed GMLAN serial data circuit, refer to **Data Link References**. Communications should not be available with two or more control modules on the low speed GMLAN serial data circuit.
   - If only one control module is not communicating, diagnose that control module only, refer to **DTC U0100-U02FF**.
   - If one or more control modules are communicating but not all, refer to Testing the Serial Data Circuit for an Open/High Resistance.
2. Disconnect the scan tool from the DLC. The following tests will be done at the DLC connector.
3. All access doors closed, ignition OFF for 60 seconds, test for less than 10 Ω between the ground circuit terminal 5 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.

4. Ignition ON, test for less than 4.5 V between the serial data circuit terminal 1 and ground.
    - If greater than the specified range, test the serial data circuit for a short to voltage, refer to Testing the Serial Data Circuit for a Short to Voltage.
5. Ignition OFF for 60 seconds, test for greater than 100 Ω between the serial data circuit terminal 1 and ground.
    - If less than the specified range, test the serial data circuit for a short to ground, refer to Testing the Serial Data Circuits for a Short to ground.
6. Disconnect the appropriate harness connector at the JX 205 splice pack.
7. Test for less than 2 Ω between the DLC serial data circuit terminal 1 and the JX 205 splice pack terminal A.
    - If greater than the specified range, test the serial data circuit for an open/high resistance. If the circuits test normal, replace the splice pack.

Testing the Serial Data Circuits for a Short to Voltage

1. Ignition OFF, disconnect the appropriate harness connectors at the JX 205 splice pack.
2. Ignition ON, test for less than 4.5 V between the DLC serial data circuit terminal 1 and ground.
    - If greater than the specified range, repair the short to voltage.
3. Test for less than 4.5 V between each serial data circuit at the splice pack connector and ground.
    - If greater than the specified range, perform the appropriate test listed below:
    - Serial data circuits with one control module, test the serial data circuit for a short to voltage. If the circuit tests normal replace the control module.
    - Serial data circuits with 2 or more control modules, test each section of the serial data circuit for a short to voltage. If the circuits test normal, replace the control module that causes the short to voltage when connected.

Testing the Serial Data Circuits for a Short to Ground

1. Ignition OFF, disconnect the appropriate harness connectors at the JX 205 splice pack.
2. Test for infinite resistance between the DLC serial data circuit terminal 1 and ground.
    - If not the specified value, repair the short to ground.
3. Ignition OFF for 60 seconds, test for greater than 100 Ω between each serial data circuit at the splice pack and ground.
    - If less than the specified range, perform the appropriate test listed below:
    - Serial data circuits with one control module, test the serial data circuit for a short to ground. If the circuit tests normal replace the control module.
    - Serial data circuits with 2 or more control modules, test each section of the serial data circuit for a short to voltage. If the circuits test normal, replace the control module that causes the short to ground when connected.

Testing the Serial Data Circuit for an Open/High Resistance

1. Ignition OFF, disconnect the appropriate harness connectors at the JX 205 splice pack.
2. Install a 3 A fused jumper wire between the disconnected splice pack connector terminal A and a low

speed GMLAN serial data circuit terminal that is not communicating.

3. Ignition ON, verify the scan tool communicates with the control modules connected to the low speed GMLAN serial data circuit.
    - If any control module does not communicate, test each section of the serial data circuit for an open/high resistance. If the circuits test normal, replace the control module that does not communicate when connected.
4. If all circuits test normal, replace the splice pack.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **Control Module References** for module replacement, setup, and programming

DATA LINK REFERENCES

This table identifies which serial data link that a particular module uses for in-vehicle data transmission. Some modules may use more than one data link to communicate. Some modules may have multiple communication circuits passing through them without actively communicating on that data link. This table is used to assist in correcting a communication malfunction. For the description and operation of these serial data communication circuits refer to **Data Link Communications Description and Operation**.

Control Module	Data Link Type	Diagnostic Procedure
Schematic Reference: Data Communication Schematics		
Body Control Module (BCM)	• High Speed GMLAN • Low Speed GMLAN	**Scan Tool Does Not Communicate with High Speed GMLAN Device**
Digital Radio Receiver (DRR)	Low Speed GMLAN	**Scan Tool Does Not Communicate with Low Speed GMLAN Device**
Electronic Brake Control Module (EBCM)	High Speed GMLAN	**Scan Tool Does Not Communicate with High Speed GMLAN Device**
Engine / Powertrain Control Module (ECM/PCM)	High Speed GMLAN	**Scan Tool Does Not Communicate with High Speed GMLAN Device**
Heated Seat Module (HSM)	Low Speed GMLAN	**Scan Tool Does Not Communicate with Low Speed GMLAN Device**
HVAC Control Module	Low Speed GMLAN	**Scan Tool Does Not Communicate with Low Speed GMLAN Device**
Inflatable Restraint Sensing and Diagnostic Module (SDM)	Low Speed GMLAN	**Scan Tool Does Not Communicate with Low Speed GMLAN Device**

Control Module	Data Link Type	Diagnostic Procedure
Schematic Reference: Data Communication Schematics		
Instrument Panel Cluster (IPC)	Low Speed GMLAN	**Scan Tool Does Not Communicate with Low Speed GMLAN Device**
Radio	Low Speed GMLAN	**Scan Tool Does Not Communicate with Low Speed GMLAN Device**
Remote Control Door Lock Receiver (RCDLR)	Low Speed GMLAN	**Scan Tool Does Not Communicate with Low Speed GMLAN Device**
Theft Deterrent Module (TDM)	Low Speed GMLAN	**Scan Tool Does Not Communicate with Low Speed GMLAN Device**
Transmission Control Module (TCM)	High Speed GMLAN	**Scan Tool Does Not Communicate with High Speed GMLAN Device**
Universal Park Assist (UPA)	Low Speed GMLAN	**Scan Tool Does Not Communicate with Low Speed GMLAN Device**
Vehicle Communication Interface Module (OnStar)	• High Speed GMLAN - pass through only • Low Speed GMLAN	**Scan Tool Does Not Communicate with Low Speed GMLAN Device**

REPAIR INSTRUCTIONS

DATA LINK CONNECTOR REPLACEMENT

Removal Procedure

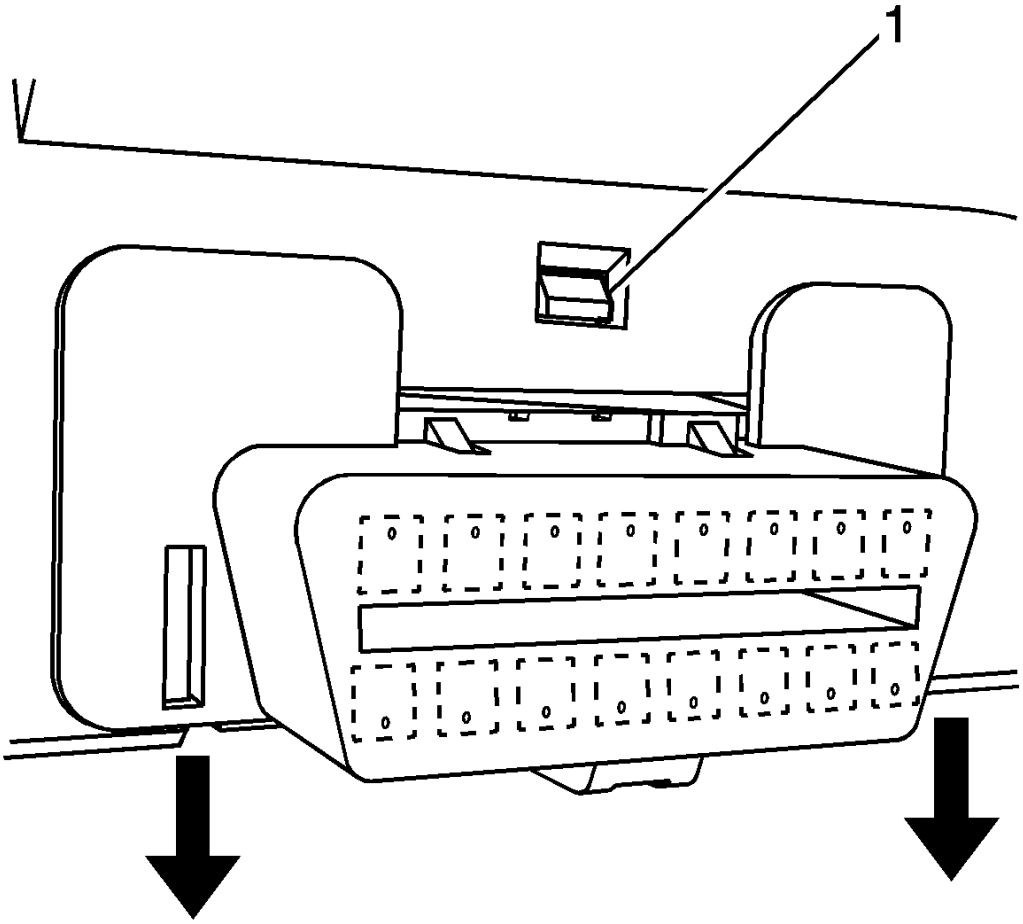


Fig. 8: View Of Data Link Connector (DLC)
Courtesy of GENERAL MOTORS COMPANY

1. Disengage the data link connector (DLC) tab (1).
2. Remove the DLC from the instrument panel (I/P) trim pad.

Installation Procedure

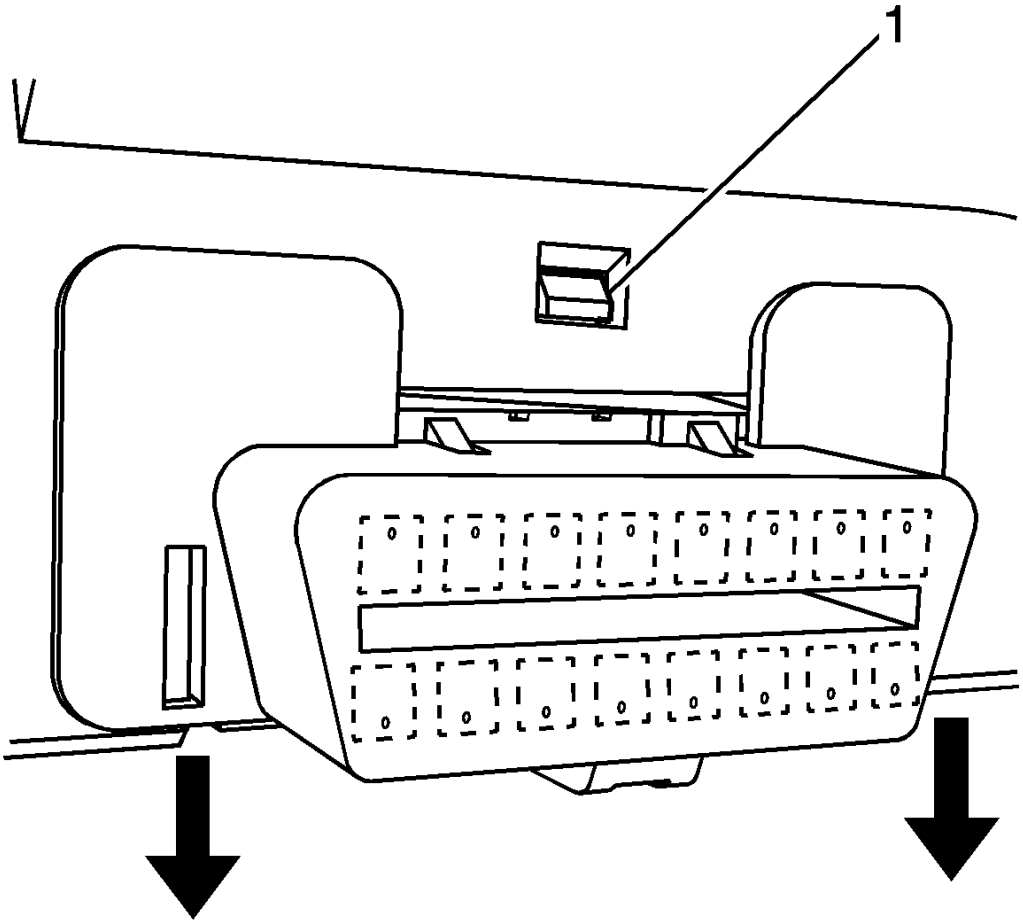


Fig. 9: View Of Data Link Connector (DLC)
Courtesy of GENERAL MOTORS COMPANY

1. Align the DLC to the I/P trim pad.
2. Slide the DLC upward in order to engage the tab (1).

BODY CONTROL MODULE REPLACEMENT

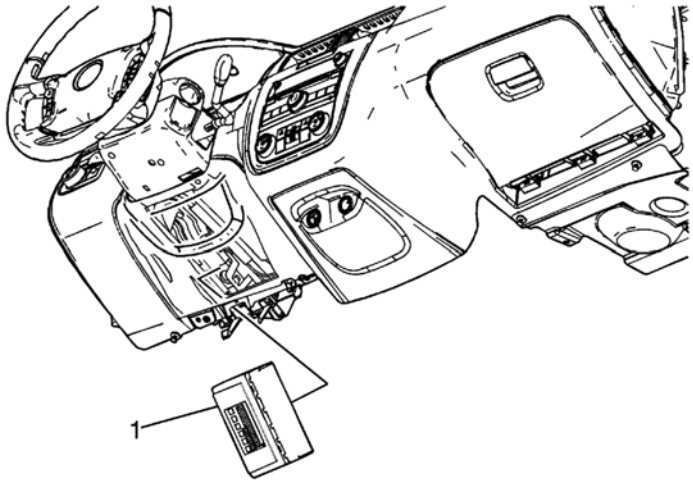


Fig. 10: Body Control Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the left closeout panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** . 2. Program the body control module after replacement. Refer to **Control Module References** .	
1	Body Control Module (BCM) Assembly **TIP:** Release the tabs on the BCM bracket and lift the module up and out.

DESCRIPTION AND OPERATION

BODY CONTROL SYSTEM DESCRIPTION AND OPERATION

The body control system consists of the body control module (BCM), communications, and various input and outputs. Some inputs, outputs and messages require other modules to interact with the BCM. The BCM also has discrete input and output terminals to control the vehicle's body functions. Battery positive voltage is provided to the BCM from the BCM fuse in the underhood fuse block. The module has two grounds at G 202 as well as one directly to the vehicle battery. The BCM is wired to the GMLAN High speed serial data buss and the GMLAN Low speed serial data buss and acts as a gateway between them. If the BCM does not communicate the vehicle will not start due to the inability of the engine/powertrain control module (ECM/PCM) and vehicle theft deterrent (VTD) control module to communicate without the BCM providing the gateway function.

Power Mode Master

This vehicle body control module (BCM) functions as the power mode master (PMM). The ignition switch is a low current switch with multiple discrete ignition switch signals to the PMM for determination the power mode that will be sent over the serial data circuits to the other modules that need this information, and so the PMM will activate relays and other direct outputs of the PMM as needed. Refer to **Power Mode Description and Operation** for a complete description of power mode functions.

Gateway

The body control module (BCM) in this vehicle functions as a gateway or translator. The purpose of the gateway is to translate serial data messages between the GMLAN high speed buss and the GMLAN low speed buss for communication between the various modules. The gateway will interact with each network according to that network's transmission protocol.

One example of this necessary communication is the communication between the engine/powertrain control module (ECM/PCM) which is high speed serial data and vehicle theft deterrent (VTD) control module which is low speed serial data. If these modules can not exchange information, the vehicle will not start.

All communication between the BCM and a scan tool is on the High speed GMLAN serial data circuits. A lost communication DTC typically is set in modules other than the module with a communication failure.

Body Control

The various body control module (BCM) input and output circuits are described in the corresponding functional areas indicated on the BCM electrical schematics. The BCM related systems include, but are not to the following:

- Chimes-Refer to **Audible Warnings Description and Operation** .
- Exterior lighting-Refer to **Exterior Lighting Systems Description and Operation** .
- Instrument cluster indicator control-Refer to **Instrument Cluster Description and Operation** .
- Interior lighting-Refer to **Interior Lighting Systems Description and Operation** .
- Power Windows-Refer to **Power Windows Description and Operation** .
- Remote function control-Refer to **Keyless Entry System Description and Operation** .
- Remote Start-Refer to **Keyless Entry System Description and Operation** .
- Retained accessory power (RAP)-Refer to **Retained Accessory Power Description and Operation** .
- Seat belt use sensing-Refer to **Seat Belt System Description and Operation** .
- Theft deterrent-Refer to **Immobilizer Description and Operation** , and **Theft Systems Description and Operation** .
- Wiper/Washer System functions-Refer to **Wiper/Washer System Description and Operation** .

DATA LINK COMMUNICATIONS DESCRIPTION AND OPERATION

Circuit Description

The communication among control modules is performed through the High speed GMLAN serial data circuits and the Low speed GMLAN serial data circuit. The modules that need real time communication are attached to the High speed GMLAN network. The body control module (BCM) is the gateway between the high and low speed networks. Communication is necessary between the high and low speed serial data modules for the vehicle to start. Refer to **Body Control System Description and Operation** for more information about the gateway.

Signal supervision is the process of determining whether an expected signal is being received or not. Some messages are sent on a periodic basis and are interpreted as a heartbeat of a device. If such a signal is lost, the signal supervision part of the software will set a no communication DTC (U code) against the missing device. This code is mapped on the Tech 2 screen as a code against the physical device. A lost communication DTC typically is set in modules other than the module with a communication failure.

GMLAN High Speed Circuit Description

The data link connector (DLC) allows a scan tool to communicate with the high speed GMLAN serial data circuit. The serial data is transmitted on two twisted wires that allow speed up to 500 Kb/s. The twisted pair is terminated with two 120 ohms resistors, one is internal to the engine control module (ECM) and the other is after the vehicle communication interface module (VCIM). The VCIM is considered a DLC termination point of the link although it does not contain the resistor and can be used as a diagnostic point. The high speed GMLAN is a differential bus. The high speed GMLAN serial data bus (+) and high speed GMLAN serial data (-) are driven to opposite extremes from a rest or idle level. The idle level, which is approximately 2.5 volts, is considered recessive transmitted data and is interpreted as a logic 1. Driving the lines to their extremes, adds one volt to the high speed GMLAN serial data bus (+) and subtracts one volt from the high speed GMLAN serial data bus (-) wire.

GMLAN Low Speed Circuit Description

The data link connector (DLC) allows a scan tool to communicate with the low speed GMLAN serial data circuit. The serial data is transmitted over a single wire to the appropriate control modules. Under normal vehicle operating conditions, the speed of the buss is 33.33 Kb/s. This protocol produces a simple pulse train sent out over the GMLAN low speed serial data bus. When a module pulls the buss high, 5 volts, this creates a logic state of 0 on the buss. When the buss is pulled low, 0 volts, it is translated as a logic state of 1. To wake the control modules connected to the GMLAN low speed serial data buss, a high voltage wake up pulse is sent out over the buss, the voltage level of the pulse is +10 volts. Modules connected to the GMLAN low speed buss can be part of a virtual network as described in GMLAN High Speed Circuit Description above. The modules on the GMLAN low speed serial data buss are connected to the buss using SP 205 as the common connection sometimes called a star connector. Refer to **Control Module References** for specific schematics information.

Data Link Connector (DLC)

The data link connector (DLC) is a standardized 16-cavity connector. Connector design and location is dictated by an industry wide standard, and is required to provide the following:

- Pin 1 GMLAN low speed communications terminal
- Pin 4 Scan tool power ground terminal
- Pin 5 Common signal ground terminal
- Pin 6 High speed GMLAN serial data bus (+) terminal
- Pin 14 High speed GMLAN serial data bus (-) terminal
- Pin 16 Scan tool power, battery positive voltage terminal

Serial Data Reference

The scan tool communicates over the various busses on the vehicle. In order to avert misdiagnoses of No Communication with a specific module and to determine if a module is low or high speed, refer to **Data Link References** for a list of modules, the busses they communicate with, and the RPO codes for a specific module.

Article GUID: A00737198

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Instrument Panel Cluster Assembly Screws	2 N.m	18 lb in

SCHEMATIC WIRING DIAGRAMS

INSTRUMENT CLUSTER WIRING SCHEMATICS

Power, Ground, and Gauges

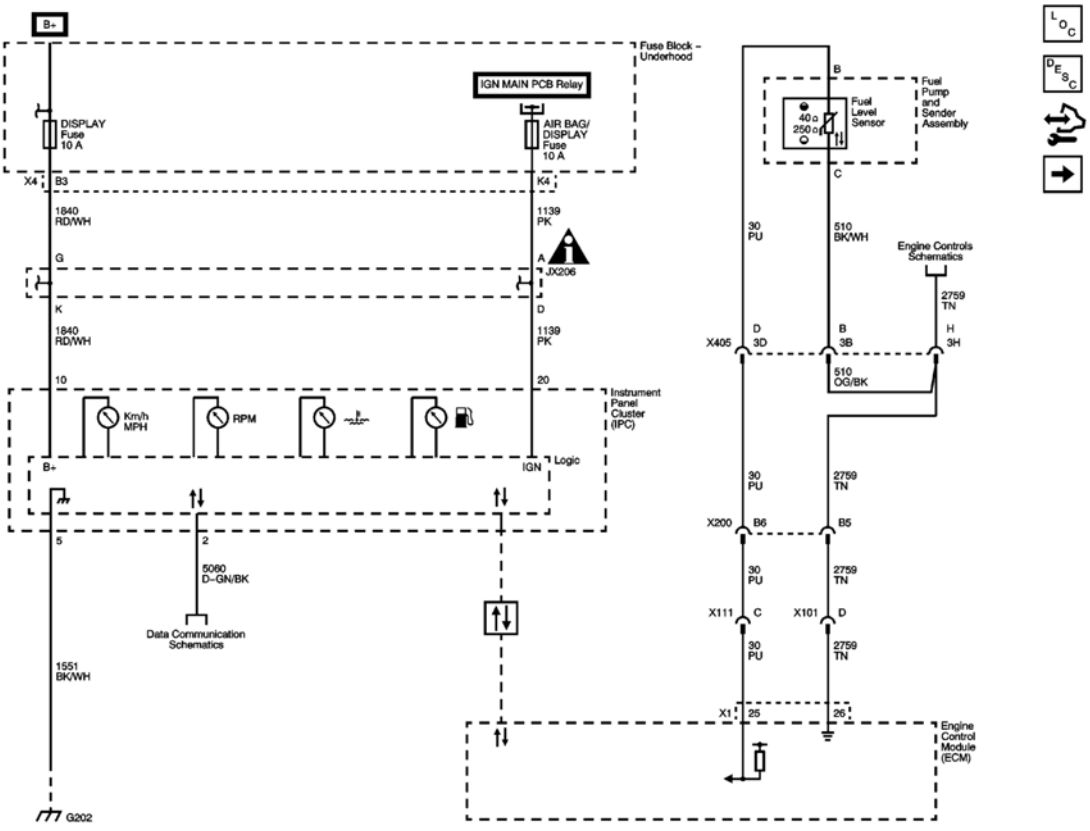


Fig. 1: Power, Ground, and Gauges Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Indicators

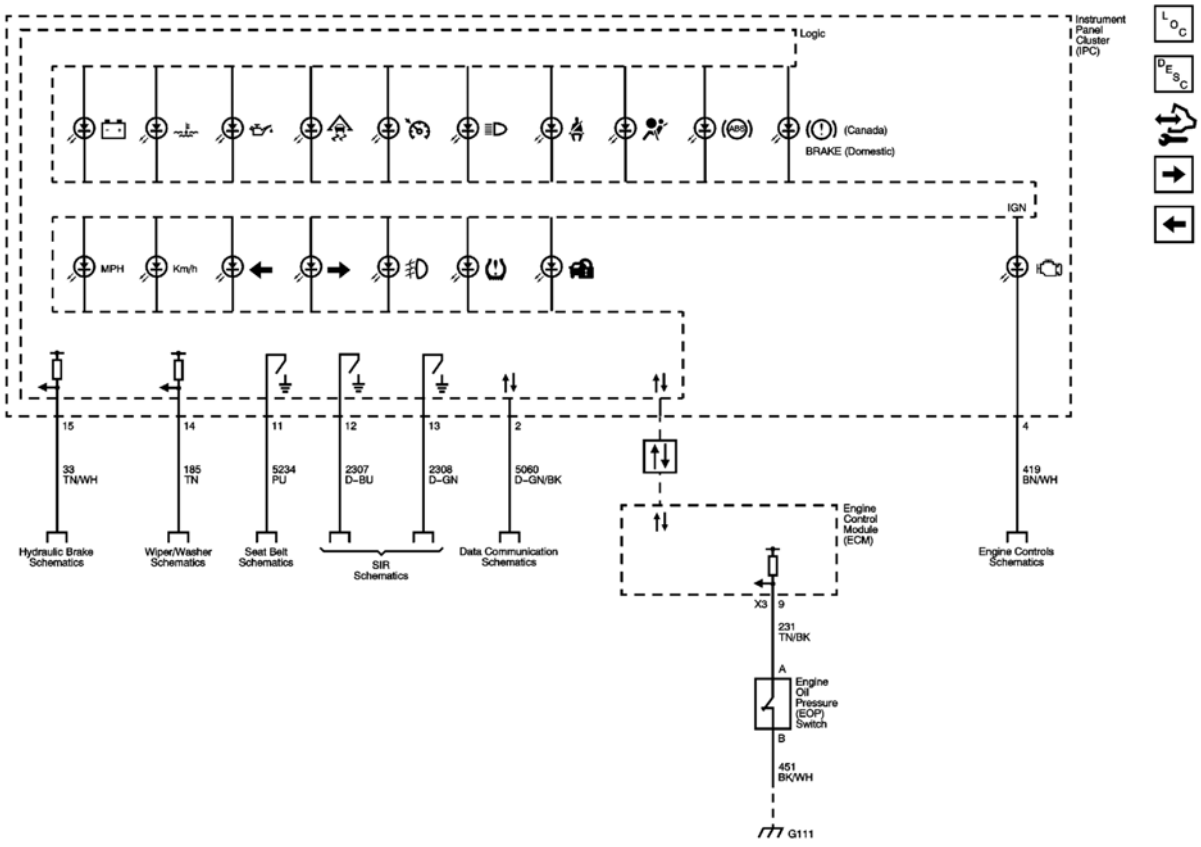


Fig. 2: Indicators Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

Driver Information Center

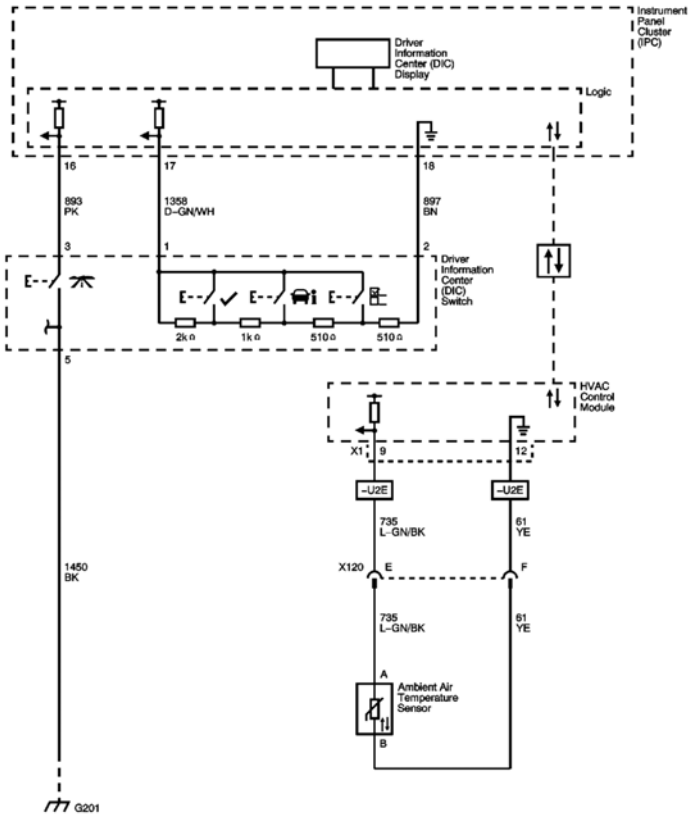


Fig. 3: Driver Information Center Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

AUDIBLE WARNINGS WIRING SCHEMATICS

Audible Warnings

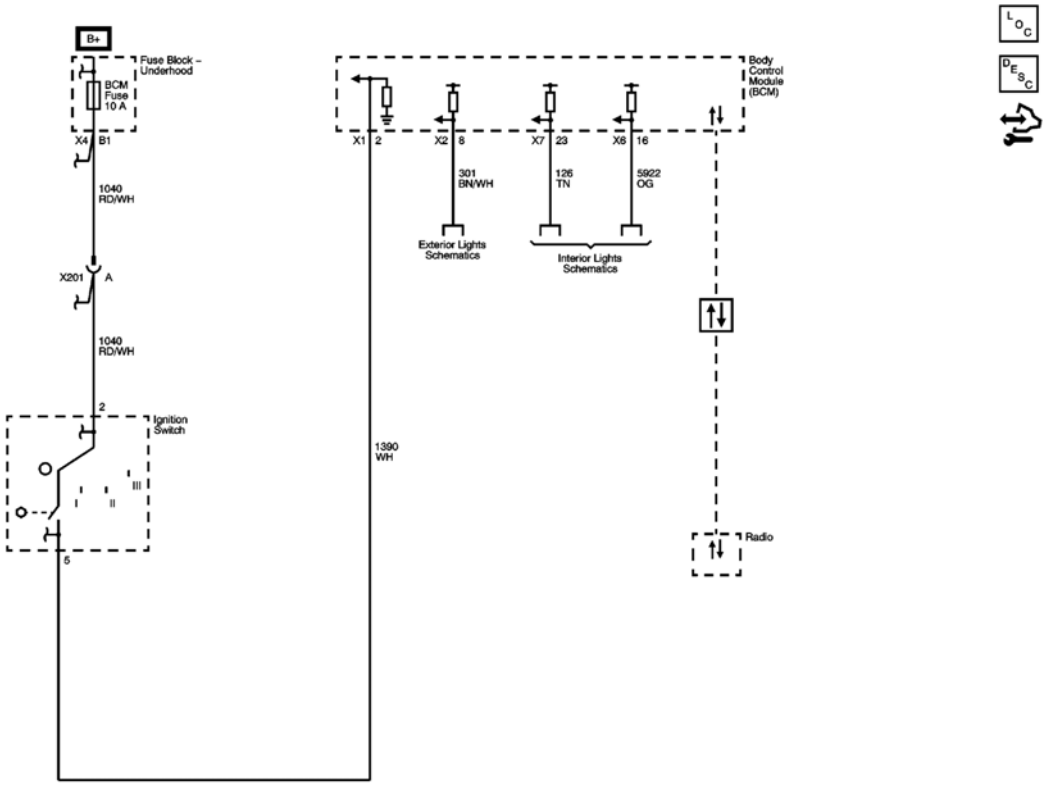


Fig. 4: Audible Warnings Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B3567: DRIVER INFORMATION CENTER SELECT SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3567 01

Driver Information Center Select Switch Circuit Short to Battery

DTC B3567 59

Driver Information Center Select Switch Circuit/Component Protection Time-Out

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
DIC Switch Signal	1	1	P3567 01	P3567 59
DIC Select Switch Signal	1	1	1	P3567
DIC Switch Low Reference	-	1	-	-
DIC Switch Ground	-	1	-	-
1. Driver Information Center (DIC) Switch Malfunction				

Circuit/System Description

The driver information center (DIC) switch is a multiplexed switch. Battery power is provided to the DIC switch via the instrument panel cluster (IPC). The DIC switch signal circuit is pulled up to battery voltage in the IPC. The IPC also provides the DIC switch with a low reference circuit. The switch input to the IPC is pulled low or grounded when a switch is activated. The DIC switch is a momentary contact switch that connects a series of resistors in a resistor ladder format. The IPC monitors the DIC switch signal circuit to determine the DIC switch inputs. Each switch state corresponds to a certain resistance value. The IPC determines the switch pressed by the voltage drop across the resistors. A stuck switch or a short to battery sets a DTC.

The Trip/Fuel switch is monitored on a separate circuit provided by the IPC. The TRIP/FUEL driver information center select menu switch signal circuit is monitored for a stuck switch but not a short to battery.

Conditions for Running the DTC

The ignition is in ACCESSORY or RUN.

Conditions for Setting the DTC

B3567 59

The IPC detects that the DIC switch is stuck.

B3567 01

The IPC detects that the DIC switch signal circuit is shorted to battery.

Action Taken When the DTC Sets

The IPC ignores the DIC switch inputs.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Diagnostic Aids

- When the Trip/Fuel switch is stuck, all other DIC switches will function correctly. When any of the DIC

switches are stuck, only the Trip/Fuel switch functions correctly.

- Only the DIC switch signal circuit can be diagnosed as shorted to battery.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Driver Information Center (DIC) Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, verify that when the DIC switches are pressed and released the DIC scan tool parameters toggle between Active and Inactive.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition OFF, disconnect the harness connector at the DIC switch assembly.
2. Ignition OFF, test for less than 1 ohm between the low reference circuit terminal 2 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance.
3. Ignition OFF, test for less than 5 ohms between the ground terminal 6 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, verify that all of the scan tool DIC Switch parameters are Inactive.
    - If any are not Inactive, test the signal circuit terminal listed below for a short to ground. If the circuit tests normal, replace the IPC.
    - Signal Terminal 1
    - Signal Terminal 3

5. Ignition ON, install a 3-A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the scan tool DIC Switch parameters, except the DIC Fuel Info. parameter, are Active.
    - If any are not Active, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the IPC.
6. Ignition ON, install a 3-A fused jumper wire between the signal circuit terminal 3 and ground. Verify the scan tool DIC Fuel Info. parameter is Active.
    - If not Active, test the signal circuit for a short to voltage or and open/high resistance. If the circuit tests normal, replace the IPC.
7. If all the circuits test normal, test or replace the DIC switch assembly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Driver Information Display Switch Replacement**
- **Control Module References** for IPC replacement, setup and programming

DTC P0461: FUEL LEVEL SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0461

Fuel Level Sensor Circuit Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor Signal	P0462	1	P0463, P0464	P0463	P0461
Fuel Level Sensor Low Reference	-	1	P0463, P0464	P0463	P0461
1. Fuel Gauge Inaccurate or Inoperative					

Circuit/System Description

The fuel level sensor changes resistance in response to the fuel level. The engine control module (ECM) monitors the signal circuit of the fuel level sensor in order to determine the fuel level. When the fuel tank is full, the sensor resistance is low and the ECM senses a low signal voltage. When the fuel tank is empty, the sensor resistance is high and the ECM senses a high signal voltage. The ECM uses the signal circuit of the fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level

percentage via serial data circuit to the instrument cluster in order to control the fuel gauge.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

The ECM detects a change in fuel level of less than a specified amount (typically 3-10 L or 0.8-2.6 gal) over a specified driving distance (typically 240-320 km or 150-200 miles).

Action Taken When the DTC Sets

- The fuel gauge defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Component Testing

1. Ignition OFF, remove the fuel level sender.

2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal B and the low reference terminal C.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
    - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

      Replace the fuel level sensor.

    - **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Level Sensor Replacement** for the 3.9L engine
- **Control Module References** for the ECM replacement, programming, and setup

DTC P0462: FUEL LEVEL SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0462

Fuel Level Sensor Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor Signal	P0462	1	P0463, P0464	P0463	P0461
Fuel Level Sensor Low Reference	-	1	P0463, P0464	P0463	P0461
1. Fuel Gauge Inaccurate or Inoperative					

Circuit/System Description

The fuel level sensor changes resistance in response to the fuel level. The engine control module (ECM) monitors the signal circuit of the fuel level sensor in order to determine the fuel level. When the fuel tank is full, the sensor resistance is low and the ECM senses a low signal voltage. When the fuel tank is empty, the sensor

resistance is high and the ECM senses a high signal voltage. The ECM uses the signal circuit of the fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gauge.

Conditions for Running the DTC

- The ignition is ON, with the engine running.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

- The sender output is less than 0.39 V.
- The above condition is present for greater than 30 seconds.

Action Taken When the DTC Sets

- The fuel gauge defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

With the scan tool installed and the ignition ON, the Fuel Tank Level Remaining parameter in the ECM EVAP Data List should indicate a value at or greater than 98 percent.

Circuit/System Testing

NOTE:

- **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**
- **If equipped, the following tests can be performed at an inline connector. See schematics for the corresponding terminals to test at.**

1. Ignition OFF, disconnect the harness connector at the fuel level sensor.
2. Ignition ON, verify that the scan tool Fuel Tank Level Remaining parameter display is less than 4 percent.
    - If greater than the specified range, test the signal circuit terminal B for a short to ground. If the circuit tests normal, replace the ECM.
3. If all circuits test normal, test or replace the fuel level sensor.

Component Testing

1. Ignition OFF, remove the fuel level sender.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal B and the low reference terminal C.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
    - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

      Replace the fuel level sensor.

    - **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Level Sensor Replacement** for the 3.9L engine
- **Control Module References** for the ECM replacement, setup, and programming

DTC P0463: FUEL LEVEL SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0463

Fuel Level Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor Signal	P0462	1	P0463, P0464	P0463	P0461
Fuel Level Sensor Low Reference	-	1	P0463, P0464	P0463	P0461
1. Fuel Gauge Inaccurate or Inoperative					

Circuit/System Description

The fuel level sensor changes resistance in response to the fuel level. The engine control module (ECM) monitors the signal circuit of the fuel level sensor in order to determine the fuel level. When the fuel tank is full, the sensor resistance is low and the ECM senses a low signal voltage. When the fuel tank is empty, the sensor resistance is high and the ECM senses a high signal voltage. The ECM uses the signal circuit of the fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gauge.

Conditions for Running the DTC

- The ignition is ON, with the engine running.
- The system voltage is between 9-16 V.

Conditions for Setting the DTC

- The sensor output is greater than 2.9 V.
- The above condition is present for greater than 30 seconds.

Action Taken When the DTC Sets

- The fuel gauge defaults to empty.
- The low fuel indicator illuminates.
- The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays the failure information in the Failure Records on the scan tool

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References

Circuit/System Verification

With the scan tool installed and the ignition ON, the Fuel Tank Level Remaining parameter in the ECM EVAP Data List indicates a value at or greater than 4 percent

Circuit/System Testing

NOTE:

- **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**
- **If equipped, the following tests can be performed at an inline connector. See schematics for the corresponding terminals to test at.**

1. Ignition OFF, disconnect the harness connector at the fuel level sensor.
2. Ignition OFF, test for less than 1 Ω between the low reference circuit terminal C and ground.
   - If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal C. Verify the scan tool Fuel Tank Level Remaining parameter display is greater than 98 percent.
   - If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, test or replace the fuel level sensor.

Component Testing

1. Ignition OFF, remove the fuel level sender.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal B and the low reference terminal C.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
    - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

      Replace the fuel level sensor.

    - **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Level Sensor Replacement** for the 3.9L engine
- **Control Module References** for the ECM replacement, programming, and setup

DTC P0464: FUEL LEVEL SENSOR 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0464

Fuel Level Sensor 1 Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor Signal	P0462	1	P0463, P0464	P0463	P0461
Fuel Level Sensor Low Reference	-	1	P0463, P0464	P0463	P0461
1. Fuel Gauge Inaccurate or Inoperative					

Circuit/System Description

The fuel level sensor changes resistance in response to the fuel level. The engine control module (ECM) monitors the signal circuit of the fuel level sensor in order to determine the fuel level. When the fuel tank is full,

the sensor resistance is low and the ECM senses a low signal voltage. When the fuel tank is empty, the sensor resistance is high and the ECM senses a high signal voltage. The ECM uses the signal circuit of the fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gauge.

This diagnostic tests for an intermittent fuel level sensor signal. If a change in fuel level is detected, DTC P0442 is aborted due to a possible refueling event. If refueling is confirmed, the test for DTC P0464 is considered a pass. The refueling event test must pass two out of three times, otherwise, the DTC P0464 will set indicating an intermittent signal problem.

Conditions for Running the DTC

- The ignition is OFF.
- DTC P0442 is running.
- DTC P0464 runs and fails 2 out of 3 test cycles.

Conditions for Setting the DTC

- The fuel level change is greater than 10 percent.
- The above condition is present for less than 30 seconds.

Action Taken When the DTC Sets

- DTC P0442 is aborted.
- The ECM records the operating conditions at the time the diagnostic fails. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction-free warm-up cycles.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 33431-C Instrument Panel Tester

Circuit/System Testing

NOTE: **If equipped, the following tests can be performed at an inline connector. See schematics for the corresponding terminals to test at.**

1. Ignition OFF, disconnect the harness connector at the fuel level sensor.
2. Ignition OFF, test for less than 1 Ω between the low reference circuit terminal C and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuits tests normal, replace the ECM.
3. Install a Signal Generator and Instrument Panel Tester between the signal circuit terminal B and the low reference circuit terminal C.
4. Ignition ON, vary the signal generator resistance between 40 and 250 Ω. Verify that the scan tool Fuel Tank Level Remaining parameter displays a range that varies between 5 and 95 percent as the signal generator resistance changes.
   - If not within the specified range, test the signal circuit for an open/high resistance. If the circuit test normal, replace the ECM.
5. If all circuits test normal, perform the fuel level sensor component test before replacing the fuel level sensor.

Component Testing

1. Ignition OFF, remove the fuel level sender.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal B and the low reference terminal C.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
   - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

     Replace the fuel level sensor.

   - **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Level Sensor Replacement** for the 3.9L engine
- **Control Module References** for the ECM replacement, programming, and setup

DTC P0520: ECM REQUESTING EOP INDICATOR TURNED ON

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Oil Pressure Switch Signal	1	P0520	1	-
Low Reference	-	P0520	-	-
1. Engine Oil Pressure Indicator Malfunction				

Circuit/System Description

The engine oil pressure (EOP) switch is a normally closed switch that opens with the proper oil pressure. With the ignition switch turned ON and the engine not running, the engine control module (ECM) should detect a low signal voltage input. With the engine running, the pressure switch opens, and the ECM should detect a high signal voltage input. The instrument panel cluster (IPC) illuminates the EOP indicator when the IPC receives a serial data message from the ECM requesting the EOP indicator turned ON.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Indicator/Warning Message Description and Operation**
- **Instrument Cluster Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, engine running, verify the scan tool Engine Oil Pressure Switch parameter is OK.

- If not the specified value, refer to:
- **Oil Pressure Diagnosis and Testing**

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

LY7 and LFW

1. Ignition OFF, disconnect the harness connector at the engine oil pressure (EOP) switch.
2. Ignition OFF, test for less than 1 ohm of resistance between the low reference circuit terminal B and ground.
   - If greater than the specified value, test the circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Engine Oil Pressure Switch parameter is OK.
   - If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the ECM.
4. Ignition ON, install a 3-amp fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool Engine Oil Pressure Switch parameter is Low.
   - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the engine oil pressure switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Oil Pressure Sensor and/or Switch Replacement (LF1, LFW or LFX)**
- **Control Module References** for ECM replacement, setup, and programming

SYMPTOMS - DISPLAYS AND GAUGES

NOTE: **The following steps must be completed before using the symptom diagnostic tables.**

1. Before using the symptom diagnostic tables, perform the **Diagnostic System Check - Vehicle** in order to determine that there are no DTCs set, and that the control modules can communicate via the serial data link.

2. Review the system operation in order to understand the system functions. Refer to the following description and operations.
    - **Instrument Cluster Description and Operation**
    - **Indicator/Warning Message Description and Operation**
    - **Driver Information Center (DIC) Description and Operation**
    - **Audible Warnings Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which can affect the operation of the instrument panel cluster or the audible warnings system. Refer to **Checking Aftermarket Accessories** .
- Inspect the accessible system components or the visible system components for obvious damage or for obvious conditions which can cause the symptom.
- Inspect for the proper fluid levels.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

Gauges and Odometer

- **Fuel Gauge Malfunction**
- **Instrument Cluster Gauges Malfunction**

Indicators

- **ABS Indicator Malfunction**
- **Airbag Indicator Malfunction (Driver)** **Airbag Indicator Malfunction (Passenger)**
- **Brake Warning Indicator Malfunction (Without UJ1)**
- **Charge Indicator Malfunction**
- **Cruise Control Indicator Malfunction**
- **Engine Coolant Temperature Indicator Malfunction**
- **Door Ajar Indicator Malfunction**
- **Engine Oil Pressure Indicator Malfunction**
- **Low Washer Fluid Indicator Malfunction**
- **Seat Belt Indicator Malfunction - Driver**
- **Seat Belt Indicator Malfunction - Passenger**
- **Security Indicator Malfunction**
- **Low Tire Pressure Indicator Malfunction**
- **StabiliTrak Indicator Malfunction**

- **Trunk Ajar Indicator Malfunction**
- **Turn Signal Lamps and/or Indicators Malfunction**

Driver Information Center

Driver Information Center Switch Malfunction

Audible Warnings

Chime Malfunction

CHARGE INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine control module (ECM) uses the generator turn ON signal circuit to control the load of the generator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON signal circuit. The ECM should detect low voltage on the generator turn on signal circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn on signal circuit. The ECM performs key ON and RUN tests to determine the status of the generator turn on signal circuit. If a malfunction is detected the ECM will illuminate the charge indicator in the instrument panel cluster (IPC).

Reference Information

Schematic Reference

- **Instrument Cluster Schematics**
- **Starting and Charging Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, engine running, verify the scan tool Battery Voltage parameter is between 12.5 and 15.5 volts.
   - If not within the specified range, refer to **Charging System Test** .
2. Ignition ON, perform the display test with the scan tool. The charge indicator should turn ON and OFF when changing between the commanded states.
   - If the indicator does not turn ON and OFF between commanded states, replace the IPC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for the IPC replacement, setup, and programming

CHIME MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Key In Ignition B+	-	1	-	-
Key In Ignition Signal	1	1	1	-
1. Chime Malfunction				

Circuit/System Description

The radio generates the audible warning through the left speaker. The radio receives audible warning requests via the serial data circuit from the instrument panel cluster (IPC) or the body control module (BCM).

Reference Information

Schematic Reference

Audible Warnings Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Audible Warnings Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Before performing this diagnostics, make sure no indicator(s) are illuminated after the IPC performs the displays test. If any indicators are illuminated after the bulb test, perform the indicator diagnostics before this diagnostic.**

1. Ignition ON, headlamp switch OFF, verify the scan tool Headlamp Switch ON parameter is Inactive.
   - If not Inactive, refer to **Headlamps Malfunction** .
2. Ignition ON, park lamp switch OFF, verify the scan tool Park Lamp Switch parameter is Inactive.
   - If not Inactive, refer to **Park, License, and/or Tail Lamps Malfunction** .
3. Ignition ON, doors closed, verify the scan tool Door Ajar Switch parameters are Door Closed.
   - If not Door Closed, refer to **Courtesy Lamps Malfunction** .
4. Ignition ON, radio ON, adjust the radio balance and fade to the left front speaker.
   - If the speaker does not operate properly, refer to **Speaker Malfunction** .
5. Verify that the Key In Ignition Status parameter is Key In when the key is in the ignition and Key Out when the key is out of the ignition.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition OFF, disconnect the harness connector at the ignition switch.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for an open/high resistance. If the circuit tests normal and the BCM circuit fuse is open, test the signal circuit terminal 5 for a short to ground.
3. Verify the scan tool Key In Ignition Status parameter is Key Out.
   - If not the specified value, test the signal circuit terminal 5 for a short to voltage. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal 5 and the B+ circuit terminal 2. Verify

the scan tool Key in Ignition Status parameter is Key In.

- If not the specified value, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the BCM.

5. If all circuits test normal, test or replace the ignition switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Ignition and Start Switch Replacement**
- **Control Module References** for the BCM replacement, setup, and programming

COMPASS MALFUNCTION (DIC)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The compass information is displayed in the driver information center (DIC). As the vehicle travels with or against the earths magnetic pull, the compass heading signal to the DIC changes. As a result of the compass heading signal change, the DIC adjusts and changes the direction of the compass display. When an invalid signal is sent to the DIC or a malfunction exists in the compass heading, the DIC blanks the display and displays '- -' , 'CAL' or C.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Driver Information Center (DIC) Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that the DIC compass does not display "C" or "CAL".
   - **If the DIC compass displays "C" or "CAL" and Compass Calibration and Magnetic Variance (Driver Information Center (DIC)) has not been performed**

     Perform the Compass Calibration and Magnetic Variance procedure. Refer to Compass Calibration and Magnetic Variance (Driver Information Center (DIC)).

   - **If the DIC compass displays "C" or "CAL" and Compass Calibration and Magnetic Variance (Driver Information Center (DIC)) has been performed**

     Replace the IPC.

   - **If the DIC compass does not display "C" or "CAL"**
2. Verify that the DIC compass display is not blank.
   - **If the DIC compass display is blank**

     Replace the IPC.

   - **If the DIC compass display is not blank**
3. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for control module replacement, programming, and setup

DRIVER INFORMATION CENTER SWITCH MALFUNCTION

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
DIC Switch Signal	1	1	P3567 01	P3567 59
DIC Select Switch Signal	1	1	1	P3567
DIC Switch Low Reference	-	1	-	-
DIC Switch Ground	-	1	-	-
1. Driver Information Center (DIC) Switch Malfunction				

Circuit/System Description

The driver information center (DIC) switch is a multiplexed switch. Battery power is provided to the DIC switch via the instrument panel cluster (IPC) with the DIC switch signal circuit pulled up to battery voltage in the IPC. The IPC also provides the DIC switch with a low reference circuit. The switch input to the IPC is pulled low or grounded when a switch is activated. The DIC switch is a momentary contact switch that connects a series of resistors in a resistor ladder format. The IPC monitors the DIC switch signal circuit to determine the DIC switch inputs. Each switch state - SET/RESET, VEHICLE INFORMATION, PERSONALIZATION (CUSTOMIZATION) - corresponds to a certain resistance value. The IPC determines the switch state by the voltage drop across the resistors.

The TRIP/FUEL DIC switch is monitored on a separate circuit provided by the IPC. The TRIP/FUEL driver information center select menu switch signal circuit is monitored for a stuck switch but not a short to battery.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Driver Information Center (DIC) Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, verify that when the DIC switches are pressed and released the DIC scan tool parameters toggle between Active and Inactive.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition OFF, disconnect the harness connector at the DIC switch assembly.
2. Ignition OFF, test for less than 1 ohm between the low reference terminal 2 and ground.

- If greater than the specified range, test the low reference circuit for an open/high resistance.

3. Ignition OFF, test for less than 1 ohm between the ground terminal 5 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON, verify that all of the scan tool DIC Switch parameters are Inactive.
    - If any are not Inactive, test the signal circuit terminal listed below for a short to ground. If the circuit tests normal, replace the IPC.
    - Signal Terminal 1
    - Signal Terminal 3
5. Ignition ON, install a 3-A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 2. Verify the scan tool DIC Switch parameters, except the DIC Fuel Info. parameter, are Active.
    - If any are not Active, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the IPC.
6. Ignition ON, install a 3-A fused jumper wire between the signal circuit terminal 3 and ground. Verify the scan tool DIC Fuel Info. parameter is Active.
    - If not Active, test the signal circuit for a short to voltage or and open/high resistance. If the circuit tests normal, replace the IPC.
7. If all the circuits test normal, test or replace the DIC switch assembly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Driver Information Display Switch Replacement**
- **Control Module References** for the IPC replacement, setup and programming

ENGINE COOLANT TEMPERATURE INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The instrument panel cluster (IPC) illuminates the TEMP indicator when the engine control module (ECM) determines that the coolant temperature is more than 128Â°C (262Â°F). The IPC receives a discrete input from the ECM requesting illumination.

The IPC illuminates the TEMP indicator during the display test at the start of each ignition cycle.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Instrument Cluster Description and Operation**
- **Cooling System Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that the engine coolant temperature indicator illuminates during the self test when the ignition is turned ON.
    - If the temperature indicator does not illuminate, replace the IPC.
2. Ignition ON, verify that the scan tool Engine Coolant Temperature (ECT) Sensor parameter is within the temperature range shown on the engine coolant temperature gauge.
    - If not within the specified range, replace the IPC.
3. If the temperature gauge is normal, refer to **Engine Overheating** .

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for the IPC replacement, setup, and programming

ENGINE OIL PRESSURE INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Oil Pressure Switch Signal	1	P0520	1	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Reference	-	P0520	-	-
1. Engine Oil Pressure Indicator Malfunction				

Circuit/System Description

The engine oil pressure (EOP) switch is a normally closed switch that opens with the proper oil pressure. With the ignition switch turned ON and the engine not running, the engine control module (ECM) should detect a low signal voltage input. With the engine running, the pressure switch opens, and the ECM should detect a high signal voltage input. The instrument panel cluster (IPC) illuminates the EOP indicator when the IPC receives a serial data message from the ECM requesting the EOP indicator turned ON.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Indicator/Warning Message Description and Operation**
- **Instrument Cluster Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, engine running, verify the scan tool Engine Oil Pressure Switch parameter is OK.

- If not the specified value, refer to:
- **Oil Pressure Diagnosis and Testing**

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with**

Circuit/System Testing.

LY7 and LFW

1. Ignition OFF, disconnect the harness connector at the engine oil pressure (EOP) switch.
2. Ignition OFF, test for less than 1 ohm of resistance between the low reference circuit terminal B and ground.
   - If greater than the specified value, test the circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Engine Oil Pressure Switch parameter is OK.
   - If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the ECM.
4. Ignition ON, install a 3-amp fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool Engine Oil Pressure Switch parameter is Low.
   - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the engine oil pressure switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Oil Pressure Sensor and/or Switch Replacement (LF1, LFW or LFX)**
- **Control Module References** for ECM replacement, setup, and programming

FUEL GAUGE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Fuel Level Sensor Signal	P0462	1	P0463, P0464	P0463	P0461
Fuel Level Sensor Low Reference	-	1	P0463, P0464	P0463	P0461
1. Fuel Gauge Inaccurate or Inoperative					

Circuit/System Description

The fuel level sensor changes resistance in response to the fuel level. The engine control module (ECM) monitors the signal circuit of the fuel level sensor in order to determine the fuel level. When the fuel tank is full, the sensor resistance is low and the ECM senses a low signal voltage. When the fuel tank is empty, the sensor

resistance is high and the ECM senses a high signal voltage. The ECM uses the signal circuit of the fuel level sensor in order to calculate the percentage of remaining fuel in the tank. The ECM sends the fuel level percentage via serial data circuit to the instrument cluster in order to control the fuel gauge.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 33431-C Instrument Panel Tester

Circuit/System Testing

NOTE: **If equipped, the following tests can be performed at an inline connector. See schematics for the corresponding terminals to test at.**

1. Ignition OFF, disconnect the harness connector at the fuel level sensor.
2. Ignition OFF, test for less than 1 Ω between the low reference circuit terminal C and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuits tests normal, replace the ECM.
3. Install a Signal Generator and Instrument Panel Tester between the signal circuit terminal B and the fuel level sensor low reference circuit terminal C.
4. Ignition ON, vary the signal generator resistance between 40 and 250 Ω. Verify that the scan tool Fuel Tank Level Remaining parameter displays a range that varies between 5 and 95 percent as the signal generator resistance changes.
   - If not within the specified range, test the signal circuit for an open/high resistance. If the circuit test normal, replace the ECM.

5. Vary the signal generator resistance between 40 and 250 Ω. Verify that the fuel gauge displays a range that varies between empty and full as the signal generator resistance changes.
    - If the fuel gauge is incorrect, replace the fuel gauge.
6. If all circuits test normal, perform the fuel level sensor component test before replacing the fuel level sensor.

Component Testing

1. Ignition OFF, remove the fuel level sender.
2. Sweep the fuel level sensor through its full range of motion while measuring resistance between the signal terminal B and the low reference terminal C.
3. Test for a minimum resistance value of 37-43 Ω and a maximum value of 245-255 Ω without any spikes or dropouts.
    - **If minimum resistance is not 37-43 Ω, maximum resistance is not 245-255 Ω, or if there are any spikes or dropouts**

      Replace the fuel level sensor.

    - **If minimum resistance is 37-43 Ω, maximum resistance is 245-255 Ω, and if there are no spikes or dropouts**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Level Sensor Replacement** for the 3.9L engine
- **Control Module References** for the ECM replacement, programming, and setup

INSTRUMENT CLUSTER GAUGES MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

This diagnostic procedure applies to serial data gauges located in the instrument panel cluster (IPC) which include the speedometer, tachometer, engine coolant temperature gauge and volt gauge if equipped.

Reference Information

Schematic Reference

Instrument Cluster Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Instrument Cluster Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Lifting and Jacking the Vehicle**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

IMPORTANT: If the suspect gauge is the speedometer, the drive wheels of the vehicle must be raised and the transmission must be placed in drive or first gear.

1. Ignition ON, perform the IPC gauge sweep test with the scan tool. Verify that all the gauges sweep from their low to high position.
    - If any gauges do not sweep from their low to high position, replace the IPC.
2. Engine ON, transmission in drive or first gear, verify the scan tool Vehicle Speed parameter matches the speedometer display.
    - If the Vehicle Speed parameter does not match the speedometer display, test or replace the IPC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for the IPC replacement, setup and programming

REPAIR INSTRUCTIONS

DRIVER INFORMATION DISPLAY SWITCH REPLACEMENT

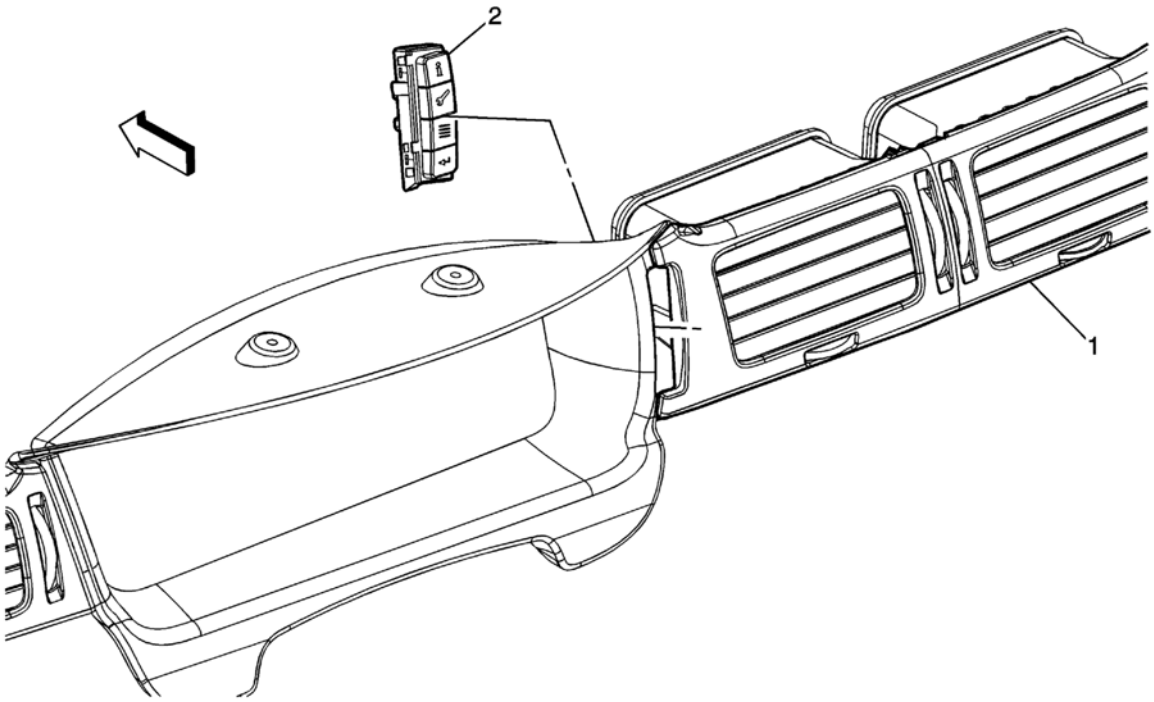


Fig. 5: Driver Information Center Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel Trim Plate Assembly Refer to **Instrument Panel Trim Plate Replacement** .
2	Driver Information Center Switch Assembly

INSTRUMENT CLUSTER REPLACEMENT

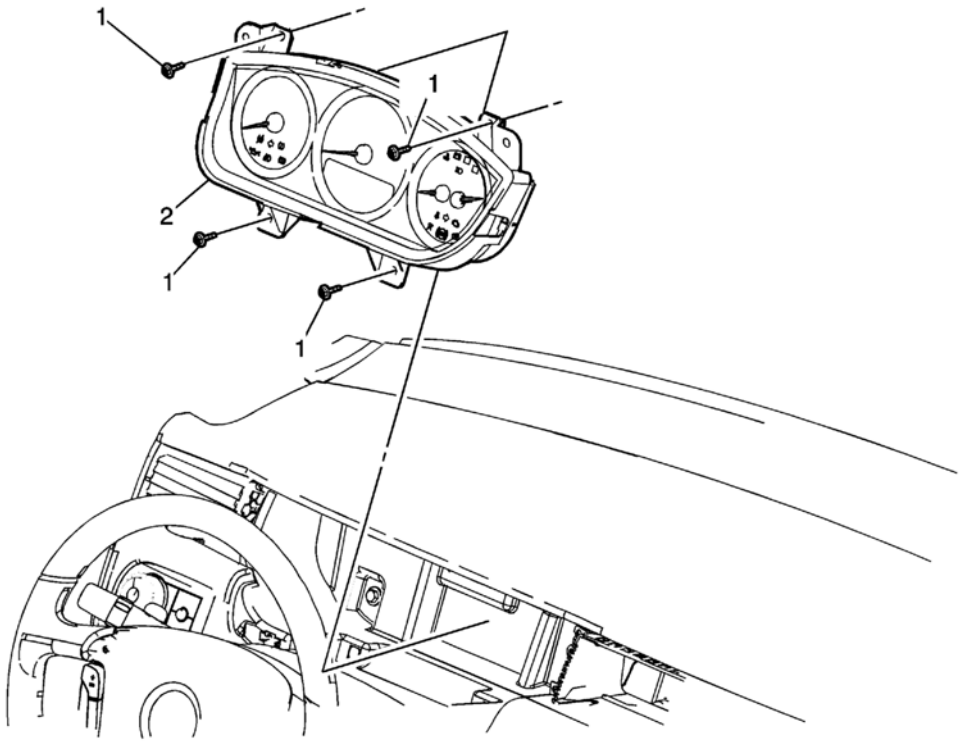


Fig. 6: Instrument Panel Cluster (IPC)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel (I/P) trim plate. Refer to **Instrument Panel Trim Plate Replacement** .	
1	Instrument Panel Cluster Screw (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 2 N.m (18 lb in)
2	Instrument Panel Cluster Assembly **Procedure** 1. Disconnect the electrical connector. 2. Refer to **Control Module References** for programming and setup information.

DESCRIPTION AND OPERATION

AUDIBLE WARNINGS DESCRIPTION AND OPERATION

The audible warnings alert the driver of a system concern or a critical vehicle condition. The audio amplifier generates the audible warnings through the left front speaker. The audio amplifier receives audible warning requests via the serial data circuit. If the audio amplifier receives multiple audible warning requests, the warning with the highest priority sounds first. The following lists the audible warning priority and the pulse rate:

1. Fast rate chime-200 pulses per minute
2. Medium rate chime-150 pulses per minute
3. Slow rate chime-50 pulses per minute
4. Single chime

Fasten Safety Belt Warning

The audio amplifier activates the fasten safety belt audible warning as requested by the body control module (BCM). The BCM sends a serial data message to the audio amplifier indicating the chime frequency at a slow rate and a duration of 8 seconds. The fasten safety belt warning sounds and the fasten safety belt indicator illuminates when the following occurs:

- The ignition switch transitions to ON.
- The inflatable restraint sensing and diagnostic module (SDM) detects that the driver's seat belt is not buckled and the signal is low. The SDM sends a serial data message to the BCM indicating the seat belt status. The instrument panel cluster (IPC) receives a serial data message from the BCM indicating the driver seat belt status.

If the seat belt is buckled when the ignition is turned ON, the chime does not sound. If the seat belt is buckled while the chime is sounding, the chime stops. If the seat belt is unbuckled after the initial transition to ON, the chime does not sound.

Lights On Warning

The audio amplifier activates the lights on warning as requested by the body control module (BCM). The BCM sends a serial data message to the audio amplifier indicating the chime frequency of a fast rate and at a continuous duration. The lights on warning sounds when the following occurs:

- The ignition is OFF.
- The BCM determines that the driver door is open and the signal circuit is low.
- The BCM determines that the headlamp switch is in the park or head position.

Brake Warning

The audio amplifier activates the brake audible warning as requested by the instrument panel cluster (IPC). The IPC sends a serial data message to the audio amplifier indicating the chime frequency and duration. The brake audible warning sounds and the BRAKE indicator illuminates when the following occurs:

- The ignition is ON.
- The vehicle speed is greater than 4 km/h (2.5 mph). The IPC receives a serial data message from the engine control module (ECM) indicating the vehicle speed.
- The IPC determines that the park brake is engaged from a BCM serial data message.
- The brake fluid is low.

- The dynamic rear proportioning (DRP) failed (if equipped)

Key-In-Ignition Warning

The audio amplifier activates the key-in-ignition audible warning as requested by the body control module (BCM). The BCM sends a serial data message to the radio indicating the chime frequency of a medium rate and continuous duration. The key-in-ignition warning sounds when the following occurs:

- The ignition switch is OFF.
- The BCM determines that the driver door is open and the signal circuit is low. The IPC also receives a serial data message from the BCM indicating the door ajar status
- The BCM determines that the key-in-ignition switch is open and the signal circuit is high. The IPC receives a serial data message from the BCM indicating the key-in-ignition status.

Door Ajar Warning

The audio amplifier activates the door ajar audible warning as requested by the IPC. The IPC sends a serial data message to the radio indicating the chime frequency. The door ajar warning sounds and the door ajar message is displayed in the DIC when the following occurs:

- The IPC determines that the driver door is open and the signal circuit is low. The IPC also displays the appropriate door ajar message in the DIC.
- The vehicle is not in PARK. The IPC receives a serial data message from the BCM indicating the gear position.

Additional Audible Warnings

The following instrument panel cluster (IPC) indicators or driver information center (DIC) messages have an associated audible warning to alert the driver of a system concern or critical vehicle condition. The audio amplifier activates the audible warning as requested by the IPC via the serial data circuit.

- Antilock Brake System (ABS)
- Vehicle Dynamics Caution (VDC)
- Hot coolant temperature
- Turn Signal
- Low fuel
- Low engine oil pressure
- Transmission Hot Idle Engine
- Buckle Seat Belt
- Buckle Passenger Seat Belt
- Engine Overheated Stop Engine
- Hood Open
- Trunk Open
- Engine Power Reduced

Refer to **Indicator/Warning Message Description and Operation**.

COMPASS CALIBRATION AND MAGNETIC VARIANCE (DRIVER INFORMATION CENTER (DIC))

Compass Calibration

The compass direction will show CAL if it needs to be calibrated. Before calibrating the compass, drive the vehicle to an area that is magnetically clean (free of large metallic objects).

1. Turn ON the ignition.
2. Before calibrating the compass, make sure the compass is set to the variance zone in which the vehicle is travelling. See Compass Magnetic Variation Adjustment below.
3. Press the vehicle information button until the PRESS TO CALIBRATE COMPASS screen is displayed.
4. Press the set/reset button to start the compass calibration.
5. The DIC will display CALIBRATING: DRIVE IN CIRCLES. Drive the vehicle in circles at less than 8 km/h (5 mph) to complete the calibration. The DIC will display CALIBRATION COMPLETE when the calibration is complete.

Compass Magnetic Variation Adjustment

Compass variance is the difference between the earth's magnetic north and true geographic north. If not adjusted to account for compass variance, the compass in the vehicle could give false readings. Under certain circumstances, such as during a long distance cross-country trip, it will be necessary to compensate for compass variance and reset the zone through the DIC.

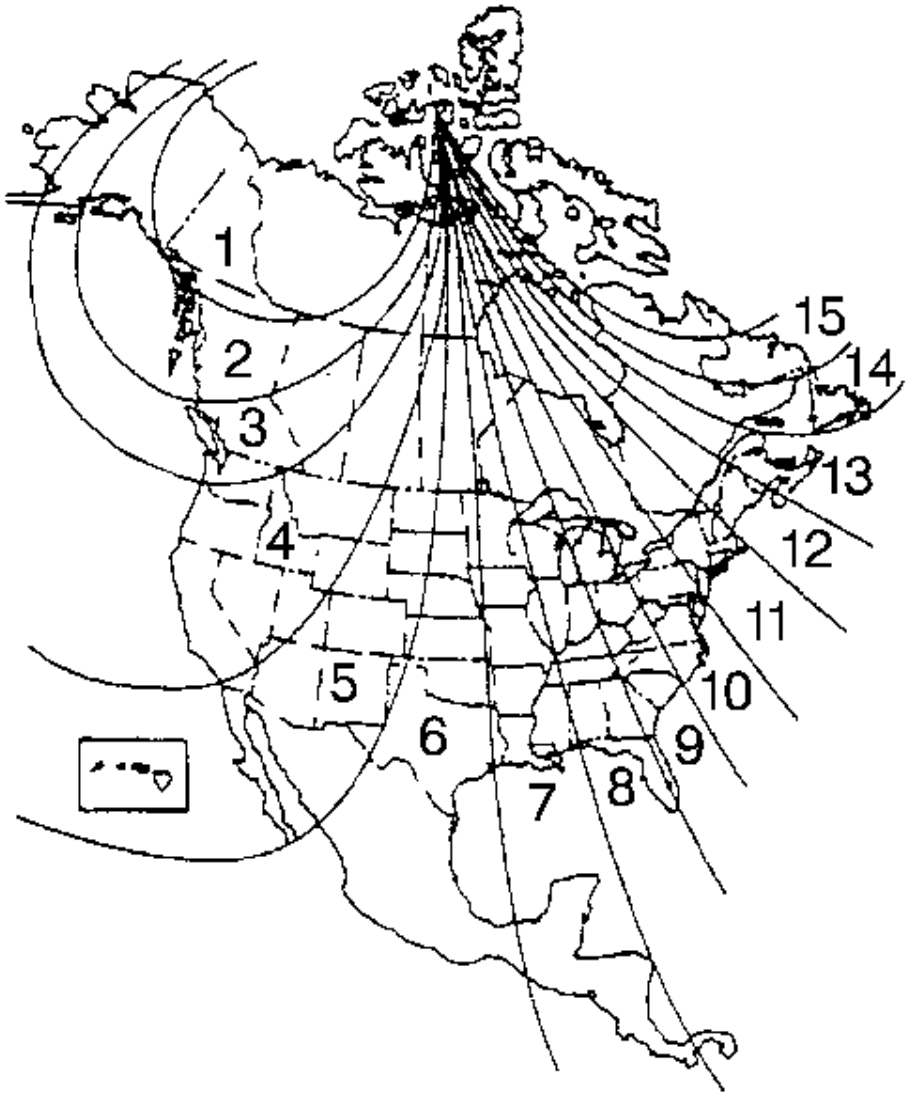


Fig. 7: Illustrating Magnetic Variation Zones
Courtesy of GENERAL MOTORS COMPANY

1. Locate your geographic location. Refer to the variation zone map.
2. Turn ON the ignition with the engine OFF.
3. Press the vehicle information button until PRESS TO CHANGE COMPASS ZONE displays on the DIC.
4. Press the set/reset button to scroll through and select the appropriate variance zone.
5. Navigate to one of the trip/fuel menu screens to view the direction the vehicle is moving. This will be shown in the top right corner of the DIC display.

If the compass needs to be calibrated, use the compass calibration procedure above.

DRIVER INFORMATION CENTER (DIC) DESCRIPTION AND OPERATION

The driver information center (DIC) displays the DIC WOW for 5 seconds when it first powers up. If enabled through Customization menu, the DIC then returns to the last display status before no power condition.

There are 4 switch functions for the DIC.

- Trip/Fuel Info Switch
- Vehicle Information Switch
- Customization Switch.
- Set/Reset Switch

Trip/Fuel Info Switch

The Trip/Fuel switch is used to navigate between vehicle fuel information parameters. Cycle through the following vehicle parameters by successive pressing of the Trip/Fuel Info switch.

- Blank Display
- Average Fuel Economy (AFE)
- Average Vehicle Speed (AVE)
- Displacement on Demand (DOD)
- Fuel Range
- Instantaneous Fuel Economy (IFE)/ Displacement on Demand (DOD)
- Instantaneous Fuel Economy (IFE)
- Odometer
- Trip A
- Trip B

Vehicle Information Switch

The Vehicle Information switch is used to navigate between vehicle information parameters. Cycle through the following vehicle parameters by successive pressing of the Vehicle Information switch.

- Blank Display
- Compass Zone Setting (without UE1)
- Compass Recalibration (without UE1)
- English/Metric Units
- Front Tire Pressure
    - Tire Pressure LF
    - Tire Pressure RF
- Key Fob Programming Menu (Relearn Remote Key)
- Oil Life Index (OLI)
- Rear Tire Pressure
    - Tire Pressure LR
    - Tire Pressure RR
- Tire Inflation Monitoring System (TIMS) Reset (Relearn Tire Position)

Customization Switch

The customization switch is used to set personalization features for the vehicle. Many of the parameters in the Trip/Fuel menu and the Vehicle Info menu can be programmed through the customization switch. In addition to the parameters in the Trip/Fuel and Vehicle Info menus, the following features can also be programmed. Refer to the vehicle owner's manual for more customization information.

- Approach Lighting
- Automatic Door Lock
- Automatic Door Unlock
- Chime Volume
- Delayed Door Lock
- Display Language
- Easy Exit Seat
- Exit Lighting
- Factory Setting
- Language
- Memory Seat Recall
- Remote Door Lock
- Remote Door Unlock
- Remote Start

Set/Reset Switch

Press the Set/Reset button in order to set or acknowledge any of the switch menu options.

Average Fuel Economy

Average fuel economy is calculated using the equation: AFE = Distance/Fuel

- Distance = The accumulated distance travelled since the last reset of this value
- Fuel = The accumulated fuel consumption since the last reset of this value

The ECM sends the average fuel economy serial data message to the IPC. The value of this mode is retained during ignition OFF and can be changed between English units and metric units by selecting from the English/Metric menu.

Average Speed

Average speed is calculated using the equation: Average Speed = AVS Distance/AVS Time

- Distance = The accumulated distance travelled since the last reset of this value
- Ignition On = The accumulated ignition on time since the last reset of this value

Fuel Range

This message indicates the estimated distance that the vehicle can travel under the current fuel economy and fuel level conditions since the last battery connection to the IPC. Fuel Range is calculated using the equation:

Fuel Range = Range Distance/Range Fuel Used.

- Range Distance = The accumulated distance travelled since the last reset of this value.
- Fuel Used = The accumulated fuel delivered since the last reset of this value

The ECM sends the fuel range value to the instrument panel cluster (IPC). The fuel range value is retained during ignition OFF and can be changed between English and Metric units by accessing the English/Metric menu. The Fuel Range display cannot be reset. LOW is displayed when fuel range is below a predetermined value.

Engine Oil Life Remaining

The engine control module (ECM) sends the engine oil life remaining percentage to the instrument panel cluster (IPC) via the serial data circuit. The instrument panel cluster receives a serial data message indicating the engine oil life remaining. The driver information center (DIC) displays the current percentage of the GM Oil Life System as determined by the ECM. When the oil life remaining percentage drops below 5 percent, the DIC displays CHANGE ENGINE OIL SOON. When the engine oil is changed, reset the GM Oil Life System. Refer to **GM Oil Life System Resetting** .

Tire Pressure Monitor

The instrument panel cluster (IPC) receives a serial data message from the tire pressure monitoring (TPM) system for front and rear tire pressure data. The driver information center (DIC) will display the pressure for each of the front and rear tires. When a tire with low air pressure is present, the DIC displays XX TIRE PRESSURE LOW.

English/Metric Button

The English/Metric button is used to toggle between English and Metric unit systems and can be accessed through the Vehicle Info switch function.

Trip A/B

The trip odometer A or B can be accessed through the Trip/Fuel switch function.

Language

The DIC is capable of displaying in three languages:

- English
- French
- Spanish

A simultaneous press of the vehicle Information and customization switches for about 1 second provides a shortcut to change the language without understanding the currently displayed language. The Language settings may also be assessed through the customization switch.

Compass

The DIC displays the compass information on the right most 2 characters of the first DIC line when the compass is an option on the vehicle. When corresponding to the true north radial degrees, the compass displays

the following directions

Compass Display

Radial Degree (True North)	Compass Direction
337.5 to 22.5	N
22.5 to 67.5	NE
67.5 to 112.5	E
112.5 to 157.5	SE
157.5 to 202.5	S
247.5 to 292.5	W

INDICATOR/WARNING MESSAGE DESCRIPTION AND OPERATION

INDICATOR LIGHT ON

Refer to the OWNER'S MANUAL for the descriptions and explanations of all indicator lights.

For diagnosis and repair information related to an indicator light refer to the System Diagnosis and the Description of Operation that the message relates to.

MESSAGE DISPLAYED

Refer to the OWNER'S MANUAL for descriptions and explanations of all messages displayed.

For diagnosis and repair information related to a displayed message refer to the System Diagnosis and the Description of Operation that the message relates to.

CHANGE TIMING BELT MESSAGE

The Instrument Cluster monitors the odometer mileage to determine when timing belt (if equipped) replacement may be necessary. After the vehicle has accumulated approximately 100,000 miles (160,000 kilometers), the Instrument Cluster may display the CHANGE TIMING BELT message. After the engine timing belt has been replaced, reset the CHANGE TIMING BELT message by locating and removing the fuses that supply power to the Instrument Cluster for two minutes.

BRAKES OVERHEATED

The Electronic Brake Control Module monitors brake usage and compares it to an internal thermal model to determine if the brakes could become overheated. If the Electronic Brake Control Module determines the brakes pads have exceeded a desirable temperature based on the thermal model, it sends a serial data message to the Instrument Cluster to display the BRAKES OVERHEATED message. The message remains displayed until the estimated temperature returns to a desirable range.

Transmission Shift Lever Position Indicator

The Transmission Shift Lever Position Indicator (if equipped) is located on the center console and indicates the current transmission shift lever position. The Transmission Shift Lever Position Indicator receives power and ground and is controlled by the Body Control Module (BCM) via serial data. The Transmission Control Module determines transmission shift lever position based on signals from the Transmission Internal Mode Switch and sends the shift lever position information to the BCM via serial data.

INSTRUMENT CLUSTER DESCRIPTION AND OPERATION

Displays Test

Certain instrument panel cluster (IPC) features are tested when the ignition is turned on in order to verify the features are working properly. The following occurs at key up:

- The air bag indicator flashes 7 times (not IPC controlled).
- The antilock brake systems (ABS) indicator illuminates briefly.
- The battery Indicator illuminates briefly.
- The brake indicator illuminates briefly.
- The coolant temperature indicator.
- The engine oil pressure indicator illuminates briefly.
- The malfunction indicator lamp (MIL) illuminates briefly (not IPC controlled).
- The seat belt indicator illuminates for 70 seconds or until the driver seat belt is latched (not IPC controlled).
- The security indicator illuminates briefly.
- The tire pressure low indicator
- The vehicle dynamics caution (VDC) indicator
- All message center segments illuminate briefly.
- All odometer segments illuminate briefly.
- The PRNDL segment illuminates briefly.

Indicators and Warning Messages

Refer to **Indicator/Warning Message Description and Operation**.

Engine Coolant Temperature Gauge

The instrument panel cluster (IPC) displays the engine coolant temperature as determined by the engine control module (ECM). The IPC receives a serial data message from the ECM indicating the engine coolant temperature. The IPC receives the coolant temperature information via serial data message from the body control module (BCM). The engine coolant temperature gauge defaults to 60Â°C (140Â°F) or below if:

- The ECM detects a malfunction in the engine coolant temperature sensor circuit.
- The IPC detects a loss of serial data communications with the ECM.
- The IPC detects a loss of serial data communications with the BCM.

Fuel Gauge

The instrument panel cluster (IPC) displays the fuel level as determined by the engine control module (ECM). The IPC receives a serial data message from the ECM indicating the fuel level percent. The body control module (BCM) sends the fuel level information from the ECM to the IPC via a serial data message indicating the fuel level percent. The fuel gauge defaults to empty if:

- The ECM detects a malfunction in the fuel level sensor circuit.
- The IPC detects a loss of serial data communications with the ECM.

- The IPC detects a loss of serial data communications with the BCM.

When the fuel level is less than a pre-determined value, the low fuel indicator illuminates in the IPC.

Odometer

The vehicle odometer is calculated and stored electronically in the instrument panel cluster (IPC). The IPC contains a season odometer and trip odometer A or B. Momentarily press the trip/fuel button in order to toggle between the season odometer and the trip odometer. Press the set/reset button for greater than 0.25 seconds, while the trip odometer is displayed, in order to reset the trip odometer. The IPC displays the vehicle mileage and trip mileage as determined by the engine control module (ECM). The IPC calculates the mileage based on the serial data vehicle speed information from the ECM. The odometer will display 'error' if an internal IPC memory failure is detected. The odometer displays either miles or kilometers and can be set through the customization menu in the driver information center (DIC).

PRNDL Display

The instrument panel cluster (IPC) displays the selected gear position as determined by the engine control module (ECM). The IPC receives a serial data message from the ECM indicating the gear position. The PRNDL display blanks if:

- The ECM detects a malfunction in the transmission range switch circuit.
- The IPC detects a loss of serial data communications with the ECM.
- The IPC detects a loss of serial data communications with the body control module (BCM).

Speedometer

The instrument panel cluster (IPC) displays the vehicle speed as determined by the engine control module (ECM). The IPC calculates the mileage based on serial data vehicle speed information from the ECM. The IPC receives vehicle speed information from the body control module (BCM) via a serial data message. The speedometer defaults to 0 km/h (0 mph) if the IPC detects a loss of serial data communications with the ECM or BCM.

Tachometer

The instrument panel cluster (IPC) displays the engine speed as determined by the engine control module (ECM). The IPC receives a serial data message from the ECM indicating the engine speed. The IPC receives the engine speed information from the body control module (BCM) via a serial data message. The tachometer will default to 0 RPM if:

- The ECM detects a malfunction in the engine speed sensor circuit.
- The IPC detects a loss of serial data communications with the ECM.
- The IPC detects a loss of serial data communications with the BCM.

Article GUID: A00737157

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Outer Belt Sealing Strip Screw, Front Door (Impala)	2 N.m	18 lb in
Outer Belt Sealing Strip Screw, Rear Door (Impala)	2 N.m	18 lb in
Weatherstrip Channel Screws, Front Door (Impala)	10 N.m	89 lb in
Window Regulator Bolts, Front Door (Impala)	10 N.m	89 lb in
Window Regulator Bolts, Rear Door (Impala)	10 N.m	89 lb in
Window to Regulator Bolts, Front Door (Impala)	10 N.m	89 lb in
Window to Regulator Bolts, Rear Door (Impala)	10 N.m	89 lb in
Window Channel Retainer Screws, Front Door (Impala)	2 N.m	18 lb in
Window Channel Retainer Screws, Rear Door (Impala)	2 N.m	18 lb in
Window Rear Channel Screws, Front Door	10 N.m	89 lb in
Window Regulator Motor	4.6 N.m	41 lb in

SCHEMATIC WIRING DIAGRAMS

MOVEABLE WINDOW WIRING SCHEMATICS

Moveable Windows

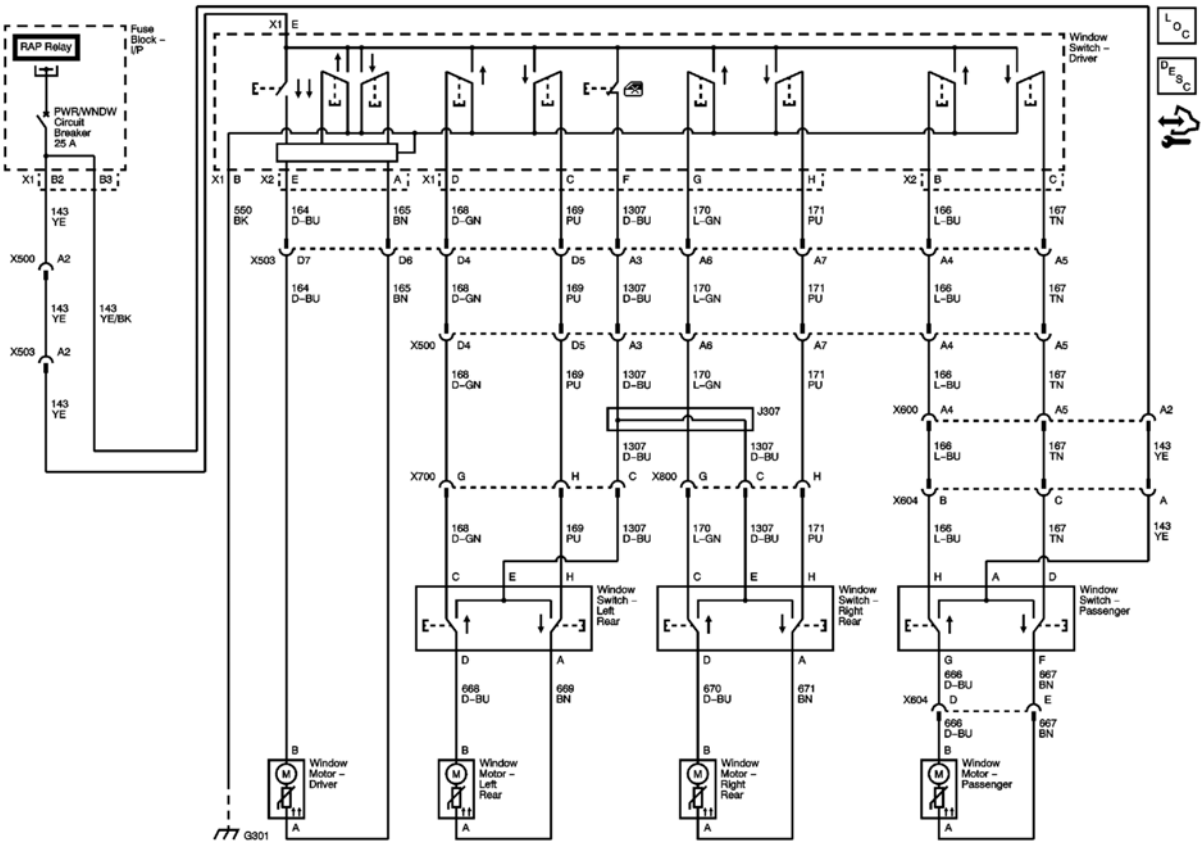


Fig. 1: Moveable Window Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DEFOGGER WIRING SCHEMATICS

Defogger

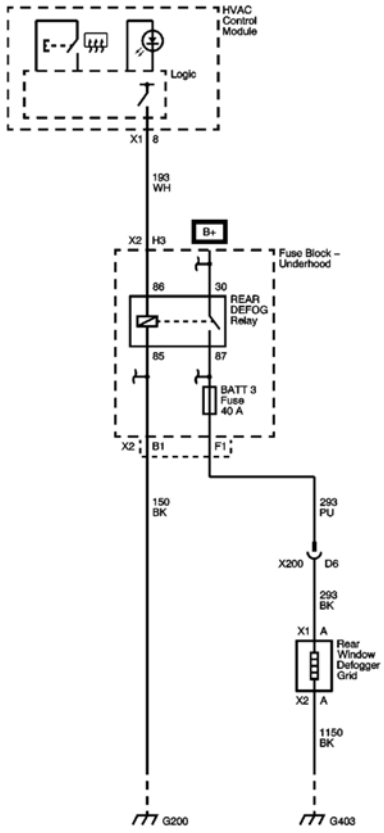


Fig. 2: Defogger Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B0283: ELECTRIC REAR DEFROST CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0283 05

Electric Rear Defrost Circuit Short to Battery or Open

DTC B0283 06

Electric Rear Defrost Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	B0283 06	B0283 05	B0283 05	-
Ground	-	B0283 05	-	-

Circuit/System Description

When the rear defogger button is pressed, voltage is supplied to the relay coil and the HVAC control module also illuminates the rear window defogger indicator. Battery positive voltage is supplied at all times to the relay switched input and the relay coil is always grounded. This allows battery positive voltage from the relay switched input through the switch contacts and out the relay switched output to the rear window defogger.

Conditions for Running the DTC

When the relay is being actively commanded by the HVAC control module.

Conditions for Setting the DTC

B0283 06

The HVAC control module detects a short to ground in the relay coil control circuit for 1 second or greater.

B0283 05

The HVAC control module detects a short to battery or open/high resistance in the relay coil control circuit for 1 second or greater.

Action Taken When the DTC Sets

The rear window defogger will malfunction.

Conditions for Clearing the DTC

- The DTC clears when the fault is no longer detected.
- The current DTC will become history when the request for the output is removed.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Defogger Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Rear Window Defogger Description and Operation

Electrical Information Reference

- **Testing for Intermittent Conditions and Poor Connections**
- **Circuit Testing**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine Running.
2. Verify the E18 Rear Defogger Grid turns ON and OFF when commanding the Rear Defog Request On and Off with a scan tool.
    - **If the E18 Rear Defogger Grid does not turn ON or OFF**

      Refer to Circuit/System Testing

    - **If the E18 Rear Defogger Grid turns ON and OFF**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR5 Rear Defogger Relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 85 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 10 Ω**
3. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85, Engine Running.
4. Verify the test lamp turns ON and OFF when commanding the Rear Defog Request On and Off with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K33 HVAC Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω, replace the K33 HVAC Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K33 HVAC Control Module, Ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K33 HVAC Control Module.

- **If the test lamp turns ON and OFF**

5. Test or replace the KR5 Rear Defogger Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR5 Rear Defogger Relay.
2. Test for 60-180 Ω between terminals 85 and 86.
    - **If less than 60 Ω or greater than 180 Ω**

      Replace the KR5 Rear Defogger Relay.

    - **If between 60-180 Ω**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - **If less than infinite resistance**

      Replace the KR5 Rear Defogger Relay.

    - **If infinite resistance**
4. Install a 3 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 Ω between terminals 30 and 87.
    - **If 2 Ω or greater**

      Replace the KR5 Rear Defogger Relay.

    - **If less than 2 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Relay Replacement (Attached to Wire Harness) Relay Replacement (Within an Electrical Center)
- Control Module References for HVAC control module replacement, setup and programming

SYMPTOMS - FIXED AND MOVEABLE WINDOWS

IMPORTANT: For the rear window defogger system, the following steps must be performed before using the symptom tables.

1. Perform the Diagnostic System Check - Vehicle before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the power window system operation or rear window defogger system operation in order to familiarize yourself with the system functions. Refer to Rear Window Defogger Description and Operation.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the rear window defogger. Refer to Checking Aftermarket Accessories .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Rear Window Defogger Malfunction
- Power Windows Malfunction

DEFOGGER GRID LINES DIAGNOSIS

NOTE: **If it has been observed during use that a grid line is inoperative, the following procedure can be used to find the break. If none of the grid lines is operating, a full system diagnosis should be completed before attempting to test the grid lines**

NOTE: **Lightly touch the grid lines when testing with the test lamp. If the test lamp point is scraped through the grid line it can cause an open in the circuit**

1. Engine running, command the Rear Defogger ON with a scan tool.
2. Verify that a test lamp illuminates between each rear window defogger grid line and ground. The test lamp should be off when testing at the ground side of the grid and get brighter as the test lamp moves

closer to the voltage supply side of the grid. The test lamp should be dim when testing each grid line in the middle

- **If the test lamp remains bright at the middle of the grid line.**

  The grid line is open between the test point and the ground side of the grid.

  Replace the rear window

- **If the test lamp remains off at the middle of the grid line.**

  The grid line is open between the test point and the voltage supply side of the grid.

  Replace the rear window

- **If the test lamp remains dim at the middle of each grid line.**

3. All OK

REAR WINDOW DEFOGGER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+	2	2	-	-
Rear Defog Relay Control	B0283 06	B0283 05	B0283 05	-
Rear Window Defogger Grid Control	2	2	1	-
Relay Coil Ground	-	B0283 05	-	-
Rear Window Defogger Grid Ground	-	2	-	-
1. Rear defogger always On 2. Rear defogger inoperative				

Circuit/System Description

When the rear defogger button is pressed, voltage is supplied to the relay coil and the HVAC control module also illuminates the rear window defogger indicator. Battery positive voltage is supplied at all times to the relay switched input and the relay coil is always grounded. This allows battery positive voltage from the relay switched input through the switch contacts and out the relay switched output to the rear window defogger grid.

Reference Information

Schematic Reference

Defogger Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Rear Window Defogger Description and Operation

Electrical Information Reference

- **Testing for Intermittent Conditions and Poor Connections**
- **Circuit Testing**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, verify the scan tool Rear Defrost State parameter changes between On and Off while pressing the rear window defogger switch.
    - If the parameter does not change, replace the HVAC control module.
2. Verify the rear defogger indicator turns ON and OFF while commanding the Rear Defog LED On and Off with a scan tool.
    - If the indicator does not turn ON or OFF, replace the HVAC control module.
3. Verify the rear window defogger grid turns ON and OFF while commanding the Rear Defog Request On and Off with a scan tool.

Circuit/System Testing

1. Ignition OFF, disconnect the REAR DEFOG relay.
2. Test for less than 10 Ω between the ground circuit terminal 85 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp does not illuminate between the control circuit terminal 87 and ground.
    - If the test lamp illuminates, test the control circuit for a short to voltage.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
    - If the test lamp does not illuminate, replace the underhood fuse block.
5. Ignition OFF, disconnect the X2 harness connector at the rear window defogger grid.
6. Test for less than 10 Ω between the ground circuit terminal A and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the X2 harness connector at the rear window defogger grid.
8. Ignition ON, connect a 40A fused jumper wire between the B+ circuit terminal 30 and the control circuit

terminal 87. Verify the rear window defogger grid is activated.

- If the rear window defogger grid does not activate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, refer to **Defogger Grid Lines Diagnosis**.

9. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
10. Engine running, command the Rear Defog Request ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the HVAC control module.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the HVAC control module.
11. If all circuits test normal, test or replace the REAR DEFOG relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the REAR DEFOG relay.
2. Test for 60-180 Ω between terminals 85 and 86.
    - If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If not the specified value, replace the relay.
4. Install a 3 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.
    - If greater than the specified range, replace the relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Rear Window Replacement**
- **Front Compartment Fuse Block Fuse Replacement (MIDI-Fuse)**
- **Control Module References** for HVAC control module replacement, setup and programming

POWER WINDOWS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Window Switch Ignition	4	1, 3	-	-
Driver Window Switch Ground	-	4	-	-
Passenger Window Switch Ignition	4	2	-	-
Passenger Window Switch Signal	4	2	2	-
Rear Window Switch Signal	4	3	3	-
Driver Window Motor Control	4	1	1	-
Lockout Switch Control	4	3	3	-
Passenger Window Motor Control	4	2	2	-
Rear Window Motor Control	4	3	3	-
1. Driver Window Malfunction 2. Passenger Window Malfunction 3. Rear Windows Malfunction 4. All Windows Inoperative				

Circuit/System Description

The driver power window switch contains individual window switches for each of power windows. All windows may be controlled up and down from the driver power window switch. The individual passenger power window switches will only control the up and down operation of their respective power window.

Each power window contains a reversible power window motor. The direction the window travels is dependent upon the polarity of the supply voltage. By reversing polarity of the supply voltage the window motor will move up or down. Each power window motor is internally circuit breaker protected.

Battery voltage is supplied to the power window switch through the accessory voltage supply circuit. The power window switch also receives a constant ground source. The power window motor control circuits are connected to ground through the normally closed up and down contacts of the power window switch. When the power switch is placed in the down position, the power window motor down control circuit is switched to 12 volts and is applied to the down side of the power window motor. Since the other side of the power motor is connected to ground through the normally closed contacts of the up switch, the window travels down. By placing the power window switch in the up position, the polarity of the power window motor is reversed and the window travels up.

Reference Information

Schematic Reference

Moveable Window Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Windows Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition ON.
2. Verify the driver window performs the UP and DOWN functions.
    - **If the driver window does not perform the UP or DOWN functions**

      Refer to Circuit/System Testing - Driver Window Inoperative

    - **If the driver window performs the UP and DOWN functions**
3. Verify the passenger window performs the UP and DOWN functions at both the driver and passenger door switches.
    - **If the passenger window is inoperative from both the driver and passenger window switches**

      Refer to Circuit/System Testing - Passenger Window Inoperative From Both Switches.

    - **If the passenger window is inoperative from the passenger window switch only**

      Refer to Circuit/System Testing - Passenger Window Switch Inoperative.

    - **If the passenger window is inoperative from the driver window switch only**

      Test or replace the S79D Window Switch - Driver.

    - **If the passenger window performs the UP and DOWN functions at both switches**
4. Verify the left rear and right rear window performs the UP and DOWN functions at both the driver and each of the rear door switches.
    - **If a rear window is inoperative from both the driver and rear window switch**

      Refer to Circuit/System Testing - Rear Window Inoperative From Both Switches

    - **If a rear window is inoperative from the rear window switch only**

      Refer to Circuit/System Testing - Rear Window Lockout Malfunction

    - **If a rear window is inoperative from the driver window switch only**

Test or replace the S79D Window Switch - Driver.

- **If the rear window performs the UP and DOWN functions at both the driver and rear window switch**

5. Lock out the rear window switches by pressing the lockout switch on the driver window switch.
6. Verify the left rear and right rear windows are inoperative at both of the rear door switches .
    - **If both rear windows continue to function from the rear door switches**

      Refer to Circuit/System Testing - Rear Window Lockout Malfunction

    - **If both rear windows are inoperative from the rear window switches**
7. All OK.

Circuit/System Testing

Driver Window Inoperative

1. Ignition OFF and all vehicle systems OFF, disconnect the X1 harness connector at the S79D Window Switch-Driver. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal B and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal E and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, refer to **Retained Accessory Power Malfunction** .
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the ignition circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for infinite resistance between the control circuits listed below and ground:
        - Control circuit terminal A X2
        - Control circuit terminal B X2
        - Control circuit terminal C X1

- Control circuit terminal C X2
- Control circuit terminal D X1
- Control circuit terminal E X2
- Control circuit terminal F X1
- Control circuit terminal G X1
- Control circuit terminal H X1
- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the S79D Window Switch-Driver.

- **If the test lamp illuminates**

5. Ignition OFF and all vehicle systems OFF, X1 connect the harness connector at the S79D Window Switch-Driver and disconnect the harness connector at the M74D Window Motor-Driver. It may take up to 2 minutes for all vehicle systems to power down
6. Test for less than 10 Ω between the control circuit terminal A and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the X2 harness connector at the S79D Window Switch-Driver.
   2. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the S79D Window Switch-Driver.
   - **If less than 10 Ω**
7. Test for less than 10 Ω between the control circuit terminal B and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the X2 harness connector at the S79D Window Switch-Driver.
   2. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the S79D Window Switch-Driver.
   - **If less than 10 Ω**
8. Connect a test lamp between control circuit terminal A and control circuit terminal B, Ignition ON.
9. Verify the test lamp turns ON when commanding the UP and DOWN states with the S79D Window Switch-Driver.
   - **If the test lamp remains OFF during either of the commands**
   1. Ignition OFF, remove the test lamp, disconnect the X2 harness connector at the S79D Window Switch-Driver.
   2. Test for infinite resistance between each control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the S79D Window Switch-Driver.
   - **If the test lamp is always ON**
   1. Ignition OFF, remove the test lamp, disconnect the X2 harness connector at the S79D Window Switch-Driver, Ignition ON.
   2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the S79D Window Switch-Driver.

- **If the test lamp turns ON and OFF**

10. Test or replace the M74D Window Motor-Driver.

Passenger Window Inoperative From Both Switches

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S79P Window Switch-Passenger. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the control circuit terminal D and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the X2 harness connector at the S79D Window Switch-Driver.
   2. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the S79D Window Switch-Driver.
   - **If less than 10 Ω**
3. Test for less than 10 Ω between the control circuit terminal D and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the X2 harness connector at the S79D Window Switch-Driver.
   2. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the S79D Window Switch-Driver.
   - **If less than 10 Ω**
4. Connect a test lamp between the control circuit terminal D and control circuit terminal H, Ignition ON.
5. Verify the test lamp turns ON when commanding the UP and DOWN functions with the S79D Window Switch-Driver.
   - **If the test lamp remains OFF during either of the commands**
   1. Ignition OFF, remove the test lamp, disconnect the X2 harness connector at the S79D Window Switch-Driver.
   2. Test for infinite resistance between each control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the S79D Window Switch-Driver.
   - **If the test lamp is always ON**
   1. Ignition OFF, remove the test lamp, disconnect the X2 harness connector at the S79D Window Switch-Driver, Ignition ON.
   2. Test for less than 1 V between the control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the S79D Window Switch-Driver.
   - **If the test lamp turns ON and OFF**
6. Ignition OFF and all vehicle systems OFF, connect the harness connector at the S79P Window Switch-

Passenger and disconnect the harness connector at the M74P Window Motor-Passenger. It may take up to 2 minutes for all vehicle systems to power down.

7. Test for less than 10 Ω between the control circuit terminal A and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the S79P Window Switch-Passenger.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the S79P Window Switch-Passenger.
    - **If less than 10 Ω**
8. Test for less than 10 Ω between the control circuit terminal B and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the S79P Window Switch-Passenger.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the S79P Window Switch-Passenger.
    - **If less than 10 Ω**
9. Connect a test lamp between control circuit terminal A and control circuit terminal B, Ignition ON.
10. Verify the test lamp turns ON when commanding the UP and DOWN functions with the S79P Window Switch-Passenger.
    - **If the test lamp remains OFF during either of the commands**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S79P Window Switch-Passenger.
    2. Test for infinite resistance between each control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the S79P Window Switch-Passenger.
    - **If the test lamp is always ON**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S79P Window Switch-Passenger, Ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the S79P Window Switch-Passenger.
    - **If the test lamp turns ON and OFF**
11. Test or replace the M74P Window Motor-Passenger.

Passenger Window Switch Inoperative

1. Ignition OFF, disconnect the harness connector at the S79P Window Switch-Passenger, Ignition ON
2. Verify a test lamp illuminates between the ignition circuit terminal A and ground.
    - **If the test lamp does not illuminate**
    1. Ignition OFF.

2. Test for less than 2 Ω in the ignition circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, verify the fuse is OK and there is voltage at the fuse.
- **If the test lamp illuminates**

3. Test or replace the S79P Window Switch-Passenger.

Rear Window Inoperative From Both Switches

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate rear S79 Window Switch. it may take up to 2 minutes for all vehicle systems to power down
2. Test for less than 10 Ω between the control circuit terminal C and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF, disconnect the X1 harness connector at the S79D Window Switch-Driver.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the S79D Window Switch-Driver.
    - **If less than 10 Ω**
3. Test for less than 10 Ω between the control circuit terminal H and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF, disconnect the X1 harness connector at the S79D Window Switch-Driver.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the S79D Window Switch-Driver.
    - **If less than 10 Ω**
4. Connect a test lamp between the control circuit terminal C and control circuit terminal H, Ignition ON.
5. Verify the test lamp turns ON when commanding the UP and DOWN states with the S79D Window Switch-Driver.
    - **If the test lamp remains OFF during either of the commands**
    1. Ignition OFF, remove the test lamp, disconnect the X1 harness connector at the S79D Window Switch-Driver.
    2. Test for infinite resistance between each control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the S79D Window Switch-Driver.
    - **If the test lamp is always ON**
    1. Ignition OFF, remove the test lamp, disconnect the X1 harness connector at the S79D Window Switch-Driver, Ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the S79D Window Switch-Driver.
    - **If the test lamp turns ON and OFF**

6. Ignition OFF and all vehicle systems OFF, connect the harness connector at the rear S79 Window Switch and disconnect the harness connector at the rear M74 Window Motor. It may take up to 2 minutes for all vehicle systems to power down.
7. Test for less than 10 Ω between the control circuit terminal listed below and ground:
    - Control terminal A
    - Control terminal B
    - **If 10 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the rear S79 Window Switch.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the rear S79 Window Switch.
    - **If less than 10 Ω**
8. Connect a test lamp between the control circuit terminal A and the control circuit terminal B, Ignition ON.
9. Verify the test lamp turns ON when commanding the UP and DOWN states with the rear S79 Window Switch.
    - **If the test lamp remains OFF during either of the commands**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the rear S79 Window Switch.
    2. Test for infinite resistance between each control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the rear S79 Window Switch.
    - **If the test lamp is always ON**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the rear S79 Window Switch, Ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the rear S79 Window Switch.
    - **If the test lamp turns ON and OFF**
10. Test or replace the rear M74 Window Motor.

Rear Window Lockout Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate rear S79 Window Switch.
2. Ignition ON, connect a test lamp between the control circuit terminal E and ground.
3. Verify the test lamp turns ON and OFF when pressing the rear window lockout switch ON and OFF on the S79D Window Switch-Driver.
    - **If the test lamp is always OFF**
    1. Ignition OFF, remove the test lamp, disconnect the X1 harness connector at the S79D Window Switch-Driver.
    2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the S79D Window Switch-Driver.

- **If the test lamp is always ON**

1. Ignition OFF, remove the test lamp, disconnect the X1 harness connector at the S79D Window Switch-Driver, Ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the S79D Window Switch-Driver.

- **If the test lamp turns ON and OFF**

4. Test or replace the rear S79 Window Switch.

Component Testing

Window Motor

1. Ignition OFF, disconnect the harness connector at the appropriate M74 Window Motor.
2. Install a 25 A fused jumper wire between one of the control terminals and 12 V. Momentarily install a jumper wire between the other control terminal and ground. Reverse the jumper wires at least two times, the M74 Window Motor should perform the UP and DOWN functions.
    - **If the M74 Window Motor does not perform the UP and DOWN functions**

      Replace the M74 Window Motor.

    - **If the M74 Window Motor performs the UP and DOWN functions**
3. All OK

Driver Window Switch

1. Ignition OFF, disconnect the X1 and X2 harness connectors at the S79D Window Switch-Driver.
2. Test for infinite resistance between the terminals listed below with the switch in the open position:
    - Ignition terminal E X1 and control terminal A X2
    - Ignition terminal E X1 and control terminal B X2
    - Ignition terminal E X1 and control terminal C X1
    - Ignition terminal E X1 and control terminal C X2
    - Ignition terminal E X1 and control terminal D X1
    - Ignition terminal E X1 and control terminal E X2
    - Ignition terminal E X1 and control terminal F X1
    - Ignition terminal E X1 and control terminal G X1
    - Ignition terminal E X1 and control terminal H X1
    - **If less than infinite resistance**

Replace the S79D Window Switch-Driver.

- **If infinite resistance**

3. Test for less than 3 Ω between the terminals listed below with the switch in the open position:
   - Ground terminal B X1 and control terminal A X2
   - Ground terminal B X1 and control terminal B X2
   - Ground terminal B X1 and control terminal C X1
   - Ground terminal B X1 and control terminal C X2
   - Ground terminal B X1 and control terminal D X1
   - Ground terminal B X1 and control terminal E X2
   - Ground terminal B X1 and control terminal F X1
   - Ground terminal B X1 and control terminal G X1
   - Ground terminal B X1 and control terminal H X1
   - **If 3 Ω or greater**

     Replace the S79D Window Switch-Driver.

   - **If less than 3 Ω**
4. Test for less than 3 Ω between the terminals listed below with the switch in the Up position.
   - Ignition terminal E X1 and control terminal B X2
   - Ignition terminal E X1 and control terminal D X1
   - Ignition terminal E X1 and control terminal E X2
   - Ignition terminal E X1 and control terminal G X1
   - Ignition terminal E X1 and control terminal H X1
   - **If 3 Ω or greater**

     Replace the S79D Window Switch-Driver.

   - **If less than 3 Ω**
5. Test for less than 3 Ω between the terminals listed below with the switch in the Down position:
   - Ignition terminal E X1 and control terminal A X2
   - Ignition terminal E X1 and control terminal C X1
   - Ignition terminal E X1 and control terminal C X2
   - Ignition terminal E X1 and control terminal H X1
   - **If 3 Ω or greater**

     Replace the S79D Window Switch-Driver.

   - **If less than 3 Ω**
6. All OK

Passenger Window Switch

1. Ignition OFF, disconnect the harness connector at the S79P Window Switch-Passenger.
2. Test for infinite resistance between the terminals listed below with the switch in the open position:
    - Ignition terminal A and control terminal F
    - Ignition terminal A and control terminal G
    - **If less than infinite resistance**

      Replace the S79P Window Switch-Passenger.

    - **If infinite resistance**
3. Test for less than 3 Ω between the control terminals listed below with the switch in the open position:
    - Control terminal G and control terminal H
    - Control terminal D and control terminal F
    - **If 3 Ω or greater**

      Replace the S79P Window Switch-Passenger.

    - **If less than 3 Ω**
4. Test for less than 3 Ω between the ignition terminal A and the control terminal G with the switch in the Up position.
    - **If 3 Ω or greater**

      Replace the S79P Window Switch-Passenger.

    - **If less than 3 Ω**
5. Test for less than 3 Ω between the ignition terminal A and the control terminal F with the switch in the Down position.
    - **If 3 Ω or greater**

      Replace the S79P Window Switch-Passenger.

    - **If less than 3 Ω**
6. All OK

Rear Window Switch

1. Ignition OFF, disconnect the harness connector at the appropriate rear S79 Window Switch.
2. Test for infinite resistance between the terminals listed below with the switch in the open position:
    - Control terminal E and control terminal A
    - Control terminal E and control terminal D
    - **If less than infinite resistance**

      Replace the rear S79 Window Switch.

    - **If infinite resistance**
3. Test for less than 3 Ω between the control terminals listed below with the switch in the open position:

- Control terminal C and control terminal D
- Control terminal A and control terminal H
- **If 3 Ω or greater**

  Replace the rear S79 Window Switch.

- **If less than 3 Ω**

4. Test for less than 3 Ω between the control terminal E and the control terminal D with the switch in the Up position.
   - **If 3 Ω or greater**

     Replace the rear S79 Window Switch.

   - **If less than 3 Ω**
5. Test for less than 3 Ω between the control terminal E and the control terminal A with the switch in the Down position.
   - **If 3 Ω or greater**

     Replace the rear S79 Window Switch.

   - **If less than 3 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Window Switch Replacement (Impala)**
- **Front Side Door Window Regulator Motor Replacement**
- **Rear Side Door Window Regulator Motor Replacement**
- **Rear Side Door Window Switch Replacement**

SIDE DOOR WINDOW MECHANICAL DIAGNOSIS

Cause	Correction
DEFINITION: A mechanical condition that requires a correction for proper operation of the side door window. Refer to **Symptoms - Fixed and Moveable Windows** prior to beginning this table.	
Intermittent Operation	Check proper glass alignment/attachment and door seal installation.
	Check switch and switch bezel to see if sticking.
	Check wire harness for pinched/shorted wire.
	THIS STEP APPLIES TO ALL TWO PIN MOTOR CONNECTORS ONLY. Perform electrical diagnostics, by first applying 12 volt power supply to the regulator motor to verify motor function.
Glass Binds	Check proper glass alignment/attachment.
	Check for defective seal and/or proper seal installation.

Cause	Correction
	Check for debris in glass run channel.
	Check for glass run channel position.
Regulator/Glass Rattles	Check for loose fasteners and retorque if required.
	Check that the glass is in the channel and reinstall if not positioned correctly.
Noisy Operation	Check for other components in the glass path such as wire harness, impact foam, lock rods, or cables.
	Check for proper glass alignment/attachment and door seal installation.
Windnoise	Check seals, mirror patch, and glass alignment.
False glass reversal, the glass goes down unexpectedly.	Check seals, reinitialize the glass and/or realign the glass.
	Check for debris in the glass run channel.

REPAIR INSTRUCTIONS

WINDSHIELD REPLACEMENT

Special Tools

- **J-24402-A** Glass Sealant Remover (Cold Knife)
- **J-39032** Stationary Glass Removal Tool
- Use a urethane adhesive systems which meet GM Specification GM 3651G

Removal Procedure

NOTE: **Before cutting out a stationary window, apply a double layer of masking tape around the perimeter of the painted surfaces and the interior trim.**

1. Open the hood.
2. Remove the windshield wiper arms and blades. Refer to **Windshield Wiper Arm Replacement** .
3. Remove the air inlet grille. Refer to **Air Inlet Grille Panel Replacement** .
4. Remove the windshield garnish moldings. Refer to **Windshield Pillar Garnish Molding Replacement** .
5. Remove the rearview mirror. Refer to **Inside Rearview Mirror Replacement** .

WARNING: **If broken glass falls into the defroster outlets, it can be blown into the passenger compartment and cause personal injury.**

6. Cover to protect the following parts from broken glass:
    1. Upper dash pad
    2. Defroster outlets and A/C outlets
    3. Seats and carpeting

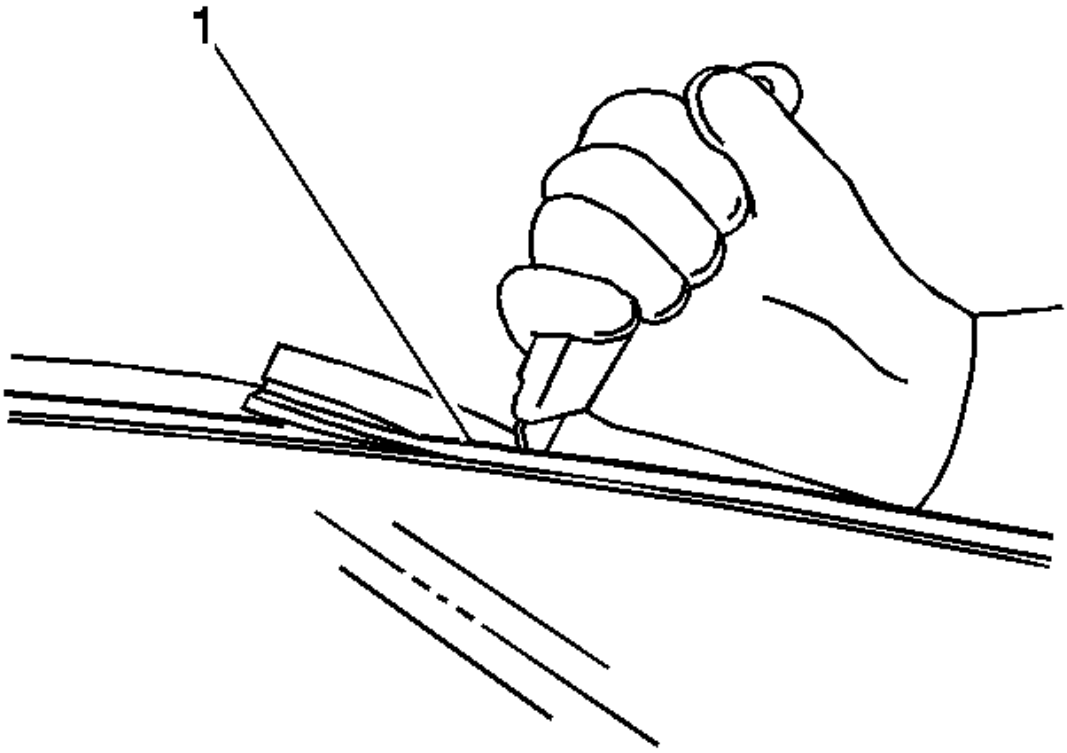


Fig. 3: Using Utility Knife To Remove Reveal Molding
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Glass and Sheet Metal Handling Warning .

7. Remove the windshield lace molding (1).

   Use a utility knife in order to cut around the windshield in order to remove the windshield lace.

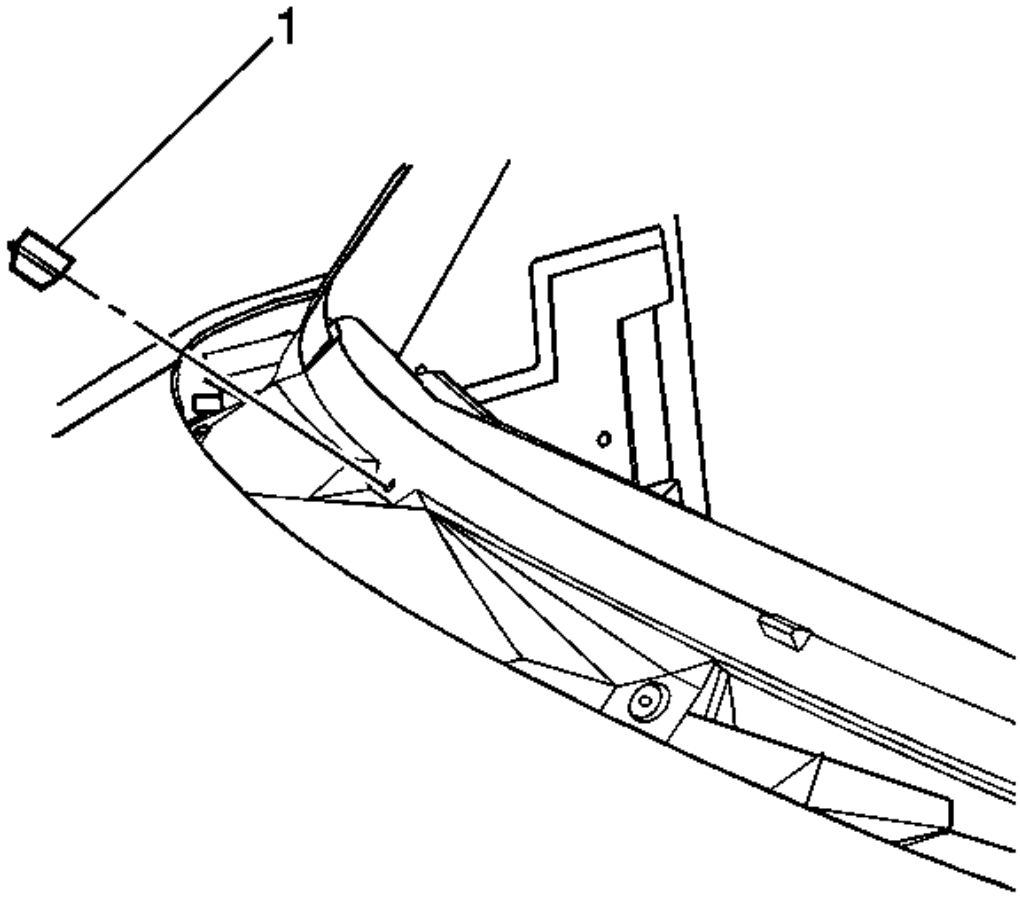


Fig. 4: Identifying Lower Windshield Supports
Courtesy of GENERAL MOTORS COMPANY

8. Remove the lower windshield supports (1) from the cowl panel, if equipped.

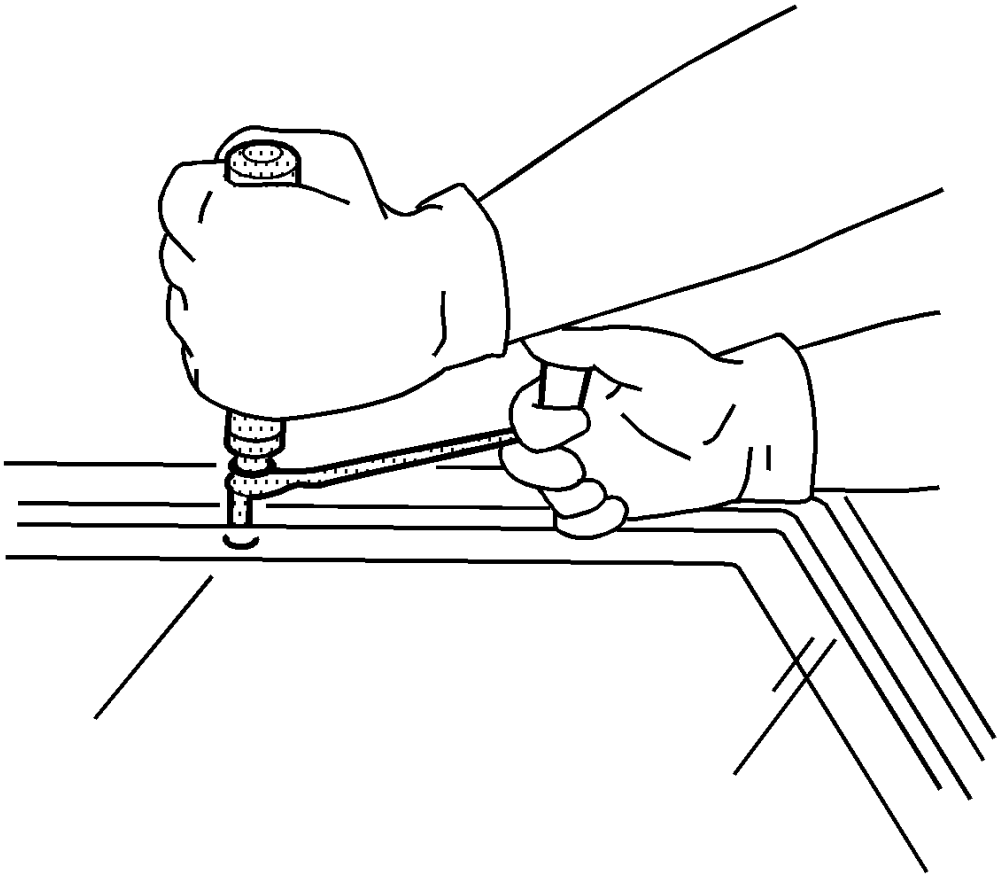


Fig. 5: Separating Urethane Adhesive From Window
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Keep the cutting edge of the tool against the window.**

9. This will allow the urethane adhesive to be separated from the window.
    - Leave a base of urethane on the pinch-weld flange.
    - The only suitable lubrication is clear water.
    - Use **J-24402-A** glass sealant remover , **J-39032** stationary glass removal tool or equivalent in order to remove the window.

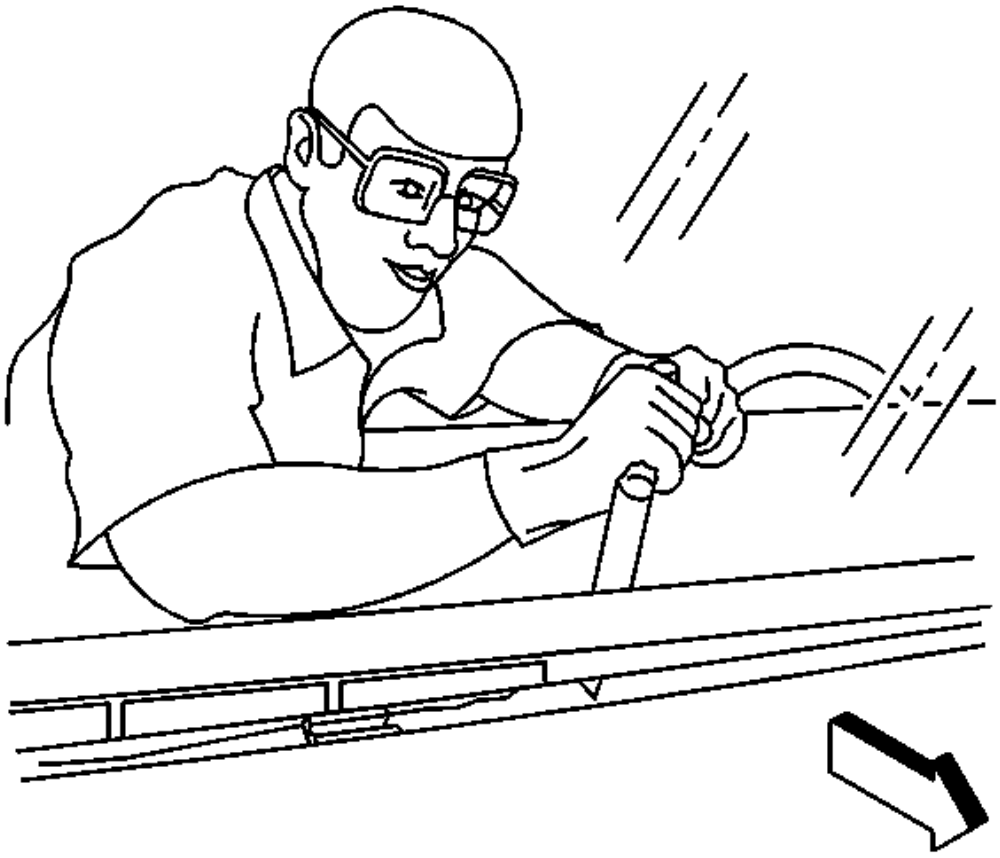


Fig. 6: Separating Bottom Of Window
Courtesy of GENERAL MOTORS COMPANY

10. Remove the bottom of the window from the urethane adhesive using a long utility knife or similar tool. Keep the cutting edge of the utility knife against the glass. Do this from inside the vehicle.

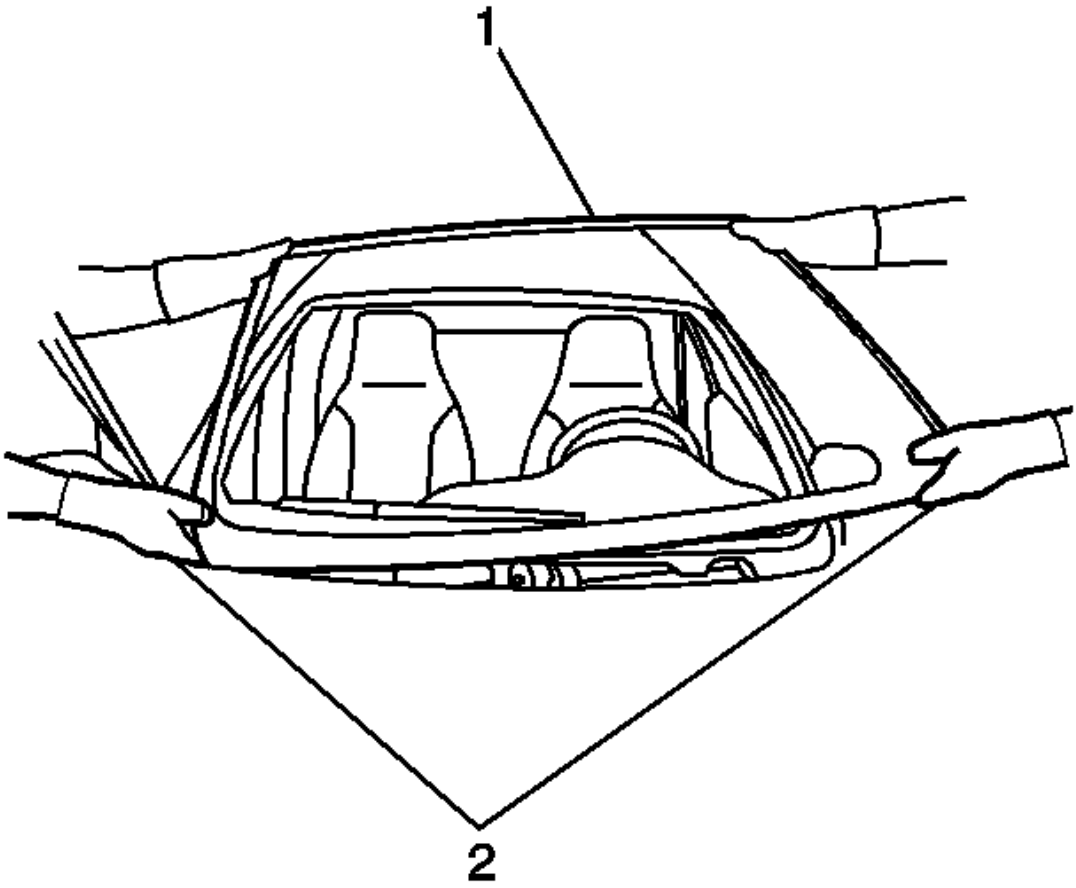


Fig. 7: Removing/Installing Windshield
Courtesy of GENERAL MOTORS COMPANY

11. Remove the windshield (1) from the vehicle with the aid of an assistant (2).

Installation Procedure

1. Install a stationary window into the opening. Refer to **Adhesive Installation of Stationary Windows**.
2. Install the rearview mirror. Refer to **Inside Rearview Mirror Replacement** .
3. Install the windshield garnish molding . Refer to **Windshield Pillar Garnish Molding Replacement** .
4. Install the air inlet grille. Refer to **Air Inlet Grille Panel Replacement** .
5. Install the windshield wipers arms and blades. Refer to **Windshield Wiper Arm Replacement** .
6. Remove the double layer of masking tape around the perimeter of the painted surfaces and the interior trim.
7. Close the hood.

FRONT SIDE DOOR WINDOW REPLACEMENT

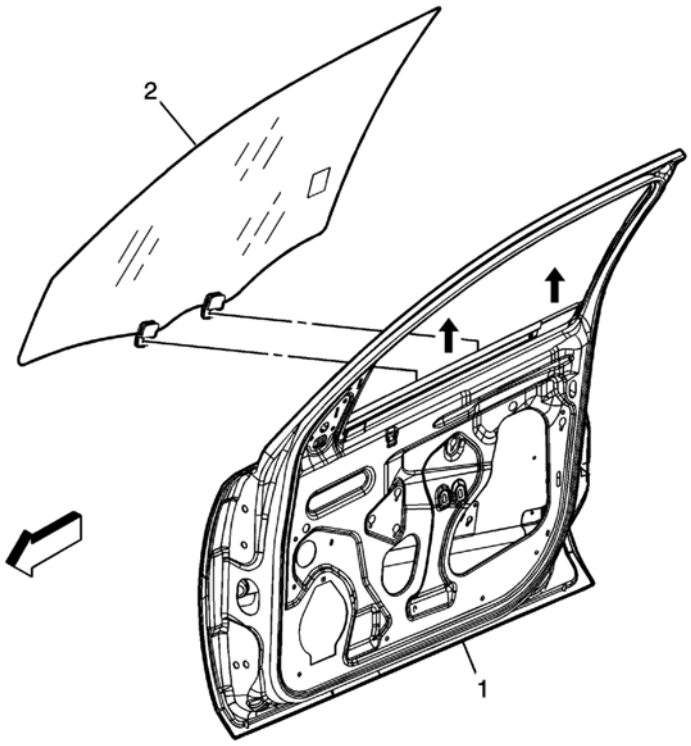


Fig. 8: Front Door Window
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Position window approximately half way down in the door. 2. Remove the interior trim panel. Refer to **Front Side Door Trim Panel Replacement** . 3. Remove the water deflector. Refer to **Front Side Door Water Deflector Replacement (Impala)** . 4. Tape the window to door frame to prevent it from moving. 5. Remove the inside sealing strip. Refer to **Front Side Door Window Belt Inner Sealing Strip Replacement**.	
1	Front Side Door Window to Regulator Bolts (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Front Side Door Window **TIP:** Remove the window from the outside of the door, tape the frame as needed.

REAR SIDE DOOR WINDOW REPLACEMENT

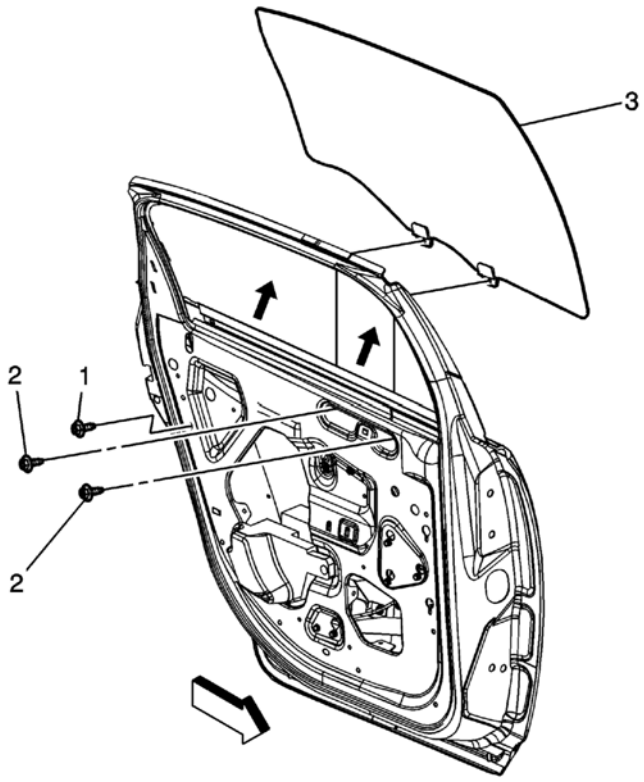


Fig. 9: Rear Side Door Window
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the rear side door trim panel. Refer to **Rear Side Door Trim Panel Replacement** . 2. Remove the water deflector. Refer to **Rear Side Door Water Deflector Replacement** . 3. Remove the rear side door inner sealing strip. Refer to **Rear Side Door Window Inner Sealing Strip Replacement**. 4. Remove the rear side door outer sealing strip. Refer to **Rear Side Door Window Outer Sealing Strip Replacement** 5. Do Not remove the rear side door window channel retainer from the door just the lower bolt (1). Refer to **Rear Side Door Window Channel Replacement**.	
1	Rear Side Door Window to Channel Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedures**

Callout	Component Name
	1. Remove the rear side door window frame rear applique, using a suitable tool to release the clips. 2. Position window approximately half way down in the door. 3. Tape the window to door frame to prevent it from moving. 4. Tape the rear side door window frame front applique. 5. Place tape around the outer edge of the rear door frame after removing the applique, this will protect the window when removing. 6. It maybe necessary to partially remove the rear side door window weatherstrip from the door frame. **Tighten** 10 N.m (89 lb in)
2	Rear Side Door Window to Window Regulator Guide Bolts (Qty: 2) **Procedure** 1. Remove the tape from the door frame. 2. Remove the door window from the door frame. Pull upward then slide the window rearward to release it from rear side door window channel retainer. **Tighten** 10 N.m (89 lb in)
3	Rear Side Door Window

QUARTER WINDOW REPLACEMENT (IMPALA) Special

Tools

- **J 24402-A** Glass Sealant Remover (Cold Knife)
- **J 39032** Stationary Glass Removal Tool
- Use a urethane adhesive systems which meet GM Specification GM 3651G

Removal Procedure

WARNING: **If a window is cracked but still intact, crisscross the window with masking tape in order to reduce the risk of damage or personal injury.**

NOTE: **Before cutting out a stationary window, apply a double layer of masking tape around the perimeter of the painted surfaces and inner trim of the window.**

1. Remove the rear quarter upper trim. Refer to **Quarter Upper Trim Panel Replacement** .
2. Remove the rear quarter lower trim. Refer to **Quarter Lower Rear Trim Panel Replacement (Impala)** .

WARNING: **If broken glass falls into the defroster outlets, it can be blown into the passenger compartment and cause personal injury.**

3. Cover to protect the following parts from broken glass:
   - Upper dash pad
   - Defroster outlets and A/C outlets
   - Seats and carpeting

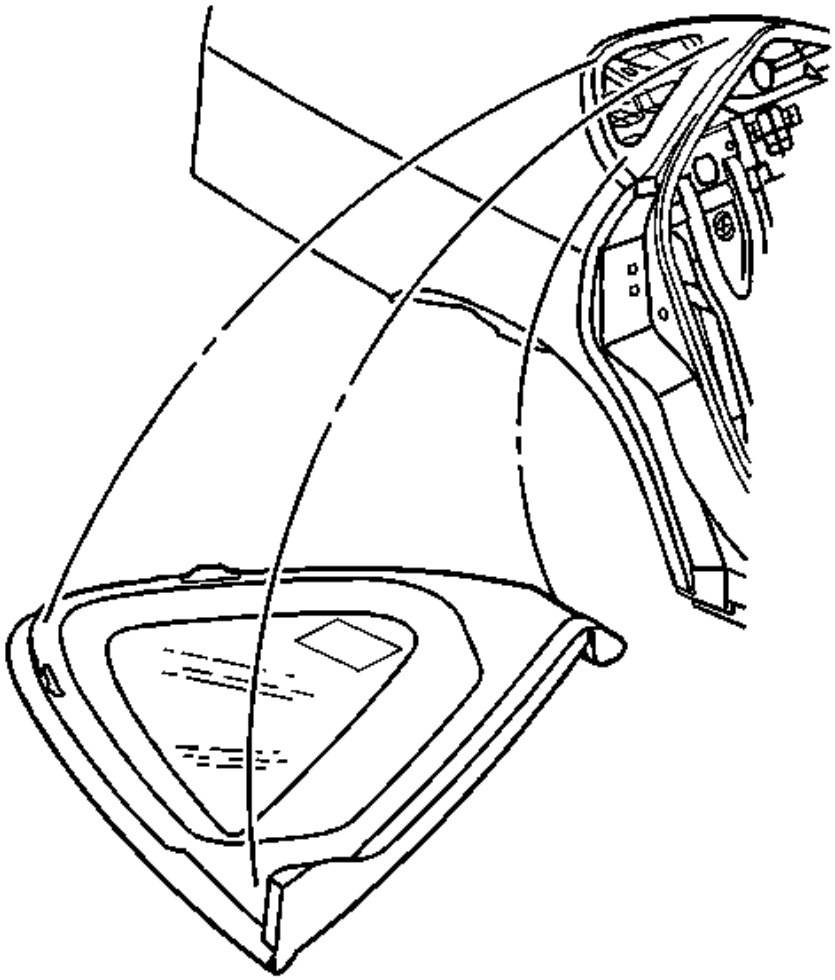


Fig. 10: Quarter Panel (Impala) Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Glass and Sheet Metal Handling Warning .**

NOTE: **Keep the cutting edge of the tool against the window. Do this from inside the vehicle to protect the outer painted surface.**

4. This will allow the urethane adhesive to be separated from the window.
   - Leave a base of urethane on the pinch-weld flange.
   - The only suitable lubrication is clear water.

- Use **J 39032** stationary glass removal tool or equivalent in order to remove the window.
- Remove the quarter modular window from the pinch-weld flange.

Installation Procedure

1. Install a stationary window into the opening. Refer to **Adhesive Installation of Stationary Windows**.
2. Install the rear quarter lower trim. Refer to **Quarter Lower Rear Trim Panel Replacement (Impala)** .
3. Install the rear quarter upper trim panel. Refer to **Quarter Upper Trim Panel Replacement** .
4. Remove the double layer of masking tape around the perimeter of the painted surfaces and the interior trim.

REAR WINDOW REPLACEMENT

Special Tools

- **J 24402-A** Glass Sealant Remover (Cold Knife)
- **J 39032** Stationary Glass Removal Tool
- Use a urethane adhesive systems which meet GM Specification GM 3651G

Removal Procedure

WARNING: **If a window is cracked but still intact, crisscross the window with masking tape in order to reduce the risk of damage or personal injury.**

NOTE: **Before cutting out a stationary window, apply a double layer of masking tape around the perimeter of the painted surfaces and the interior trim.**

1. Open the rear compartment lid in order to access the reveal molding.
2. Disconnect the rear window defogger electrical connectors.
3. Disconnect the rear window radio antenna connector. If equipped.

WARNING: **If broken glass falls into the defroster outlets, it can be blown into the passenger compartment and cause personal injury.**

4. Cover to protect the following parts from broken glass:
   - Upper dash pad
   - Defroster outlets and A/C outlets
   - Seats and carpeting

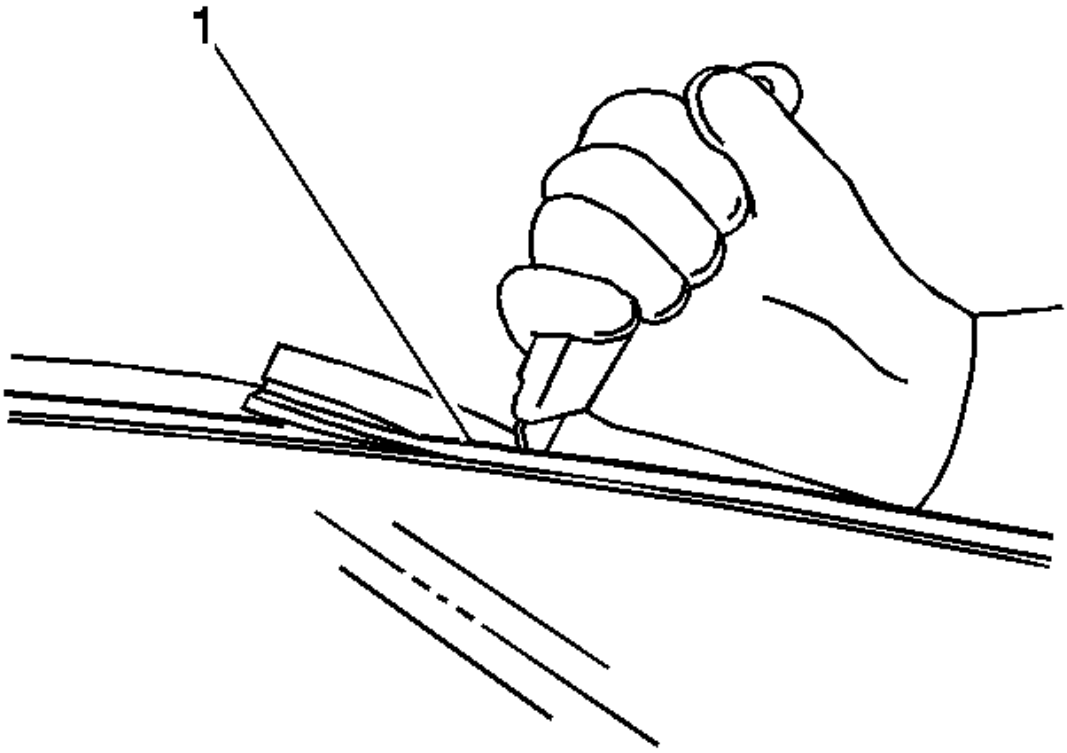


Fig. 11: Using Utility Knife To Remove Reveal Molding
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Glass and Sheet Metal Handling Warning .

5. Using a utility knife, carefully cut the rear window lace molding (1) in order to access the urethane adhesive bead.

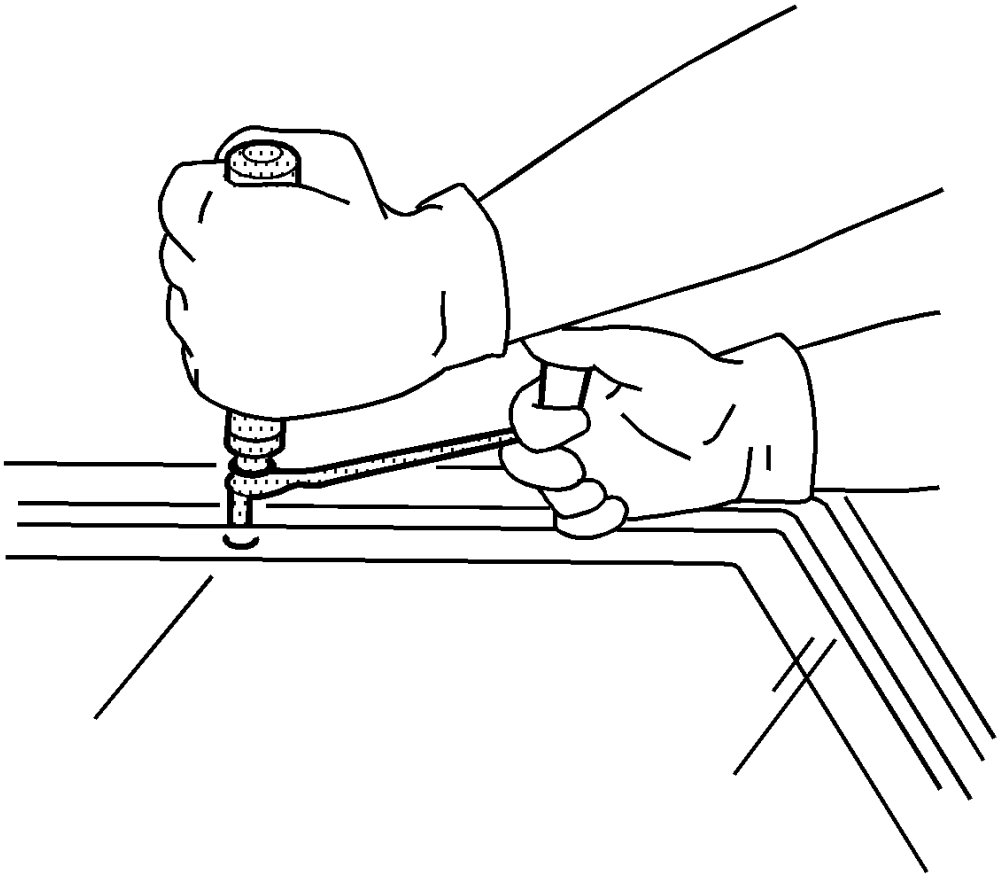


Fig. 12: Separating Urethane Adhesive From Window
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Keep the cutting edge of the tool against the window.**

6. This will allow the urethane adhesive to be separated from the window.
    - Leave a base of urethane on the pinchweld flange.
    - The only suitable lubrication is clean water.
    - Use **J 24402-A** glass sealant remover (cold knife) , **J 39032** stationary glass removal tool or equivalent in order to remove the window.

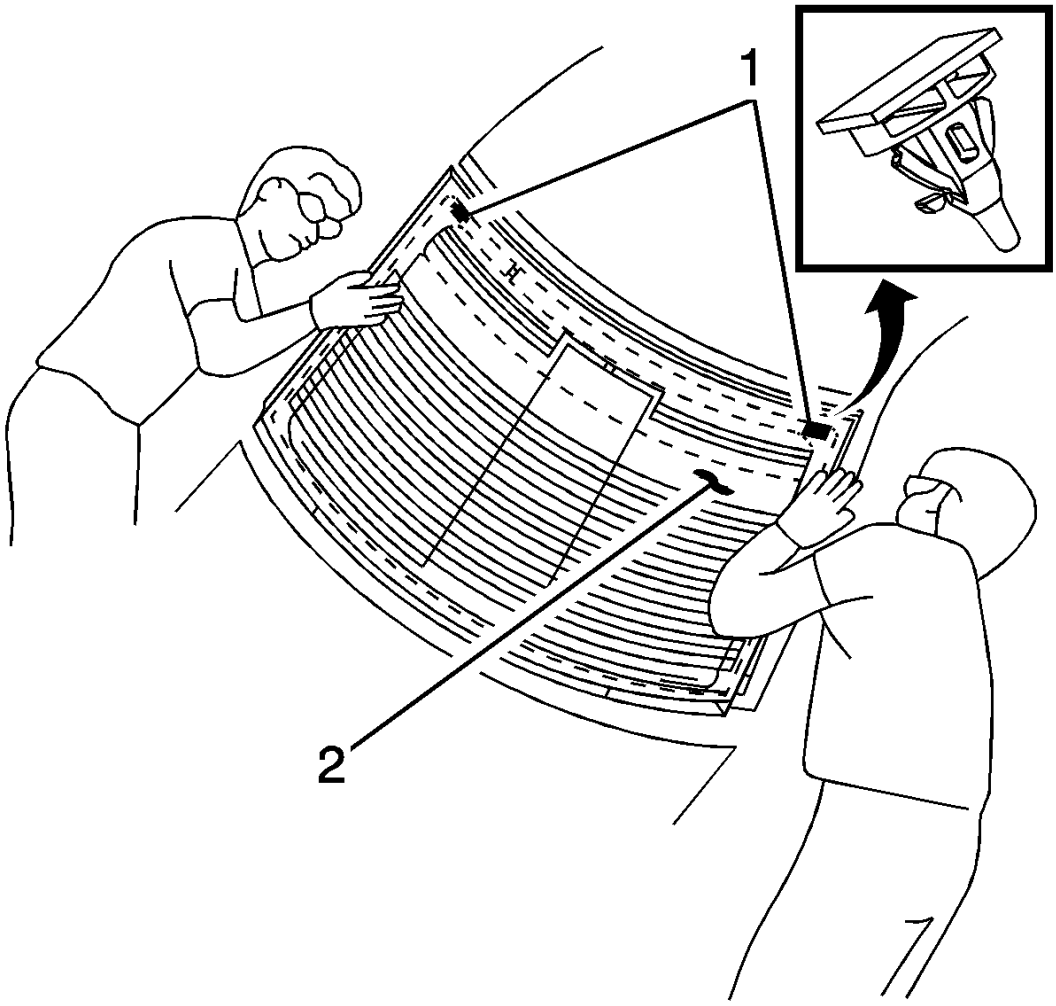


Fig. 13: View Of Window & Locator Pins
Courtesy of GENERAL MOTORS COMPANY

7. Remove the rear window (1) with the an assistant (2) from the vehicle .

Installation Procedure

1. Install the rear window into the opening. Refer to **Adhesive Installation of Stationary Windows**.
2. Connect the rear window defogger electrical connectors. If equipped.
3. Install the rear window radio antenna connector.
4. Connect the OnStarÂ® antenna, if equipped.

   Check the radio and OnStarÂ® system to verify reception.

5. Close the rear compartment lid.
6. Remove the double layer of masking tape around the perimeter of the painted surfaces and the interior trim.

REAR SIDE DOOR WINDOW CHANNEL REPLACEMENT

Removal Procedure

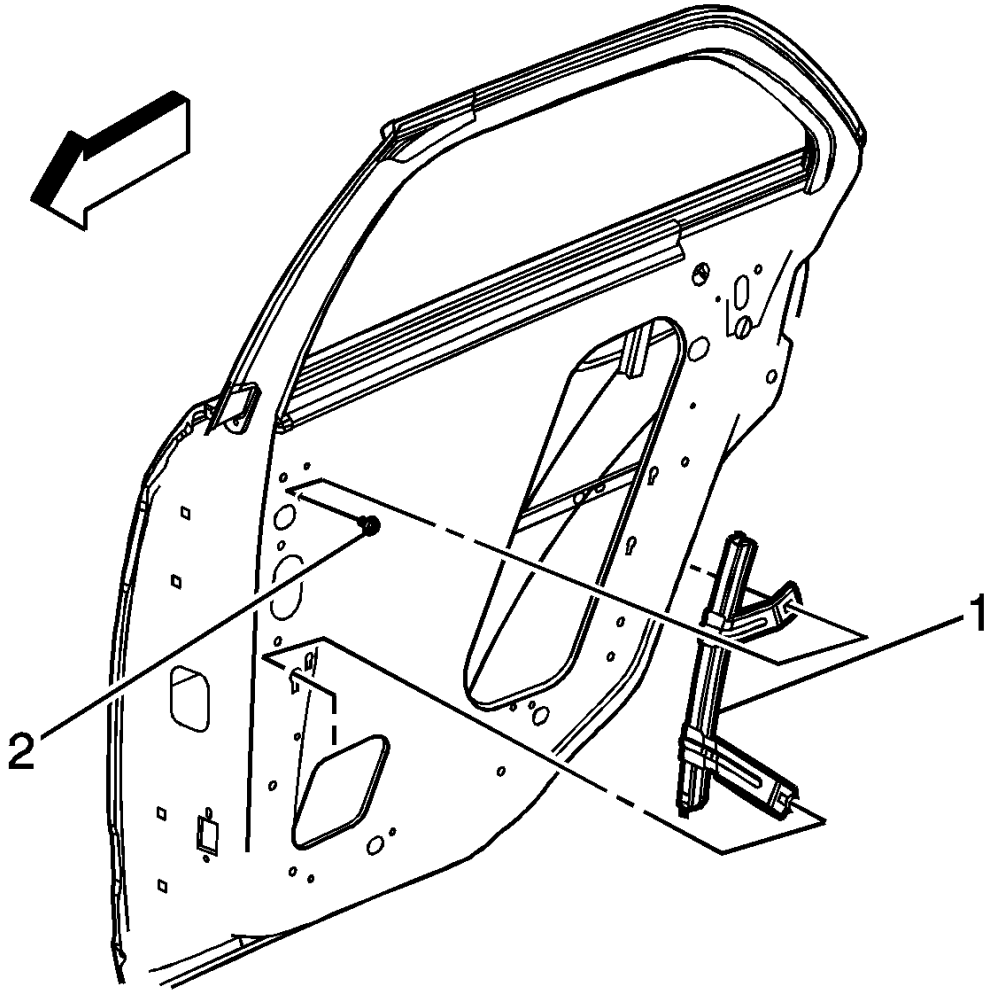


Fig. 14: Identifying Rear Door Window Run Channel
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Apply masking tape to the door frame and applique.
2. Remove the rear door trim panel. Refer to **Rear Side Door Trim Panel Replacement** .
3. Remove the rear door water deflector. Refer to **Rear Side Door Water Deflector Replacement** .
4. Position the window in the full down position.
5. Remove the window channel bolt (2).
6. Remove the window channel from the door.

Installation Procedure

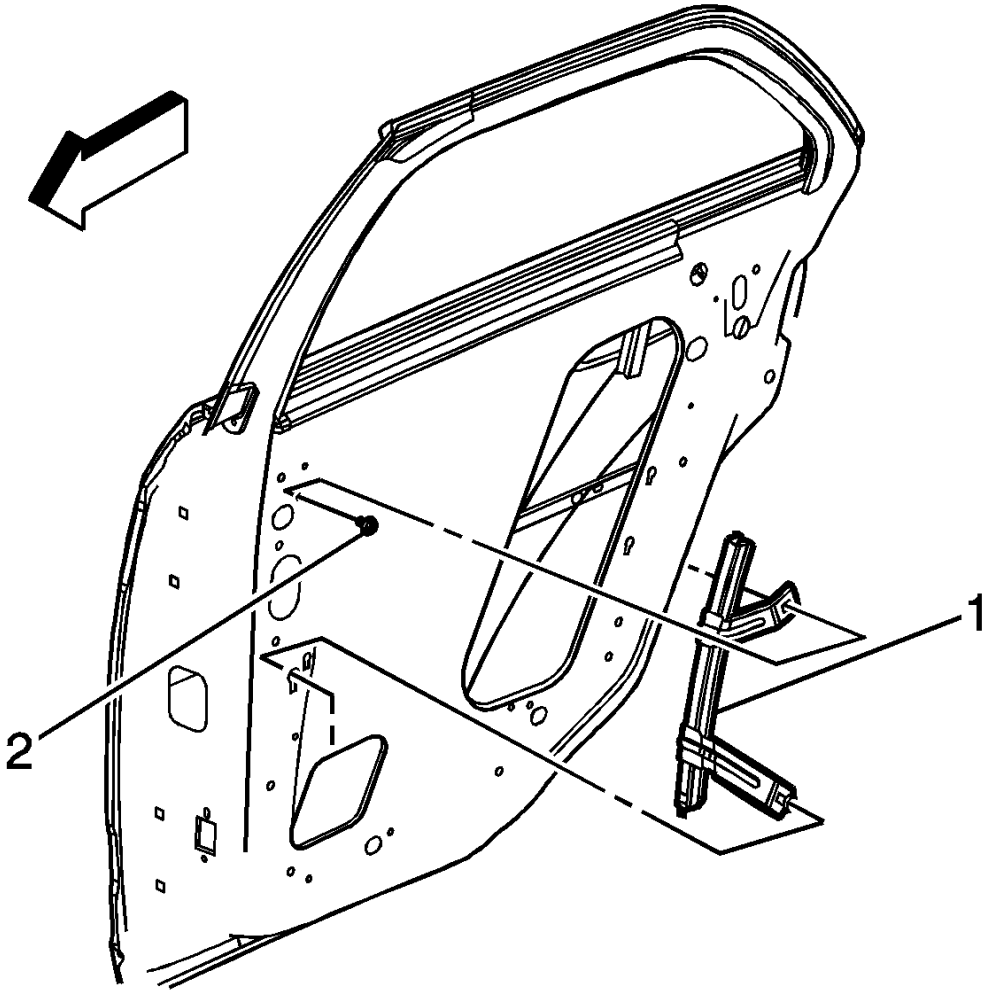


Fig. 15: Identifying Rear Door Window Run Channel
Courtesy of GENERAL MOTORS COMPANY

1. Install the window channel (1) in the door.

CAUTION: **Refer to Fastener Caution .**

2. Install the window run channel bolts (2).

Tighten

Tighten the bolts to 10 N.m (89 lb in).

3. Inspect the window for proper operation.
4. Remove the masking tape from the frame and applique.
5. Install the rear door water deflector. Refer to **Rear Side Door Water Deflector Replacement** .
6. Install the rear door trim panel. Refer to **Rear Side Door Trim Panel Replacement** .

FRONT SIDE DOOR WINDOW SWITCH REPLACEMENT (IMPALA)

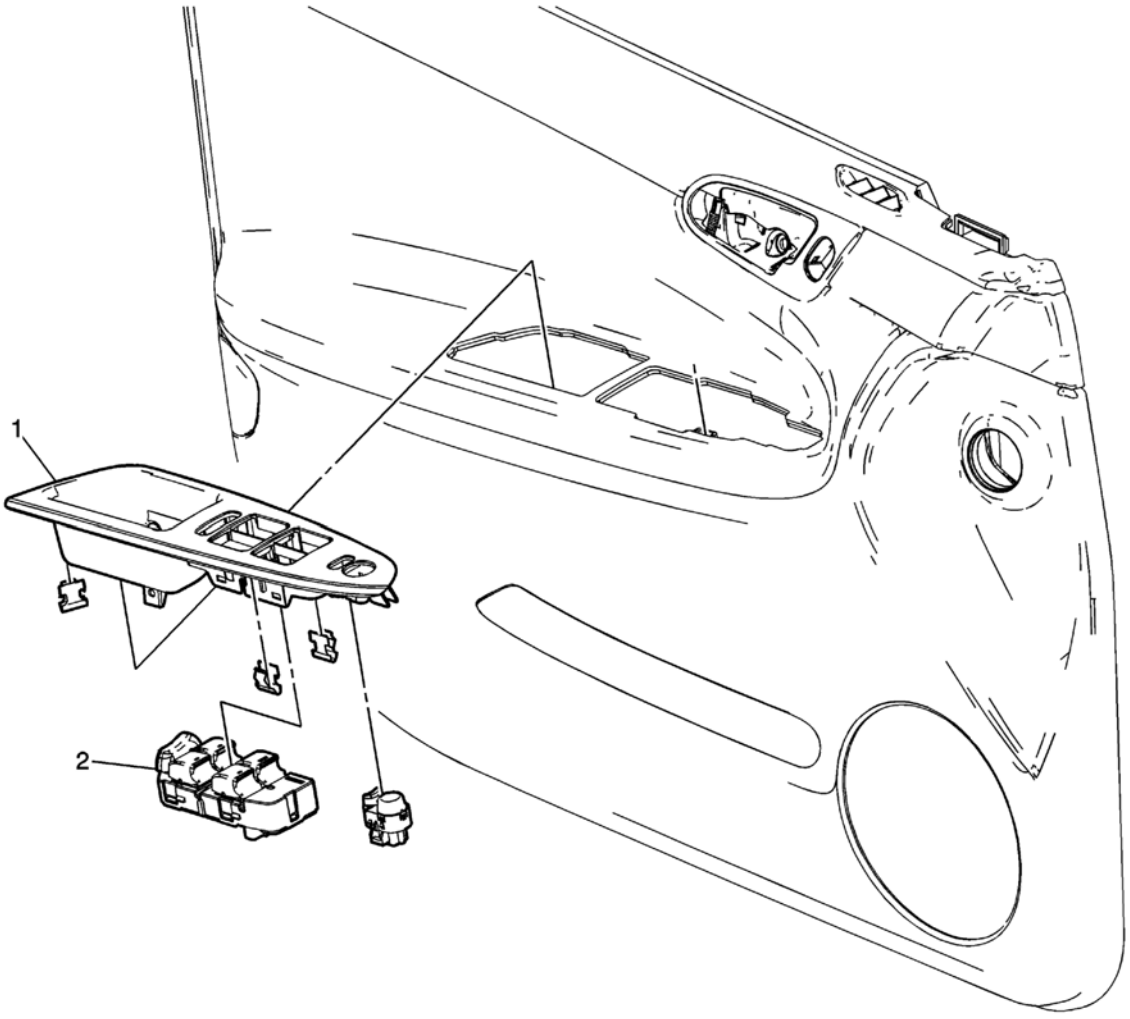


Fig. 16: View Of Power Mirror Switch (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Side Window Switch Bezel Refer to **Front Side Door Window Switch Bezel Replacement** .
2	Front Side Door Window and Rear Side Door Window Switch **TIP:** Use a flat bladed tool to help disengage the switch from the bezel.

REAR SIDE DOOR WINDOW SWITCH REPLACEMENT

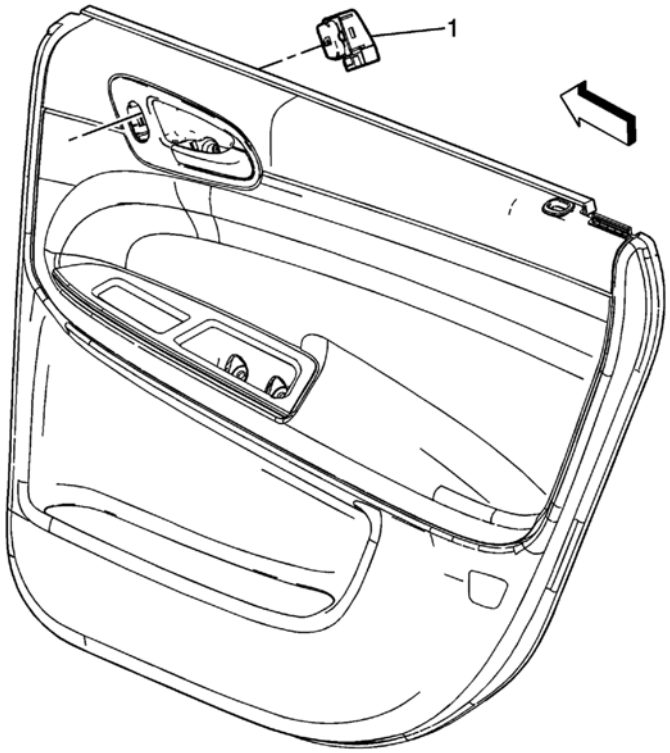


Fig. 17: View Of Rear Side Door Window Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedure** Remove the rear side door trim panel. Refer to **Rear Side Door Trim Panel Replacement** .	
1	Rear Side Door Window Switch Assembly **TIP:** Disconnect the electrical connector.

FRONT SIDE DOOR WINDOW REGULATOR REPLACEMENT

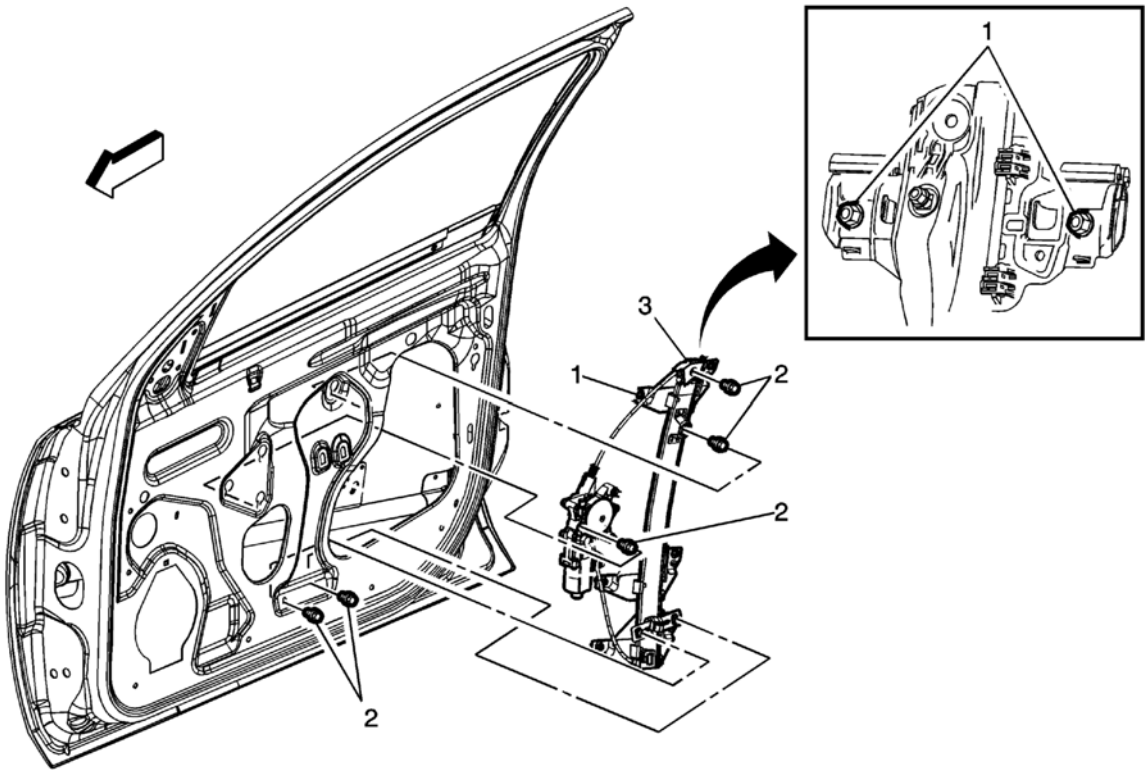


Fig. 18: Front Door Window Regulator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front side door window from the regulator guide bolts. Do Not remove the window from the vehicle, raise the window to the fully up position, tape in place. Refer to **Front Side Door Window Replacement**.	
1	Front Side Door Window Regulator to Guide Bolts (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Remove the front side door water deflector. 2. Disconnect the electrical connector from the window regulator motor. **Tighten** 5 N.m (44 lb in)
2	Front Side Door Window Regulator Screw (Qty: 5) **Tighten** 10 N.m (89 lb in)

Callout	Component Name
3	Front Side Door Window Regulator **Procedure** 1. Transfer parts as necessary. 2. Inspect the door window for proper operation before installing the door trim panel.

FRONT SIDE DOOR WINDOW REGULATOR MOTOR REPLACEMENT

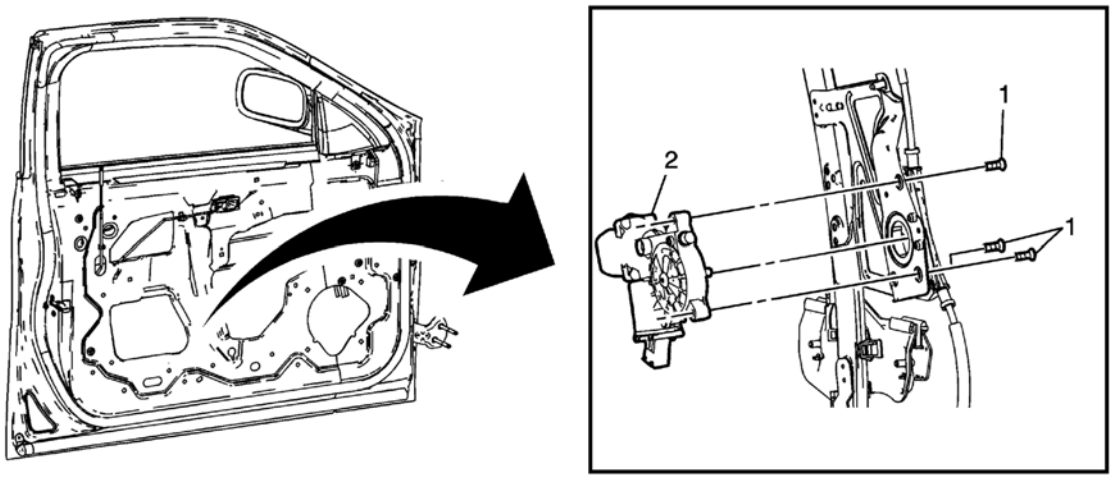


Fig. 19: Front Side Door Window Regulator Motor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front side door window regulator. Refer to **Front Side Door Window Regulator Replacement**.	
1	Front Side Door Window Regulator Motor Screw (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Remove the front side door water deflector. 2. Disconnect the electrical connector from the window regulator motor. **Tighten** 4.6 N.m (41 lb in)

Callout	Component Name
2	Front Side Door Window Regulator Motor **Procedure** Inspect the door window for proper operation before installing the door trim panel.

REAR SIDE DOOR WINDOW REGULATOR REPLACEMENT

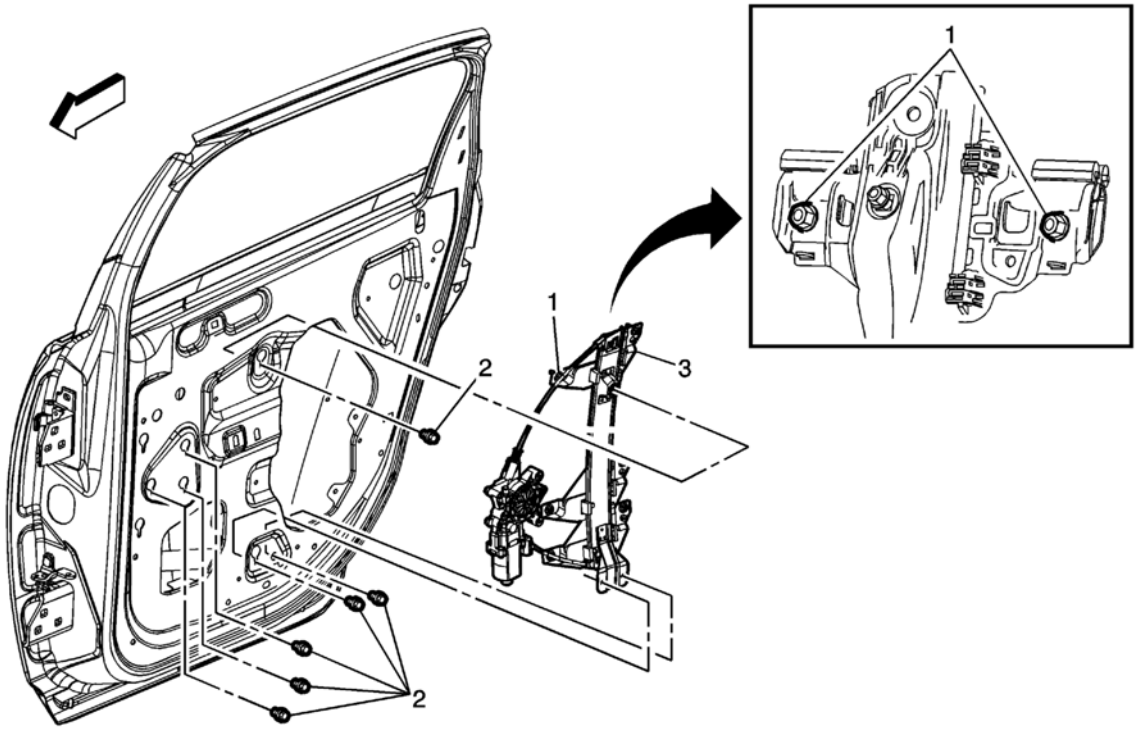


Fig. 20: Rear Door Window Regulator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear side door window from the regulator guide bolts. Do Not remove the window from the vehicle, raise the window to the fully up position, tape in place. Refer to **Rear Side Door Window Replacement**.	
1	Rear Side Door Window Regulator to Guide Bolts (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Remove the rear side door water deflector. 2. Disconnect the electrical connector from the window regulator motor.

Callout	Component Name
	Tighten 5 N.m (44 lb in)
2	Rear Side Door Window Regulator Bolt (Qty: 6) **Tighten** 10 N.m (89 lb in)
3	Rear Side Door Window Regulator

REAR SIDE DOOR WINDOW REGULATOR MOTOR REPLACEMENT

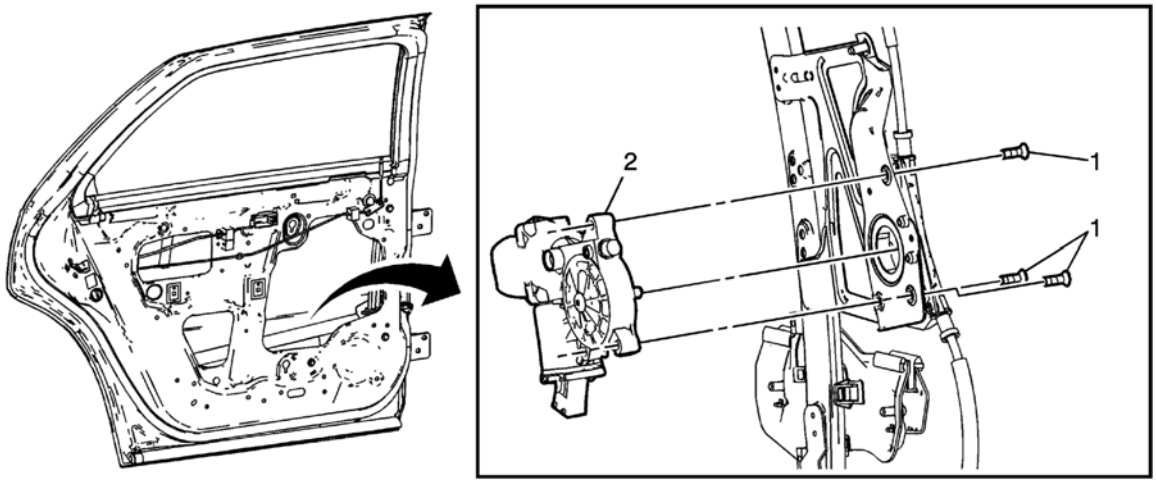


Fig. 21: Rear Door Window Regulator Motor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear side door window regulator. Do Not remove the window from the vehicle, raise the window to the fully up position, tape in place. Refer to **Rear Side Door Window Regulator Replacement**.	
1	Rear Side Door Window Regulator Motor Screw (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Remove the rear side door water deflector. 2. Disconnect the electrical connector from the window regulator motor. **Tighten**

Callout	Component Name
	4.6 N.m (41 lb in)
2	Rear Side Door Window Regulator Motor

FRONT SIDE DOOR WINDOW CHANNEL RETAINER REPLACEMENT (IMPALA)

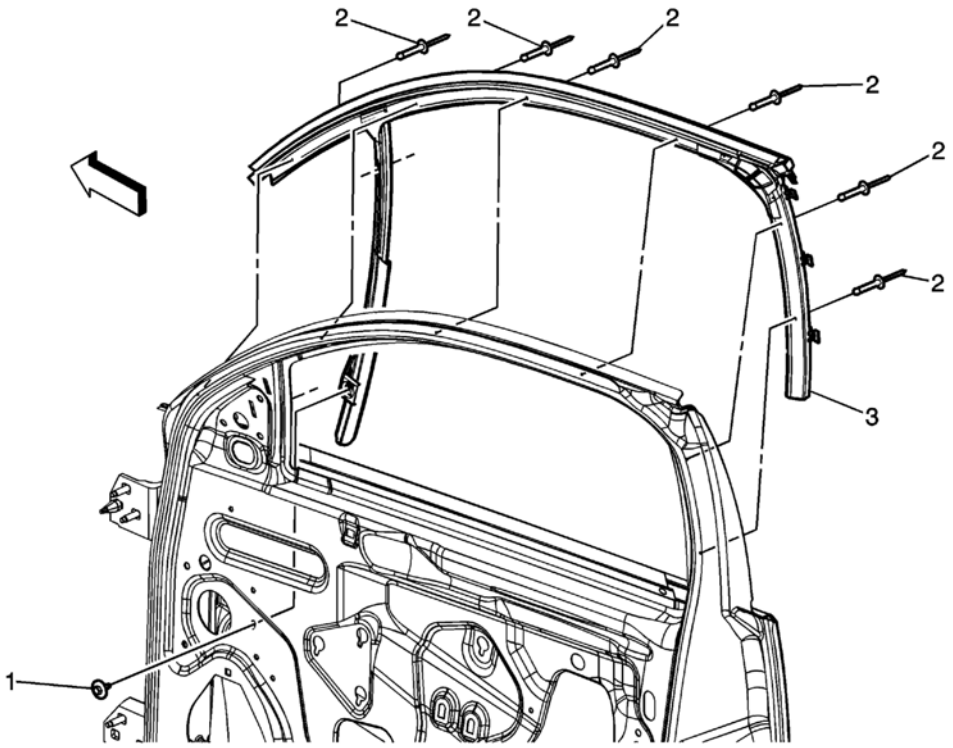


Fig. 22: Front Door Window Channel Retainer
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the interior trim panel. Refer to **Front Side Door Trim Panel Replacement** . 2. Remove the water deflector. Refer to **Front Side Door Water Deflector Replacement (Impala)** . 3. Remove the inside sealing strip. Refer to **Front Side Door Window Belt Inner Sealing Strip Replacement**.	
1	Front Door Weatherstrip Seal Retainer Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)

Callout	Component Name
2	Front Door Weatherstrip Seal Retainer Rivets (Qty: 7) **TIP:** Drill out the rivets from around the upper door frame.
3	Front Door Weatherstrip Seal Retainer **TIP:** Pull the weatherstrip retainer upward, slightly twisting weatherstrip retainer to clear the outer sealing strip.

REAR SIDE DOOR WINDOW CHANNEL RETAINER REPLACEMENT

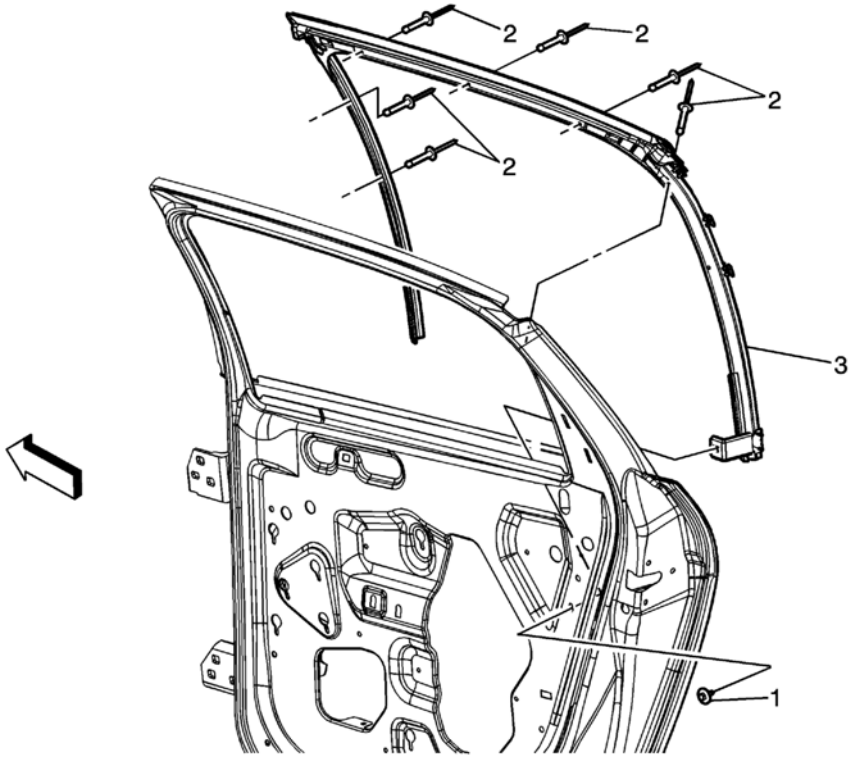


Fig. 23: Rear Door Window Channel Retainer
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the interior trim panel. Refer to **Rear Side Door Trim Panel Replacement** . 2. Remove the water deflector. Refer to **Rear Side Door Water Deflector Replacement** . 3. Remove the inside sealing strip. Refer to **Rear Side Door Window Inner Sealing Strip Replacement**.	
1	Rear Door Weatherstrip Seal Retainer Bolt **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	Tighten 10 N.m (89 lb in)
2	Rear Door Weatherstrip Seal Retainer Rivets (Qty: 6) **TIP:** Drill out the rivets from around the upper door frame.
3	Rear Door Weatherstrip Seal Retainer **TIP:** Pull the weatherstrip retainer upward, slightly twisting weatherstrip retainer to clear the outer sealing strip.

FRONT SIDE DOOR WINDOW BELT OUTER SEALING STRIP REPLACEMENT (IMPALA)

Removal Procedure

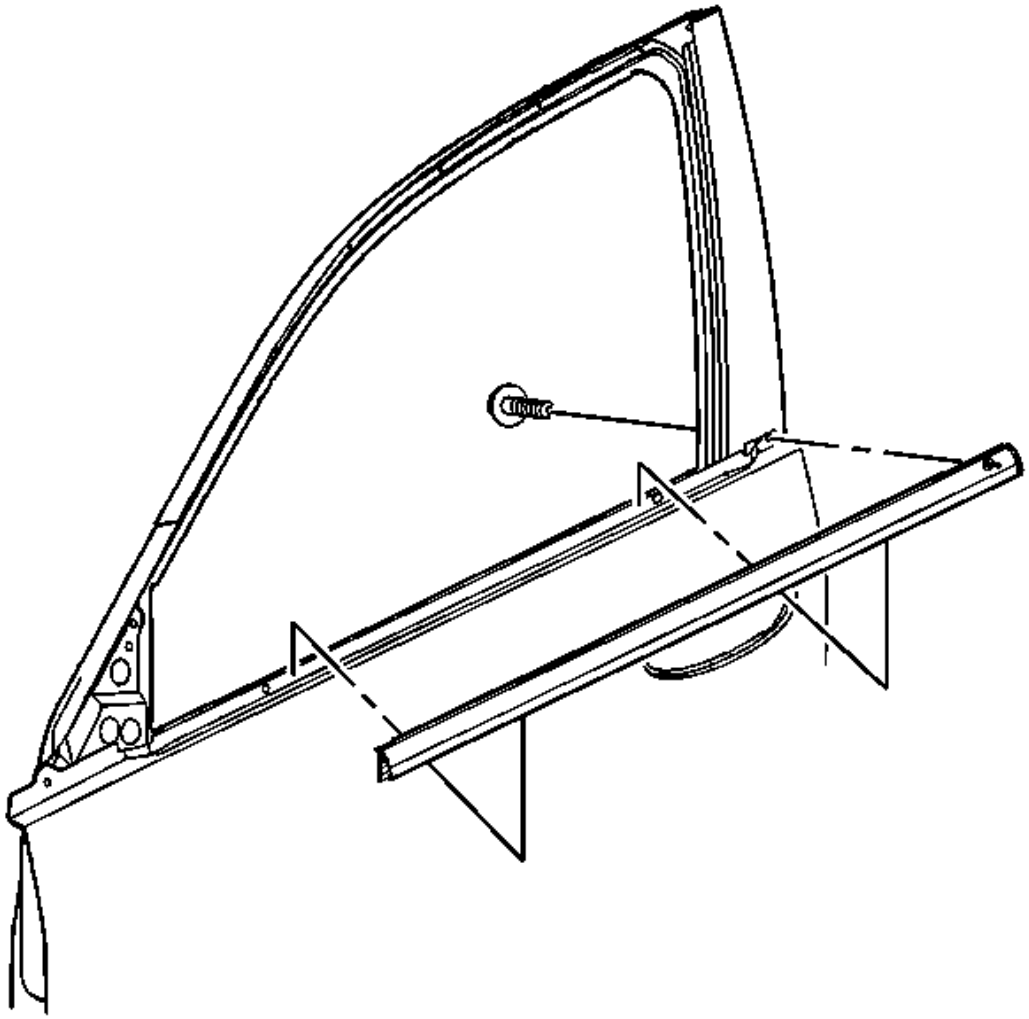


Fig. 24: Front Door Sealing Strip (Impala)
Courtesy of GENERAL MOTORS COMPANY

1. Remove the outside rearview mirror. Refer to **Power Mirror Replacement** .

2. Remove the rear screw from the front door outer belt sealing strip.
3. Remove the front door outer belt sealing strip.

Installation Procedure

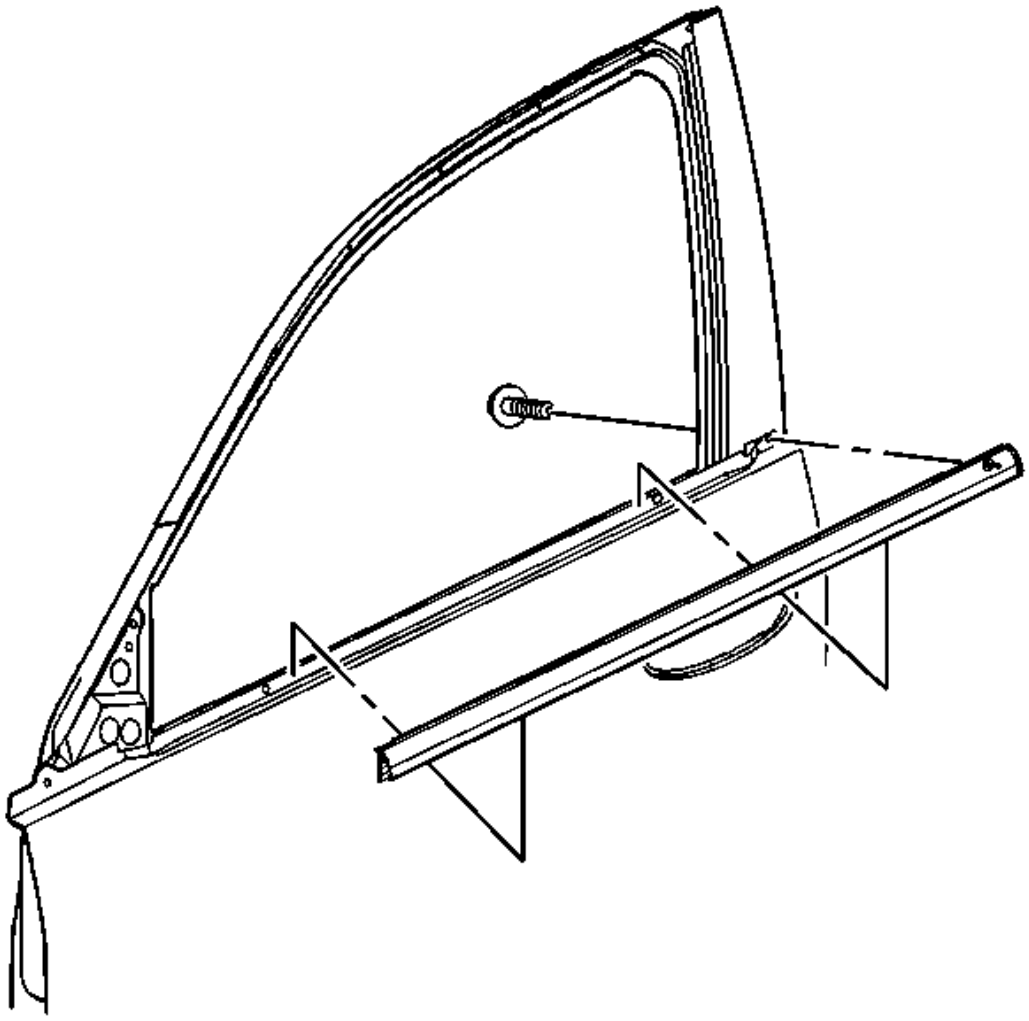


Fig. 25: Front Door Sealing Strip (Impala)
Courtesy of GENERAL MOTORS COMPANY

1. Position the front door outer belt sealing strip to the front door pinch-weld flange.
2. Install the front door outer belt sealing strip to the front door pinch-weld flange pressing into place until fully seated.

CAUTION: Refer to Fastener Caution .

3. Install the screw to the rear of the front door outer belt sealing strip.

Tighten

Tighten the outer belt sealing strip screw to 2 N.m (18 lb in).

4. Install the outside rearview mirror. Refer to **Power Mirror Replacement** .

FRONT SIDE DOOR WINDOW BELT INNER SEALING STRIP REPLACEMENT

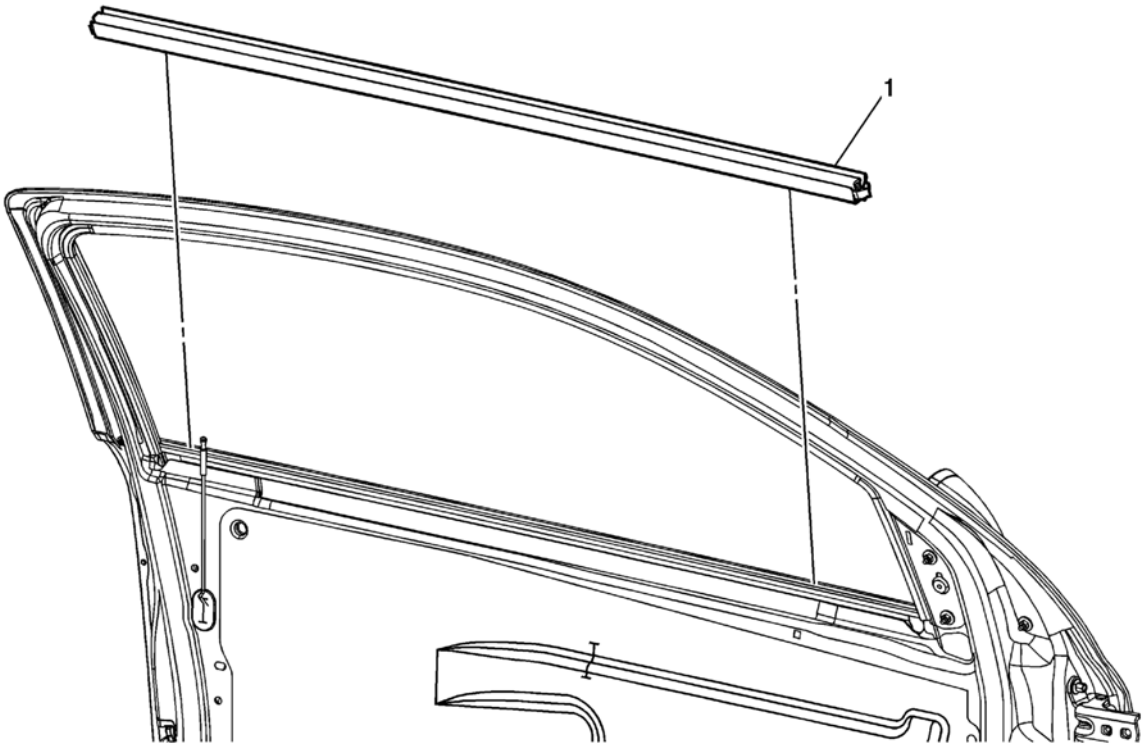


Fig. 26: Identifying Front Door Window Belt Inner Sealing Strip
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedures** Remove the interior trim panel. Refer to **Front Side Door Trim Panel Replacement** .	
1	Sealing Strip, Front Side Door Window Inner **TIP:** Pull up and away from inner panel to remove from the door.

REAR SIDE DOOR WINDOW INNER SEALING STRIP REPLACEMENT

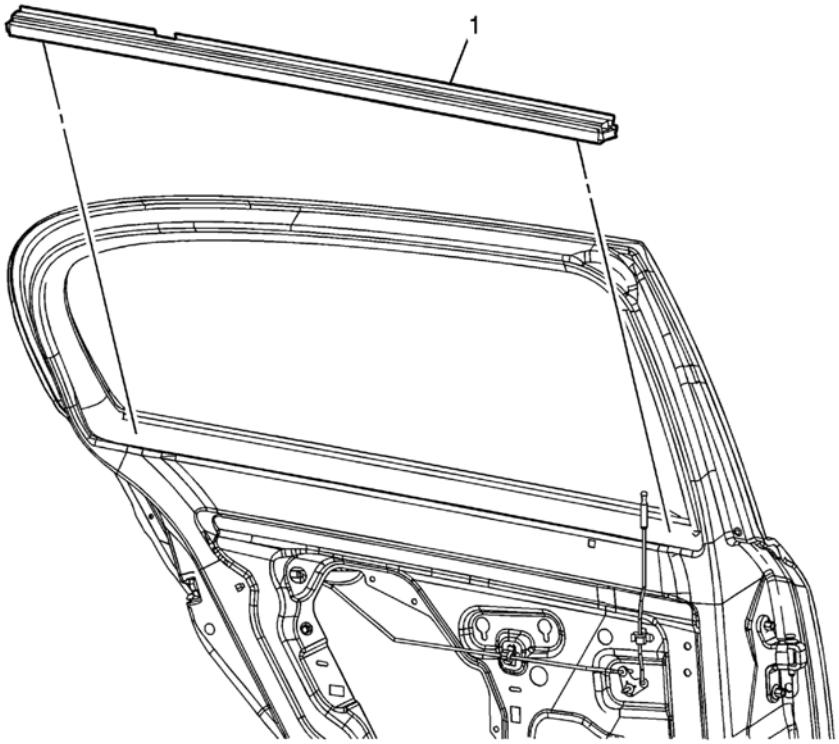


Fig. 27: View Of Rear Door Window Belt Inner Sealing Strip
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedures** Remove the interior trim panel. Refer to **Rear Side Door Trim Panel Replacement** .	
1	Sealing Strip, Front Side Door Window Inner **TIP:** Pull up and away from inner panel to remove from the door.

REAR SIDE DOOR WINDOW OUTER SEALING STRIP REPLACEMENT

Removal Procedure

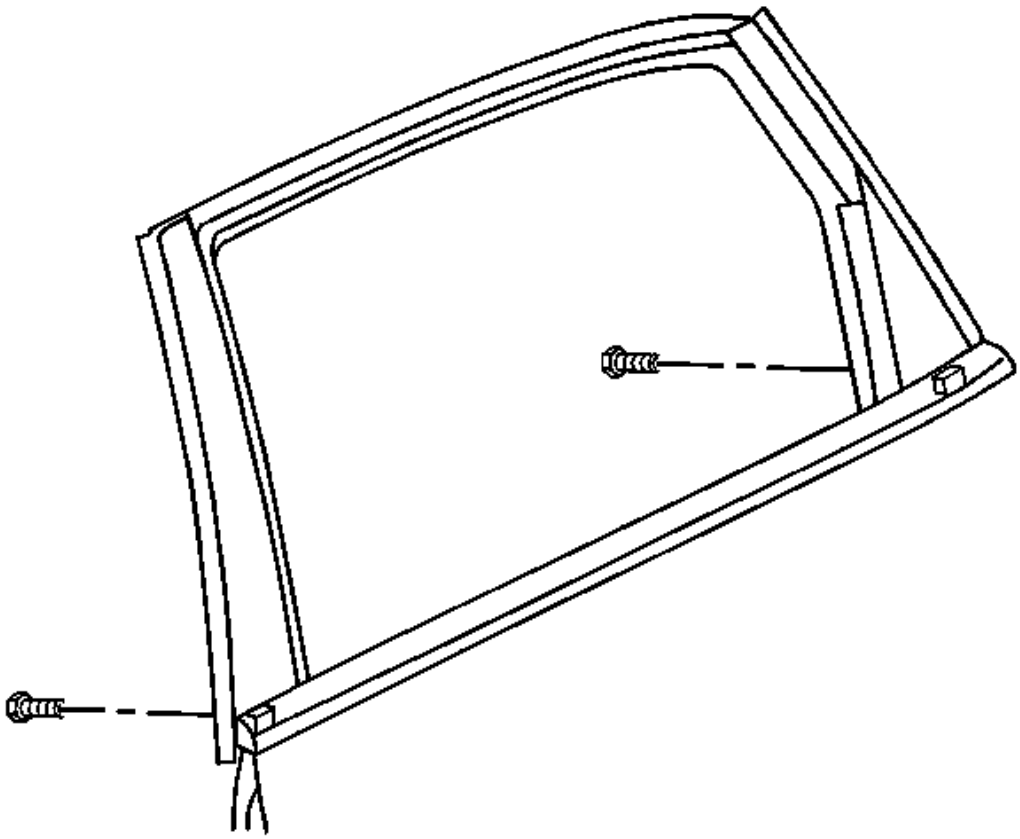


Fig. 28: Rear Door Sealing Strip Screws
Courtesy of GENERAL MOTORS COMPANY

1. Position the rear window all the way down.

NOTE: **Pull rearward on the rear door frame applique to release clips from the door frame.**

2. Remove the rear door inner door frame applique to access the rear screws.

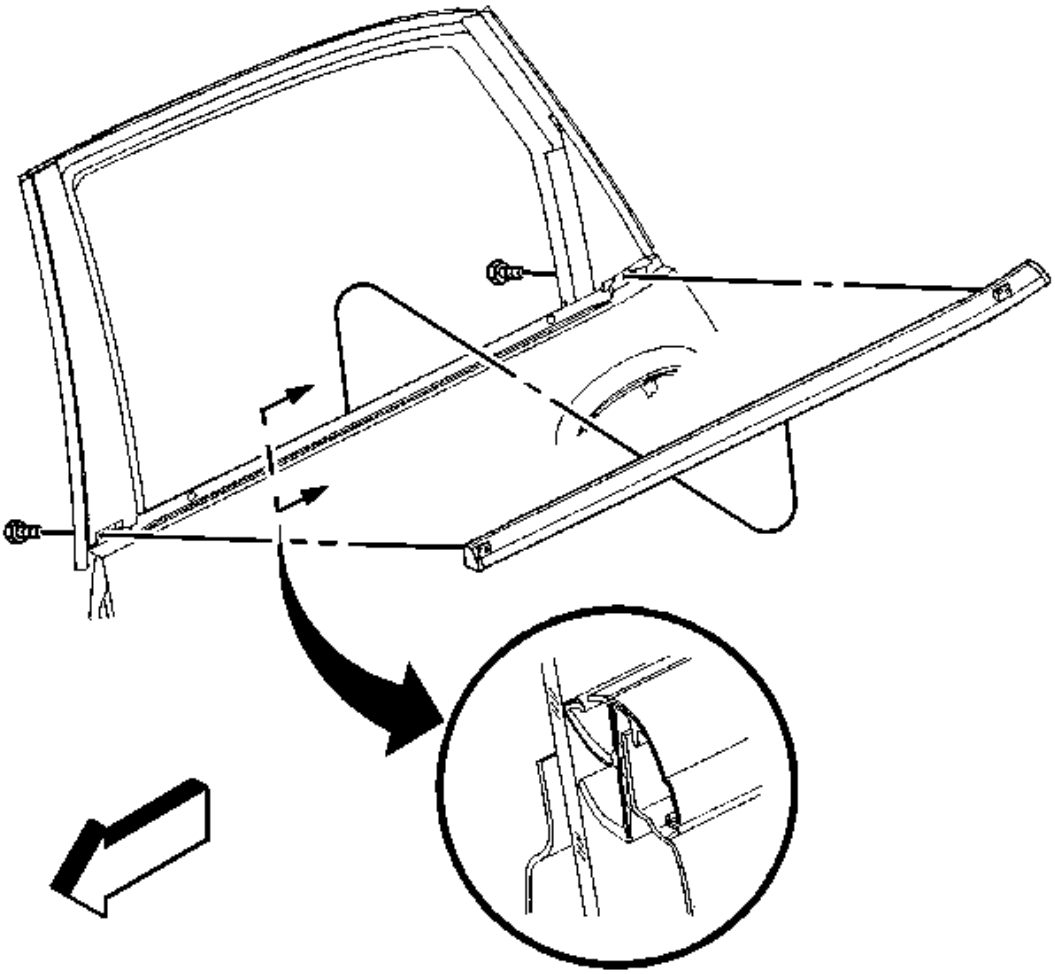


Fig. 29: Rear Door Window Outer Belt Sealing Strip
Courtesy of GENERAL MOTORS COMPANY

3. Remove the rear door outer belt sealing strip screws.

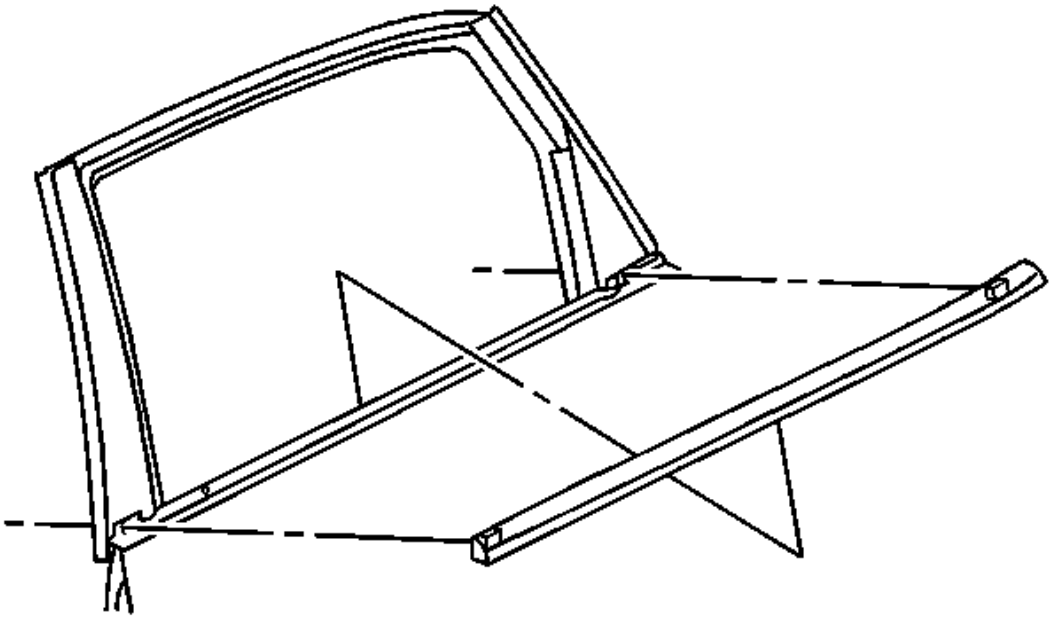


Fig. 30: Rear Door Sealing Strip
Courtesy of GENERAL MOTORS COMPANY

4. Remove the rear window outer belt sealing strip by pulling the sealing strip from the rear door pinch-weld flange.

Installation Procedure

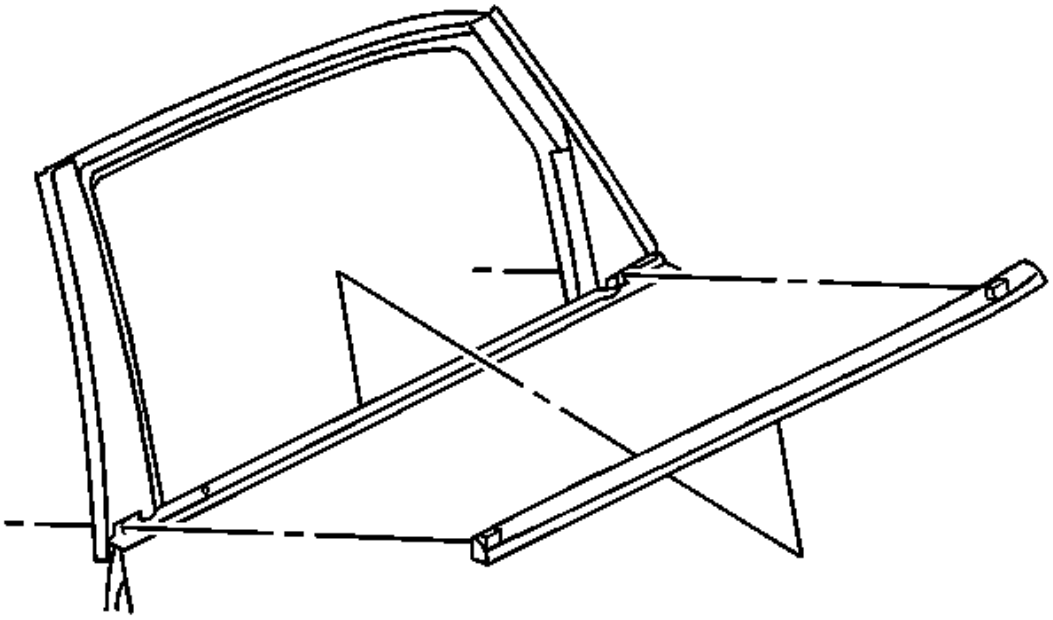


Fig. 31: Rear Door Sealing Strip
Courtesy of GENERAL MOTORS COMPANY

1. Position the rear door outer belt sealing strip to the rear door pinch-weld flange.

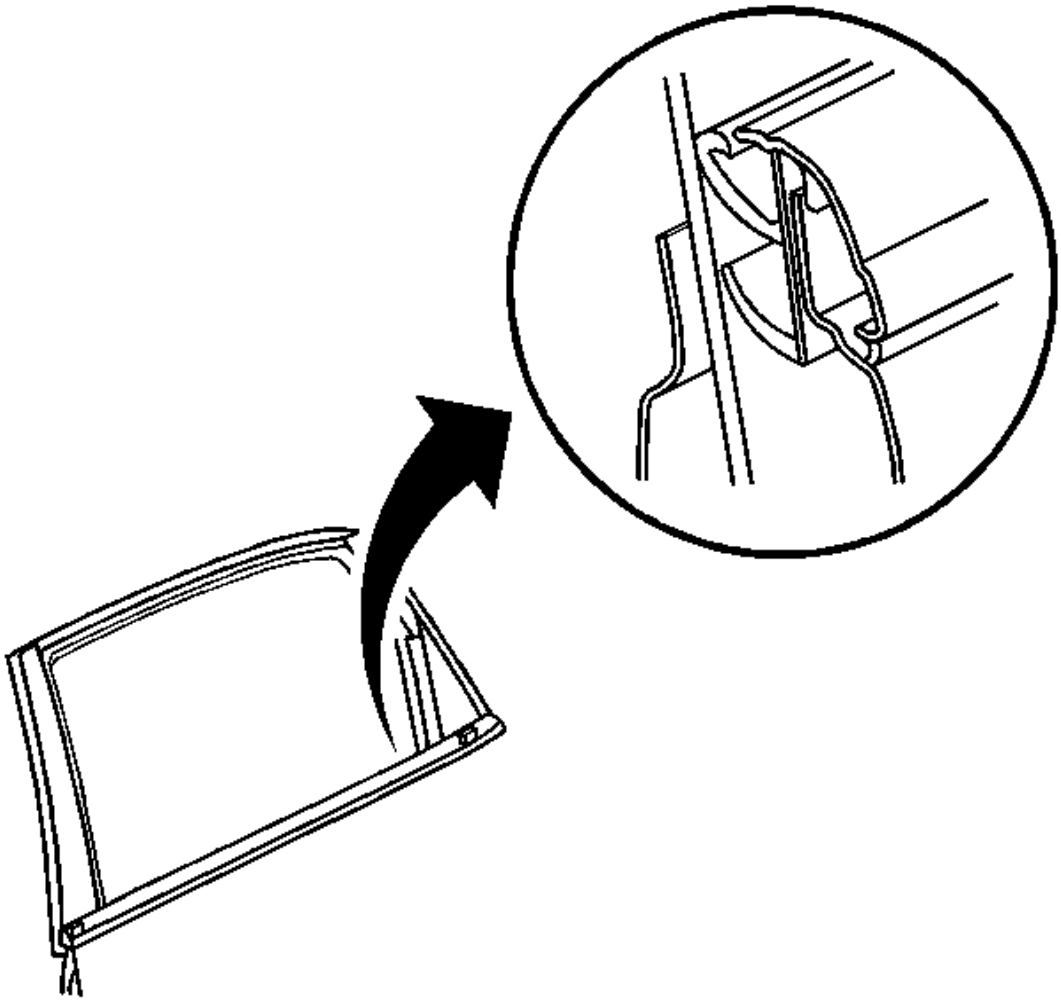


Fig. 32: Rear Door Pinch-Weld Flange
Courtesy of GENERAL MOTORS COMPANY

2. Install the rear door outer belt sealing strip to the pinch-weld flange, pressing into place until full seated.

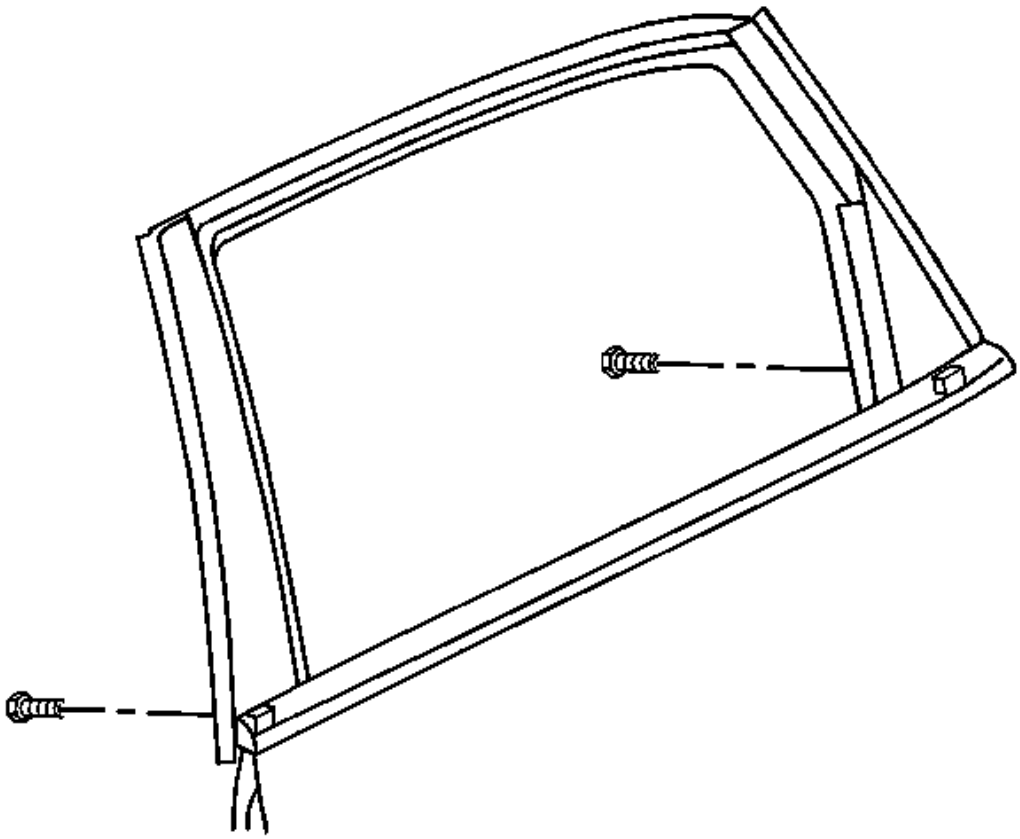


Fig. 33: Rear Door Sealing Strip Screws
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the rear door outer belt sealing strip screws.

   Tighten

   Tighten the rear door outer belt sealing strip screws to 2 N.m (18 lb in).

4. Install the rear door frame applique, align the clips to the door frame and push in place.

FRONT SIDE DOOR WINDOW WEATHERSTRIP REPLACEMENT

Removal Procedure

1. Remove the front door trim panel. Refer to **Front Side Door Trim Panel Replacement** .
2. Remove the front door water deflector. Refer to **Front Side Door Water Deflector Replacement (Impala)** .
3. Remove the front door outer belt sealing strip. Refer to **Front Side Door Window Belt Outer Sealing**

Strip Replacement (Impala).

4. Remove the front door window. Refer to **Front Side Door Window Replacement**.

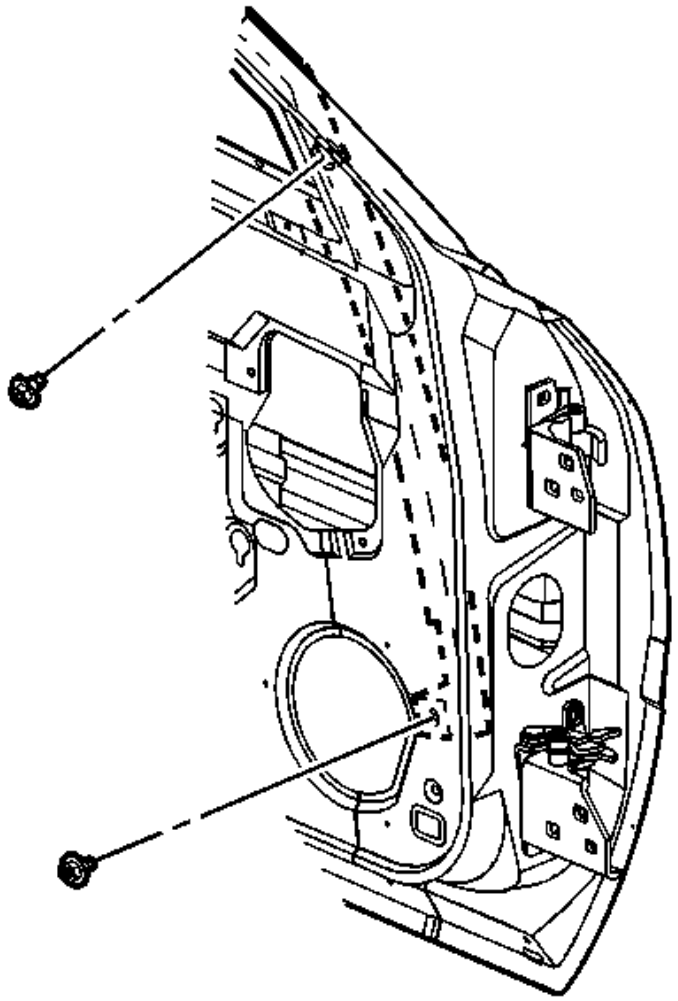


Fig. 34: Front Door Window Channel Screws (Impala)
Courtesy of GENERAL MOTORS COMPANY

5. Remove the screws from the front door window channel.

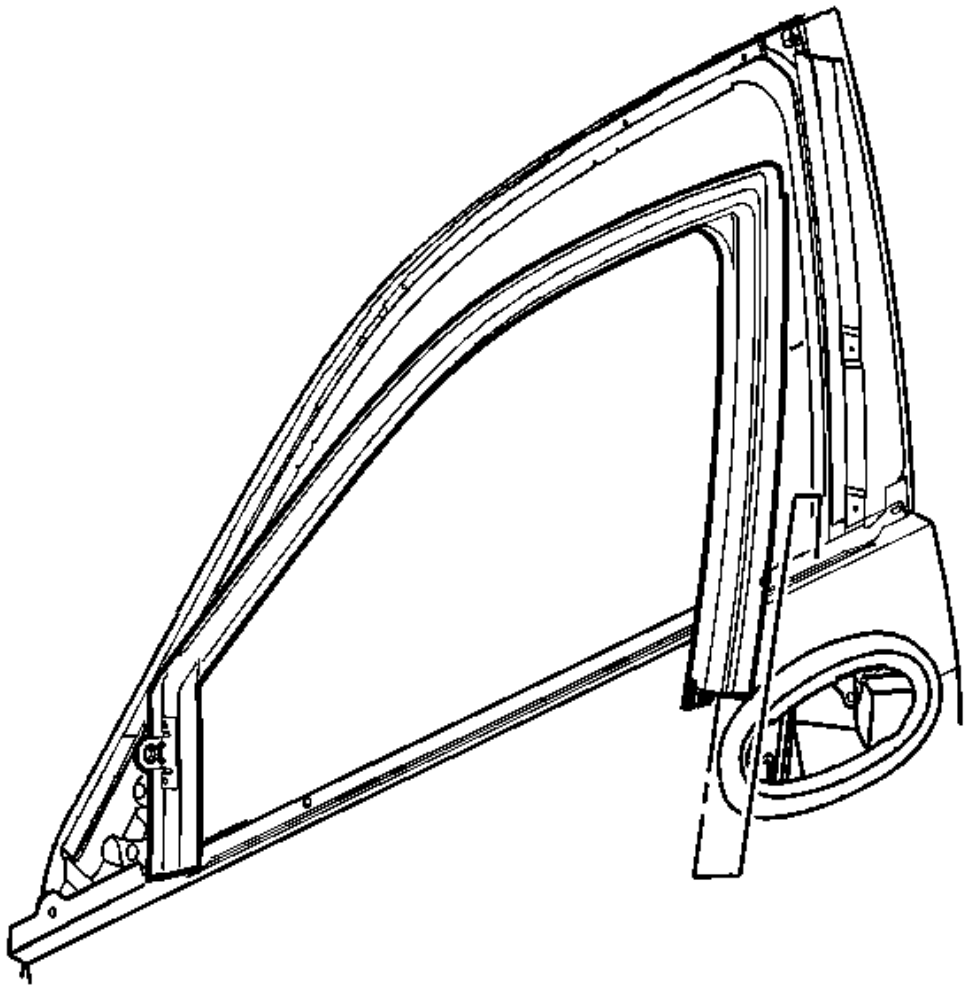


Fig. 35: Front Door Window Channel And Front Door Frame (Impala)
Courtesy of GENERAL MOTORS COMPANY

6. Remove the front door window channel from the front door frame.

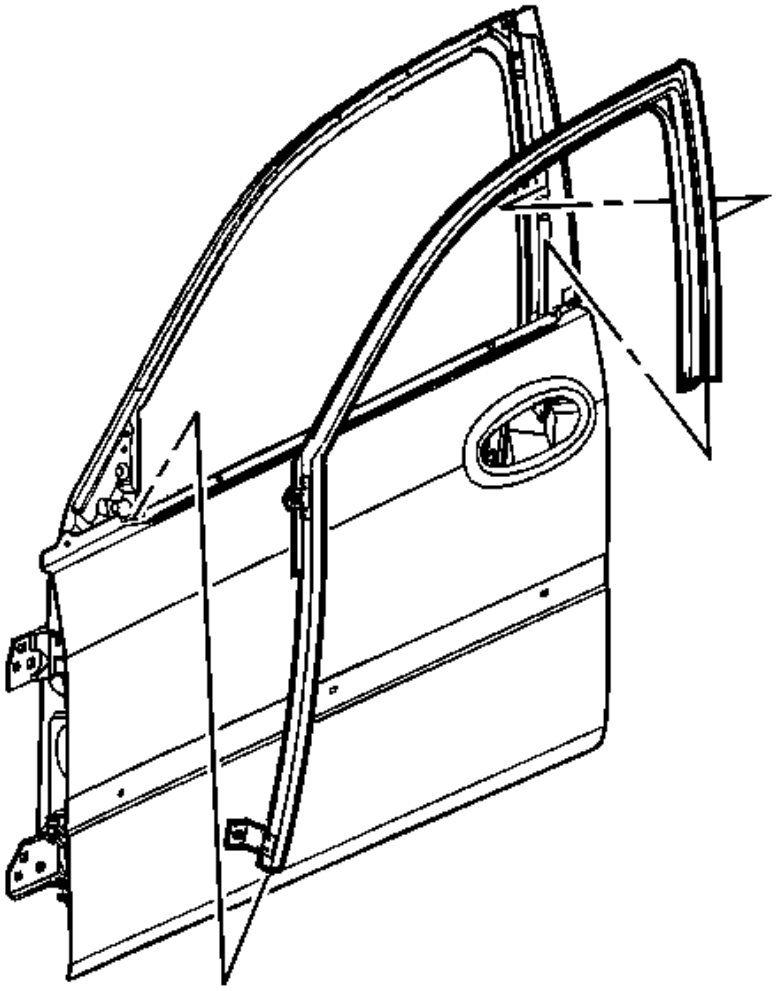


Fig. 36: Front Door Window Channel (Impala)
Courtesy of GENERAL MOTORS COMPANY

7. Remove the front door window channel from the front door.

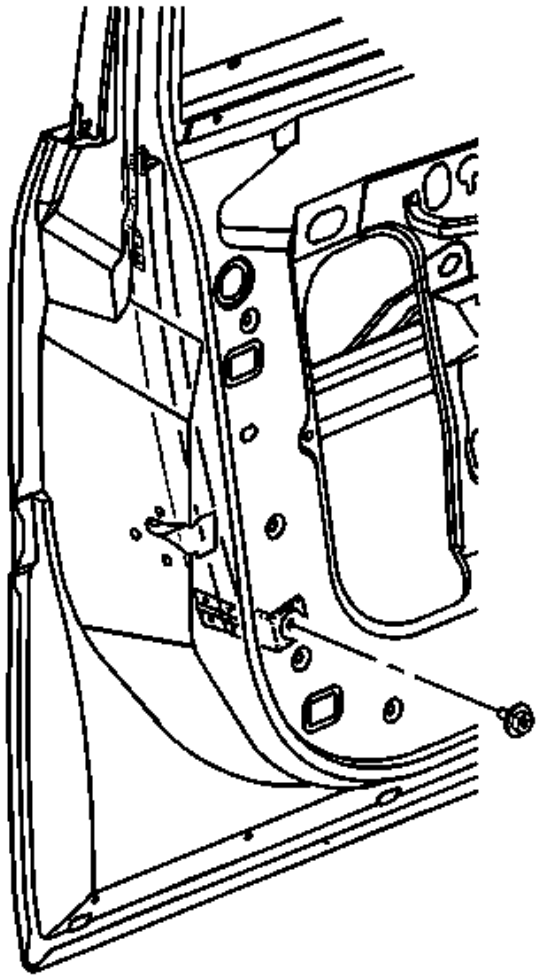


Fig. 37: Front Door Rear Window Channel Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the screw from the front door rear window channel.

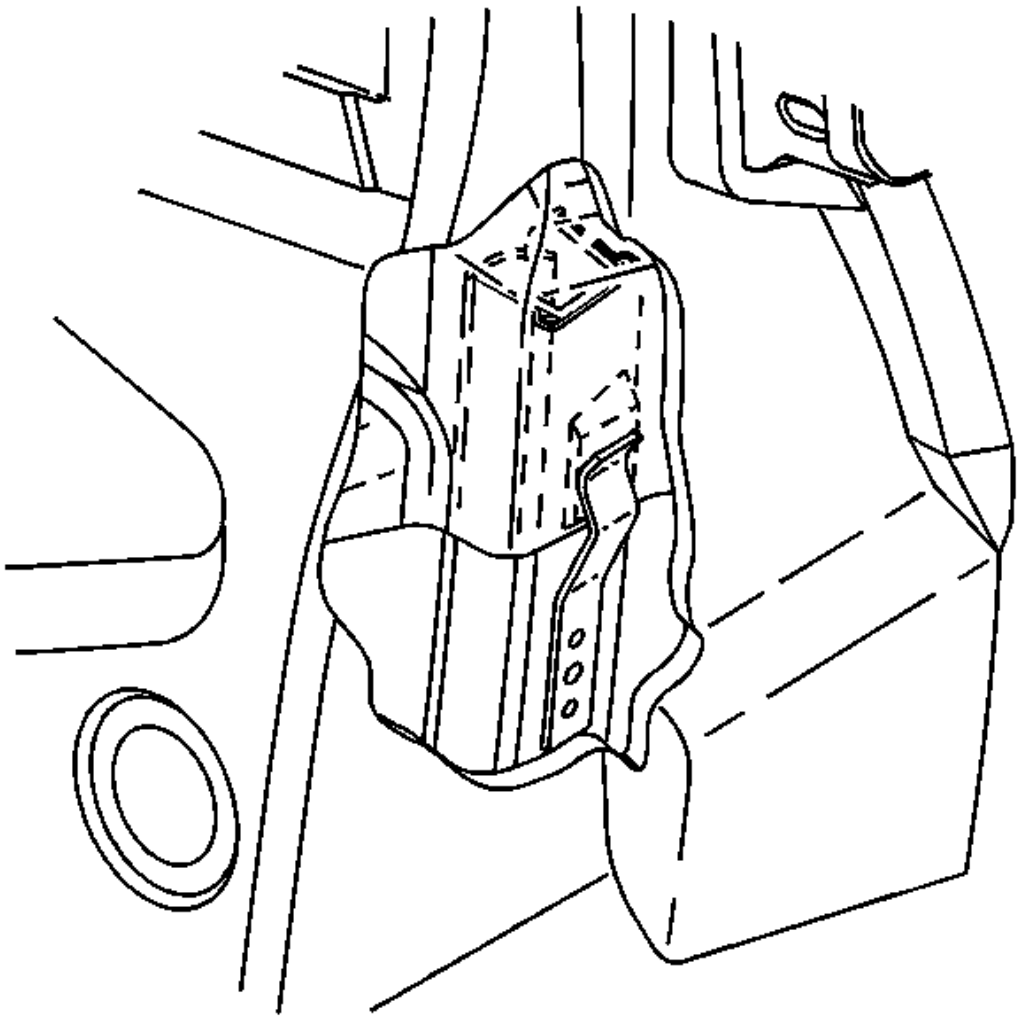


Fig. 38: Front Door Rear Window Channel
Courtesy of GENERAL MOTORS COMPANY

9. Remove the front door rear window channel from the front door slot by pulling down to disengage the retainer clip.

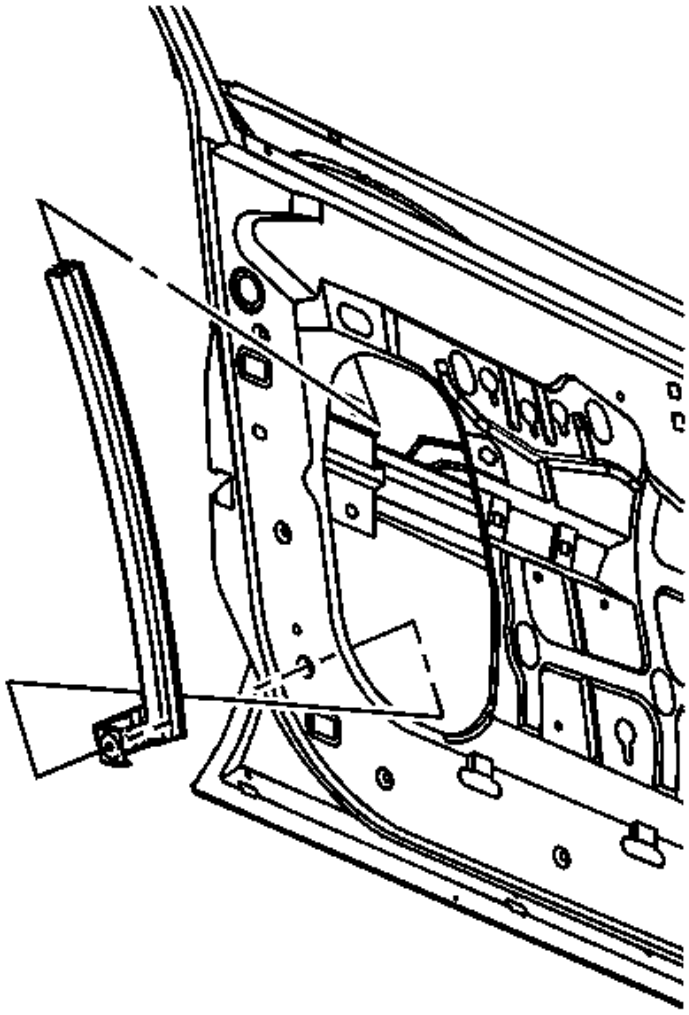


Fig. 39: Front Door Rear Window Channel (Impala)
Courtesy of GENERAL MOTORS COMPANY

10. Remove the front door rear window channel from the front door through the access hole in the inner front door panel.

Installation Procedure

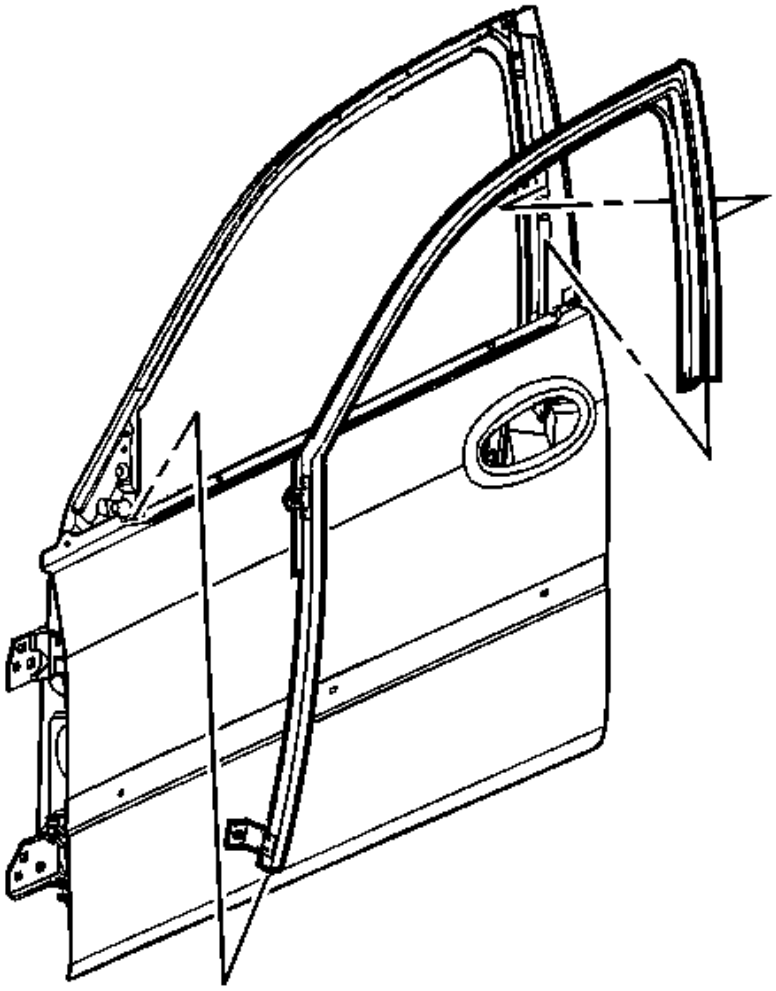


Fig. 40: Front Door Window Channel (Impala)
Courtesy of GENERAL MOTORS COMPANY

1. Position the front door window channel front channel into the front door.

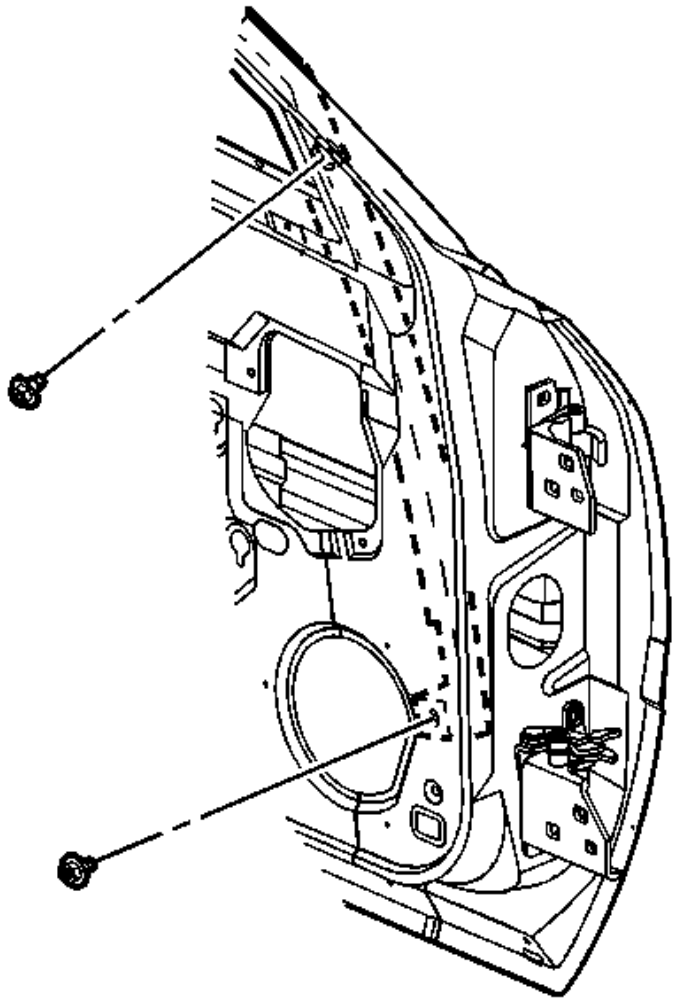


Fig. 41: Front Door Window Channel Screws (Impala)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the front door window channel screws.

Tighten

Tighten the front door window channel screws to 10 N.m (89 lb in).

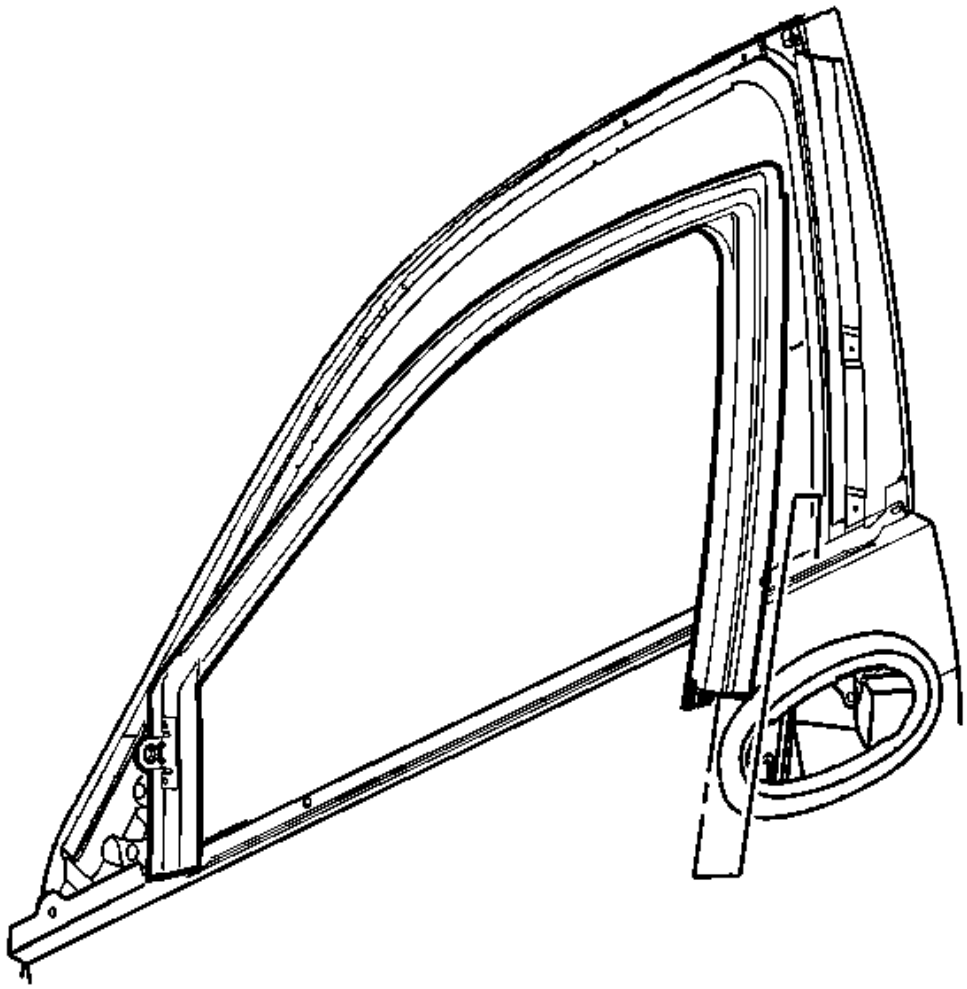


Fig. 42: Front Door Window Channel From Front Door Frame (Impala)
Courtesy of GENERAL MOTORS COMPANY

3. Install the front door window channel to the front door starting in the top corner working out in both directions.

   Firmly seat the front door window channel to the front door.

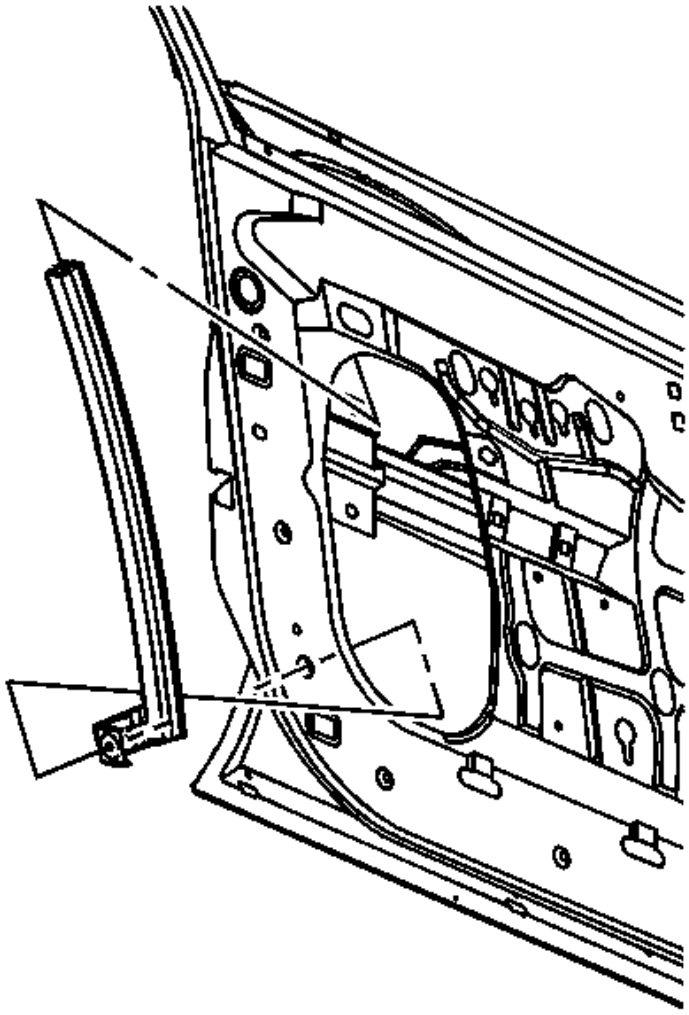


Fig. 43: Front Door Rear Window Channel (Impala)
Courtesy of GENERAL MOTORS COMPANY

4. Install the front door rear window channel to the front door through the access hole in the inner front door panel.

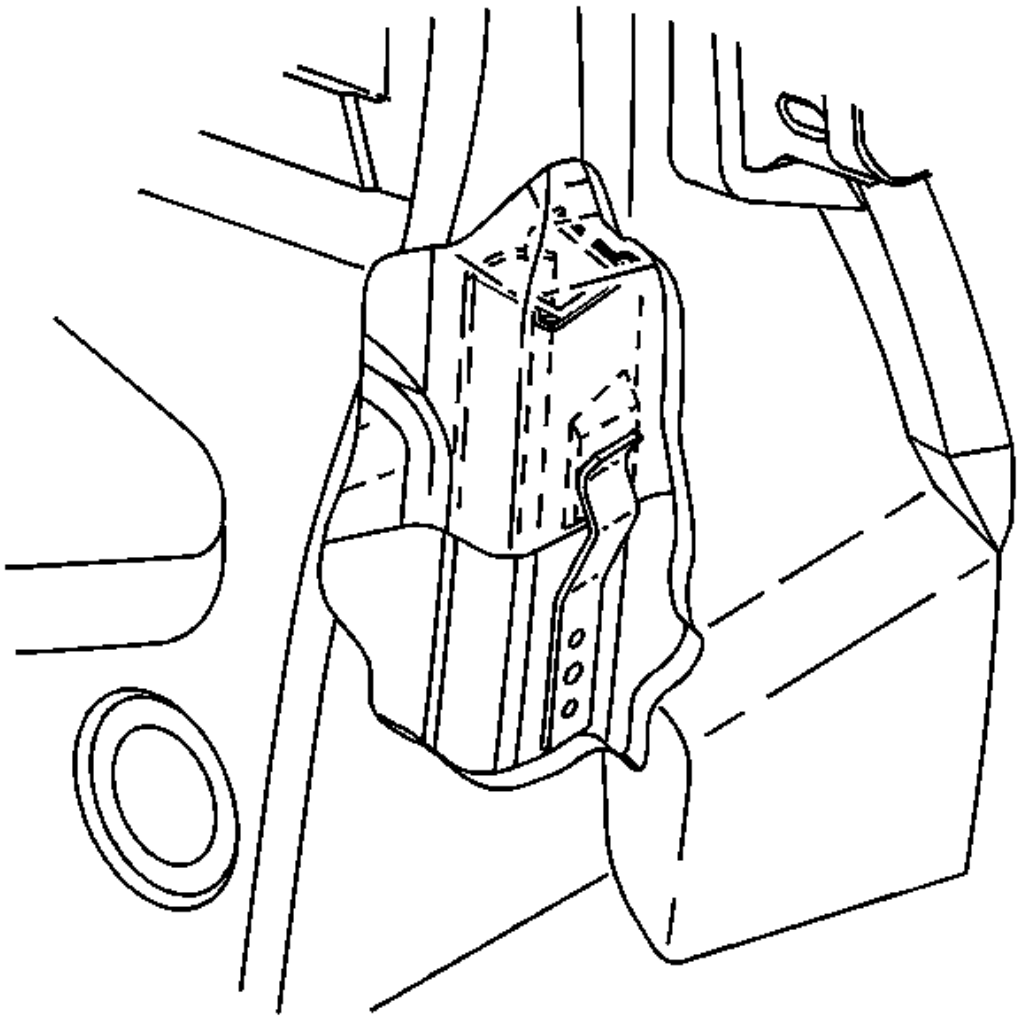


Fig. 44: Front Door Rear Window Channel
Courtesy of GENERAL MOTORS COMPANY

5. Install the front door rear window channel to the front door slot by pushing up to engage the retainer clip.

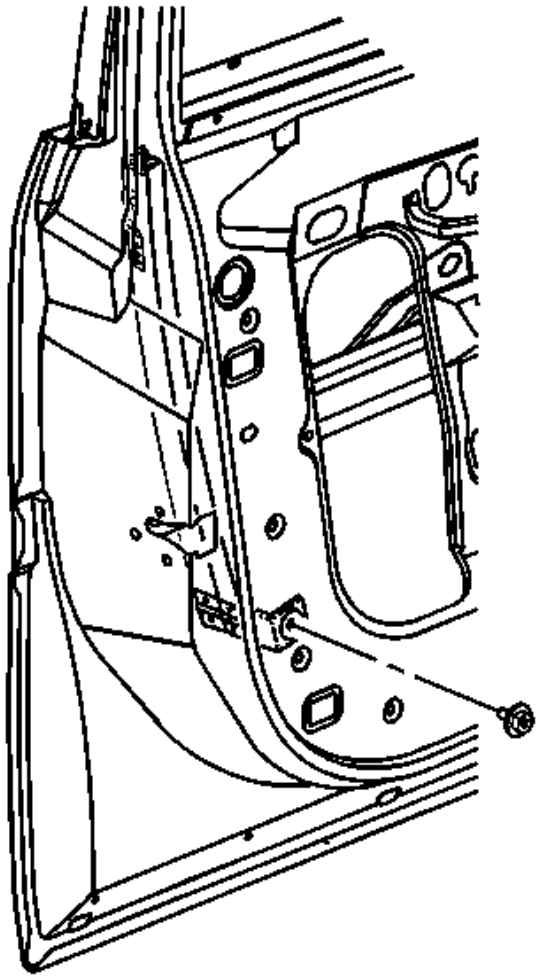


Fig. 45: Front Door Rear Window Channel Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install the screw to the front door rear window channel.

   Tighten

   Tighten the front door weatherstrip channel screws to 10 N.m (89 lb in).

7. Install the front door window. Refer to **Front Side Door Window Replacement**.
8. Inspect the front door window for proper operation.
9. Install the front door outer belt sealing strip. Refer to **Front Side Door Window Belt Outer Sealing Strip Replacement (Impala)**.
10. Install the front door water deflector. Refer to **Front Side Door Water Deflector Replacement (Impala)** .
11. Install the front door trim panel. Refer to **Front Side Door Trim Panel Replacement** .

REAR SIDE DOOR WINDOW WEATHERSTRIP REPLACEMENT

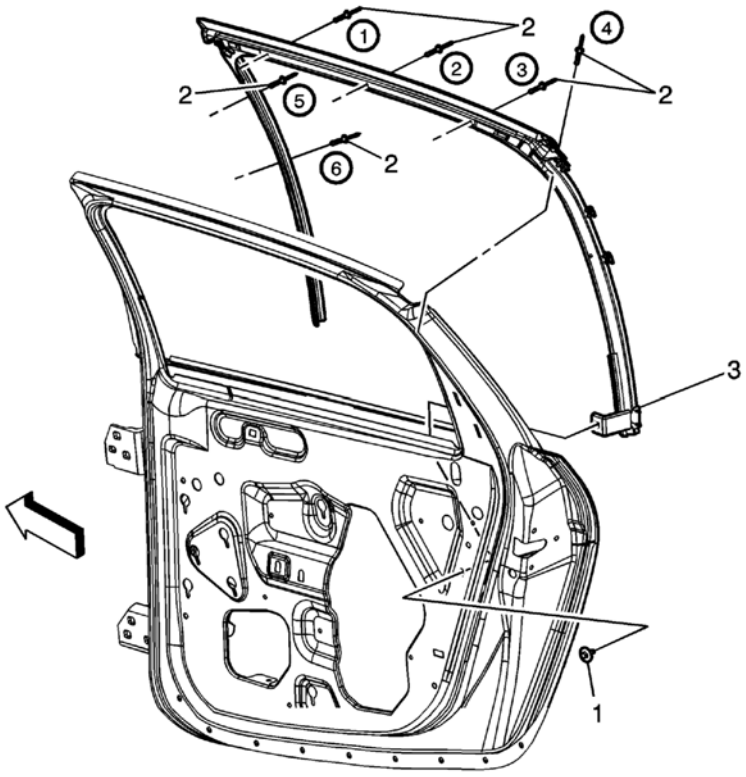


Fig. 46: Rear Side Door Window Weatherstrip
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the rear door trim panel. Refer to **Rear Side Door Trim Panel Replacement** . 2. Remove the rear door inner belt sealing strip. Refer to **Rear Side Door Window Inner Sealing Strip Replacement**. 3. Remove the rear door outer belt sealing strip. Refer to **Rear Side Door Window Outer Sealing Strip Replacement**.	
1	Rear Side Door Window Weatherstrip Bolt **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Apply masking tape to the door frame and applique. 2. Remove the rear door water deflector. 3. Position the window to the full down position.

Callout	Component Name
	Tighten 10 N.m (89 lb in)
2	Rear Side Door Window Weatherstrip Rivet (Qty: 6) **Procedure** 1. Remove the window weatherstrip by grasping the center and pulling downward to expose the rivets. 2. Drill out the 4 mm (5/32 in) rivets (1) along the inside edge of the rear side door window weatherstrip (3) retainer.
3	Rear Side Door Window Weatherstrip **Procedure** 1. Removing the weatherstrip starting at the rear lower end, pull the inner window weatherstrip away from the door frame. 2. Install the weatherstrip at the upper, rear corner, install the inner window weatherstrip to the door pinchweld flange. 3. Install the window channel weatherstrip by working it around the door frame. Ensure that the weatherstrip is fully seated into the window channel retainer. 4. Inspect the window for proper operation.

ADHESIVE INSTALLATION OF STATIONARY WINDOWS

1. Use a urethane adhesive systems which meet GM Specification GM 3651G

   WARNING: Refer to Glass and Sheet Metal Handling Warning .

2. Remove all mounds or loose pieces of urethane adhesive from the pinch-weld area.
3. If the original window is being reused, remove all but approximately 2 mm (3/64 in) of the existing bead of urethane adhesive from the pinch-weld flange surface by using a clean utility knife or razor blade scraper.
4. Inspect for any of the following problems in order to help prevent future breakage of the window:
   - High weld
   - Solder spots on the pinch-weld
   - Hardened sealer
   - Any other obstruction or irregularity in the pinch-weld flange

   NOTE: If corrosion of the pinch-weld flange is present or if sheet metal repairs or replacements are required, the pinch-weld flange must be refinished in order to restore the bonding area strength. If paint repairs are required, mask the flange bonding area prior to applying the color coat in order to provide a clean primer only surface. Materials such as BASF DE15Â®,

DuPont 2610Â®, Sherwin-Williams PSE 4600 and NP70Â® and Martin-Semour 5120 and 5130Â® PPG DP90LF SPIES/HECKER 3688/8590 - 3688/5150 - 4070/5090 STANDOX 11158/13320 - 14653/14980 products are approved for this application.

5. After repairing the opening as indicated, perform the following steps:
    1. Remove all traces of broken window from the outer cowl panel, seats, floor and defroster ducts.
    2. Clean around the edge of the inside surface of the window with a 50/50 mixture of isopropyl alcohol and water by volume on a dampened lint-free cloth.

WARNING: Refer to Window Retention Warning .

6. Verify all primers and urethane adhesive are within expiration dates.

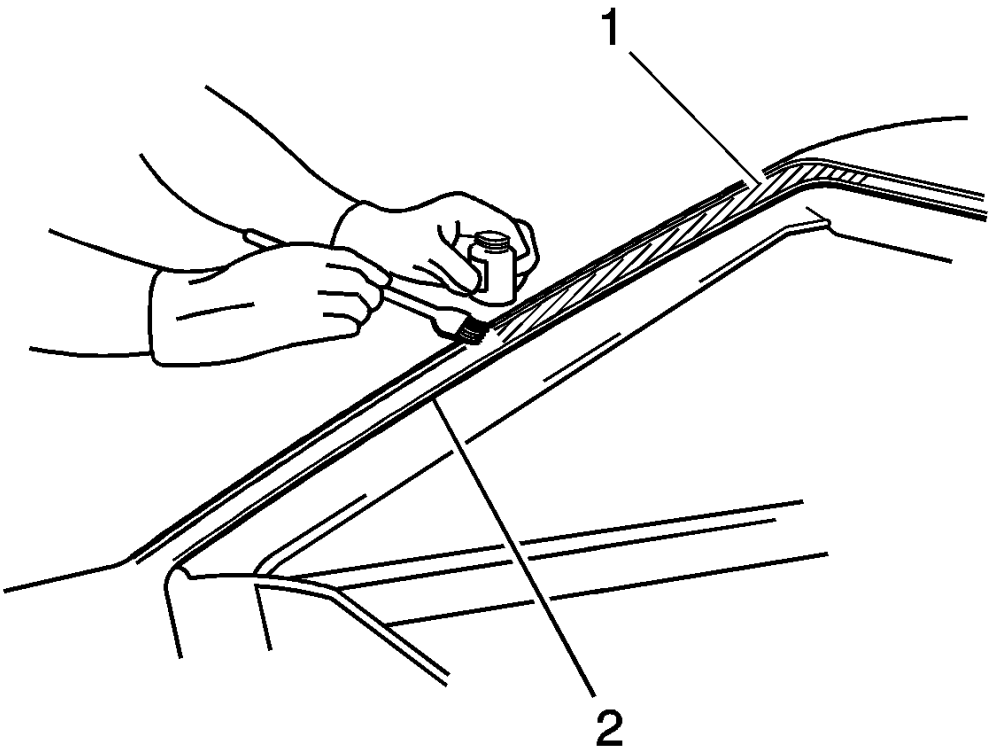


Fig. 47: Applying Pinch-Weld Primer
Courtesy of GENERAL MOTORS COMPANY

WARNING: Failure to prep the area prior to the application of primer may cause insufficient bonding of urethane adhesive. Insufficient bonding of urethane adhesive may allow unrestrained occupants to be ejected from

the vehicle resulting in personal injury.

WARNING: **Refer to Window Retention Warning .**

NOTE: **Do not apply the black #3 primer to the existing bead (1) of the urethane adhesive on the pinch-weld flange. Apply the primer only to nicks, scratches or the primed surfaces.**

7. Shake the pinch-weld primer black #3 for at least 1 minute.
8. Use a new dauber in order to apply the primer to the surface of the pinch-weld flange (2).
9. Allow the pinch-weld primer to dry for approximately 10 minutes.

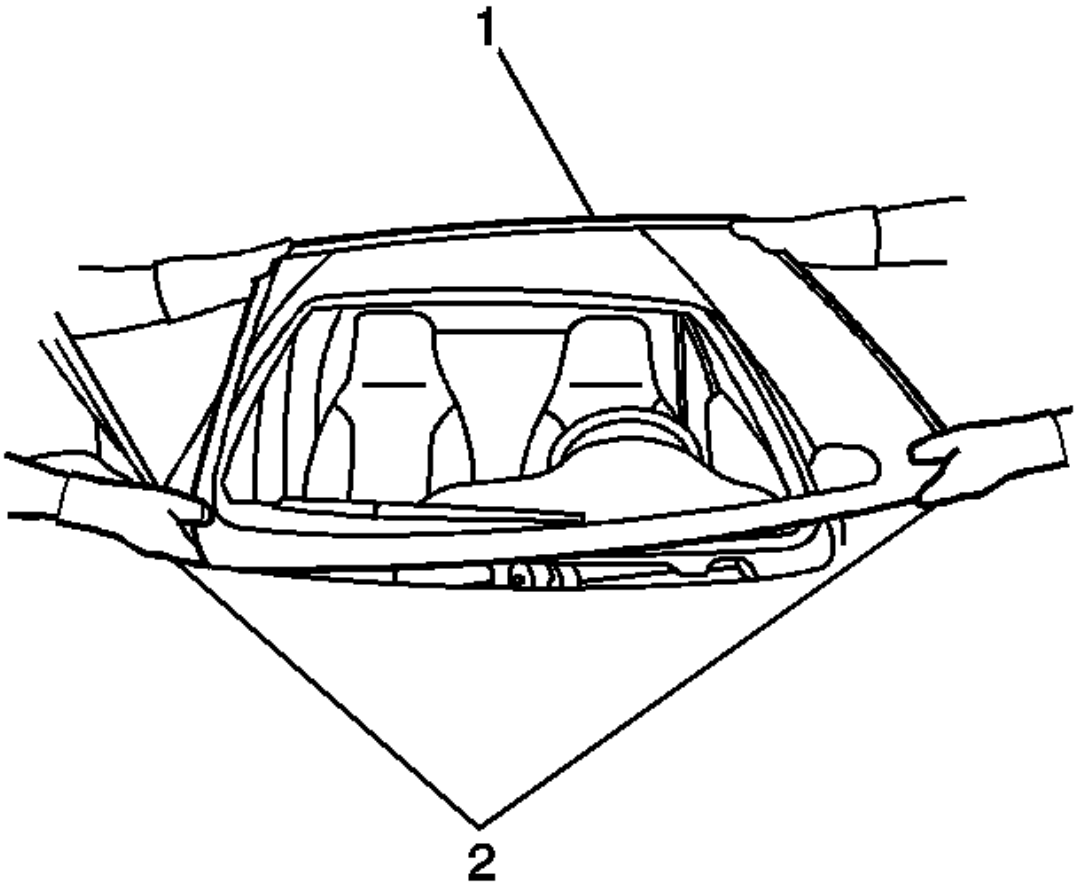


Fig. 48: Removing/Installing Windshield
Courtesy of GENERAL MOTORS COMPANY

10. With the aid of an assistant, dry fit the window (1) to the opening in order to determine the correct position.

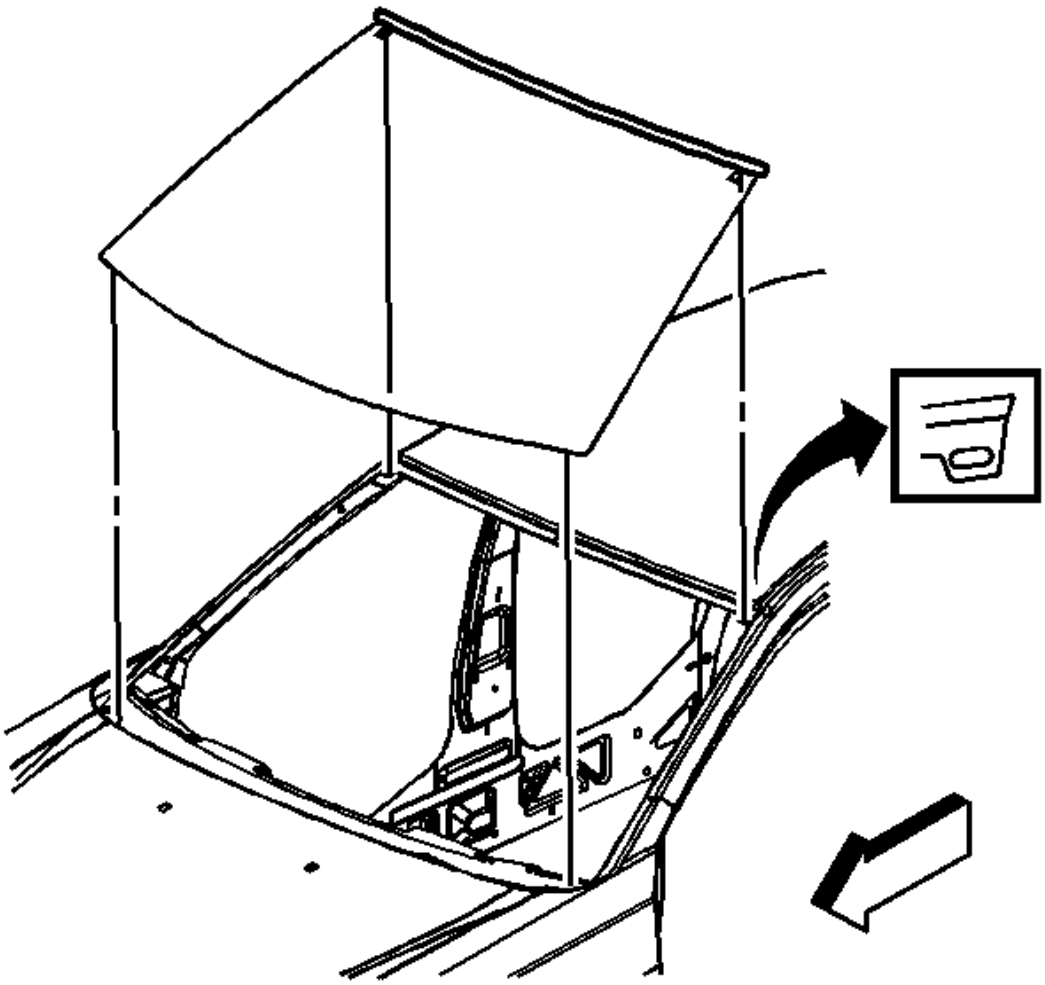


Fig. 49: Identifying Locator Slots On Upper Pinch-Weld Flange
Courtesy of GENERAL MOTORS COMPANY

11. Position the locator pins on the window into the upper sheet metal slots in order to hold the window in place.

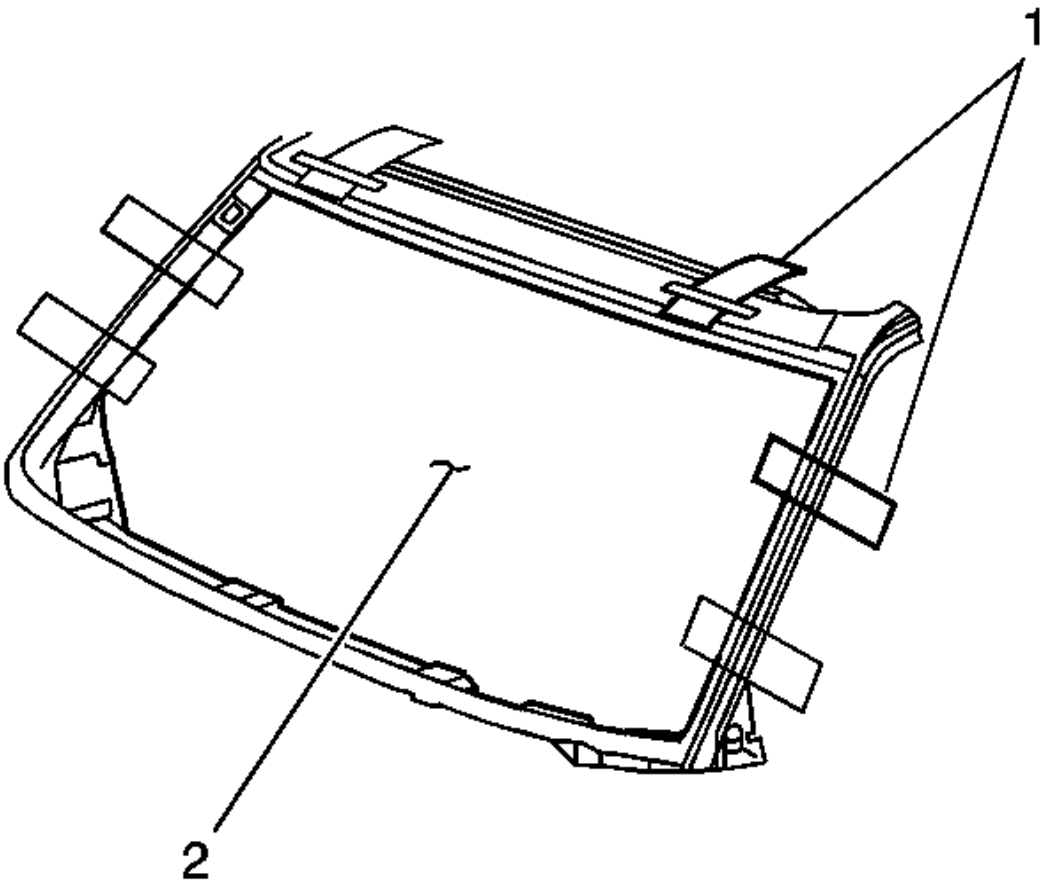


Fig. 50: Aligning Tape Lines On Window To Body
Courtesy of GENERAL MOTORS COMPANY

12. Use masking tape in order to mark the locations (1) of the window (2) in the opening.
13. Cut the masking tape in the center and remove the window from the opening.

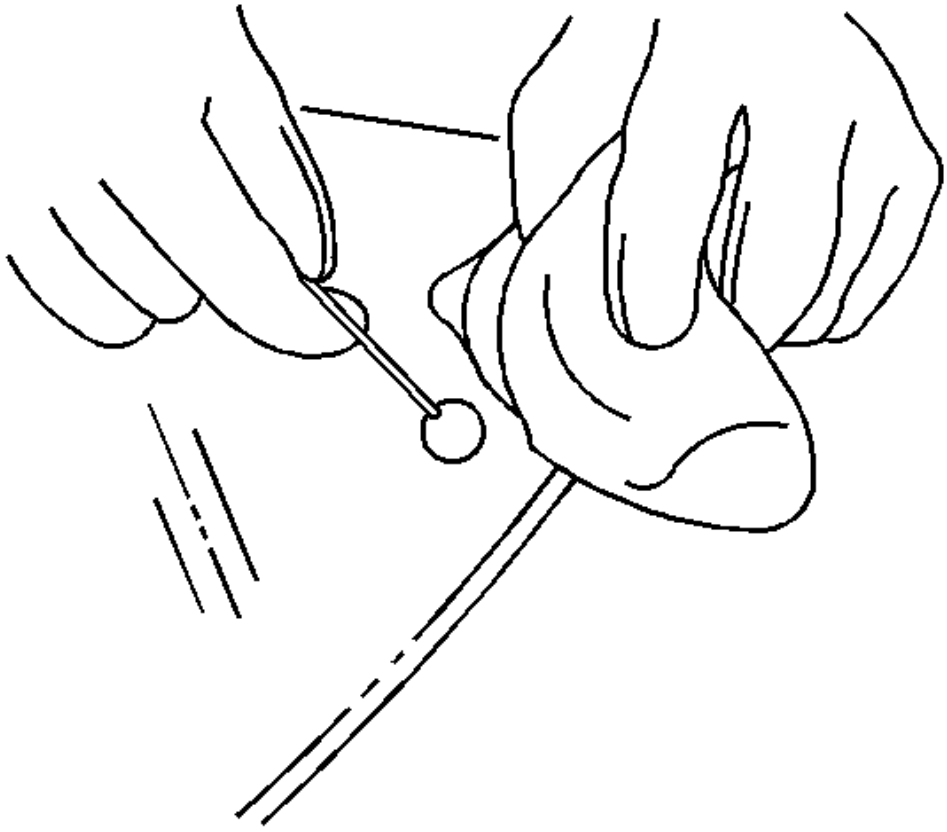


Fig. 51: Applying Glass Prep
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use care when applying window prep clear #1 on the window. This primer dries almost instantly, and may stain the viewing area of the window if not applied evenly.**

14. Use a new dauber in order to apply window prep clear #1 to the area approximately 10-16 mm (3/8-5/8 in) around the entire perimeter of the window inner surface.

    Immediately wipe the window primed area using a clean, lint-free cloth.

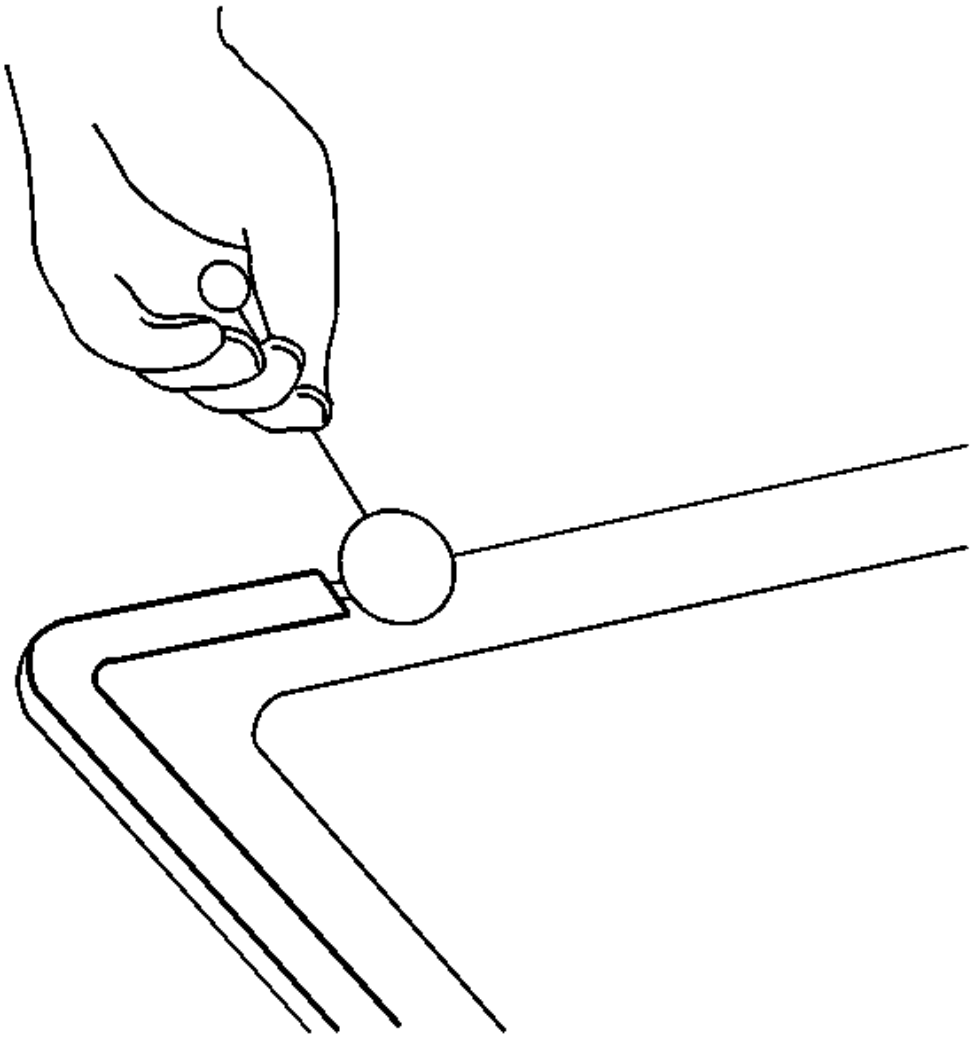


Fig. 52: Applying Glass Prep
Courtesy of GENERAL MOTORS COMPANY

15. Apply a second coat of the window prep clear #1 to the same area of the window.

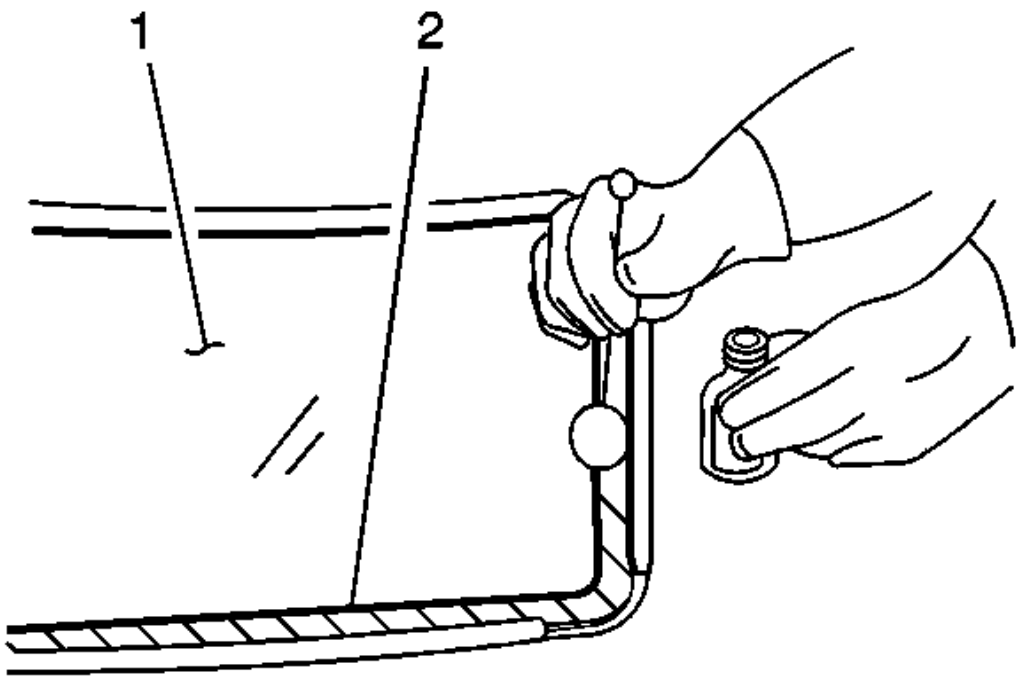


Fig. 53: Applying Glass Primer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The window primer black #2 is effective up to 8 hours after applying it to the window. The primed surface of the window must be kept clean.**

16. Shake the window primer black #2 for at least 1 minute.
17. Use a new dauber in order to apply the window primer black #2 to the same areas (2) that window prep clear #1 was applied.
18. Allow the window primer to dry for approximately 10 minutes.

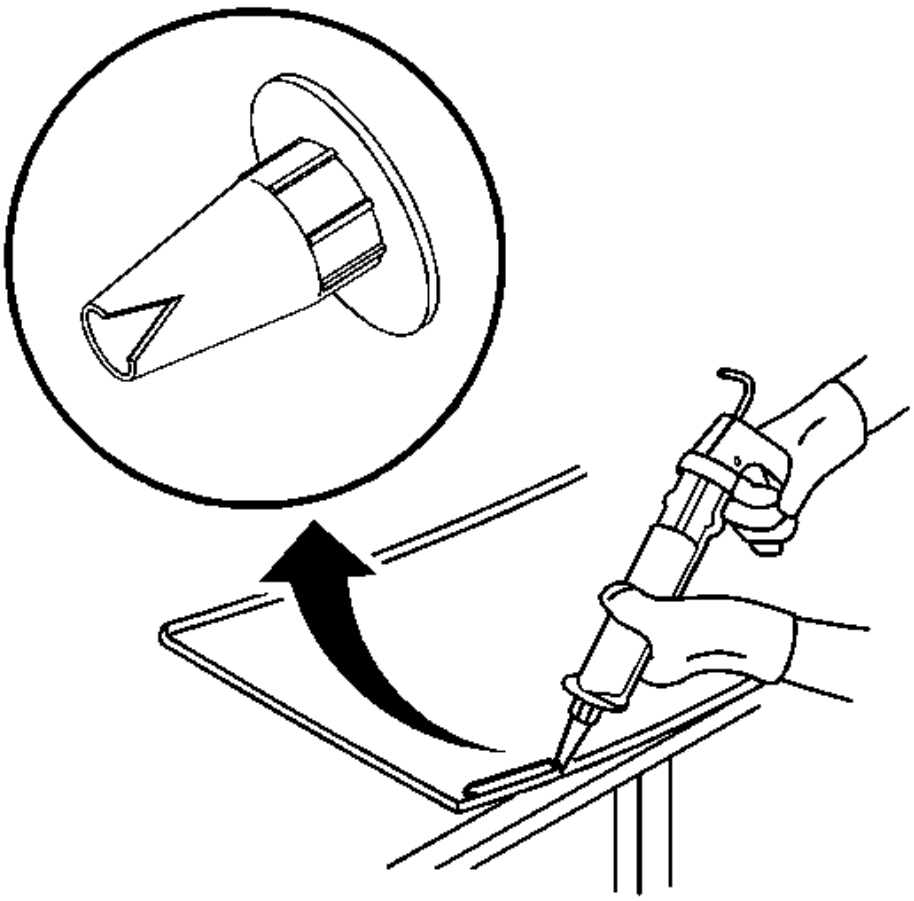


Fig. 54: View Of Modified Applicator Nozzle
Courtesy of GENERAL MOTORS COMPANY

19. Cut the applicator nozzle in order to provide a bead of 13 mm (1/2 in) wide and 13 mm (1/2 in) high.

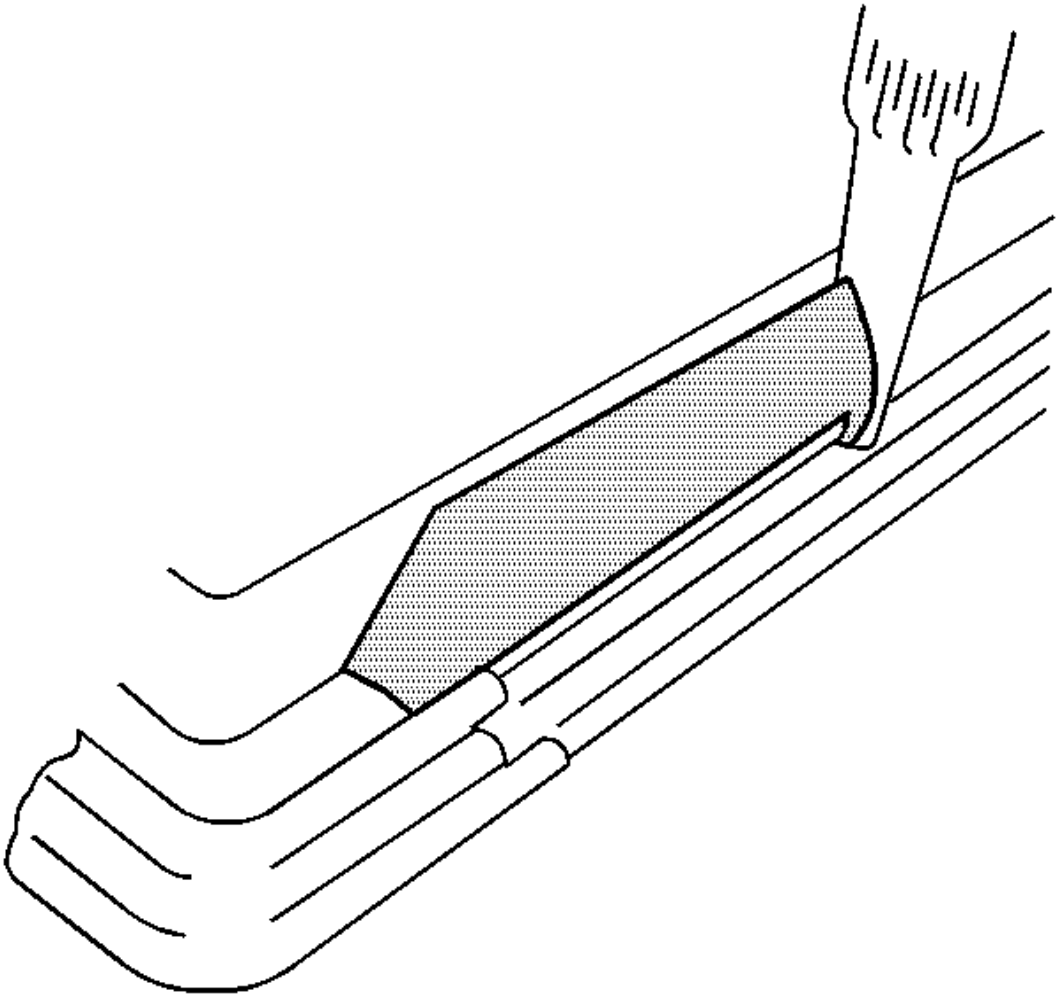


Fig. 55: Applying Continuous Bead Of Urethane Adhesive
Courtesy of GENERAL MOTORS COMPANY

20. Use a cartridge-type caulking gun in order to apply a smooth, continuous bead of urethane adhesive.

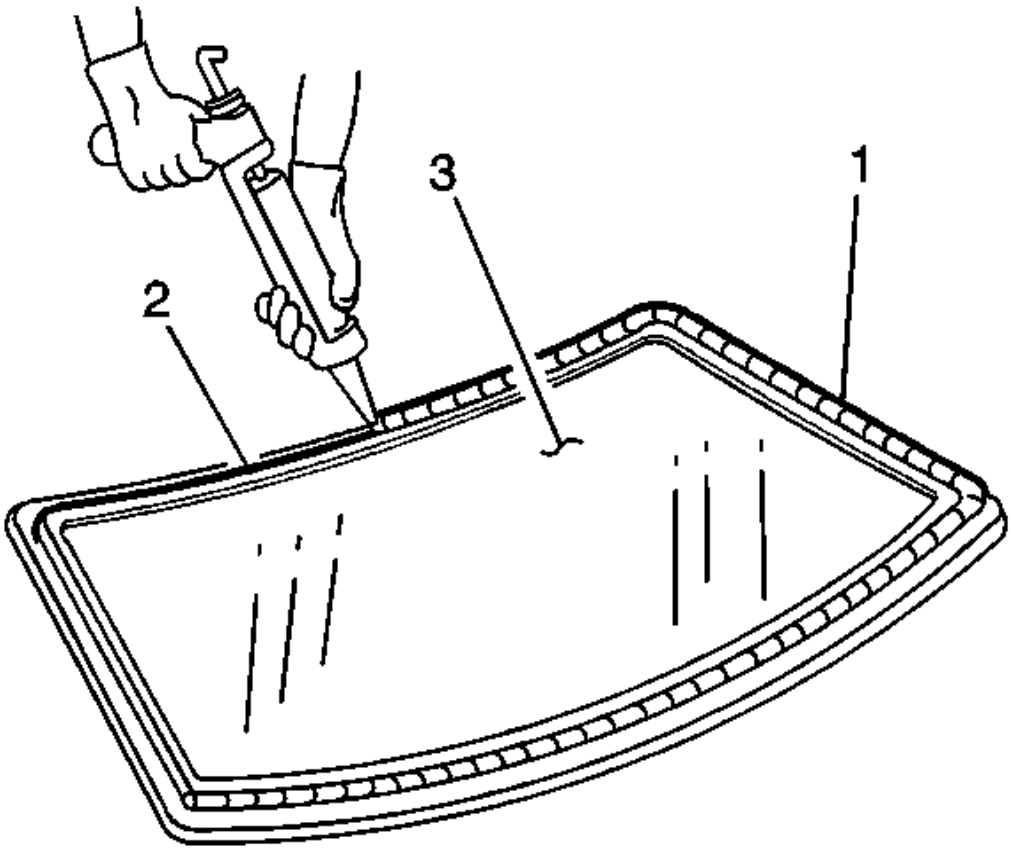


Fig. 56: Applying Urethane Adhesive To Inner Surface Of Window
Courtesy of GENERAL MOTORS COMPANY

21. Use the edge of the window (3) as a guide for the nozzle in order to apply the urethane adhesive (2) to the inner surface of the window (3).

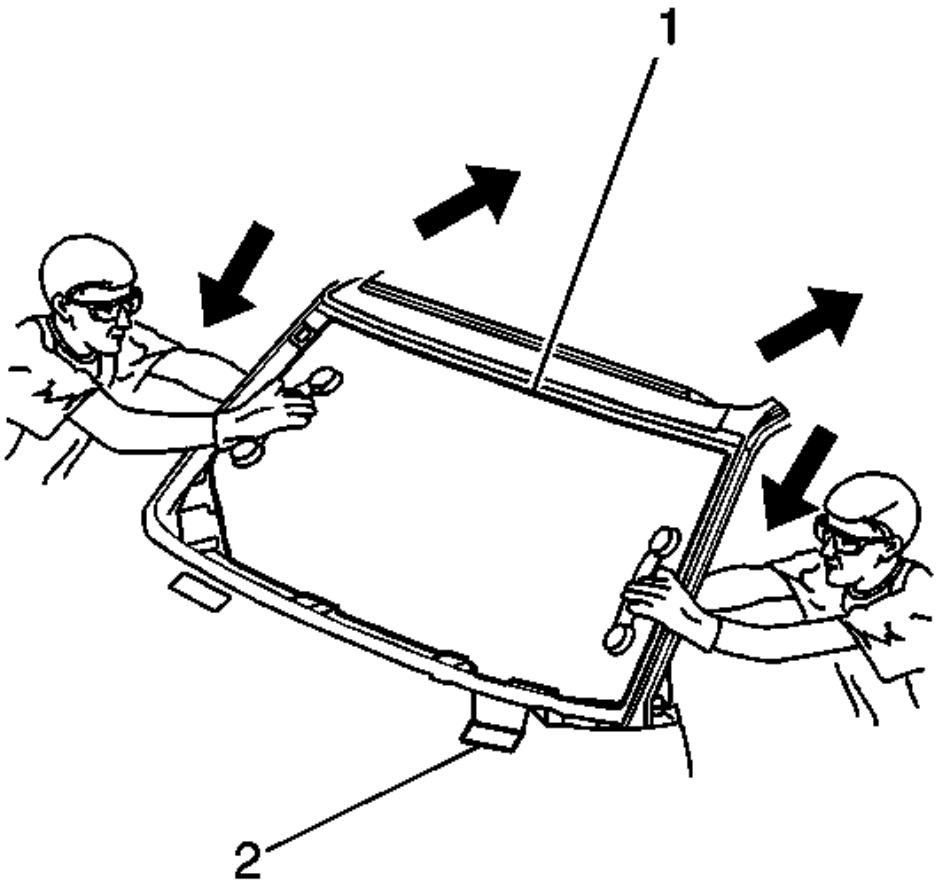


Fig. 57: Windshield
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the locator pins were damage when removing it will be necessary to tape the window in place until chemical-curing for the type of urethane adhesive used.**

22. Place the window on the lower supports (2), if equipped with the aid of an assistant, place the window in the opening ensuring that the locator pins on the window align with the upper sheet metal slots in order to hold the window in place.

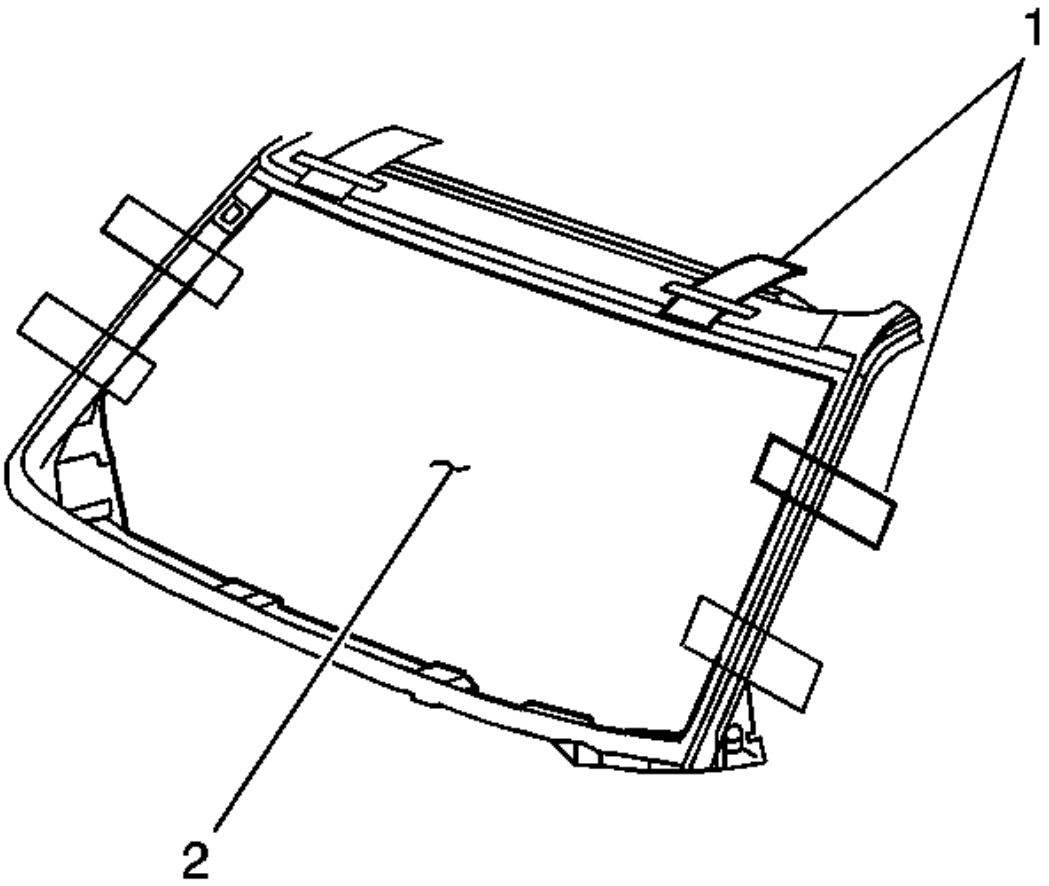


Fig. 58: Aligning Tape Lines On Window To Body
Courtesy of GENERAL MOTORS COMPANY

23. Align the masking tape (1) lines on the window (2) and the body.

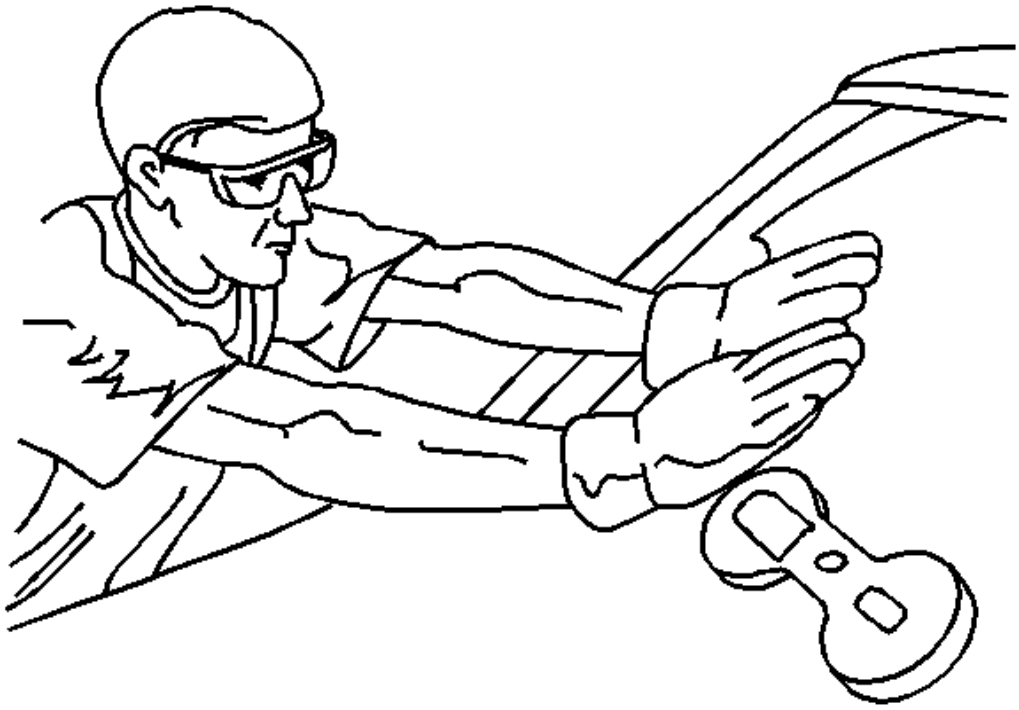


Fig. 59: Pressing Window Into Place
Courtesy of GENERAL MOTORS COMPANY

24. Press the window firmly into place.
25. Tape the window to the body in order to minimize movement until the urethane adhesive cures.

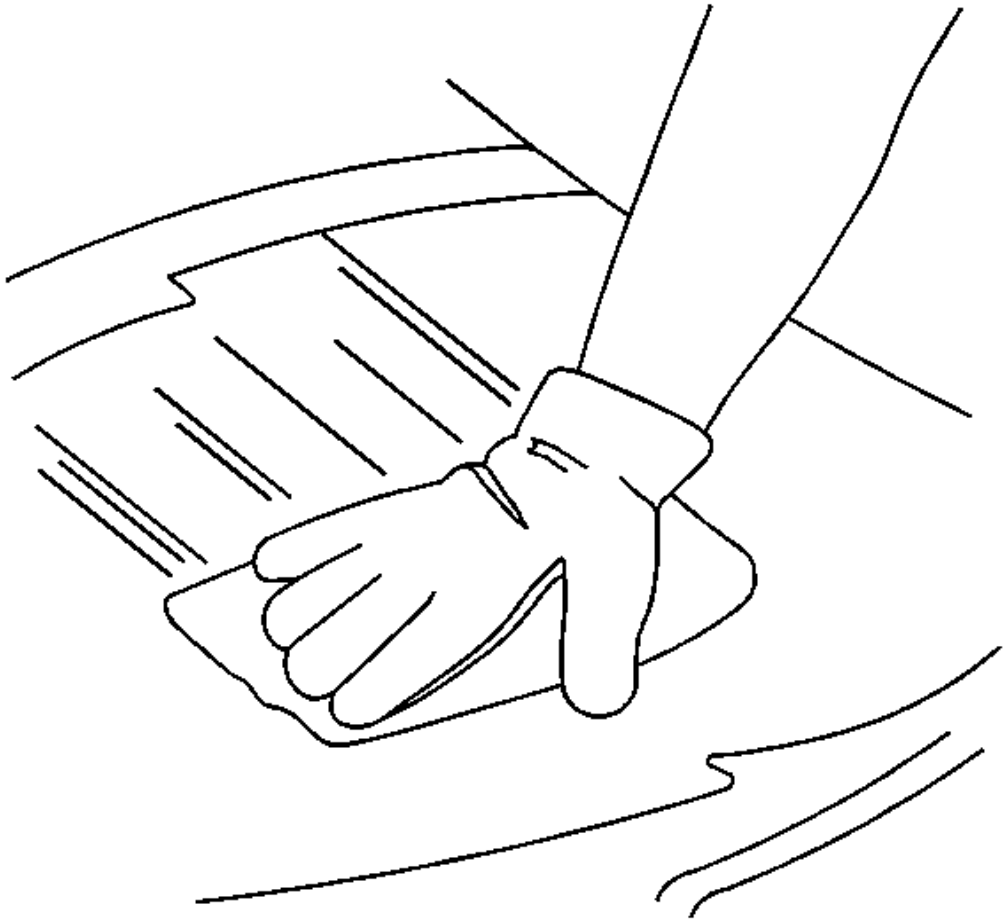


Fig. 60: Cleaning Excess Urethane Adhesive From Body
Courtesy of GENERAL MOTORS COMPANY

26. Clean any excess urethane adhesive from the body.

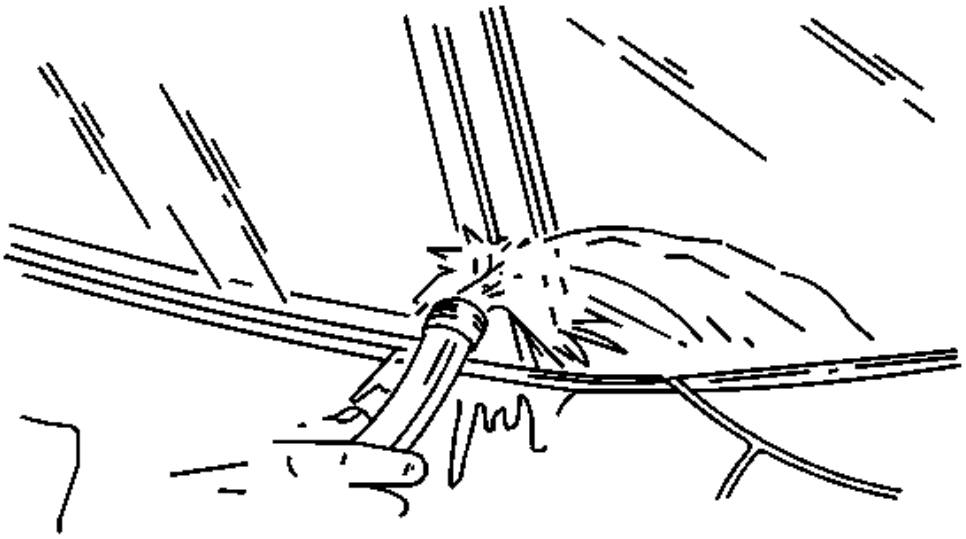


Fig. 61: Performing Water Hose Test
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not direct a hard stream of high pressure water to the freshly applied urethane adhesive.**

27. Use a soft spray of warm water in order to immediately water test the window.
28. Inspect the window for leaks.
29. If any leaks are found, use a plastic paddle in order to apply extra urethane adhesive at the leak point.
30. Retest the window for leaks.

WARNING: **Insufficient curing of urethane adhesive may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.**

- **For the moisture-curing type of urethane adhesive, allow a minimum of 6 hours at 21Â°C (70Â°F) or greater and with at least 30 percent relative humidity. Allow at least 24 hours for the complete curing of the urethane adhesive.**

- **For the chemical-curing type of urethane adhesive, allow a minimum of 1 hour .**

Do NOT physically disturb the repair area until after these minimum times have elapsed.

31. Maintain the following conditions in order to properly cure the urethane adhesive:
    - Partially lower a door window in order to prevent pressure buildups when closing doors before the urethane adhesive cures.
    - Do not drive the vehicle until the urethane adhesive is cured. Refer to the above curing times.
    - Do not use compressed air in order to dry the urethane adhesive.
32. Complete the window installation.

ADHESIVE INSTALLATION OF ENCAPSULATED STATIONARY WINDOWS

1. Use a urethane adhesive systems which meet GM Specification GM 3651G

WARNING: **Refer to Glass and Sheet Metal Handling Warning .**

2. Remove all mounds or loose pieces of urethane adhesive from the pinch-weld area.
3. If the original window is being reused, remove all but approximately 2 mm (3/64 in) of the existing bead of urethane adhesive from the pinch-weld flange surface by using a clean utility knife or razor blade scraper.
4. Inspect for any of the following problems in order to help prevent future breakage of the window:
    - High weld
    - Solder spots on the pinch-weld
    - Hardened sealer
    - Any other obstruction or irregularity in the pinch-weld flange

NOTE: **If corrosion of the pinch-weld flange is present or if sheet metal repairs or replacement are required, the pinch-weld flange must be refinished in order to restore the bonding area strength. If paint repairs are required, mask the flange bonding area prior to applying the color coat in order to provide a clean primer only surface. Materials such as BASF DE15, Dupont 2610, Sherwin-Williams PSE 4600 and NP70, Martin-Semour 5120, PPG DP90LF, Spies/Hecker 3688/8590 3688/5150 4070/5090, and Standox 11158/13320 14653/14980 are approved for this application.**

5. After repairing the opening as indicated, perform the following steps:
    1. Remove all traces of broken window from the outer cowl panel, seats, floor and defroster ducts.
    2. Clean around the edge of the inside surface of the window with a 50/50 mixture of isopropyl alcohol and water by volume on a dampened lint-free cloth.
6. Verify all primers an urethane adhesives are within expiration dates.

WARNING: **Refer to Window Retention Warning .**

WARNING: **Failure to prep the area prior to the application of primer may cause insufficient bonding of urethane adhesive. Insufficient bonding of urethane adhesive may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.**

NOTE: **Do not apply the black #3 primer to the existing bead of urethane adhesive on the pinch-weld flange. Apply the primer only to nicks, scratches or the primed surfaces.**

7. Shake the black #3 primer for at least 1 minute.
8. Use a dauber in order to apply the primer to the surface of the pinch-weld flange.
9. Allow the pinch-weld primer to dry for approximately 10 minutes.
10. With an assistant, dry fit the window assembly into the opening to determine correct position.
11. Using masking tape, mark the location of the window assembly to the opening.
12. Apply Glass Prep #1 followed by Glass Primer #2 on the encapsulation material. Allow to dry for 6-10 minutes.

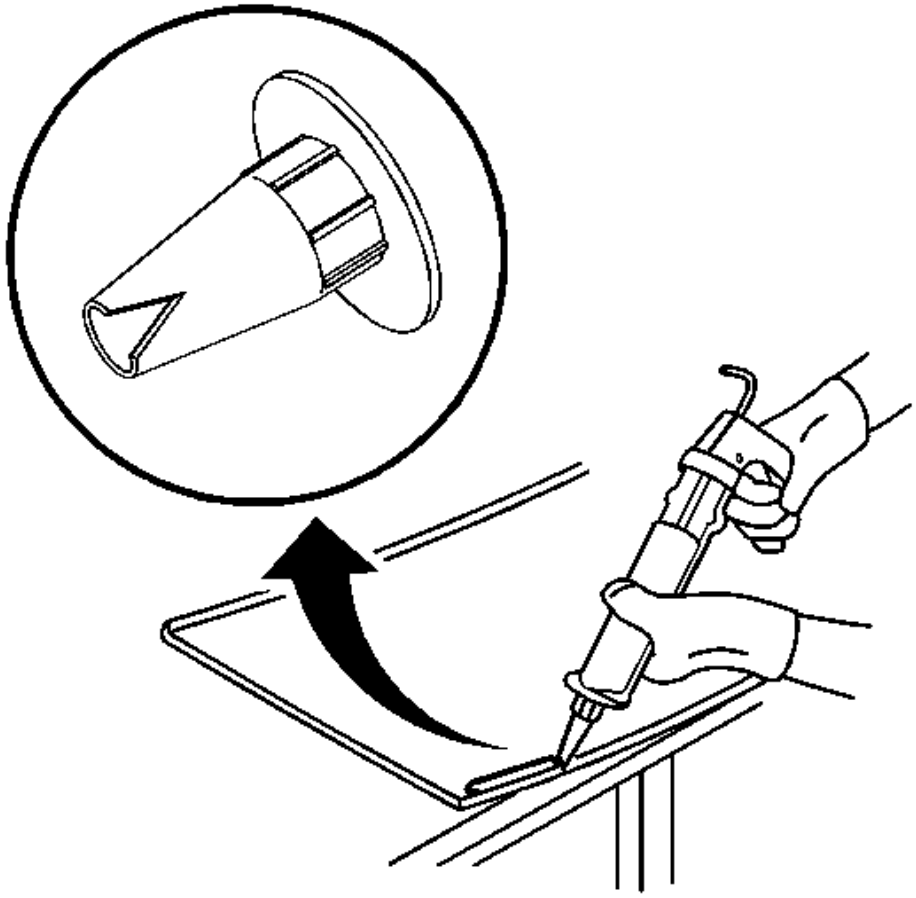


Fig. 62: View Of Modified Applicator Nozzle
Courtesy of GENERAL MOTORS COMPANY

13. Using a cartridge-type caulking gun in order to apply a smooth continuous bead of urethane adhesive.

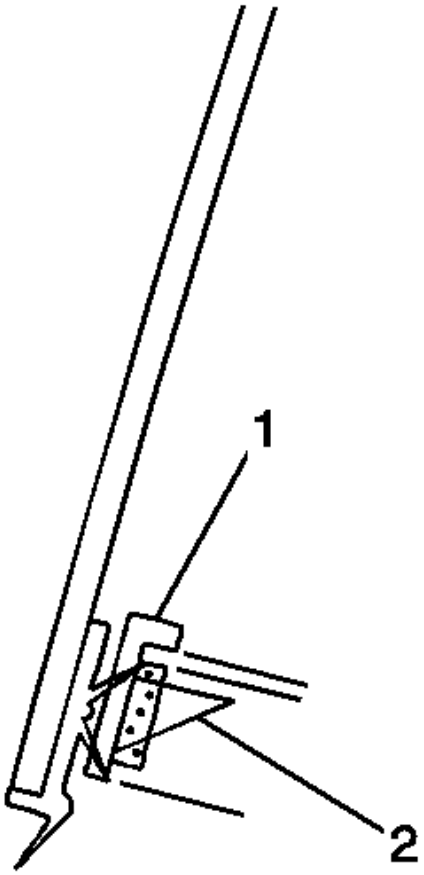


Fig. 63: Window Frame And Urethane Adhesive Bead
Courtesy of GENERAL MOTORS COMPANY

14. Use the inside edge of the window frame (1) as a guide for the nozzle in order to apply the urethane adhesive bead (2) to the window frame bonding surface.
15. With the aid of an assistant, place the window assembly into the opening. Make sure window frame alignment pins are properly located.
16. Press the window firmly into place.
17. Tape to window to the body in order to minimize movement until the urethane adhesive cures.
18. Clean any excess urethane adhesive from the body.

NOTE: **Do not direct a stream of high pressure water to the freshly applied urethane adhesive.**

19. Use a soft spray of warm water in order to immediately water test the window.
20. Inspect the window for leaks.
21. If any leaks are found, use a plastic paddle in order to apply extra urethane adhesive at the leak point.

22. Retest the window for leaks.

WARNING: **Insufficient curing of urethane adhesive may allow unrestrained occupants to be ejected from the vehicle resulting in personal injury.**

- **For the moisture-curing type of urethane adhesive, allow a minimum of 6 hours at 21Â°C (70Â°F) or greater and with at least 30 percent relative humidity. Allow at least 24 hours for the complete curing of the urethane adhesive.**
- **For the chemical-curing type of urethane adhesive, allow a minimum of 1 hour .**

Do NOT physically disturb the repair area until after these minimum times have elapsed.

23. Maintain the following conditions in order to properly cure the urethane adhesive.
    - Partially lower a door window in order to prevent pressure buildups when closing doors before the urethane cures.
    - Do not drive the vehicle until the urethane adhesive is cured. Refer to above curing times.
    - Do not use compressed air in order to dry urethane adhesive.

DESCRIPTION AND OPERATION

FULL-CUT METHOD DESCRIPTION

- If corrosion of the pinch-weld flange is present, or if sheet metal repairs or replacements are required, refinish the pinch-weld flange in order to present a clean, primer-only surface.
- If paint repairs are required, mask the flange bonding area, prior to applying the color coat, in order to provide a clean, primer-only surface.

IMPORTANT:

- Appropriate materials for these primer applications are typically 2 component catalyzed products. Use materials such as BASF DE15Â®, DuPont 2610Â®, Sherwin-Williams PSE 4600 and NP70Â® and Martin-Semour 5120 ,5130Â® , PPG DP90LF SPIES/HECKER 3688/8590 - 3688/5150 - 4070/5090 STANDOX 11158/13320 - 14653/14980 products are approved for this application. Follow the manufacturer's directions for the mix, the application, and the drying times.
- After repairing the opening as indicated, use adhesive systems which meet GM Specification GM 3651G.

Use only the full cut method, also known in the field as full strip method, when installing windows.

This method includes the following:

- The replacement of a majority of the adhesive bead. Remove all but approximately 2 mm (3/64 in) of the existing bead of adhesive from the pinch-weld flange.
- Apply pinch-weld primer to any exposed painted areas on the pinch-weld flange.

No mounds or loose pieces of adhesive should remain on the pinch-weld flange. Do not remove all traces of adhesive.

POWER WINDOWS DESCRIPTION AND OPERATION

Power Window System Components

The power window system consists of the following components:

- Driver window switch
- Front passenger window switch
- Left rear window switch
- Right rear window switch
- Window regulator motors in each of the doors
- PWR WDO Circuit Breaker 25 amp

Power Window System Controls

The power window system can be controlled by a power window up or down switch activation.

Window Operation and the Driver Window Switch

When the ignition switch is in the RUN or ACCY position, or Retained Accessory Power (RAP) is enabled, battery positive voltage is supplied to the driver window switch. Ground for the switch is provided by a ground circuit connected to a ground stake. When the driver window switch is pressed in the down position, the voltage is applied to the driver window motor down circuit and ground is applied to the driver window motor up circuit causing the window to open. When the driver window switch is pressed in the up position, the polarity is reversed, voltage and ground are applied to the opposite circuits and the window closes. In order to control the passenger windows from the driver door, the driver window switch assembly contains a separate window switch for each passenger door window. These window switches operate in the same way as the driver window switch, except that the applied voltage and ground must also pass through the remote passenger window switch to get to the respective window motor.

The driver window switch also provides power and ground for the remote rear window switches. Battery positive voltage is supplied, through the power window master switch lockout signal circuit, to each remote rear window switch. The remote front passenger door window switch has a separate battery positive voltage circuit, however, this circuit is spliced into the driver window switch voltage supply circuit within the IP Fuse Block. Ground for all three of the passenger door switches, is also supplied by the driver window switch.

Express Down Feature

The driver window will travel to the fully down position when the driver window switch is pressed past the first detent. Pressing the driver window switch to the up position will cancel the express down feature.

Lockout Switch Feature

The driver window switch contains a rear window lockout switch which disconnects the battery positive voltage supply to the remote rear passenger door window switches, disabling them. The remote front passenger door window switch cannot be locked out.

Window Operation and the Passenger Window Switches

When the ignition switch is in the RUN or ACCY position, or Retained Accessory Power (RAP) is enabled, battery positive voltage is supplied to each of the remote passenger door window switches. When a remote window switch is pressed in the down position, voltage is applied to the window motor down circuit and ground is applied to the window motor up circuit, causing the window to open. When the window switch is pressed in the up position, the polarity is reversed, voltage and ground are applied to the opposite circuits, and the window closes.

REAR WINDOW DEFOGGER DESCRIPTION AND OPERATION

Rear Window Defogger System Components

The rear window defogger system consists of the following components:

- HVAC control module
- Rear defogger relay
- Rear defogger grid
- Driver outside rearview mirror
- Passenger outside rearview mirror
- 40A Fuse

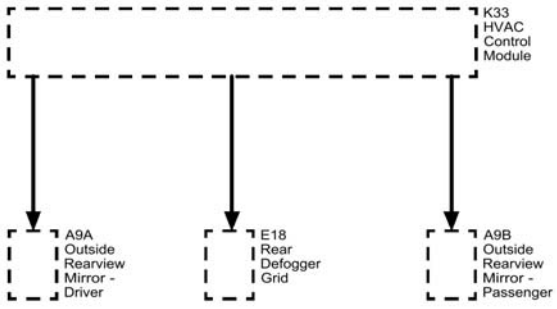


Fig. 64: Rear Window Defogger Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
A9B	A9B Outside Rearview Mirror - Passenger
E18	E18 Rear Defogger Grid
A9A	A9A Outside Rearview Mirror - Driver
K33	K33 HVAC Control Module

Rear Window Defogger Operation

The rear defog control system utilizes a single zone backlight design, driven with a single relay configuration. Additionally, up to two outside rear view mirrors can be heated if equipped. A switch for the customer to control the system is provided within the HVAC control module, also included in the HVAC control module is an indicator to inform the customer with the current state of the system. The system is only operational when engine is running or during remote start.

Pressing the heated rear window switch on the HVAC control module causes the HVAC control module to provide voltage to the coil side of the rear defogger relay, this will energize the relay causing the relay switch contacts to close allowing B+ voltage to flow through the rear defogger grid control circuit to the rear defogger grid.

When the rear heated window switch is pressed and the engine is running, the rear window defog will be active for 10 minutes with the first switch press and 5 minutes for each subsequent switch press. The rear window defog timer would be suspended when the vehicle speed has exceeded a value of 44.7 MPH (72KPH). When the vehicle is being driven at speeds greater than 72 KPH for an extended period of time and the rear heated window switch is pressed, then the customer would have the rear window defog to be active for 20 minutes or greater.

Heated Mirrors

The heated mirrors are also controlled through the rear defogger relay. Whenever the rear window defogger is turned on battery voltage is supplied to the mirror heater elements through the left and right mirror heater element control circuits.

STATIONARY WINDOW DESCRIPTION

Most stationary windows, specifically windshields, are retained to the body with adhesive which adheres the window to the body, increasing structural integrity. The reinstallation of the windows with adhesive requires complete replacement of the adhesive bead, and is known as the full cut method. All stationary windows must use a adhesive systems which meet GM Specification GMW-15672.

URETHANE ADHESIVE DESCRIPTION

For replacement of any adhesive-installed window, use the full cut method only.

Use an adhesive that is approved by GM, Specification GMW-15672.

Use these materials based on specific manufacturer. Do NOT intermix primers or adhesives from one manufacturer to another.

Always follow the system manufacturers instructions for application, handling, and curing.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

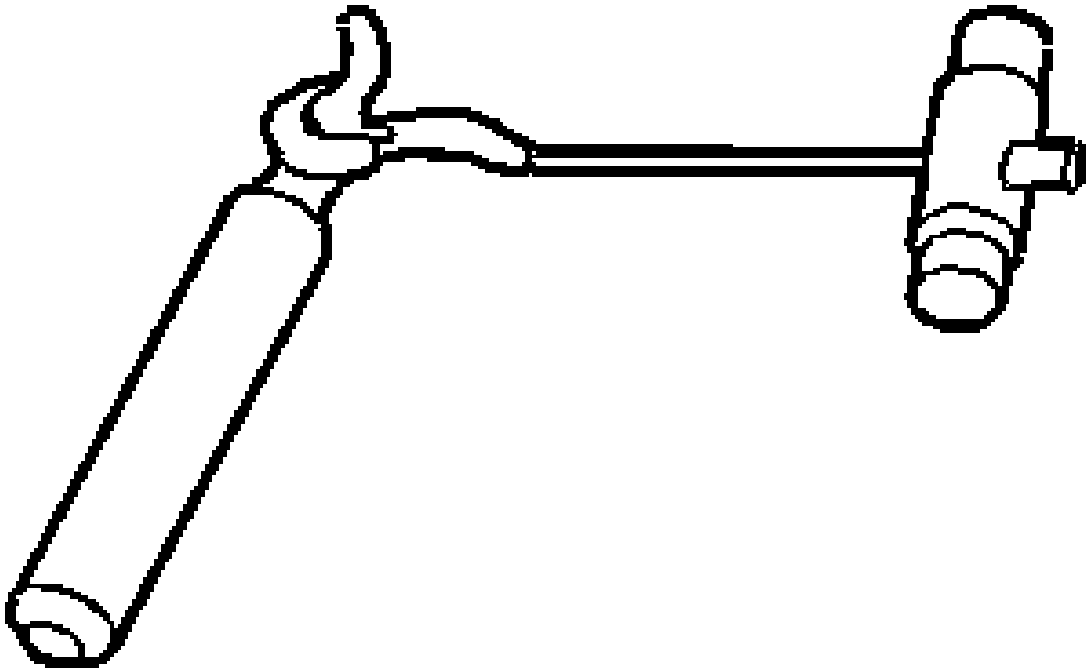
Illustration	Tool Number/ Description
	BO-24402-A J-24402-A Glass Sealant Cold Knife Remover

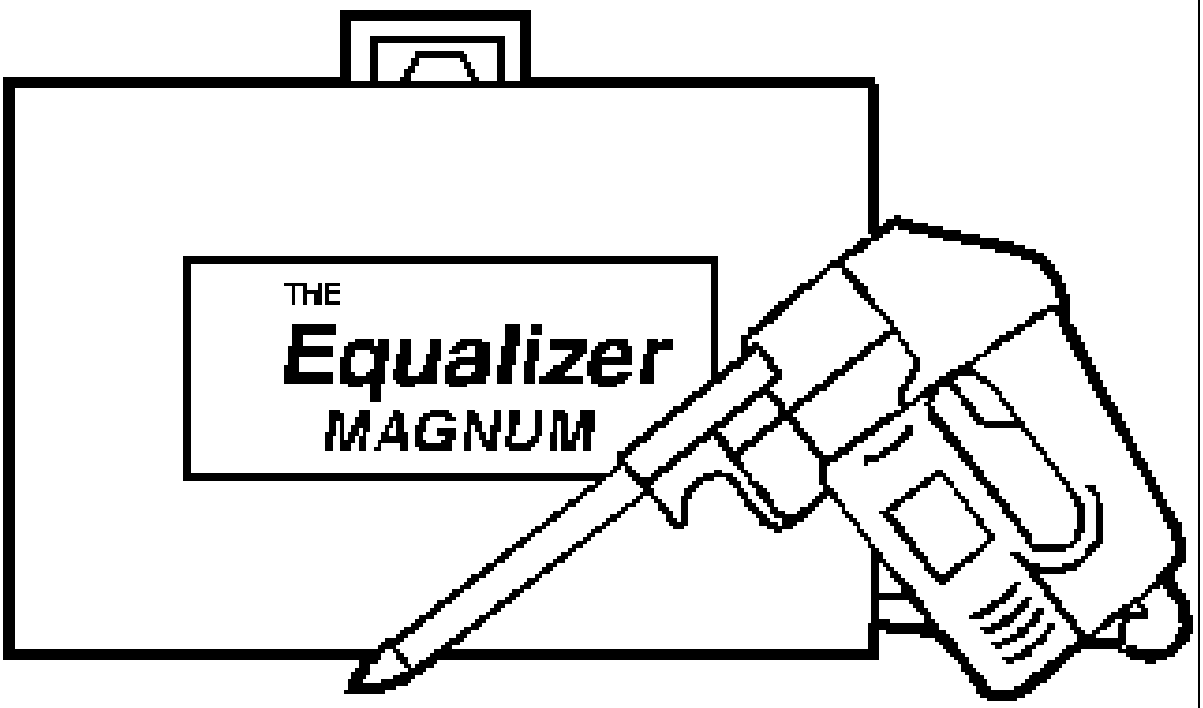
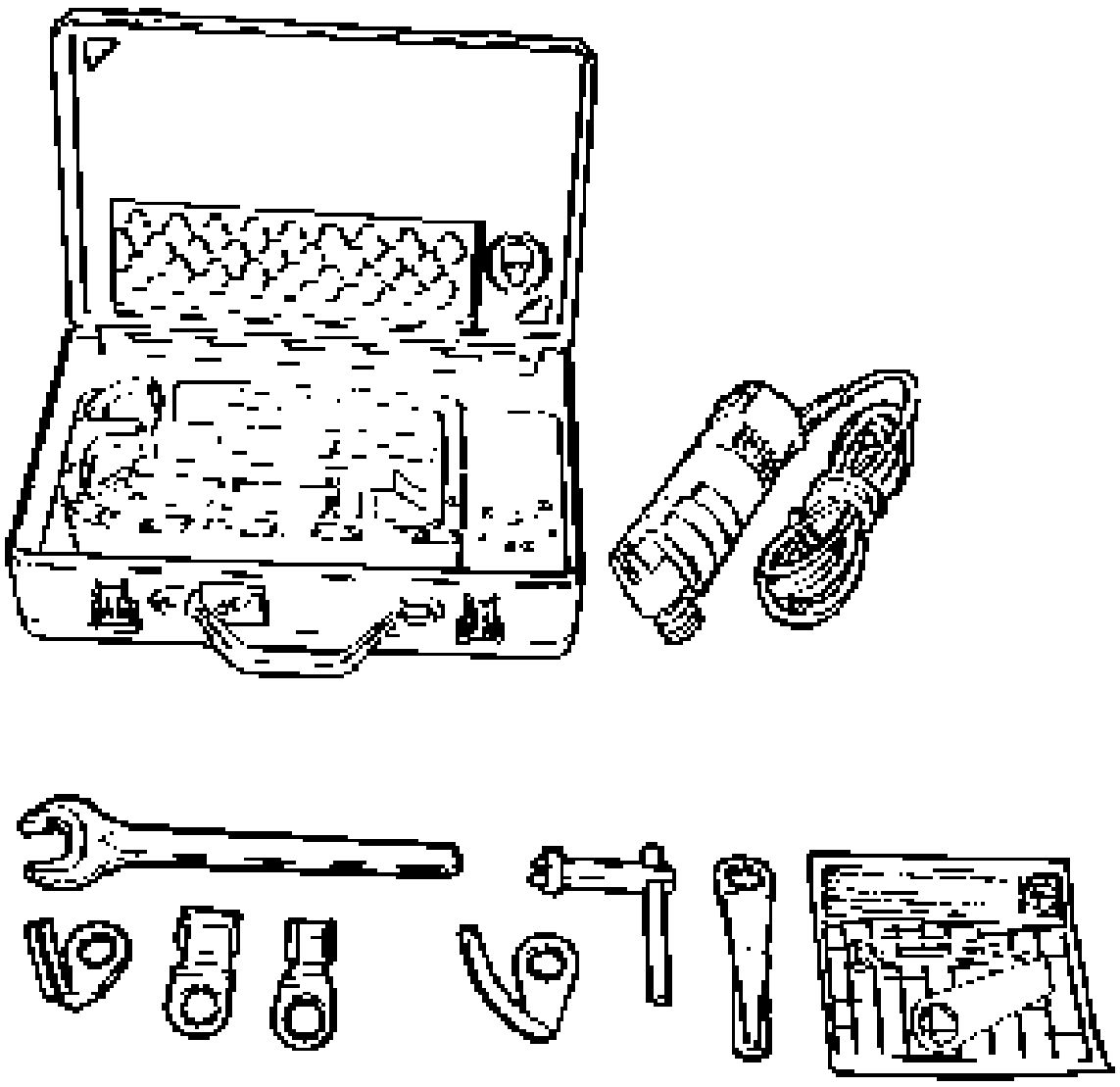
Illustration	Tool Number/ Description
	BO-39032 J-39032 Stationary Glass Removal Tool

Illustration	Tool Number/ Description
	BO-39040 J-39040 Quarter Window Remover

Article GUID: A00737201

INTRODUCTION

ARROWS AND SYMBOLS

This service manual uses various symbols in order to describe different service operations.

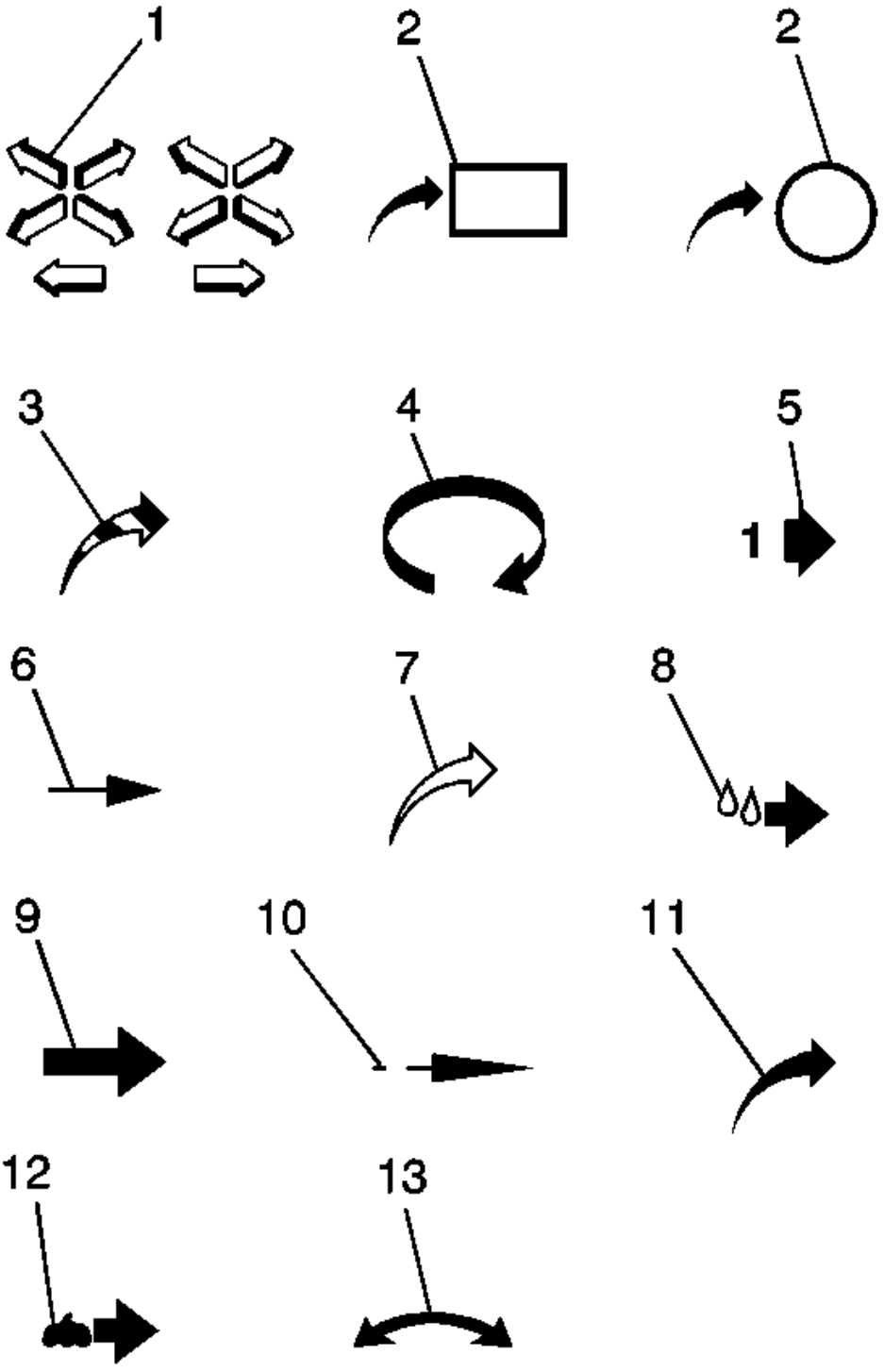


Fig. 1: Identifying Different Service Operations Symbols
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front of Vehicle
2	View Detail

Callout	Component Name
2	View Detail
3	Ambient Air Mixed with Another Gas or Indicate Temperature Change
4	Motion or Direction
5	View Angle
6	Dimension (1:2)
7	Ambient/Clean Air Flow or Cool Air Flow
8	Lubrication Point- Oil or Fluid
9	Task Related
10	Sectioning (1:3)
11	Gas Other Than Ambient Air or Hot Air Flow
12	Lubrication Point- Grease or Jelly
13	Multidirectional Arrow

ACRONYMS AND UNITS

Acronyms

Acronym	Meaning	Definition
2WD	Two-Wheel Drive	Indicates that a vehicle has 2 driven wheels OR that a 4WD vehicle uses only 2 wheels for propulsion. So it can be the description of a vehicle configuration OR the operational mode of the drivetrain.
4WD	Four-Wheel Drive	Four-wheeled vehicle with a drivetrain that allows all four wheels to receive power from the engine simultaneously which provides better control on various surfaces. Can be used to describe the configuration of the vehicle OR as the operational mode of the drivetrain. 4WD vehicles usually can turn 2 wheels off to be in a 2WD mode. See also AWD.
A/C	Air Conditioning	The cooling and dehumidification of indoor air for thermal comfort.
A/D	Analog to Digital	Used in context of converting electrical analog signals to digital signals.
ABS	Antilock Braking System	System on motor vehicles which prevents the wheels from locking while braking which helps the driver maintain control in heavy braking conditions.
AC	Alternating Current	An electrical current whose magnitude and direction vary cyclically.
AM	Amplitude Modulation	Method of impressing data onto an alternating-current (AC) carrier waveform.
APP	Accelerator Pedal Position	A pedal that controls the throttle valve.
AWD	All-Wheel Drive	All-wheel-drive systems are designed to function on all types of surfaces, both on- and off-road, and most of them cannot be switched off. This can also be called full-time four wheel drive. See also 4WD.

Acronym	Meaning	Definition
AWG	American Wire Gauge	American wire gauge is a standardized wire gauge system used since 1857 predominantly in the United States for the diameters of round, solid, nonferrous, electrically conducting wire. E.g. a wire of AWG10 has a diameter of 2.588mm, AWG20 corresponds to a diameter of 0.812mm.
B+	Battery Positive Voltage	The electrical potential on the positive terminal of the battery.
BARO	Barometric Pressure	Atmospheric pressure as measured by a barometer.
BCM	Body Control Module	This module supplies vehicle occupants with visual and audible information and controls various vehicle functions,
BECM	Battery Energy Control Module	Control module used to regulate the battery voltage.
BPP	Brake Pedal Position	Position of the foot pedal that moves a piston in the master brake cylinder.
CAN	Controller Area Network	Serial data connection between control modules by Bosch
CCM	Chassis Control Module	The module that controls various vehicle functions on the Chassis, like Engine/Trans Mount, Active Grille Air Shutter, Load Leveling, etc•••
CD	Compact Disc	A small optical disk on which data such as music, text, or graphic images is digitally encoded.
CNG	Compressed Natural Gas	This a substitute for gasoline or diesel fuel. It is made by compressing natural gas (which is mainly composed by methane (CH4), in a percentage range of 70% to 98%)
CO	Carbon Monoxide	This is a product of the incomplete combustion of carbon-containing compounds, at room temperature this is a gas. It consists of one carbon atom covalently bonded to one oxygen atom.
CO2	Carbon Dioxide	Chemical compound composed of two oxygen atoms covalently bonded to a single carbon atom.
CPA	Connector Position Assurance	Part of an electrical connector that prevents the connector from moving out of its socket. Usually needs to be pressed to unlock the connector when disconnecting it.
CPP	Clutch Pedal Position	A lever operated with the foot that controls the coupling that connects or disconnects driving and driven parts of a driving mechanism.
CV	Constant Velocity	Used in conjunction with CV joints, which connect two shafts at an angle while both shafts always have the same rotational speed without variations.
CVT	Continuously Variable Transmission	A transmission in which the ratio of the rotational speeds of two shafts, as the input shaft and output

Acronym	Meaning	Definition
		shaft of a vehicle or other machine, can be varied continuously within a given range, providing an infinite number of possible ratios which improves fuel economy.
D	Drive	D on the transmission gear selector lever.
DAB	Digital Audio Broadcast	Technology for broadcasting of audio using digital radio (carries information via digital signal) transmission.
DC	Direct Current	Continuous current, constant flow of electric charge.
DLC	Data Link Connector	This is an electronic connector typically located underneath the driver's side dashboard, just above the pedals. The connector has 16 pins.
DMM	Digital Multimeter	Electronic measuring instrument that combines several functions in one unit. The most basic instruments include an ammeter, voltmeter, and ohmmeter.
DOHC	Dual Overhead Camshaft	Dual overhead camshafts (DOHC) are higher performance engines, they produce more power, and can run at higher speeds because they allow an engine to have four valves per cylinder. Each camshaft operates two of the valves, one camshaft handles the intake valves, and one handles the exhaust valves
DPF	Diesel Particulate Filter	Device designed to remove diesel particulate matter or soot from the exhaust gas of a diesel engine.
DRL	Daytime Running Lamps	White lights mounted on the front of an automobile that automatically switch on when the key is turned and are intended for daytime use, to increase the visibility of the automobile.
DSCC	Distance Sensing Cruise Control	A type of cruise control that automatically maintains the distance between vehicles.
DSP	Digital Signal Processor	A specialized microprocessor designed specifically for digital signal processing, generally in real-time computing.
DTC	Diagnostic Trouble Code	An electronic signal stored in an automotive computer, indicating the presence of a fault detected by that computer.
DVD	DVD	A popular optical disc storage media format the size of a CD. Used mainly for movies but also for data. DVD has no spelled out version (officially it does not mean Digital Video Disc or Digital Versatile Disc, it just means DVD).
EBCM	Electronic Brake Control Module	This module contains a microprocessor and software for antilock braking system operation.

Acronym	Meaning	Definition
ECM	Engine Control Module	This electronic module works with a vehicle's sensors and engine control devices to insure that the engine operates at maximum efficiency and performance. It performs three vital functions. Receives electronic signals from engine sensors. Analyzes the data and makes an engine performance decision (based on the pre-set parameters within the unit). Sends an "output command" to an actuator that adjusts engine performance.
ECT	Engine Coolant Temperature	A measure of how hot or cold the fluid which flows through the engine in order to prevent its overheating, transferring the heat produced by the device to other devices that utilize or dissipate it.
EEPROM	Electrically Erasable Programmable Read-Only Memory	A non-volatile storage chip used in computers and other devices to store small amounts of volatile data, e.g. calibration tables or device configuration.
EGR	Exhaust Gas Recirculation	Is an NOx (nitrogen oxide and nitrogen dioxide) reduction technique used in most gasoline and diesel engines. EGR works by recirculating a portion of an engine's exhaust gas back to the engine cylinders.
EMI	Electromagnetic Interference	Electromagnetic interference (also called radio frequency interference) is a disturbance that affects an electrical circuit due to either electromagnetic conduction or electromagnetic radiation emitted from an external source.
ESD	Electrostatic Discharge	The sudden and momentary electric current that flows between two objects at different electrical potentials.
EV	Electric Vehicle	A category of vehicles that only have an electric drive system.
EVAP	Evaporative Emission	A system that controls the fuel fumes in the fuel tank.
FM	Frequency Modulation	In telecommunication this is a way to convey information over a carrier wave by varying its frequency.
FWD	Front-Wheel Drive	A form of engine/transmission layout used in motor vehicles, where the engine drives the front wheels only.
GMLAN	General Motors Local Area Network	A local-area network is a computer network covering a small geographic area, like a home or vehicle. This specific type of LAN connects several controllers inside the vehicle and was developed by General Motors.
GPS	Global Positioning System	Satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense.

Acronym	Meaning	Definition
GSM	Global System for Mobile Communications	Globally accepted standard for digital cellular communication.
GVW	Gross Vehicle Weight	Maximum total weight of a road vehicle or trailer that is loaded, including the weight of the vehicle itself plus fuel, passengers, cargo, and trailer tongue weight.
HD	Heavy Duty	Robust design to accommodate large work loads.
HID	High Intensity Discharge	A type of light that produces a bright light by using gas filled bulbs. (gas is usually mercury, metal halide, and high-pressure sodium) Uses very little battery power and is a very "cool" light.
HO2S	Heated Oxygen Sensor	Heated oxygen sensors have an internal heater circuit that brings the sensor up to operating temperature more quickly than an unheated sensor. An oxygen sensor must be hot (about 600-650Â°F) before it will generate a voltage signal. The hot exhaust from the engine will provide enough heat to bring an O2 sensor up to operating temperature.
HVAC	Heating Ventilation Air Conditioning	This system is sometimes referred to as climate control. Ventilation air ducts installed throughout a vehicle that supply conditioned air to a room through rectangular or round outlet vents.
I^2C	Inter-Integrated Circuit	Serial data connection between Integrated Circuits (microchips) inside a control module invented by Phillips
IAT	Intake Air Temperature	Temperature of the air entering intake air flow system of the engine.
ICE	Internal Combustion Engine	An engine in which the combustion of fuel and an oxidizer (typically air) occurs in a confined space called a combustion chamber.
ID	Identification	Number or Code that identifies a component or control module. Can be written on the part or be transmitted on a bus or via radio.
ISP	Internet Service Provider	A company that furnishes corporations and individual consumers with various services, mainly access to the Internet.
ISS	Input Shaft Speed	Rotational speed of the input shaft of a transmission.
LAN	Local Area Network	Standard network connection PC's.
LCD	Liquid Crystal Display	A thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector.
LED	Light Emitting Diode	Small light bulbs that fit easily into an electrical circuit they do not have a filament that will burn out, and they do not get especially hot. They are

Acronym	Meaning	Definition
		illuminated solely by the movement of electrons in a semiconductor material.
LIN	Local Interconnect Network	Computer networking bus system used within automotive network architectures. Similar to CAN, but cheaper and less powerful.
LPG	Liquefied Petroleum Gas	A mixture of mainly propane and butane, produced commercially and stored under pressure to keep it in a liquid state.
MAF	Mass Air Flow	The amount of air drawn into the engine
MAP	Manifold Absolute Pressure	Pressure in the engine intake system after the throttle valve referenced to a perfect vacuum.
MDI	Multiple Diagnostics Interface	A device used by GM dealers that enables a PC to communicate with the control modules in a vehicle.
MIL	Malfunction Indicator Lamp	An indicator of the internal status of a car engine.
MOST	Media Oriented Systems Transport	Serial communication bus to transmit audio and video information.
N	Neutral	A state of the transmission in which it is not engaged.
NiMH	Nickel Metal Hydride	A type of rechargeable battery that uses a hydrogen absorbing alloy for the negative electrode.
NOx	Nitrogen Oxides	Refers to any of the following oxygen compounds of nitrogen or a mixture of them. Nitric Oxide, Nitrogen dioxide, Nitrous Oxide, Dinitrogen trioxide, Dinitrogen tetroxide, Dinitrogen pentoxide.
O2	Oxygen	A colorless, odorless, tasteless, gaseous chemical element with the chemical symbol O and atomic number 8.
O2S	Oxygen Sensor	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed.
OBD	On-Board Diagnostic	A generic term referring to a vehicle's self-diagnostic and reporting capability.
OEM	Original Equipment Manufacturer	A producer that provides a product to its customers, who proceed to modify or bundle it before distributing it to their customers.
OSS	Output Shaft Speed	Rotational speed of the output shaft of a transmission.
P	Park	A state in which the transmission is set so one can leave the vehicle.
PCB	Printed Circuit Board	A thin plate on which chips and other electronic components are placed.
PCM	Powertrain Control Module	A control module that features the functions of both, the engine and the transmission control module.
PCMCIA	Personal Computer Memory Card Industry Association	An international standards body and trade association with over 100 member companies that was founded in 1989 to establish standards for Integrated Circuit cards and to promote interchangeability among

Acronym	Meaning	Definition
		mobile computers where ruggedness, low power, and small size were critical.
PIN	Personal Identification Number	A secret numeric password shared between a user and a system that can be used to authenticate the user to the system.
PPE	Personal Protective Equipment	Protective clothing, helmets, goggles, or other garment designed to protect the wearer's body from injury.
PRNDL	Park, Reverse, Neutral, Drive, Low	Park, Reverse, Neutral, Drive, Low (automatic transmission positions).
PTC	Positive Temperature Coefficient	Refers to materials that experience an increase in electrical resistance when their temperature is raised.
PTO	Power Take-Off	A splined driveshaft, usually on a tractor or truck that can be used to provide power to an attachment or separate machine. This mechanism allows implements to draw energy from the tractor's engine.
PVC	Polyvinyl Chloride	A thermoplastic copolymer.
PWM	Pulse Width Modulation	Square shaped type of signal that carries the information in the ratio between on and off times.
R	Reverse	Rearward: directed or moving toward the rear;
RAM	Random Access Memory	A type of computer data storage. It today takes the form of integrated circuits that allow the stored data to be accessed in any order.
RCT	Radiator Coolant Temperature	This is the heat intensity of the radiator coolant measured in degrees. The radiator is a part of the cooling system that removes the engine heat. Coolant is a mixture of water and antifreeze (ethylene glycol) which lowers the freezing point of the water in the coolant system, this fluid also picks up heat from the engine and transfers it to the air.
RDS	Radio Data System	A standard from the European Broadcasting Union for sending small amounts of digital information using conventional FM radio broadcasts.
RF	Radio Frequency	A frequency or rate of oscillation within the range of about 3 Hz and 300 GHz. This range corresponds to frequency of alternating current electrical signals used to produce and detect radio waves.
ROM	Read-Only Memory	A class of storage media used in computers and other electronic devices. Data stored in ROM cannot be modified.
RPO	Regular Production Option	A three digit/letter code given to parts, assemblies, and systems originally installed on the vehicle. These RPO codes designate options and are assigned by General Motors.

Acronym	Meaning	Definition
RSA	Rear Seat Audio	An auxiliary set of controls that operate the main audio system from the rear seat. Rear passengers can also operate a different media source than the front passengers.
RWD	Rear-Wheel Drive	A common engine/transmission layout in which the engine is in the front of the vehicle, but the front mid-engine, rear mid-engine and rear engine layouts are also used.
SCV	Speed Controlled Volume	The volume control is set for a desired sound level in the vehicle as the vehicle increases its speed, the sound level is adjusted.
SDM	Sensing and Diagnostic Module	The name given to air bag modules used in General Motors vehicles.
SIM	Subscriber Identity Module	Part of a removable smart card Integrated Circuit Card. This is used for mobile cellular telephone devices such as mobile computers and mobile phones. SIM cards securely store the service-subscriber key used to identify a subscriber. The SIM card allows users to change phones by simply removing the SIM card from one mobile phone and inserting it into another mobile phone or broadband telephony device.
SIR	Supplemental Inflatable Restraint	Technical term for the air bag. Air bag is a stretchable membrane, which inflates during an automobile accident to provide cushioning to the passenger's head and torso to prevent injury to the passengers.
SPI	Serial Peripheral Interface	This is an interface that enables the serial (one bit at a time) exchange of data between two devices. An SPI operates in full duplex mode. This means that data can be transferred in both directions at the same time. It is a standard bus technology like CAN or I2C.
SPS	Service Programming System	System that enables repair facilities to update the software in control modules.
SUV	Sport Utility Vehicle	A passenger vehicle which combines the towing capacity of a pickup truck with the passenger-carrying space of a minivan.
SVS	Service Vehicle Soon	Indicator lamp or symbol for a malfunction related to a vehicle component or system.
TA	Traffic Announcement	Message spoken on radio regarding the movement of vehicles or pedestrians through an area or along a route. The buttons on radios that enable this announcements are also often labeled TA.
TAC	Throttle Actuator Control	A motor which moves the engine throttle plate or valve, controlled by the engine control module. A throttle plate limits the amount of air entering a internal combustion gasoline engine.

Acronym	Meaning	Definition
TAP	Transmission Adaptive Pressure	The transmission control module learns each component's characteristics and adjusts fluid pressure accordingly.
TCC	Torque Converter Clutch	Resides in a torque converter to connect an engine to an automatic transmission. The clutch is applied when conditions are correct to achieve a 1:1 ratio of engine crankshaft to transmission input shaft.
TCM	Transmission Control Module	A module that controls electronic automatic transmissions. It uses sensors from the vehicle as well as data provided by the Engine Control Module to calculate how and when to change gears in the vehicle for optimum performance, fuel economy and shift quality.
TDC	Top Dead Center	The piston is in its highest position relative to the combustion chamber.
TIS	Techline Information System	The PC-based global dealership diagnostic software that provides the technician the ability to reference the most recent service information via the service department's computer.
TPA	Terminal Position Assurance	An additional locking mechanism inside an electric connector that holds the pins in place.
TV	Television	A telecommunication system for broadcasting and receiving moving pictures and sound over a distance.
USB	Universal Serial Bus	A type of communication bus connection between a computer and a peripheral device.
VCI	Vehicle Communications Interface	A diagnostic tool that communicates to modules of multiple communication protocols in a vehicle by converting vehicle serial data into PC serial data communication.
VIN	Vehicle Identification Number	Used by manufacturers to uniquely identify motor vehicles using 17 characters.
VSCM	Vehicle Stability Control Module	This module uses information from several sensors to detect a loss of vehicle traction, then works with the antilock brake system to apply individual brakes to help keep the vehicle on its intended path.
VSS	Vehicle Speed Sensor	Sends data regarding how fast the car is traveling at the moment of driving. It is designed to be able to record the rate at which the vehicle's crankshaft is spinning.
WOT	Wide Open Throttle	When the throttle blade or valve is at its maximum open position, allowing maximum air to enter an internal combustion gasoline engine.
WLAN	Wireless Local Area Network	Standard to transmit digital data via radio frequency.

Acronym	Meaning	Definition
XM	XM (Satellite Radio)	XM Satellite Radio Holdings (XM) is one of two satellite radio services in the United States and Canada. XM provides pay-for-service radio, analogous to cable television. Its service includes 73 different music channels, 39 news, sports, talk, and entertainment channels, 21 regional traffic and weather channels and 23 play-by-play sports channels (2008).
XML	Extensible Markup Language	A markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable.

Units

Unit	Meaning	Definition
m^2	Square Meter	Area
A	Ampere	Electrical
Ah	Ampere Hour	Electrical
C	Coulomb	Electrical
dBm	Decibel Meter	Electrical
dBmV	Decibel Millivolt	Electrical
mV/DIV	Millivolts per Division	Electrical
mV/s	Millivolts per Second	Electrical
Ω	Ohm	Electrical
V	Volt	Electrical
V/DIV	Volts per Division	Electrical
V/ms	Volts per Millisecond	Electrical
W	Watt	Electrical
mm^3 /stroke	Cubic Millimeters per Stroke	Flow
gal/h	Gallons per Hour	Flow
g/s	grams per second	Flow
g/stroke	Grams per Stroke	Flow
kg/100km	Kilograms per 100 Kilometer	Flow
kg/h	Kilograms per Hour	Flow
km/L	kilometer/liter	Flow
L/100km	Liters per 100 Kilometers	Flow
L/h	Liters per Hour	Flow
L/min	Liters per Minute	Flow
MPG	Miles per Gallon	Flow
mg/s	Milligrams per Second	Flow
mg/stroke	Milligrams per stroke	Flow
ft	feet	Length
in	Inch	Length

Unit	Meaning	Definition
m	Meter	Length
mi	Mile	Length
bar	Bar	Mechanical
bar/min	Bars per Minute	Mechanical
in. H2O	Inches of Water	Mechanical
in. H2O/s	Inches of Water per second	Mechanical
kPa/s	Kilopascals per Second	Mechanical
N	Newton	Mechanical
Â	Newton Meter	Mechanical
Pa	Pascal	Mechanical
Pa/s	Pascals per Second	Mechanical
lb ft	Pound Foot	Mechanical
PSI	Pound-Force per Square Inch	Mechanical
Counts	Counts	Misc.
Cycles	Cycles	Misc.
dB	Decibel	Misc.
Â°	Degree	Misc.
Â°C	Degree Centigrade	Misc.
Â°CA	Degree Crankshaft Angle	Misc.
Â°F	Degree Fahrenheit	Misc.
Â°/s	Degree per Second	Misc.
Hz	Hertz	Misc.
kbit/s	Kilobit per second	Misc.
lx	Lux	Misc.
ppm	Parts per Million	Misc.
%	Percent	Misc.
%/min	Percents per Minute	Misc.
%/sec	Percents per Second	Misc.
Pulses	Pulses	Misc.
:1	Ratio	Misc.
RPM	Revolutions per Minute	Misc.
Steps	Steps	Misc.
W/m^2	Watts per Square Meter	Misc.
g	g (Acceleration)	Movement
km/h	Kilometers per Hour	Movement
m/s	Meters per Second	Movement
m/s^3	Meters per Second Cubed	Movement
m/s^2	Meters per Second Squared	Movement
MPH	Miles per Hour	Movement
mm/s	Millimeters per Second	Movement

Unit	Meaning	Definition
d	Day	Time
h	Hour	Time
hh:mm:ss	Hour:Minute:Second	Time
ms/DIV	Milliseconds per Division	Time
min	Minute	Time
s	Second	Time
s/DIV	Seconds per Division	Time
yy-mm-dd	Year-Month-Day (2 digits)	Time
yyyy-mm-dd	Year-Month-Day (4 digits, preferred)	Time
m^3	Cubic Meter	Volume
gal	Gallon	Volume
L	Liter	Volume
mL	milliliters	Volume
US gal	US Gallon	Volume
US pt	US Pint	Volume
US qt	US Quart	Volume
kg	Kilogram	Weight

CUSTOMER CONCERN VERIFICATION SHEETS

The GM Customer Concern Verification Sheets have been designed to improve communications between the service customer and the technician. The more clearly the technician understands the concern and its symptoms, the more likely the concern will be fixed right the first time.

The GM-wide Customer Concern Verification Sheets are available in GM GlobalConnect. The Customer Concern Verification Sheets may be printed and reproduced locally.

TRAINING

Dealers

All U.S. GM Dealers participating in the Center of Learning / GM Service Technical College (STC) Programs can enroll through the Center of Learning website at https://www.centerlearning.com. Within the website, there are individual training paths that are designed to assist in planning the training needs for each individual and their job role. Dealers who have questions about Center of Learning Training should contact the Center of Learning help desk at 1-888-748-2687. The help desk is available Monday through Friday, 8:00 am - 9:00 pm Eastern Standard Time, excluding holidays. For GM Access support, contact the GM Access Help Desk at 1-888-337-1010.

Fleets

GM Fleet customers with GM Warranty In-Shop agreements are able to participate in service technical training through the Center of Learning/GM Service Technical College (STC).

Assistance for GM fleet registered customers using GM STC training is provided by the Center of Learning help desk at 1-888-748-2687. The help desk is available Monday through Friday, 8:00 am-9:00 pm Eastern

Standard Time, excluding holidays. For GM Access support, contact the GM Access Help Desk at 1-888-337-1010.

Most GM STC course materials have associated charges.

To purchase authentic GM STC Training Materials, contact the GM Training Materials Headquarters at 1-800-393-4831.

Non-GM Dealer Technicians

Technician training for non-GM dealers is available through ACDelco. This training is for ACDelco PSC and Fleet program members employed in the automotive or truck service industry.

ACDelco courses are available at approved GM STC Training Centers. Availability and schedules can be obtained by calling 1-800-825-5886 (prompt 1) or contact us via the web at www.acdelcotechconnect.com and select the Training tab. Seminars are also offered through the ACDelco Warehouse Distribution channel. Contact your Local ACDelco representative or distributor directly for more information.

VEHICLE, ENGINE AND TRANSMISSION ID AND VIN LOCATION, DERIVATIVE AND USAGE

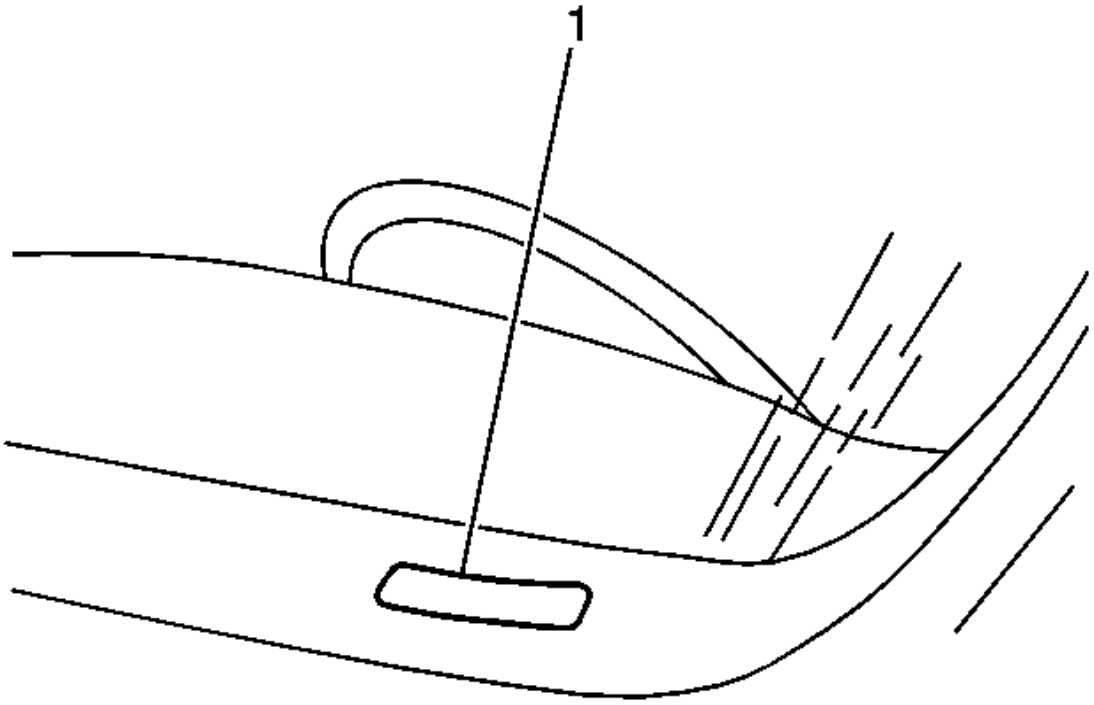


Fig. 2: View Of VIN Plate Location
Courtesy of GENERAL MOTORS COMPANY

Vehicle Identification Number (VIN) System

Position	Definition	Character	Description
The vehicle identification number (VIN) plate (1) is the legal identifier of the vehicle. The VIN plate is located on the upper left corner of the instrument panel (I/P) and can be seen through the windshield from the outside of the vehicle.			
1	Region of Build	2	Canada
2	Manufacturer	G	General Motors
3	Vehicle Brand/Type	1	Chevrolet Passenger Car
4 5	Carline/Series	W/A	Impala LS Fleet
		W/B	Impala LT Fleet
		W/C	Impala LTZ
		W/D	Impala Police Vehicle
6	Body Type	5	Sedan, 4-door, 6 Window, Notchback
7	Restraint System	E	Active Manual Belts, Airbags - Driver and Passenger - Front (1st row), Front Seat Side (1st row), Roof Side (all seating rows)
8	Engine Code	3	RPO LFX Engine - Gas, 6 Cylinder, 3.6L, V6, SIDI, DOHC,VVT, E85 Max, ALUM, GM
9	Check Digit	-	Check Digit
10	Model Year	F	2015
11	Plant Location	1	Oshawa #2, ONT, Canada
12-17	Plant Sequence Number	-	Plant Sequence Number

VIN Derivative Characters

Position	Definition	Character	Description
All engines and transmissions are stamped with a partial vehicle identification number (VIN). This table identifies the different VIN derivative characters and their respective positions.			
1	Division	2	Chevrolet
2	Model Year	F	2015
3	Plant Location	1	Oshawa #2, ONT, Canada
4-9	Plant Sequence Number	-	Plant Sequence Number
A VIN derivative can be used to determine if a vehicle contains the original engine or transmission by matching the VIN derivative positions to their accompanying positions in the complete VIN.			

VIN Positions

VIN Derivative Position	Equivalent VIN Position
1	3
2	10
3	11

VIN Derivative Position	Equivalent VIN Position
4-9	12-17

VEHICLE CERTIFICATION, TIRE PLACARD, ANTI-THEFT, AND SERVICE PARTS ID LABEL

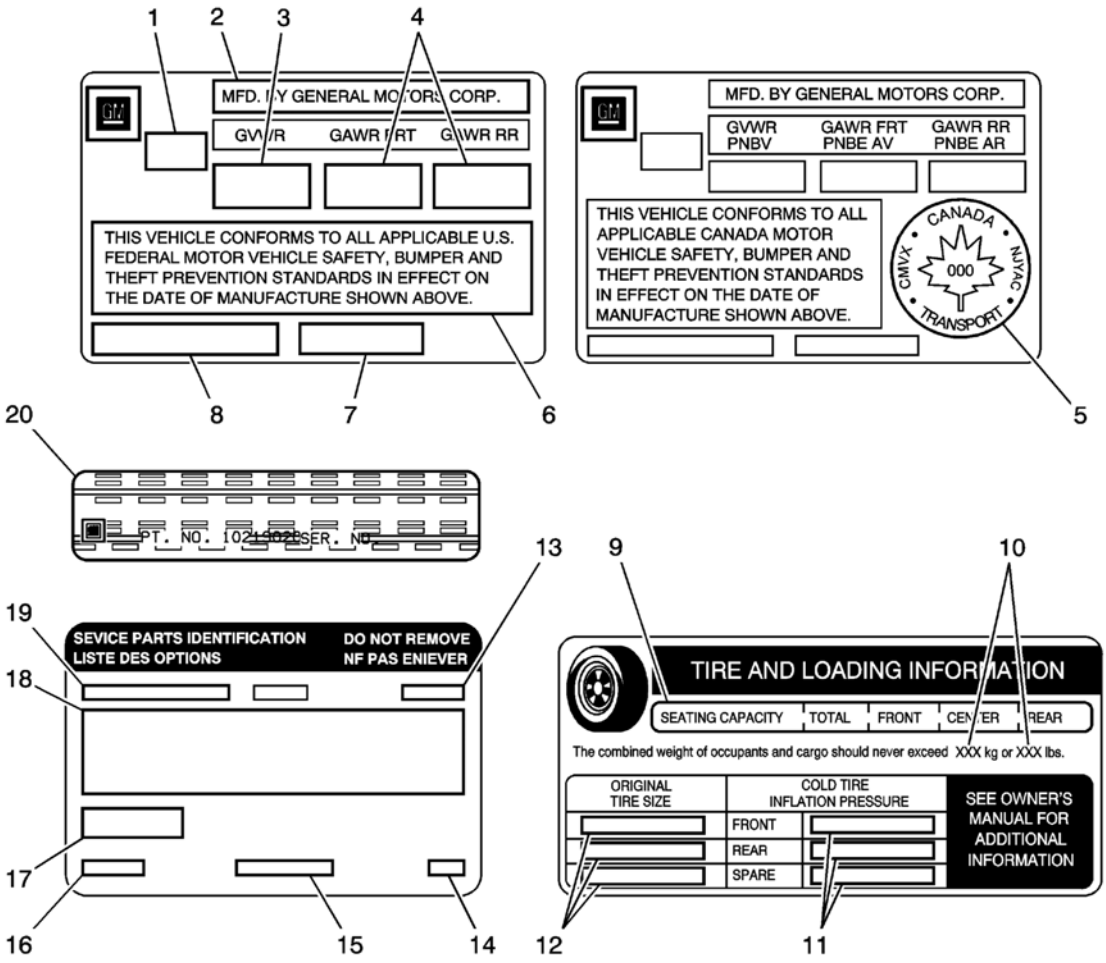


Fig. 3: Identifying Vehicle Certification, Tire Place Card, Anti-Theft & Service Parts ID Labels
Courtesy of GENERAL MOTORS COMPANY

Callout	Description

Vehicle Certification Label
The vehicle certification label is located on the driver door and displays the following assessments:
• Gross vehicle weight rating (GVWR)
• Gross axle weight rating (GAWR), front and rear
• The gross vehicle weight (GVW) is the weight of the vehicle and everything it carries. The gross vehicle weight must not exceed the GVWR. Include the following items when figuring the GVW:
  • The base vehicle weight (factory weight)
  • The weight of all vehicle accessories
  • The weight of the driver and the passengers	

Callout	Description
	• The weight of the cargo
1	Name of Manufacturer
2	Gross Vehicle Weight Rating
3	Gross Axle Weight Rating (Front, Rear)
4	Canadian Safety Mark (w/RPO Z49)
5	Certification Statement
6	Vehicle Class Type (Pass Car, etc.)
7	Vehicle Identification Number
8	Date of Manufacture (Mo/Yr)
Tire Placard The tire placard label is located on the driver side center pillar, below the door latch, and displays the following assessments:	
9	Specified Occupant Seating Positions
10	Maximum Vehicle Capacity Weight
11	Tire Pressure, Front, Rear, and Spare (Cold)
12	Original Equipment Tire Size
Service Parts ID Label The vehicle service parts identification label is located in the instrument panel (I/P) compartment. The label is use to help identify the vehicle original parts and options.	
13	Vehicle Identification Number
14	Engineering Model Number (Vehicle Division, Line and Body Style)
15	Interior Trim Level and Decor
16	Exterior (Paint Color) WA Number
17	Paint Technology
18	Special Order Paint Colors and Numbers
19	Vehicle Option Content
Anti-Theft Label	
20	The Federal law requires that General Motors label certain body parts on this vehicle with the VIN. The purpose of the law is to reduce the number of motor vehicle thefts by helping in the tracing and recovery of parts from stolen vehicles. Labels are permanently affixed to an interior surface of the part. The label on the replacement part contains the letter R, the manufacturer's logo, and the DOT symbol. The anti-theft label must be covered before any painting, and rustproofing procedures, and uncovered after the procedures. Failure to follow the precautionary steps may result in liability for violation of the Federal Vehicle Theft Prevention Standard and possible suspicion to the owner that the part was stolen.

RPO CODE DESCRIPTION

The following table provides the description of the Regular Production Option (RPO) codes that are available on the vehicle. The vehicle's RPO list is printed on the Service Parts Identification Label.

RPO	Description

RPO	Description
17U	PRIMARY COLOR EXTERIOR, SWITCHBLADE SILVER MET (09)
192	TRIM COMBINATION LEATHER, EBONY (02) (00)
19C	TRIM COMBINATION CLOTH, EBONY (C) (00)
19E	TRIM COMBINATION CLOTH, EBONY (C)
19G	TRIM COMBINATION CLOTH, EBONY (G) (04)
19I	INTERIOR TRIM EBONY (I) (00)
41U	PRIMARY COLOR EXTERIOR, BLACK (97)
50U	PRIMARY COLOR EXTERIOR, OLYMPICS WHITE (02)
6A3	COVERING - FLOOR MAT, FRONT AND REAR, HD.
6B2	HANDLE - REAR DOOR, INOPERATIVE
6B7	WIRING PROVISIONS - ROOF PANEL ACCESS HOLE CENTER
6C7	LAMP - DOME PASS
6C8	CABLE - RG58 A/U COAX RADIO ANTENNA
6E2	CYLINDER UNIT - SINGLE KEY SYSTEM, CODED DF81
6E8	CYLINDER UNIT - SINGLE KEY SYSTEM, CODED NU97
6F5	WIRING PROVISIONS - ROOF
6J1	WIRING PROVISIONS - IGNITION AND MAIN POWER SUPPLY
6J3	WIRING PROVISIONS - HEADLAMP FLASHER, GRILLE LAMPS AND SPEAKERS
6J4	WIRING PROVISIONS - HORN/SIREN CIRCUIT
6J5	WIRING PROVISIONS - ROOF PANEL ACCESS HOLE RH SI
6J6	LAMP PACKAGE - EMERGENCY VEHICLE R/WDO PANEL
6J7	FLASHER - HEADLAMP
6N5	HANDLE - INOPERATIVE, REAR WINDOW
6N6	LOCK CONTROL - REAR DOOR, INOPERATIVE
702	TRIM COMBINATION-LEATHER, LT NEUTRAL (2) (05)
70C	TRIM COMBINATION-CLOTH, LT NEUTRAL (C) (05)
70I	PRIMARY COLOR-EXTERIOR, VICTORY RED (9260)
7B3	SUSPENSION SYSTEM - SPECIAL HANDLING
7M9	COOLING SYSTEM - STEERING OIL AND ENGINE OIL
7X6	SPOTLAMP - LEFT, PILLAR MOUNTED, HALOGEN
7X7	SPOTLAMP - LEFT AND RIGHT, PILLAR MOUNTED, HALOGEN
7X8	SPOTLAMP - PROVISIONS, LEFT
7X9	SPOTLAMP - PROVISIONS, LEFT AND RIGHT
7Y6	SWITCH - DOME LAMP, DOOR JAMB INOPERATIVE
832	TRIM COMBINATION LEATHER, TITANIUM (2) (06)
83C	TRIM COMBINATION CLOTH, TITANIUM (C) (06)
83I	INTERIOR TRIM TITANIUM (06)
8X1	VEHICLE LABEL - FASTEN SEAT BELTS
9C1	SEO VEHICLE - POLICE CAR
9C3	SEO VEHICLE - POLICE CAR, CONTENT

RPO	Description
9G8	EQUIPMENT - DAYTIME RUNNING LAMP AND HEADLAMPS CONTROL, DELETE
A75	SEAT CUSHION - BACK FRONT, HD
A76	SEAT CUSHION - BACK REAR, HD
A98	LOCK CONTROL REAR COMPARTMENT - LID, REMOTE CONTROL ELECTRIC RELEASE, IGNITION POWERED
AG1	ADJUSTER FRONT SEAT - POWER, MULTIDIRECTIONAL, DRIVER
AG2	ADJUSTER PASSENGER SEAT - POWER MULTIDIRECTIONAL
AH5	ADJUSTER FRONT SEAT - POWER, 8-WAY, NO MEMORY, DRIVER
AL0	SENSOR INDICATOR - INFLATABLE RESTRAINT, FRONT PASSENGER/CHILD PRESENCE DETECTOR
AM9	SEAT REAR - SPLIT BACK, FOLDING
AMF	LOCK CONTROL - ADDITIONAL, PROGRAMMABLE, REMOTE ENTRY, MULTIPLE UNITS
AN3	SEAT FRONT - INDIVIDUAL (NON BKT)
AP3	LOCK CONTROL, ENTRY - REMOTE, KEYLESS ENTRY, START
AR9	SEAT - FRONT BUCKET, DELUXE
AT8	RESTRAINT PROVISIONS - CHILD, REAR SEAT, REAR FACING
AXJ	VEHICLE TYPE PASSENGER CAR
AY0	RESTRAINT SYSTEM - SEAT, INFLATABLE, DRIVER AND PASS FRT, SEAT SIDE, ROOF SIDE
B34	COVERING FRONT - FLOOR MATS, CARPETED INSERT
B35	COVERING REAR - FLOOR MATS, CARPETED INSERT
B3B	ORNAMENTATION - INTERIOR, SPORT
B3V	TEST - EXTENDED WATER
B42	COVERING - FLOOR MAT, LUGGAGE COMPARTMENT, FITTED
B86	MOLDING BODY SIDE - BODY COLOR
B9V	HANDLING CHARGE - OSHAWA ASSEMBLY TO KERR INDUSTRIES IN OSHAWA, BACK TO OSHAWA ASSEMBLY
BAG	PARTS PACKAGE - EXPORT
BDR	LOCK CYLINDER - RR COMPT
BZP	ORNAMENTATION - INTERIOR, WOODGRAIN
C67	HVAC SYSTEM - AIR CONDITIONER FRONT, ELECTRONIC CONTROLS
CAV	ACCESSORY-TRAY - TRUNK/CARGO AREA
CF5	ROOF - SUN GLASS, SLIDING ELECTRIC
CJ3	HVAC SYSTEM - AIR CONDITIONER FRONT, MANUAL TEMPERATURE CONTROL, AUXILIARY TEMPERATURE CONTROL
CW7	COUNTRY - PUERTO RICO/US VIRGIN ISLANDS
D55	CONSOLE - FRONT COMPARTMENT, FLOOR
D81	SPOILER - REAR, AERO WING
DD6	MIRROR INSIDE REAR VIEW - LIGHT SENSITIVE, DUAL READING LAMPS

RPO	Description
DG7	MIRROR OUTSIDE - LH AND RH, REMOTE CONTROL, ELECTRIC, COLOR
DH6	MIRROR INSIDE FRONT VAN - LH AND RH SUNSHADE, ILLUMINATED
DK2	MIRROR O/S LH & RH, REMOTE CONTROL, ELECTRIC, HEATED, COLOR
EF7	COUNTRY - UNITED STATES OF AMERICA (USA)
EXP	EXPORT
F71	RATIO-TRANSAXLE FINAL DRIVE 2.44
FAS	ACCESSORY-NAVIGATION SYSTEM - PORTABLE - LEVEL 2
FAW	ACCESSORY-NAVIGATION SYSTEM - PORTABLE - LEVEL 3
FE1	SUSPENSION SYSTEM - SOFT RIDE
FE2	SUSPENSION SYSTEM - RIDE, HANDLING
FE3	SUSPENSION SYSTEM - SPORT
FE9	CERTIFICATION - EMISSION, FEDERAL
FHS	VEHICLE FUEL - GASOLINE E85
GAM	VEHICLE - GOVERNMENT (G.S.A. SALES)
GBE	PRIMARY COLOR-EXTERIOR, CRYSTAL CLARET TINTCOAT (G) 505Q
GLJ	PRIMARY COLOR-EXTERIOR, ASHEN GRAY METALLIC 810T
I15	ENGINEERING YEAR-2015
IKC	TRIM-INTERIOR DESIGN (KC)
IP2	TRIM-INTERIOR DESIGN (P2)
IPC	TRIM-INTERIOR DESIGN (PC)
IPE	TRIM-INTERIOR DESIGN (PE)
IPG	TRIM-INTERIOR DESIGN (PG)
JA9	BRAKE - HEAVY WEIGHT, DISC/DISC
JB9	BRAKE - LIGHT WEIGHT, DISC/DISC
JL9	BRAKE SYSTEM - POWER FRONT AND REAR DISC, ANTILOCK FRONT AND REAR WHEEL
K05	HEATER - ENGINE BLOCK
KA1	HEATER - SEAT, FRT
KD1	COOLING SYSTEM - TRANSMISSION, OIL
KG4	GENERATOR - 150 AMP
KW7	GENERATOR-170 AMP
LFX	ENGINE - GAS, 6 CYL, 3.6L, SIDI, DOHC, VVT, E85 MAX, ALUM, GM
MH2	TRANSMISSION - AUTOMATIC 6-SPEED, HMD, 6T70
MX0	MERCHANDISED TRANSMISSION - AUTOMATIC PROVISIONS, O/D
NB8	EMISSION OVERRIDE - CALIFORNIA SYSTEM
NC7	EMISSION OVERRIDE - FEDERAL SYSTEM
NE1	CERTIFICATION - EMISSION, GEOGRAPHICALLY RESTRICTED REGISTRATION FOR VEHICLES UP TO 14,000 LBS GVW
NK5	STEERING WHEEL - STANDARD

RPO	Description
NP5	STEERING WHEEL - LEATHER-WRAPPED
NT7	EMISSION SYSTEM - FEDERAL, TIER 2
NU5	EMISSION SYSTEM - CALIFORNIA, BIN 4
OST	PLANT CODE - OSHAWA 2, ONT, CANADA
QCF	TIRE SPARE-P235/55R17 SL 98 W BW AL3
QCL	TIRE SPARE-T125/70R17 SL 98M BW SPR
QDG	TIRE ALL - P235/50R18-97W BW R/PE ST TL HWY
QPX	TIRE ALL - P225/60R16-97S BW R/PE ST TL ALS
QVS	TIRE ALL-P225/55R17 SL 95T BW AL2
QWM	TIRE ALL-P235/55R17 SL 98W BW AL3
RS7	WHEEL-17 X 6.5, J, ALUMINUM, DESIGN 1
RSF	WHEEL-17 X 7.5, J, STEEL, DESIGN 1
RSX	WHEEL-18 X 7.0, J, ALUMINUM, DESIGN 1
RUF	WHEEL SPARE-17 X 7.5, J, STEEL, DESIGN 1
RV5	WHEEL-16 X 6.5, J, ALUMINUM, DESIGN 2
RV9	WHEEL SPARE-17 X 4.0, T, STEEL, DESIGN 1
RVZ	WHEEL SPARE-16 X 4.0, T, STEEL, DESIGN 1
RWP	ACCESSORY-CABLE - PORTABLE MUSIC PLAYER
RWS	ACCESSORY-FLOOR MATS - CARPET
RWV	ACCESSORY-CARGO AREA ORGANIZER - FIXED
RXH	ACCESSORY-CENTER CAP - WHEEL - DESIGN 1
RXJ	ACCESSORY-CENTER CAP - WHEEL - DESIGN 2
RYH	ACCESSORY-DVD PLAYER SYSTEM - RSE HEADREST - SINGLE - UPGRADEABLE
S02	ACCESSORY-HEADPHONES - NOISE CANCELING
S08	ACCESSORY-HIGHWAY SAFETY KIT
S4J	ACCESSORY-LOCK - VEHICLE COVER
S5Q	ACCESSORY-NAVIGATION SYSTEM - PORTABLE
S5U	ACCESSORY-ORGANIZER - CD - DVD HOLDER - VISOR MOUNTED
S6P	ACCESSORY-REMOTE START KIT
SAO	ACCESSORY-SMOKERS PACKAGE
SB1	ACCESSORY-SPLASH GUARDS - FLAT
SB3	ACCESSORY-SPOILER - DECKLID - WING
SD5	ACCESSORY-TIRE PRESSURE MONITOR
SDS	ACCESSORY-WEATHER DEFLECTORS - SIDE WINDOW - SMOKED
SE0	ACCESSORY-WHEEL - 17" - ALUMINUM - DESIGN 1
SE1	ACCESSORY-WHEEL - 17" - ALUMINUM - DESIGN 2
SE2	ACCESSORY-WHEEL - 17" - ALUMINUM - DESIGN 3
SE4	ACCESSORY-WHEEL - 18" - ALUMINUM - DESIGN 1
SFE	ACCESSORY-WHEEL LOCKS
T53	LAMP PACKAGE - EMERGENCY VEHICLE REAR COMPARTMENT LID

RPO	Description
T96	LAMP - FOG, FRONT
U1C	RADIO - AM/FM STEREO, SEEK/SCAN, CD, CLOCK, ETR
U2E	INSTRUMENT CLUSTER - COOLANT TEMPERATURE, TRIP ODOMETER
U2K	DIGITAL AUDIO SYSTEM - S-BAND
U77	ANTENNA - REAR WINDOW, RADIO
UA6	THEFT DETERRENT SYSTEM
UE0	COMMUNICATION SYSTEM-VEHICLE - NONE
UE1	COMMUNICATION SYSTEM - VEHICLE, G.P.S. 1
UG1	OPENER GARAGE DOOR, UNIVERSAL
UH8	CLUSTER - INSTRUMENT, COOLANT TEMPERATURE, TRIP ODOMETER, TACHOMETER
UJM	TIRE PRESS INDICATOR MANUAL LEARN
UK3	CONTROL - STEERING WHEEL, ACCESSORY
UN9	RADIO EQUIPMENT - SUPPRESSION
UPF	WIRELESS INTERFACE - SHORT RANGE, VOICE REC
UQ3	SPEAKER SYSTEM - ENHANCED AUDIO
US8	RADIO - AM/FM STEREO, SEEK/SCAN, CD, AUTO TONE, CLOCK, ETR, MP3, RDS
UT7	PROVISION - AUXILIARY ELECTRICAL SYSTEM GROUND
UW6	SPEAKER SYSTEM - 6, CUSTOM
VAV	ACCESSORY-FLOOR MATS - ALL WEATHER
VC4	LABEL - PRICE/FUEL ECON, PUERTO RICO AND VIRGIN ISLANDS
VG6	LABEL INFORMATION - BUMPER IMPACT, 5 MPH, CALIFORNIA
VH3	LABEL INFORMATION - BUMPER IMPACT, 5 MPH, HAWAII
VK3	LICENSE PLATE FRONT - FRONT MOUNTING PACKAGE,
VL7	LABEL INFORMATION - BUMPER IMPACT, 5 MPH, FRONT AND REAR, NEW YORK
VM3	LABEL INFORMATION - CONSUMER, CONTAINS BUMPER IMPACT STANDARD FOR FRONT, 5 MPH AND REAR 5 MPH
VQG	ACCESSORY-WEATHER PROTECTION PACKAGE
VQK	ACCESSORY-SPLASH GUARDS - CUSTOM MOLDED
VQZ	ACCESSORY-EXHAUST TIP - DESIGN 1
VT7	OWNERS MANUAL - ENGLISH LANGUAGE
VY7	KNOB-TRANS CONT LEVER, LEATHER
W2D	ACCESSORY-CARGO NET
WL9	MODEL CONVERSION - POLICE VEHICLE
WMF	VIN MODEL YEAR-2015
WX7	WIRING PROVISIONS
Y3N	MODEL CONVERSION - LT FLEET
Y3P	MODEL CONVERSION - LS FLEET
YF5	CERTIFICATION - EMISSION, CALIFORNIA

RPO	Description
YM8	IDENTIFICATION- PERSONALIZATION OPTION (LPO)
Z64	MODEL CONVERSION - LTZ
ZFH	TIRE SPARE - COMPACT, T125/70D16

FASTENERS

Metric Fasteners

This vehicle provides fastener dimensions using the metric system. Most metric fasteners are approximate in diameter to equivalent English fasteners. Make replacements using fasteners of the same nominal diameter, thread pitch, and strength.

A number marking identifies the OE metric fasteners except cross-recess head screws. The number also indicates the strength of the fastener material. A PosidriveÂ® or Type 1A cross-recess identifies a metric cross-recess screw. For best results, use a Type 1A cross-recess screwdriver, or equivalent, in PosidriveÂ® recess head screws.

GM Engineering Standards and North American Industries have adopted a portion of the ISO-defined standard metric fastener sizes. The purpose was to reduce the number of fastener sizes used while retaining the best thread qualities in each thread size. For example, the metric M6.0 X 1 screw, with nearly the same diameter and 25.4 threads per inch replaced the English 1/4-20 and 1/4-28 screws. The thread pitch is midway between the English coarse and fine thread pitches.

Fastener Strength Identification

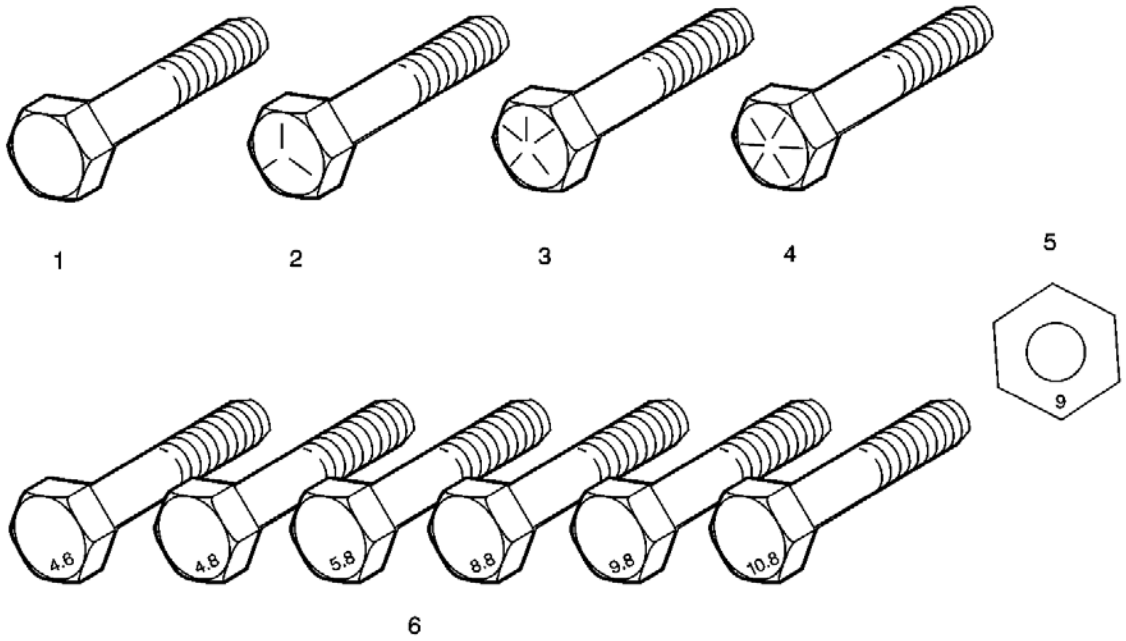


Fig. 4: Identifying Fastener Strength Marks
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	English Bolt, Grade 2 (Strength Class)
2	English Bolt, Grade 5 (Strength Class)
3	English Bolt, Grade 7 (Strength Class)
4	English Bolt, Grade 8 (Strength Class)
5	Metric Nut, Strength Class 9
6	Metric Bolts, Strength Class Increases as Numbers Increase

The most commonly used metric fastener strength property classes are 9.8 and 10.9. The class identification is embossed on the head of each bolt. The English, inch strength classes range from grade 2 to grade 8. Radial lines are embossed on the head of each bolt in order to identify the strength class. The number of lines on the head of the bolt is 2 lines less than the actual grade. For example, a grade 8 bolt will have 6 radial lines on the bolt head. Some metric nuts are marked with a single digit strength identification number on the nut face.

The correct fasteners are available through GM SPO. Many metric fasteners available in the aftermarket parts channels are designed to metric standards of countries other than the United States, and may exhibit the following:

- Lower strength
- No numbered head marking system
- Wrong thread pitch

The metric fasteners on GM products are designed to new, international standards. The following are the common sizes and pitches, except for special applications:

- M6.0 X 1
- M8 X 1.25
- M10 X 1.5
- M12 X 1.75
- M14 X 2.00
- M16 X 2.00

Prevailing Torque Fasteners

Prevailing torque fasteners create a thread interface between the fastener and the fastener counterpart in order to prevent the fastener from loosening.

All Metal Prevailing Torque Fasteners

These fasteners accomplish the thread interface by a designed distortion or deformation in the fastener.

Nylon Interface Prevailing Torque Fasteners

These fasteners accomplish the thread interface by the presence of a nylon material on the fastener threads.

Adhesive Coated Fasteners

These fasteners accomplish the thread interface by the presence of a thread-locking compound on the fastener threads. Refer to the appropriate repair procedure in order to determine if the fastener may be reused and the applicable thread-locking compound to apply to the fastener.

Adhesive Coated Fasteners

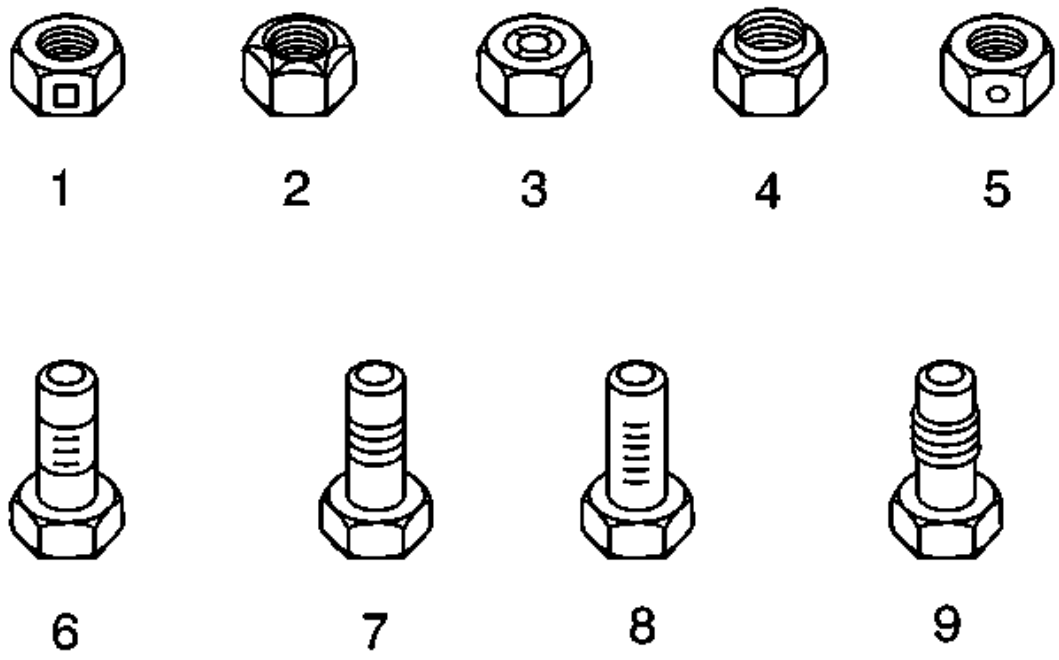


Fig. 5: Identifying Adhesive Coated Fasteners
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Prevailing Torque Nut, Center Lock Type
2	Prevailing Torque Nut, Top Lock Type
3	Prevailing Torque Nut, Nylon Patch Type
4	Prevailing Torque Nut, Nylon Washer Insert Type
5	Prevailing Torque Nut, Nylon Insert Type
6	Prevailing Torque Bolt, Dry Adhesive Coating Type
7	Prevailing Torque Bolt, Thread Profile Deformed Type
8	Prevailing Torque Bolt, Nylon Strip Type

Callout	Component Name
9	Prevailing Torque Bolt, Out-of-Round Thread Area Type

A prevailing torque fastener may be reused ONLY if:

- The fastener and the fastener counterpart are clean and not damaged
- There is no rust on the fastener
- The fastener develops the specified minimum torque against its counterpart prior to the fastener seating

Metric Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
• 6 mm	0.4	4 lb in
• 8 mm	0.8	7 lb in
• 10 mm	1.4	12 lb in
• 12 mm	2.1	19 lb in
• 14 mm	3	27 lb in
• 16 mm	4.2	37 lb in
• 20 mm	7	62 lb in
• 24 mm	10.5	93 lb in
Nylon Interface Prevailing Torque Fasteners		
• 6 mm	0.3	3 lb in
• 8 mm	0.6	5 lb in
• 10 mm	1.1	10 lb in
• 12 mm	1.5	13 lb in
• 14 mm	2.3	20 lb in
• 16 mm	3.4	30 lb in
• 20 mm	5.5	49 lb in

Application	Specification	
	Metric	English
• 24 mm	8.5	75 lb in

English Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
• 1/4 in	0.5	4.5 lb in
• 5/16 in	0.8	7.5 lb in
• 3/8 in	1.3	11.5 lb in
• 7/16 in	1.8	16 lb in
• 1/2 in	2.3	20 lb in
• 9/16 in	3.2	28 lb in
• 5/8 in	4	36 lb in
• 3/4 in	7	62 lb in
Nylon Interface Prevailing Torque Fasteners		
• 1/4 in	0.3	3 lb in
• 5/16 in	0.6	5 lb in
• 3/8 in	1	9 lb in
• 7/16 in	1.3	12 lb in
• 1/2 in	1.8	16 lb in
• 9/16 in	2.5	22 lb in
• 5/8 in	3.4	30 lb in
• 3/4 in	5	45 lb in

THREAD INSERTS

General Purpose Thread Repair Kits.

These kits are available commercially.

Repair Procedure

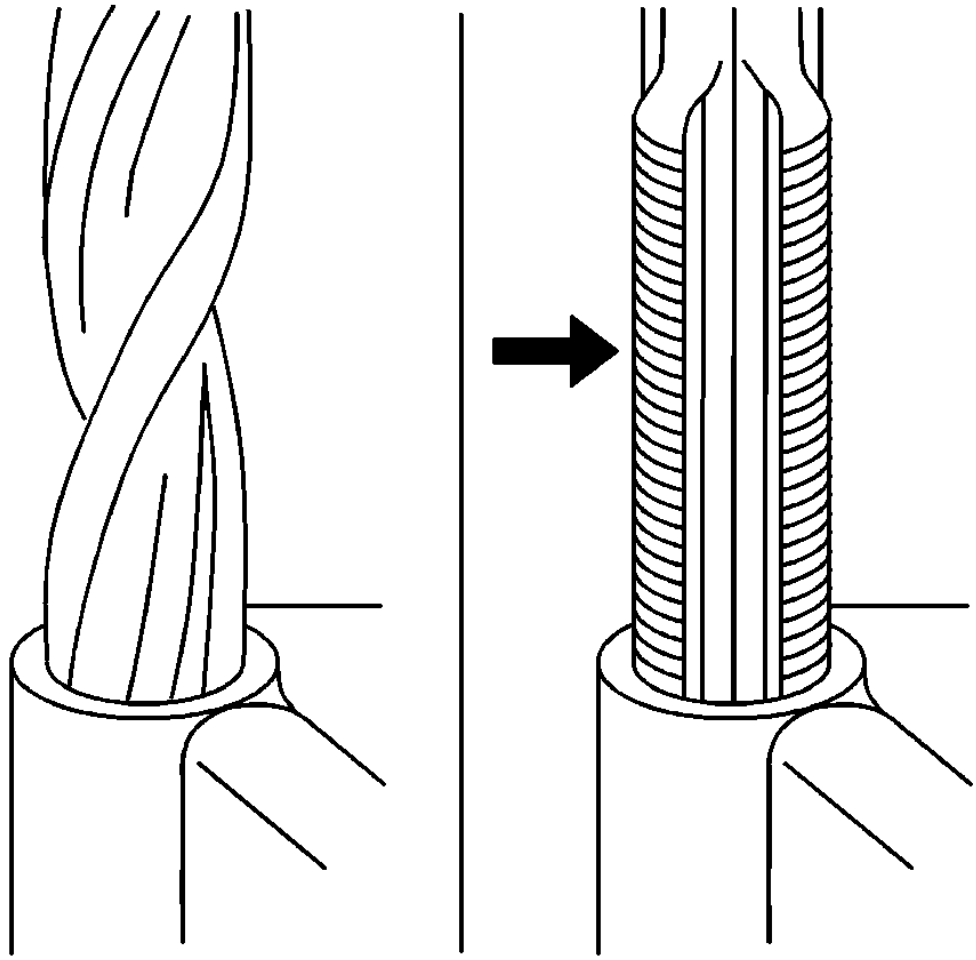


Fig. 6: Drilling & Tapping Damaged Threads
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Safety Glasses Warning .**

NOTE: **Refer to the thread repair kit manufacturer's instructions regarding the size of the drill and tap to use.**

Avoid any buildup of chips. Back out the tap every few turns and remove the chips.

1. Determine the size, the pitch, and the depth of the damaged thread. If necessary, adjust the stop collars on the cutting tool and tap to the required depth.

2. Drill out the damaged threads. Clean out any chips.
3. Lubricate the tap with light engine oil. Tap the hole. Clean the threads.

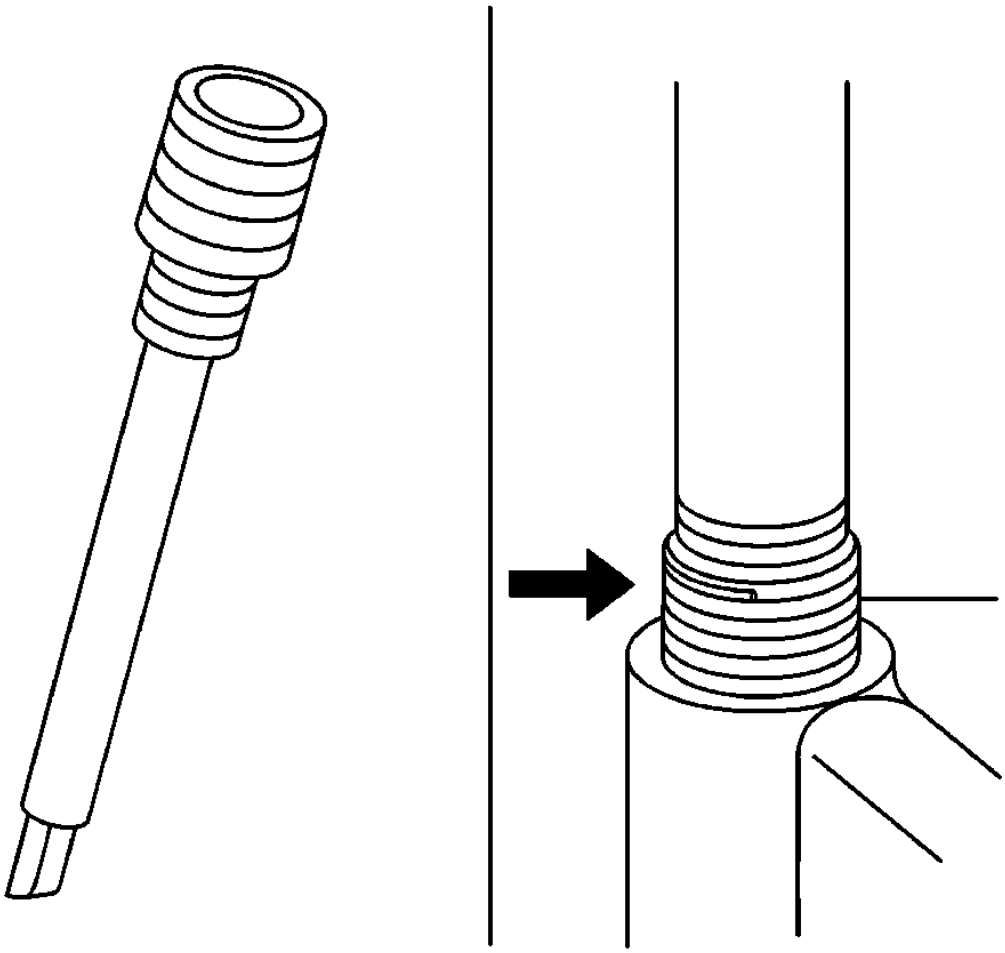


Fig. 7: View Of Thread Insert
Courtesy of GENERAL MOTORS COMPANY

4. Thread the thread insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.

NOTE: **The insert should be flush to one turn below the surface.**

5. Lubricate the insert with light engine oil, except when installing in aluminum and install the insert.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift.

REGISTERED AND NON-REGISTERED TRADEMARKS

Listed below are Registered Trademarks (Â®) or Non-Registered Trademarks (™) which may appear in this service manual.

A
ACÂ®
ACCUTURNÂ®
ACDelcoÂ®
Active Fuel Management™
AcuzincÂ®
AirbankÂ®
AllisonÂ®
AMMCOÂ®
AUTOFUSEÂ®
AUTOTRACÂ®
B
BendixÂ®
BluetoothÂ®
BON-AMIÂ®
BoschÂ®
BoseÂ®
C
CaterpillarÂ®
CATÂ®
C-QuamÂ®
D
DelcoÂ®
Delco BoseÂ®
Delco ElectronicsÂ®
Delco FreedomÂ®
Delco LOC IIÂ®
Delco MoraineÂ®
Delco RemyÂ®
Delco SoundÂ®
Delco SupremeÂ®
Delco TechÂ®
DELCOREÂ®
DelphiÂ®
DEX-COOLÂ®
DEXOILÂ®
DEXRONÂ®
DEXSTEER™
DNRÂ®
DolbyÂ®
DRÂ®
DuracellÂ®

DuraguardÂ®
DurastopÂ®
Duramax™
E
Eaton CorporationÂ®
EMDÂ®
ETRÂ®
F
FLO-LITEÂ®
G
General MotorsÂ®
GMÂ®
GM Goodwrench ServiceÂ®
GM OptikleenÂ®
GM Parts™
GM PassÂ®
GM UltraliteÂ®
GMACÂ®
GoodwrenchÂ®
GTPÂ®
H
Homelink™
HYDRA-MATICÂ®
I
IlluminationÂ®
INSTA-TRACÂ®
IntuneÂ®
L
LOCTITE™
Lord Fusor™
M
MAGNASTEERÂ®
MaxifuseÂ®
MetripackÂ®
MicropackÂ®
MinifuseÂ®
Mr GoodwrenchÂ®
N
NorthstarÂ®
O
OnStarÂ®
OptikleenÂ®

P
PASS-KEYÂ®
PASS-KEYIIÂ®
PASSLOCK™
PK3Â®
PosidriveÂ®
ProÂ®
Q
Quad 4Â®
R
RAINSENSE™
Rapid FireÂ®
S
ScotchBrite™
Scotchguard™
SignalsÂ®
Sikkens™
Soft-RayÂ®
Solar-RayÂ®
StabilitrakÂ®
SunrayceÂ®
SuperlubeÂ®
SycloneÂ®
T
Tech 2Â®
TechlineÂ®
TeflonÂ®
TefzelÂ®
Theft-IÂ®
TheftlockÂ®
TiltmasterÂ®
TORXÂ®
TransjelÂ®
TransguideÂ®
Twilight SentinelÂ®
U
UltraliteÂ®
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VelcroÂ®
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Weatherpack™

KEY AND LOCK CYLINDER CODING

Special Tools

BO-48370 Lock Cylinder Cap Installer

Ignition Lock Cylinder

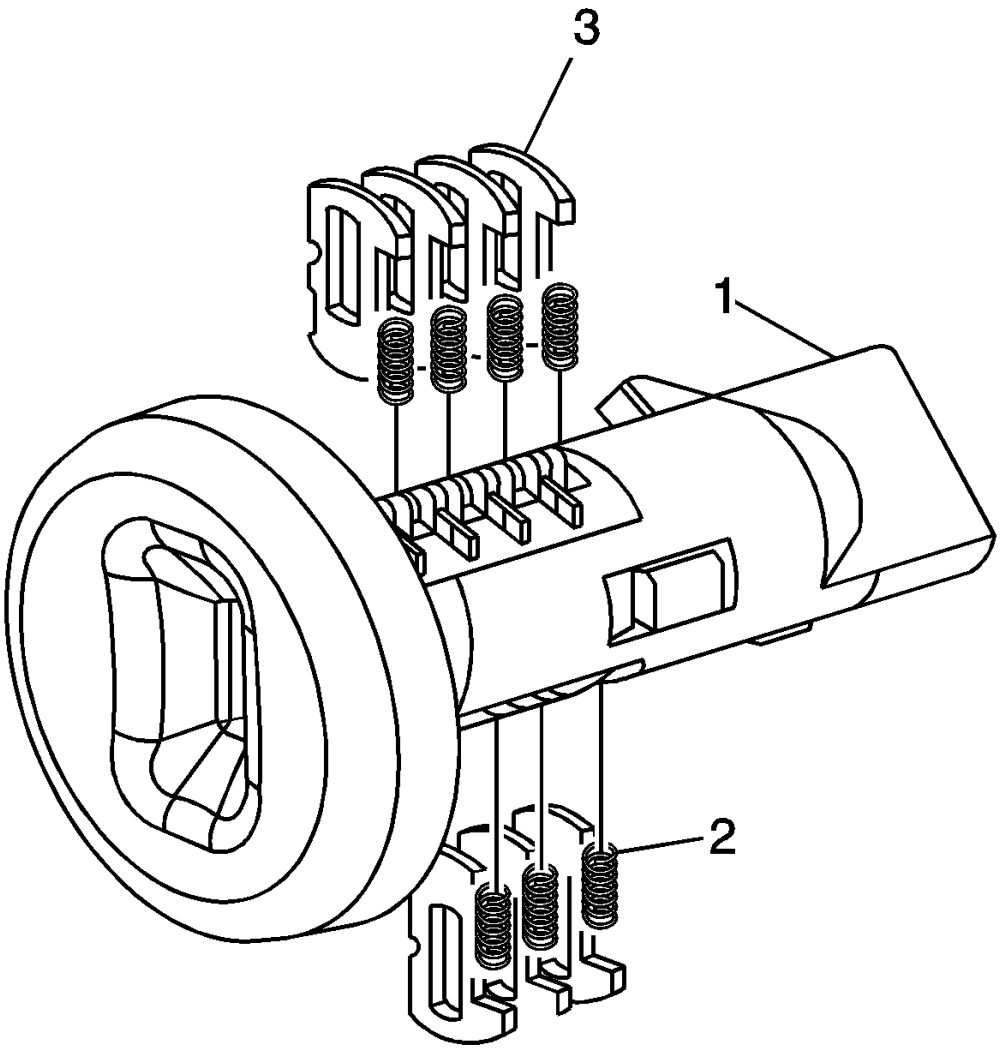

Fig. 8: Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

The ignition lock cylinder uses only 7 of the 10 cut positions, 3 through 9. The ignition cylinder tumblers are all located on alternate sides of the cylinder (1). They are snap-in and self-retaining. It follows the key code with the first tumbler being the first depth of the key code, closest to the head of the key.

1. Hold the ignition cylinder assembly (1) so the side with the 4 tumblers spring pocket of the cylinder is facing up.
2. Insert the tumbler springs (2) into each of the spring pockets of the cylinder assembly.
3. The first tumbler (3) to be loaded will be the third key cut position, the third number in the key code. Install the first tumbler in the slot nearest the head of the lock cylinder. Install the remaining tumblers for cuts 5, 7 and 9 following the key code and same process. Press the tumblers in place until they are secure.
4. Rotate cylinder assembly so the 3 tumblers springs pocket of the cylinder is facing up. Insert tumbler springs (2) into each of the spring pockets of the cylinder assembly.
5. The first tumbler (3) to be loaded will be the fourth key cut position, the fourth number in the key code. Install the first tumbler in the slot nearest the head of the lock cylinder. Install the remaining tumblers for cuts 6 and 8 following the key code and same process. Press the tumblers in place until they are secure.
6. Inspect for correct loading of the tumblers by inserting the key into cylinder. The side bar should drop flush with the lock cylinder body diameter.
7. Lightly lubricate the outside surfaces in the tumbler area of the lock body and down the key slot using the provided grease. Insert and extract the key 5 times to lubricate the keyway.
8. Line-up the lock to the run position. Insert lock in steering column. Rotate lock to key out position and remove key. Insert key and rotate lock 3 times to distribute the grease from the lock to column housing inside diameter.

Front Side Door Lock Cylinder

The front side door lock cylinder uses 8 of the 10 key cut positions, 3 through 10 when counting from the key head. The tumbler orientations alternate in adjacent locations from side to side with 4 on each side.

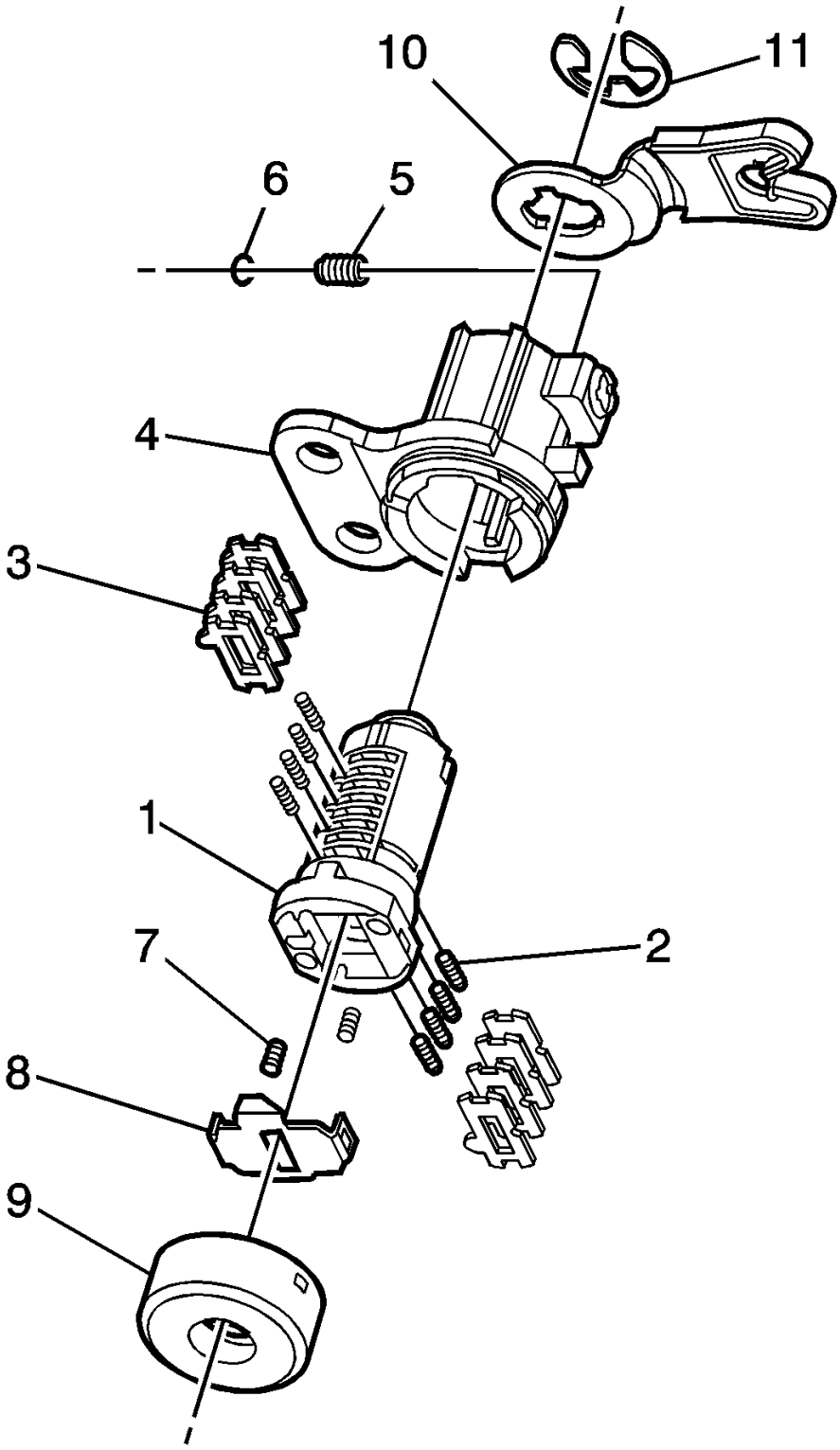

Fig. 9: Front Side Door Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The front side door lock cylinder tumblers (3) are not self-retaining and must be held in place if the key in not fully inserted into the lock cylinder or until the cylinder (1) is assembled into the case assembly (4). Left side shown, right side opposite.**

1. Hold the uncoded cylinder (1) positioned so the side with the rotational stop lug is facing upward, as shown.
2. Insert one tumbler spring (2) each into the 4 tumbler spring holes.
3. The first tumbler to be loaded will be key cut position 3, the third number in the key code. Determine the cut depth at this position and install the corresponding tumbler (3) into the tumbler slot nearest the front of the lock cylinder assembly (1), the end where the key is inserted.
4. In the same manner, determine the cut depth and corresponding tumbler and install the 3 remaining tumblers (3) into the tumbler slots located at key cut positions 5, 7, and 9.
5. Check the correct loading by holding the tumblers (3) in position and fully inserting the matching key into the cylinder (1). All tumblers should be flush with the outside diameter of the cylinder.
6. Rotate the cylinder (1) so the side with the rotational stop lug is facing downward and then remove the matching key. Remember the tumblers (3) are not self-retaining and must be held in place.
7. Insert one tumbler spring (2) each into the 4 tumbler spring holes.
8. The first tumbler to be loaded will be key cut position number 4. Determine the cut depth at this position and install the corresponding tumbler (3) into the tumbler slot nearest the front of the cylinder assembly.
9. In the same manner, determine the cut depth and corresponding tumbler and install the 3 remaining tumblers (3) into the tumbler slots located at key cut positions 6, 8, and 10.
10. Check for correct loading by holding the tumblers (3) in position and fully inserting the matching key into the cylinder (1). All tumblers should be flush with the outside diameter of the cylinder.
11. Lightly lubricate the tumbler (3) surfaces using the lubrication provided.
12. Hold the case assembly (4), left side shown, right side opposite, with the pre-staked detent spring retainer facing downward.
13. First insert one detent spring (5) and then one detent ball (6) into the detent spring hole located to the rear and inside of the cylinder case assembly (4). The detent spring and detent ball are not self-retaining and must be held in place until the coded cylinder is installed into the case assembly.

WARNING: Wear safety glasses in order to avoid eye damage.

14. With the matching key fully inserted into the coded cylinder, install the coded cylinder into the case assembly (4). Make sure the detent spring (5) and detent ball (6) are held in place until the coded cylinder is fully installed. The detent ball should line up with the V-shaped groove on the rear of the cylinder, which will prevent the detent spring and detent ball from falling out of the case assembly.
15. Remove the matching key being careful to keep the coded cylinder (1) fully inserted into the case assembly (4).
16. Insert one shutter spring (7) each into the two shutter spring holes located on the front face of the cylinder (1).
17. Install the shutter assembly (8) into the recessed area on the front face of the cylinder (1). Be sure that the ends of the pin on the shutter assembly are positioned in the pin cavities located in the front face of the cylinder.
18. Install the lock cylinder cap (9) by aligning the drain hole in the cap with the bottom of the case assembly (4). Snap the cap into place with light hand pressure. Be sure the cap is securely retained on the case assembly. Also, be sure that the shutter springs (7) push the shutter assembly (8) up against the inside surface of the cap.

19. Install the lever (10), left side shown, right side opposite, onto the end of the cylinder (1).
20. Install the retaining ring (11) in the groove at the end of the cylinder (1) to secure the lever (10) to the cylinder.

Rear Compartment Lid Lock Cylinder - Police Vehicles 9C1 and 9C3

The rear compartment lid lock cylinder uses 8 of the 10 key cut positions, 3-10 when counting from the key head. The tumbler orientations alternate in adjacent locations from side to side with 4 on each side.

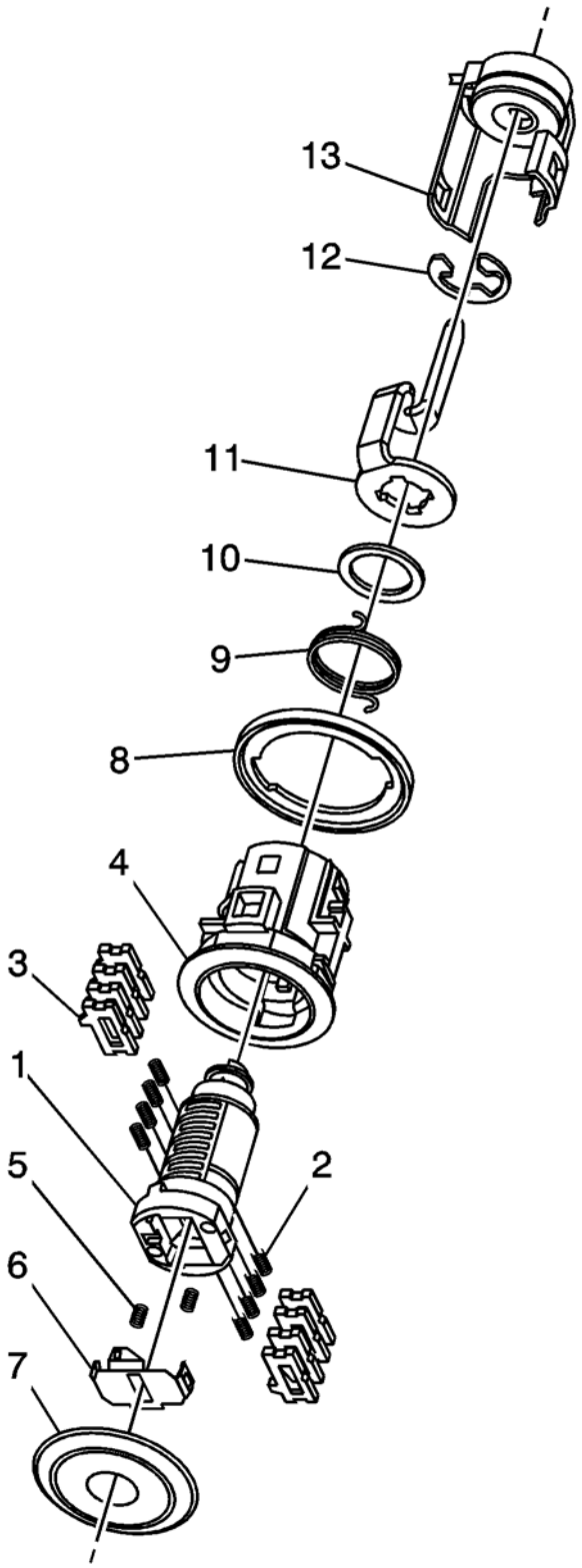

Fig. 10: Identifying Rear Compartment Lid Lock Cylinder Components (1 Of 2)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The rear compartment lid lock cylinder tumblers (3) are not self-retaining and must be held in place if the key is not fully inserted into the lock cylinder or until the cylinder (1) is assembled into the case (4).**

1. Hold the uncoded cylinder (1) positioned so the side with the drain hole is facing downward.
2. Insert one tumbler spring (2) each into the 4 tumbler spring holes.
3. The first tumbler to be loaded will be key cut position number 3, the third number in the key code. Determine the cut depth at this position and install the corresponding tumbler (3) into the tumbler slot nearest the front of the cylinder (1), the end where the key is inserted.
4. In the same manner, determine the cut depth and corresponding tumbler and install the 3 remaining tumblers (3) into the tumbler slots located at key cut positions 5, 7, and 9.
5. Check for correct loading by holding the tumblers (3) in position and fully inserting the matching key into the cylinder (1). All tumblers should be flush with the outside diameter of the cylinder.
6. Rotate the cylinder (1) so that the side with the drain hole is facing upward and then remove the matching key. Remember the tumblers (3) are not self-retaining and must be held in place.
7. Insert one tumbler spring (2) each into the 4 tumbler spring holes.
8. The first tumbler to be loaded will be key cut position number 4. Determine the cut depth at this position and install the corresponding tumbler (3) into the open tumbler slot nearest the front of the cylinder.
9. In the same manner, determine the cut depth and corresponding tumbler and install the 3 remaining tumblers into the tumbler slots located at key cut positions 6, 8, and 10.
10. Check for correct loading by holding the tumblers (3) in position and fully inserting the matching key into the cylinder (1). All tumblers should be flush with the outside diameter of the cylinder.
11. Lightly lubricate tumbler (3) surfaces using the lubrication provided.
12. With the matching key fully inserted into the coded cylinder, install the coded cylinder into the case (4).
13. Remove the matching key being careful to keep the coded cylinder (1) fully inserted into the case (4).
14. Insert one shutter spring (5) each into the 2 shutter spring holes located on the front face of the cylinder (1).
15. Install the shutter assembly (6) into the recessed area on the front face of the cylinder (1). Be sure that the ends of the pin on the shutter assembly are positioned in the pin cavities located in the front face of the cylinder.

NOTE: **Be careful not to scratch or dent the cosmetic surface of the cap or damage the lock cylinder in any way while staking the cap.**

16. Stake the cap (7) onto the head of the case (4) by using the appropriate staking tool **BO-48370** lock cylinder cap installer. Ensure proper orientation and set the cylinder assembly (14), (which includes the case (4), coded cylinder (1), shutter springs (5), and shutter assembly (6)) and the cap (7) into the staking cup (15) and clamp into vise. Remove any debris and install the cleaned staking ram (16) into staking cup (15) and with a dead blow hammer, hit the staking ram (16) with moderate force 2 or 3 times. Check to determine if cap is securely staked to the cylinder assembly (14). Repeat previous step until cap is securely staked to the cylinder assembly. Remove assembly from the staking cup (15). If necessary, insert the removal punch (17) into the opposite end of the staking cup and tap lightly. Confirm that the shutter springs (5) push the shutter assembly (6) up against the inside surface of the cap (7).

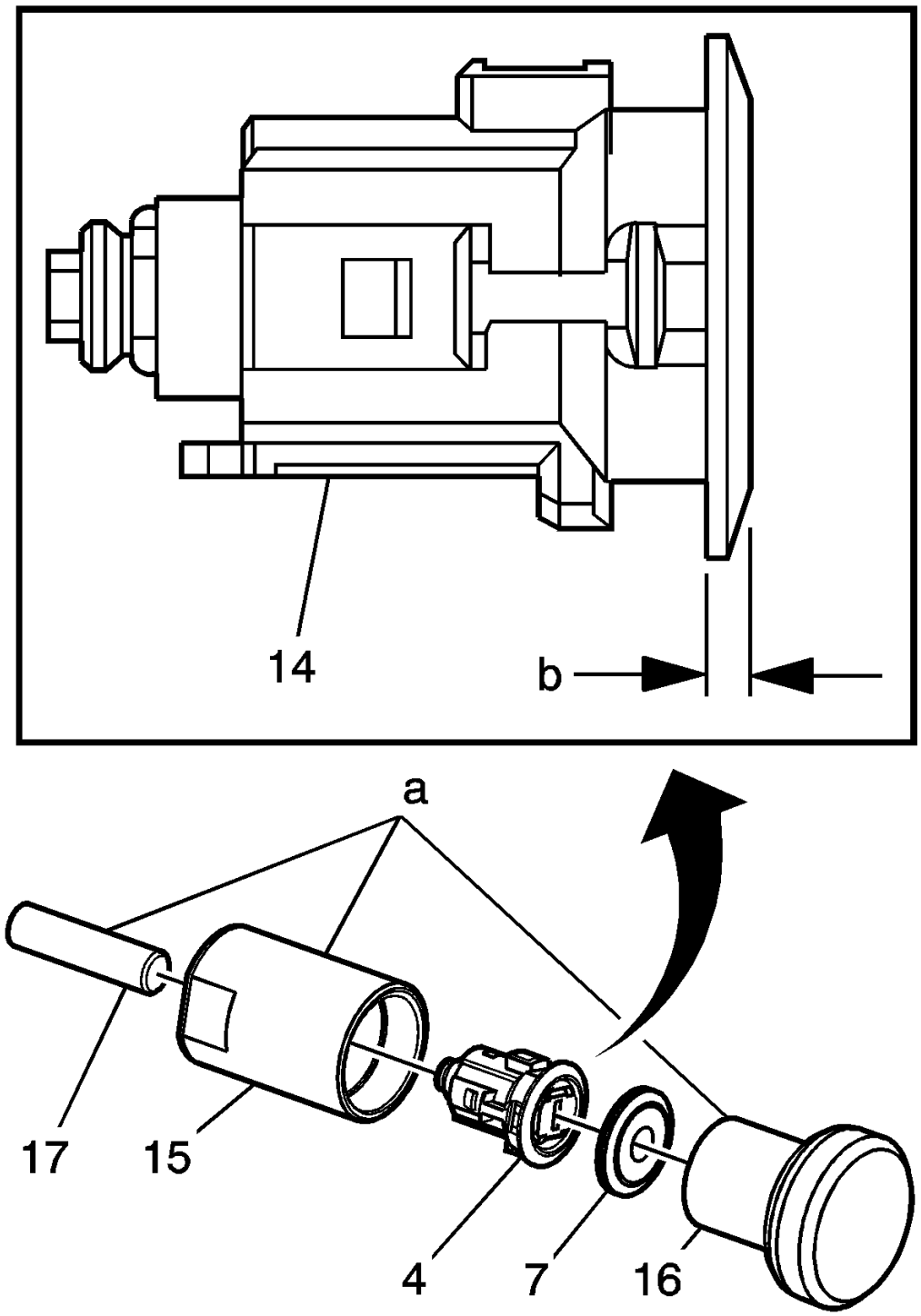

Fig. 11: Identifying Rear Compartment Lid Lock Cylinder Components (2 Of 2)
Courtesy of GENERAL MOTORS COMPANY

17. Install the gasket (8) over the end of the cylinder assembly and slide it all the way up the case (4) until it seats behind the cap (7).
18. Install the return spring (9) over the back end of the cylinder (1) with the straight hook facing the rear of the case (4). Engage the straight hook of the return spring with the hook feature on the rear of the case.

19. Install the spacer (10) and lever (11) onto the end of the cylinder (1).
20. Install the retaining ring (12) in the groove at the end of the cylinder (1) to secure the lever (11) to the cylinder. Engage the bent hook of the return spring (9) with the lever.
21. Install the theft deterrent switch (13) onto the end of the cylinder (1) and snap the switch legs onto the case (4). Be sure the theft deterrent switch is engaged with the end of the cylinder and is securely attached to the case.
22. Check the operation of the lock assembly. The return spring (9) should provide a counterclockwise snap back.

LIFTING AND JACKING THE VEHICLE

WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.

WARNING: To avoid any vehicle damage, serious personal injury or death, always use the jackstands to support the vehicle when lifting the vehicle with a jack.

CAUTION: Perform the following steps before beginning any vehicle lifting or jacking procedure:

- **Remove or secure all of the vehicle contents in order to avoid any shifting or any movement that may occur during the vehicle lifting or jacking procedure.**
- **The lifting equipment or the jacking equipment weight rating must meet or exceed the weight of the vehicle and any vehicle contents.**
- **The lifting equipment or the jacking equipment must meet the operational standards of the lifting equipment or jacking equipment manufacturer.**
- **Perform the vehicle lifting or jacking procedure on a clean, hard, dry, level surface.**
- **Perform the vehicle lifting or jacking procedure only at the identified lift points. DO NOT allow the lifting equipment or jacking equipment to contact any other vehicle components.**

Failure to perform the previous steps could result in damage to the lifting equipment or the jacking equipment, the vehicle, and/or the vehicle contents.

Automotive Lift and Floor Jack Contact Points

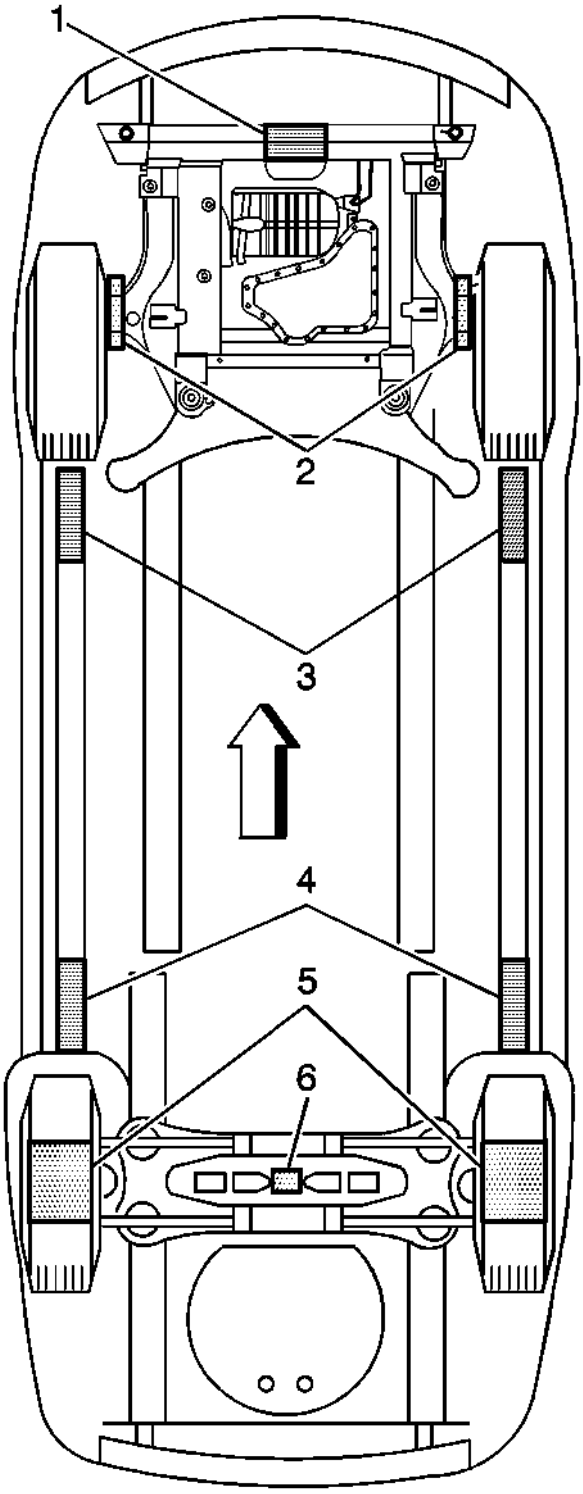

Fig. 12: Automotive Lift and Floor Jack Contact Points
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Floor Jacking-Front Location
2	Suspension Contact Lift-Front Location

Callout	Component Name
3	Frame Contact Lift-Front Location
4	Frame Contact Lift-Rear Location
5	Suspension Contact Lift-Rear Location
6	Floor Jacking-Rear Location

Vehicle Lifting-Frame Contact Lift

Front Lift Pads

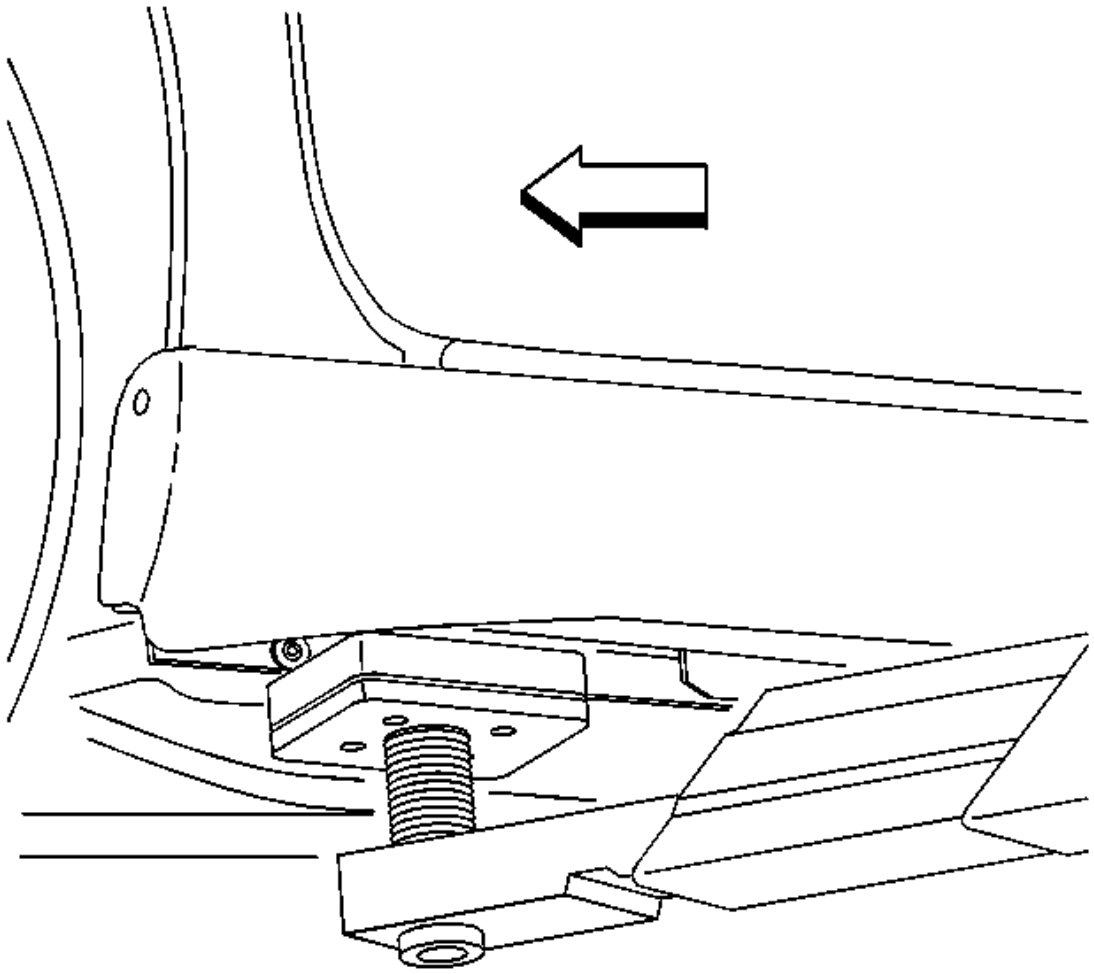

Fig. 13: Positioning Front Hoist Pads
Courtesy of GENERAL MOTORS COMPANY

When lifting the vehicle with a frame-contact lift, place the front lift pads at the front pinchweld flanges.

Rear Lift Pads

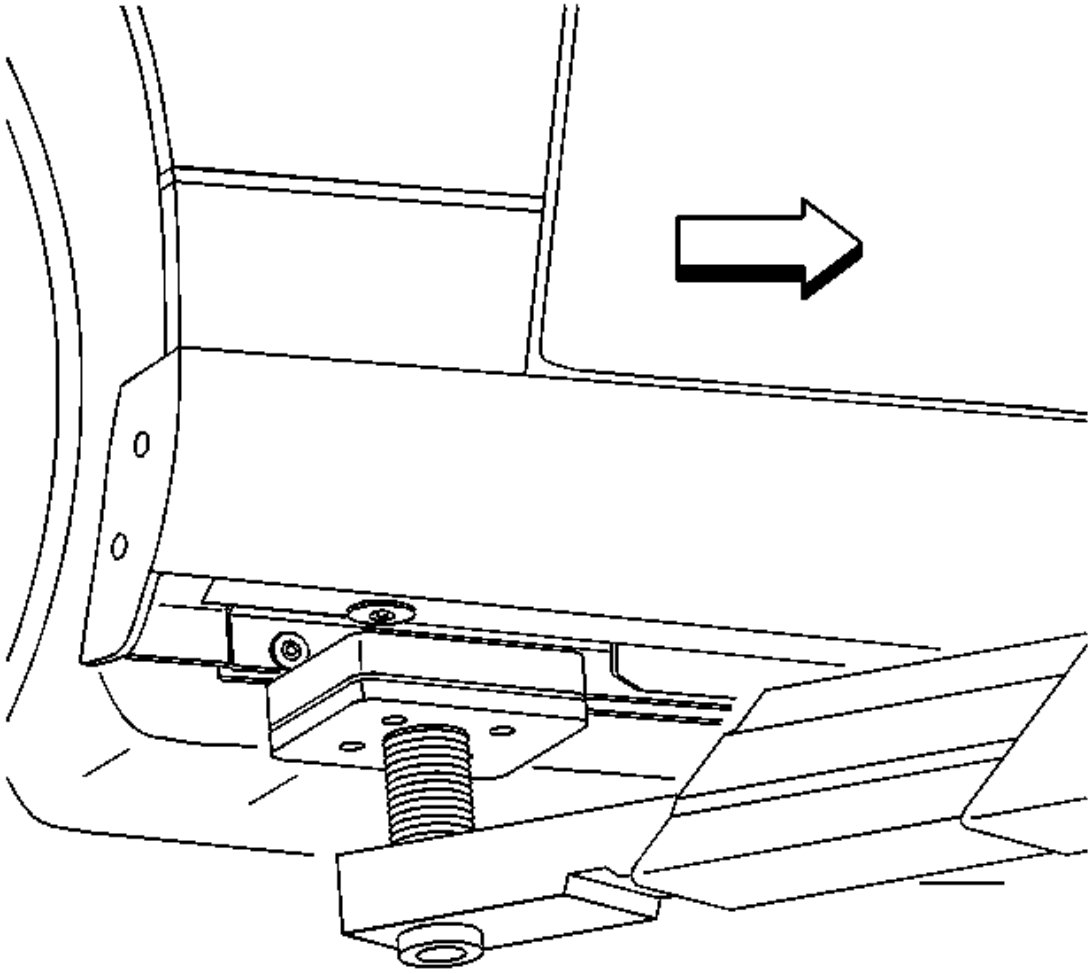

Fig. 14: Positioning Rear Hoist Pads
Courtesy of GENERAL MOTORS COMPANY

When lifting the vehicle with a frame-contact lift, place the rear lift pads at the rear pinchweld flanges.

Vehicle Lifting-Suspension Contact Lift

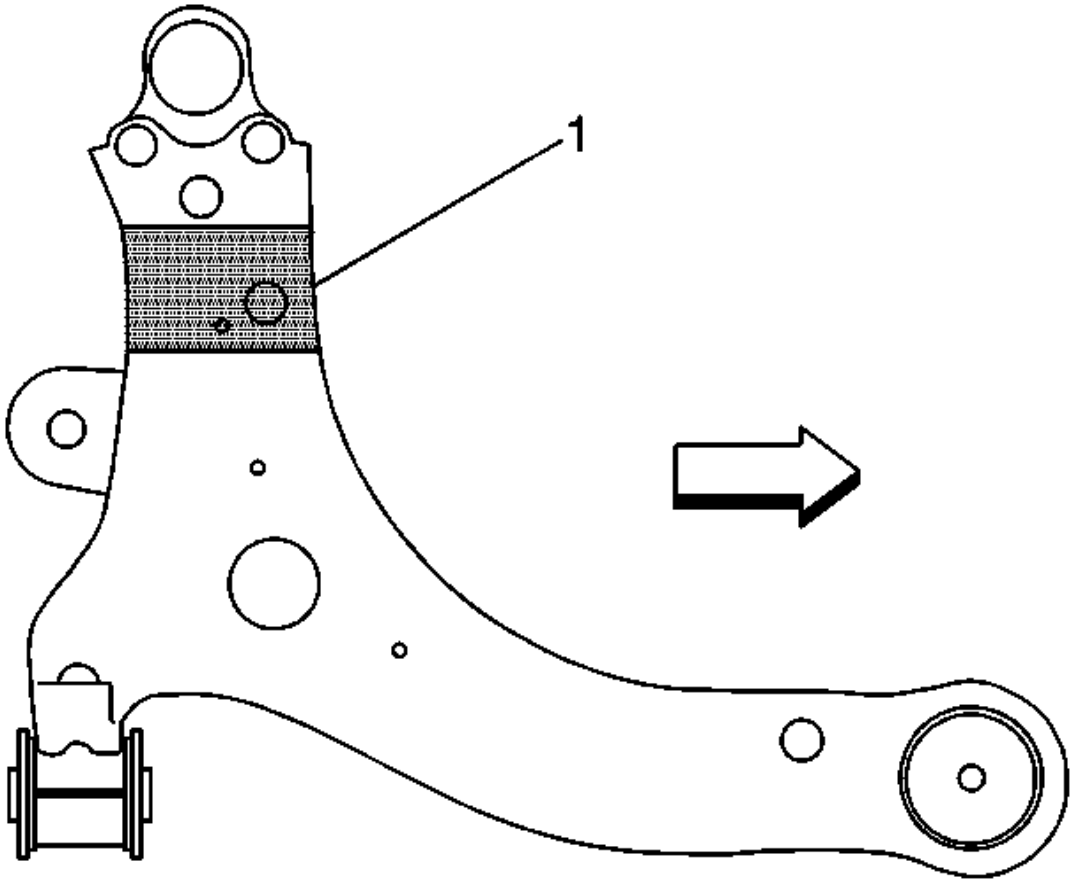

Fig. 15: Identifying Front Post Lift Points At The Lower Control Arms
Courtesy of GENERAL MOTORS COMPANY

When lifting the vehicle with a suspension-contact lift, place the front post lift points at the lower control arms in the area shown (1). Lift the rear of the vehicle with the rear post lift points ONLY under the rear wheels.

Vehicle Jacking

Under the Front Frame

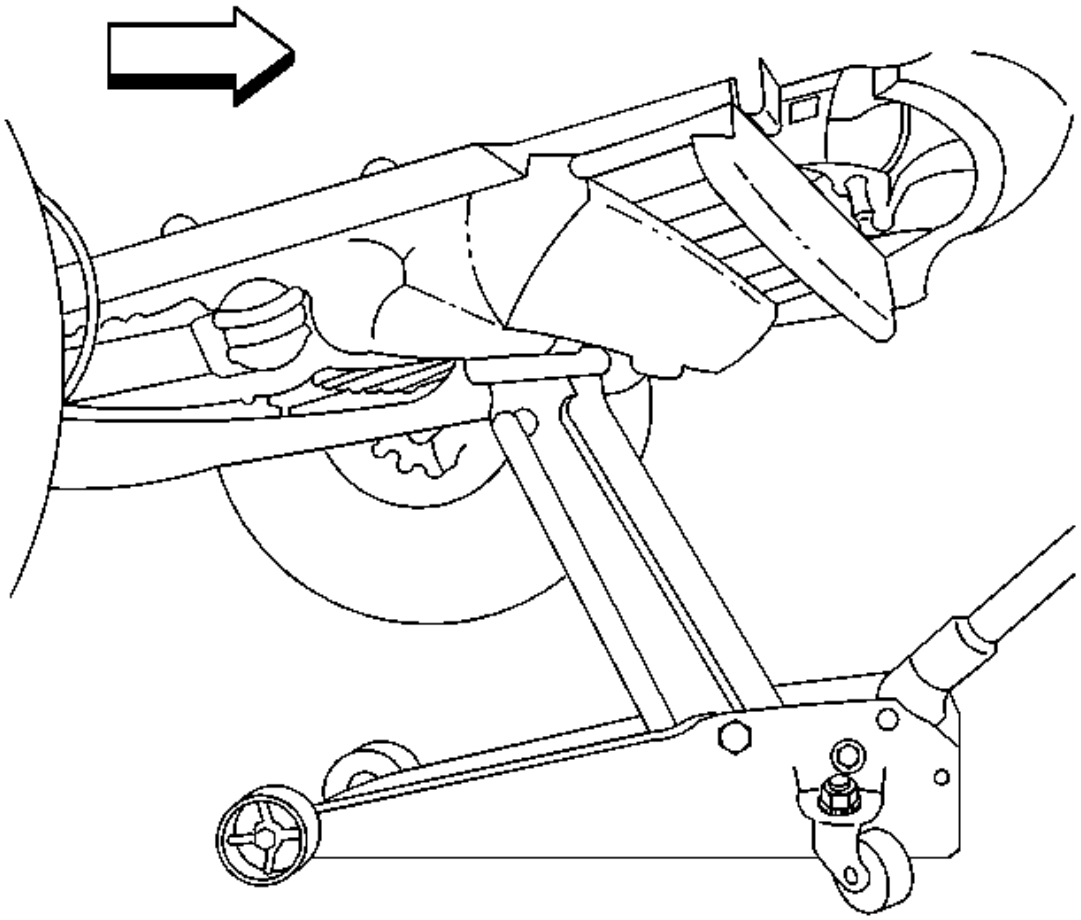

Fig. 16: Placing Jack Under Front Frame
Courtesy of GENERAL MOTORS COMPANY

When lifting the front of the vehicle with a floor jack, place the floor jack lift pad at the center of the front frame.

Under the Center of the Rear Suspension

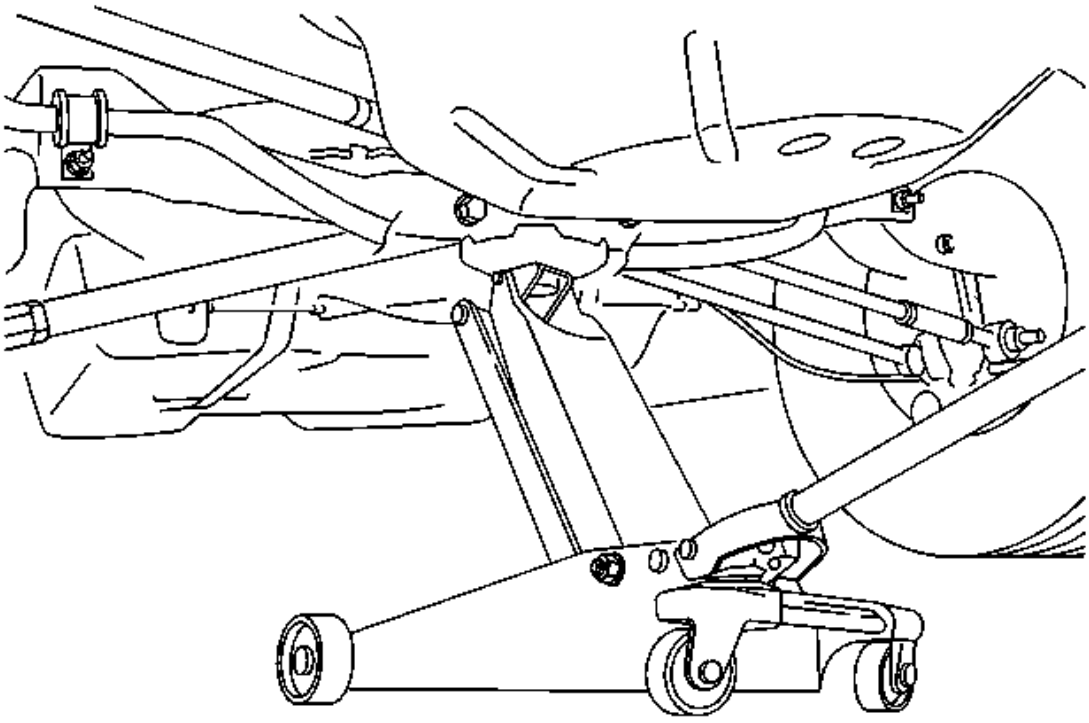

Fig. 17: Placing Jack Under Center Of Rear Suspension
Courtesy of GENERAL MOTORS COMPANY

Lift the rear of the vehicle by placing the floor jack lift pad at the center of the rear suspension.

Supporting the Vehicle with Jackstands

NOTE: **Place jackstands ONLY under strong and stable vehicle structures.**

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS ORDERING INFORMATION

Special Tools

The special service tools shown in this service manual that have product numbers beginning with J, BO, GE, CH, DT, EN, EL, SA, OR KM are available for worldwide distribution.

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ACCESSORIES AND EQUIPMENT

Horns - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Horn Bracket Bolt	10 N.m	7 lb ft

SCHEMATIC WIRING DIAGRAMS

HORN WIRING SCHEMATICS

Horn

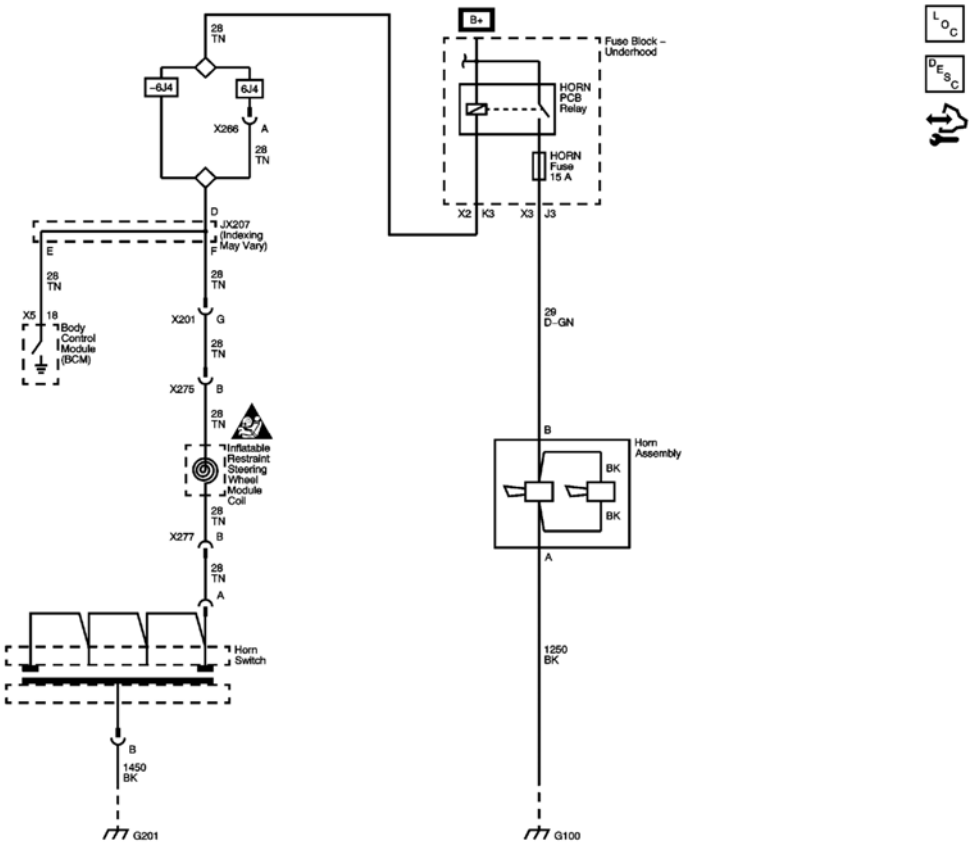

Fig. 1: Horn Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B2750: HORN RELAY COIL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2750 00

Horn Relay Coil Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Horn Relay Control	B2750 00	B2750 00	B2750 00	-
Horn Control	2	2	1	-
Horn Switch Ground	-	2	2	-
Horn Ground	-	2	2	-
1. Horn Always On 2. Horn Inoperative				

Circuit/System Description

The body control module (BCM) controls the HORN relay by grounding the control circuit of the horn relay coil energizing the relay. When the HORN relay is energized, the horn relay contacts close applying voltage through the HORN fuse and the horn control circuit to the horns.

Conditions for Running the DTC

When the output is actively being requested by the BCM.

Conditions for Setting the DTC

The BCM detects a short to ground, open, or short to voltage in the horn relay control circuit for approximately 125 milliseconds.

Action Taken When the DTC Sets

The BCM disables the output to the HORN relay until the next ignition cycle.

Conditions for Clearing the DTC

- The DTC clears when the fault is no longer detected.
- The current DTC will become history when the request for the output is removed.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Horn Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Horns System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Command the horns ON and OFF with the scan tool. The horns should turn ON and OFF when changing between the commanded states.

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block.
2. Connect a test lamp between B+ and the control circuit terminal K3.
3. Press and release the horn switch. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground or a sticking horn switch. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage, an open high resistance, or a horn switch which is not closing. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, replace the underhood fuse block.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup and programming

SYMPTOMS - HORNS

The following steps must be completed before using the symptom tables:

IMPORTANT:

1. Perform **Diagnostic System Check - Vehicle** , before using the symptom tables in order to verify that all of the following are true:

- There are no DTCs set
- The control modules can communicate via the serial data link

2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Horns System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the horn system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Perform the following if a horn buzzes or has a harsh tone.
  - Inspect for debris in the joint where the horn fastens to the vehicle.
  - Test the torque of the horn mounting hardware. The horn mounting hardware should be tightened to a torque of 10 N.m (7 lb ft).

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure **Horns Malfunction** in order to diagnose the symptom.

HORNS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Horn Relay Control	2	1	B2750 00	-
Horn Control	2	2	1	-
Horn Switch Ground	-	2	-	-
Horn Ground	-	2	-	-
1. Horn Always On 2. Horn Inoperative				

Circuit/System Description

Battery positive voltage is applied at all times to the horn relay coil and the horn relay switch. Pressing the horn

switch applies ground through the switch contacts and the horn relay control circuit to the coil side of the relay, energizing the relay. Battery voltage is then applied through the switch side of the relay, the HORN fuse, and the horn control circuit to the horns. The body control module (BCM) may also apply ground to the horn relay control circuit as described above. The horns sound as long as ground is applied to the horn relay control circuit.

Diagnostic Aids

OnStarÂ® RemoteLink™ applications or "apps" downloads are available to owners of certain mobile devices. Unwanted or inadvertent horn activations have been associated with these applications to which the customer may be unaware. Contact the GM Technical Assistance Center regarding information on a remedy for this situation.

A short to ground in the horn relay control circuit or a short to voltage in the horn control circuit will cause the horn to sound continuously until the horn overheats and become inoperative.

Rotate the steering wheel while pressing the horn pad to identify intermittent and poor connections within the steering column.

If diagnosing a Horn- Poor Tone condition, inspect the following:

- Debris or water in the horn assembly.
- Proper horn mounting hardware torque. Refer to **Fastener Specifications**.
- Debris in the joint where the horns attach to the vehicle.
- Debris in direct contact with the horn
- Vehicle components vibrating while the horn is sounding

Reference Information

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Horn Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, connect a test lamp between the horn fuse test point and ground.
2. Press and release the horn switch. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp does not illuminate or remains illuminated at all times, refer to Horn Switch Circuit Test.
3. Connect a 15 A fused jumper wire between the horn fuse test point and B+. The horns should sound and emit a clear and even tone.
    - If the horns do not sound, refer to Horn Circuit Test.
    - If the sound emitted is not clear and even, refer to Horn - Poor Tone.

Circuit/System Testing

Horn Switch Circuit Test

1. Ignition OFF, disconnect the harness connector at the horn switch.
2. Test for less than 1 Ω between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for and open/high resistance.
3. Connect the harness connector at the horn switch.
4. Disconnect the X2 harness connector at the underhood fuse block.
5. Connect a test lamp between B+ and the control circuit terminal K3.
6. Press and release the horn switch. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground or a sticking horn switch. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage, an open high resistance, or a horn switch which is not closing.
7. Ignition OFF, connect the X2 harness connector at the underhood fuse block. Disconnect the harness connector at the horn assembly.
8. Verify that a test lamp does not illuminate between the control circuit terminal B and ground.
    - If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the underhood fuse block.
9. If all circuits test normal, replace the underhood fuse block.

Horn Circuit Test

1. Ignition OFF, disconnect the harness connector at the horn assembly.
2. Test for less than 1 Ω between the ground circuit terminal A and ground.
    - If greater than the specified range, test the ground circuit for and open/high resistance.
3. Connect a test lamp between the control circuit terminal B and ground.
4. Press and release the horn switch. The test lamp should turn ON and OFF when changing between the

commanded states.

- If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the underhood fuse block.
- If the test lamp is always OFF and the circuit fuse is good, test the control circuit for an open/high resistance. If the circuit tests normal, replace the underhood fuse block.
- If the test lamp is always OFF and the circuit fuse is open, test the control circuit for a short to ground. If the circuit tests normal, test or replace the horn assembly.

5. If all circuit test normal, test or replace the horn assembly.

Horn - Poor Tone

1. Ignition OFF, disconnect the harness connector at the horn assembly.
2. Test for less than 1 Ω between the ground circuit terminal A and ground.
   - If greater than the specified range, test the ground circuit for high resistance.
3. Disconnect the X3 harness connector at the underhood fuse block.
4. Test for less than 1 Ω between the control circuit terminal J3 at the underhood fuse block and the control circuit terminal B at the horn assembly.
   - If greater than the specified range, test the control circuit for high resistance.
5. If all circuits test normal, test or replace the horn assembly.

Component Testing

Horn

1. Ignition OFF, disconnect the harness connector at the horn assembly.
2. Install a 15 A fused jumper wire between the control terminal B and 12 V. Install a jumper wire between the ground terminal A and ground. Verify the horn emits a clear and even tone.
   - If the sound emitted is not clear and even, replace the horn assembly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Horn Replacement**
- **Steering Wheel Horn Switch Replacement**
- **Instrument Panel Electrical Center or Junction Block Replacement - Right Side (Impala)**
- **Control Module References** for BCM replacement, programming and setup

REPAIR INSTRUCTIONS

HORN REPLACEMENT

Removal Procedure

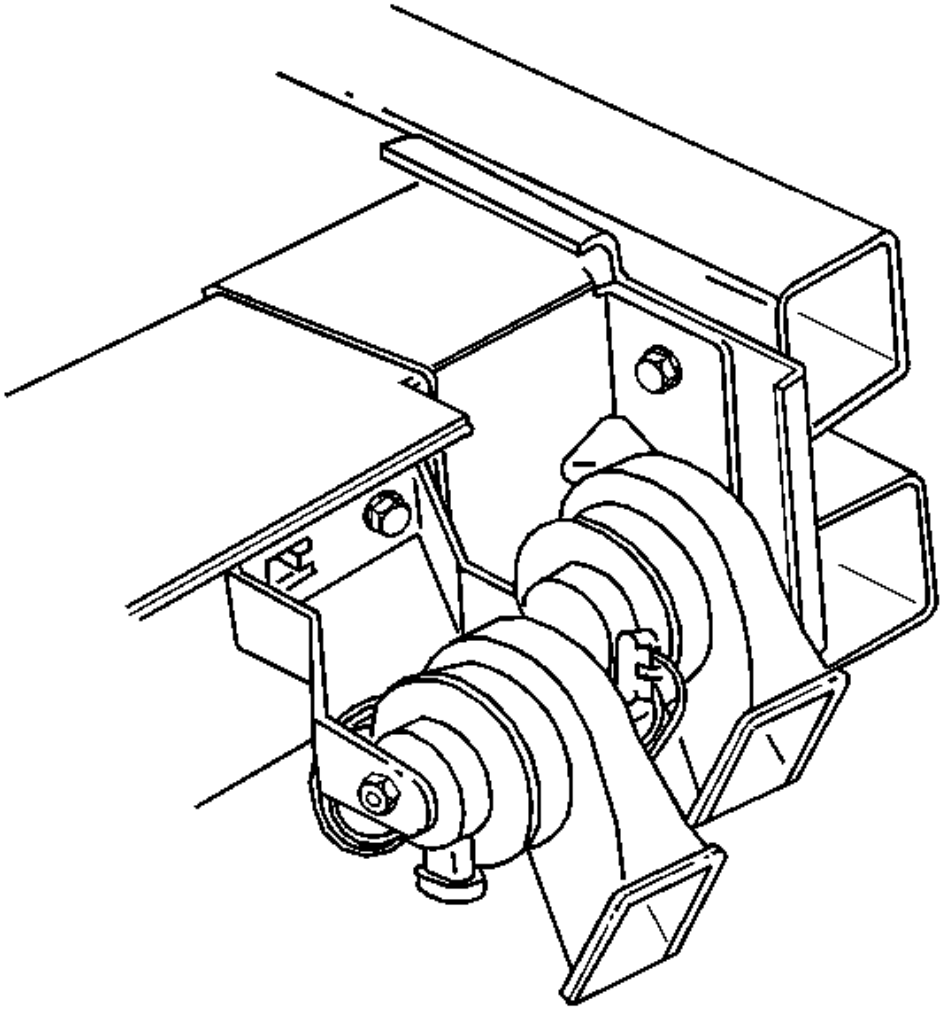


Fig. 2: Vehicle Horn
Courtesy of GENERAL MOTORS COMPANY

1. Open the hood.
2. Remove the right headlamp. Refer to **Headlamp Replacement** .
3. Disconnect the horn electrical connector.

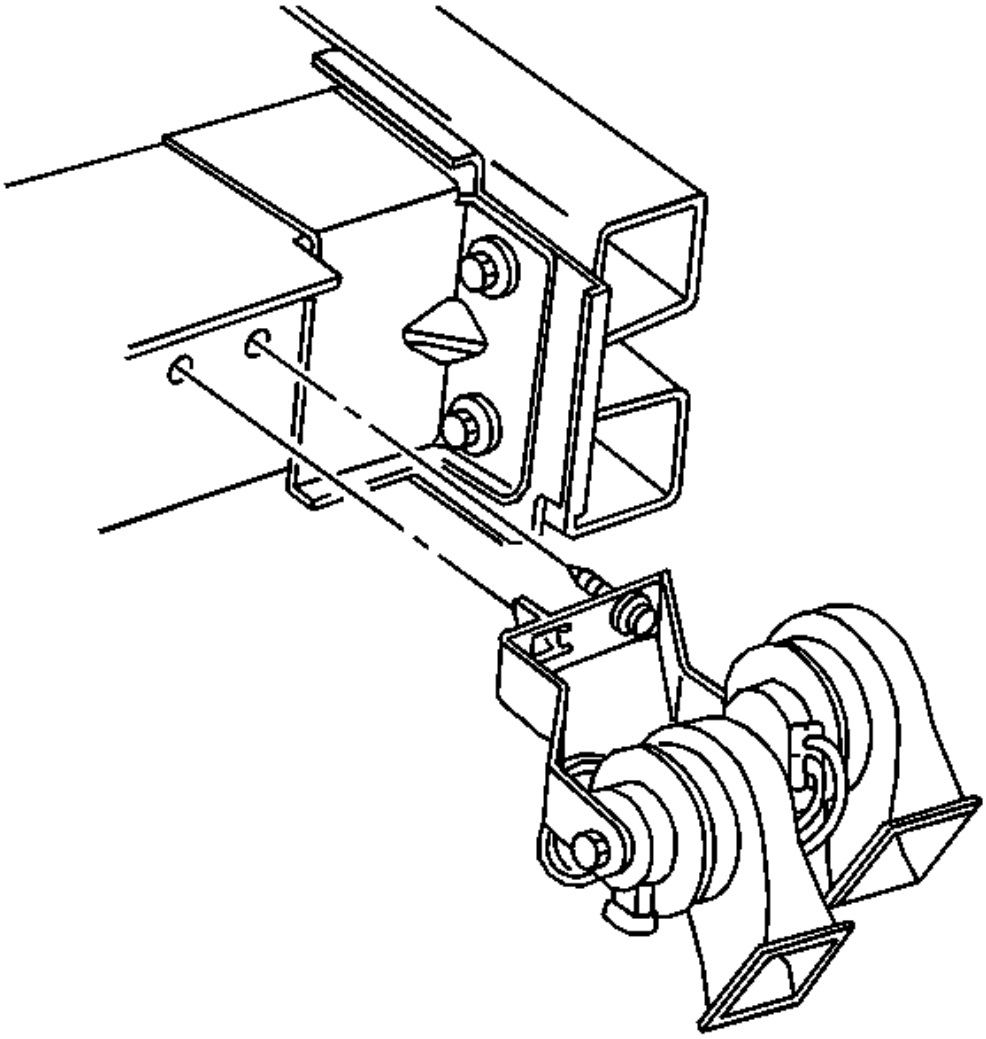


Fig. 3: Horn Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the horn bracket bolt.
5. Remove the horn from the frame rail extension.

Installation Procedure

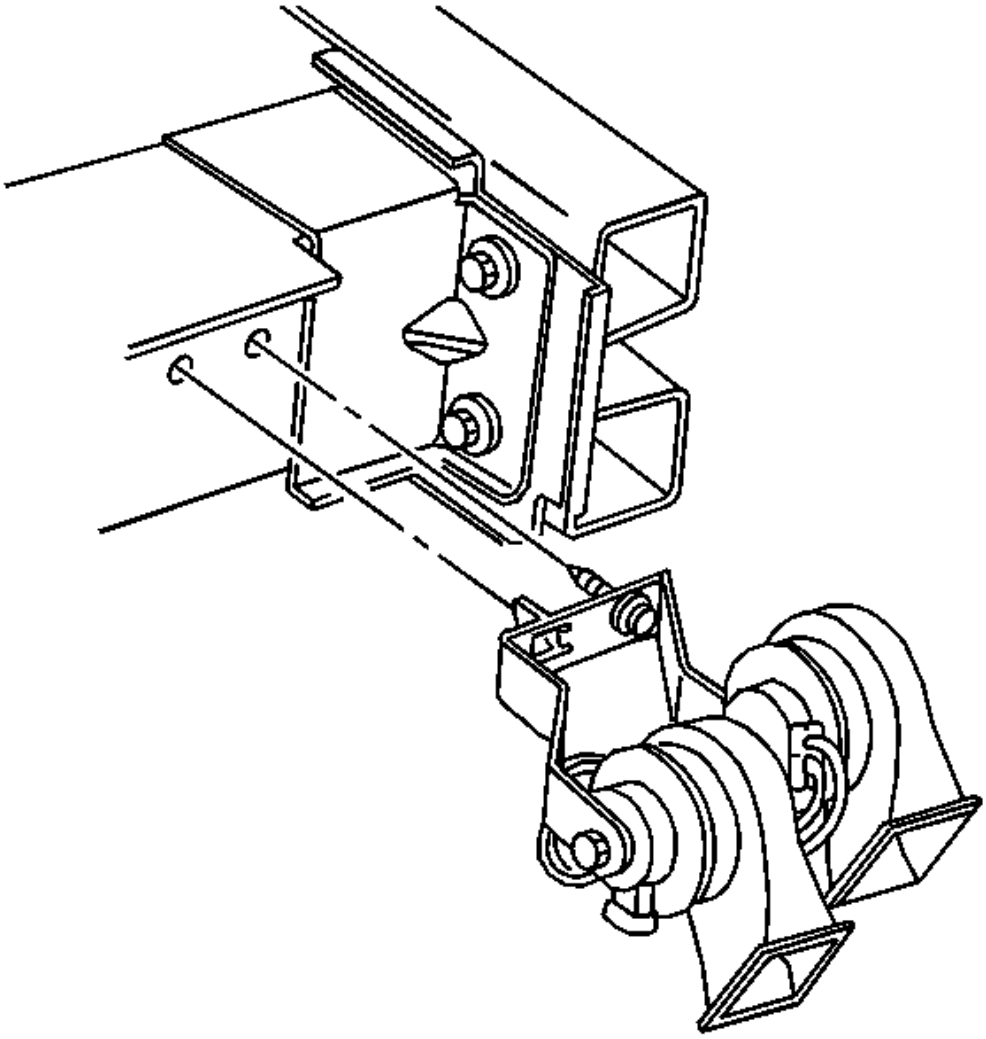


Fig. 4: Horn Bracket & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the horn to the frame rail extension and insert the horn anti-rotation tab into the slot on the frame rail.

CAUTION: **Refer to Fastener Caution .**

2. Install the horn bracket bolt.

Tighten

Tighten the bolt to 15 N.m (11 lb ft).

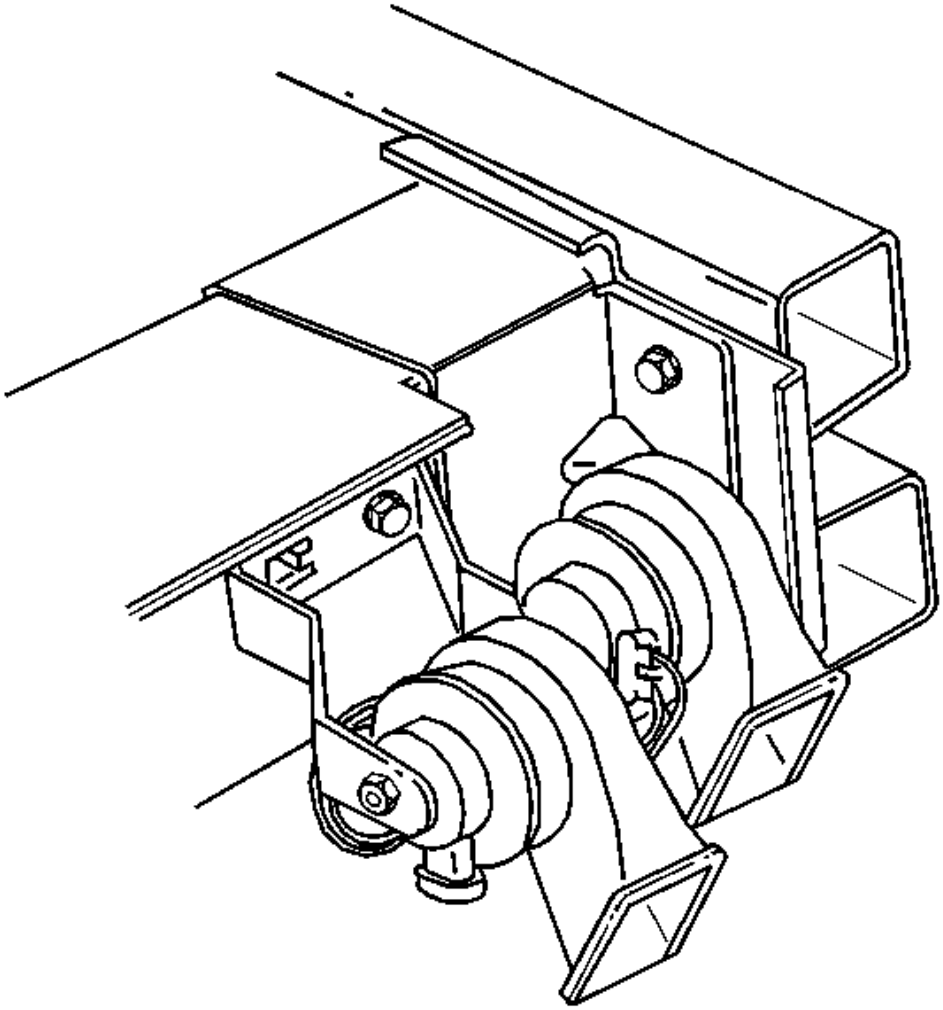


Fig. 5: Vehicle Horn
Courtesy of GENERAL MOTORS COMPANY

3. Connect the horn electrical connector.
4. Install the right headlamp. Refer to **Headlamp Replacement** .
5. Close the hood.

STEERING WHEEL HORN SWITCH REPLACEMENT

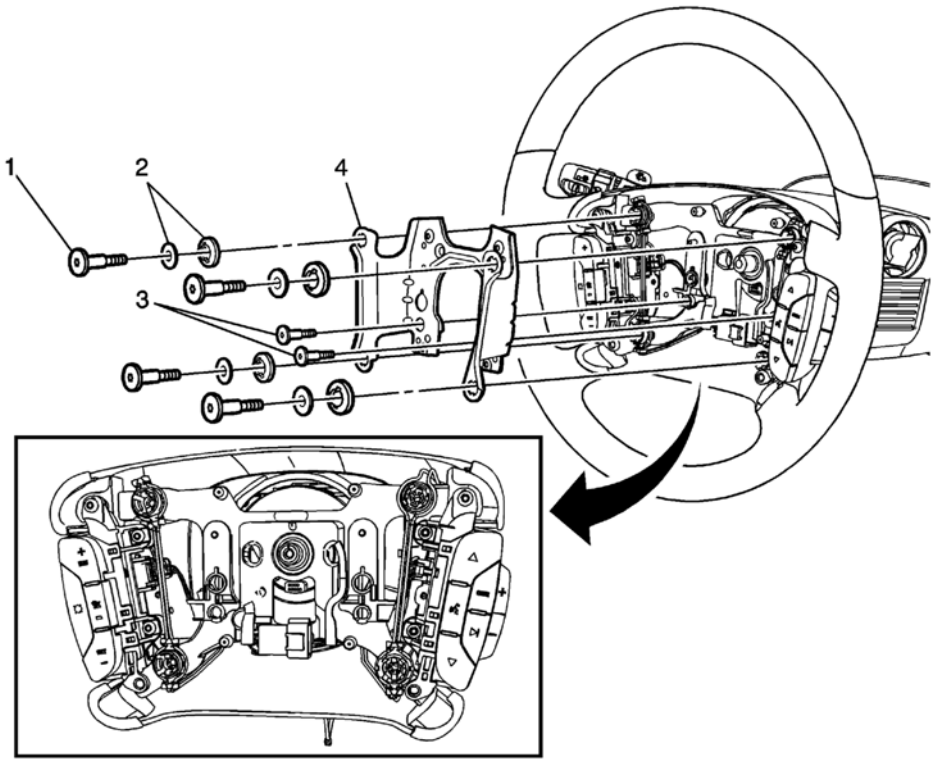


Fig. 6: Horn Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the inflatable restraint steering wheel module. Refer to **Airbag Steering Wheel Module Replacement** .	
1	Steering Wheel Horn Switch Bolts (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution** **.** **TIP:** Hand start the bolts on installation to avoid cross threading. **Tighten** 7 N.m (62 lb in)
2	Steering Wheel Horn Switch Washers (Qty: 4)
3	Steering Wheel Horn Switch Screws (Qty: 2) **TIP:** Hand start the screws on installation to avoid cross threading. **Tighten** 5 N.m (44 lb in)
4	Steering Wheel Horn Switch Assembly **TIP:** Disconnect the steering wheel horn switch electrical connector.

DESCRIPTION AND OPERATION

HORNS SYSTEM DESCRIPTION AND OPERATION

System Description

The horn system consists of the following components:

- The HORN fuse
- The Horn PCB relay
- The Horn switch contacts
- The Horn assembly
- Body control module (BCM)

System Operation

- The vehicle horns are activated whenever the horn switch is depressed.
- The BCM commands the horns ON under any of the following conditions:
  - When the panic button is depressed on the remote control door lock transmitter. For further information refer to **Keyless Entry System Description and Operation** .
  - When the content theft deterrent system detects a vehicle intrusion. For further information refer to **Theft Systems Description and Operation** .
  - When the keyless entry system is used to lock the vehicle, a horn chirp may sound to notify the driver that the vehicle has been locked. The notification feature may be enabled or disabled through personalization. For further information refer to **Keyless Entry System Description and Operation** .

Circuit Operation

Battery positive voltage is applied at all times to the horn relay coil and the horn relay switch. Pressing the horn switch applies ground to the horn relay control circuit. When the horn relay control circuit is grounded, the horn relay is energized and battery positive voltage is applied to the horns through the horn control circuit. The horns sound as long as ground is applied to the horn relay control circuit.

Article GUID: A00737214

ACCESSORIES AND EQUIPMENT

Immobilizer - Impala

SCHEMATIC WIRING DIAGRAMS

IMMOBILIZER WIRING SCHEMATICS

Immobilizer

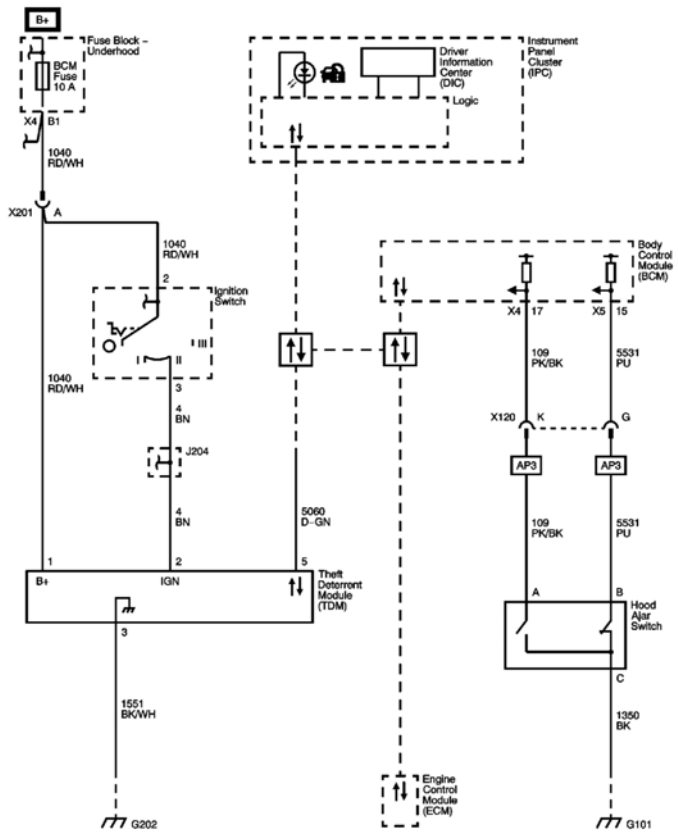


Fig. 1: Immobilizer Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B302A: TELEMATIC REQUESTED IMMOBILIZATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B302A 00

Telematic Requested Immobilization

Circuit/System Description

As part of the vehicle telematics enhanced services, a request may be sent to the theft deterrent module (TDM) to disable vehicle starting. If a valid message is received by the TDM requesting that starting be disabled, the start enable message will not be sent to the engine control module (ECM).

Conditions for Running the DTC

The TDM continuously monitors for this DTC.

Conditions for Setting the DTC

A start disable message has been received from the telematics module.

Action Taken When the DTC Sets

Vehicle starting will be suspended and the security indicator will be illuminated.

Conditions for Clearing the DTC

- A current DTC will clear when the telematics start disable request is no longer received.
- A history DTC will clear after 100 ignition cycles in which the telematic start disable request is not seen.

Diagnostic Aids

- DTC B302A is only an indicator that a start disable request has been received from the vehicle telematics system and does not indicate a fault in the immobilizer or telematics system.
- To remove the start disable request, the vehicle account must be updated with the OnStar stolen vehicle team. This will require that a law enforcement agency or the customer contact OnStar to indicate that the vehicle has been successfully and safely recovered.
- If the OnStar system has been disabled or damage during a theft attempt, the system will not be able to communicate and the start disable request will not be removed. OnStar must be functioning properly for the start disable request to be removed.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the OnStar system is not damaged and is functioning properly with no DTCs set.
    - If the OnStar system is damaged, inoperative, or any OnStar DTCs are set, these concerns must be corrected before the start disable can be removed.
2. Press the blue OnStar button and ask the advisor to be transferred to the stolen vehicle team to verify the vehicle account has been updated.
3. Very that OnStar is aware the vehicle has been recovered and that the vehicle account has been updated as such.
    - If OnStar has not been notified that the vehicle has been recovered, contact the customer and advise them that for security purposes, they must contact OnStar and the law enforcement agency to update the vehicle account.
4. After the vehicle account has been updated and the start disable request has been removed, DTC B302A will transition to a history DTC. Clear the history DTC.

DTC B3031: SECURITY SYSTEM CONTROLLER IN LEARN MODE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3031 00

Security System Controller In Learn Mode

Circuit/System Description

When learning a coded key, the theft deterrent module (TDM) is placed in learn mode. DTC B3031 will set automatically as an indicator that the system is in learn mode and not as a fault indicator. Once the coded key is learned, learn mode will be exited and the DTC cleared. If the TDM does not exit learn mode, B3031 will remain current and indicate a fault.

Conditions for Running the DTC

The immobilizer system is the learn coded keys state.

Conditions for Setting the DTC

DTC B3031 will set any time the TDM enters the learn coded keys state.

Action Taken When the DTC Sets

The security indicator will illuminate.

Conditions for Clearing the DTC

- A current DTC B3031 will be cleared upon the successful exit of learn mode.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

IMPORTANT: When performing the 10-Minute Vehicle Key Relearn Procedure, all keys not learned at that time will be erased and not be recognized. Perform the Adding Keys procedure on all keys or instruct the customer how to perform the Adding Keys procedure should all keys not be present at the time of repair.

1. Verify DTC B3055 is not set.
   - If the DTC is set, refer to **DTC B3055**.
2. Verify the scan tool TDM Learn Coded Key parameter displays Yes.
   - If not the specified value, perform the 10 Minute Vehicle Key Relearn procedure. Refer to

Replacing Keys (North America except Canada)Replacing Keys (Canada).

3. Perform the 10 Minute Vehicle Key Relearn procedure. Refer to Replacing Keys (North America except Canada)Replacing Keys (Canada). The TDM should exit the learn coded key state and DTC B3031 should clear.
    - If the TDM does not exit the learn coded key state after the programming attempt, replace the TDM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Control Module References for TDM replacement, setup and programming

DTC B3055: NO TRANSPONDER MODULATION OR NO TRANSPONDER

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B3055 00

No Transponder Modulation or No Transponder

Circuit/System Description

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coils surrounding the ignition lock cylinder. The energized transponder transmits a signal that contains its unique value, which is received by the theft deterrent module (TDM). The TDM then compares this value to a value stored in memory. This stored value is the learned key code. If the value is correct, the TDM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the learned key code does not match or a transponder value is not received, the TDM will send the start disable password to the ECM.

Conditions for Running the DTC

Ignition is in the Accessory or Run position.

Conditions for Setting the DTC

The TDM is unable to measure the ignition key transponder value.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator will be illuminated.

Conditions for Clearing the DTC

- A current DTC will be cleared when the TDM detects a valid transponder value from the ignition key.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

In some instances, RF devices attached to a keychain or otherwise in close proximity of the ignition cylinder may cause interference in the immobilizer system and lead to a no-start condition. Some common RF devices that may be attached to a keychain are Speedpass gas station payment device, swipe devices used to gain access locked gates or 24-hour gyms, or other "smart" keys.

These RF devices interfere with the communication between the transponder located in the key and the TDM. The immobilizer systems operates at a frequency of 125 kHz. RF devices that operate in the 120 to 135 kHz range, or a multiplier of these frequencies, are most likely to cause interference. If interference occurs, DTC B3055, B3060, or B3935 may be set.

If interference is suspected, removed the suspect device from the keychain and attempt to start the vehicle. If vehicle starting occurs with the device removed, instruct the customer to remove the device from the keychain to prevent further occurrences. It may also be necessary to inspect all of the customers keychains if the concern is intermittent and doesn't occur with every key.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

IMPORTANT:	• When using this diagnostic, more than one vehicle key is required to ensure proper diagnosis. If more than one key is not available at the time of service, contact the

customer and ask if any other keys can be provided for service. If unavailable, a new second key can be created.

- Interference from an RF device located on the keychain may cause this DTC to set. Remove any RF devices from the keychain before proceeding with the diagnostic.

1. Inspect all available vehicle keys that they are correct vehicle keys .
   - If not a correct vehicle key, replace the key.
2. While viewing the scan tool TDM Transponder Key parameter, turn ON the ignition with each of the available vehicle keys. The parameter should read Present with all available keys.
   - If only one key results in the parameter reading Not Present, replace the appropriate key.
   - If all available keys result in the parameter reading Not Present, replace the TDM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Replacing Keys (North America except Canada)Replacing Keys (Canada)**
- **Control Module References** for TDM replacement, setup, and programming

DTC B3060: UNPROGRAMMED TRANSPONDER IDENTIFICATION CODE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3060 00

Unprogrammed Transponder Identification Code Received

Circuit/System Description

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coils surrounding the ignition lock cylinder. The energized transponder transmits a signal that contains its unique value, which is received by the theft deterrent module (TDM). The TDM then compares this value to a value stored in memory. This stored value is the learned key code. If the value is correct, the TDM will send the prerelease password via the serial data circuit to the engine control module (ECM). If the transponder value does not match the learned key code or a transponder value is not received, the TDM will send the start disable password to the ECM.

Conditions for Running the DTC

Ignition is in the Accessory or Run position.

Conditions for Setting the DTC

The transponder value measured by the TDM is incorrect or not learned to the vehicle.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator will be illuminated.
- The security indicator will flash (Canada only).

Conditions for Clearing the DTC

- A current DTC will be cleared when the TDM detects a valid transponder value from the ignition key.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

In some instances, RF devices attached to a keychain or otherwise in close proximity of the ignition cylinder may cause interference in the immobilizer system and lead to a no-start condition. Some common RF devices that may be attached to a keychain are Speedpass gas station payment device, swipe devices used to gain access locked gates or 24-hour gyms, or other "smart" keys.

These RF devices interfere with the communication between the transponder located in the key and the TDM. The immobilizer systems operates at a frequency of 125 kHz. RF devices that operate in the 120 to 135 kHz range, or a multiplier of these frequencies, are most likely to cause interference. If interference occurs, DTC B3055, B3060, or B3935 may be set.

If interference is suspected, removed the suspect device from the keychain and attempt to start the vehicle. If vehicle starting occurs with the device removed, instruct the customer to remove the device from the keychain to prevent further occurrences. It may also be necessary to inspect all of the customers keychains if the concern is intermittent and doesn't occur with every key.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

IMPORTANT:

- When using this diagnostic, more than one vehicle key is required to ensure proper diagnosis. If more than one key is not available at the time of service, contact the customer and ask if any other keys can be provided for service. If unavailable, a new second key can be created.
- Interference from an RF device located on the keychain may cause this DTC to set. Remove any RF devices from the keychain before proceeding with the diagnostic.

1. Perform the 10-Minute Vehicle Key Relearn procedure. Refer to **Replacing Keys (North America except Canada)Replacing Keys (Canada)**.
2. While viewing the scan tool TDM Valid Key parameter, turn ON the ignition with each of the available vehicle keys. The parameter should read Yes with all available keys.
    - If not the specified value, replace the appropriate key.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Replacing Keys (North America except Canada)Replacing Keys (Canada)**
- **Control Module References** for TDM replacement, setup, and programming

DTC B3935: TRANSPONDER AUTHENTICATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3935 57

Transponder Authentication Error

Circuit/System Description

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coils surrounding the ignition lock cylinder. The energized transponder transmits a signal that contains its unique value, which is received by the theft deterrent module (TDM). The TDM then compares this value to a value stored in memory. This stored value is the learned key code. If the value is correct, the TDM will send the prerelease password via the serial data circuit to

the engine control module (ECM). If the transponder value does not match the learned key code or a transponder value is not received, the TDM will send the start disable password to the ECM.

Conditions for Running the DTC

- Ignition is in the Accessory or Run position.
- A valid transponder value has been read.

Conditions for Setting the DTC

- The transponder value is valid and matches the value stored in the TDM memory.
- The transponder calculation to the challenge from the TDM does not match the TDM calculation.

Action Taken When the DTC Sets

- Vehicle starting will be disabled.
- The security indicator will be illuminated.

Conditions for Clearing the DTC

- A current DTC will be cleared when a valid transponder value has been read and authenticated.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

In some instances, RF devices attached to a keychain or otherwise in close proximity of the ignition cylinder may cause interference in the immobilizer system and lead to a no-start condition. Some common RF devices that may be attached to a keychain are Speedpass gas station payment device, swipe devices used to gain access locked gates or 24-hour gyms, or other "smart" keys.

These RF devices interfere with the communication between the transponder located in the key and the TDM. The immobilizer systems operates at a frequency of 125 kHz. RF devices that operate in the 120 to 135 kHz range, or a multiplier of these frequencies, are most likely to cause interference. If interference occurs, DTC B3055, B3060, or B3935 may be set.

If interference is suspected, removed the suspect device from the keychain and attempt to start the vehicle. If vehicle starting occurs with the device removed, instruct the customer to remove the device from the keychain to prevent further occurrences. It may also be necessary to inspect all of the customers keychains if the concern is intermittent and doesn't occur with every key.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

IMPORTANT: Interference from an RF device located on the keychain may cause this DTC to set. Remove any RF devices from the keychain before proceeding with the diagnostic.

Replace the suspected inoperative or malfunctioning key. DTC B3935 should not reset and the vehicle should start.

- If the replacement key results in the resetting of DTC B3935, replace the TDM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Replacing Keys (North America except Canada)Replacing Keys (Canada)**
- **Control Module References** for theft deterrent module replacement, setup, and programming

DTC B3976: UNCONFIGURED TRANSPONDER/VEHICLE CONFIGURATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3976 46

Unconfigured Transponder/Vehicle Configuration Not Programmed

Circuit/System Description

When the theft deterrent module (TDM) is in the learn coded key state, the TDM checks the current key to ensure it has been configured as a proper vehicle key.

Conditions for Running the DTC

- Ignition is in the Accessory or Run position.
- The TDM is in the learn coded key state.

Conditions for Setting the DTC

The TDM has determined the current key is not configured as a proper vehicle key.

Action Taken When the DTC Sets

- The security indicator will be illuminated.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

- A current DTC will be cleared when the TDM detects a properly configured vehicle key.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

IMPORTANT: When using this diagnostic, more than one vehicle key is required to ensure proper diagnosis. If more than one key is not available at the time of service, contact the customer and ask if any other keys can be provided for service. If unavailable, a new second key can be created.

While viewing DTCs with a scan tool, attempt to start the vehicle using all of the available keys. The vehicle should start with all available keys.

- If any key results in inoperative starting and DTC B3976 is set, replace the appropriate key.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Replacing Keys (North America except Canada)Replacing Keys (Canada)

DTC P0513: THEFT DETERRENT KEY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0513

Theft Deterrent Key Incorrect

Circuit/System Description

The theft deterrent module (TDM) sends the prerelease password to the engine control module (ECM) via the serial data circuit. The ECM then sends a challenge to the TDM. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

Conditions for Running the DTC

Ignition is in the ACCESSORY or RUN position.

Conditions for Setting the DTC

The calculated response from the TDM does not equal the calculation performed by the ECM.

Action Taken When the DTC Sets

- The security indicator will illuminate.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

- A current DTC P0513 will be cleared when a valid calculation is received.
- A history DTC will be cleared after 40 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

The "key" referenced in the DTC descriptor does not refer to the vehicle key. In this case, "key" is referring to the challenge response.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the following BCM DTCs are not present:
    - U1814
    - U2099
    - B1428
    - B1370
    - B1380
    - B1440
    - B1441
    - If any listed DTC is present, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** to diagnose that DTC prior to this diagnostic.

    IMPORTANT: Because of normal system communications between the TDM and ECM, any theft deterrent B-codes must be diagnosed prior to the diagnosis of P-codes.

2. Perform the 10-Minute Immobilizer Relearn procedure. Refer to **Immobilizer System Component Programming**. The ECM should successfully complete the password learn and the vehicle should start.
    - If the ECM does not complete the learn or vehicle starting remains disabled, replace the ECM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, setup, and programming

DTC P0633: THEFT DETERRENT KEY NOT PROGRAMMED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0633

Theft Deterrent Key Not Programmed

Circuit/System Description

When learning the prerelease password, as well as the challenge and response sequence, the engine control module (ECM) is placed in learn mode. DTC P0633 will set automatically as an indicator that the system is in learn mode and not as a fault indicator. Once the password and challenge/response are learned, learn mode will be exited when the engine is successfully started. If the ECM does not exit learn mode, P0633 will remain current and indicate a fault.

Conditions for Running the DTC

The ECM is in learn mode.

Conditions for Setting the DTC

DTC P0633 will set any time the ECM enters learn mode.

Action Taken When the DTC Sets

The security indicator will illuminate.

Conditions for Clearing the DTC

- A current DTC P0633 will be cleared upon a successful engine start after exit of learn mode.
- A history DTC will be cleared after 100 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

The "key" referenced in the DTC descriptor does not refer to the vehicle key. In this case, "key" is referring to the challenge response.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Because of normal system communications between the TDM and ECM, any theft deterrent B-codes must be diagnosed prior to the diagnosis of P-codes.

IMPORTANT: DTC P0633 will clear upon a successful engine start. Any malfunction that will cause a no-start condition will prevent DTC P0633 from clearing. Prior to diagnosing DTC P0633, ensure that all power moding and engine control systems are operating properly and all conditions that may cause a no-start have been corrected. Do not replace the ECM. Replacing the ECM will not correct the no-start condition.

1. Ignition in the CRANK position, verify the scan tool Ignition Run/Crank parameter is Active.
   - If not the specified value, refer to **Power Mode Mismatch** .
2. Perform the 10-Minute Immobilizer Relearn procedure. Refer to **Immobilizer System Component Programming**. The ECM should successfully complete the password learn and the vehicle should start.
   - If the ECM does not complete the learn or vehicle starting remains disabled, an undiagnosed no-start condition exists. Refer to the appropriate subsection and diagnostic to correct the no-start condition.

DTC P1629: THEFT DETERRENT FUEL ENABLE SIGNAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1629

Theft Deterrent Fuel Enable Signal Not Received

Circuit/System Description

The theft deterrent module (TDM) sends the prerelease password to the engine control module (ECM) via the serial data circuit. The ECM then sends a challenge to the TDM. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

Conditions for Running the DTC

- Ignition is in the ACCESSORY or RUN position.
- The ECM is not in learn mode.

Conditions for Setting the DTC

The ECM receives does not receive the challenge response from the TDM within the required amount of time.

Action Taken When the DTC Sets

The security indicator will illuminate.

Conditions for Clearing the DTC

- A current DTC P1629 will be cleared when a challenge response is received.
- A history DTC will be cleared after 40 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

DTC P1629 is an indicator that the challenge/response was not received within the required time. This does not necessarily indicate a fault is present with the TDM or ECM. Factors such as a long engine crank, a delay in the serial data communication, or B-codes set in the TDM will cause DTC P1629 to set. This DTC should not be used as a fault indicator, but rather as a symptom to assist in the diagnosis of these other systems.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

DTC P162B: REMOTE VEHICLE SPEED LIMITING SIGNAL MESSAGE COUNTER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P162B

Remote Vehicle Speed Limiting Signal Message Counter Incorrect

Circuit/System Description

When a remote slow-down request is sent from OnStar, the vehicle communication interface module sends a serial data message to the engine control module (ECM) indicating that reduced vehicle speed has been requested. Once the request is active, the ECM begins reducing engine torque to match requested vehicle speed and the REDUCED ENGINE POWER message is displayed.

Conditions for Running the DTC

- The engine run time is greater than 5 s.
- A remote slow-down request is received by the ECM.

Conditions for Setting the DTC

- The VIN embedded in the slow-down request does not match the VIN stored in the ECM.
- The rolling code counter embedded in the slow-down request does not increment for ten consecutive messages.

Action Taken When the DTC Sets

- ECM ignores all reduced vehicle speed request messages from the vehicle communication interface module.
- The ECM stores DTC P162B in history.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear after 40 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Remote Vehicle Speed Limiting Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the vehicle is equipped with OnStar (RPO UE1) and DTC P162B is set
   - **If the vehicle is not equipped with OnStar (RPO UE1) and DTC P162B is set**

     Replace the ECM.

   - **If the vehicle is equipped with OnStar (RPO UE1) and DTC P162B is set**
2. Perform the Stolen Vehicle Slow-Down Reset procedure with the scan tool.
3. Verify DTC P162B is not set.
   - **If DTC P162B is set**
   1. Reprogram the ECM. Refer to **Control Module References** .
   2. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.
      - If the DTC sets, replace the ECM. If the DTC continues to set after ECM replacement, replace the vehicle communication interface module.
      - If the DTC does not set
   3. All OK.
   - **If DTC P162B is not set**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for vehicle communication interface module and ECM replacement, programming, and setup

DTC P1631: THEFT DETERRENT FUEL ENABLE SIGNAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1631

Theft Deterrent Fuel Enable Signal Not Correct

Circuit/System Description

The theft deterrent module (TDM) sends the prerelease password to the engine control module (ECM) via the serial data circuit. The ECM then sends a challenge to the TDM. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

Conditions for Running the DTC

Ignition is in the ACCESSORY or RUN position.

Conditions for Setting the DTC

The ECM receives an incorrect prerelease password from the TDM.

Action Taken When the DTC Sets

- The security indicator will illuminate.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

- A current DTC P1631 will be when a correct fuel enable password is received.
- A history DTC will be cleared after 40 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

IMPORTANT: Because of normal system communications between the TDM and ECM, any theft deterrent B-codes must be diagnosed prior to the diagnosis of P-codes.

Perform the 10-Minute Immobilizer Relearn procedure. Refer to **Immobilizer System Component Programming**. The ECM should successfully complete the password learn and the vehicle should start.

- If the ECM does not complete the learn or vehicle starting remains disabled, replace the ECM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, setup and programming

DTC P1632: THEFT DETERRENT FUEL DISABLE SIGNAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1632

Theft Deterrent Fuel Disable Signal Received

Circuit/System Description

The theft deterrent module (TDM) sends the prerelease password to the engine control module (ECM) via the serial data circuit. The ECM then sends a challenge to the TDM. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

Conditions for Running the DTC

Ignition is in the RUN position.

Conditions for Setting the DTC

A fuel disable signal from the TDM is received by the ECM.

Action Taken When the DTC Sets

- The security indicator will illuminate.
- Vehicle starting will be disabled.

Conditions for Clearing the DTC

- A current DTC P1632 will be when a valid calculation is received.
- A history DTC will be cleared after 40 malfunction-free ignition cycles or when a scan tool is used to clear DTCs.

Diagnostic Aids

The prerelease password sent to the ECM by the TDM is reliant on the communications between the transponder located in the vehicle key and the TDM. Failure to establish communications or an interruption in the communications between the vehicle key and the TDM will cause the fuel disable message to be sent and the setting of DTC B1632. DTC B3055 or B3060 will be set in the TDM. To properly diagnose DTC P1632, DTC B3055 or B3060 must be diagnosed and corrected first.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

IMPORTANT: Because of normal system communications between the TDM and ECM, any theft deterrent B-codes must be diagnosed prior to the diagnosis of P-codes.

Perform the 10-Minute Immobilizer Relearn procedure. Refer to **Immobilizer System Component Programming**. The ECM should successfully complete the password learn and the vehicle should start.

- If the ECM does not complete the learn or vehicle starting remains disabled, replace the ECM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for ECM replacement, setup and programming

SYMPTOMS - IMMOBILIZER

IMPORTANT: The following steps must be completed before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data links.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Immobilizer Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the systems. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to **OnStar Stolen Vehicle Slowdown Active** to diagnose the symptom.

ONSTAR STOLEN VEHICLE SLOWDOWN ACTIVE

Diagnostic Instructions

NOTE: **This procedure is not used in Brazil.**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

When a remote slow-down request is sent from OnStar, the vehicle communication interface module sends a serial data message to the engine control module (ECM) indicating that reduced vehicle speed has been requested. Once the request is active, the ECM begins reducing engine torque to match requested vehicle speed and the REDUCED ENGINE POWER message is displayed.

Reference Information

Schematic Reference

OnStar/Telematics Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Remote Vehicle Speed Limiting Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify the vehicle is not in the OnStar initiated Stolen Vehicle Slowdown mode. Verify the scan tool ECM Reduced Engine Power History parameter is not Spd Limit Active.

- If the parameter is Spd Limit Active, perform the scan tool VCIM Stolen Vehicle Slowdown Clear. When the Stolen Vehicle Slowdown Clear is complete, press the blue OnStar button and inform the advisor that you need to be transferred to the stolen vehicle team to update the vehicle account.

REPAIR INSTRUCTIONS

THEFT DETERRENT MODULE REPLACEMENT

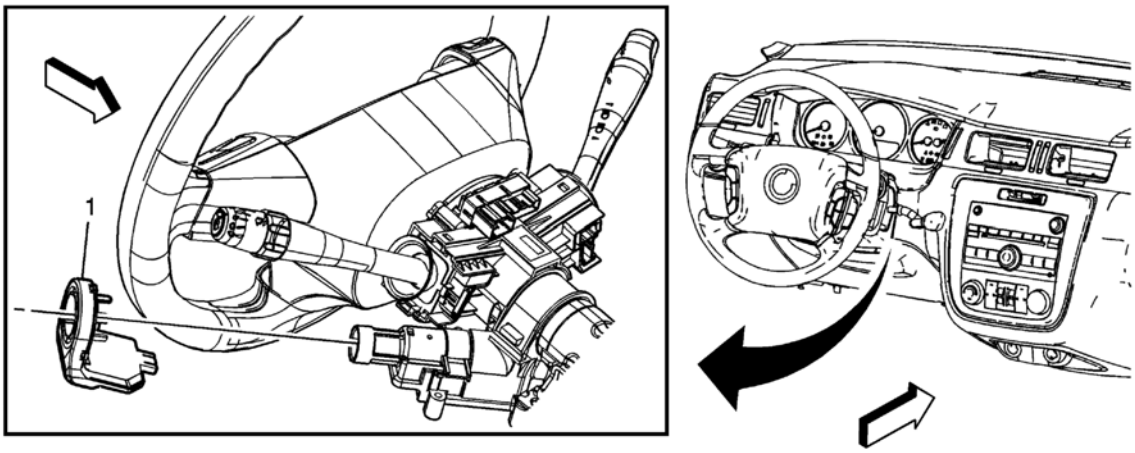


Fig. 2: Theft Deterrent Control Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement** .	
1	Theft Deterrent Module **Procedure** 1. Disconnect the electrical connector. 2. Refer to **Control Module References** for programming and set up procedures.

IMMOBILIZER SYSTEM COMPONENT PROGRAMMING

10-Minute Immobilizer Relearn

This 10-minute relearn procedure will relearn the prerelease password and the challenge/response data between the theft deterrent module (TDM) and the engine control module (ECM).

1. Connect a scan tool to the vehicle and to the TIS terminal.
2. Turn ON the ignition, with the engine OFF.
3. Ensure that all power consuming devices are turned OFF on the vehicle.
4. On the Techline Terminal, select Service Programming System and follow the Techline Terminal on-screen instructions. Go to TDM Theft Deterrent Module from the controller list and select the appropriate on-screen calibration options.
5. After the programming has completed, turn the ignition OFF for 30 seconds.
6. Turn ON the ignition with the engine OFF.
7. On the TIS terminal, select Service Programming System and follow the TIS terminal on-screen

instructions. Ensure the correct programming selection is chosen based on component being replaced or programmed. For this procedure, go to the V.T.D. Vehicle Theft Deterrent Learn menu and choose the Vehicle Theft Deterrent Learn, ECM, or PK3 Replaced selection.

8. At this point the vehicle must remain connected for the duration of the 10-minute relearn procedure.

IMPORTANT:

- Actual programming time may be as long as 12 Minutes. The first 2 minutes allow the scan tool to initialize the appropriate control module. The remaining 10 minutes is the relearn timer.
- On some vehicles, the security indicator may be illuminated for the duration of the 10-minute relearn procedure.

9. After approximately 10 minutes the TIS terminal will display "Programming Successful, Turn OFF Ignition". The vehicle is now ready to relearn the key information and/or the passwords on the next ignition switch transition from OFF to CRANK.
10. Turn OFF the ignition and wait 2 minutes.
11. With a master vehicle key, turn the ignition to the RUN position for 15 seconds, then start the vehicle. The TDM and ECM have now relearned the pre-release password and the challenge/response data.
12. With a scan tool, clear any DTCs.

ADDING KEYS

North America

NOTE:

- **To initiate, this procedures requires that a learned master key be available.**
- **A total of 10 keys may be programmed to a single vehicle.**
- **This procedure adds keys only. The procedure does not erase previously learned keys.**
- **The keys to be learned must duplicate the mechanical cut of the current key.**

1. With a learned master key, turn ON the ignition, with the engine OFF.
2. Turn OFF the ignition and remove the key.
3. Within 10 seconds of turning OFF the ignition, insert the key to be learned and turn ON the ignition. The vehicle has now learned the new key.

Except North America

NOTE:

- **To initiate, this procedures requires that two learned master keys be available.**
- **A total of 10 keys may be programmed to a single vehicle.**
- **This procedure adds keys only. The procedure does not erase previously learned keys.**
- **The keys to be learned must duplicate the mechanical cut of the current key.**

1. With a learned master key, turn ON the ignition, with the engine OFF.
2. Turn OFF the ignition and remove the key.
3. With a second learned master key, turn ON the ignition, with the engine OFF.
4. Within 10 seconds of turning OFF the ignition, insert the key to be learned and turn ON the ignition. The vehicle has now learned the new key.

REPLACING KEYS (NORTH AMERICA EXCEPT CANADA)

10-Minute Vehicle Key Relearn

IMPORTANT: This procedure will only relearn the vehicle keys. This procedure will not learn the immobilizer prerelease password or the challenge/response data. Do not use this procedure as a substitute for a 10-minute relearn when replacing or reprogramming a theft deterrent module (TDM) or engine control module (ECM). Doing so will result in a failure to learn the pre-release password and/or the challenge/response data.

This 10-minute learn procedure should be used when all vehicle keys are desired to be replaced or reprogrammed. This procedure will erase all previously learned vehicle keys from the TDM. Once the 10-minute learn procedure has been completed, any remaining vehicle keys may be programmed using the Adding Keys procedure to ensure their continued functionality.

1. Connect a scan tool to the vehicle in the pass-thru arrangement.
2. Turn ON the ignition, with the engine OFF.
3. Ensure that all power consuming devices are turned OFF on the vehicle.
4. On the Techline Terminal, select Service Programming System and follow the Techline Terminal on-screen instructions, using the Pass-Thru method. Ensure the correct programming selection is chosen based on component being replaced or programmed. For this procedure, go to the V.T.D. Vehicle Theft Deterrent Learn menu and choose the Vehicle Theft Deterrent Learn for Learning Replacement Keys selection.
5. At this point the scan tool must remain connected for the duration of the 10-minute relearn procedure.

IMPORTANT:

- The scan tool will initially display 12 Minutes. The first 2 minutes allow the scan tool to initialize the appropriate control module. The remaining 10 minutes is the relearn timer.
- On some vehicles the security indicator may be illuminated for the duration of the 10-minute relearn procedure.

6. Observe the scan tool, after approximately 10 minutes the scan tool will display "Programming Successful, Turn OFF Ignition". The vehicle is now ready to relearn the key information and/or the passwords on the next ignition switch transition from OFF to CRANK.
7. Turn OFF the ignition and wait 2 minutes.
8. With a master vehicle key, turn the ignition to the RUN position for 15 seconds, then start the vehicle. The TDM has now learned the key transponder information.
9. With a scan tool, clear any DTCs.

30-Minute Vehicle Key Relearn

IMPORTANT: This procedure will only relearn the vehicle keys. This procedure will not learn the immobilizer prerelease password or the challenge/response data. Do not use this procedure as a substitute for a 10-minute relearn when replacing or reprogramming a TDM or ECM. Doing so will result in a failure to learn the prerelease password and/or the challenge/response data.

This 30-minute learn procedure should be used when all vehicle keys are desired to be replaced or reprogrammed. This procedure will erase all previously learned vehicle keys from the TDM. Once the 30-minute learn procedure has been completed, any remaining vehicle keys may be programmed using the Adding Keys procedure to ensure their continued functionality.

1. With an unlearned master vehicle key, turn ON the ignition, with the engine OFF.
2. Observe the security indicator, after approximately 10 minutes the telltale will turn off.
3. Turn OFF the ignition, and wait 5 seconds.
4. Repeat steps 1-3 two more times for a total of 3 cycles or 30 minutes.

IMPORTANT: The TDM learns the key transponder information upon the ignition switch transition from OFF to ON. You must turn the ignition OFF before attempting to start the vehicle.

5. With a master vehicle key, start the vehicle. The vehicle has now learned the key transponder information.
6. If additional keys are required to be learned, refer to **Adding Keys**.
7. With a scan tool, clear any DTCs.

REPLACING KEYS (CANADA)

10-Minute Vehicle Key Relearn

IMPORTANT: This procedure will only relearn the vehicle keys. This procedure will not learn the immobilizer prerelease password or the challenge/response data. Do not use this procedure as a substitute for a 10-minute relearn when replacing or reprogramming a theft deterrent module (TDM) or engine control module (ECM). Doing so will result in a failure to learn the pre-release password and/or the challenge/response data.

This 10-minute learn procedure should be used when all vehicle keys are desired to be replaced or reprogrammed. This procedure will erase all previously learned vehicle keys from the TDM. Once the 10-minute learn procedure has been completed, any remaining vehicle keys may be programmed using the Adding Keys procedure to ensure their continued functionality.

1. Connect a scan tool to the vehicle in the pass-thru arrangement.
2. Turn ON the ignition, with the engine OFF.
3. Ensure that all power consuming devices are turned OFF on the vehicle.
4. On the Techline Terminal, select Service Programming System and follow the Techline Terminal on-screen instructions, using the Pass-Thru method. Ensure the correct programming selection is chosen based on component being replaced or programmed. For this procedure, go to the VTD Vehicle Theft Deterrent Learn menu and choose the Vehicle Theft Deterrent Learn for Learning Replacement Keys selection.
5. At this point the scan tool must remain connected for the duration of the 10-minute relearn procedure.

IMPORTANT:

- The scan tool will initially display 12 Minutes. The first 2 minutes allow the scan tool to initialize the appropriate control module. The remaining 10 minutes is the relearn timer.
- On some vehicles the security indicator may be illuminated for the duration of the 10-minute relearn procedure.

6. Observe the scan tool, after approximately 10 minutes the scan tool will display "Programming Successful, Turn OFF Ignition". The vehicle is now ready to relearn the key information and/or the passwords on the next ignition switch transition from OFF to RUN.
7. Turn OFF the ignition and wait 2 minutes.
8. With a master vehicle key, turn the ignition to the RUN position for 15 seconds, then start the vehicle. The TDM has now learned the key transponder information.
9. With a scan tool, clear any DTCs.

DESCRIPTION AND OPERATION

IMMOBILIZER DESCRIPTION AND OPERATION

The immobilizer system functions are provided by the theft deterrent module (TDM) and the engine control module (ECM). When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coil surrounding the ignition lock cylinder. This exciter coil is part of the TDM. The energized transponder transmits a signal that contains its unique value, which is received by the TDM. The TDM then compares this value to a value stored in memory. If the values match, the TDM will send the prerelease password via the serial data circuit to the ECM. If the transponders unique value is incorrect, the TDM will send the fuel disable password to the ECM.

When the ECM receives the TDM prerelease password, the ECM will challenge the password. The ECM sends this challenge back to the TDM via the serial data circuit. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

The components of the theft system are as follows:

- TDM
- ECM
- Ignition key (Transponder)
- Security indicator

Theft Deterrent Module (TDM)

Vehicles with steering column mounted ignition switches have the exciter integral with the theft deterrent module (TDM), which is located within the steering column. The TDM can learn up to 10 keys (transponder values).

The TDM uses the following inputs:

- Battery voltage

- Ignition switched voltage
- Ground circuit

The theft deterrent control module uses the following outputs:

- Password exchange
- Challenge/response with the engine control module (ECM)

When an ignition key is inserted into the ignition lock cylinder and the ignition is switched ON, the transponder embedded in the head of the key is energized by the exciter coils surrounding the ignition lock cylinder. The energized transponder transmits a signal that contains its unique value, which is received by the TDM. The TDM then compares this value to the learned key code stored in memory. The TDM then performs one of the following functions:

- If the transponder value matches the values stored in the TDM memory, the TDM will send the prerelease password to the ECM via the serial data circuit.
- If the transponders unique value does not match the value stored in the TDM, the TDM will send the fuel disable message to the ECM via the serial data circuit.
- If the TDM is unable to measure the ignition key transponder value, the TDM will not send any messages to the ECM.

Engine Control Module (ECM)

When the engine control module (ECM) receives the theft deterrent module (TDM) prerelease password, the ECM will challenge the password. The ECM sends this challenge back to the TDM via the serial data circuit. Both the ECM and TDM perform a calculation on this challenge. If the calculated response from the TDM equals the calculation performed by the ECM, the ECM will allow vehicle starting.

The ECM will disable vehicle starting if any of the following conditions occur:

- The prerelease password is invalid.
- The fuel disable password is sent by the TDM.
- No passwords are received. There is no communication with the TDM.
- The TDM calculated response to the challenge does not equal the calculation performed by the ECM.

The Ignition Key (Transponder)

NOTE: **The ignition key will be stamped with a + or a + surrounded by a circle. This symbol only identifies the key as a PassKey III+ transponder key and is not a reliable way to determine if a particular key is the correct key for a vehicle. Service parts may have a different stamped symbol than the production part. The only way to determine the proper key for a vehicle is by referencing the parts catalog.**

The ignition key for PassKey III+ (PK3+) equipped vehicles is a standard ignition key with a transponder located in the plastic head of the key. The transponder value is fixed and unable to be changed. The immobilizer system uses the ignition key transponder value to determine if a valid ignition key is being used to start the vehicle. There are approximately 3 trillion possible transponder values. There are no visible electrical contacts.

The immobilizer system use the following types of ignition keys:

Master Keys

Master keys have a black plastic head for full access operation of the vehicle. Master keys may perform the following functions:

- Start the vehicle.
- Lock/unlock all of the door locks and rear compartment.
- Lock/unlock all of the storage compartments.

Valet Keys

IMPORTANT: Valet keys are NOT standard equipment on all GM vehicle lines.

Valet keys have a gray plastic head and are for restricted operation of the vehicle. Valet keys may perform the following functions:

- Start the vehicle.
- Lock/unlock all of the door locks.

Fleet Keys

IMPORTANT: Fleet keys are NOT standard equipment on all GM vehicle lines.

Fleets keys allow full access to the vehicle just as a master key would. However, unlike a master key which may only learn 10 keys to a particular vehicle, an unlimited number of fleet keys may be learned to the vehicle. Fleet keys are only used in vehicles configured for fleet use with RPO 6E2 or 6E8.

- Start the vehicle.
- Lock/unlock all of the door locks and rear compartment.
- Lock/unlock all of the storage compartments.

Security Indicator

The theft deterrent module (TDM) can command the instrument panel cluster (IPC) to illuminate the security indicator only when the ignition key is in the ON position. The TDM will command the security indicator be illuminated any time a fault is noted in the immobilizer system and when the engine starting is disabled.

REMOTE VEHICLE SPEED LIMITING DESCRIPTION AND OPERATION

Certain vehicles equipped with OnStarÂ® now have an additional feature that allows for remote limiting of the vehicle's speed. This OnStarÂ® feature is called Stolen Vehicle Slow-Down and is now part of the OnStarÂ® Stolen Vehicle Assistance service. This feature, when used in conjunction with local law enforcement and strict guidelines at the OnStarÂ® Call Center, will slow the vehicle by interacting with the engine control system.

When the engine control system receives a valid request from the OnStarÂ® telematics communications interface module, it will enter into a reduced engine power/vehicle speed limiting mode, which will decelerate the vehicle. Once the request is active the engine control module begins reducing engine torque to match

requested vehicle speed and a REDUCED ENGINE POWER indication is displayed. No DTCs will be set during this process.

Article GUID: A00737203

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Door Armrest Bracket Screws	10 N.m	89 lb in
Door Check Link	25 N.m	18 lb ft
Door Hinge Bolts	33 N.m	24 lb ft
Door Lock Striker Screws	25 N.m	18 lb ft
Door Rear Energy Absorbers Pad Screw	2 N.m	18 lb in
Front Door Lock Actuator Screws	2 N.m	18 lb in
Intermediate Door Hinge Bolts	33 N.m	24 lb ft
Lock Screws- Front Door	10 N.m	89 lb in
Lock Screws- Rear Door	10 N.m	89 lb in
Outside Handle Bolts- Front Door	10 N.m	89 lb in
Outside Handle Bolts- Rear Door	10 N.m	89 lb in
Rear Door Lock Actuator Screws	2 N.m	18 lb in

SCHEMATIC WIRING DIAGRAMS

DOOR LOCK/INDICATOR WIRING SCHEMATICS

Door Lock Switches

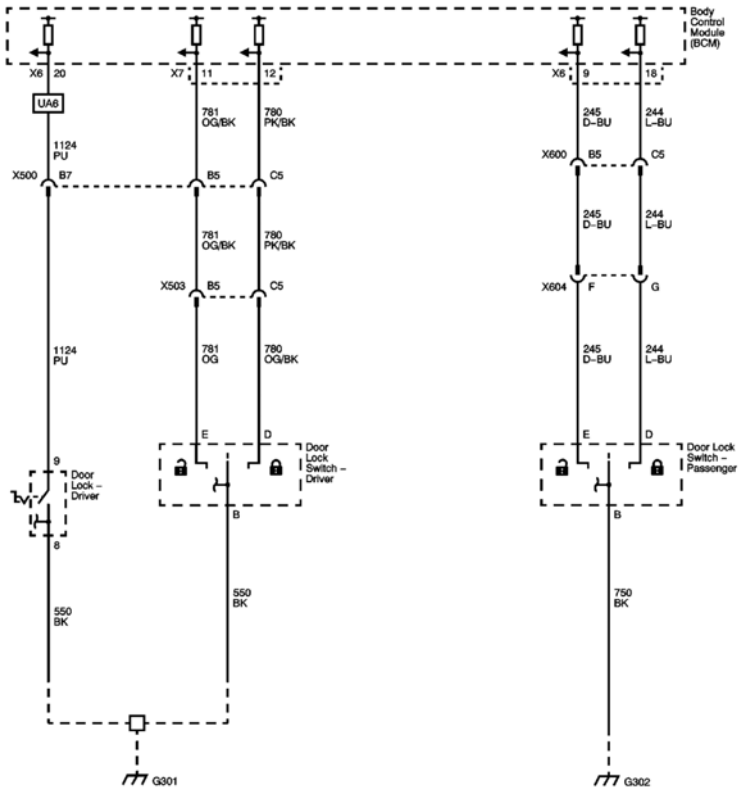


Fig. 1: Door Lock Switches Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Door Lock Actuators

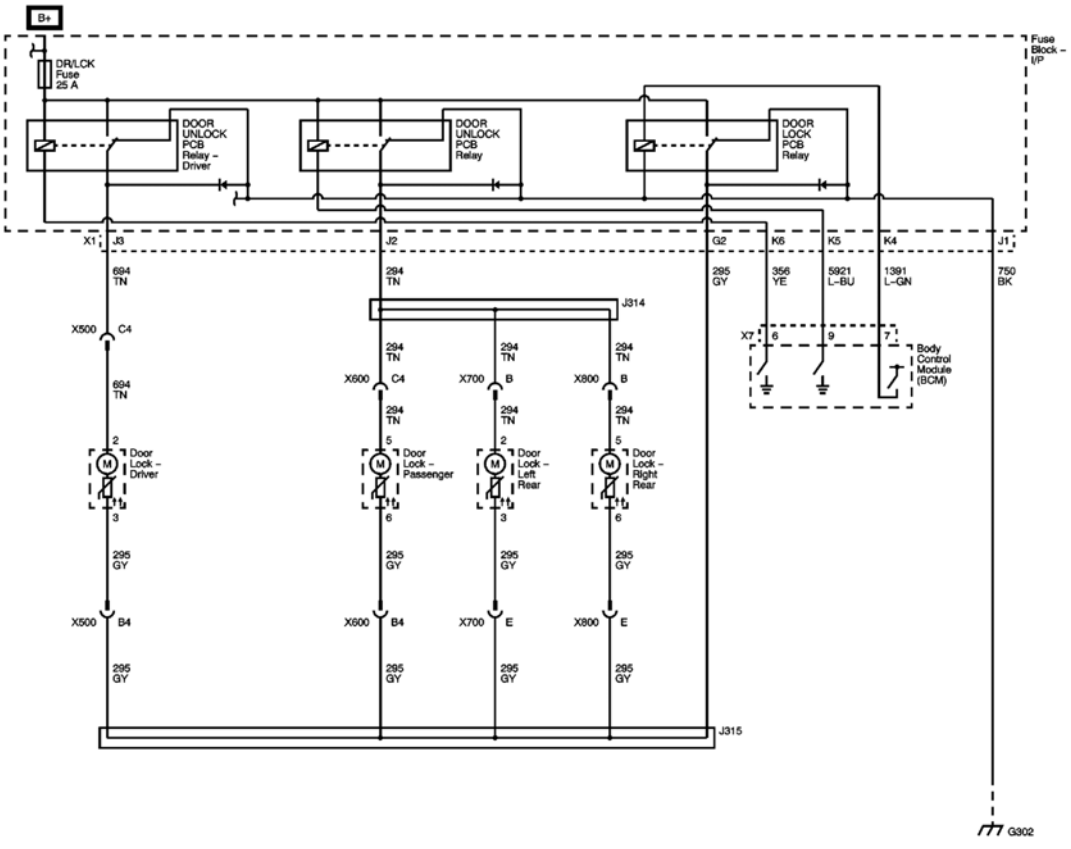


Fig. 2: Door Lock Actuators Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

Door Ajar Indicators

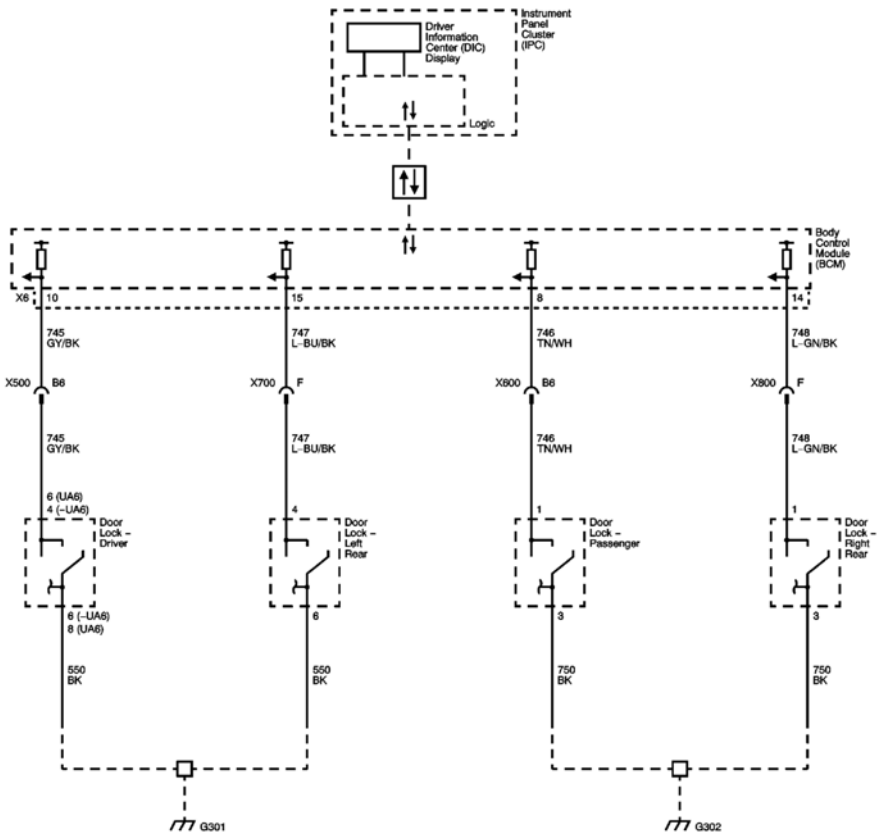


Fig. 3: Door Ajar Indicators Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

RELEASE SYSTEMS WIRING SCHEMATICS

Release Systems

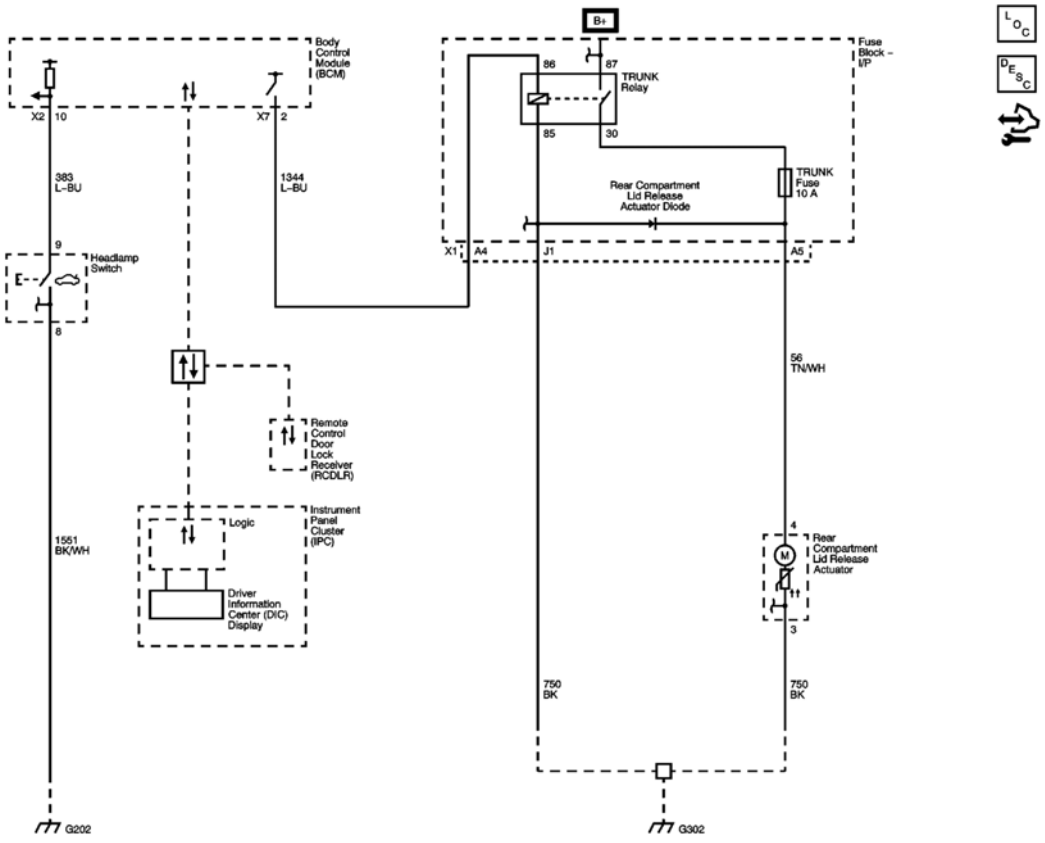


Fig. 4: Release Systems Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B2976: DRIVER DOOR AJAR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2976 00

Driver Door Ajar Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B2976 00	1	1	-
Ground	-	1	-	-
1. Door Ajar Indicator Inoperative When Driver Door Is Open				

Circuit/System Description

The body control module (BCM) provides a 12V signal to each of the door ajar switch signal circuit. The door ajar switches are normally open when the door is fully closed. When a door is opened, the door ajar switch contacts close providing a path to ground. The driver information center (DIC) displays ajar icon when the BCM detects that one or more of the doors are open. The instrument panel cluster (IPC) receives a serial data message from the BCM indicating the door ajar status.

Conditions for Running the DTC

The system voltage is 9-16 volts.

Conditions for Setting the DTC

The BCM detects a short to ground in the driver door ajar circuit for longer than 10 minutes.

Action Taken When the DTC Sets

The ajar indicator is on at all times.

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will become a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Door Ajar Indicator Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Driver Door Ajar Sw parameter changes between Door Closed and Door Open when opening and closing the driver door.
    - **If the parameter does not change**

      Refer to Circuit/System Testing

    - **If the parameter changes**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the driver door lock. It may take up to 2 minutes for all vehicle systems to power down
2. Test for less than 10 Ω between the ground circuit terminal listed below and ground:
    - Ground circuit terminal 6 (Without UA6)
    - Ground circuit terminal 8 (With UA6)
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 10 Ω**
3. Ignition ON.
4. Verify the scan tool Driver Door Ajar Sw parameter is Door Closed.
    - **If not Door Closed**
    1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
    2. Test for infinite resistance between the signal circuit terminal listed below and ground:
        - Signal circuit terminal 4 (Without UA6)
        - Signal circuit terminal 6 (With UA6)
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K9 Body Control Module.
    - **If Door Closed**
5. Install a 3 A fused jumper wire between the signal circuit terminal listed below and ground:
    - Signal circuit terminal 4 (Without UA6)
    - Signal circuit terminal 6 (With UA6)
6. Verify the scan tool Driver Door Ajar Sw parameter is Door Open.
    - **If not Door Open**
    1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V

3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K9 Body Control Module.
- **If Door Open**

7. Test or replace the driver door lock.

Component Testing

1. Ignition OFF, disconnect the harness connector at the driver door lock.
2. Test for infinite resistance between the signal terminal and the ground terminal listed below with the switch in the open position:
    - Signal terminal 4 and ground terminal 6 (Without UA6)
    - Signal terminal 6 and ground terminal 8 (With UA6)
    - **If less than infinite resistance**

      Replace the driver door lock.

    - **If infinite resistance**
3. Test for less than 3 Ω between the signal terminal and the ground terminal listed below with the switch in the closed position.
    - Signal terminal 4 and ground terminal 6 (Without UA6)
    - Signal terminal 6 and ground terminal 8 (With UA6)
    - **If 3 Ω or greater**

      Replace the driver door lock.

    - **If less than 3 Ω**
4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Side Door Lock Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B3125, B3130, OR B3135: FRONT/DRIVER DOOR ONLY UNLOCK/ALL DOOR LOCK/UNLOCK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3125 00

Left Front/Driver Door Only Unlock Circuit

DTC B3130 00

All Door Unlock Circuit

DTC B3135 00

All Door Lock Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Door Unlock Relay Control	2	2	B3130 00	-
Driver Door Unlock Relay Control	1	1	B3125 00	-
Door Lock Relay Control	B3135 00	3	3	-
1. Driver Door Unlock Malfunction 2. Passenger Door Unlock Malfunction 3. All Door Lock Malfunction				

Circuit/System Description

The body control module (BCM), upon receipt of a lock switch lock signal, will switch the Door Lock Relay Control circuit to battery positive voltage. This will energize the LOCK relay. The remaining unlock relays receive voltage from the underhood fuse block, the BCM upon receipt of a unlock signal or driver door unlock signal will switch the appropriate unlock relay to ground. This will energize the appropriate unlock relay unlocking the appropriate doors.

Conditions for Running the DTC

When the relay is being actively commanded by the BCM.

Conditions for Setting the DTC

B3125 00

The BCM detects a short to voltage in the driver door unlock control circuit while commanding the DRIVER UNLOCK relay.

B3130 00

The BCM detects short to voltage in the door unlock control circuit while commanding the UNLOCK relay.

B3135 00

The BCM detects a short to ground in the door lock control circuit while commanding the LOCK relay.

Action Taken When the DTC Sets

The power door locks will malfunction

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the driver door will Unlock when commanding the Driver Door Unlock with a scan tool.
    - **If the driver door Unlock function does not work**

      Refer to Circuit/System Testing - Driver Door Unlock Malfunction.
3. Verify the passenger, left rear and right rear door will Unlock when commanding the Unlock Rear Doors with a scan tool.
    - **If the passenger, left rear and right rear door Unlock function does not work**

      Refer to Circuit/System Testing - Passenger Door Unlock Malfunction.
4. Verify the driver, passenger, left rear and right rear door will Lock when commanding the Lock Rear

Doors with a scan tool.

- **If the door Lock function does not work**

  Refer to Circuit/System Testing - Door Lock Malfunction.

- **If the Lock and Unlock function for all doors works**

5. All OK.

Circuit/System Testing

Driver Door Unlock Malfunction

1. Ignition OFF, disconnect the X1 harness connector at the X51A Fuse Block-Instrument Panel, ignition ON.
2. Verify that a test lamp does not illuminate between the control circuit terminal K6 and ground.
   - **If the test lamp illuminates**
   1. Ignition OFF, remove the test lamp, disconnect the X7 harness connector at the K9 Body Control Module.
   2. Test for less than 1 V between the X51A Fuse Block-Instrument Panel control circuit terminal K6 X1 and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K9 Body Control Module.
   - **If the test lamp is not illuminated**
3. Ignition OFF, connect the X1 harness connector at the X51A Fuse Block-Instrument Panel and disconnect the X7 harness connector at the K9 Body Control Module, ignition ON.
4. Connect a 3A fused jumper wire between the control circuit terminal 6 and ground.
5. Listen for an audible click from the X51A Fuse Block-Instrument Panel as the Driver Door Unlock Relay activates.
   - **If the Driver Door Unlock Relay does not activate**
   1. Ignition OFF, remove the fused jumper wire, disconnect the X1 harness connector at the X51A Fuse Block-Instrument Panel.
   2. Test for infinite resistance between the K9 Body Control Module control circuit terminal 6 X7 and ground.
      - If less than Infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the X51A Fuse Block-Instrument Panel.
   - **If the Driver Door Unlock Relay activates**
6. Replace the K9 Body Control Module.

Passenger Door Unlock Malfunction

1. Ignition OFF, disconnect the X1 harness connector at the X51A Fuse Block-Instrument Panel, ignition

ON.

2. Verify that a test lamp does not illuminate between the control circuit terminal K5 and ground.
    - **If the test lamp illuminates**
    1. Ignition OFF, remove the test lamp, disconnect the X7 harness connector at the K9 Body Control Module.
    2. Test for less than 1 V between the X51A Fuse Block-Instrument Panel control circuit terminal K5 X1 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K9 Body Control Module.
    - **If the test lamp is not illuminated**
3. Ignition OFF, connect the X1 harness connector at the X51A Fuse Block-Instrument Panel and disconnect the X7 harness connector at the K9 Body Control Module, ignition ON.
4. Connect a 3A fused jumper wire between the control circuit terminal 9 and ground.
5. Listen for an audible click from the X51A Fuse Block-Instrument Panel as the Door Unlock Relay activates.
    - **If the Door Unlock Relay does not activate**
    1. Ignition OFF, remove the fused jumper wire, disconnect the X1 harness connector at the X51A Fuse Block-Instrument Panel.
    2. Test for infinite resistance between the K9 Body Control Module control circuit terminal 9 X7 and ground.
        - If less than Infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the X51A Fuse Block-Instrument Panel.
    - **If the Door Unlock Relay activates**
6. Replace the K9 Body Control Module.

Door Lock Malfunction

1. Ignition OFF, disconnect the X7 harness connector at the K9 Body Control Module, ignition ON.
2. Verify that a test lamp does not illuminate between the control circuit terminal 7 and ground.
    - **If the test lamp illuminates**
    1. Ignition OFF, remove the test lamp, disconnect the X1 harness connector at the X51A Fuse Block-Instrument Panel.
    2. Test for less than 1 V between the K9 Body Control Module control circuit terminal 7 X7 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the X51A Fuse Block-Instrument Panel.
    - **If the test lamp is not illuminated**
3. Connect a 3A fused jumper wire between the control circuit terminal 7 and B+.

4. Listen for an audible click from the X51A Fuse Block-Instrument Panel as the Door Lock Relay activates.
    - **If the Door Lock Relay does not activate**
    1. Ignition OFF, remove the jumper wire, disconnect the X1 harness connector at the X51A Fuse Block-Instrument Panel.
    2. Test for infinite resistance between the K9 Body Control Module control circuit terminal 7 X7 and ground.
        - If less than Infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the X51A Fuse Block-Instrument Panel.
    - **If the Door Lock Relay activates**
5. Replace the K9 Body Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Instrument Panel Electrical Center or Junction Block Replacement - Right Side (Impala) Control**
- **Module References** for BCM replacement, setup, and programming

DTC B3265: TRUNK RELEASE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3265 00

Trunk Release Output Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Control	B3265 00	1	1	-
Relay Ground	-	1	-	-
1. Trunk release is inoperative from both the release switch and keyless entry transmitter				

Circuit/System Description

The body control module (BCM) applies battery positive voltage to the trunk release relay control circuit, which

energizes the coil side of the trunk relay. The switch side of the trunk relay then closes, supplying battery positive voltage through the relay and the relay controlled output circuit to the rear compartment lid latch. The rear compartment lid latch then releases the rear compartment lid so that it may be manually raised to an open position.

Conditions for Running the DTC

When the BCM is actively commanding the relay.

Conditions for Setting the DTC

The BCM detects a short to ground in the relay control circuit.

Action Taken When the DTC Sets

The BCM will command the relay, but the rear compartment lid release actuator will be inoperative

Conditions for Clearing the DTC

- The DTC will be current for as long as the fault is present.
- When the fault is no longer present, the DTC will be a history DTC.
- A history DTC will clear after 50 ignition cycles.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Luggage Compartment Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, command the Trunk Release with a scan tool. The rear compartment lid release actuator should

release the trunk lid.

Circuit/System Testing

1. Ignition OFF, disconnect the TRUNK relay.
2. Test for less than 1 Ω between the ground circuit terminal 85 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
4. Ignition ON, command the Trunk Release with a scan tool. The test lamp should turn briefly illuminate during the RELEASE command.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the TRUNK relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the TRUNK relay.
2. Test for 60-180 Ω between terminals 85 and 86.
    - If not within the specified range, replace the TRUNK relay.
3. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If not the specified value, replace the TRUNK relay.
4. Install a 5A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.
    - If greater than the specified range, replace the TRUNK relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for BCM replacement, setup, and programming

SYMPTOMS - VEHICLE ACCESS

Power Door Locks

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
    - There are no DTCs set.
    - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions:
    - **Power Door Locks Description and Operation**.
    - **Luggage Compartment Description and Operation**.
    - **Door Ajar Indicator Description and Operation**.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Trunk Release Malfunction**
- **Door Ajar Indicator Malfunction**
- **Power Door Locks Malfunction**
- **Power Door Lock Key Cylinder Switches Malfunction**
- **Trunk Ajar Indicator Malfunction**
- **Door Will Not Open/Close, Door Binding, or Locks, Handles, or Cylinders Do Not Function**

DOOR AJAR INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Ajar Signal	B2976 00	2	2	-
Passenger Door Ajar Signal	1	3	3	-
Right Rear Door Ajar Signal	1	4	4	-
Left Rear Door Ajar Signal	1	5	5	-
Driver Door Lock Ground	-	2	-	-
Passenger Door Lock Ground	-	3	-	-
Left Rear Door Lock Ground	-	4	-	-
Right Rear Door Lock Ground	-	5	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
1. Door Ajar Indicator Always On 2. Door Ajar Indicator Inoperative When Driver Door Is Open 3. Door Ajar Indicator Inoperative When Passenger Door Is Open 4. Door Ajar Indicator Inoperative When Left Rear Door Is Open 5. Door Ajar Indicator Inoperative When Right Rear Door Is Open				

Circuit/System Description

The body control module (BCM) provides a 12 V signal to each door ajar switch signal circuits. When a door is opened, the normally open ajar switch closes. With the ajar switch closed, a ground path is provided to the ajar switch signal circuit. The BCM interprets this and communicates via serial data with the instrument panel cluster to display the door ajar icon.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Door Ajar Indicator Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, with all doors closed, observe the scan tool Driver Door Ajar Sw, LR Door Ajar Sw, Passenger Door Ajar Sw, and Right Rear Door Ajar Sw parameters while opening and closing each door. The parameters should change between Door Closed and Door Ajar.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate door lock.
2. Test for less than 1 Ω between ground circuit terminal listed below and ground:

- Driver door lock ground circuit terminal 6 (Without UA6).
- Driver door lock ground circuit terminal 8 (With UA6).
- Passenger door lock ground circuit terminal 3.
- Right rear door lock ground circuit terminal 3.
- Left rear door lock ground circuit terminal 6.
- If greater than the specified range, test the ground circuit for an open/high resistance.

3. Ignition ON, verify the scan tool Door Ajar Sw parameter is Door Closed.
    - If not the specified value, test the signal circuit terminal listed below for a short to ground. If the circuit tests normal, replace the BCM.
    - Driver door lock signal circuit terminal 6 (With UA6).
    - Driver door lock signal circuit terminal 4 (Without UA6).
    - Passenger door lock signal circuit terminal 1.
    - Right rear door lock signal circuit terminal 1.
    - Left rear door lock signal circuit terminal 4.
4. Install a 3A fused jumper wire between the signal circuit terminal below and ground. Verify the scan tool Door Ajar Switch parameter is Door Ajar.
    - Driver door lock signal circuit terminal 6 (With UA6).
    - Driver door lock signal circuit terminal 4 (Without UA6).
    - Passenger door lock signal circuit terminal 1.
    - Right rear door lock signal circuit terminal 1.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the door lock.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate door lock.
2. With the switch in the open position, test for infinite resistance between the signal terminal and the ground terminal listed below:
    - Driver door lock signal terminal 6 and ground terminal 8 (With UA6).
    - Driver door lock signal terminal 4 and ground terminal 6 (Without UA6).
    - Passenger door lock signal terminal 1 and ground terminal 3.
    - Right rear door lock signal terminal 1 and ground terminal 3.
    - Left rear door lock signal terminal 4 and ground terminal 6.
    - If not the specified value, replace the door lock.
3. With the switch in the closed position, test for less than 3 Ω between the signal and the ground terminals listed below:
    - Driver door lock signal terminal 6 and ground terminal 8 (With UA6).
    - Driver door lock signal terminal 4 and ground terminal 6 (Without UA6).
    - Passenger door lock signal terminal 1 and ground terminal 3.

- Right rear door lock signal terminal 1 and ground terminal 3.
- Left rear door lock signal terminal 4 and ground terminal 6.
- If greater than the specified range, replace the door lock.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair procedure.

- **Front Side Door Lock Replacement**
- **Rear Side Door Lock Replacement**
- **Control Module References** for BCM replacement, setup, and programming

POWER DOOR LOCK KEY CYLINDER SWITCHES MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Door Key Switch Unlock Signal	1	1	1	-
Driver Door Lock Ground	-	1	1	-
1. Key Cylinder Switch Malfunction				

Circuit/System Description

The key cylinder unlock feature will unlock all of the doors when the body control module (BCM) receives a Door Lock Key Switch Unlock signal for greater than 1 second and will unlock all of the doors.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Testing for Intermittent Conditions and Poor Connections**
- **Circuit Testing**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, insert the key into the driver door lock cylinder, turn the key the unlock position and hold for greater than 1 second while observing the scan tool Door Key Cyl Unlock Switch parameter. The parameter should change between Active and Inactive.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the driver door lock.
2. Test for less than 1 ohm between the ground circuit terminal 8 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Door Key Cyl Unlock Switch parameter is Inactive.
    - If not the specified value, test the signal circuit terminal 9 for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3-amp fused jumper wire between the signal circuit terminal 9 and ground. Verify the scan tool Door Key Cyl Unlock Switch parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the driver door lock.

Component Testing

1. Ignition OFF, disconnect the harness connector at the driver door lock.
2. Test for infinite resistance between the signal terminal 9 and the ground terminal 8 with the switch in the open position.
    - If not the specified value, replace the driver door lock.
3. Test for less than 2 ohms between the signal terminal 9 and the ground terminal 8 with the switch in the Unlock position.
    - If greater than the specified range, replace the driver door lock.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Door Lock Cylinder Replacement (Impala)**
- **Control Module References** for BCM replacement, setup, and programming

POWER DOOR LOCKS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
I/P Fuse Block B+	2	2	-	-
Driver Door Lock Switch Lock Signal	1	1	1	-
Driver Door Lock Switch Unlock Signal	1	1	1	-
Passenger Door Lock Switch Lock Signal	1	1	1	-
Passenger Door Lock Switch Unlock Signal	1	1	1	-
Door Unlock Relay Control	B3130 00	B3130 00	B3130 00	-
Driver Door Relay Unlock Control	B3125 00	B3125 00	B3125 00	-
Door Lock Relay Control	B3135 00	B3135 00	B3135 00	-
Door Lock Switch Ground	-	1	-	-
I/P Fuse Block Ground	-	2	-	-
1. Door Lock Switch Malfunction 2. Door Latch Malfunction				

Circuit/System Description

The DR/LCK fuse supplies battery positive voltage to the I/P fuse block for the door lock system. The body control module (BCM) supplies and monitors a reference voltage to the door lock switch through the door lock switch lock/unlock signal circuit. The door lock switch also receives a constant ground source. If a door lock switch is placed in the lock position or unlock position, the reference voltage is taken directly to ground and the BCM detects the voltage drop on the signal circuit.

The BCM, upon receipt of a door lock switch lock or unlock signal, will switch the appropriate door lock actuator control circuits to battery positive voltage. The opposing side of the door lock actuators are connected to ground internally within the BCM through the other door lock actuator control circuit and the doors will lock or unlock appropriately.

Diagnostic Aids

Verify the smooth and consistent mechanical operation of each part of the door latch system prior to performing extensive electrical diagnostics

Any door that does not function smoothly or consistently, refer to **Door Will Not Open/Close, Door Binding, or Locks, Handles, or Cylinders Do Not Function**.

Reference Information

Schematic Reference

Door Lock/Indicator Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Door Locks Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Driver Door Lock Sw, Psgr Door Lock Sw, Driver Door Unlock Sw and Psgr Door Unlock Sw parameters while using the driver and passenger door lock switches. The parameters should change between Active and Inactive.
    - If the values are always Active or always Inactive, refer to Door Lock Switch Malfunction.
2. Command the driver door and passenger door lock actuators to LOCK and UNLOCK with the scan tool, the doors should LOCK and UNLOCK when changing between commanded states.
    - If the driver door does not LOCK or UNLOCK, refer to Driver Door Lock Malfunction.
    - If a passenger door does not LOCK or UNLOCK functions, refer to Passenger Door Lock Malfunction.
    - If all doors locks are inoperative, refer to I/P Fuse Block Test.

Circuit/System Testing

Door Lock Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate door lock switch.
2. Test for less than 1 Ω between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Door Lock Sw parameter is Inactive.
    - If not the specified value, test the signal circuit terminal D for a short to ground. If the circuit tests normal, replace the BCM.

4. Install a 3A fused jumper wire between the signal circuit terminal D and ground. Verify the scan tool Door Lock Sw parameter is Active
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. Verify the scan tool Door Unlock Sw parameter is Inactive.
    - If not the specified value, test the signal circuit terminal E for a short to ground. If the circuit tests normal, replace the BCM.
6. Install a 3A fused jumper wire between the signal circuit terminal E and ground. Verify the scan tool Door Unlock Sw parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. If all circuits test normal, test or replace the door lock switch.

Driver Door Lock Malfunction

1. Ignition OFF, disconnect the harness connector at the driver door latch.
2. Ignition ON, connect a test lamp between the control circuit terminal 3 and control circuit terminal 2.
3. Command the driver door to LOCK and UNLOCK by using the driver door lock switch. The test lamp should briefly illuminate when commanding the LOCK and UNLOCK states.
    - If the test lamp does not illuminate during either of the commands and the B+ circuit fuse is open, test either control circuit for a short to ground. If the circuit tests normal, test or replace the driver door lock.
    - If the test lamp does not illuminate during either of the commands and the B+ circuit fuse is good, test either control circuit for an open/high resistance. If the circuit tests normal, refer to I/P Fuse Block Test.
4. If all circuits test normal, test or replace the driver door latch.

Passenger Door Lock Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate passenger or rear door latch.
2. Ignition ON, connect a test lamp between the control circuit terminals listed below:
    - Terminal 2 and terminal 3 - left rear door latch
    - Terminal 5 and terminal 6 - right rear door latch
    - Terminal 5 and terminal 6 - passenger door latch
3. Command the door to LOCK and UNLOCK by using the driver door lock switch. The test lamp should briefly illuminate when commanding the LOCK and UNLOCK states.
    - If the test lamp does not illuminate during either of the commands and the B+ circuit fuse is open, test either control circuit for a short to ground. If the circuit tests normal, test or replace the passenger or rear door latch.
    - If the test lamp does not illuminate during either of the commands and the B+ circuit fuse is good, test either control circuit for an open/high resistance. If the circuit tests normal, refer to I/P Fuse Block Test.
4. If all circuits test normal, test or replace the passenger or rear door latch.

I/P Fuse Block Test

1. Ignition OFF, disconnect the X1 harness connector at the I/P fuse block.
2. Test for less than 1 Ω between the ground circuit terminal J1 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between control circuit terminal K4 and ground.
4. Ignition ON, command the doors to LOCK with a scan tool. The test lamp should briefly illuminate during the LOCK command.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. Connect a test lamp between control circuit terminal K5 and B+.
6. Command the doors to UNLOCK with a scan tool. The test lamp should briefly illuminate during the UNLOCK command.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or and open/high resistance. If the circuit tests normal, replace the BCM.
7. Connect a test lamp between control circuit terminal K6 and B+.
8. Command the driver door to UNLOCK with a scan tool. The test lamp should briefly illuminate during the UNLOCK command.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or and open/high resistance. If the circuit tests normal, replace the BCM.
9. If all circuits test normal, replace the I/P fuse block.

Component Testing

Door Lock Switch

1. Ignition OFF, disconnect the harness connector at the appropriate door lock switch.
2. Test for infinite resistance between the signal terminals D and E and the ground terminal B with the switch in the open position.
    - If not the specified value, replace the door lock switch.
3. Test for less than 2 Ω between the signal terminal D and the ground terminal B with the switch in the lock position.
    - If greater than the specified range, replace the door lock switch.
4. Test for less than 2 Ω between the signal terminal E and the ground terminal B with the switch in the unlock position
    - If greater than the specified range, replace the door lock switch.

Door Lock Assembly

1. Ignition OFF, disconnect the harness connector at the appropriate door lock.
2. Install a 15A fused jumper wire between one of the control terminals and 12V. Momentarily install a jumper wire between the other control terminal and ground. Reverse the jumper wires at least two times, the door lock should perform the LOCK and UNLOCK functions.
    - If it does not perform as specified, replace the door lock.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Door Lock Switch Replacement (Impala)**
- **Front Side Door Lock Replacement**
- **Rear Side Door Lock Replacement**
- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup, and programming

TRUNK RELEASE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Trunk Relay Switch B+	1	1	-	-
Trunk Release Switch Signal	2	2	2	-
Rear Compartment Lid Release Actuator Control	2	2	2	-
Trunk Relay Control	B3265 00	B3265 00	B3265 00	-
Trunk Relay Coil Ground	1	1	1	-
Headlamp Switch Ground	-	2	2	-
Rear Compartment Lid Release Actuator Ground	-	1	1	-
1. Trunk release is inoperative from both the switch and keyless entry transmitter. 2. Trunk release switch inoperative				

Circuit/System Description

When the ignition is ON, the BCM supplies a reference voltage to the rear compartment lid release switch, which is part of the headlamp switch assembly, through the trunk release switch signal circuit. When the rear compartment lid release switch is operated, the trunk release signal circuit is grounded through the headlamp

switch ground circuit and the reference voltage is pulled low within the BCM. In response, the BCM applies battery positive voltage to the trunk release relay control circuit, which energizes the coil side of the trunk relay. The switch side of the trunk relay then closes, supplying battery positive voltage through the relay and the relay controlled output circuit to the rear compartment lid latch. The rear compartment lid latch, then releases the trunk lid so that it may be manually raised to an open position.

Reference Information

Schematic Reference

Release Systems Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Luggage Compartment Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Int. Trunk/Liftglass Sw. parameter while pressing and releasing the trunk release switch. The parameter should change between Active and Inactive.
    - If the value does not change, refer to Trunk Release Switch Malfunction.
2. Command the Trunk Release with a scan tool. The rear compartment lid release actuator should release the trunk lid.
    - If the release actuator does not release the trunk lid, refer to Trunk Release Malfunction.

Circuit/System Testing

Trunk Release Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the headlamp switch.
2. Test for less than 1 ohm between the ground circuit terminal 8 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Int. Trunk/Liftglass Sw. parameter is Inactive.
    - If not the specified value, test the signal circuit terminal 9 for a short to ground. If the circuit tests

normal, replace the BCM.

4. Install a 3A fused jumper wire between the signal circuit terminal 9 and ground. Verify the scan tool Int. Trunk/Liftglass Sw. parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the headlamp switch.

Trunk Release Malfunction

1. Ignition OFF, disconnect the TRUNK relay.
2. Test for less than 1 ohm between the ground circuit terminal 85 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 30 and ground.
    - If the test lamp illuminates, test the control circuit for a short to voltage.
4. Verify that a test lamp illuminates between the B+ circuit terminal 87 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.
5. Ignition OFF, disconnect the harness connector at the rear compartment lid release actuator.
6. Test for less than 1 ohm between the ground circuit terminal 3 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the rear compartment lid release actuator.
8. Ignition ON, connect a 10A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30. Verify the rear compartment lid release actuator is activated.
    - If the rear compartment lid release actuator does not activate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the rear compartment lid release actuator.
9. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
10. Command the Trunk Release with a scan tool, the test lamp should illuminate during the RELEASE command.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
11. If all circuits test normal, test or replace the TRUNK relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the TRUNK relay.
2. Test for 60-180 ohms between terminals 85 and 86.
    - If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87
- If not the specified value, replace the relay.

4. Install a 25A fused jumper wire between relay terminal 85 and 12V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
    - If greater than the specified range, replace the relay.

Rear Compartment Lid Release Actuator

1. Ignition OFF, disconnect the harness connector at the rear compartment release actuator.
2. Install a 10A fused jumper wire between the control terminal 4 and 12V. Install a jumper wire between the ground terminal 3 and ground. Verify the rear compartment release actuator activates.
    - If the latch does not perform as specified, replace the rear compartment release actuator.

Trunk Release Switch

1. Ignition OFF, disconnect the harness connector at the headlamp switch.
2. Test for infinite resistance between the signal terminal 9 and the ground terminal 8 with the switch in the open position.
    - If not the specified value, replace the headlamp switch.
3. Test for less than 2 ohms between the signal terminal 9 and the ground terminal 8 with the switch in the closed position.
    - If greater than the specified range, replace the headlamp switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness) Relay Replacement (Within an Electrical Center)**
- **Headlamp Switch Replacement (Impala)**
- **Rear Compartment Lid Latch Replacement**
- **Control Module References** for BCM replacement, setup, and programming

TRUNK AJAR INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to	Open/High	Short to	Signal

	Ground	Resistance	Voltage	Performance
Signal	1	2	2	-
Ground	-	3	-	-
1. Ajar Indicator Always Illuminated 2. Ajar Indicator Inoperative 3. Trunk Release Inoperative				

Circuit/System Description

The rear compartment lid can be released by operating the rear compartment lid release switch or by pressing the rear compartment release button on the remote keyless entry transmitter. The gear selector may be in any position, but the vehicle speed must equal 0 for the rear compartment lid to release.

When the ignition is ON, the body control module (BCM) supplies battery positive voltage to the rear compartment lid ajar switch through the rear compartment lid ajar switch signal circuit. When the rear compartment lid is opened, the signal circuit is connected to ground through the rear compartment lid ajar switch ground circuit and the voltage is pulled low within the BCM. In response, the BCM sends a serial data message to the driver information center (DIC) in the instrument panel cluster (IPC) to illuminate the rear compartment lid ajar indicator.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Door Ajar Indicator Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Rear Closure Ajar Sw parameter changes between Inactive and Active when opening and closing the rear compartment lid.

- **If the parameter does not change**

  Refer to Circuit/System Testing.

- **If the parameter changes**

3. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the rear compartment lid release actuator. Ignition ON.
2. Verify the scan tool Rear Closure Ajar Sw parameter is Inactive.
   - **If not Inactive**
   1. Ignition OFF, disconnect the harness connector at the body control module.
   2. Test for infinite resistance between the signal circuit terminal 2 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the body control module.
   - **If Inactive**
3. Install a 3 A fused jumper wire between the signal circuit terminal 2 and ground.
4. Verify the scan tool Rear Closure Ajar Sw parameter is Active.
   - **If not Active**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the body control module, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the body control module.
   - **If Active**
5. Test or replace the rear compartment lid release actuator.

Component Testing

1. Ignition OFF, disconnect the harness connector at the rear compartment lid release actuator.
2. Test for infinite resistance between the signal terminal 2 and the ground terminal 3 with the switch in the open position.
   - **If less than infinite resistance**

     Replace the rear compartment lid release actuator.

   - **If infinite resistance**
3. Test for less than 3 Ω between the signal terminal 2 and the ground terminal 3 with the switch in the closed position.

- **If 3 Ω or greater**

  Replace the rear compartment lid release actuator.

- **If less than 3 Ω**

4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Rear Compartment Lid Latch Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DOOR WILL NOT OPEN/CLOSE, DOOR BINDING, OR LOCKS, HANDLES, OR CYLINDERS DO NOT FUNCTION

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to address the mechanical diagnosis of the door latching system, which could include the inside and outside handles, latch rods/cables, latches, or latch cylinders.			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to **Step 2**	Go to **Diagnostic System Check - Vehicle**
2	Were you sent here from a Vehicle Access Symptom Table?	Go to **Step 3**	Go to **Symptoms - Vehicle Access**
3	Does the door open with the outside handle?	Go to **Step 4**	Go to **Step 10**
4	Does the door open with the inside handle?	Go to **Step 5**	Go to **Step 11**
5	Does the manual latch knob latch and unlatch the latch smoothly without binding?	Go to **Step 6**	Go to **Step 12**
6	Does the door latch switch and/or the keyless entry transmitter latch and unlatch the door latch or door latches?	Go to **Step 7**	Go to **Step 14**
7	Is the outside key cylinder loose or does it rattle or fall out? (if equipped)	Go to **Step 15**	Go to **Step 8**
8	Does the outside key cylinder latch and unlatch the latch and function smoothly without binding? (if equipped)	Go to **Step 9**	Go to **Step 16**
9	Does the door bind, does it take excessive effort to open, or is it misaligned?	Go to **Step 17**	Go to **Step 18**
10	If the door will not open with the outside handle, or the handle is obstructed or loose, check the following: • For cold weather freezing, thaw as necessary. • Check the handle for foreign material. Remove material as necessary. • Check the handle grab bar for looseness or damage. Repair as necessary.	Go to **Step 18**	Go to **Step 11**

Step	Action	Yes	No
	• Check the handle for full travel. If the issue is not resolved, remove the trim panel as necessary to gain access to door hardware and check the following: • Check the handle chassis for loose fasteners, broken chassis inserts, loose or missing spring, or a loose, missing or bent rod lever. • Check for bent rod to the outside handle. • Check that the handle grab bar engages the rod lever properly. • Check for interference of rod and handle to other components in the door. • Check that handle rod is securely attached at both latch and handle. • Check if rod is positioned properly in the clip on the latch. At rest position, the handle should be fully against the down stop and the latch lever should be at the bottom of its travel. Correct by opening clip, repositioning rod in clip and closing clip till it snaps, as necessary. Did you find and correct the condition?		
11	Door will not open with the inside handle: • Check the inside handle for foreign material. Remove material as necessary. • Check that the handle is secure. Correct as necessary. • If rear door, verify child security is not engaged. • Remove the trim panel as necessary to and check the inside handle rod/cable attachments at both the latch and handle. If the cable is kinked or pinched, correct as necessary. Did you find and correct the condition?	Go to **Step 18**	Go to **Step 12**
12	The door will not or is difficult to unlatch with the inside manual latch knob: • For cold weather freezing, thaw as necessary • Check the latch knob for a loose condition. Repair	Go to **Step 18**	Go to **Step 13**

Step	Action	Yes	No
	or replace as necessary. Check the latch knob for binding or dragging using the following procedure: 1. Remove the latch knob. 2. If condition goes away, check for drag/interference of the latch knob against the inner belt seal, or the trim panel. Correct as required. If further action is required, remove the trim panel and check the latch rod and latch knob for interference with the following: • Water deflector/paper • Side impact foam • Rod grommet in sheet metal • Glass run channel • Other rods or cables • Trim panel Did you find and correct the condition?		
13	With a manual lock, if the latch will not function properly do the following: 1. Function the lock/unlatch lever on the latch to unlatch the latch. Check for high internal resistance. 2. With the door open, manually close the latch with a screwdriver. 3. Check the latch for internal binding by actuating the latch with the inside door handle lever. 4. Manually close the latch with a screwdriver again. 5. Check the latch for internal binding by actuating the latch with the outside door handle lever. Did you find and correct the condition?	Go to **Step 18**	Go to **Step 14**
14	If power locks are included in vehicle options and do not function with either the keyless entry transmitter or switch:	Go to **Step 18**	Go to **Step 15**

Step	Action	Yes	No
	1. For cold weather freezing, thaw as necessary. 2. Remove trim pad as required and check the following: • Verify door harness has appropriate power connectors for switches and latch. • Check harness connector pins for corrosion. • Assure wire harness connectors are seated and locked properly at latch and switch. Remove and re-seat if required. • Check door harness for cuts/chafing /corrosion. Correct/replace as required. • Check for 12V at latch and door switch. Correct/proceed accordingly. • Check BCM for trouble codes. Correct/proceed accordingly. 3. If power locks still do not function do the following: 1. Remove latch from door cavity. 2. Connect latch to electrical connector outside the door. 3. Function power lock/unlatch switch in both latch and unlatch directions. Watch for lock/unlatch lever on latch to move completely from one position to the other. 4. If lever does not move, remove connector from old latch and attach to new latch outside of door cavity. 5. Verify new latch is functional, if so, attach rods and install new latch in door. Did you find and correct the condition?		
15	If the key cylinder is loose do the following: • Remove the trim if necessary. • Check that the retaining clip is properly seated. (if equipped) • Check that the fastener is properly torqued. (if equipped) Did you find and correct the condition?	Go to **Step 18**	Go to **Step 16**

Step	Action	Yes	No
16	The outside key cylinder will not latch and unlatch the latch and function smoothly without binding: 1. For cold weather freezing, thaw as necessary 2. Remove trim if required. 3. Check that the key cylinder rod is securely attached both to the key cylinder pawl and the latch. 4. Check that key cylinder lever, rod and latch lever are free of interferences. Remove interferences as required. 5. Check that latch cylinder rod is routed properly. Re-route as required. 6. Remove rod from latch cylinder and actuate cylinder. Check for internal resistance. Lubricate latch cylinder as required 7. Verify Cylinder rotates with vehicle key. If not, code and replace cylinder to match vehicle key. See latch cylinder coding and replacing. Did you find and correct the condition?	Go to **Step 18**	Go to **Step 17**
17	The door is difficult to open: • Check for interference with the fender, adjacent door, body opening or door striker and adjust as necessary. • Check for binding door hinges. Lubricate or align/adjust as necessary. • Check the door check link for binding. Lubricate as necessary. • Adjust the door as necessary. Did you find and correct the condition?	Go to **Step 18**	Go to appropriate Door Lock Striker Adjustment procedure.

18	Verify proper operation of the door closing system.
	• Outside handle
	• Inside handle
	• Manual lock/unlatch
	  • Outside key cylinder
	  • Inside latch knob
	  • Double pull handle
		Go to **Step 1**	System OK

Step	Action	Yes	No

	• Power lock/unlatch
	  • Key fob
	  • Door switches
	• Door opening/closing effort
	
	Is the condition still present?		

REPAIR INSTRUCTIONS

FRONT SIDE DOOR INSIDE HANDLE CABLE REPLACEMENT (IMPALA) Removal

Procedure

1. Raise the door window to the full up position.

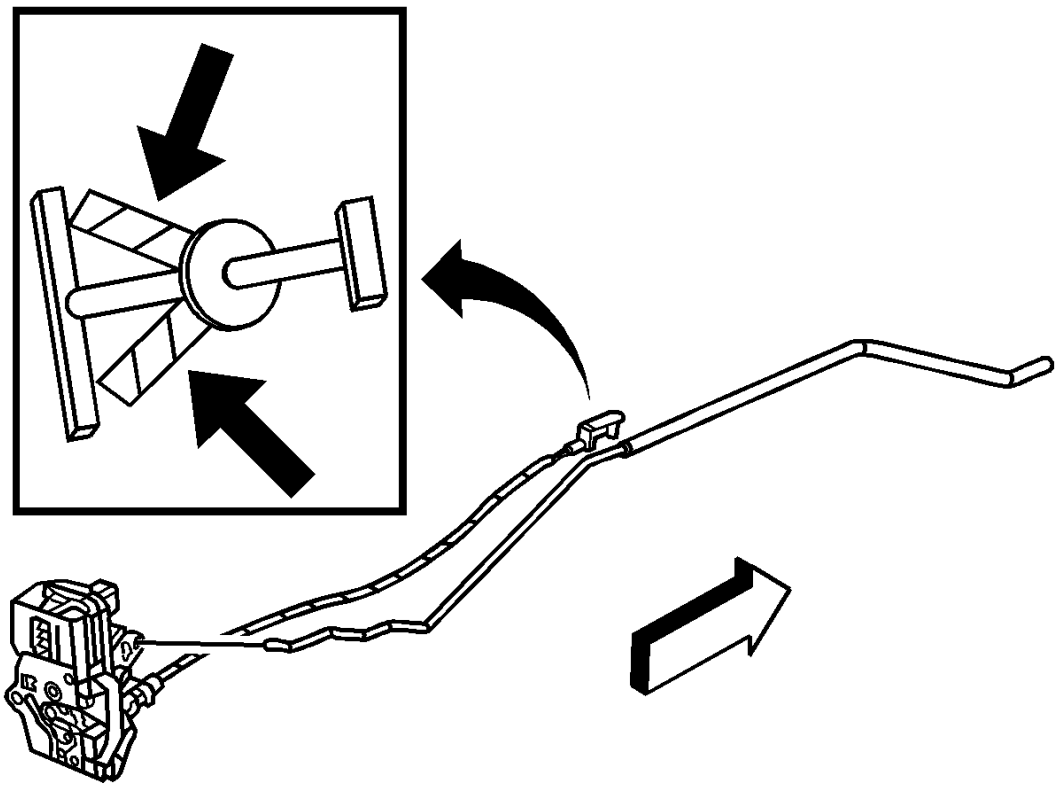


Fig. 5: View Of Inside Door Handle Cable
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: The latch or cable is not serviceable separately. It must be replaced as an assembly.

2. Remove the front door trim panel. Refer to **Front Side Door Trim Panel Replacement** .
3. Remove the front door water deflector. Refer to **Front Side Door Water Deflector Replacement (Impala)** .
4. Remove the front door lock. Refer to **Front Side Door Lock Replacement**.
5. Remove the lock and cable through the opening in the inner door panel.

Installation Procedure

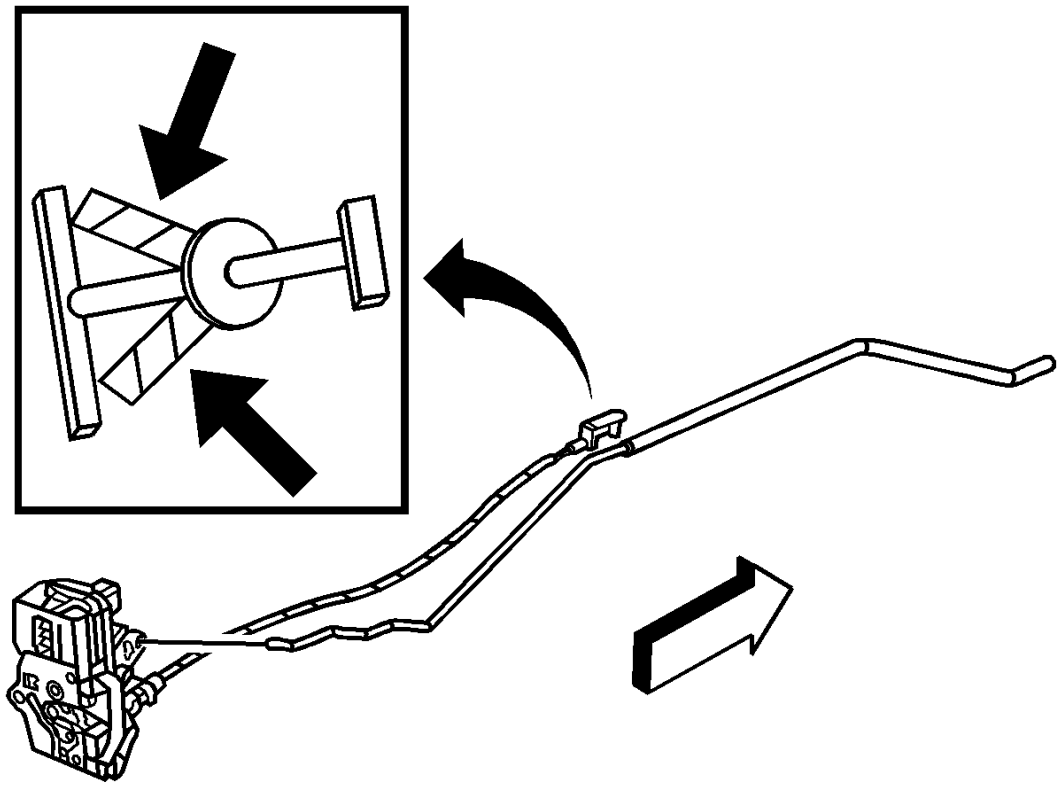


Fig. 6: View Of Inside Door Handle Cable
Courtesy of GENERAL MOTORS COMPANY

1. Install the lock and cable through the opening in the inner door panel.
2. Install the front door lock. Refer to **Front Side Door Lock Replacement**.
3. Inspect the door for proper operation.
4. Install the front door water deflector. Refer to **Front Side Door Water Deflector Replacement (Impala)** .
5. Install the front door trim panel. Refer to **Front Side Door Trim Panel Replacement** .

REAR SIDE DOOR INSIDE HANDLE CABLE REPLACEMENT

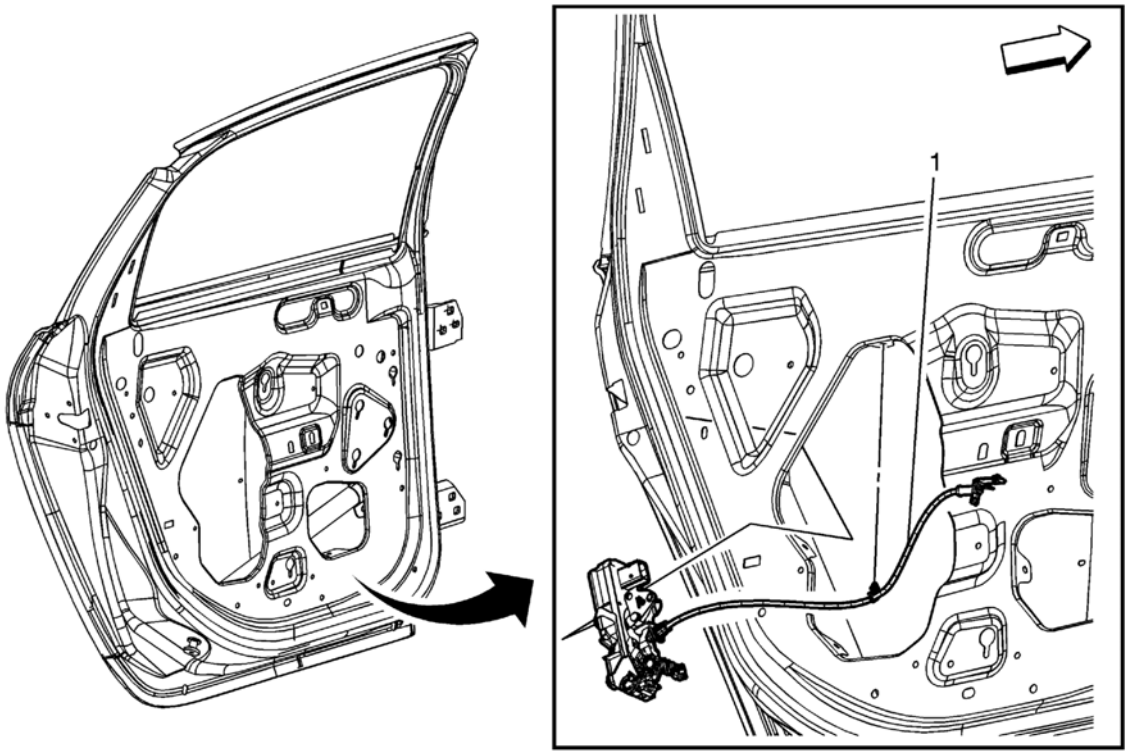


Fig. 7: Rear Side Door Inside Handle Cable
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the interior trim panel. Refer to **Rear Side Door Trim Panel Replacement** . 2. Remove the water deflector. Refer to **Rear Side Door Water Deflector Replacement** . 3. Remove the rear side door lock. Refer to **Rear Side Door Lock Replacement**.	
1	Rear Door Lock Cable **NOTE:** **Use a flat-bladed screwdriver to release the inside door handle from the trim panel.**

DOOR LOCK CYLINDER REPLACEMENT (IMPALA)

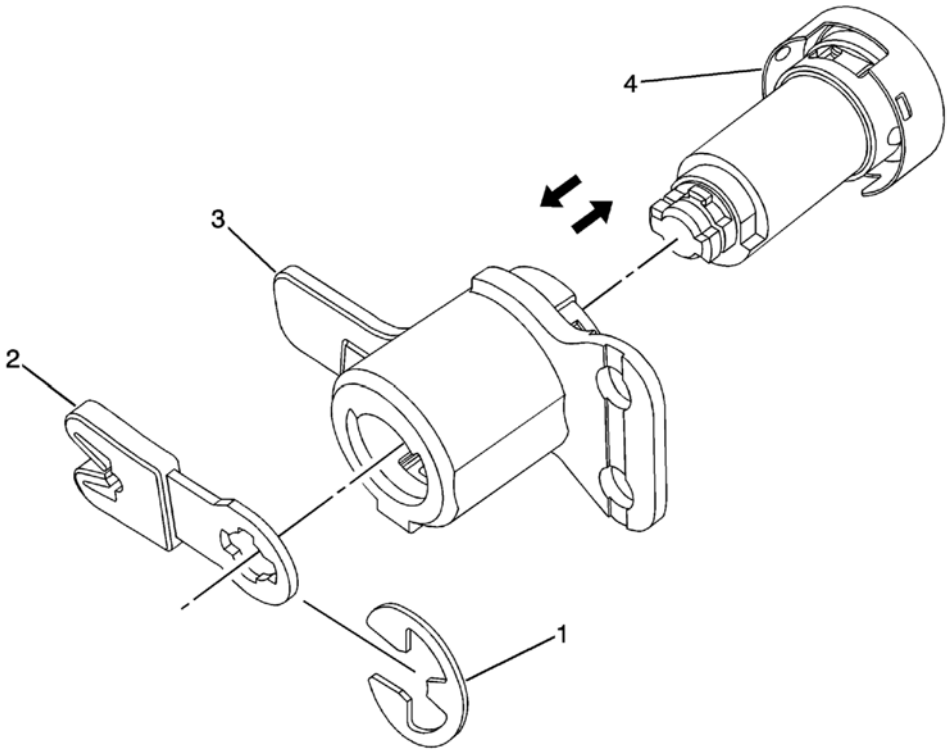


Fig. 8: Door Lock Cylinder Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front side door outside handle. Refer to **Front Side Door Outside Handle Replacement (Impala)**.	
1	Front Side Door Lock Cylinder C-Clip
2	Front Side Door Lock Cylinder Paw
3	Front Side Door Lock Cylinder Case
4	Front Side Door Lock Cylinder **Procedure** 1. Remove the lock cylinder by sliding it rearward releasing the case. 2. Inspect the door lock for proper operation before installing the door trim panel. **TIP:** Do not attempt repairs in order to correct lock cylinder discrepancies. Replace the lock cylinder.

FROZEN LOCK CYLINDER REPAIR

The frozen lock cylinders due to the cold weather may be repaired using the following procedure:

1. Apply heat to the cylinder area with a heat gun.

2. Hold the shutter door open with a paper clip or similar item and force air into the cylinder using compressed air and a blow gun attachment.
3. While holding the shutter door open inject a small amount of multi-purpose lubricant GM P/N 12346241 or equivalent.
4. Work the key into the cylinder several times and wipe any excess lubrication residue from the key.

REAR COMPARTMENT LID LOCK CYLINDER REPLACEMENT

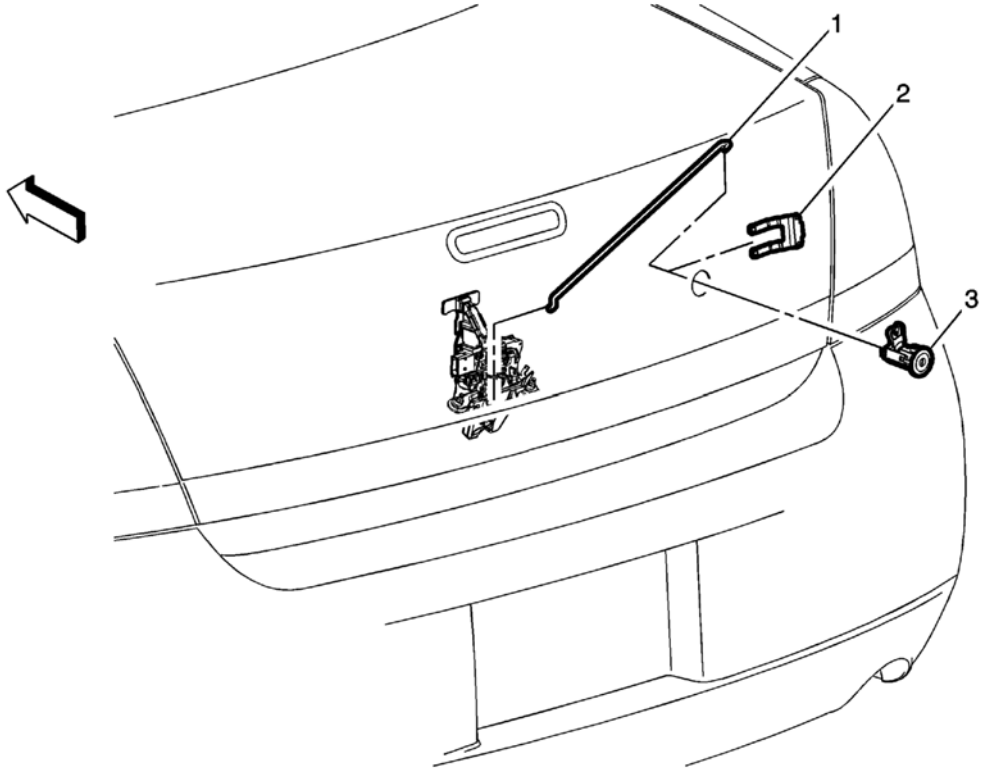


Fig. 9: Rear Compartment Lid Lock Cylinder Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Compartment Lid Lock Cylinder Rod **Procedure** Disconnect the lock cylinder rod from the latch and the lock cylinder.
2	Rear Compartment Lid Lock Cylinder Retainer Clip **CAUTION:** **Refer to Fastener Caution .** **Procedure** Disconnect the retainer clip from the lock cylinder.

Callout	Component Name
3	Rear Compartment Lid Lock Cylinder **Procedure** 1. Remove the lock cylinder from the rear compartment. 2. Ensure the lock cylinder rod is installed properly. 3. Inspect the lock cylinder for proper operation by closing and opening the rear compartment.

FRONT SIDE DOOR OUTSIDE HANDLE REPLACEMENT (IMPALA) Removal

Procedure

NOTE: **The outside handles have adjustable outside handle lock rods. This allows for adjustment of the amount of travel needed in order to operate the outside handle.**

When servicing a vehicle with adjustable outside handle lock rods, remove all free play between the outside handle and the lock. Also, do not operate the outside handle before these connections are made.

1. Raise the window to the full up position.
2. Remove the front door trim panel. Refer to **Front Side Door Trim Panel Replacement** .
3. Remove the front water deflector, as necessary. Refer to **Front Side Door Water Deflector Replacement (Impala)** .

CAUTION: **To avoid paint damage, protect the area surrounding the part which you are removing or installing.**

4. Apply masking tape around the outside handle.

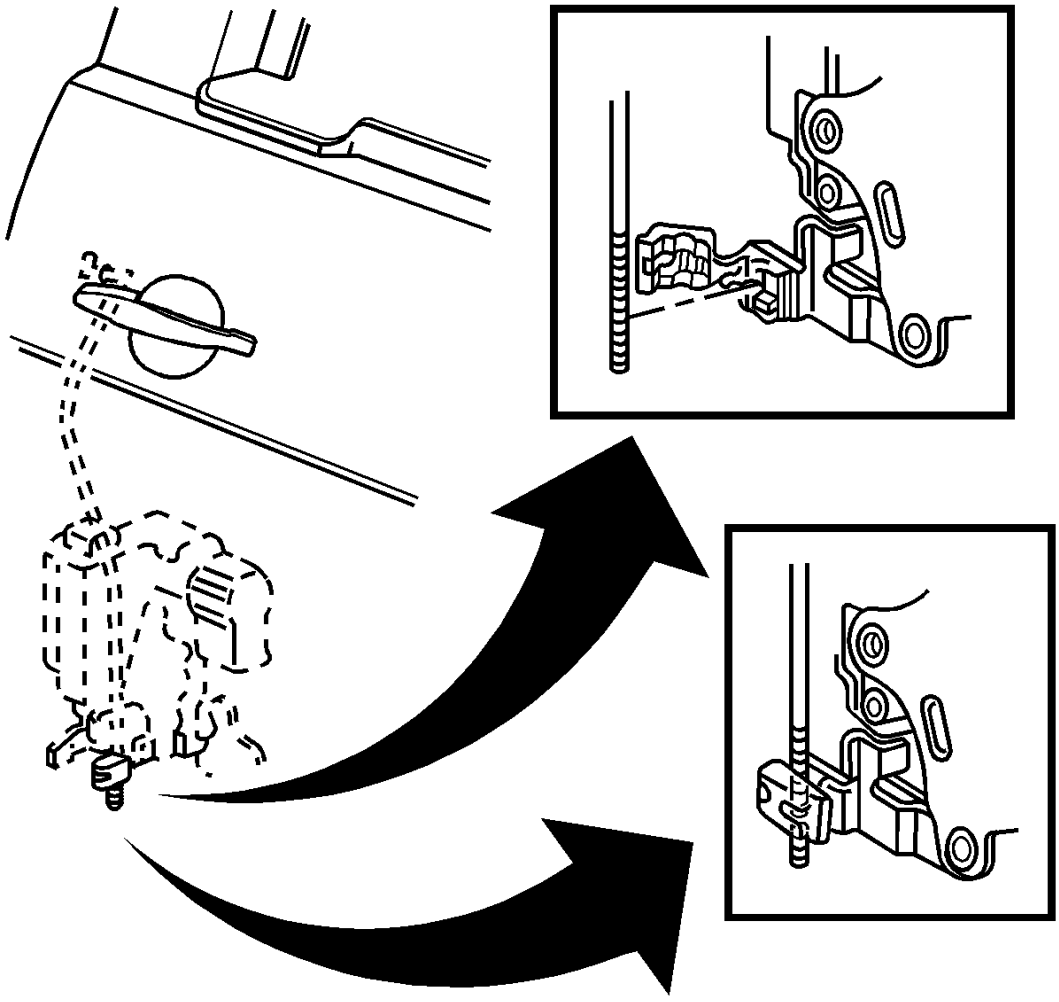


Fig. 10: View Of Handle Rod To Lock Clip
Courtesy of GENERAL MOTORS COMPANY

5. Open the outside door handle rod to lock clip located on the door lock.
6. Remove the front side door window rear run channle bolts.
7. Remove the front side door window rear run channle from the door.

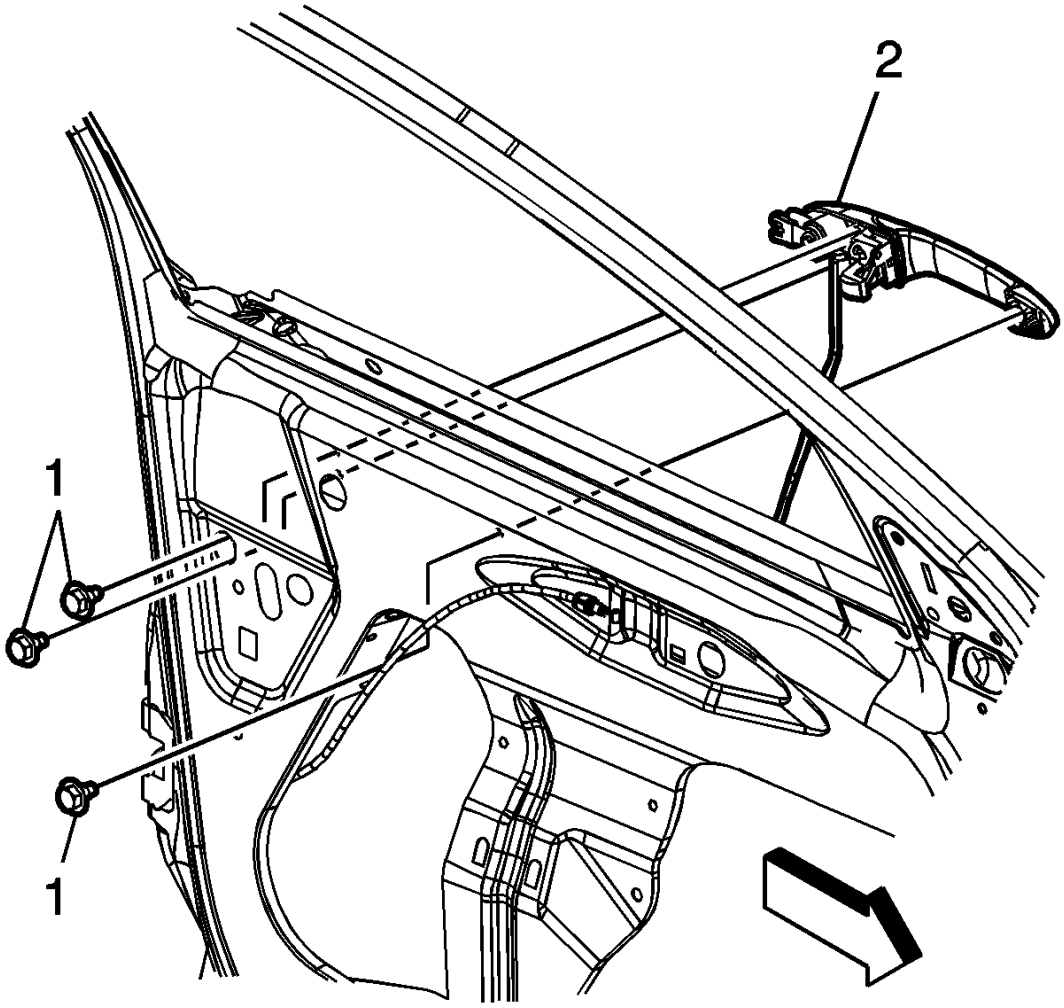


Fig. 11: Identifying Outside Handle Bolts Door
Courtesy of GENERAL MOTORS COMPANY

8. Remove the door handle bolt access tape from the inner door panel.
9. Remove the bolts (1) from the outside handle.

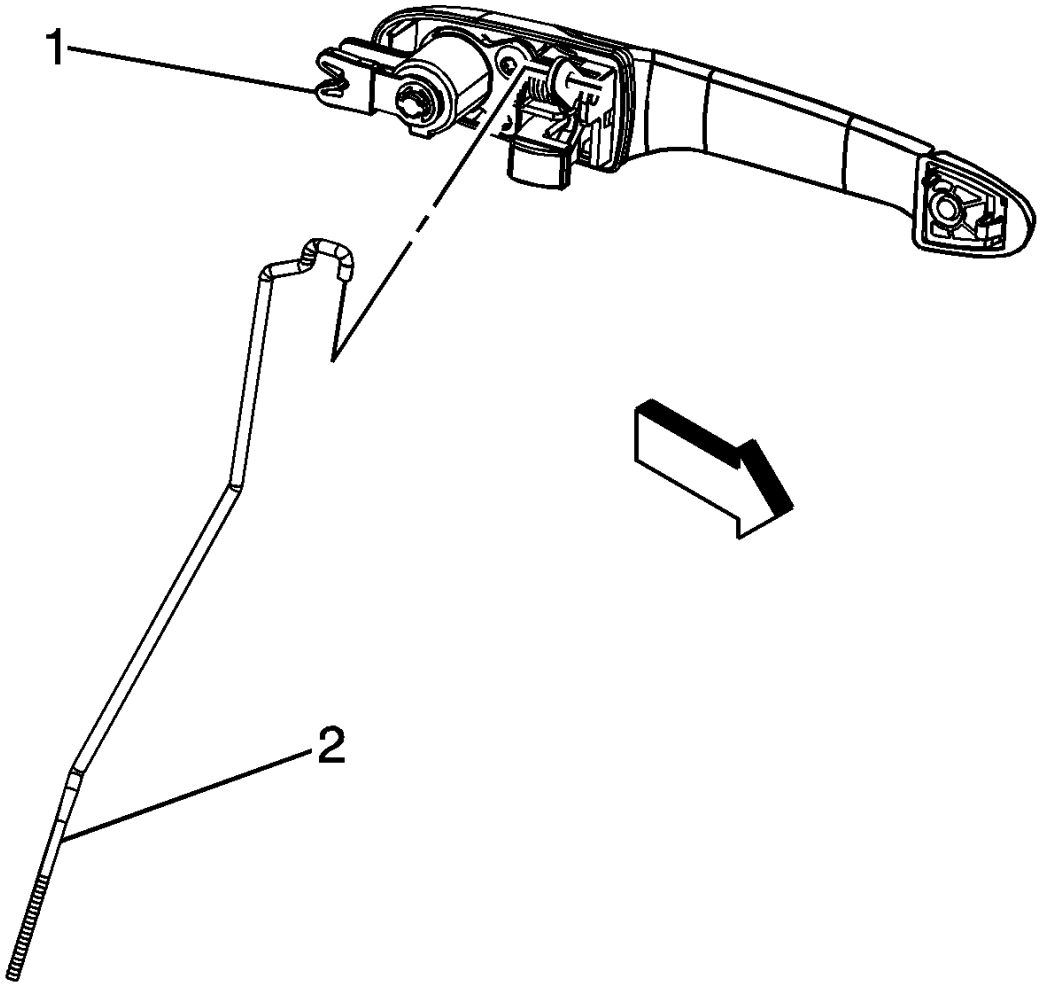


Fig. 12: View Of Outside Handle & Rod
Courtesy of GENERAL MOTORS COMPANY

10. Remove the outside handle (1) and the rod (2) from the door.

Installation Procedure

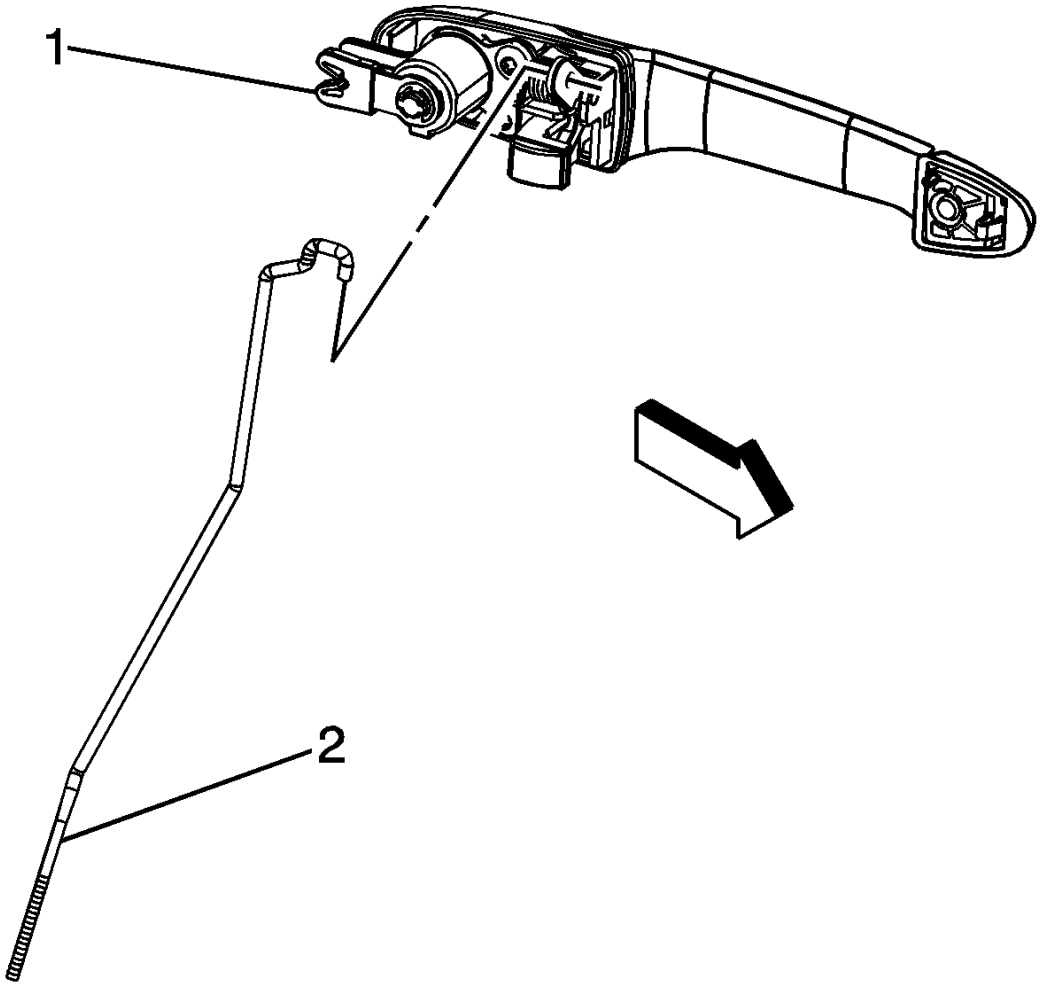


Fig. 13: View Of Outside Handle & Rod
Courtesy of GENERAL MOTORS COMPANY

1. Install the outside handle (1) and the rod (2) to the door.

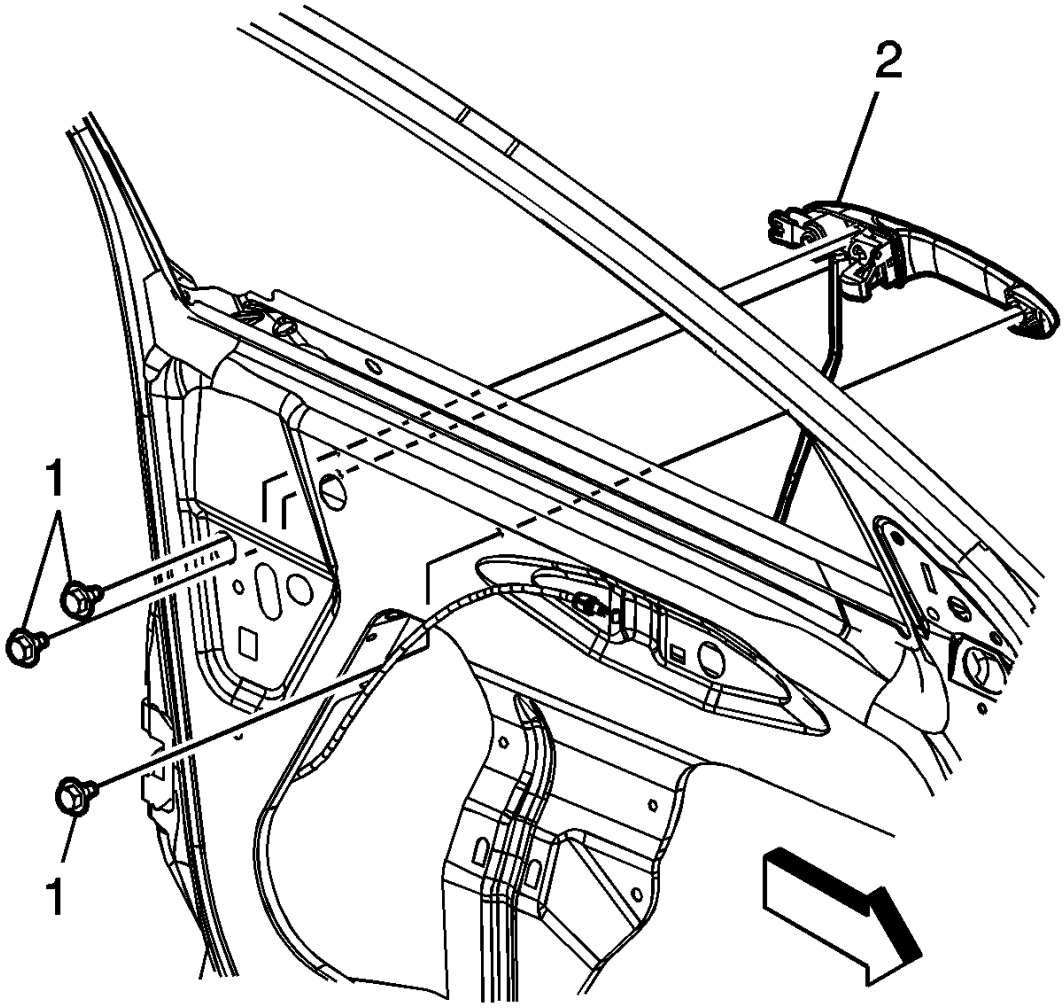


Fig. 14: Identifying Outside Handle Bolts Door
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the outside handle bolts (1) to the door.

Tighten

Tighten the bolts to 10 N.m (89 lb in).

3. Install the outside handle bolt access tape to the inner door panel.
4. Install the front side door window rear run channle to the door.
5. Install the front side door window rear run channle bolts.

Tighten

Tighten the bolts to 10 N.m (89 lb in).

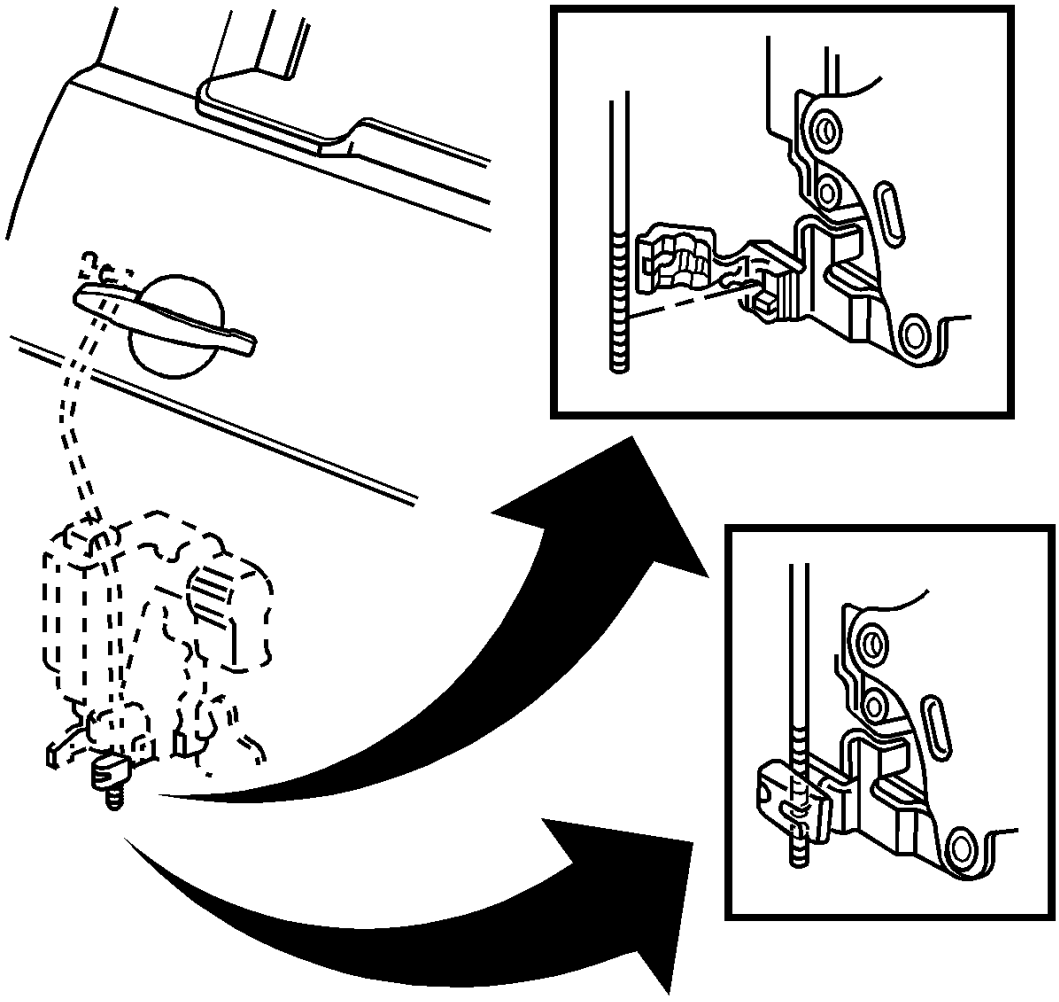


Fig. 15: View Of Handle Rod To Lock Clip
Courtesy of GENERAL MOTORS COMPANY

6. Install the outside handle rod into the clip
7. Close the clip cover over the outside handle rod.
8. Inspect the outside handle for proper operation.
9. Remove the masking tape.
10. Install the front door water deflector. Refer to **Front Side Door Water Deflector Replacement (Impala)** .
11. Install the front door trim panel. Refer to **Front Side Door Trim Panel Replacement** .

FRONT AND REAR SIDE DOOR OUTSIDE HANDLE ROD CLIP REPLACEMENT

Removal Procedure

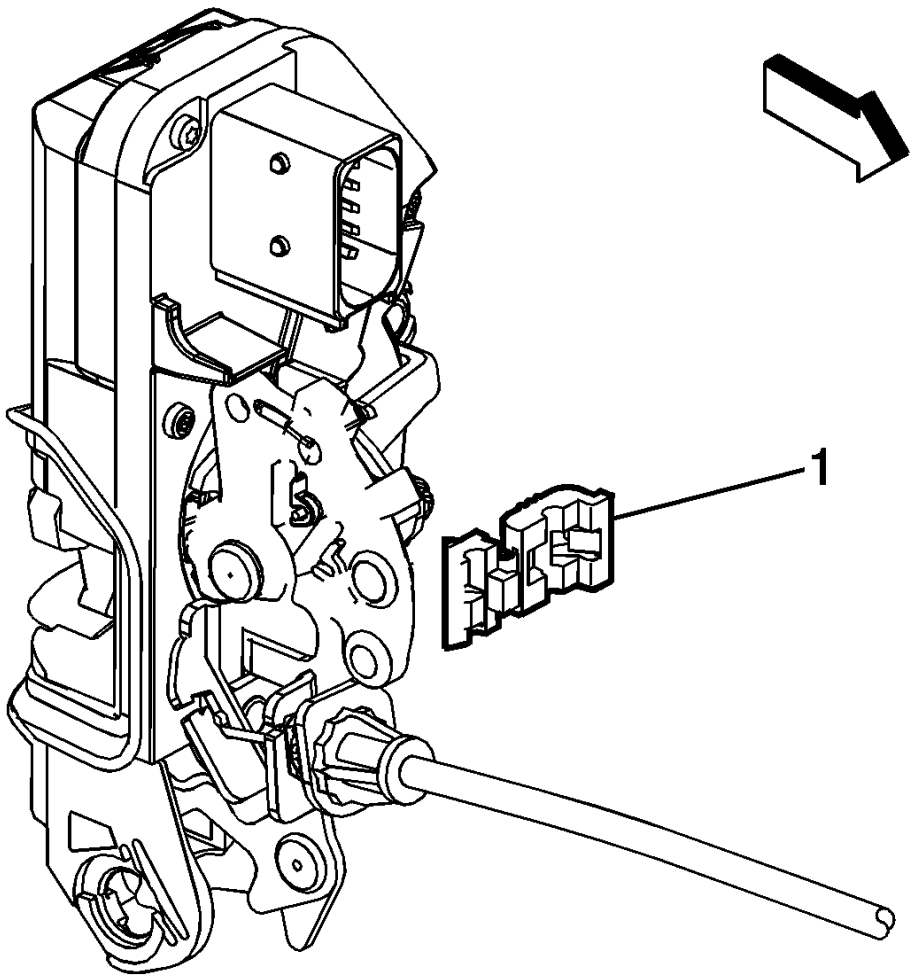


Fig. 16: Outside Door Handle Rod Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: **It maybe necessary to remove the front or rear side door latch from some of the vehicles to access the rod clip, refer to the appropriate procedure in this sub-section.**

1. Using the appropriate tool, open the outside door handle rod clip (1) on the latch.

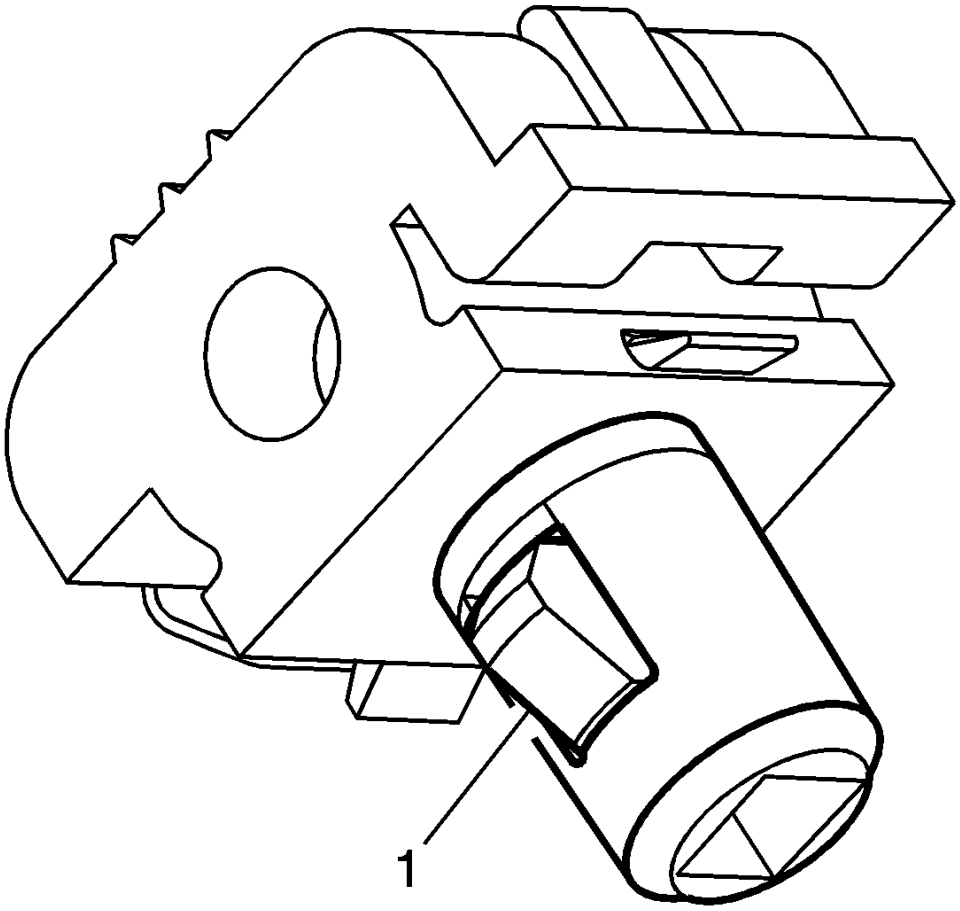


Fig. 17: Outside Door Handle Rod Clip Retaining Tabs
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The clip for the outside door handle rod is designed for one use only, a new clip Must be installed to the door latch to retain the outside handle rod.**

NOTE: **Use the appropriate tool to push in on the retaining tabs (1) located on each side of the old clip to remove.**

2. Remove the old outside door handle rod clip from the door latch.

Installation Procedure

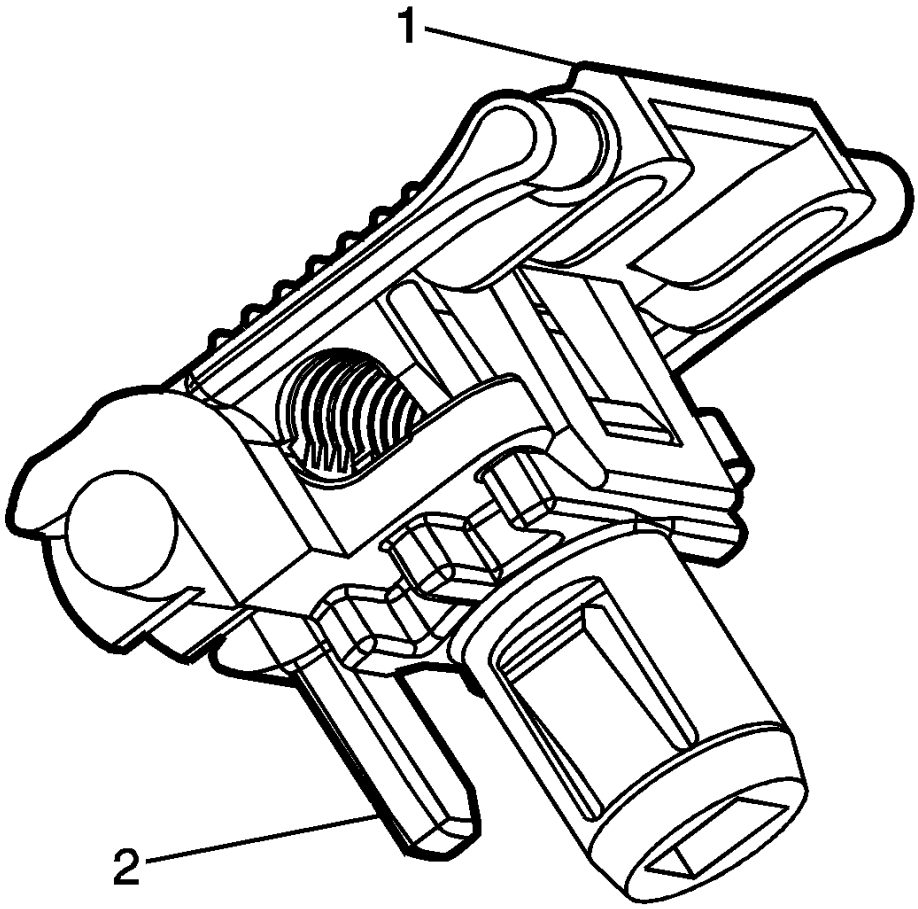


Fig. 18: Outside Door Handle Rod Clip
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When replacing the old designed outside door handle rod clip with the new designed clip (1) the anti rotation tab (2) will need to be removed.**

NOTE: **When installing the outside door handle rod to latch in order to prevent outside handle lever pre-load, the outside handle shall be fully secured to the door prior to securing integral latch clip to outside handle release rod. Push upward at the bottom the rod clip.**

1. Install the new outside door handle rod clip (1) to the latch.
2. Verify the outside door handle will release the door latch.

REAR SIDE DOOR OUTSIDE HANDLE REPLACEMENT

Removal Procedure

NOTE: **The outside handles have adjustable outside handle lock rods. This allows for adjustment of the amount of travel needed in order to operate the**

outside handle.

When servicing a vehicle with adjustable outside handle lock rods, remove all free play between the outside handle and the lock. Also, do not operate the outside handle before these connections are made.

1. Remove the rear door trim panel. Refer to **Rear Side Door Trim Panel Replacement** .
2. Remove the rear door water deflector. Refer to **Rear Side Door Water Deflector Replacement** .
3. Raise the window to the full up position.

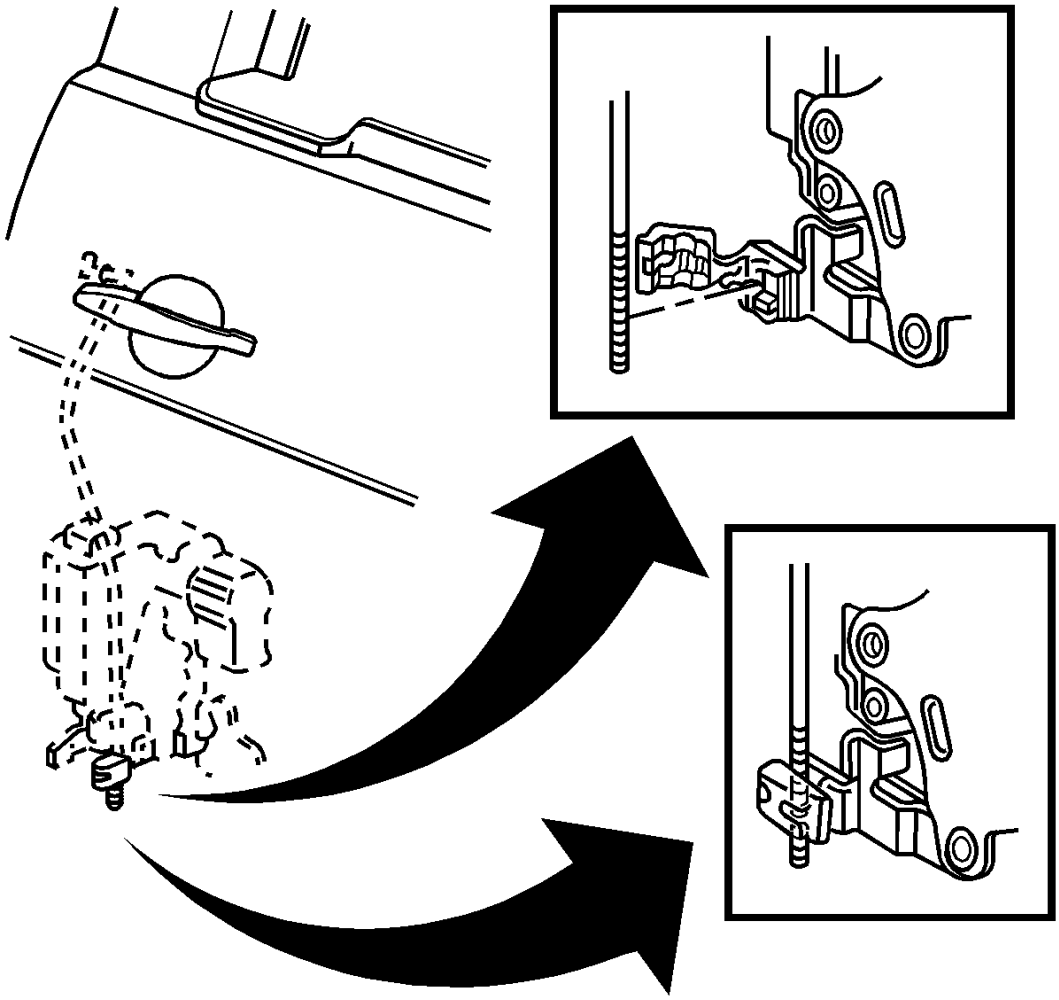


Fig. 19: View Of Handle Rod To Lock Clip
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Paint Damage Caution .

4. Apply masking tape around the outside handle.
5. Open the outside handle rod to lock clip located on the door lock.
6. Remove the rear door lock . Refer to **Rear Side Door Lock Replacement**.

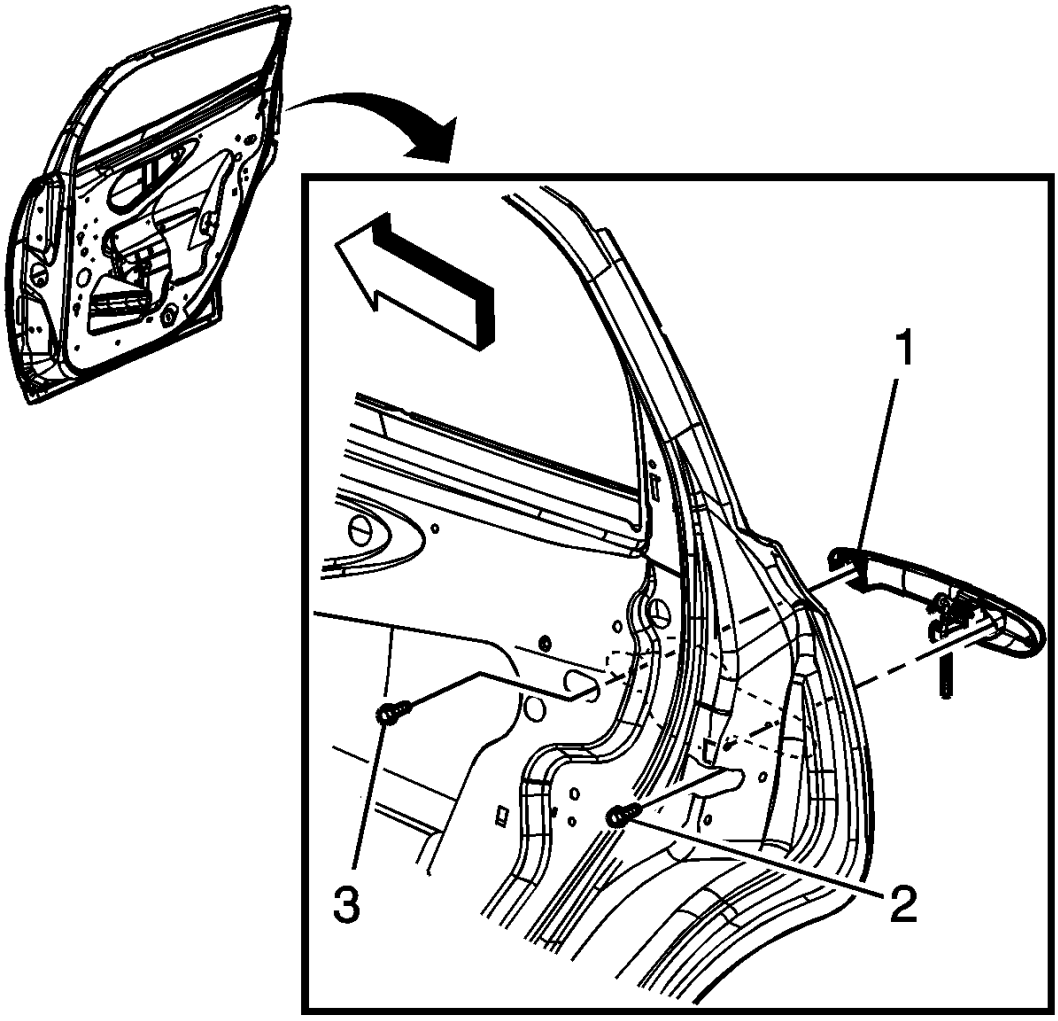


Fig. 20: View Of Rear Door Hinge Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the outside door handle bolt access tape.
8. Remove the bolts (3) from the rear door handle.
9. Remove the outside handle bolt (2) through the latch hole.

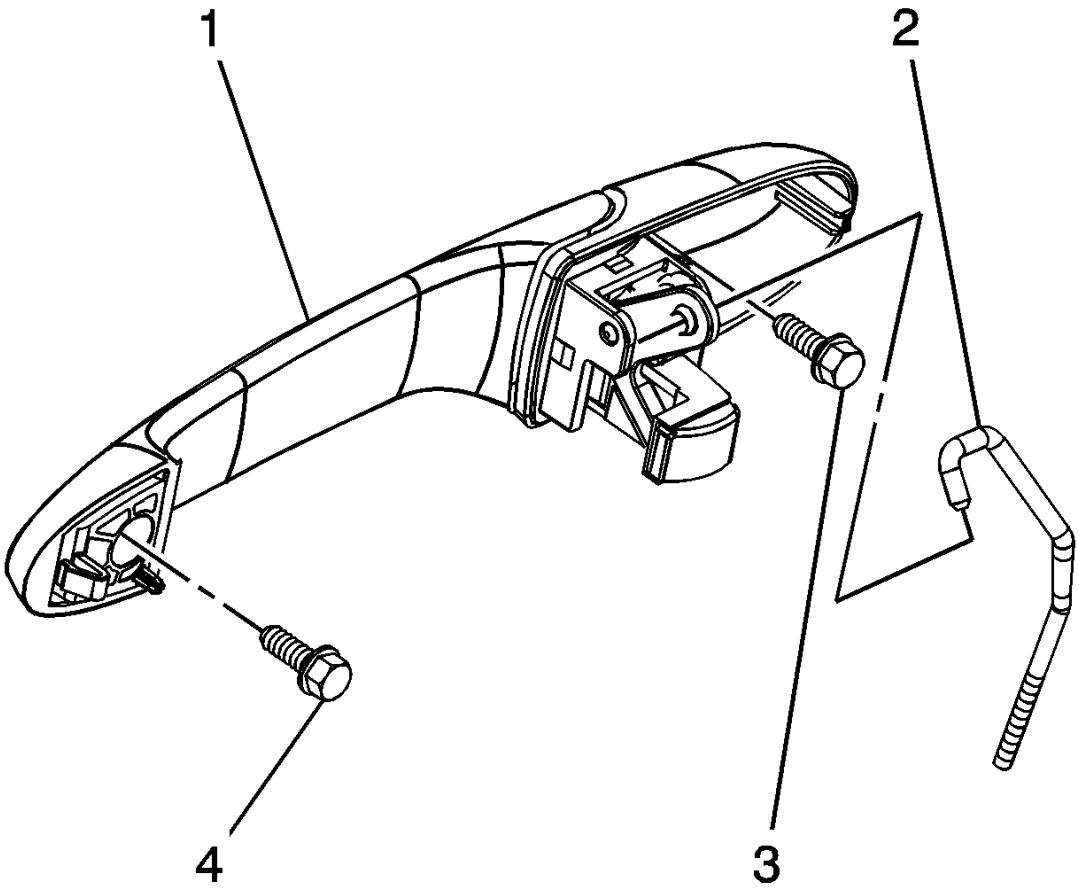


Fig. 21: Outside Door Handle and Rod
Courtesy of GENERAL MOTORS COMPANY

10. Remove the outside handle (1) and the rod (2) from the door.

Installation Procedure

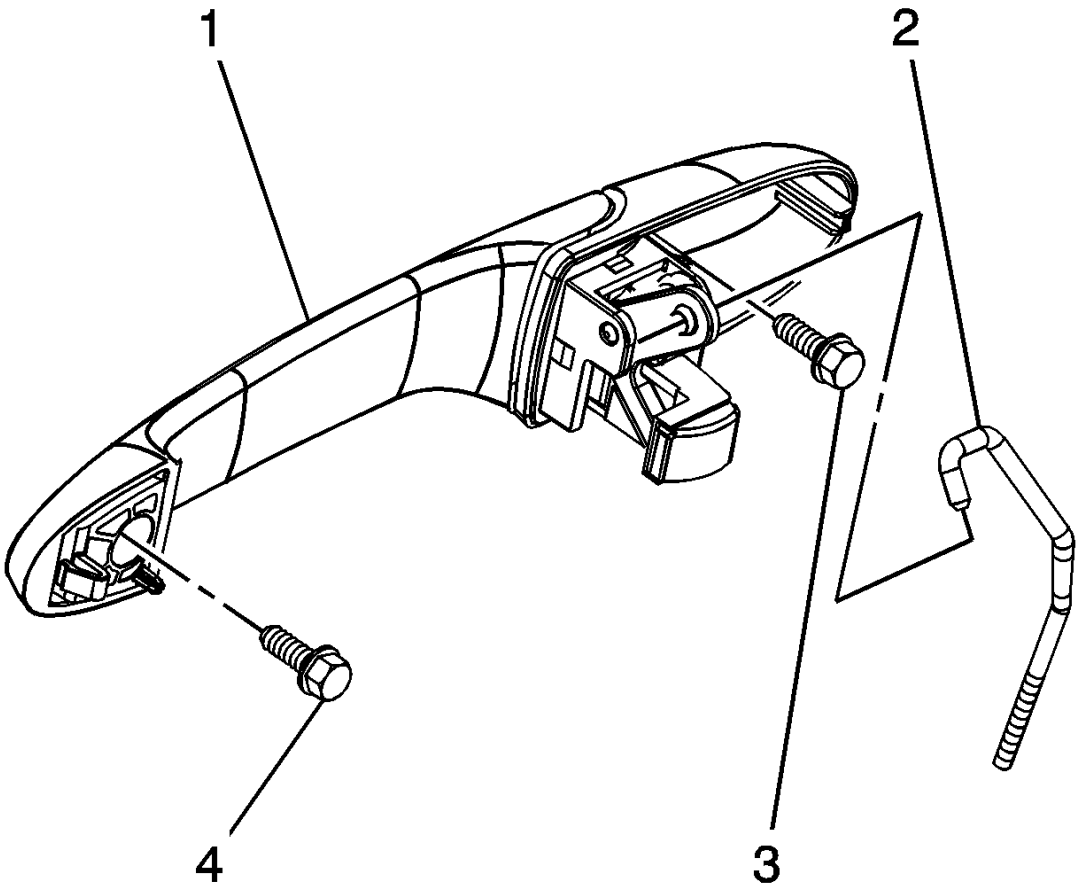


Fig. 22: Outside Door Handle and Rod
Courtesy of GENERAL MOTORS COMPANY

1. Install the outside door handle (1) and the rod (2) to the door.

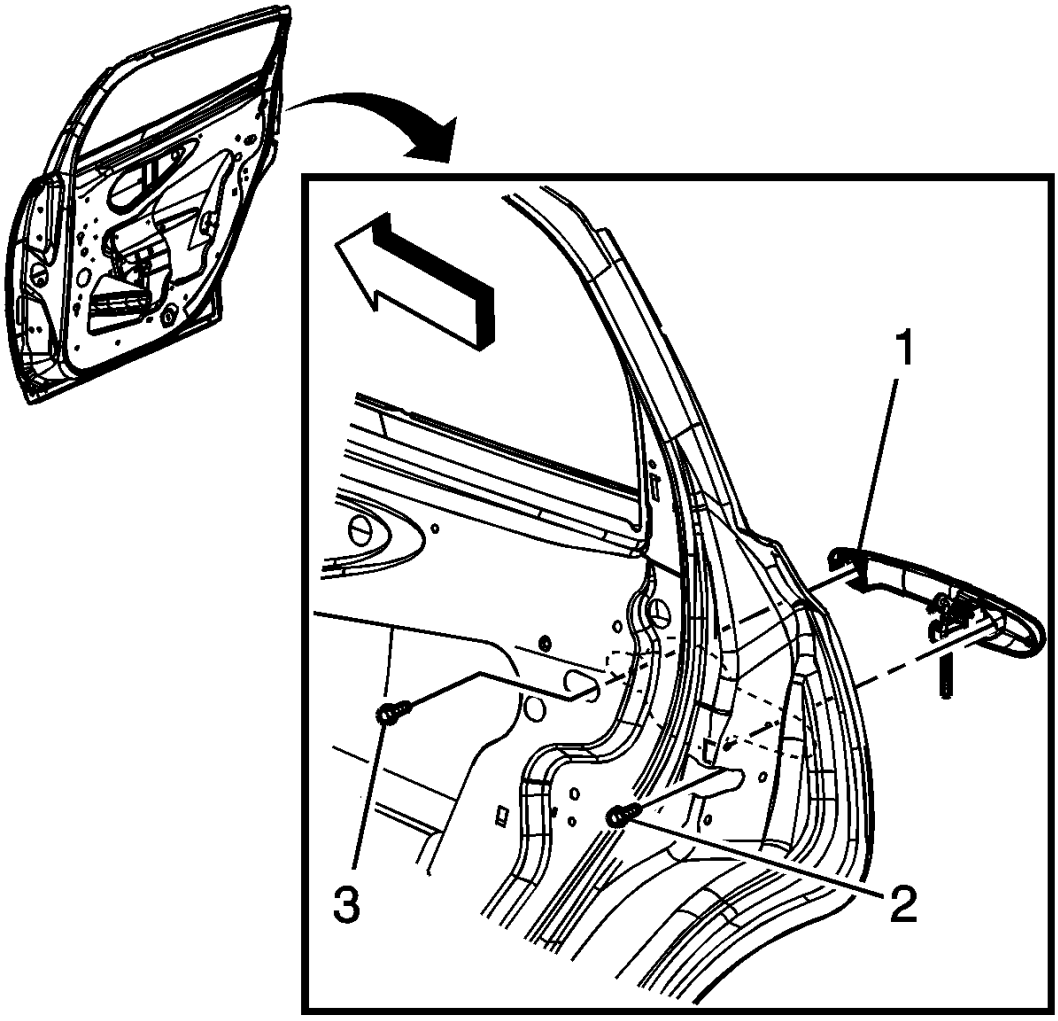


Fig. 23: View Of Rear Door Hinge Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the outside handle bolt (2) through the latch hole.

   Tighten

   Tighten the bolt to 10 N.m (89 lb in).

3. Install the bolts (3) to the rear door handle.

   Tighten

   Tighten the bolt to 10 N.m (89 lb in).

4. Install the rear door lock. Refer to **Rear Side Door Lock Replacement**.
5. Install the outside door handle bolt access tape.

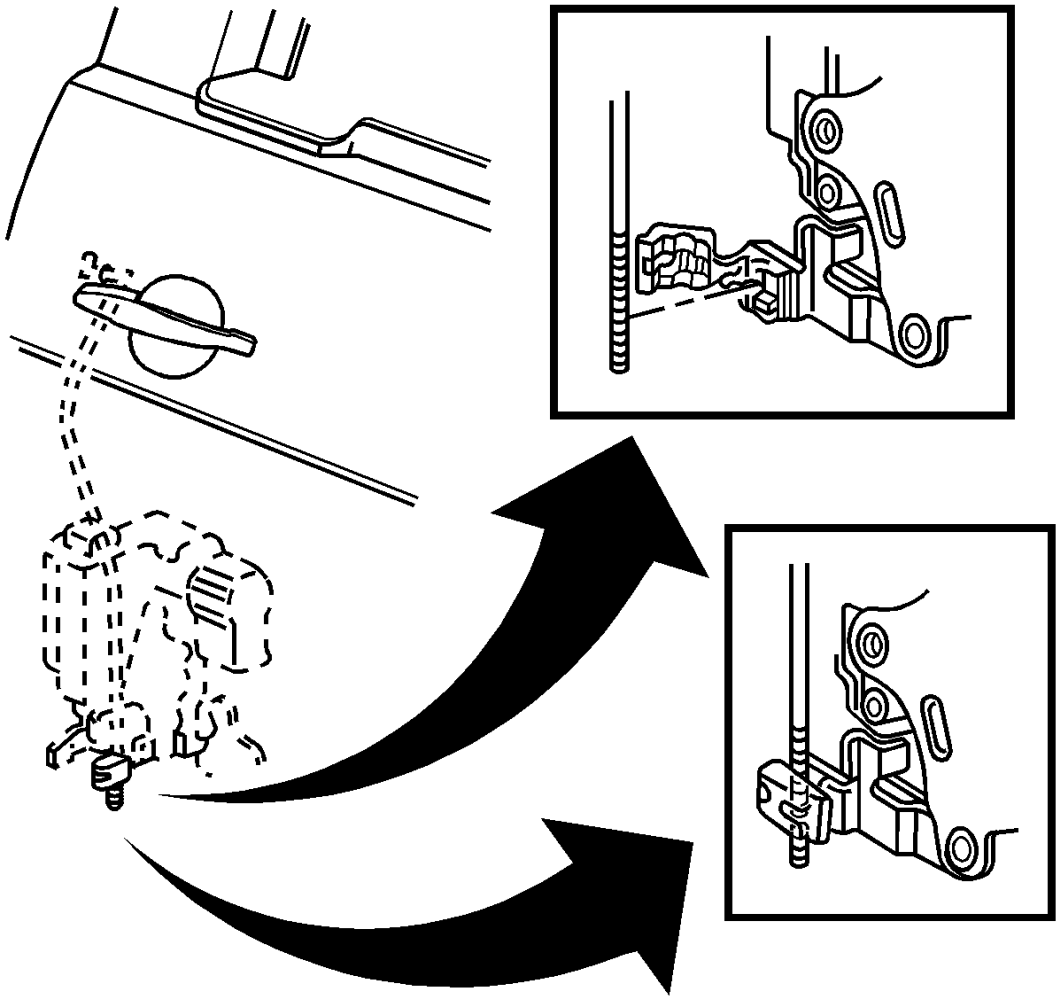


Fig. 24: View Of Handle Rod To Lock Clip
Courtesy of GENERAL MOTORS COMPANY

6. Install the outside handle rod into the clip.
7. Close the clip cover over the outside door handle rod.
8. Inspect the outside door handle for proper operation.
9. Remove the masking tape.
10. Install the rear door water deflector. Refer to **Rear Side Door Water Deflector Replacement** .
11. Install the rear door trim panel. Refer to **Rear Side Door Trim Panel Replacement** .

REAR COMPARTMENT LID LATCH REPLACEMENT

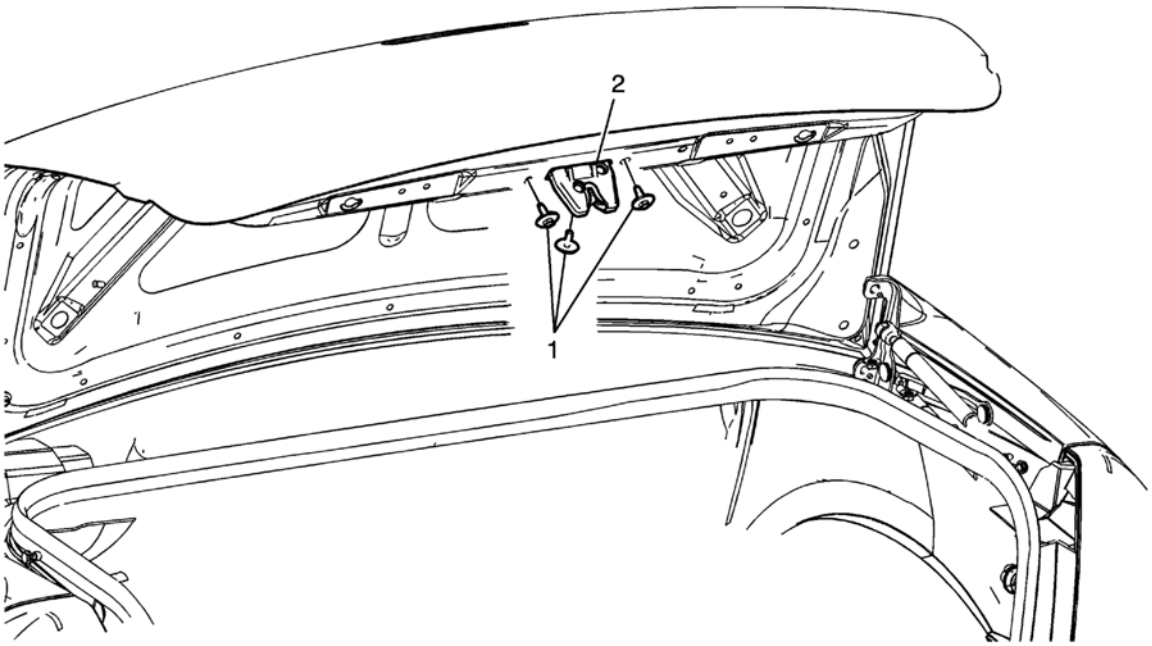


Fig. 25: Rear Compartment Lid Latch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Compartment Latch Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Rear Compartment Latch **TIP:** Disconnect the electrical connection.

FRONT SIDE DOOR LOCK REPLACEMENT

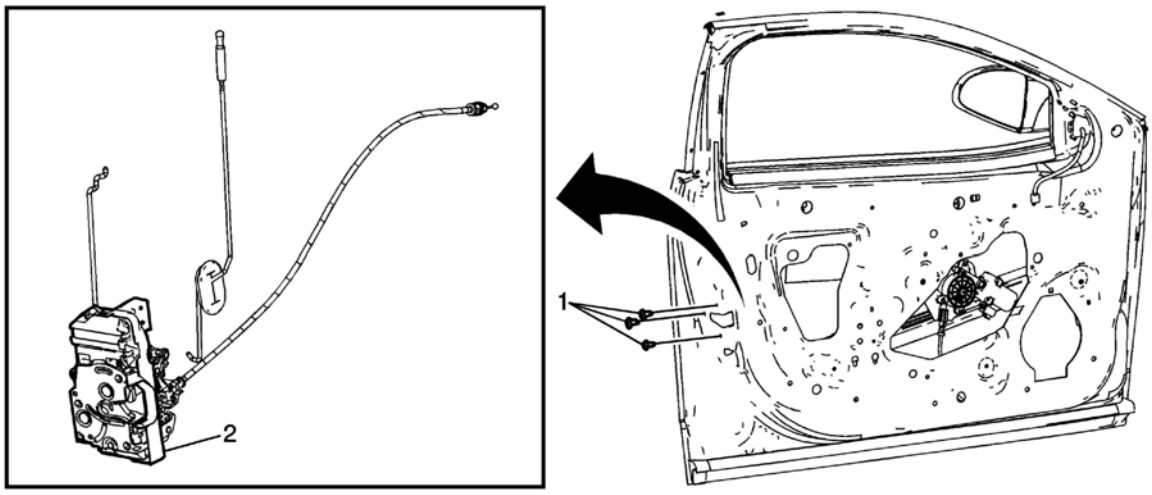


Fig. 26: Front Door Lock
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front side door trim panel. Refer to **Front Side Door Trim Panel Replacement** .	
1	Front Side Door Lock Screws (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution** . **Procedures** 1. Remove the water deflector. 2. Release the front inside door handle cable retainers from the door. 3. Remove the window run channel bolts, slide the channel to the side while removing the lock. 4. Release the door handle rod clip. **Tighten** 10 N.m (89 lb in)
2	Front Side Door Lock Assembly **Procedure** 1. Disconnect the front side door lock electrical connector. 2. Transfer the front side door lock rods.

REAR SIDE DOOR LOCK REPLACEMENT

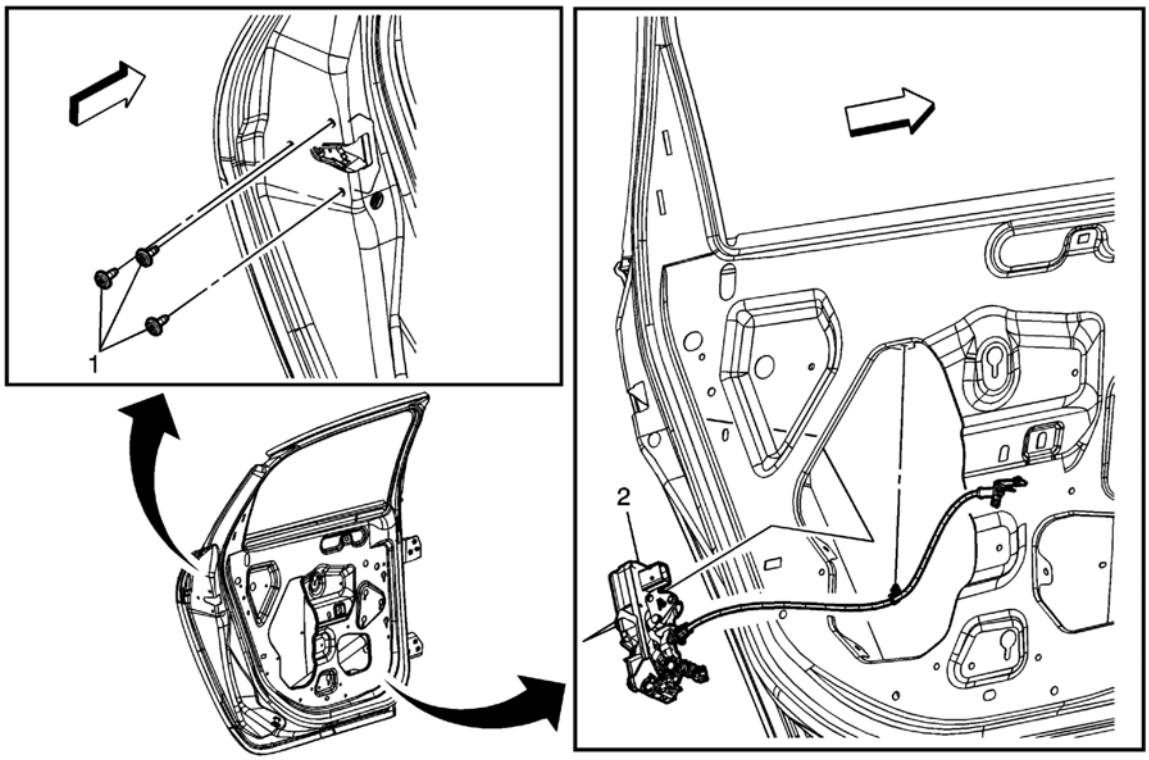


Fig. 27: Rear Door Lock
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear side door trim panel. Refer to **Rear Side Door Trim Panel Replacement** .	
1	Rear Side Door Lock Bolt (Qty: 3) **CAUTION:** **Refer to** **Fastener** **Caution** **.** **Procedure** 1. Remove the water deflector. 2. Release the inside handle cable retainers before removing the door lock. 3. Disconnect the door lock electrical connector. 4. Remove the window run channel bolts, slide the channel to the side while removing the lock. 5. Release the door handle rod clip. **Tighten** 10 N.m (89 lb in)

Callout	Component Name
2	Rear Side Door Lock Assembly **Procedure** Transfer the lock rods to the new door lock.

FRONT SIDE DOOR LOCKING ROD REPLACEMENT (IMPALA)

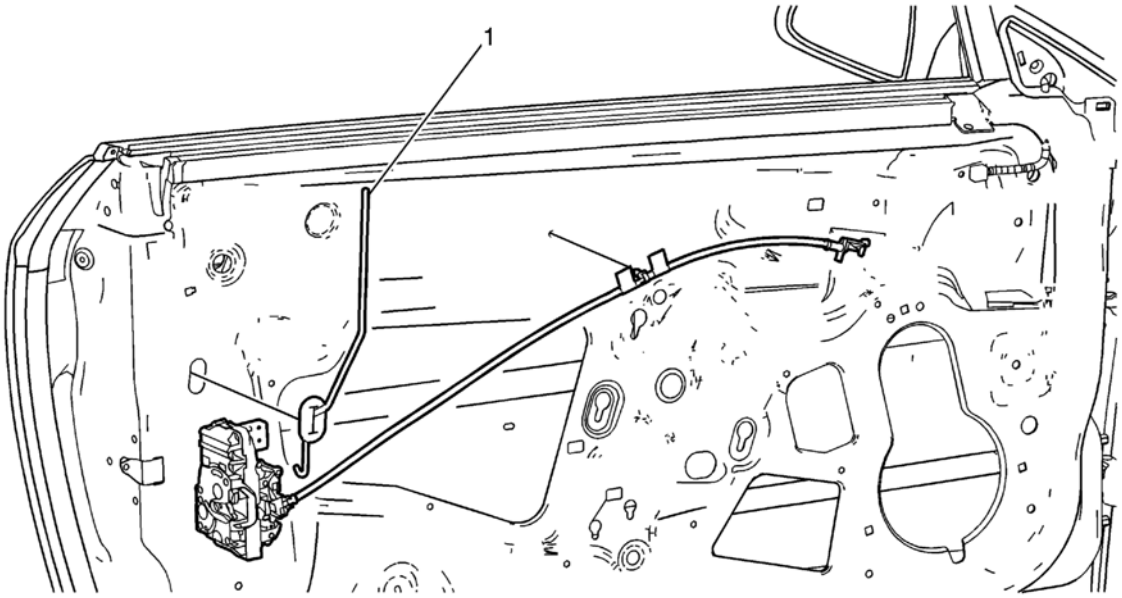


Fig. 28: View Of Front Side Door Locking Rod
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front side door lock. Refer to **Front Side Door Lock Replacement**.	
1	Front Side Door Lock Rod

FRONT SIDE DOOR OUTSIDE HANDLE ROD ADJUSTMENT

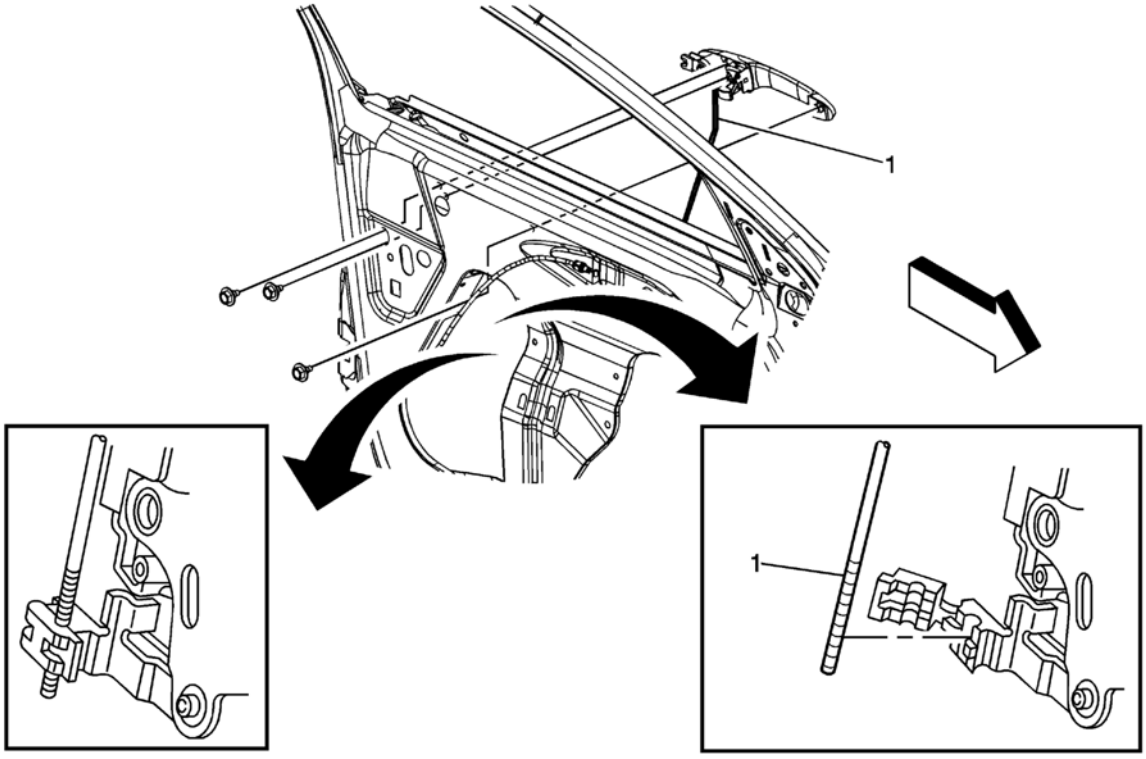


Fig. 29: Front Outside Door Handle Rod
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the front door trim panel. Refer to **Front Side Door Trim Panel Replacement** . 2. Remove the water deflector as needed. Refer to **Front Side Door Water Deflector Replacement (Impala)** .	
1	Outside Door Handle Rod **Procedure** 1. Use a flat-bladed tool to release the threaded rod (1) from the clip (2). 2. Position the rod in the clip in order to eliminate any free play in the outside door handle. 3. Inspect the door lock system for proper operation.

FRONT SIDE DOOR OUTSIDE HANDLE ROD REPLACEMENT

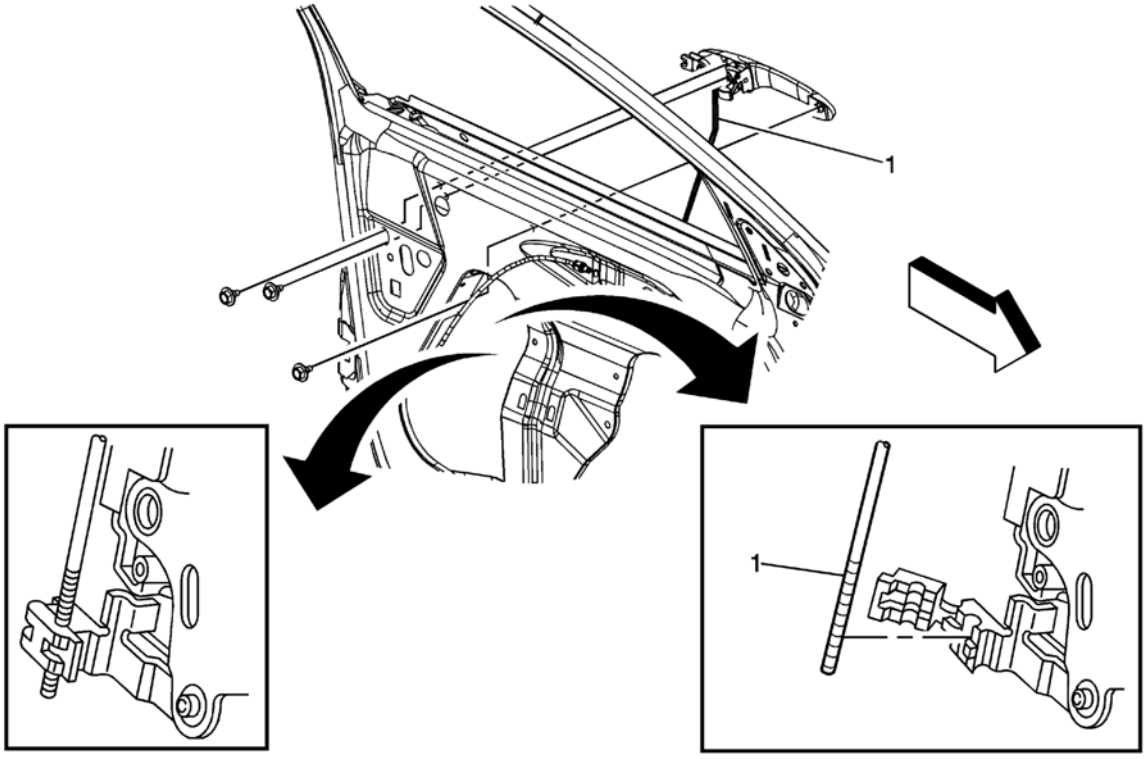


Fig. 30: Front Outside Door Handle Rod
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the outside door handle. Refer to **Front Side Door Outside Handle Replacement (Impala)**.	
1	Outside Door Handle Rod **Procedure** 1. Remove the water deflector as needed. Refer to **Front Side Door Water Deflector Replacement (Impala)** . 2. Use a flat-bladed tool to release the threaded rod from the clip. 3. Position the rod in the clip in order to eliminate any free play in the outside door handle. 4. Inspect the door lock system for proper operation before installing the trim panel.

REAR SIDE DOOR OUTSIDE HANDLE ROD ADJUSTMENT

Removal Procedure

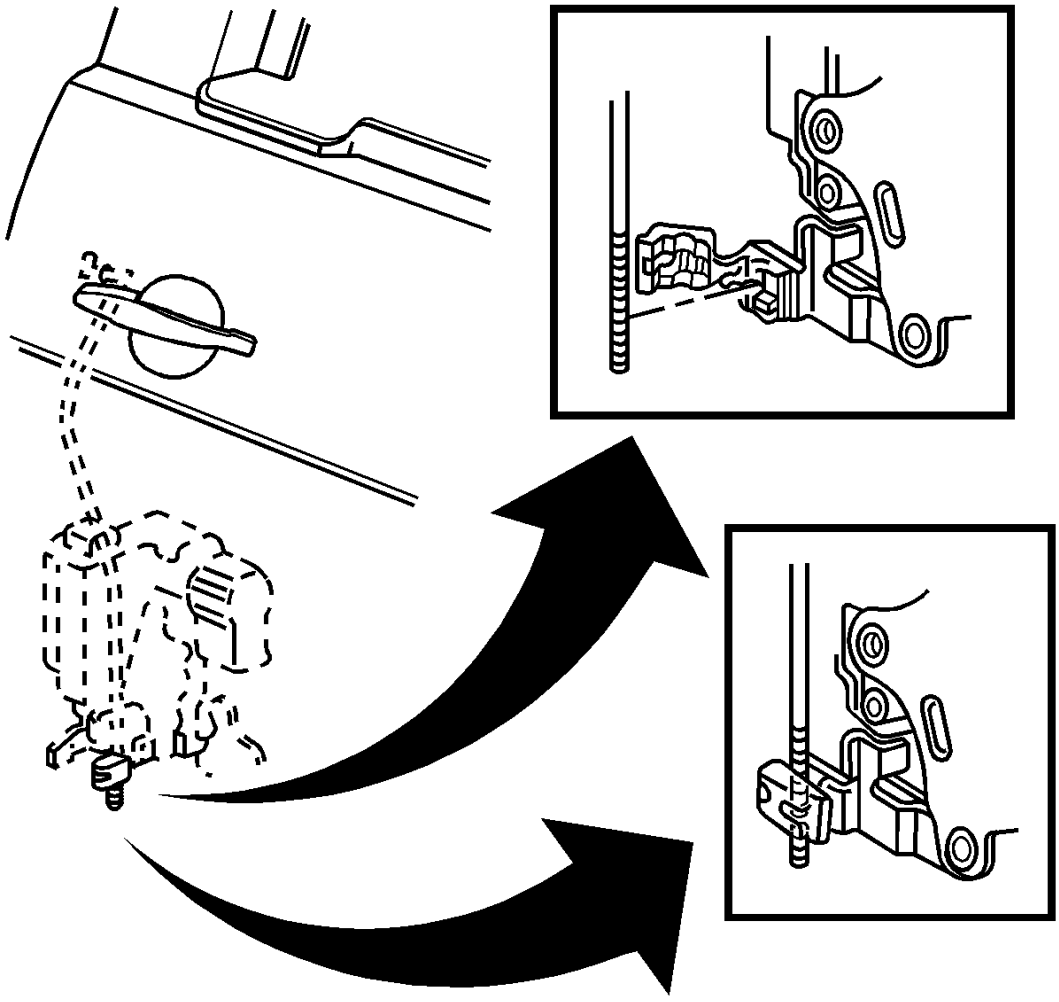


Fig. 31: View Of Handle Rod To Lock Clip
Courtesy of GENERAL MOTORS COMPANY

1. Remove the rear door trim panel. Refer to **Front Side Door Trim Panel Replacement** .
2. Remove the rear door water deflector as needed. Refer to **Rear Side Door Water Deflector Replacement** .
3. Use a flat-head tool to open the clip from the threaded rod connecting the lock to the outside handle.
4. Adjust the travel of the handle by removing the threaded rod from the clip.

Installation Procedure

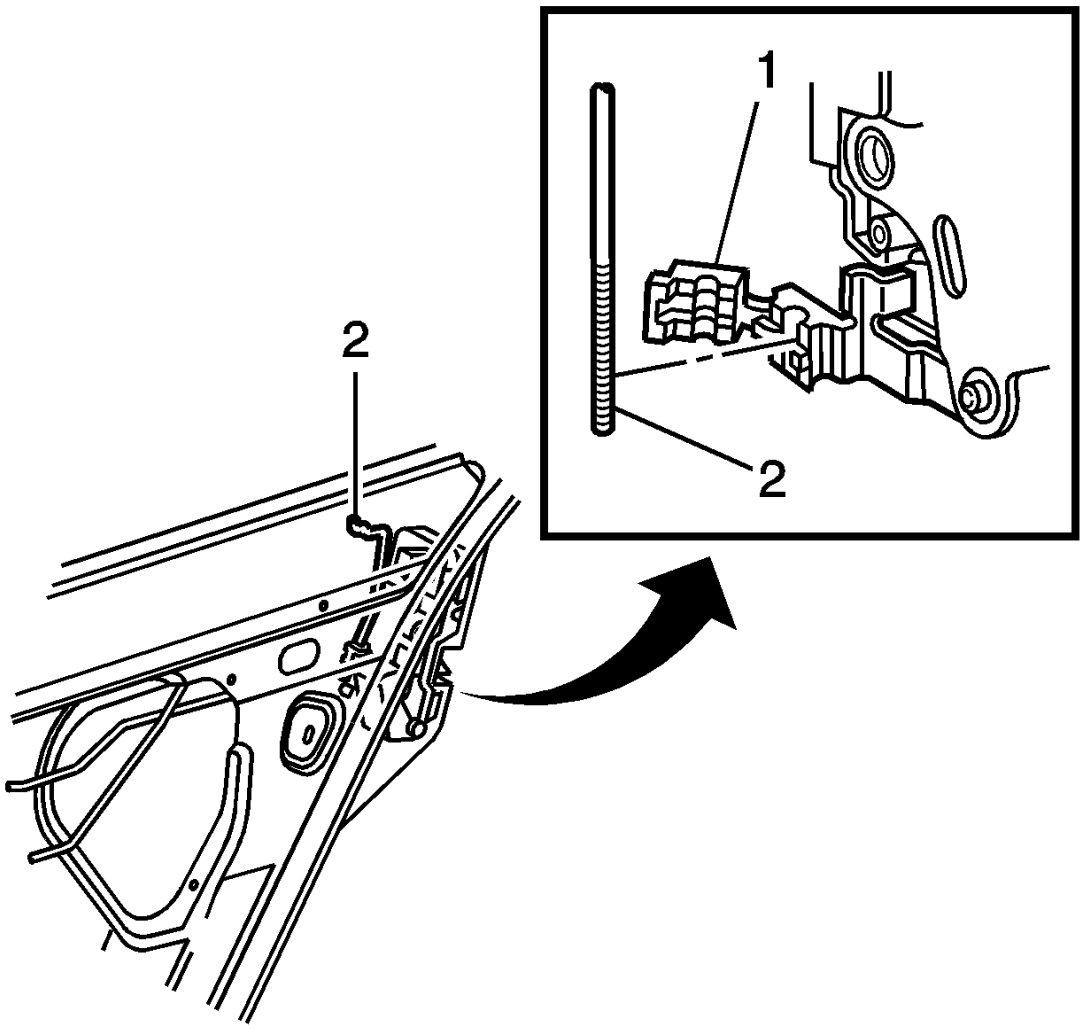


Fig. 32: Positioning Outside Door Handle Rod In Clip
Courtesy of GENERAL MOTORS COMPANY

1. Position the outside door handle rod (2) in the clip (1) in order to eliminate any free play in the outside door handle.
2. Install the clip cover closed over the threaded outside door handle rod.
3. Inspect the door lock system for proper operation.
4. Install the rear door water deflector as needed. Refer to **Rear Side Door Water Deflector Replacement** .
5. Install the rear door trim panel. Refer to **Front Side Door Trim Panel Replacement** .

DOOR LOCK STRIKER ADJUSTMENT (IMPALA) Special

Tools

J 39346-A Mini-Wedge Door Striker Aligner

NOTE: **Properly align the door before adjusting the striker.**

1. Open the door.

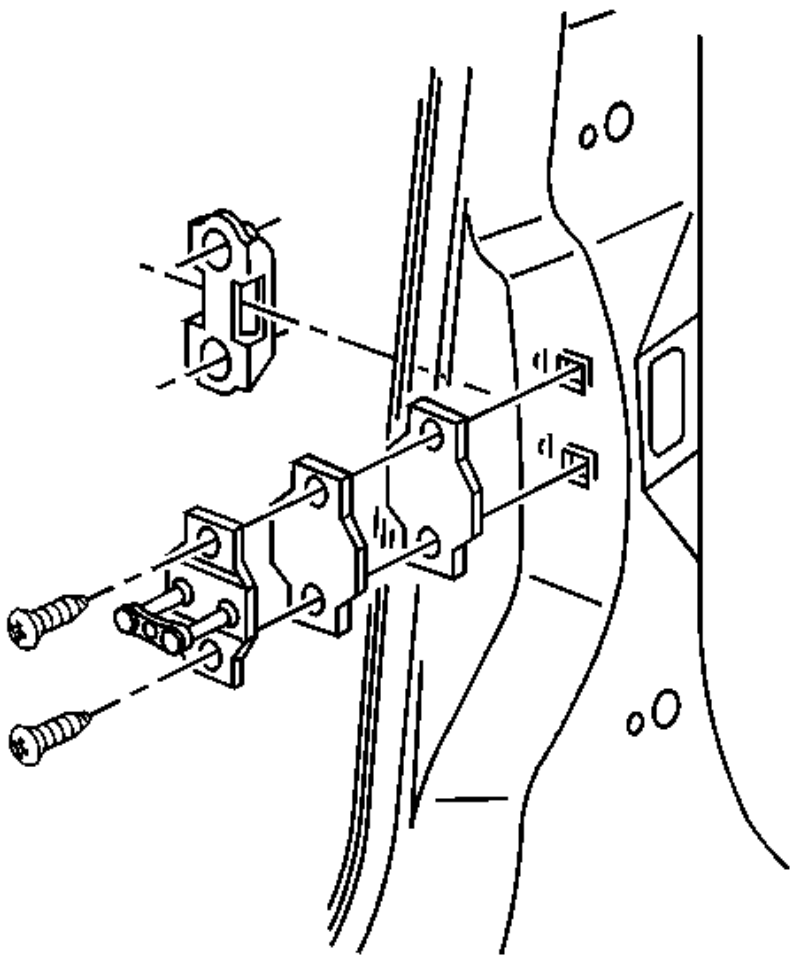


Fig. 33: View Of Lock Striker Components
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the door striker screws just enough to allow movement of the door striker.
3. Install the **J 39346-A** mini-wedge door striker aligner.

NOTE: **Do not slam the door.**

4. Close the door while holding the outside handle in the open position.
5. Open the door.

CAUTION: **Refer to Fastener Caution .**

6. Tighten the door lock striker screws.

Tighten

Tighten the door striker screws to 25 N.m (18 lb ft).

7. Remove the **J 39346-A** mini-wedge door striker aligner.
8. Close the door.

REAR COMPARTMENT LATCH STRIKER REPLACEMENT

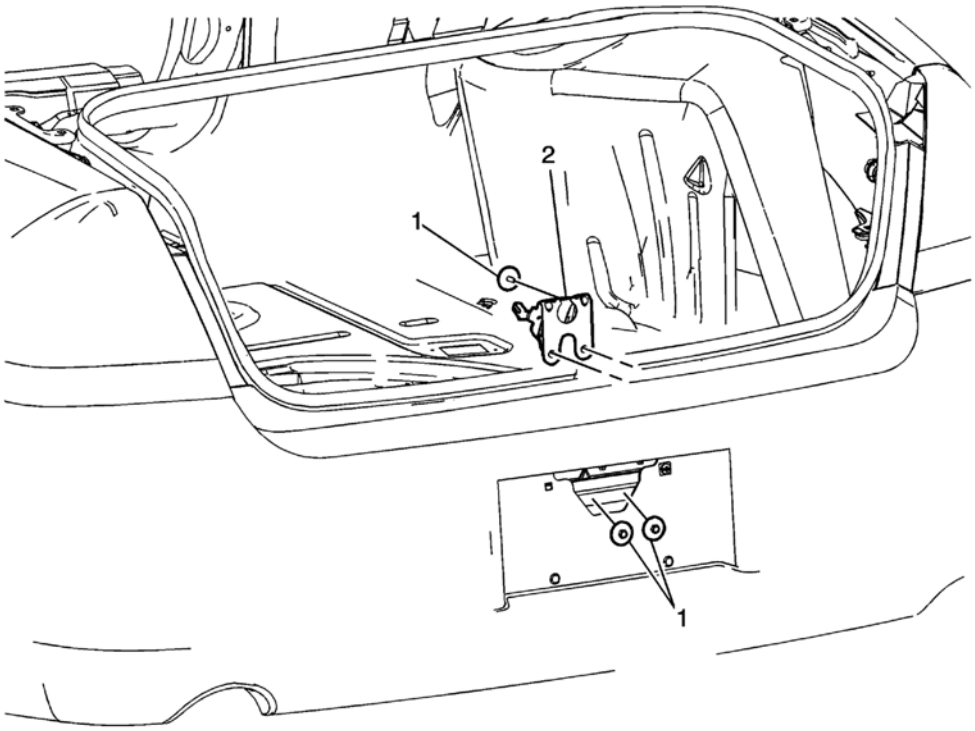


Fig. 34: Rear Compartment Latch Striker
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear compartment lid inner panel trim. Refer to **Rear Compartment Sill Trim Plate Replacement** .	
1	Latch Striker Bolt (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 25 N.m (19 lb ft)
2	Rear Compartment Lid Latch Striker **TIP:** Remove the licence plate to gain access to the 2 outer bolts.

DOOR LOCK SWITCH REPLACEMENT (IMPALA)

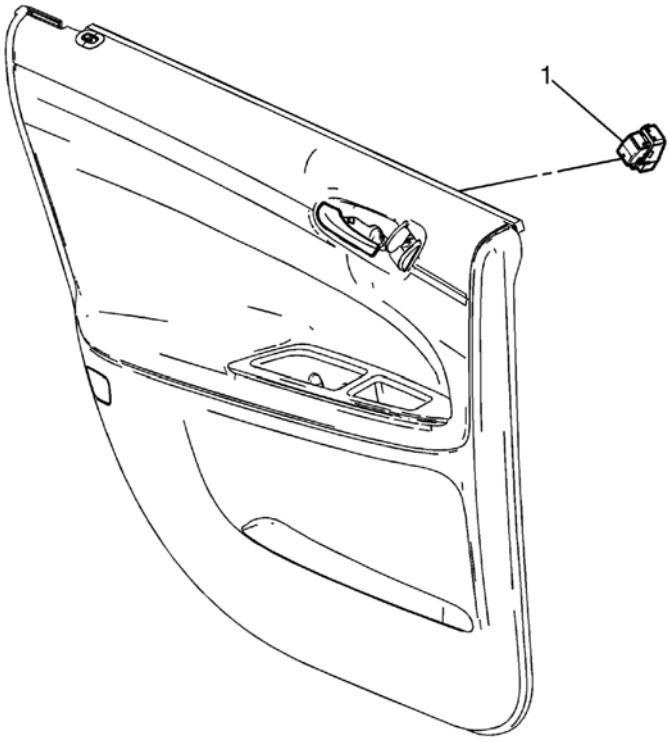


Fig. 35: Door Lock Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front side door trim panel. Refer to **Front Side Door Trim Panel Replacement** .	
1	Front Side Door Lock Switch Assembly **Procedure** Disconnect the electrical connector and remove from the back side of the door trim panel.

DESCRIPTION AND OPERATION

DOOR AJAR INDICATOR DESCRIPTION AND OPERATION

Door Ajar Indicator System Components

The door ajar indicator system consists of the following components:

- Body control module
- Instrument cluster
- Driver door latch
- Passenger door latch
- Left rear door latch
- Right rear door latch

Driver, Passenger and Rear Doors Ajar

The body control module provides a 12V signal to each door ajar switch within the door latch to indicate the status of the door. When the door is open, the contract within the ajar switch closes providing a ground path for the signal circuit. The body control module will detect the voltage drop in the ajar signal circuit and will send a message to the instrument cluster which will illuminate the door ajar icon

LUGGAGE COMPARTMENT DESCRIPTION AND OPERATION

Rear Compartment Lid System Components

The rear compartment lid release system consists of the following components:

- Rear Compartment Lid Latch
- Trunk Release Switch
- Trunk Release Relay
- Trunk Release 10A Fuse
- Body Control Module (BCM)

Rear Compartment Lid System Controls

The rear compartment lid may be released by any of the following:

- Trunk release switch activation
- Keyless entry trunk release command

Rear Compartment Lid Release Operation

In order for the rear compartment lid latch to release the trunk lid, the transaxle must be in the PARK position and the trunk release button is pressed or the trunk symbol on the remote keyless entry transmitter is pressed.

POWER DOOR LOCKS DESCRIPTION AND OPERATION

Power Door Locks System Components

The power window system consists of the following components:

- Body control module (BCM).
- Driver door lock cylinder switch.
- Front passenger door lock cylinder switch.
- Driver door lock switch.
- Front passenger door lock switch.
- Door lock actuators in each of the doors.
- DR LK Fuse 20-amp.

Door Lock System Controls

The Power Door Lock System is controlled by the body control module (BCM) and can be activated by any one of the following:

- A door lock switch lock or unlock actuation.

- A door lock cylinder switch unlock actuation.
- A keyless entry transmitter actuation.
- An automatic door lock actuation (Personalization function).
- An automatic door unlock actuation (Personalization function).
- A last door closed locking (LDCL) actuation (Personalization function).

Door Lock Operation

When the body control module (BCM) detects a transition of either of the door lock switches to the lock position, it switches the door lock actuator lock control circuit to voltage. Since the lock actuator unlock control circuits are at ground potential within the BCM, the door lock actuator motors transition to the lock position.

Driver Door Unlock Operation

When the body control module (BCM) detects a transition of either of the door lock switches to the unlock position, it switches the driver door lock actuator unlock control circuit to voltage. Since the door lock actuator lock control circuit is at ground potential within the BCM, the left front (LF) door lock actuator motor transitions to the Unlock position.

The driver door lock actuator unlock control circuit is a dedicated control circuit used only for the driver door lock actuator motor. This is done so that the driver door may be unlocked by itself using a keyless entry transmitter or an automatic door unlock function (if programmed).

Passenger Door Unlock Operation

When the body control module (BCM) detects a transition of either of the door lock switches to the unlock position, it switches the door lock actuator unlock control circuits to voltage. Since the door lock actuator lock control circuit is at ground potential within the BCM, the passenger door lock actuator motors transition to the unlock position.

The door lock actuator unlock control circuits are dedicated control circuits used only for the passenger door lock actuator motors. This is done so that the driver door may be unlocked separate from the passenger doors using a keyless entry transmitter or an automatic door unlock function (if programmed).

Lockout Prevention

This function is intended to prevent the vehicle operator from locking the doors if the key is left in the ignition and any vehicle door is open. The body control module (BCM) will react after locking all the doors by unlocking the driver door. The lockout prevention function can be overridden by manually locking the door.

Key Cylinder Unlock

The body control module (BCM) will provide unlocking of all the doors when either the driver or front passenger key cylinder switch is actuated to the unlock position for longer than one second.

Automatic Door Lock/Unlock

The automatic door lock/unlock function is a Vehicle Personalization feature with the following four programmable modes of operation:

1. The automatic door lock feature is disabled.

2. All of the doors lock when the vehicle is shifted out of Park with the ignition ON.
3. All of the doors lock when the vehicle is shifted out of Park with the ignition ON, and only the driver door Unlocks when the vehicle is shifted into Park.
4. All of the doors lock when the vehicle is shifted out of Park with the ignition ON, and all of the doors Unlock when the vehicle is shifted into Park.

The automatic door lock function can only be enabled by the body control module (BCM) if the driver door open switch and door ajar switches are in the Closed state. For information on programming the automatic door locks, refer to the owners manual.

Air Bag Deployment Unlock

The body control module (BCM) will provide unlocking of all the doors 15 seconds after determining the air bags have been deployed.

Article GUID: A00737170

ACCESSORIES AND EQUIPMENT

Mirrors - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Outside Rearview Mirror	10 N.m	89 lb in
Outside Rearview Mirror Motor	10 N.m	89 lb in
Rearview Mirror Screw	1.8 N.m	16 lb in

SCHEMATIC WIRING DIAGRAMS

INSIDE REARVIEW MIRROR WIRING SCHEMATICS

Inside Rearview Mirror

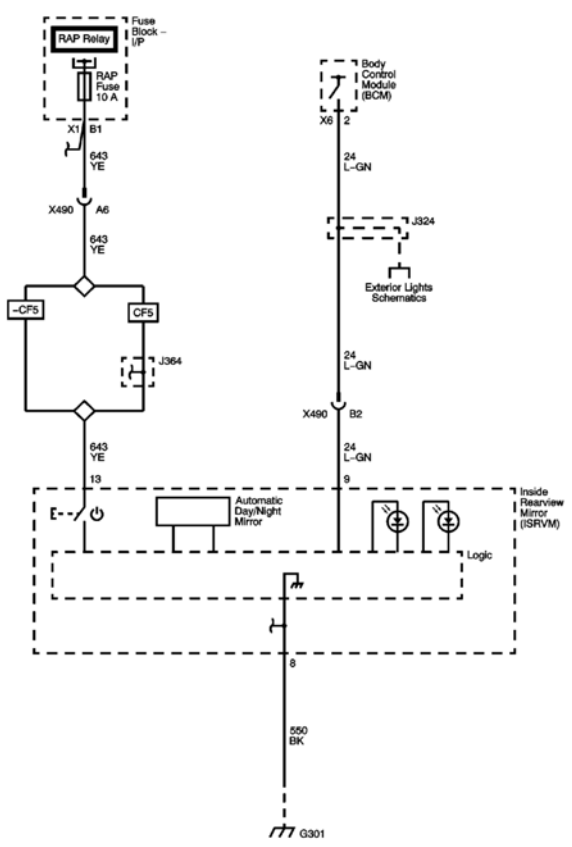


Fig. 1: Inside Rearview Mirror Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

OUTSIDE REARVIEW MIRROR WIRING SCHEMATICS

Outside Rearview Mirrors

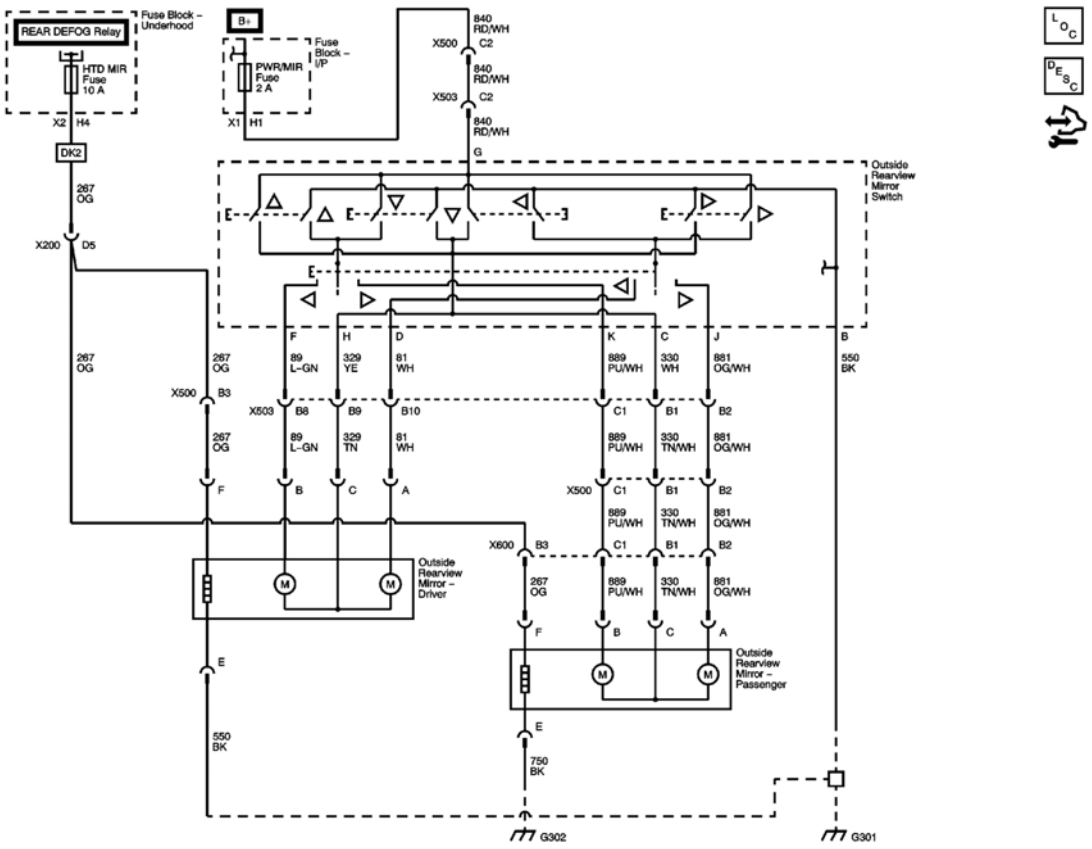


Fig. 2: Outside Rearview Mirror Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - MIRRORS

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following system descriptions:
   - **Automatic Day-Night Mirror Description and Operation**
   - **OnStar Description and Operation**
   - **Outside Mirror Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Automatic Day-Night Mirrors Malfunction**
- **Heated Mirrors Malfunction**
- **OnStar Button LED Malfunction**
- **OnStar Button Malfunction**
- **Power Mirror Malfunction**

HEATED MIRRORS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Heated Mirror Element Control	1	1	2	-
Ground	-	1	-	-
1. Heated Mirror Inoperative 2. Heated Mirror Always On				

Circuit/System Description

The REAR DEFOG relay supplies voltage to the outside rearview mirror heater elements based on the current state of the rear window defogger. The relay supplies B+ through the driver/passenger mirror heating element control circuits when a request is seen.

Reference Information

Schematic Reference

Outside Rearview Mirror Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Outside Mirror Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Verification

1. Ignition ON, press the rear window defogger switch. Verify the rear window defogger turns ON and the rear window becomes warm.
    - If the rear window defogger does not turn on, refer to Rear Window Defogger Malfunction .
2. Verify both the left and right outside mirror glass become warm.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the outside rearview mirror.
2. Test for less than 10 ohms between the ground circuit terminal E and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the heater element control circuit terminal F and ground.
4. Ignition ON, operate the rear window defogger ON and OFF with the rear defogger switch. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance.
5. If all circuits test normal, test or replace the outside rearview mirror glass.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

Outside Rearview Mirror Glass Replacement

AUTOMATIC DAY-NIGHT MIRRORS MALFUNCTION

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-
Backup Lamp Control	B2545 00	2	2	-
Ground	-	1	-	-
1. Automatic Mirror Dimming Inoperative 2. Mirror Automatic Day-Night Disable Feature Malfunction				

Circuit/System Description

The inside rearview mirror uses 2 photocell sensors. One sensor is the rear light sensor, located on the face side of the mirror, facing the rear of the vehicle. The rear light sensor is used to determine light conditions present at the mirror face. The other sensor is the front light sensor, located on the backside of the mirror, facing the front of the vehicle. The front light sensor is used to determine the exterior light conditions at the front of the vehicle. With a low exterior light condition detected by the front light sensor and a high light condition from the rear light sensor, the inside rearview mirror will automatically darken the face of the inside rearview mirror.

With the gear selector lever in the REVERSE position, backup lamp control voltage is supplied as an input to the inside rearview mirror. The mirror monitors this input to disable the automatic day-night feature. This allows the driver to see objects in the mirror clearly when backing up, regardless of the rear light sensor status.

Reference Information

Schematic Reference

Inside Rearview Mirror Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Automatic Day-Night Mirror Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

2. Cover the windshield with a blanket or other suitable item.
3. Verify the A10 Inside Rearview Mirror face dims when shining a bright light into the rear light sensor
    - **If the A10 Inside Rearview Mirror does not dim**

      Refer to Circuit/System Testing - Inside Review Mirror Dimming Inoperative

    - **If the A10 Inside Rearview Mirror dims**
4. Verify the A10 Inside Rearview Mirror face transitions from dim to bright while commanding the Backup Lamps On and Off with a scan tool.
    - **If the A10 Inside Rearview Mirror does not transition between dim and bright.**

      Refer to Circuit/System Testing - Day-Night Disable Malfunction

    - **If the A10 Inside Rearview Mirror transitions between bright and dim states**
5. All OK.

Circuit/System Testing

Inside Review Mirror Dimming Inoperative

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A10 Inside Rearview Mirror. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 8 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal 13 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, refer to **Retained Accessory Power Malfunction** .
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the ignition circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the A10 Inside Rearview Mirror.
    - **If the test lamp illuminates**
5. Replace the A10 Inside Rearview Mirror.

Day-Night Disable Malfunction

1. Ignition OFF, disconnect the harness connector at the A10 Inside Rearview Mirror.
2. Connect a test lamp between the control circuit terminal 9 and ground
3. Ignition ON, verify the test lamp turns ON and OFF while commanding the Backup Lamps On and Off with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module.
    2. Test for infinite resistance between the control circuit terminal 9 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, refer to **Backup Lamps Malfunction** .
    - **If the test lamp is always ON**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K9 Body Control Module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, refer to **Backup Lamps Malfunction**
    - **If the test lamp turns ON and OFF**
4. Replace the A10 Inside Rearview Mirror.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Inside Rearview Mirror Replacement

POWER MIRROR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Outside Rearview Mirror Switch B+	1	1	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Mirror Motor Horizontal Control	1	2	2	-
Driver Mirror Motor Vertical Control	1	2	2	-
Passenger Mirror Motor Horizontal Control	1	3	3	-
Passenger Mirror Motor Vertical Control	1	3	3	-
Outside Rearview Mirror Switch Ground	-	1	-	-
1. Both Outside Power Mirrors Inoperative 2. Driver Outside Power Mirror Malfunction 3. Passenger Outside Power Mirror Malfunction				

Circuit/System Description

The outside rearview mirror switch controls the outside rearview mirrors based on the position of the mirror selector switch and which movement position is selected. The outside rearview mirror switch has four positions: up, down, left, and right. B+ is applied to the switch and when a movement position switch is selected, B+ is sent to the mirror via a motor control circuit. The opposite motor control circuit acts as a ground circuit for the bi-directional mirror motor.

Reference Information

Schematic Reference

Outside Rearview Mirror Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Outside Mirror Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition ON.
2. Verify the mirror glass of the A9A Outside Rearview Mirror-Driver and the A9B Outside Rearview

Mirror-Passenger move UP, DOWN, LEFT and RIGHT with the S52 Outside Rearview Mirror Switch.

- **If both outside mirror glasses do not move**

  Refer to Circuit/System Testing - Both Outside Rearview Mirrors Inoperative.

- **If the driver outside mirror glass does not move UP, DOWN, LEFT or RIGHT**

  Refer to Circuit/System Testing - Driver Outside Mirror Movement Malfunction.

- **If the passenger outside mirror glass does not move UP, DOWN, LEFT or RIGHT**

  Refer to Circuit/System Testing - Passenger Outside Mirror Movement Malfunction.

- **If the mirror glass of the A9A Outside Rearview Mirror-Driver and the A9B Outside Rearview Mirror-Passenger move UP, DOWN, LEFT and RIGHT**

3. All OK.

Circuit/System Testing

Both Outside Rearview Mirrors Inoperative

1. Ignition OFF, disconnect the harness connector at the S52 Outside Rearview Mirror Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal B and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
3. Verify a test lamp illuminates between the B+ circuit terminal G and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for infinite resistance between each of the control circuit terminals listed below and ground:
      - Control circuit terminal C
      - Control circuit terminal D

- Control circuit terminal F
- Control circuit terminal H
- Control circuit terminal J
- Control circuit terminal K
- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the S52 Outside Rearview Mirror Switch.

- **If the test lamp illuminates**

4. Test or replace the S52 Outside Rearview Mirror Switch.

Driver Outside Mirror Movement Malfunction

1. Ignition OFF, disconnect the harness connector at the M77D Outside Rearview Mirror Motor-Driver. Ignition ON
2. Connect a test lamp between the control circuit terminal B and control circuit terminal C.
3. Verify the test lamp turns ON when commanding the UP and DOWN states with the S52 Outside Rearview Mirror Switch.
   - **If the test lamp remains OFF during either of the commands**
   1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
   2. Test for infinite resistance between each control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in each control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, test or replace the S52 Outside Rearview Mirror Switch.
   - **If the test lamp is always ON**
   1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, Ignition ON.
   2. Test for less than 1 V between each control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, test or replace the S52 Outside Rearview Mirror Switch
   - **If the test lamp turns ON during each of the commands**
4. Connect a test lamp between the control circuit terminal A and control circuit terminal C.
5. Verify the test lamp turns ON when commanding the LEFT and RIGHT states with the S52 Outside Rearview Mirror Switch.
   - **If the test lamp remains OFF during either of the commands**
   1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
   2. Test for infinite resistance between each control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance

3. Test for less than 2 Ω in each control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, test or replace the S52 Outside Rearview Mirror Switch.

- **If the test lamp is always ON**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, Ignition ON.
2. Test for less than 1 V between each control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, test or replace the S52 Outside Rearview Mirror Switch

- **If the test lamp turns ON during each of the commands**

6. Test or replace the M77D Outside Rearview Mirror Motor-Driver.

Passenger Outside Mirror Movement Malfunction

1. Ignition OFF, disconnect the harness connector at the M77P Outside Rearview Mirror Motor-Passenger. Ignition ON
2. Connect a test lamp between the control circuit terminal B and control circuit terminal C.
3. Verify the test lamp turns ON when commanding the UP and DOWN states with the S52 Outside Rearview Mirror Switch.
    - **If the test lamp remains OFF during either of the commands**

    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
    2. Test for infinite resistance between each control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in each control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, test or replace the S52 Outside Rearview Mirror Switch.

    - **If the test lamp is always ON**

    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, Ignition ON.
    2. Test for less than 1 V between each control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, test or replace the S52 Outside Rearview Mirror Switch

    - **If the test lamp turns ON during each of the commands**

4. Connect a test lamp between the control circuit terminal A and control circuit terminal C.
5. Verify the test lamp turns ON when commanding the LEFT and RIGHT states with the S52 Outside Rearview Mirror Switch.
    - **If the test lamp remains OFF during either of the commands**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch.
2. Test for infinite resistance between each control circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in each control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, test or replace the S52 Outside Rearview Mirror Switch.

- **If the test lamp is always ON**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the S52 Outside Rearview Mirror Switch, Ignition ON.
2. Test for less than 1 V between each control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, test or replace the S52 Outside Rearview Mirror Switch

- **If the test lamp turns ON during each of the commands**

6. Test or replace the M77P Outside Rearview Mirror Motor-Passenger.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Power Mirror Switch Replacement**
- **Outside Rearview Mirror Motor Replacement**

REPAIR INSTRUCTIONS

POWER MIRROR SWITCH REPLACEMENT

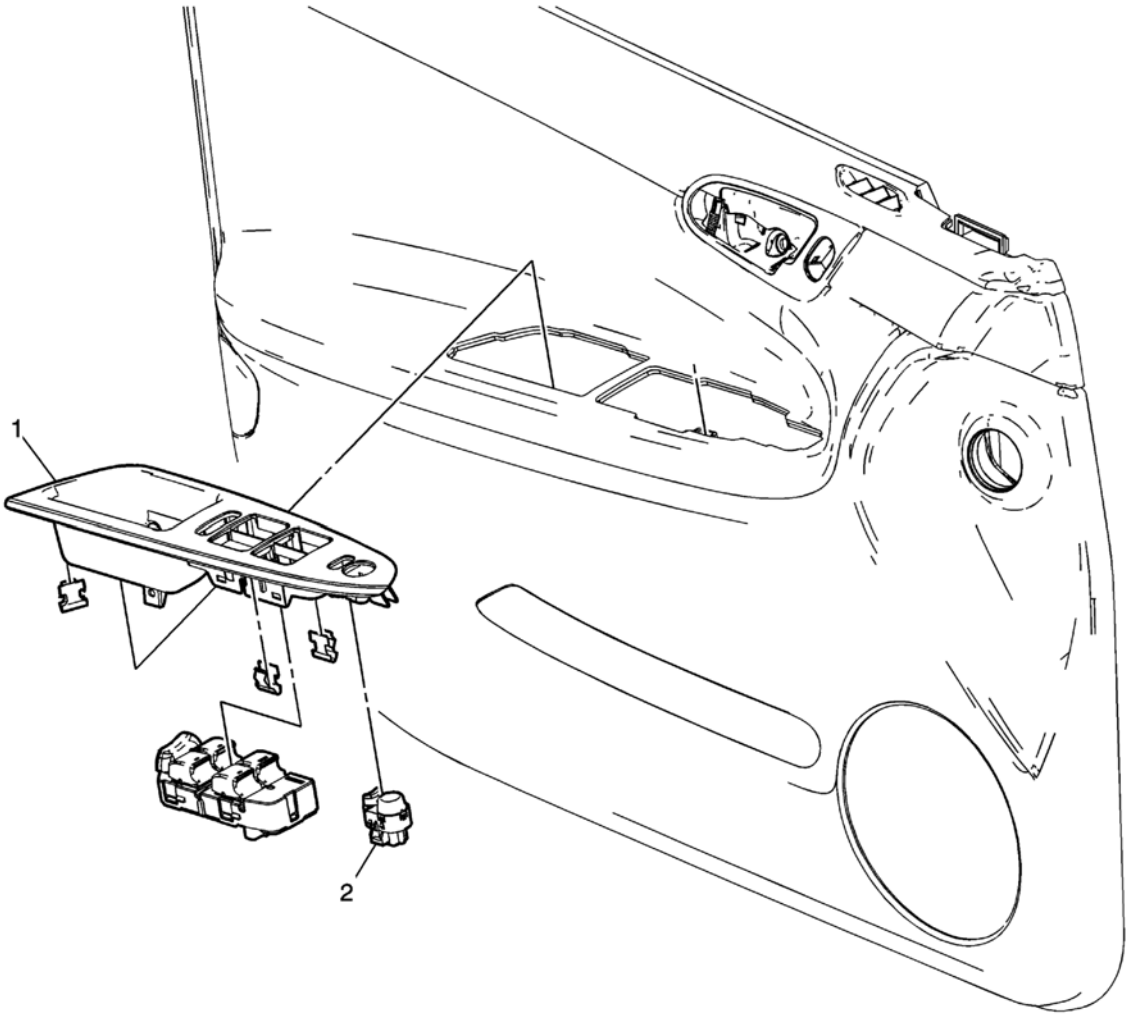


Fig. 3: Identifying Power Mirror Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Side Window Switch Bezel Refer to **Front Side Door Window Switch Bezel Replacement** .
2	Outside Rear View Mirror Switch Assembly **TIP:** Use a flat bladed tool to help disengage the switch from the bezel.

POWER MIRROR REPLACEMENT

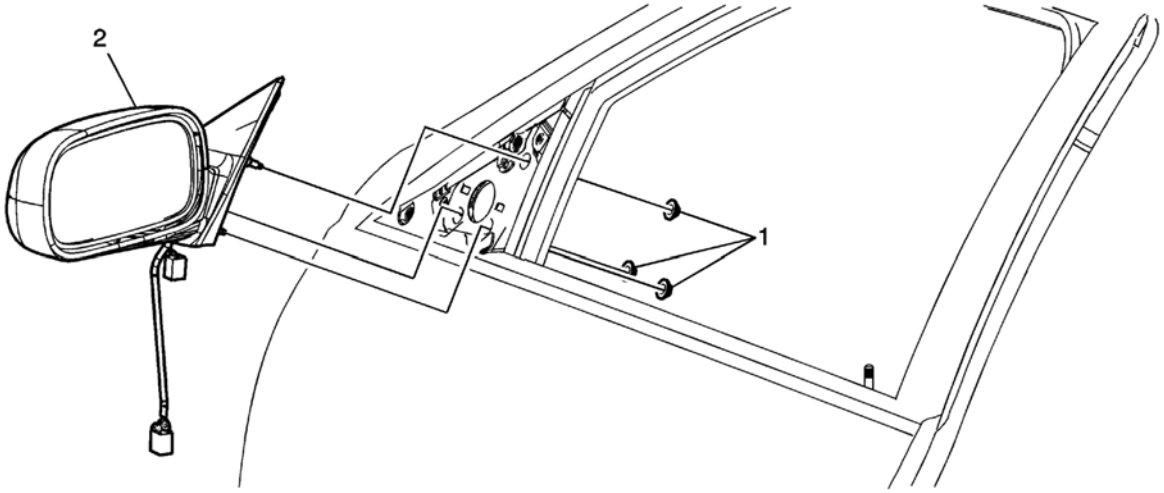


Fig. 4: Identifying Power Mirror
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front door trim panel. Refer to **Front Side Door Trim Panel Replacement**	
1	Outside Rearview Mirror Nut (Qty: 3) **CAUTION:** **Refer to** **Fastener** **Caution** . **TIP:** Disconnect the mirror electrical connector. **Tighten** 10 N.m (89 lb in)
2	Outside Rearview Mirror Assembly

OUTSIDE REARVIEW MIRROR MOTOR REPLACEMENT

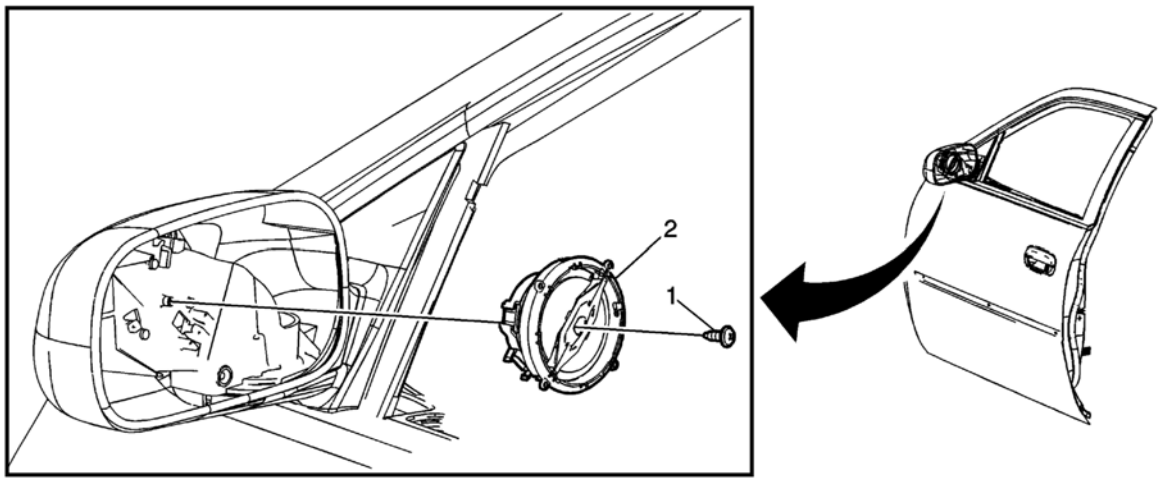


Fig. 5: Identifying Outside Rearview Mirror Motor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the door mirror face. Refer to Outside Rearview Mirror Glass Replacement.	
1	Front Door Mirror Motor Screw **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	Front Door Mirror Motor **TIP:** Disconnect the electrical connector from the mirror motor.

OUTSIDE REARVIEW MIRROR GLASS REPLACEMENT

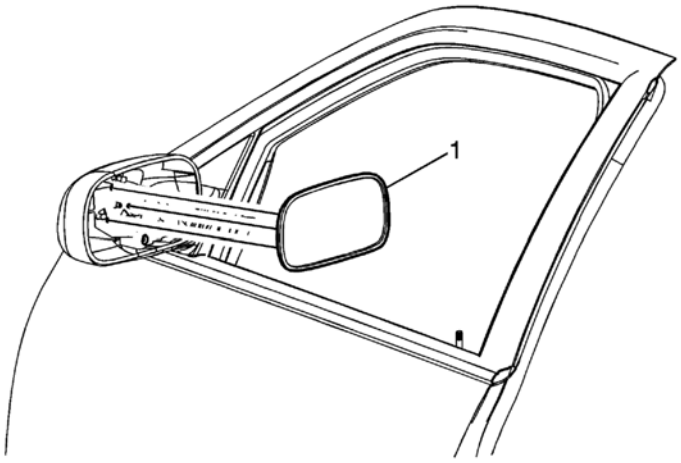


Fig. 6: Identifying Mirror Face
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Outside Rearview Mirror Face **Procedure** 1. Release the mirror face backing from the mirror housing by pulling outward. 2. Disconnect electrical connectors from mirror, if equipped.

INSIDE REARVIEW MIRROR REPLACEMENT

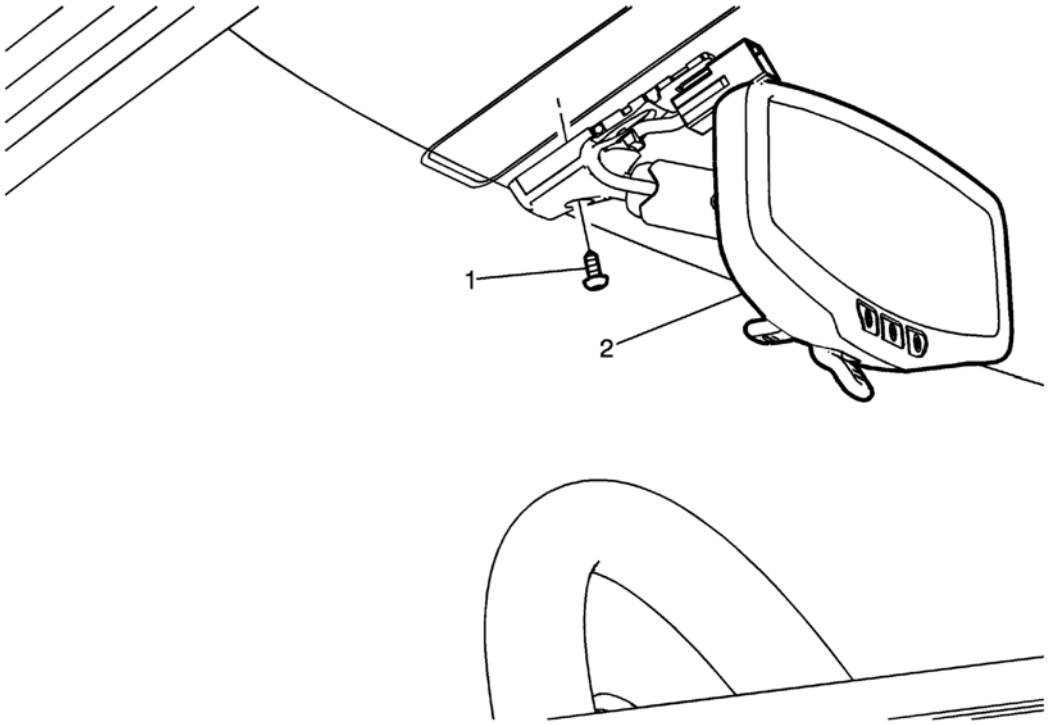


Fig. 7: Inside Rearview Mirror
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Inside Rearview Mirror Screw **CAUTION:** **Refer to Fastener Caution .** **Procedure** Remove the inside rearview mirror cover, if equipped. **Tighten** 2 N.m (18 lb in)
2	Inside Rearview Mirror **Procedure** 1. Disconnect the electrical connector, if equipped. 2. Adjust the mirror to the full upward position. 3. Slide the mirror upward off of the rearview mirror button. 4. Refer to **Control Module References** for programming and setup information.

DESCRIPTION AND OPERATION

AUTOMATIC DAY-NIGHT MIRROR DESCRIPTION AND OPERATION

The inside rearview mirror uses 2 photocell sensors. One sensor is the headlight sensor, located on the face side of the mirror. The headlight sensor is used to determine light conditions present at the mirror face. The other sensor is the ambient light sensor, located on the rear of the mirror or windshield side. The ambient light sensor is used to determine the exterior light conditions. With a low exterior light condition detected, and a high light condition from behind of the car, at the headlight sensor, the inside rearview mirror will automatically darken the face of the mirror. In the daytime, the mirror is in a normal state because of the high exterior light condition that is indicated by the ambient light sensor. With the gear selector lever in the REVERSE position, backup lamp supply voltage is supplied as an input to the inside rearview mirror. The mirror monitors this input to disable the automatic day-night feature. This allows the driver to see objects in the mirror clearly when backing up, even during the night.

OUTSIDE MIRROR DESCRIPTION AND OPERATION

Power Mirror System Components

The power mirror system consists of the following components:

- Outside rearview mirror switch
- Mirror selector switch
- Left outside rearview mirror
- Right outside rearview mirror
- Power mirror fuse

Each of the outside rearview mirrors contains two motors. The vertical motor operates the mirror in the up and down directions, and the horizontal motor operates the mirror in the left and right directions. Each of the outside rearview mirror motors are circuit breaker protected.

Power Mirror System Controls

The outside rearview mirror switch is a four position directional switch: Up, Down, Left and Right.

The mirror select switch is a three position switch: left, neutral, and right.

Power Mirror System Operation

The outside rearview mirror switch receives power through the battery positive voltage circuit from the power mirror fuse. The power mirror switch also receives a constant ground.

The four positions of the direction switch have dual switch contacts. Each of the contacts are connected to opposing sides of the appropriate power mirror motors through the selector switch. The selector switch completes these circuits depending on the position of the selector switch, left or right.

If the selector switch is placed in the left position and the up switch is depressed, battery positive voltage will be supplied to the left outside rearview mirror vertical motor through the left mirror motor down control circuit and ground through the left mirror motor left control circuit. If the down switch is depressed, battery positive voltage will be supplied to the left outside rearview mirror vertical motor through the left mirror motor left

control circuit and ground through the left mirror motor down control circuit.

The remainder of the mirror functions operate in the same manner as described above. Placing the power mirror switch in opposing positions, left/right or up/down, will reverse the polarity to the mirror motor, reversing the direction of movement.

Heated Mirrors (If Equipped)

Battery positive voltage is supplied through the fuse in the underhood electrical center to the rear defog relay. With the ignition in the ON position, voltage is supplied to the rear defog relay coil when the rear window defogger switch is activated. This energizes the rear window defogger relay and allows battery positive voltage to the HTD MIRROR fuse. The HTD MIRROR fuse provides battery positive voltage to the heated mirrors.

Article GUID: A00737215

ACCESSORIES AND EQUIPMENT

Power Door Locks And Release Systems - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Garage Door Opener Push-Button Nuts	2 N.m	18 lb in
Garage Door Opener Push-Button Screws	2 N.m	18 lb in

SCHEMATIC WIRING DIAGRAMS

REMOTE FUNCTION WIRING SCHEMATICS

Keyless Entry

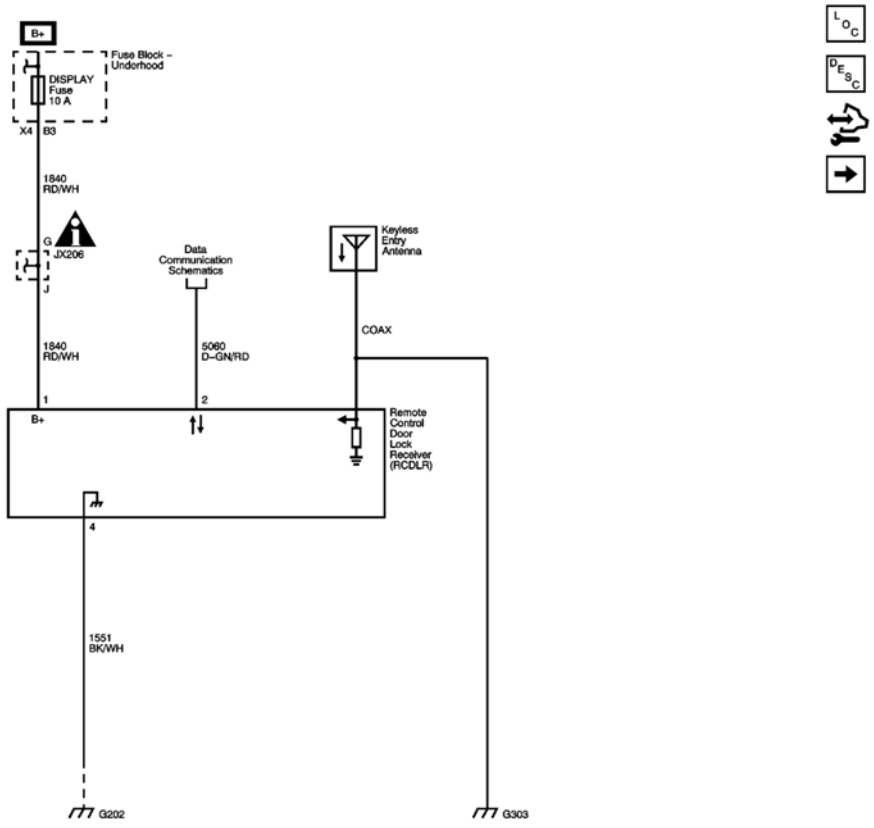


Fig. 1: Keyless Entry Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Garage Door Opener

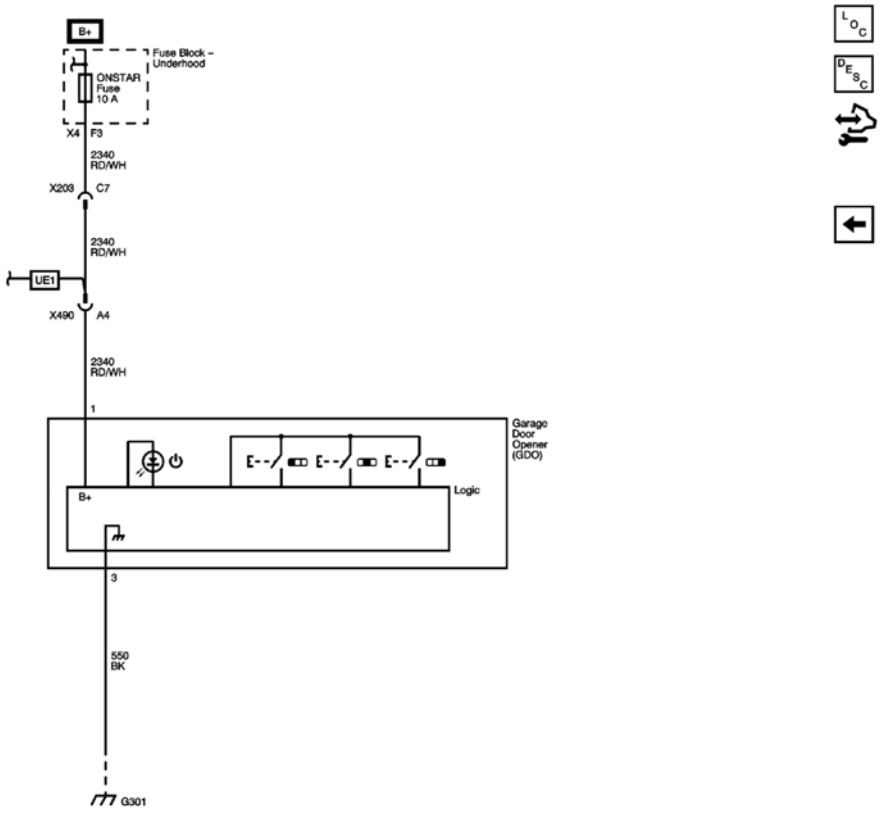


Fig. 2: Garage Door Opener Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B1008: CALIBRATION DATA NOT PROGRAMMED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1008 00

Calibration Data Not Programmed

Circuit/System Description

When replacing a remote control door lock receiver (RCDLR), the service replacement part is shipped with no installed software. Before the new RCDLR is operational, a software calibration is required to be downloaded using the SPS terminal. Failure to download this software calibration will result in the setting of DTC B1008.

Conditions for Running the DTC

This DTC runs continuously

Conditions for Setting the DTC

The RCDLR has no calibration loaded.

Action Taken When the DTC Sets

All functions handled by the RCDLR are inoperative

Conditions for Clearing the DTC

A current DTC will clear when software calibrations are installed.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Perform the RCDLR Programming and Setup procedure. Refer to **Remote Control Door Lock Receiver Programming and Setup** .

- If the DTC resets, replace the RCDLR.

Repair Instructions

IMPORTANT:	This vehicle may be equipped with the 2 Way Advanced Remote Start System. Vehicle equipped with the 2 Way Advanced Remote Start System can be identified by an LCD screen on the keyless entry transmitter or a yellow label on the RCDLR. When servicing the 2 Way Advanced Remote Start System, ensure that the correct parts are installed during replacement. Service parts for the 2 Way Advanced Remote Start System can be found in the Accessory section of the parts manual.

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for RCDLR replacement, setup, and programming

DTC B3105: KEYLESS ENTRY SYSTEM KEY FOBS NOT PROGRAMMED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3105 00

Keyless Entry System Key Fobs Not Programmed

Circuit/System Description

The remote control door lock receiver (RCDLR) monitors the number of keyless entry transmitters programmed. Until at least one transmitter is programmed, the RCDLR determines a malfunction condition exists.

Conditions for Running the DTC

The keyless entry system must be enabled.

Conditions for Setting the DTC

The DTC is set if there are no keyless entry transmitter programmed to the RCDLR.

Action Taken When the DTC Sets

The keyless entry system is inoperative.

Conditions for Clearing the DTC

A current DTC is cleared at least one transmitter has been programmed to the RCDLR.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 43241 Keyless Entry Tester

Circuit/System Verification

1. Place the transmitter on the test pad of the **J 43241** keyless entry tester and press each transmitter button one at a time. The tester should sound a tone and illuminate a green light with each button press.
    - If one or more buttons does not sound the tone and illuminate the green light, replace the transmitter battery and retest with the **J 43241** keyless entry tester. If the condition continues after battery replacement, replace the transmitter.
2. Program the transmitter. Refer to **Remote Control Door Lock Transmitter Learn**. The transmitter should successfully complete the programming procedure.
    - If the transmitter does not program, replace the keyless entry transmitter. If the new keyless entry transmitter does not complete the programming, replace the RCDLR.
3. Operate the transmitter function while observing the vehicle. The vehicle should perform each of the corresponding functions when selected on the transmitter.
    - If any of the vehicle functions are inoperative, replace the keyless entry transmitter. If the functions remain inoperative after replacement of the transmitter, replace the RCDLR.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for RCDLR replacement, setup, and programming

DTC B3109, B3110, B3111, OR B3112: KEYLESS ENTRY TRANSMITTER BATTERY 1-4

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3109 00

Keyless Entry Transmitter 1 Low Battery

DTC B3110 00

Keyless Entry Transmitter 2 Low Battery

DTC B3111 00

Keyless Entry Transmitter 3 Low Battery

DTC B3112 00

Keyless Entry Transmitter 4 Low Battery

Circuit/System Description

With each press of a keyless entry transmitter button, a message containing the current battery state of the transmitter is sent to the remote control door lock receiver (RCDLR) along with the commanded keyless entry function.

Conditions for Running the DTC

A keyless transmitter button is pressed.

Conditions for Setting the DTC

The DTC sets after 3 consecutive low battery signals from the same programmed transmitter.

Action Taken When the DTC Sets

The keyless entry system is inoperative.

Conditions for Clearing the DTC

The DTC is cleared when a normal transmitter voltage signal is received from the programmed transmitter that set the DTC.

Diagnostic Aids

The keyless entry transmitter used in the 2-Way Advanced Remote Start System is unique to the system. When servicing or replacing a transmitter, ensure that the correct transmitter is used. The correct transmitter part number can be found in the Accessory section of the parts catalog. Attempting to replace a 2-Way Advanced Remote Start transmitter with a regular service part may result in a failure to program the transmitter.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify DTC B3109, B3110, B3111, or B3112 are not set .

- If any of the DTCs are set, replace the battery in the appropriate keyless entry transmitter. Operate the transmitter 3 consecutive times. If the DTC resets, replace the keyless entry transmitter.

Repair Instructions

IMPORTANT: This vehicle may be equipped with the 2-Way Advanced Remote Start System. Vehicle equipped with the 2-Way Advanced Remote Start System can be identified by an LCD screen on the keyless entry transmitter or a yellow label on the RCDLR. When servicing the 2-Way Advanced Remote Start System, ensure that the correct parts are installed during replacement. Service parts for the 2-Way Advanced Remote Start System can be found in the Accessory section of the parts manual.

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Remote Control Door Lock Transmitter Learn

SYMPTOMS - REMOTE FUNCTIONS

NOTE: The following steps must be completed before using the symptom tables.

1. Perform **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Keyless Entry System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Keyless Entry System. Refer to

Checking Aftermarket Accessories .

- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections, wiring, terminals, connectors, poor voltage and ground connections, temperature sensitivity, electromagnetic interference, electrical noise and/or incorrect control module installed may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Garage Door Opener Malfunction**
- **Keyless Entry System Malfunction**
- **Remote Vehicle Start Malfunction**

GARAGE DOOR OPENER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The garage door opener (GDO) is a transmitter operating between 288 and 399 MHz. The GDO has 3 buttons that may be programmed for individual transmitter/receiver combinations to control up to 3 GDOs, security gates, and lighting systems. Each button represents a transmitter code section of the transmitter, which operates separately from any other button, and may be considered a separate transmitter.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Garage Door Opener Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 41540 Universal Home Remote Tester

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the GDO.
2. Ignition OFF, test for less than 10 Ω between the ground circuit terminal 3 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 1 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.

NOTE: **This step will clear any learned transmitters from the GDO. This will require reprogramming by the customer to reestablish GDO functionality.**

4. Ignition ON, hold the two outer buttons on the GDO for 30 seconds. After 20 seconds, the LEDs will flash indicating that all learned transmitter values have been cleared. After an additional 10 seconds, the LEDs will flash again indicating it has entered the diagnostic mode. Place the **J 41540** universal home remote tester near the GDO and individually press each button of the GDO. The tester should indicate when each button is pressed.
   - If one or more of the buttons does not respond when each button is pressed, replace the GDO.
5. Instruct the customer to program the GDO. Refer to the vehicle owners manual. A possible rolling code or incompatibility with the GDO receiver will prevent programming.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for GDO replacement, setup, and programming

KEYLESS ENTRY SYSTEM MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The keyless entry system is a vehicle entry device. The keyless entry will unlock the vehicle doors or open the

rear compartment when a corresponding button on the keyless entry transmitter is pressed. This is accomplished by the keyless entry transmitter sending a radio frequency to the remote control door lock receiver (RCDLR). The RCDLR interprets the signal and activates the requested function via a message over the GMLAN serial data line. A low transmitter battery or radio frequency (RF) interference from aftermarket devices such as 2-way radios, power inverters, cellular phone chargers, computers, etc. may cause a system malfunction. High RF traffic areas, such as gas stations which use pay-at-the-pump RF transponders, may also cause interference that could lead to a malfunction.

Diagnostic Aids

Unwanted or inadvertent door lock/unlock activation may actually be triggered by the OnStarÂ® Remote Link Apps. Customer may be unaware of account usage, contact Technical Assistance Center (TAC) if root cause cannot be diagnosed to vehicle.

For the **J 43241** keyless entry tester , inspect the keyless entry transmitter part number to determine that it is the correct model for the vehicle. A wrong model transmitter may pass the test, but it will not activate the vehicle remote system.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 43241 Keyless Entry Tester

Circuit/System Verification

1. Place the transmitter on the test pad of the **J 43241** keyless entry tester and press each transmitter button one at a time, holding each button for three seconds. The tester should sound a tone and illuminate a

green light for the entire three second button press.

- If one or more buttons does not sound the tone and illuminate the green light for the entire three seconds, replace the transmitter battery and retest with the **J 43241** keyless entry tester. If the condition continues after battery replacement, replace the transmitter.

2. Program the transmitter. Refer to **Remote Control Door Lock Transmitter Learn**. The transmitter should successfully complete the programming procedure.
    - If the transmitter does not program, replace the keyless entry transmitter. If the new keyless entry transmitter does not complete the programming, replace the RCDLR.
3. Operate the transmitter function while observing the vehicle. The vehicle should perform each of the corresponding functions when selected on the transmitter.
    - If any of the vehicle functions are inoperative, replace the keyless entry transmitter. If the functions remain inoperative after replacement of the transmitter, replace the RCDLR.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Remote Control Door Lock Transmitter Learn**
- **Control Module References** for RCDLR replacement, programming and setup

REMOTE VEHICLE START MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of each diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

Remote vehicle start (RVS) begins as an RF message received by the remote control door lock receiver (RCDLR) from a keyless entry transmitter. The RVS request is sent by the RCDLR to the body control module (BCM) via serial data. The BCM monitors system conditions such as content theft deterrent (CTD), hood ajar status, and body DTCs to determine if an RVS event will occur. If conditions are determined to be acceptable, the RVS message is sent to the engine control module (ECM). The ECM monitors system conditions such as engine control parameters and vehicle theft deterrent (VTD) to determine if engine starting will be allowed. If conditions are acceptable, the ECM will initiate engine starting. During the engine run time in a RVS attempt, before the operator enters the vehicle, the ECM may discontinue engine operation if system conditions require it or a message is received from the BCM requesting the engine be turned OFF.

Diagnostic Aids

Unwanted or inadvertent remote start activation may actually be triggered by the OnStarÂ® Remote Link Applications. Customer may be unaware of account usage, contact Technical Assistance Center (TAC) if root cause cannot be diagnosed to vehicle.

NOTE: **If the vehicle has a current vehicle DTC that illuminates the malfunction indicator lamp (MIL), the cause of the DTC must be diagnosed before**

proceeding with the Remote Vehicle Start Inoperative diagnostic.

The RVS system will not operate if any of the following conditions are present:

- A current vehicle DTC that illuminates the malfunction indicator lamp (MIL)
- A low fuel level with a low fuel warning light message.
- More than 2 remote starts have been attempted.
- The hazard switch is in the ON position.
- A current hazard switch DTC is set.
- The vehicle hood is ajar.
- A current hood ajar DTC is set.
- The CTD system detects an alarm trigger.
- Excessive engine RPM
- Excessive coolant temperature
- Accelerator pedal position greater than 0 percent
- Vehicle not in park
- Vehicle theft deterrent malfunction
- A current automatic transmission shift lock control system DRC is set.
- A vehicle speed sensor signal is detected by the ECM.

Reference Information

Schematic Reference

Remote Function Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that RVS is enabled through vehicle personalization.
    - If RVS is not enabled, use vehicle personalization to turn on RVS functionality. Refer to the vehicle owners manual.
2. Verify that the keyless entry functions operate with all available keyless entry transmitters.
    - If the keyless entry system does not function properly, refer to **Remote Control Door Lock Transmitter Learn**.
3. Observe the scan tool ECM and BCM RVS Disable History parameters, Verify that no RVS Disable History items are present.
    - If RVS Disable History items are present, refer to the appropriate subsection in which the failure occurred.
4. Verify the scan tool BCM Current CTD Trigger parameter displays None.
    - If not specified value, refer to **Content Theft Deterrent Malfunction** .

REPAIR INSTRUCTIONS

REMOTE CONTROL DOOR LOCK RECEIVER REPLACEMENT

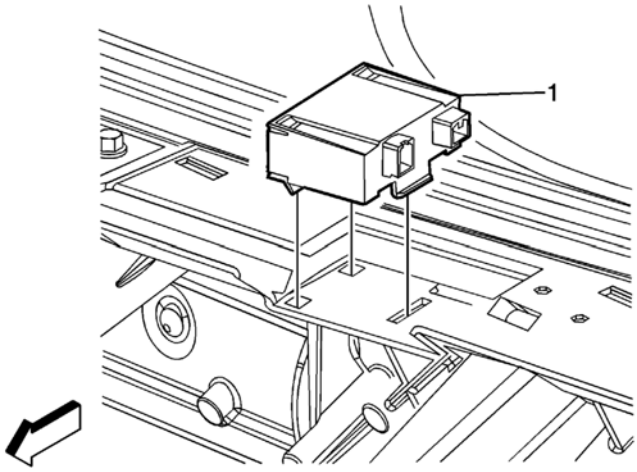


Fig. 3: Remote Control Door Lock Receiver
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the instrument panel (I/P) upper trim panel. Refer to **Instrument Panel Upper Trim Panel Replacement** . 2. Program the remote control door lock receiver after replacement. Refer to **Control Module References** .	
1	Remote Control Door Lock Transmitter Assembly • Disconnect the electrical connector. • Push the 2 tabs towards the module assembly in order to release the module.

REMOTE CONTROL DOOR LOCK RECEIVER ANTENNA REPLACEMENT

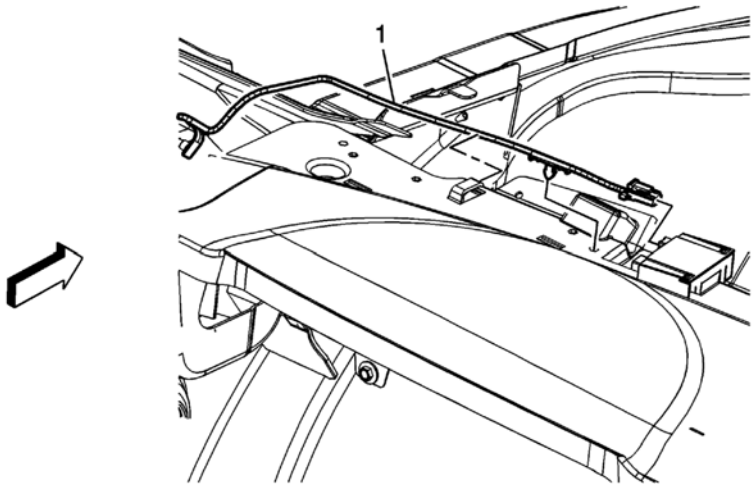


Fig. 4: Keyless Entry Antenna
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel upper trim panel. Refer to **Instrument Panel Upper Trim Panel Replacement** .	
1	Remote Control Door Lock Receiver Antenna Assembly • Disconnect the antenna from the door lock receiver. • Vehicles produced after December 6, 2006 will not have the antenna cable connected to the windshield. • Service antenna cables cannot be connected to the windshield.

GARAGE DOOR OPENER TRANSMITTER REPLACEMENT

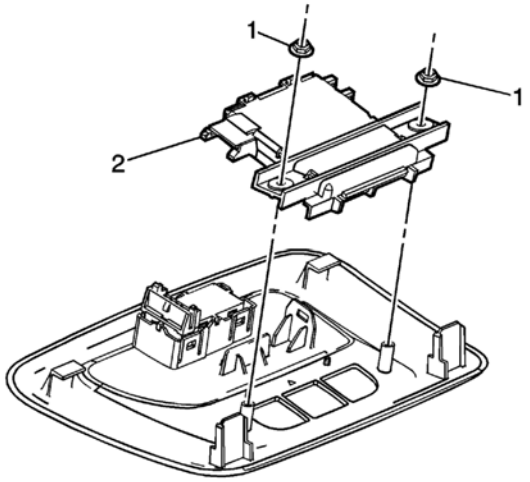


Fig. 5: Garage Door Opener

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the overhead console. Refer to **Roof Console Replacement** . 2. Program the garage door opener after replacement. Refer to **Control Module References** .	
1	Garage Door Opener Pushbutton Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	Garage Door Opener Pushbutton

REMOTE CONTROL DOOR LOCK TRANSMITTER LEARN

Next Available Slot

NOTE:

- **On some vehicles, keyless entry transmitters may also be programmed using the driver information center (DIC). Refer to the vehicle owners manual for information.**
- **All transmitters which are to be recognized by the remote control door lock receiver (RCDLR) must be programmed in a single programming sequence. Once the Invalidate All Fobs selection is made, all learned transmitters are erased. If all the existing transmitters associated with the vehicle are not learned at this time, they will become inoperative and require additional programming.**
- **Do not operate or program the transmitters in the vicinity of other vehicles that are in the keyless entry program mode. This prevents the programming of the transmitters to the incorrect vehicle.**

This procedure will program keyless entry transmitters in sequential order. If two transmitters are currently learned to the vehicle as transmitters 1 and 2, using this procedure will learn the next transmitter are transmitter 3, and so on.

1. With a scan tool, access the Remote Control Door Lock Receiver Module Setup menu. Select Program Key Fobs.
2. Select Next Available Slot. The vehicle chime will sound two times to indicate programming mode has been entered. Follow the on-screen instructions. After each transmitter has been programmed, the vehicle chime will sound to confirm the programming.
3. When all the desired transmitters have been programmed, cycle the ignition from ON to OFF, exit the

vehicle, and operate the transmitter functions in order to verify correct system operation.

Invalidate All Fobs

NOTE:

- **On some vehicles, keyless entry transmitters may also be programmed using the driver information center (DIC). Refer to the vehicle owners manual for information.**
- **All transmitters which are to be recognized by the remote control door lock receiver (RCDLR) must be programmed in a single programming sequence. Once the Invalidate All Fobs selection is made, all learned transmitters are erased. If all the existing transmitters associated with the vehicle are not learned at this time, they will become inoperative and require additional programming.**
- **Do not operate or program the transmitters in the vicinity of other vehicles that are in the keyless entry program mode. This prevents the programming of the transmitters to the incorrect vehicle.**

This procedure will first erase all known keyless entry transmitters. After all transmitters are erased, the procedure will begin to program keyless entry transmitters in sequential order, beginning with transmitter 1.

1. With a scan tool, access the Remote Control Door Lock Receiver Module Setup menu. Select Program Key Fobs.
2. Select Invalidate All Fobs. This will erase all learned transmitters and prepare the RCDLR to learn new transmitters. Follow the on-screen instructions. After each transmitter has been programmed, the vehicle chime will sound to confirm the programming.
3. When all the desired transmitters have been programmed, cycle the ignition from ON to OFF, exit the vehicle, and operate the transmitter functions in order to verify correct system operation.

Transmitter Slot Programming

Transmitter slot programming allows a single transmitter to be programmed into a specific slot without affecting any of the other programmed transmitters. By using slot programming, the transmitter originally programmed to a specific slot is erased and the new transmitter learned in its placed.

1. Install a scan tool.
2. Turn ON the ignition with the engine OFF.
3. With the scan tool, select Body.
4. Select Remote Control Door Lock Receiver (RCDLR).
5. Select Module Setup.
6. Select Program Key Fobs.
7. Select the key fob desired to be programmed.
8. Follow the scan tool on screen instructions.
9. Remove the scan tool.
10. Exit the vehicle. Operate all functions on transmitters to verify correct system operation.

DESCRIPTION AND OPERATION

GARAGE DOOR OPENER DESCRIPTION AND OPERATION

The garage door opener is fixed and rolling code capable. Rolling code is a system that allows the code that the customers receiver receives from the garage door opener to change every time the garage door opener is used within operating range of the receiver. Rolling code programming requires the customer to push a learn/program button on the garage door opener receiver at their home. This button is usually located on the receiver unit under a cover (light cover) on one end of the unit. The customer must follow the garage door opener manufacturers instructions to program/learn the receiver to accept the Universal Home Remote System as an authorized opener for their unit . When the receiver and the garage door opener are initially programmed together, a code is established and a new code is created for every new transmission. The software in the receiver recognizes the garage door opener and accepts the new code.

The garage door opener is compatible with most, but not all types and brands of transmitters.

The garage door opener is a transmitter operating between 288-434 MHz. The power and range of the transmitter is to comply with laws governing the generation of radio frequency interference. The transmitter is programmed by the user to accept the signal generated by the user's transmitters.

The garage door opener has 3 buttons that may be programmed for individual transmitter/receiver combinations to control up to 3 garage door openers, security gates, lighting systems, etc. Each button represents a transmitter code section of the transmitter, which operates separately from any other button, and may be considered a separate transmitter. Operation consists of simply pressing a button to activate the corresponding transmitter.

KEYLESS ENTRY SYSTEM DESCRIPTION AND OPERATION

The keyless entry system is a vehicle entry device. The keyless entry system is used in conjunction with the body control module (BCM) to remotely activate certain vehicle features. Keyless entry will lock/unlock the doors, or release the rear compartment lid when a corresponding button on the keyless entry transmitter is pressed. This is accomplished by the transmitter sending a radio frequency to the remote control door lock receiver (RCDLR). The RCDLR interprets the signal and activates the requested function via a serial data message to the BCM. A low transmitter or vehicle battery or radio frequency (RF) interference from aftermarket devices, such as 2-way radios, power inverters, computers, etc., may cause a system malfunction. High RF traffic areas may also cause interference that could lead to a malfunction. Keyless entry allows you to operate the following components:

- Door locks
- Rear compartment lid release
- Remote vehicle starting, if equipped
- Illuminated entry lamps
- Vehicle locator/Panic alarm

The keyless entry system has the following components:

- Keyless entry transmitters
- Keyless entry antenna
- BCM

- RCDLR

Keyless Entry Transmitters

The keyless entry transmitters are used to lock and unlock the vehicle door while away from the immediate area of the vehicle. Vehicles without remote vehicle start will operate at a distance of up to 20 m (65 ft) away. Vehicle with remote vehicle start will operate at a distance of up to 60 m (195 ft) away. Up to 8 transmitters may be programmed to a single vehicle. The vehicle comes with two transmitters. Each transmitter will have a number on top of it, "1" or "2", and each number corresponds to a separate driver of the vehicle.

Keyless Entry Antenna

The keyless entry antenna is used to receive radio frequency (RF) communications sent by the keyless entry transmitters. The keyless entry antenna also receives RF signals from the tire pressure monitoring (TPM) sensors located at each wheel.

A coax antenna lead connects the antenna to the remote control door lock receiver (RCDLR). When a transmitter button is present, the RF signal sent by the transmitter is received by the antenna and the communications are inputted to the RCDLR.

OnStarÂ® Remote Link

A vehicle operator may have the ability to perform some of the keyless entry functions using applications on personal devices such as smart phones. Refer to **OnStar Description and Operation** .

Remote Control Door Lock Receiver (RCDLR)

The remote control door lock receiver (RCDLR) is a multifunction module that operates both the keyless entry system as well as the TPM system. When an RF message is received from a keyless entry transmitter, the RCDLR interprets this signal and will request via serial data that the body control module (BCM) perform the specific function, i.e. door lock, door unlock, or vehicle locate.

Unlock Driver Door Only

Momentarily press the transmitter UNLOCK button in order to perform the following functions:

- Unlock only the driver door.
- Illuminate the interior lamps for a determined length of time, or until the ignition is turned ON
- Flash the exterior lights, if enabled through personalization
- Disarm the Content Theft Deterrent (CTD) System, if equipped
- Deactivate the CTD system when in the alarm mode

Unlock All Doors - Second Operation

Momentarily press the transmitter UNLOCK button a second time, within 5 seconds of the first press, to perform the following function:

Unlock the remaining doors

Lock All Doors

Press the transmitter LOCK button to perform the following functions:

- Lock all vehicle doors
- Immediately turn OFF the interior lamps
- Flash the exterior lights, if enabled through personalization
- Chirp the horn, if enabled through personalization
- Arm the CTD System, if equipped

Rear Compartment Lid Release

Press the transmitter rear compartment lid release button to perform the following function:

Open the rear compartment lid

Vehicle Locator/Panic Alarm

A single press of the panic button performs the following functions. Some functions may be dependent on personalization settings:

- Pulse the horn three times
- Flash the exterior lamps three times

A press and hold of the panic button performs the following functions:

- Illuminate the interior lamps
- Pulse the horn and flash the exterior lamps for 30 second or until the following conditions occur:
    - The panic button is pressed
    - The ignition switch is turned to the RUN position with a valid key

Remote Vehicle Start (RVS) - if equipped

The remote vehicle start (RVS) function allows engine starting while not in the vehicle. It also allows the vehicle HVAC system and other vehicle systems to enable, providing a comfortable vehicle upon entry. RVS functions have an operating range of up to 195 feet, depending on conditions. The RVS sequence begins by pressing and releasing the lock button and then pressing and holding the RVS buttons on the keyless entry transmitter. The turn signal lamps will illuminate to indicate the vehicle has received the remote start request. Each time an RVS is performed, the vehicle doors are locked, however they may then be unlocked/locked with the transmitter or vehicle key at any time. Once activated, the engine is allowed to run for 10 minutes. The RVS time may be extended by an additional 10 minute by again pressing and releasing the lock button and then pressing and holding the RVS buttons on the transmitter. This feature is called a RVS continue and allows a maximum of 20 minutes of engine running. If the RVS continue is performed at 7 minutes into the initial 10 minute time-out, a total of 17 minutes of engine running would occur. The RVS event may be suspended at any time by pressing only the RVS button on the transmitter or by entering the vehicle and turning ON the hazard lamps.

In between ignition cycles, only two RVS events may occur or be attempted. Once two events or attempts have been made, future RVS events will be suspended until the vehicle is started using the ignition.

Enable/Disable RVS

Using the driver information center (DIC), RVS may be enabled or disabled as a part of vehicle personalization. Refer to the vehicle owners manual for more information.

Hood Ajar Switch

The hood switch provides status of the hood to the BCM for RVS purposes. The switch is integrated into the hood latch assembly. The hood ajar switch provides 2 separate inputs to the BCM. These separate inputs allow the BCM to actively monitor for a hood ajar switch fault.

RVS Circuit Description

The RCDLR receives a signal from the keyless entry transmitter indicating a RVS request. A message is then sent to the BCM which determines if a crank request message will be sent to the ECM to allow engine starting. To determine if conditions are correct for an RVS event, the BCM will ensure the following conditions are met:

- All vehicle doors are closed
- A valid hood ajar switch closed signal is present
- The doors are locked
- The hazard switch is OFF
- The vehicle power mode is correct
- No content theft deterrent (CTD) alarm triggers are present
- The vehicle is not in valet mode (if equipped)

When the BCM determines all conditions meet those required for an RVS event, a message is sent via serial data to the ECM. The ECM relies on the RVS message from BCM to enable RVS when the crank request signal is received. If the ECM does not receive a valid RVS message, it will not attempt to start the engine. While the ECM is in RVS mode it will suspend engine operation if any of the following additional conditions occur:

- Vehicle speed is greater than 0
- Transmission is not in PARK
- Excessive engine coolant temperature
- Low oil pressure
- The malfunction indicator lamp (MIL) is commanded ON
- Engine crank time is greater than 30 seconds
- Excessive engine speed
- Accelerator pedal position too high
- Remote start timer equals 0
- Immobilizer system indicates tamper

Keyless Entry Personalization

Vehicle lock/unlock functions and remote vehicle start (RVS) settings may be personalized. For functional descriptions and personalization instructions, refer to the vehicle owners manual.

Rolling Code

The Keyless Entry System uses rolling code technology. Rolling code technology prevents anyone from

recording the message sent from the transmitter and using the message in order to gain entry to the vehicle. The term "rolling code" refers to the way that the Keyless Entry System sends and receives the signals. The transmitter sends the signal in a different order each time. The transmitter and the remote control door lock receiver (RCDLR) are synchronized to the appropriate order. If a programmed transmitter sends a signal that is not in the order that the RCDLR expects, then the transmitter is out of synchronization. This occurs after 256 presses of any transmitter button when it is out of range of the vehicle.

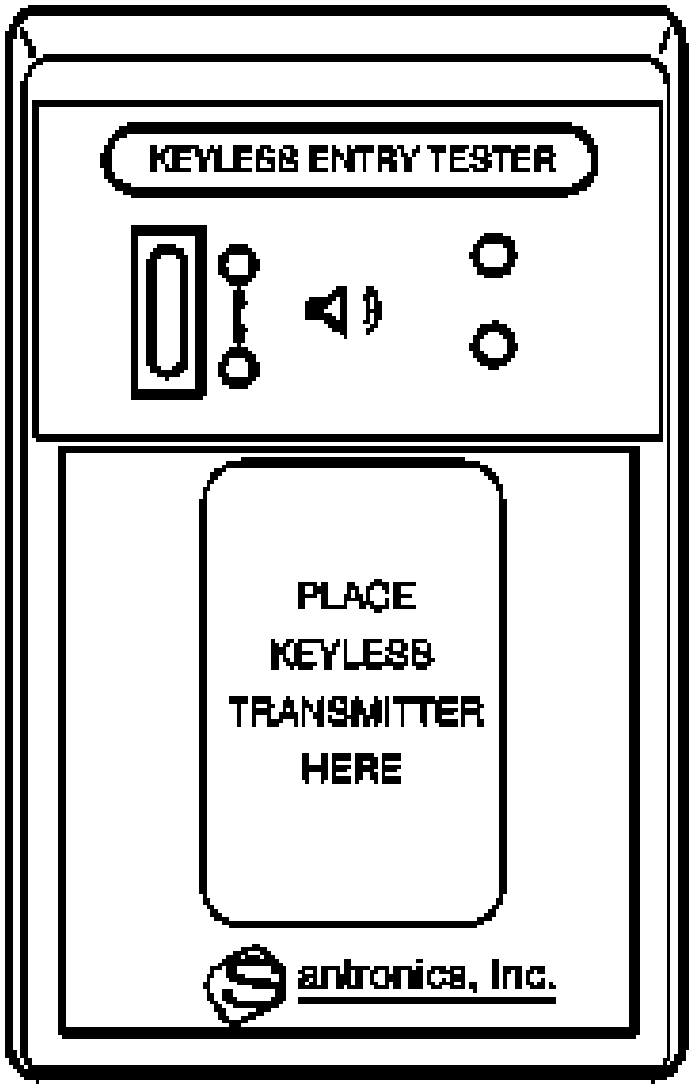
Automatic Synchronization

The keyless entry transmitters do not require a manual synchronization procedure. If needed, the transmitters automatically re-synchronize when any button on the transmitter is pressed within range of the vehicle. The transmitter will operate normally after the automatic synchronization.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

Illustration	Tool Number/ Description
	EL 43241 Keyless Entry Tester

Article GUID: A00737202

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Front Seat Back Cushion Frame Bolt	9 N.m	80 lb in

SCHEMATIC WIRING DIAGRAMS

DRIVER SEAT WIRING SCHEMATICS

Driver Seat

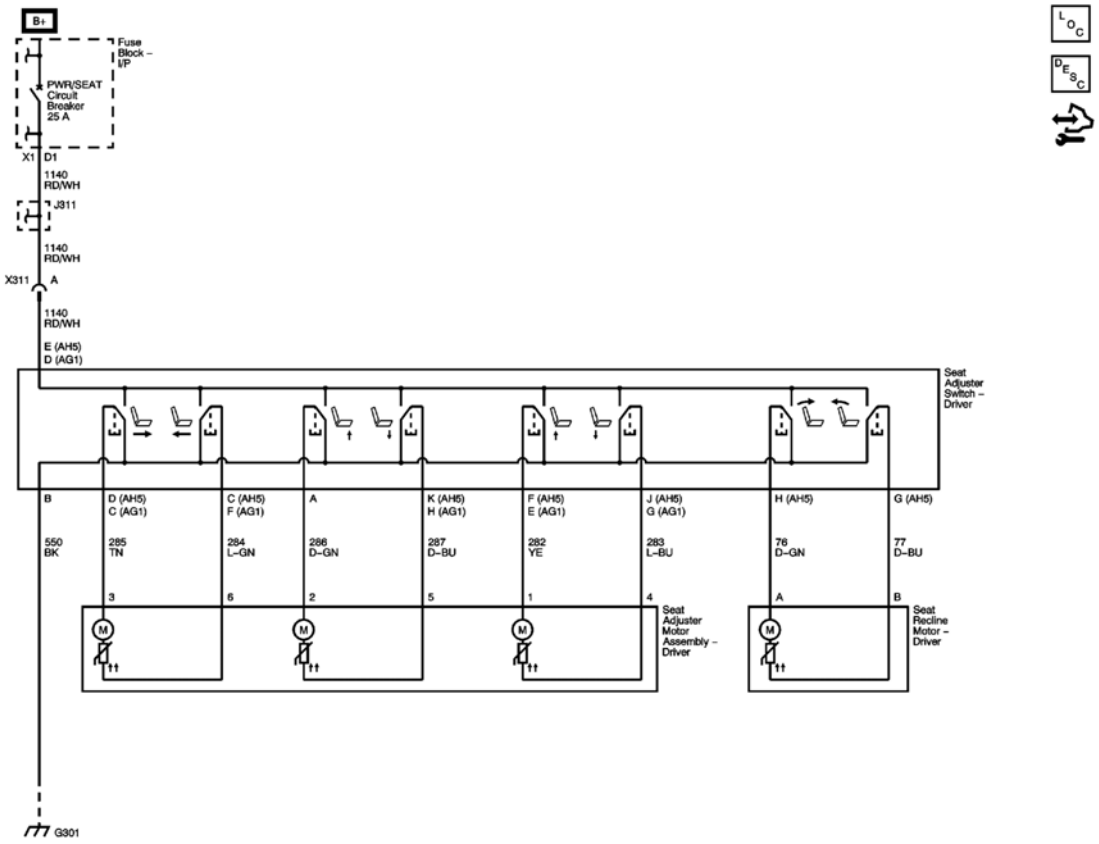


Fig. 1: Driver Seat Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

PASSENGER SEAT WIRING SCHEMATICS

Passenger Seat

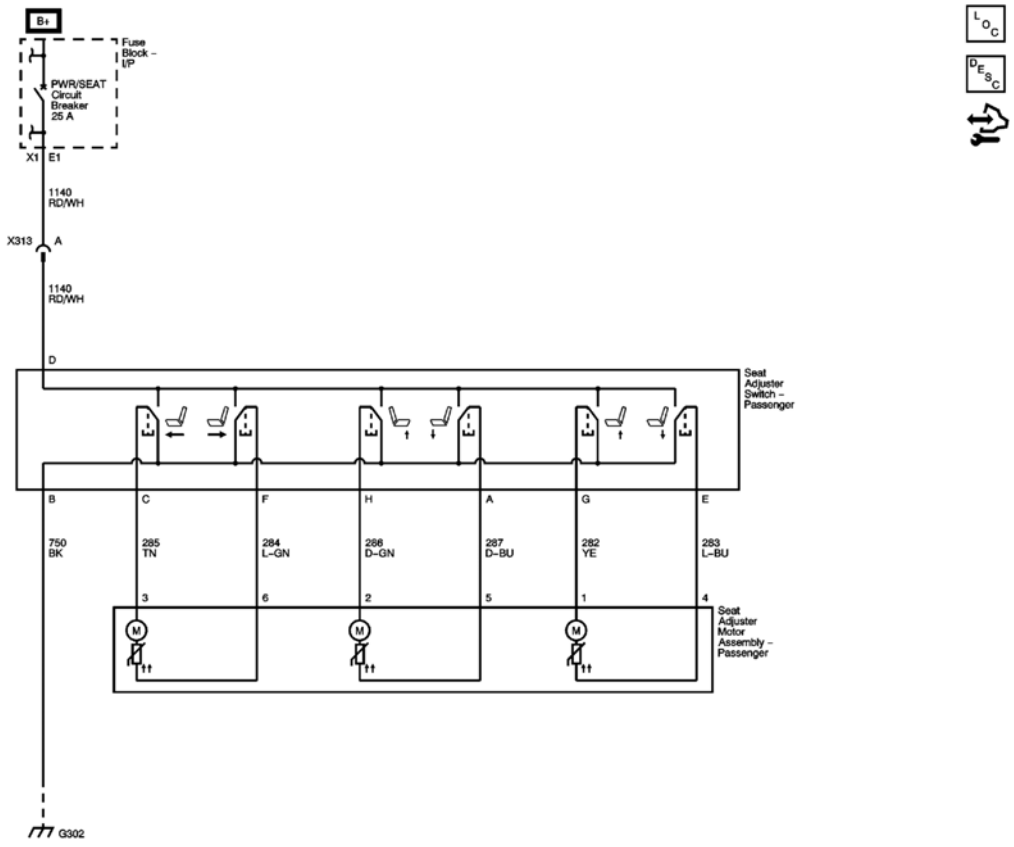


Fig. 2: Passenger Seat Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - POWER SEATS

IMPORTANT: Review the system description in order to familiarize yourself with the system functions. Refer to **Power Seats System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the seat systems. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Power Seat Adjuster Mechanical Diagnosis**

- **Power Seat Inoperative**

POWER SEAT ADJUSTER MECHANICAL DIAGNOSIS

Condition	Possible Cause	Correction
Horizontal Operation of Seat Not Smooth but Jerky-Apparent Hard Operation	The adjuster horizontal actuator is damaged.	Replace the adjuster assembly.
Horizontal Chuck or Looseness	• The horizontal actuator is improperly adjusted to the rack. • The top plate subassembly is loose.	• Replace the adjuster assembly. • Replace the adjuster assembly.
One Adjuster Will Not Operate Horizontally	• The horizontal drive cable is disconnected or damaged. • The horizontal actuator is inoperative.	• Inspect the drive cables, they must be stright to be engaged. Replace if damaged. • Replace the adjuster assembly.
One Adjuster Will not Operate Vertically	• The vertical drive cable is disconnected or damaged. • The vertical actuator subassembly is inoperative.	• Inspect the vertical drive cables, replace if damaged. • Replace the adjuster assembly.
Both Adjusters Will Not Operate Horizontally and/or Vertically	• The motor is damaged or inoperative. • The wiring harness is damaged.	• Replace the adjuster assembly • Replace the wiring harness.
Vertical Chuck or Looseness	The vertical actuator is inoperative.	Replace the adjuster assembly.

POWER SEAT INOPERATIVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Adjuster Switch B+	1	1	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Front Vertical Motor Front Down Control	1	1	-	-
Front Vertical Motor Front Up Control	1	1	-	-
Horizontal Motor Forward Control	1	1	-	-
Horizontal Motor Rearward Control	1	1	-	-
Rear Vertical Motor Rear Down Control	1	1	-	-
Rear Vertical Motor Rear Up Control	1	1	-	-
Recline Motor Forward Control	1	1	-	-
Recline Motor Rearward Control	1	1	-	-
Seat Adjuster Switch Ground	-	1	-	-
1. Power seat inoperative				

Circuit/System Description

Power seat without memory is completely controlled through the seat adjuster switch. Battery voltage is supplied at all times to the seat adjuster switch through the PWR/SEAT 25 A circuit breaker located in the I/P fuse block. When the seat adjuster switches are in an inactive state, the switch contacts are closed to the switch ground circuit.

All seat motors are reversible. For example, when the seat horizontal forward switch is pressed to move the entire seat forward, battery voltage is applied through the switch contacts and the seat horizontal motor forward control circuit to the motor. The motor is grounded through the horizontal motor rearward switch contacts and the horizontal motor rearward control circuit to the motor. The motor runs in order to drive the entire seat forward until the switch is released. Moving the entire seat rearward works similarly to moving the entire seat forward, except that battery positive voltage and ground are applied on opposite circuits causing the motor to run in the opposite direction. All seat motors are powered this way.

Reference Information

Schematic Reference

- **Driver Seat Schematics**
- **Passenger Seat Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Seats System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

Operate the seat switches for the seat directional motors listed below in both directions. The seat should move in the commanded directions.

- Horizontal Motor
- Front Vertical Motor
- Rear Vertical Motor
- Recline Motor

- If the power seat is inoperative in all directions, refer to the Seat Adjuster Switch Circuit Test.
- If just the recline function is inoperative, refer to the Recline Motor Circuit Test.
- If 1 or more of the seat adjuster motors operate, refer to the Seat Adjuster Motor Circuit Test.

Circuit/System Testing

Seat Adjuster Switch Circuit Test

1. Disconnect the harness connector at the seat adjuster switch.
2. Test for less than 5 Ω between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Verify that a test lamp illuminates between the appropriate B+ circuit terminal listed below and ground.
    - Driver seat terminal E (AH5)
    - Driver seat terminal D (AG1)
    - Passenger seat terminal D
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, test or replace the seat adjuster switch.

Recliner Motor Circuit Test

1. Ignition OFF, disconnect the harness connector at the recline motor.
2. Connect a test lamp between control circuit terminal A and control circuit terminal B.
3. Ignition ON, command the seat recline motor Forward and Rearward using the seat recline switch. The test lamp should turn ON when commanding the forward and rearward states.
    - If the test lamp remains OFF for either of the commands, test the control circuits for a short to ground or an open/high resistance. If the circuits test normal, test or replace the seat adjuster switch.
4. If all circuits test normal, test or replace the recline motor.

Seat Adjuster Motor Circuit Test

1. Ignition OFF, disconnect the harness connector at the appropriate seat adjuster assembly.
2. Connect a test lamp between the appropriate control circuit terminals listed below:
    - Seat horizontal motor terminal 3 and terminal 6
    - Seat front vertical motor terminal 2 and terminal 5
    - Seat rear vertical motor terminal 1 and terminal 4
3. Ignition ON, command the appropriate seat motor Up and Down or Forward and Rearward using the seat adjuster switch. The test lamp should turn ON when commanding the up and down or forward and rearward states.
    - If the test lamp remains OFF for either of the commands, test the control circuits for a short to ground or an open/high resistance. If the circuits test normal, test or replace the seat adjuster switch.
4. If all circuits test normal, test or replace the seat adjuster assembly.

Component Testing

Seat Adjuster Switch

1. Ignition OFF, disconnect the harness connector at the seat adjuster switch.
2. Test for infinite resistance between each control terminal and the B+ terminal with the switch in the open position.
    - If not the specified value, replace the seat adjuster switch.
3. Test for less than 1 ohm between each control terminal and the B+ terminal with the switch in the closed position.
    - If greater than the specified range, replace the seat adjuster switch.
4. Test for less than 1 ohm between each control terminal and the ground terminal with the switch in the open position.
    - If greater than the specified range, replace the seat adjuster switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Power Seat Switch Replacement (Impala) Front**
- **Seat Adjuster Replacement**
- **Front Seat Recliner Actuator Motor Replacement**

REPAIR INSTRUCTIONS

DRIVER OR PASSENGER SEAT ADJUSTER SWITCH KNOB REPLACEMENT (IMPALA)

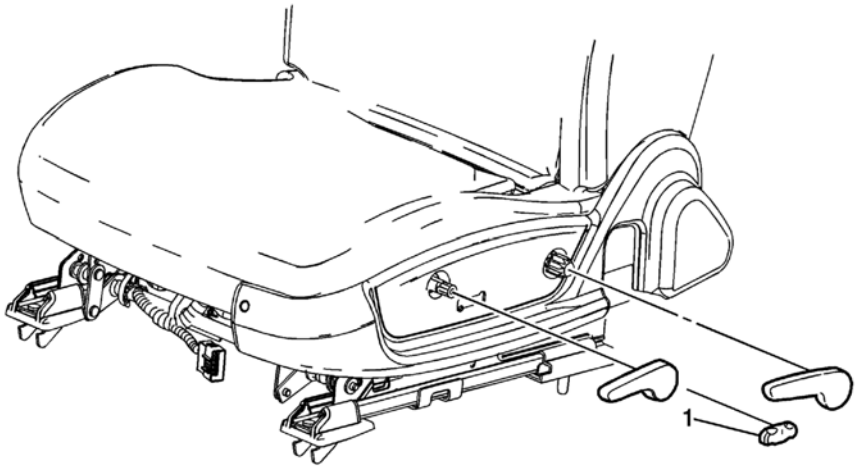


Fig. 3: Power Seat Switch And Seat Cushion Knob
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** .	
1	Knob, Power Seat Switch **TIP:** Pull outward to remove.

POWER SEAT SWITCH REPLACEMENT (IMPALA)

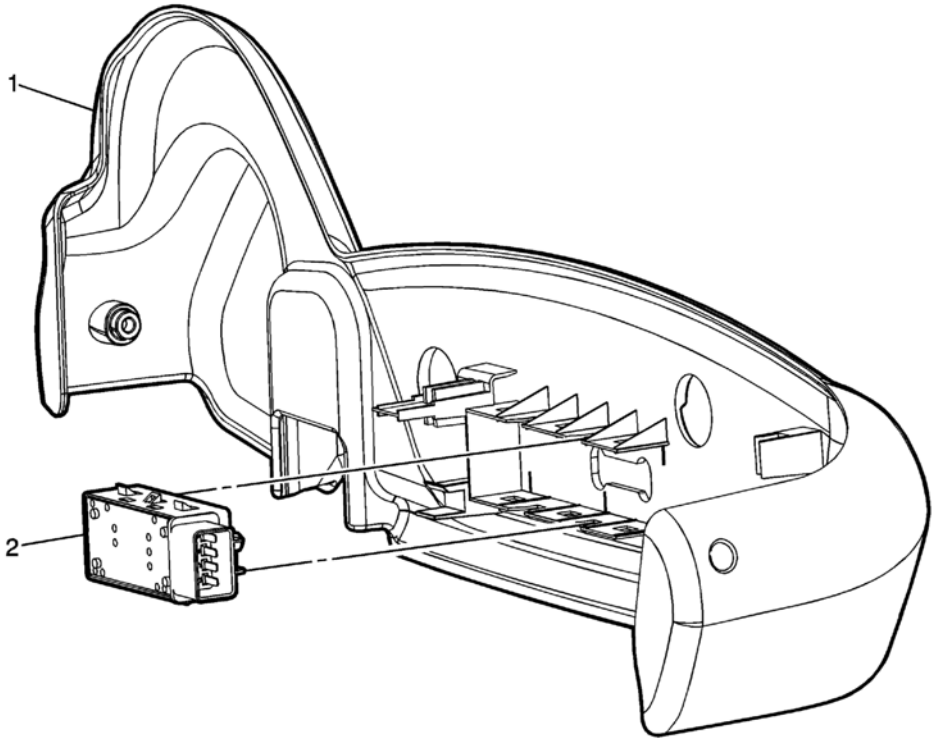


Fig. 4: Power Seat Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** .	
1	Panel, Seat Cushion Outer Trim Refer to **Seat Cushion Outer Trim Panel Replacement** .
2	Switch, Power Seat 1. Disconnect the electrical connector. 2. Release the tabs and pull out of the outer trim panel to remove.

FRONT SEAT ADJUSTER REPLACEMENT

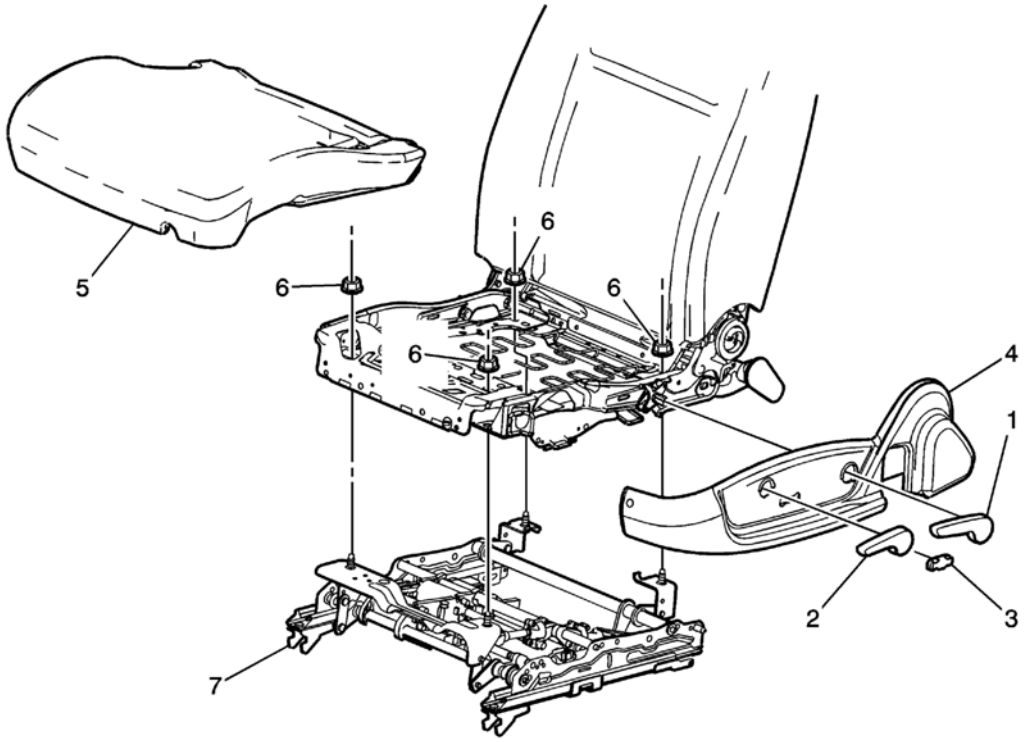


Fig. 5: Locating Front Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala)** .	
1	Recliner Handle **TIP:** Using a flat-bladed tool, push the retainer clip downward and pull outward to release the handle.
2	Lumbar Actuator Handle **TIP:** Pull outward to remove.
3	Power Seat Switch Knob **TIP:** Pull outward to remove.

Callout	Component Name
4	Seat Cushion Outer Trim Panel Refer to **Seat Cushion Outer Trim Panel Replacement** .
5	Seat Cushion Cover **Procedure** 1. Release the j-channel from the seat cushion frame. 2. Disconnect the seat cushion heater electrical connector, if equipped. 3. Remove the seat cushion cover and pad as an assembly from the frame.
6	Front Seat Cushion Frame Nut (Qty: 4) **CAUTION:** **Refer to Fastener Caution** . **Tighten** 9 N.m (80 lb in)
7	Front Seat Adjuster Assembly

FRONT SEAT RECLINER ACTUATOR MOTOR REPLACEMENT

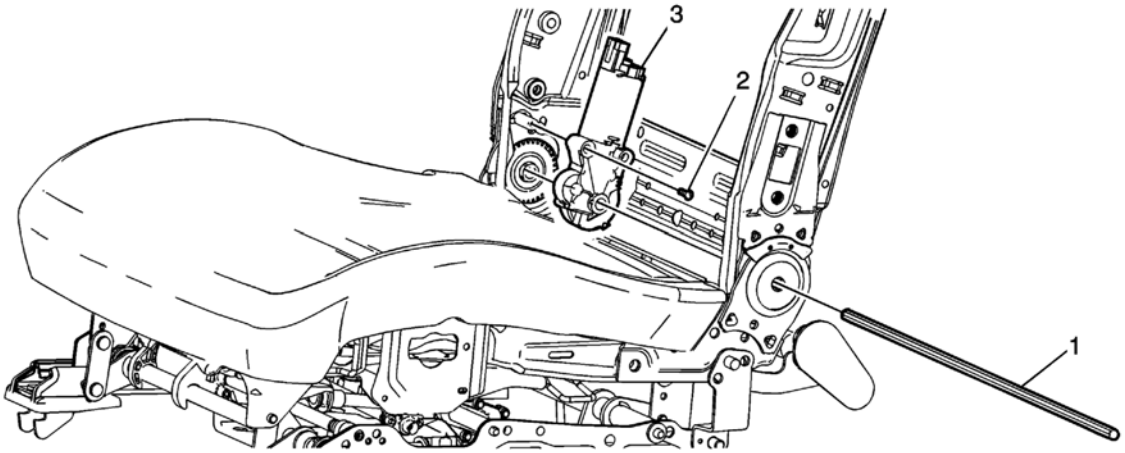


Fig. 6: Front Seat Power Recliner Motor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1.Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala)** .	

Callout	Component Name
2. Remove the lumbar actuator knob. Refer to **Lumbar Support Knob Replacement (Impala)** . Remove the recliner handle. Refer to **Front Seat Back Recliner Handle Replacement (Impala)** . 3. Remove the power seat switch knob. Refer to **Driver or Passenger Seat Adjuster Switch Knob Replacement (Impala)**. 4. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement** . 5. Remove the front seat back cushion cover and pad. ~~Refer to **Seat Back Cover and Pad Replacement (Impala Limited)** .~~ 6.	
1	Seat Recliner Bracket **TIP:** Remove the push on nuts from the ends for the rod and slide out to remove.
2	Front Seat Back Cushion Frame Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
3	Front Seat Recliner Actuator Motor

DESCRIPTION AND OPERATION

POWER SEATS SYSTEM DESCRIPTION AND OPERATION

The driver and passenger power seat systems each consist of the following components:

- Seat Adjuster Switch
- Seat Horizontal Motor
- Seat Front Vertical Motor
- Seat Rear Vertical Motor
- Seat Recline Motor
- PWR/SEAT Circuit Breaker 25 A

Seat Adjuster Switch

The seat adjuster switches provide both power and ground to the selected seat motors. Battery positive voltage is supplied at all times to the driver and passenger seat adjuster switches from the PWR/SEAT Circuit Breaker located in the I/P fuse block. The driver seat adjuster switch receives ground through the switch ground circuit and G301, while the passenger seat switch receives ground through the switch ground circuit and G302.

Motors

All of the seat motors operate independently of each other. Each motor contains an electronic circuit breaker (PTC) that opens in the event of a circuit overload and will reset only after voltage has been removed from the circuit. There are four seat position motors. These are the horizontal motor, front vertical motor, rear vertical motor, and the seat back recline motor. The horizontal motor moves the entire seat forward and rearward. The seat vertical motors may operate independently to tilt the front or rear of the seat cushion up or down. Both motors can also run simultaneously to move the entire seat up or down. The recline motor moves the angle of the seat back forward or rearward.

Horizontal

When the seat switch is operated to move the entire seat forward, battery positive voltage is applied through the switch contacts and the horizontal motor forward control circuit to the motor. The motor is grounded through the horizontal motor rearward switch contacts and the horizontal motor rearward control circuit to the motor. The motor runs in order to drive the entire seat forward until the switch is released. Moving the entire seat rearward works similarly to moving the entire seat forward, except that battery positive voltage and ground are applied on opposite circuits causing the motor to run in the opposite direction.

Rear Vertical

When the seat switch is operated to tilt the rear of the seat cushion up, battery positive voltage is applied through the switch contacts and the rear vertical motor up control circuit to the rear vertical motor. The motor is grounded through the down switch contacts and the rear vertical motor down control circuit to the motor. The motor runs in order to drive the rear of the seat cushion up until the switch is released. Tilting the rear of the seat cushion down works similarly to tilting the rear of the seat cushion up, except that battery positive voltage and ground are applied on opposite circuits causing the motor to run in the opposite direction.

Front Vertical

When the seat switch is operated to tilt the front of the seat cushion up, battery positive voltage is applied through the switch contacts and the front vertical motor up control circuit to the motor. The motor is grounded through the down switch contacts and the front vertical motor down control circuit to the motor. The motor runs in order to drive the front of the seat cushion up until the switch is released. Tilting the front of the seat cushion down works similarly to tilting the front of the seat cushion up, except that battery positive voltage and ground are applied on opposite circuits causing the motor to run in the opposite direction.

Entire Seat Up or Down

When the seat switch is operated in order to move the entire seat to the up position, battery positive voltage is simultaneously applied through the front and rear vertical motor up switch contacts and the front and rear vertical motor up control circuits to both vertical motors. The motors are grounded through the down switch contacts and the front and rear vertical motor down control circuits to both vertical motors. Both motors run simultaneously in order to drive the entire seat up until the switch is released. Moving the entire seat down works similarly to moving the entire seat up, except that battery positive voltage and ground are applied on the opposite circuits causing the motors to run in the opposite direction.

Recline

When the seat recline switch is operated to move the seat back forward, battery positive voltage is applied through the switch contacts and the recline motor forward control circuit to the motor. The motor is grounded

through the rearward switch contacts and the recline motor rearward control circuit to the motor. The motor runs in order to move the seat back forward until the switch is released. Moving the seat back rearward works similarly to moving the seat back forward, except that battery positive voltage and ground are applied on the opposite circuits causing the motor to run in the opposite direction.

Article GUID: A00737194

DIAGNOSTIC INFORMATION AND PROCEDURES

CONTROL MODULE REFERENCES

Reference Information

- Data Link References
- Diagnostic System Check - Vehicle
- Diagnostic Trouble Code (DTC) List - Vehicle
- Symptoms - Vehicle

Code	Control Module/Scan Tool Information	Schematic	Repair Instruction	Programming and Setup
A11	Radio Scan Tool Information	Radio/Navigation System Schematics	Radio Replacement	Radio Programming and Setup
A12	Digital Radio Receiver Scan Tool Information	Radio/Navigation System Schematics	Digital Radio Receiver Replacement	Digital Radio Receiver Programming and Setup
K9	Body Control Module Scan Tool Information	Body Control System Schematics	Body Control Module Replacement	Body Control Module Programming and Setup
K17	Electronic Brake Control Module Scan Tool Information	Antilock Brake System Schematics	Electronic Brake Control Module Replacement	Electronic Brake Control Module Programming and Setup
K20	K20 Engine Control Module: Scan Tool Information	Engine Controls Schematics	Engine Control Module Replacement	K20 Engine Control Module: Programming and Setup
K29	Driver Seat and Passenger Seat Heater Control Module Scan Tool Information	Heated/Cooled Seat Schematics	Front Seat Heater Control Module Replacement (Impala)	Heated Seat Control Module Programming and Setup
K33	Heating, Ventilation and Air Conditioning Control Module Scan Tool Information	HVAC Schematics	Blower Motor Control Module Replacement	HVAC System Control Module Programming and Setup

Code	Control Module/Scan Tool Information	Schematic	Repair Instruction	Programming and Setup
K36	Inflatable Restraint Sensing and Diagnostic Module Scan Tool Information	SIR Schematics	Airbag Sensing and Diagnostic Module Replacement	Inflatable Restraint Sensing and Diagnostic Module Programming and Setup
K38	Chassis Control Module Scan Tool Information AKA: Fuel Pump Control Module	Engine Controls Schematics	Fuel Pump Flow Control Module Replacement	Chassis Control Module Programming and Setup AKA: Fuel Pump Control Module
K61	Sunroof Control Module	Sunroof Schematics	Sunroof Motor/Actuator Replacement	Sunroof Control Module Programming and Setup
K71	Control Solenoid Valve and Transmission Control Module Assembly Transmission Control Module Scan Tool Information	Automatic Transmission Controls Schematics	Control Solenoid Valve and Transmission Control Module Assembly Replacement	Control Solenoid Valve and Transmission Control Module Assembly Programming and Setup
K73	Communication Interface Module Scan Tool Information	OnStar/Telematics Schematics	Communication Interface Module Replacement	Communication Interface Module Programming and Setup
K77	Remote Control Door Lock Receiver Scan Tool Information	Remote Function Schematics	Remote Control Door Lock Receiver Replacement	Remote Control Door Lock Receiver Programming and Setup
K85	Inflatable Restraint Passenger Presence System Scan Tool Information	SIR Schematics	Inflatable Restraint Passenger Presence System Replacement - Front	Passenger Presence System Programming and Setup
K89	Immobilizer Control Module Theft Deterrent Module Scan Tool Information	Immobilizer Schematics	Theft Deterrent Module Replacement	Theft Deterrent Module Programming and Setup
P16	Instrument Cluster Scan Tool Information	Instrument Cluster Schematics	Instrument Cluster Replacement	Instrument Cluster Programming and Setup

Code	Control Module/Scan Tool Information	Schematic	Repair Instruction	Programming and Setup
S25	Garage Door Opener	Remote Function Schematics	Garage Door Opener Transmitter Replacement	Garage Door Opener Programming and Setup
T3	Audio Amplifier	Radio/Navigation System Schematics	Radio Speaker Amplifier Replacement	Audio Amplifier Programming and Setup

REPAIR INSTRUCTIONS

AUDIO AMPLIFIER PROGRAMMING AND SETUP

This device requires no programming or setup.

BODY CONTROL MODULE PROGRAMMING AND SETUP

Introduction

A new Body Control Module (BCM) must be programmed with the latest operating software and vehicle calibrations. Ensure that the following conditions exist in order to prepare for BCM programming:

- The battery is fully charged.
- The ignition switch is in the ON position.
- The Data Link Connector (DLC) is accessible.
- All control modules and devices are connected.

The procedures below are designed to program the Body Control Module (BCM) correctly during BCM related service. Before you start, read these procedures carefully and completely.

Programming the BCM

NOTE: **The vehicle will not start and many other functions may not operate properly if a replacement BCM is not properly set up. The following procedures must be completed.**

NOTE: **After the procedure is completed, the personalization settings of the BCM are set to default settings. Inform the customer that the personalization must be set again.**

1. Programming the BCM-Refer to Service Programming System (SPS).
2. Brake Pedal Position (BPP) Sensor calibration-Refer to Brake Pedal Position Sensor Calibration .
3. Learning the Restraints ID-Navigate to Body Control Module > Configuration/Reset Functions > Setup SDM Part Number in BCM, then follow the instructions on the screen.

NOTE: **After any programming or setup, perform the following to avoid future misdiagnosis:**

1. Turn the ignition OFF for 10 s.
2. Connect the scan tool to the Data Link Connector.
3. Turn the ignition ON, with the engine OFF.
4. Use the scan tool in order to retrieve history DTCs from all control modules.
5. Clear all history DTCs.

CHASSIS CONTROL MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select K38 Chassis Control Module - Programming and follow the on-screen instructions.

4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
5. With a scan tool, perform the Suspension Sensor Trim Height Calibration, if applicable.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
    - **If the control module cannot be reprogrammed**
    1. Ignition OFF for one minute, ignition ON.
    2. Verify the control module can be reprogrammed.
        - If the control module cannot be reprogrammed, replace the control module.
        - If the control module can be reprogrammed.
    3. All OK.
    - **If the control module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Control Module replacement, programming and setup

COMMUNICATION INTERFACE MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**

- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Diagnostic Aids

- Before beginning any programming first determine which Generation of the Telematics Communication Interface Control Module you are working with. One way to accomplish this is by using a scan tool. The Telematics Communication Interface Control Module Generation will be listed under the Selected Vehicle Configuration section, in addition the Generation (9 or 10) can be determined from the Module ID data table. Additional programming steps may be necessary depending on the generation of the module.
- It is critical to use the service replacement Communication Interface Module only in the vehicle for which it was ordered.
- Failure to perform the following procedures will result in a red LED, DTC(s) being set, and or incomplete OnStarÂ® services.
- An OnStarÂ® button press to the OnStarÂ® call center is required to complete the procedure.
- To fully activate an OnStarÂ® module, both the setup and activation request procedures must be completed on all vehicles with and without an active OnStarÂ® subscription to insure the unit has been setup properly for the vehicle it has been installed into and also to update the OnStarÂ® with the correct unit information.
- If the vehicle is equipped with RPO VV4 the Telematics Communication Interface Control Module WiFi Enable (Gen 10 only) Programming step must be performed AFTER the Programming and Service Activation step. Failure to complete this step in the proper sequence will result in WiFi being disabled.
- To initialize the Turn-by-Turn feature, the vehicle must first be driven In open sky condition at speeds greater than 10 mph (16 kph) or more for a minimum of 5 miles (8 km) , and perform at least 2 left and 2 right 90 degree turns coming to complete stops prior to each turn.
- On vehicles up fitted with TTY capabilities, it is necessary to perform a power cycle of the OnStarÂ® Interface Module (OTIM), and toggle the TTY mode after completing the Communication Interface Module installation and setup procedures.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install **EL-49642** SPS programming support tool .
2. Access the Service Programming System (SPS) and follow the on-screen instructions.

NOTE:

- **Due to a change in SPS you must select 'Reprogram ECU', for Telematics Communication Interface Control Module Programming from the Selected Programming Process even if**

the unit is being replaced.

- **If 'Replace and Program ECU' is selected the Telematics Communication Interface Control Module will not be listed in the Supported Controllers screen. You must go back and select 'Reprogram ECU'.**

3. In the SPS Supported Controllers screen, select Telematics Communication Interface Control Module Programming and Service Activation and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
5. After Telematics Communication Interface Control Module Programming and Service Activation, if the vehicle is equipped with RPO VV4, on the Supported Controllers screen select Telematics Communication Interface Control Module WiFi Enable (Gen 10 only) Programming and follow the on-screen instructions.

NOTE: **The WiFi Enable step must be performed AFTER the Programming and Service Activation step, or WiFi will not function. If Programming and Service Activation step is performed after the WiFi Enable step, WiFi will be disabled.**

6. Press the OnStarÂ® Blue Button to call OnStarÂ® and have the system activated. If the customer refused OnStarÂ® services (terms and conditions) and the vehicle is equipped with RPO VV4 have the OnStarÂ® consultant turn off the WiFi demo message that occurs after every ignition on event.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
   - **If the control module cannot be reprogrammed**
   1. Ignition OFF for one minute, ignition ON.
   2. Verify the control module can be reprogrammed.
      - If the control module cannot be reprogrammed, replace the control module.
      - If the control module can be reprogrammed.
   3. All OK.
   - **If the control module can be reprogrammed**
3. All OK.

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly**

configured with the correct calibration software, the control module will not control all of the vehicle features properly.

- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required, install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module

To program a replacement transmission control module (TCM), perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Transmission Control Module - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
5. With a scan tool, perform the Reset Transmission Adapts. Refer to **Reset Transmission Adapts** .

Reprogram Control Module

To reprogram an existing TCM, perform the following procedure:

1. Access the Service Programming System (SPS) and follow the on-screen instructions.
2. On the SPS Supported Controllers screen, select Transmission Control Module - Programming and follow the on-screen instructions.
3. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

4. With a scan tool, perform the Reset Transmission Adapts. Refer to **Reset Transmission Adapts** .

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
    - **If the control module cannot be reprogrammed**
    1. Ignition OFF for one minute, ignition ON.
    2. Verify the control module can be reprogrammed.
        - If the control module cannot be reprogrammed, replace the control module.
        - If the control module can be reprogrammed.
    3. All OK.
    - **If the control module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for control module replacement, programming, and setup.

DIGITAL RADIO RECEIVER PROGRAMMING AND SETUP

Each of the following service procedures requires programming or setup procedures to be performed on the digital radio receiver.

XM™ Activation

IMPORTANT: After replacement of an XM™ receiver, call XM™ radio to deactivate the receiver that has been removed from the vehicle. The vehicle must be parked in view of a satellite within 24 hours after an activation call.

1. Radio ON, tune to the XM™ channel 0 and record the radio ID. The radio ID will be required for activation of the new receiver. The customer's name, address and phone number may also be needed for account verification.
2. Call XM™ radio to deactivate the faulty receiver and activate the new receiver.
    - US: 1-800-556-3600
    - Canada: 1-877-438-9677
3. Park the vehicle outside in an area with an unobstructed view of the southern sky.
4. Leave the vehicle outside with the ignition switch in the ACC position and the radio ON, tune to the XM™ channel 1 for 30 minutes to activate XM™ service.
5. Once activated, the radio will receive the remaining XM™ channels.

ELECTRONIC BRAKE CONTROL MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Special Tools

EL-49642 SPS Programming Support Tool

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing Electronic Brake Control Module (EBCM), perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Electronic Brake Control Module - Programming and follow the on-screen instructions.
4. On the SPS Supported Controllers screen, select Electronic Brake Control Module - Configuration and follow the on-screen instructions.
5. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
6. With a scan tool, perform the Steering Angle Sensor Centering. Refer to **Steering Angle Sensor Centering** .
7. With a scan tool, perform the Yaw Rate Sensor Recalibration. Refer to **Vehicle Yaw Sensor Learn** .

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
    - **If the control module cannot be reprogrammed**
    1. Ignition OFF for one minute, ignition ON.
    2. Verify the control module can be reprogrammed.
        - If the control module cannot be reprogrammed, replace the control module.
        - If the control module can be reprogrammed.
    3. All OK.
    - **If the control module can be reprogrammed**
3. All OK.

K20 ENGINE CONTROL MODULE: PROGRAMMING AND SETUP

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector (DLC). If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**
- **Note the engine oil life remaining percentage.**

Replace and Program Control Module

To program a replacement K20 Engine Control Module (ECM), perform the following procedure:

1. Install **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. Before removing the old control module, perform the SPS function Prepare Control Module for Removal, if available.

> **NOTE:** **The Prepare Control Module for Removal function can only be performed when communication with the old control module is still possible.**

4. Replace the ECM.
5. Perform the SPS function K20 Engine Control Module - Programming and follow the on-screen instructions.
6. Clear the DTCs after completing the Programming procedure.
7. Perform the SPS function Immobilizer Learn and follow the on-screen instructions. Refer to **Immobilizer System Component Programming** .
8. Perform the SPS function K20 Engine Control Module - Configuration & Setup and follow the on-screen instructions.
9. Clear DTCs after completing the Configuration & Setup procedure.

Reprogram Control Module

To reprogram an existing K20 Engine Control Module, perform the following procedure:

1. Install **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. Clear DTCs after completing the Programming procedure.

> **NOTE:** **If vehicle fails to start during Configuration and Setup, perform the SPS Function Immobilizer Learn and follow the on-screen instructions.**

4. Perform the SPS function Engine Control Module - Configuration & Setup and follow the on-screen instructions, if available.
5. Clear DTCs after completing the Configuration & Setup procedure.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following:

1. Ignition ON. Ensure the control module, DLC, and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
    - **If the control module cannot be reprogrammed**
    1. Ignition OFF for one minute, ignition ON.

2. Verify the control module can be reprogrammed.
    - If the control module cannot be reprogrammed, replace the K20 Engine Control Module.
- **If the control module can be reprogrammed**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for ECM replacement, programming and setup.

GARAGE DOOR OPENER PROGRAMMING AND SETUP

Replace and Program ECU or Reprogram ECU

This ECU does not require SPS programming but does require the following setup procedures after a new ECU is installed:

The customer must learn the device they wish to control. This must be done at the device (garage door opener, electric gate, etc.) and cannot be performed at a dealership. Refer to the vehicle owner's manual for programming instructions.

HEATED SEAT CONTROL MODULE PROGRAMMING AND SETUP

Heated Seat Module Replacement

If the heated seat module is replaced or if the module needs to be reprogrammed, refer to **Service Programming System (SPS)**.

HVAC SYSTEM CONTROL MODULE PROGRAMMING AND SETUP

Each of the following service procedures may require programming or setup procedures to be performed on the HVAC control module or HVAC actuators.

HVAC Control Module Replacement

If the HVAC control module is replaced, the following procedure must be performed: Reprogram the HVAC control module. Refer to **Service Programming System (SPS)**.

HVAC Control Module Reprogramming

Do not reprogram the HVAC control module unless directed by a service procedure or a service bulletin.

Reprogram the HVAC control module. Refer to **Service Programming System (SPS)**.

Actuator Replacement

If an actuator is replaced, the following procedure must be performed: Re-Calibrating Actuators. Refer to **Actuator Recalibration** .

INFLATABLE RESTRAINT SENSING AND DIAGNOSTIC MODULE PROGRAMMING AND SETUP

NOTE: **The air bag indicator light may remain ON after the body control module (BCM), or inflatable restraint sensing and diagnostic module (SDM) is replaced, and during the programming procedure for the BCM until after the procedure is completed. When installing a new SDM, there may be several DTCs set prior to programming. Once programmed, these DTCs should be in history and can be cleared.**

1. Ignition ON, program the SDM. Refer to **Service Programming System (SPS)**.
2. In the Inflatable Restraint Sensing and Diagnostic Module, Configuration / Reset Functions menu, select Setup SDM Part Number in BCM. Follow the scan tool on screen instructions.
3. In the Inflatable Restraint Sensing and Diagnostic Module, Configuration / Reset Functions menu, select Configure New Module. Follow the scan tool on screen instructions. If during this procedure a fault is detected, the SDM will not allow this procedure to complete. Repair any existing DTCs, then use the scan tool to command the Configuration / Reset Function again.
4. Cycle the ignition from OFF to ON. Verify no DTCs are set. If any DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

INSTRUMENT CLUSTER PROGRAMMING AND SETUP

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the ECU is not properly configured with the correct calibration software, the ECU will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or ECU damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install the EL-49642 tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Replace and Program ECU or Reprogram ECU

To program a replacement or an existing ECU, perform the following procedure:

1. Install **EL-49642** tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Instrument Cluster - Programming and follow the on-screen instructions.
4. On the SPS Supported Controllers screen, select Instrument Cluster - Setup and follow the on-screen instructions.
5. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. DO NOT turn the ignition OFF. Ensure that all ECU, DLC and programming tool connections are secure and the TIS terminal operating software is up to date.
2. Attempt to reprogram the ECU.
3. If the ECU can still not be programmed, turn the ignition OFF for at least one minute.
4. Turn the ignition ON and attempt to reprogram the ECU. The ECU should program.
    - If the ECU still cannot be programmed, replace the ECU.

PASSENGER PRESENCE SYSTEM PROGRAMMING AND SETUP

Passenger Presence System Preload Test

The passenger presence system (PPS) consists of an electronic control module, a sensor mat in the seat, a harness, and PASSENGER AIR BAG ON/OFF indicators. The passenger presence detection system transmits and receives a low-level electric field. The measured capacitance value of this field is used to determine the type of occupant sitting in the front passenger seat. If the measured capacitance is less than a calibrated value, then the passenger presence module will send a hard wire signal to the inflatable restraint sensing and diagnostic module to disable the passenger instrument panel air bag. If the measured capacitance is greater than a calibrated value, then the passenger presence module will send a serial data signal to the inflatable restraint sensing and diagnostic module to enable the passenger instrument panel air bag. The passenger presence detection system module will notify the customer of the enable/disable status by illuminating one of the PASSENGER AIR BAG ON/OFF indicator. If the passenger seat bottom cushion, seat bottom trim, or heater pad has been serviced, reinstalled, or removed for any reason, the procedure below will check for any preloads on the passenger presence system. A service replacement passenger presence system module does not require an unlock procedure prior to an initial preload test.

NOTE:

- **Before the passenger presence system can be checked for preloads the front passenger seat must be completely empty of all items. The presence of any items on the front passenger seat will affect the calibration and operation of the passenger presence system.**
- **DTC B0081 will set if the preload system test is performed with:**
    - **An aftermarket seat heater located too close to the sensor mat**
    - **A scan tool, laptop, or other electronic device is in the seat**

- The seat is damp or wet
- An object or person is in the seat

- **When the preload test is perform, the instrument panel cluster and dash lights will begin illuminating at varying intensity. This is normal operation during the preload test procedure and does not indicate additional system faults.**
- **The Diagnostic Repair Verification must be performed after successfully completing the preload test procedure to ensure the system is functioning properly.**

Passenger Presence System Preload System Test

1. Empty the front outboard passenger seat (this system is susceptible to conductive material).
2. With the scan tool, perform the Passenger Presence Sensor Learn procedure.
3. Using the scan tool, check for DTC B0081 in history. If the test fails or DTC B0081 11 is current, confirm that the seat is empty. Perform the passenger presence sensor learn test again. If the test fails again, for heated seats, ensure that the sensor pad is on top of the heater element. Once the test successfully completes, cycle the Vehicle OFF.
4. Perform the **Diagnostic Repair Verification** after successfully completing the preload test procedure to ensure the system is functioning properly.

RADIO PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the ECU is not properly configured with the correct calibration software, the ECU will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or ECU damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Diagnostic Aids

- During radio programming you may be required to select multiple calibrations dependant upon vehicle equipment. Have the vehicle build/RPO information available during the following procedure to ensure the correct calibrations are selected.
- The XM satellite radio (if equipped) is integrated into the radio. If XM was activated in the previous radio, the replacement radio will require additional activation steps after programming to transfer customer subscription information.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select A11 Radio - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

XM Activation (If Equipped)

NOTE: **After replacement of an XM receiver, call XM radio to deactivate the receiver that has been removed from the vehicle.**

1. Turn the radio ON, tune to the XM channel 0, and record the radio ID. The radio ID will be needed for activation of the receiver.
2. From the USA, Call XM radio at 1-800-556-3600 to activate the receiver. From Canada, call 1-877-438-9677.
3. Park the vehicle outside in an area with an unobstructed view of the southern sky.
4. Leave the vehicle outside with the ignition switch in the ACC position and the radio on for 30 minutes to activate XM service.
5. Once activated, the radio will receive the remaining XM channels.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
    - **If the control module cannot be reprogrammed**
    1. Ignition OFF for one minute, ignition ON.

2. Verify the control module can be reprogrammed.
    - If the control module cannot be reprogrammed, replace the control module.
    - If the control module can be reprogrammed.
3. All OK.

- **If the control module can be reprogrammed**

3. All OK.

REMOTE CONTROL DOOR LOCK RECEIVER PROGRAMMING AND SETUP

NOTE:

- **When replacing the remote control door lock receiver (RCDLR), the tire pressure monitoring (TPM) information can be learned to the new RCDLR in one of two ways. These two methods are reflected in the selections below. Only choose one of the methods; it is not required to do both methods when replacing the RCDLR.**
- **If you choose to perform the Copy and Restore TPM Information procedure, Step 1 must be performed BEFORE removing the old RCDLR. This procedure requires that specific TPM information be extracted from the old RCDLR prior to its removal.**

Remote Control Door Lock Receiver Replacement (Copy and Restore TPM Information)

This procedure will learn the TPM information to the new RCDLR using the Copy and Restore function on the scan tool. This procedure will extract the TPM Tire Type information as well as the sensor data from the existing RCDLR prior to its replacement and store this information in the scan tool. After RCDLR replacement and SPS programming, the tire type and sensor data stored in the scan tool is written to the new RCDLR, negating the need to perform the tire type setup and sensor learn procedure.

This procedure should be considered as the first programming choice when replacing an RCDLR. The Copy and Restore procedure eliminates the possibility of incorrectly inputting the tire type or learning stray TPM sensors.

NOTE: **This step must be performed prior to the removal or replacement of the old RCDLR.**

1. Using a scan tool, navigate to the Copy and Restore TPM Information procedure and copy the existing TPM information from the RCDLR using the outline below. Follow the on-screen instructions.
    - Remote Control Door Lock Receiver
    - Configure/Reset Functions
    - Copy and Restore TPM Information
2. At this point, install the new RCDLR.
3. Program the RCDLR. Refer to **Service Programming System (SPS)**.
4. Using a scan tool, navigate to the Copy and Restore TPM Information procedure to restore the TPM information. Follow the on-screen instructions.
5. Program the keyless entry transmitters - Refer to **Remote Control Door Lock Transmitter Learn** .

6. Perform the 10-Minute Immobilizer Relearn procedure. Refer to **Immobilizer System Component Programming**

   When performing the relearn procedure, select Theft Deterrent Learn - Keyless Ignition (with rotary switch) on the SPS terminal.

Remote Control Door Lock Receiver Replacement (TPM Sensor Learn)

This procedure will learn TPM information to the new RCDLR by manually inputting the tire type using the scan tool and performing the TPM sensor learn. This procedure should be performed if the above Copy and Paste procedure can not be completed. An example of this would be an RCDLR that is unable to communicate with the scan tool and is required to be replaced.

1. RCDLR Programming-Refer to **Service Programming System (SPS)**.
2. Keyless Entry Transmitter Programming-Refer to **Remote Control Door Lock Transmitter Learn** .
3. Tire Type Setup:
   1. Install a scan tool.
   2. Select Remote Control Door Lock Receiver Configuration/Reset Functions.
   3. Select Tire Type/Pressure Selection.
   4. Follow the on-sceen instructions.
4. Perform the 10-Minute Immobilizer Relearn procedure. Refer to **Immobilizer System Component Programming** .

   When performing the relearn procedure, select Theft Deterrent Learn - Keyless Ignition (with rotary switch) on the SPS terminal.

5. Tire Pressure Monitoring Sensor Learn-Refer to **Tire Pressure Indicator Sensor Learn** .

SERVICE PROGRAMMING SYSTEM (SPS)

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

For step-by-step control module programming instructions, please refer to the techline information system (TIS) terminal.

Review the information below to ensure proper programming protocol.

NOTE:

- **DO NOT program a control module unless you are directed by a service procedure or you are directed by a General Motors service bulletin. Programming a control module at any other time will not permanently correct a customers concern.**
- **It is essential that the TIS terminal, MDI, and/or Scan Tool, is equipped with the latest software before performing service programming.**
- **Stable battery voltage is critical during programming. Any fluctuation,**

spiking, over voltage or loss of voltage will interrupt programming. When required, install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12V jumper or booster pack disconnected from the AC voltage supply.

- **Some modules will require additional programming/setup events to be performed before or after programming.**
- **Some vehicles may require the use of a CANDi or MDI module for programming.**
- **Review the appropriate service information for these procedures.**
- **DTCs may set during programming. Clear DTCs after programming is complete.**
- **Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Ensure the following conditions are met before programming a control module:

- Vehicle system voltage:
  - There is not a charging system concern. All charging system concerns must be repaired before programming a control module.
  - Battery voltage is greater than 12 volts but less than 16 volts. The battery must be fully charged before programming the control module.
  - Turn OFF or disable any system that may put a load on the vehicles battery, such as the following components:
    - Interior lights
    - Exterior lights including daytime running lights (DRL)-Applying the parking brake, on most vehicles, disables the DRL system
    - Heating, ventilation, and air conditioning (HVAC) systems
    - Engine cooling fans
    - Radio, etc.
- The ignition switch must be in the proper position. SPS prompts you to turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the programming procedure, unless instructed to do so.
- Make certain all tool connections are secure, including the following components and circuits:
  - Scan Tool
    - The RS-232 communication cable port
    - The connection at the data link connector (DLC)
    - The voltage supply circuits
  - MDI
    - The USB, Ethernet or Wireless communication port
    - The connection at the data link connector (DLC)
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the

programming procedure, programming failure or control module damage may occur.

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. DO NOT turn the ignition OFF. Ensure that all control module and DLC connections are secure and the TIS terminal operating software is up to date.
2. Attempt to reprogram the control module.
3. If the control module can still not be programmed, turn the ignition OFF for at least one minute.
4. Turn the ignition ON and attempt to reprogram the control module. The control module should program.
    - If the control module still cannot be programmed, replace the control module.

After successfully programming the control module, ensure that all post programming procedures are performed; refer to **Control Module References** for the appropriate control module Programming and Setup document for any required procedures.

SUNROOF CONTROL MODULE PROGRAMMING AND SETUP

When replacing the sunroof motor/control module, the sunroof motor/actuator initialization/teach procedure must be followed. Refer to **Sunroof Motor/Actuator Initialization/Teach Process** before starting the repair procedure.

THEFT DETERRENT MODULE PROGRAMMING AND SETUP

1. Connect a scan tool to the vehicle in the Pass-thru arrangement.
2. Turn ON the ignition, with the engine OFF.
3. Ensure that all power consuming devices are turned OFF on the vehicle.
4. On the Techline Terminal, select Service Programming System and follow the Techline Terminal on-screen instructions. Go to TDM Theft Deterrent Module from the controller list and select the appropriate on-screen calibration options.
5. After the programming has completed, turn the ignition OFF for 30 seconds.
6. Turn ON the ignition with the engine OFF.
7. On the Techline Terminal, go to V.T.D. Vehicle Theft Deterrent Learn from the controller list and select Vehicle Theft Deterrent Learn, ECM or PK3 Replaced. Follow the on-screen instructions.
8. At this point the scan tool must remain connected for the duration of the 10-minute relearn procedure.

NOTE:

- **The Techline Terminal will initially display 12 Minutes. The first 2 minutes allow the scan tool to initialize the appropriate control module. The remaining 10 minutes is the relearn timer.**
- **On some vehicles the security indicator may be illuminated for the duration of the 10-minute relearn procedure.**

9. Observe the scan tool, after approximately 12 minutes the scan tool will display "Programming Successful, Turn OFF Ignition". The vehicle is now ready to relearn the key information and/or the passwords on the next ignition switch transition from OFF to CRANK.
10. Turn OFF the ignition and wait 2 minutes.

11. With a master vehicle key, turn the ignition to the RUN position for 15 seconds, then start the vehicle. The TDM and ECM have now relearned the pre-release password and the challenge/response data.
12. With a scan tool, clear any DTCs.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

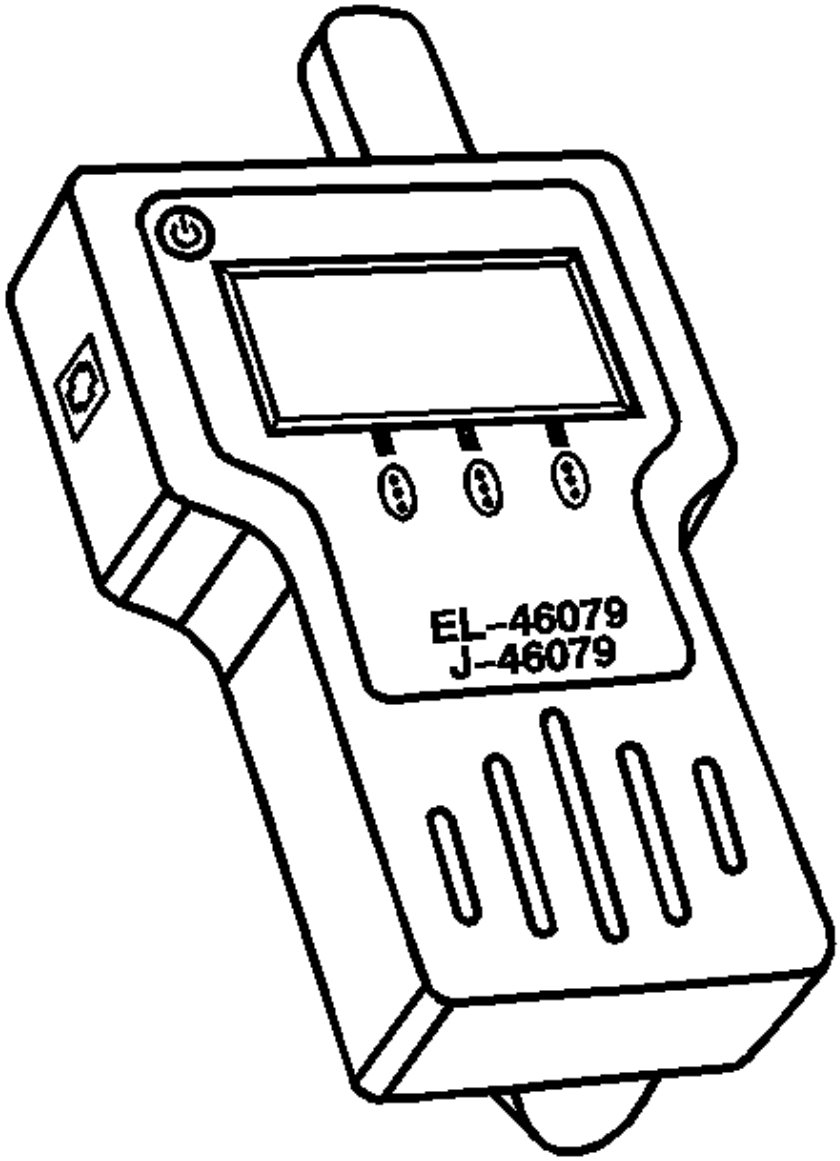
Illustration	Tool Number/ Description
	EL 46079 J 46079 Tire Pressure Monitor Diagnostic Tool

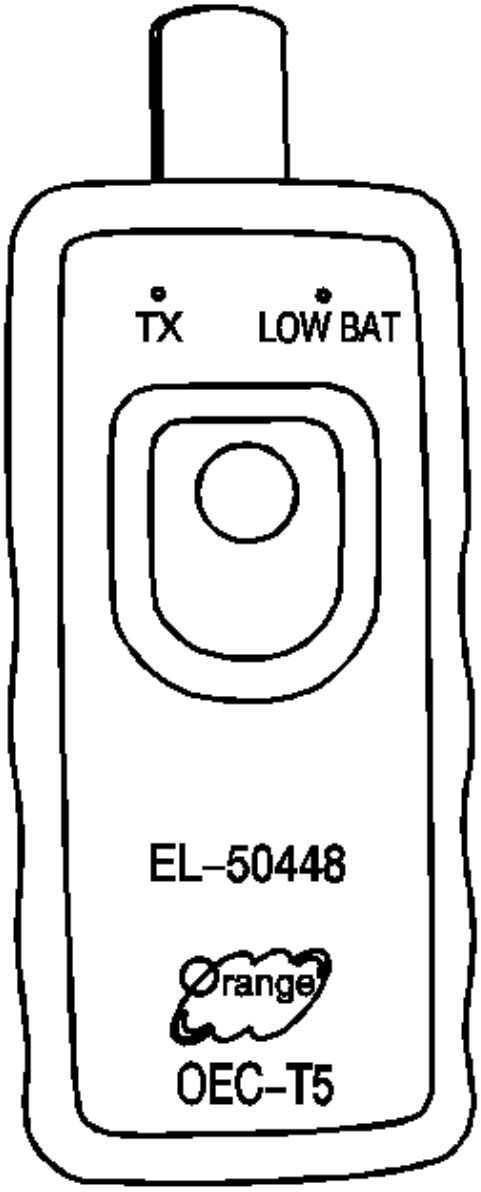
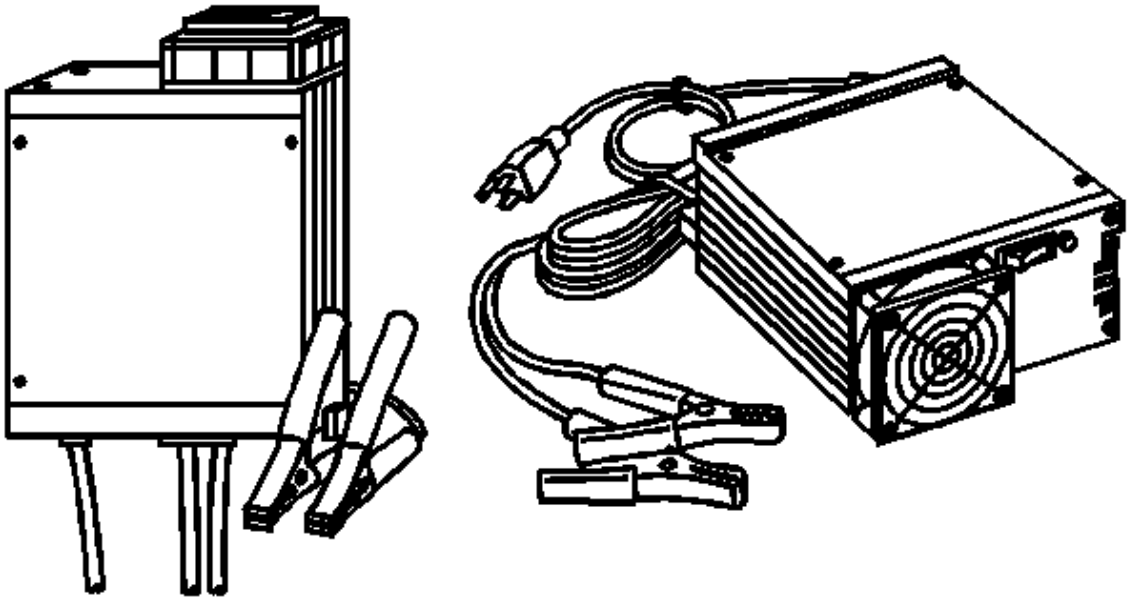
Illustration	Tool Number/ Description
	EL 50448 Tire Pressure Monitor Sensor Activation Tool

Illustration	Tool Number/ Description
	EL 49642 EL 50113 Europe- Use recommended equivalent workshop equipment SPS Programming Support Tool

Article GUID: A00737162

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Front Center Seat Armrest Bolt	3 N.m	25 lb in
Front Center Seat Bolt	44 N.m	32 lb ft
Front Seat Adjuster Bolt	45 N.m	33 lb ft
Front Seat Back Cushion Frame Bolt	45 N.m	33 lb ft
Front Seat Cushion Frame Bolt	45 N.m	33 lb ft
Front Seat Cushion Frame Nut	9 N.m	80 lb in
Front Seat Cushion Outer Trim Panel Screw	2 N.m	18 lb in
Front Seat Heater Control Module Screw	2 N.m	18 lb in
Power Recliner Motor Bolt	9 N.m	80 lb in
Rear Seat Armrest Nut	3 N.m	25 lb in
Rear Seat Back Cushion Bolt	45 N.m	33 lb ft
Rear Seat Back Cushion Nut	45 N.m	33 lb ft

REPAIR INSTRUCTIONS

FRONT SEAT REMOVAL AND INSTALLATION - BUCKET (IMPALA)

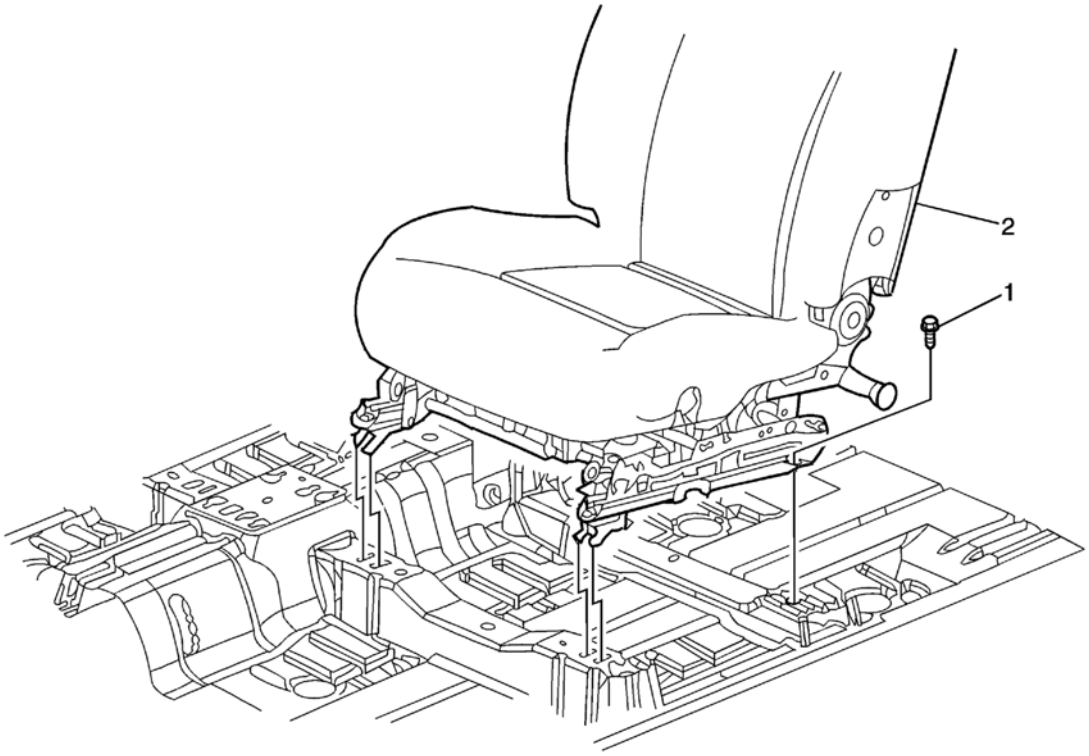


Fig. 1: View Of Front Bucket Seat (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the seat belt from the seat. Refer to **Seat Belt Retractor Pretensioner Replacement - Front** .	
1	Seat Adjuster Bolt (Qty: 2) **CAUTION:** **Refer to** **Fastener** **Caution** . **Procedure** Remove the front seat track covers to access the bolts. **Tighten** 45 N.m (33 lb ft)
2	Seat Assembly **Procedure** Disconnect the electrical connectors.

FRONT CENTER SEAT REMOVAL AND INSTALLATION

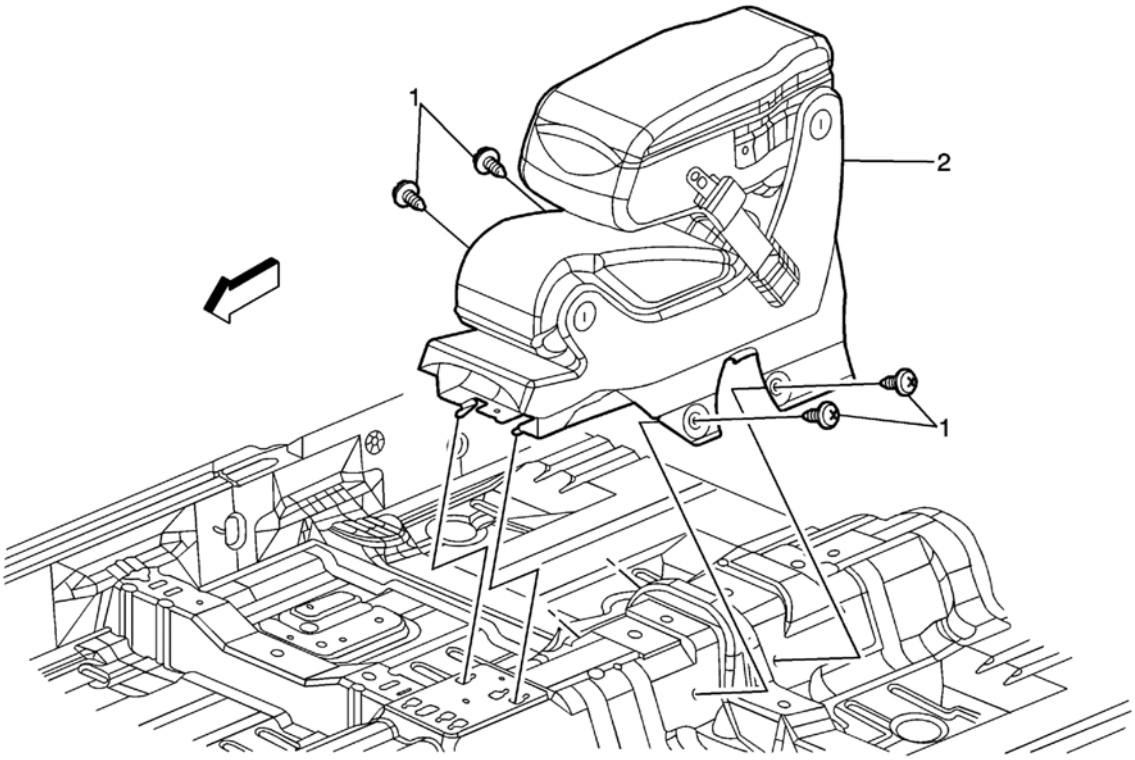


Fig. 2: Center Seat
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Move the driver and passenger seats forward or rearward.	
1	Front Center Seat Assembly Bolt (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution .** **TIP:** Remove the plastic caps that cover the bolts. **Tighten** 44 N.m (32 lb ft)
2	Front Center Seat Assembly • Slide the center seat assembly forward and lift up to disengage the retaining hooks at the front of the seat. • Disconnect the electrical connectors.

FRONT SEAT ADJUSTER REPLACEMENT

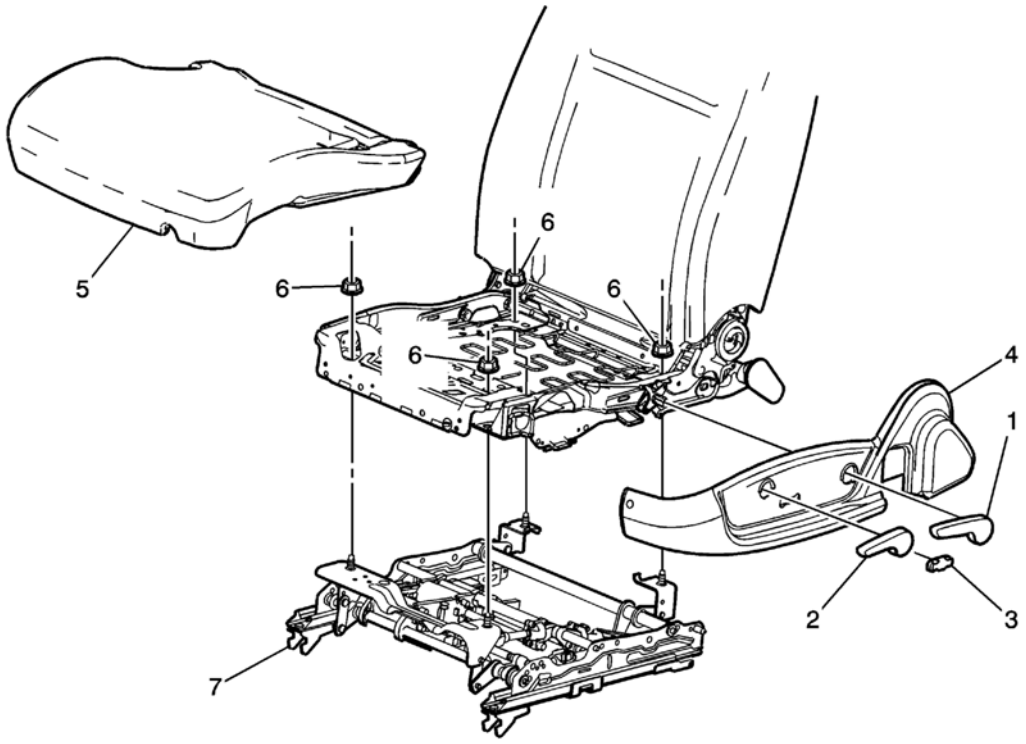


Fig. 3: Locating Front Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala)**.	
1	Recliner Handle **TIP:** Using a flat-bladed tool, push the retainer clip downward and pull outward to release the handle.
2	Lumbar Actuator Handle **TIP:** Pull outward to remove.
3	Power Seat Switch Knob **TIP:** Pull outward to remove.
4	Seat Cushion Outer Trim Panel Refer to **Seat Cushion Outer Trim Panel Replacement**.
5	Seat Cushion Cover **Procedure** 1. Release the j-channel from the seat cushion frame. 2. Disconnect the seat cushion heater electrical connector, if equipped. 3. Remove the seat cushion cover and pad as an assembly from the frame.
6	Front Seat Cushion Frame Nut (Qty: 4) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 9 N.m (80 lb in)
7	Front Seat Adjuster Assembly

PASSENGER SEAT ADJUSTER REPLACEMENT (IMPALA W/O AG2)

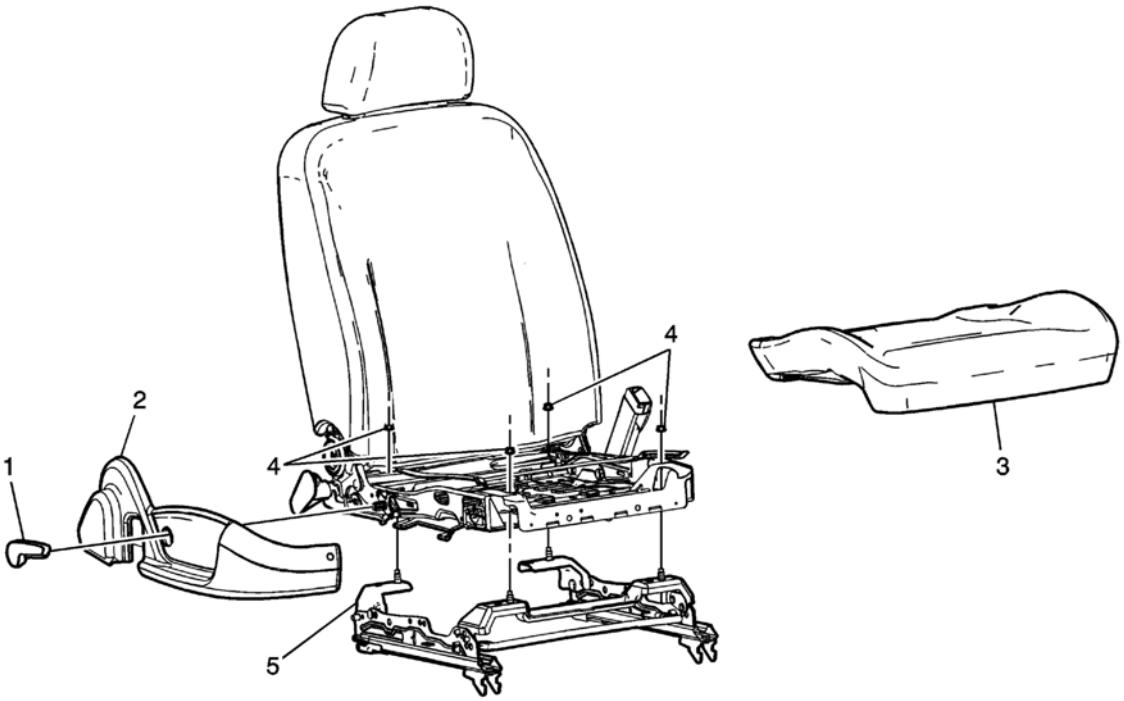


Fig. 4: Passenger Side Seat Adjuster (Impala w/o AG2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala).**	
1	Recliner Handle **TIP:** Using a flat-bladed tool, push the retainer clip downward and pull outward to release the handle.
2	Seat Cushion Outer Trim Panel Refer to **Seat Cushion Outer Trim Panel Replacement**.
3	Seat Cushion Cover **Procedure**

Callout	Component Name
	1. Release the j-channel from the seat cushion frame. 2. Disconnect the seat cushion heater electrical connector, if equipped. 3. Remove the seat cushion cover and pad as an assembly from the frame.
4	Front Seat Cushion Frame Nut (Qty: 4) **CAUTION:** **Refer to** Fastener Caution . **Tighten** 9 N.m (80 lb in)
5	Front Seat Adjuster Assembly

FRONT SEAT ARMREST LATCH REPLACEMENT (IMPALA)

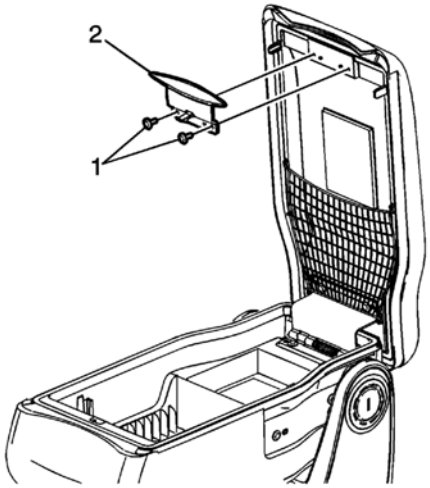


Fig. 5: Identifying Front Seat Armrest Latch (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Armrest Hinge Screw (Qty: 2) **CAUTION:** **Refer to** Fastener Caution . **Tighten** 3 N.m (25 lb in)

Callout	Component Name
2	Front Seat Armrest Latch Assembly

FRONT SEAT ARMREST REPLACEMENT (IMPALA)

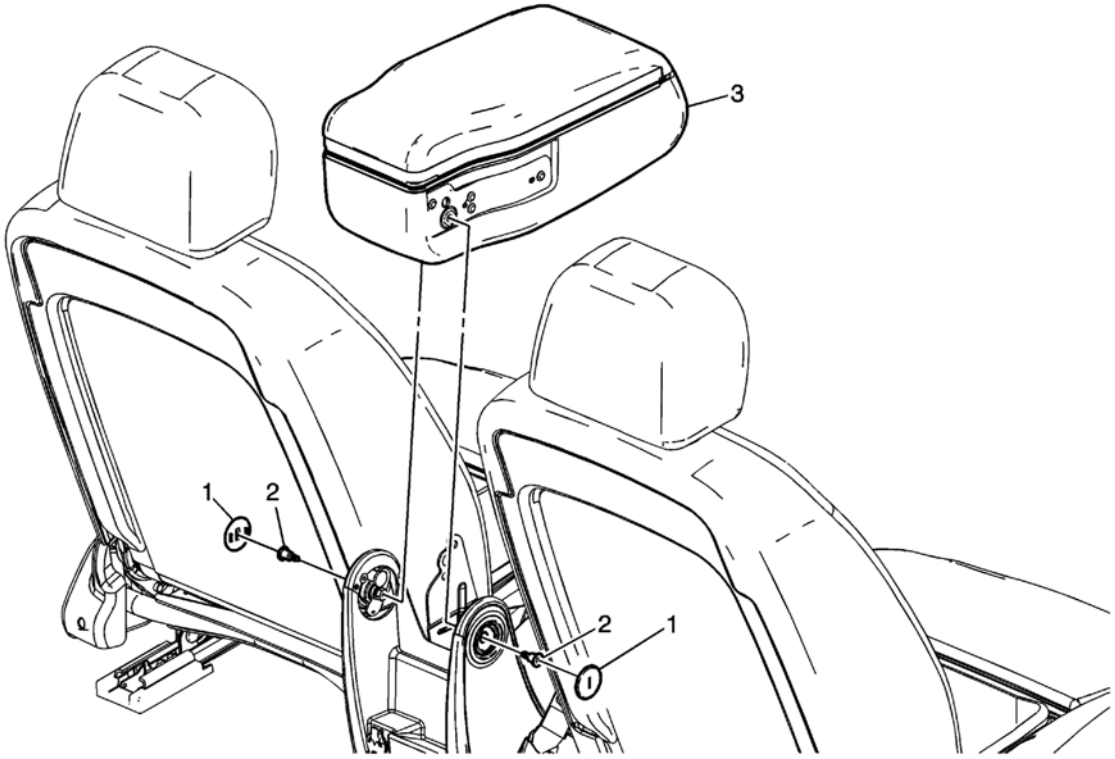


Fig. 6: Front Seat Armrest (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Center Seat Armrest Bolt Cover (Qty: 2) **TIP:** Move the front bucket seats forward far enough to gain access to the armrest bolt cover.
2	Front Center Seat Armrest Bolt (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 3 N.m (25 lb in)
3	Front Center Seat Armrest Assembly

FRONT SEAT ARMREST HINGE REPLACEMENT (IMPALA)

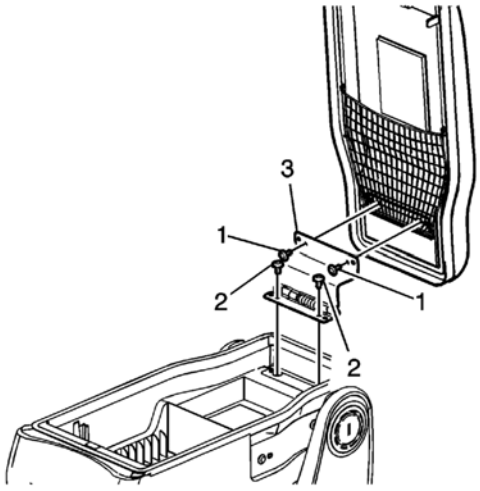


Fig. 7: Identifying Front Seat Armrest Hinge (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Armrest Hinge Screw (Qty: 2) **CAUTION:** **Refer to** Fastener Caution . **Tighten** 3 N.m (25 lb in)
2	Front Seat Armrest Hinge Screw (Qty: 2) **Tighten** 3 N.m (25 lb in)
3	Front Seat Armrest Hinge

FRONT SEAT ARMREST LID REPLACEMENT (IMPALA)

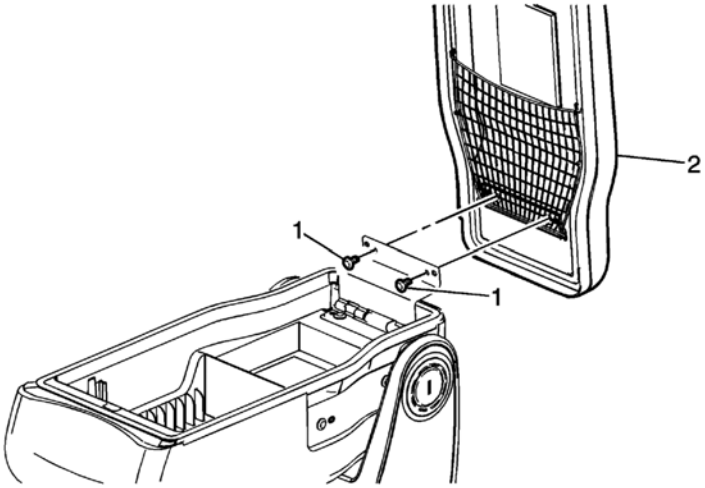


Fig. 8: Identifying Front Seat Armrest Lid (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Armrest Hinge Screw (Qty: 2) **CAUTION:** **Refer to** Fastener Caution . **Tighten** 3 N.m (25 lb in)
2	Front Seat Armrest Lid Assembly

FRONT SEAT ARMREST STOWAGE COMPARTMENT REPLACEMENT (IMPALA)

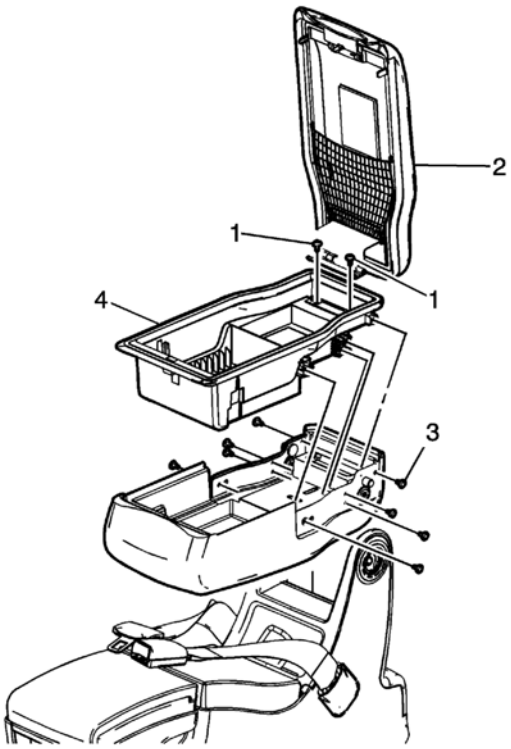


Fig. 9: Identifying Front Seat Armrest Stowage Compartment (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Armrest Hinge Screw (Qty: 2) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 3 N.m (25 lb in)
2	Front Seat Armrest Lid Assembly
3	Front Seat Armrest Bin Screw (Qty: 8) **Tighten** 3 N.m (25 lb in)
4	Front Seat Armrest Stowage Compartment Assembly

DRIVER OR PASSENGER SEAT HEAD RESTRAINT REPLACEMENT (IMPALA)

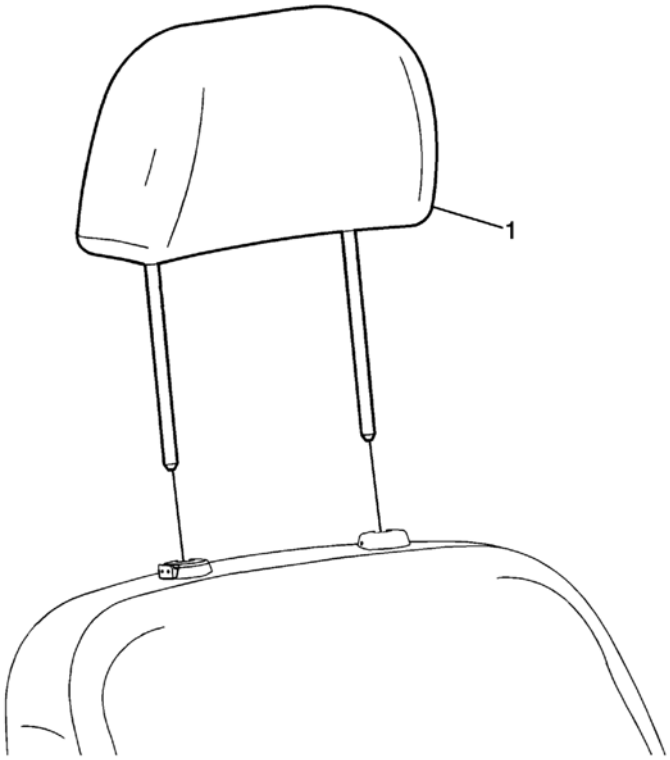


Fig. 10: Front Seat Head Restraint (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Head Restraint **Procedure** 1. Depress the button on the inboard head restraint guide to raise the head restraint to the full up position. 2. Insert a small diameter tool into the hole on the inboard side of the outboard head

Callout	Component Name
	restraint guide and pull upward to remove.

DRIVER OR PASSENGER SEAT HEAD RESTRAINT GUIDE REPLACEMENT (IMPALA)

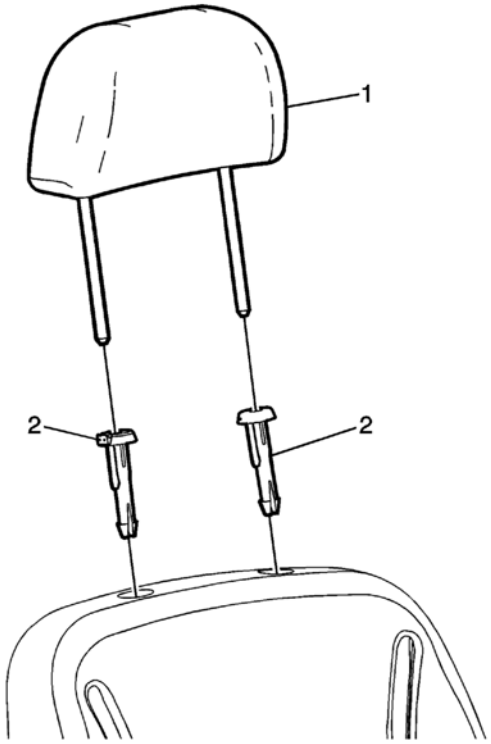


Fig. 11: Front Seat Head Restraint Guide (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat back panel. Refer to **Front Seat Back Cushion Finish Panel Replacement (Impala)**.	
1	Front Seat Head Restraint **Procedure** 1. Depress the button on the inboard head restraint guide to raise the head restraint to the full up position. 2. Insert a small diameter tool into the hole on the inboard side of the outboard head restraint guide and pull upward to remove.
2	Front Seat Head Restraint Guide (Qty: 2) **TIP:** Reach up and into the top of the seat back, while pressing the tabs on the bottom of the head restraint guide, pull the guide from the seat back frame.

DRIVER SEAT ADJUSTER HORIZONTAL PINION GEAR SHAFT REPLACEMENT

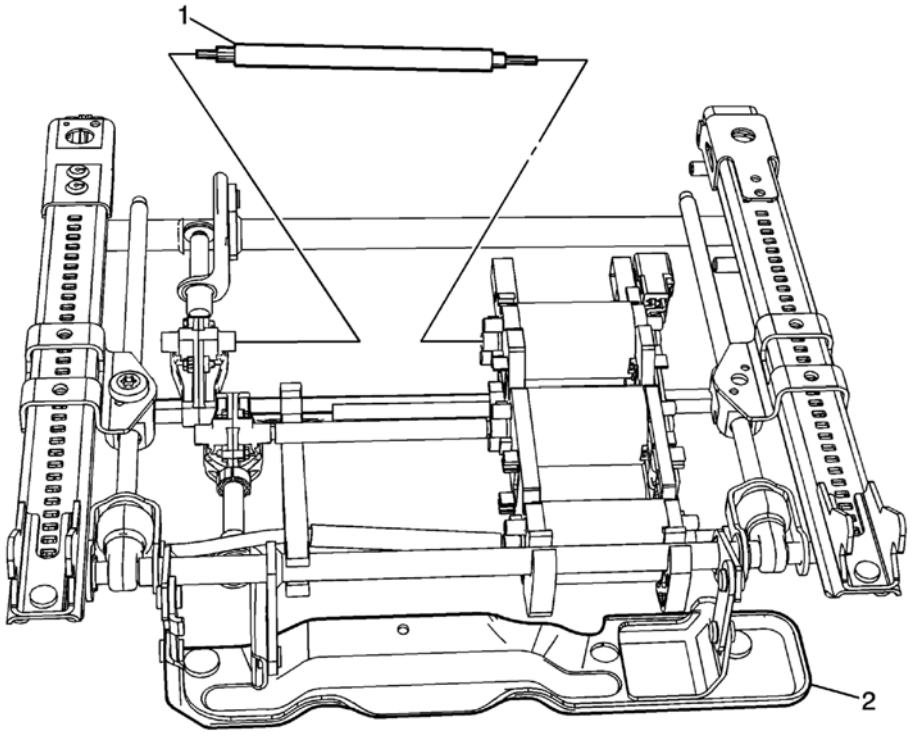


Fig. 12: Driver Seat Adjuster Horizontal Pinion Gear Shaft Replacement
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat adjuster. Refer to **Front Seat Adjuster Replacement**.	
1	Driver Seat Adjuster Horizontal Pinion Gear Shaft **TIP:** Remove the cable by pulling on the end of each side.
2	Driver Seat Adjuster Horizontal Pinion Gear Shaft **Procedure** Follow the steps below to reinstall the seat adjuster horizontal pinion gear shaft 1. Ensure both inboard and outboard tracks fully rearward position. 2. Reinstall seat adjuster horizontal pinion gear shaft cable 3. activated the motor ensure the adjuster is operating normal.

DRIVER OR PASSENGER SEAT CUSHION FRAME REPLACEMENT

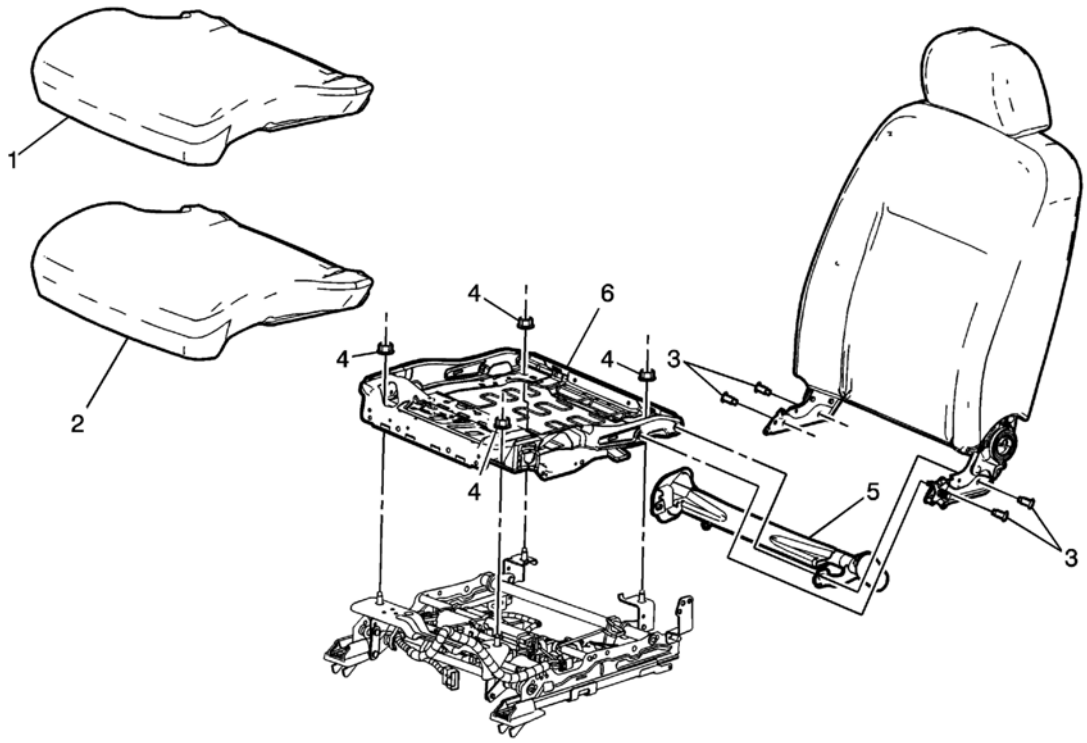


Fig. 13: Front Seat Cushion Frame
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala)**. Remove the lumbar actuator knob. Refer to **Lumbar Support Knob Replacement (Impala)**. 2. Remove the recliner handle. Refer to **Front Seat Back Recliner Handle Replacement (Impala Limited)**. 3. Remove the power seat switch knob. Refer to **Driver or Passenger Seat Adjuster Switch Knob Replacement (Impala)** . 4. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement**. 5.	
1	Seat Cushion Cover Refer to **Front Seat Cushion Cover and Pad Replacement (Impala).**
2	Seat Cushion Pad Refer to **Front Seat Cushion Cover and Pad Replacement (Impala).**
3	Front Seat Cushion Frame Bolt (Qty: 4) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 45 N.m (33 lb ft)
4	Front Seat Cushion Frame Nut (Qty: 4) **Tighten** 9 N.m (80 lb in)
5	Seat Cushion Frame Rear Reinforcement
6	Front Seat Cushion Frame **Procedure** 1. Remove the heated seat module, if equipped. Refer to **Front Seat Heater Control Module Replacement (Impala)** . 2. Remove the inflatable restraint passenger presence system if working on the passenger seat. Refer to **Inflatable Restraint Passenger Presence System Replacement - Front** . 3. Disconnect the wiring harness from the seat cushion. 4. Re-zero the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. Refer to **Passenger Presence System Programming and Setup** .

SEAT CUSHION OUTER TRIM PANEL REPLACEMENT

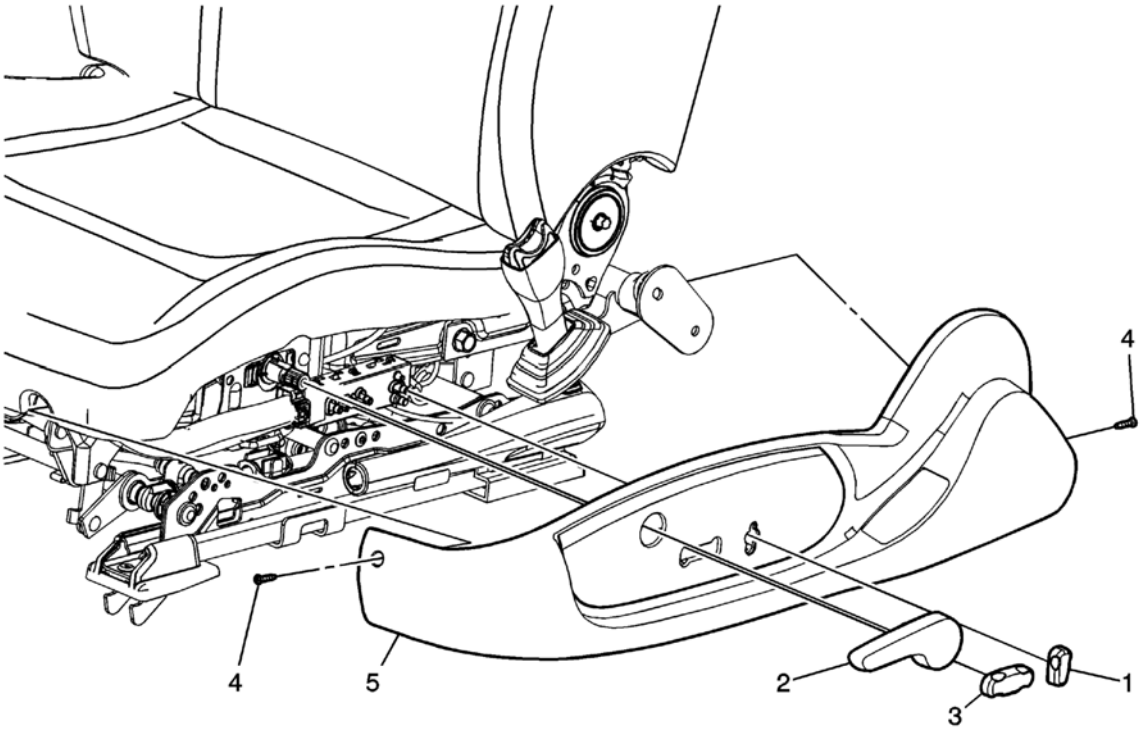


Fig. 14: Seat Cushion Outer Trim Panel & Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Recliner Knob (If equipped) **TIP:** Pull outward to remove.
2	Lumbar Actuator Handle (If equipped) **TIP:** Pull outward to remove.
3	Power Seat Switch Knob (If equipped) **TIP:** Pull outward to remove.
4	Seat Cushion Outer Trim Panel Screw (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
5	Seat Cushion Outer Trim Panel **Procedure** 1. Disconnect the electrical connector. 2. Remove the seat cushion outer trim panel by pulling it upward over the pretensioner

Callout	Component Name
	upper and lower boot. 3. If replacing the cover, transfer components as necessary.

FRONT SEAT CUSHION COVER AND PAD REPLACEMENT (IMPALA)

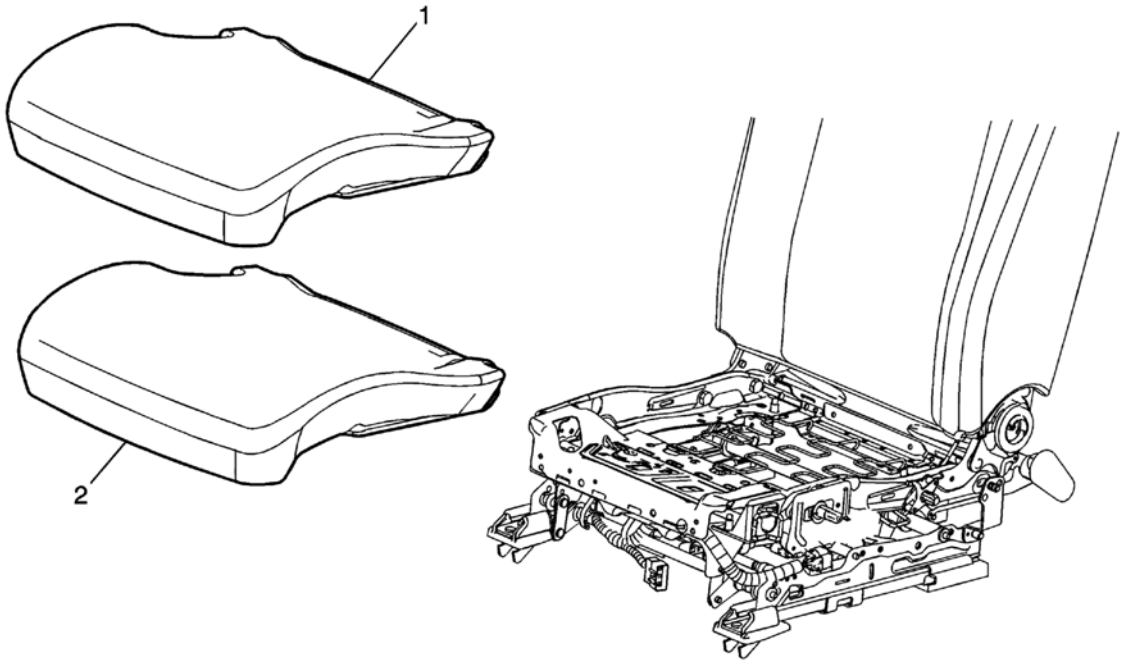


Fig. 15: Front Seat Cushion Cover And Pad (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the front seats. Refer to **Front Seat Removal and Installation - Bucket (Impala)**. 2. Remove the front seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement**.	
1	Seat Cushion Cover **Procedure** 1. Release the j-channel from the seat cushion frame. 2. Disconnect the seat cushion heater electrical connector, if equipped. 3. Remove the seat cushion cover and pad as an assembly from the frame.

Callout	Component Name
2	Seat Cushion Pad **Procedure** 1. Remove the seat cushion pad from the cover by pulling away to release to hook and loop fasteners. 2. When working on the passenger seat re-zero the passenger presence system. Refer to **Control Module References** .

SEAT BACK COVER AND PAD REPLACEMENT (IMPALA)

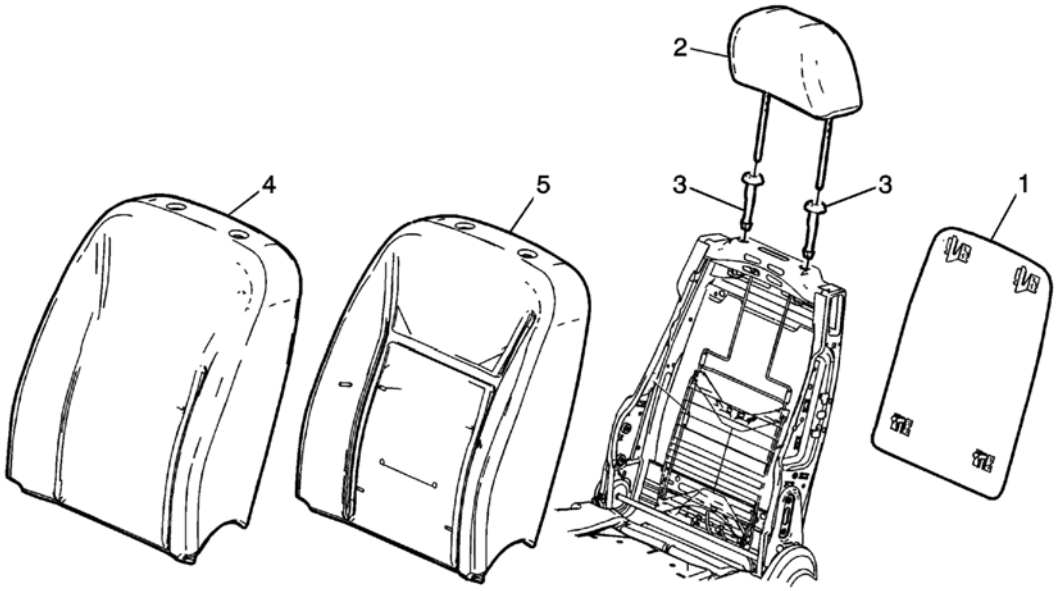


Fig. 16: Seat Back Cover And Pad (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala)**. 2. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement**.	
1	Seat Back Cushion Finish Panel Refer to **Front Seat Back Cushion Finish Panel Replacement (Impala)**.

Callout	Component Name
2	Front Seat Head Restraint Refer to **Driver or Passenger Seat Head Restraint Replacement (Impala Limited)**.
3	Front Seat Head Restraint Guides Refer to **Driver or Passenger Seat Head Restraint Guide Replacement (Impala)**.
4	Seat Back Cushion Cover **Procedure** 1. Disconnect the j-channel from the seat back frame. 2. Remove the 2 lower push pin retainers that secures the cover to the frame. 3. Remove the pad and cover as an assembly.
5	Seat Back Cushion Pad **Procedure** 1. Remove the cover from the pad by pulling apart to release the hook and loop fasteners. 2. Disconnect the electrical connector, if equipped.

DRIVER OR PASSENGER SEAT BACK CUSHION PAD SUPPORT REPLACEMENT

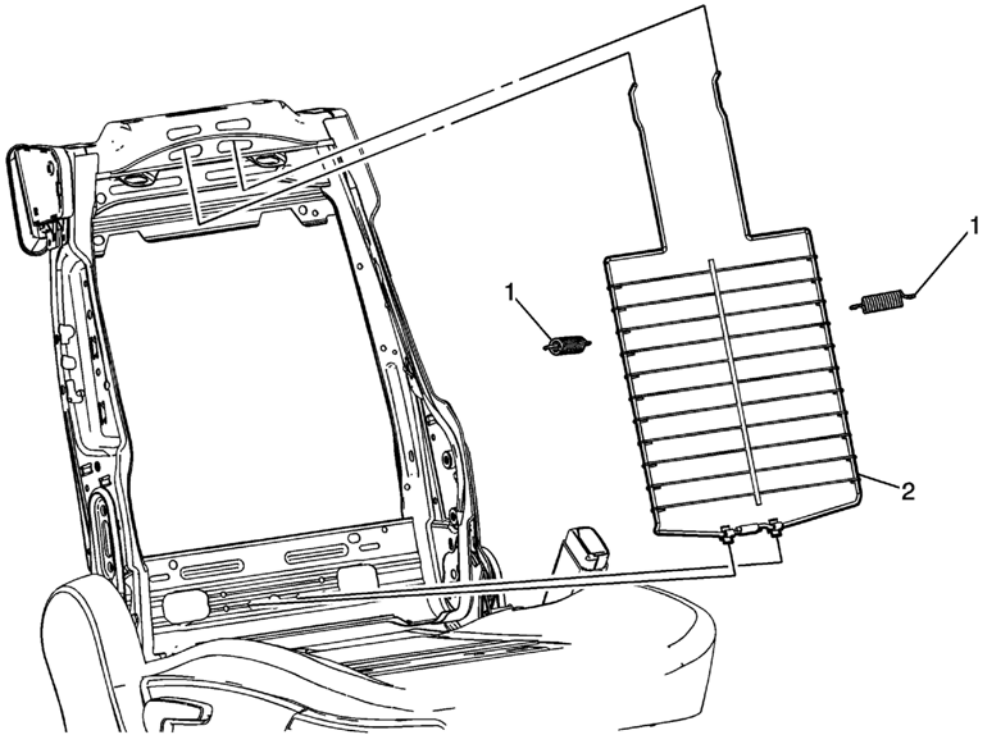


Fig. 17: Front Seat Lumbar Support Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat back cushion cover and pad. Refer to **Seat Back Cover and Pad Replacement (Impala)**.	
1	Front Seat Lumbar Spring (Qty: 2)
2	Front Seat Back Cushion Pad Support **Procedure** 1. Push the retainers at the bottom out of the seat back frame to release the bottom of the lumbar assembly. 2. Tilt and pull down and forward to remove the top portion of the lumbar assembly from the seat back frame.

DRIVER OR PASSENGER SEAT BACK CUSHION FRAME REPLACEMENT (IMPALA)

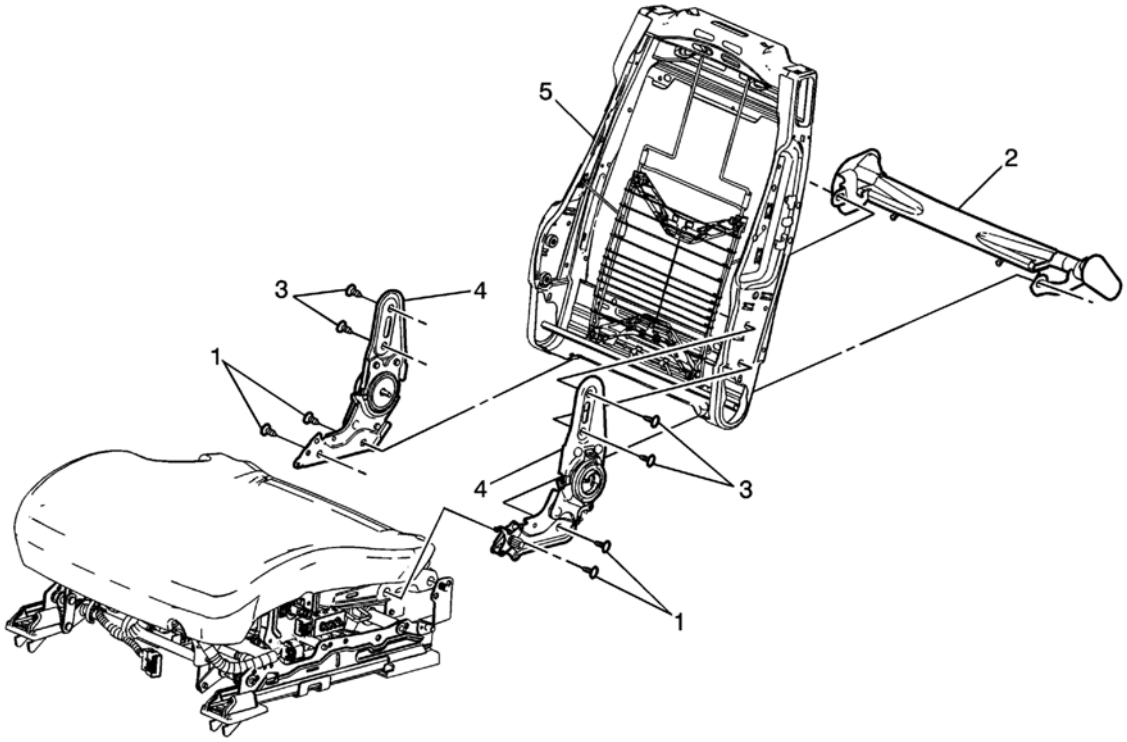


Fig. 18: Identifying Front Seat Back Frame (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala)**. 2. Remove the lumbar actuator knob. Refer to **Lumbar Support Knob Replacement (Impala)**.	

Callout	Component Name
3. Remove the recliner handle. Refer to **Front Seat Back Recliner Handle Replacement (Impala Limited)**. 4. Remove the power seat switch knob. Refer to **Driver or Passenger Seat Adjuster Switch Knob Replacement (Impala)** . 5. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement**. 6. Remove the front seat back cushion cover and pad. Refer to **Seat Back Cover and Pad Replacement (Impala)**. 7. Remove the lumbar assembly. Refer to **Driver or Passenger Seat Lumbar Support Replacement**.	
1	Front Seat Cushion Frame Bolt (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 45 N.m (33 lb ft)
2	Seat Cushion Frame Rear Reinforcement
3	Front Seat Back Cushion Frame Bolt (Qty: 4) **Tighten** 45 N.m (33 lb ft)
4	Seat Recliner Assembly
5	Seat Back Frame Assembly

DRIVER OR PASSENGER SEAT RECLINER REPLACEMENT (IMPALA)

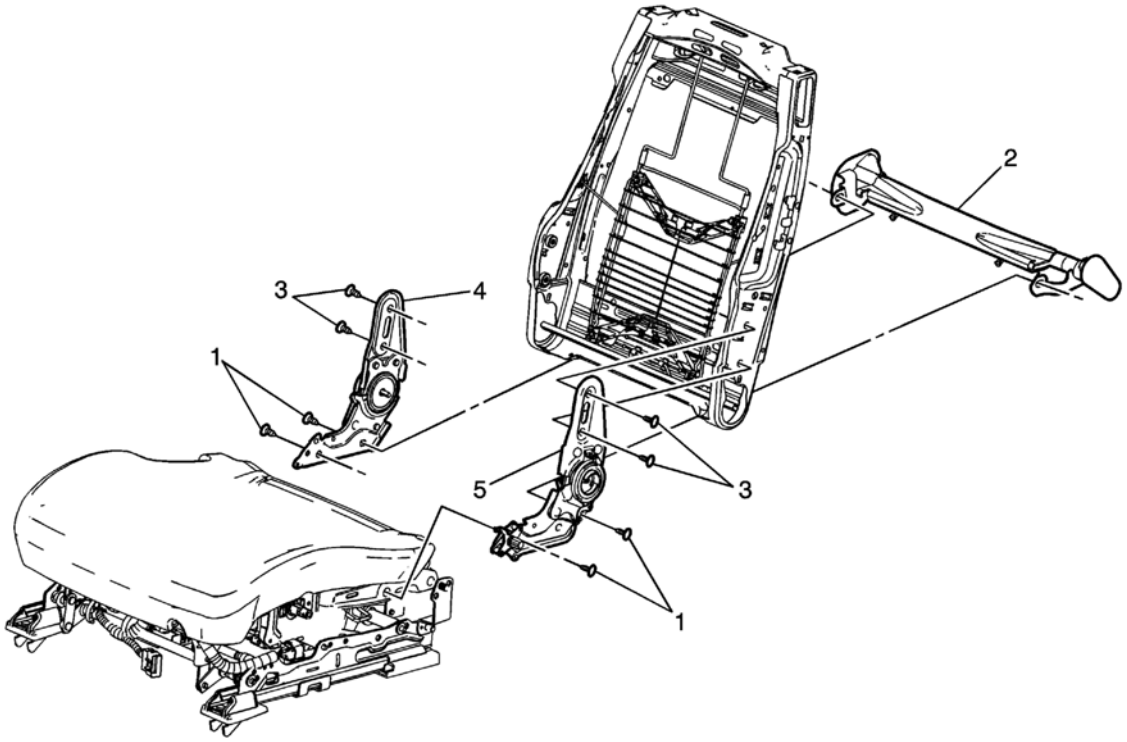


Fig. 19: Seat Back Recliner (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala)**. Remove the lumbar actuator knob. Refer to **Lumbar Support Knob Replacement (Impala)**. 2. Remove the recliner handle. Refer to **Front Seat Back Recliner Handle Replacement (Impala)**. 3. Remove the power seat switch knob. Refer to **Driver or Passenger Seat Adjuster Switch Knob Replacement (Impala Limited)** . 4. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement**. 5. Remove the front seat back cushion cover and pad. Refer to **Seat Back Cover and Pad Replacement (Impala)**. 6. Remove the lumbar assembly. Refer to **Driver or Passenger Seat Lumbar Support Replacement**. 7.	
1	Front Seat Cushion Frame Bolt (Qty: 4) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 45 N.m (33 lb ft)
2	Seat Cushion Frame Rear Reinforcement
3	Front Seat Back Cushion Frame Bolt (Qty: 4) **Tighten** 45 N.m (33 lb ft)
4	Seat Inner Recliner Assembly
5	Seat Outer Recliner Assembly

FRONT SEAT BACK RECLINER HANDLE REPLACEMENT (IMPALA)

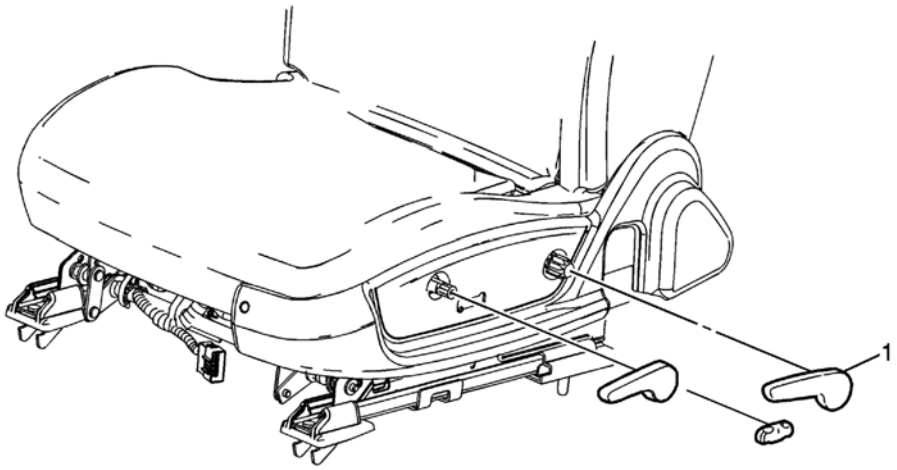


Fig. 20: Front Seat Back Recliner Handle (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to Fastener Specifications.	
1	Handle, Recliner **TIP:** Using a flat-bladed tool, push the retainer clip downward and pull outward to release the handle.

FRONT SEAT BACK CUSHION FINISH PANEL REPLACEMENT (IMPALA)

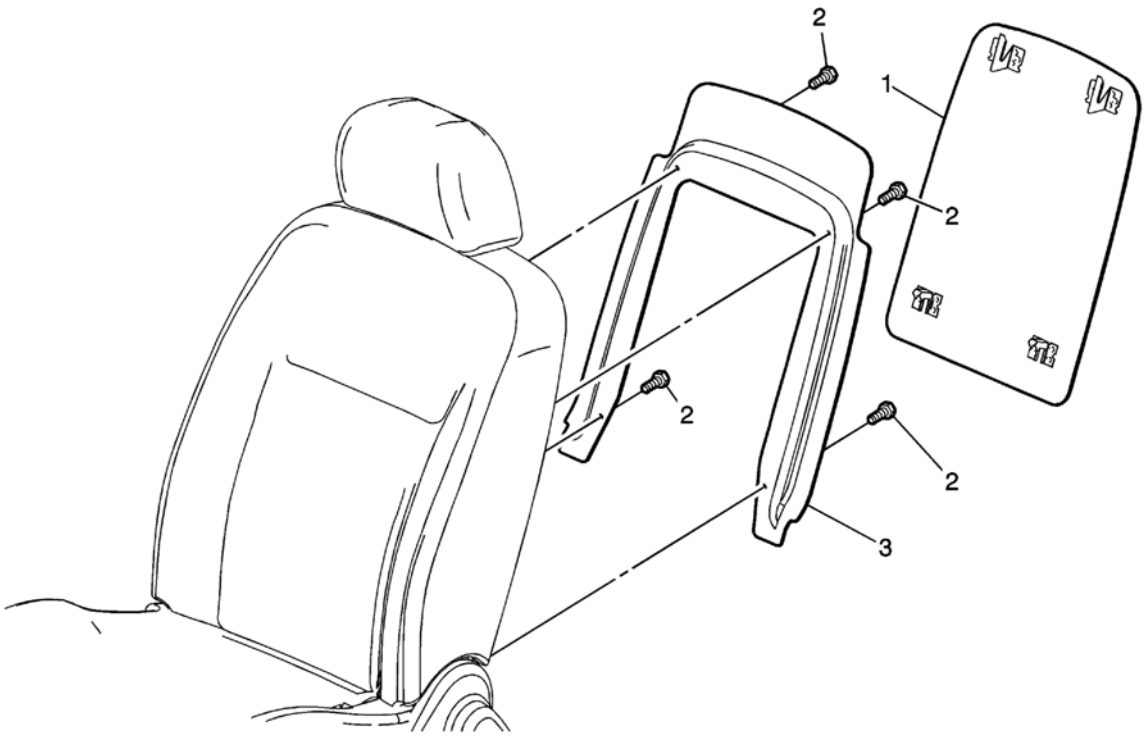


Fig. 21: Front Seat Back Panel (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Back Cushion Finish Panel **Procedure** Pull up on the bottom of the panel while bowing the panel outward in the center, and when the panel disengages then pull rearward.
2	Seat Back Cushion Rear Finish Retainer (Qty: 4) **Procedure** Release the rear seat back cover j-channel retainers and reposition the cover to gain access to the retainers.
3	Seat Back Cushion Rear Finish Panel

DRIVER OR PASSENGER SEAT LUMBAR SUPPORT REPLACEMENT

Removal Procedure

1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala)**.
2. Remove the front seat back cover and pad. Refer to **Seat Back Cover and Pad Replacement (Impala)**.
3. Remove the front seat cushion cover and pad. Refer to **Front Seat Cushion Cover and Pad Replacement (Impala)**.

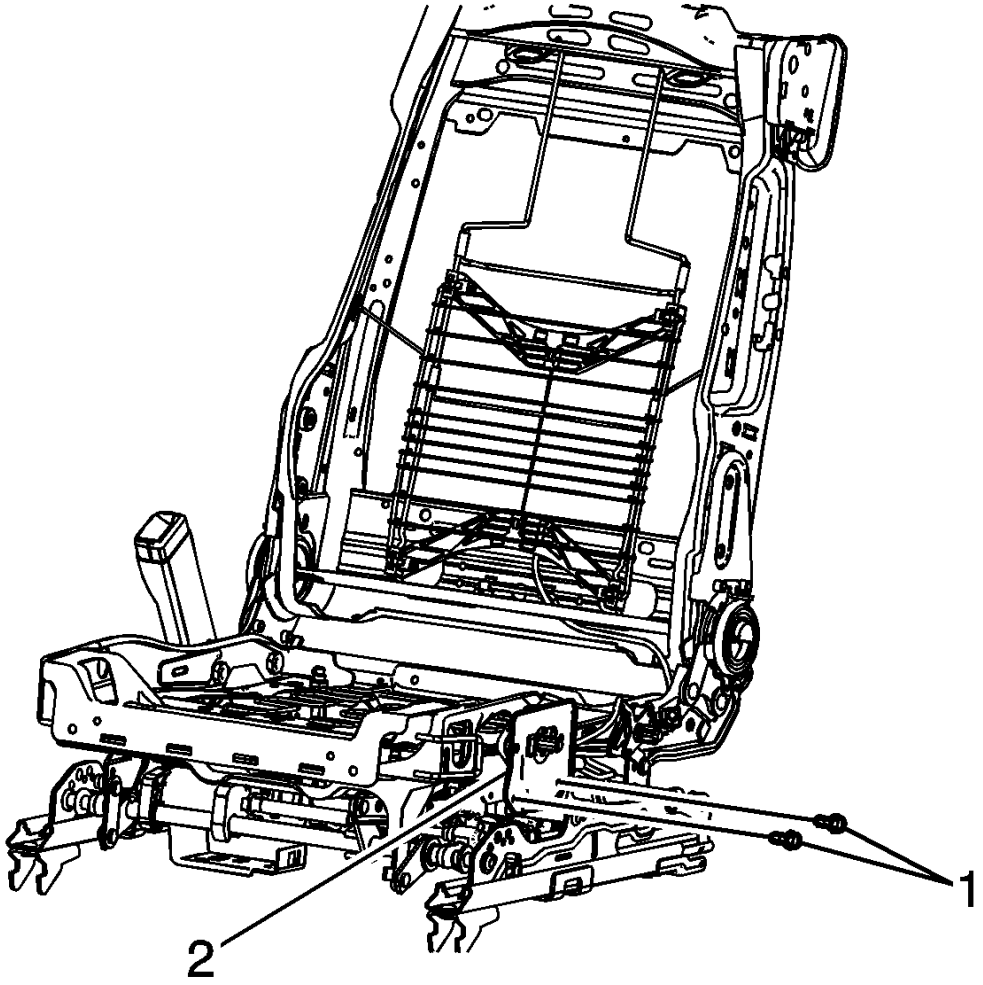


Fig. 22: Identifying Lumbar Support Actuator Retaining Screws
Courtesy of GENERAL MOTORS COMPANY

4. Remove the screws (1) that retain the lumbar actuator to the seat cushion pan.

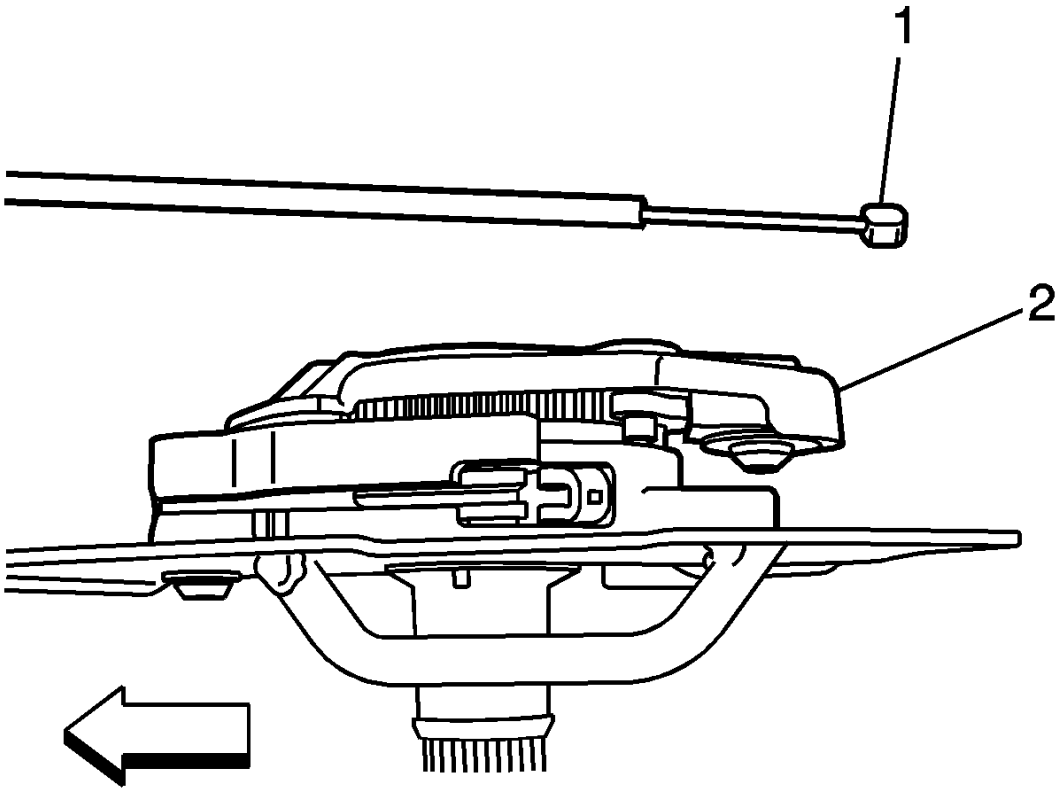


Fig. 23: Identifying Lumbar Cable & Lumbar Actuator
Courtesy of GENERAL MOTORS COMPANY

5. Move the lumbar actuator away from the seat far enough to disconnect the lumbar cable (1) from the actuator (2).

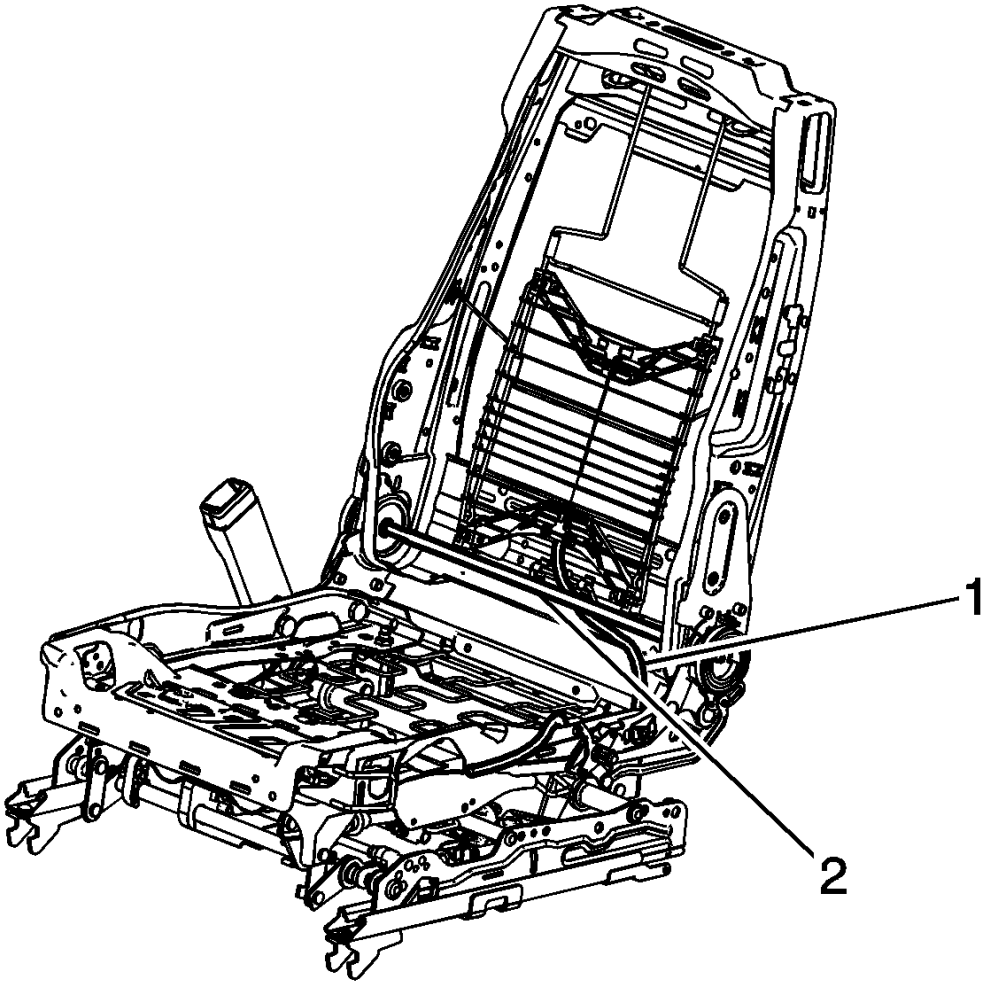


Fig. 24: Locating Lumbar Support Cable & Recliner Rod
Courtesy of GENERAL MOTORS COMPANY

6. Note the routing of the cable for installation purposes, the cable (1) must route between the recliner rod (2) and the seat back frame.

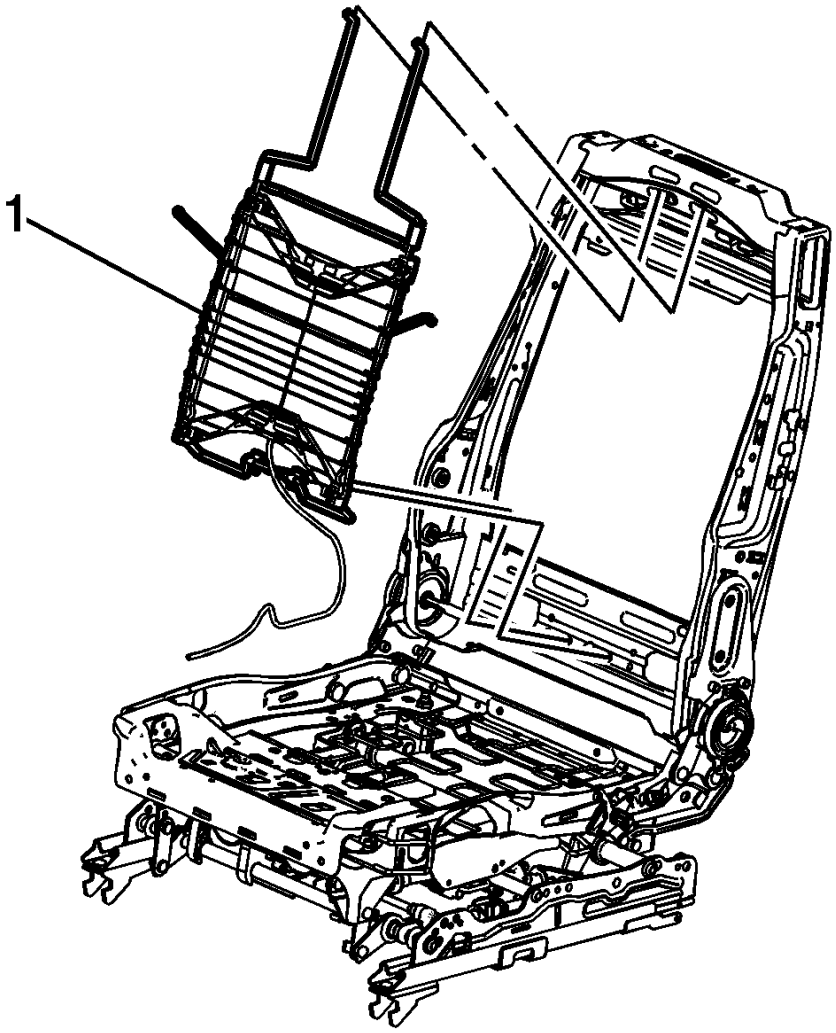


Fig. 25: View Of Lumbar Support Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Remove the lumbar assembly (1) from the seat back frame by doing the following:
    - Disconnect the lumbar assembly (1) from each side of the seat back frame.
    - Pull the bottom of the lumbar assembly (1) forward to disengage the retainers from the seat back frame.
    - Slide the lumbar assembly (1) downward and forward to release from the seat back frame.

Installation Procedure

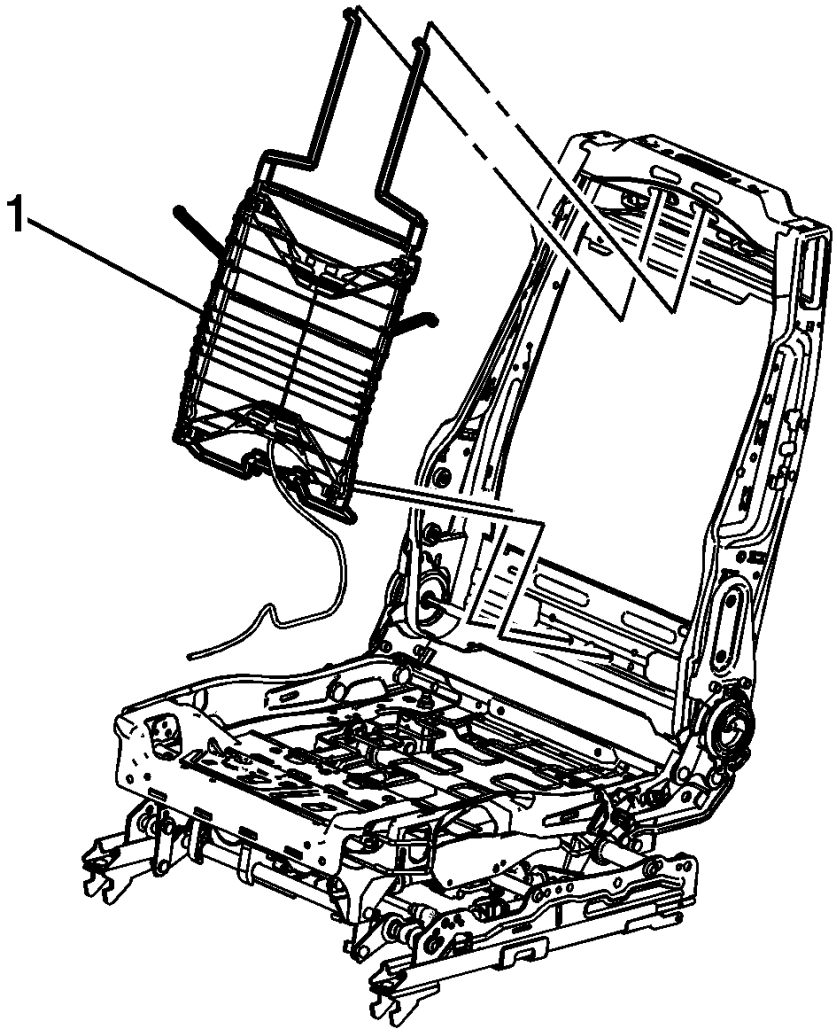


Fig. 26: View Of Lumbar Support Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the lumbar assembly (1) to the front seat back frame by doing the following:
    - Insert the top of the lumbar assembly (1) into the upper locations on the seat back frame.
    - Secure the lower portion of the lumbar assembly (1) by pushing the retainers firmly into the seat back frame.
    - Attach the sides of the lumbar assembly (1) to the sides of the seat back frame.

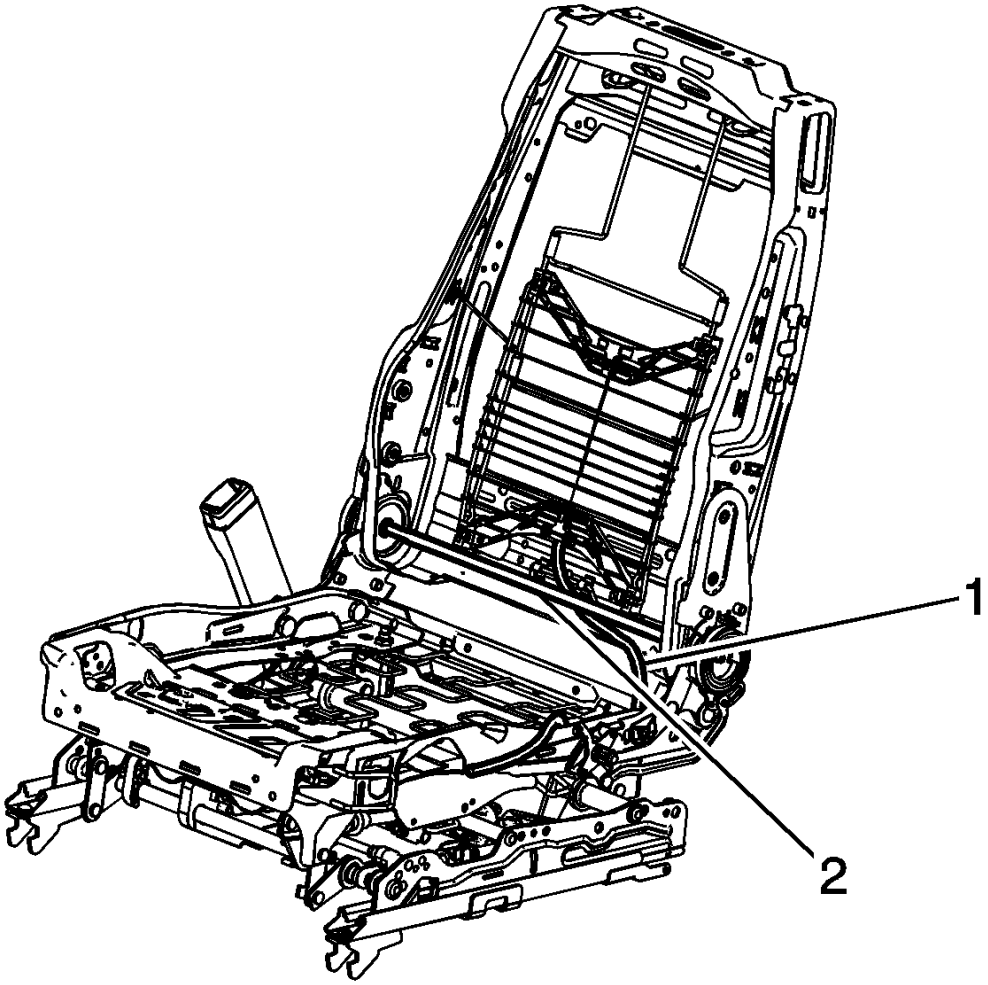


Fig. 27: Locating Lumbar Support Cable & Recliner Rod
Courtesy of GENERAL MOTORS COMPANY

2. Route the lumbar cable (1) between the front seat back frame and the recliner rod (2).

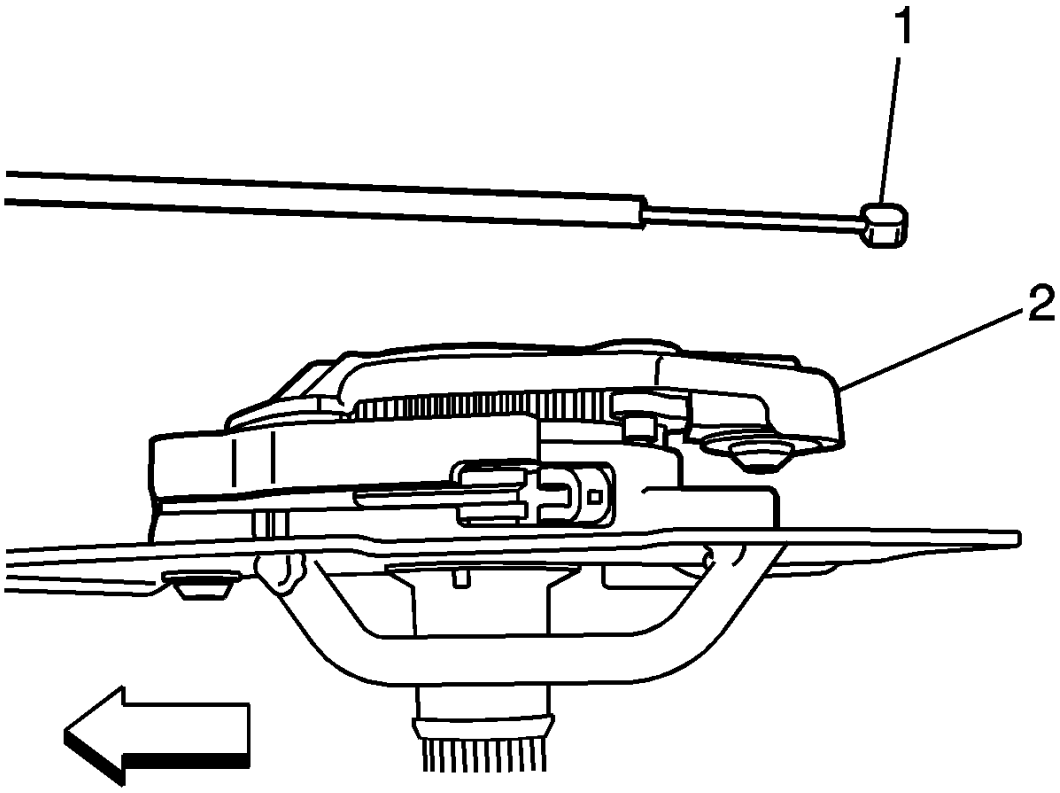


Fig. 28: Identifying Lumbar Cable & Lumbar Actuator
Courtesy of GENERAL MOTORS COMPANY

3. Connect the lumbar cable (1) to the lumbar actuator (2).

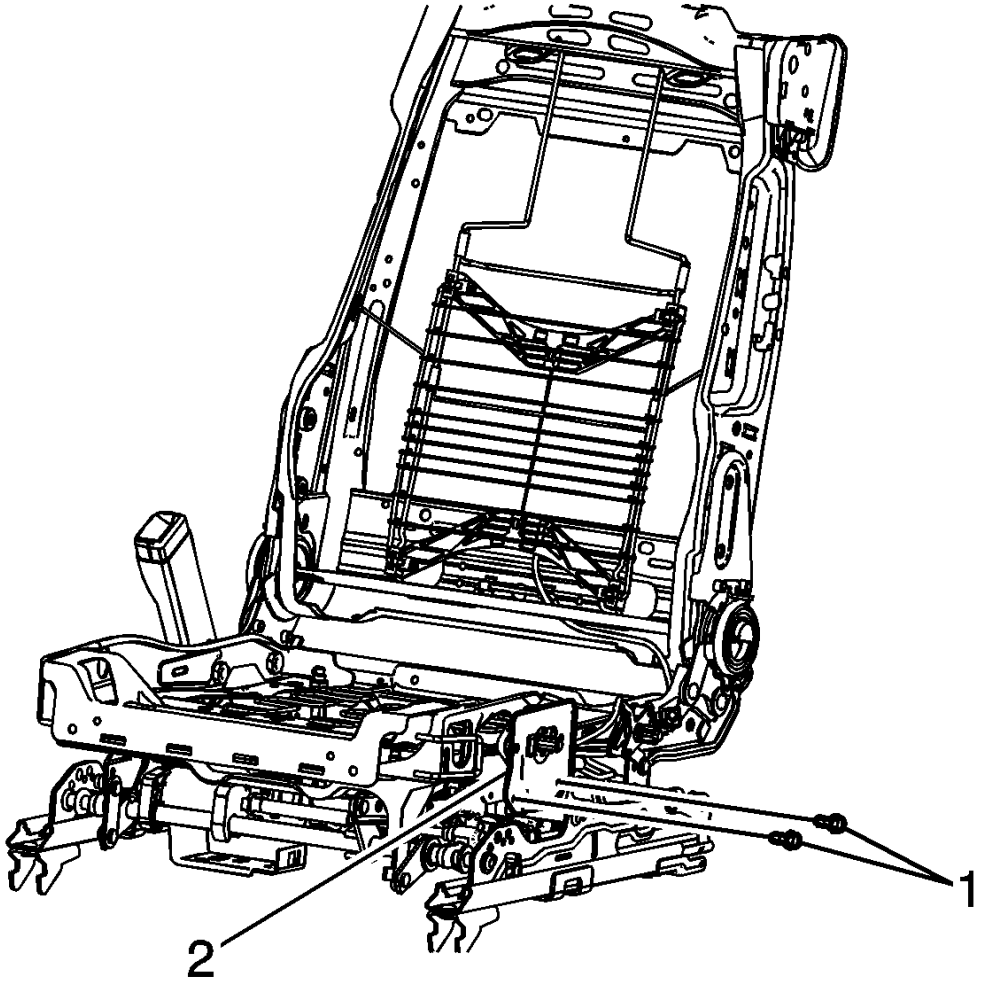


Fig. 29: Identifying Lumbar Support Actuator Retaining Screws
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Position the lumbar actuator to the seat cushion frame and install the 2 screws that secure the lumbar actuator to the seat cushion frame.

   Tighten

   Tighten the bolts to 6 N.m (53 lb in).

5. Install the seat cushion cover and pad. Refer to **Front Seat Cushion Cover and Pad Replacement (Impala)**.
6. Install the seat back cushion cover and pad. Refer to **Seat Back Cover and Pad Replacement (Impala)**.
7. Install the front seat to the vehicle. Refer to **Front Seat Removal and Installation - Bucket (Impala)**.

LUMBAR SUPPORT KNOB REPLACEMENT (IMPALA)

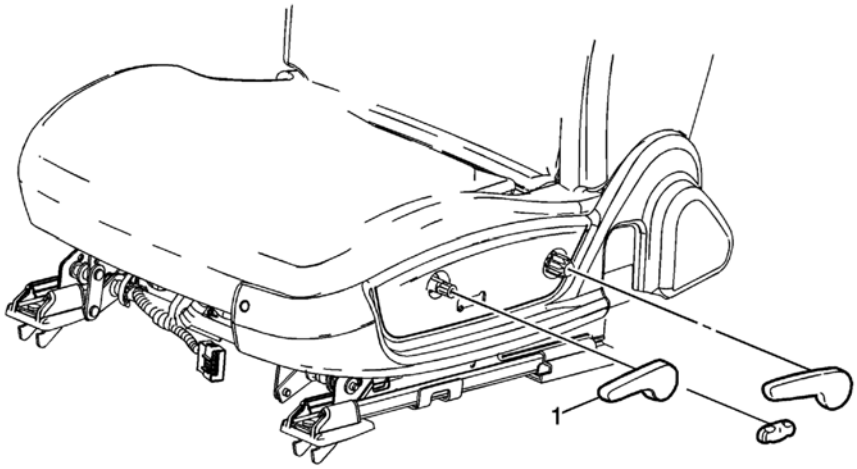


Fig. 30: Lumbar Support Knob (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Knob, Lumbar Actuator **TIP:** Pull outward to remove.

REAR SEAT ARMREST REPLACEMENT (IMPALA W/AM9)

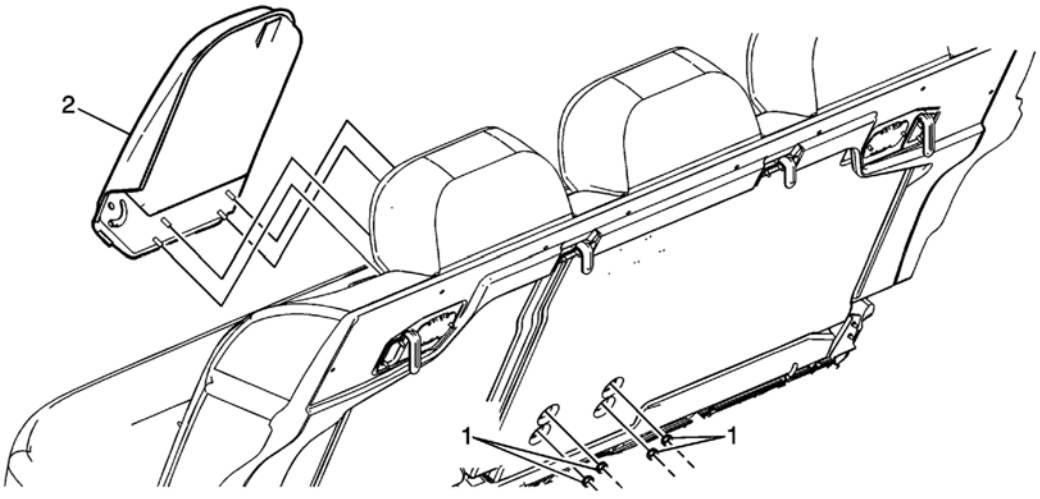


Fig. 31: Rear Seat Armrest (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Seat Armrest Nut (Qty: 4) **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	Procedure 1. Fold the rear seat back cushion forward to gain access to the nuts. 2. Release J-Channel at bottom of seat-back Trim Cover and fold cover open to gain access to the nuts. **TIP:** Armrest is only serviced as an assembly. **Tighten** 3 N.m (25 lb in)
2	Rear Seat Armrest Assembly

REAR SEAT PULL STRAP REPLACEMENT

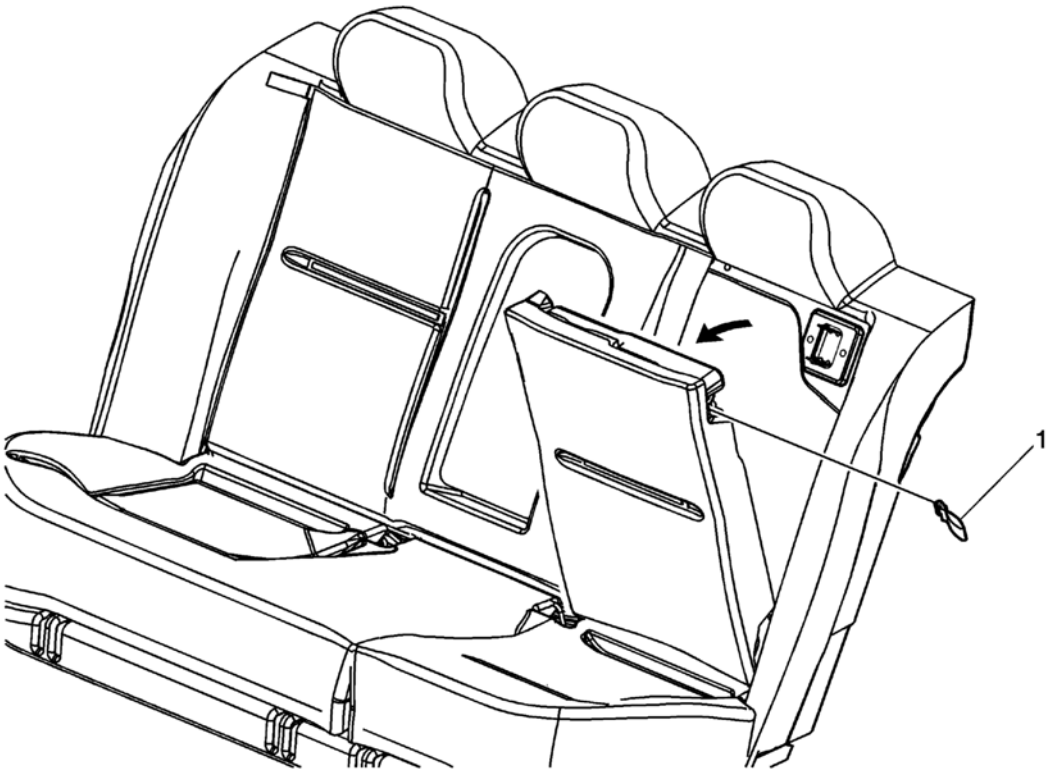


Fig. 32: Rear Seat Pull Strap
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Seat Pull Strap **Procedure** Lay the seat back down before removing the pull strap from the latch.

REAR SEAT HINGE BRACKET REPLACEMENT (REAR SPLIT FOLDING)

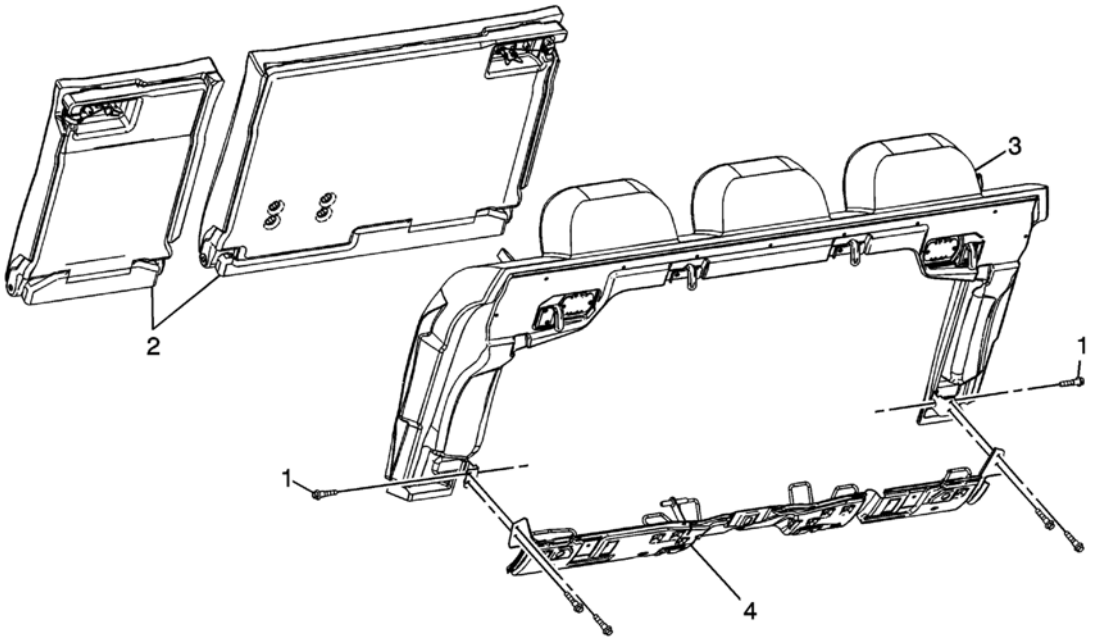


Fig. 33: Identifying Rear Seat Hinge Bracket (Rear Split Folding)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear seat back cushion. Refer to **Rear Seat Back Cushion Removal and Installation (Impala)**.	
1	Rear Seat Back Cushion Pivot Support Bolt (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 15 N.m (11 lb ft)
2	Rear Seat Back Cushion Assembly (Qty: 2) **TIP:** Tilt and slide outward to remove the rear seat back cushion assembly from the rear seat back hinge.
3	Rear Seat Back Hinge Bolt (Qty: 4) **Tighten** 15 N.m (11 lb ft)
4	Rear Seat Back Cushion Hinge Bracket

REAR SEAT CUSHION COVER AND PAD REPLACEMENT (IMPALA)

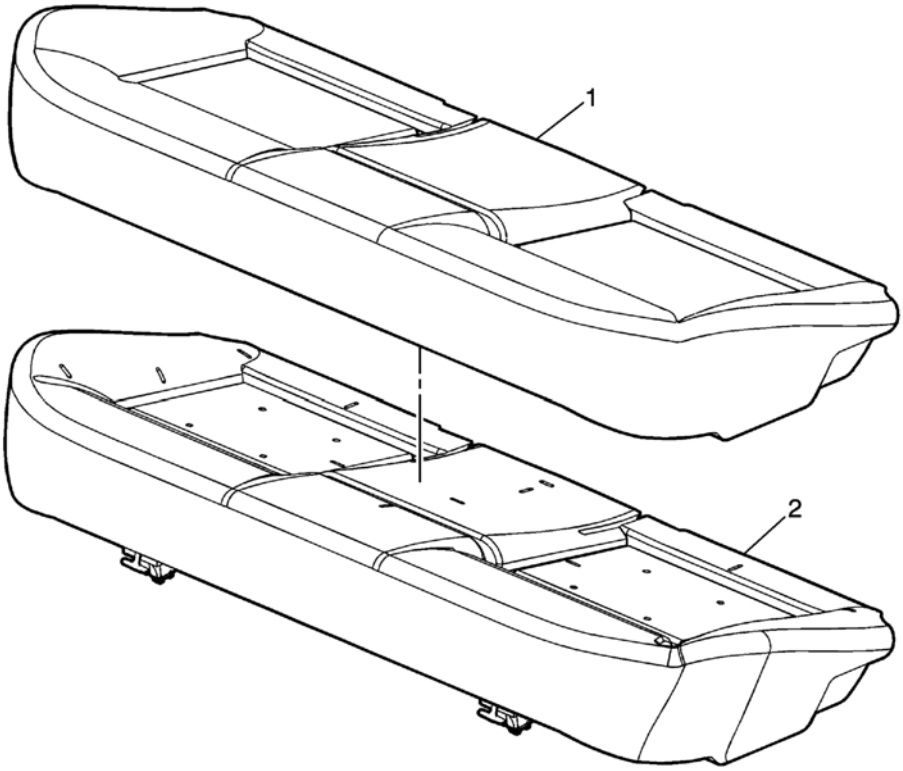


Fig. 34: Rear Seat Cushion Cover And Pad (Impala)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala)**.	
1	Rear Seat Cushion Cover **TIP:** The cushion cover and pad are serviced as an assembly.
2	Rear Seat Cushion Pad

REAR SEAT CUSHION COVER AND PAD REPLACEMENT (IMPALA W/AM9)

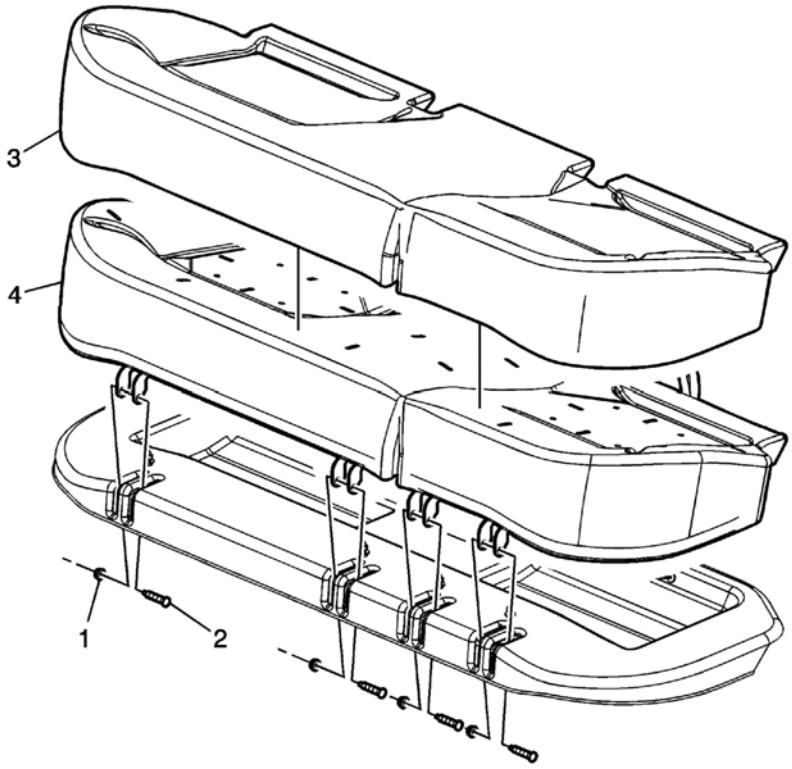


Fig. 35: Rear Seat Cushion Cover and Pad (Impala w/AM9)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedures** Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)**.	
1	Rear Seat Cushion Compartment Tray Nut (Qty 4) **Procedure** With the seat assembly on bench (up-side down), remove the nuts on the underside of the compartment tray at the cushion hinge locations.
2	Rear Seat Cushion Compartment Tray Hinge Pin (Qty 4) **Procedure** Gently tap the hinge pins outward until the cushion assembly is free of the stowage compartment.
3	Rear Seat Cushion Cover
4	Rear Seat Cushion Pad **TIP:** The cushion cover and pad are serviced as an assembly.

REAR SEAT CUSHION FLOOR STOWAGE COMPARTMENT REPLACEMENT (IMPALA LIMITED W/AM9)

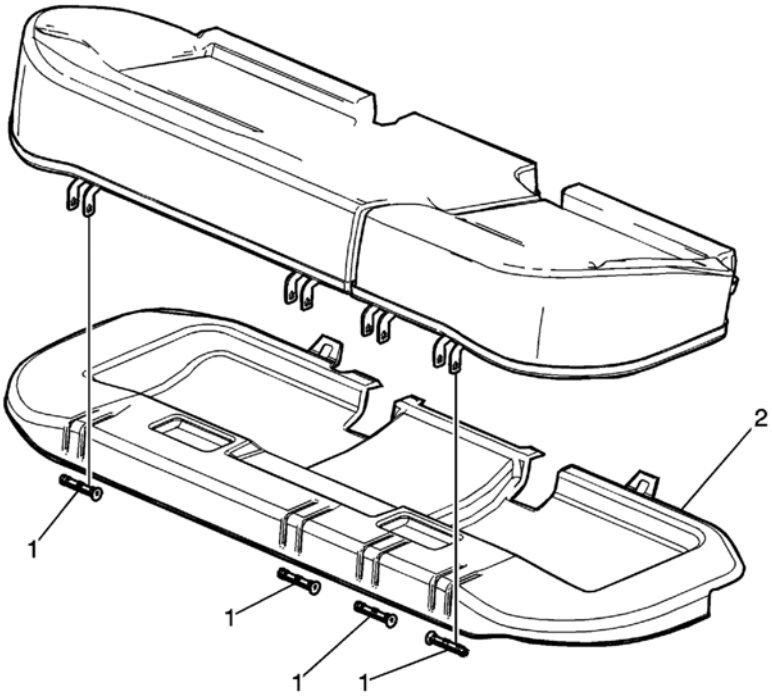


Fig. 36: Rear Seat Cushion Floor Stowage Compartment (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)** 2. Remove the rear seat cushion cover and pad. Refer to **Rear Seat Cushion Cover and Pad Replacement (Impala Limited)Rear Seat Cushion Cover and Pad Replacement (Impala Limited w/AM9)**	
1	Rear Seat Cushion Hinge Pin (Qty: 4)
2	Rear Seat Cushion Floor Stowage Compartment **TIP:** Floor stowage compartment is only serviced as an assembly.

REAR SEAT CUSHION REMOVAL AND INSTALLATION (IMPALA LIMITED)

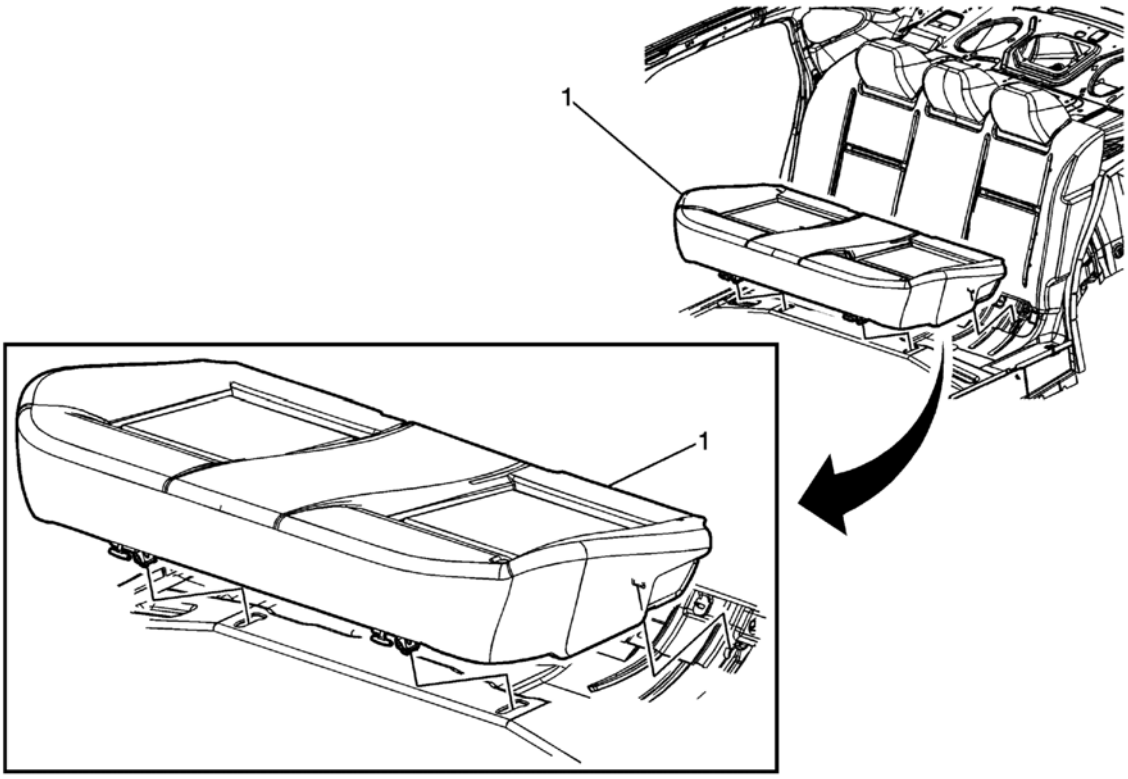


Fig. 37: Identifying Rear Seat Cushion (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Seat Cushion Assembly **Procedure** 1. Reach under the seat cushion and locate both the left and the right "T" handles. 2. Press down on the seat and pull the handles to release the seat retainer. 3. Remove the seat cushion by lifting the cushion up and pulling the cushion outward from the seat back. **TIP:** The handles are hidden from view by the floor stowage compartment for the flip folding seat.

REAR SEAT BACK CUSHION REMOVAL AND INSTALLATION (IMPALA LIMITED)

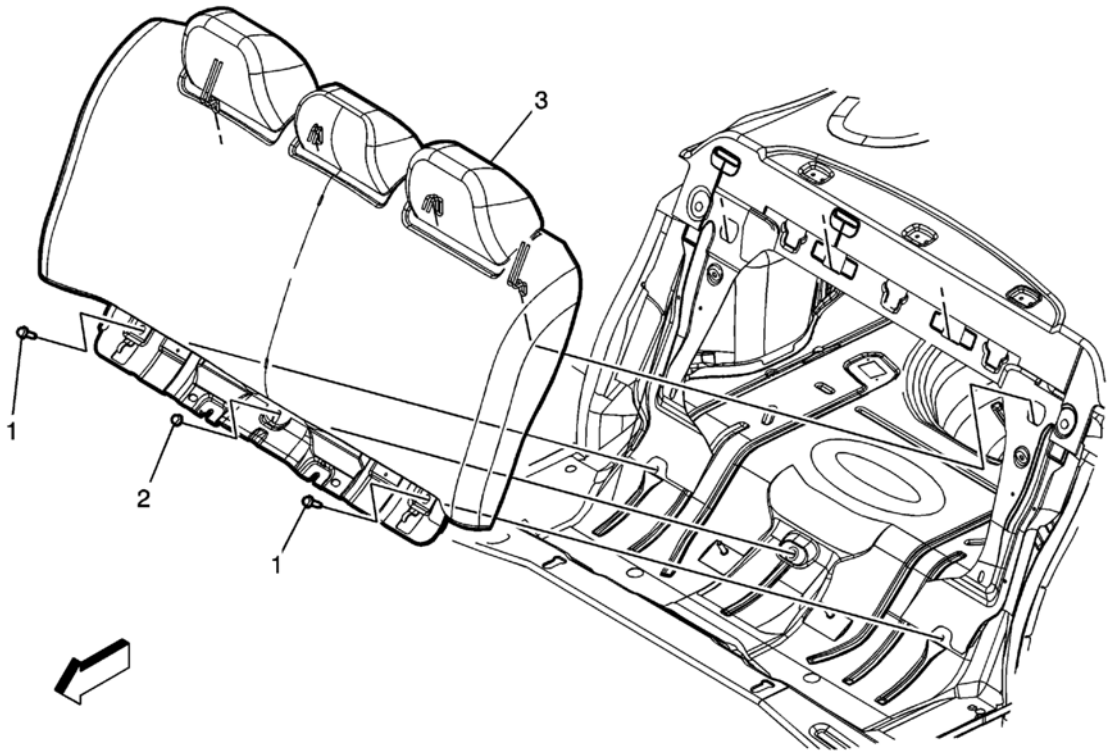


Fig. 38: Rear Seat Back (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the seat belt buckles. Refer to **Rear Seat Buckle Side Belt Replacement (Impala Limited without AM9)** **Rear Seat Buckle Side Belt Replacement (Impala Limited with AM9)** . 2. Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)**.	
1	Rear Seat Back Cushion Bolts (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution** **.** **Tighten** 45 N.m (33 lb ft)
2	Rear Seat Back Cushion Nut **Tighten** 45 N.m (33 lb ft)
3	Rear Seat Back Cushion • Lift upward to clear the retaining hooks on the seat back to remove.

Callout	Component Name
	• The removal and installation for the standard and the split bench seat are the same.

REAR SEAT BACK CUSHION OPENING TRIM COVER AND OUTER COVER PAD REPLACEMENT (REAR SPLIT FOLDING)

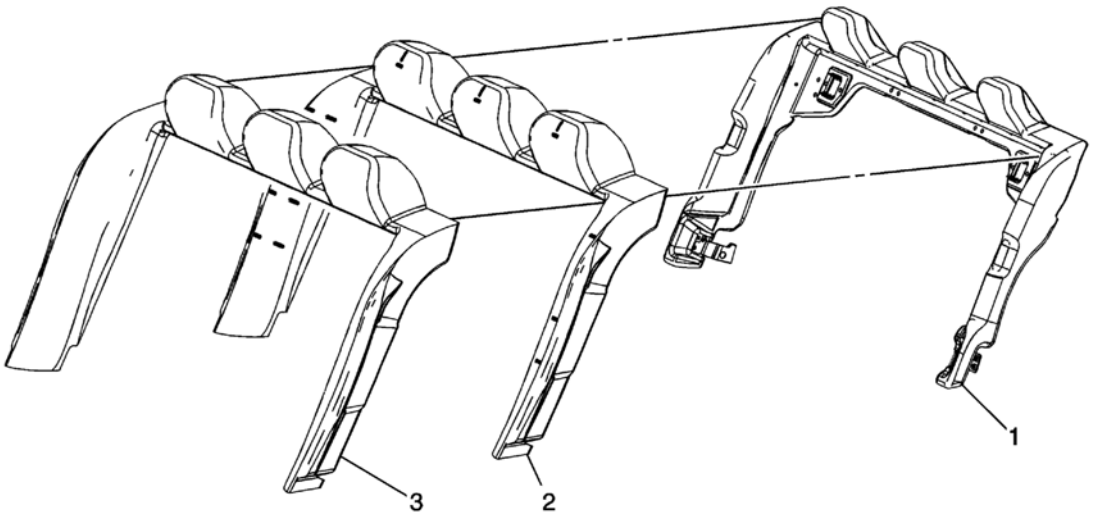


Fig. 39: Rear Seat Back Cushion Opening Trim Cover and Outer Cover Pad (Rear Split Folding)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Seat Back Cushion Opening Panel Refer to **Rear Seat Back Cushion Opening Panel Replacement**.
2	Rear Seat Back Cushion Opening Trim Cover
3	Rear Seat Back Cushion Outer Cover Pad

REAR SEAT BACK CUSHION PANEL REPLACEMENT (REAR SPLIT FOLDING)

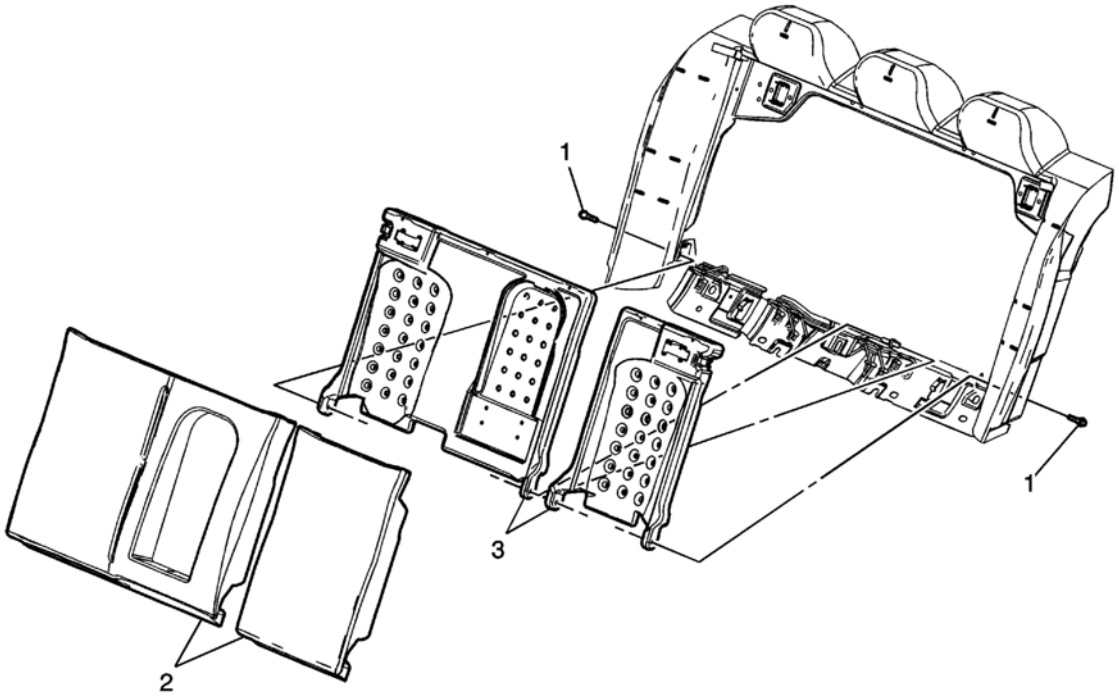


Fig. 40: Identifying Rear Seat Back Cushion Panel (Rear Split Folding)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the rear seat back cushion. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)**. 2. Remove the rear seat armrest. Refer to **Rear Seat Armrest Replacement (Impala Limited w/AM9)**.	
1	Rear Seat Back Cushion Pivot Support Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 15 N.m (11 lb ft)
2	Rear Seat Back Cushion Cover **TIP:** Remove the seat back cover by disengaging the retainers securing the cover to the seat back cushion panel.
3	Rear Seat Back Cushion Panel

REAR SEAT BACK CUSHION OPENING PANEL REPLACEMENT

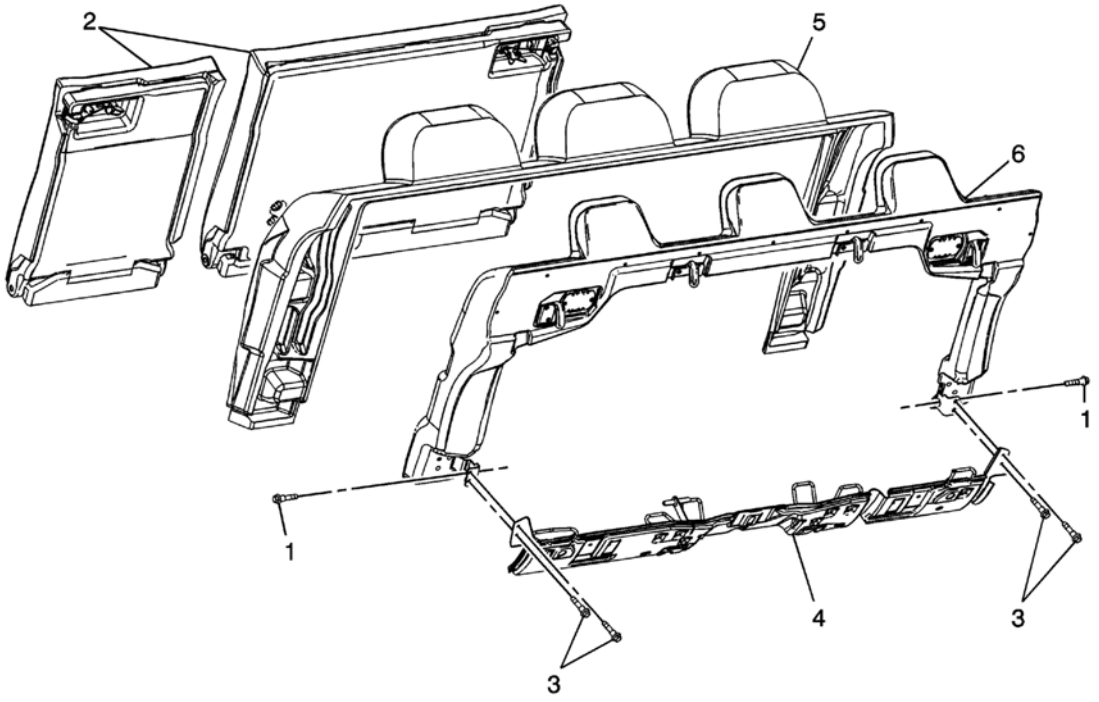


Fig. 41: Rear Seat Back Cushion Opening Panel & Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear seat back cushion. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)**.	
1	Rear Seat Back Cushion Pivot Support Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 15 N.m (11 lb ft)
2	Rear Seat Back Cushion Assembly (Qty: 2) **TIP:** Tilt and slide outward to remove the rear seat back cushion assembly from the rear seat back hinge.
3	Rear Seat Back Hinge Bolt (Qty: 4) **Tighten** 15 N.m (11 lb ft)
4	Rear Seat Back Cushion Hinge Bracket
5	Rear Seat Back Cushion Opening Trim Cover and Pad
6	Rear Seat Back Cushion Opening Panel

REAR SPLIT FOLDING SEAT BACK CUSHION COVER AND PAD REPLACEMENT

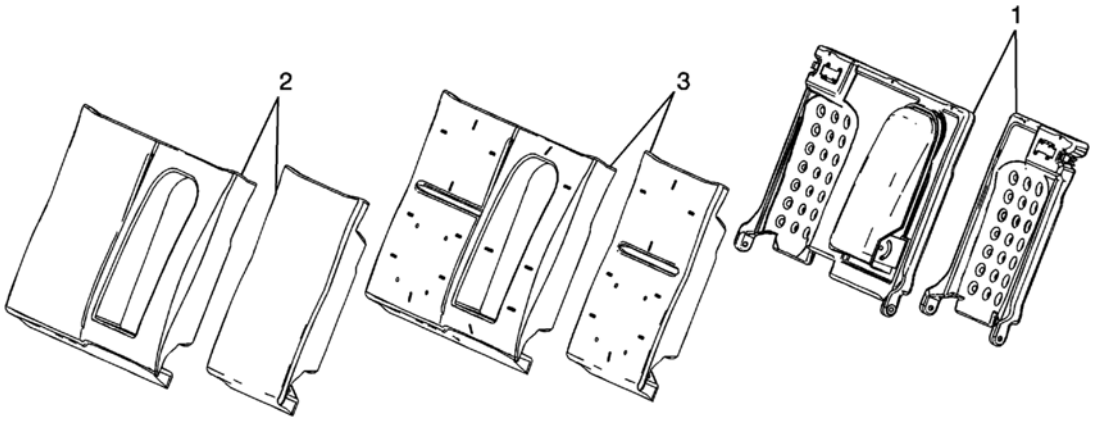


Fig. 42: Identifying Rear Split Folding Seat Back Cover & Pad
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Seat Back Cushion Panel Refer to **Rear Seat Back Cushion Panel Replacement (Rear Split Folding)**.
2	Rear Seat Back Cushion Cover (Qty: 2) **TIP:** Remove the seat back cover by disengaging the retainers securing the cover to the seat back cushion panel.
3	Rear Seat Back Cushion Pad (Qty: 2)

REAR SEAT BACK CUSHION COVER AND PAD REPLACEMENT (IMPALA LIMITED)

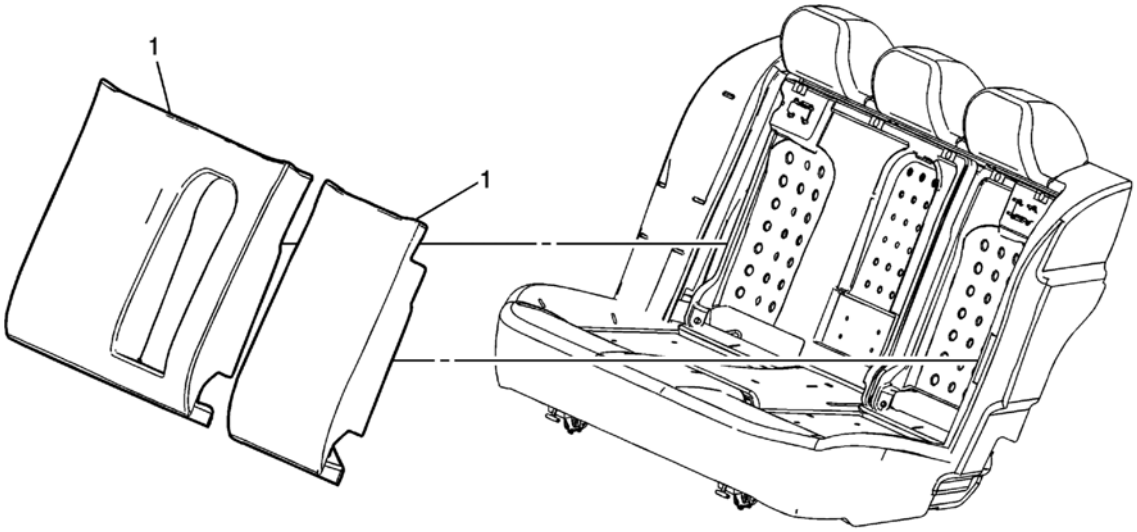


Fig. 43: Rear Seat Back Cover and Pad (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedures** 1. Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)**. 2. Remove the rear seat back cushion. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)**. 3. Remove the rear seat center shoulder belt assemblies. Refer to **Rear Seat Buckle Side Belt Replacement (Impala Limited without AM9)** **Rear Seat Buckle Side Belt Replacement (Impala Limited with AM9)** . 4. Remove the rear seat armrest. Refer to **Rear Seat Armrest Replacement (Impala Limited w/AM9)**.	
1	Cover, Rear Seat Back Cushion 1. Fold the rear seat back cushion panels forward enough to gain access to the retainers for the seat back cushion cover. 2. Remove the rear seat back cushion cover and pad from the rear seat back panels. 3. The seat back cushion cover and pad are serviced as an assembly.

ACCESSORIES AND EQUIPMENT

Seat Heating and Cooling - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Heated Seat Control Module Screw	2 N.m	18 lb in

SCHEMATIC WIRING DIAGRAMS

HEATED/COOLED SEAT WIRING SCHEMATICS

Driver

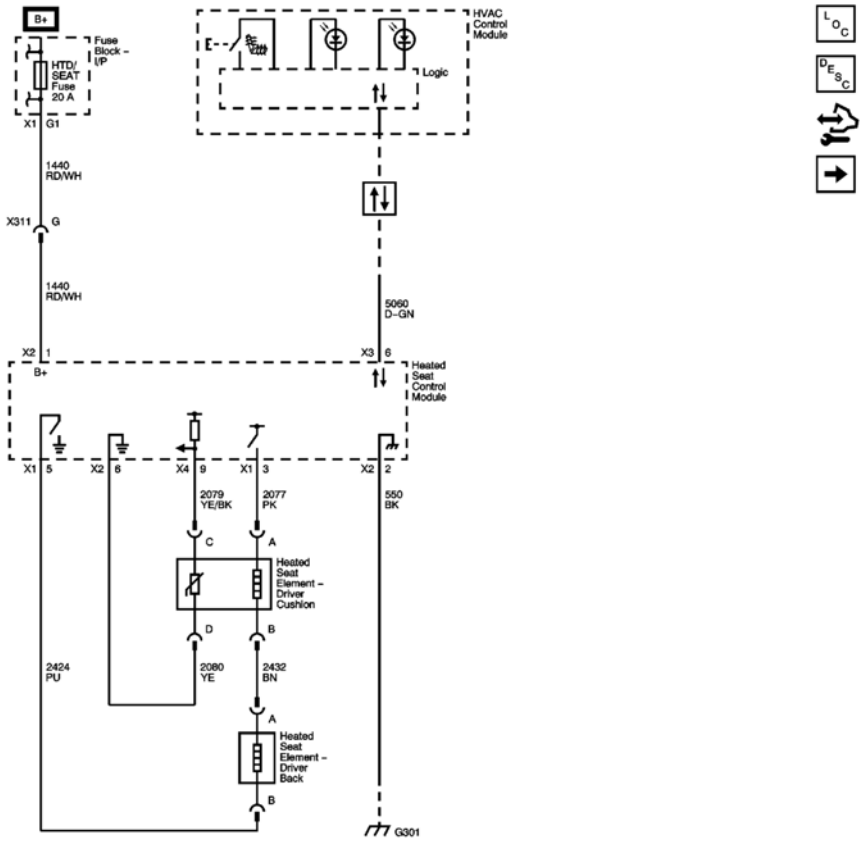


Fig. 1: Driver Seat Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Passenger

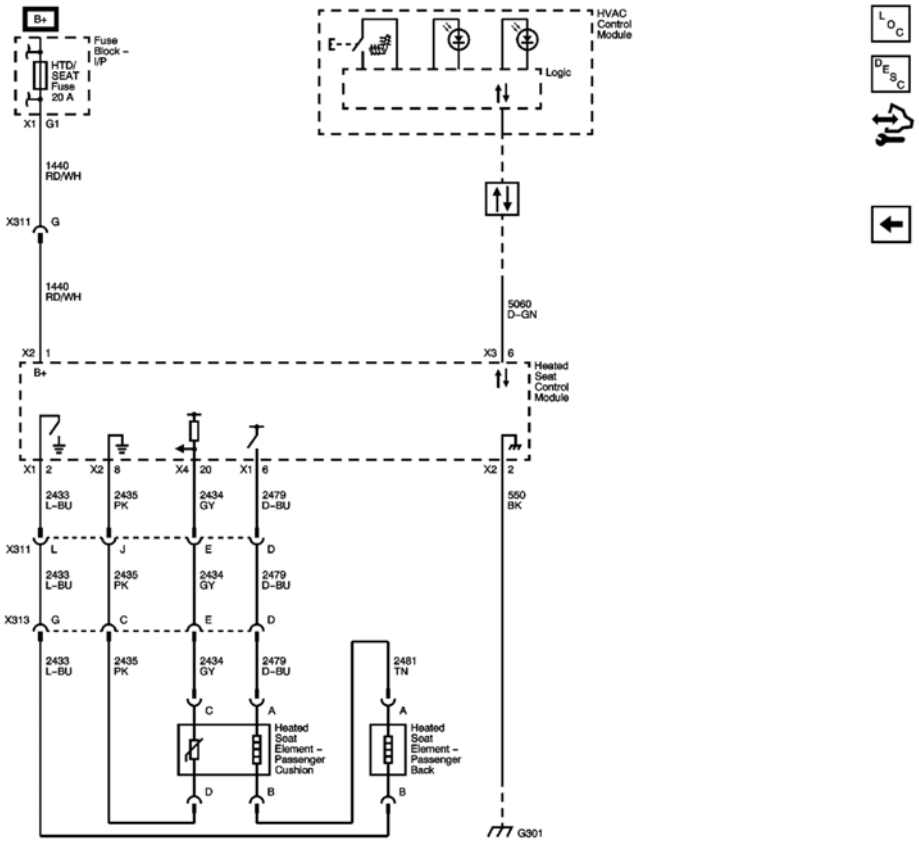


Fig. 2: Passenger Seat Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B1395: DEVICE VOLTAGE REFERENCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1395 02

Device Voltage Reference Output Circuit Short to Ground

DTC B1395 05

Device Voltage Reference Output Circuit Short to Battery or Open

Description

This diagnostic applies to internal microprocessor integrity conditions within the heated seat module (HSM).

Conditions for Running the DTC

The HSM must be powered.

Conditions for Setting the DTC

The voltage sensing calibration data is out of range.

Action Taken When the DTC Sets

The heated seat function for both front seats will be disabled.

Conditions for Clearing the DTC

- The current DTC clears when the malfunction is no longer present and the power mode changes to OFF then back to RUN or ACC.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

If either DTC is set history or current, replace the HSM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for HSM replacement, programming and setup

DTC B1925 OR B2170: SEAT HEATER SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1925 02

Left Seat Heater Sensor Circuit Short to Ground

DTC B1925 05

Left Seat Heater Sensor Circuit Short to Battery or Open

DTC B2170 02

Right Seat Heater Cushion Sensor Circuit Short to Ground

DTC B2170 05

Right Seat Heater Cushion Sensor Circuit Short to Battery or Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Supply Voltage	B2508 02	B2425 0C, B2425 0D	B2508 01	-
Driver Heated Seat Element Control	B2508 02	B2425 0C, B2425 0D	B2508 01	-
Driver Heated Seat Temperature Sensor Signal	B1925 02	B1925 05, B2425 04, B2425 1F	B1925 05, B2425 04, B2425 1F	B2345 13, B2345 42, B2345 4B
Driver Heated Seat Temperature Sensor Low Reference	-	B1925 05, B2425 04, B2425 1F	-	B2345 13, B2345 42, B2345 4B
Passenger Heated Seat Element Supply Voltage	B2508 02	B2430 0C, B2430 0D	B2508 01	-
Passenger Heated Seat Element Control	B2508 02	B2430 0C, B2430 0D	B2508 01	-
Passenger Heated Seat Temperature Sensor Signal	B2170 02	B2170 05, B2430 04, B2430 1F	B2170 05, B2430 04, B2430 1F	B2345 13, B2345 42, B2345 4B
Passenger Heated Seat Temperature Sensor Low Reference	-	B2170 05, B2430 04, B2430 1F	-	B2345 13, B2345 42, B2345 4B

Circuit/System Description

The heated seat temperature sensor that set this diagnostic trouble code (DTC) is located in the seat cushion just under the seat cover with the seat heating element. The heated seat module (HSM) supplies a 5-volt reference voltage through the temperature sensor signal circuit and a ground through the low reference circuit to the sensor. The HSM monitors the voltage of the sensor signal circuit to determine the temperature of the seat. The temperature sensor varies in resistance based on the temperature of the heating element causing the signal voltage to change. Once the seat reaches the set temperature, the HSM will then cycle the control circuit of the heating elements ON and OFF in order to maintain the desired seat temperature based on the feedback voltage from the sensor.

Conditions for Running the DTC

The HSM must be powered.

Conditions for Setting the DTC

B1925 02, B2170 02

The temperature sensor voltage drops below 0.8 volt for more than 1 second.

B1925 05, B2170 05

The temperature sensor voltage is greater than 5 volts for more than 1 second.

Action Taken When the DTC Sets

The heated seat function for the affected seat will be disabled.

Conditions for Clearing the DTC

- The current DTC will clear and set the code to history 3 seconds after the reference voltage returns to normal operating range and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B1925 02 or B1925 05

1. Ignition OFF, disconnect the X2, X4 harness connectors at the HSM.

   IMPORTANT: When measuring the resistance, the resistance values are based on the seat being at room temperature of 20Â°C (68Â°F).

2. Test for 1.9K-300K ohms between the signal circuit terminal 9 X4 and the low reference circuit terminal 6 X2.
   - If greater than the specified range, test the signal circuit and the low reference circuit for a short to voltage or an open/high resistance. If the circuits test normal, replace the seat temperature sensor.
   - If less than the specified range, test for a short between the signal and low reference circuits. If the circuits test normal, replace the seat temperature sensor.
3. Ignition OFF, connect the X2, X4 harness connectors at the HSM.
4. Disconnect the harness connector at the seat cushion heating element/temperature sensor.
5. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal C and ground.
   - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the HSM.
   - If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the HSM.
6. If all circuits test normal, replace the HSM.

B2170 02 or B2170 05

1. Ignition OFF, disconnect the X2, X4 harness connectors at the HSM.

   IMPORTANT: When measuring the resistance, the resistance values are based on the seat being at room temperature of 20Â°C (68Â°F).

2. Test for 1.9K-300K ohms between the signal circuit terminal 20 X4 and the low reference circuit terminal 8 X2.
   - If greater than the specified range, test the signal circuit and the low reference circuit for a short to voltage or an open/high resistance. If the circuits test normal, replace the seat temperature sensor.
   - If less than the specified range, test for a short between the signal and low reference circuits. If the circuits test normal, replace the seat temperature sensor.
3. Ignition OFF, connect the X2, X4 harness connectors at the HSM.

4. Disconnect the harness connector at the seat cushion heating element/temperature sensor.
5. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal C and ground.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the HSM.
    - If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the HSM.
6. If all circuits test normal, replace the HSM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Front Seat Cushion Heater Replacement (Driver Only)**
- **Control Module References** for HSM replacement, setup, and programming

DTC B2345: SEAT HEATER DISABLE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2345 00

Seat Heater Disable Circuit

DTC B2345 4B

Seat Heater Disable Circuit Calibration Not Learned

DTC B2345 13

Seat Heater Disable Circuit Voltage Low/High Temperature

DTC B2345 42

Seat Heater Disable Circuit Calibration Data Set Not Programmed

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Supply Voltage	B2508 02	B2425 0C, B2425 0D	B2508 01	-
Driver Heated Seat Element Control	B2508 02	B2425 0C, B2425 0D	B2508 01	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Temperature Sensor Signal	B1925 02	B1925 05, B2425 04, B2425 1F	B1925 05, B2425 04, B2425 1F	B2345 13, B2345 42, B2345 4B
Driver Heated Seat Temperature Sensor Low Reference	-	B1925 05, B2425 04, B2425 1F	-	B2345 13, B2345 42, B2345 4B
Passenger Heated Seat Element Supply Voltage	B2508 02	B2430 0C, B2430 0D	B2508 01	-
Passenger Heated Seat Element Control	B2508 02	B2430 0C, B2430 0D	B2508 01	-
Passenger Heated Seat Temperature Sensor Signal	B2170 02	B2170 05, B2430 04, B2430 1F	B2170 05, B2430 04, B2430 1F	B2345 13, B2345 42, B2345 4B
Passenger Heated Seat Temperature Sensor Low Reference	-	B2170 05, B2430 04, B2430 1F	-	B2345 13, B2345 42, B2345 4B

Circuit/System Description

The heated seat heating elements are controlled by a common high current relay internal to the heated seat module (HSM) and by individual low side element control circuits. The HSM connects the heater element supply voltage circuits for both seats to a common reference point. This reference point is biased to approximately 2 volts. Before the HSM will allow heated seat operation, it checks to see if the heating element supply voltage circuits and control circuits are shorted to ground or voltage. Once the HSM verifies that it is not closing into a shorted heating element, it allows heated seat operation. After which it continues to monitor for a shorted a circuit.

Conditions for Running the DTC

The HSM must be powered.

Conditions for Setting the DTC

B2345 00

After the heated seat is activated, the HSM detects a short on either the heating element supply voltage circuit or control circuit.

B2345 13

Any temperature sensor input that remains below 1.5 volts for more that 1 second.

B2345 42

This DTC will set if the module calibration is not programmed.

B2345 4B

This DTC will set if the module calibration is out of range.

Action Taken When the DTC Sets

The heated seat function for both seats will be disabled.

Conditions for Clearing the DTC

- The current DTC will clear and set the code to history 3 seconds after the reference voltage returns to normal operating range and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B2345 00

1. Ignition OFF, disconnect the X1 harness connector at the HSM.
2. Test for infinite resistance between the control circuit terminal 3 and ground.
    - If less than the specified range, test the control circuit for a short to ground.
3. Test for infinite resistance between the control circuit terminal 6 and ground.
    - If less than the specified range, test the control circuit for a short to ground.
4. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 3 and ground.
    - If the test lamp illuminates, test the control circuit for a short to voltage.
5. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 6 and ground.

- If the test lamp illuminates, test the control circuit for a short to voltage.

6. If all circuits test normal, replace the HSM.

B2345 13

1. Ignition OFF, disconnect the X2, X4 harness connector at the HSM.
2. Test for greater than 1.9K ohms between the signal and low reference circuits listed below:
   - Driver seat cushion terminal 9 X4 and terminal 6 X2
   - Passenger seat cushion terminal 20 X4 and terminal 8 X2
   - If less than the specified range, test for a short between the signal and low reference circuits. If the circuits test normal, replace the appropriate seat temperature sensor.
3. If all circuits test normal, replace the HSM.

B2345 42 or B2345 4B

If either DTC is set, replace the HSM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Driver or Passenger Seat Back Heater Replacement (Impala Limited)**
- **Front Seat Cushion Heater Replacement (Driver Only)**
- **Control Module References** for the HSM replacement, setup, and programming

DTC B2425 OR B2430: SEAT HEATER CUSHION CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2425 04

Left Seat Heater Cushion Circuit Open

DTC B2425 0A

Left Seat Heater Cushion Circuit Rate of Change Below Threshold

DTC B2425 0B

Left Seat Heater Cushion Circuit Current Above Threshold

DTC B2425 0C

Left Seat Heater Cushion Circuit Current Below Threshold

DTC B2425 0D

Left Seat Heater Cushion Resistance Above Threshold

DTC B2425 0E

Left Seat Heater Cushion Resistance Below Threshold

DTC B2425 1F

Left Seat Heater Cushion Circuit Intermittent

DTC B2430 04

Right Seat Heater Cushion Circuit Open

DTC B2430 0A

Right Seat Heater Cushion Circuit Rate of Change Below Threshold

DTC B2430 0B

Right Seat Heater Cushion Circuit Current Above Threshold

DTC B2430 0C

Right Seat Heater Cushion Circuit Current Below Threshold

DTC B2430 0D

Right Seat Heater Cushion Resistance Above Threshold

DTC B2430 0E

Right Seat Heater Cushion Resistance Below Threshold

DTC B2430 1F

Right Seat Heater Cushion Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Supply Voltage	B2508 02	B2425 0C, B2425 0D	B2508 01	-
Driver Heated Seat Element Control	B2508 02	B2425 0C, B2425 0D	B2508 01	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Temperature Sensor Signal	B1925 02	B1925 05, B2425 04, B2425 1F	B1925 05, B2425 04, B2425 1F	B2345 13, B2345 42, B2345 4B
Driver Heated Seat Temperature Sensor Low Reference	-	B1925 05, B2425 04, B2425 1F	-	B2345 13, B2345 42, B2345 4B
Passenger Heated Seat Element Supply Voltage	B2508 02	B2430 0C, B2430 0D	B2508 01	-
Passenger Heated Seat Element Control	B2508 02	B2430 0C, B2430 0D	B2508 01	-
Passenger Heated Seat Temperature Sensor Signal	B2170 02	B2170 05, B2430 04, B2430 1F	B2170 05, B2430 04, B2430 1F	B2345 13, B2345 42, B2345 4B
Passenger Heated Seat Temperature Sensor Low Reference	-	B2170 05, B2430 04, B2430 1F	-	B2345 13, B2345 42, B2345 4B

Circuit/System Description

Both, the driver and passenger heated seats are controlled by the heated seat module (HSM) that is located under the driver seat cushion. When the heated seat is active, the HSM applies power through a common voltage supply circuit to the seat heater elements. The HSM controls the seat temperature by providing a pulse width modulation (PWM) ground through the seat heater element control circuit to the heater elements. The HSM then monitors the current flow through the heating elements and the rate of change of the temperature sensor to verify correct heated seat operation.

Conditions for Running the DTC

The HSM must be powered and the heated seat must be enabled.

Conditions for Setting the DTC

B2425 04 or B2430 04

The HSM does not detect a temperature change for up to 210 seconds.

B2425 0A or B2430 0A

The HSM detects that the set point temperature has not been reached for up to 8.5 minutes.

B2425 0B, B2425 0E, B2430 0B, or B2430 0E

By measuring current and voltage output to the seat heating elements every 10 seconds, the HSM calculates that the heating element resistance is below the minimum resistance.

B2425 0C, B2425 0D, B2430 0C, or B2430 0D

By measuring current and voltage output to the seat heating elements every 10 seconds, the HSM calculates that

the heating element resistance is above the maximum resistance.

B2425 1F or B2430 1F

The temperature sensor voltage is erratic or changes suddenly.

Action Taken When the DTC Sets

The heated seat function for the affected seat will be disabled.

Conditions for Clearing the DTC

- The current DTC clears when the malfunction is no longer present, and the power mode changes to OFF then back to ACC or RUN.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B2425 0A, B2425 0B, B2425 0C, B2425 0D, B2425 0E, B2425 04, or B2425 1F

1. Ignition OFF, disconnect the harness connector at the seat back heating element.

   IMPORTANT: When measuring the resistance, all of the resistance values below are based on the seat being at room temperature of 20Â°C (68Â°F).

2. Test for 1.64 - 5.54 Ω between terminal A and terminal B.

- If not within the specified range, replace the seat back heating element.

3. Connect the harness connector at the seat back heating element.
4. Disconnect the X1 harness connector at the HSM.
5. Test for 1.64 - 5.54 Ω between control circuit terminal 3 and control circuit terminal 5.
    - If less than the specified range, test for a short between the control circuits. If the circuits test normal, replace the seat cushion heating element.
    - If greater than the specified range, test the control circuits for an open/high resistance. If the circuits test normal, replace the seat cushion heating element.
6. Disconnect the X2, X4 harness connectors at the HSM.
7. Test for 1.9 k - 300 kΩ between the signal circuit terminal 9 X4 and the low reference circuit terminal 6 X2.
    - If less than the specified range, test for a short between the signal and low reference circuits. If the circuits test normal, replace the seat temperature sensor.
    - If greater than the specified range, test the signal circuit and the low reference circuit for a short to voltage or an open/high resistance. If the circuits test normal, replace the seat temperature sensor.
8. Ignition OFF, connect the X1, X2, X4 harness connectors at the HSM.
9. Disconnect the harness connector at the seat cushion heating element/temperature sensor.
10. Ignition ON, test for 4.8 - 5.2 V between the signal circuit terminal C and ground.
    - If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the HSM.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the HSM.
11. If all circuits test normal, replace the HSM.

B2430 0A, B2430 0B, B2430 0C, B2430 0D, B2430 0E, B2430 04, or B2430 1F

1. Ignition OFF, disconnect the harness connector at the seat back heating element.

    IMPORTANT: When measuring the resistance, all of the resistance values below are based on the seat being at room temperature of 20Â°C (68Â°F).

2. Test for 1.64 - 5.76 Ω between terminal A and terminal B.
    - If not within the specified range, replace the seat back heating element.
3. Connect the harness connector at the seat back heating element .
4. Disconnect the X1 harness connector at the HSM.
5. Test for 1.64 - 5.76 Ω between control circuit terminal 6 and control circuit terminal 2.
    - If less than the specified range, test for a short between the control circuits. If the circuits test normal, replace the seat cushion heating element.
    - If greater than the specified range, test the control circuits for an open/high resistance. If the circuits test normal, replace the seat cushion heating element.
6. Disconnect the X2, X4 harness connectors at the HSM.
7. Test for 1.9 k - 300 kΩ between the signal circuit terminal 20 X4 and the low reference circuit terminal 8

X2.

- If less than the specified range, test for a short between the signal and low reference circuits. If the circuits test normal, replace the seat temperature sensor.
- If greater than the specified range, test the signal circuit and the low reference circuit for a short to voltage or an open/high resistance. If the circuits test normal, replace the seat temperature sensor.

8. Ignition OFF, connect the X1, X2, X4 harness connectors at the HSM.
9. Disconnect the harness connector at the seat cushion heating element/temperature sensor.
10. Ignition ON, test for 4.8 - 5.2 V between the signal circuit terminal C and ground.
    - If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the HSM.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the HSM.
11. If all circuits test normal, replace the HSM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Driver or Passenger Seat Back Heater Replacement (Impala Limited)**
- **Front Seat Cushion Heater Replacement (Driver Only)**
- **Control Module References** for HSM replacement, setup, and programming

DTC B2508 OR B2509: SEAT HEATER RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2508 01

Seat Heater Relay Circuit Short to Battery

DTC B2508 02

Seat Heater Relay Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Supply Voltage	B2508 02	B2425 0C, B2425 0D	B2508 01	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Control	B2508 02	B2425 0C, B2425 0D	B2508 01	-
Driver Heated Seat Temperature Sensor Signal	B1925 02	B1925 05, B2425 04, B2425 1F	B1925 05, B2425 04, B2425 1F	B2345 13, B2345 42, B2345 4B
Driver Heated Seat Temperature Sensor Low Reference	-	B1925 05, B2425 04, B2425 1F	-	B2345 13, B2345 42, B2345 4B
Passenger Heated Seat Element Supply Voltage	B2508 02	B2430 0C, B2430 0D	B2508 01	-
Passenger Heated Seat Element Control	B2508 02	B2430 0C, B2430 0D	B2508 01	-
Passenger Heated Seat Temperature Sensor Signal	B2170 02	B2170 05, B2430 04, B2430 1F	B2170 05, B2430 04, B2430 1F	B2345 13, B2345 42, B2345 4B
Passenger Heated Seat Temperature Sensor Low Reference	-	B2170 05, B2430 04, B2430 1F	-	B2345 13, B2345 42, B2345 4B

Circuit/System Description

The driver and passenger seat heating elements are controlled by a common high current relay internal to the heated seat module (HSM) and by individual low side element control circuits. The HSM connects the heated seat heater element supply voltage circuits for both seats to a common reference point. This reference point is biased to approximately 2.0 volts. Before the HSM will allow heated seat operation, it checks to see if this reference voltage is shorted to ground or voltage. Once the HSM verifies that it is not closing to a shorted heating element, it allows for heated seat operation. The HSM will then continue to monitor the heating elements for a shorted circuit.

Conditions for Running the DTC

The HSM must be powered.

Conditions for Setting the DTC

B2508 01

The HSM detects a short to voltage on the heater element supply voltage circuit or control circuit.

B2508 02

The HSM detects a short to ground for on the heater element supply voltage circuit or control circuit.

Action Taken When the DTC Sets

The heated seat function for both seats will be disabled.

Conditions for Clearing the DTC

- The current DTC will clear and set a history code 3 seconds after the reference voltage returns to normal operating range and the ignition is cycled OFF then back to ACC or RUN.
- The history DTC will clear after 50 consecutive fault-free ignition cycles have occurred.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the HSM.
2. Test for infinite resistance between the control circuit terminal 3 and ground.
    - If not the specified value, test the control circuit for a short to ground.
3. Test for infinite resistance between the control circuit terminal 6 and ground.
    - If not the specified value, test the control circuit for a short to ground.
4. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 3 and ground.
    - If the test lamp illuminates, test the control circuit for a short to voltage.
5. Verify that a test lamp does not illuminate between the control circuit terminal 6 and ground.
    - If the test lamp illuminates, test the control circuit for a short to voltage.
6. If all circuits test normal, replace the HSM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Driver or Passenger Seat Back Heater Replacement (Impala Limited)**
- **Front Seat Cushion Heater Replacement (Driver Only)**

- **Control Module References** for HSM replacement, setup, and programming

SYMPTOMS - SEAT HEATING AND COOLING

IMPORTANT: The following steps must be completed before using the symptom tables.

1. When diagnosing a heated seat system condition perform the **Diagnostic System Check - Vehicle** , before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control module(s) can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Heated Seats Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the power seats. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the seat adjuster track for conditions which may cause binding or objects within the seat adjustment range which obstruct movement or interfere with wiring.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to the **Heated Seat Inoperative** diagnostic procedure in order to diagnose the symptom.

HEATED SEAT INOPERATIVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Element Supply Voltage	B2508 02	B2425 0C, B2425 0D	B2508 01	-
Driver Heated Seat Element Control	B2508 02	B2425 0C, B2425 0D	B2508 01	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Driver Heated Seat Temperature Sensor Signal	B1925 02	B1925 05, B2425 04, B2425 1F	B1925 05, B2425 04, B2425 1F	B2345 13, B2345 42, B2345 4B
Driver Heated Seat Temperature Sensor Low Reference	-	B1925 05, B2425 04, B2425 1F	-	B2345 13, B2345 42, B2345 4B
Passenger Heated Seat Element Supply Voltage	B2508 02	B2430 0C, B2430 0D	B2508 01	-
Passenger Heated Seat Element Control	B2508 02	B2430 0C, B2430 0D	B2508 01	-
Passenger Heated Seat Temperature Sensor Signal	B2170 02	B2170 05, B2430 04, B2430 1F	B2170 05, B2430 04, B2430 1F	B2345 13, B2345 42, B2345 4B
Passenger Heated Seat Temperature Sensor Low Reference	-	B2170 05, B2430 04, B2430 1F	-	B2345 13, B2345 42, B2345 4B

Circuit/System Description

The driver and passenger heated seats are controlled by separate heated seat switches. Both switches are located in the HVAC control module face plate. When a heated seat switch is pressed, the HVAC control module sends a serial data message to the heated seat control module (HSM) indicating the heated seat request. In response to this signal, the HSM activates the heated seat by applying battery voltage to the seat heating elements. The HSM then sends a serial data message back to the HVAC control module commanding it to illuminate the appropriate seat temperature indicator.

Reference Information

Schematic Reference

Heated/Cooled Seat Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Heated Seats Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no DTCs are set.
    - **If any DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **If no DTCs are set**
3. Verify that both the driver and front passenger heated seats operate.
    - **If just one or both of the heated seats is inoperative**

      Refer to Circuit/System Testing.

    - **If both heated seats operate**
4. All OK.

Circuit/System Testing

1. Ignition OFF.
2. Replace the heated seat control module, ignition ON.
3. Verify the heated seat operates.
    - **If the heated seat does not operate**

      Replace the HVAC control module.

    - **If the heated seat operates**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for HVAC control module and heated seat control module replacement, programming and setup

REPAIR INSTRUCTIONS

FRONT SEAT HEATER CONTROL MODULE REPLACEMENT (IMPALA LIMITED)

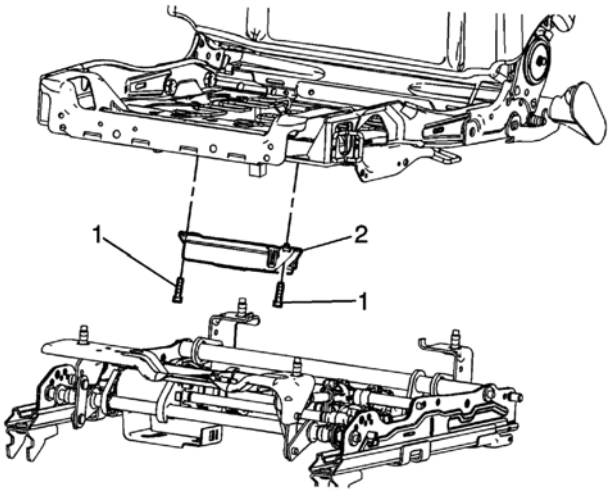


Fig. 3: Front Heated Seat Control Module (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)** . 2. Remove the front seat adjuster. Refer to **Front Seat Adjuster Replacement** .	
1	Front Seat Heater Control Module Screw (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	Front Seat Heater Control Module **TIP:** Disconnect the electrical connector. Refer to **Control Module References** for programming and setup information.

DRIVER OR PASSENGER SEAT BACK HEATER REPLACEMENT (IMPALA LIMITED)

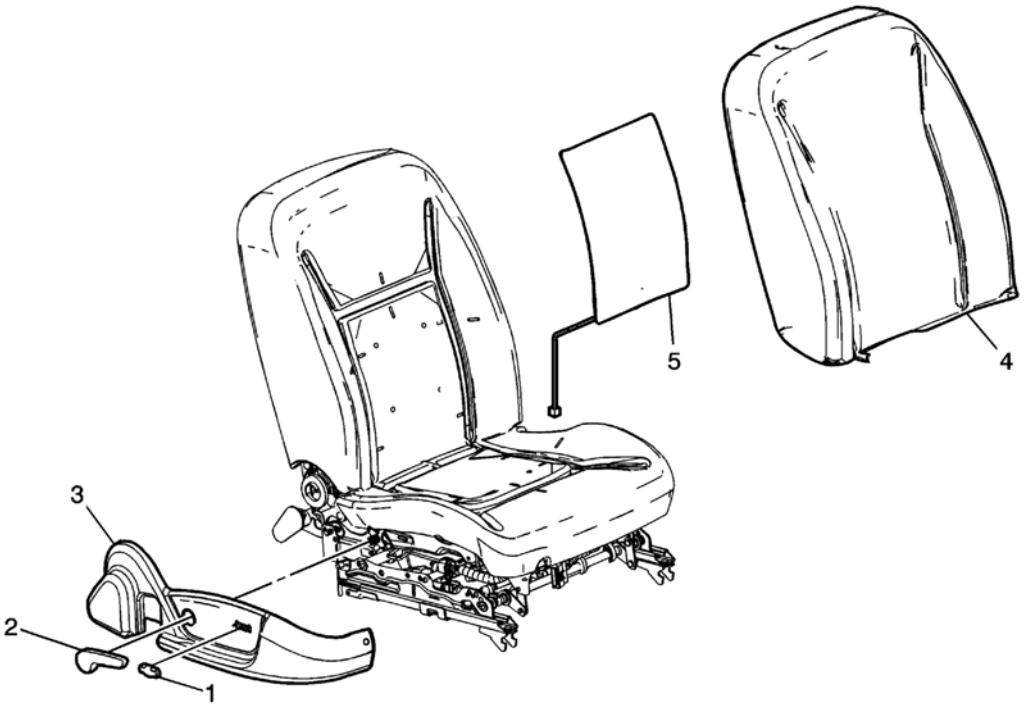


Fig. 4: Front Seat Back Heater Element (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** . **Preliminary Procedure** 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)** . 2. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement** .	
1	Handle, Recliner **TIP:** Using a flat-bladed tool, push the retainer clip downward and pull outward to release the handle.
2	Knob, Power Seat Switch **TIP:** Pull outward to remove.
3	Panel, Seat Cushion Outer Trim Refer to **Seat Cushion Outer Trim Panel Replacement** .
4	Cover, Seat Back Cushion Refer to **Seat Back Cover and Pad Replacement (Impala Limited)** .
5	Heater Assembly, Seat Back Cushion 1. Disconnect the electrical connector. 2. The seat cushion back heater is attached to the pad with adhesive, peel away from the

Callout	Component Name
	pad to remove.

FRONT SEAT CUSHION HEATER REPLACEMENT (DRIVER ONLY)

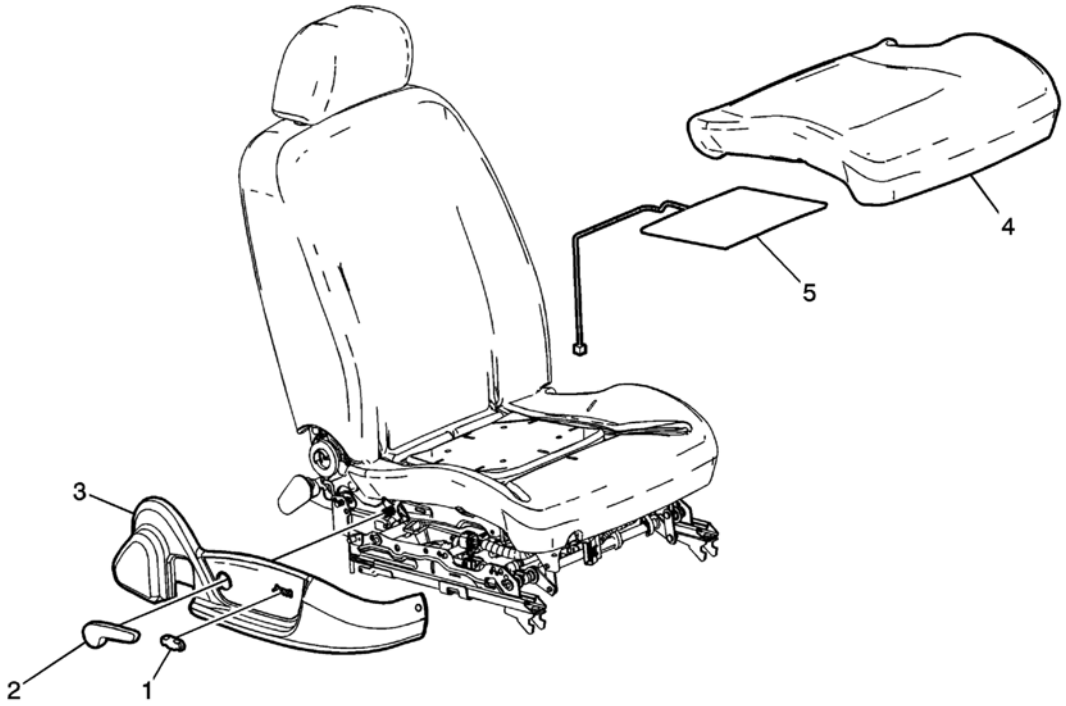


Fig. 5: Front Seat Cushion Heater Element (Driver Only)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Replace the passenger presence system as a complete assembly to prevent possible injury to the occupant. All the components in the service kit are assembled**	

Callout	Component Name
and calibrated as a unit. Using only some of the components in the service kit will cause the passenger presence system to operate improperly. **Preliminary Procedure** Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)** .	
1	Recliner Handle **TIP:** Using a flat-bladed tool, push the retainer clip downward and pull outward to release the handle.
2	Power Seat Switch Knob **TIP:** Pull outward to remove.
3	Seat Cushion Outer Trim Panel Refer to **Seat Cushion Outer Trim Panel Replacement** .
4	Seat Cushion Cover Refer to **Front Seat Cushion Cover and Pad Replacement (Impala Limited)** .
5	Seat Cushion Heater Assembly **Procedure** 1. Disconnect the electrical connector. 2. The seat cushion heater is attached to the pad with adhesive, peel away from the pad to remove.

DESCRIPTION AND OPERATION

HEATED SEATS DESCRIPTION AND OPERATION

The front heated seat system consists of the following components.

- Left heated seat switch
- Right heated seat switch
- Heated seat module
- Left seat cushion heater element

- Left seat back heater element
- Left seat temperature sensor
- Right seat cushion heater element
- Right seat back heater element
- Right seat temperature sensor
- Climate Control Panel (CCP)
- HTD/SEAT 10 A

Power and Ground

Battery positive voltage is supplied at all times to the heated seat module from the HTD/SEAT fuse located in the I/P fuse block. This voltage is used by the module to supply power to the seat heating elements. The module is grounded through the module ground circuit and G301.

Heated Seat Operation

The driver and passenger heated seats are controlled by a single heated seat module that is located under the driver seat cushion. Both heated seats are controlled by separate heated seat switches that are located in the climate control panel (CCP). When a heated seat switch is pressed, the CCP sends a GMLAN message via the serial data line to the heated seat module indicating the heated seat command. In response to this signal, the heated seat module then applies battery positive voltage through the element supply voltage circuit to the appropriate seat heating elements. The heated seat module then sends a GMLAN message back to the CCP to either illuminate or turn off the appropriate temperature indicator.

Temperature Regulation

When the ignition is turned to the ON position, the heated seats will initialize in the OFF state. With each activation of the heated seat switch, the heated seat module will cycle the temperature setting in the following manner: HIGH, LOW, and OFF.

The heated seat module monitors the seat temperature through the temperature sensor signal circuit and the temperature sensor (thermistor) that is located in the seat cushion. The temperature sensor is a variable resistor, it's resistance changes as the temperature of the seat changes. When the temperature sensor resistance indicates to the heated seat module that the seat has reached the desired temperature, the module opens the ground path of the seat heating elements through the heated seat element control circuit. The module will then cycle the element control circuit open and closed in order to maintain the desired temperature.

Load Management

The load-shed operation is a means of reducing vehicle electrical loads during a low voltage or low battery state of charge (SOC) condition. During certain load-shed conditions, all heated seat functions will be disabled. Refer to **Electrical Power Management Description and Operation** .

Article GUID: A00737219

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Steering Wheel Shroud Screws	2 N.m	18 lb in

SCHEMATIC WIRING DIAGRAMS

STEERING WHEEL SECONDARY/CONFIGURABLE CONTROL WIRING SCHEMATICS

Steering Wheel Secondary/Configurable Control

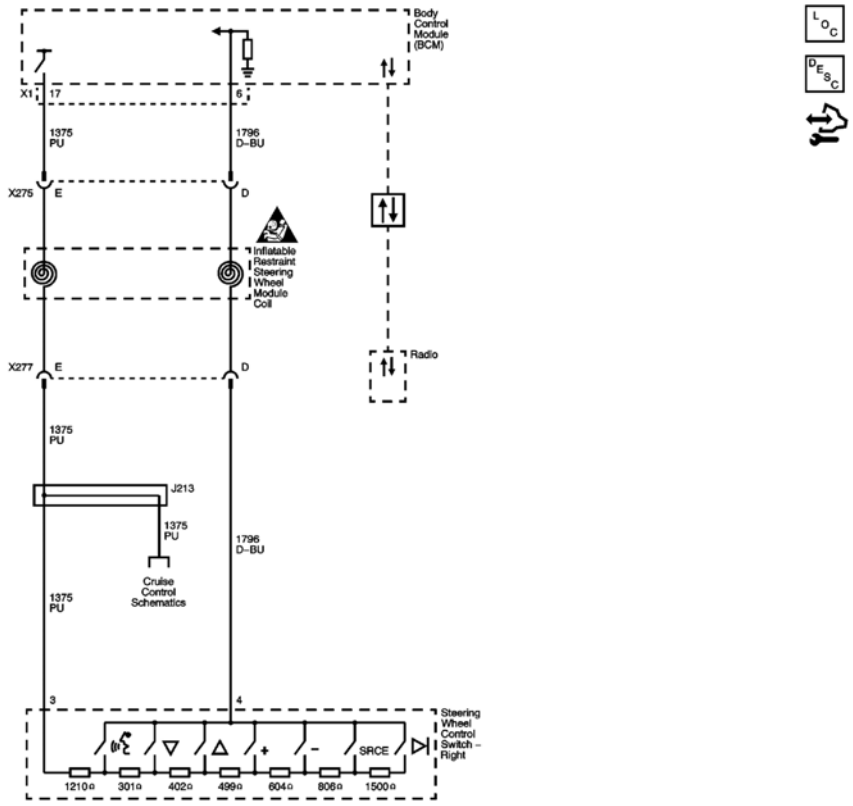


Fig. 1: Steering Wheel Secondary/Configurable Control Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B1529: DEVICE VOLTAGE REFERENCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1529 03

Device Voltage Reference Output Circuit Voltage Below Threshold

DTC B1529 07

Device Voltage Reference Output Circuit Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Voltage Reference	B1529 03	1	-	B1529 07
Signal	1	1	B3622 07	-
1. Steering Wheel Controls Inoperative				

Circuit/System Description

The body control module (BCM) supplies voltage to the audio steering wheel control switches and monitors the return signal. Each switch state is associated to a set resistance value and when pressed a specific voltage drop occurs across the resistor unique to the switch. The BCM identifies the switch selection and activates the feature.

Conditions for Running the DTC

- Battery voltage is between 9-16 V
- The ignition is ON.

Conditions for Setting the DTC

B1529 03

- The BCM detects a short to ground in the B+ voltage reference circuit.
- The above condition is present for greater than 30 seconds.

B1529 07

- The BCM detects a short to voltage in the B+ voltage reference circuit.
- The above condition is present for greater than 30 seconds.

Action Taken When the DTC Sets

The BCM will ignore switch inputs.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction free ignition cycles have occurred.

Reference Information

Schematic Reference

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool BCM SWC Bank 1 Status parameter. The reading should be idle and change between SW1-SW7 when pushing the appropriate switch.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the right steering wheel control switch.
2. Ignition ON, test for B+ between the voltage reference circuit terminal 3 and ground.
    - If less than the specified value, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
    - If greater than the specified value, test the voltage reference circuit for a short to voltage. If the circuit tests normal, replace the BCM.
3. If all circuits test normal, test or replace the right steering wheel control switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the right steering wheel control switch.
2. Test the resistance between the voltage reference terminal 3 and the signal terminal 4 while depressing the appropriate steering wheel controls switch listed below.
    - If not the specified range, replace the steering wheel switch.

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Mute/Voice Recognition	1.0k Ohms	1.4k Ohms
Volume Down	1.3k Ohms	1.7k Ohms
Volume Up	1.7k Ohms	2.1k Ohms
Previous	2.8k Ohms	2.6k Ohms
Next	2.2k Ohms	3.2k Ohms
Source	3.6k Ohms	4.0k Ohms
Seek	5.1k Ohms	5.5k Ohms
No Switch Pressed	O.L.	O.L.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for BCM replacement, programming and setup

DTC B3622: STEERING WHEEL CONTROLS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3622 07

Steering Wheel Controls Signal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Voltage Reference	B1529 03	1	-	B1529 07
Right Steering Wheel Control Switch Signal	1	1	B3622 07	-
1. Steering Wheel Controls Inoperative				

Circuit/System Description

The body control module (BCM) monitors the steering wheel control signal circuit voltage. If the voltage level is too high, damage may result in the system. When a high voltage condition is detected, the BCM will ignore the switch command.

Conditions for Running the DTC

- Battery voltage is between 9-16 volts
- The ignition is ON.

Conditions for Setting the DTC

The BCM detects a short to voltage in the steering wheel control switch signal circuit.

Action Taken When the DTC Sets

The BCM will ignore switch inputs.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction free ignition cycles have occurred.

Reference Information

Schematic Reference

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool BCM SWC Bank 1 Status parameter. The reading should be idle and change between SW1-SW7 when pushing the appropriate switch.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the right steering wheel control switch.
2. Ignition ON, test for B+ between the voltage reference circuit terminal 3 and ground.
    - If less than the specified value, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
3. Test for B+ between the voltage reference circuit terminal 3 and the signal circuit terminal 4.
    - If less than the specified value, test the signal circuit for a short to voltage or an open/high

resistance. If the circuit tests normal, replace the BCM.

4. Ignition OFF, disconnect the X1 harness connector at the BCM.
5. Test for infinite resistance between the signal circuit terminal 4 and ground.
    - If less than the specified value, test the signal circuit for a short to ground.
6. If all circuits test normal, test or replace the right steering wheel control switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the right steering wheel control switch.
2. Test the resistance between the voltage reference terminal 3 and the signal terminal 4 while depressing the appropriate steering wheel controls switch listed below.
    - If not the specified range, replace the steering wheel switch.

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Mute/Voice Recognition	1.0k Ohms	1.4k Ohms
Volume Down	1.3k Ohms	1.7k Ohms
Volume Up	1.7k Ohms	2.1k Ohms
Previous	2.2k Ohms	2.6k Ohms
Next	2.8k Ohms	3.2k Ohms
Source	3.6k Ohms	4.0k Ohms
Seek	5.1k Ohms	5.5k Ohms
No Switch Pressed	O.L.	O.L.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Steering Wheel Control Switch Assembly Replacement**
- **Control Module References** for BCM replacement, setup, and programming

SYMPTOMS - SECONDARY AND CONFIGURABLE CUSTOMER CONTROLS

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
    - There are no DTCs set.
    - The control modules can communicate via the serial data link.
2. Review the system description and operation in order to familiarize yourself with the system functions. Refer to **Steering Wheel Controls Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the steering wheel controls. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components, for obvious damage or conditions, which

could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

Refer to **Steering Wheel Controls Malfunction** in order to diagnose the symptom.

STEERING WHEEL CONTROLS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Voltage Reference	B1529 03	1	-	B1529 07
Right Steering Wheel Control Switch Signal	1	1	B3622 07	-
1. Steering Wheel Controls Inoperative				

Circuit/System Description

The body control module (BCM) supplies voltage to the audio steering wheel control switches and monitors the return signal. Each switch state is associated to a set resistance value and when pressed a specific voltage drop occurs across the resistor unique to the switch. The BCM identifies the switch selection and activates the feature.

Diagnostic Aids

- This diagnostic is for the audio steering wheel controls.
- Before diagnosis of the steering wheel controls, ensure the primary controls of the associated component are functioning properly.

Reference Information

Schematic Reference

Steering Wheel Secondary/Configurable Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Steering Wheel Controls Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool BCM SWC Bank 1 Status parameter. The reading should be idle and change between SW1-SW7 when pushing the appropriate switch.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the right steering wheel control switch.
2. Ignition ON, test for B+ between the voltage reference circuit terminal 3 and ground.
    - If less than the specified value, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
3. Test for B+ between the voltage reference circuit terminal 3 and the signal circuit terminal 4.
    - If less than the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Ignition OFF, disconnect the X1 harness connector at the BCM.
5. Test for infinite resistance between the signal circuit terminal 4 and ground.
    - If less than the specified value, test the signal circuit for a short to ground.
6. If all circuits test normal, test or replace the right steering wheel control switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the right steering wheel control switch.
2. Test the resistance between the voltage reference terminal 3 and the signal terminal 4 while depressing the appropriate steering wheel controls switch listed below.
    - If not the specified range, replace the steering wheel switch.

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Mute/Voice Recognition	1.0k Ohms	1.4k Ohms
Volume Down	1.3k Ohms	1.7k Ohms
Volume Up	1.7k Ohms	2.1k Ohms

Function Switch	Minimum Resistance Value	Maximum Resistance Value
Previous	2.2k Ohms	2.6k Ohms
Next	2.8k Ohms	3.2k Ohms
Source	3.6k Ohms	4.0k Ohms
Seek	5.1k Ohms	5.5k Ohms
No Switch Pressed	O.L.	O.L.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Steering Wheel Control Switch Assembly Replacement**
- **Control Module References** for BCM replacement, setup, and programming

REPAIR INSTRUCTIONS

STEERING WHEEL CONTROL SWITCH ASSEMBLY REPLACEMENT

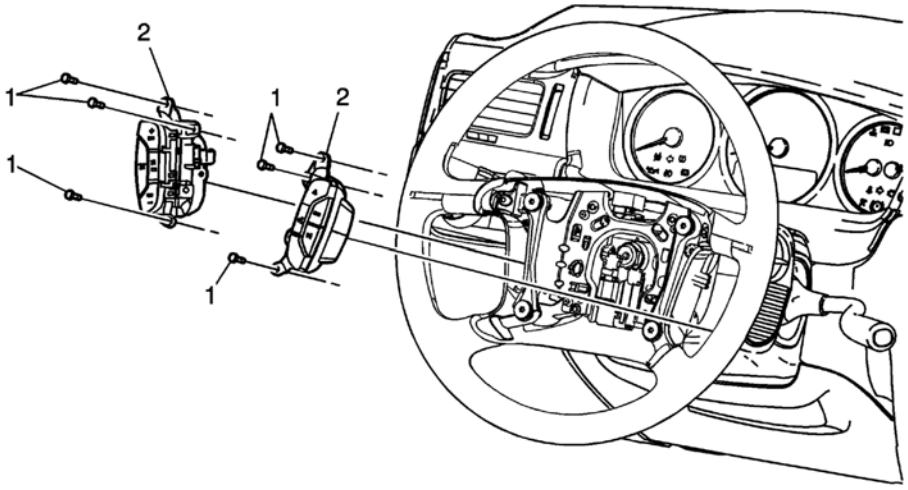


Fig. 2: Steering Wheel Control Switch Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the inflatable restraint steering wheel module. Refer to **Airbag Steering Wheel Module Replacement** .	
1	Steering Wheel Switch Bolt/Screw **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	TIP: Disconnect the electrical connector. **Tighten** 2 N.m (18 lb in)
2	Radio, HVAC and Cruise Control Assembly Switch Assembly

DESCRIPTION AND OPERATION

STEERING WHEEL CONTROLS DESCRIPTION AND OPERATION

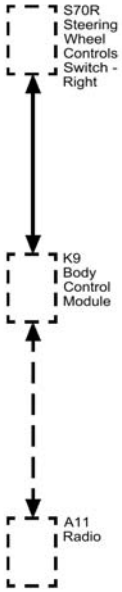


Fig. 3: Steering Wheel Controls Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
S70R	S70R Steering Wheel Controls Switch - Right
K9	K9 Body Control Module
A11	A11 Radio

The steering wheel control switches duplicate the function of the primary controls of the associated component, through a network of momentary contact switches and a series of resistors. The body control module (BCM) supplies voltage to the switches and monitors the return signal. When a switch is pressed, a specific voltage drops across the resistor unique to that switch. The BCM identifies the switch selected and sends a serial data message to the component controlled by the switch, activating the feature.

This section is intended to diagnose the circuits between the BCM and the steering wheel control switches. If the primary control for the device is inoperative, refer to the appropriate section for the component the steering

wheel control switch is used for.

Article GUID: A00737206

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Intermediate Steering Shaft Bolt	62 N.m	46 lb ft
Intermediate Steering Shaft Lower Bolt	48 N.m	35 lb ft
Intermediate Steering Shaft Seal Bolt	3 N.m	27 lb in
Linear Shift Assembly Bolt	10 N.m	89 lb in
Shift Lever Bolt	20 N.m	15 lb ft
Steering Column Bolt	25 N.m	18 lb ft
Steering Column Nut	25 N.m	18 lb ft
Steering Column Support Bolt	17 N.m	13 lb ft
Steering Column Trim Bolt	3 N.m	27 lb in
Steering Wheel Nut	41 N.m	30 lb ft
Turn Signal Multifunction Switch Bolt	1 N.m	11 lb in

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Centering Sphere	Lubricant	12345718	10953516
Pivot Pin	Lubricant	12346293	992723
Turn Signal Cancel Cam	Lubricant	12377900	10953529

COMPONENT LOCATOR

STEERING COLUMN DISASSEMBLED VIEW (COLUMN SHIFT)

Tilt Steering Column, Column Shift

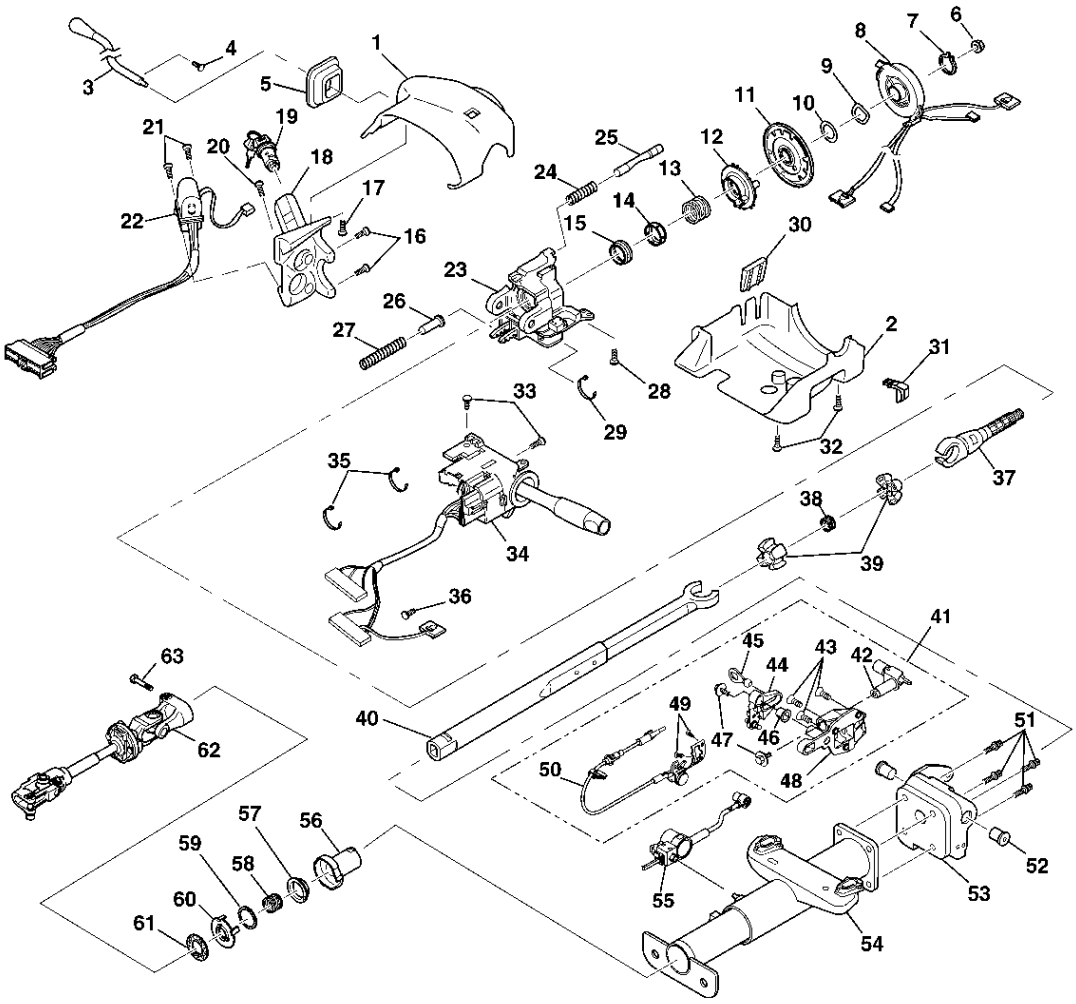


Fig. 1: Tilt Steering Column Disassembled View, Column Shift
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Upper Trim Cover
2	Lower Trim Cover
3	Shift Lever Assembly
4	Shift Lever Screw
5	Shift Lever Seal
6	Flanged Prevailing Torque Nut
7	Retaining Ring
8	SIR Coil
9	Wave Washer
10	Bearing Retainer
11	Shaft Lock Shield Assembly
12	Turn Signal Cancel Cam Assembly
13	Upper Bearing Spring
14	Upper Bearing Inner Race Seat

Callout	Component Name
15	Inner Race
16	Pan Head Tapping Screws
17	TORXÂ® Head Screw
18	Ignition Lock Cylinder Case Assembly
19	Steering Column Lock Cylinder Set
20	Pan Head Tapping Screw
21	Tapping Screws
22	Ignition Switch Assembly
23	Steering Column Tilt Head Housing Assembly
24	Lock Bolt Spring
25	Lock Bolt Assembly
26	Spring Guide
27	Tilt Spring
28	TORXÂ® Head Screw
29	Wire Harness Strap
30	Trim Cover Protector
31	Tilt Knob
32	TORXÂ® Head Screws
33	Pan Head Tapping Screws
34	Turn Signal and Multifunction Switch Assembly
35	Wire Harness Straps
36	Position Assurance Connector
37	Race and Upper Shaft Assembly
38	Joint Preload Spring
39	Centering Sphere
40	Lower Steering Shaft Assembly
41	Linear Shift Assembly
42	Shift Lever Clevis
43	Flat Head 6-Lobed Soc Tap Screws
44	Cable Shift Cam Assembly
45	Ball and Actuator Assembly
46	Cam Bushing
47	Hexagon Flange Head Bolts
48	Gear Shift Lever Assembly Support Bracket
49	Oval Head 6-Lobed Soc Tap Screws
50	Park Lock Cable System
51	TORXÂ® Head Screws
52	Pivot Pins
53	Steering Column Support Assembly
54	Steering Column Jacket Assembly
55	Automatic Transmission Shift Lock Control

Callout	Component Name
56	Adapter and Bearing Assembly
57	Lower Bearing Seat
58	Lower Bearing Spring
59	Lower Spring Retainer
60	Retainer
61	Steering Shaft Seal
62	Intermediate Steering Shaft Assembly
63	Pinch Bolt

STEERING COLUMN DISASSEMBLED VIEW (FLOOR SHIFT)

Tilt Steering Column, Floor Shift

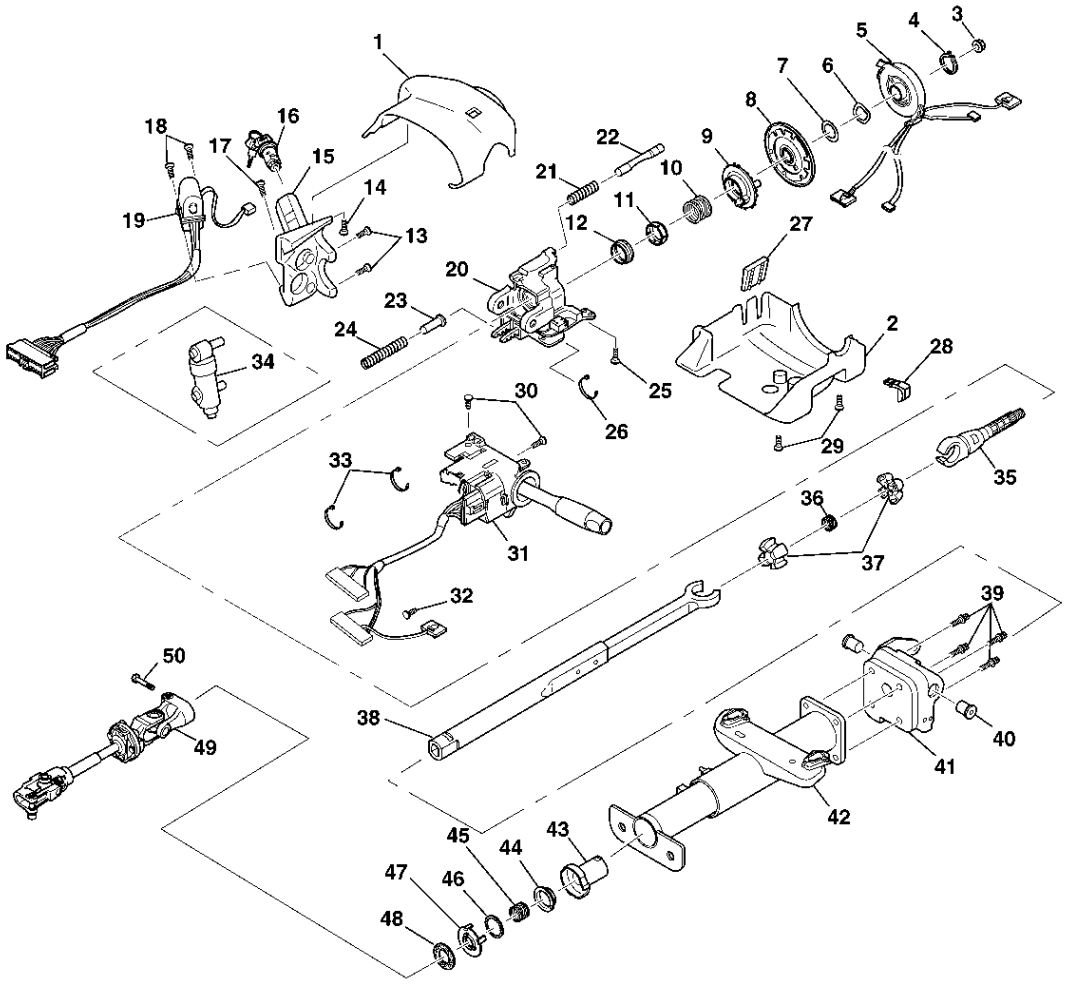


Fig. 2: Tilt Steering Column Disassembled View, Floor Shift
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Upper Trim Cover

Callout	Component Name
2	Lower Trim Cover
3	Flanged Prevailing Torque Nut
4	Retaining Ring
5	SIR Coil
6	Wave Washer
7	Bearing Retainer
8	Shaft Lock Shield Assembly
9	Turn Signal Cancel Cam Assembly
10	Upper Bearing Spring
11	Upper Bearing Inner Race Seat
12	Inner Race
13	Pan Head Tapping Screws
14	TORXÂ® Head Screw
15	Ignition Lock Cylinder Case Assembly
16	Steering Column Lock Cylinder Set
17	Pan Head Tapping Screw
18	Tapping Screws
19	Ignition Switch Assembly
20	Steering Column Tilt Head Assembly
21	Lock Bolt Spring
22	Lock Bolt Assembly
23	Spring Guide
24	Tilt Spring
25	TORXÂ® Head Screw
26	Wire Harness Strap
27	Trim Cover Protector
28	Tilt Knob
29	Pan Head Tapping Screws
30	Pan Head Tapping Screws
31	Turn Signal and Multifunction Switch Assembly
32	Position Assurance Connector
33	Wire Harness Straps
34	Steering Wheel Theft Deterrent Park Lock
35	Race and Upper Shaft Assembly
36	Joint Preload Spring
37	Centering Sphere
38	Lower Shaft Assembly
39	TORXÂ® Head Screws
40	Pivot Pins
41	Steering Column Support Assembly
42	Steering Column Jacket Assembly

Callout	Component Name
43	Adapter and Bearing Assembly
44	Lower Bearing Seat
45	Lower Bearing Spring
46	Lower Spring Retainer
47	Retainer
48	Steering Shaft Seal
49	Intermediate Steering Shaft Assembly
50	Pinch Bolt

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - STEERING WHEEL AND COLUMN

Review the system description and operation in order to familiarize yourself with the system functions. Refer to **Steering Wheel and Column Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the steering wheel and column.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Symptoms List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Noise in Steering Column**
- **Looseness in Steering Column**
- **Steering Column Tilt Function Inoperative**
- **Ignition Can/Cannot Be Turned Off with Transmission in Any Gear**

STEERING COLUMN TILT FUNCTION INOPERATIVE

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Steering Wheel and Column**
2	Verify that the steering column tilt function is inoperative. Does the steering column tilt function operate normally?	System OK	Go to **Step 3**

Step	Action	Yes	No
3	If equipped, verify that the following components are not seized or corroded: • Tilt pivot pins • Tilt head lock shoes Are the components seized or corroded?	Go to **Step 7**	Go to **Step 4**
4	Inspect the tilt pivot pins for binding. Are the tilt pivot pins binding?	Go to **Step 8**	Go to **Step 5**
5	Inspect for a weak or broken steering column tilt spring. Is the steering column tilt spring weak or broken?	Go to **Step 9**	Go to **Step 6**
6	Inspect the steering column wiring harness routing for tightness. Was the steering column wiring harness routed correctly?	Go to **Step 11**	Go to **Step 10**
7	Replace the steering column. Refer to **Steering Column Replacement**. Did you complete the repair?	Go to **Step 11**	-
8	If serviceable, replace the pivot pins. If not serviceable replace the steering column. Refer to **Steering Column Replacement**. Did you complete the repair?	Go to **Step 11**	-
9	If serviceable, replace the tilt spring. Did you complete the repair?	Go to **Step 11**	-
10	Route the steering column wiring harness to the correct location. Did you correctly route the wiring harness?	Go to **Step 11**	-
11	Operate the steering column tilt function in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

NOISE IN STEERING COLUMN

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Steering Wheel and Column**
2	Verify that noise is present in the steering column during operation. Is noise present in the steering column during operation?	Go to **Step 3**	System OK

Step	Action	Yes	No
3	Inspect the steering column mounting features for the following conditions: • The steering column mounting fasteners are loose. • The steering column mounting features are sheared. Are the steering column mounting features loose or sheared?	Go to **Step 10**	Go to **Step 4**
4	Inspect the SIR/SRS coil for noise. Is the SIR/SRS coil noisy?	Go to **Step 11**	Go to **Step 5**
5	If equipped, inspect the lock plate retaining ring for correct installation. Is the lock plate retaining ring installed incorrectly?	Go to **Step 12**	Go to **Step 6**
6	Inspect the steering column upper and lower bearings for the following conditions: • Damage • Lubrication • Wear • Proper seating Are the bearings in need of repair or replacement?	Go to **Step 13**	Go to **Step 7**
7	Does the steering column tilt joint need to be lubricated?	Go to **Step 14**	Go to **Step 8**
8	**NOTE:** **Inspect the intermediate steering shaft for noise while driving the vehicle, turning the steering wheel, and applying the brakes.** Inspect the intermediate steering shaft for noise.Is the intermediate steering shaft noisy?	Go to **Step 15**	Go to **Step 9**

Step	Action	Yes	No
9	**NOTE:** **For vehicles equipped with a telescoping steering column, perform this step. If not equipped, go to next step.** Inspect the steering column for noise while telescoping the column.Is the steering column noisy while telescoping?	Go to **Step 16**	Go to **Step 17**
10	**NOTE:** **If the steering column mounting features are damaged or sheared, replace the steering column. Refer to Steering Column Replacement.** Tighten the steering column mounting fasteners to specification. Refer to **Fastener Specifications**.Did you complete the repair?	Go to **Step 17**	-
11	Replace the SIR/SRS coil. Refer to **Steering Wheel Airbag Coil Replacement** . Did you complete the repair?	Go to **Step 17**	-
12	Install the lock plate retaining ring correctly. Did you complete the repair?	Go to **Step 17**	-
13	**NOTE:** **If the steering column upper and/or lower bearings are**	Go to **Step 17**	-

Step	Action	Yes	No
	not serviceable, replace the steering column. Refer to Steering Column Replacement. Replace the steering column upper and/or lower bearings, if serviceable.Did you complete the replacement?		
14	Lubricate the steering column tilt joint. Did you complete the repair?	Go to **Step 17**	-
15	Replace the appropriate intermediate steering shaft component. Did you complete the repair?	Go to **Step 17**	-
16	Redistribute or add lubricant to the steering column lower jacket with the column telescoped to its end of outward travel. Did you complete the repair?	Go to **Step 17**	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

LOOSENESS IN STEERING COLUMN

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Steering Wheel and Column**
2	Verify that the steering column is loose. Is the steering column loose?	Go to **Step 3**	System OK
3	Inspect the steering column mounting features for the following conditions. • The steering column mounting fasteners are loose. • The steering column mounting features are sheared. Are the steering column mounting features loose or sheared?	Go to **Step 5**	Go to **Step 4**
4	Inspect the upper and/or lower bearings for looseness. Are any of the bearings worn or loose?	Go to **Step 6**	Go to **Step 7**

Step	Action	Yes	No
5	**NOTE:** **If the steering column mounting features are damaged or sheared, replace the steering column. Refer to Steering Column Replacement.** Tighten the steering column mounting fasteners to specification. Refer to **Fastener Specifications**.Did you complete the repair?	Go to **Step 7**	-
6	**NOTE:** **If the steering column upper and/or lower bearings are not serviceable, replace the steering column. Refer to Steering Column Replacement.** Replace the upper and/or lower bearings, if serviceable.Did you complete the repair?	Go to **Step 7**	-
7	Operate the steering column in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

REPAIR INSTRUCTIONS

INTERMEDIATE STEERING SHAFT SEAL REPLACEMENT

Special Tools

J-42640 Steering Column Anti-rotation Pin

Removal Procedure

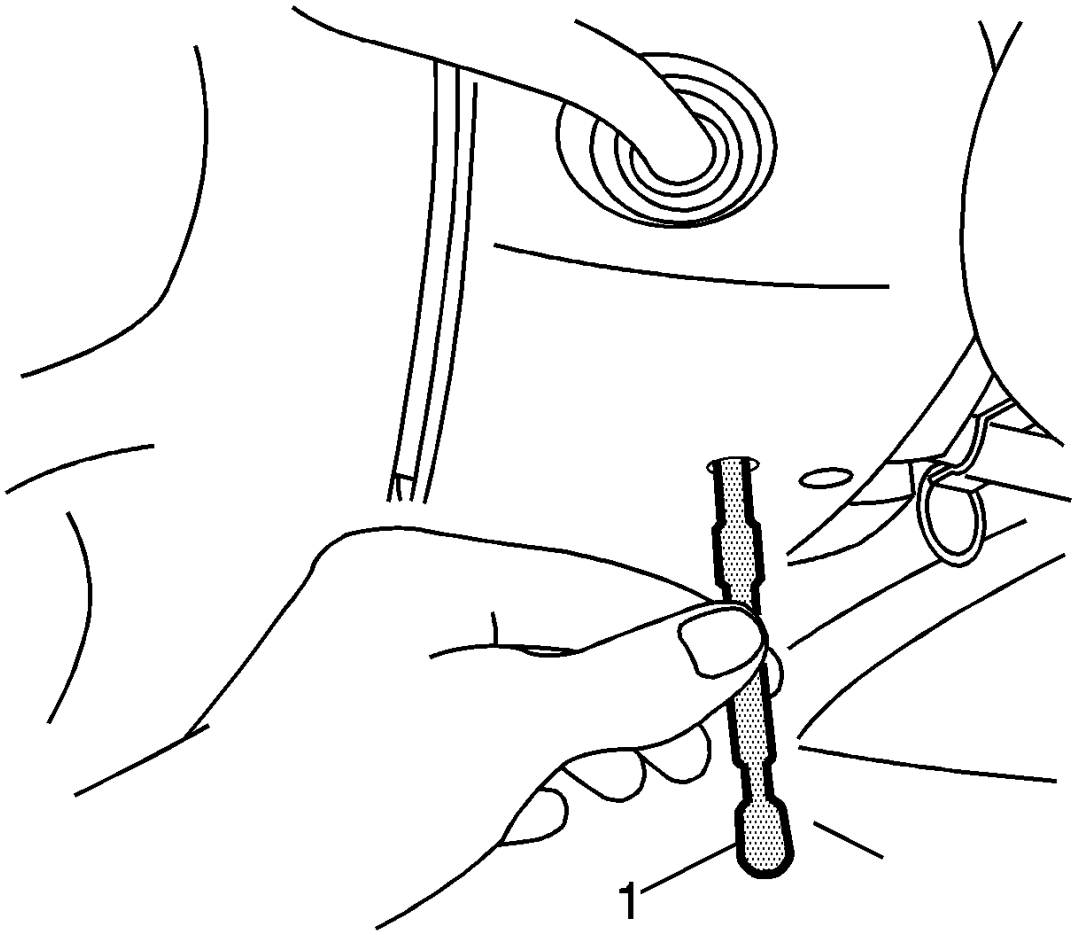


Fig. 3: Locking/Unlocking Steering Column
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:**

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible

damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. Insert the **J-42640** pin into the steering column access hole in order to lock the steering column.
2. Separate the intermediate steering shaft seal from the steering column.
3. Disconnect the intermediate steering shaft from the steering column. Refer to **Intermediate Steering Shaft Replacement**.
4. Push the intermediate steering shaft down in order to collapse the intermediate steering shaft.

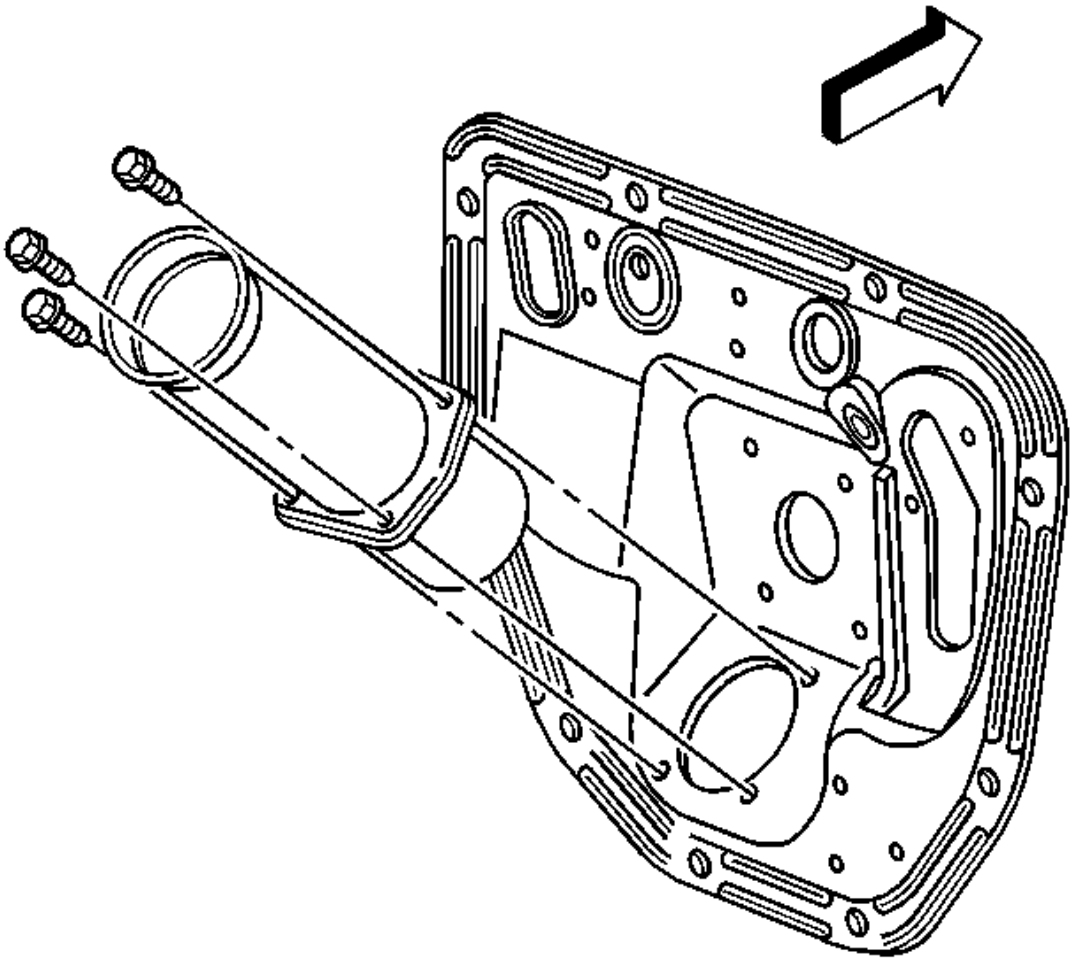


Fig. 4: Locating Intermediate Shaft Seal Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the intermediate steering shaft seal bolts.
6. Separate the intermediate steering shaft seal from the steering gear.
7. Remove the intermediate steering shaft seal from the vehicle.

Installation Procedure

1. Position the intermediate steering shaft seal in the vehicle.
2. Position the intermediate steering shaft lower seal on the intermediate shaft and on the steering gear.
3. Position the intermediate steering shaft upper seal over the lower seal and on the dash panel.
4. Connect the intermediate steering shaft to the steering column. Refer to **Intermediate Steering Shaft Replacement**.
5. Install the intermediate steering shaft seal to the steering column.

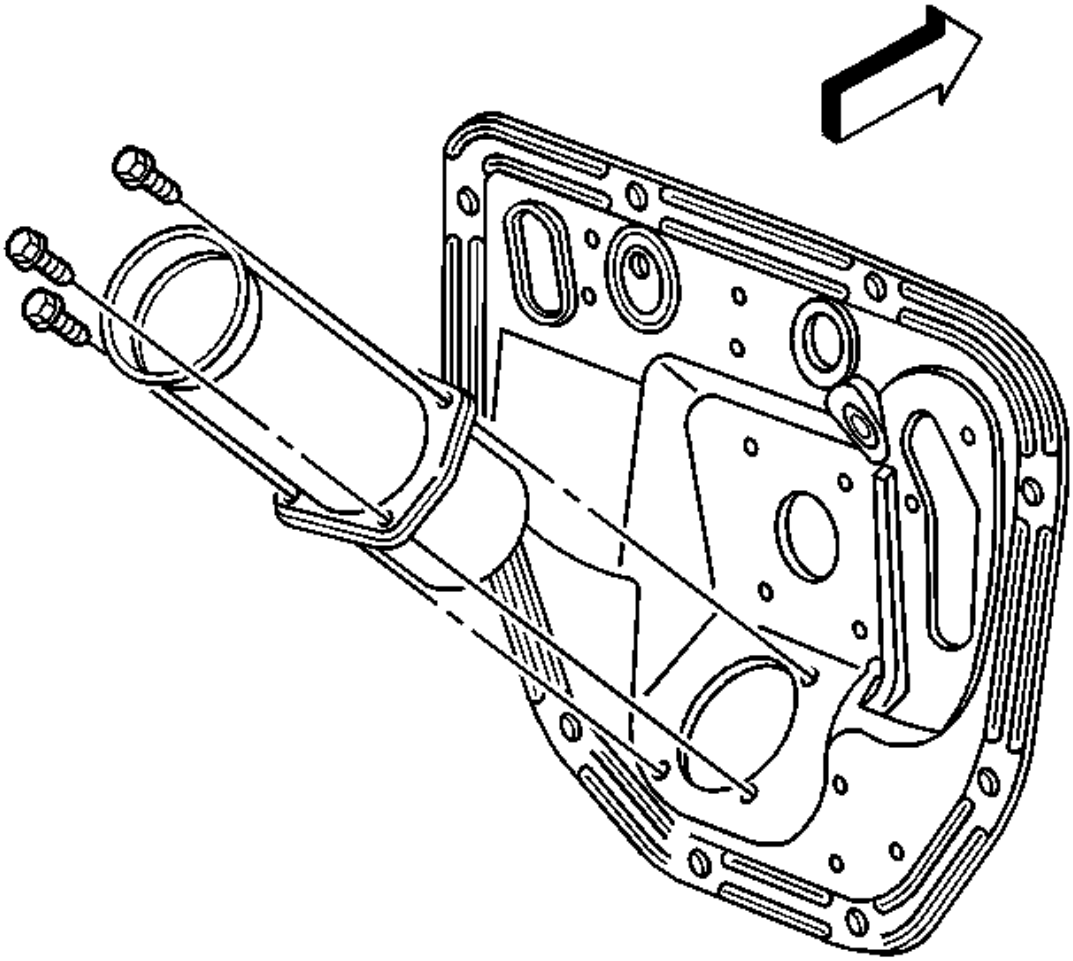


Fig. 5: Locating Intermediate Shaft Seal Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Install the intermediate steering shaft seal bolts and tighten to 3 N.m (27 lb in).
7. Remove the **J-42640** pin.

INTERMEDIATE STEERING SHAFT REPLACEMENT

Special Tools

J 42640 Steering Column Anti-rotation Pin

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

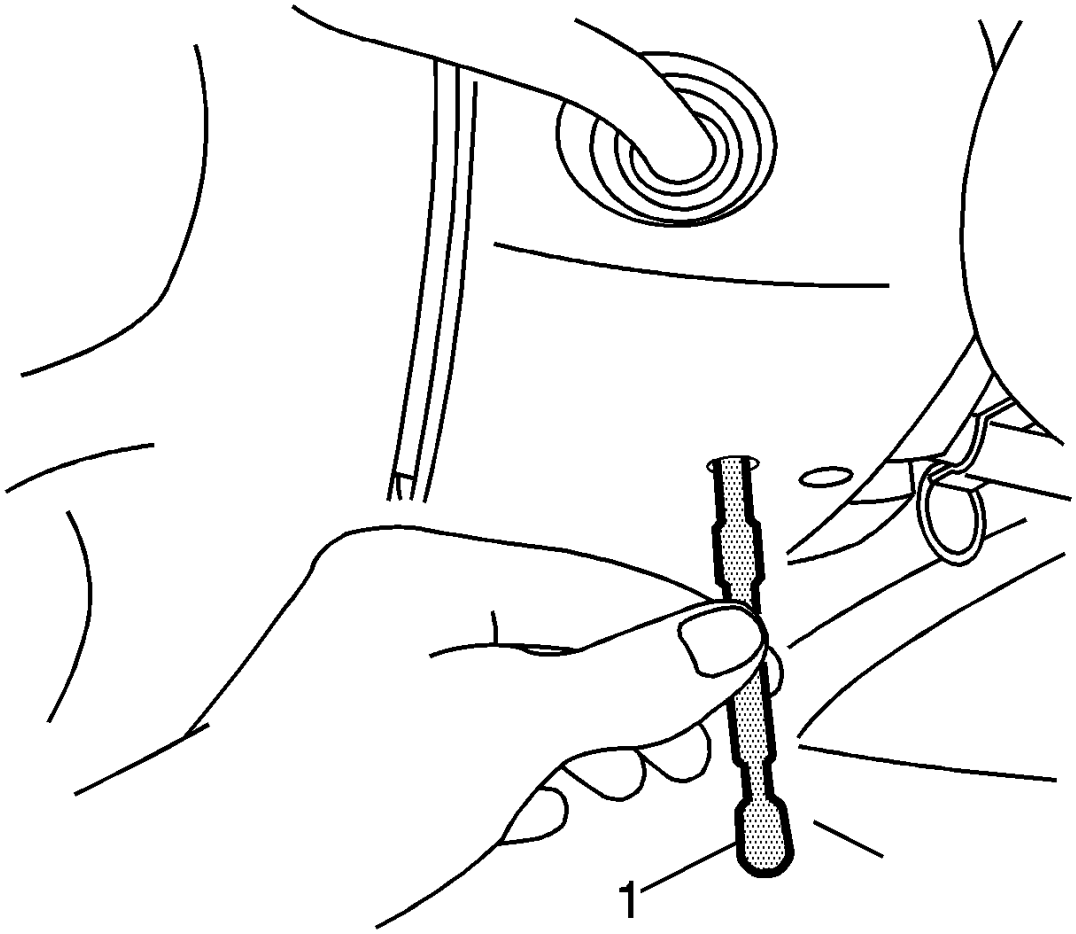


Fig. 6: Locking/Unlocking Steering Column
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:**

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may

cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has became un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. Insert the **J-42640** pin into the steering column access hole in order to lock the steering column.
2. Remove the front left tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

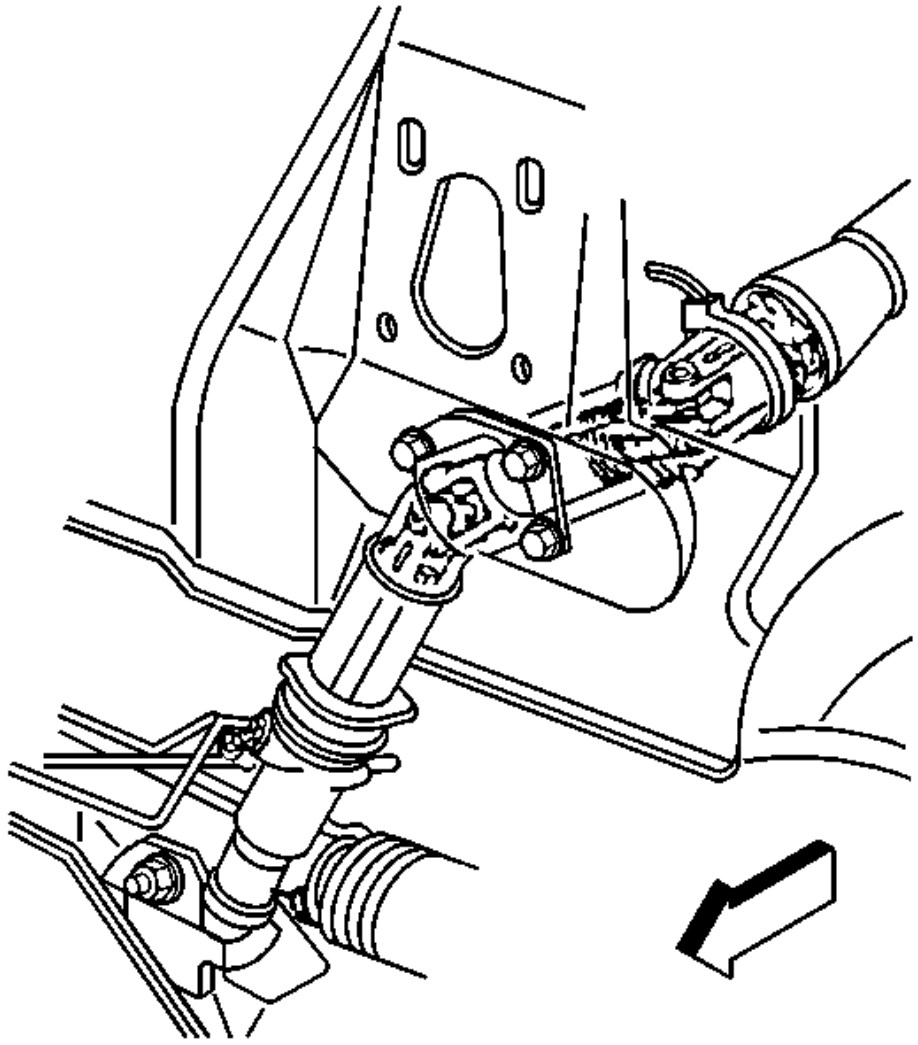


Fig. 7: Providing Access To Intermediate Steering Shaft Lower Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Move the intermediate steering shaft seal at the steering gear in order to provide access to the intermediate steering shaft lower bolt.
4. Use paint in order to place match marks on the intermediate shaft and on the steering gear.

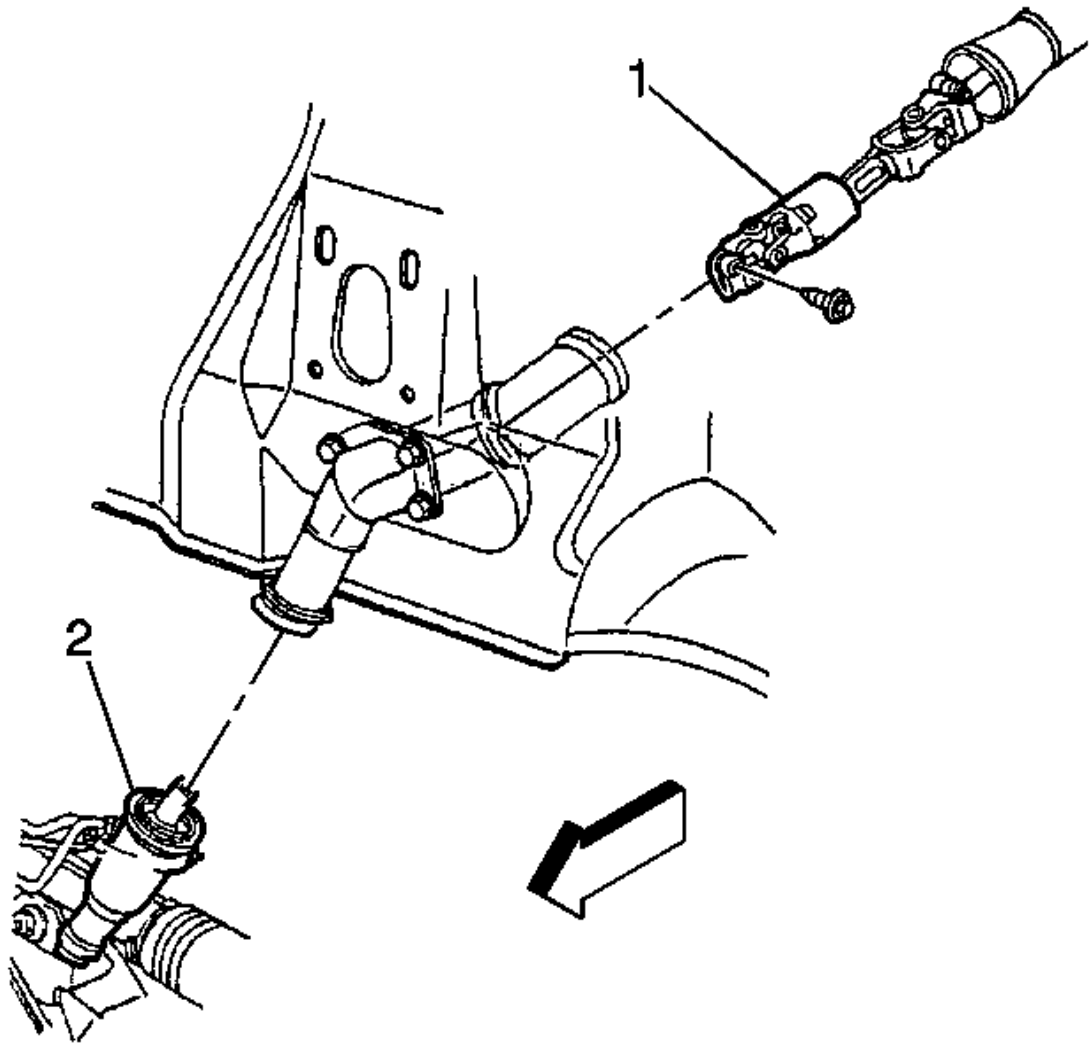


Fig. 8: View Of Intermediate Steering Shaft To Power Steering Gear Stub Shaft
Courtesy of GENERAL MOTORS COMPANY

5. Remove the intermediate steering shaft lower pinch bolt from the steering gear (2).
6. Separate the intermediate steering shaft (1) from the steering gear (2).
7. Remove the left instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .

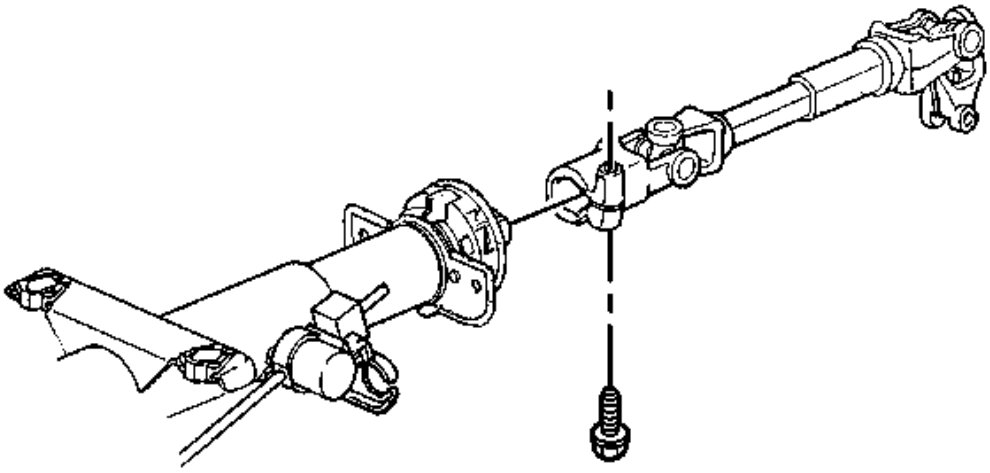


Fig. 9: View Of Upper Pinch Bolt Of Intermediate Steering Shaft
Courtesy of GENERAL MOTORS COMPANY

8. Reposition the intermediate steering shaft seal in order to gain access to the intermediate steering shaft bolt at the steering column.
9. Use paint in order to place match marks on the intermediate shaft and on the steering column.
10. Remove the intermediate steering shaft bolt and nut at the steering column.
11. Disconnect the intermediate steering shaft from the steering column.
12. Remove the intermediate steering shaft from the vehicle.

Installation Procedure

1. If you are installing a NEW intermediate shaft, copy the match marks from the old intermediate shaft to the new intermediate shaft.

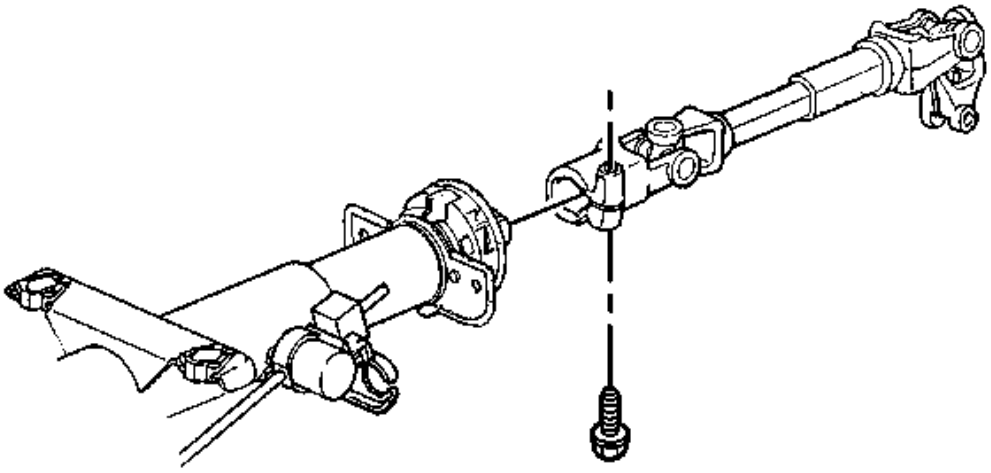


Fig. 10: View Of Upper Pinch Bolt Of Intermediate Steering Shaft
Courtesy of GENERAL MOTORS COMPANY

2. Position the intermediate steering shaft in the vehicle.
3. Align the match marks and connect the intermediate shaft to the steering column.

CAUTION: Refer to Fastener Caution .

4. Install the intermediate steering shaft bolt at the steering column and tighten to 62 N.m (46 lb ft).
5. Position the intermediate steering shaft seal onto the steering column.
6. Install the left instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .

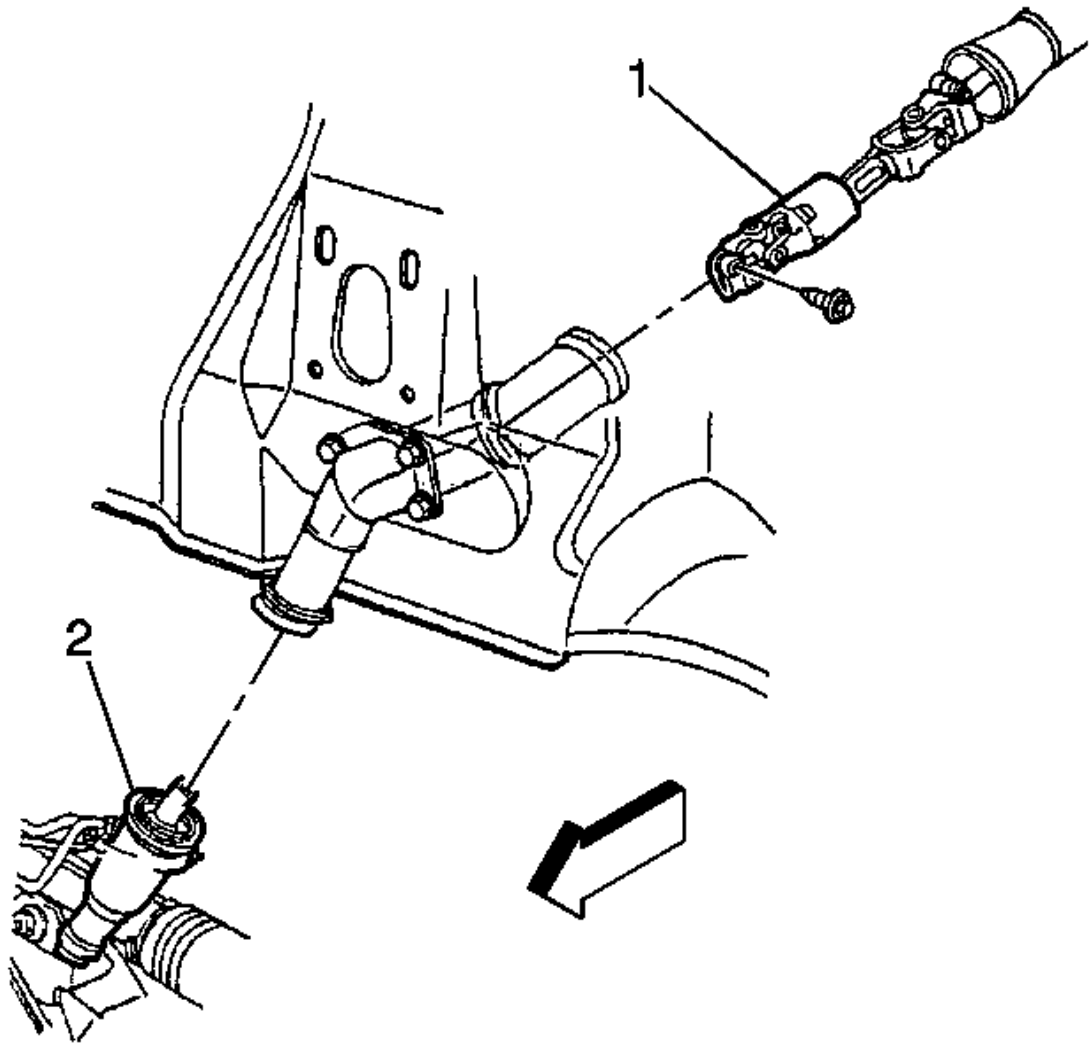


Fig. 11: View Of Intermediate Steering Shaft To Power Steering Gear Stub Shaft
Courtesy of GENERAL MOTORS COMPANY

7. Align the match marks and connect the intermediate steering shaft (1) to the power steering gear stub shaft (2).
8. Install the intermediate steering shaft lower bolt at the steering gear and tighten to 48 N.m (35 lb ft).

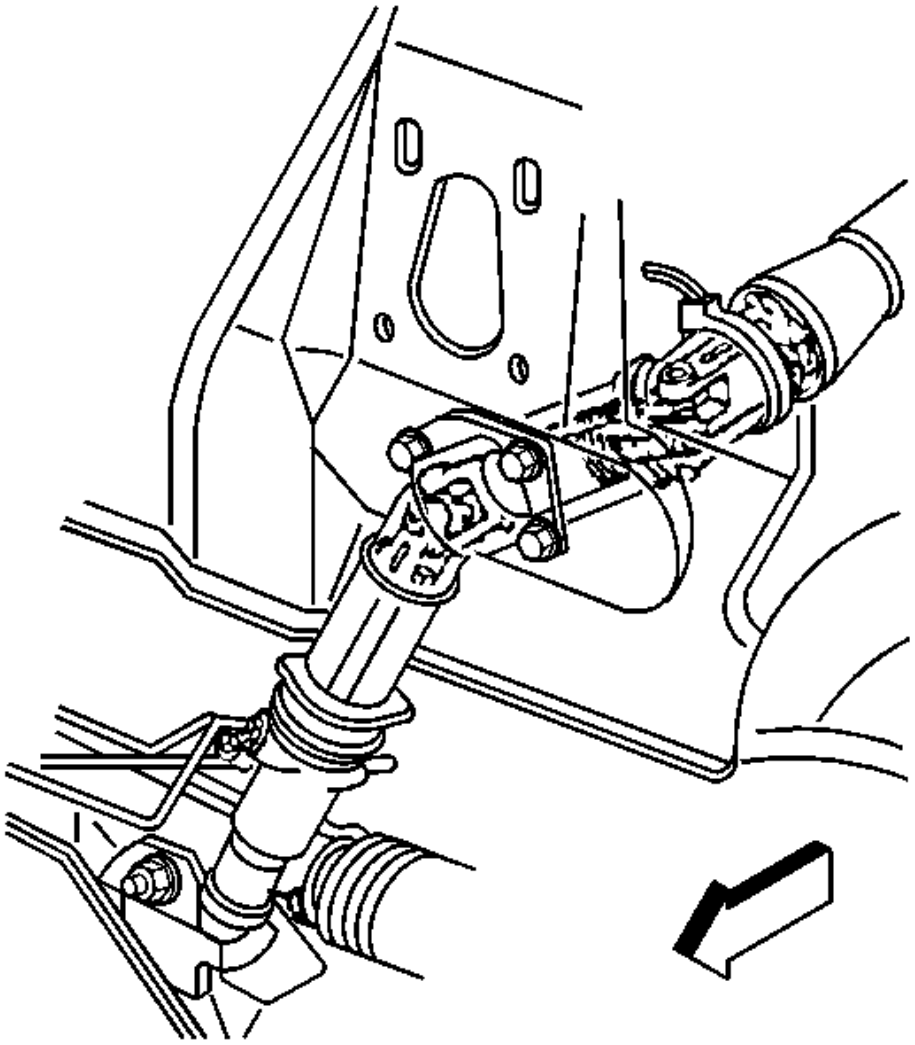


Fig. 12: Providing Access To Intermediate Steering Shaft Lower Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Position the intermediate steering shaft seal onto the steering gear.
10. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
11. Remove the **J 42640** pin.

STEERING COLUMN ACCIDENT DAMAGE INSPECTION

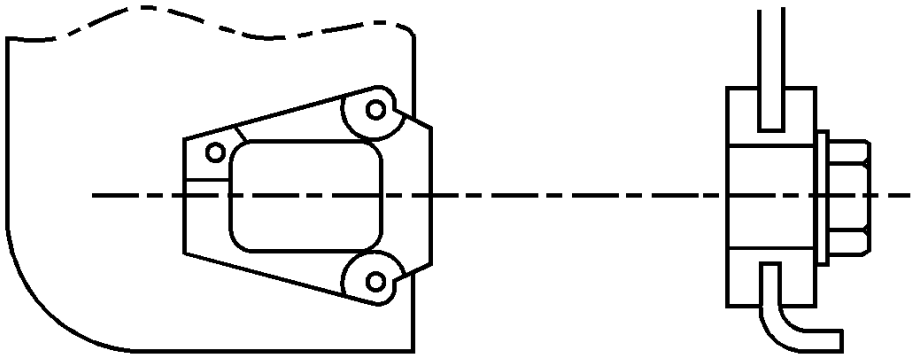


Fig. 13: Inspecting Capsules On Steering Column Bracket Assembly
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Vehicles involved in accidents that result in any of the following kinds of damage or situations, may also have a damaged or misaligned steering column:

- **Frame damage**
- **Major body damage**
- **Sheet metal damage**
- **If the steering column has been impacted**
- **If the supplemental inflatable restraints system was deployed**

- Inspect the capsules on the steering column bracket assembly. All capsules must be securely seated in the bracket slots and inspected for any loose conditions when pushed or pulled by hand.
- Observe how the bracket is attached to the jacket assembly.
  - If the capsules are not securely seated and the bracket is bolted to the jacket assembly, replace only the bracket.

- If the capsules are not securely seated and the bracket is welded to the jacket assembly, replace only the jacket assembly.

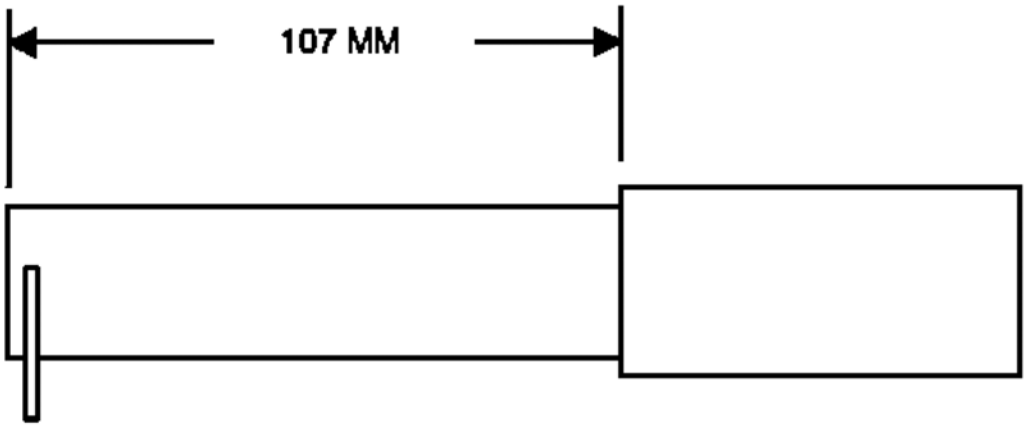


Fig. 14: Measuring Distance From Lower Edge Of Upper Jacket To A Defined Point On Lower Jacket
Courtesy of GENERAL MOTORS COMPANY

- Inspect for jacket assembly collapse by measuring the distance from the lower edge of the upper jacket to a defined point on the lower jacket. Replace the jacket assembly if the measured dimensions are not within specifications.

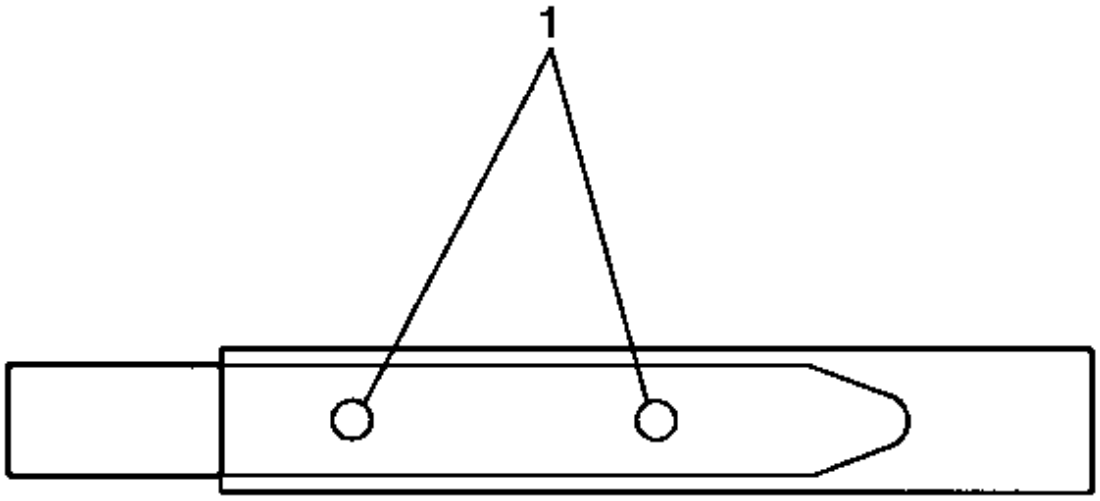


Fig. 15: Inspecting Steering Shaft For Sheared Injected Plastic
Courtesy of GENERAL MOTORS COMPANY

- Visually inspect the steering shaft for sheared injected plastic (1). If the steering shaft shows sheared plastic (1), replace the steering shaft.
- Any frame damage that could cause a bent steering shaft must have the steering shaft runout checked. Using a dial indicator at the lower end of the steering shaft, rotate the steering wheel. The runout must not exceed 1.60 mm (0.06 in).

STEERING COLUMN TRIM COVER REPLACEMENT

Removal Procedure

1. Remove the steering wheel. Refer to **Steering Wheel Replacement**.
2. Remove the steering column opening filler. Refer to **Steering Column Opening Filler Replacement** .

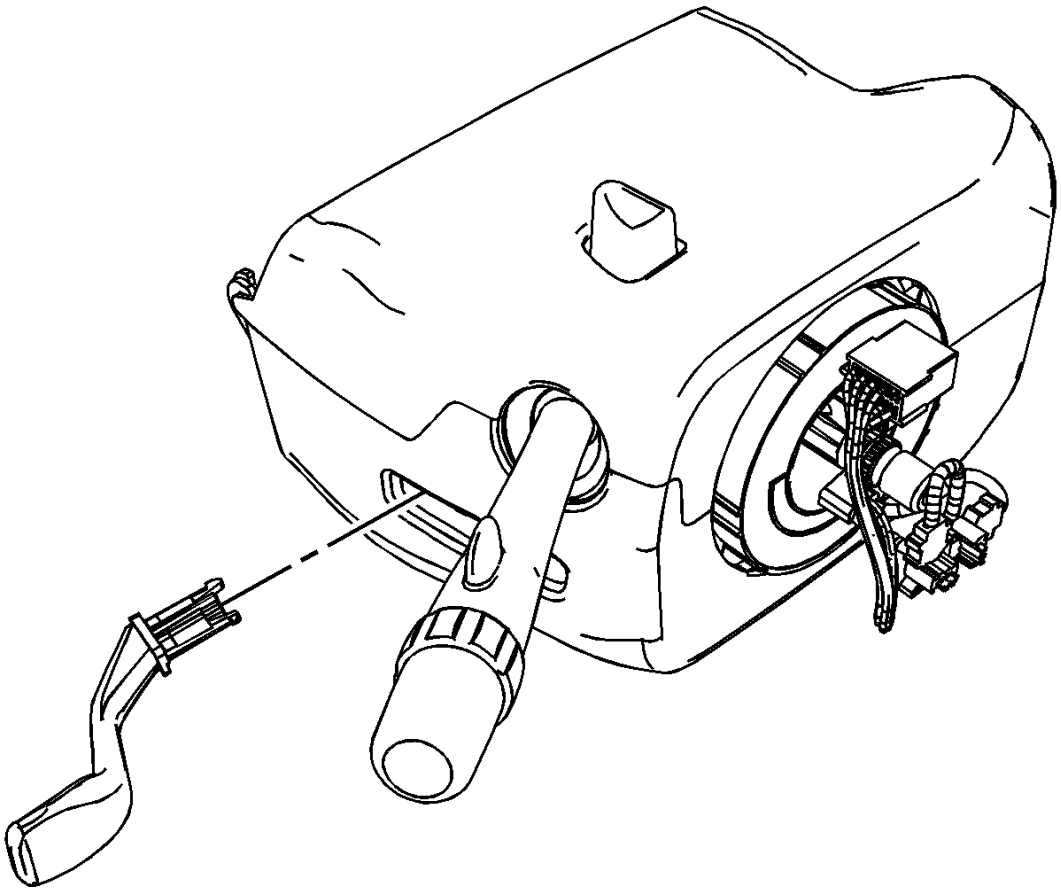


Fig. 16: View Of Tilt Lever
Courtesy of GENERAL MOTORS COMPANY

3. Remove the tilt lever.

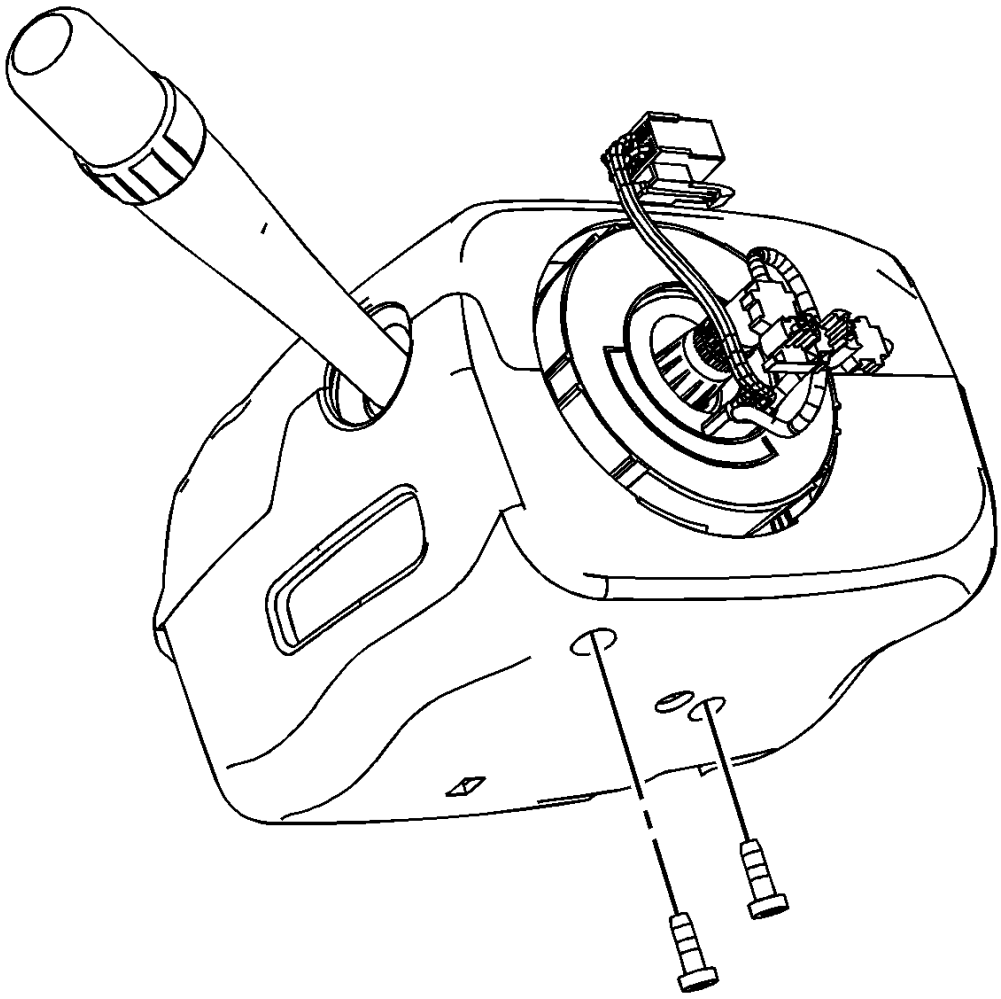


Fig. 17: View Of Lower Steering Column Trim Cover & Retaining Screws
Courtesy of GENERAL MOTORS COMPANY

4. Remove the steering column trim cover bolts.

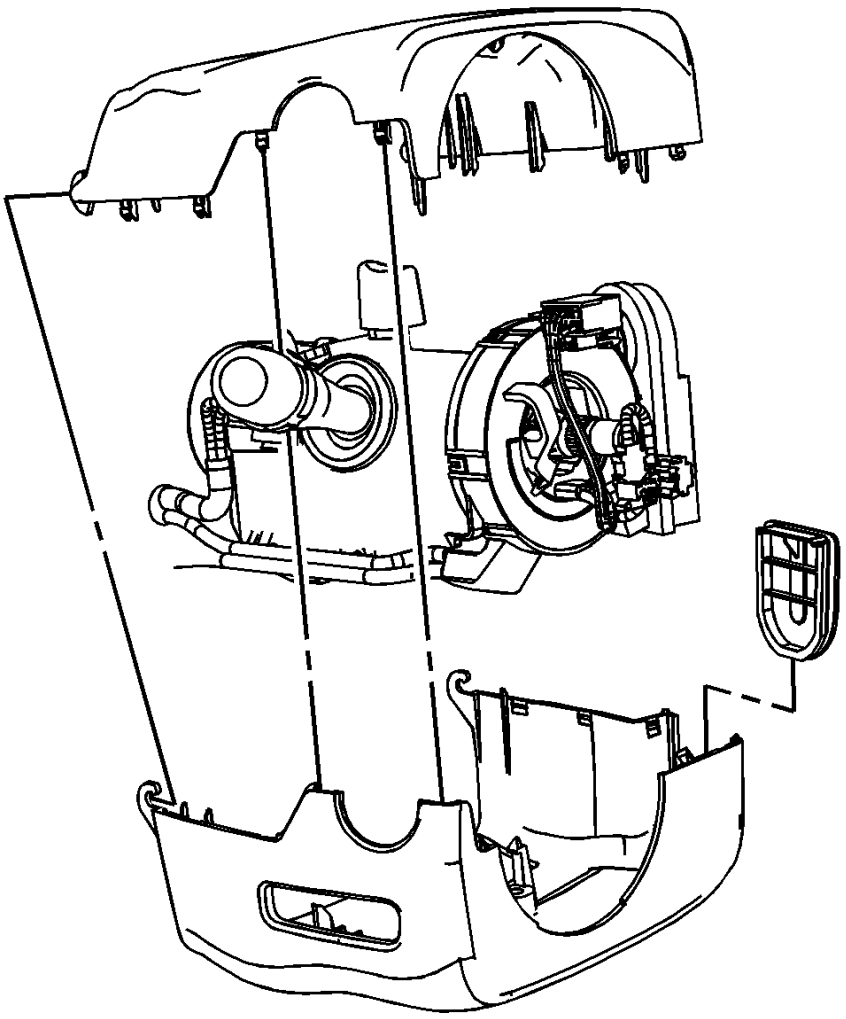


Fig. 18: View Of Upper & Lower Steering Column Cover & Steering Column
Courtesy of GENERAL MOTORS COMPANY

5. Separate the upper steering column trim cover from the lower steering column trim cover and remove them from the vehicle.

Installation Procedure

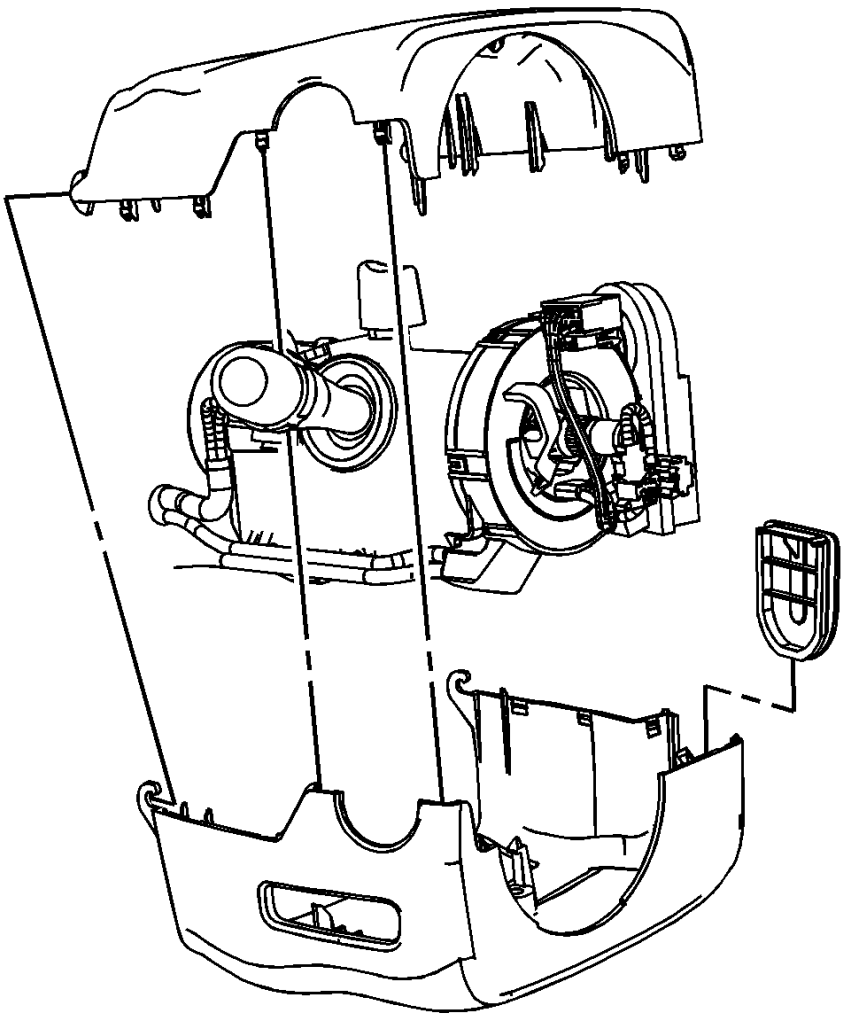


Fig. 19: View Of Upper & Lower Steering Column Cover & Steering Column
Courtesy of GENERAL MOTORS COMPANY

1. Position the upper steering column trim cover and the lower steering column trim cover together on the steering column.

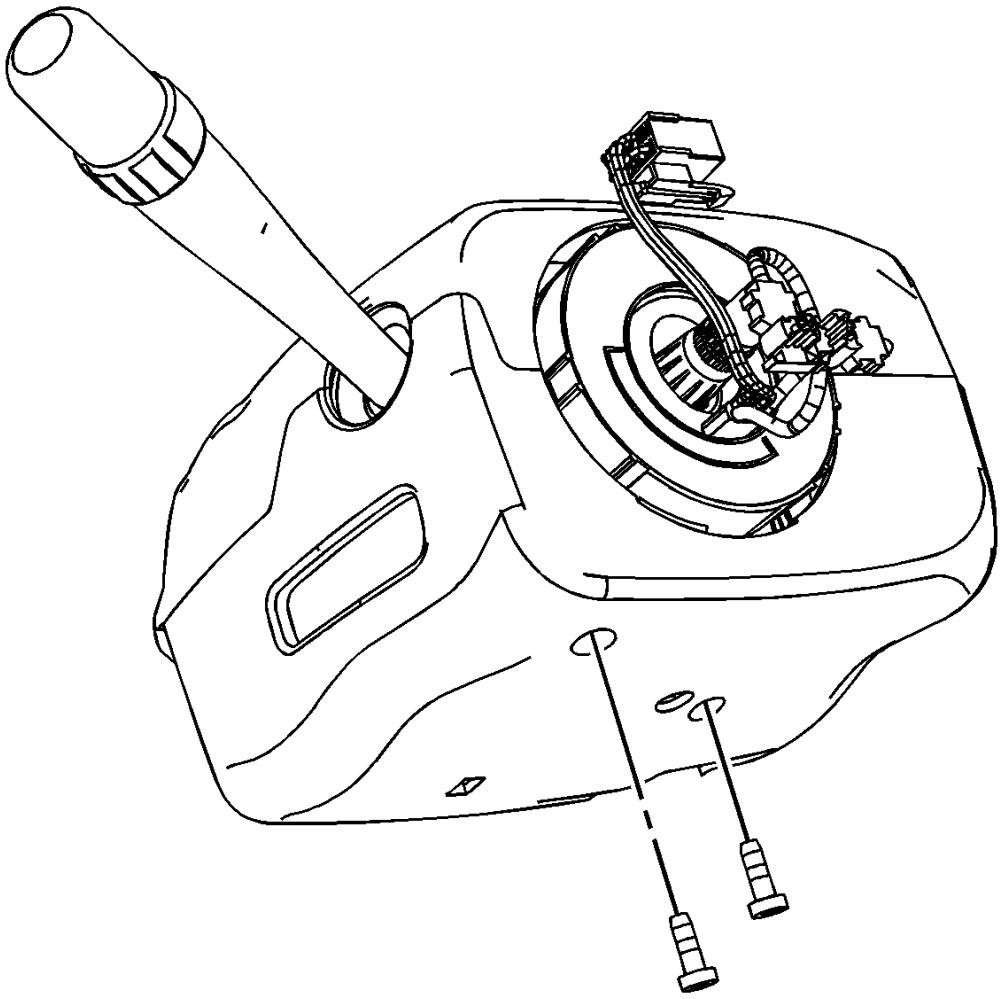


Fig. 20: View Of Lower Steering Column Trim Cover & Retaining Screws
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the steering column trim cover bolts and tighten to 3 N.m (27 lb in).

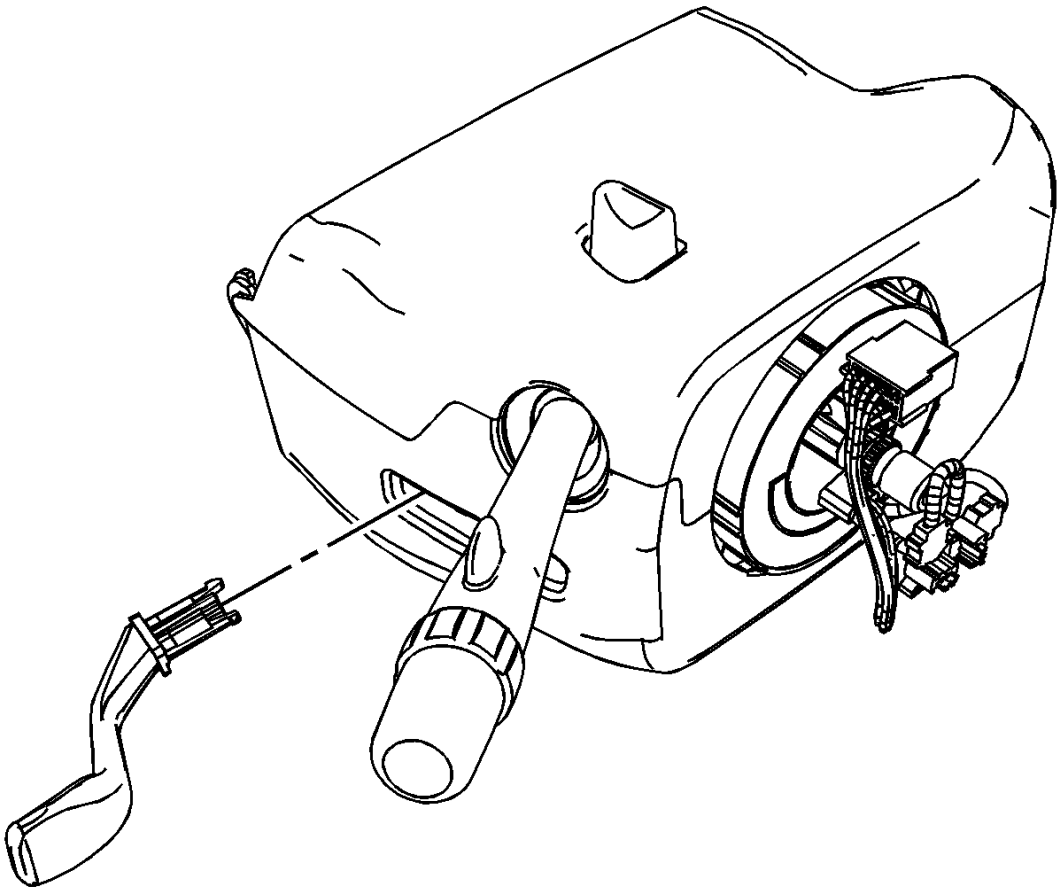


Fig. 21: View Of Tilt Lever
Courtesy of GENERAL MOTORS COMPANY

3. Install the tilt lever.
4. Install the steering column opening filler. Refer to **Steering Column Opening Filler Replacement** .
5. Install the steering wheel. Refer to **Steering Wheel Replacement**.

TURN SIGNAL CANCEL CAM AND STEERING SHAFT UPPER BEARING SPRING REPLACEMENT

Special Tools

- **J 23653-SIR** Steering Column Lock Plate Compressor
- **J 42137** Steering Column Lock Plate Compressor Adapter

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the inflatable restraint steering wheel module coil. Refer to **Steering Wheel Airbag Coil**

Replacement .

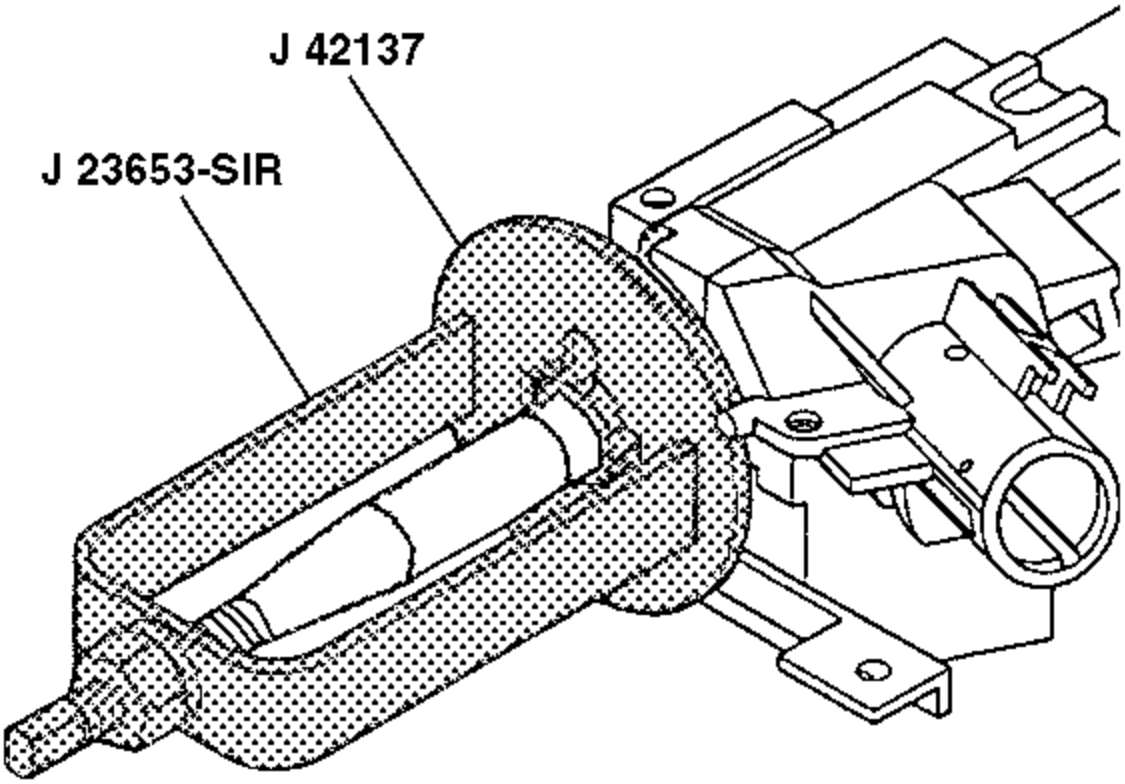


Fig. 22: Compressing Cam Orientation Plate
Courtesy of GENERAL MOTORS COMPANY

2. Remove the steering shaft lock plate retaining ring using the **J 23653-SIR** compressor and the **J 42137** adapter and dispose of it.

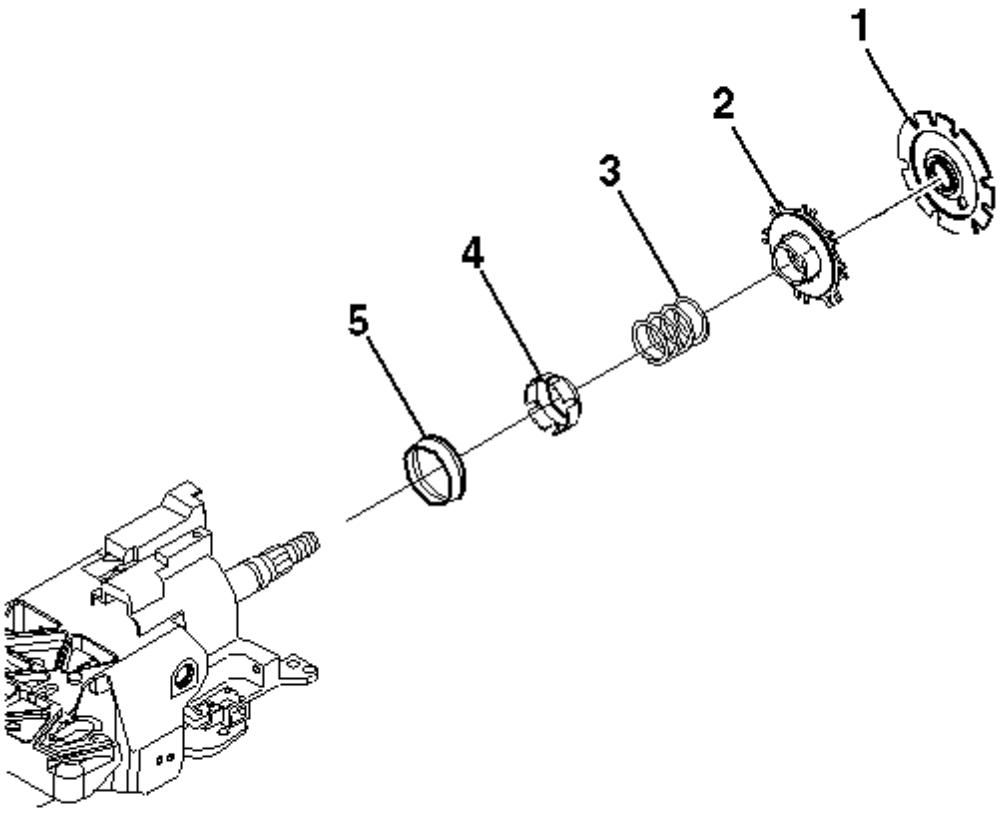


Fig. 23: View of Shaft Lock Shield Assembly, Turn Signal Cancel Cam Assembly, Upper Bearing Spring, Bearing Inner Race Seat and Inner Race
Courtesy of GENERAL MOTORS COMPANY

3. Remove the turn signal cancel cam plate (1).
4. Remove the turn signal cancel cam (2).
5. Remove the steering shaft upper bearing spring (3).
6. Remove the steering shaft upper bearing race seat (4).
7. Remove the steering shaft upper bearing (5).

Installation Procedure

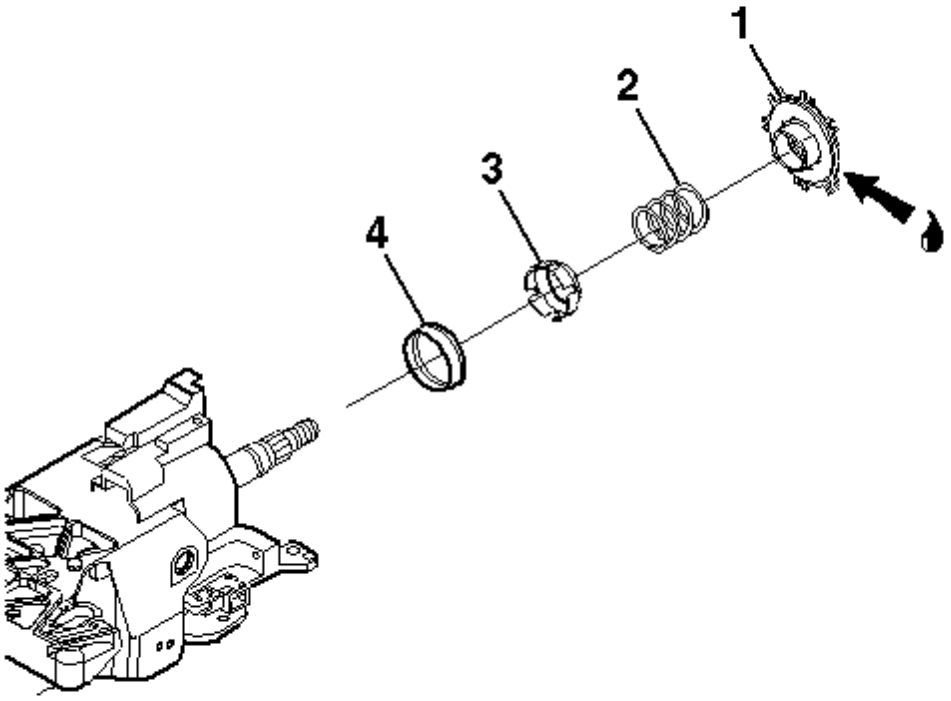


Fig. 24: View of Inner Race, Upper Bearing Inner Race Seat, Upper Bearing Spring, and Turn Signal Cancel Cam Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the steering shaft upper bearing (4).
2. Install the steering shaft upper bearing race seat (3).
3. Install the steering shaft upper bearing spring (2).
4. Apply lubricant to the turn signal cancel cam (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended lubricant.
5. Install the turn signal cancel cam (1).

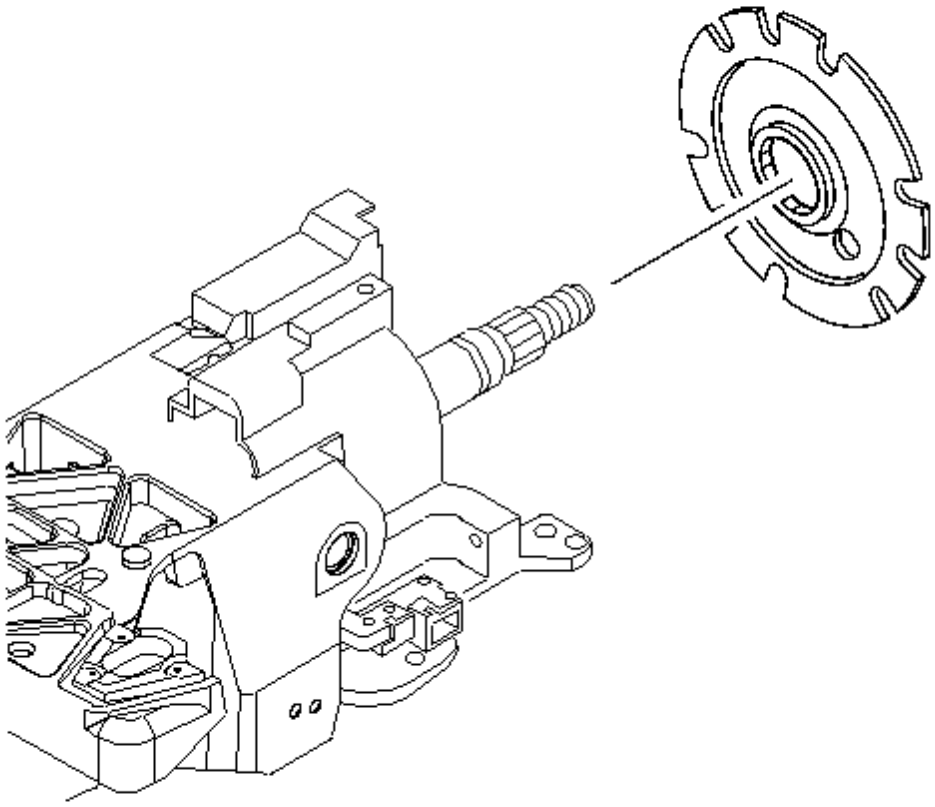


Fig. 25: View of Shaft Lock Shield Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Install the turn signal cancel cam plate.

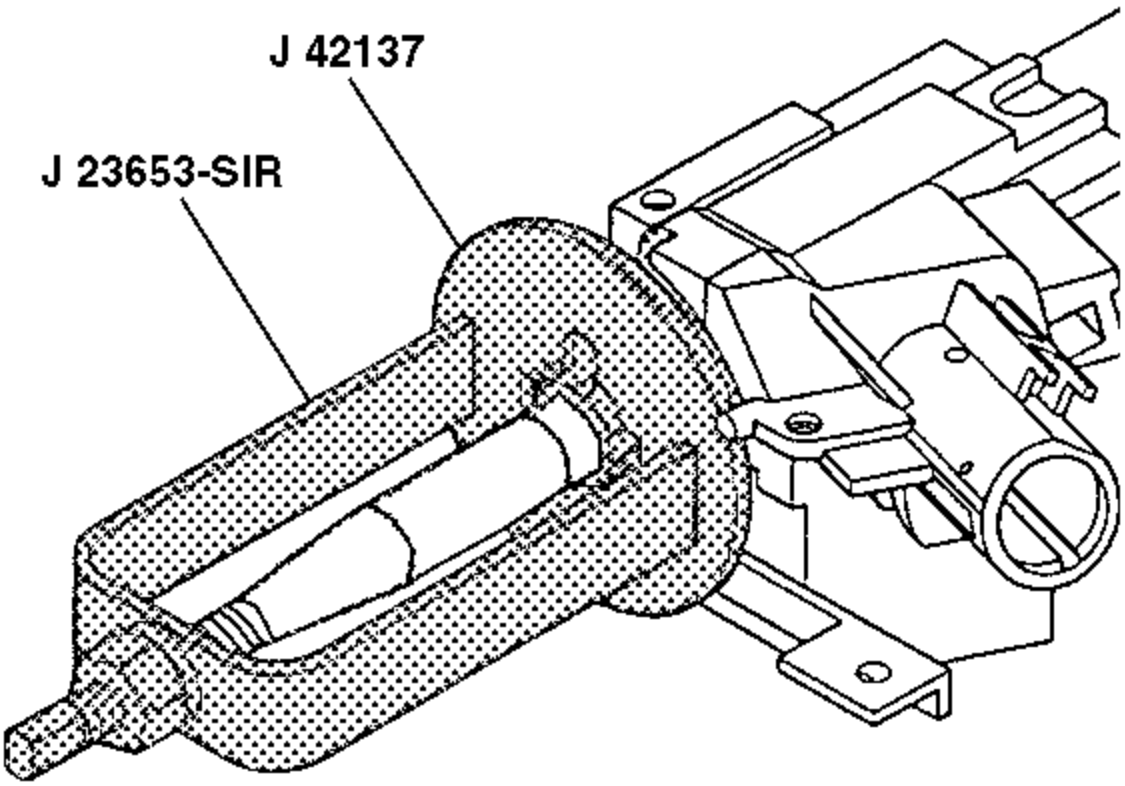


Fig. 26: Compressing Cam Orientation Plate
Courtesy of GENERAL MOTORS COMPANY

7. Install the new steering shaft lock plate retaining ring using the **J 23653-SIR** compressor and the **J 42137** adapter.

TURN SIGNAL MULTIFUNCTION SWITCH REPLACEMENT

Removal Procedure

1. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

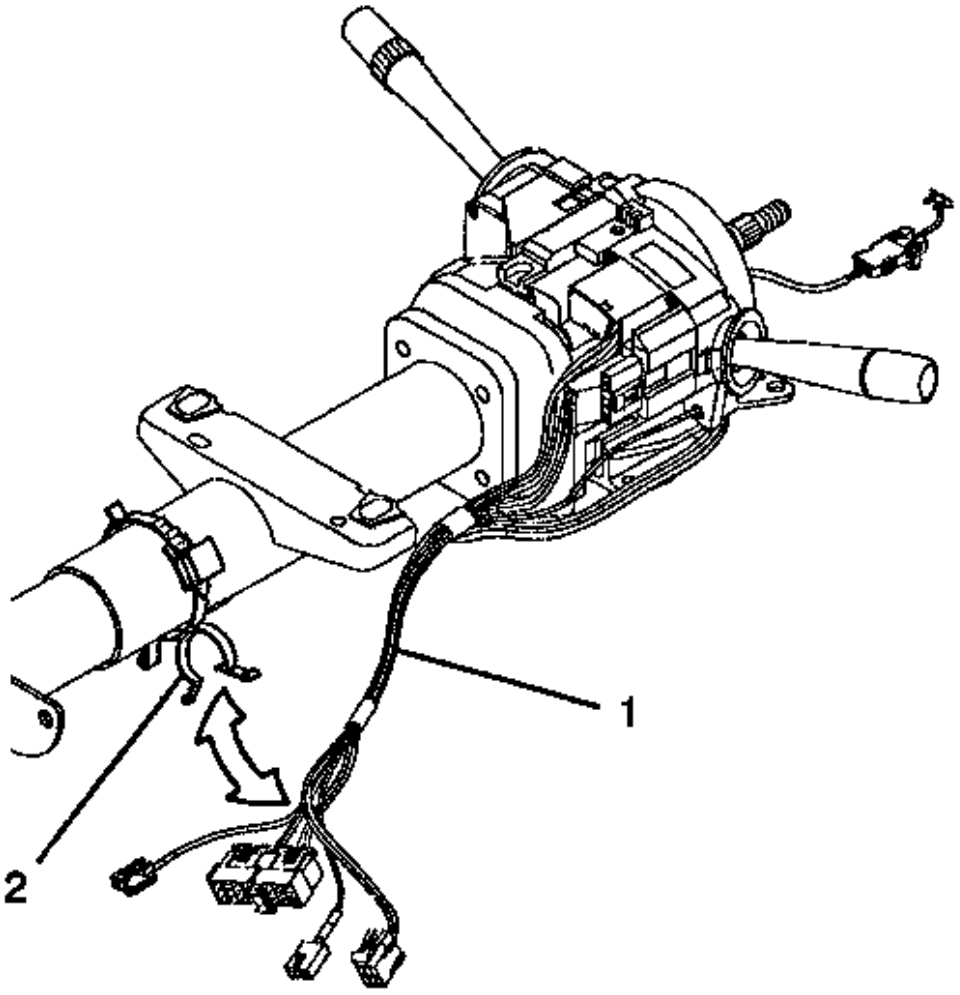


Fig. 27: View Of Steering Column Wire Harness Assembly & Wire Harness Strap
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The abrasion sleeve located on the steering column wire harness assembly must be reinstalled. Make note of what connector is coming out of the abrasion sleeve for installation purposes.**

2. Remove the wire harness assembly (1) from the wire harness strap (2).
3. Disconnect the turn signal multifunction switch connector from the inflatable restraint steering wheel module coil connector.

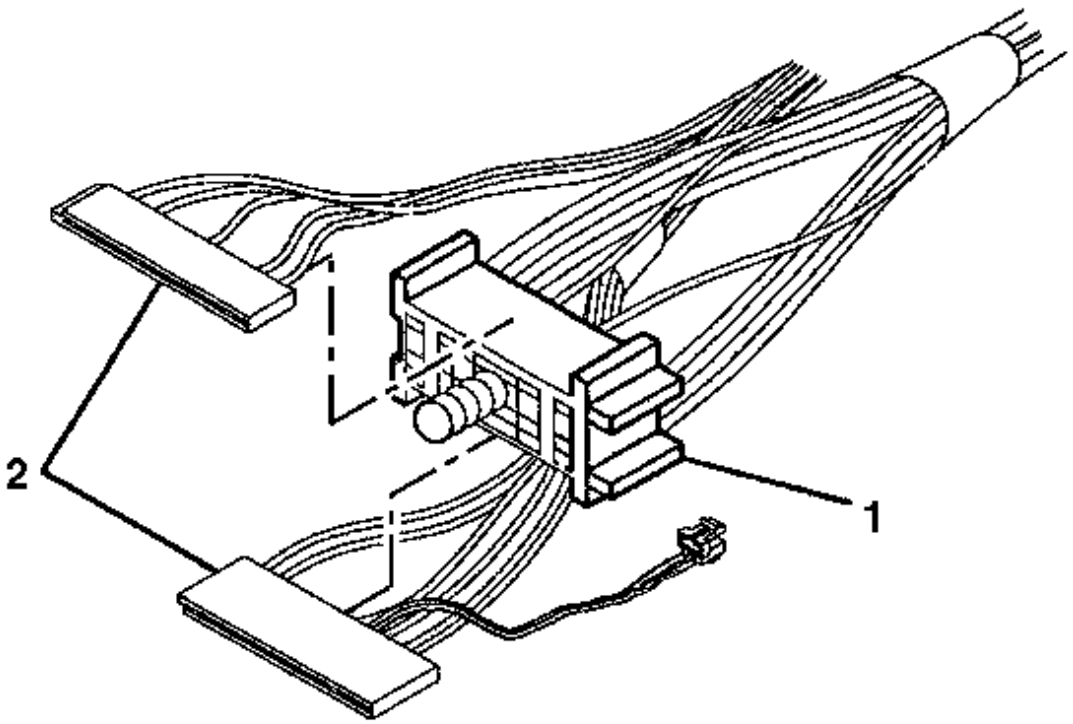


Fig. 28: Turn Signal & Multifunction Switch Assembly Connectors
Courtesy of GENERAL MOTORS COMPANY

4. Slide the 2 connectors (2) of the turn signal multifunction switch assembly out of the bulkhead connector (1).

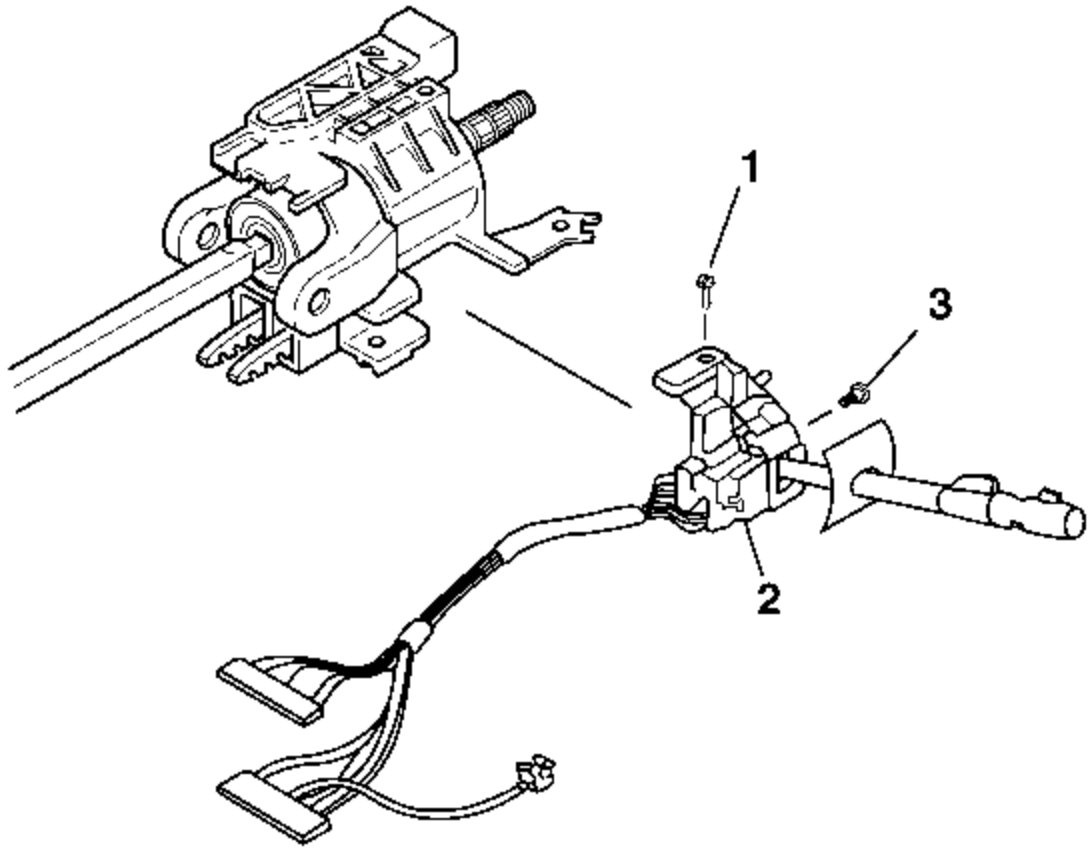


Fig. 29: View Of Turn Signal & Multifunction Switch Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Remove the turn signal multifunction switch bolts (1) and (3) from the turn signal multifunction switch (2).
6. Remove the turn signal multifunction switch (2) from the steering column tilt head assembly.

Installation Procedure

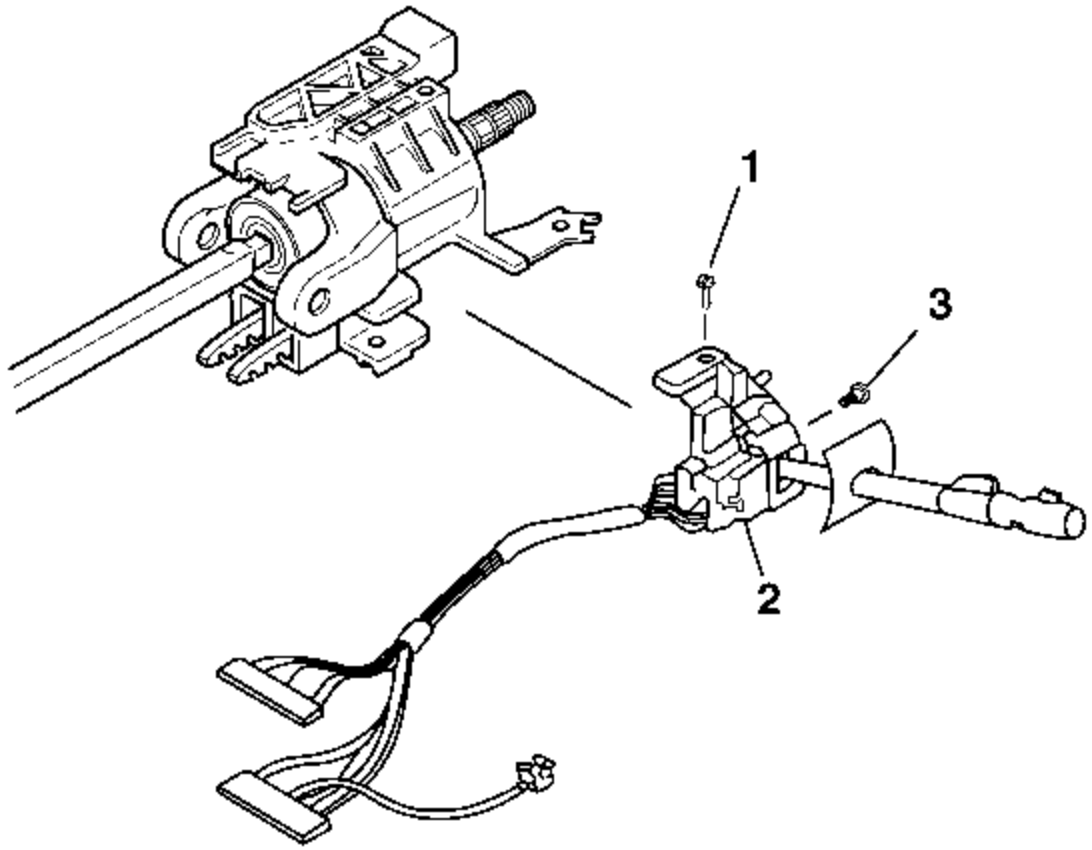


Fig. 30: View Of Turn Signal & Multifunction Switch Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Position the turn signal multifunction switch (2) onto the steering column tilt head assembly.

CAUTION: **Refer to Fastener Caution .**

NOTE: **Be sure that the electrical contact of the turn signal and multifunction switch assembly (2) rests on the turn signal cancel cam assembly.**

2. Install the turn signal multifunction switch bolts (1) and (3) into the turn signal multifunction (2) and tighten to 1 N.m (11 lb in).

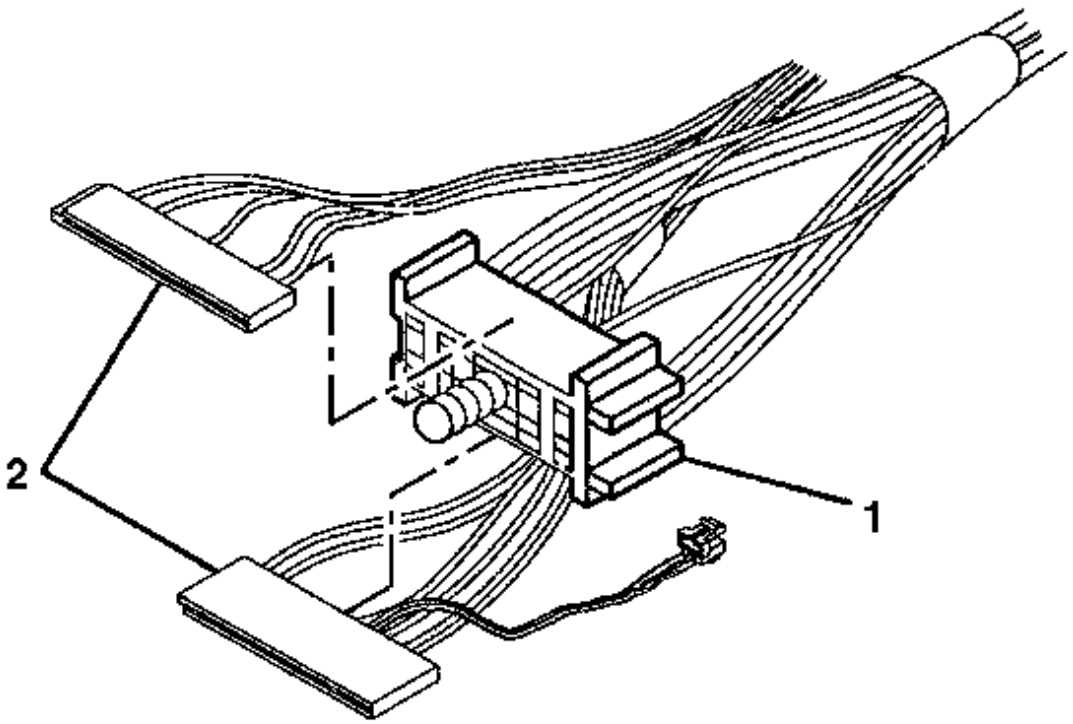


Fig. 31: Turn Signal & Multifunction Switch Assembly Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Slide the 2 connectors (2) of the turn signal multifunction switch assembly into the bulkhead connector (1).

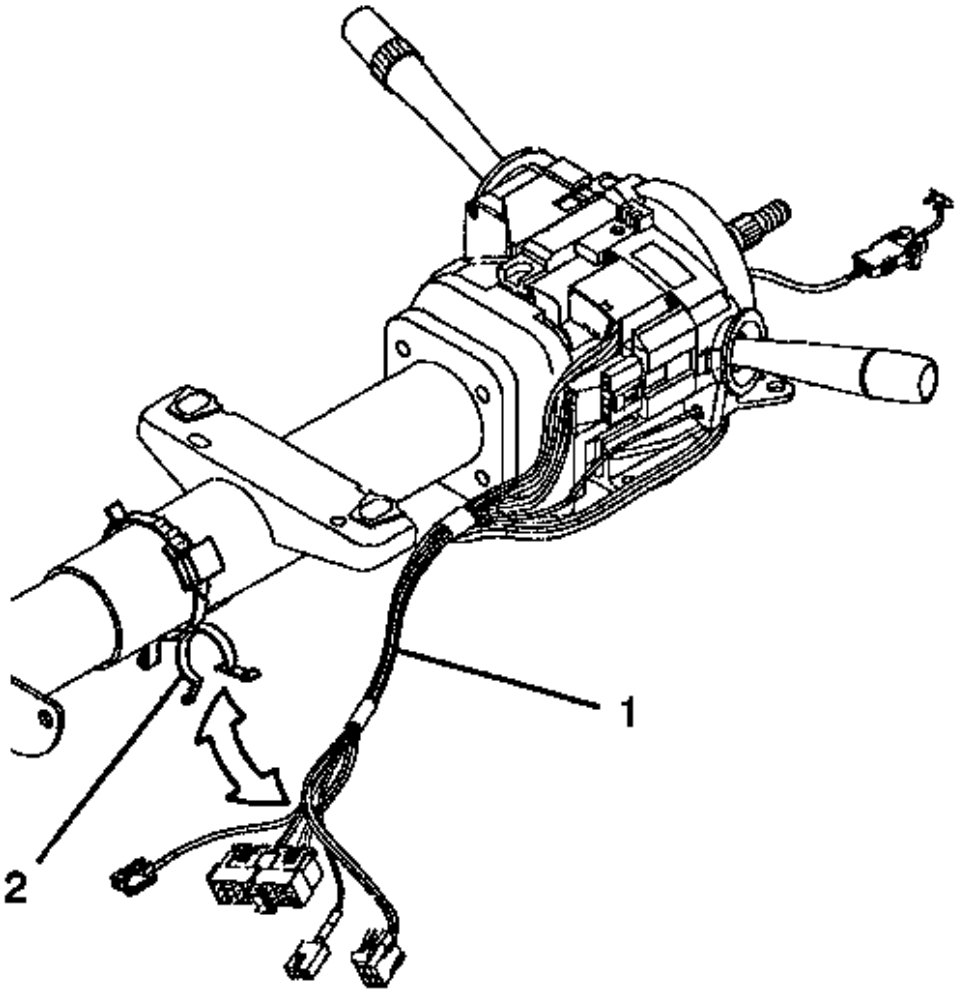


Fig. 32: View Of Steering Column Wire Harness Assembly & Wire Harness Strap
Courtesy of GENERAL MOTORS COMPANY

4. Connect the turn signal multifunction switch connector to the inflatable restraint steering wheel module coil connector.

NOTE: **The abrasion sleeve must be installed back onto the steering column wire harness assembly. The ignition lock cylinder case wires and connector must be hanging out of the middle of the abrasion sleeve.**

5. Install the wire harness assembly (1) to the wire harness strap (2).
6. Install the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

TURN SIGNAL SWITCH HOUSING REPLACEMENT

Removal Procedure

1. Remove the turn signal cancel cam and steering shaft upper bearing spring. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement**.
2. Remove the turn signal multifunction switch. Refer to **Turn Signal Multifunction Switch Replacement**.

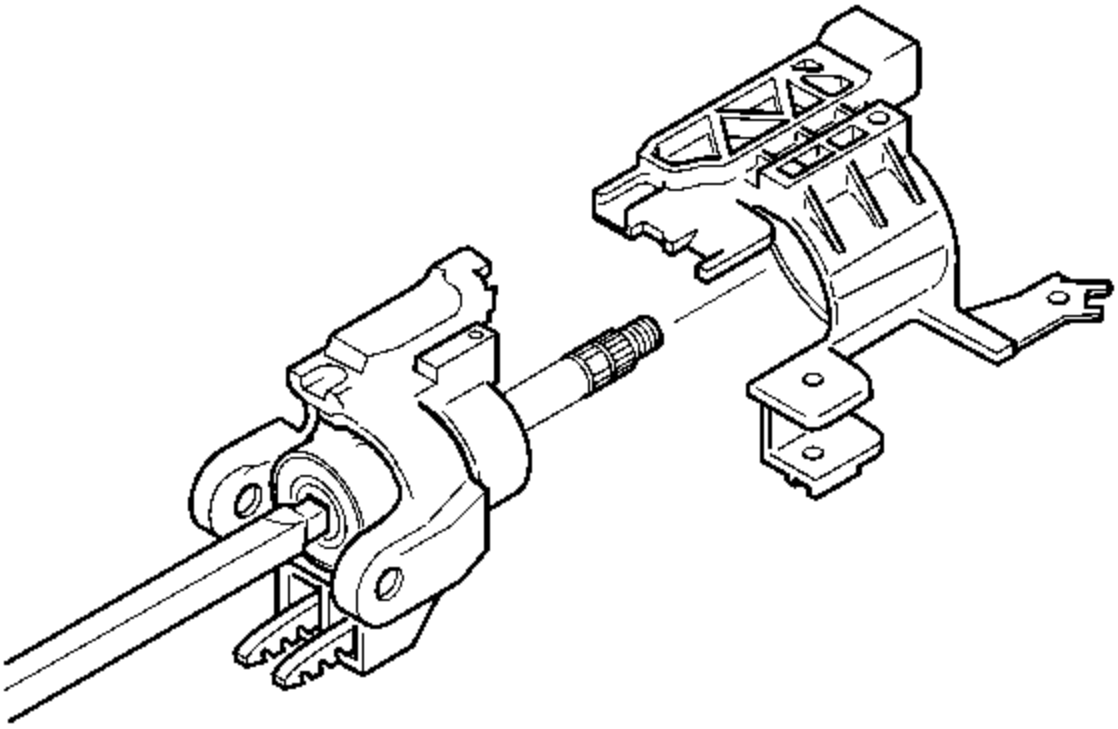


Fig. 33: View Of Turn Signal Switch Housing & Steering Column Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Slide the turn signal switch housing off of the steering column.

Installation Procedure

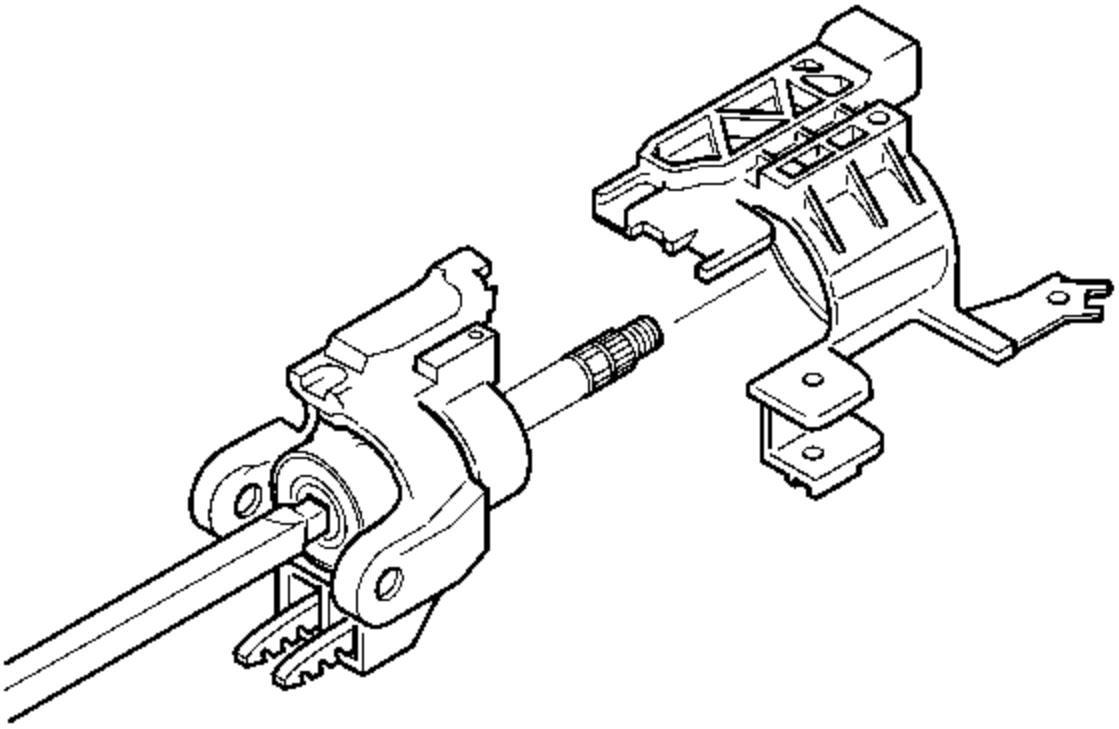


Fig. 34: View Of Turn Signal Switch Housing & Steering Column Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The turn signal switch housing must be pressed firmly against the steering column to seat it properly.**

1. Slide the turn signal switch housing onto the steering column.
2. Install the turn signal multifunction switch. Refer to **Turn Signal Multifunction Switch Replacement**.
3. Install the turn signal cancel cam and steering shaft upper bearing spring. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement**.

SHIFT LEVER REPLACEMENT

Removal Procedure

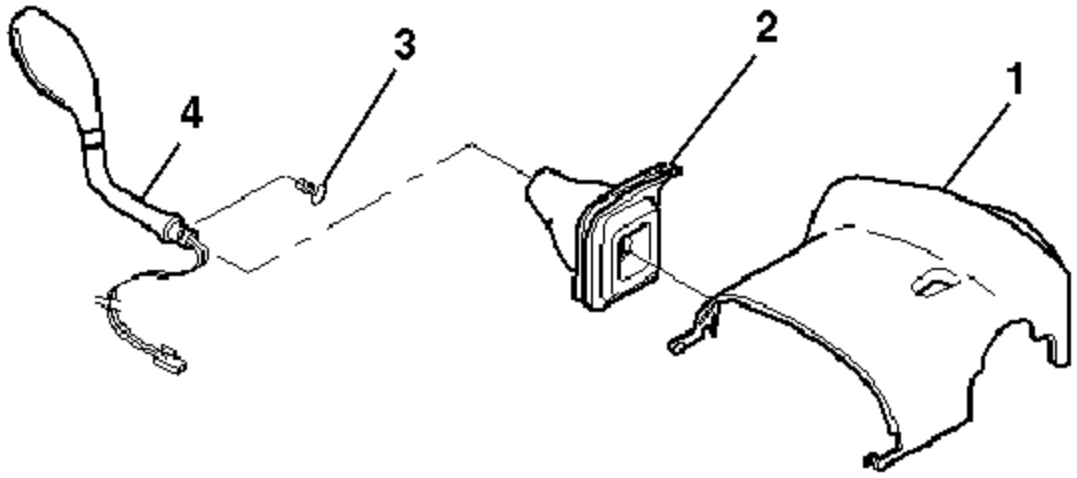


Fig. 35: View Of Shift Lever, Seal (Boot), Screw & Upper Trim Cover
Courtesy of GENERAL MOTORS COMPANY

1. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.
2. Disconnect the shift lever electrical connector at the base of the steering column.
3. Remove the shift lever screw (3) from the shift lever (4).
4. Disengage the shift lever (4) from the linear shift assembly.
5. Transfer the shift lever seal (2) if needed.

Installation Procedure

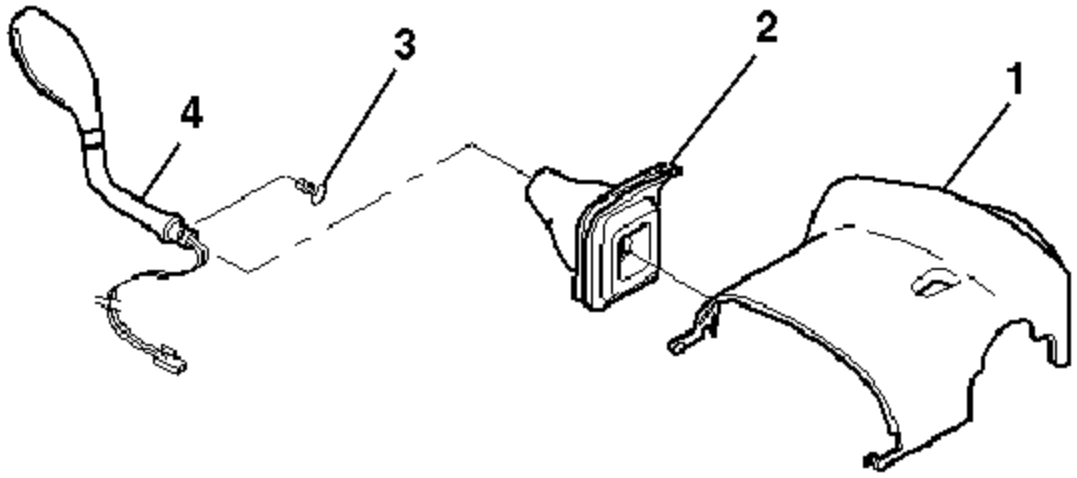


Fig. 36: View Of Shift Lever, Seal (Boot), Screw & Upper Trim Cover
Courtesy of GENERAL MOTORS COMPANY

1. Engage the shift lever (4) to the linear shift assembly.

CAUTION: Refer to Fastener Caution .

2. Install the shift lever screw (3) to the shift lever (4) and tighten it to 20 N.m (15 lb ft).
3. Connect the shift lever electrical connector at the base of the steering column.
4. Install the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

LINEAR SHIFT ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.
2. Remove the shift lever. Refer to **Shift Lever Replacement**.

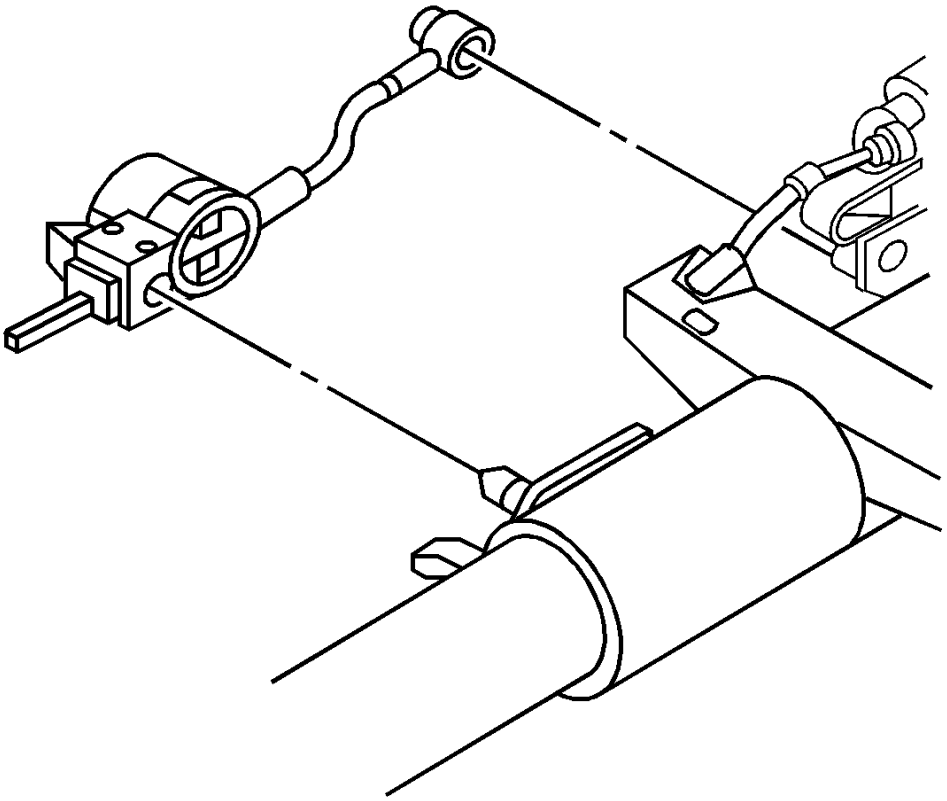


Fig. 37: View Of Automatic Transmission Shift Lock Control Actuator
Courtesy of GENERAL MOTORS COMPANY

3. With a screwdriver, carefully pry the automatic transmission shift lock control away from the steering column jacket.
4. Place the ignition lock cylinder in the OFF-LOCK position.

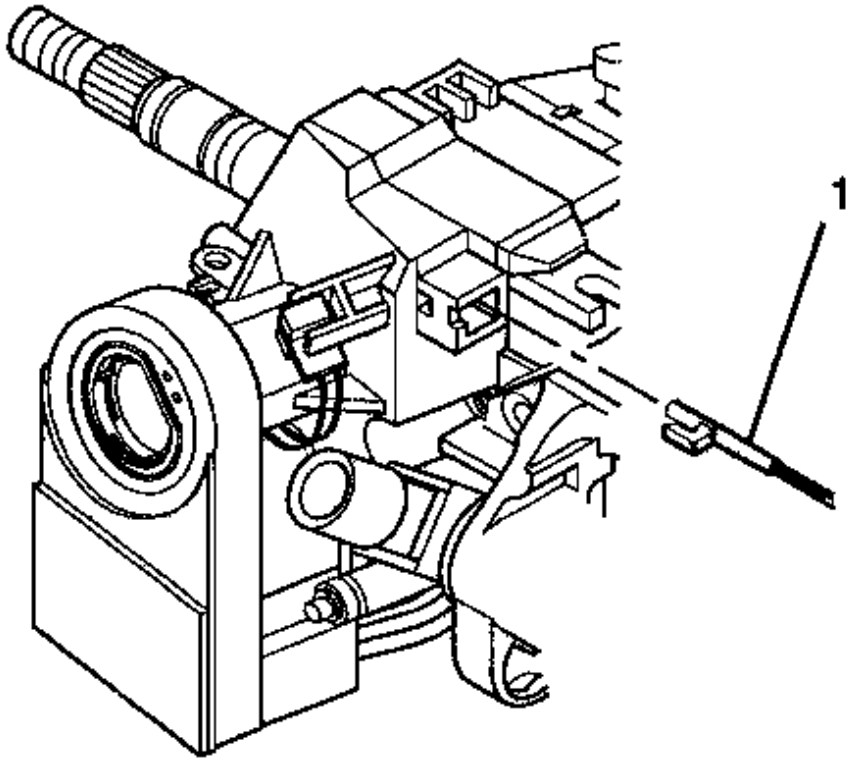


Fig. 38: Identifying Park Lock Cable At Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT remove the tape on the park lock cable. If the tape is removed from the park lock cable, you MUST order a new linear shift assembly.**

5. Insert a small screwdriver into the slot on the ignition lock cylinder case and push against the locking tab to remove the park lock cable (1).

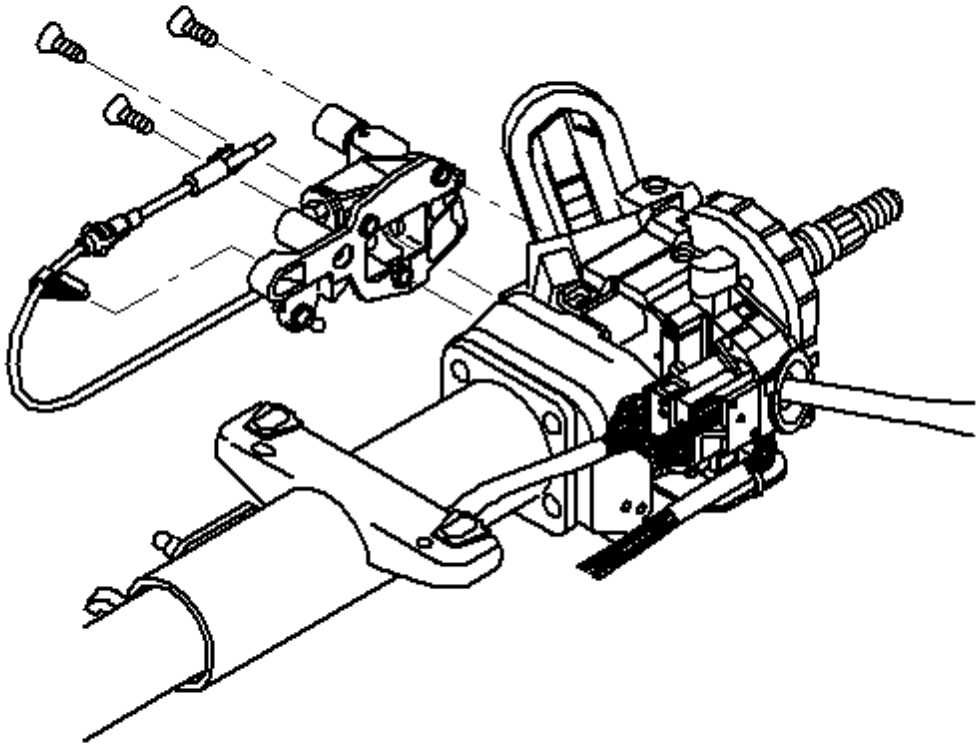


Fig. 39: Flat-Head 6-Lobed Socket Tap Screws & Linear Shift Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **It may be necessary to move the linear shift assembly out of park to access the lower linear shift assembly bolt.**

6. Remove the linear shift assembly bolts.
7. Remove the linear shift assembly.

Installation Procedure

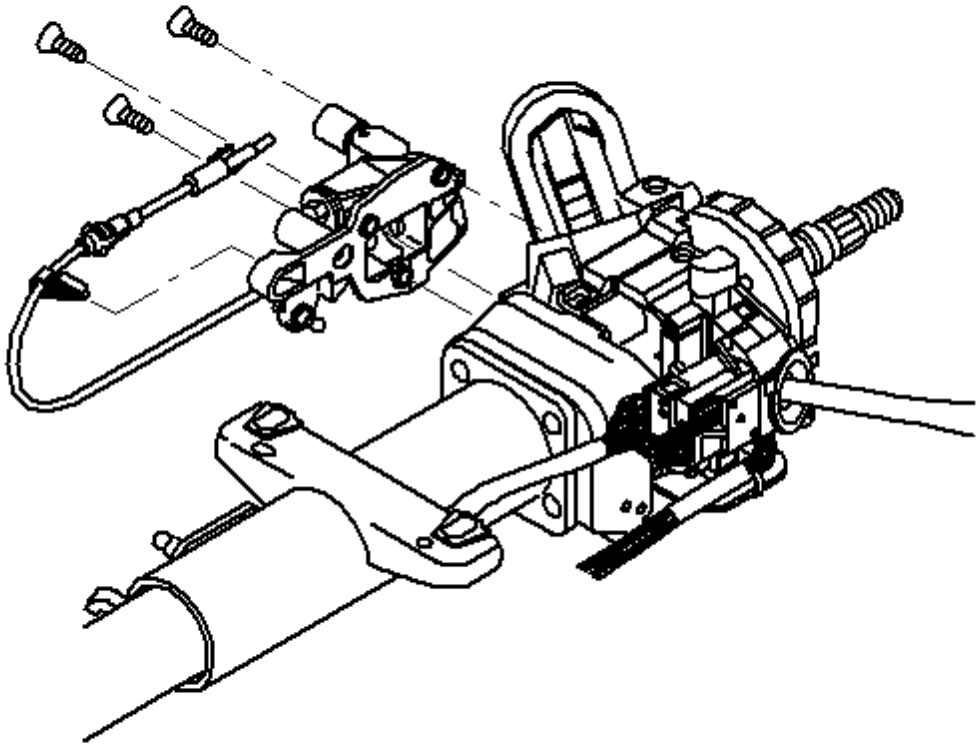


Fig. 40: Flat-Head 6-Lobed Socket Tap Screws & Linear Shift Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Position the linear shift assembly to the steering column.

CAUTION: **Refer to Fastener Caution .**

NOTE: **Start all linear shift assembly bolts by hand before finalizing any torques.**

2. Install the linear shift assembly bolts and tighten to 10 N.m (89 lb in).

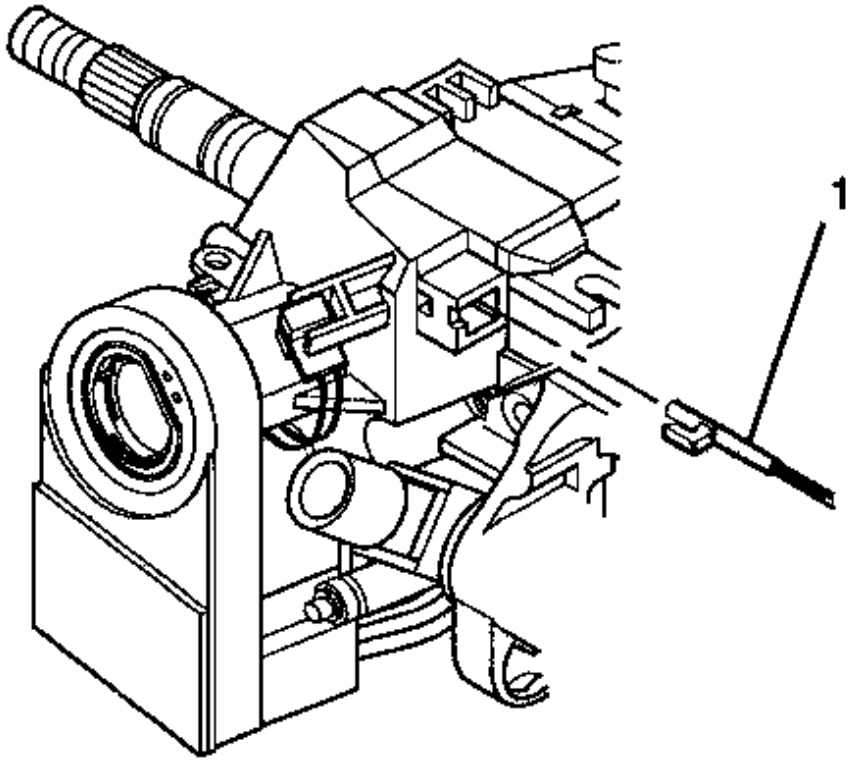


Fig. 41: Identifying Park Lock Cable At Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

3. Connect the park lock cable (1) to the ignition lock cylinder case.
    - The ignition lock cylinder should be in the OFF-LOCK position.
    - The locking tab at the end of the park lock cable (1) must be installed into the ignition lock cylinder case completely.

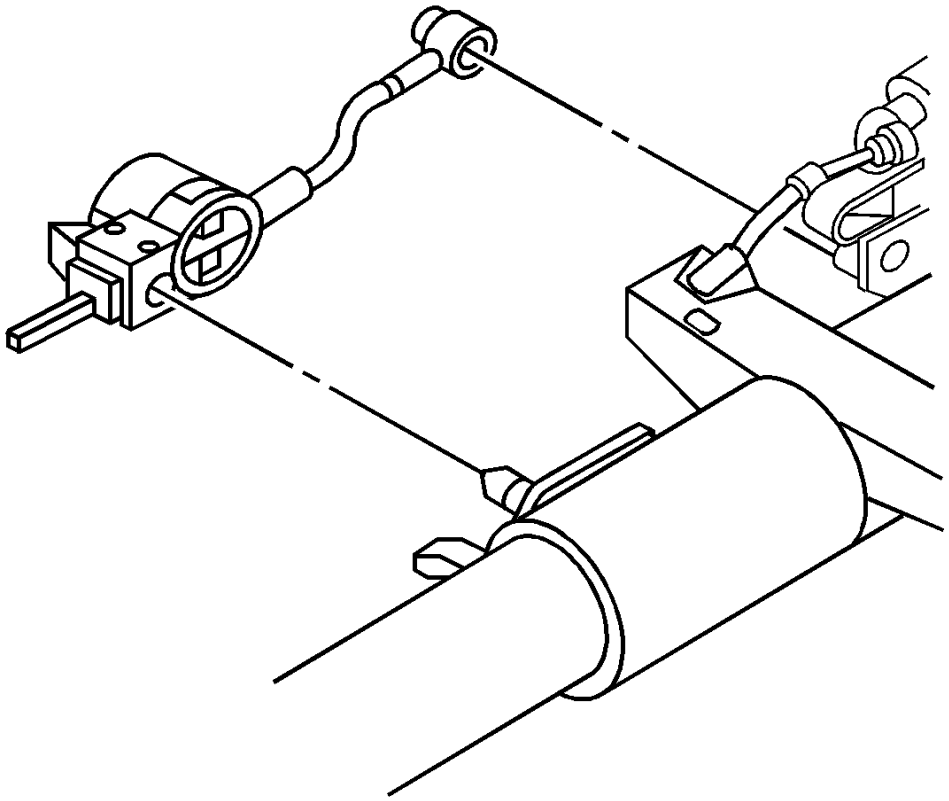


Fig. 42: View Of Automatic Transmission Shift Lock Control Actuator
Courtesy of GENERAL MOTORS COMPANY

4. Install the automatic transmission shift lock control.
5. Install the shift lever and put the column in the NEUTRAL position. Refer to **Shift Lever Replacement**.

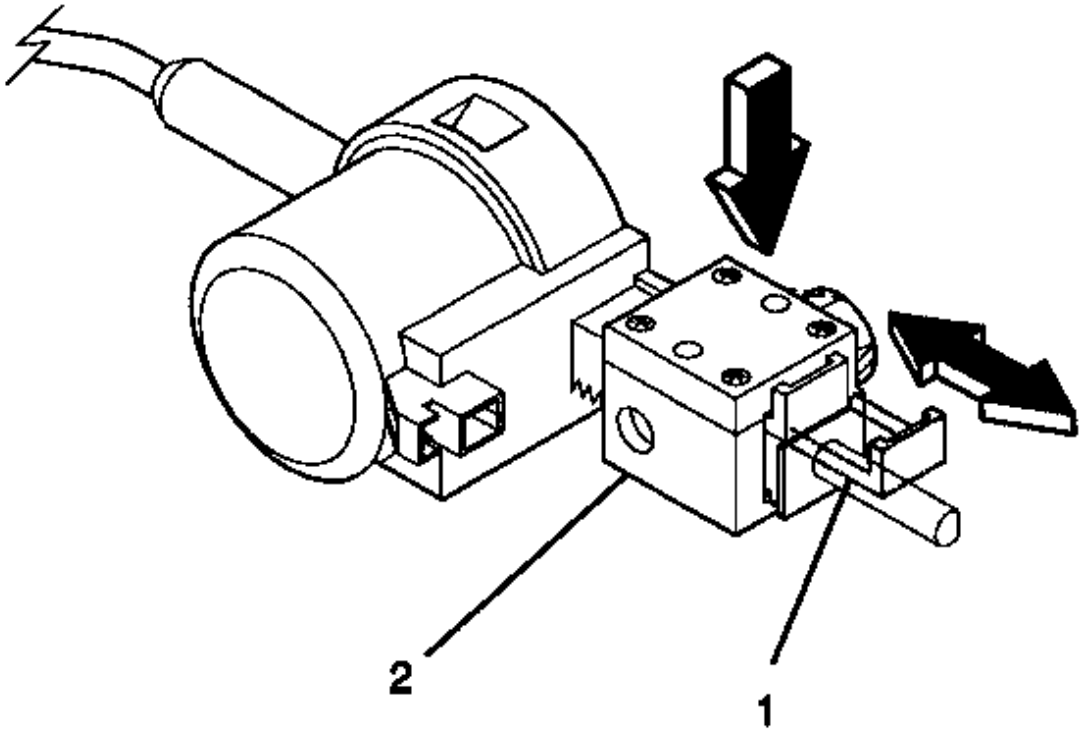


Fig. 43: Adjusting Automatic Transmission Shift Lock Control Actuator
Courtesy of GENERAL MOTORS COMPANY

6. Adjust the automatic transmission shift lock control.
    1. Pull the tab (1) out on the block side (2) of the automatic transmission shift lock control.
    2. Press on the adjuster block (2) to compress the internal adjuster spring to disengage the adjuster teeth. Slide the adjuster block as far away from the solenoid as possible.
    3. Lock in place by pushing the tab (1) back in.
7. Inspect the automatic transmission shift lock control.
    1. The automatic transmission shift lock control must lock the shift lever when it is put into the PARK position.
    2. When the column is installed in the vehicle you will not be able to move the shift lever out of the PARK position without pressing on the brake pedal. The solenoid will be energized.
    3. Readjust if needed.
8. Install the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

STEERING COLUMN TILT WHEEL RELEASE LEVER REPLACEMENT

Removal Procedure

1. Disable the supplemental inflatable restraint (SIR) system. Refer to **SIR Disabling and Enabling** .

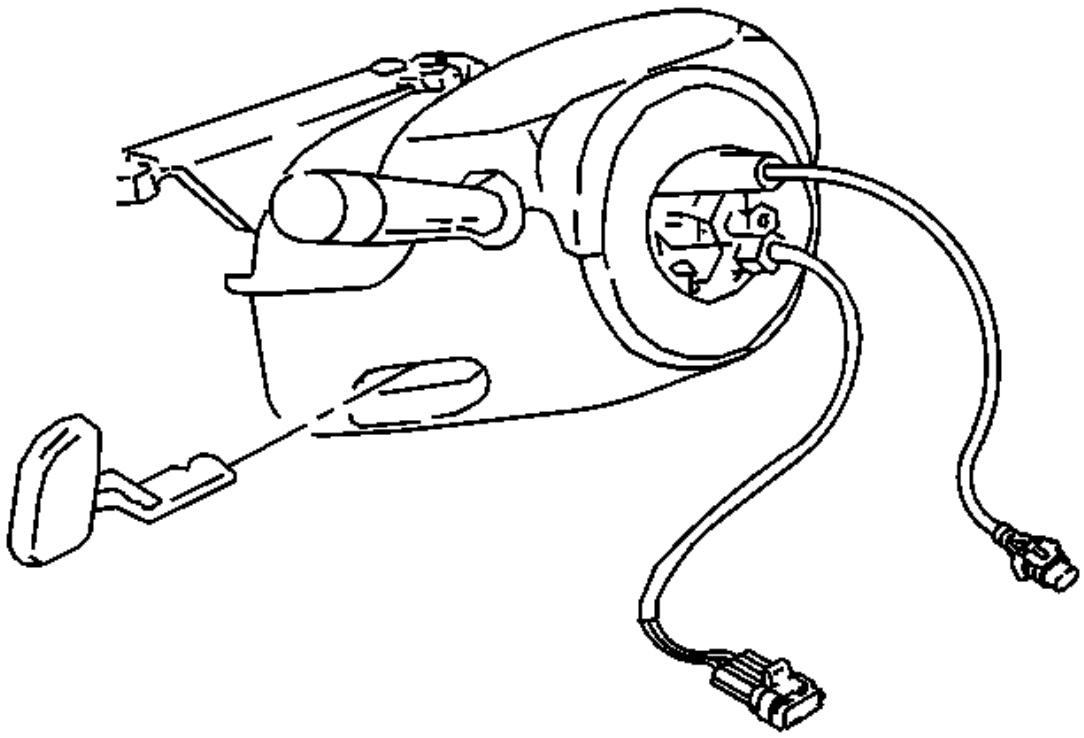


Fig. 44: Identifying Tilt Lever
Courtesy of GENERAL MOTORS COMPANY

2. Pull the tilt lever out from the steering column.

Installation Procedure

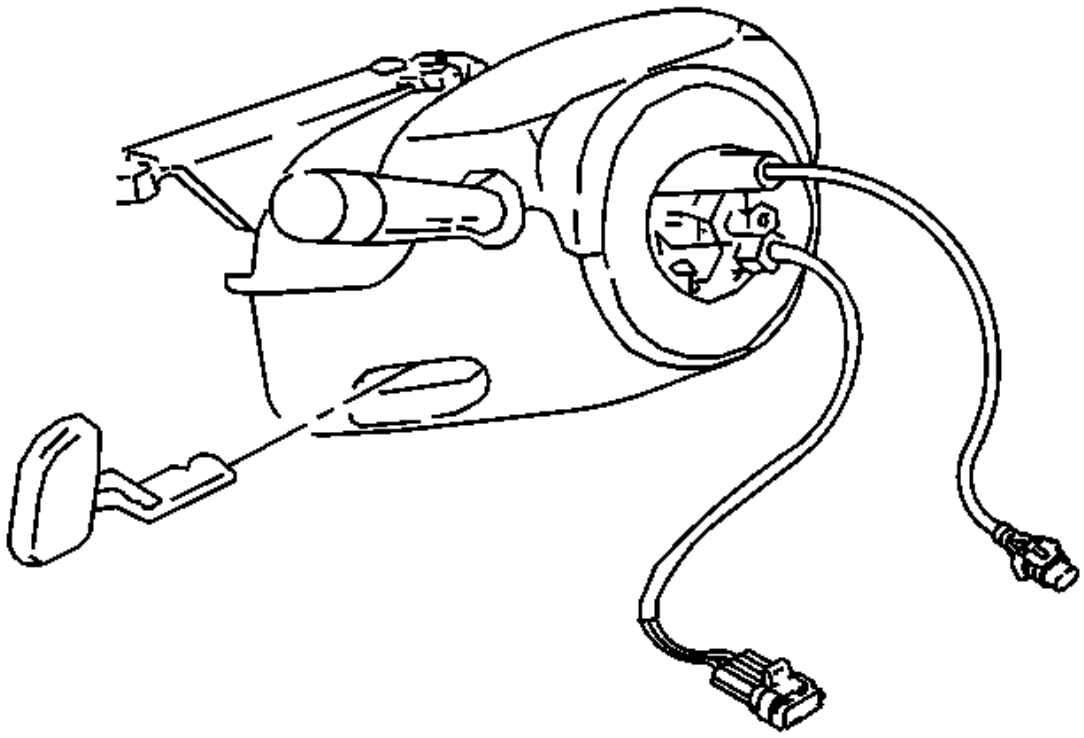


Fig. 45: Identifying Tilt Lever
Courtesy of GENERAL MOTORS COMPANY

1. Push the tilt lever into the steering column.
2. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

STEERING WHEEL REPLACEMENT

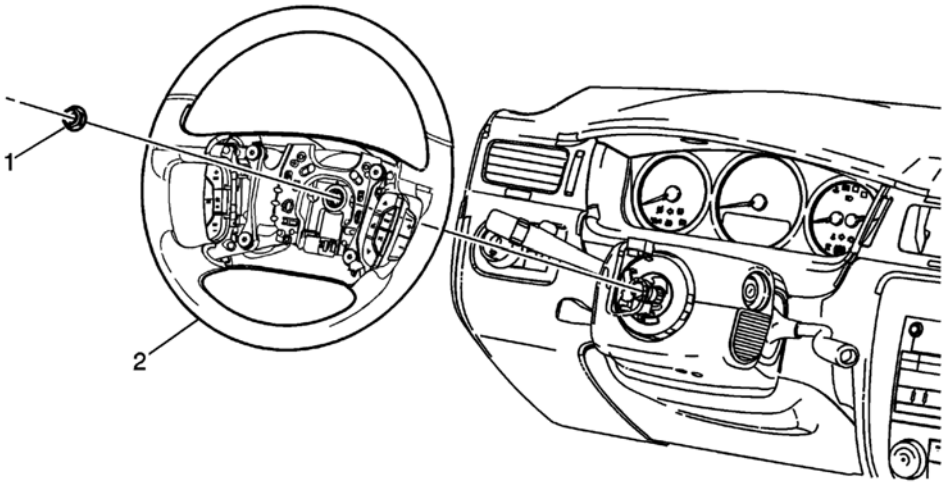


Fig. 46: Steering Wheel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the inflatable restraint steering wheel module. Refer to **Airbag Steering Wheel Module Replacement** .	
1	Steering Wheel Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten** 41 N.m (30 lb ft)
2	Steering Wheel **Procedure** 1. Disconnect any electrical connectors as needed. 2. Use the **J 1859-A** puller and the **J 42578** legs to remove the steering wheel. **Special Tools** • **J 1859-A** Steering Wheel Puller • **J 42578** Steering Wheel Puller Legs For regional tools, refer to **Special Tools**.

STEERING WHEEL THEFT DETERRENT LOCK REPLACEMENT

Removal Procedure

1. Remove the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement** .

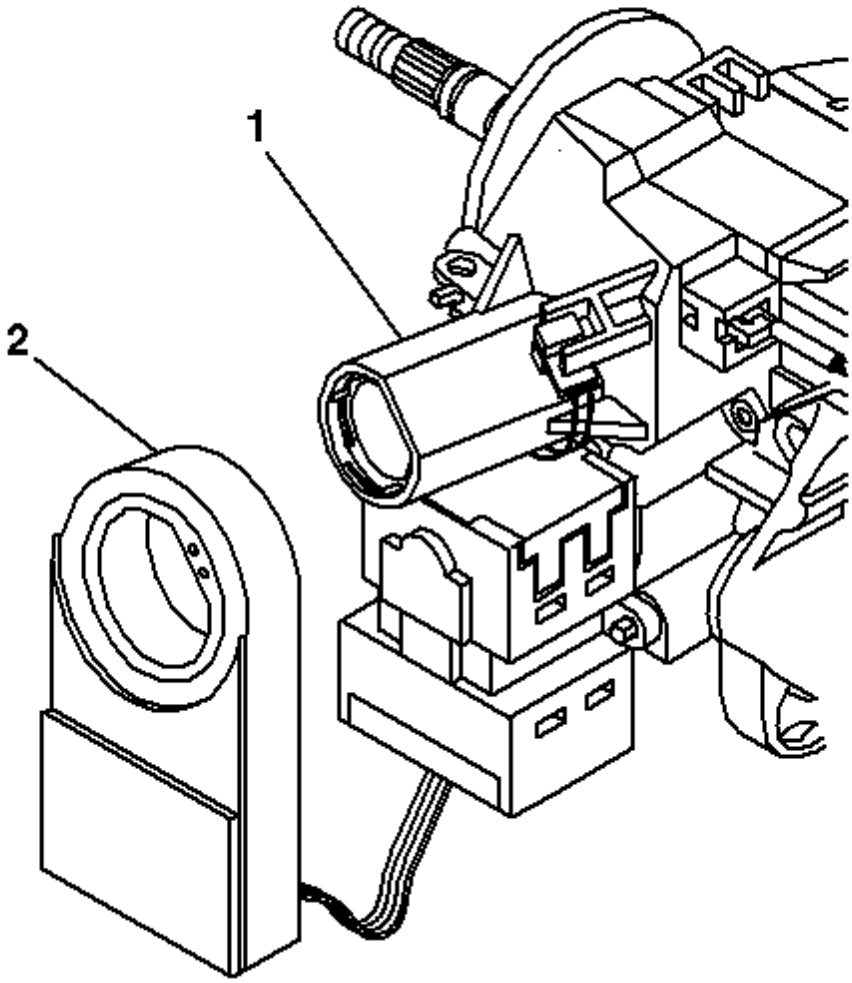


Fig. 47: Locating Theft Deterrent Module & Ignition Lock Cylinder Case Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical connector from the steering wheel theft deterrent lock.
3. If necessary, disconnect the electrical connector from the ignition lock cylinder case (1).
4. Remove the steering wheel theft deterrent lock (2) from ignition lock cylinder case (1).

Installation Procedure

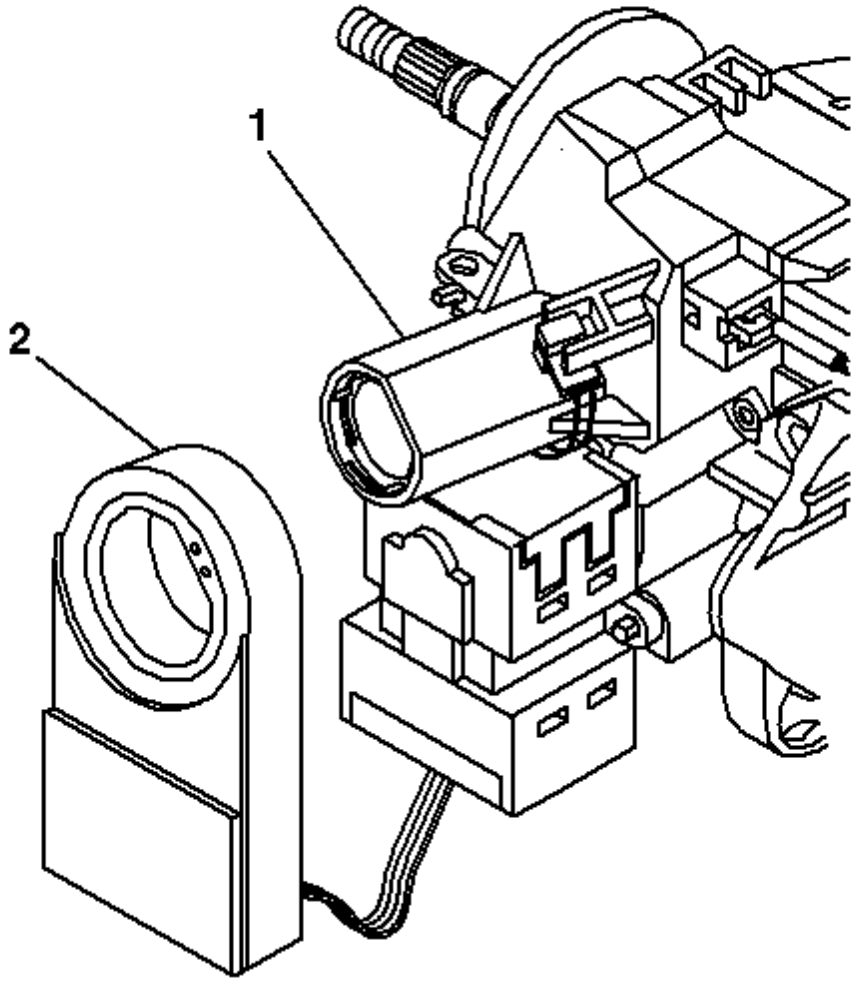


Fig. 48: Locating Theft Deterrent Module & Ignition Lock Cylinder Case Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the steering wheel theft deterrent lock (2) to ignition lock cylinder case (1).
2. Connect the electrical connector to the steering wheel theft deterrent lock.
3. If necessary, connect the electrical connector to the ignition lock cylinder case (1).
4. Install the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement** .

STEERING COLUMN TILT SPRING REPLACEMENT

Removal Procedure

1. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

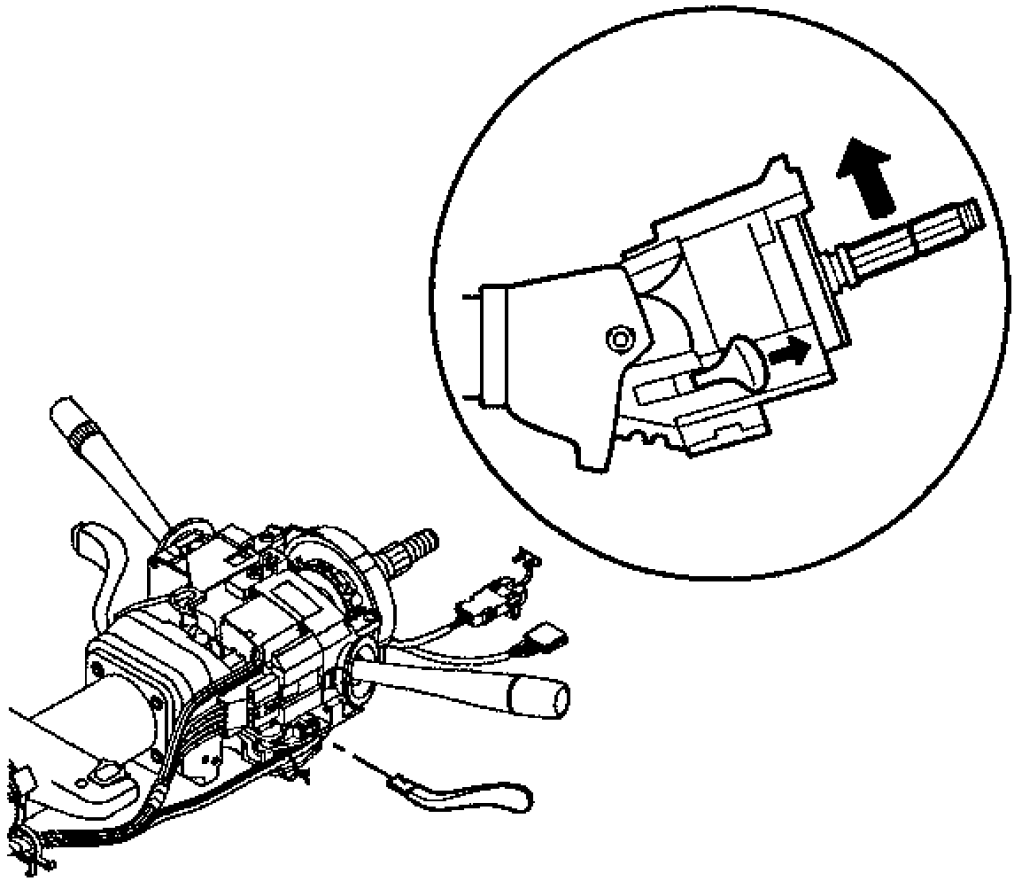


Fig. 49: Tilting Column To Up Position
Courtesy of GENERAL MOTORS COMPANY

2. Install the tilt lever onto the steering column tilt head assembly.
3. Use the tilt lever to tilt the column to the UP position.

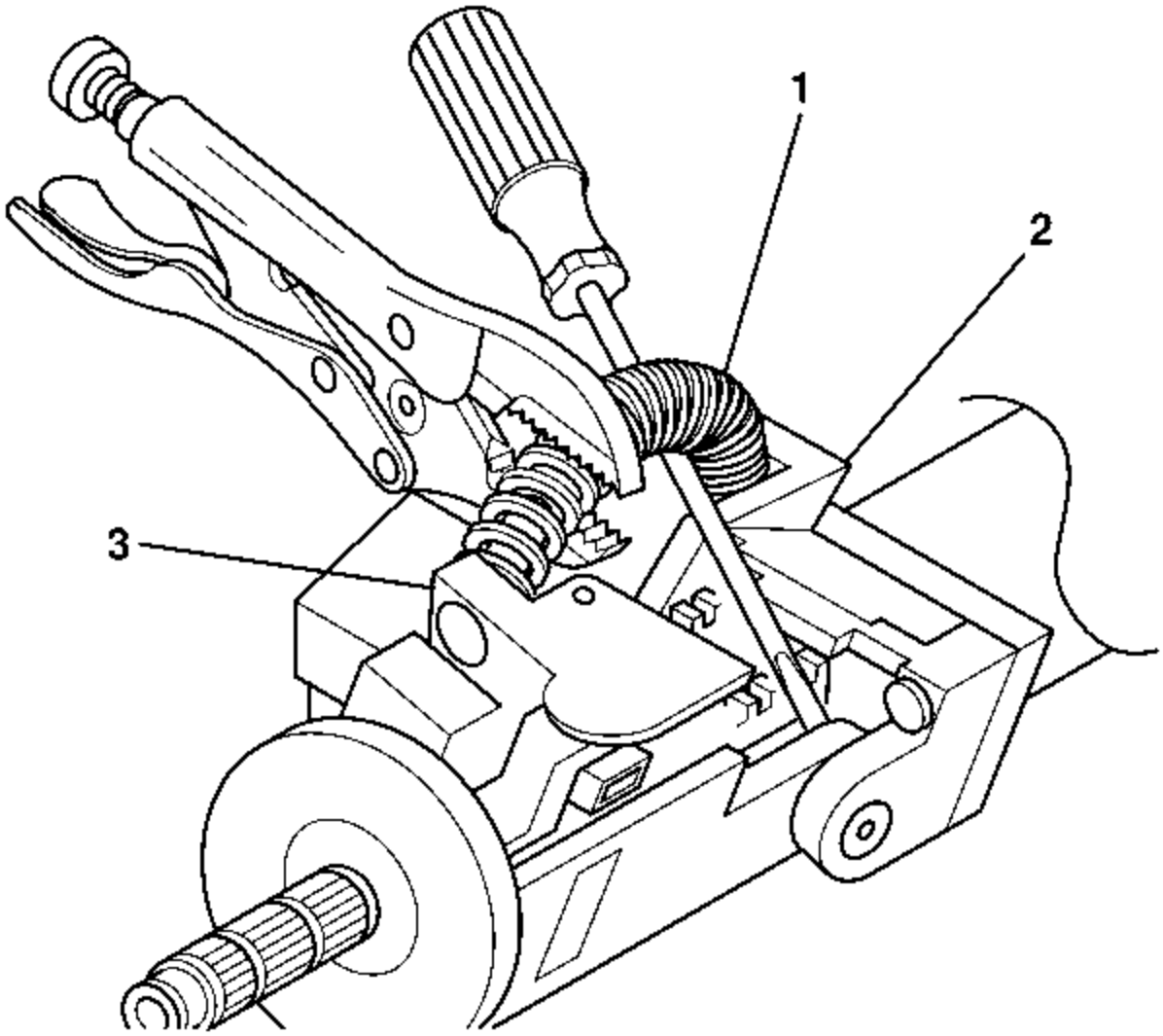


Fig. 50: View Of Tilt Spring And Steering Column Support Assembly
Courtesy of GENERAL MOTORS COMPANY

WARNING: The tilt spring and the spring guide are under pressure. The tilt spring and the spring guide may become a projectile. Secure the spring with locking pliers during removal. Secure the spring with locking pliers during installation. Bodily injury may result during removal and installation of the tilt spring and the spring guide. Always use caution during removal and installation of the tilt spring and the spring guide.

4. Remove the steering column tilt spring (1) from the steering column support assembly (2) and from the steering column tilt head assembly (3) by using the following procedure:
    1. Pry up the steering column tilt spring (1) until a bulge occurs and most of the tension is removed.
    2. Secure the steering column tilt spring (1) with locking pliers.
    3. Continue prying up the steering column tilt spring (1) until it disengages from the post on the steering column support assembly (2) and from the steering column tilt head assembly (3).

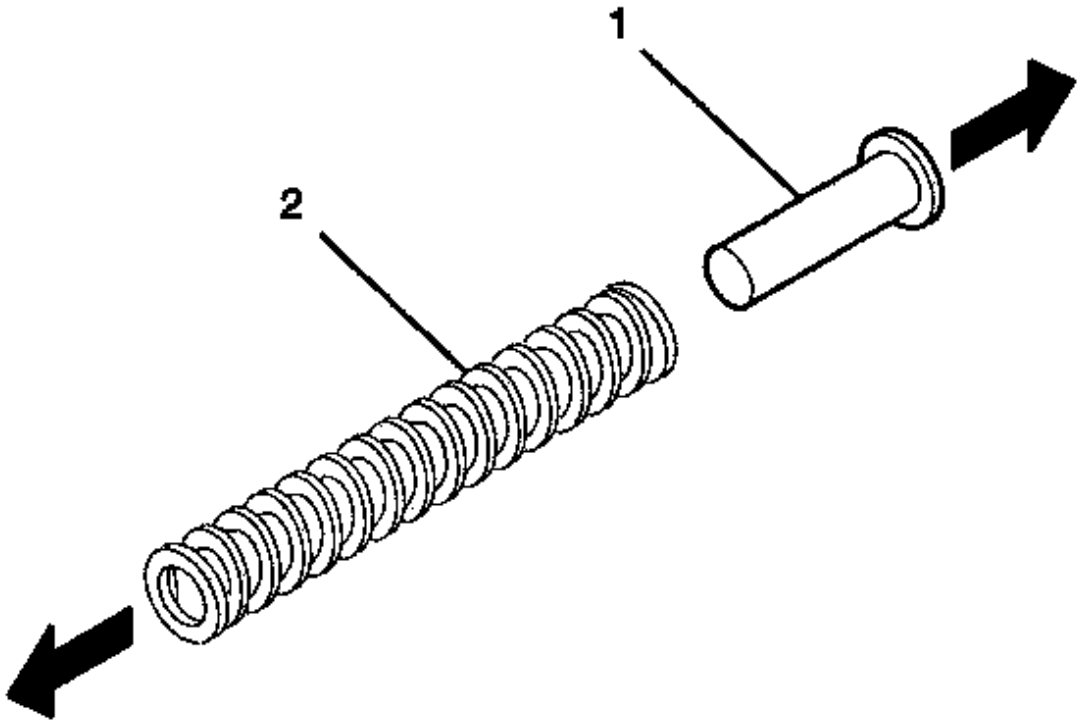


Fig. 51: Identifying Spring Guide Components
Courtesy of GENERAL MOTORS COMPANY

5. Remove the steering column tilt spring guide (1) from the steering column tilt spring (2).

Installation Procedure

1. Tilt the steering column to the UP position.

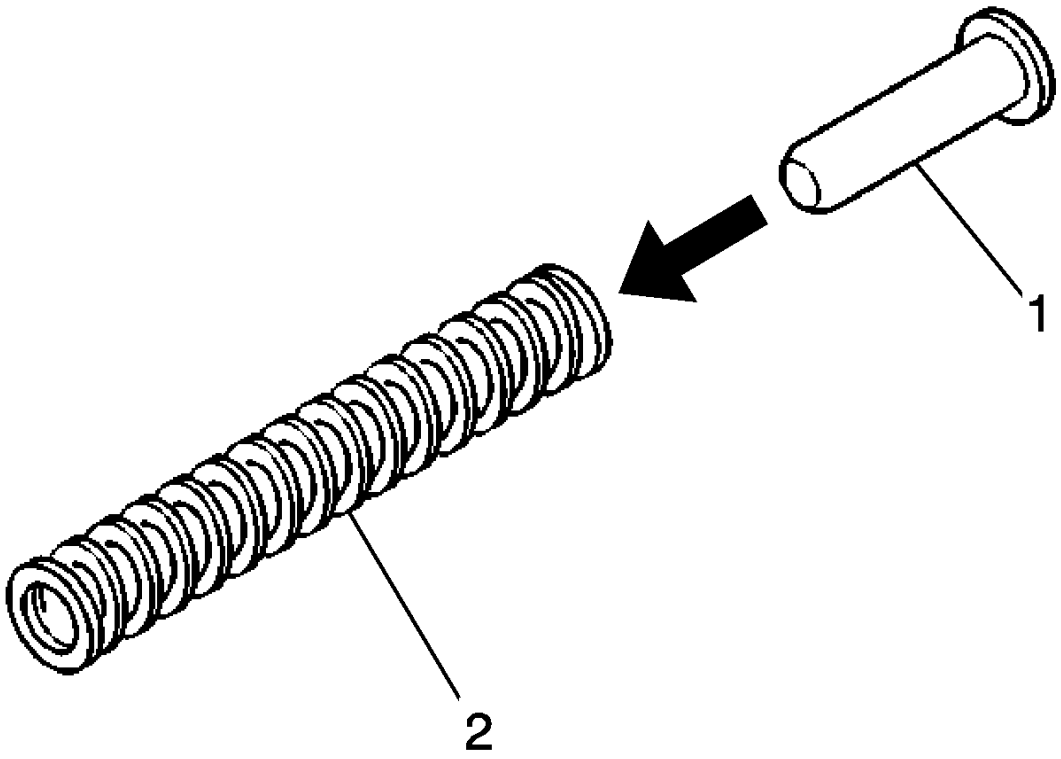


Fig. 52: Spring Guide & Tilt Spring
Courtesy of GENERAL MOTORS COMPANY

2. Install the steering column spring guide (1) into the steering column tilt spring (2).

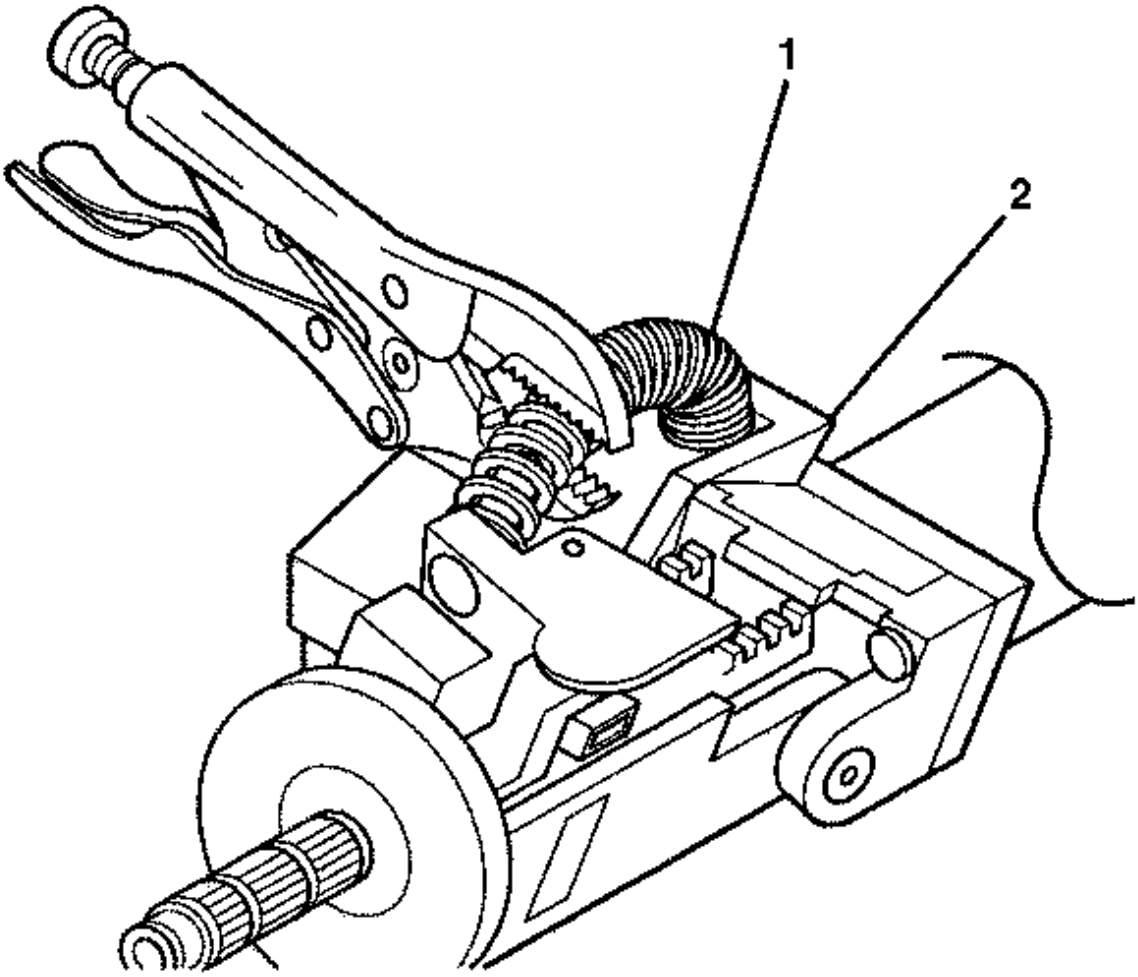


Fig. 53: Identifying Tilt Spring And Steering Column Support Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Install the steering column tilt spring (1) onto the steering column support assembly (2) and onto the steering column tilt head assembly by using the following procedure:
    1. Install the steering column tilt spring (1) onto the steering column tilt head assembly.
    2. Install the steering column tilt spring (1) onto the post on the steering column support assembly (2).
4. Install the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

STEERING COLUMN TILT HEAD REPLACEMENT

Special Tools

J 21854-01 Pivot Pin Remover

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the turn signal cancel cam and steering shaft upper bearing spring. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement**.

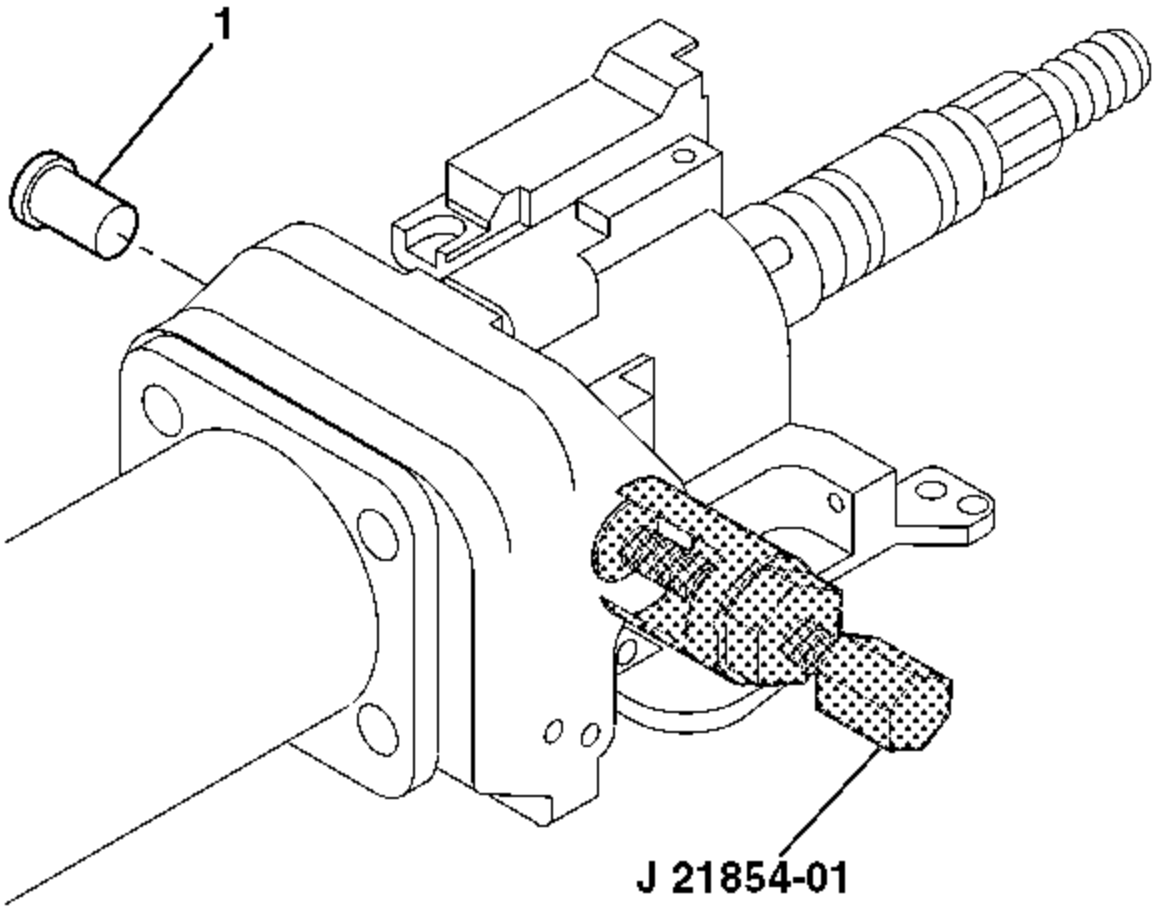


Fig. 54: Pivot Pins And Special Tool
Courtesy of GENERAL MOTORS COMPANY

2. Use the **J 21854-01** remover to remove the pivot pins (1).

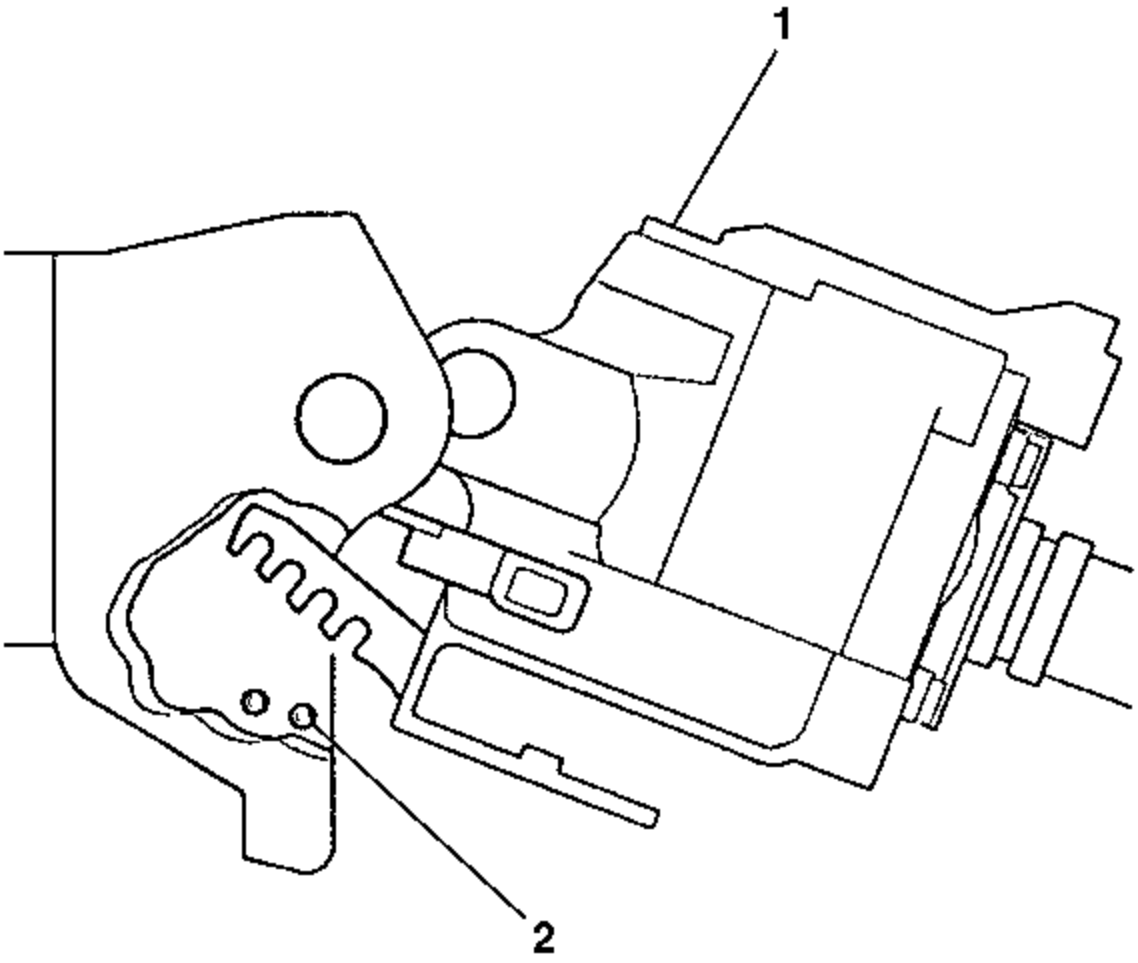


Fig. 55: Disengaging Steering Wheel Lock Shoes From Dowel Pins
Courtesy of GENERAL MOTORS COMPANY

3. Pull the tilt arm in order to disengage the steering wheel lock shoes from the dowel pins (2) in the steering column support assembly.

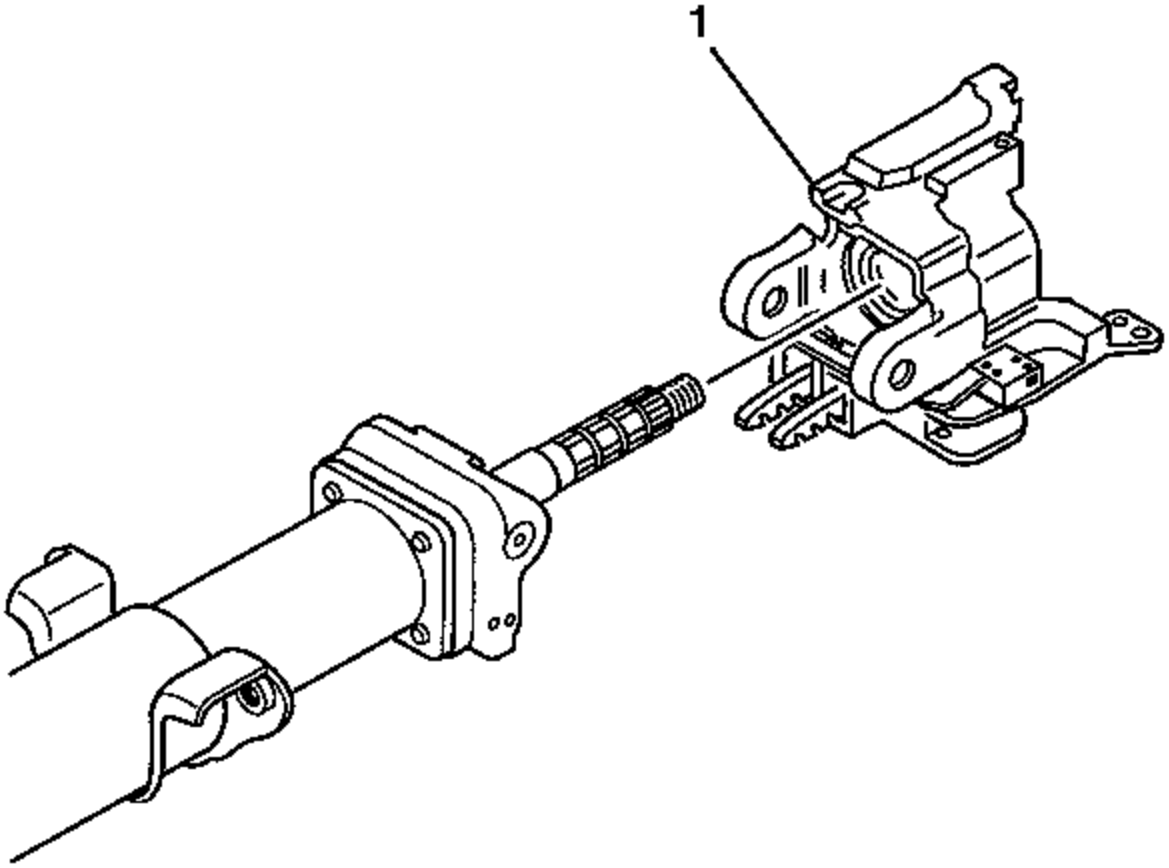


Fig. 56: View Of Steering Column Housing And Bearing Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Remove the steering column tilt head (1).

Installation Procedure

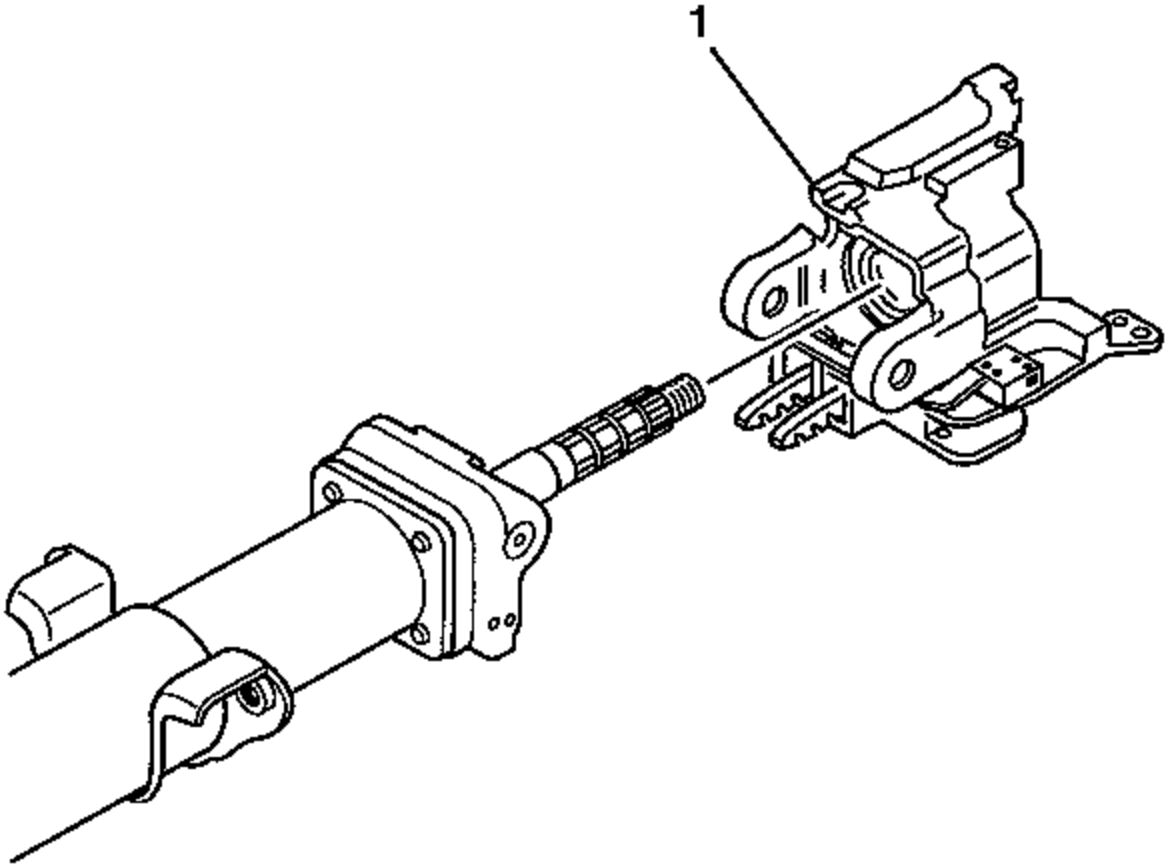


Fig. 57: View Of Steering Column Housing And Bearing Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Position the steering column tilt head (1) on to the steering column.

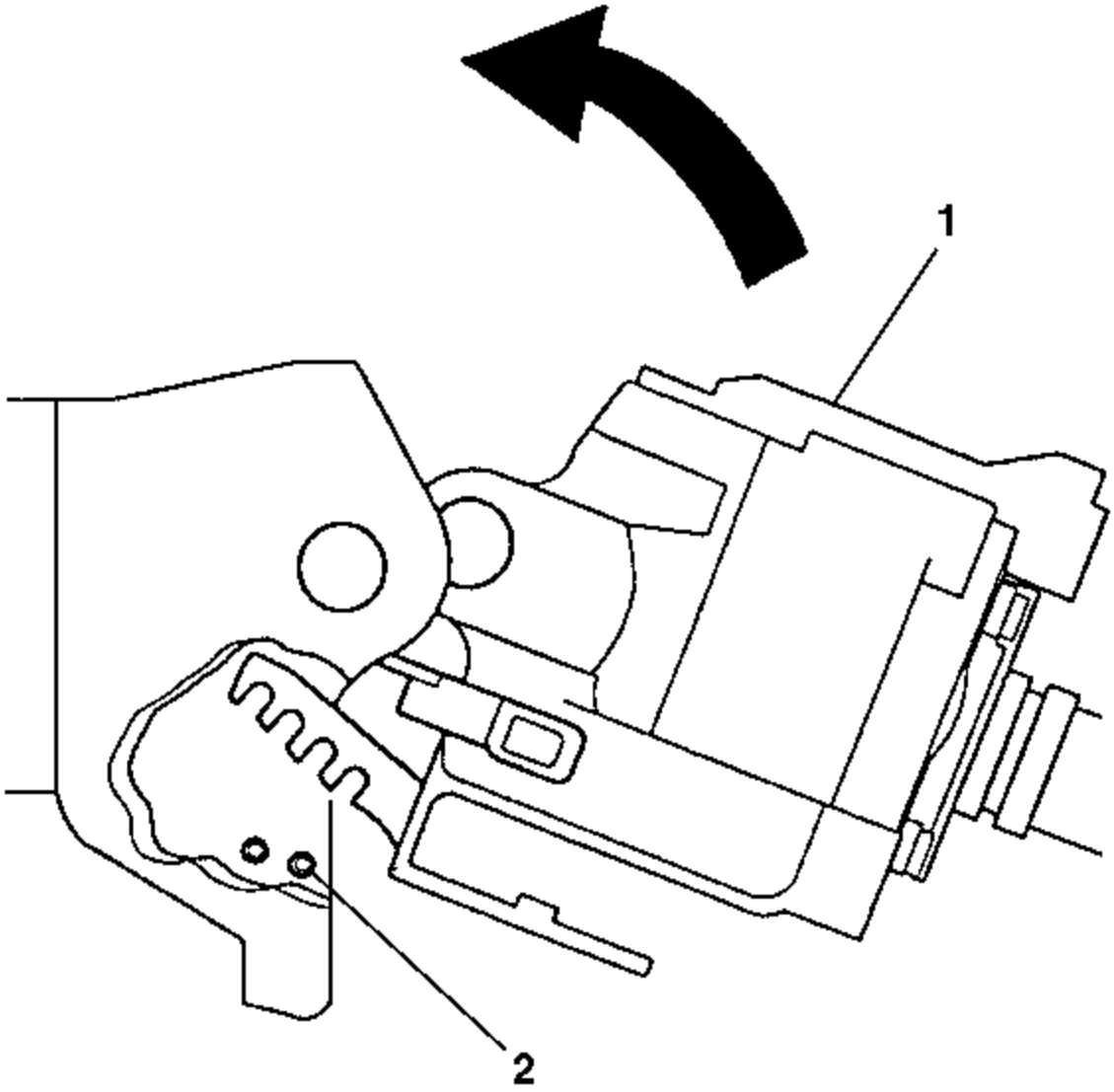


Fig. 58: Locking Shoes To Dowel Pins
Courtesy of GENERAL MOTORS COMPANY

2. Using the tilt lever position, lock the shoes to the dowel pins (2).
3. Rotate the steering column tilt head (1) in order to align the holes for the pivot pins.

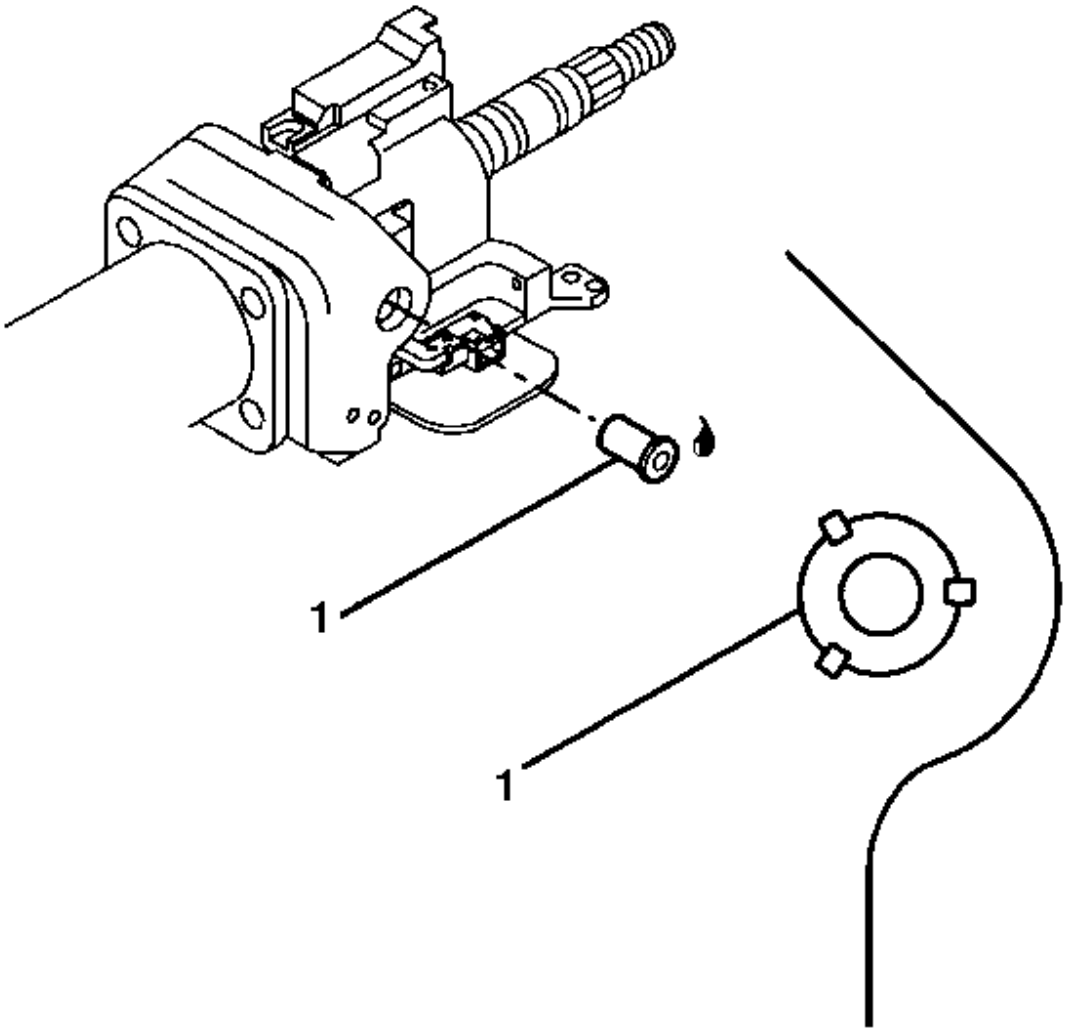


Fig. 59: View Of Pivot Pins At Steering Column Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Install the 2 pivot pins by performing the following steps:
    1. Lubricate the pivot pins (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended lubricant.
    2. Press the pivot pins (1) until the pins are firmly seated.
    3. Stake the pivot pins at three new locations (1).
5. Install the turn signal cancel cam and steering shaft upper bearing spring. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement**.

STEERING COLUMN REPLACEMENT

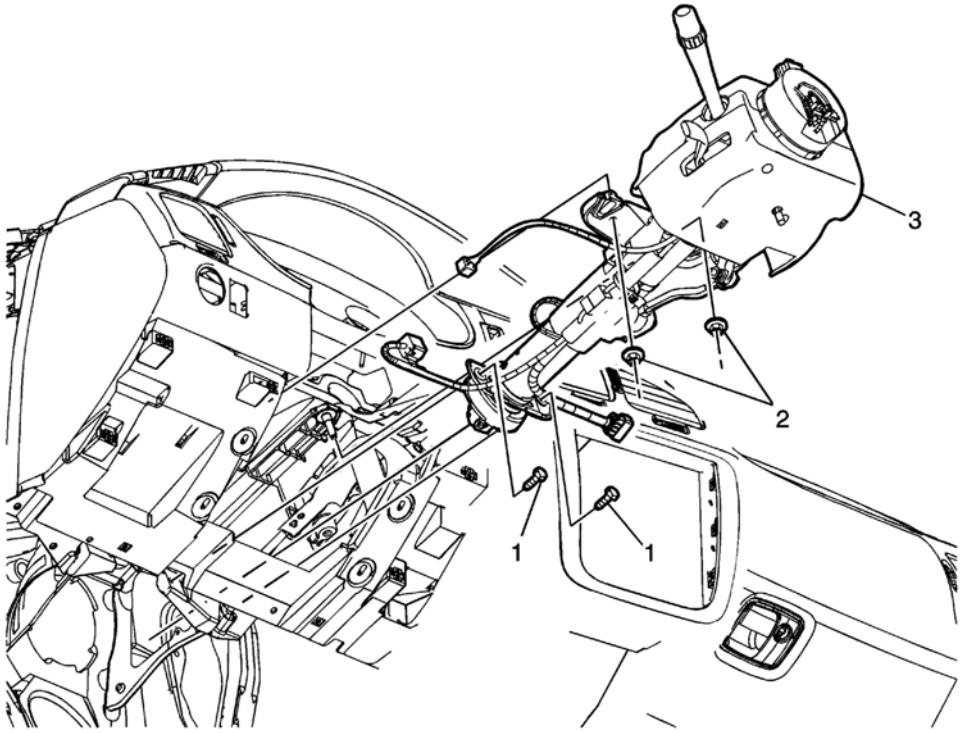


Fig. 60: Steering Column
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to SIR Warning .** **WARNING:** **Refer to Battery Disconnect Warning .** **CAUTION:** **With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation.**	

Callout	Component Name
Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components: • **The steering column** • **The intermediate shaft(s)** • **The steering gear** **After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-**	

Callout	Component Name
center SIR Coil. **Preliminary Procedures** 1. Insert the **J-42640** pin into the steering column access hole in order to lock the steering column. 2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** . 3. Disable the SIR system. Refer to **SIR Disabling and Enabling** . 4. Remove the steering wheel. Refer to **Steering Wheel Replacement**. 5. Remove the left closeout/insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** . 6. Remove the steering column filler panel. Refer to **Steering Column Opening Filler Replacement** . 7. Remove the knee bolster reinforcement. Refer to **Driver Knee Bolster Reinforcement Replacement** . 8. Remove the intermediate shaft from the bottom of the steering column. Refer to **Intermediate Steering Shaft Replacement**. 9. Perform passkey relearn after the ignition lock cylinder has been replaced. Refer to **Control Module References** . **Special Tools J 42640** Steering Column Anti-rotation Pin	
1	Steering Column Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
2	Steering Column Nut (Qty: 2) **Procedure** Once all steering column bolts and nuts are started, torque the steering column bolts first. **Tighten** 25 N.m (18 lb ft)
3	Steering Column **Procedure** 1. Disconnect any electrical connectors as needed. 2. Transfer any parts as needed.

STEERING SHAFT LOWER BEARING REPLACEMENT

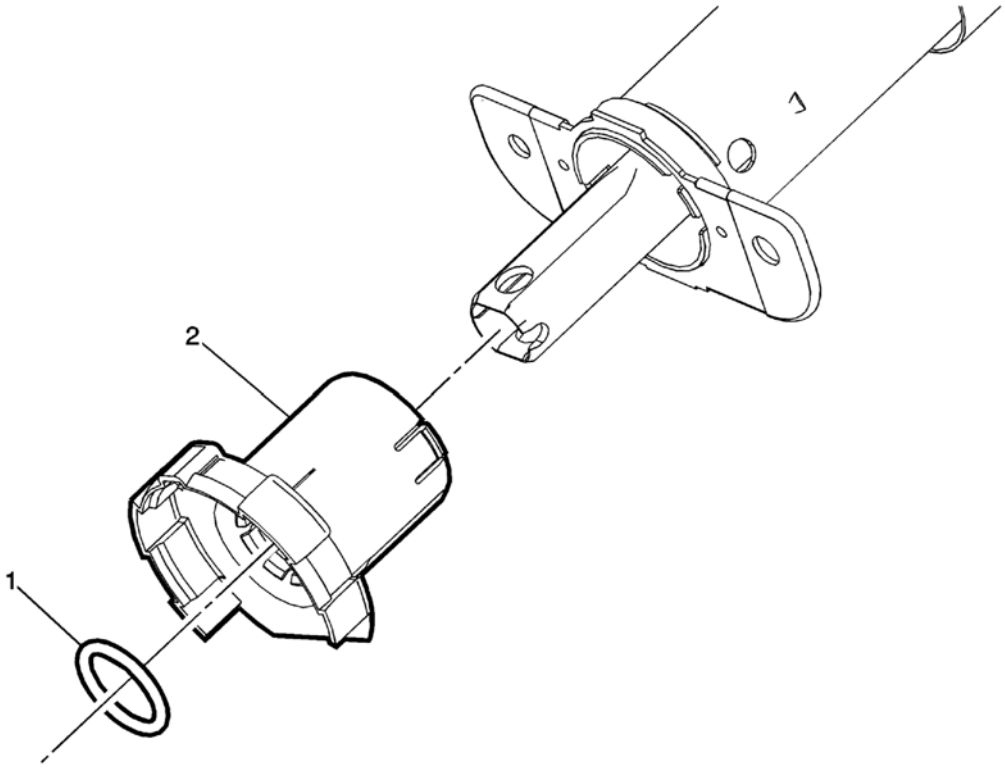


Fig. 61: Steering Shaft Lower Bearing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the steering angle sensor. Refer to **Steering Angle Sensor Replacement** .	
1	Steering Shaft Lower Bearing Retaining Ring **CAUTION:** **Refer to Fastener Caution .** **Procedure** Remove and discard the old retaining ring. Do NOT reuse the retaining ring, replace with NEW only.
2	Steering Shaft Lower Bearing

DESCRIPTION AND OPERATION

STEERING WHEEL AND COLUMN DESCRIPTION AND OPERATION

The steering wheel and column has 4 primary functions:

- Heated Steering Wheel

- Vehicle steering
- Vehicle security
- Driver convenience
- Driver safety

Heated Steering Wheel

The heated steering wheel control module controls the heated steering wheel and the heated steering wheel ON indicator based on an input from the heated steering wheel switch. When the heated steering wheel switch is pressed, the switch signal circuit is pulled to ground. This indicates to the heating steering wheel control module that steering wheel heat is requested. When the request is seen, the heated steering wheel control module supplies ground to the indicator lamp and supplies voltage to the heating elements, which are internal to the steering wheel. The heated steering wheel temperature is monitored through an internal temperature sensor. When the steering wheel reaches operating temperature the module will cycle the voltage on and off to maintain the operating temperature.

Vehicle Steering

The steering wheel is the first link between the driver and the vehicle. The steering wheel is fastened to a steering shaft within the column. At the lower end of the column, the intermediate shaft connects the column to the steering gear.

Vehicle Security, Found on Some Vehicle Models

Theft deterrent components are mounted and designed into the steering column. The following components allow the column to be locked in order to minimize theft:

- The ignition switch-location varies
- The steering column lock-content varies
- The ignition cylinder-location varies
- The theft deterrent module-location varies

Driver Convenience

The steering wheel and column may also have driver controls attached for convenience and comfort. The following controls may be mounted on or near the steering wheel or column.

- The turn signal switch
- The hazard switch
- The headlamp dimmer switch
- The wiper/washer switch
- The horn pad/cruise control switch
- The redundant radio/entertainment system controls
- The manual/power tilt or tilt/telescoping functions
- The power pedal adjustment control switch
- The navigation/OnStarÂ® features

- The HVAC controls

Driver Safety

The steering wheel and column has safety features to protect the driver. The following components may be mounted on or near the steering column:

Energy-Absorbing Steering Column

The energy-absorbing steering column compresses in the event of a front-end collision, which reduces the chance of injury to the driver. The energy-absorbing feature, collapsible steering shaft, and break away mounting features help reduce the injury in the event of an accident. In addition to these features, the following driver safety features may be on the steering column. To inspect the steering column for damage, refer to **Steering Column Accident Damage Inspection**.

Electronic Park Lock (EPL)/Ignition Lock Cylinder Control Actuator

If the vehicle is equipped with automatic transmission and a floor mounted console gear shift, it has an ignition lock cylinder control actuator system in the steering column. The ignition lock cylinder control actuator purpose is to prevent the ignition key from being turned to the OFF position when the transmission is in any position other than PARK and the vehicle may still be moving. The column ignition lock system consists of an ignition lock cylinder control actuator, and a park position switch that is located in the automatic transmission shift lock control switch. The ignition lock cylinder control actuator contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

Linear Shift Assembly

If the vehicle is equipped with a column mounted gear shift, it has a linear shift assembly on the steering column. The linear shift assembly has a cable that runs from the linear shift assembly to the ignition lock cylinder case. The purpose of this cable is to prevent the ignition key from being turned to the OFF position when the transmission is in gear and the vehicle may still be moving. The linear shift assembly cable contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

SIR Coil and Module

For additional information on the operation of the SIR coil and module, refer to **Supplemental Inflatable Restraint System Description and Operation** .

Automatic Transmission Shift Lock Actuator

The automatic transmission shift lock control system is a safety device that prevents an inadvertent shift out of PARK when the engine is running. The driver must press the brake pedal before moving the shift lever out of the PARK position. The system consists of the following components: the automatic transmission shift lock control solenoid, the automatic transmission shift lock control switch, the body

control module (BCM), the powertrain control module (PCM)/engine control module (ECM). With the ignition in the ON position, voltage is supplied to automatic transmission shift lock control switch. Voltage flows through the normally closed contacts of the automatic transmission shift lock control switch to the automatic transmission shift lock control solenoid. When the BCM receives a class 2 message from the PCM/ECM indicating the transmission is in the park position the BCM then grounds the automatic transmission shift lock solenoid control circuit . This energizes the automatic transmission shift lock control solenoid causing the transmission shift lever to be physically locked in the PARK position. When the brake pedal is pressed the contacts in the automatic transmission shift lock control switch open, de-energizing the automatic transmission shift lock control solenoid. This allows the shift lever to be move out of the PARK position.

Steering Wheel Angle Sensor or Steering Wheel Position Sensor

The steering wheel position sensor is located somewhere along the steering shaft assembly. The sensor measures the position of the steering wheel and the speed at which it is rotated. A signal representing this measurement is provided to the vehicle stability enhancement system (VSES) module. The VSES module uses this signal, along with several others representing different vehicle conditions, to monitor the driving behavior of the vehicle and ensure that it stays in control. If the VSES module determines that the vehicle is out of control it provides signals to the powertrain control module (PCM) and the ABS module. These output signals are used to modulate the transmission torque and brake pressure of each of the vehicles wheels in order to regain control of the vehicle.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

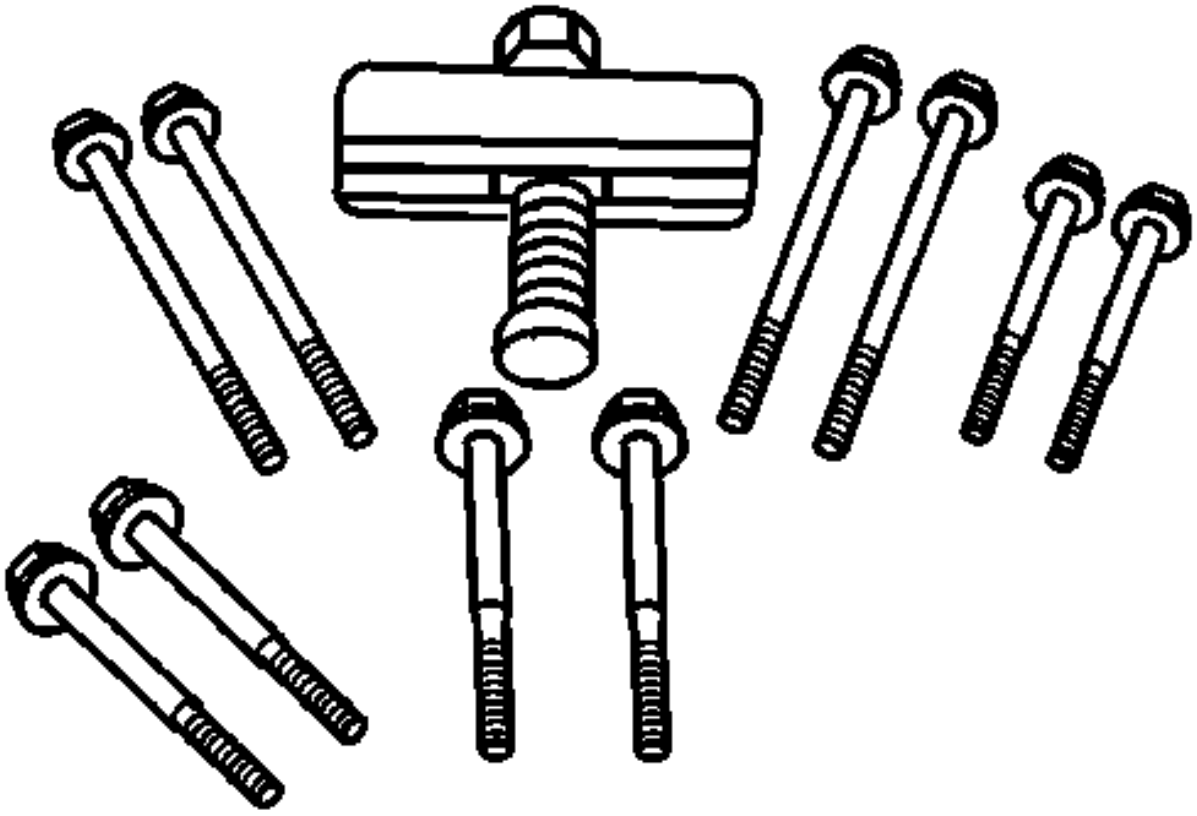
Illustration	Tool Number/ Description
	J-1859-A Countergear and Steering Wheel Puller

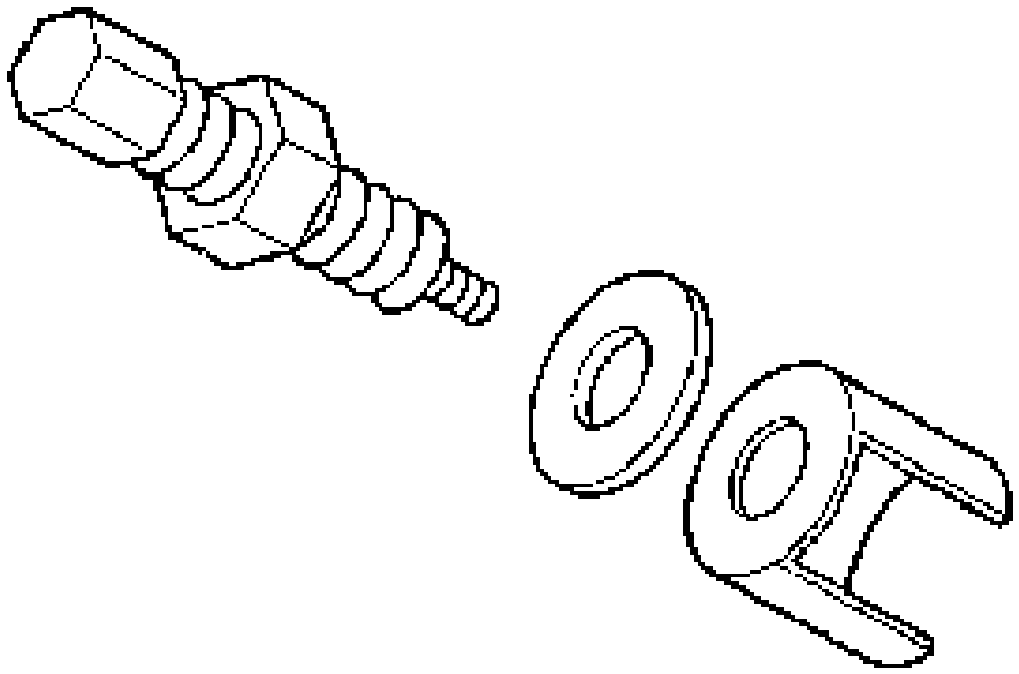
Illustration	Tool Number/ Description
	J-21854-01 Pivot Pin Remover

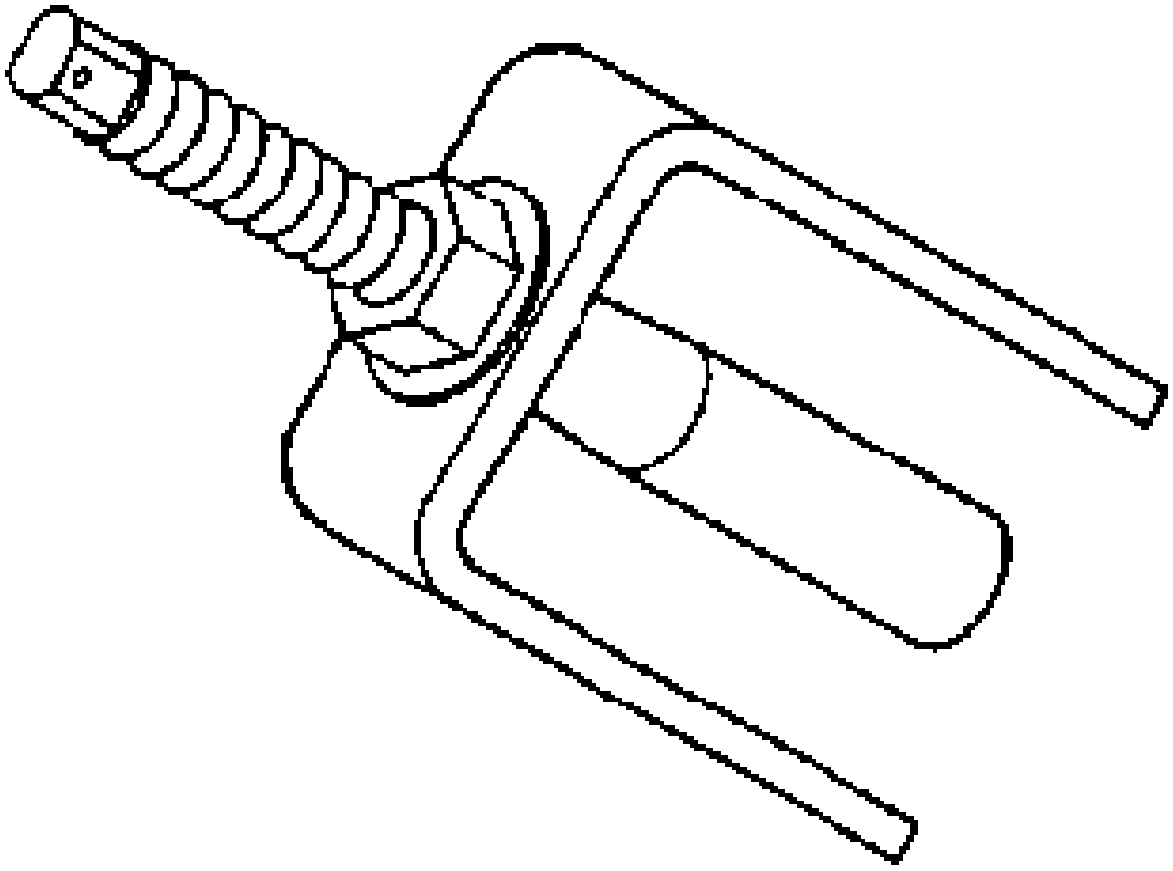
Illustration	Tool Number/ Description
	J-23653-SIR Steering Column Lock Plate Compressor

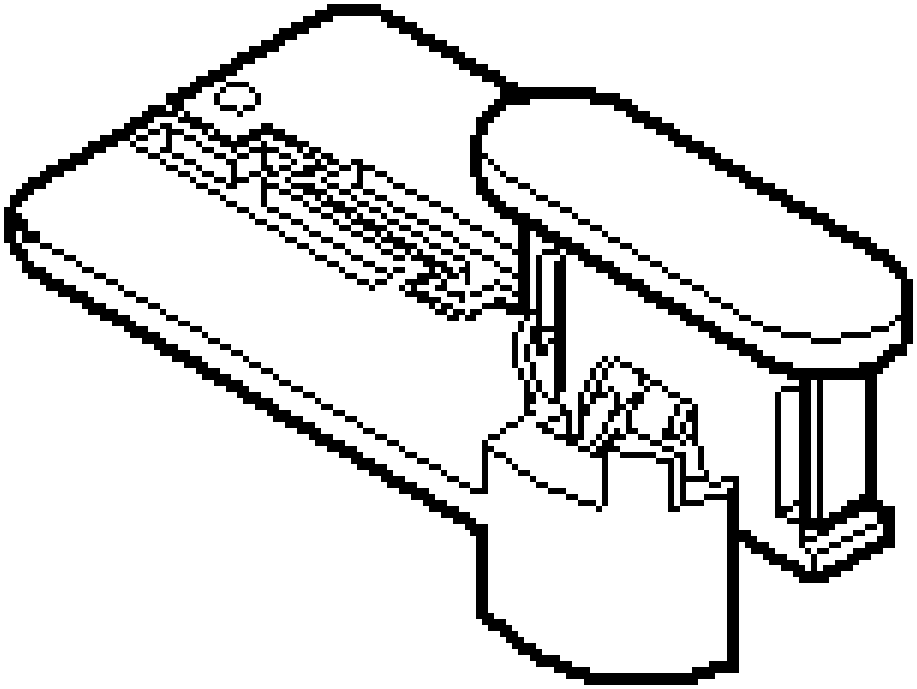
Illustration	Tool Number/ Description
	J-41688 Centering Sphere Installer - Tilt Steering Wheel

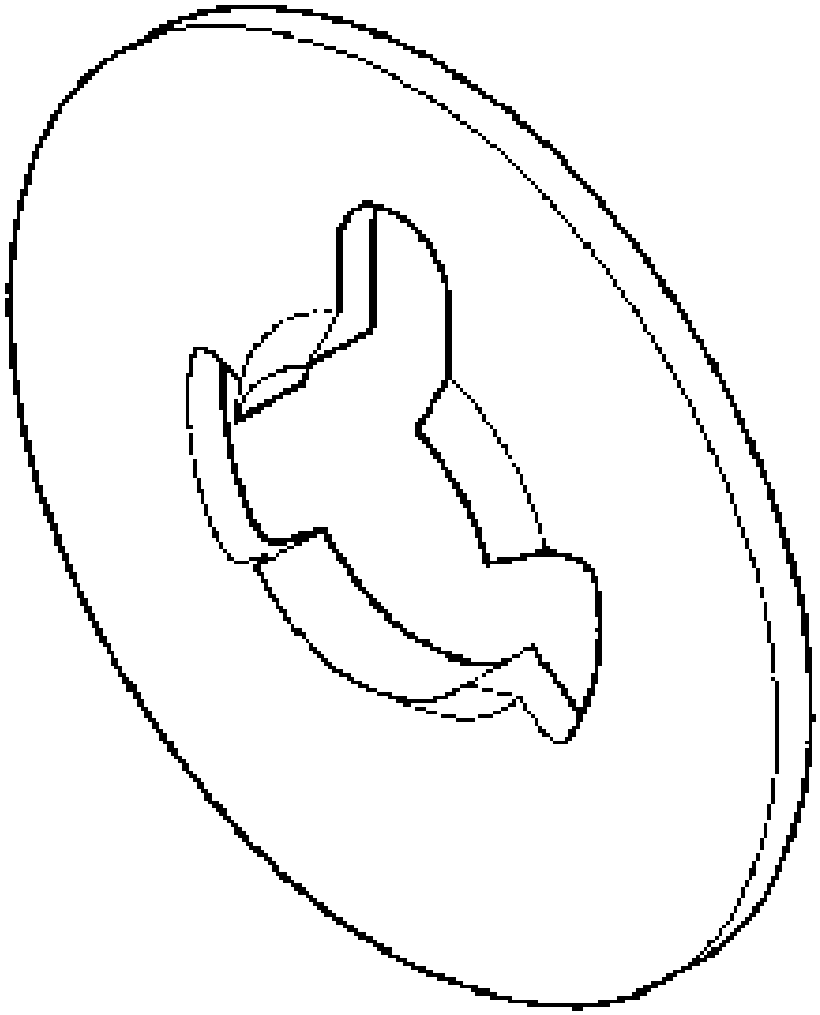
Illustration	Tool Number/ Description
	J-42137 Cam Orientation Plate Adapter

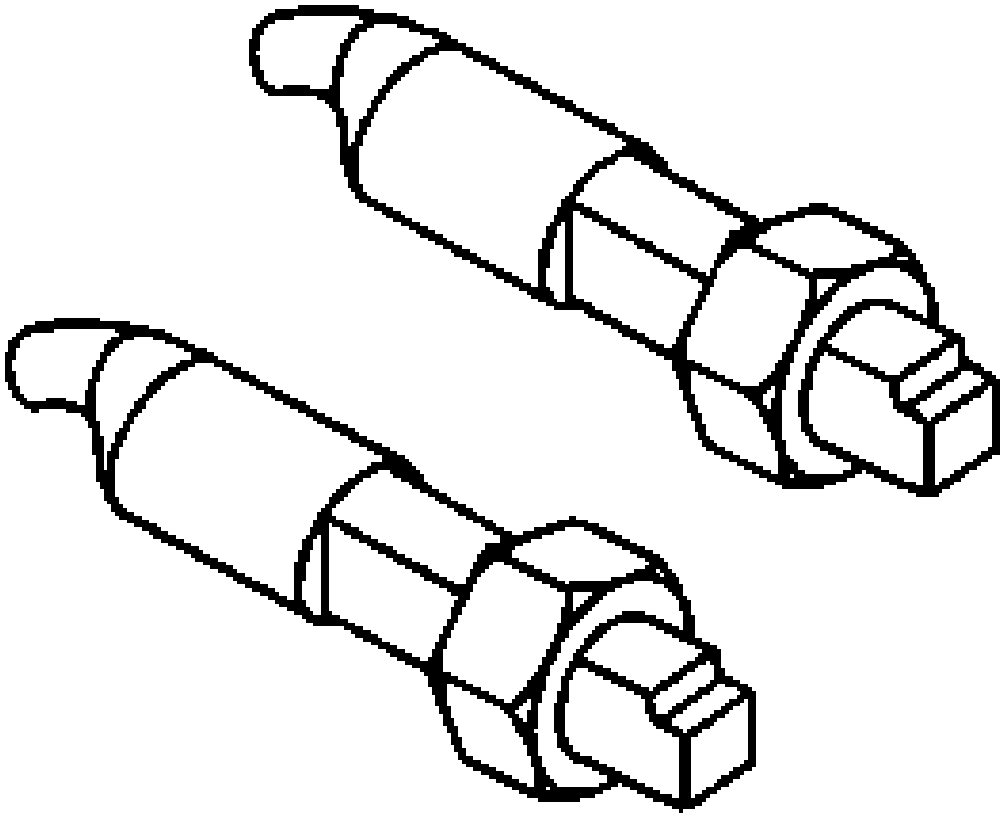
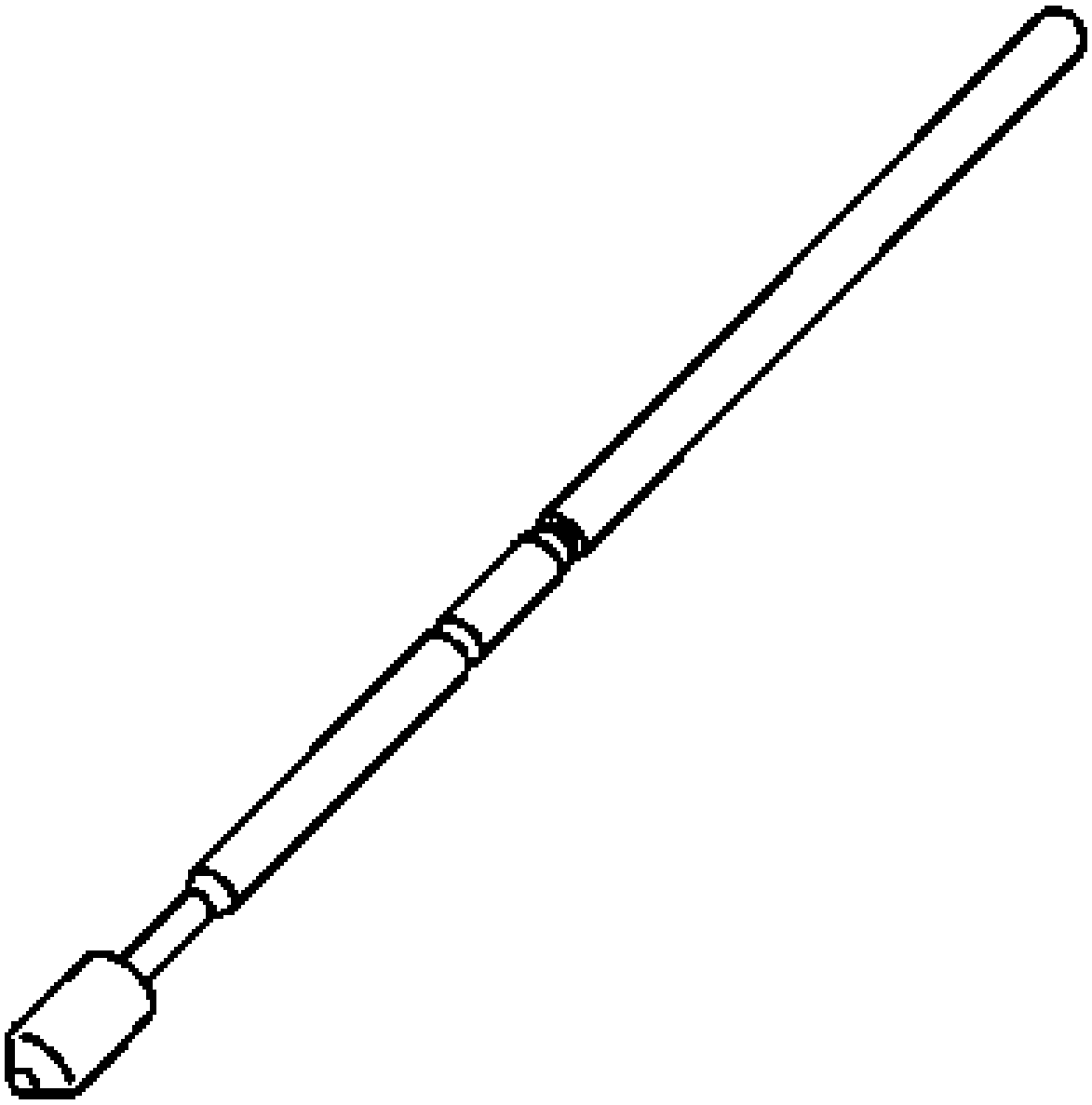
Illustration	Tool Number/ Description
	J-42578 Steering Wheel Puller Legs

Illustration	Tool Number/ Description
	J-42640 Steering Column Anti-Rotation Pin

Article GUID: A00737186

ACCESSORIES AND EQUIPMENT

Theft Deterrent - Impala

SCHEMATIC WIRING DIAGRAMS

THEFT DETERRENT SYSTEM WIRING SCHEMATICS

Theft Deterrent System

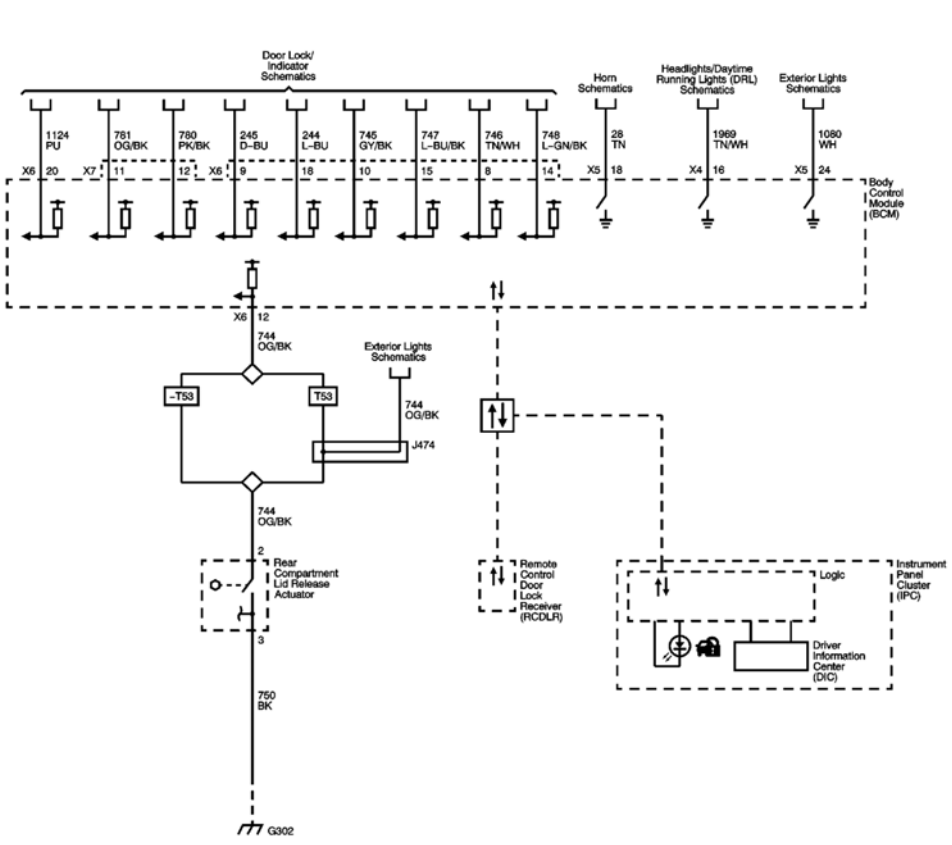


Fig. 1: Theft Deterrent System Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - THEFT DETERRENT

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform **Diagnostic System Check - Vehicle** in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following **Theft Systems Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Theft Deterrent System. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Content Theft Deterrent Malfunction**
- **Security Indicator Malfunction**

CONTENT THEFT DETERRENT MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The content theft deterrent (CTD) system is a software based system in which the body control module (BCM) actively monitors certain inputs to determine if unauthorized vehicle access is being attempted. Based on inputs such as the door ajar switches, the rear compartment ajar switch, and the hood ajar switch, the BCM determines whether a CTD alarm is warranted. If unauthorized access is being detected, the BCM will pulse the vehicle horn and flash the turn signals as a means of theft deterrence.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Theft Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Individually open and close each vehicle door while observing the door ajar indicator/message. The indicator/message should accurately transition between the door ajar and door closed state when each door is opened and closed.
    - If the door ajar indicator/message does not properly transition when each door is opened and closed, refer to **Door Ajar Indicator Malfunction** .
2. Open and close the trunk while observing the trunk ajar indicator/message. The indicator/message should accurately transition between the trunk ajar and trunk closed state when the trunk is opened and closed.
    - If the trunk ajar indicator/message does not properly transition when the trunk is opened and closed, refer to **Trunk Ajar Indicator Malfunction** .
3. Completely lower the driver door window and close all vehicle doors.
4. Ignition OFF, arm the CTD system using the keyless entry system by pressing the transmitter LOCK button twice. Verify the scan tool CTD Status parameter displays Armed.
    - If not the specified value, refer to **Remote Control Door Lock Transmitter Learn** .
5. Without disarming the system, reach in through the open driver window, unlock and open the driver door. Verify the scan tool CTD Status parameter displays Alarm Active.
    - If not the specified value, replace the BCM.
6. With the door open, verify the vehicle horn is pulsing and the exterior lamps are flashing.
    - If the horn is not pulsing, refer to **Horns Malfunction** .
    - If the exterior lights are not flashing, refer to **Turn Signal Lamps and/or Indicators Malfunction** .

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for BCM replacement, setup, and programming

SECURITY INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

Circuit/System Description

The security indicator acts as a status indicator for the content theft deterrent (CTD) system when the ignition is

OFF and as a fault indicator for the immobilizer system when the ignition is ON. When either the body control module (BCM) or theft deterrent module (TDM) requires the security indicator to be illuminated, a serial data message is sent to the instrument panel cluster (IPC), which will illuminate the indicator.

Reference Information

Schematic Reference

Theft Deterrent System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Theft Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, verify the security indicator illuminates when performing the scan tool IPC Display Test.

- If the security indicator does not illuminate, replace the IPC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for IPC replacement, setup, and programming

DESCRIPTION AND OPERATION

THEFT SYSTEMS DESCRIPTION AND OPERATION

When armed, the content theft deterrent (CTD) system is designed to deter vehicle content theft by pulsing the horns and exterior lamps for approximately 30 seconds when an unauthorized vehicle entry is detected. However, the CTD system does not affect engine starting.

An unauthorized entry can be any of the following with the CTD system armed:

- Unauthorized entry into the underhood area, if equipped with remote vehicle start
- Unauthorized entry into the rear compartment
- When any door is opened without first being unlocked using the vehicle key or using the UNLOCK command from a keyless entry transmitter
- After a battery reconnect, if the battery was disconnected with the CTD system armed

The components of the CTD system are:

- Body Control Module (BCM)
- Remote Control Door Lock Receiver (RCDLR)
- Security indicator
- Door ajar switches
- Driver door key cylinder switch
- Rear compartment lid ajar switch
- Hood ajar switch (if equipped)

Arming the CTD System

Use the following procedure in order to arm the system:

1. Place the shift lever in P (park).
2. Turn OFF the ignition.
3. Open any door.

IMPORTANT: The system is not armed if the doors are locked manually; the power door lock switch or remote keyless entry transmitter must be used to arm the content theft deterrent (CTD) system.

4. Lock the doors with the power door lock switch or the LOCK button on the transmitter. The system is in standby mode and will not start the arming timer until all doors are closed.
5. The system will begin the arm sequence immediately after the last door is closed. If the keyless entry transmitter is used to arm the system after the vehicle doors are closed, the arm sequence will begin as soon as the LOCK command is received from the transmitter.

Locking the Vehicle Without Arming the CTD System

Locking the vehicle may be accomplished without arming the content theft deterrent (CTD) system. Use of the manual door locks or using the key to lock the doors will lock the vehicle, but will not arm the CTD system.

Disarming an Armed System/Silencing an Alarm

If system arming has been requested by the power door lock switch or the keyless entry transmitter, it must be disarmed.

IMPORTANT: Using the power door unlock switch or manually unlocking the doors does not disable the content theft deterrent (CTD) arm mode. Also, disconnecting the battery or pulling fuses does not disable the arm mode, since the BCM stores the CTD mode status in memory.

- To disarm the CTD system in standby mode, perform one of the following:
  - Press either power door unlock switch.
  - Use the vehicle key to unlock the driver door.
  - Press the UNLOCK button on the keyless entry transmitter.
  - Insert a valid key into the ignition and switch to the ON position.
- To disarm the CTD system in the armed mode (non-event) or when activated (during an alarm event):
  - Use the vehicle key to unlock the driver door.
  - Press the UNLOCK button on the keyless entry transmitter.
  - Insert a valid key into the ignition and switch to the ON position

CTD Circuit Description

The following is a description of each component used in the content theft deterrent (CTD) system:

Body Control Module (BCM)

The CTD system is an internal function of the BCM which utilizes serial data and various switch inputs information to perform CTD functions. When the BCM detects an unauthorized entry, it activates the horns and exterior lamps. The BCM has 4 basic modes (disarmed, standby, armed, and alarm) for operating the CTD system. The different modes are described below.

1. The BCM has the CTD system in a disarmed mode until the following conditions are detected:
   - Ignition key turned to the OFF position.
   - Doors locked by either the power door lock switch or the LOCK button on the transmitter.
2. The BCM enters the standby mode when the above conditions are detected. If a door was already opened when the arm mode was requested, the standby mode does not start the timer until the last door is closed.
3. When the last door is closed, a 15 second timer is activated. Once the timer has expired, the BCM enters the armed mode. After this delay, any forced entry activates the alarm mode.
4. When the BCM detects a forced entry, the BCM enters the alarm mode. The BCM activates the horns and exterior lamps for 30 seconds. This is followed by a three minute time-out with the horn no longer active. If no new intrusions are detected after the time-out, the horn is not active. The system must be disarmed or the intrusion condition removed after the time-out for the system to exit alarm mode.

Remote Control Door Lock Receiver (RCDLR)

The keyless entry system can arm and disarm the CTD system. When the keyless entry module receives a door lock or unlock signal from the transmitter, the keyless entry module sends a message to the BCM via serial data to perform the appropriate arm/disarm functions.

Security Indicator

The security indicator is illuminated by the instrument panel cluster (IPC) based on information (via serial data) from the BCM for CTD, or theft deterrent module (TDM) for immobilizer. The CTD system uses the security indicator to inform the driver of system status prior to arming. The security indicator on the instrument cluster is controlled by both the CTD system and the immobilizer system.

- The CTD system, integral to the BCM, commands the IPC to control the security indicator only when the ignition switch is OFF. The CTD system uses the indicator to identify system status.
- The immobilizer system, integral to the theft deterrent module (TDM) or the RCDLR when the vehicle has keyless entry, commands the IPC to control the security indicator only when the ignition switch is ON as a malfunction indicator. The immobilizer system is to deter vehicle theft. Refer to **Immobilizer Description and Operation** for more information on the immobilizer system.

Door Ajar Switches

The CTD system uses the door ajar switches as a status indicator to activate the alarm. The door ajar switches are monitored by the BCM via a discrete input from each door ajar switch. If the BCM receives a signal indicating a door is opened when the CTD system is armed, the BCM activates the alarm.

Driver Door Key Cylinder Switch

The CTD system uses the driver door cylinder switch as a means to disarm the CTD system. The BCM receives the status of the driver door cylinder switch based on a discrete input from the switch. When the driver door key cylinder is rotated the CTD system will immediately disarm.

Hood Ajar Switch

The CTD system uses the hood ajar switch as a status indicator to activate the alarm. The BCM monitors the hood ajar switch via a discrete input from the switch. If the BCM receives a signal indicating the hood has been opened when the CTD system is armed, the BCM activates the alarm.

Rear Compartment Lid Ajar Switch

The CTD system uses the rear compartment ajar switch as a status indicator to activate the alarm. The BCM monitors the rear compartment ajar switch via a discrete input from the switch. If the BCM receives a signal indicating the rear compartment has been opened when CTD system is armed, the BCM activates the alarm.

Inputs

The BCM monitors the following inputs for CTD:

- The door ajar switches
- Driver door cylinder switch
- The keyless entry transmitter LOCK/UNLOCK buttons; a serial data message from the RCDLR
- The immobilizer status-The BCM uses the immobilizer status for disarming the system or silencing an alarm when the correct vehicle key is used to start the vehicle
- The rear compartment ajar switch
- The hood ajar switch

Outputs

The BCM controls the following for CTD:

- The horn relay
- The exterior lamps

Article GUID: A00737173

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Tire Pressure Sensor Nut	7 N.m	62 lb in

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC C0569: SYSTEM CONFIGURATION ERROR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0569 00

System Configuration Error

Circuit/System Description

If the tire type and pressure selection information is not entered with the scan tool during the remote control door lock receiver (RCDLR) setup, the tire pressure monitor indicator icon on the instrument panel cluster (IPC) will flash for 1 minute and then remain illuminated after the ignition switch is cycled ON and the IPC bulb check is complete. If equipped, the driver information center (DIC) will also display a service tire monitor type message. Under these circumstances, DTC C0569 will be set and the tire type and pressure information will need to be entered for the system to function correctly.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The RCDLR has not undergone the programming procedure.

Action Taken When the DTC Sets

- The tire pressure monitor indicator icon on the instrument panel cluster (IPC) flashes for 1 minute and then remains illuminated after the ignition switch is cycled ON and the IPC bulb check is complete.
- If equipped, the driver information center (DIC) displays the suspect tire pressure as dashes.
- If equipped, the DIC displays a service tire monitor type message.

Conditions for Clearing the DTC

A current DTC will clear when the RCDLR has undergone the tire type and pressure selection setup procedure and 1 ignition cycle has occurred.

Diagnostic Aids

A newly replaced RCDLR will set DTC C0569 after programming on its initial ignition ON cycle if the module setup information has not been entered. The Tire Type and Tire Pressure Selection setup must be performed with the scan tool.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that the DTC C0569 is not set.

- If the DTC is set, perform the RCDLR tire type and pressure selection setup with the scan tool and cycle the ignition. If the DTC resets, replace the RCDLR.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for RCDLR replacement, setup, and programming

DTC C0750, C0755, C0760, OR C0765: LOW TIRE PRESSURE SENSOR SIGNAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0750 00

Left Front Low Tire Pressure Sensor

DTC C0750 08

Left Front Low Tire Pressure Sensor Signal Invalid

DTC C0755 00

Right Front Low Tire Pressure Sensor

DTC C0755 08

Right Front Low Tire Pressure Sensor Signal Invalid

DTC C0760 00

Left Rear Low Tire Pressure Sensor

DTC C0760 08

Left Rear Low Tire Pressure Sensor Signal Invalid

DTC C0765 00

Right Rear Low Tire Pressure Sensor

DTC C0765 08

Right Rear Low Tire Pressure Sensor Signal Invalid

Circuit/System Description

The tire pressure monitor (TPM) system has a radio frequency (RF) transmitting pressure sensor in each wheel/tire assembly. As vehicle speed increases, centrifugal force closes the sensors internal roll switch, which puts the sensor into Rolling mode. The remote control door lock receiver (RCDLR) receives and translates the data contained in the tire pressure sensor RF transmissions into sensor presence, sensor mode, and tire pressure. Once vehicle speed is greater than 40 km/h (25 mph), the RCDLR waits for the sensors to go into rolling mode. If one or more sensors do not go into rolling mode, or do not transmit at all, the RCDLR will set DTC C0750, C0755, C0760, or C0765 respectively.

Conditions for Running the DTC

Vehicle speed is greater than 40 km/h (25 mph).

Conditions for Setting the DTC

- A sensor does not transmit for 18 minutes.
- A sensor low battery condition.

Action Taken When the DTC Sets

- The tire pressure monitor indicator icon on the instrument panel cluster (IPC) flashes for 1 minute and then remains illuminated after the ignition switch is cycled ON and the IPC bulb check is complete.
- If equipped, the driver information center (DIC) displays the suspect tire pressure as dashes.
- If equipped, the DIC displays a service tire monitor type message.

Conditions for Clearing the DTC

- A current DTC will clear when the malfunction is no longer present and 1 ignition cycle occurs.
- The RCDLR automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

- Some aftermarket wheel valve stem holes are located further from the wheel rim than original equipment wheels. When using the TPM special tool to activate a sensor, ensure the tool antenna is no further than 15 cm (6 in) from the sensor and is aiming upward.
- Aftermarket wheel valve stem locations can cause a sensor to not function correctly.
- A sensor may have been damaged due to a previous wheel/tire service or flat tire event.
- The use of other than GM approved tire sealants can obstruct the sensor pressure sensing port and cause inaccurate tire pressure readings. If this condition is verified, remove the sealer from the tire and replace the sensor. Refer to **Tire Pressure Indicator Sensor Replacement**.
- Occasionally sensor transmissions are not received by the RCDLR due to vehicle level RF interference from items such as but not limited to aftermarket ignition systems, DVD players, CB radios, or metallic type window tinting.
- The sensor activation procedure may have to be repeated up to 3 times before determining a sensor is malfunctioning. In the event a particular sensor's information is displayed on the special tool upon activation but the horn does not chirp, it may be necessary to rotate the wheel valve stem to a different position due to the RF signal is being blocked by another component.
- Occasionally sensors can become mislocated due to previous tire rotations where the sensor learn procedure was not performed or stray sensor transmissions have been received from other vehicles . Always learn the sensors to ensure the DTC set is for that actual physical corner of the vehicle. Refer to **Tire Pressure Indicator Sensor Learn**.
- A sensor low battery condition will set a sensor DTC but will not illuminate the low tire pressure indicator or display a message on the DIC, if equipped. The sensor battery condition can be verified in the scan tool RCDLR data list. If a sensor low battery condition is indicated on the scan tool, the sensor will need to be replaced. Refer to **Tire Pressure Indicator Sensor Replacement**.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-46079/J-46079 Tire Pressure Monitor Diagnostic Tool

Circuit/System Verification

1. Using the **EL-46079/J-46079** tool , activate each tire pressure sensor and record each sensors transmission data and physical location. Verify **EL-46079/J-46079** tool displays the 8-digit ID number, accurate tire pressure Â±27.6 kPa (4 psi), Learn Mode, and at least a 1/4 graph signal strength displayed.

- If any of the parameters listed above are not displayed, replace the suspect tire pressure sensor.

2. With the scan tool, verify tire pressure sensors ID and locations displayed on the scan tool match the IDs and locations recorded from the special tool.
   - If the IDs and locations do not match, perform the **Tire Pressure Indicator Sensor Learn**.
3. Enable the TPM learn mode. Use the **EL-46079/J-46079** tool in simulate mode to learn 4 simulated sensor transmissions into the RCDLR. Verify that all 4 simulated sensor locations, IDs, and tire pressures displayed on the TPM special tool match the corresponding scan tool parameters displayed.
   - If the scan tool does not match, replace the RCDLR.
4. Test drive the vehicle above 40 km/h (25 mph) for greater than 2 minutes. With the scan tool, observe the suspect Pressure Sensor Mode data parameter. Verify the sensor mode changes to Rolling.
   - If the Pressure Sensor Mode does not change, replace the suspect tire pressure sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Tire Pressure Indicator Sensor Replacement**
- **Tire Pressure Indicator Sensor Learn**
- **Control Module References** for RCDLR replacement, programming, and setup

DTC C0775: LOW TIRE PRESSURE SYSTEM SENSORS NOT LEARNED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0775

Low Tire Pressure System Sensors Not Learned

Circuit/System Description

If the tire pressure sensor learn procedure has not been performed, the tire pressure monitor indicator icon on the instrument panel cluster (IPC) will flash for 1 minute and then remain illuminated after the ignition switch is cycled ON and the IPC bulb check is complete. If equipped, the driver information center (DIC) will also display a service tire monitor type message. Under these circumstances, DTC C0775 will be set and the tire pressure sensor learn procedure will need to be performed for the system to function correctly.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The remote control door lock receiver (RCDLR) has not undergone the tire pressure sensor learn procedure.

Action Taken When the DTC Sets

- The tire pressure monitor indicator icon on the instrument panel cluster (IPC) will flash for 1 minute and then remain illuminated after the ignition switch is cycled ON and the IPC bulb check is complete.
- If equipped, the driver information center (DIC) displays a service tire monitor type warning message.

Conditions for Clearing the DTC

A current DTC will clear when the RCDLR has undergone the tire pressure sensor learn procedure and 1 ignition cycle has occurred.

Diagnostic Aids

A newly replaced RCDLR will set DTC C0775 on its initial ignition ON cycle. The tire pressure sensor learn procedure must be performed.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that the DTC C0775 is not set.

- If the DTC is set, perform the tire pressure sensor learn procedure. Cycle the ignition. If the DTC resets, replace the RCDLR.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Tire Pressure Indicator Sensor Learn**
- **Control Module References** for RCDLR replacement, setup, and programming

SYMPTOMS - TIRE PRESSURE MONITORING

1. Perform the **Diagnostic System Check - Vehicle** , before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Tire Pressure**

Monitor Description and Operation.

Visual/Physical Inspection

- Inspect if tires are inflated per placard values.
- Inspect for aftermarket devices which could affect the operation of the Tire Pressure Monitoring (TPM) System. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to **Low Tire Pressure Indicator Malfunction** in order to diagnose the symptom.

LOW TIRE PRESSURE INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The remote control door lock receiver (RCDLR) receives a radio frequency (RF) transmission from each tire pressure sensor. Each sensor has its own unique identification (ID) code, which it transmits as part of each RF message, that must be learned into the RCDLR memory. Once all 4 IDs have been learned and vehicle speed is greater than 40 km/h (25 mph), the RCDLR continuously compares IDs in received transmission to its learned IDs to determine if all 4 sensors are present. If the RCDLR detects a low tire pressure condition or a malfunction in the system, it will send a serial data message to the instrument panel cluster (IPC) requesting the appropriate tire pressure monitor indicator illumination and also to display the appropriate data message on the driver information center (DIC), if equipped.

Diagnostic Aids

- If unsure about the condition, cycle the ignition and observe the tire pressure monitor indicator icon. If the tire pressure monitor indicator icon is continuously illuminated after the IPC bulb check is completed, a low tire pressure condition is present. Check the tires for damage or leaks and inflate to the tire placard specifications. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** , . If the tire pressure monitor indicator icon flashes for 1 minute after the IPC bulb check is completed and then remains illuminated, a tire pressure monitor system DTC is set. Perform the **Diagnostic System Check - Vehicle** to proceed with the proper diagnosis.
- Temperature can greatly effect tire pressures. Low tire pressure on a cold morning may cause the tire pressure monitor indicator icon to turn ON. The air pressure in the tire increases as the ambient temperature rises or as the tire warms up while the vehicle is driven. The pressure may increase enough to exceed the predetermined low pressure threshold which will turn OFF the tire pressure monitor indicator icon .
- Some aftermarket wheel valve stem holes are located further from the wheel rim than original equipment

wheels. When using the TPM special tool to activate a sensor, ensure the tool antenna is no further than 15 cm (6 in) from the sensor and is aiming upward.

- Aftermarket wheel value stem locations can cause a sensor to not function correctly.
- A sensor may have been damaged due to a previous wheel/tire service or flat tire event.
- The use of other than GM approved tire sealants can obstruct the sensor pressure sensing port and cause inaccurate tire pressure readings. If this condition is verified, remove the sealer from the tire and replace the sensor. Refer to **Tire Pressure Indicator Sensor Replacement**.
- Occasionally sensor transmissions are not received by the RCDLR due to vehicle level RF interference from items such as but not limited to aftermarket ignition systems, DVD players, CB radios, or metallic type window tinting.
- The sensor activation procedure may have to be repeated up to 3 times before determining a sensor is malfunctioning. In the event a particular sensor's information is displayed on the special tool upon activation but the horn does not chirp, it may be necessary to rotate the wheel valve stem to a different position due to the RF signal is being blocked by another component.
- Occasionally sensors can become mislocated due to previous tire rotations where the sensor learn procedure was not performed or stray sensor transmissions have been received from other vehicles. Always learn the sensors to ensure the DTC set is for that actual physical corner of the vehicle. Refer to **Tire Pressure Indicator Sensor Learn**.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 46079 Tire Pressure Monitor Diagnostic Tool

Circuit/System Verification

NOTE: **Low tire pressure in one or more tires is indicated by a continuously illuminated tire pressure monitor indicator icon after the IPC bulb check is completed. If equipped with a DIC, a check tire pressure type message will also be displayed. It is not necessary to perform the Learn procedure for a low tire condition.**

When a TPM DTC is set, the tire pressure monitor indicator icon will flash for 1 minute after the IPC bulb check is completed and then remains illuminated. If equipped with a DIC, a service tire monitor type message will also be displayed.

1. Verify all tires are inflated to the proper pressure Â±10%. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .
    - If not within the specified range, adjust all tire pressures to specification and drive the vehicle over 40 km/h (25 mph) for greater than 2 minutes. Verify the tire pressure monitor indicator icon is OFF.
2. Using the **J 46079** tire pressure monitor diagnostic tool , activate each B2 Tire Pressure Sensor and record each sensor tire pressure reading. Check the tire pressures with a known accurate hand held tire pressure gauge. Verify that the pressure readings from the special tool do not differ more than 27.6 kPa (4 psi) from the actual tire pressure readings.
    - If not within the specified range, replace the appropriate B2 Tire Pressure Sensor.
3. Using a scan tool, enable the TPM learn mode. Use the **J 46079** tire pressure monitor diagnostic tool in simulate mode to learn 4 simulated sensor transmissions into the RCDLR. Observe tire pressures in the scan tool data display. Verify the simulated tire pressures do not differ more than +/-27.6 kPa (4 psi) of the scan tool reading.
    - If not within the specified range, replace the RCDLR.
4. Using a scan tool, perform the instrument panel special functions Lamp Test. Command the instrument panel warning lamps ON and OFF. Verify the tire pressure monitor indicator icon turns ON and OFF.
    - If the tire pressure monitor icon does not turn ON and OFF, replace the IPC.
5. Ignition ON, use the scan tool to setup the Tire Type/Pressure Selection in the RCDLR Module Setup menu. Refer to the **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** . Drive the vehicle over 40 km/h (25 mph) for greater than 2 minutes. Verify the tire pressure monitor indicator icon is OFF.
    - If the tire pressure monitor indicator icon is ON, replace the RCDLR.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Tire Pressure Indicator Sensor Replacement**
- **Tire Pressure Indicator Sensor Learn**
- **Control Module References** for IPC or RCDLR replacement, setup, and programming

REPAIR INSTRUCTIONS

TIRE PRESSURE INDICATOR SENSOR REPLACEMENT

Removal Procedure

1. Raise the vehicle on a suitable support. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire/wheel assembly from the vehicle. Refer to **Tire and Wheel Removal and Installation** .
3. Dismount the tire from the rim. Refer to **Tire Dismounting and Mounting** .

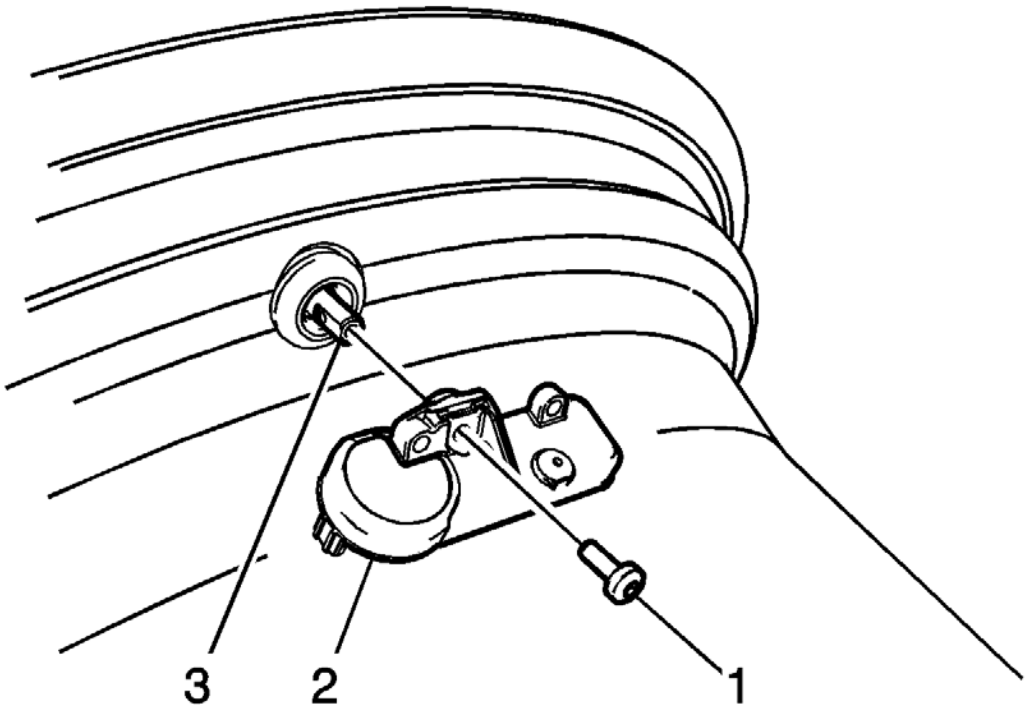


Fig. 1: View Of Tire Pressure Indicator Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When servicing the tire pressure sensor always use a new SchraderÂ® tire pressure monitor (TPM) and a new TORX screw during installation.**

4. Remove the TORX screw (1) from the tire pressure sensor (2) and pull it straight off the tire pressure valve stem (3).

CAUTION: **Do not scratch or damage the clear coating on aluminum wheels with the tire changing equipment. Scratching the clear coating could cause the aluminum wheel to corrode and the clear coating to peel from the wheel.**

5. Remove the tire pressure valve stem by pulling it through the rim.

Installation Procedure

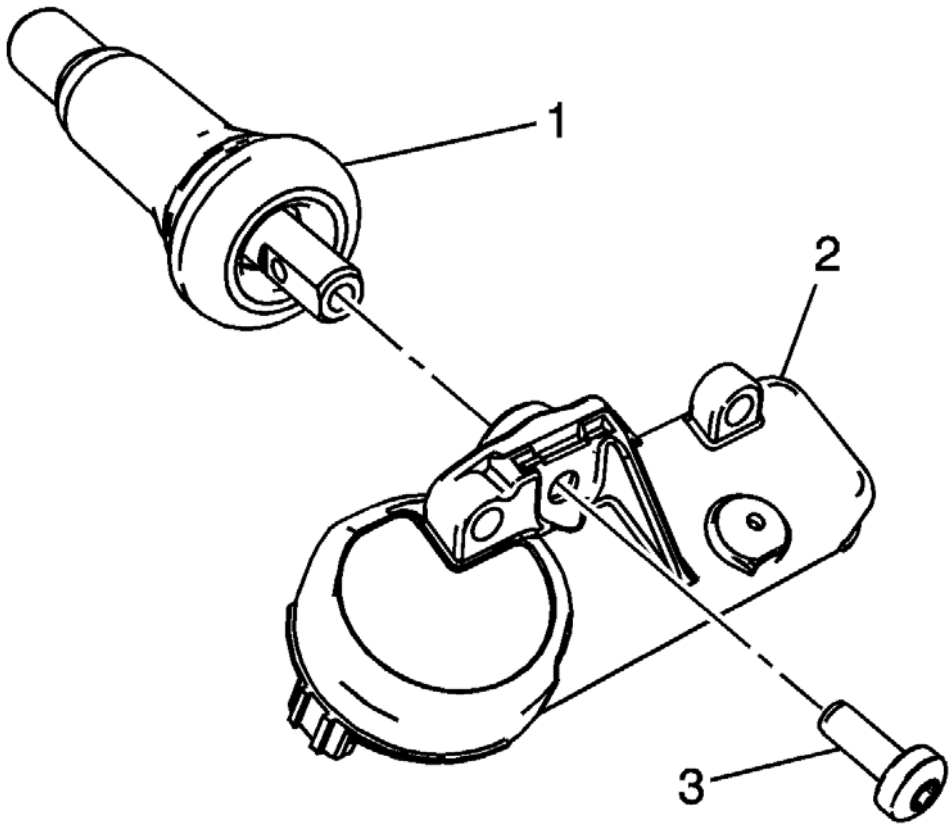


Fig. 2: View Of Tire Pressure Indicator Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE:

- **Ensure the flat of the valve, lines up with the flats of the snap in the enclosure.**
- **TPM valves and TORX screws are one-time use only.**

1. Assemble the tire pressure sensor (2) to the valve stem and install the new TORX screw (3) and tighten to 1.3 N.m (11.5 lb in).

NOTE: **Use and approved tire mounting lubricant. DO NOT use silicon or corrosive base compounds to lubricate the tire bead and the wheel rim. A corrosive type compound can cause tire or rim deterioration.**

2. Apply tire soap to the rubber portion of the valve stem (1).

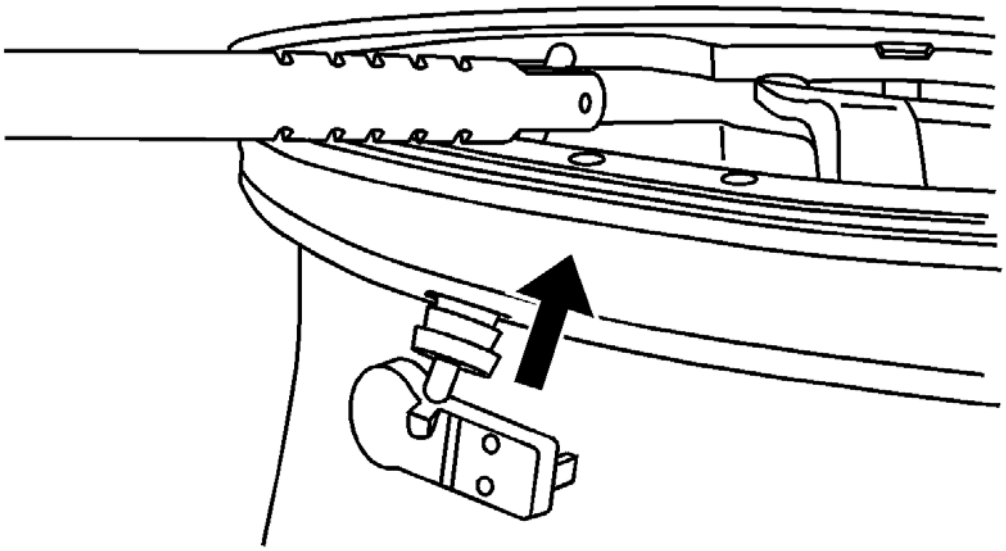


Fig. 3: View Of Tire Valve Stem Mounting Tool
Courtesy of GENERAL MOTORS COMPANY

3. Using a tire valve stem mounting tool, pull the valve stem through in a direction parallel to the valve hole on the rim.

NOTE: **Snap Fit TPM sensors are still shipped in the OFF mode. However, the TPM no longer needs to be spun to remove it from the OFF mode. The sensor will exit its OFF state when the tire is inflated. The technician can then program the vehicle as normal.**

4. Mount the tire to the rim. Refer to **Tire Dismounting and Mounting** .
5. Install the tire/wheel assembly on the vehicle. Refer to **Tire and Wheel Removal and Installation** .
6. Lower the vehicle.
7. Learn the tire pressure sensors. Refer to **Tire Pressure Indicator Sensor Learn**.

TIRE PRESSURE INDICATOR SENSOR LEARN

Special Tools

- **EL-46079** Tire Pressure Monitor Diagnostic Tool

or

- **EL-50448** Tire Pressure Monitor Sensor Activation Tool

For equivalent regional tools, refer to **Special Tools**.

Learn Mode Description

The tire pressure monitor (TPM) system uses the instrument panel cluster (IPC), body control module (BCM), remote control door lock receiver (RCDLR), keyless entry transmitter, 4 radio frequency transmitting pressure sensors, and the serial data circuit to perform the TPM learn mode functions. The sensor learn procedure must be performed after every tire rotation, RCDLR replacement, or sensor replacement. Once the learn mode has been enabled, each of the sensors unique identification codes can be learned into the RCDLR memory. When a sensor ID has been learned, the RCDLR sends a serial data message to the BCM to sound a horn chirp. This verifies the sensor has transmitted its ID and the RCDLR has received and learned it. The RCDLR must learn the sensor IDs in the proper sequence to determine correct sensor location. The first learned ID is assigned to the left front location, the second to right front, the third to right rear and the fourth to left rear. The turn signals will individually illuminate indicating which location is to be learned in the proper sequence.

Sensor Functions Using EL-46079, EL-50448, or Equivalent

Each sensor has an internal low frequency coil. When the TPM special tool is used in activate mode, it produces a low frequency transmission that activates the sensor. The sensor responds to a low frequency activation by transmitting in learn mode. When the RCDLR receives a learn mode transmission while in TPM learn mode, it will assign that sensors ID to the location on the vehicle relative to the order in which it was learned.

Learn Mode Cancellation

The learn mode will cancel if the ignition is cycled to OFF or if more than 2 minutes has elapsed for any sensor that has not been learned. If the learn mode is cancelled before the first sensor is learned, the original sensor IDs will be maintained. If the learn mode is canceled after the first sensor is learned, the following will occur:

- All stored sensor IDs will be invalidated in the RCDLR memory.
- If equipped, the DIC will display dashes instead of tire pressures.
- DTC C0775 will be set.

These conditions will now require the learn procedure to be repeated for the system to function properly.

TPM Learn Procedure

NOTE: **In the event a particular sensor's information is displayed on the special tool upon activation but the horn does not chirp, it may be necessary to rotate the wheel valve stem to a different position due to the sensor signal is being blocked by another component.**

TPM Learn Enable Methods

1. Ignition ON, initiate the TPM Learn Mode using one of the following procedures:
    - Using a scan tool, initiate the TPM Learn Mode. A double horn chirp will sound indicating the Learn Mode has been enabled. The left front turn signal will also be illuminated.
    - On vehicles equipped with keyless entry, simultaneously press the keyless entry transmitters lock and unlock buttons until a double horn chirp sounds indicating the Learn Mode has been enabled. The left

front turn signal will also be illuminated.

- On vehicles not equipped with keyless entry, press and release the driver information center (DIC) INFO button until the TIRE LEARN message appears on the DIC display. Press and hold the SET/RESET button until a double horn chirp sounds indicating the Learn Mode has been enabled. The left front turn signal will also be illuminated.

2. Starting with the left front tire, active the sensor by holding the antenna of the TPM special tool aimed upward against the tire sidewall close to the wheel rim at the valve stem location. Press and release the Activate button. Ensure that the transmit indicator on the special tool indicates that the sensor activation signal is being transmitted. Wait for a horn chirp. If the horn does not chirp, repeat the sensor activation sequence with the tool. Once the horn chirp has sounded, the sensor information is learned and the turn signal in the next location to be learned will illuminate.
3. After the horn chirp has sounded and the right front turn signal is illuminated, repeat step 2 for the remaining 3 sensors in the following order:
    1. Right front
    2. Right rear
    3. Left rear
4. When the left rear sensor has been learned and a double horn chirp has sounded, the learn process is complete and the RCDLR exits the learn mode.

DESCRIPTION AND OPERATION

TIRE PRESSURE MONITOR DESCRIPTION AND OPERATION

The tire pressure monitor (TPM) system warns the driver when a significant loss, or gain of tire pressure occurs in any of the 4 tires and allows the driver to display the individual tire pressures and their locations on the driver information center (DIC).

The system uses the body control module (BCM), driver information center (DIC), instrument panel cluster (IPC), remote control door lock receiver (RCDLR), a radio frequency (RF) transmitting pressure sensor in each wheel/tire assembly, and the serial data circuit to perform the system functions. Each sensor has an internal power supply with a 10 year service life.

When the vehicle is stationary, the sensors internal accelerometer is inactive, which puts the sensors into a stationary state. In this state the sensors sample tire pressure once every 30 seconds and do not transmit at all if the tire pressure does not change. As vehicle speed increases, centrifugal force activates the sensors internal accelerometer causing the sensors to go into rolling mode. In this mode, the sensors sample tire pressure once every 30 seconds and transmit in rolling mode once every 60 seconds. The RCDLR receives and translates the data contained in each sensors RF transmission into sensor presence, sensor mode, and tire pressure. The RCDLR sends the tire pressure and tire location data to the DIC via the serial data circuit where they are displayed.

The sensors continuously compare their last pressure sample to their current pressure sample and will transmit in re-measure mode if a 8.3 kPa (1.2 psi) change in tire pressure has been detected in either a stationary or rolling state. When the TPM system detects a significant loss, or gain of tire pressure, the tire pressure monitor indicator icon is illuminated on the IPC and if equipped, a check tire pressure type message is displayed on the DIC. Both the indicator icon and DIC message can be cleared by adjusting the tire pressures to the recommended kPa/psi and driving the vehicle above 40 km/h (25 mph) for at least 2 minutes.

If power is disconnected from the RCDLR or if the vehicle battery is disconnected each TPM sensor ID is retained but all of the tire pressure information is lost. Under these circumstances the RCDLR cannot assume that the tire

pressures were maintained over an unknown period of time. If equipped, the DIC will display all dashes and the scan tool will indicate a default tire pressure value of 1020 kPa (148 psi) for each tire. Driving the vehicle above 40 km/h (25 mph) for at least 2 minutes will activate the sensors causing the DIC to display the current tire pressures. The Tire Pressure Monitor Diagnostic Tool special tool or the pressure increase/decrease method may also be used to activate the sensors as well.

The RCDLR has the ability to detect malfunctions within the TPM system. In the event a DTC is set, the tire pressure monitor indicator icon on the IPC will flash for 1 minute and then remain illuminated after the ignition is turned ON and the IPC bulb check has been completed. Any malfunction detected will cause the DIC to display a service tire monitor system type message. For more information on other functions of the RCDLR, refer to **Keyless Entry System Description and Operation** .

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

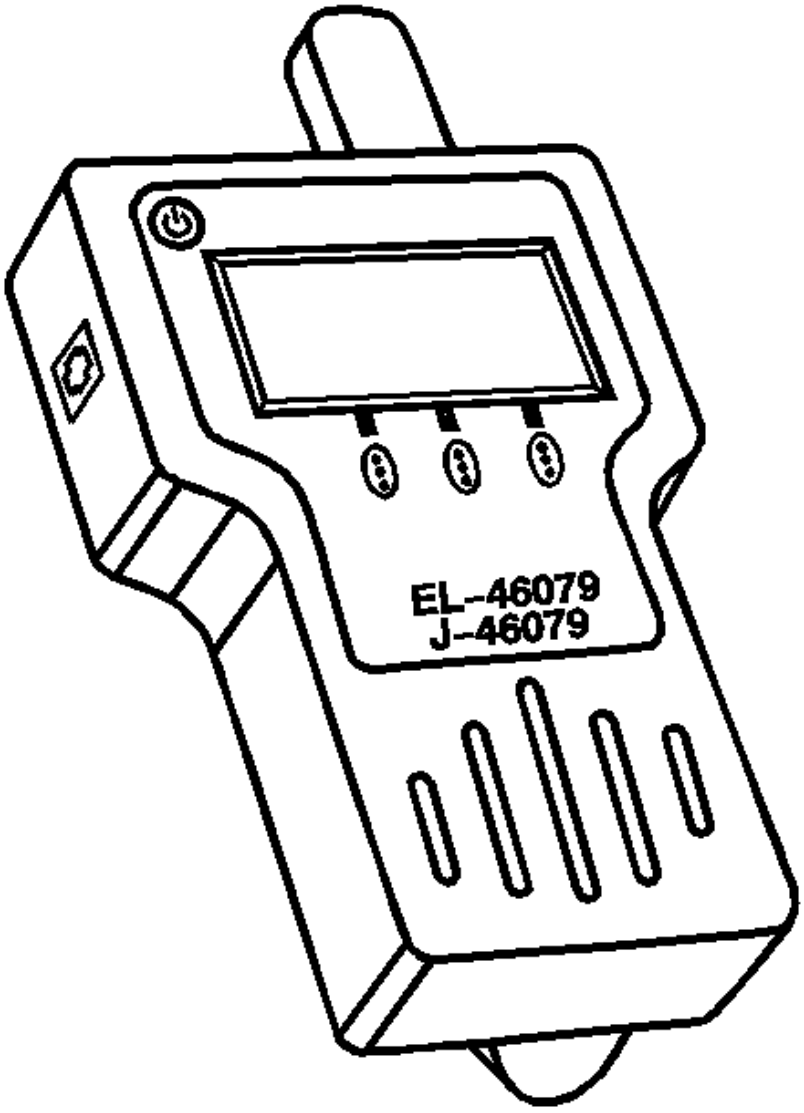
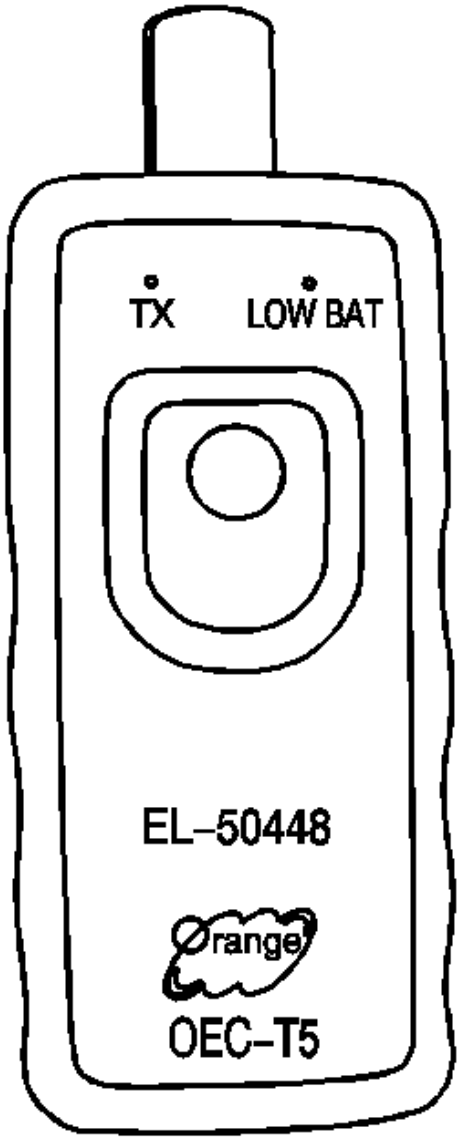
Illustration	Tool Number/Description
	EL 46079 Tire Pressure Monitor Diagnostic Tool

Illustration	Tool Number/Description
	EL 50448 Tire Pressure Monitor Sensor Activation Tool

Article GUID: A00737174

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Washer Solvent Container Nuts	10 N.m	89 lb in
Wiper Arm Nut	35 N.m	25 lb ft
Wiper Module Bolts	10 N.m	89 lb in
Wiper Motor Bolts	4.5 N.m	40 lb in
Wiper Motor Support Bracket Screws	5.5 N.m	49 lb in

SCHEMATIC WIRING DIAGRAMS

WIPER/WASHER WIRING SCHEMATICS

Wiper/Washer

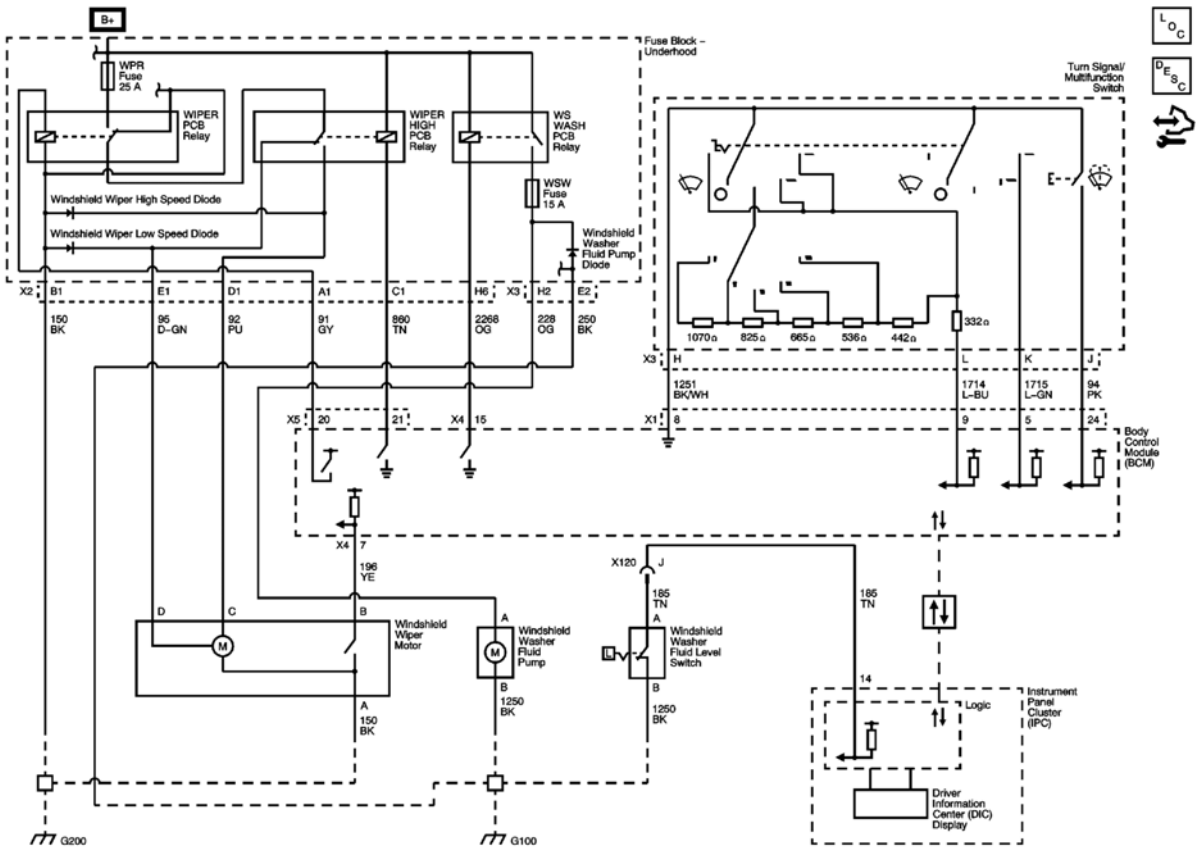


Fig. 1: Wiper/Washer Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B3715: FRONT WIPER RELAY CONTROL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3715 02

Front Wiper Relay Control Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Wiper Switch Signal terminal L	B3922 02	1	1	-
Windshield Wiper Switch Signal terminal K	4	2	2	-
Windshield Wiper Relay Control	B3715 02	1, 2	4	-
Windshield Wiper High Speed Control Relay Control	B3875 02	2	B3875 01	-
Windshield Wiper Motor Control terminal D	2	2	4	-
Windshield Wiper Motor Control terminal C	1	1	4	-
Windshield Wiper Park Signal	6	5	-	-
Windshield Wiper Switch Low Reference	-	1, 2	1, 2	-
Windshield Wiper Motor Ground	-	1, 2, 3	-	-
Windshield Wiper Relay Ground	-	1, 2	-	-

1. Delay or Low Speed Wipers Inoperative
2. High Speed Wipers Inoperative
3. Wipers Do Not Park
4. Wipers Always ON
5. Wiper Park Switch never ON
6. Wiper Park Switch always ON

Circuit/System Description

The body control module (BCM) monitors the control circuit of the WIPER PCB Relay. The voltage level should be low while the wiper relay is de-energized and near system voltage when the relay is energized. After the BCM receives a low, intermittent, or mist signal from the wiper/washer switch, it responds by applying

battery voltage through the wiper relay control circuit to the coil side of the relay, energizing the relay. Ground is supplied at all times to the coil side of the WIPER relay from G200.

Conditions for Running the DTC

This DTC can set only when the output is actively being requested by the BCM.

Conditions for Setting the DTC

If the BCM detects a short to ground in the wiper relay control circuit.

Action Taken When the DTC Sets

The BCM will not activate the output.

Conditions for Clearing the DTC

- The current DTC will become history when the request for the output is removed or when the condition for setting the fault is corrected.
- The history DTC will clear after 50 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the X2 harness connector at the X50A underhood fuse block, ignition ON. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal B1 and ground.

- **If greater than 10 Ω**

1. Test for less than 2 Ω in the ground circuit end to end.
    - If greater than 2 Ω, repair the open/high resistance in the circuit.
    - If less than 2 Ω, repair the open/high resistance in the ground connection.

- **If less than 10 Ω**

3. Connect a test lamp between the control circuit terminal A1 and ground.
4. Verify the test lamp turns ON and OFF while commanding the Wiper Relay ON and OFF with a scan tool.
    - **If test lamp always OFF**

    1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If greater than 2 Ω, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 body control module.

    - **If test lamp always ON**

    1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If greater than 1 V, repair the short to voltage in the circuit.
        - If less than 1 V, replace the K9 body control module.

    - **If test lamp turns ON and OFF**

5. Test or replace the underhood fuse block.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B3873: FRONT WASHER RELAY CONTROL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3873 01

Front Washer Relay Control Circuit short to voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Wiper Switch Signal	B3922 02	1	1	-
Windshield Washer Relay Control	-	1	B3873 01	-
Windshield Washer Fluid Pump Control	1	1	2	-
Windshield Wiper Switch Low Reference	-	1	-	-
Windshield Washer Pump Ground	-	1	-	-
1. Washers Inoperative 2. Washers Always ON				

Circuit/System Description

The windshield washer function is controlled by the body control module (BCM). When the washer switch is pressed, ground is applied through the switch contacts and the signal circuit to the BCM indicating the wash request. The BCM then applies ground through the control circuit to the coil side of the WS WASH relay energizing the relay. With the relay energized, battery voltage from the WPR fuse is applied through the switch contacts of the relay, the WSW fuse and the control circuit to the windshield washer fluid pump.

Conditions for Running the DTC

This DTC can set only when the output is actively being requested by the BCM.

Conditions for Setting the DTC

This DTC sets if the BCM detects a short to ground in the wiper high speed relay control circuit.

Action Taken When the DTC Sets

The BCM will not activate the output.

Conditions for Clearing the DTC

- The current DTC will become history when the request for the output is removed or when the condition for setting the fault is corrected.
- The history DTC will clear after 50 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the X50A underhood fuse block.
2. Connect a test lamp between the control circuit terminal H6 and ground, ignition ON.
3. Verify the test lamp turns ON and OFF when commanding the Windshield Washer Relay ON and OFF with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, disconnect the harness connector at the K9 body control module, ignition ON.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 body control module.
    - **If the test lamp is always ON**
    1. Ignition OFF, disconnect the harness connector at the K9 body control module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K9 body control module.
    - **If the test lamp turns ON and OFF**
4. Replace the X50A underhood fuse block.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B3875: WIPER HIGH SPEED CONTROL RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3875 02

Wiper High Speed Control Relay Short to Ground

DTC B3875 01

Wiper High Speed Control Relay Short to Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Wiper Switch Signal terminal L	B3922 02	1	1	-
Windshield Wiper Switch Signal terminal K	4	2	2	-
Windshield Wiper Relay Control	B3715 02	1, 2	4	-
Windshield Wiper High Speed Control Relay Control	B3875 02	2	B3875 01	-
Windshield Wiper Motor Control terminal D	2	2	4	-
Windshield Wiper Motor Control terminal C	1	1	4	-
Windshield Wiper Park Signal	6	5	-	-
Windshield Wiper Switch Low Reference	-	1, 2	1, 2	-
Windshield Wiper Motor Ground	-	1, 2, 3	-	-
Windshield Wiper Relay Ground	-	1, 2	-	-

1. Delay or Low Speed Wipers Inoperative
2. High Speed Wipers Inoperative
3. Wipers Do Not Park
4. Wipers Always ON
5. Wiper Park Switch never ON
6. Wiper Park Switch always ON

Circuit/System Description

The body control module (BCM) monitors the wiper high speed relay control circuit only when wiper high speed mode is active. When the wiper high speed mode is requested, the BCM responds by applying a ground through the wiper high speed relay control circuit to the coil side of the relay, energizing the wiper high relay.

Conditions for Running the DTC

This DTC can set only when the output is actively being requested by the BCM.

Conditions for Setting the DTC

This DTC sets if the BCM detects a short to battery voltage in the wiper high speed relay control circuit.

Action Taken When the DTC Sets

The BCM will not activate the output.

Conditions for Clearing the DTC

- The current DTC will become history when the request for the output is removed or when the condition for setting the fault is corrected.
- The history DTC will clear after 50 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block, ignition ON.
2. Connect a test lamp between the control circuit terminal C1 and battery voltage.
3. Verify the test lamp turns ON and OFF when commanding the Wiper High Speed Wiper ON and OFF with a scan tool.
    - **If test lamp is always OFF**
    1. Ignition OFF, remove the X5 harness connector from the K9 body control module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.

- If greater than 1 V, repair the short to voltage in the circuit.
- If less than 1 V

3. Ignition OFF.
4. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K9 body control module.

- **If test lamp is always ON**

1. Ignition OFF, disconnect the X5 harness connector at the K9 body control module.
2. Test for infinite resistance between the control circuit and ground.
    - If less than infinite resistance, repair the short to ground in the circuit.
    - If infinite resistance, replace the K9 body control module.

- **If test lamp turns ON and OFF**

4. Test or replace the underhood fuse block.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B3922: WINDSHIELD WIPER LOW SPEED SIGNAL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3922 02

Windshield Wiper Low Speed Signal Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Wiper Switch Signal terminal L	B3922 02	1	1	-
Windshield Wiper Switch Signal terminal K	4	2	2	-
Windshield Wiper Relay Control	B3715 02	1, 2	4	-
Windshield Wiper High Speed Control Relay Control	B3875 02	2	B3875 01	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Wiper Motor Control terminal D	2	2	4	-
Windshield Wiper Motor Control terminal C	1	1	4	-
Windshield Wiper Park Signal	6	5	-	-
Windshield Wiper Switch Low Reference	-	1, 2	1, 2	-
Windshield Wiper Motor Ground	-	1, 2, 3	-	-
Windshield Wiper Relay Ground	-	1, 2	-	-
1. Delay or Low Speed Wipers Inoperative 2. High Speed Wipers Inoperative 3. Wipers Do Not Park 4. Wipers Always ON 5. Wiper Park Switch never ON 6. Wiper Park Switch always ON				

Circuit/System Description

The body control module (BCM) monitors the windshield wiper switch low signal circuit. When the wiper switch is place in the low position, battery voltage is applied through the switch contacts, a series of resistors, and the wiper switch low signal circuit to the BCM. The BCM then applies battery voltage through the wiper relay control circuit to energize the WPR Relay. When energized, battery voltage from the WPR Fuse is applied through the switch side of the WPR relay then through the switch side of the WPR HI relay to the windshield wiper motor.

Conditions for Running the DTC

The ignition switch is in the ON position.

Conditions for Setting the DTC

The BCM detects a short to ground on the windshield wiper switch low signal circuit.

Action Taken When the DTC Sets

- The BCM will not activate the low speed output.
- The windshield wipers will only operate in the high speed mode.

Conditions for Clearing the DTC

- The DTC will clear the current status when the condition for setting the fault is corrected.
- A history DTC will clear after 50 consecutive ignition cycles without a fault present.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Testing

1. Ignition OFF, disconnect the X3 harness connector at the turn signal/multifunction switch, ignition ON.
2. Verify a test lamp illuminates between the low reference circuit terminal H and B+.
    - **If test lamp does not illuminate**
    1. Ignition OFF, disconnect the harness connector at the K9 body control module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 body control module.
    - **If test lamp does illuminate**
3. Verify the scan tool Windshield Washer Switch parameter is not Active.
    - **If Active**
    1. Ignition OFF, disconnect the harness connector at the K9 body control module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite , repair the short to ground on the circuit.
        - If infinite resistance, replace the K9 body control module.
    - **If not Active**
4. Install a 3 A fused jumper wire between the signal circuit terminal L and the low reference circuit terminal H.
5. Verify the scan tool Windshield Washer Switch parameter is Active.
    - **If not Active**
    1. Ignition OFF, disconnect the harness connector at the K9 body control module.
    2. Test for infinite resistance between the signal circuit and ground.

- If less than infinite , repair the short to voltage on the circuit.
- If less than 1 V

3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K9 body control module.

- **If Active**

6. Test or replace the turn signal/multifunction switch.

Component Testing

IMPORTANT: If the switch tests open in any switch position other than Off, test the wiper/washer switch signal circuits for a short to voltage before replacing the switch.

Wiper Switch Values

Switch Position	Resistance
Off	Infinite
Mist	300-364 Ω
Delay 1	3.48K-4.25K Ω
Delay 2	2.52K-3.08K Ω
Delay 3	1.78K-2.18K Ω
Delay 4	1.17K-1.44K Ω
Delay 5	697-851 Ω
Low	300-364 Ω

Multifunction Switch

1. Ignition OFF, disconnect the X3 harness connector at the turn signal/multifunction switch.
2. Rotate the wiper switch and compare the resistance readings to the values in the Windshield Wiper Switch Values table above for MIST, each DELAY and LOW speed.
3. Verify the correct resistance readings between signal circuit terminal L and low reference circuit terminal H.
    - **If the resistance values are not within the specified range**

      Replace the turn signal/multifunction switch.

    - **If the resistance values are within the specified range**
4. Test for infinite resistance between signal circuit terminals L and K while rotating the wiper switch to MIST, each DELAY and LOW speed positions.
    - **If the less than infinite**

      Replace the turn signal/multifunction switch.

    - **If infinite resistance**
5. Test for less than 5 Ω of between the signal circuit terminal K and low reference circuit terminal H.
    - **If greater than 5 Ω**

Replace the turn signal/multifunction switch.

- **If less than 5 Ω**

6. Test for infinite resistance between signal circuit terminals J and low reference circuit terminal H.
   - **If less than infinite**

     Replace the turn signal/multifunction switch.

   - **If infinite resistance**

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Turn Signal Multifunction Switch Replacement**
- **Control Module References** for BCM replacement, setup, and programming

SYMPTOMS - WIPER/WASHER SYSTEMS

The following steps must be completed before using the symptom tables:

IMPORTANT:

1. Perform the **Diagnostic System Check - Vehicle** , in order to verify that all of the following conditions are true.
   - No DTCs are set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Wiper/Washer System Description and Operation**.

Visual/Physical Inspection

- Inspect the washer fluid reservoir for the proper fluid level and condition.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for aftermarket devices which could affect the operation of the Windshield Wiper/Washer System.

Intermittent

- If the wipers operate at low speed for approximately 3 seconds and then stop, the wiper motor park switch, or its signal circuit, may be malfunctioning.
- Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Windshield Wiper System Malfunction**
- **Low Washer Fluid Indicator Malfunction**

- **Washer Malfunction**

WINDSHIELD WIPER SYSTEM MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Wiper High Speed Relay B+	1, 2	1, 2	-	-
Windshield Wiper Switch Low Signal	1	1	1	-
Windshield Wiper Switch High Signal	4	2	2	-
Windshield Wiper Motor Park Switch Signal	3	3	-	-
Front Wiper Relay Control	B3715 02	B3715 04	B3715 01	-
Windshield Wiper High Speed Relay Control	B3875 02	B3875 04	B3875 01	-
Windshield Wiper High Speed Relay Control	2	2	4	-
Front Wiper Motor Low Speed Control	1	1	4	-
Windshield Wiper Switch Low Reference	-	1, 2	1, 2	-
Windshield Wiper Motor Ground	-	1, 2, 3	-	-
Front Wiper Relay Ground	-	1	-	-
1. Delay or Low Speed Wipers Inoperative 2. High Speed Wipers Inoperative 3. Wipers Do Not Park 4. Wipers Always ON				

Circuit/System Description

Wiper Mist, Delay 1-5, and Low are all low speed wiper motor functions that are controlled by the body control module (BCM). When the wiper switch is placed in one of the Low speed wiper modes, ground is applied through the switch contacts a series of internal resistors and the wiper switch low signal circuit to the BCM. In response to this signal, the BCM energizes the Wiper Relay by applying battery voltage through the wiper relay control circuit to the coil side of the relay. This allows battery positive voltage from the WPR fuse to flow through the switch input side of the wiper relay and out to the switch input side of the WIPER HIGH relay. Since the wiper high relay is de-energized and its switch contacts are normally closed to the low speed control

circuit of the windshield wiper motor, the motor will operate at low speed.

When the wiper switch is placed in the High speed position, ground is applied through the switch contacts and the wiper switch high signal circuit to the BCM indicating the wiper high speed request. The BCM then energizes WIPER relay as stated above and the WIPER HIGH relay by applying ground through the control circuit to the coil side of the relay. With the wiper high relay energized and its switch contacts closed to the high speed control circuit of the wiper motor, the motor will operate at high speed.

Diagnostic Aids

- A short to ground in the following circuits will open the WPR fuse:
  - Windshield wiper motor relay coil supply voltage
  - Windshield wiper motor low speed control
  - Windshield wiper motor high speed control
- A short to B+ on any of the wiper/washer switch signal circuits will open the ground trace in the wiper switch.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the windshield wipers operate when commanding the Windshield Wipers ON with a scan tool.
   - **If Wipers Do Not Operate**
   1. Verify the solenoid in the relays listed below turn on and off/clicks when commanding the Windshield Wipers ON and OFF with a scan tool.

- KR12B Windshield Wiper Relay
- KR12C Windshield Wiper Speed Control Relay
- If the solenoid does not turn on and off/clicks, refer to Circuit/System Testing - Windshield Wiper Dual Relays Test.
- If the solenoid does turn on and off/clicks

2. Verify the scan tool Windshield Wiper Switch parameter changes between OFF, LOW, and HIGH while turning the wiper switch to the OFF, LOW, and HIGH positions.
   - If the parameter does not change between OFF, LOW, and HIGH, refer to Circuit/System Testing - Windshield Wiper/Washer Switch Circuit Test.
   - If the parameter does change between OFF, LOW, and HIGH, Refer to, refer to Circuit/System Testing - Windshield Wiper Motor Circuit Test.

- **If Wipers Operate**

3. Verify the scan tool Windshield Wiper Switch parameter changes between OFF, LOW, and HIGH while turning the wiper switch to the OFF, LOW, and HIGH positions.
   - **If the parameter does not change between OFF, LOW, and HIGH**

     Refer to Circuit/System Testing - Windshield Wiper/Washer Switch Circuit Test.

   - **If the parameter does change between OFF, LOW, and HIGH**
4. Verify the scan tool Windshield Wiper Switch parameter cycles from Delay 1 through Delay 5 while cycling through the INT delay adjustment positions with the wiper switch.
   - **If the parameter does not change from Delay 1 through Delay 5**

     Replace the S82 windshield wiper/washer switch.

   - **If the parameter changes from Delay 1 through Delay 5**
5. Verify the body control module Wiper Park Switch parameter is Active when the wipers are parked and Inactive when the wipers are ON or out of the park position.
   - **If the parameter is always Active or Inactive or the wipers do not park**

     Refer to Circuit/System Testing - Windshield Park Circuit Test.

   - **If the parameter changes between Active and Inactive and the wipers park**
6. All OK.

Circuit/System Testing

Windshield Wiper/Washer Switch Circuit Test

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the S82 windshield wiper/washer switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal H and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K9 body control module.
   2. Test for less than 2 Ω in the ground circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K9 body control module.

- **If less than 10 Ω**

3. Ignition ON.
4. Verify the scan tool Windshield Wiper Switch parameter is Off.
    - **If not Off**
    1. Ignition OFF, disconnect the harness connector at the K9 body control module.
    2. Test for infinite resistance between the signal circuit terminal L and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K9 body control module.
    - **If Off**
5. Install a 3 A fused jumper wire between the signal circuit terminal L and the low reference circuit terminal H.
6. Verify the scan tool Windshield Wiper Switch parameter is On.
    - **If not On**
    1. Ignition OFF, disconnect the harness connector at the K9 body control module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 body control module.
    - **If On**
7. Verify the scan tool Windshield Wiper High Speed Switch parameter is Inactive.
    - **If not Inactive**
    1. Ignition OFF, disconnect the harness connector at the K9 body control module.
    2. Test for infinite resistance between the signal circuit terminal K and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K9 body control module.
    - **If Inactive**
8. Install a 3 A fused jumper wire between the signal circuit terminal K and the low reference circuit terminal H.
9. Verify the scan tool Windshield Wiper High Speed Switch parameter is Active.
    - **If not Active**
    1. Ignition OFF, disconnect the harness connector at the K9 body control module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K9 body control module.

- **If Active**

10. Test or replace the S82 windshield wiper/washer switch.

Windshield Wiper Motor Circuit Test

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the M75 Windshield Wiper Motor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal A and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
3. Ignition ON.
4. Connect a test lamp between the control circuit terminal D and the ground circuit terminal A .
5. Verify the test lamp turns ON and OFF when commanding the LOW speed wipers ON and OFF with a scan tool.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, test or replace the KR12C windshield wiper speed control relay.
   - **If the test lamp is always ON**
   1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
   2. Test for less than 1 V between the control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, test replace the KR12C windshield wiper speed control relay.
   - **If the test lamp turns ON and OFF**
6. Connect a test lamp between the B+ circuit terminal C and the ground circuit terminal A.
7. Verify the test lamp turns ON and OFF when commanding the HIGH speed wipers ON and OFF with a scan tool.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module, ignition ON.
   2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V

3. Ignition OFF.
4. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, test or replace the KR12B windshield wiper relay.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the control circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, test or replace the KR12B windshield wiper relay.

- **If the test lamp turns ON and OFF**

8. Test or replace the M75 windshield wiper motor.

Wiper Park Circuit Test

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the M75 windshield wiper motor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal A and ground.
    - **If 10 Ω or greater**

    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ωor greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.

    - **If less than 10 Ω**

3. Ignition ON.
4. Verify the scan tool Windshield Wiper Park Switch parameter is Active.
    - **If not Active**

    1. Ignition OFF, disconnect the harness connector at the K9 body control module.
    2. Test for infinite resistance between the signal circuit terminal B and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K9 body control module.

    - **If Active**

5. Install a 3 A fused jumper wire between the signal circuit terminal B and the ground circuit terminal A.
6. Verify the scan tool Windshield Wiper Park Switch parameter is Inactive.
    - **If not Inactive**

    1. Ignition OFF, disconnect the harness connector at the K9 body control module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V

3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K9 body control module.
- **If Inactive**

7. Test or replace the M75 windshield wiper motor.

Windshield Wiper Dual Relays Test

1. Ignition OFF and all vehicle systems OFF, disconnect the KR12B Windshield Wiper Relay and the KR12C Windshield Wiper Speed Control Relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuits listed below and ground.
    - Terminal 87A at the KR12B Windshield Wiper Relay
    - Terminal 86 at the KR12C Windshield Wiper Speed Control Relay
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuits end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuits listed below and ground.
    - Terminal 87 at the KR12B Windshield Wiper Relay
    - Terminal 85 at the KR12C Windshield Wiper Speed Control Relay
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the B+ circuits end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the B+ circuits and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for infinite resistance between the B+ circuits and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the X50A underhood fuse block.
    - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85 at the

KR12B Windshield Wiper Relay.

6. Verify the test lamp turns ON and OFF when commanding the Windshield Wipers ON and OFF with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 Body Control Module.
    - **If the test lamp is always ON**
    1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K9 Body Control Module.
    - **If the test lamp turns ON and OFF**
7. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86 at the KR12C Windshield Wiper Speed Control Relay.
8. Verify the test lamp turns ON and OFF when commanding the Windshield Wipers ON and OFF with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If greater than 1 V, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 Body Control Module.
    - **If the test lamp is always ON**
    1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module, ignition ON.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K9 Body Control Module.
    - **If the test lamp turns ON and OFF**
9. Ignition OFF, reconnect the KR12C Windshield Wiper Speed Control Relay and KR12B Windshield Wiper Relay.
10. Disconnect the X4 Harness connector at the K9 Body Control Module, ignition ON.
11. Connect a 3 A fused jumper wire between B+ and the control circuit terminal 16 at the KR12B

Windshield Wiper Relay.

12. Verify the M75 Windshield Wiper Motor is activated.
    - **If the M75 Windshield Wiper Motor does not activate**
    1. Ignition OFF, disconnect the KR12C Windshield Wiper Speed Control Relay and KR12B Windshield Wiper Relay.
    2. Test for less than 2 Ω in the control circuit between control circuit terminal 30 at the KR12C Windshield Wiper Speed Control Relay and the control circuit terminal 30 at the KR12B Windshield Wiper Relay.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω
    3. Reconnect the KR12B Windshield Wiper Relay and the X4 harness connector at the K9 Body Control Module.
    4. Connect a test lamp between the control circuit terminal 30 and the control circuit terminal 87 at the KR12C Windshield Wiper Speed Control Relay, ignition ON.
    5. Verify the test lamp illuminates when commanding the Windshield Wipers ON.
        - If test lamp does not illuminate, test or replace the KR12C Windshield Wiper Speed Control Relay.
        - If test lamp illuminates, KR12B Windshield Wiper Relay.
    - **If the M75 Windshield Wiper Motor does activate**
13. All OK.

Component Testing

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 60-200 Ω between terminals 85 and 86.
    - **If less than 60 or greater than 200**

      Replace the relay.

    - **If between 60-200 Ω**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - **If less than infinite resistance**

      Replace the relay.

    - **If infinite resistance**
4. Test for less than 5 Ω between terminals 30 and 87A.

- **If 5 Ω or greater**

  Replace the relay.

- **If less than 5 Ω**

5. Install a 10 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
6. Test for less than 5 Ω between terminals 30 and 87.
   - **If 5 Ω or greater**

     Replace the relay.

   - **If less than 5 Ω**
7. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Turn Signal Multifunction Switch Replacement**
- **Windshield Wiper Motor Replacement**
- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup, and programming

LOW WASHER FLUID INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Washer Fluid Indicator Signal	1	2	-	-
Windshield Washer Fluid Level Switch Ground	-	1	-	-
1. Low washer fluid indicator inoperative 2. Low washer fluid indicator always on				

Circuit/System Description

The low washer fluid indicator is located in the instrument cluster. Ground is applied at all times to the windshield washer fluid level switch and the low washer fluid indicator signal circuit to the instrument cluster. When the washer fluid is low, the switch opens and ground is removed from the low washer fluid indicator signal circuit to the instrument cluster. The instrument cluster then displays the Low Washer Fluid Level

message.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Washer Fluid Level Switch parameter changes between On and Off when filling or depleting the windshield washer reservoir.
    - **If the parameter does not change**

      Refer to Circuit/System Testing

    - **If the parameter changes**
3. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B118B Windshield Washer Fluid Level Switch. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal B and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω, repair the open/high resistance in the ground connection.
- **If less than 10 Ω**

3. Ignition ON.
4. Verify the scan tool Washer Fluid Level Switch parameter is Off.
   - **If not Off**
   1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster.
   2. Test for infinite resistance between the signal circuit terminal A and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the P16 Instrument Cluster.
   - **If Off**
5. Install a 3 A fused jumper wire between the signal circuit terminal A and the ground circuit terminal B.
6. Verify the scan tool Washer Fluid Level Switch parameter is On.
   - **If not On**
   1. Ignition OFF, disconnect the harness connector at the P16 Instrument Cluster, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the P16 Instrument Cluster.
   - **If On**
7. Test or replace the B118B Windshield Washer Fluid Level Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Windshield Washer Solvent Level Switch Replacement**
- **Control Module References** for Instrument cluster replacement, setup, and programming

WASHER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Windshield Washer Switch	2	1	3	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal				
Windshield Washer Pump Control	1	1	2	-
Windshield Washer Relay Control	2	1	B3873 00	-
Windshield Washer Pump Ground	-	1	-	-
Windshield Wiper Switch Ground	-	3	-	-
1. Washers Inoperative 2. Washers Always On 3. Windshield Wiper System Malfunction				

Circuit/System Description

The windshield washer function is controlled by the body control module (BCM). When the washer switch is pressed, ground is applied through the switch contacts and the signal circuit to the BCM indicating the wash request. The BCM then applies ground through the control circuit to the coil side of the WS WASH relay energizing the relay. With the relay energized, battery voltage is applied through the switch contacts of the relay, the WSW fuse, and the control circuit to the windshield washer fluid pump.

Reference Information

Schematic Reference

Wiper/Washer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Wiper/Washer System Description and Operation

Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Testing

Washers Inoperative Starting Point

Ignition ON, with a test lamp connected to ground, probe each of the test points on the WSW fuse while activating the Windshield Washer Switch. The test lamp should illuminate at one or both of the fuse test points.

- If the test lamp does not illuminate at either test point, refer to the Washer Switch Test .
- If the test lamp illuminates, refer to the Washer Fluid Pump Test.

Washer Switch Test

1. Ignition ON, observe the scan tool Windshield Washer Switch parameter while pressing the Washer Switch. The reading should change between Inactive and Active.
    - If not Active, test the following:
    - Perform the multifunction switch component test.
    - Test the windshield washer switch signal circuit for an open/high resistance. If the washer switch and circuit test normal, test or replace the body control module.
2. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block.
3. Connect a test lamp between the washer relay control circuit terminal H6 and battery voltage.
4. Ignition ON, command the Wiper Washer Motor ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always OFF, test the control circuit terminal H6 for a short to voltage or an open/high resistance. If the circuit tests normal, replace the body control module.
5. If all circuits test normal, test or replace the underhood fuse block.

Washer Fluid Pump Test

1. Ignition OFF, disconnect the harness connector at the windshield washer fluid pump.
2. Test for less than 1 ohm of resistance between the ground circuit terminal B and ground.
    - If greater than 1 ohm, repair the ground circuit for an open/high resistance.
3. Connect a test lamp between the washer pump control circuit terminal A and ground.
4. Ignition ON, command the Wiper Washer Motor ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the underhood fuse block.
5. If all the circuits test normal, test or replace the windshield washer fluid pump.

Washers Always On

1. Remove the WSW fuse from the underhood fuse block. The washer pump should turn OFF.
    - If the washer pump does not turn OFF, repair the short to voltage on the washer pump control circuit.
2. Ignition ON, verify the scan tool Windshield Washer Switch parameter is Inactive.
    - If not Inactive, test the following:
    - Perform the multifunction switch component test.

- Test the windshield washer switch signal circuit for a short to ground. If the washer switch and circuit test normal, replace the body control module.

3. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block.
4. Ignition ON, verify that a test lamp does not illuminate between the windshield washer relay control circuit terminal H6 and battery voltage.
    - If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the body control module.
5. If all circuits test normal, test or replace the underhood fuse block.

Component Testing

Multifunction Switch

1. With the ignition OFF, disconnect the X3 harness connector at the turn signal/multifunction switch.
2. Test the resistance between terminals H and L. Rotate the wiper switch and compare the resistance readings to the values in the Windshield Wiper Switch Values table below for MIST, each DELAY and LOW speed.
    - If the resistance is not within the specified range, replace the turn signal/multifunction switch.
3. Test for infinite resistance with the wiper switch in the High speed position.
    - If less than infinite ohms, replace the turn signal/multifunction switch.
4. Test for infinite resistance between terminals H and K while rotating the wiper switch to MIST, each DELAY and LOW speed positions.
    - If the less than infinite, replace the turn signal/multifunction switch.
5. Test for less than 5 ohms of resistance with the wiper switch in the High speed position. .
    - If greater than 5 ohms, replace the turn signal/multifunction switch.
6. Test for infinite resistance between terminals H and J while rotating the wiper switch to MIST, each DELAY and LOW speed positions.
    - If less than infinite, replace the turn signal/multifunction switch.
7. Test for less than 5 ohms of resistance while pressing the WASHER switch.
    - If greater than 5 ohms, replace the turn signal/multifunction switch.

IMPORTANT: If the switch tests open in any switch position other than Off, test the wiper/washer switch signal circuits for a short to voltage before replacing the switch.

Wiper Switch Values

Switch Position	Resistance
Off	Infinite
Mist	300-364 Ω
Delay 1	3.48K-4.25K Ω
Delay 2	2.52K-3.08K Ω
Delay 3	1.78K-2.18K Ω
Delay 4	1.17K-1.44K Ω
Delay 5	697-851 Ω

Switch Position	Resistance
Low	2.52K-3.08K Ω

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Windshield Wiper Motor Replacement**
- **Washer Pump Replacement**
- **Control Module References** for BCM replacement, setup, and programming

REPAIR INSTRUCTIONS

WINDSHIELD WASHER HOSE REPLACEMENT (IMPALA LIMITED)

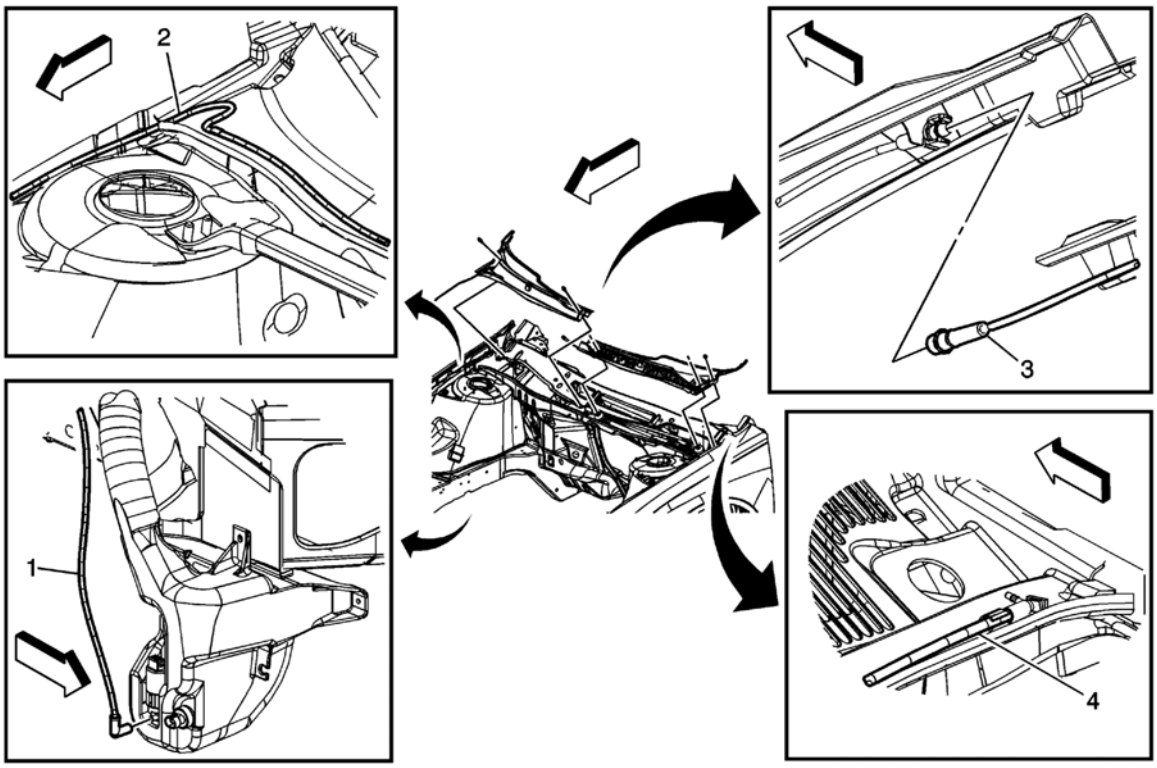


Fig. 2: Windshield Washer Hose (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures	

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the washer hose from the washer pump spout.
3. Remove the right fender liner. Refer to **Front Fender Liner Replacement** .
4. Drain the washer solvent into a suitable container.
5. Lower the vehicle.

Callout	Component Name
6. Open the hood. 7. Remove the passenger side wiper arm. Refer to **Windshield Wiper Arm Replacement**. 8. Remove the passenger side air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement**.	
1	Windshield Washer Hose to Washer Pump Connection
2	Washer Pump Hose **TIP:** Note the routing of the washer hose to the air inlet grille panel.
3	Windshield Washer Solvent Pump to Driver Side Washer Hose **TIP:** Ensure washer hose is re-connected upon passenger side air inlet grille installation.
4	Windshield Washer Container Hose **TIP:** Remove the washer hose from the large hole in behind the right front headlamp and fender assembly bracket.

WINDSHIELD WASHER SOLVENT CONTAINER REPLACEMENT

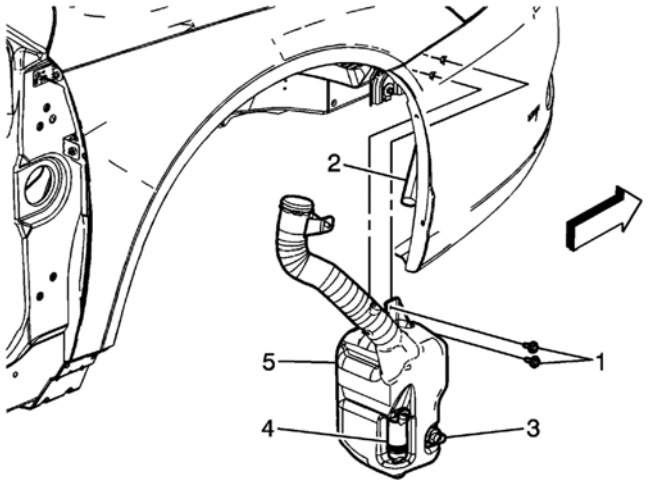


Fig. 3: Washer Solvent Container
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the right front wheelhouse panel liner. Refer to **Front Fender Liner Replacement** . 2. Disconnect the electrical connector from the windshield washer solvent level sensor switch. 3. Disconnect the electrical connector at the windshield washer pump. 4. Lower the vehicle. 5. Remove the screw from the filler neck at the RF fender flange. 6. Remove the washer solvent container filler cap.	
1	Windshield Washer Solvent Container Bolt (Qty: 2) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **TIP:** Transfer the cap and lower mounting bracket on the container to the new washer solvent container. **Tighten** 6 N.m (53 lb in)
2	Windshield Washer Pump Hose Assembly **TIP:** Disconnect the hose from the windshield washer pump spout and drain washer solvent into a suitable clean container.
3	Windshield Washer Level Sensor Switch
4	Windshield Washer Pump **TIP:** Discard old grommet and replace with a new grommet. Transfer the old pump to the new container.
5	Windshield Washer Container Assembly **TIP:** Lower the windshield washer container from RH chassis rail in between the RF fender bracket and bumper fascia.

WASHER PUMP REPLACEMENT

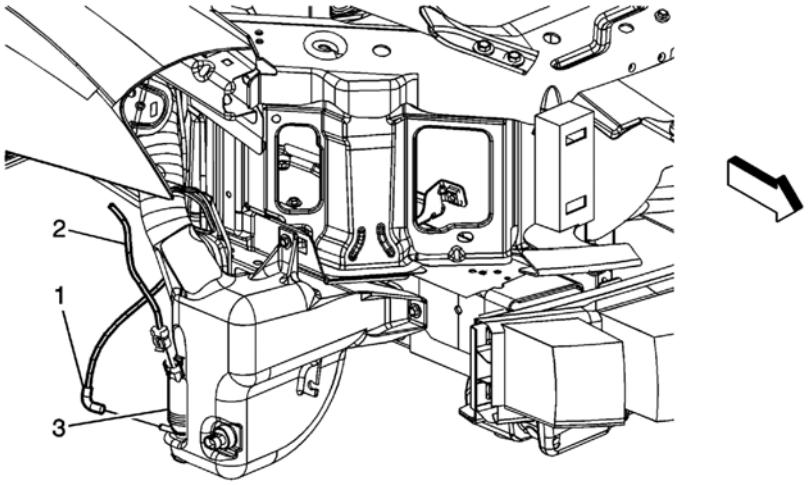


Fig. 4: Washer Pump
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to Fastener Specifications. **Preliminary Procedures** 1. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle . 2. Remove the right front wheelhouse panel liner. Refer to Front Fender Liner Replacement .	

Callout	Component Name
3. Drain the washer solvent into a suitable clean container.	
1	Hose, Windshield Washer Pump
2	Connector, Washer Pump Electrical **TIP:** Disconnect and position out of the way.
3	Pump, Windshield Washer **Tip** 1. Use two flat-bladed tools and pry upward in order to release the washer pump from the washer solvent container grommet. 2. Discard the old washer pump grommet. 3. Install a new grommet into the washer solvent container prior to installing the new washer pump. 4. Lubricate the new grommet with straight washer fluid. 5. Secure the new pump to the washer solvent container.

WINDSHIELD WASHER SOLVENT LEVEL SWITCH REPLACEMENT

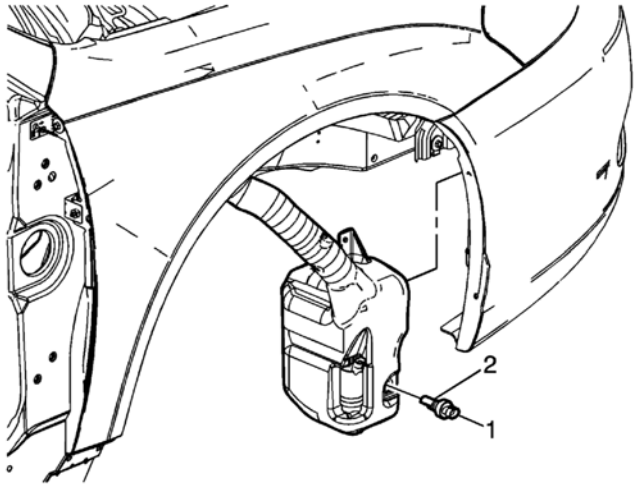


Fig. 5: Washer Solvent Container Level Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedures** 1. Remove the right front wheelhouse panel liner. Refer to **Front Fender Liner Replacement** . 2. Remove the windshield washer solvent container. Refer to **Windshield Washer Solvent Container Replacement**. 3. Drain the washer solvent into a suitable clean container.	

AIR INLET GRILLE PANEL REPLACEMENT

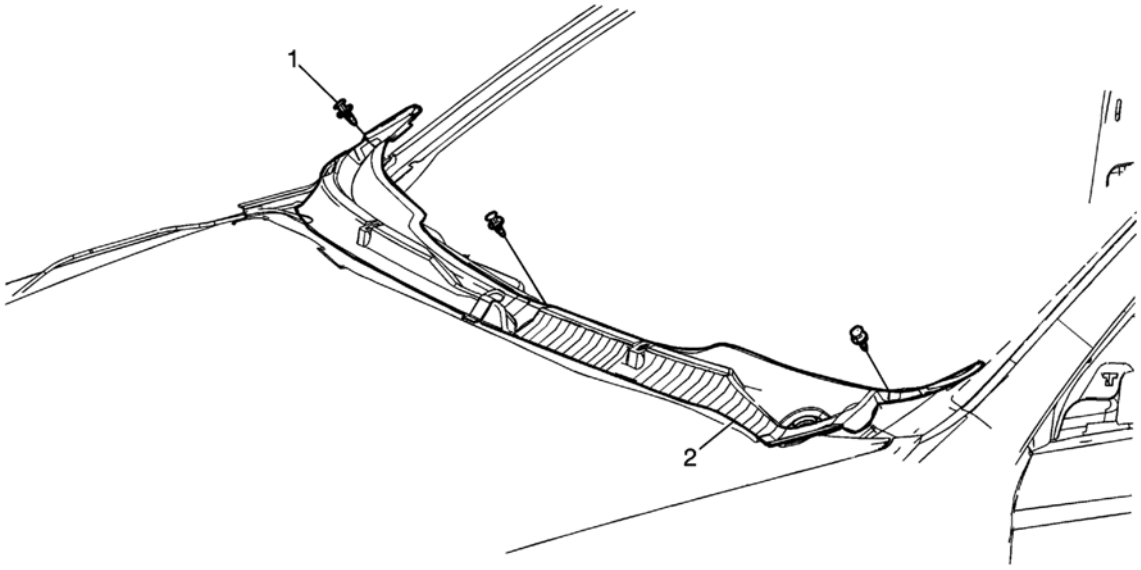


Fig. 6: Air Inlet Grille Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** . **Preliminary Procedure** Remove the wiper arms. Refer to **Windshield Wiper Arm Replacement**.	
1	Retainers, Air Inlet Grille (Qty: 4)
2	Grille, Air Inlet

WINDSHIELD WIPER ARM REPLACEMENT

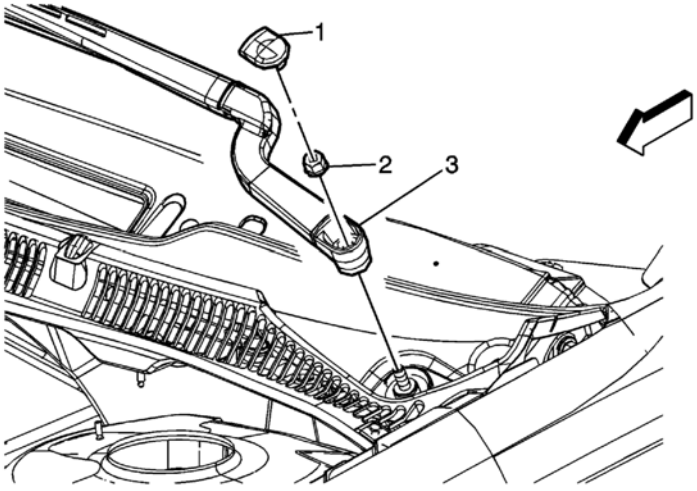


Fig. 7: Wiper Arm
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the wiper arm blades. Refer to **Windshield Wiper Blade Replacement (Impala Limited)**.	
1	Windshield Washer Transmission Nut Cap **TIP:** Use a small flat-bladed tool to remove the transmission cap.
2	Windshield Washer Transmission Support Nut **CAUTION:** **Refer to Fastener Caution .** **TIP:** Hold the wiper arm blade tip to the target points in the lower blackout area of the windshield while tightening the nut. **Tighten** 32 N.m (24 lb ft)
3	Windshield Washer Arm Assembly **TIP:** Use a **J 39637** Wiper Arm Puller or slightly rock the arm on the wiper pivot shaft to remove. **Special Tools** **J 39637** Wiper Arm Puller

WINDSHIELD WIPER BLADE REPLACEMENT (IMPALA LIMITED)

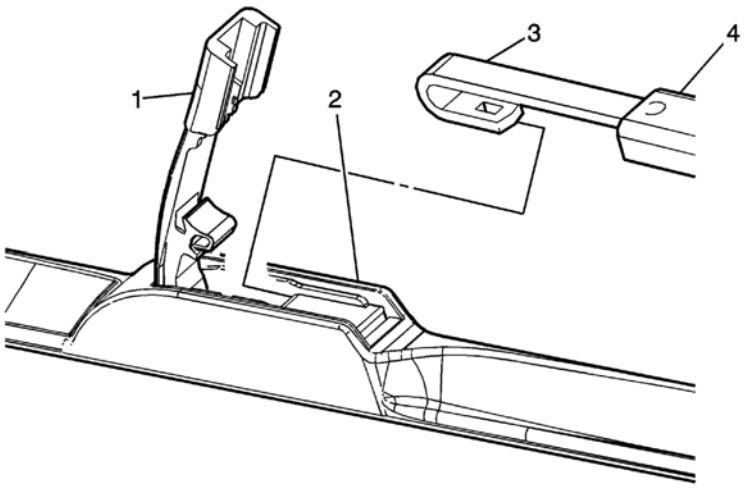


Fig. 8: Wiper Arm Blade (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	

Callout	Component Name
Preliminary Procedures 1. Raise the wiper arm off the glass, service up. 2. Do not let the wiper arm strike the glass without the blade attached.	
1	Retention Clip, Windshield Wiper Blade **TIP:** Lift the locking tab away from the wiper arm hook in order to disengage the wiper arm from the wiper blade.
2	Blade, Windshield Wiper Arm
3	Hook, Wiper Arm Sheep **TIP:** Push the wiper blade assembly onto the hook, pull the blade outward then secure the locking tab to the arm assembly.
4	Arm Assembly, Windshield Wiper

WIPER BLADE ELEMENT REPLACEMENT

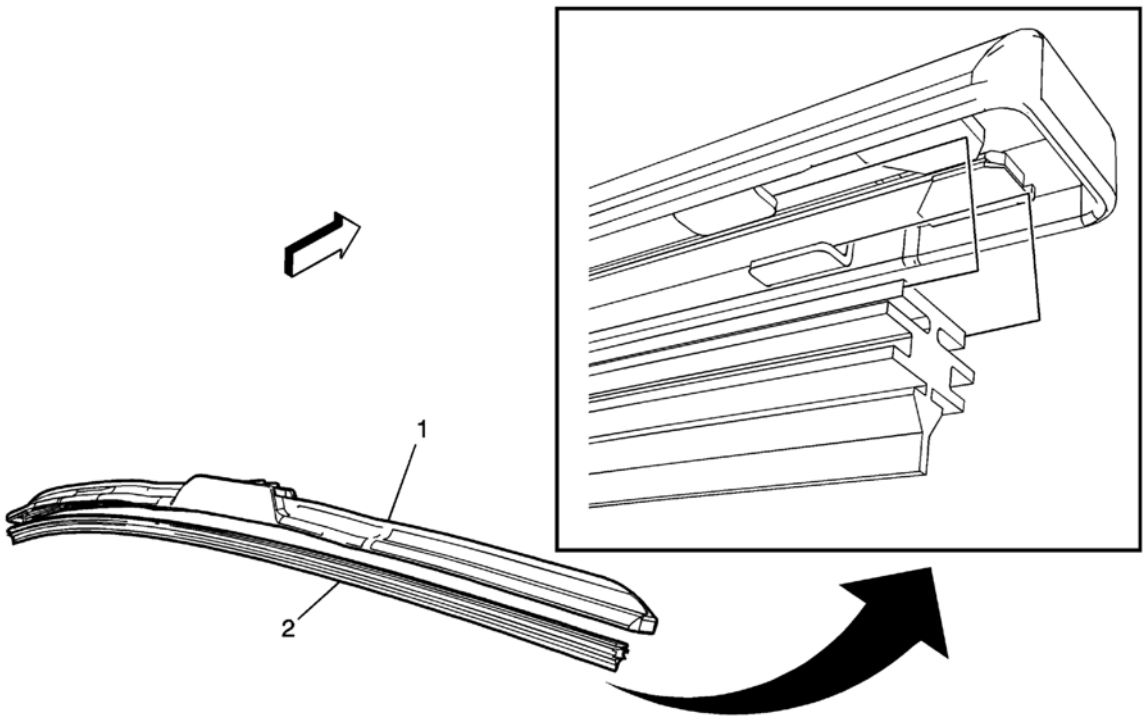


Fig. 9: Wiper Blade Element
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedures** 1. Position the wiper blade at a mid-wipe on the windshield. 2. Cycle the ignition key to the OFF position.	

Callout	Component Name
3. Raise the wiper blade off the glass.	
1	Blade Assembly, Windshield Washer
2	Element Assembly, Windshield Washer **TIP:** With a small pair of needle-nose pliers, secure the end of the wiper element and pull outward from the wiper blade claws in order to remove the element.

WINDSHIELD WIPER MOTOR REPLACEMENT

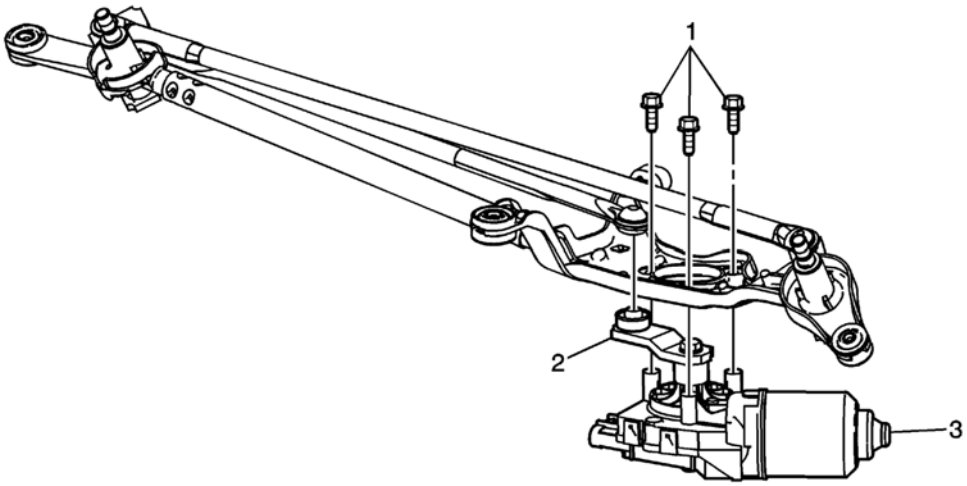


Fig. 10: Wiper Motor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the wiper arms. Refer to **Windshield Wiper Arm Replacement**. 2. Remove the air inlet grille panel. Refer to **Air Inlet Grille Panel Replacement**. 3. Remove the wiper drive system module. Refer to **Windshield Wiper System Module Replacement (Impala Limited)**.	
1	Windshield Wiper Motor Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 8 N.m (71 lb in)
2	Windshield Wiper Motor Crank Arm

Callout	Component Name
	Procedure 1. Use the **J 39232** Wiper Linkage Separator or equivalent to separate the transmission arm from the wiper motor crank arm pivot. 2. Use the **J 39529** Wiper Linkage Installer or equivalent to install the transmission arm onto the wiper motor crank arm pivot. **Special Tools** • **J 39232** Wiper Linkage Separator • **J 39529** Wiper Linkage Installer
3	Windshield Wiper Motor

WINDSHIELD WIPER SYSTEM MODULE REPLACEMENT (IMPALA LIMITED)

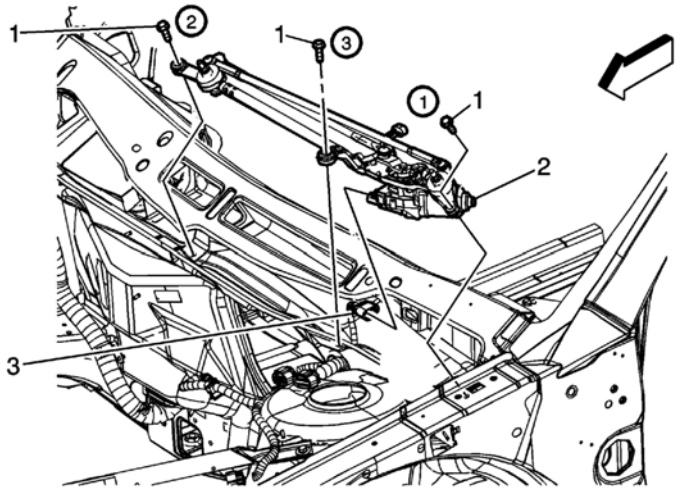


Fig. 11: Wiper Drive System Module (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the wiper arms. Refer to **Windshield Wiper Arm Replacement**. 2. Remove the air inlet grille panels. Refer to **Air Inlet Grille Panel Replacement**.	
1	Windshield Wiper Module Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	Procedure Tighten bolts in sequence as shown upon installation. **Tighten** 9 N.m (80 lb in)
2	Windshield Washer System Module Assembly 1. Raise the forward edge of the windshield washer module assembly out of the plenum panel first followed by disconnecting the wiper motor electrical connector. 2. Upon installation of the windshield washer module, turn the module 180 degrees, slide the module under the hood and align the rear locator to the backside of the plenum. 3. Tighten the bolts in sequence as shown.
3	Windshield Wiper Motor Connector **TIP:** Connect the electrical connector to the wiper motor prior to installing the module assembly back into the plenum.

WINDSHIELD GLASS CLEANING

Exterior:

Clean the windshield with windshield cleaner, GM P/N 19287404 (18 oz.) or 19259280 (6 oz.) (Canadian P/N 88865156) or equivalent. The cleaner should not harm the paint finish or scratch the glass. The glass is clean when the water no longer beads, but sheets across the entire glass surface.

Interior:

The interior glass should be cleaned with plain water only applied with a clean terry cloth towel. Water only eliminates any film or haze on the window and helps prevent fogging.

WIPER BLADE ELEMENT CLEANING

Lift each blade assembly off of the windshield and clean the element with a cloth saturated with full strength washer solvent. Then rinse the blade assemblies with clear water.

WIPER CHATTER REPAIR

Some vehicles may exhibit a condition where the windshield wipers chatter and/or wipe unevenly. Several items may contribute to this condition. To completely repair this condition, ALL of the items listed should be tested and repaired as necessary.

- Clean the windshield glass. Refer to **Windshield Glass Cleaning**.
- Clean the wiper blade elements. Refer to **Wiper Blade Element Cleaning**.
- Clean and inspect the wiper blade element set. Refer to **Wiper Blade Element Cleaning**.

DESCRIPTION AND OPERATION

WIPER/WASHER SYSTEM DESCRIPTION AND OPERATION

Wiper/Washer System Components

The Wiper/Washer System consists of the following components:

- Windshield wiper/washer switch
- Body control module (BCM)
- Wiper PCB relay
- Wiper high PCB relay
- Windshield wiper motor
- Windshield washer fluid pump
- Windshield washer fluid level switch
- WPR fuse 25 A
- WSW fuse 10 A

Refer to **Master Electrical Component List** .

Power and Grounds

With the ignition in the ON position, accessory voltage is supplied through the 25A WPR fuse to the WIPER PCB relay, the WIPER HIGH PCB relay and the WS WASH PCB relay that are all located in the underhood fuse block. Refer to **Wiper/Washer Schematics**.

G200 provides ground for the windshield wiper motor and the WIPER PCB relay. G100 provides ground for the windshield washer fluid pump and the windshield washer fluid level switch.

Low Speed Operation

When the wiper switch is in the low speed position, ground is applied through the switch internal resistor and the wiper switch low signal circuit to the body control module (BCM). In response to this signal, the BCM energizes the WIPER PCB relay by applying battery voltage through the wiper relay control circuit to the coil side of the relay. This allows battery positive voltage from the WPR fuse to flow through the switch input side of the WIPER PCB relay and out to the switch input side of the WIPER HIGH PCB relay. Since the wiper high relay is de-energized and its switch contacts are normally closed to the low speed control circuit of the windshield wiper motor, the motor will operate at low speed.

Wiper motor low speed operation and the wiper PCB relay can also be commanded ON/OFF by using a scan tool. Refer to **Control Module References** .

Mist Operation

Windshield wiper/washer system MIST operation is identical to wiper Low operation, except that the mist switch is a press and release type switch. When the wiper switch is moved to the mist position and released, low speed wiper motor operation is started and will continue until 1 wipe cycle is complete. If the wiper switch is moved to the mist position and held, the wiper motor will operate in the low mode until the switch is released.

Delay Operation

Windshield wiper delay operation is a low speed wiper motor function with a variable delay interval between the wiper motor cycles. The delay interval is determined by a series of 6 resistors within the wiper/washer

switch. The body control module (BCM) monitors the wiper switch low signal circuit to determine the delay interval between the low speed wiper motor wipe cycles.

High Speed Operation

When the wiper switch is in the high speed position, ground is applied through the windshield wiper switch high signal circuit to the body control module (BCM) indicating the wiper high speed request. In response to this signal, the BCM then energizes the wiper PCB relay, as stated above, and the wiper high PCB relay by applying ground through the control circuit to the coil side of the relay. With the wiper high relay energized and its switch contacts closed to the high speed control circuit of the wiper motor, the motor will operate at high speed.

Wiper motor high speed operation and the wiper high speed PCB relay can also be commanded ON/OFF by using a scan tool. Refer to **Control Module References** .

Wash Operation

When the windshield Wash switch is pressed, ground is applied through the switch contacts and the windshield washer switch signal circuit to the body control module (BCM) indicating the windshield wash request. The BCM then energizes the wiper PCB relay, as stated above, and the WS WASH PCB relay by applying ground through the control circuit to the coil side of the relay. With the wash relay energized, battery voltage from the WPR fuse is applied through the switch side of the relay and out to the control circuit of the windshield washer fluid pump. The washer fluid pump and the wiper motor will operate for 2 wipe cycles after the wash switch is released.

The WS WASH PCB relay can also be commanded ON/OFF by using a scan tool. Refer to **Control Module References** .

Park Position Operation

Windshield wiper motor park operation is controlled by the body control module (BCM) using an input from the park switch that is located within the wiper motor assembly. The BCM monitors the windshield wiper motor park switch signal circuit, to determine if the windshield wiper blades are at the bottom of the glass. During wiper operation, each time the wiper blades are at the bottom of the glass, the park switch is momentarily closed to ground signaling the BCM the wiper position. When the wiper switch is turned to the OFF position while the wiper motor is somewhere in mid-cycle, the BCM will continue to operate the motor until the wipers reach the park position. If the ignition is turned OFF while the wipers are in mid-cycle, the wipers will stop immediately where they are. The BCM will park the wipers the next time the ignition is turned ON.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

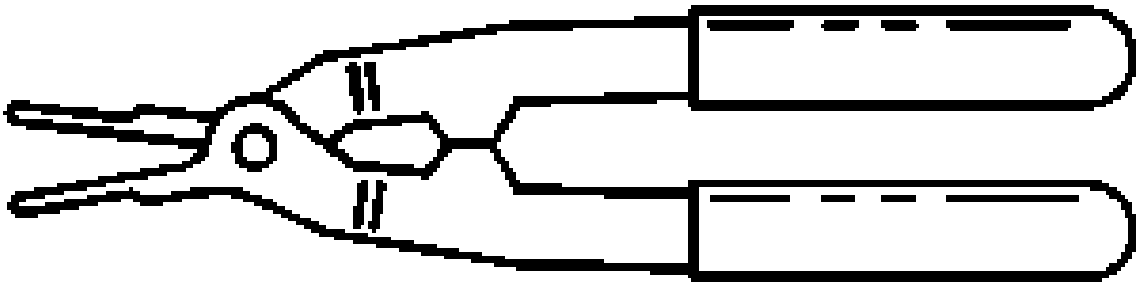
Illustration	Tool Number/ Description
	J 39232 Wiper Linkage Separator

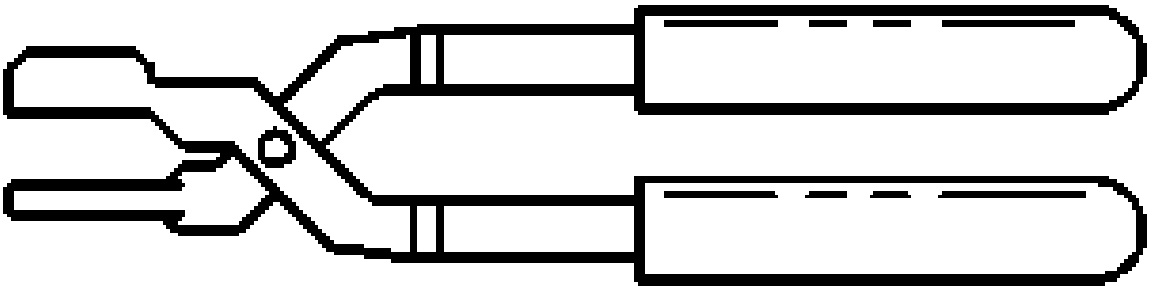
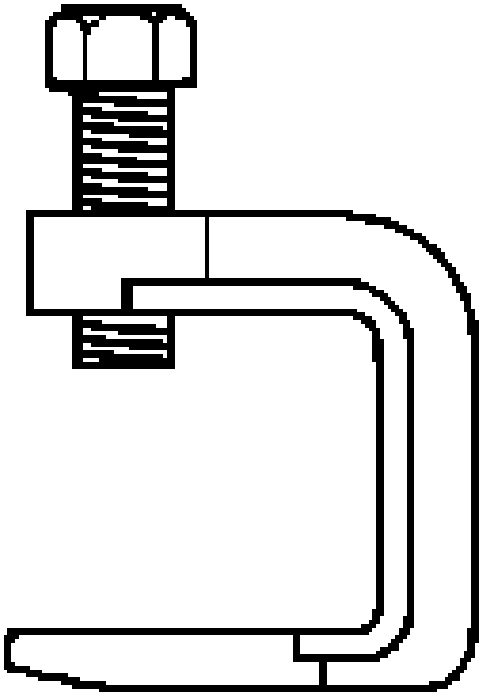
Illustration	Tool Number/ Description
	J 39529 Wiper Linkage Installer

Illustration	Tool Number/ Description
	J 39637 Wiper Arm Remover Tool

Article GUID: A00737171

REPAIR INSTRUCTIONS

GMLAN AND MEDIA ORIENTED SYSTEMS TRANSPORT (MOST) WIRING REPAIRS

Special Tools

- **EL-38125-10** Splice Sleeve Crimping Tool
- DuraSeal splice sleeves
- A wire stripping tool

For equivalent regional tools, refer to Special Tools .

The DuraSeal splice sleeves have the following 2 critical features:

- A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.
- A cross hatched (knurled) core crimp provides necessary contact integrity for the sensitive, low energy circuits.

The GM Local Area Network (GMLAN) System requires special wiring repair procedures due to the sensitive nature of the circuitry. Follow the specific procedures and instructions when working on GMLAN connectors and terminals.

GMLAN Repairs

NOTE: **When making a repair to any GMLAN network, the original wire length after the repair must be the same length as before the repair. If the network is a twisted pair, the twist must be maintained after the repair is completed.**

GMLAN has 2 types of networks, low speed and high speed. Low speed GMLAN has a single wire and works at slow speeds. High speed GMLAN has 2 wires in a twisted pair and works at higher speeds. For more information on GMLAN, refer to **Data Link Communications Description and Operation** .

GMLAN Connector Terminal Repair

NOTE: **A terminated lead can be used to replace damaged connector terminals for both high speed and low speed GMLAN systems. When making a connector terminal repair on a GMLAN high speed system with twisted pair wires, do not untwist the wires more than necessary to make the repair.**

If the individual terminals are damaged on any GMLAN connection, use the appropriate connector repair procedure in order to repair the terminal. Refer to **Connector Repairs** for the appropriate connector repair procedure.

GMLAN Wire Repair

NOTE: **Refer to Wiring Repairs in the service information connector end views or the vehicle schematics in order to determine the correct wire size for the circuit you are repairing. You must obtain this information in order to ensure circuit integrity.**

If any wire except the pigtail is damaged, repair the wire by splicing in a new section of wire of the same gauge size (0.5 mm^2 , 0.8 mm^2 , 1.0 mm^2 etc.). Use the DuraSeal splice sleeves and **EL-38125-10** tool. For wiring repair, refer to **Splicing Copper Wire Using Splice Sleeves** .

Media Oriented Systems Transport (MOST) Wiring Repair

NOTE: **If harness repair/analysis is performed, MOST bus Twist Pair unshielded wire should be 0.35 mm^2 (22 AWG) wire with at least one twist per each 1 45/64 inch (45 mm) and must not be untwisted for more than 3 15/16 of an inch (10 cm).**

The following conditions need to be met to ensure a valid continuity:

- Untwisted length for all MOST 50 circuits at each wire harness connector should be no longer 50 mm max (25 mm preferred).
- When wire repairs are made, a minimum 25 twists/meter for all MOST 50 circuits.
- MOST 50 has specific receive and transmit I/O.

The transmit of one module is connected to receive of the next module in ring topology.

RELAY REPLACEMENT (ATTACHED TO WIRE HARNESS)

Removal Procedure

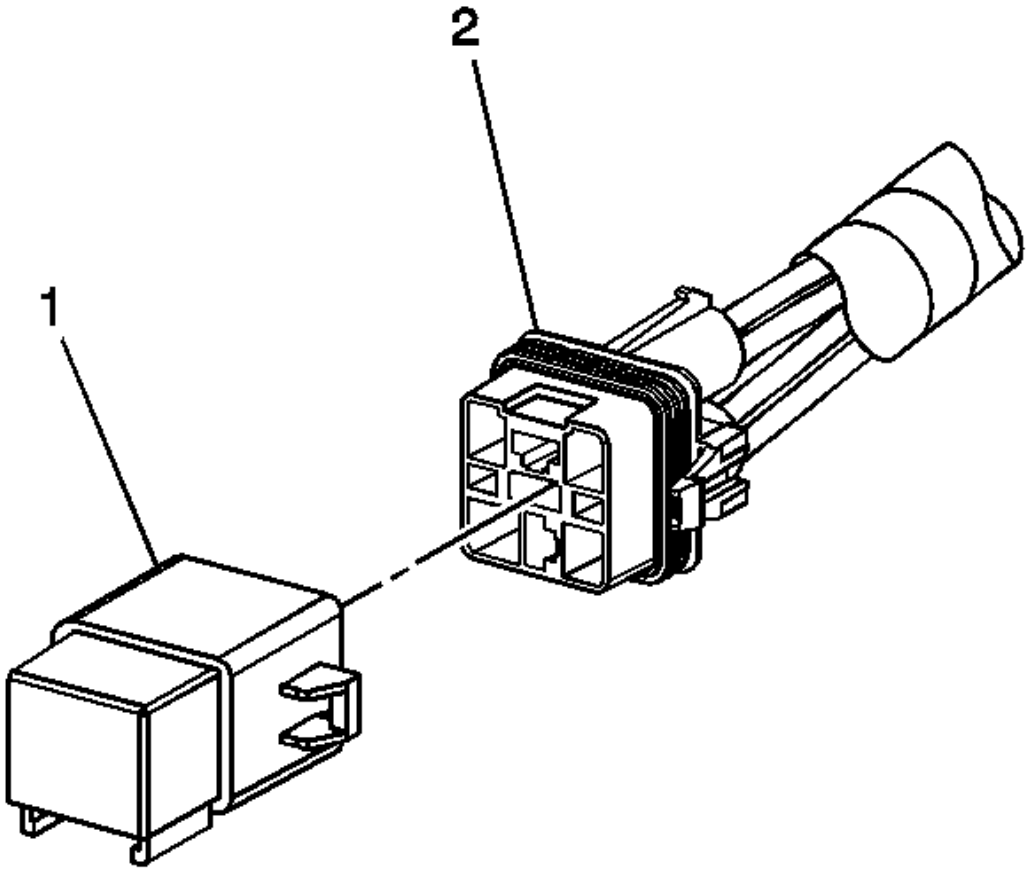


Fig. 1: Identifying Relay & Wire Harness Connector
Courtesy of GENERAL MOTORS COMPANY

1. Locate the relay. Refer to the **Master Electrical Component List** to locate the relay in the vehicle.
2. Remove any fasteners which hold the relay in place.
3. Remove any connector position assurance (CPA) devices or secondary locks.

NOTE: **Use care when removing a relay in a wiring harness when the relay is secured by fasteners or tape.**

4. Separate the relay (1) from the wire harness connector (2).

Installation Procedure

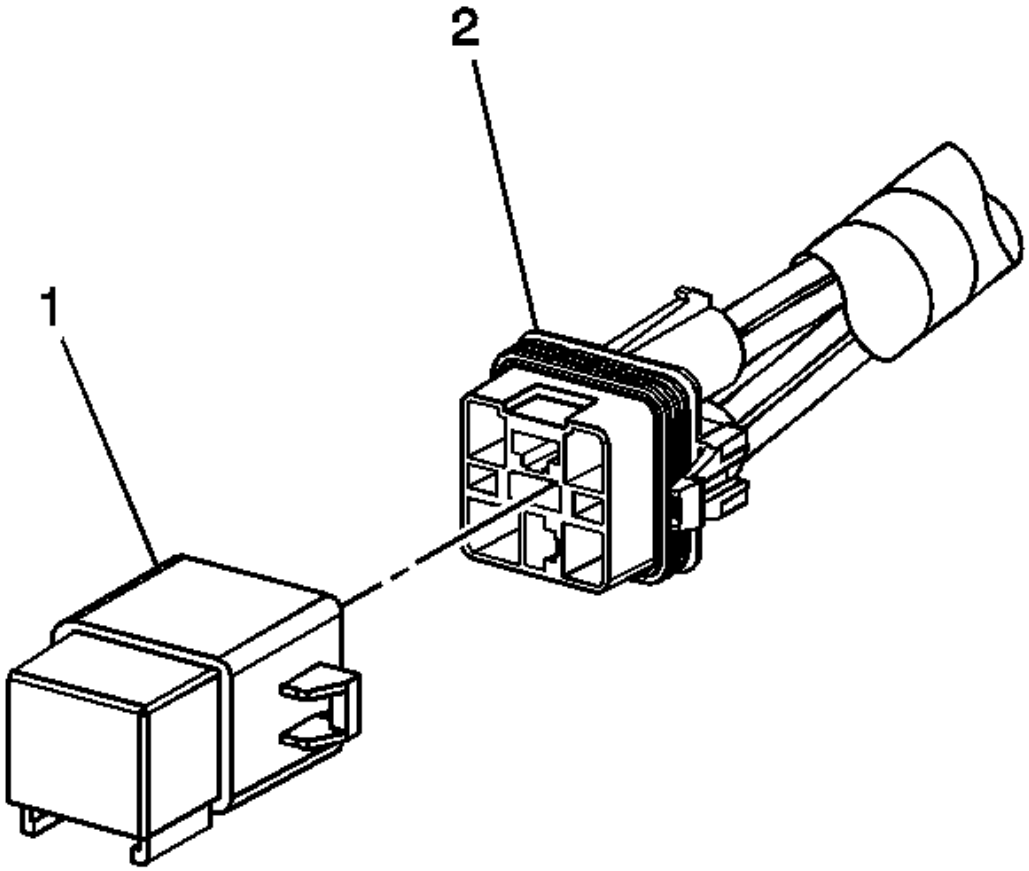


Fig. 2: Identifying Relay & Wire Harness Connector
Courtesy of GENERAL MOTORS COMPANY

1. Connect the relay (1) to the wire harness connector (2).
2. Install any connector position assurance (CPA) devices or secondary locks.
3. Install the relay using any fasteners or tape that originally held the relay in place.

RELAY REPLACEMENT (WITHIN AN ELECTRICAL CENTER)

Special Tools

EL-43244 Relay Puller Pliers

Removal Procedure

1. Remove the electrical center cover.

NOTE:

- **Always note the orientation of the relay.**
- **If equipped with a notch style relay; observe the location of the notch on the old relay to verify the new relay is installed with the notch in**

the same location.

- **Ensure that the electrical center is secure, as not to put added stress on the wires or terminals.**

2. Locate the relay. Refer to **Electrical Center Identification Views** to locate the electrical center where the relay exists.

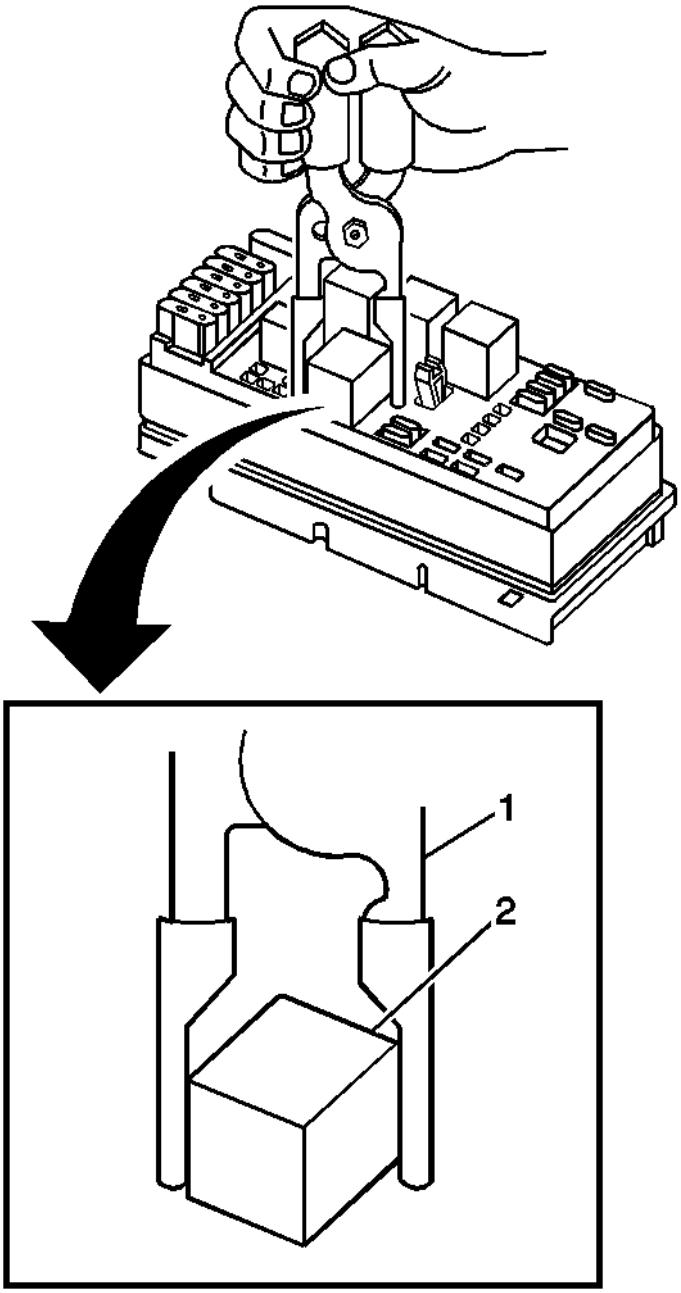


Fig. 3: Removing/Installing Relay
Courtesy of GENERAL MOTORS COMPANY

3. Using the EL-43244 (1) position the tool on opposing corners of the relay (2).

CAUTION: Use EL-43244 to pull the relay straight out from the electrical center terminals. The use of pliers or a flat bladed tool could damage the electrical center.

4. Remove the relay (2) from the electrical center.

Installation Procedure

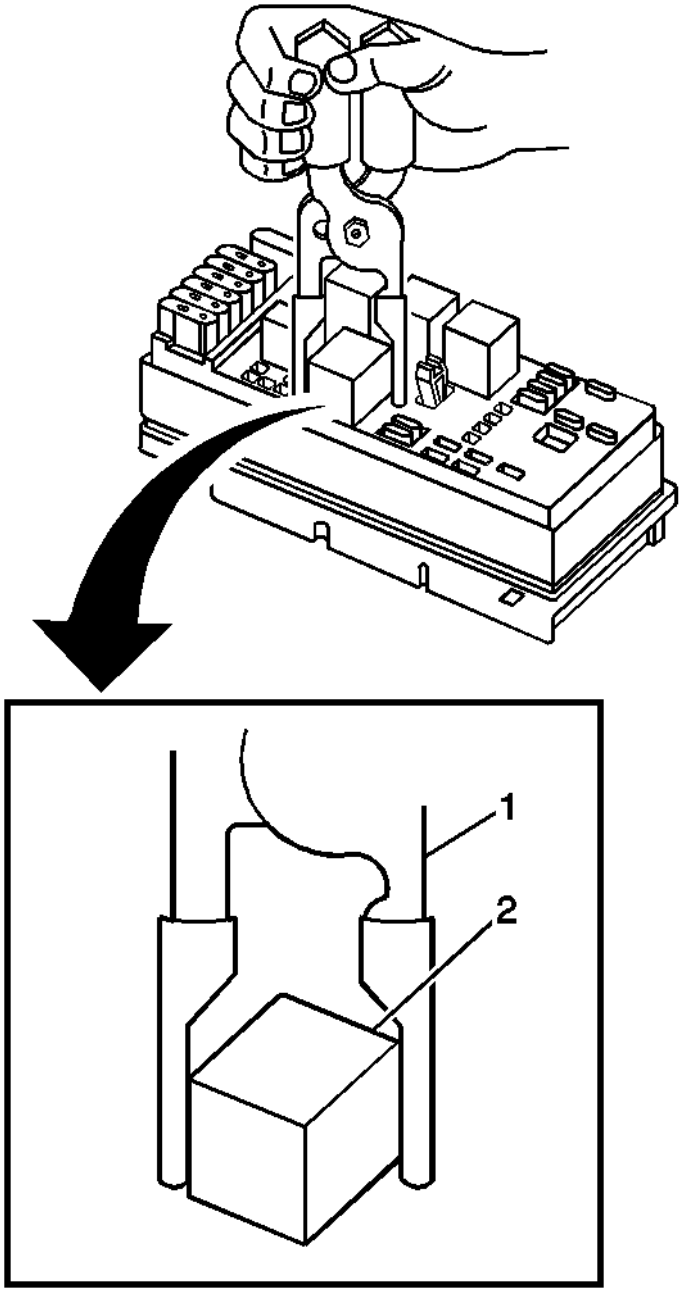


Fig. 4: Removing/Installing Relay
Courtesy of GENERAL MOTORS COMPANY

1. Install the relay (2) in the same position as removed.
2. Install the electrical center cover.

GROUND REPAIR

Electrical Grounds

Proper electrical system function relies on secure, positive, corrosion-free ground connections. Loose, stripped, or corroded connections increase the possibility of improper system function and loss of module communication. These conditions may also lead to unnecessary repairs and component replacements.

In general, electrical ground connections are accomplished using one, or a combination of, three attachment methods:

- Welded M6 stud and nut
- Welded M6 nut and bolt
- Welded M8 nut and bolt

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

Determine which attachment method is used, and carry out the appropriate repair.

M6 Weld Stud Replacement

1. Select a location adjacent the damaged or missing M6 ground stud having 20 mm (0.79 in) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the M6 rivet stud flange.
2. Using GM approved residue-free solvent or equivalent, remove any grease from the repair site and allow to dry.

   NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

3. Drill a 10 mm (0.40 in) diameter hole through the panel.
4. Carefully remove paint and primer from the area surrounding the rivet stud flange until bare metal is visible.

   CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

5. Select a replacement conductive M6 rivet stud. Refer to GM parts catalog for the correct part number and application.
6. Using a rivet stud installer, install the replacement conductive M6 rivet stud.
7. Ensure the new rivet stud is securely fastened, with no detectable movement.

   NOTE: The rivet stud and surrounding panel area must be properly refinished prior to the installation of the ground terminal and nut to maintain positive electrical grounding.

8. Completely wrap the threads of the rivet stud with painters tape or equivalent.
9. Refinish the repair area using an anti-corrosion primer.
10. Allow the refinished repair area to cure sufficiently before removing the protective material applied to the

rivet stud threads.

11. Remove the painters tape or equivalent from the rivet stud threads.
12. Using GM approved residue-free solvent or equivalent, thoroughly clean the rivet stud threads to remove any adhesive and allow to dry.
13. Carefully remove any corrosion from the electrical ground wire terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
14. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new conductive M6 rivet stud threads.
15. Install the ground terminal to the new rivet stud.
16. Select a new, conductive M6 nut. Refer to GM parts catalog for the correct part number and application.

CAUTION: Refer to Fastener Caution .

17. Install the M6 nut and tighten to 8 (71 lb in).
18. Check for proper system operation.

M6 Weld Nut

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the M6 weld nut at the electrical ground location is damaged or stripped, a new, conductive self-threading M7 bolt may be used to secure the ground terminal. Refer to GM parts catalog for the correct part number and application.
2. Using GM approved residue-free solvent or equivalent, remove any grease from the surface surrounding the weld nut and allow to dry.
3. Remove any loose metal particles from the damaged or stripped weld nut with a stiff brush.
4. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new, conductive, self-threading M7 bolt threads.
5. Carefully remove any corrosion from the electrical ground terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
6. Install the electrical ground terminal to the new, conductive M7 bolt.

CAUTION: Refer to Fastener Caution .

7. Install the M7 bolt and tighten to 9 (80 lb in).
8. Check for proper system operation.

M6 Weld Nut (Alternative Repair)

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the electrical ground location is accessible from both sides of the panel, a conductive M6 bolt and a conductive M6 nut may be used to secure the electrical ground terminal. Refer to GM parts catalog for

the correct part number and application.

2. Select a location adjacent the damaged M6 weld nut having 20 mm (0.79) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the new electrical ground site.
3. Using GM approved residue-free solvent or equivalent, remove any grease from the surface surrounding the ground location and allow to dry.

NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

4. Drill a 10 mm (0.40 in) diameter hole through the panel.
5. Carefully remove paint and primer from the area surrounding the new ground site until bare metal is visible.
6. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new, conductive M6 bolt threads.
7. Carefully remove any corrosion from the electrical ground terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
8. Install the electrical ground terminal and new, conductive M6 bolt to the ground location.

CAUTION: Refer to Fastener Caution .

9. Install the conductive M6 nut and tighten to 8 (71 lb in).

NOTE: The repair area must be properly refinished to maintain positive electrical grounding.

10. Refinish the repair area using an anti-corrosion primer.
11. Check for proper system operation.

M8 Weld Nut

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the M8 weld nut electrical ground location is accessible from both sides of the panel, a conductive M8 bolt and a conductive M8 nut may be used to secure the ground terminal. Refer to GM parts catalog for the correct part numbers and application.
2. Select a location adjacent to M8 weld nut having 20 mm (0.79 in) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the new electrical ground site.
3. Using GM approved residue-free solvent or equivalent, remove any grease from the surface surrounding the ground location and allow to dry.

NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

4. Drill a 10 mm (0.40 in) diameter hole through the panel.
5. Carefully remove paint and primer from the area surrounding the new ground site until bare metal is

visible.

6. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new, conductive M8 bolt threads.
7. Carefully remove any corrosion from the electrical ground terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
8. Install the electrical ground terminal and new, conductive M8 bolt to the ground location.

CAUTION: Refer to Fastener Caution .

9. Install the conductive M8 nut and tighten to 22 (16 lb ft).

NOTE: The repair area must be properly refinished to maintain positive electrical grounding.

10. Refinish the repair area using an anti-corrosion primer.
11. Check for proper system operation.

M8 Weld Nut (Alternative Repair)

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the M8 weld nut electrical ground location is not accessible from both sides of the panel, a conductive M6 rivet stud and a conductive M6 nut may be used to secure the ground terminal. Refer to GM parts catalog for the correct part numbers and application.
2. Select a location adjacent the damaged M8 weld nut having 20 mm (0.79 in) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the new, conductive M6 rivet stud flange.
3. Using GM approved residue-free solvent or equivalent, remove any grease from the repair site and allow to dry.

NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

4. Drill a 10 mm (0.40 in) diameter hole through the panel.
5. Carefully remove paint and primer from the area surrounding the rivet stud flange until bare metal is visible.
6. Using a rivet stud installer, install the replacement conductive M6 rivet stud.
7. Ensure the new rivet stud is securely fastened, with no detectable movement.

NOTE: The rivet stud and surrounding panel area must be properly refinished prior to the installation of the ground terminal and nut to maintain positive electrical grounding.

8. Completely wrap the threads of the rivet stud with painters tape or equivalent.
9. Refinish the repair area using an anti-corrosion primer.
10. Allow the refinished repair area to cure sufficiently before removing the protective material applied to the

rivet stud threads.

11. Remove the painters tape or equivalent from the rivet stud threads.
12. Using GM approved residue-free solvent or equivalent, thoroughly clean the rivet stud threads to remove any adhesive and allow to dry.
13. Carefully remove any corrosion from the electrical ground wire terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
14. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new conductive M6 rivet stud threads.
15. Install the ground terminal to the new, conductive M6 rivet stud.

CAUTION: Refer to Fastener Caution .

16. Install the conductive M6 nut and tighten to 8 (71 lb in).
17. Check for proper system operation.

Securing Loose Electrical Ground Connections

If the electrical ground connection is loose and the ground attachments are not damaged, properly securing the loose electrical ground may be all that is necessary. Carry out the following procedure to secure loose electrical ground connections.

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. Using GM approved residue-free solvent or equivalent, thoroughly clean the ground stud threads and allow to dry.
2. Carefully remove any corrosion from the electrical ground wire terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
3. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the ground stud threads.
4. Install the ground wire terminal to the ground stud.

CAUTION: Refer to Fastener Caution .

5. Install the ground stud nut.
   - M6 ground stud nut: Tighten to 9 (80 lb in)
   - M8 ground stud nut: Tighten to 22 (16 lb ft)
   - M10 ground stud nut: Tighten to 45 (33 lb ft)
6. Check for proper system operation.

FRONT COMPARTMENT FUSE BLOCK FUSE REPLACEMENT (MIDI-FUSE)

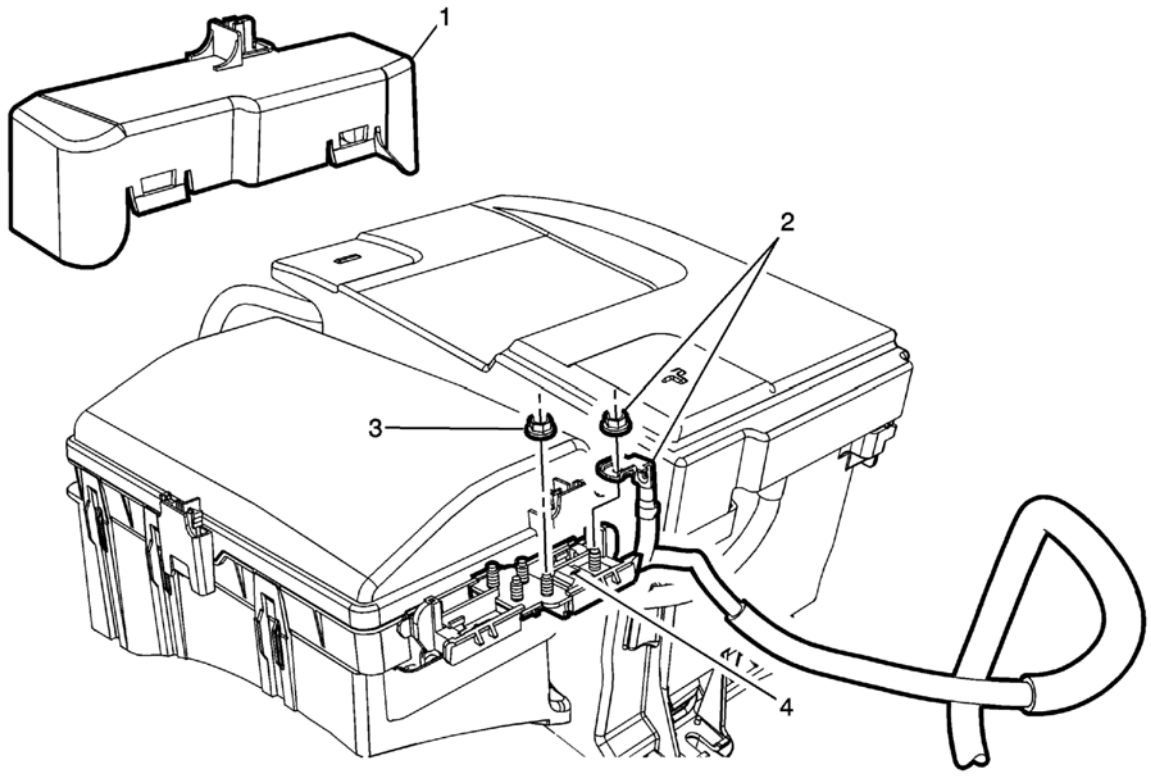


Fig. 5: Front Compartment Fuse Block Fuse (MIDI-Fuse)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .	
1	Fuse Block Fuse Cover
2	Battery Positive Cable and Nut **CAUTION:** **Refer to** **Fastener Caution** . **Procedure** Disconnect the battery positive cable(s) from the fuse. **Tighten** 4.7 (42 lb in)
3	Fuse Block Fuse Holder Nut - MIDI-Fuse **Tighten** 4.7 (42 lb in)
4	Fuse Block Fuse - MIDI-Fuse

INSTRUMENT PANEL ELECTRICAL CENTER OR JUNCTION BLOCK REPLACEMENT - RIGHT

SIDE (IMPALA LIMITED)

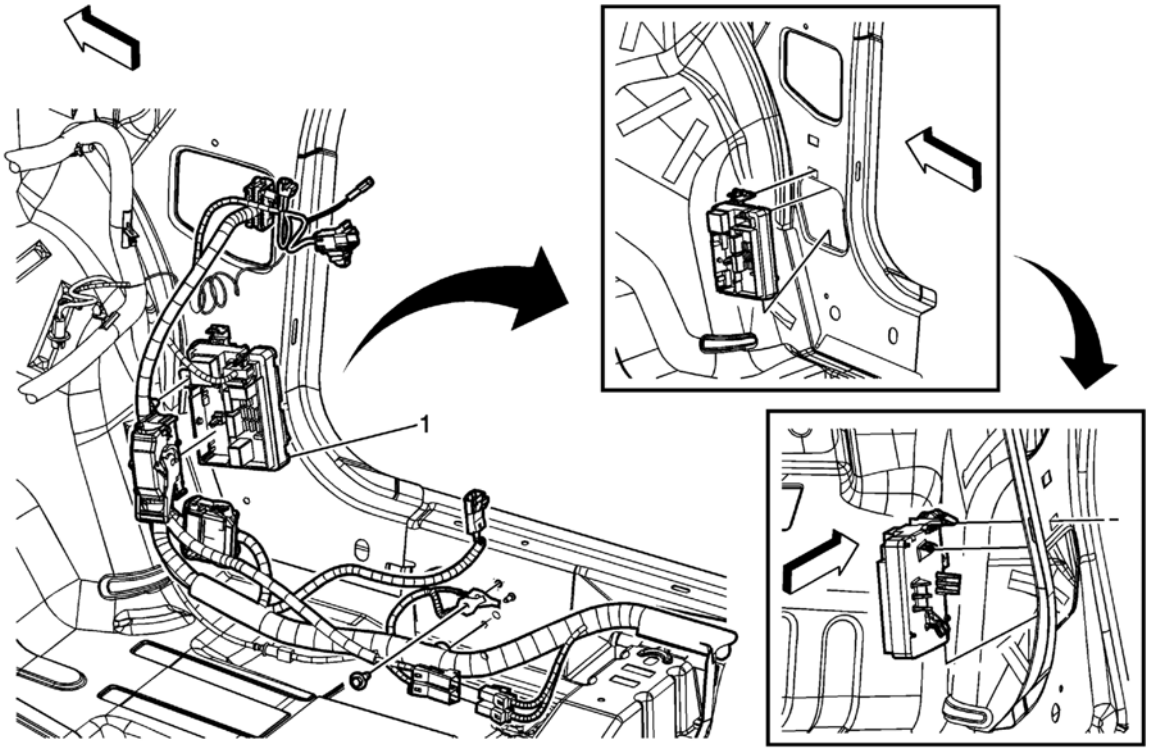


Fig. 6: Exploded View Of Junction Block - Right Side (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** . **Preliminary Procedure** Remove right side carpet retainer. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala Limited)** .	
1	Body and I/P Wiring Harness Junction Block 1. Pull back carpet to reveal junction block. 2. Press release tab to pull block out.

ACCESSORY WIRING JUNCTION BLOCK REPLACEMENT

Removal Procedure

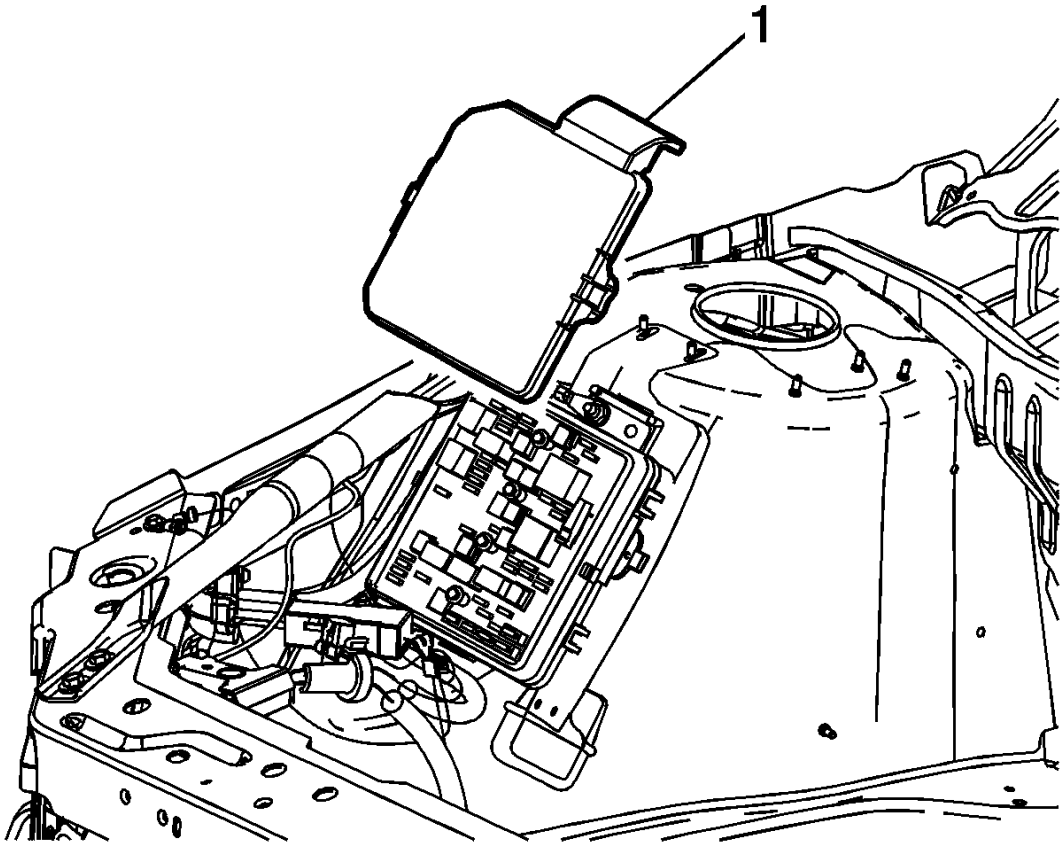


Fig. 7: Identifying Electrical Center Cover
Courtesy of GENERAL MOTORS COMPANY

1. Remove the electrical center cover (1).
2. Disconnect the positive battery cable from junction box. Refer to **Battery Positive and Negative Cable Replacement** .

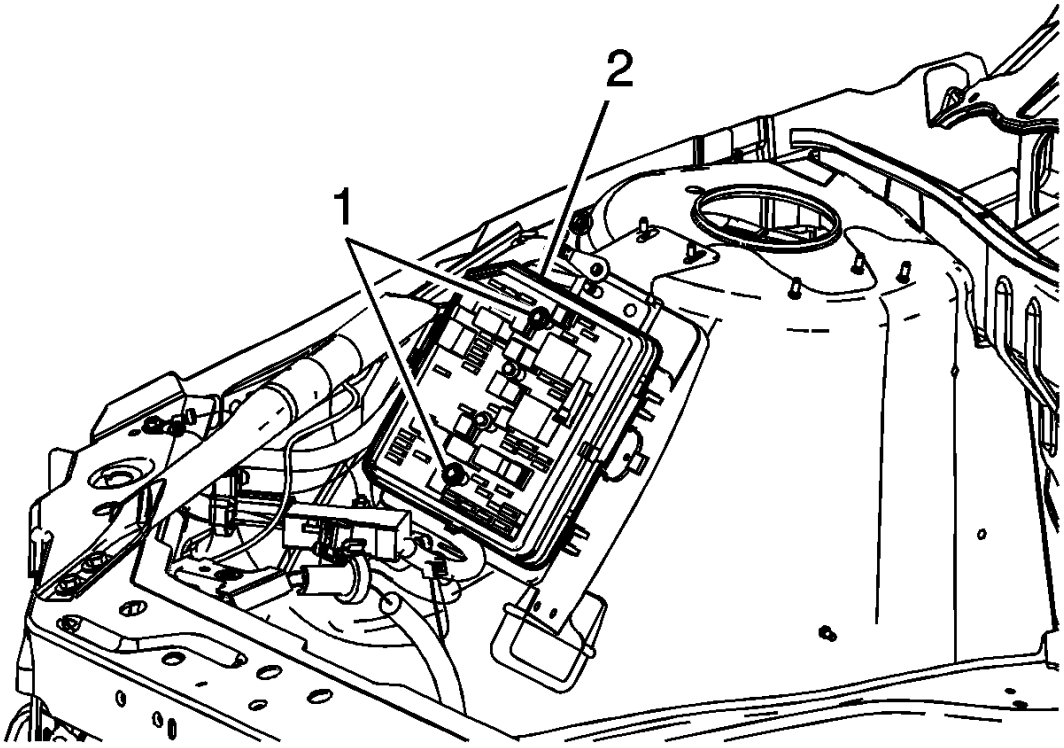


Fig. 8: Identifying Fasteners & Electrical Center Board
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fasteners (1) securing the electrical center board (2).
4. Unlock the tabs on the electrical center board.
5. Lift up on the electrical center board.

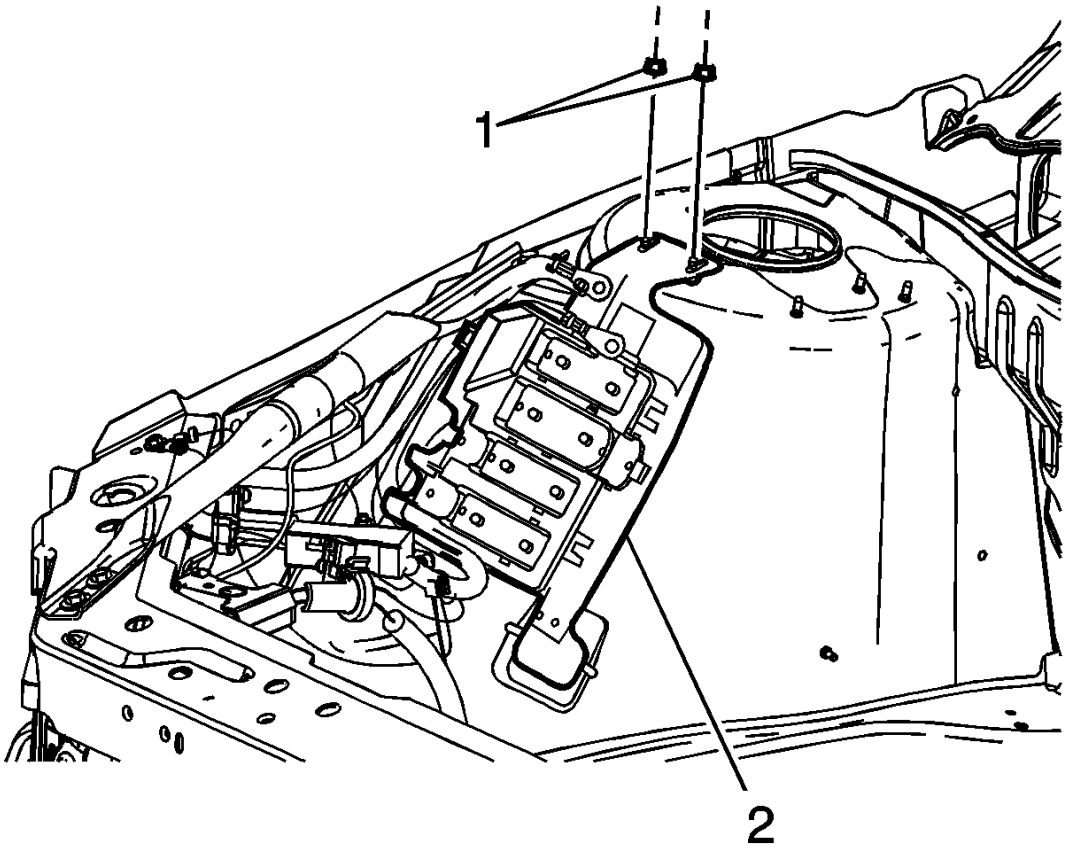


Fig. 9: Identifying Fasteners & Electrical Center Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Remove the fasteners (1) securing the electrical center bracket (2) to vehicle.

Installation Procedure

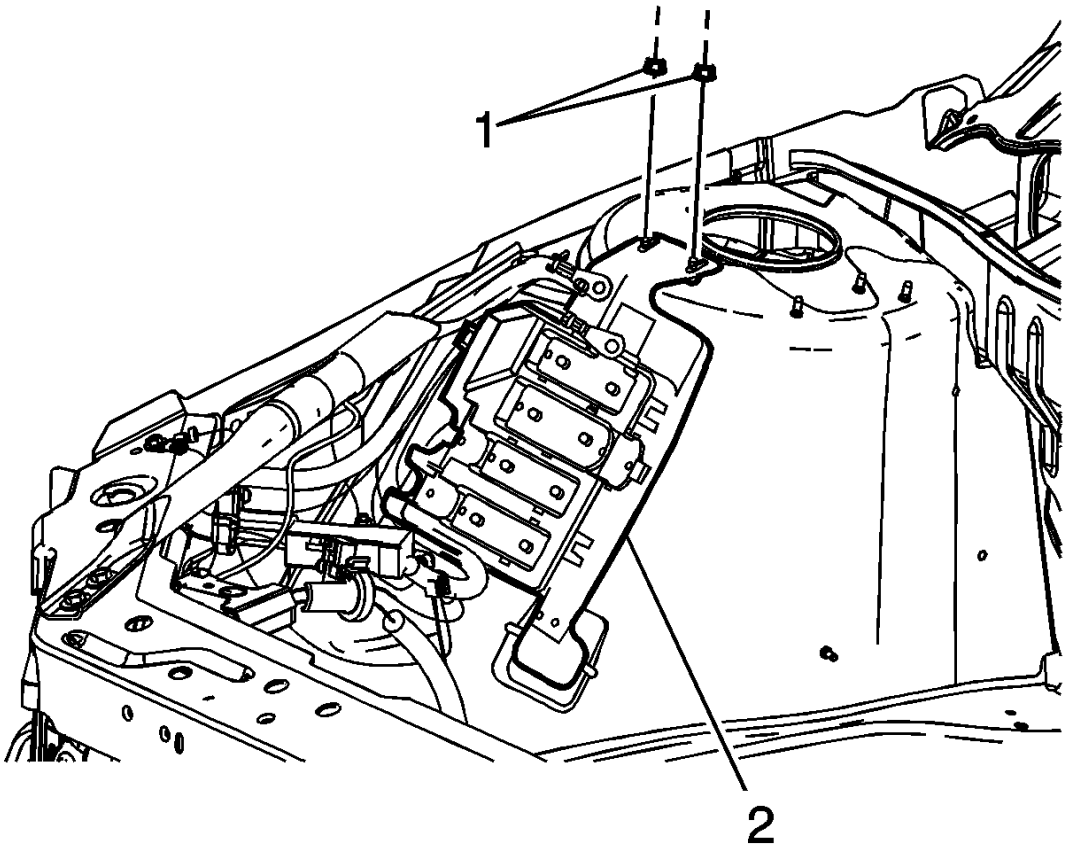


Fig. 10: Identifying Fasteners & Electrical Center Bracket
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install fasteners (1) securing the electrical center (2) to vehicle.

   Tighten

   Tighten the fasteners to 10 N.m (86 lb in).

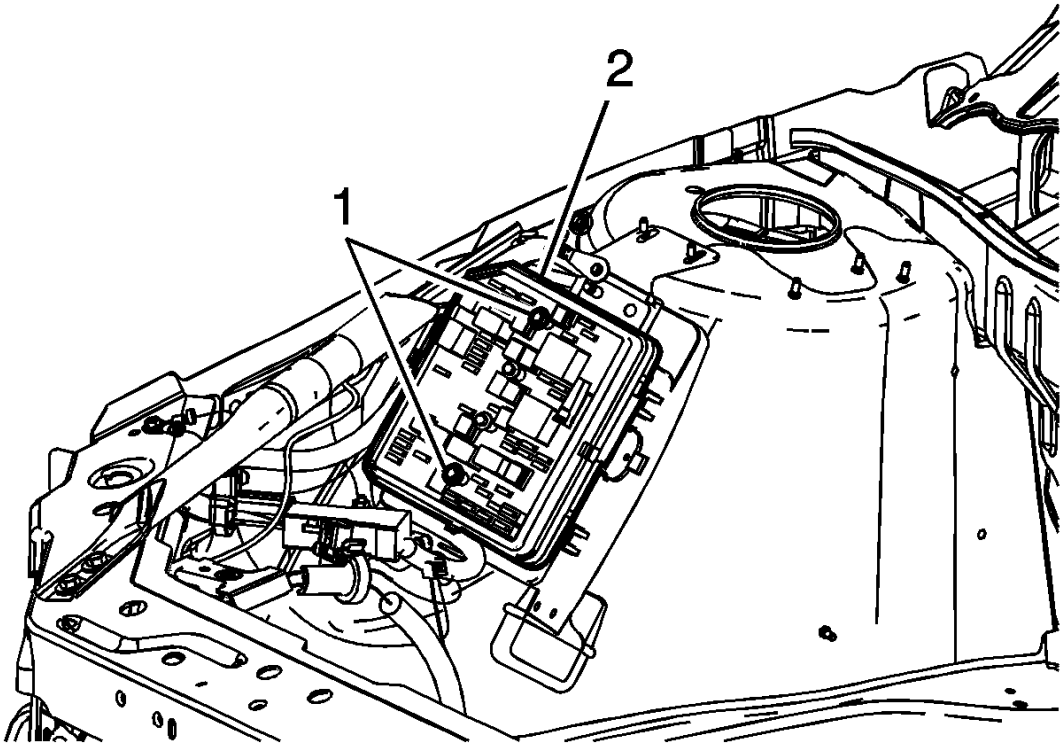


Fig. 11: Identifying Fasteners & Electrical Center Board
Courtesy of GENERAL MOTORS COMPANY

2. Install the fasteners (1) securing the electrical center board (2).

   Tighten

   Tighten the fasteners to 7 N.m (62 lb in).

3. Connect the positive battery cable. Refer to **Battery Positive and Negative Cable Replacement** .

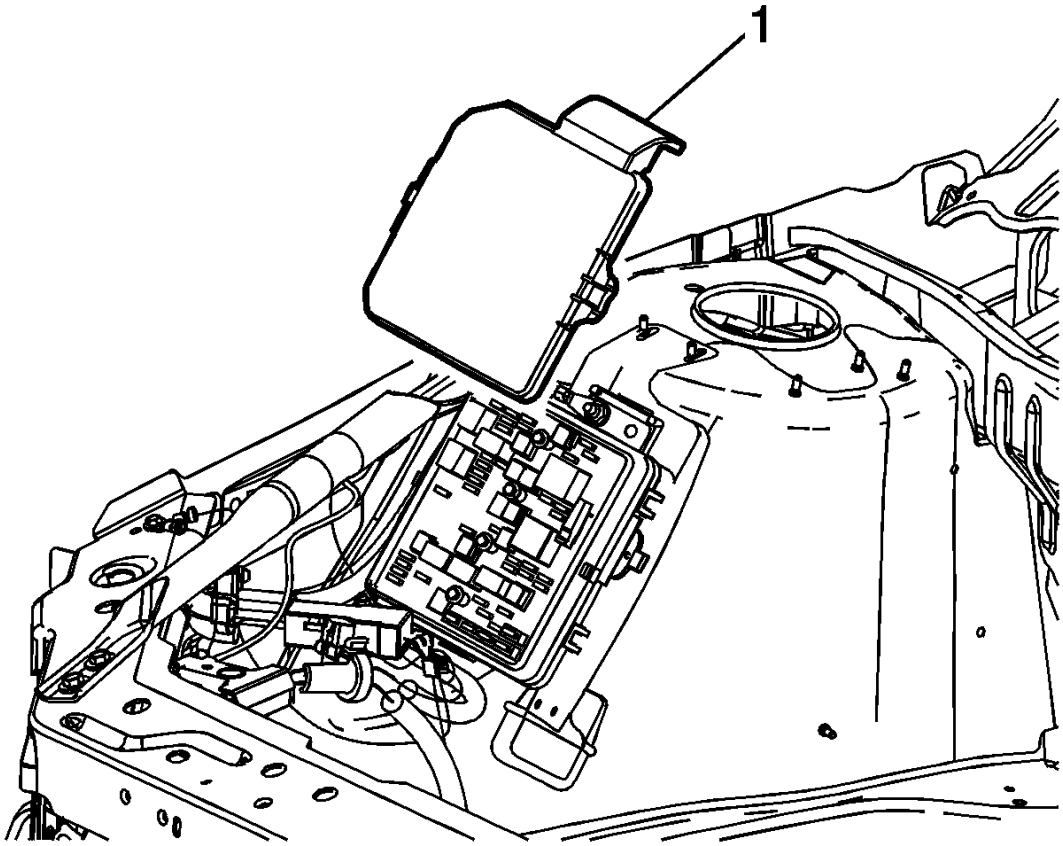


Fig. 12: Identifying Electrical Center Cover
Courtesy of GENERAL MOTORS COMPANY

4. Install the electrical center cover (1).

IGNITION LOCK CYLINDER REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

WARNING: Refer to SIR Warning .

2. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
3. Remove the tilt lever. Refer to **Steering Column Tilt Wheel Release Lever Replacement** .
4. Remove the steering wheel. Refer to **Steering Wheel Replacement** .
5. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement** .
6. Rotate the ignition lock cylinder to the crank position.

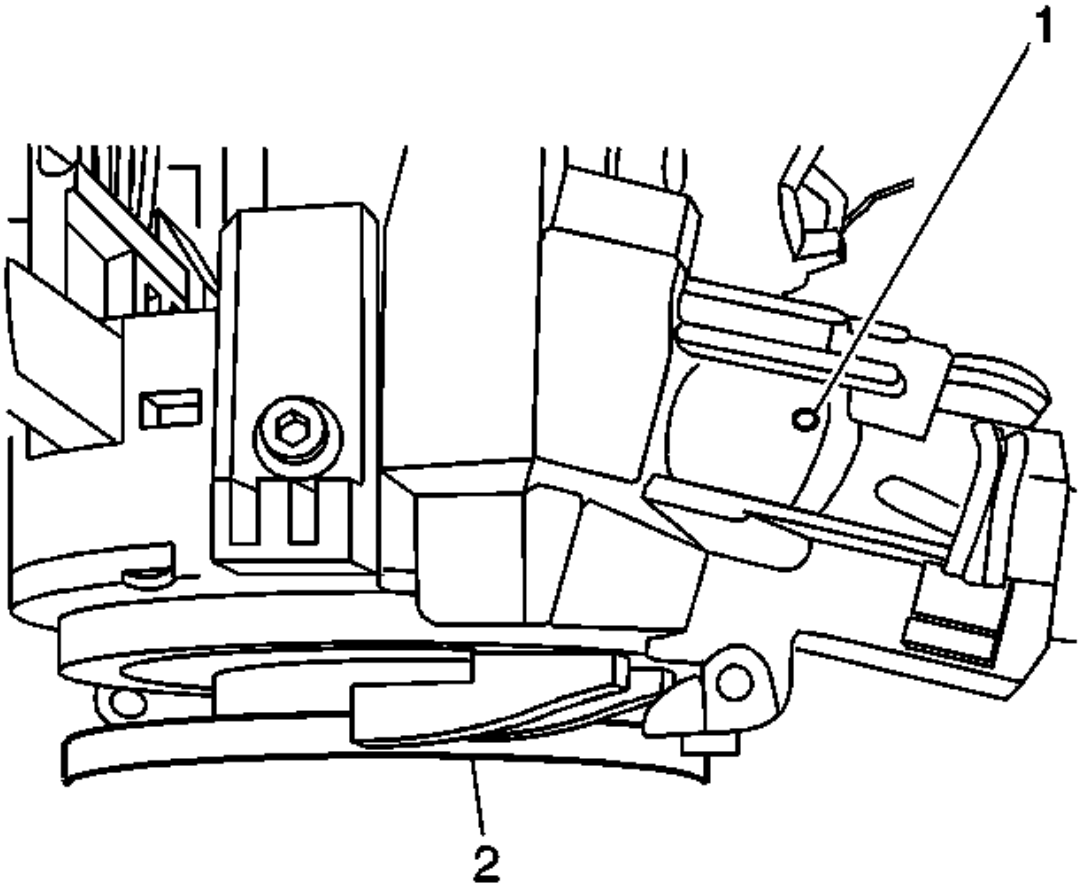


Fig. 13: Locating Ignition Lock Cylinder Release Access Hole
Courtesy of GENERAL MOTORS COMPANY

7. Use a suitable tool in order to push down and hold the lock cylinder retaining pin through the access hole (1) in the ignition lock cylinder case .
8. Release the ignition lock cylinder to the run position.

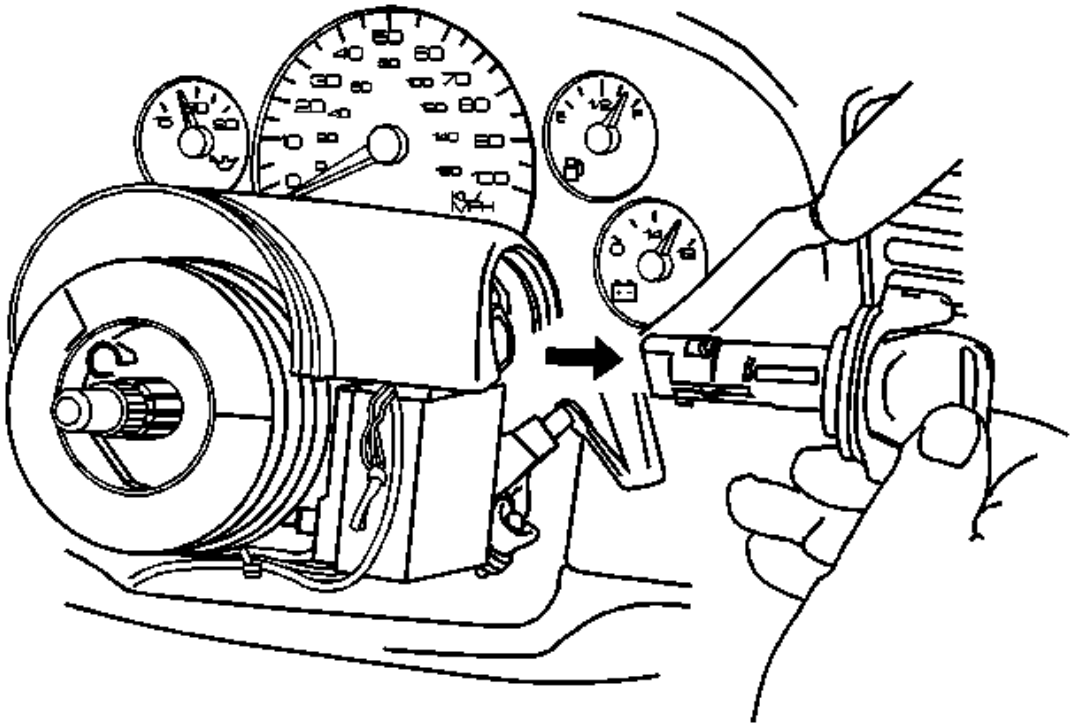


Fig. 14: View of Ignition Lock Cylinder, Ignition Lock Cylinder Case Assembly, and Steering Column

Courtesy of GENERAL MOTORS COMPANY

9. Remove the ignition lock cylinder from the steering column.

Installation Procedure

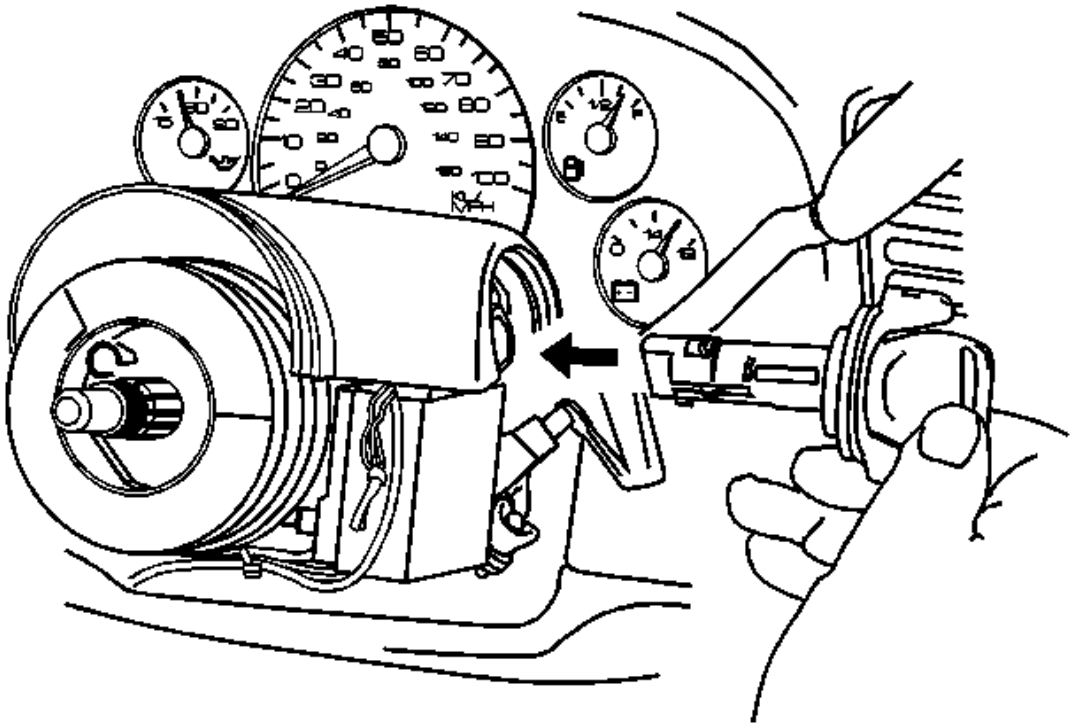


Fig. 15: View of Ignition Cylinder Lock, Ignition Lock Cylinder Case Assembly and Upper Steering Column

Courtesy of GENERAL MOTORS COMPANY

1. Align the lock cylinder retaining pin with the access hole in the ignition lock cylinder case.
2. Push the ignition lock cylinder into the ignition lock cylinder case. Ensure the lock cylinder retaining pin engages the access hole.
3. Install the steering column trim covers. Refer to **Steering Column Trim Cover Replacement** .
4. Install the steering wheel. Refer to **Steering Wheel Replacement** .
5. Install the tilt lever. Refer to **Steering Column Tilt Wheel Release Lever Replacement** .
6. Enable the SIR system. Refer to **SIR Disabling and Enabling** .
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

IGNITION AND START SWITCH REPLACEMENT

Removal Procedure

WARNING: Refer to SIR Warning .

1. Disable the SIR system **SIR Disabling and Enabling** .
2. Remove the upper and lower trim covers. Refer to **Steering Column Trim Cover Replacement** .
3. Remove the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement**.

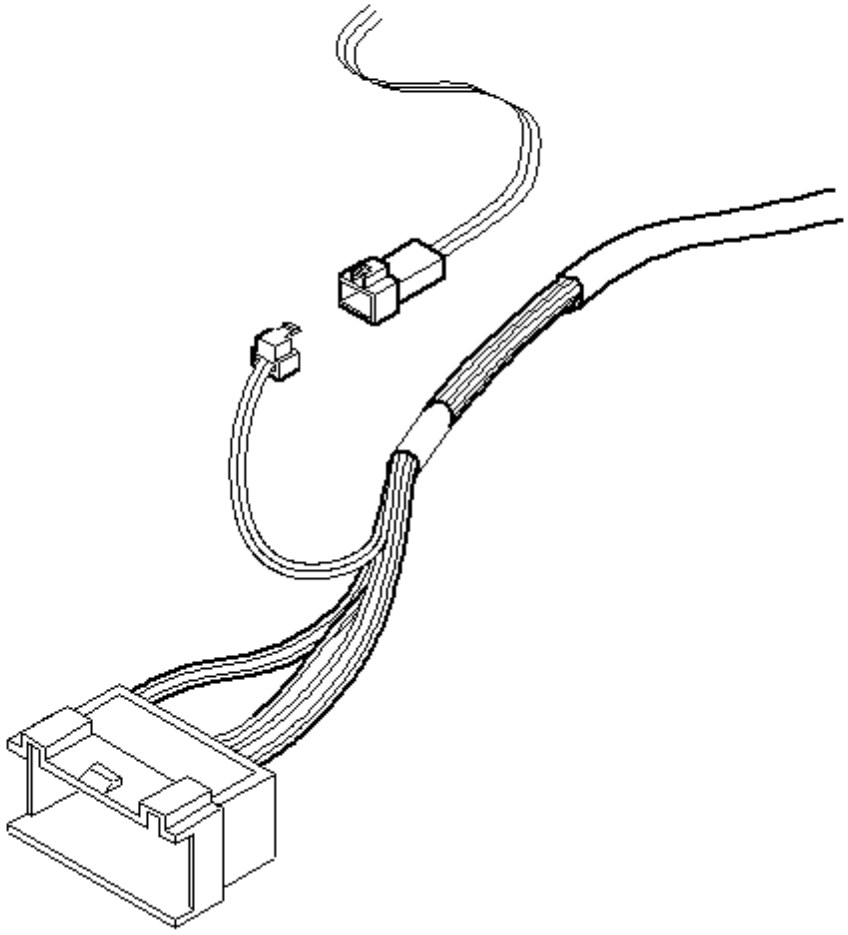


Fig. 16: Theft Deterrent Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the theft deterrent control module connector.
5. Disconnect the fused jumper assembly connector.

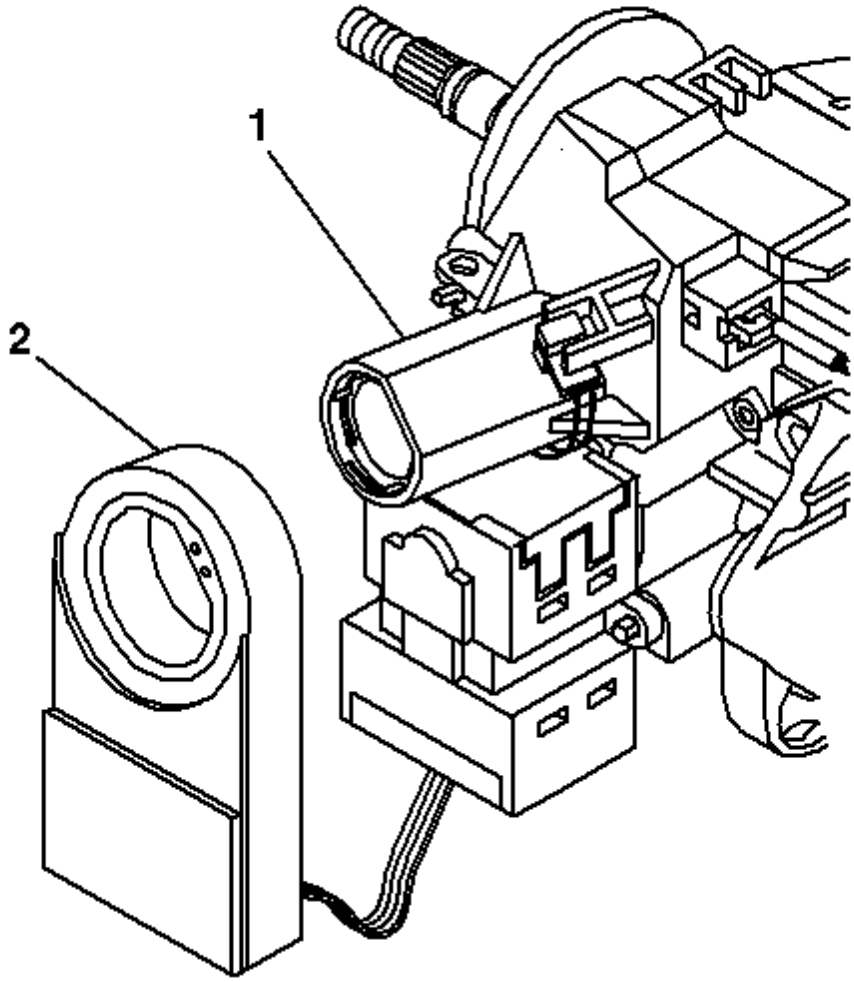


Fig. 17: Locating Theft Deterrent Module & Ignition Lock Cylinder Case Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Slide the theft deterrent control module (2) from the ignition lock cylinder case (1).

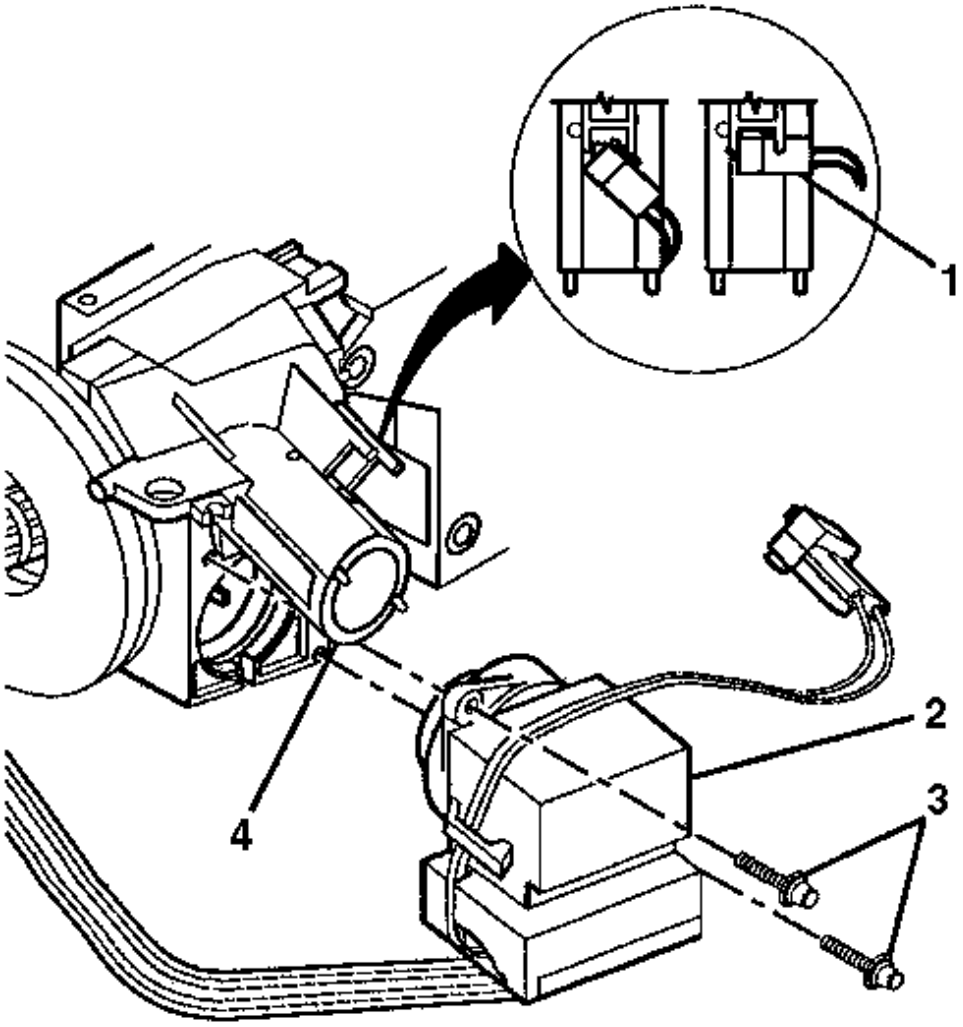


Fig. 18: Key Alarm Connector To/From Ignition Lock Cylinder Case
Courtesy of GENERAL MOTORS COMPANY

7. Remove the key alarm connector (1) from the ignition lock cylinder case (4).
8. Remove the 2 tapping screws (3) from the ignition switch assembly (2).

Installation Procedure

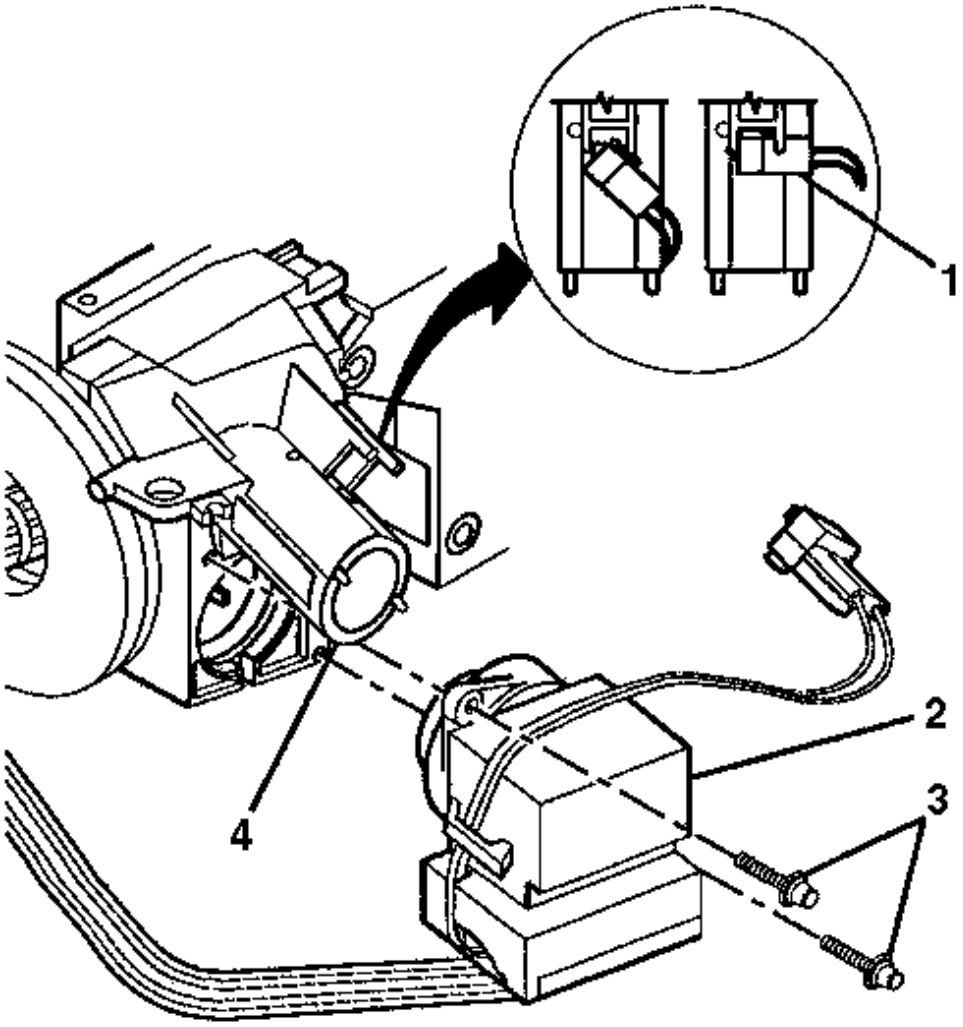


Fig. 19: Key Alarm Connector To/From Ignition Lock Cylinder Case
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the ignition switch assembly (2) and secure by using 2 tapping screws (3).

   Tighten

   Tighten the screws to 7 N.m (62 lb in).

2. Install the ignition switch assembly connector (1) onto the ignition lock cylinder case (4).

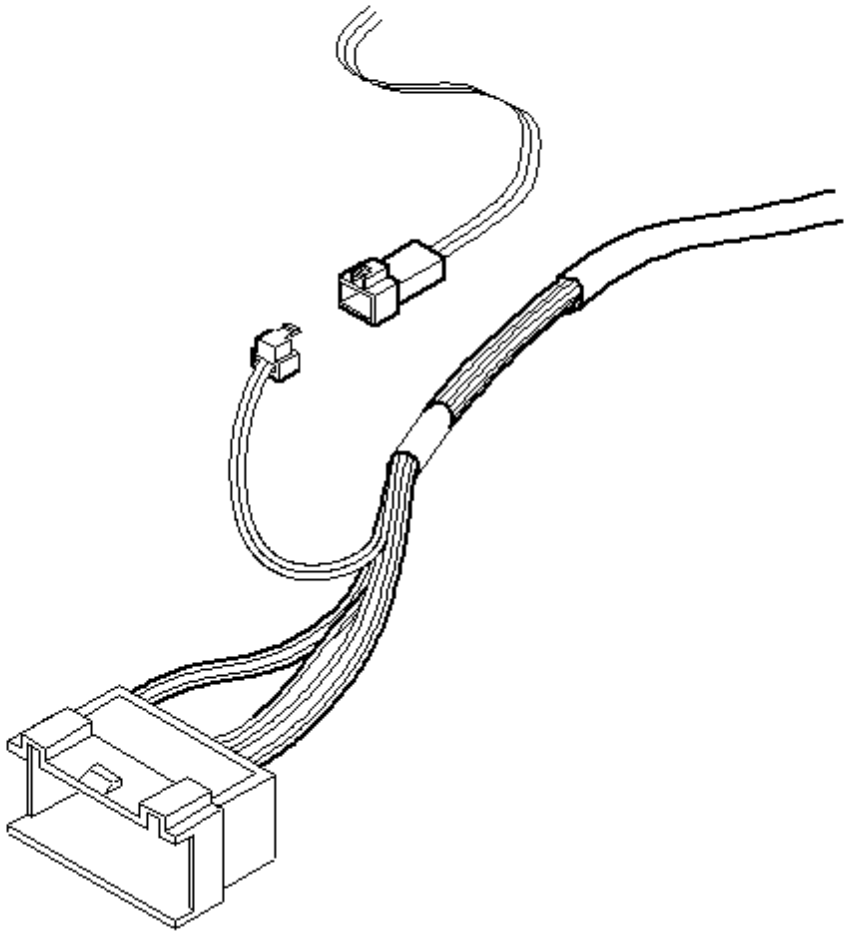


Fig. 20: Theft Deterrent Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect the theft deterrent control module connector.
4. Connect the fused jumper assembly connector.

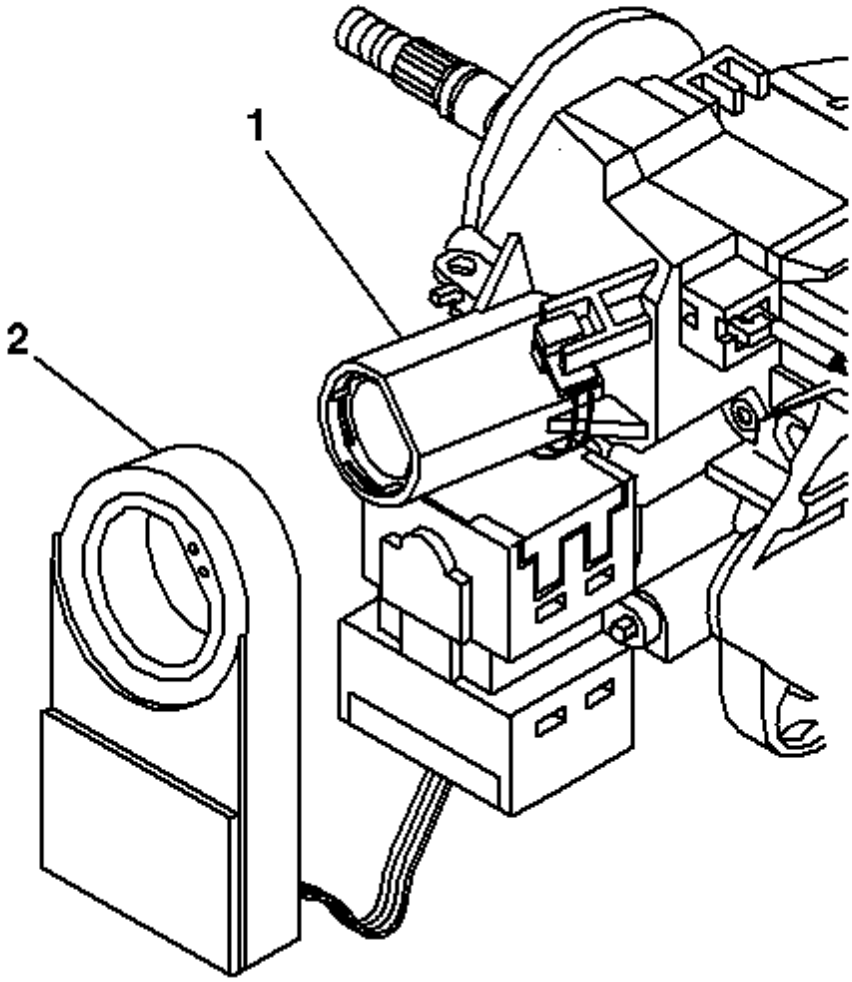


Fig. 21: Locating Theft Deterrent Module & Ignition Lock Cylinder Case Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Install the theft deterrent control module (2) onto the ignition lock cylinder case (1).
6. Install the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement**.
7. Install the upper and lower trim covers. Refer to **Steering Column Trim Cover Replacement** .
8. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

IGNITION LOCK CYLINDER CASE REPLACEMENT

Removal Procedure

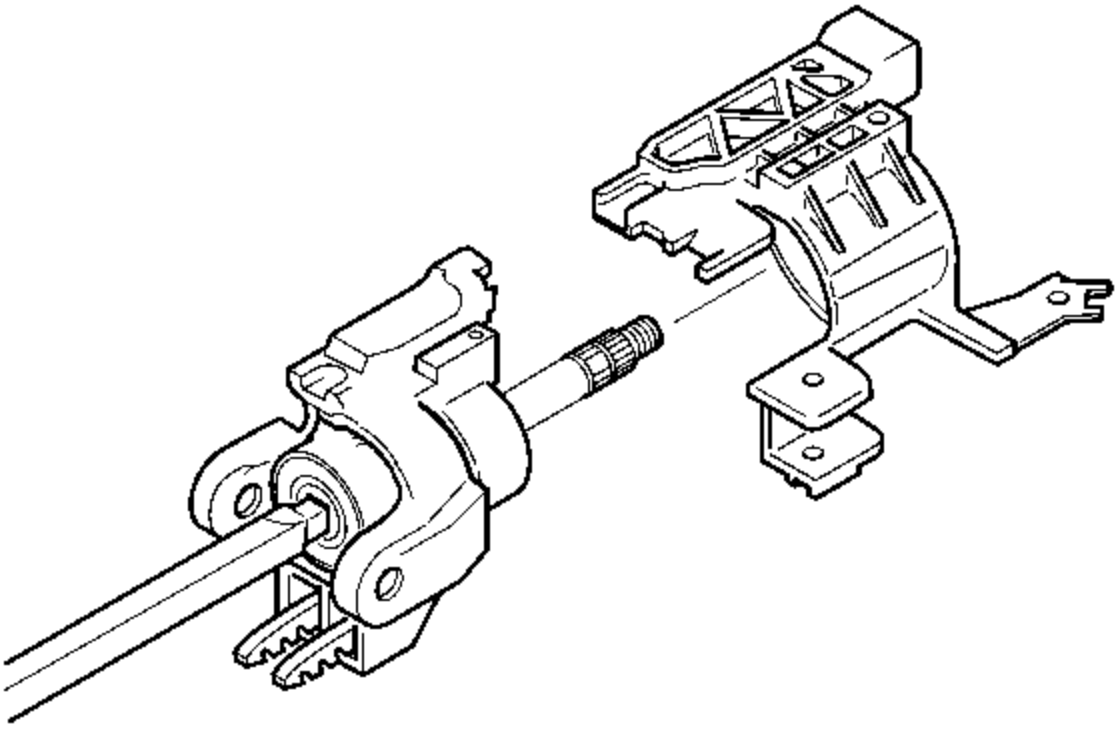


Fig. 22: View Of Turn Signal Switch Housing & Steering Column Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to SIR Warning .

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
2. Remove the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement**.
3. Remove the ignition switch. Refer to **Ignition and Start Switch Replacement**.
4. Remove the steering column tilt head components. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement** .
5. Remove the turn signal switch housing. Refer to **Turn Signal Switch Housing Replacement** .
6. Remove the turn signal and multifunction switch assembly only. Refer to **Turn Signal Multifunction Switch Replacement** .

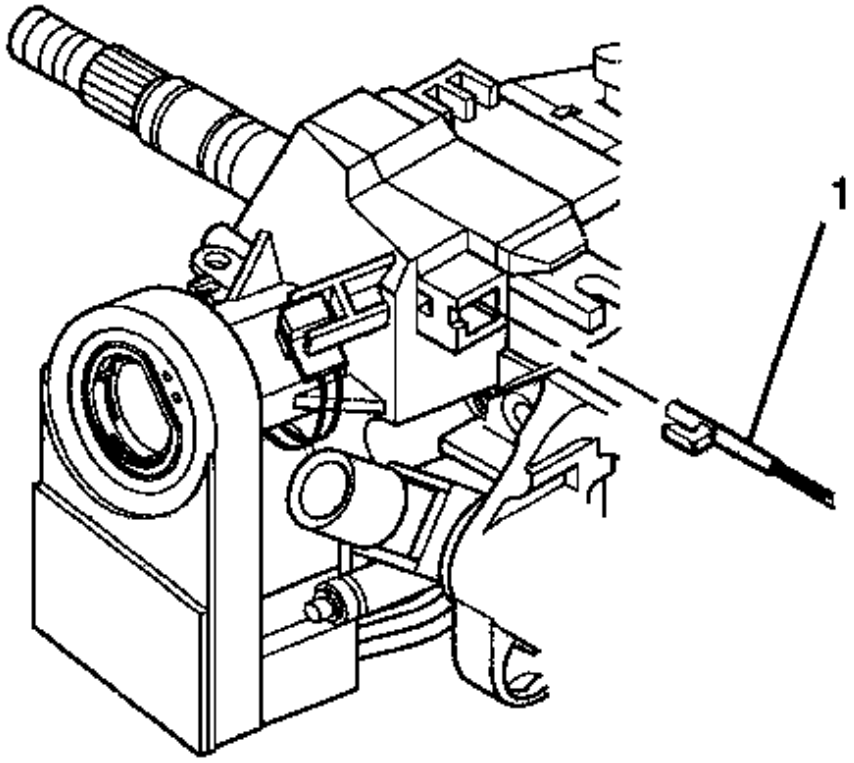


Fig. 23: Identifying Park Lock Cable At Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

7. Remove the park lock cable assembly (1) from the ignition lock cylinder case in the following way:
    1. Use a small blade to push against the locking tab on the end of the park lock cable assembly (1).
    2. Disconnect the park lock cable assembly (1) from the ignition lock cylinder case.

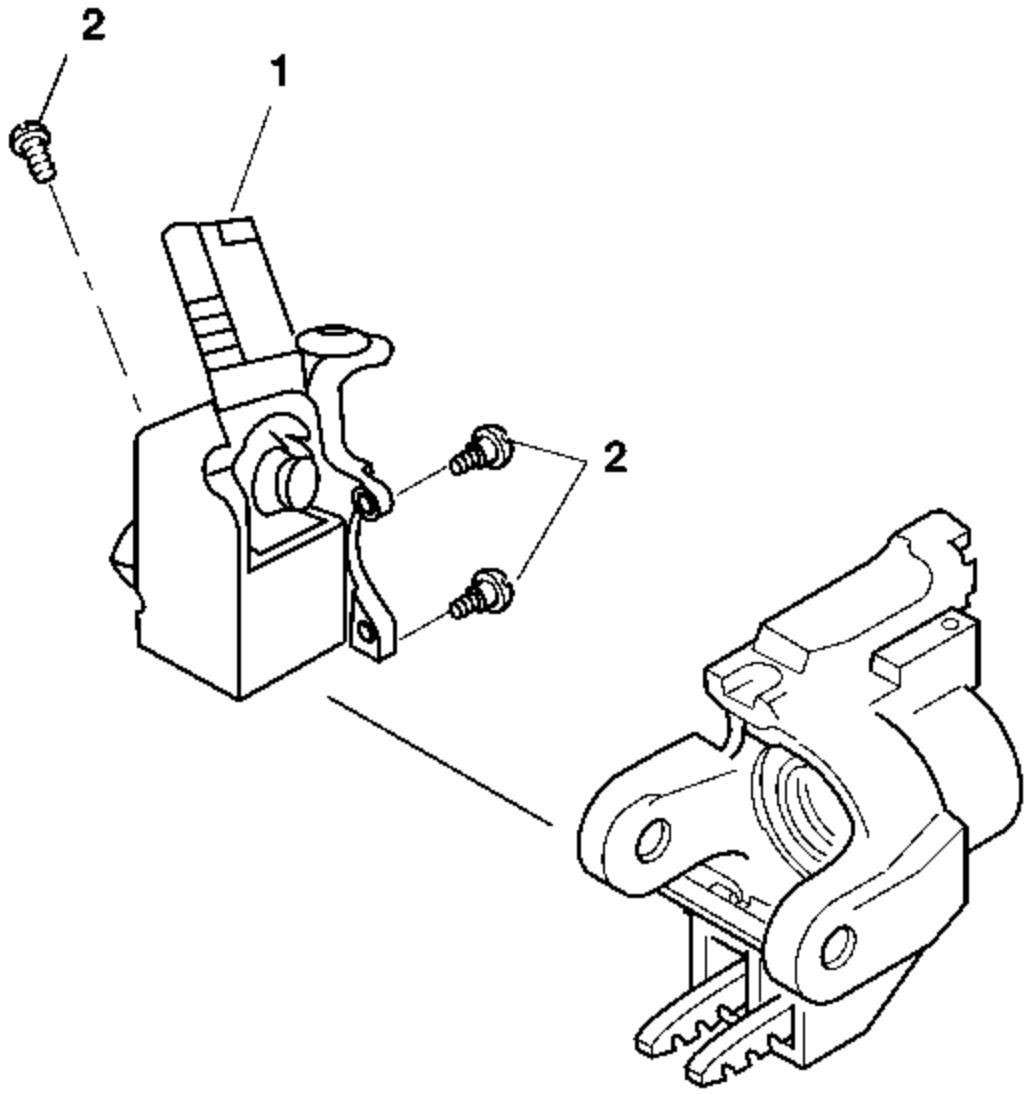


Fig. 24: View Of Ignition Lock Cylinder Case Assembly & Screws
Courtesy of GENERAL MOTORS COMPANY

8. Remove the 3 TORXÂ® screws (2) from the ignition lock cylinder case (1).
9. Remove the ignition lock cylinder case (1) from the steering column tilt head assembly.

Installation Procedure

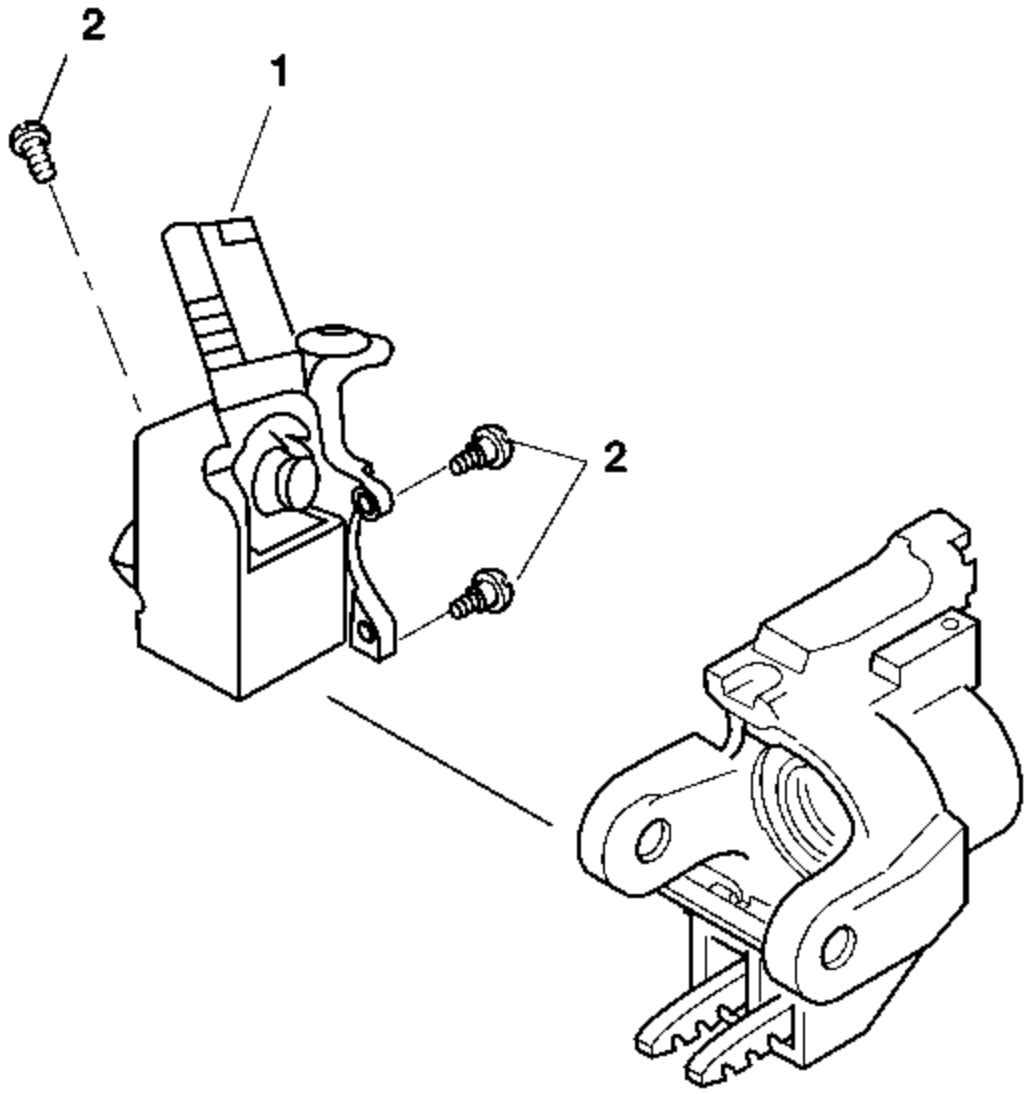


Fig. 25: View Of Ignition Lock Cylinder Case Assembly & Screws
Courtesy of GENERAL MOTORS COMPANY

1. Align the ignition lock cylinder case (1) with the steering column tilt head assembly.

CAUTION: Refer to Fastener Caution .

2. Screw the 3 TORXÂ® screws (2) into the ignition lock cylinder case (1).

Tighten

Tighten the 3 TORXÂ® screws to 7 N.m (62 lb in).

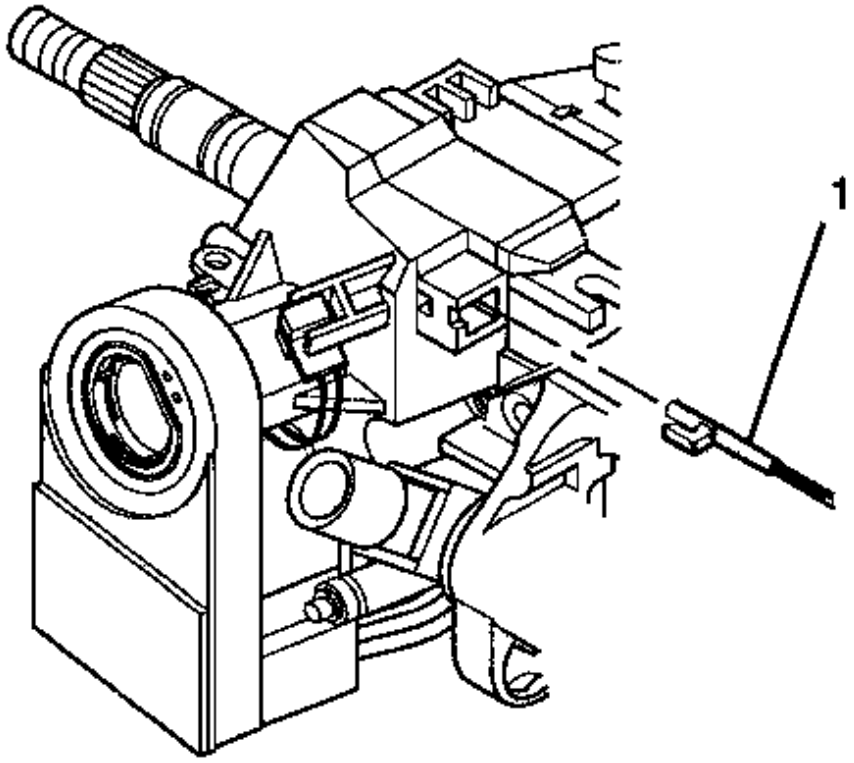


Fig. 26: Identifying Park Lock Cable At Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

3. Press the locking tab on the end of the park lock cable assembly (1) into the slot in the ignition lock cylinder case.

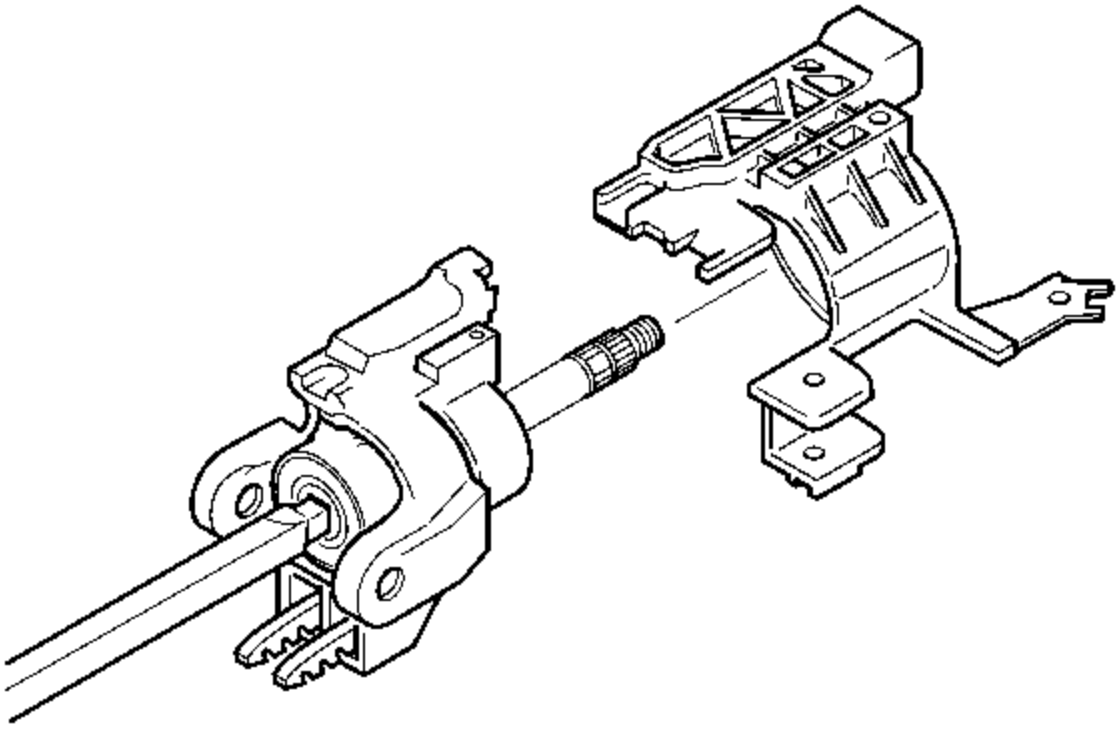


Fig. 27: View Of Turn Signal Switch Housing & Steering Column Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Press the turn signal switch housing firmly against the steering column tilt head in order for the screws from the turn signal and multifunction switch assembly to align.**

4. Install the turn signal switch housing. Refer to **Turn Signal Switch Housing Replacement** .
5. Install the turn signal and multifunction switch assembly only. Refer to **Turn Signal Multifunction Switch Replacement** .
6. Install the steering column tilt head components. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement** .
7. Install the ignition switch only. Refer to **Ignition and Start Switch Replacement**.
8. Install the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement**.
9. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

Article GUID: A00737178

GENERAL INFORMATION

Air/Wind Noise - Impala

DIAGNOSTIC INFORMATION AND PROCEDURES

AIR/WIND NOISE

Special Tools

- **CH-39570** Chassis Ear
- **GE-41416** Ultrasonic Leak Detector

For equivalent regional tools, refer to **Special Tools**.

WARNING: Refer to Assistant Driving Warning .

To analyze a reported windnoise condition, test drive the vehicle to determine the origin of the noise.

Choose a regular route with smooth and straight streets that run in all 4 directions: North, South, East, and West. The area should have little traffic or little noise in order to eliminate interference with the test.

NOTE: Often there is one primary leak source and one or more secondary leaks that contribute to the noise condition. Repairing only one of the contributing leak sources may not completely repair the total condition but only reduce the condition.

Drive the vehicle at the speed in which the noise was noticed, or until the noise is heard. Maintain safe and legal speeds.

Many of the waterleak diagnosis tests are also used for the windnoise diagnosis.

Most windnoise is caused either by leaking seals or by misaligned body surfaces. You can diagnose the following types of windnoise with the aid of **CH-39570** ear or **GE-41416** detector.

- Wind whistle
- Wind roar
- Wind rush

When moving at highway speeds, air pressure inside the vehicle becomes greater than the air pressure outside. When a leak occurs, the escaping air causes a hiss or a whistle.

Wind roar occurs when air passes over or through an opening between the 2 body surfaces. To correct the condition, adjust the alignment to the body surfaces.

Wind rush occurs when air presses over the vehicle's body, and is related to the aerodynamics of the vehicle. Wind whistle and wind roar are repairable. Rule out wind whistle and wind roar before concluding that the wind noise is due to wind rush.

Use the following inspections in order to aid in diagnosing wind whistle or wind roar:

1. Note the details for wind noise:
    - The perceived location
    - The location where the noise is loudest
    - When the noise occurs
    - The vehicle speed
    - The interior fan speed
    - The position of the windows
    - What the noise sounds like
2. Inspect the vehicle for the possible cause of the windnoise.
3. Test drive the vehicle and determine if the windnoise is external or internal.
4. Perform a visual inspection of the following components:
    - Loose fasteners
    - Torn weatherstrips
    - Broken weld joints
    - Sealer and/or adhesive skips

TRACING POWDER OR CHALK TEST

Clean the weatherstrips and the contact surfaces with cleaning solvent.

1. Apply powder or chalk in an unbroken line to the contact surface of the weatherstrip surrounding the perimeter of the suspected areas.
2. Close the panel completely without slamming the panel. Closing the panel completely presses the weatherstrip firmly against the mating surface.
3. Inspect the applied line on the weatherstrip. The applied line is marred where contact is good. A corresponding imprint is on the mating surfaces.
4. Gaps or irregularities in the powder or the chalk line on the mating surfaces indicate the areas with a poor seal.

AIR PRESSURE TEST

1. Mask off both the pressure relief valves.
2. Close all the windows.
3. Turn the vehicles ventilation fan to the on position, with the selector on high speed and in the defrost mode.
4. Unlock and close the doors.
5. Listen for escaping air along the door and the window seals with a stethoscope or a length of heater hose.

SOAP SUDS OR BUBBLE TEST

1. Mask off the pressure relief valves.
2. Close all the windows and the doors.

3. Turn the vehicles ventilation fan to the on position, with the selector on high speed and in the defrost mode.
4. Unlock and close the doors.
5. Apply the soap solution to the potential leak areas.
6. Look for bubbles revealing escaping air.

REPAIR INSTRUCTIONS

EXTERIOR WINDNOISE

WARNING: Refer to Assistant Driving Warning .

Exterior windnoise is louder when the vehicle is driven with one or more windows down. Exterior windnoise occurs when air passes over the body panels, the seams, or the openings. Use the following items during the test drive in order to aid in the detection of leaks:

- Mechanic's stethoscope or heater hose
- Masking tape-51 mm (2 in) width
- Strip caulk
- A water soluble marking pencil

1. While driving, determine the location of the exterior windnoise by lowering one window at a time. If the location corresponds with the condition in step 2, pull over and make a temporary repair with 51 mm (2 in) wide masking tape.
2. Tape over the gaps and the moldings one at a time. Test between each taping. Taping over the gaps and moldings will correct the condition.
3. Temporarily repair the condition with masking tape. Adjust the tape when needed.
4. Continue testing in order to determine if the noise has been eliminated or other leak areas exist.
5. When all the reported leak conditions are located, make permanent repairs using the proper alignment techniques and the sealing materials.

INTERIOR WINDNOISE

WARNING: Refer to Assistant Driving Warning .

Interior windnoise is not heard when the window is lowered. Interior windnoise is caused by the air leaving the inside of the vehicle through a seal or a seam.

1. Tape over the relief valves to cause added air pressure within the vehicle.
2. Test drive the vehicle and listen for windnoise or a whistle.
3. Pull the vehicle over and make the temporary repairs using masking tape. If you cannot determine the source of the windnoise, perform one or more of the following diagnostic tests:
    - **Air Pressure Test**
    - **Soap Suds or Bubble Test**
    - **Tracing Powder or Chalk Test**

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

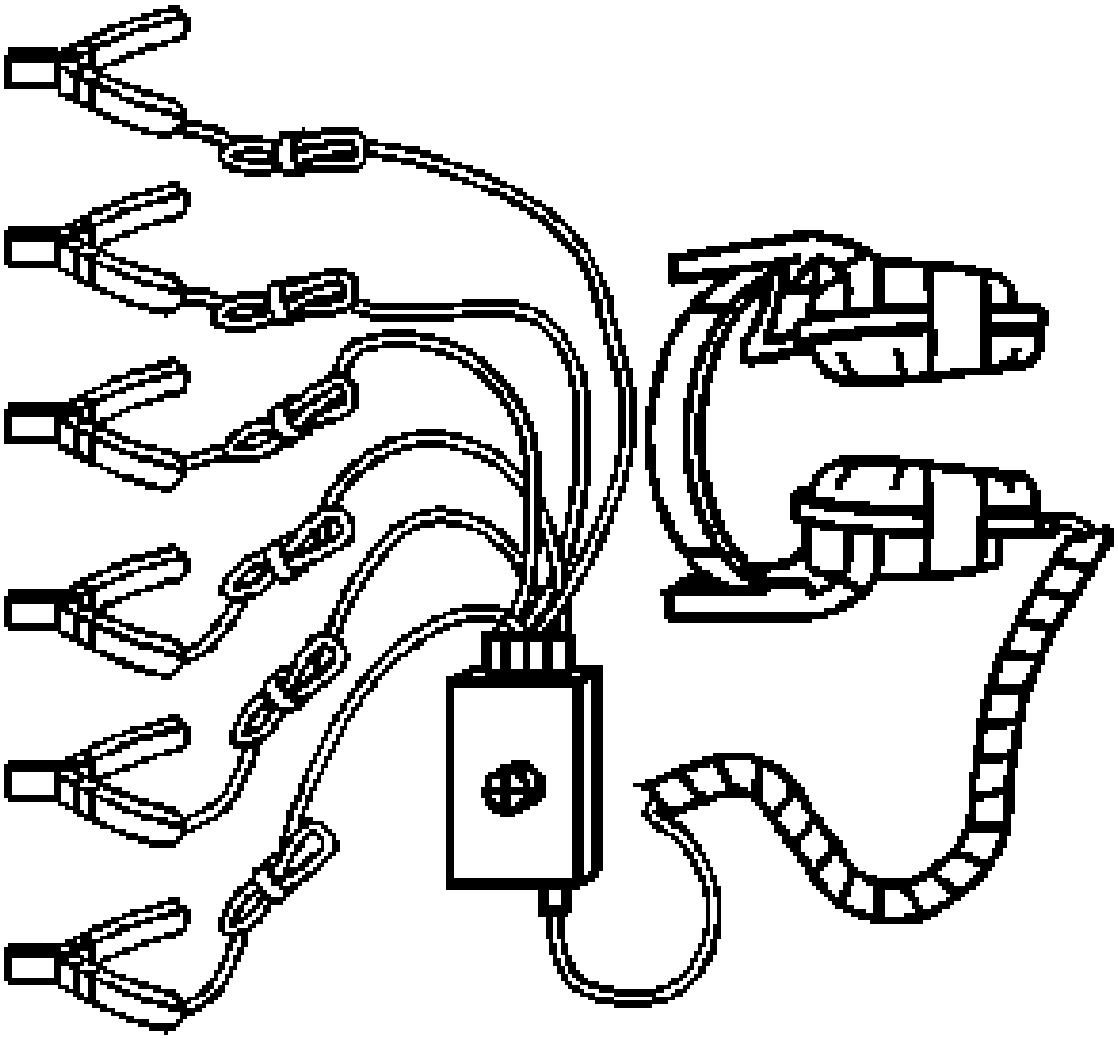
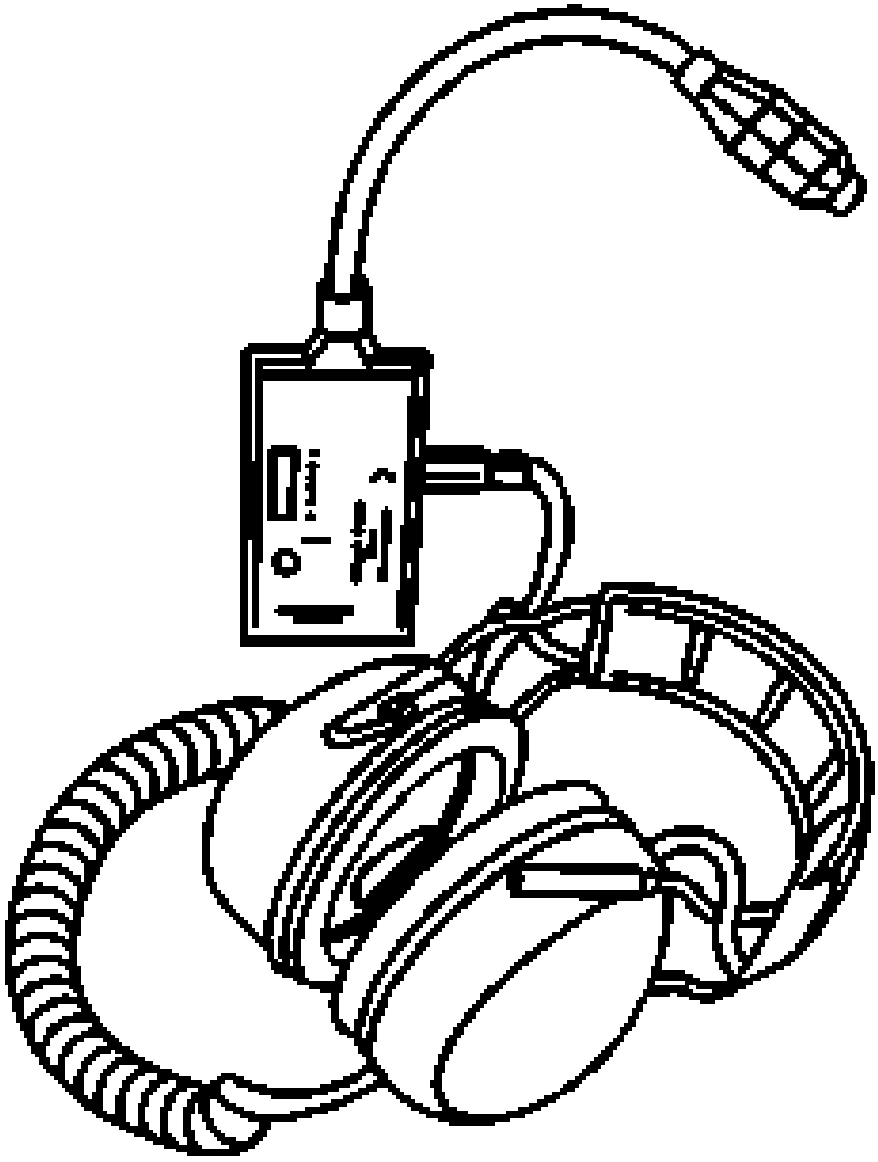
Illustration	Tool Number/ Description
	CH-39570 J 39570 Chassis Ear

Illustration	Tool Number/ Description
	GE-41416 J 41416 Ultrasonic Leak Detector

Article GUID: A00737242

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Front Fender Bolts	10 N.m	89 lb in
Front Fender Nut	10 N.m	89 lb in
Front Fender Upper Brace Bolts	10 N.m	89 lb in
Front Side Door Check Link Bolts	25 N.m	18 lb ft
Front Side Door Hinge Bolts	33 N.m	24 lb ft
Fuel Filler Door Pocket Bolts	10 N.m	89 lb in
Hood Hinge Bolts	25 N.m	18 lb in
Hood Latch Bolts	25 N.m	18 lb ft
Hood Latch Support Bolts	10 N.m	89 lb in
Hood Release Handle Nut	10 N.m	89 lb in
Hood Release Handle Screw	10 N.m	89 lb in
Rear Compartment Lid Hinge Bolts	25 N.m	18 lb ft
Rear Compartment Lid Hinge Nuts	25 N.m	18 lb ft
Rear Side Door Check Link Bolts	25 N.m	18 lb ft
Rear Side Door Hinge Bolts	33 N.m	24 lb ft
Rear Side Door Hinge Nuts	26 N.m	19 lb ft

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B3006: HOOD AJAR CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3006 5A

Hood Ajar Circuit Plausibility Failure

Diagnostic Fault Information

Circuit	Short to	Open/High	Short to	Signal

	Ground	Resistance	Voltage	Performance
Hood Ajar Switch Signal	B3006 5A	B3006 5A	B3006 5A	-
Hood Closed Switch Signal	B3006 5A	B3006 5A	B3006 5A	-
Ground	B3006 5A	B3006 5A	-	-

Circuit/System Description

The body control module (BCM) monitors the voltage input of the hood open switch signal circuit and the hood open closed switch signal circuit. With the hood open, the hood ajar portion of the switch is closed, grounding the hood ajar switch signal circuit from the BCM, and the hood closed portion of the switch is open. With the hood closed, the hood closed portion of the switch is closed, grounding the hood closed switch signal circuit from the BCM, and the hood ajar portion of the switch is open. During proper operation, the two separate voltage signals at the BCM should never be at the same voltage.

Conditions for Running the DTC

The BCM continuously monitors for this DTC

Conditions for Setting the DTC

Both the hood open switch signal circuit and the hood closed switch signal circuit are simultaneously in an active or inactive state.

Action Taken When the DTC Sets

- Remote start functions will be disabled.
- The hood ajar switch inputs will be ignored by content theft deterrent (CTD).

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting are no longer present.
- A history DTC will clear after 40 malfunction free ignition cycles.

Reference Information

Schematic Reference

- **Immobilizer Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool BCM Hood Open Switch and Hood Closed Switch parameters. With the hood open, the Hood Open Switch parameter should read Active and the Hood Closed Switch parameter should read Inactive. With the hood closed, the Hood Open Switch parameter should read Inactive and the Hood Closed Switch parameter should read Active.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the hood ajar switch.
2. Ignition OFF, test for less than 5 ohms between the ground circuit terminal C and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for 11.5-12.0 volts between the signal circuit terminal A and ground.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Ignition ON, test for 11.5-12.0 volts between the signal circuit terminal B and ground.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the hood ajar switch.

Component Testing

Hood Ajar Switch

1. Ignition OFF, disconnect the harness connector at the hood ajar switch.
2. With the switch in the hood closed position, test for infinite resistance between the ground terminal C and the signal terminal A.
    - If not infinite, replace the hood ajar switch.
3. Test for less than 2.0 ohms between the ground terminal C and the signal terminal B.
    - If greater than the specified range, replace the hood ajar switch.
4. With the switch in the hood open position, test for infinite resistance between the ground terminal C and the signal terminal B.
    - If not infinite, replace the hood ajar switch.
5. Test for less than 2.0 ohms between the ground terminal C and the signal terminal A.

- If greater than the specified range, replace the hood ajar switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Hood Primary and Secondary Latch Replacement**
- **Control Module References** for BCM replacement, programming and setup

SYMPTOMS - BOLTED EXTERIOR BODY PANELS AND CLOSURES

IMPORTANT: The following steps must be completed before using the symptom tables.

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data links.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Hood Ajar Indicator Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the systems. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to **Hood Ajar Indicator/Message Malfunction** in order to diagnose the symptom.

HOOD AJAR INDICATOR/MESSAGE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Hood Ajar Switch Signal	1	1	1	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Hood Closed Switch Signal	1	1	1	-
Ground	-	1	-	-
1. Hood ajar switch malfunction				

Circuit/System Description

The body control module (BCM) monitors the voltage input of the hood open switch signal circuit and the hood open closed switch signal circuit. With the hood open, the hood ajar portion of the switch is closed, grounding the hood ajar switch signal circuit from the BCM, and the hood closed portion of the switch is open. With the hood closed, the hood closed portion of the switch is closed, grounding the hood closed switch signal circuit from the BCM, and the hood ajar portion of the switch is open. During proper operation, the two separate voltage signals at the BCM should never be at the same voltage.

Reference Information

Schematic Reference

- **Immobilizer Schematics**
- **Remote Function Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Keyless Entry System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool BCM Hood Open Switch and Hood Closed Switch parameters. With the hood open, the Hood Open Switch parameter should read Active and the Hood Closed Switch parameter should read Inactive. With the hood closed, the Hood Open Switch parameter should read Inactive and the Hood Closed Switch parameter should read Active.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the hood ajar switch.
2. Ignition OFF, test for less than 5 ohms between the ground circuit terminal C and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for 11.5-12.0 volts between the signal circuit terminal A and ground.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Ignition ON, test for 11.5-12.0 volts between the signal circuit terminal B and ground.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the hood ajar switch.

Component Testing

Hood Ajar Switch

1. Ignition OFF, disconnect the harness connector at the hood ajar switch.
2. With the switch in the hood closed position, test for infinite resistance between the ground terminal C and the signal terminal A.
    - If not infinite, replace the hood ajar switch.
3. Test for less than 2 ohms between the ground terminal C and the signal terminal B.
    - If greater than the specified range, replace the hood ajar switch.
4. With the switch in the hood open position, test for infinite resistance between the ground terminal C and the signal terminal B.
    - If not infinite, replace the hood ajar switch.
5. Test for less than 2 ohms between the ground terminal C and the signal terminal A.
    - If greater than the specified range, replace the hood ajar switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Hood Primary and Secondary Latch Replacement**
- **Control Module References** for BCM or instrument cluster replacement, programming and setup

REPAIR INSTRUCTIONS

FRONT FENDER UPPER DIAGONAL BRACE REPLACEMENT

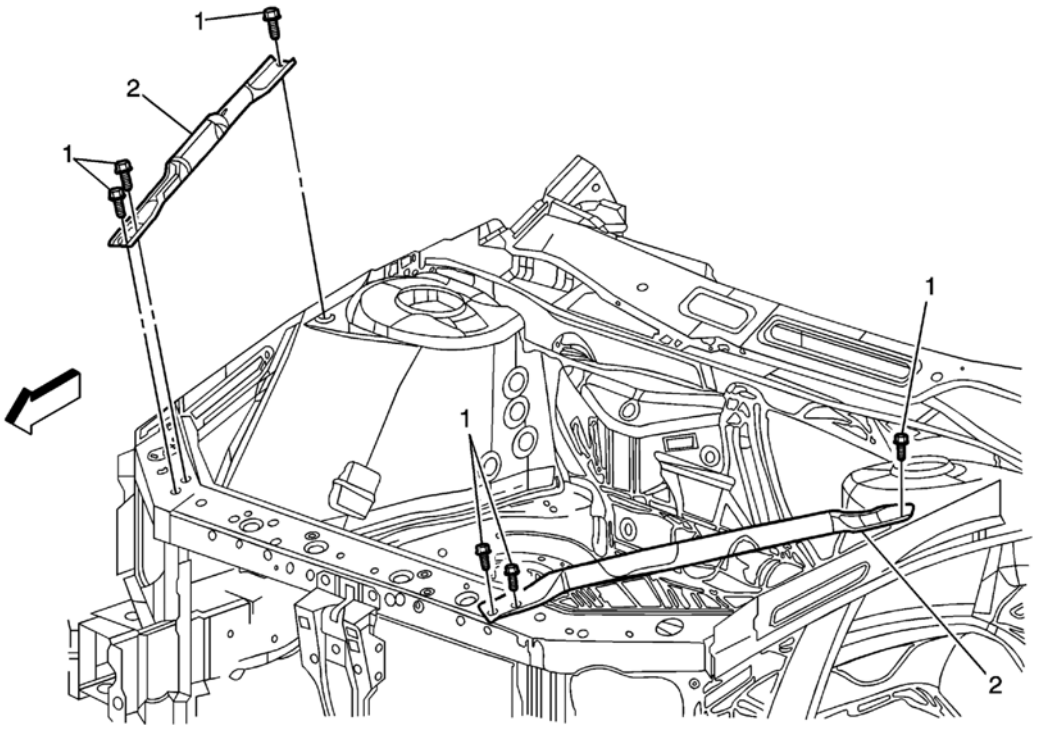


Fig. 1: Front Fender Upper Diagonal Brace
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Fender Upper Brace Bolts (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Fender Upper Diagonal Brace

HOOD PRIMARY LATCH RELEASE CABLE REPLACEMENT

Removal Procedure

1. Open the hood.
2. Remove the hood latch. Refer to **Hood Primary and Secondary Latch Replacement**.

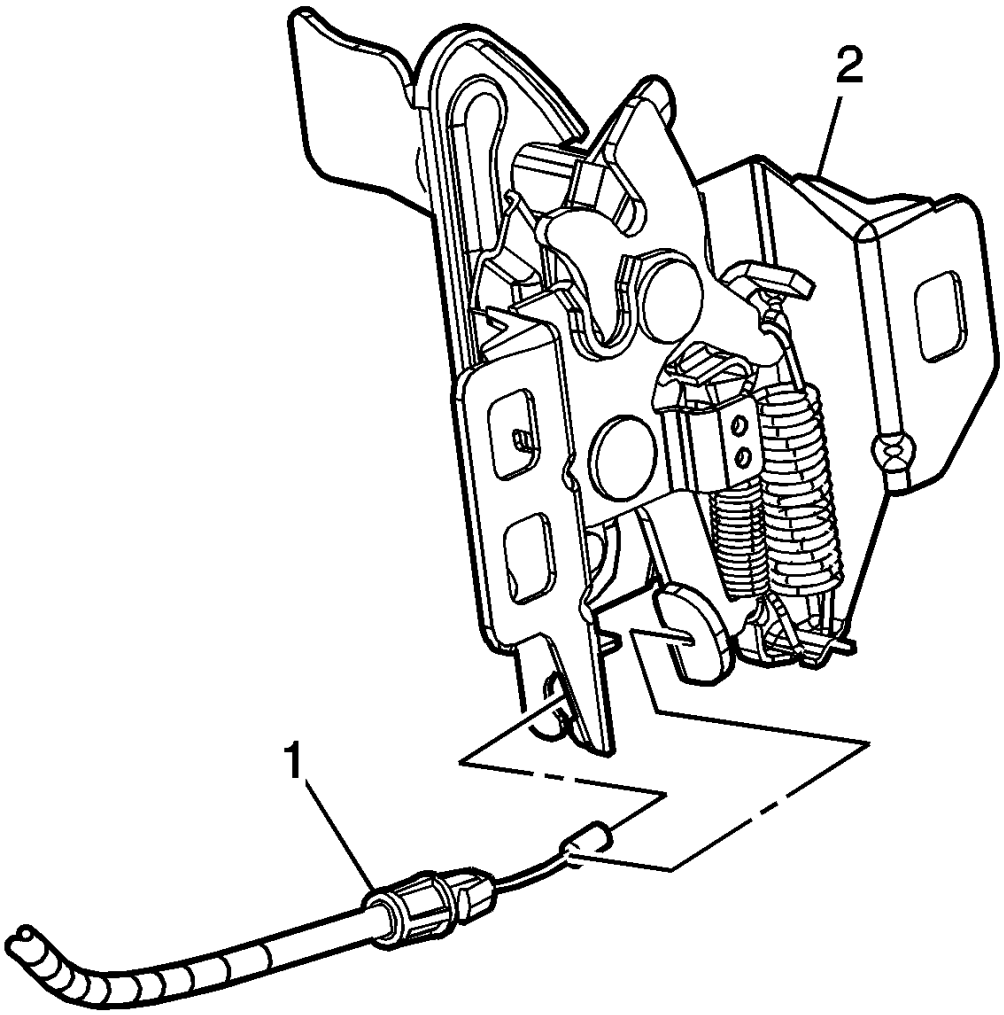


Fig. 2: Identifying Hood Latch Release Cable
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the hood release cable (1) from the hood latch (2).
4. Remove the carpet retainer. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala Limited)** .
5. Disconnect the hood release cable from the hood release handle.
6. Tie a piece of string around the hood release cable. This will ease the installation of the hood release cable through the passenger compartment.

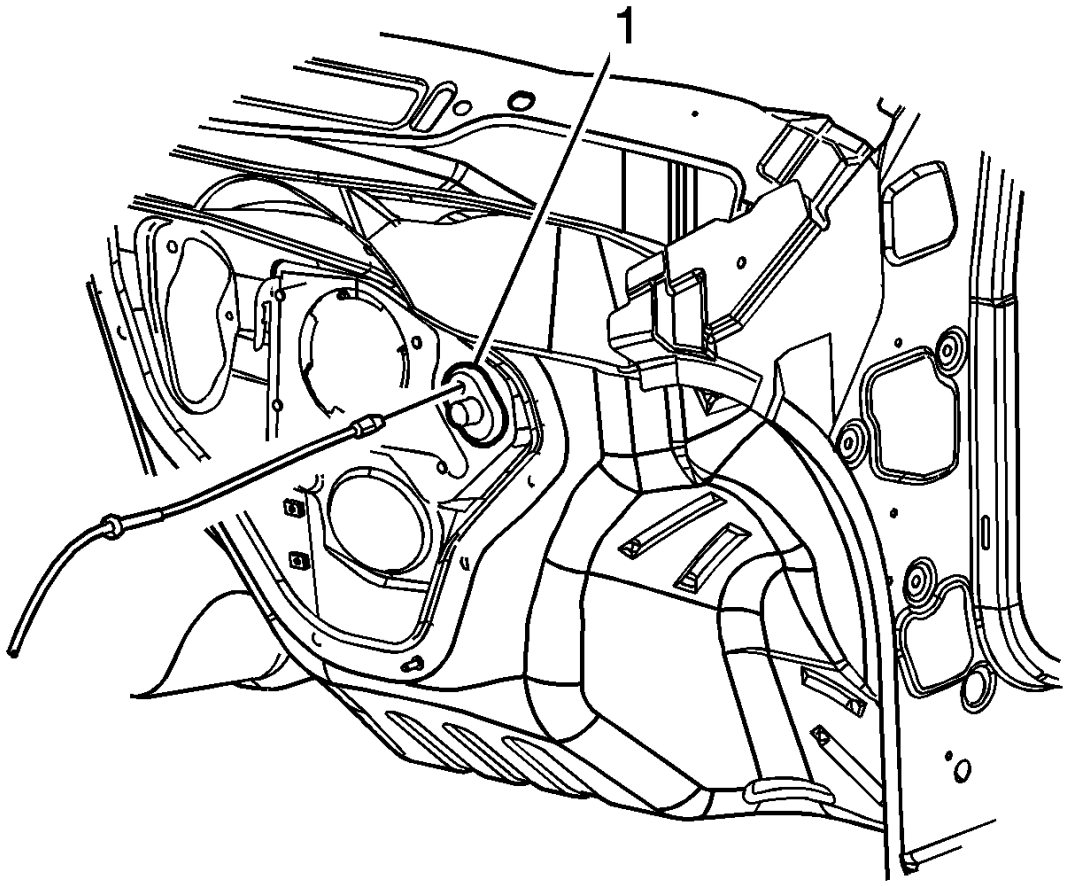


Fig. 3: Hood Release Cable Grommet At Dash Panel
Courtesy of GENERAL MOTORS COMPANY

7. Remove the hood release cable grommet (1) from the dash panel.
8. Note routing of cable.
9. Remove the hood release cable from the vehicle.

Installation Procedure

1. Transfer the string to either end of the new hood release cable.

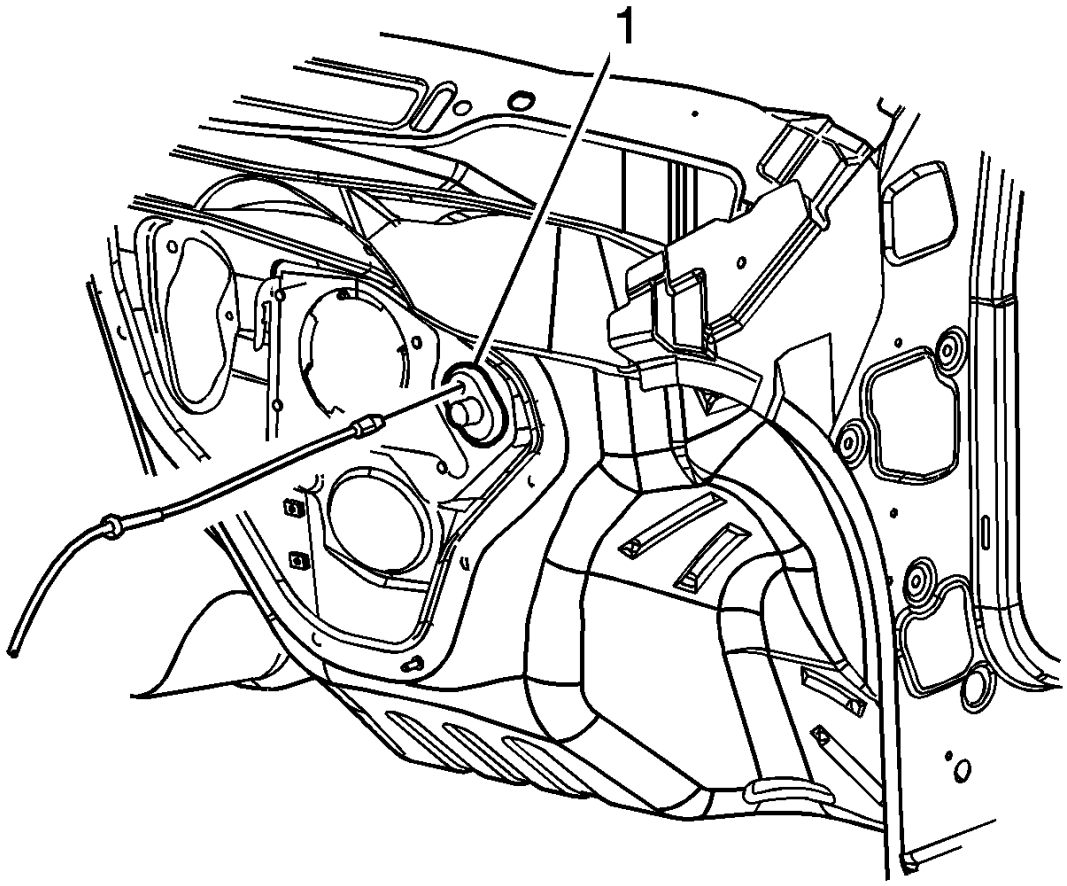


Fig. 4: Hood Release Cable Grommet At Dash Panel
Courtesy of GENERAL MOTORS COMPANY

2. Route the string and the hood release cable into the passenger compartment.
3. Remove the string from the hood release cable.
4. Seat the hood release cable grommet (1) into the cowl.
5. Connect the hood release cable to the hood release handle.
6. Install the carpet retainer. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala Limited)** .

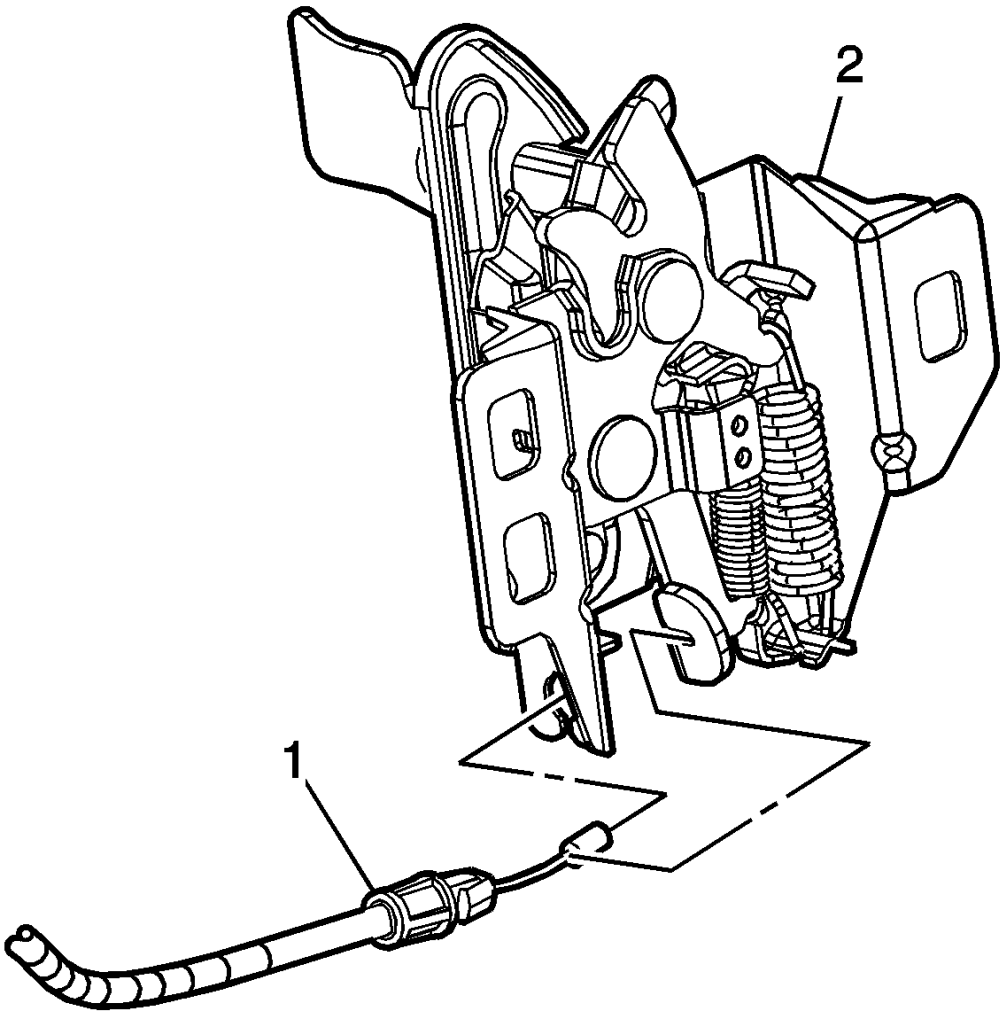


Fig. 5: Identifying Hood Latch Release Cable
Courtesy of GENERAL MOTORS COMPANY

7. Remove the string from the hood release cable.
8. Install the hood release cable (1) from the hood latch (2).
9. Install the hood latch. Refer to **Hood Primary and Secondary Latch Replacement**.
10. Close the hood.
11. Pull the string and the hood release cable into the engine compartment.

FRONT SIDE DOOR WIRING CONDUIT REPLACEMENT (IMPALA LIMITED)

Removal Procedure

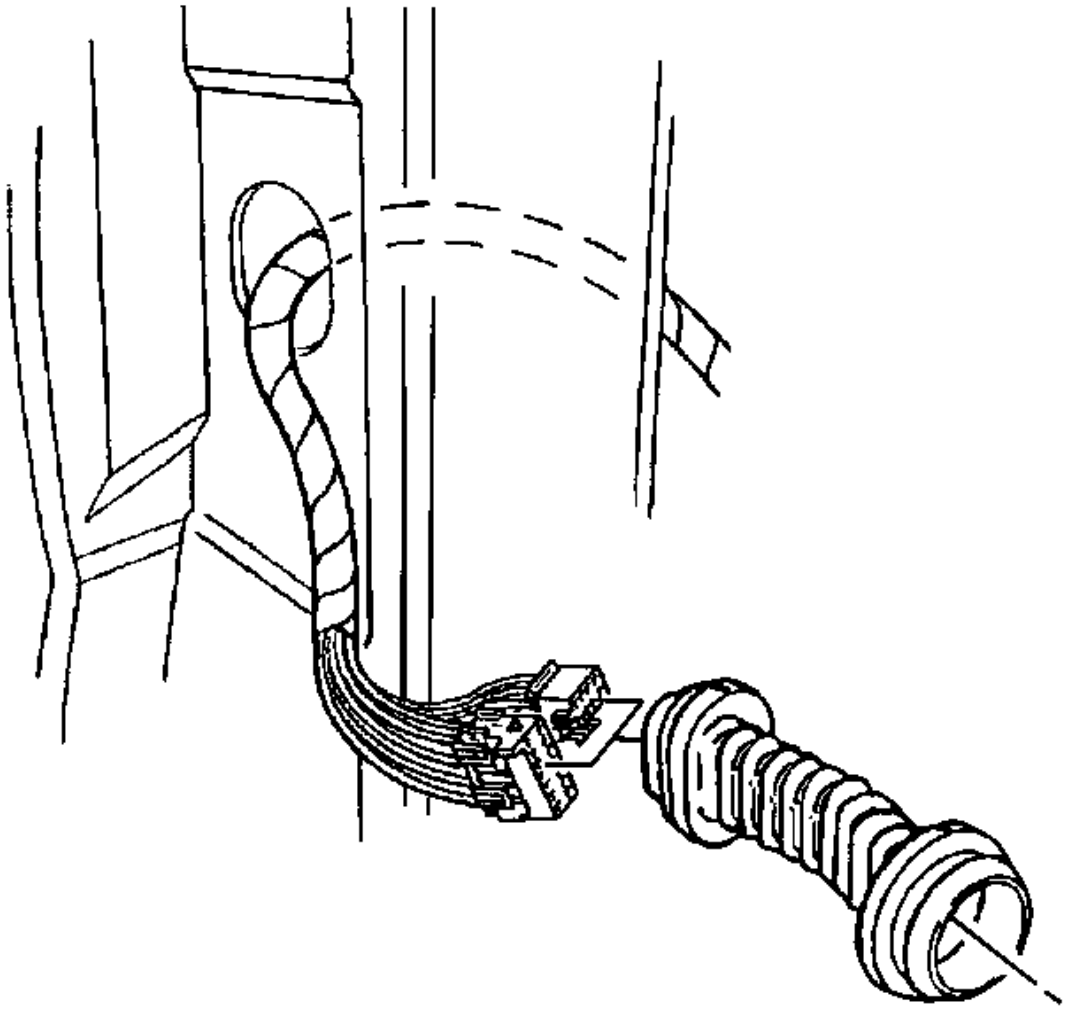


Fig. 6: Front Door Rubber Conduit
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right instrument panel insulator if removing the right conduit. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** .
2. Remove the door rubber conduit from where it attaches at the windshield pillar.
3. Disconnect the body harness electrical connector from the front door wiring harness.
4. Remove the conduit from the front door.
5. Remove the front door wiring harness out from the rubber conduit.

Installation Procedure

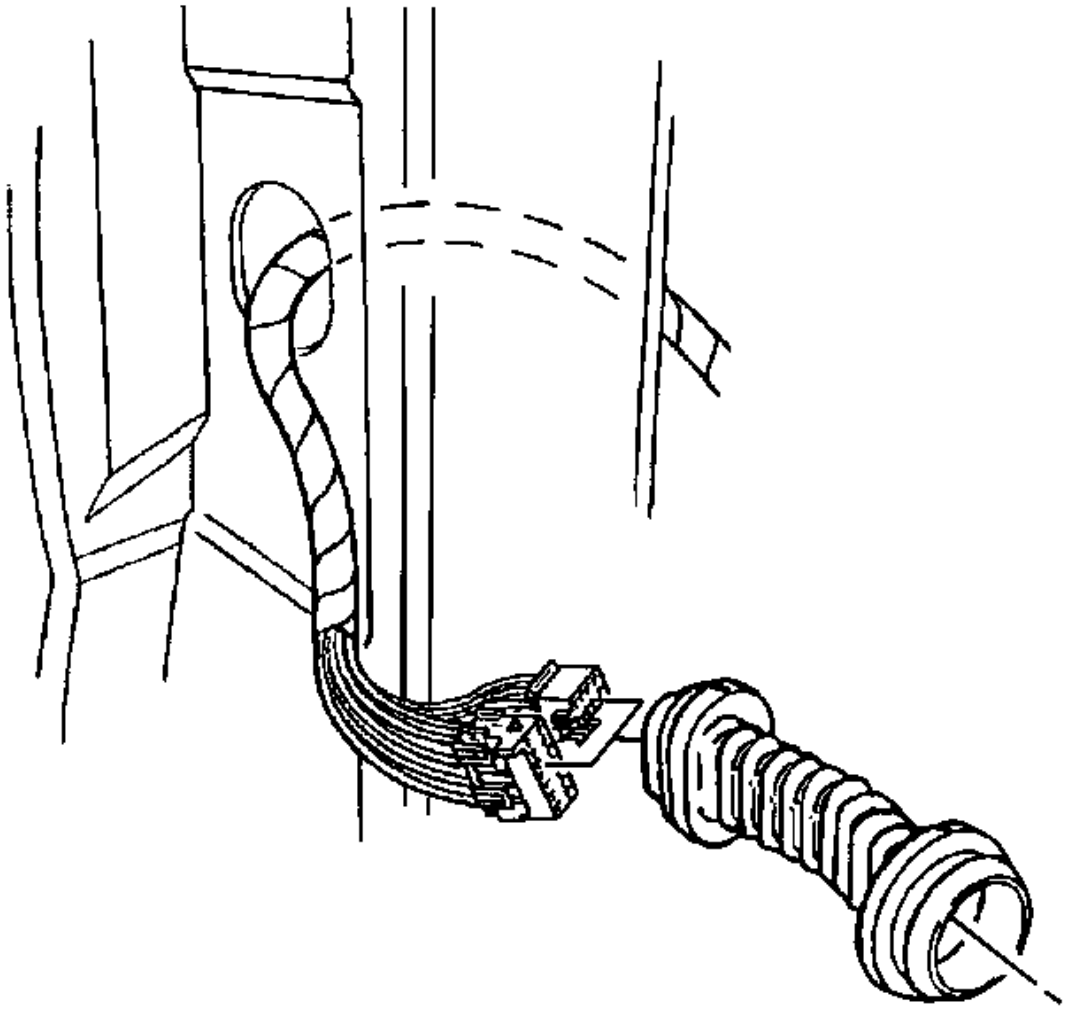


Fig. 7: Front Door Rubber Conduit
Courtesy of GENERAL MOTORS COMPANY

1. Install the wiring harness to the front door through the rubber conduit.
2. Install the rubber conduit to the front door.
3. Install the rubber conduit to the windshield pillar.
4. Connect the front door wiring harness electrical connector to the body harness.
5. Install the right instrument panel insulator if required. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** .

REAR SIDE DOOR WIRING CONDUIT REPLACEMENT

Removal Procedure

IMPORTANT: Mark the location and the color of the wires to the electrical socket before removing the wires.

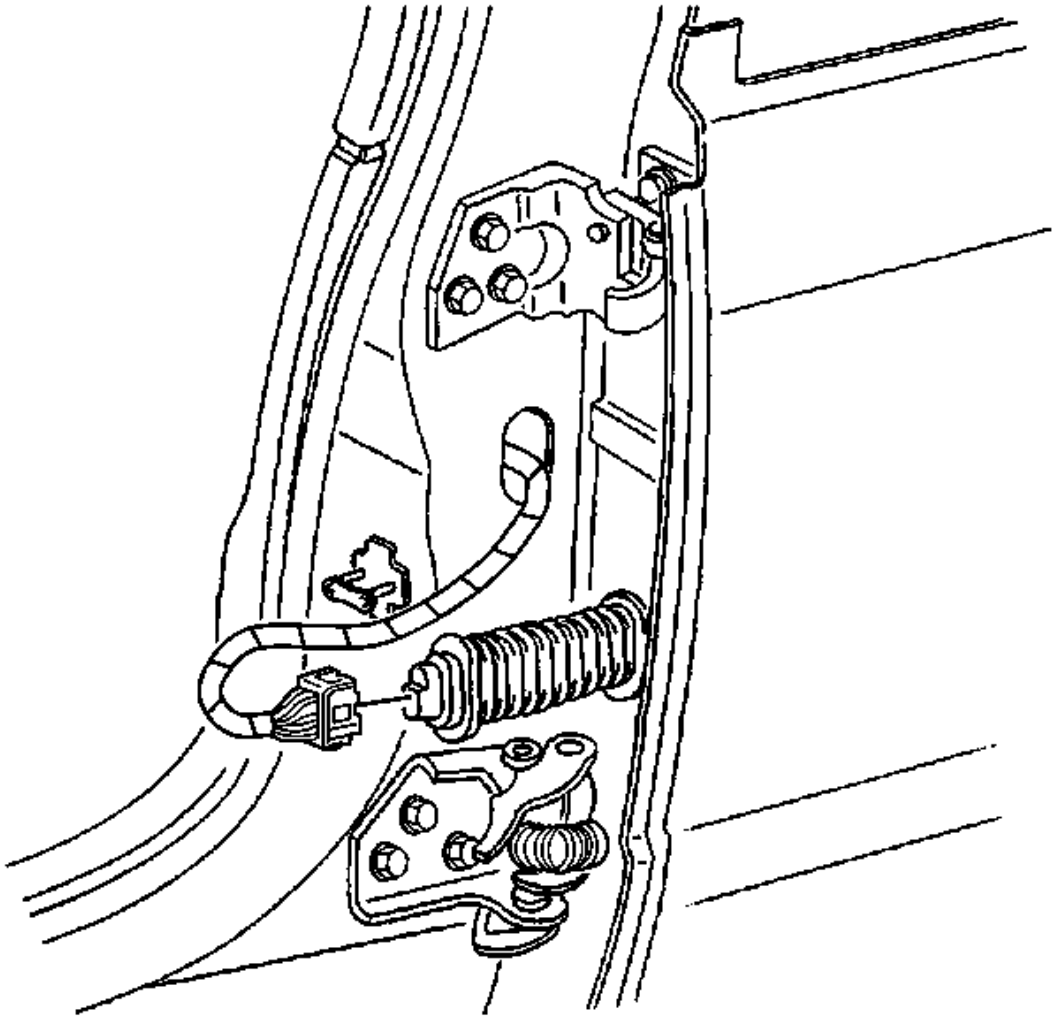


Fig. 8: View Of Rear Door Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

1. Remove the conduit from the center pillar.
2. Disconnect the rear door wiring harness electrical connector from the body harness.
3. Disconnect the wire harness retainer from the wiring harness socket.
4. Remove the wiring harness wiring one at a time from the socket.
5. Remove the rubber conduit from the rear door.
6. Remove the wiring harness wiring from the rubber conduit.

Installation Procedure

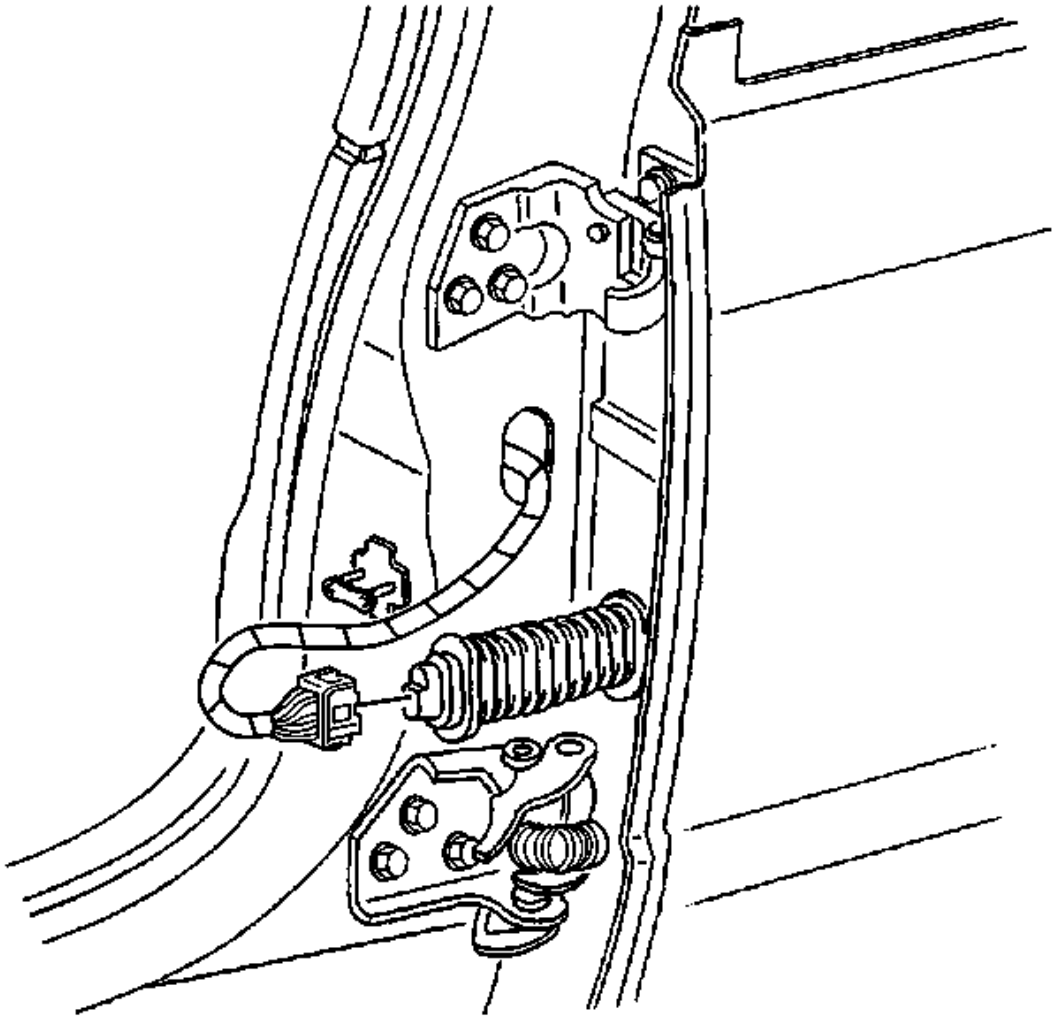


Fig. 9: View Of Rear Door Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

1. Install the rear door electrical harness through the rubber conduit.
2. Install the rear door wiring harness wires to the electrical socket.
3. Connect the rear door wiring harness electrical connector.

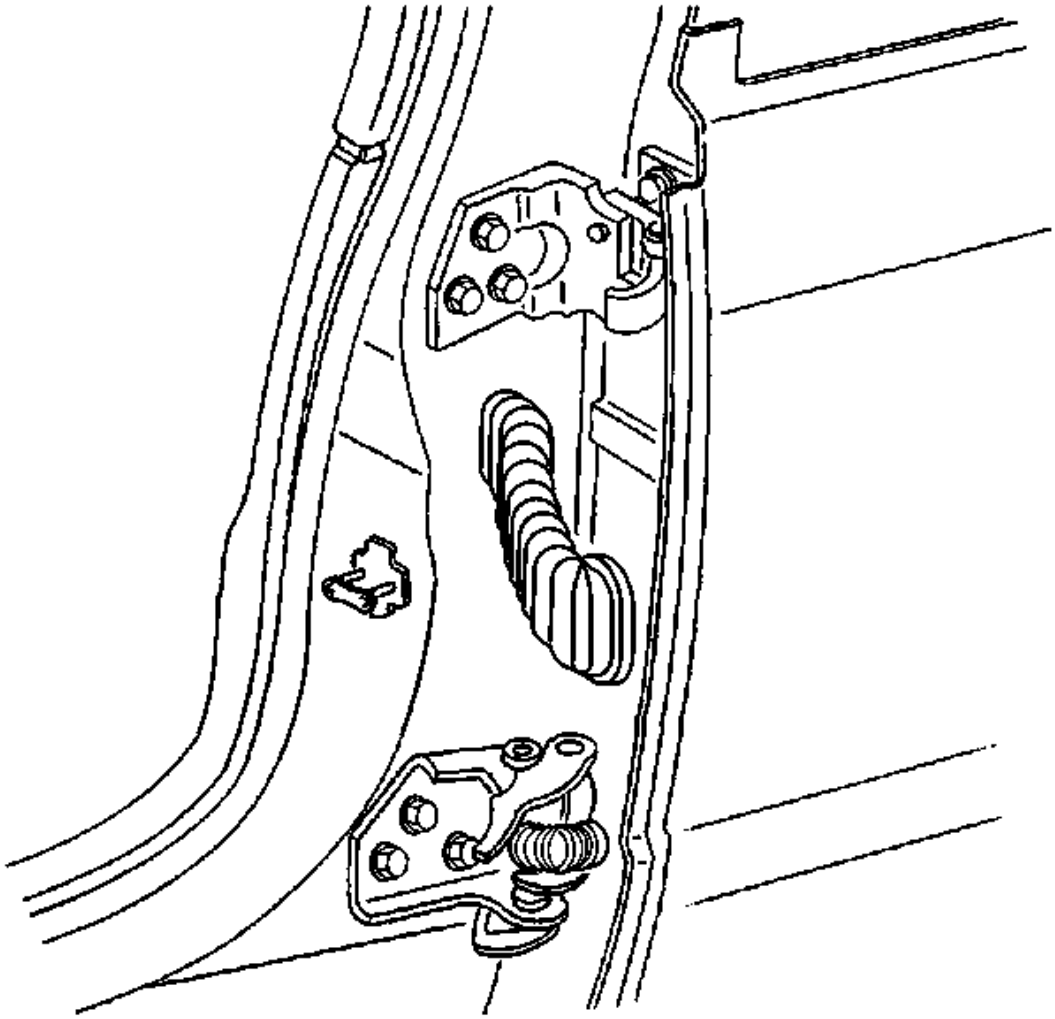


Fig. 10: Identifying Rear Door Rubber Conduit
Courtesy of GENERAL MOTORS COMPANY

4. Install the rubber conduit to the rear door.
5. Install the rubber conduit to the center pillar.

FRONT SIDE DOOR ADJUSTMENT

Up/Down or In/Out Adjustment

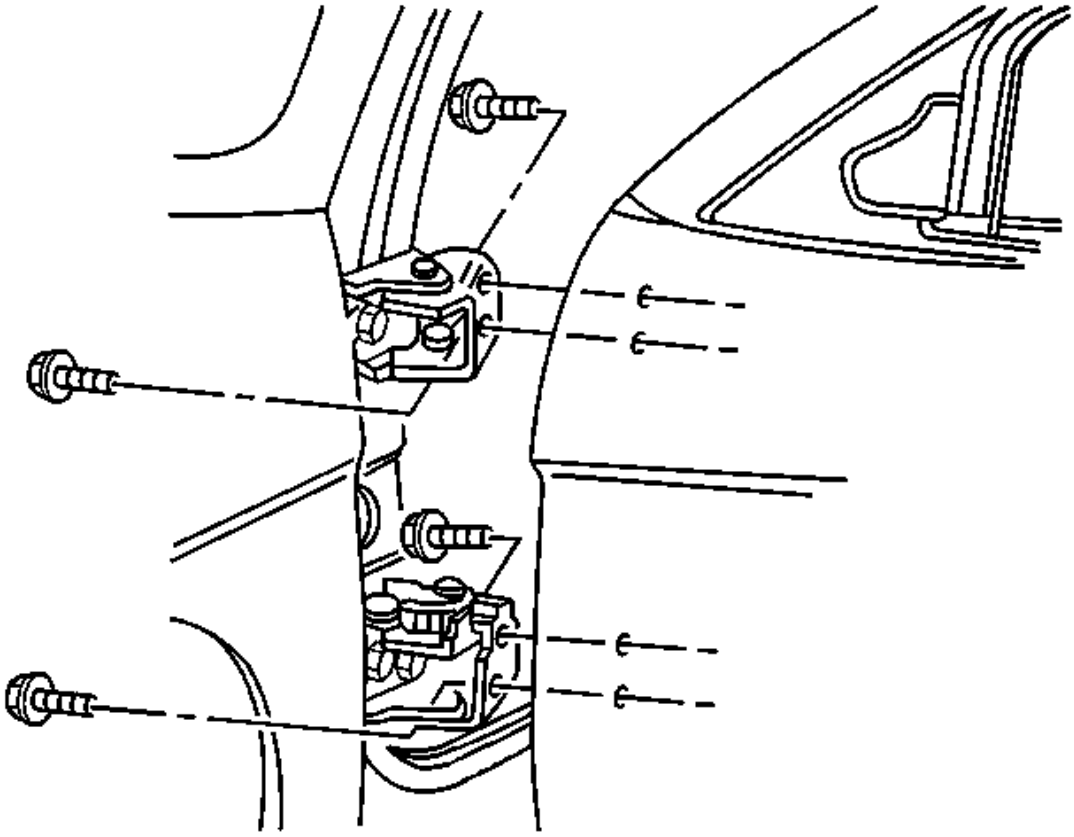


Fig. 11: Front Door Hinges
Courtesy of GENERAL MOTORS COMPANY

1. Open the font door to access the front door hinge bolts.

NOTE: **Do not remove the front door hinge bolts.**

2. Loosen the front door side hinge bolts.

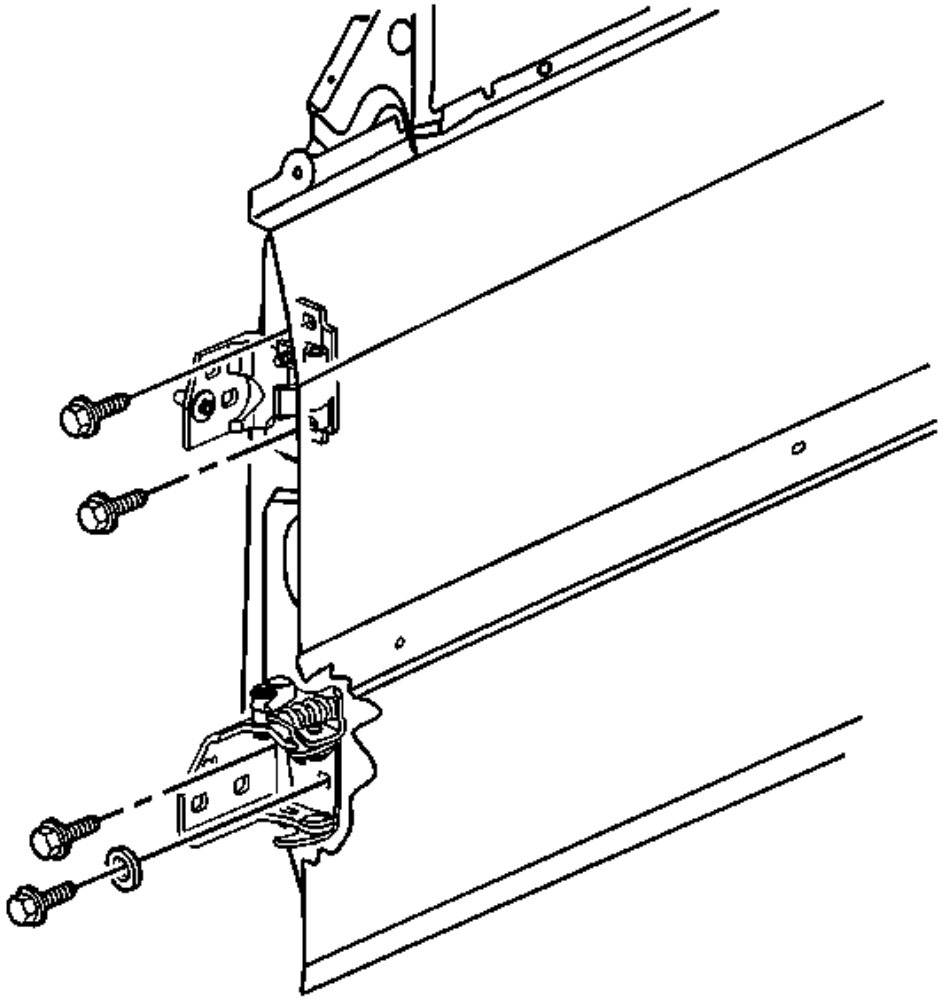


Fig. 12: Front Door Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Pry off the washer from the lower bolt on the lower hinge.

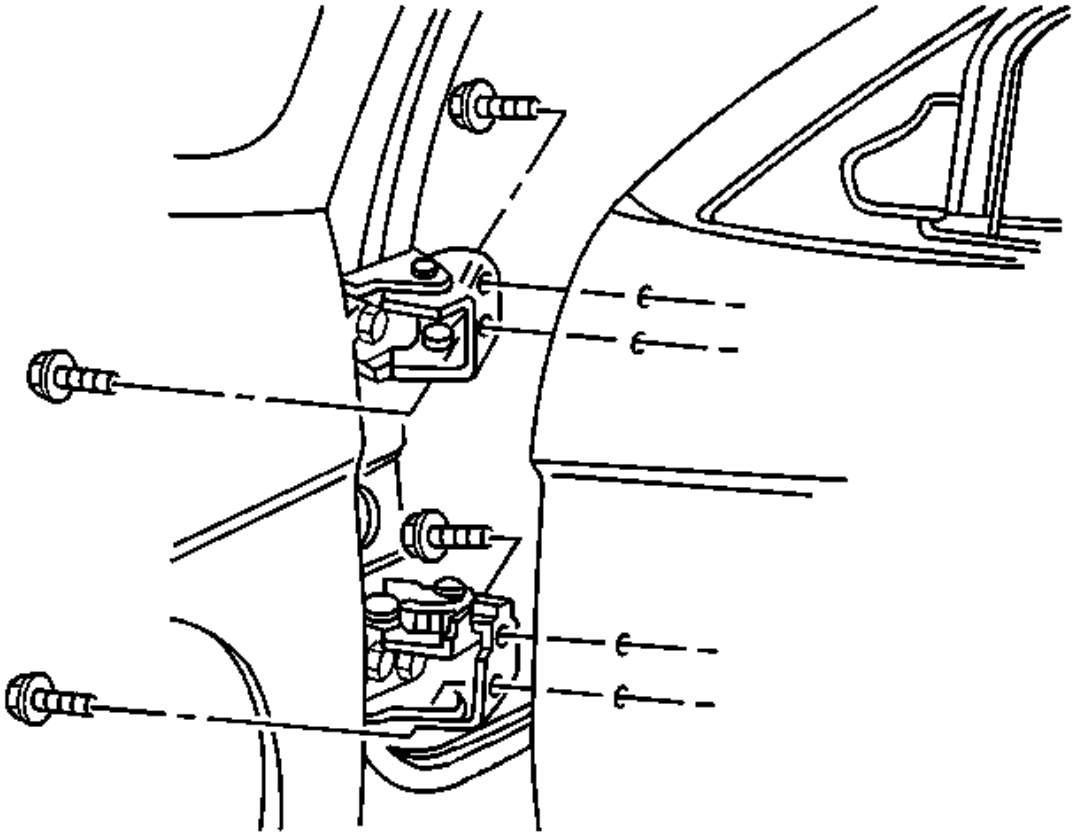


Fig. 13: Front Door Hinges
Courtesy of GENERAL MOTORS COMPANY

4. Adjust the front door up or down and in and out as required.

CAUTION: Refer to Fastener Caution .

5. Tighten the door side hinge bolts to 33 N.m (24 lb ft).

Fore/Aft Adjustment

NOTE: Do not remove the bolts.

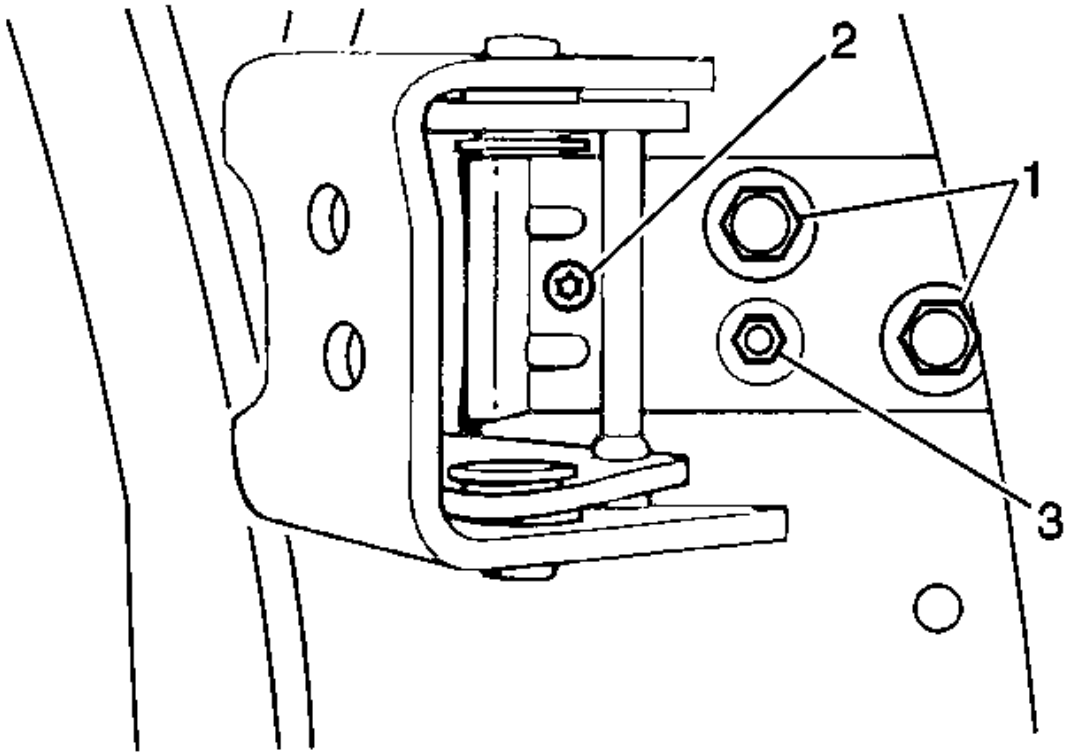


Fig. 14: Front Door Hinge & Components
Courtesy of GENERAL MOTORS COMPANY

1. Loosen the body side hinge bolts (1).
2. Adjust the door fore and aft as required.
3. Tighten the body side hinge bolts (1) to 33 N.m (24 lb ft).

REAR SIDE DOOR ADJUSTMENT

Up/Down or In/Out Adjustment

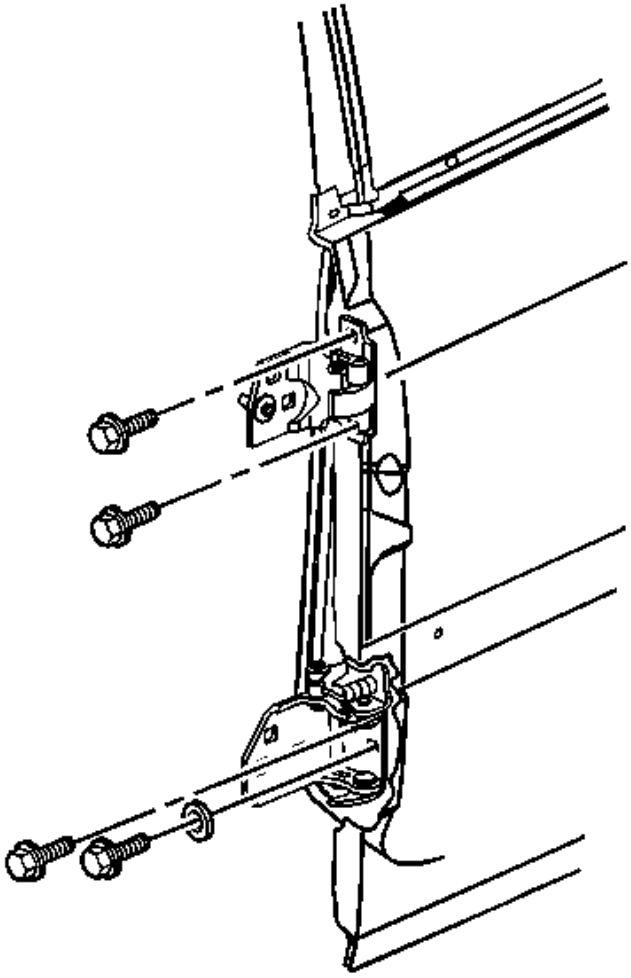


Fig. 15: Locating Door Hinge Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Open the front door to access the rear door hinge bolts.

NOTE: **Do not remove the rear door hinge bolts.**

2. Loosen the rear door side hinge bolts.
3. Pry off the washer from the lower bolt on the lower hinge.
4. Adjust the rear door up or down and in and out as required.

CAUTION: **Refer to Fastener Caution .**

5. Tighten the door side hinge bolts.

Tighten

Tighten the rear door hinge to door bolts to 33 N.m (24 lb ft).

FRONT SIDE DOOR REPLACEMENT

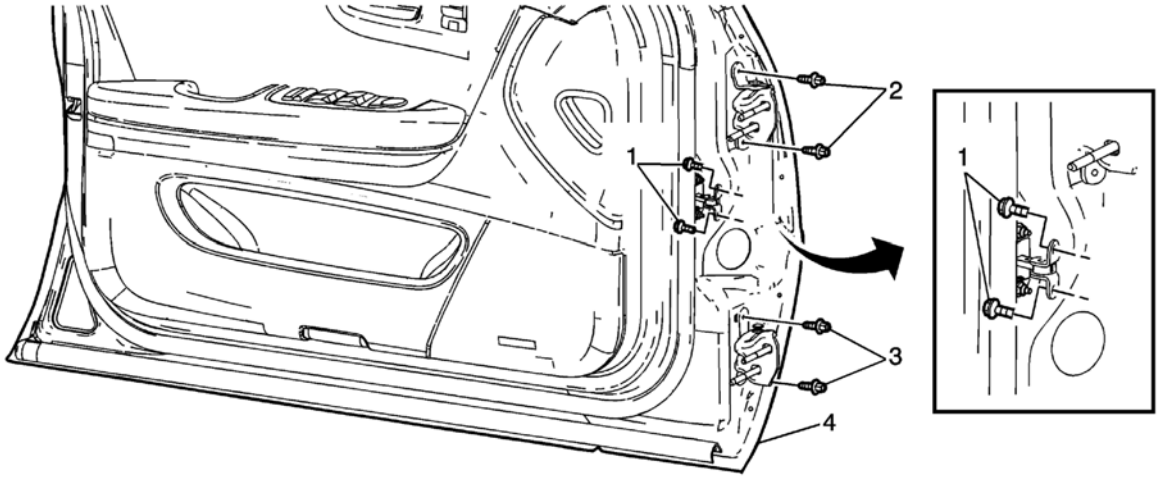


Fig. 16: Front Side Door Bolts
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to SIR Warning .** **Preliminary Procedures** 1. Disable the supplemental inflatable restraint (SIR) system. Refer to **SIR Disabling and Enabling** . 2. Remove the front door trim panel. Refer to **Front Side Door Trim Panel Replacement** .	
1	Front Side Door Check Link Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 20 N.m (15 lb ft)
2	Front Side Door Upper Hinge Bolt (Qty: 2) **Procedure** 1. Remove the water deflector. 2. Support the door before removing the hinge bolts. 3. Disconnect the electrical connector, if equipped. 4. With the aid of an assistant, remove the door.

Callout	Component Name
	Tighten 35 N.m (26 lb ft)
3	Front Side Door Lower Hinge Bolt (Qty: 2) **Tighten** 33 N.m (24 lb ft)
4	Front Side Door Assembly **Procedure** When replacing the door it is necessary to transfer all of the internal components.

REAR SIDE DOOR REPLACEMENT

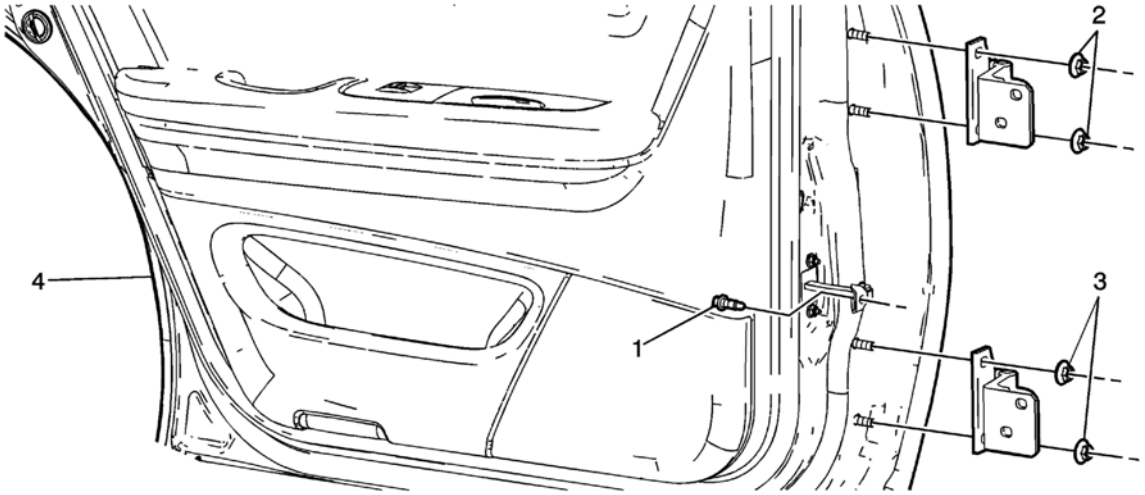


Fig. 17: Rear Side Door Bolts & Nuts
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to SIR Warning .** **Preliminary Procedures** 1. Disable the supplemental inflatable restraint (SIR) system. Refer to **SIR Disabling and Enabling** . 2. Remove the rear door trim panel. Refer to **Rear Side Door Trim Panel Replacement** .	

Callout	Component Name
1	Rear Side Door Check Link Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 20 N.m (15 lb ft)
2	Rear Side Door Hinge Upper Bolt (Qty: 2) **Procedure** 1. Remove the water deflector. 2. Support the door before removing the hinge bolts. 3. Disconnect the electrical connector, if equipped. 4. With the aid of an assistant, remove the door. **Tighten** 26 N.m (19 lb ft)
3	Rear Side Door Hinge Lower Bolt (Qty: 2) **Tighten** 26 N.m (19 lb ft)
4	Rear Side Door Assembly **Procedure** When replacing the door it is necessary to transfer all of the internal components.

FRONT FENDER REPLACEMENT

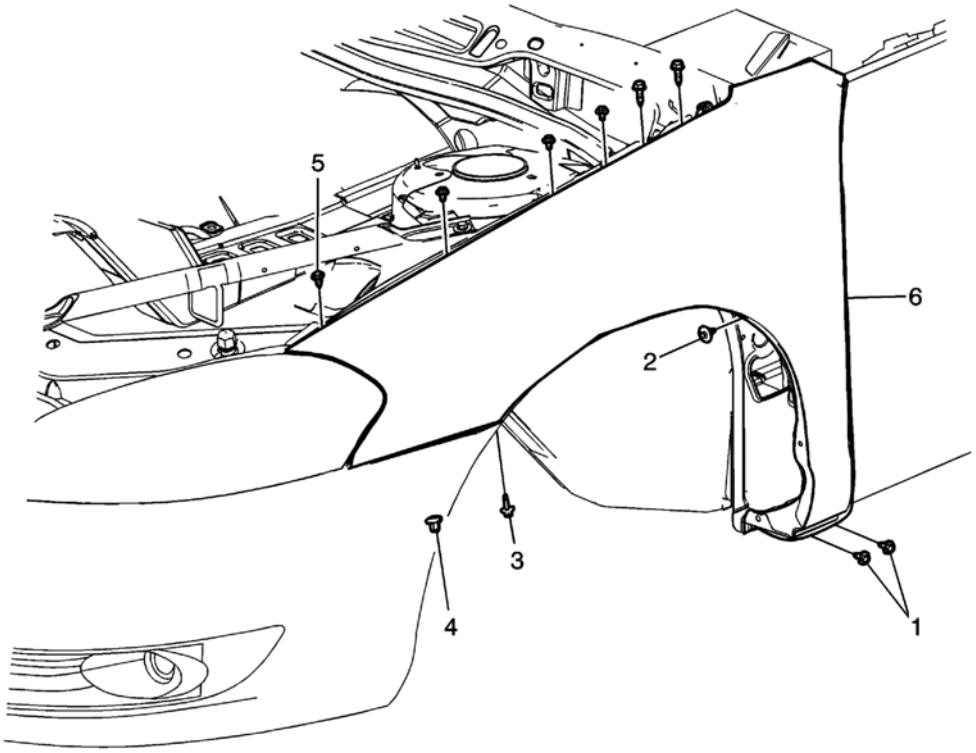


Fig. 18: Front Fender
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Fender Bolts (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Front Fender Bolt **Tighten** 10 N.m (89 lb in)
3	Front Fender Bolt **Tighten** 10 N.m (89 lb in)
4	Front Fender Nut **Tighten** 10 N.m (89 lb in)
5	Front Fender Bolts (Qty: 6) **Tighten** 10 N.m (89 lb in)

Callout	Component Name
6	Front Fender

HOOD PRIMARY LATCH RELEASE CABLE HANDLE REPLACEMENT

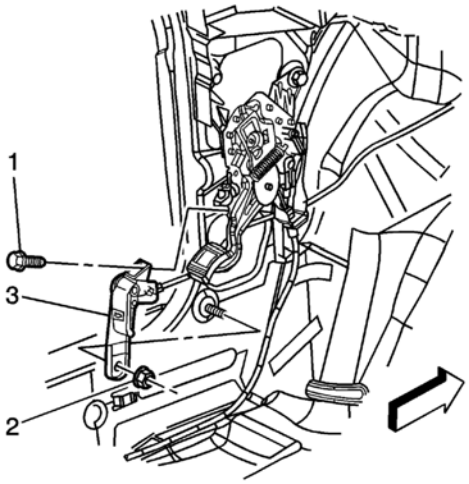


Fig. 19: Hood Latch Release Handle
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the carpet retainer. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala)** .	
1	Hood Release Handle Screw **CAUTION:** **Refer to** **Fastener Caution** **.** **Tighten** 10 N.m (89 lb in)
2	Hood Release Handle Nut **Tighten** 10 N.m (89 lb in)
3	Hood Release Handle **TIP:** Disconnect the cable from the handle.

FRONT SIDE DOOR UPPER HINGE AND LOWER HINGE REPLACEMENT

Removal Procedure

NOTE: **In order to minimize door realignment, do not remove both door hinges at the same time. Do each door hinge separately, and replace the broken door hinge**

first.

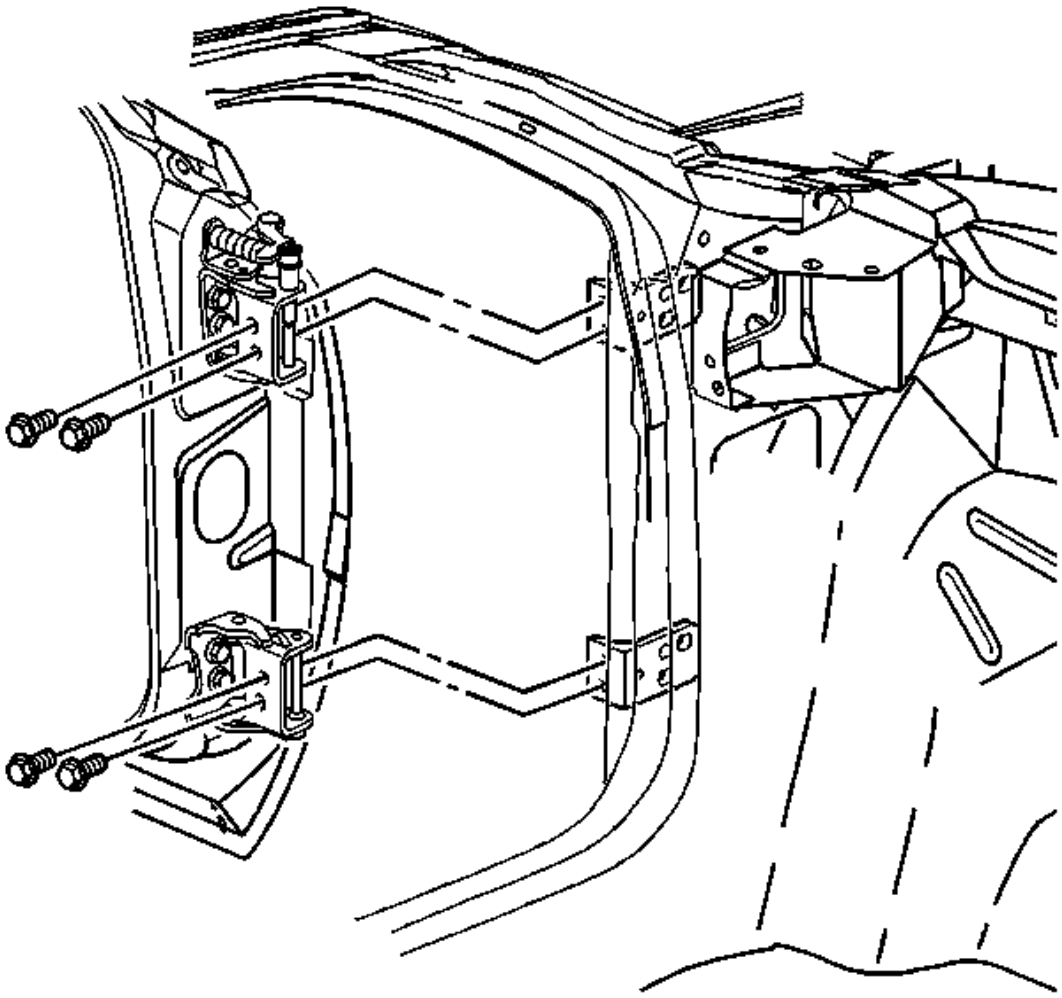


Fig. 20: Front Door Hinges
Courtesy of GENERAL MOTORS COMPANY

1. Open the front door.
2. Support the front door.
3. Remove the intermediate hinge bolts from the front door hinge.
4. Move the door as far as the rubber conduit will allow.
5. Clean the mounting surfaces of the hinges with a clean rag and mark the front door hinge locations on each surface with a grease pencil or other suitable marker.
6. Remove the bolts from the front doorside hinge.
7. Remove the doorside hinge.
8. Remove the bolts from the bodyside hinge.
9. Remove the bodyside hinge.

Installation Procedure

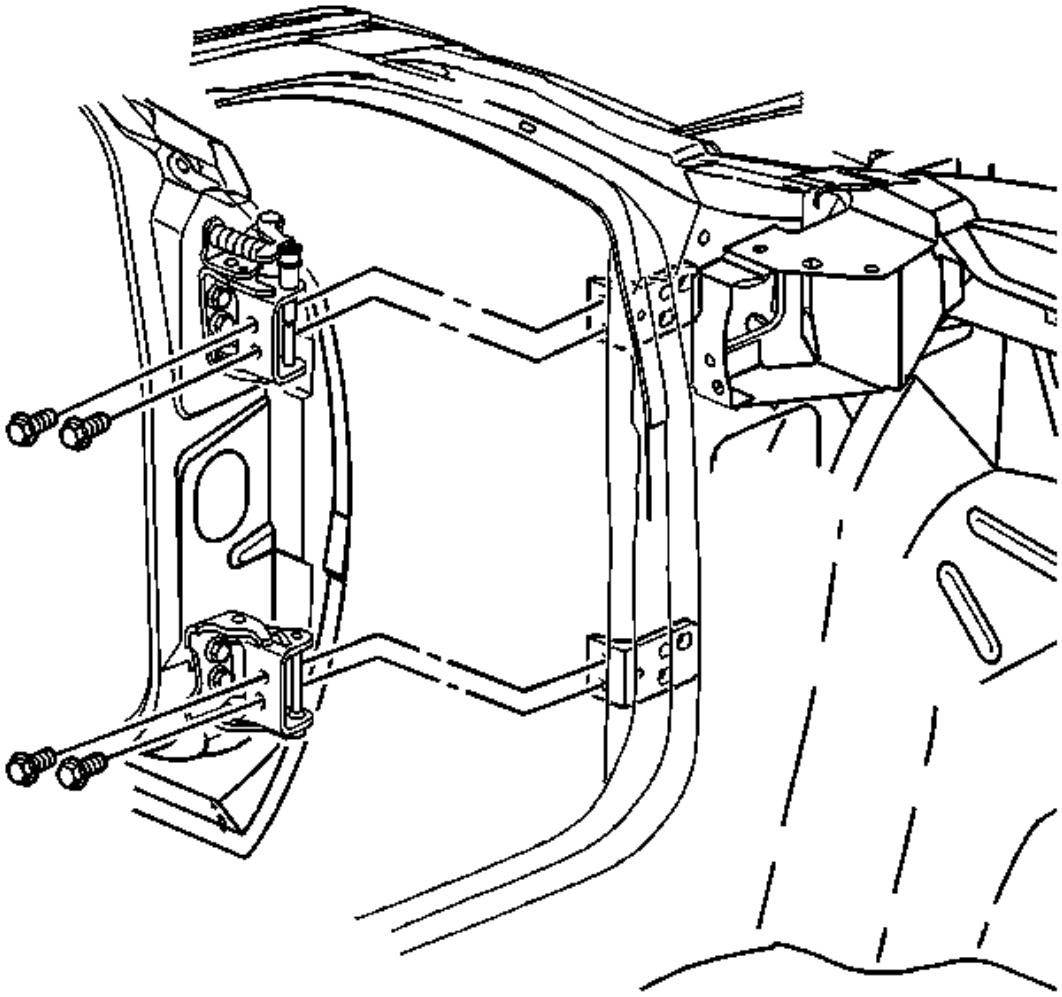


Fig. 21: Front Door Hinges
Courtesy of GENERAL MOTORS COMPANY

1. Position the bodyside hinge to the alignment marks.

CAUTION: **Refer to Fastener Caution .**

2. Install the bolts to the bodyside hinge.

Tighten

Tighten the bolts to the bodyside hinge to 33 N.m (24 lb ft).

3. Position the doorside hinge to the bodyside hinge.
4. Install the intermediate hinge bolts to the front door hinge.

Tighten

Tighten the bolts to the intermediate hinge to 33 N.m (24 lb ft).

5. Install the doorside hinge bolts.

   Tighten

   Tighten the bolts to the doorside hinge to 33 N.m (24 lb ft).

6. Remove the door support.
7. Inspect the door for proper operation and alignment. Refer to **Front Side Door Adjustment**.

HOOD HINGE REPLACEMENT

Removal Procedure

WARNING: When a hood hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

1. Remove the hood. Refer to **Hood Replacement**.
2. Remove the rear hood side seal. Refer to **Hood Rear Outer Seal Replacement**.
3. Remove the hood assist rod. Refer to **Hood Open Assist Rod Replacement**.

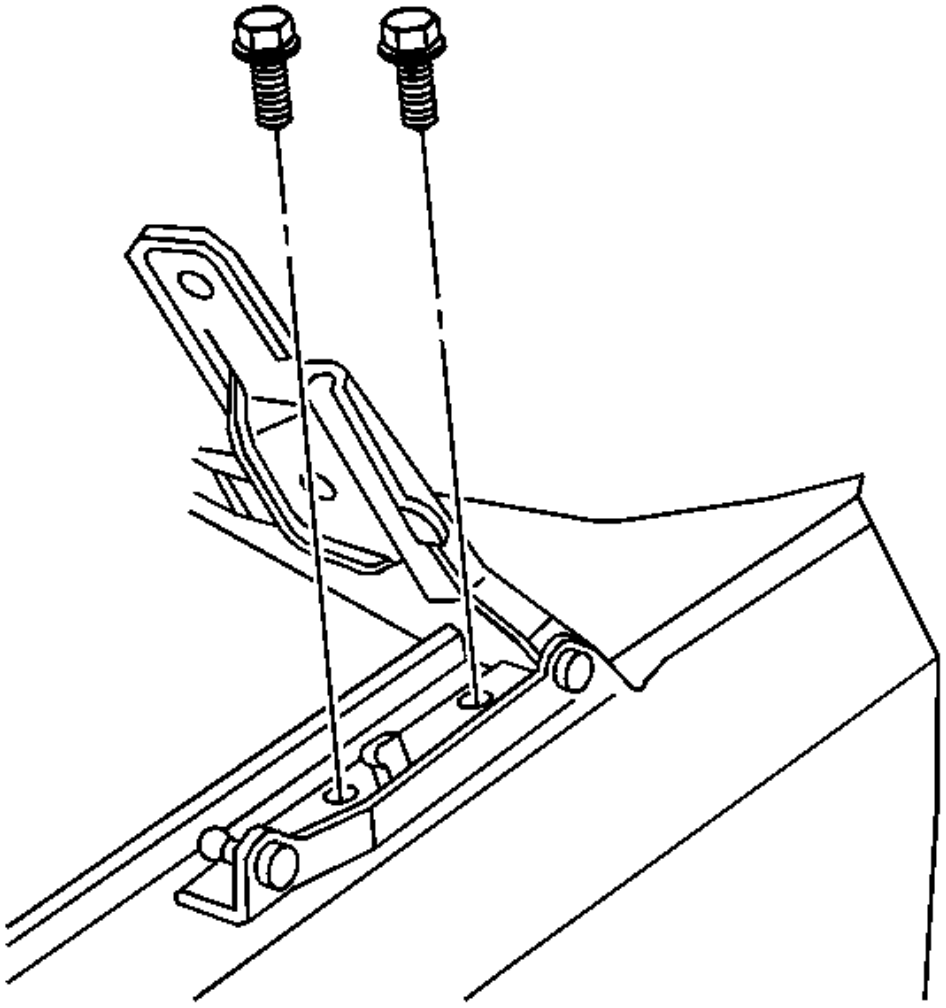


Fig. 22: Hinge Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the hood hinge to fender bolts, but do not remove the bolts.

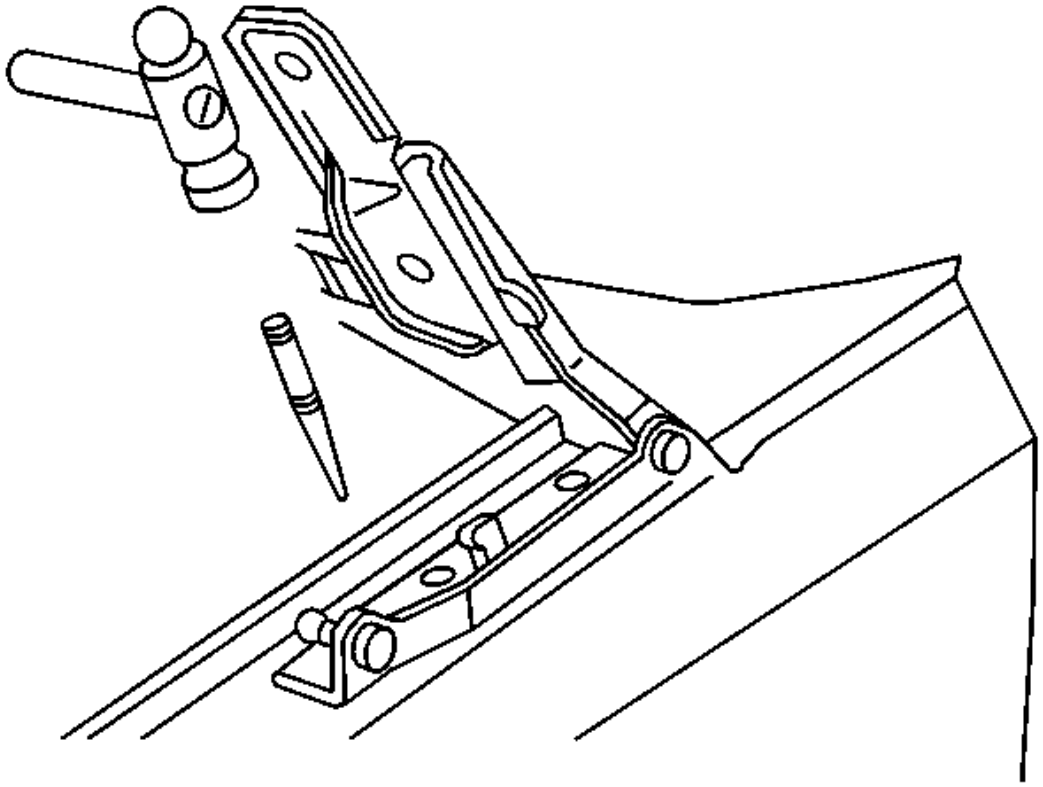


Fig. 23: Center Punching Hood Hinge Spot Weld
Courtesy of GENERAL MOTORS COMPANY

5. Center punch the spot weld

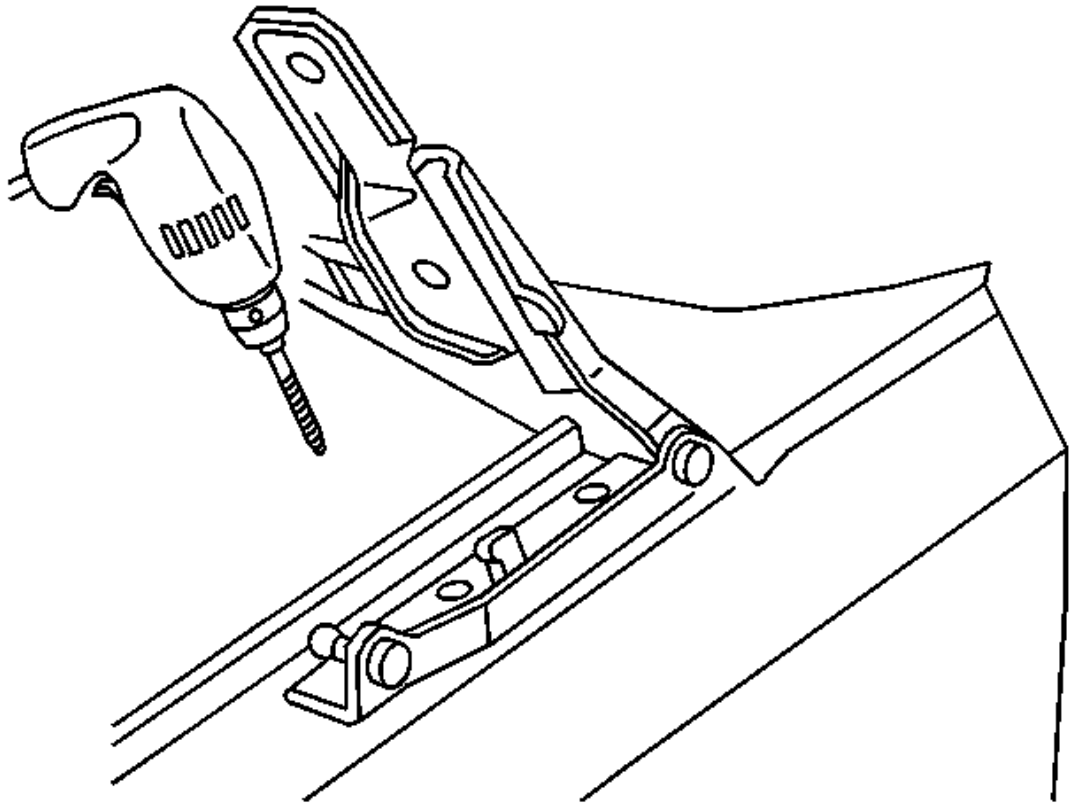


Fig. 24: Drilling Hood Hinge Spot Weld
Courtesy of GENERAL MOTORS COMPANY

6. Drill out the spot weld using a 9.5 mm (3/8 in) drill bit.
7. Remove the hood hinge to fender bolts.
8. Remove the hood hinge from the fender.
9. Repair the paint on the fender where the hood hinge was removed. Refer to **Anti-Corrosion Treatment and Repair** .

Installation Procedure

NOTE: **Weld on body side is an assembly plant assembly aid only. Weld is not required when installing a replacement hinge.**

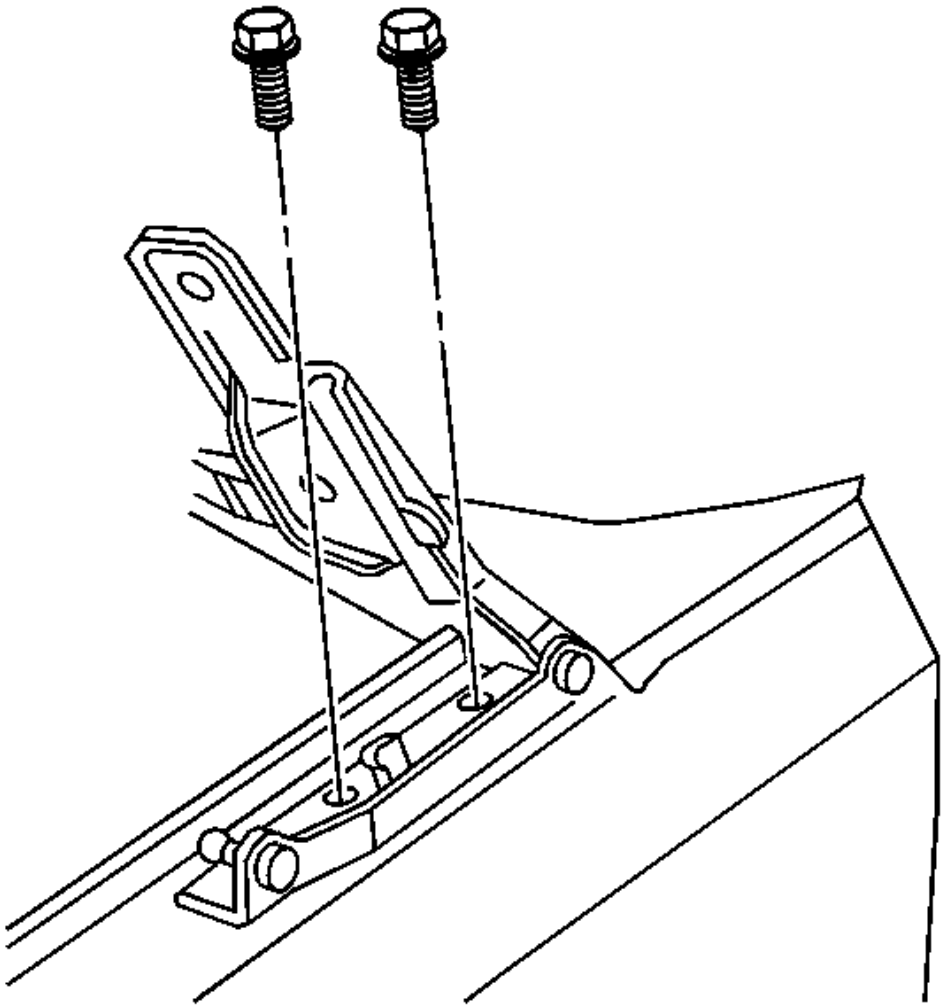


Fig. 25: Hinge Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the hood hinge to the fender.

CAUTION: **Refer to Fastener Caution .**

2. Install the hood hinge to the fender bolts.

Tighten

Tighten the hood hinge to fender bolts to 25 N.m (18 lb ft).

3. Install the rear hood side seal. Refer to **Hood Rear Outer Seal Replacement**.
4. Install the hood assist rod. Refer to **Hood Open Assist Rod Replacement**.
5. Install the hood. Refer to **Hood Replacement**.
6. Adjust the hood as required. Refer to **Hood Adjustment**.

REAR COMPARTMENT LID HINGE REPLACEMENT

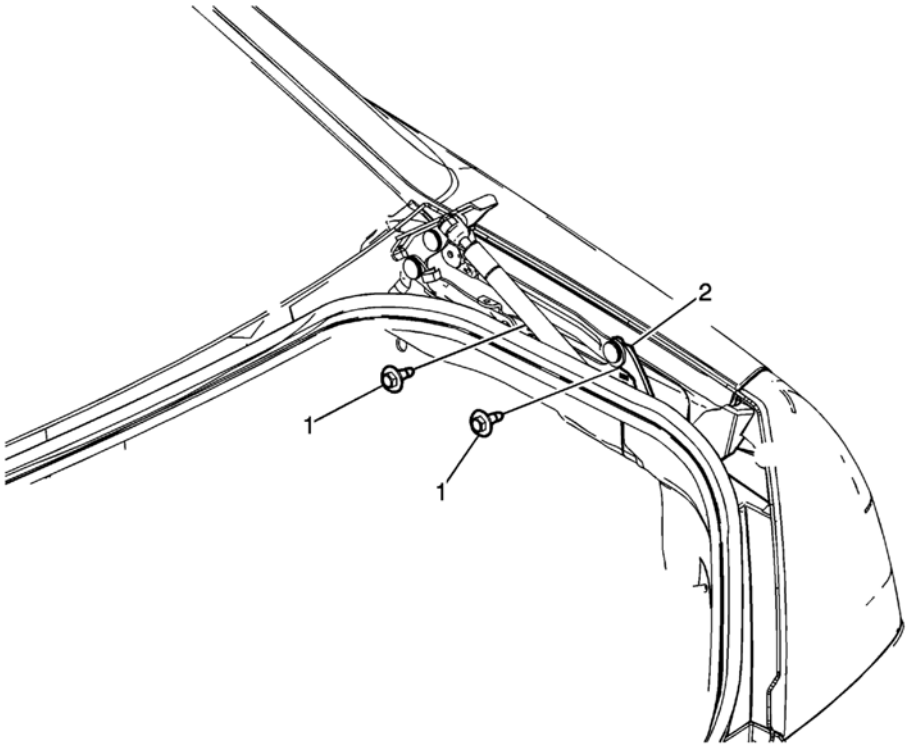


Fig. 26: Rear Compartment Lid Hinge
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove rear compartment lid. Refer to **Rear Compartment Lid Replacement**.	
1	Rear Compartment Lid Hinge Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (19 lb ft)
2	Rear Compartment Hinge

REAR SIDE DOOR UPPER HINGE AND LOWER HINGE REPLACEMENT

Removal Procedure

NOTE: **This procedure is completed with the rear door closed at all times. Do each door hinge separately, and replace the broken door hinge first.**

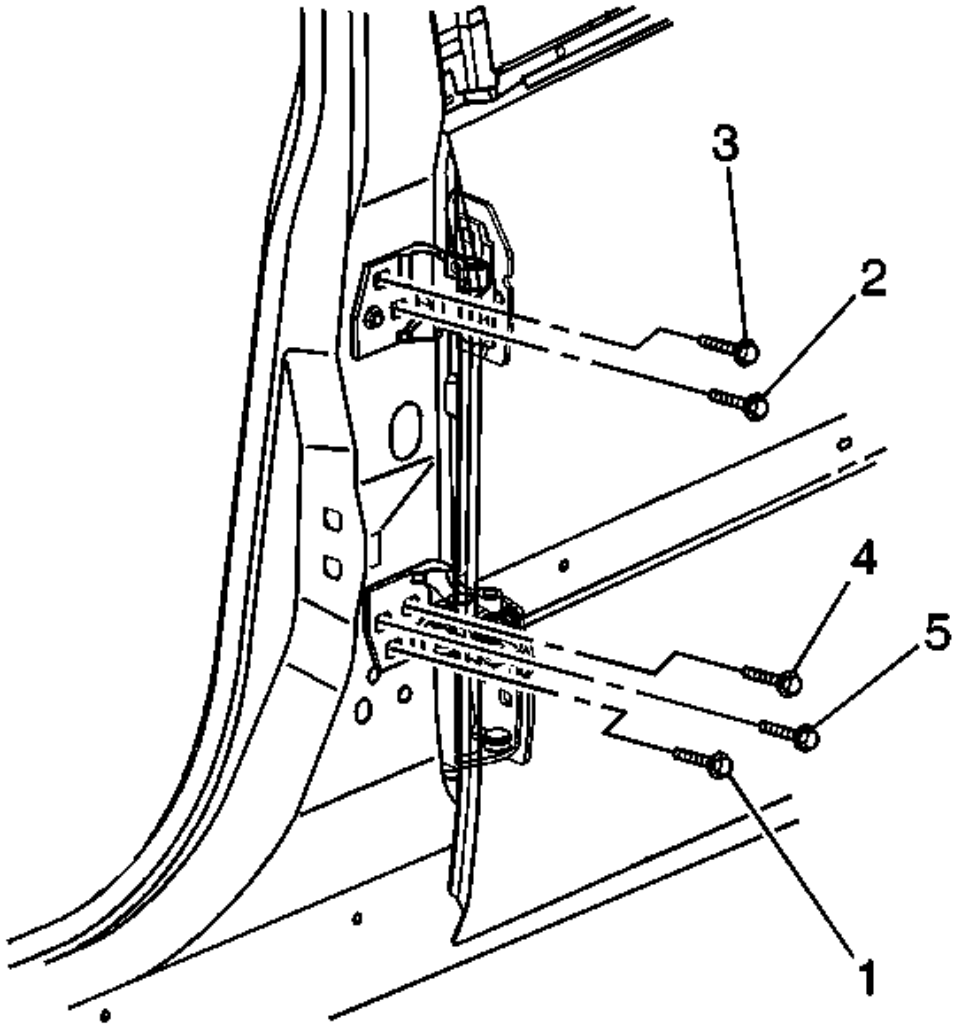


Fig. 27: Body Side Rear Door Hinge Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Open the front door in order to remove the rear door hinges.
2. Clean the mounting surfaces with clean a rag and mark the rear door hinge locations on each surface with a grease pencil or other suitable marker.
3. Remove the bolts from the doorside rear door hinge.
4. Remove the bolts (1-5) from the bodyside rear door hinge.
5. Remove the rear door hinge from the vehicle.

Installation Procedure

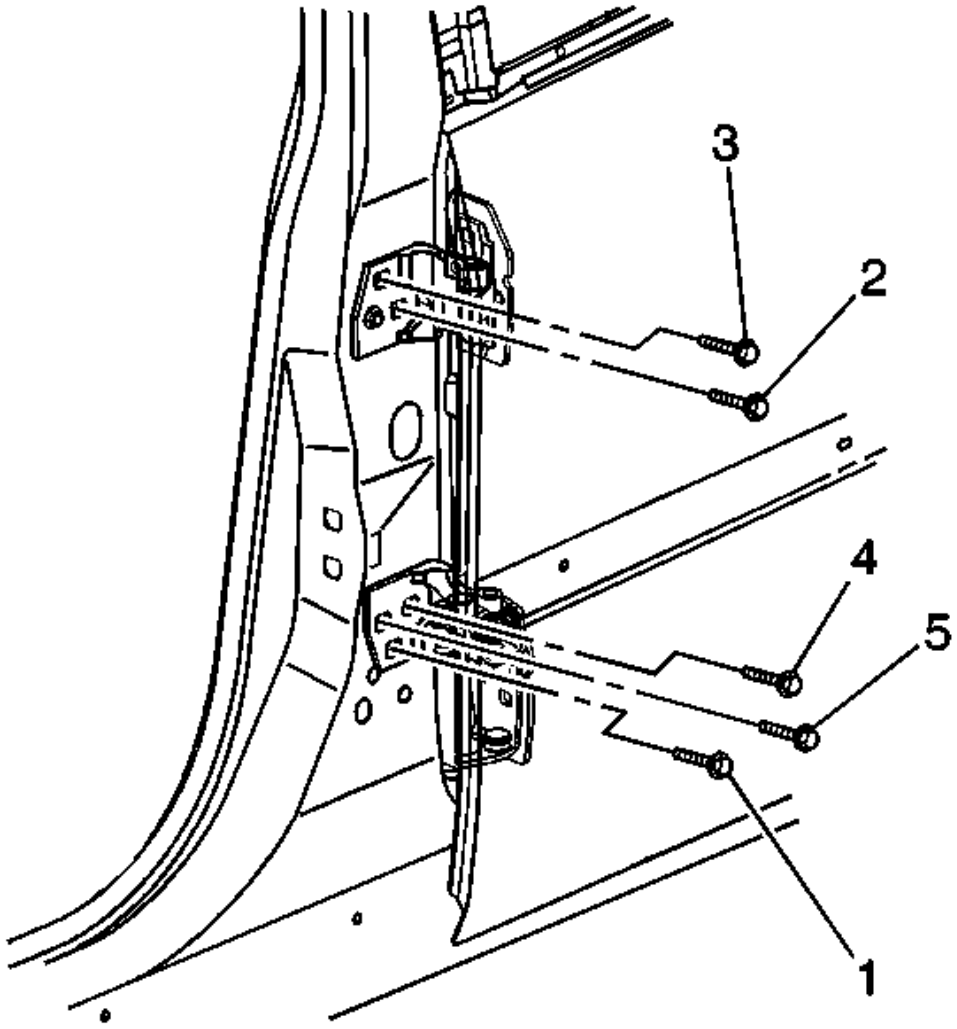


Fig. 28: Body Side Rear Door Hinge Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the rear door hinge to the alignment marks.

CAUTION: **Refer to Fastener Caution .**

2. Install the bolts (1-5) to the bodyside rear door hinge.

Tighten

Tighten the bodyside rear door hinge bolts to 33 N.m (24 lb ft).

3. Install the bolts to the doorside rear door hinge.

Tighten

Tighten the doorside rear door hinge bolts to 33 N.m (24 lb ft).

4. Close the rear door.

5. Inspect the rear door for proper operation and alignment. Refer to **Rear Side Door Adjustment**.

HOOD ADJUSTMENT

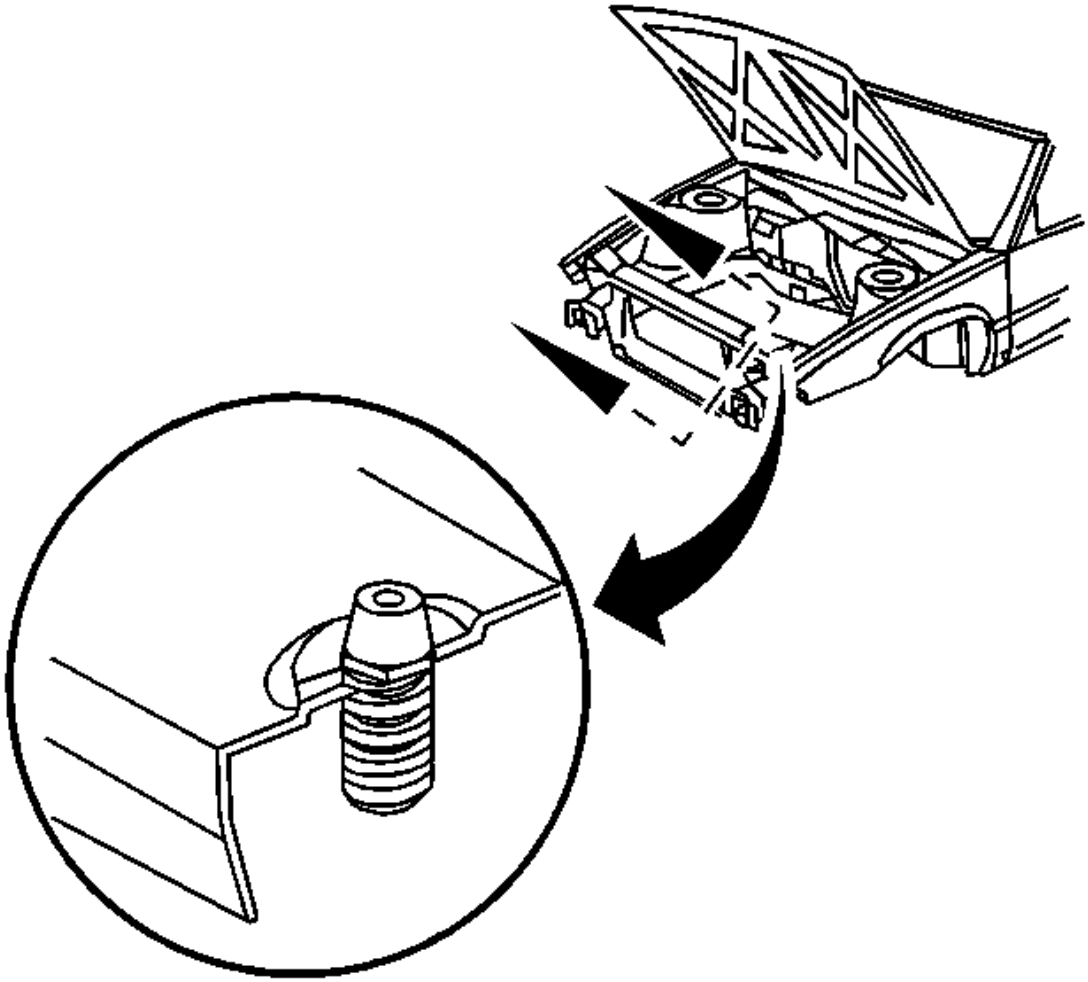


Fig. 29: View Of Hood Bumpers (Front)
Courtesy of GENERAL MOTORS COMPANY

1. The hood hinges are bolted to the fender and to the hood.
2. Make fore and aft adjustments by elongating the hood-side hinge holes.
3. Make vertical adjustment at the front by adjusting the hood bumpers up or down.

Specification

- Gap tolerances are 2-6 mm (0.08-0.22 in).
- Flush tolerances are 0-2 mm (0-0.08 in).

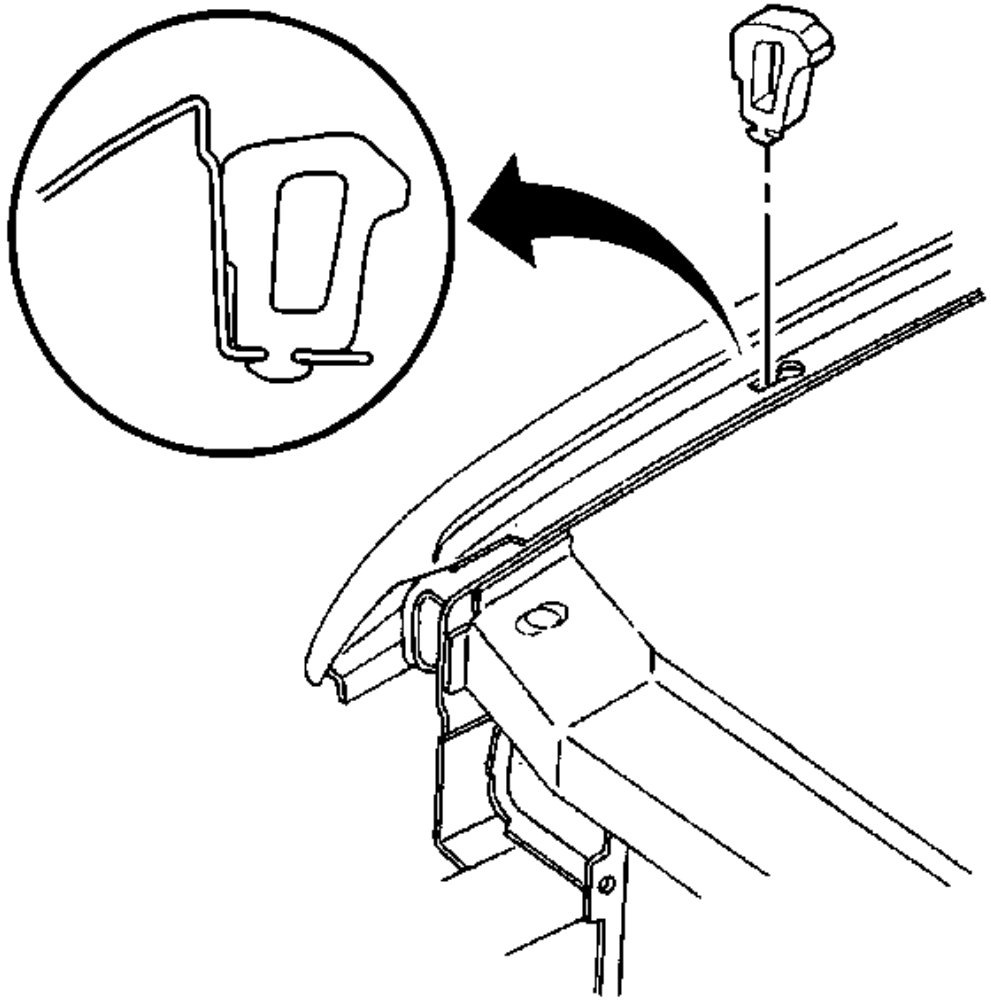


Fig. 30: Identifying Hood Bumpers (Side)
Courtesy of GENERAL MOTORS COMPANY

4. Open the hood.
5. Loosen the hinge to hood bolts. Refer to **Hood Replacement**.
6. Adjust the hood to the fender position.
7. Close the hood.
8. Check the hood alignment.
9. Open the hood.
10. Adjust the hood as needed.

CAUTION: Refer to Fastener Caution .

11. Install the hood-to-hinge bolts with an assistant.

Tighten

Tighten the upper hood hinge bolts to 27 N.m (20 lb ft).

12. Adjust the hood bumpers.
13. Close the hood.

HOOD REPLACEMENT

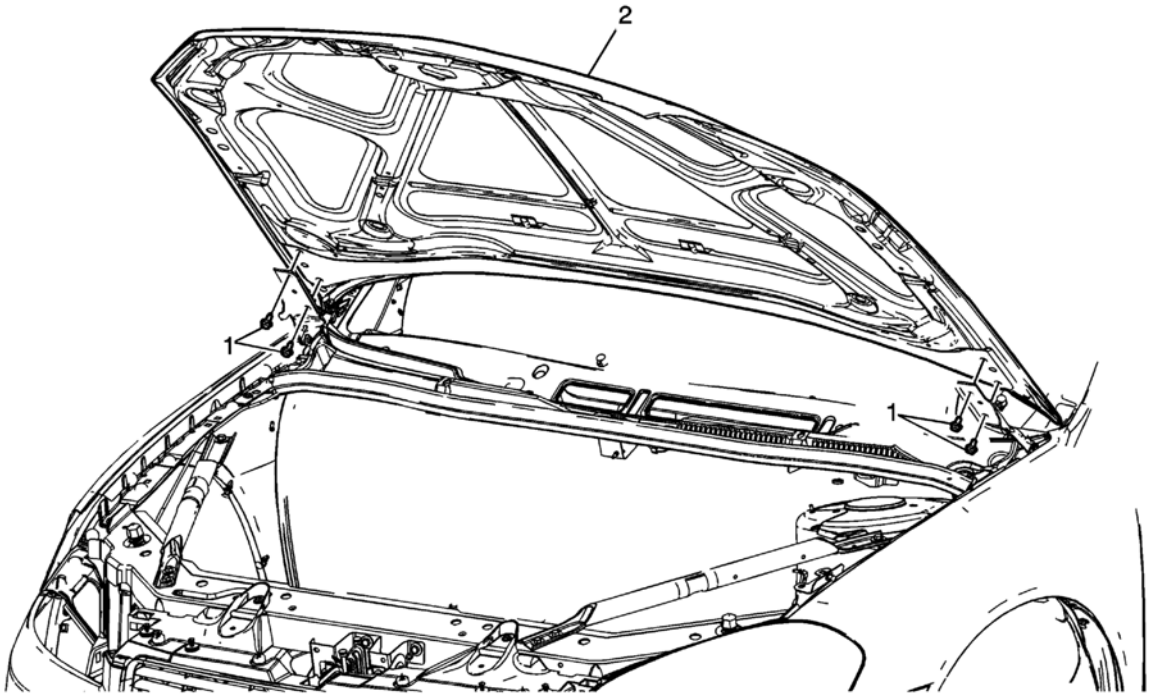


Fig. 31: Hood
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the hood open assist rod. Refer to **Hood Open Assist Rod Replacement**.	
1	Hood Hinge Bolts (Qty: 4) **WARNING:** **When a hood hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle**

Callout	Component Name
	or personal injury. **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (19 lb ft)
2	Hood

HOOD INSULATOR REPLACEMENT (IMPALA LIMITED)

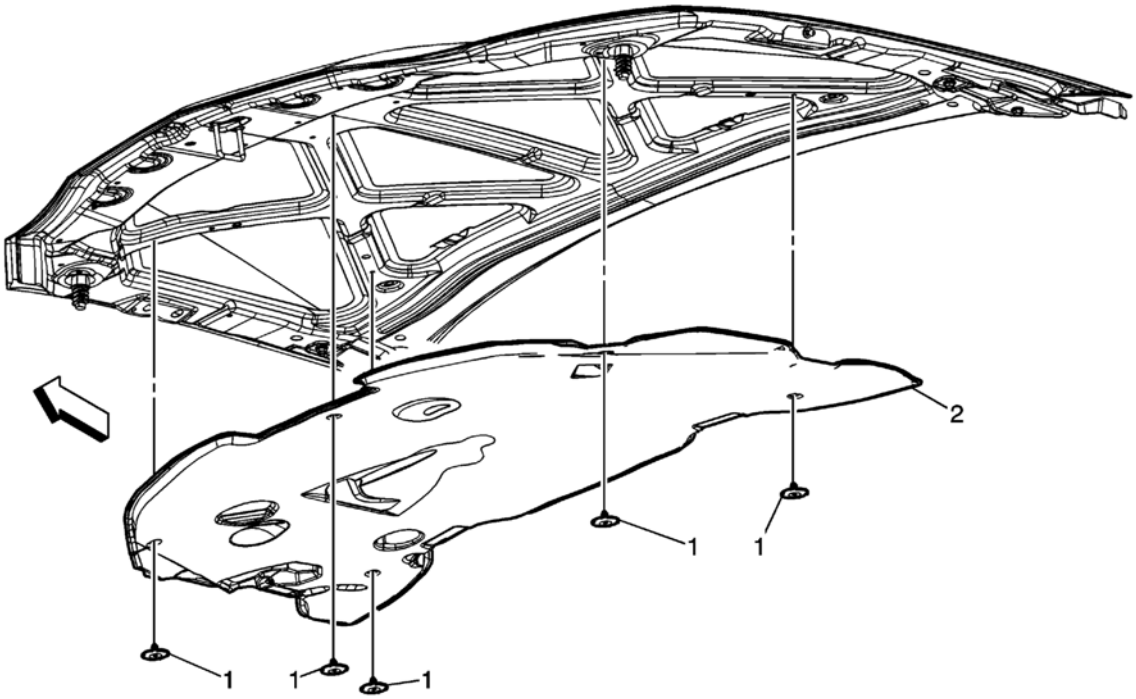


Fig. 32: Hood Insulator Pad & Retainers
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Fastener Specifications	
1	Retainers, Hood Insulator Pad (Qty: 5)
2	Pad, Hood Insulator

HOOD PRIMARY AND SECONDARY LATCH REPLACEMENT

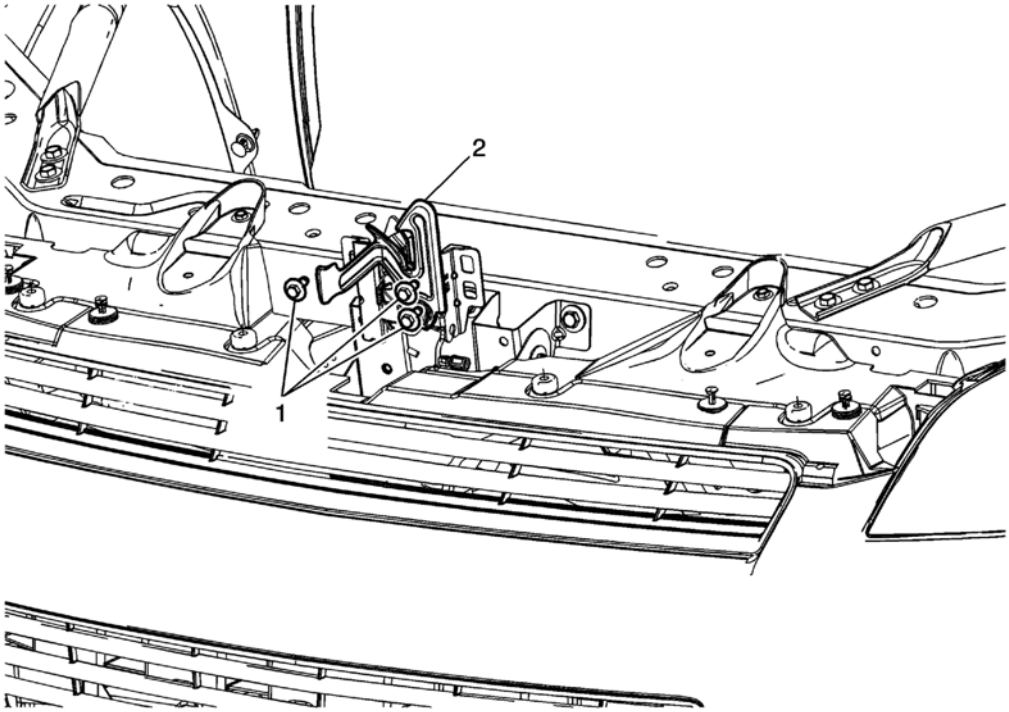


Fig. 33: Replacing Hood Latch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Hood Latch Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (19 lb ft)
2	Hood Latch • Disconnect the release cable. • Disconnect the electrical connector for the remote start, if equipped.

REAR COMPARTMENT LID REPLACEMENT

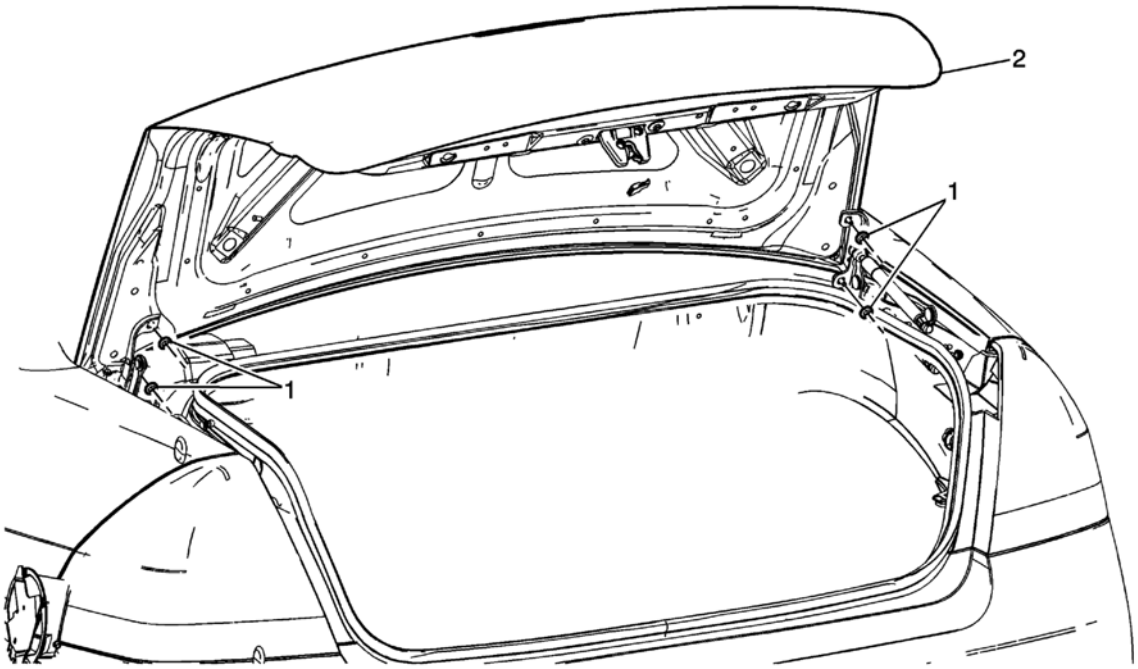


Fig. 34: Rear Compartment Lid
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Compartment Lid Nut (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution** **.** **Tighten** 25 N.m (19 lb ft)
2	Rear Compartment Lid **TIP:** Disconnect the electrical connector.

REAR COMPARTMENT LID LOCK CYLINDER ROD REPLACEMENT

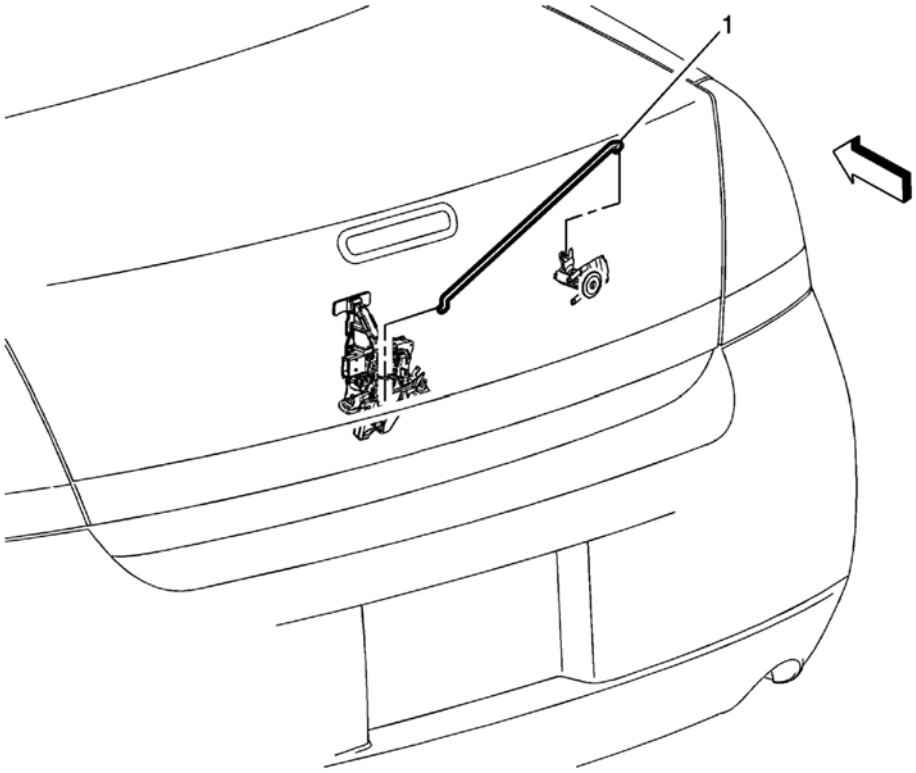


Fig. 35: Rear Compartment Lid Lock Cylinder Rod
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Compartment Lid Lock Cylinder Rod **Procedure** 1. Disconnect the lock cylinder rod from the rear compartment latch and the lock cylinder. 2. Inspect the lock cylinder rod attachment points. 3. Ensure the lock cylinder rod is installed properly. 4. Inspect the lock cylinder for proper operation by closing and opening the rear compartment.

FUEL TANK FILLER DOOR REPLACEMENT

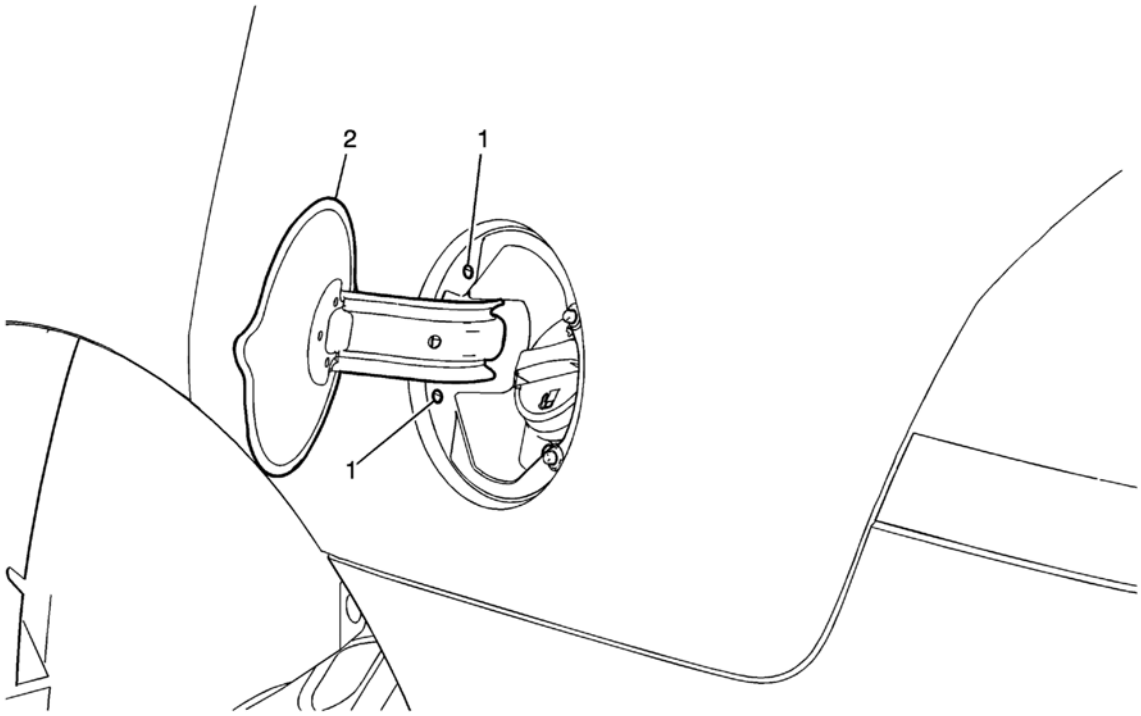


Fig. 36: Fuel Filler Door
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Filler Door Rivet (Qty: 2) **WARNING:** **Eye protection must be worn when drilling rivets to reduce the chance of personal injury.**
2	Fuel Filler Door

FUEL TANK FILLER PIPE HOUSING REPLACEMENT

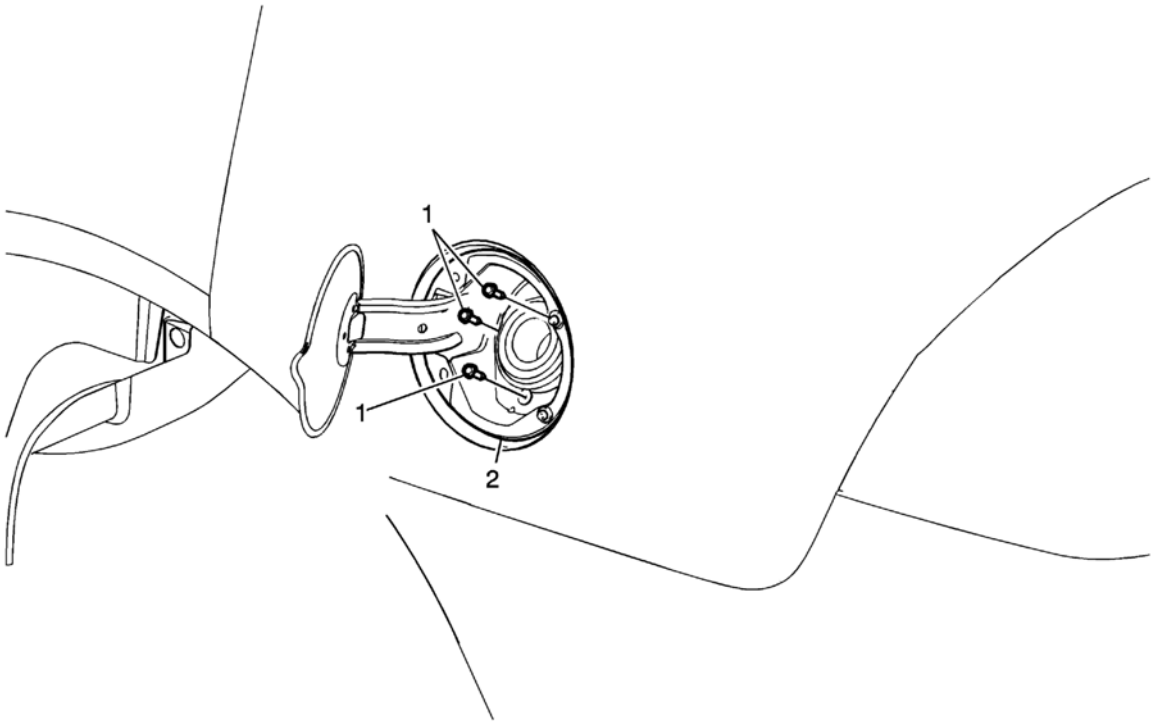


Fig. 37: Fuel Filler Pocket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Filler Door Pocket Bolt (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution .** **TIP:** Remove fuel filler cap. **Tighten** 10 N.m (89 lb in)
2	Fuel Filler Door Pocket

HOOD OPEN ASSIST ROD REPLACEMENT

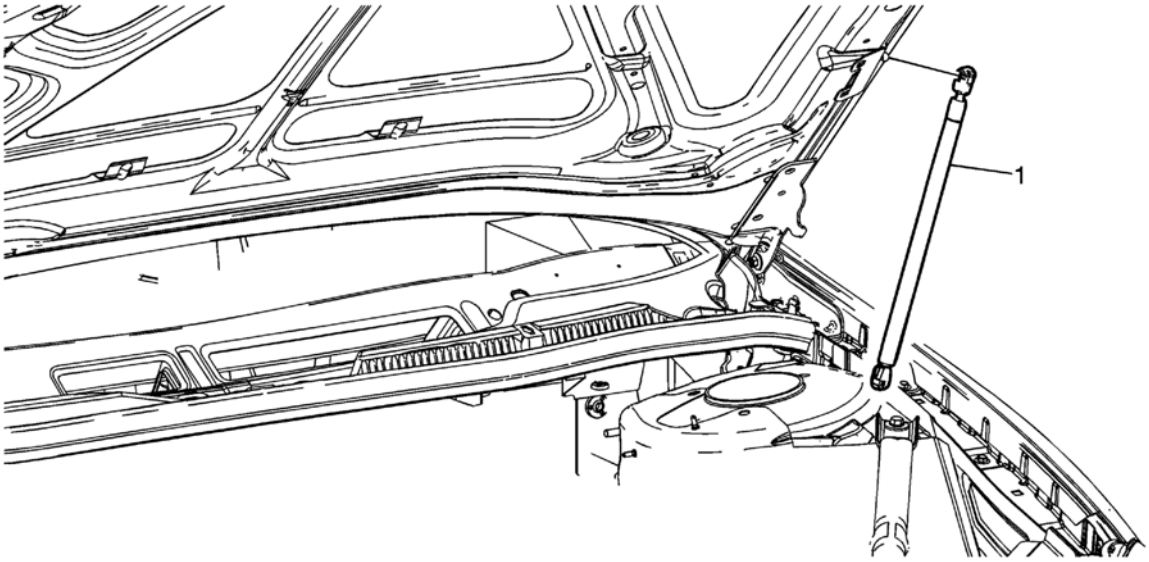


Fig. 38: Hood Assist Rod
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Hood Strut Assembly **WARNING:** **When a hood hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.** **CAUTION:** **Apply pressure only at the**

Callout	Component Name
	end of the liftgate/hood assist rod that you are removing or attaching. Do NOT apply pressure to the middle of the rod because damage or bending will result. **TIP:** Remove the metal clip at the ends of the assist rod, then pull away from the stud.

HOOD REAR SEAL REPLACEMENT

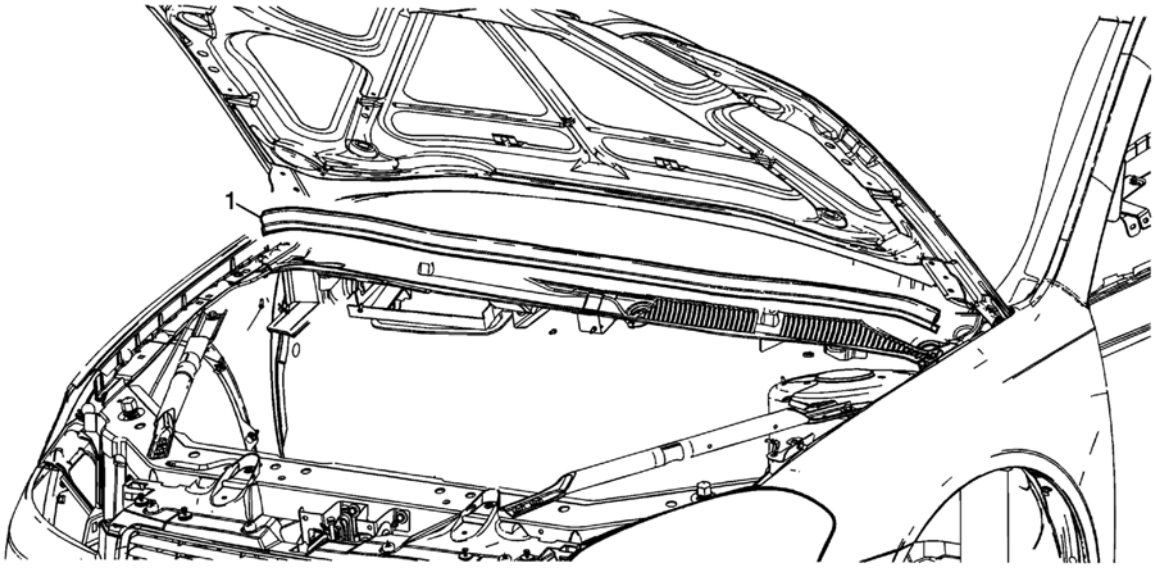


Fig. 39: Hood Rear Seal
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** .	

Callout	Component Name
1	Weatherstrip, Rear

HOOD REAR OUTER SEAL REPLACEMENT

Removal Procedure

1. Open the hood.

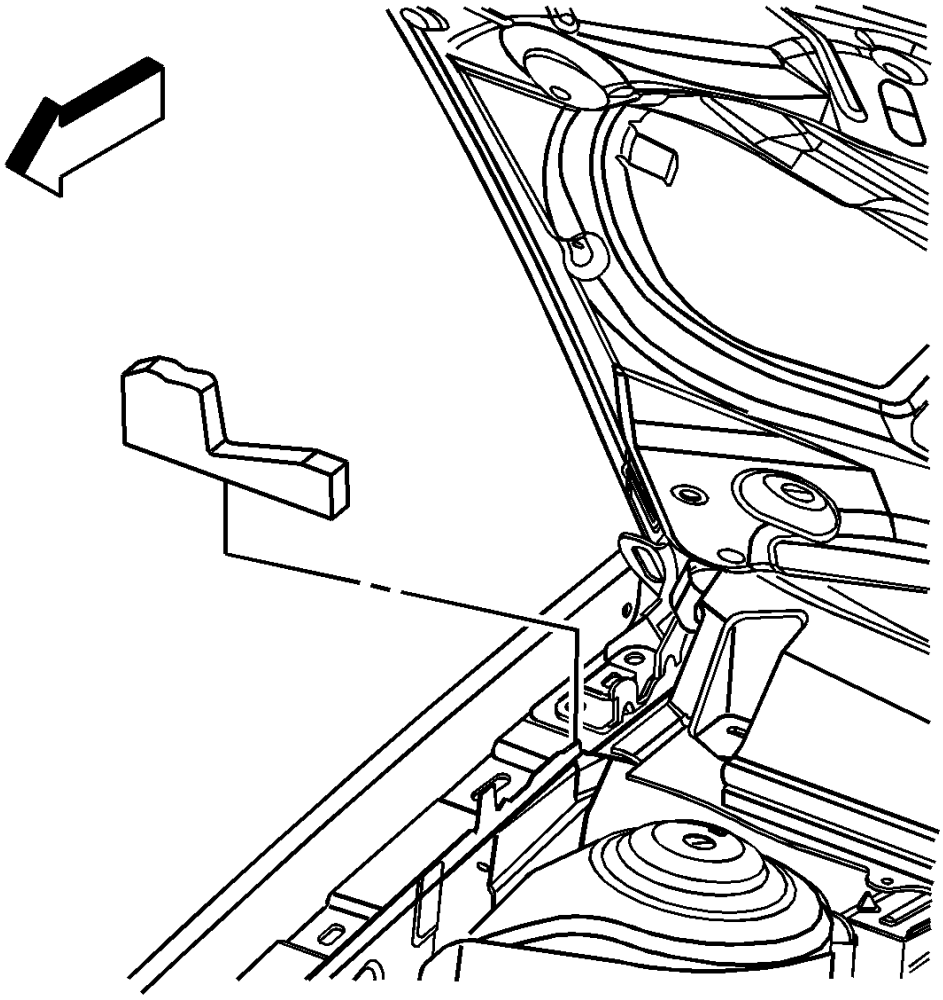


Fig. 40: View Of Rear Side Hood Seal
Courtesy of GENERAL MOTORS COMPANY

2. Pull the rear side hood seal, located at the end of the plenum to hood seal, from the fender.
3. Remove the seal from the vehicle.
4. Clean any adhesive from the pinch-weld flange and hood hinge using 3M™ P/N 8984.

Installation Procedure

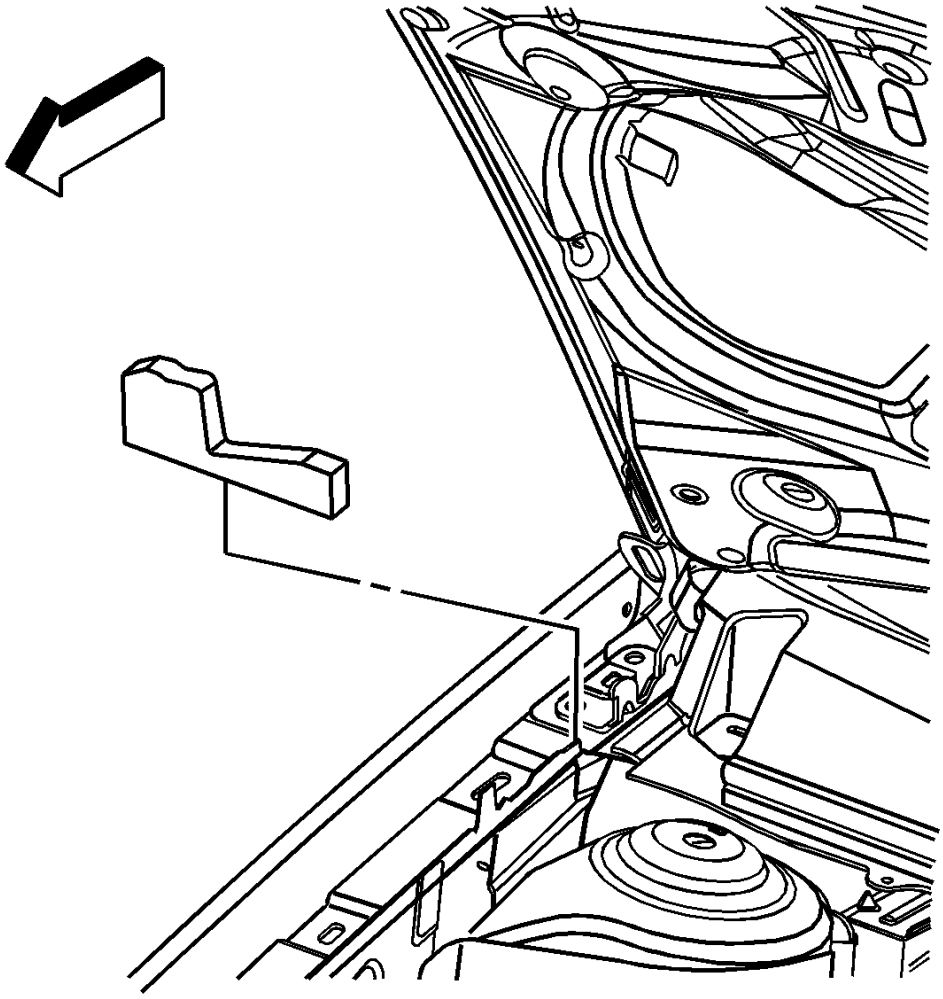


Fig. 41: View Of Rear Side Hood Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the protective backing paper from the adhesive on the rear side hood seal.
2. With the rear side hood seal butted to the plunum to hood seal, press the side hood seal until the adhesive is fully adhered.
3. Close the hood.

FRONT SIDE DOOR HINGE SPRING REPLACEMENT

Tools Required

J 36604 Door Hinge Spring Compressor

Removal Procedure

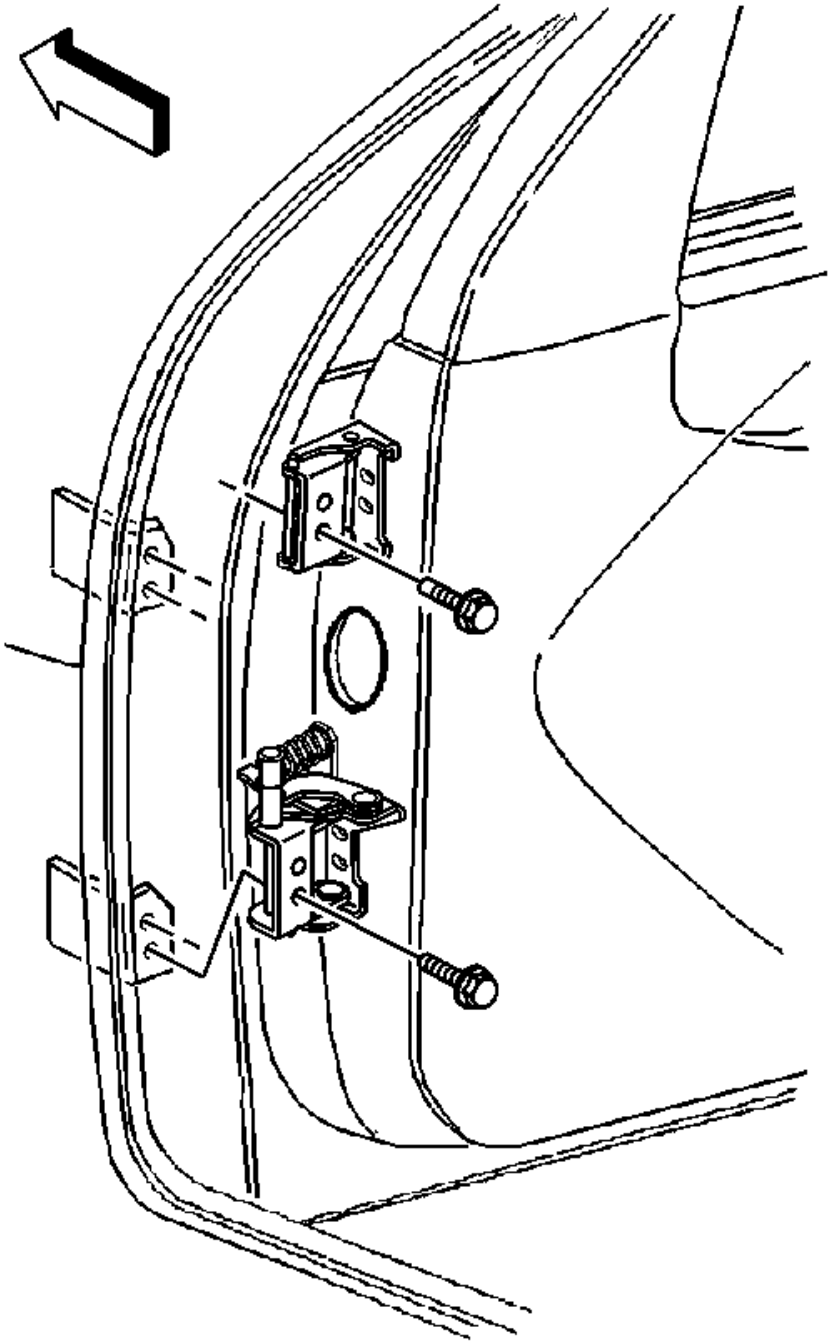


Fig. 42: Front Door Hinge
Courtesy of GENERAL MOTORS COMPANY

1. Open the door.
2. Using **J 36604** compressor , remove the door hinge spring from the door hinge.
3. Remove the door hinge spring from the vehicle.

Installation Procedure

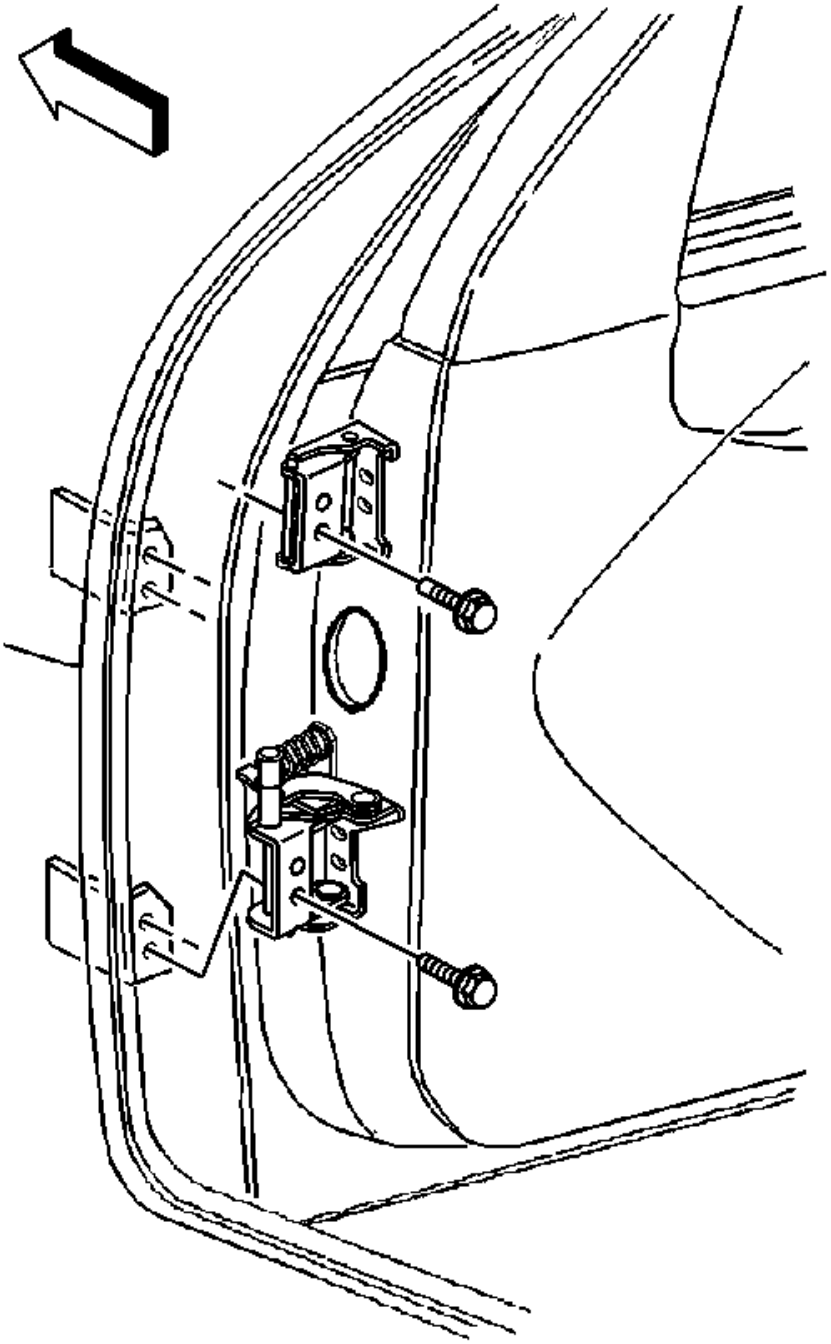


Fig. 43: Front Door Hinge
Courtesy of GENERAL MOTORS COMPANY

1. Using **J 36604** compressor , install the door hinge spring to the door hinge.
2. Close the door.

REAR COMPARTMENT LID STRUT REPLACEMENT

Removal Procedure

WARNING: When a hood hold open device is being removed or installed, provide alternate support to avoid the possibility of damage to the vehicle or personal injury.

CAUTION: Apply pressure only at the end of the liftgate/hood assist rod that you are removing or attaching. Do NOT apply pressure to the middle of the rod because damage or bending will result.

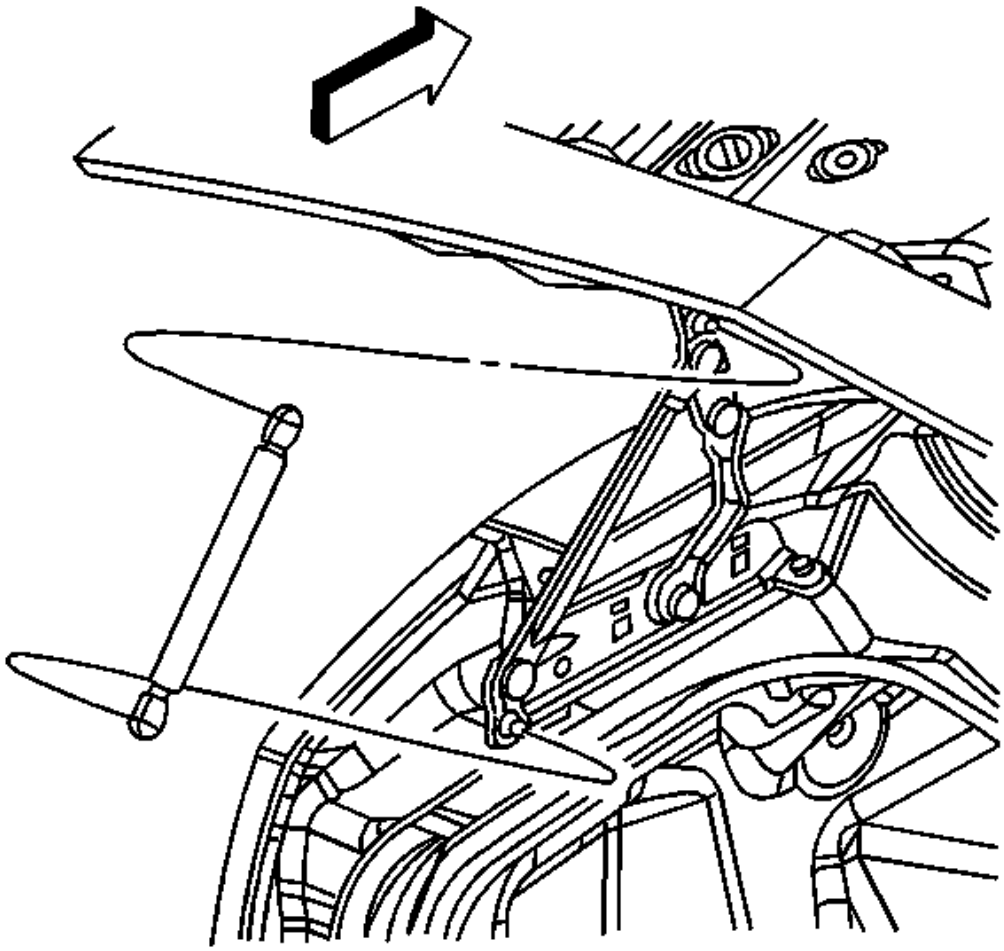


Fig. 44: Rear Compartment Lid Strut
Courtesy of GENERAL MOTORS COMPANY

1. Open and support the rear compartment lid.
2. Using a small flat-bladed tool, release the clip retaining the rear compartment lid assist rod to the lower assist rod ball stud.
3. Using a small flat-bladed tool, release the clip retaining the rear compartment assist rod to the upper assist rod ball stud.
4. Remove the rear compartment lid assist rod from the vehicle.

Installation Procedure

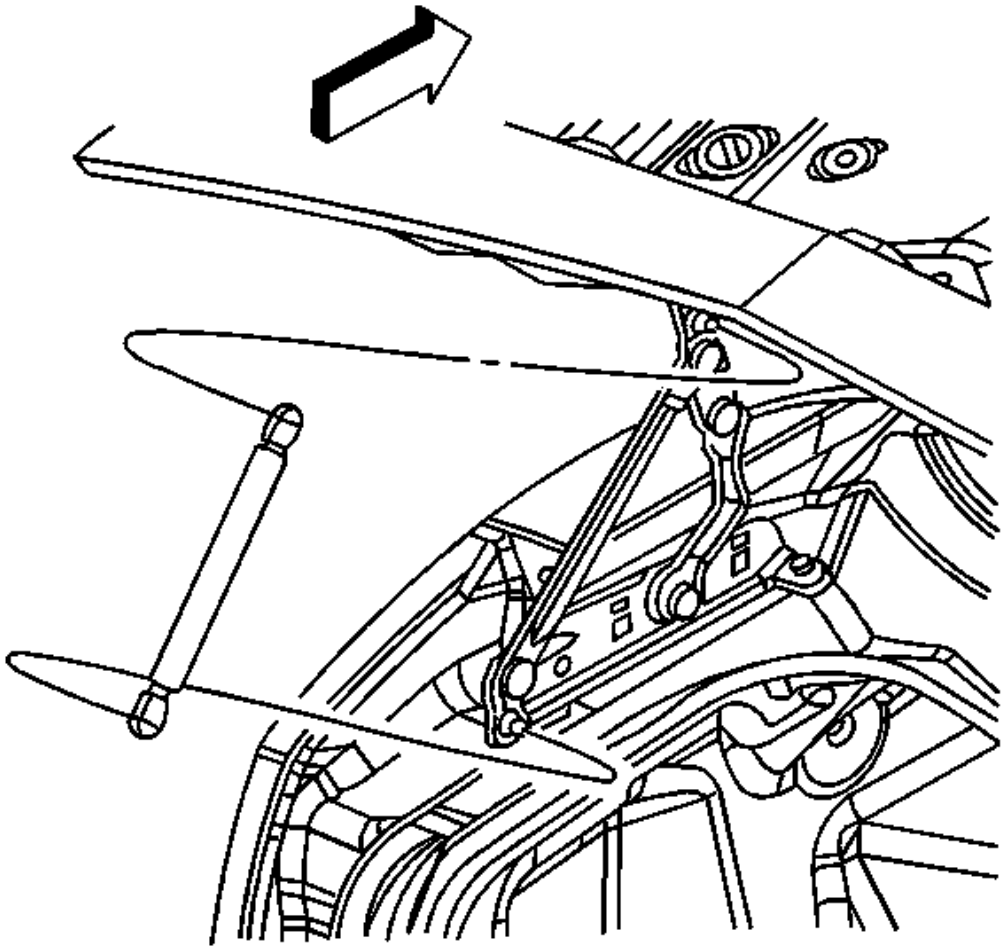


Fig. 45: Rear Compartment Lid Strut
Courtesy of GENERAL MOTORS COMPANY

1. Press the rear compartment lid assist rod onto the upper rear compartment lid assist rod ball stud.
2. Press the rear compartment lid assist rod onto the lower assist rod ball stud.
3. Ensure that both clips are fully seated on the rear compartment assist rod.
4. Close the rear compartment.

HOOD LATCH SUPPORT REPLACEMENT

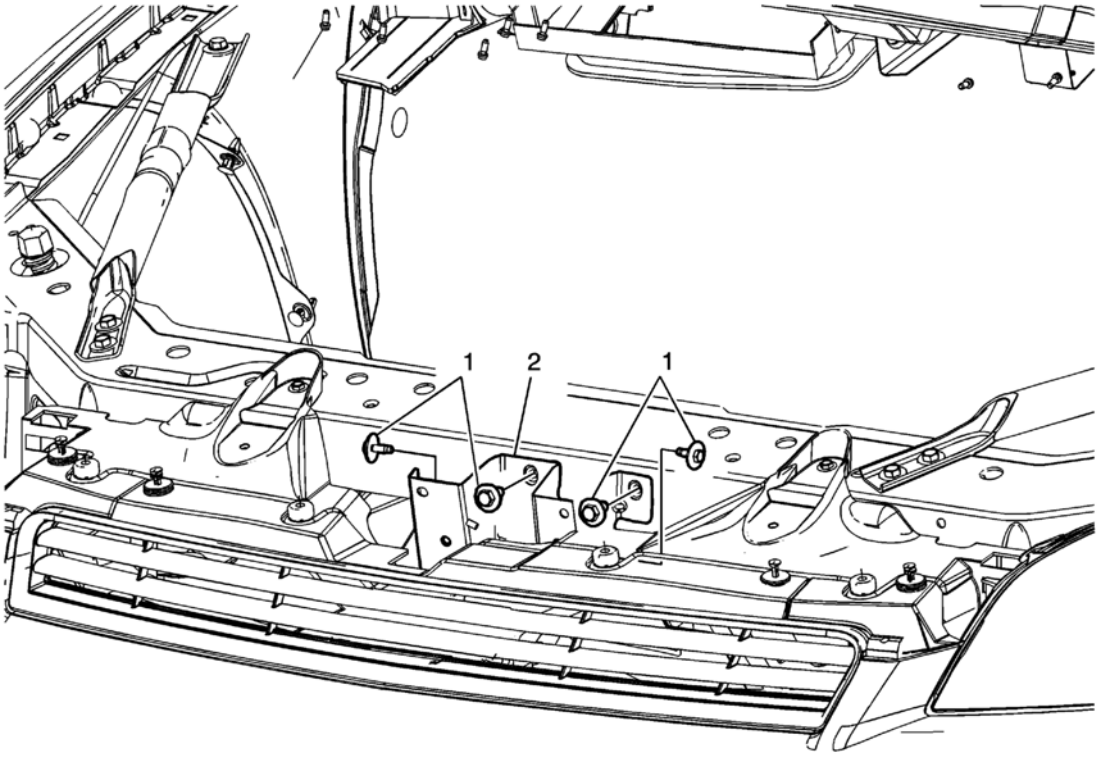


Fig. 46: Hood Latch Support
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Hood Latch Support Bolts (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Hood Latch Support

FRONT OR REAR SIDE DOOR LOWER WEATHERSTRIP REPLACEMENT (50TH ANNIVERSARY EDITION)

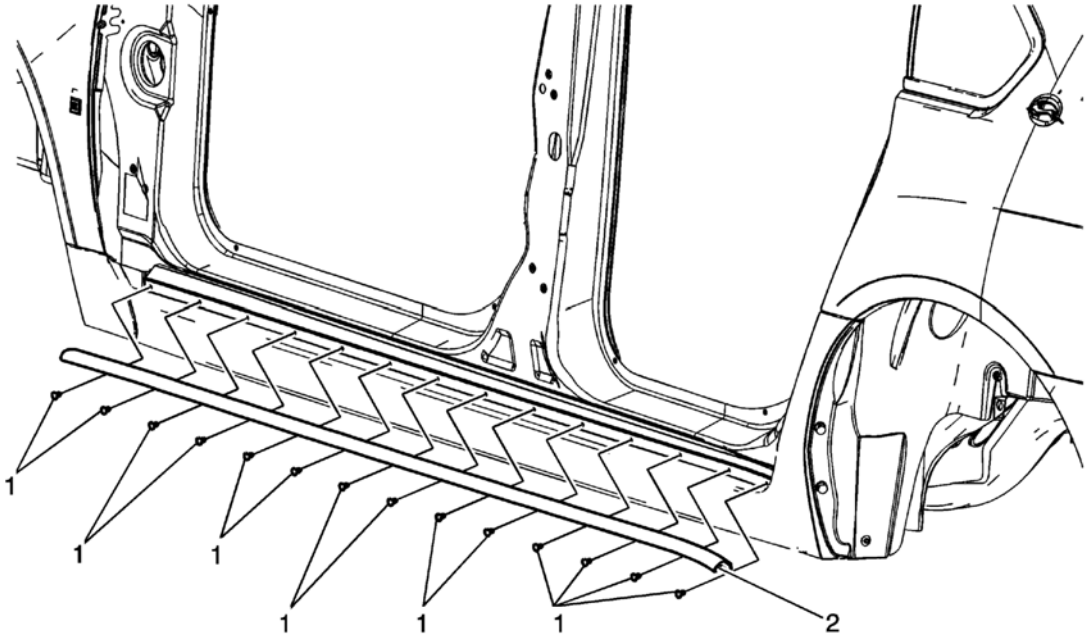


Fig. 47: Front or Rear Side Door Lower Weatherstrip (50th Anniversary Edition)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Open both the front and rear side door on the same side the front and rear side door lower weather-strip is to be replaced. 2. Use an appropriate trim release tool in order to release the retainers from the rear rocker molding assembly.	
1	Front and Rear Side Door Lower Weather-strip Retainer (Qty: 14) **TIP:** Replace any broken or damaged retainer prior to installation of the lower weather-strip.
2	Front and Rear Side Door Lower Weather-strip

FRONT SIDE DOOR WEATHERSTRIP REPLACEMENT (IMPALA LIMITED)

Removal Procedure

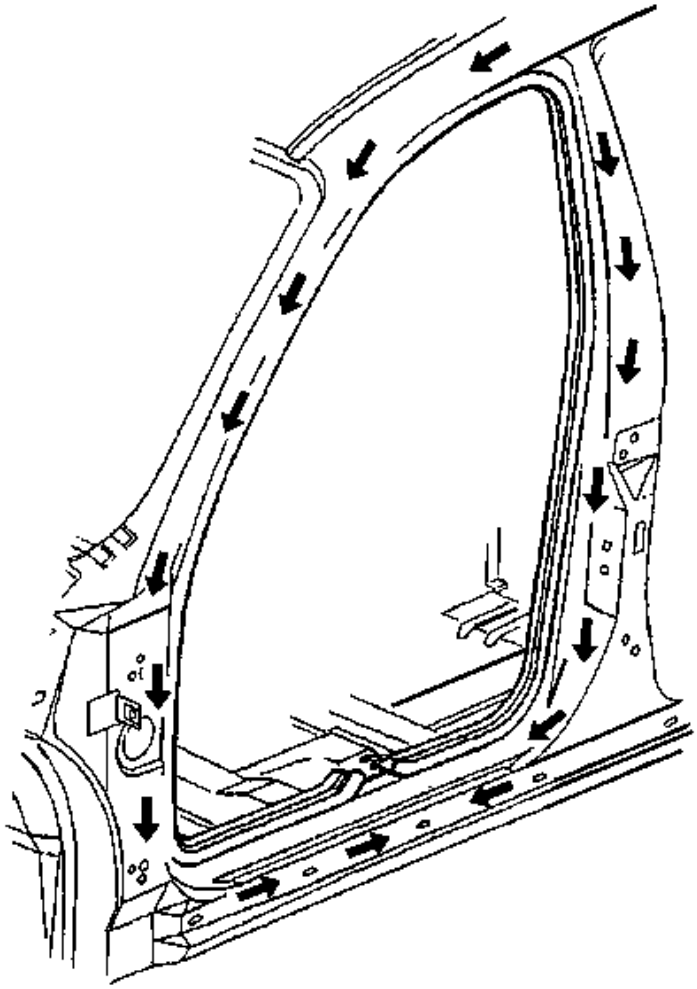


Fig. 48: Front Door Weatherstrip Positioning (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

1. Open the front door.
2. Remove the carpet retainers. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala Limited)** .
3. Remove the windshield garnish molding. Refer to **Windshield Pillar Garnish Molding Replacement** .
4. Remove the upper center pillar trim panel. Refer to **Center Pillar Upper Trim Panel Replacement** .
5. Remove the center lower trim panel. Refer to **Center Pillar Lower Trim Panel Replacement** .
6. Remove the front door opening weatherstrip by pulling it off the pinch-weld flange.

Installation Procedure

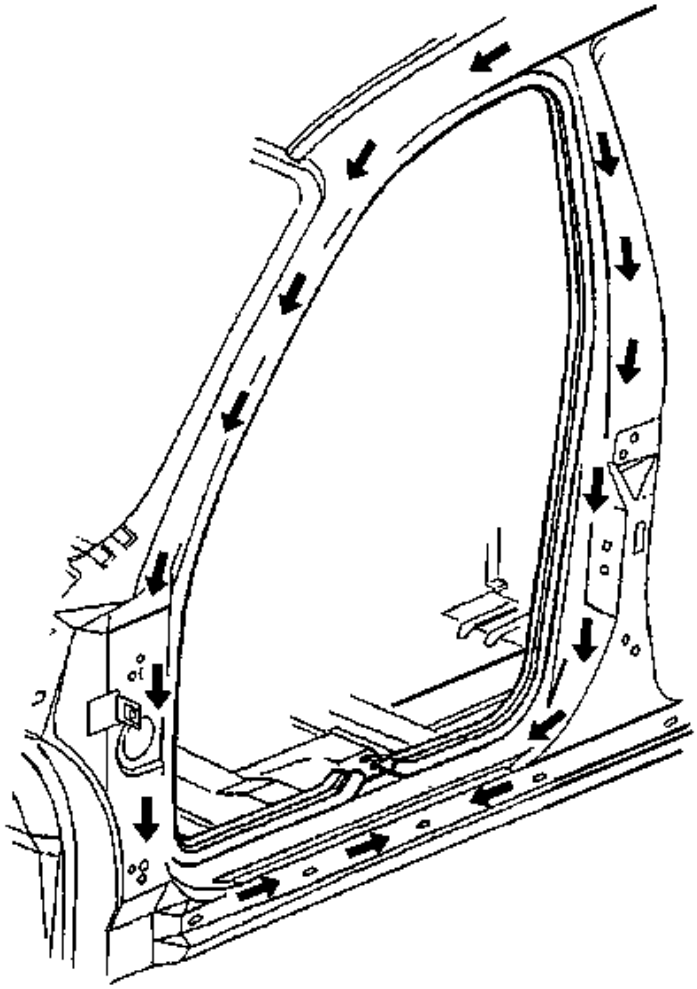


Fig. 49: Front Door Weatherstrip Positioning (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

1. Position the front door opening weatherstrip to the pinch-weld flange.

   Starting at the center of the rocker panel area and moving in a clockwise direction press the front door opening weatherstrip to the pinch-weld flange until fully seated.

   IMPORTANT: The joint butt ends must have no gap and be located in the center of the of the rocker panel area.

2. Install joint butt ends together.
3. Install the carpet retainers. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala Limited)** .
4. Install the windshield garnish molding. Refer to **Windshield Pillar Garnish Molding Replacement** .
5. Install the upper center pillar trim panel. Refer to **Center Pillar Upper Trim Panel Replacement** .
6. Install the center lower trim panel. Refer to **Center Pillar Lower Trim Panel Replacement** .
7. Close the front door.

REAR COMPARTMENT LID WEATHERSTRIP REPLACEMENT

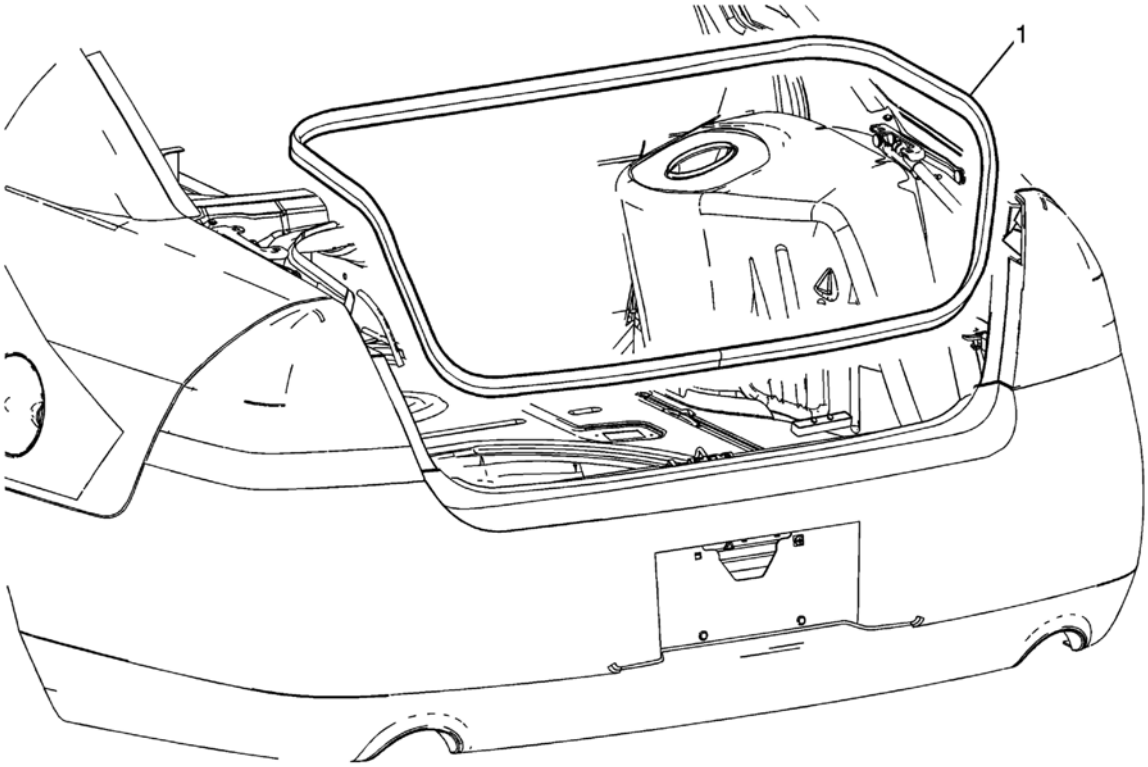


Fig. 50: Rear Compartment Opening Weatherstrip
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Compartment Lid Weatherstrip

REAR DOOR OPENING WEATHERSTRIP REPLACEMENT

Removal Procedure

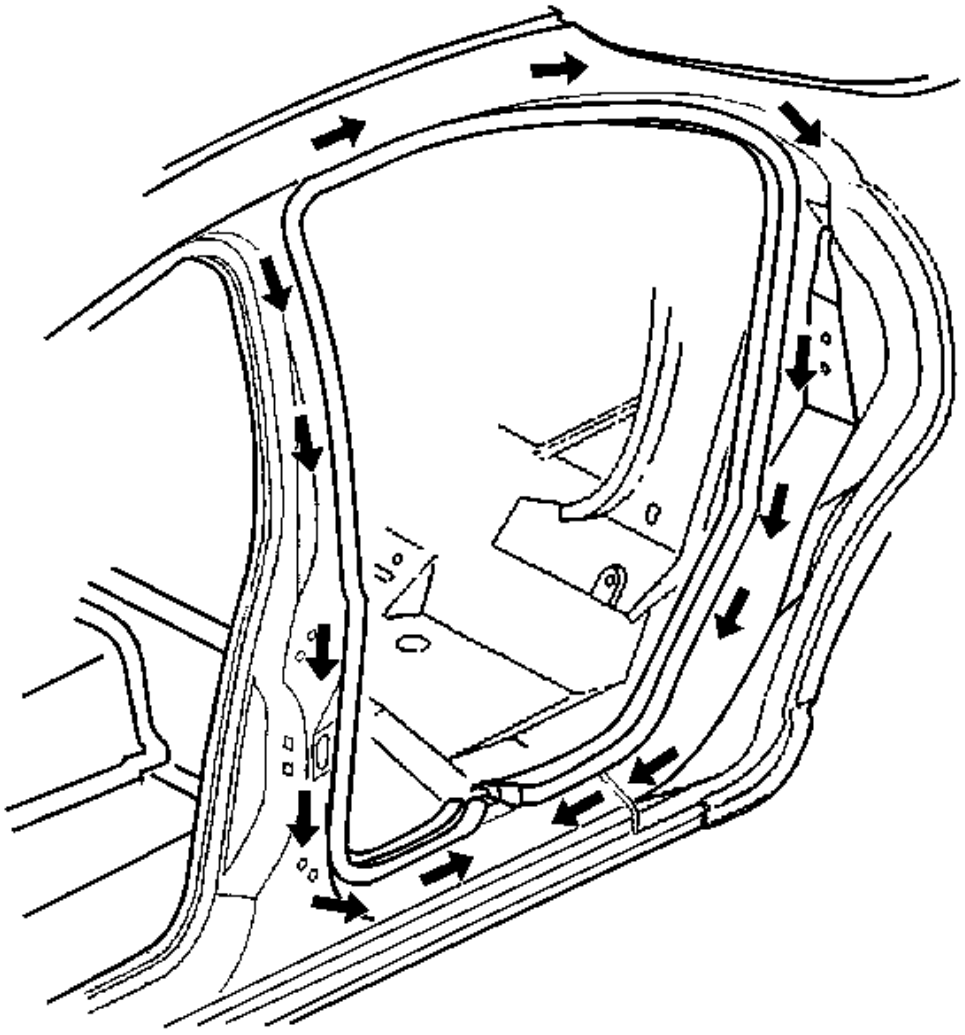


Fig. 51: Rear Door Weatherstrip Positioning
Courtesy of GENERAL MOTORS COMPANY

1. Open the rear door.
2. Remove the trim panels. Refer to the following procedures:
   - **Quarter Lower Rear Trim Panel Replacement (Impala Limited)**
   - **Quarter Upper Trim Panel Replacement**
   - **Center Pillar Upper Trim Panel Replacement**
   - **Center Pillar Lower Trim Panel Replacement**
3. Remove the weatherstrip from the rear door opening by pulling the weatherstrip off the pinchweld flange.

Installation Procedure

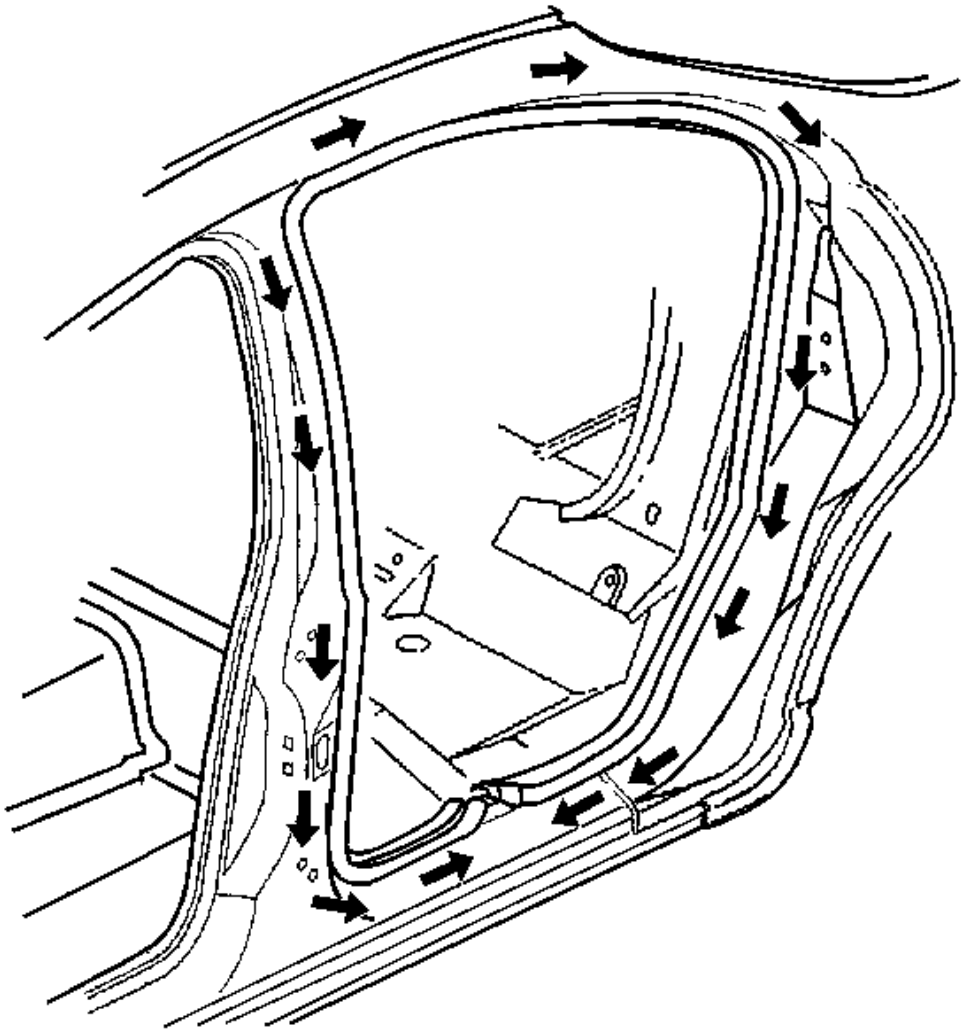


Fig. 52: Rear Door Weatherstrip Positioning
Courtesy of GENERAL MOTORS COMPANY

1. Position the rear door opening weatherstrip to the pinchweld flange.

   Starting at the center of the rocker panel area and moving in a clockwise direction, press the weatherstrip to the pinchweld flange until fully seated.

   IMPORTANT: The joint butt ends must have no gap and must be located in the center of the of the rocker panel area.

2. Install the joint butt ends together.
3. Install the trim panels. Refer to the following procedures:
   - **Quarter Lower Rear Trim Panel Replacement (Impala Limited)**
   - **Quarter Upper Trim Panel Replacement**
   - **Center Pillar Upper Trim Panel Replacement**
   - **Center Pillar Lower Trim Panel Replacement**
4. Close the rear door.

DESCRIPTION AND OPERATION

HOOD AJAR INDICATOR DESCRIPTION AND OPERATION

Hood Ajar Switch

The hood ajar switch provides closure status of the hood to the body control module (BCM). The switch is integrated into the hood latch assembly. The hood ajar switch provides two separate inputs to the BCM. These separate inputs allow the BCM to actively monitor for a hood ajar switch fault.

The BCM uses the hood ajar switch as a content theft deterrent alarm trigger.

Hood Ajar Indicator/Message

When the hood is ajar, a message is displayed on the driver information center (DIC) or the hood ajar indicator will be illuminated.

Article GUID: A00737191

Bumpers and Fascias - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Center Support Bracket Bolts	10 N.m	89 lb in
Front Bumper Fascia Bolts	7 N.m	62 lb in
Front Bumper Impact Bar at Frame Bolts	25 N.m	18 lb ft
Front Fascia Bolts	2 N.m	18 lb in
Front Fascia Nuts	7 N.m	62 lb in
Rear Bumper Fascia Bolts	10 N.m	89 lb in
Rear Bumper Fascia Top Center Nuts	10 N.m	89 lb in
Rear Bumper Impact Bar at Frame Bolts	25 N.m	18 lb ft
Rear Wheelhouse Splash Shield to Body Bolts	10 N.m	89 lb in

REPAIR INSTRUCTIONS

FRONT BUMPER FASCIA ENERGY ABSORBER REPLACEMENT

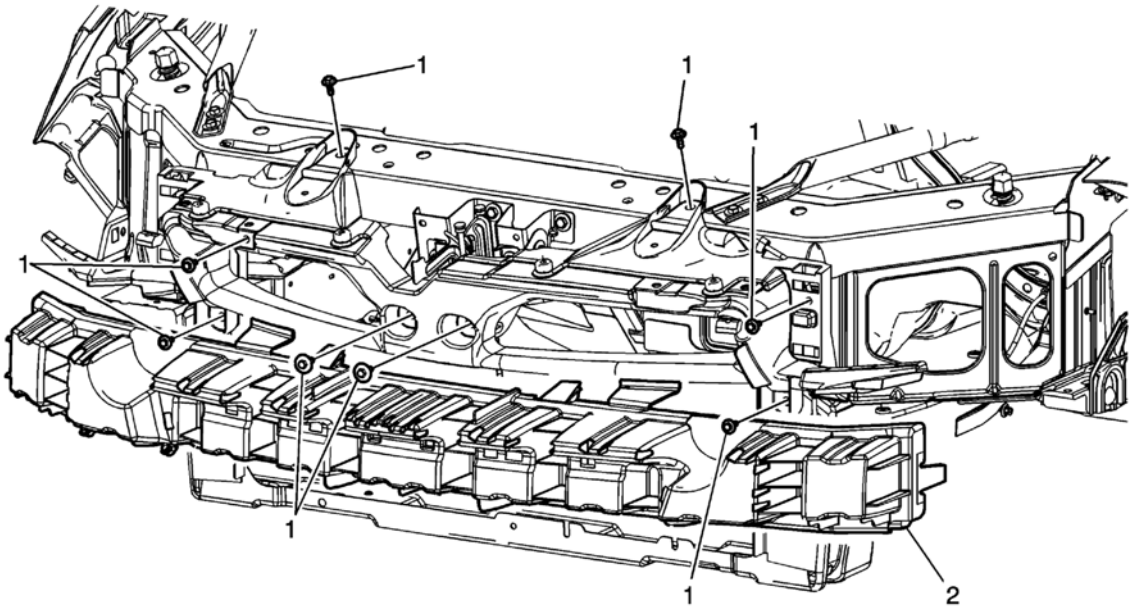


Fig. 1: Front Bumper Energy Absorber

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front fascia. Refer to **Front Bumper Fascia Replacement**.	
1	Energy Absorber Bolt (Qty: 8) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 8 N.m (70 lb in)
2	Energy Absorber

FRONT BUMPER IMPACT BAR REPLACEMENT

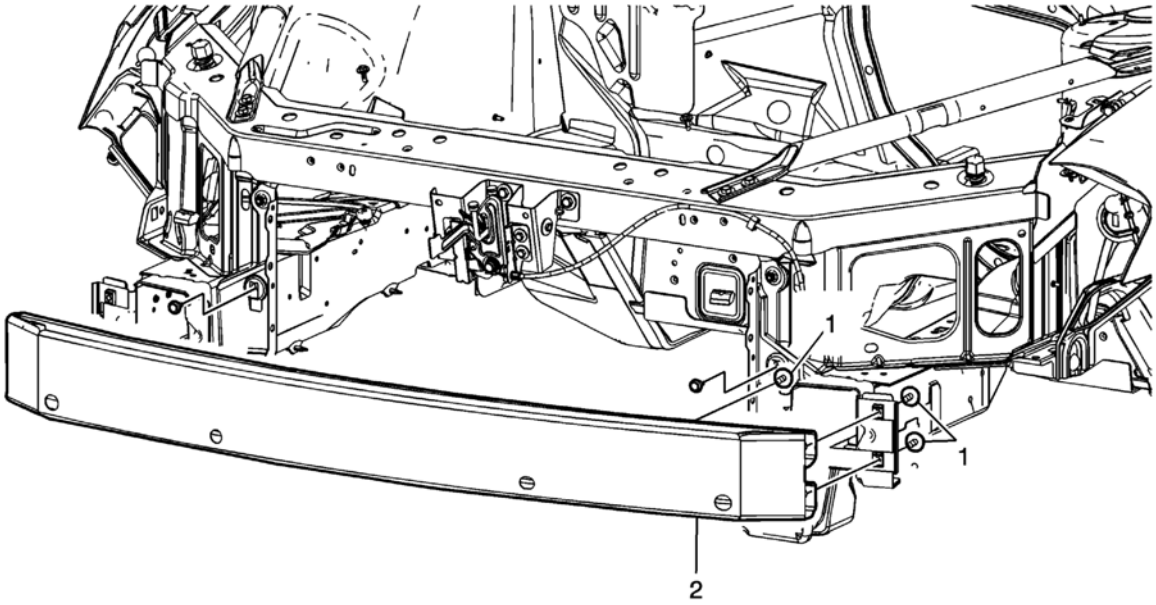


Fig. 2: Front Bumper Impact Bar
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the front fascia. Refer to **Front Bumper Fascia Replacement**. 2. Remove the energy absorber. Refer to **Front Bumper Fascia Energy Absorber Replacement**.	

FRONT BUMPER FASCIA REPLACEMENT

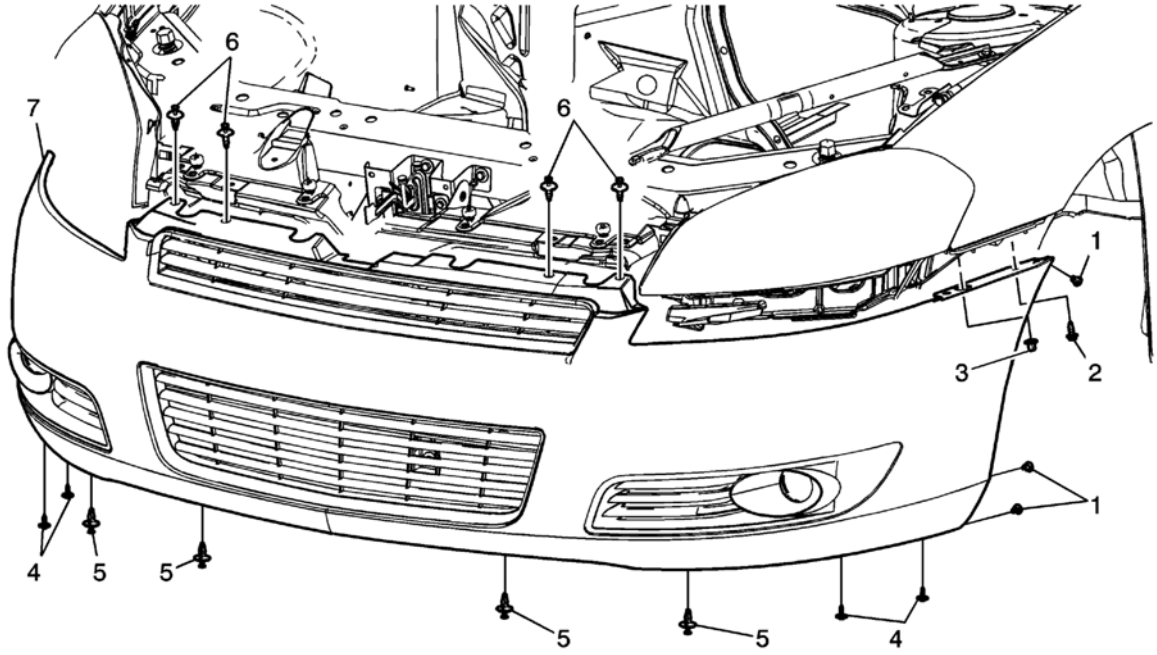


Fig. 3: Front Bumper Fascia
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Fascia Retainer (Qty: 6)
2	Front Fascia Bolt (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 6 N.m (53 lb in)
3	Front Fascia Nut (Qty: 2) **Tighten** 6 N.m (53 lb in)
4	Front Fascia Bolt (Qty: 4) **Tighten** 2 N.m (18 lb in)
5	Front Fascia Retainer (Qty: 6)
6	Front Fascia Retainer (Qty: 4)
7	Front Fascia

REAR BUMPER FASCIA REPLACEMENT

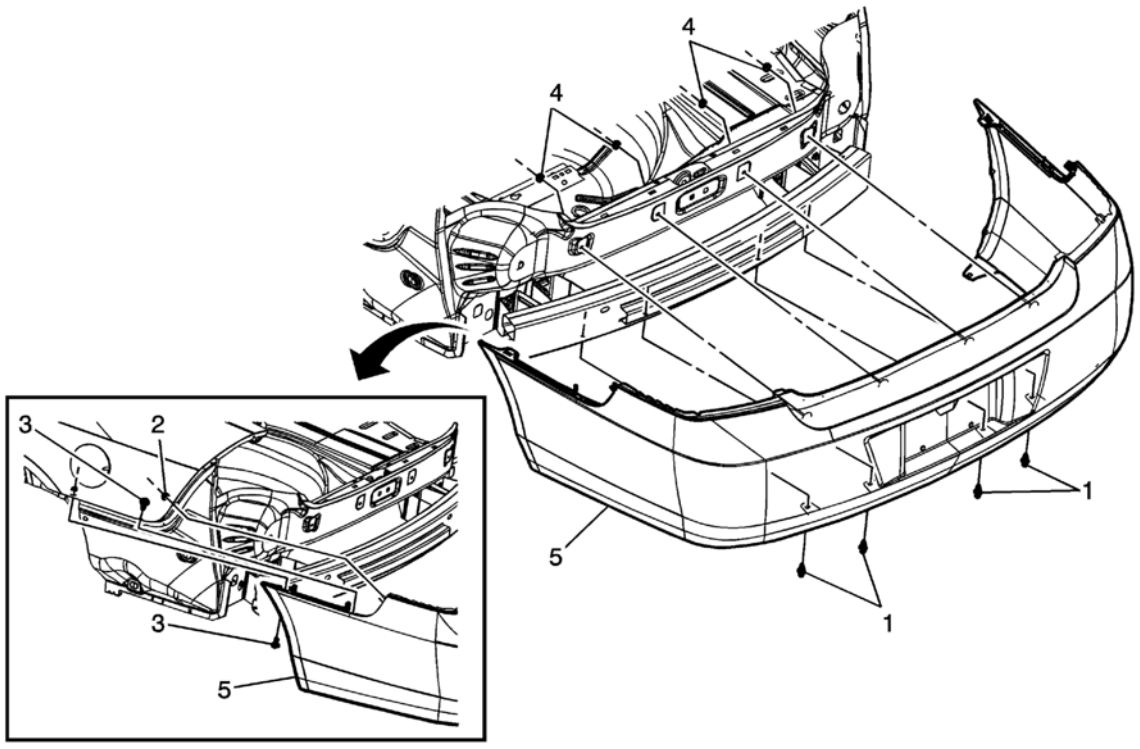


Fig. 4: Rear Bumper Fascia
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the rear wheel liner bolts to the rear fascia. Refer to **Rear Wheelhouse Liner Replacement** . 2. Remove the rear trim sill plate. Refer to **Rear Compartment Sill Trim Plate Replacement** . 3. Remove the license the lamp. Refer to **Rear License Plate Lamp Replacement (Impala)** .	
1	Rear Fascia Retainer (Qty: 4)
2	Rear Fascia Retainer (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
3	Rear Fascia Bolt (Qty: 6) **Tighten** 10 N.m (89 lb in)

Callout	Component Name
4	Rear Fascia Top Center Nut (Qty: 4) **Tighten** 10 N.m (89 lb in)
5	Rear Fascia **TIP:** Disconnect the electrical connector.

REAR ENERGY ABSORBER REPLACEMENT

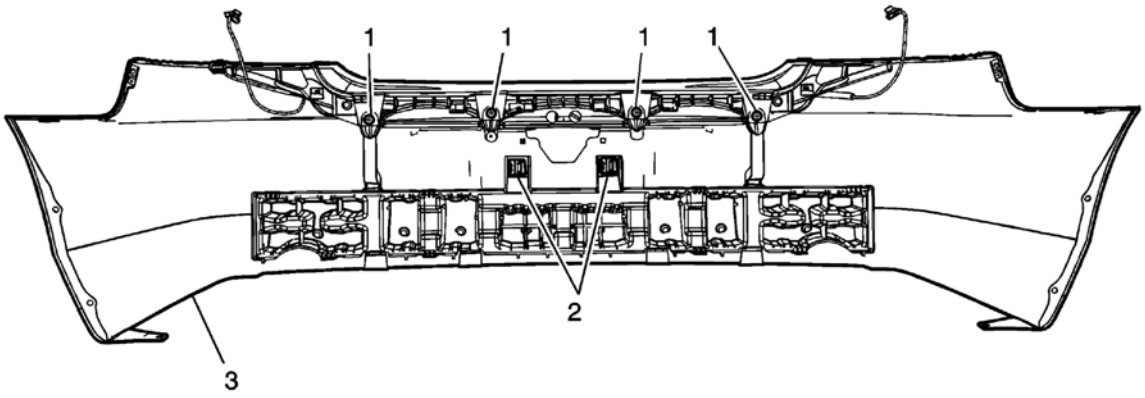


Fig. 5: Identifying Rear Energy Absorber
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear fascia. Refer to **Rear Bumper Fascia Replacement**.	
1	Rear Fascia Absorber Nut (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 6 N.m (53 lb in)
2	Rear Fascia Absorber Retainer (Qty: 2)
3	Rear Fascia Absorber • Disconnect/reposition the electrical harness. • Pry the energy absorber out of the fascia from the bottom.

REAR BUMPER IMPACT BAR REPLACEMENT

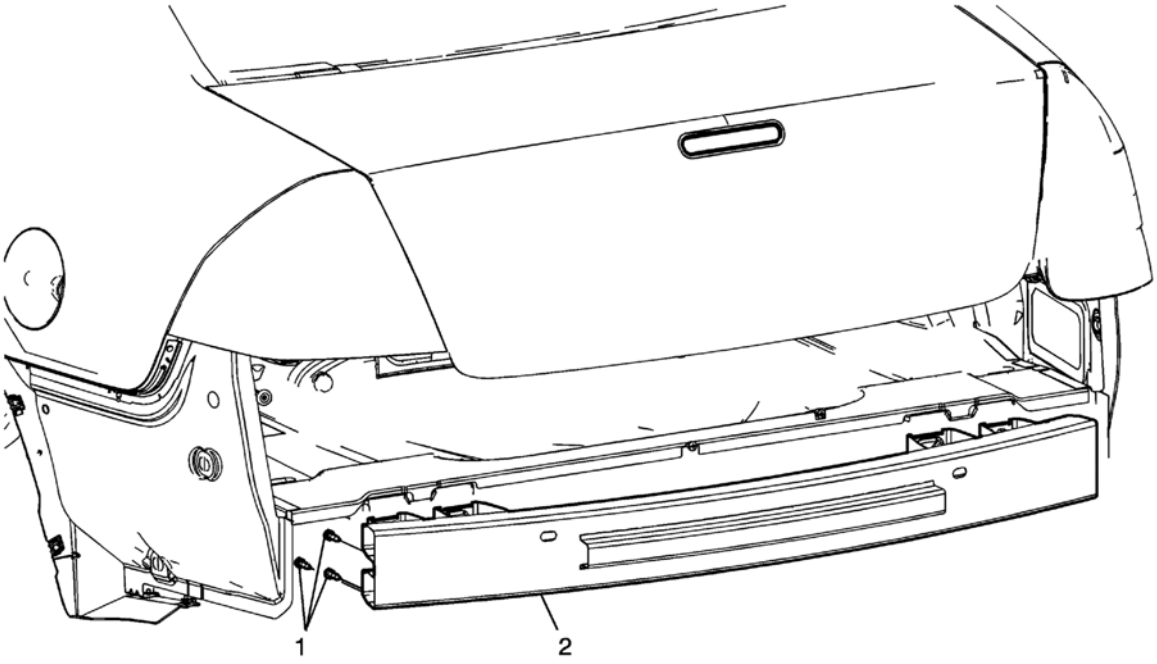


Fig. 6: Rear Bumper Impact Bar
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the rear fascia. Refer to **Rear Bumper Fascia Replacement**. 2. Remove the rear energy absorber. Refer to **Rear Energy Absorber Replacement**.	
1	Rear Impact Bar Bolt (Qty: 6) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
2	Rear Impact Bar

Article GUID: A00737236

SPECIFICATIONS

DIMENSIONS - BODY

Point to Point Measurements

Point-to-point measurements are for reference only. All Measurements are given in millimeters. Use these measurements for diagnosing and estimating. Point-to-point measurements are duplicated with tram bar pointers set at equal lengths. All die marks, holes, slots, and fasteners are measured to the center. All dimensions are symmetrical unless otherwise specified.

Side

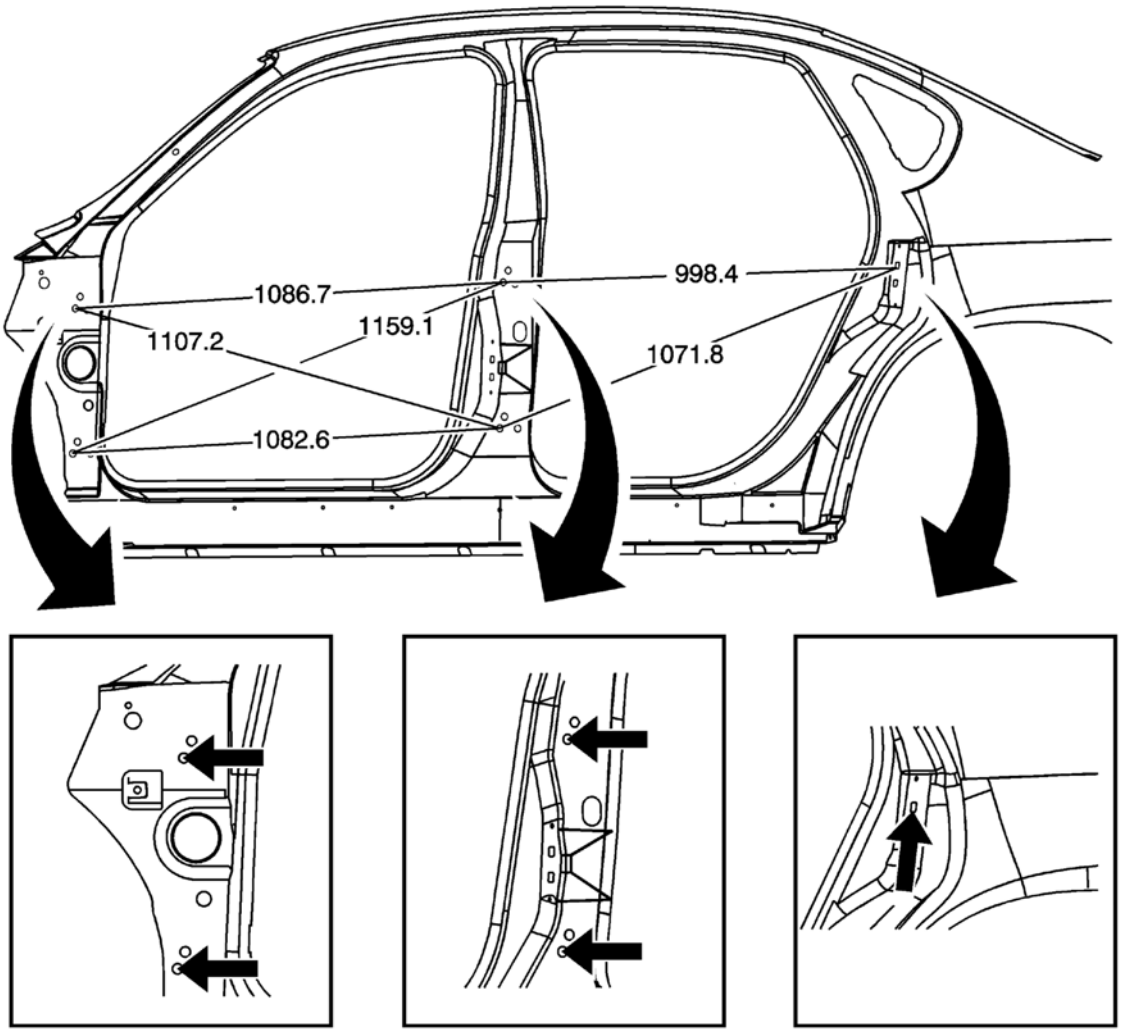


Fig. 1: View Of Side Body Dimensions
Courtesy of GENERAL MOTORS COMPANY

VISUAL IDENTIFICATION

STRUCTURE IDENTIFICATION (SEDAN)

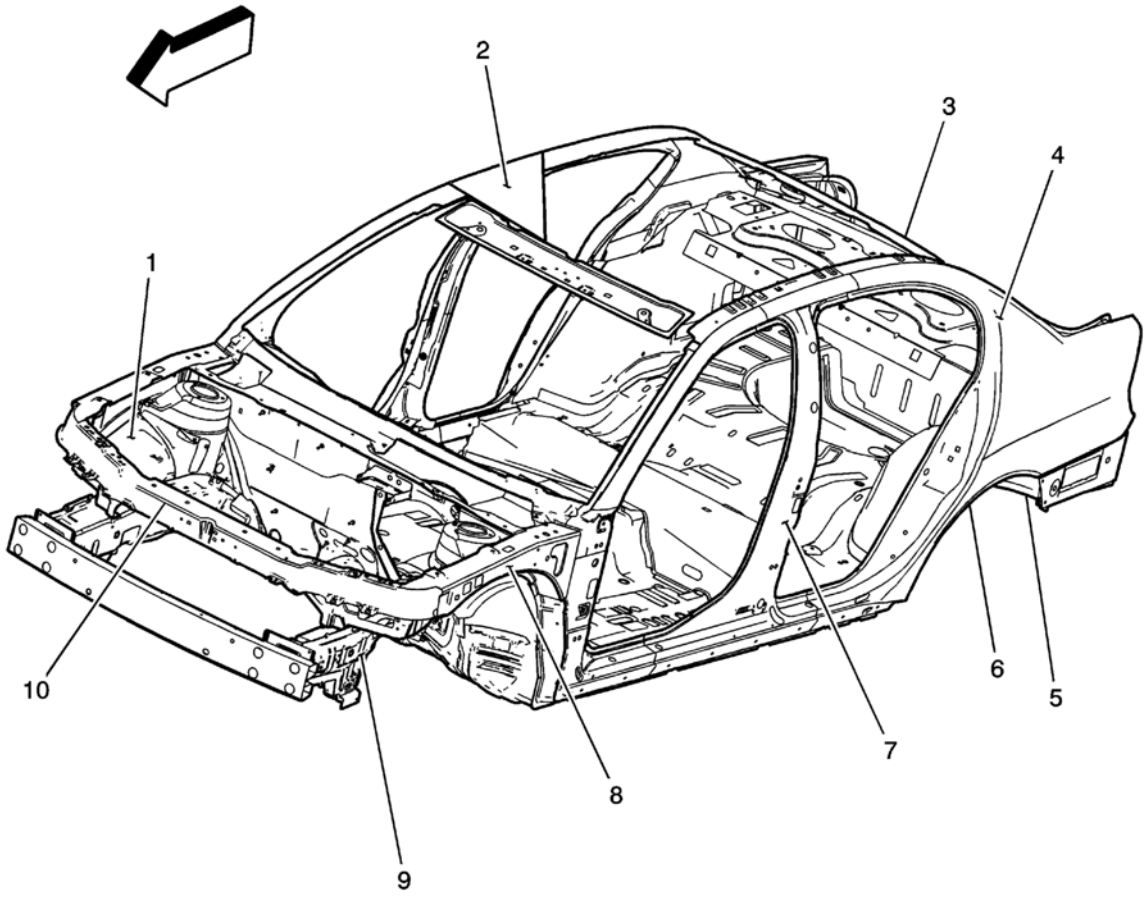


Fig. 2: Structure Identification (Sedan)
Courtesy of GENERAL MOTORS COMPANY

Number	Description	Material	Procedure
1	Front Wheelhouse	Mild Steel	• Front Wheelhouse Panel Replacement • Front Wheelhouse Extension Replacement
2	Roof Outer Panel	Mild Steel	Roof Panel Replacement
3	Rear Floor Panel	Mild Steel	Floor Panel Replacement
4	Body Side Outer	Mild Steel	• General Door Frame Opening Sectioning • Quarter Panel Replacement

Number	Description	Material	Procedure
5	Rear Rail	High Strength Low Alloy Steel	• Rear Rail Replacement • Rear Rail Sectioning
6	Rear Outer Wheelhouse	Mild Steel	Rear Wheelhouse Outer Panel Replacement
7	Center Pillar	Mild Steel	• Door Frame Reinforce Sectioning - Center Pillar • Center Pillar Replacement
8	Upper Rail	Mild Steel	Upper Rail Replacement
9	Lower Rail	High Strength Low Alloy Steel	• Lower Rail Sectioning • Lower Rail Replacement
10	Radiator Support	High Strength Low Alloy Steel	Radiator Support Replacement

REPAIR INSTRUCTIONS

FRONT WHEELHOUSE PANEL REPLACEMENT

Removal Procedure

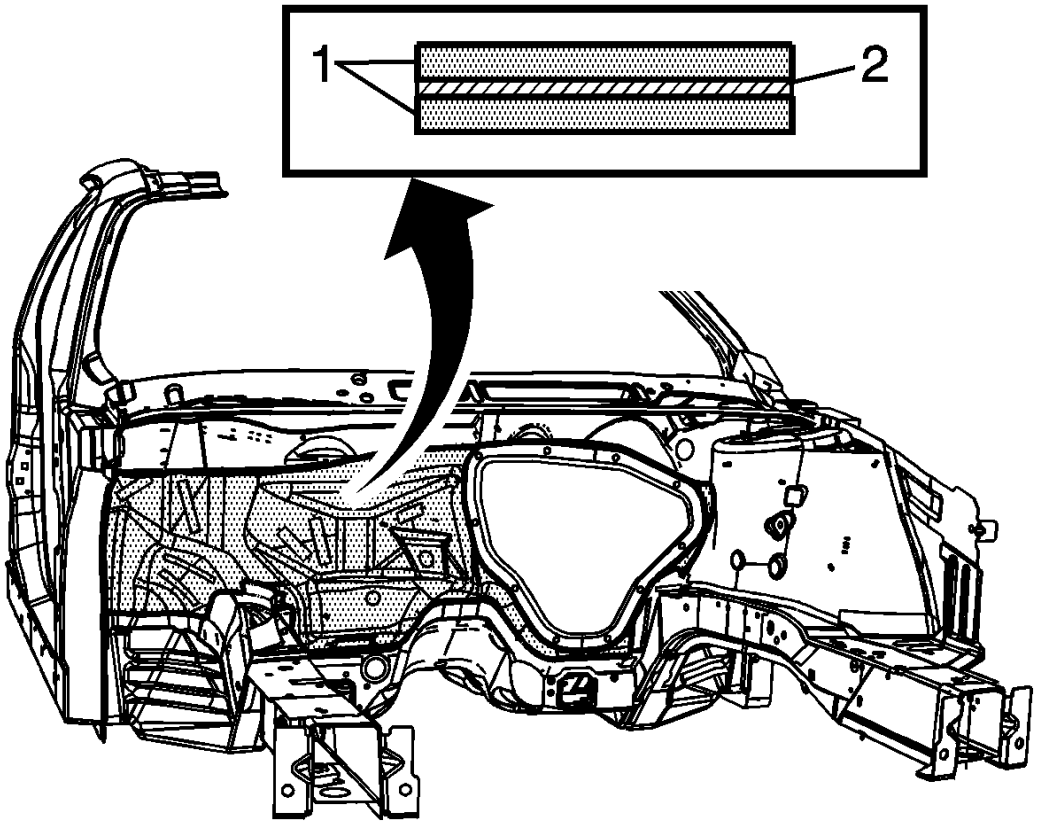


Fig. 3: View Of Laminated Steel
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

WARNING: **Refer to Foam Sound Deadeners Warning .**

NOTE:

- **Model year 2004 and prior vehicles are not manufactured with laminated steel in front of the dashes. Therefore, the front wheelhouse assembly can be metal inert gas (MIG) welded instead of the rivet and bonding process, as stated in these instructions.**

  The front of the dash panel is formed from laminated steel. This steel is constructed by bonding 2 pieces of cold rolled steel (1) with a viscoelastic layer of adhesive (2). MIG welding laminated steel does not meet GM Corporate standards for structural integrity. As an alternative, all factory welds will be replaced by using the rivet and adhesive bond method described in the installation portion of this procedure. The rivet and adhesive bond method must only be used in the areas, as described in this procedure.

- **Failure to follow this procedure will compromise the structural integrity of the vehicle.**

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

WARNING: Refer to Collision Sectioning Warning .

3. Remove all related panels and components.
4. Repair as much of the damage as possible.
5. Remove the sealers and the anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

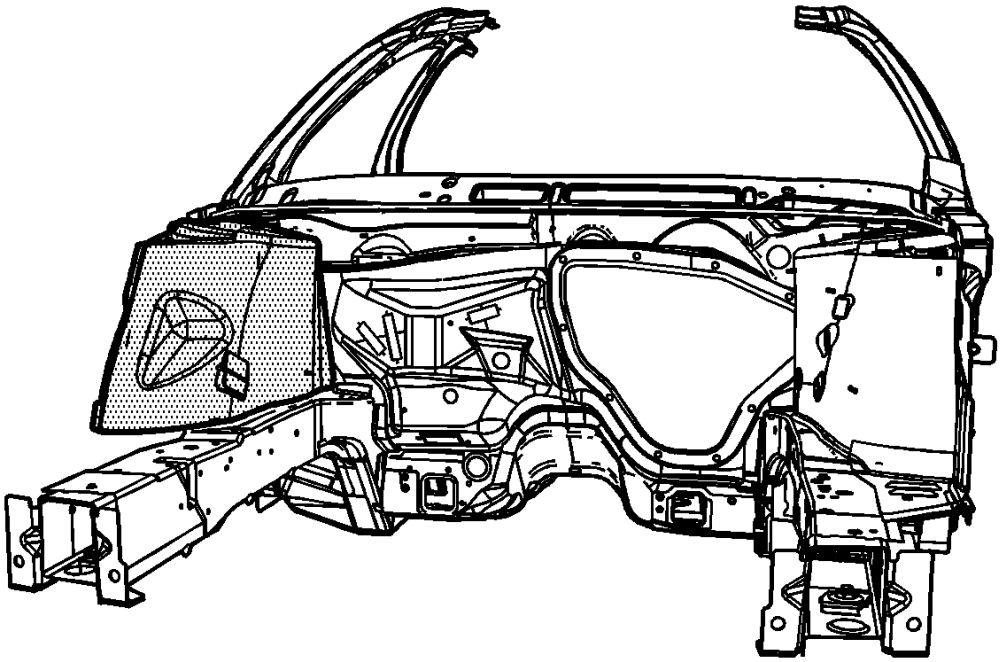


Fig. 4: View Of Full Wheelhouse Service Part
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the number and location of the factory welds for installation of the

full wheelhouse service part.

6. Remove the radiator support assembly. Refer to **Radiator Support Replacement**.
7. Remove the upper fender rail. Refer to **Upper Rail Replacement**.

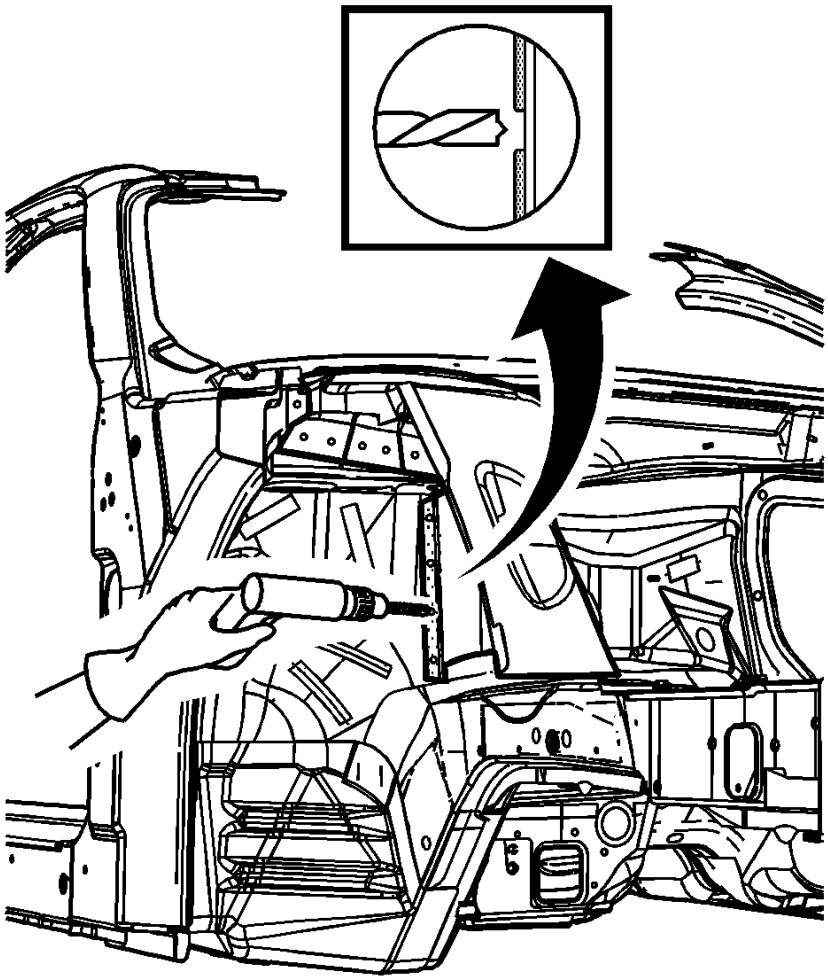


Fig. 5: Drilling Through Wheelhouse Flange Only
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Drill through the wheelhouse flange only. Do NOT drill into the dash panel or the inner reinforcements.**

8. Using an 8-mm (5/16-in) spot weld remover, locate and drill out the factory welds on the weld flange connecting the wheelhouse to the dash panel.

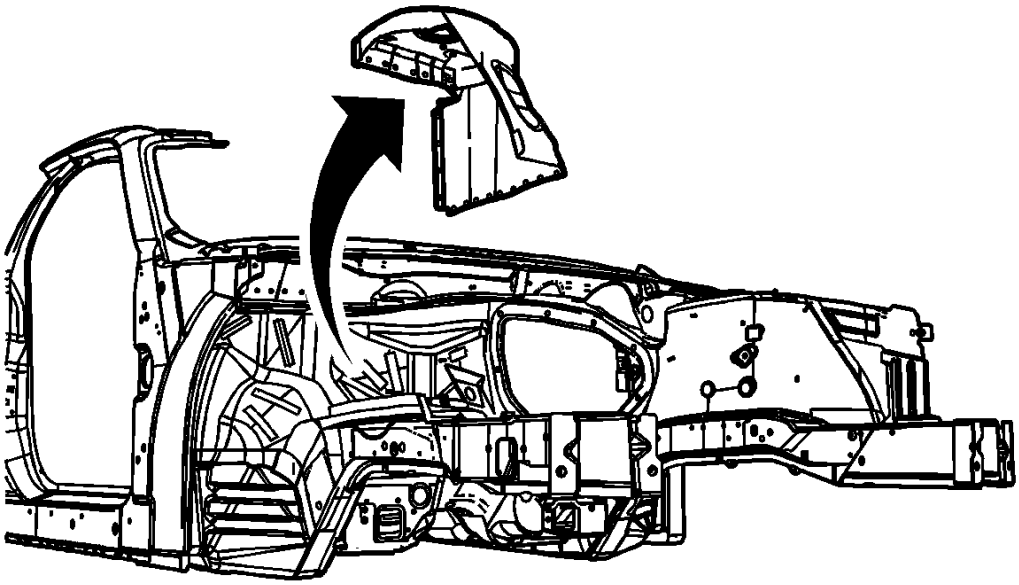


Fig. 6: Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

9. Remove the wheelhouse.

Installation Procedure

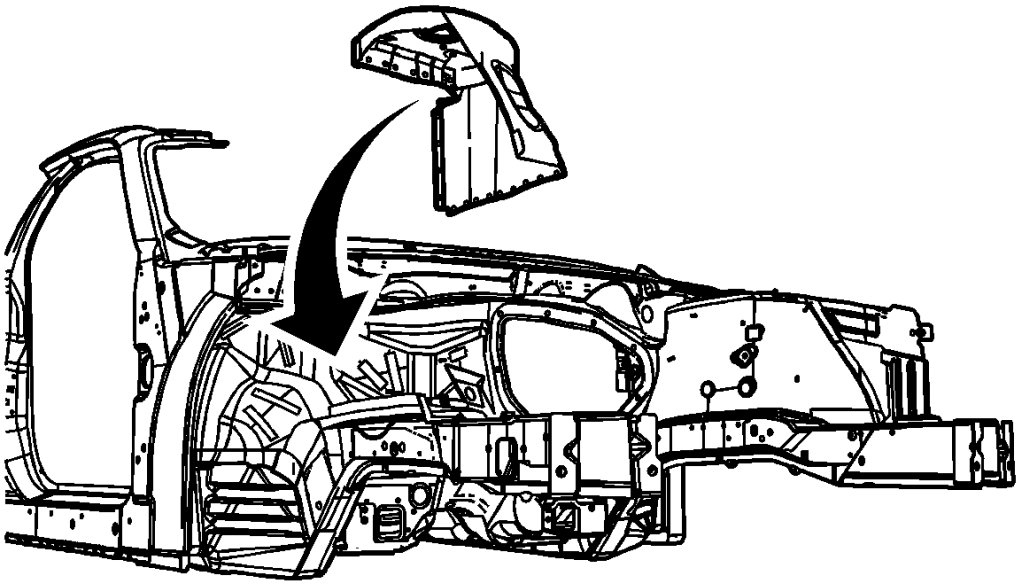


Fig. 7: Positioning Service Wheelhouse To Vehicle
Courtesy of GENERAL MOTORS COMPANY

1. Position the service wheelhouse to the vehicle using 3-dimensional measuring equipment.
2. Clamp the wheelhouse in place.

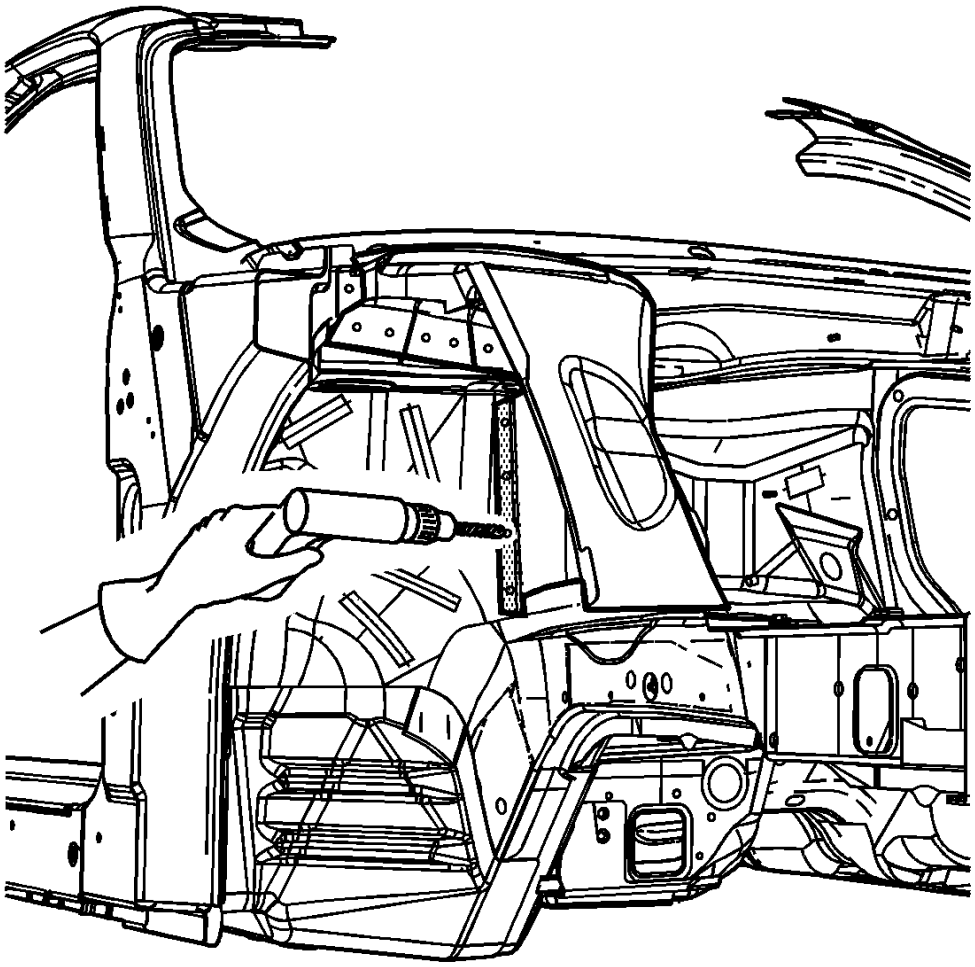


Fig. 8: Drilling Service Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

3. Using a 7-mm (17/64-in) bit, drill the rivet attachment holes through the service wheelhouse and the dash panel, in the exact locations as noted from the factory wheelhouse.

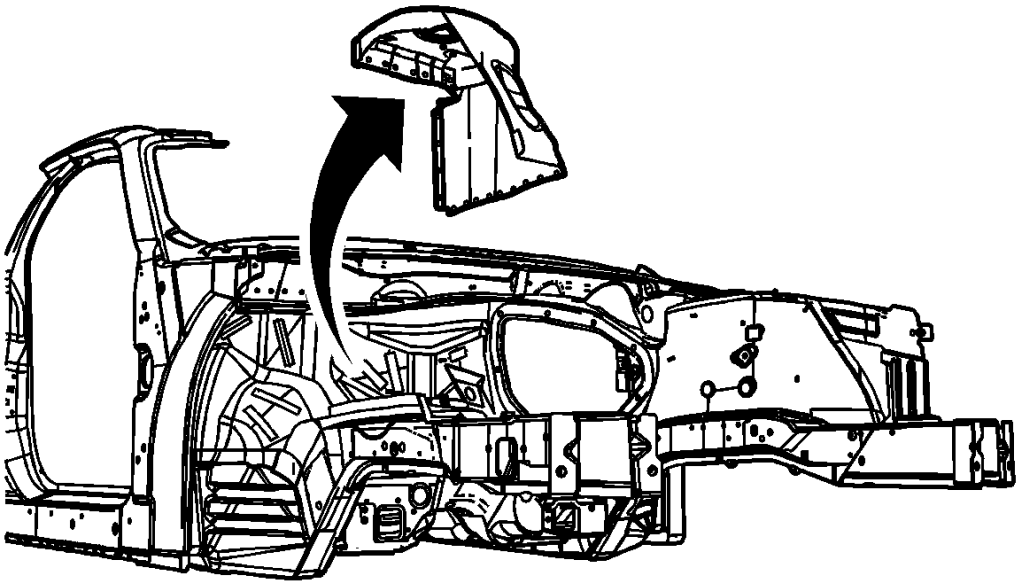


Fig. 9: Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

4. Remove the service wheelhouse.

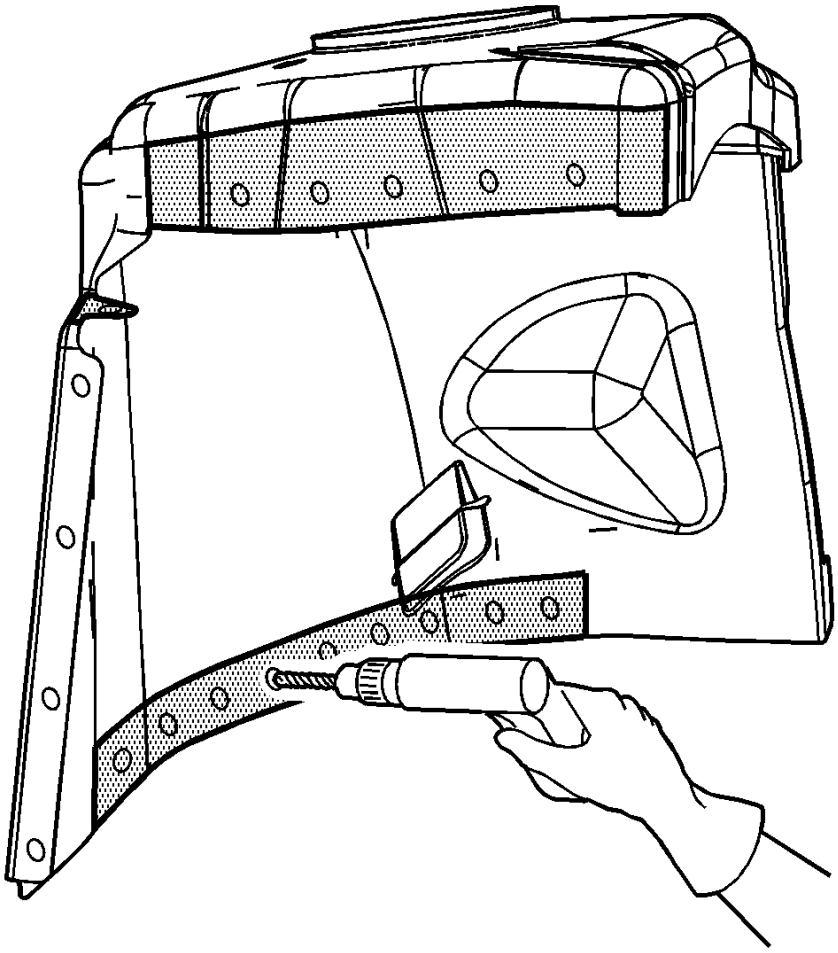


Fig. 10: Drilling Plug Weld Holes In Service Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the location of the original plug weld holes cannot be determined, space the plug weld holes every 40 mm (1.5 in) apart.**

5. Drill 8-mm (5/16-in) plug weld holes in the service wheelhouse, as necessary, in the remaining locations noted from the original wheelhouse.
6. Prepare the plug weld mating surfaces, as necessary.
7. Apply 3MÂ® Weld-Thru Coating P/N 05913 or equivalent to the plug weld mating surfaces.

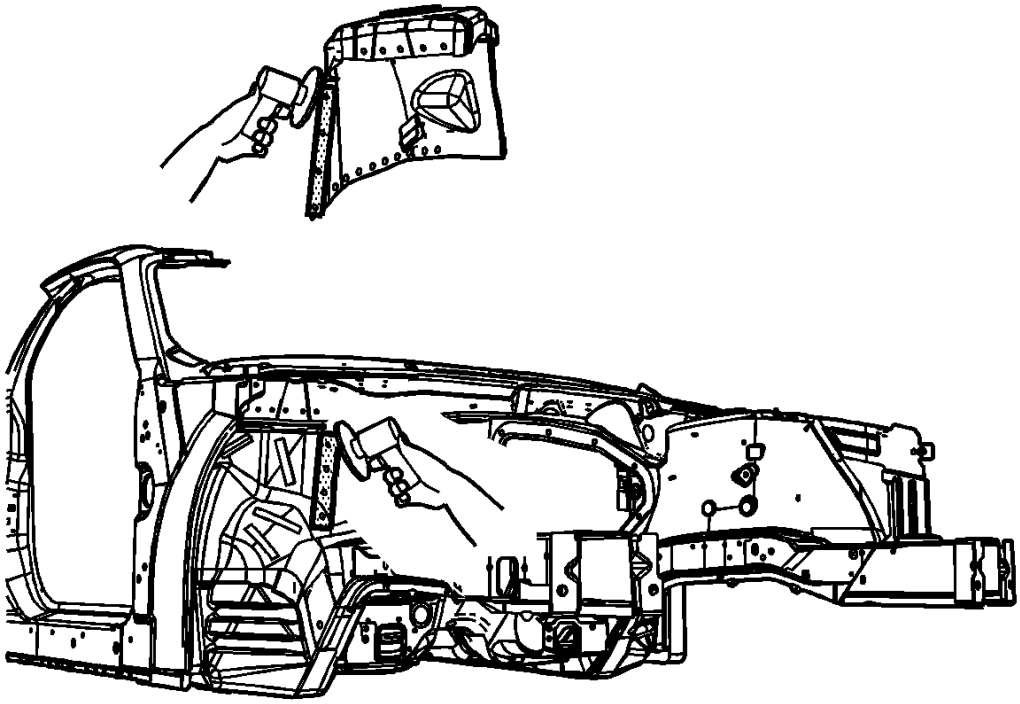


Fig. 11: Grinding Body Mating And Service Part Flanges
Courtesy of GENERAL MOTORS COMPANY

8. Prepare the bond mating areas by grinding the body mating and the service part flanges to bare steel. Do NOT damage the corners or thin the metal during the grinding process.
9. Clean the mating surfaces.

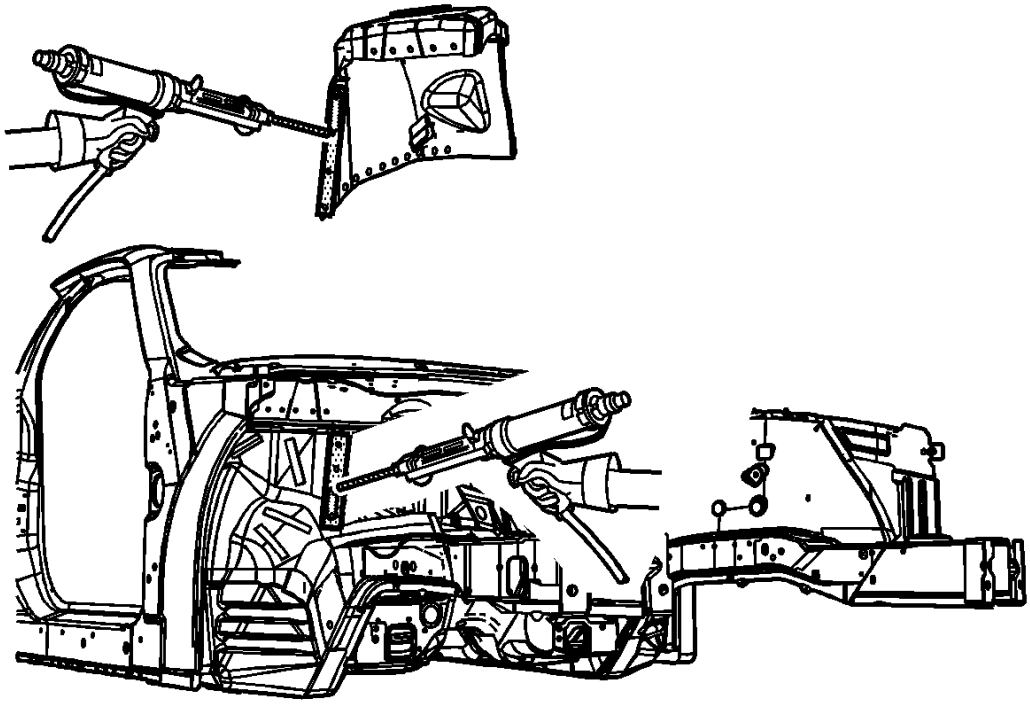


Fig. 12: Applying Metal Panel Bonding Adhesive
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The adhesive has a 40-50 minute working time. Do NOT allow the adhesive to cure prior to installing the service wheelhouse.**

10. Apply a 3-6 mm (1/8 to 1/4 in) bead of metal panel bonding adhesive GM P/N 12378567 (Canadian P/N 88901675) or equivalent to both of the mating surfaces.

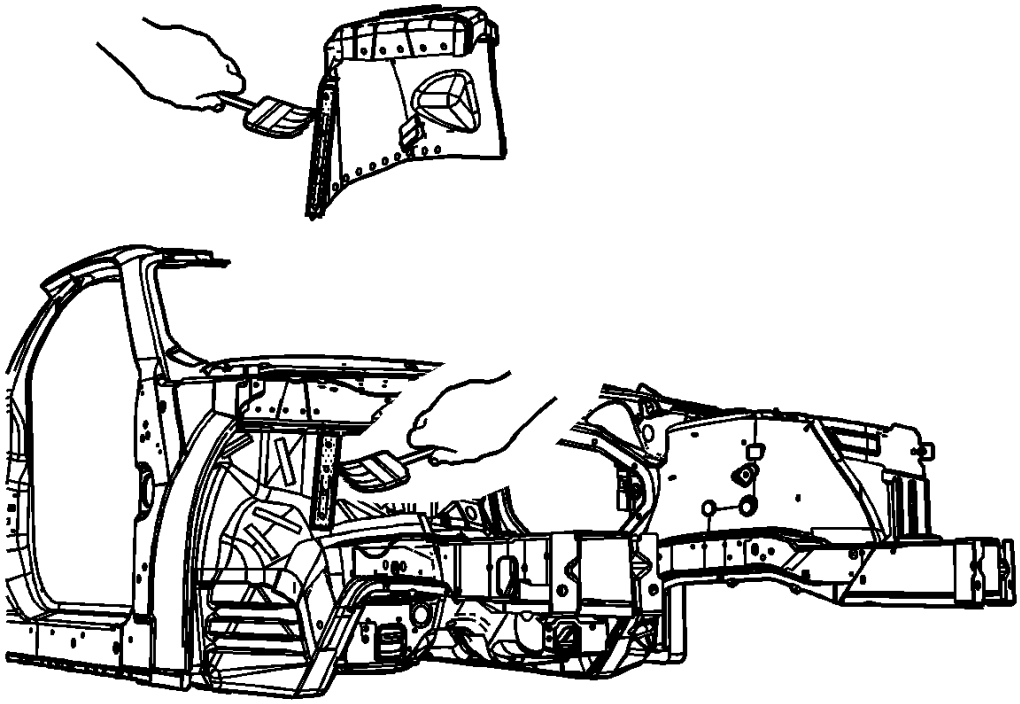


Fig. 13: Spreading Metal Panel Bonding Adhesive
Courtesy of GENERAL MOTORS COMPANY

11. Using a small acid brush, spread a coat of adhesive to both of the mating surfaces. Cover all of the bare metal to ensure corrosion protection.

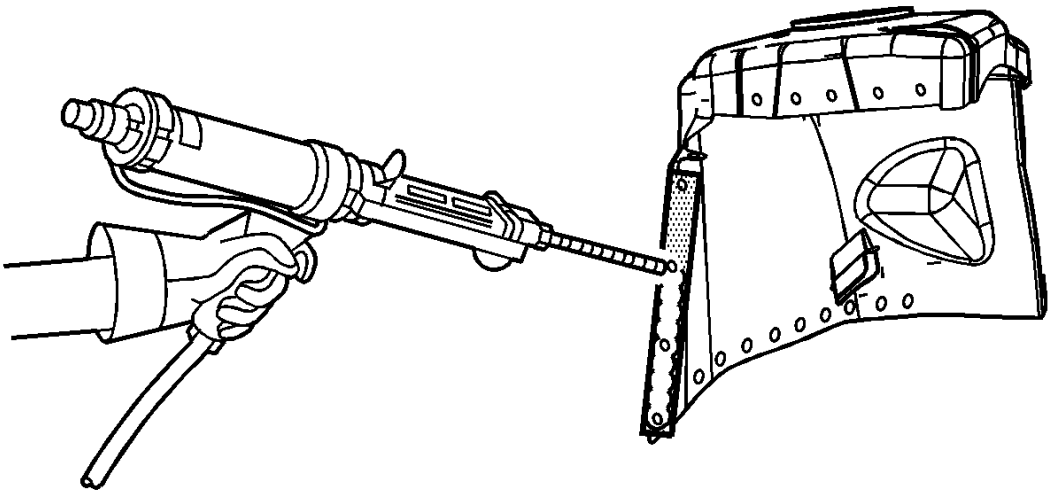


Fig. 14: Applying Bead Of Metal Panel Bonding Adhesive
Courtesy of GENERAL MOTORS COMPANY

12. Apply a 3-6 mm (1/8 to 1/4 in) bead of metal panel bonding adhesive GM P/N 12378567 (Canadian P/N 88901675) or equivalent to the mating surface of the service wheelhouse.

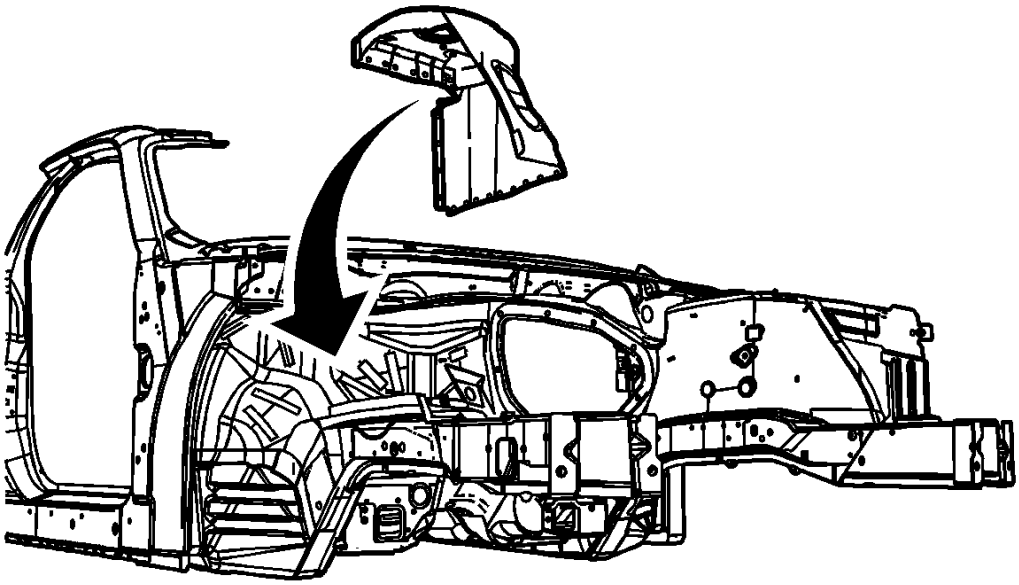


Fig. 15: Positioning Service Wheelhouse To Vehicle
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT pull the wheelhouse off of the dash after adhesion. To align the parts, slide the wheelhouse against the front of the dash.**

13. Position the service wheelhouse to the vehicle using 3-dimensional measuring equipment.
14. Clamp the wheelhouse in place.

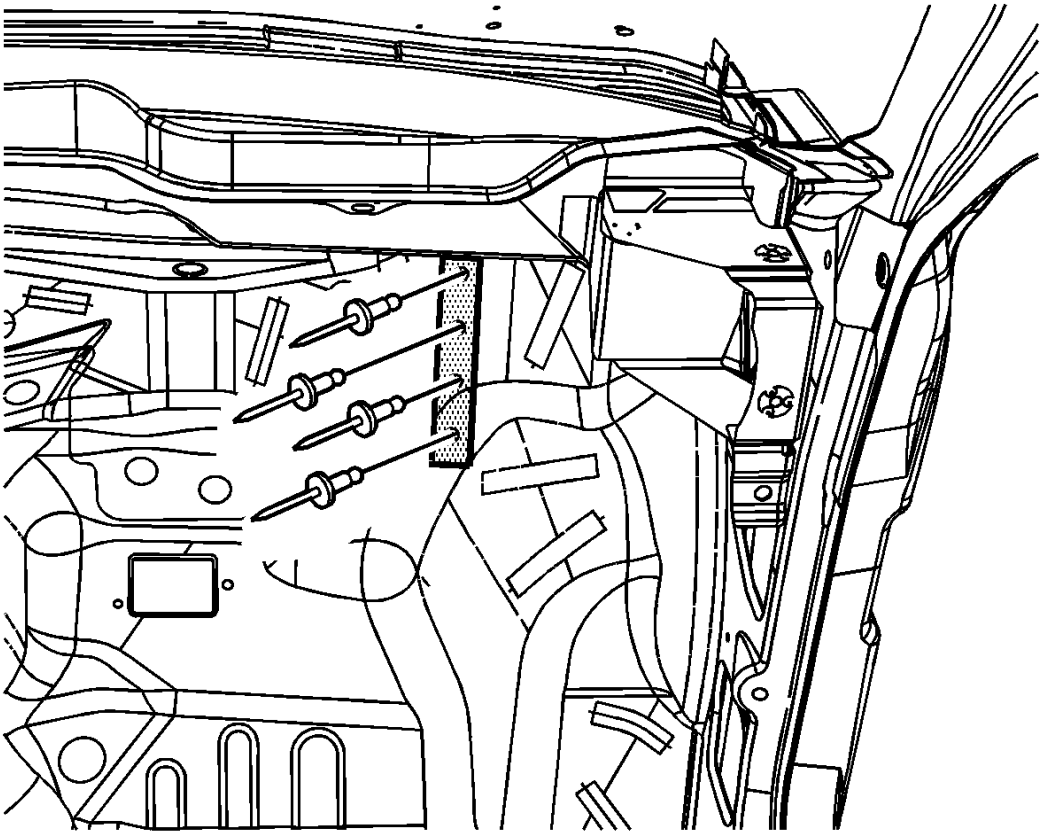


Fig. 16: Riveting Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

NOTE: Verify proper positioning of the service wheelhouse prior to riveting and welding.

15. Install the 9 mm (11/32 in) long rivets so that the rivet head contacts the passenger compartment side of the dash.
16. Remove the excess adhesive from the wheelhouse area.

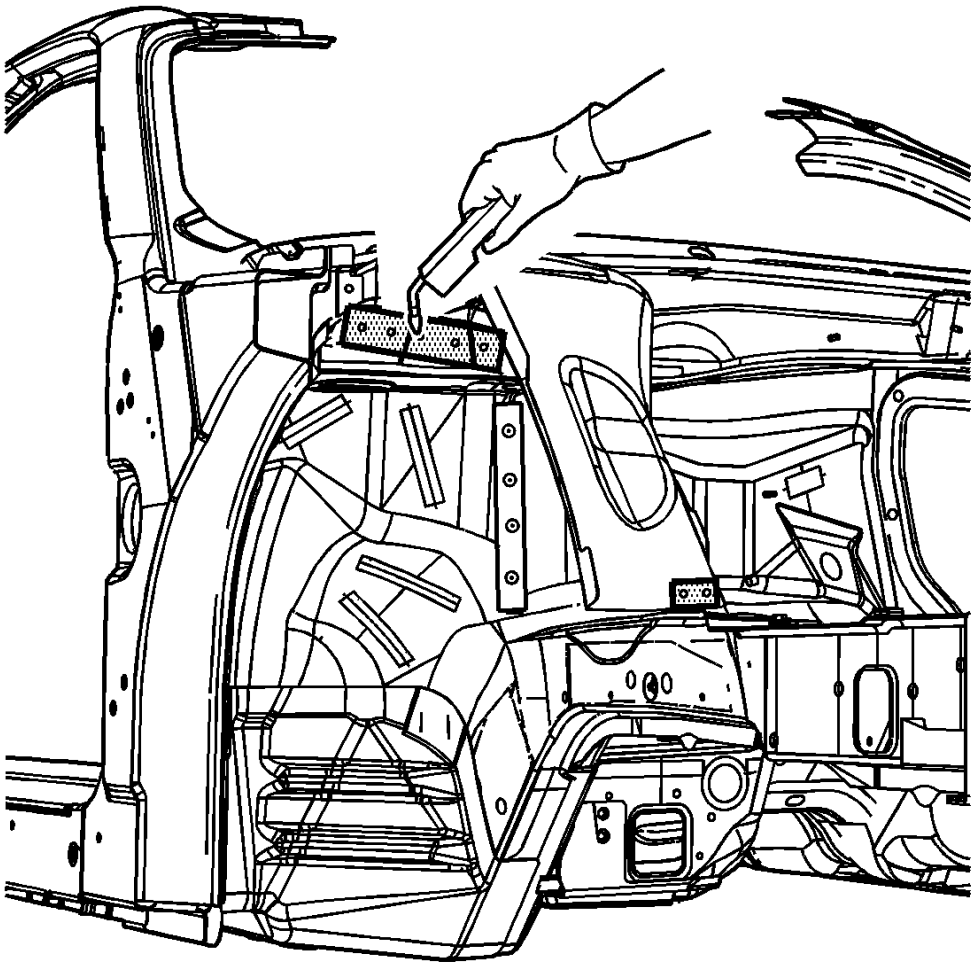


Fig. 17: Plug Welding Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

17. Plug weld the remaining holes accordingly.
18. Clean and prepare all of the welded surfaces.
19. Install the radiator support assembly. Refer to **Radiator Support Replacement**.
20. Install the upper fender rail. Refer to **Upper Rail Replacement**.
21. Apply the sealers and anti-corrosion materials to the repaired area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
22. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
23. Install all of the related panels and components.
24. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
25. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

FRONT WHEELHOUSE EXTENSION REPLACEMENT

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

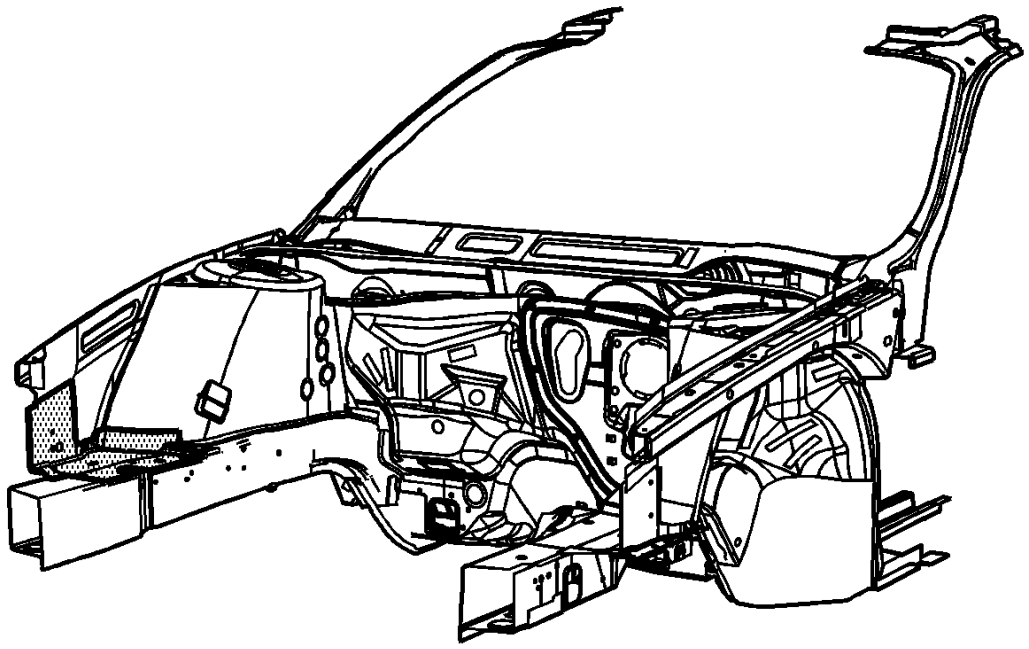


Fig. 18: View Of Front Wheelhouse
Courtesy of GENERAL MOTORS COMPANY

3. Remove all related panels and components.
4. Repair as much of the damage as possible to factory specifications. Refer to **Dimensions - Body**.

WARNING: Refer to Foam Sound Deadeners Warning .

5. Note the location and remove the sealers and anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
6. Remove the radiator support. Refer to **Radiator Support Replacement**.

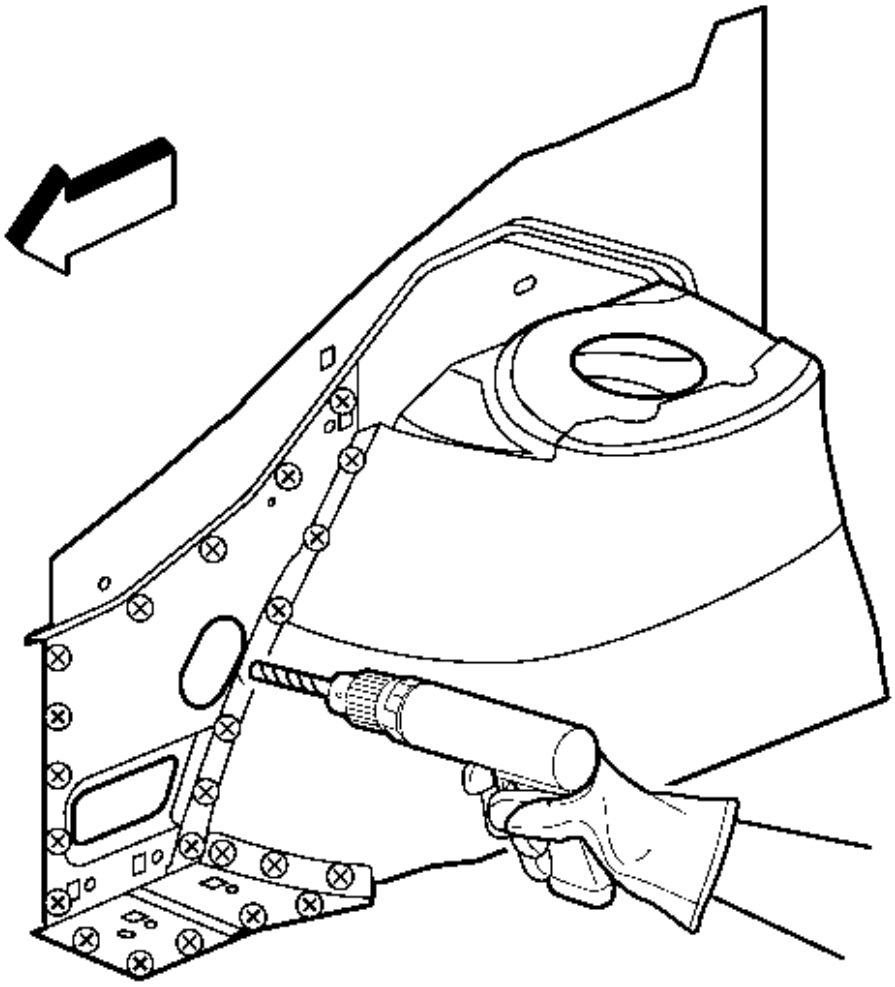


Fig. 19: Locating Factory Welds For Drilling
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not damage any inner panels or reinforcements.**

7. Locate and drill out all factory welds. Note the number and location of welds for installation of the service part.

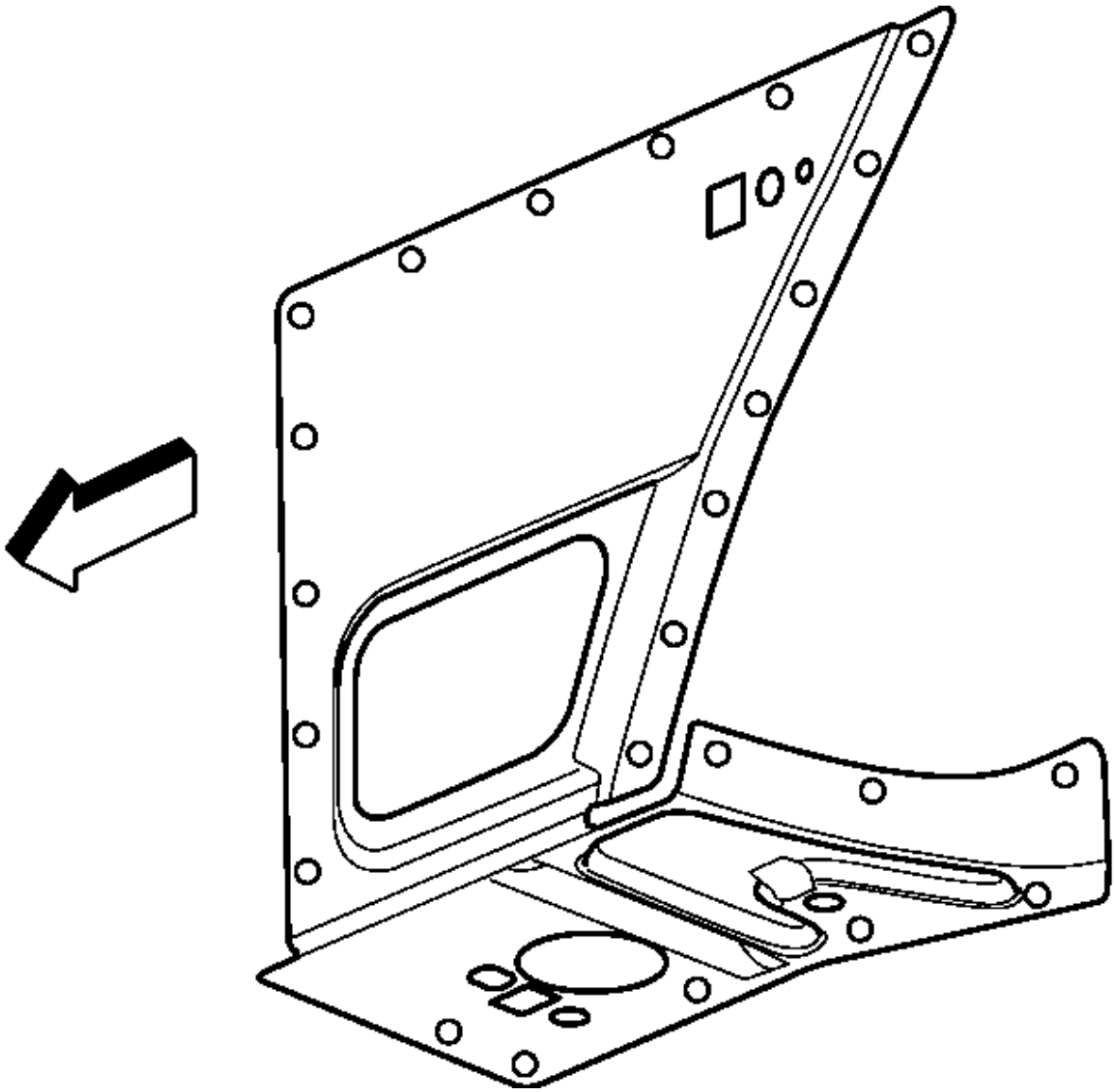


Fig. 20: Identifying Apron Extension
Courtesy of GENERAL MOTORS COMPANY

8. Remove the damaged apron extension.

Installation Procedure

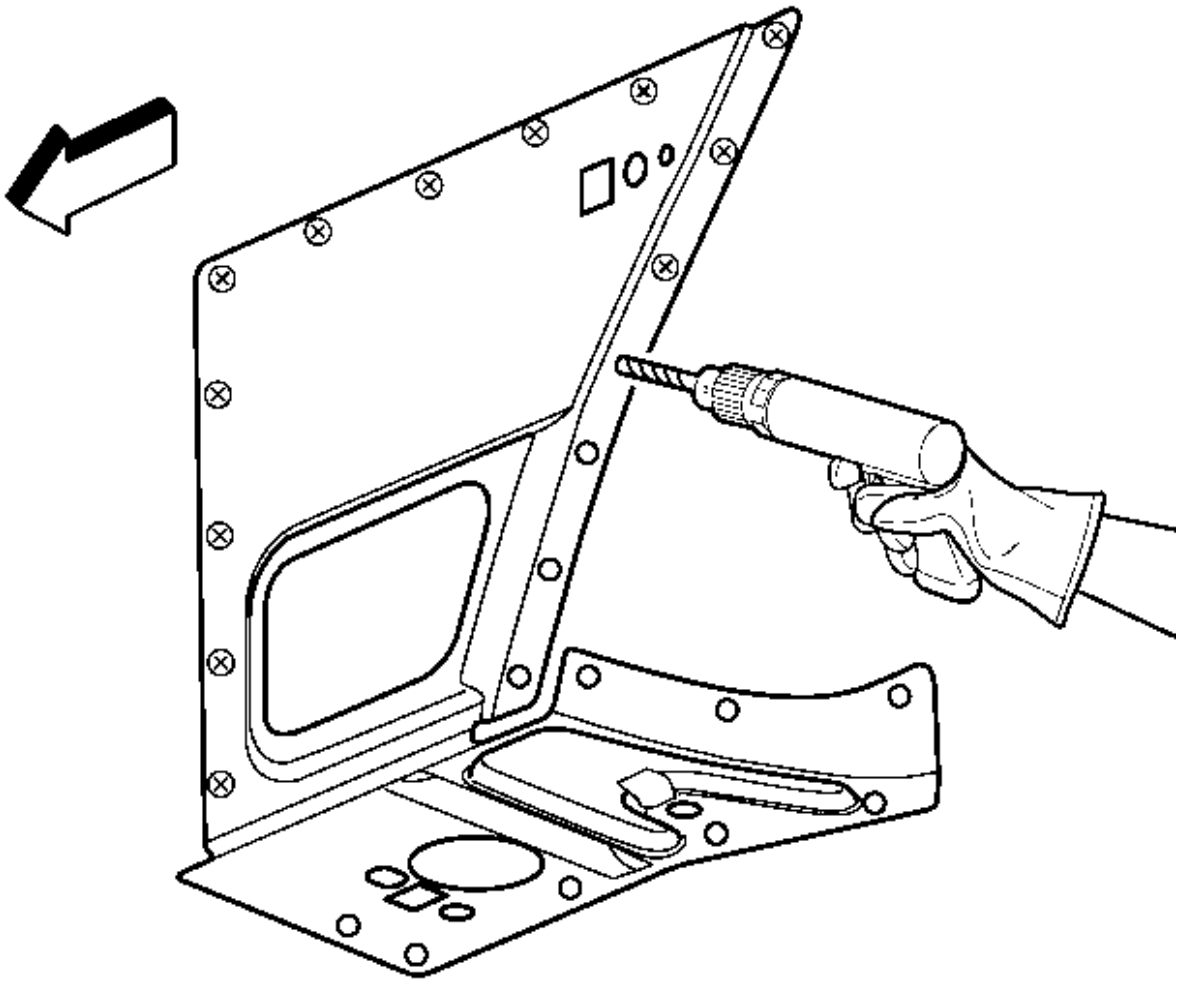


Fig. 21: Drilling Out Plug Weld Holes
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the location of the original plug weld holes can not be determined, or if structural weld-thru adhesive is present, space the plug weld holes every 40 mm (1 1/2 in) apart.**

1. Drill 8 mm (5/16 in) plug weld holes in the service part as necessary in the locations noted from the original panel and along the sectioning cut.
2. Prepare all mating surfaces as necessary.
3. Apply 3MÂ® Weld-Thru coating P/N 05916 or equivalent to all mating surfaces

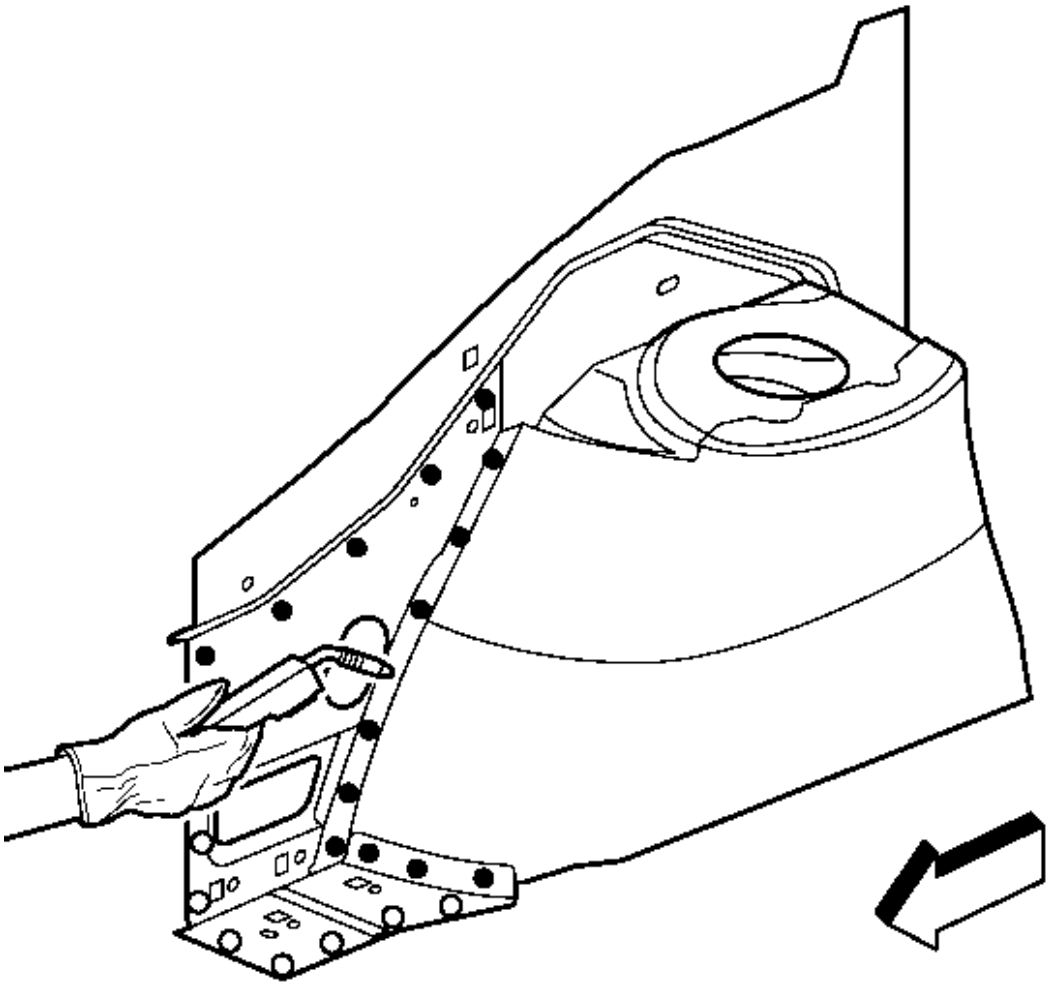


Fig. 22: Applying Weld-Thru Primer To Apron Extension
Courtesy of GENERAL MOTORS COMPANY

4. Position the apron extension.
5. Plug weld accordingly.
6. Replace the radiator support. Refer to **Radiator Support Replacement**.
7. Clean and prepare all welded surfaces.
8. Apply the sealers and anti-corrosion materials to the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
9. Paint and repair the area. Refer to **Basecoat/Clearcoat Paint Systems** .
10. Install all related panels and components.
11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
12. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

FRONT COMPARTMENT SIDE RAIL REAR EXTENSION REPLACEMENT

Removal Procedure

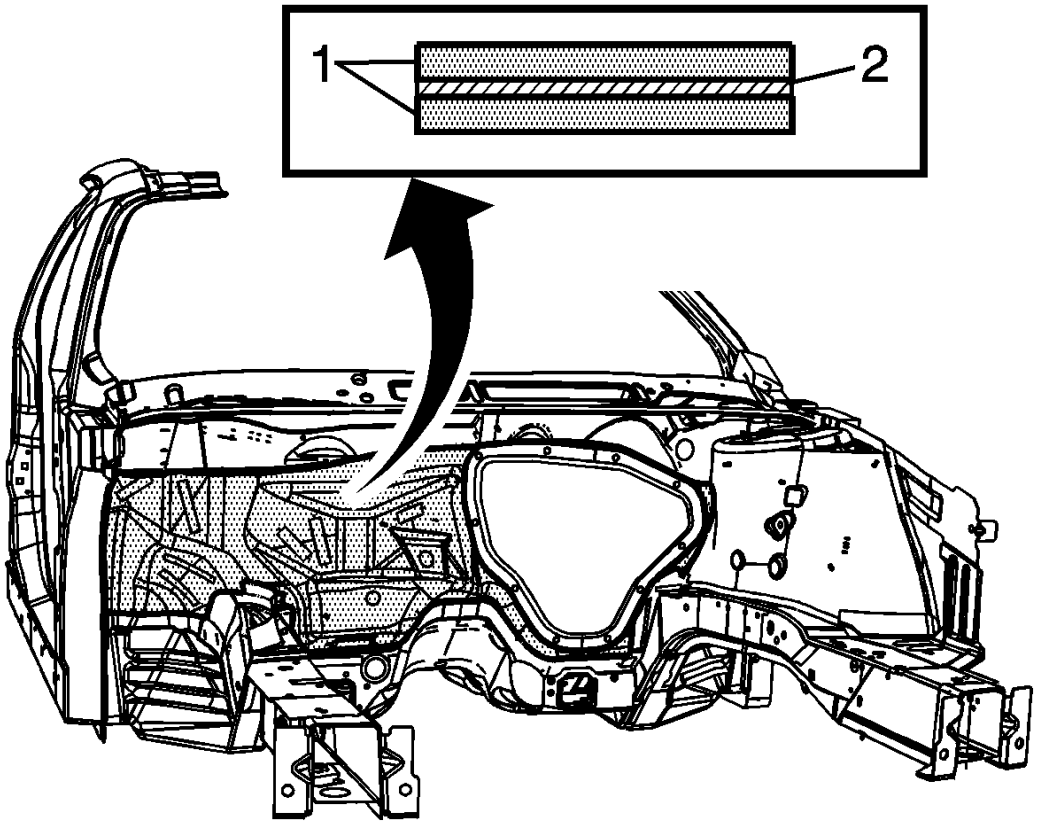


Fig. 23: View Of Laminated Steel
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

WARNING: **Refer to Foam Sound Deadeners Warning .**

NOTE:

- **Model year 2004 and prior vehicles are not manufactured with laminated steel in front of the dashes. Therefore, the front lower rail extension can be metal inert gas (MIG) welded instead of the rivet and bonding process, as stated in these instructions.**

  The front of the dash panel is formed from laminated steel. This steel is constructed by bonding 2 pieces of cold rolled steel (1) with a viscoelastic layer of adhesive (2). MIG welding laminated steel does not meet GM Corporate standards for structural integrity. As an alternative, all factory welds will be replaced by using the rivet and adhesive bond method, described in the installation portion of this procedure. The rivet and adhesive bond method must only be used in the areas as described in this procedure.

- **Failure to follow this procedure will compromise the structural integrity of the vehicle.**

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

WARNING: Refer to Collision Sectioning Warning .

3. Remove all related panels and components.
4. Repair as much of the damage as possible.
5. Remove the sealers and the anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

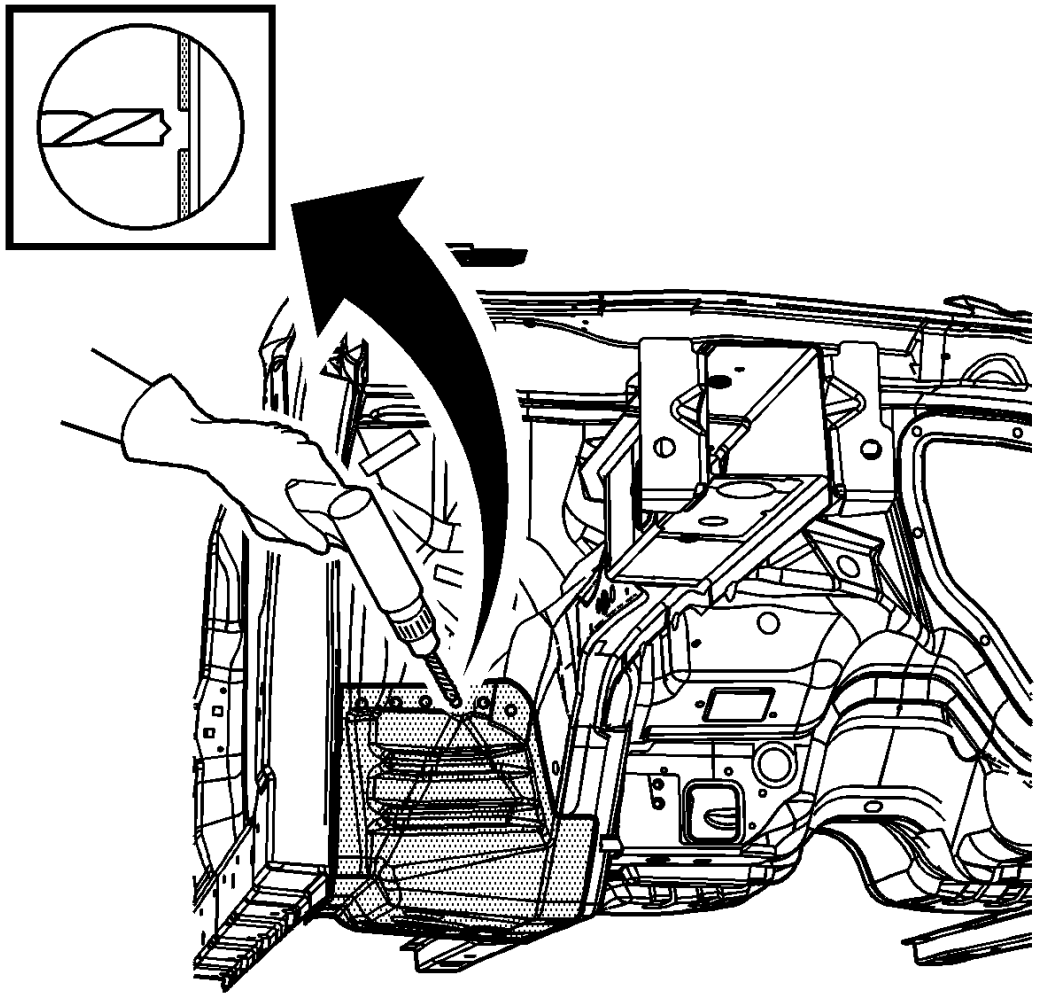


Fig. 24: Drilling Through Rail Side Extension Flange
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Note the number and location of the factory welds, for installation of**

the rail side extension service part.

- **Drill through the rail side extension flange only. Do NOT drill into the dash panel or the inner reinforcements.**

6. Using an 8-mm (5/16-in) spot weld remover, locate and drill out the factory welds on the weld flange connecting the lower rail side extension to the vehicle structure.

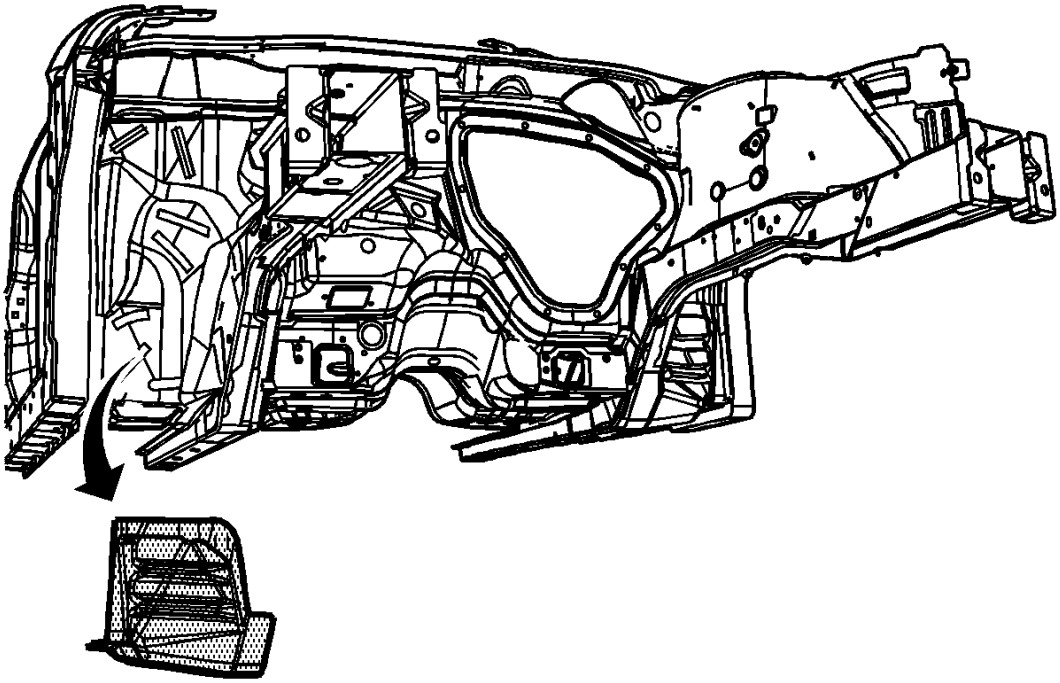


Fig. 25: Rail Side Extension
Courtesy of GENERAL MOTORS COMPANY

7. Remove the rail side extension.

Installation Procedure

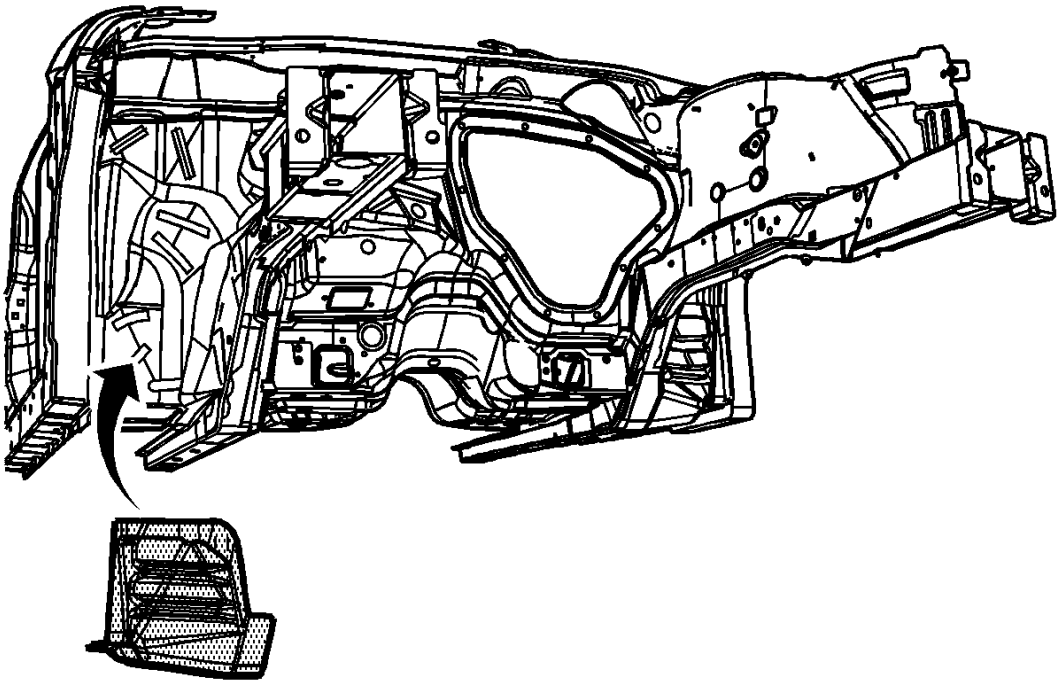


Fig. 26: Positioning Service Rail Side Extension To Vehicle
Courtesy of GENERAL MOTORS COMPANY

1. Position the service rail side extension to the vehicle.
2. Clamp the rail in place.

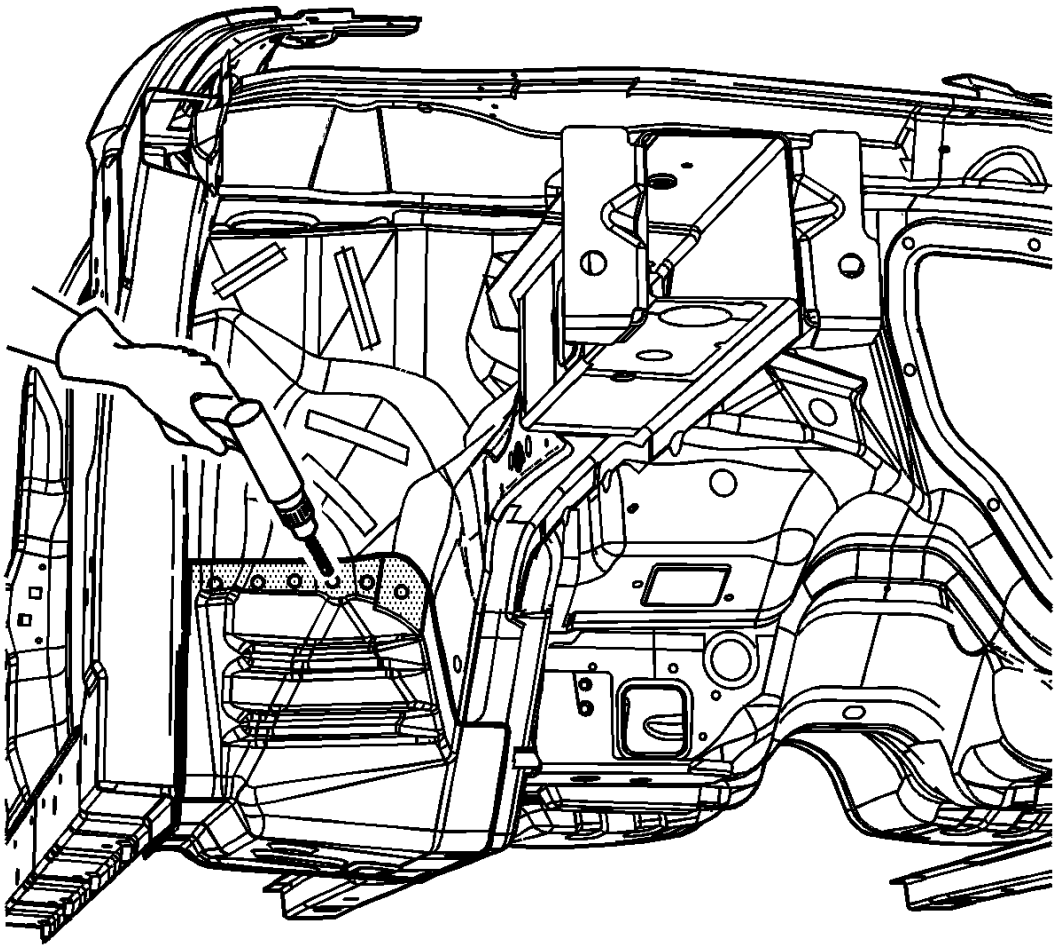


Fig. 27: Drilling Plug Weld Holes
Courtesy of GENERAL MOTORS COMPANY

3. Using a 7-mm (17/64-in) bit, drill the rivet attachment holes through the service rail side extension and the dash panel, in the exact locations, as noted from the factory rail side extension.

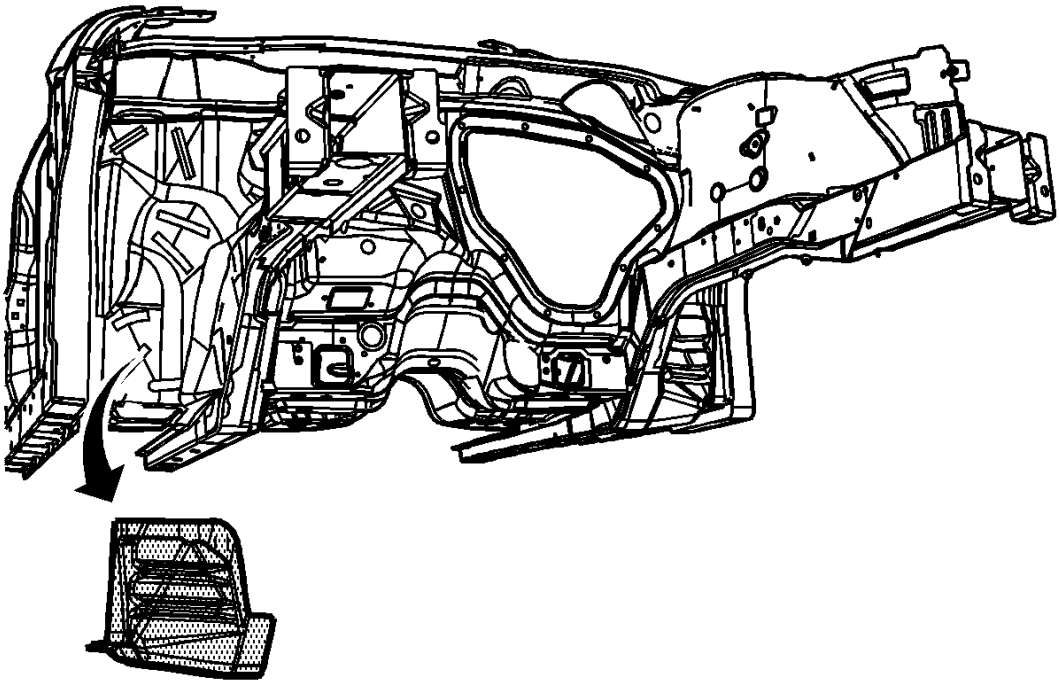


Fig. 28: Removing The Rail Side Extension
Courtesy of GENERAL MOTORS COMPANY

4. Remove the service rail side extension.

NOTE: **If the location of the original plug weld holes cannot be determined, space the plug weld holes every 40 mm (1.5 in) apart.**

5. Drill 8-mm (5/16-in) plug weld holes in the service rail side extension as necessary, in the remaining locations noted from the original rail side extension.
6. Prepare the plug weld mating surfaces, as necessary.
7. Apply 3MÂ® Weld-Thru Coating P/N 05913 or equivalent to the plug weld mating surfaces.

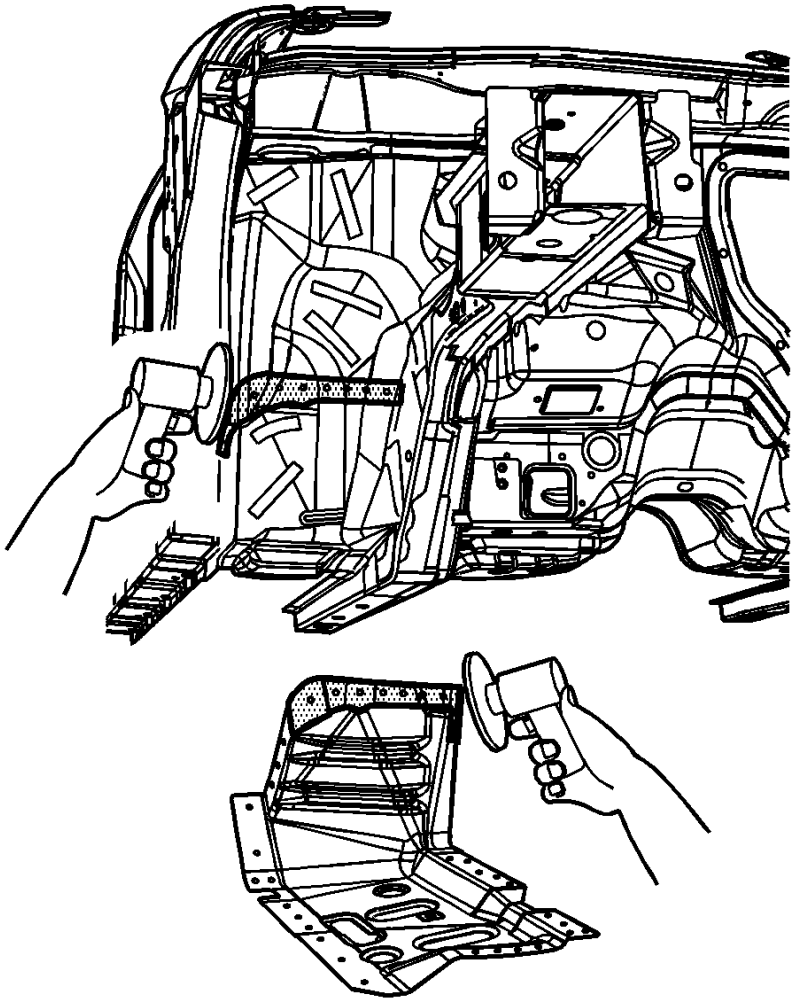


Fig. 29: Grinding Body Mating And Service Part Flanges
Courtesy of GENERAL MOTORS COMPANY

8. Prepare the bond mating areas by grinding the body mating and the service part flanges to bare steel. Do NOT damage the corners or thin the metal during the grinding process.
9. Clean the mating surfaces.

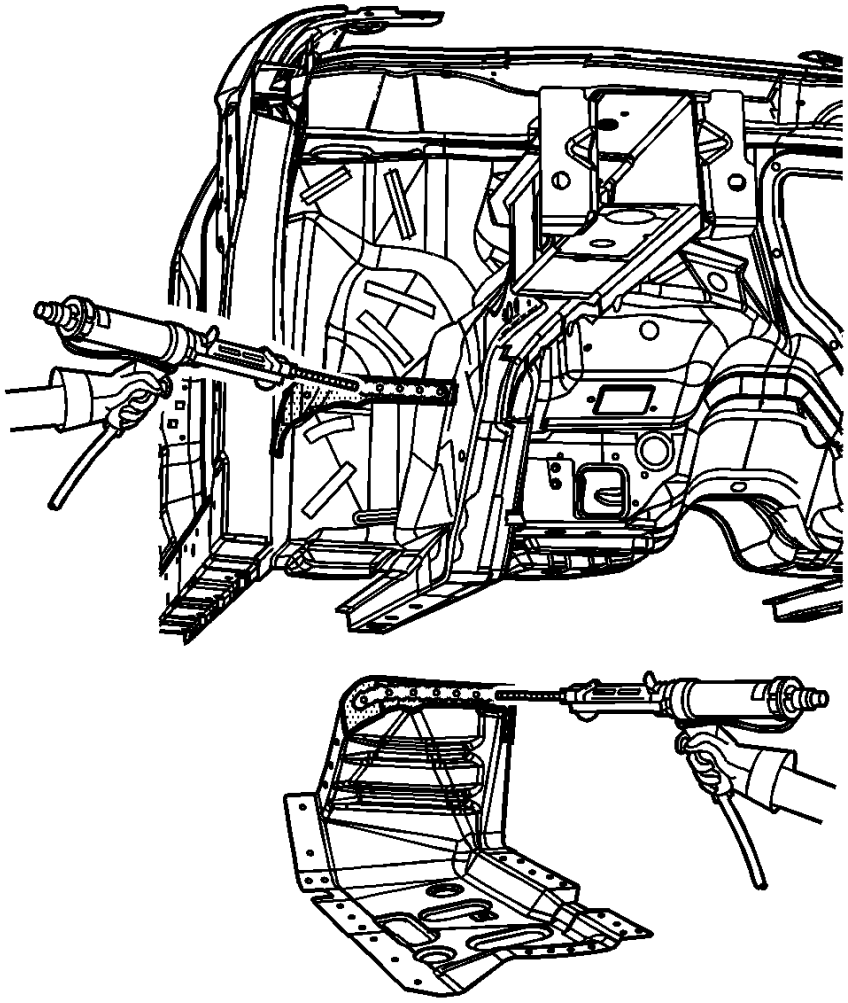


Fig. 30: Applying Metal Panel Bonding Adhesive
Courtesy of GENERAL MOTORS COMPANY

NOTE: The adhesive has a 40-50 minute working time. Do NOT allow the adhesive to cure prior to installing the service rail side extension.

10. Apply a 3-6 mm (1/8 to 1/4 in) bead of metal panel bonding adhesive GM P/N 12378567 (Canadian P/N 88901675) or equivalent to both of the mating surfaces.

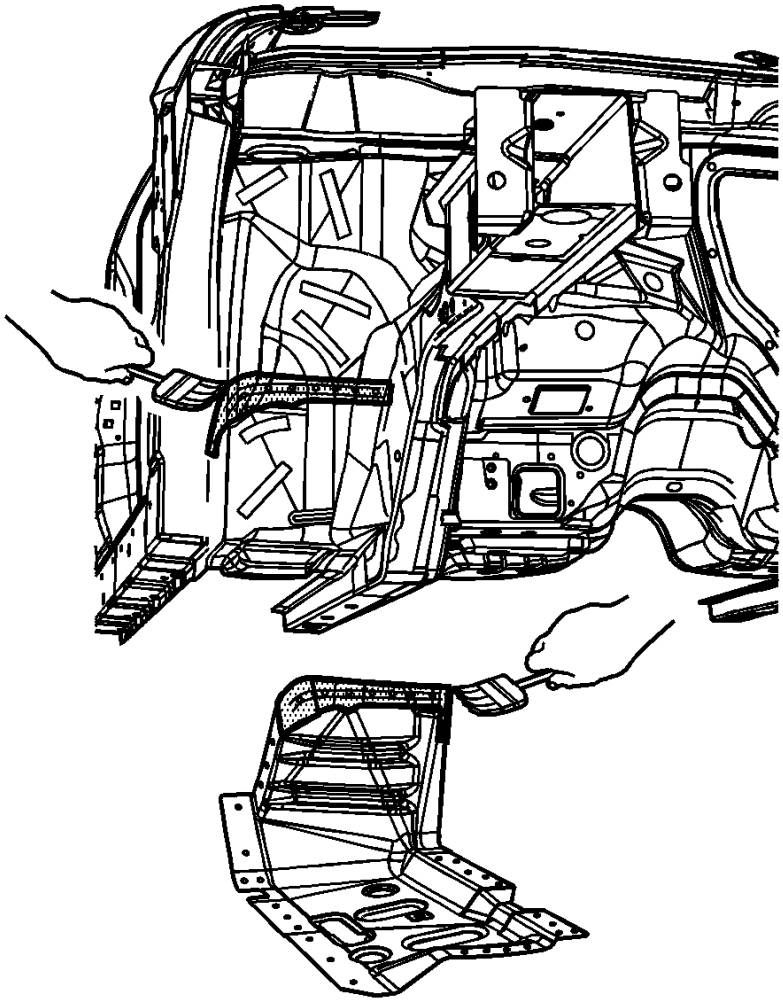


Fig. 31: Spreading Metal Panel Bonding Adhesive
Courtesy of GENERAL MOTORS COMPANY

11. Using a small acid brush, spread a coat of adhesive to both of the mating surfaces. Cover all of the bare metal to ensure corrosion protection.

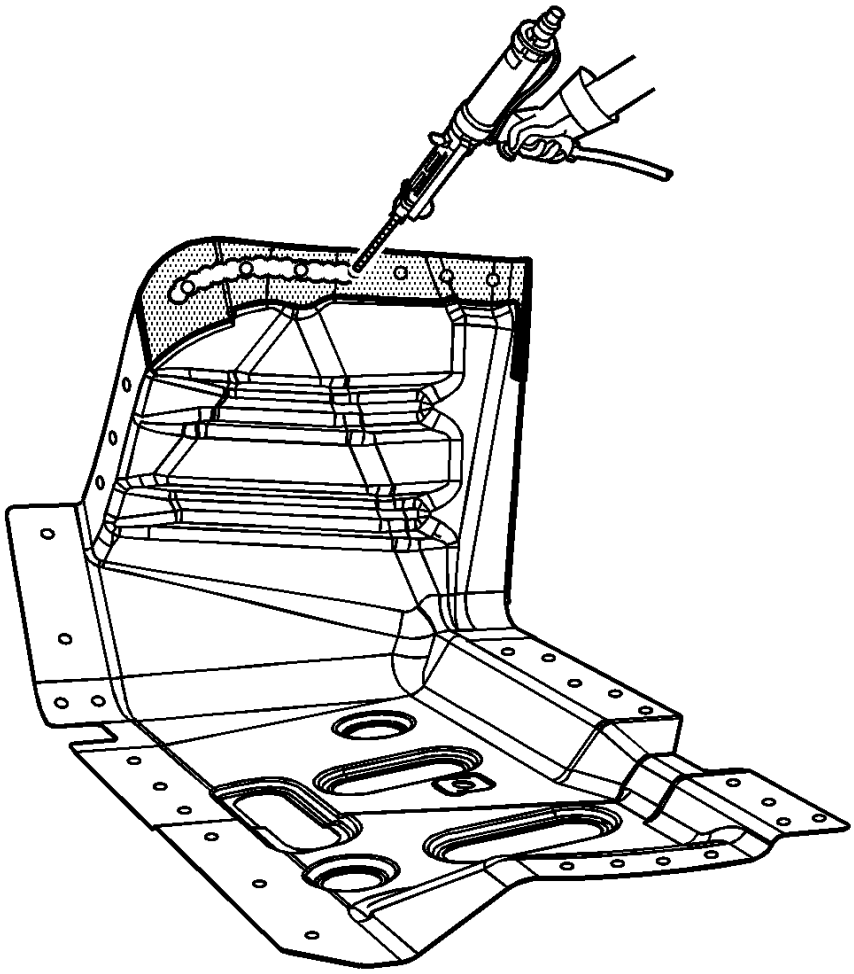


Fig. 32: Applying Bead Of Metal Panel Bonding Adhesive
Courtesy of GENERAL MOTORS COMPANY

12. Apply a 3-6 mm (1/8 to 1/4 in) bead of metal panel bonding adhesive GM P/N 12378567 (Canadian P/N 88901675) or equivalent to the mating surface of the service rail side extension.

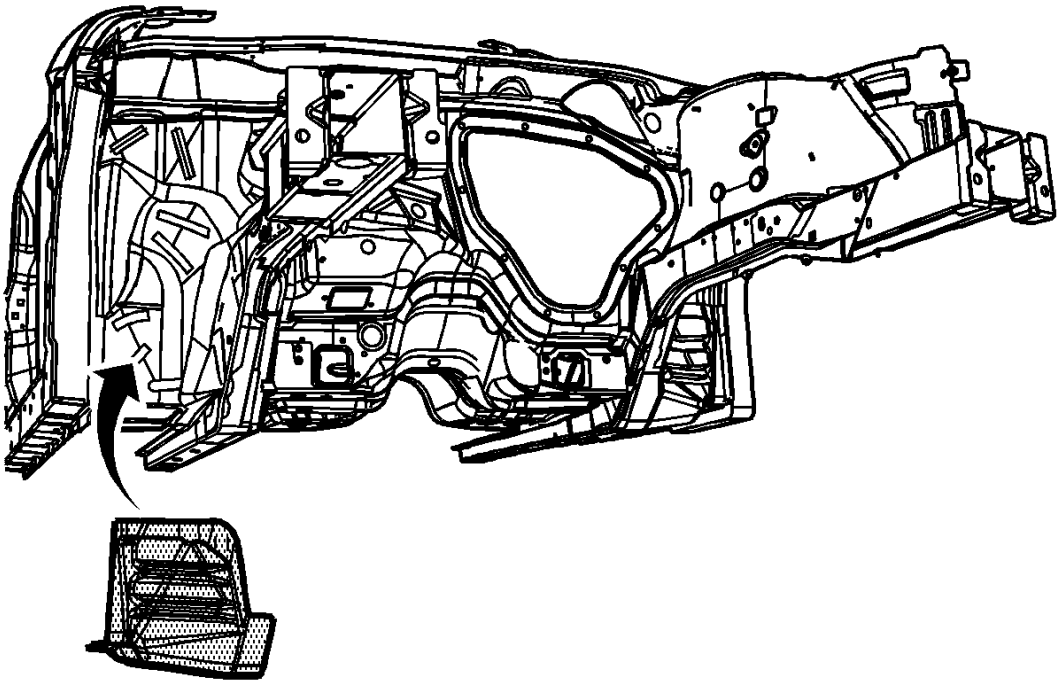


Fig. 33: Positioning Service Rail Side Extension To Vehicle
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT pull the service rail side extension off of the dash after adhesion. To align the parts, slide the service rail side extension against the front of the dash.**

13. Position the service rail side extension to the vehicle using 3-dimensional measuring equipment.
14. Clamp the service rail side extension in place.

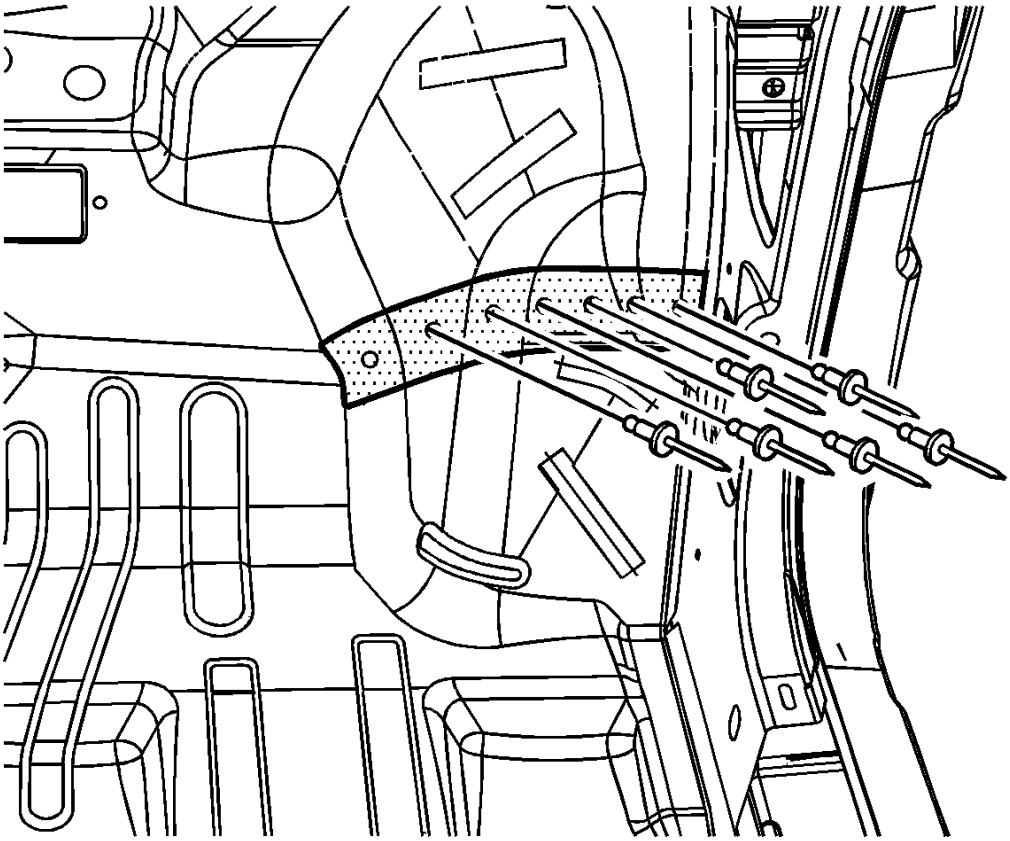


Fig. 34: 9 mm Rivets
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Verify proper positioning of the service rail side extension prior to riveting and welding.**

15. Install the 9-mm (11/32-in) long rivets so that the rivet head contacts the passenger compartment side of the dash.

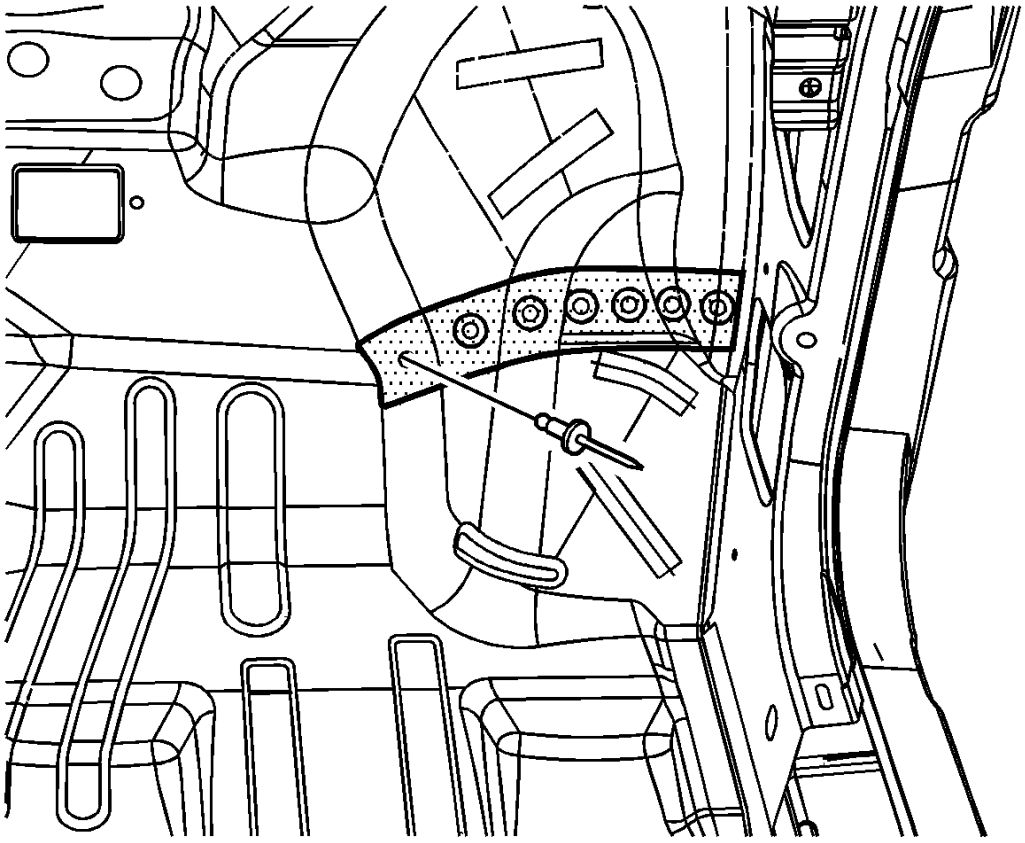


Fig. 35: Identifying 14-mm (17/32-in) Long Rivet
Courtesy of GENERAL MOTORS COMPANY

16. Install the 14-mm (17/32-in) long rivets so that the rivet head contacts the passenger compartment side of the dash.
17. Remove the excess adhesive from the service rail side extension area.

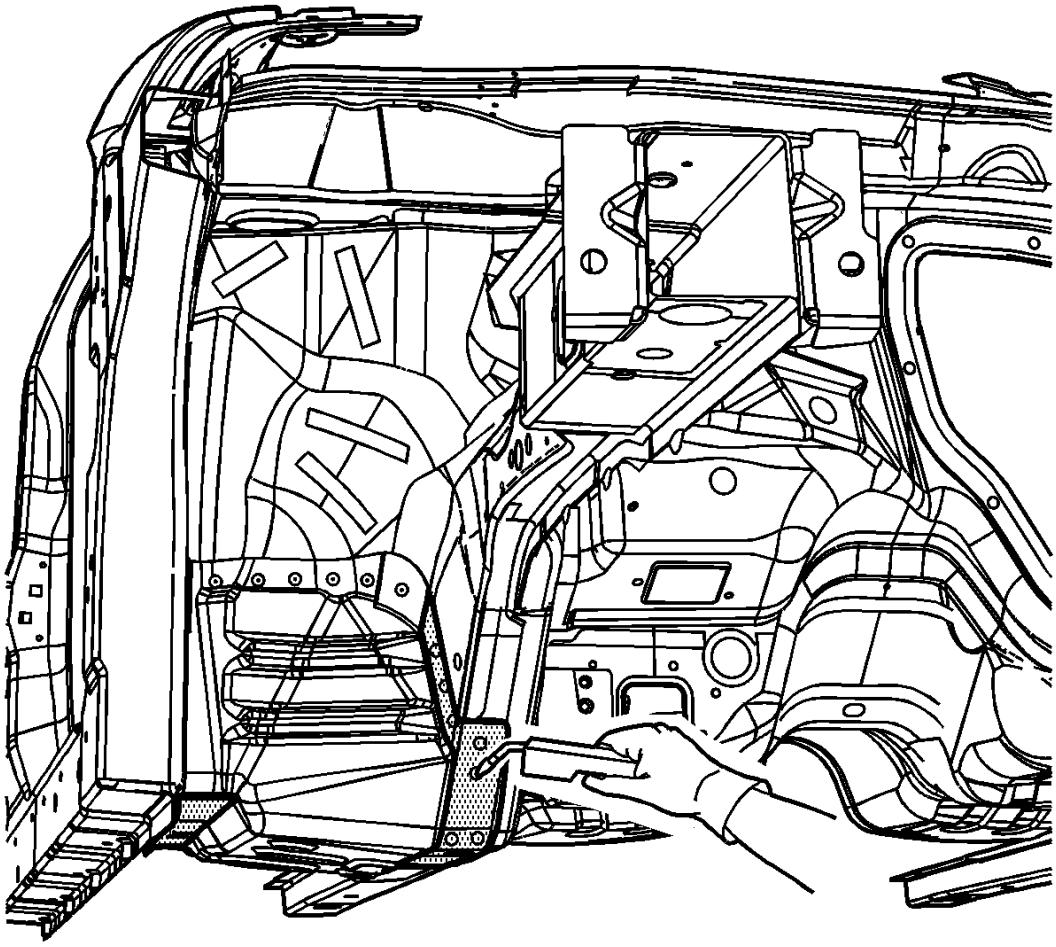


Fig. 36: Plug Welding Remaining Holes
Courtesy of GENERAL MOTORS COMPANY

18. Plug weld the remaining holes accordingly.
19. Clean and prepare all of the welded surfaces.
20. Apply the sealers and anti-corrosion materials to the repaired area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
21. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
22. Install all of the related panels and components.
23. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
24. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

REAR WHEELHOUSE OUTER PANEL REPLACEMENT

Removal Procedure

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

NOTE: **Although full replacement of the rear outer wheelhouse can be performed,**

sectioning procedures have been developed for use when damage permits.

1. Remove all of the related panels and components including the quarter panel.
2. Visually inspect and restore as much of the damage as possible.
3. Remove the following materials as necessary:
    - The sealers
    - The sound deadeners
    - The anti-corrosion materials
4. After removing the quarter panel, locate, mark and drill out the welds attaching the reinforcement panel (1) to the outer wheelhouse and the quarter panel.

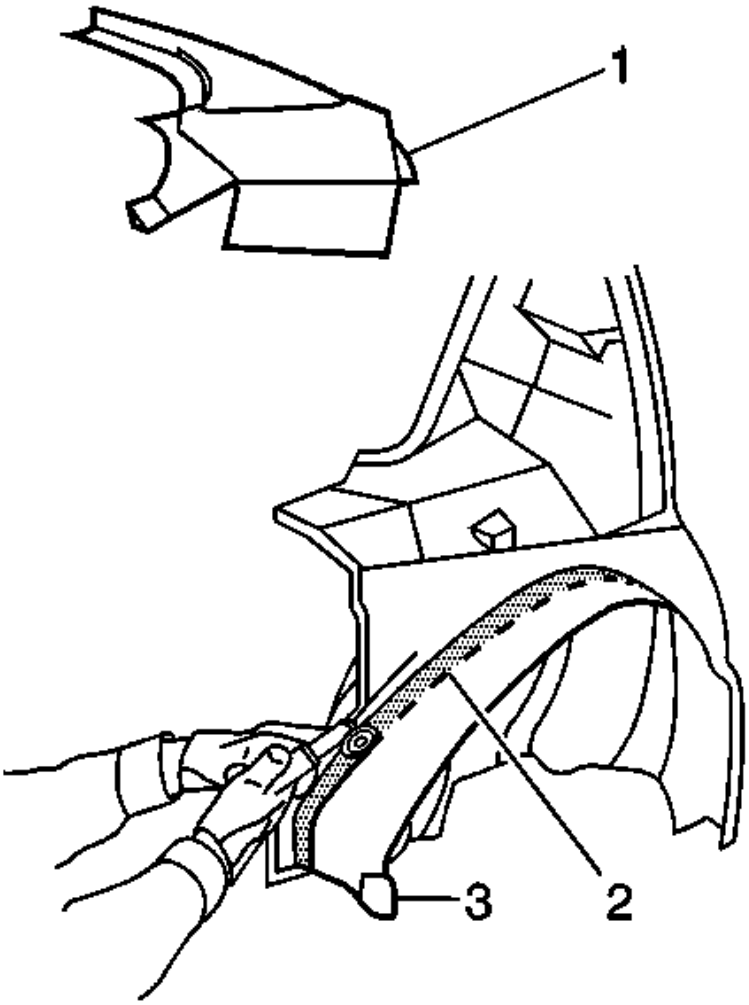


Fig. 37: Rear Outer Wheelhouse Components
Courtesy of GENERAL MOTORS COMPANY

5. Apply a strip of 25 mm (1 in) masking tape along the horizontal surface of the bend in the wheelhouse (2).
6. Cut along the outboard side of the masking tape to create a 25 mm (1 in) flange (2).

7. Remove the damaged section of the wheelhouse (3).

Installation Procedure

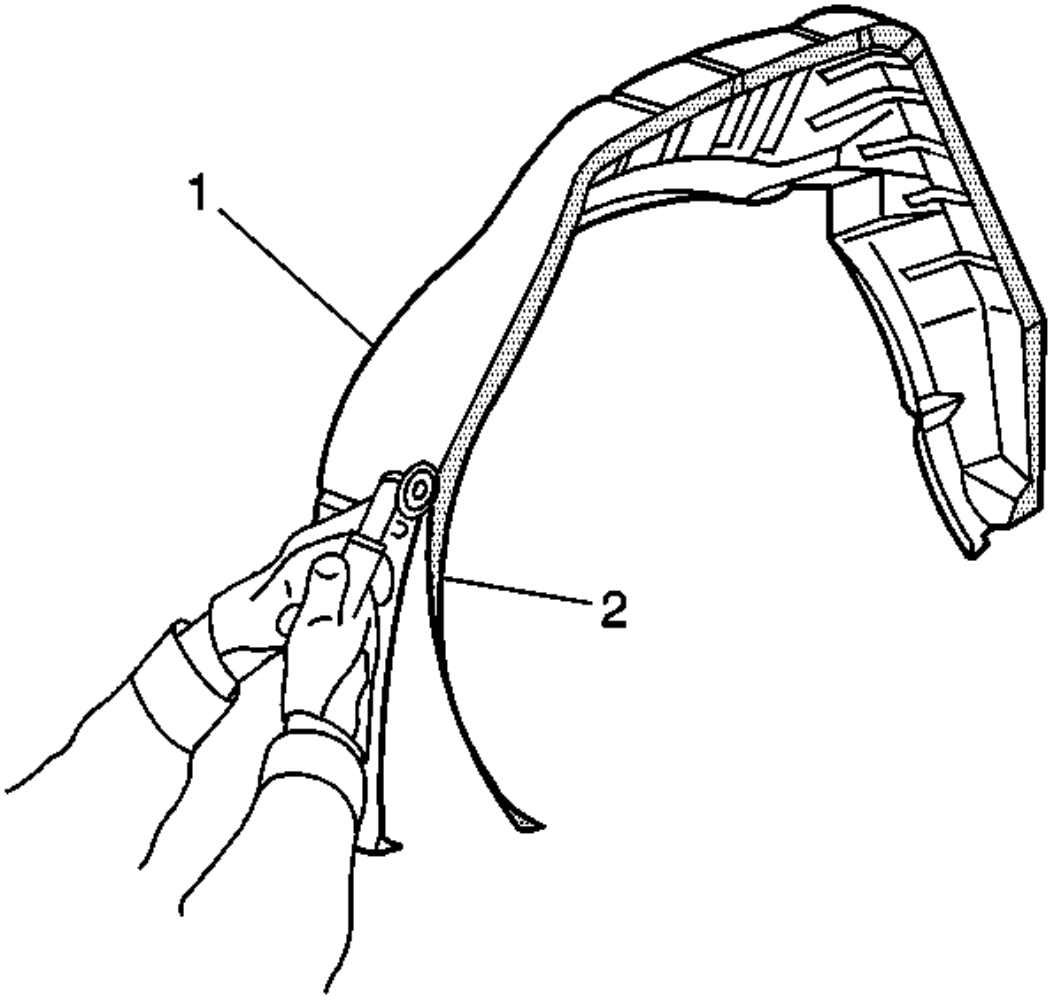


Fig. 38: Preparing Mating Surfaces For Adhesives
Courtesy of GENERAL MOTORS COMPANY

1. Cut the wheelhouse service part (1) along the corner of the bend (2).
2. Remove and discard the unused section of the wheelhouse.
3. On the service part, drill 8 mm (5/16 in) plug weld holes every 40 mm (1 1/2 in) along the cut.

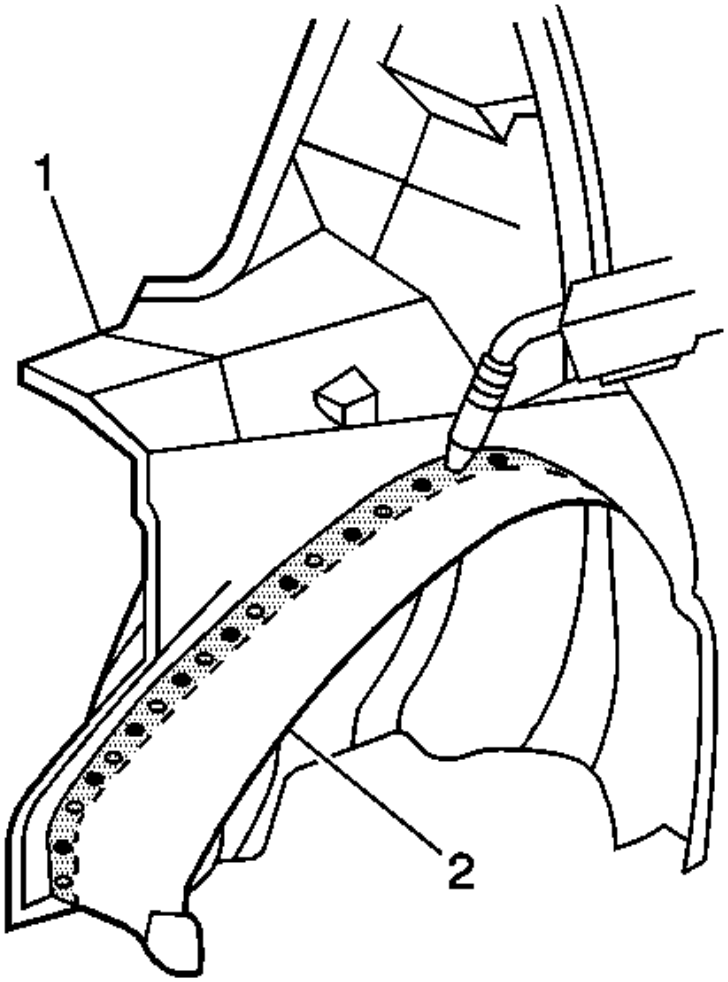


Fig. 39: Plug Welding Wheelhouse Mating Surface
Courtesy of GENERAL MOTORS COMPANY

4. Prepare the mating surfaces as necessary. Inspect for proper fit of the service part.
5. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.
6. Check for proper fit and plug weld accordingly (2). Take care not to warp or distort the metal.
7. Repair or replace the outer wheelhouse reinforcement as necessary.
8. Position the reinforcement panel as noted from the original panel location.
9. Plug weld accordingly.
10. Clean and prepare welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

11. Prime with 2-part catalyzed primer.
12. Apply the sealers and the anti-corrosion materials as necessary.

13. Install all of the related panels and components.

RADIATOR SUPPORT REPLACEMENT

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

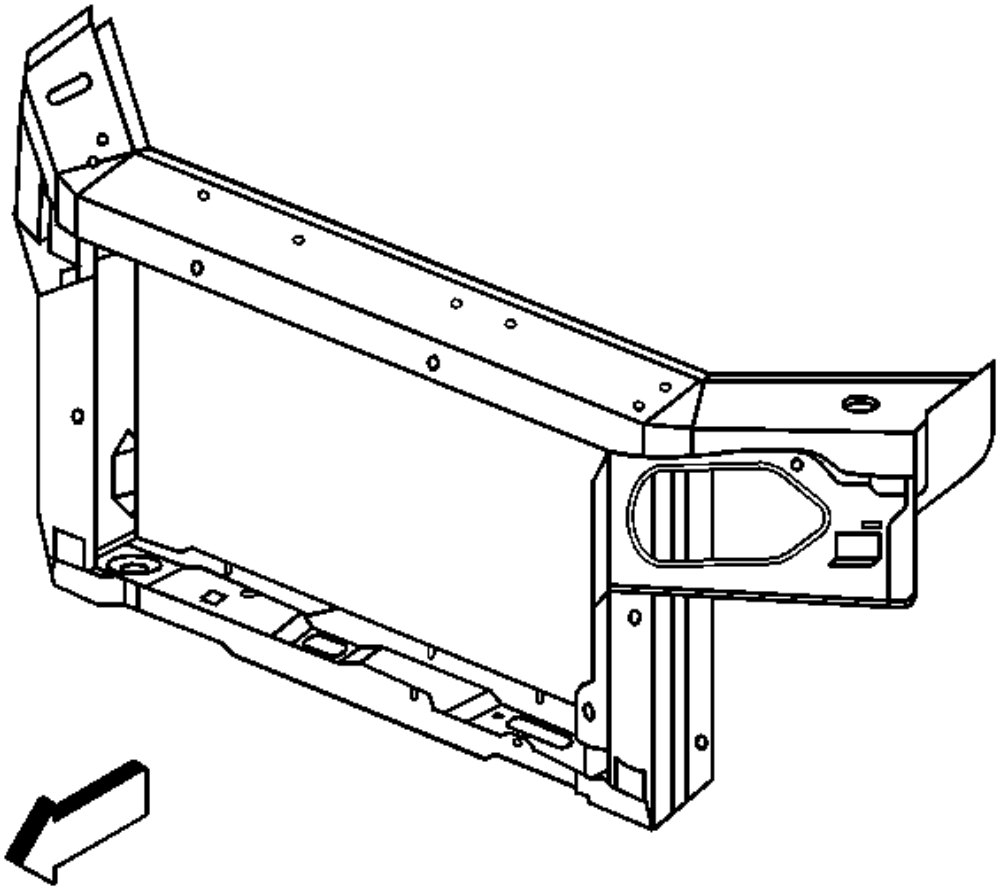


Fig. 40: Radiator Support
Courtesy of GENERAL MOTORS COMPANY

1. Remove all related panels and components.
2. Visually inspect and restore as much of the damage as possible to factory specifications.
3. Locate, mark, and drill out all factory welds. Note the number and location of welds for installation of the service assembly.
4. Remove the damaged radiator support assembly.

Installation Procedure

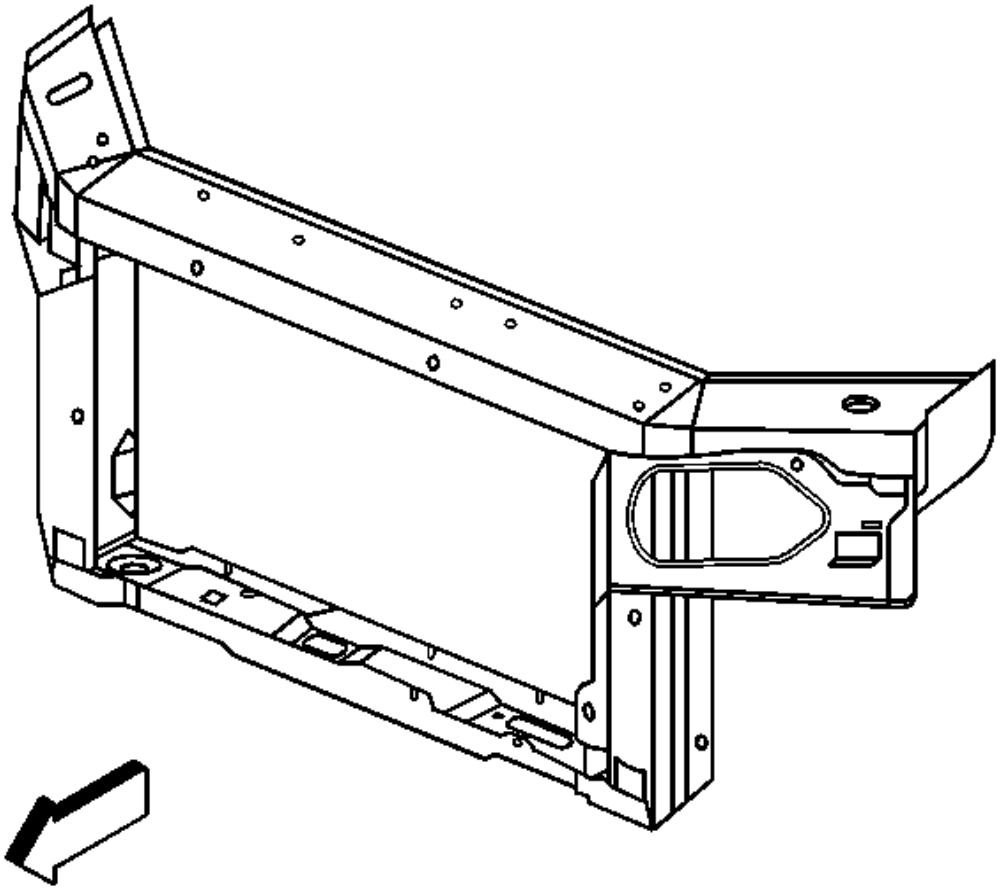


Fig. 41: Radiator Support
Courtesy of GENERAL MOTORS COMPANY

1. Prepare the mating surfaces as necessary. Inspect for proper fit of the service part.
2. Check for proper fit of the service assembly.
3. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original assembly.
4. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.
5. Position the service assembly using 3-dimensional measuring equipment.
6. Plug weld accordingly with frequent measurements to ensure proper fit and alignment.
7. Clean and prepare all welded surfaces.
8. Prime with 2-part catalyzed primer.
9. Apply sealers and anti-corrosion materials as necessary.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

10. Install all related panels and components.

UPPER RAIL REPLACEMENT

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

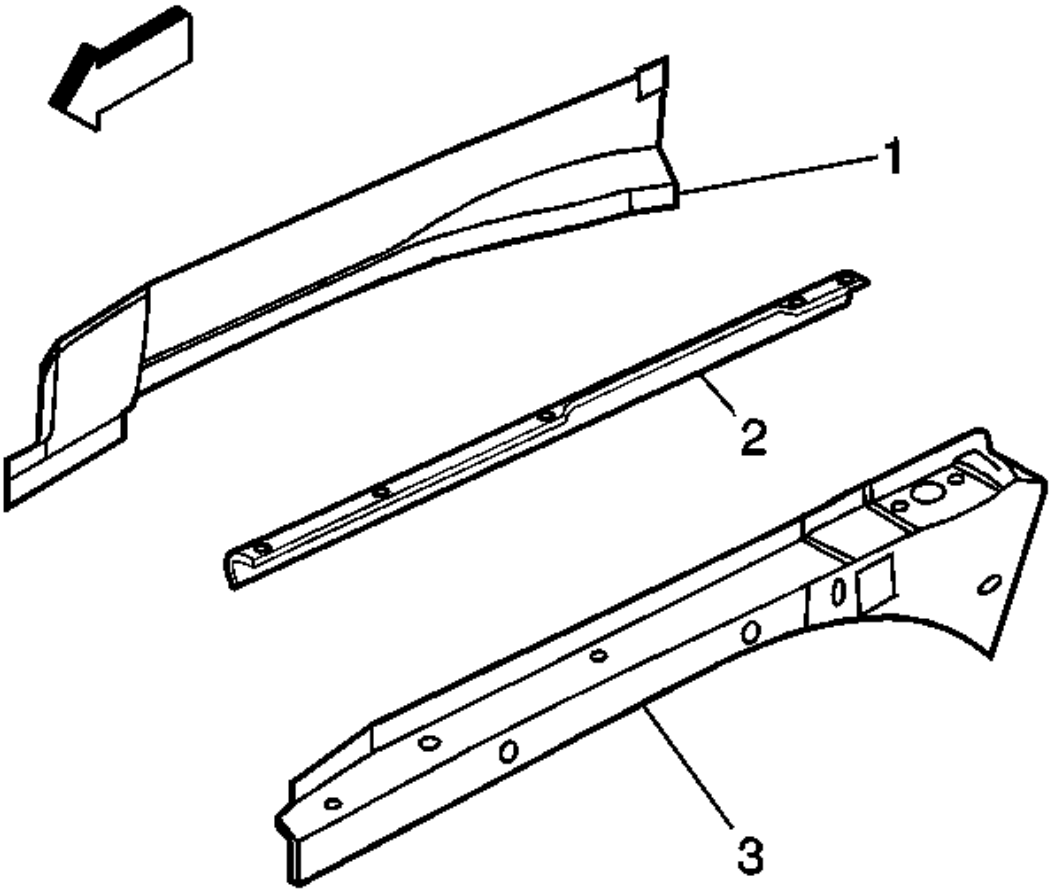


Fig. 42: Inner Reinforcement, Inner Rail & Outer Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: The front upper rail is serviced as 2 components: inner (1) and outer (3) panels. The outer panel is serviced as a sub-assembly and includes an inner reinforcement (2). After the outer rail has been removed, the inner rail is completely accessible and can be serviced at the factory seams.

NOTE: Sectioning of the front upper rails is not recommended.

1. Remove all related panels and components.

2. Remove sealers and anti-corrosion materials as necessary.
3. Locate, mark, and drill out all factory welds attaching the outer rail.
4. Remove the damaged outer rail (3).
5. Locate, mark, and drill out the welds attaching the inner rail (1).
6. Remove the damaged inner rail.

Installation Procedure

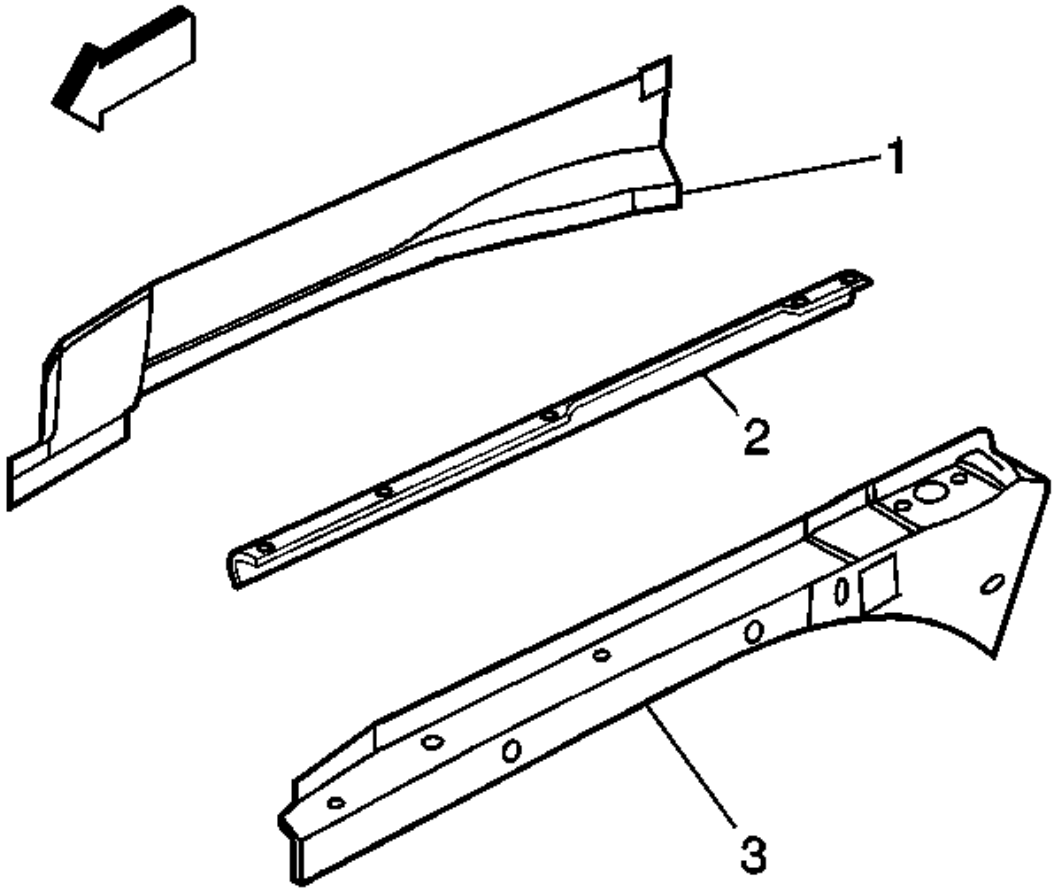


Fig. 43: Inner Reinforcement, Inner Rail & Outer Rail
Courtesy of GENERAL MOTORS COMPANY

1. Prepare the mating surfaces as necessary. Inspect for proper fit of the service part.
2. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original panels.

NOTE: **If the original plug weld locations can not be determined, locate the holes for plug welding 40 mm (1 1/2 in) apart.**

3. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.

4. Temporarily position the inner (1) and outer (3) rails on the vehicle.
5. Use 3-dimensional measuring to locate and mark front fender mounting-bolt holes in the outer rail (2).
6. Drill 5.5 mm (7/32 in) holes for self-tapping bolts as marked.

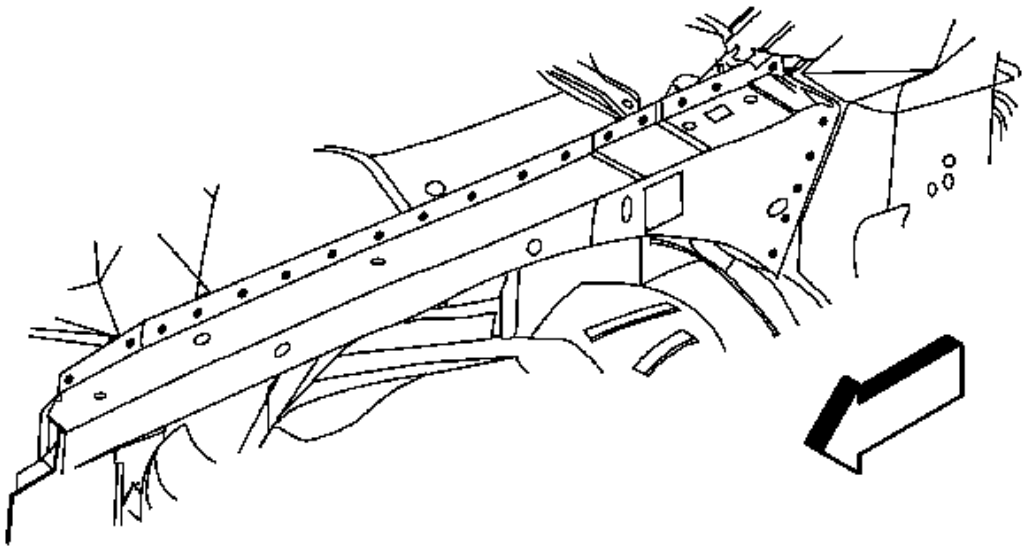


Fig. 44: Upper Rail Installed
Courtesy of GENERAL MOTORS COMPANY

7. When the service panels are correctly positioned, remove the outer panel and plug weld the inner panel as necessary.
8. Reposition the outer rail with frequent measurements to ensure proper fit and alignment.
9. Plug weld accordingly.
10. Clean and prepare all of the welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

11. Prime with 2-part catalyzed primer.

12. Apply the sealers and the anti-corrosion materials as necessary.
13. Install all of the related panels and components.

LOWER RAIL SECTIONING

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

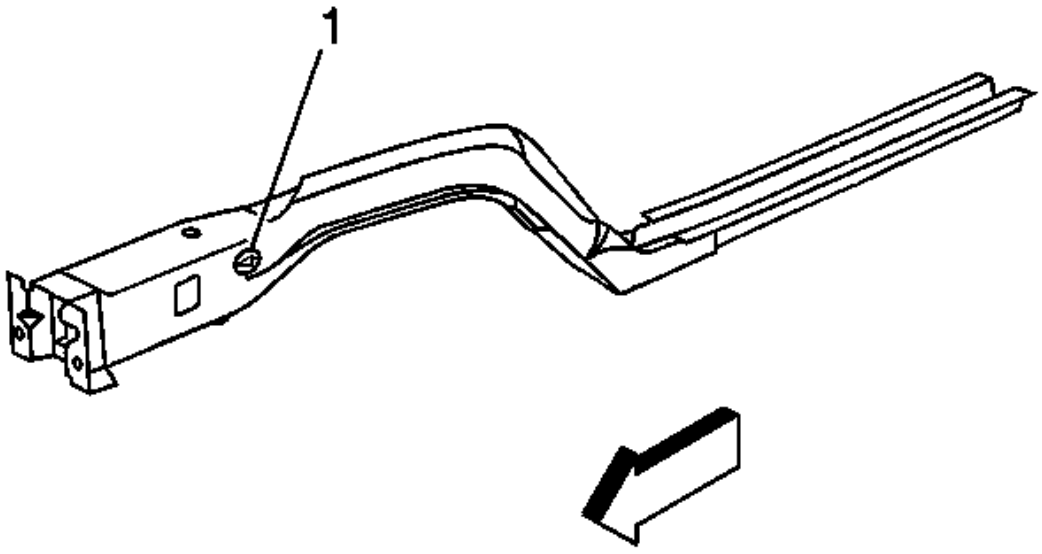


Fig. 45: Lower Rail
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Sectioning should take place only in the locations recommended in the service instructions. Failure to follow these instructions may compromise the structural integrity of the vehicle.

NOTE: Sectioning procedures have been developed to simplify repair of the lower rails, providing the majority of the damage can be returned to factory specifications. This allows the damaged front section to be replaced without performing a full

rail replacement. The rails are manufactured with diemarks (1) inboard and outboard to indicate the location for the sectioning joint.

NOTE: If the damage exceeds the recommended area for sectioning and the rail cannot be straightened, the complete rail must be replaced.

1. Support the powertrain assembly.
2. Remove 4 engine cradle bolts.
3. Position the cradle away from the rail.

NOTE: It is not necessary to completely remove the powertrain or engine cradle for rail sectioning.

4. Remove all panels and components necessary for access, including the strut and axle assemblies.
5. Remove sealers and anti-corrosion materials as necessary.
6. Locate the diemarks in the rail.

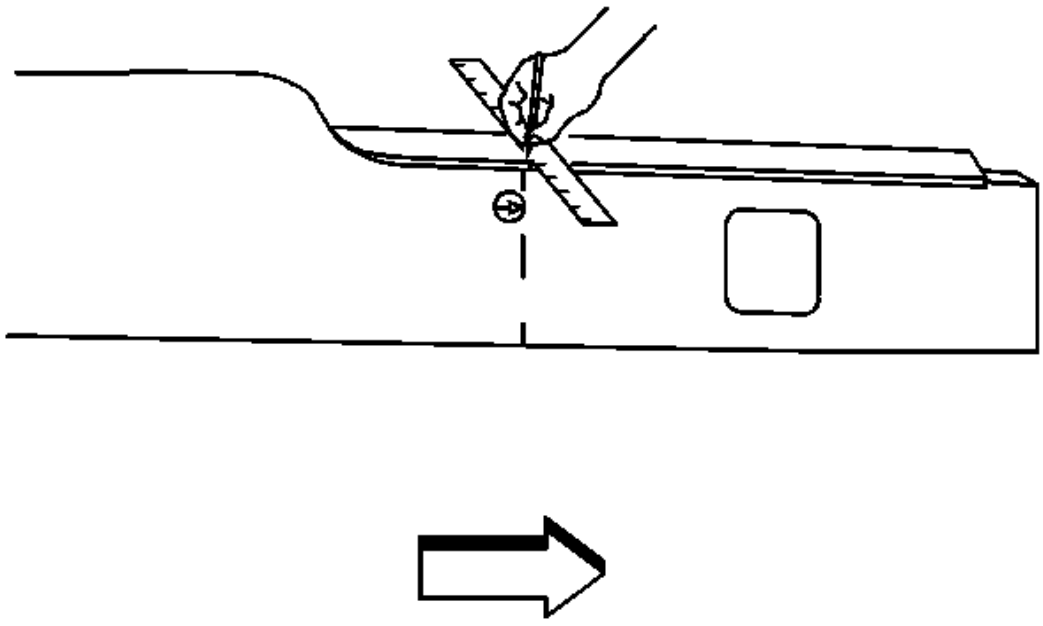


Fig. 46: Scribing Lines Around Rail

Courtesy of GENERAL MOTORS COMPANY

7. Use a straight edge to scribe lines around the rail.

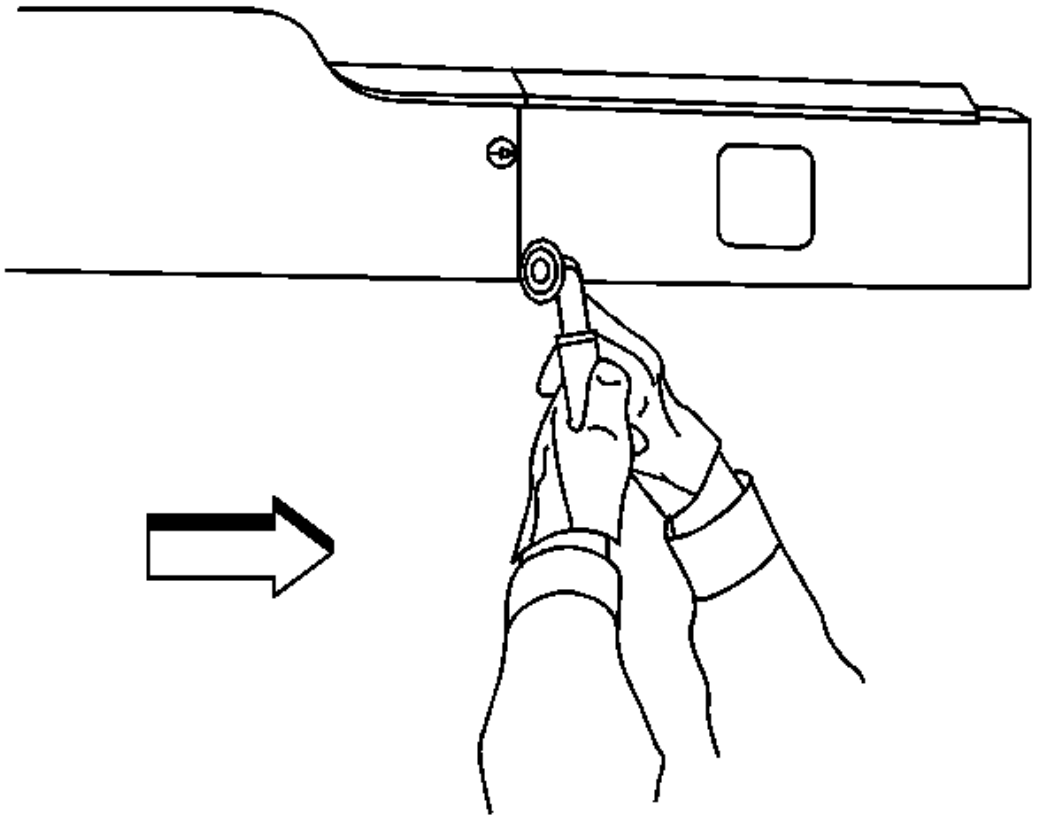


Fig. 47: Cutting Rail At Diemarks
Courtesy of GENERAL MOTORS COMPANY

8. Mark and cut the damaged rail at the diemarks.
9. Remove the damaged section of the rail.

Installation Procedure

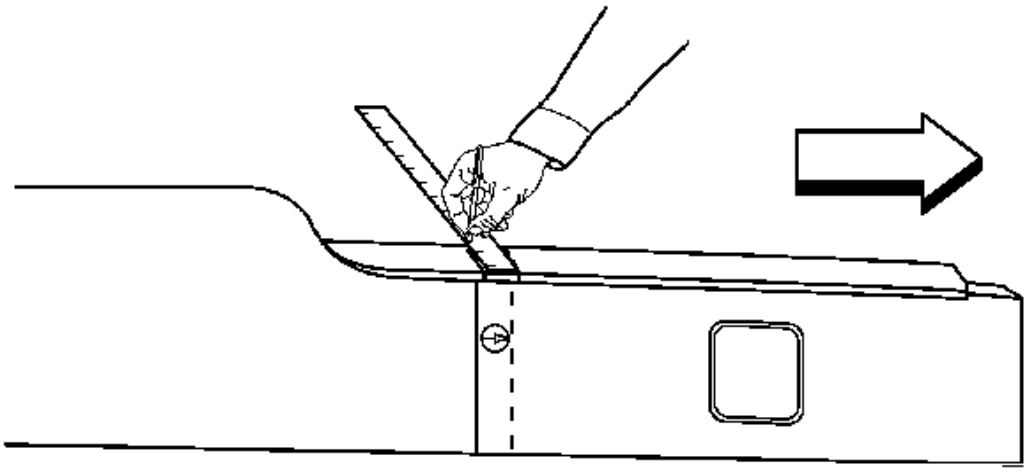


Fig. 48: Adding 20 mm (3/4 in) In Length To Service Part
Courtesy of GENERAL MOTORS COMPANY

1. Measure from the diemarks to add 20 mm (3/4 in) in length to the service part.
2. Align marks with a straight edge and scribe line for sectioning cut.
3. Cut the service part along the marked lines.
4. Leave 20 mm (3/4 in) added lengths to the service part for sectioning overlap.
5. Cut and remove approximately 20 mm (3/4 in) of the outboard and downward turned flanges of the service part.

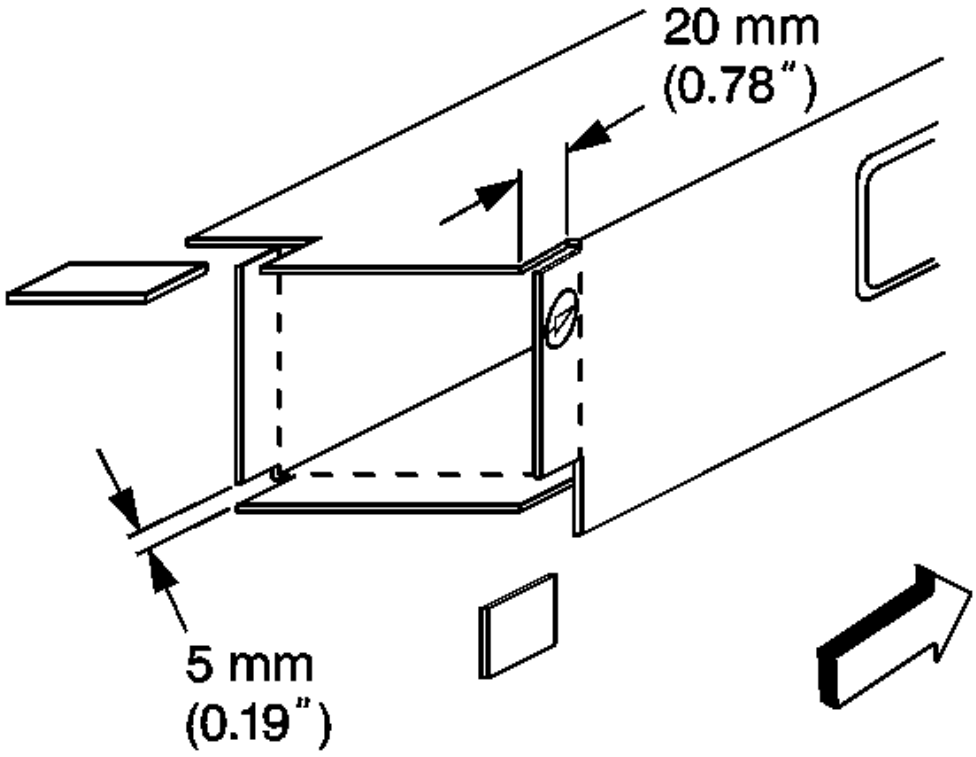


Fig. 49: Cutting Tabs Into Rail
Courtesy of GENERAL MOTORS COMPANY

6. Cut 5 mm (3/16 in) wide and 20 mm (3/4 in) long slots along the corners of the service part to create tabs on the four sides of the rail.

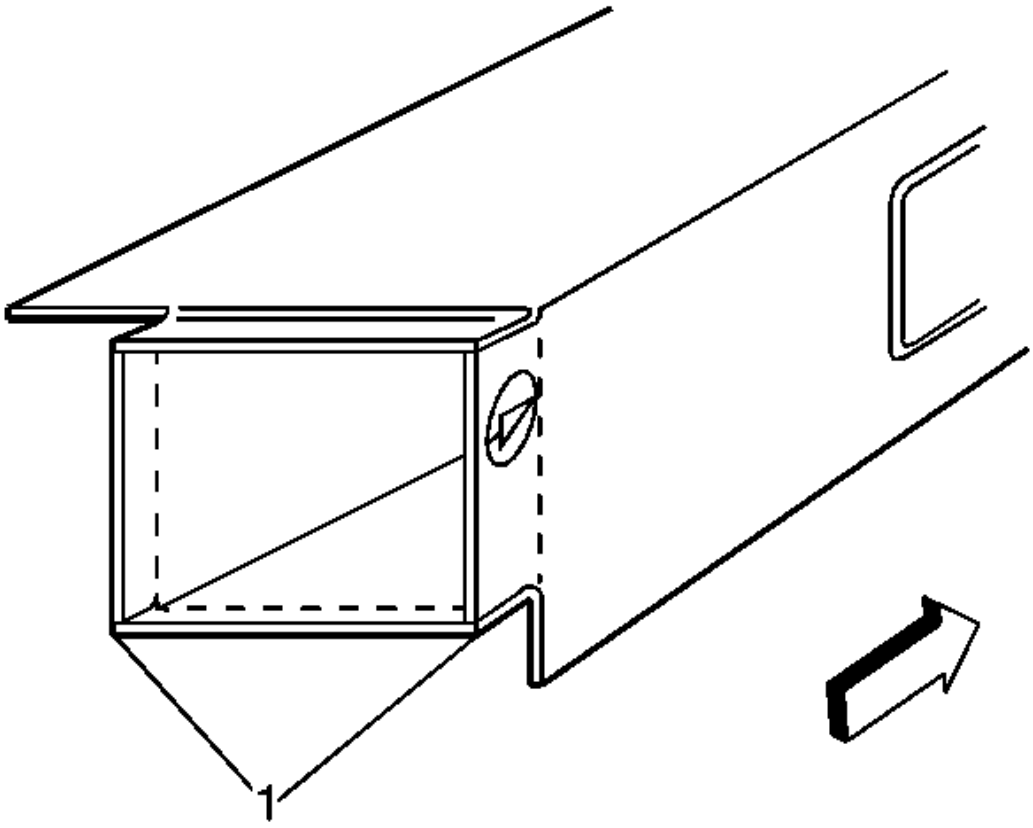


Fig. 50: Fitting Service Part Inside Original Rail
Courtesy of GENERAL MOTORS COMPANY

7. Step the top, bottom and side tabs inward to allow the service part to fit inside the original rail.
8. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.
9. Welds the tabs (1) together along the corners of the service part.

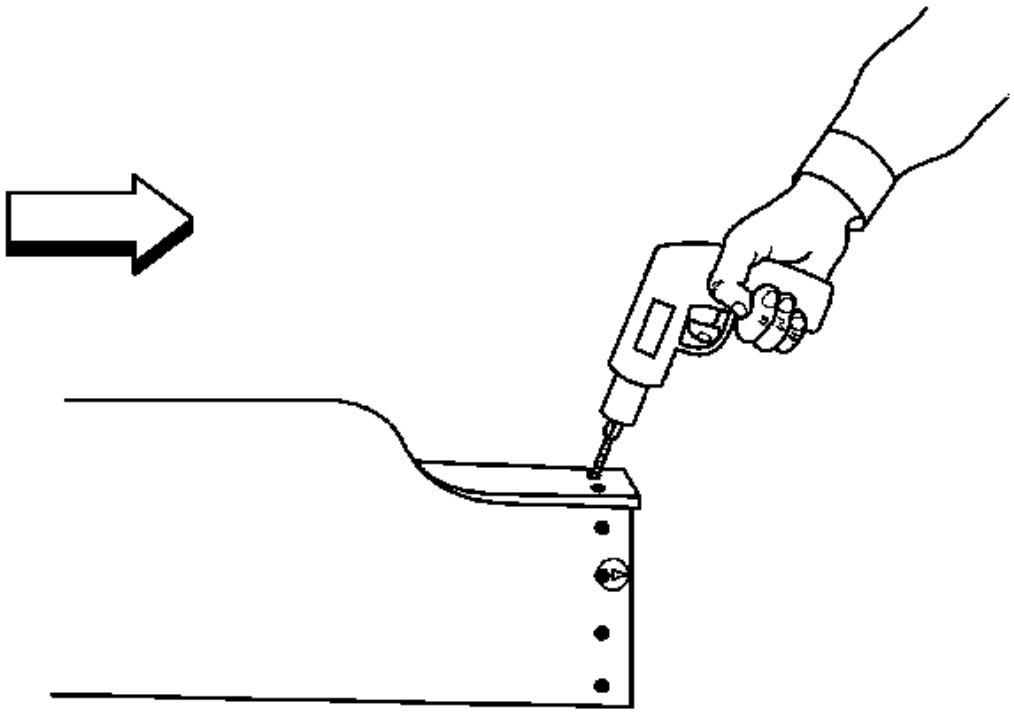


Fig. 51: Drilling Plug Weld Holes Into Rail
Courtesy of GENERAL MOTORS COMPANY

10. Drill 8 mm (5/16 in) plug weld holes in the top, bottom and sides of the original approximately 10 mm (3/8 in) from the sectioning cut.
11. Clean and prepare the mating surfaces as necessary.
12. Position the stepped tabs of the modified service part inside the original rail. Allow 20 mm (3/4 in) of overlap.
13. Align and check fit using three dimensional measuring equipment.
14. Plug weld accordingly.
15. Check measurements frequently to ensure proper fit and alignment.
16. Stitch weld along the entire sectioning joint.

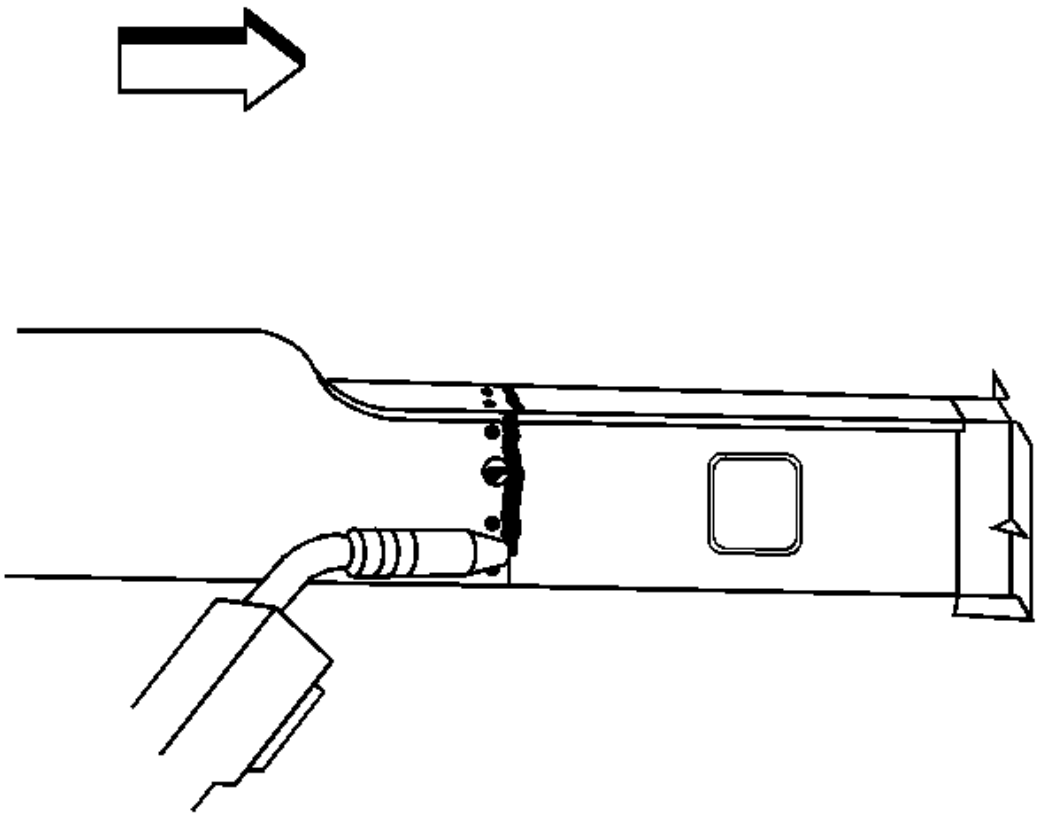


Fig. 52: Welding Rail
Courtesy of GENERAL MOTORS COMPANY

17. Make 25 mm (1 in) welds along the seam with 25 mm (1 in) gaps between them.
18. Go back and complete the stitch weld. This will create a solid joint with minimal heat distortion.
19. Clean and prepare welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

20. Prime with 2-part catalyzed primer.
21. Apply sealers and anti-corrosion materials as necessary.
22. Install all related panels and components.

LOWER RAIL REPLACEMENT

Removal Procedure

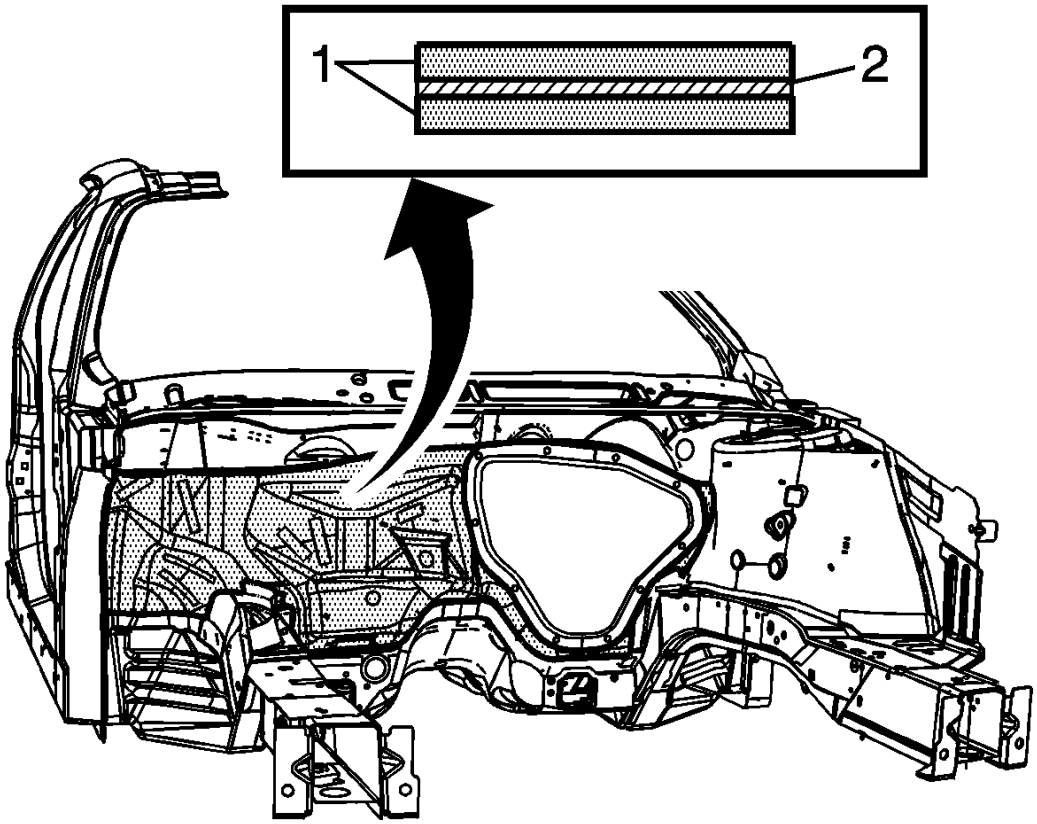


Fig. 53: View Of Laminated Steel
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

WARNING: **Refer to Foam Sound Deadeners Warning .**

NOTE:

- **Model year 2004 and prior vehicles are not manufactured with laminated steel in front of the dashes. Therefore, the front lower rail can be metal inert gas (MIG) welded instead of the rivet and bonding process, as stated in these instructions.**
- **Failure to follow this procedure will compromise the structural integrity of the vehicle.**

The front of the dash panel is formed from laminated steel. This steel is constructed by bonding 2 pieces of cold rolled steel (1) with a viscoelastic layer of adhesive (2). MIG welding laminated steel does not meet GM Corporate standards for structural integrity. As an alternative, all factory welds will be replaced by using the rivet and adhesive bond method described in the installation portion of this procedure. The rivet and

adhesive bond method must only be used in the areas as described in this procedure.

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

WARNING: Refer to Collision Sectioning Warning .

3. Remove all related panels and components.
4. Repair as much of the damage as possible.
5. Remove the sealers and the anti-corrosion materials from the repair area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .

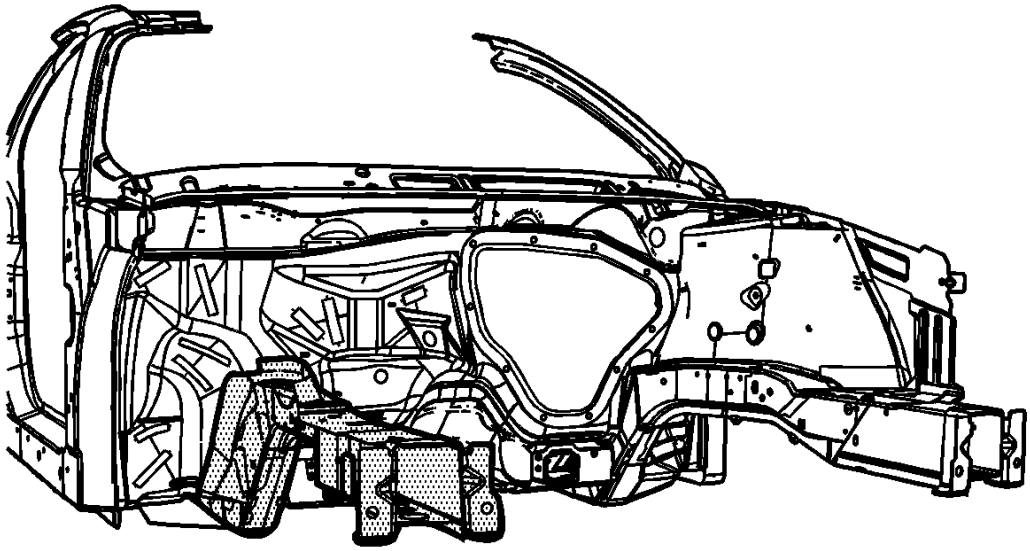


Fig. 54: View Of Front Rail Side Extension
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the number and location of the factory welds for installation of the

full rail service part.

6. Remove the front wheelhouse assembly. Refer to **Front Wheelhouse Panel Replacement**.
7. Remove the radiator support assembly. Refer to **Upper Rail Replacement**.
8. Remove the front rail side extension. Refer to **Front Compartment Side Rail Rear Extension Replacement**.

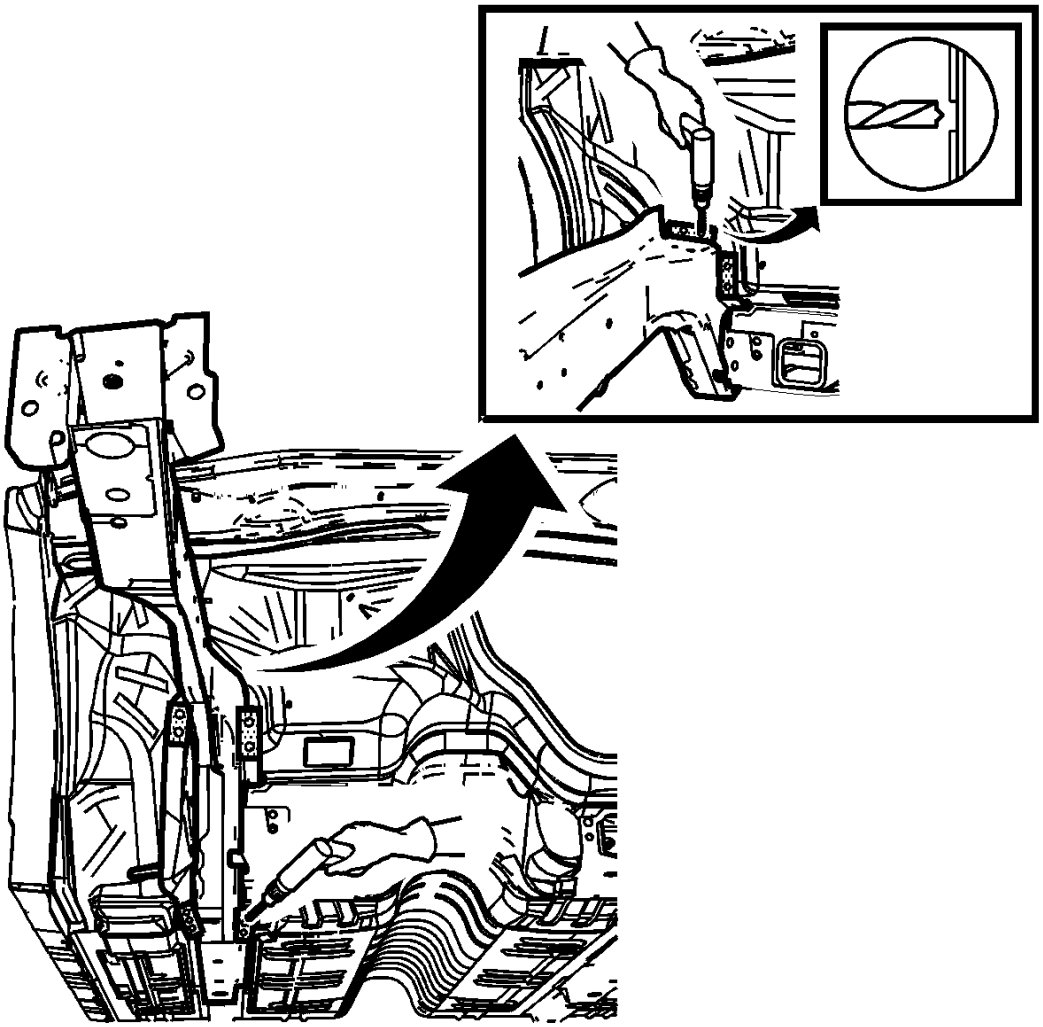


Fig. 55: Drilling Factory Welds
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Drill through the rail flange only. Do NOT drill into the dash panel or the inner reinforcements.**

9. Using an 8-mm (5/16-in) spot weld remover, locate and drill out the factory welds on the weld flange connecting the lower rail to the dash panel.

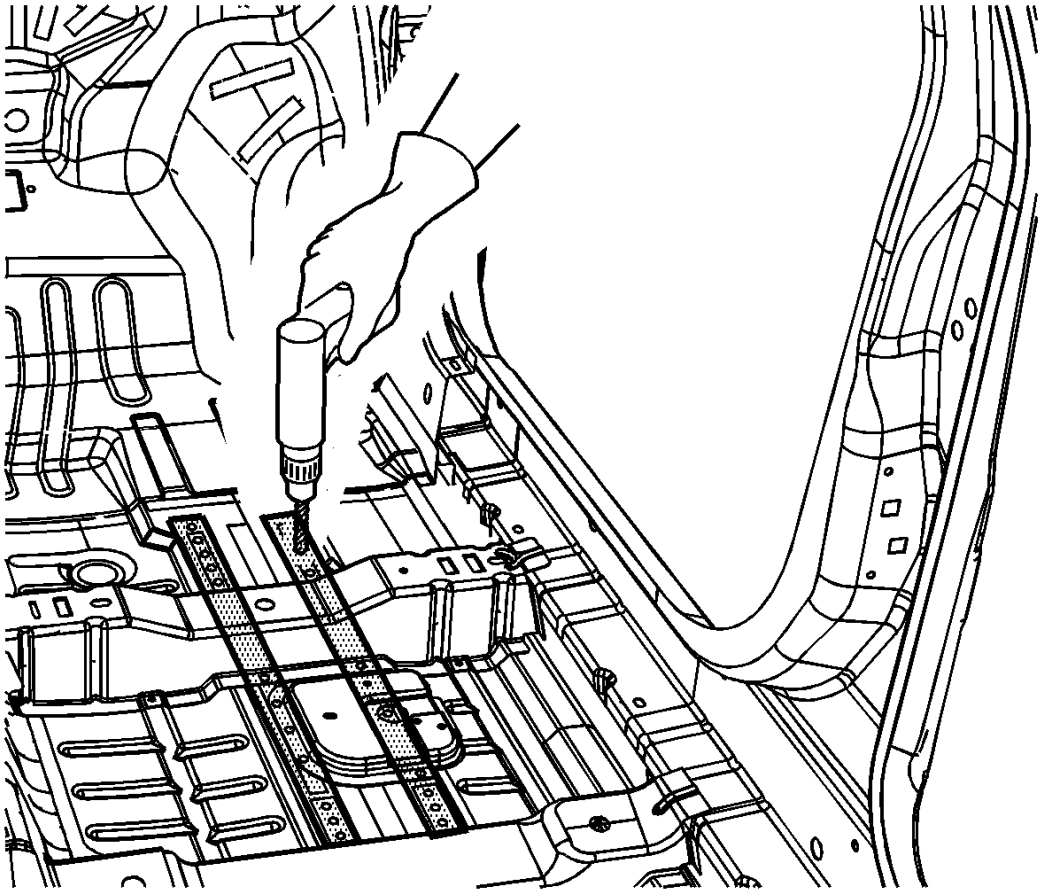


Fig. 56: Drilling Factory Welds (Passenger Compartment)
Courtesy of GENERAL MOTORS COMPANY

10. From the passenger compartment, locate and drill out the remaining factory weld.

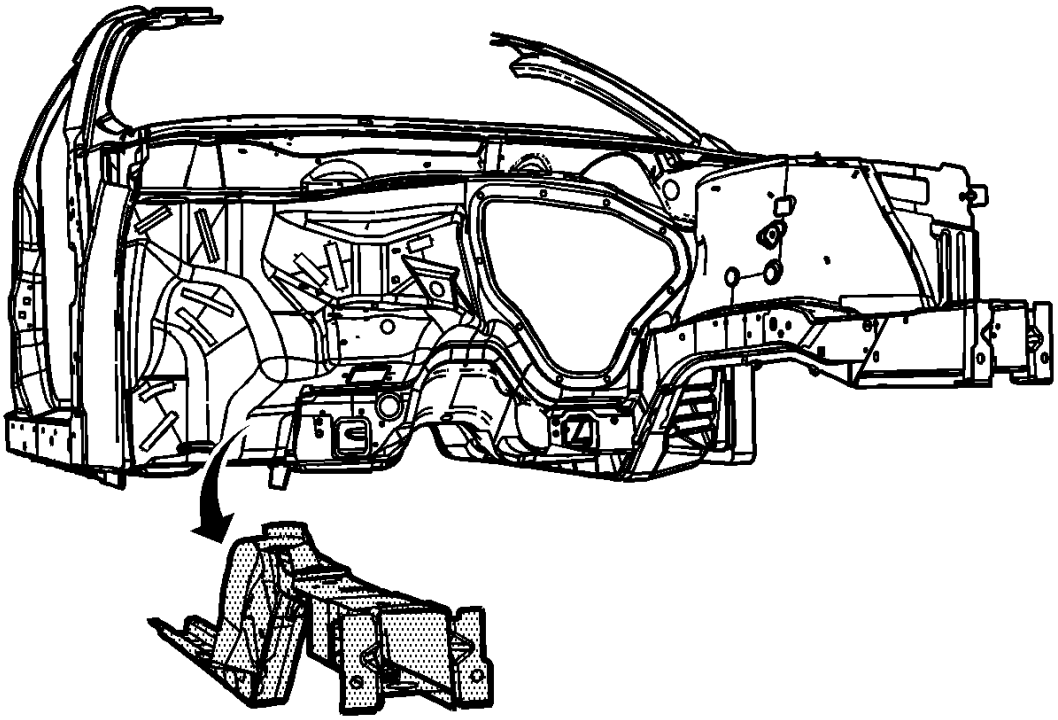


Fig. 57: View Of Service Rail
Courtesy of GENERAL MOTORS COMPANY

11. Remove the full rail.

Installation Procedure

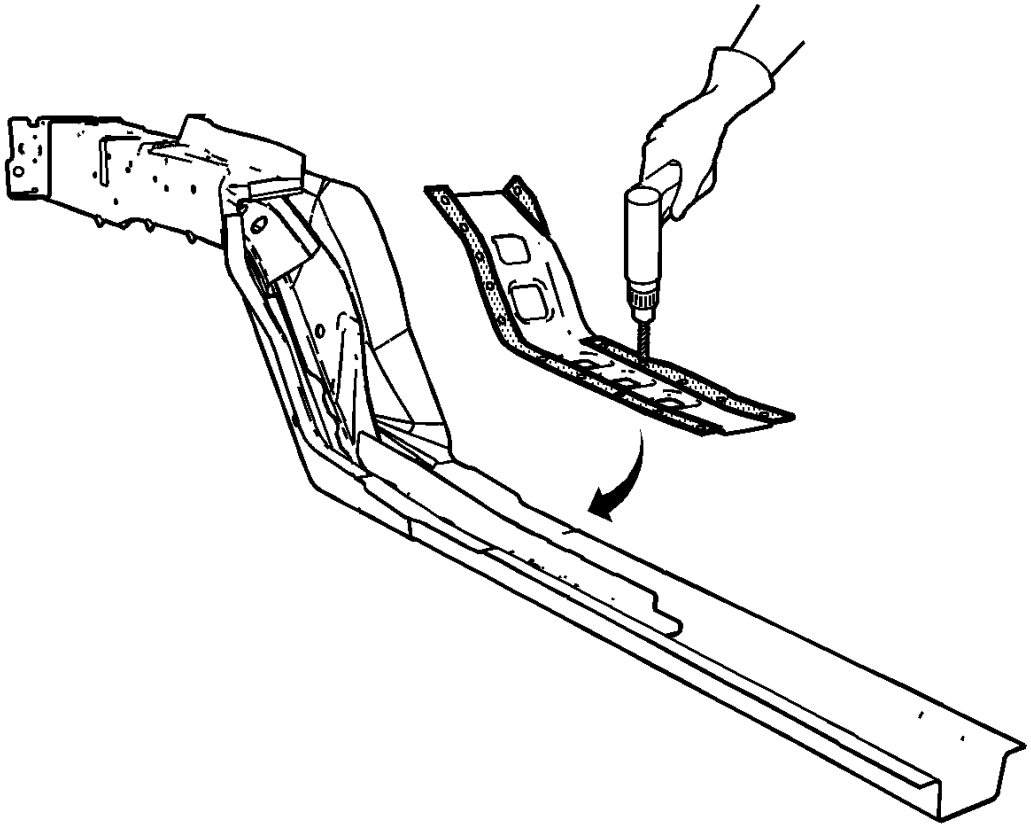


Fig. 58: Drilling Plug Weld Holes
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Failure to install the front compartment lower rail reinforcement to the front compartment lower rail will compromise the structural integrity of the vehicle.**

1. Drill 8-mm (5/16-in) plug weld holes in the service front lower rail reinforcement in the location noted from the original rail.
2. Prepare the plug weld mating surfaces, as necessary.
3. Apply 3MÂ® Weld-Thru Coating P/N 05913 or equivalent to the plug weld mating surfaces.
4. Position the front lower rail reinforcement.

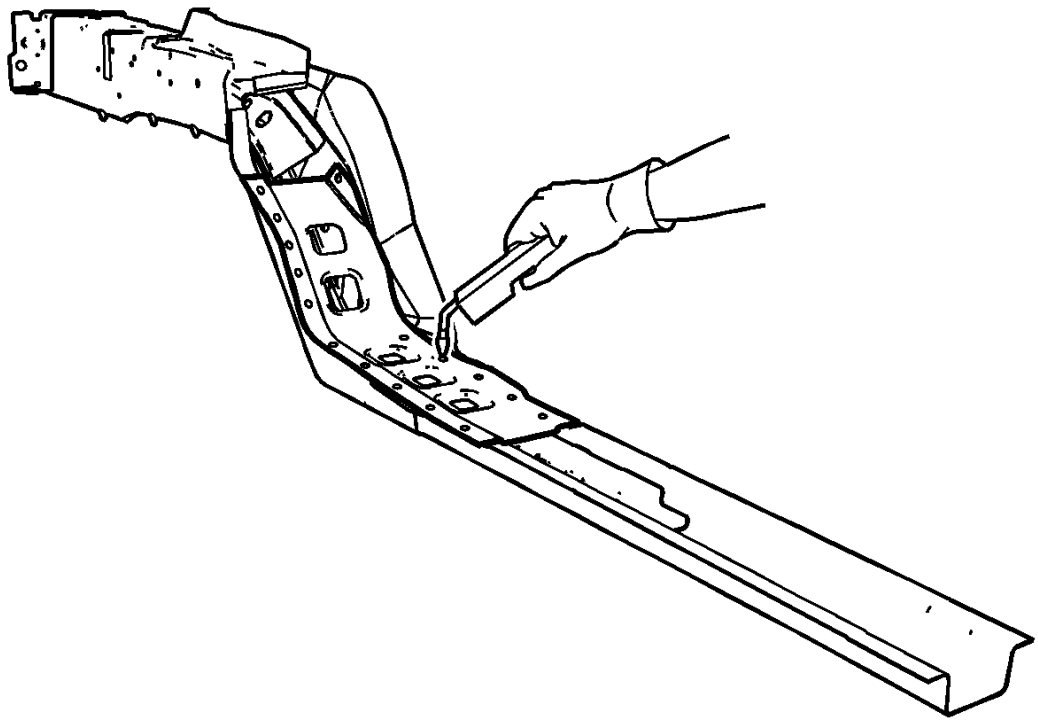


Fig. 59: Plug Welding Holes
Courtesy of GENERAL MOTORS COMPANY

5. Plug weld the holes accordingly.

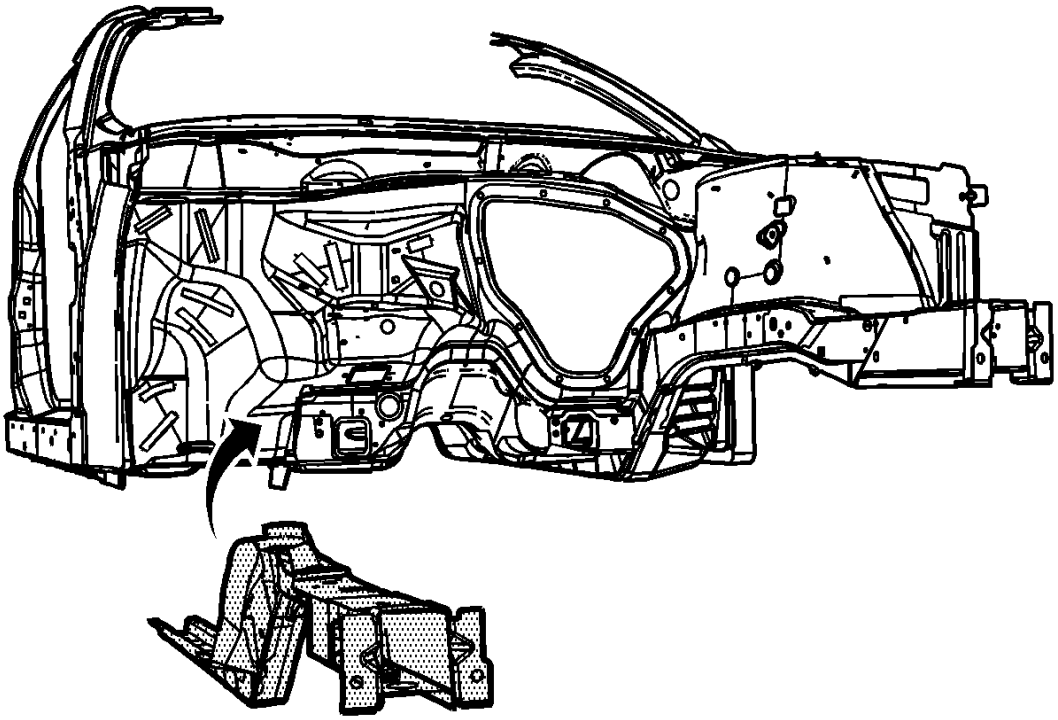


Fig. 60: Positioning Service Rail
Courtesy of GENERAL MOTORS COMPANY

6. Position the service rail to the vehicle using 3-dimensional measuring equipment.
7. Clamp the rail in place.

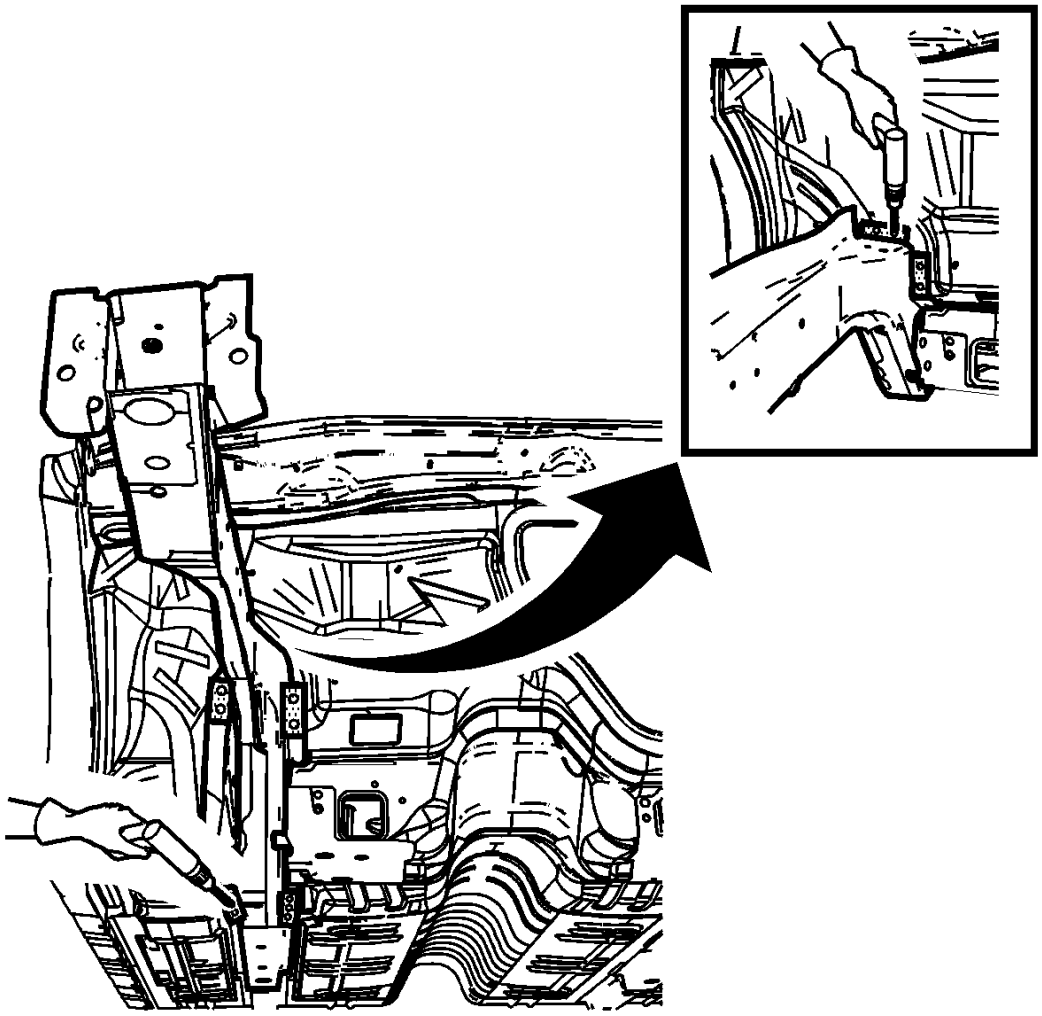


Fig. 61: Rivet Attachment Holes
Courtesy of GENERAL MOTORS COMPANY

8. Using a 7-mm (17/64-in) bit, drill the rivet attachment holes through the service rail and the dash panel in the exact locations, as noted from the factory rail.

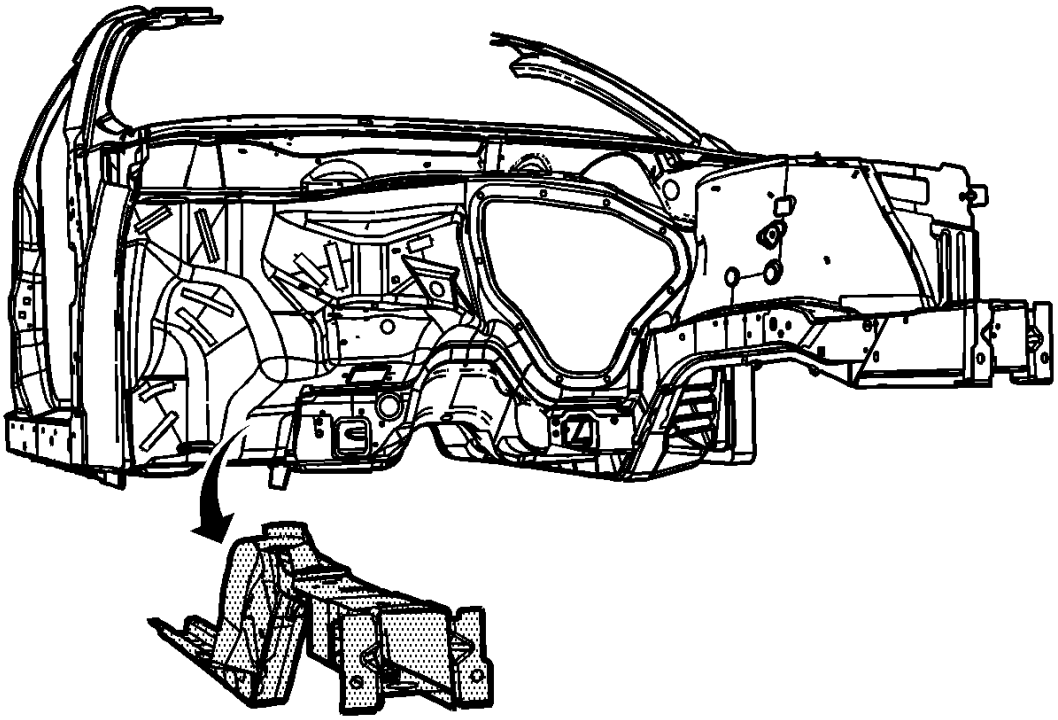


Fig. 62: View Of Service Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the location of the original plug weld holes cannot be determined, space the plug weld holes every 40 mm (1.5 in) apart.**

9. Remove the service rail.
10. Prepare the plug weld mating surfaces, as necessary.
11. Apply 3MÂ® Weld-Thru Coating P/N 05913 or equivalent to the plug weld mating surfaces.

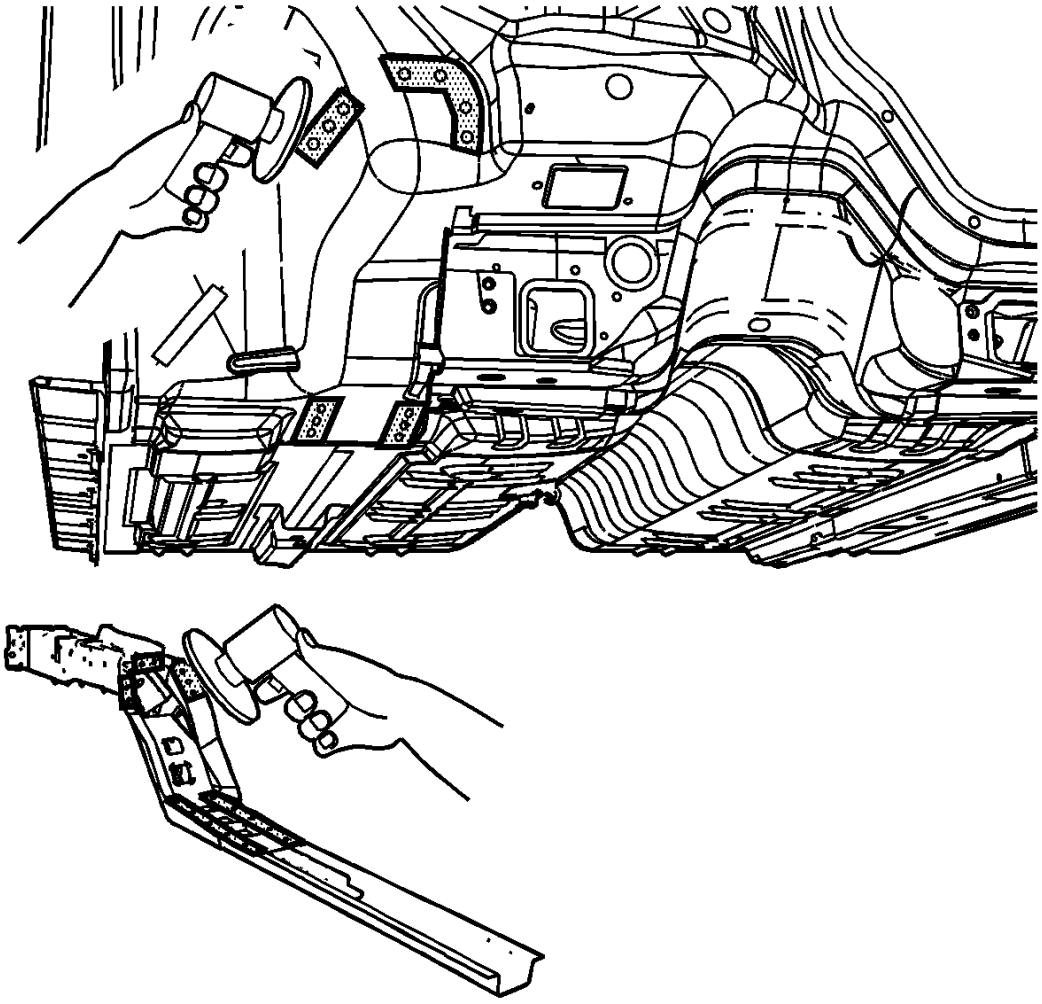


Fig. 63: Grinding Body Mating And Service Part Flanges
Courtesy of GENERAL MOTORS COMPANY

12. Prepare the bond mating areas by grinding the body mating and the service part flanges to bare steel. Do NOT damage the corners or thin the metal during the grinding process.

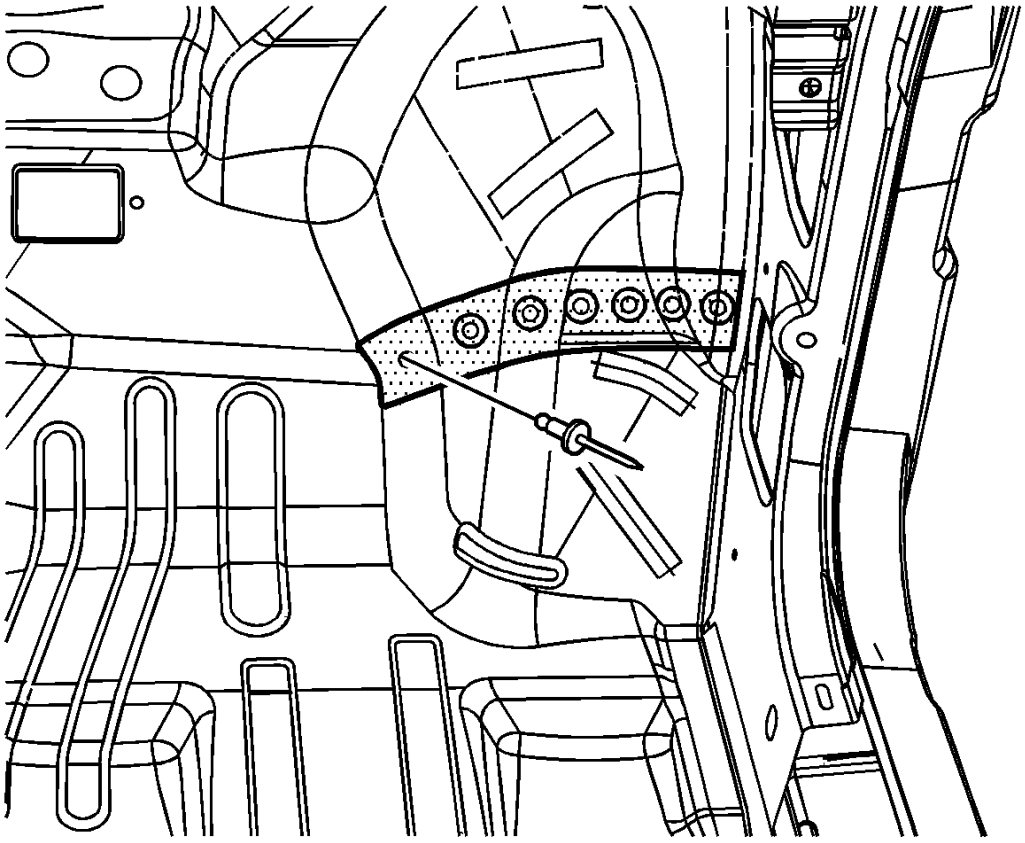


Fig. 64: Identifying 14-mm (17/32-in) Long Rivet
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do NOT allow the adhesive to cure prior to installation of the front rail side extension. Refer to Front Compartment Side Rail Rear Extension Replacement.**
- **Note the necessary location for installation of a 14-mm (17/32-in) long rivet.**

13. Clean the mating surfaces.

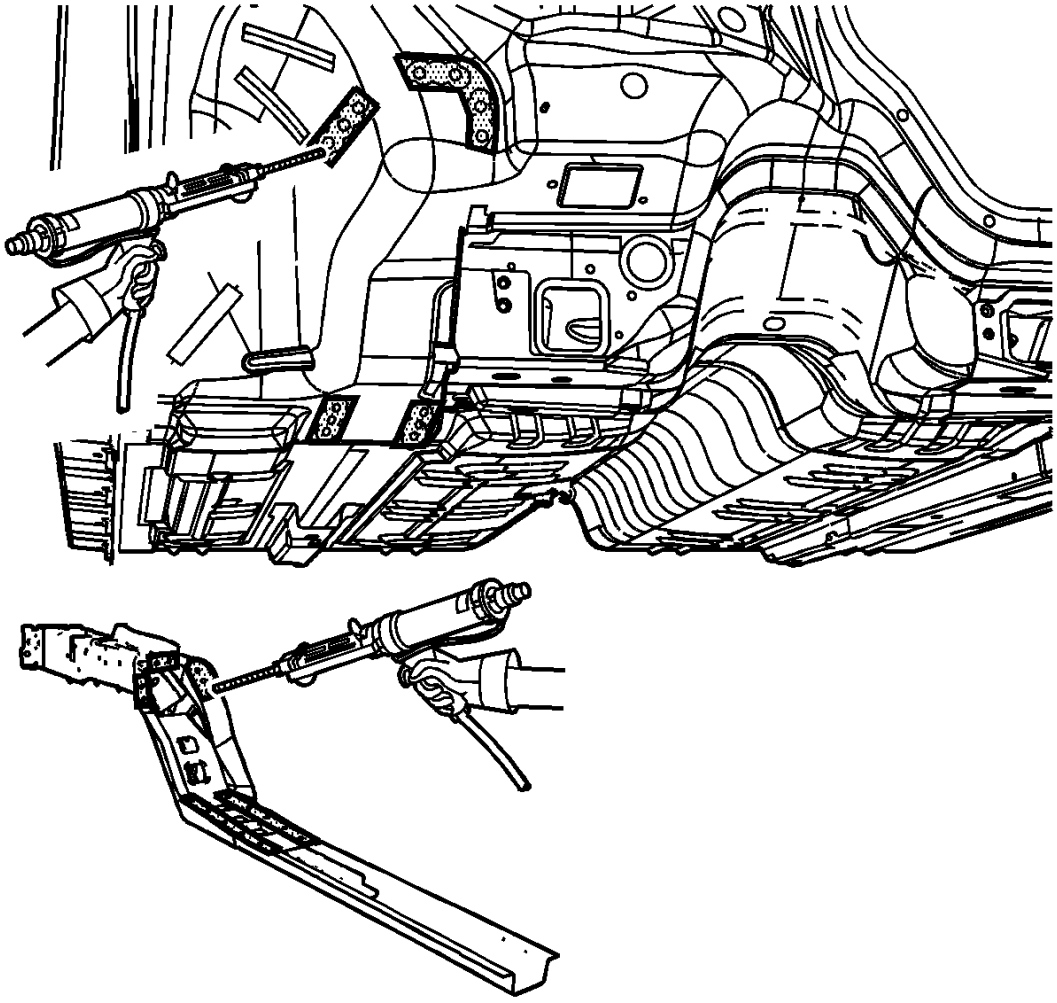


Fig. 65: Applying Metal Panel Bonding Adhesive
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The adhesive has a 40-50 minute working time. Do NOT allow the adhesive to cure prior to installing the service rail.**

14. Apply a 3-6 mm (1/8 to 1/4 in) bead of metal panel bonding adhesive GM P/N 12378567 (Canadian P/N 88901675) or equivalent to both of the mating surfaces.

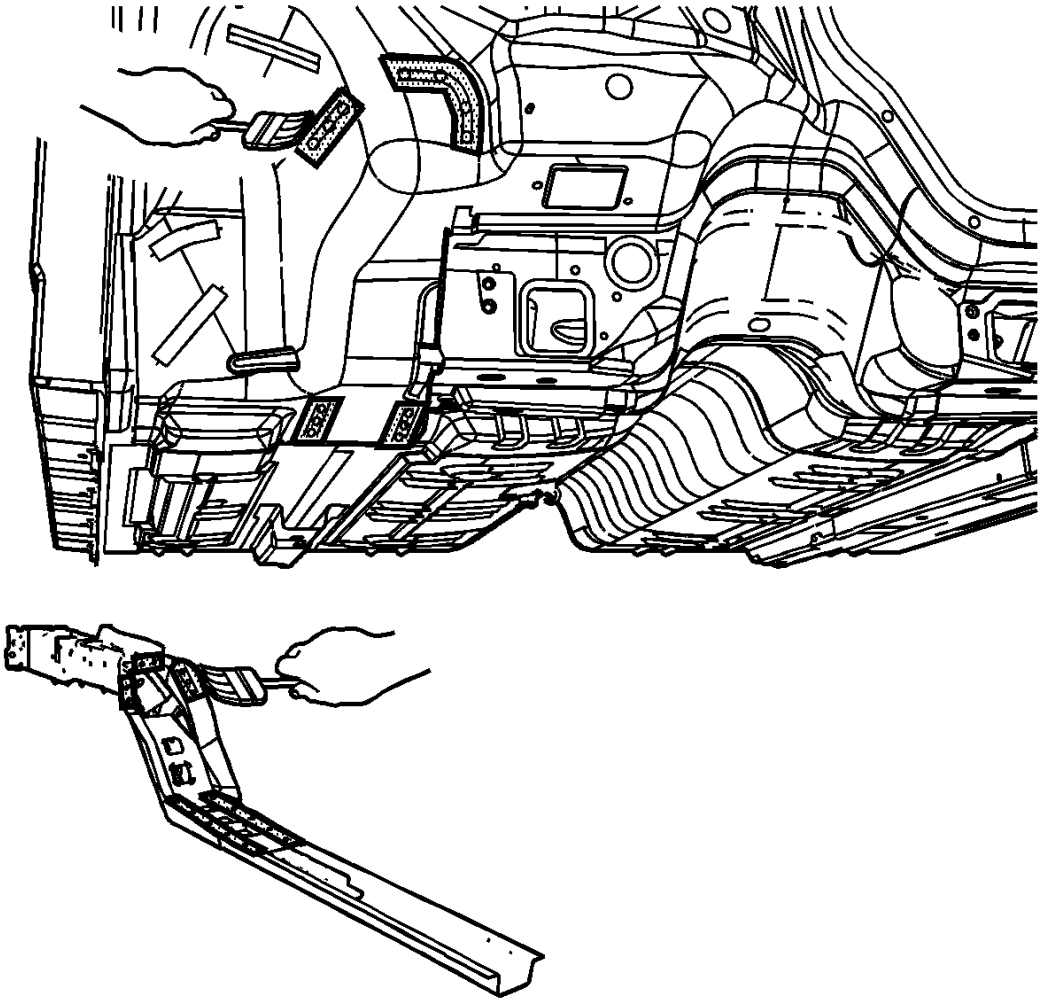


Fig. 66: Spreading Metal Panel Bonding Adhesive
Courtesy of GENERAL MOTORS COMPANY

15. Using a small acid brush, spread a coat of adhesive to both of the mating surfaces. Cover all of the bare metal to ensure corrosion protection.

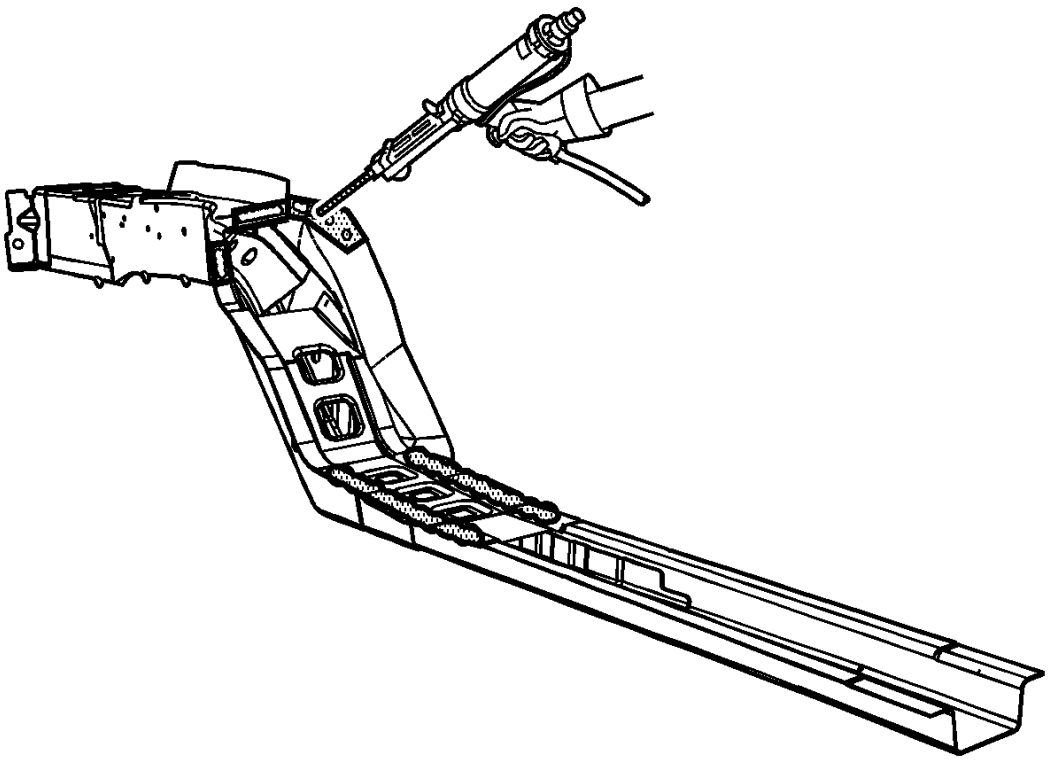


Fig. 67: Applying Bead Of Metal Panel Bonding Adhesive
Courtesy of GENERAL MOTORS COMPANY

16. Apply a 3-6 mm (1/8 to 1/4 in) bead of metal panel bonding adhesive GM P/N 12378567 (Canadian P/N 88901675) or equivalent to the mating surface of the service rail.

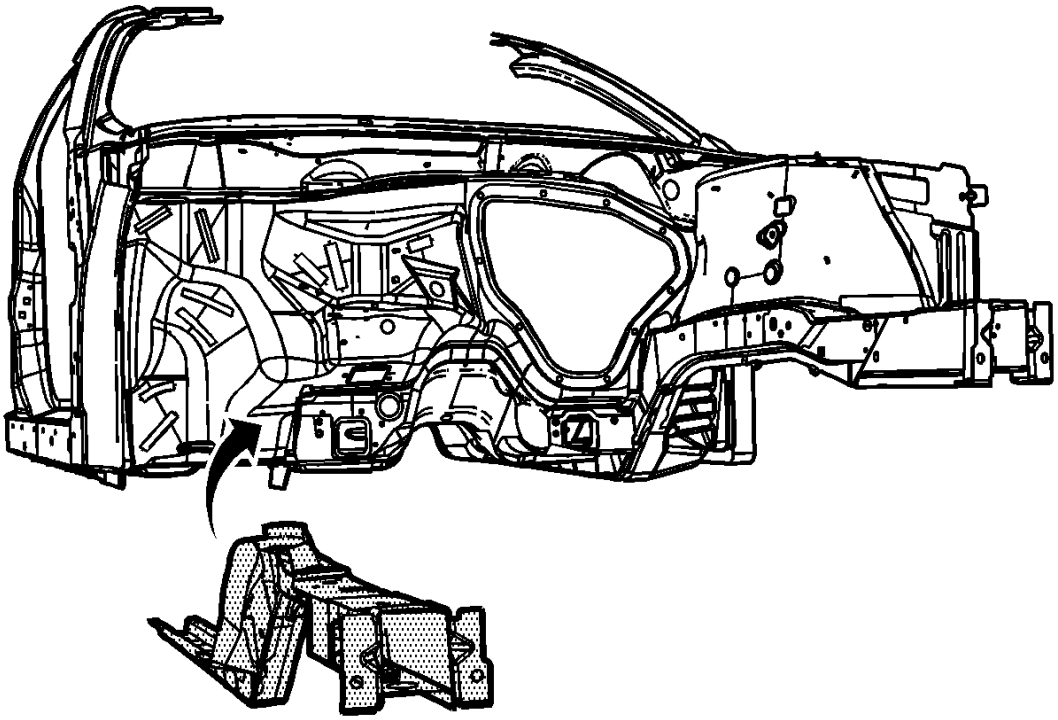


Fig. 68: Positioning Service Rail
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT pull the rail off of the dash after adhesion. To align the parts, slide the rail against the front of the dash.**

17. Position the service rail to the vehicle using 3-dimensional measuring equipment.
18. Clamp the rail in place.

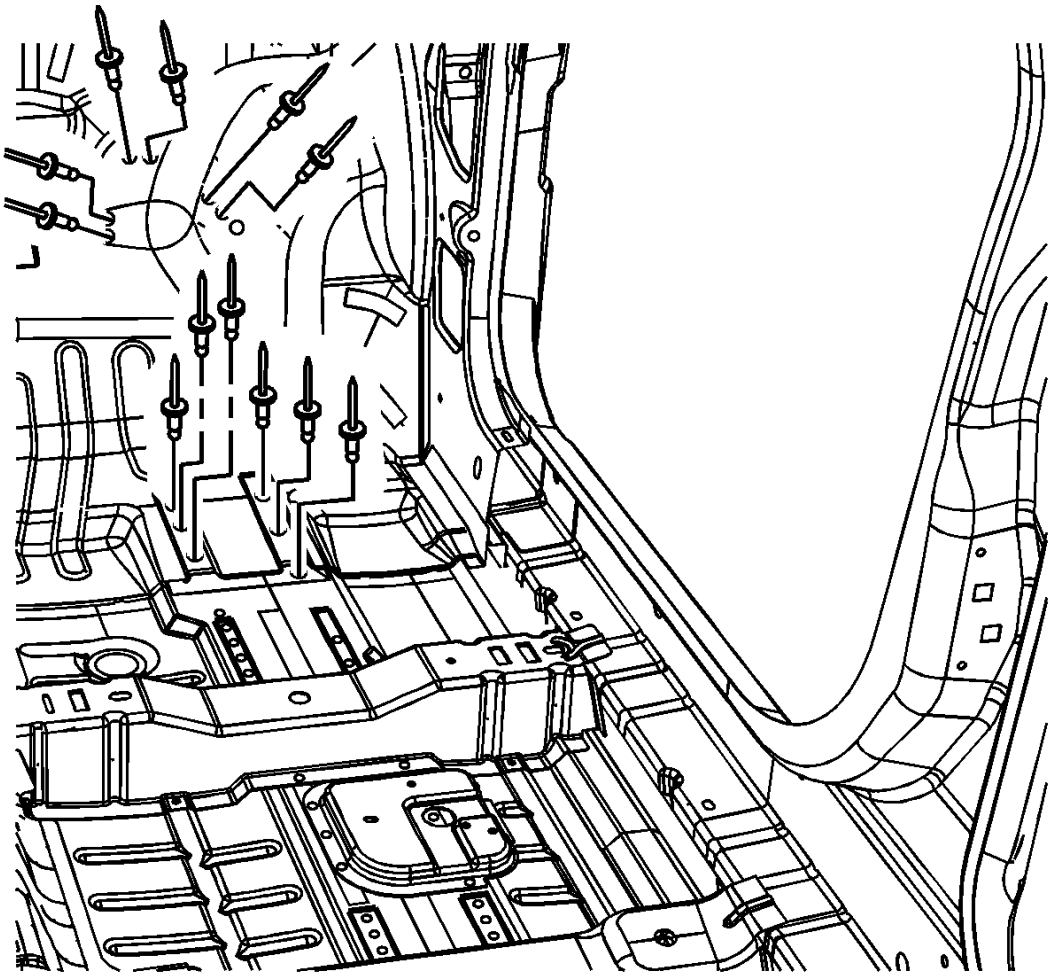


Fig. 69: Installing 9 mm (11/32 in) Long Rivets
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Verify proper positioning of the service rail prior to riveting and welding.**

19. Install the 9-mm (11/32-in) long rivets, so that the rivet head contacts the passenger compartment side of the dash.

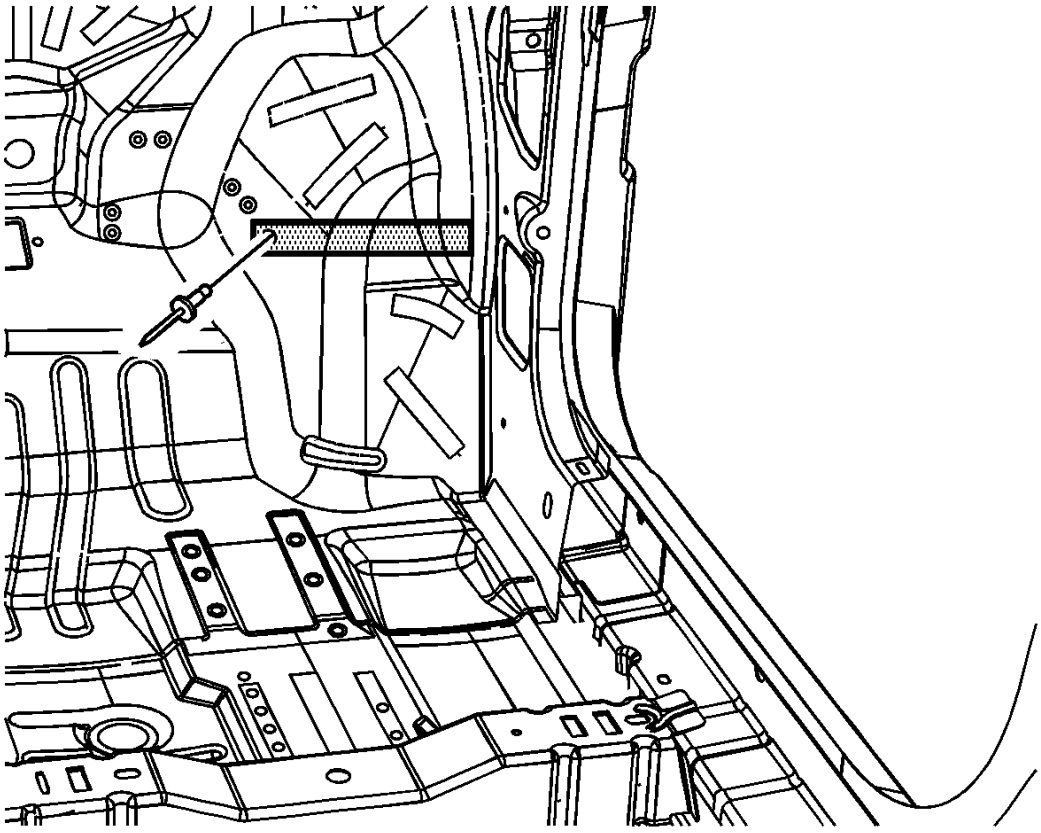


Fig. 70: Installing 14-mm (17/32-in) Long Rivet
Courtesy of GENERAL MOTORS COMPANY

20. Install the 14-mm (17/32-in) long rivet, so that the rivet head contacts the passenger compartment side of the dash, extending through the front rail and through the rail side extension.
21. Remove the excess adhesive from the rail area.

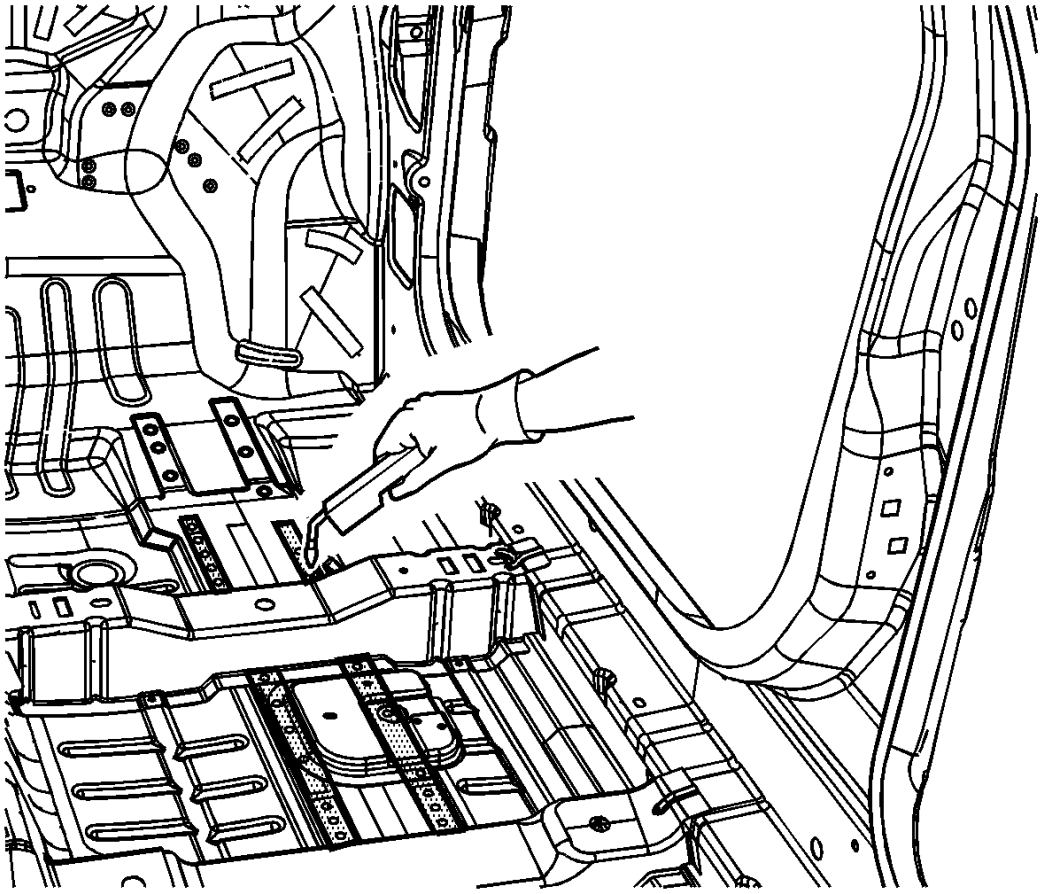


Fig. 71: Plug Welding Remaining Holes
Courtesy of GENERAL MOTORS COMPANY

22. Plug weld the remaining holes, accordingly.
23. Clean and prepare all of the welded surfaces.
24. Install the front wheelhouse assembly. Refer to **Front Wheelhouse Panel Replacement**.
25. Install the front rail side extension. Refer to **Front Compartment Side Rail Rear Extension Replacement**.
26. Install the radiator support assembly. Refer to **Upper Rail Replacement**.
27. Apply the sealers and anti-corrosion materials to the repaired area, as necessary. Refer to **Anti-Corrosion Treatment and Repair** .
28. Paint the repaired area. Refer to **Basecoat/Clearcoat Paint Systems** .
29. Install all of the related panels and components.
30. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
31. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

FRONT HINGE PILLAR SECTIONING

Removal Procedure

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

NOTE: **Do not cut adjacent panels.**

NOTE: **Follow general sectioning for the outer rocker panel. Sectioning should take place in shaded areas only. There are key structural areas on the outer rocker panel where sectioning should not be performed. Sectioning in these areas may compromise the structural integrity of the vehicle.**

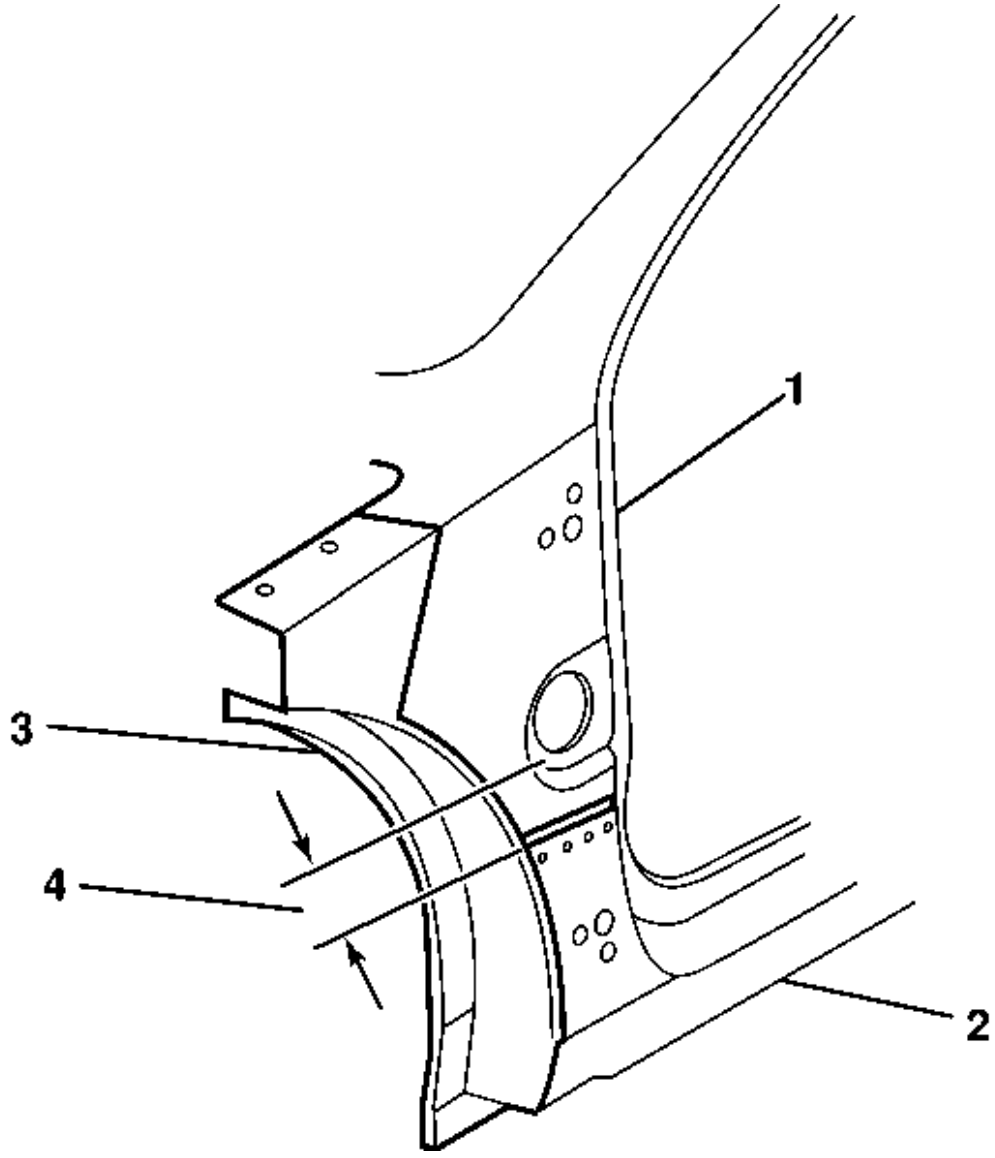


Fig. 72: Original Outer Door Frame, Inner Reinforcement & Service Panel
Courtesy of GENERAL MOTORS COMPANY

1. Visually inspect and restore as much of the damage as possible to factory specifications.
2. Remove all related panels and components.
3. Position all wiring out of the way to prevent damage and for best access to vehicle.
4. Remove all sealers and anti-corrosion materials as necessary.

5. On the original outer door frame (1) measure down 35 mm (1 3/8 in) from the large wiring harness hole in the pillar and mark a horizontal line (4).
6. Cut the outer door frame along this line for sectioning.
7. Perform additional sectioning procedures as necessary to remove damaged areas of the door frame opening.
8. Locate and mark all factory welds. Note the number and location of welds for installation of the service part.
9. Drill out all factory welds as necessary.

NOTE: **Note the location of the sound deadening foam for installation.**

10. Remove the damaged section of the outer door frame opening (2).

Installation Procedure

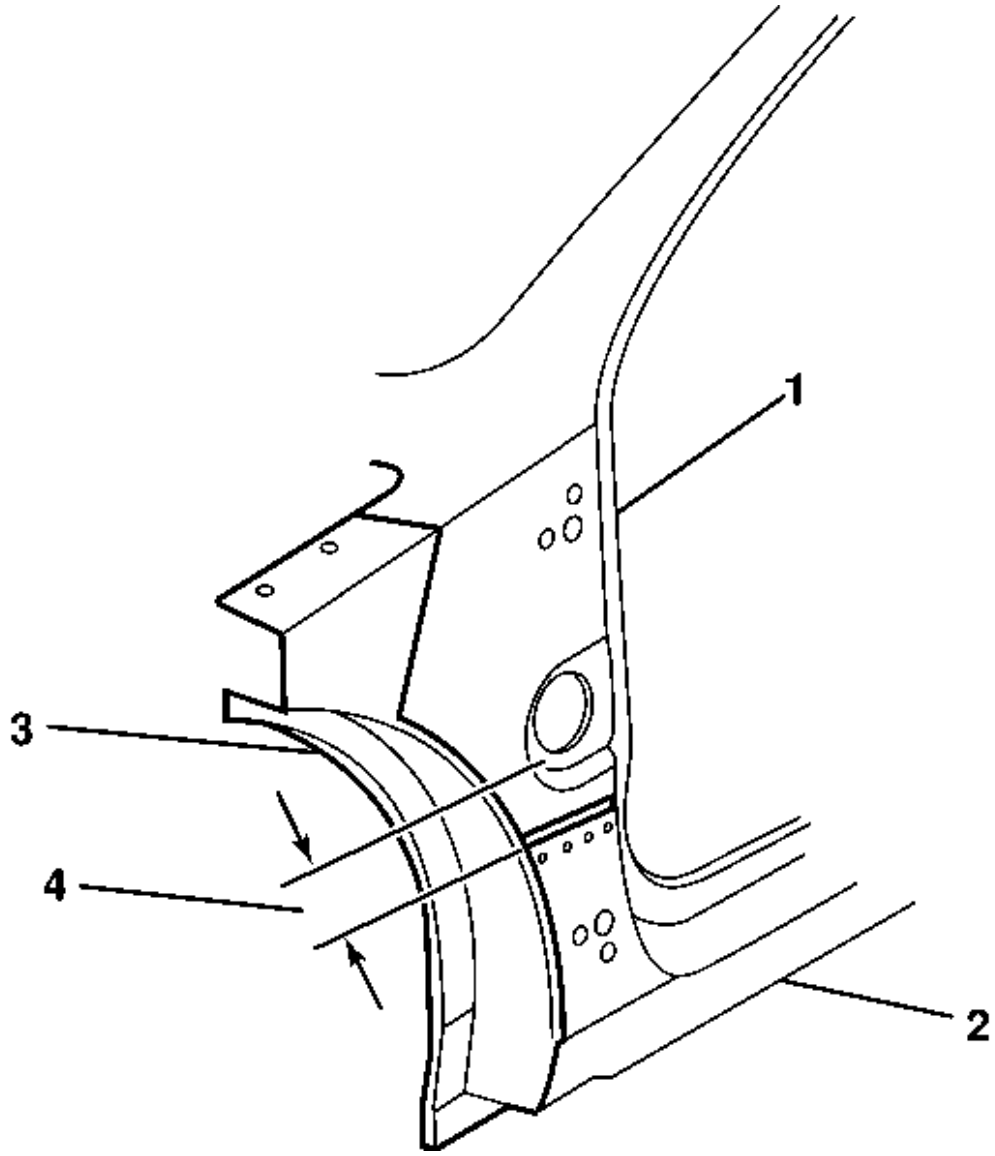


Fig. 73: Original Outer Door Frame, Inner Reinforcement & Service Panel
Courtesy of GENERAL MOTORS COMPANY

1. On the service part (2), mark a horizontal line to leave a gap of 1 1/2 times the thickness of the metal at the section joint.
2. Cut the service panel along this line.
3. Drill 8 mm (5/16 mm) holes for plug welding in the service part in the locations noted from the original panel.
4. Drill holes for plug welding along the sectioning cut on the service part. Locate these holes approximately 13 mm (1/2 in) from the edge of the sectioning cut.
5. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.
6. Use the inner reinforcement (3) as a backing plate.
7. Stitch weld along the entire joint with 25 mm (1 in) welds along the seams with 25 mm (1 in) gaps between.
8. Go back and complete the stitch weld. This will create a solid joint with minimal heat distortion.
9. Complete all other welds and sectioning procedures as necessary.
10. Clean and prepare welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

11. Prime with two-part catalyzed primer.

NOTE: **It is necessary to apply the sound-deadening foam in the locations as noted from removal.**

12. Apply sealers and anti-corrosion materials as necessary.
13. Install all related panels and components.

FRONT INNER HINGE PILLAR REINFORCEMENT SECTIONING

Removal Procedure

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

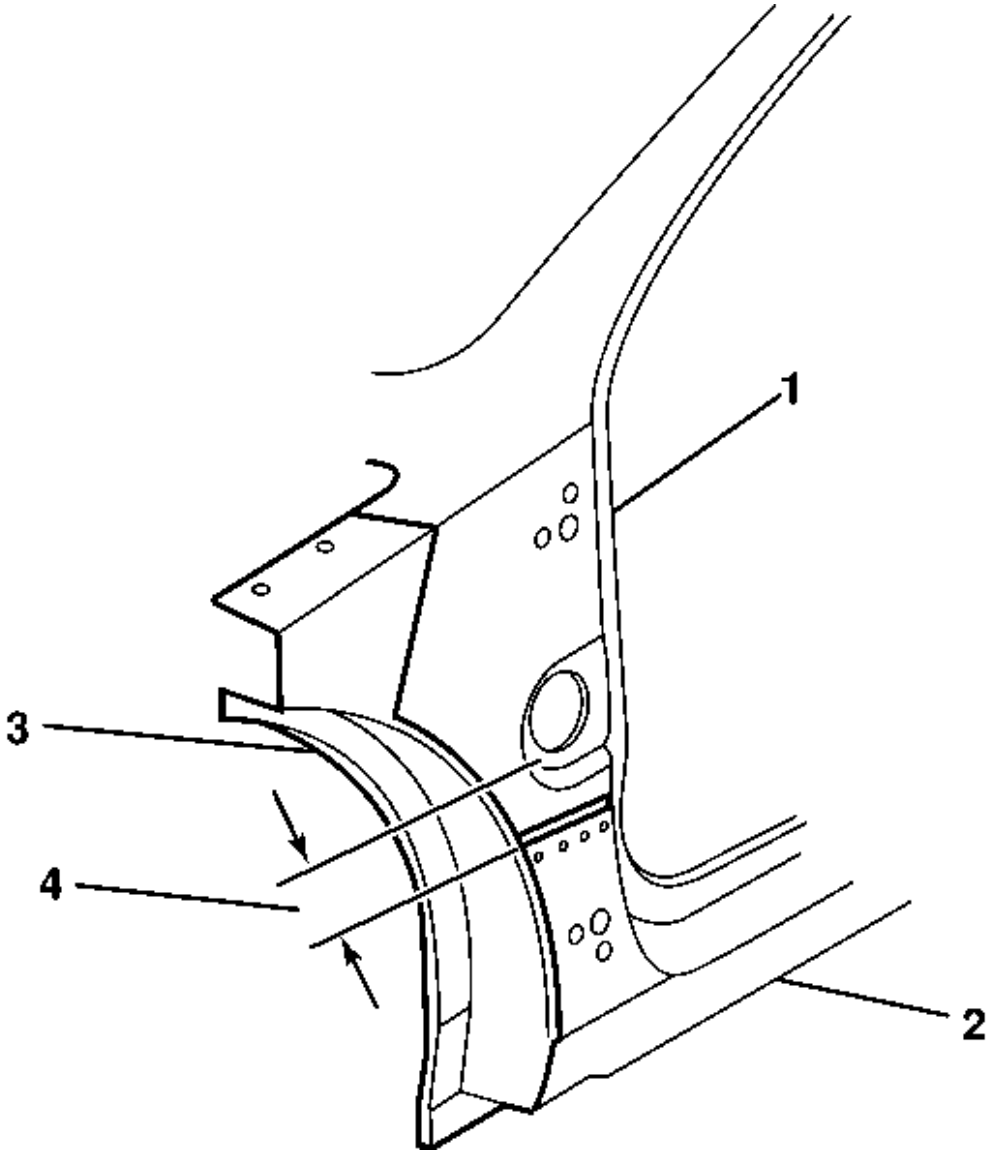


Fig. 74: Original Outer Door Frame, Inner Reinforcement & Service Panel
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Sectioning of the inner reinforcement panel (3) can only take place with outer door frame replacement or sectioning procedures. Sectioning the outer door (1) frame at the front hinge pillar requires a 25 mm (1 in) offset from the inner reinforcement sectioning joint. The inner reinforcement can serve as a backing plate for the outer panel sectioning.**

1. Visually inspect and restore as much of the damage as possible to factory specifications.
2. Remove all related panels and components.
3. Position all wiring out of the way to prevent damage and for best access to vehicle.
4. Remove all sealers and anti-corrosion materials as necessary.

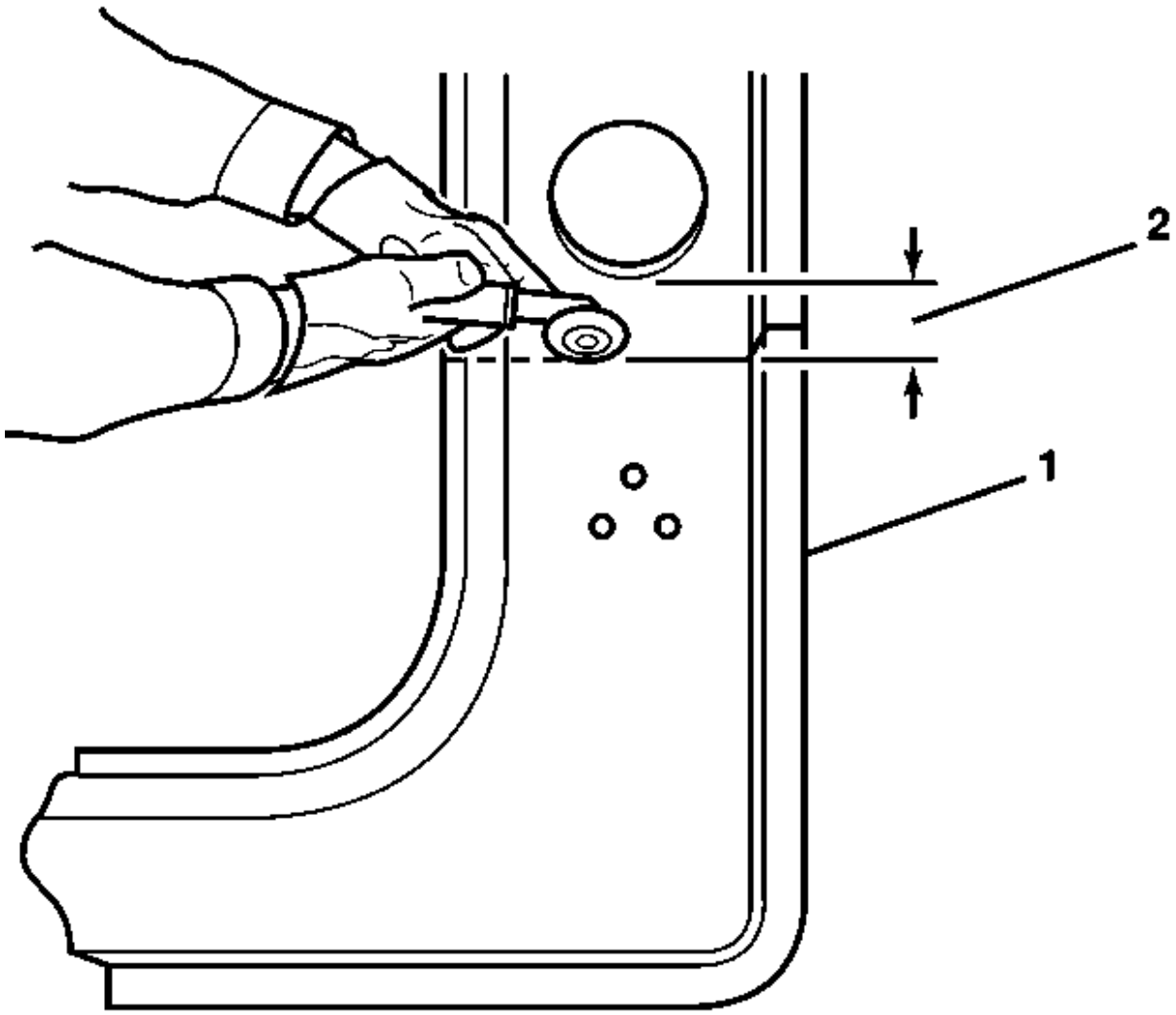


Fig. 75: Removing Damaged Inner Reinforcement (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

5. On the original reinforcement panels (1) measure down 90 mm (3 9/16 in) from the large wiring harness hole in the pillar and mark a horizontal line.
6. Cut the inner reinforcement along this line for sectioning.
7. Locate and mark all factory welds. Note the number and location of welds for installation of the service part.
8. Drill out all factory welds as necessary.

NOTE: **Note the locations of the sound-deadening foam for installation.**

9. Remove the damaged section of the inner reinforcement (2).

Installation Procedure

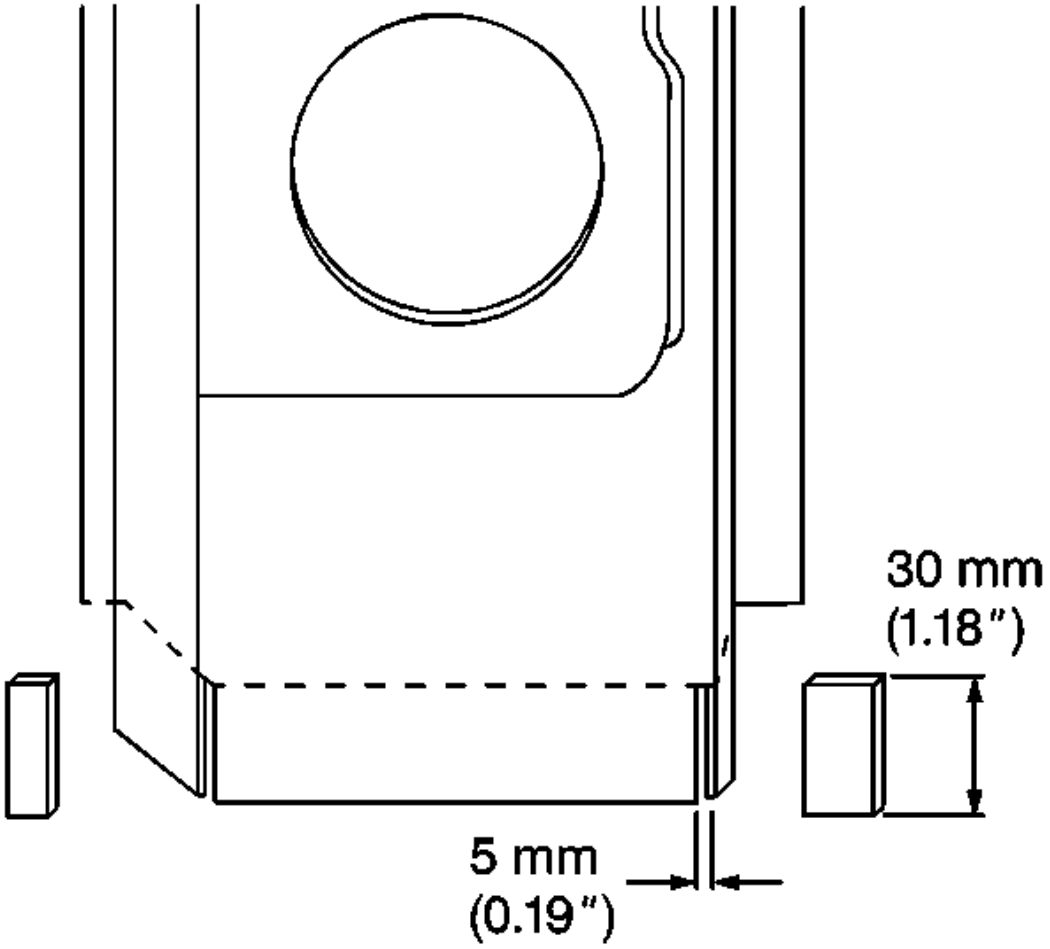


Fig. 76: Cutting Sections Of Hinge Pillar
Courtesy of GENERAL MOTORS COMPANY

1. Cut and remove 30 mm (1 3/16 in) from the flanges on either side of the remaining section of the original hinge pillar to create a 30 mm (1 3/16 in) flange.
2. Cut 5 mm (3/16 in) wide gaps in the bottom corners.
3. Step the tabs inward to allow the door frame inner reinforcement service section to fit over the original inner reinforcement.
4. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.

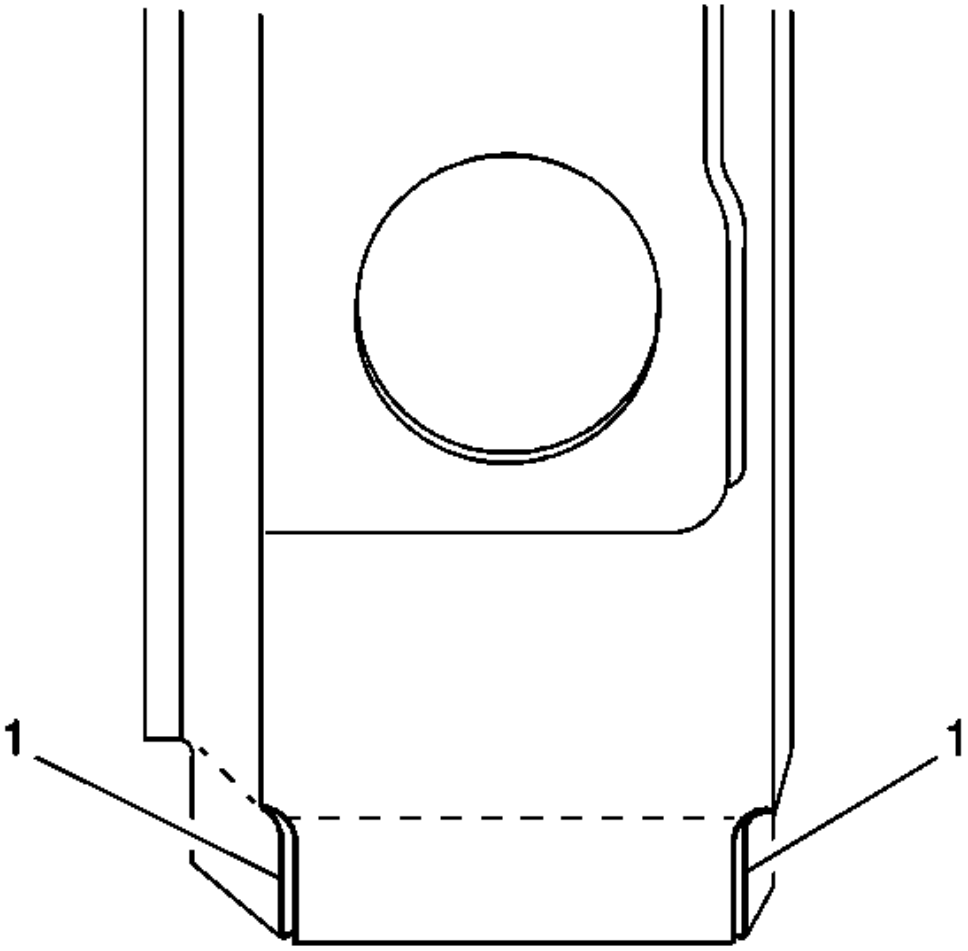


Fig. 77: Welding Tabs Together
Courtesy of GENERAL MOTORS COMPANY

5. Weld the tabs together along the edges (1).

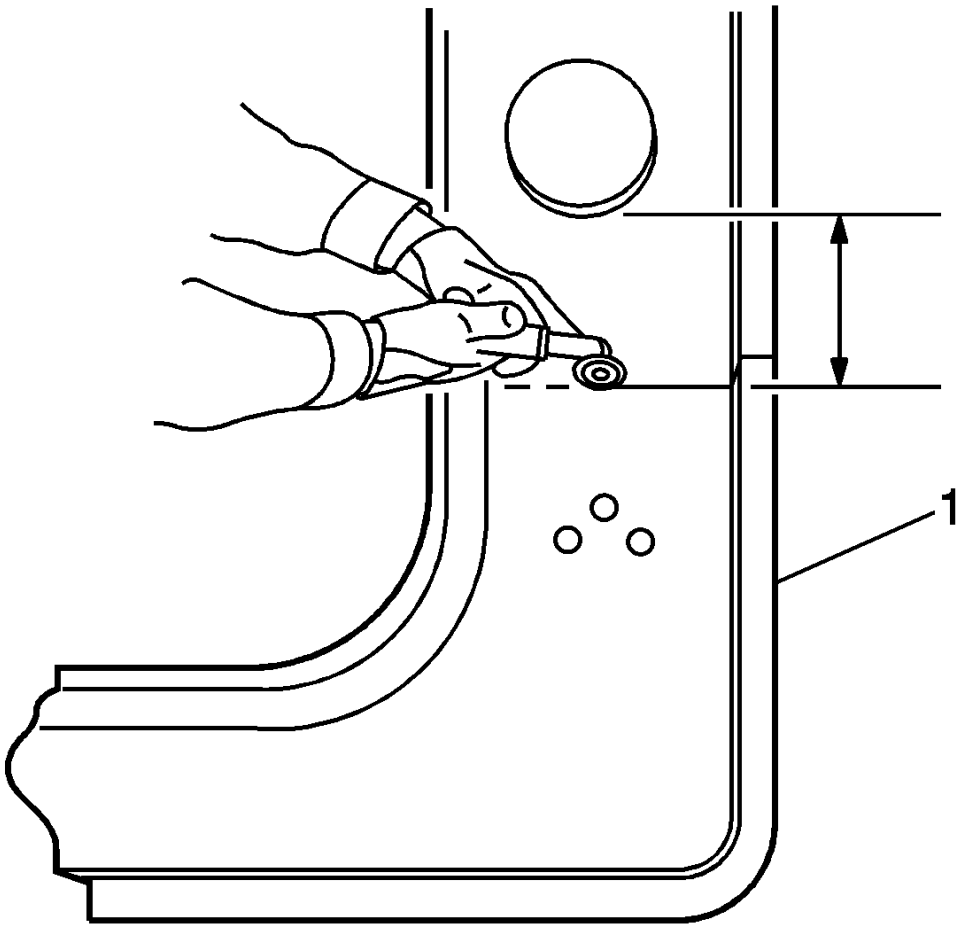


Fig. 78: Cutting Hinge Pillar (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

6. On the service part (1) measure 60 mm (2 3/8 in) down from the large wiring harness hole in the hinge pillar and mark a horizontal line.
7. Cut the hinge pillar along this line.

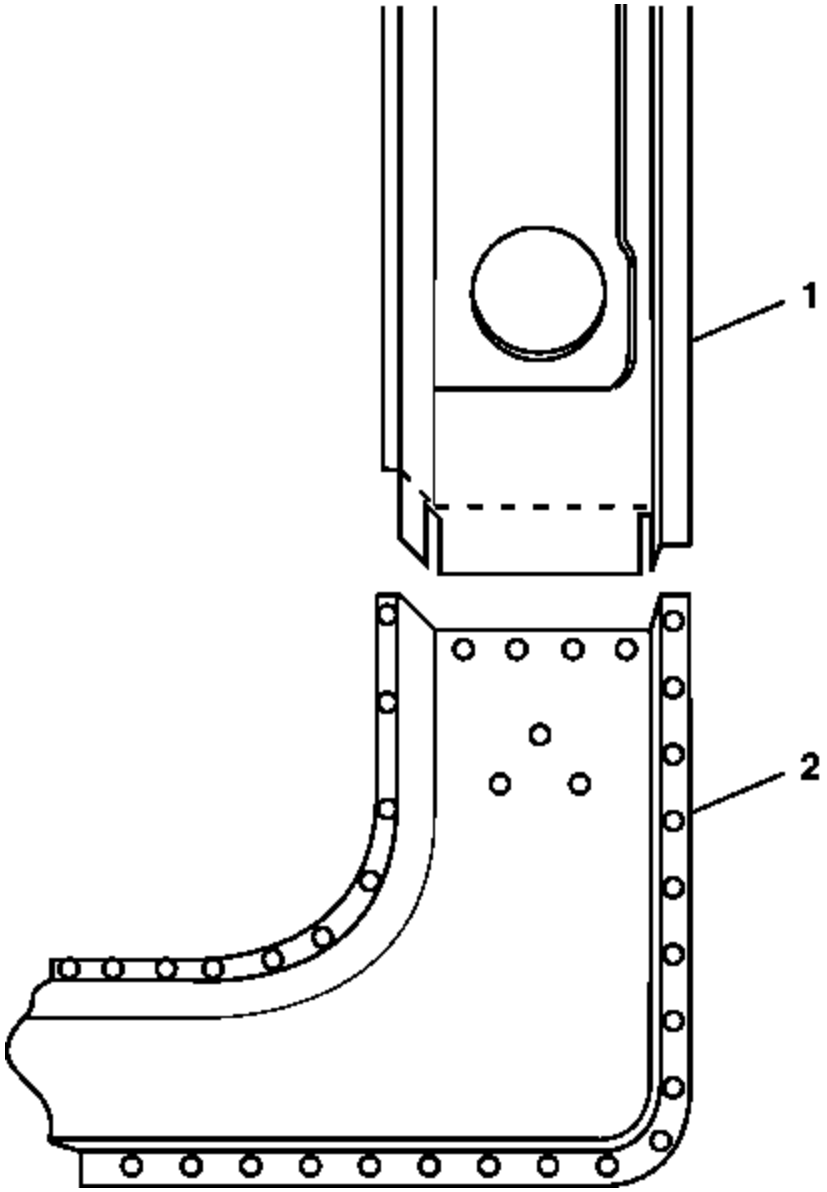


Fig. 79: Original Inner Reinforcement & Service Section
Courtesy of GENERAL MOTORS COMPANY

8. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original panel.
9. Drill plug weld holes along the sectioning cut of the service part (2).
10. Prepare the mating surfaces as necessary. Position the service section (2) over the stepped tab on the original inner reinforcement (1).
11. Check and make sure the door hinge bolt holes are properly located.

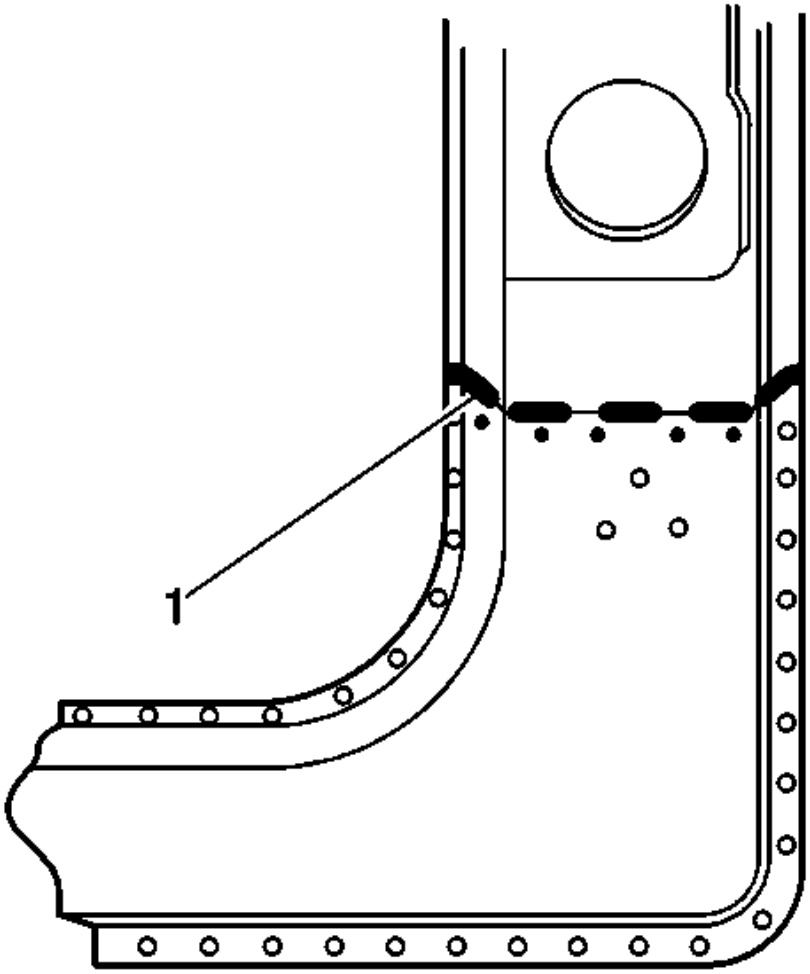


Fig. 80: Stitch Welding Joint
Courtesy of GENERAL MOTORS COMPANY

12. Plug weld accordingly.
13. Stitch weld along the entire joint (1).
14. Make 25 mm (1 in) welds along the seam with 25 mm (1 in) gaps between.
15. Go back and complete the stitch weld. This will create a solid joint with minimal heat distortion.
16. Clean and prepare welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

17. Prime with 2-part catalyzed primer.

NOTE: **It is important to re-apply the sound-deadening foam in the locations noted from the removal process.**

18. Apply sealers and anti-corrosion materials as necessary.

19. Install all related panels and components.

DOOR FRAME REINFORCE SECTIONING - CENTER PILLAR

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

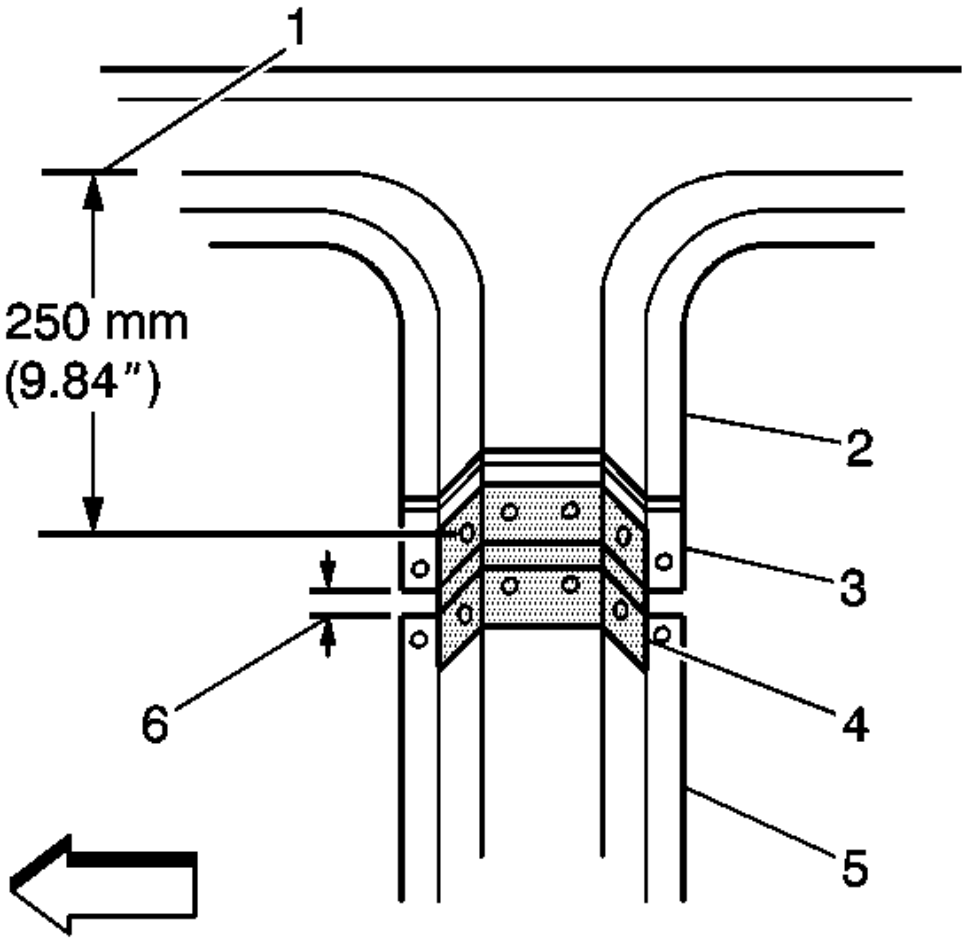


Fig. 81: Central Pillar Reinforcement
Courtesy of GENERAL MOTORS COMPANY

NOTE: The striker plate is mounted in a cage that allows some degree of adjustment independent of the outer panels position. Use body dimensions to ensure that the striker mounting location falls within the plates range of adjustment.

1. Remove all related panels and components.
2. Visually inspect and restore as much of the damage as possible.
3. Remove sealers and anti-corrosion materials as necessary.

NOTE: **When sectioning both the inner (3) and the outer panels (2) this should result in a 100 mm (4 in) offset in the sectioning joints. Use care not to cut the inner door opening frame when cutting the center pillar reinforcement.**

NOTE: **Sectioning of the center pillar reinforcement should be performed only in the specified sectioning locations.**

4. Cut the reinforcement (3) panel 250 mm (13 3/4 in) from the lower edge of the door opening (1).
5. Locate and mark all factory welds. Note the number and location of welds for installation of the service assembly.
6. Drill out all factory welds.

Installation Procedure

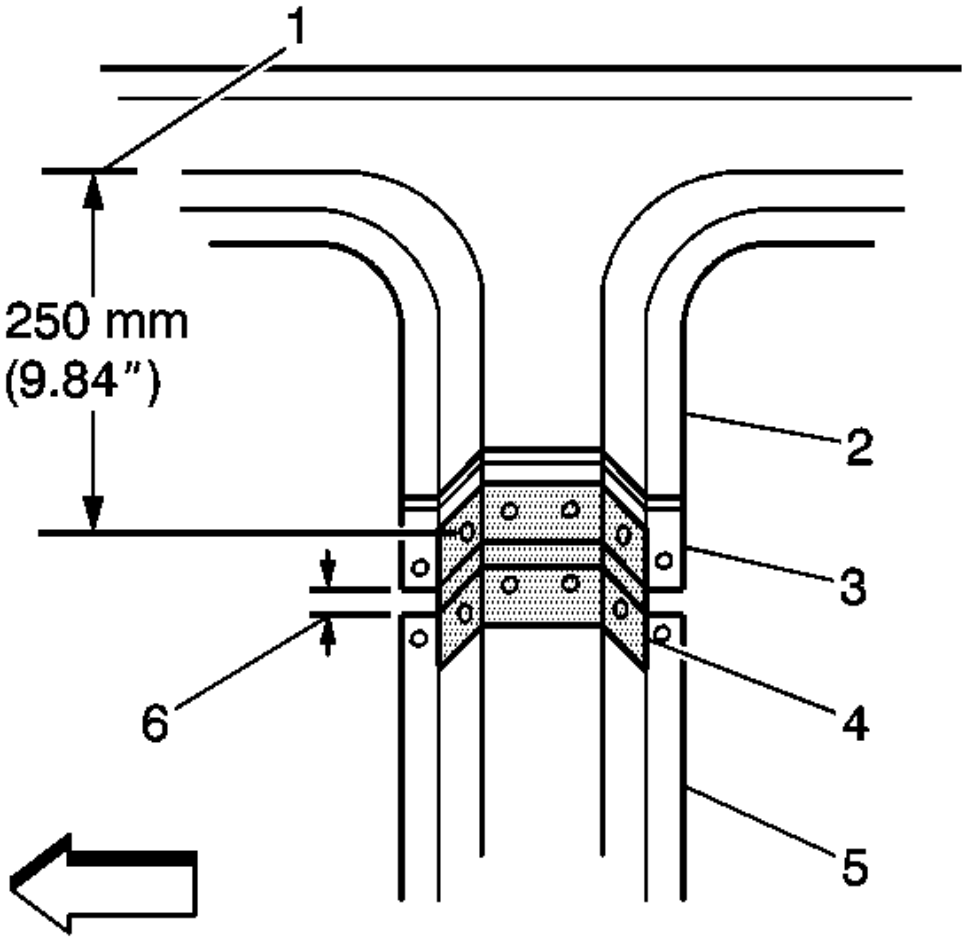


Fig. 82: Central Pillar Reinforcement
Courtesy of GENERAL MOTORS COMPANY

1. On the service part (5) mark a horizontal line to leave a gap of 1 1/2 times the thickness of the metal (6) at the sectioning joint.
2. Cut the service reinforcement panel along this line.

3. Cut a 50 mm (2 in) piece from the unused portion of the service part (5) for a backing plate.
4. Remove the flange on each side of the backing plate (4) so that it will fit behind the sectioning joint (6).
5. Drill 8 mm (5/16 in) holes for plug welding in the service part in the location noted from the original panel.
6. Drill holes for plug welding along the sectioning cuts on both the service part (5) and the original panel (3).
7. Locate these holes approximately 13 mm (1/2 in) from the edge of the sectioning cuts.
8. Prepare the mating surfaces as necessary. Position the backing plate with 25 mm (1 in) of the backing plate exposed. Position the service part (5) to overlap the exposed backing plate.
9. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.
10. Make 25 mm (1 in) welds along the seams with 25 mm (1 in) gaps between.
11. Go back and complete the stitch weld. This will create solid joint with minimal heat distortion.
12. Complete all other welds as necessary.
13. Clean and prepare welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

14. Prime with 2 part catalyzed primer.
15. Apply sealers and anti-corrosion materials as necessary.

CENTER PILLAR REPLACEMENT

Removal Procedure

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

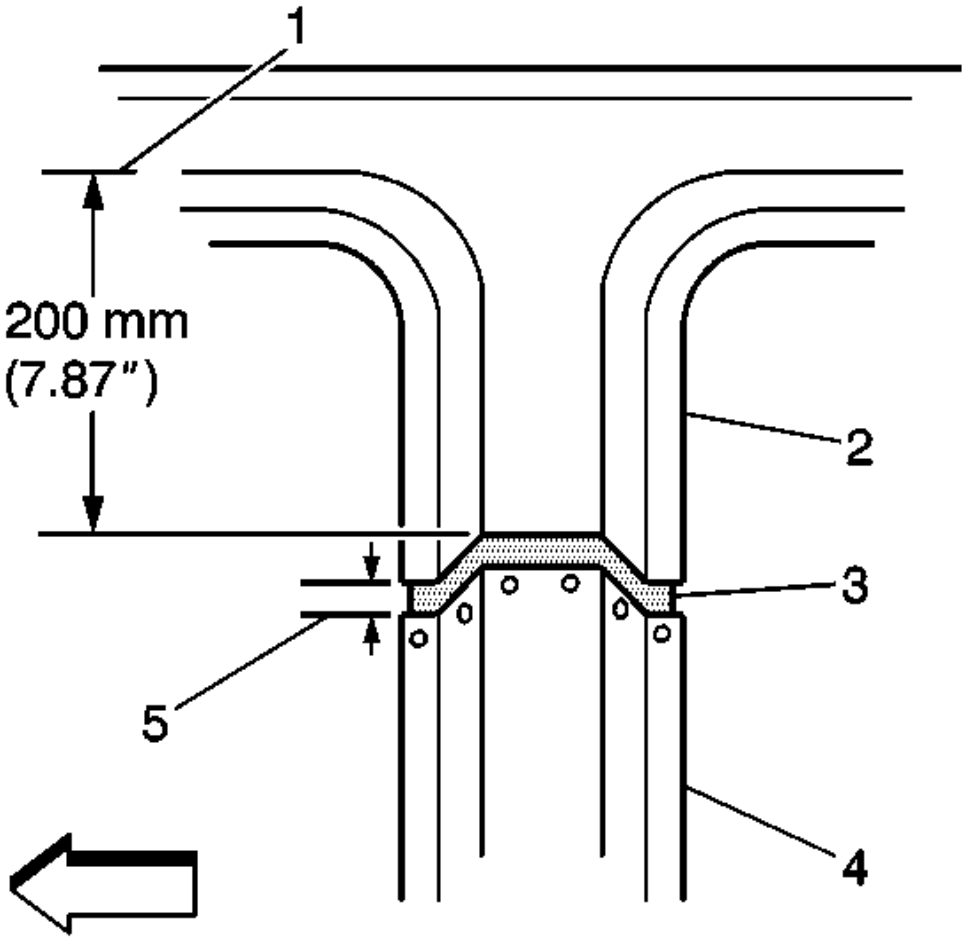


Fig. 83: Outer Door Frame Measurements
Courtesy of GENERAL MOTORS COMPANY

1. Visually inspect and restore as much of the damage as possible to factory specifications.
2. Remove all related panels and components.
3. Position all wiring out of the way to prevent damage.
4. Remove sealers and anti-corrosion materials as necessary.
5. On the original outer door frame (2) measure down from the lower edge (1) of the door opening 200 mm (8 in) and mark a horizontal line.
6. Cut the outer door frame along this line for sectioning. Do not cut into the inner reinforcement.
7. Locate and mark all factory welds. Note the number and location of welds for installation of the service section.
8. Drill out all factory welds as necessary.
9. Perform additional sectioning procedures as necessary to remove the center lock pillar.
10. Remove the damaged section of the door frame opening (4).

Installation Procedure

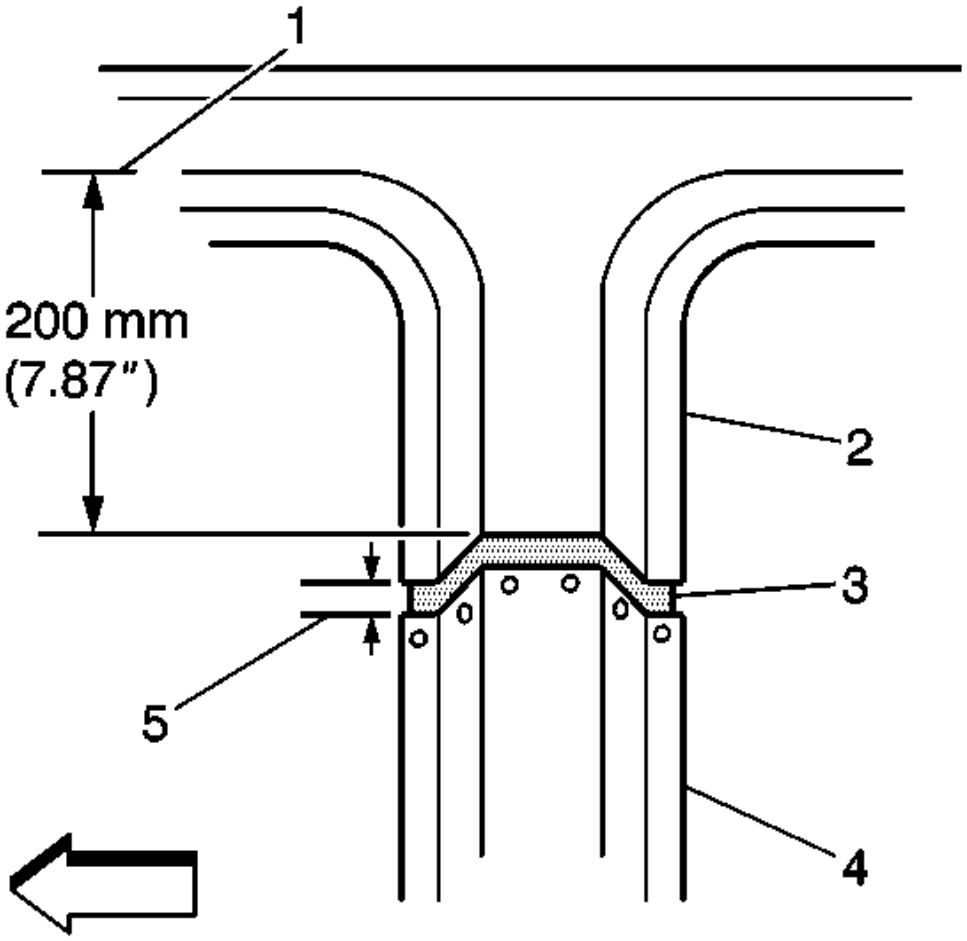


Fig. 84: Outer Door Frame Measurements
Courtesy of GENERAL MOTORS COMPANY

1. On the service part (4), mark a horizontal line to leave a gap of 1 1/2 times the thickness of the metal (5) at the sectioning joint.
2. Cut the service panel along this line.
3. Drill 8 mm (5/16 in) holes for plug welding in the service part (4) in the locations noted from the original panel.
4. Drill holes for plug welding long the sectioning cuts on the services part.
5. Locate these holes approximately 13 mm (17/32 in) from the edge of the sectioning cuts.
6. Prepare the mating surfaces as necessary. Position the service part using three-dimensional measuring equipment.
7. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.
8. Plug weld accordingly.
9. Use the inner reinforcement (3) as a backing plate and stitch weld along the entire sectioning joint.
10. Make 25 mm (1 in) welds along the seam with 25 mm (1 in) gaps between.
11. Go back and complete the stitch weld. This will create a solid joint with minimal heat distortion.

12. Complete all other welds and sectioning procedures as necessary.
13. Clean and prepare welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

14. Prime with 2-part catalyzed primer.
15. Apply sealers and anti-corrosion materials as necessary.
16. Install all related panels and components.

GENERAL DOOR FRAME OPENING SECTIONING

Removal Procedure

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

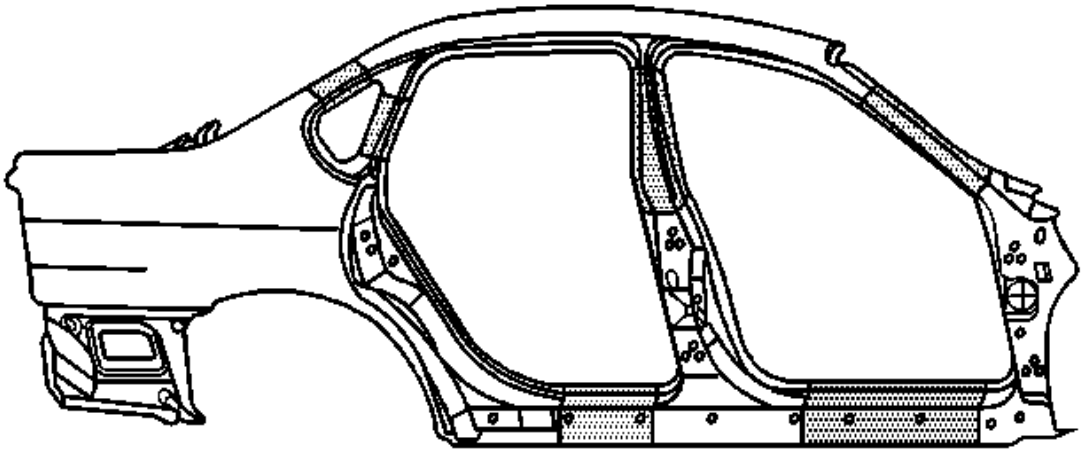


Fig. 85: Door Frame Opening (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

1. Visually inspect and restore as much of the damage as possible.
2. Remove all related panels and components.
3. Remove sealers and anti-corrosion materials as necessary.
4. Cut the panel in the areas where the sectioning is to take place. Sectioning should take place in shaded areas only.

NOTE: **Use care not to cut the inner reinforcements when cutting the outer door opening frame.**

5. Locate and mark all factory welds. Note the number and location of welds for installation of the service assembly.
6. Drill out all factory welds.

NOTE: **Note the location of the sound deadening foam for installation.**

7. Remove the damaged outer door opening frame.

Installation Procedure

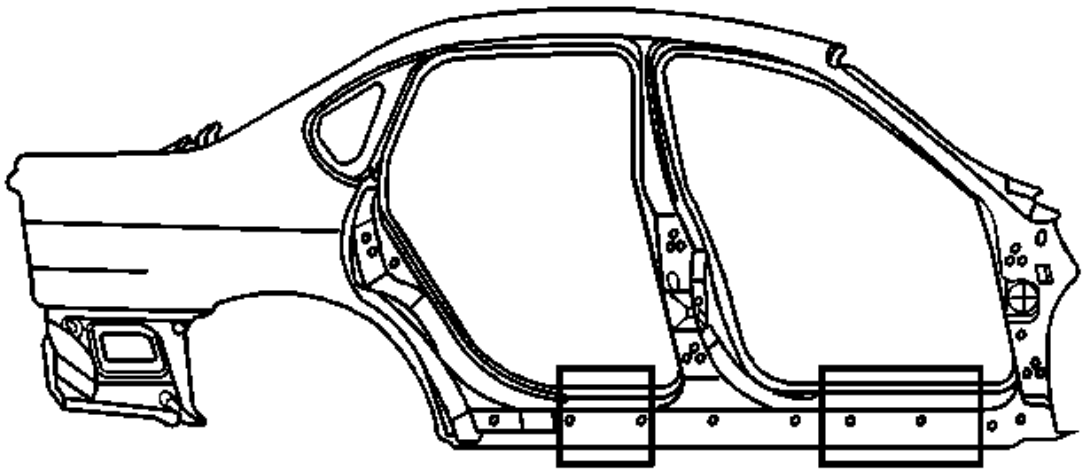


Fig. 86: Rocker Locations

Courtesy of GENERAL MOTORS COMPANY

NOTE: **Sectioning in the rocker locations requires the use of a 100 mm (4 in) backing plate.**

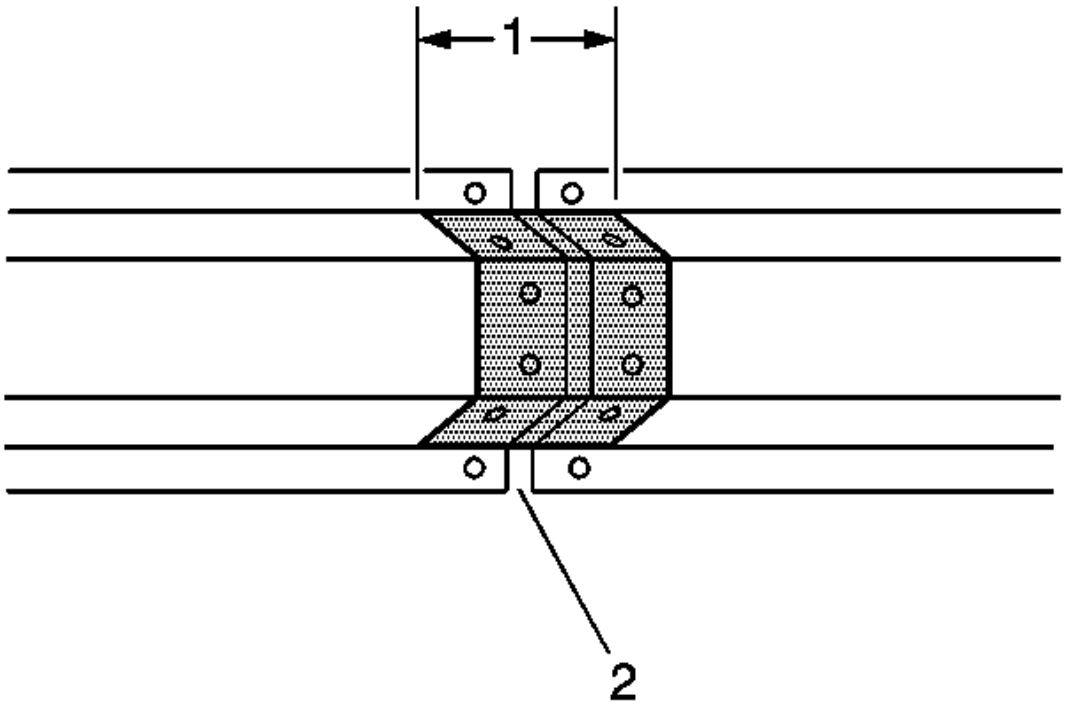


Fig. 87: Cutting Door Frame Opening Service Part (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

1. On the service part, mark a line to leave a gap of one and one-half times the thickness of the metal at the sectioning joint (2).
2. Cut the outer door frame opening service part along this line.
3. Cut a 100 mm (4 in) piece (1) from the unused portion of the service part for a backing plate when sectioning in the rocker areas of the door frame opening.

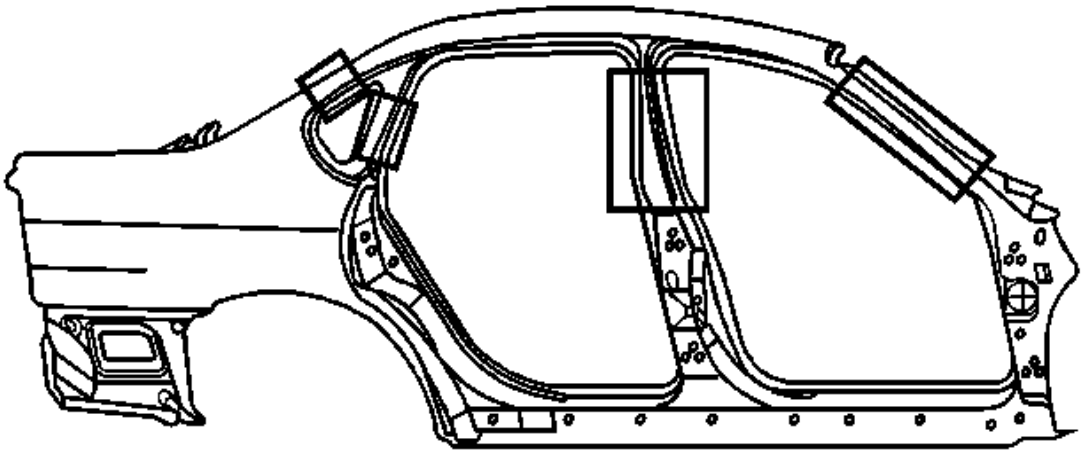


Fig. 88: Sectioning Outer Door Frame (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

4. Sectioning in the A, B, or C pillars of the outer door frame opening requires the use of a 50 mm (2 in) backing plate.

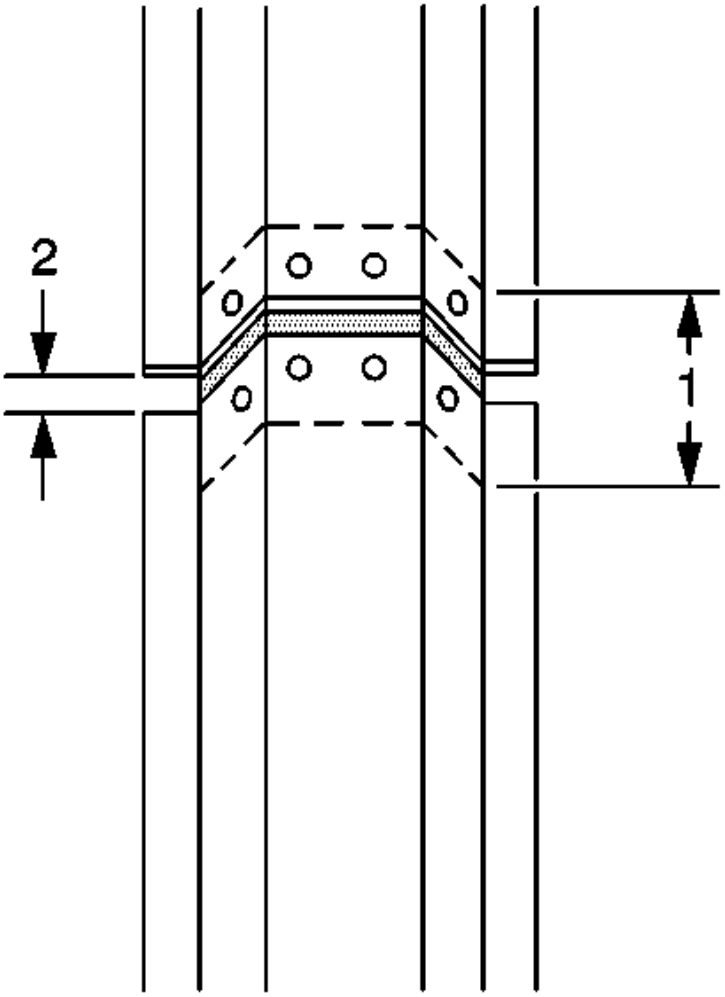


Fig. 89: Cutting Service Part For Backing Plate (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When sectioning the outer door frame at the lower front hinge pillar of at the center lock pillar, the inner reinforcement panel can be used as a backing plate.**

5. Cut a 50 mm (2 in) piece (1) from the unused portion of the service part for a backing plate, leaving a gap of 1 1/2 times the thickness of the metal (2).
6. Drill 8 mm (5/16 in) holes for plug welding in the service part in the locations noted from the original panel.
7. Drill holes for plug welding along the sectioning cuts on both the service part and the original panel.
8. Prepare the mating surfaces as necessary. Position the backing plates on the body with 50 percent of the backing plate exposed.
9. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.
10. Plug weld accordingly.
11. Position the service part to overlap the exposed 50 percent of the backing plate.
12. Check the fit using 3-dimensional measuring equipment.

13. Plug weld accordingly.

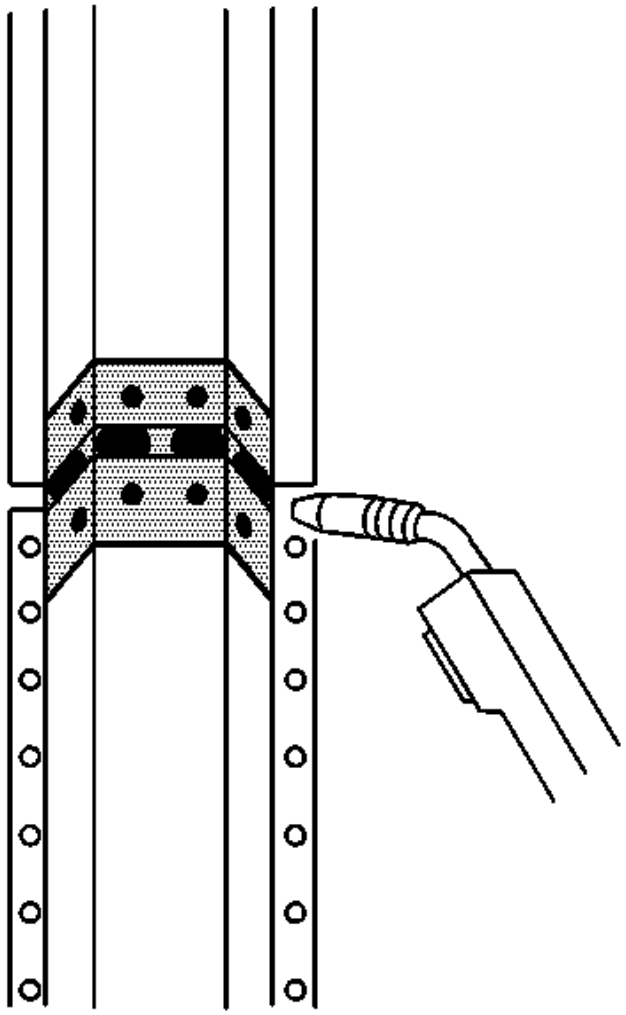


Fig. 90: Welding Sectioning Joint (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

14. Stitch weld along the entire sectioning joint.
15. Make 25 mm (1 in) welds along the seam with 25 mm (1 in) gaps between.
16. Go back and complete the stitch weld. This will create a solid joint with minimal heat distortion.
17. Complete all other welds and sectioning procedures as necessary.
18. Clean and prepare welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

NOTE: **Apply the sound deadening foam in the locations noted from the removal process.**

19. Prime with 2-part catalyzed primer.

20. Apply sealers and anti-corrosion materials as necessary.
21. Install all related panels and components.

ROOF PANEL REPLACEMENT

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

NOTE: The roof panel is serviced as a complete assembly, including the outer panel and the inner reinforcements. The roof panel is attached by a number of welds which must be drilled to remove the outer panel and inner reinforcements for servicing.

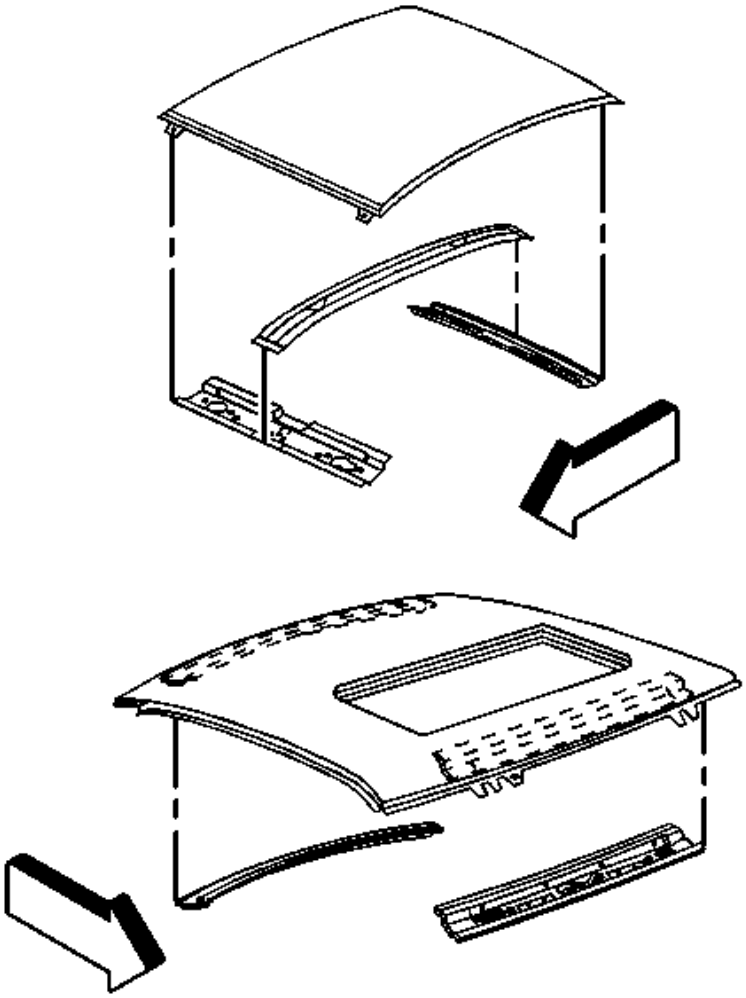


Fig. 91: Roof Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Remove all related panels and components necessary to access the welds attaching the roof assembly to the vehicle.
2. Visually inspect and restore as much of the damage as possible.

3. Remove sealers and anti-corrosion materials as necessary.
4. Locate, mark, and drill out all factory welds. Note the number and location of welds for installation of the service assembly.

NOTE: **A second person may be needed to safely remove the roof assembly and prevent damage to the vehicle.**

5. Remove the damaged roof panel assembly.

Installation Procedure

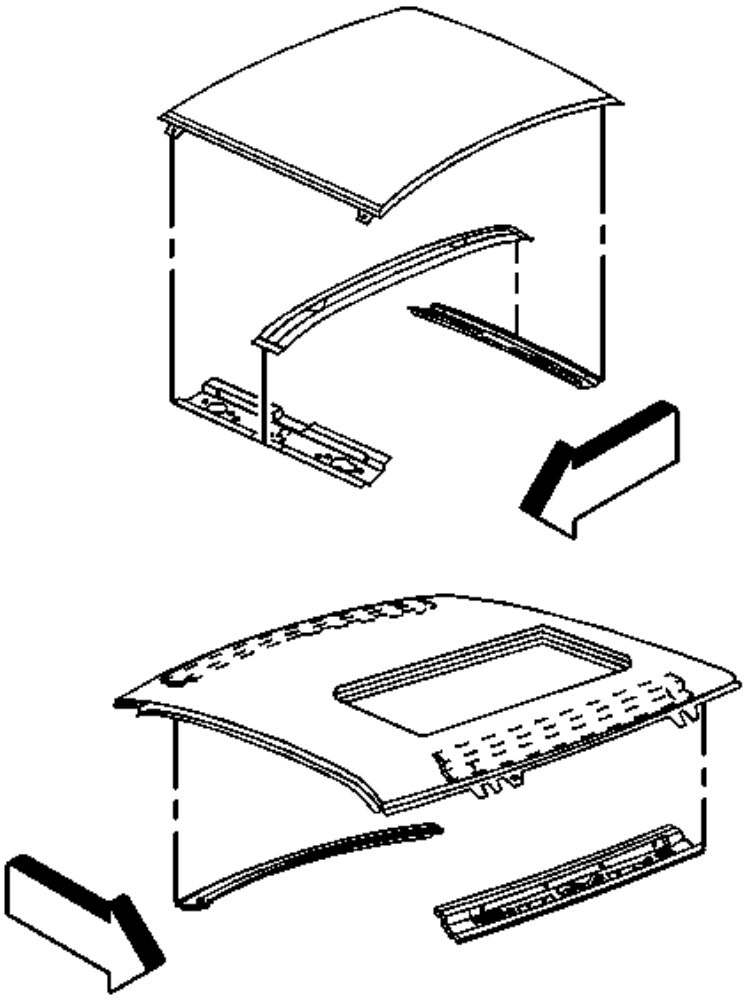


Fig. 92: Roof Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Clean and prepare the mating surfaces as necessary.
2. Position the roof panel on the vehicle.
3. Check fit and alignment.
4. Correctly position the service assembly and plug weld accordingly.
5. Clean and prepare all welded surfaces.

6. Prime with 2-part catalyzed primer.
7. Apply sealers and anti-corrosion materials as necessary.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

8. Install all related panels and components.

QUARTER PANEL REPLACEMENT

Removal Procedure

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

NOTE: **The quarter panel is serviced as a body side service assembly which includes the outer door frame opening, and the lower rear quarter close-out panel. Replacement of the quarter panel requires removal of the quarter glass and the back glass. A special sectioning procedure has been developed for improved serviceability.**

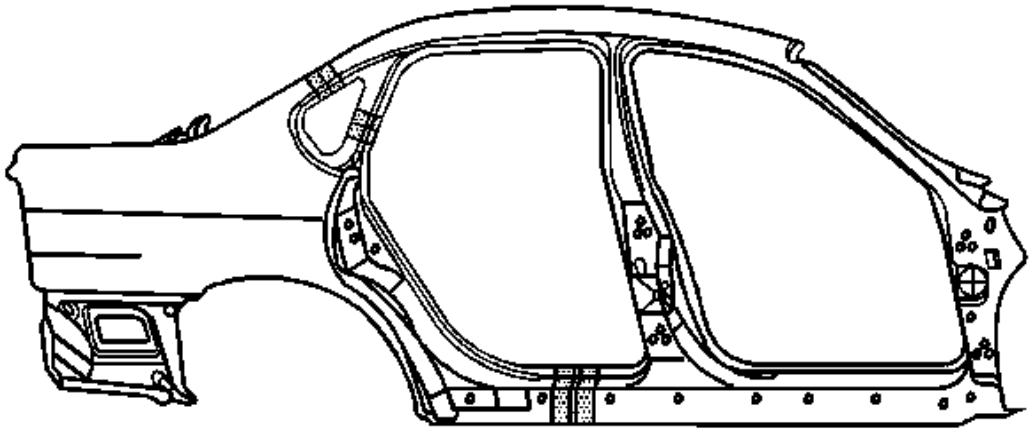


Fig. 93: Quarter Panel Location (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

1. Visually inspect and restore as much of the damage as possible to factory specifications.
2. Remove all related panels and components.
3. Remove sealers and anti-corrosion materials as necessary.
4. Scribe a cut line in upper quarter area.
5. Scribe a cut line in the rocker panel area.
6. Cut damaged section at marked locations.
7. Locate and mark all factory welds. Note the number and location of welds for installation of the service assembly.
8. Drill out all factory welds.

NOTE: **Note the location of the sound deadening foam for installation.**

9. Remove the damaged quarter panel.

Installation Procedure

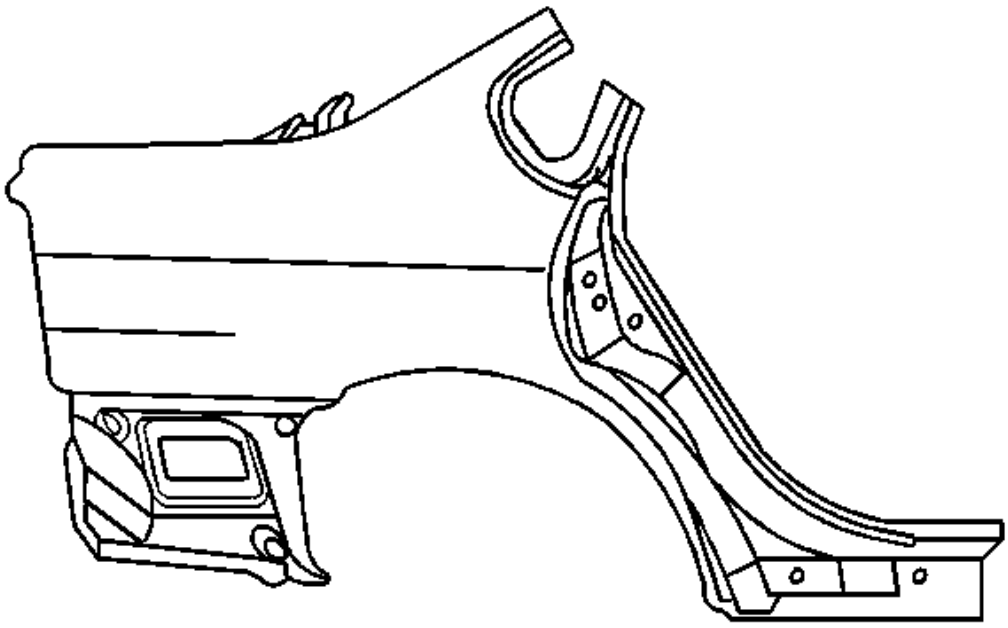


Fig. 94: Quarter Panel (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

1. Prepare the mating surfaces as necessary.
2. On the service part, locate where to cut the upper quarter and rocker areas. Leave extra length in these areas for trimming.
3. Refer to general sectioning for appropriate usage of backing plates.
4. Trim the quarter panel to leave a gap of one and one-half times the thickness of the metal at the sectioning joints.
5. Check for proper fit and alignment.
6. Plug weld accordingly.

NOTE: **The glass bonding area should be a primer surface ONLY, and NOT an after-market top-coated (paint, or color coated) surface.**

7. Clean and prepare all welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendation.**

8. Prime with 2-part catalyzed primer.

NOTE: **It is important to apply the sound deadening foam in the locations noted from removal.**

9. Apply sealers and anti-corrosion materials as necessary.
10. Install all related panels and components.

REAR RAIL REPLACEMENT

Removal Procedure

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

NOTE: **Full rail replacement will require the removal of either the crossbar or an inner wheelhouse assembly. If sectioning is permitted, locate the diemark (3) on the lower surface of rail.**

1. Remove all related panels and components including the rear suspension and seat.
2. Visually inspect and restore as much of the damage as possible to factory specifications.
3. Remove the following as necessary:
    - Sealers
    - Sound deadeners
    - Anti-corrosion materials

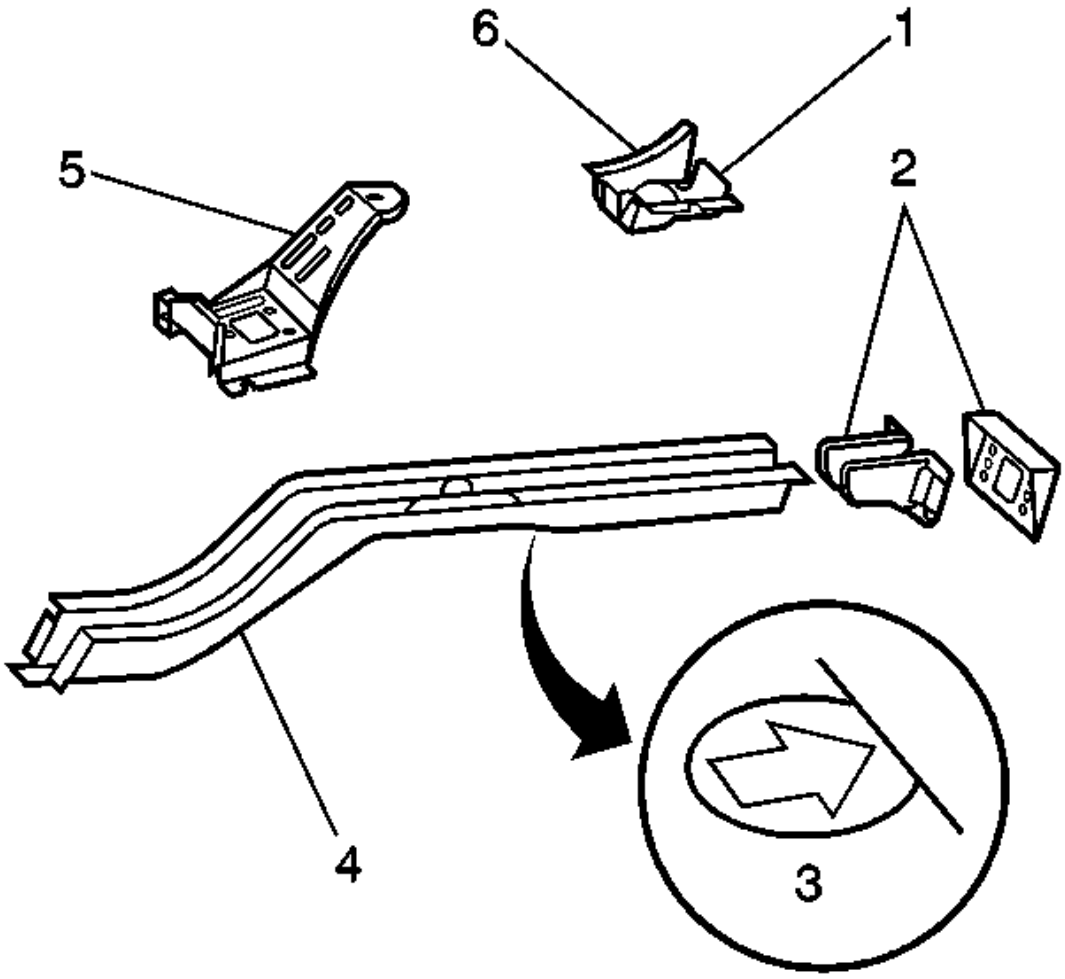


Fig. 95: Rear Rail Components
Courtesy of GENERAL MOTORS COMPANY

4. Locate, mark, and drill out all factory welds attaching the control arm mounting bracket (1) and the rear rail (4) to the vehicle.
5. The factory welds attaching the control arm mounting bracket weld flange (6) to the inner rocker panel must be drilled out from inside the vehicle.

NOTE: **The corner of the floor panel above this area will need to be positioned out of the way (6).**

6. Locate, mark and drill out all factory welds. Note the number and location of welds for installation of the service assembly.
7. Remove the damaged rear rail assembly.

Installation Procedure

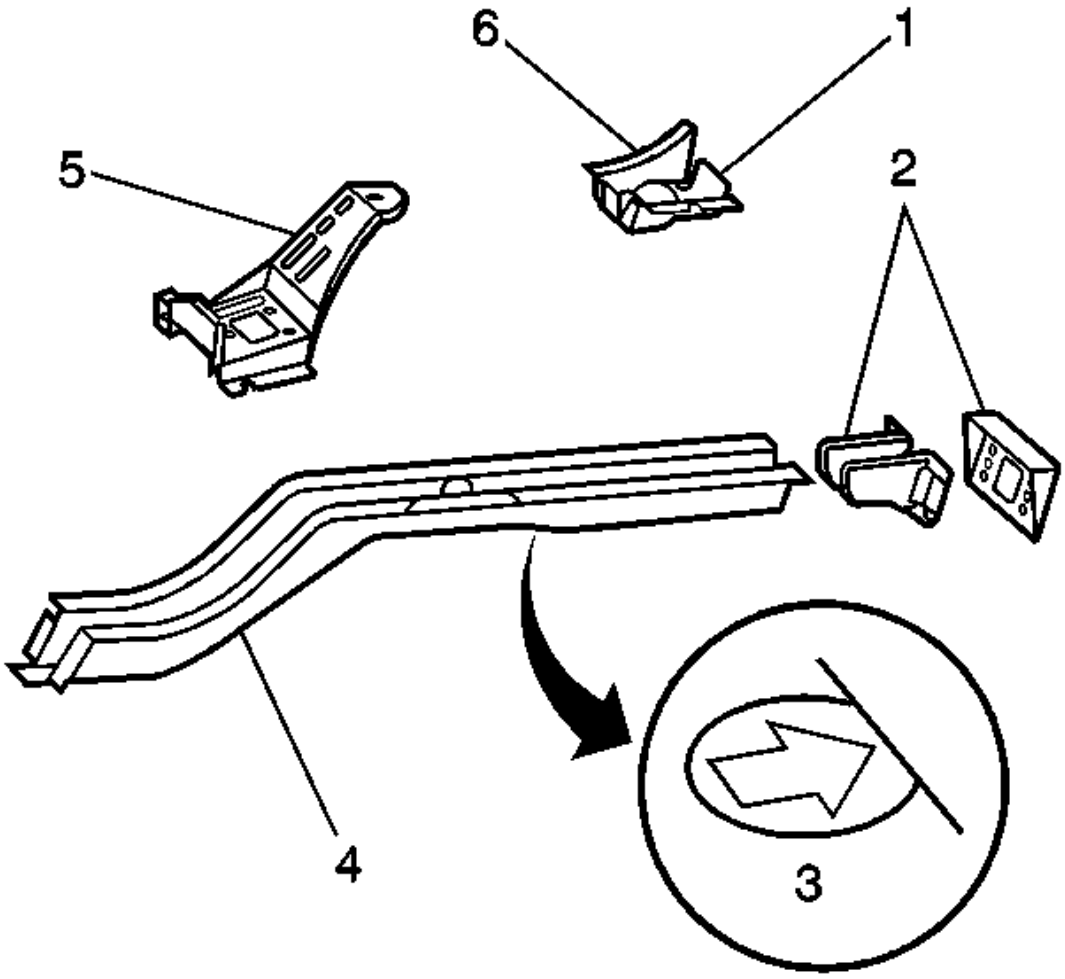


Fig. 96: Rear Rail Components
Courtesy of GENERAL MOTORS COMPANY

1. Clean and prepare the mating surfaces.
2. Check for proper fit of the rear rail service assembly.
3. Drill 8 mm (5/16 in) plug weld holes on the service assembly as necessary in the locations noted from the original assembly.
4. Position the service assembly.
5. Check fit with 3-dimensional measuring equipment.
6. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.
7. Plug weld accordingly with frequent measurements to ensure proper fit.
8. Plug weld the control arm mounting bracket weld flange (6) to the inner rocker.
9. Reposition the floor panel into its original location.
10. Weld as necessary.

NOTE: **The bumper mounting bracket (2) holes must be properly located and**

drilled. Use 3-dimensional measuring equipment.

11. Clean and prepare all welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

12. Prime with 2-part catalyzed primer.
13. Apply sealers and anti-corrosion materials as necessary.
14. Apply sound deadening materials to restore sound deadening quality as manufactured.
15. Install all related panels and components.

REAR RAIL SECTIONING

Removal Procedure

WARNING: **Refer to Approved Equipment for Collision Repair Warning .**

Sectioning procedures can be used to repair the rear rail if just the portion rearward of the crossbar is damaged. Unique service parts are available for sectioning. The sub-assembly consists of the outer rail panel with the bumper mounting brackets attached.

NOTE: **If damage exceeds the recommended area for sectioning and the rail cannot be straightened, the complete rail must be replaced.**

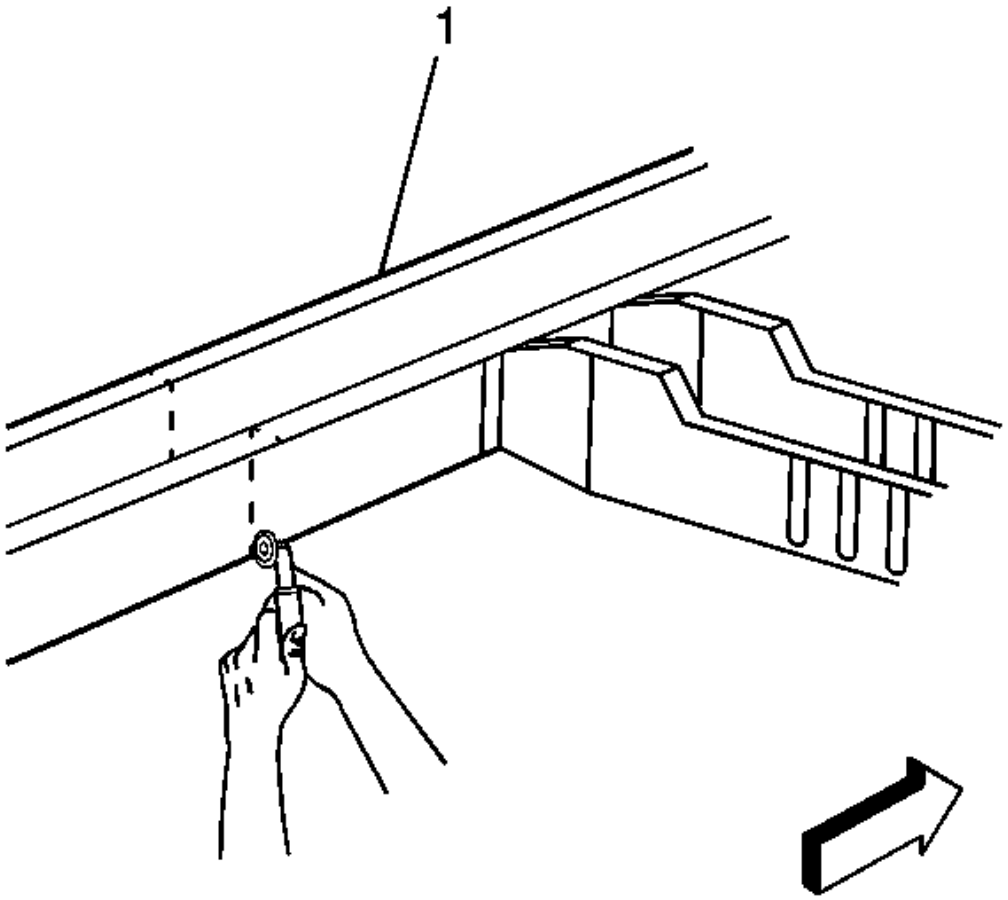


Fig. 97: Marking Damaged Rail
Courtesy of GENERAL MOTORS COMPANY

1. Remove all related panels and components.
2. Visually inspect and restore as much of the damage as possible to factory specifications.
3. Remove sealers and anti-corrosion materials as necessary.
4. Locate, mark, and drill out all factory welds. Note the number and location of welds for installation of the service assembly.
5. Use a straight edge to scribe a line around the rail.
6. Cut the damaged rail (1).
7. Remove the damaged section of the rail.

Installation Procedure

NOTE: **Note the size and the location of the precut service part.**

1. Measure 30 mm (1 3/16 in) on the service part and mark cut lines.

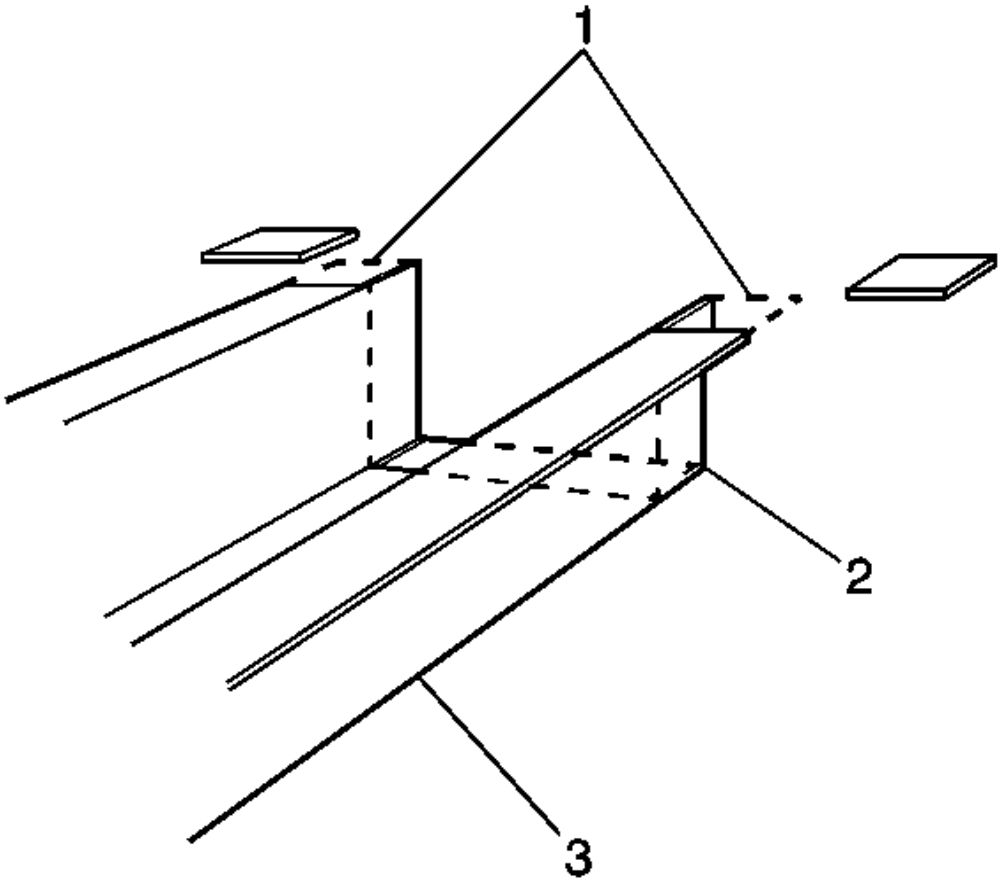


Fig. 98: Cutting Service Rail
Courtesy of GENERAL MOTORS COMPANY

2. Cut and remove 30 mm (1 3/16 in) from the flanges on either side (1) of the service rail (3) to create 30 mm (1 3/16 in) tabs.
3. Cut 5 mm (3/16 in) wide gaps in the bottom corners (2).

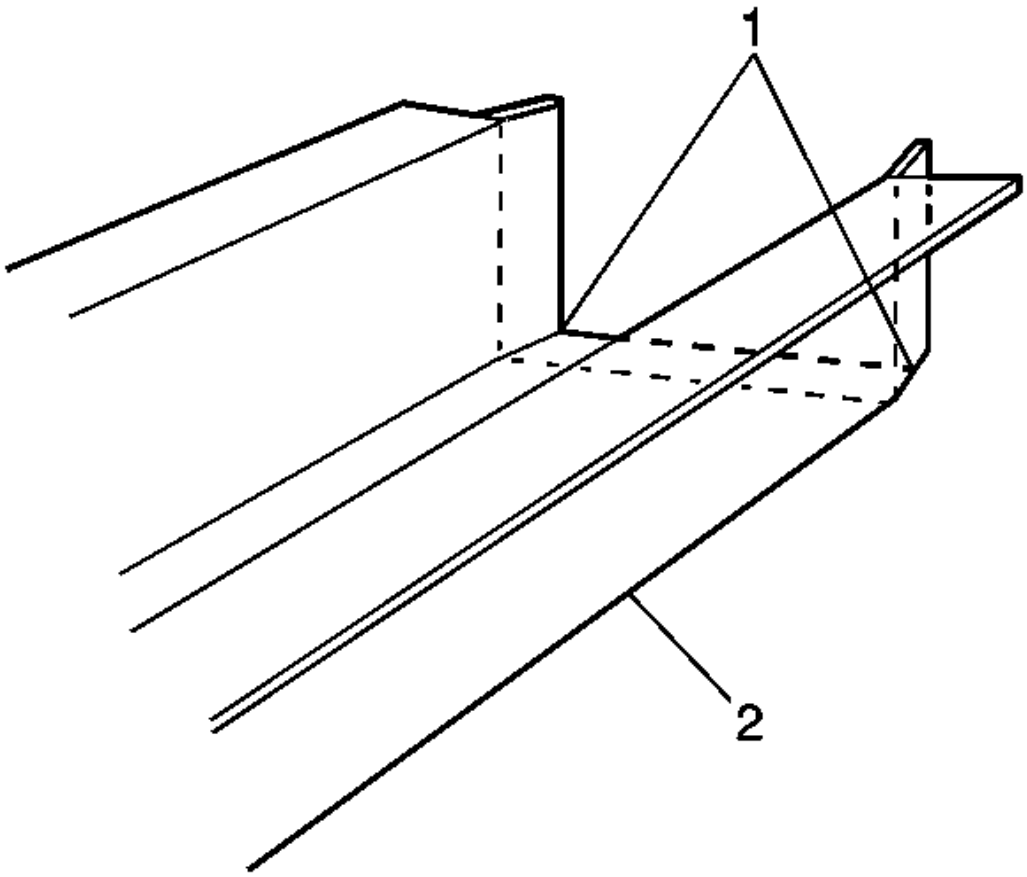


Fig. 99: Service Rail & Tabs
Courtesy of GENERAL MOTORS COMPANY

4. Step the tabs inward (1) to allow the service part (2) to fit inside of the original rail.
5. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.
6. Weld the tabs together along the edges (1).
7. Clean and prepare the mating surfaces.
8. Position the service part.
9. Check fit with 3-dimensional measuring equipment.
10. Plug weld accordingly.

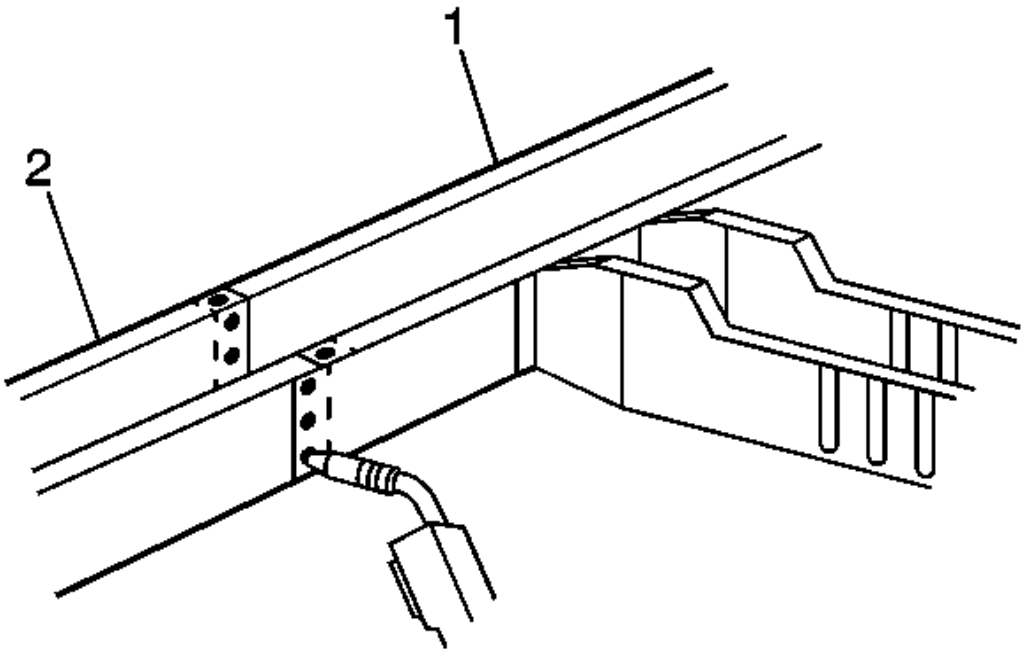


Fig. 100: Stitch Welding Service Rail Joint
Courtesy of GENERAL MOTORS COMPANY

11. Stitch weld along the entire joint (2).
12. Make 25 mm (1 in) welds along the seam with 25 mm (1 in) gaps between.
13. Go back and complete the stitch weld. This will create a solid joint with minimal heat distortion.

NOTE: **The bumper mounting holes must be properly located and drilled. Use 3-dimensional measuring equipment.**

14. Clean and prepare welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

15. Prime with 2-part catalyzed primer.
16. Apply sealers and anti-corrosion materials as necessary.

17. Install all related panels and components.

FLOOR PANEL REPLACEMENT

Removal Procedure

WARNING: Refer to Approved Equipment for Collision Repair Warning .

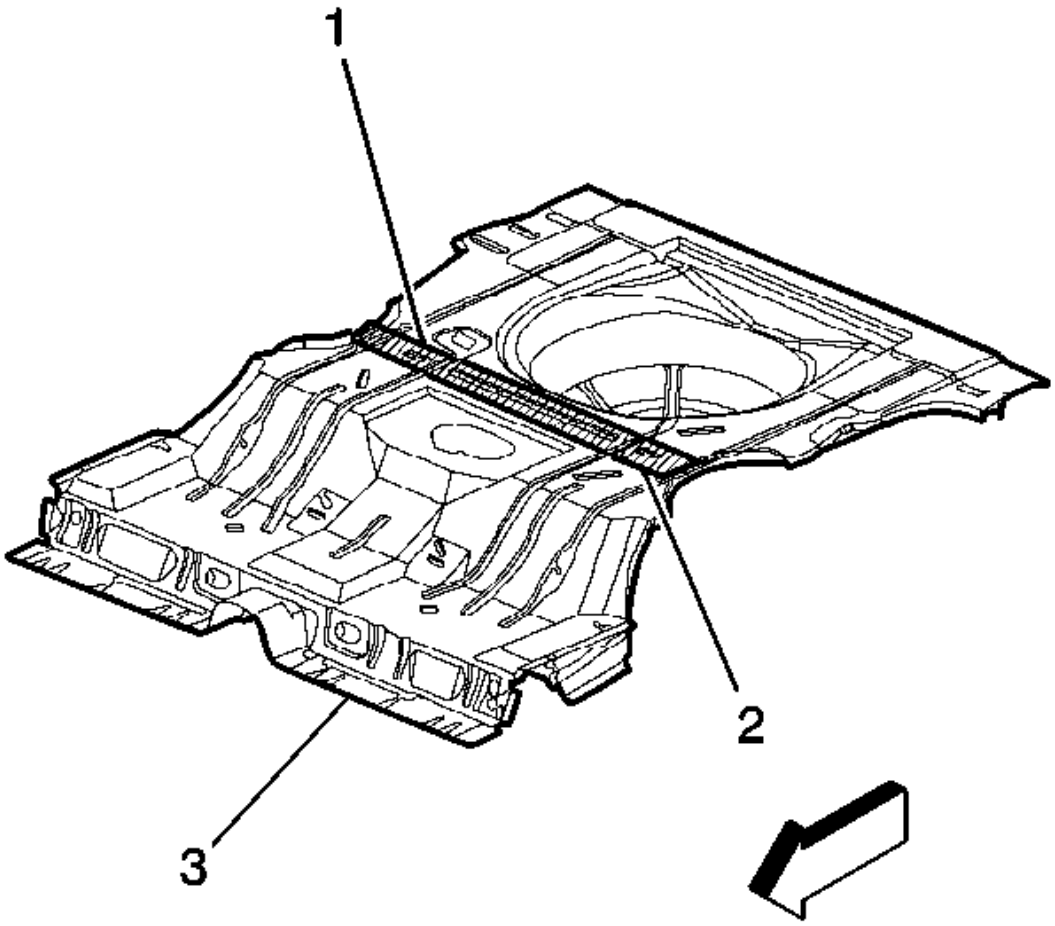


Fig. 101: Floor Panel (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

NOTE: The damaged rear floor should be cut along the rearward edge of the rear crossbar (1), and the service part should be cut so that the new floor section extends to the forward edge of the rear crossbar (2). This allows the two sections to overlap where the crossbar is attached (2). The cut to the damaged floor will be about 790 mm (31 1/8 in) from the rear edge of the floor panel.

1. Remove all related panels and components as necessary, including the following:
   - The rear end panel

- The quarter panels
- The quarter panel extensions

2. Visually inspect and restore as much of the damage as possible.
3. Remove the following as necessary:
    - The sealers
    - The sound deadeners
    - The anti-corrosion materials
4. Locate and mark all factory welds rearward of the rear crossbar including those along the lower edge of the wheelhouse.
5. Note the number and location of welds for installation of the floor service assembly.
6. Drill out all factory welds.

NOTE: **Drill out the factory welds rearward of the crossbar only. Do not drill out the welds attaching the floor to the crossbar.**

7. Cut the damaged floor along the rear edge of the crossbar.
8. Do not damage the following:
    - The rear rails
    - The crossbar
    - The wheelhouse
9. Remove the damaged floor section.

Installation Procedure

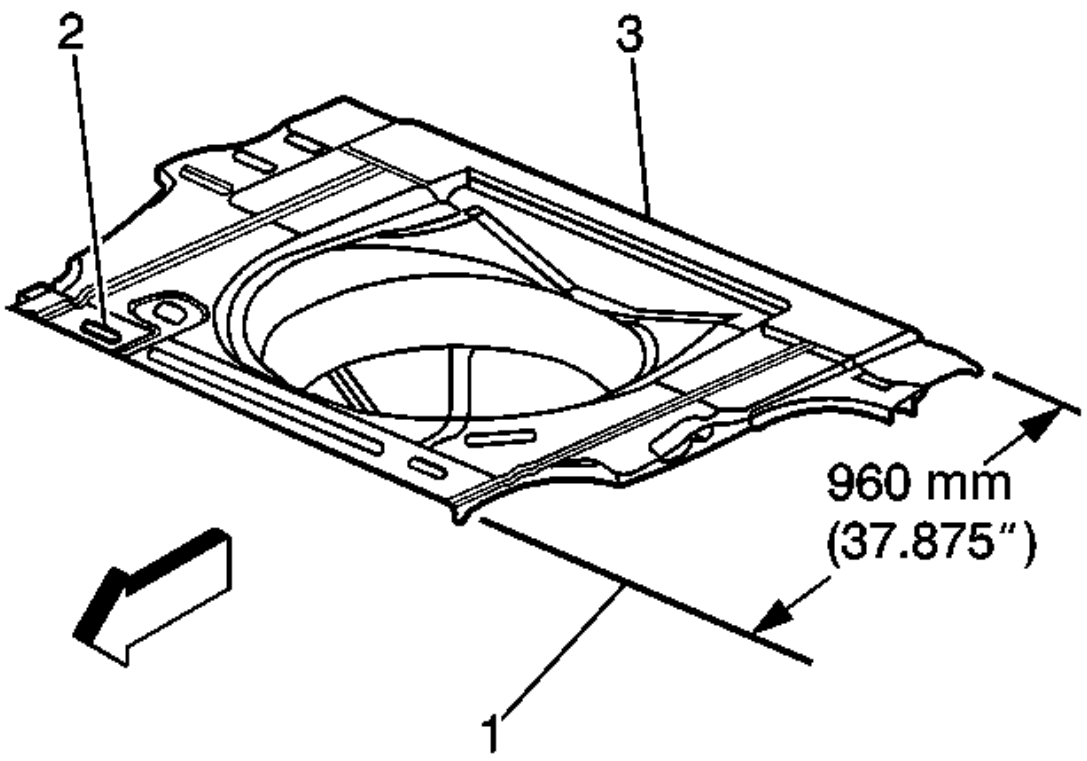


Fig. 102: Rear Floor Service Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The service part is supplied as a rear floor assembly.**

1. Measure 960 mm (37 3/4 in) forward from the rear edge of the rear floor service assembly, mark the location, and cut accordingly.
2. Prepare the mating surfaces as necessary.
3. Check for proper fit.
4. Allow the floor service assembly (3) to overlap the original floor on top of the rear crossbar (2).
5. Mark the location of the rear rail and crossbar flanges on the bottom of the floor service assembly.
6. Drill 8 mm (5/16 in) plug weld holes as necessary in the locations noted from the original floor assembly (3).
7. Drill holes approximately 40 mm (1 in) apart where the new floor section attaches to the rear rail and crossbar flanges.
8. Position the service assembly and check for proper fit.
9. Apply 3M Weld-Thru Coating P/N 05916 or equivalent to all mating surfaces.
10. Plug weld accordingly (1).

11. Clean and prepare all welded surfaces.

NOTE: **Prior to refinishing, refer to GM 4901MD-99 Refinish Manual for recommended products. Do not combine paint systems. Refer to paint manufacturer's recommendations.**

12. Apply 2-part catalyzed primer.

NOTE: **The rear crossbar areas must be properly sealed from moisture and dirt to seal both the front and rear edges of the crossbar as well as the inner seams.**

13. Apply the following materials as necessary:
    - The sealers
    - The sound deadeners
    - The anti-corrosion materials
14. Install all related panels and components.

DESCRIPTION AND OPERATION

DOOR FRAME DESCRIPTION

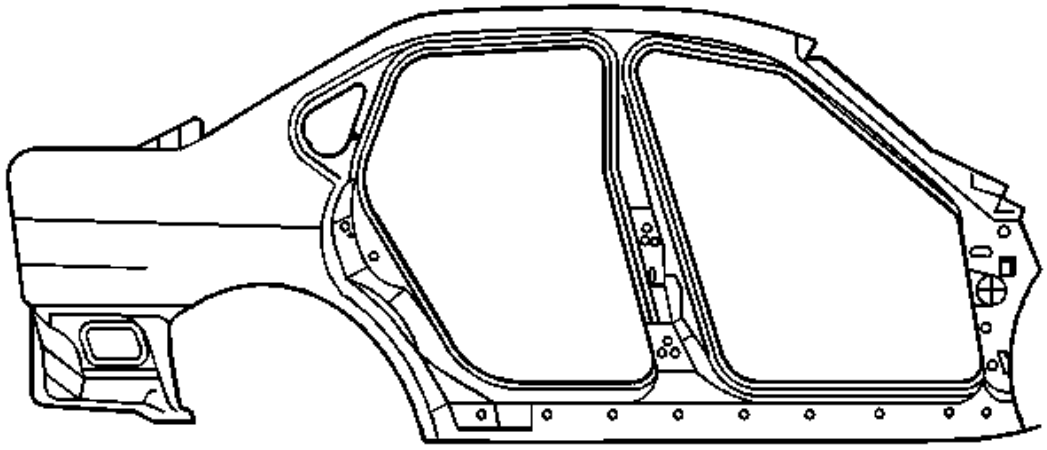


Fig. 103: Outer Door Frame
Courtesy of GENERAL MOTORS COMPANY

The outer door frame can be replaced as a complete service part or various segments can be sectioned. Complete service part replacement requires the removal of the roof panel. Sectioning the outer door frame and inner door frame reinforcement is usually much faster and more cost effective. Since the outer door frame is manufactured as a single component, service parts for sectioning must be cut from the service panel and modified as necessary. Sectioning should take place in shaded areas only.

HIGH STRENGTH LOW ALLOY STEEL

This information provides repair recommendations and general guidelines for steel classified as High Strength Low Alloy Steel, also known as HSLA. This type of steel normally has a tensile strength range from 300-700 MPa.

General Motors recommends the following when repairing or replacing this type of steel during collision repair.

Recommended Repairs

- Cold repairs can be performed on this type of steel, unless the damage includes kinks. If the damage includes kinks, the part should be replaced.

- Controlled use of heat can be used to repair damage, if the heat does not exceed 650Â°C (1200Â°F). The heat should be applied a maximum of 2 times, for up to 90 seconds.
- Sectioning or partial replacement of this type of steel is recommended only at approved locations, in a specific sectioning procedure.
- When recommended in a specific sectioning procedure, this type of steel can be used as a weld plate for reinforcing the sectioning location.
- Squeeze Resistance Spot Welding can be used to replace factory spot welds, where applicable.
- MIG plug welding and MIG stitch welding can be used on this type of steel.
- MIG Brazing can be used on this type of steel.

MILD STEEL

This information provides repair recommendations and general guidelines for steel classified as Mild Steel. This type of steel normally has a tensile strength less than 270 MPa. This includes the common steel names of:

- Mild Steel
- Bake Hardenable Steel (BH)
- Solid Solution Strengthened Steel

General Motors recommends the following when repairing or replacing this type of steel during collision repair.

Recommended Repairs:

- Cold repairs can be performed on this type of steel, unless the damage includes kinks. If the damage includes kinks, the part should be replaced.
- Controlled use of heat can be used to repair damage, if the heat does not exceed 650Â°C (1200Â°F). The heat should be applied a maximum of 2 times, for up to 90 seconds.
- Sectioning or partial replacement of this type of steel is recommended only at approved locations, in a specific sectioning procedure.
- When recommended in a specific sectioning procedure, this type of steel can be used as a weld plate for reinforcing the sectioning location.
- Squeeze Resistance Spot Welding can be used to replace factory spot welds, where applicable
- MIG plug welding and MIG stitch welding can be used on this type of steel.
- MIG Brazing can be used on this type of steel.

RADIATOR SUPPORT DESCRIPTION

Radiator Support Assembly

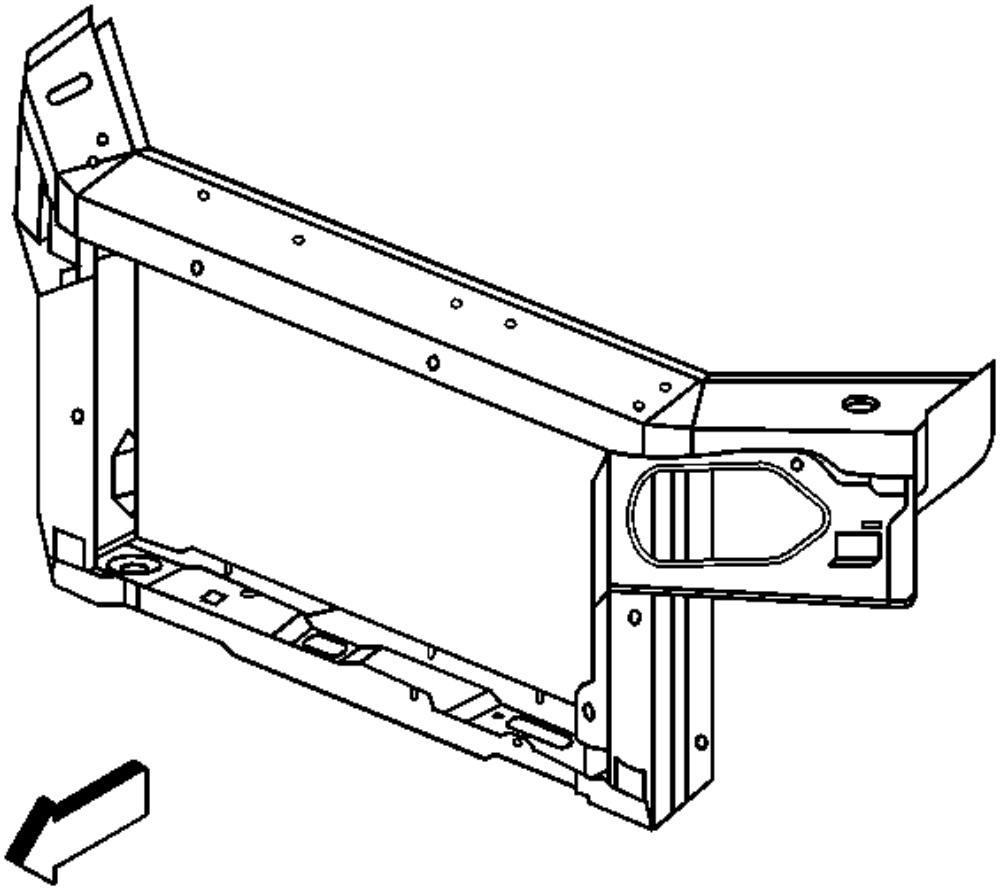


Fig. 104: Radiator Support
Courtesy of GENERAL MOTORS COMPANY

The radiator support can be serviced as a complete assembly.

The radiator is made up of 5 major components:

- Four upper
- One lower

Upper Radiator Support

The upper radiator support is an assembly consisting of four components:

- Two-piece upper tie bar
- Left and Right engine compartment front panels

Lower Radiator Support

The lower radiator support is available as a separate replaceable component if necessary.

Article GUID: A00737239

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Door Frame Screws	2 N.m	18 lb in
Rear Spoiler Nuts	10 N.m	89 lb in
Rocker Panel Molding Screws	2 N.m	18 lb in

REPAIR INSTRUCTIONS

FRONT FENDER EMBLEM/NAMEPLATE REPLACEMENT

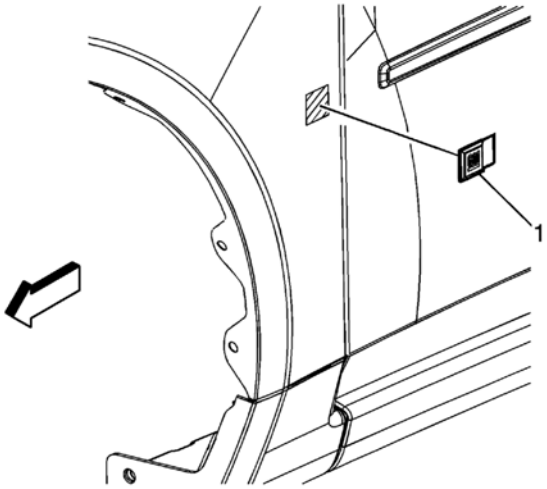


Fig. 1: Front Fender Emblem/Nameplate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Fender Nameplate • When removing protective liners from adhesive backed nameplates, be careful not to touch the tape with hands and do not allow the tape to come in contact with dirt or any foreign matter prior to adhesion. • Use a **J 25070** heat gun 500-750Â°F or equivalent to remove the old nameplate. Clean all the adhesive residue from the fender, wipe the surface dry with a clean lint-free towel prior to installing new nameplate. **Special Tools**

Callout	Component Name
	J 25070 Heat Gun 500-750Â°F

FRONT SIDE DOOR EMBLEM/NAMEPLATE REPLACEMENT

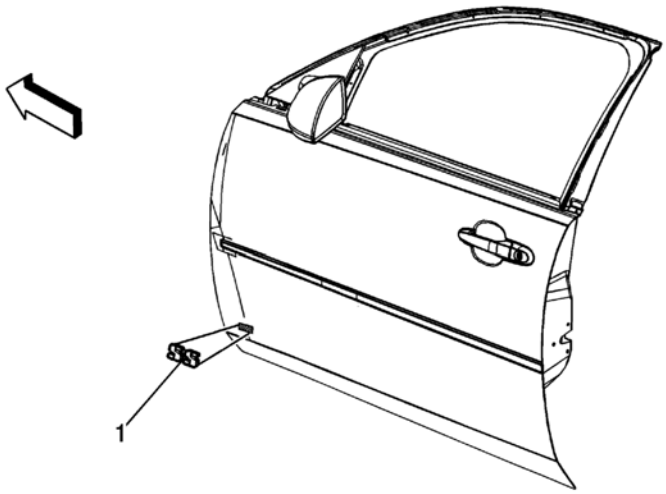


Fig. 2: Door Emblem/Nameplate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Emblem Assembly, Front Door IMPORTANT: When removing protective liners from adhesive backed emblems, be careful not to touch tape with hands and do not allow tape to come in contact with dirt or any foreign matter prior to adhesion. **TIP:** Use a **J 25070** heat gun 500-750Â°F or equivalent to remove the old emblem. Clean all the adhesive residue from the door, wipe surface dry with a clean lint-free towel prior to installing new emblem.

FRONT SIDE DOOR WINDOW FRAME REAR APPLIQUE AND OUTER WEATHERSTRIP REPLACEMENT (IMPALA LIMITED)

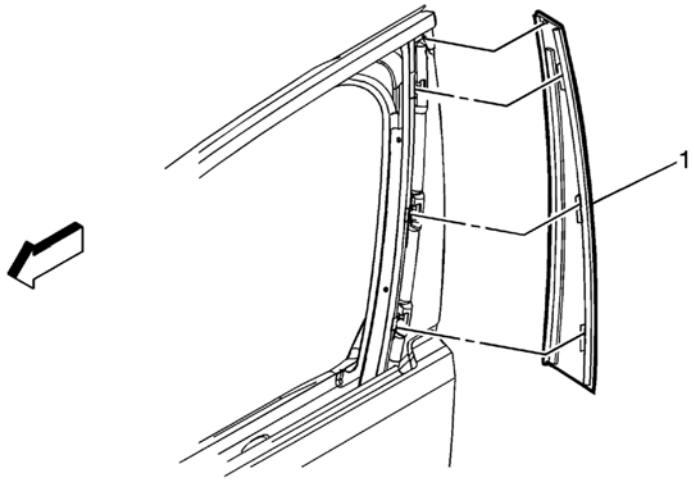


Fig. 3: Front Door Frame Applique/Runchannel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** .	
1	Front Side Door Window Frame Applique **TIP:** The applique is secured with 3 metal clips located in the glass run channel.

REAR COMPARTMENT LID APPLIQUE REPLACEMENT

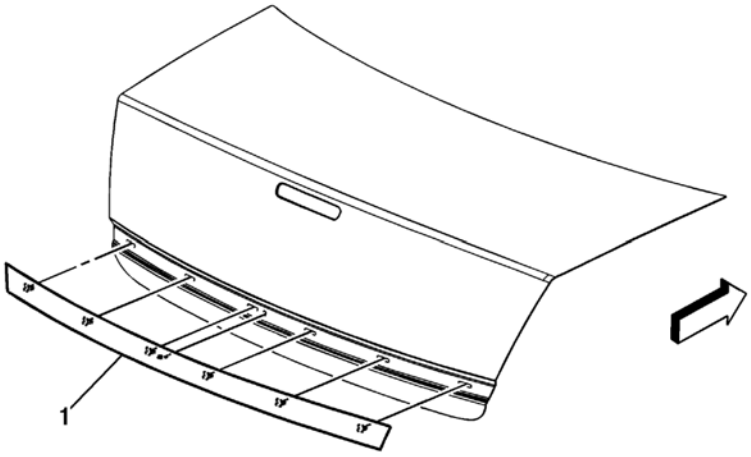


Fig. 4: Rear Compartment Lid Applique
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Applique, Rear Compartment **TIP:** Use a flat-bladed tool and gently pry the applique from the compartment lid.

REAR SIDE DOOR WINDOW FRAME FRONT APPLIQUE AND FRONT CHANNEL REPLACEMENT

Removal Procedure

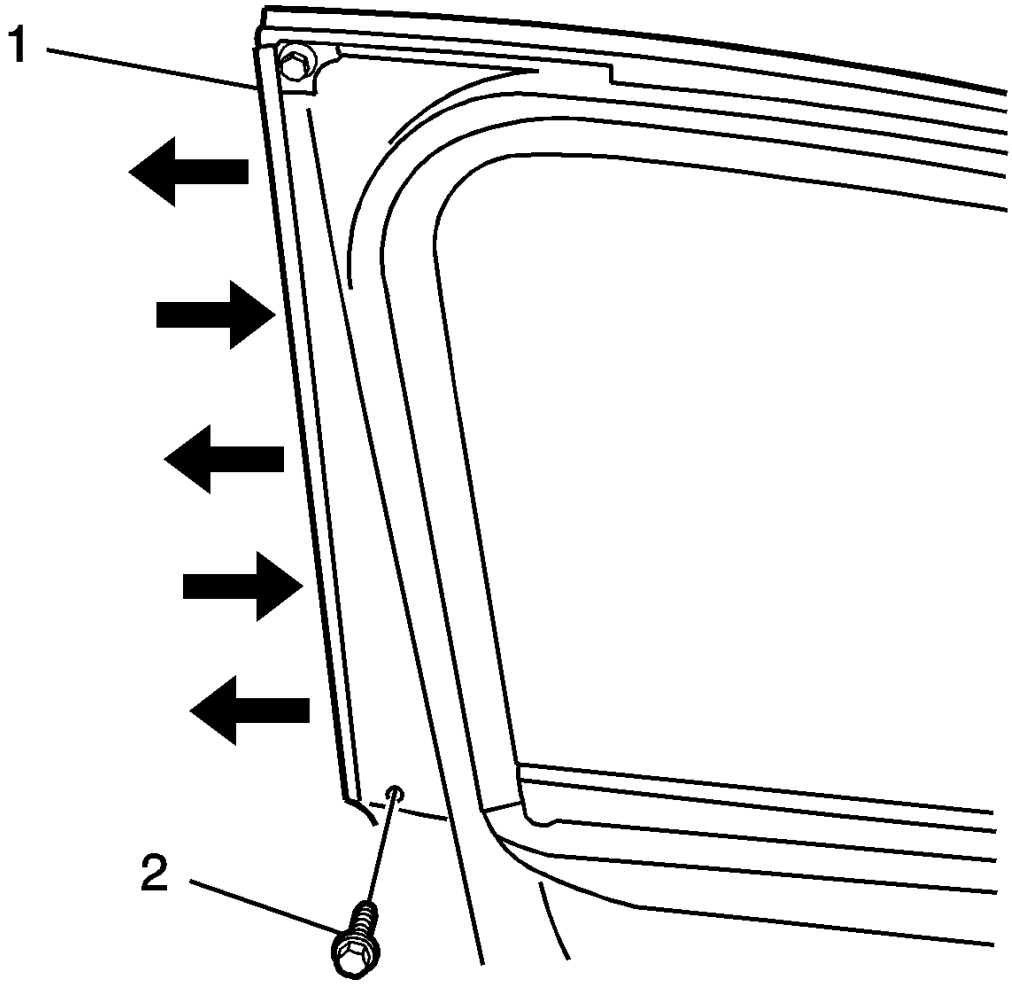


Fig. 5: Inside Door Frame Screws & Weatherstrip (Front Door)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: To avoid paint damage, protect the area surrounding the part which you are removing or installing.

1. Apply masking tape to the door frame and applique.
2. Lower the window to the full down position.
3. Remove the window channel retainer. Refer to **Rear Side Door Window Channel Retainer Replacement** .
4. Remove the screws (1, 2) from the upper and lower corners of the inside door frame.
5. Pull the window run channel weatherstrip out of the retainer and reposition it in order to access to the applique rivets.

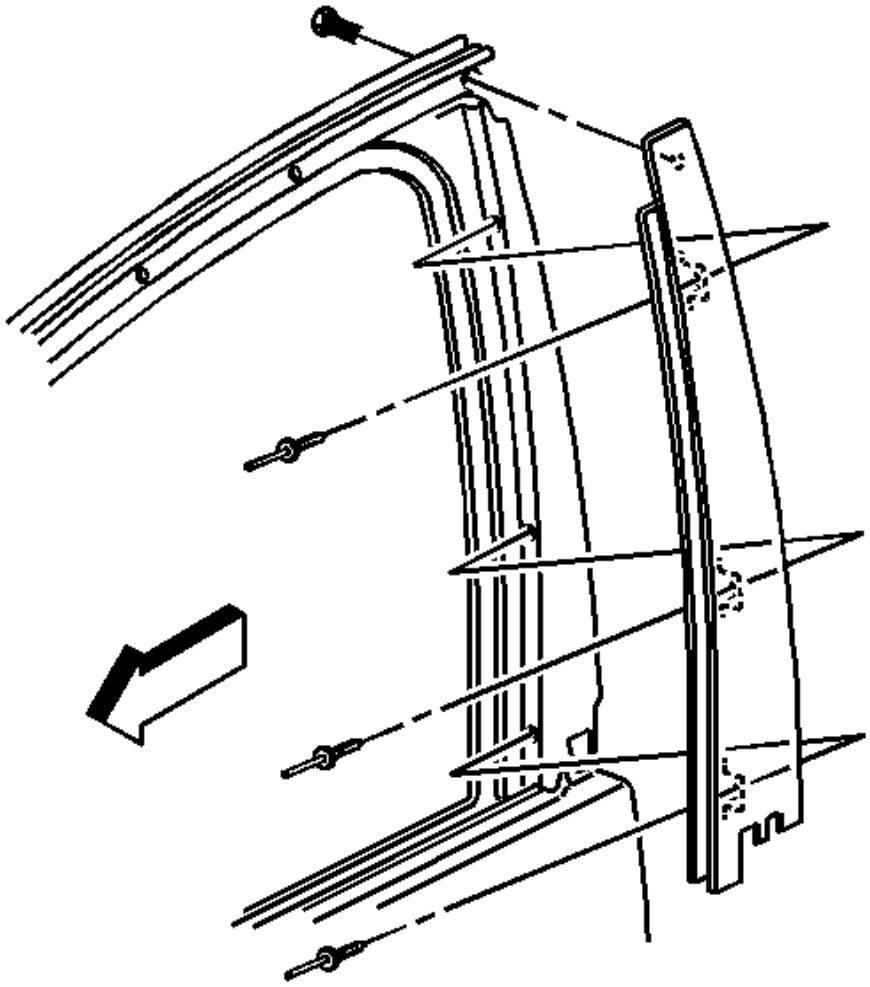


Fig. 6: Window Channel Retainer Rivets & Door Frame Applique/Run Channel (Front Door)
Courtesy of GENERAL MOTORS COMPANY

6. Drill out the 4 mm (5/32 in) rivets along the inside edge of the window channel retainer.
7. Pull upward to release the applique from the door frame.

Installation Procedure

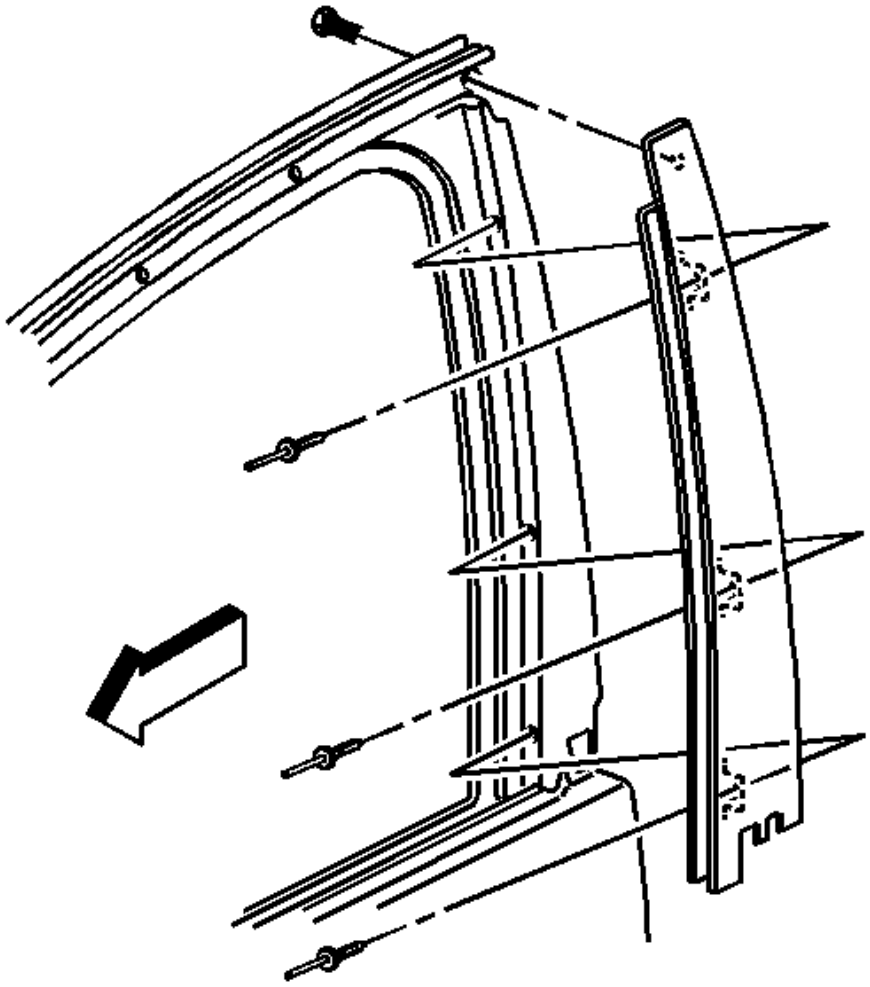


Fig. 7: Window Channel Retainer Rivets & Door Frame Applique/Run Channel (Front Door)
Courtesy of GENERAL MOTORS COMPANY

1. Install the applique to the door frame.
2. Install the new 4 mm (5/32 in) rivets along the inside edge of the window channel retainer to secure the applique to the door frame.

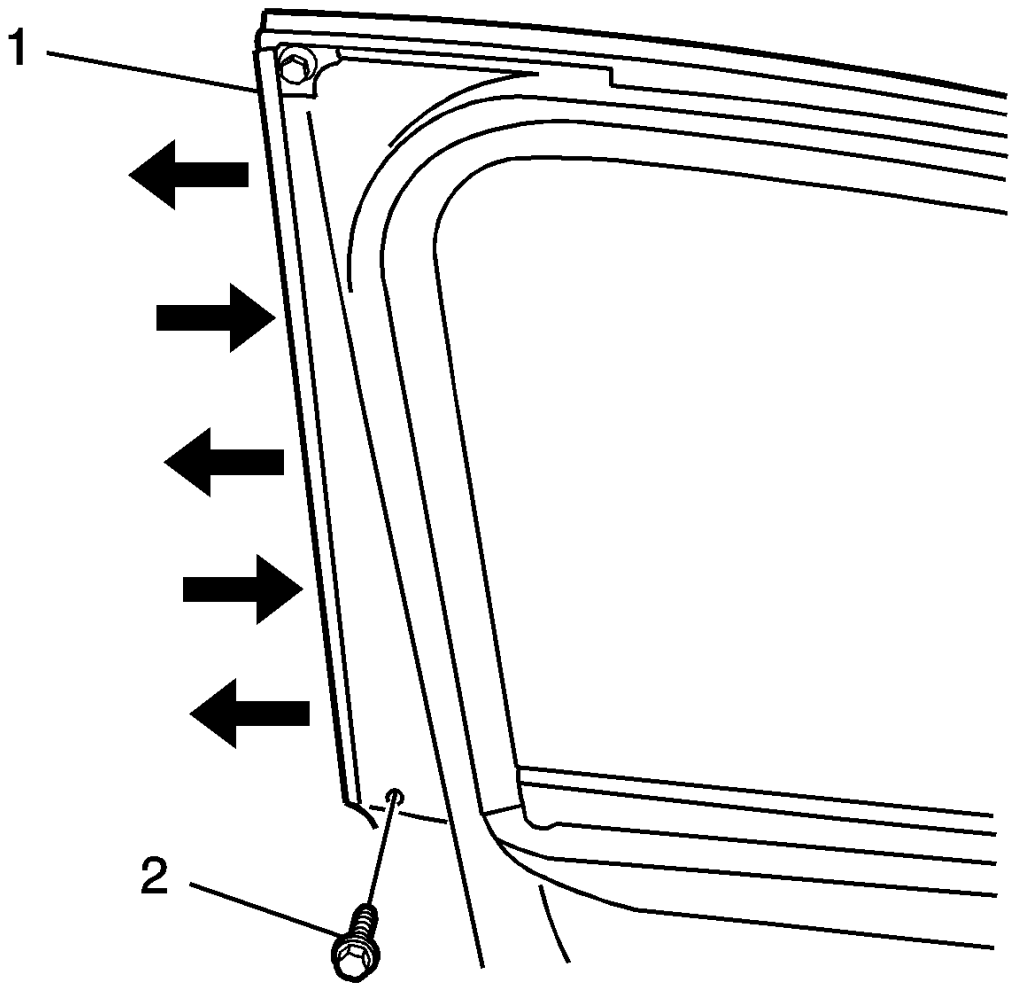


Fig. 8: Inside Door Frame Screws & Weatherstrip (Front Door)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the screws (1, 2) to the upper and lower corners of the inside door frame.

   Tighten

   Tighten the screws to 2 N.m (18 lb in).

4. Install the window channel retainer. Refer to **Rear Side Door Window Channel Retainer Replacement** .
5. Install the window weatherstrip.
6. Remove masking tape.
7. Inspect the window for proper operation.

DECAL OR STRIPE REPLACEMENT

A pressure sensitive adhesive adheres the stripes and decals to the painted surfaces.

Use a wetting solution in order to lift and position the stripe or decal during installation.

A wetting solution ensures a better bond between the stripe or decal and the panel assembly.

If the metal or underlying painted surfaces are damaged, repair and refinish the metal as needed before you install the stripes or decals.

CAUTION: **Striping material highlights vehicle surface imperfection. All dings, rough metal, paint defects and uneven two-tone paint breaklines must be eliminated before stripe/decal application. Freshly painted surfaces must be allowed to dry thoroughly before installing stripe or decal. Residual solvents in fresh painted surfaces can lead to subsequent blistering problems if stripe or decal is applied before complete release of solvents.**

Maintain body surface and decal temperature between 21-38Â°C (70 -100Â°F) during installation.

NOTE: **DO NOT apply the decals when the body surface and the decal temperatures are below 21Â°C (70Â°F).**

Use auxiliary heat sources to warm the body surface and decals if the temperature is less than 21Â°C (70Â°F).

CAUTION: **Use of harsh chemicals when cleaning can damage exterior lamps. Suggested cleaners are a mild soap and water, or Varnish Makers and Painters (VM&P) Naptha. VM&P Naptha is a specific type of naptha and should not be substituted by any other naptha.**

NOTE: **When you apply stripes or decals on flexible surfaces (fascias, etc.), use the WET method. The WET method reduces the formation of bubbles under the decal due to the outgassing potential of the flexible materials.**

You may apply stripes and decals dry. If the stripe or decal shows bubbles, use the "wet" method. Use the "wet" method for large graphics packages.

The following equipment and materials, or the equivalent, are necessary when making a quality stripe or decal installation:

- Wetting solution foaming type window cleaner that does not contain ammonia
- Silicone, wax and grease remover
- Varnish Makers and Painters (VM&P) naphtha
- Isopropyl alcohol
- Squeegee about 75-100 mm (3-4 in) wide, plastic or hard rubber. Deburr any sharp or rough edges in order to prevent scratching of the stripe or decal
- Water bucket and sponge or spray bottle
- Sandpaper 800 grit or finer, wet or dry type
- Heat gun
- Clean, lint-free wiping cloth
- Sharp knife or razor blade

- Scissors
- Fine pin or needle
- Marking pencil

Removal Procedure

1. Remove the necessary molding and trim panel.
2. Wash and clean the following items using Liquid Wash and Wax GM P/N 1052870 or the equivalent:
    - The repair surfaces
    - The adjacent panel
    - The openings
3. Remove the following components:
    - The molding attaching clips
    - The handles
    - The sidemarker reflector
    - Other stripe or decal overlapping parts

    CAUTION: To avoid damaging the paint finish, do not use pointed or sharp instruments to remove the stripe or the decal.

4. Use heat in order to remove the stripe or decal. Start at one edge and peel the stripe or decal from the panel surface.
5. Remove all traces of adhesive residue from the painted surfaces using the following items:
    - Silicone, wax and grease remover
    - Varnish makers and painters (VM&P) naphtha

Installation Procedure

1. Prepare the surface.

    CAUTION: To prevent possible vehicle, stripe or decal damage, always refer to manufacturer's packaged instructions.

    NOTE: If the area where you apply the stripe or decal has been refinished, remove any imperfections that may show through the stripe or decal.

2. Clean the painted surface with the following items:
    - Silicone
    - Wax
    - Grease remover
3. Clean the area where you apply the stripe or decal. Use a 50/50 mixture of isopropyl alcohol and water.
4. Wipe the panel surface with a clean cloth while the solvent drys.
5. Apply the wetting solution to the area where you install the stripe or decal.

NOTE: **DO NOT touch the adhesive backing of the stripes.**

6. Use the wetting solution on the adhesive side of the stripe or decal.
7. Remove the backing material of the stripe or decal as needed.
8. Install the stripe or decal to the panel.
9. Working from the center if possible, squeegee the stripe or decal into position.
10. Apply additional wetting solution in order to ease installation of the stripe or decal.

    Apply a soapy wetting solution on the top side of the stripe or decal for the following reasons:

    - In order to ease the pull of the squeegee on the stripe or decal
    - In order to eliminate the possibility of damage
11. Apply heat to the stripe or decal at recessed areas.
12. Press the stripe or decal into recess in order to obtain a firm bond.
13. Use adequate light reflection in order to detect any irregularities in the stripe or decal that may have developed during installation.

NOTE: **DO NOT use a razor blade or a knife edge.**

14. Use one of the following items in order to remove all bubbles by piercing:
    - A safety pin
    - A needle
    - A tool with the same size piercing tip
15. Pierce a bubble on the outer edge.
16. Force the air out from the opposite edge with the blade of the squeegee.
17. Install all previously removed components. Clean the components as needed.

FRONT BUMPER FASCIA EMBLEM/NAMEPLATE REPLACEMENT (BASE)

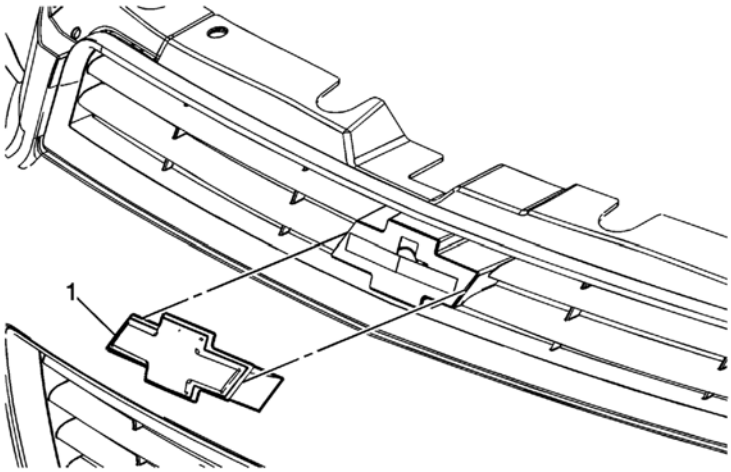


Fig. 9: Front Bumper Fascia Emblem/Nameplate (Base)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Plate Assembly, Front Bumper Fascia Name IMPORTANT: When removing protective liners from adhesive tape, be careful not to touch tape with hands and do not allow tape to come in contact with dirt or any foreign matter prior to adhesion. **TIP:** Use a **J 25070** heat gun 500-750Â°F or equivalent to remove the old nameplate. Clean all adhesive from front bumper fascia, wipe surface dry with a clean lint-free towel prior to installing new nameplate.

QUARTER WINDOW REAR APPLIQUE EMBLEM REPLACEMENT (BASE)

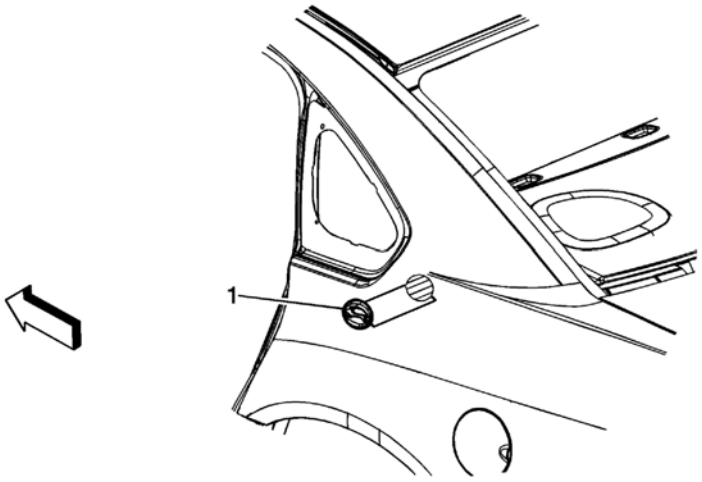


Fig. 10: Quarter Window Rear Applique Emblem (Base)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Quarter Window Rear Applique **Procedure** 1. Use a **J 25070** heat gun 500-750Â°F or equivalent to remove the old quarter window rear applique. Clean all adhesive from the quarter panel, wipe the surface dry with a clean lint-free towel prior to installing the new quarter window rear applique. 2. Apply the new quarter window rear applique in the same location as shown. 3. Apply pressure to the new quarter window rear applique to ensure full adhesion is made to the quarter panel. **TIP:** When removing protective liners from adhesive tape backed nameplates, be careful not to touch tape with hands and do not allow tape to come in contact with dirt or any foreign

Callout	Component Name
	matter prior to adhesion. **Special Tools** **J 25070** Heat Gun 500-750Â°F

QUARTER WINDOW REAR APPLIQUE EMBLEM REPLACEMENT (50TH ANNIVERSARY EDITION)

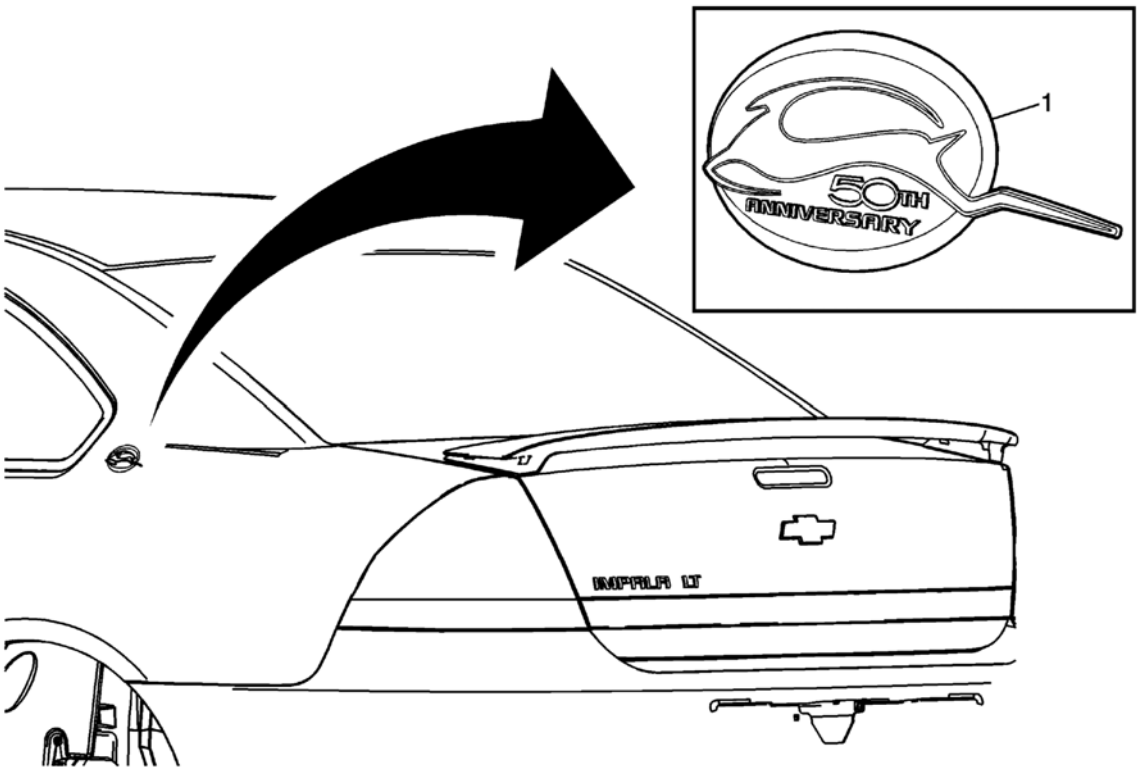


Fig. 11: Quarter Window Rear Applique Emblem (50th Anniversary Edition)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Quarter Window Rear Applique **Procedure** 1. Use a **J 25070** heat gun 500-750Â°F or equivalent to remove the old quarter window rear applique. Clean all adhesive from the quarter panel, wipe the surface dry with a clean lint-free towel prior to installing the new quarter window rear applique. 2. Apply the new quarter window rear applique in the same location as shown. 3. Apply pressure to the quarter window rear applique to ensure full adhesion is made to the quarter panel. **TIP:** When removing protective liners from adhesive tape backed nameplates, be careful not to touch tape with hands and do not allow tape to come in contact with dirt or any foreign

Callout	Component Name
	matter prior to adhesion. **Special Tools** **J 25070** Heat Gun 500-750Â°F

REAR COMPARTMENT LID EMBLEM/NAMEPLATE REPLACEMENT (FFU)

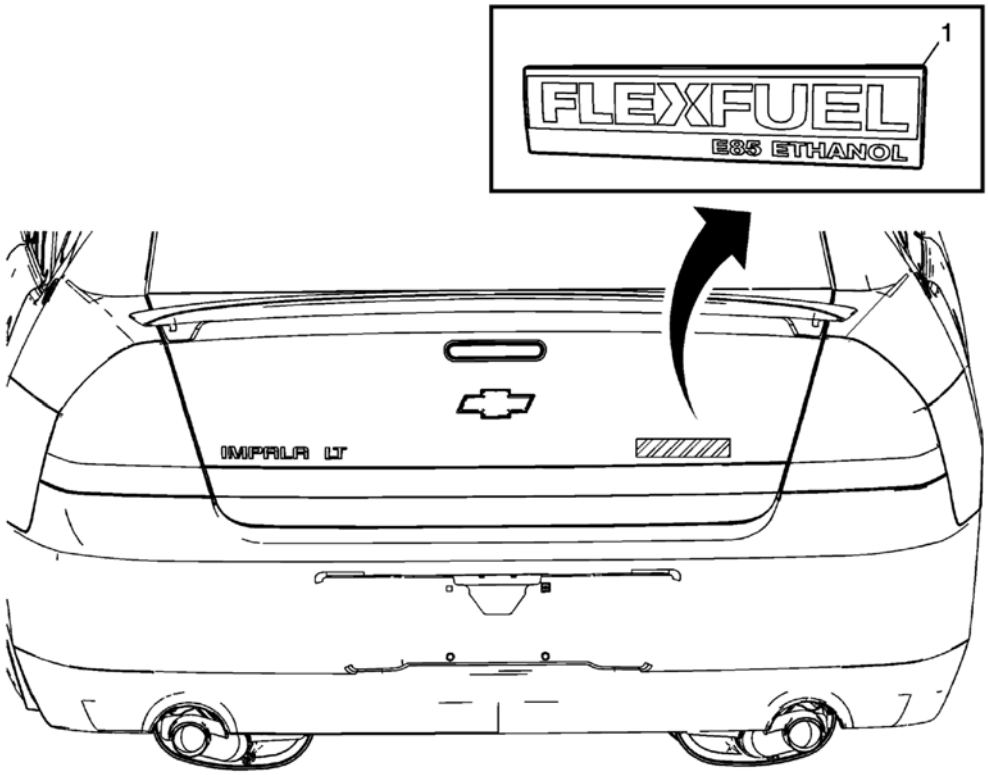


Fig. 12: Rear Compartment Lid Emblem/Nameplate (FFU)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Flex Fuel Badge **CAUTION:** **Refer to** **Exterior Trim Emblem Removal Caution .** **Procedure** 1. The part and surface should be 21Â°C (70Â°F) prior to installation. The vehicle should remain 21Â°C (70Â°F) for one hour after assembly to allow adhesive to develop sufficient bond strength. 2. Use a **J 25070** heat gun 500-750Â°F or equivalent to remove the old nameplate.

Callout	Component Name
	3. Clean all adhesive from rear compartment lid panel and wipe the surface dry with a clean lint-free towel prior to installing the new name plate. 4. When removing protective liners from the adhesive tape, be careful not to touch tape with hands and do not allow tape to come in contact with dirt or any foreign matter prior to adhesion. 5. Close the rear compartment lid prior to installing the nameplate. 6. Using the palm of the hand, wet out the name plate to the rear compartment lid panel and ensure full adhesion of the name plate is made. **Special Tools** **J 25070** Heat Gun 500-750Â°F

REAR COMPARTMENT LID EMBLEM/NAMEPLATE REPLACEMENT (GRAPHITE)

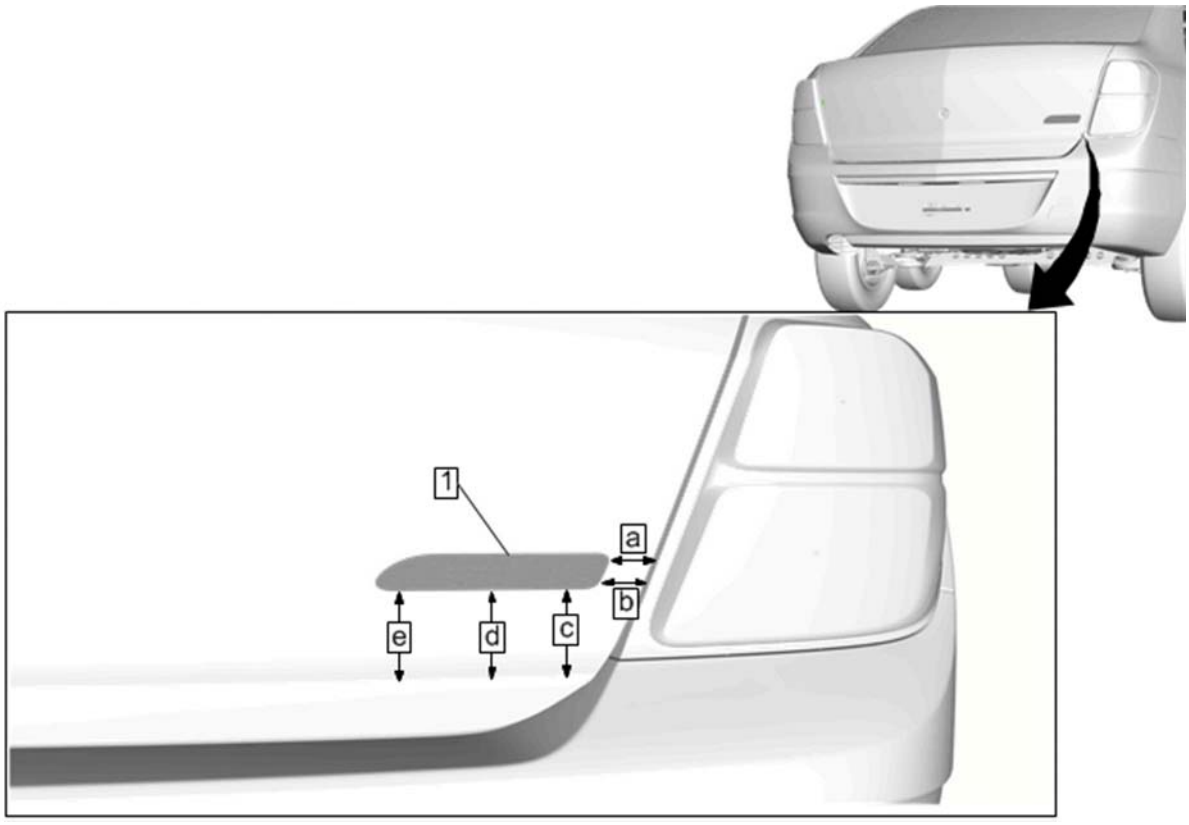


Fig. 13: Rear Compartment Lid Emblem/Nameplate (Graphite)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Liftgate Emblem/Nameplate **CAUTION:** **Refer to** **Exterior Trim**

Callout	Component Name
	Emblem Removal Caution . **Procedure** 1. Using a heat gun in a circular motion, warm the emblem/nameplate in order to help to remove the adhesive tape backing from the liftgate. 2. Clean any left over tape residue with a 50/50 mixture by volume of isopropyl alcohol and clean drinkable water. 3. Partially peel the adhesive tape liner from the backside of the emblem/nameplate before applying to the liftgate. 4. Using a clean cotton towel and hand pressure, wet out the emblem/nameplate to the liftgate. **Measurement** 1. A equals the measurement from the edge of the rear compartment lid to the upper side point of the graphite emblem. (26.3 mm) 2. B equals the measurement from the edge of the rear compartment lid to the lower side point of the graphite emblem. (27.3 mm) 3. C equals the measurement from the bottom edge of the graphite emblem to the center of the rear compartment cavity edge line. (77.8 mm) 4. D equals the measurement from the bottom edge of the graphite emblem to the center of the rear compartment cavity edge line. (79.5 mm) 5. E equals the measurement from the bottom edge of the graphite emblem to the center of the rear compartment cavity edge line. (80.2 mm)

FASCIA GRILLE REPLACEMENT (IMPALA LIMITED)

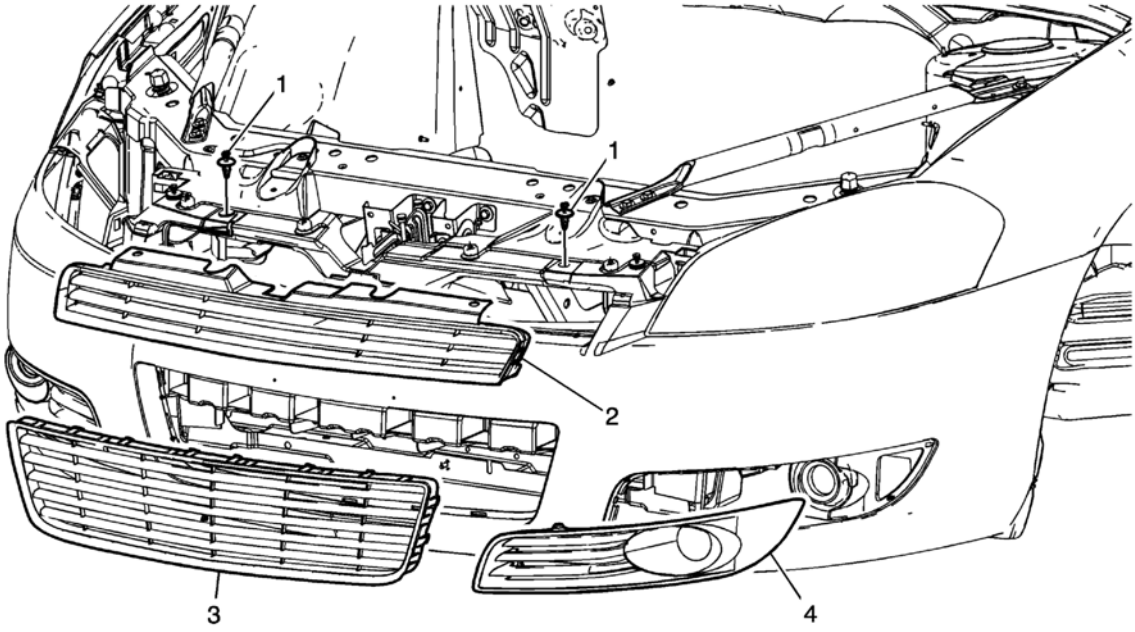


Fig. 14: Fascia Grille
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** .	
1	Retainer, Front Fascia Grille (Qty: 2)
2	Grille, Upper Fascia
3	Grille, Center
4	Grille, Side

FRONT SIDE DOOR MOLDING REPLACEMENT (IMPALA LIMITED)

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedure** Using a **J 25070** heat gun 500-750Â°F in a circular motion, warm the door bodyside molding prior to removal. Carefully clean the body panel thoroughly prior to bonding the new front bodyside molding to the door.	
1	Molding Asm, Bodyside Door **Tip** 1. Upon installation of the new front door bodyside molding, position the pin on the backside of the molding to the round hole at the front edge of the door first then to the oval holes. 2. Remove the protective liner from the backside of the molding adhesive tape.

Callout	Component Name
	3. Ensure full adhesion of the molding to the door using the palm of the hand with a dry towel working from the front edge of the door to the rear, down the entire molding.

REAR SIDE DOOR MOLDING REPLACEMENT (IMPALA LIMITED)

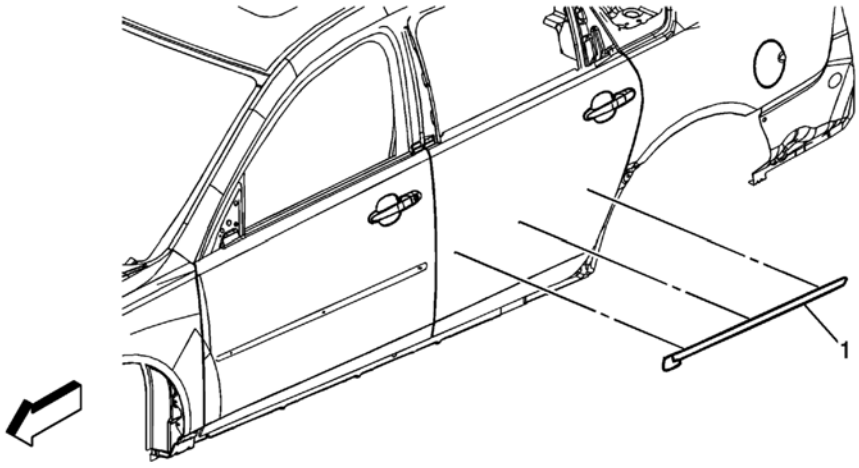


Fig. 15: Rear Door Body Side Molding
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedure** Use a **J 25070** heat gun 500-750Â°F in a circular motion to warm the door bodyside molding prior to removal. Carefully clean the body panel thoroughly prior to bonding the new bodyside molding to the door.	
1	Molding Asm, Bodyside Door **Tip:** 1. Upon installation of the new rear door molding, position the pin on the frontside of the molding to the round hole first at the front edge of the door then to the oval holes. 2. Remove the protective liner from the backside of the molding adhesive tape. 3. Ensure full adhesion of the molding to the door using the palm of the hand with a dry towel working from the rear edge of the door forward down the entire molding.

ROCKER PANEL MOLDING REPLACEMENT (BASE)

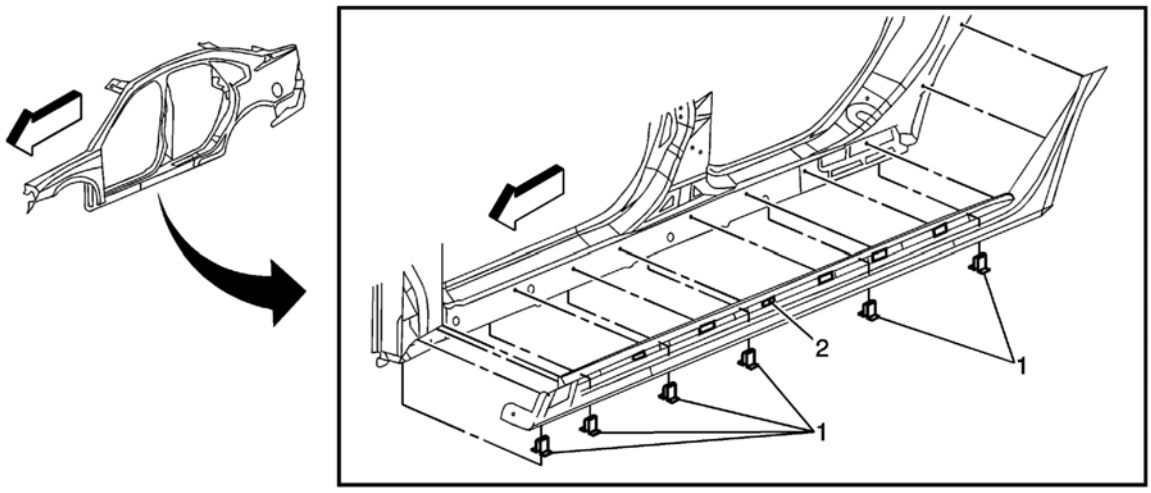


Fig. 16: Rocker Panel Molding (Base)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedure** Open both doors on the side that the lower rocker panel molding is being removed from.	
1	Clips, Rocker Panel Integral (Qty: 6) Release the lower integral clips by pulling downward at each location prior to releasing the upper retainers from the lower rocker.
2	Retainers, Rocker Panel (Qty: 12) **TIP:** Release the lower 12 retainers from the rocker by pulling panel outward and removing the lower rocker panel.

ROOF WELD JOINT REVEAL MOLDING REPLACEMENT

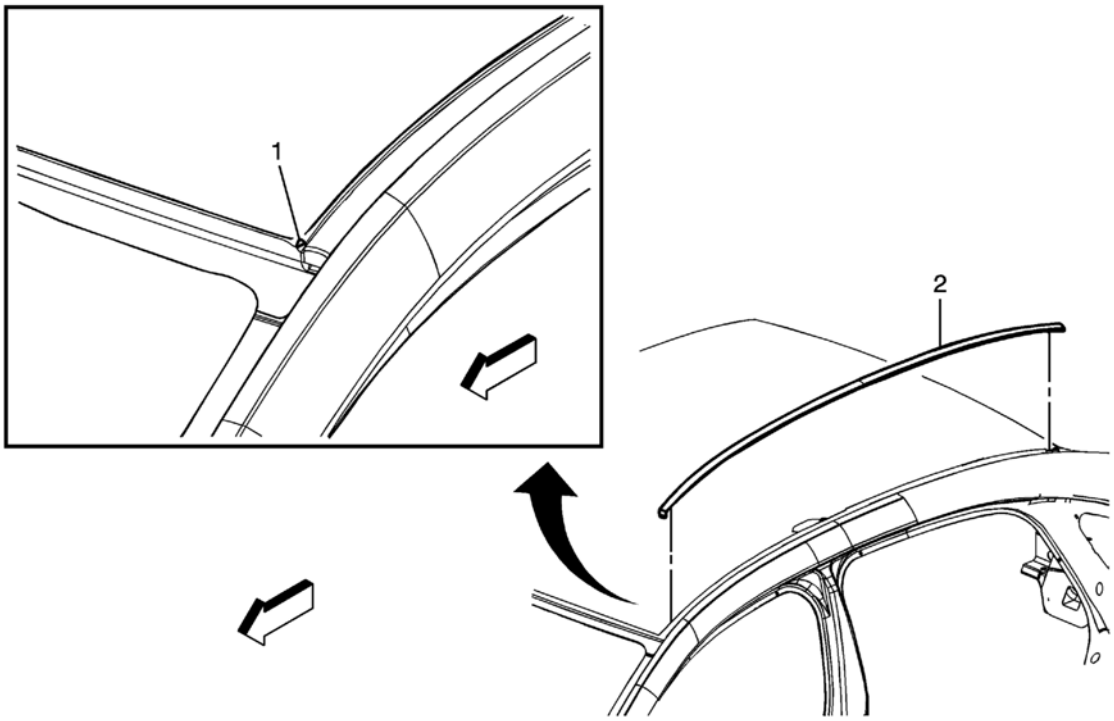


Fig. 17: Roof Weld Joint Reveal Molding
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedure** Use a **J 25070** heat gun 500-750Â°F in a circular motion to warm the roof ditch molding prior to removal. Carefully clean the roof panel ditch thoroughly prior to bonding the new ditch molding to the roof panel.	
1	Molding Assembly, Roof Ditch **Tip** 1. Upon installation of the new ditch molding, engage the front edge of the molding into the clip at the front roof header. 2. Remove the protective liner from the backside of the molding adhesive tape surface. 3. Ensure full adhesion of the ditch molding to the roof using the palm of the hand with a dry towel or a roller type tool working from the front of the vehicle to the rear. 4. Engage the rear end of the molding to the retainer clip in the roof ditch.
2	Molding Assembly, Roof Ditch

REAR SPOILER REPLACEMENT (T43)

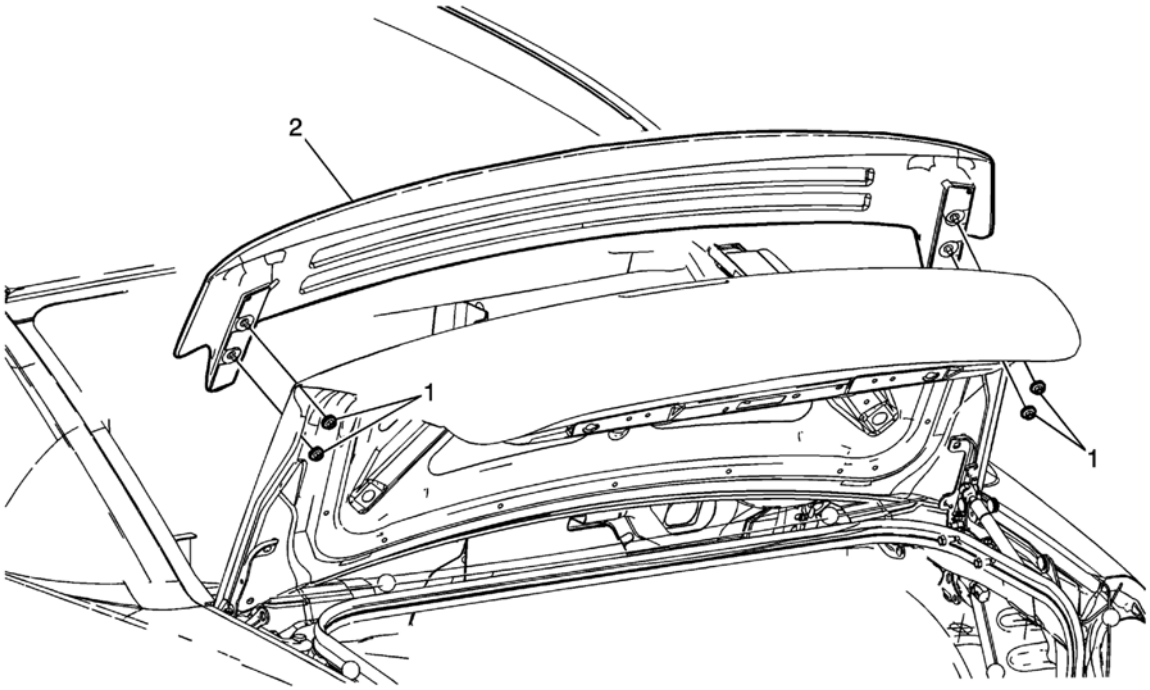


Fig. 18: Rear Spoiler (T43)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Spoiler Nuts (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Rear Spoiler

Article GUID: A00737235

REPAIR INSTRUCTIONS

ELIMINATING UNWANTED ODORS IN VEHICLES

GM Vehicle Care Odor Eliminator, GM P/N 88861431 (Canadian P/N 88861436), may control or eliminate odors in the interior and luggage compartment areas of GM vehicles. This non-toxic, biodegradable, odorless product has been shown to greatly reduce or remove the following types of odor:

- Objectionable smells of mold and mildew resulting from vehicle water leaks
- Customer created odors, such as smoke

You may safely use GM Vehicle Care Odor Eliminator on fabrics, vinyl, leather, carpet, and sound deadening materials. You may also induce this product into HVAC modules and instrument panel ducts for the control of non-bacterial related odors.

IMPORTANT: This product leaves no residual scent and should not be used as an air freshener.

This product may result in the permanent elimination of an odor and may be preferable to customers whose allergies make them sensitive to perfumes. This product may effectively remove odors when directly contacting the odor source. In cases such as water leaks, use this product with diagnostic procedures to first eliminate the primary cause of the odor. Then use further applications on the residual odor to permanently correct the vehicle condition.

How to Use this Product

- Spray GM Vehicle Care Odor Eliminator directly or as an additive with carpet shampoo in steam cleaners.
- Do not use on any interior surface that plain water would deteriorate, because this product will have the same effect. Also avoid letting this product come into contact with vinegar or any acidic substance. Acid-based products will hamper the effectiveness of GM Vehicle Care Odor Eliminator.
- Complete eight page treatment sheets are enclosed within each case of GM Vehicle Care Odor Eliminator. These treatment instructions range from simple vehicle odor elimination to full step by step procedures for odor removal from water leaks. If lost, contact 800-977-4145 to get a replacement set faxed or e-mailed to your dealership.
- Instructions and cautions are printed on the bottle, but additional help is available. If you encounter a persistent or recurring odor, you may call to obtain additional information and usage suggestions.
    - In the USA, call 1-800-955-8591.
    - In Canada, call 1-800-977-4145.

FLOOR CARPET DRYING

If the carpet or the pad or insulator is wet, use the following criteria for drying or for replacing the components:

- For a 1-piece carpet assembly bonded to a cotton or a fiber padding, replace the entire assembly.
- For a 2-piece carpet assembly with a cotton or a fiber padding, replace the padding only. While the carpet is out of the vehicle, dry the carpet using the method described below.
- For a 1-piece carpet assembly bonded to a foam padding or attached to a synthetic padding, dry the carpet using the method described below.
- For a 2-piece carpet assembly with a synthetic padding, dry the assembly using the method described below.
- For a 1-piece carpet assembly with a separate cotton or a fiber padding, replace the cotton or fiber padding. While the carpet is out of the vehicle, dry the carpet using the method described below.

Drying Method

1. If you observe puddles of liquid on the carpet face, use a wet vacuum to remove the excess moisture.
2. Blot the face of the carpet with a towel in order to absorb as much moisture as possible.
3. Point a fan at the affected area and air dry the carpet.

FLOOR PANEL CARPET REPLACEMENT (IMPALA LIMITED)

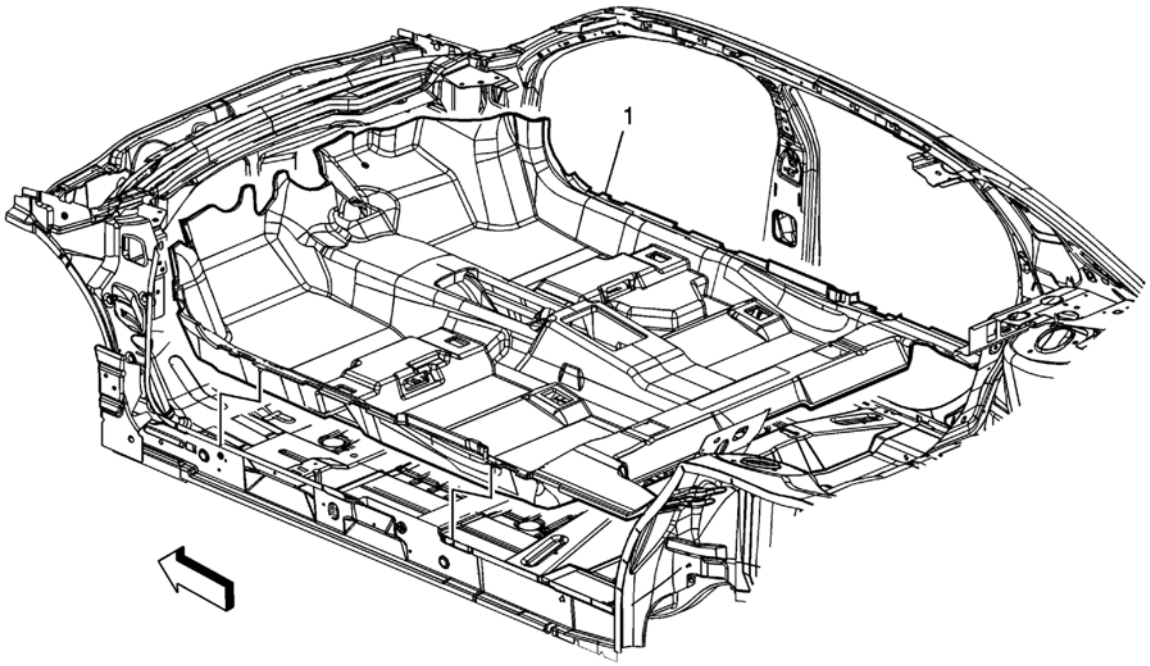


Fig. 1: Floor Panel Carpet
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures	
1. Remove the front seats. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)** .	

Callout	Component Name
2. Remove the rear seat. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)** . 3. Remove the floor console. Refer to **Front Floor Console Replacement** . 4. Remove the carpet retainers. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala Limited)**. 5. Loosen the center lower pillar garnish moldings. Refer to **Center Pillar Lower Trim Panel Replacement** . 6. Loosen the lower lock pillar garnish moldings. Refer to **Quarter Lower Rear Trim Panel Replacement (Impala Limited)** 7. Remove the lower front seat belt bolt.	
1	Floor Panel Carpet Assembly

FRONT SIDE DOOR OPENING FLOOR CARPET RETAINER REPLACEMENT (IMPALA LIMITED)

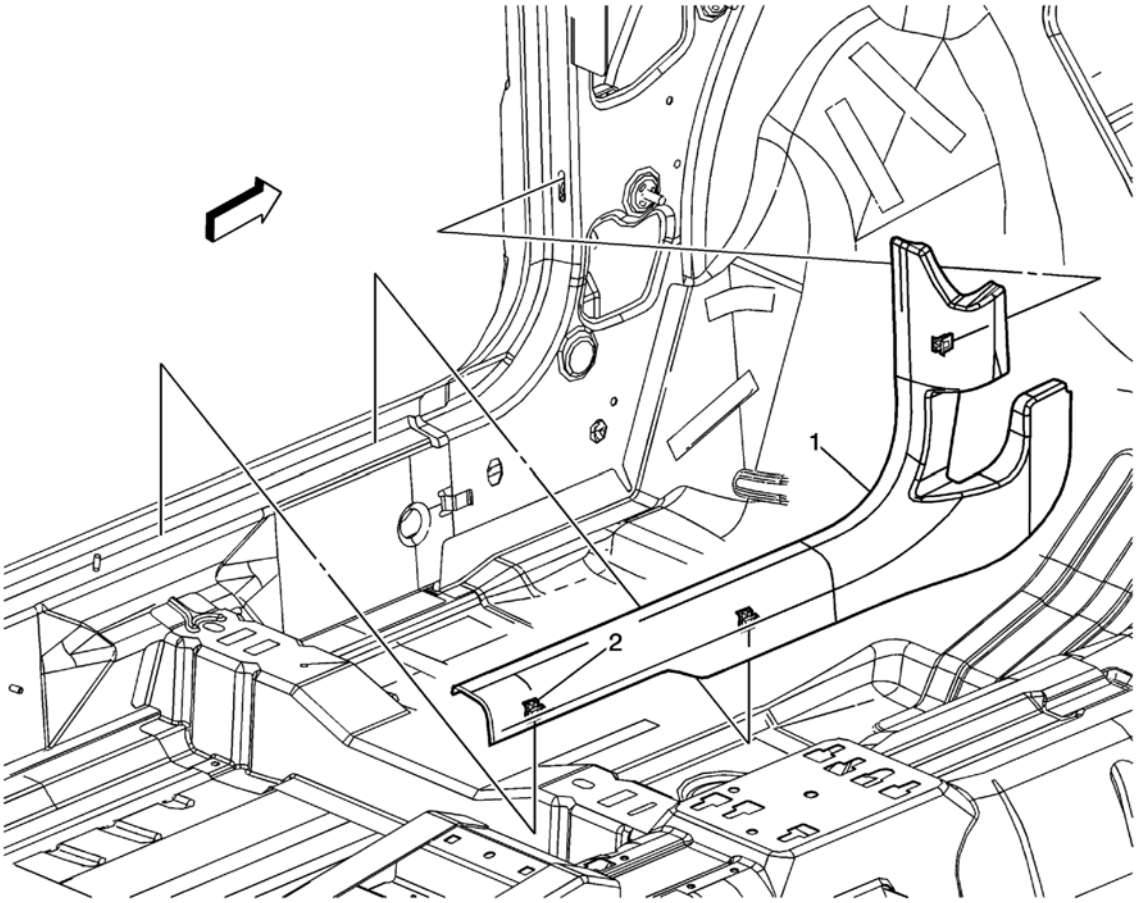


Fig. 2: Front Carpet Retainer
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Side Door Carpet Retainer Assembly
2	Front Side Door Carpet Retainer Assembly Clip

HEADLINING TRIM PANEL REPLACEMENT

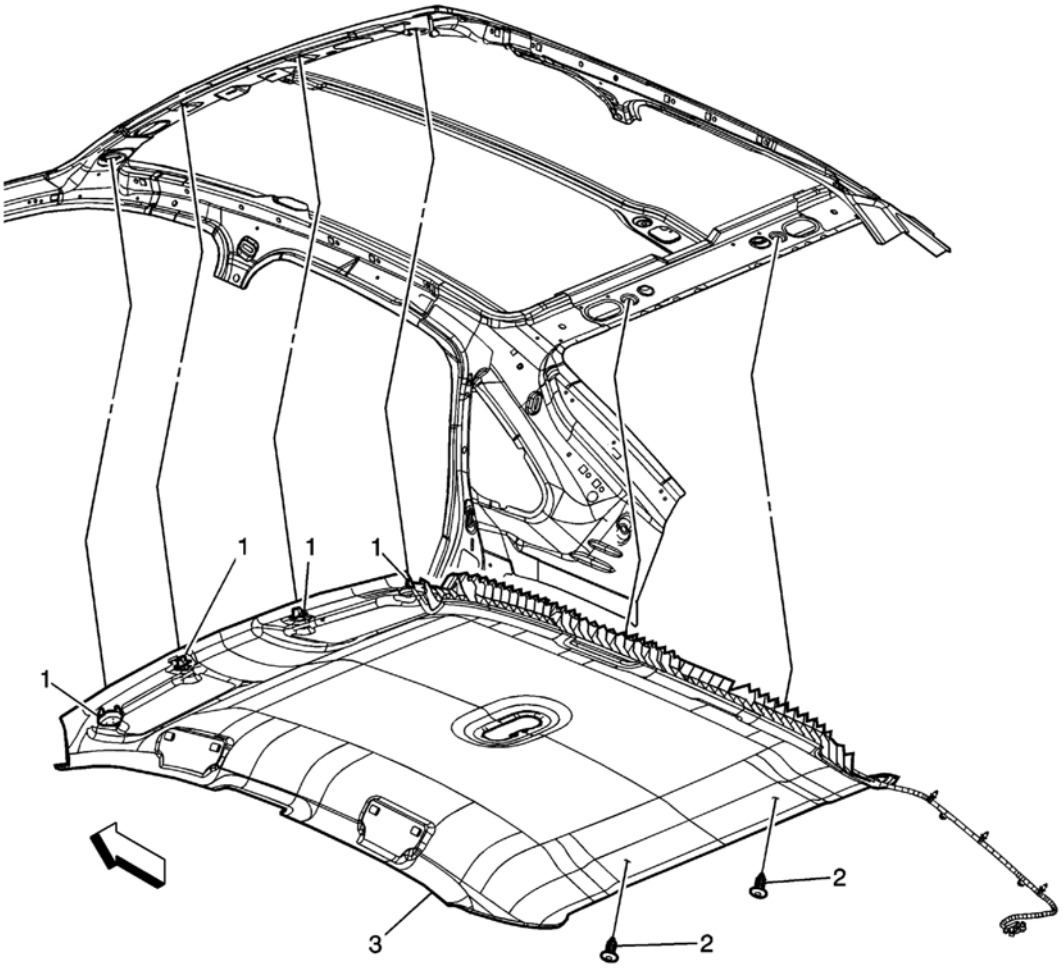


Fig. 3: Headlining Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Do not attempt to repair or alter the head impact energy-absorbing material glued to the**	

Callout	Component Name
headliner or to the garnish trims. If the material is damaged, replace the headliner and/or the garnish trim. Failure to do so could result in personal injury. **CAUTION:** **Use care when working around the head curtain inflator module. Sharp tools may puncture the curtain airbag. If the head curtain inflator module is damaged in any way, it must be replaced.** **CAUTION:** **If a vehicle is equipped with a head curtain inflator module ensure that the inflator module and**	

Callout	Component Name
tether are undamaged. If tether or curtain airbag are damaged in any way, they must be replaced. **Preliminary Procedures** 1. Disable the SIR. Refer to **SIR Disabling and Enabling** . 2. Remove the rear quarter upper trim panel. Refer to **Quarter Upper Trim Panel Replacement** . 3. Remove the upper center pillar trim. Refer to **Center Pillar Upper Trim Panel Replacement** . 4. Remove the windshield pillar trim. Refer to **Windshield Pillar Garnish Molding Replacement** . 5. Remove the sunshades. Refer to **Sunshade Replacement** . 6. Remove the sunshade anchors. Refer to **Sunshade Anchor Replacement** . 7. Remove the assist handles. Refer to **Assist Handle Replacement** .	
1	Headlining Trim Screw **TIP:** The screws come off with the sunshade and sunshade anchors.
2	Headlining Trim Retainer (Qty: 2)
3	Headlining Trim **Procedure** 1. Disconnect the electrical connectors. 2. Fully recline the front seat backs. 3. Tilt the steering wheel fully upward. 4. Set the parking brake and put shifter in low gear. 5. Cover the instrument panel (I/P) to protect from damage. 6. Remove through the front passenger door opening. **TIP:** When installing a new headliner, tape any unused connector to the headliner with a high adhesive tape.

Article GUID: A00737192

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Frame Reinforcement Bolt	20 N.m	15 lb ft
Frame Reinforcement Nut	20 N.m	15 lb ft
Front Frame Bolt	145 N.m	107 lb ft
Rear Frame Bolt	160 N.m	118 lb ft
Rear Wheelhouse Liner Nut	10 N.m	89 lb in

REPAIR INSTRUCTIONS

FRAME REPLACEMENT

Special Tools

J 39580 Universal Engine Support Table

Removal Procedure

1. Install the engine support fixture to support the engine/transaxle assembly. Refer to **Engine Support Fixture** .
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the front tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
4. Remove the lower radiator air deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
5. Remove the positive battery cable retainers. Position the positive battery cable aside. Refer to **Battery Positive and Negative Cable Replacement** .
6. Disconnect the power steering cooler pipe from the frame. Refer to **Power Steering Fluid Cooling Pipe Replacement** .
7. Secure the power steering cooler to the exhaust pipe.
8. Remove the stabilizer shaft links. Rotate the stabilizer shaft up to gain access to the mounting bolts for the power steering gear. Refer to **Stabilizer Shaft Link Replacement** .
9. Remove the mounting fasteners for the power steering gear. Refer to **Steering Gear Replacement** .

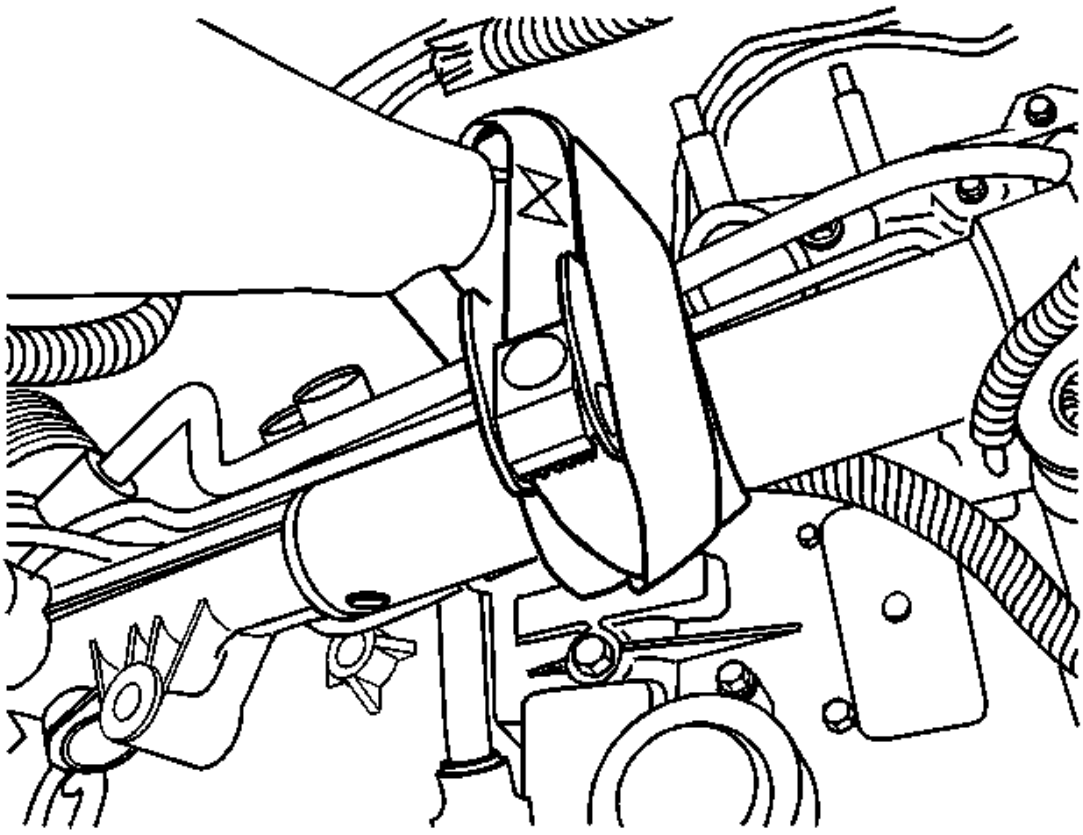


Fig. 1: Securing Power Steering Gear To Exhaust Manifold
Courtesy of GENERAL MOTORS COMPANY

10. Secure the power steering gear to the exhaust front pipe using mechanics wire.

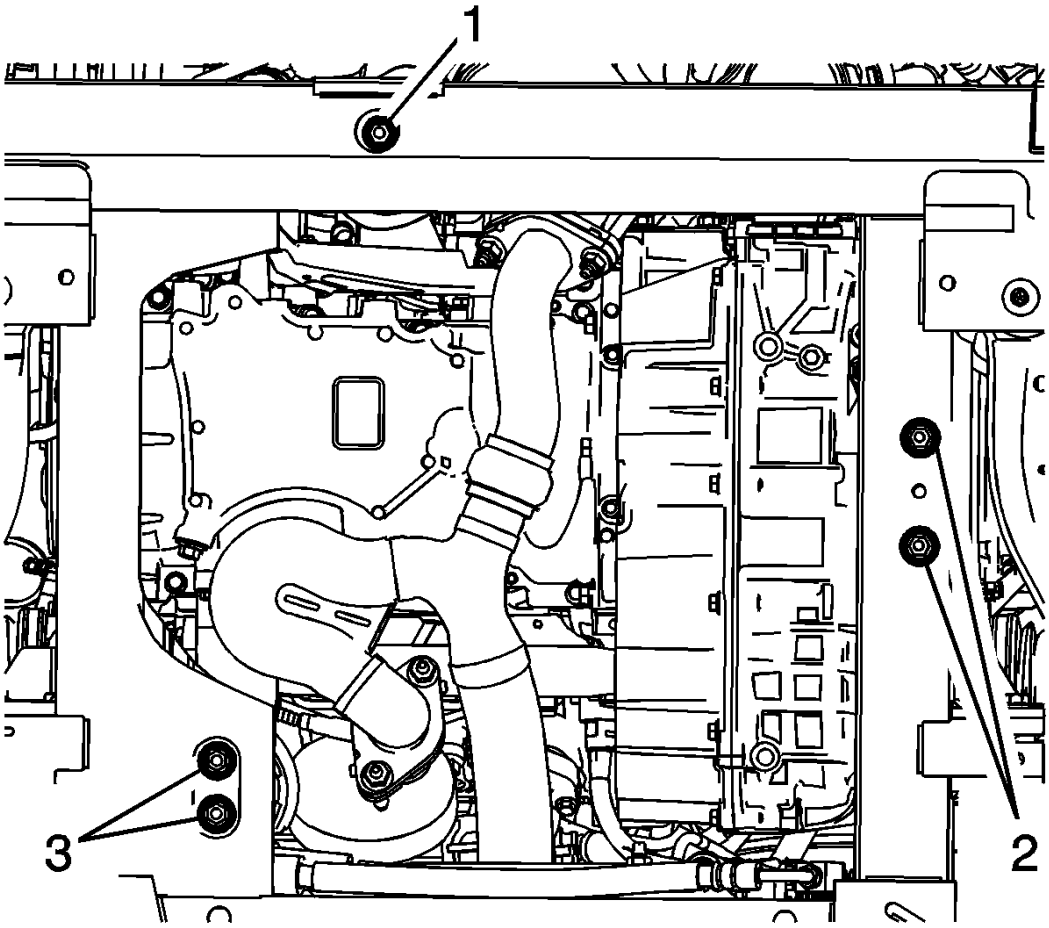


Fig. 2: Engine Mount Fasteners
Courtesy of GENERAL MOTORS COMPANY

11. Remove the front engine mount to frame fastener (1).
12. Remove the rear engine mount to frame fasteners (3).
13. Loosen the transmission mount fasteners (2).

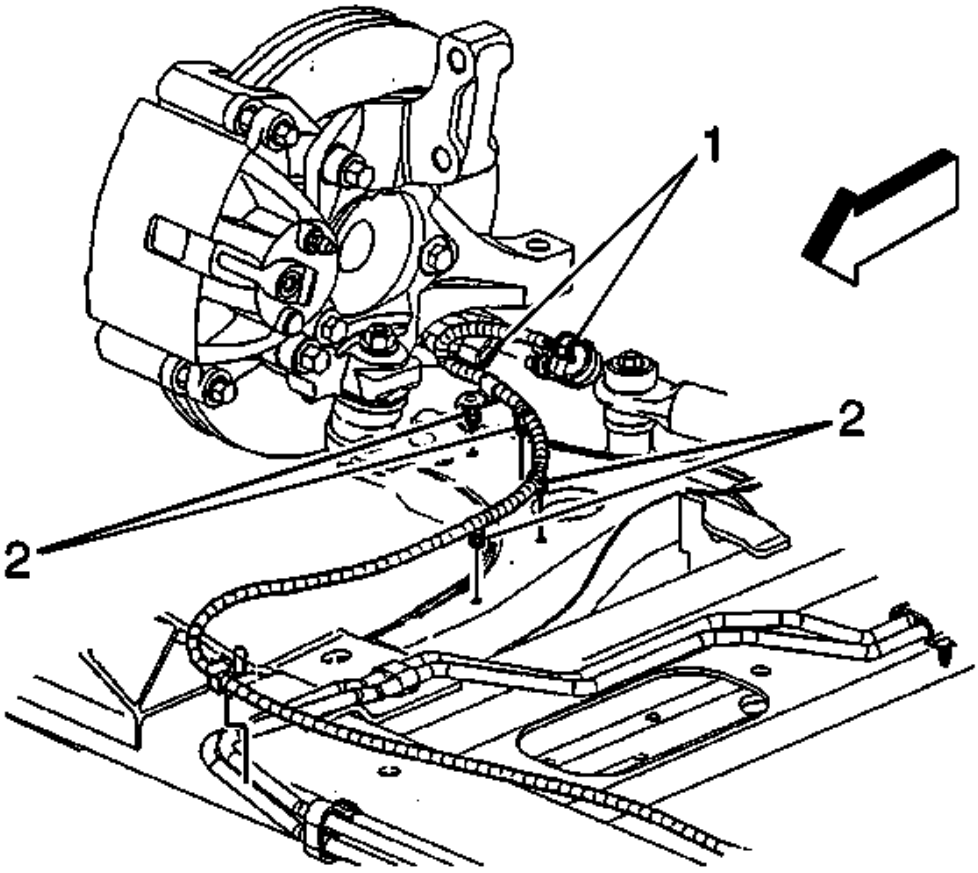


Fig. 3: Front Wheel Speed Sensor Connectors & Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

14. Disconnect both front wheel speed sensor connectors (1), if equipped.
15. Remove both front wheel speed harness retainers (2) from the frame and the lower control arms, if equipped.
16. Separate both of the lower ball joints from the steering knuckle. Refer to **Lower Control Arm Ball Joint Replacement** .

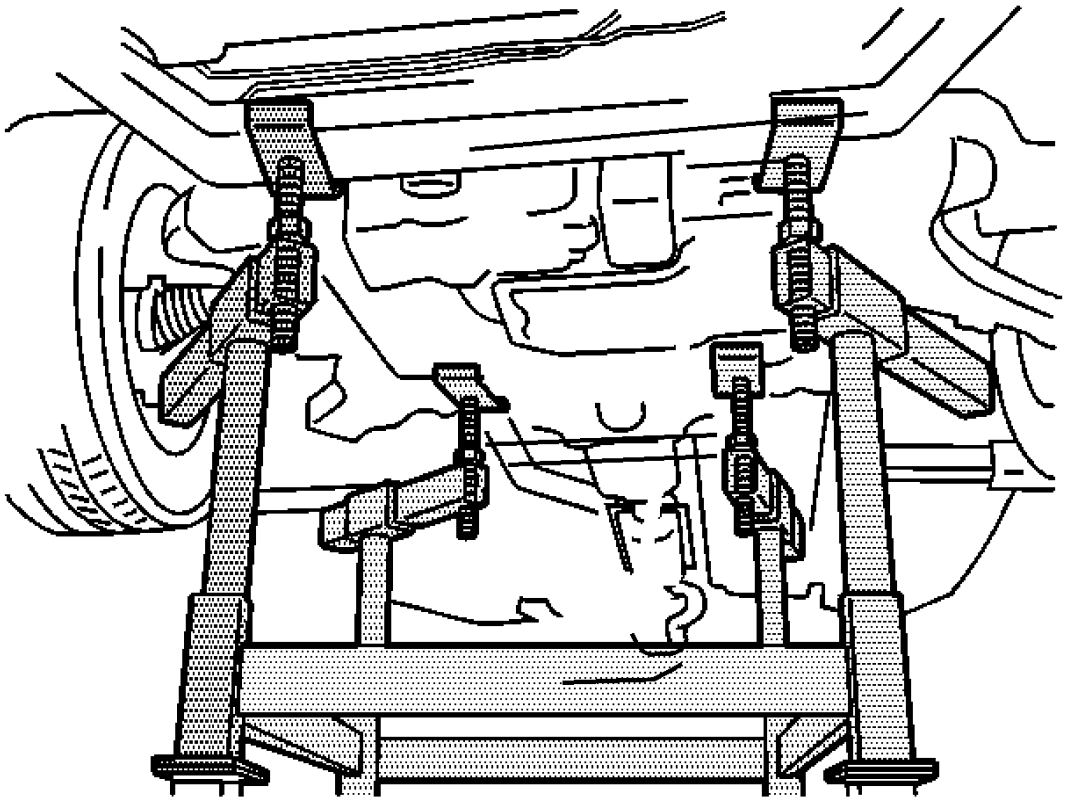


Fig. 4: Identifying Utility Stand
Courtesy of GENERAL MOTORS COMPANY

17. Lower the vehicle until the frame contacts **J 39580** table.

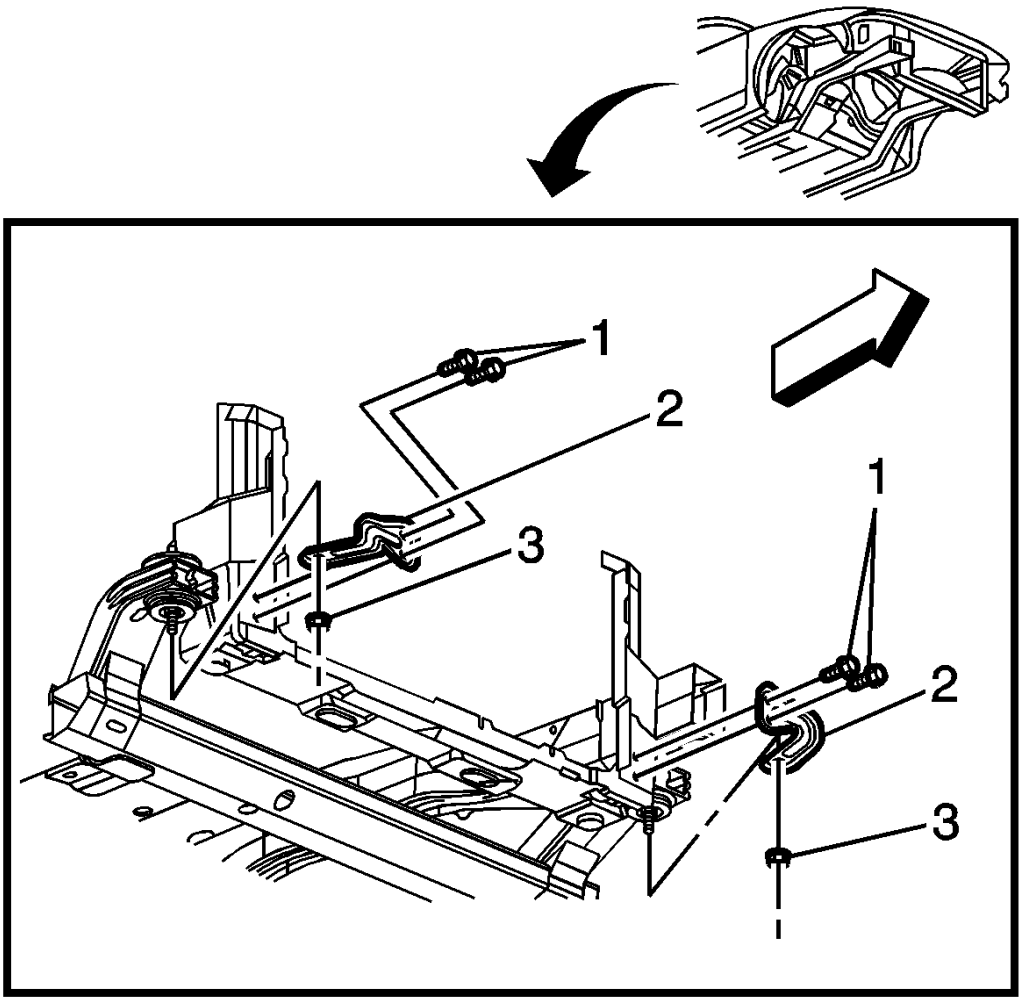


Fig. 5: Frame Reinforcements & Bolts
Courtesy of GENERAL MOTORS COMPANY

18. Remove the frame reinforcement nuts (3).
19. Remove the frame reinforcement bolts (1).
20. Remove the frame reinforcements (2).

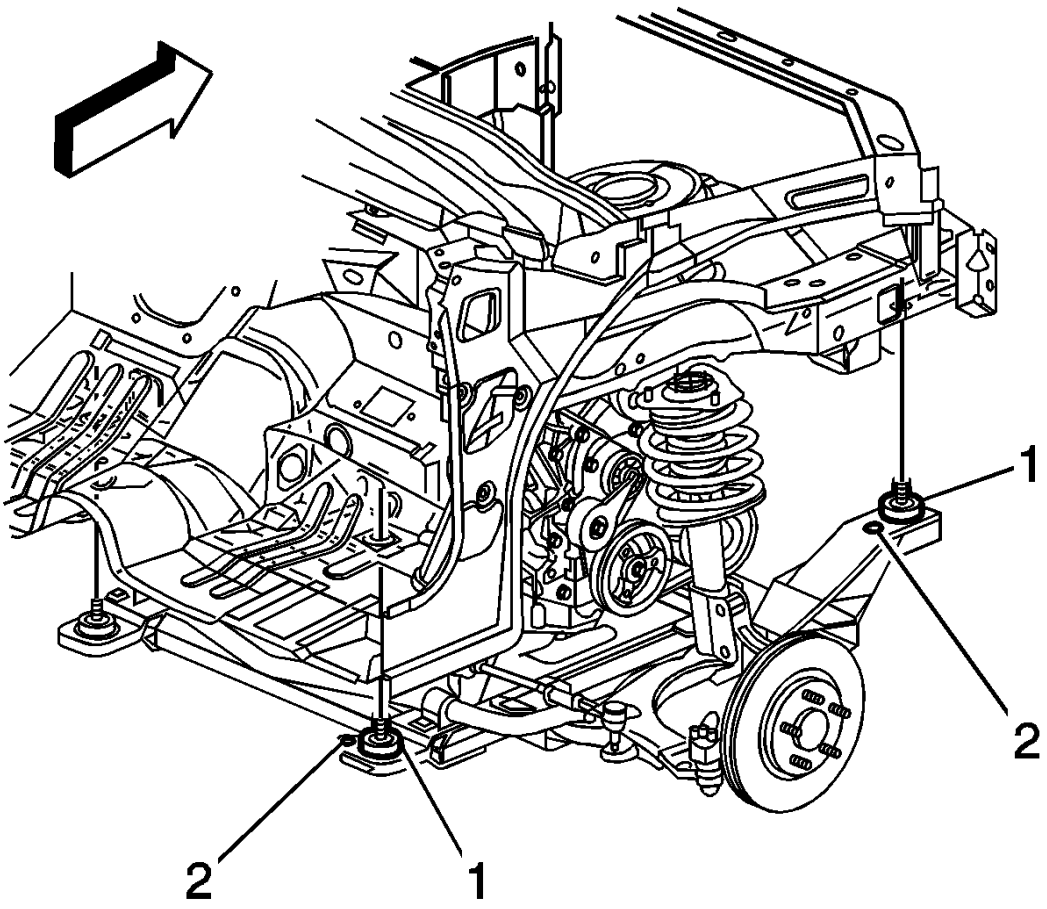


Fig. 6: Frame Securing Bolts
Courtesy of GENERAL MOTORS COMPANY

21. Remove the bolts (1) which secure the frame to the body.
22. Raise the vehicle in order to separate the frame from the body.
23. If replacement of the frame is necessary, remove the following components:
    - Both of the lower control arms-Refer to **Lower Control Arm Replacement** .
    - The stabilizer shaft-Refer to **Stabilizer Shaft Replacement** .
    - The spacers, the upper insulator, the lower insulator, and the retainers-Refer to **Drivetrain and Front Suspension Frame Front Insulator Replacement**, and to **Drivetrain and Front Suspension Frame Rear Insulator Replacement**.

Installation Procedure

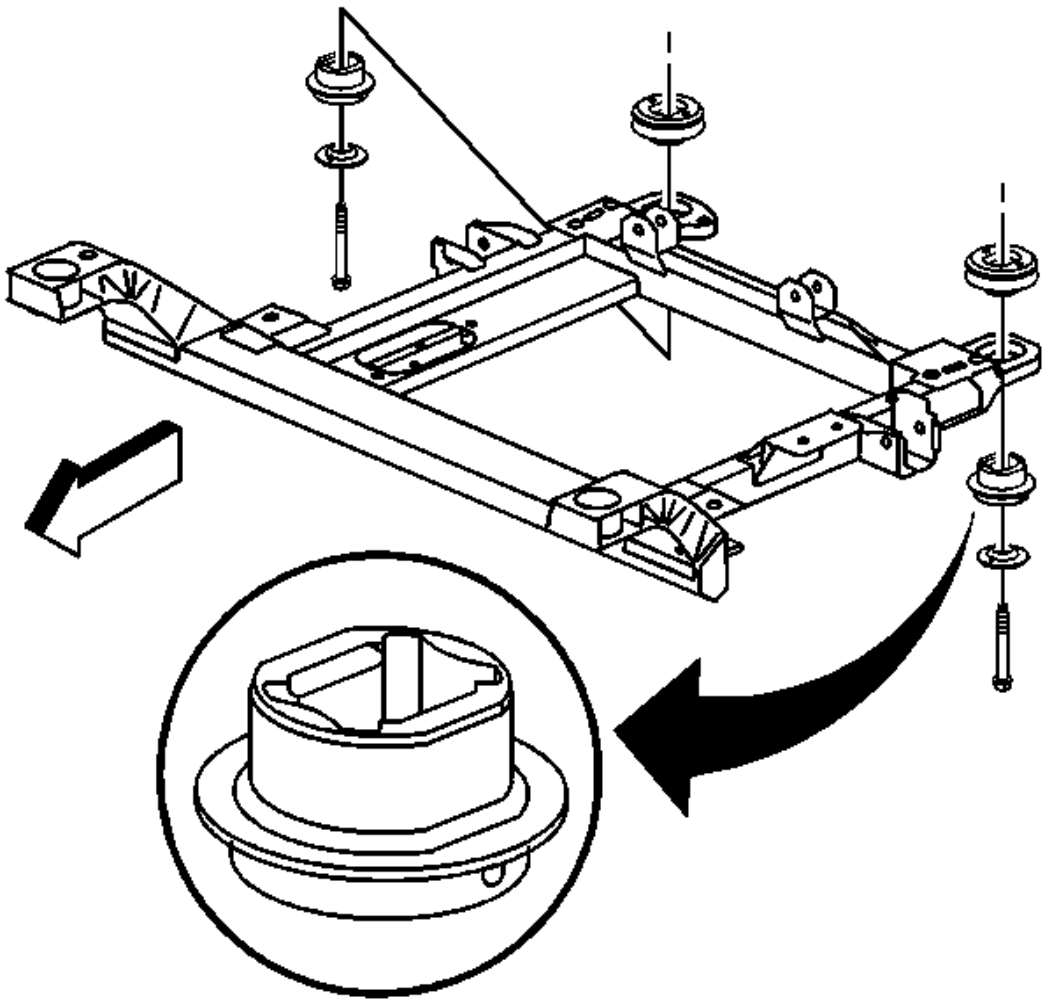


Fig. 7: Rear Frame To Body Bolts
Courtesy of GENERAL MOTORS COMPANY

1. If a new frame is being installed, install the following components:
    - Both of the lower control arms-Refer to **Lower Control Arm Replacement** .
    - The stabilizer shaft-Refer to **Stabilizer Shaft Replacement** .
    - The spacers, the upper insulator, the lower insulator, and the retainers-Refer to **Drivetrain and Front Suspension Frame Front Insulator Replacement**, and to **Drivetrain and Front Suspension Frame Rear Insulator Replacement**.

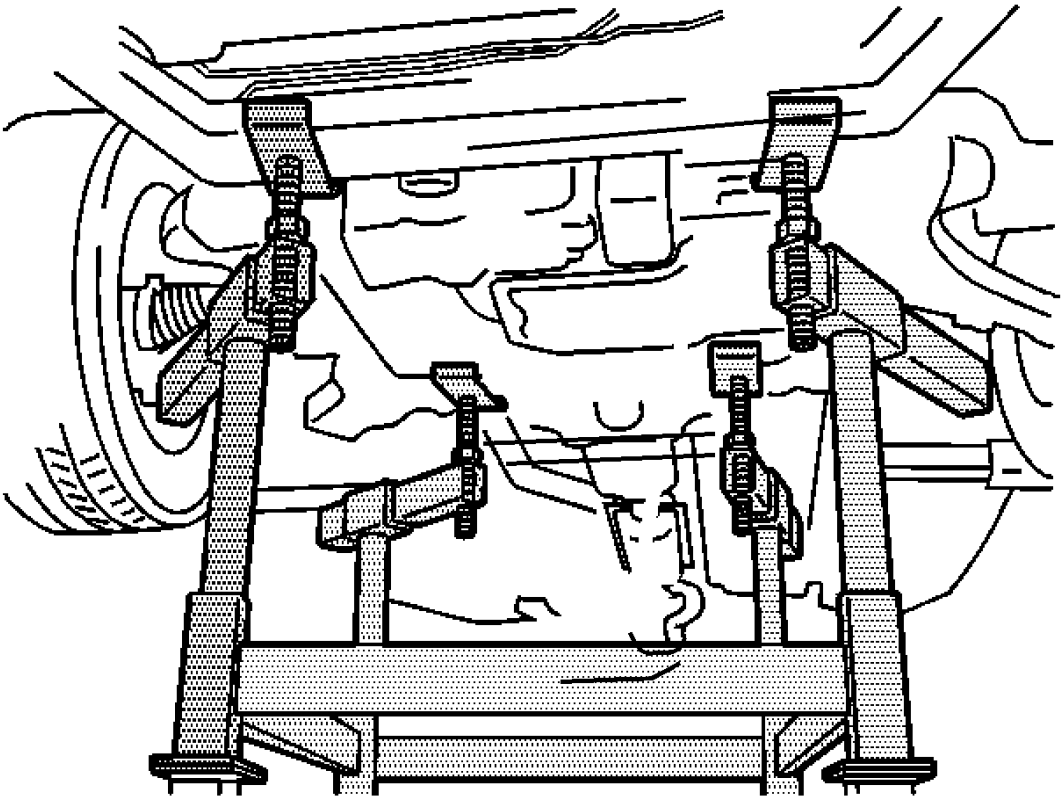


Fig. 8: Identifying Utility Stand
Courtesy of GENERAL MOTORS COMPANY

2. Position the engine support table with the frame under the vehicle.
3. Lower the vehicle to the frame.

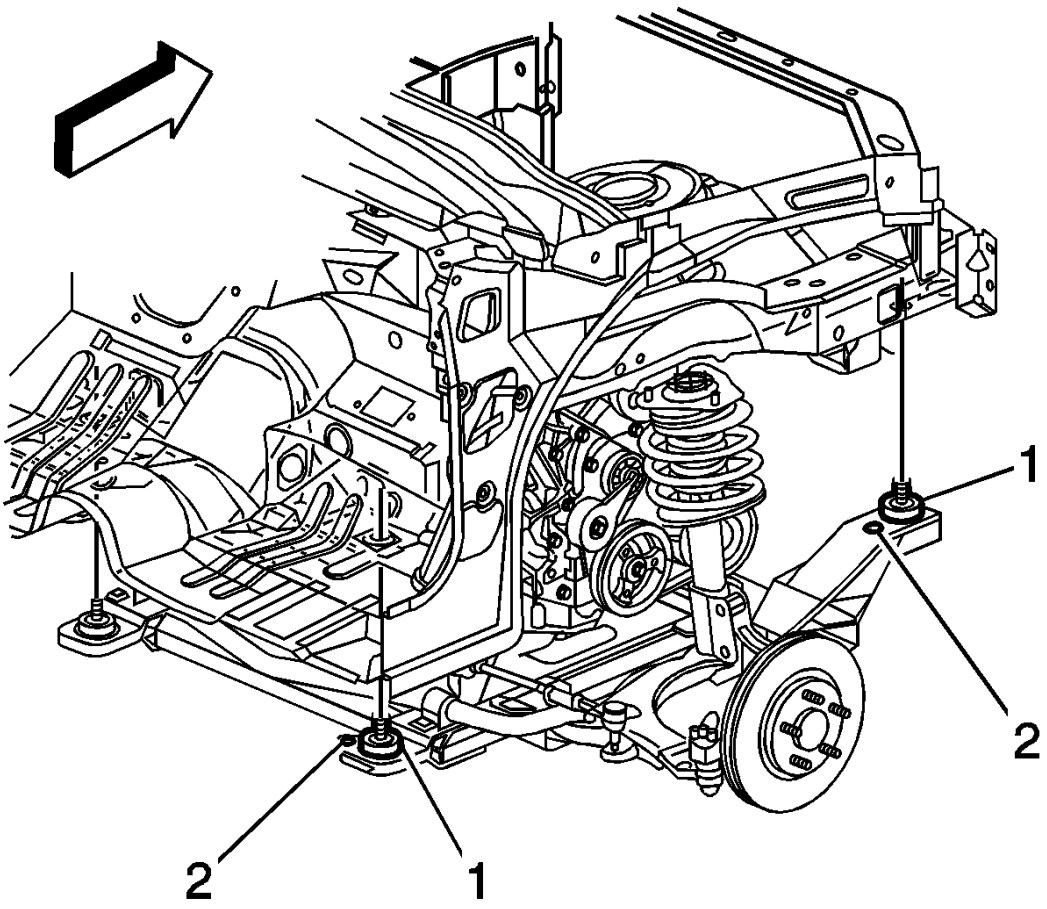


Fig. 9: Frame Securing Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Loosely install the bolts (1) to secure the frame to the body.

CAUTION: Refer to Fastener Caution .

5. Align the frame to the body by inserting two 19X203 mm (0.74X8.0 in) pins in the alignment holes (2) on the right side of the frame.

Tighten

- Tighten the front frame bolts to 145 N.m (107 lb ft).
- Tighten the rear frame bolts to 160 N.m (118 lb ft).

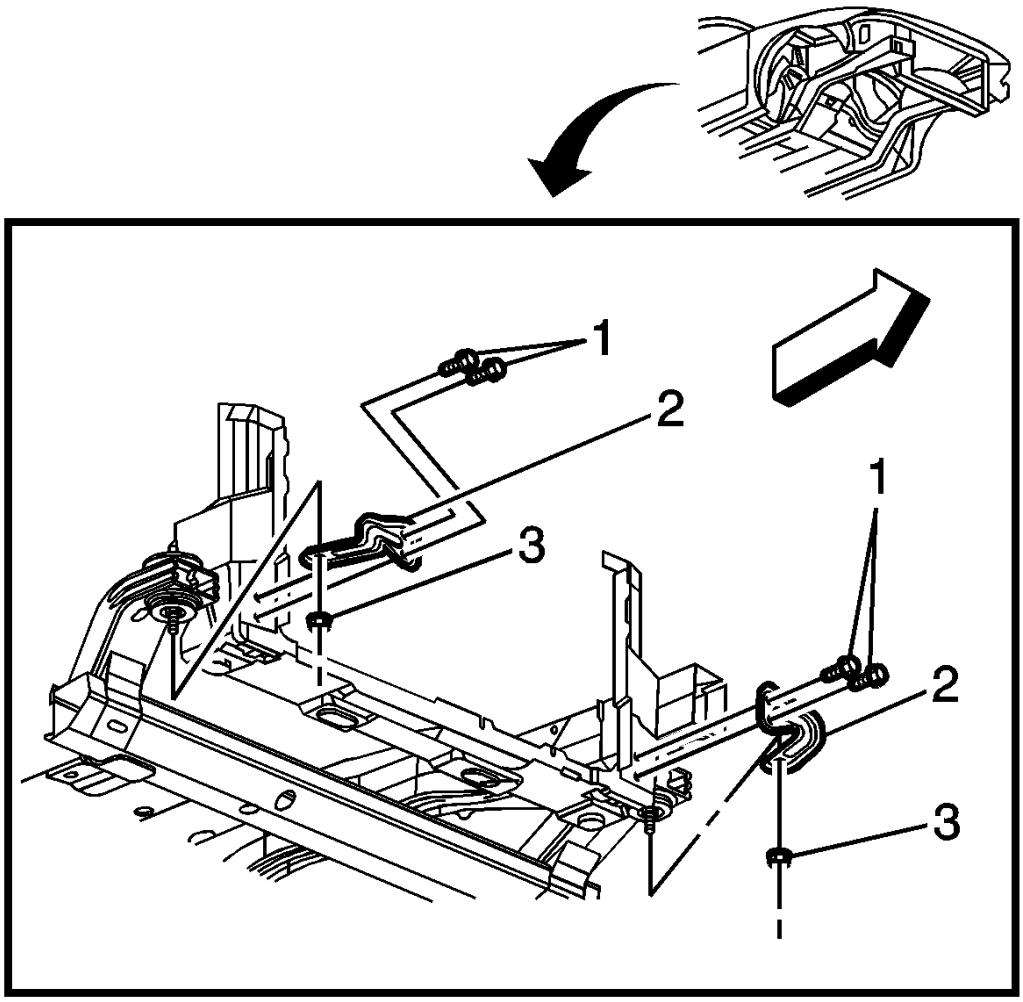


Fig. 10: Frame Reinforcements & Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the frame reinforcements (2).
7. Install the frame reinforcement bolts (1).

   Tighten

   Tighten the bolts to 20 N.m (15 lb ft).

8. Install the frame reinforcement nuts (3).

   Tighten

   Tighten the nuts to 20 N.m (15 lb ft).

9. Connect both the lower ball joints to the steering knuckle. Refer to **Lower Control Arm Ball Joint Replacement** .

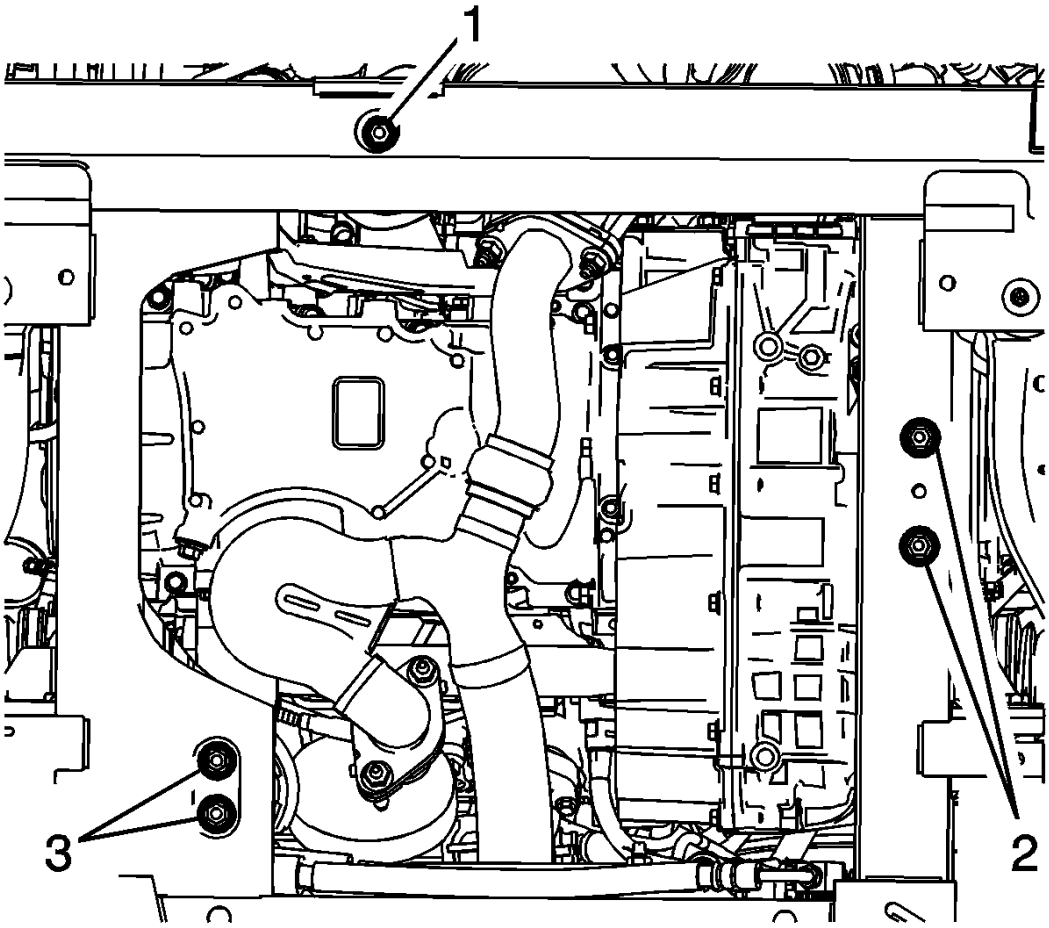


Fig. 11: Engine Mount Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Install the front engine mount to frame fastener (1) and tighten to 80 N.m (59 lb ft).
11. Remove the rear engine mount to frame fasteners (3) to 52 N.m (38 lb ft).
12. Loosen the transmission mount fasteners (2) to 52 N.m (38 lb ft).
13. Remove the power steering gear from the exhaust pipe. Position to the frame.
14. Install the steering gear mounting fasteners. Refer to **Steering Gear Replacement** .
15. Install the stabilizer shaft links. Refer to **Stabilizer Shaft Link Replacement** .

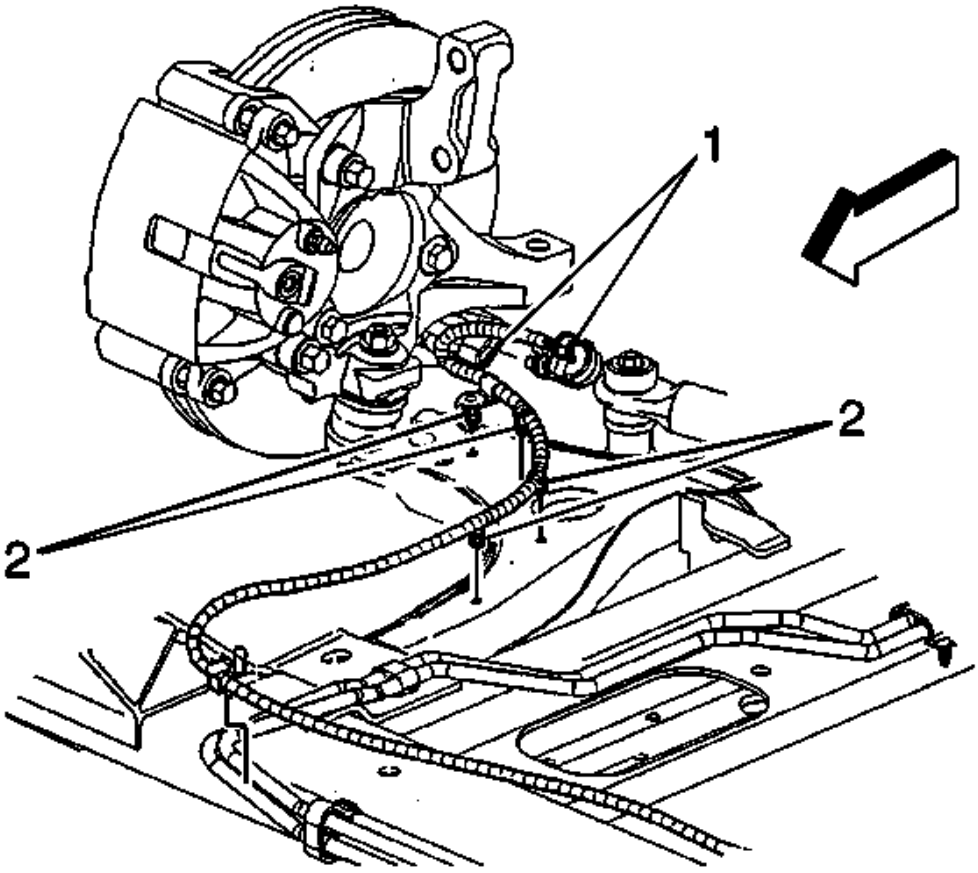


Fig. 12: Front Wheel Speed Sensor Connectors & Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

16. Connect both front wheel speed sensor connectors (1), if equipped.
17. Install both front wheel speed harness retainers (2) to the frame and to the lower control arm, if equipped.
18. Install the positive battery cable. Refer to **Battery Positive and Negative Cable Replacement** .
19. Install the power steering cooler pipe. Refer to **Power Steering Fluid Cooling Pipe Replacement** .
20. Install the radiator lower air deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
21. Install the front tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
22. Lower the vehicle.
23. Remove the engine support fixture.
24. Inspect the front wheel alignment. Refer to **Wheel Alignment Measurement** .

DRIVETRAIN AND FRONT SUSPENSION FRAME FRONT INSULATOR REPLACEMENT

Removal Procedure

NOTE: **In order to remove any frame insulator, loosen the adjacent frame insulators to**

permit the frame to separate from the body. Do not break the fan shroud or damage the frame attachments, such as steering hoses and brake pipes during the replacement of body mounts.

When installing a body mount, ensure the lower insulator is seated into the frame. The lower insulator should not be loose. The spacer and the corresponding upper insulator is pressed into the lower insulator thus squeezing the frame. The bolt is then inserted through the mount, capturing the lower retainer. The body mount components prevent contact of the frame to the body.

Do not over tighten the body mount. Over tightening may collapse a spacer or strip a bolt. When the frame insulator bolts are removed, always discard the bolts and replace with new bolts.

When clamping by the mount, ensure the surfaces are clean and dry. If the frame insulator bolt does not screw in smoothly, run a tap through the frame crossmember nut in the body in order to remove foreign material. Ensure the tap does not punch through the underbody.

Whenever the body is moved in relation to the frame, disconnect the intermediate shaft from the rack and pinion steering gear and stub shaft.

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

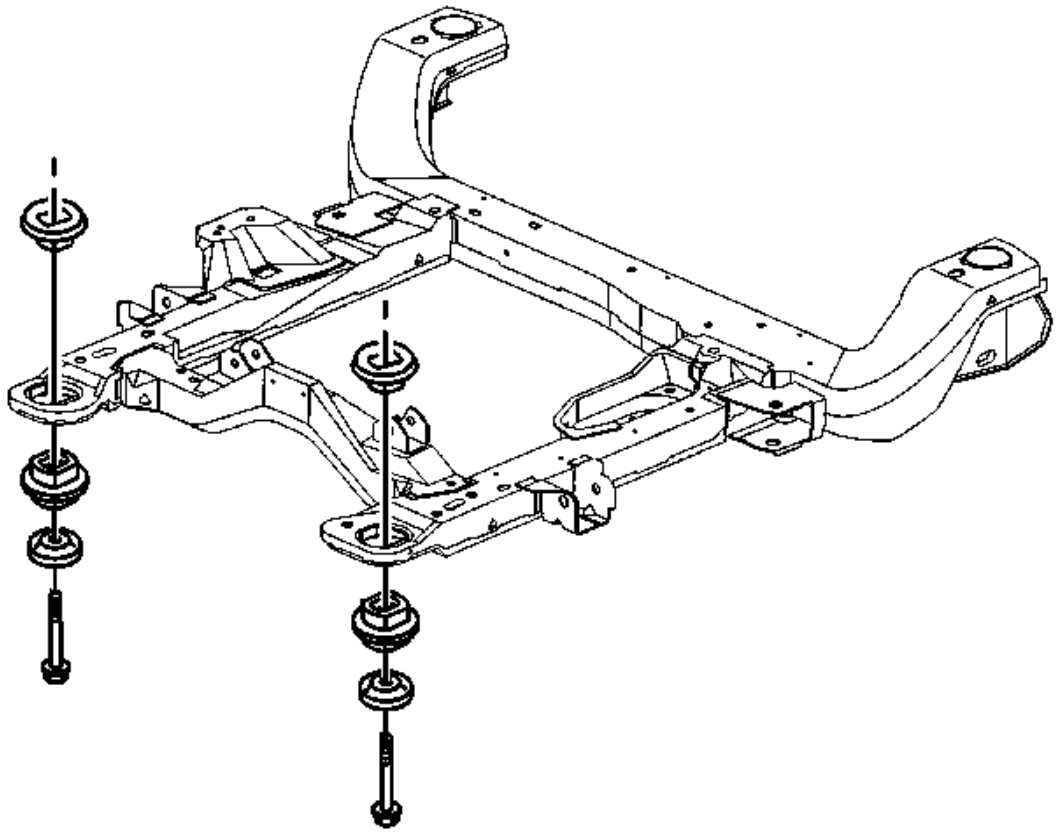


Fig. 13: View Of Rear Frame
Courtesy of GENERAL MOTORS COMPANY

2. Remove the intermediate shaft from the steering gear stub shaft. Refer to **Intermediate Steering Shaft Replacement** .
3. Install a utility stand to the rear of the frame.
4. Remove the rear frame bolts.
5. Lower the rear of the frame.
6. Remove the upper and lower insulators from the rear of the frame as a set.

Installation Procedure

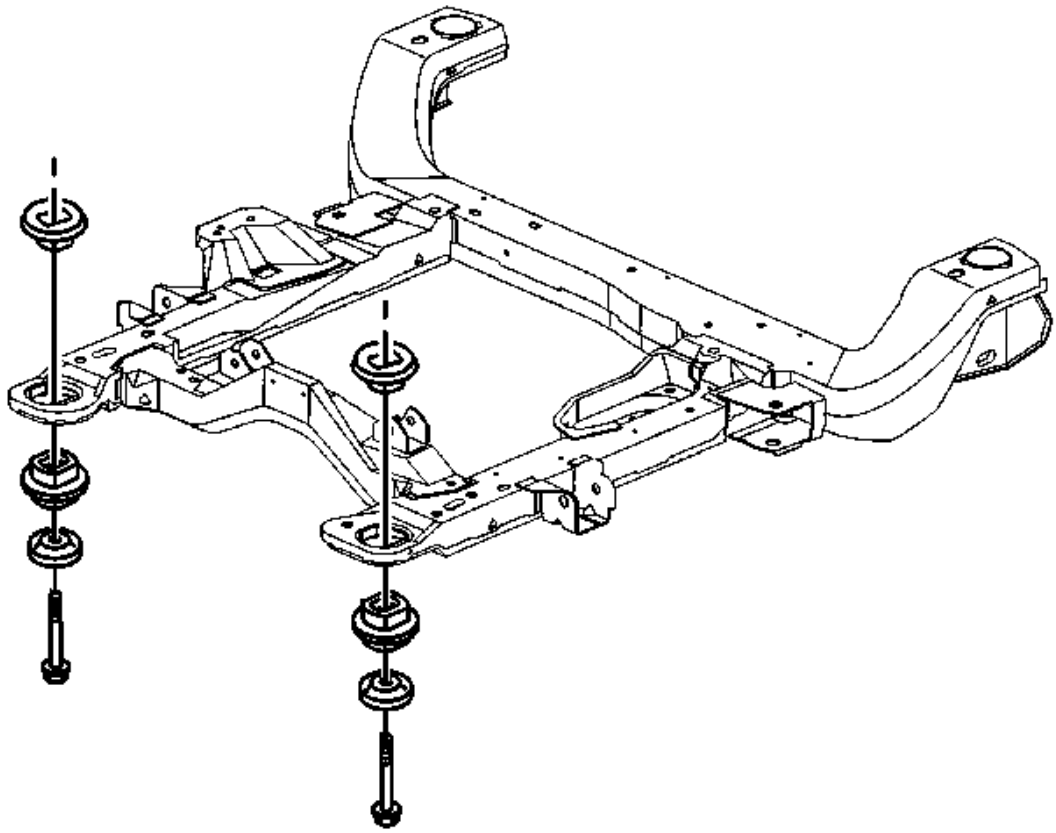


Fig. 14: View Of Rear Frame
Courtesy of GENERAL MOTORS COMPANY

1. Apply lube to inside surface of lower insulator and to top surface of upper insulator.
2. Install the upper and lower insulators to the rear of the frame as a set.
3. Raise the rear of the frame.

CAUTION: Refer to Fastener Caution .

4. Install the rear frame bolts.

Tighten

Tighten the rear frame bolts to 160 N.m (118 lb ft).

5. Remove the utility stand.
6. Install the intermediate shaft to the steering gear stub shaft. Refer to **Intermediate Steering Shaft Replacement** .
7. Lower the vehicle.

DRIVETRAIN AND FRONT SUSPENSION FRAME REAR INSULATOR REPLACEMENT

Special Tools

J 45296 Frame Insulator Remover/Installer

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Disconnect the steering intermediate shaft. Refer to **Intermediate Steering Shaft Replacement** .
3. Disconnect the fog lamp electrical connectors from the fog lamps.

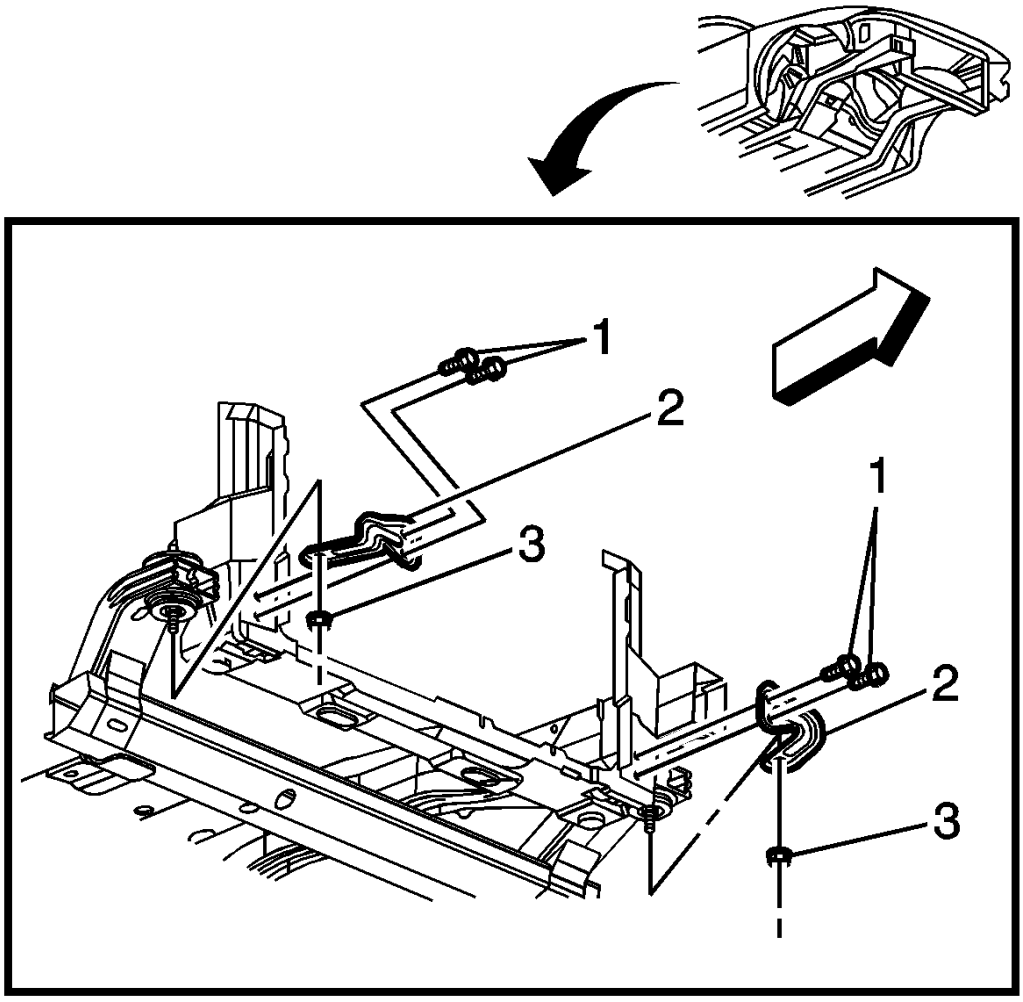


Fig. 15: Frame Reinforcements & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the frame reinforcement nuts (3).
5. Remove the frame reinforcement bolts (1).
6. Remove the frame reinforcements (2).
7. Install a jackstand under the center of the frame, between the front frame insulators.

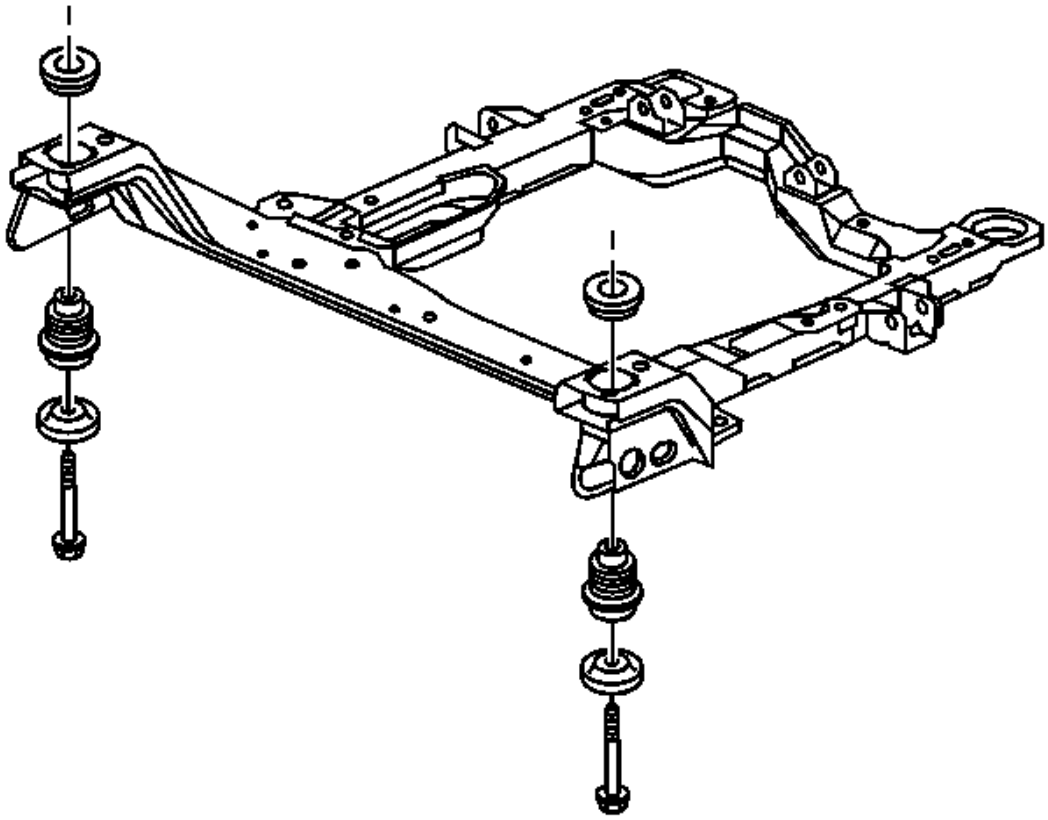


Fig. 16: View Of Front Frame Bolts And Retainers
Courtesy of GENERAL MOTORS COMPANY

8. Remove the front frame bolts and retainers.
9. Lower the front of the frame.
10. Remove the frame front upper insulators.

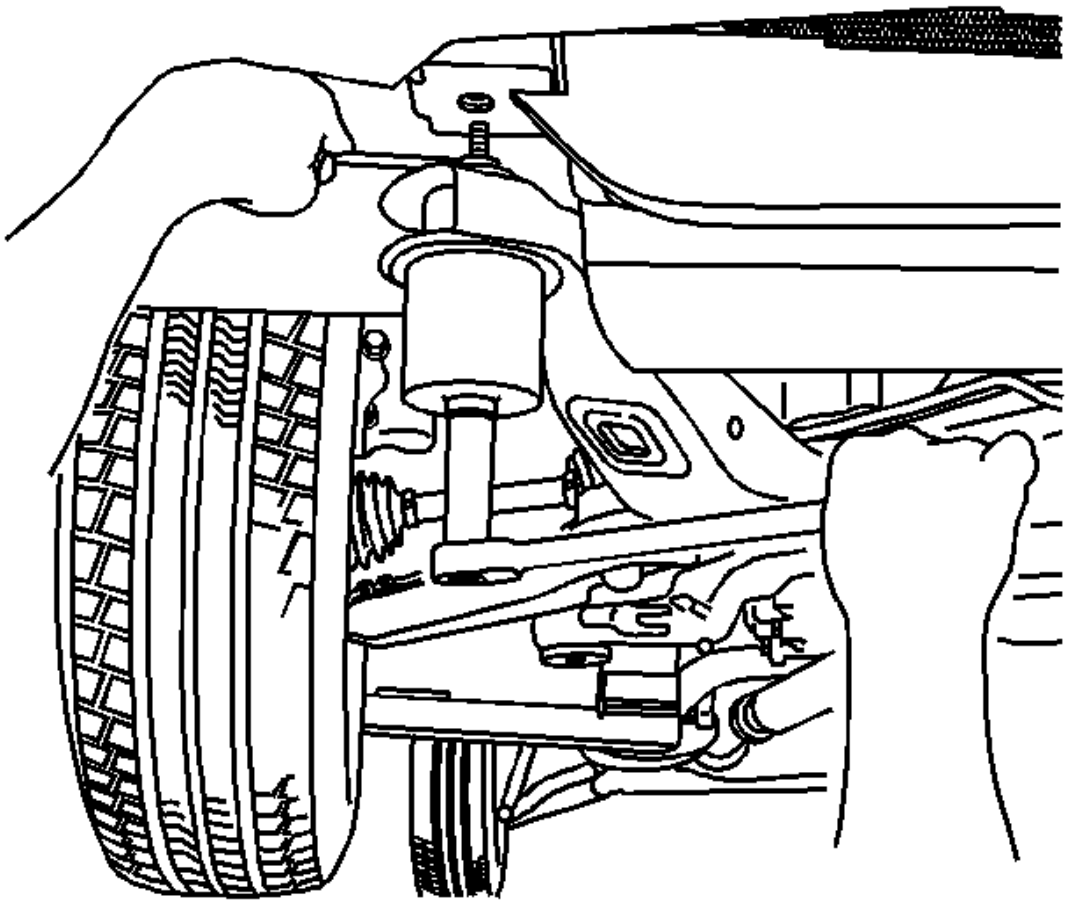


Fig. 17: View Of Frame Front Upper Insulators
Courtesy of GENERAL MOTORS COMPANY

11. Install the **J 45296** remover/installer , or equivalent to the front frame insulator you are removing.
12. Using the **J 45296** remover/installer , or equivalent remove the front frame insulator from the frame.

Installation Procedure

1. Clean the front frame insulator opening.
2. Apply a thin coat of rubber lubricant GM P/N 01051717 (Canadian P/N 12345884) or equivalent to the inside of the front frame insulator opening.
3. Apply a thin coat of rubber lubricant GM P/N 01051717 (Canadian P/N 12345884) or equivalent to the front frame insulator.

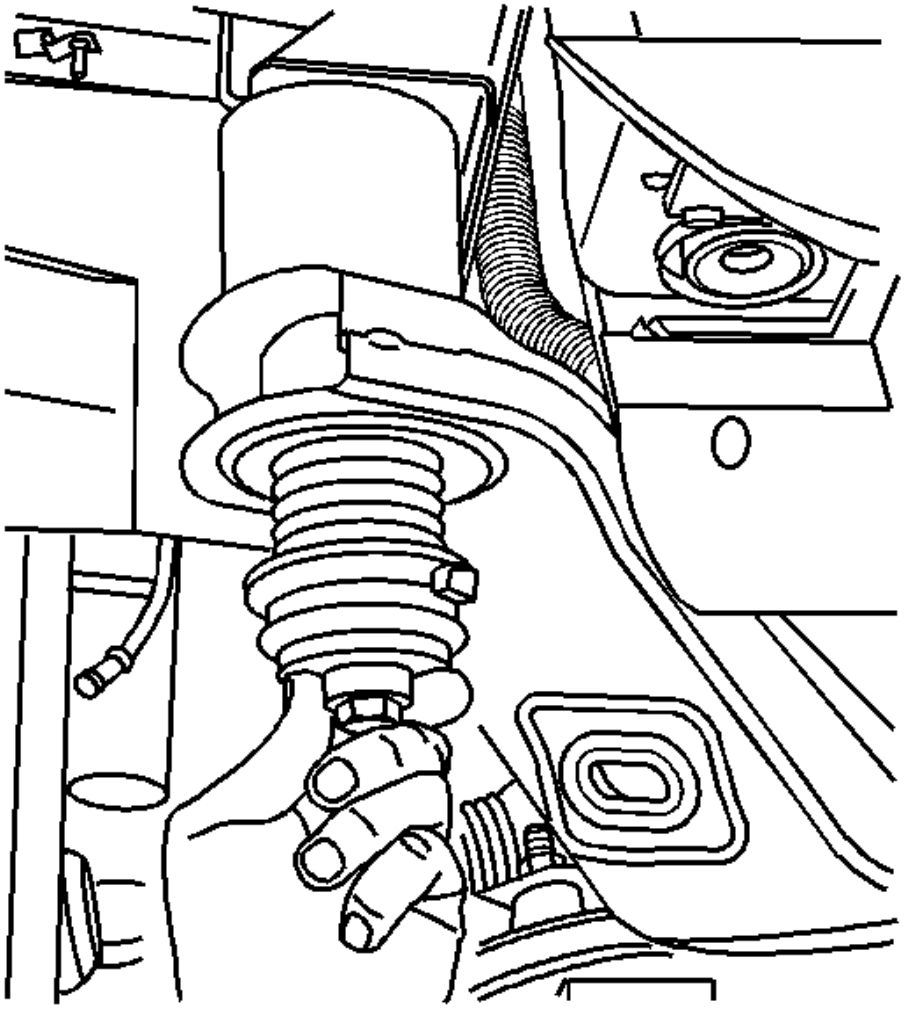


Fig. 18: Aligning Front Frame Insulator
Courtesy of GENERAL MOTORS COMPANY

4. Align the front frame insulator to the front frame opening with the front frame alignment tabs facing to the front.
5. Using the **J 45296** remover/installer , or equivalent install the front frame insulator to the front frame.

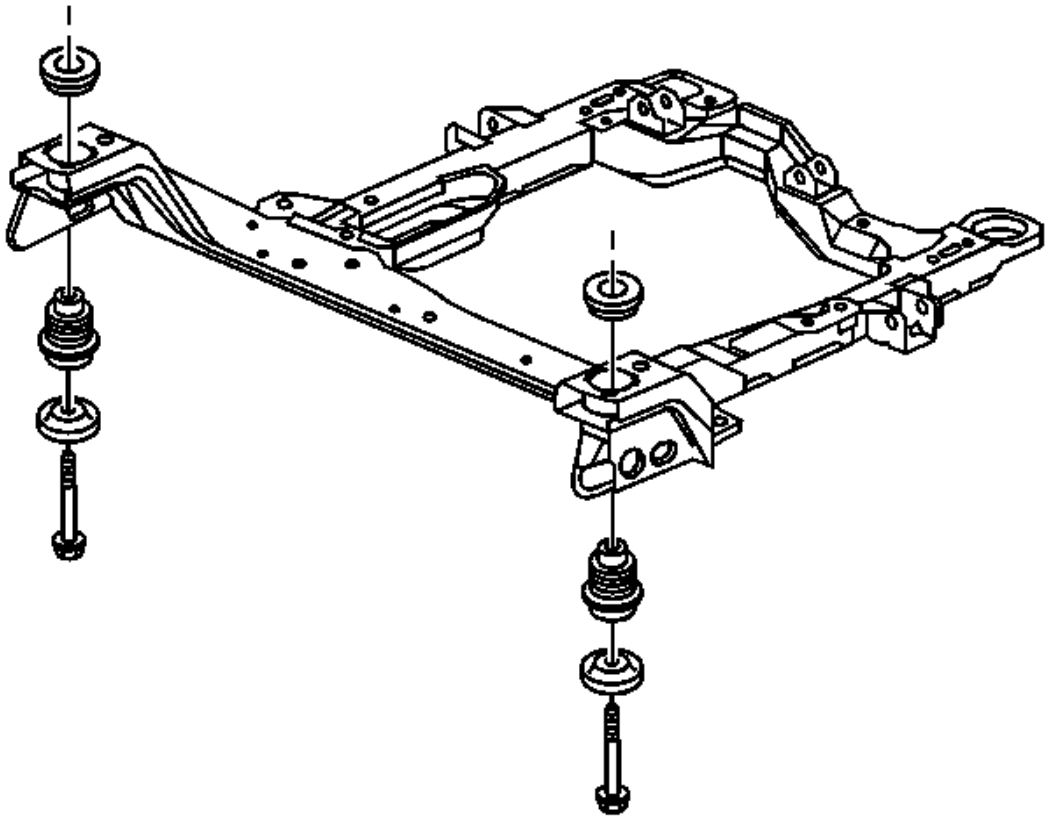


Fig. 19: View Of Front Frame Bolts And Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Install the frame front upper insulators.
7. Raise the front of the frame.

CAUTION: Refer to Fastener Caution .

8. Install the front frame bolts and retainers.

Tighten

Tighten the front frame bolts to 145 N.m (107 lb ft).

9. Remove the jackstand.

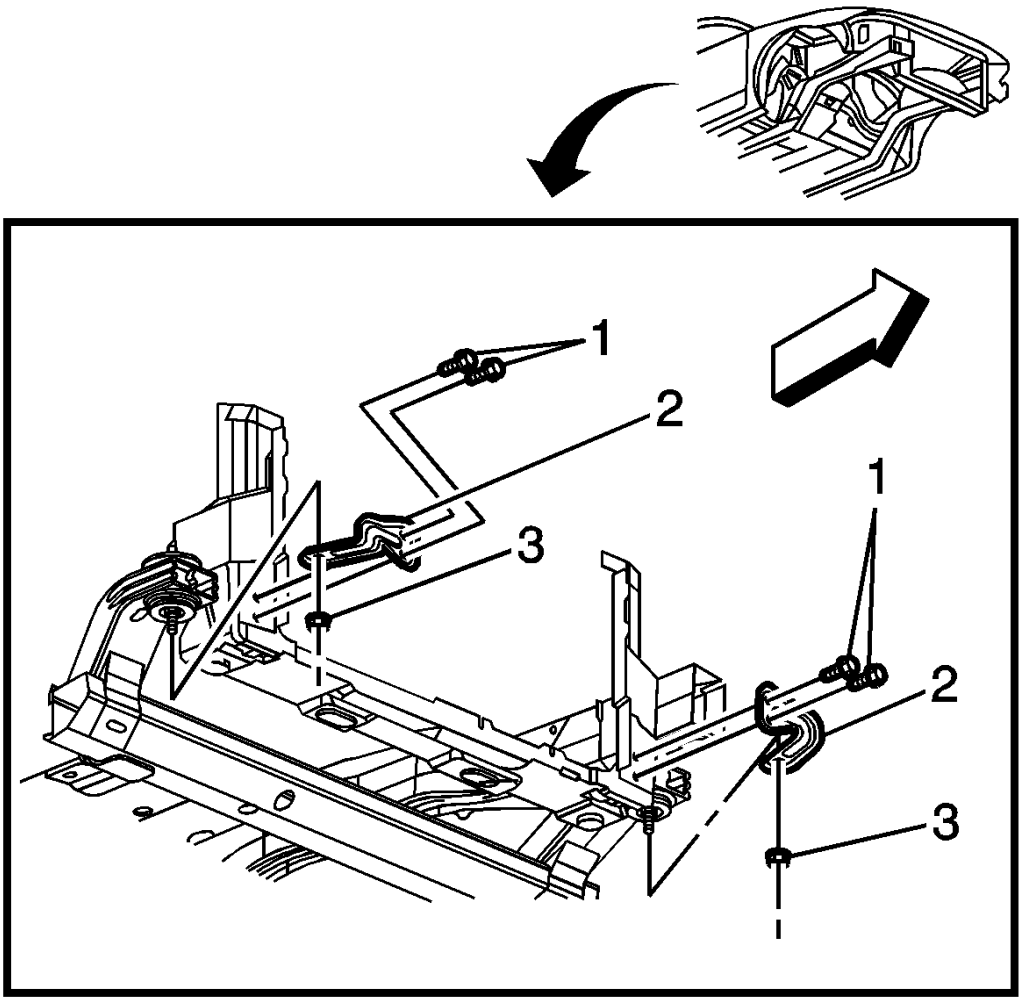


Fig. 20: Frame Reinforcements & Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Install the frame reinforcements (2).
11. Install the frame reinforcement bolts (1).

    Tighten

    Tighten the bolts to 20 N.m (15 lb ft).

12. Install the frame reinforcement nuts (3).

    Tighten

    Tighten the nuts to 20 N.m (15 lb ft).

13. Connect the fog lamp electrical connectors to the fog lamps.
14. Connect the steering intermediate shaft. Refer to **Intermediate Steering Shaft Replacement** .
15. Lower the vehicle.

FRONT FENDER LINER REPLACEMENT

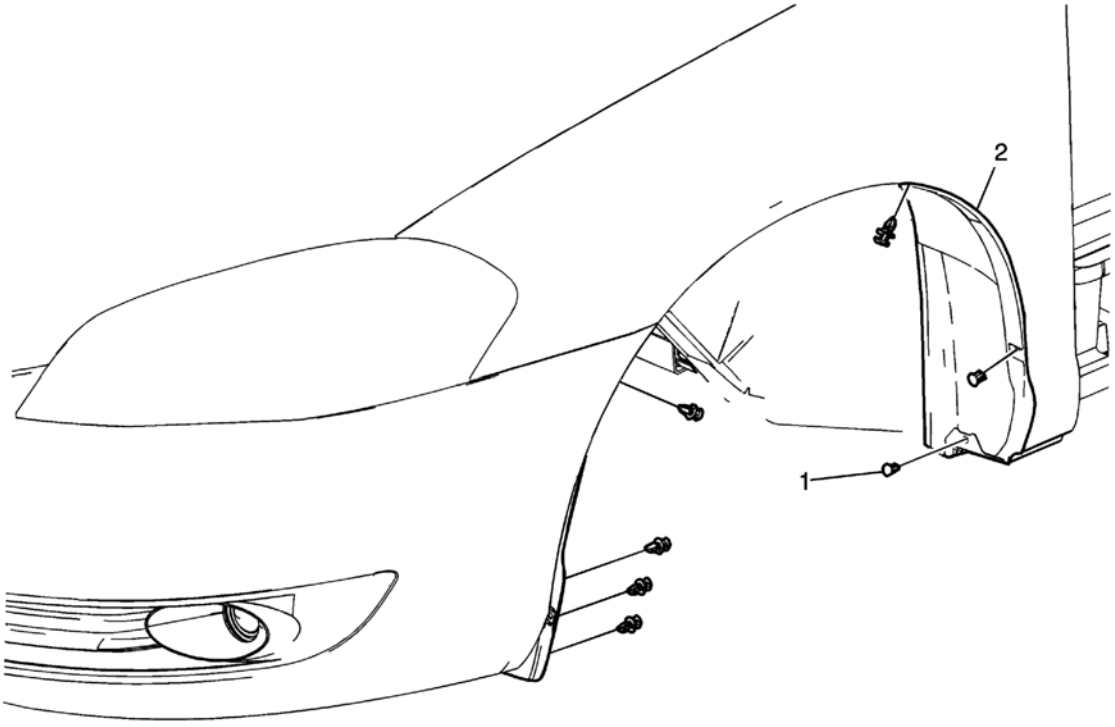


Fig. 21: Front Fender Liner
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Lift and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the front wheel. Refer to **Tire and Wheel Removal and Installation** .	
1	Front Fender Liner Retainer (Qty: 7)
2	Front Fender Liner

REAR WHEELHOUSE LINER REPLACEMENT

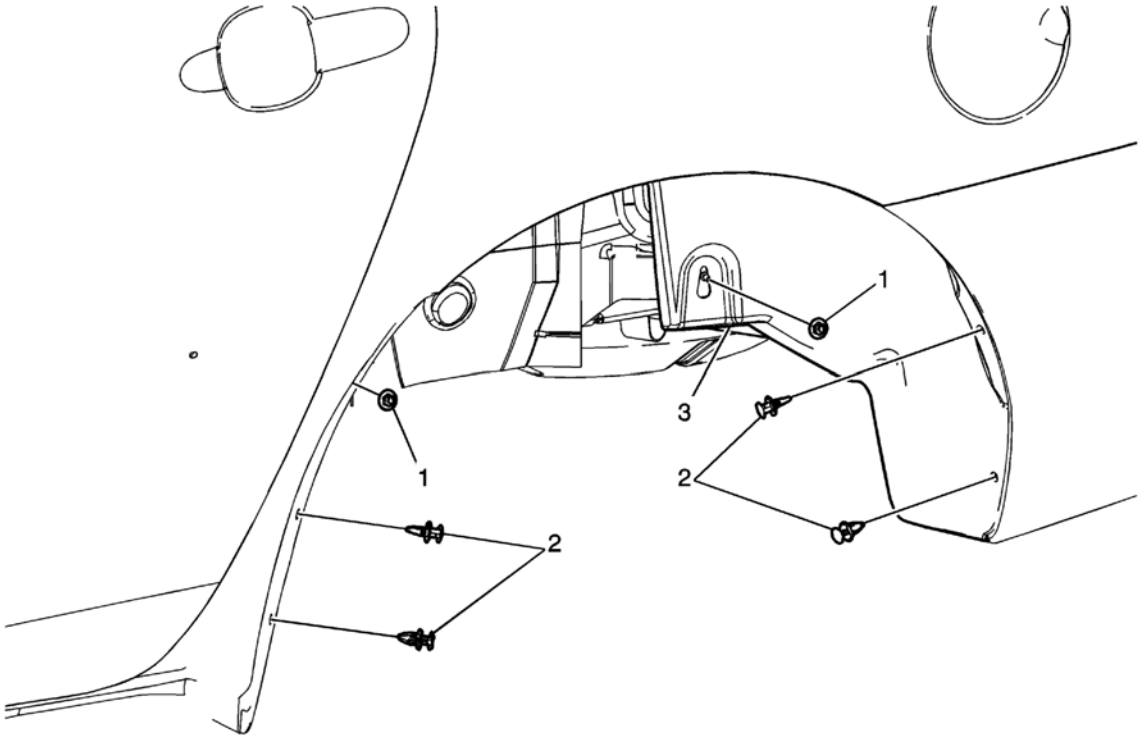


Fig. 22: Rear Wheelhouse Liner Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Lift and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the rear wheel. Refer to **Tire and Wheel Removal and Installation** .	
1	Rear Wheelhouse Liner Nut (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Rear Wheelhouse Liner Retainer (Qty: 4)
3	Rear Wheelhouse Liner

ENGINE SPLASH SHIELD REPLACEMENT (RIGHT)

Tools Required

J 38778 Door Trim Pad and Garnish Clip Remover

Removal Procedure

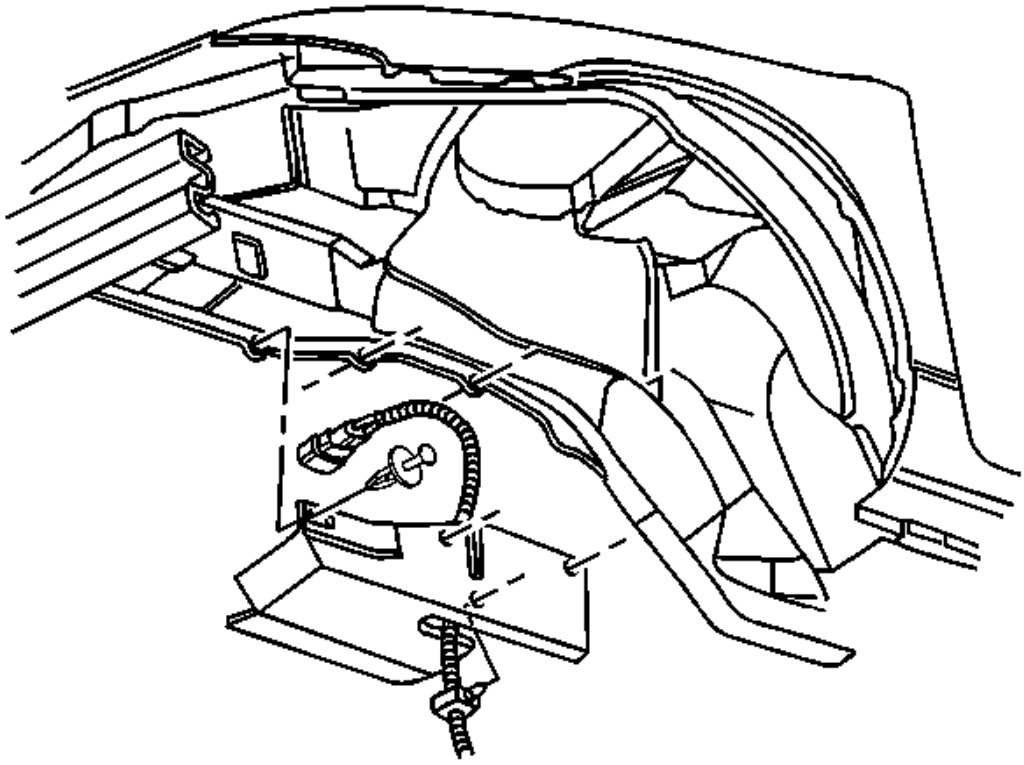


Fig. 23: Engine Splash Shield & Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Remove the push-in retainers that hold the ABS lead to the engine splash shield.

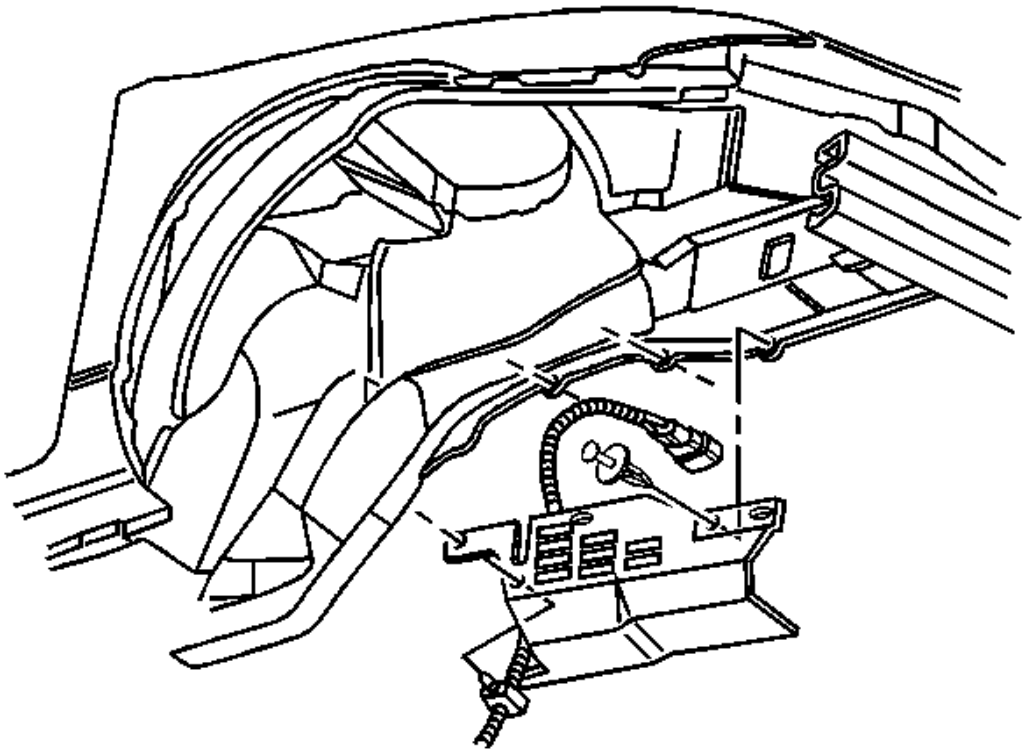


Fig. 24: Right Engine Splash Shield & Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine splash shield from the lower flange of the engine compartment side rail.

Installation Procedure

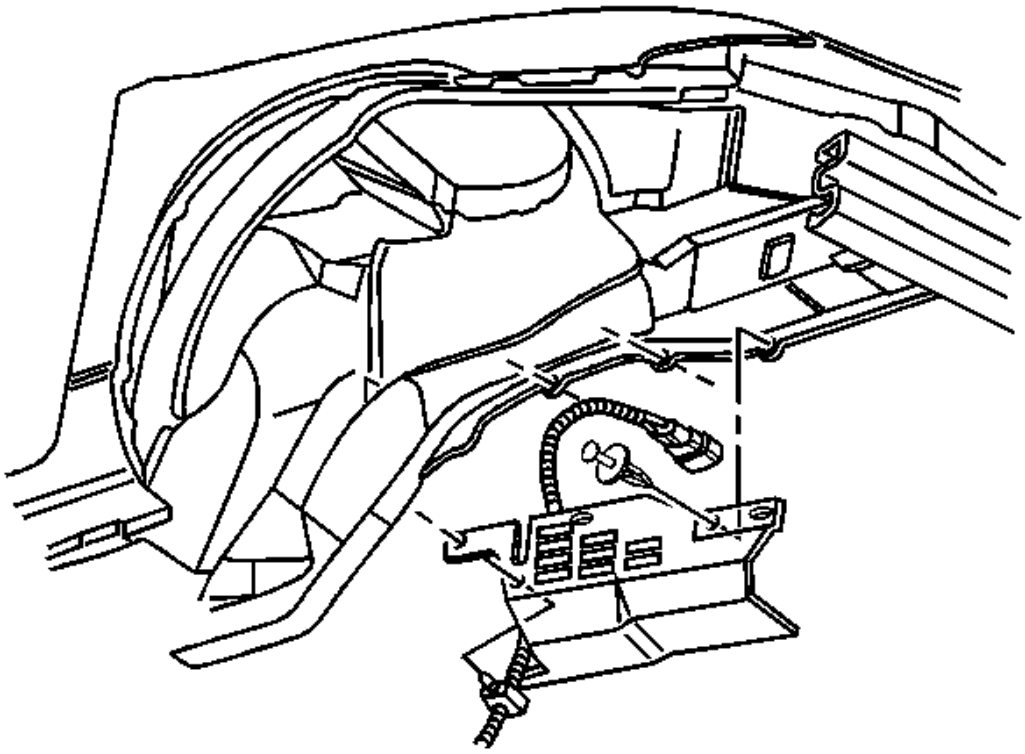


Fig. 25: Right Engine Splash Shield & Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine splash shield to the lower flange of the engine compartment side rail.
2. Route the ABS lead through the slot in the engine splash shield.

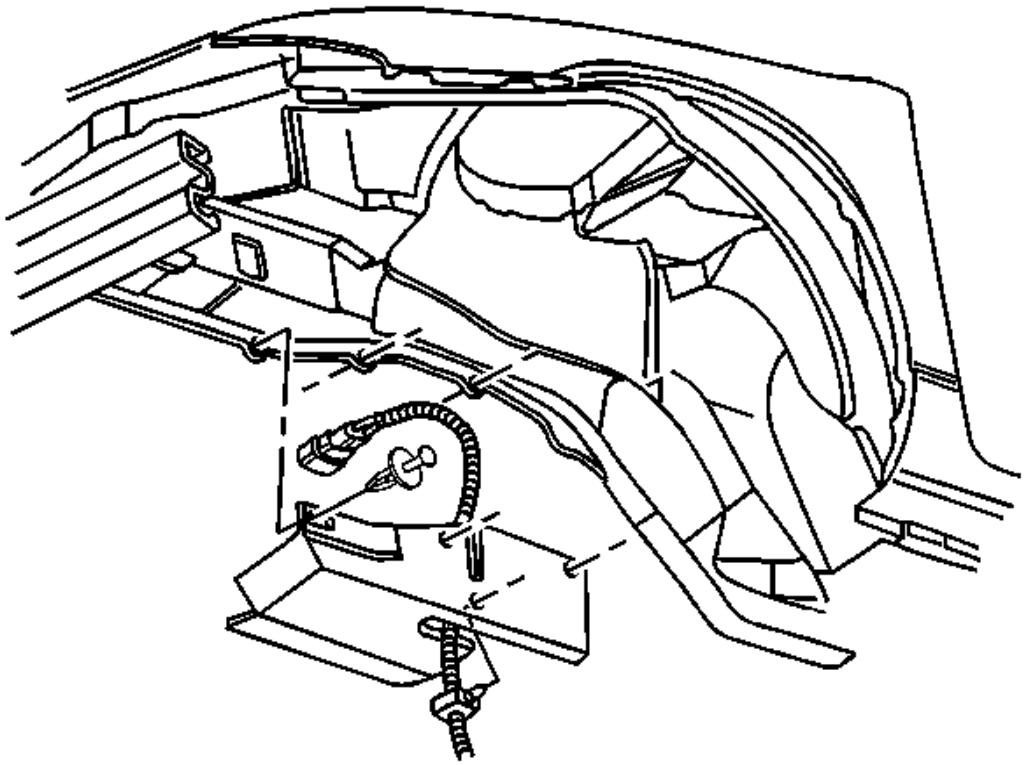


Fig. 26: Engine Splash Shield & Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Align the holes in the engine splash shield to holes in the outboard side engine compartment side rail.
4. Install the push-in retainers to the engine splash shield.

ENGINE SPLASH SHIELD REPLACEMENT (LEFT)

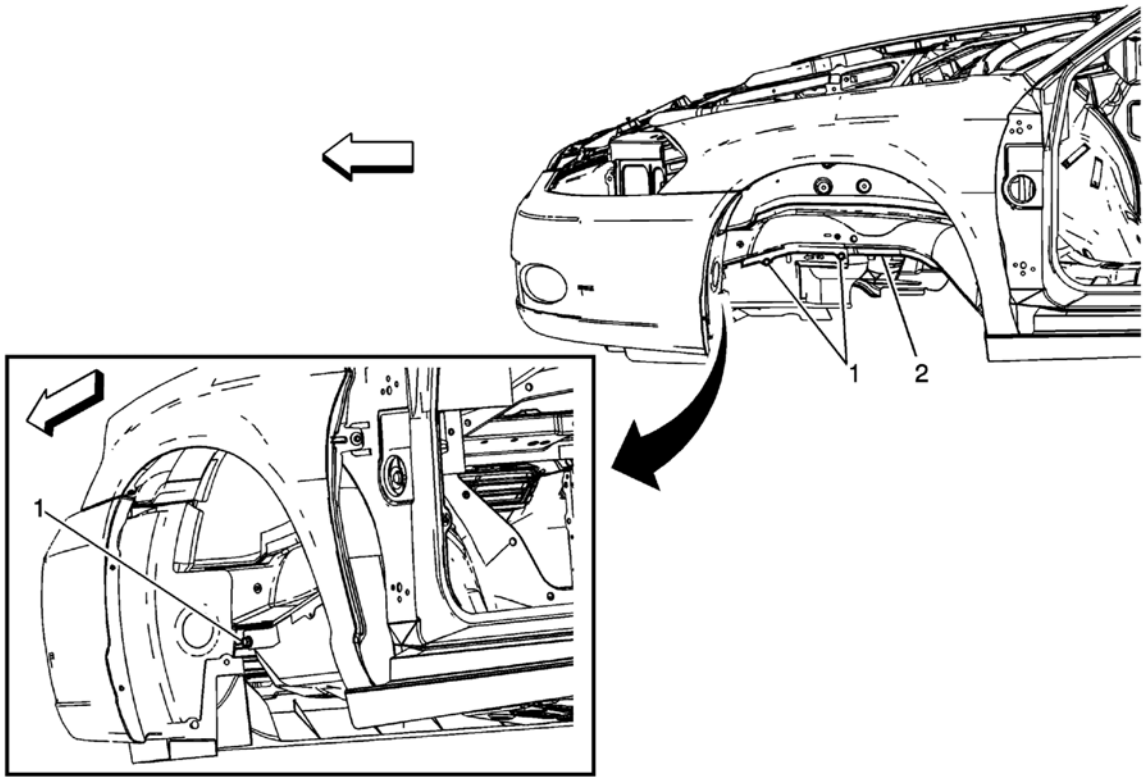


Fig. 27: Engine Splash Shield - Engine (Left)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the left tire/wheel assembly. Refer to **Tire and Wheel Removal and Installation** .	
1	Engine Splash Shield (Left) Plastic Retainer (Qty: 3)
2	Engine Splash Shield (Left)

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

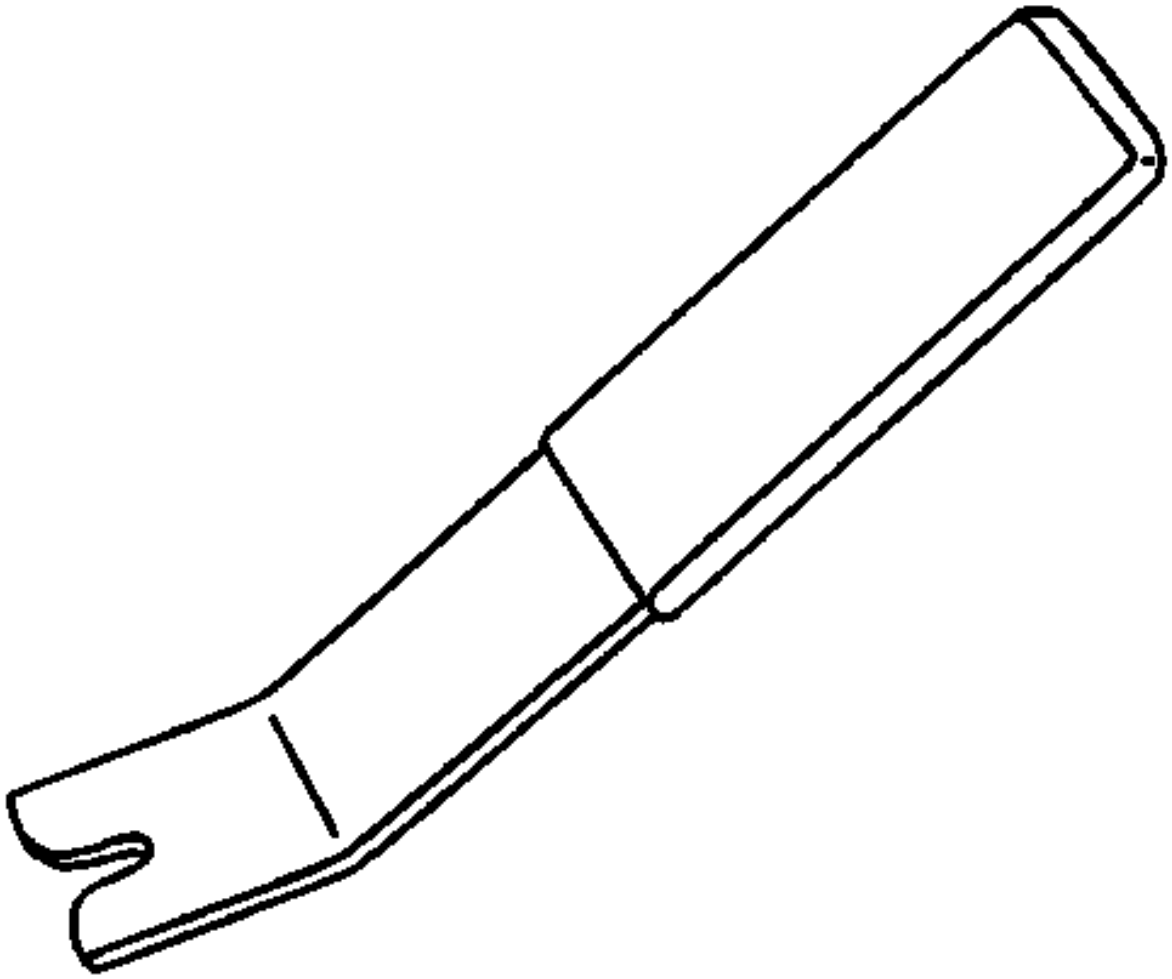
Illustration	Tool Number/ Description
	J 38778 Door Trim Pad Clip Remover

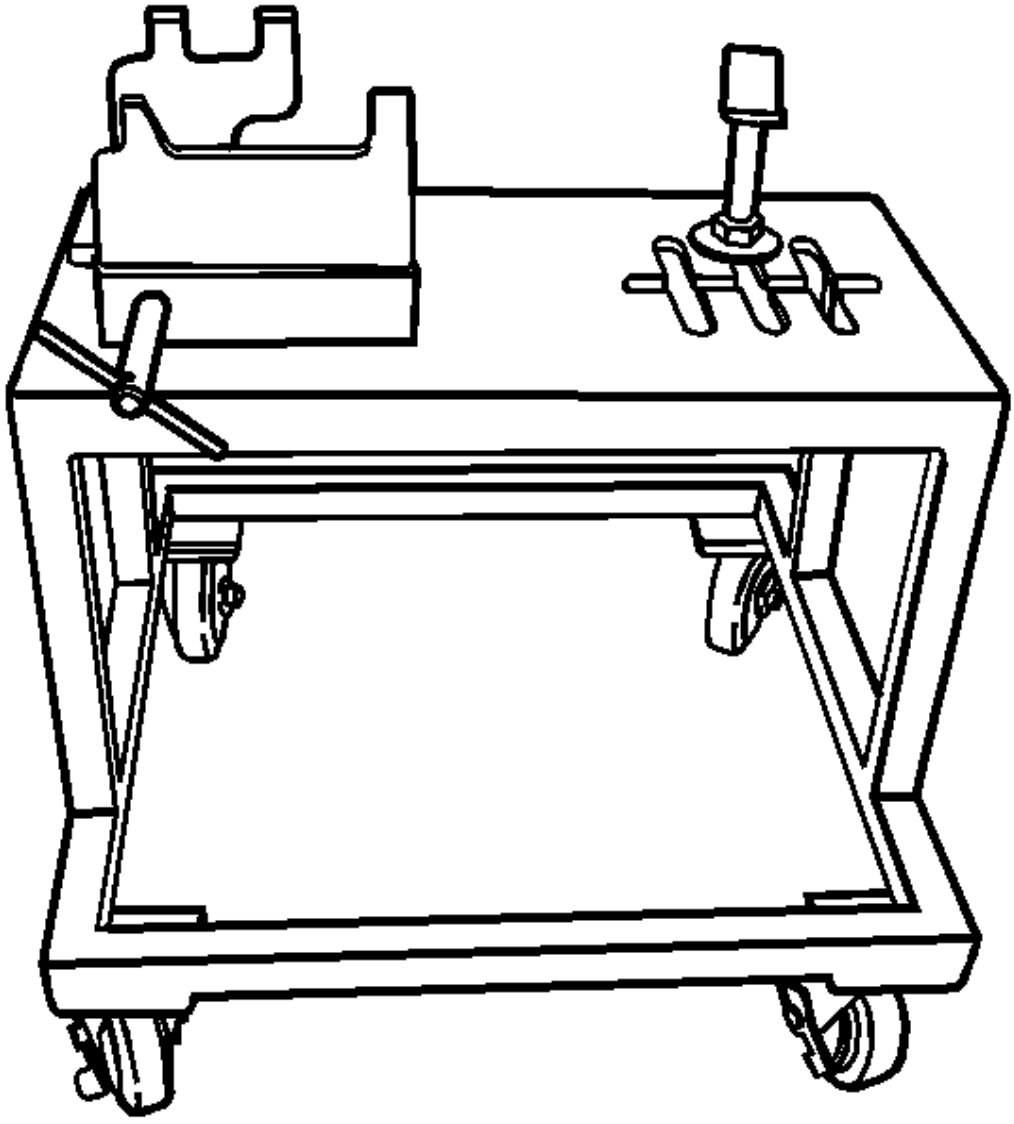
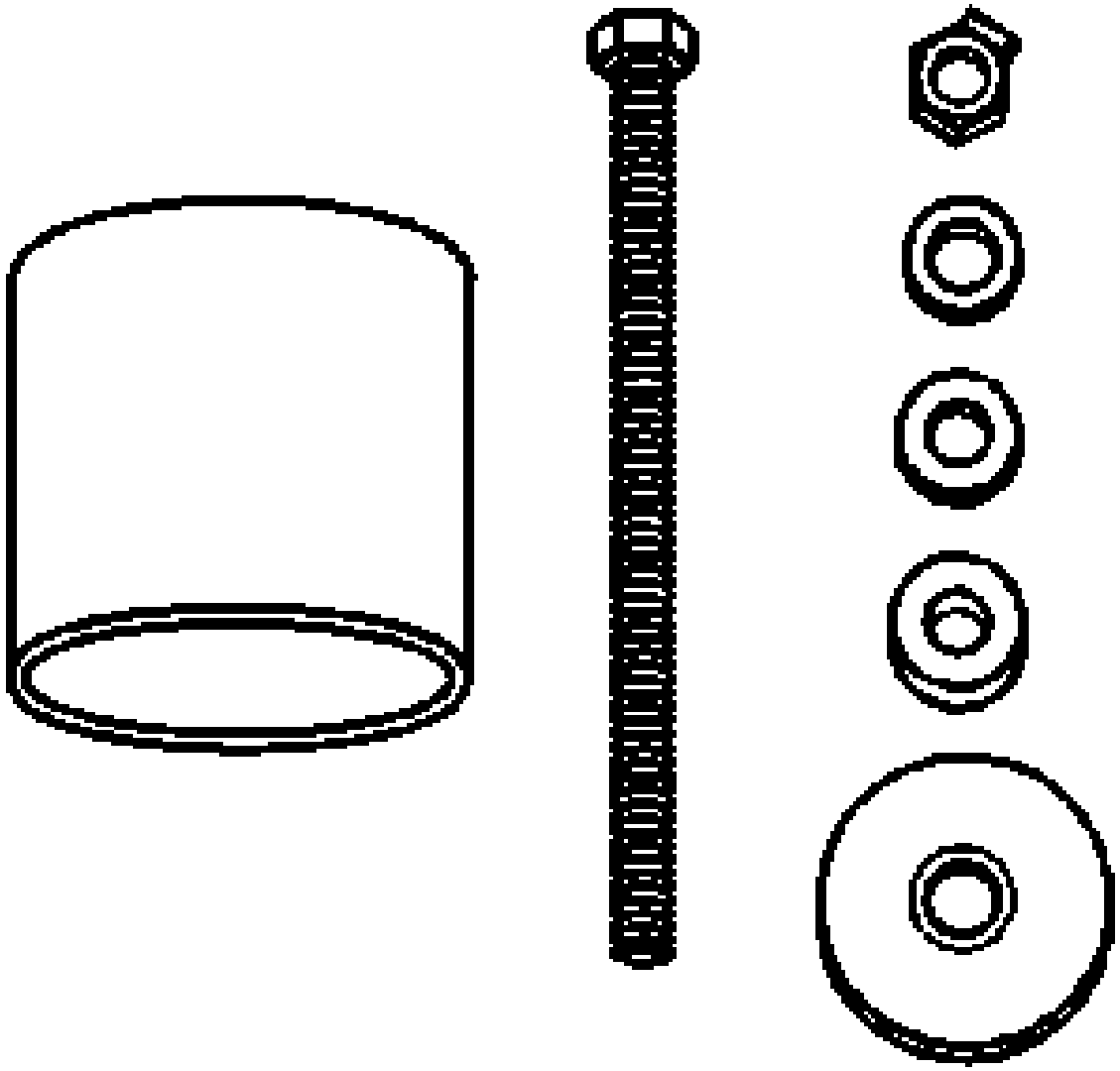
Illustration	Tool Number/ Description
	J 39580 Power Pack Stand Engine And Transaxle Assembly Support Remove/Installer

Illustration	Tool Number/ Description
	J 45296 Frame Insulator Remover/Installer

Article GUID: A00737237

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Front Floor Console Armrest Screws	2 N.m	18 lb in
Front Floor Console Armrest Hinge Screws	2 N.m	18 lb in
Front Floor Console Armrest Inner Screws	2 N.m	18 lb in
Front Floor Console Bolts/Screws	7 N.m	62 lb in
Front Floor Console Bracket Bolts	10 N.m	89 lb in
Front Floor Console Cupholder Screws	2 N.m	18 lb in
Front Floor Console Front Trim Plate Screws	2 N.m	18 lb in
Instrument Panel Carrier to Body Bolts	25 N.m	18 lb ft
Instrument Panel Carrier to HVAC Module Bolts	4 N.m	35 lb in
Instrument Panel Center Support Bracket Bolts	10 N.m	89 lb in
Instrument Panel Compartment Dampener Screws	2 N.m	18 lb in
Instrument Panel Compartment Inner Panel Screws	2 N.m	18 lb in
Instrument Panel Compartment Latch Screws	2 N.m	18 lb in
Instrument Panel Lower Trim Panel Bolts/Screws	2 N.m	18 lb in
Instrument Panel Trim Plate Screws	2 N.m	18 lb in
Instrument Panel Upper Trim Pad Bolts/Screws	2 N.m	18 lb in
Knee Bolster Bracket to Carrier Bolts	10 N.m	89 lb in
Knee Bolster Bracket to HVAC Module Bolts	4 N.m	35 lb in
Knee Bolster Reinforcement Bolts	2 N.m	18 lb in

REPAIR INSTRUCTIONS

INSTRUMENT PANEL INSULATOR PANEL REPLACEMENT - RIGHT SIDE

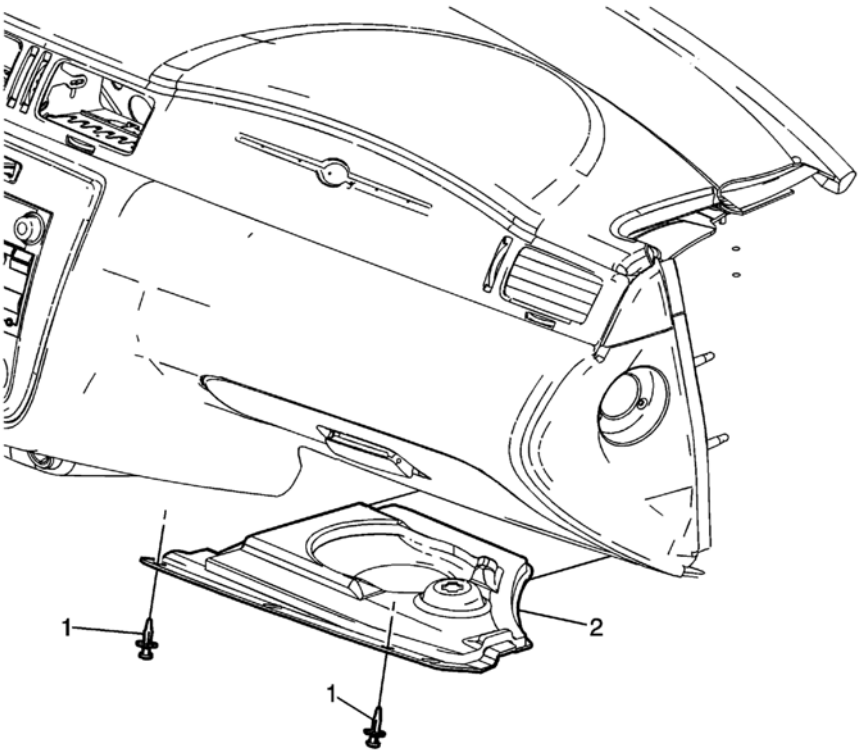


Fig. 1: Right Closeout/Insulator Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Push Pin Retainer (Qty: 2)
2	Instrument Panel Closeout/Insulator Panel **TIP:** Remove the courtesy lamp, if equipped.

INSTRUMENT PANEL INSULATOR PANEL REPLACEMENT - LEFT SIDE

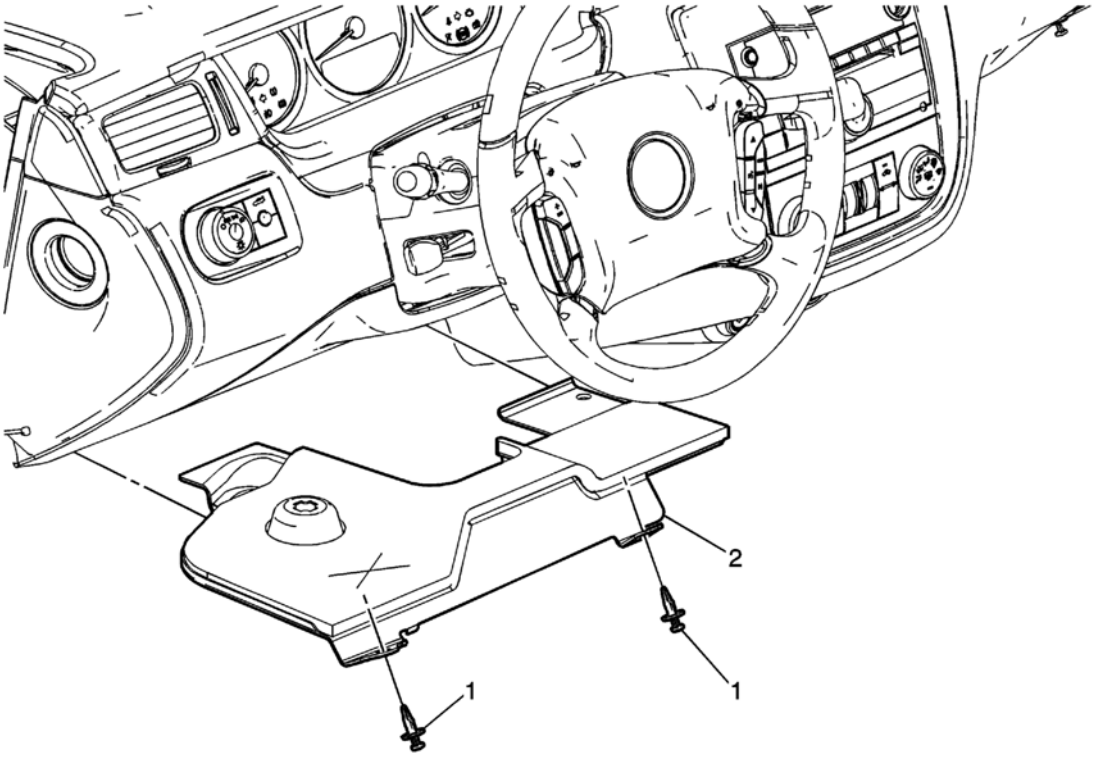


Fig. 2: Left Closeout/Insulator Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Push Pin Retainer (Qty: 2)
2	Instrument Panel Closeout/Insulator Panel **TIP:** Remove the courtesy lamp, if equipped.

STEERING COLUMN OPENING FILLER REPLACEMENT

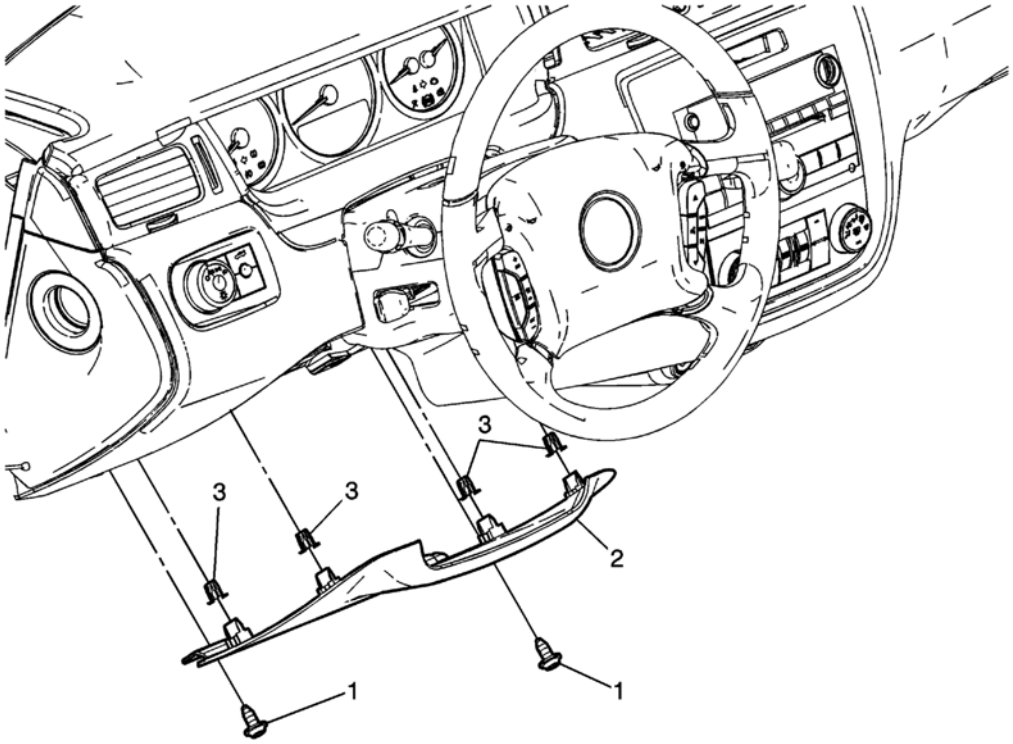


Fig. 3: Steering Column Filler
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Steering Column Filler Panel Screw (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	Steering Column Filler Panel Assembly
3	Retainer Clip (Qty: 4)

INSTRUMENT PANEL LOWER CENTER TRIM REPLACEMENT

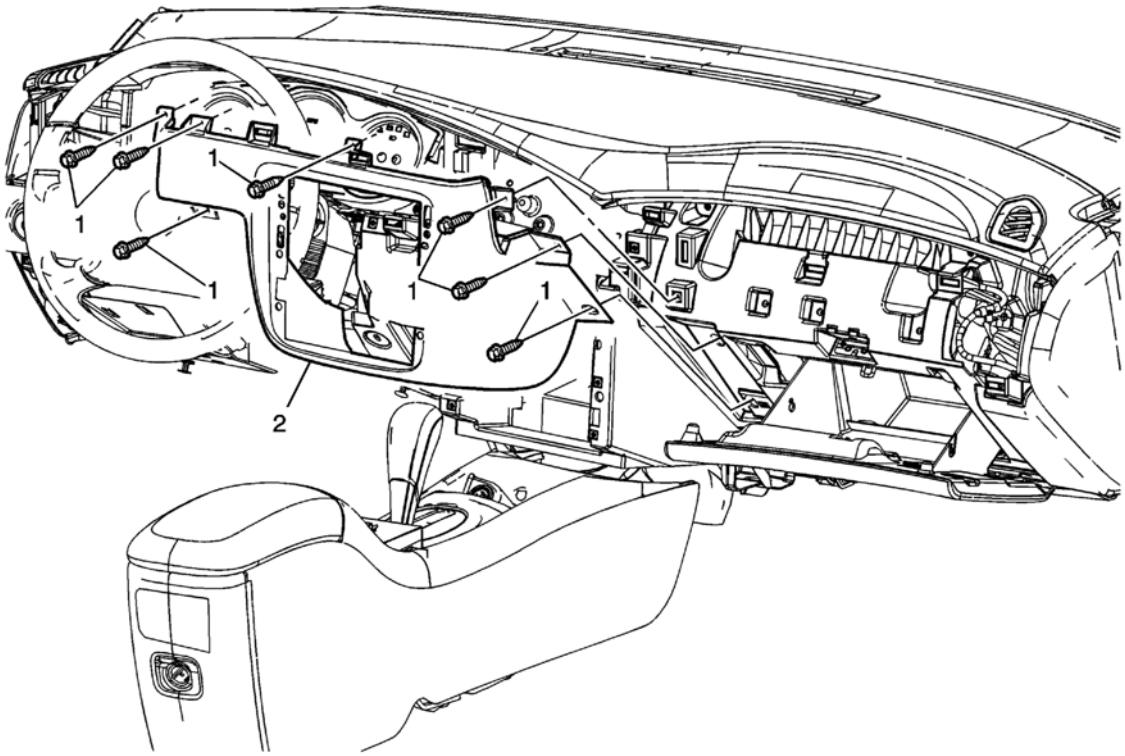


Fig. 4: Instrument Panel (I/P) Lower Center Trim
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the instrument panel trim plate. Refer to **Instrument Panel Trim Plate Replacement**. 2. Remove the radio. Refer to **Radio Replacement** . 3. Remove the HVAC control module. Refer to **Heater and Air Conditioning Control Replacement** .	
1	Instrument Panel Center Lower Trim Panel Screw (Qty: 7) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 2 N.m (18 lb in)
2	Instrument Panel Center Lower Trim Panel

INSTRUMENT PANEL EXTENSION TRIM PLATE REPLACEMENT

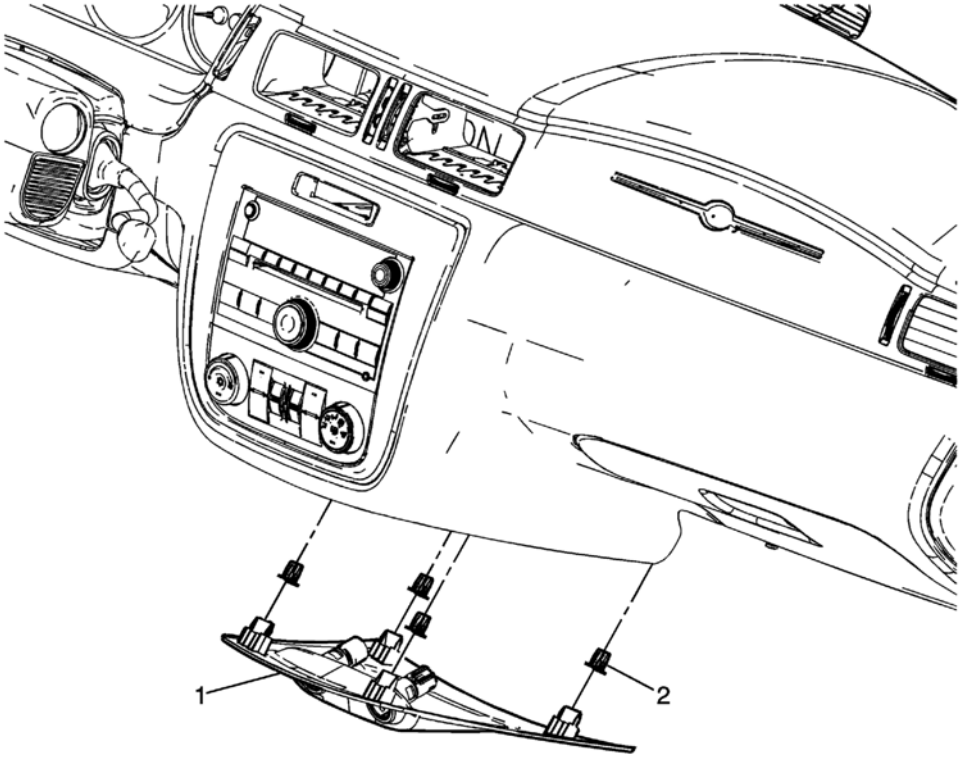


Fig. 5: Instrument Panel (I/P) Extension Trim Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel Extension Panel Assembly 1. Disconnect electrical connectors. 2. Remove the 12-volt accessory power receptacles. Refer to **Cigar Lighter Receptacle or 12-Volt Accessory Power Receptacle Replacement** .
2	Retainer Clips (Qty 4)

PASSENGER KNEE BOLSTER BRACKET REPLACEMENT

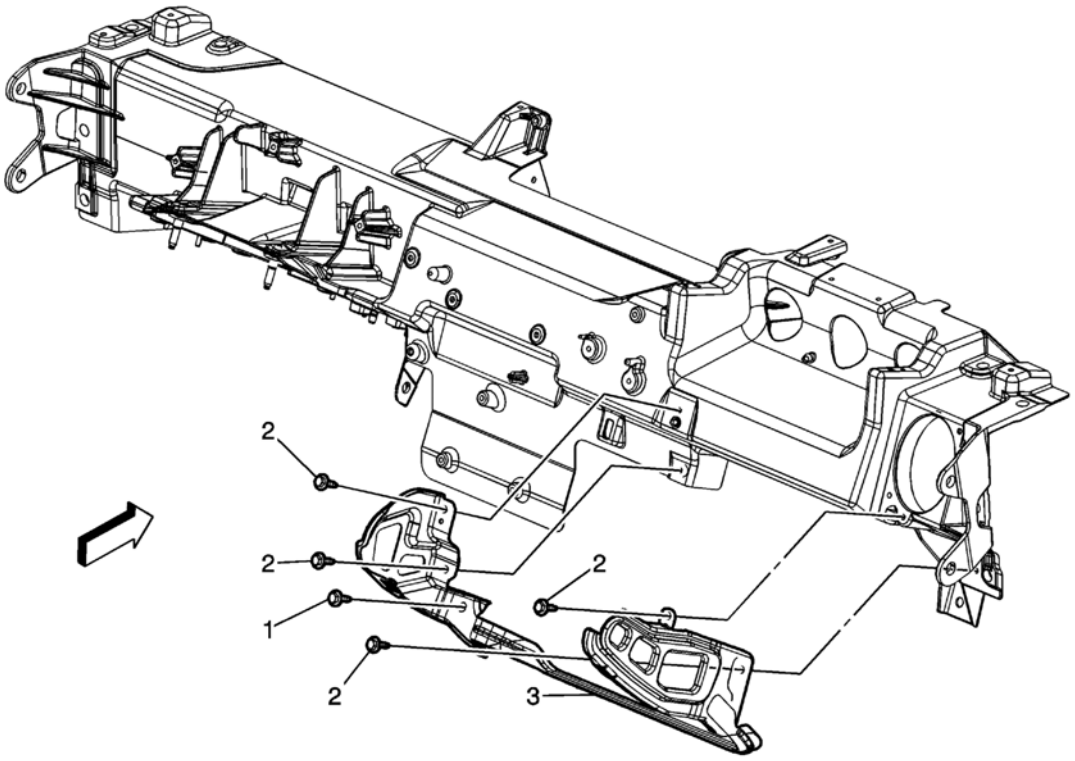


Fig. 6: Right Knee Bolster Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel lower trim panel. Refer to **Instrument Panel Lower Trim Panel Replacement**.	
1	Passenger Knee Bolster Bracket to HVAC Module Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	Passenger Knee Bolster Bracket Bolt (Qty: 4) **Tighten** 10 N.m (89 lb in)
3	Passenger Knee Bolster Bracket Assembly

DRIVER KNEE BOLSTER BRACKET REPLACEMENT

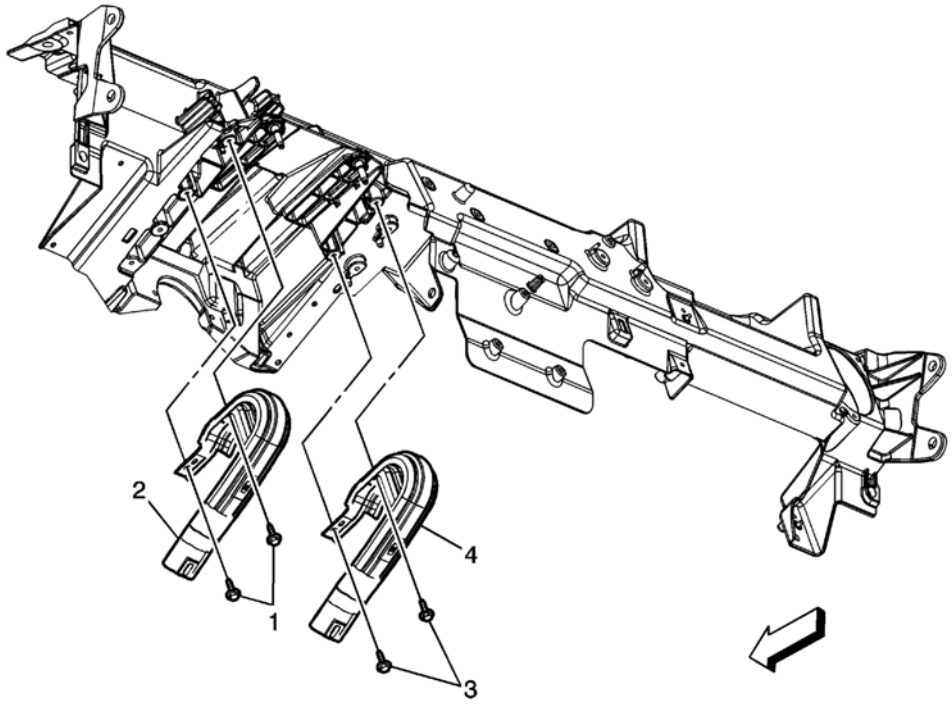


Fig. 7: Left Knee Bolster Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel lower trim panel. Refer to **Instrument Panel Lower Trim Panel Replacement**.	
1	Driver Knee Bolster Bracket Bolt (Qty 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Driver Knee Bolster - Left Bracket Assembly
3	Driver Knee Bolster Bracket Bolt (Qty 2) **Tighten** 10 N.m (89 lb in)
4	Driver Knee Bolster - Right Bracket Assembly

DRIVER KNEE BOLSTER REINFORCEMENT REPLACEMENT

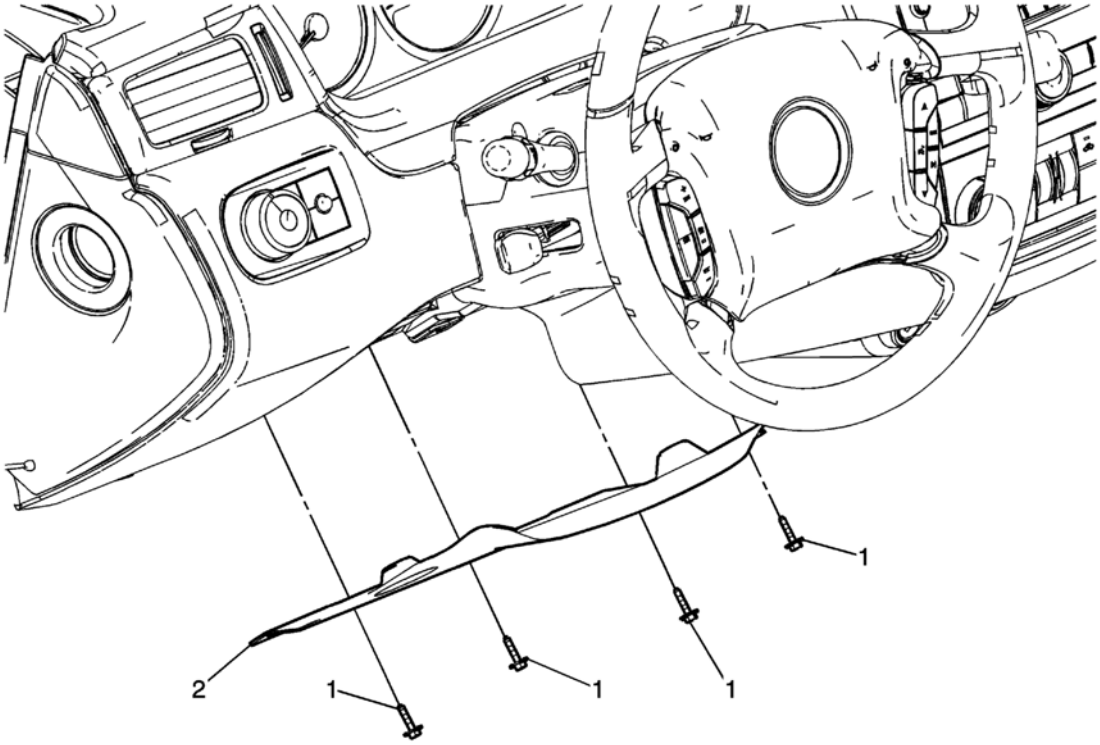


Fig. 8: Knee Bolster Reinforcement
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the steering column filler panel. Refer to **Steering Column Opening Filler Replacement**.	
1	Knee Bolster Reinforcement Bolt (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 2 N.m (18 lb in)
2	Instrument Panel Drivers Knee Bolster Reinforcement

INSTRUMENT PANEL TRIM PLATE REPLACEMENT

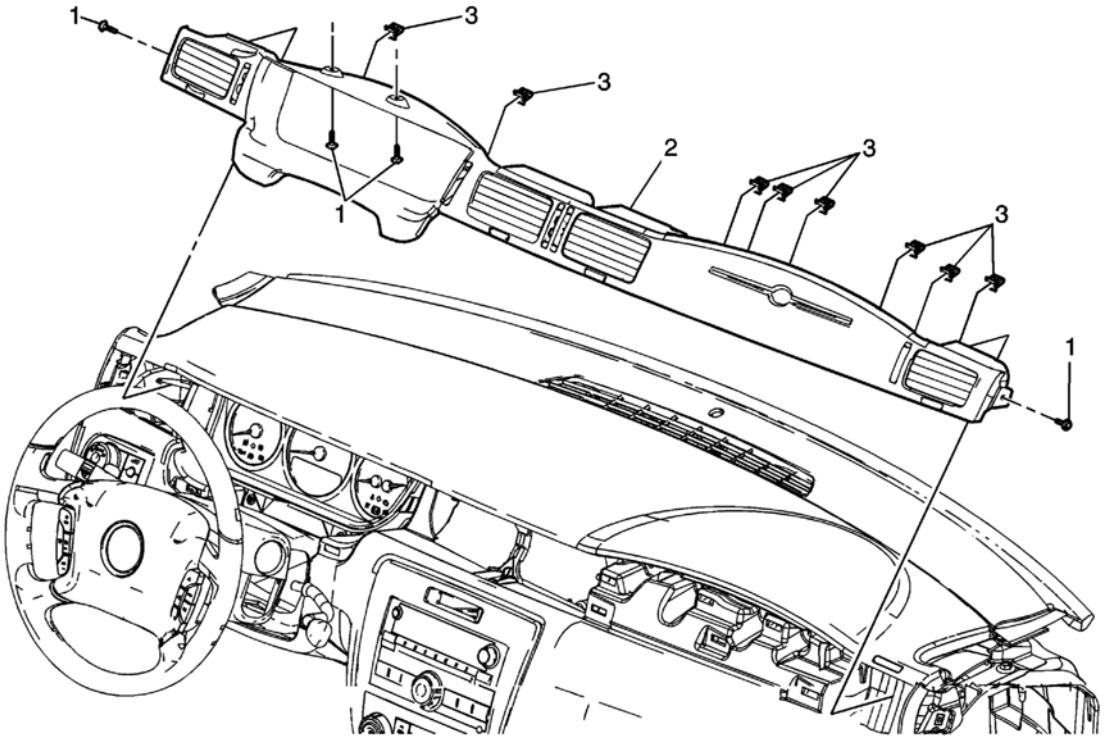


Fig. 9: Instrument Panel (I/P) Trim Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel (I/P) outer trim covers. Refer to **Instrument Panel Outer Trim Cover Replacement - Left Side**, and **Instrument Panel Outer Trim Cover Replacement - Right Side**.	
1	Instrument Panel Trim Plate Screw (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	Instrument Panel Trim Plate Assembly **Procedure** 1. Disconnect the electrical connector. 2. Tilt the steering column to the lowest position. 3. Remove the driver information center switch. Refer to **Driver Information Display Switch Replacement** .
3	Retainer Clip (Qty: 8)

INSTRUMENT PANEL LOWER TRIM PLATE REPLACEMENT

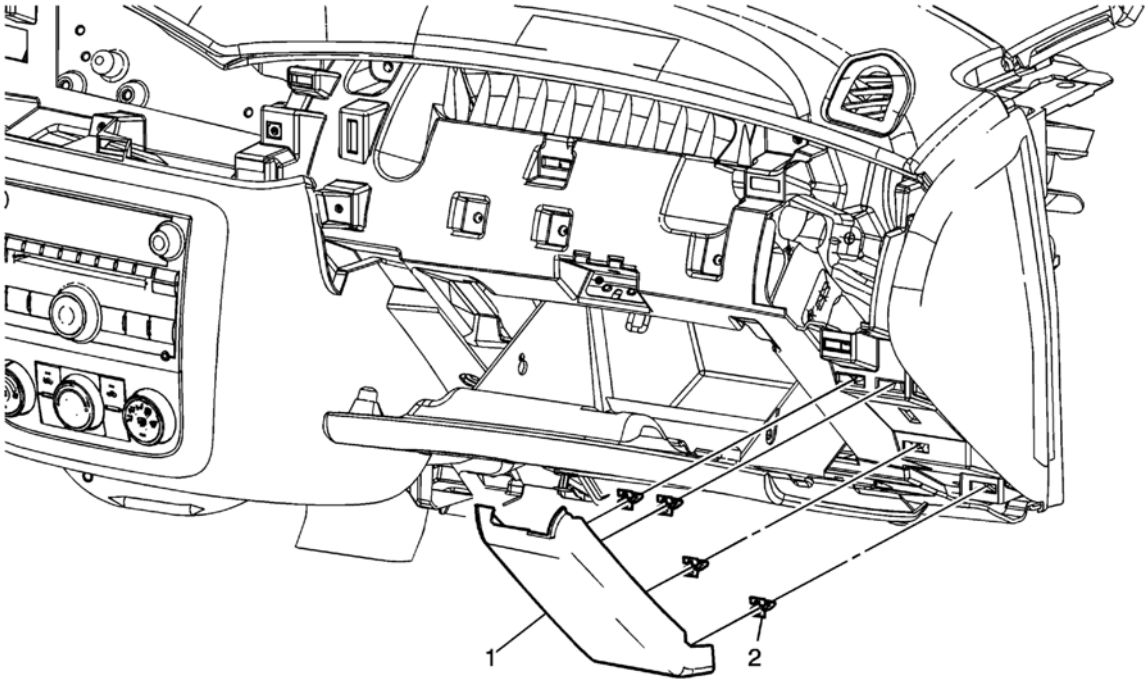


Fig. 10: Instrument Panel (I/P) Lower Trim Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedure** Remove the instrument panel trim plate. Refer to **Instrument Panel Trim Plate Replacement**.	
1	Instrument Panel Lower Trim Plate
2	Retainer Clips (Qty: 4)

INSTRUMENT PANEL ACCESSORY TRIM PLATE REPLACEMENT

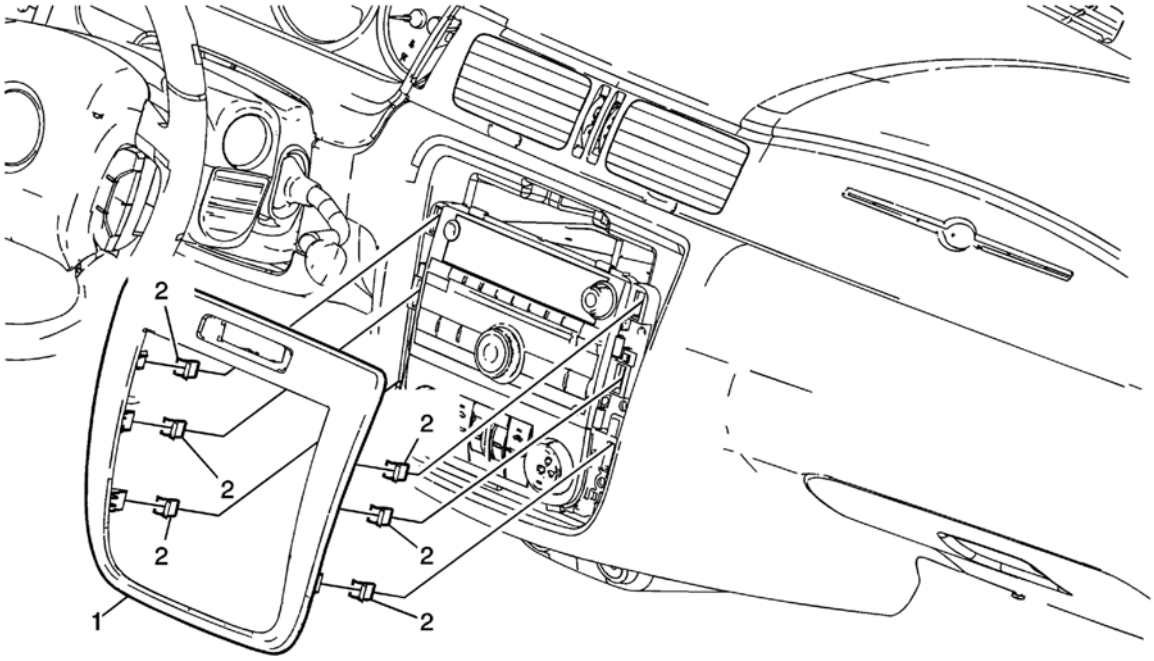


Fig. 11: Instrument Panel (I/P) Accessory Trim Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel Accessory Plate Assembly **Procedure** 1. Disconnect electrical connectors. 2. Remove the inflatable restraint iIndicator. Refer to **Instrument Panel Airbag Arming Status Display Replacement** .
2	Retainer Clip (Qty 6)

INSTRUMENT PANEL UPPER TRIM PANEL REPLACEMENT

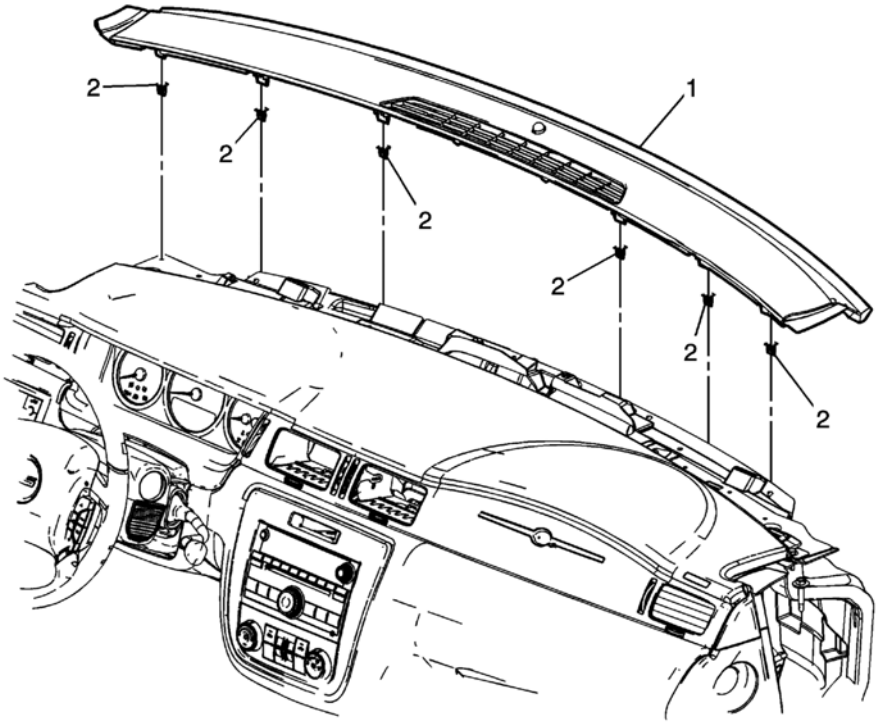


Fig. 12: Instrument Panel (I/P) Upper Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the windshield garnish moldings. Refer to **Windshield Pillar Garnish Molding Replacement** .	
1	Instrument Panel Upper Trim Panel Assembly **Procedure** 1. Disconnect electrical connectors. 2. Remove the ambient light sensor.
2	Retainer Clip (Qty: 6)

INSTRUMENT PANEL OUTER TRIM COVER REPLACEMENT - RIGHT SIDE

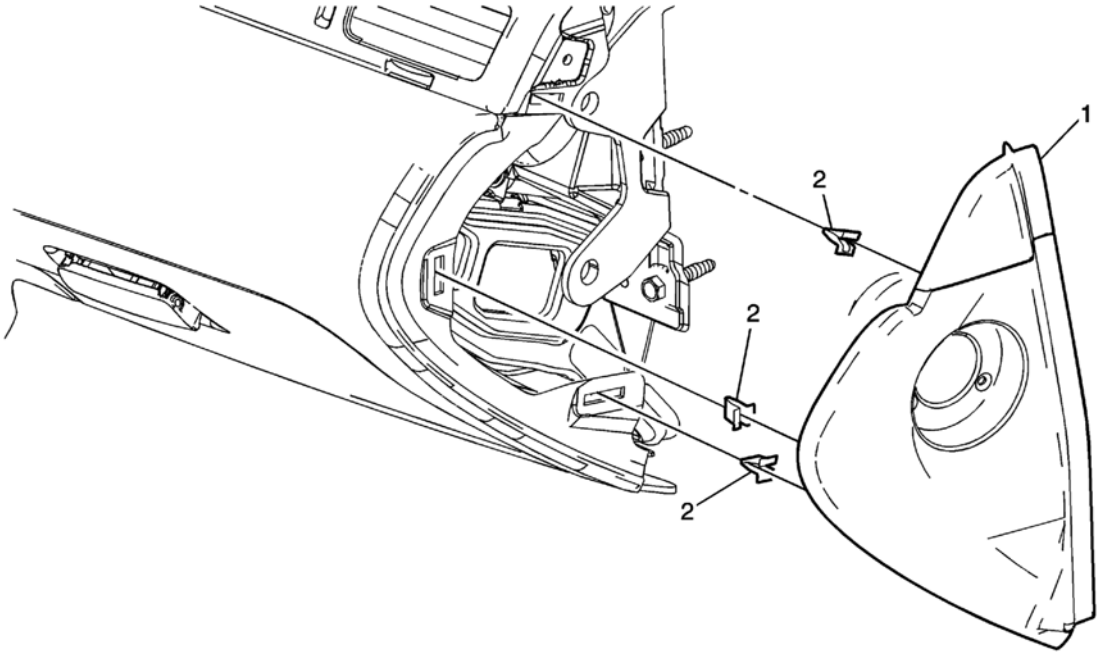


Fig. 13: Right Instrument Panel (I/P) Outer Trim Cover
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel Outer Trim Cover
2	Retainer Clip (Qty: 3)

INSTRUMENT PANEL OUTER TRIM COVER REPLACEMENT - LEFT SIDE

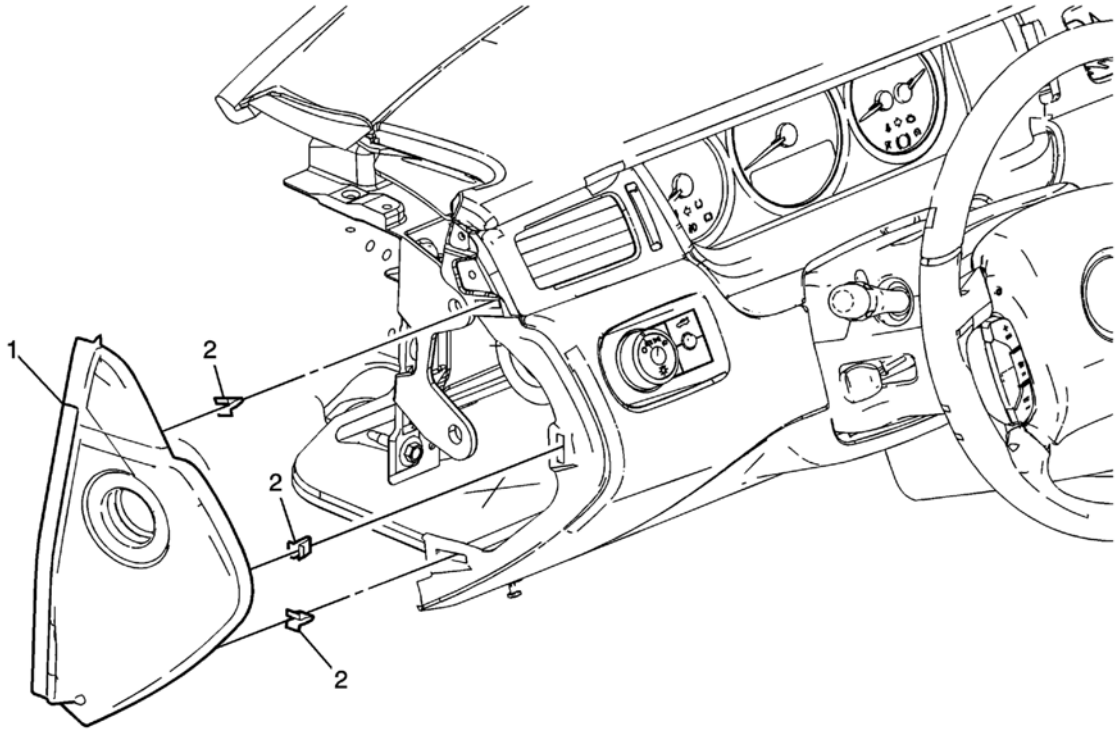


Fig. 14: Left Instrument Panel (I/P) Outer Trim Cover
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel Outer Trim Cover
2	Retainer Clip (Qty: 3)

INSTRUMENT PANEL LOWER TRIM PANEL REPLACEMENT

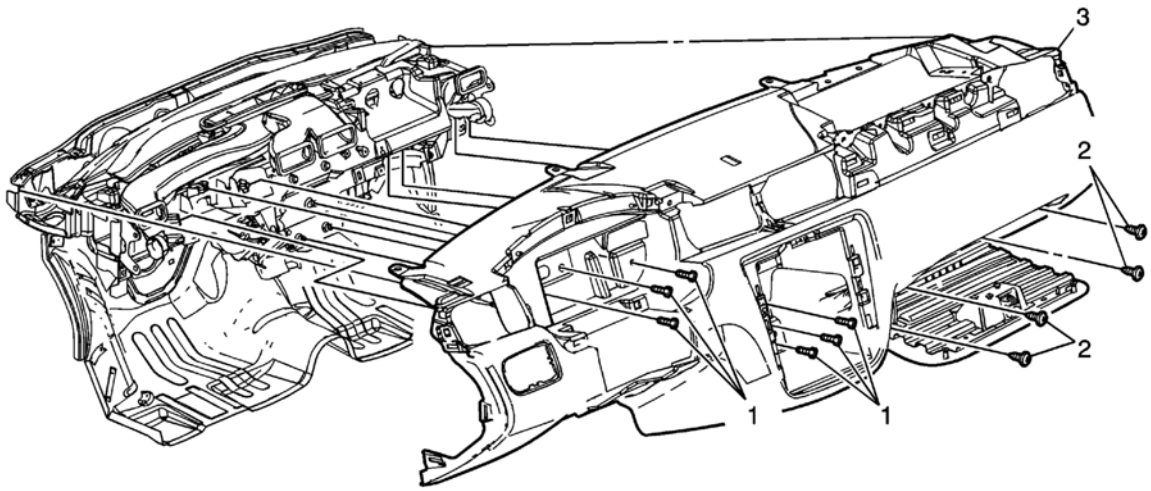


Fig. 15: Lower Instrument Panel (I/P) Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the instrument panel (I/P) upper trim pad. Refer to **Instrument Panel Upper Trim Pad Replacement**. 2. Remove the I/P cluster assembly. Refer to **Instrument Cluster Replacement** . 3. Remove the headlamp switch assembly. Refer to **Headlamp Switch Replacement (Impala)** . 4. Remove the right and left insulator panels. Refer to **Instrument Panel Insulator Panel Replacement - Right Side**, and **Instrument Panel Insulator Panel Replacement - Left Side**. 5. Remove the I/P inflatable restraint. Refer to **Airbag Instrument Panel Module Replacement (Impala)** . 6. Remove the drivers knee bolster reinforcement. Refer to **Driver Knee Bolster Reinforcement Replacement**. 7. Remove the steering column. Refer to **Steering Column Replacement** . 8. Remove the radio. Refer to **Radio Replacement** . 9. Remove the HVAC control module. Refer to **Heater and Air Conditioning Control Replacement** .	
1	Instrument Panel Lower Trim Panel Bolt (Qty 6) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 10 N.m (88 lb in)
2	Instrument Panel Lower Trim Panel Screw (Qty 4) **Tighten** 2 N.m (18 lb in)
3	Instrument Panel Lower Trim Panel Assembly **Procedure** 1. Note routing of the wiring harness prior to removal to aid in the reinstallation. 2. Disconnect all electrical connections to the trim panel.

INSTRUMENT PANEL COMPARTMENT DOOR LOCK STRIKER REPLACEMENT

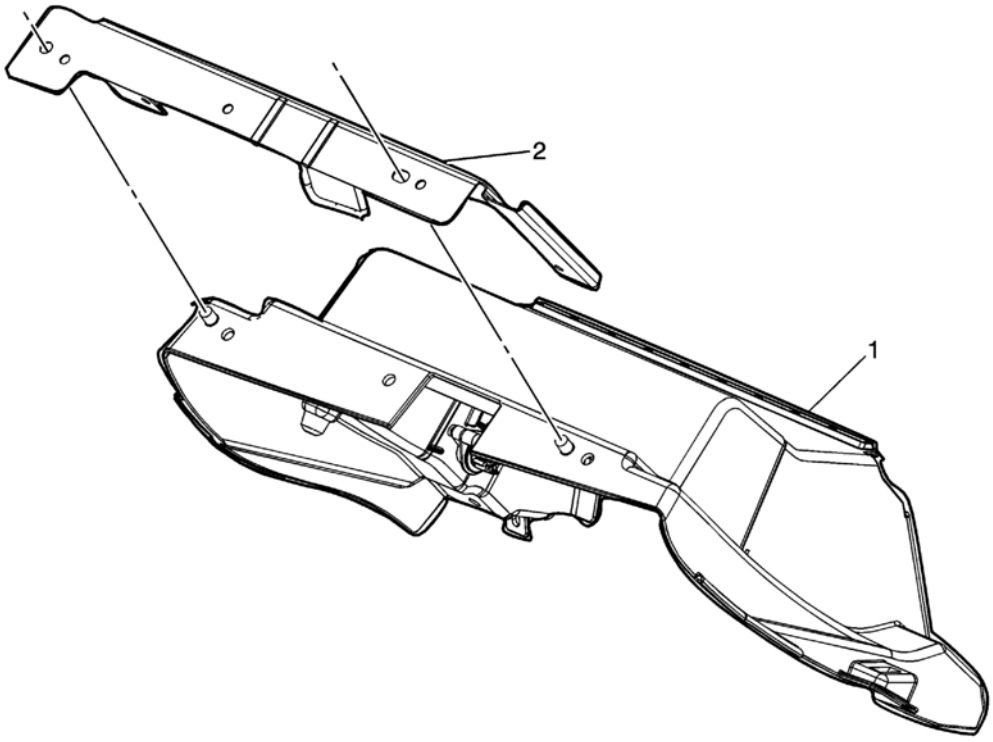


Fig. 16: Instrument Panel (I/P) Compartment Striker
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel Compartment Inner Panel Assembly Refer to Instrument Panel Compartment Inner Panel Replacement.

Callout	Component Name
2	Instrument Panel Compartment Striker Assembly

INSTRUMENT PANEL COMPARTMENT DOOR REPLACEMENT

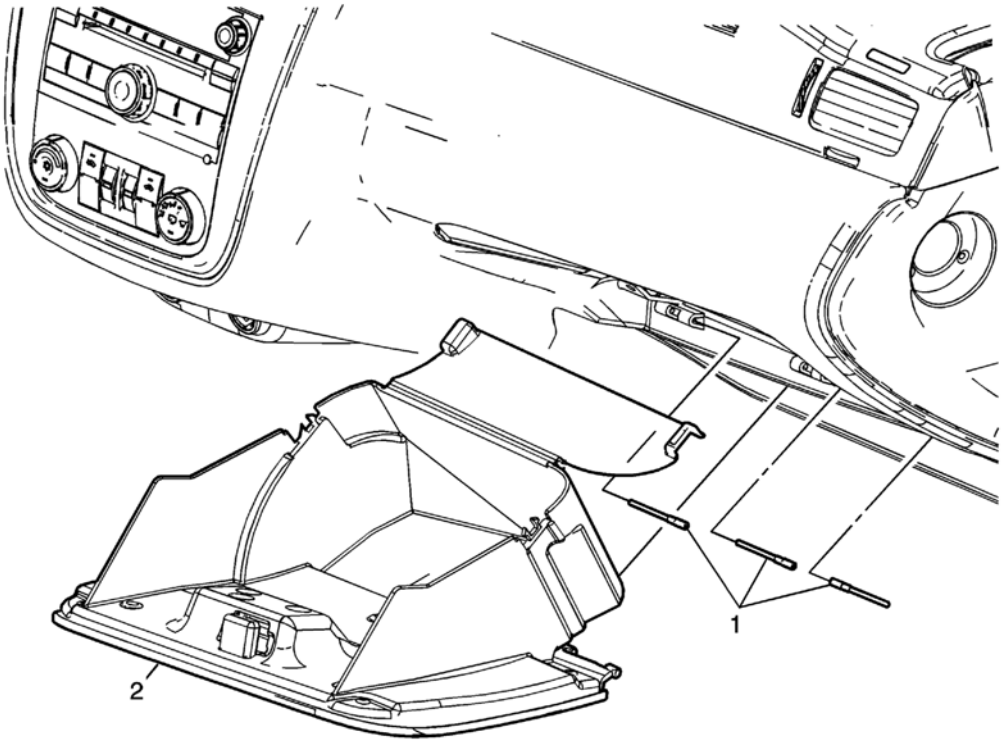


Fig. 17: Instrument Panel (I/P) Compartment Door
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Pin, Compartment Door Hinge (Qty 3) **TIP:** Use a small pointed tool in order to drive the pins out of the hinge.
2	Door Assembly, Instrument Panel Compartment 1. Squeeze the compartment bin enough to pull the door and bin assembly out the opening past the stops and the dampener. 2. Remove the compartment Latch Assembly. Refer to **Instrument Panel Compartment Door Latch Replacement**.

INSTRUMENT PANEL COMPARTMENT DOOR LATCH REPLACEMENT

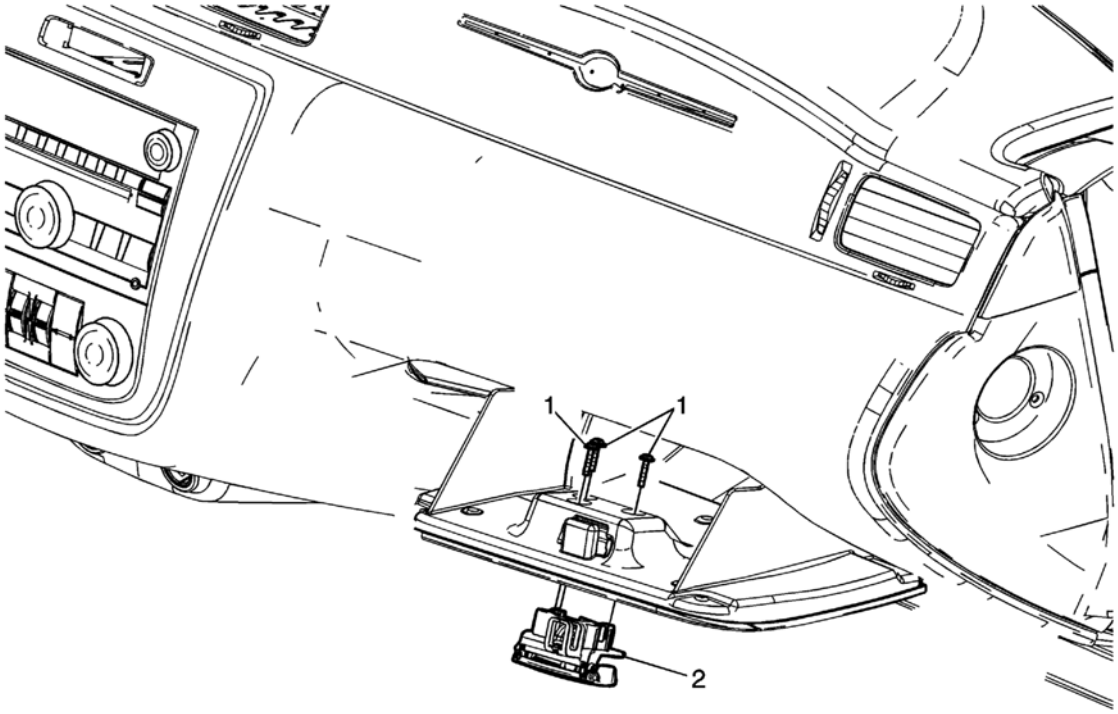


Fig. 18: Instrument Panel (I/P) Compartment Latch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel Compartment Latch Screw (Qty 3) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	Instrument Panel Compartment Latch Assembly

INSTRUMENT PANEL COMPARTMENT DOOR DAMPENER REPLACEMENT

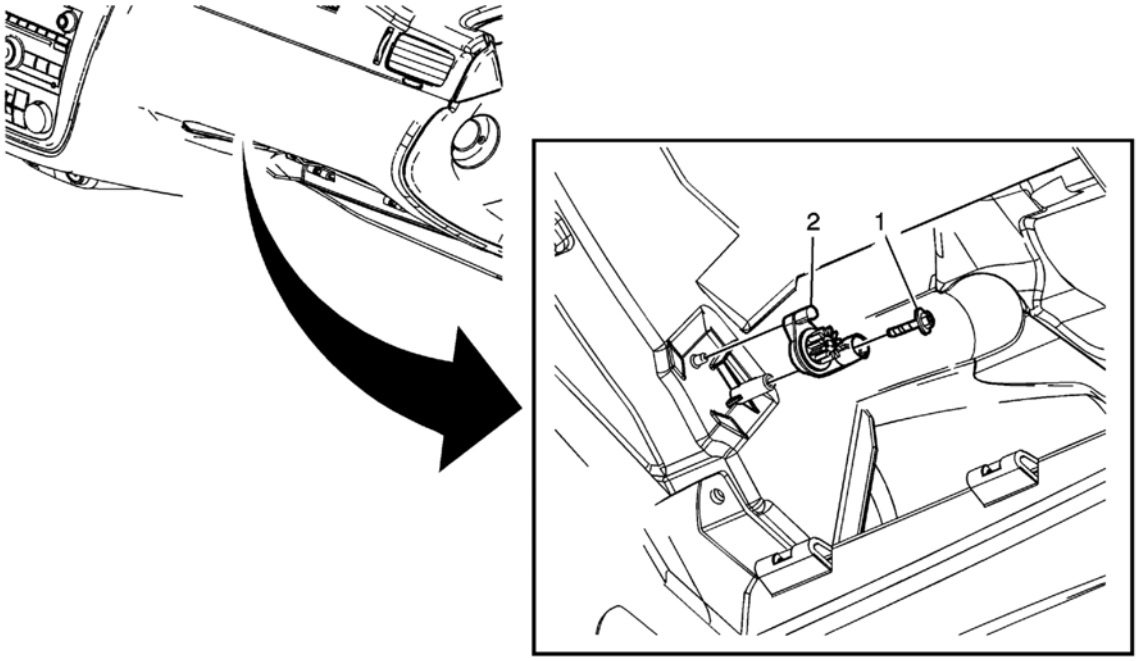


Fig. 19: I/P Compartment Dampener
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel compartment door assembly . Refer to **Instrument Panel Compartment Door Replacement**.	
1	Instrument Panel Compartment Striker Screw (Qty 1) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	Instrument Panel Compartment Dampener Assembly

INSTRUMENT PANEL COMPARTMENT INNER PANEL REPLACEMENT

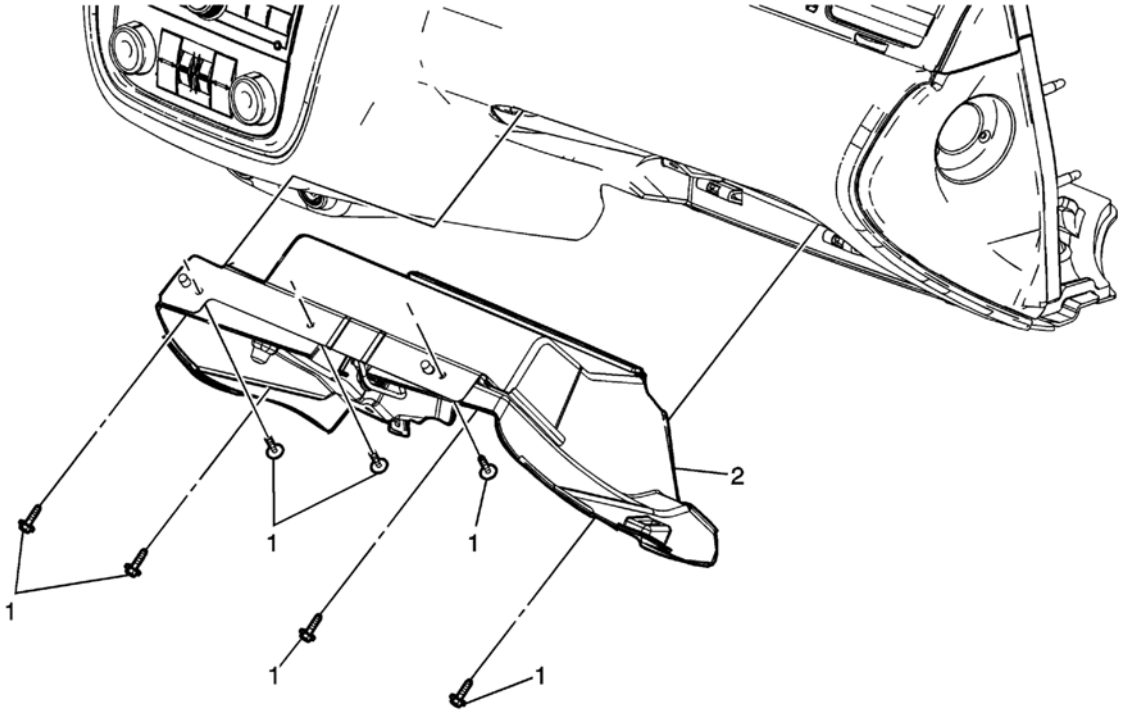


Fig. 20: Instrument Panel Compartment Inner Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the instrument panel compartment door assembly. Refer to **Instrument Panel Compartment Door Replacement**. 2. Remove the right side instrument panel closeout/insulator. Refer to **Instrument Panel Insulator Panel Replacement - Right Side**. 3. Remove the right side carpet retainer. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala)** . 4. Remove the instrument panel right hand outer trim cover. Refer to **Instrument Panel Outer Trim Cover Replacement - Right Side**. 5. Remove the instrument panel trim plate right outer screw. Refer to **Instrument Panel Trim Plate Replacement**.	
1	Instrument Panel Compartment Inner Panel Screw (Qty 7) **CAUTION:** **Refer to Fastener Caution .** **Tighten**

Callout	Component Name
	2 N.m (18 lb in)
2	Instrument Panel Compartment Inner Panel Assembly **TIP:** Flex the bottom right hand corner of the instrument panel in order to remove the instrument panel compartment inner panel assembly.

INSTRUMENT PANEL UPPER TRIM PAD REPLACEMENT

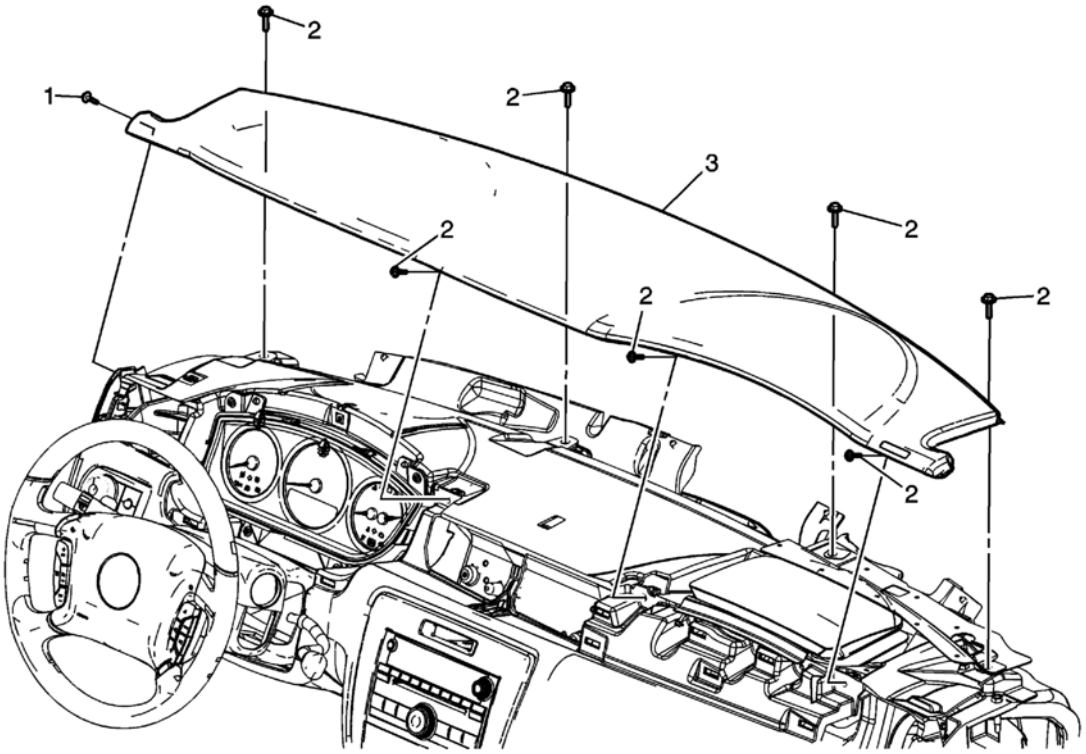


Fig. 21: Instrument Panel (I/P) Upper Trim Pad
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the instrument panel (I/P) upper trim panel. Refer to **Instrument Panel Upper Trim Panel Replacement**. 2. Remove the I/P trim plate. Refer to **Instrument Panel Trim Plate Replacement**.	
1	Instrument Panel Upper Trim Pad Screw **CAUTION:** **Refer to Fastener Caution .** **Tighten**

Callout	Component Name
	2 N.m (18 lb in)
2	Instrument Panel Upper Trim Pad Bolt (Qty: 7) **Tighten** 10 N.m (88 lb in)
3	Instrument Panel Upper Trim Pad Assembly **Procedure** Disconnect the electrical connector.

INSTRUMENT PANEL CENTER SUPPORT BRACKET REPLACEMENT

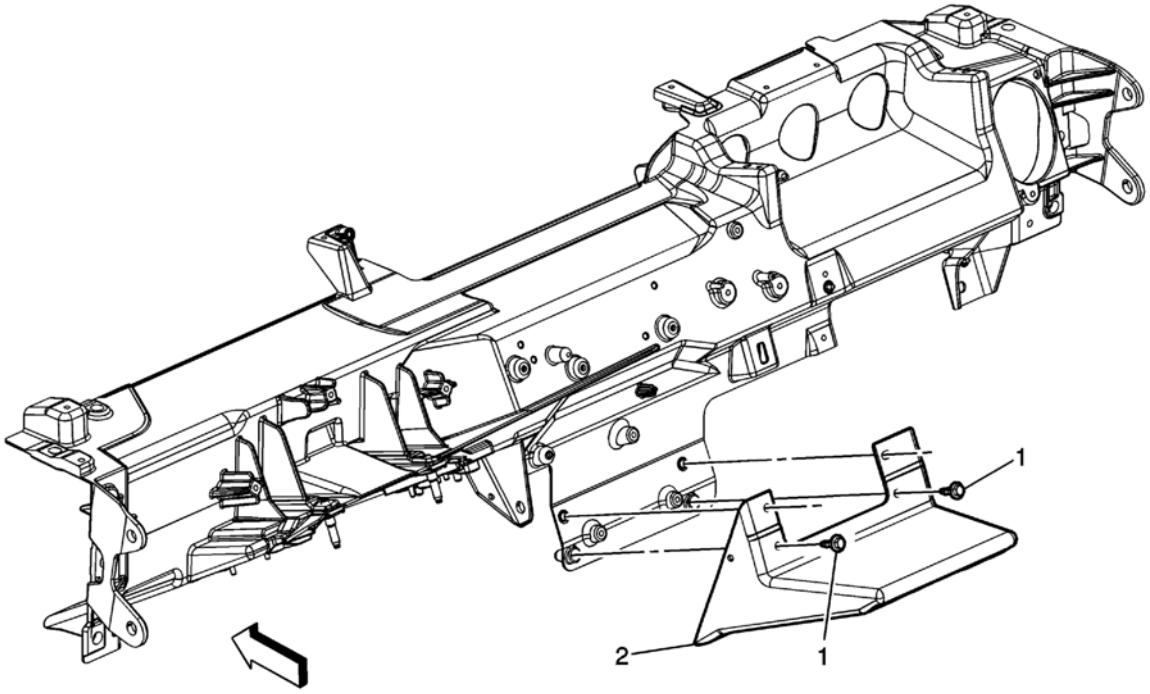


Fig. 22: Instrument Panel (I/P) Center Support Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel lower trim panel. Refer to **Instrument Panel Lower Trim Panel Replacement**.	
1	Instrument Panel Center Support Bracket Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	Tighten 10 N.m (89 lb in)
2	Instrument Panel Center Support Bracket Assembly

INSTRUMENT PANEL CARRIER REPLACEMENT

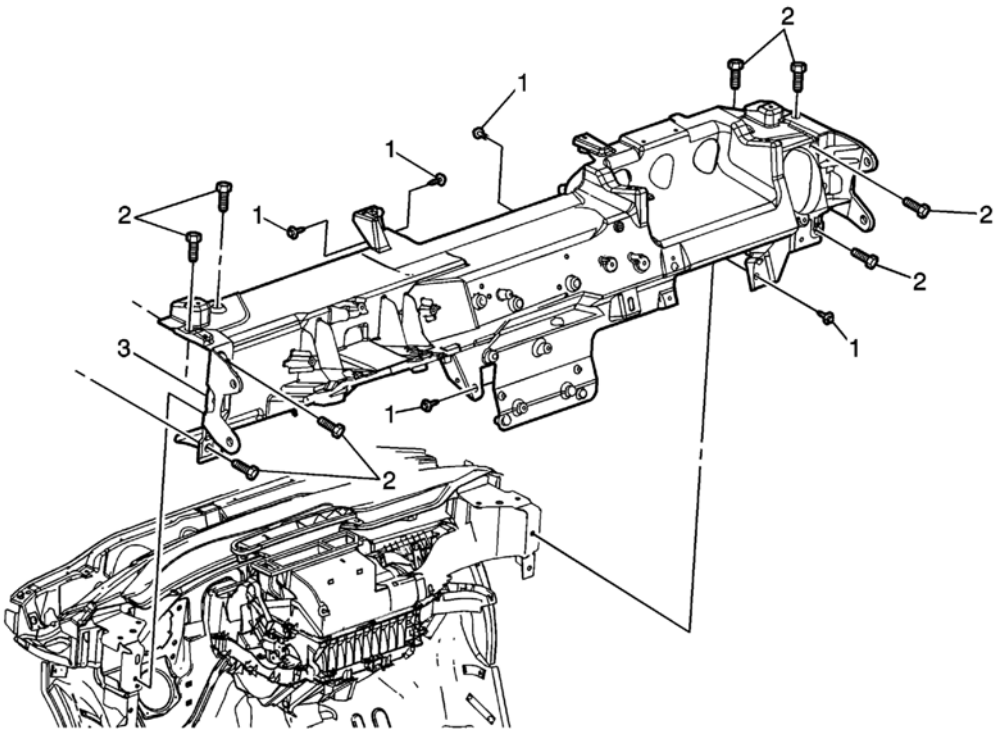


Fig. 23: Instrument Panel (I/P) Carrier
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	

1. Remove the instrument panel lower trim panel. Refer to **Instrument Panel Lower Trim Panel Replacement**.
2. Remove the drivers knee bolster brackets. Refer to **Driver Knee Bolster Bracket Replacement**.
3. Remove the passenger knee bolster bracket. Refer to **Passenger Knee Bolster Bracket Replacement**.
4. Remove the brake pedal nut and bolt, and pedal bracket bolts. Refer to **Brake Pedal Assembly Replacement** .
5. Remove the instrument panel center support bracket. Refer to **Instrument Panel Center Support Bracket Replacement**.
6. Remove the air distributor duct assembly. Refer to **Air Distributor Duct Replacement** .
7. Remove the right air outlet duct assembly. Refer to **Instrument Panel Outer Air Outlet Upper Duct Replacement - Right Side** .

Callout	Component Name
1	Instrument Panel Carrier to HVAC Module Bolt (Qty: 5) **CAUTION:** **Refer to** Fastener Caution . **Tighten** 4 N.m (35 lb in)
2	Instrument Panel Carrier to Body Bolt (Qty: 8) **Tighten** 25 N.m (18 lb ft)
3	Instrument Panel Carrier Assembly **Procedure** 1. Note routing of the wiring harness to aid in the reinstallation. 2. With the aid of an assistant, remove the carrier from the vehicle. 3. Remove the defroster air outlet duct assembly. Refer to **Defroster Air Outlet Duct Replacement** .

FRONT FLOOR CONSOLE COMPARTMENT DOOR HINGE REPLACEMENT

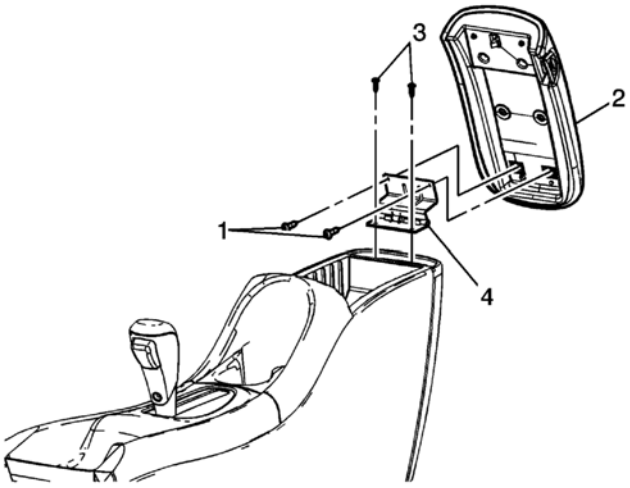


Fig. 24: Console Compartment Door Hinge
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Floor Console Door Screw (Qty: 2) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 2 N.m (18 lb in)
2	Front Floor Console Door Assembly
3	Front Floor Console Hinge Screw (Qty: 2) **Tighten** 2 N.m (18 lb in)
4	Front Floor Console Door Hinge

FRONT FLOOR CONSOLE COMPARTMENT DOOR LATCH REPLACEMENT

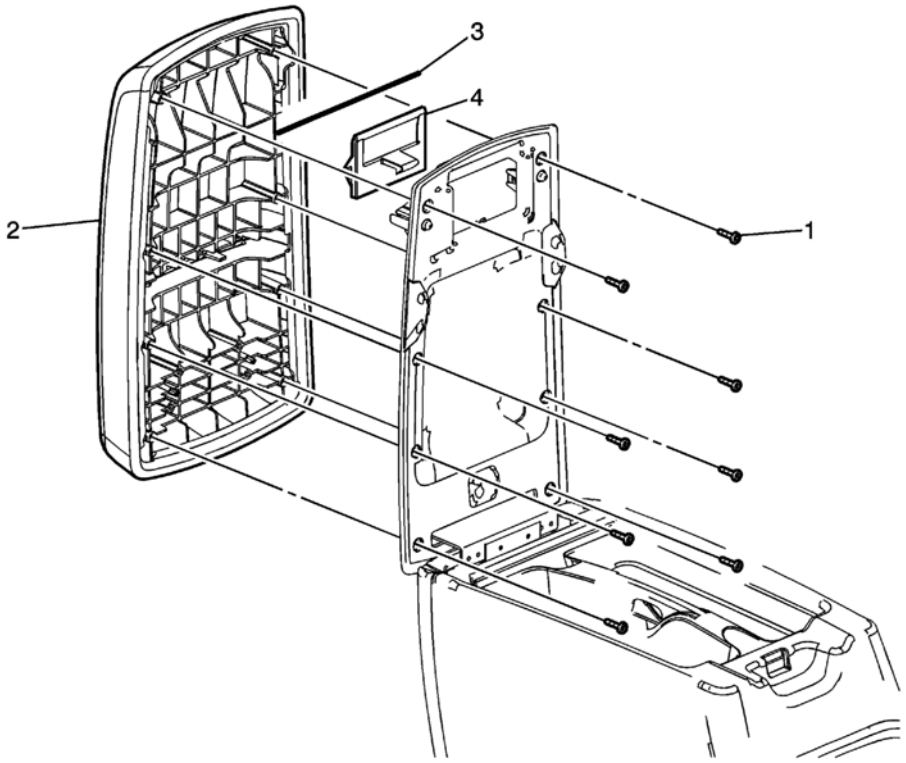


Fig. 25: Console Compartment Door Latch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
1	Front Floor Console Armrest Inner Screw (Qty 8) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	Front Floor Console Armrest Cover Assembly **Procedure** Separate the armrest cover assembly from the inner panel.
3	Front Floor Console Armrest Latch Spring
4	Front Floor Console Armrest Latch Assembly

FRONT FLOOR UPPER CONSOLE TRIM PLATE REPLACEMENT

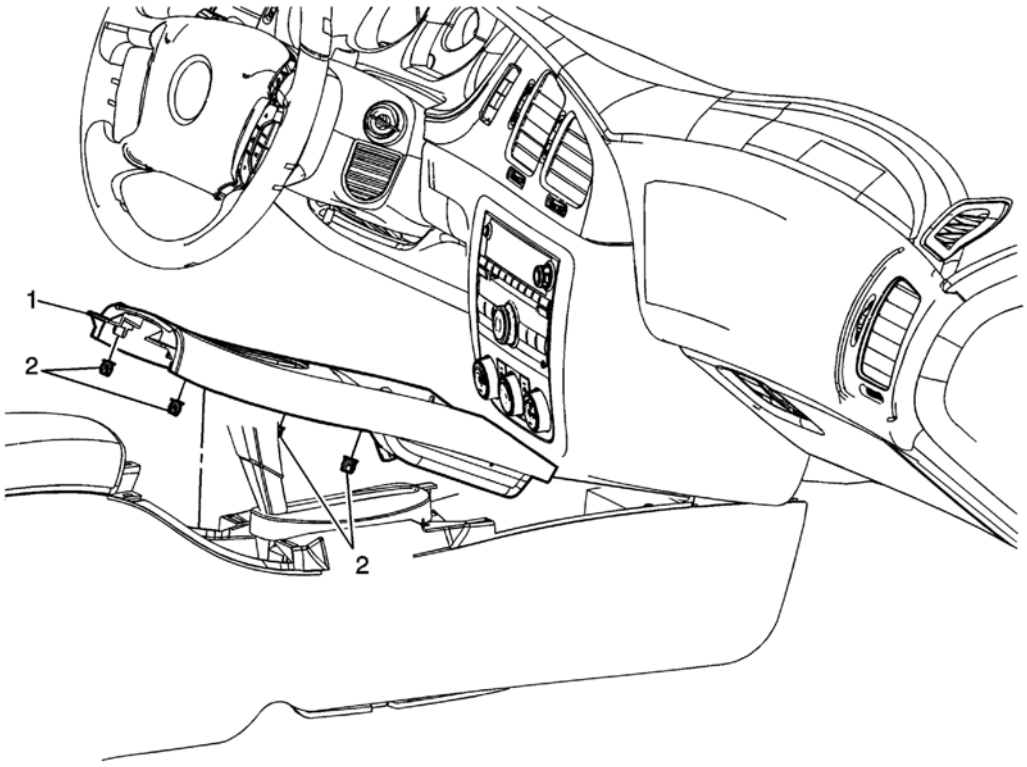


Fig. 26: Console Upper Trim Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
CAUTION: **To prevent component**	

Callout	Component Name
damage, DO NOT use metal tools to remove the trim. **Preliminary Procedures** 1. Place the front floor shiftier in the Neutral position. 2. Remove the front floor console cupholder assembly. Refer to **Front Floor Console Cup Holder Replacement (Impala)** .	
1	Front Floor Console Trim Plate **Procedure** 1. For console removal and shift lock actuator access, use ONLY a plastic trim tool to lift the trim plate from the console. Do not use any tool between the trim plate and the shiftier. 2. Apply the park brake and shift lever rearward. The sound deadener must be reinstalled if the wire harness is removed or replaced.
2	Retainer Clip (Qty: 4)

CONSOLE REAR TRIM PLATE REPLACEMENT

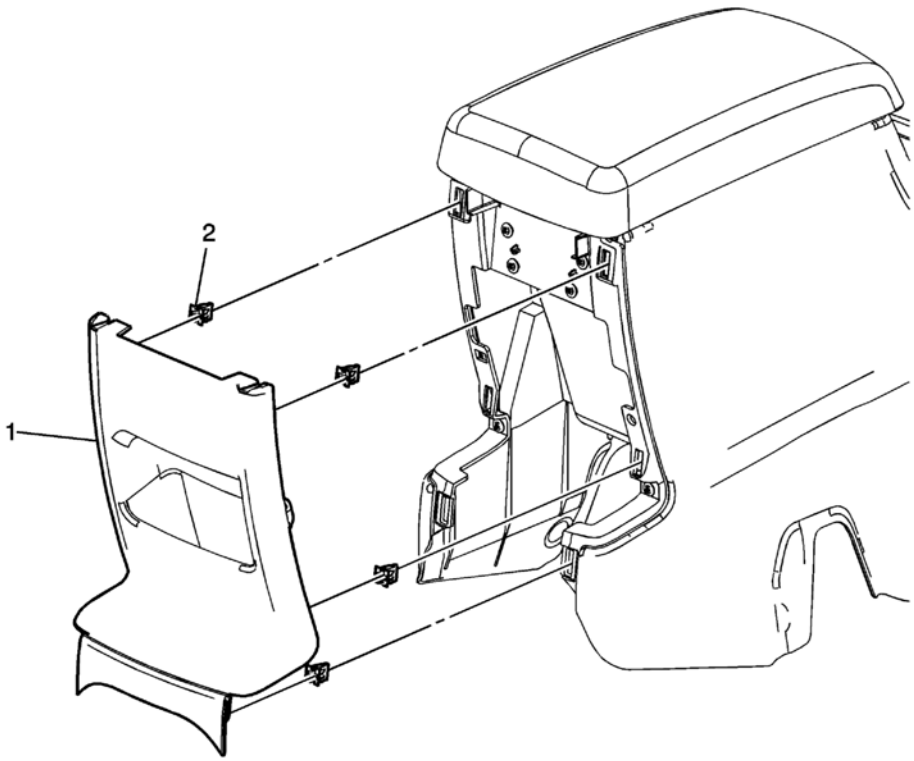


Fig. 27: Console Rear Trim Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Floor Console Plate Assembly
2	Retainer Clip (Qty 6)

CONSOLE FRONT TRIM PLATE REPLACEMENT

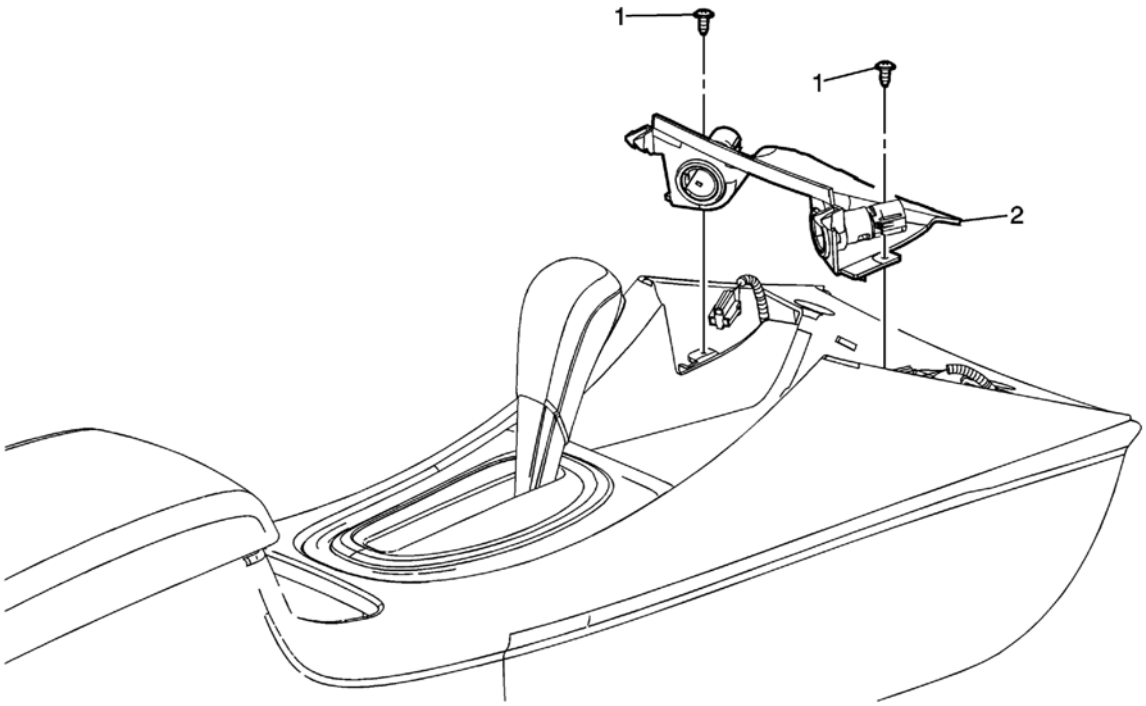


Fig. 28: Console Front Trim Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front floor console. Refer to **Front Floor Console Replacement**.	
1	Front Floor Console Trim Panel Screw (Qty 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)

Callout	Component Name
2	Front Floor Console Trim Panel Assembly **Procedure** 1. Disconnect electrical connectors. 2. Remove the 12 volt accessory power receptacles. Refer to **Cigar Lighter Receptacle or 12-Volt Accessory Power Receptacle Replacement** .

CONSOLE SHIFT LEVER BEZEL REPLACEMENT

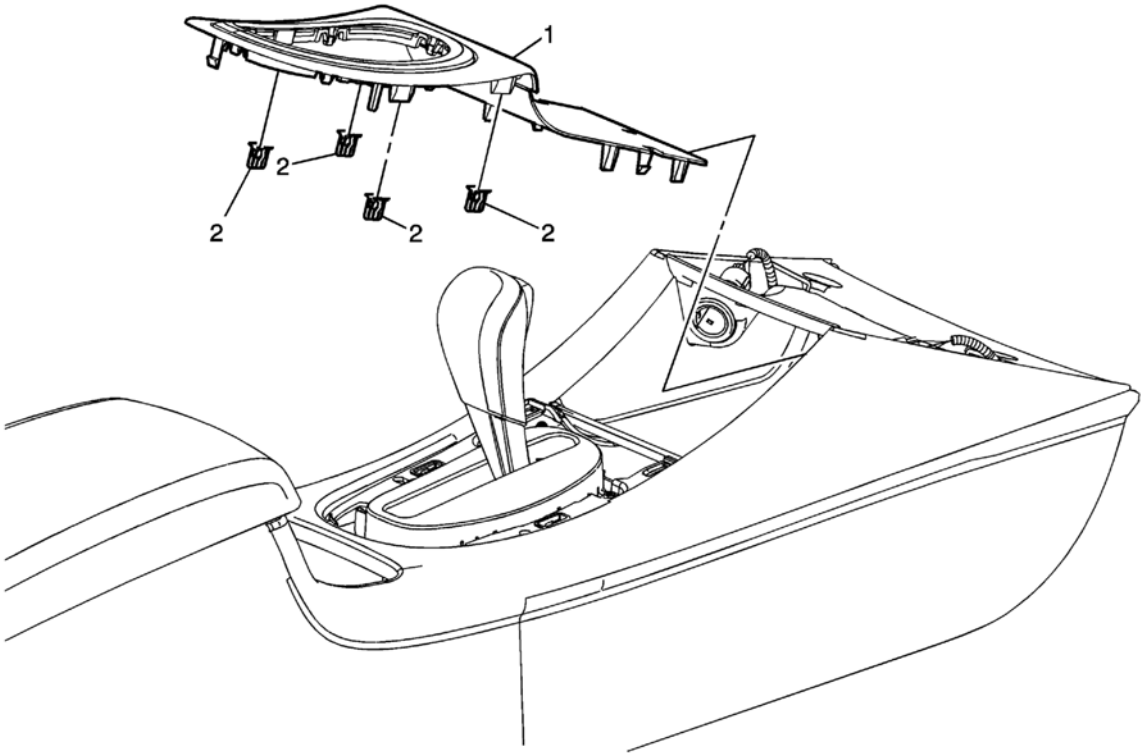


Fig. 29: Console Shift Lever Bezel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Console Shift Lever Bezel Assembly 1. Block the drive wheels. 2. Move shift lever to the neutral position. 3. Use a flat-bladed plastic trim tool to aid in the removal of the shift bezel. 4. For console removal and shift lock actuator access, use ONLY a plastic trim tool to lift the trim bezel from the console. Do not use any tool between the trim bezel and the shifter. 5. Apply the park brake and shift lever rearward. The sound deadener must be reinstalled

Callout	Component Name
	if the wire harness is removed or replaced.
2	Retainer Clips (Qty: 4)

FRONT FLOOR CONSOLE REPLACEMENT

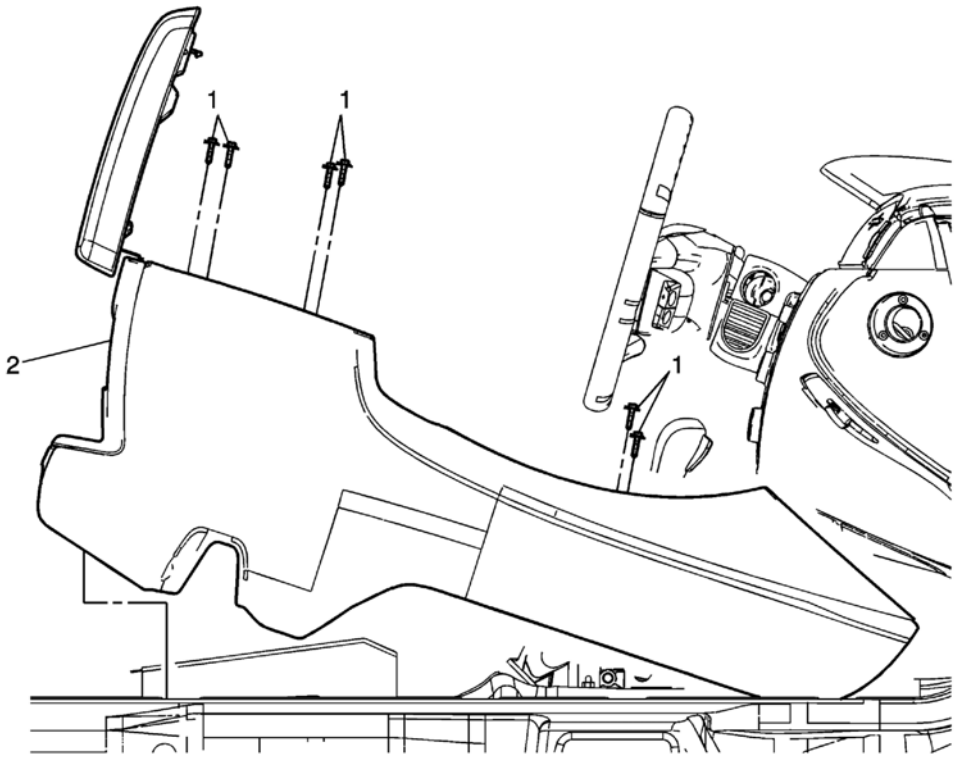


Fig. 30: Front Floor Console
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
CAUTION: **To prevent component damage, DO NOT use metal tools to remove the trim.**	

Preliminary Procedure

1. Remove the front floor console bin liner.
2. Remove the console shift lever bezel. Refer to **Console Shift Lever Bezel Replacement**.
3. Use ONLY a plastic trim tool to lift the shift lever bezel from the console. Do not use any tool between the trim bezel and the shifter.

Callout	Component Name
4. Apply the park brake and shift lever rearward. The sound deadener must be reinstalled if the wire harness is removed or replaced.	
1	Front Floor Console Bolt (Qty: 6) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 7 N.m (62 lb in)
2	Front Floor Console Assembly **Procedure** Disconnect the electrical connector.

FLOOR CONSOLE BRACKET REPLACEMENT

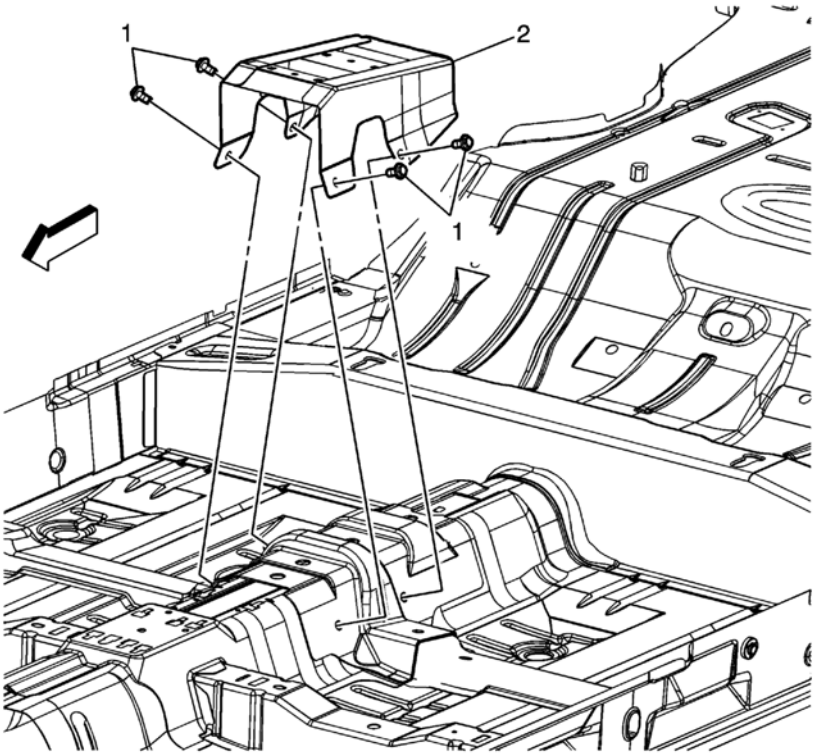


Fig. 31: Console Floor Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front floor console. Refer to **Front Floor Console Replacement**.	

Callout	Component Name
1	Front Floor Console Reinforcement Bracket Bolt (Qty 4) **CAUTION:** **Refer to** **Fastener Caution .** **TIP:** Pull the carpet back enough to access the bolts. **Tighten** 44 N.m (32 lb ft)
2	Front Floor Console Reinforcement Bracket Assembly

FRONT FLOOR CONSOLE ARMREST REPLACEMENT

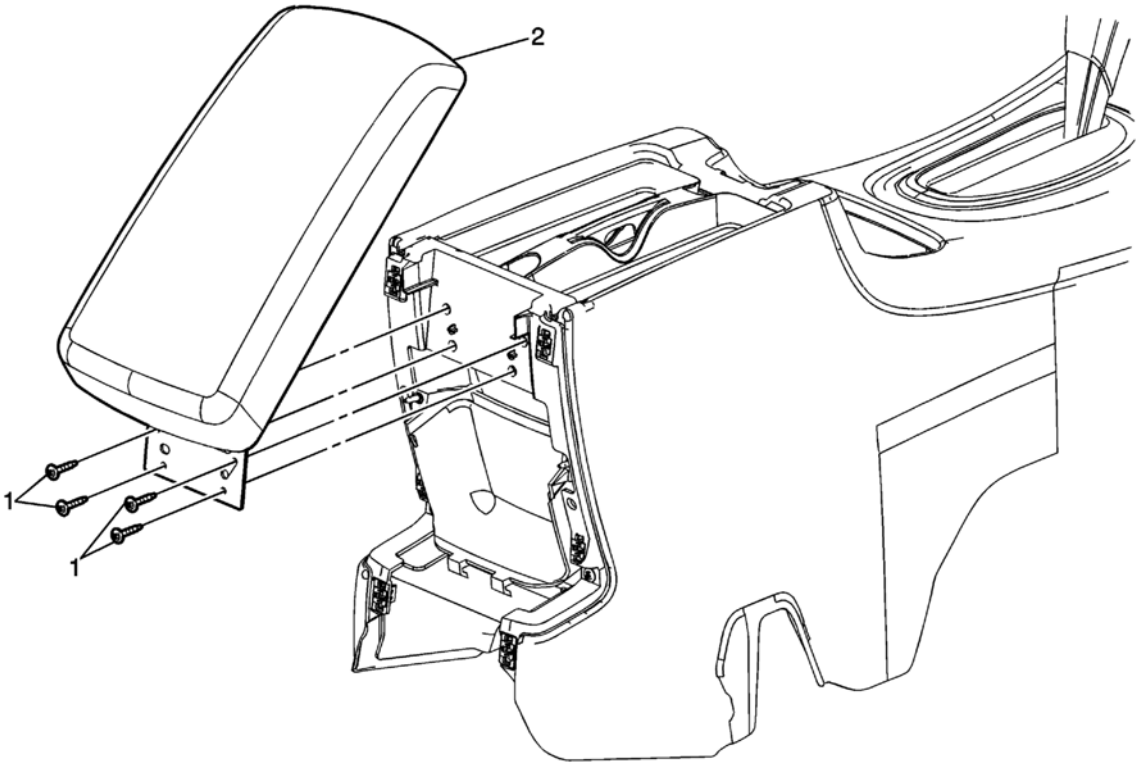


Fig. 32: Front Floor Console Armrest
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front floor console rear trim plate. Refer to **Console Rear Trim Plate Replacement**.	
1	Front Floor Console Armrest Hinge Screw (Qty 4) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 2 N.m (18 lb in)
2	Front Floor Console Armrest Assembly

FRONT FLOOR CONSOLE ARMREST HINGE REPLACEMENT

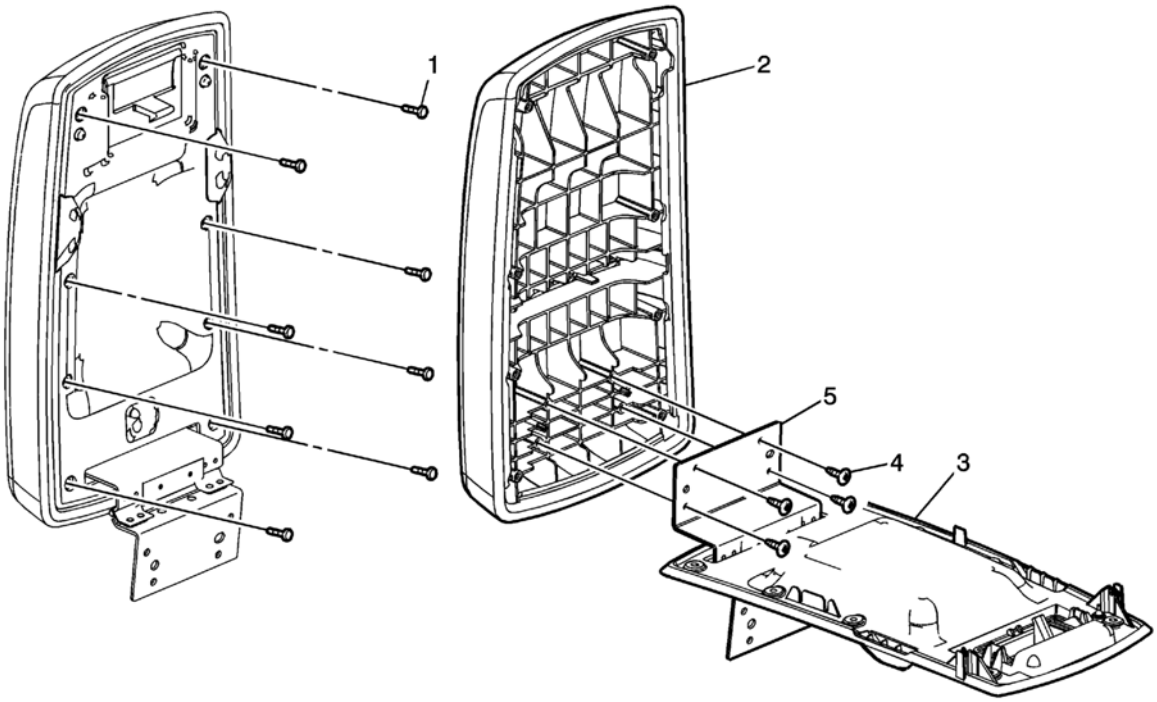


Fig. 33: Floor Console Arm Rest Hinge
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front floor console armrest assembly. Refer to **Front Floor Console Armrest Hinge Replacement**.	
1	Front Floor Console Armrest Screw (Qty 8) **CAUTION:** **Refer to** Fastener Caution .

Callout	Component Name
	Tighten 2 N.m (18 lb in)
2	Front Floor Console Armrest Armrest Assembly **TIP:** Separate the armrest cover assembly from the inner panel.
3	Front Floor Console Armrest Inner Panel **TIP:** Rotate the inner panel in order to access the hinge screws.
4	Front Floor Console Armrest Hinge Screw (Qty 4) **Tighten** 2 N.m (18 lb in)
5	Front Floor Console Armrest Hinge Assembly **TIP:** Remove the hinge from the inner panel.

ROOF CONSOLE REPLACEMENT

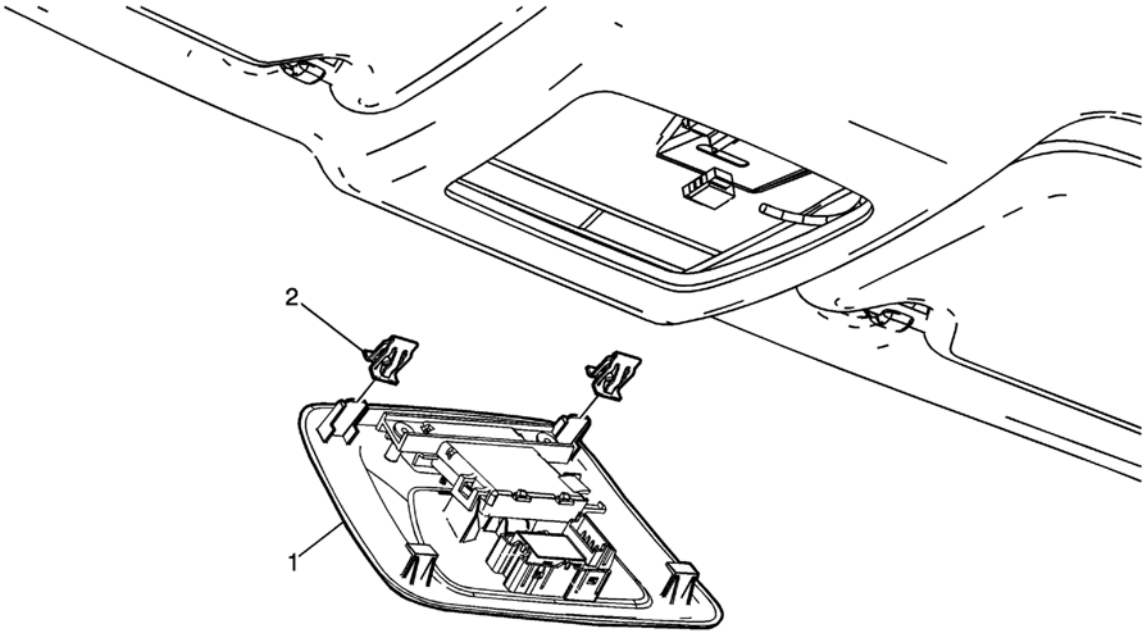


Fig. 34: Overhead Console
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** .	
1	Overhead Console • Lower the front of the console first. • Disconnect the electrical connectors.
2	Overhead Console Retainer Clip

Article GUID: A00737181

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Assist Handle Screw	2 N.m	18 lb in
Center Pillar Upper Trim Screw	2 N.m	18 lb in
Headliner Trim Retainer	2 N.m	18 lb in
Sunshade Screws	2 N.m	18 lb in
Sunshade Anchor Screws	2 N.m	18 lb in
Quarter Upper Trim Panel Screw	2 N.m	18 lb in
Windshield Garnish Molding Screw	2 N.m	18 lb in

REPAIR INSTRUCTIONS

FRONT SIDE DOOR WINDOW SWITCH BEZEL REPLACEMENT

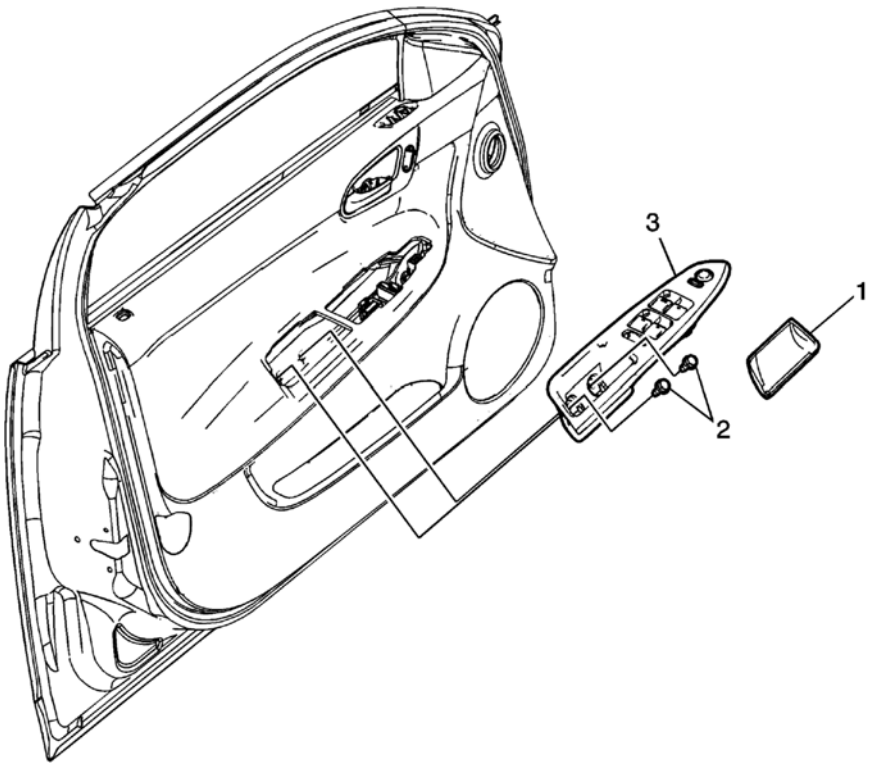


Fig. 1: View Of Front Door Switch Bezel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Side Door Armrest Opening Cover
2	Front Side Door Armrest Bolt (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 2 N.m (18 lb in)
3	Side Window Switch Bezel **Procedure** 1. Lift upward at the rear edge of the bezel first and slide rearward while lifting to disengage the retaining clips. 2. Disconnect the electrical connectors from the switches. If replacing the switch bezel, transfer all necessary components.

UPPER EXTENSION TRIM PANEL REPLACEMENT

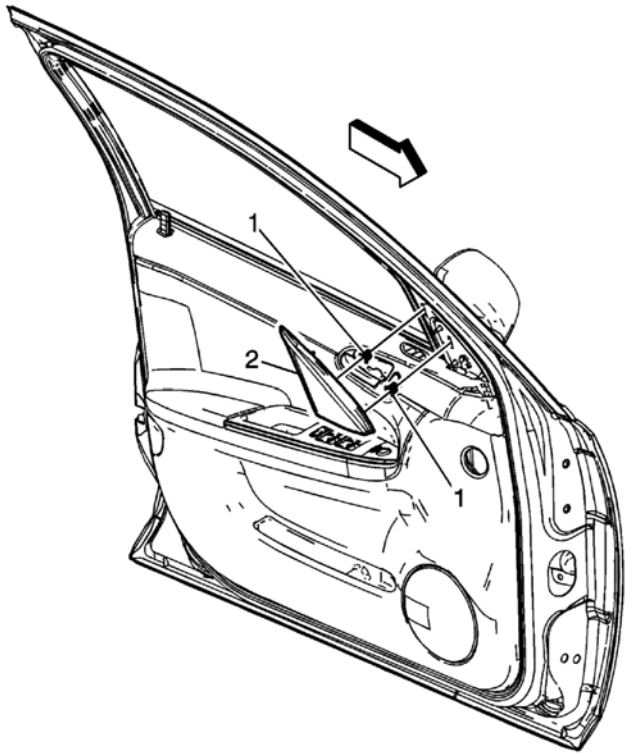


Fig. 2: Identifying Upper Extension Trim Panel Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Side Door Upper Trim Panel Clip (Qty: 2)
2	Front Side Door Upper Trim Panel Assembly 1. Pull on the top end of extension panel to disengage attaching clips. 2. Lift extension panel out from behind the door trim panel.

FRONT SIDE DOOR TRIM PANEL REPLACEMENT

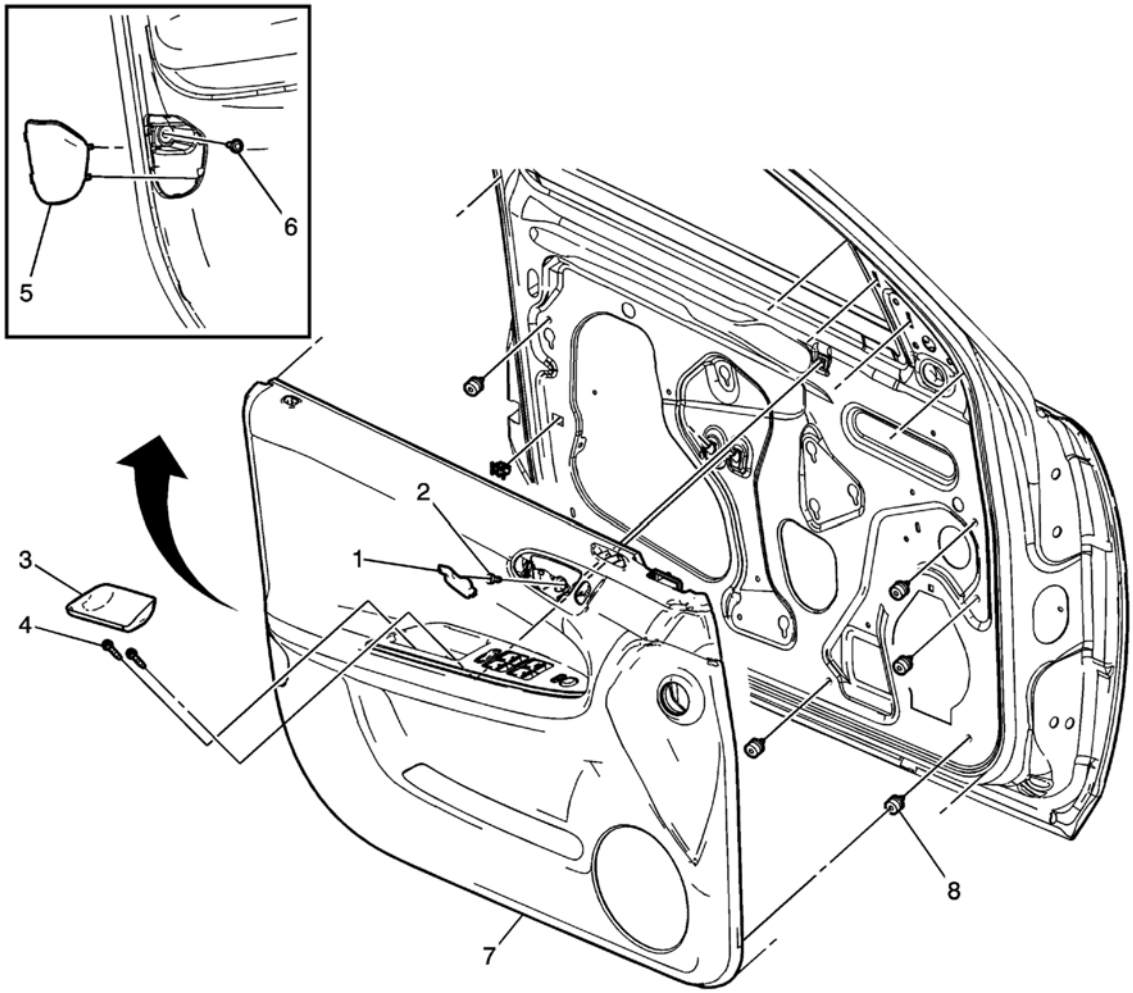


Fig. 3: Side Front Door Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front side door upper trim panel. Refer to **Upper Extension Trim Panel Replacement**.	
1	Front Side Door Inside Handle Bezel Cover
2	Front Side Door Inside Handle Bezel Screw **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 2 N.m (18 lb in)
3	Armrest Finish Cover
4	Front Side Door Pull Handle Screw **Tighten** 2 N.m (18 lb in)
5	Front Side Door Trim Panel Reflector
6	Front Side Door Trim Panel Screw **Tighten** 2 N.m (18 lb in)
7	Front Side Door Trim Assembly **Procedure** 1. Pull upwards on the door lock retainer cable to disengage. 2. Disconnect the electrical connectors.
8	Side Door Trim Retainer

REAR SIDE DOOR TRIM PANEL REPLACEMENT

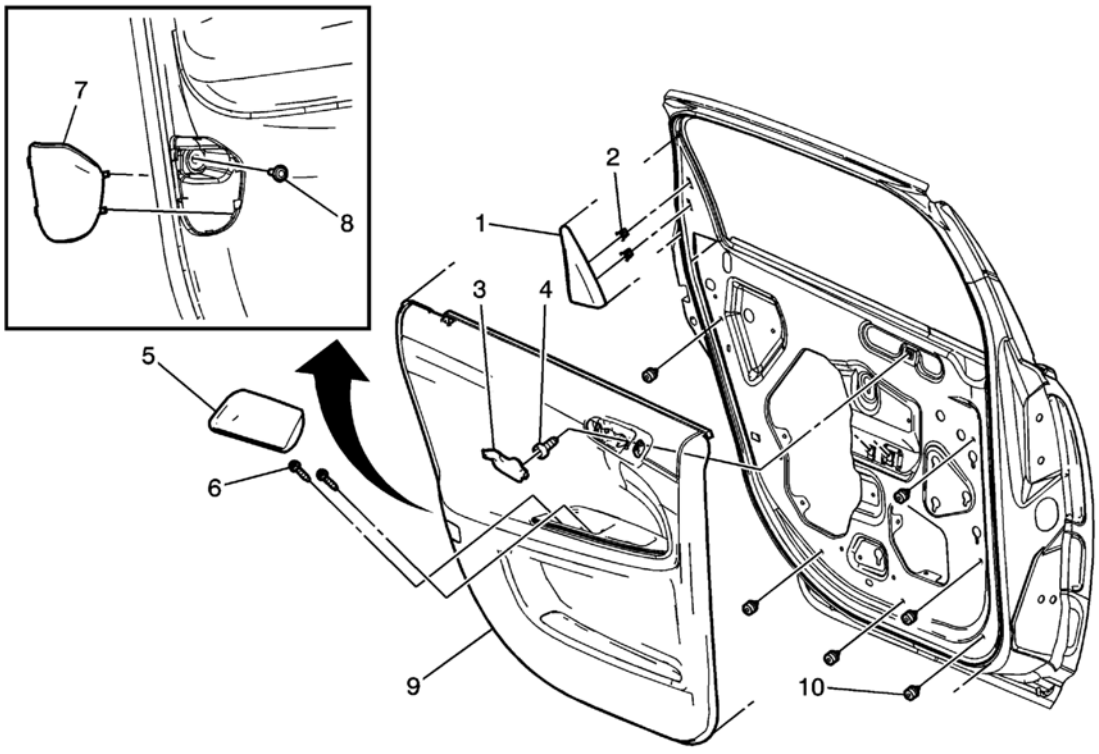


Fig. 4: Side Rear Door Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Side Door Upper Trim Panel Assembly
2	Side Door Upper Trim Clip
3	Rear Side Door Inside Handle Bezel Cover
4	Rear Side Door Inside Handle Bezel Screw **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
5	Armrest Finish Cover
6	Rear Side Door Pull Handle Screw **Tighten** 2 N.m (18 lb in)
7	Rear Side Door Trim Panel Reflector
8	Rear Side Door Trim Panel Screw **Tighten** 2 N.m (18 lb in)
9	Rear Side Door Trim Assembly **Procedure** 1. Release the inside door handle cable. 2. Disconnect the electrical connectors.
10	Side Door Trim Retainer

REAR SIDE DOOR INNER PANEL LOWER ENERGY ABSORBER REPLACEMENT

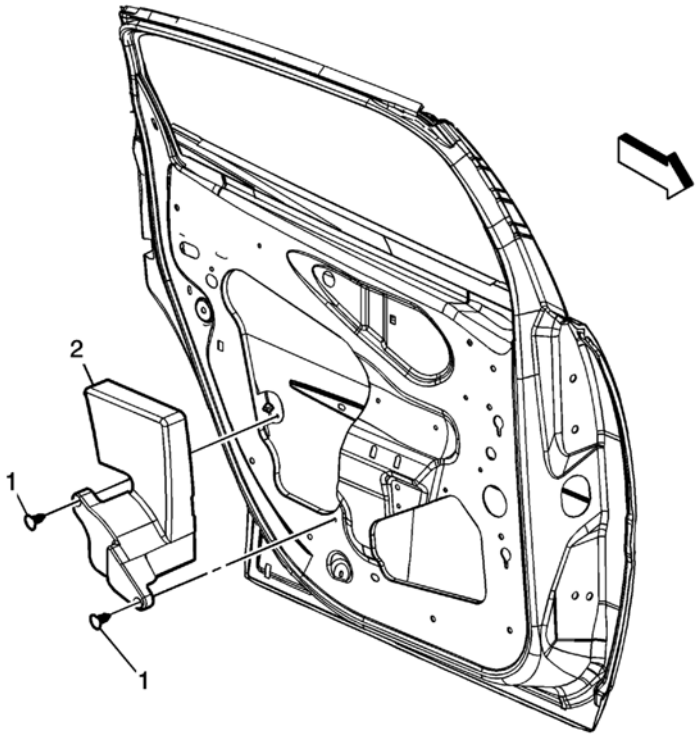


Fig. 5: Inner Rear Energy Absorber Pad
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedures** 1. Remove the interior trim panel. Refer to **Rear Side Door Trim Panel Replacement**. 2. Remove the water deflector. Refer to **Rear Side Door Water Deflector Replacement**.	
1	Retainer, Push Pin (Qty: 2)
2	Absorber, Rear Side Door Energy **TIP:** Pull the absorber from the door to release the retainers and adhesive.

FRONT SIDE DOOR INNER PANEL LOWER ENERGY ABSORBER REPLACEMENT

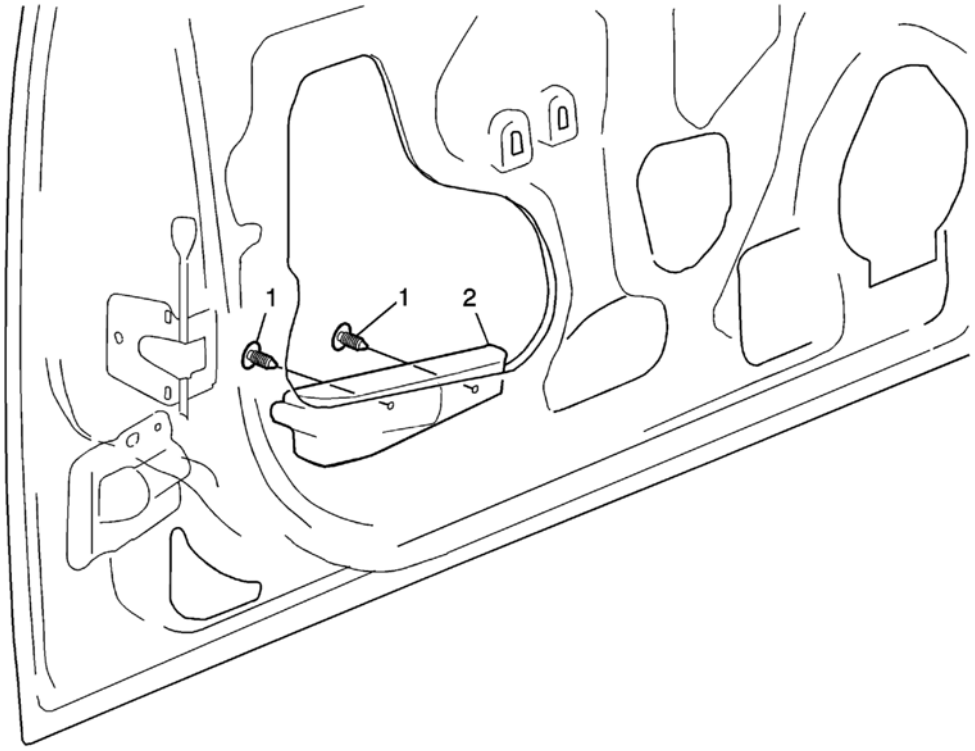


Fig. 6: Inner Front Energy Absorber Pad
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedures** 1. Remove the interior trim panel. Refer to **Rear Side Door Trim Panel Replacement**. 2. Remove the water deflector. Refer to **Rear Side Door Water Deflector Replacement**.	
1	Retainer, Push Pin (Qty: 2)
2	Absorber, Front Side Door Energy **TIP:** Pull the absorber from the door to release the retainers and adhesive.

FRONT SIDE DOOR WATER DEFLECTOR REPLACEMENT (IMPALA LIMITED)

Removal Procedure

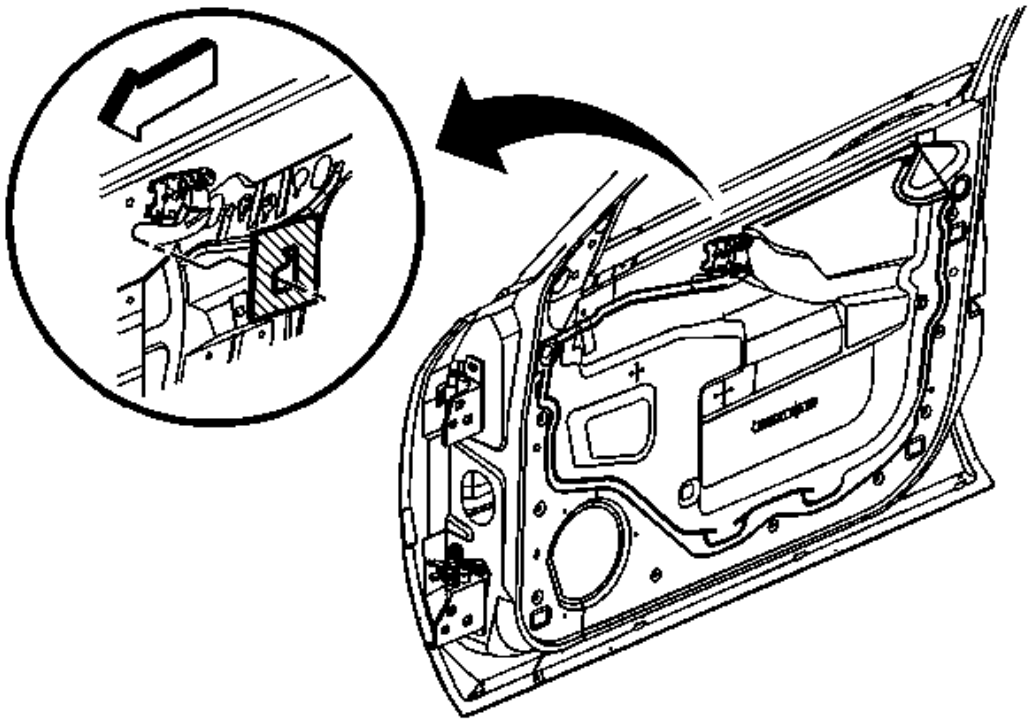


Fig. 7: Front Door Water Deflector (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

1. Remove the front door trim panel. Refer to **Front Side Door Trim Panel Replacement**.
2. Remove the front door pull handle bracket from the front door inner panel.
3. Disconnect all of the required electrical connectors.
4. Remove the inside door handle gasket.
5. Remove the front door water deflector from the front door inner panel.

Installation Procedure

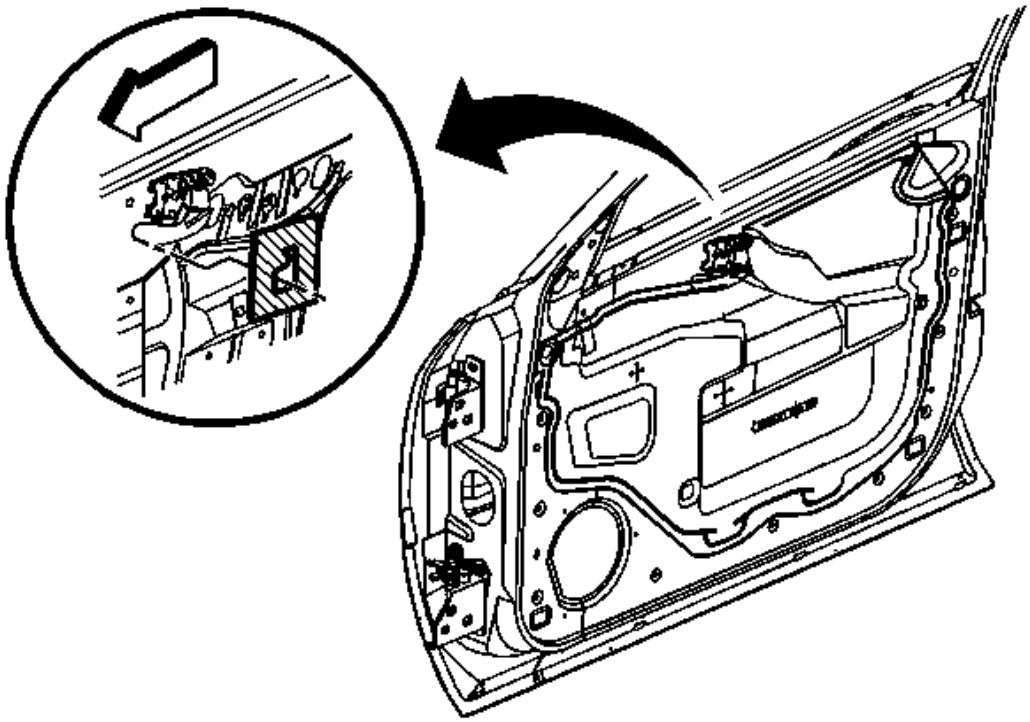


Fig. 8: Front Door Water Deflector (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

1. Align the front door water deflector to the front door inner panel. Secure the water deflector at the corners.
2. Pull the front door wiring harness leads through the slits in the front door water deflector.
3. Install the front door water deflector, start pressing the adhesive pattern at the bottom center and working outward and upward in order to prevent puckering.
4. Install the inside door handle gasket.
5. Connect all of the required electrical connectors.
6. Install the front door pull handle bracket to the front door inner panel.
7. Install the front door trim panel. Refer to **Front Side Door Trim Panel Replacement**.

REAR SIDE DOOR WATER DEFLECTOR REPLACEMENT

Removal Procedure

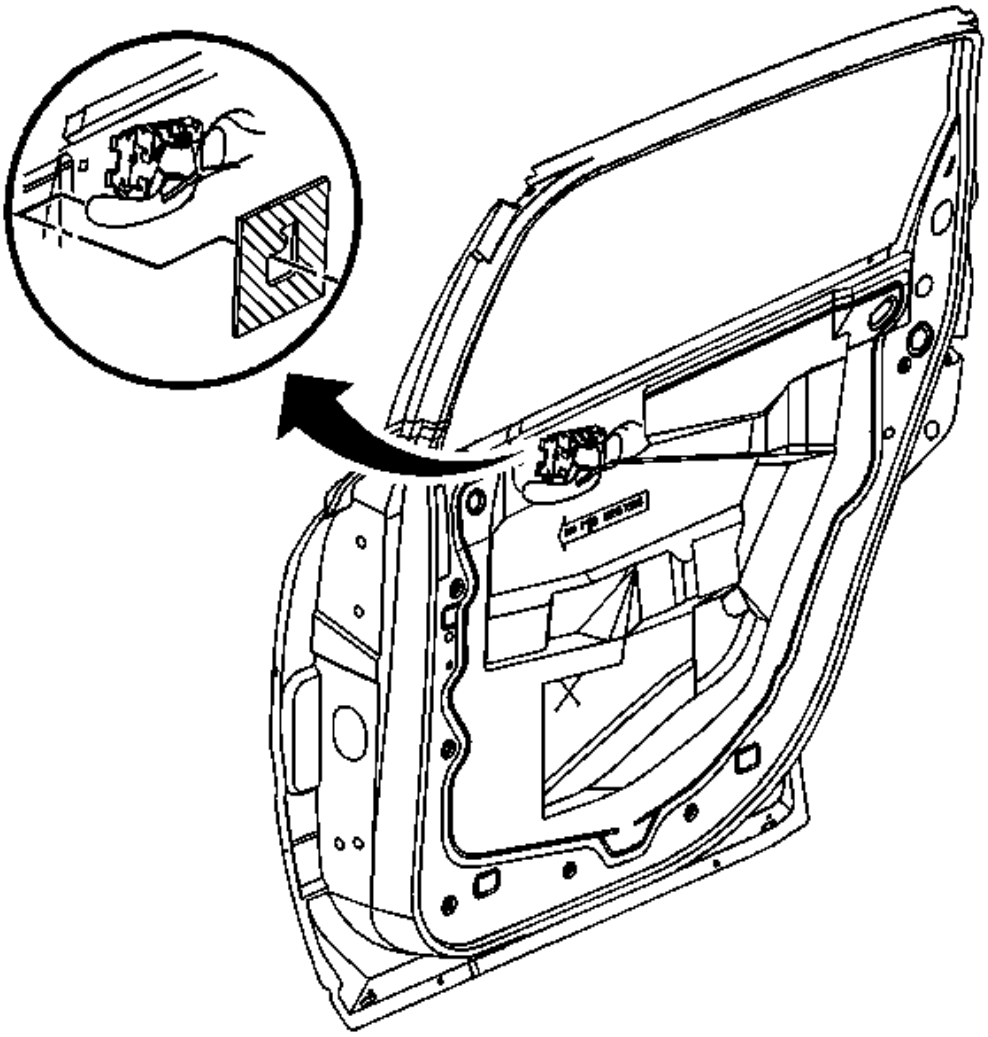


Fig. 9: Rear Door Water Deflector (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

1. Remove the rear door trim panel. Refer to **Rear Side Door Trim Panel Replacement**.
2. Remove the rear door pull handle bracket from the rear door inner panel.
3. Disconnect all of the required electrical connectors.
4. Remove the inside door handle gasket.
5. Remove the rear door water deflector from the rear door inner panel.

Installation Procedure

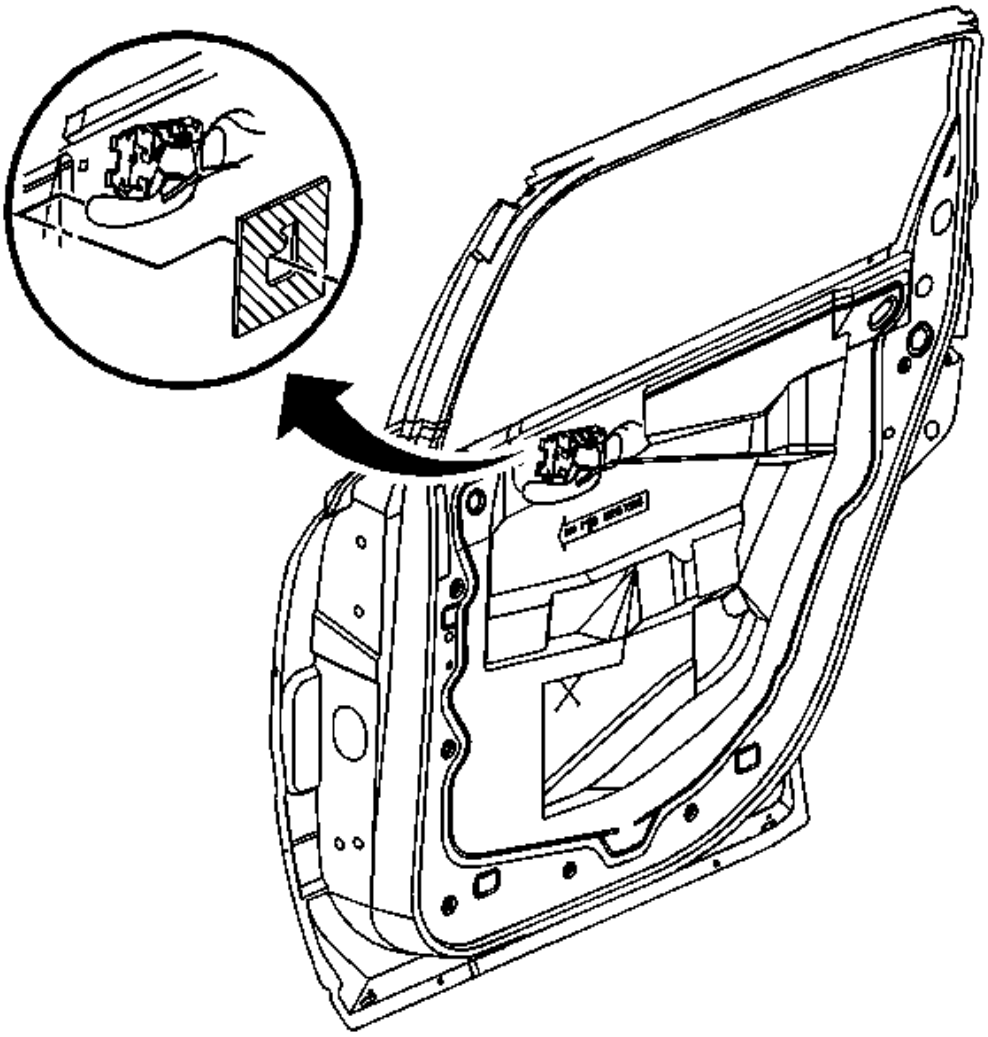


Fig. 10: Rear Door Water Deflector (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

1. Align the rear door water deflector to the rear door inner panel. Secure the water deflector at the corners.
2. Pull the rear door wiring harness leads through the slits in the rear door water deflector.
3. Install the rear door water deflector, start pressing the adhesive pattern at the bottom center and working outward and upward in order to prevent puckering.
4. Install the inside door handle gasket.
5. Connect all of the required electrical connectors.
6. Install the rear door pull handle bracket to the rear door inner panel.
7. Install the rear door trim panel. Refer to **Rear Side Door Trim Panel Replacement**.

FRONT SEAT ARMREST CUP HOLDER REPLACEMENT

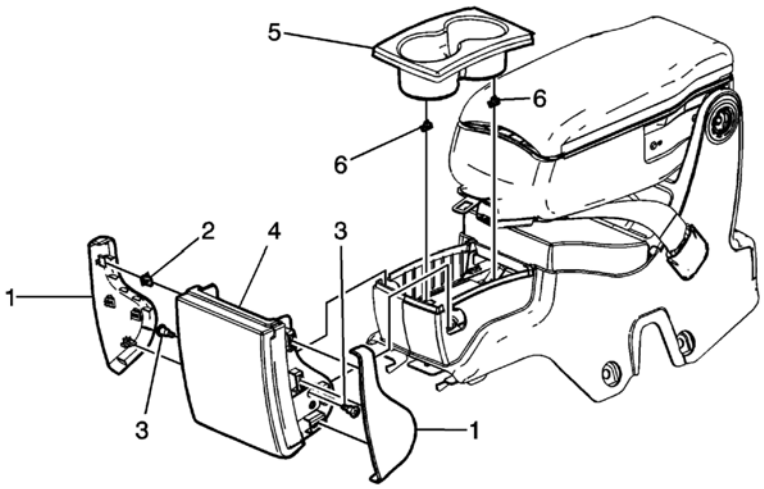


Fig. 11: Identifying Front Seat Armrest Cup Holder
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Cup Holder End Cap (Qty: 2)
2	End Cap Retainer Clip (Qty: 8)
3	Front Seat Panel Pivot Bolt (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 3 N.m (25 lb in)
4	Front Seat Panel Assembly
5	Front Center Seat Cup Holder
6	Front Center Seat Cup Holder Clip (Qty: 2)

ASSIST HANDLE REPLACEMENT

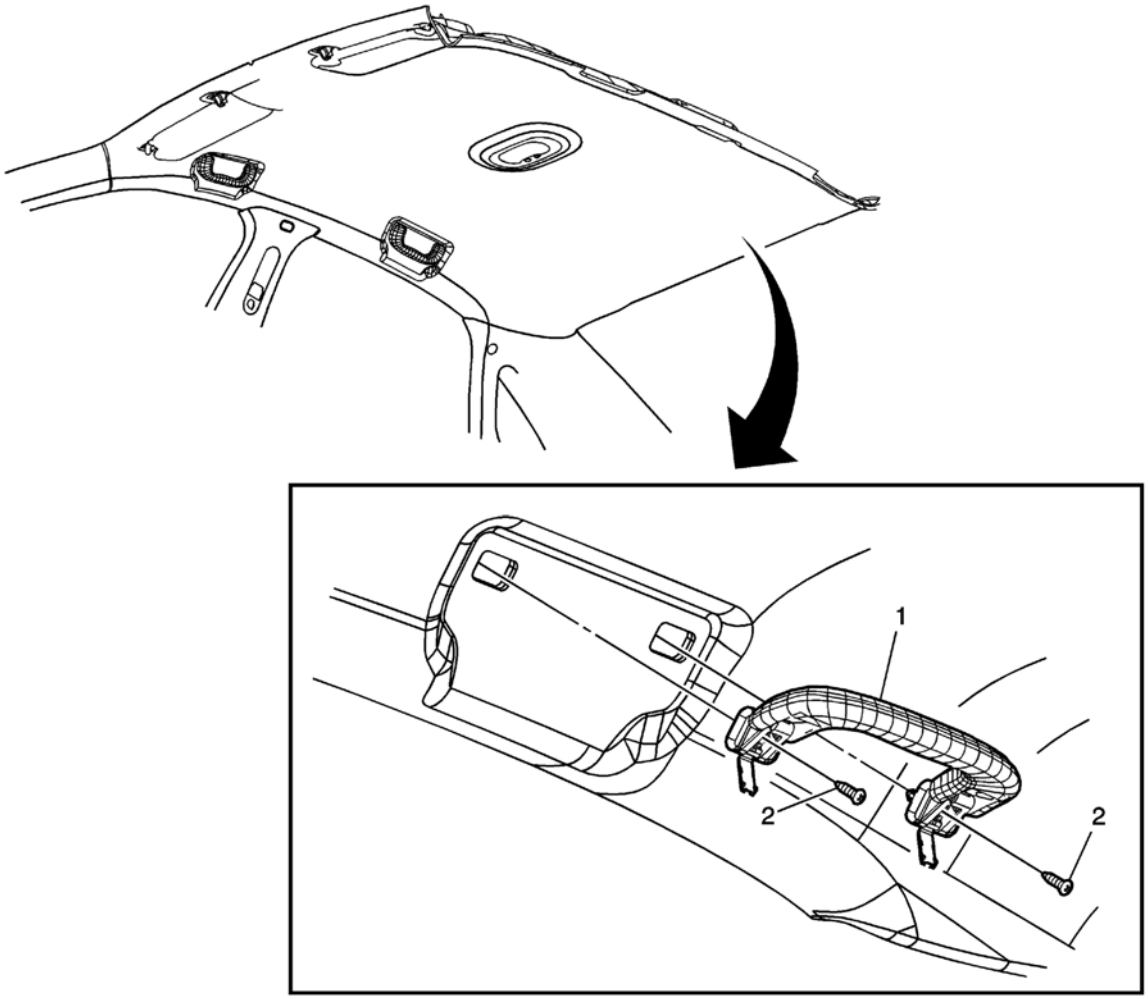


Fig. 12: Assist Handle
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Assist Handle Screw **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	Assist Handle Assembly

SUNSHADE REPLACEMENT

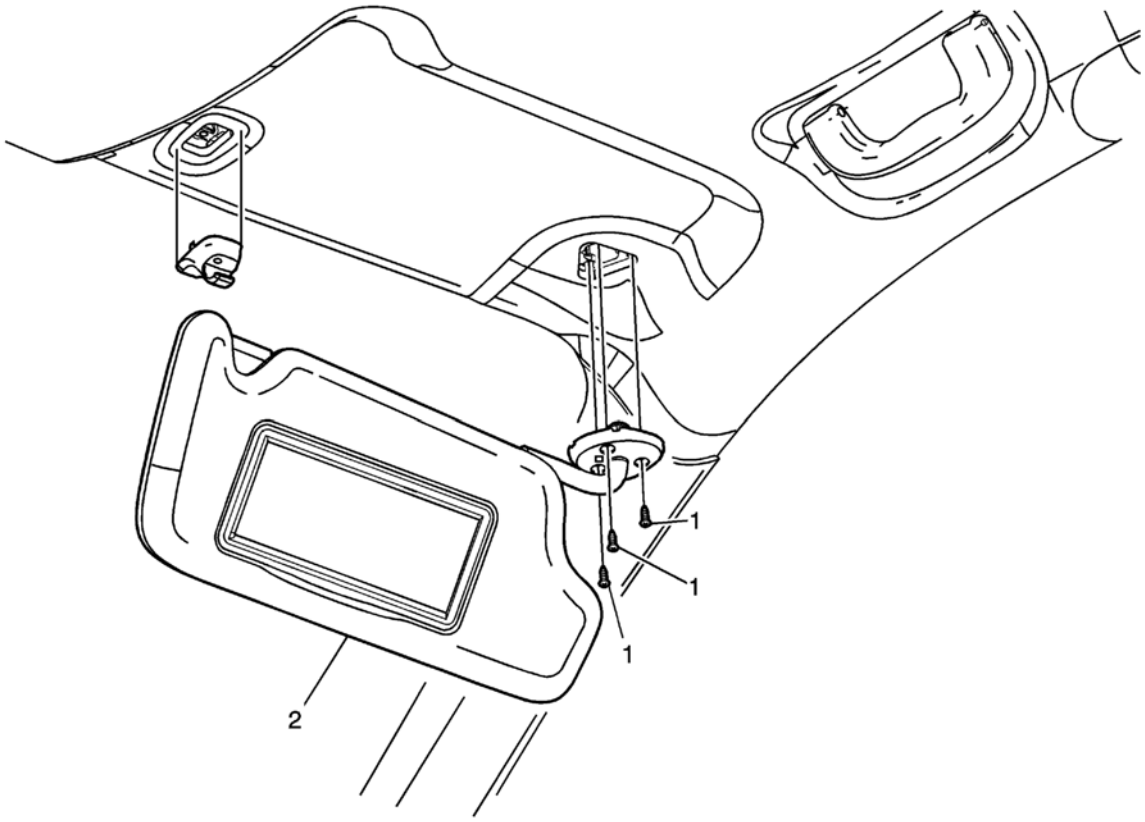


Fig. 13: Sunshade
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the windshield pillar trim. Refer to **Windshield Pillar Garnish Molding Replacement**.	
1	Sunshade Assembly Screw (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 2 N.m (18 lb in)
2	Sunshade Assembly **Procedure**

Callout	Component Name
	1. Lower the front of the headliner enough to gain access to the sunshade electrical connector which is glued to the headliner. 2. Disconnect the electrical connector.

SUNSHADE ANCHOR REPLACEMENT

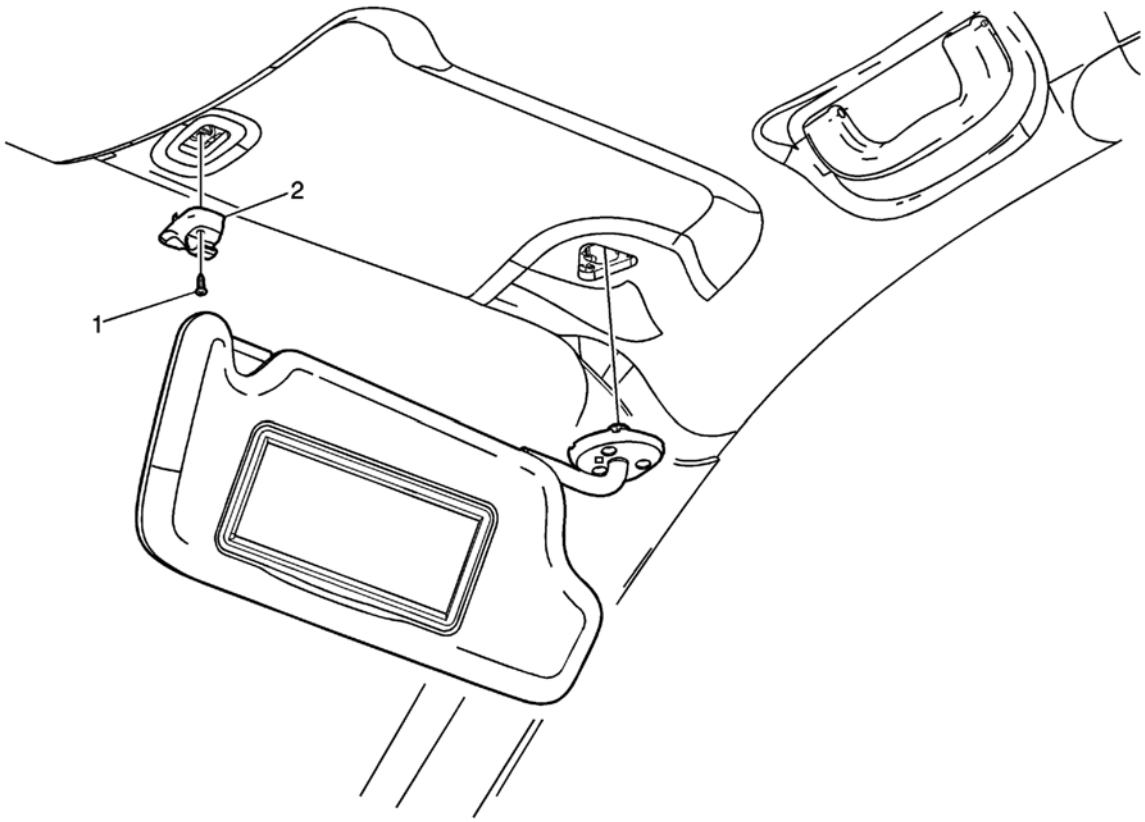


Fig. 14: Sunshade Anchor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Sunshade Anchor Screw **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	Tighten 2 N.m (18 lb in)
2	Sunshade Anchor

WINDSHIELD PILLAR GARNISH MOLDING REPLACEMENT

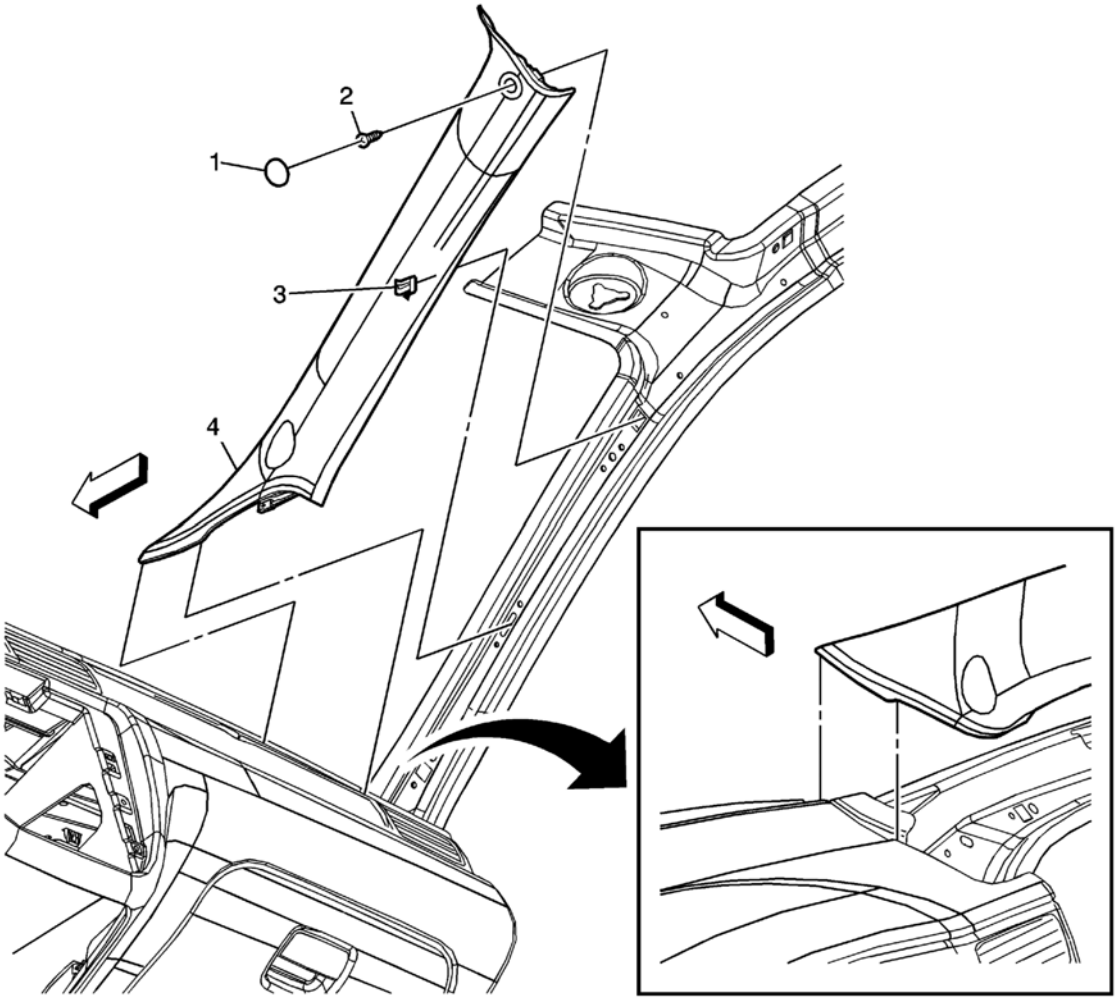


Fig. 15: Windshield Pillar Garnish Molding
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the instrument panel outer trim panels. Refer to **Instrument Panel Outer Trim Cover Replacement - Right Side** , or **Instrument Panel Outer Trim Cover Replacement - Left Side** . 2. Disconnect the windshield garnish molding speaker electrical connector.	
1	Windshield Side Upper Garnish Screw Cover

Callout	Component Name
2	Windshield Side Upper Garnish Screw **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 2 N.m (18 lb in)
3	Windshield Side Upper Garnish Retainer Clip
4	Windshield Side Upper Garnish Molding Assembly

CENTER PILLAR UPPER TRIM PANEL REPLACEMENT

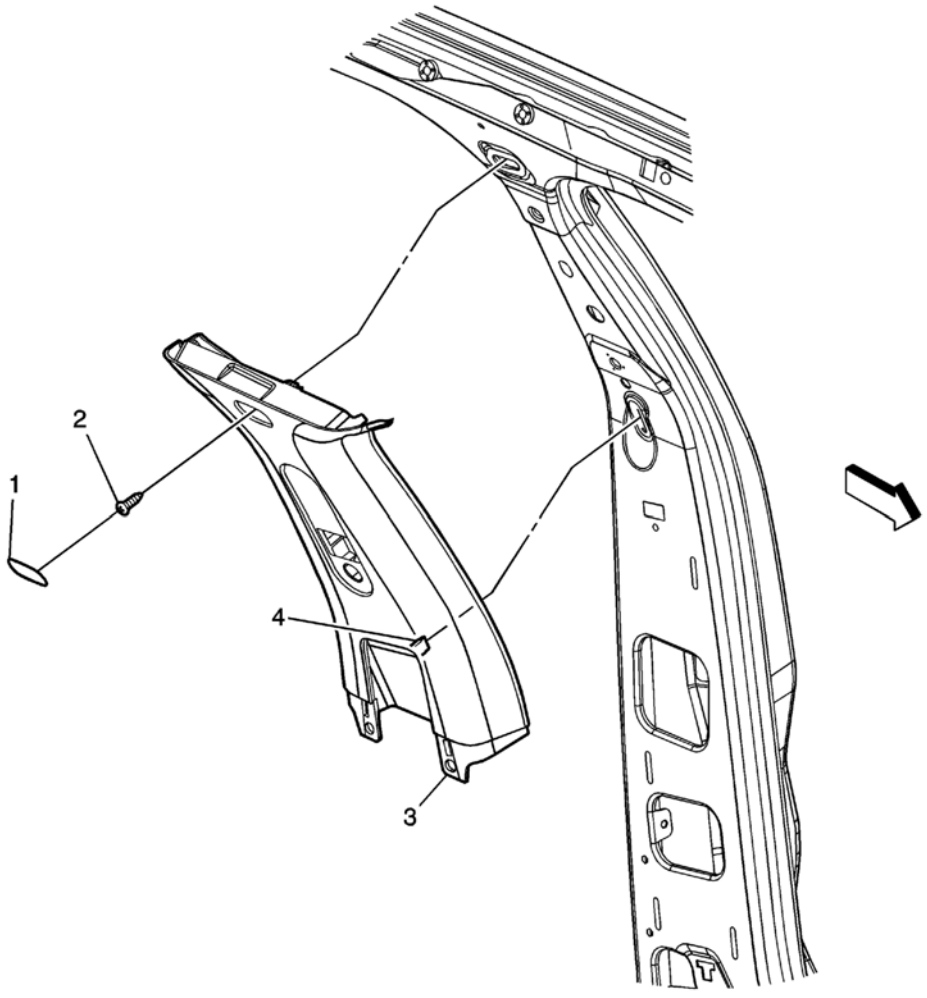


Fig. 16: Upper Center Pillar Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
Preliminary Procedure Remove the lower center pillar trim. Refer to **Center Pillar Lower Trim Panel Replacement**.	
1	Center Pillar Upper Trim Screw Cover
2	Center Pillar Upper Trim Screw **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
3	Center Pillar Upper Trim **Procedure** 1. Remove the seat belt D-ring from the adjuster assembly. 2. Pull the trim panel toward the inside of the vehicle to disengage the retainers. **Tighten** 42 N.m (31 lb ft)
4	Center Pillar Upper Trim Clip

CENTER PILLAR LOWER TRIM PANEL REPLACEMENT

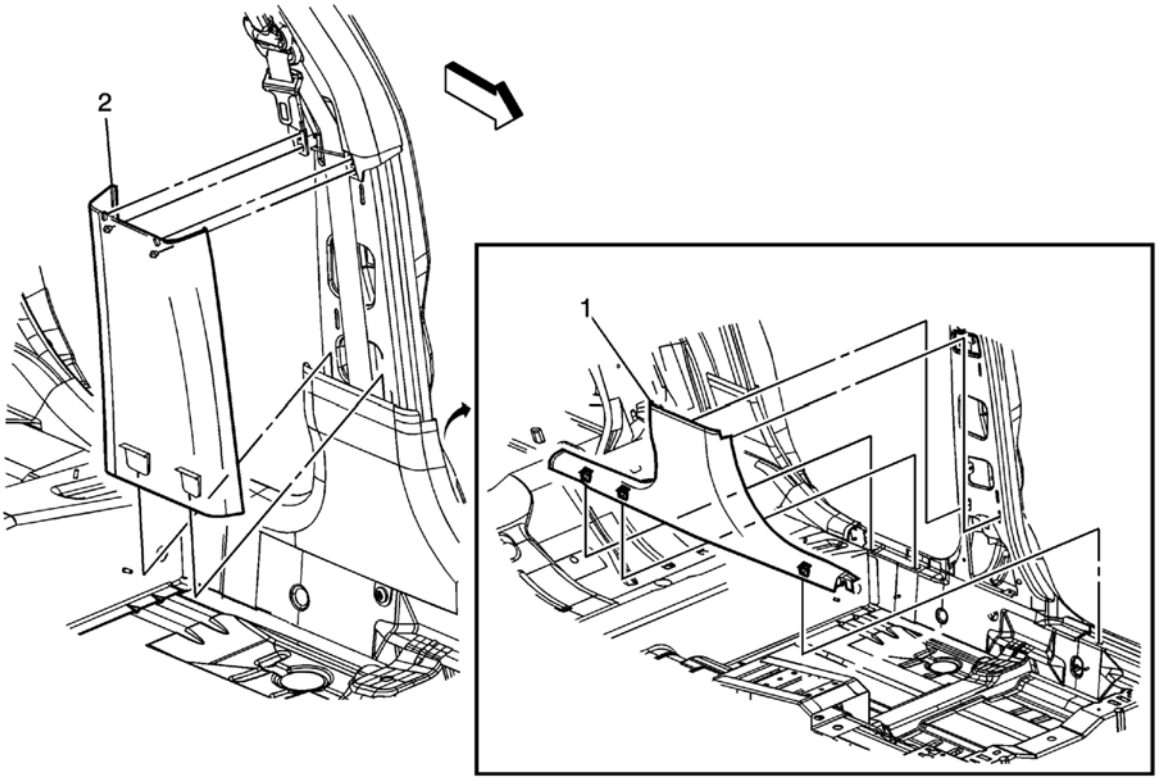


Fig. 17: Lower Center Pillar Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front and Rear Side Door Opening Retainer Assembly
2	Center Pillar Lower Trim Panel Assembly

QUARTER UPPER TRIM PANEL REPLACEMENT

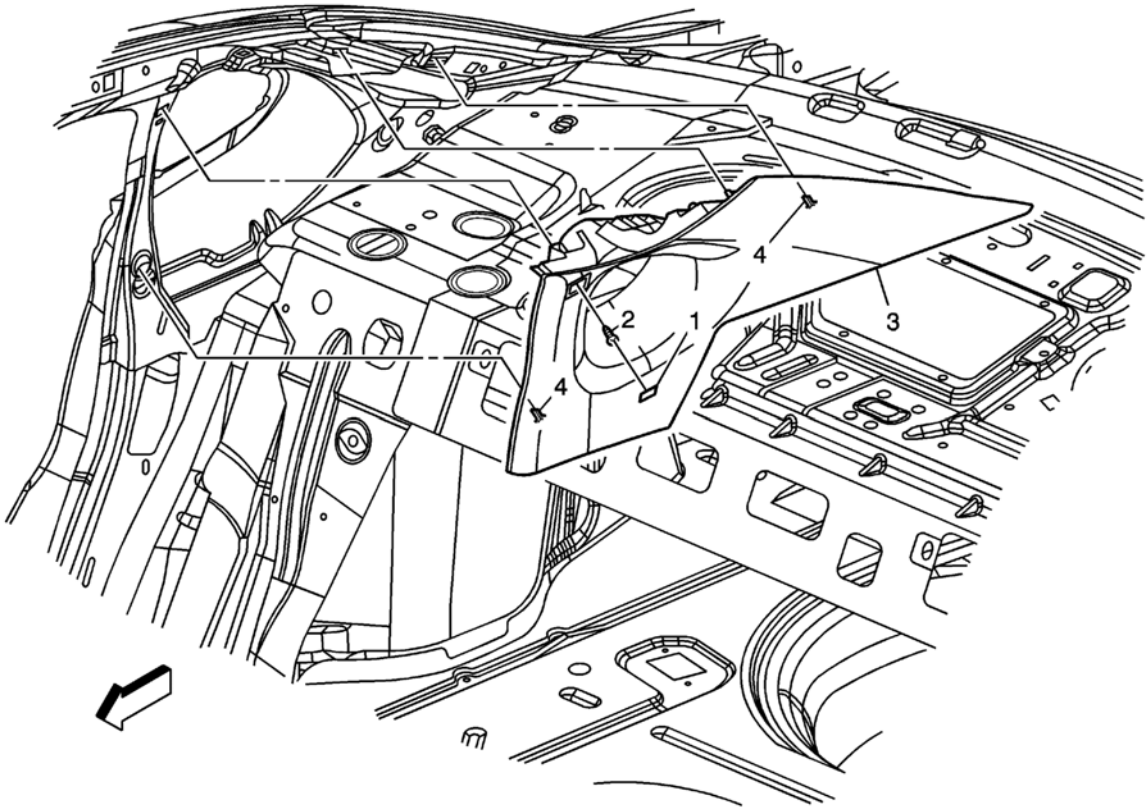


Fig. 18: Rear Quarter Upper Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Upper Quarter Upper Trim Panel Screw Cover
2	Upper Quarter Upper Trim Panel Screw **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 2 N.m (18 lb in)
3	Upper Quarter Upper Trim Panel Assembly
4	Upper Quarter Upper Trim Clip

QUARTER LOWER REAR TRIM PANEL REPLACEMENT (IMPALA LIMITED)

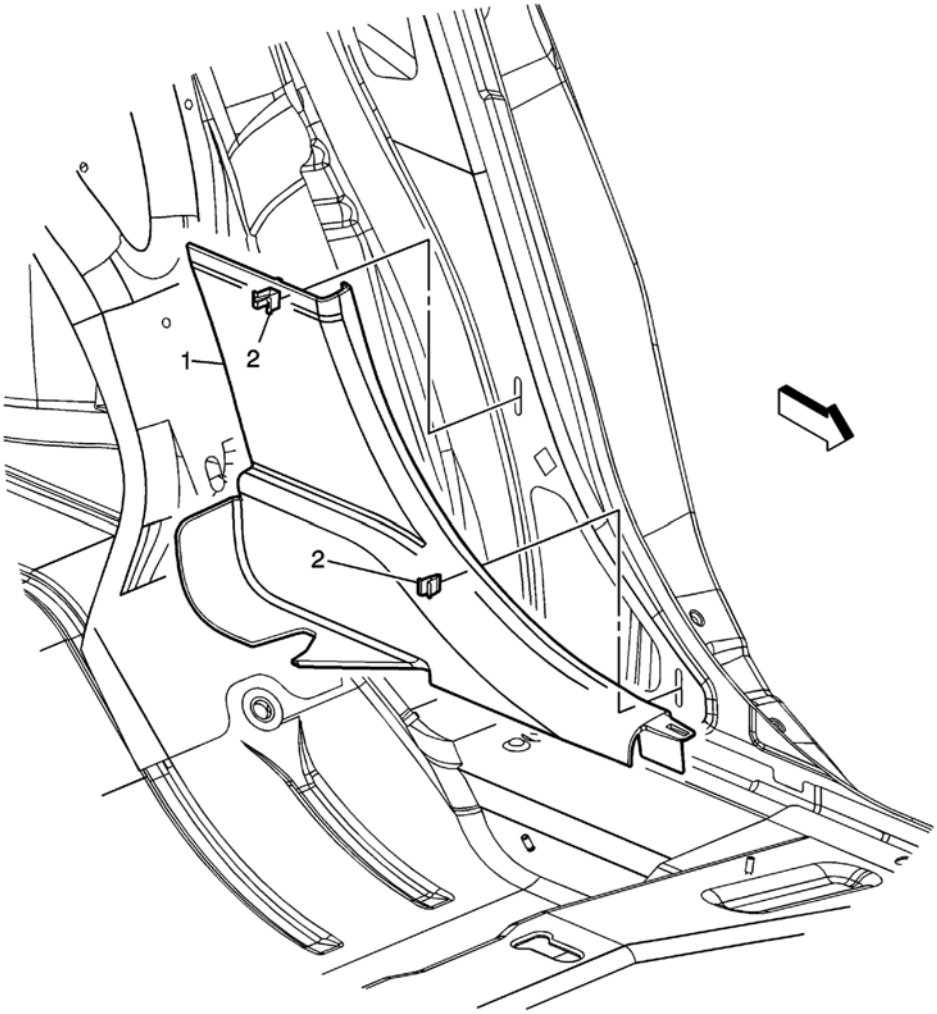


Fig. 19: Rear Quarter Lower Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedure** Remove the lower center pillar trim. Refer to **Center Pillar Lower Trim Panel Replacement**.	
1	Quarter Lower Trim Finish Panel Assembly
2	Quarter Lower Trim Finish Panel Retainer Clip (Qty: 2)

REAR WINDOW SHELF TRIM PANEL REPLACEMENT

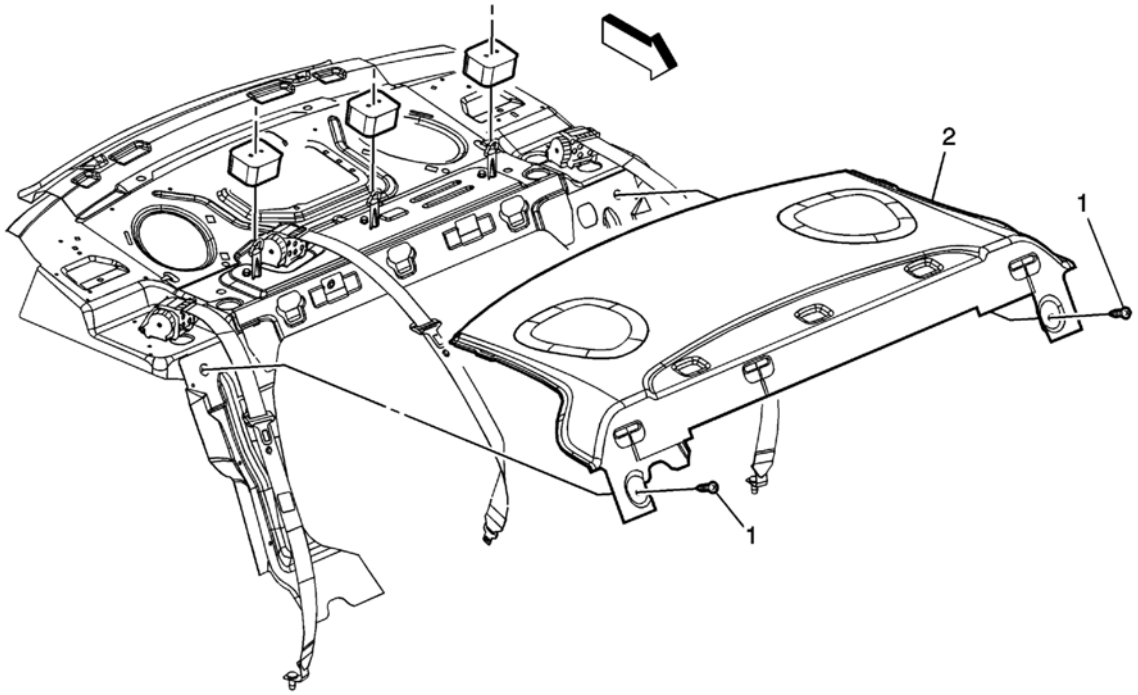


Fig. 20: Rear Window Shelf Trim Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the rear quarter upper trim panel. Refer to **Quarter Upper Trim Panel Replacement**. 2. Remove the rear seat back. Refer to **Rear Seat Back Cushion Removal and Installation (Impala)** . 3. Remove the rear seat belt bolts.	
1	Rear Window Trim Panel Retainer
2	Rear Window Trim Panel Assembly

REAR COMPARTMENT SILL TRIM PLATE REPLACEMENT

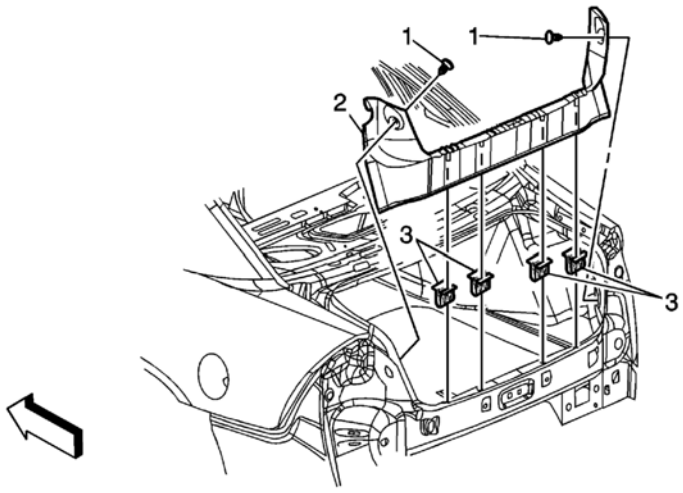


Fig. 21: Rear Compartment Sill Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Compartment Sill Trim Plate Assembly Retainer (Qty: 2)
2	Rear Compartment Sill Trim Plate Assembly
3	Rear Compartment Sill Trim Plate Assembly Retainer (Qty: 4)

REAR COMPARTMENT LID INNER PANEL TRIM REPLACEMENT

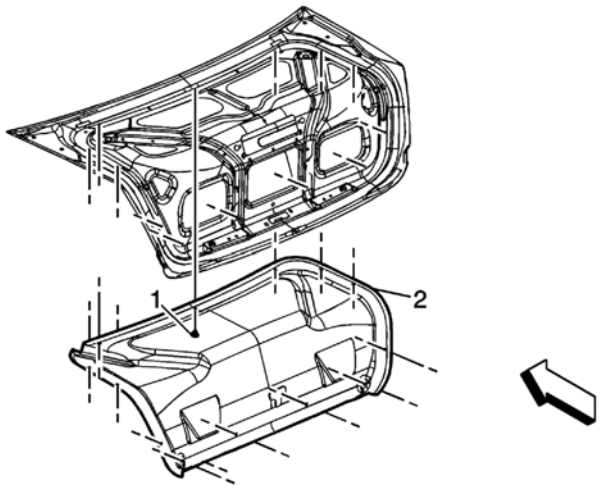


Fig. 22: Rear Compartment Lid Trim
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** .	
1	Retainer, Rear Compartment Lid Inner Panel Trim (Qty: 12)
2	Trim, Rear Compartment Lid Inner Panel

REAR COMPARTMENT SIDE TRIM REPLACEMENT - LEFT SIDE

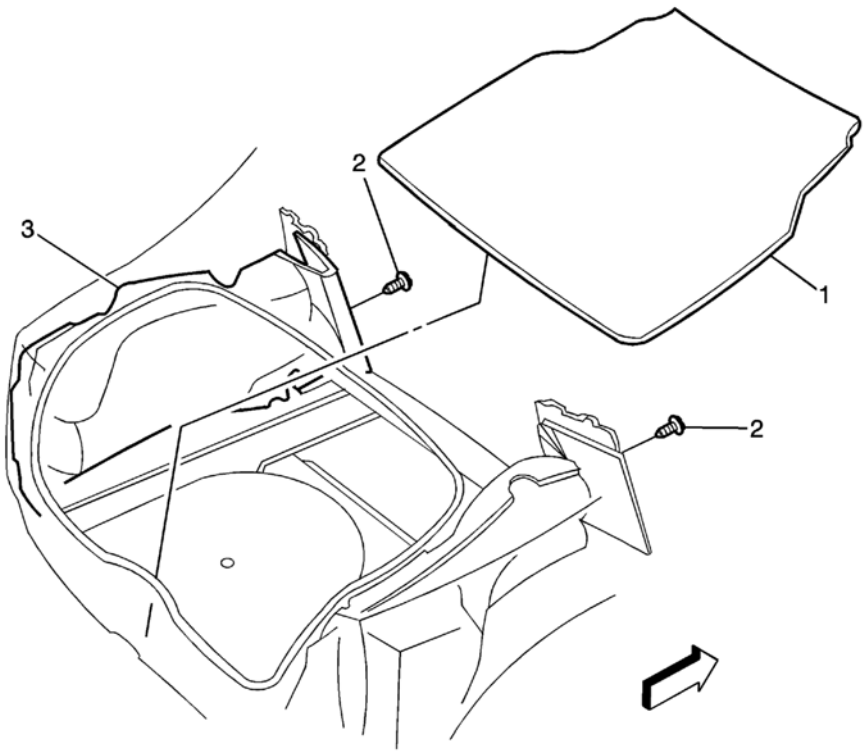


Fig. 23: LH Rear Compartment Side Trim
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the rear seat back. Refer to **Rear Seat Back Cushion Removal and Installation (Impala)** . 2. Remove the rear compartment sill plate. Refer to **Rear Compartment Sill Trim Plate Replacement**.	
1	Rear Compartment Floor Panel Trim
2	Rear Compartment Trim Panel Retainer
3	Rear Compartment Side Panel Trim

REAR COMPARTMENT SIDE TRIM REPLACEMENT - RIGHT SIDE

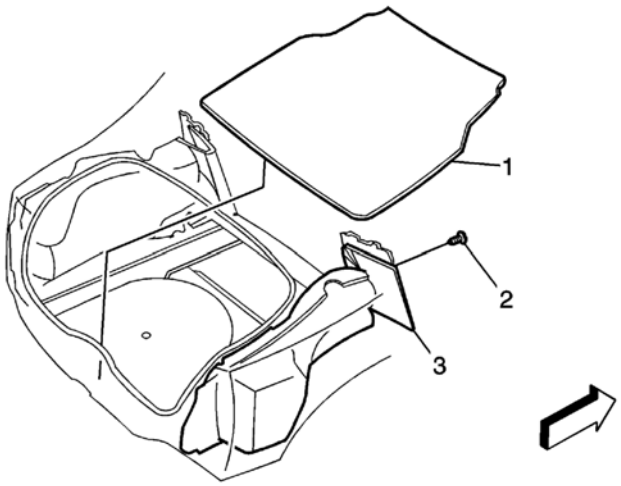


Fig. 24: RH Rear Compartment Side Trim
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the rear seat back . Refer to **Rear Seat Back Cushion Removal and Installation (Impala)** . 2. Remove the rear compartment sill plate. Refer to **Rear Compartment Sill Trim Plate Replacement**.	
1	Rear Compartment Floor Panel Trim
2	Rear Compartment Trim Panel Retainer
3	Rear Compartment Side Panel Trim

FRONT FLOOR CONSOLE CUP HOLDER REPLACEMENT (IMPALA LIMITED)

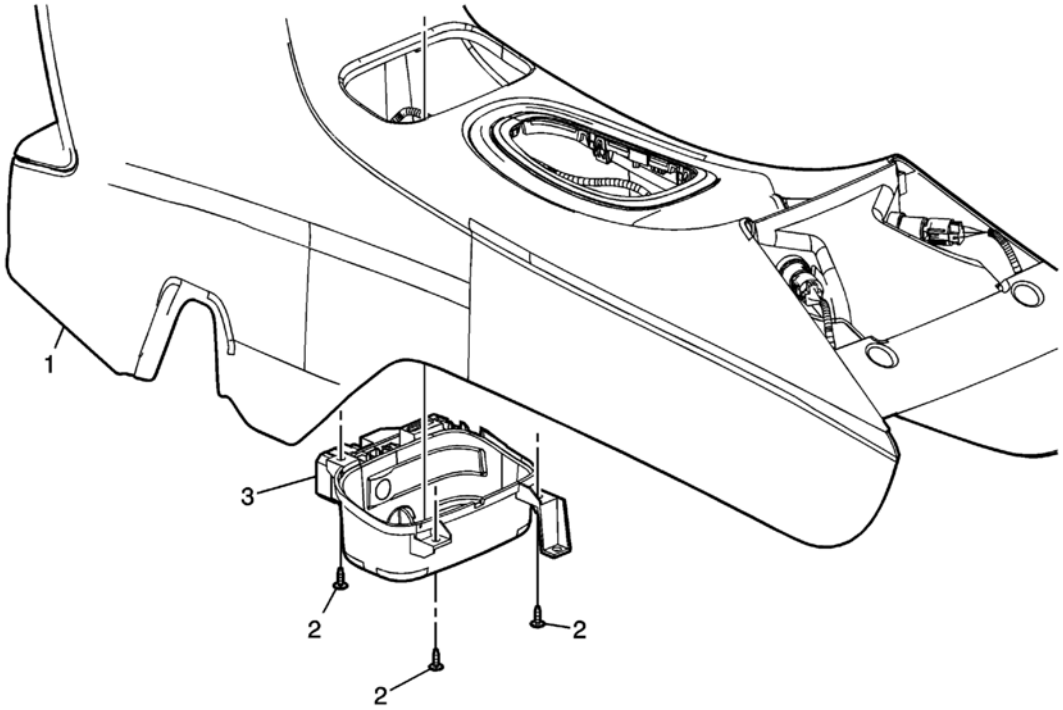


Fig. 25: Front Floor Console Cupholder
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Floor Console **TIP:** Remove the front floor console. Refer to **Front Floor Console Replacement** .
2	Front Floor Console Cup Holder Screw (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 2 N.m (18 lb in)
3	Front Floor Console Cup Holder Assembly

PRESSURE RELIEF VALVE REPLACEMENT

Removal Procedure

1. Open the rear compartment.
2. Remove the rear bumper fascia. Refer to **Rear Bumper Fascia Replacement** .
3. Pull back the right rear compartment trim panel as needed.
4. Use a small, flat-bladed tool to release the snaps on the pressure relief valve. Apply pressure at two upper locations and two lower locations.

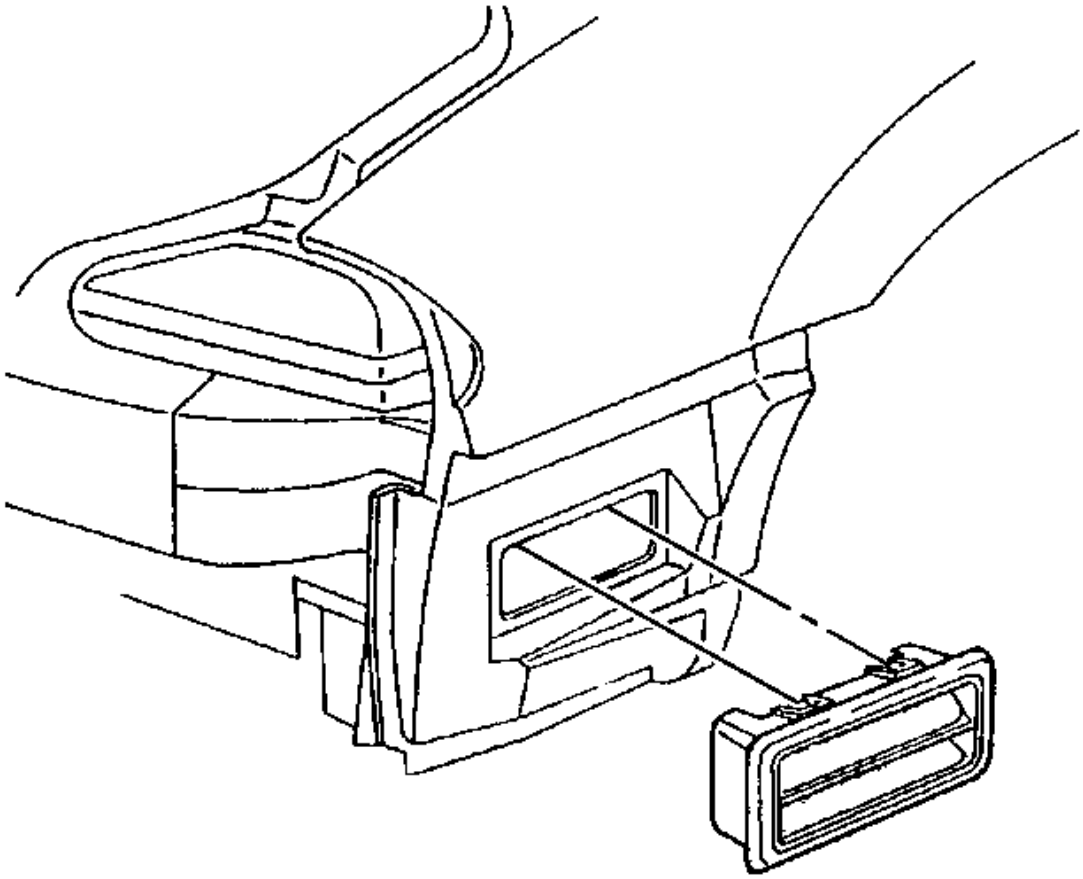


Fig. 26: Pressure Relief Valve
Courtesy of GENERAL MOTORS COMPANY

5. Remove the pressure relief valve from the lower quarter panel.

Installation Procedure

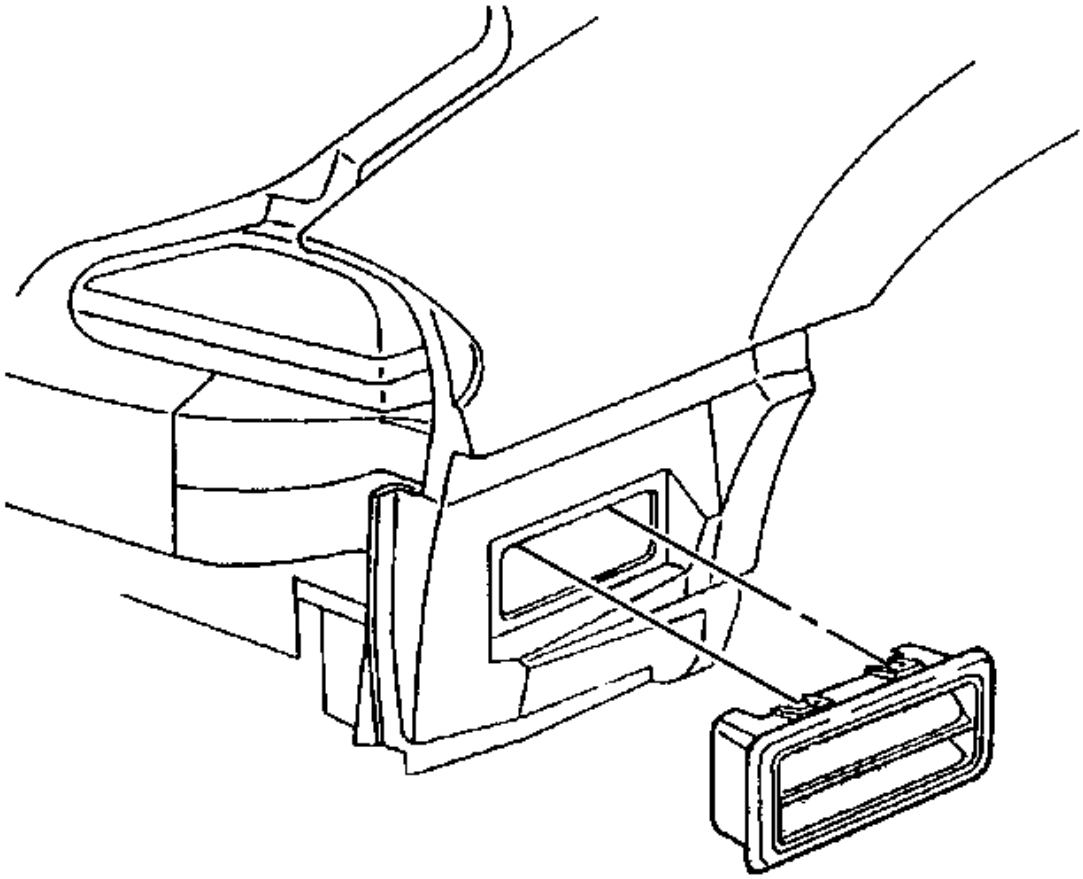


Fig. 27: Pressure Relief Valve
Courtesy of GENERAL MOTORS COMPANY

1. Install the pressure relief valve in the lower quarter panel.
2. Press the pressure relief valve into the quarter lower panel until the snaps lock into place at the upper and lower locations.
3. Install the rear compartment trim panel.
4. Install the rear bumper fascia. Refer to **Rear Bumper Fascia Replacement** .
5. Close the rear compartment.

Article GUID: A00737205

SPECIFICATIONS

CLEARCOAT REPAIR SPECIFICATIONS - 3M PRODUCTS

Paint Condition	Wet Sanding	Scratch Refinement	Compounding	Rotary Polisher	Dual Action Orbital Polisher	Hand Glazing/ Polishing
New vehicle prep or fine wheel marks	-	-	-	-	• Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6-inch Backup Pad P/N 05776	• Perfect-It Wax P/N 39026/39526 • Detail Cloth P/N 06016
Swirl marks, water spotting, or light oxidation	-	-	-	• Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit SBS/Perfect-it Backup Pad P/N 05717/18	• Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6-inch Backup Pad P/N	• Perfect-It 3000 Swirl Mark Remover P/N 06066 • Perfect-It III Foam DA Pad P/N 05729 • Detail Cloth P/N 06016 • Perfect-It Wax P/N 39026/39526

Paint Condition	Wet Sanding	Scratch Refinement	Compounding	Rotary Polisher	Dual Action Orbital Polisher	Hand Glazing/ Polishing
					05776	
Overspray or medium oxidation	-	-	• Perfect-It III Cleaning Clay P/N 38070 • Perfect-It 3000 Rubbing Compound P/N 06060/62 • Superbuff III Buff Pad P/N 05703/04	• Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit SBS/Perfect-it Backup Pad P/N 05717/18	• Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6-inch Backup Pad P/N 05776	• Perfect-It 3000 Swirl Mark Remover P/N 06066 • Perfect-It III Foam DA Pad P/N 05729 • Detail Cloth P/N 06016 • Perfect-It Wax P/N 39026/39526
Heavy oxidation or minor acid rain pitting	Micro Fine 2000	-	• Perfect-It 3000 Rubbing Compound P/N 06060/62 • Superbuff III Buff Pad P/N 05703/04	• Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit SBS/Perfect-It Backup Pad P/N 05717/18	• Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6 in Backup Pad P/N 05776	• Perfect-It 3000 Swirl Mark Remover P/N 06066 • Perfect-It III Foam DA Pad P/N 05729 • Detail Cloth P/N 06016 • Perfect-It Wax P/N 39026/39526
Dust nibs, minor scratches, or major acid rain	Micro Fine 1500 or 2000	• Trizact Hookit II Foam Disc 6 in 3000	• Perfect-It 3000 Rubbing Compound P/N	• Perfect-It 3000 Swirl Mark Remover P/N 06064	• Perfect-It 3000 Swirl Mark Remover	• Perfect-It 3000 Swirl Mark Remover P/N 06066

Paint Condition	Wet Sanding	Scratch Refinement	Compounding	Rotary Polisher	Dual Action Orbital Polisher	Hand Glazing/ Polishing
pitting		P/N 02075 • Hookit II Soft Interface Pad 6 in P/N 05274 • Hookit II Painters Disc Pad 6 in P/N 05251	06060/62 • Superbuff III Buff Pad P/N 05703/04	• Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit SBS/Perfect-It Backup Pad P/N 05717/18	P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6 in Backup Pad P/N 05776	• Perfect-It III Foam DA Pad P/N 05729 • Detail Cloth P/N 06016 • Perfect-It Wax P/N 39026/39526
Orange peel, paint runs or sags	• Hookit II Film Disc 6 in P1200 P/N 00868 • Hookit II Film Disc 6 in P1500 P/N 000850 • Hookit II Painters Disc Pad P/N 05251	• Trizact Hookit II Foam Disc 6 in 3000 P/N 02075 • Hookit II Soft Interface Pad 6 in P/N 05274 • Hookit II Painters Disc Pad 6 in P/N 05251	• Perfect-It 3000 Rubbing Compound P/N 06060/62 • Superbuff III Buff Pad P/N 05703/04	• Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit SBS/Perfect-It Backup Pad P/N 05717/18	• Perfect-It 3000 Swirl Mark Remover P/N 06064 • Perfect-It Foam Polishing Pad P/N 05725/38 • Hookit DA 6 in Backup Pad P/N 05776	• Perfect-It 3000 Swirl Mark Remover P/N 06066 • Perfect-It III Foam DA Pad P/N 05729 • Detail Cloth P/N 06016 • Perfect-It Wax P/N 39026/39526

INTRODUCTION

BASECOAT/CLEARCOAT PAINT SYSTEMS

WARNING: Exposure to isocyanates during paint preparation and application processes can cause severe breathing problems. Read and follow all of the instructions from the

manufacturers of painting materials, equipment, and protective gear.

All paint finish repairs of rigid exterior surfaces must meet GM standards. Refer to the latest revision of the GM Approved Refinish Materials book to identify the paint systems you may use that have been engineered to meet GM standards. The GM Approved Refinish Materials book supplies all approved products, including volatile organic compound (VOC) compliant regulations recommended by the individual manufacturer, and detailed procedures for materials used in their paint system.

The latest revision of the GM Approved Refinish Materials booklet is located on the Genuine GM Parts website at www.genuinegmparts.com.

ANTI-CORROSION TREATMENT AND REPAIR

Corrosion Preventative Paint (Chassis Coating) and Primer Coatings

NOTE: **Always use these products according to their manufacturer's recommendations. Corrosion Resistant paint and primers will only function properly when mixed properly and when applied to a properly prepared metal surface. Always follow paint manufacturers recommendations for application and use of Corrosion Preventative Paint Products.**

Corrosion Preventative Primers are also referred to as Direct to Metal or DTM primers. Extensive testing is done for corrosion resistance and adhesion of these products. Most paint manufacturers require a bare metal treatment chemical first be applied before the paint or primer product is applied. These coatings are very important to providing a properly prepared metal surface for the paint or primer to perform properly. The GM Approved Primers are listed in the GM Approved Refinish Materials book. The latest revision of the GM Approved Refinish Materials booklet is located on the GM Genuine Parts website at www.genuinegmparts.com.

Corrosion Preventative Paint Products are recommended for under-carriage areas like frames, drive line and suspension components that often show corrosion and need to be painted in the field. Any place where bare metal is exposed for stud repair or where corrosion prevention is desired from a paint like product that will not likely be top coated with color can use this Corrosion Preventative Paint. A Phosphate metal treatment MUST be applied to the cleaned and dried surface that is free of corrosion scale. This Phosphate prep works well on both Aluminum and steel. While sandblasting can be performed for corrosion removal, it is not necessary for these products to work properly. Application of this product must be performed to Manufacturer's recommendations for them to work properly. See product listing below for Corrosion Preventative Paint Products.

Stock number	Type	Description
36500 or 36502	Kryptonite Solvent Based Chassis Coating	Solvent based rust protective coating for all areas of under vehicle corrosion protection on aluminum and steel.
25418	Pure Prep Phosphate Metal Treatment	Phosphate bare metal treatment for metal preparation of clean or oxidized metal surfaces, areas of under vehicle corrosion protection on aluminum and steel

Undercoating and Closed Cavity Coatings

WARNING: **When applying sound deadeners, or anti-corrosion materials due care and preventative measures must be exercised to prevent any material from being sprayed into door and quarter panel mechanisms such as door locks, window run**

channels, window regulators and seat belt retractors, as well as any moving or rotating mechanical or suspension parts on the underbody, particularly the parking brake cable. After material application, be sure that all body drain holes are open. Improper application may increase chance of corrosion damage or limit the operation of moving parts, resulting in personal injury.

Any procedure that disturbs these special treatments, such as panel replacement or collision damage repair operations, may leave the metal unprotected and result in corrosion. Proper recoating of these surfaces with service-type anti-corrosion material is essential.

After repair and/or replacement parts are installed, all accessible bare metal surfaces must be treated with metal conditioner and reprimed. Refer to the GM Approved Refinish Materials book which identifies the paint systems you may use.

The latest revision of the GM Approved Refinish Materials booklet is located on the GM Genuine Parts website at www.genuinegmparts.com.

After a collision, some vehicle structure areas such as frame rails, cross-members and rocker panel sections may need to be repaired. In most cases, the anti-corrosion materials need to be removed to perform these repairs. These materials are classified into two types: Closed Cavity coatings and Undercoat coatings. The primary difference is the way the products set up or "dry". Both are intended to protect the surface they are applied to from corrosion caused by water, salt water or Magnesium Chloride blended de-icing compounds used to thaw icy winter roads. They also can provide a measure of sound deadening.

The Closed Cavity coatings remain sticky to the touch and will seep into seams initially and over extended periods of time. Closed Cavity coatings provide the best corrosion protection inside of rocker panel sections, pillar sections, frame rails, cross-members, doors, rear compartment lids and closed areas of hoods - anywhere that is concealed or closed off to exterior surfaces.

The Undercoat coatings are "dry to the touch" and offer the best corrosion protection and sound deadening for floor pans, wheelhouses, inside rear compartment and underhood areas - anywhere the coated surface is exposed.

Below is a listing of Undercoat coatings and Closed Cavity coatings that GM believes to be reliable. While others may exist, we have found these products, or equivalents to them, can be used with satisfactory results. Always use these products according to their manufacturer's recommendations.

The following products are available from *Automotive International/Valugard. Contact them at 1-800-543-7156, or at www.valugard.net

Stock number	Type	Description
VG-104	WAX/SOLVENT BASED UNDERCOAT	Traditional Wax/Solvent based Undercoating available in aerosol or spray gun canister Meets OE specifications for corrosion resistance
VG-076M	HYBRID (SOLV./WATER) UNDERCOAT	Meets OE specifications for corrosion resistance
VG-140	WATER BASED UNDERCOAT	Meets OE specifications for corrosion resistance
VG-101	WAX BASED CLOSED CAVITY COATING	Meets OE specifications for corrosion resistance
VG-UCG	CANISTER UNDERCOATING GUN	High quality undercoating gun uses canister packaging of undercoating

Stock number	Type	Description
VG-CRG	CANISTER CLOSED CAVITY COATING GUN	High quality closed cavity coating gun uses canister packaging of coating and comes with 30 in inner panel application tube with nozzle

The following products are available through your local *3MÂ® distributor. Information about 3MÂ® product retailers in your area may be obtained at 1-866-364-3577 or at www.mmm.com/automotive.

Stock number	Type	Description
08804	No Cleanup Water-Based Undercoating - Black	Coarse texture SBR rubber and acrylic applied with 3M No-Cleanup Gun 08801
08964	No Cleanup Undercoating - Black	Smooth texture SBR rubber applied with 3M No-Cleanup Gun 08801
08881	16 oz aerosol Undercoating	Calcium Carbonate and asphalt based undercoating
08882	17 oz aerosol Underseal™ Undercoating - Black	Rubber based, paintable undercoating
08883	19.7 oz aerosol Rubberized Undercoating - Black	Synthetic polymer based undercoating
08891	Rust Fighter - 1 Amber Closed Cavity Coating - quart canister	Synthetic Resin remains tacky seeps into crevices; Applied with 3M Applicator Gun 08997 and Application Wand 08998
08892	Rust Fighter - 1 Amber Closed Cavity Coating - 24 oz aerosol	Synthetic Resin remains tacky seeps into crevices; aerosol can
08801	No Cleanup Undercoating Gun	-

The following products are available from *Crest Industries, Inc. at 1-800-822-4100 or www.crestauto.com.

Stock number	Type	Description
AH-C	HONEY COAT/WAX BASED CLOSED CAVITY COATING	16.5 OZ AEROSOL CAN AMBER COLORED SEEPS INTO CREVICES AND REMAINS PLIABLE 36 in spray wand with 360 degree nozzle available (WA-HC)
BZ-BAC BZ-BACB	AMBER COAT/WAX BASED CLOSED CAVITY COATING	GALLON - AMBER COLORED (BZ-BAC) OR BLACK (BZ-BACB) SEEPS INTO CREVICES AND REMAINS PLIABLE APPLIED WITH WZ-GRP GUN AND SIPHON HOSE Flexible spray wand also available (WA-ND)
AC-R	RUBBER COAT/RUBBER BASED UNDERCOATING, PAINTABLE	17.75 OZ AEROSOL
AR-C	SUPER RUBBER COAT/LOW V.O.C. RUBBER BASED UNDERCOATING, PAINTABLE	17.75 OZ AEROSOL
BA-C	AUTO COAT/RUBBER BASED UNDERCOATING, PAINTABLE	28.7 FL OZ CONE-TOP CAN AND GALLON APPLIED WITH GU-C UNDERCOATING GUN
GU-C	UNDERCOATING GUN	ATTACHES TO BA-C CONE-TOP CAN

Stock number	Type	Description
WZ-GRP	GUN AND SIPHON HOSE	USED WITH BZ-BAC AND BZ-BACB
WA-ND	FLEXIBLE SPRAY WAND	USED WITH WZ-GRP

The following products are available from *Kent Automotive. Contact them at 1-888-YES-KENT (888-937-5368) or at www.kent-automotive.com.

Stock number	Type	Description
P60305	Wax Based Inner Panel Rustproofer - CLOSED CAVITY COATING	24 oz Aerosol (can apply with 36 in wand and 360 degree nozzle kit)
KT14912	Rubber Guard Low VOC Rubber Based Undercoating	24 oz Aerosol (can apply with 36 in wand and 360 degree nozzle kit)
KT14725	Aerosol Extension Wand Kit	36 in wand and 360 degree nozzle
KT14796	Rubber Guard Low VOC Rubber Based Undercoating	QUART - Applied with undercoating gun
P30025	Siphon Feed Gun	-
P86079	360 Degree Wand for siphon feed gun	-

Weld Thru Coating

Part Number	Description
4353	Weld-Through Primer

*We believe these sources and their products to be reliable. There may be additional manufacturers of such material. General Motors does not endorse, indicate any preference for or assume any responsibility for the products from these firms or for any such items which may be available from other sources.

Seam Sealers

Sealers are intended to prevent water and dust from entering the vehicle and also are anti-corrosion barriers. Sealers are applied to such areas as rear compartment lid hem flanges, wheelhouse, quarter outer, floor, cowl, roof, and various other panel to panel attaching points. The originally sealed joints are obvious and any damage to these sealed locations should be corrected by resealing. Attaching points of new replacement panels should be resealed. Replacement lids and doors will also require sealing in the hem flange areas.

Flanged joints, overlap joints, and seams should be sealed using a quality sealer of medium-bodied consistency. The sealer used must retain its flexible characteristics after curing and be paintable.

Open joints which require bridging of the sealer in order to close a gap should be sealed using a heavy-bodied caulking material. Follow the label directions for the material selected.

Color application may be required in order to restore repaired areas such as hood, fenders, doors, quarters, lid, roof, engine compartment, underbody, and inner panels to original appearance. When this is necessary, conventional refinishing preparation, undercoat buildup, and color application techniques should be followed.

Deadener materials, spray-on type, are used on various metal panels in order to provide corrosion resistance and joint sealing. They control the general noise level inside the passenger area of the vehicle. When deadeners are disturbed because of damage, are removed during repair operations, or a new replacement panel is installed, the

deadener material must be replaced by a service equivalent material. The application pattern and location of deadener materials can be determined by observing the original production installation.

Cleaning of the interior and underbody panel surfaces is necessary when original galvanized or other anti-corrosion materials have been burned off during welding or heating operations. Removal of the residue from burning will require additional care in such areas as interior surfaces of box-type construction and when configurations of the metal panels limit access to interior surfaces.

PAINT IDENTIFICATION

WARNING: **Exposure to isocyanates during paint preparation and application processes can cause severe breathing problems. Read and follow all of the instructions from the manufacturers of painting materials, equipment, and protective gear.**

NOTE: **Always refer to the GM Approved Refinish Materials book . This book identifies the paint systems you may use.**

The latest revision of the GM Approved Refinish Materials booklet is located on the Goodwrench website at www.gmgoodwrench.com.

Use the service parts identification label to identify the type of paint technology, paint codes, trim level, and any special order paint colors on the vehicle. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .

REPAIR INSTRUCTIONS

CLEARCOAT REPAIR WITHOUT REPAINTING

Repair Procedure

1. Thoroughly wash the repair area with Liquid Wash and Wax GM P/N 1052870 or the equivalent.
2. Environmental damage may be corrected. Refer to **Environmental Fallout (Acid Rain)**, or **Rail Dust Damage Repair**.

   IMPORTANT: Follow all of the instructions from the manufacturer of the polishing material.

3. Use a paint gauge before, during, and after sanding and/or polishing, to avoid removing too much clearcoat. Refer to **Paint Gauges**.

ENVIRONMENTAL FALLOUT (ACID RAIN)

CAUTION: **Refer to Clearcoat/Ultraviolet Screeners Caution .**

NOTE: **Always refer to the manufacturer's packaged instructions for the detailed procedures of materials used for compounding and/or polishing.**

Since the severity of the condition varies from area to area, proper diagnosis of the contamination extent is critical to the success of the repairs. Perform the diagnosis under high intensity fluorescent lighting on the horizontal surfaces (hood, roof panel, rear compartment lid), after the surfaces have been properly cleaned by washing the vehicle with GM Wash and Wax GM P/N 1237841 (Canadian P/N 10953203), or equivalent.

There are 3 basic types of acid rain damage:

Surface Level Contamination

May be repaired by simply washing the vehicle, cleaning the surface with a silicone wax and grease remover, neutralizing acidic residue, and finesse polishing-Refer to Surface Level Contamination Repair.

Clearcoat Etching

Slight etching is still noticeable after the above washing and finesse polishing procedure. Refer to Slight Clearcoat Damage - Wet Sanding, Finesse Polishing.

Basecoat Etching

Severe etching beyond the clearcoat into the basecoat in the affected areas will require refinishing. Refer to **Basecoat/Clearcoat Paint Systems**.

Surface Level Contamination Repair

1. Thoroughly wash and dry the contaminated area with GM Wash and Wax GM P/N 1237841 (Canadian P/N 10953203), or equivalent.
2. Clean the affected area with silicone, wax and grease remover.
3. Remove and neutralize acidic residue by cleaning the contaminated areas with a mixture of baking soda and water (1 tablespoon of baking soda per 1 liter or 1 quart of water). Rinse thoroughly and dry the panel completely.
4. Apply finesse-type polish with a foam panel. If damage has been repaired, remove any swirl marks with a dual action orbital polisher and foam pad. Refer to **Clearcoat Repair Specifications - 3M Products**.
5. If some damage remains, refer to Slight Clearcoat Damage - Wet Sanding, Finesse Polishing.

Slight Clearcoat Damage - Wet Sanding, Finesse Polishing

1. Select a small contaminated test area.
2. Film thickness should be taken prior to the sanding and polishing. Refer to **Paint Gauges**.
3. Wet sand and finesse polish the contaminated test area. Refer to **Clearcoat Repair Specifications - 3M Products**, . If during the polishing you suspect or observe that etching has penetrated into the basecoat, too much clearcoat has been removed during sanding, or base color is transferred to the polishing pad during polishing, then the affected areas will require refinishing. Refer to **Basecoat/Clearcoat Paint Systems**.

PAINT GAUGES

Paint thickness gauges measure the total thickness of the vehicle finish. It is important to accurately measure the thickness of the finish on each vehicle as the thickness of the finish will vary on each vehicle. Use a paint gauge before the sanding process in order to accurately measure how much finish there is to remove before, during, and after the sanding process. Paint gauges range from magnetic pull type to sophisticated electronic types, and are available from a variety of sources. The older magnetic type gauges, at best have a 5 percent accuracy range and are not sensitive enough to detect removal of 0.02 mm 0.5 mil (0.0005 in) clearcoat. The newer type magnetic gauges have improved accuracy ranges. Most gauges are confined to checking either ferrous metal, steel, non-ferrous metal, or aluminum panel. At this time, there are no viable gauges for reading film thickness on composite (SCM doors, RIM fenders) panels. The more sophisticated (ETG) electronic paint thickness gauges digital type gauges are able to read film thickness on both ferrous and non-ferrous metal panel. Digital ETG gauges may have

an accuracy range of 1 percent and include thickness standards for recalibration. The following paint thickness gauges are available. Call 1-800-GM-TOOLS for information:

Paint Thickness Gauges

- 147-5437-ETG Standard model
- 147-5437-ETG-P Standard model with print option
- 147-5437-N-ETG-N Non-ferrous model for aluminum panels
- 147-5437-NP-ETG-NP Non-ferrous model with print option
- 147-54437-SD-ETG Steel and aluminum gauge

CLEARCOAT THICKNESS

The clearcoat on the vehicle is typically 0.059-0.078 mm (1.5-2 mils [0.0015-0.0020 in]) thick. The clearcoat contains ultraviolet screeners. Removing more than 0.5 mils (0.019 in) of the clearcoat may result in early paint failure.

RAIL DUST DAMAGE REPAIR

WARNING: **Refer to Eye Protection Warning .**

NOTE: **If rail dust has penetrated into the basecoat, the panel requires refinishing. Ensure all the rail dust has been removed prior to refinishing or the rust spots will return.**

Rail dust damage comes from the tiny iron particles produced from the friction between the train wheels and the track. It can also be deposited on vehicles if stored near any operation producing iron dust (i.e., steel ore yards). This dust can either lay on top of, or embed into the paint surface. It is usually diagnosed as bumps in the paint surface or rust colored spots in the paint.

1. Move the vehicle to a cool shaded area and ensure the vehicle surfaces are cool during the removal process.
2. Thoroughly wash the repair area with Liquid Wash and Wax GM P/N 1052870, or equivalent.
3. Wipe the area dry.
4. Clean the affected area with silicone, wax and grease remover.
5. Perform the removal process according to the manufacturer's directions of the type of repair material used (Gel Type Oxalic Acid or Clay Type Non-Acid Based). If, upon inspection, some particles are still present, the process may be repeated. If the damage has been repaired, complete the repair to the entire panel.
6. Polish the entire panel after the removal process. Refer to **Clearcoat Repair Specifications - 3M Products**, . If small pits remain in the clearcoat after all of the damage has been repaired, refer to **Clearcoat Repair without Repainting**.

Article GUID: A00737222

ACCESSORIES AND EQUIPMENT

Plastic Panel Information and Repair - Impala

SPECIFICATIONS

FLEXIBLE PLASTIC PART REPAIR MATERIALS

Product- 88861039, *88861040, High Strength Plastic Repair 50 ml

Components- 12 cartridges with 2 mixers each

Structural and Cosmetic

Recommended Repair Material

Product	Components	Recommended Repair Material	Work Time 70Â°F	Handling Strength at 70Â°F
88861039 *88861040 High Strength Plastic Repair 50 ml	12 cartridges with 2 mixers each	Structural and cosmetic bonding and repairing of all flexible plastics. Requires GM P/N 12378462 on TPO plastics. Will also bond e-coated/primed metals.	90 seconds	10 minutes
* TPO, TEO, (Polyolefin Plastics) require the application of polyolefin adhesive primer before the GM P/N 88861039 repair compound is applied.				

Working Time

Product	Adhesive Sandability at 70Â°F	Part Paintability at 70Â°F	Adhesive Full Cure at 70Â°F	Program
88861039 *88861040 High Strength Plastic Repair 50 ml	20 minutes	30 minutes	24 hours	Bumper covers, emblems, door trims, exterior and interior repairs*
* TPO, TEO, (Polyolefin Plastics) require the application of polyolefin adhesive primer before the GM P/N 88861039 repair compound is applied.				

RIGID PLASTIC PART REPAIR MATERIALS

Thermoset Plastic Type	Type of Repair	Recommended Repair Material	Availability
Sheet metal compound (SMC), RIM rigid plastic parts	Cosmetic filling	GM GoodwrenchÂ® Structural Bonding Epoxy (GM P/N 12345726 or	GM Dealer

Thermoset Plastic Type	Type of Repair	Recommended Repair Material	Availability
		equivalent)	
		Sikkens Polystop LP™ or equivalent polyester repair putty	Refer to a local paint supplier
Most rigid plastic parts	Cosmetic repair, adhesive bonding	GM GoodwrenchÂ® Structural Bonding Epoxy (GM P/N 12345726 or equivalent)	GM Dealer
		Lord FusorÂ® SMC Body Panel Repair Adhesive or equivalent	Refer to local paint supplier
Most rigid plastic parts	Adhesive bonding	GM GoodwrenchÂ® Structural Bonding Epoxy (GM P/N 12345726 or equivalent)	GM Dealer
		Dynatron Dyna-Weld Plio GripÂ® or equivalent (OE structural adhesive)	Refer to local paint supplier
Most rigid plastic parts	Adhesive structural* bonding	GM GoodwrenchÂ® Structural Bonding Epoxy (GM P/N 12345726 or equivalent)	GM Dealer
Most rigid plastic parts	Adhesive bonding Structural bonding	Ashland PliogripÂ® 7773B-3-minute Ashland PliogripÂ® 7779B-10-minute Ashland PliogripÂ® 7770B-35-minute	Supplied by Crest Industries 1-800-822-4100 fax 1-800-344-4461
SRIM most rigid plastic parts	Cosmetic repair, adhesive bonding	GM GoodwrenchÂ® SRIM™ repair kit (GM P/N 12378523) or SIA™ Adhesives, INC. SRIM™ repair kit P/N 30208030001 adhesive 200ML TUBES P/N 30208020001 50ML TUBES P/N 30208010001	SIA Adhesives, INC. customer service 1-330-374-2468
* Structural adhesive bonding may require the use of a pneumatic applicator, A8-37479-1A, or equivalent, to speed the application of the GM P/N 12345726 epoxy.			Kent-Moore 1-800-GM-TOOLS

REPAIR INSTRUCTIONS

GENERAL PLASTIC REPAIR

WARNING: **In order to reduce the risk of personal injury when exposed to toxic fumes while grinding, cutting, or applying repair material on any type of sheet molded compound or RIM rigid plastic, observe the following guidelines:**

- **Work in a properly ventilated area**
- **Apply protective cream to any exposed skin**
- **Remove any mixture that comes into contact with skin**
- **Wash skin with cold water to remove glass and resin dust**
- **Use a sander with a vacuum attachment**
- **Follow the repair material manufacturer's instructions**

Also, always wear the following:

- **An approved respirator, or air supplied respirator**
- **Eye protection**
- **Rubber gloves**
- **Earplugs**
- **Protective clothing**

The following procedures should be followed when repairing all types of thermoset plastic:

- Follow the manufacturer's application and curing recommendations.
- Do not intermix systems. Use the supplies and the repair materials from the same manufacturer.
- Clean the inner and outer surfaces of the repair area with a soap impregnated scouring pad in order to remove any dirt or mold release agent.
- Clean the area with a wax and grease remover, using only enough of the remover to dampen a cloth. Allow the panel to dry thoroughly.
- Remove the surface finish from the area to be repaired. Adhesives are designed to adhere to the plastic substrate, not the finish.
- Prime a metal surface before applying the repair material.
- Inspect the rear side of the work area before making repairs in order to avoid possible damage to wires, motors, etc.

DESCRIPTION AND OPERATION

HOW TO IDENTIFY PLASTIC PARTS

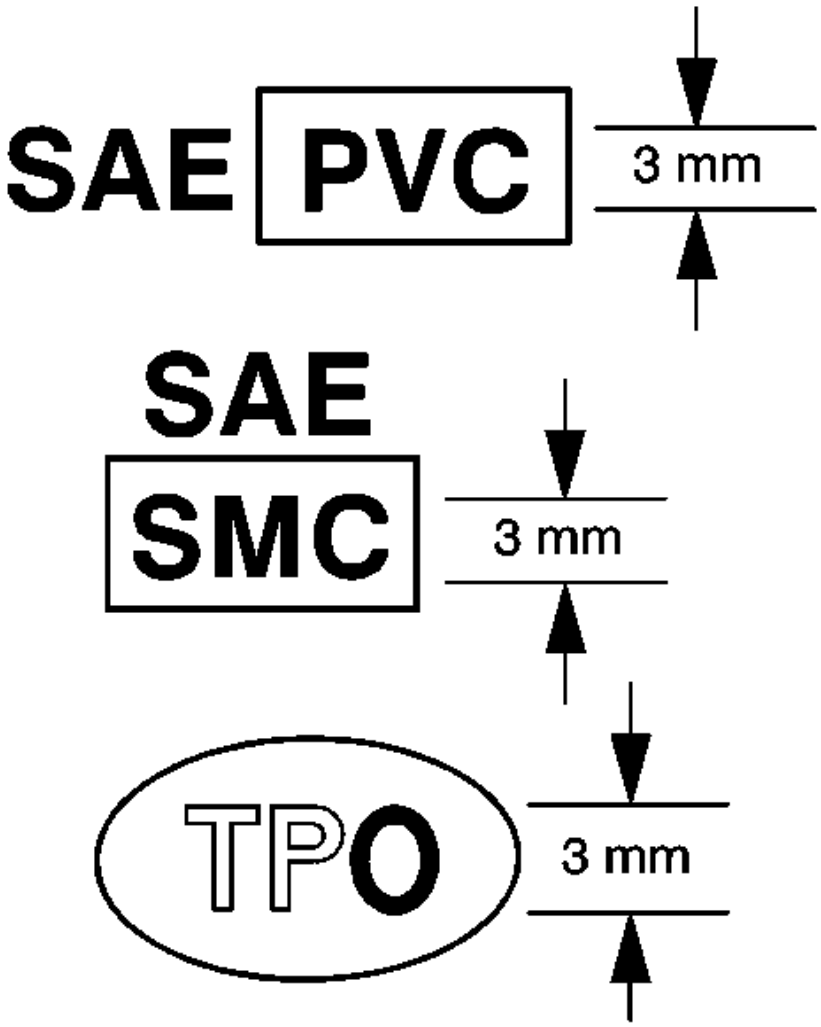


Fig. 1: Identifying SAE Code
Courtesy of GENERAL MOTORS COMPANY

Plastic parts can be identified by the SAE code, which is usually found on the rear of the part, and/or by the characteristics of the plastic. Knowing the type of plastic aids in selecting the proper repair materials and in selecting the proper repair procedure.

Look for the SAE code stamped into the part.

Code Found

Match the code to those in the plastic identification chart to determine whether the plastic is thermoplastic or thermoset plastic, and whether the plastic is rigid or flexible. Refer to **Plastic Identification and Refinishing Systems**.

No Code Found

WARNING: Do NOT use a plastic burn test to distinguish the type of plastic. The burn test produces vapors which are harmful.

Perform one or both of the following tests to determine if the part is thermoplastic polyolefin or thermoset non-polyolefin.

Float Test

1. Cut a shaving of plastic from the back of the part.

   The shaving should be free of mold release agents and paint.

2. Place the shaving in a container of water.
   - Thermoplastic polyolefin floats.
   - Thermoset non-polyolefin sinks.

Abrasion Test

- Sand a spot near the damaged area with Grade 36 Roloc Disc.
- Thermoplastic polyolefin material melts or frays when sanded.
- Thermoset non-polyolefin material sands cleanly.

Thermoplastic and thermoset plastics can be either rigid or flexible. Thermoplastic plastic parts are best repaired with a hot iron plastic material-feed welder, but are usually replaced. Thermoset plastic can be repaired with epoxy or other more rigid 2 package repair material.

- For rigid thermoset repair materials, refer to **Rigid Plastic Part Repair Materials**.
- For flexible thermoset repair materials, refer to **Flexible Plastic Part Repair Materials**.
- For general repair instructions, refer to **General Plastic Repair**.

PLASTIC IDENTIFICATION AND REFINISHING SYSTEMS

Identifying Symbol- Old Symbol in ( )s	Chemical Composition or Plastic Family Name	Typical Area(s) Where Part is Used	Examples of Common / Trade Names	Type of Plastic
ABS	Acrylonitrile / Butadiene-Styrene	Armrest Support, Console, IPC, Steering Column Bracket / Jacket, Trim Molding	ABS, Absafil, Magnum, Cycolac, Dyel, Kralastic, Lustran	Thermoplastic
ABS + PC	Acrylonitrile / Butadiene-Styrene + Polycarbonate	Instrument Panel, IPC	Bayblend, Cycoloy, KHA, Pulse	Rigid
ABS / PVC	ABS/Vinyl (Soft)	Head Rest Cover, Instrument Panel Pad, Trim Molding / Panel	ABS Vinyl	Flexible, Vinyl
EPDM	Ethylene Propylene Diene Monomer	Body Panel, Bumper Impact Strip	EPDM, Nordel	Rigid

Identifying Symbol- Old Symbol in ( )s	Chemical Composition or Plastic Family Name	Typical Area(s) Where Part is Used	Examples of Common / Trade Names	Type of Plastic
EVA (EVAC)	Ethylene / Vinyl Acetate	Head Rest Cover, Misc Soft Trim	Elvax, Microthane	Flexible
PA	Polyamide	Headlamp Bezels, Quarter Panel Extensions, Exterior Finish Trim Panels	Nylon, Capron, Zytel, Rilsan, Minion, Vydyne, Welland	Rigid
PA, PAG, PAGG	Polyamide	Exterior Finish Trim Panel, Headlamp Bezel, Quarter Panel Extension	Capron, Minlon, Nylon, Rilsan, Vydyne, Wellamid, Zytel	Rigid, Thermoset
PA + PPE	Polymide + Polypheneylene Ether	Exterior Trim, Fender	GTX	Rigid, Thermoset
PBT + TEEE (PBTP + EEBC)	Polybutylene, Terephthalate + Ether, Ester Block Compound	Fascia, Rocker Panel Molding	Bexloy M	Rigid
PC	Polycarbonate	Interior Rigid / Hard Trim Panel, Valance Panel	Calibre, Lexan, Merlon, Makrolon	Rigid, Thermoset
PC + PETP	Polycarbonate + Polybutylene, Terephthalate	Bumper Fascia	Macroblend, Valox, Xenoy	Flexible, Thermoset
PE	Polyethylene	Fuel Tank Shield, Inner Fender Panel, Interior Trim Panel, Seat Belt Cover, Spoiler, Valance	Alathon, Dylan, Foriflex, Hi-fax, Hosalen, Marlex, Paxon	Rigid, Thermoplastic
PF	Phenol Formaldehyde	Ashtray	Amberol, Bakelite, Durez, Genal, Phenolic, Plyophen, Resinox	Rigid, Thermoset
PP	Polypropylene	Bumper Fascia, Cowl Panel, Deflector Panel, Door Panel, Inner Fender, Interior Molding, Kick Panel, Load Floor, Radiator Shroud, Wheel Cover	Azdel, Daplen, Escorene, Marlex, Novolen, Oleflo, Profax, Tenite	Flexible, Thermoplastic
PPE (PPO)	Polyphenylene Ether	Bezels, Chromed Plastic, Headlamp Door, Ornaments	Noryl, Oleflo, Prevex	Rigid, Thermoset

Identifying Symbol- Old Symbol in ( )s	Chemical Composition or Plastic Family Name	Typical Area(s) Where Part is Used	Examples of Common / Trade Names	Type of Plastic
PS	Polystyrene	Dash Panel, Door Panel	Durathon, Dylan, Lustrex, Polystyrol, Styron	Flexible, Soft
PUR	Polyurethane, Thermoset (Unsaturated)	Bumper Fascia, Filler Panel, Front/Rear Body Panel, Pickup Box	Bayflex, Castethane, RIM, RRIM, SRIM	Thermoset
PVC	Polyvinyl Chloride (Vinyl)	Interior Soft Trim, I/P Skins, Roof Cover	Geon, Pliovic, Unichem, Vinoflex, Vinyl, Vinylite	Flexible, Vinyl
SAN (SA)	Styrene Acrylonitrite	Center Console, Glove Box Door, Interior Trim Panel	Foracryl, Lustran, Tyril	Rigid
TEO (EP, EPM, TPO)	Ethylene / Propylene (Rubber)	Air Dam, Bumper Fascia, Valance Panel	EPI, EPII, TPO, TPR (Thermoplastic Rubber)	Flexible, Thermoplastic
TPO	Thermal Plastic Oletin	Bumper Covers	TPO	Flexible Thermoplastic
TPU (TPUR)	Polyurethane, Polyolefin	Bumper Fascia, Gravel Deflector, Soft Filler Panel, Window Molding	Estane, Pellethane, Roylar, Toxin	Flexible, Thermoplastic
UP	Polyester / Thermoset	Air Scoop, Air Spoiler, Fascia Extension, Hood, Instrument Housing, Rear Compartment Lid, Roof, Ventilation Grid	Fiberglass, Premi-glass, Selectron, SMC, Vibrinmat	Rigid, Thermoset
For symbols not listed in this table, contact the Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096-0001.				

Article GUID: A00737223

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Front Center Seat Armrest Bolt	3 N.m	25 lb in
Front Center Seat Bolt	44 N.m	32 lb ft
Front Seat Adjuster Bolt	45 N.m	33 lb ft
Front Seat Back Cushion Frame Bolt	45 N.m	33 lb ft
Front Seat Cushion Frame Bolt	45 N.m	33 lb ft
Front Seat Cushion Frame Nut	9 N.m	80 lb in
Front Seat Cushion Outer Trim Panel Screw	2 N.m	18 lb in
Front Seat Heater Control Module Screw	2 N.m	18 lb in
Power Recliner Motor Bolt	9 N.m	80 lb in
Rear Seat Armrest Nut	3 N.m	25 lb in
Rear Seat Back Cushion Bolt	45 N.m	33 lb ft
Rear Seat Back Cushion Nut	45 N.m	33 lb ft

REPAIR INSTRUCTIONS

FRONT SEAT REMOVAL AND INSTALLATION - BUCKET (IMPALA LIMITED)

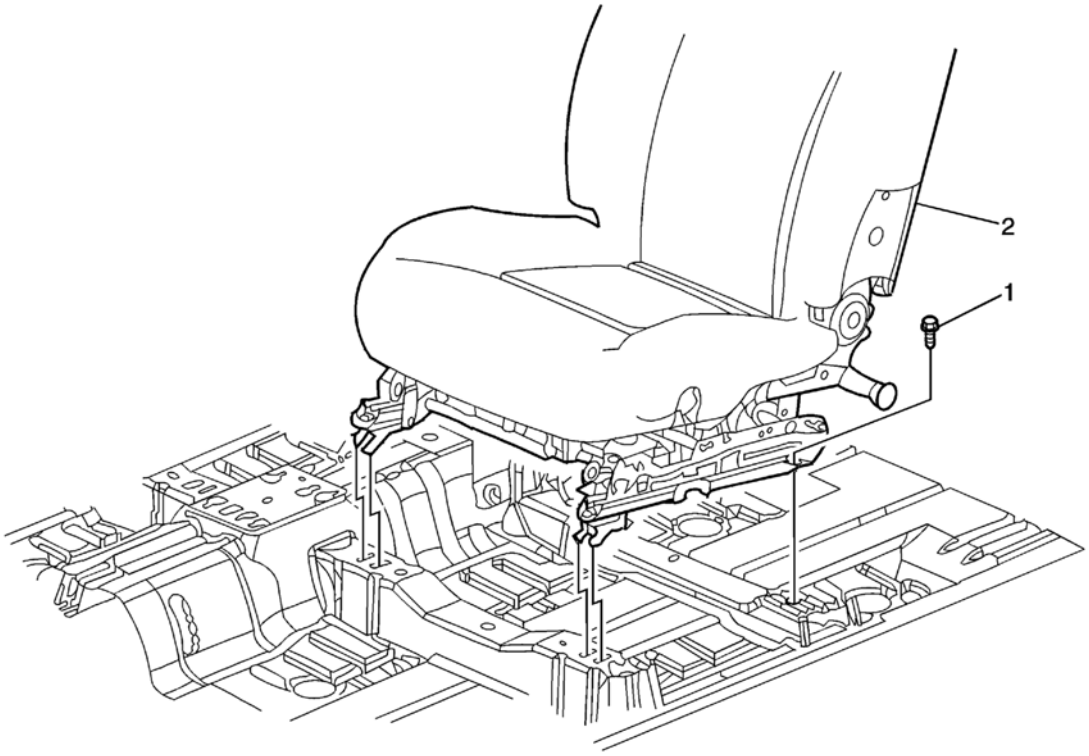


Fig. 1: View Of Front Bucket Seat (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the seat belt from the seat. Refer to **Seat Belt Retractor Pretensioner Replacement - Front** .	
1	Seat Adjuster Bolt (Qty: 2) **CAUTION:** **Refer to** **Fastener** **Caution** . **Procedure** Remove the front seat track covers to access the bolts. **Tighten** 45 N.m (33 lb ft)
2	Seat Assembly **Procedure** Disconnect the electrical connectors.

FRONT CENTER SEAT REMOVAL AND INSTALLATION

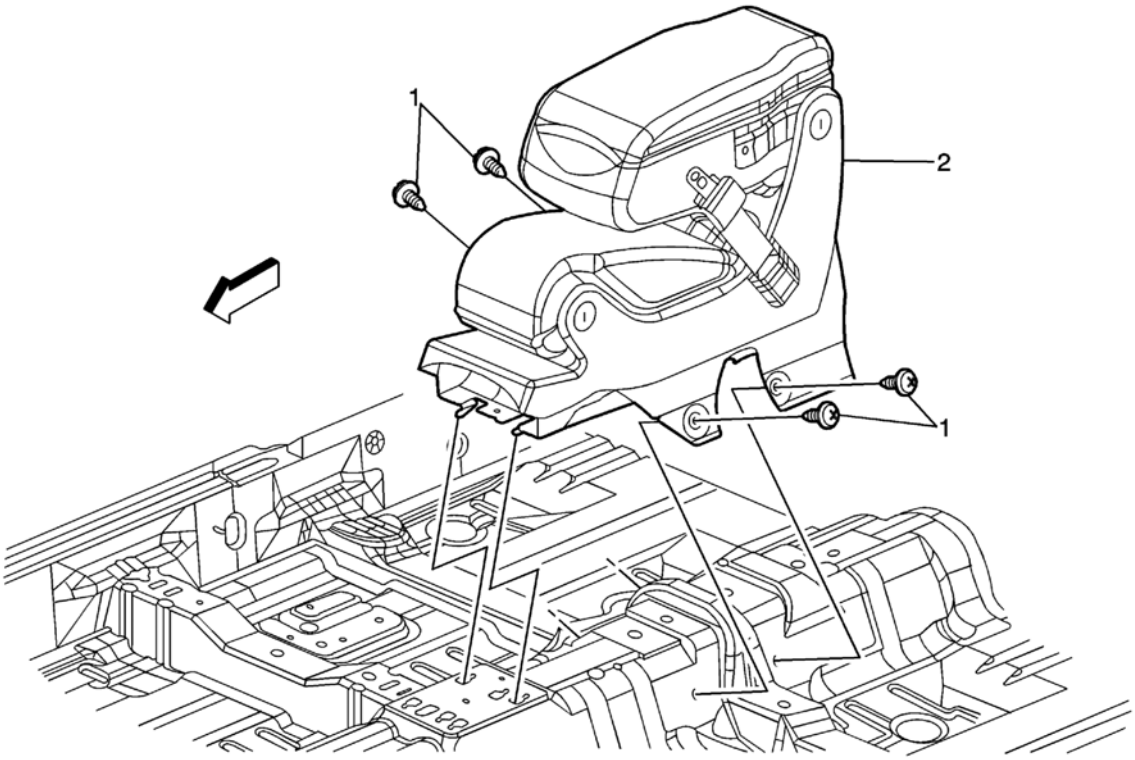


Fig. 2: Center Seat
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Move the driver and passenger seats forward or rearward.	
1	Front Center Seat Assembly Bolt (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution .** **TIP:** Remove the plastic caps that cover the bolts. **Tighten** 44 N.m (32 lb ft)
2	Front Center Seat Assembly • Slide the center seat assembly forward and lift up to disengage the retaining hooks at the front of the seat. • Disconnect the electrical connectors.

FRONT SEAT ADJUSTER REPLACEMENT

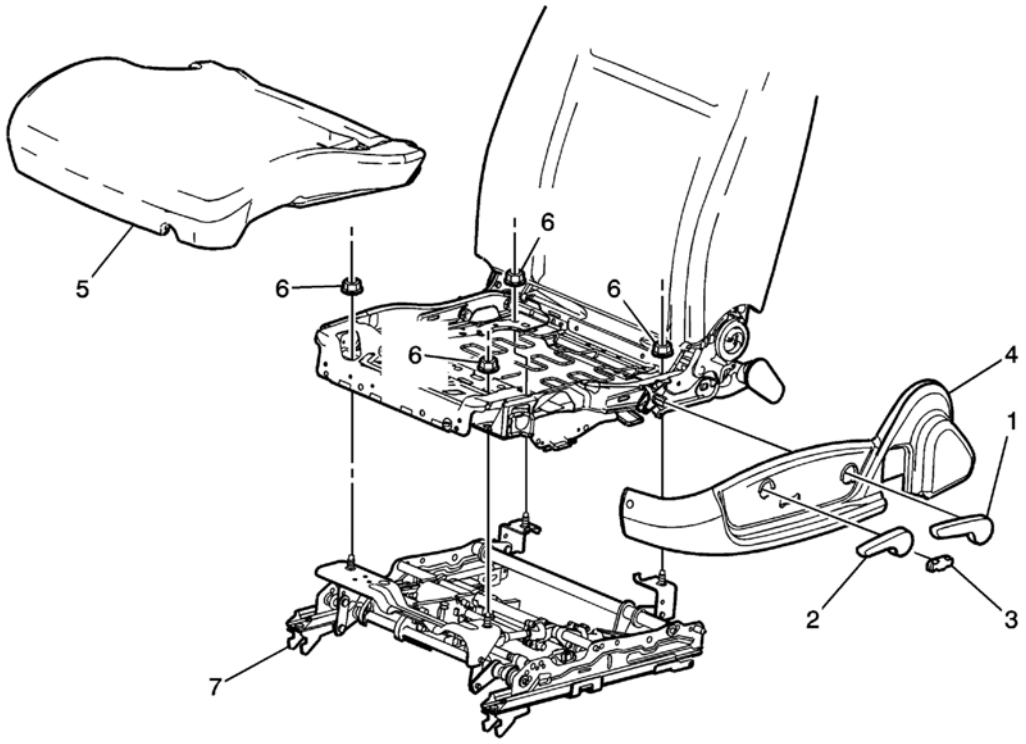


Fig. 3: Locating Front Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)**.	
1	Recliner Handle **TIP:** Using a flat-bladed tool, push the retainer clip downward and pull outward to release the handle.
2	Lumbar Actuator Handle **TIP:** Pull outward to remove.
3	Power Seat Switch Knob **TIP:** Pull outward to remove.
4	Seat Cushion Outer Trim Panel Refer to **Seat Cushion Outer Trim Panel Replacement**.
5	Seat Cushion Cover **Procedure** 1. Release the j-channel from the seat cushion frame. 2. Disconnect the seat cushion heater electrical connector, if equipped. 3. Remove the seat cushion cover and pad as an assembly from the frame.
6	Front Seat Cushion Frame Nut (Qty: 4) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 9 N.m (80 lb in)
7	Front Seat Adjuster Assembly

PASSENGER SEAT ADJUSTER REPLACEMENT (IMPALA LIMITED W/O AG2)

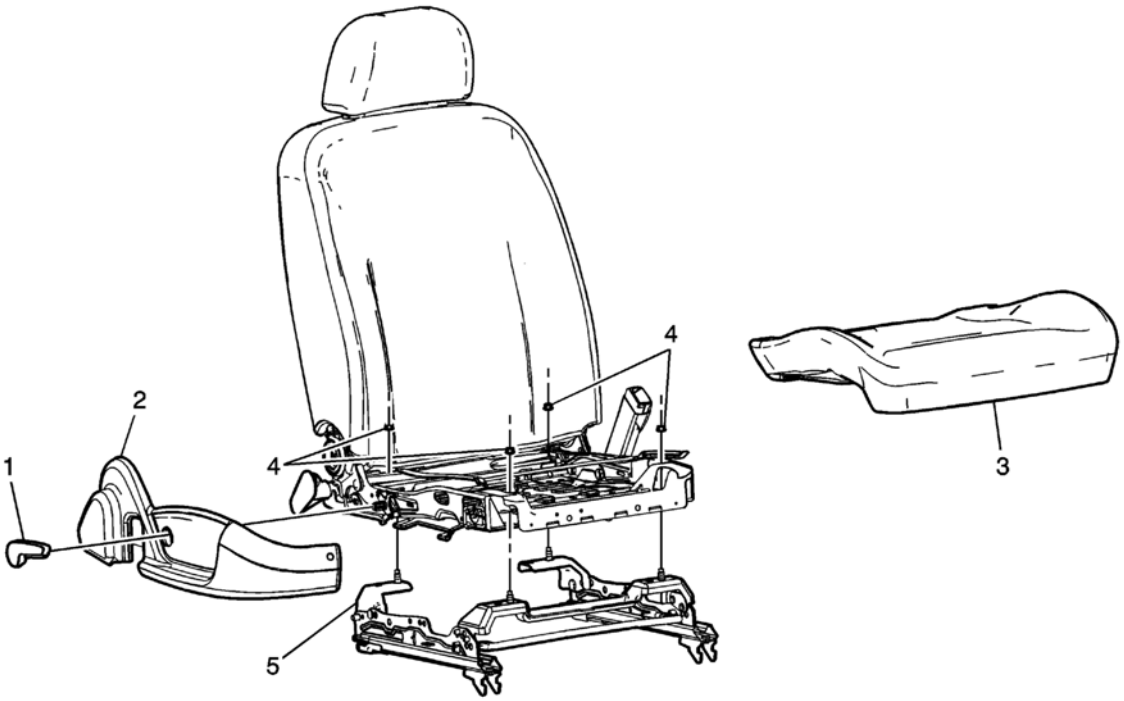


Fig. 4: Passenger Side Seat Adjuster (Impala Limited w/o AG2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)**.	
1	Recliner Handle **TIP:** Using a flat-bladed tool, push the retainer clip downward and pull outward to release the handle.
2	Seat Cushion Outer Trim Panel Refer to **Seat Cushion Outer Trim Panel Replacement**.
3	Seat Cushion Cover **Procedure**

Callout	Component Name
	1. Release the j-channel from the seat cushion frame. 2. Disconnect the seat cushion heater electrical connector, if equipped. 3. Remove the seat cushion cover and pad as an assembly from the frame.
4	Front Seat Cushion Frame Nut (Qty: 4) **CAUTION:** **Refer to** Fastener Caution . **Tighten** 9 N.m (80 lb in)
5	Front Seat Adjuster Assembly

FRONT SEAT ARMREST LATCH REPLACEMENT (IMPALA LIMITED)

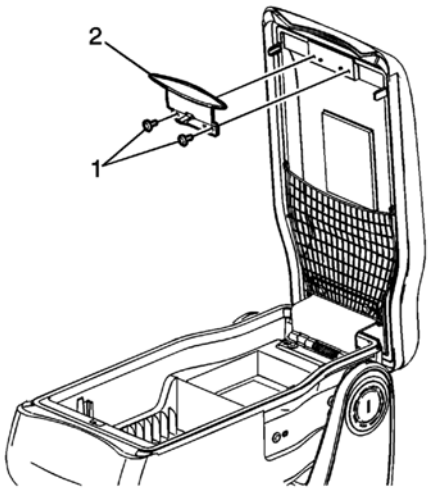


Fig. 5: Identifying Front Seat Armrest Latch (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Armrest Hinge Screw (Qty: 2) **CAUTION:** **Refer to** Fastener Caution . **Tighten** 3 N.m (25 lb in)

Callout	Component Name
2	Front Seat Armrest Latch Assembly

FRONT SEAT ARMREST REPLACEMENT (IMPALA LIMITED)

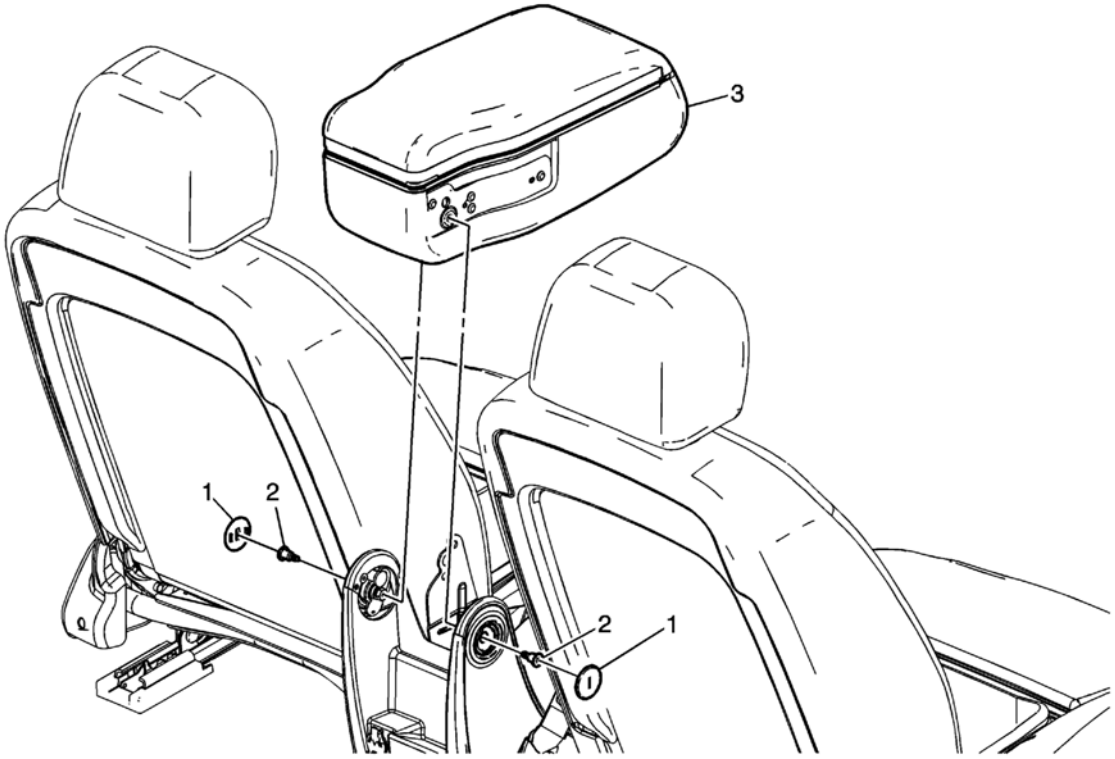


Fig. 6: Front Seat Armrest (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Center Seat Armrest Bolt Cover (Qty: 2) **TIP:** Move the front bucket seats forward far enough to gain access to the armrest bolt cover.
2	Front Center Seat Armrest Bolt (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 3 N.m (25 lb in)
3	Front Center Seat Armrest Assembly

FRONT SEAT ARMREST HINGE REPLACEMENT (IMPALA LIMITED)

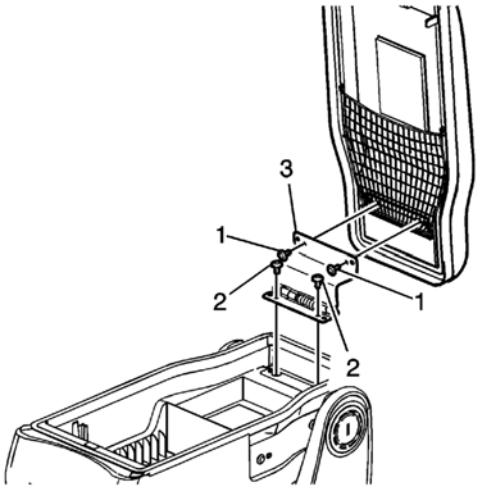


Fig. 7: Identifying Front Seat Armrest Hinge (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Armrest Hinge Screw (Qty: 2) **CAUTION:** **Refer to** Fastener Caution . **Tighten** 3 N.m (25 lb in)
2	Front Seat Armrest Hinge Screw (Qty: 2) **Tighten** 3 N.m (25 lb in)
3	Front Seat Armrest Hinge

FRONT SEAT ARMREST LID REPLACEMENT (IMPALA LIMITED)

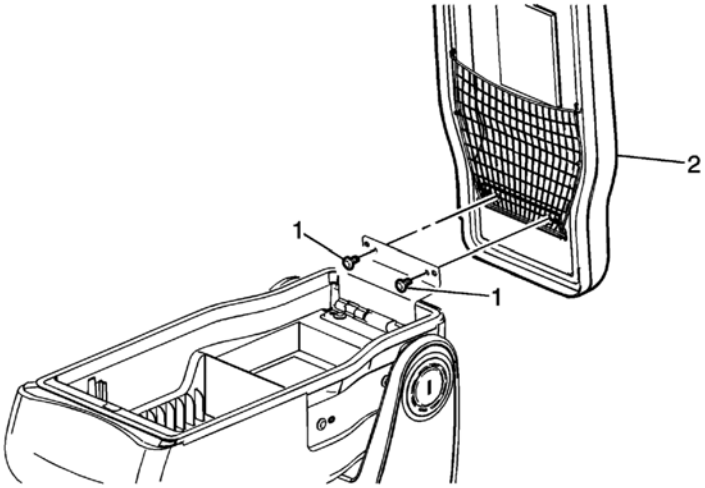


Fig. 8: Identifying Front Seat Armrest Lid (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Armrest Hinge Screw (Qty: 2) **CAUTION:** **Refer to** Fastener Caution . **Tighten** 3 N.m (25 lb in)
2	Front Seat Armrest Lid Assembly

FRONT SEAT ARMREST STOWAGE COMPARTMENT REPLACEMENT (IMPALA LIMITED)

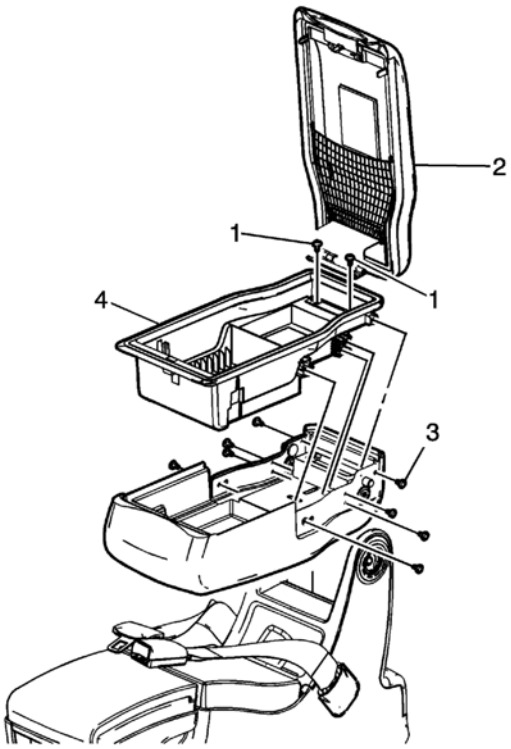


Fig. 9: Identifying Front Seat Armrest Stowage Compartment (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Armrest Hinge Screw (Qty: 2) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 3 N.m (25 lb in)
2	Front Seat Armrest Lid Assembly
3	Front Seat Armrest Bin Screw (Qty: 8) **Tighten** 3 N.m (25 lb in)
4	Front Seat Armrest Stowage Compartment Assembly

DRIVER OR PASSENGER SEAT HEAD RESTRAINT REPLACEMENT (IMPALA LIMITED)

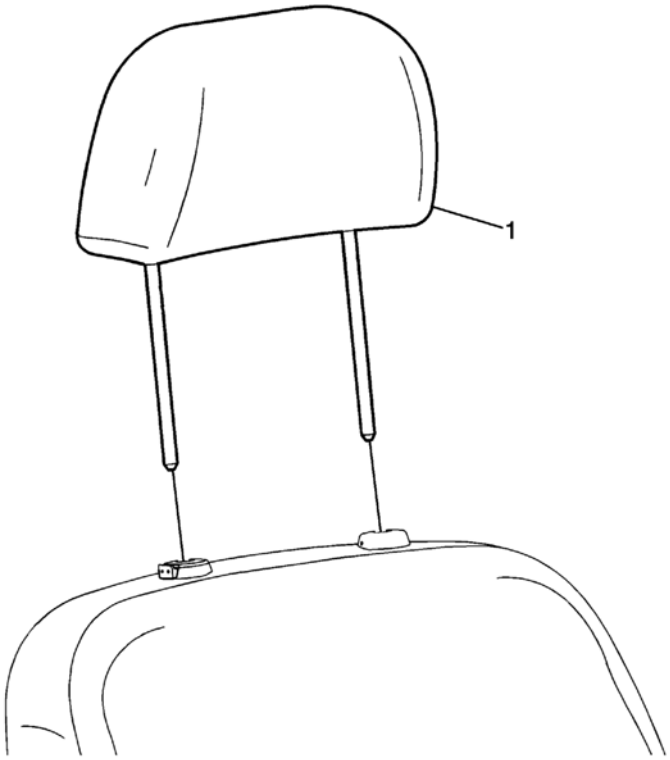


Fig. 10: Front Seat Head Restraint (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Seat Head Restraint **Procedure** 1. Depress the button on the inboard head restraint guide to raise the head restraint to the full up position. 2. Insert a small diameter tool into the hole on the inboard side of the outboard head

Callout	Component Name
	restraint guide and pull upward to remove.

DRIVER OR PASSENGER SEAT HEAD RESTRAINT GUIDE REPLACEMENT (IMPALA LIMITED)

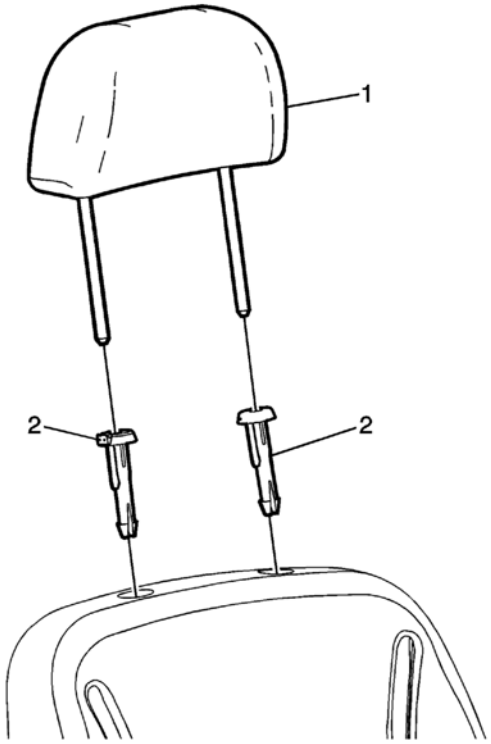


Fig. 11: Front Seat Head Restraint Guide (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat back panel. Refer to **Front Seat Back Cushion Finish Panel Replacement (Impala Limited)**.	
1	Front Seat Head Restraint **Procedure** 1. Depress the button on the inboard head restraint guide to raise the head restraint to the full up position. 2. Insert a small diameter tool into the hole on the inboard side of the outboard head restraint guide and pull upward to remove.
2	Front Seat Head Restraint Guide (Qty: 2) **TIP:** Reach up and into the top of the seat back, while pressing the tabs on the bottom of the head restraint guide, pull the guide from the seat back frame.

DRIVER SEAT ADJUSTER HORIZONTAL PINION GEAR SHAFT REPLACEMENT

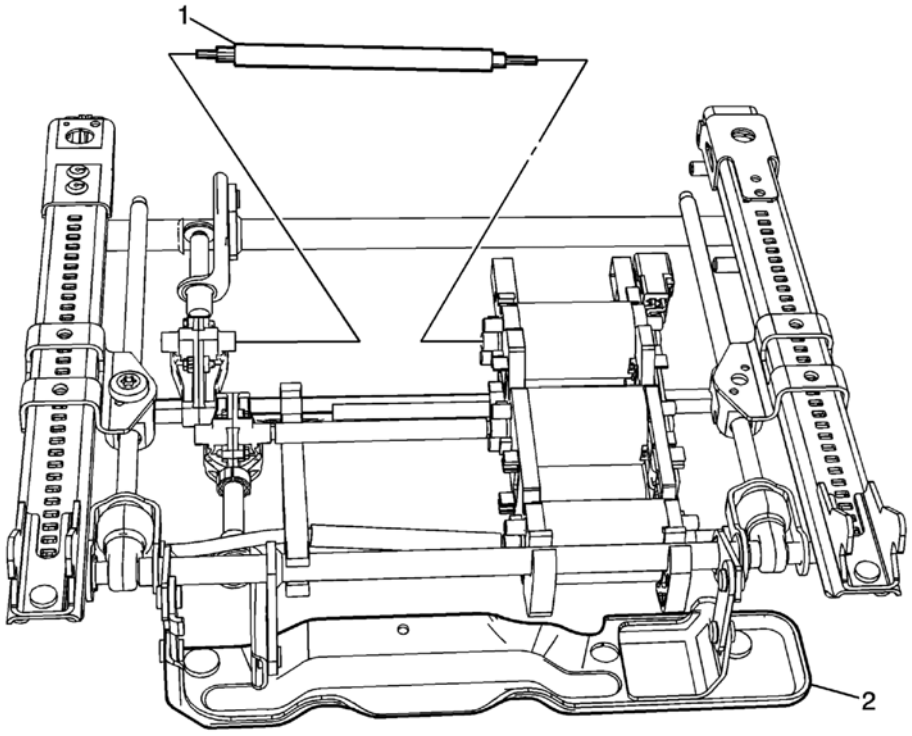


Fig. 12: Driver Seat Adjuster Horizontal Pinion Gear Shaft Replacement
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat adjuster. Refer to **Front Seat Adjuster Replacement**.	
1	Driver Seat Adjuster Horizontal Pinion Gear Shaft **TIP:** Remove the cable by pulling on the end of each side.
2	Driver Seat Adjuster Horizontal Pinion Gear Shaft **Procedure** Follow the steps below to reinstall the seat adjuster horizontal pinion gear shaft 1. Ensure both inboard and outboard tracks fully rearward position. 2. Reinstall seat adjuster horizontal pinion gear shaft cable 3. activated the motor ensure the adjuster is operating normal.

DRIVER OR PASSENGER SEAT CUSHION FRAME REPLACEMENT

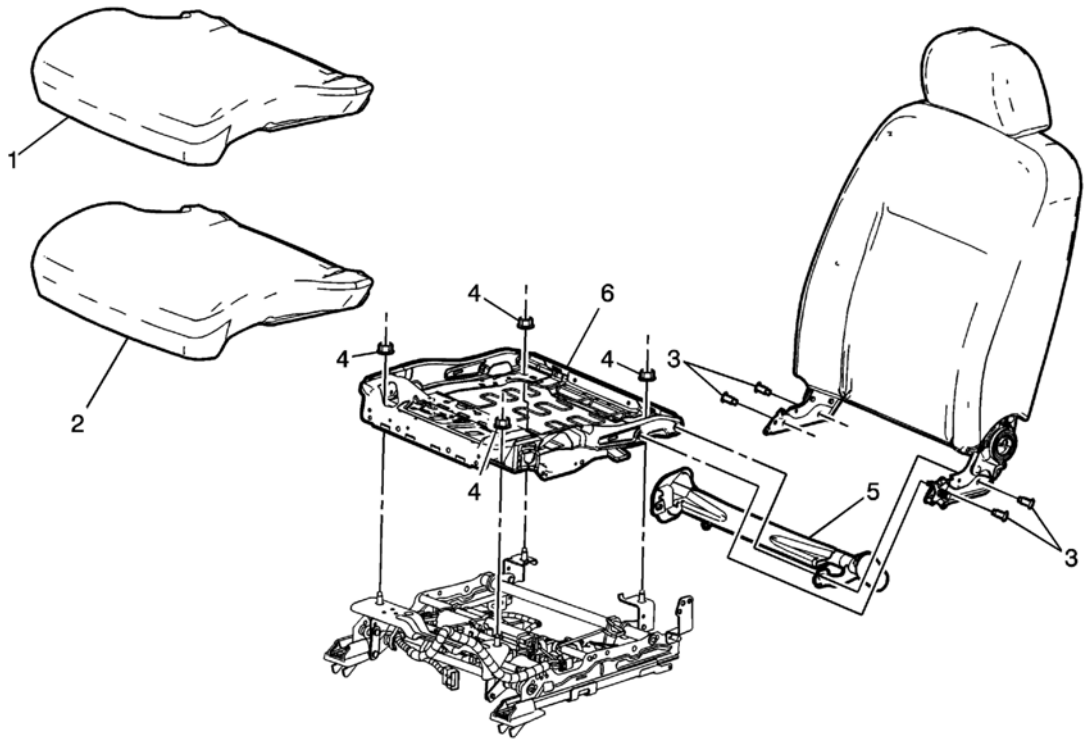


Fig. 13: Front Seat Cushion Frame
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)**. 2. Remove the lumbar actuator knob. Refer to **Lumbar Support Knob Replacement (Impala Limited)**. 3. Remove the recliner handle. Refer to **Front Seat Back Recliner Handle Replacement (Impala Limited)**. 4. Remove the power seat switch knob. Refer to **Driver or Passenger Seat Adjuster Switch Knob Replacement (Impala Limited)** . 5. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement**.	
1	Seat Cushion Cover Refer to **Front Seat Cushion Cover and Pad Replacement (Impala Limited)**.
2	Seat Cushion Pad Refer to **Front Seat Cushion Cover and Pad Replacement (Impala Limited)**.
3	Front Seat Cushion Frame Bolt (Qty: 4) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 45 N.m (33 lb ft)
4	Front Seat Cushion Frame Nut (Qty: 4) **Tighten** 9 N.m (80 lb in)
5	Seat Cushion Frame Rear Reinforcement
6	Front Seat Cushion Frame **Procedure** 1. Remove the heated seat module, if equipped. Refer to **Front Seat Heater Control Module Replacement (Impala Limited)** . 2. Remove the inflatable restraint passenger presence system if working on the passenger seat. Refer to **Inflatable Restraint Passenger Presence System Replacement - Front** . 3. Disconnect the wiring harness from the seat cushion. 4. Re-zero the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. Refer to **Passenger Presence System Programming and Setup** .

SEAT CUSHION OUTER TRIM PANEL REPLACEMENT

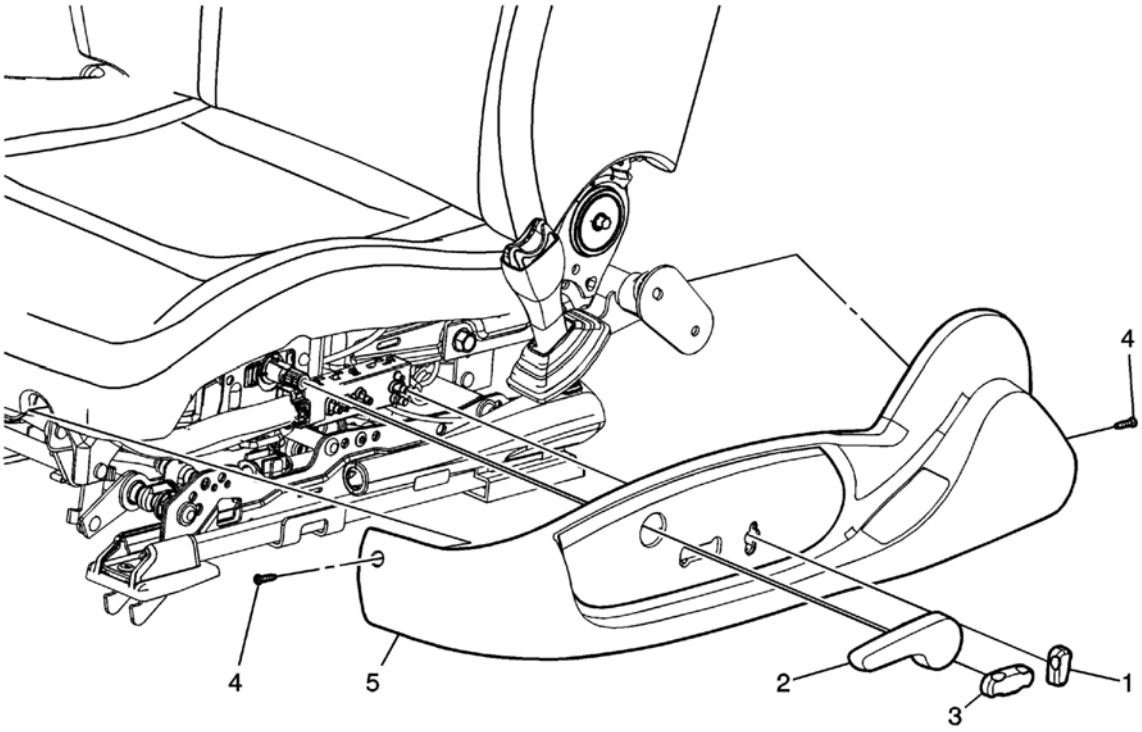


Fig. 14: Seat Cushion Outer Trim Panel & Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Recliner Knob (If equipped) **TIP:** Pull outward to remove.
2	Lumbar Actuator Handle (If equipped) **TIP:** Pull outward to remove.
3	Power Seat Switch Knob (If equipped) **TIP:** Pull outward to remove.
4	Seat Cushion Outer Trim Panel Screw (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
5	Seat Cushion Outer Trim Panel **Procedure** 1. Disconnect the electrical connector. 2. Remove the seat cushion outer trim panel by pulling it upward over the pretensioner

Callout	Component Name
	upper and lower boot. 3. If replacing the cover, transfer components as necessary.

FRONT SEAT CUSHION COVER AND PAD REPLACEMENT (IMPALA LIMITED)

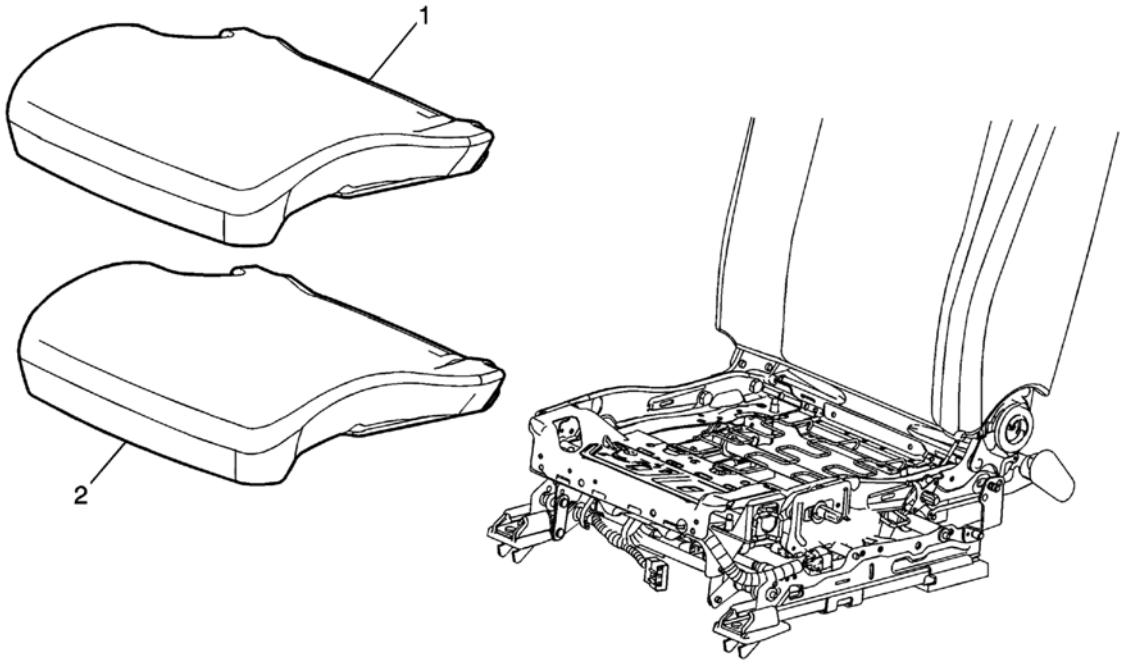


Fig. 15: Front Seat Cushion Cover And Pad (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the front seats. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)**. 2. Remove the front seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement**.	
1	Seat Cushion Cover **Procedure** 1. Release the j-channel from the seat cushion frame. 2. Disconnect the seat cushion heater electrical connector, if equipped. 3. Remove the seat cushion cover and pad as an assembly from the frame.

Callout	Component Name
2	Seat Cushion Pad **Procedure** 1. Remove the seat cushion pad from the cover by pulling away to release to hook and loop fasteners. 2. When working on the passenger seat re-zero the passenger presence system. Refer to **Control Module References** .

SEAT BACK COVER AND PAD REPLACEMENT (IMPALA LIMITED)

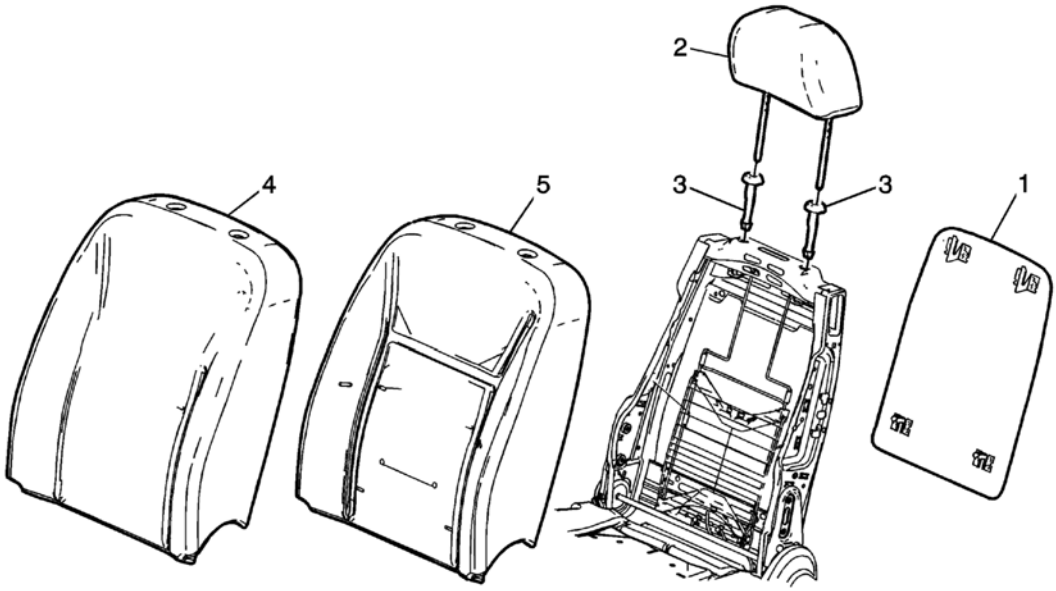


Fig. 16: Seat Back Cover And Pad (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)**. 2. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement**.	
1	Seat Back Cushion Finish Panel Refer to **Front Seat Back Cushion Finish Panel Replacement (Impala Limited)**.

Callout	Component Name
2	Front Seat Head Restraint Refer to **Driver or Passenger Seat Head Restraint Replacement (Impala Limited)**.
3	Front Seat Head Restraint Guides Refer to **Driver or Passenger Seat Head Restraint Guide Replacement (Impala Limited)**.
4	Seat Back Cushion Cover **Procedure** 1. Disconnect the j-channel from the seat back frame. 2. Remove the 2 lower push pin retainers that secures the cover to the frame. 3. Remove the pad and cover as an assembly.
5	Seat Back Cushion Pad **Procedure** 1. Remove the cover from the pad by pulling apart to release the hook and loop fasteners. 2. Disconnect the electrical connector, if equipped.

DRIVER OR PASSENGER SEAT BACK CUSHION PAD SUPPORT REPLACEMENT

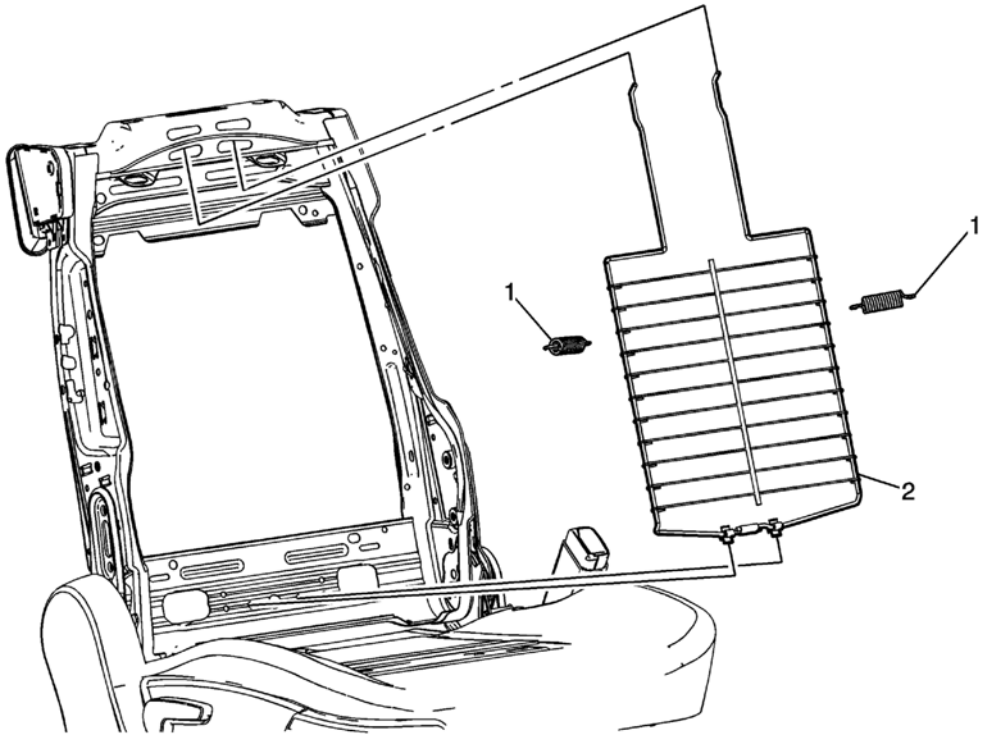


Fig. 17: Front Seat Lumbar Support Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the front seat back cushion cover and pad. Refer to **Seat Back Cover and Pad Replacement (Impala Limited)**.	
1	Front Seat Lumbar Spring (Qty: 2)
2	Front Seat Back Cushion Pad Support **Procedure** 1. Push the retainers at the bottom out of the seat back frame to release the bottom of the lumbar assembly. 2. Tilt and pull down and forward to remove the top portion of the lumbar assembly from the seat back frame.

DRIVER OR PASSENGER SEAT BACK CUSHION FRAME REPLACEMENT (IMPALA LIMITED)

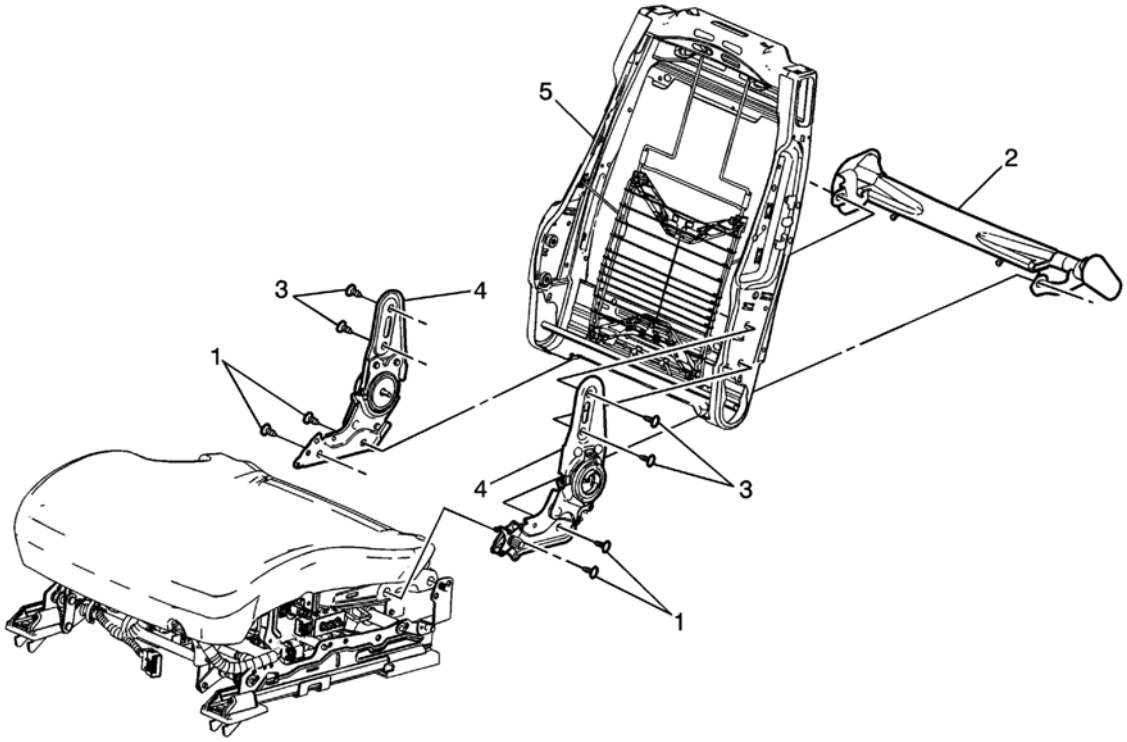


Fig. 18: Identifying Front Seat Back Frame (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)**. 2. Remove the lumbar actuator knob. Refer to **Lumbar Support Knob Replacement (Impala Limited)**.	

Callout	Component Name
3. Remove the recliner handle. Refer to **Front Seat Back Recliner Handle Replacement (Impala Limited)**. 4. Remove the power seat switch knob. Refer to **Driver or Passenger Seat Adjuster Switch Knob Replacement (Impala Limited)** . 5. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement**. 6. Remove the front seat back cushion cover and pad. Refer to **Seat Back Cover and Pad Replacement (Impala Limited)**. 7. Remove the lumbar assembly. Refer to **Driver or Passenger Seat Lumbar Support Replacement**.	
1	Front Seat Cushion Frame Bolt (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 45 N.m (33 lb ft)
2	Seat Cushion Frame Rear Reinforcement
3	Front Seat Back Cushion Frame Bolt (Qty: 4) **Tighten** 45 N.m (33 lb ft)
4	Seat Recliner Assembly
5	Seat Back Frame Assembly

DRIVER OR PASSENGER SEAT RECLINER REPLACEMENT (IMPALA LIMITED)

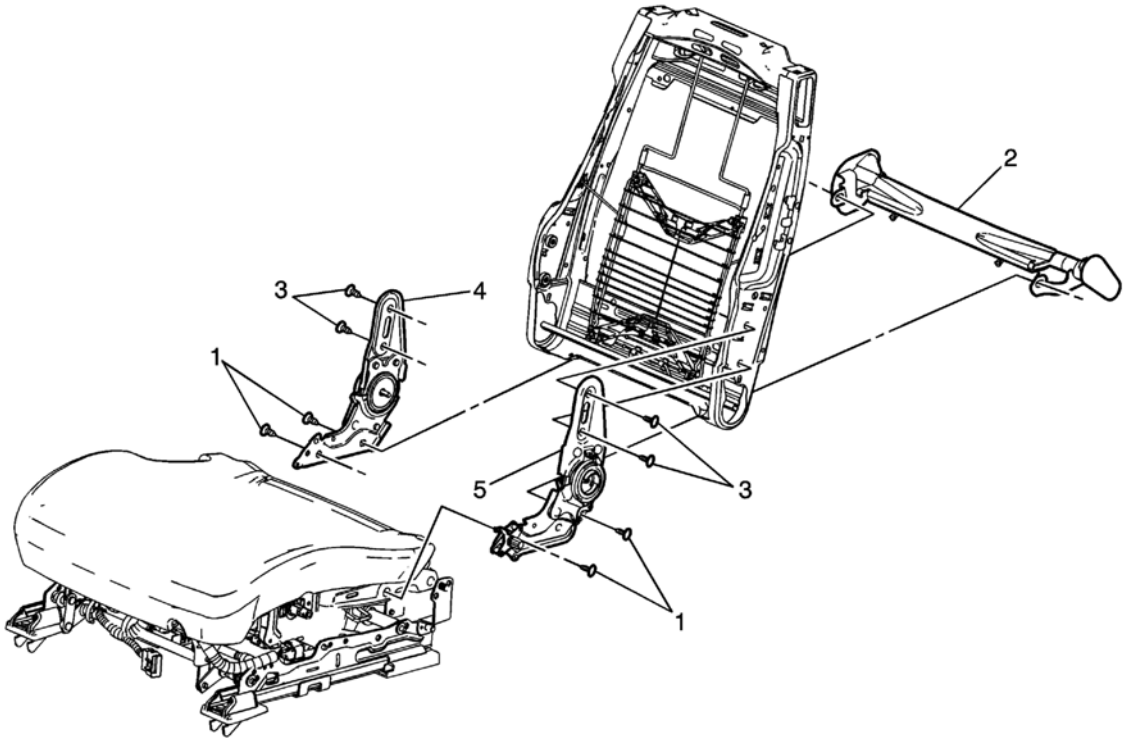


Fig. 19: Seat Back Recliner (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)**. 2. Remove the lumbar actuator knob. Refer to **Lumbar Support Knob Replacement (Impala Limited)**. 3. Remove the recliner handle. Refer to **Front Seat Back Recliner Handle Replacement (Impala Limited)**. 4. Remove the power seat switch knob. Refer to **Driver or Passenger Seat Adjuster Switch Knob Replacement (Impala Limited)** . 5. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement**. 6. Remove the front seat back cushion cover and pad. Refer to **Seat Back Cover and Pad Replacement (Impala Limited)**. 7. Remove the lumbar assembly. Refer to **Driver or Passenger Seat Lumbar Support Replacement**.	
1	Front Seat Cushion Frame Bolt (Qty: 4) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 45 N.m (33 lb ft)
2	Seat Cushion Frame Rear Reinforcement
3	Front Seat Back Cushion Frame Bolt (Qty: 4) **Tighten** 45 N.m (33 lb ft)
4	Seat Inner Recliner Assembly
5	Seat Outer Recliner Assembly

FRONT SEAT BACK RECLINER HANDLE REPLACEMENT (IMPALA LIMITED)

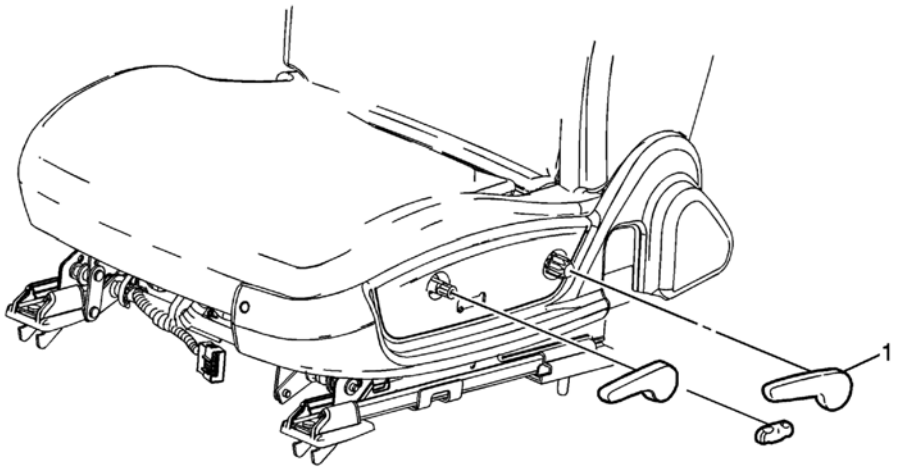


Fig. 20: Front Seat Back Recliner Handle (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to Fastener Specifications.	
1	Handle, Recliner **TIP:** Using a flat-bladed tool, push the retainer clip downward and pull outward to release the handle.

FRONT SEAT BACK CUSHION FINISH PANEL REPLACEMENT (IMPALA LIMITED)

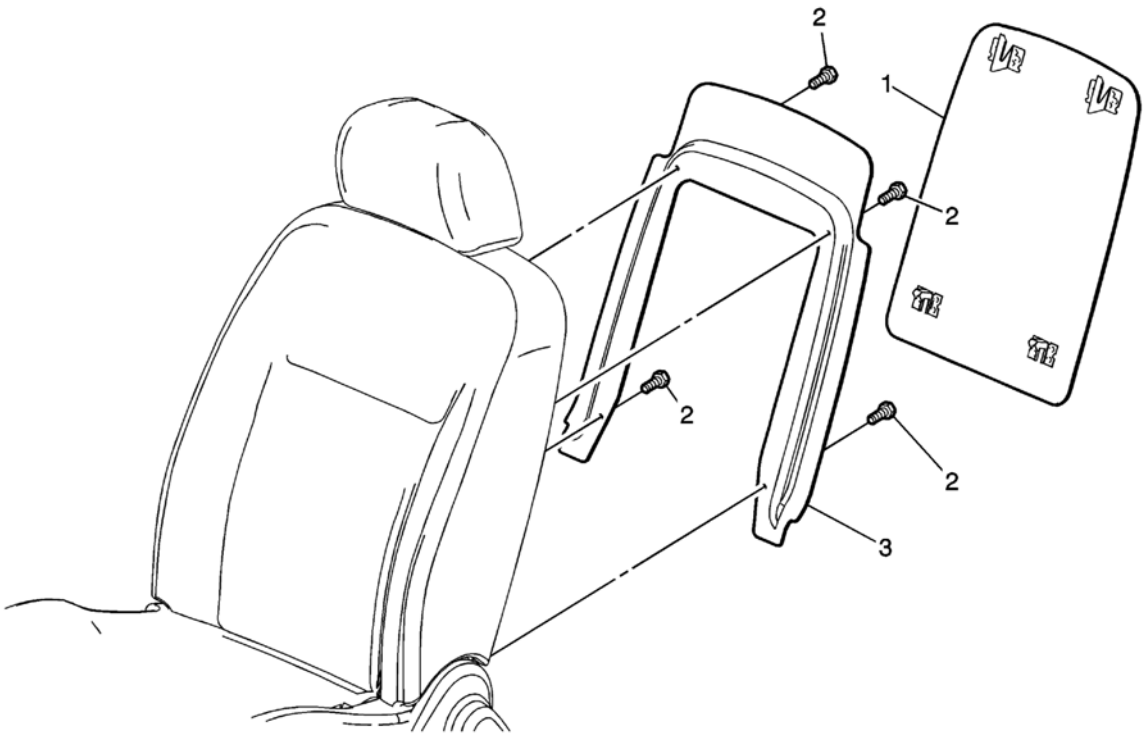


Fig. 21: Front Seat Back Panel (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Back Cushion Finish Panel **Procedure** Pull up on the bottom of the panel while bowing the panel outward in the center, and when the panel disengages then pull rearward.
2	Seat Back Cushion Rear Finish Retainer (Qty: 4) **Procedure** Release the rear seat back cover j-channel retainers and reposition the cover to gain access to the retainers.
3	Seat Back Cushion Rear Finish Panel

DRIVER OR PASSENGER SEAT LUMBAR SUPPORT REPLACEMENT

Removal Procedure

1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)**.
2. Remove the front seat back cover and pad. Refer to **Seat Back Cover and Pad Replacement (Impala Limited)**.
3. Remove the front seat cushion cover and pad. Refer to **Front Seat Cushion Cover and Pad Replacement (Impala Limited)**.

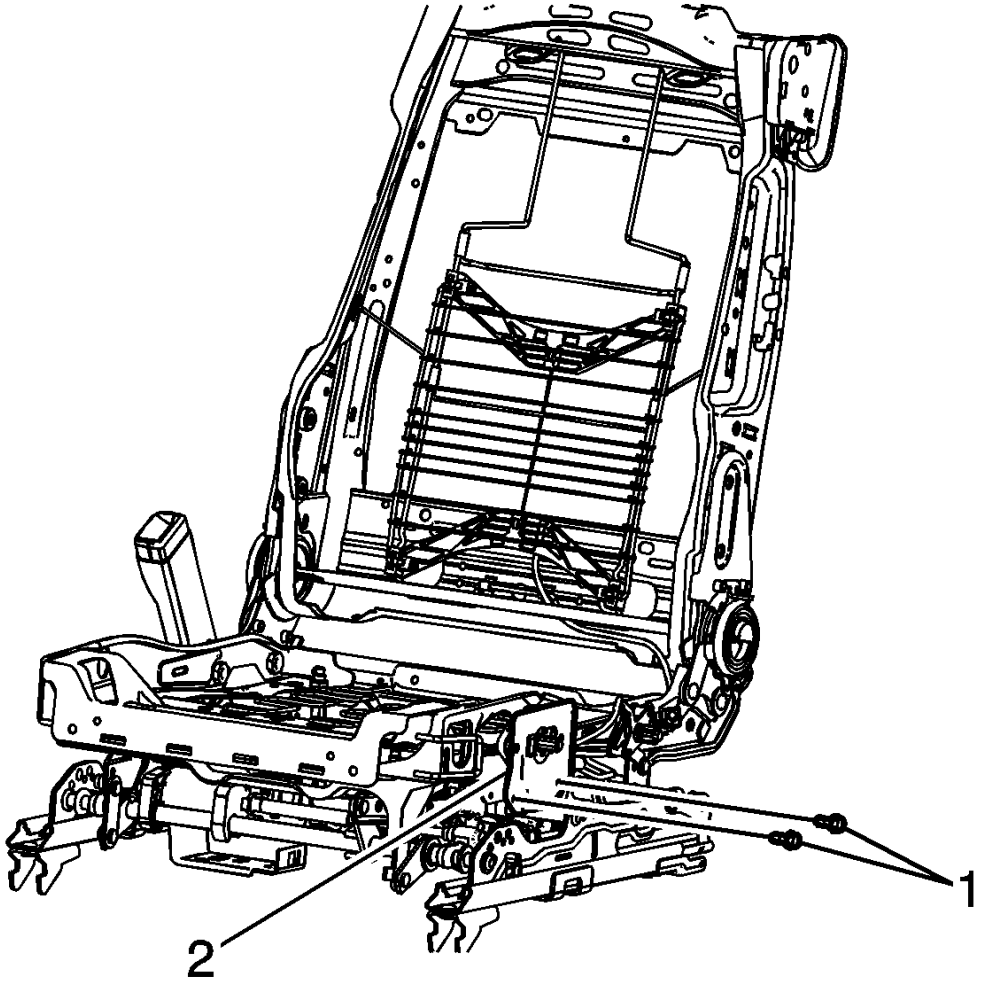


Fig. 22: Identifying Lumbar Support Actuator Retaining Screws
Courtesy of GENERAL MOTORS COMPANY

4. Remove the screws (1) that retain the lumbar actuator to the seat cushion pan.

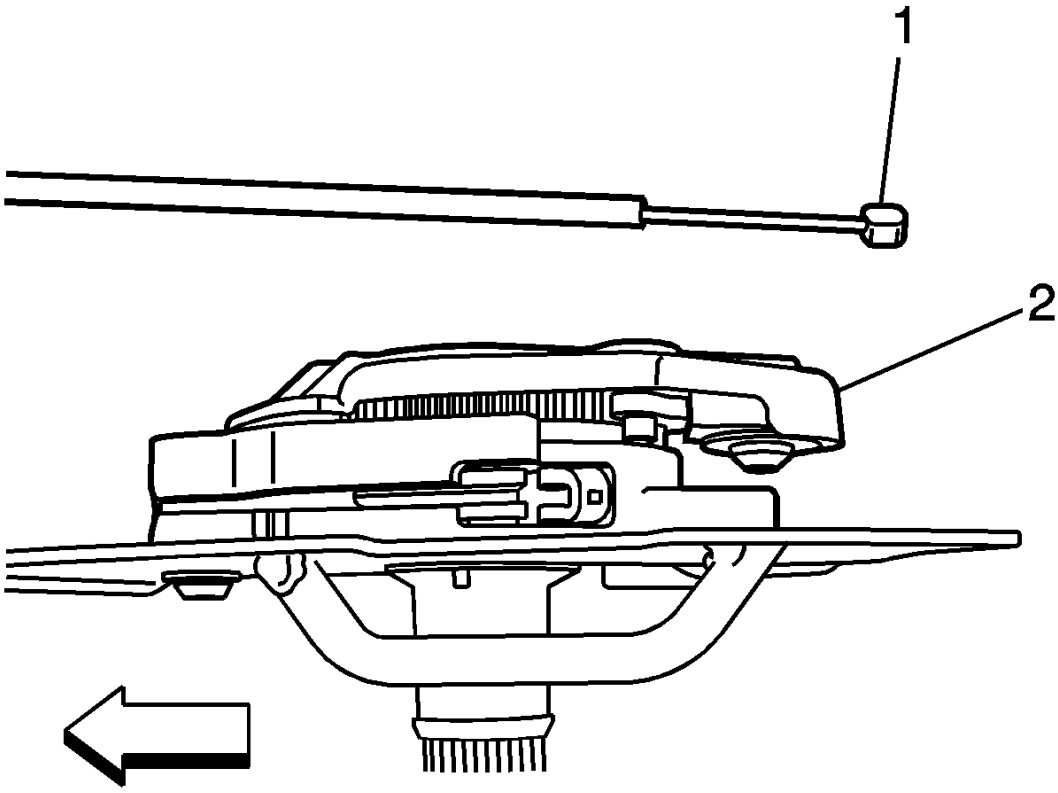


Fig. 23: Identifying Lumbar Cable & Lumbar Actuator
Courtesy of GENERAL MOTORS COMPANY

5. Move the lumbar actuator away from the seat far enough to disconnect the lumbar cable (1) from the actuator (2).

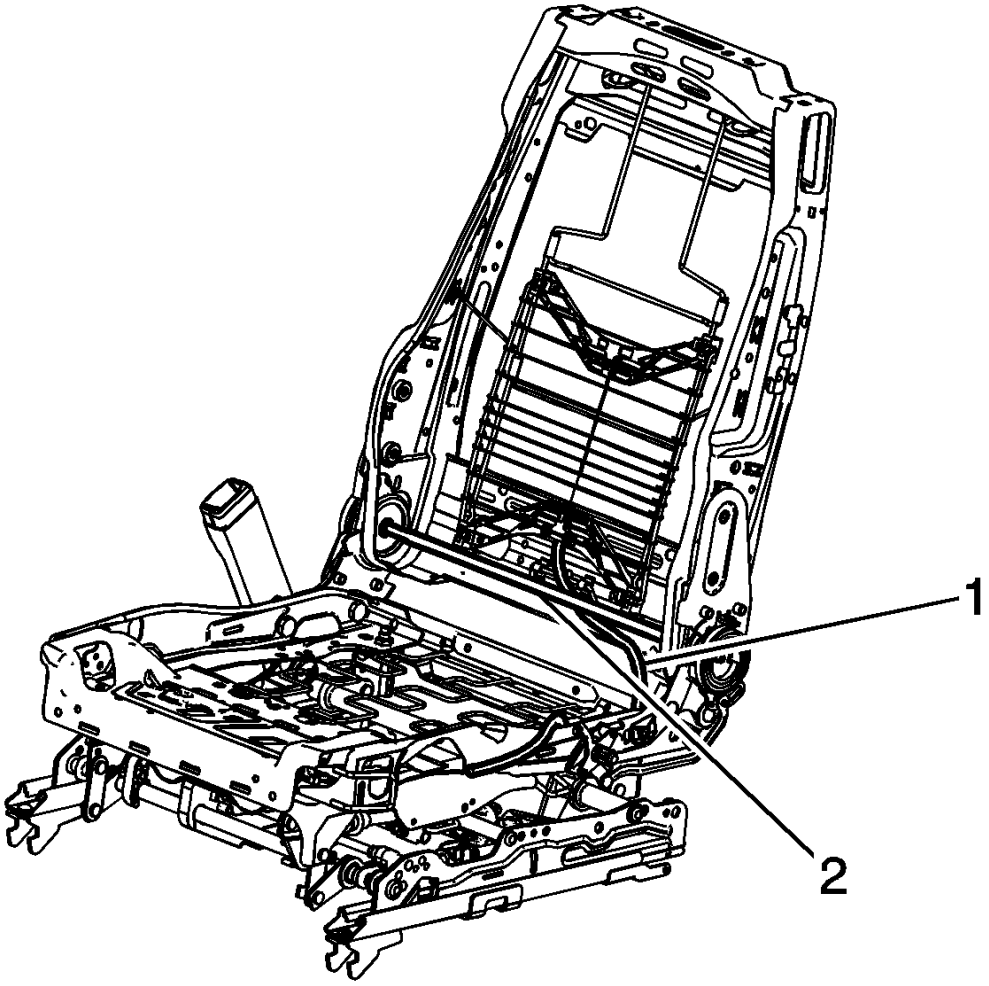


Fig. 24: Locating Lumbar Support Cable & Recliner Rod
Courtesy of GENERAL MOTORS COMPANY

6. Note the routing of the cable for installation purposes, the cable (1) must route between the recliner rod (2) and the seat back frame.

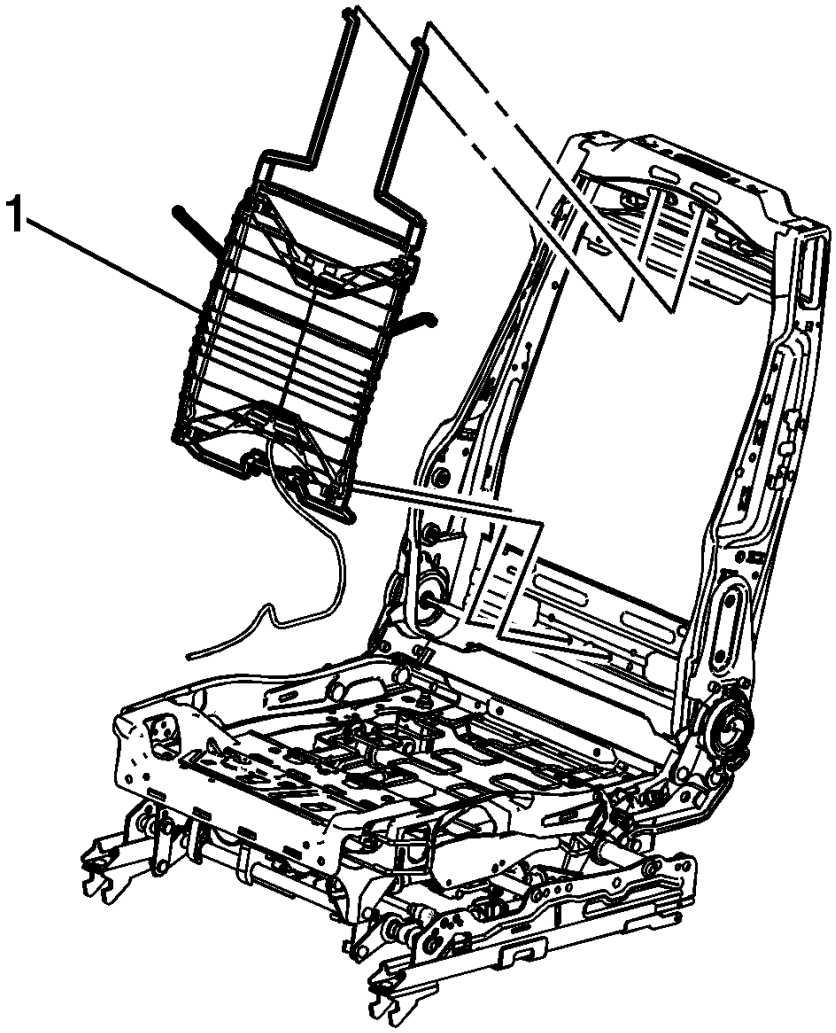


Fig. 25: View Of Lumbar Support Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Remove the lumbar assembly (1) from the seat back frame by doing the following:
    - Disconnect the lumbar assembly (1) from each side of the seat back frame.
    - Pull the bottom of the lumbar assembly (1) forward to disengage the retainers from the seat back frame.
    - Slide the lumbar assembly (1) downward and forward to release from the seat back frame.

Installation Procedure

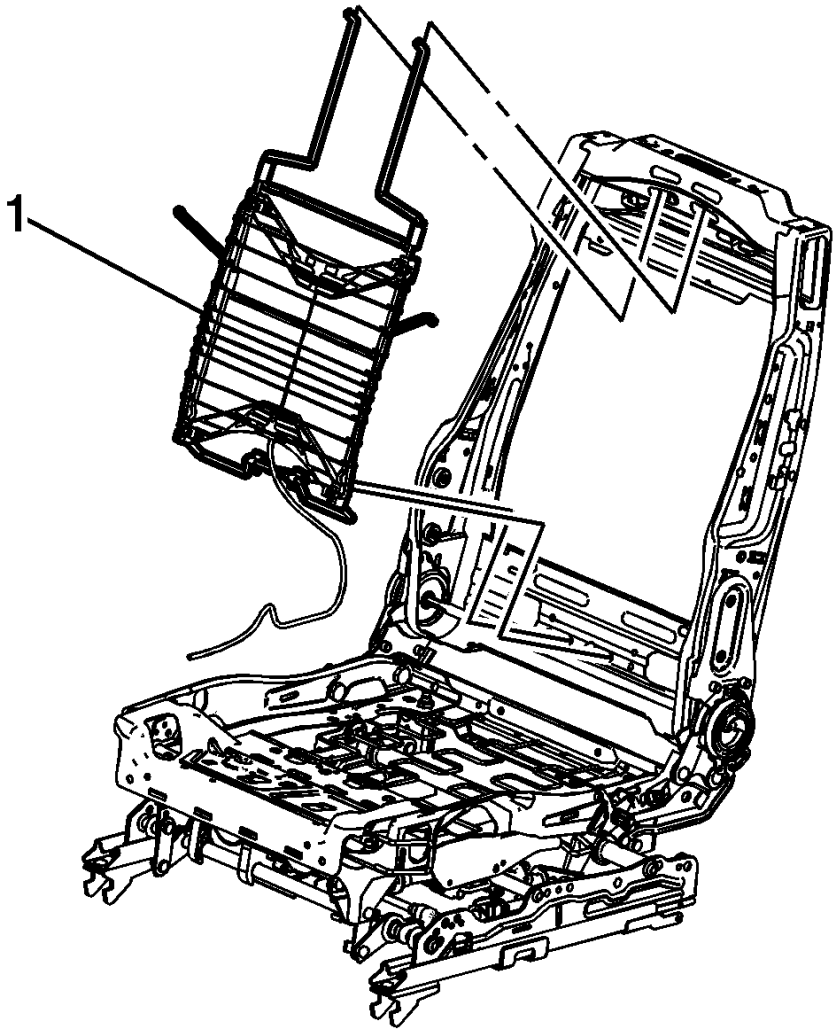


Fig. 26: View Of Lumbar Support Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the lumbar assembly (1) to the front seat back frame by doing the following:
    - Insert the top of the lumbar assembly (1) into the upper locations on the seat back frame.
    - Secure the lower portion of the lumbar assembly (1) by pushing the retainers firmly into the seat back frame.
    - Attach the sides of the lumbar assembly (1) to the sides of the seat back frame.

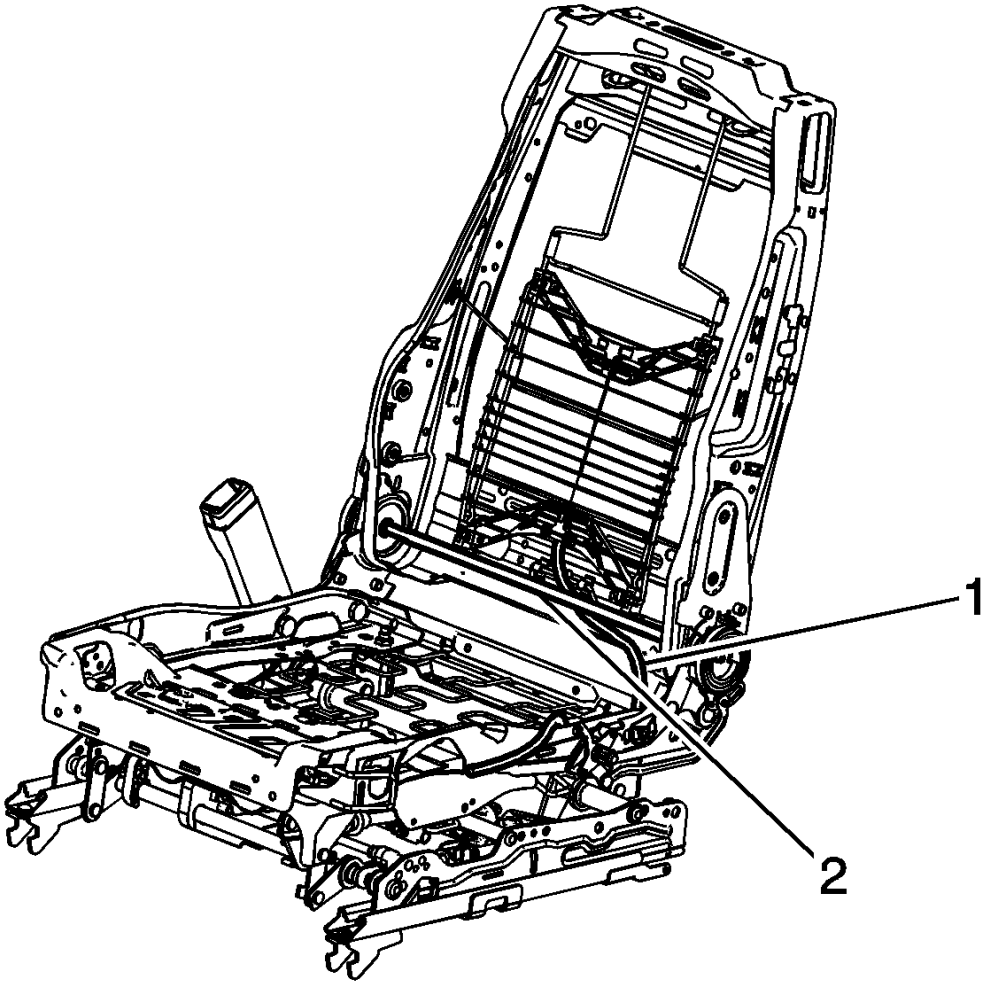


Fig. 27: Locating Lumbar Support Cable & Recliner Rod
Courtesy of GENERAL MOTORS COMPANY

2. Route the lumbar cable (1) between the front seat back frame and the recliner rod (2).

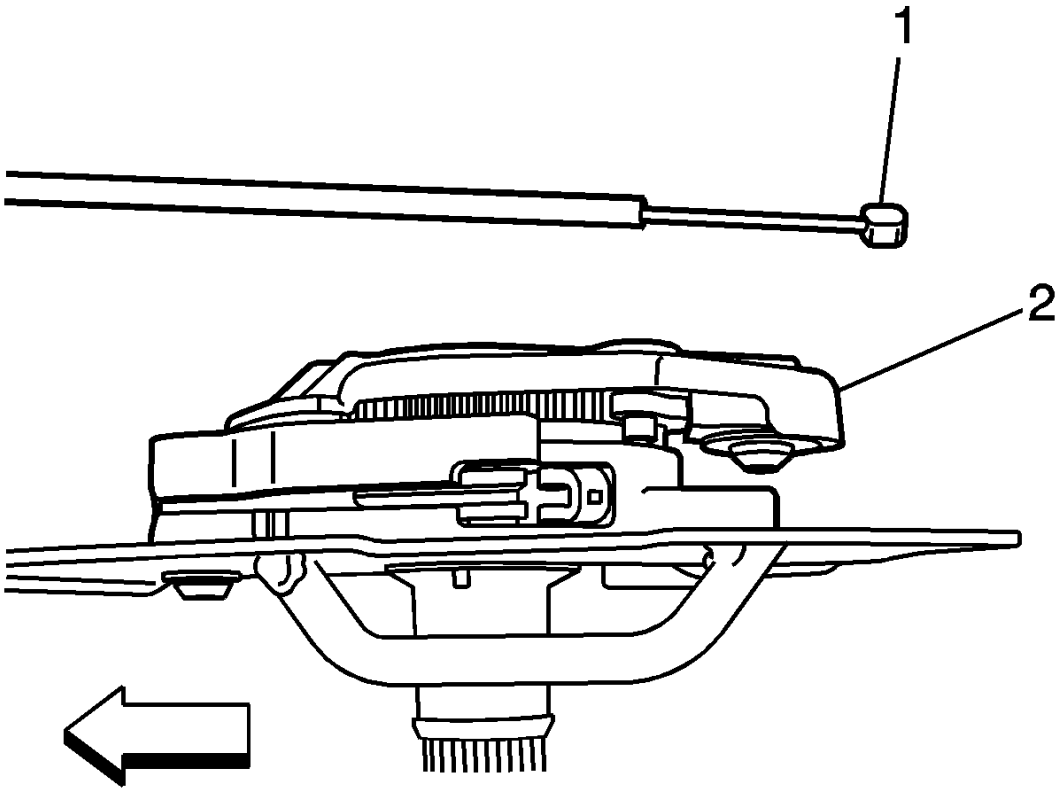


Fig. 28: Identifying Lumbar Cable & Lumbar Actuator
Courtesy of GENERAL MOTORS COMPANY

3. Connect the lumbar cable (1) to the lumbar actuator (2).

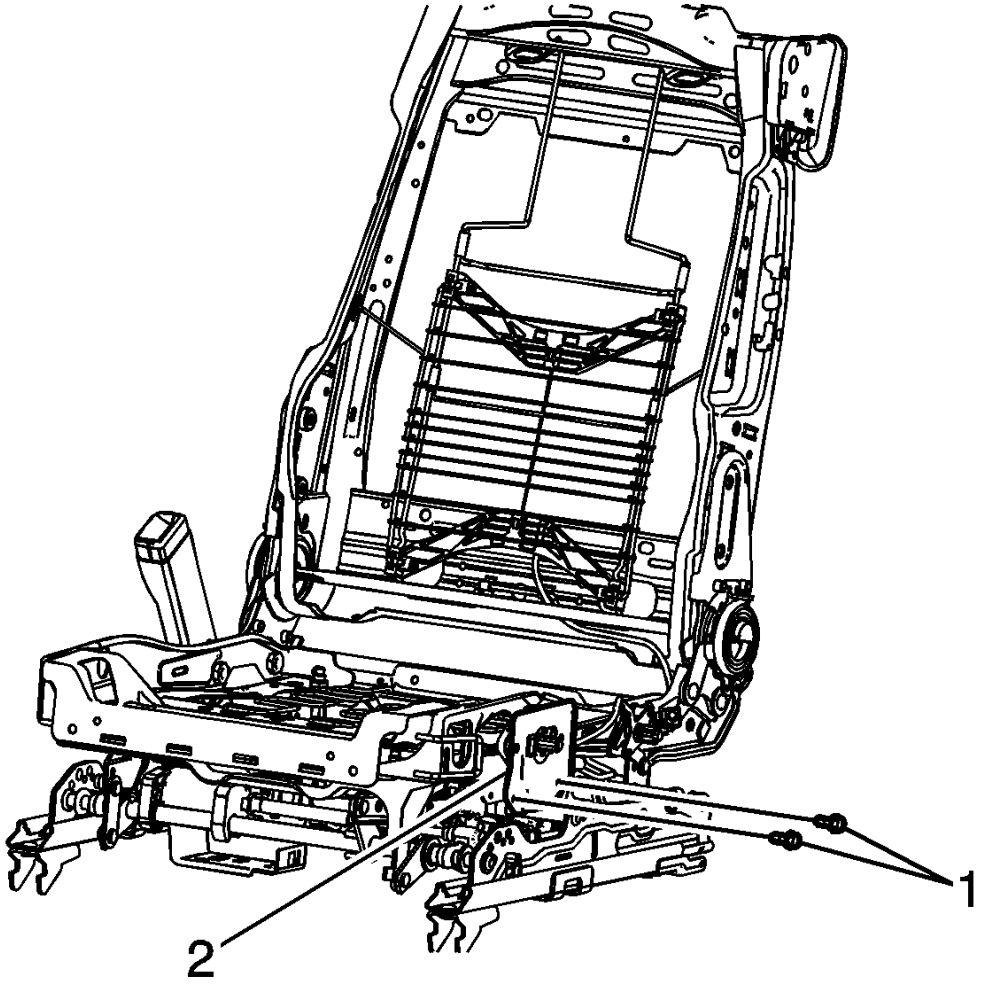


Fig. 29: Identifying Lumbar Support Actuator Retaining Screws
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Position the lumbar actuator to the seat cushion frame and install the 2 screws that secure the lumbar actuator to the seat cushion frame.

   Tighten

   Tighten the bolts to 6 N.m (53 lb in).

5. Install the seat cushion cover and pad. Refer to **Front Seat Cushion Cover and Pad Replacement (Impala Limited)**.
6. Install the seat back cushion cover and pad. Refer to **Seat Back Cover and Pad Replacement (Impala Limited)**.
7. Install the front seat to the vehicle. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)**.

LUMBAR SUPPORT KNOB REPLACEMENT (IMPALA LIMITED)

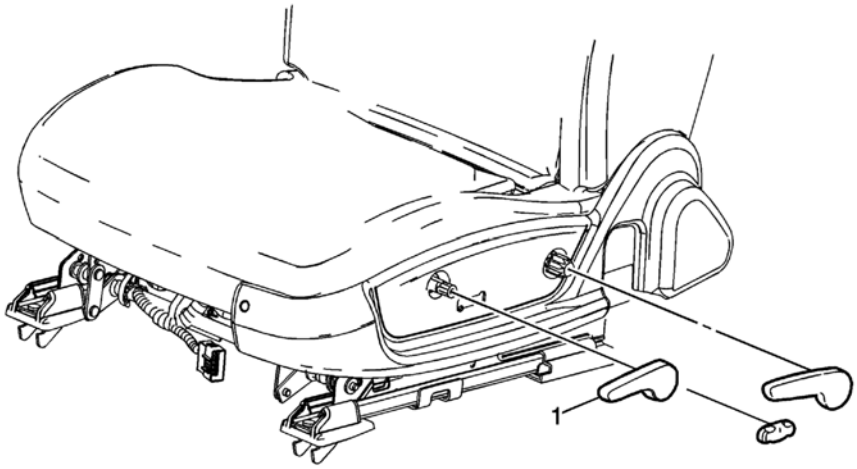


Fig. 30: Lumbar Support Knob (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Knob, Lumbar Actuator **TIP:** Pull outward to remove.

REAR SEAT ARMREST REPLACEMENT (IMPALA LIMITED W/AM9)

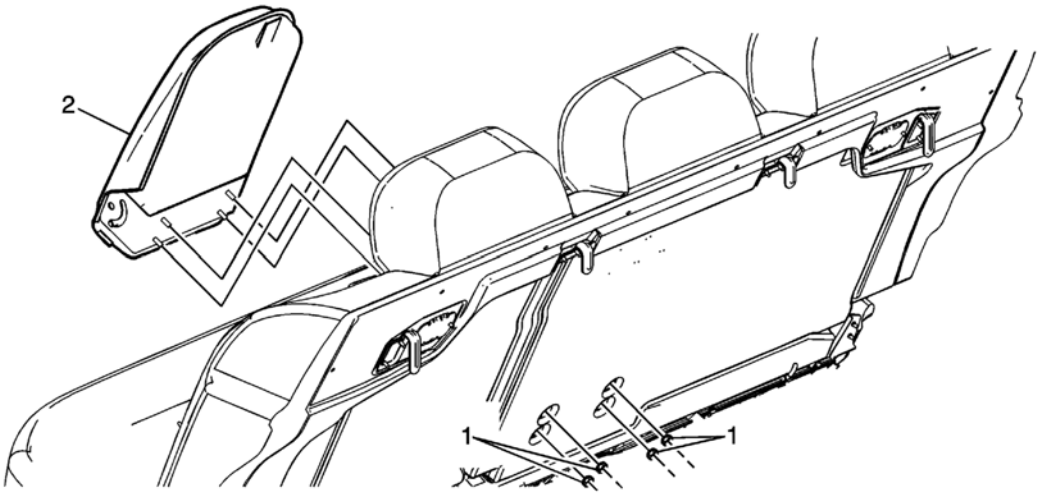


Fig. 31: Rear Seat Armrest (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Seat Armrest Nut (Qty: 4) **CAUTION:** **Refer to** **Fastener** **Caution .**

Callout	Component Name
	Procedure 1. Fold the rear seat back cushion forward to gain access to the nuts. 2. Release J-Channel at bottom of seat-back Trim Cover and fold cover open to gain access to the nuts. **TIP:** Armrest is only serviced as an assembly. **Tighten** 3 N.m (25 lb in)
2	Rear Seat Armrest Assembly

REAR SEAT PULL STRAP REPLACEMENT

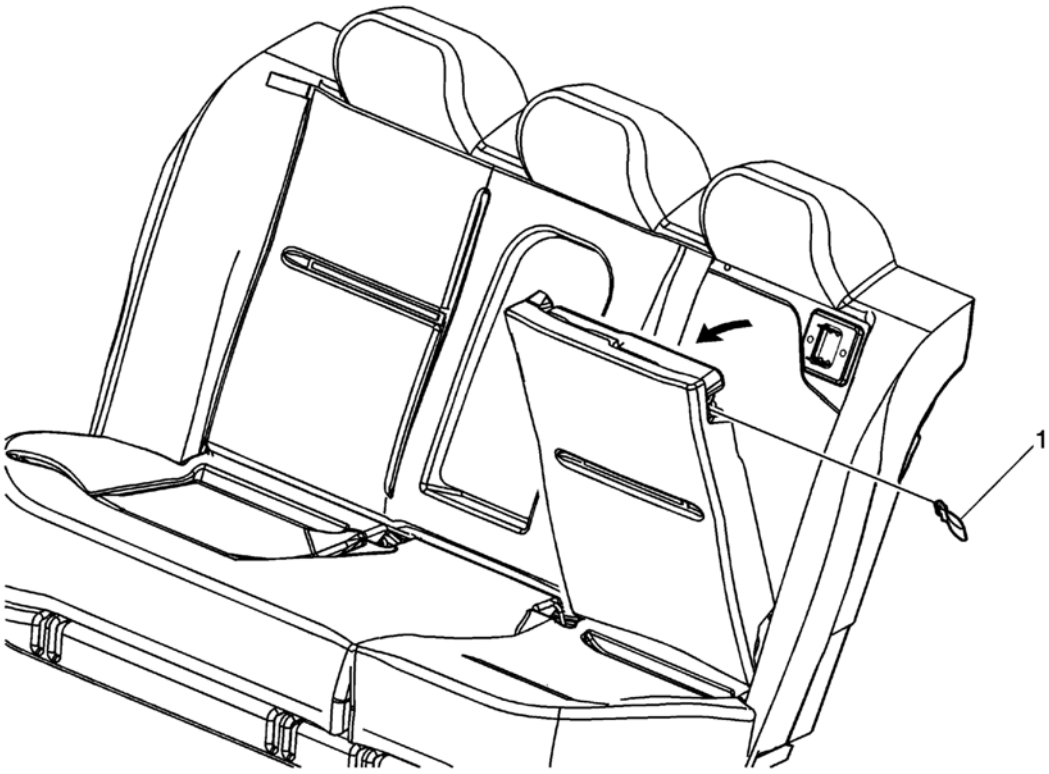


Fig. 32: Rear Seat Pull Strap
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Seat Pull Strap **Procedure** Lay the seat back down before removing the pull strap from the latch.

REAR SEAT HINGE BRACKET REPLACEMENT (REAR SPLIT FOLDING)

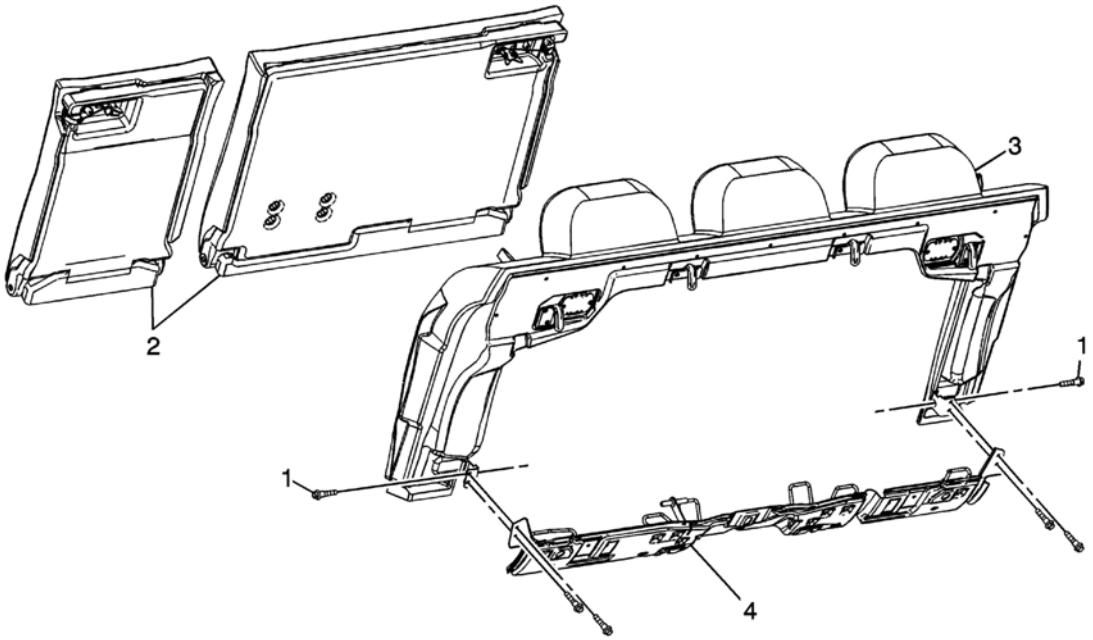


Fig. 33: Identifying Rear Seat Hinge Bracket (Rear Split Folding)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear seat back cushion. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)**.	
1	Rear Seat Back Cushion Pivot Support Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 15 N.m (11 lb ft)
2	Rear Seat Back Cushion Assembly (Qty: 2) **TIP:** Tilt and slide outward to remove the rear seat back cushion assembly from the rear seat back hinge.
3	Rear Seat Back Hinge Bolt (Qty: 4) **Tighten** 15 N.m (11 lb ft)
4	Rear Seat Back Cushion Hinge Bracket

REAR SEAT CUSHION COVER AND PAD REPLACEMENT (IMPALA LIMITED)

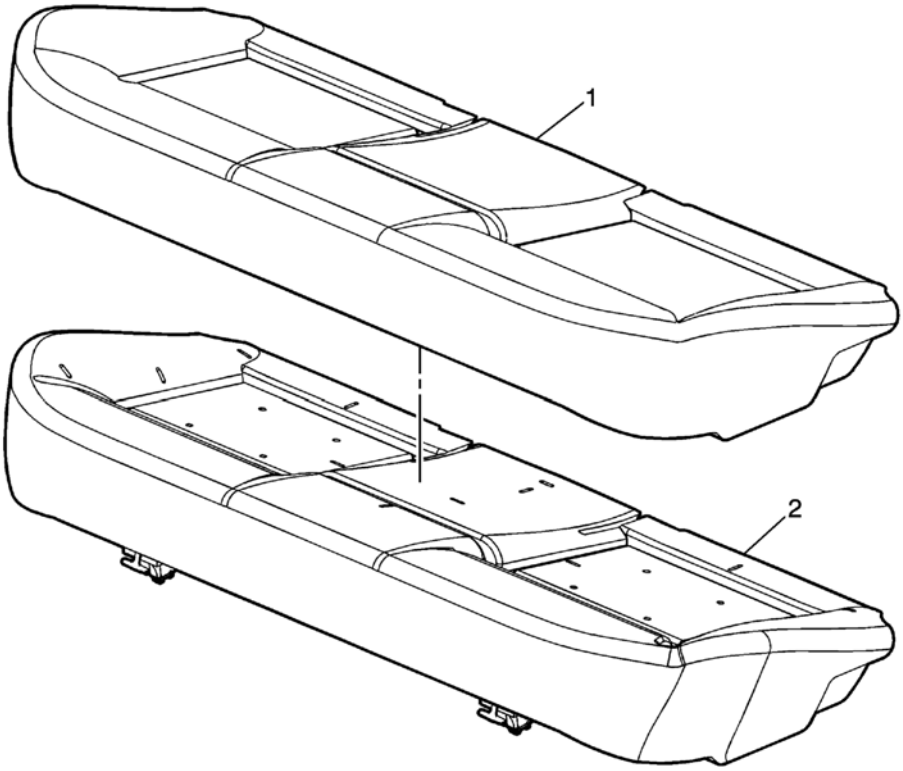


Fig. 34: Rear Seat Cushion Cover And Pad (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)**.	
1	Rear Seat Cushion Cover **TIP:** The cushion cover and pad are serviced as an assembly.
2	Rear Seat Cushion Pad

REAR SEAT CUSHION COVER AND PAD REPLACEMENT (IMPALA LIMITED W/AM9)

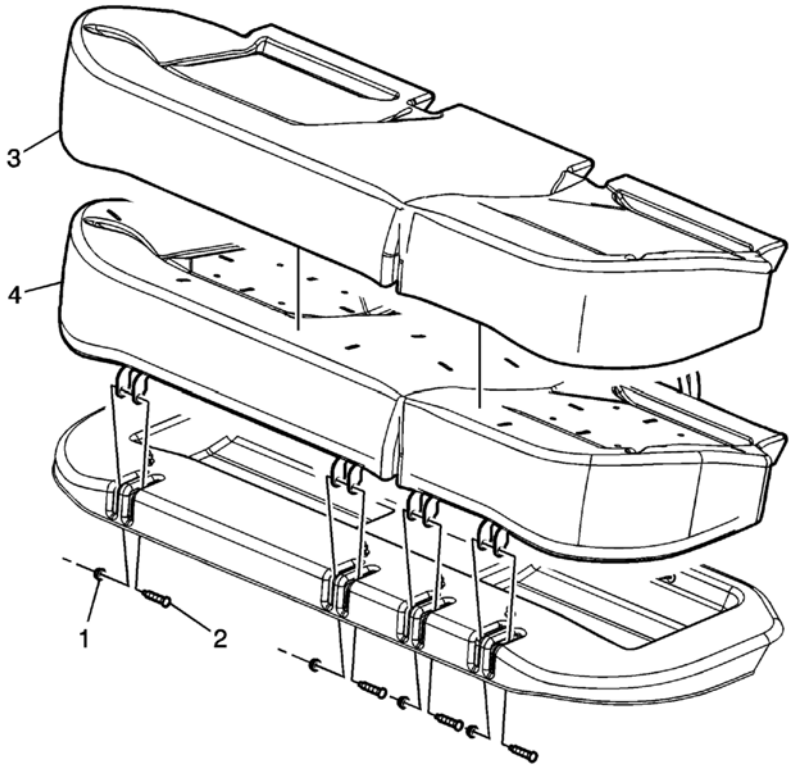


Fig. 35: Rear Seat Cushion Cover and Pad (Impala Limited w/AM9)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedures** Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)**.	
1	Rear Seat Cushion Compartment Tray Nut (Qty 4) **Procedure** With the seat assembly on bench (up-side down), remove the nuts on the underside of the compartment tray at the cushion hinge locations.
2	Rear Seat Cushion Compartment Tray Hinge Pin (Qty 4) **Procedure** Gently tap the hinge pins outward until the cushion assembly is free of the stowage compartment.
3	Rear Seat Cushion Cover
4	Rear Seat Cushion Pad **TIP:** The cushion cover and pad are serviced as an assembly.

REAR SEAT CUSHION FLOOR STOWAGE COMPARTMENT REPLACEMENT (IMPALA LIMITED W/AM9)

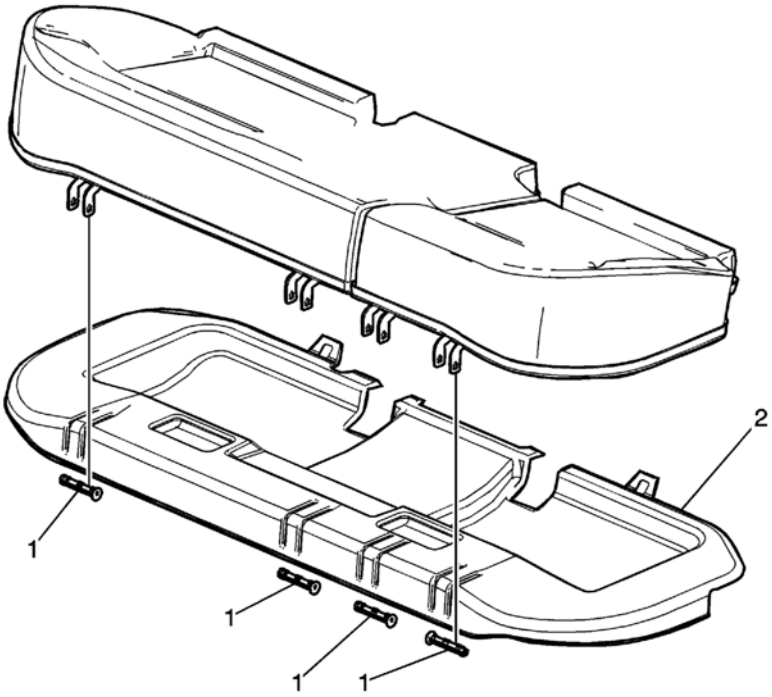


Fig. 36: Rear Seat Cushion Floor Stowage Compartment (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)** 2. Remove the rear seat cushion cover and pad. Refer to **Rear Seat Cushion Cover and Pad Replacement (Impala Limited)Rear Seat Cushion Cover and Pad Replacement (Impala Limited w/AM9)**	
1	Rear Seat Cushion Hinge Pin (Qty: 4)
2	Rear Seat Cushion Floor Stowage Compartment **TIP:** Floor stowage compartment is only serviced as an assembly.

REAR SEAT CUSHION REMOVAL AND INSTALLATION (IMPALA LIMITED)

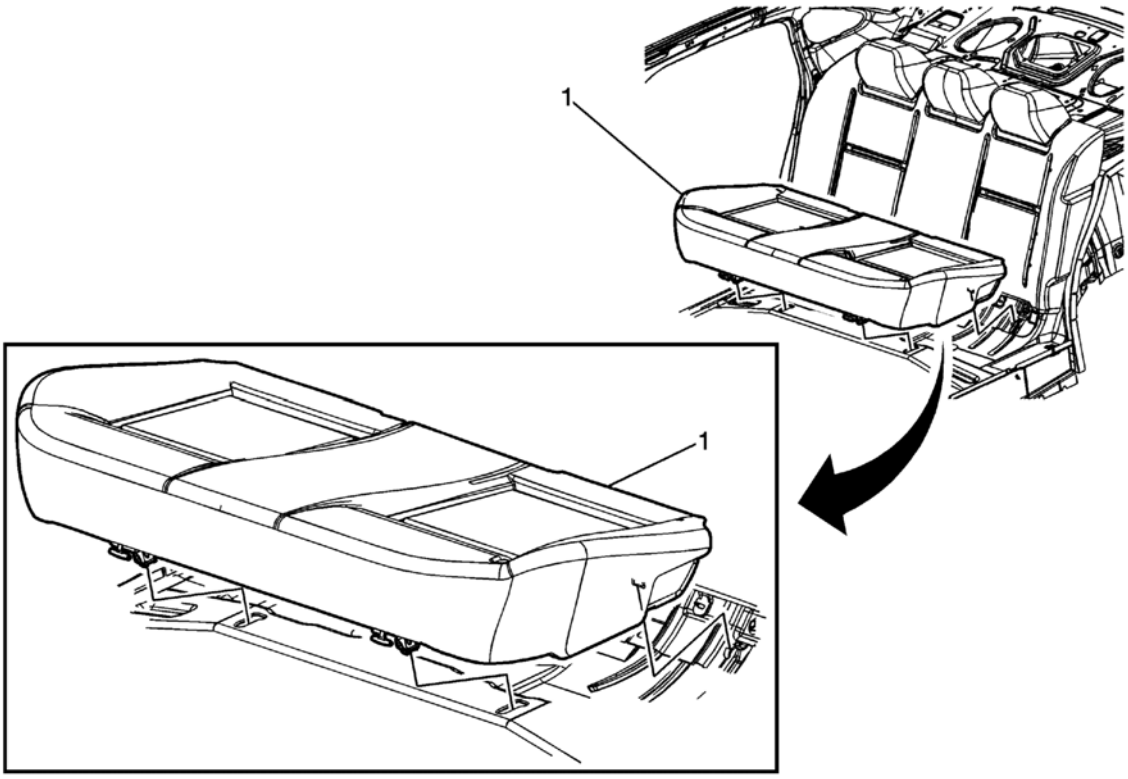


Fig. 37: Identifying Rear Seat Cushion (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Seat Cushion Assembly **Procedure** 1. Reach under the seat cushion and locate both the left and the right "T" handles. 2. Press down on the seat and pull the handles to release the seat retainer. 3. Remove the seat cushion by lifting the cushion up and pulling the cushion outward from the seat back. **TIP:** The handles are hidden from view by the floor stowage compartment for the flip folding seat.

REAR SEAT BACK CUSHION REMOVAL AND INSTALLATION (IMPALA LIMITED)

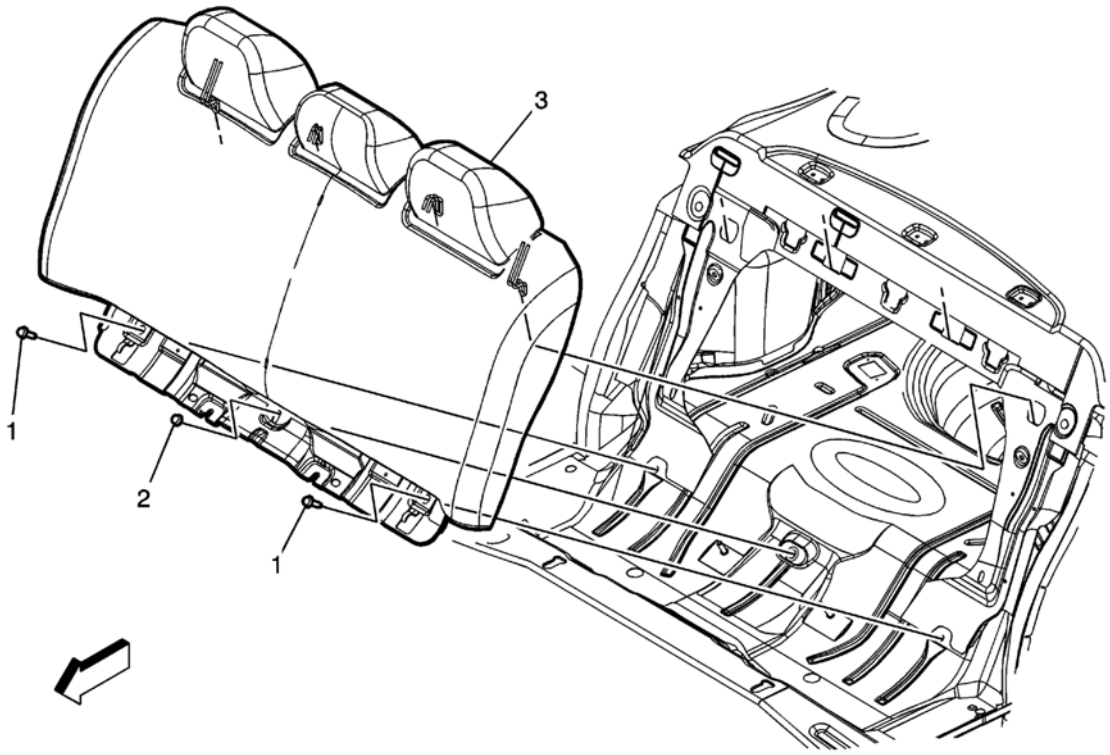


Fig. 38: Rear Seat Back (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the seat belt buckles. Refer to **Rear Seat Buckle Side Belt Replacement (Impala Limited without AM9)** **Rear Seat Buckle Side Belt Replacement (Impala Limited with AM9)** . 2. Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)**.	
1	Rear Seat Back Cushion Bolts (Qty: 3) **CAUTION:** **Refer to** **Fastener Caution** **.** **Tighten** 45 N.m (33 lb ft)
2	Rear Seat Back Cushion Nut **Tighten** 45 N.m (33 lb ft)
3	Rear Seat Back Cushion • Lift upward to clear the retaining hooks on the seat back to remove.

Callout	Component Name
	• The removal and installation for the standard and the split bench seat are the same.

REAR SEAT BACK CUSHION OPENING TRIM COVER AND OUTER COVER PAD REPLACEMENT (REAR SPLIT FOLDING)

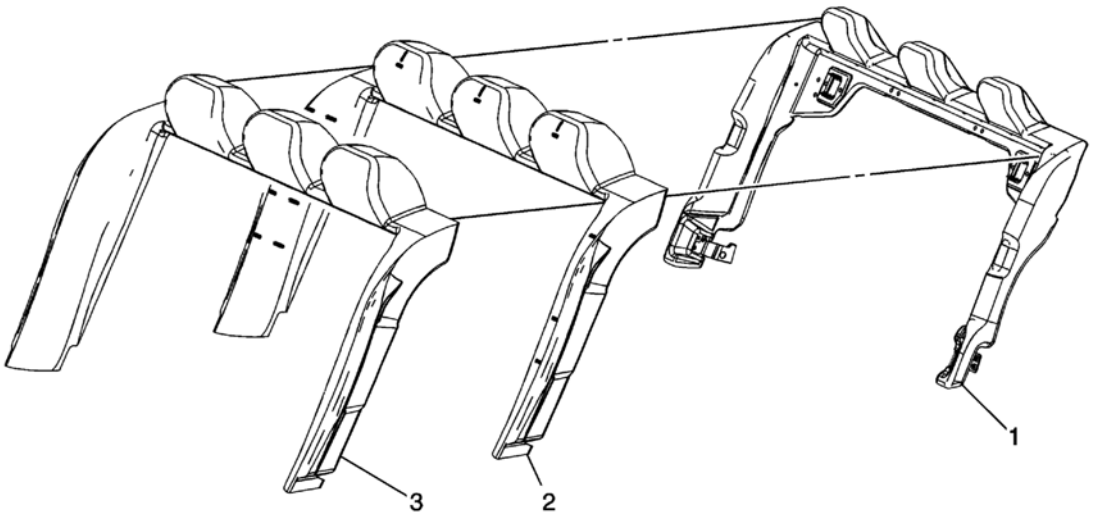


Fig. 39: Rear Seat Back Cushion Opening Trim Cover and Outer Cover Pad (Rear Split Folding)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Seat Back Cushion Opening Panel Refer to **Rear Seat Back Cushion Opening Panel Replacement**.
2	Rear Seat Back Cushion Opening Trim Cover
3	Rear Seat Back Cushion Outer Cover Pad

REAR SEAT BACK CUSHION PANEL REPLACEMENT (REAR SPLIT FOLDING)

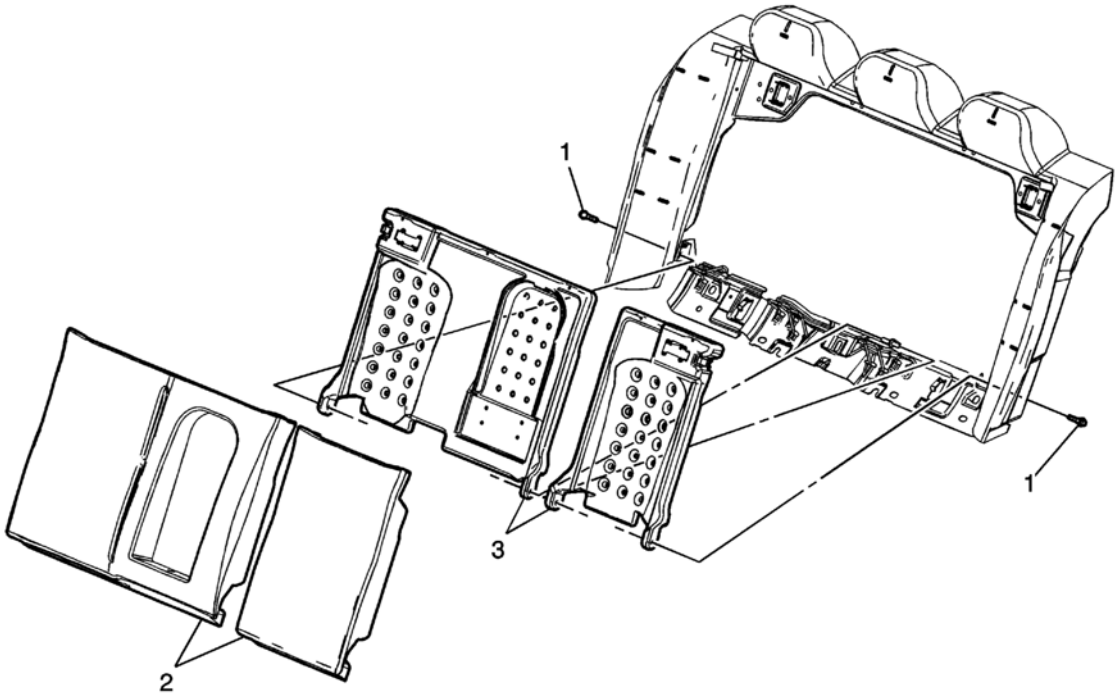


Fig. 40: Identifying Rear Seat Back Cushion Panel (Rear Split Folding)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the rear seat back cushion. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)**. 2. Remove the rear seat armrest. Refer to **Rear Seat Armrest Replacement (Impala Limited w/AM9)**.	
1	Rear Seat Back Cushion Pivot Support Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 15 N.m (11 lb ft)
2	Rear Seat Back Cushion Cover **TIP:** Remove the seat back cover by disengaging the retainers securing the cover to the seat back cushion panel.
3	Rear Seat Back Cushion Panel

REAR SEAT BACK CUSHION OPENING PANEL REPLACEMENT

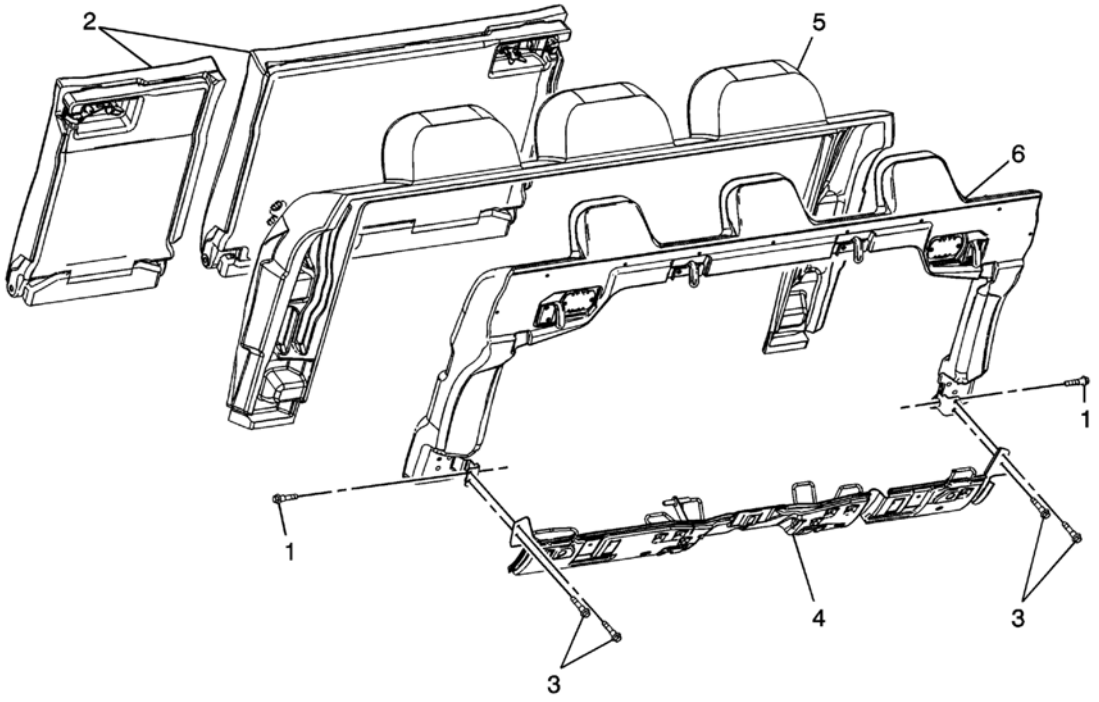


Fig. 41: Rear Seat Back Cushion Opening Panel & Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear seat back cushion. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)**.	
1	Rear Seat Back Cushion Pivot Support Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 15 N.m (11 lb ft)
2	Rear Seat Back Cushion Assembly (Qty: 2) **TIP:** Tilt and slide outward to remove the rear seat back cushion assembly from the rear seat back hinge.
3	Rear Seat Back Hinge Bolt (Qty: 4) **Tighten** 15 N.m (11 lb ft)
4	Rear Seat Back Cushion Hinge Bracket
5	Rear Seat Back Cushion Opening Trim Cover and Pad
6	Rear Seat Back Cushion Opening Panel

REAR SPLIT FOLDING SEAT BACK CUSHION COVER AND PAD REPLACEMENT

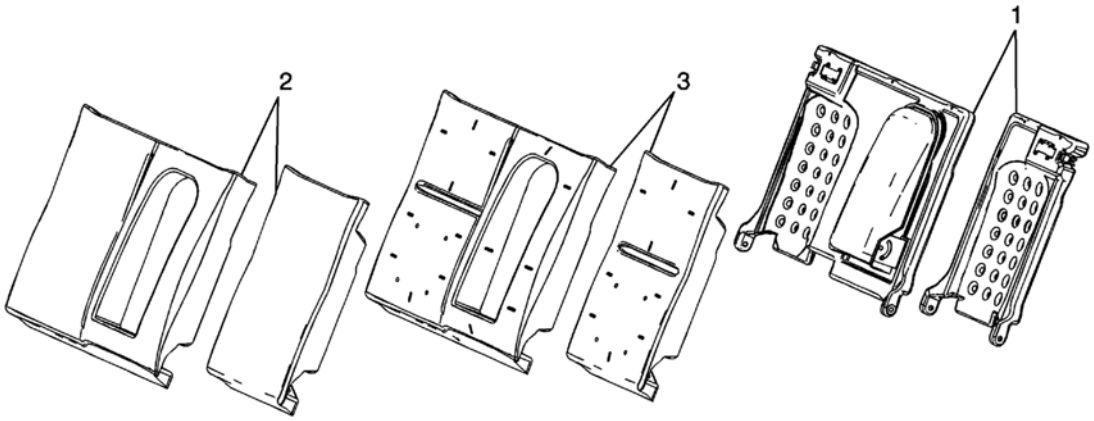


Fig. 42: Identifying Rear Split Folding Seat Back Cover & Pad
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Seat Back Cushion Panel Refer to **Rear Seat Back Cushion Panel Replacement (Rear Split Folding)**.
2	Rear Seat Back Cushion Cover (Qty: 2) **TIP:** Remove the seat back cover by disengaging the retainers securing the cover to the seat back cushion panel.
3	Rear Seat Back Cushion Pad (Qty: 2)

REAR SEAT BACK CUSHION COVER AND PAD REPLACEMENT (IMPALA LIMITED)

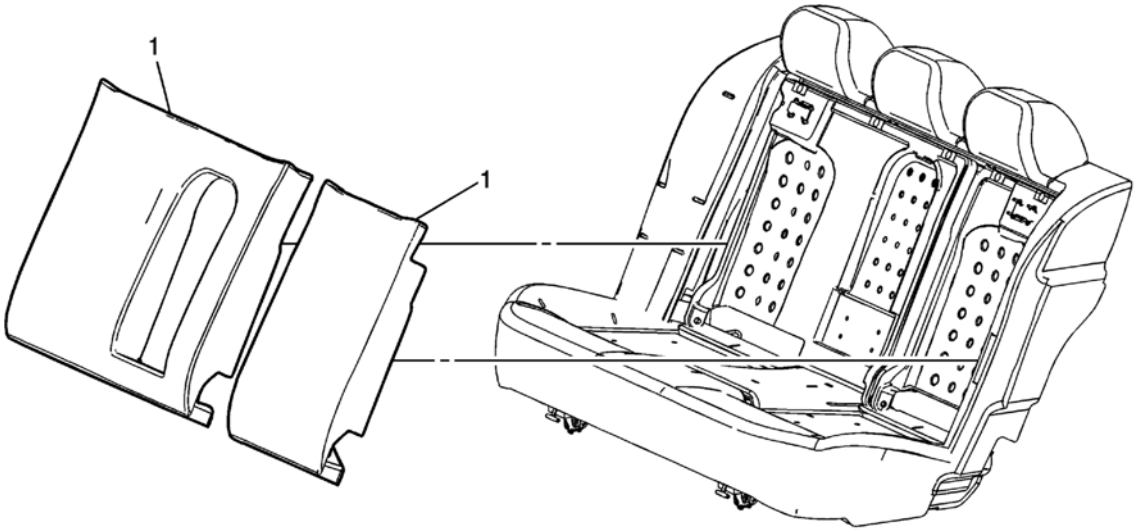


Fig. 43: Rear Seat Back Cover and Pad (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedures** 1. Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)**. 2. Remove the rear seat back cushion. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)**. 3. Remove the rear seat center shoulder belt assemblies. Refer to **Rear Seat Buckle Side Belt Replacement (Impala Limited without AM9)** **Rear Seat Buckle Side Belt Replacement (Impala Limited with AM9)** . 4. Remove the rear seat armrest. Refer to **Rear Seat Armrest Replacement (Impala Limited w/AM9)**.	
1	Cover, Rear Seat Back Cushion 1. Fold the rear seat back cushion panels forward enough to gain access to the retainers for the seat back cushion cover. 2. Remove the rear seat back cushion cover and pad from the rear seat back panels. 3. The seat back cushion cover and pad are serviced as an assembly.

General Information

Squeaks and Rattles - Impala

DIAGNOSTIC INFORMATION AND PROCEDURES

SQUEAKS AND RATTLES

Special Tools

- **CH-39570** Chassis Ear
- **GE-41416** Ultrasonic Leak Detector

For equivalent regional tools, refer to **Special Tools**.

NOTE: **Squeaks and rattles are caused by improperly controlled relative motion between vehicle components. There are 4 ways to prevent squeaks and rattles.**

To aid in diagnosing, use CH-39570 ear or GE-41416 detector.

- Attach the component that squeaks or rattles securely.
- Separate the components that squeak or rattle to prevent contact.
- Insulate the components that squeak or rattle.
- Insulate low uniform friction surfaces to eliminate stickslip motion.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

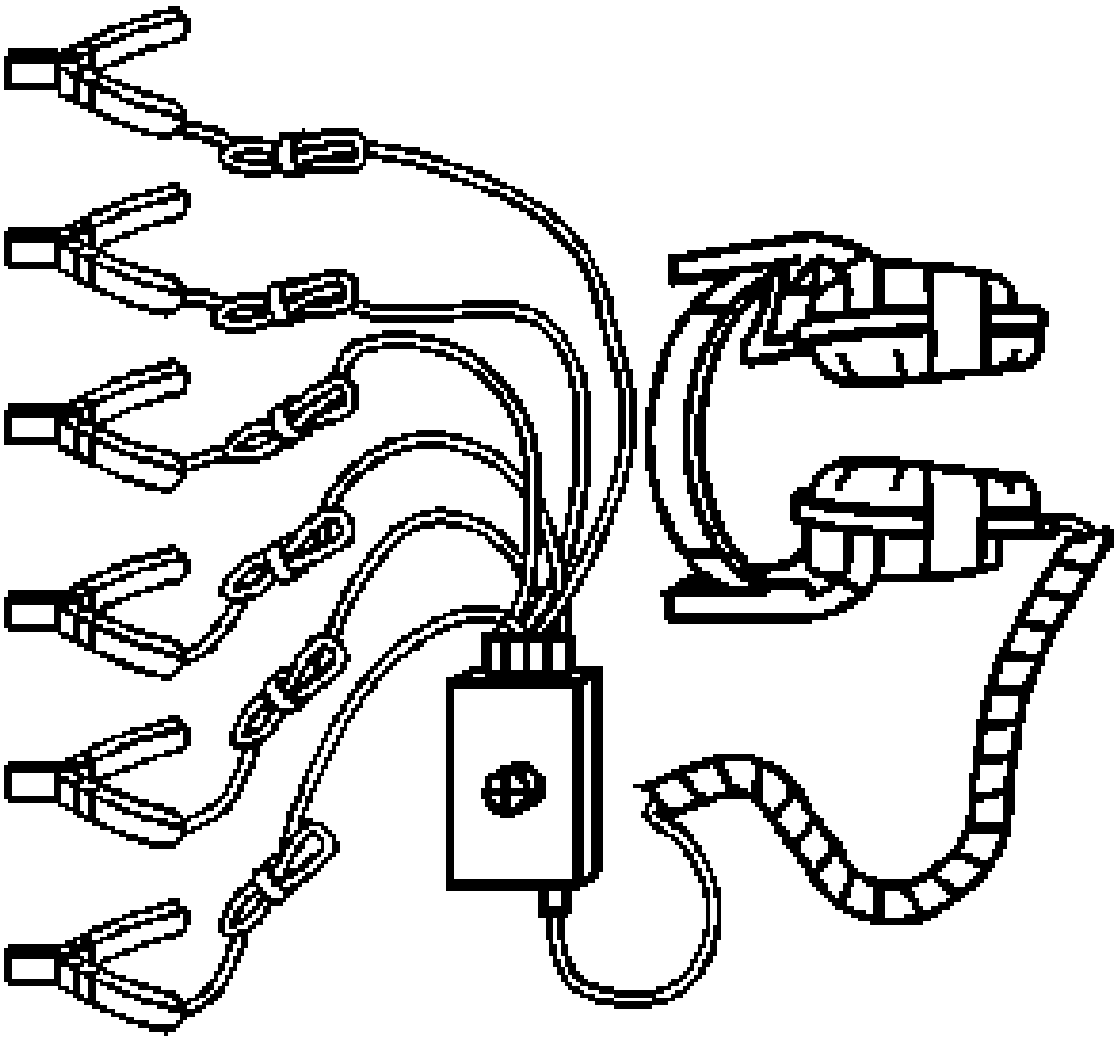
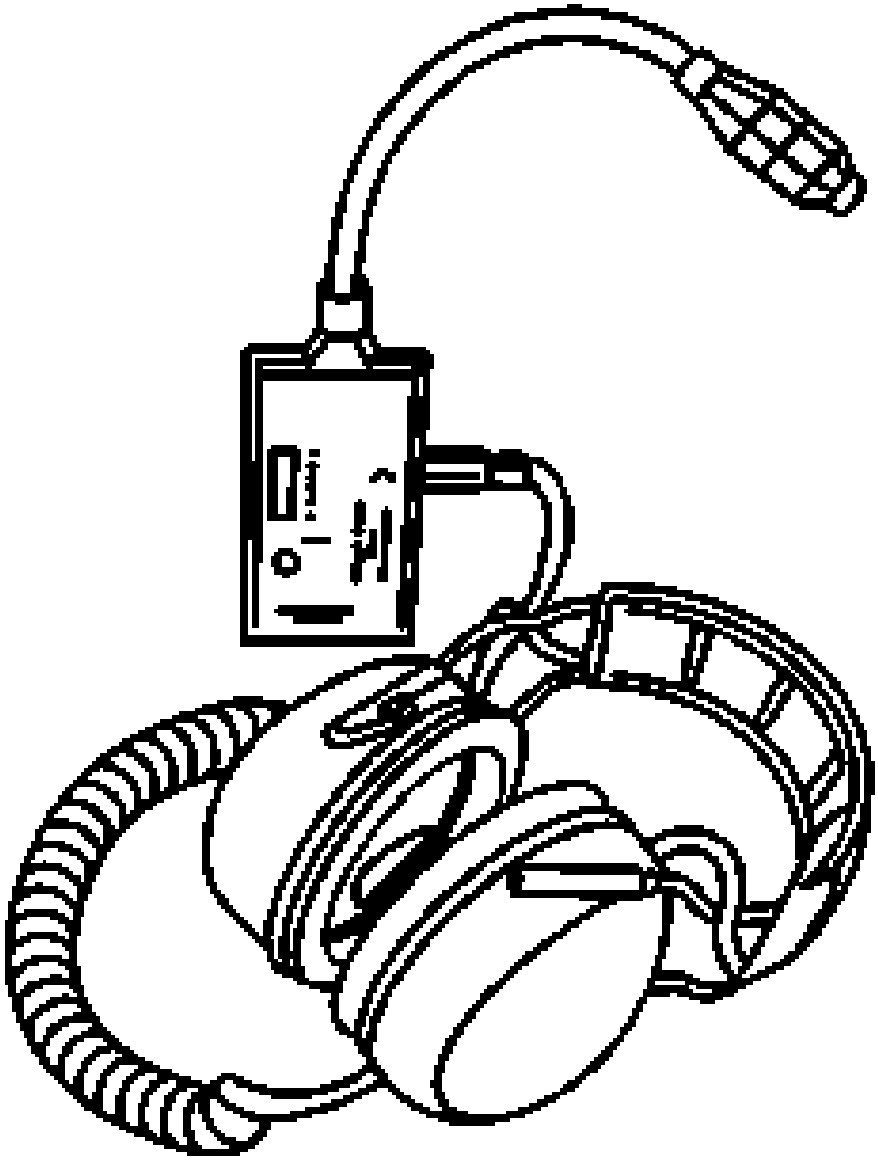
Illustration	Tool Number/ Description
	CH-39570 J 39570 Chassis Ear

Illustration	Tool Number/ Description
	GE-41416 J 41416 Ultrasonic Leak Detector

Article GUID: A00737251

ACCESSORIES AND EQUIPMENT

Sunroof - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Sunroof Air Deflector Screws	3 N.m	26 lb in
Sunroof Module Bolts	10 N.m	89 lb in
Sunroof Motor/Actuator Bolts	3.5 N.m	31 lb in
Sunroof Window Screws	4 N.m	35 lb in

SCHEMATIC WIRING DIAGRAMS

SUNROOF WIRING SCHEMATICS

Sunroof

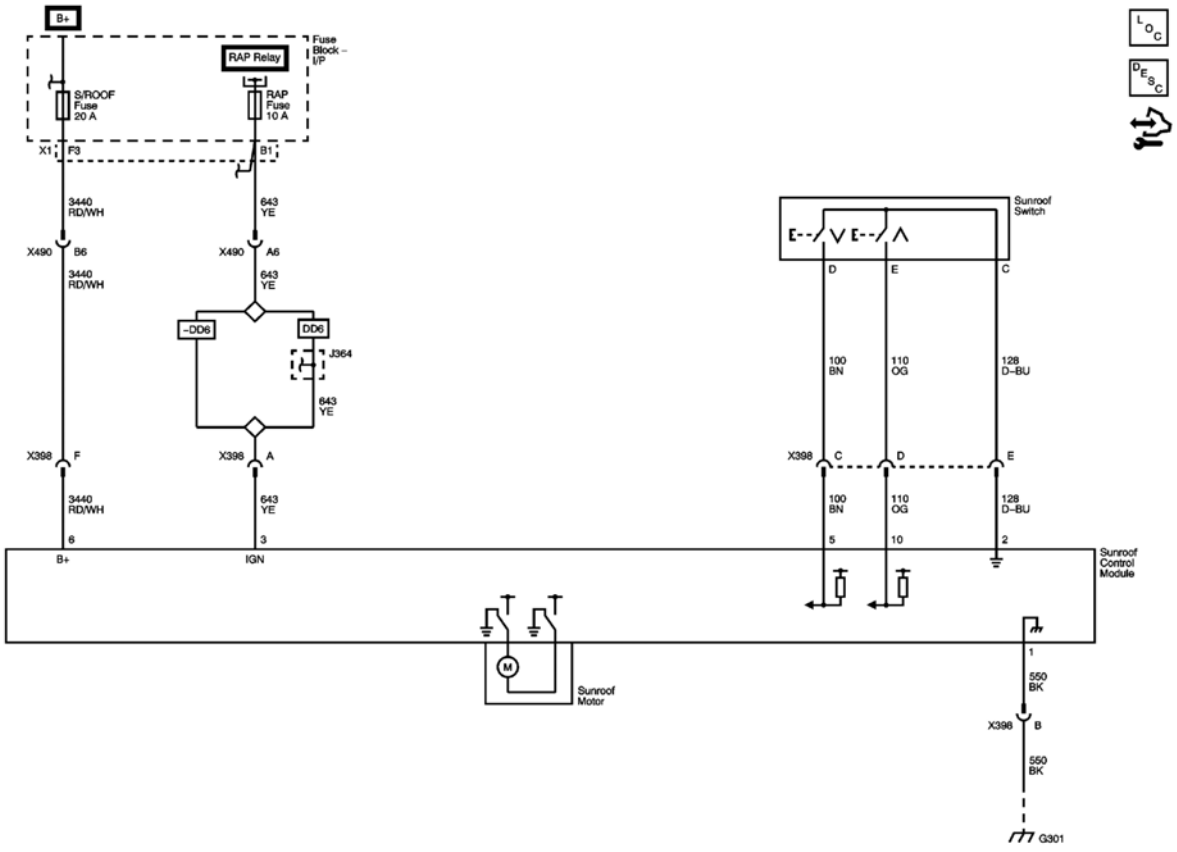


Fig. 1: Sunroof Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - ROOF

NOTE: **Complete the following procedures before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** in order to verify that all of the following conditions are true:
   - No DTCs are set.
   - The control modules can communicate via the serial data link.
2. Review the system description and operation in order to learn the system functions. Refer to **Sunroof Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the power sunroof system. Refer to **Checking Aftermarket Accessories** .
- Inspect the accessible system components for obvious damage or for conditions which can cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Power Sunroof Malfunction**
- **Retained Accessory Power Description and Operation** , if the power sunroof should operate longer than the retained accessory power (RAP) time-out.

POWER SUNROOF MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Ignition	1	1	-	-
Sunroof Switch Close Signal	1	3	1	-
Sunroof Switch Open Signal	1	2	1	-
Sunroof Switch Low Reference	-	1	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Sunroof Control Module Ground	-	1	-	-
1. Power sunroof malfunction 2. Power sunroof does not open 3. Power sunroof does not close				

Circuit/System Description

Ignition voltage is supplied to the sunroof control module by the RAP fuse. B+ is applied to the sunroof motor via the S/ROOF fuse. The sunroof control module supplies each of the sunroof switch signal circuits with a 12-volt reference. When a switch is pressed the signal circuit is pulled low signaling the sunroof open or close request. The sunroof control module determines the motor direction based on inputs received from the sunroof switch. When the motor reverses the polarity of the applied voltage, the motor reverses direction.

Reference Information

Schematic Reference

Sunroof Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Sunroof Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. With the sunroof in the closed position, press the sunroof open switch. The sunroof should open.
2. With the sunroof in the open position, press the sunroof close switch. The sunroof should close.

Circuit/System Testing

IMPORTANT: Because of the accessibility of the sunroof switch, perform the sunroof switch component test before beginning the Circuit/System Testing.

1. Ignition OFF, disconnect the harness connector at the sunroof control module.
2. Test for less than 5.0 ohm between the ground circuit terminal 1 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.

3. Verify that a test lamp illuminates between the B+ circuit terminal 6 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, replace the sunroof control module.
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 3 and ground.
    - If the test lamp does not illuminate, test the ignition circuit for an open/high resistance. If the circuit tests normal, refer to **Retained Accessory Power Malfunction** .
5. Ignition OFF, connect the harness connector at the sunroof control module.
6. Disconnect the harness connector at the sunroof switch.
7. Test for less than 5.0 ohm between the low reference circuit terminal C and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the sunroof control module.

Apply ground to the module for no longer than 2 seconds at a time or the module could be damaged.

IMPORTANT: When performing the following tests, make sure that the sunroof is not at its end of travel position by switching the grounded jumper to the other signal circuit if the sunroof did not move in one direction.

8. Ignition ON, momentarily install a 10-amp fused jumper wire between the signal circuit terminal D and ground. The sunroof should move.
    - If the sunroof does not move, test the signal circuit for a short to ground, short to voltage or an open/high resistance. If the circuit test is normal, replace the sunroof control module.
9. Momentarily install a 10-amp fused jumper wire between the signal circuit terminal E and ground. The sunroof should move.
    - If the sunroof does not move, test the signal circuit for a short to ground, short to voltage or an open/high resistance. If the circuit test is normal, replace the sunroof control module.
10. If all circuits test normal, test or replace the sunroof switch.

Component Testing

1. With the ignition OFF, disconnect the harness connector at the sunroof switch.
2. Test for infinite resistance between the switch terminals listed below and the low reference terminal C with the switch in the neutral position.
    - Roof open terminal D
    - Roof close terminal E
    - If not the specified value, replace the sunroof switch.

IMPORTANT: If the switch tests open in any switch position other than Off, test the sunroof switch signal circuits for a short to voltage before replacing the switch.

3. Test for less than 5.0 ohm of resistance between the switch terminals listed below the low reference terminal C with the switch in the appropriate position.

- Roof open terminal D
- Roof close terminal E
- If greater than the specified range, replace the sunroof switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Sunroof Switch Replacement (Impala Limited)**
- **Control Module References** for sunroof motor/actuator replacement, setup, and programming

POWER SUNROOF DOES NOT CLOSE

Perform the Initialization/Teach Process any time a new sunroof motor actuator is installed in the vehicle or any time an existing sunroof motor actuator is removed from the vehicle. Refer to **Sunroof Motor/Actuator Initialization/Teach Process**.

POWER SUNROOF WINDOW IS SKEWED

Parallel positioning of the window track guides or lift mechanism and cable is crucial to the proper function of the system. If the guides are misaligned, refer to **Sunroof Track Timing/Synchronization (Impala Limited)**.

POWER SUNROOF WHEN OPERATED FROM VENT TO CLOSE ONE SIDE WILL DROP BEFORE THE OTHER

Parallel positioning of the window track guides or lift mechanism and cable is crucial to the proper function of the system. If the guides are misaligned, refer to **Sunroof Track Timing/Synchronization (Impala Limited)**.

POWER SUNROOF WHEN CLOSING FROM THE VENT POSITION THE WINDOW WILL REVERSE DIRECTION

Perform the Initialization/Teach Process any time a new sunroof motor actuator is installed in the vehicle or any time an existing sunroof motor actuator is removed from the vehicle. Refer to **Sunroof Motor/Actuator Initialization/Teach Process**.

POWER SUNROOF WILL STOP AT THE WRONG LOCATION

Perform the Initialization/Teach Process any time a new sunroof motor actuator is installed in the vehicle or any time an existing sunroof motor actuator is removed from the vehicle. Refer to **Sunroof Motor/Actuator Initialization/Teach Process**.

POWER SUNROOF WILL OVER TRAVEL THE OPEN POSITION AND STALL THE MOTOR

Perform the Initialization/Teach Process any time a new sunroof motor actuator is installed in the vehicle or any time an existing sunroof motor actuator is removed from the vehicle. Refer to **Sunroof Motor/Actuator Initialization/Teach Process**.

POWER SUNROOF WILL OVER TRAVEL THE CLOSE POSITION AND STALL THE MOTOR

Perform the Initialization/Teach Process any time a new sunroof motor actuator is installed in the vehicle or any

time an existing sunroof motor actuator is removed from the vehicle. Refer to **Sunroof Motor/Actuator Initialization/Teach Process**.

REPAIR INSTRUCTIONS

SUNROOF AIR DEFLECTOR REPLACEMENT (IMPALA LIMITED)

Removal Procedure

1. Remove the sunroof window. Refer to **Sunroof Window Replacement**.
2. Power sunroof tracks to the fully rear position.

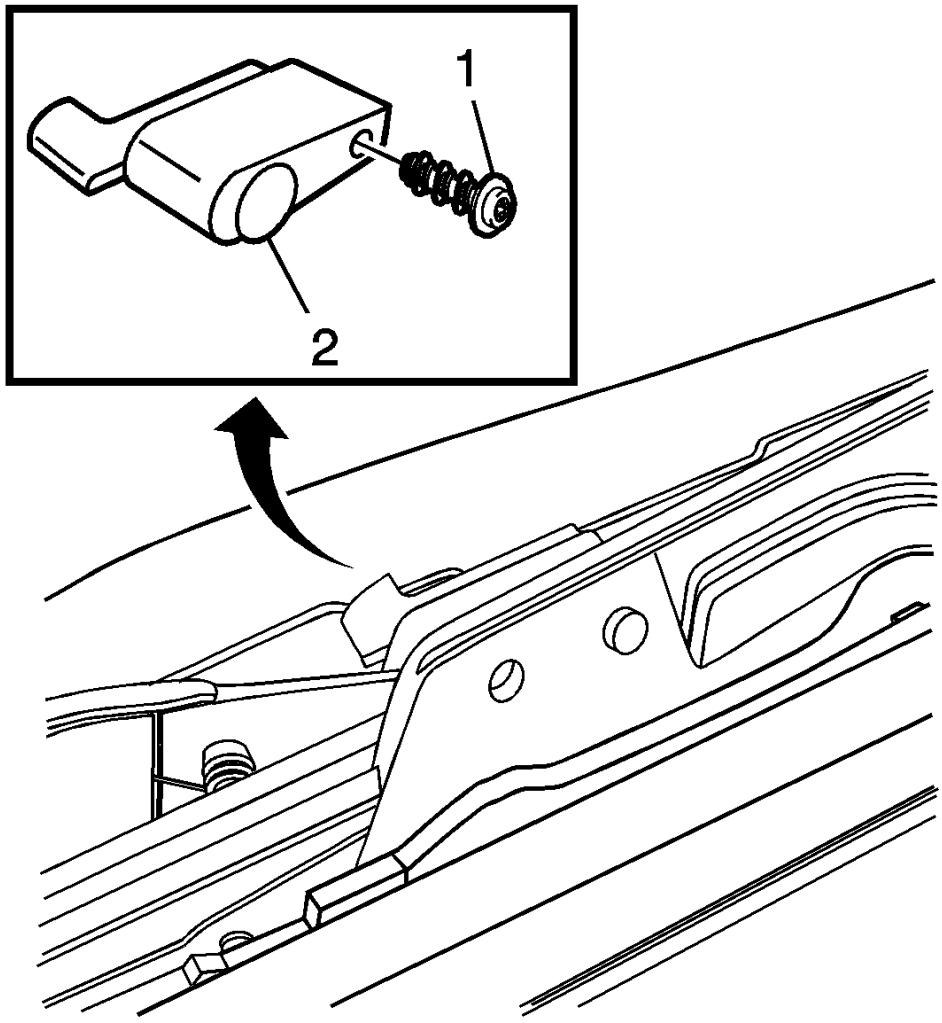


Fig. 2: Actuator Blocks
Courtesy of GENERAL MOTORS COMPANY

3. Remove the screw (1) from the actuator (2) located at the front of each window track.

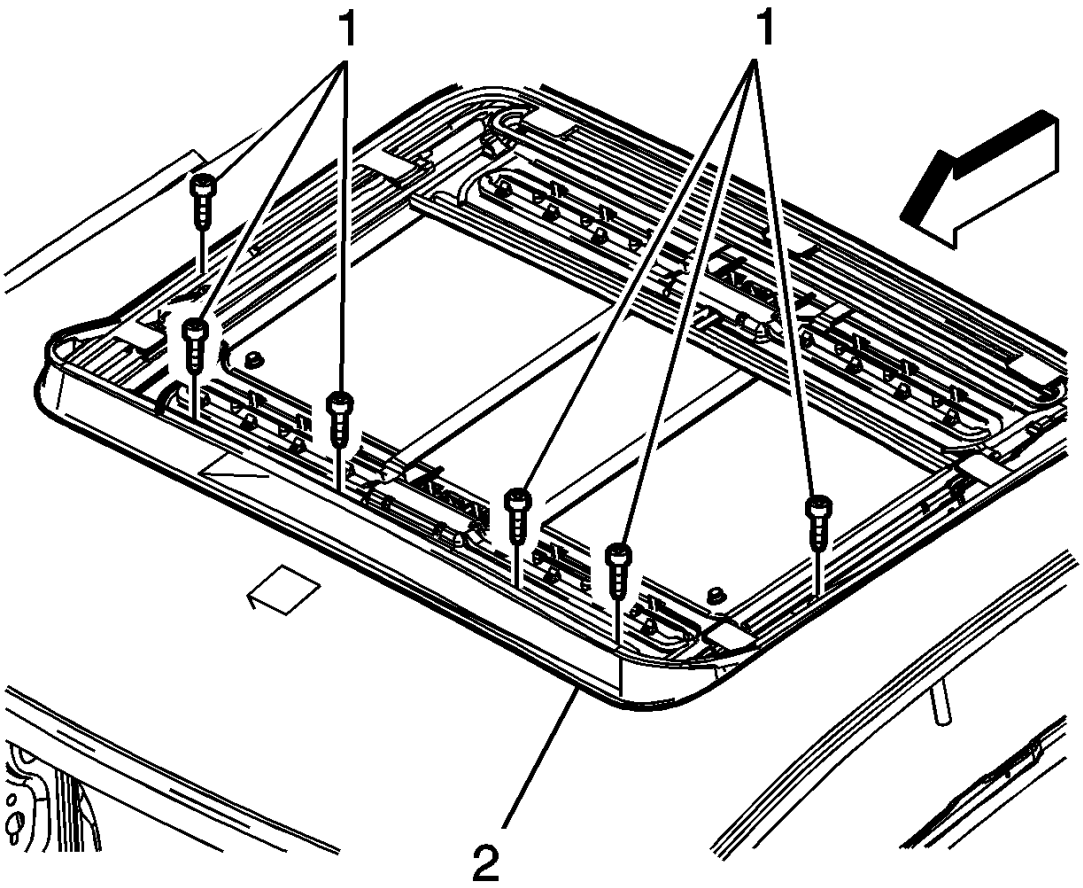


Fig. 3: View Of Screws In Sunroof Air Deflector
Courtesy of GENERAL MOTORS COMPANY

4. Remove the screws (1) from the sunroof air deflector.
5. Remove the sunroof air deflector from the sunroof module (2).

   Slide the air deflector rearward until it releases from the module.

Installation Procedure

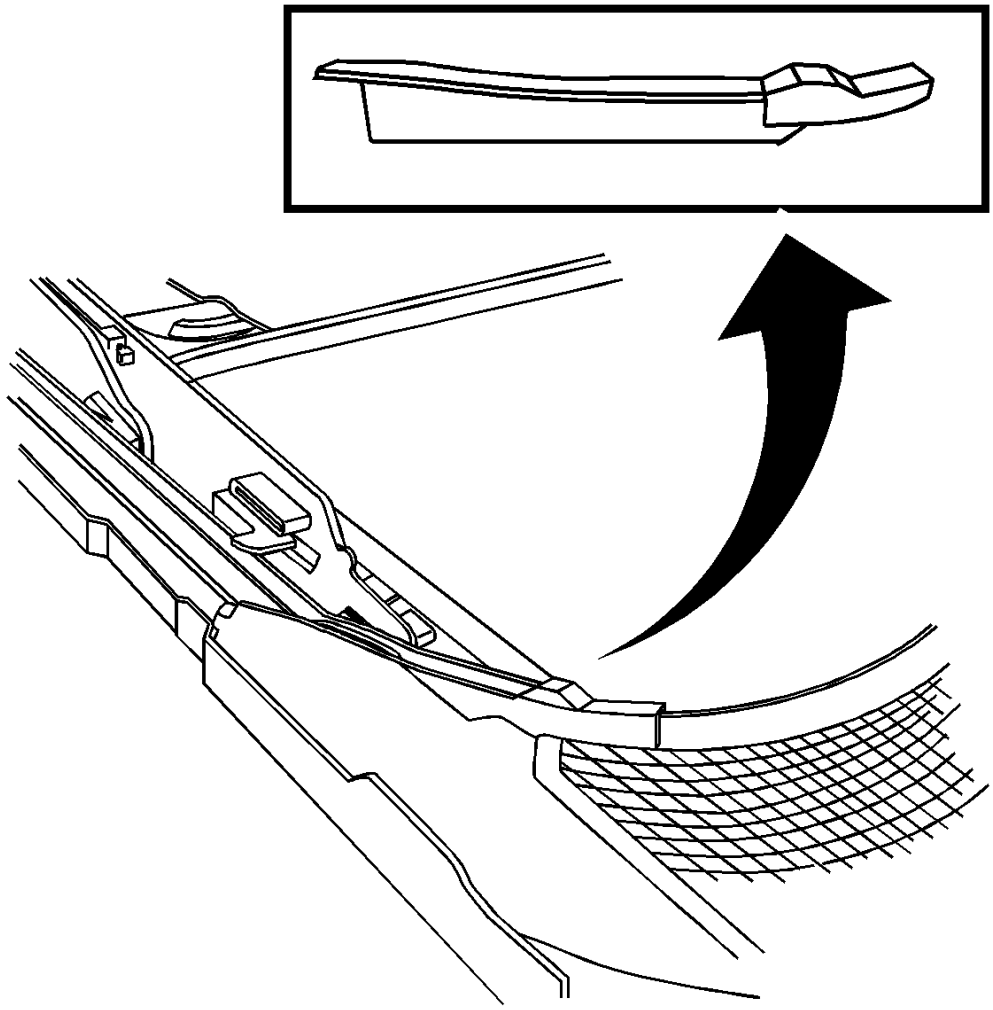


Fig. 4: Wear Plate
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Transfer the air deflector guides to the new air deflector. The air deflector guides can be replaced separately if damaged.**

1. Install the guides to the air deflector.

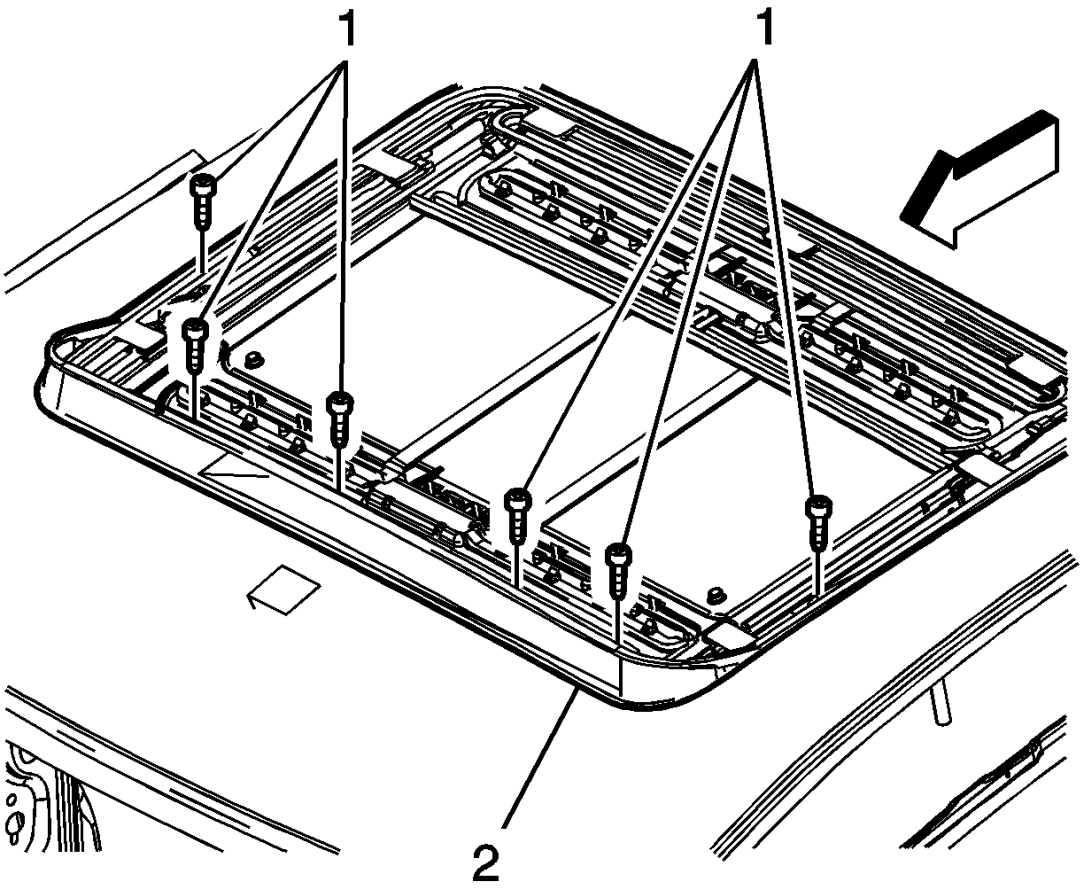


Fig. 5: View Of Screws In Sunroof Air Deflector
Courtesy of GENERAL MOTORS COMPANY

2. Position the sunroof air deflector to the sunroof module.

CAUTION: Refer to Fastener Caution .

3. Install the screws (1) attaching the sunroof air deflector to the sunroof module (2).

Tighten

Tighten the screws to 3 N.m (26 lb in).

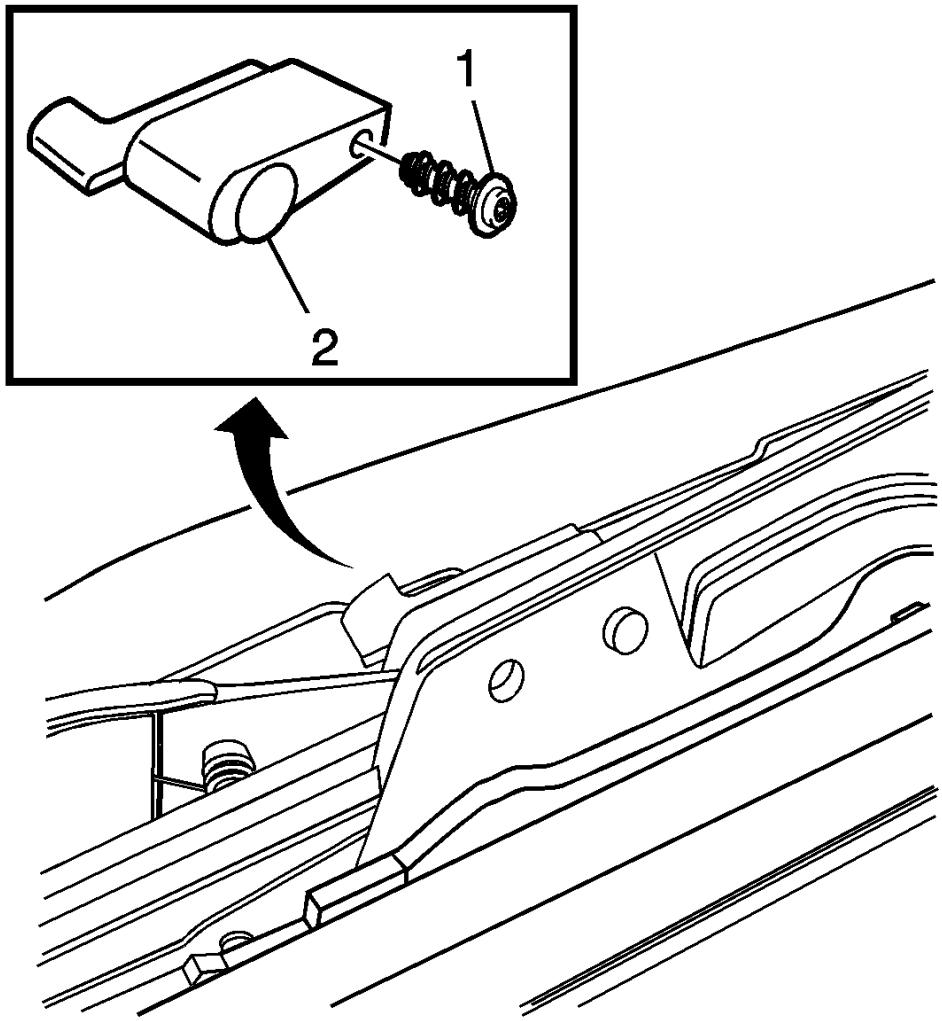


Fig. 6: Actuator Blocks
Courtesy of GENERAL MOTORS COMPANY

4. Install the screw (1) to the actuator (2) located at the front of each window track.

   Tighten

   Tighten the screws to 2 N.m (18 lb in).

5. Power the sunroof window tracks to the close position.
6. Install sunroof window. Refer to **Sunroof Window Replacement**.
7. Verify that the spring action of the sunroof air deflector is operating.
8. Close the sunroof window.

SUNROOF DRAIN INSPECTION AND CLEANING

Drain Hose Routing

NOTE: **If the headliner is wet DO NOT remove any interior trim. Do the Plugged Drain Hose test first.**

A drain trough encircles the sunroof window panel and water is drained off by the drain hoses located at each corner of the housing. A drain channel spans across the sunroof module at the rear of the window panel and directs water into the trough.

1. The front drain hoses are routed down the windshield pillars and out the center of the pillar between the door hinges. The front hoses are installed in a rubber grommet and retained by clips.
2. The rear drain hoses are routed through the rear pillars and out of the rocker panel. In some vehicle the drain hoses are routed out through the metal roof slots and routed to the lower wheelhouse to drain out of the vehicle. The rear hoses are installed in a rubber grommet and retained by clips.

Plugged Drain Hose

If a waterleak has occurred check for a plugged drain hose at each corner of drainage system.

1. Open the sunroof window.
2. To test for blockage, pour a small container of water into the module housing drain trough. Check each corner to confirm the drain hose is draining water.

WARNING: Wear safety glasses in order to avoid eye damage.

3. Use compressed air, 241 kPa (35 psi) or less to blow out any drain hose that is plugged.
4. Test the system again.
5. If the hose remains plugged, check to see it is properly routed and does not have a kink. Refer to **Sunroof Housing Front Drain Hose Replacement**, or **Sunroof Housing Rear Drain Hose Replacement**.
6. Remove the blockage using the following steps.
    1. Push mechanics wire through the hose to remove the obstruction.
    2. Use compressed air in order to blow out any remaining material.

Disconnected Drain Hose

Inspect the drainage system for disconnected drain hoses. Complete the following steps in order to obtain partial access to drain hoses and check for a disconnected hose.

1. Open the sunroof window panel.
2. Lower the headliner as needed. Refer to **Headlining Trim Panel Replacement** .
3. Connect any disconnected hoses.
4. Ensure that the rear drain hoses are properly routed in the metal roof slot and taped in place.

SUNROOF FRAME REPLACEMENT

Removal Procedure

NOTE: A new sunroof frame assembly will not have the sunroof window or the sunshade as components of the new service part.

1. The old sunroof window and sunshade will need to be installed to the new sunroof frame assembly.

   Remove the sunroof window. Refer to **Sunroof Window Replacement**.

2. Remove the sunshade panel. Refer to **Sunroof Sunshade Replacement (CF5)**.
3. Remove the air deflector. Refer to **Sunroof Air Deflector Replacement (Impala Limited)**.

NOTE: **It is only necessary to lower the headliner. Only do the steps in headliner replacement that will lower the headliner enough to gain access.**

4. Lower the headliner. Refer to **Headlining Trim Panel Replacement** .
5. Disconnect the electrical connector on the sunroof actuator.
6. Remove the sunroof motor/actuator. Refer to **Sunroof Motor/Actuator Replacement**.
7. Cut the tie straps securing the electrical harness to the sunroof cable rear drive tube.

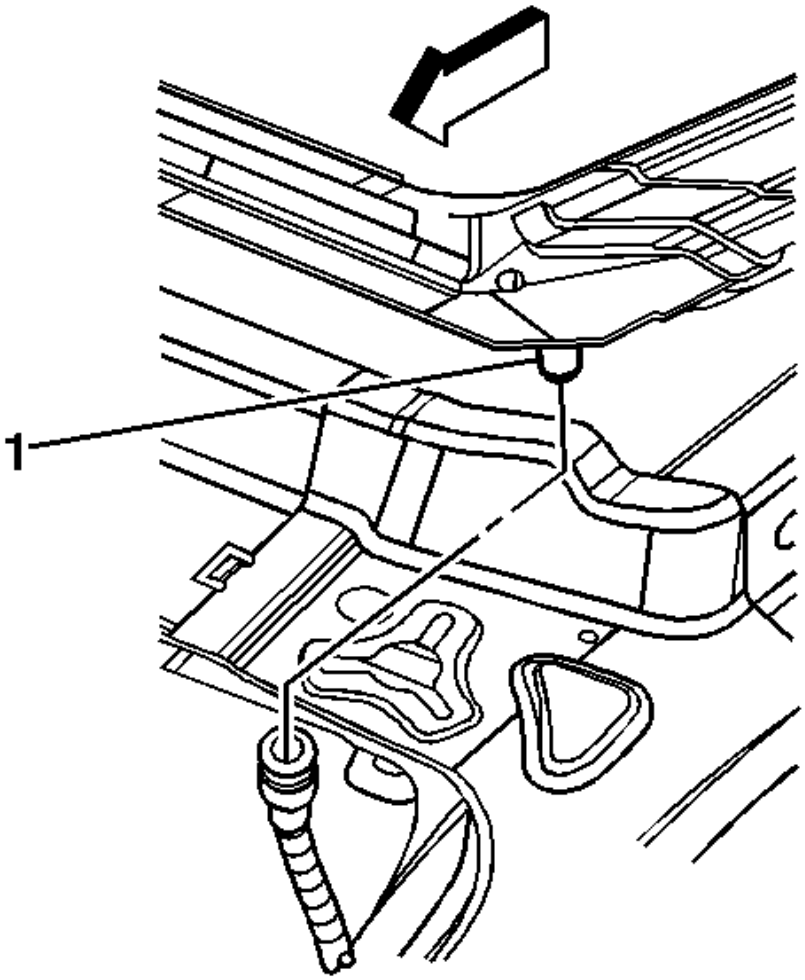


Fig. 7: Identifying Drain Spout
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the drain hoses from the front sunroof frame drain spouts (1).

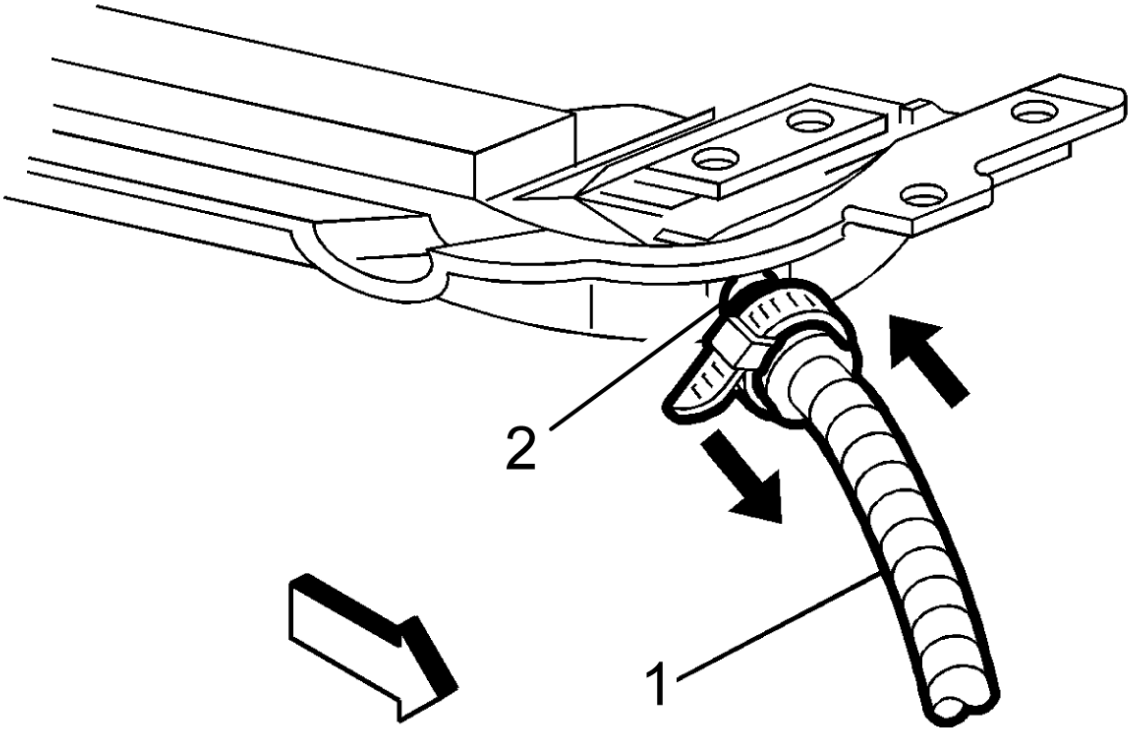


Fig. 8: Identifying Drain Hose At Drain Spout On Rear Of The Sunroof Module
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the drain hoses (1) from the rear sunroof frame drain spouts (2).

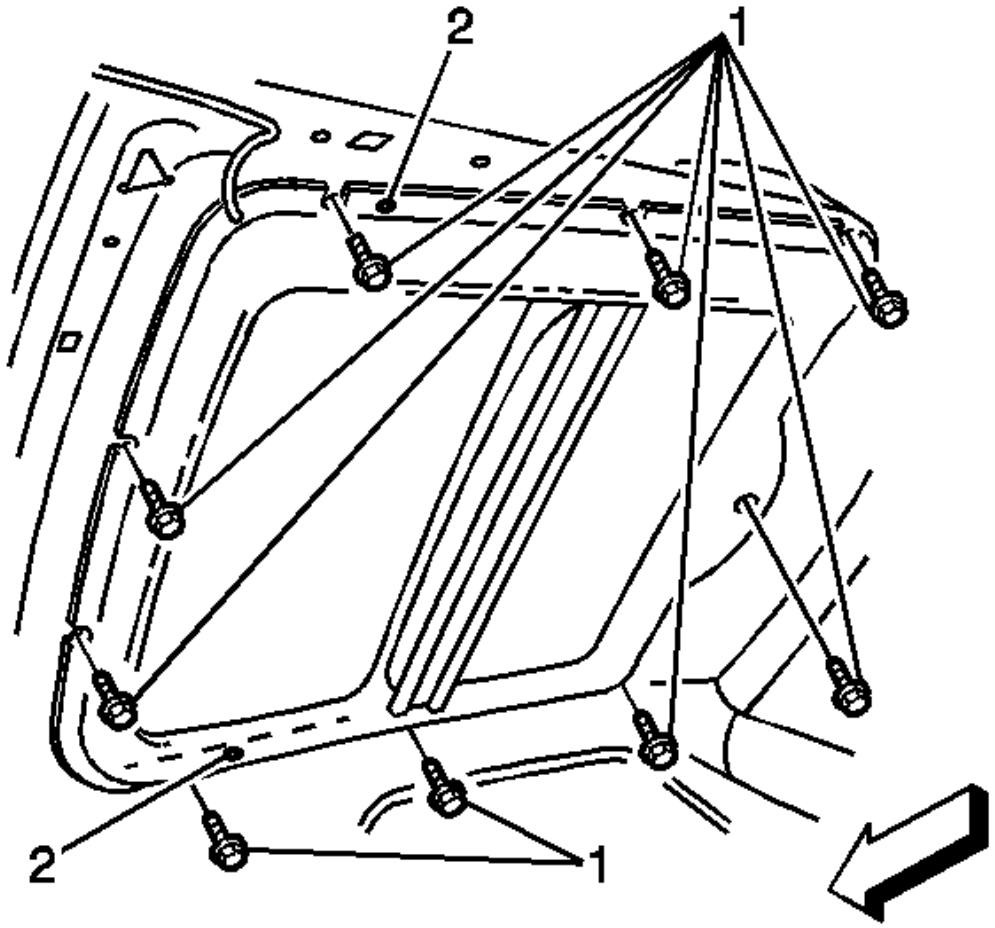


Fig. 9: Locating Sunroof Module-To-Roof Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the sunroof bolts (1) from the sunroof frame.
11. Remove the 2 center bolts (1) last in order to help support the sunroof frame to the roof ring.
12. With the aid of an assistant, lower the sunroof frame assembly from the alignment pins (2) and remove frame assembly out the passenger side door.

Installation Procedure

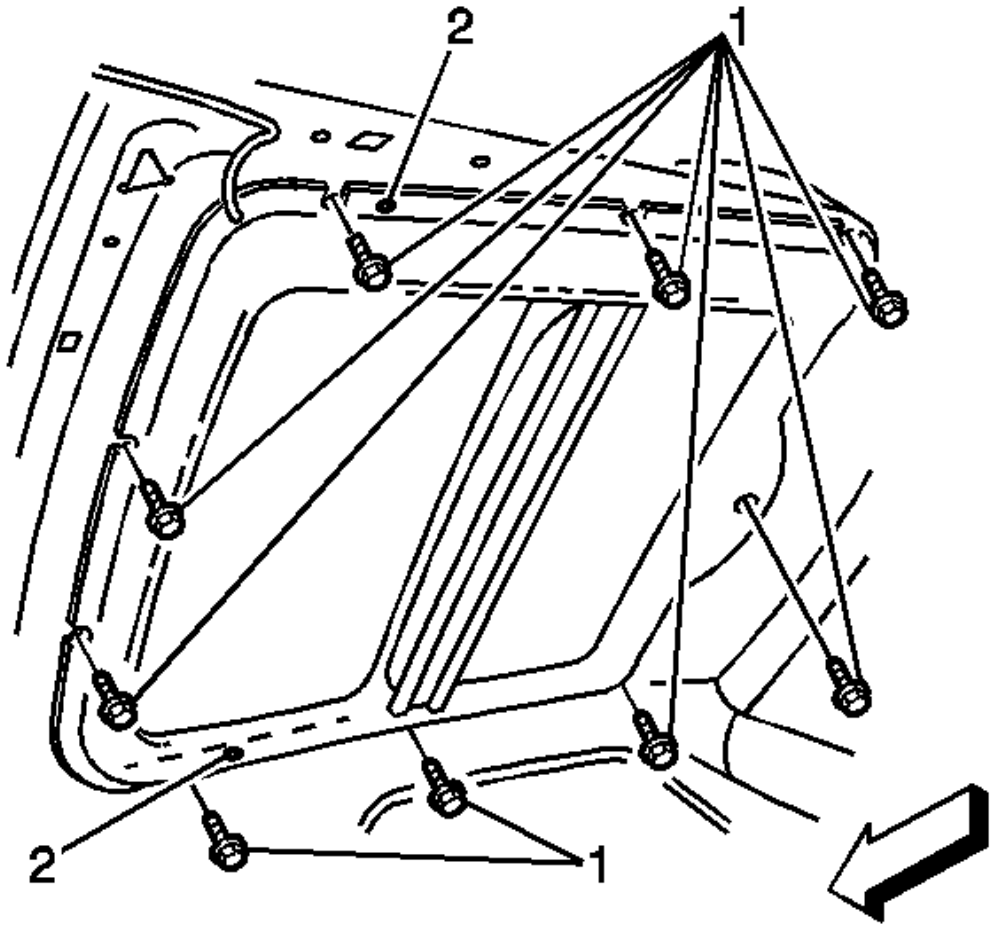


Fig. 10: Locating Sunroof Module-To-Roof Bolts
Courtesy of GENERAL MOTORS COMPANY

1. With the aid of an assistant, position the new sunroof frame assembly into the alignment pins (2) located on the roof ring.
2. Hand start the 2 center sunroof bolts (1) in order to hold the sunroof frame into place.
3. Finger tighten the 2 center sunroof bolts (1).

CAUTION: Refer to Fastener Caution .

4. Install the remaining sunroof bolts (1) to the sunroof frame and tighten the bolts to 9 N.m (80 lb in).

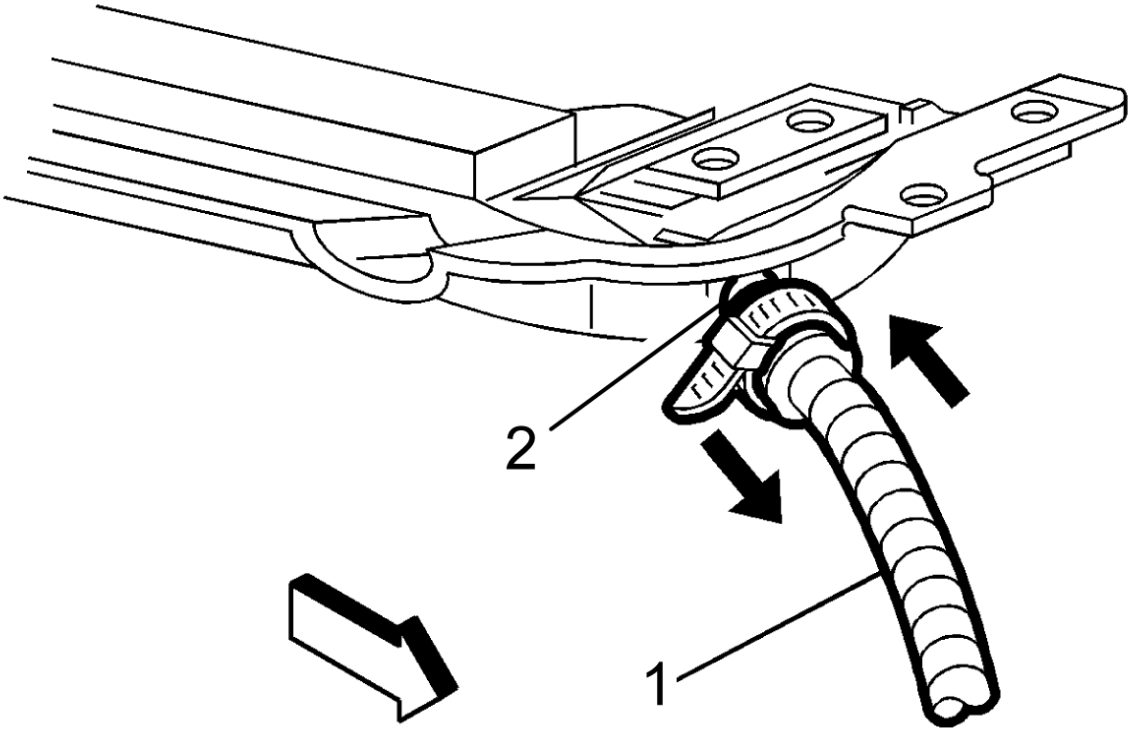


Fig. 11: Identifying Drain Hose At Drain Spout On Rear Of The Sunroof Module
Courtesy of GENERAL MOTORS COMPANY

5. Install the drain hoses (1) to the rear sunroof frame drain spouts (2).

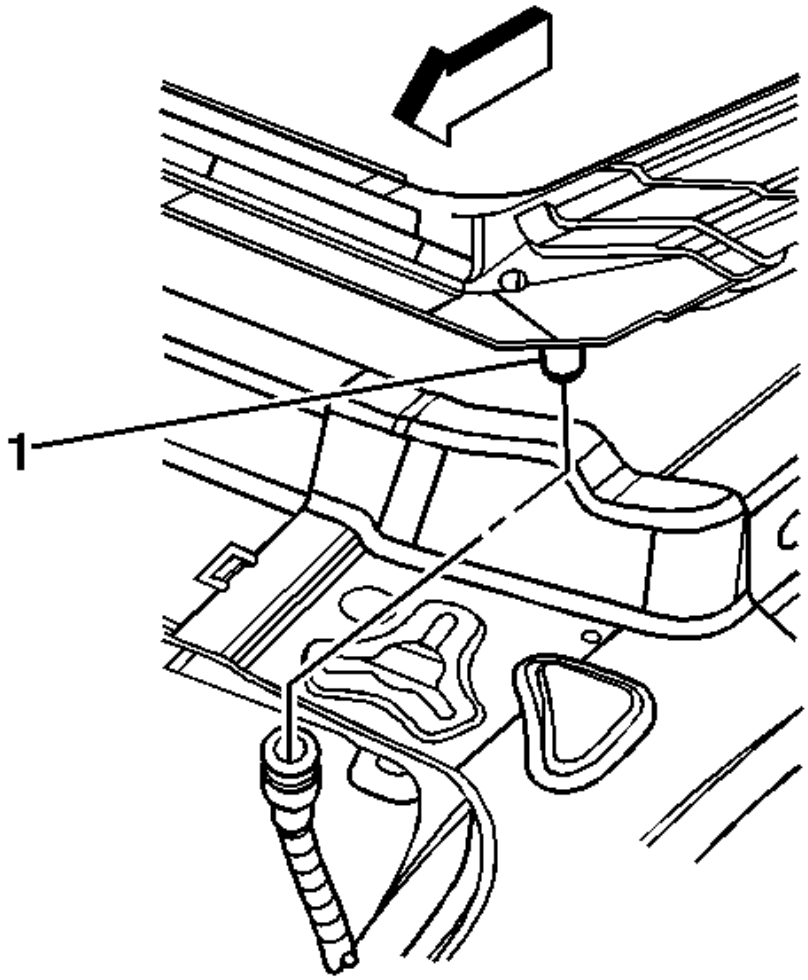


Fig. 12: Identifying Drain Spout
Courtesy of GENERAL MOTORS COMPANY

6. Connect the front drain hoses to the drain spouts (1) on the sunroof frame.
7. Install the sunroof motor/actuator. Refer to **Sunroof Motor/Actuator Replacement**.
8. Connect the electrical connector to the sunroof motor/actuator.
9. Secure the harness with suitable straps.
10. Install the air deflector. Refer to **Sunroof Air Deflector Replacement (Impala Limited)**.
11. Install the sunshade. Refer to **Sunroof Sunshade Replacement (CF5)**.
12. Install the sunroof window and loosely install the screws. Refer to **Sunroof Window Replacement**.
13. Adjust the sunroof window. Refer to **Sunroof Window Height and Opening Fit Adjustment**.
14. Verify the proper operation of the sunroof before securing the headliner.
15. Initialization/Teach the sunroof motor. Refer to **Sunroof Motor/Actuator Initialization/Teach Process**.
16. Raise and install the headliner, with the aid of an assistant. Refer to **Headlining Trim Panel Replacement** .

SUNROOF HOUSING FRONT DRAIN HOSE REPLACEMENT

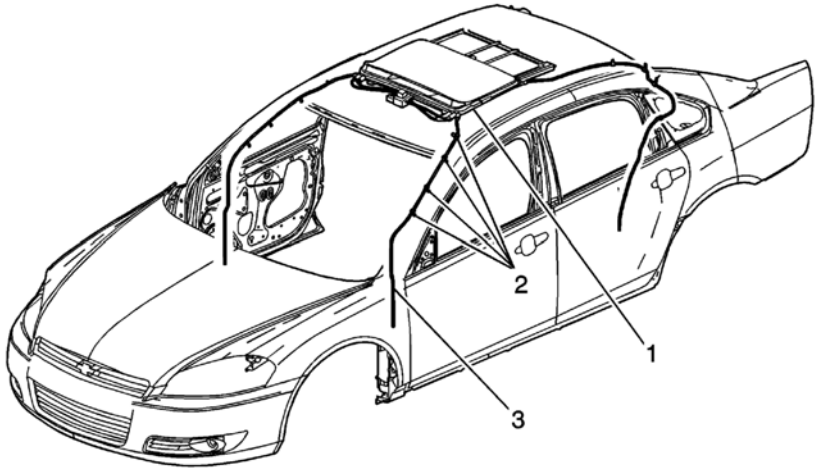


Fig. 13: Sunroof Housing Front Drain Hose
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the carpet retainer. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala Limited)** . 2. Remove the sunshade. Refer to **Sunshade Replacement** . 3. Remove the pillar garnish molding. Refer to **Windshield Pillar Garnish Molding Replacement** . 4. Remove the upper center pillar. Refer to **Center Pillar Upper Trim Panel Replacement** . 5. Remove the rear upper quarter trim. Refer to **Quarter Upper Trim Panel Replacement** . 6. Remove the rear window trim. Refer to **Rear Window Shelf Trim Panel Replacement** . 7. Remove the headliner. Refer to **Headlining Trim Panel Replacement** .	
1	Sunroof Module Spigot **Procedure** Disconnect the front sunroof drain hose from the module spigot.
2	Sunroof Drain Hose Retainer (Qty: 3)
3	Sunroof Drain Hose **Procedure** 1. Reposition the carpet in order to gain access to the access hole in the front pillar. 2. Remove the grommet at the end of the front sunroof drain hose from the hole in the front pillar. 3. Remove the front sunroof drain hose from the front pillar. **TIP:** Tie a string to the hose at the module end of the front sunroof drain hose. Pull the hose from the access hole in the front pillar, allowing the string to remain in the pillar.

SUNROOF HOUSING REAR DRAIN HOSE REPLACEMENT

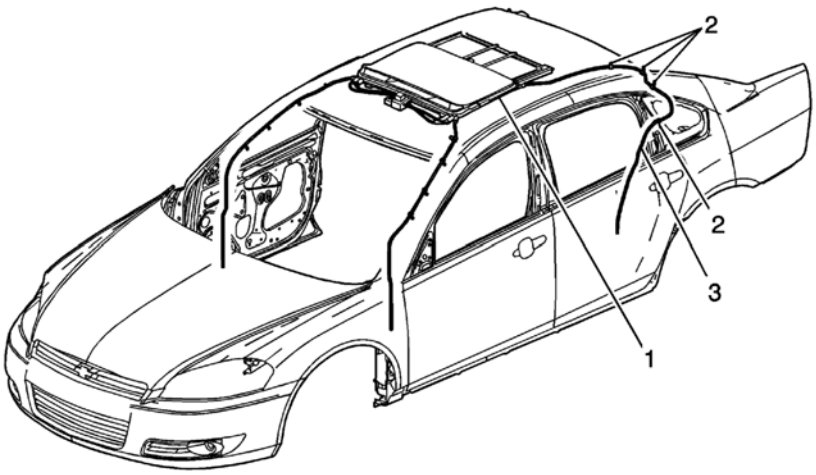


Fig. 14: Sunroof Housing Rear Drain Hose
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the carpet retainer. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala Limited)** . 2. Remove the sunshade. Refer to **Sunshade Replacement** . 3. Remove the pillar garnish molding. Refer to **Windshield Pillar Garnish Molding Replacement** . 4. Remove the upper center pillar. Refer to **Center Pillar Upper Trim Panel Replacement** . 5. Remove the rear upper quarter trim. Refer to **Quarter Upper Trim Panel Replacement** . 6. Remove the rear window trim. Refer to **Rear Window Shelf Trim Panel Replacement** . 7. Remove the rear seat. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)** . 8. Remove the headliner. Refer to **Headlining Trim Panel Replacement** .	
1	Sunroof Module Spigot **Procedure** Disconnect the rear sunroof drain hose from the module spigot.
2	Sunroof Drain Hose Retainer (Qty: 3)

Callout	Component Name
3	Sunroof Drain Hose **Procedure** 1. Reposition the carpet in order to gain access to the access hole in the rear quarter panel. 2. Remove the grommet at the rear end of the sunroof drain hose from the hole in the quarter panel. 3. Remove the rear sunroof drain hose from the rear quarter panel. **TIP:** Tie a string to the hose at the module end of the rear sunroof drain hose. Pull the hose from the access hole in the rear quarter panel, allowing the string to remain in the quarter panel.

SUNROOF OPENING TRIM FINISH LACE REPLACEMENT

Removal Procedure

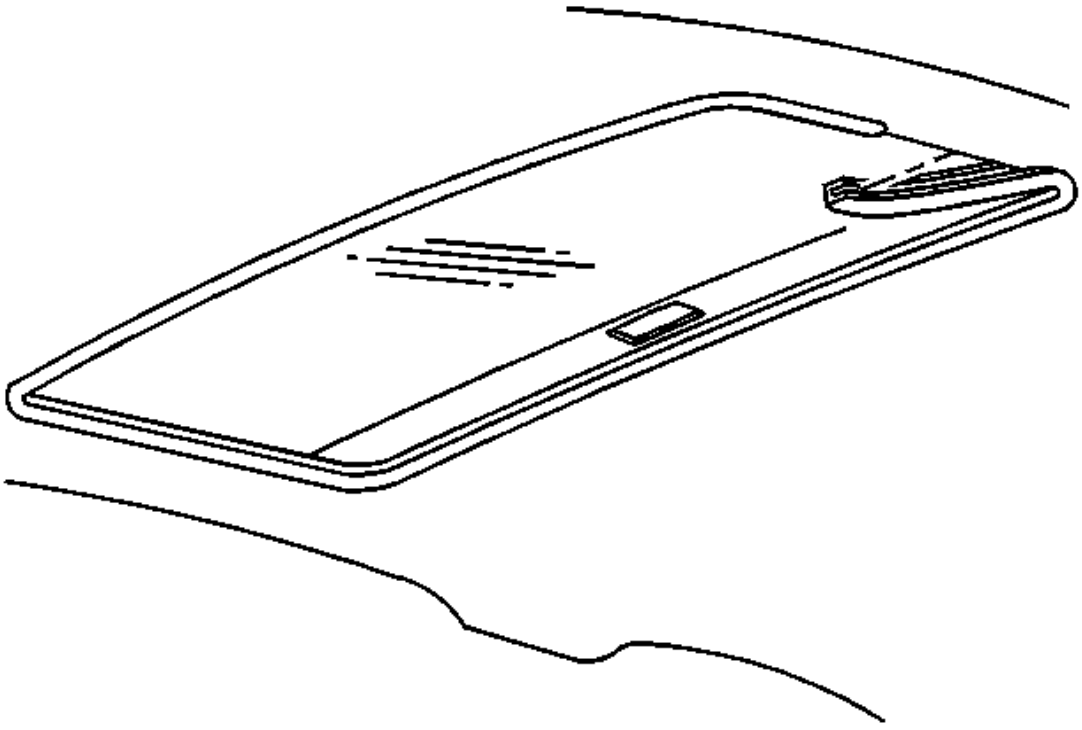


Fig. 15: Identifying Sunroof Opening Finishing Lace
Courtesy of GENERAL MOTORS COMPANY

1. Beginning at the joint, pull the sunroof opening trim lace from the headliner.
2. Remove the sunroof opening trim lace from the headliner.

Installation Procedure

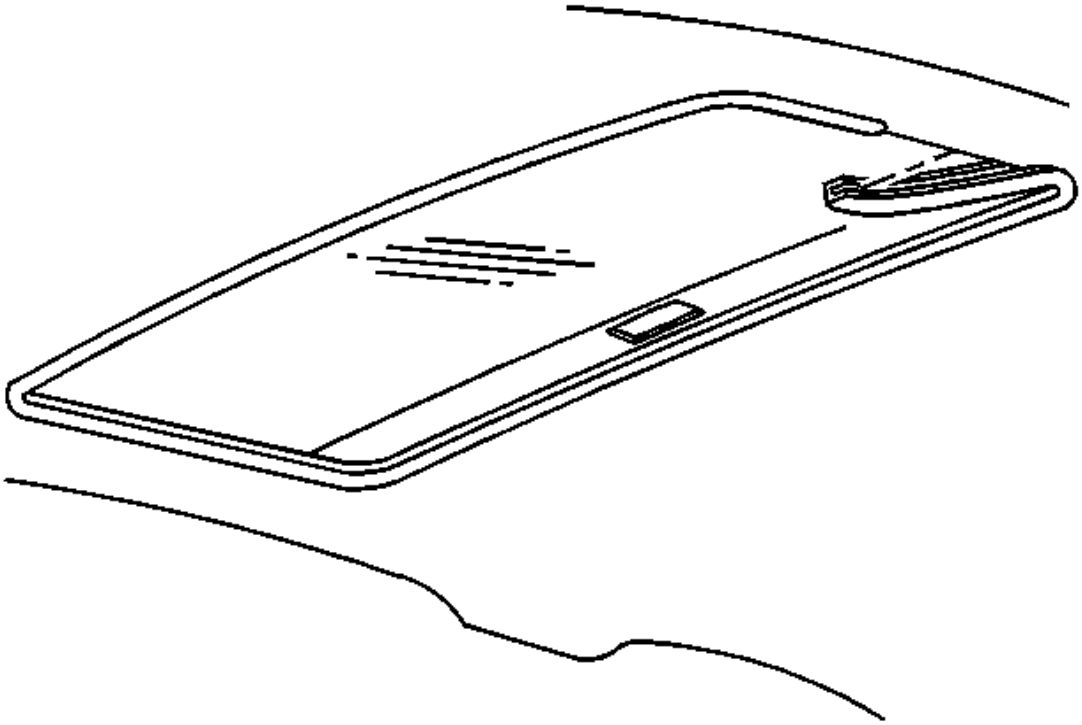


Fig. 16: Identifying Sunroof Opening Finishing Lace
Courtesy of GENERAL MOTORS COMPANY

1. Beginning at the joint, install the sunroof opening trim lace into place around the sunroof opening.
2. Ensure the sunroof trim lace is fully seated to the headliner.

SUNROOF MOTOR/ACTUATOR INITIALIZATION/TEACH PROCESS

Perform the Initialization/Teach Process any time a new sunroof motor actuator is installed in the vehicle.

1. Ensure that the electrical harness on the headliner is connected to the sunroof.

2. Press the sunroof switch to the close position until the window stops at the front hard stop in the fully closed position, then moves slightly back to the soft stop position. Release the switch. (This is the initialization portion).
3. Within 6 seconds, press and hold the close switch again. After 3 more seconds, the sunroof window will move toward the open position . (This is the teach portion).
4. Continue holding the switch until the sunroof window moves back to the close and stops at the closed position. Release the button. The initialization/Teach procedure is complete.
5. Verify the operation of the sunroof.

IMPORTANT: Re-Initialization/Teach for the original motor.

1. Perform the Reinitialization/Teach process any time the sunroof motor in removed form the sunroof.
2. Ensure that the electrical harness on the headliner is connected to the sunroof.
3. Press the sunroof switch to the close position until the window stops at the front soft stop in the fully closed position. Release the switch then press to the close position again and hold for 10 seconds or greater. The sunroof will then stall at the hard stop, and move back sightly to the soft stop position. Release the switch. (This is the re-initialization portion).
4. Within 6 seconds, press and hold the close switch again. After 3 more seconds, the sunroof window will move toward the open position. (This is the teach portion).
5. Continue holding the switch until the sunroof window moves back to the close and stops at the closed position. Release the button. The initialization/Teach procedure is complete.
6. Verify the operation of the sunroof.

IMPORTANT:

If in the Initialization/Teach Process is not complete, the following actions must take place before the initialization cycle is done:

- The sunroof switch is not held in the close position.
- The ignition and/or battery power has been removed.
- The glass panel has not reached the closed position.

The Initialization/Teach Process must be restarted if the procedure is not carried out completely.

SUNROOF MOTOR/ACTUATOR REPLACEMENT

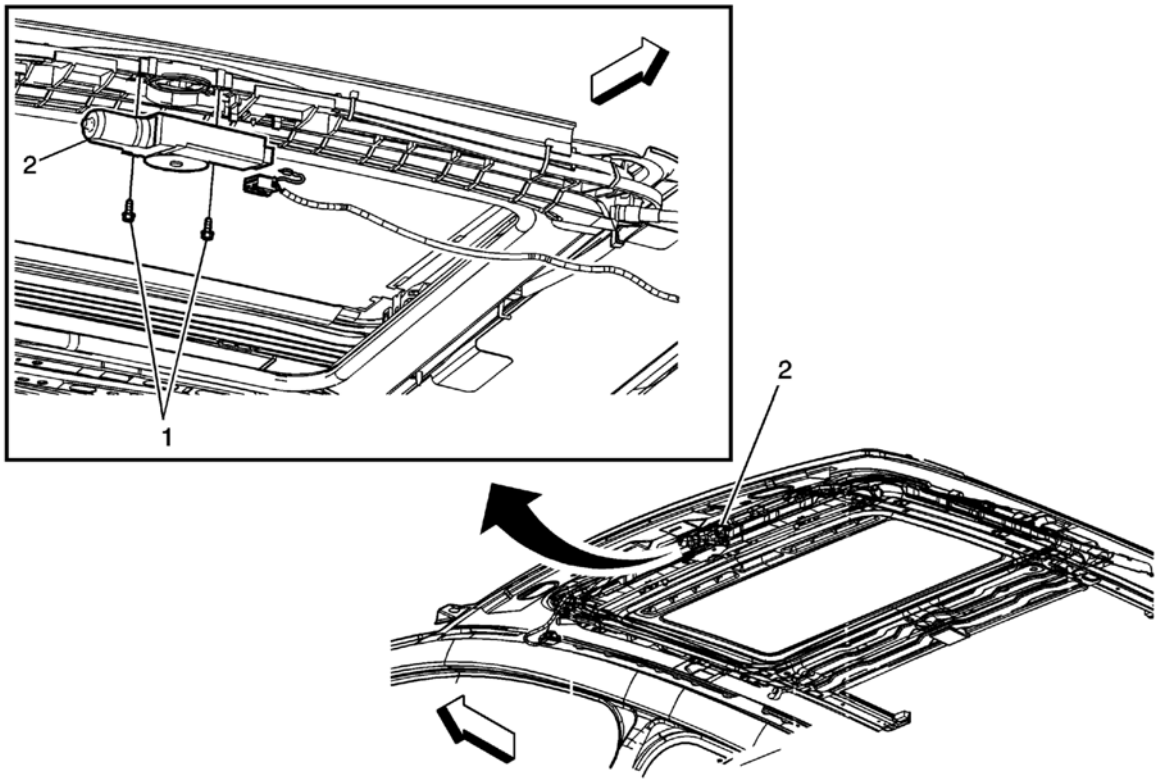


Fig. 17: View Of Sunroof Motor/Actuator Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Motor Sunroof Bolts (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Procedure** It is only necessary to lower the headliner. Only do those steps in headliner replacement that will lower the headliner enough to gain access to the parts. Refer to **Headlining Trim Panel Replacement** **Tighten** 10 N.m (89 lb in)
2	Sunroof Motor **Procedure** After install the sunroof motor it will be necessary to initialization teach process. Refer to **Sunroof Motor/Actuator Initialization/Teach Process**.

SUNROOF SUNSHADE REPLACEMENT (CF5)

Removal Procedure

1. Remove the sunroof frame from the vehicle. Refer to **Sunroof Frame Replacement**.

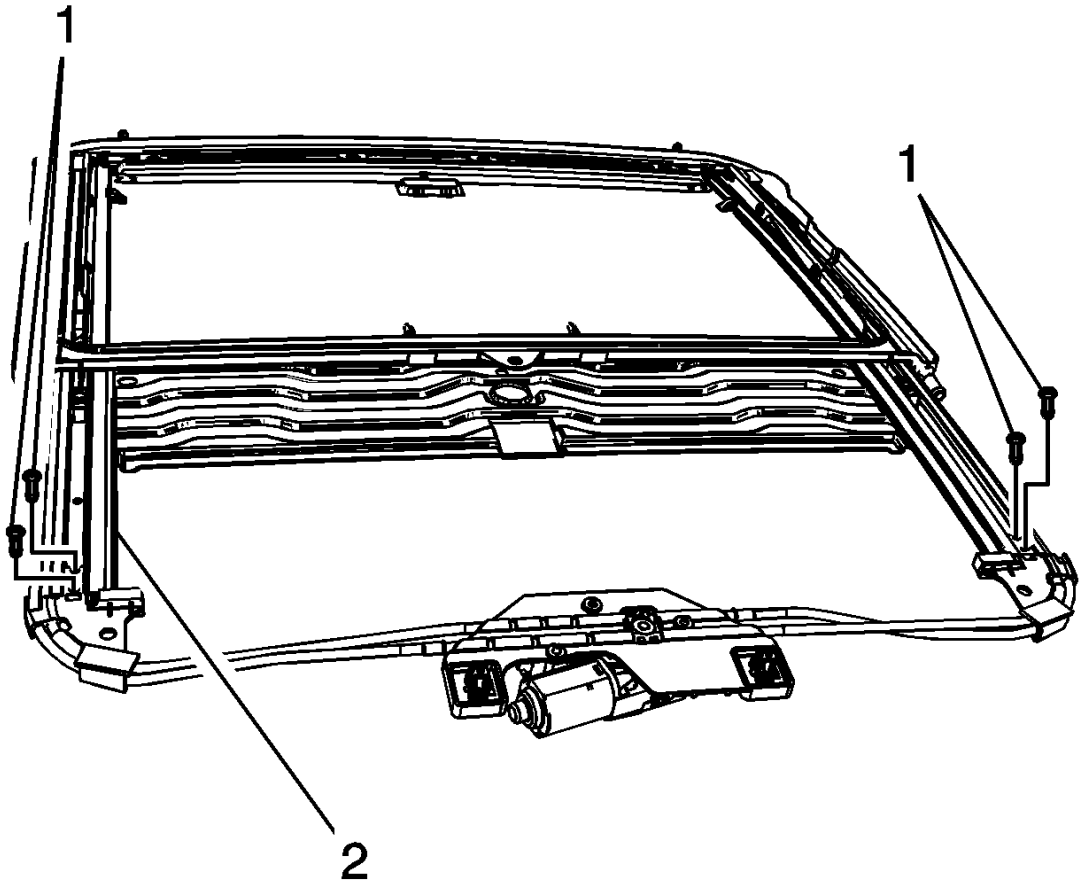


Fig. 18: Sunroof Sunshade Rivets
Courtesy of GENERAL MOTORS COMPANY

WARNING: Approved safety glasses and gloves should be worn when performing this procedure to reduce the chance of personal injury.

2. Use the appropriate tool, drill out the rivets (1) from the sunroof guide tracks.

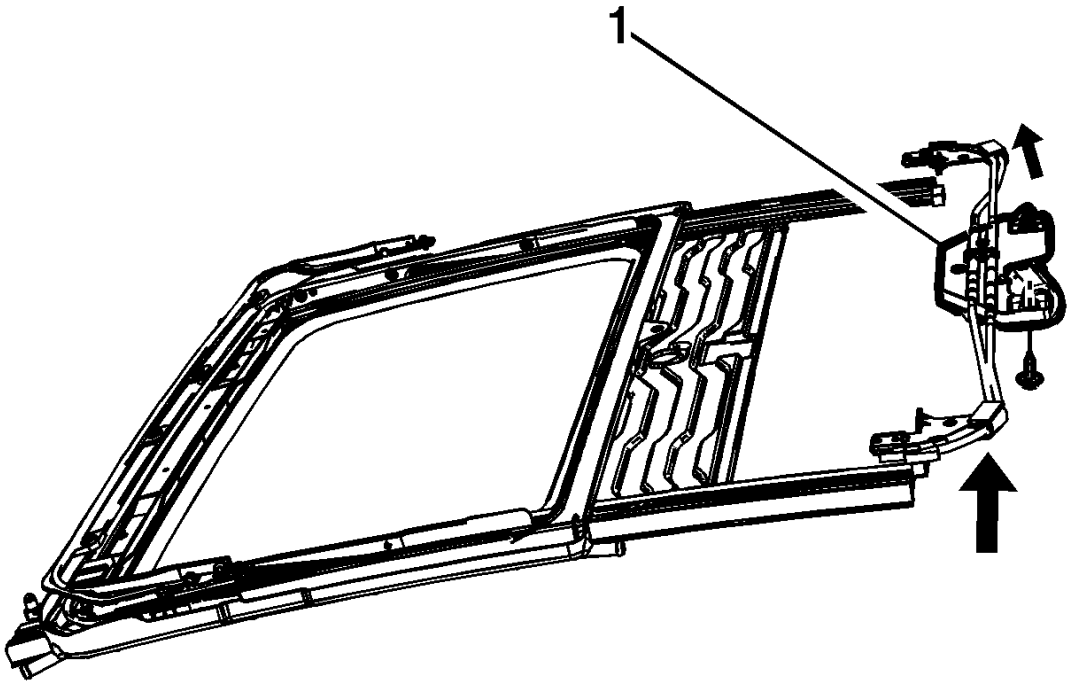


Fig. 19: Sunroof Sunshade Cable Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not remove motor/actuator and cable assembly from the sunroof frame.**

3. Slide the motor and cable assembly (1) rearward allowing the sunshade to clear.

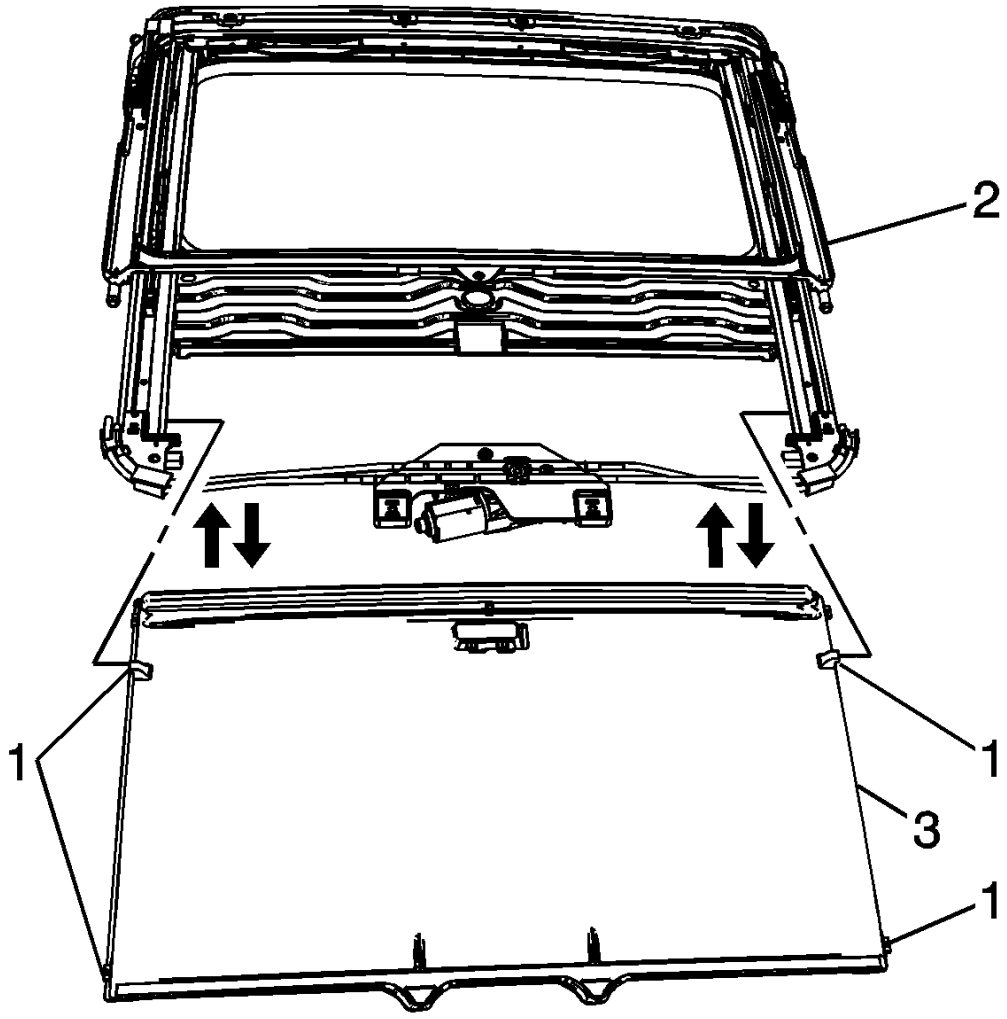


Fig. 20: Sunroof Sunshade
Courtesy of GENERAL MOTORS COMPANY

4. Remove the sunroof sunshade (3) from the sunroof frame as follows:
    1. Sliding the sunshade rearward.
    2. Lift upward in the rear center of the sunshade until the guide tabs (1) releases the sunroof guide tracks (2).

Installation Procedure

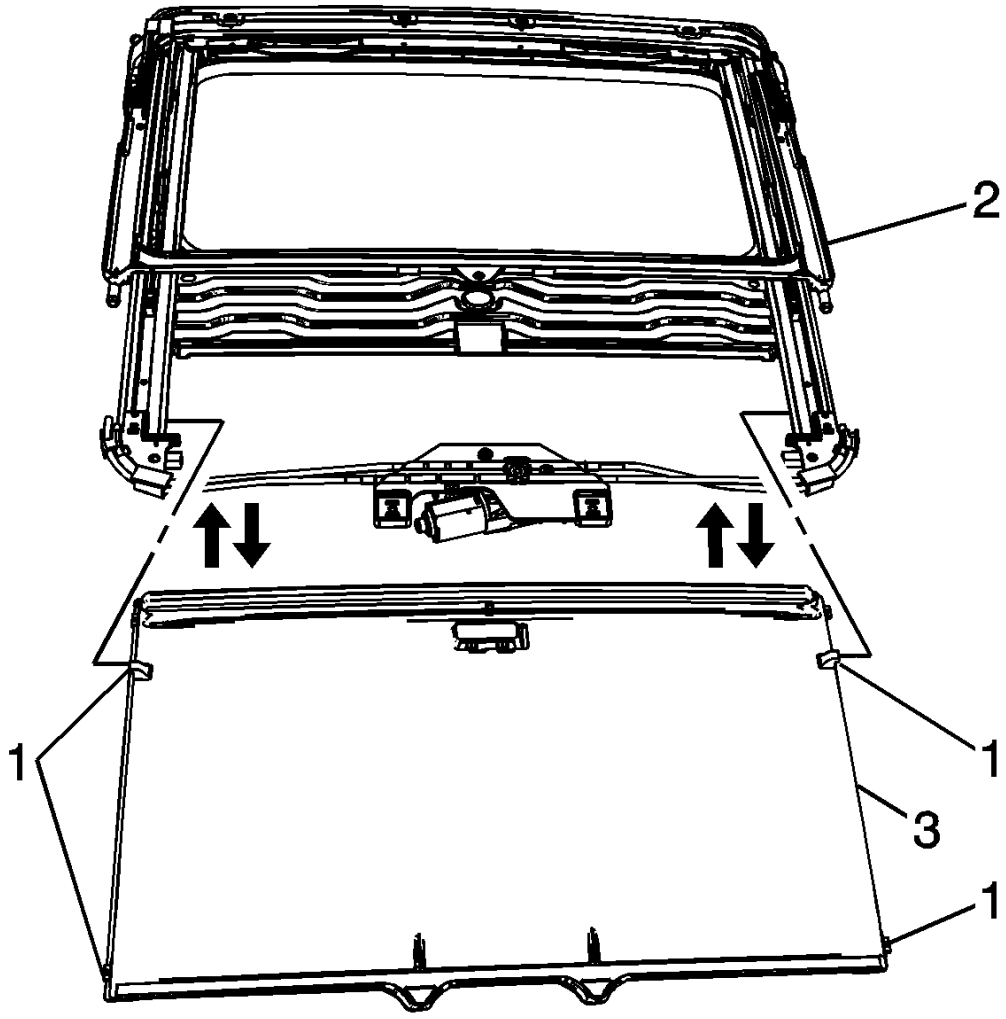


Fig. 21: Sunroof Sunshade
Courtesy of GENERAL MOTORS COMPANY

1. Install the sunshade (3) front tabs (1) to the left and right corners of sunroof guide tracks (2) .
2. Slide the sunshade forward until all the tabs (1) are inserted in the sunroof guide tracks (2).
3. Ensure that the sunshade is sliding back and forth in the sunroof guide tracks freely.

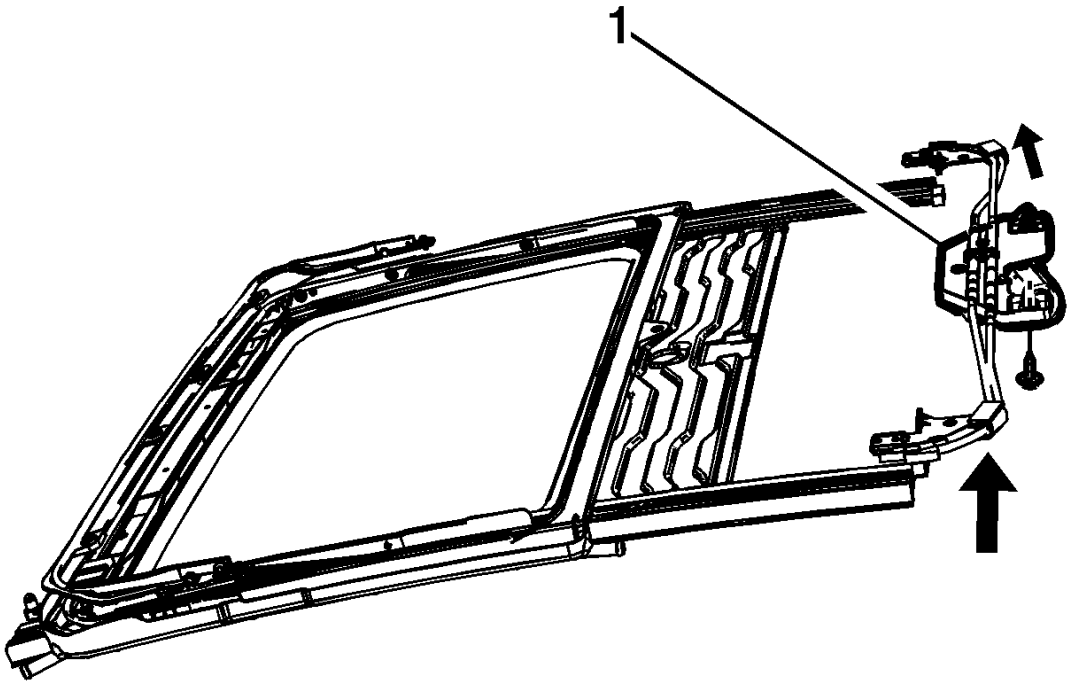


Fig. 22: Sunroof Sunshade Cable Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Slide the motor and cable assembly (1) back in place.

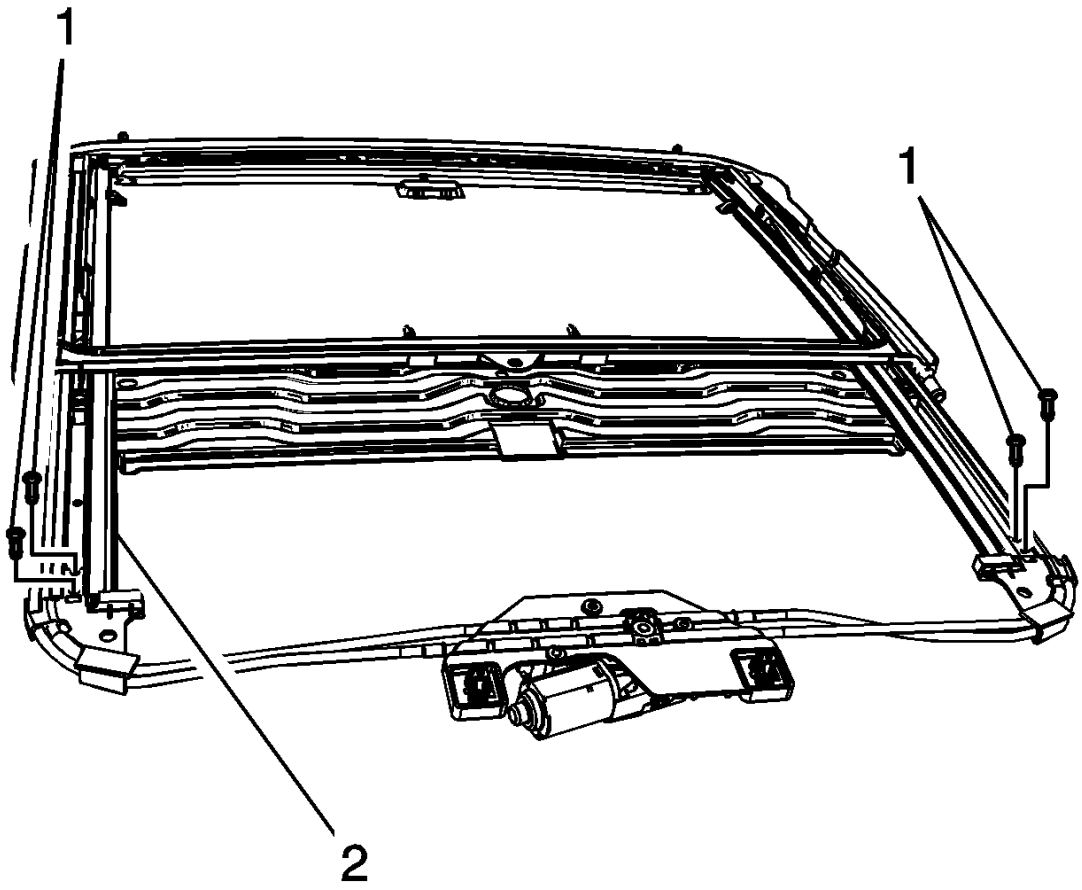


Fig. 23: Sunroof Sunshade Rivets
Courtesy of GENERAL MOTORS COMPANY

5. Use the appropriate tool, install the rivets (1) to the sunroof guide tracks (2).
6. Install the sunroof frame in the vehicle. Refer to **Sunroof Frame Replacement**.
7. While seated inside the vehicle with the sunshade in the closed position, verify that the front of the sunroof is not bent upward.
8. Perform the Initialization/Teach Process any time the sunroof motor actuator is installed in the vehicle. Refer to **Sunroof Motor/Actuator Initialization/Teach Process**.
9. Before install the interior trim verify all that all position of the sunroof and sunshade assembly are working properly.

SUNROOF WINDOW SEAL REPLACEMENT

Removal Procedure

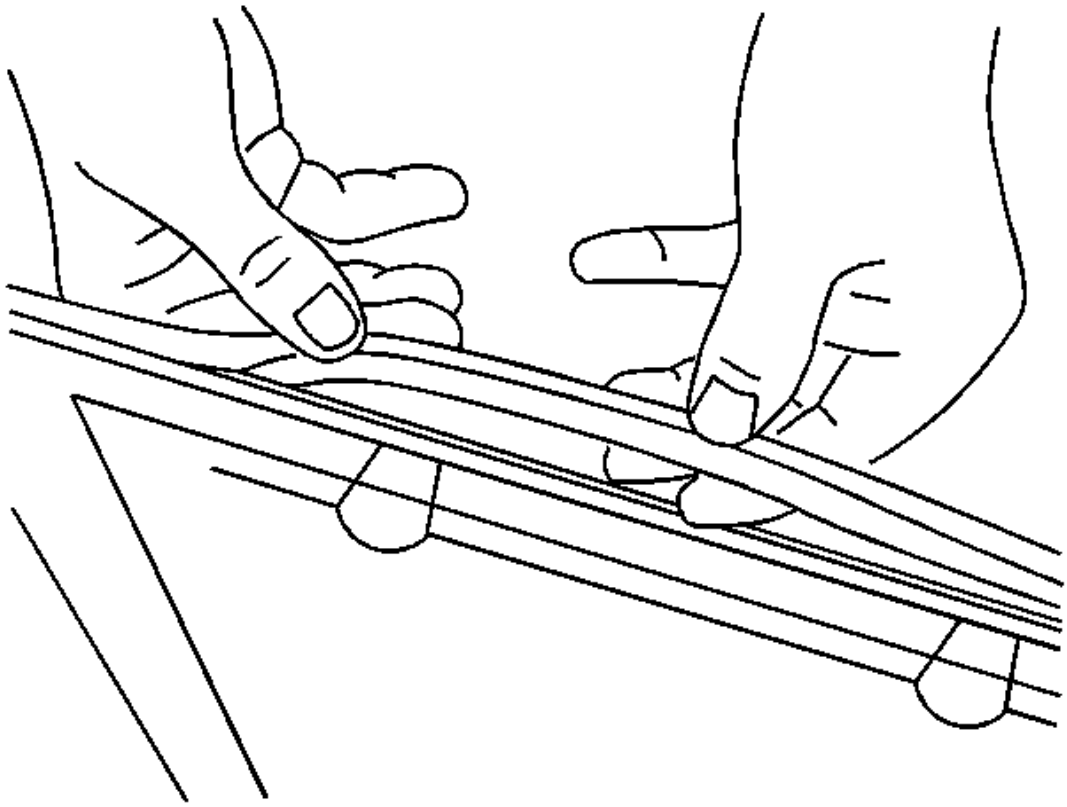


Fig. 24: Sunroof Window Weatherstrip
Courtesy of GENERAL MOTORS COMPANY

1. Remove the sunroof window . Refer to **Sunroof Window Replacement**.
2. Remove the sunroof window seal from the sunroof window frame by pulling the sunroof window seal away at one point and continuing around the perimeter of the sunroof window frame.
3. Wipe the perimeter of the sunroof window frame area with a clean, dampened cloth using window cleaner GM P/N 1050427 (Canadian P/N 992727), or isopropyl alcohol in order to clean the surface of the perimeter of the sunroof window frame.

   Allow to air dry.

Installation Procedure

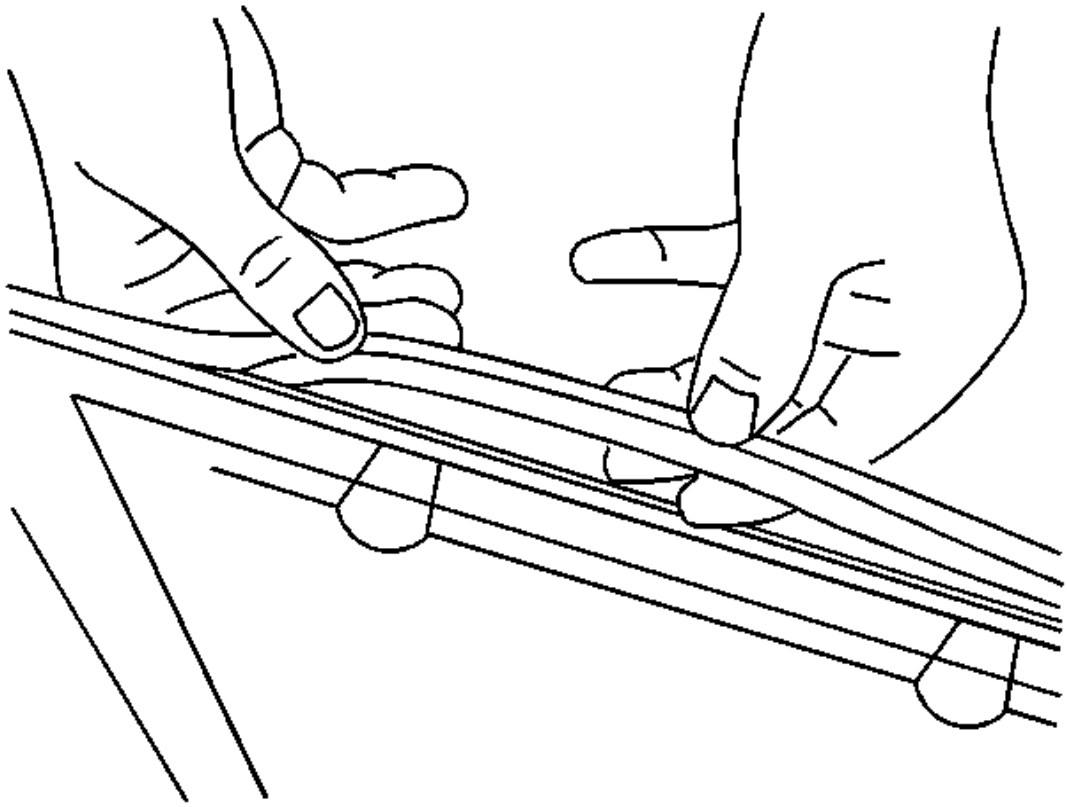


Fig. 25: Sunroof Window Weatherstrip
Courtesy of GENERAL MOTORS COMPANY

1. Position the sunroof window seal into the gutter of the sunroof window frame.

   IMPORTANT: Ensure that the sunroof window seal is properly seated around the entire perimeter of the sunroof window frame.

2. Firmly press the sunroof window seal into place.
3. Install the sunroof window. Refer to **Sunroof Window Replacement**.

SUNROOF SWITCH REPLACEMENT (IMPALA LIMITED)

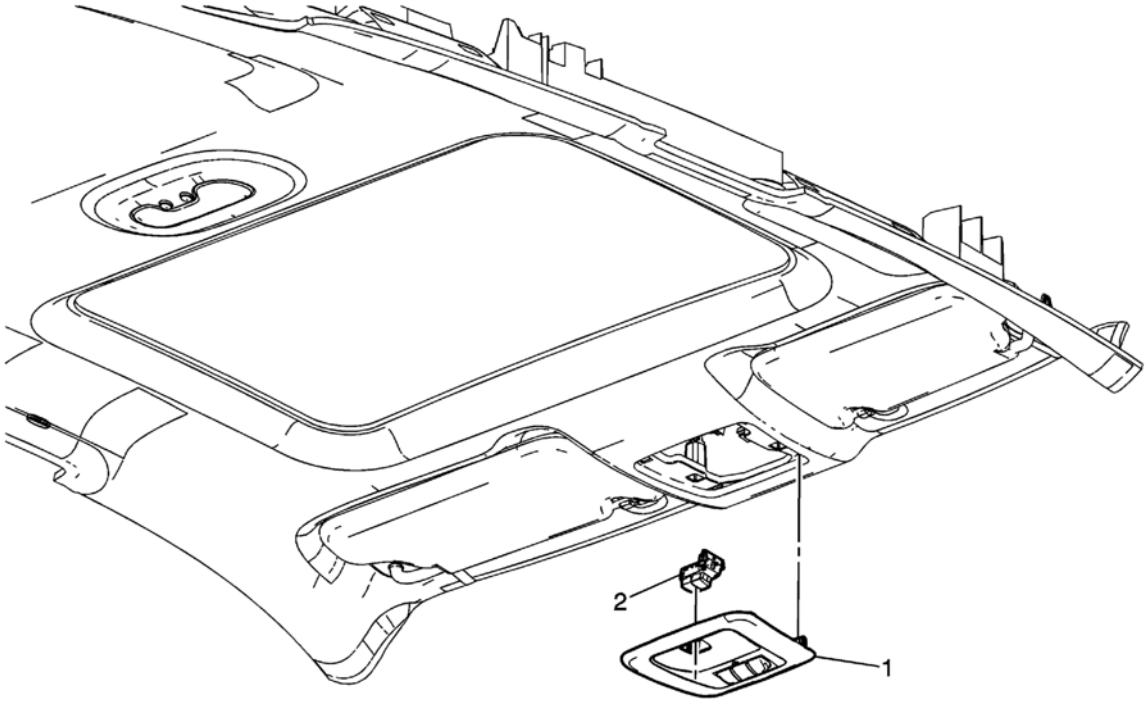


Fig. 26: Sunroof Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** .	
1	Overhead Console Assembly Refer to **Roof Console Replacement** **TIP:** Disconnect the electrical connector.
2	Sunroof Switch Assembly

SUNROOF TRACK TIMING/SYNCHRONIZATION (IMPALA LIMITED)

Removal Procedure

1. Place the module in the full open position.
2. It is only necessary to lower the headliner. Only do those step in headliner replacement that will lower the headliner enough to gain access to the part. Refer to **Headlining Trim Panel Replacement** .
3. Disconnect the electrical connector from the motor/actuator.
4. Remove the motor. Refer to **Sunroof Motor/Actuator Replacement**.
5. Push the window guides rearward on the track until the guides are positioned against the rear hard stop.

Installation Procedure

1. Install the motor. Refer to **Sunroof Motor/Actuator Replacement**.
2. Connect the electrical connector to the motor/actuator.
3. Install the headliner. Refer to **Headlining Trim Panel Replacement** .

4. Perform the Initialization/Teach Procedure. Refer to **Sunroof Motor/Actuator Initialization/Teach Process**.
5. Verify the operation of the sunroof.

SUNROOF WINDOW HEIGHT AND OPENING FIT ADJUSTMENT

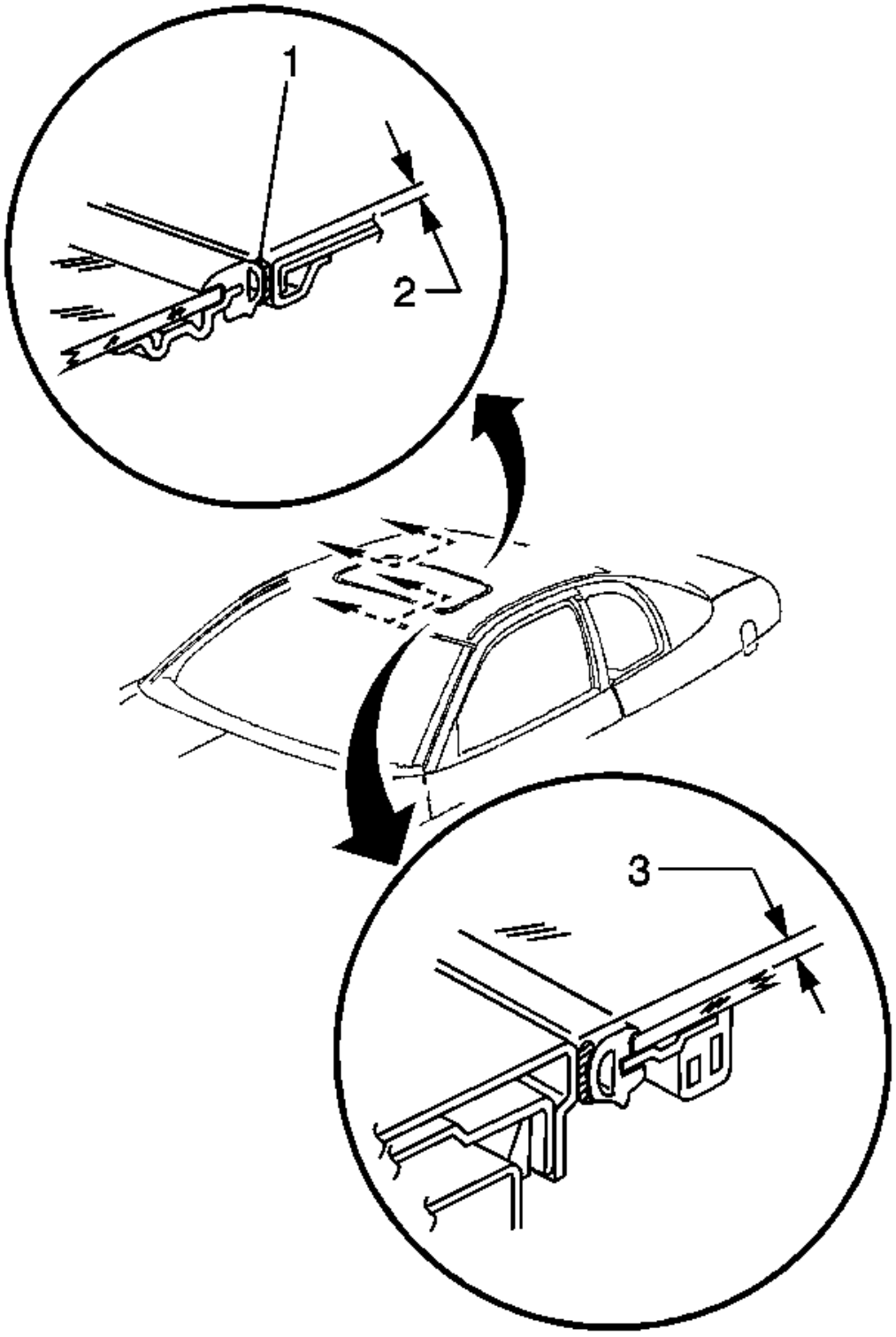


Fig. 27: Adjusting Sunroof Window Panel

Courtesy of GENERAL MOTORS COMPANY

1. Slide the sunroof sunshade to the open position.
2. Move the sunroof glass panel to the fully closed position.
3. Loosen the sunroof glass panel screws.
4. Individually adjust the 4 corners (1) of the sunroof glass panel.
5. Adjust the front of the sunroof glass panel to 1.5 mm (0.050 in) below the top surface of the roof panel (3).
6. Adjust the rear of the sunroof glass panel to 1.5 mm (0.050 in) above the top surface of the roof panel (2).

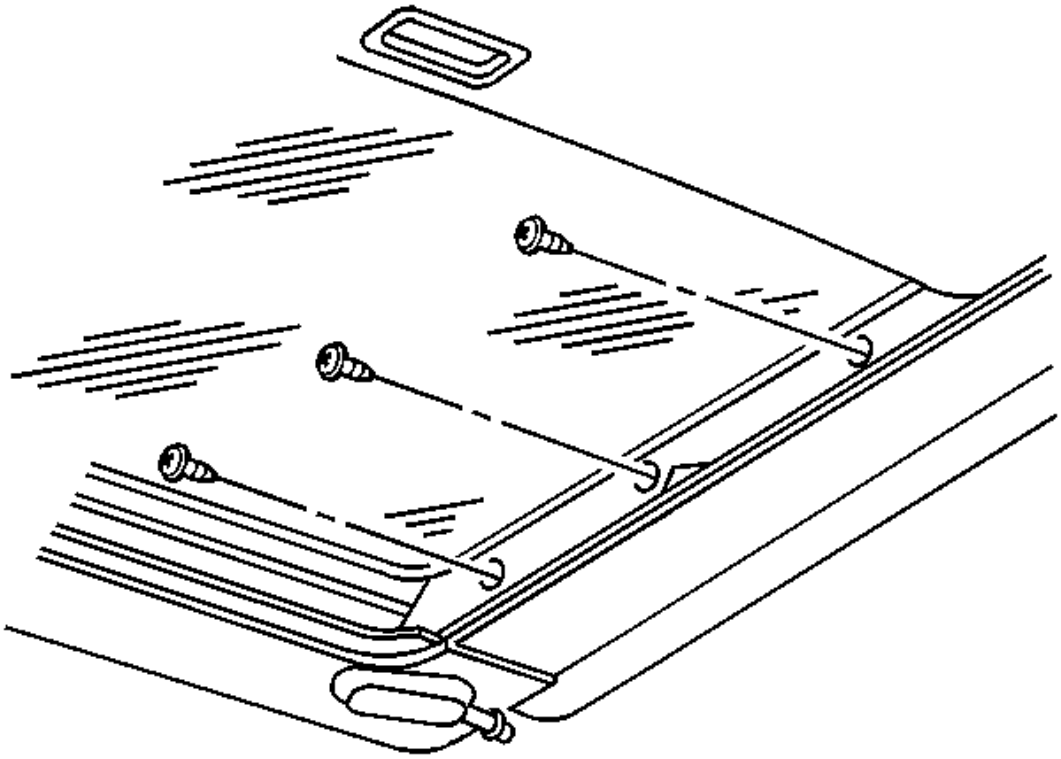


Fig. 28: View Of Sunroof Window Panel Screws
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. Tighten the sunroof glass panel screws.

Tighten

Tighten the screws to 4 N.m (35 lb in).

SUNROOF WINDOW REPLACEMENT

Removal Procedure

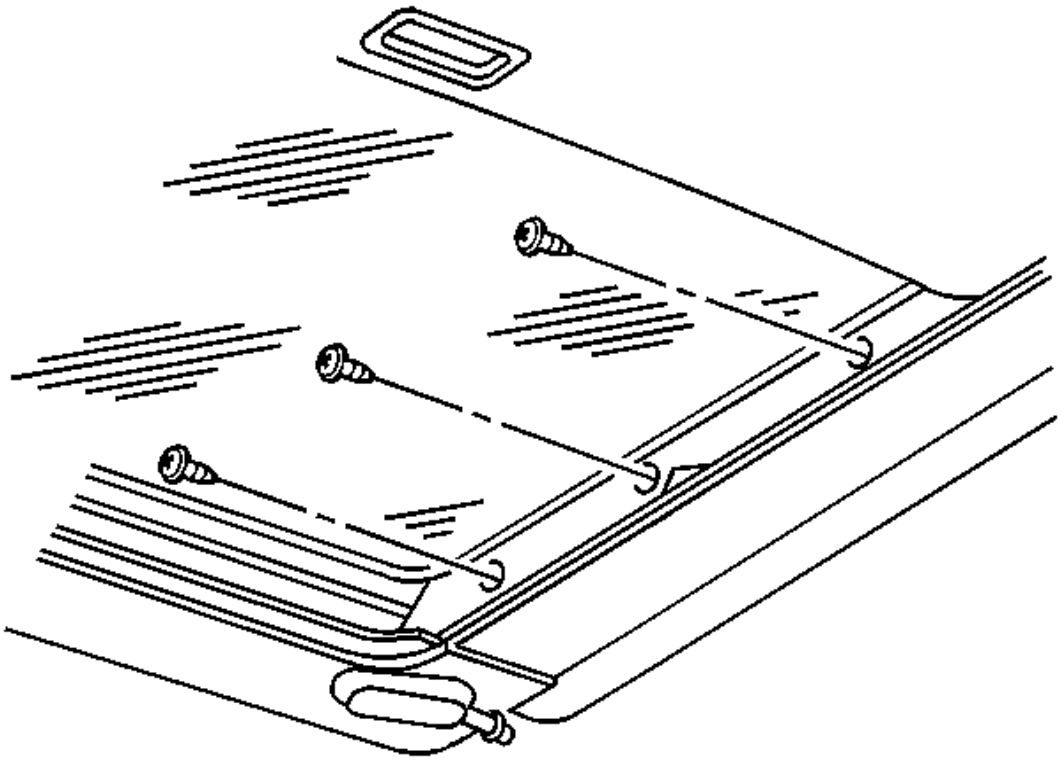


Fig. 29: View Of Sunroof Window Panel Screws
Courtesy of GENERAL MOTORS COMPANY

1. Position the sunshade panel fully rearward.
2. Position the sunroof window panel to the vent position.
3. Remove the sunroof window panel screws from the sunroof window panel.
4. Remove the sunroof window panel from the sunroof module.

Installation Procedure

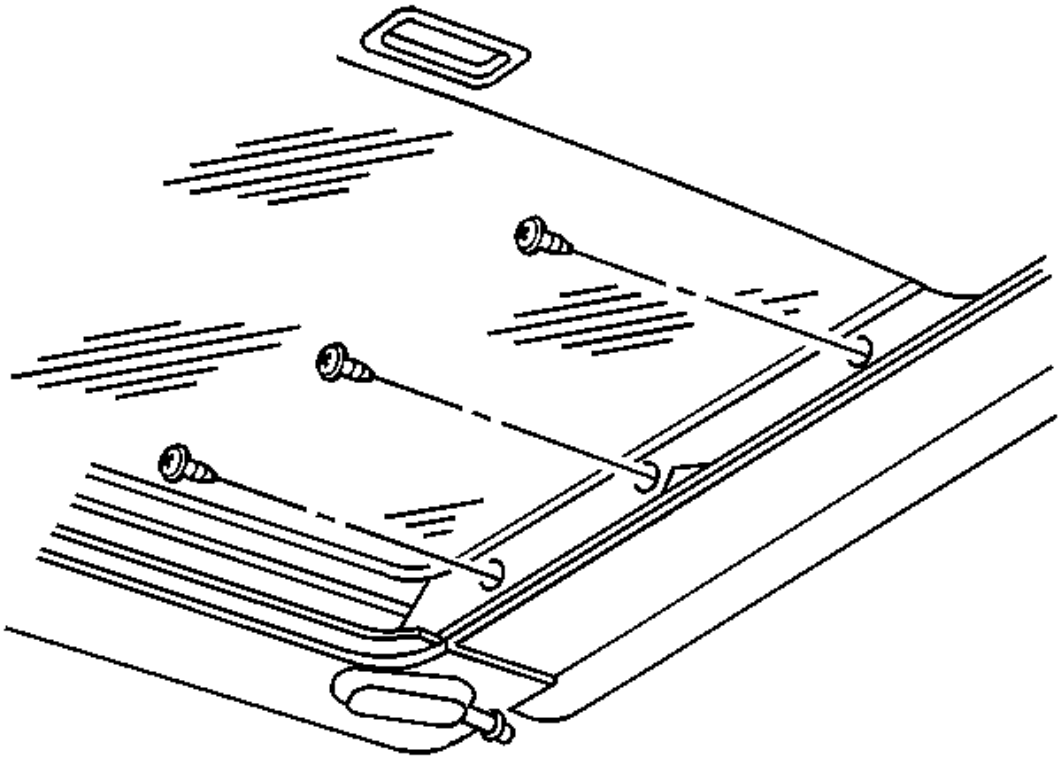


Fig. 30: View Of Sunroof Window Panel Screws
Courtesy of GENERAL MOTORS COMPANY

1. Position the sunroof window panel to the sunroof module.

   Ensure that the information logo stencil is towards the rear of the sunroof opening.

   CAUTION: Refer to Fastener Caution .

2. Install the sunroof window panel screws to the sunroof window panel.

   Tighten

   Tighten the sunroof window panel screws to 4 N.m (35 lb in).

3. Adjust the sunroof window panel as necessary. Refer to **Sunroof Window Height and Opening Fit Adjustment**.
4. Inspect the sunroof window panel for proper operation.

DESCRIPTION AND OPERATION

SUNROOF DESCRIPTION AND OPERATION

Power Sunroof System Components

The Power Sunroof System consists of the following components:

- Sunroof control module
- Sunroof switch
- Sunroof glass
- Rail and track assembly upon which the sunroof glass rides
- Sunroof sunshade
- S/ROOF 20A Fuse
- Ground G301

Power and Grounds

Battery positive voltage is supplied at all times to the sunroof control module from the 20 A S/ROOF fuse located in the instrument panel fuse block. Ground is supplied to the sunroof control module through the module ground circuit and G301.

Ground is supplied to the sunroof switch through the switch ground circuit and G301.

Power Sunroof Operation

The Power Sunroof System will operate only with the ignition turned to the RUN or Accessory position, this allows for retained accessory power (RAP) control of the sunroof through the body control module (BCM). With the ignition in the run or accessory position, the BCM supplies the sunroof with ignition voltage which allows sunroof operation. Once the ignition switch is turned off the sunroof will continue to operate until any door is opened or when the RAP timer reaches its shut-off limit. For a description and operation of the RAP operation, refer to **Retained Accessory Power Description and Operation** .

IMPORTANT:

- If, during service, the sunroof control module has lost battery positive voltage or ground, or has been replaced, it will be necessary to initialize the control module once service has been completed. Refer to **Control Module References** .
- The sunroof can be manually cycled with a regular screwdriver, once the headliner is removed. This screwdriver fits into the drive gear, and when turned will operate the sunroof drive cables and simultaneously open or close the sunroof.

When the sunroof is commanded to open, it will move the sunshade to the open position as well. The sunshade can be manually opened and closed from inside of the vehicle while the sunroof is in the closed position. The sunshade is designed to stay in the open position while the sunroof is in the open position.

Any water that passes the roof seal is drained from the sunroof tray by 4 tubes that lead from the corners of the tray to the rocker panels of the vehicle. The tray which acts as a framework for the sunroof assembly, has a water channel that encircles the sunroof opening and directs the water to the drain tubes.

Sunroof Switch Operation

When the sunroof is in the closed position, it can be raised to the vent position by pressing the OPEN side of the switch once. The sunroof may then be expressed to the fully open position by momentarily pressing the OPEN side of the switch a second time, or it may be adjusted to any preferred open position by pressing and holding the OPEN switch until the sunroof has reached the desired position. To fully close the sunroof, press and hold the CLOSE side of the switch. Release the CLOSE side of the switch in order to stop the sunroof at any preferred closed position. Whenever the sunroof is in the express open mode, it can be stopped by momentarily pressing either side of the switch.

Sunroof Control Module

The sunroof control module is located between the headliner and the roof structure, while the sunroof switch is located above the rearview mirror. The sunroof control module supplies voltage to the contacts of the sunroof switch through the sunroof switch close signal circuit and the sunroof switch open signal circuit. The sunroof control module also supplies ground to the switch contacts through the sunroof switch low reference circuit. When the switch is operated, the contacts and signal circuit for the selected mode are closed to ground, the voltage is pulled low in the sunroof control module, and the appropriate signal is recognized by the sunroof control module. The sunroof control module then internally applies battery positive voltage and ground to the appropriate circuits of the reversible motor in order to move the sunroof glass to the open, close, or vent position.

Article GUID: A00737218

General Information

Waterleaks - Impala

DIAGNOSTIC INFORMATION AND PROCEDURES

WATERLEAK TEST PREPARATION

- GM vehicles are designed to operate under normal environmental conditions.
- The design criteria for sealing materials and components takes into consideration the sealing forces required to withstand the natural elements. These specifications cannot take into consideration any artificial conditions, i.e., high pressure car washes.
- The water leak test procedure has been correlated to the natural elements and will determine the ability of a vehicle to perform under normal operating conditions.
- The first step in diagnosing a leak is determining the conditions under which a leak occurs. If the general leak area can be found, the exact entry point can be isolated using a water hose or an air hose. Some trim panels or components may need to be removed in order to repair the leak.
- If leaks are found around a door, door window, rear compartment lid or liftgate area this does not necessarily indicate a bad weatherstrip. An adjustment to these areas may resolve the condition.

1. **Watertest Stand Assembly**

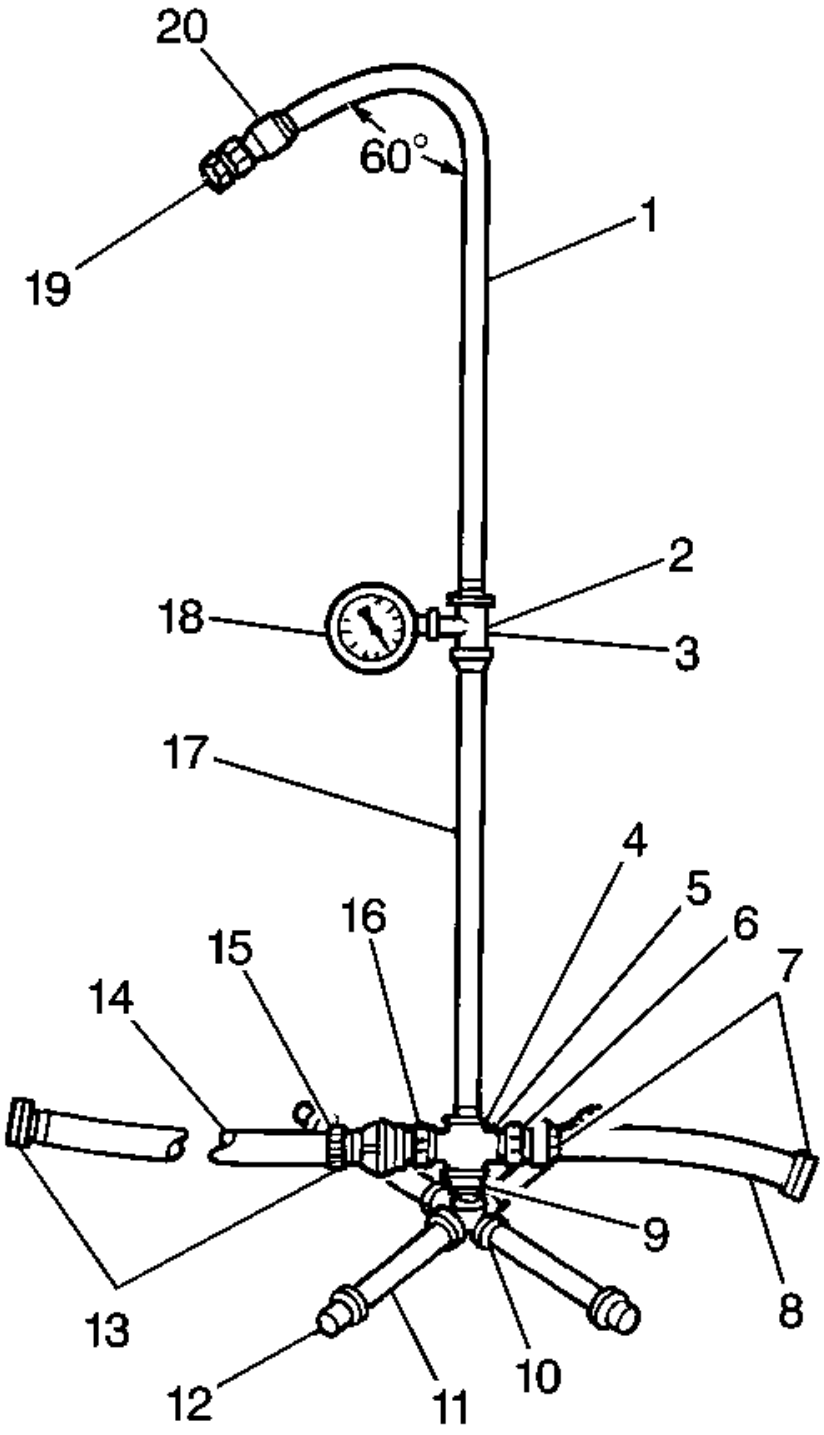


Fig. 1: View Of Watertest Stand Assembly
Courtesy of GENERAL MOTORS COMPANY

Assemble the water test stand as shown.

Callout	Component Name
1	Pipe (0.5 x 36 in)

Callout	Component Name
2	Reducing Tee, Right Stand Only (0.5 x 0.5 x 0.25 in)
3	Coupling, Left Stand Only, (0.5 in)
4	Tee, Left Stand Only (0.5 in)
5	Cross, Right Stand Only (0.5 in)
6	Pipe to Hose Nipple, Right Stand Only (0.5 in)
7	Female Hose Coupling (5/8 in)
8	Input Hose, Right Stand Only (2.0 ft) (5/8 in diameter)
9	Close Nipple (0.5 in)
10	Cross (0.5 in) with Weld-On Cap (0.5 in)
11	Nipple (0.5 x 12 in)
12	Cap (0.5 in)
13	Female Hose Coupling (5/8 in)
14	Cross Hose (12 ft) (5/8 in diameter)
15	Hose Quick Connect
16	Pipe to Hose Nipple (0.5 in)
17	Pipe (0.5 x 60 in)
18	Water Pressure Gauge, Right Stand Only
19	Full Jet Spray Nozzle, No. 1/2GG-25 or Equivalent
20	Coupling (0.5 in)

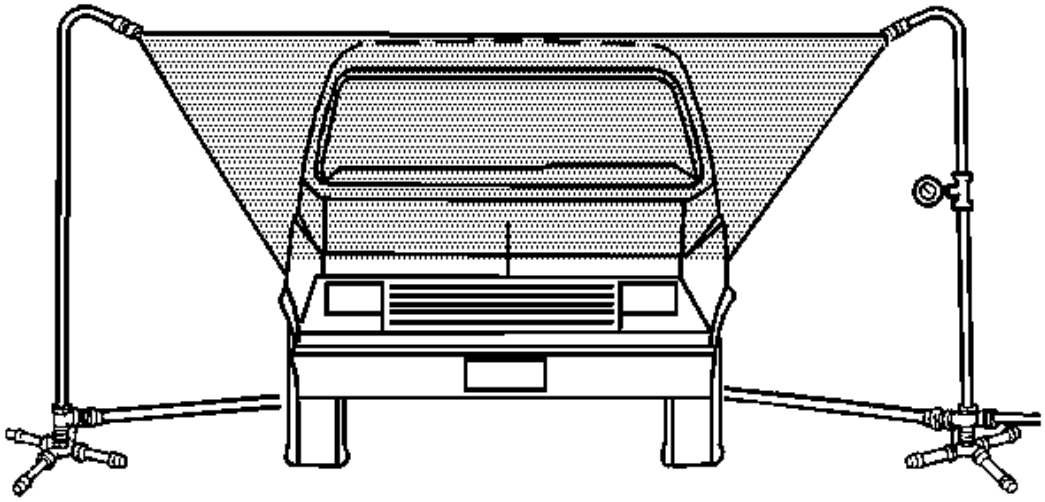


Fig. 2: Illustrating How Water Spray From Stands Should Overlap Vehicle
Courtesy of GENERAL MOTORS COMPANY

2. Position the stands as shown.

   The water spray from the stands should overlap the vehicle as shown.

3. Have an assistant inside of the vehicle during the test in order to locate any leaks.
4. The water pressure at the nozzle should maintain a 155 kPa (22 psi), for at least 4 minutes.

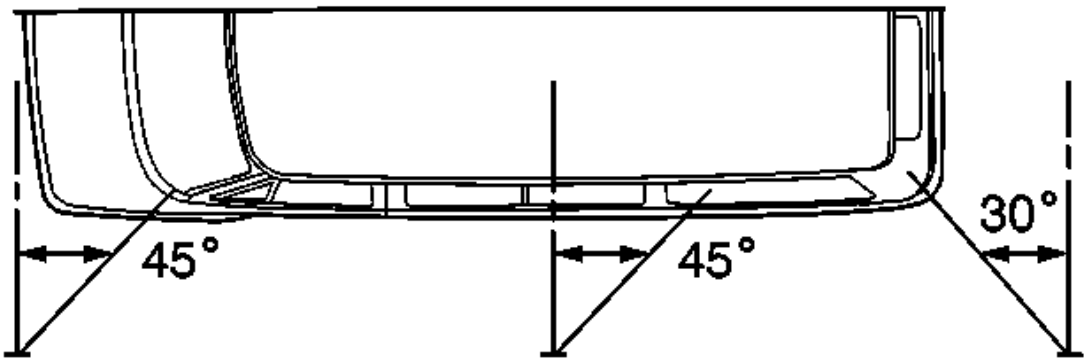


Fig. 3: Identifying Proper Water Spray Angles
Courtesy of GENERAL MOTORS COMPANY

5. In order to check the windshield, aim the water spray 30 degrees down and 45 degrees toward the rear.

   Aim the water towards the corner of the windshield.

6. In order to check the side windows for leaks, position the water stand towards the center of the rear quarter, aiming the water spray 30 degrees down and 45 degrees toward the rear.
7. In order to check the back window, aim the water spray 30 degrees down and 30 degrees toward the front.

DUST LEAKS

Dust may leak into the vehicle where water will not. This happens particularly in the lower portion of the interior.

Forward motion of the vehicle can create a slight vacuum which pulls air and dust into the vehicle.

In order to determine the location of dust leaks, perform the following steps:

1. Remove the mats from the floor.
2. Remove the mats from the kick panel.
3. Remove the insulation from the floor.
4. Remove the insulation from the kick panel.
5. Drive the vehicle on a dusty road.
6. Examine the interior.

   Dust in the shape of a small cone or slit will usually be found at the point of leakage.

7. Mark the points of leakage.

   NOTE: **Ensure that the interior is darkened when performing this step.**

8. Shine bright lamps on the underside of the floor and the cowl.
9. Have an assistant mark any points inside of the vehicle for any points where the light shines through.
   - Inspect the weld joints.
   - Inspect the body mounts.
10. Seal any leaks with an air-drying, body-sealing compound.

WATER HOSE TEST

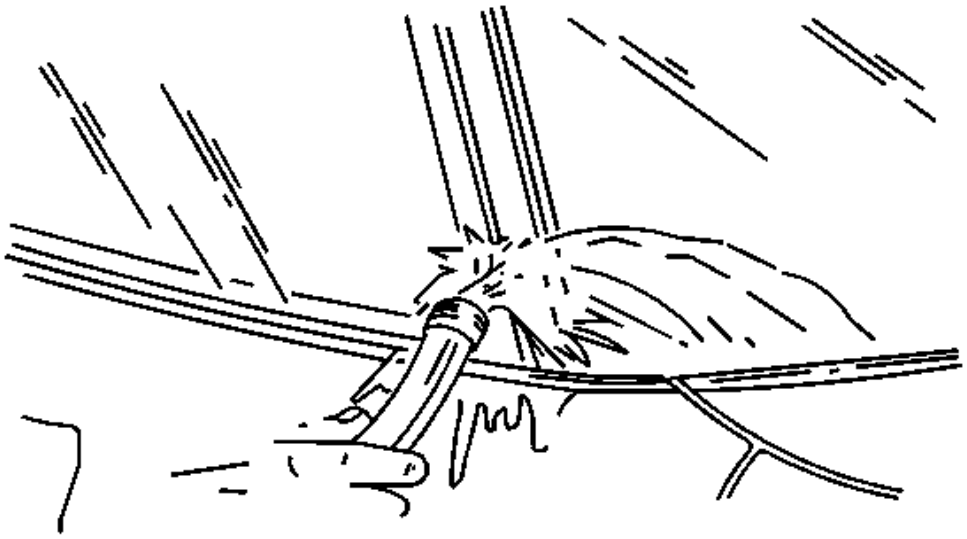


Fig. 4: Performing Water Hose Test
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a water hose without the nozzle attached.**

1. Have an assistant inside of the vehicle in order to locate the leak.
2. Begin testing at the base of the window or the windshield.
3. Slowly move the hose upward and across the top of the vehicle.

AIR HOSE TEST

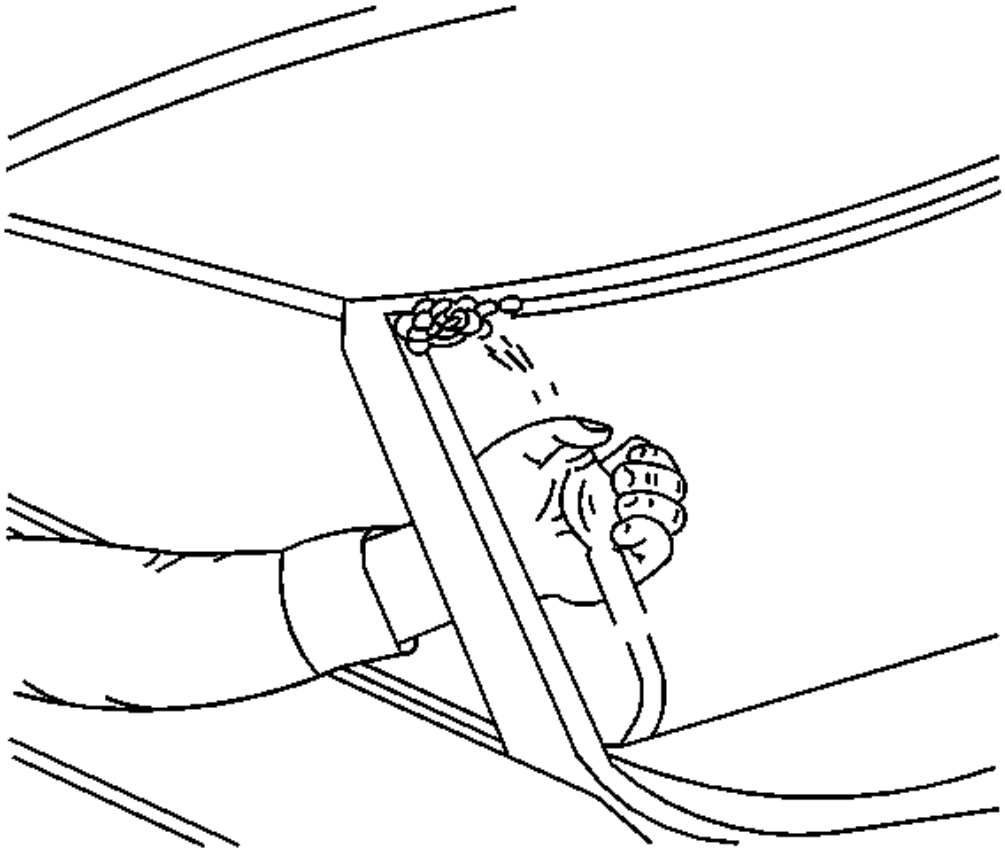


Fig. 5: Performing Air Hose Test
Courtesy of GENERAL MOTORS COMPANY

CAUTION: The air hose test should only be used on fully cured urethane adhesive. Otherwise, damage to the urethane adhesive bead could result in additional leaks.

1. Using a liquid detergent, diluted with water in a spray bottle, spray the window at the edges. Begin at the bottom and gradually move up and across the top.

NOTE: The compressed air should not exceed 205 kPa (30 psi).

2. Have an assistant inside of the vehicle with an air hose.
3. Have the assistant aim the compressed air at the suspected areas.

Bubbles will form in the soap solution at the location of the leak.

REPAIR INSTRUCTIONS

BODY WATERLEAK REPAIR

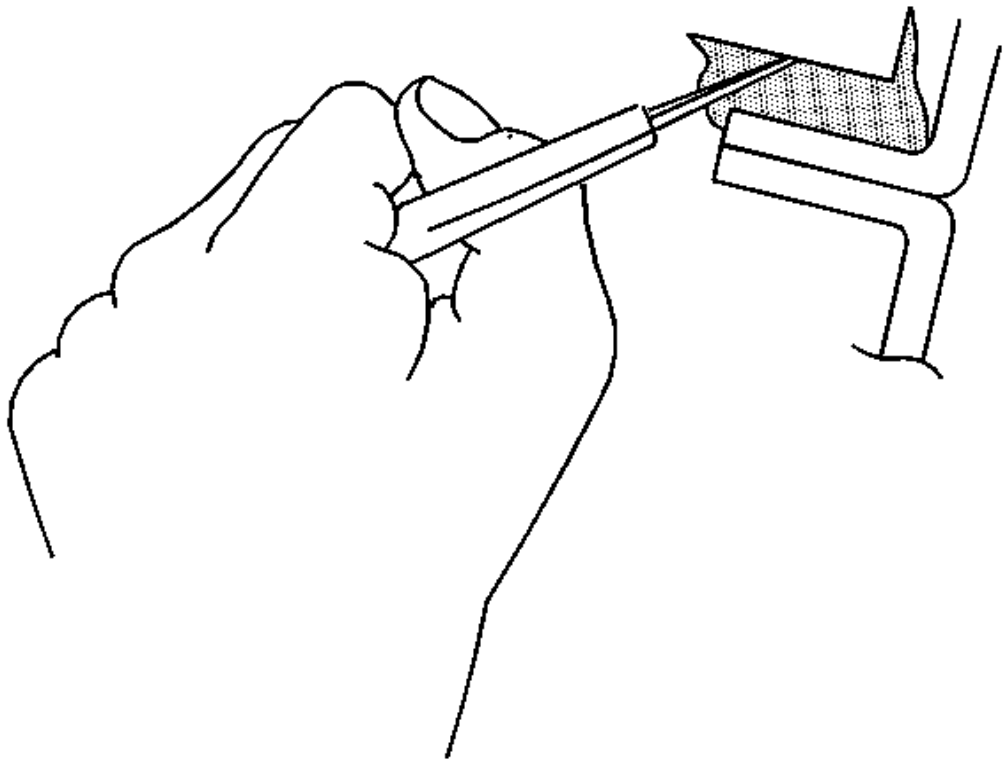


Fig. 6: Cutting Out A Portion Of The Adhesive Caulking (1 Of 2)
Courtesy of GENERAL MOTORS COMPANY

WARNING: If the vehicle interior is exposed to moisture and becomes soaked up to the level of the sensing and diagnostic module (SDM), the SDM and SDM harness connector must be replaced. The SDM could be activated when powered, which could cause airbag deployment and result in personal injury.

Depending on the location of the waterleak, you may have to remove certain interior components in order to repair the leak.

1. If the floor carpet is wet refer to **Floor Carpet Drying** .

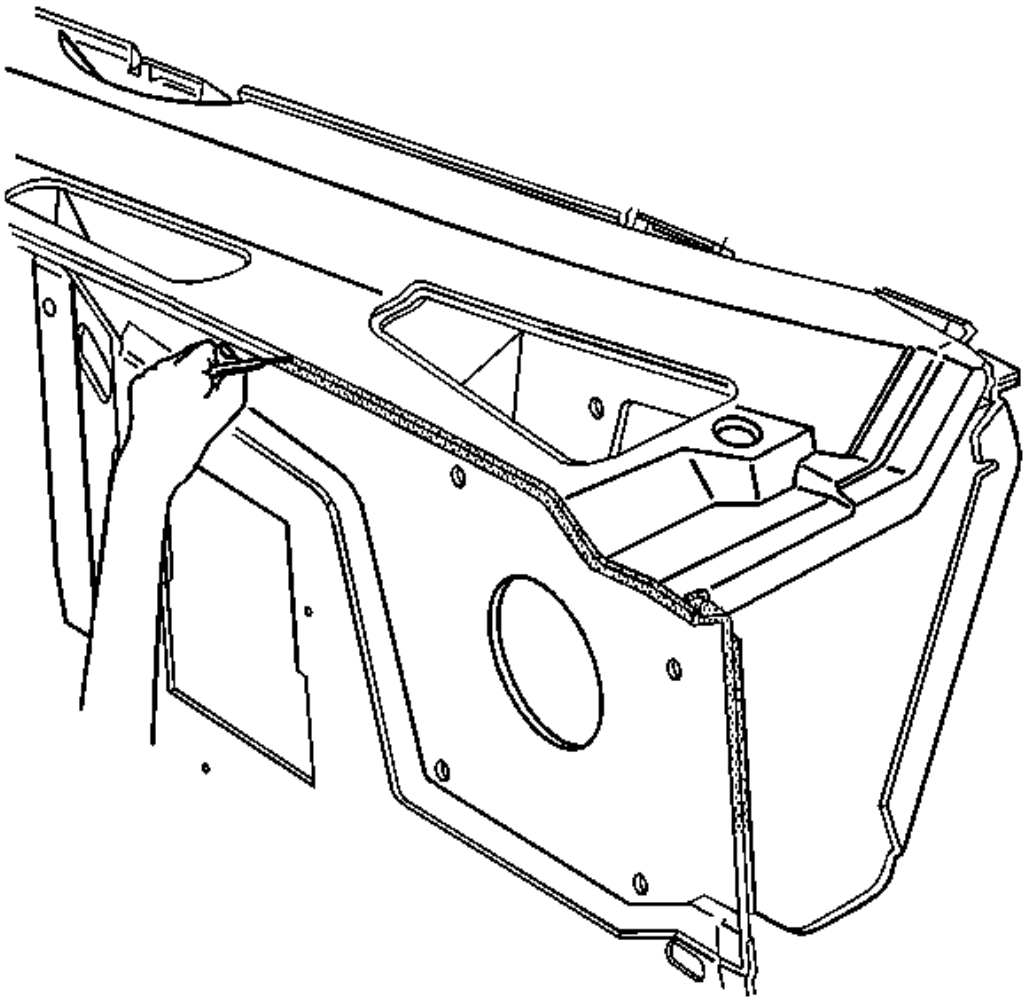


Fig. 7: Cutting Out A Portion Of The Adhesive Caulking (2 Of 2)
Courtesy of GENERAL MOTORS COMPANY

2. Cut out a portion of the adhesive caulking in the leak area from inside or outside of the vehicle.
3. Clean and remove all loose particles of the adhesive old caulking from the area.
4. Apply joint body and seam sealer where the old adhesive caulking was removed.
5. Allow the adhesive caulking to dry for several hours.
6. Test for leaks.
7. Install the trim, if removed.

STATIONARY WINDOW WATERLEAK REPAIR

WARNING: If any water enters the vehicle interior up to the level of the carpet or higher and soaks the carpet, the sensing and diagnostic module (SDM) and the SDM harness connector may need to be replaced. The SDM could be activated when powered, which could cause deployment of the air bag(s) and result in personal injury. Before attempting these procedures, the SIR system must be disabled. Refer to Disabling the SIR System.

With the ignition OFF, inspect the SDM mounting area, including the carpet. If any significant soaking or evidence of significant soaking is detected, you must perform the following tasks:

1. **Remove all water.**
2. **Repair the water damage.**
3. **Replace the SDM harness connector.**
4. **Replace the SDM.**

Failure to follow these tasks could result in possible air bag deployment, personal injury, or otherwise unneeded SIR system repairs.

1. If the floor carpet is wet refer to **Floor Carpet Drying** .
2. Remove the trim moldings or the headliner in order to repair the leak, if needed.
3. Determine the source of water entry.
4. If water is leaking at the edge of the windshield, reseal the windshield using Urethane Adhesive Systems which meet GM Specification GM 3651G.
5. If water leaks into the vehicle at the sides of the stationary windows, reseal the window using Urethane Adhesive Systems which meet GM Specification GM 3651G.

Article GUID: A00737255

Brakes

Antilock Brake System - Impala Limited

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Brake Pipe Fittings	24 N.m	18 lb ft
Brake Pressure Modulator Valve (BPMV) Bracket Nut- Engine Compartment	3 N.m	27 lb in
BPMV Bracket Nut- Wheelhouse	10 N.m	89 lb in
Electronic Brake Control Module (EBCM) Bolt	10 N.m	89 lb in
EBCM Screws	5 N.m	44 lb in
Yaw Sensor with Lateral Accelerometer Nut	26 N.m	19 lb ft

SCHEMATIC WIRING DIAGRAMS

ANTILOCK BRAKE SYSTEM WIRING SCHEMATICS

Power, Ground, and Brake Pressure Modulator Valves

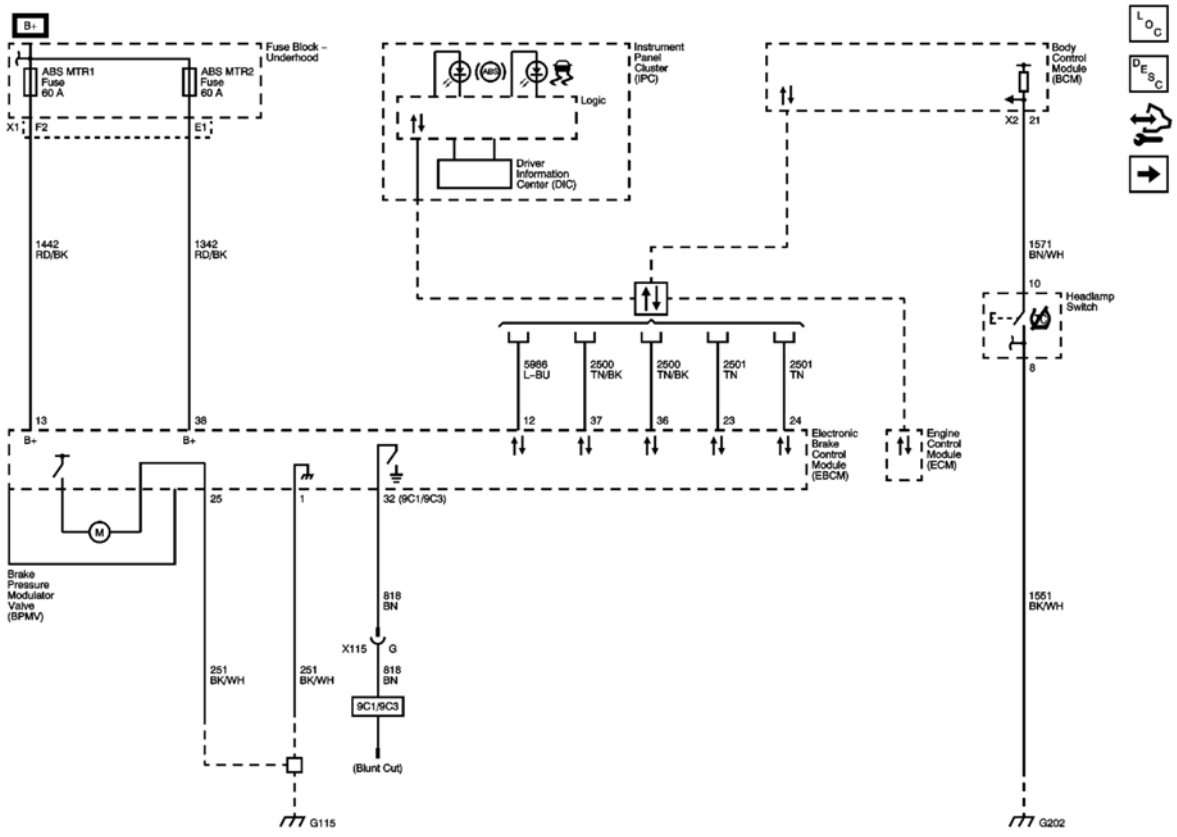


Fig. 1: Power, Ground, and Brake Pressure Modulator Valves Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

Wheel Speed Sensors

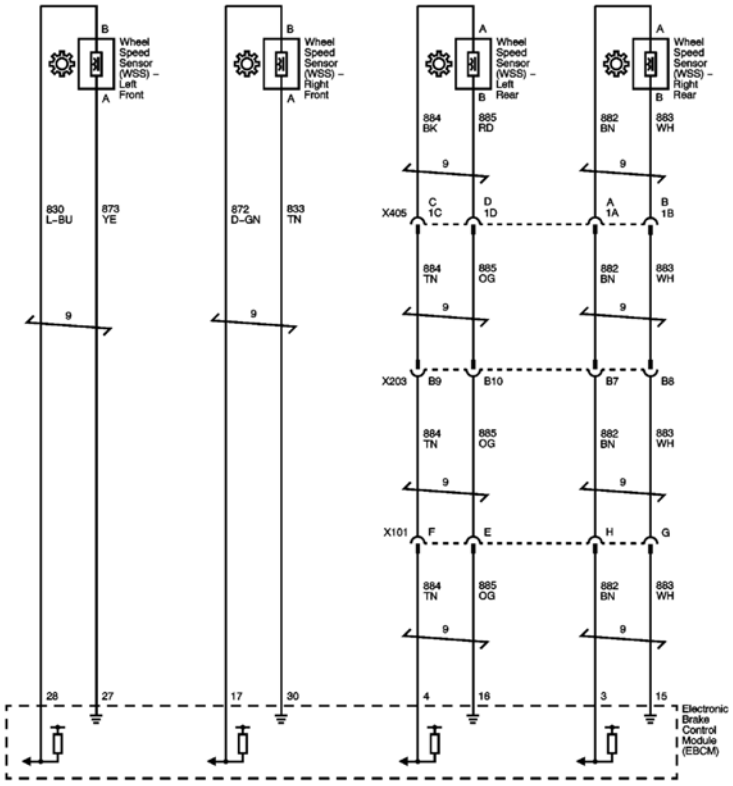


Fig. 2: Wheel Speed Sensors Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Steering Angle and Yaw and Lateral Accelerometer Sensors

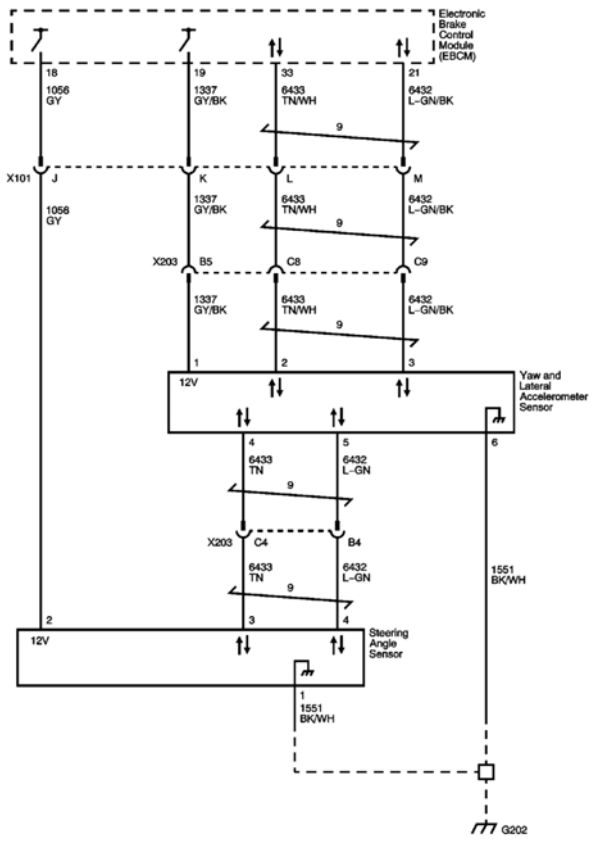


Fig. 3: Steering Angle and Yaw and Lateral Accelerometer Sensors Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC C0035-C0050: WHEEL SPEED SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0035 00

Left Front Wheel Speed Sensor Circuit No Additional Information

DTC C0035 0F

Left Front Wheel Speed Sensor Circuit Erratic Signal

DTC C0035 18

Left Front Wheel Speed Sensor Circuit Signal Amplitude Less Than Minimum

DTC C0035 5A

Left Front Wheel Speed Sensor Circuit Signal Plausibility Failure

DTC C0040 00

Right Front Wheel Speed Sensor Circuit No Additional Information

DTC C0040 0F

Right Front Wheel Speed Sensor Circuit Erratic Signal

DTC C0040 18

Right Front Wheel Speed Sensor Circuit Signal Amplitude Less Than Minimum

DTC C0040 5A

Right Front Wheel Speed Sensor Circuit Signal Plausibility Failure

DTC C0045 00

Left Rear Wheel Speed Sensor Circuit No Additional Information

DTC C0045 0F

Left Rear Wheel Speed Sensor Circuit Erratic Signal

DTC C0045 18

Left Rear Wheel Speed Sensor Circuit Signal Amplitude Less Than Minimum

DTC C0045 5A

Left Rear Wheel Speed Sensor Circuit Signal Plausibility Failure

DTC C0050 00

Right Rear Wheel Speed Sensor Circuit No Additional Information

DTC C0050 0F

Right Rear Wheel Speed Sensor Circuit Erratic Signal

DTC C0050 18

Right Rear Wheel Speed Sensor Circuit Signal Amplitude Less Than Minimum

DTC C0050 5A

Right Rear Wheel Speed Sensor Circuit Signal Plausibility Failure

Diagnostic Fault Information

Circuit	Short to	Open or High	Short to	Signal

	Ground	Resistance	Voltage	Performance
Left Front Sensor Signal	C0035 00	C0035 00	C0035 00	C0035 0F, C0035 18, C0035 5A
Left Front Sensor Low Reference	C0035 00	C0035 00	C0035 00	C0035 0F, C0035 18, C0035 5A
Right Front Sensor Signal	C0040 00	C0040 00	C0040 00	C0040 0F, C0040 18, C0040 5A
Right Front Sensor Low Reference	C0040 00	C0040 00	C0040 00	C0040 0F, C0040 18, C0040 5A
Left Rear Sensor Signal	C0045 00	C0045 00	C0045 00	C0045 0F[1] , C0045 18, C0045 5A
Left Rear Sensor Low Reference	C0045 00	C0045 00	C0045 00	C0045 0F[1] , C0045 18, C0045 5A
Right Rear Sensor Signal	C0050 00	C0050 00	C0050 00	C0050 0F[1] , C0050 18, C0050 5A
Right Rear Sensor Low Reference	C0050 00	C0050 00	C0050 00	C0050 0F[1] , C0050 18, C0050 5A
[1] Damaged rear wheel speed sensor ring can cause code to set.				

Circuit/System Description

As the wheel spins, the wheel speed sensor produces an AC signal. The electronic brake control module (EBCM) uses the frequency of the AC signal to calculate the wheel speed.

Conditions for Running the DTC

C0035 00-C0050 00

- The ignition is ON.
- Ignition voltage is greater than 8 volts.

C0035 0F-C0050 0F

- The ignition is ON.
- Ignition voltage is greater than 8 volts.
- The brake pedal is not pressed.
- A DTC is not set for the other wheel speed circuit on the same axle.

C0035 18-C0050 18

- The ignition is ON.
- Ignition voltage is greater than 8 volts.
- The brake pedal is not pressed.
- No other wheel speed circuit DTCs are set.
- At least two other wheel speeds are not 0 km/h.

Conditions for Setting the DTC

C0035 00-C0050 00 Open or Shorted Signal

- An open is detected on the wheel speed sensor signal circuit.
- A short to ground is detected on the wheel speed sensor signal circuit.
- A short to voltage is detected on the wheel speed sensor signal circuit.

C0035 0F-C0050 0F Sensor Dropout

Detects a missing sensor signal when the vehicle has been in motion with all sensors working.

- All wheel speeds have been read as greater than 12.9 km/h (8 mph).
- One wheel speed suddenly reads 0 km/h (0 mph) within 15 msec.
- Vehicle velocity remains greater than 12.9 km/h (8 mph).

OR

C0035 0F-C0050 0F Erratic Signal

- Any wheel speed changes by 17.7 km/h (11 mph) or more in 0.01 second.
- Vehicle velocity remains greater than 12.9 km/h (8 mph).

C0035 18-C0050 18 Missing Sensor

Detects a missing sensor signal (or signals) when the vehicle accelerates from a standstill.

- One wheel speed is less than 20 percent of the maximum of the others for 5 seconds.
- At least one of the remaining wheel speeds are greater than 12.9 km/h (8 mph).
- There has been no wheel acceleration/deceleration exceeding 21.9 mph/sec.

OR

- The 2 wheel speed sensor inputs are less than 20 percent of the maximum of the others for 120 seconds.
- At least one of the remaining wheel speeds are greater than 12.9 km/h (8 mph).
- There has been no wheel acceleration/deceleration exceeding 21.9 mph/sec.

Action Taken When the DTC Sets

- The EBCM disables the Antilock Brake System (ABS)/Traction Control System (TCS)/Vehicle Stability Enhancement System (VSES) for the duration of the ignition cycle.
- The dynamic rear proportion (DRP) does not function optimally.
- The ABS indicator turns ON.
- The Traction Control indicator turns ON.
- The driver information center (DIC) displays the Service Stability System message.

Conditions for Clearing the MIL/DTC

- The condition for setting the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

- A damaged rear wheel speed sensor ring can cause failure type byte 04 (Erratic Signal) to set.
- If 2 or more wheel speed sensors are inoperative diagnose each wheel speed sensor individually.

C0035 18, 0F, 00-C0050 18, 0F, 00

If the customer comments that the ABS indicator is ON only during moist environmental conditions: rain, snow, vehicle wash, etc., inspect the wheel speed sensor wiring for signs of water intrusion. If the DTC is not current, clear all DTCs and simulate the effects of water intrusion by using the following procedure:

1. Spray the suspected area with a 5 percent saltwater solution. To create a 5 percent saltwater solution, add 2 teaspoons of salt to 8 fl oz of water (10 g of salt to 200 ml of water).
2. Test drive the vehicle over various road surfaces: bumps, turns, etc., above 40 km/h (25 mph) for at least 30 seconds.
3. Rinse the area thoroughly when completed.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

With scan tool installed drive the vehicle in a straight line at a speed greater than 8 km/h (5 mph), all wheel speed sensors should read the same miles per hour.

Circuit/System Testing

IMPORTANT: Component Testing is performed before Circuit Testing when diagnosing wheel speed sensors.

1. With the ignition OFF, disconnect the EBCM connector.
2. With the ignition ON, measure for 0 volt between the sensor signal circuit terminal or the low reference circuit and ground at the EBCM connector.
    - If over 0 volt, repair short to voltage in sensor signal circuit or the low reference circuit.
3. With the ignition OFF, measure for infinite ohms of resistance between the wheel speed sensor signal or the low reference circuit and ground at the EBCM connector.
    - If less than infinite ohms, repair short to ground in the sensor signal or the low reference circuit.
4. Measure for 850-1350 ohms of resistance between the wheel speed sensor signal and low reference circuits at the EBCM connector.
    - If greater than 1350 ohms test for an open/high resistance in the circuit or faulty wheel speed sensor.
    - If less than 850 ohms test for a short between the circuits or faulty wheel speed sensor.
5. If all circuits test normal replace the EBCM.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate wheel speed sensor.
2. Test for 850-1350 ohms between the signal terminal A and the low reference signal terminal B. During the test, check for an intermittent circuit condition by gentle moving the wheel speed sensor pigtail harness.
    - If not within the specified range, replace the wheel speed sensor.
3. Test for infinite resistance between each terminal and the steering knuckle. Reverse the test leads, test for infinite resistance between each terminal and the steering knuckle again.
    - If less than the specified value, replace the appropriate wheel speed sensor.
4. Spin the wheel while monitoring the voltage between the signal terminal A and the low reference terminal B. The voltage should be greater than 100 mV AC.
    - If less than the specified range, replace the wheel speed sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Front Wheel Bearing and Hub Replacement**
- **Rear Wheel Bearing and Hub Replacement**
- **Control Module References** for EBCM replacement, setup, and programming

DTC C0110: PUMP MOTOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0110 00

Pump Motor Circuit No Additional Information

DTC C0110 04

Pump Motor Circuit Open Circuit

DTC C0110 07

Pump Motor Circuit Voltage Above Threshold

DTC C0110 61

Pump Motor Circuit Actuator Stuck

Diagnostic Fault Information

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
Pump Motor Ground	-	1	-	-
EBCM Battery Positive Voltage	-	1	-	-
Pump Motor Circuit	-	C0110 04	C0110 07	C0110 61 C0110 00
1-Circuit Inoperative				

Circuit/System Description

The electronic brake control module (EBCM) supplies ground to activate the Antilock Brake System (ABS) pump motor. An internal system relay in the EBCM supplies battery positive voltage to the pump motor when the ignition is turned ON. The EBCM monitors pump motor feedback voltage after activation to detect a stalled or binding pump motor.

Conditions for Running the DTC

C0110 04

- System and ignition voltage is above 10.5 volts.
- The system enable relay is ON.
- The pump motor has been commanded OFF for 2.5 seconds.

C0110 61

- The ignition is ON.
- The system enable relay is ON.
- The pump motor has been commanded ON, OFF and ON again.

Conditions for Setting the DTC

C0110 04

The EBCM detects an open in the pump motor circuit when the feedback voltage remains greater than 0.75 volt for more than 50 msec.

C00110 61

The pump motor continues to rotate briefly after activation creating a feedback voltage. The EBCM sets the code if the measured feedback voltage indicates a binding or stalled pump motor.

Action Taken When the DTC Sets

- The EBCM disables the ABS and the Traction Control System (TCS) (JL9) for the duration of the ignition cycle.
- The ABS indicator turns ON.
- The Traction Control indicator turns ON.
- The driver information center (DIC) displays the SERVICE TRACTION CONTROL message.

Conditions for Clearing the DTC

- The ABS indicator may remain illuminated after repairs are made and DTCS are cleared, until the vehicle is operated at speeds greater than 13 km/h (8 mph) and the self test is completed.
- The condition for the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

The pump motor is integral to the brake pressure modulator valve (BPMV). The pump motor is not serviceable.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Testing

1. Ignition OFF, disconnect the EBCM harness connector and connect a test lamp between the battery positive voltage circuit terminal, and to chassis ground.
2. Verify that the test lamp illuminates.
    - If the test lamp does not illuminate, repair the open or high resistance in the battery positive voltage circuit.
3. Connect a test lamp between the battery positive voltage circuit and pump motor ground circuit at the EBCM connector, verify that the test lamp illuminates.
    - If the test lamp does not illuminate, repair the open or high resistance in the pump motor ground circuit.
4. Ignition OFF, remove the EBCM from the BPMV.
5. Inspect the EBCM to BPMV connector for conditions such as damage, corrosion, or presence of brake fluid.
    - If connector corrosion or damage is evident, replace BPMV and/or EBCM as necessary.
    - If brake fluid is present, replace both BPMV and EBCM.
6. Connect the EBCM harness to the EBCM with the BPMV still separated.
7. Connect a test lamp between the pump motor circuits, internal EBCM side.
8. Ignition ON, use the scan tool to perform the Pump Motor Test.
    - If test lamp illuminates replace the BPMV.
    - If test lamp does not illuminate replace the EBCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Brake Pressure Modulator Valve Replacement**
- **Control Module References** for EBCM replacement, setup, and programming

DTC C0131: ANTILOCK BRAKE SYSTEM (ABS) TRACTION CONTROL SYSTEM (TCS) PRESSURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0131 00

Antilock Brake System (ABS) Traction Control System (TCS) Pressure Circuit

Circuit/System Description

The electronic brake control module (EBCM) monitors the internal brake pressure sensor signal, and correlates the reading with brake pedal position parameter.

Conditions for Running the DTC

- Ignition ON.
- System voltage is above 9 volts.
- The vehicle speed is greater than 40 km/h (24 mph).

Conditions for Setting the DTC

- A short to voltage, a short to ground, or an open high resistance is detected with the internal brake pressure sensor.
- Brake pedal signal does not correlate to brake pressure signal.
- Signal is erratic.

Action Taken When the DTC Sets

- The EBCM disables the VSES for the duration of the ignition cycle.
- A driver information center message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Verify that DTC C0277, C0297, B3445 or B3884 is not set.
   - If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, observe the scan tool EBCM, BPP Signal parameter. The parameter should be Released when the brake pedal is not applied, and change to Applied when the brake pedal is applied.
   - If not within the specified value, perform the scan tool BCM, BPP Sensor Calibration procedure. Refer to **Brake Pedal Position Sensor Calibration** . If the DTC resets, replace the brake pedal position sensor.
3. Replace the brake pressure modulator valve assembly and verify the DTC does not reset. If the DTC resets, replace the EBCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Brake Pedal Position Sensor Replacement**
- **Brake Pressure Modulator Valve Replacement**
- **Control Module References** for EBCM replacement, programming and setup

DTC C0161: ANTILOCK BRAKE SYSTEM (ABS) BRAKE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0161 00

Antilock Brake System (ABS) Brake Switch Circuit

Circuit/System Description

The brake pedal position (BPP) sensor is an input to the body control module (BCM). The BCM activates the brake lamps when the BPP is in an applied state. The BCM then sends a brake pedal applied state status via high speed GMLAN serial data messages to the electronic brake control module (EBCM). The brake pressure modulator valve (BPMV) sensor monitors the brake pressure and sends a variable voltage signal to the EBCM.

Conditions for Running the DTC

- The vehicle speed is greater than 16 km/h (10 mph).

- The ignition voltage is greater than 9.5 volts.

Conditions for Setting the DTC

- The EBCM detects the vehicle speed greater than 21 km/h (13 mph), the brake pedal is Applied for 1 minute, and brake pressure is not increasing.
- The EBCM detects the brake pedal is Released and the vehicle speed is decreasing while brake pressure is increasing.

Action Taken When the DTC Sets

- The EBCM disables the antilock brake system (ABS), traction control system (TCS) and vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- A driver information center message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

The DTC C0161 00 can be set if the brake pedal is applied while accelerating, the brake pedal position sensor is out of adjustment, or the pedal is binding causing residual brake pressure to be detected, without the brake light signal detected.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Diagnose all other brake light DTCs or Symptoms prior to performing this diagnostic procedure.**

1. Verify that DTC C0277 or C0297 is not set.
   - If DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Apply and release the brake pedal. Verify brake lamps operate properly.
   - If brake lamps do not operate properly, refer to **Symptoms - Lighting** .
3. Verify the brake pedal position sensor or the brake pedal is not binding causing residual brake pressure to be detected, while the brake lights operate properly.
   - If a condition is found, repair or replace the applicable component.
4. Replace the brake pressure modulator valve assembly (BPMV). Verify DTC does not reset. If DTC resets, replace the EBCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Brake Pressure Modulator Valve Replacement**
- **Control Module References** for EBCM replacement, programming and setup

DTC C0179: SYSTEM THERMAL TEMPERATURE HIGH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0179 00

System Thermal Temperature High

Circuit/System Description

The electronic brake control module (EBCM) monitors traction control system activation in order to calculate an estimate of the EBCM solenoid valve temperatures. In most cases high solenoid valve temperatures are caused by traction control system extended activation. If the EBCM calculates that the solenoid valve temperatures are too high, the EBCM will temporarily suspend the traction control system function until the solenoid valves cool.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

The EBCM detects the temperature of the solenoid valves is too high.

Action Taken When the DTC Sets

- The EBCM disables the traction control system/vehicle stability enhancement system.
- A driver information center message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The EBCM calculates the brakes have cooled sufficiently.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

DTC C0179 does not indicate a malfunction has occurred. Most occurrences of this DTC are caused by excessive traction control activation or braking. This DTC indicates there was excessive ABS or traction control activation.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that the DTC sets outside of the Conditions for Running and Setting. Since most occurrences of this DTC are caused by an excessive braking or traction control usage, review with the customer the conditions under which the DTC set.

- If the DTC set within the Conditions for Running and Setting, the brake system is operating as designed.

DTC C0186: LATERAL ACCELEROMETER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0186

Lateral Accelerometer Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	C0292	C0292	C0292	-
Yaw Rate Sensor Signal	C0196	C0196	C0196	-
Lateral Accelerometer Signal	C0186	C0186	C0186	-
Ground	C0186 C0196	C0186, C0196	C0186, C0196	C0196
Yaw Rate Sensor test control	C0196	C0196	C0196	-
Longitudinal Accelerometer Sensor Signal	-	-	-	-

Circuit/System Description

The lateral accelerometer and the yaw rate sensors are combined into one sensor external to the electronic brake control module (EBCM). The vehicle stability enhancement system (VSES) uses the lateral accelerometer input when calculating the desired yaw rate. The usable output voltage range for the lateral accelerometer is 0.25-4.75 volts.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

- The yaw/lateral combination sensor fails an internal self test.
- Ignition voltage to the yaw/lateral combination sensor is less than 9.5 volts.
- Communication is lost between the EBCM and the yaw/lateral combination sensor.

Action Taken When the DTC Sets

- The EBCM turns OFF the 5-volt reference circuit, until the ignition is cycled.
- The driver information center (DIC) displays the Service Stabilitrak message.
- The ABS indicator turns ON.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

- If the yaw and lateral acceleration sensor is disconnected, DTCs will set and the EBCM will not provide 5-volt reference.
- The yaw rate and lateral accelerometer sensors are located in one unit and cannot be serviced separately.
- A poor ground connection for the EBCM may cause this DTC to set.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for EBCM

Circuit/System Testing

1. If DTC C0292 is set, diagnose that DTC first.
2. Ignition OFF, disconnect the yaw and lateral accelerometer sensor connector.
3. Ignition OFF, test for less than 1 ohm between the ground circuit terminal and ground.
    - If greater than 1 ohm, test the ground circuit terminal and the EBCM ground circuit terminal for a short to voltage or an open/high resistance. If the circuits test normal, replace the EBCM.
4. Test the lateral accelerometer signal circuit terminal, the 5-volt reference circuit terminal, and the ground circuit terminal for an open/high resistance or a short to voltage or ground.
    - If all circuits test normal, replace the yaw and lateral accelerometer sensor, and clear the yaw rate sensor offset value in the EBCM.
    - If the DTC sets again after replacing the yaw and lateral accelerometer sensor, replace the EBCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Vehicle Yaw Sensor with Vehicle Lateral Accelerometer Replacement**
- **Control Module References** for EBCM replacement, setup, and programming

DTC C0196: YAW RATE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0196 00

Yaw Rate Circuit No Additional Information

DTC C0196 28

Yaw Rate Circuit Incorrect Frequency

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
12-Volt Reference	C0292 00	C0292 00	C0292 00	-
Yaw Rate Sensor Signal	C0196 00	C0196 00	C0196 00, C0196 28, C0292 00	-
Lateral Accelerometer Signal	C0186 00	C0186 00	C0186 00, C0292 00	-
Yaw Rate Diagnostic Signal	C0196 28	C0196 28	C0196 28	C0196 28
Low Reference	C0186 00, C0196 00	C0186 00, C0196 00	C0186 00, C0196 00	-

Circuit/System Description

The vehicle stability enhancement system (VSES) is activated by the electronic brake control module (EBCM) calculating the desired yaw rate and comparing it to the actual yaw rate input. The desired yaw rate is calculated from measured steering wheel position, vehicle speed, and lateral acceleration. The difference between the desired yaw rate and actual yaw rate is the yaw rate error, which is a measurement of oversteer or understeer. If the yaw rate error becomes too large, the EBCM will attempt to correct the vehicle yaw motion by applying differential braking to the wheels.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is greater than 8 volts.

Conditions for Setting the DTC

C0196 00

- The vehicle speed has reached at least 15 km/h (9 mph) from a stop more three times during the same ignition cycle. Then during the time the vehicle is stationary, the yaw rate signal value is more than 7 deg/sec for 2 seconds.
- When vehicle speed is more than 25 km/h (16 mph) in a turn the difference between the yaw rate, steering angle, lateral acceleration, and wheel speed sensor values are not correlated three consecutive times.
- Yaw rate changes greater than 20 deg/sec in 6 ms 4 times in 1 second.
- The yaw/lateral combination sensor fails an internal self test.

C0196 28

The yaw frequency measured is not between 13400.0-14600.0 Hz for more than 200 msec.

Action Taken When the DTC Sets

- The EBCM turns OFF the 12-volt reference circuit, until the ignition is cycled.
- The driver information center (DIC) displays the Service Stabilitrak message.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

IMPORTANT: When testing the yaw rate diagnostic frequency circuit include all bulkhead, and splice connectors in the harness between the EBCM and the sensor.

- If DTC C0292 is set, diagnose that DTC first.
- If the yaw and lateral accelerometer sensor is disconnected, DTCs will set and the EBCM will not provide 12-volt reference.
- The yaw rate and lateral accelerometer sensors are located in one unit and cannot be serviced separately.
- A poor ground connection for the EBCM may cause this DTC to set.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

C0196 00

1. Visually inspect the yaw rate sensor/lateral accelerometer for proper and secure mounting.
    - If the sensor is improperly secured, remove and properly install the sensor.
2. Ignition OFF, disconnect the harness connector at the yaw rate sensor/lateral accelerometer.
3. Ignition OFF for 30 seconds, test for less than 1 ohm between the low reference circuit terminal 6 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the EBCM.
4. Ignition ON, test for 12-volts between the 12-volt reference circuit terminal 1 and ground.
    - If greater than the specified value, test the 12-volt reference circuit for a short to voltage. If the circuit tests normal, replace the EBCM.
    - If less than the specified range, test the 12-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the EBCM.
5. Ignition OFF, disconnect the harness connector at the EBCM.
6. Ignition ON, test for less than 1 volt between the following signal circuits and ground:
    - Yaw rate signal terminal 3
    - Lateral accelerometer signal terminal 2
    - If greater than the specified range, test the signal circuit for a short to voltage.
7. Test for less than infinite resistance between the following signal circuits and ground:
    - Yaw rate signal terminal 3
    - Lateral accelerometer signal terminal 2
    - If not the specified value, test the signal circuit for a short to ground.
8. Test for less than 2 ohms between the following signal circuit terminals:
    - Terminal 3 at the sensor harness connector and terminal 21 at the EBCM harness connector

- Terminal 2 at the sensor harness connector and terminal 33 at the EBCM harness connector
- If greater than the specified range, test the signal circuit for an open/high resistance.

9. If all circuits test normal, test or replace the yaw rate sensor/lateral accelerometer. After replacement and programming, operate the vehicle within the conditions for running the DTC and verify DTC C0196 00 does not set.
    - If the DTC sets, replace the EBCM.

C0196 28

1. Verify DTC C0196 00 is not set.
    - If DTC C0196 00 is set, refer to the above diagnostic procedure for C0196 00 before proceeding.
2. Ignition OFF, disconnect the harness connector at the yaw rate sensor/lateral accelerometer.
3. Test for 2.5k-6.5k ohms between the yaw rate diagnostic signal circuit terminal 4 and ground.
    - If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the EBCM.
    - If less than the specified range, test the signal circuit for short to ground. If the circuit tests normal, replace the EBCM.
4. If all circuits test normal, test or replace the yaw rate sensor/lateral accelerometer. After replacement and programming, operate the vehicle within the conditions for running the DTC and verify DTC C0196 28 does not set.
    - If the DTC sets, replace the EBCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Vehicle Yaw Sensor with Vehicle Lateral Accelerometer Replacement**
- **Control Module References** for EBCM replacement, setup, and programming

DTC C0201: ANTILOCK BRAKE SYSTEM (ABS) ENABLE RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0201 00

Antilock Brake System (ABS) Enable Relay Contact Circuit

Circuit/System Description

The solenoid relay, located within the electronic brake control module (EBCM), supplies battery voltage to all of the valve solenoids.

Conditions for Running the DTC

- Ignition ON.
- The solenoid relay is commanded ON.

Conditions for Setting the DTC

One or more of the following conditions exists:

- The EBCM detects no change in voltage when the relay is commanded.
- The EBCM detects a stuck closed solenoid valve relay.

Action Taken When the DTC Sets

The EBCM sends a serial data message to illuminate the warning indicator/message.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that DTC C0201 is not set.
    - If DTC is set, replace the EBCM and verify the DTC does not reset.
2. If the DTC resets, replace the brake pressure modulator valve.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Brake Pressure Modulator Valve Replacement**
- **Control Module References** for EBCM replacement, programming and setup

DTC C0242 OR P0856: TCS MALFUNCTION/TRACTION CONTROL TORQUE REQUEST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0242 71

Engine Control Module (ECM) Indicated TCS Malfunction Invalid Serial Data Received

DTC C0242 75

Engine Control Module (ECM) Indicated TCS Malfunction Signal Above Allowable Range

DTC P0856 00

Traction Control Torque Request Circuit

Circuit/System Description

The electronic brake control module (EBCM) and the engine control module (ECM) simultaneously control the traction control. The EBCM sends a serial data message to the ECM requesting torque reduction. When certain ECM DTCs are set, the ECM will not be able to perform the torque reduction for traction control. A serial data message is sent to the EBCM indicating that traction control is not allowed.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is greater than 8 volts.

Conditions for Setting the DTC

The ECM diagnoses a condition preventing the engine control portion of the traction control function and sends a serial data message to the EBCM indicating that torque reduction is not allowed. The ECM will typically set DTC P0856 and the EBCM will set C0242.

Action Taken When the DTC Sets

- The EBCM disables the TCS for the duration of the ignition cycle.
- The Traction Off indicator turns ON.

- The DIC displays the Service Traction Control message.
- The ABS remains functional.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present and the DTC is cleared with a scan tool.
- The electronic brake control module (EBCM) automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that no DTCs are set in the ECM.

- If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

DTC C0245: WHEEL SPEED SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0245 00

Wheel Speed Sensor Frequency

Circuit/System Description

The wheel speed sensor receives ignition voltage from the electronic brake control module (EBCM) and provides an output signal back to the EBCM. As the wheel spins the sensor sends a DC square wave signal to the EBCM. The EBCM uses the frequency of this signal to calculate the wheel speed.

Conditions for Running the DTC

- Brake is not applied.
- Vehicle is not cornering.
- No wheel speed sensor faults exist.
- Ignition voltage is greater than 10 V.

Conditions for Setting the DTC

Wheel speed differences between one wheel and the others is greater than 25 percent.

Action Taken When the DTC Sets

- A DIC message may be displayed.
- A instrument cluster warning indicator may be displayed.
- The EBCM disables the traction control system and the vehicle stability enhancement system for the duration of the ignition cycle.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The history DTC will clear after 40 consecutive fault-free drive cycles have occurred.

NOTE: **During normal diagnostic and/or repair verification technicians may find that the ABS, Traction Control and/or Stability indicators may be ON with NO DTCs displayed by the EBCM. Do not replace the EBCM for this condition.**

If the ABS, Traction Control and/or Stability indicators are ON with no DTCs set, perform the following steps:

1. Remove the key from the ignition, open and close the driver's door to turn off retained accessory power, and wait 60 seconds.
2. Ignition ON, if the ABS, Traction Control and/or Stability indicators are still illuminated, operate the vehicle at speeds greater than 16 km/h (10 MPH) to complete the self test. The EBCM should request all indicators to turn OFF.
3. If the indicators remain ON with no DTCs set after the drive cycle, disconnect the battery for at least 60 seconds then reconnect the battery.
4. Operate the vehicle at speeds greater than 40 km/h (25 MPH), the EBCM should request all indicators to turn OFF.

Diagnostic Aids

- Faulty wheel speed sensor will not set this DTC.
- A vehicle using a space saver spare will not set this code.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Wheel Speed Sensor parameters while spinning the wheels. The readings should be analog to the wheel speeds.

Circuit/System Testing

1. Verify that all tires have the proper air pressure.
    - If not the proper air pressure, adjust the air pressure for all tires to specification and verify the DTC does not reset. If the DTC resets, replace the EBCM.
2. Verify that all wheels and tires are the proper size.
    - If incorrect wheel or tire size, replace the incorrect wheel or tire and verify the DTC does not reset. If the DTC resets, replace the EBCM.
3. If all components test normal, replace the EBCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for EBCM replacement, programming and setup

DTC C0292: VSES COMBINATION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0292 00

VSES Combination Sensor Circuits

DTC C0292 02

VSES Combination Sensor Circuit Short to Ground

DTC C0292 07

VSES Combination Sensor Circuit Voltage Above Threshold

Circuit/System Description

The electronic brake control module (EBCM) supplies 12 V to the yaw rate sensor/lateral acceleration sensor and the steering angle sensor. The sensor supply voltage is monitored via an internal feedback circuit to the EBCM microprocessor.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is greater than 8 V.

Conditions for Setting the DTC

The EBCM detects that the sensor supply voltage feedback indicates that the voltage level is less than 8.0 V or greater than 16.0 V for more than 30 msec, a fault is set.

Action Taken When the DTC Sets

- The EBCM turns OFF the 12 V reference circuit, until the ignition is cycled.
- The EBCM disables the traction control system (TCS)/vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- The driver information center (DIC) displays the Service Stabilitrak message.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

If the yaw and lateral accelerometer sensor is disconnected, DTCs will set and the EBCM will not provide 12 V reference.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the yaw rate and lateral acceleration sensor connector.
2. Ignition OFF, test for less than 1 Ω between the low reference circuit terminal 6 and ground.
    - If greater than 1 Ω, test the low reference circuit terminal 6 and the EBCM ground circuit terminal 25 for an open/high resistance. If the circuits test normal, replace the EBCM.
3. Test the lateral accelerometer 12 V reference circuit terminal 1, for an open/high resistance or a short to voltage or ground.
    - If all circuits test normal, replace the yaw rate sensor/lateral acceleration sensor.
    - If the DTC sets again after replacing the yaw rate sensor/lateral acceleration sensor, replace the EBCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for EBCM replacement, setup, and programming

DTC C0558: CALIBRATION DATA NOT PROGRAMMED/LEARNED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0558 00

Calibration Data Not Programmed/Learned

Circuit/System Description

The electronic brake control module (EBCM) must be programmed using the service programming system (SPS).

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is greater than 8 volts.

Conditions for Setting the DTC

The EBCM has not been programmed.

Actions Taken When DTC Sets

- The EBCM disables the traction control system for the duration of the ignition cycle.
- The ABS remains functional.
- The Traction OFF Indicator turns ON.
- A driver information center message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present and the DTC is cleared with a scan tool.
- The electronic brake control module (EBCM) automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Testing for Intermittent Conditions and Poor Connections**
- **Circuit Testing**

- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that DTC C0558 is not set.

- If the DTC is set, program the EBCM. If the DTC resets, replace the EBCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for EBCM replacement, programming and setup

DTC C0561: SYSTEM DISABLED INFORMATION STORED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0561 71

System Disabled Information Stored Invalid Serial Data Received invalid serial data received

DTC C0561 72

System Disabled Information Stored Invalid Serial Data Received alive counter incorrect/not updated

DTC C0561 74

System Disabled Information Stored Invalid Serial Data Received value of signal protection calculation incorrect

DTC C0561 75

System Disabled Information Stored Invalid Serial Data Received signal above allowable range

Circuit/System Description

The electronic brake control module (EBCM) receives messages from other modules over GMLAN which are needed to perform antilock brake system (ABS) or traction control system (TCS) functions.

Conditions for Running the DTC

- The ignition switch is in the ON position.
- Ignition voltage is greater than 8 volts.

Conditions for Setting the DTC

The EBCM receives an invalid message from another module over GMLAN which causes the EBCM to deactivate ABS, and TCS, etc.

Action Taken When the DTC Sets

One or more of the following actions may occur:

- The EBCM disables the TCS until the DTC becomes a history DTC.
- The ABS remains functional.
- The Traction Off indicator turns ON.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

This DTC is for information only. As an aid to the technician, this DTC indicates that there are no problems in the ABS/TCS. The ECM and BCM should be checked for a possible fault .

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

DTC C0563: CALIBRATION READ ONLY MEMORY (ROM) CHECKSUM ERROR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0563 00

Calibration Read Only Memory (ROM) Checksum Error

Circuit/System Description

The electronic brake control module (EBCM) correlates the module calibration programmed.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

Incorrect calibration programmed.

Action Taken When the DTC Sets

- The EBCM disables the antilock brakes.
- The EBCM sends a serial data message to illuminate the appropriate warning indicator/message.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

If the DTC was set after EBCM replacement, verify that the replacement EBCM and software are correct for the vehicle.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that DTC C0563 is not set.

- If the DTC is set, program the EBCM. If the DTC resets, replace the EBCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for EBCM replacement, setup, and programming

DTC C0710: STEERING POSITION SIGNAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0710 4B

Steering Position Signal Calibration not Learned

DTC C0710 5A

Steering Position Signal Plausibility Failure

DTC C0710 17

Steering Position Signal Shape/Waveform Failure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	C0710 4B, C0710 5A, C0710 17	C0710 4B, C0710 5A, C0710 17	-	C0710 4B, C0710 5A, C0710 17
CAN Bus High Serial Data	C0710 4B, C0710 5A, C0710 17	C0710 4B, C0710 5A, C0710 17	C0710 4B, C0710 5A, C0710 17	C0710 4B, C0710 5A, C0710 17
CAN Bus Low Serial Data	C0710 4B, C0710 5A, C0710 17	C0710 4B, C0710 5A, C0710 17	C0710 4B, C0710 5A, C0710 17	C0710 4B, C0710 5A, C0710 17
Low Reference	C0710 4B, C0710 5A, C0710 17	C0710 4B, C0710 5A, C0710 17	C0710 4B, C0710 5A, C0710 17	C0710 4B, C0710 5A, C0710 17

Circuit/System Description

The steering angle sensor supplies 2 analog inputs, position signal A and position signal B, to the electronic brake control module (EBCM). The 2 input signals are approximately 90 degrees out of phase. By interpreting the relationship between the 2 inputs, the EBCM can determine the position of the steering wheel and the direction of the steering wheel rotation.

Conditions for Running the DTC

C0710 5A, and 17

- The ignition is ON.
- Ignition voltage is greater than 8 volts.
- The steering wheel position sensor has been powered ON for 0.2 seconds.
- The steering wheel position sensor is centered.
- The steering rate of position signal A is less than 80 degrees per second.

C0710 5A

Fault is set when the calculated steering angle from the sensor does not correlate with the steering angle calculated from the yaw rate.

C0710 4B

- The ignition is ON.
- Ignition voltage is greater than 8 volts.
- The steering wheel position sensor has been powered ON for 0.2 seconds.
- The steering wheel position sensor is centered.
- Steering Wheel Position Sensor not calibrated after installation.

Conditions for Setting the DTC

C0710 4B, 5A, and 17

Both position signal A and position signal B are greater than 4.9 volts or less than 0.2 volts for 1.6 seconds.

C0710 4B, 5A, and 17

The steering bias is greater than 40 degrees.

C0710 4B, 5A, and 17

The difference in the phase angle between position signal A and position signal B is greater than 106 degrees or less than 84 degrees continuously for 0.25 seconds.

C0710 4B, 5A, and 17

The changes in position signal A or position signal B is greater than 36 degrees between consecutive scans of the signal.

Action Taken When the DTC Sets

- The EBCM disables the vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- The vehicle dynamic caution (VDC) indicator illuminates.
- The driver information center (DIC) displays the SERVICE TRACTION message.
- The ABS remains functional.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The electronic brake control module (EBCM) clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

- Inspect the vehicle for proper alignment. The car should not pull in either direction while driving straight on a level surface.
- The Snapshot function on the scan tool can help find an intermittent DTC.
- Possible causes for this DTC are the following conditions:
  - One of the steering wheel position sensor inputs are open, shorted to ground, or shorted to battery.
  - Internal steering angle sensor malfunction.
  - Noise on the steering wheel position signal circuits.
  - Yaw and lateral acceleration sensor malfunction causing drifting signal outputs.
  - Internal EBCM malfunction.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit System/Verification

1. With the scan tool perform the Steering Angle Sensor Centering.
2. Verify the DTC does not reset.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the steering angle sensor.
2. Ignition OFF, scan tool disconnected, all vehicle systems OFF, this may take up to 2 minutes, test for less than 10 Ω between the low reference circuit terminal 1 and ground.
    - If greater than the specified range, test for an open/high resistance in the low reference circuit. If the circuit tests normal, replace the EBCM.
3. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the EBCM.
4. Ignition OFF, disconnect the harness connector at the EBCM.
5. Ignition ON, test for less than 1 V between the EBCM Bus- communication terminal 33 and ground.
    - If greater than the specified value, test the communication circuit for a short to voltage.
6. Test for less than 1 V between the EBCM Bus- communication circuit terminal 21 and ground.
    - If greater than the specified value, test the communication circuit for a short to voltage.
7. Ignition OFF, test for infinite resistance between the EBCM Bus- communication circuit terminal 33 and ground.
    - If not the specified value, test the communication circuit for a short to ground.
8. Test for infinite resistance between the EBCM Bus- communication circuit terminal 21 and ground.
    - If not the specified value, test the communication circuit for a short to ground.
9. Test for less than 1 Ω of resistance between the EBCM communication circuit terminal 33 and Yaw Lateral Accelerometer Sensor terminal 2.

- If greater than the specified range, test the communication circuits for an open/high resistance.

10. Test for less than 1 Ω of resistance between the EBCM communication circuit terminal 21 and Yaw Lateral Accelerometer terminal 3.
    - If greater than the specified range, test the communication circuits for an open/high resistance.
11. Test for infinite resistance between the EBCM communication circuit terminal 21 and terminal 33.
    - If not the specified value, test the communication circuits for a short together.
12. If all circuits test normal, replace the steering wheel position sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Steering Angle Sensor Replacement**
- **Control Module References** for EBCM replacement, setup, and programming

SYMPTOMS - ANTILOCK BRAKE SYSTEM

The following steps must be completed before using the symptom tables.

IMPORTANT:

1. Perform the ABS Diagnostic System Check before using the symptom tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system description and operation in order to familiarize yourself with the system functions. Refer to **ABS Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the ABS. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components, for obvious damage or conditions, which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

ABS Indicator Malfunction

ABS INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The instrument panel cluster (IPC) momentarily illuminates the antilock brake system (ABS) indicator during the bulb check when the ignition is cycled ON. When the electronic brake control module (EBCM) detects a fault requiring ABS indicator ON, it sends a serial data message to the IPC to illuminate the ABS indicator.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit Verification

1. With a scan tool command the IPC display test ON and OFF. The ABS indicator should turn ON and OFF.
    - If the ABS indicator does not turn ON and OFF when commanded, replace the IPC.
2. Replace the EBCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for EBCM or IPC replacement, setup, and programming

STABILITRAK INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Traction Control Switch Signal	1	1	-	-
Ground	-	1	-	-
1. Traction Control Indicator Malfunction				

Circuit Description

The instrument panel cluster (IPC) momentarily illuminates the StabiliTrak indicator during the IPC bulb check. When a fault affecting the stabilitrak system is detected, the warning indicator is illuminated.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with a scan tool command the IPC display test ON and OFF. The StabiliTrak indicator should turn ON and OFF.
    - If the indicator does not turn ON and OFF, replace the IPC.
2. Observe the scan tool BCM Traction Control Switch parameter while pressing and releasing the traction control switch. The reading should change between Active and Inactive.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the traction control switch.
2. Test for less than 1 ohm between the ground circuit terminal below and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool BCM Traction Control Switch parameter is Inactive.
    - If not the specified value, test the signal circuit terminal for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal and the ground circuit terminal. Verify the scan tool BCM Traction Control Switch parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the traction control switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the traction control switch.
2. Test for infinite resistance between the signal terminal and the ground terminal with the switch in the open position.
    - If not the specified value, replace the traction control switch.
3. Test for less than 3 ohms between the signal terminal and the ground terminal with the switch in the closed position.
    - If greater than the specified range, replace the traction control switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Electronic Traction Control Switch Replacement**
- **Control Module References** for BCM or IPC replacement, setup, and programming

REPAIR INSTRUCTIONS

ANTILOCK BRAKE SYSTEM AUTOMATED BLEED

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

NOTE:

- **Before performing the ABS Automated Bleed Procedure, first perform a manual or pressure bleed of the base hydraulic brake system. Refer to Hydraulic Brake System Bleeding (Manual) Hydraulic Brake System Bleeding (Pressure) .**
- **The automated bleed procedure must be performed when a new brake pressure modulator valve (BPMV) is installed, because the secondary circuits of the new BPMV are not prefilled with brake fluid.**

- **The automated bleed procedure is recommended when one of the following conditions exist:**
  - **Base brake system bleeding does not achieve the desired pedal height or feel**
  - **Extreme loss of brake fluid has occurred**
  - **Air ingestion is suspected in the secondary circuits of the brake modulator assembly**

The ABS Automated Bleed Procedure uses a scan tool to cycle the system solenoid valves and run the pump in order to purge any air from the secondary circuits. These circuits are normally closed off, and are only opened during system initialization at vehicle start up and during ABS operation. The automated bleed procedure opens these secondary circuits and allows any air trapped in these circuits to flow out away from the brake modulator assembly, which is then forced out at the brake corners by the pressure bleeder.

Automated Bleed Procedure

CAUTION: The Auto Bleed Procedure may be terminated at any time during the process by pressing the EXIT button. No further Scan Tool prompts pertaining to the Auto Bleed procedure will be given. After exiting the bleed procedure, relieve bleed pressure and disconnect bleed equipment per manufacturers instructions. Failure to properly relieve pressure may result in spilled brake fluid causing damage to components and painted surfaces.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
3. Inspect the brake system for leaks and visual damage. Refer to **Symptoms - Hydraulic Brakes** . Repair or replace components as needed.
4. Lower the vehicle.
5. Prepare the brake bleeding equipment and the vehicle for a pressure bleed of the base hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** **Hydraulic Brake System Bleeding (Pressure)** .
6. Inspect the battery state of charge. Refer to **Battery Inspection/Test** .
7. Install a scan tool.
8. Turn the ignition ON, with the engine OFF.
9. With the scan tool, perform the following steps:
   1. Select Diagnostics
   2. Select the appropriate vehicle information
   3. Select Chassis
   4. Select Electronic Brake Control Module (EBCM)
   5. Select Special Functions
   6. Select Automated Bleed
10. With an assistant ready, raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

NOTE:

- **Apply the brake pedal when instructed, using moderate effort.**
- **Ensure the pedal remains applied until instructed to release by the scan tool.**
- **Do not exceed the time period allowed by the scan tool for having the bleeder valves open.**
- **The bleed sequence for each corner is as follows:**
  - **Left front**
  - **Right front**
  - **Right rear**
  - **Left rear**

11. Perform the automated bleed procedure as instructed by the scan tool.
12. If the automated bleed procedure is aborted, a malfunction exists. If a DTC is detected, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** to diagnose the DTC.
13. After completion of the automated bleed procedure, press and hold the brake pedal to inspect for pedal firmness.
14. If the brake pedal feels spongy, repeat the bleed procedure completely.
15. Remove the scan tool.
16. Install the tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
17. Lower the vehicle.
18. Adjust the brake fluid level. Refer to **Master Cylinder Reservoir Filling** .
19. Road test the vehicle while confirming the brake pedal remains high and firm.

STEERING ANGLE SENSOR REPLACEMENT

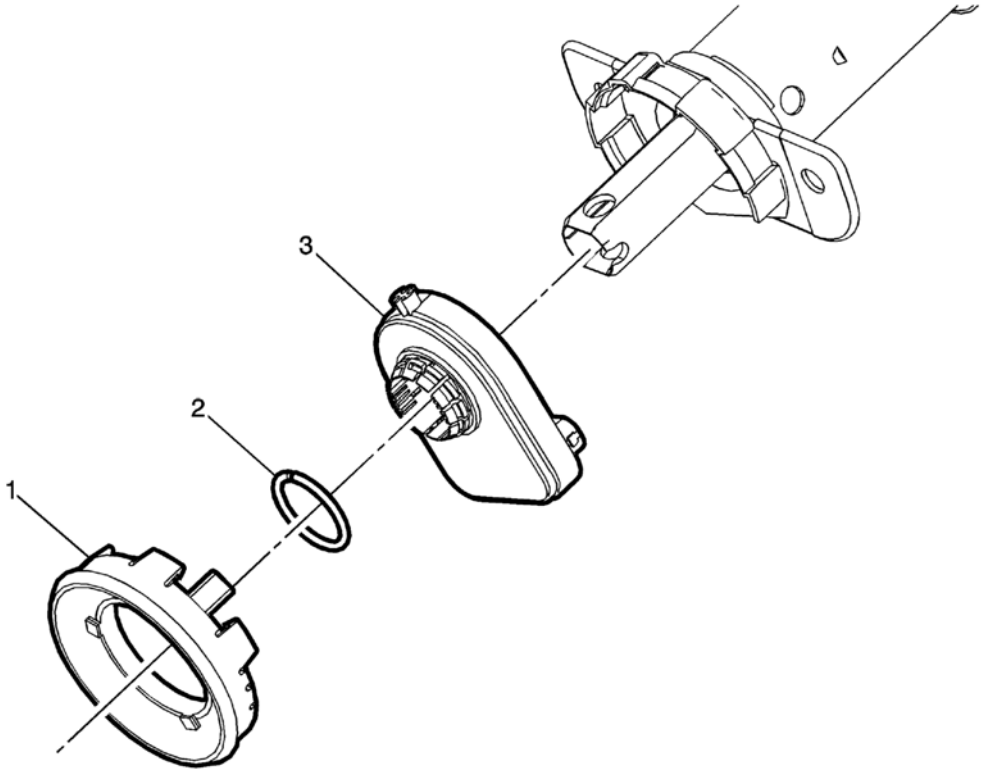


Fig. 4: Steering Angle Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the steering column. Refer to **Steering Column Replacement** .	
1	Steering Angle Sensor Retainer
2	Steering Angle Sensor Retaining Ring **CAUTION:** **Refer to Fastener Caution .** **Procedure** Remove and discard the old retaining ring. Do NOT reuse the retaining ring, replace with NEW only.
3	Steering Angle Sensor **Procedure** After the installation is complete, center the steering angle sensor. Refer to **Steering Angle Sensor Centering**.

STEERING ANGLE SENSOR CENTERING

The steering angle sensor does not require centering often. Centering of the steering angle sensor might be

required after certain service procedures are performed. Some of these procedures are as follows:

- Steering gear replacement
- Steering column replacement
- Steering angle sensor replacement
- Intermediate shaft replacement
- Electronic brake control module (EBCM) replacement
- Collision or other physical damage

The steering angle sensor centering procedure can be completed with a scan tool using the following steps:

1. Using the steering wheel, align the front wheels forward.
2. Set the transmission in the PARK position.
3. Turn the ignition switch ON, with the engine OFF.
4. Clear any DTCs that may be set.
5. Select Steering Angle Sensor Centering in the Special Functions list.
6. Press the Reset button or follow the scan tool directions to complete the centering procedure.

ELECTRONIC BRAKE CONTROL MODULE REPLACEMENT

Removal Procedure

1. Place the ignition switch in the OFF position.
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
4. Without draining the engine coolant and without disconnecting the hoses, remove the nuts and position aside the radiator surge tank. Refer to **Radiator Surge Tank Replacement** .
5. Clean the area surrounding the electronic brake control module (EBCM) to brake pressure modulator valve (BPMV) mating surfaces.

   CAUTION: To prevent equipment damage, never connect or disconnect the wiring harness connection from the EBCM with the ignition switch in the ON position.

6. Disconnect the EBCM electrical connector.

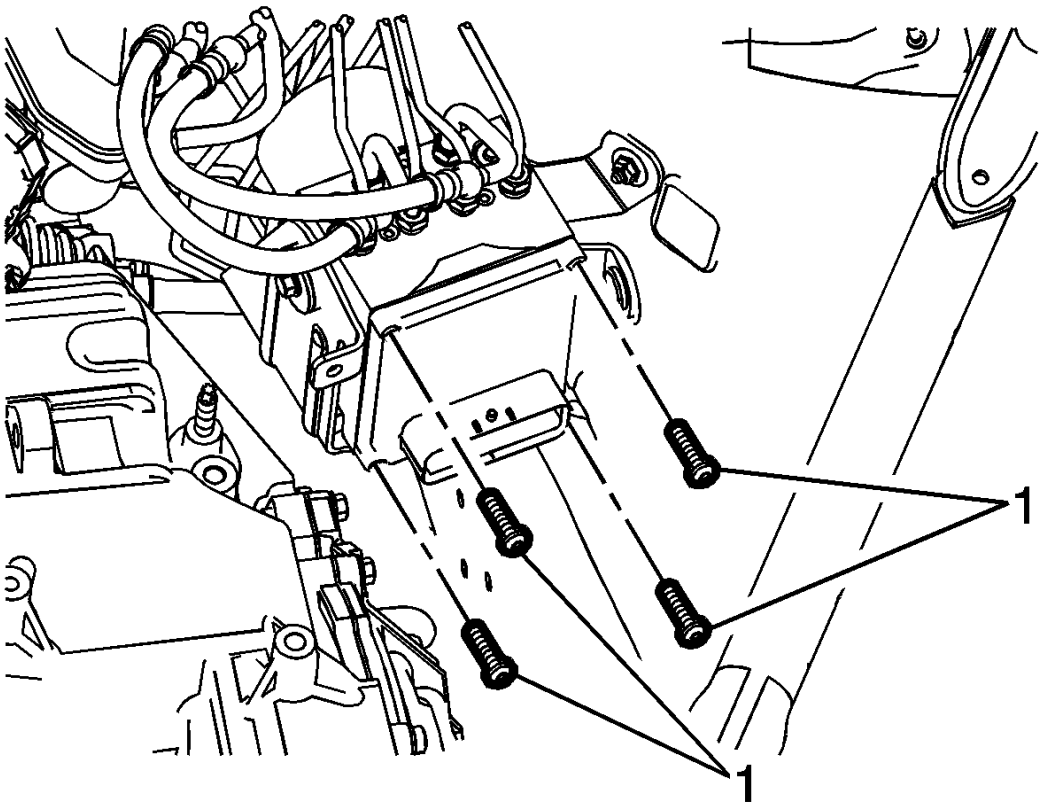


Fig. 5: Electronic Brake Control Module Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the EBCM bolts (1).

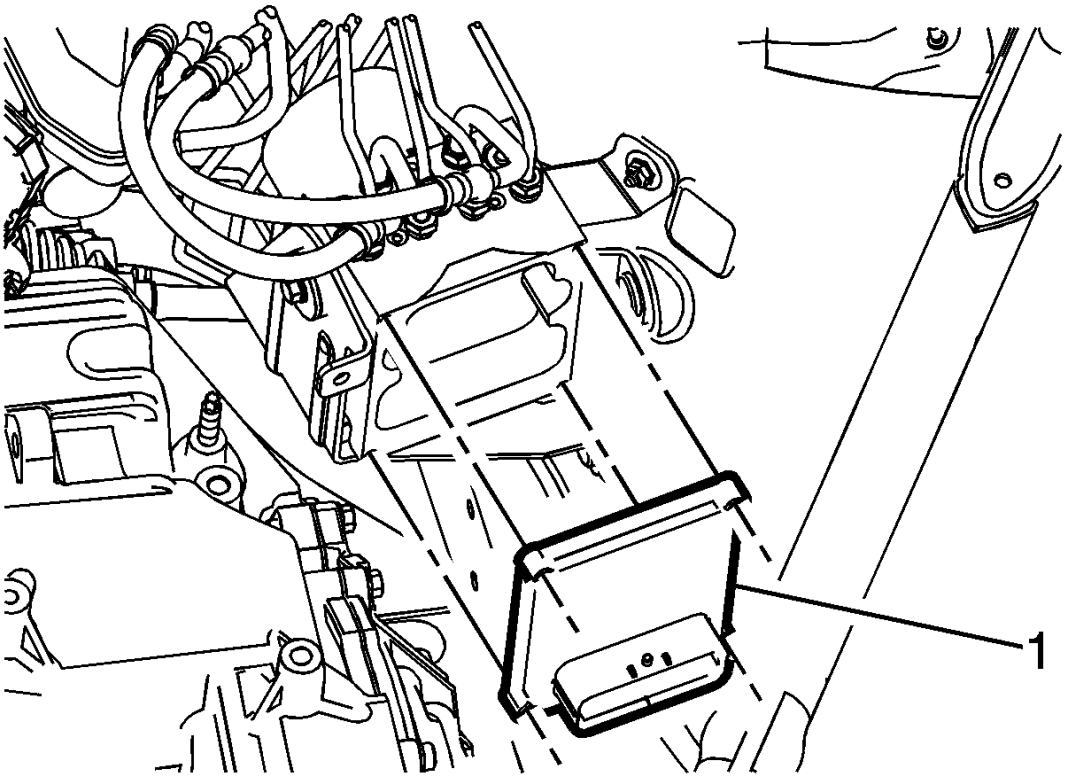


Fig. 6: Electronic Brake Control Module
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not pry the components apart.**

8. Separate the EBCM (1) from the BPMV.
9. Clean the sealing surfaces of the BPMV with denatured alcohol and a clean cloth.

Installation Procedure

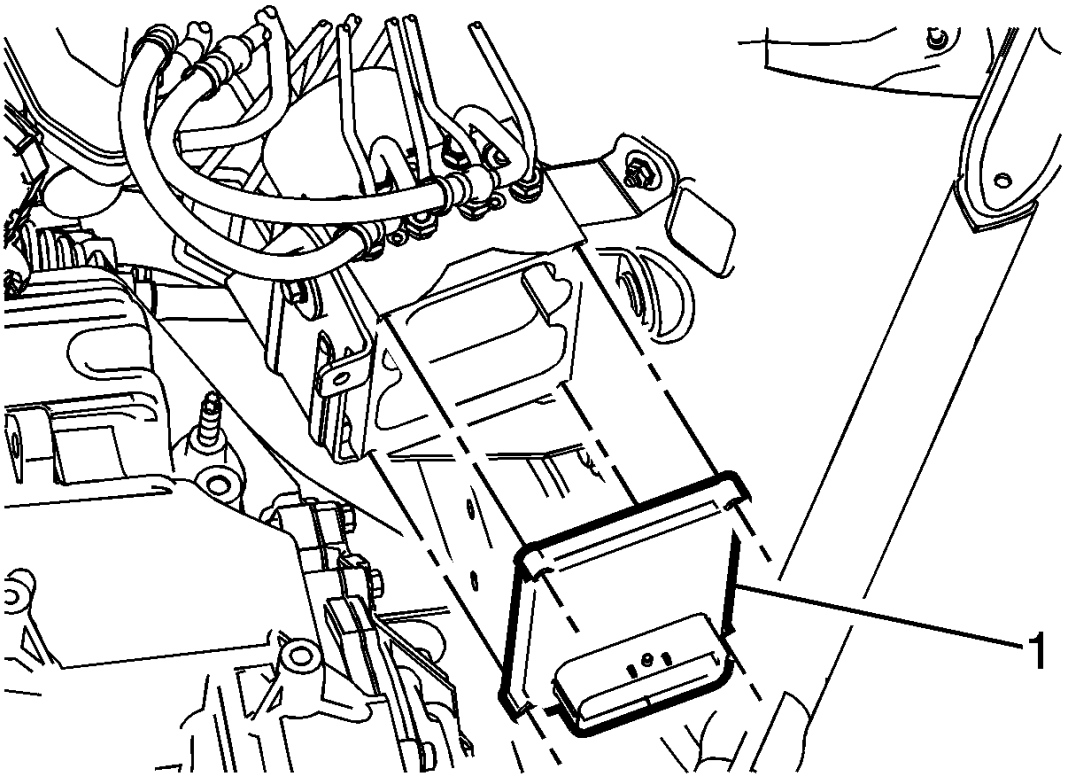


Fig. 7: Electronic Brake Control Module
Courtesy of GENERAL MOTORS COMPANY

1. Install the EBCM (1) to the BPMV.

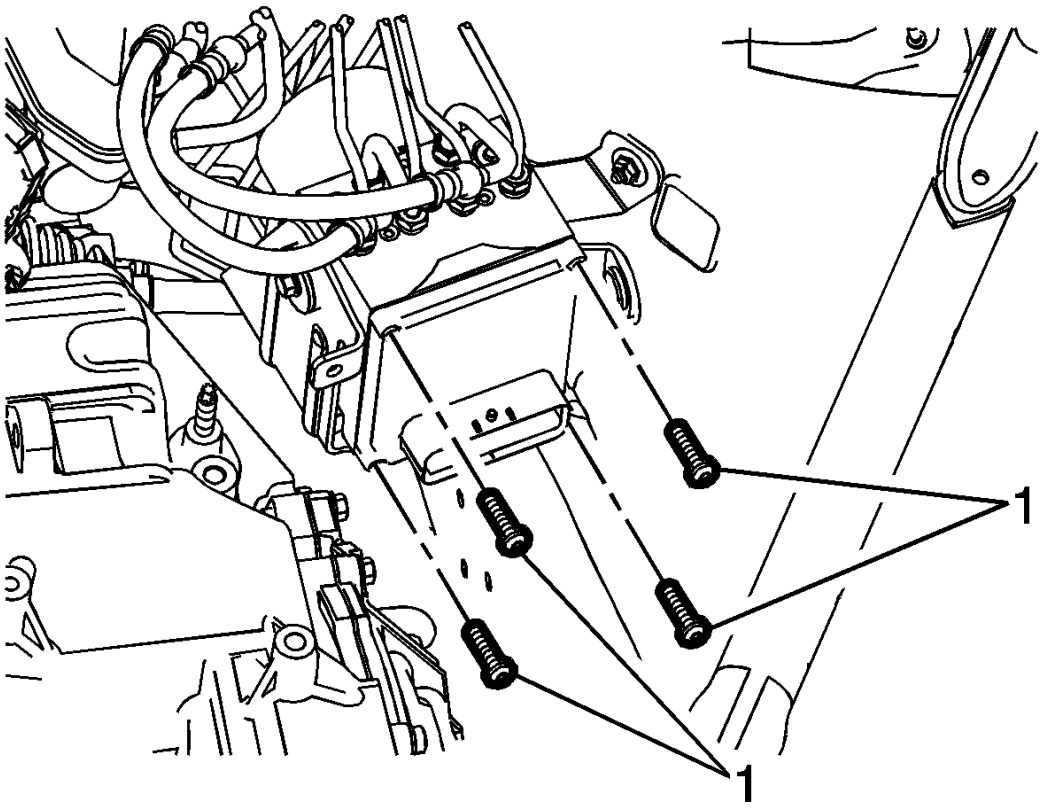


Fig. 8: Electronic Brake Control Module Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the EBCM bolts (1) and tighten to 3 N.m (27 lb in).
3. Connect the EBCM electrical connector.
4. Reposition the radiator surge tank and install the nuts. Refer to **Radiator Surge Tank Replacement** .
5. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
6. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
7. Program the EBCM. Refer to **Control Module References** .

BRAKE PRESSURE MODULATOR VALVE REPLACEMENT

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Place the ignition switch in the OFF position.
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
3. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
4. Without draining the engine coolant and without disconnecting the hoses, remove the nuts and position aside the radiator surge tank. Refer to **Radiator Surge Tank Replacement** .
5. Clean the area surrounding the electronic brake control module (EBCM) to brake pressure modulator valve (BPMV) mating surfaces.

CAUTION: To prevent equipment damage, never connect or disconnect the wiring harness connection from the EBCM with the ignition switch in the ON position.

6. Disconnect the EBCM electrical connector.

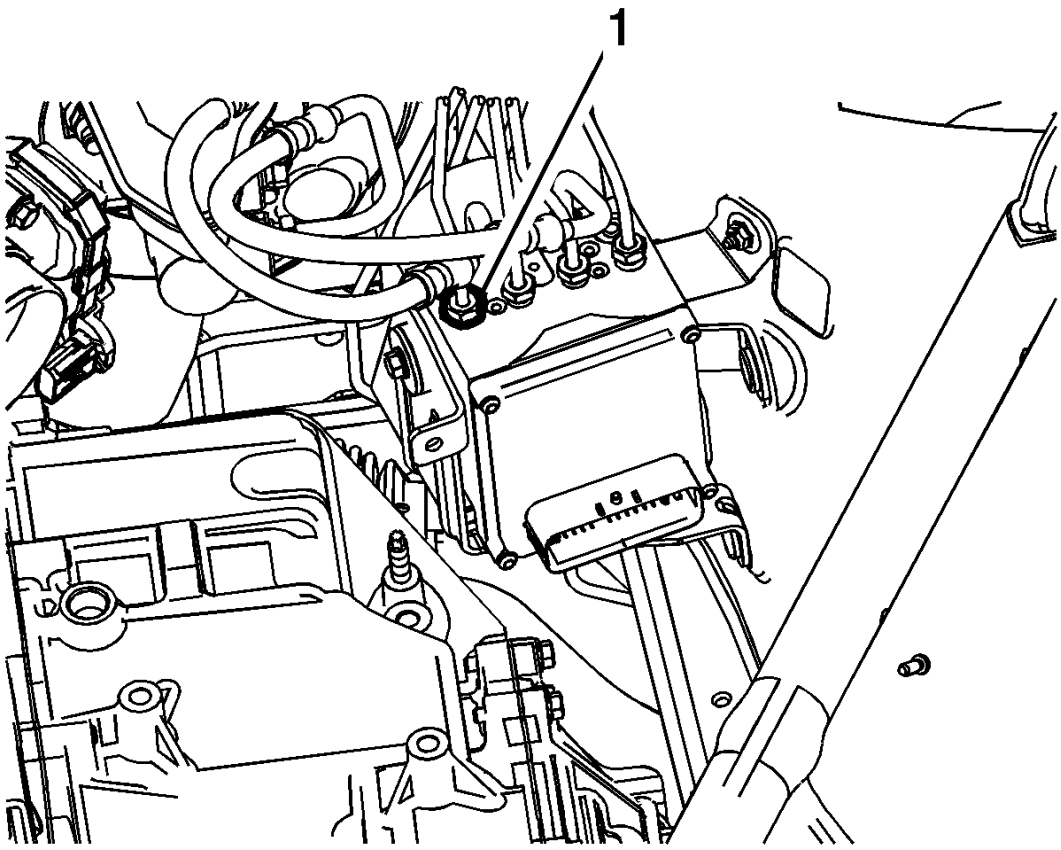


Fig. 9: Right Front Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the right front brake pipe fitting (1) from the BPMV.
8. Cap the brake pipe fitting and plug the BPMV outlet port to prevent brake fluid loss and contamination.

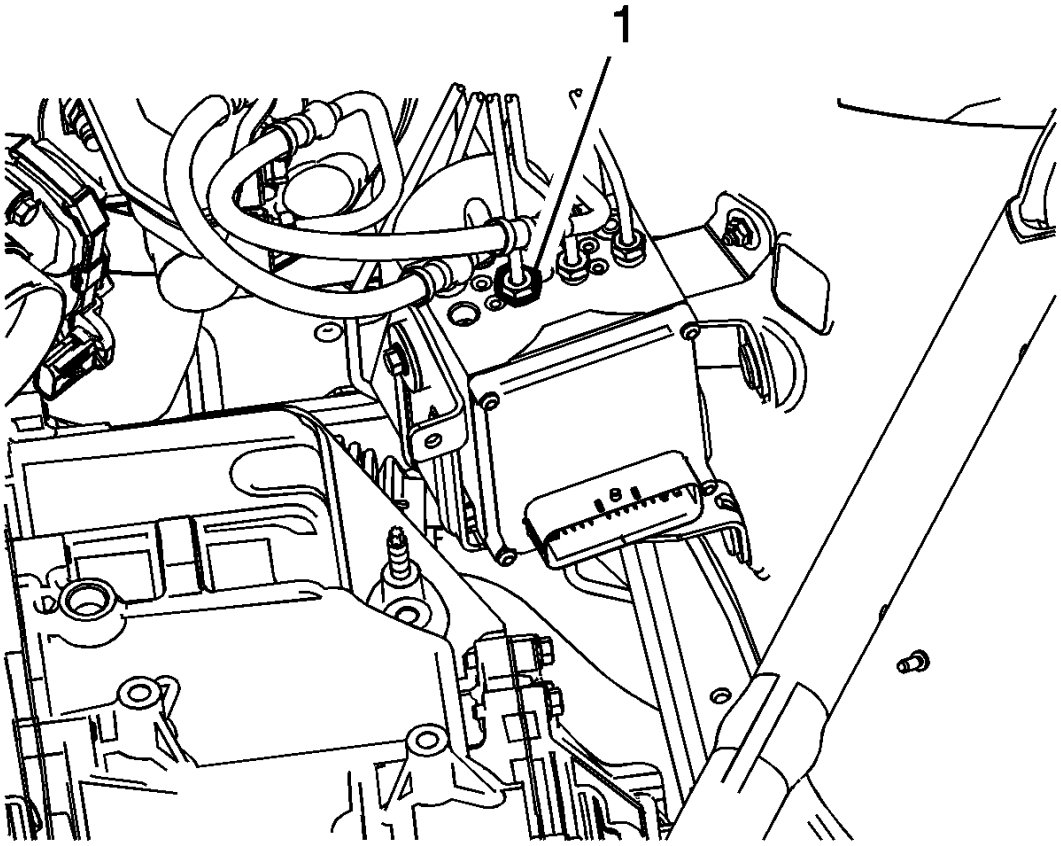


Fig. 10: Left Rear Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the left rear brake pipe fitting (1) from the BPMV.
10. Cap the brake pipe fitting and plug the BPMV outlet port to prevent brake fluid loss and contamination.

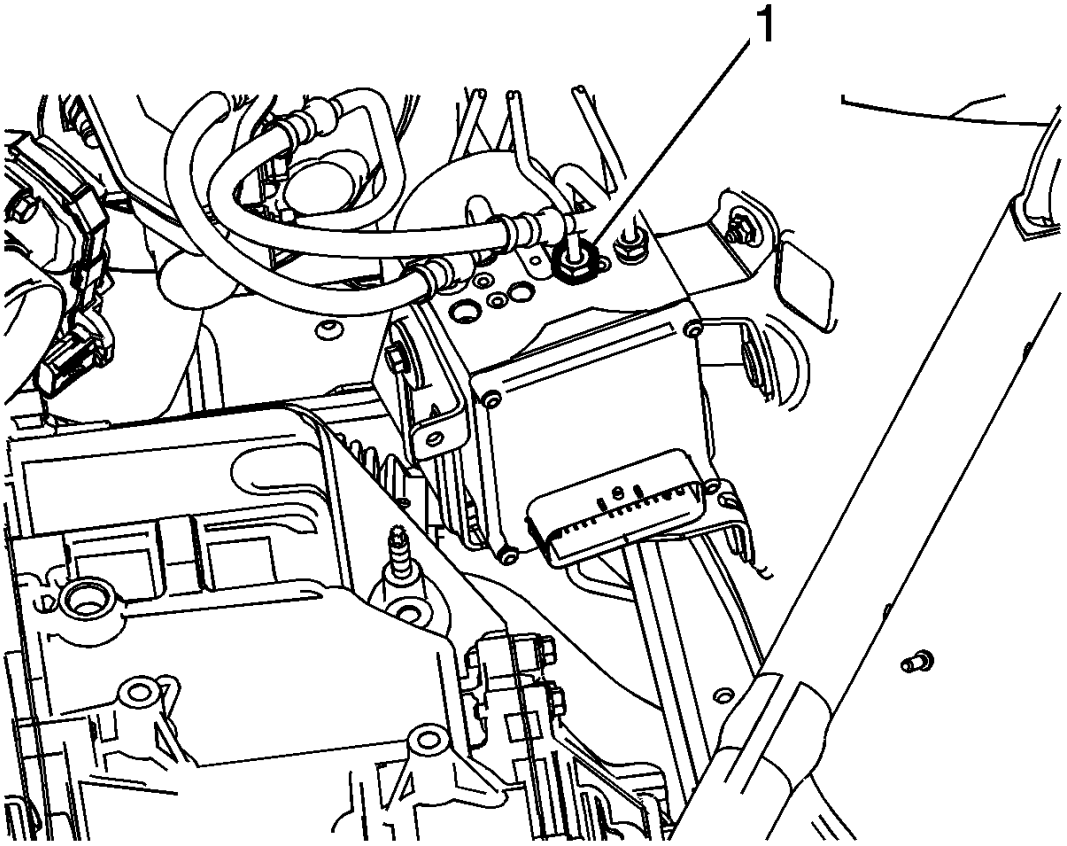


Fig. 11: Right Rear Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect the right rear brake pipe fitting (1) from the BPMV.
12. Cap the brake pipe fitting and plug the BPMV outlet port to prevent brake fluid loss and contamination.

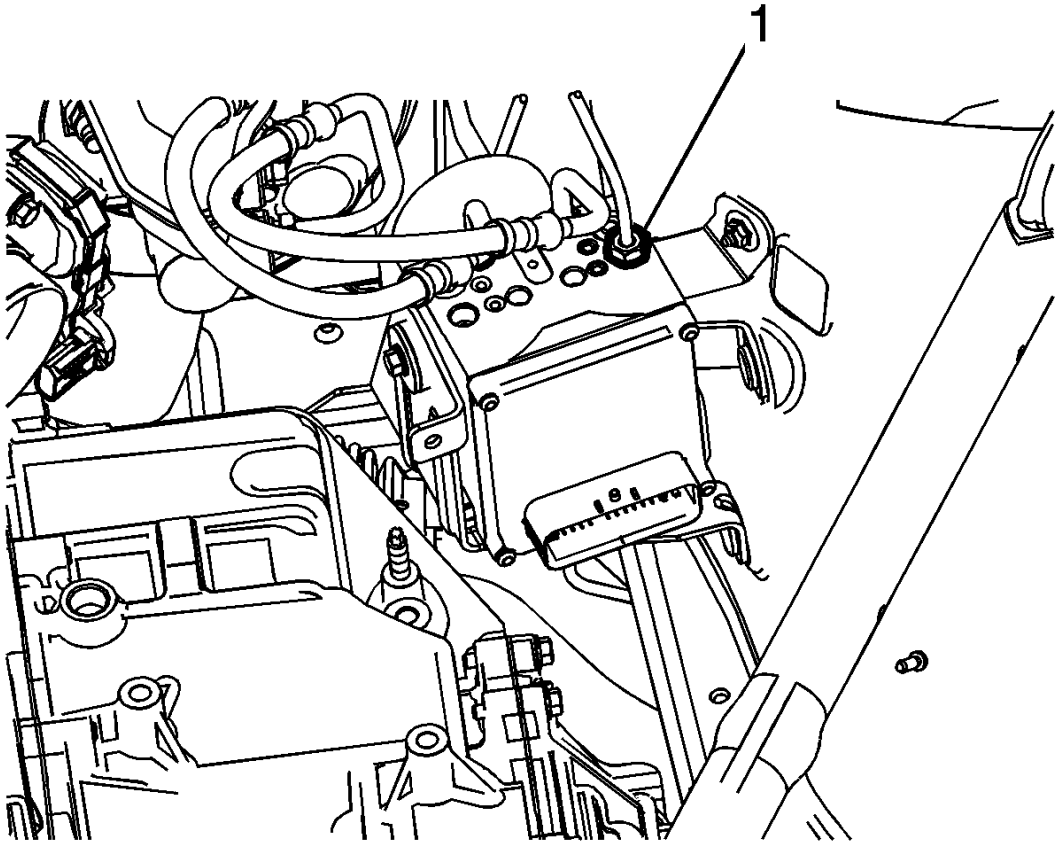


Fig. 12: Left Front Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the left front brake pipe fitting (1) from the BPMV.
14. Cap the brake pipe fitting and plug the BPMV outlet port to prevent brake fluid loss and contamination.

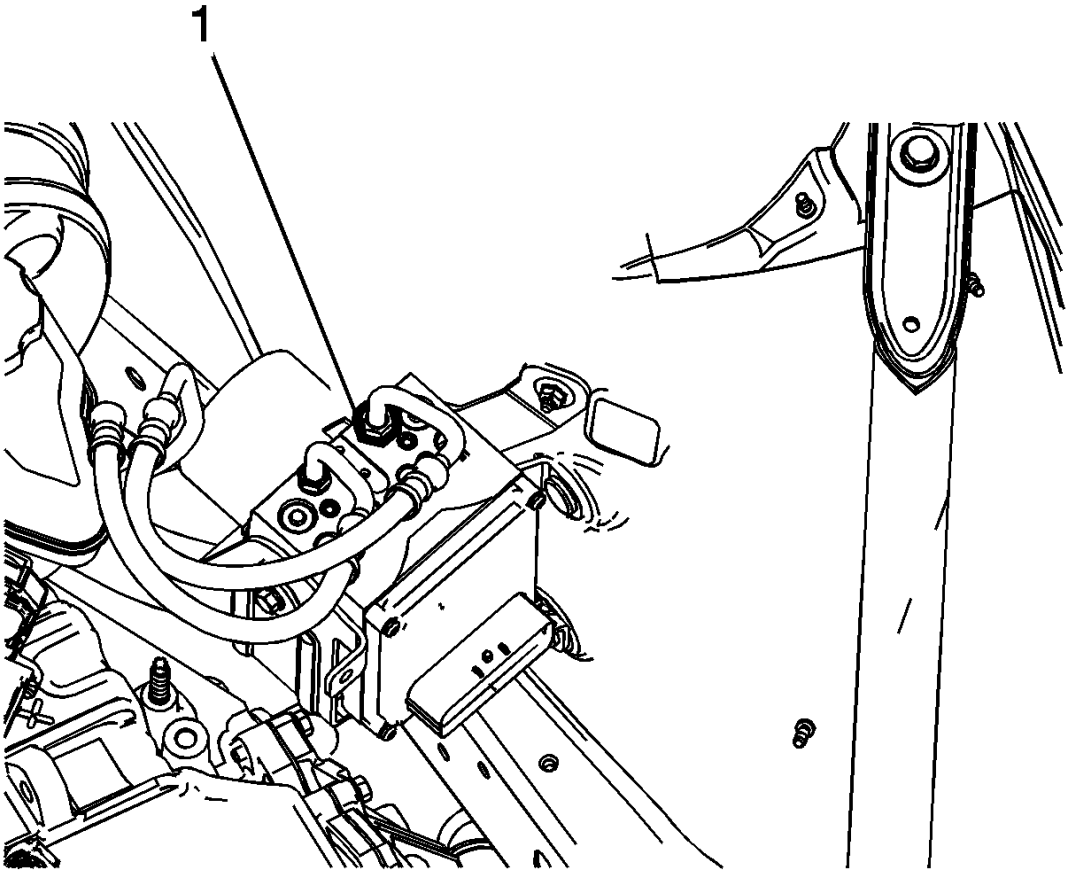


Fig. 13: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

15. Disconnect the master cylinder secondary brake pipe fitting (1) from the BPMV.
16. Cap the brake pipe fitting and plug the BPMV inlet port to prevent brake fluid loss and contamination.

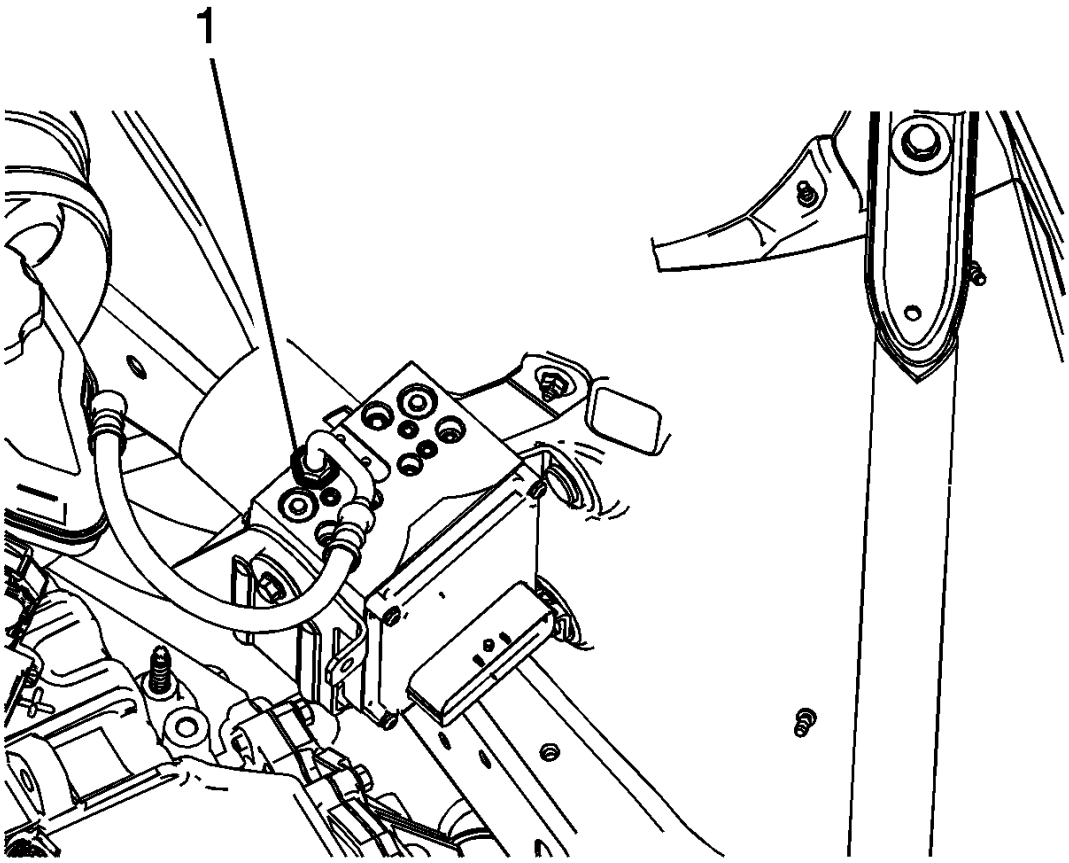


Fig. 14: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the master cylinder primary brake pipe fitting (1) from the BPMV.
18. Cap the brake pipe fitting and plug the BPMV inlet port to prevent brake fluid loss and contamination.

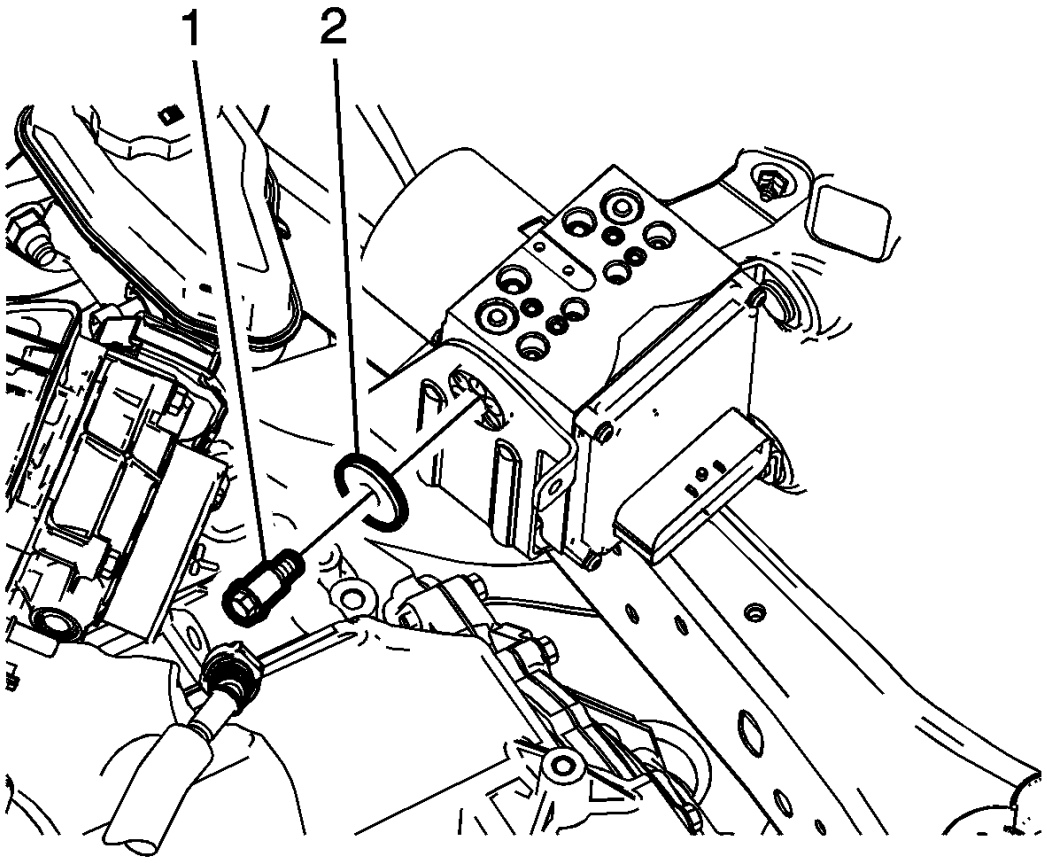


Fig. 15: Brake Pressure Modulator Valve Bolt And Washer
Courtesy of GENERAL MOTORS COMPANY

19. Remove the BPMV bolt (1) and washer (2).
20. Remove the BPMV assembly.
21. If necessary, remove the EBCM. Refer to **Electronic Brake Control Module Replacement**.

Installation Procedure

1. If removed, install the EBCM. Refer to **Electronic Brake Control Module Replacement**.
2. Install the BPMV assembly to the BPMV bracket.

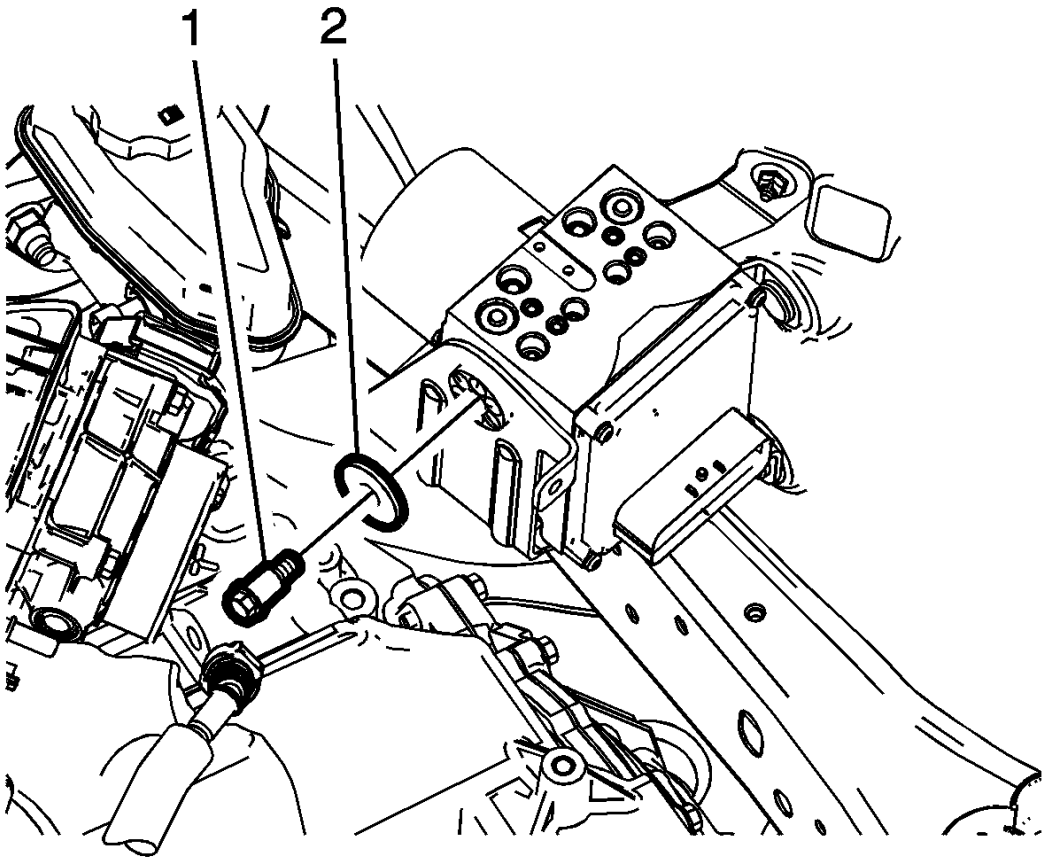


Fig. 16: Brake Pressure Modulator Valve Bolt And Washer
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the BPMV bolt (1) and washer (2) and tighten the bolt to 10 N.m (89 lb in).

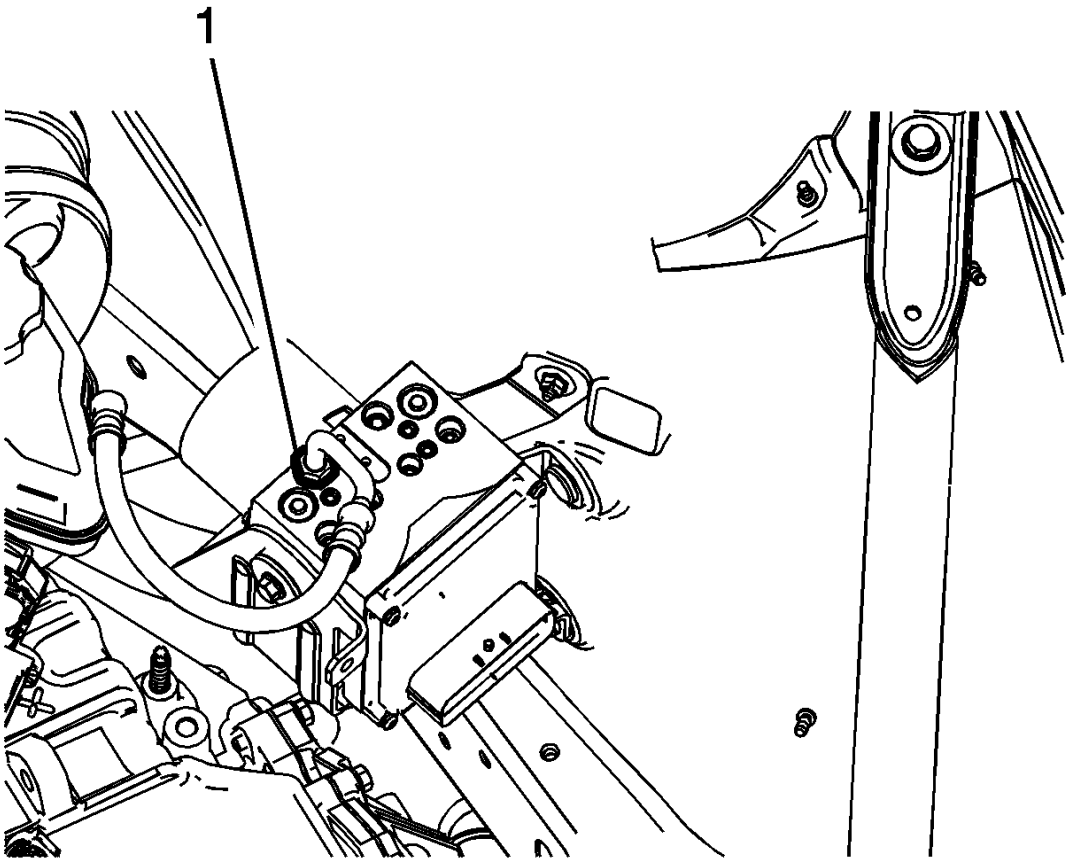


Fig. 17: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

4. Install the master cylinder primary brake pipe fitting (1) to the BPMV and tighten the fitting to 24 N.m (18 lb ft).

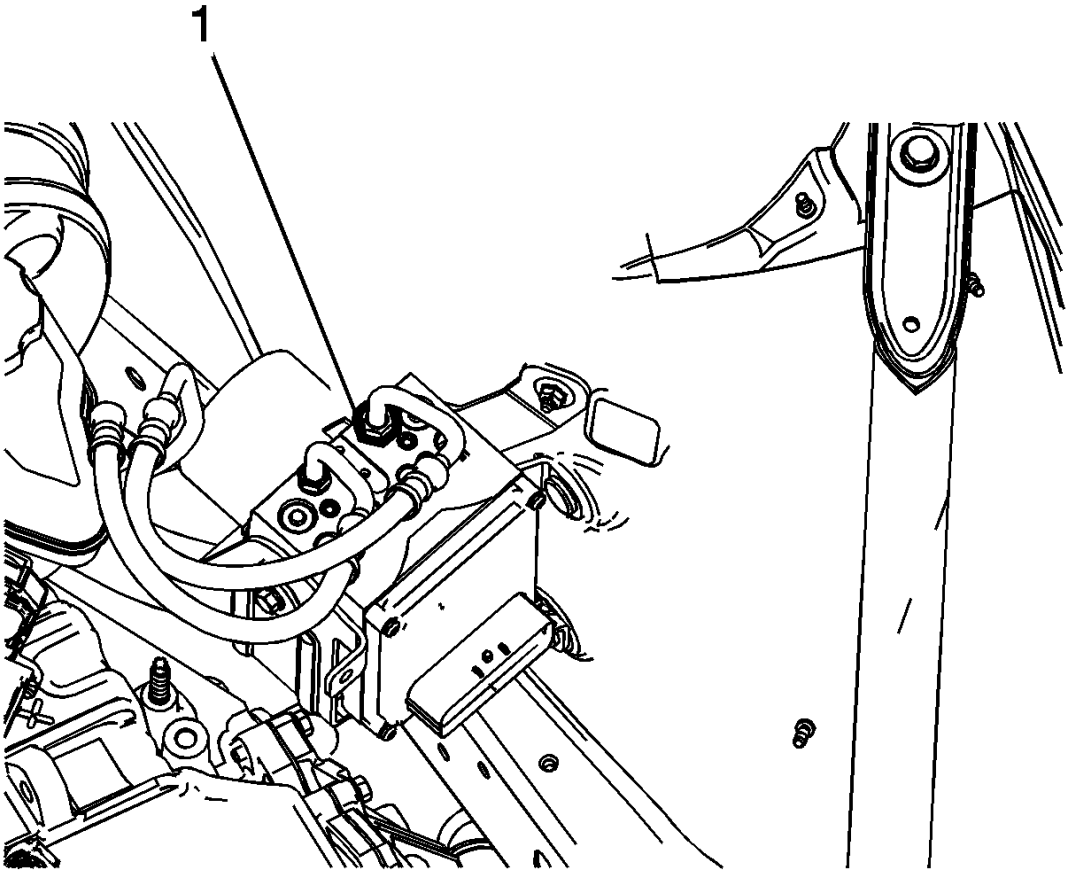


Fig. 18: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Install the master cylinder secondary brake pipe fitting (1) to the BPMV and tighten the fitting to 24 N.m (18 lb ft).

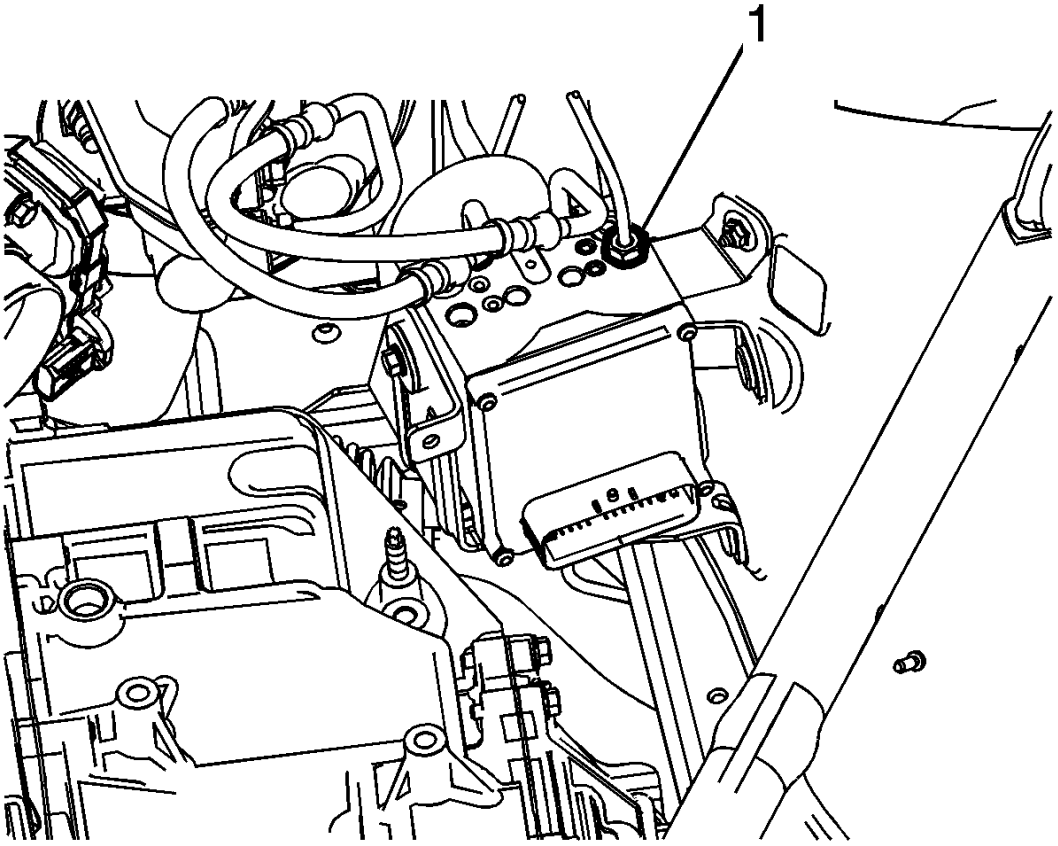


Fig. 19: Left Front Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

6. Install the left front brake pipe fitting (1) to the BPMV and tighten the fitting to 24 N.m (18 lb ft).

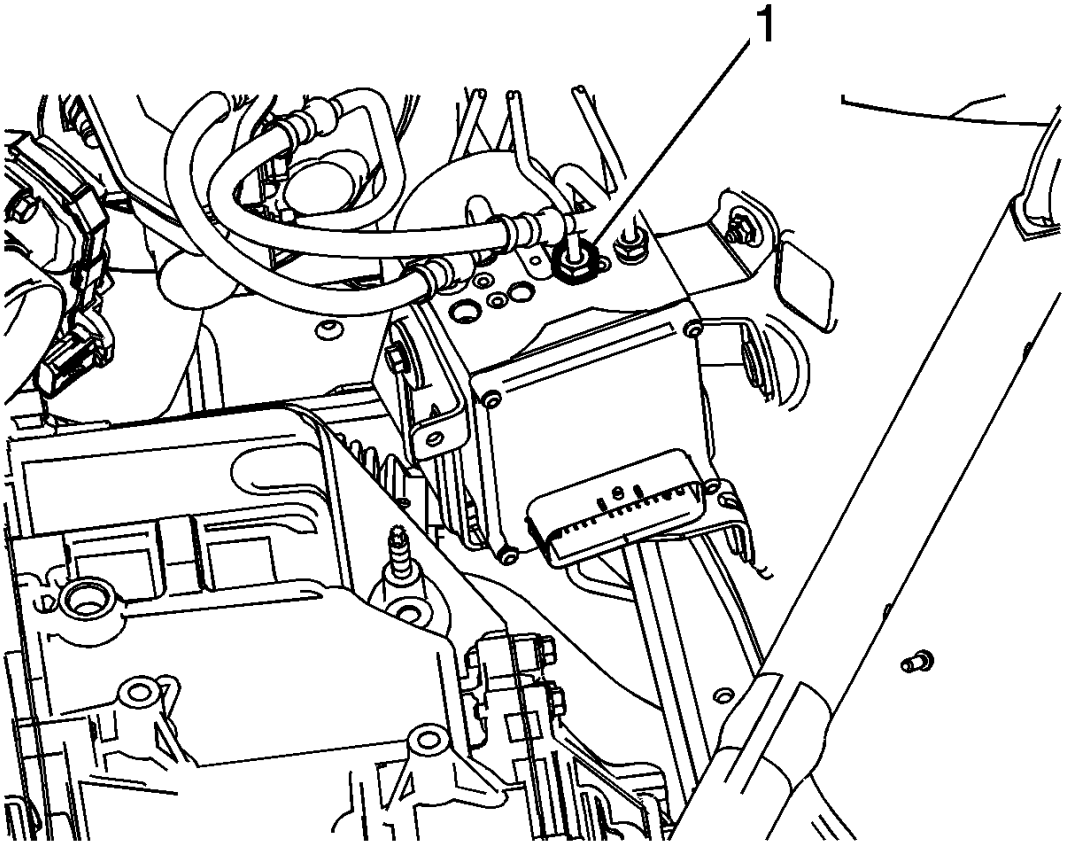


Fig. 20: Right Rear Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

7. Install the right rear brake pipe fitting (1) to the BPMV and tighten the fitting to 24 N.m (18 lb ft).

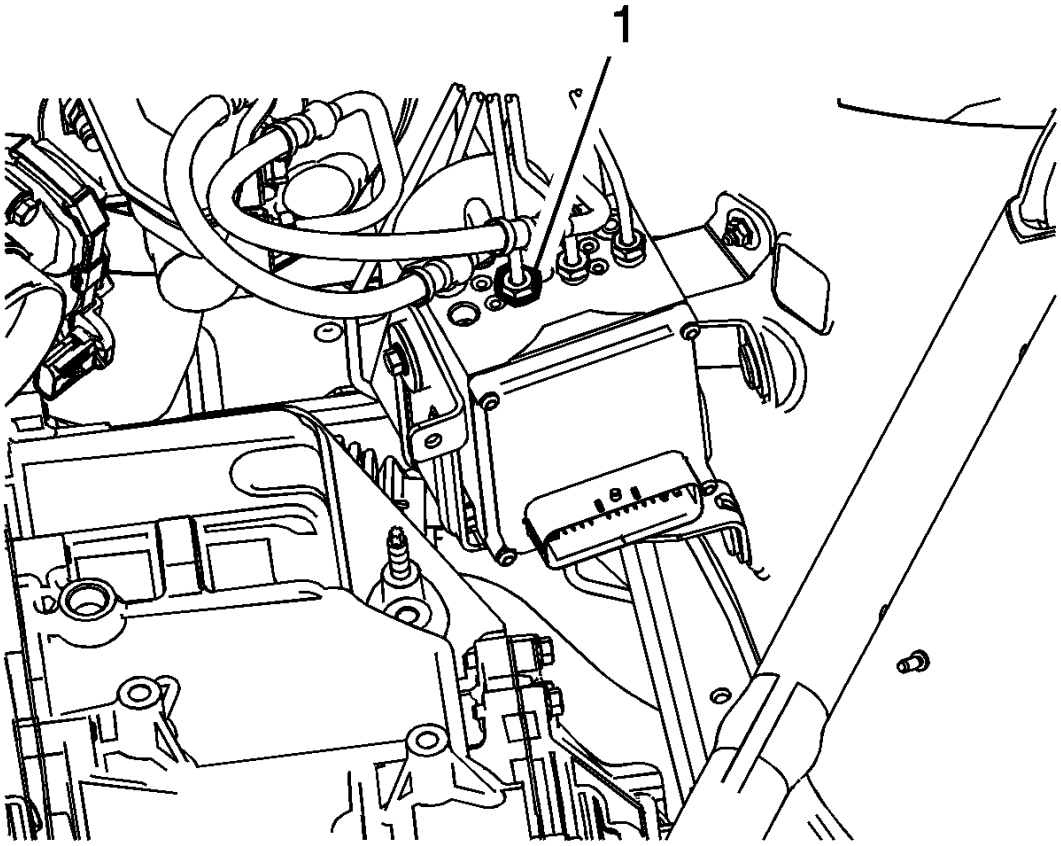


Fig. 21: Left Rear Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

8. Install the left rear brake pipe fitting (1) to the BPMV and tighten the fitting to 24 N.m (18 lb ft).

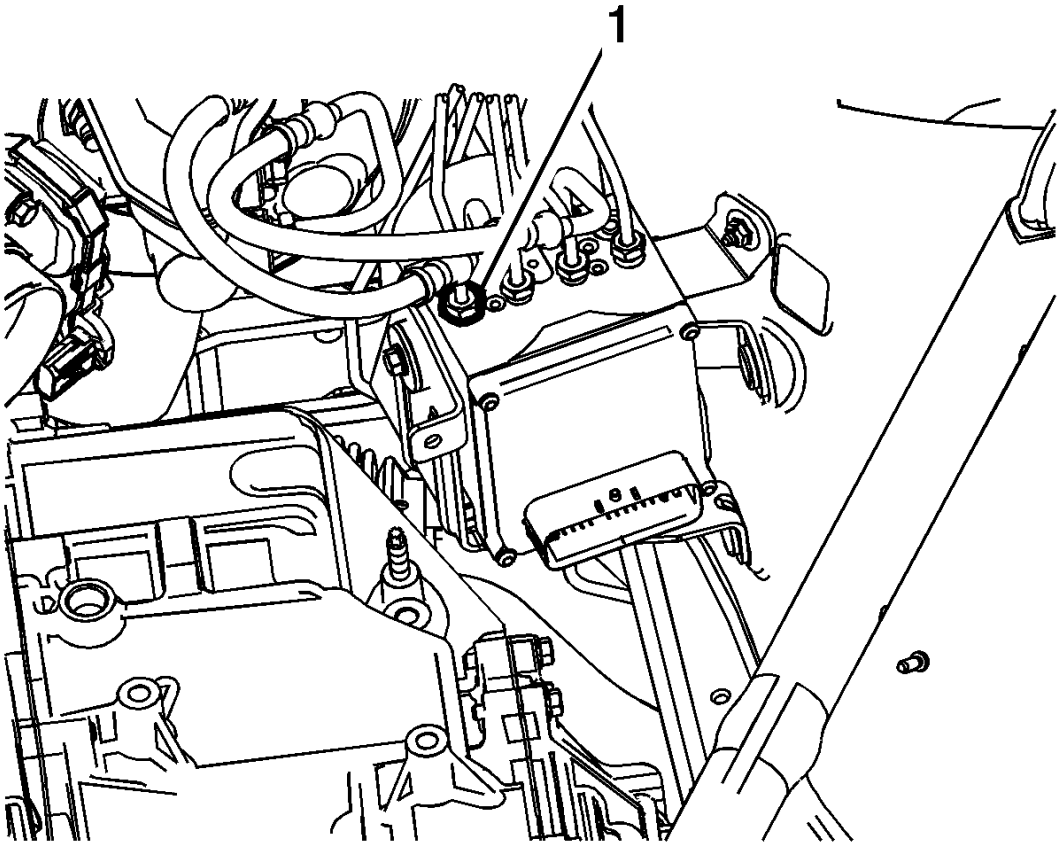


Fig. 22: Right Front Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

9. Install the right front brake pipe fitting (1) to the BPMV and tighten the fitting to 24 N.m (18 lb ft).
10. Connect the EBCM electrical connector.
11. Reposition the radiator surge tank and install the nuts. Refer to **Radiator Surge Tank Replacement** .
12. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
13. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
14. Bleed the antilock brake system. Refer to **Antilock Brake System Automated Bleed**.

BRAKE PRESSURE MODULATOR VALVE BRACKET REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the left front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

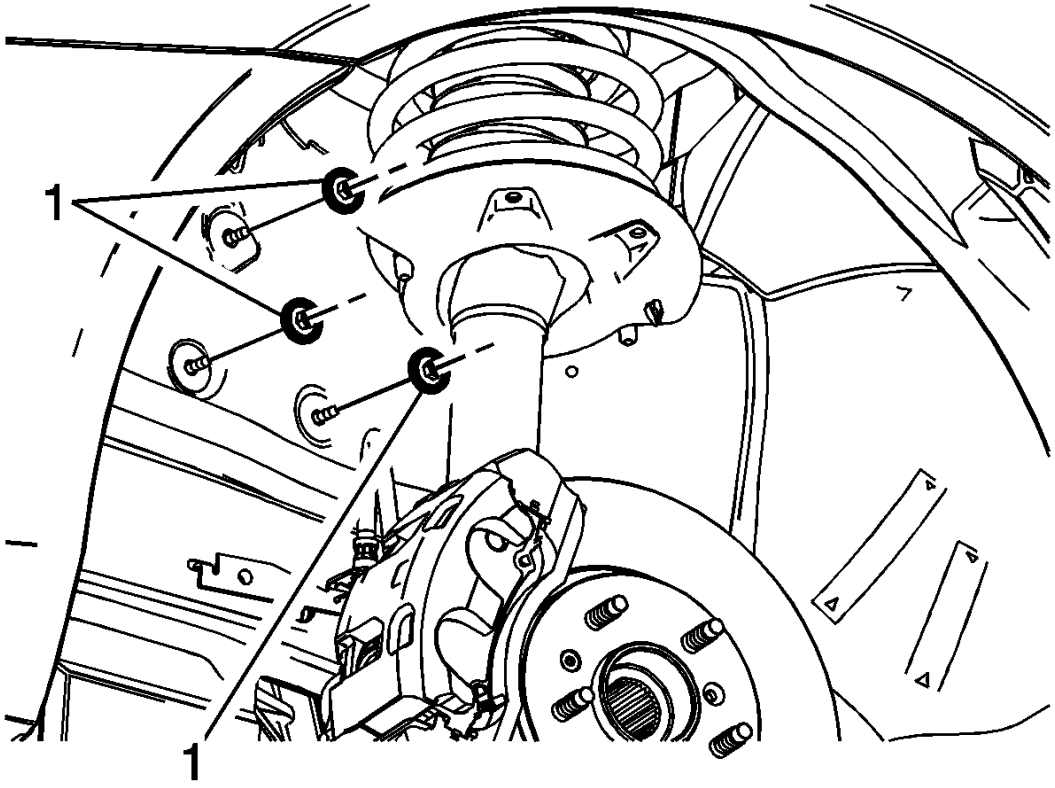


Fig. 23: Brake Pressure Modulator Valve Bracket Outer Nuts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the brake pressure modulator valve (BPMV) bracket outer nuts (1).
4. Lower the vehicle to access the engine compartment.
5. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
6. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
7. Without draining the engine coolant and without disconnecting the hoses, remove the nuts and position aside the radiator surge tank. Refer to **Radiator Surge Tank Replacement** .

CAUTION: To prevent equipment damage, never connect or disconnect the wiring harness connection from the EBCM with the ignition switch in the ON position.

8. Disconnect the electronic brake control module (EBCM) electrical connector.

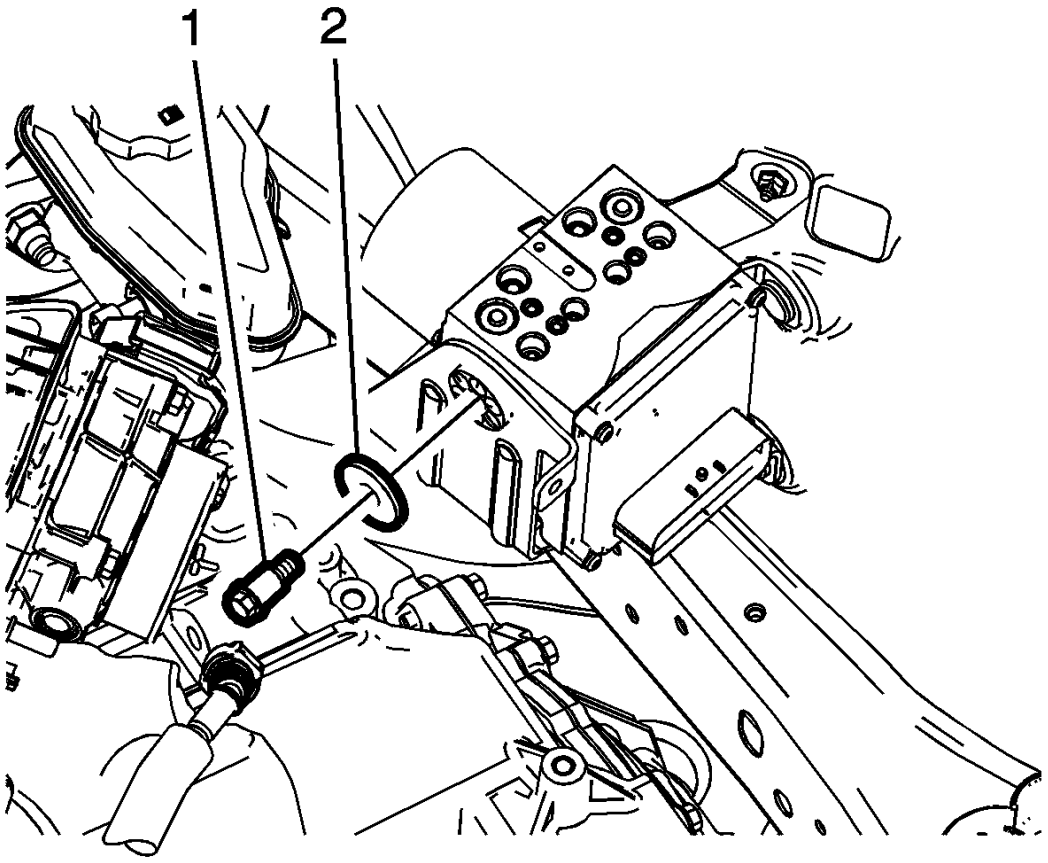


Fig. 24: Brake Pressure Modulator Valve Bolt And Washer
Courtesy of GENERAL MOTORS COMPANY

9. Remove the BPMV bolt (1) and washer (2).
10. Without disconnecting the brake pipes, carefully lift the BPMV assembly from the BPMV bracket and secure with heavy mechanics wire.

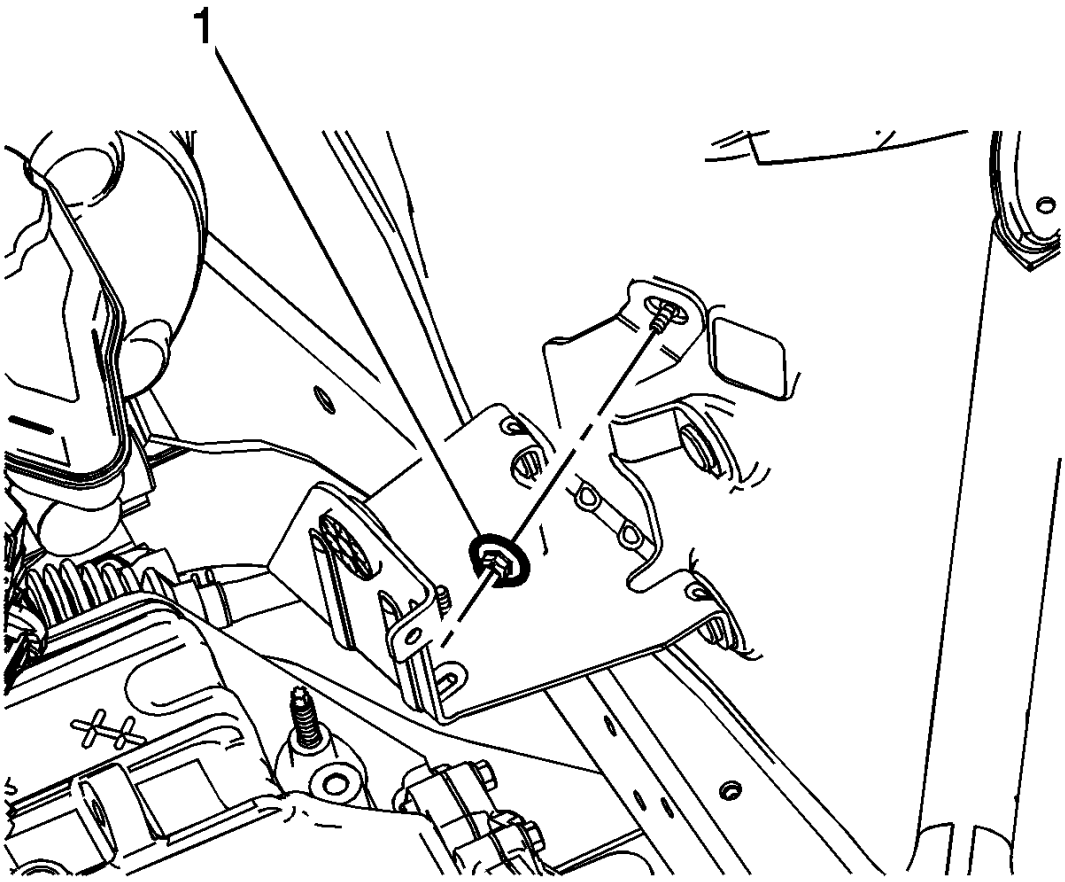


Fig. 25: Brake Pressure Modulator Valve Bracket Inner Nut
Courtesy of GENERAL MOTORS COMPANY

11. Remove the BPMV bracket inner nut (1).
12. Remove the BPMV bracket.

Installation Procedure

1. Install the BPMV bracket to the strut tower.

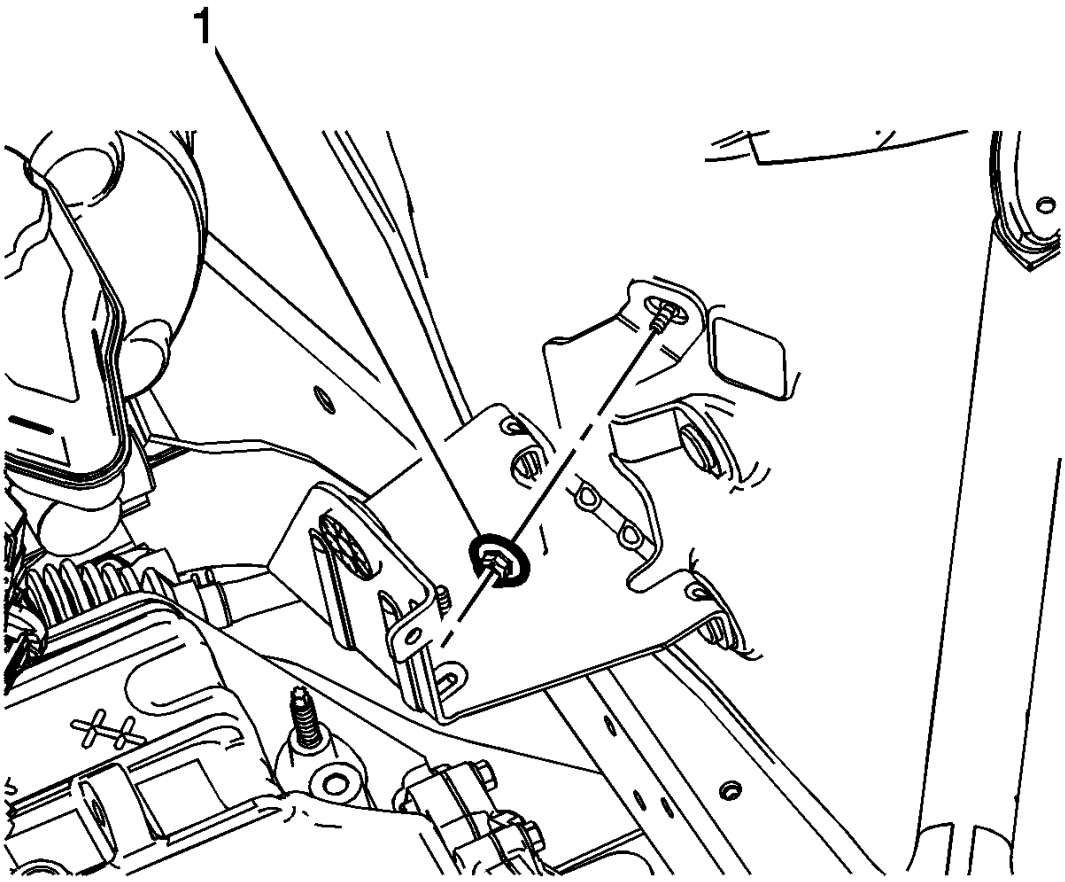


Fig. 26: Brake Pressure Modulator Valve Bracket Inner Nut
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the BPMV bracket inner nut (1) and tighten to 3 N.m (27 lb in).
3. Carefully position the BPMV assembly to the BPMV bracket.

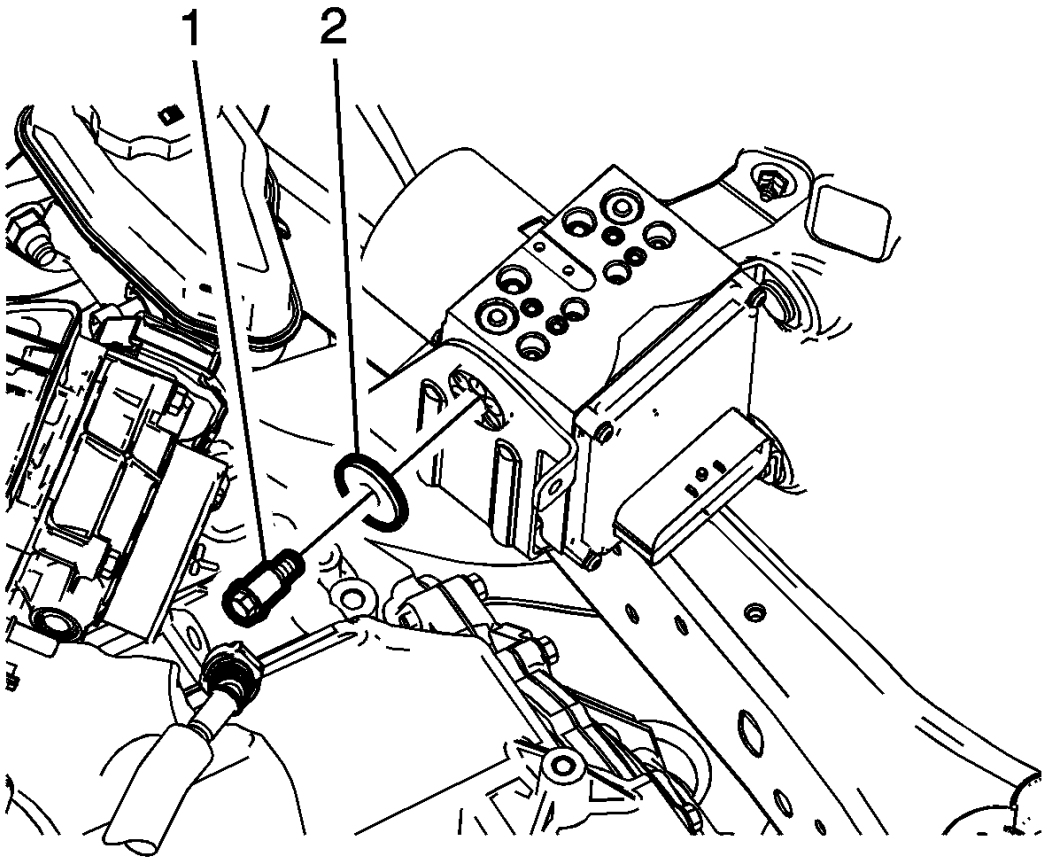


Fig. 27: Brake Pressure Modulator Valve Bolt And Washer
Courtesy of GENERAL MOTORS COMPANY

4. Install the BPMV bolt (1) and washer (2) and tighten the bolt to 10 N.m (89 lb in).
5. Connect the EBCM electrical connector.
6. Reposition the radiator surge tank and install the nuts. Refer to **Radiator Surge Tank Replacement** .
7. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
8. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
9. Raise and support the vehicle.

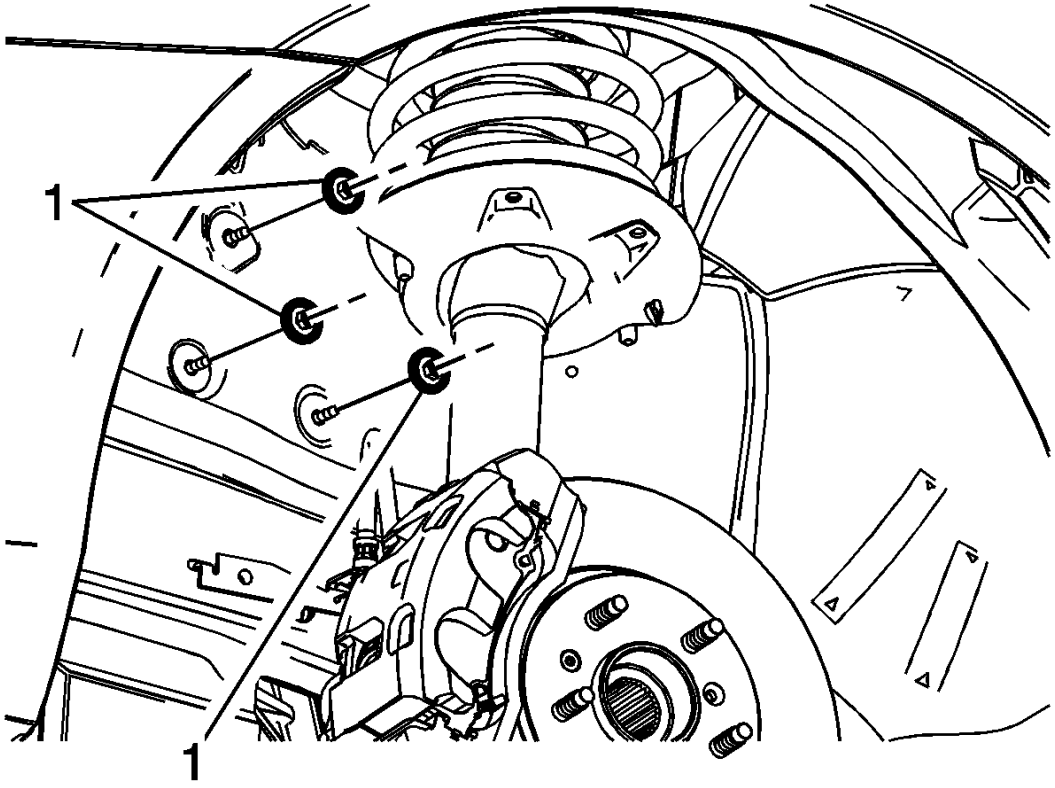


Fig. 28: Brake Pressure Modulator Valve Bracket Outer Nuts
Courtesy of GENERAL MOTORS COMPANY

10. Install the BPMV bracket outer nuts (1) and tighten to 10 N.m (89 lb in).
11. Install the left front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

ELECTRONIC TRACTION CONTROL SWITCH REPLACEMENT

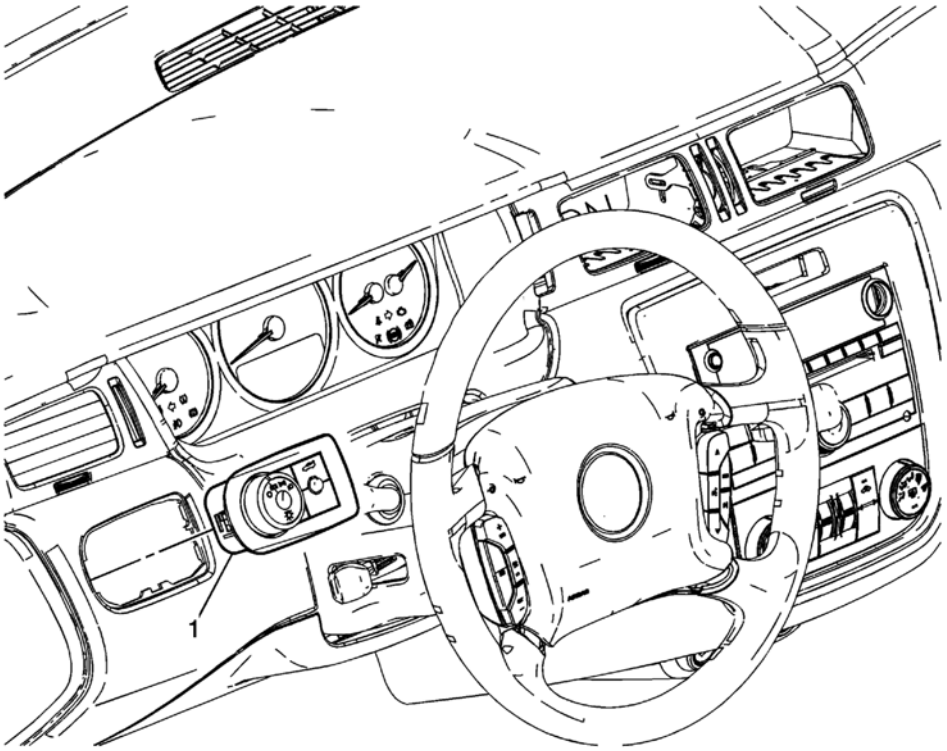


Fig. 29: View Of Traction Control Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** .	
1	Switch Assembly, Headlamp Instrument Panel Dimmer • The traction control switch is part of the headlamp switch and must be serviced as an assembly. • Disconnect the electrical connector.

VEHICLE YAW SENSOR LEARN

The yaw and lateral accelerometer sensor does not require calibration often. Calibration of the accelerometer sensor might be required after certain service procedures are performed. Some of these procedures are as follows:

- Electronic brake control module (EBCM) replacement
- Yaw and lateral accelerometer sensor replacement

The Yaw Rate Sensor Learn procedure can be completed with a scan tool using the following steps:

1. Place vehicle on a level surface
2. Apply the parking brake, or set the transmission in the P position.
3. Ignition ON, engine OFF
4. Install the scan tool to the data link connector.

5. Scroll to the EBCM, special functions menu on the scan tool.
6. Select Yaw Rate Sensor Recalibration.
7. Press the Reset.
8. Clear any DTCs that may be set.

VEHICLE YAW SENSOR WITH VEHICLE LATERAL ACCELEROMETER REPLACEMENT

Removal Procedure

1. Turn the ignition switch to the OFF position.
2. Remove the front floor center console. Refer to **Front Floor Console Replacement** .

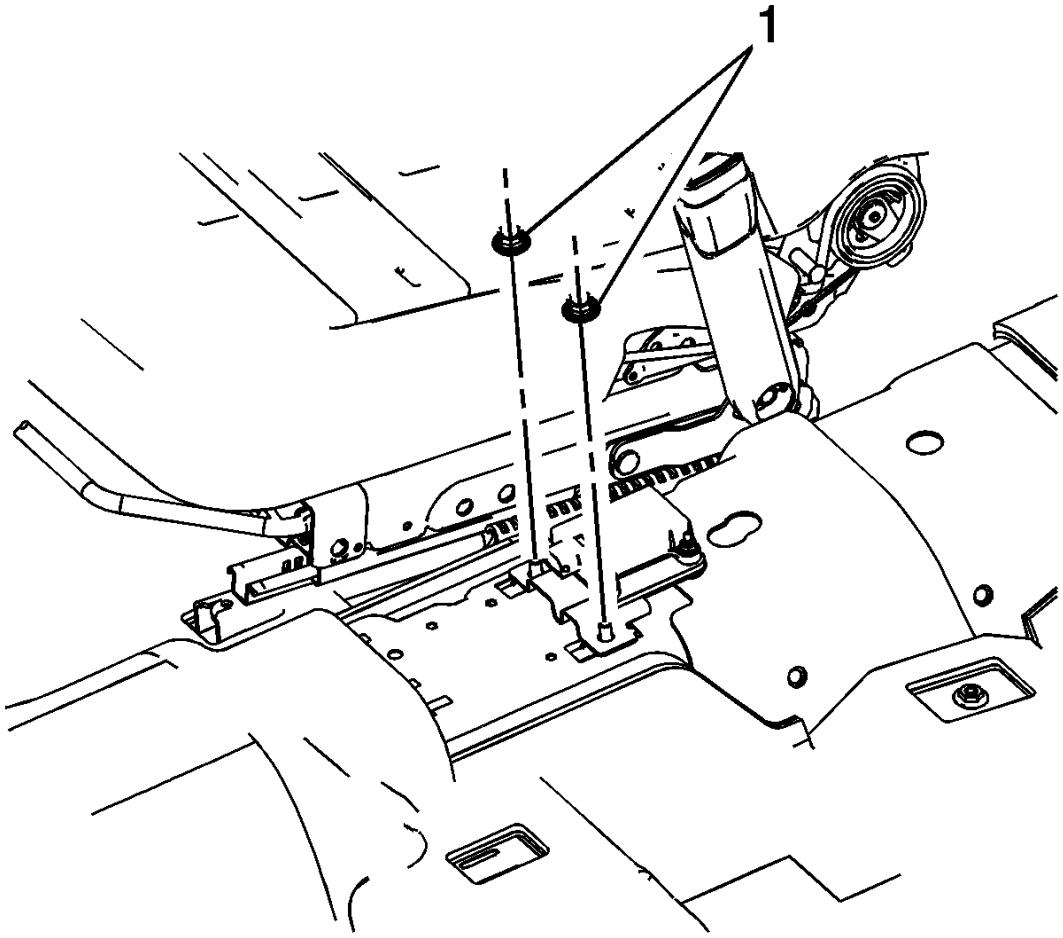


Fig. 30: Lateral Accelerometer Nuts
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the yaw sensor with lateral accelerometer electrical connector.
4. Remove the yaw sensor with lateral accelerometer nuts (1).

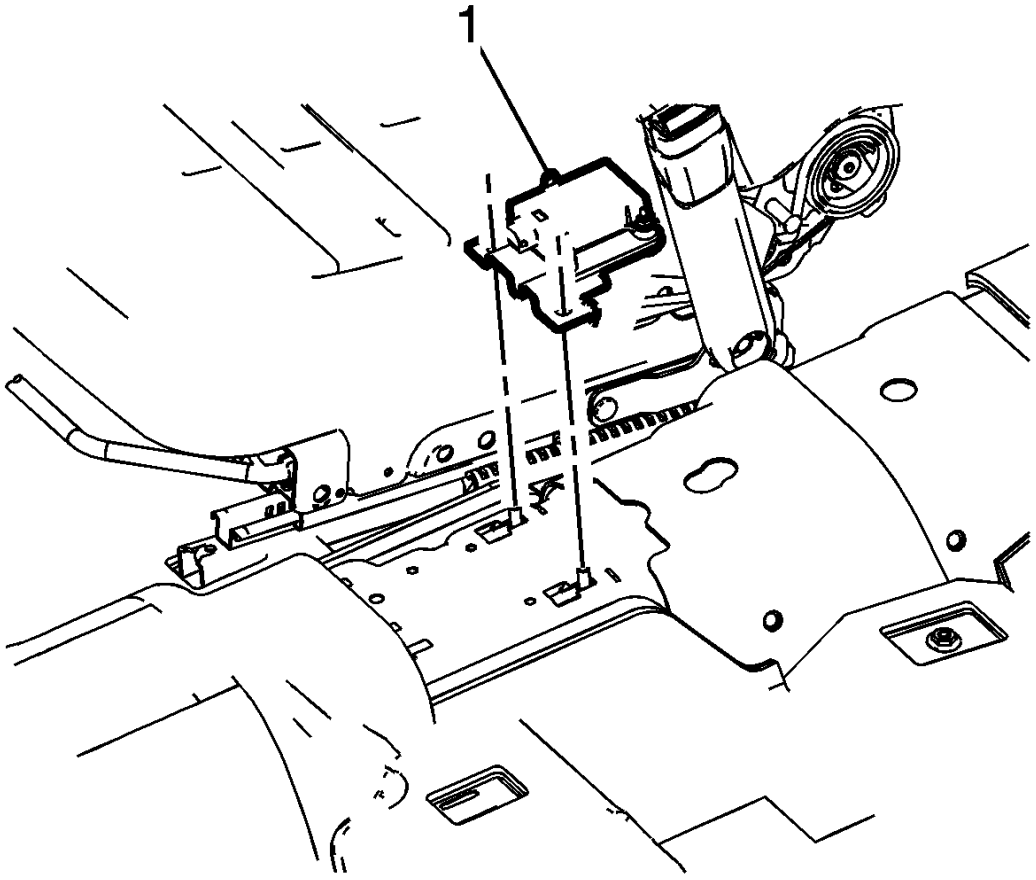


Fig. 31: Lateral Accelerometer
Courtesy of GENERAL MOTORS COMPANY

5. Remove the yaw sensor with lateral accelerometer (1).

Installation Procedure

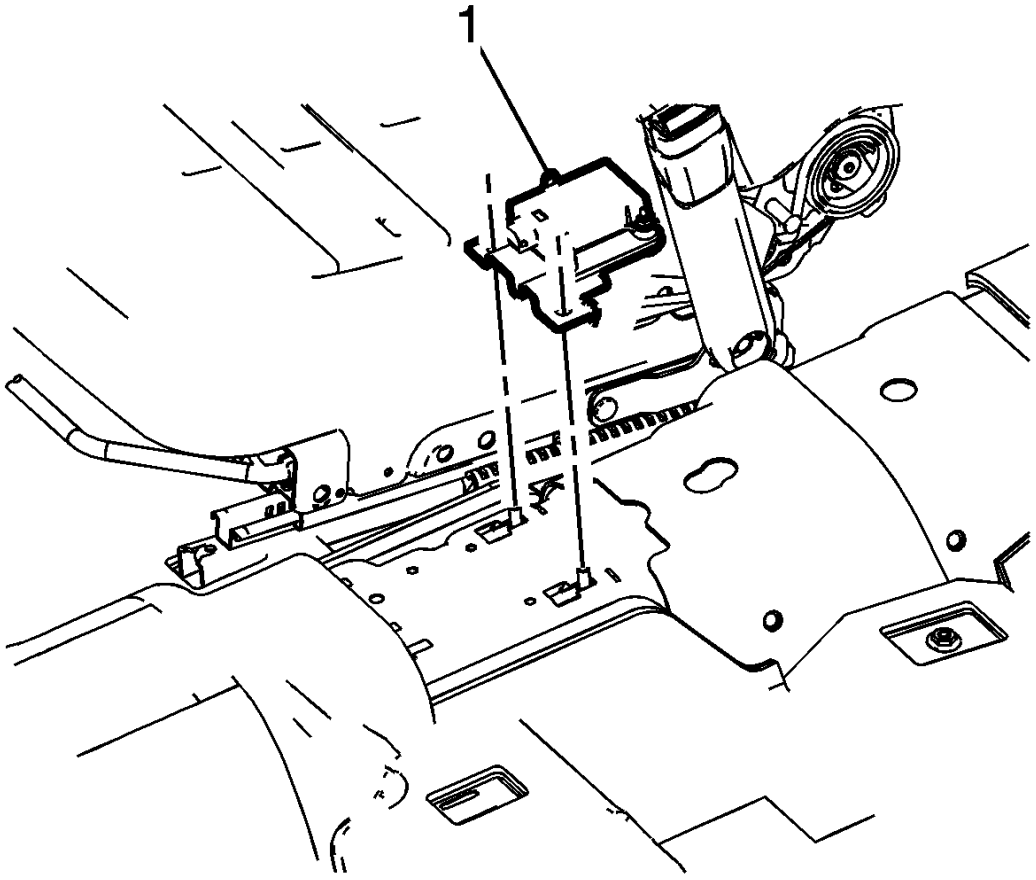


Fig. 32: Lateral Accelerometer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the yaw sensor with lateral accelerometer with the electrical connection facing forward.**

1. Install the yaw sensor with lateral accelerometer (1).

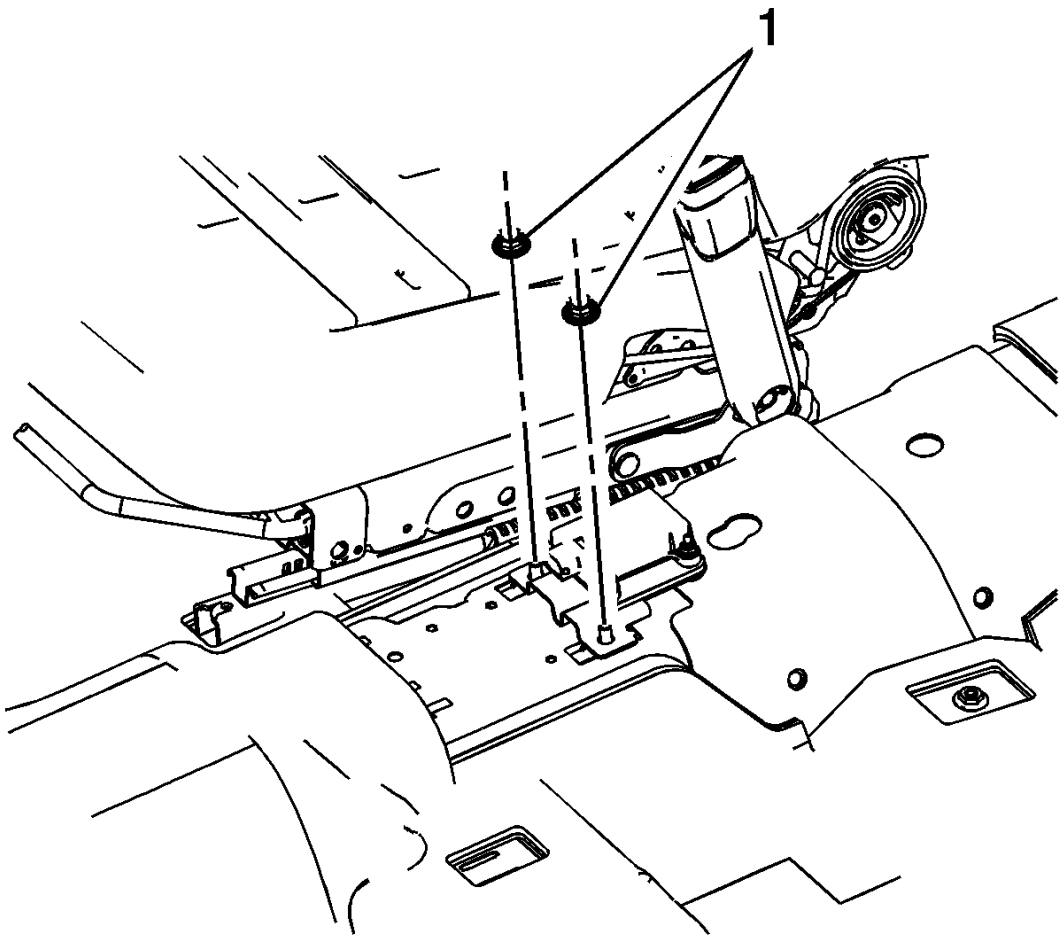


Fig. 33: Lateral Accelerometer Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the yaw sensor with lateral accelerometer nuts (1) and tighten to 26 N.m (19 lb ft).
3. Connect the yaw sensor with lateral accelerometer electrical connector.
4. Install the front floor center console. Refer to **Front Floor Console Replacement** .
5. Install a scan tool.
6. Using the special functions menu on the scan tool, reset the yaw rate sensor.
7. Perform the **Diagnostic System Check - Vehicle** .

DESCRIPTION AND OPERATION

ABS DESCRIPTION AND OPERATION

This vehicle is equipped with an TRW 440 brake master cylinder assembly. The electronic brake control module (EBCM) and the brake pressure modulator valve (BPMV) can be serviced separately. The BPMV uses a 4 circuit configuration to control hydraulic pressure to each wheel independently.

The following vehicle performance enhancement systems are provided.

- Antilock brake system (ABS)
- Dynamic rear proportioning (DRP)
- Traction control system (TCS) (w/NW9)

The following components are involved in the operation of the above systems:

- Brake pressure modulator valve (BPMV)-The BPMV contains the hydraulic valves and pump motor that are controlled electrically by the EBCM. The BPMV uses a 4 circuit configuration with a diagonal split. The BPMV directs fluid from the reservoir of the master cylinder to the left front and right rear wheels and fluid from the other reservoir to the right front and left rear wheels. The diagonal circuits are hydraulically isolated so that a leak or malfunction in one circuit will allow continued braking ability on the other.
- Solenoids-The solenoids are commanded ON and OFF by the EBCM to operate the appropriate valves in the BPMV.
- System relay-There are 2 system relays internal to the EBCM. The system relays are energized when the ignition is ON. The system relays supply battery positive voltage to the valve solenoids and to the ABS pump motor. This voltage is referred to as system voltage
- Traction control switch (w/NW9 and w/JL4)-TCS and vehicle stability enhancement system (VSES) is manually disabled or enabled using the traction control switch.
- Wheel speed sensors (WSS) - As the wheel spins, the wheel speed sensor produces an AC signal. The EBCM uses this AC signal to calculate wheel speed. The wheel speed sensors are replaceable only as part of the wheel hub and bearing assemblies.
- Brake pedal position (BPP) sensor-The EBCM receives a serial data message from the body control module (BCM) to indicate that the brake pedal is applied.

Initialization Sequence

The electronic brake control module (EBCM) performs 1 initialization test each ignition cycle. The initialization of the EBCM occurs when 1 set of the following conditions occur:

- The EBCM detects that there is a minimum of 500 RPM from the engine control module (ECM) via a serial data message.
- The brake pedal is not applied.

OR

- The vehicle speed is greater than 16 km/h (10 mph).
- The brake pedal is applied.

Antilock Brake System (ABS) Operation

When wheel slip is detected during a brake application, an ABS event occurs. During antilock braking, hydraulic pressure in the individual wheel circuits is controlled to prevent any wheel from slipping. A separate hydraulic line and specific solenoid valves are provided for each wheel. The ABS can decrease, hold, or increase hydraulic pressure to each wheel. The ABS does not, however, increase hydraulic pressure above the amount which is transmitted by the master cylinder during braking.

During antilock braking, a series of rapid pulsations is felt in the brake pedal. These pulsations are caused by the rapid changes in position of the individual solenoid valves as the electronic brake control module (EBCM) responds to wheel speed sensor inputs and attempts to prevent wheel slip. These pedal pulsations are present only during antilock braking and stop when normal braking is resumed or when the vehicle comes to a stop. A ticking or popping noise may also be heard as the solenoid valves cycle rapidly. During antilock braking on dry pavement, intermittent chirping noises may be heard as the tires approach slipping. These noises and pedal pulsations are considered normal during antilock operation.

Vehicles equipped with ABS may be stopped by applying normal force to the brake pedal. Brake pedal operation during normal braking is no different than that of previous non-ABS systems. Maintaining a constant force on the brake pedal provides the shortest stopping distance while maintaining vehicle stability. The typical ABS activation sequence is as follows:

Pressure Hold

The EBCM closes the isolation valve and keeps the dump valve closed in order to isolate the slipping wheel when wheel slip occurs. This holds the pressure steady on the brake so that the hydraulic pressure does not increase or decrease.

Pressure Decrease

If a pressure hold does not correct the wheel slip condition, a pressure decrease occurs. The isolation valve remains closed and the dump valve is opened. This allows a small amount of brake fluid to escape from the hydraulic circuit into the reservoir.

Pressure Increase

After the wheel slip is corrected, a pressure increase occurs. The isolation and dump valves are returned to their off states and brake pressure in the hydraulic circuit is once again dependant on the amount of force applied to the brake pedal by the driver. If the driver applies too much pressure causing wheel slip, the ABS activation sequence reoccurs.

Dynamic Rear Proportioning (DRP) Operation

The dynamic rear proportioning (DRP) is a control system that enhances the hydraulic proportioning function of the mechanical proportioning valve in the base brake system. The DRP control system is part of the operation software in the electronic brake control module (EBCM). The DRP uses active control with existing ABS in order to regulate the vehicle's rear brake pressure.

Traction Control System (TCS)

When drive wheel slip is noted while the brake is not applied, the electronic brake control module (EBCM) will enter traction control mode. The traction control system (TCS) controls vehicle traction by applying brakes and limiting engine torque to the drive wheels. The EBCM performs the fallowing TCS operations:

- The EBCM requests the engine control module (ECM) to reduce the amount of torque to the drive wheels via serial data messages.
- The ECM reduces torque to the drive wheels by retarding spark timing and throttle actuator control (TAC).
- The ECM reports the amount torque delivered to the drive wheels via serial data messages.

- The EBCM applies brake pressure to the slipping wheel in order to transfer torque to the gripping wheel.

Power-Up Self-Test

The electronic brake control module (EBCM) is able to detect many malfunctions whenever the ignition is ON. However, certain failures cannot be detected unless active diagnostic tests are performed on the components. Shorted solenoid coil or motor windings, for example, cannot be detected until the components are commanded ON by the EBCM. Therefore, a power-up self-test is required at the beginning of each ignition cycle to verify correct operation of components before the various control systems can be enabled. The EBCM performs the power-up self-test when the vehicle achieves a speed greater than 10 km/h (7 mph). The system relay, solenoids, and the ABS pump motor are commanded ON and OFF to verify proper operation and the EBCM verifies the ability to return the system to base braking in the event of a failure. The power-up self-test may sometimes be heard by the driver or passengers of the vehicle.

Vehicle Stability Enhancement System (VSES)

The vehicle stability enhancement system (VSES) adds an additional level of vehicle control to the electronic brake control module (EBCM).

Yaw rate is the rate of rotation about the vehicle's vertical axis. The lateral accelerometer measures the sideways acceleration of the vehicle. The VSES is activated when the EBCM determines that the desired yaw rate and lateral forces do not match the actual attitude of the vehicle.

The desired attitude of the vehicle are calculated from the following inputs:

- The position of the steering wheel
- The speed of the vehicle
- The lateral, or sideways acceleration of the vehicle
- Yaw rate of the vehicle
- Master cylinder brake pressure

The difference between the desired yaw rate and the actual yaw rate is the yaw rate error, which is a measurement of oversteer or understeer. If the yaw rate error becomes too large, the EBCM attempts to correct the vehicle's yaw motion by applying differential braking to the appropriate wheel. The amount of differential braking applied to the left or right front wheel is based on both the yaw rate error and side slip rate error.

The VSES activations generally occur during aggressive driving, in turns, or on poor road conditions, without much use of the accelerator pedal. When braking during VSES activation, the pedal pulsations feel different than the ABS pedal pulsations. The brake pedal pulsates at a higher frequency during VSES activation.

Driver Information Indicators and Messages

The following indicators are used to inform the driver of several different conditions:

Brake System Warning Indicator

The instrument panel cluster (IPC) illuminates the brake warning indicator when any of the following instances occur.

- The body control module (BCM) detects that the park brake is engaged. The BCM sends a serial data

message to the IPC requesting illumination.

- The electronic brake control module (EBCM) detects a low brake fluid condition. The EBCM sends a serial data message to the IPC requesting illumination.
- The IPC performs the bulb check.
- The IPC detects a loss of serial data communication with the EBCM.
- The EBCM detects an ABS-disabling malfunction which also disables dynamic rear proportioning (DRP). The EBCM sends a serial data message to the IPC requesting illumination.

ABS Indicator

The IPC illuminates the ABS indicator when any of the following instances occur.

- The EBCM detects an ABS-disabling malfunction. The EBCM sends a serial data message to the IPC requesting illumination.
- The IPC performs the bulb check.
- The IPC detects a loss of serial data communication with the EBCM.

Usually, the ABS indicator is turned OFF during the following ignition cycle unless the fault is detected during that ignition cycle. However, the setting of certain DTCs will cause the ABS indicator to remain illuminated during the following ignition cycle until the vehicle is operated at a speed greater than 13 km/h (8 mph). This allows the EBCM to verify that no malfunction exists, before turning OFF the ABS indicator, in order to comply with the United Nations Economic Commission for Europe (ECE) regulation no. 13. This response occurs even if the ABS indicator turns OFF when the scan tool is used to clear the DTCs. When repairing these vehicles, it is important to ensure that the ECE 13 response has occurred and that the ABS indicator does not illuminate after returning the vehicle to the customer. It is also important to verify that ECE 13 is not the cause of an ABS indicator which is illuminated when no DTCs are set, before attempting to diagnose other possible causes.

Vehicle Dynamics Caution (VDC) Indicator

The IPC illuminates the VDC indicator when there is a traction event, or if the traction control system (TCS) has been disabled due to a malfunction.

SERVICE TRACTION Message

The IPC displays the SERVICE TRACTION message when either of the following instances occur:

- The EBCM detects a malfunction that requires traction control to be disabled. The EBCM sends a serial data message to the IPC requesting that the message be displayed.
- The IPC detects a loss of serial data communication with the EBCM.

TRACTION CONTROL OFF Message

The IPC displays this message when the traction control system (TCS) or vehicle stability enhancement system (VSES) has been turned off by the driver.

The IPC also displays this message momentarily on the DIC on an initial Key up after the power moding times out and is reset.

STABILITRAK NOT READY Message

The IPC may display this message and the ESC/TCS light on the instrument panel cluster may be on until the vehicle is driven above 19 mph (30 km/h) for 30 seconds. The ESC system is not functional until the light has turned off.

SERVICE STABILITRAK Message

The IPC displays this message and the ESC/TCS light on the instrument panel cluster will be on when EBCM detects a malfunction with the vehicle stability enhancement system (VSES) that requires the system to be disabled.

Article GUID: A00737166

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Front Brakes		
• Brake Hose Bolt	54 N.m	40 lb ft
• Brake Rotor Retension Screw	14 N.m	124 lb in
• Front Caliper Bolts	36 N.m	26 lb ft
• Front Caliper Bracket Bolts	180 N.m	133 lb ft
Rear Brakes		
• Brake Hose Bolt	54 N.m	40 lb ft
• Brake Rotor Retension Screw	14 N.m	124 lb in
• Rear Caliper Bolts	44 N.m	32 lb ft
• Rear Caliper Bracket Bolts	120 N.m	88 lb ft

DISC BRAKE COMPONENT SPECIFICATIONS

Application	Specification	
	Metric	English
Front Brake Rotor		
• Rotor Discard Thickness*	28.6 mm	1.126 in
• Rotor Maximum Allowable Assembled Lateral Runout	0.06 mm	0.002 in
• Rotor Maximum Allowable Scoring	1.50 mm	0.059 in
• Rotor Maximum Thickness Variation	0.025 mm	0.001 in

Application	Specification	
	Metric	English
• Rotor Minimum Allowable Thickness after Refinishing	29.0 mm	1.142 in
• Rotor Thickness- New	30 mm	1.181 in
Rear Brake Rotor		
• Rotor Discard Thickness*	12.5 mm	0.492 in
• Rotor Maximum Allowable Assembled Lateral Runout	0.06 mm	0.002 in
• Rotor Maximum Allowable Scoring	1.50 mm	0.059 in
• Rotor Maximum Allowable Thickness Variation	0.025 mm	0.001 in
• Rotor Minimum Allowable Thickness after Refinishing	13.0 mm	0.512 in
• Rotor Thickness- New	14.0 mm	0.551 in
*All brake rotors have a discard dimension cast into them. Replace any rotor that does not meet this specification. After refinishing the rotor, replace any rotor that does not meet the minimum thickness specification.		

DIAGNOSTIC INFORMATION AND PROCEDURES

BRAKE ROTOR THICKNESS MEASUREMENT

WARNING: Two different designs of the front brake rotors and front brake pads are used on this vehicle. Do NOT interchange first design and second design parts, or a loss of braking and personal injury could occur.

WARNING: Refer to Brake Dust Warning .

1. If the inboard friction surface of the brake rotor is not accessible, reposition and support the caliper with the brake pads. Refer to **Front Disc Brake Pads Replacement**, and/or **Rear Disc Brake Pads Replacement**.
2. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.

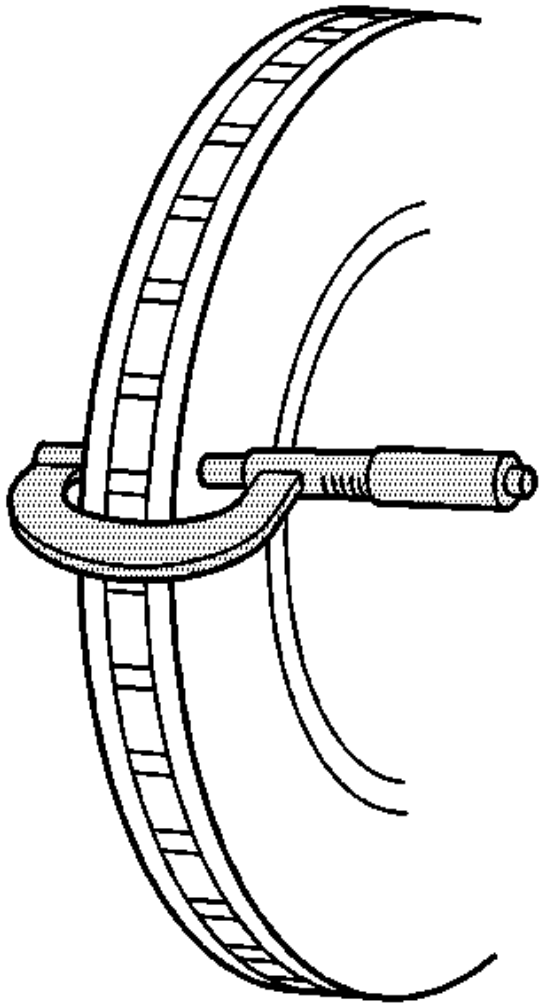


Fig. 1: Measuring Brake Rotor Thickness
Courtesy of GENERAL MOTORS COMPANY

3. Using a micrometer calibrated in thousanths-of-a-millimeter, or ten-thousanths-of-an-inch, measure and record the thickness of the brake rotor at four or more points, evenly spaced around the rotor.

   Ensure that the measurements are only taken within the friction surfaces and that the micrometer is positioned the same distance from the outer edge of the rotor, about 13 mm (1/2 in), for each measurement.

4. Compare the lowest thickness measurement recorded to the specifications listed in **Disc Brake Component Specifications**.
5. If the lowest thickness measurement of the brake rotor is above the minimum allowable thickness after refinishing specification, the rotor may be able to be refinished, depending upon surface and wear conditions which may be present.
6. If the lowest thickness measurement of the brake rotor is at or below the minimum allowable thickness after refinishing specification, the rotor may not be refinished.
7. If the lowest thickness measurement of the brake rotor is at or below the discard thickness specification, the rotor requires replacement.

BRAKE ROTOR THICKNESS VARIATION MEASUREMENT

WARNING: **Refer to Brake Dust Warning .**

NOTE: **Any disc brake rotor that exhibits thickness variation exceeding the maximum acceptable level must be refinished or replaced. Thickness variation exceeding the maximum acceptable level can cause brake pulsation.**

1. If the inboard friction surface of the brake rotor is not accessible, reposition and support the caliper with the brake pads. Refer to **Front Disc Brake Pads Replacement**, and/or **Rear Disc Brake Pads Replacement**.
2. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.

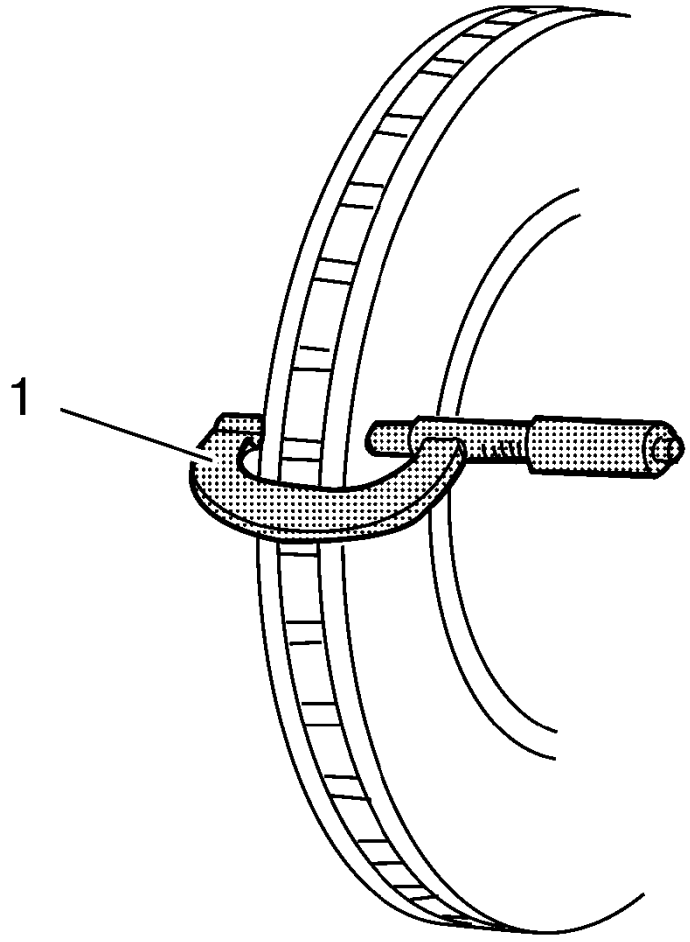


Fig. 2: Micrometer On Brake Rotor
Courtesy of GENERAL MOTORS COMPANY

3. Using a micrometer (1) calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure

and record the thickness of the brake rotor at 4 or more points, evenly spaced around the rotor.

Ensure that the measurements are only taken within the friction surfaces and that the micrometer is positioned the same distance from the outer edge of the rotor, about 13 mm (1/2 in), for each measurement.

4. Calculate the difference between the highest and lowest thickness measurements recorded to obtain the amount of thickness variation.
5. Compare the thickness variation measurement to the following specification:

Specification

Brake rotor maximum allowable thickness variation: 0.025 mm (0.001 in)

NOTE: **Whenever a brake rotor is refinished or replaced, the assembled lateral runout (LRO) of the rotor must be measured to ensure optimum performance of the disc brakes.**

6. If the brake rotor thickness variation measurement exceeds the specification, the rotor requires refinishing or replacement.

BRAKE ROTOR SURFACE AND WEAR INSPECTION

WARNING: **Refer to Brake Dust Warning .**

1. If the inboard friction surface of the brake rotor is not accessible, reposition and support the caliper with the brake pads. Refer to **Front Disc Brake Pads Replacement**, and/or **Rear Disc Brake Pads Replacement**.
2. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.
3. Inspect the friction surfaces of the brake rotor for the following Braking Surface Conditions:
    - Heavy rust and/or pitting

      Light surface rust can be removed with an abrasive disc. Heavy surface rust and/or pitting must be removed by refinishing the rotor.

    - Cracks and/or heat spots
    - Excessive blueing discoloration
4. If the friction surfaces of the brake rotor exhibit one or more of the Braking Surface Conditions, the rotor requires refinishing or replacement.

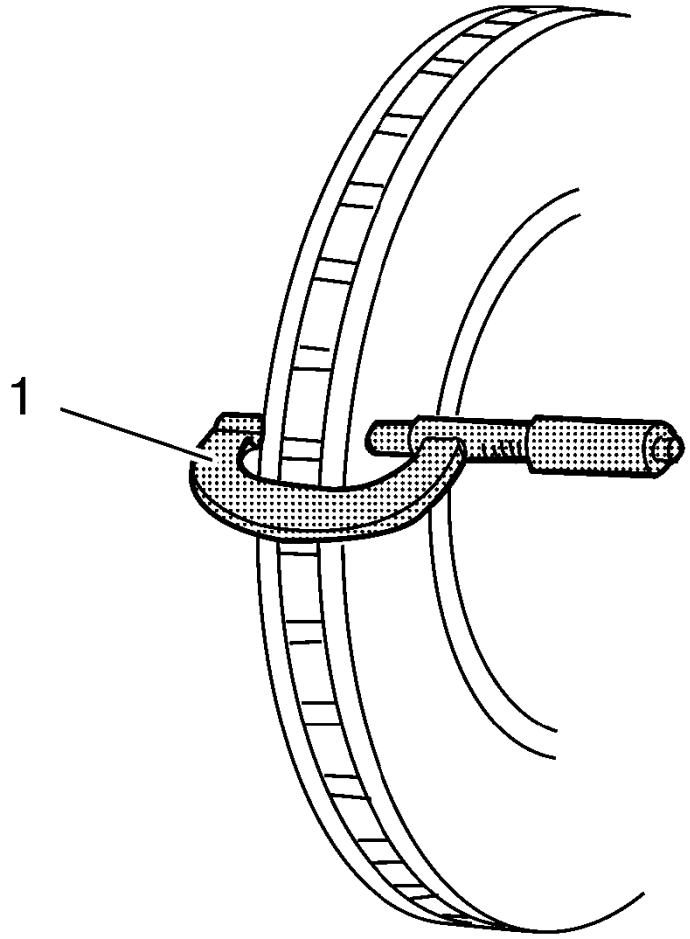


Fig. 3: Micrometer On Brake Rotor
Courtesy of GENERAL MOTORS COMPANY

5. Using a micrometer (1) calibrated in thousandths-of-a-millimeter, or ten-thousandths-of-an-inch, measure and record the scoring depth of any grooves present on the rotor friction surfaces.
6. Compare the groove scoring depth recorded to the following specification:

   Specification

   Brake rotor maximum allowable scoring: 1.50 mm (0.059 in)

7. If the brake rotor scoring depth exceeds the specification, or if an excessive amount of scoring is present, the rotor requires refinishing or replacement.

BRAKE ROTOR ASSEMBLED LATERAL RUNOUT MEASUREMENT

Special Tools

- **CH-41013** Rotor Resurfacing Kit

- **CH-42450-A** Wheel Hub Resurfacing Kit
- **CH-45101** Hub and Wheel Runout Gauge
- **CH-45101-100** Conical Brake Rotor Washers

For equivalent regional tools, refer to **Special Tools**.

WARNING: Refer to Brake Dust Warning .

NOTE:

- **Brake rotor assembled lateral runout (LRO) exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4,800-11,300 km (3,000-7,000 mi).**
- **Brake rotor thickness variation MUST be checked BEFORE checking for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.**

1. Matchmark the position of the brake rotor to the wheel studs if this has not been done already.

NOTE: **Whenever the brake rotor has been separated from the hub/axle flange, any rust or contaminants should be cleaned from the hub/axle flange and the brake rotor mating surfaces. Failure to do this may result in excessive assembled lateral runout (LRO) of the brake rotor, which could lead to brake pulsation.**

2. Inspect the mating surface of the hub/axle flange and the brake rotor to ensure that there are no foreign particles, corrosion, rust, or debris remaining. If the wheel hub/axle flange and/or if the brake rotor mating surfaces exhibit these conditions, perform the following steps:
    1. Remove the brake rotor from the vehicle. Refer to **Front Brake Rotor Replacement**, and/or **Rear Brake Rotor Replacement**.
    2. Using the **CH-42450-A** wheel hub resurfacing kit , thoroughly clean any rust or corrosion from the mating surface of the hub/axle flange.
    3. Using the **CH-41013** rotor resurfacing kit , thoroughly clean any rust or corrosion from the mating surface of the brake rotor.
    4. Clean the friction surfaces of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.
3. Install the rotor to the hub/axle flange using the matchmark made prior to removal.

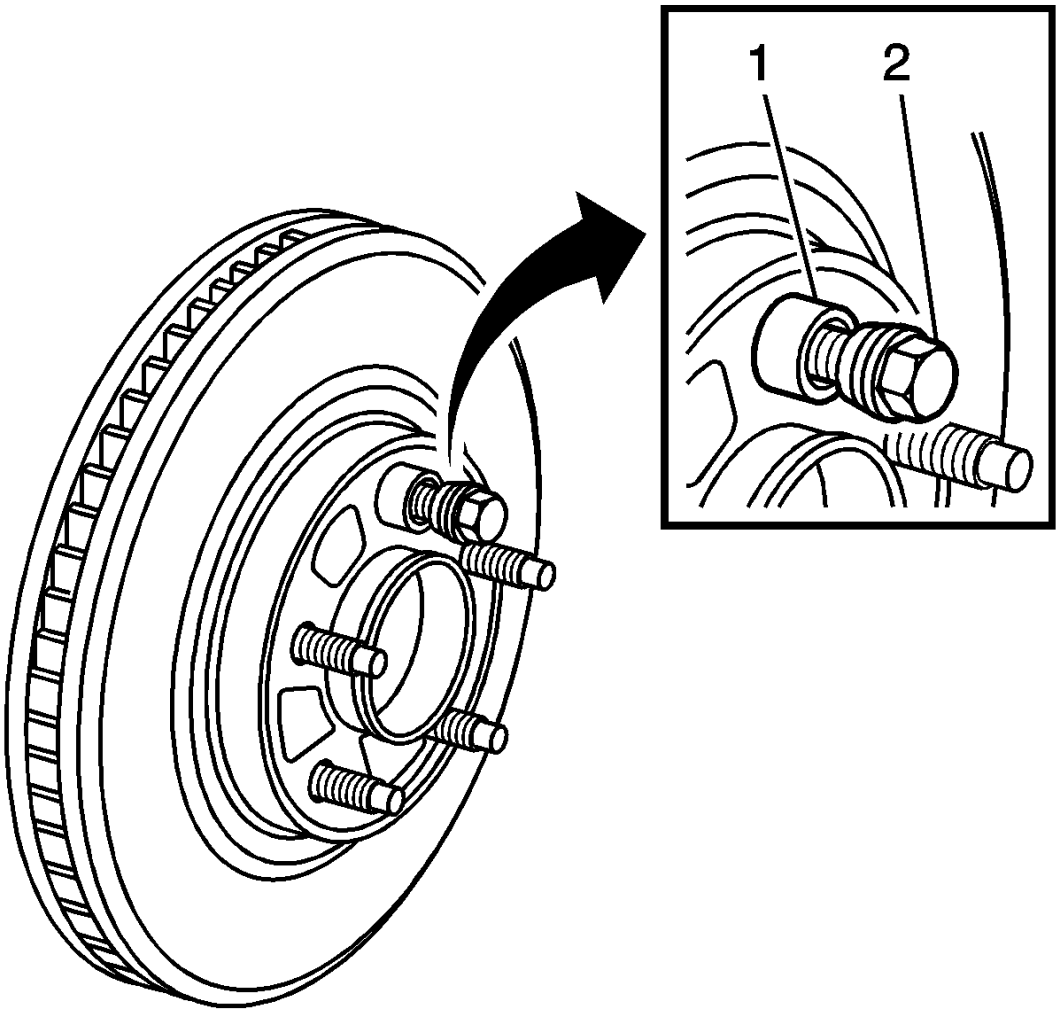


Fig. 4: Lug Nuts & Conical Washers
Courtesy of GENERAL MOTORS COMPANY

4. Hold the rotor firmly in place against the hub/axle flange and install one of th **CH-45101-100** conical brake rotor washers (1), and one lug nut (2) onto the upper-most wheel stud.
5. Continue to hold the rotor secure and tighten the lug nut firmly by hand.

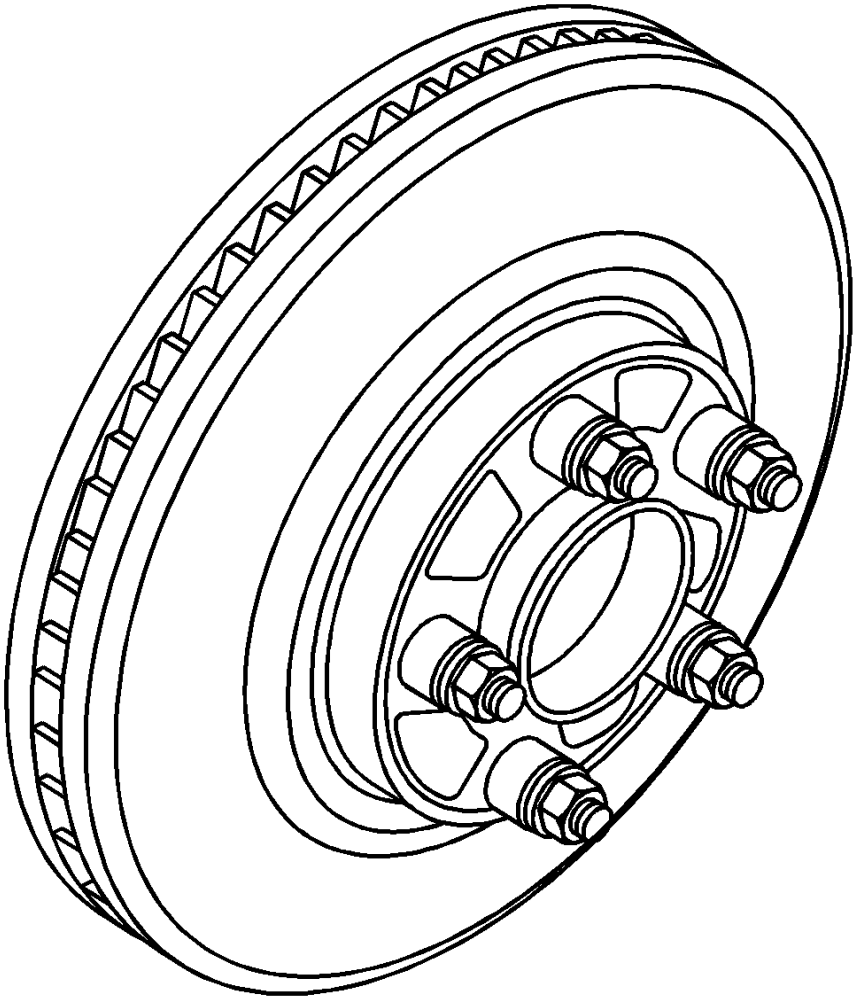


Fig. 5: Lug Nuts & Conical Washers
Courtesy of GENERAL MOTORS COMPANY

6. Install the remaining **CH-45101-100** conical brake rotor washers and lug nuts onto the wheel studs and tighten the nuts firmly by hand in a star-pattern.
7. Tighten the lug nuts in a star-pattern to specification. Refer to **Tire and Wheel Removal and Installation** .
8. If the brake rotor has been REFINISHED or REPLACED with a new rotor, proceed to step 14.
9. If the brake rotor meets the following criteria, proceed to step 10.
    - The rotor is within specifications and is being REUSED.
    - The rotor has NOT been refinished.
    - The rotor does NOT exhibit thickness variation exceeding the maximum allowable level.

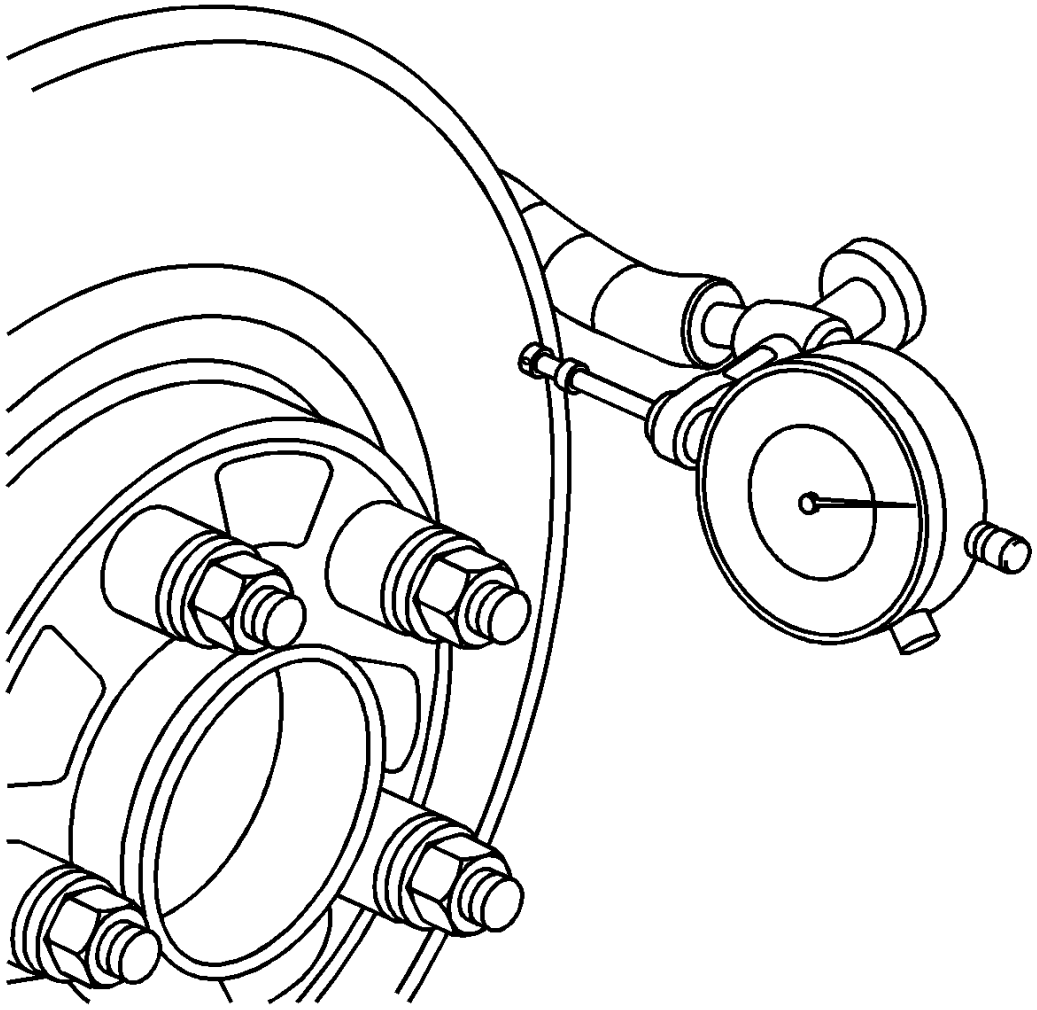


Fig. 6: Using Dial Indicator To Measure Lateral Runout
Courtesy of GENERAL MOTORS COMPANY

10. Mount a dial indicator, **CH-45101** hub and wheel runout gauge , or equivalent, to the steering knuckle and position the indicator button so it contacts the brake rotor friction surface at a 90 degree angle, approximately 13 mm (0.5 in) from the outer edge of the rotor.
11. Measure and record the assembled LRO of the brake rotor.
    1. Rotate the rotor until the lowest reading is displayed on the indicator dial, then set the dial to zero.
    2. Rotate the rotor until the highest reading is displayed on the dial.
    3. Mark the location of the high spot relative to the nearest wheel stud, or studs.
    4. Measure and record the amount of LRO.
12. Compare the brake rotor assembled LRO to the following specification:

    Specification

    - Front brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)
    - Rear brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)
13. If the brake rotor assembled LRO is within specifications, proceed to step 18.

If the brake rotor assembled LRO exceeds the specification, refinish the rotor to ensure true parallelism. Refer to **Brake Rotor Refinishing**. After refinishing the rotor, proceed to step 14.

14. Mount a dial indicator, **CH-45101** hub and wheel runout gauge , or equivalent, to the steering knuckle and position the indicator button so it contacts the brake rotor friction surface at a 90 degree angle, approximately 13 mm (0.5 in) from the outer edge of the rotor.
15. Measure and record the assembled LRO of the brake rotor.
    1. Rotate the rotor until the lowest reading is displayed on the indicator dial, then set the dial to zero.
    2. Rotate the rotor until the highest reading is displayed on the dial.
    3. Mark the location of the high spot relative to the nearest wheel stud, or studs.
    4. Measure and record the amount of LRO.
16. Compare the brake rotor assembled LRO to the following specification:

    Specification

    - Front brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)
    - Rear brake rotor maximum allowable assembled lateral runout: 0.05 mm (0.002 in)
17. If the brake rotor assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to **Brake Rotor Assembled Lateral Runout Correction**.
18. If the brake rotor assembled LRO measurement is within specification, install the brake caliper and depress the brake pedal several times to secure the rotor in place before removing the **CH-45101-100** conical brake rotor washers and the lug nuts.

BRAKE PAD INSPECTION

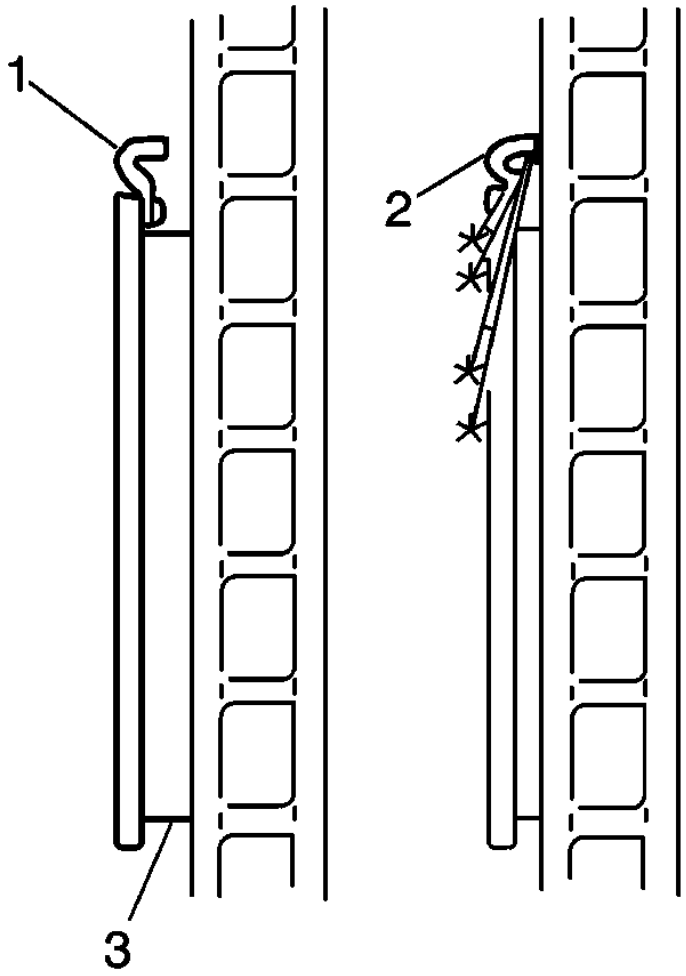


Fig. 7: View Of Brake Pads & Audible Wear Sensors
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Dust Warning .

1. Inspect the disc brake pads at regular intervals, or whenever the tire and wheel assemblies are removed from the vehicle.
2. If replacement is necessary, always replace disc brake pads in axle sets.
3. Inspect both edges of the disc brake pad friction surfaces (3). The highest rate of wear normally occurs at the trailing edge of the disc brake pads.
4. Inspect the thickness of the disc brake pads (3) in order to ensure that they have not worn prematurely. The disc brake pad wear should be approximately even per axle set.

NOTE: When replacing the disc brake pads, maintain the same disc brake pad wear sensor orientation.

5. Both front and rear disc brake pads have integral, audible wear sensors (1). When the disc brake pad wear reaches the minimum allowable thickness, the wear sensor contacts the disc brake rotor (2). The wear

indicator will then produce an audible, high-pitched warning noise during wheel rotation.

6. Replace the disc brake pads when the friction surface (3) is worn to within 0.76 mm (0.030 in) of the mounting plates.
7. Remove the brake calipers and inspect the friction surfaces of the inner and outer disc brake pads to ensure that they are level. Place the disc brake pad friction surfaces together and measure the gap between the surfaces. If more than 0.13 mm (0.005 in) gap exists midway between the length of the disc brake pads, replace the disc brake pads.
8. Verify that any disc brake pad shims that may be required are in place and not damaged or excessively corroded. Replace any missing or damaged shims in order to preserve proper disc brake performance.
9. Replace the disc brake pads if any have separated from the mounting plates.
10. Inspect the disc brake pads friction surfaces for cracks, fractures, or damage which may cause noise or otherwise impair disc brake performance.

BRAKE CALIPER INSPECTION

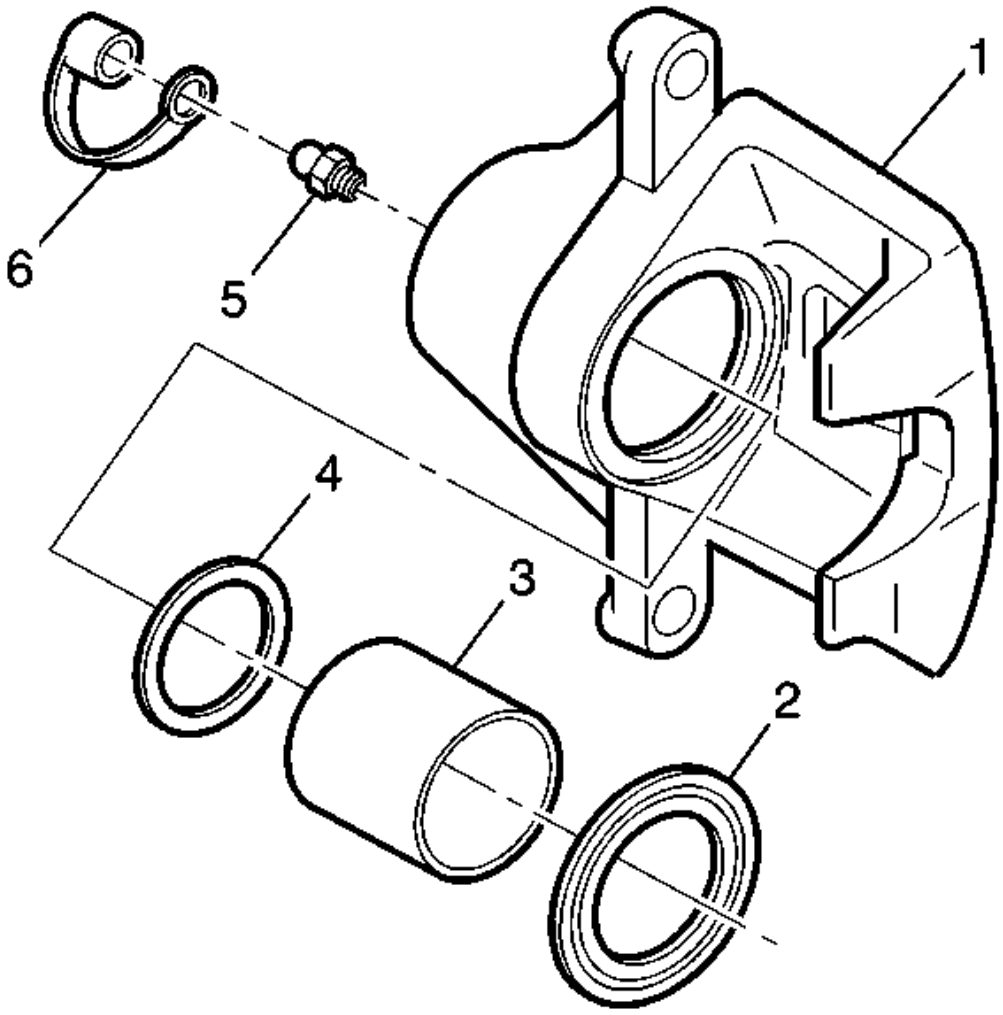


Fig. 8: Exploded View Of Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Brake Dust Warning .**

1. Inspect the brake caliper housing (1) for cracks, excess wear, and/or damage. If any of these conditions are present, the brake caliper requires replacement.
2. Inspect the caliper piston dust boot seal (2) for cracks, tears, cuts, deterioration and/or improper seating in the caliper body. If any of these conditions are present, the brake caliper requires overhaul or replacement.
3. Inspect for brake fluid leakage around the caliper piston dust boot seal (2) and on the disc brake pads. If there is any evidence of brake fluid leakage, the brake caliper requires overhaul or replacement.

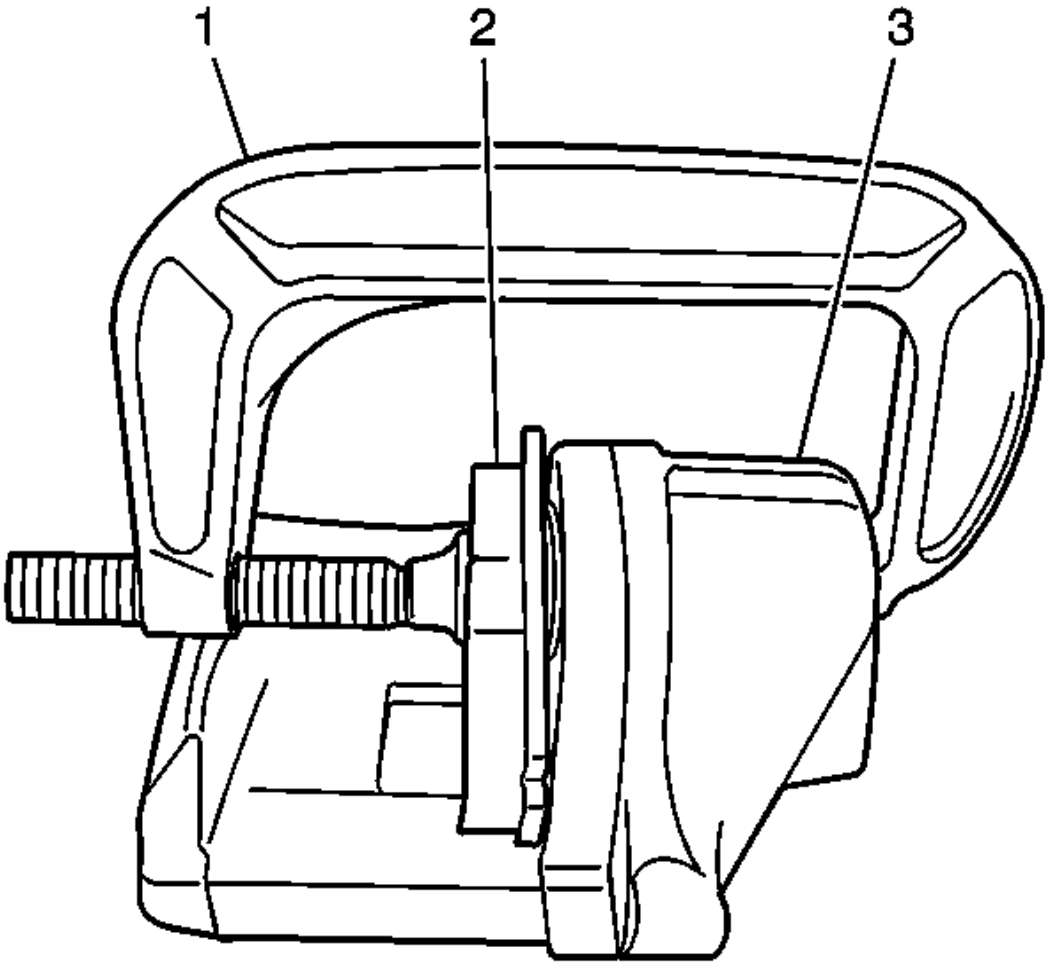


Fig. 9: Compressing Caliper Piston
Courtesy of GENERAL MOTORS COMPANY

4. Inspect for smooth and complete travel of the caliper pistons into the caliper bores:

   The movement of the caliper pistons into the caliper bores should be smooth and even. If the caliper piston is frozen or difficult to bottom, the caliper requires overhaul or replacement.

   - For single piston caliper applications, insert a discarded inner brake pad (2) or block of wood in front of the piston. Using a large C-clamp (1) installed over the body of the caliper (3) and against

the brake pad or block of wood, slowly bottom the piston in the bore.

- For dual piston caliper applications, insert a discarded inner brake pad (2) or block of wood in front of the pistons. Using 2 large C-clamps (1) installed over the body of the caliper (3) and against the brake pad or block of wood, slowly bottom the pistons evenly into the bores.

FRONT DISC BRAKE MOUNTING AND HARDWARE INSPECTION

WARNING: Refer to Brake Dust Warning .

1. Inspect the fluid level in the brake master cylinder reservoir.
2. If the brake fluid level is midway between the maximum-full point and the minimum allowable level then no brake fluid needs to be removed from the reservoir before proceeding.
3. If the brake fluid level is higher than midway between the maximum-full point and the minimum allowable level then remove brake fluid to the midway point before proceeding.
4. Raise and support the vehicle. Refer **Lifting and Jacking the Vehicle** .
5. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
6. Grasp the brake caliper housing and try to move the brake caliper housing up/down and forward/reverse in relation to the brake caliper mounting bracket. If excessive looseness is observed the brake caliper bracket bushings and/or the brake caliper mounting bolts may need to be replaced.
7. Compress the front caliper pistons.
   - Install a large C-clamp over the top of the caliper housing and against the back of the outboard pad.
   - Slowly tighten the C-clamp until the pistons are pushed completely into the caliper bores.
   - Remove the C-clamp from the caliper.
8. With the pistons compressed into the caliper bores, grasp the brake caliper housing and slide it back and forth on the brake caliper mounting bolts. Check for smooth operation. If the brake caliper housing slide force is high or the brake caliper housing does not slide smoothly, inspect the brake caliper mounting bolts and/or the brake caliper mounting bracket bushings for wear or damage. If wear or damage conditions are found, replacement of the brake caliper mounting bolts and/or the brake caliper mounting bracket bushings is necessary.
9. Remove the brake caliper mounting bolts from the brake caliper mounting bracket and support the brake caliper using heavy mechanics wire. Do Not remove the hydraulic brake hose from the caliper. Refer to **Front Brake Caliper Replacement**.

   NOTE: When replacing the disc brake pads, maintain the same disc brake pad wear sensor orientation.

10. Remove the disc brake pads from the brake caliper mounting bracket.
11. Inspect the disc brake pad mounting hardware for the following:
    - Missing mounting hardware
    - Excessive corrosion
    - Bent mounting tabs
    - Looseness at the brake caliper mounting bracket
    - Looseness at the disc brake pads

- Excessive contaminants in the brake caliper mounting bracket surface and threads.

12. If any of the conditions listed are found, the disc brake pad mounting hardware requires replacement.
13. Ensure the disc brake pads are held firmly in place on the brake caliper mounting bracket, yet slide easily on the mounting hardware without binding.

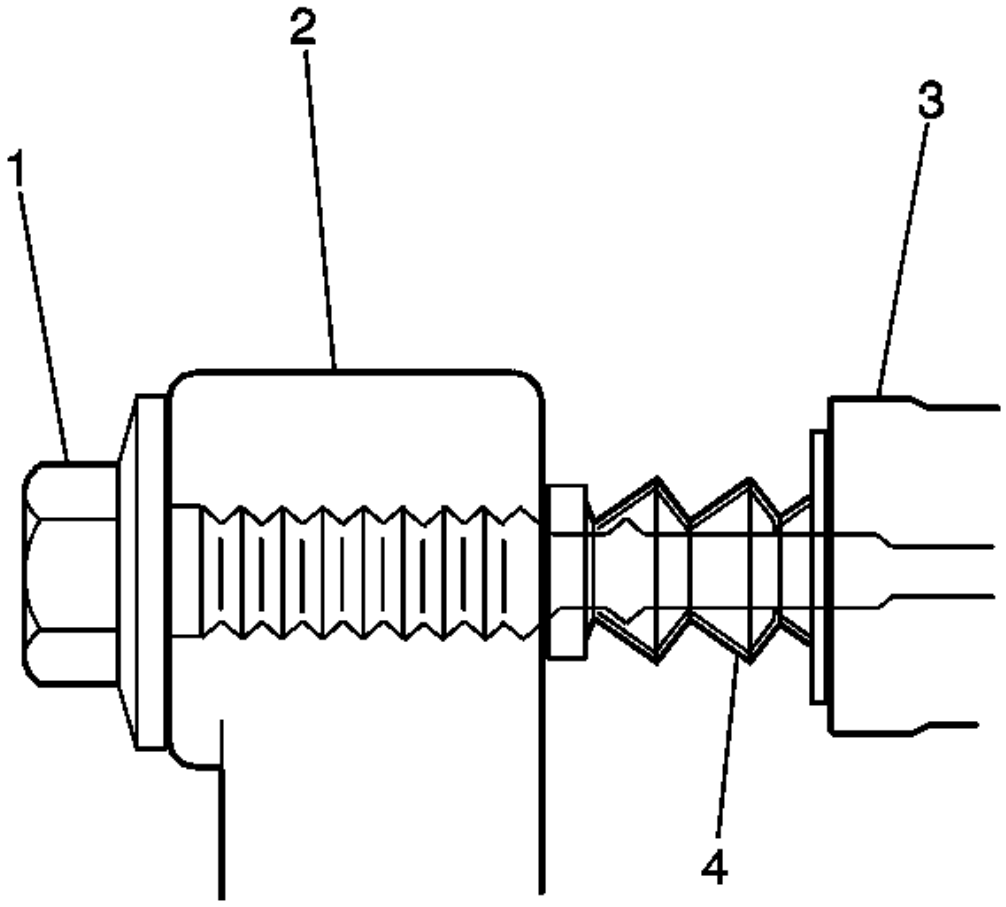


Fig. 10: View Of Caliper, Pin, Boots & Caliper Mounting Bracket
Courtesy of GENERAL MOTORS COMPANY

14. Inspect the brake caliper guide pin bolt (1), brake caliper (2), caliper bracket (3), and the guide pin seal (4) for the following:
    - Binding
    - Seizing
    - Looseness in the brake caliper mounting bracket
    - Bent or damaged brake caliper mounting bolts
    - Cracked or torn boots
    - Missing boots
    - Bent or damaged brake caliper mounting bracket

15. If any of the conditions listed are found then the brake caliper mounting hardware requires replacement.
16. Install the disc brake pads to the brake caliper mounting bracket.
17. Install the disc brake caliper to the brake caliper mounting bracket. Refer to **Front Brake Caliper Replacement**.

REAR DISC BRAKE MOUNTING AND HARDWARE INSPECTION

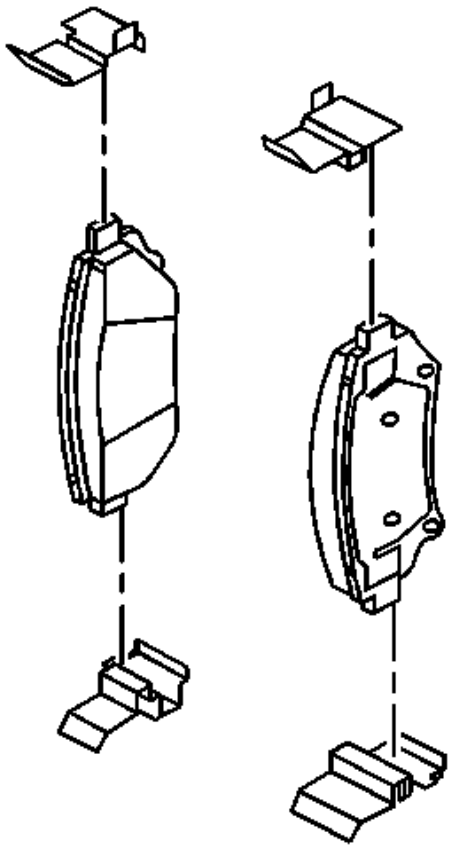


Fig. 11: Disc Brake Pad Mounting Hardware
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Dust Warning .

1. Inspect the disc brake pad mounting hardware for the following:
   - Missing mounting hardware
   - Excessive corrosion
   - Bent mounting tabs
   - Looseness at the caliper mounting bracket
   - Looseness at the disc brake pads

2. If any of the conditions listed are found, the disc brake pad mounting hardware requires replacement.
3. Ensure the disc brake pads are held firmly in place on the caliper mounting bracket, yet slide easily on the mounting hardware without binding.

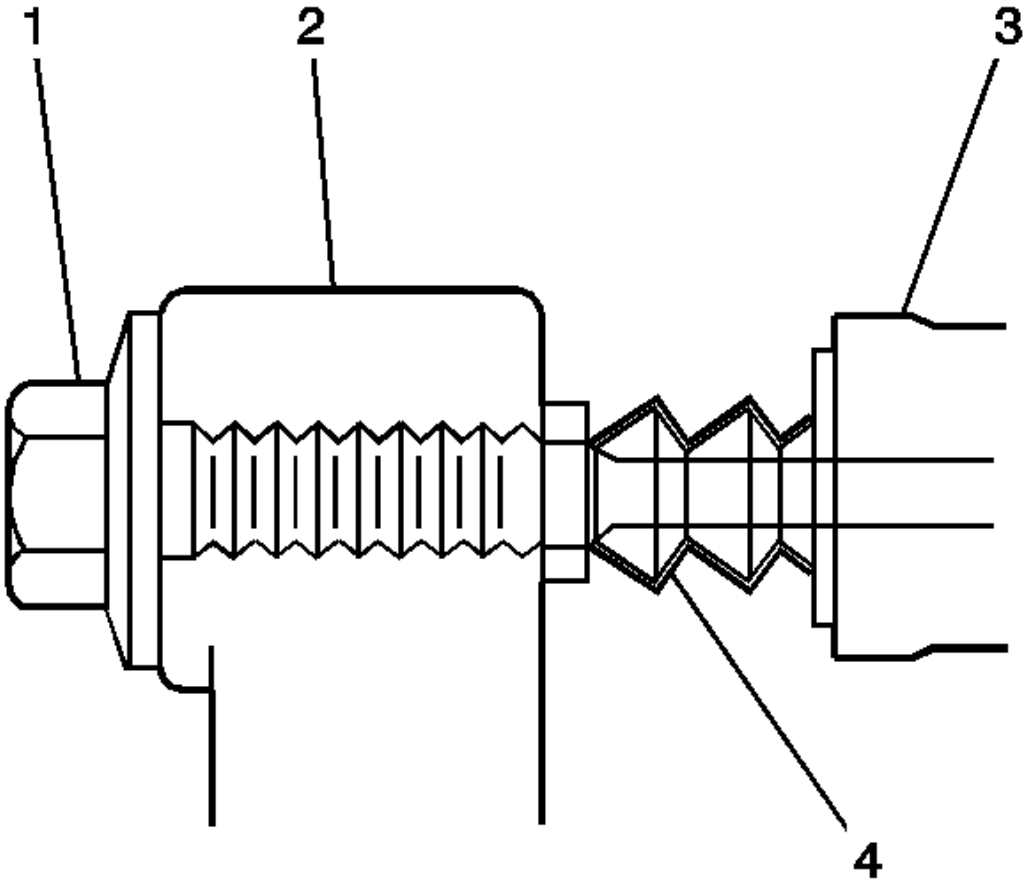


Fig. 12: Inspecting Caliper Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the caliper bolts (1) for the following:
    - Binding
    - Seizing
    - Looseness in the caliper mounting bracket (3)
    - Bent or damaged caliper bolts
    - Cracked or torn boots (4)
    - Missing boots
    - Bent or damaged caliper mounting bracket (3)
5. If any of the conditions listed are found, the caliper mounting hardware requires replacement.

REPAIR INSTRUCTIONS

FRONT DISC BRAKE PADS REPLACEMENT

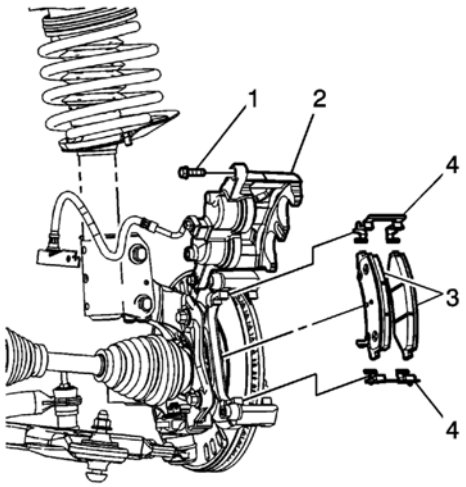


Fig. 13: Front Brake Pads
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Brake Fluid Irritant Warning .** **WARNING:** **Refer to Brake Dust Warning .** **CAUTION:** **Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to**	

Callout	Component Name
support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. **NOTE:** **Always replace disc brake pads in axle sets.** **Preliminary Procedures** 1. Inspect the fluid level in the brake master cylinder reservoir. 2. If the brake fluid level is midway between the maximum-full point and the minimum allowable level, no brake fluid needs to be removed before proceeding. 3. If the brake fluid level is higher than midway between the maximum-full point and the minimum allowable level, remove brake fluid to the midway point before proceeding. 4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 5. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .	
1	Guide Pin Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 36 N.m (26 lb ft)

Callout	Component Name
2	Brake Caliper **Procedure** 1. Rotate the brake caliper up and to the rear until it rests on the mounting bracket and support with heavy mechanics wire or equivalent. 2. Place a block of wood or an old disc brake pad against the brake caliper pistons. 3. Using a brake pad spreader or equivalent tool, slowly compress the brake caliper pistons squarely into the caliper bores.
3	Brake Pad **Procedure** 1. If installing the original brake pads, note the brake pad location for proper installation. 2. When replacing the brake pads, ensure the brake pad with the wear indicator is positioned inboard of the brake rotor and the wear indicator is pointing down. 3. Clean the friction surfaces of the brake rotor with denatured alcohol.
4	Spring Retainer (Qty: 2) **Procedure** 1. If replacing the brake pads, DO NOT reuse the spring retainers. Install NEW spring retainers. 2. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance. 3. Slowly release the brake pedal. 4. Wait 15 seconds, then repeat steps 2-3 until a firm brake pedal is obtained. This will properly seat the brake caliper pistons and the brake pads. 5. Fill the master cylinder reservoir to the proper level. Refer to **Master Cylinder Reservoir Filling** . 6. Burnish the pads and rotors. Refer to **Brake Pad and Rotor Burnishing**.

REAR DISC BRAKE PADS REPLACEMENT

Removal Procedure

WARNING: Refer to Brake Dust Warning .

NOTE: Always replace disc brake pads in axle sets.

1. Inspect the fluid level in the brake master cylinder reservoir.
2. If the brake fluid level is midway between the maximum-full point and the minimum allowable level, then no brake fluid needs to be removed from the reservoir before proceeding. If the brake fluid level is

higher than midway between the maximum-full point and the minimum allowable level, then remove brake fluid to the midway point before proceeding.

3. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the rear tire and the wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
5. Install a hand tightened lug nut to retain the rotor to the hub.

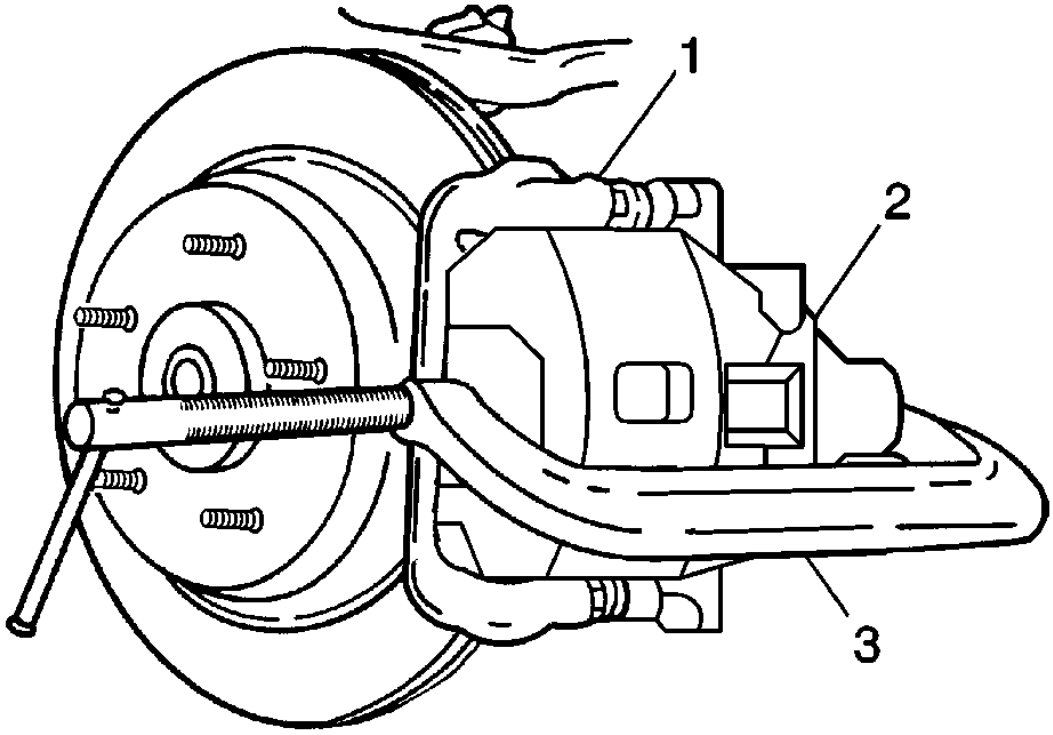


Fig. 14: Pushing In Brake Caliper Piston
Courtesy of GENERAL MOTORS COMPANY

6. Compress the caliper piston enough for clearance. Use a C-clamp (3).

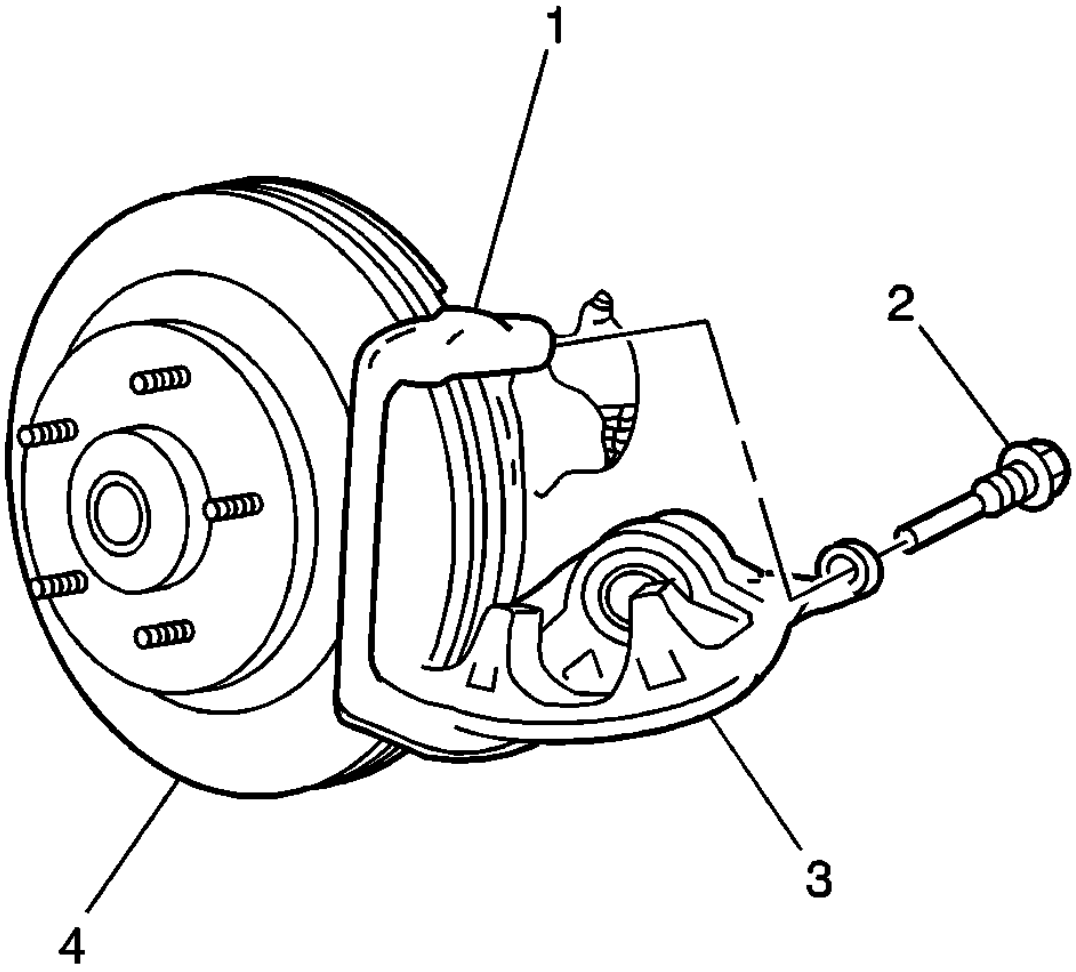


Fig. 15: View Of Upper Caliper Bolt - Rear
Courtesy of GENERAL MOTORS COMPANY

7. Remove the upper caliper bolt (2).

CAUTION: Use care to avoid damaging pin boot when rotating caliper.

CAUTION: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

8. Pivot the caliper down in order to access the pads. It is not necessary to remove the caliper.

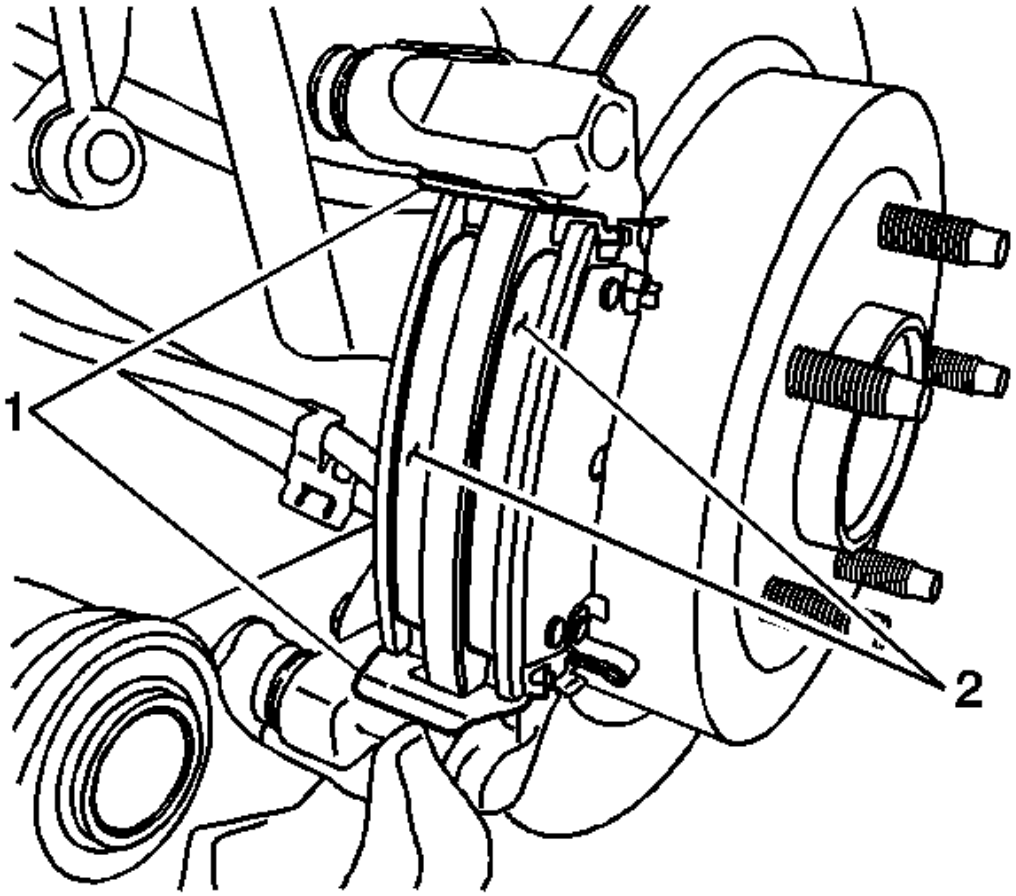


Fig. 16: Rear Brake Pads & Clips
Courtesy of GENERAL MOTORS COMPANY

9. Remove the brake pads (2) from the caliper bracket.
10. Remove the 2 pad clips (1) from the caliper bracket.
11. Inspect the caliper mounting hardware for the following conditions:
    - Cuts
    - Tears
    - Deterioration

    Replace any hardware if damage exists. Refer to **Rear Disc Brake Mounting and Hardware Inspection**.

12. Inspect the caliper dust boot for the following conditions:
    - Cuts
    - Tears
    - Deterioration

Replace the caliper dust boot if damage exists. Refer to **Brake Caliper Inspection**.

13. Inspect the caliper bolts for corrosion or damage. If corrosion exists, use new caliper bolts when installing the caliper.

Installation Procedure

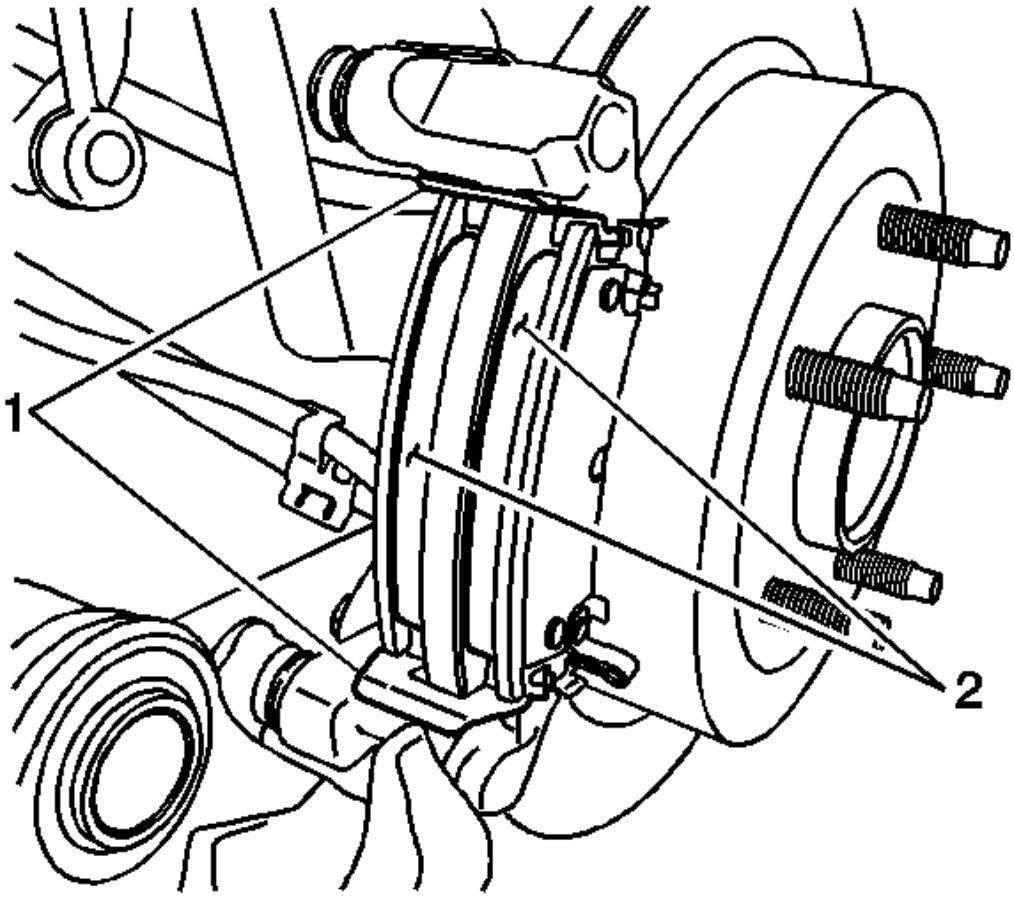


Fig. 17: Rear Brake Pads & Clips
Courtesy of GENERAL MOTORS COMPANY

1. Bottom the piston into the caliper bore.

   Use a C-clamp before installing new brake pads in order to compress the piston. Use an old brake pad or wooden block across the face of the piston to avoid damage to the piston or the caliper boot.

2. Install the 2 retainers (1) to the caliper bracket.

   NOTE: The wear sensor is on the outside pad. The sensor is positioned at the trailing or downward edge of the pad during forward wheel rotation.

3. Install the pads (2) to the caliper bracket.

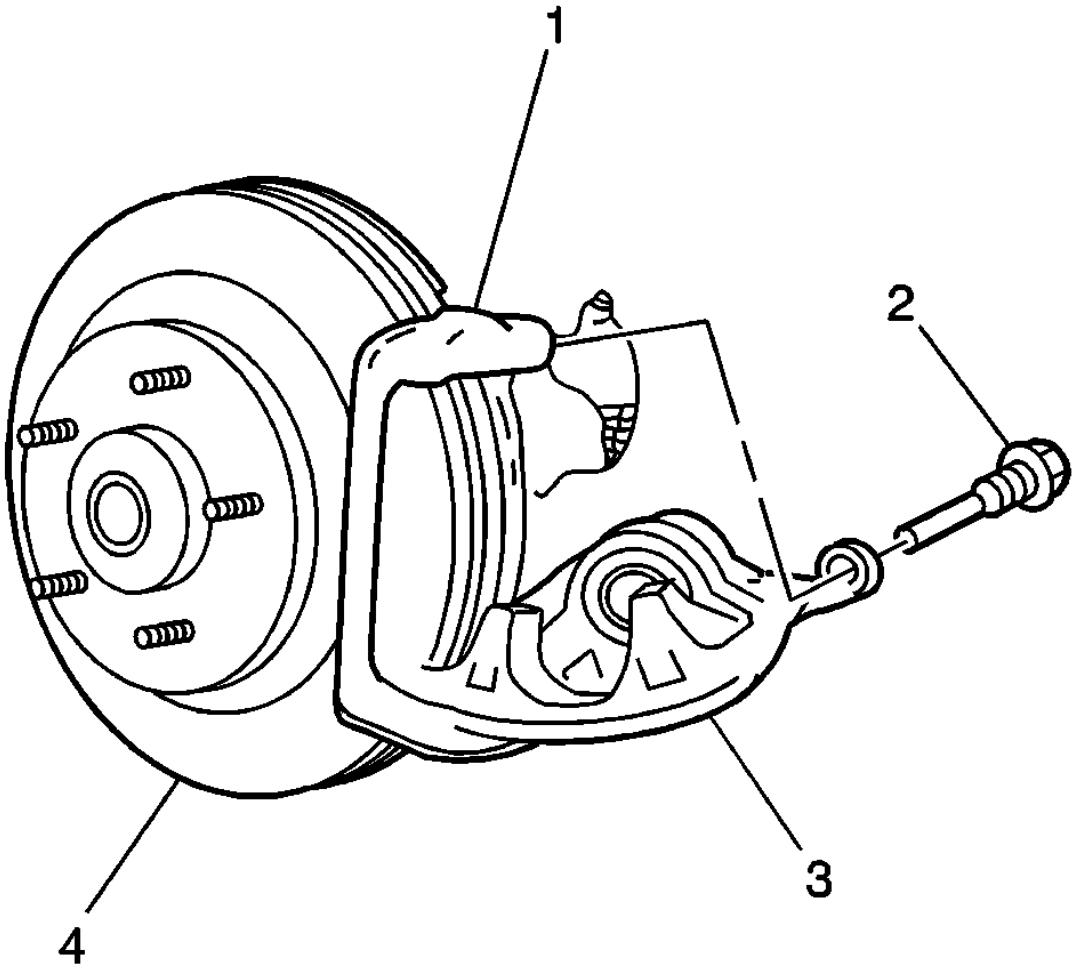


Fig. 18: View Of Upper Caliper Bolt - Rear
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use care to avoid damaging pin boot when rotating caliper.

4. Swing the caliper (3) upward in position around the pads.
5. Lubricate the bolt and the bolt boot. Use silicone grease.

CAUTION: Refer to Fastener Caution .

6. Install the upper caliper bolt (2).

Tighten

Tighten the caliper bolt to 44 N.m (32 lb ft).

7. Remove the wheel lug nut retaining the rotor to the hub.
8. Install the rear tire and the wheel assembly. Refer to **Tire and Wheel Removal and Installation** . Align the previous marks on the wheel, hub and bearing.

9. Lower the vehicle.
10. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance.
11. Slowly release the brake pedal.
12. Wait 15 seconds, then repeat steps 10 and 11 until a firm brake pedal is obtained. This will properly seat the brake caliper pistons and brake pads.
13. Fill the brake master cylinder reservoir to the proper level. Refer to **Master Cylinder Reservoir Filling** .
14. Burnish the pads and rotors. Refer to **Brake Pad and Rotor Burnishing**.

BRAKE PAD AND ROTOR BURNISHING

WARNING: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

Burnishing the brake pads and brake rotors is necessary in order to ensure that the braking surfaces are properly prepared after service has been performed on the disc brake system.

This procedure should be performed whenever the disc brake rotors have been refinished or replaced, and/or whenever the disc brake pads have been replaced.

1. Select a smooth road with little or no traffic.
2. Accelerate the vehicle to 48 km/h (30 mph).

NOTE: Use care to avoid overheating the brakes while performing this step.

3. Using moderate to firm pressure, apply the brakes to bring the vehicle to a stop. Do not allow the brakes to lock.
4. Repeat steps 2 and 3 until approximately 20 stops have been completed. Allow sufficient cooling periods between stops in order to properly burnish the brake pads and rotors.

FRONT BRAKE CALIPER REPLACEMENT

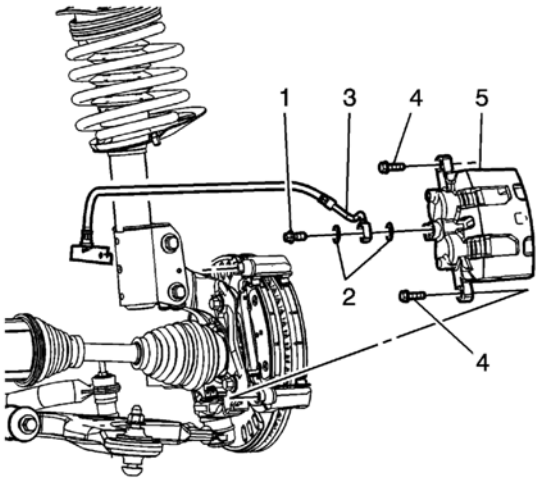


Fig. 19: Front Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Brake Dust Warning .** **WARNING:** **Refer to Brake Fluid Irritant Warning .** **Preliminary Procedures** 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .	
1	Brake Hose Fitting Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 54 N.m (40 lb ft)
2	Brake Hose Fitting Gasket (Qty: 2) **TIP:** DO NOT reuse the brake hose fitting gaskets. Install NEW gaskets.
3	Brake Hose **TIP:** Cap the brake hose fitting to prevent brake fluid loss and contamination.
4	Guide Pin Bolt (Qty: 2) **Tighten** 36 N.m (26 lb ft)
5	Brake Caliper **Procedure** 1. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** **Hydraulic Brake System Bleeding (Pressure)** . 2. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance. 3. Slowly release the brake pedal.

Callout	Component Name
	4. Wait 15 seconds, then repeat steps 2-3 until a firm brake pedal is obtained. This will properly seat the brake caliper pistons and brake pads. 5. Fill the master cylinder reservoir to the proper level. Refer to **Master Cylinder Reservoir Filling** . 6. Burnish the pads and rotors. Refer to **Brake Pad and Rotor Burnishing**.

REAR BRAKE CALIPER REPLACEMENT

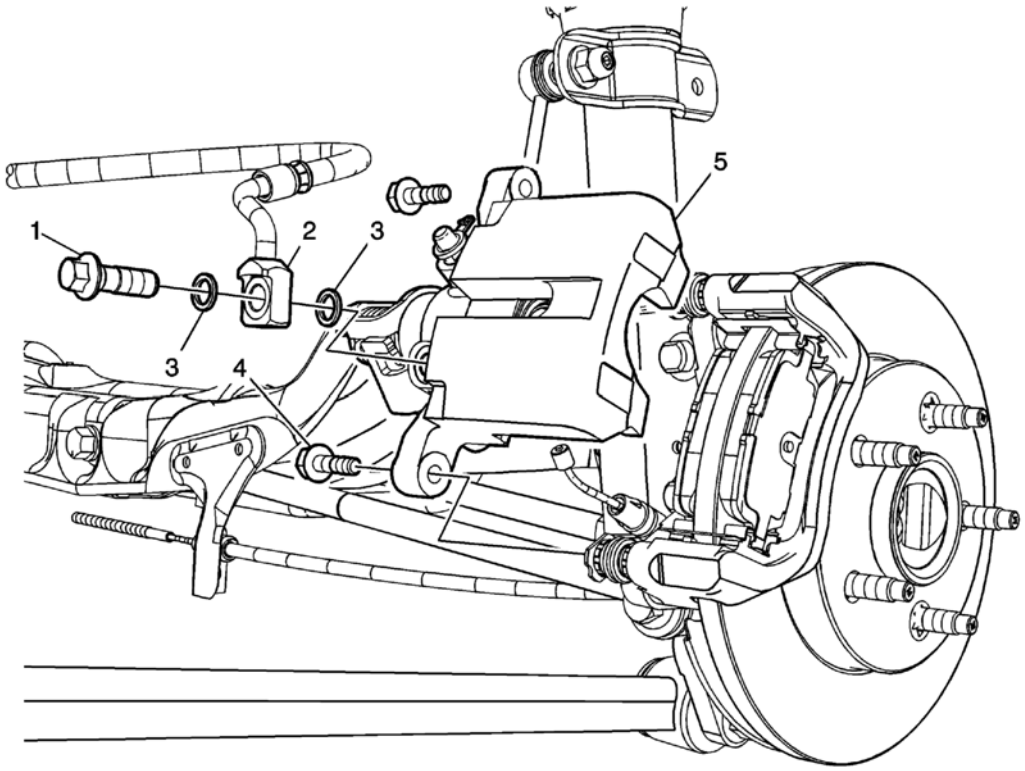


Fig. 20: Rear Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Brake Dust Warning .** **WARNING:** **Refer to Brake Fluid Irritant Warning .** **Preliminary Procedures**	

Callout	Component Name
1. Inspect the brake fluid level in the master cylinder reservoir. 2. If the brake fluid level is midway between the maximum-full point and the minimum allowable level, no brake fluid needs to be removed from the reservoir before proceeding. 3. If the brake fluid level is higher than midway between the maximum-full point and the minimum allowable level, remove brake fluid to the midway point before proceeding. 4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 5. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .	
1	Brake Hose Fitting Bolt **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 54 N.m (40 lb ft)
2	Brake Hose Fitting **TIP:** Cap the brake hose fitting and plug the brake caliper inlet port to prevent brake fluid loss and contamination.
3	Brake Hose Fitting Gasket (Qty: 2) **Procedure** 1. Discard the brake hose fitting gaskets. 2. Install new brake hose fitting gaskets.
4	Brake Caliper Guide Pin Bolt (Qty: 2) **Tighten** 44 N.m (32 lb ft)
5	Brake Caliper **Procedure** 1. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)** **Hydraulic Brake System Bleeding (Pressure)** . 2. With the engine OFF, gradually apply the brake pedal to approximately 2/3 of its travel distance. 3. Slowly release the brake pedal. 4. Wait 15 seconds, then repeat steps 2-3 until a firm brake pedal is obtained. This will properly seat the brake caliper pistons and the brake pads.

FRONT BRAKE CALIPER OVERHAUL

Special Tools

- **J-8092** Driver Handle 3/4 inch-10
- **J-45863** Dust Seal Installer

WARNING: Refer to Brake Fluid Irritant Warning .

Disassembly Procedure

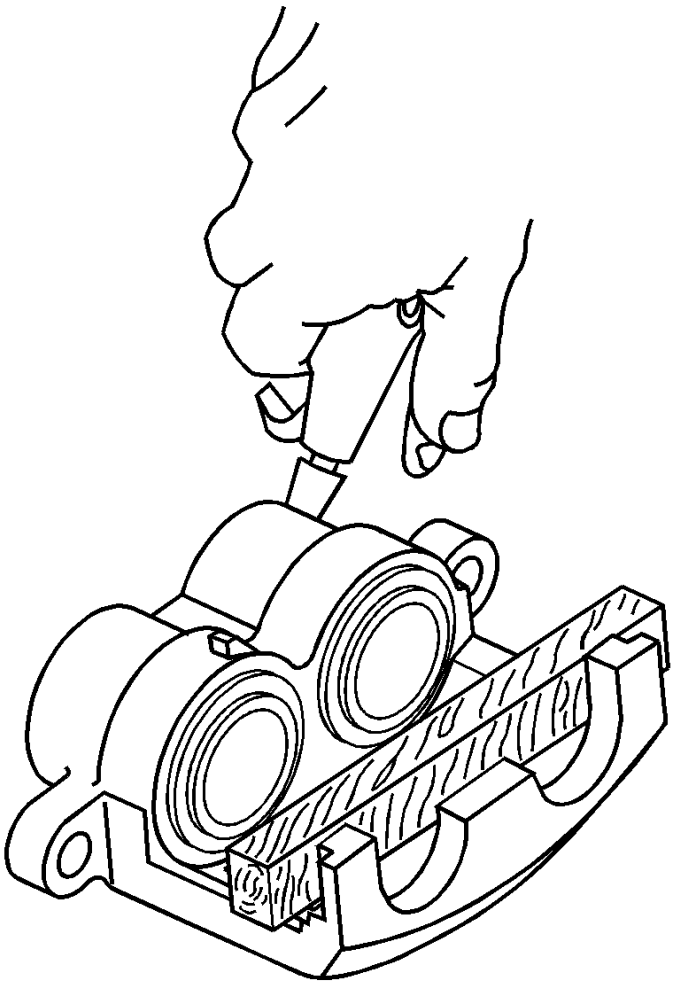


Fig. 21: Applying Air To Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

1. Drain all the brake fluid from the caliper.

WARNING: Do not place fingers in front of the caliper piston(s) in an attempt to catch or protect it when applying compressed air. The piston(s) can fly out with force and could result in serious bodily injury.

NOTE: In the following service procedure, the caliper piston may become damage when it is removed from the brake caliper assembly. If this happens, DO

NOT reuse the piston. Discard and replaced with new.

2. Install the brake caliper in a suitable holding devise.
3. Insert a piece of wood in the brake caliper.
4. Cover the brake caliper with a shop towel.
5. Using compressed filtered, non-lubricated air, apply the air to the remove the pistons from the brake caliper.

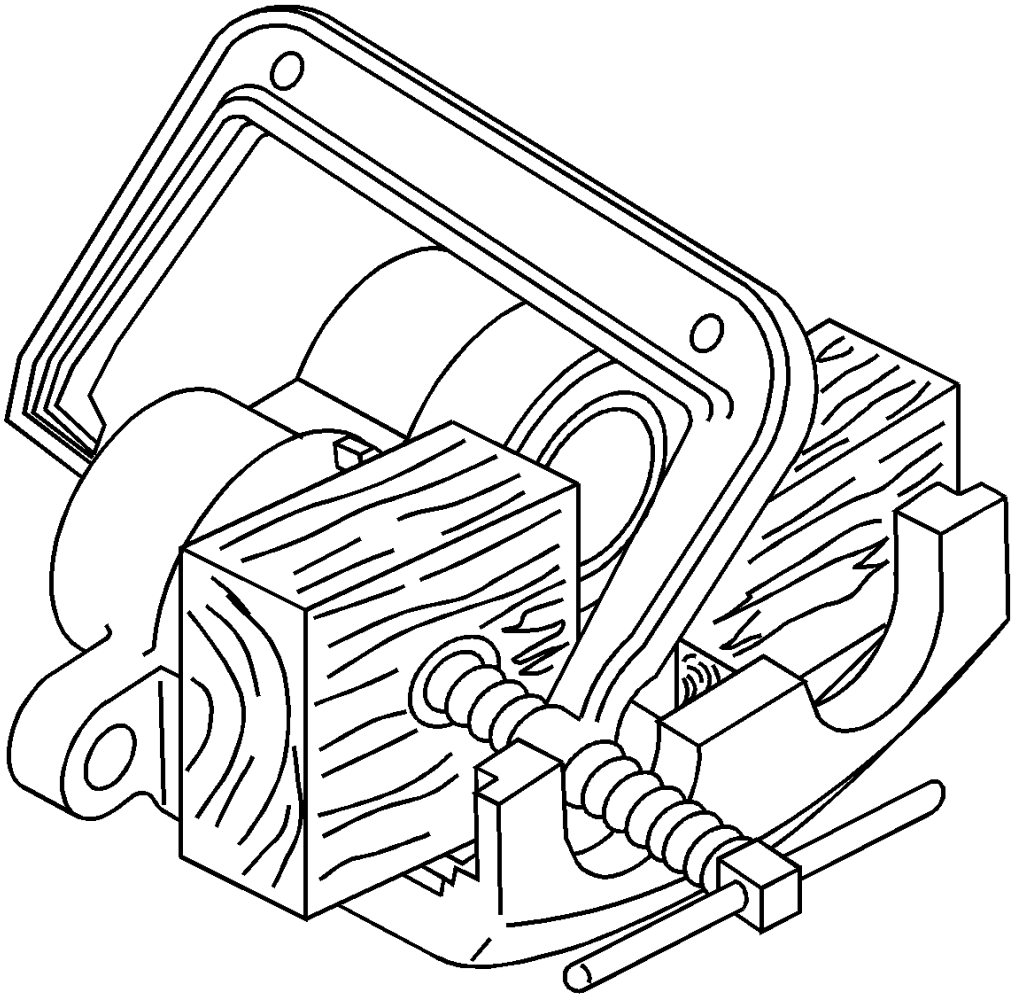


Fig. 22: Clamping Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

6. If one of the pistons fails to be removed from the brake caliper, perform the following steps.
    1. Reposition the piston that has been removed back in the brake caliper.
    2. Using a small block of wood and a C-clamp, slowly tighten the C-clamp until the piston it is half way in the brake caliper. It does not have to be fully seated.
    3. Position a second block of wood in front of the piston that remains in the brake caliper.
    4. Cover the brake caliper with a shop towel.
    5. Using compress filtered, non lubricated air, apply the air to the remove the pistons from the brake

caliper.

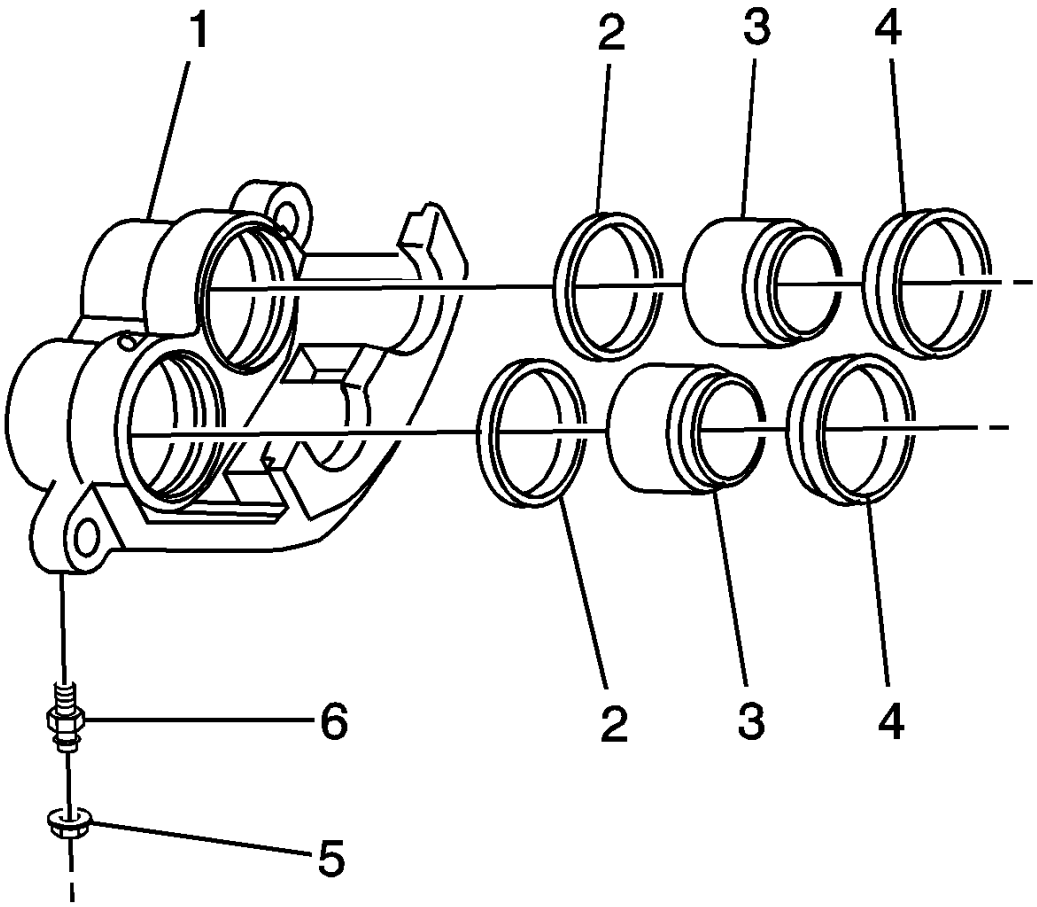


Fig. 23: Exploded View Of Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

7. Remove the pistons (3) from the caliper bores.
8. Remove the piston seals (2) from the caliper bores. Do not use a metal tool.
9. Remove the bleeder valve cap (5).
10. Remove the bleeder valve (6) from the caliper housing (1).
11. Clean the bleeder valve, the caliper bores, the caliper passages and the pistons with denatured alcohol. Dry the parts and blow out the brake fluid passages. Use dry and filtered compressed air.

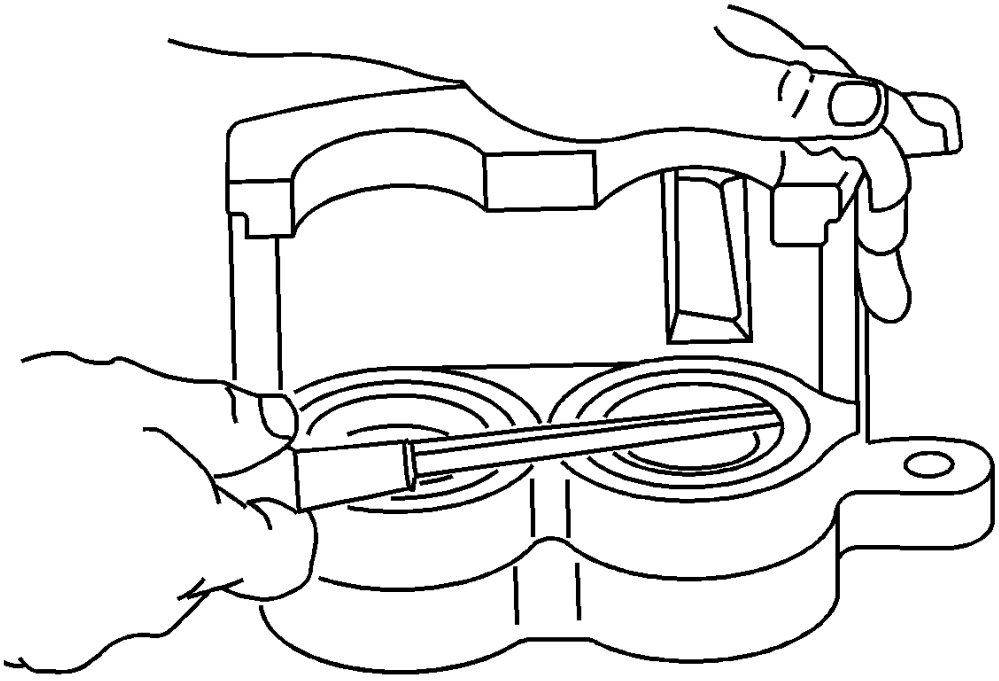


Fig. 24: Brake Caliper Boots
Courtesy of GENERAL MOTORS COMPANY

12. Remove the boots from the caliper bores. Do not scratch the caliper bores.
13. Replace the pistons or the caliper if any of the following conditions exist:
    - Scoring in the caliper bores
    - Corrosion in the caliper bores
    - Pitting in the caliper bores
    - Damage to the pistons (phenolic)
14. Clean the brake caliper assembly with denatured alcohol.
15. Dry with filtered , lubricated compressed air.

Assembly Procedure

NOTE: **When applying the clean brake fluid to the piston bores and pistons, only apply the brake fluid to one bore at a time. This is done to ensure that the brake caliper, seals and pistons DO NOT become contaminated with dirt or other foreign material.**

1. Apply a small amount of clean DOT-3 brake fluid to the piston, piston seal, and piston bore.

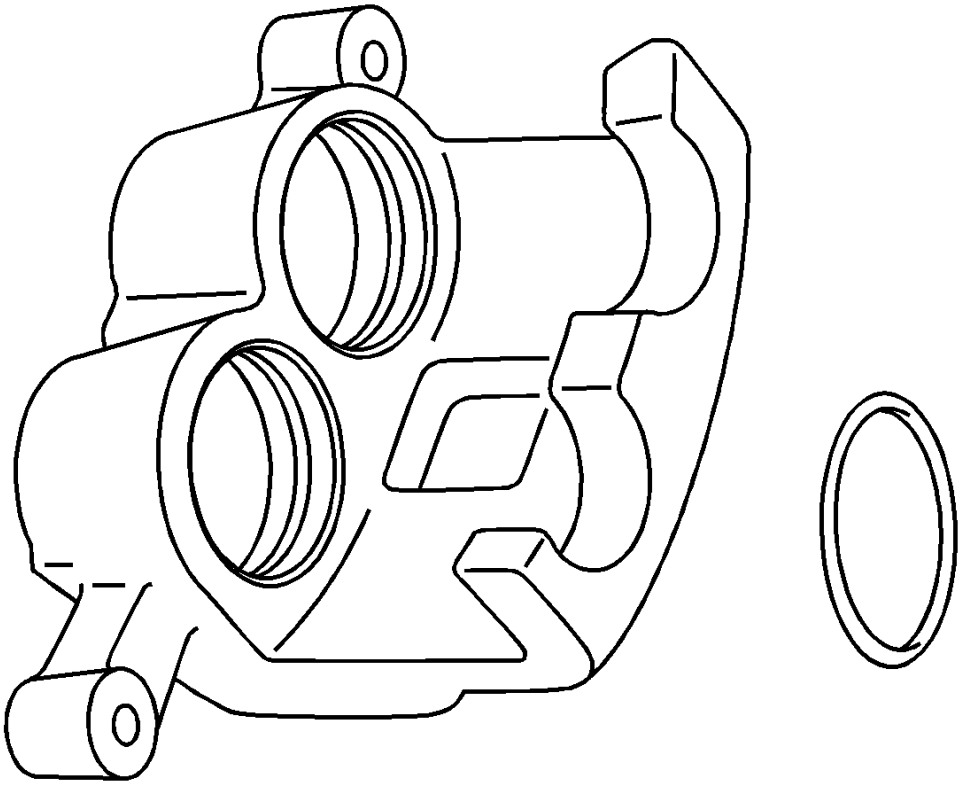


Fig. 25: View Of Brake Caliper Piston Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install the piston seal in the brake caliper.

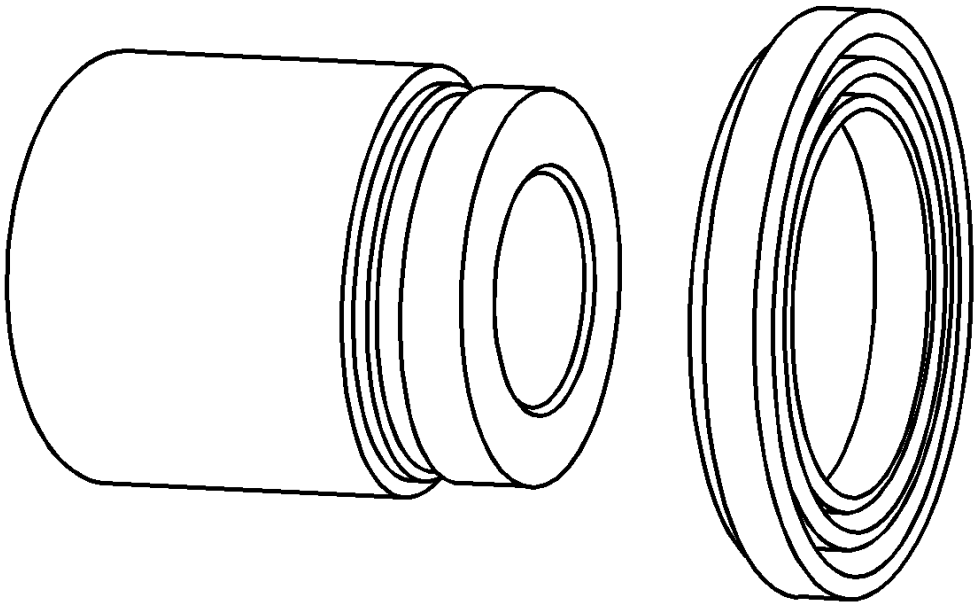


Fig. 26: View Of Piston Dust Seal
Courtesy of GENERAL MOTORS COMPANY

3. Install the dust seal on the piston.

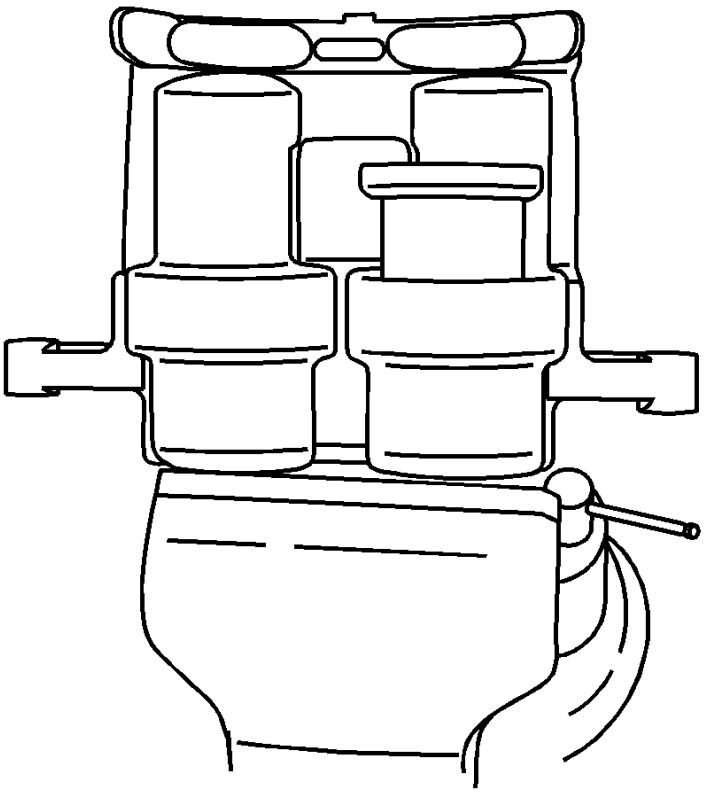


Fig. 27: Installing Piston To Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Position the piston in the bore so that it is straight and level.**

4. Install the piston in the brake caliper.

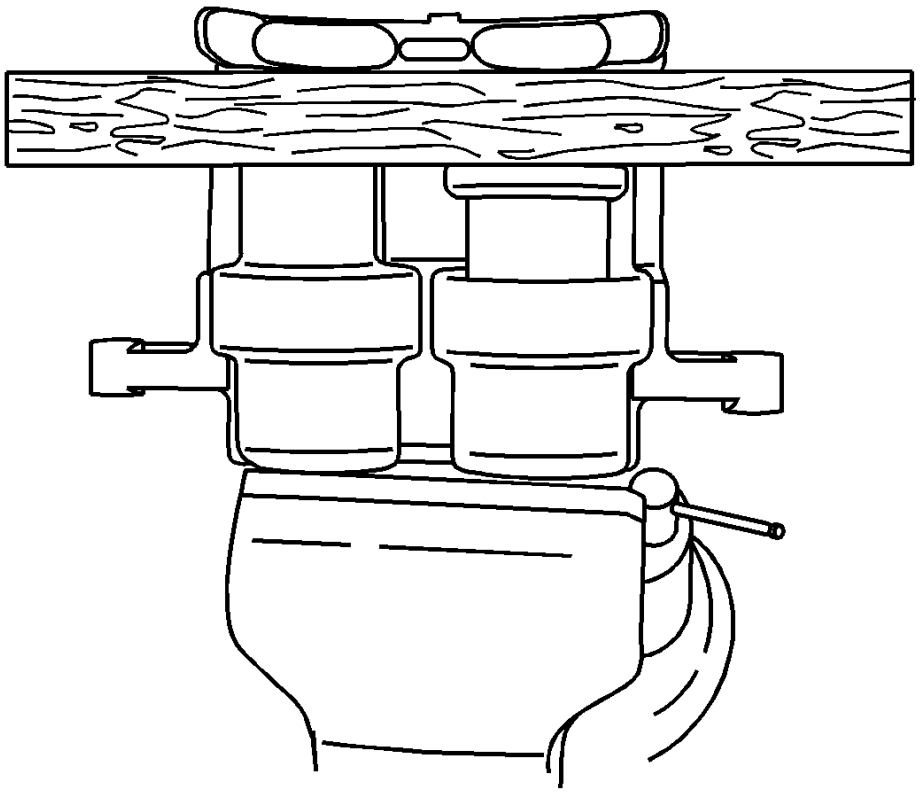


Fig. 28: Installing Piston Into Bore
Courtesy of GENERAL MOTORS COMPANY

5. Position a piece of wood across the piston to be installed.
6. Applying equal pressure by hand while pushing down, install the piston in the bore.
7. Remove the piece of wood.

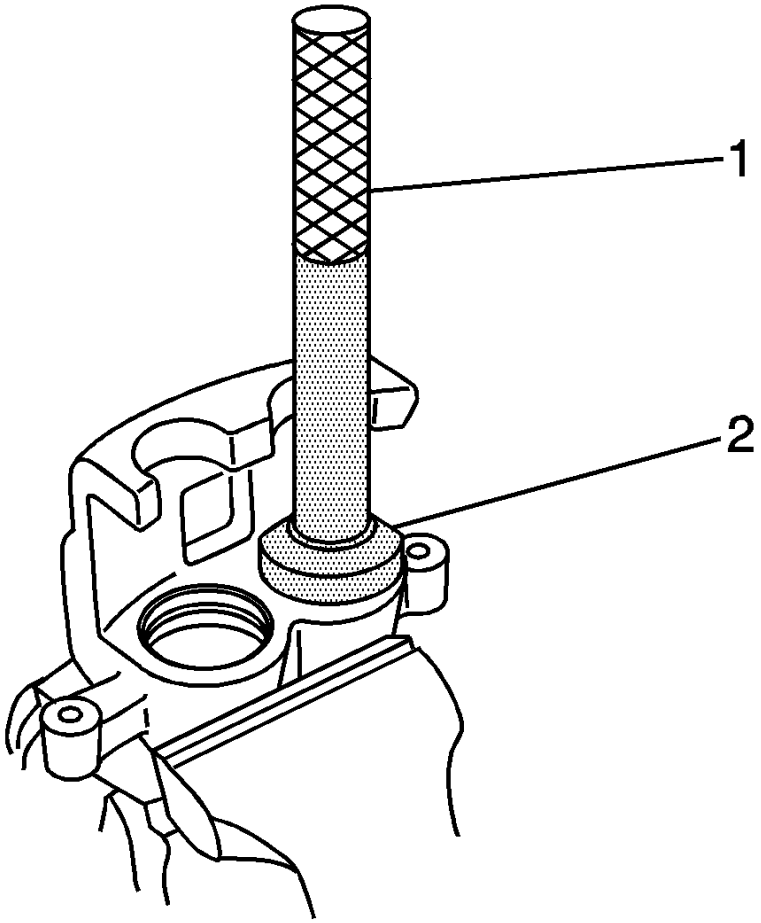


Fig. 29: Installing Piston Dust Seal
Courtesy of GENERAL MOTORS COMPANY

8. Using the **J-8092** Driver Handle 3/4 inch-10 (1) and the **J-45863** Dust Seal Installer (2) , install the piston dust seal in the brake caliper.

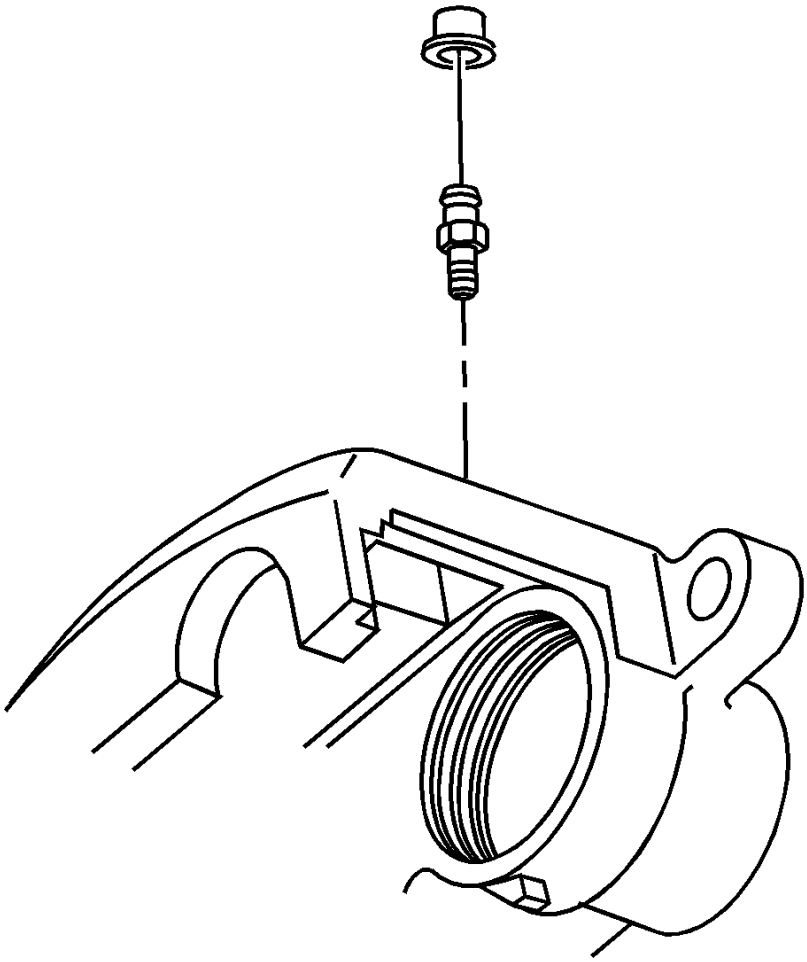


Fig. 30: View Of Bleeder Valve Cap
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

9. Install the bleeder valve in the brake caliper housing and tighten to 13 N.m (115 lb in).
10. Install bleeder valve cap.

REAR BRAKE CALIPER OVERHAUL

Removal Procedure

WARNING: Refer to Brake Dust Warning .

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Remove the rear brake caliper from the vehicle. Refer to **Rear Brake Caliper Replacement**.

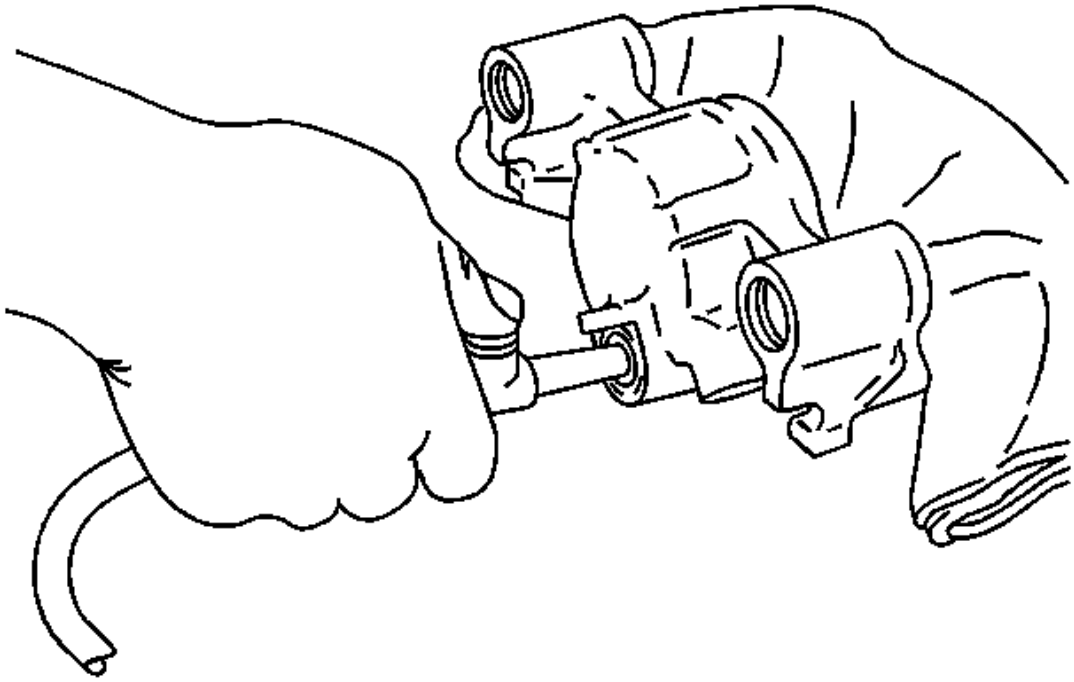


Fig. 31: Removing Brake Caliper Piston Using Low Pressure Compressed Air
Courtesy of GENERAL MOTORS COMPANY

WARNING: Do not place fingers in front of the caliper piston(s) in an attempt to catch or protect it when applying compressed air. The piston(s) can fly out with force and could result in serious bodily injury.

CAUTION: Use clean cloths to pad interior of caliper housing during piston removal. Use just enough air to ease the pistons out of the bores. If the pistons are blown out, even with the padding provided, it may be damaged.

2. Remove the brake caliper piston from the caliper bore by directing low pressure compressed air into the caliper bore through the fluid inlet hole.

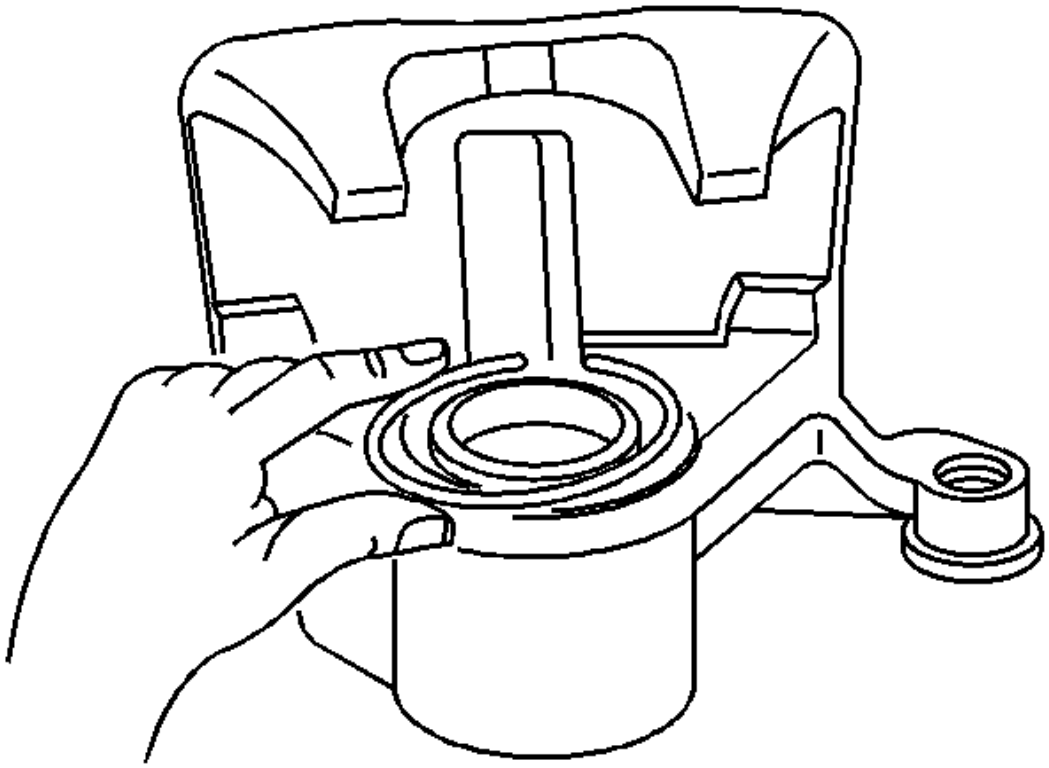


Fig. 32: View Of Dust Boot Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

3. Remove the retaining ring that secures the dust boot to the caliper housing.

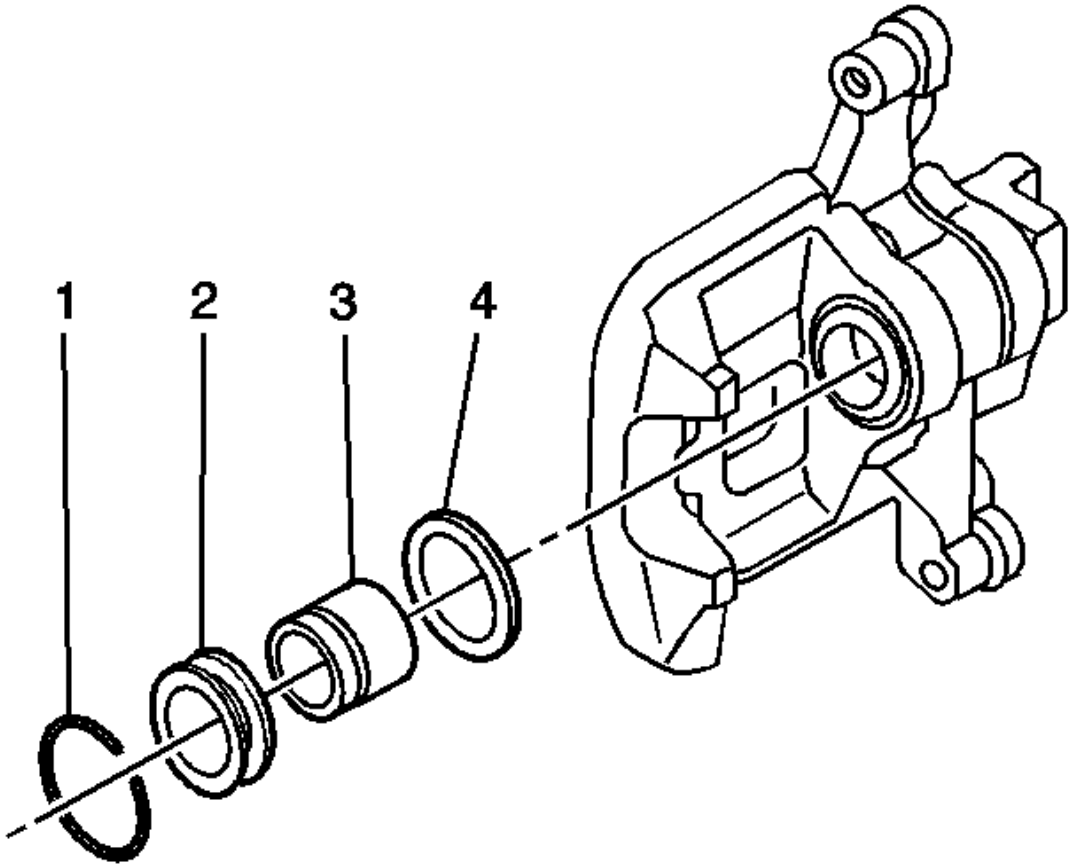


Fig. 33: Exploded View Of Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

4. Remove the piston dust boot seal (2) from the seal counterbore in the caliper. Discard the boot seal.
5. Using a small wooden or plastic tool, remove the piston seal (4) from the caliper bore . Discard the piston seal.

NOTE: **Do not use abrasives to clean the brake caliper piston.**

6. Clean the brake caliper piston bore and seal counterbore, and the caliper piston with denatured alcohol, or equivalent.
7. Dry the caliper piston bore and counterbore, and the piston with non-lubricated, filtered air.
8. Inspect the caliper bore for cracks, scoring, pitting, excessive rust, and/or excessive corrosion.
9. If light rust or light corrosion are present in the caliper bore, attempt to remove the imperfection with a fine emery paper. If the imperfection cannot be removed, replace the caliper assembly.
10. If cracks, scoring, pitting, excessive rust, and/or excessive corrosion are present in the caliper bore, replace the caliper assembly.
11. Inspect the caliper piston for cracks, scoring, and/or damage to the chrome plating. Replace the caliper piston if any of these conditions exist.

Installation Procedure

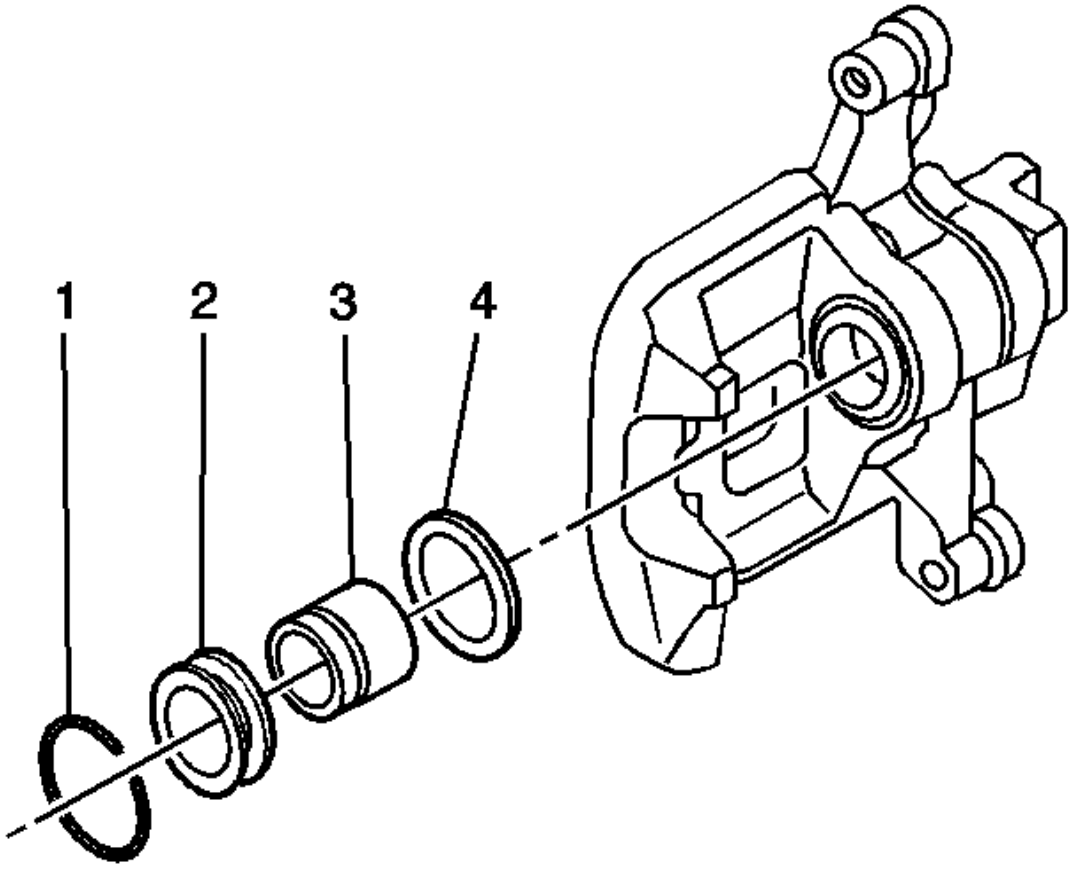


Fig. 34: Exploded View Of Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the new piston seal (4) with Delco Supreme 11Â®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
2. Install the lubricated, new piston seal (4) into the caliper bore.
3. Apply a thin coat of Delco Supreme 11Â®, GM P/N 12377967 (Canadian P/N 992667) or equivalent, DOT-3 brake fluid from a clean, sealed brake fluid container onto the outer surface area of the caliper piston (3).

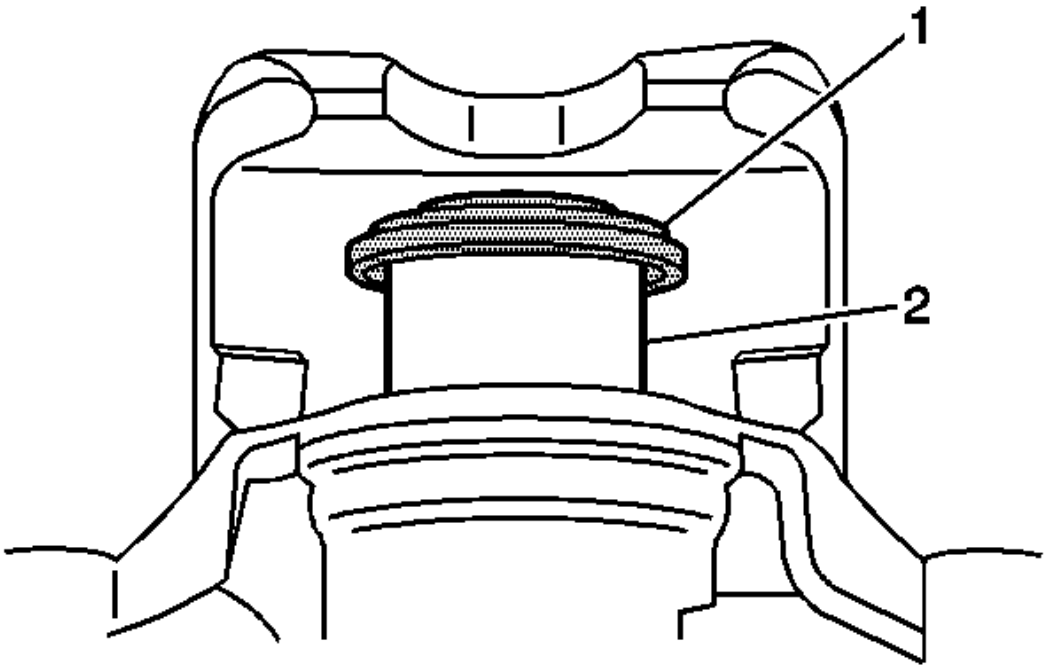


Fig. 35: Identifying Caliper Piston & Piston Dust Boot Seal
Courtesy of GENERAL MOTORS COMPANY

4. Install the bottom half of the caliper piston (2) into the caliper bore.
5. Install the new piston dust boot seal (1) over the caliper piston (2).
6. Compress the caliper piston (2) to the bottom of the caliper bore.
7. Fully seat the piston dust boot seal (1) into caliper counterbore.

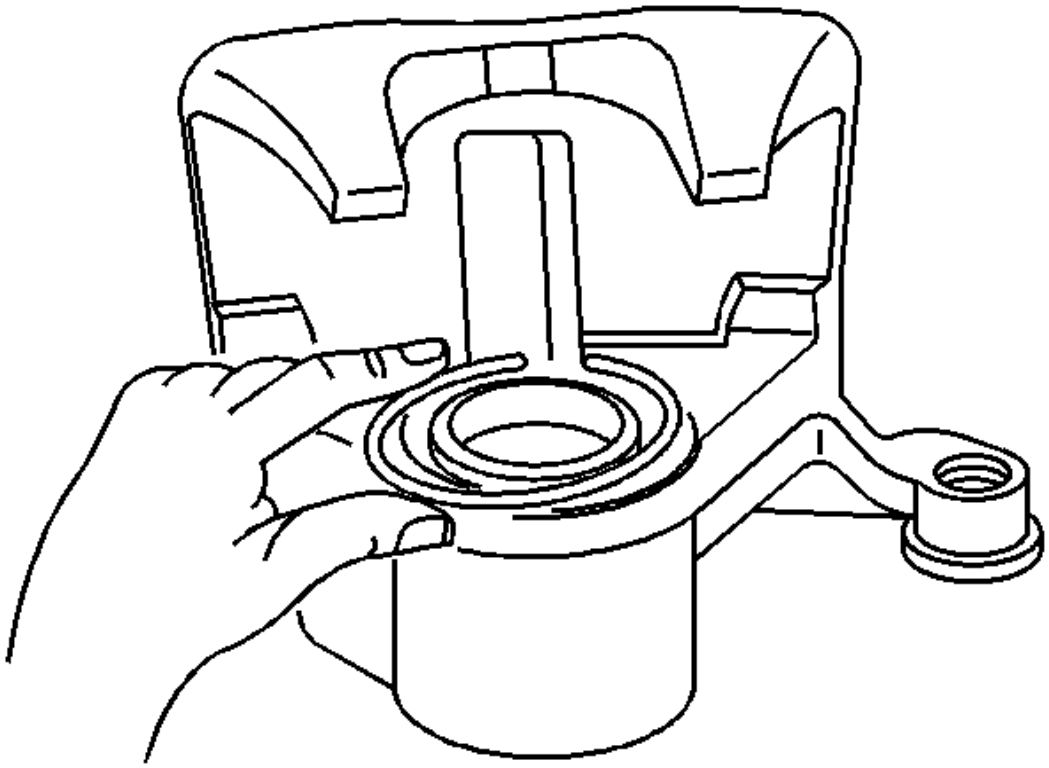


Fig. 36: View Of Dust Boot Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

8. Install the retaining ring that secures the dust boot to the caliper housing.
9. Install the bleeder valve and cap to the caliper and tighten the valve securely.
10. Install the rear brake caliper to the vehicle. Refer to **Rear Brake Caliper Replacement**.

FRONT BRAKE CALIPER HARDWARE REPLACEMENT

Removal Procedure

WARNING: **Refer to Brake Dust Warning .**

CAUTION: **Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.**

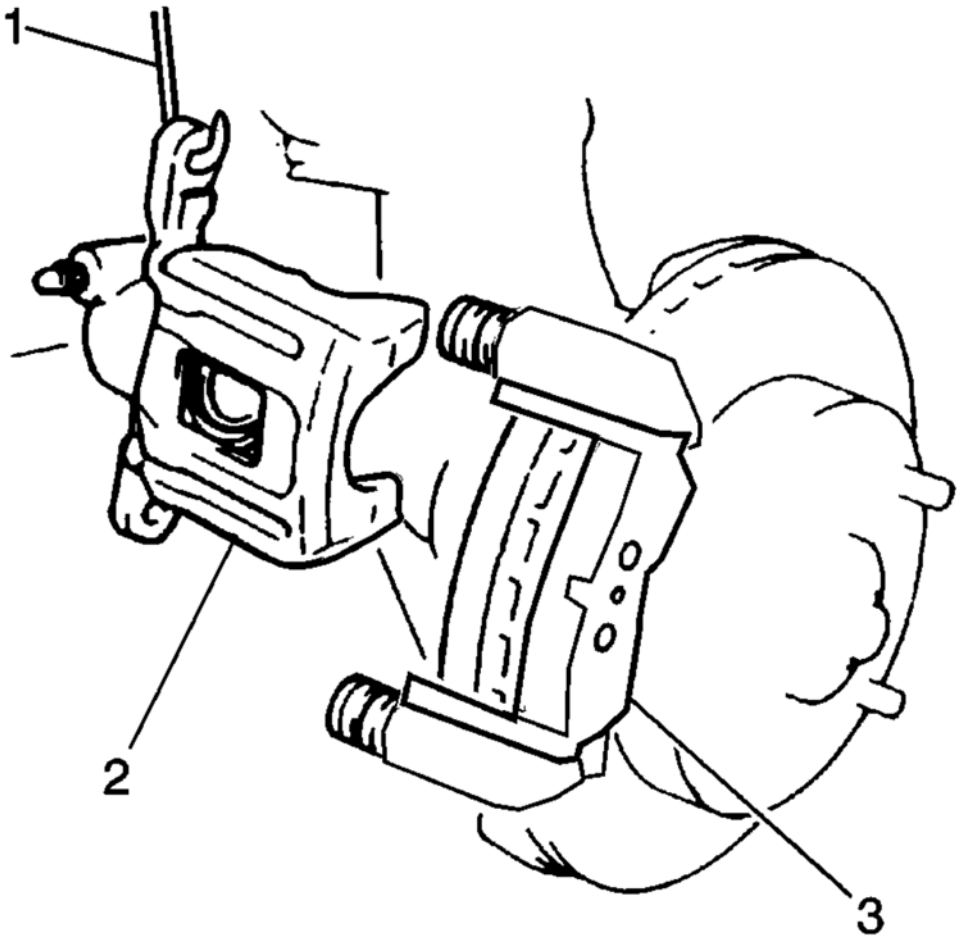


Fig. 37: View Of Brake Caliper And Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Remove the brake caliper from the mounting bracket and support the brake caliper (2) with heavy mechanic's wire (1), or equivalent. Discard the old caliper pin bolts, new bolts are supplied in the hardware kit. It is not necessary to disconnect the hydraulic brake flexible hose from the caliper. Refer to **Front Brake Caliper Replacement**.

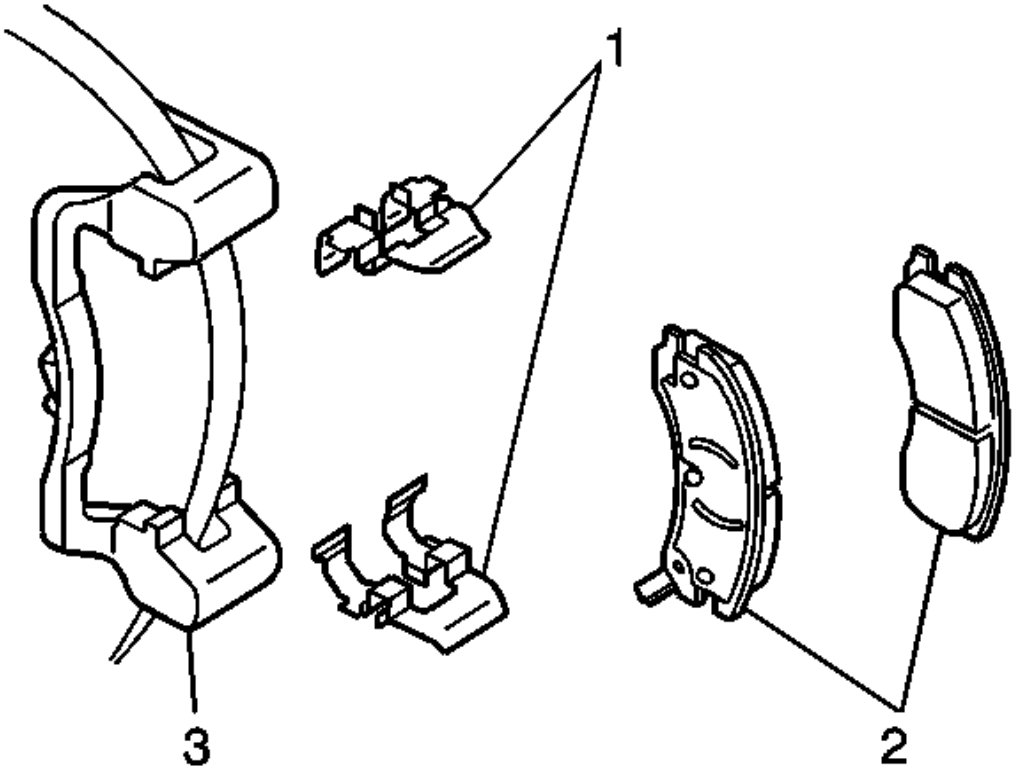


Fig. 38: View Of Brake Pads, Brake Pad Retainers, & Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

2. Remove the brake pads (2) from the brake caliper bracket.
3. Remove the brake pad retainers (1) from the brake caliper bracket.

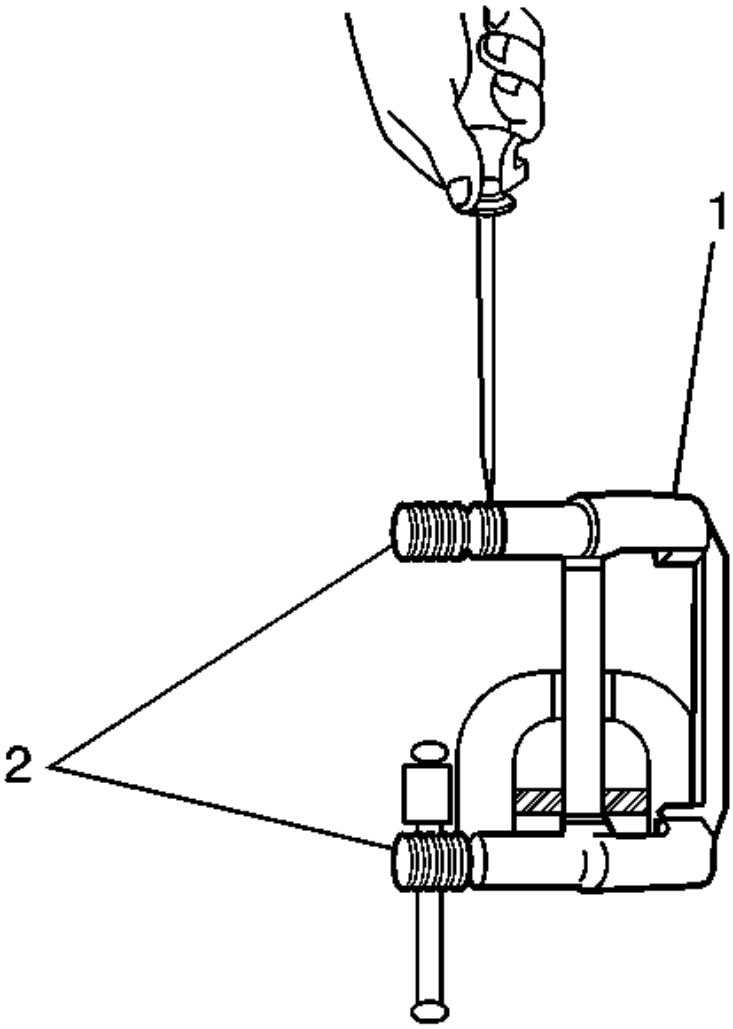


Fig. 39: Removing Front Caliper Pin Boots From Bracket
Courtesy of GENERAL MOTORS COMPANY

4. Remove the brake caliper bracket. Refer to **Front Brake Caliper Bracket Replacement**.
5. Mount the brake caliper bracket (1) in a vise.
6. Using a flat bladed tool or punch carefully remove the caliper pin boots (2) from brake caliper bracket (1).

NOTE:

- **Clean the caliper bracket with denatured alcohol.**
- **Dry with low pressure, non-lubricated, filtered air.**
- **Inspect the brake caliper bracket for damage. If damaged, replace the bracket.**

7. Thoroughly clean the caliper bracket bores of all lubricant.

Installation Procedure

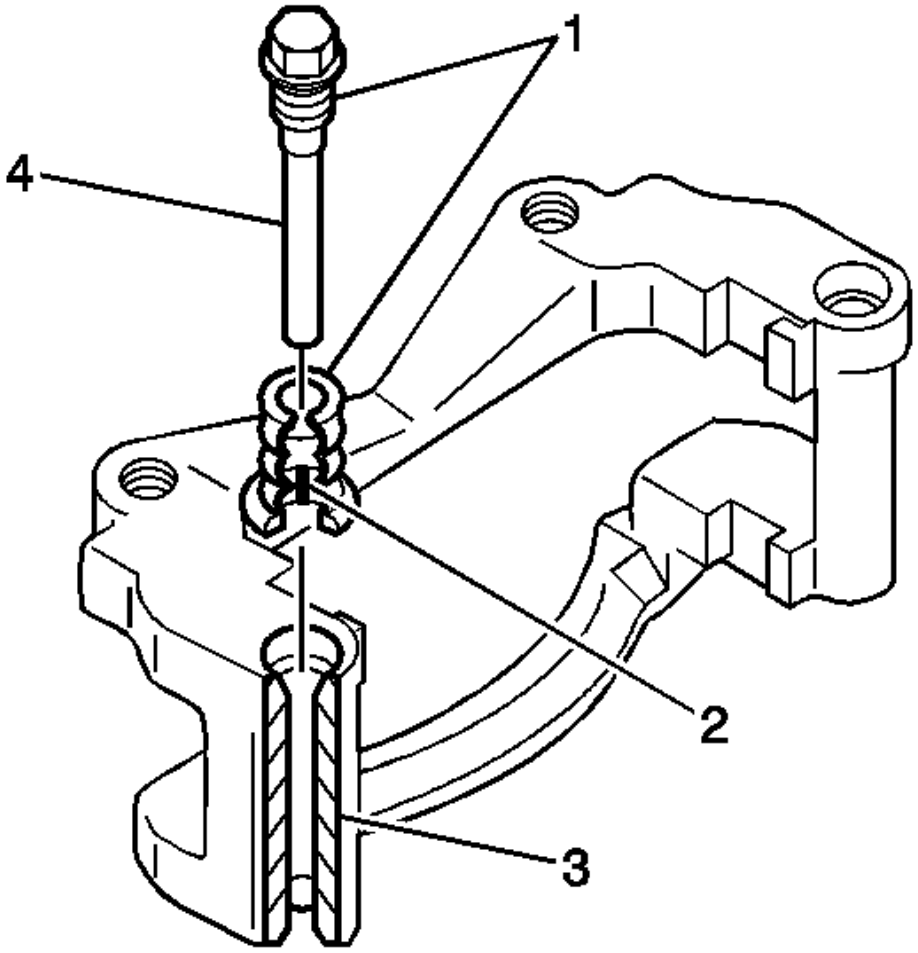


Fig. 40: Installing Pin Bolts & Boots
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the bores (3), the inside part of the bolt boot (2) and the caliper pin bolts (4) with GM P/N 18047666, or equivalent.
2. Press the new caliper pin bolt boots into the caliper pin bores.
3. Install the brake caliper bracket. Refer to **Front Brake Caliper Bracket Replacement**.

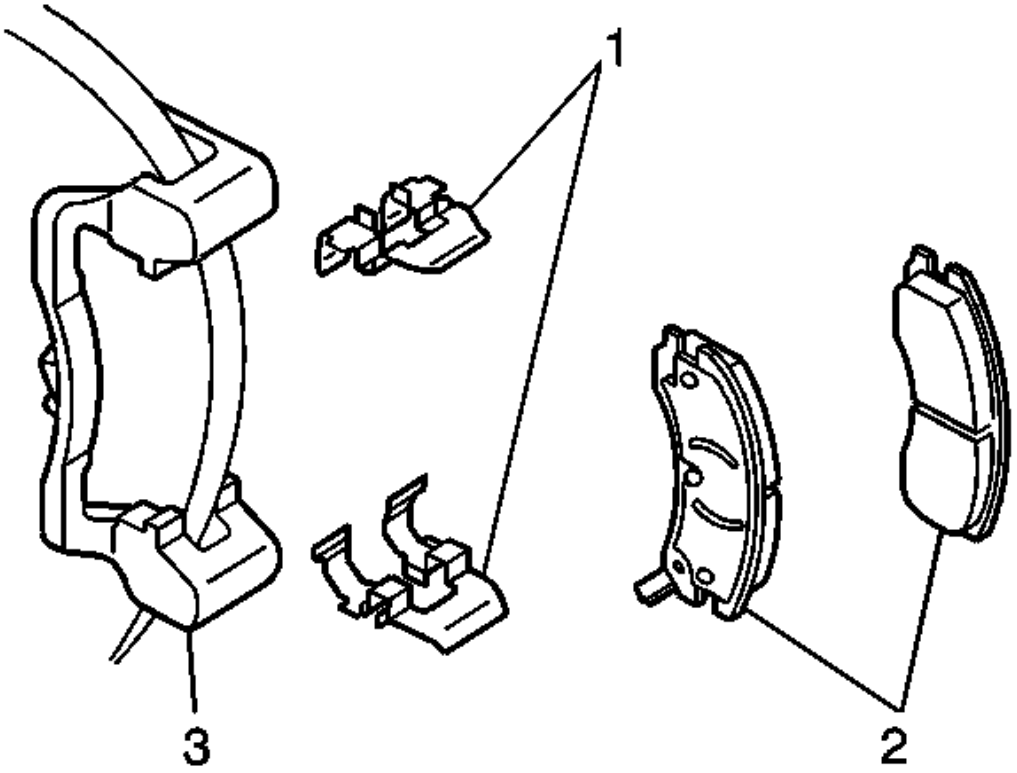


Fig. 41: View Of Brake Pads, Brake Pad Retainers, & Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

4. Install the brake pad retainers (1) to the caliper bracket.
5. Install the brake pads (2) to the caliper bracket.

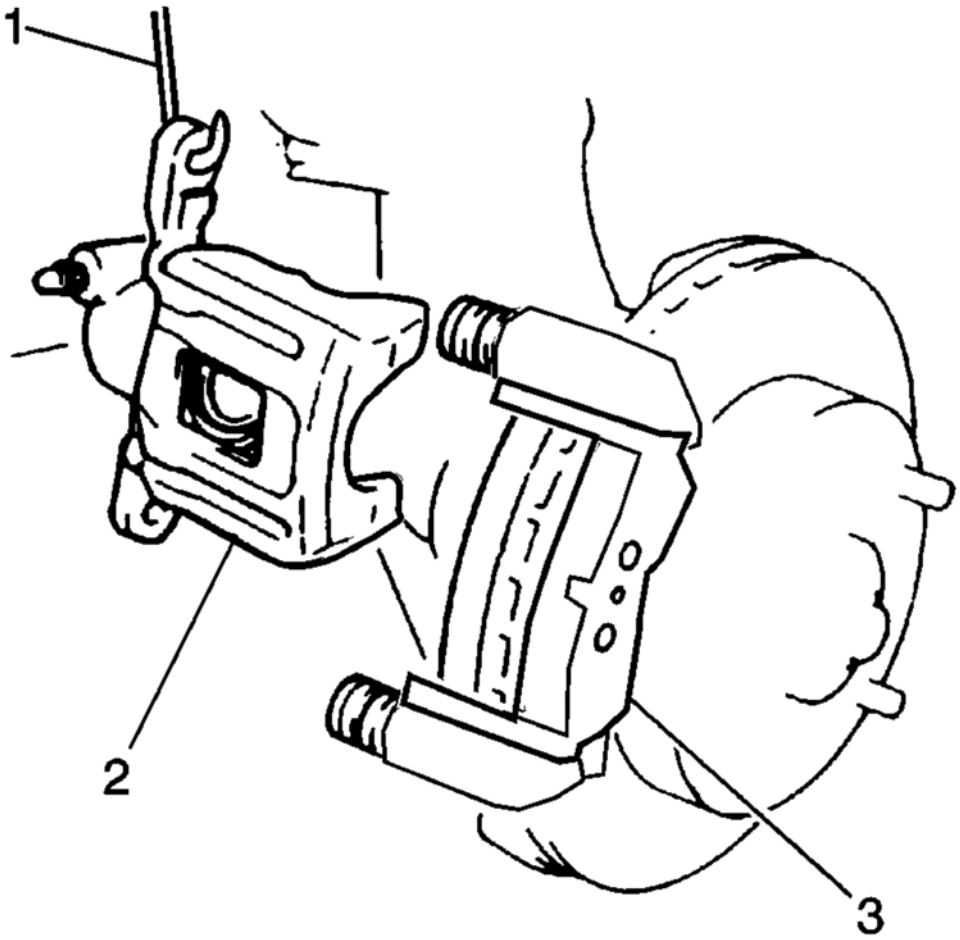


Fig. 42: View Of Brake Caliper And Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Remove the heavy mechanics wire (1) and install the brake caliper. Refer to **Front Brake Caliper Replacement**.

REAR BRAKE CALIPER HARDWARE REPLACEMENT

Removal Procedure

WARNING: **Refer to Brake Dust Warning .**

CAUTION: **Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.**

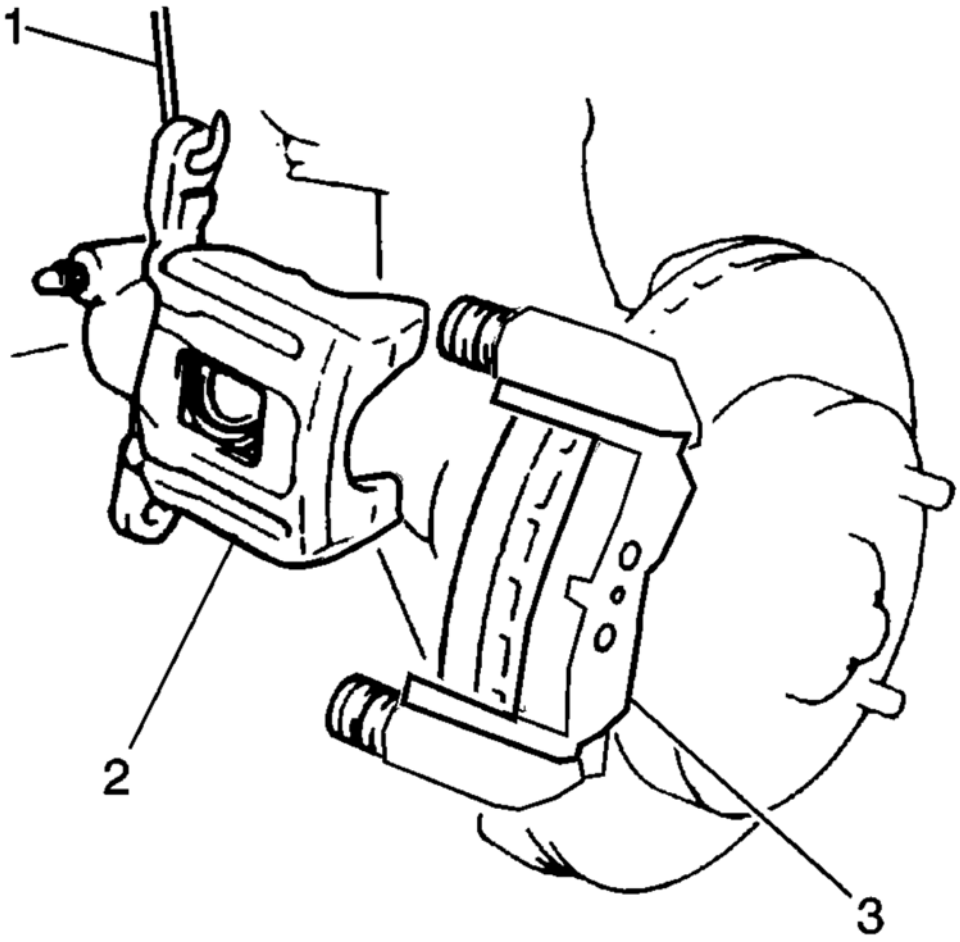


Fig. 43: View Of Brake Caliper And Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Remove the brake caliper from the mounting bracket and support the brake caliper (2) with heavy mechanic's wire (1), or equivalent. It is not necessary to disconnect the hydraulic brake flexible hose from the caliper. Refer to **Rear Brake Caliper Replacement**.

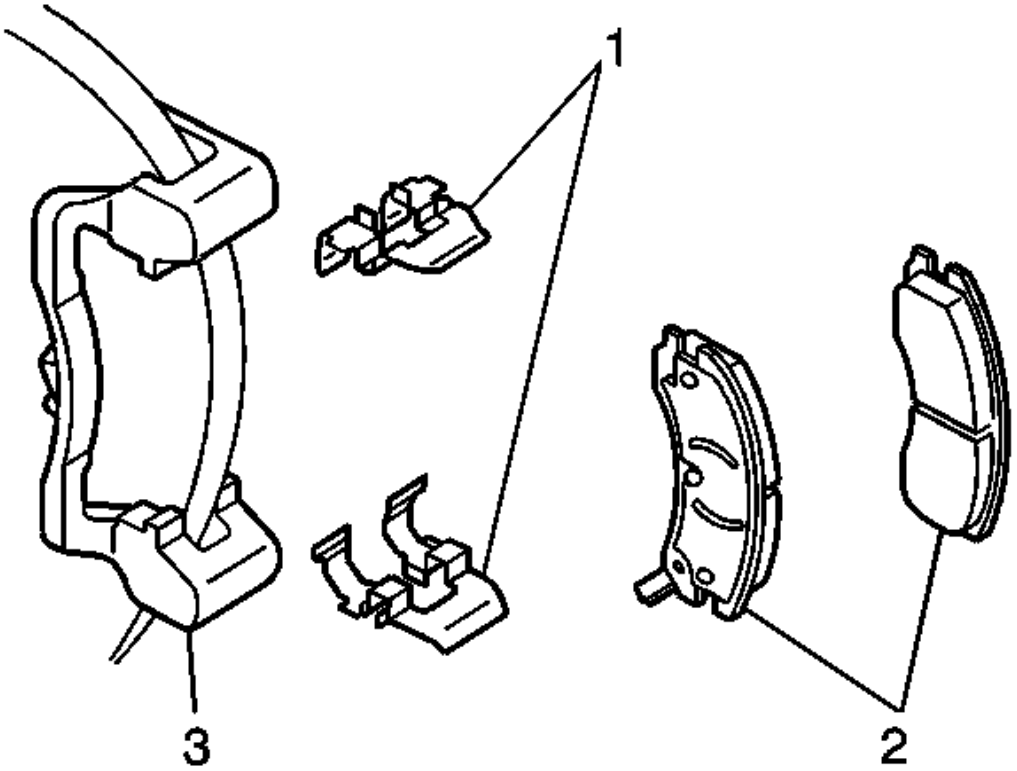


Fig. 44: View Of Brake Pads, Brake Pad Retainers, & Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

2. Remove the brake pads (2) from the brake caliper bracket (1).
3. Remove the brake pad retainers (1) from the brake caliper bracket (3).
4. Remove the brake caliper bracket (3). Refer to **Rear Brake Caliper Bracket Replacement**.
5. Mount the brake caliper bracket (3) in a vise.

Installation Procedure

1. Clean all parts in clean, denatured alcohol.
2. Dry with low pressure, non-lubricated, filtered air.
3. Inspect the brake caliper bracket for cracks. If cracked, replace bracket.
4. Lubricate the brake caliper pin bolt sleeves with high temperature silicone lubricant.
5. Install the brake caliper bracket. Refer to **Rear Brake Caliper Bracket Replacement**.

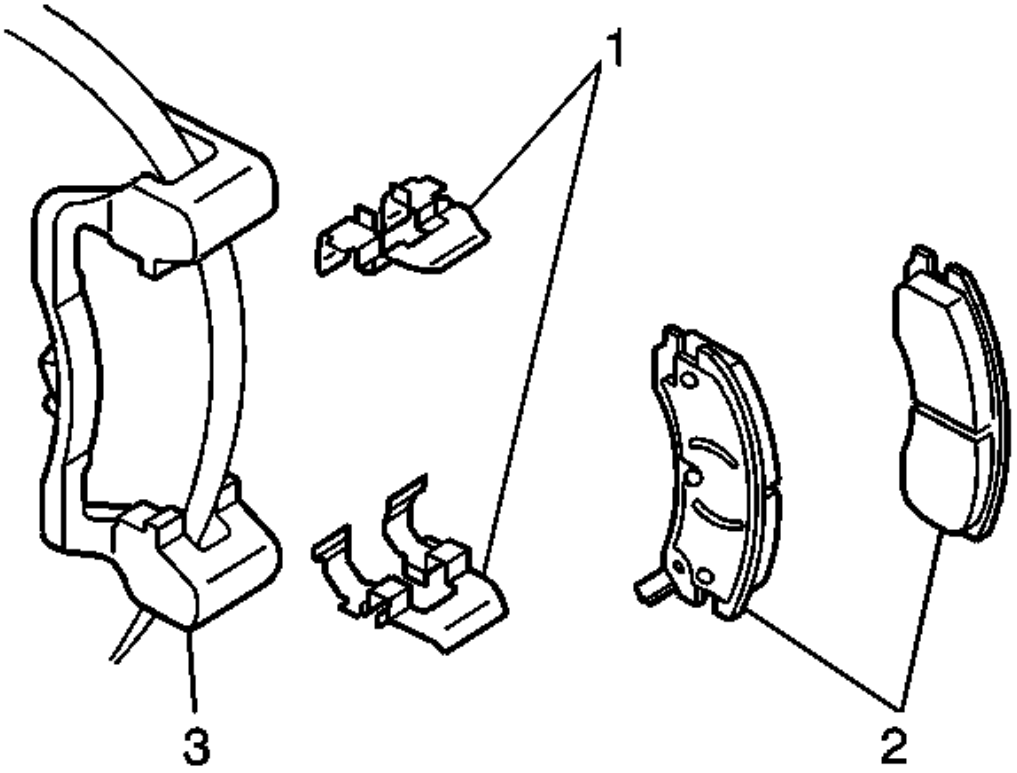


Fig. 45: View Of Brake Pads, Brake Pad Retainers, & Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Install the brake pad retainers (1) to the bracket caliper bracket (3).
7. Install the brake pads (2) to the bracket caliper bracket (3).
8. Install the brake caliper to the brake caliper bracket. Refer to **Rear Brake Caliper Replacement**.

FRONT BRAKE CALIPER BRACKET REPLACEMENT

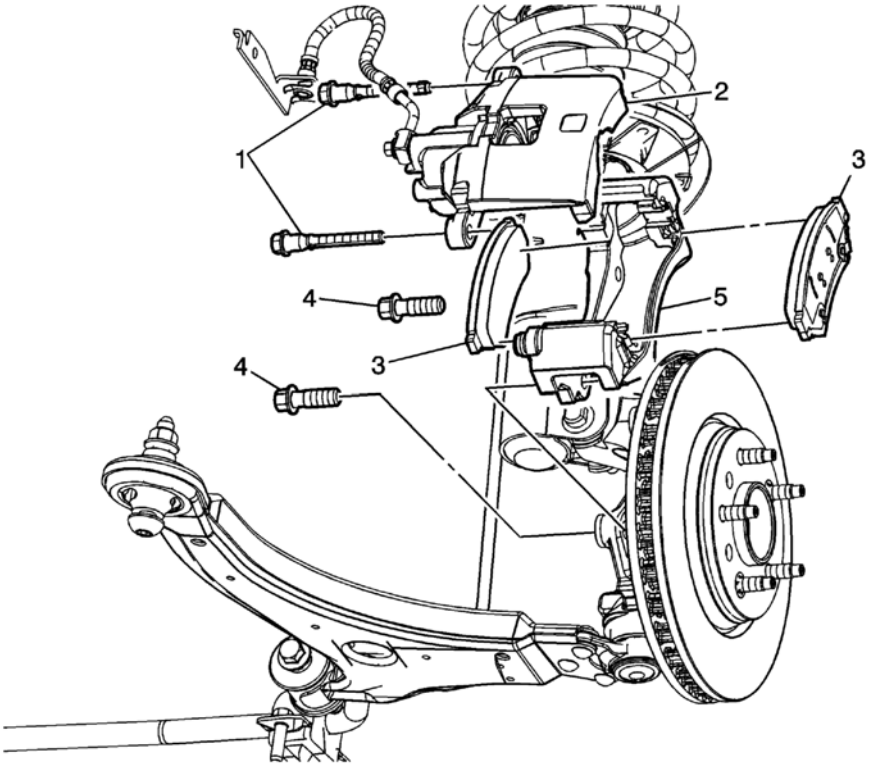


Fig. 46: Front Brake Caliper Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Brake Dust Warning .** **CAUTION:** **Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to**	

Callout	Component Name
support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. **Preliminary Procedures** 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .	
1	Brake Caliper Guide Pin Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Note the location of the brake caliper guide pin bolts. The upper guide pin bolt is equipped with a bushing and must be installed in the same location. 2. Clean the guide pin bolts with denatured alcohol and a clean cloth. 3. Apply a thin coat of high temperature silicone brake lubricant to the brake caliper guide pin bolt and the brake caliper bracket bore. **Tighten** 36 N.m (26 lb ft)
2	Brake Caliper **Procedure** Position the brake caliper aside and support with heavy mechanics wire or equivalent.
3	Disc Brake Pad

Callout	Component Name
4	Brake Caliper Bracket Bolt (Qty: 2) **Tighten** 180 N.m (133 lb ft)
5	Brake Caliper Bracket **Procedure** 1. Prepare the bolts and the threaded holes for assembly. 2. Thoroughly clean the residue from the fastener threads using denatured alcohol or equivalent and allow to dry. 3. Thoroughly clean the residue from the threaded holes using denatured alcohol or equivalent and allow to dry. 4. If reusing the old caliper bracket bolts, apply threadlocker GM P/N 12345493 (Canadian P/N 10953488), or equivalent to 2/3 of the threaded length of the fastener. Ensure that there are no gaps in the threadlocker along the length of the filled area of the fastener. 5. Allow the threadlocker to cure approximately 10 minutes before installation.

REAR BRAKE CALIPER BRACKET REPLACEMENT

Removal Procedure

WARNING: Refer to Brake Dust Warning .

CAUTION: Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak.

1. Remove the caliper from the mounting bracket and support the caliper with heavy mechanics wire or equivalent. It is not necessary to disconnect the hydraulic brake flexible hose from the caliper. Refer to **Rear Brake Caliper Replacement**.
2. Remove the rear brake pads.

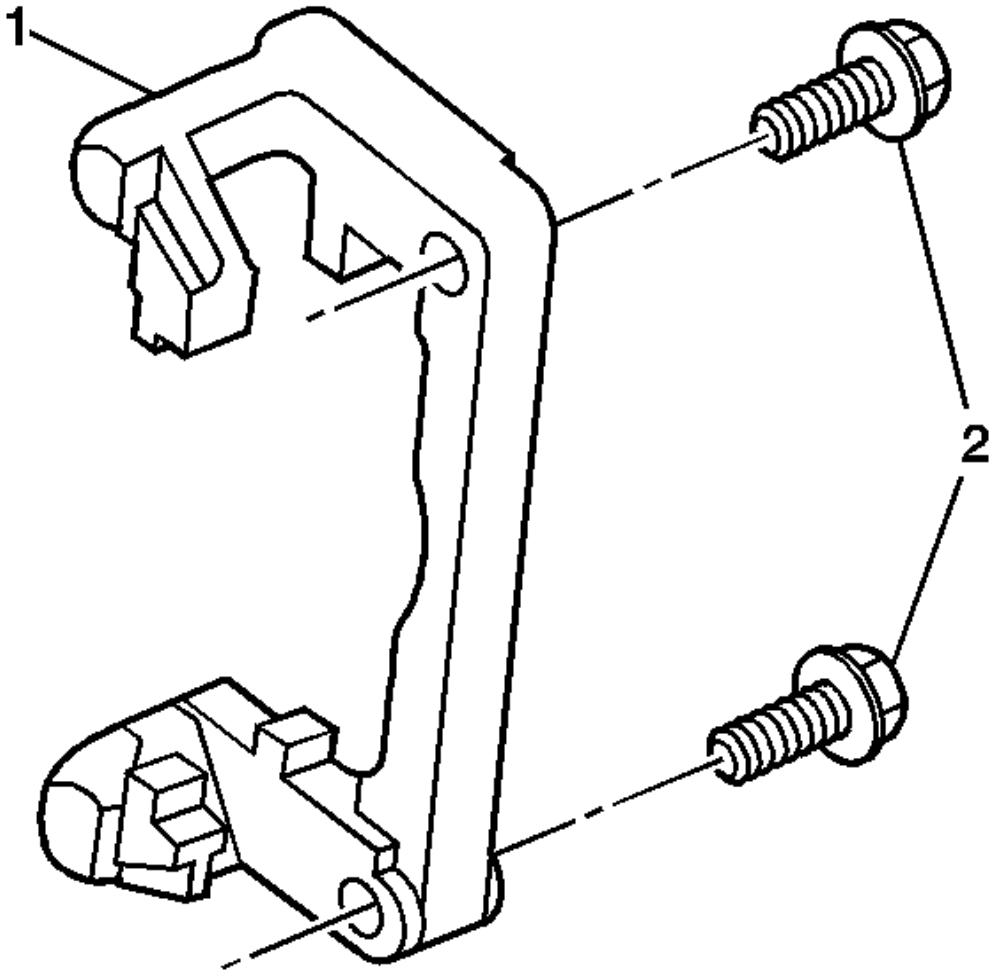


Fig. 47: View Of Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the caliper bracket bolts (2).
4. Remove the caliper bracket (1).

Installation Procedure

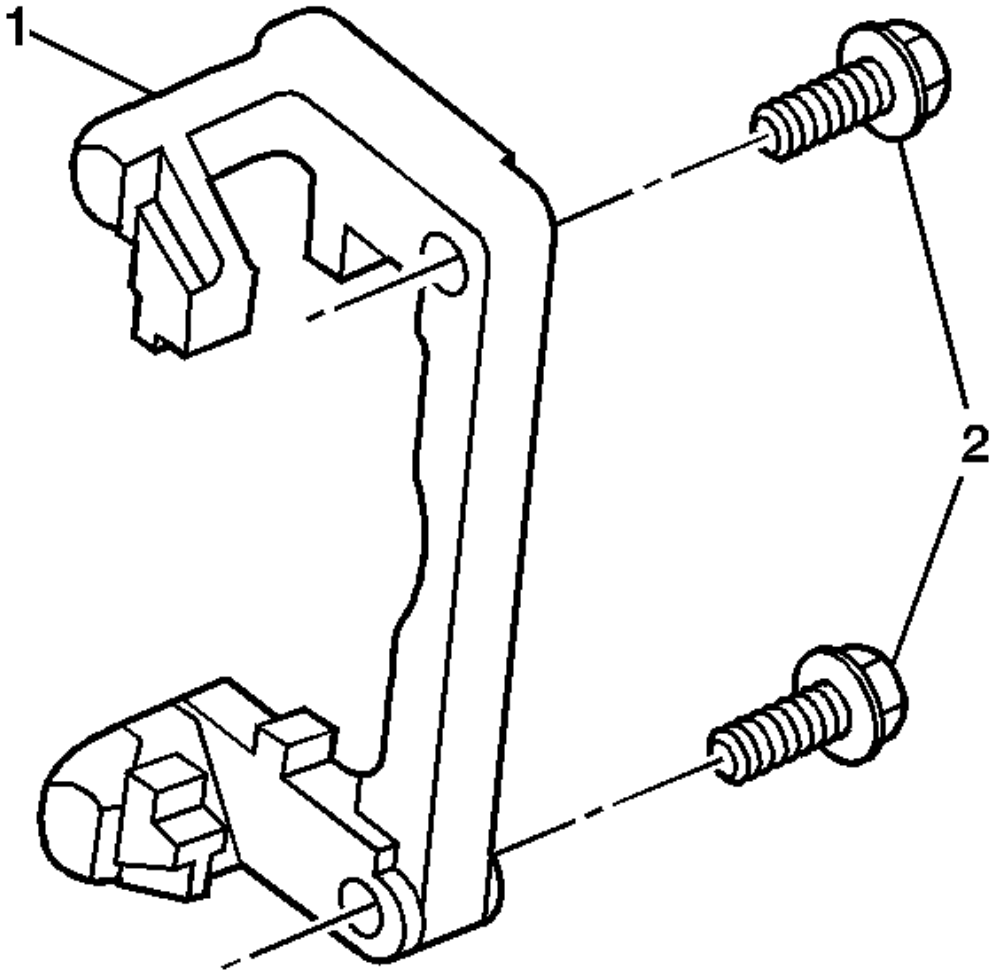


Fig. 48: View Of Caliper Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **To ensure that the proper clamp load will be present when installed. It is imperative that the threads on the caliper bracket bolts, as well as the mounting holes in the knuckle, be cleaned of all debris and inspected before proceeding with installation.**

1. Clean and visually inspect threads of the caliper bracket bolts (2) and mounting holes in the knuckle.
2. Apply threadlocker, GM P/N 12345493 (Canadian P/N 10953488), or equivalent to the threads of the brake caliper bracket bolts (2).

CAUTION: **Refer to Fastener Caution .**

3. Install the caliper bracket (1) with the bracket bolts (2).

Tighten

Tighten the caliper bracket bolts to 120 N.m (88 lb ft).

4. Install the rear brake pads.
5. Install the caliper. Refer to **Rear Brake Caliper Replacement**.

FRONT BRAKE ROTOR REPLACEMENT

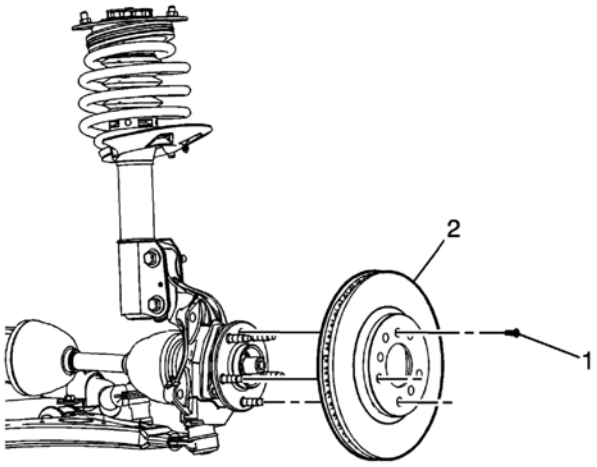


Fig. 49: Front Brake Rotor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Brake Dust Warning .** **Preliminary Procedures** 1. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** . 2. Remove the brake caliper bracket. Refer to **Front Brake Caliper Bracket Replacement**.	
1	Retaining Screw **CAUTION:** **Refer to Fastener Caution .** **Tighten** 14 N.m (124 lb in)
2	Brake Rotor **Procedure** 1. Using the **J 41013** rotor resurfacing kit , clean the contact area of the brake rotor and

Callout	Component Name
	the wheel bearing if the rotor is to be reused. 2. Using the **J 42450-A** wheel hub resurfacing kit , remove the rust and dirt from the contact area of the wheel bearing if replacing the rotor. 3. If the brake rotor has been refinished or replaced, burnish the brake pads and rotors. Refer to **Brake Pad and Rotor Burnishing**. **Special Tools** • **J 41013** Rotor Resurfacing Kit • **J 42450-A** Wheel Hub Resurfacing Kit

REAR BRAKE ROTOR REPLACEMENT

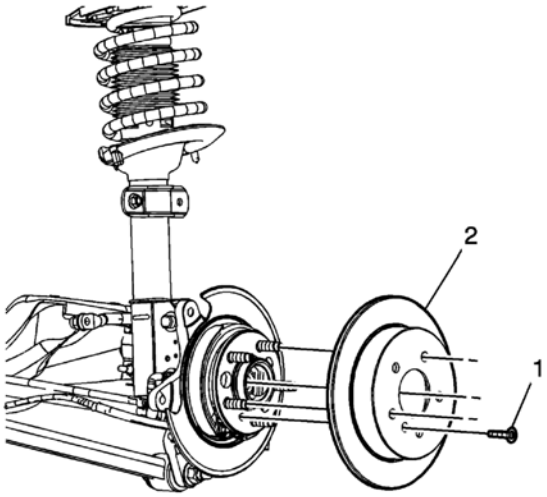


Fig. 50: Rear Brake Rotor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Brake Dust Warning .** **Preliminary Procedures** 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** . 3. Remove the rear brake caliper mounting bracket. Refer to **Rear Brake Caliper Bracket Replacement**.	
1	Rotor Retention Screw

Callout	Component Name
	CAUTION: **Refer to Fastener Caution .** **Tighten** 14 N.m (124 lb in)
2	Brake Rotor **Procedure** 1. If removing the rotor to service the brake system, mark the relationship of the rotor to the wheel stud for proper installation. 2. Using the **J 41013** rotor resurfacing kit , clean the contact area of the brake rotor and the wheel bearing if the rotor is to be reused. 3. Using the **J 42450-A** wheel hub resurfacing kit , remove the rust and dirt from the contact area of the wheel bearing if replacing the rotor. 4. After the installation is complete, inspect the parking brake operation and adjust, if necessary. Refer to **Parking Brake Adjustment** . 5. If the brake rotor has been refinished or replaced, burnish the brake pads and rotors. Refer to **Brake Pad and Rotor Burnishing**. **Special Tools** • **J 41013** Rotor Resurfacing Kit • **J 42450-A** Wheel Hub Resurfacing Kit

BRAKE ROTOR ASSEMBLED LATERAL RUNOUT CORRECTION

NOTE:

- **Brake rotor thickness variation MUST be checked BEFORE checking for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.**
- **Brake rotor assembled lateral runout (LRO) exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4 800-11 300 km (3,000-7,000 mi). Refer to Brake Rotor Assembled Lateral Runout Measurement.**

Review the following acceptable methods for bringing the brake rotor assembled LRO to within specifications. Determine which method to use for the specific vehicle being repaired.

- The indexing method of correcting assembled LRO is most effective when the LRO specification is only exceeded by a relatively small amount: 0.025-0.127 mm (0.001-0.005 in). Indexing is used to achieve the best possible match of high spots to low spots between related components. Refer to **Brake Rotor Assembled Lateral Runout Correction - Indexing**.
- The correction plate method of correcting assembled LRO involves the addition of a tapered plate

between the brake rotor and the hub/axle flange. The correction plate method can be used to correct LRO that exceeds the specification by up to 0.23 mm (0.009 in). Refer to **Brake Rotor Assembled Lateral Runout Correction - Correction Plates**.

- The on-vehicle brake lathe method is used to bring the LRO to within specifications through compensating for LRO while refinishing the brake rotor. Refer to **Brake Rotor Assembled Lateral Runout Correction - On Vehicle Lathe**.

If the assembled LRO cannot be corrected using these methods, then other components must be suspected as causing and/or contributing to the LRO concern.

BRAKE ROTOR ASSEMBLED LATERAL RUNOUT CORRECTION - INDEXING

NOTE: **This Procedure is not used in Europe**

Special Tools

CH-45101-100 Conical Brake Rotor Washers

For equivalent regional tools, refer to **Special Tools**.

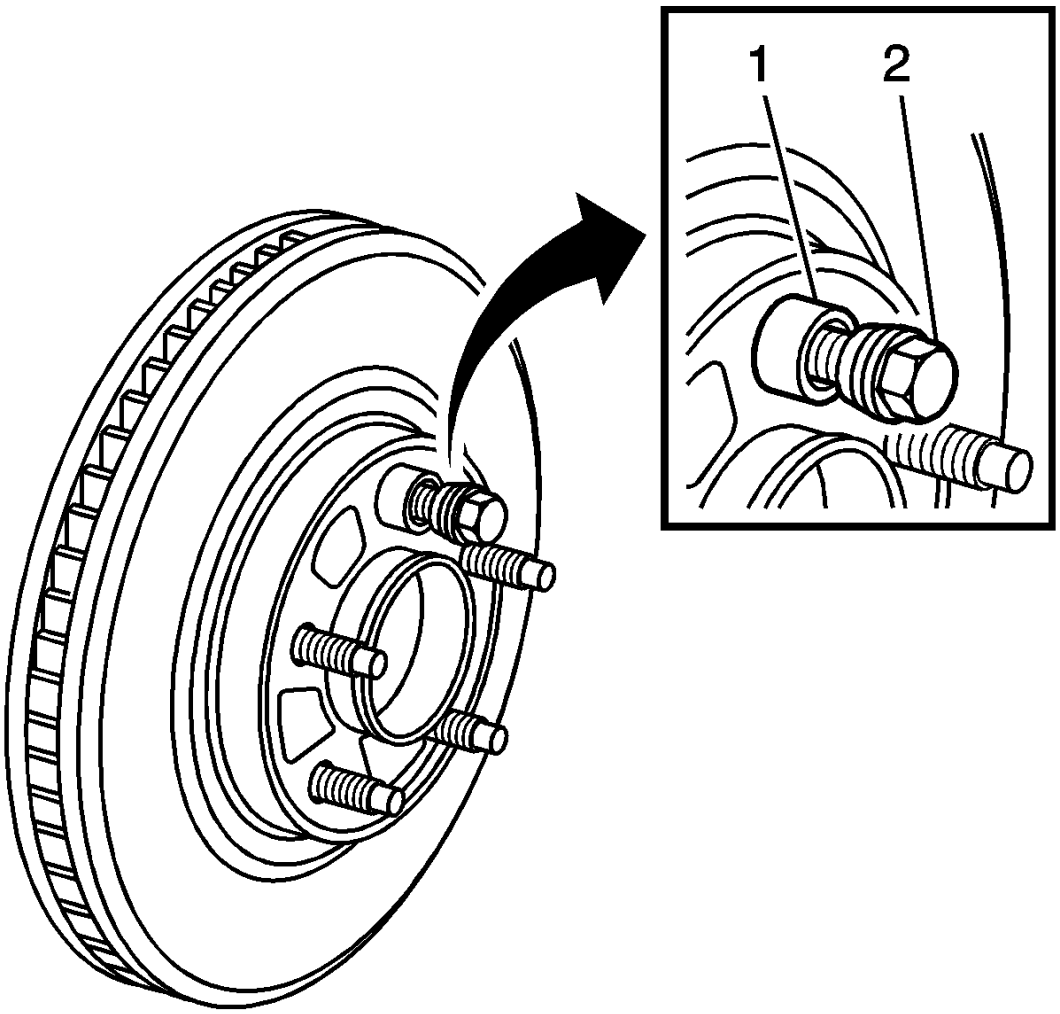


Fig. 51: Lug Nuts & Conical Washers

Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Brake Dust Warning .**

NOTE:

- **Brake rotor thickness variation MUST be checked BEFORE checking for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.**
- **Brake rotor assembled LRO exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4,800-11, 300 km (3,000-7,000 mi). Refer to Brake Rotor Assembled Lateral Runout Measurement.**

1. Remove the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts that were installed during the assembled LRO measurement procedure.
2. Inspect the mating surface of the hub/axle flange and the brake rotor to ensure that there are no foreign particles or debris remaining.
3. Index the brake rotor in a different orientation to the hub/axle flange.
4. Hold the rotor firmly in place against the hub/axle flange and install one of the **CH-45101-100** Conical Brake Rotor Washers (1) and one lug nut (2) onto the upper-most wheel stud.
5. Continue to hold the rotor secure and tighten the lug nut firmly by hand.

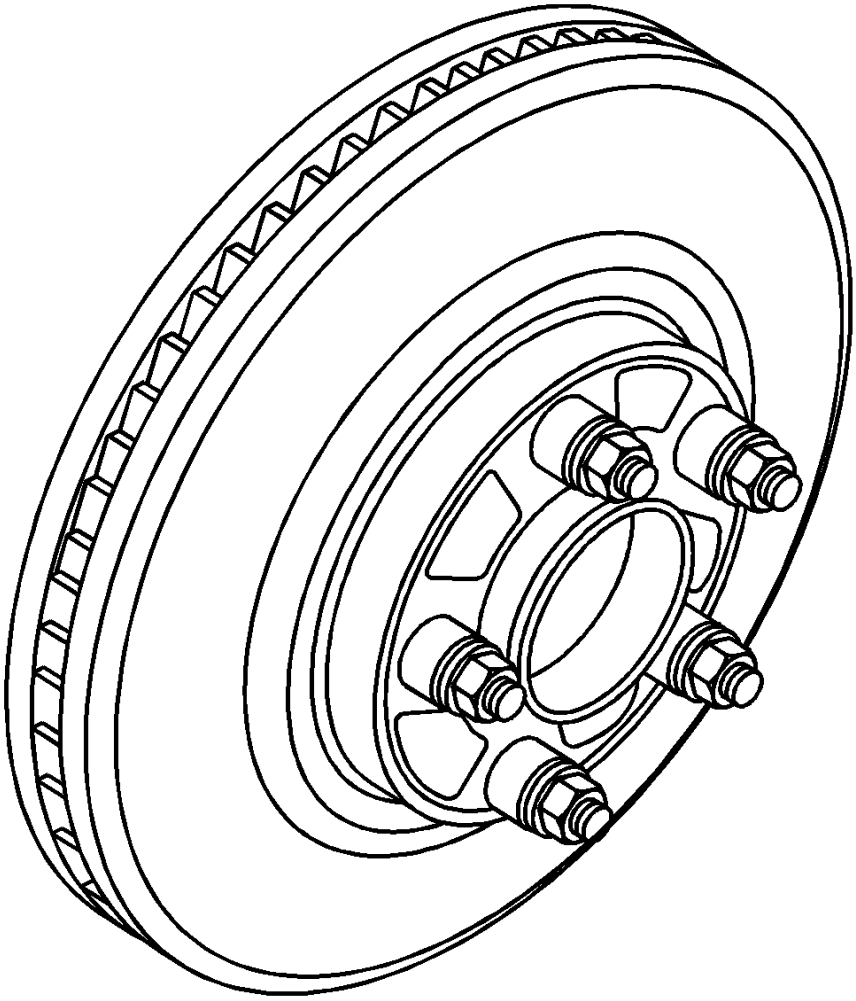


Fig. 52: Lug Nuts & Conical Washers
Courtesy of GENERAL MOTORS COMPANY

6. Install the remaining **CH-45101-100** Conical Brake Rotor Washers and lug nuts onto the wheel studs and tighten the nuts firmly by hand in a star-pattern.
7. Tighten the lug nuts in a star-pattern to specification, in order to properly secure the rotor. Refer to **Tire and Wheel Removal and Installation** .
8. Measure the assembled LRO of the brake rotor. Refer to **Brake Rotor Assembled Lateral Runout Measurement**.
9. Compare the amount of change between this measurement and the original measurement.
10. If this measurement is within specifications, proceed to step 14.
11. If this measurement still exceeds specifications, repeat steps 1-9 until the best assembled LRO measurement is obtained.
12. Matchmark the final location of the rotor to the wheel studs if the orientation is different than it was originally.
13. If the brake rotor assembled LRO measurement still exceeds the maximum allowable specification, refer to **Brake Rotor Assembled Lateral Runout Correction**.
14. If the brake rotor assembled LRO is within specification, install the brake caliper and depress the brake

pedal several times to secure the rotor in place before removing the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts.

BRAKE ROTOR ASSEMBLED LATERAL RUNOUT CORRECTION - CORRECTION PLATES

NOTE: **This procedure not used in Europe**

Special Tools

CH-45101-100 Conical Brake Rotor Washers

For equivalent regional tools, refer to **Special Tools**.

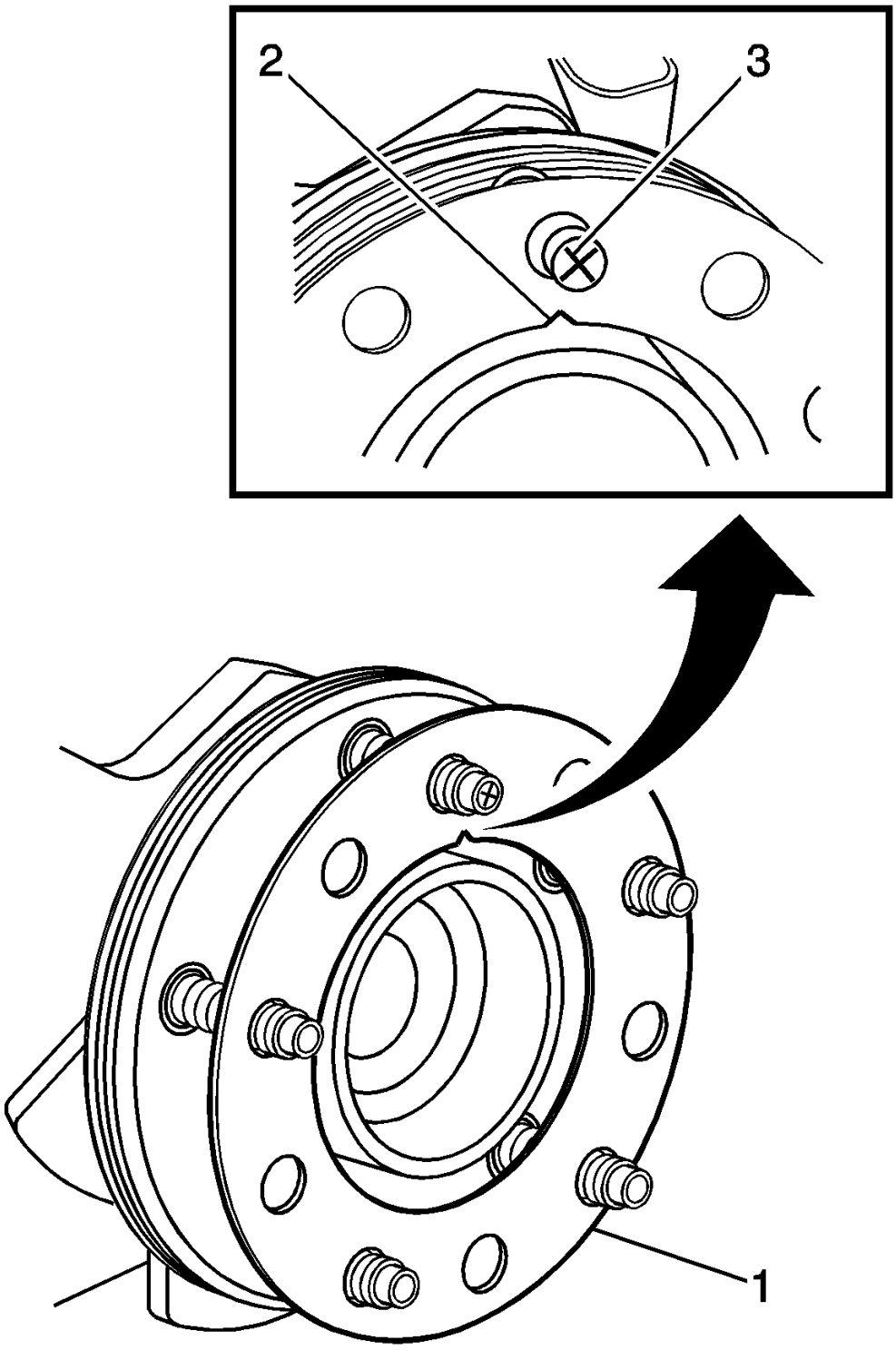


Fig. 53: Identifying Correction Plate, High Spot Mark & V-Shaped Notch
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Brake Dust Warning .**

NOTE:

- **Brake rotor thickness variation MUST be checked BEFORE checking**

for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.

- **Brake rotor assembled LRO exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4,800-11,300 km (3,000-7,000 mi). Refer to Brake Rotor Assembled Lateral Runout Measurement.**

1. Rotate the brake rotor to position the high spot, identified and marked during the brake rotor assembled LRO measurement procedure, to face upward.
2. Remove the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts that were installed during the assembled LRO measurement procedure and/or the indexing correction procedure.
3. Inspect the mounting surface of the hub/axle flange and the brake rotor to ensure that there are no foreign particles or debris remaining.
4. Select the correction plate, following the manufacturer's instructions, which has a specification closest to the assembled LRO measurement.

   For example: If the assembled LRO measurement was 0.076 mm (0.003 in), the 0.076 mm (0.003 in) correction plate would be used. If the measurement was 0.127 mm (0.005 in), the 0.152 mm (0.006 in) correction plate would be used.

5. Determine the positioning for the correction plate (1) using the high spot mark (3) made during the brake rotor assembled LRO measurement procedure.

NOTE:

- **Do NOT install used correction plates in an attempt to correct brake rotor assembled LRO.**
- **Do NOT stack up, or install more than one correction plate onto one hub/axle flange location, in an attempt to correct brake rotor assembled LRO.**

6. Install the correction plate (1) onto the hub/axle flange, with the V-shaped notch (2) orientated to align with the high spot mark (3), that was positioned to face upward.

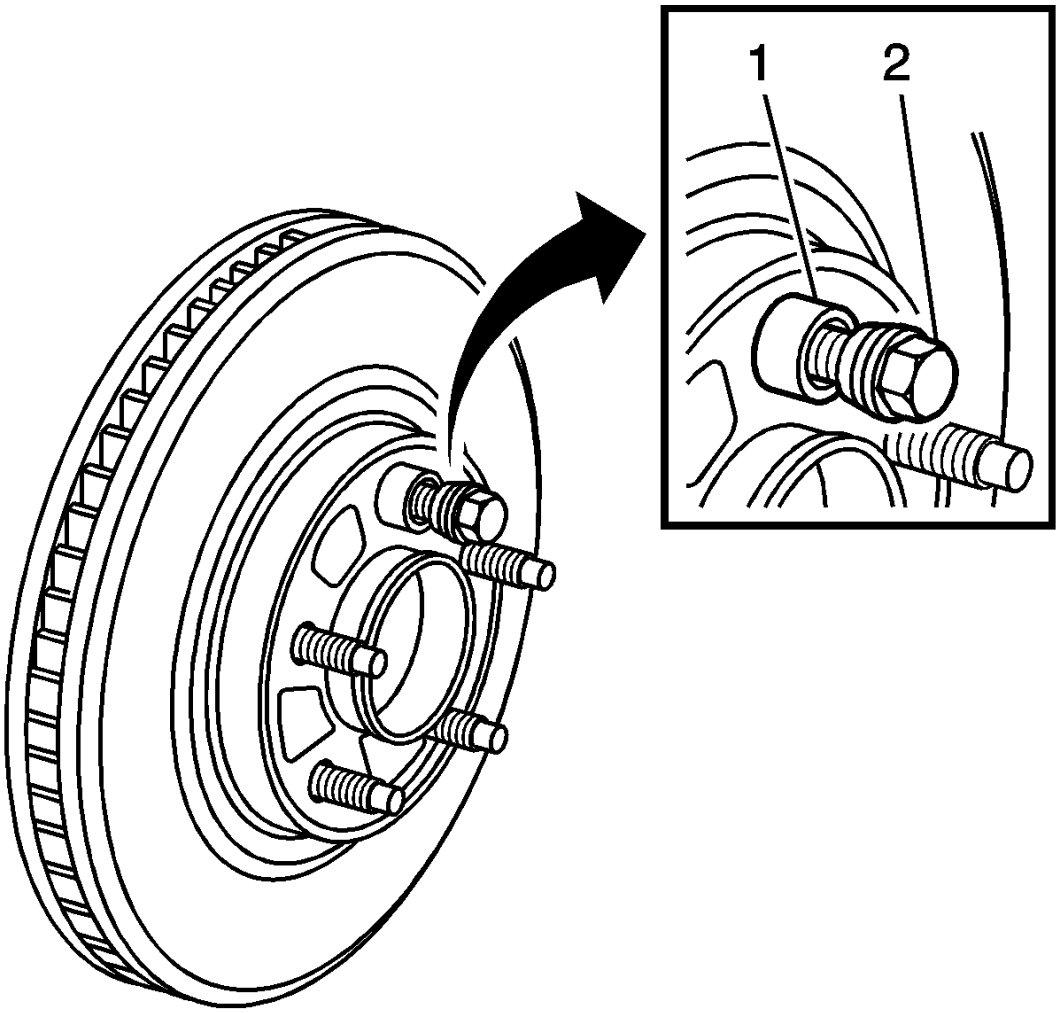


Fig. 54: Lug Nuts & Conical Washers
Courtesy of GENERAL MOTORS COMPANY

7. Install the brake rotor to the hub/axle flange. Use the matchmark made prior to removal for proper orientation to the flange.
8. Hold the rotor firmly in place against the hub/axle flange and install one of the **CH-45101-100** Conical Brake Rotor Washers (1) and one lug nut (2) onto the upper-most wheel stud.
9. Continue to hold the rotor secure and tighten the lug nut firmly by hand.

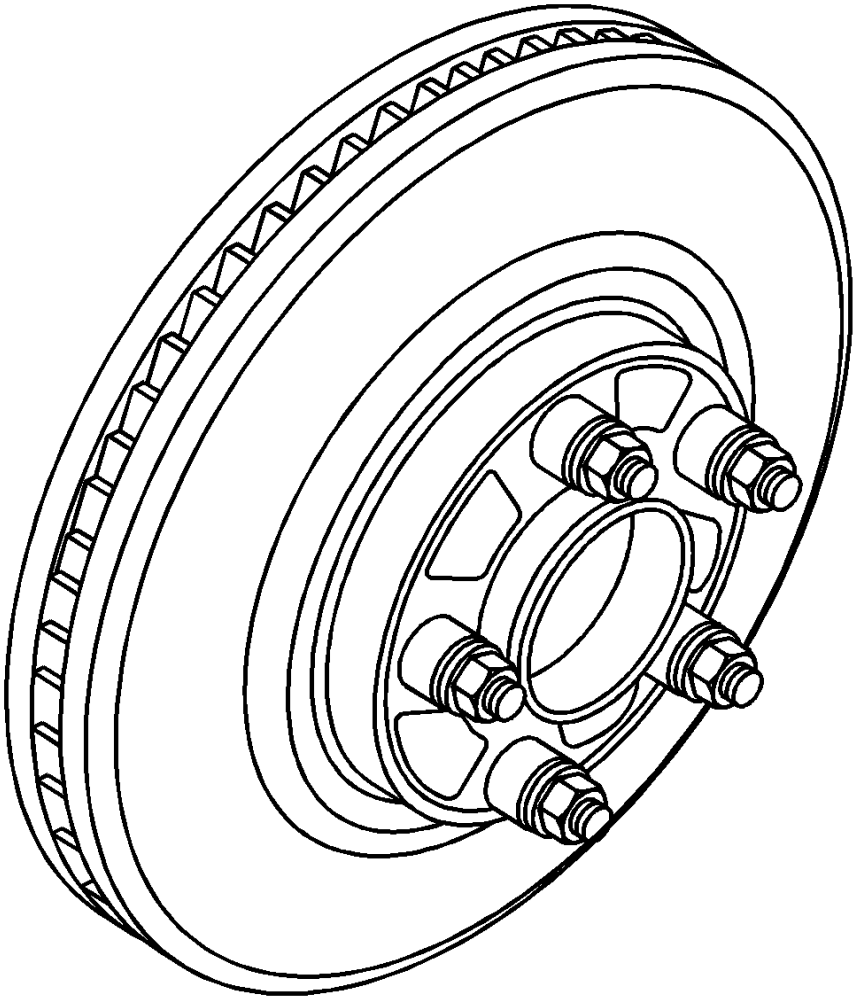


Fig. 55: Lug Nuts & Conical Washers
Courtesy of GENERAL MOTORS COMPANY

10. Install the remaining **CH-45101-100** Conical Brake Rotor Washers and lug nuts onto the wheel studs and tighten the nuts firmly by hand in a star-pattern.
11. Tighten the lug nuts in a star-pattern to specification, in order to properly secure the rotor. Refer to **Tire and Wheel Removal and Installation** .
12. Measure the assembled LRO of the brake rotor. Refer to **Brake Rotor Assembled Lateral Runout Measurement**.
13. If the brake rotor assembled LRO measurement still exceeds the maximum allowable specification, refer to **Brake Rotor Assembled Lateral Runout Correction**.
14. If the brake rotor assembled LRO measurement is within specification, install the brake caliper and depress the brake pedal several times to secure the rotor in place before removing the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts.

BRAKE ROTOR ASSEMBLED LATERAL RUNOUT CORRECTION - ON VEHICLE LATHE

NOTE: **This procedure is not used in Europe.**

Special Tools

CH-45101-100 Conical Brake Rotor Washers

For equivalent regional tools, refer to **Special Tools**.

WARNING: Refer to Brake Dust Warning .

NOTE:

- **Brake rotor thickness variation MUST be checked BEFORE checking for assembled lateral runout (LRO). Thickness variation exceeding the maximum acceptable level can cause brake pulsation. Refer to Brake Rotor Thickness Variation Measurement.**
- **Brake rotor assembled LRO exceeding the maximum allowable specification can cause thickness variation to develop in the brake rotor over time, usually between 4 800-11 300 km (3,000-7,000 mi). Refer to Brake Rotor Assembled Lateral Runout Measurement.**

1. Ensure that the caliper and caliper bracket that are already being supported, are clear from contacting any rotating components, such as the brake rotor.
2. Remove the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts that were installed during the assembled LRO measurement procedure and/or the indexing correction procedure.
3. Inspect the mounting surface of the hub/axle flange and the brake rotor to ensure that there are no foreign particles or debris remaining.
4. Set up the lathe, following the manufacturer's instructions.
5. Refinish the brake rotor, following the brake lathe manufacturer's instructions.
6. After each successive cut, inspect the brake rotor thickness. Refer to **Brake Rotor Thickness Measurement**.
7. If at any time the brake rotor exceeds the minimum allowable thickness after refinish specification, the brake rotor must be replaced. After replacing the rotor, proceed to step 10.
8. After refinishing the brake rotor, use the following procedure in order to obtain the desired non-directional finish:
    1. Follow the brake lathe manufacturer's recommended speed setting for applying a non-directional finish.
    2. Using moderate pressure, apply the non-directional finish:
        - If the lathe is equipped with a non-directional finishing tool, apply the finish with 120-grit aluminum oxide sandpaper.
        - If the lathe is not equipped with a non-directional finishing tool, apply the finish with a sanding block and 150-grit aluminum oxide sandpaper.
    3. After applying a non-directional finish, clean each friction surface of the brake rotor with denatured alcohol, or an equivalent approved brake cleaner.
9. Remove the lathe from the vehicle.
10. Measure the assembled LRO of the brake rotor. Refer to **Brake Rotor Assembled Lateral Runout Measurement**.
11. If the brake rotor assembled LRO measurement still exceeds the maximum allowable specification, refer

to **Brake Rotor Assembled Lateral Runout Correction**.

12. If the brake rotor assembled LRO is within specification, install the brake caliper and depress the brake pedal several times to secure the rotor in place before removing the **CH-45101-100** Conical Brake Rotor Washers and the lug nuts.

BRAKE ROTOR REFINISHING

Special Tools

- **CH-41013** Rotor Resurfacing Kit
- **CH-42450-A** Wheel Hub Resurfacing Kit

For equivalent regional tools, refer to **Special Tools**.

WARNING: **Refer to Brake Dust Warning .**

NOTE:

- **The disc brake rotors do not require refinishing as part of routine brake system service. New disc brake rotors do not require refinishing.**

  Do not refinish disc brake rotors in an attempt to correct the following conditions:

  - **Brake system noise - squeal, growl, groan**
  - **Uneven and/or premature disc brake pad wear**
  - **Superficial or cosmetic corrosion/rust of the disc brake rotor friction surface**
  - **Scoring of the disc brake rotor friction surface less than the maximum allowable specification**
- **Before refinishing a brake rotor, the rotor MUST first be checked for adequate thickness to allow the rotor to be refinished and remain above the minimum allowable thickness after refinish specification. Refer to Brake Rotor Thickness Measurement.**

  Disc brake rotors should only be refinished if they have adequate thickness to be refinished and if one or more of the following conditions exist:

  - **Thickness variation in excess of the maximum allowable specification**
  - **Excessive corrosion/rust and/or pitting**
  - **Cracks and/or heat spots**
  - **Excessive blueing discoloration**
  - **Scoring of the disc brake rotor surface in excess of the maximum allowable specification**
- **Disc brake rotors may need to be refinished as part of the process for correcting brake rotor assembled lateral runout (LRO) that exceeds the maximum allowable specification.**

NOTE: **If the vehicle is equipped with cross-drilled rotors, use a lathe with positive rake tooling. This setup requires less cutting pressure, which will result in less vibration, and a better surface finish. Also, use a vibration dampener when cutting. Otherwise, refinish according to the following instructions.**

NOTE: **Whenever the brake rotor has been separated from the hub/axle flange, clean any rust or contaminants from the hub/axle flange and the brake rotor mating surfaces. Failure to do this may result in increased assembled lateral runout (LRO) of the brake rotor, which could lead to brake pulsation.**

1. Using the **CH-42450-A** Wheel Hub Resurfacing Kit , thoroughly clean any rust or corrosion from the mating surface of the hub/axle flange.
2. Using the **CH-41013** Rotor Resurfacing Kit , thoroughly clean any rust or corrosion from the mating surface and mounting surface of the brake rotor.
3. Inspect the mating surfaces of the hub/axle flange and the rotor to ensure that there are no foreign particles or debris remaining.
4. Mount the brake rotor to the brake lathe according to the lathe manufacturer's instructions, ensuring that all mounting attachments and adapters are clean and free of debris.
5. Ensure that any vibration dampening attachments are securely in place.
6. With the brake lathe running, slowly bring in the cutting tools until they just contact the brake rotor friction surfaces.
7. Observe the witness mark on the brake rotor. If the witness mark extends approximately three-quarters or more of the way around the brake rotor friction surface on each side, the brake rotor is properly mounted to the lathe.
8. If the witness mark does not extend three-quarters or more of the way around the brake rotor, re-mount the rotor to the lathe.
9. Following the brake lathe manufacturer's instructions, refinish the brake rotor.
10. After each successive cut, inspect the brake rotor thickness. Refer to **Brake Rotor Thickness Measurement**.
11. If at any time the brake rotor exceeds the minimum allowable thickness after refinish specification, the brake rotor must be replaced.
12. After refinishing the brake rotor, use the following procedure in order to obtain the desired non-directional finish:
    1. Follow the brake lathe manufacturer's recommended speed setting for applying a non-directional finish.
    2. Using moderate pressure, apply the non-directional finish:
        - If the lathe is equipped with a non-directional finishing tool, apply the finish with 120-grit aluminum oxide sandpaper.
        - If the lathe is not equipped with a non-directional finishing tool, apply the finish with a sanding block and 150-grit aluminum oxide sandpaper.

NOTE: **Thoroughly cleaning the brake rotor will prevent the possible transfer of finite metal dust left as a by-product of machining to the brake pad**

material during the burnishing process, thereby reducing the possibility for brake squeal or other brake noises to occur.

3. After applying a non-directional finish, clean each friction surface of the brake rotor with a solution of mild dish washing detergent and water, or a GM approved brake cleaner and a clean shop towel to remove metal particles remaining from machining. Repeat the cleaning process if necessary to remove all metal particles.

13. Remove the brake rotor from the brake lathe.
14. Measure the assembled LRO of the brake rotor to ensure optimum performance of the disc brakes. Refer to **Brake Rotor Assembled Lateral Runout Measurement**.
15. If the brake rotor assembled LRO measurement exceeds the specification, bring the LRO to within specifications. Refer to **Brake Rotor Assembled Lateral Runout Correction**.

DESCRIPTION AND OPERATION

DISC BRAKE SYSTEM DESCRIPTION AND OPERATION

System Component Description

The disc brake system consists of the following components:

Disc Brake Pads

Applies mechanical output force from the hydraulic brake calipers to friction surfaces of brake rotors.

Disc Brake Rotors

Uses mechanical output force applied to friction surfaces from the disc brake pads to slow speed of tire and wheel assembly rotation.

Disc Brake Pad Hardware

Secures disc brake pads firmly in proper relationship to the hydraulic brake calipers. Enables a sliding motion of brake pads when mechanical output force is applied.

Disc Brake Caliper Hardware (Floating Caliper)

Provides mounting for hydraulic brake caliper and secures the caliper firmly in proper relationship to caliper bracket. Enables a sliding motion of the brake caliper to the brake pads when mechanical output force is applied.

System Operation (Floating Caliper)

Mechanical output force is applied from the hydraulic brake caliper pistons to the inner brake pads. As the pistons press the inner brake pads outward, the caliper housings draw the outer brake pads inward. This allows the output force to be equally distributed. The brake pads apply the output force to the friction surfaces on both sides of the brake rotors, which slows the rotation of the tire and wheel assemblies. The correct function of both the brake pad and brake caliper hardware is essential for even distribution of braking force.

System Operation (Fixed Caliper)

Mechanical output force is applied from the hydraulic brake caliper inboard and outboard pistons to the inner and outer brake pads. The brake calipers are a fixed, opposed-piston design, allowing the output force to be equally distributed through the distribution of the pressurized brake fluid within the caliper. The brake pads apply the output force to the friction surfaces on both sides of the brake rotors, which slows the rotation of the tire and wheel assemblies. The correct function of the brake pad hardware and of the brake caliper inboard and outboard pistons is essential for even distribution of braking force.

System Characteristics

Brake Noise

Brake noise can occur and to a degree, some brake noise is normal. Variations in driving conditions such as the weather, environment, driving patterns, differences in vehicle loading, and type or style of driving, can affect brake wear. Any one of these variations can cause brake noise to become apparent. Inspect and verify that all metal-to-metal contact areas of the brake pads, brake pad guides or springs, brake caliper housing, caliper bracket and/or suspension knuckle, as applicable, are clean and free of corrosion and scale.

Brake noise is a "slip-stick" vibration of disc brake components and, if it occurs intermittently, can be considered normal. Most brake noise may be eliminated or temporarily reduced by performing 3 or 4 aggressive brake applications. If the brake noise persists or consistently recurs, application of a damping compound to the brake pad mounting plate where it contacts the caliper can lessen the vibration as the components move relative to each other. Refer to Adhesives, Fluids, Lubricants, and Sealers in this section for recommended compounds.

The following brake noises are characteristic of all brake systems. These noises cannot be avoided, and may not indicate improper operation of the brake system.

Squeak/Squeal Noise

A squeak or squeal noise can occur on vehicles with front semi-mettalic brake pads during light to medium brake pedal application at low to moderate vehicle speeds. Occasionally this noise may appear from the front or rear brakes after a period of non-use such as overnight, or cold brakes and/or in high humidity conditions.

Grinding Noise

Common occurrence for rear brakes and some front disc brakes during initial brake applications after the vehicle has been parked overnight. Caused by light corrosion forming on the metal brake component friction surfaces during vehicle non-use. Typically disappears after the first few brake applications.

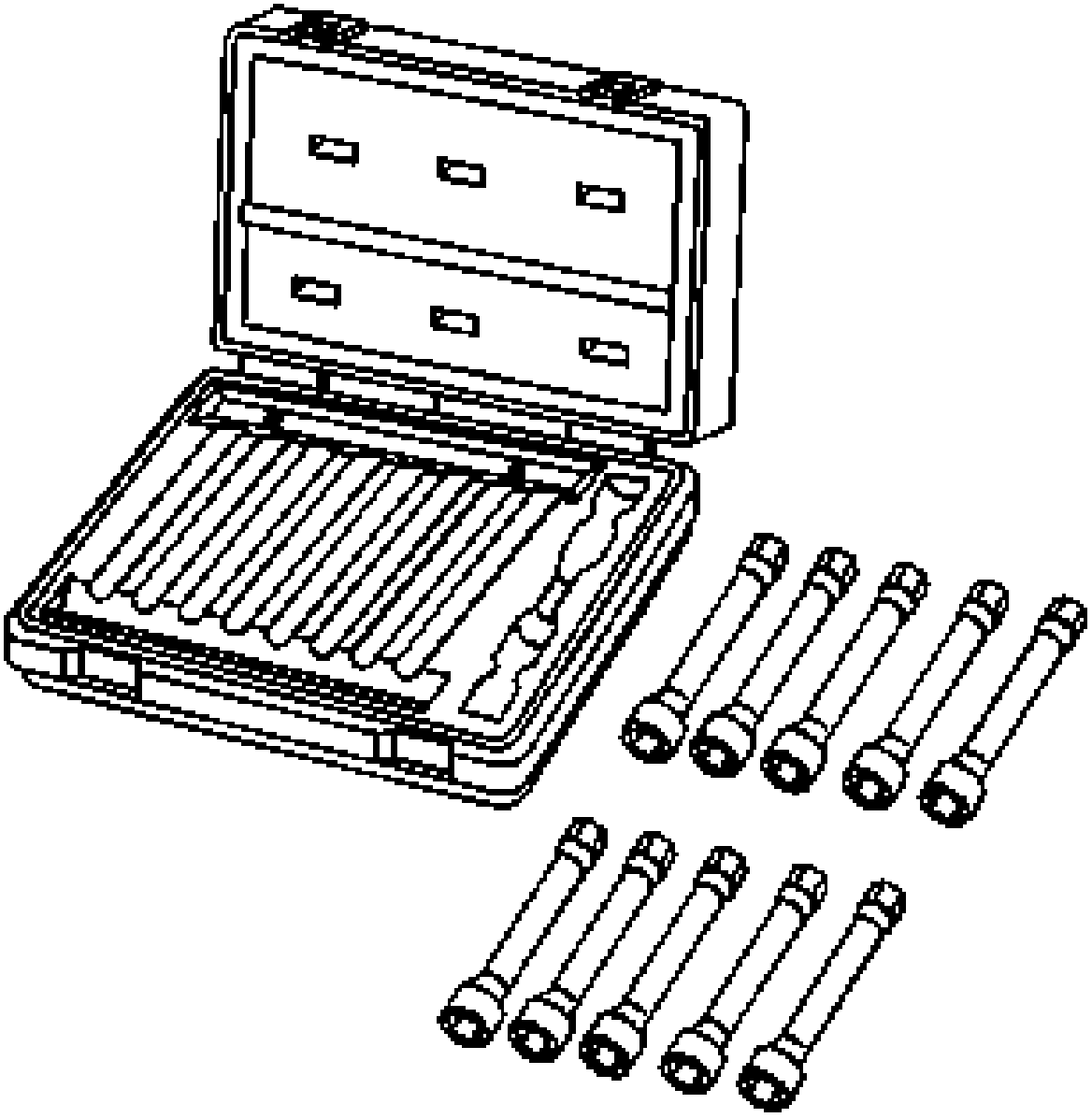
Groan Noise

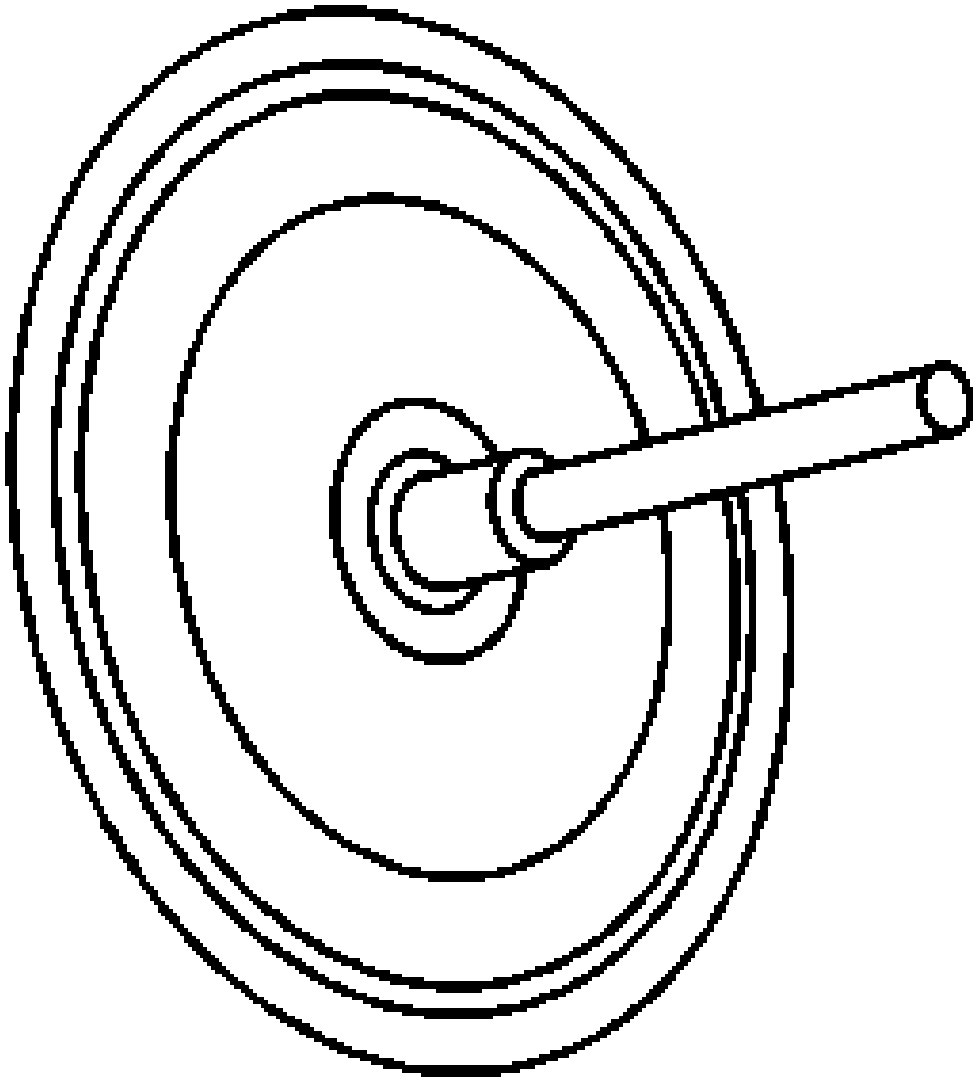
A groan type noise may be heard during a quick stop, or when slowly moving forward from a complete stop. On vehicles equipped with antilock brake systems (ABS), a groan or moan noise may occur during heavy brake application or on road surfaces with compromised traction such as loose gravel, or on wet or icy roads. This is a normal function of ABS activation.

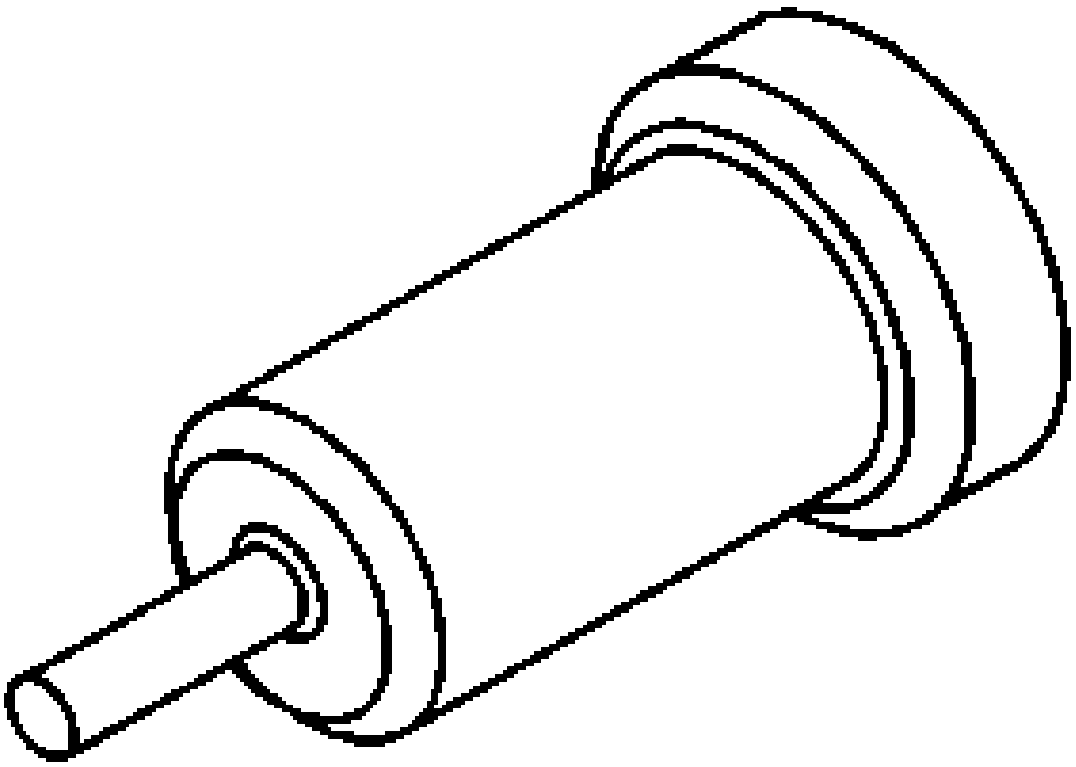
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

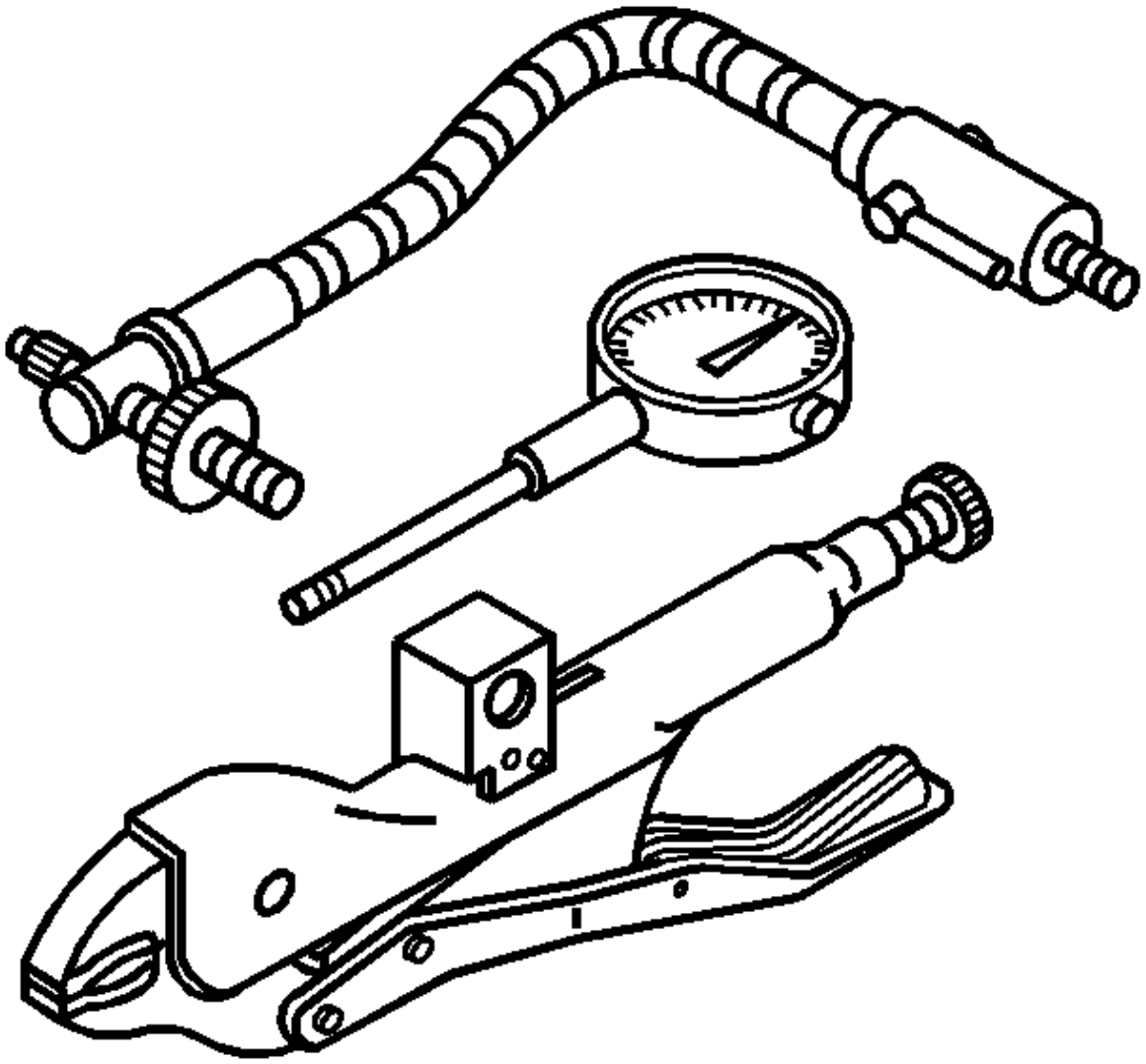
Illustration	Tool

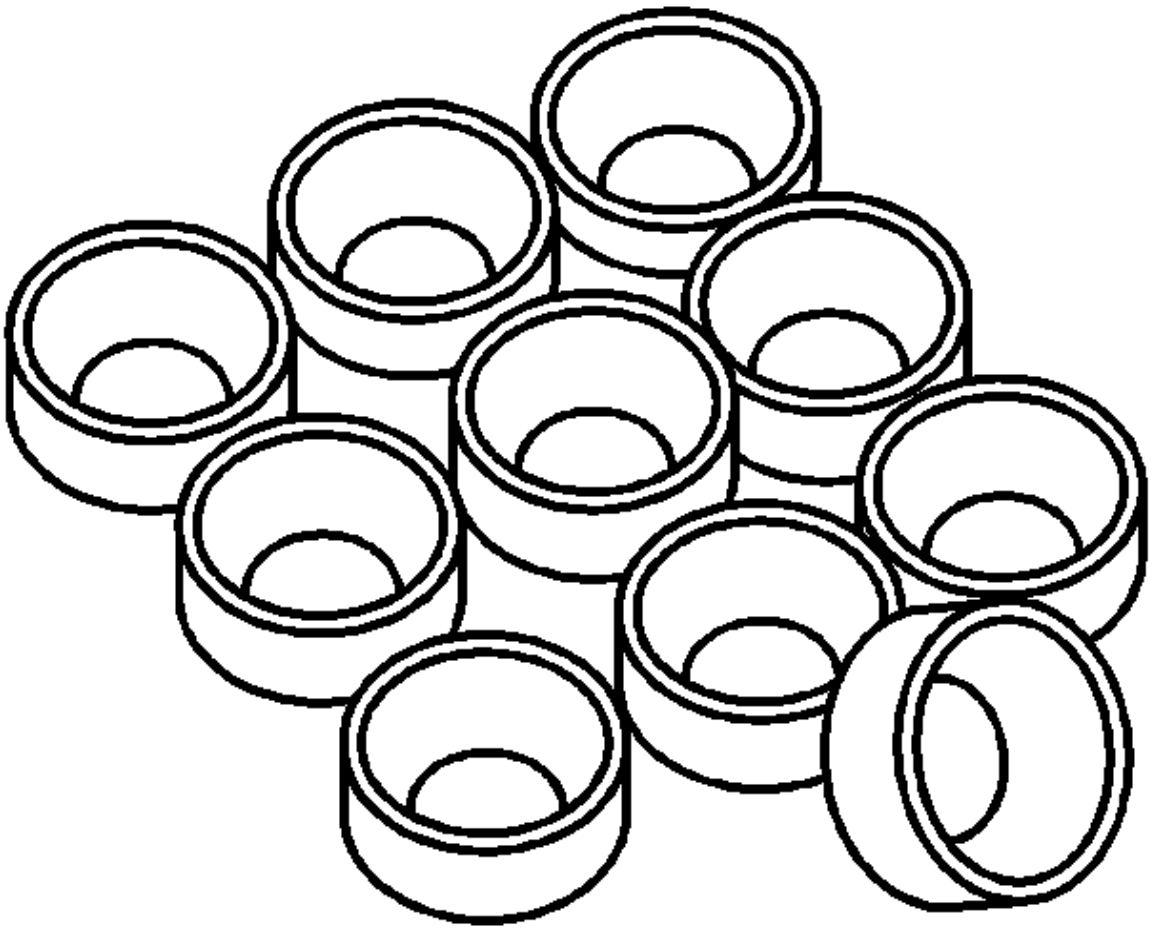
	Number/ Description
	J-39544-KIT Complete Torque Socket Set - 10 Pieces

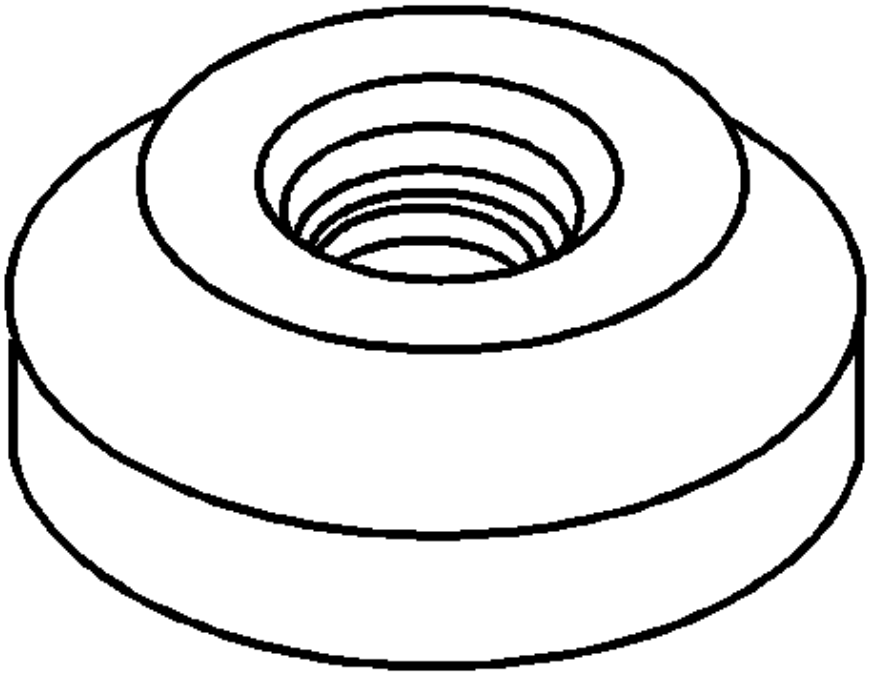
	J-41013 Rotor Resurfacing Kit

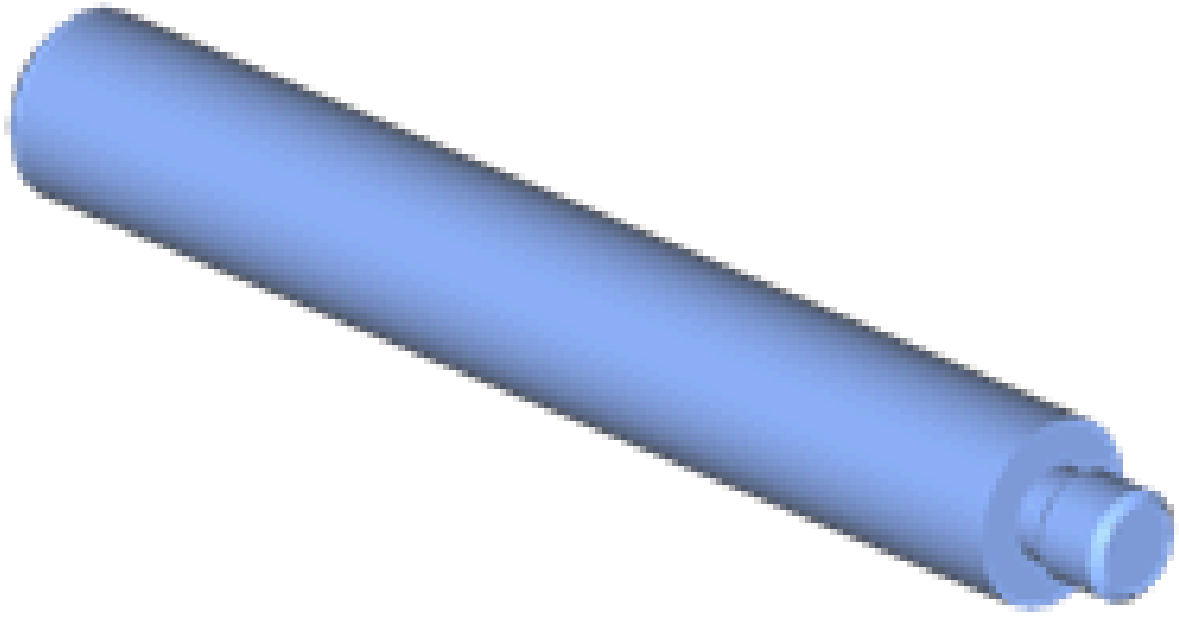


J-42450-A
Wheel Hub
Resurfacing
Kit

	J-45101 Hub and Wheel Runout Gauge

	J-45101-100 Conical Brake Rotor Washers

	J-45863 Dust Seal Installer GMT355

	J-8092 Drive Handle

Article GUID: A00737240

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Brake Hose Fitting Bolt	54 N.m	40 lb ft
Brake Pedal Bolt and Nut	40 N.m	30 lb ft
Brake Pedal Pushrod Nut	13 N.m	115 lb in
Brake Pipe Fitting	18 N.m	13 lb ft
Master Cylinder Nut	33 N.m	24 lb ft
Power Brake Booster Vacuum Pump Bracket Bolt	58 N.m	43 lb ft
Power Brake Booster Vacuum Pump Nut	9 N.m	80 lb in

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	US English
Hydraulic Brake System	1.0 L	2.11 pt

BRAKE COMPONENT SPECIFICATIONS

Application	Specification	
	Metric	English
Brake Caliper Bleeder Valve - Front	13 N.m	115 lb in
Brake Caliper Bleeder Valve - Rear	11 N.m	97 lb in

BRAKE SYSTEM SPECIFICATIONS

Application	Specification	
	Metric	English
Brake Pedal Travel • Maximum specification with 445 N (100 lbs) of force applied to the brake pedal with the ignition OFF and the booster power reserve depleated	74 mm	2.91 in

SCHEMATIC WIRING DIAGRAMS

HYDRAULIC BRAKE WIRING SCHEMATICS

Hydraulic Brake

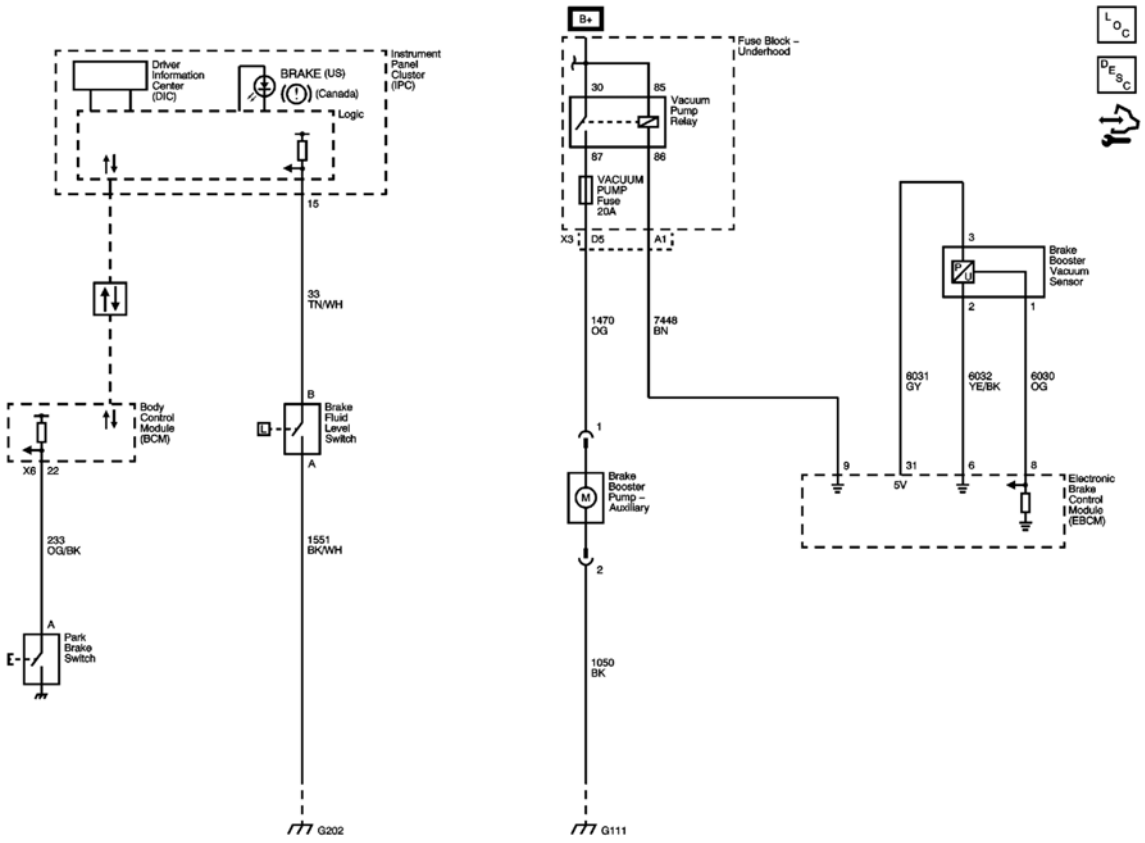


Fig. 1: Hydraulic Brake Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC C0267: LOW BRAKE FLUID

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0267 00

Low Brake Fluid Indicated

DTC C0267 71

Low Brake Fluid Indicated Invalid Serial Data

Diagnostic Fault Information

Circuit	Short to	Open/High	Short to	Signal

	Ground	Resistance	Voltage	Performance
Brake Fluid Level Signal	C0267 00	1	1	-
Park Brake Signal	1	1	1	-
Ground	-	1	-	-
1. Brake Warning Indicator Malfunction				

Circuit/System Description

The brake fluid level switch monitors the level of brake fluid in the master cylinder. When the instrument panel cluster (IPC) sees the brake fluid level switch input closed, it turns ON the Red Brake Warning indicator and sends a serial data message to the electronic brake control module (EBCM) that the brake fluid level is low.

Conditions for Running the DTC

Ignition ON.

Conditions for Setting the DTC

- Low brake fluid is detected.
- A short to ground exists on the signal circuit.

Action Taken When the DTC Sets

- The EBCM disables the antilock brake system (ABS)/traction control system (TCS) dynamic rear proportion (DRP) and vehicle stability enhancement system (VSES).
- A DIC message and/or a warning indicator may be displayed.

Conditions for Clearing the DTC

- The condition for the DTC is no longer present.
- The EBCM clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Brake Warning System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Inspect for proper brake fluid level, the fluid level should be at or above the proper level.
    - If low, refer to **Brake Fluid Loss**.
2. Ignition ON, observe the scan tool IPC Brake Fluid parameter. The reading should be OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for less than 10 ohm between the ground circuit terminal A and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool IPC Brake Fluid parameter is Ok.
    - If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the IPC.
4. Install a 3A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool IPC Brake Fluid parameter is Low.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the IPC.
5. If all circuits test normal, remove the brake fluid level switch.
6. Connect the harness connector to the brake fluid level switch, verify the scan tool IPC Brake Fluid parameter is OK.
    - If not the specified value, replace the brake fluid level switch.
    - If at the specified value, replace the brake fluid reservoir.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Brake Fluid Level Indicator Switch Replacement**
- **Control Module References** for IPC replacement, setup, and programming

DTC C027B: AUXILIARY BRAKE BOOSTER PUMP MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C027B 00

Auxiliary Brake Booster Pump Malfunction

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Booster Pump Relay Switch B+	1	1	-	-
Brake Booster Pump Relay Coil Ignition	C027B 00	C027B 00	-	-
Brake Booster Pump Relay Control	1	C027B 00	C027B 00	-
Auxilary Brake Booster Pump Control	1	1	1	-
Auxiliary Brake Booster Pump Ground	-	1	-	-
1. Auxiliary Brake Booster Pump Motor Malfunction				

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. When the vacuum within the system drops, the EBCM turns ON the auxiliary brake booster pump by providing ground to the brake booster pump relay. The relay activates and supplies voltage to the auxiliary brake booster pump motor.

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

A short to ground, open/high resistance is detected on the brake booster pump relay control circuit.

Action Taken When the DTC Sets

The brake warning indicator turns ON.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The EBCM will turn OFF the indicator in the next ignition cycle.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Brake Assist System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, apply and release the brake pedal several times to ventilate the brake booster.
2. Engine running, the auxiliary brake booster pump motor should turn ON for a short time.

Circuit/System Testing

1. Ignition OFF, remove the brake booster pump relay.
2. Ignition ON, verify that a test lamp does not illuminate between the auxiliary brake booster pump control circuit terminal 87 and ground.
    - If the test lamp illuminates, test the auxiliary brake booster pump control circuit for a short to voltage.
3. Test for more than 10 Ω between the auxiliary brake booster pump control circuit terminal 87 and ground.
    - If less than the specified range, test the auxiliary brake booster pump control circuit for a short to ground.
4. Verify that a test lamp illuminates between the brake booster pump relay switch B+ circuit terminal 30 and ground.
    - If the test lamp does not illuminate, test the brake booster pump relay switch B+ circuit for a short to ground or an open/high resistance.
5. Verify that a test lamp illuminates between the brake booster pump relay coil B+ circuit terminal 85 and ground.
    - If the test lamp does not illuminate, test the brake booster pump relay coil B+ circuit for a short to ground or an open/high resistance.
6. Disconnect the harness connector at the auxiliary brake booster pump.
7. Test for less than 10 Ω between the auxiliary brake booster pump ground circuit terminal 2 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
8. Connect the harness connector at the auxiliary brake booster pump.
9. Connect a 20 A fused jumper wire between the brake booster pump relay switch B+ circuit terminal 30 and the auxiliary brake booster pump control circuit terminal 87. Verify the auxiliary brake booster pump is activated.

- If the auxiliary brake booster pump does not activate, test the auxiliary brake booster pump control circuit for an open/high resistance. If the circuit tests normal, test or replace the auxiliary brake booster pump.

10. Connect a test lamp between the brake booster pump relay coil B+ circuit terminal 85 and the brake booster pump relay control circuit terminal 86.
11. Command the auxiliary brake booster pump ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the brake booster pump relay control circuit for a short to ground. If the circuit tests normal, replace the electronic brake control module.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the electronic brake control module.
12. If all circuits test normal, test or replace the brake booster pump relay.

Component Testing

Auxiliary Brake Booster Pump Test

1. Ignition OFF, disconnect the harness connector at the auxiliary brake booster pump.
2. Connect a 20 A fused jumper wire between the control circuit terminal 1 and B+.
3. Connect a jumper wire between the ground circuit terminal 2 and ground, verify the auxiliary brake booster pump activates.
    - If the auxiliary brake booster pump does not activate, replace the auxiliary brake booster pump.

Relay Test

1. Ignition OFF, disconnect the brake booster pump relay.
2. Test for 60-100 Ω between terminals 85 and 86 of the relay.
    - If not within the specified range, replace the brake booster pump relay.
3. Test for infinite resistance between the following terminals:
    - 30 and 85
    - 30 and 86
    - 30 and 87
    - If less than the specified value, replace the brake booster pump relay.
4. Install a fused jumper wire between relay terminal 86 and B+. Install a jumper wire between relay terminal 85 and ground.
5. Test for less than 5 Ω between terminals 30 and 87.
    - If greater than the specified value, replace the brake booster pump relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Power Brake Booster Auxiliary Pump Replacement**
- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

- **Control Module References** for EBCM replacement, setup, and programming

DTC C1100: BRAKE BOOSTER VACUUM SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C1100 01

Brake Booster Vacuum Sensor Circuit Short to Voltage

DTC C1100 06

Brake Booster Vacuum Sensor Circuit Short to Ground or Open

DTC C1100 5A

Brake Booster Vacuum Sensor Circuit Plausible Failure

DTC C1100 75

Brake Booster Vacuum Sensor Circuit Signal Above Allowable Range

Circuit/System Description

The brake booster vacuum sensor measures the vacuum in the brake booster assembly. The electronic brake control module (EBCM) supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the EBCM.

Conditions for Running the DTC

Engine Running.

Conditions for Setting the DTC

C1100 01

The EBCM detects a voltage greater than 4.9 V for more than 100 m/sec on the vacuum sensor 5 V reference circuit.

C1100 06

The EBCM detects a voltage less than 0.2 V for more than 100 m/sec on the vacuum sensor 5 V reference circuit.

C1100 5A

The vacuum sensor signal is not plausible (erractic).

C1100 75

The vacuum sensor is out of range.

Action Taken When the DTC Sets

The DIC displays Service Brake System Soon.

Conditions for Clearing the DTC

- A current DTC clears when the diagnostic runs and passes.
- The EBCM will turn OFF the indicator in the next ignition cycle.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

ABS Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the brake booster vacuum sensor.
2. Ignition OFF, test for less than 10 Ω between the low reference circuit terminal 2 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the EBCM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the EBCM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit

tests normal, replace the EBCM.

4. Ignition ON, test for 4.5-5.2 V between the 5 V reference circuit terminal 3 and the signal circuit terminal 1.
    - If less than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the EBCM.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the EBCM.
5. Ignition OFF, disconnect the X1 harness connector at the EBCM.
6. Ignition OFF, test for infinite resistance between the signal circuit terminal 8 and ground.
    - If not the specified value, test the signal circuit for a short to ground.
7. If all circuits test normal, replace the power brake booster vacuum sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Power Brake Booster Vacuum Sensor Replacement**
- **Control Module References** for EBCM replacement, setup and programming

DTC P258A-P258D: VACUUM PUMP/VACUUM PUMP RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P258A

Vacuum Pump Relay Control Circuit

DTC P258B

Vacuum Pump Performance

DTC P258C

Vacuum Pump Relay Control Circuit Low Voltage

DTC P258D

Vacuum Pump Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil B+	P258A	P258A, P258C	-	P258B
Relay Coil Control	P258C	P258A	P258D	P258B
Brake Booster Pump Control	1	1	1	-
Brake Booster Pump Ground	1	1	-	-
1. Brake Booster Pump Malfunction				

Circuit/System Description

The engine control module (ECM) monitors the control circuit of the brake booster pump relay. The ECM supplies ground through the pump relay control circuit which then supplies B+ voltage to actuate the brake booster pump. B+ voltage is supplied at all times to the coil side of the pump relay.

Conditions for Running the DTC

P258A, P258C, P258D

Ignition ON.

P258B

- Engine Running
- Vacuum pump is activated for greater than 1.6 seconds.

Conditions for Setting the DTC

P258A, P258C

The ECM detects an open/high resistance on the relay coil control circuit.

P258B

The ECM detects an excessive difference in vacuum levels between the power brake booster and the manifold absolute pressure (MAP).

P258D

The ECM detects a short to voltage on the relay control circuit.

Action Taken When the DTC Sets

DTC P258A, P258B, P258C, P258D are Type B DTCs.

Conditions for Clearing the DTC

DTC P258A, P258B, P258C, P258D are Type B DTCs.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Brake Assist System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that a vacuum leak is not present, refer to **Brake System Vacuum Source Test**
2. Ignition ON, command the relay ON and OFF with a scan tool. Observe to verify that the vacuum relay and motor turns ON and OFF with each command.

Circuit/System Testing

1. Ignition OFF, disconnect the vacuum pump relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 87 and ground.
    - If the test lamp illuminates, test the control circuit for a short to voltage.
3. Verify that a test lamp illuminates between the B+ circuit terminals listed below and ground.
    - Terminal 30
    - Terminal 86
        - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test or replace the relay.
4. Verify that a test lamp does not illuminate between the control circuit terminal 85 and ground.
    - If the test lamp illuminates, test the control circuit for a short to voltage.
5. Disconnect the harness connector at the vacuum pump.
6. Test for less than 2 ohms between the vacuum pump ground circuit terminal 2 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.

7. Connect the harness connector at the vacuum pump.
8. Connect a 20A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87. Verify the vacuum pump is activated.
    - If the vacuum pump does not activate, test the control circuit for a short ground or an open/high resistance. If the circuit tests normal, test or replace the vacuum pump.
9. Ignition OFF, test for infinite resistance between the control circuit terminal 85 and ground.
    - If less than the specified value, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.
10. Disconnect the X1 harness connector at the ECM.
11. Test for less than 2 ohms between the control circuit terminal 85 at the relay cavity and terminal 18 at the ECM harness connector.
    - If greater than the specified range, test the control circuit for an open/high resistance.
12. If all circuits test normal, replace the brake booster pump relay. If the DTC resets, replace the power brake booster vacuum pump.

Component Testing

1. Ignition OFF, disconnect the vacuum pump relay.
2. Test for 60-180 ohms between terminals 85 and 86.
    - If the resistance is not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
    - 30 and 85
    - 30 and 87
    - 30 and 86
    - 86 and 87
        - If not the specified value, replace the relay.
4. Install a 30A fused jumper wire between relay terminal 86 and B+. Install a jumper wire between relay terminal 85 and ground.
5. Test for less than 2 ohms between terminals 30 and 87.
    - If greater than the specified range, replace the relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Power Brake Booster Auxiliary Pump Replacement**
- **Control Module References** for ECM replacement, setup, and programming

SYMPTOMS - HYDRAULIC BRAKES

IMPORTANT: The following steps must be completed before using the symptom tables.

1. Perform **Diagnostic System Check - Vehicle** before using the brake indicator symptom tables in order to

verify that all of the following are true:

- There are no DTCs set.
- The control module(s) can communicate via the serial data link.

2. Perform the **Brake System Vehicle Road Test** before using the hydraulic brake symptom tables in order to duplicate the customer's concern.
3. Review the system operation in order to familiarize yourself with the system functions. Refer to the following:
   - **Brake Warning System Description and Operation**
   - **Hydraulic Brake System Description and Operation**
   - **Brake Assist System Description and Operation**
   - **Disc Brake System Description and Operation**
   - **Brake Booster Vacuum Assist Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the brake warning system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Brake Warning Indicator Malfunction (Without UJ1)**
- **Brake Pulsation**
- **Brake System Noise**
- **Braking Action Uneven - Pulls to One Side**
- **Braking Action Uneven - Front to Rear**
- **Brake Pedal Excessive Travel**
- **Brake Pedal Excessive Effort**
- **DTC C027B - Auxiliary Brake Booster Pump Malfunction**
- **Brakes Drag**
- **Brake System Slow Release**
- **Brake Fluid Loss**

BRAKE WARNING INDICATOR MALFUNCTION (WITHOUT UJ1)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Fluid Level Signal	C0267 00	1	1	-
Park Brake Signal	1	1	1	-
Ground	-	1	-	-
1. Brake Warning Indicator Malfunction				

Circuit/System Description

The instrument panel cluster (IPC) sees the brake fluid level switch input opens and illuminates the Red Brake Warning indicator. The body control module (BCM) sees the park brake switch input grounded, it sends a serial data message to the IPC requesting illumination of the Red Brake Warning indicator.

Reference Information

Schematic Reference

Hydraulic Brake Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Brake Warning System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the park brake is released and the brake fluid is at or above the proper level.
   - If low, refer to **Brake Fluid Loss**.
2. Command the IPC display test with a scan tool, the warning indicator should turn ON.

- If the red brake warning indicator does not illuminate, replace the IPC.

3. Ignition ON, observe the scan tool BCM Park Brake Switch parameter while applying and releasing the park brake. The parameter should cycle between Applied and Release.
    - If the parameter does not cycle between the specified values, refer to Park Brake Switch Malfunction.
4. Observe the scan tool IPC Brake Fluid parameter. The reading should be OK.
    - If not the specified value, refer to Brake Fluid Level Switch Malfunction.

Circuit/System Testing

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the park brake switch.
2. Ignition ON, verify the scan tool BCM Park Brake Switch parameter is Released.
    - If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the BCM.
3. Install a 3A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool BCM Park Brake Switch parameter is Applied.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance.
4. If all circuits test normal, test or replace the park brake switch.

Brake Fluid Level Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for less than 1 ohm between the ground circuit terminal A and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool IPC Brake Fluid parameter is Ok.
    - If not the specified value, test the signal circuit for a short to ground. If the circuit tests normal, replace the IPC.
4. Install a 3A fused jumper wire between the signal circuit terminal B and ground. Verify the scan tool IPC Brake Fluid parameter is Low.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the IPC.
5. If all circuits test normal, test or replace the brake fluid level switch.

Component Testing

Park Brake Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the park brake switch.
2. Test for infinite resistance between the signal terminal A and ground with the park brake released.
    - If less than the specified value, replace the park brake switch.
3. Test for less than 1 ohm between the signal terminal A and ground with the park brake applied.
    - If greater than the specified range, replace the park brake switch.

Brake Fluid Level Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the brake fluid level switch.
2. Test for infinite resistance between the ground terminal A and the signal terminal B.
    - If less than the specified value, replace the brake fluid level switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Brake Fluid Level Indicator Switch Replacement**
- **Parking Brake Indicator Switch Replacement**
- **Control Module References** for BCM and IPC replacement, setup, and programming

BRAKE PULSATION

Step	Action	Yes	No
DEFINITION: Fluctuation or pulsation is felt through the brake pedal, steering wheel, seat, floor, and/or in the vehicle ONLY when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**
2	1. Inspect the disc brake system for the following conditions. • Excessive thickness variation of rotor friction surfaces • Excessive assembled lateral runout (LRO) of rotor friction surfaces • Hard spots, heat checks, bluing discoloration of rotor friction surfaces; possibly due to brake drag • Excessive corrosion of rotor friction surfaces; including red, gray or black oxidation • Loose, damaged or missing caliper or lining hardware • Bent or damaged caliper or mounting component • Excessive LRO of wheel hub/axle flange; due to damage and/or loose or excessively worn bearings 2. Adjust, repair or replace components as necessary. Refer to **Disc Brake System Diagnosis**. Did you find and correct a condition?	Go to **Step 3**	Go to **Symptoms - Hydraulic Brakes**

Step	Action	Yes	No
3	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to **Brake System Vehicle Road Test**. Is the condition still present?	Go to **Step 2**	System OK

BRAKE SYSTEM NOISE

Step	Action	Yes	No
DEFINITION: Vehicle exhibits abnormal noise when braking; vehicle may exhibit abnormal noise during motion just after brake pedal release.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**
2	1. Inspect the disc brake system for the following conditions. • Lining wear indicator contact with rotor • Debris trapped between rotor and splash shield or backing plate; and/or debris trapped between rotor and linings • Contaminated linings • Aftermarket linings • Glazed linings • Distorted, cracked or damaged linings • Excessively worn linings • Damaged or excessively worn caliper hardware and/or lining hardware • Incorrectly installed, loose or missing caliper hardware and/or lining hardware • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Bent or damaged splash shield or backing plate • Hard spots, heat checks, blueing discoloration of rotor friction surfaces • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to **Disc Brake System Diagnosis**.	Go to **Step 9**	Go to **Step 3**

Step	Action	Yes	No
	Did you find and correct a condition?		
3	1. Inspect the brake assist system for the following conditions. • Lack of lubrication or excessively worn pushrod or pedal pivots or pivot bushings • Bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating vacuum booster and/or check valve, if equipped • Low power steering fluid level, if equipped with hydraulic boost • Improperly tensioned, excessively worn or damaged power steering belt, if equipped with hydraulic boost • Restricted return hose from hydraulic booster, if equipped • Improperly operating hydraulic booster, if equipped • Improperly functioning power steering system, if equipped with a hydraulic booster assembly • Contaminated power steering fluid, if equipped with hydraulic boost 2. Adjust, repair or replace components as necessary. Refer to **Brake Assist System Diagnosis**. Did you find and correct a condition?	Go to **Step 9**	Go to **Step 4**
4	1. Inspect the hydraulic brake system for the following conditions. • Improper operation of caliper pistons • Contaminated brake fluid 2. Adjust, repair or replace components as necessary. Refer to **Hydraulic Brake System Diagnosis**. Did you find and correct a condition?	Go to **Step 9**	Go to **Step 5**
5	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to **Step 6**	Go to **Step 9**
6	Ensure the park brake shoes are not adjusted too tightly, possibly causing a noise under certain conditions. Are the park brake shoes adjusted too tightly?	Go to **Step 7**	Go to **Step 9**
7	1. Clean and inspect the park brake shoes for excessive wear and/or damage.	Go to **Step 9**	Go to **Step 8**

Step	Action	Yes	No
	2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration, heat spots, and excessive radial runout. 3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. Did you find and correct a condition?		
8	Inspect the park brake system for proper operation. Refer to **Park Brake System Diagnosis** . Did you find and correct a condition?	Go to **Step 9**	Go to **Symptoms - Hydraulic Brakes**
9	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to **Brake System Vehicle Road Test**. Is the condition still present?	Go to **Step 2**	System OK

BRAKING ACTION UNEVEN - PULLS TO ONE SIDE

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4

Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

5

Steering components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

Step	Action	Yes	No
DEFINITION: Vehicle pulls to one side only when braking.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**
2	1. Inspect the hydraulic brake system for the following conditions. • Kinked, pinched or damaged brake pipe or flexible brake hose • Sticking or improperly operating caliper piston	Go to **Step 6**	Go to **Step 3**

Step	Action	Yes	No
	• Brake fluid leak 2. Adjust, repair or replace components as necessary. Refer to **Hydraulic Brake System Diagnosis**. Did you find and correct a condition?		
3	1. Inspect the disc brake system for the following conditions. • Contaminated linings • Glazed linings • Distorted, cracked or damaged linings on one side • Loose, damaged or missing caliper hardware and/or lining hardware • Incorrect linings on one side • Hard spots, heat checks, blueing discoloration of rotor friction surfaces; possibly due to brake drag • Glazed rotor friction surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to **Disc Brake System Diagnosis**. Did you find and correct a condition?	Go to **Step 6**	Go to **Step 4**
4	1. Inspect the suspension system for the following conditions. • Incorrect tire pressures • Loose suspension component connections • Excessively worn or damaged suspension components 2. Adjust, repair or replace components as necessary. Refer to **Symptoms - Suspension General Diagnosis** . Did you find and correct a condition?	Go to **Step 6**	Go to **Step 5**
5	1. Inspect the steering system for the following conditions. • Loose steering component connections • Excessively worn or damaged steering components 2. Adjust, repair or replace components as necessary.	Go to **Step 6**	Go to **Symptoms - Hydraulic Brakes**

Step	Action	Yes	No
	Did you find and correct a condition?		
6	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to **Brake System Vehicle Road Test**. Is the condition still present?	Go to **Step 2**	System OK

BRAKING ACTION UNEVEN - FRONT TO REAR

Test Descriptions

The number below refers to the step number on the diagnostic table.

4

Suspension components that are not operating properly may cause a disturbance to the vehicle during application of the brake system.

Step	Action	Yes	No
DEFINITION: Braking action or stopping force sensitive or grabbing and/or more pronounced at the front or at the rear axle. Sensitive or grabbing brakes: Excessive brake jump-in force relative to brake pedal input.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**
2	1. Inspect the hydraulic brake system for the following conditions: • Improper operation of caliper pistons • Kinked, pinched or damaged brake pipe or flexible brake hose • Brake fluid leak • Improperly functioning proportion valve, if equipped • Improper operation of dynamic rear proportion (DRP) system, if equipped 2. Adjust, repair or replace components as necessary. Refer to **Hydraulic Brake System Diagnosis**. Did you find and correct a condition?	Go to **Step 6**	Go to **Step 3**
3	1. Inspect the disc brake system for the following conditions: • Contaminated linings • Glazed linings	Go to **Step 6**	Go to **Step 4**

Step	Action	Yes	No
	• Distorted, cracked or damaged linings • Excessively worn linings • Aftermarket linings • Damaged or excessively worn caliper hardware and/or lining hardware • Hard spots, heat checks, blueing discoloration of rotor friction surfaces • Glazed rotor friction surfaces 2. Adjust, repair or replace components as necessary. Refer to **Disc Brake System Diagnosis**. Did you find and correct a condition?		
4	1. Inspect the suspension system for the following conditions: • Loose suspension component connections • Excessively worn or damaged suspension components 2. Adjust, repair or replace components as necessary. Refer to **Symptoms - Suspension General Diagnosis** . Did you find and correct a condition?	Go to **Step 6**	Go to **Step 5**
5	1. Inspect the brake assist system for the following conditions: • Binding, bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating vacuum booster, if equipped • Damaged or improperly operating hydraulic booster, if equipped 2. Adjust, repair or replace components as necessary. Refer to **Brake Assist System Diagnosis**. Did you find and correct a condition?	Go to **Step 6**	Go to **Symptoms - Hydraulic Brakes**
6	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to **Brake System Vehicle Road Test**. Is the condition still present?	Go to **Step 2**	System OK

BRAKE PEDAL EXCESSIVE TRAVEL

Step	Action	Yes	No
DEFINITION: Brake pedal travels further than expected to obtain firm pedal and/or firm pedal cannot be obtained, pedal fades away, or pedal is spongy.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**
2	Inspect the travel and feel of brake pedal applies. Perform the following: 1. Apply the brake pedal several times to fully deplete the power reserve. 2. With power reserve depleted, apply the brake pedal with light, steady pressure and hold for 15 seconds. Observe pedal travel and feel. 3. Apply the brake pedal with light, steady pressure, then without pumping the pedal, reduce pressure and reapply pressure several times. Observe pedal travel and feel for each apply. 4. Apply the brake pedal slowly, then release and apply the pedal quickly. Observe pedal travel and feel for each apply. Did you complete the brake pedal travel and feel inspections?	Go to **Step 3**	-

3	1. Inspect the hydraulic brake system for the conditions listed, based on the following symptoms observed during the pedal travel and feel inspections:
	• Pedal feel was spongy
	  • Air in hydraulic system
	  • External brake fluid leaks
	  • Soft, weak or damaged hydraulic hoses; expanding under pressure
	• Pedal fell away and/or traveled to or almost to floor
	  • External brake fluid leaks
	  • Poor brake fluid quality; low boiling point
	  • Internal brake fluid leaks; improperly functioning master cylinder
	• Pedal was somewhat firm then dropped slightly, or pedal rose with successive
		Go to **Step 8**	Go to **Step 4**

Step	Action	Yes	No
	applies, or pedal travel was different between slow and quick applies • Internal brake fluid leaks; improperly functioning master cylinder • Poor brake fluid quality; low boiling point • Pedal returned to rest slowly after any of the applies • Internally damaged flexible brake hoses; hindering fluid return • Binding caliper pistons • Internal brake fluid leaks; improperly functioning master cylinder 2. Repair or replace components as necessary. Refer to **Hydraulic Brake System Diagnosis**. 3. Re-inspect brake pedal apply travel and feel. Did you find and correct a condition?		
4	1. Inspect the disc brake system for the following conditions: • Cracked, excessively worn or damaged linings • Cracked, excessively worn or damaged rotors • Improperly operating, binding or damaged caliper hardware and/or lining hardware • Loose or missing caliper hardware and/or lining hardware • Excessive assembled lateral runout (LRO) of rotor friction surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to **Disc Brake System Diagnosis**. 3. Re-inspect brake pedal apply travel and feel. Did you find and correct a condition?	Go to **Step 8**	Go to **Step 5**
5	Inspect for proper brake pedal travel. Refer to **Brake Pedal Travel Measurement and Inspection**. Is the brake pedal travel distance within the acceptable limits?	Go to **Step 7**	Go to **Step 6**

Step	Action	Yes	No
6	1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. • For the brake pedal pushrod component inspection, refer to **Brake Pedal Pushrod Inspection**. • Inspect the brake pedal bushings for binding, excessive wear and/or damage and inspect the brake pedal for a misaligned, bent, and/or damaged condition. 2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?	Go to **Step 8**	Go to **Step 7**
7	1. Inspect the brake assist system for the following conditions: • Vacuum leaks and/or improperly operating check valve, if equipped with vacuum assist • Power steering fluid leaks, if equipped with hydraulic power assist • Damaged or improperly operating brake booster assembly 2. Adjust, repair or replace components as necessary. Refer to **Brake Assist System Diagnosis**. Did you find and correct a condition?	Go to **Step 8**	Go to **Symptoms - Hydraulic Brakes**
8	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to **Brake System Vehicle Road Test**. Is the condition still present?	Go to **Step 2**	System OK

BRAKE PEDAL EXCESSIVE EFFORT

Step	Action	Yes	No
DEFINITION: Brake pedal requires an increased amount of input from the driver to obtain good braking action and/or stopping distance is increased.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**
2	1. Inspect the brake assist system for the following conditions:	Go to **Step 5**	Go to **Step 3**

Step	Action	Yes	No
	• Vacuum leaks, if equipped with vacuum power assist • Power steering fluid leaks, if equipped with hydraulic power assist • Lack of lubrication, binding or excessively worn pushrod or pedal pivots or pivot bushings • Bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating brake booster assembly 2. Adjust, repair or replace components as necessary. Refer to **Brake Assist System Diagnosis**. Did you find and correct a condition?		
3	1. Inspect the hydraulic brake system for the following conditions: • Binding caliper pistons • Internally damaged flexible brake hoses; hindering fluid flow • External brake fluid leaks • Kinked or damaged flexible brake hoses and/or pipes • Internal brake fluid leaks; improperly operating master cylinder • Poor brake fluid quality; low boiling point 2. Adjust, repair or replace components as necessary. Refer to **Hydraulic Brake System Diagnosis**. Did you find and correct a condition?	Go to **Step 5**	Go to **Step 4**
4	1. Inspect the disc brake system for the following conditions: • Excessively worn linings • Glazed linings • Cracked, distorted or damaged linings • Contaminated linings • Binding, damaged or excessively worn caliper hardware and/or lining hardware • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Excessively worn or corroded rotor friction	Go to **Step 5**	Go to **Symptoms - Hydraulic Brakes**

Step	Action	Yes	No
	surfaces • Glazed rotor friction surfaces • Hard spots, heat checks, blueing discoloration of rotor friction surfaces 2. Adjust, repair or replace components as necessary. Refer to **Disc Brake System Diagnosis**. Did you find and correct a condition?		
5	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to **Brake System Vehicle Road Test**. Is the condition still present?	Go to **Step 2**	System OK

BRAKES DRAG

Step	Action	Yes	No
DEFINITION: Brake system does not fully release or has delayed release; vehicle motion may be hindered by brake system without applying brakes.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**
2	Is the vehicle equipped with an adjustable stop lamp switch and/or an adjustable cruise control release switch?	Go to **Step 3**	Go to **Step 4**
3	1. Inspect the stop lamp switch for proper adjustment to ensure that the brake pedal is fully releasing. 2. Inspect the cruise control release switch, if equipped, for proper adjustment to ensure that the brake pedal is fully releasing. Did you find and correct a condition?	Go to **Step 14**	Go to **Step 4**
4	Is the vehicle equipped with a drum-in-rotor type of park brake system?	Go to **Step 5**	Go to **Step 7**
5	Ensure the park brake shoes are not adjusted too tightly, possibly causing drag under certain conditions. Are the park brake shoes adjusted too tightly?	Go to **Step 6**	Go to **Step 7**
6	1. Clean and inspect the park brake shoes for excessive wear and/or damage. 2. Inspect the drum portion of the rotors for excessive wear, blueing discoloration and heat spots.	Go to **Step 14**	Go to **Step 7**

Step	Action	Yes	No
	3. If any of these conditions are present, replace the affected components. 4. Adjust the park brake system. Did you find and correct a condition?		
7	Inspect the park brake system for proper operation. Refer to **Park Brake System Diagnosis** . Did you find and correct a condition?	Go to **Step 14**	Go to **Step 8**
8	1. Inspect the disc brake system for the following conditions: • Binding, incorrectly installed or missing caliper hardware and/or lining hardware- Ensure free movement of linings and of caliper, if equipped with sliding type caliper • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Distorted or damaged linings • Damaged or excessively worn caliper hardware and/or lining hardware • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to **Disc Brake System Diagnosis**. Did you find and correct a condition?	Go to **Step 14**	Go to **Step 9**
9	1. Separate the brake booster pushrod from the brake pedal. 2. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition?	Go to **Step 11**	Go to **Step 10**
10	1. Inspect the pushrod for improper positioning and/or damage. Correctly position or replace the pushrod if necessary. 2. Inspect the brake pedal assembly for damage and replace if necessary. Did you complete the repair or replacement?	Go to **Step 14**	-
11	1. For vacuum boost systems, disconnect the vacuum check valve from the booster to relieve vacuum reserve. 2. Separate the master cylinder from the brake	Go to **Step 13**	Go to **Step 12**

Step	Action	Yes	No
	booster. Do not disconnect any brake pipes. 3. Inspect the brake corners to determine if the brake drag condition is still present. Do the brake corners still exhibit the brake drag condition?		
12	Replace the brake booster assembly. Did you complete the replacement?	Go to **Step 14**	-
13	1. Inspect the hydraulic brake system for the following conditions. • Improper operation of caliper pistons • Contaminated brake fluid • Internally damaged flexible brake hoses; hindering brake release • Damaged or improperly operating master cylinder 2. Adjust, repair or replace components as necessary. Refer to **Hydraulic Brake System Diagnosis**. Did you find and correct a condition?	Go to **Step 14**	Go to **Symptoms - Hydraulic Brakes**
14	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to **Brake System Vehicle Road Test**. Is the condition still present?	Go to **Step 2**	System OK

BRAKE SYSTEM SLOW RELEASE

Step	Action	Yes	No
DEFINITION: Brake system releases and returns to rest slowly; vehicle motion is hindered by brake system briefly after release of brake pedal.			
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**
2	1. Inspect the hydraulic brake system for the following conditions: • Improper operation of caliper pistons • Internally damaged flexible brake hoses; hindering brake release • Contaminated brake fluid • Damaged or improperly operating master cylinder	Go to **Step 5**	Go to **Step 3**

Step	Action	Yes	No
	2. Adjust, repair or replace components as necessary. Refer to **Hydraulic Brake System Diagnosis**. Did you find and correct a condition?		
3	1. Inspect the brake assist system for the following conditions: • Binding, bent or damaged pedal pushrod, pedal, or pedal bracket • Damaged or improperly operating vacuum booster, if equipped • Restricted return hose from hydraulic booster, if equipped • Damaged or improperly operating hydraulic booster, if equipped 2. Adjust, repair or replace components as necessary. Refer to **Brake Assist System Diagnosis**. Did you find and correct a condition?	Go to **Step 5**	Go to **Step 4**
4	1. Inspect the disc brake system for the following conditions: • Damaged or excessively worn caliper hardware and/or lining hardware • Distorted or damaged linings • Lack of lubrication or excessive corrosion on metal to metal contact surfaces • Bent or damaged caliper or mounting component 2. Adjust, repair or replace components as necessary. Refer to **Disc Brake System Diagnosis**. Did you find and correct a condition?	Go to **Step 5**	Go to **Symptoms - Hydraulic Brakes**
5	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle in order to confirm proper operation. Refer to **Brake System Vehicle Road Test**. Is the condition still present?	Go to **Step 2**	System OK

BRAKE FLUID LOSS

Step	Action	Yes	No
DEFINITION: Brake fluid level is low not related to lining wear.			

Step	Action	Yes	No
1	Were you sent here from the Hydraulic Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**
2	1. Inspect the following hydraulic brake system components for brake fluid leaks: • Flexible brake hose connections; threaded and bolted • Flexible brake hose crimp joints • Brake pipe fittings • Caliper piston seals • Wheel cylinder piston seals, if equipped • Master cylinder reservoir • Master cylinder reservoir low pressure hose, if equipped • Brake pressure modulator valve (BPMV) assembly, if equipped 2. Repair or replace components as necessary. Refer to **Hydraulic Brake System Diagnosis**. Did you find and correct a condition?	Go to **Step 8**	Go to **Step 3**
3	Is the vehicle equipped with a vacuum brake booster?	Go to **Step 4**	Go to **Step 6**
4	1. Disconnect the vacuum check valve from the booster to relieve vacuum reserve. 2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. 3. Inspect the rear of the master cylinder for a brake fluid leak. 4. Inspect for brake fluid in the vacuum brake booster. Did you find a brake fluid leak?	Go to **Step 5**	Go to **Symptoms - Hydraulic Brakes**
5	Replace the brake master cylinder and the vacuum brake booster. Did you complete the replacement?	Go to **Step 8**	-
6	1. Wipe clean the external surface of the master cylinder to hydraulic brake booster area, if equipped. 2. Separate the master cylinder from the hydraulic brake booster, if equipped. Do not disconnect any brake pipes. 3. Inspect the rear of the master cylinder for a brake fluid leak.	Go to **Step 7**	Go to **Symptoms - Hydraulic Brakes**

Step	Action	Yes	No
	Did you find a brake fluid leak?		
7	Replace the brake master cylinder. Did you complete the replacement?	Go to **Step 8**	-
8	1. Install or connect components that were removed or disconnected during diagnosis. 2. Road test the vehicle to confirm proper operation. Refer to **Brake System Vehicle Road Test**. Is the condition still present?	Go to **Step 2**	System OK

DISC BRAKE SYSTEM DIAGNOSIS

Test Description

The numbers below refer to the step numbers on the diagnostic table.

9

Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

10

Lubricant leaks from non-brake system components may come in contact with and contaminate brake system components.

12

Disc brake rotor shields/backing plates that come in contact with disc brake rotors may cause brake system noise.

15

Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

19

Disc brake rotor thickness variation that exceeds the maximum acceptable level can cause brake pulsation.

22

Disc brake rotor assembled lateral runout (LRO) that exceeds the maximum acceptable level can lead to thickness variation.

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the DISC brake system in order to determine if the DISC brake system is operating properly. You will be directed by the			

Step	Action	Yes	No
appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**
2	Visually inspect the disc brake pads for the following conditions: Refer to **Brake Pad Inspection** . • Lining thickness below specifications • Uneven and/or abnormal wear - edge-to-edge and/or side-to-side • Looseness or damage - including pad hardware • Evidence of contamination from an external substance Did you find any conditions to indicate a concern with any of the front and/or rear disc brake pads?	Go to **Step 3**	Go to **Step 12**
3	Are any of the front and/or rear disc brake pads contaminated?	Go to **Step 8**	Go to **Step 4**
4	Are any of the front and/or rear disc brake pads worn unevenly?	Go to **Step 7**	Go to **Step 5**
5	Are any of the front and/or rear disc brake pads and/or pad hardware loose or damaged?	Go to **Step 7**	Go to **Step 6**
6	1. Remove and inspect the worn disc brake pads for glazing, looseness, heat spots or damage. 2. Replace the worn disc brake pads as a complete axle set. Refer to **Front Disc Brake Pads Replacement** , and/or **Rear Disc Brake Pads Replacement** . Did you complete the inspection and replacement?	Go to **Step 12**	-
7	**CAUTION:** **Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible**	Go to **Step 12**	-

Step	Action	Yes	No
	brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. **NOTE:** **Do NOT disconnect the hydraulic brake flex hoses from the calipers.** 1. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support the calipers. Refer to **Front Brake Caliper Replacement** , and/or **Rear Brake Caliper Replacement** . 2. Inspect the disc brake caliper mounting bracket and the mounting/sliding hardware for the following conditions: Refer to **Front Disc Brake Mounting and Hardware Inspection** , and/or **Rear Disc Brake Mounting and Hardware Inspection** . • Binding or seized hardware • Worn, damaged or missing hardware components		

Step	Action	Yes	No
	• Loose, bent, cracked, or damaged caliper mounting bracket 3. Replace components as required. Refer to the following procedures, as required: • **Front Brake Caliper Bracket Replacement** • **Rear Brake Caliper Bracket Replacement** • **Front Brake Caliper Hardware Replacement** • **Rear Brake Caliper Hardware Replacement** 4. Replace the unevenly-worn, loose or damaged disc brake pads as a complete axle set. Refer to **Front Disc Brake Pads Replacement** , and/or **Rear Disc Brake Pads Replacement** . Did you complete the inspection and replacement?		
8	1. Inspect the disc brake calipers, brake hoses and brake pipes for evidence of an external brake fluid leak. 2. Replace any components found to be leaking brake fluid. Refer to the following procedures as required: • **Front Brake Caliper Overhaul** , or **Front Brake Caliper Replacement** • **Rear Brake Caliper Overhaul** , or **Rear Brake Caliper Replacement** • **Front Brake Hose Replacement** • **Rear Brake Hose Replacement** • **Brake Pipe Replacement** Did you find and correct the source of the leak causing contamination of the pads?	Go to **Step 11**	Go to **Step 9**
9	1. Inspect the wheel drive shaft outer seals for damage and evidence of a grease leak. 2. Replace any wheel drive shaft seal that is found to be leaking grease which may be the source of the contamination to the pads. Refer to **Wheel Drive Shaft Outer Joint and Boot Replacement (Without WL9)** **Wheel Drive Shaft Outer Joint and Boot Replacement**	Go to **Step 11**	Go to **Step 10**

Step	Action	Yes	No
	(With WL9) . Did you find and correct the source of the leak causing contamination of the pads?		
10	1. Inspect the automatic transmission cooling system lines, if equipped, for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 2. Inspect the power steering system hoses for damage and evidence of an external fluid leak which may be the source of the contamination to the pads. 3. Replace any components found to be leaking fluid which may be the source of the contamination to the pads. Did you find and correct the source of the leak causing contamination of the pads?	Go to **Step 11**	-
11	1. Clean the remaining disc brake system components to remove any traces of the contaminant. **CAUTION:** **Support the brake caliper with heavy mechanic wire, or equivalent, whenever it is separated from its mount and the hydraulic flexible brake hose is still connected. Failure to support the caliper in this manner will cause the flexible brake hose to bear the**	Go to **Step 12**	-

Step	Action	Yes	No
	weight of the caliper, which may cause damage to the brake hose and in turn may cause a brake fluid leak. **NOTE:** **Do NOT disconnect the hydraulic brake flex hoses from the calipers.** 2. Remove the front and/or rear disc brake calipers, as appropriate, from the mounting brackets and support the calipers. Refer to **Front Brake Caliper Replacement** , and/or **Rear Brake Caliper Replacement** . 3. Inspect the disc brake caliper mounting/sliding hardware for the following conditions: Refer to **Front Disc Brake Mounting and Hardware Inspection** , and/or **Rear Disc Brake Mounting and Hardware Inspection** . • Binding or seized hardware • Distorted, worn, damaged or missing hardware components 4. Replace the caliper mounting/sliding hardware components as required. Refer to **Front Brake Caliper Hardware Replacement** , and/or **Rear Brake Caliper Hardware Replacement** . 5. Replace the contaminated disc brake pads as a complete axle set. Refer to **Front Disc Brake Pads Replacement** , and/or **Rear Disc Brake Pads Replacement** . Did you complete the cleaning, inspection and replacement?		

Step	Action	Yes	No
12	Visually inspect each of the rear disc brake rotor shields/backing plates, if equipped, for evidence of contact with the brake rotors. Are any of the brake rotor shields/backing plates contacting the brake rotors?	Go to **Step 13**	Go to **Step 14**
13	Repair or replace the disc brake rotor shields/backing plates as required. Did you complete the repair or replacement?	Go to **Step 14**	-
14	1. Check the thickness of each of the disc brake rotors. **NOTE:** **Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.** 2. Make a determination for each brake rotor if the rotor can be REFINISHED and REMAIN ABOVE the minimum requirements. Refer to **Brake Rotor Thickness Measurement** .Does the disc brake rotor meet the minimum requirements for REFINISHING?	Go to **Step 15**	Go to **Step 18**
15	**NOTE:** **Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.** Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to **Brake Rotor Thickness Variation Measurement** .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?	Go to **Step 17**	Go to **Step 16**
16	1. Inspect each of the disc brake rotors for the following surface and wear conditions:	Go to **Step 17**	Go to **Step 22**

Step	Action	Yes	No
	Refer to **Brake Rotor Surface and Wear Inspection** . • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level **NOTE:** **Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.** 2. Make a determination for each brake rotor if the rotor requires refinishing based upon the results of the inspection. If the brake rotor exhibits any of the conditions listed previously, it requires refinishing. Does the brake rotor require REFINISHING?		
17	1. Refinish the brake rotor. Refer to **Brake Rotor Refinishing** . 2. Inspect the brake rotor thickness. Refer to **Brake Rotor Thickness Measurement** . Were you able to REFINISH the brake rotor within the minimum requirements?	Go to **Step 22**	Go to **Step 21**
18	Is the brake rotor at or below the DISCARD requirements (J55), or below the MINIMUM THICKNESS requirements, (JL9)?	Go to **Step 21**	Go to **Step 19**
19	**NOTE:** **Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH**	Go to **Step 21**	Go to **Step 20**

Step	Action	Yes	No
	rotor. Inspect each of the disc brake rotors for thickness variation that exceeds the maximum acceptable level. Refer to **Brake Rotor Thickness Variation Measurement** .Does the brake rotor exhibit thickness variation that exceeds the maximum acceptable level?		
20	1. Inspect each of the disc brake rotors for the following surface and wear conditions: Refer to **Brake Rotor Surface and Wear Inspection** . • Heavy rust and/or pitting • Cracks and/or heat spots • Excessive blueing discoloration • Deep or excessive scoring beyond maximum acceptable level **NOTE:** **Make the following determination AND ANSWER the question INDIVIDUALLY for EACH rotor.** 2. Make a determination for each brake rotor if the rotor requires replacement based upon the results of the inspection. If the brake rotor exhibits any of the conditions listed previously, it requires replacement. Does the brake rotor require REPLACEMENT?	Go to **Step 21**	Go to **Step 22**
21	**NOTE:** **Whenever a brake rotor is replaced, the assembled lateral runout (LRO) of the rotor**	Go to **Step 24**	-

Step	Action	Yes	No
	must be measured to ensure optimum performance of the disc brakes. Replace the brake rotor. Refer to **Front Brake Rotor Replacement** , or **Rear Brake Rotor Replacement** .Did you complete the replacement?		
22	**NOTE:** **Perform the following inspection AND ANSWER the question INDIVIDUALLY for EACH rotor.** Inspect each of the disc brake rotors for assembled lateral runout (LRO) that exceeds the maximum acceptable level. Refer to **Brake Rotor Assembled Lateral Runout Measurement** .Does the brake rotor exhibit assembled LRO that exceeds the maximum acceptable level?	Go to **Step 23**	Go to **Step 24**
23	Correct the LRO for each brake rotor that was determined to have LRO exceeding the maximum acceptable level. Refer to **Brake Rotor Assembled Lateral Runout Correction** . Did you complete the operation?	Go to **Step 24**	-
24	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Disc Brake System OK Return to Symptom Table	-

HYDRAULIC BRAKE SYSTEM DIAGNOSIS

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the HYDRAULIC brake system in order to determine if the HYDRAULIC brake system is operating properly. You will be directed by the appropriate Symptom Table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom Table?	Go to **Step 2**	Go to **Symptoms - Hydraulic Brakes**

Step	Action	Yes	No
2	Inspect and adjust the brake fluid level in the brake master cylinder. Refer to **Master Cylinder Reservoir Filling**. Was the brake fluid level low?	Go to **Step 3**	Go to **Step 4**
3	1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination: • Fluid separation (indicating 2 types of fluid are present) • Swirled appearance - oil-based substance • Layered appearance - silicone-based substance • Fluid discoloration • Cloudy appearance - moisture • Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust 2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. Do any of the above conditions exist?	Go to **Step 5**	Go to **Step 6**
4	1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination: • Fluid separation (indicating 2 types of fluid are present) • Swirled appearance - oil-based substance • Layered appearance - silicone-based substance • Fluid discoloration • Cloudy appearance - moisture • Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust 2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating fluid contamination. Do any of the above conditions exist?	Go to **Step 5**	Go to **Step 12**
5	1. Flush the hydraulic brake system. Refer to **Hydraulic Brake System Flushing**. 2. If the brake fluid WAS contaminated with an oil-based or a silicone-based fluid (indicated by fluid separation and/or a swollen master cylinder reservoir	Go to **Step 9**	-

Step	Action	Yes	No
	cap diaphragm and/or swollen reservoir-to-master cylinder grommets), perform the following: 1. Remove ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. 2. Clean out the hydraulic brake pipes using denatured alcohol (or equivalent). 3. Dry the brake pipes using non-lubricated, filtered air. 4. Repair or replace ALL of the following components listed. Each component contains internal rubber seals/linings which have been contaminated. • **Master Cylinder Overhaul**, or **Master Cylinder Replacement** ; also perform the following: Clean the brake master cylinder reservoir using denatured alcohol (or equivalent), then dry the reservoir using non-lubricated, filtered air, or if necessary, replace the brake master cylinder reservoir. Replace the brake master cylinder reservoir cap diaphragm. • **Front Brake Hose Replacement** • **Rear Brake Hose Replacement** • **Front Brake Caliper Overhaul** , or **Front Brake Caliper Replacement** . • **Rear Brake Caliper Overhaul** , or **Rear Brake Caliper Replacement** . • **Brake Pressure Modulator Valve Replacement** , if equipped. 3. If the brake fluid was NOT contaminated with an oil-based fluid, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm which may have allowed moisture or dirt to enter the system. 4. Refill and bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding**		

Step	Action	Yes	No
	(Manual)Hydraulic Brake System Bleeding (Pressure). Did you complete the operation and any required repairs and/or replacements?		
6	1. Inspect the following hydraulic brake system components for external fluid leaks; repair or replace any of the components found to be leaking brake fluid. Refer to the appropriate procedures: • **Master Cylinder Overhaul**, or **Master Cylinder Replacement** Brake master cylinder reservoir cap diaphragm • **Front Brake Hose Replacement** • **Rear Brake Hose Replacement** • **Brake Pipe Replacement** • **Front Brake Caliper Overhaul** , or **Front Brake Caliper Replacement** . • **Rear Brake Caliper Overhaul** , or **Rear Brake Caliper Replacement** . • **Brake Pressure Modulator Valve Replacement** , if equipped. 2. If you repaired or replaced any of the brake system components listed, bleed the hydraulic brake system. While bleeding the hydraulic brake system, observe for the following: Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)**. • The presence of air in the system at a bleeder valve location other than at the repair location (except if the brake master cylinder and/or the proportioning valves, if equipped [non-ABS], were replaced) • An unrestricted and even flow of brake fluid per axle (during the bleeding procedure) Did you find and correct a condition?	Go to **Step 7**	Go to **Step 12**

Step	Action	Yes	No
7	Was there air in the system at a bleeder valve location other than at the repair location, (except if the brake master cylinder and/or the proportioning valves, if equipped [non-ABS], were replaced)?	Go to **Step 19**	Go to **Step 8**
8	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to **Step 9**	Go to **Step 10**
9	Inspect the hydraulic function of the brake calipers for proper operation. Refer to **Hydraulic Brake Component Operation Visual Inspection**. Was the hydraulic function of the brake calipers operating properly?	Go to **Step 21**	Go to **Step 14**
10	Was the flow of brake fluid restricted or uneven through front axle hydraulic components during the bleeding procedure?	Go to **Step 13**	Go to **Step 11**
11	Was the flow of brake fluid restricted or uneven through rear axle hydraulic components during the bleeding procedure?	Go to **Step 17**	-
12	Inspect the hydraulic function of the brake calipers for proper operation. Refer to **Hydraulic Brake Component Operation Visual Inspection**. Was the hydraulic function of the brake calipers operating properly?	Go to **Step 15**	Go to **Step 13**
13	Determine if the brake caliper is restricting the flow of brake fluid and/or not operating properly: 1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** . 3. Open the suspected caliper bleeder valve. 4. Using a large C-clamp, compress the caliper piston and observe for an unrestricted flow of brake fluid and for free movement of the caliper piston. 5. Close the caliper bleeder valve. Was the flow of brake fluid unrestricted and did the caliper piston move freely?	Go to **Step 17**	Go to **Step 14**

Step	Action	Yes	No
14	Repair or replace any brake caliper that was not operating properly. Refer to the appropriate procedures. • **Front Brake Caliper Overhaul** , or **Front Brake Caliper Replacement** . • **Rear Brake Caliper Overhaul** , or **Rear Brake Caliper Replacement** . Did you complete the repair and/or replacement?	Go to **Step 21**	-
15	Bleed the hydraulic brake system to observe for the presence of air in the system and to observe for an unrestricted and even flow of brake fluid per axle (during the bleeding procedure). Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)**. Was there air in the system?	Go to **Step 19**	Go to **Step 16**
16	Was the flow of brake fluid unrestricted and even per axle during the bleeding procedure?	Go to **Step 21**	Go to **Step 17**
17	1. Inspect the hydraulic brake pipes and flexible brake hoses for signs of a fluid restriction; such as being bent, kinked, pinched or damaged. Refer to **Brake Pipe and Hose Inspection**. 2. Replace any of the hydraulic brake pipes and/or flexible brake hoses found to be bent, kinked, pinched or damaged. Refer to the following procedures as necessary: • **Front Brake Hose Replacement** • **Rear Brake Hose Replacement** • **Brake Pipe Replacement** 3. If none of the hydraulic brake pipes or flexible brake hoses were visibly bent, kinked, pinched, or damaged, replace the hydraulic brake flex hoses at the restricted location. Did you find and correct a condition?	Go to **Step 21**	Go to **Step 18**
18	If equipped with Antilock Brakes, replace the brake pressure modulator valve (BPMV), in order to correct the hydraulic brake dynamic rear proportioning mechanical operation. Refer to **Brake Pressure Modulator Valve Replacement** . Did you complete the replacement?	Go to **Step 21**	-
19	1. Inspect the hydraulic brake system components for brake fluid seepage at a seal and/or fitting location,	Go to **Step 21**	Go to **Step 20**

Step	Action	Yes	No
	which may have drawn air into the system. 2. Inspect the hydraulic brake system components for evidence of a recent repair, which may have introduced air into the system. 3. Repair or replace any of the components found to be installed incorrectly or seeping brake fluid. Did you find and correct a condition?		
20	1. Inspect the brake master cylinder for internal fluid leaks. Refer to **Brake System Internal Leak Test**. 2. Repair or replace the brake master cylinder if it is found to be leaking brake fluid internally. Refer to **Master Cylinder Overhaul**, or **Master Cylinder Replacement**. Did you find and correct a condition?	Go to **Step 21**	Return to Symptom Table
21	Install or connect components that were removed or disconnected during diagnosis. Did you complete the operation?	Hydraulic Brake System OK Return to Symptom Table	-

BRAKE ASSIST SYSTEM DIAGNOSIS

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the components of the brake ASSIST system in order to determine if the brake ASSIST system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Brake Symptom table?	Go to **Step 3**	Go to **Step 2**
2	Were you sent here directly from an electrical diagnostic to investigate vacuum as a possible concern?	Go to **Step 5**	Go to **Diagnostic Starting Point - Vehicle**
3	Inspect for proper brake pedal travel. Refer to **Brake Pedal Travel Measurement and Inspection**. Is the brake pedal travel distance within the acceptable limits?	Go to **Step 5**	Go to **Step 4**
4	1. Inspect for worn, missing, misaligned, bent or damaged brake pedal system components. • For the brake pedal pushrod component inspection, refer to **Brake Pedal Pushrod Inspection**. • Inspect the brake pedal bushings for excessive wear and/or damage and inspect the brake pedal for a misaligned, bent and/or damaged condition.	Go to **Step 5**	Go to **Hydraulic Brake System Diagnosis** to check for internal and external fluid leaks and air in the hydraulic brake system

Step	Action	Yes	No
	2. Replace the brake pedal system components that are worn, missing, misaligned, bent or damaged. Did you find and replace any worn, missing, misaligned, bent or damaged brake pedal system components?		
5	Check the engine vacuum source that supplies vacuum to the vacuum brake booster. Refer to **Brake System Vacuum Source Test**. Is the vacuum reading within the acceptable limits?	Go to **Step 6**	Go to Engine Controls Diagnostics Information to check for vacuum issues, including vacuum pump operation, if equipped
6	Does the condition occur during cold start-up conditions?	Go to **Step 7**	Go to **Step 8**
7	Check engine vacuum, and vacuum pump operation, if equipped, under the same cold start-up conditions. Refer to **Auxiliary Brake Booster Pump Malfunction - DTC C027B**. Did you find and correct a condition?	Go to **Step 22**	Go to **Step 9**
8	During the vacuum source test, did the vacuum booster check valve operate properly?	Go to **Step 10**	Go to **Step 9**
9	Replace the vacuum booster check valve. Refer to **Power Brake Booster Vacuum Check Valve and Hose Replacement**. Did you complete the replacement?	Go to **Step 10**	-
10	If equipped with a booster mounted separate vacuum sensor, inspect the vacuum sensor grommet for cracks, cuts, dry-rot, or damage. Does the vacuum sensor grommet exhibit any of the conditions listed?	Go to **Step 11**	Go to **Step 12**
11	Replace the vacuum sensor grommet. Did you complete the replacement?	Go to **Step 12**	-
12	1. If the vehicle is equipped with a vacuum sensor, install a scan tool. 2. Using the Data Display function, determine if brake booster vacuum sensor data is available within either the chassis brake controls area or the powertrain engine controls area. Is vacuum sensor data available through the scan tool?	Go to **Step 13**	Go to **Step 16**
13	Perform the vacuum booster leak-down test using a scan tool: 1. Release the brake pedal.	Go to **Step 18**	Go to **Step 14**

Step	Action	Yes	No
	2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Turn the ignition ON. Do not start the engine. 5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds. **NOTE:** **Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level.** 6. Determine the rate of vacuum leak. **Specification** Maximum allowable vacuum leak rate: 10 kPa (3 in Hg) in 60 seconds Was the rate of vacuum leak within the specified allowable range?		
14	1. Deplete the vacuum reserve by pressing the brake pedal several times, or by removing the vacuum booster check valve. 2. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Refer to **Master Cylinder Replacement**. 3. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder. Replace the vacuum seal as necessary. 4. Carefully reinstall the master cylinder to the brake booster. Refer to **Master Cylinder Replacement**.	Go to **Step 15**	-

Step	Action	Yes	No
	Did you complete the operation?		
15	Perform the vacuum booster leak-down test using a scan tool: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000 RPM, then release the throttle. Wait 2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Turn the ignition ON. Do not start the engine. 5. Observe and record the vacuum sensor reading on the scan tool over a period of 60 seconds. **NOTE:** **Vacuum readings will decrease by approximately 2.7 kPa (0.8 Hg) for every 305 m (1000 ft) of elevation above sea level.** 6. Determine the rate of vacuum leak. **Specification** Maximum allowable vacuum leak rate: 10 kPa (3 in Hg) in 60 seconds Was the rate of vacuum leak within the specified allowable range?	Go to **Step 22**	Go to **Step 21**
16	1. Separate the master cylinder from the vacuum brake booster. Do not disconnect any brake pipes. Before removing the master cylinder, first deplete the vacuum by removing the check valve or applying the brake pedal several times. Refer to **Master Cylinder Replacement**. 2. If equipped with a vacuum seal on the rear of the master cylinder, inspect the seal for damage and correct positioning on the master cylinder.	Go to **Step 17**	Go to **Step 18**

Step	Action	Yes	No
	3. If equipped with a vacuum seal that is part of the booster, inspect the seal for damage. Does the vacuum seal exhibit any of the conditions listed?		
17	1. If equipped with a vacuum seal on the rear of the master cylinder, replace the vacuum seal as necessary. Ensure the seal is positioned correctly during installation. 2. If equipped with a vacuum seal that requires replacement and which is part of the booster, the booster assembly must be replaced. 3. Carefully reinstall the master cylinder to the brake booster. Refer to **Master Cylinder Replacement**. Did you complete the replacement?	Go to **Step 18**	-
18	Perform the vacuum boost functional test: 1. If still separated, reinstall the master cylinder to the booster. Refer to **Master Cylinder Replacement**. 2. If the engine was started after reinstalling the master cylinder to the booster, perform the following: With the engine OFF, depress the brake pedal several times to deplete the vacuum reserve. 3. Depress and maintain moderate foot pressure on the brake pedal. 4. Start the engine and observe pedal operation. 5. Observe for audible vacuum leaks. The brake pedal should fall slightly, then hold. Is there an audible vacuum leak coming from the brake pedal area?	Go to **Step 21**	Go to **Step 19**
19	Did the brake pedal fall slightly after the engine was started, then hold?	Go to **Step 20**	Go to **Step 21**
20	Perform the vacuum booster leak-down test: 1. Release the brake pedal. 2. Accelerate the engine to approximately 3000	Go to **Step 22**	Go to **Step 21**

Step	Action	Yes	No
	RPM, then release the throttle. Wait 2-3 seconds and repeat once. 3. Turn the ignition OFF. 4. Wait 60 seconds. 5. Depress the brake pedal 2 times to check for vacuum booster available vacuum reserve. Observe pedal effort. • Both pedal applies should be assisted • The amount of assist could diminish slightly with the second apply Were both pedal applies power assisted?		
21	Replace the vacuum brake booster. Refer to **Power Vacuum Brake Booster Replacement**. Did you complete the replacement?	Go to **Step 22**	-
22	Install or connect any components that were removed or disconnected during diagnosis. Did you complete the operation?	Brake Assist System OK Return to Symptom Table	-

BRAKE SYSTEM VEHICLE ROAD TEST

Preliminary Inspections

1. Visually inspect easily accessible brake system components for obvious damage and/or leaks which may indicate that the vehicle should not be driven until further inspections have been completed.
2. Inspect the brake master cylinder reservoir fluid level and adjust only if necessary for brake system road testing. Refer to **Master Cylinder Reservoir Filling**.
3. Inspect the tire inflation pressures and adjust as necessary.
4. Inspect the tire tread patterns to ensure that they are the same or very similar, especially per axle.
5. Ensure that the vehicle is not loaded unevenly prior to brake system road testing.

Road Testing Procedure

WARNING: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

1. Start the engine and allow it to idle.
2. Check to see if the brake system warning lamp remains illuminated.
3. If the brake system warning lamp remains illuminated, DO NOT proceed to test drive the vehicle until it is diagnosed and repaired. Refer to **Symptoms - Hydraulic Brakes**.
4. Select a smooth, dry, clean and level road or large lot that is as free of traffic and obstacles as possible for

brake system low speed road testing.

5. With the transmission in PARK, lightly apply the brake pedal. Observe both the pedal feel and the pedal travel.
6. If the brake pedal apply felt spongy, or the pedal travel was excessive, DO NOT drive the vehicle until it is repaired.
7. If the brake pedal apply did not feel spongy and the pedal travel was not excessive, proceed to step 8.
8. Release and apply the brakes.
9. While continuing to apply the brakes, shift the transmission into DRIVE, release the brakes and allow the engine to idle the vehicle away from the stopped position. Observe for a slow release of the brake system.
10. With the aid of an assistant to observe the vehicle's performance from outside of the vehicle, drive the vehicle at a low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to them, while you observe both the pedal effort and the pedal travel.
11. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
12. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 13.
13. Drive the vehicle in the opposite direction, at the same low speed and lightly apply the brakes while driving past the assistant. Have the assistant observe for brake system noise from the side of the vehicle closest to him.
14. Drive the vehicle at a low speed and shift the transmission into NEUTRAL without applying the brakes. Observe for a rapid deceleration in vehicle speed, indicating possible brake drag.
15. Select a smooth, dry, clean and level road that is as free of heavy traffic as possible for brake system moderate speed road testing.
16. Drive the vehicle at a moderate speed. Observe for a pull and/or incorrect tracking of the vehicle without the brakes applied.
17. While continuing to drive the vehicle at a moderate speed, perform several light applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system noise, pulsation and/or brake drag.
18. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.
19. If the brake pedal apply effort was not excessive and the pedal travel was not excessive, proceed to step 20.
20. While continuing to drive the vehicle at a moderate speed, perform several moderate applies of the brakes. Observe the pedal effort and the pedal travel, observe for brake system pulsation and/or uneven braking action - either side to side, or front to rear.

    A small amount of vehicle front end dip is expected during a moderate apply of the brakes.

21. If the brake pedal apply effort was excessive, or the pedal travel was excessive, DO NOT continue to test drive the vehicle until it is repaired.

BRAKE PEDAL TRAVEL MEASUREMENT AND INSPECTION

Tools Required

J 28662 Brake Pedal Effort Gage Brake Pedal Effort Gauge

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal becomes firm, in order to deplete the brake booster power reserve.
2. Install the **J 28662** brake pedal effort gage to the brake pedal.

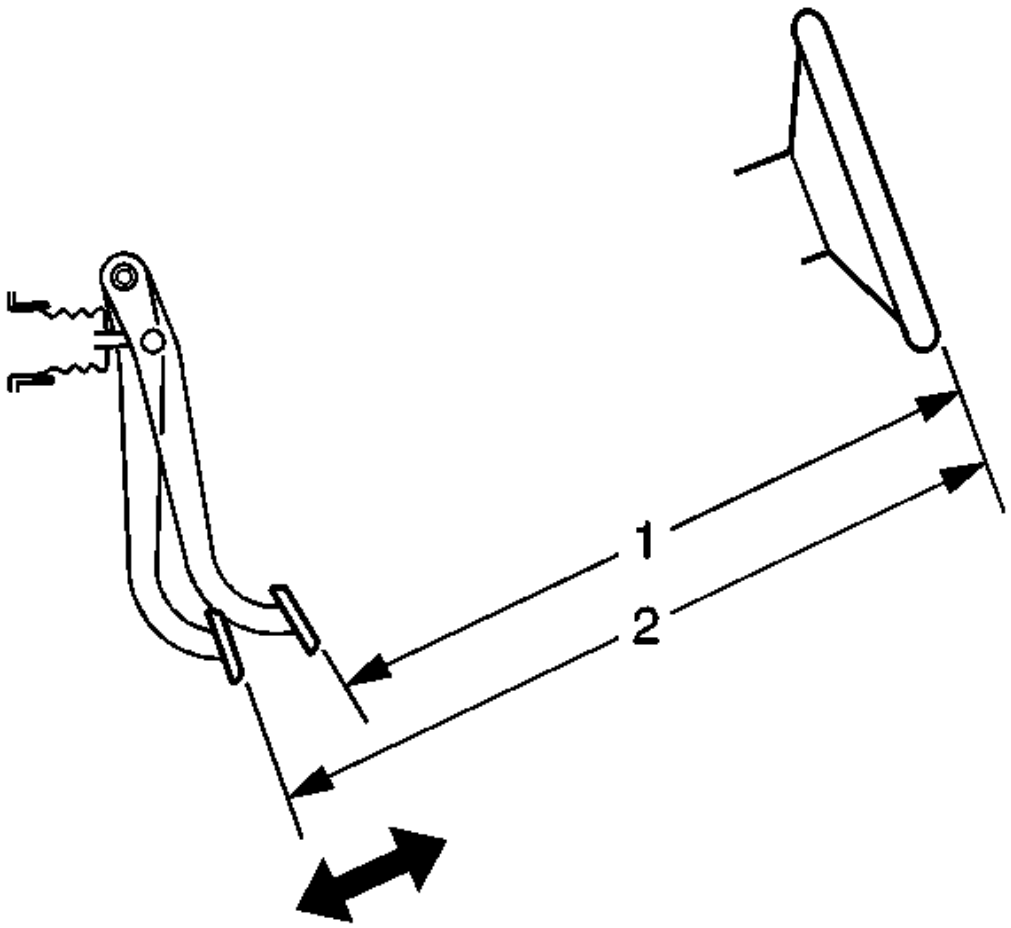


Fig. 2: Measuring Brake Pedal Travel
Courtesy of GENERAL MOTORS COMPANY

3. Measure and record the distance (1) from the brake pedal to the rim of the steering wheel; note the points of measurement.
4. Apply and maintain the brakes with 445 N (100 lb) of force to the brake pedal, as indicated on the **J 28662** brake pedal effort gage.
5. While maintaining 445 N (100 lb) of force to the brake pedal, measure and record the distance (2) from the same point on the brake pedal to the same point on the rim of the steering wheel.
6. Release the brakes and repeat steps 4 and 5 to obtain a second measurement. After obtaining a second measurement, proceed to step 7.
7. Average the first and second measurements recorded during the two applies of the brakes.
8. Subtract the initial measurement, unapplied (1), from the averaged, applied measurement (2) to obtain the

brake pedal travel distance.

Specification

Maximum brake pedal travel (measured with the ignition OFF, brake booster power assist depleted, and the brakes cool): 74 mm (2.91 in).

BRAKE SYSTEM VACUUM SOURCE TEST

NOTE:

- **Engine temperature, accessory load, and elevation level will affect engine vacuum.**
- **Vacuum readings will decrease by approximately 2.7 kPa (0.8 in Hg) for every 305 m (1000 ft) of elevation above sea level.**

1. Disconnect the engine vacuum hose from the vacuum brake booster check valve.
2. Install a vacuum gauge to the engine vacuum hose.
3. Start the engine and allow the engine to idle until normal operating temperatures are reached.
4. With the vehicle in PARK, the engine idling, and the air conditioning (A/C) system OFF, check to see if the engine vacuum reading is within the specified normal engine vacuum range.

   Specification

   47-68 kPa (14-20 in Hg)

5. Turn the ignition OFF.
6. If the engine vacuum reading was within the specified normal range, proceed to step 10.
7. If the engine vacuum reading was NOT within the specified normal range, inspect the engine vacuum hose for the following conditions:
   - Loose connection to the engine
   - Collapse, deformation or contamination
   - Cracks, cuts, dry-rot
8. If any of these conditions were found with the engine vacuum hose, replace the hose, then repeat steps 2-4.
9. If none of these conditions were found with the engine vacuum hose, then there is an engine vacuum source problem, check the engine vacuum system.
10. Remove the vacuum brake booster check valve from the booster.
11. Install the check valve to the engine vacuum hose.
12. Install the vacuum gauge to the check valve.
13. Start the engine and allow the engine to idle in PARK with the A/C system OFF, until normal operating temperatures are reached.
14. Turn the ignition OFF.
15. Check to see if the engine vacuum reading is maintained within the specified normal engine vacuum range.

Specification

47-68 kPa (14-20 in Hg)

16. If the engine vacuum reading is maintained within the specified normal range, proceed to step 18.
17. If the engine vacuum reading is NOT maintained within the specified normal range, replace the brake booster check valve, then repeat steps 11-15.
18. Inspect the brake booster check valve grommet for the following conditions:
    - Loose connection to the vacuum brake booster
    - Deformation or contamination
    - Cracks, cuts, dry-rot
19. If any of these conditions were found with the check valve grommet, replace the grommet.

BRAKE SYSTEM EXTERNAL LEAK INSPECTION

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. In order to inspect for external brake fluid leaks, first check the fluid level in the master cylinder.

   While a slight brake fluid level drop can be considered a normal condition due to brake lining wear, a very low level may indicate a brake fluid leak in the hydraulic system.

2. If the fluid level is abnormally low, adjust the brake fluid level. Refer to **Master Cylinder Reservoir Filling**.
3. Start the engine and allow it to idle.
4. Apply constant, moderate foot pressure to the brake pedal.

   If the brake pedal gradually falls away while under foot pressure, there may be a brake fluid leak.

5. Turn OFF the ignition.
6. Visually inspect the following brake system components for brake fluid leaks, excessive corrosion, and damage. Give particular attention to all brake pipe and flexible hose connections to ensure that there are not any slight brake fluid leaks - even though the brake pedal may feel firm and hold steady:
   - Master cylinder brake pipe fittings
   - All brake pipe connections
   - Brake pipes
   - Brake hoses and connections
   - Brake calipers and/or wheel cylinders, if equipped
7. While slight dampness around the master cylinder reservoir can be considered acceptable, brake fluid leaking from any of the brake system components requires immediate attention. If any of these components exhibit signs of brake fluid leakage, repair or replace those components. After the repair or replacement, reinspect the hydraulic brake system to assure proper function.

BRAKE SYSTEM INTERNAL LEAK TEST

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Start the engine and allow it to idle.
2. Apply light, steady pressure to the brake pedal. Observe both the brake pedal feel and travel.
3. Release the brakes and turn OFF the ignition.
4. If the brake pedal apply felt spongy, but the brake pedal travel was not excessive, perform the following steps:
    1. Inspect the brake system for external leaks. Refer to **Brake System External Leak Inspection**.
    2. Pressure bleed the brake system in order to purge any air that may be trapped in the system. Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)**.

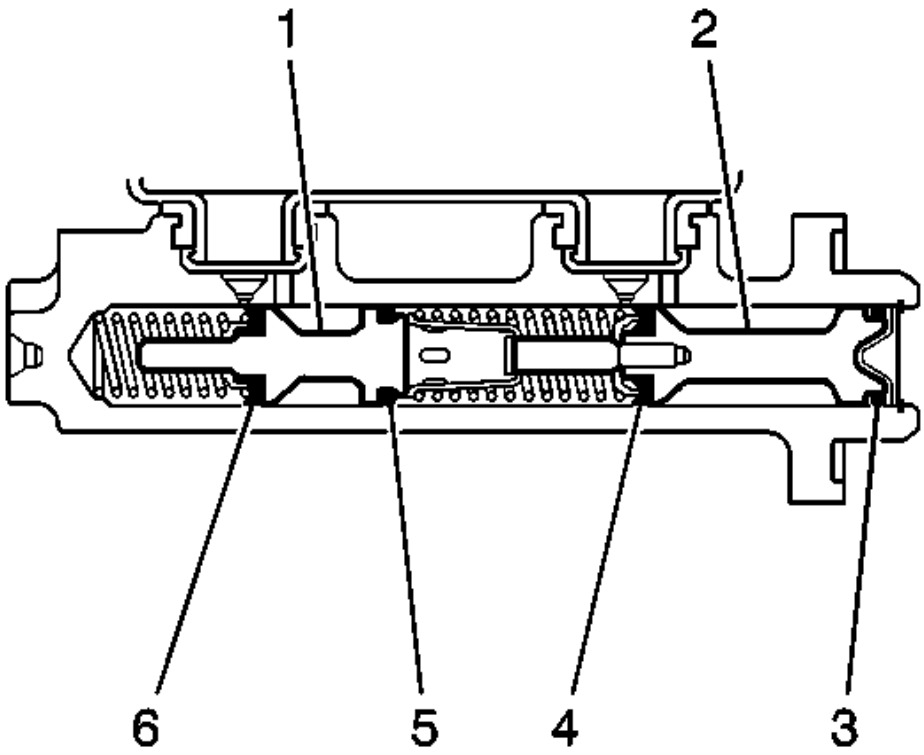


Fig. 3: Identifying Brake Master Cylinder (Cross Sectional View)
Courtesy of GENERAL MOTORS COMPANY

5. If the brake pedal apply did not feel spongy, but the brake pedal travel was excessive, perform the

following steps:

1. Loosen the master cylinder-to-brake power booster mounting nuts.
2. Carefully pull the master cylinder away from the brake power booster just enough to inspect the mounting surface of the master cylinder.
3. Inspect the master cylinder mounting surface at the primary piston (2) for brake fluid leaks.

6. If the master cylinder exhibits any leakage around the primary piston (2), then the primary piston primary seal (4) and/or secondary seal (3) is leaking and the master cylinder requires overhaul or replacement.
7. If the master cylinder primary piston (2) does not exhibit any leakage, pressure bleed the brake system. Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)**.
8. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not excessive, but then gradually fell, then the master cylinder requires overhaul or replacement due to an internal leak past the secondary piston (1) from the secondary piston primary seal (6) or secondary seal (5).
9. If the brake pedal apply did not feel spongy, and the brake pedal travel was initially steady and not excessive, then fell slightly, then became steady again, then the brake pressure modulator valve (BPMV) may be leaking internally, and may require replacement.

HYDRAULIC BRAKE COMPONENT OPERATION VISUAL INSPECTION

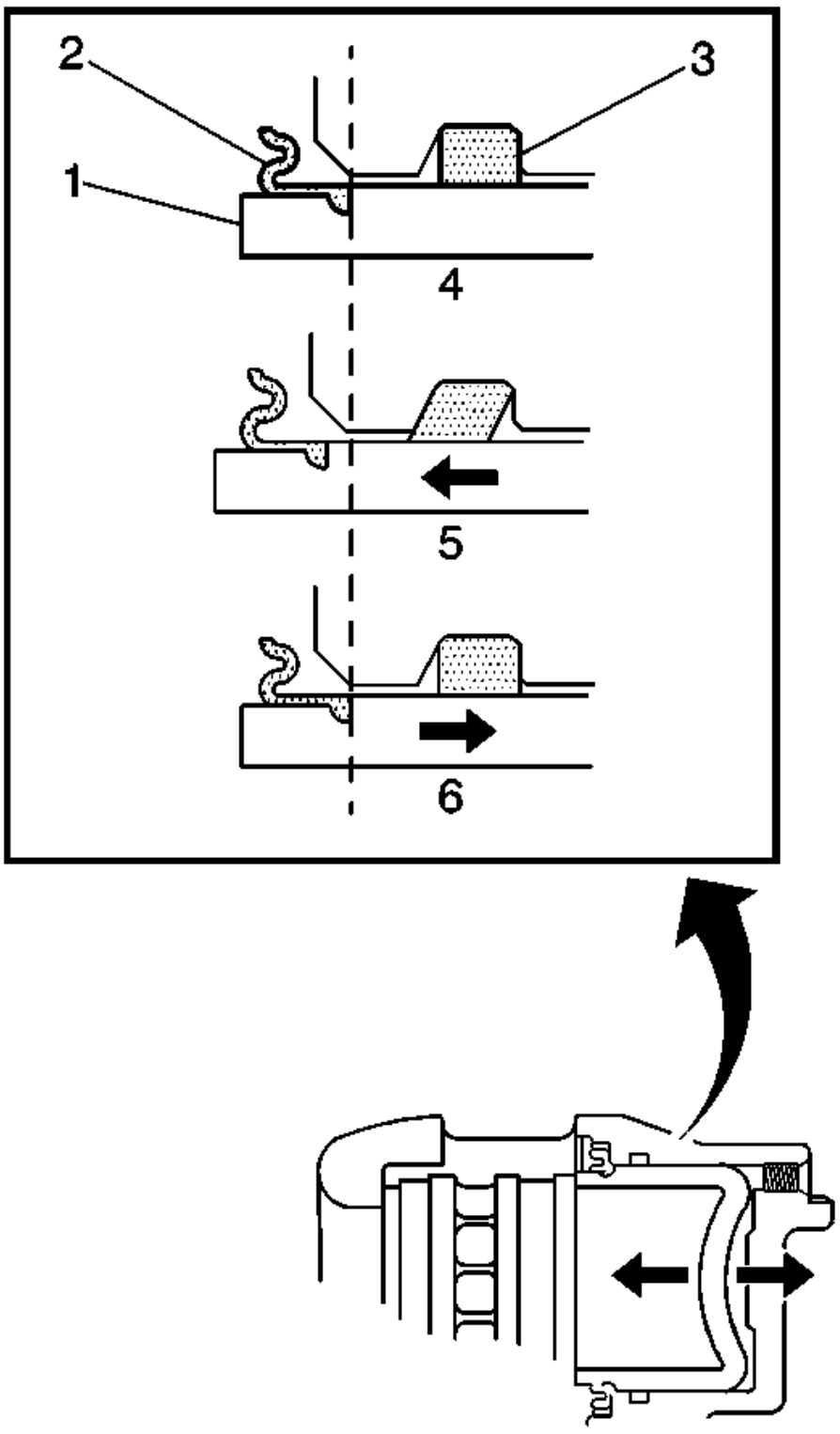


Fig. 4: Identifying Brake Caliper/Pad Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. With the tire and wheel assemblies removed and the brake rotors retained by wheel lug nuts, visually inspect the caliper piston dust boot (2) sealing area to ensure that there are no brake fluid leaks.
2. If any evidence of a brake fluid leak is present, the brake caliper requires overhaul or replacement.
3. While the brake system is at rest (4), observe the position of the caliper piston (1) in relation to the caliper housing.
4. Have an assistant apply and release the brake pedal several times while you observe the operation of the hydraulic brake caliper.
    1. Observe the caliper piston (1) for unrestricted and even movement during each apply of the brake system (5).
    2. Observe the caliper piston (1) for an unrestricted and even return motion during each release of the brake system (6).
5. If the caliper piston (1) did not exhibit unrestricted and even movement during brake system apply and/or release, the piston square seal (3) may be worn or damaged and the caliper may require overhaul or replacement.

BRAKE PIPE AND HOSE INSPECTION

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Visually inspect all of the brake pipes for the following conditions:
    - Kinks, improper routing, missing or damaged retainers
    - Leaking fittings, excessive corrosion
2. If any of the brake pipes exhibited any of the conditions listed, then the identified pipe, or pipes, require replacement.
3. Ensure that the vehicle axles are properly supported at ride height in order to maintain the proper relationship of the flexible brake hoses to the chassis.

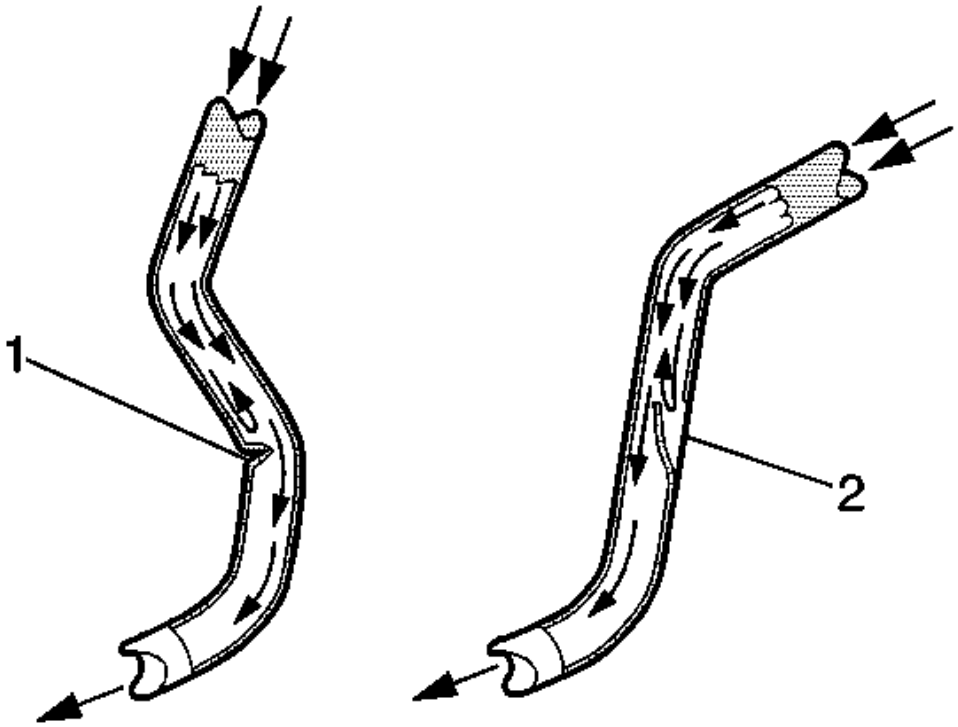


Fig. 5: Identifying Flexible Brake Hose Failure Conditions
Courtesy of GENERAL MOTORS COMPANY

4. Visually inspect all of the flexible brake hoses for the following conditions:
    - Kinks (1), improper routing, twists, chafing, missing or damaged retainers
    - Leaking connections, cracking, dry-rot, blisters, bulges
5. If any of the flexible brake hoses exhibited any of the conditions listed, then the identified flexible brake hose, or hoses require replacement.
6. Squeeze the flexible brake hoses with firm finger pressure to check for soft spots (2), indicating an internal restriction. Check the entire length of each flexible brake hose.
7. If any of the flexible brake hoses were found to have soft spots (2), then the identified flexible brake hose, or hoses require replacement.

BRAKE PEDAL PUSHROD INSPECTION

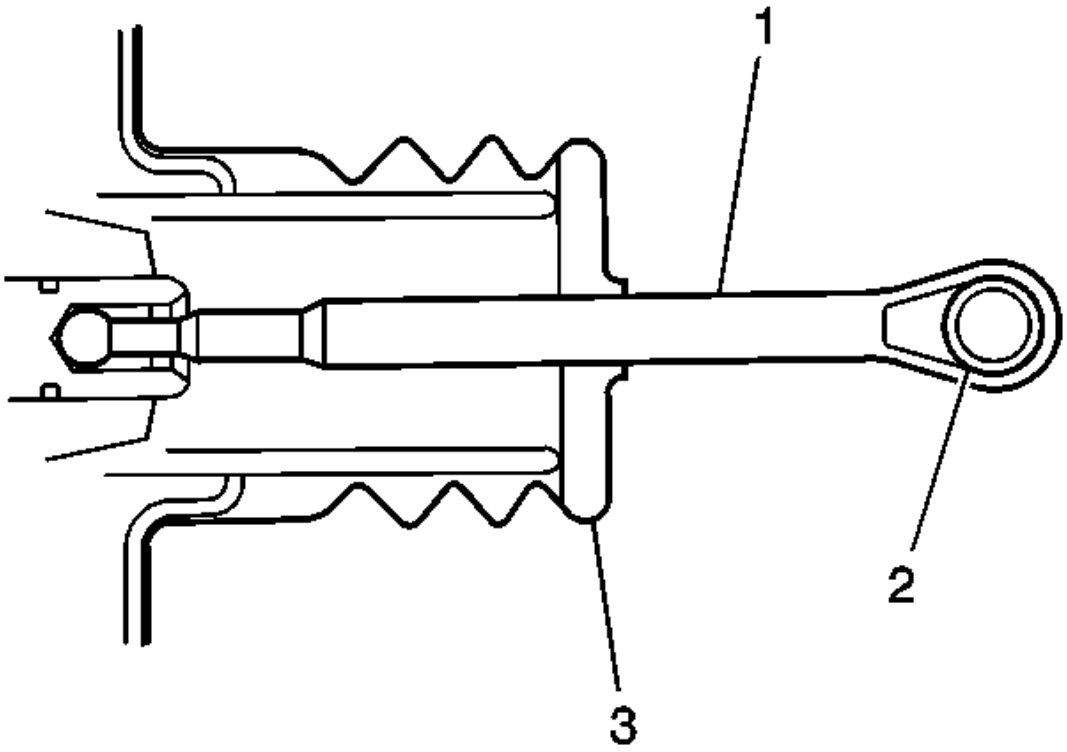


Fig. 6: View of Brake Pedal Pushrod
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the brake pedal pushrod (1) from the brake pedal.
2. Inspect the brake pedal pushrod eyelet bushing (2), if equipped, for cracks and/or excessive wear.
3. Reposition the pedal pushrod boot (3) toward the front of the vehicle to expose as much of the pedal pushrod (1) as possible.
4. Inspect the brake pedal pushrod (1) for straightness.
5. If the brake pedal pushrod eyelet bushing (2) exhibited cracks and/or excessive wear, then the bushing requires replacement.
6. If the brake pedal pushrod (1) is not straight, then the pushrod requires replacement.
7. Return the pedal pushrod boot (3) to its original position on the pedal pushrod (1).
8. Connect the brake pedal pushrod (1) to the brake pedal.

REPAIR INSTRUCTIONS

MASTER CYLINDER RESERVOIR FILLING

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Visually inspect the brake fluid level through the brake master cylinder reservoir.
2. If the brake fluid level is at or below the half-full point during routine fluid checks, the brake system should be inspected for wear and possible brake fluid leaks.
3. If the brake fluid level is at or below the half-full point during routine fluid checks, and an inspection of the brake system did not reveal wear or brake fluid leaks, the brake fluid may be topped-off up to the maximum-fill level.
4. If brake system service was just completed, the brake fluid may be topped-off up to the maximum-fill level.
5. If the brake fluid level is above the half-full point, adding brake fluid is not recommended under normal conditions.
6. If brake fluid is to be added to the master cylinder reservoir, clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm. Use only GM approved brake fluid from a clean, sealed brake fluid container.

MASTER CYLINDER RESERVOIR REPLACEMENT

Removal Procedure

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Remove and properly dispose of the fluid in the brake master cylinder reservoir.
2. Disconnect the brake fluid level indicator switch electrical connector.

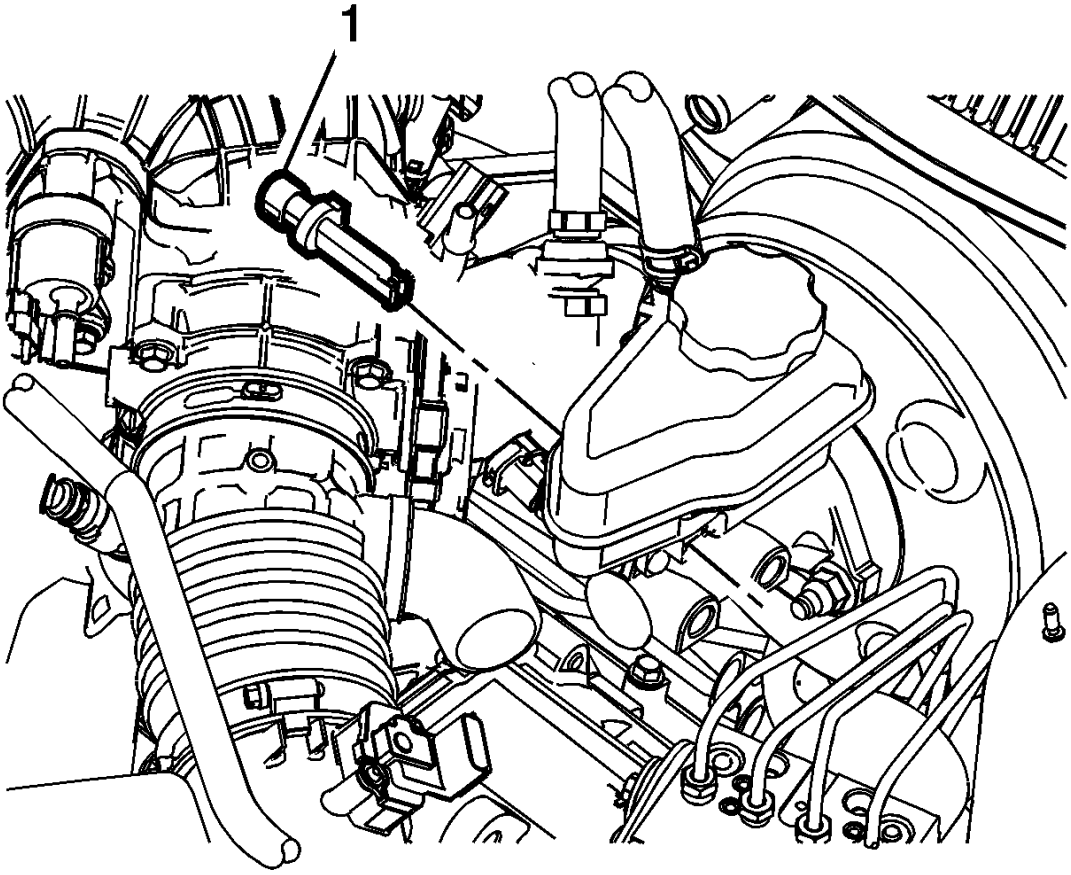


Fig. 7: Brake Fluid Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

3. Compress the locking tabs and remove the brake fluid level indicator switch (1).

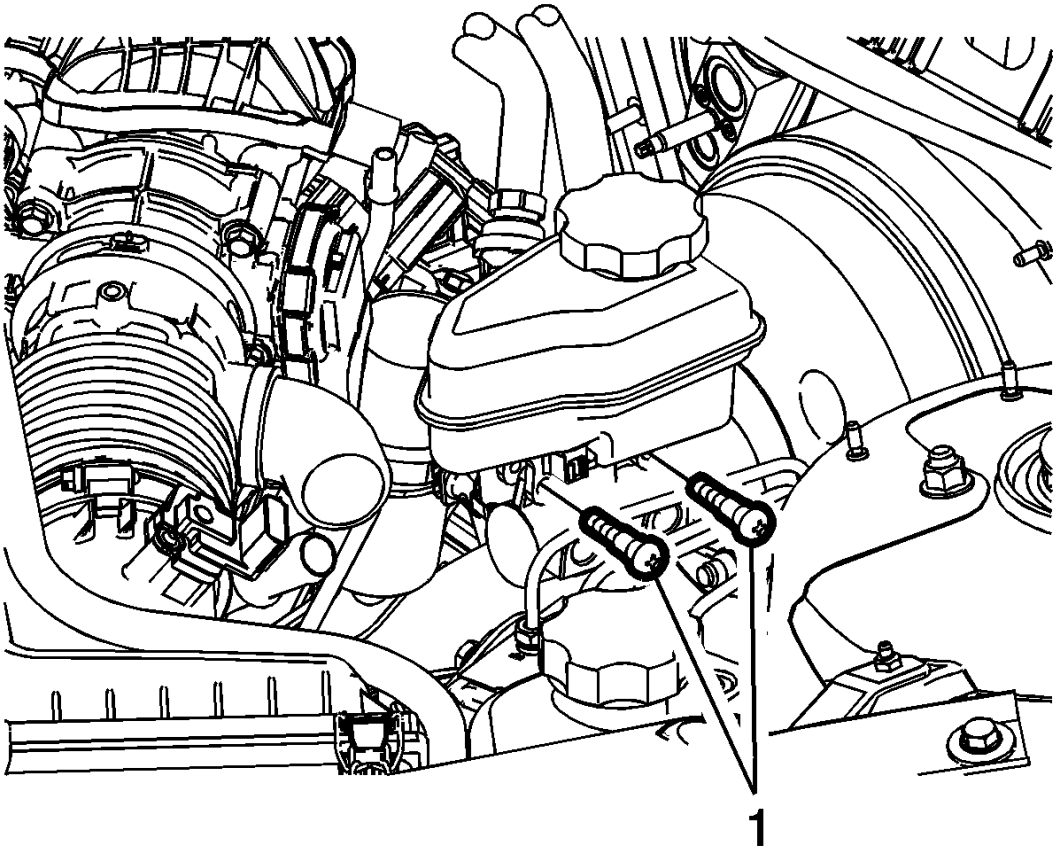


Fig. 8: Master Cylinder Reservoir Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the master cylinder reservoir bolts (1).

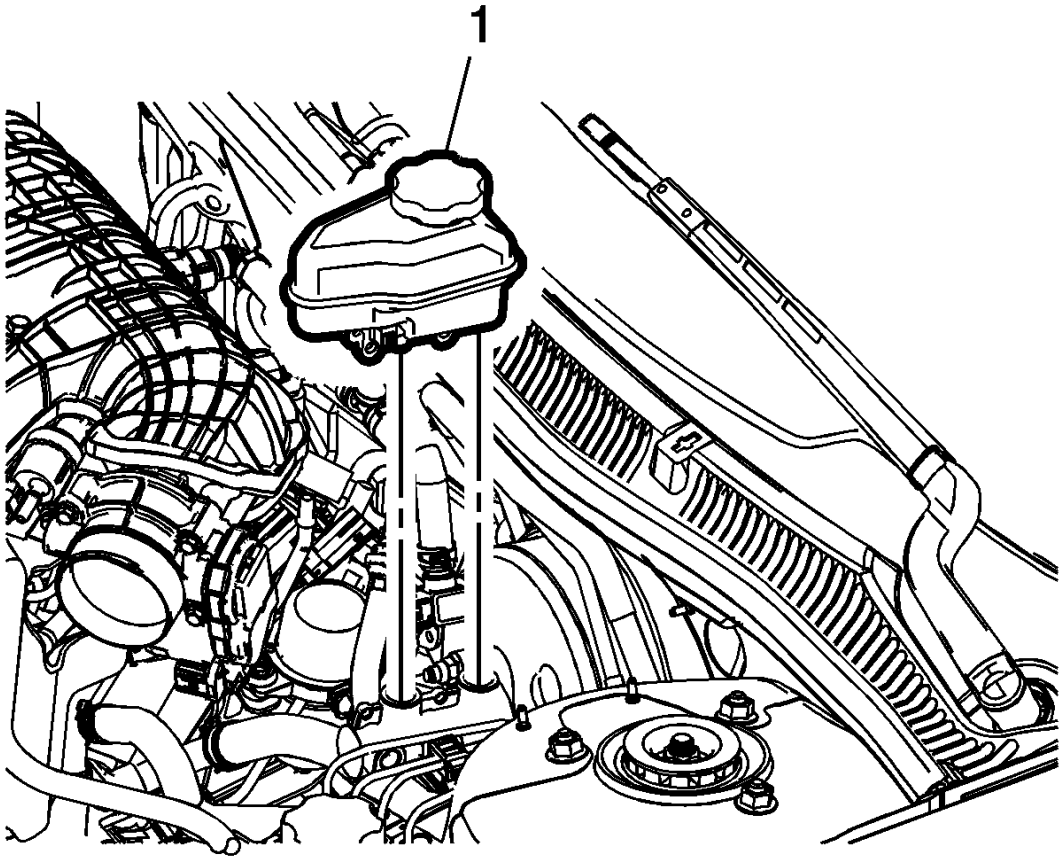


Fig. 9: Master Cylinder Reservoir
Courtesy of GENERAL MOTORS COMPANY

5. Remove the master cylinder reservoir (1) by lifting the reservoir straight upward.

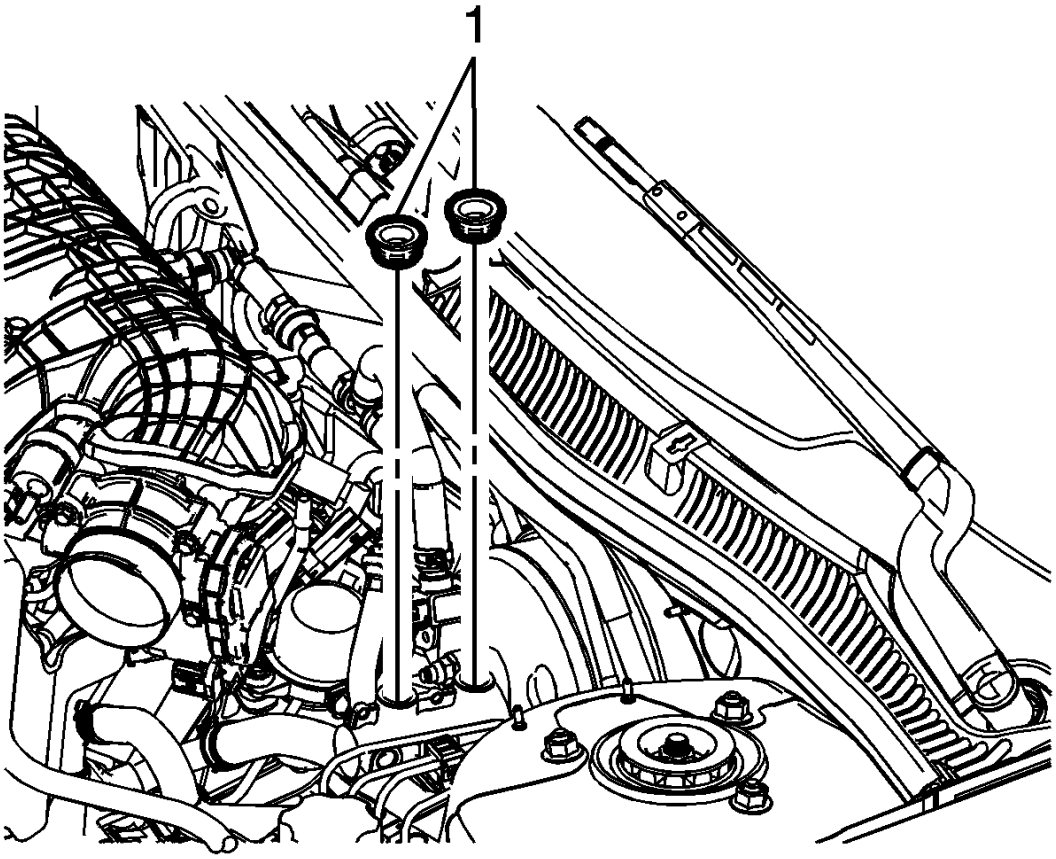


Fig. 10: Master Cylinder Reservoir Seals
Courtesy of GENERAL MOTORS COMPANY

6. Remove the master cylinder reservoir seals (1).

Installation Procedure

1. Lightly lubricate the master cylinder reservoir seals with GM approved brake fluid from a clean, sealed, brake fluid container.

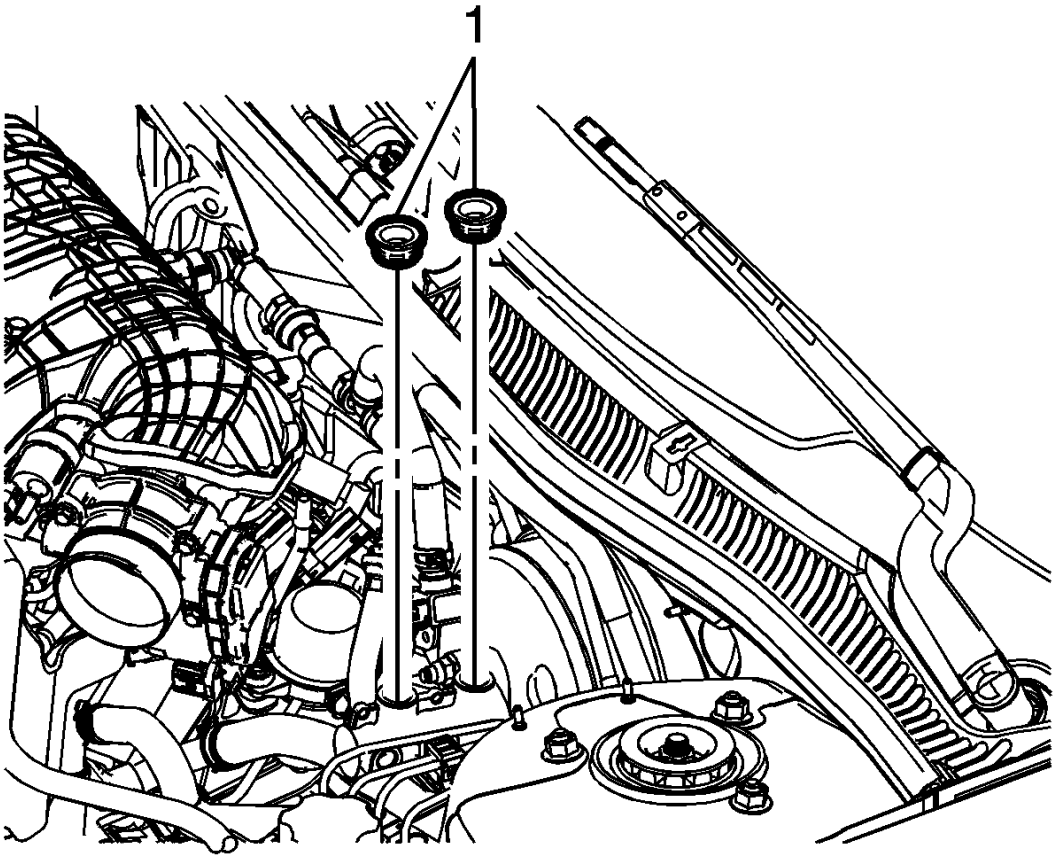


Fig. 11: Master Cylinder Reservoir Seals
Courtesy of GENERAL MOTORS COMPANY

2. Install the master cylinder reservoir seals (1).

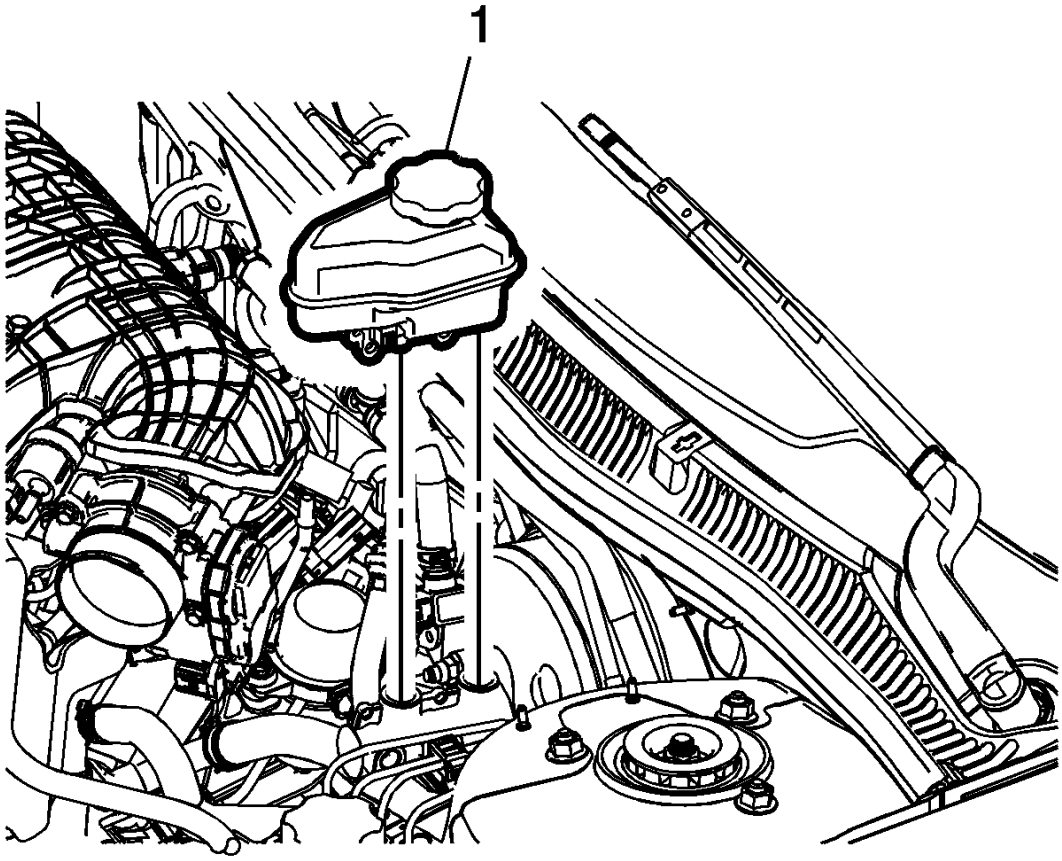


Fig. 12: Master Cylinder Reservoir
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the master cylinder reservoir is fully seated in the master cylinder reservoir seals.**

3. Install the master cylinder reservoir (1) by aligning the reservoir bayonets with the master cylinder ports and pressing the reservoir straight downward.

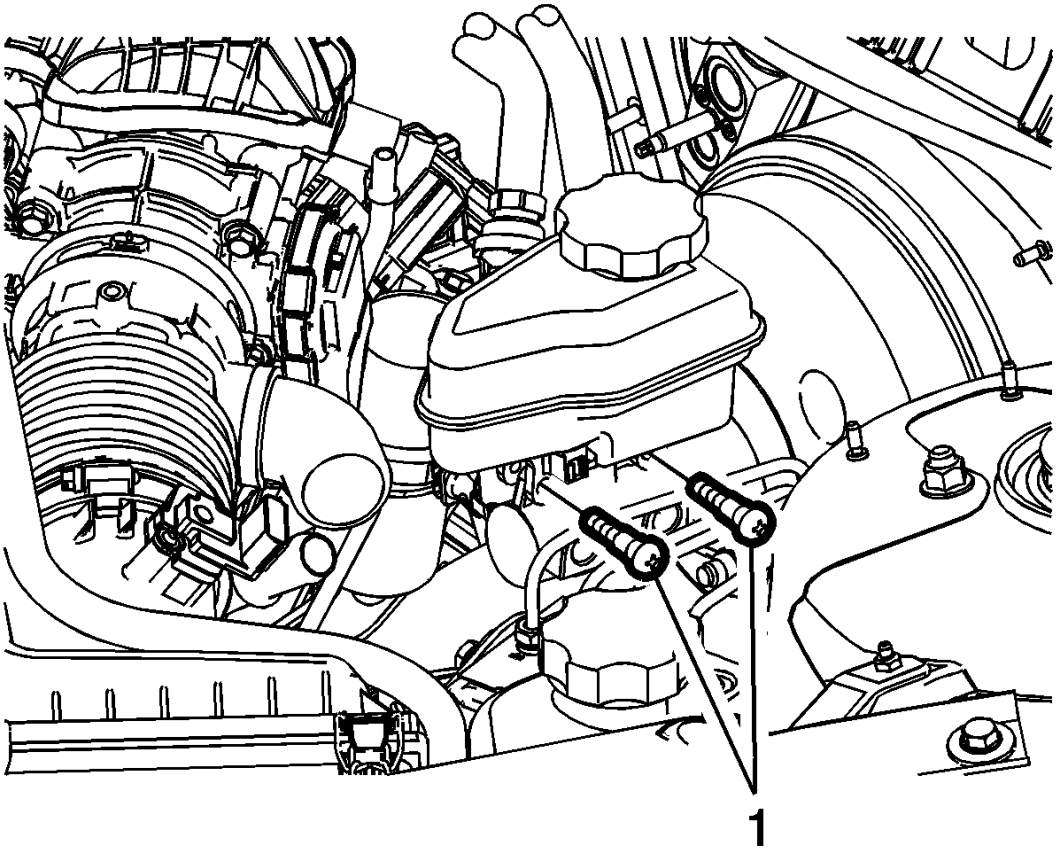


Fig. 13: Master Cylinder Reservoir Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the master cylinder reservoir bolts (1).

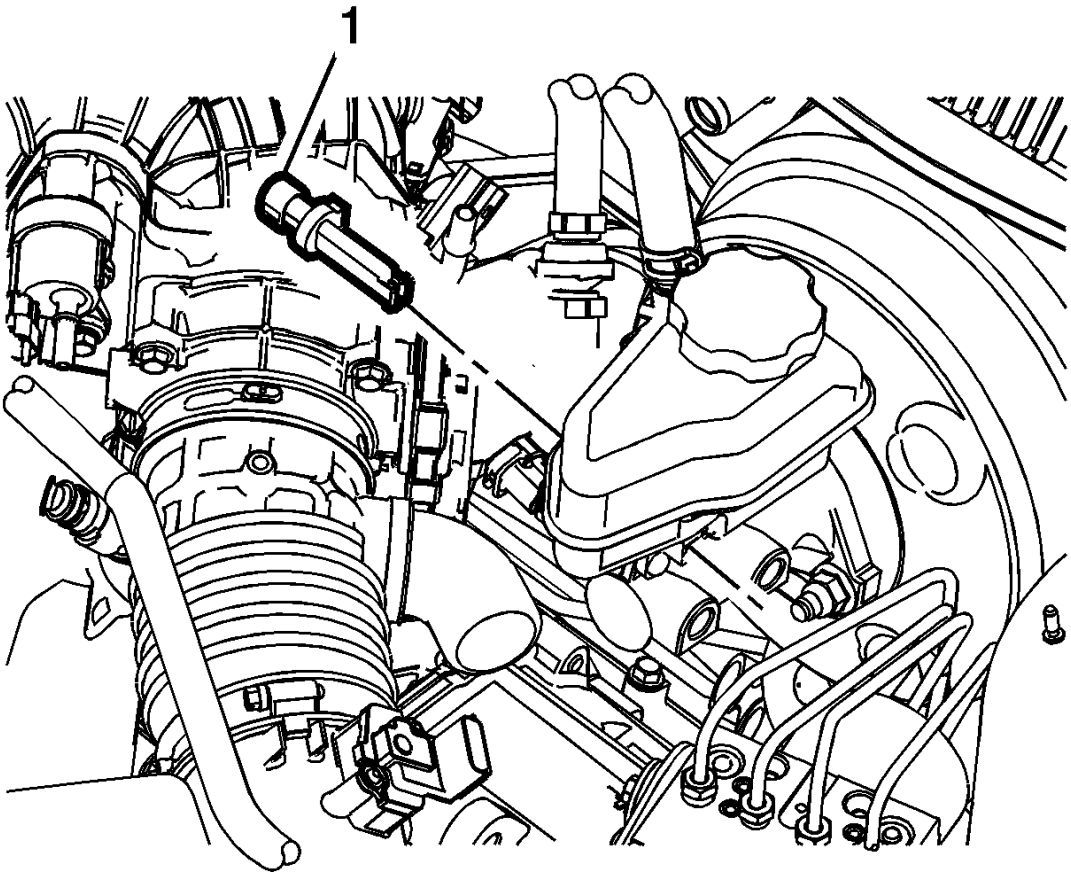


Fig. 14: Brake Fluid Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the locking tabs are fully engaged in the master cylinder reservoir.**

5. Install the brake fluid level indicator switch (1).
6. Connect the brake fluid level indicator switch electrical connector.
7. Fill the master cylinder reservoir. Refer to **Master Cylinder Reservoir Filling**.

MASTER CYLINDER REPLACEMENT

Removal Procedure

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Remove and properly dispose of the brake fluid in the master cylinder reservoir.
2. Disconnect the brake fluid level indicator switch electrical connector.

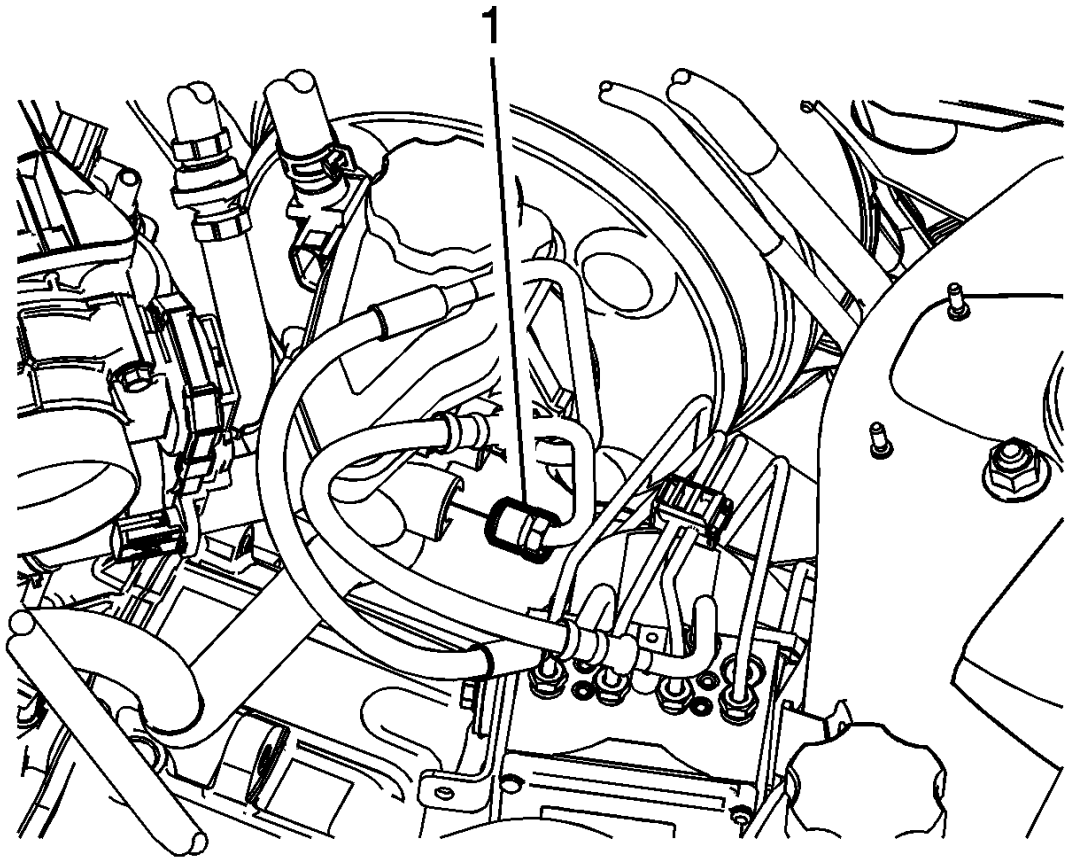


Fig. 15: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the master cylinder secondary brake pipe fitting (1).
4. Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.

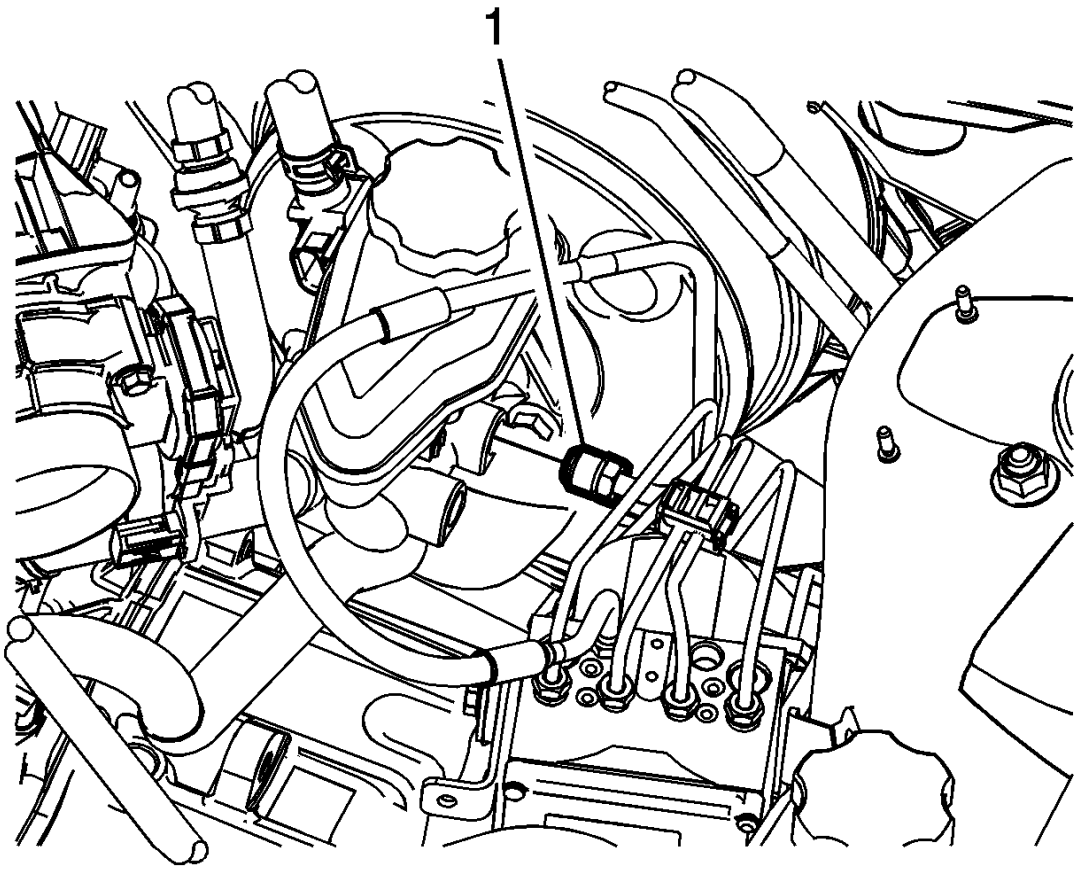


Fig. 16: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the master cylinder primary brake pipe fitting (1).
6. Cap the brake pipe fitting and plug the master cylinder outlet port to prevent brake fluid loss and contamination.

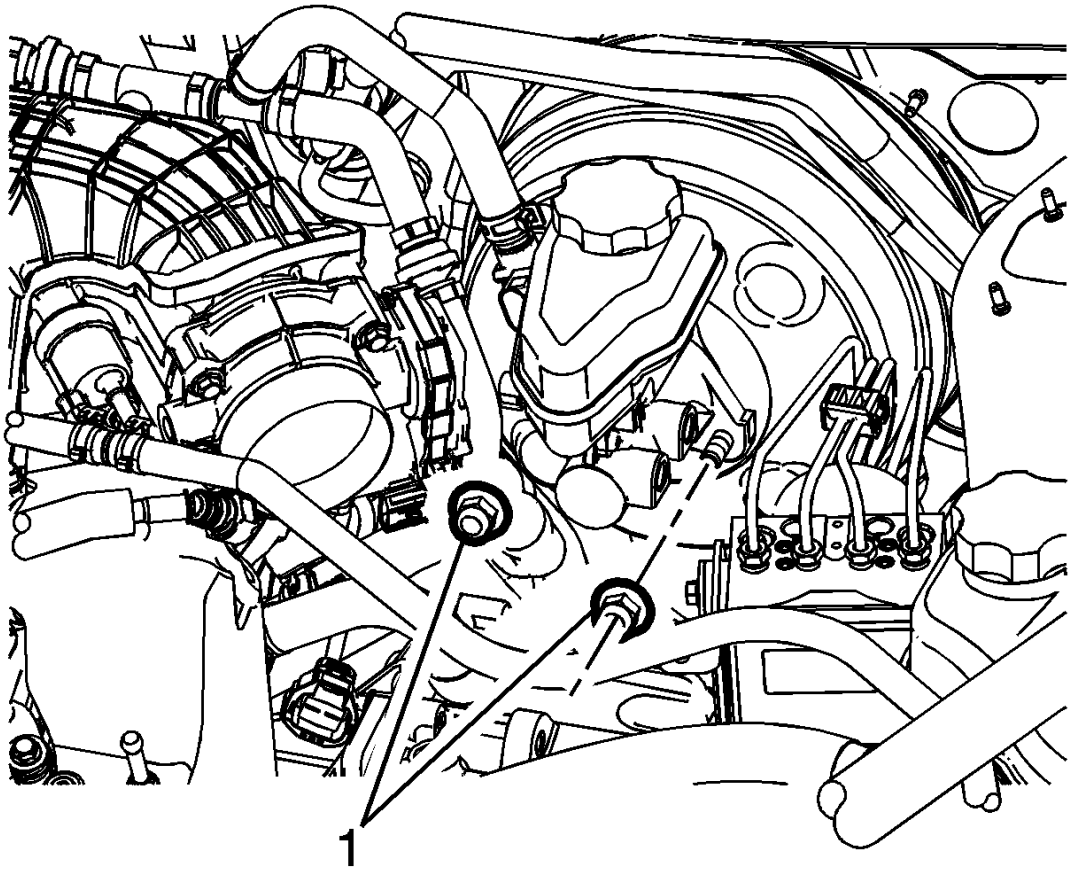


Fig. 17: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the master cylinder nuts (1).

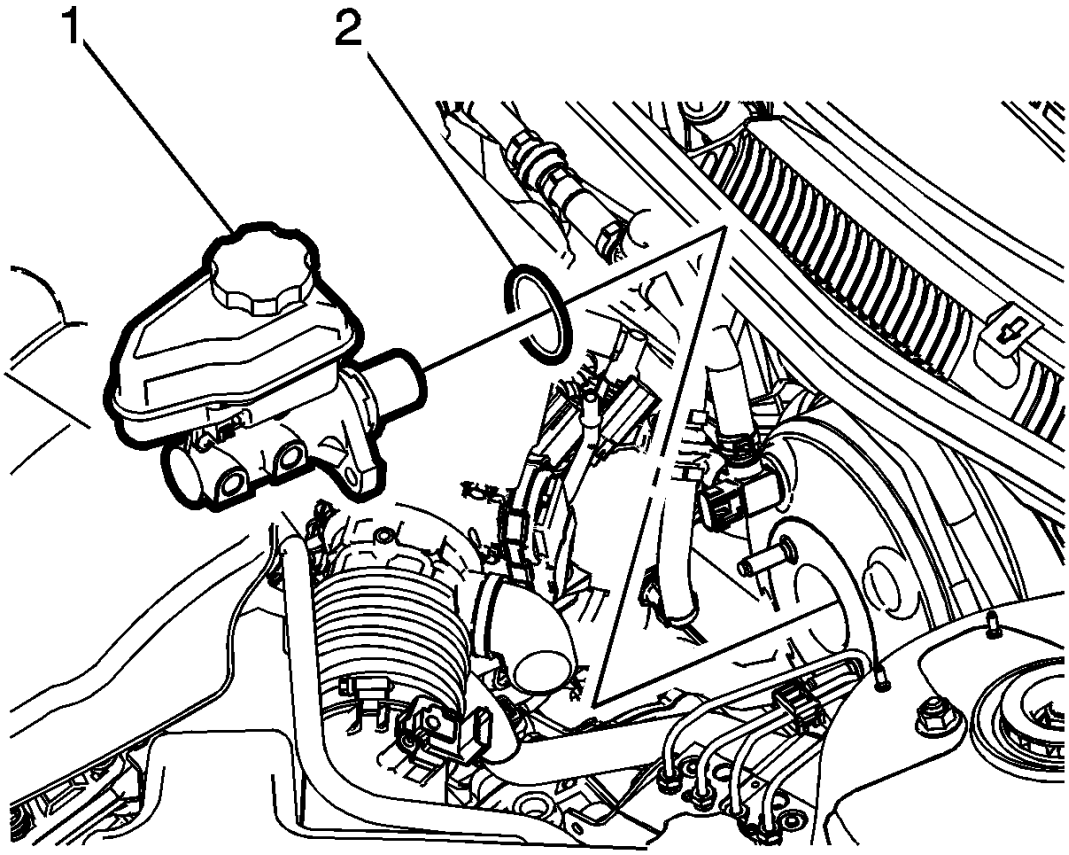


Fig. 18: Master Cylinder And Master Cylinder Seal
Courtesy of GENERAL MOTORS COMPANY

8. Remove the master cylinder (1) and the master cylinder seal (2).
9. Inspect the master cylinder seal for damage and replace, if necessary.

Installation Procedure

1. Bench bleed the master cylinder. Refer to **Master Cylinder Bench Bleeding**.

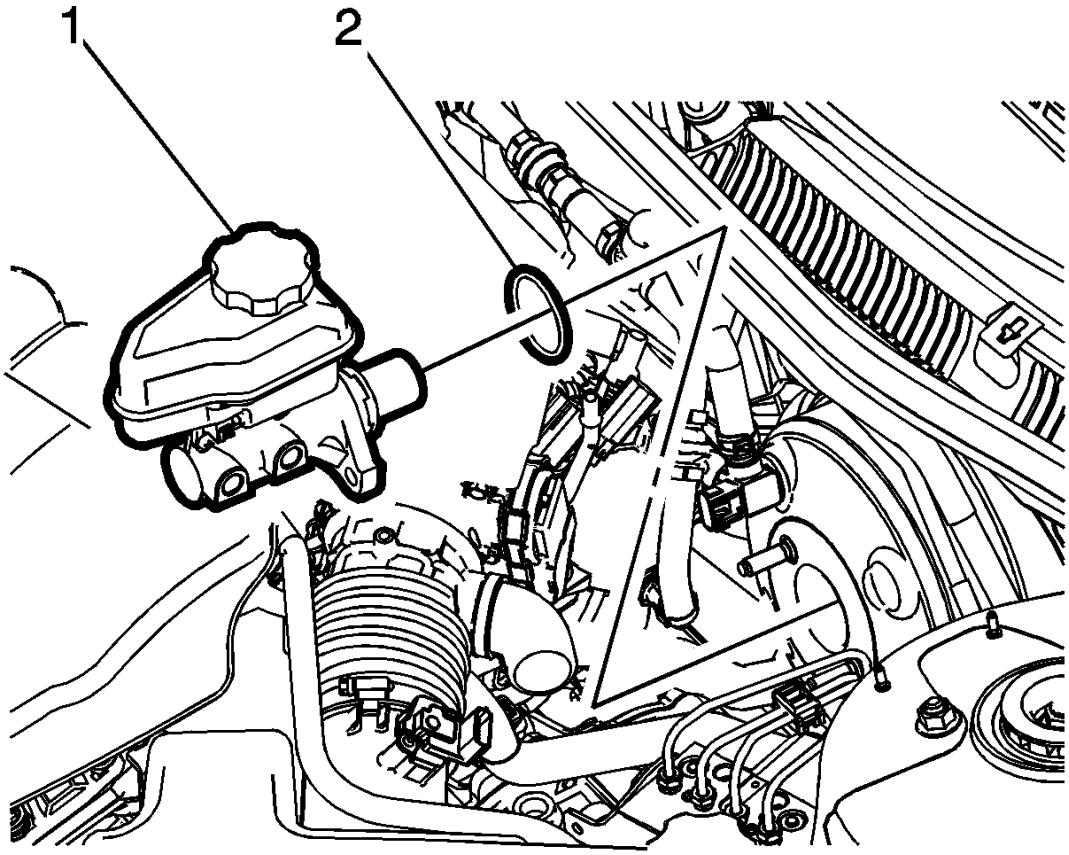


Fig. 19: Master Cylinder And Master Cylinder Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install the master cylinder (1) and the master cylinder seal (2).

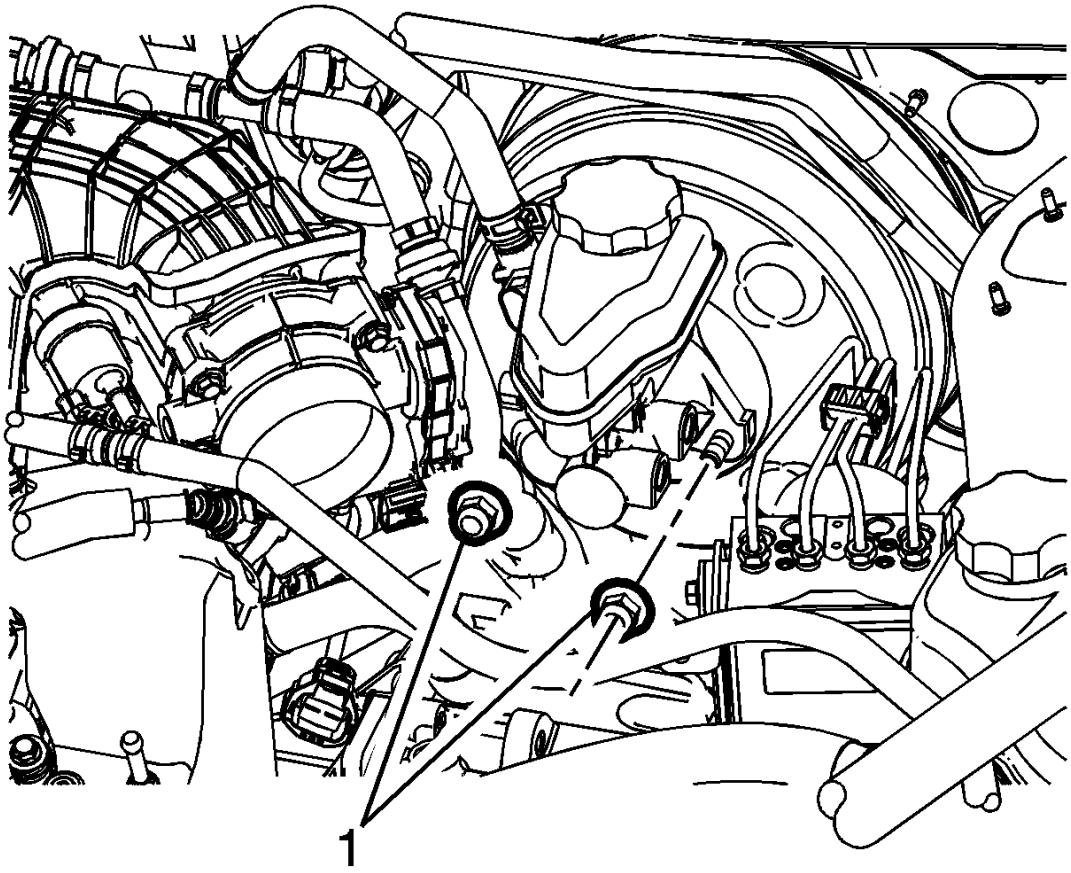


Fig. 20: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the master cylinder nuts (1) and tighten to 33 N.m (24 lb ft).

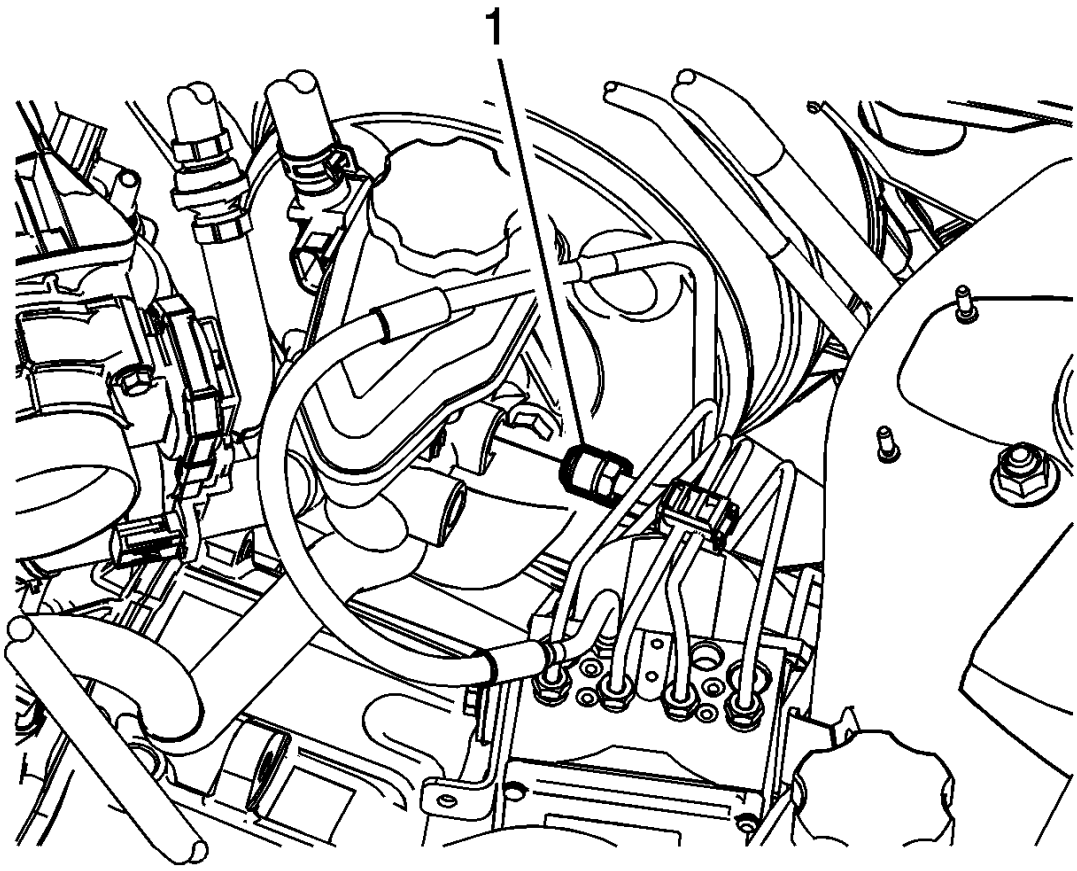


Fig. 21: Master Cylinder Primary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

4. Install the master cylinder primary brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).

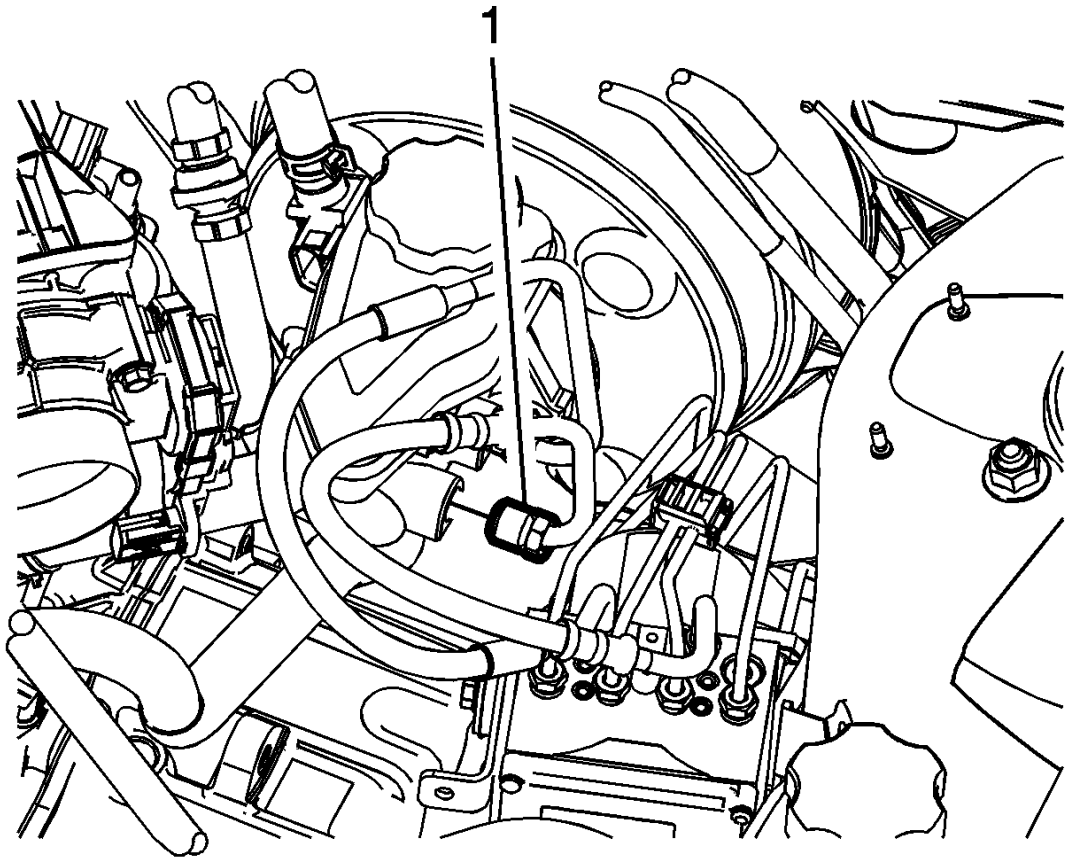


Fig. 22: Master Cylinder Secondary Brake Pipe Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Install the master cylinder secondary brake pipe fitting (1) and tighten to 18 N.m (13 lb ft).
6. Connect the brake fluid level indicator switch electrical connector.
7. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)**.

MASTER CYLINDER OVERHAUL

Disassembly Procedure

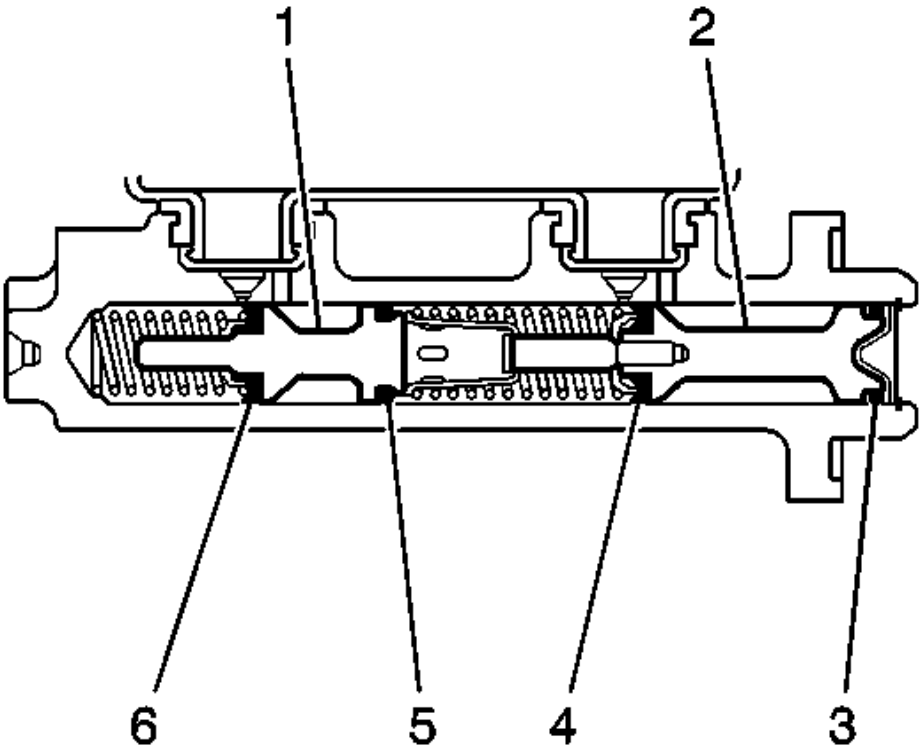


Fig. 23: Identifying Brake Master Cylinder (Cross Sectional View)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Remove the brake master cylinder from the vehicle. Refer to **Master Cylinder Replacement**.
2. Secure the mounting flange of the brake master cylinder in a bench vise so that the rear of the primary piston is accessible.
3. Clean the outside of the master cylinder reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Remove the reservoir cap and diaphragm from the reservoir.
5. Inspect the reservoir cap and diaphragm for the following conditions. If any of these conditions are present, replace the affected components.
    - Cuts or cracks
    - Nicks or deformation
6. Remove the master cylinder reservoir from the master cylinder. Refer to **Master Cylinder Reservoir**

Replacement.

7. Using a smooth, round-ended tool, depress the primary piston (2) and remove the piston retainer.
8. Remove the primary piston assembly from the cylinder bore.
9. Plug the cylinder inlet ports and the rear outlet port. Apply low pressure, non-lubricated, filtered air into the front outlet port, in order the remove the secondary piston (1) with the primary (6) and secondary (5) seals, and the return spring.
10. Discard the primary piston assembly, the piston retainer, and the seals and seal retainer from the secondary piston.

Assembly Procedure

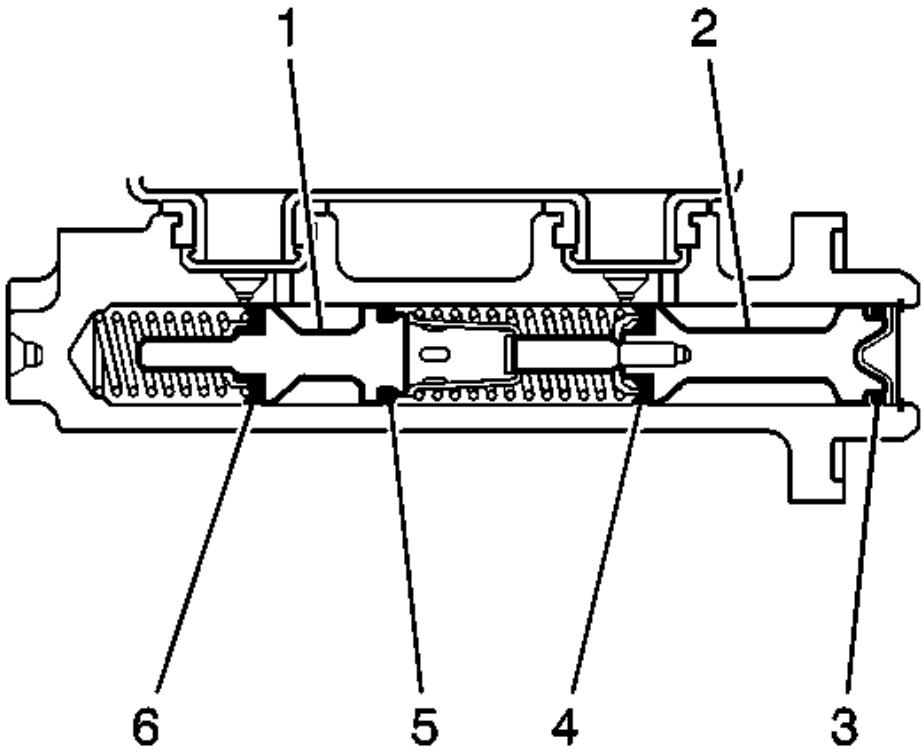


Fig. 24: Identifying Brake Master Cylinder (Cross Sectional View)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use abrasives to clean the brake master cylinder bore.**

1. Clean the interior and exterior of the master cylinder, the secondary piston (1), and the return spring in denatured alcohol, or equivalent.
2. Inspect the master cylinder bore, inlet and outlet ports, the secondary piston (1), and the return spring for

cracks, scoring, pitting, and/or corrosion. Replace the master cylinder if any of these conditions exist.

3. Dry the master cylinder and the individual components with non-lubricated, filtered air.
4. Lubricate the master cylinder bore, the secondary piston (1), the return spring, and all of the individual overhaul components with Delco Supreme 11Â®, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT-3 brake fluid from a clean, sealed brake fluid container.
5. Assemble the lubricated, new primary seal (6) and retainer, and new secondary seal (5) onto the secondary piston.
6. Install the lubricated return spring and secondary piston assembly (1) into the cylinder bore.
7. Install the lubricated, new primary piston assembly (2) into the cylinder bore.
8. Using a smooth, round-ended tool, depress the primary piston (2) and install the new piston retainer.
9. Install the master cylinder reservoir to the master cylinder. Refer to **Master Cylinder Reservoir Replacement**.
10. Install the reservoir cap and diaphragm to the reservoir.
11. Install the master cylinder to the vehicle. Refer to **Master Cylinder Replacement**.

MASTER CYLINDER BENCH BLEEDING

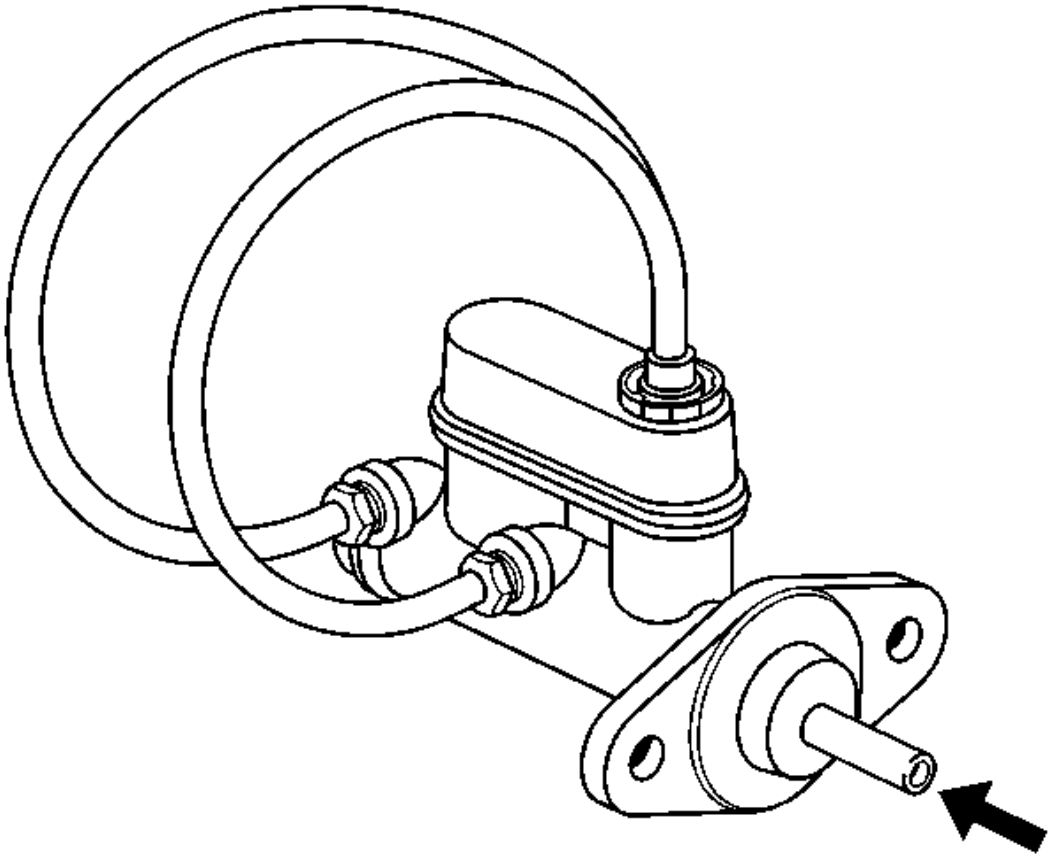


Fig. 25: Bleeding Master Cylinder
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Secure the mounting flange of the brake master cylinder in a bench vise so that the rear of the primary piston is accessible.
2. Remove the master cylinder reservoir cap and diaphragm.
3. Install suitable fittings to the master cylinder ports that match the type of flare seat required and also provide for hose attachment.
4. Install transparent hoses to the fittings installed to the master cylinder ports, then route the hoses into the master cylinder reservoir.
5. Fill the master cylinder reservoir to at least the half-way point with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Master Cylinder Reservoir Filling**.
6. Ensure that the ends of the transparent hoses running into the master cylinder reservoir are fully submerged in the brake fluid.
7. Using a smooth, round-ended tool, depress and release the primary piston as far as it will travel, a depth of about 25 mm (1 in), several times. Observe the flow of fluid coming from the ports.

   As air is bled from the primary and secondary pistons, the effort required to depress the primary piston will increase and the amount of travel will decrease.

8. Continue to depress and release the primary piston until fluid flows freely from the ports with no evidence of air bubbles.
9. Remove the transparent hoses from the master cylinder reservoir.
10. Install the master cylinder reservoir cap and diaphragm.
11. Remove the fittings with the transparent hoses from the master cylinder ports. Wrap the master cylinder with a clean shop cloth to prevent brake fluid spills.
12. Remove the master cylinder from the vise.

BRAKE FLUID LEVEL INDICATOR SWITCH REPLACEMENT

Removal Procedure

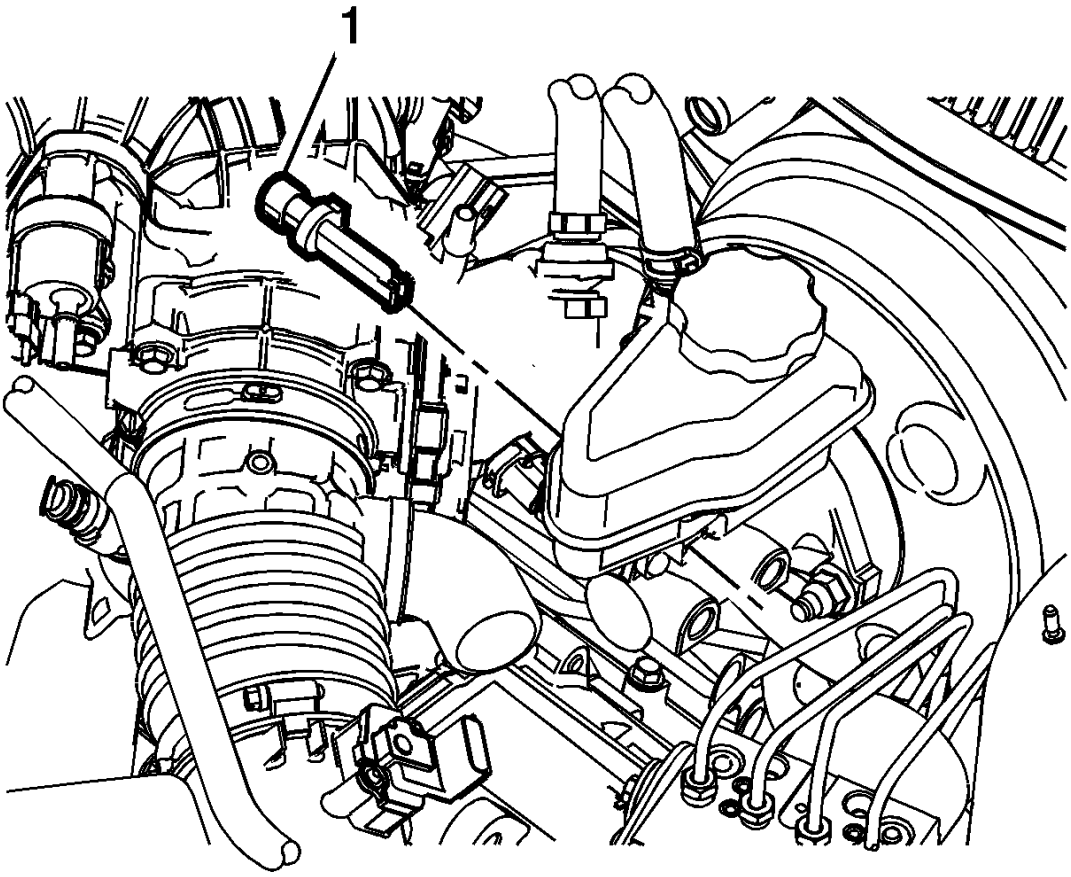


Fig. 26: Brake Fluid Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the brake fluid level indicator switch electrical connector.
2. Compress the locking tabs and remove the brake fluid level indicator switch (1).

Installation Procedure

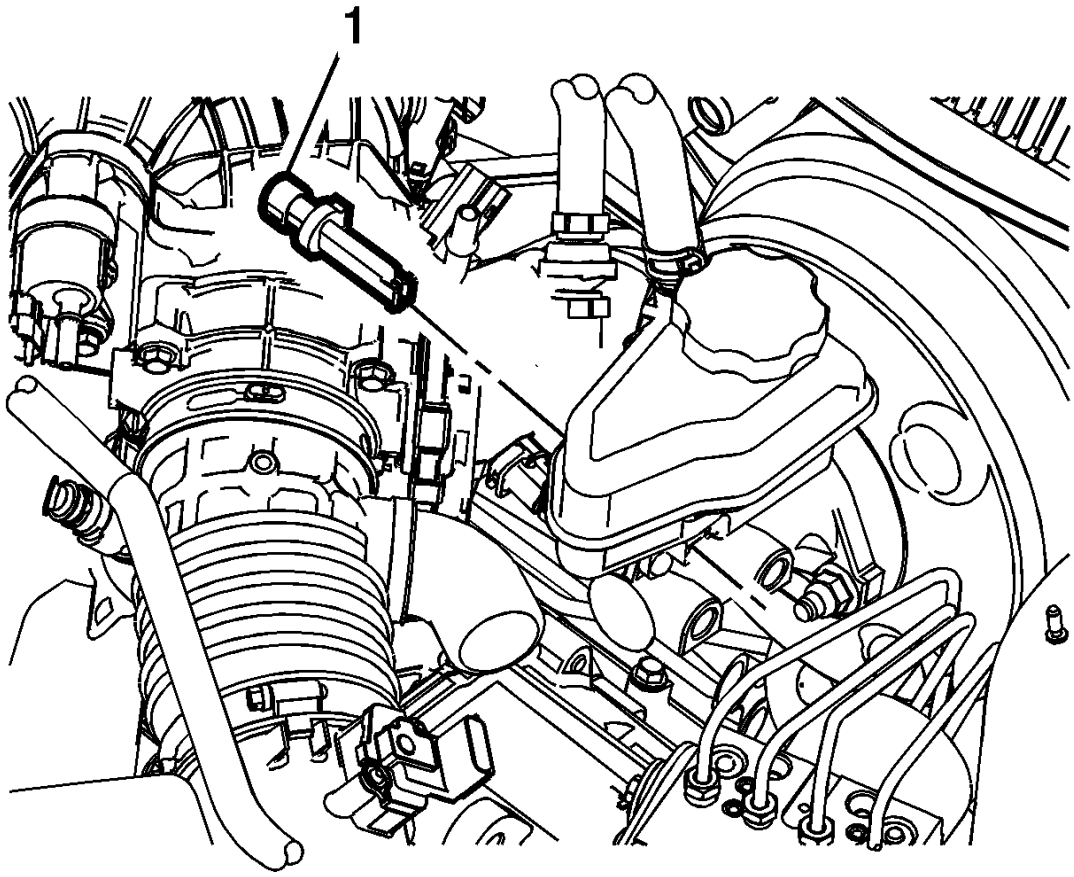


Fig. 27: Brake Fluid Level Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the locking tabs are fully engaged in the master cylinder reservoir.**

1. Compress the locking tabs and install the brake fluid level indicator switch (1).
2. Connect the brake fluid level indicator switch electrical connector.

BRAKE PEDAL ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the left instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .
2. Push the body control module (BCM) up and move the bottom of the BCM away from and out of the mounting bracket slot. Position the BCM aside.
3. Disconnect the brake pedal position sensor electrical connector.
4. Release the wiring harness clips from the bracket.

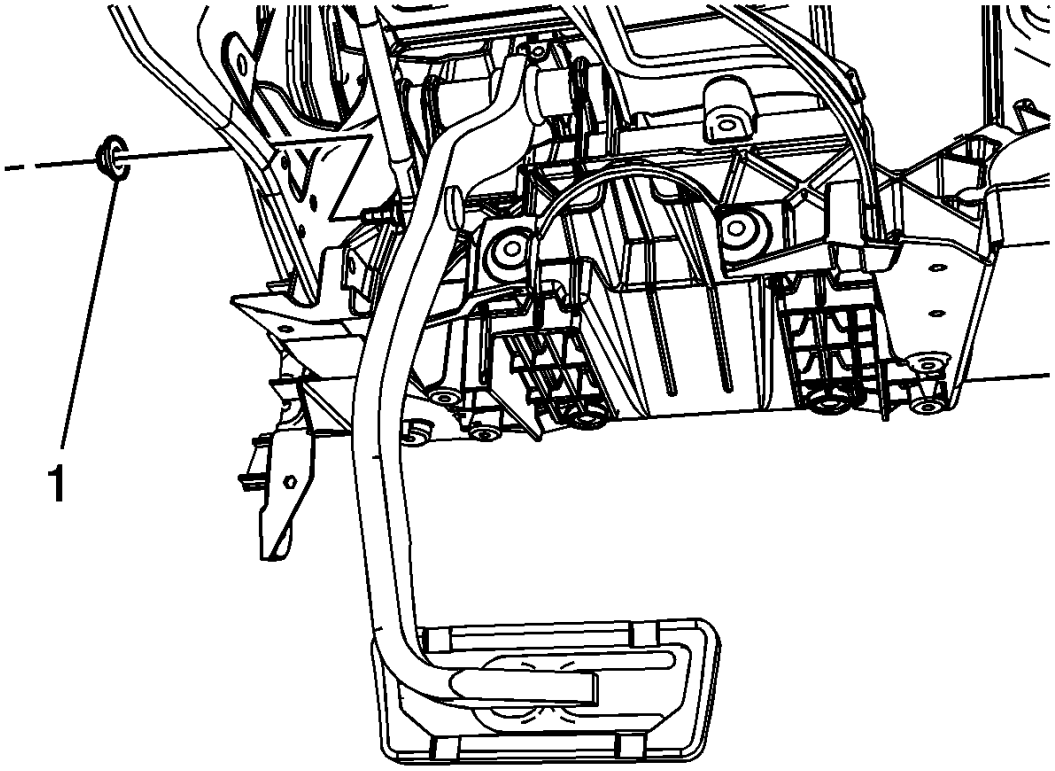


Fig. 28: Identifying Brake Pedal Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

5. Remove the brake pedal pushrod nut (1).

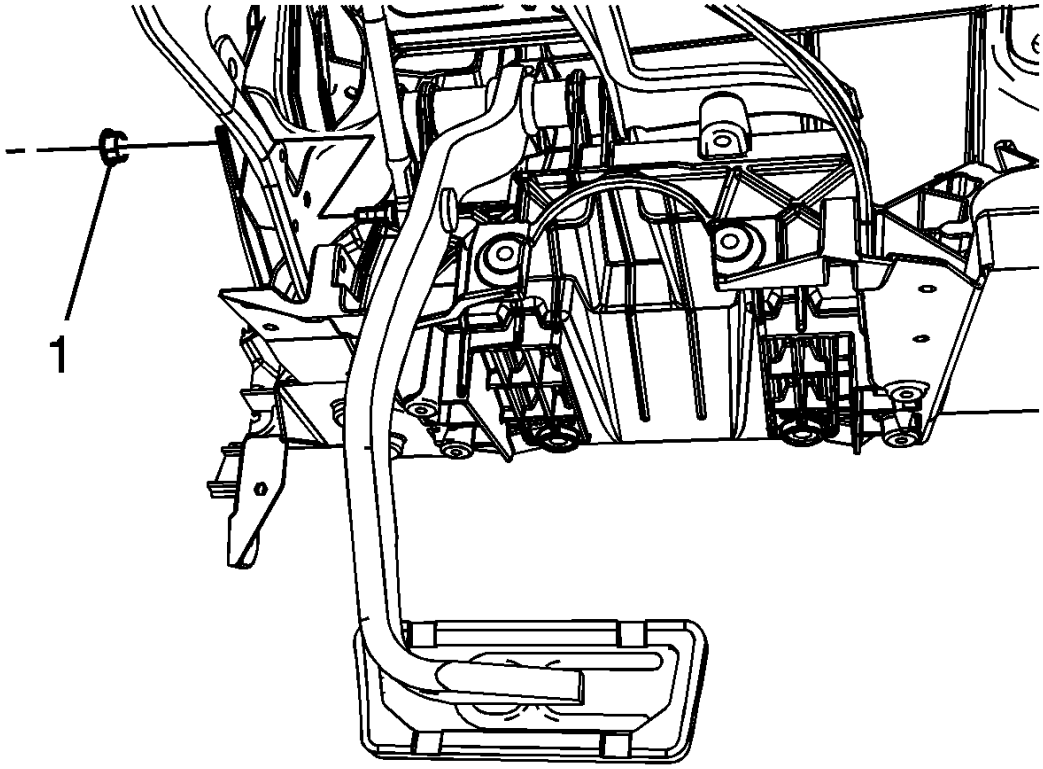


Fig. 29: Identifying Brake Pedal Pushrod Bushing
Courtesy of GENERAL MOTORS COMPANY

6. Remove the brake pedal pushrod bushing (1).

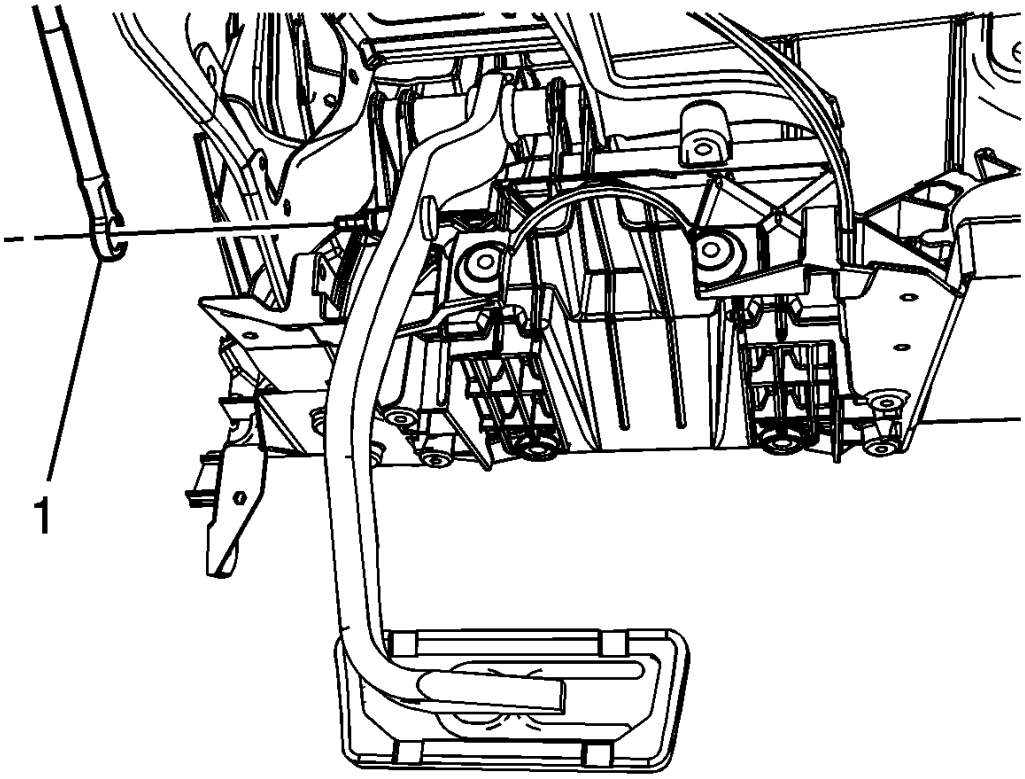


Fig. 30: View Of Brake Pedal Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the brake pedal pushrod (1) from the brake pedal.

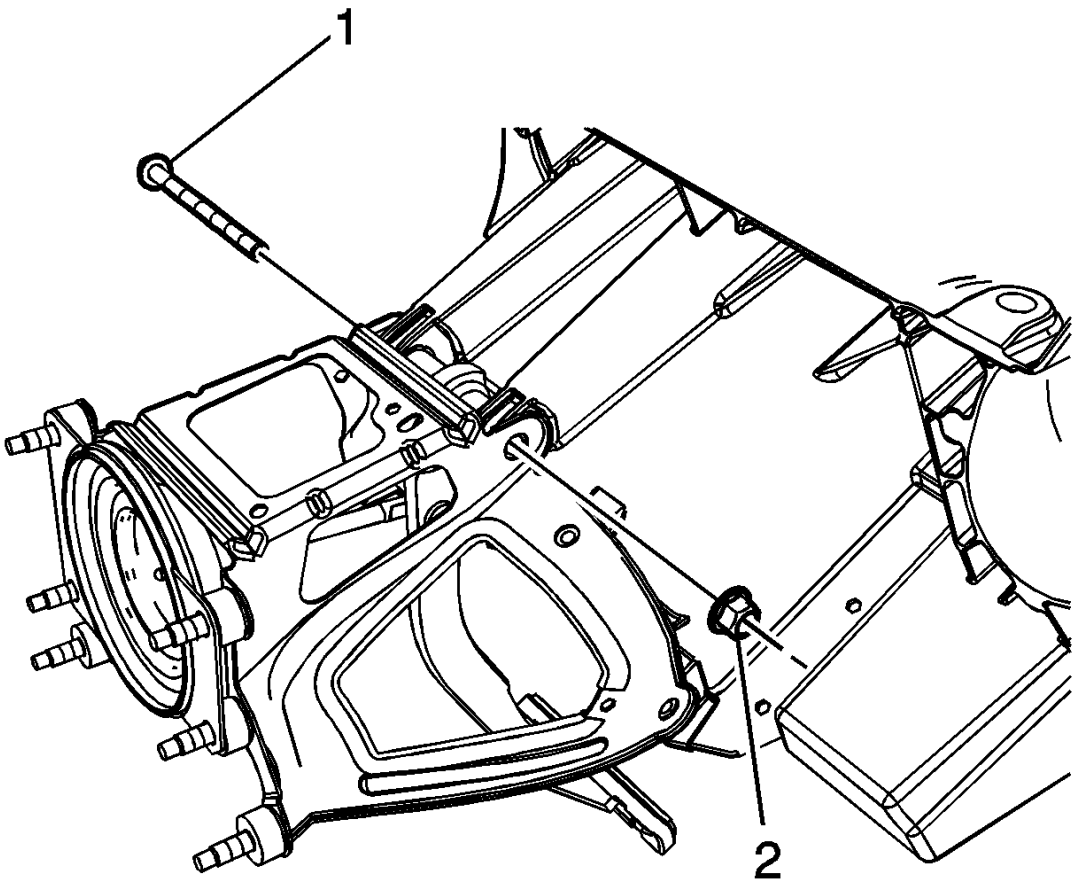


Fig. 31: View Of Brake Pedal Assembly, Bolt & Nut
Courtesy of GENERAL MOTORS COMPANY

8. Remove the brake pedal bolt (1) and nut (2).

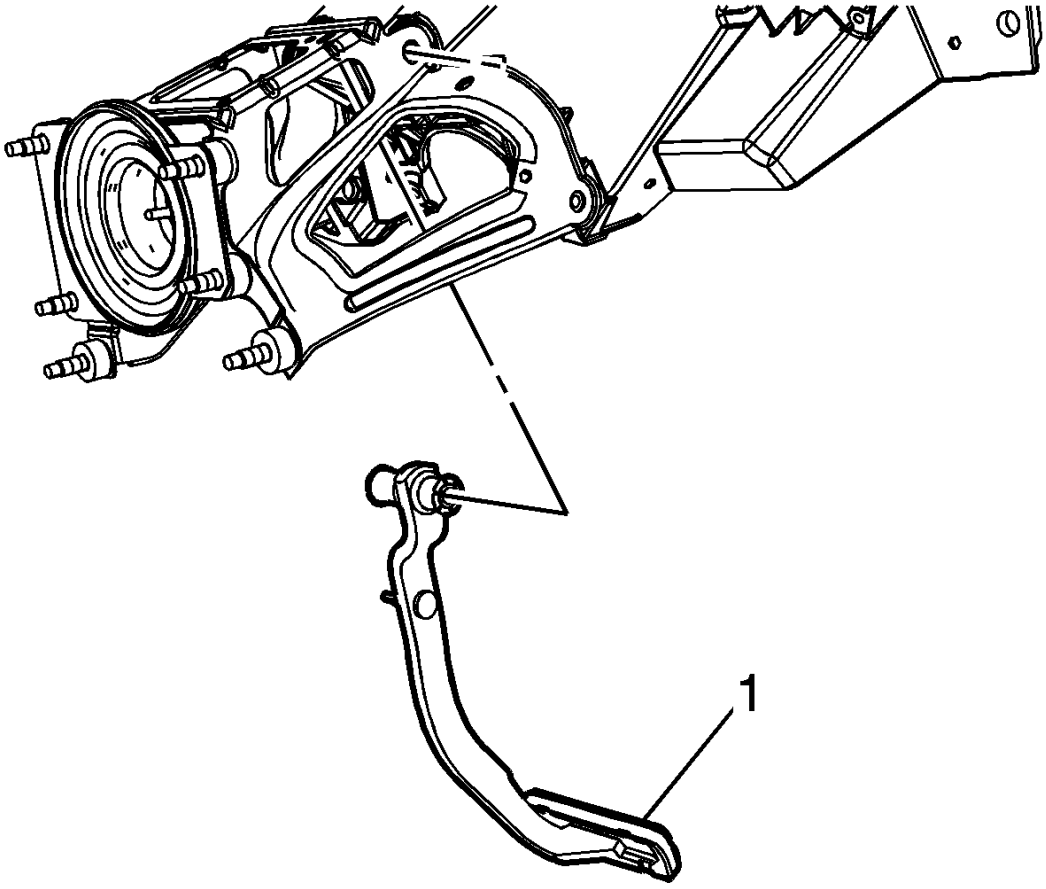


Fig. 32: View Of Brake Pedal Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Remove the brake pedal (1).

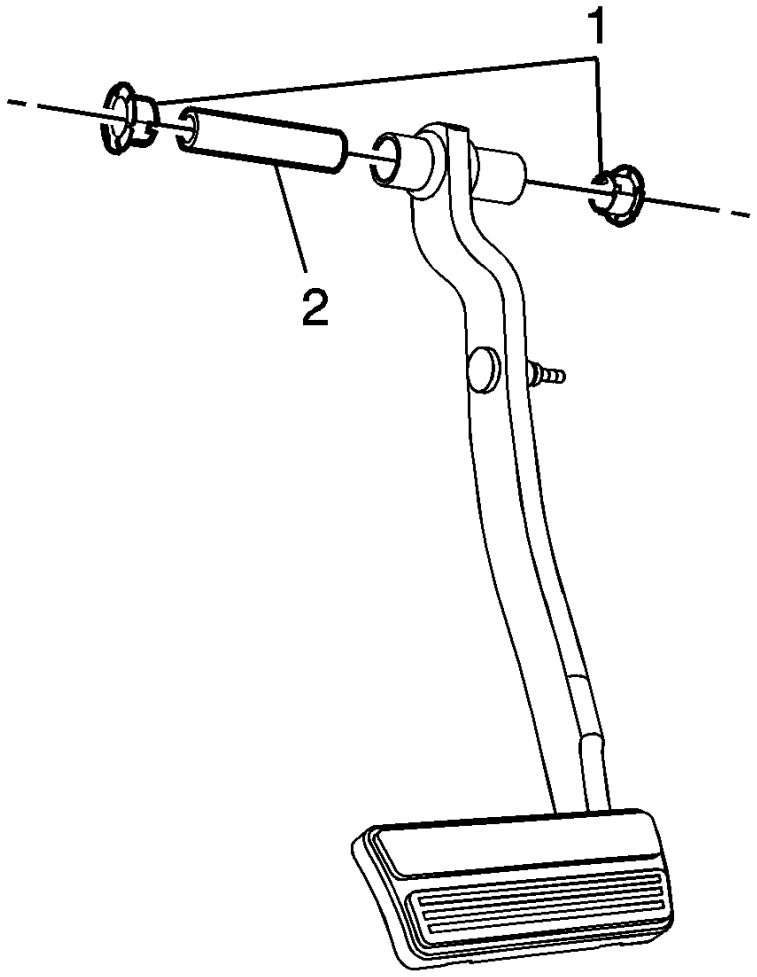


Fig. 33: View Of Brake Pedal Pivot Bushing & Spacer
Courtesy of GENERAL MOTORS COMPANY

10. Remove the brake pedal pivot bushings (1) and spacer (2).

Installation Procedure

1. Apply a light coating of silicone lubricant to the brake pedal pivot spacer.

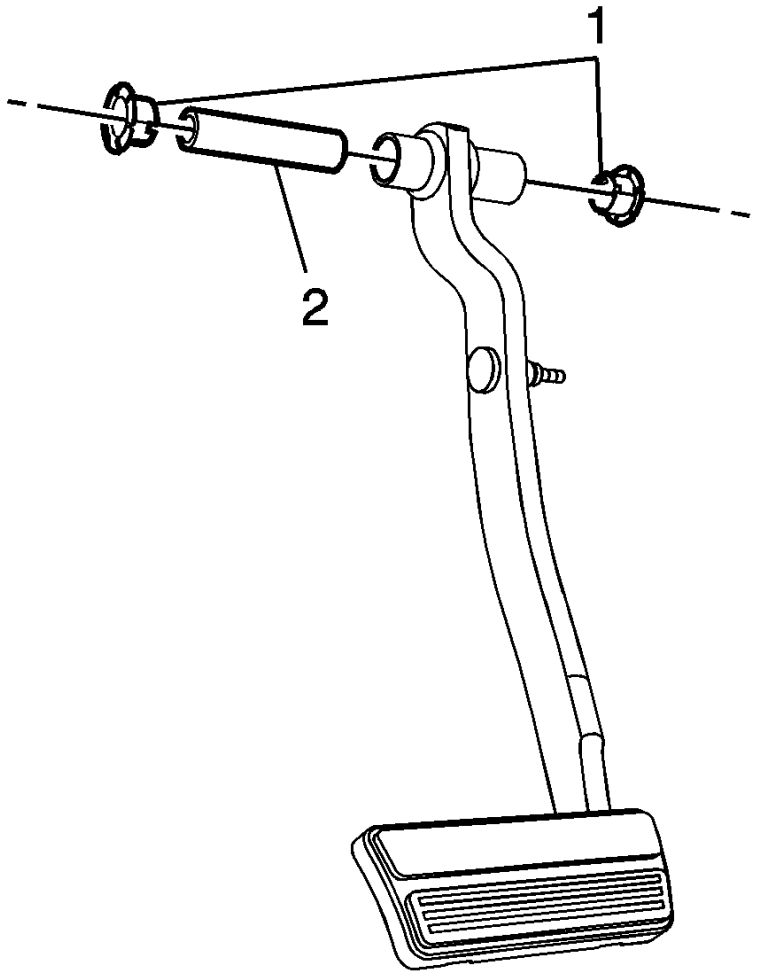


Fig. 34: View Of Brake Pedal Pivot Bushing & Spacer
Courtesy of GENERAL MOTORS COMPANY

2. Install the brake pedal pivot bushings (1) and spacer (2).

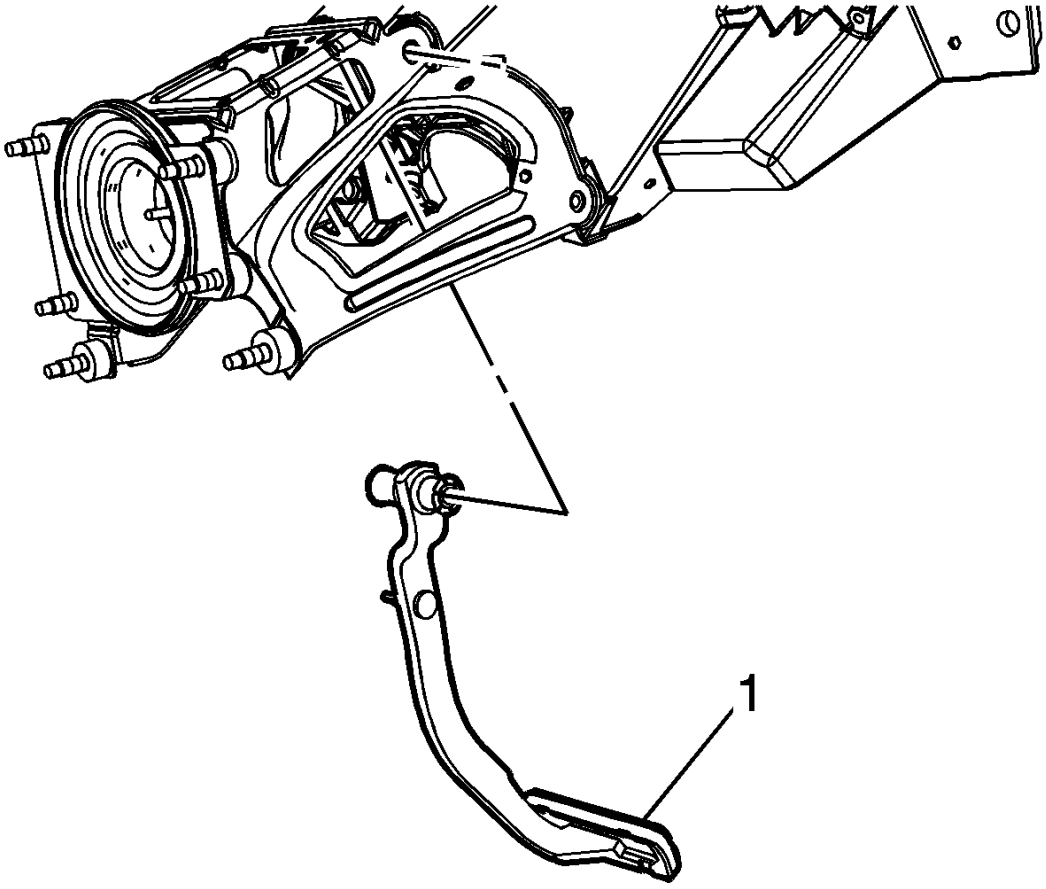


Fig. 35: View Of Brake Pedal Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Install the brake pedal (1).

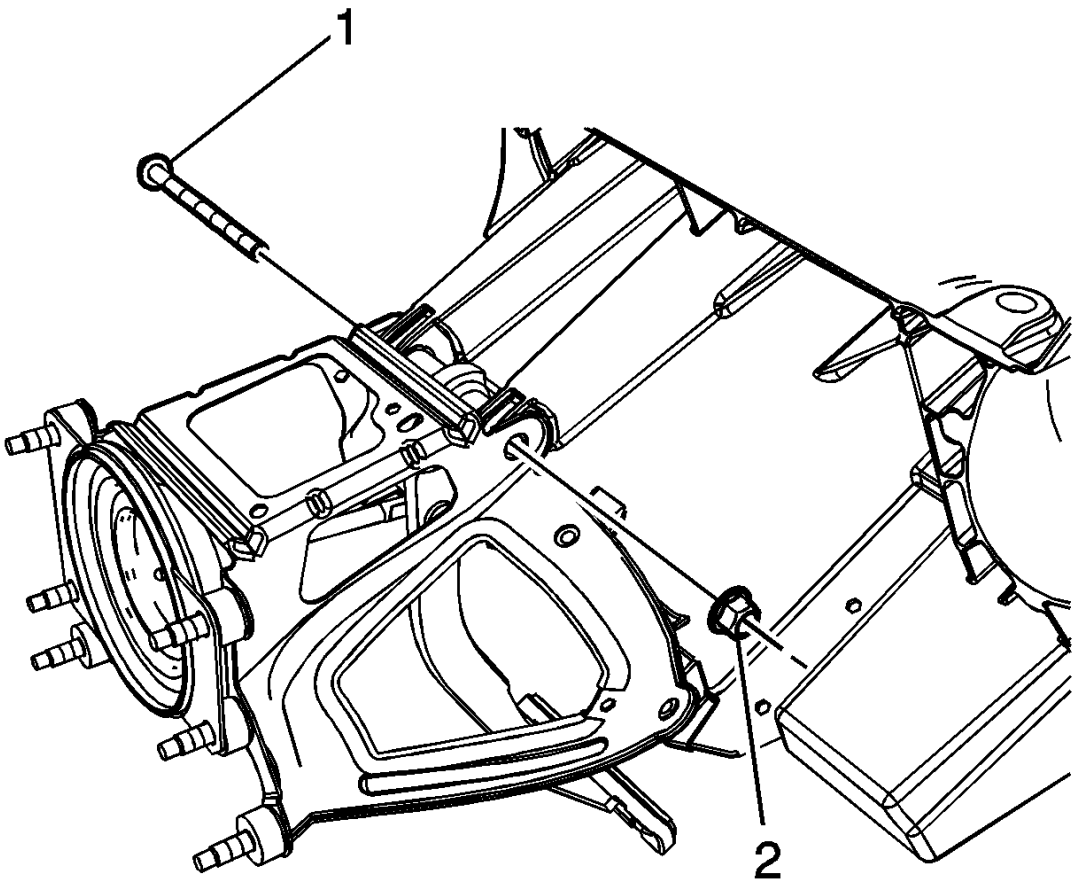


Fig. 36: View Of Brake Pedal Assembly, Bolt & Nut
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the brake pedal bolt (1) and nut (2) and tighten to 40 N.m (30 lb ft).

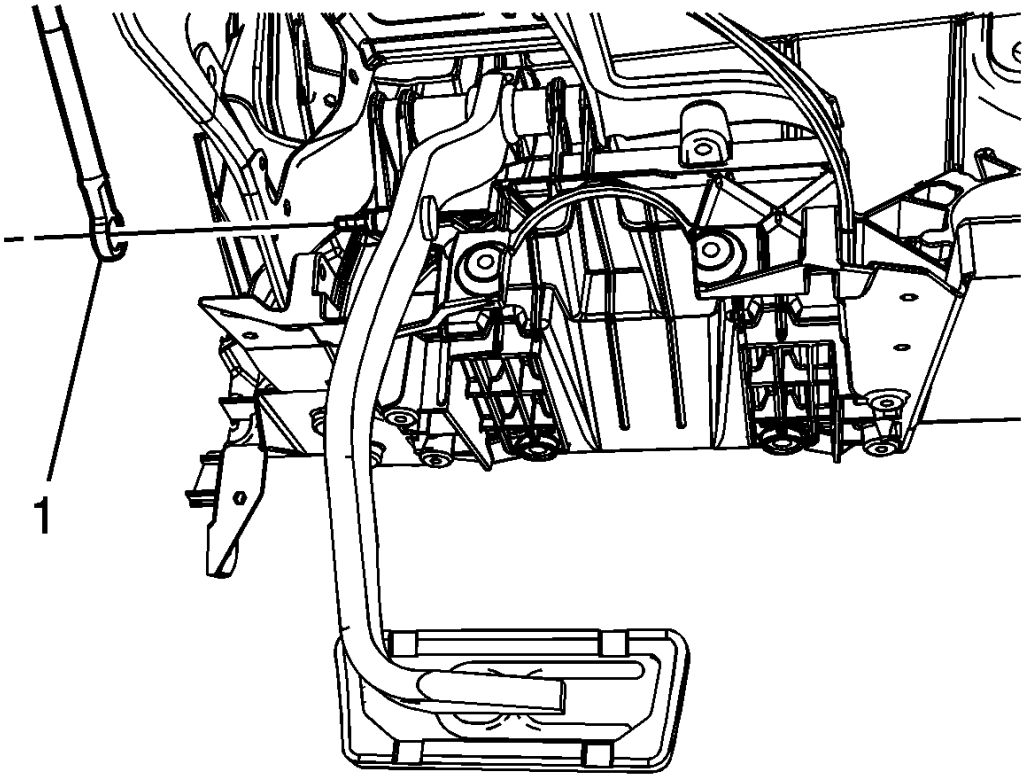


Fig. 37: View Of Brake Pedal Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

5. Connect the brake pedal pushrod (1) to the brake pedal.

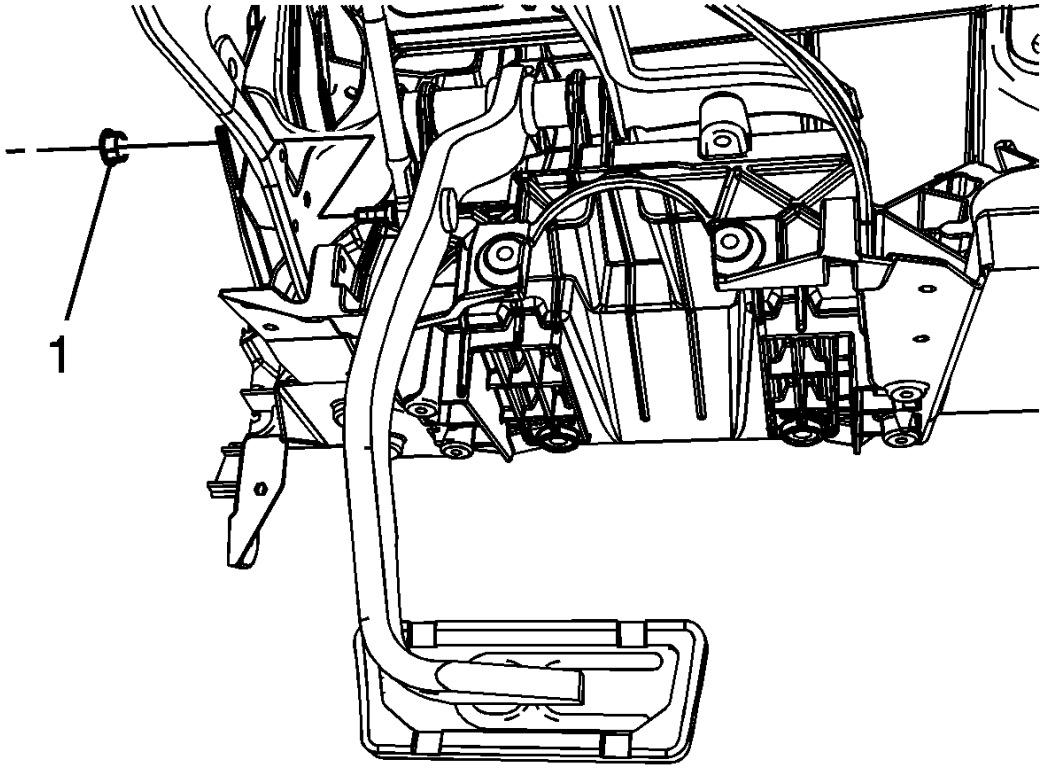


Fig. 38: Identifying Brake Pedal Pushrod Bushing
Courtesy of GENERAL MOTORS COMPANY

6. Install the brake pedal pushrod bushing (1).

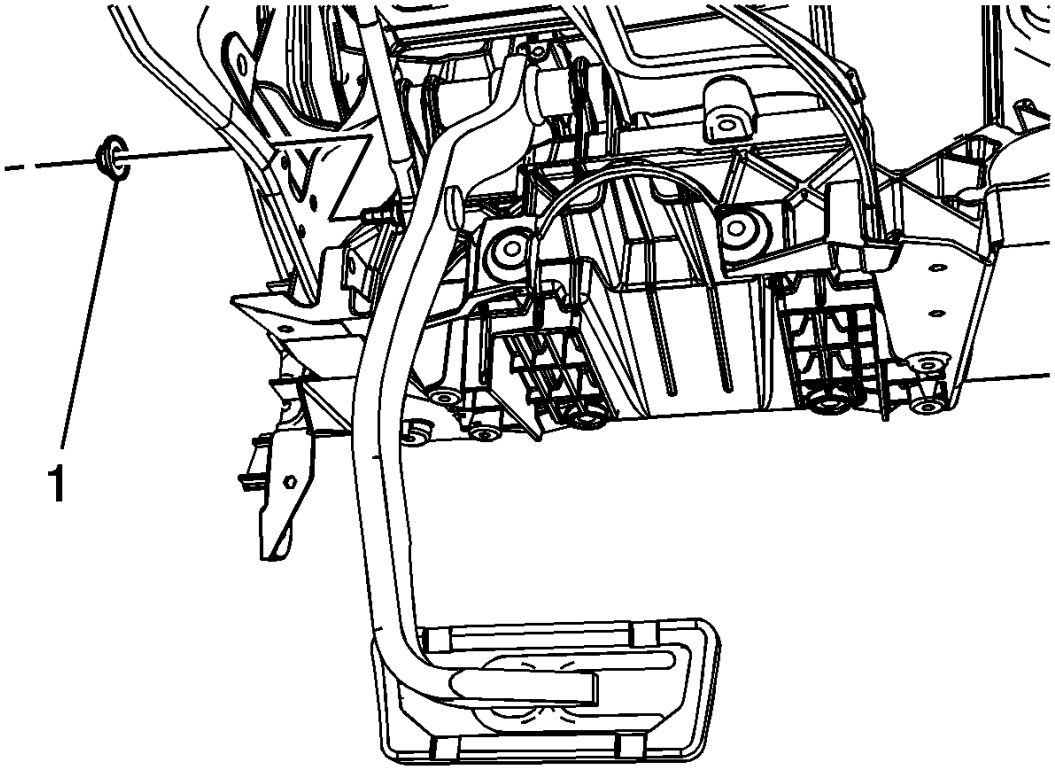


Fig. 39: Identifying Brake Pedal Pushrod Nut
Courtesy of GENERAL MOTORS COMPANY

7. Install the brake pedal pushrod nut (1) and tighten to 13 N.m (115 lb in).
8. Secure the wiring harness clips to the bracket.
9. Connect the brake pedal position sensor electrical connector.
10. Insert the top of the BCM up into the mounting bracket, then engage the bottom of the BCM into the mounting bracket slot.
11. Install the left instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .

BRAKE PIPE REPLACEMENT

Special Tools

J 45405 Pipe Flaring Tool Kit

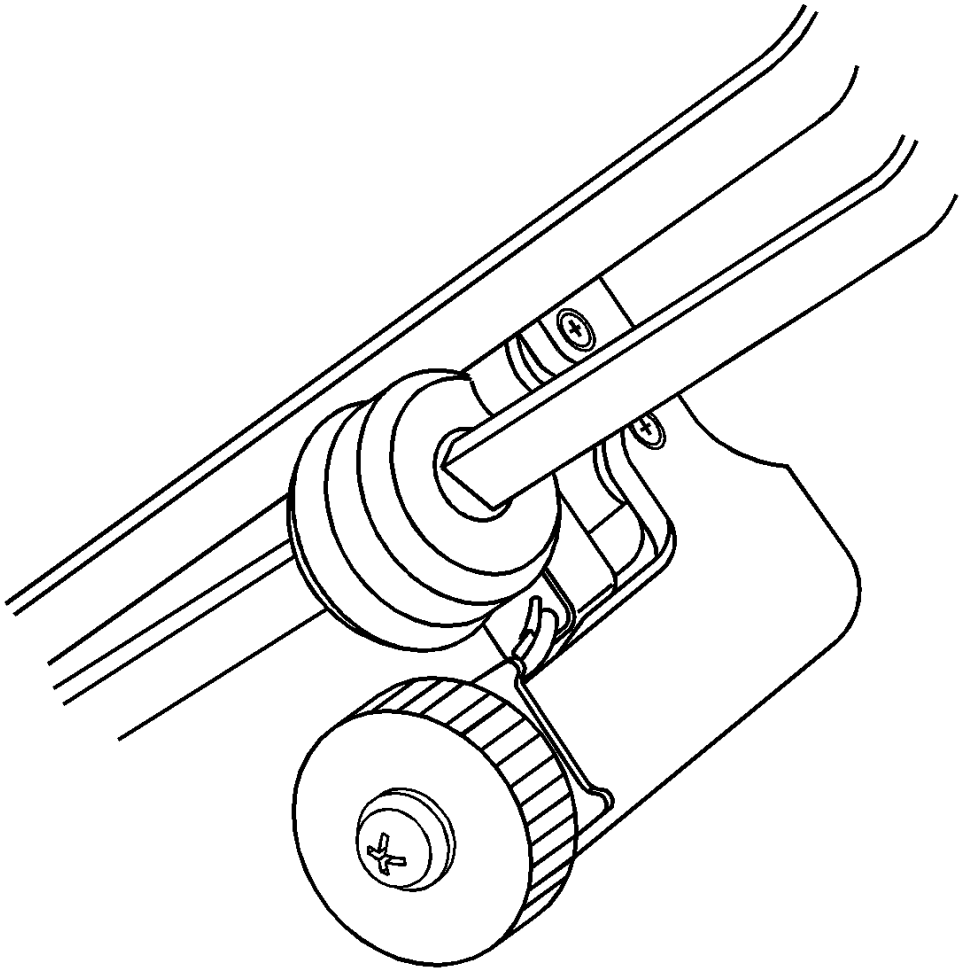


Fig. 40: Sectioning Brake Pipe Using Pipe Cutter
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Brake Fluid Irritant Warning .**

WARNING: **Always use double walled steel brake pipe when replacing brake pipes. The use of any other pipe is not recommended and may cause brake system failure. Carefully route and retain replacement brake pipes. Always use the correct fasteners and the original location for replacement brake pipes. Failure to properly route and retain brake pipes may cause damage to the brake pipes and cause brake system failure.**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

NOTE: **When servicing brake pipes, note the following:**

- **If sectioning brake pipe, use replacement pipe of the same type and outside diameter.**
- **Use fittings of the appropriate size and type.**

- **Only create flares of the same type or design as originally equipped on the vehicle.**

1. Inspect the section of brake pipe to be replaced.
2. Release the brake pipe to be replaced from the retainers, as required.
3. Select an appropriate location to section the brake pipe, if necessary.
   - Allow adequate clearance in order to maneuver the **J 45405** pipe flaring tool kit.
   - Avoid sectioning the brake pipe at bends or mounting points.
4. Using a string or wire, measure the length of the pipe to be replaced including all pipe bends.
5. Add to the measurement taken the appropriate additional length required for each flare to be created.

   Specification

   6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe

   NOTE: **Ensure that the brake pipe end to be flared is cut at a square, 90 degree angle to the pipe length.**

6. Using the pipe cutter included in the **J 45405** pipe flaring tool kit carefully cut the brake pipe squarely to the measured length.
7. Remove the sectioned brake pipe from the vehicle.
8. Select the appropriate size of brake pipe and tube nuts, as necessary. The brake pipe outside diameter determines brake pipe size.

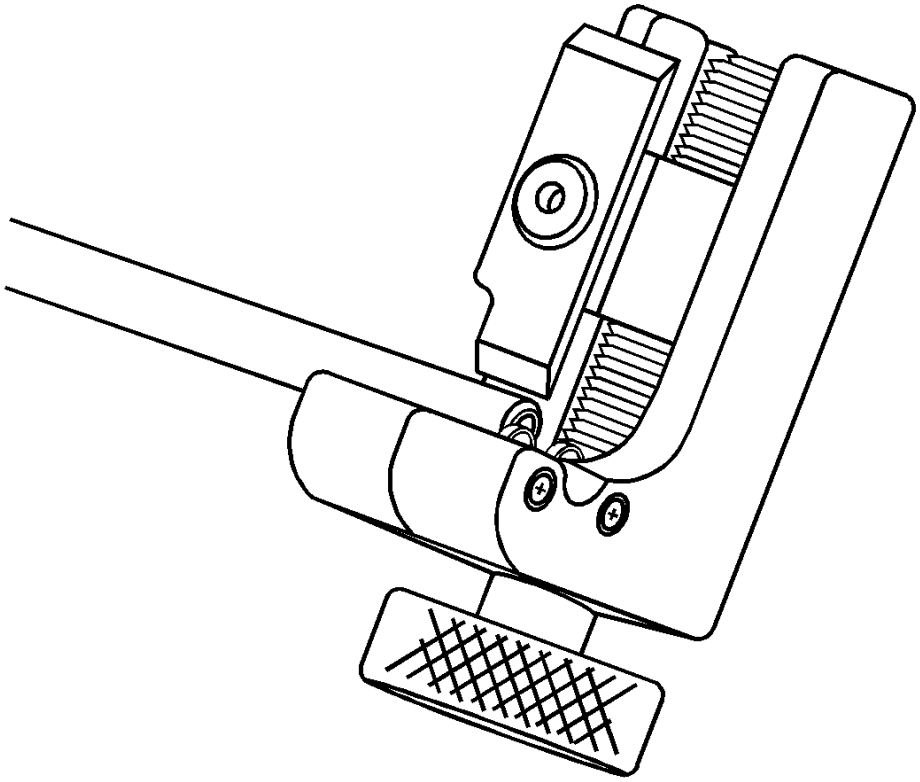


Fig. 41: Stripping Nylon Coating From Brake Pipe Ends
Courtesy of GENERAL MOTORS COMPANY

9. Strip the nylon coating from the brake pipe ends to be flared, if necessary.
    - Select the appropriate blade on the coating stripping tool included in the **J 45405** pipe flaring tool kit by unthreading the blade block from the stripping tool and installing the block with the desired blade facing the tool rollers.

      Specification

      6.35 mm (0.250 in) blade for 4.76 mm (3/16 in) diameter pipe

    - Insert the brake pipe end to be flared into the stripping tool to the depth of the ledge on the tool rollers.
    - While holding the brake pipe firmly against the stripping tool roller ledges, rotate the thumbwheel of the tool until the blade contacts the brake pipe coated surface.

      NOTE: Do not gouge the metal surface of the brake pipe.

    - Rotate the stripping tool in a clockwise direction, ensuring that the brake pipe end remains against

the tool roller ledges.

- After each successive revolution of the stripping tool, carefully rotate the thumbwheel of the tool clockwise, in order to continue stripping the coating from the brake pipe until the metal pipe surface is exposed.
- Loosen the thumbwheel of the tool and remove the brake pipe.

NOTE: **Ensure that all loose remnants of the nylon coating have been removed from the brake pipe.**

- Inspect the stripped end of the brake pipe to ensure that the proper amount of coating has been removed.

Specification

6.35 mm (0.250 in) for 4.76 mm (3/16 in) diameter pipe

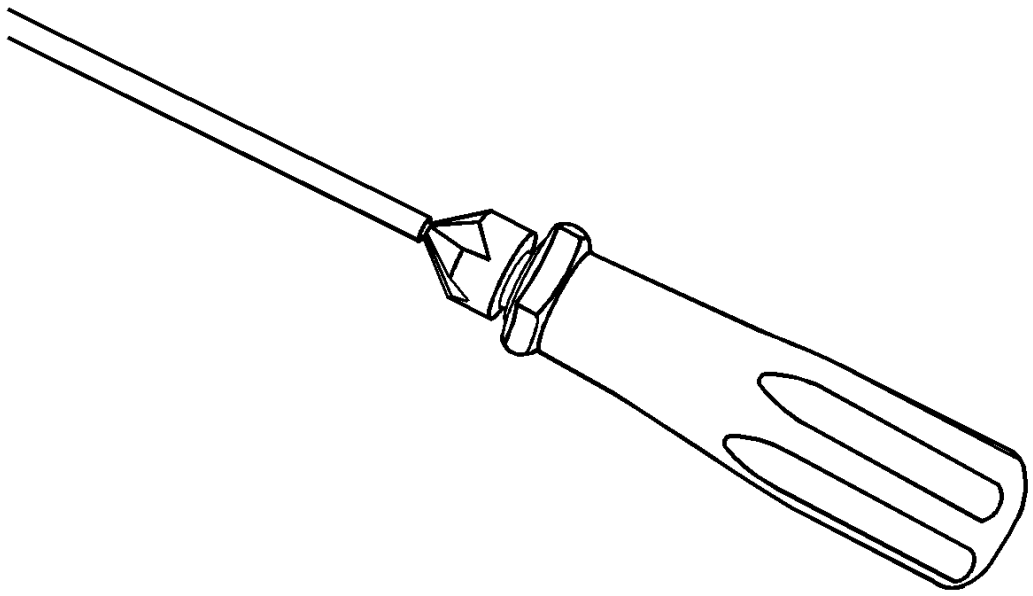


Fig. 42: Chamfering Pipe Using De-Burring Tool
Courtesy of GENERAL MOTORS COMPANY

10. Chamfer the inside and outside diameter of the pipe with the de-burring tool included in the **J 45405** pipe

flaring tool kit .

11. Install the tube nuts on the brake pipe, noting their orientation.
12. Clean the brake pipe and the **J 45405** pipe flaring tool kit of lubricant, contaminants, and debris.

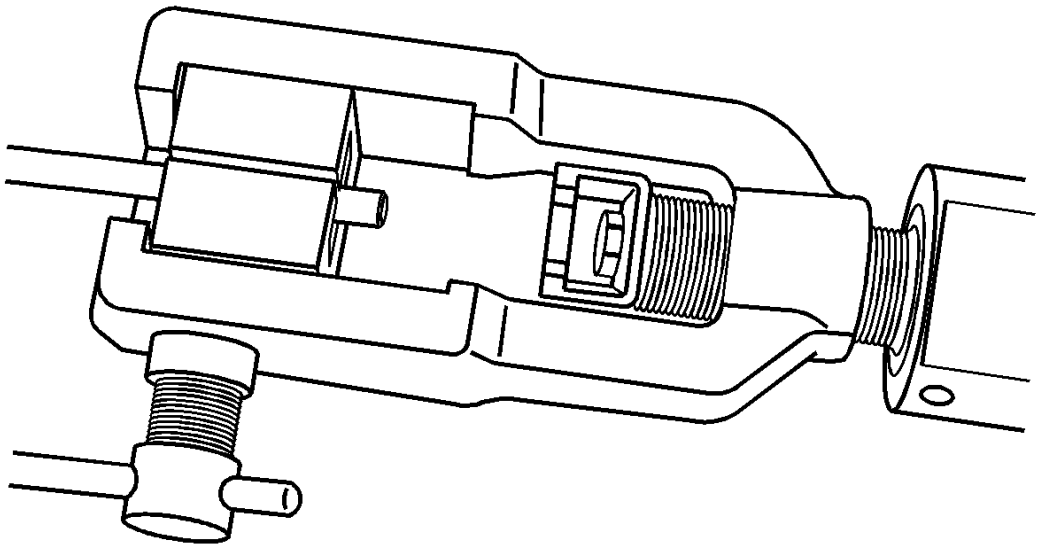


Fig. 43: Installing Die Halves Into Die Cage
Courtesy of GENERAL MOTORS COMPANY

13. Loosen the die clamping screw of the **J 45405** pipe flaring tool kit.
14. Select the corresponding die set and install the die halves into the die cage with the full, flat face of one die facing the clamping screw, and the counterbores of both dies facing the forming ram.

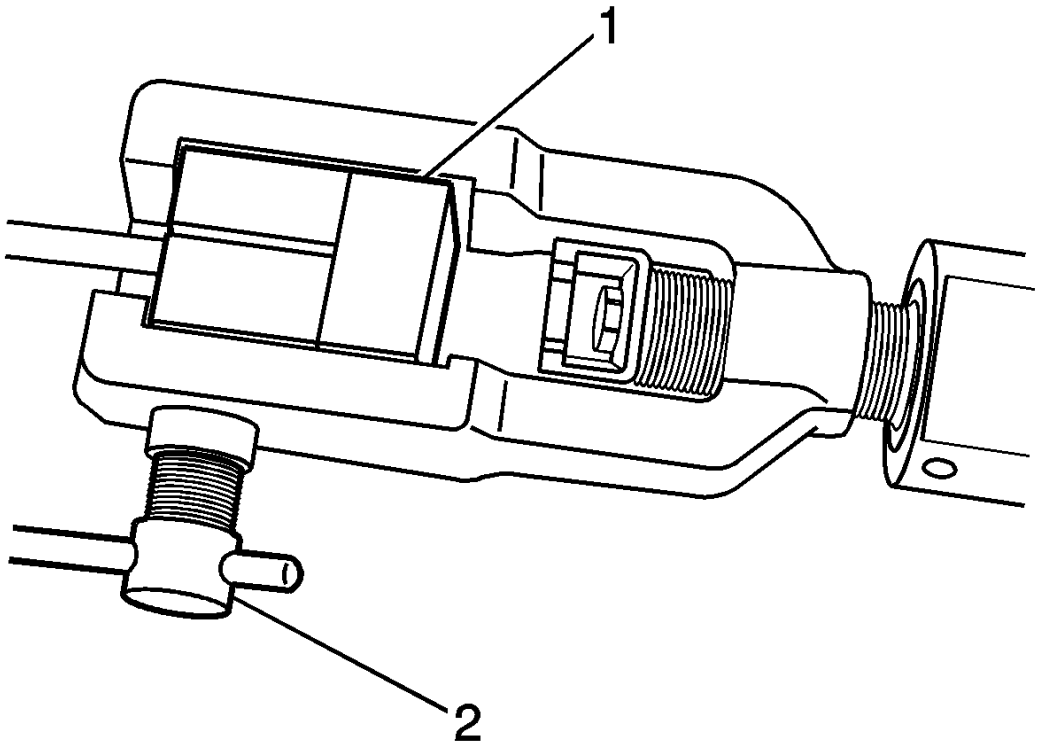


Fig. 44: View Of Clamping Screw & Unused Die
Courtesy of GENERAL MOTORS COMPANY

15. Place the flat face of an unused die (1) against the die halves in the clamping cage and hold firmly against the counterbored face of the dies.
16. Insert the prepared end of the pipe to be flared through the back of the dies until the pipe is seated against the flat surface of the unused die (1).
17. Remove the unused die (1).
18. Ensure that the rear of both dies are seated firmly against the enclosed end of the die cage.
19. Firmly hand tighten the clamping screw (2) against the dies.

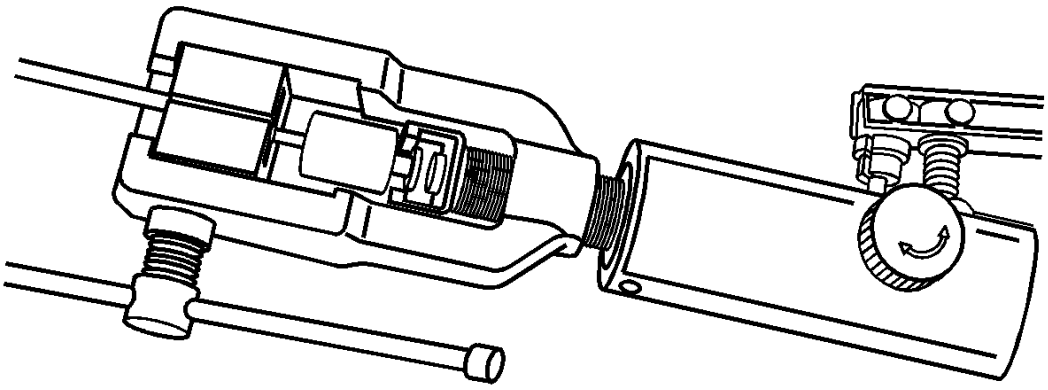


Fig. 45: Rotating J 45405 To Bottom Against Die Cage
Courtesy of GENERAL MOTORS COMPANY

20. Select the appropriate forming mandrel and place into the forming ram.
21. Rotate the hydraulic fluid control valve clockwise to the closed position.
22. Rotate the body of the **J 45405** pipe flaring tool kit until it bottoms against the die cage.

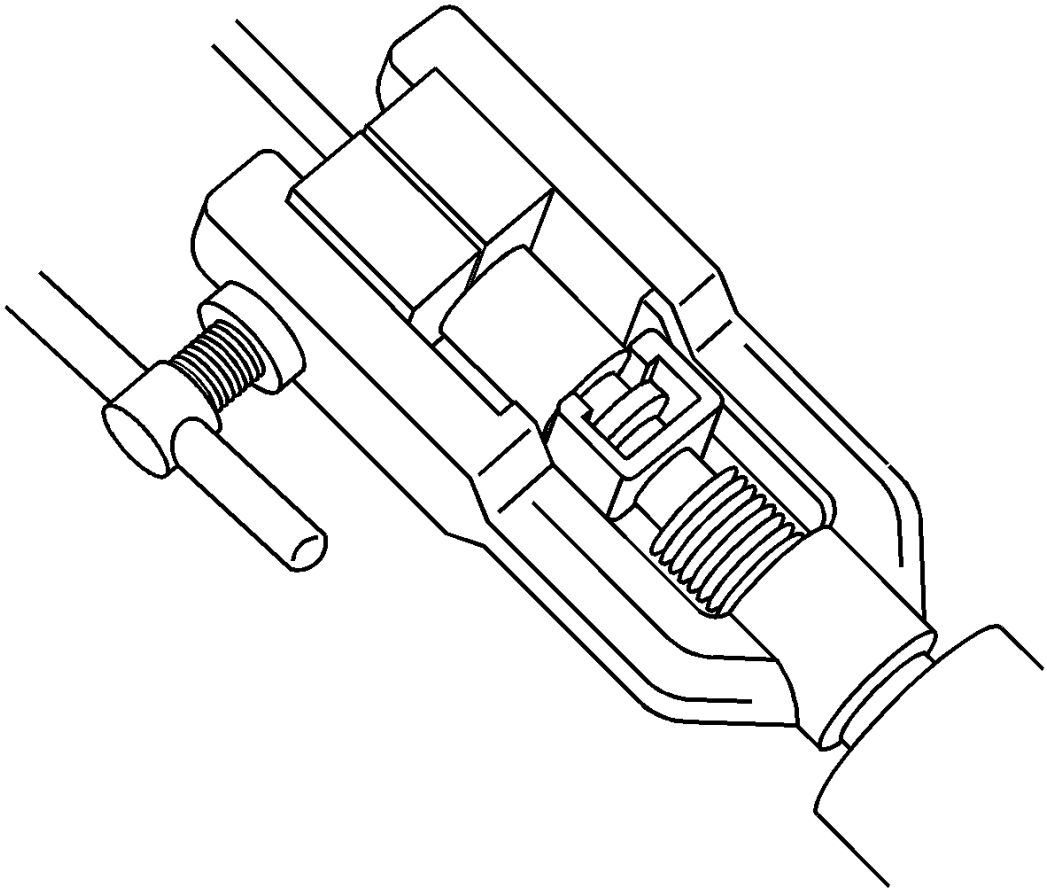


Fig. 46: Bottoming Forming Mandrel Against Clamping Dies Using Pipe Flaring Tool
Courtesy of GENERAL MOTORS COMPANY

23. While guiding the forming mandrel into the exposed end of pipe to be flared, operate the lever of the **J 45405** pipe flaring tool kit until the forming mandrel bottoms against the clamping dies.
24. Rotate the hydraulic fluid control valve counterclockwise to the open position to allow the hydraulic forming ram to retract.
25. Loosen the die clamping screw and remove the dies and pipe.
26. If necessary, lightly tap the dies until the die halves separate.

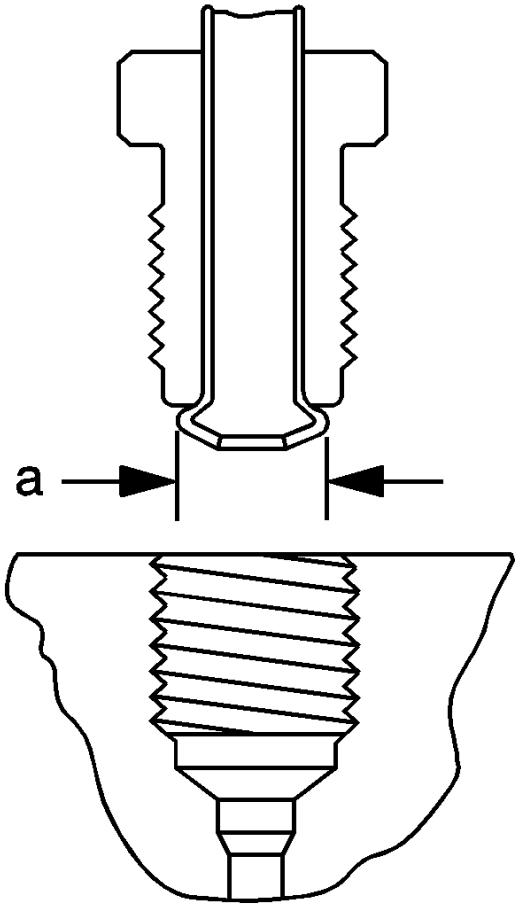


Fig. 47: Inspecting Brake Pipe Flare Diameter
Courtesy of GENERAL MOTORS COMPANY

27. Inspect the brake pipe flare for correct shape and diameter (a).

    Specification

    7.10 mm (0.279 in) +/- 0.18 mm (0.007 in) flare diameter for 4.76 mm (3/16 in) diameter pipe

28. If necessary, using the removed section of pipe as a template, shape the new pipe with a suitable brake pipe bending tool.

    NOTE: When installing the pipe, maintain a clearance of 19 mm (3/4 in) from all moving or vibrating components.

29. Install the pipe to the vehicle with the appropriate brake pipe unions as required.
30. If previously released, secure the brake pipe to the retainers.
31. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)**.
32. With the aid of an assistant, inspect the brake pipe flares for leaks by starting the engine and applying the

brakes.

FRONT BRAKE HOSE REPLACEMENT

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Clean all dirt and foreign material from the brake hoses and brake pipe fitting.

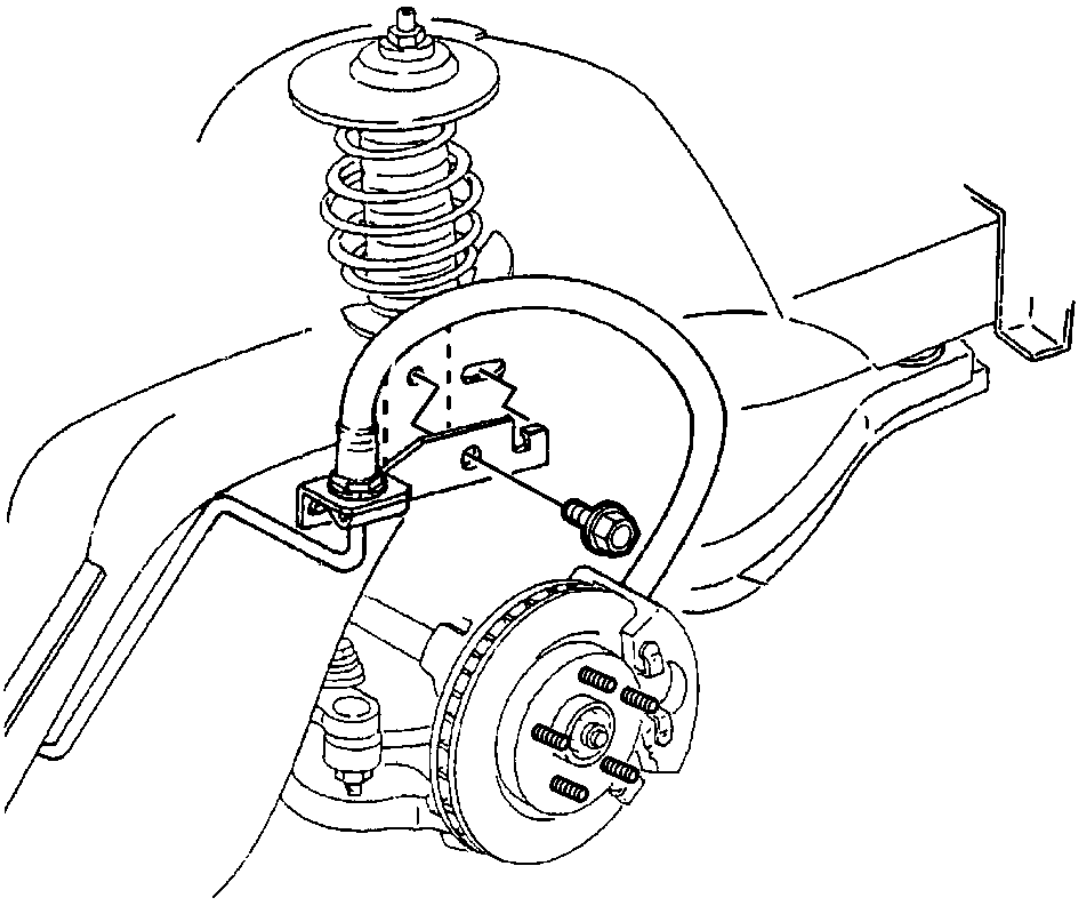


Fig. 48: Front Brake Hose & Mounting Bracket
Courtesy of GENERAL MOTORS COMPANY

NOTE: Install a rubber cap or plug to the exposed brake pipe fitting end to prevent brake fluid loss and contamination.

4. Use a backup wrench on the hose fitting, disconnect the brake pipe fitting from the brake hose, then cap or plug the brake pipe fitting end.

   Do not bend the brake pipe or the bracket.

5. Remove the brake hose retaining clip from the hose mounting bracket.
6. Remove the hose from the bracket.

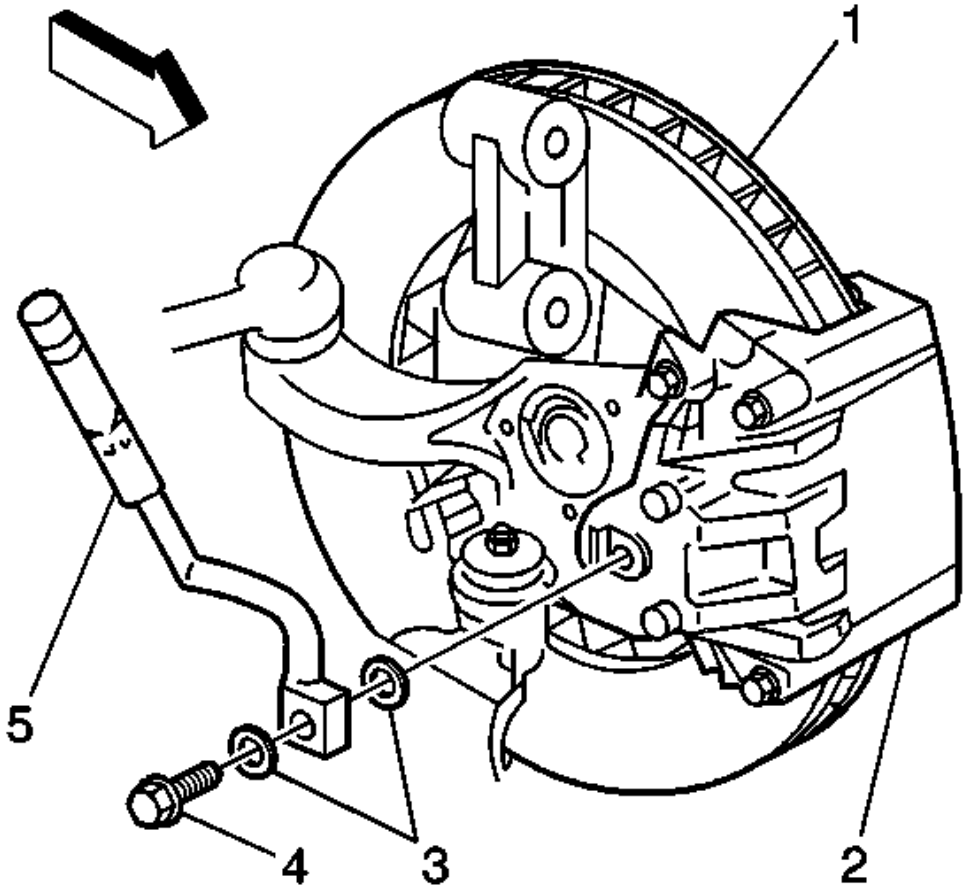


Fig. 49: Identifying Brake Hose At Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

7. Remove the brake hose to caliper bolt (4) from the brake caliper (2).
8. Remove the brake hose (5) from the brake caliper (2).
9. Remove and discard the two copper brake hose gaskets (3). These gaskets may be stuck to the brake caliper and/or the brake hose end.

Installation Procedure

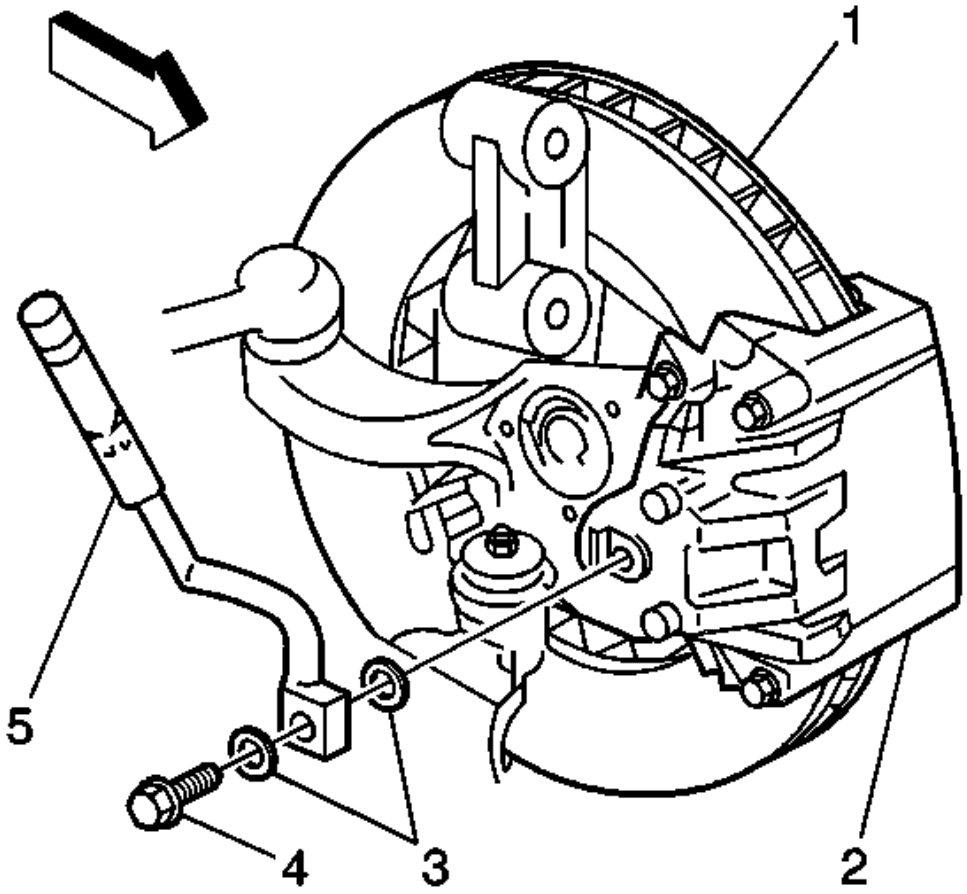


Fig. 50: Identifying Brake Hose At Brake Caliper
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install NEW copper brake hose gaskets (3).**

1. Assemble the NEW copper brake hose gaskets (3), and the brake hose bolt (4) to the brake hose.

CAUTION: **Refer to Fastener Caution .**

2. Install the brake hose to caliper bolt to the brake caliper.

Tighten

Tighten the brake hose to brake caliper bolt to 54 N.m (40 lb ft).

3. With the weight of the vehicle on the suspension, install the brake hose into the bracket.

There should not be any kinks in the hose.

Align the hose fitting with the notch in the bracket. Use the hose paint stripe as a visual aid.

4. Install the retainer onto the hose fitting at the bracket.
5. Remove the rubber cap or plug from the exposed brake pipe fitting end.

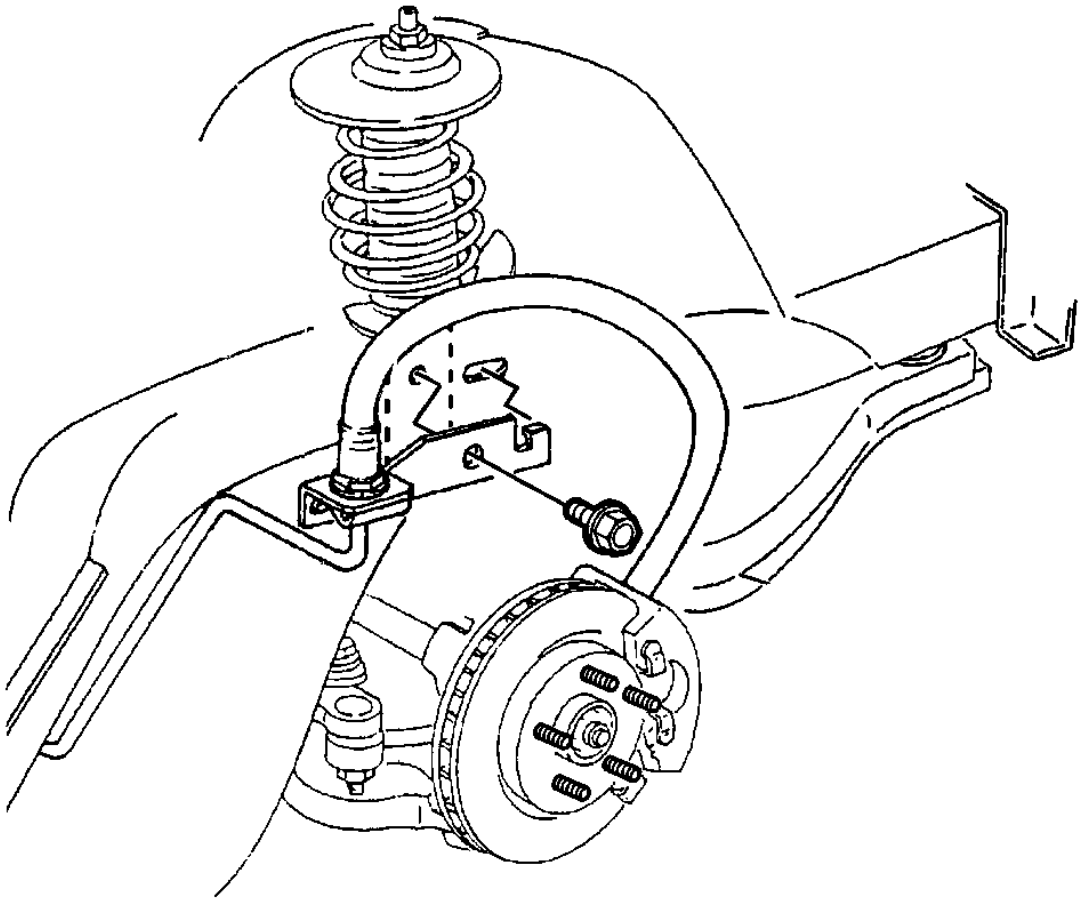


Fig. 51: Front Brake Hose & Mounting Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Connect the brake pipe fitting to the brake hose:
    - Use a backup wrench on the hose fitting.
    - Do not bend the bracket or pipe.

    Tighten

    Tighten the brake pipe fitting to 18 N.m (13 lb ft).

7. Install the front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
8. Ensure that the hose does not make contact with any part of the suspension. Check the hose in extreme right and extreme left turn conditions. If the hose makes contact, remove the hose and correct the condition.

9. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)**.
10. Lower the vehicle.

REAR BRAKE HOSE REPLACEMENT

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the rear tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Clean all dirt and foreign material from the brake hoses and brake pipe fitting.

   NOTE: Install a rubber cap or plug to the exposed brake pipe fitting end to prevent brake fluid loss and contamination.

4. Use a backup wrench on the hose fitting, disconnect the brake pipe fitting from the brake hose, then cap or plug the brake pipe fitting end.

   Do not bend the brake pipe or the bracket.

5. Remove the brake hose retaining clip from the hose mounting bracket.
6. Remove the hose from the bracket.

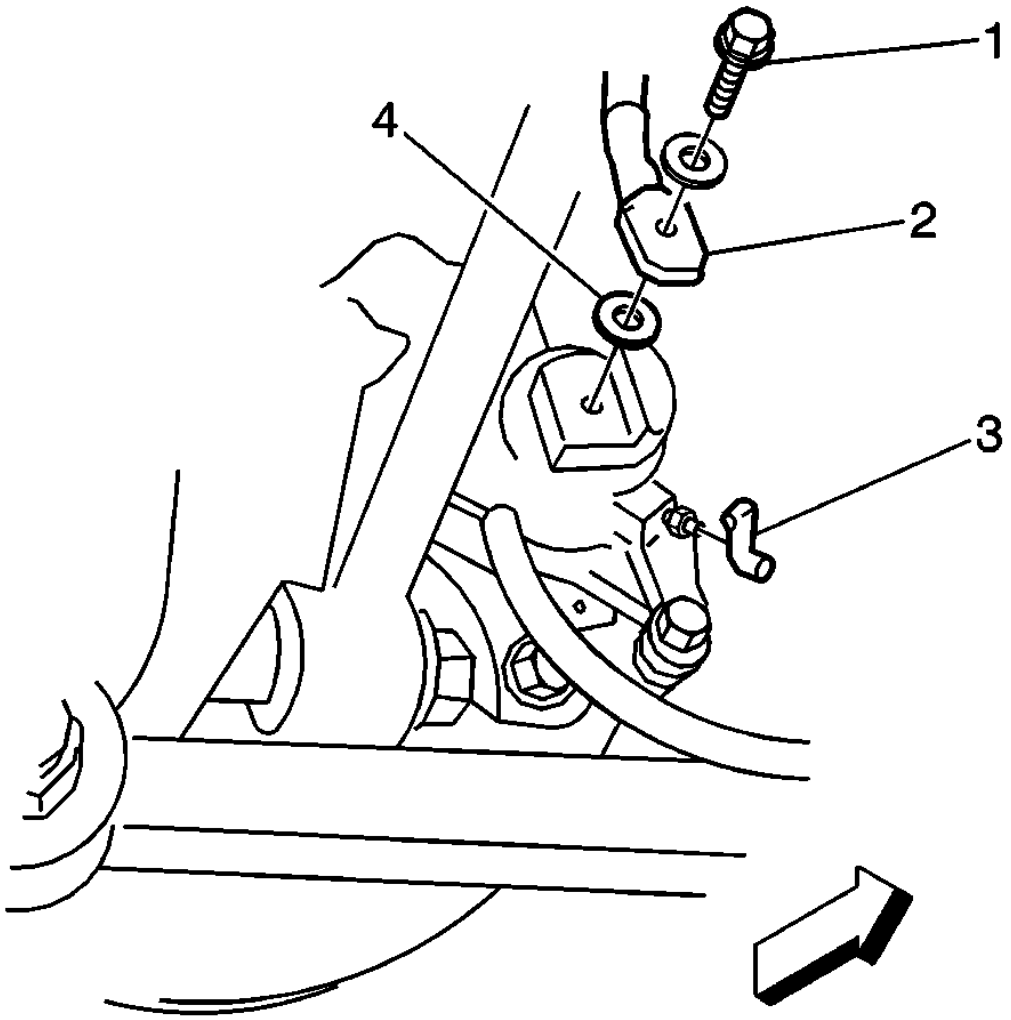


Fig. 52: Rear Brake Hose At Caliper
Courtesy of GENERAL MOTORS COMPANY

7. Remove the brake hose to caliper bolt (1) from the brake caliper.
8. Remove the brake hose (2) from the brake caliper.
9. Remove and discard the two copper brake hose gaskets (4). These gaskets may be stuck to the brake caliper and/or the brake hose end.

Installation Procedure

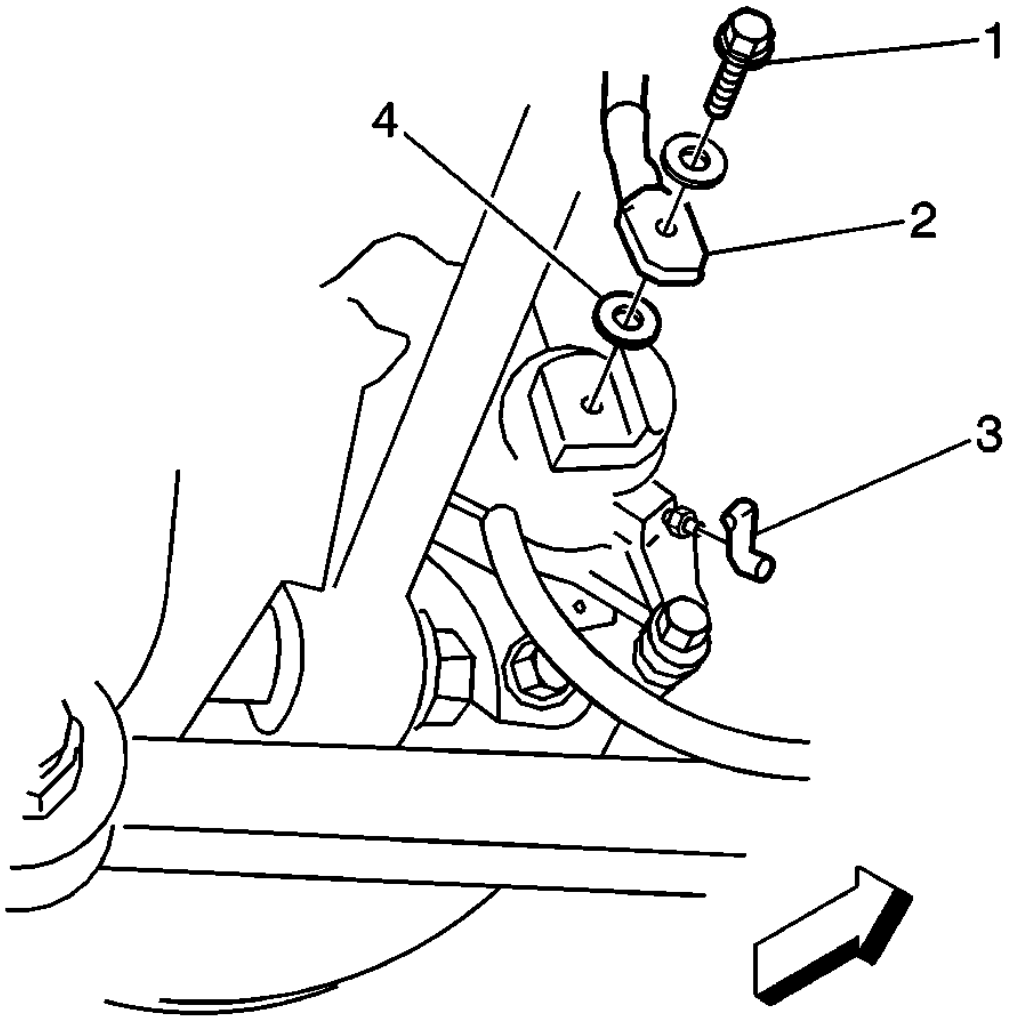


Fig. 53: Rear Brake Hose At Caliper
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install NEW copper brake hose gaskets (4).**

1. Assemble the NEW copper brake hose gaskets (4), and the brake hose bolt (1) to the brake hose (2).

CAUTION: **Refer to Fastener Caution .**

2. Install the brake hose to caliper bolt (1) to the brake caliper.

Tighten

Tighten the brake hose to brake caliper bolt to 54 N.m (40 lb ft).

3. With the weight of the vehicle on the suspension, install the brake hose into the bracket.

There should not be any kinks in the hose.

Align the hose fitting with the notch in the bracket. Use the hose paint stripe as a visual aid.

4. Install the retainer onto the hose fitting at the bracket.
5. Remove the rubber cap or plug from the exposed brake pipe fitting end.
6. Connect the brake pipe fitting to the brake hose:
    - Use a backup wrench on the hose fitting.
    - Do not bend the bracket or pipe.

    Tighten

    Tighten the brake pipe fitting to 18 N.m (13 lb ft).
7. Install the rear tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
8. Ensure that the hose does not make contact with any part of the suspension. If the hose makes contact, remove the hose and correct the condition.
9. Bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)**.
10. Lower the vehicle.

HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL)

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

CAUTION: Only use products that comply with GM specifications and check manufacturer information respectively. We recommend the use of GM genuine products. Instructions must be followed at all times. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.

If hydraulic components were serviced on only one wheel hydraulic circuit, perform the following procedure.

Bleeding a Single Hydraulic Brake Circuit

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Add brake fluid as needed to ensure that the brake master cylinder reservoir remains at least half-full throughout the bleed procedure. The reservoir cap must be installed at all times except when filling the reservoir. Refer to **Fluid and Lubricant Recommendations** .
5. Install a proper box-end wrench onto the wheel hydraulic circuit bleeder valve which has been serviced.
6. Install a transparent hose over the end of the bleeder valve.
7. Submerge the open end of the transparent hose into a transparent container partially filled with brake fluid

from a clean, sealed brake fluid container.

8. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
9. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
10. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
11. Wait 15 seconds, then repeat steps 8-10 until all air is purged from the wheel hydraulic circuit.
12. After all air has been purged from the hydraulic circuit, tighten the bleeder valve and install the dust cap.
13. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
14. Slowly press and release the brake pedal. Observe the brake pedal feel.
15. If the brake pedal feels spongy, perform the Bleeding the Complete Brake Hydraulic System procedure:
16. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

NOTE: **DO NOT allow the vehicle to be driven until it is diagnosed and repaired.**

17. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

Bleeding the Complete Brake Hydraulic System

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Add brake fluid as needed to ensure that the brake master cylinder reservoir remains at least half-full throughout the bleed procedure. The reservoir cap must be installed at all times except when filling the reservoir. Refer to **Fluid and Lubricant Recommendations** .
5. If the master cylinder was replaced, the master cylinder must be bench bled. Refer to **Master Cylinder Bench Bleeding**.
6. If the brake pipes have been removed from the master cylinder, the following steps must be performed.
    1. With the rear brake pipe installed securely to the master cylinder, loosen and separate the front brake pipe fitting from the front port of the brake master cylinder.
    2. Allow a small amount of brake fluid to gravity bleed from the open port of the master cylinder. Capture and properly dispose of the brake fluid in an approved container.
    3. Install the front brake pipe fitting to the front port of the brake master cylinder and tighten the fitting. Refer to **Fastener Specifications**.
    4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
    5. Loosen the front brake pipe fitting from the front port of the brake master cylinder to purge air from the master cylinder port.
    6. Tighten the front brake pipe fitting, then have the assistant slowly release the brake pedal.
    7. Wait 15 seconds, then repeat steps 6.4-6.6 until all air is purged from the front brake pipe fitting of the front port of the master cylinder.

8. After all air is purged from the front port of the brake master cylinder, tighten the front master cylinder brake pipe fitting. Refer to **Fastener Specifications**.
9. With the front brake pipe fitting installed securely to the front port of the brake master cylinder, loosen and separate the rear brake pipe fitting from the rear port of the brake master cylinder.
10. Repeat steps 6.2-6.7 for the rear port of the brake master cylinder.
11. After all air is purged from the rear port of the brake master cylinder, tighten the rear master cylinder brake pipe fitting. Refer to **Fastener Specifications**.
12. Slowly press and release the brake pedal. Observe the brake pedal feel.
13. If the brake pedal feels spongy, proceed to step 7.
14. If the brake pedal feels firm, proceed to step 24.

7. If the brake pipes have been removed from the brake pressure modulator valve (BPMV) assembly, if equipped, or the brake proportion valve assembly, if equipped, air must be purged from each port of the respective assembly beginning with the feed pipes from the master cylinder.
    1. Loosen and separate one of the master cylinder brake pipe fittings from the inlet port of the assembly to be bled.
    2. Allow a small amount of brake fluid to gravity bleed from the open port of the assembly. Capture and properly dispose of the brake fluid in an approved container.
    3. Install the brake pipe fitting and to the inlet port of the assembly and tighten securely.
    4. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the pedal.
    5. Loosen the same brake pipe fitting to purge air from the open port of the assembly.
    6. Tighten the brake pipe fitting, then have the assistant slowly release the brake pedal.
    7. Wait 15 seconds, then repeat steps 7.4-7.6 until all air is purged from the brake pipe fitting of the assembly.
    8. Repeat steps 7.1-7.7 for all of the remaining ports of the assembly.
    9. After bleeding each port of the assembly, tighten all of the brake pipe fittings on the assembly. Refer to **Fastener Specifications**.
    10. Fill the master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container.
    11. Slowly press and release the brake pedal. Observe the brake pedal feel.
    12. If the brake pedal feels spongy, proceed to step 8.
    13. If the brake pedal feels firm, proceed to step 24.
8. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
9. Install a transparent hose over the end of the bleeder valve.
10. Submerge the open end of the transparent hose into a transparent container partially filled with GM approved brake fluid from a clean, sealed brake fluid container.
11. Have an assistant slowly press the brake pedal fully and maintain steady pressure on the brake pedal.
12. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
13. Tighten the bleeder valve, then have the assistant slowly release the brake pedal.
14. Wait 15 seconds, then repeat steps 11-13 until all air is purged from the wheel hydraulic circuit.
15. Tighten the RIGHT REAR hydraulic wheel circuit bleeder valve securely.

16. Install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
17. Install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
18. Install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 9-14..
19. After completing the final wheel hydraulic circuit bleeding procedure, tighten all of the wheel hydraulic circuit bleeder valves and install the bleeder valve dust caps.
20. Fill the master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container.
21. Slowly press and release the brake pedal. Observe the brake pedal feel.
22. If the brake pedal feels spongy, perform the following procedure.
    1. If equipped with antilock brakes, install a scan tool and perform the **Antilock Brake System Automated Bleed** to remove air which may be trapped in the BPMV.
    2. Inspect the hydraulic brake system for external leaks. Refer to **Brake System External Leak Inspection**.
    3. Repeat the Bleeding the Complete Brake Hydraulic System procedure.
23. If the brake pedal still feels spongy, pressure bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)**
24. Turn the ignition switch ON with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

NOTE: **DO NOT allow the vehicle to be driven until the brake system is diagnosed and repaired.**

25. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE)

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

CAUTION: **Only use products that comply with GM specifications and check manufacturer information respectively. We recommend the use of GM genuine products. Instructions must be followed at all times. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.**

If hydraulic components were serviced on only one wheel hydraulic circuit, perform the following procedure.

Bleeding a Single Hydraulic Brake Circuit

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.

2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations** .

NOTE: **The pressure bleeding equipment must be the diaphragm type. The rubber diaphragm between the air supply and the brake fluid prevents air, moisture, oil, and other contaminants from entering the hydraulic system.**

5. Following the brake pressure bleeder manufacturer's instructions, fill the brake pressure bleeder with GM approved brake fluid from a clean, sealed brake fluid container.
6. Install the appropriate master cylinder reservoir adapter and connect the brake pressure bleeder.
7. Charge the brake pressure bleeder air tank to 170-200 kPa/1.7-2.0 bar (25-30 psi), or as recommended by the brake pressure bleeder manufacturer's instructions.
8. Open the brake pressure bleeder fluid tank valve to allow pressurized brake fluid to enter the brake hydraulic system.

NOTE: **Any brake fluid leaks identified require repair prior to completing this procedure.**

9. Wait approximately 30 seconds, then inspect the entire hydraulic brake system for external brake fluid leaks.
10. Install a proper box-end wrench onto the wheel hydraulic circuit bleeder valve which has been serviced.
11. Install a transparent hose over the end of the bleeder valve.
12. Submerge the open end of the transparent hose into a transparent container partially filled with brake fluid from a clean, sealed brake fluid container.
13. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
14. Allow fluid to flow until air bubbles stop flowing from the bleeder.
15. After all air has been purged from the hydraulic circuit, tighten the bleeder valve and install the dust cap.

NOTE: **The brake reservoir may have residual pressure after the bleeding operation is complete. Wrap a clean shop towel around the bleeder adapter and all hose connections before disconnecting the pressure bleeding equipment to prevent brake fluid from contacting and damaging vehicle components and painted surfaces.**

16. Close the brake pressure bleeder fluid tank valve then disconnect the brake pressure bleeder from the master cylinder reservoir bleeder adapter.
17. Remove the master cylinder reservoir bleeder adapter from the master cylinder reservoir.
18. Fill the brake master cylinder reservoir to the maximum-fill level with GM approved brake fluid from a clean, sealed brake fluid container.
19. Slowly press and release the brake pedal. Observe the brake pedal feel.
20. If the brake pedal feels spongy, perform the Bleeding the Complete Brake Hydraulic System procedure:

21. Turn the ignition key ON, with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

NOTE: **DO NOT allow the vehicle to be driven until it is diagnosed and repaired.**

22. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

Bleeding the Complete Brake Hydraulic System

1. With the ignition OFF and the brakes cool, apply the brakes 3-5 times, or until the brake pedal effort increases significantly, in order to deplete the brake booster power reserve.
2. Place a clean shop cloth beneath the brake master cylinder to catch brake fluid spills.
3. Clean the outside of the reservoir on and around the reservoir cap prior to removing the cap and diaphragm.
4. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations** .
5. If the master cylinder was replaced, the master cylinder must be bench bled. Refer to **Master Cylinder Bench Bleeding**.

NOTE: **The pressure bleeding equipment must be the diaphragm type. The rubber diaphragm between the air supply and the brake fluid prevents air, moisture, oil, and other contaminants from entering the hydraulic system.**

6. Following the brake pressure bleeder manufacturer's instructions, fill the brake pressure bleeder with GM approved brake fluid from a clean, sealed brake fluid container.
7. Install the appropriate master cylinder reservoir adapter and connect the brake pressure bleeder.
8. Charge the brake pressure bleeder air tank to 170-200 kPa/1.7-2.0 bar (25-30 psi), or as recommended by the brake pressure bleeder manufacturer's instructions.
9. Open the brake pressure bleeder fluid tank valve to allow pressurized brake fluid to enter the brake hydraulic system.

NOTE: **Any brake fluid leaks identified require repair prior to completing this procedure.**

10. Wait approximately 30 seconds, then inspect the entire hydraulic brake system for external brake fluid leaks.
11. Install a proper box-end wrench onto the RIGHT REAR wheel hydraulic circuit bleeder valve.
12. Install a transparent hose over the end of the bleeder valve.
13. Submerge the open end of the transparent hose into a transparent container partially filled with GM approved brake fluid from a clean, sealed brake fluid container.
14. Loosen the bleeder valve to purge air from the wheel hydraulic circuit.
15. Allow fluid to flow until air bubbles stop flowing from the bleeder.
16. After all air has been purged from the hydraulic circuit, tighten the bleeder valve and install the dust cap.
17. Install a proper box-end wrench onto the LEFT REAR wheel hydraulic circuit bleeder valve, then repeat steps 12-16.

18. Install a proper box-end wrench onto the RIGHT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 12-16.
19. Install a proper box-end wrench onto the LEFT FRONT wheel hydraulic circuit bleeder valve, then repeat steps 12-16.
20. Close the brake pressure bleeder fluid tank valve.

NOTE: **The brake reservoir may have residual pressure after the bleeding operation is complete. Wrap a clean shop towel around the bleeder adapter and all hose connections before disconnecting the pressure bleeding equipment to prevent brake fluid from contacting and damaging vehicle components and painted surfaces.**

21. Remove the brake pressure bleeding equipment from the vehicle.
22. Fill the brake master cylinder reservoir to the maximum-full level with GM approved brake fluid from a clean, sealed brake fluid container. Refer to **Fluid and Lubricant Recommendations** .
23. Slowly press and release the brake pedal. Observe the brake pedal feel.
24. If the brake pedal feels spongy, perform the following procedure.
    1. If equipped with antilock brakes, install a scan tool and perform the **Antilock Brake System Automated Bleed** to remove air which may be trapped in the BPMV.
    2. Inspect the hydraulic brake system for external leaks. Refer to **Brake System External Leak Inspection**.
    3. Repeat the Bleeding the Complete Brake Hydraulic System procedure.
25. If the brake pedal still feels spongy, pressure bleed the hydraulic brake system. Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)** .
26. Turn the ignition switch ON with the engine OFF. Check to see if the brake system warning lamp remains illuminated.

NOTE: **DO NOT allow the vehicle to be driven until the brake system is diagnosed and repaired.**

27. If the brake system warning lamp remains illuminated, refer to **Diagnostic Starting Point - Vehicle** .

HYDRAULIC BRAKE SYSTEM FLUSHING

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

CAUTION: **Only use products that comply with GM specifications and check manufacturer information respectively. We recommend the use of GM genuine products. Instructions must be followed at all times. The use of any type of fluid other than the recommended type of brake fluid, may cause contamination which could result in damage to the internal rubber seals and/or rubber linings of hydraulic brake system components.**

1. Inspect the brake fluid for the following conditions, indicating brake fluid contamination:

- Fluid separation, indicating 2 types of fluid are present; a substance other than the recommended brake fluid has been introduced into the brake hydraulic system
  - Swirled appearance - oil-based substance
  - Layered appearance - silicone-based substance
- Fluid discoloration, indicating the presence of moisture or particles that have been introduced into the brake hydraulic system
  - Cloudy appearance - moisture
  - Dark appearance/suspended particles in fluid - dirt, rust, corrosion, brake dust

2. Inspect the master cylinder reservoir cap diaphragm and the reservoir-to-master cylinder grommets for swelling, indicating brake fluid contamination.
3. If the brake fluid WAS contaminated with an oil-based or a silicone-based substance, indicated by fluid separation and/or a swollen master cylinder reservoir cap diaphragm and/or swollen reservoir-to-master cylinder grommets, perform the following:
   1. Remove ALL of the following components listed from the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

      Refer to the procedures indicated:

      - **Master Cylinder Replacement**
      - **Front Brake Hose Replacement**
      - **Rear Brake Hose Replacement**
      - **Front Brake Caliper Replacement**
      - **Rear Brake Caliper Replacement**
      - **Brake Pressure Modulator Valve Replacement**
   2. Clean out all the hydraulic brake pipes using denatured alcohol, or equivalent.
   3. Dry the brake pipes using non-lubricated, filtered air.
   4. Repair or replace ALL of the following components listed and install them to the vehicle. Each component contains internal rubber seals/linings which have been contaminated by the contaminated brake fluid in the brake hydraulic system.

      Refer to the procedures indicated:

      - **Master Cylinder Overhaul**, or **Master Cylinder Replacement** ; also perform the following:

        Clean the brake master cylinder reservoir using denatured alcohol, or equivalent, then dry the reservoir using non-lubricated, filtered air. Inspect the reservoir for cracks and/or damage and replace if necessary. Refer to **Master Cylinder Reservoir Replacement**.

        Replace the brake master cylinder reservoir cap diaphragm.

      - **Front Brake Hose Replacement**
      - **Rear Brake Hose Replacement**

- **Front Brake Caliper Overhaul** , or **Front Brake Caliper Replacement**
- **Rear Brake Caliper Overhaul** , or **Rear Brake Caliper Replacement**
- **Brake Pressure Modulator Valve Replacement**

4. If the brake fluid was NOT contaminated with an oil-based or a silicone-based substance, but WAS contaminated with water or dirt, rust, corrosion, and/or brake dust, replace the brake master cylinder reservoir cap diaphragm. The diaphragm may have allowed the moisture or particles to enter the hydraulic system.
5. Fill the brake master cylinder reservoir to the maximum-fill level with Delco Supreme 11Â®, GM P/N 12377967 (Canada P/N 992667) or equivalent, DOT-3 brake fluid from a clean, sealed brake fluid container.
6. Pressure bleed the hydraulic brake system. Begin the procedure with the pressure bleeder reservoir filled to the maximum-fill level with the correct brake fluid as indicated. Refer to **Hydraulic Brake System Bleeding (Manual)Hydraulic Brake System Bleeding (Pressure)**.

POWER VACUUM BRAKE BOOSTER REPLACEMENT

Special Tools

J-22805-C Brake Booster Holder

Removal Procedure

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
3. Disconnect the brake fluid level indicator switch electrical connector.

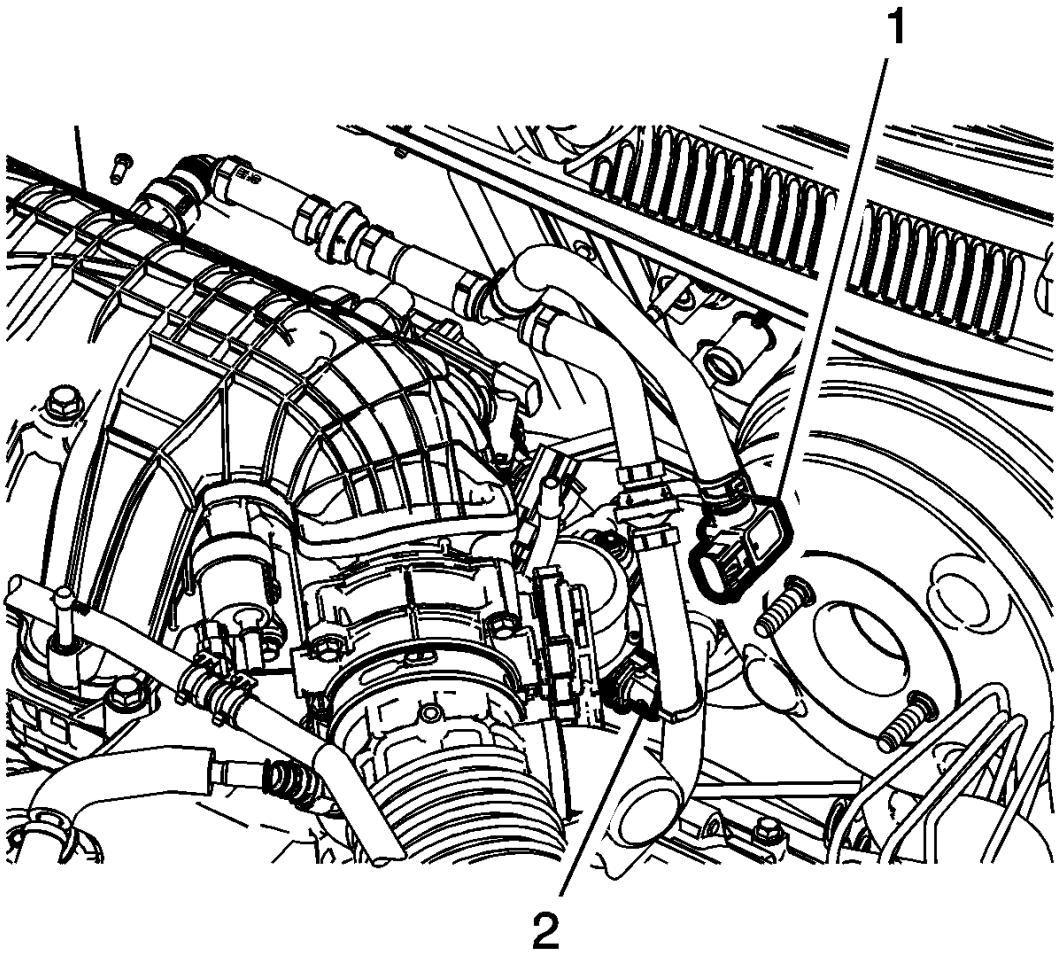


Fig. 54: Power Brake Booster Vacuum Sensor And Power Brake Vacuum Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

4. Remove the power brake booster vacuum sensor (1) from the power vacuum brake booster.
5. Disconnect the power brake vacuum booster hose quick connect (2) from the power brake booster pump.
6. Position the power brake booster vacuum hose and check valve assembly upward.

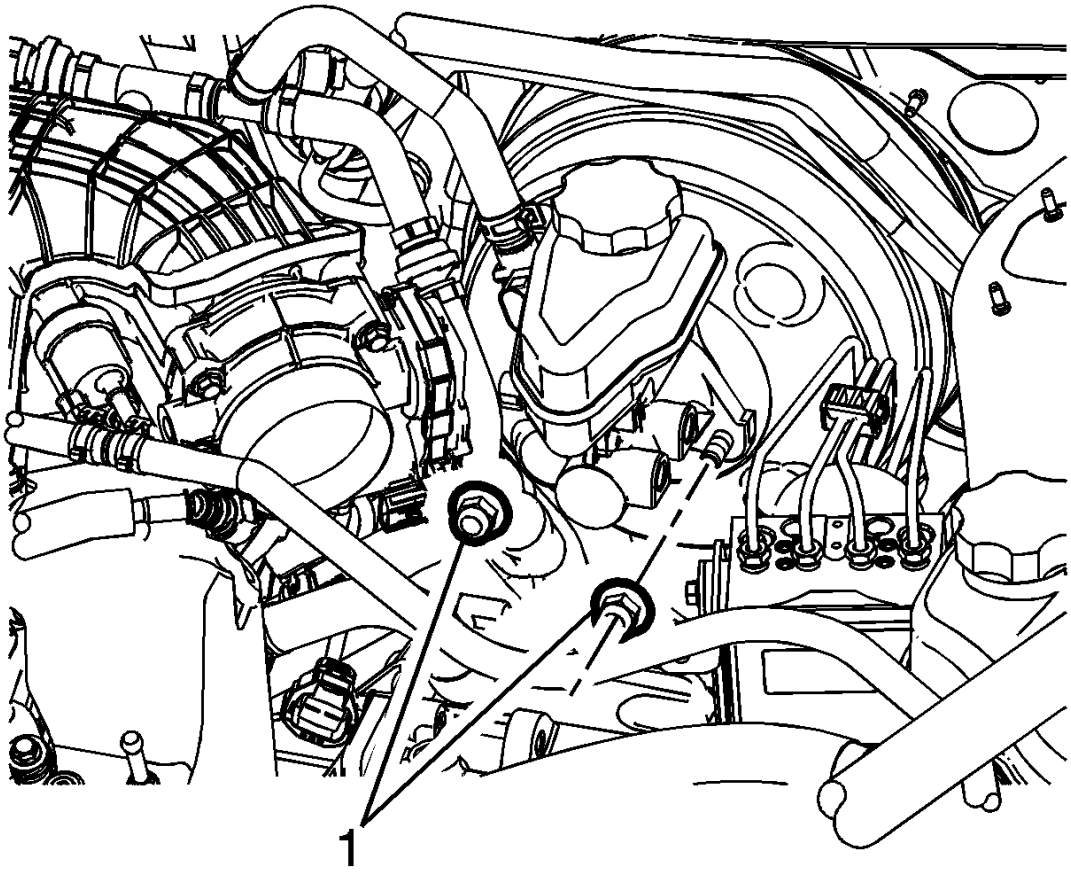


Fig. 55: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

7. Remove the master cylinder nuts (1).
8. Without disconnecting the brake pipes, remove and position aside the master cylinder.
9. Secure the master cylinder in an upright position and secure with heavy mechanics wire.
10. Install the **J-22805-C** Brake Booster Holder to the power vacuum brake booster studs and secure using the master cylinder nuts.

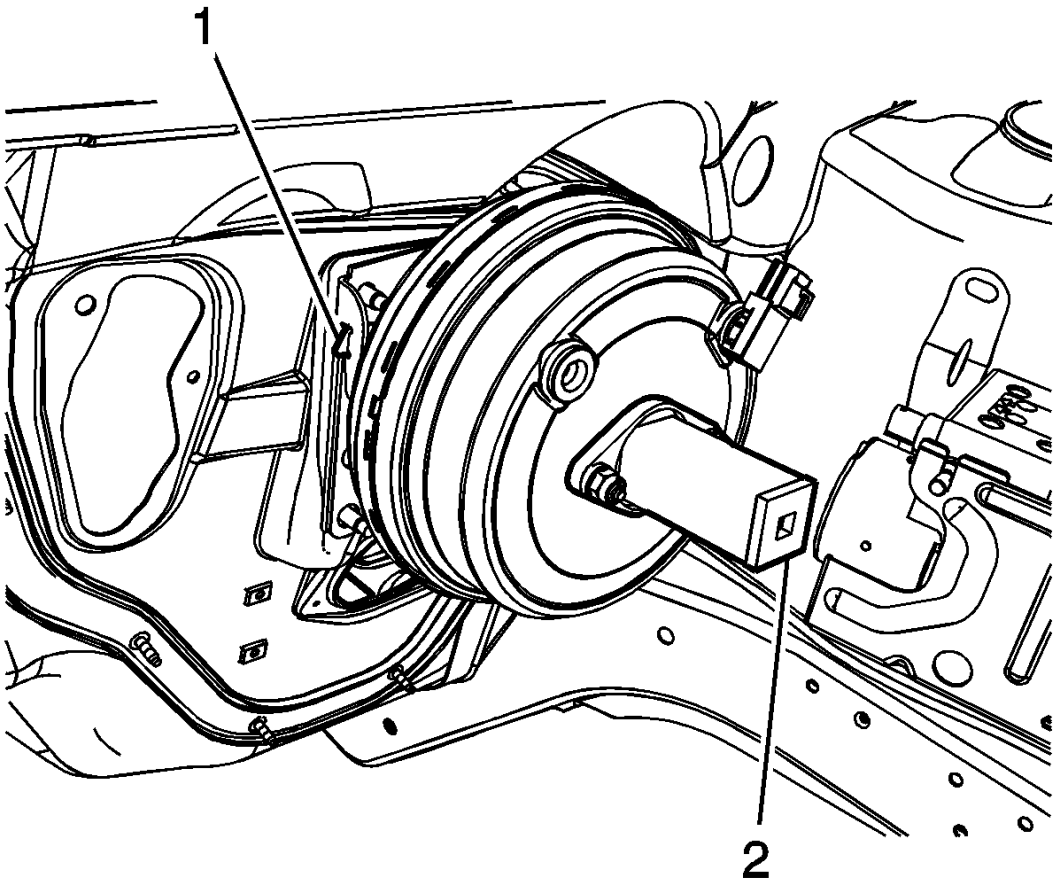


Fig. 56: View Of Power Brake Booster Assembly
Courtesy of GENERAL MOTORS COMPANY

11. Press the locking tab (1) and rotate the **J-22805-C** Brake Booster Holder (2) counter clockwise.
12. Carefully pull the power vacuum brake booster forward slightly and support the booster to access the brake booster pushrod retaining clip.

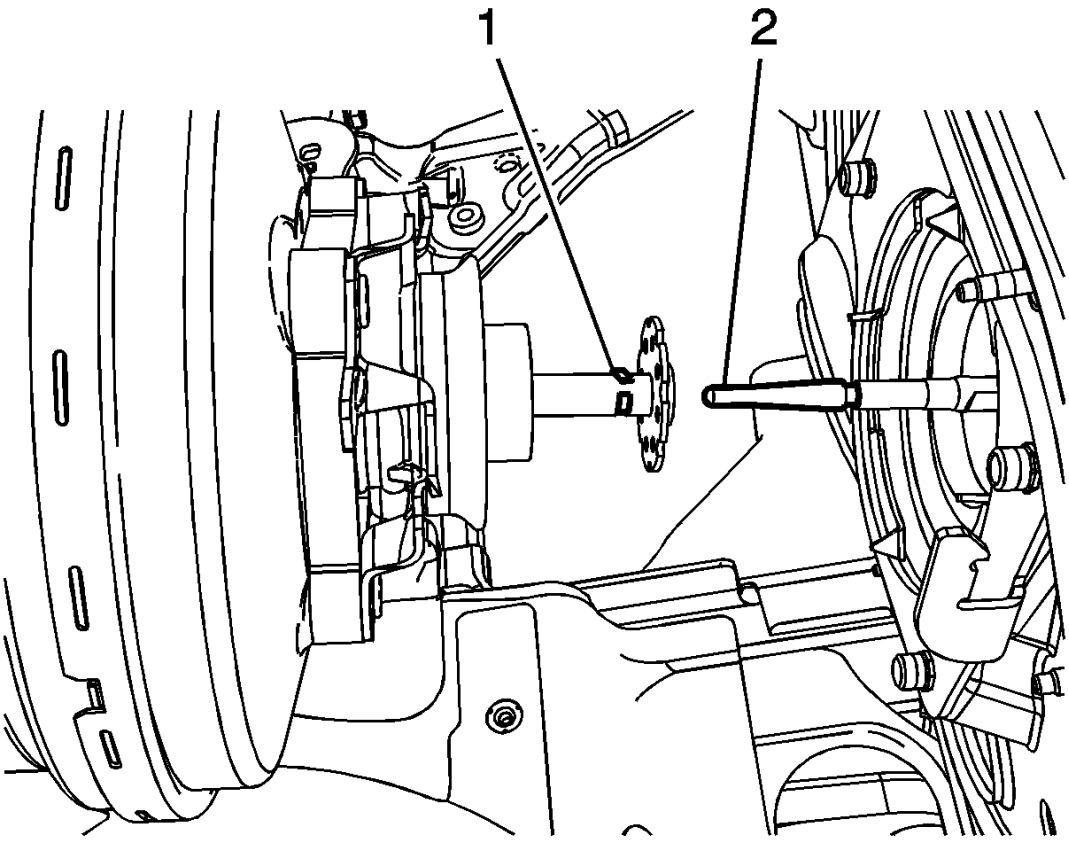


Fig. 57: View Of Brake Booster Pushrod & Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

13. Release the retaining clip (1) and disengage the power vacuum brake booster input rod from the brake booster pushrod (2).
14. Remove the power vacuum brake booster from the vehicle.

Installation Procedure

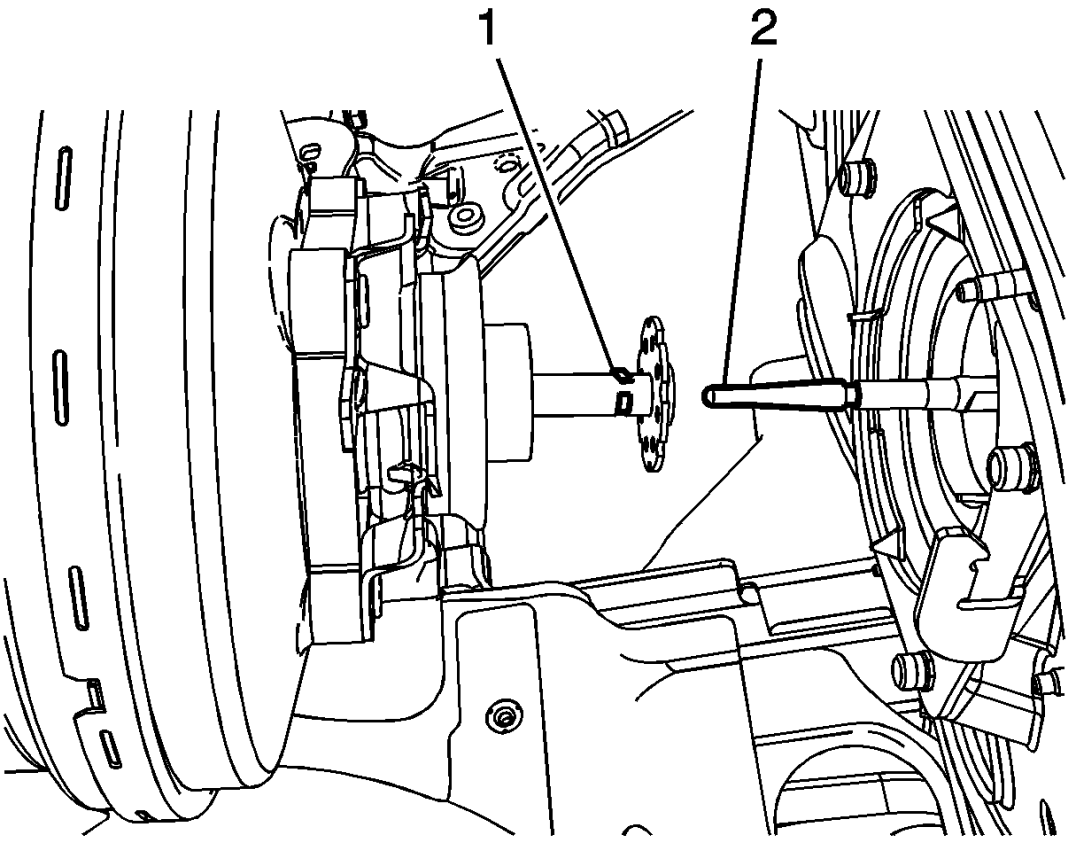


Fig. 58: View Of Brake Booster Pushrod & Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

1. Install the power vacuum brake booster to the vehicle.
2. Release the retaining clip (1) and engage the power vacuum brake booster input rod to the brake booster pushrod (2).
3. Press the retaining clip into position on the brake booster pushrod

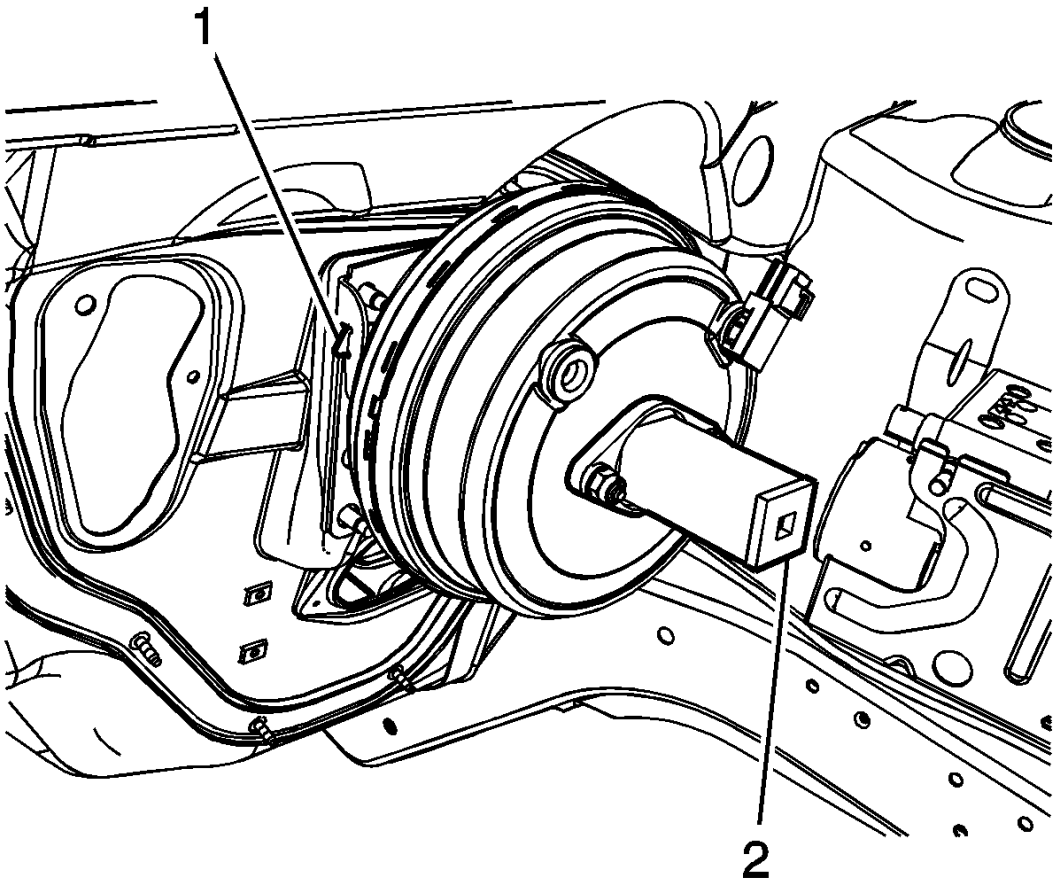


Fig. 59: View Of Power Brake Booster Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Position the power vacuum brake booster to the vehicle front of dash.
5. Install the **J-22805-C** Brake Booster Holder to the power vacuum brake booster studs.
6. Secure the **J-22805-C** Brake Booster Holder using the master cylinder nuts.
7. Press the locking tab (1) and rotate the **J-22805-C** Brake Booster Holder (2) clockwise.
8. Ensure the locking tab is fully engaged in the power vacuum brake booster mounting plate on the front of dash.
9. Remove the **J-22805-C** Brake Booster Holder and discard the master cylinder nuts.

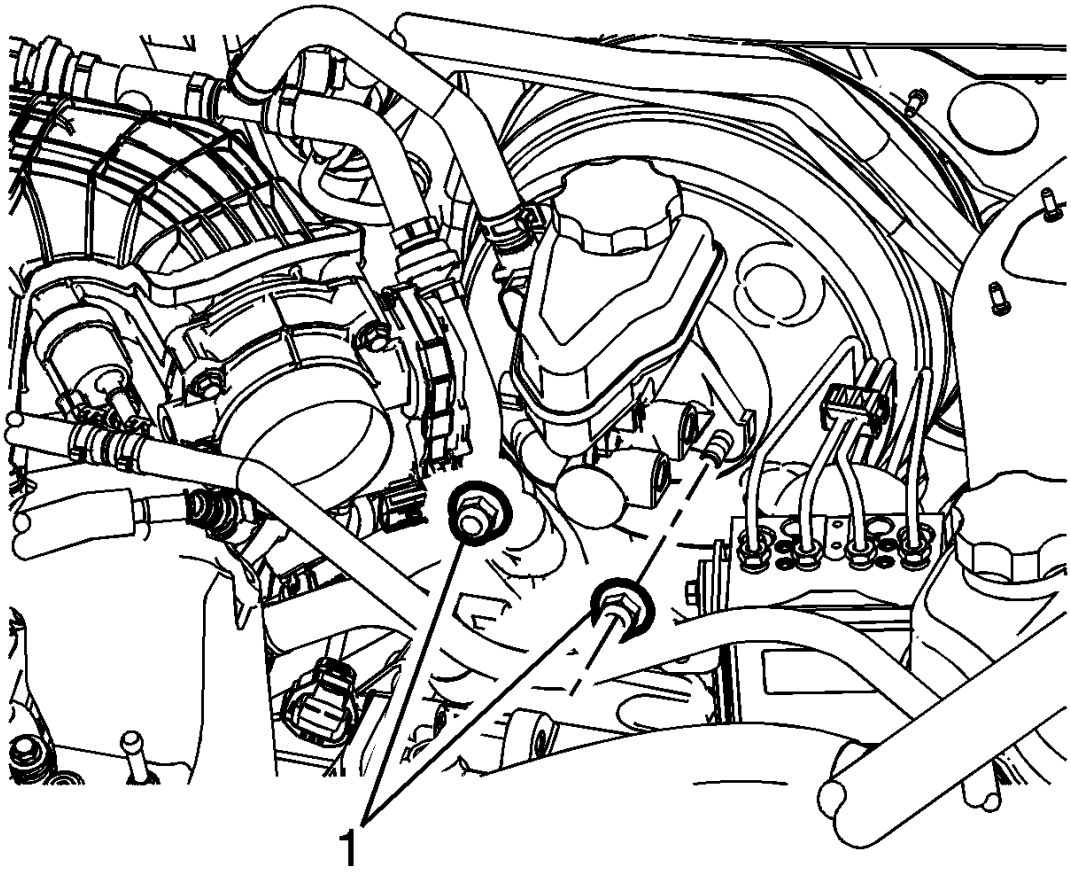


Fig. 60: Master Cylinder Nuts
Courtesy of GENERAL MOTORS COMPANY

10. Install the master cylinder to the power vacuum brake booster.

CAUTION: Refer to Fastener Caution .

11. Install new master cylinder nuts (1) and tighten to 33 N.m (24 lb ft).

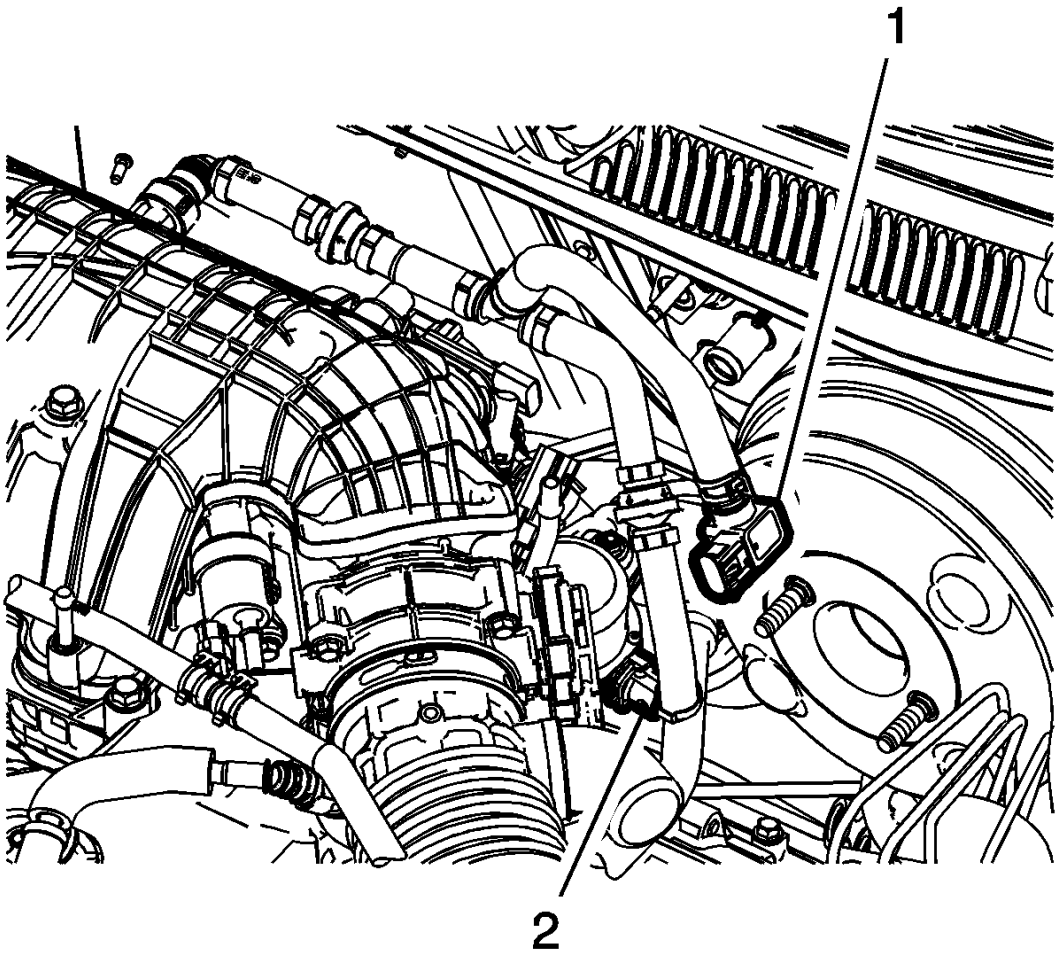


Fig. 61: Power Brake Booster Vacuum Sensor And Power Brake Vacuum Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

NOTE: **A small amount of denatured alcohol may be used as a lubricant for assembly.**

12. Install the power brake booster vacuum sensor (1) to the power vacuum brake booster.
13. Connect the power brake vacuum booster hose quick connect (2) to the power brake booster pump.
14. Connect the brake fluid level indicator switch electrical connector.
15. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** .
16. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

POWER BRAKE BOOSTER VACUUM CHECK VALVE AND HOSE REPLACEMENT

Removal Procedure

1. Turn the ignition to the OFF position.
2. Apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power

vacuum brake booster vacuum reserve.

3. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
4. Disconnect the power brake booster vacuum sensor electrical connector.

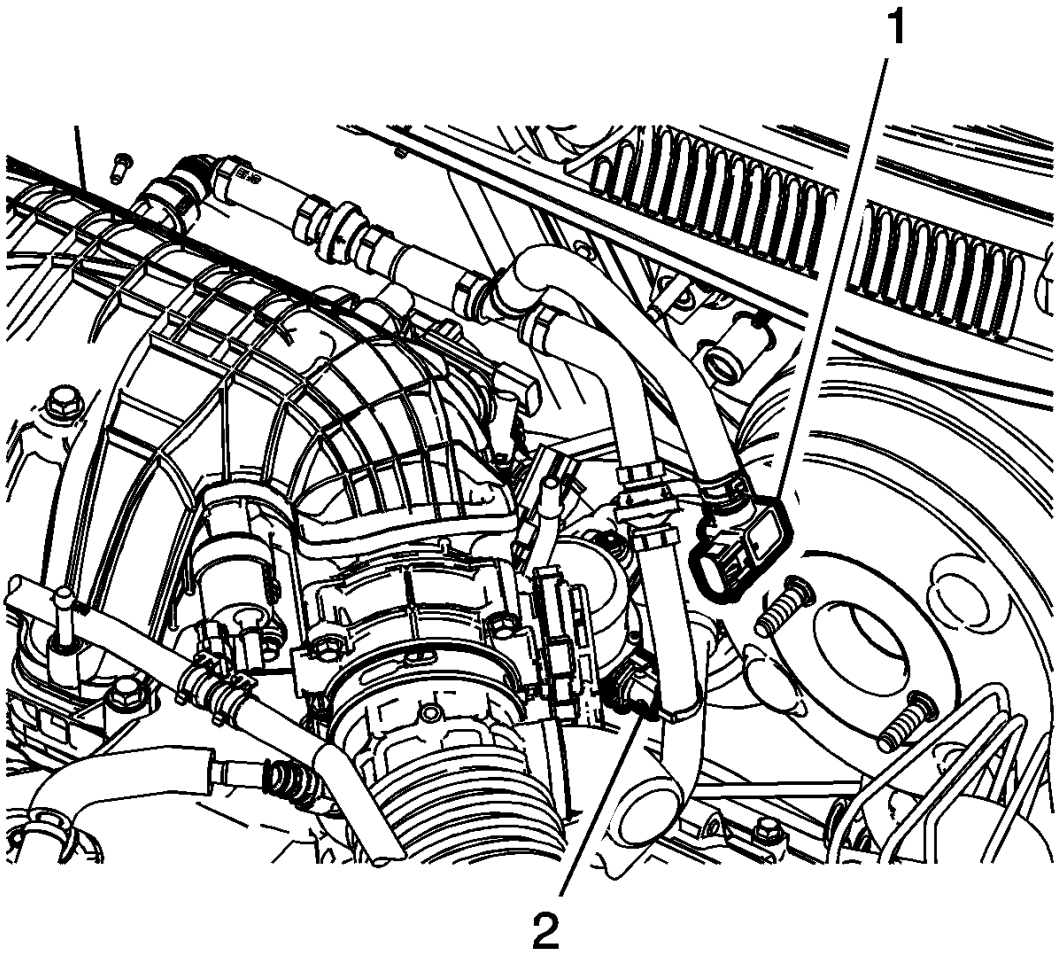


Fig. 62: Power Brake Booster Vacuum Sensor And Power Brake Vacuum Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

5. Remove the power brake booster vacuum sensor (1) from the power vacuum brake booster.
6. Disconnect the power brake booster vacuum hose quick connect (2) from the power brake booster pump.

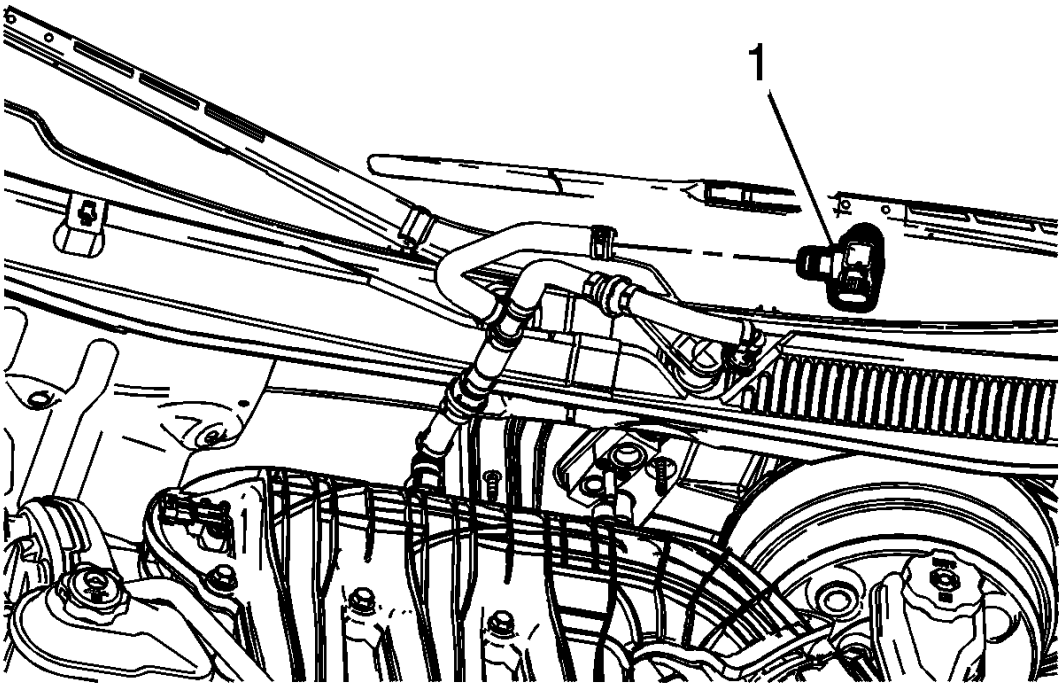


Fig. 63: Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS COMPANY

7. If necessary, compress the clamp and remove the power brake booster vacuum sensor (1) from the power brake booster vacuum hose.

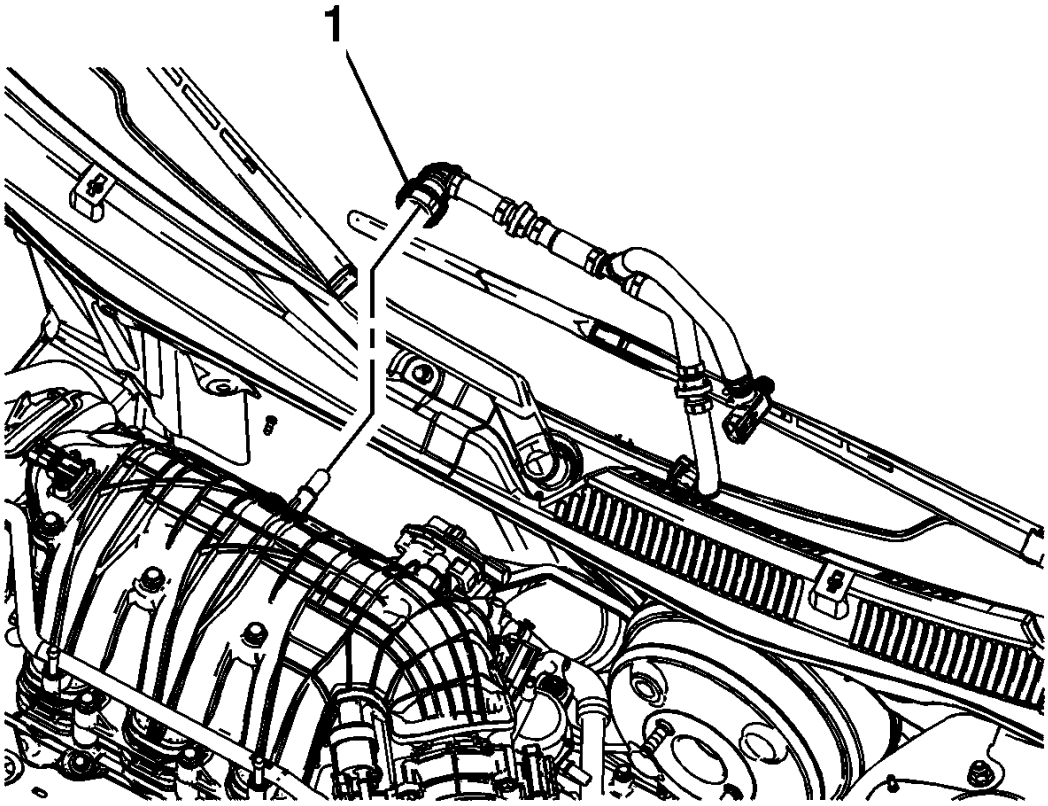


Fig. 64: Power Brake Booster Vacuum Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the power brake booster vacuum hose quick connect (1) from the intake manifold fitting.

Installation Procedure

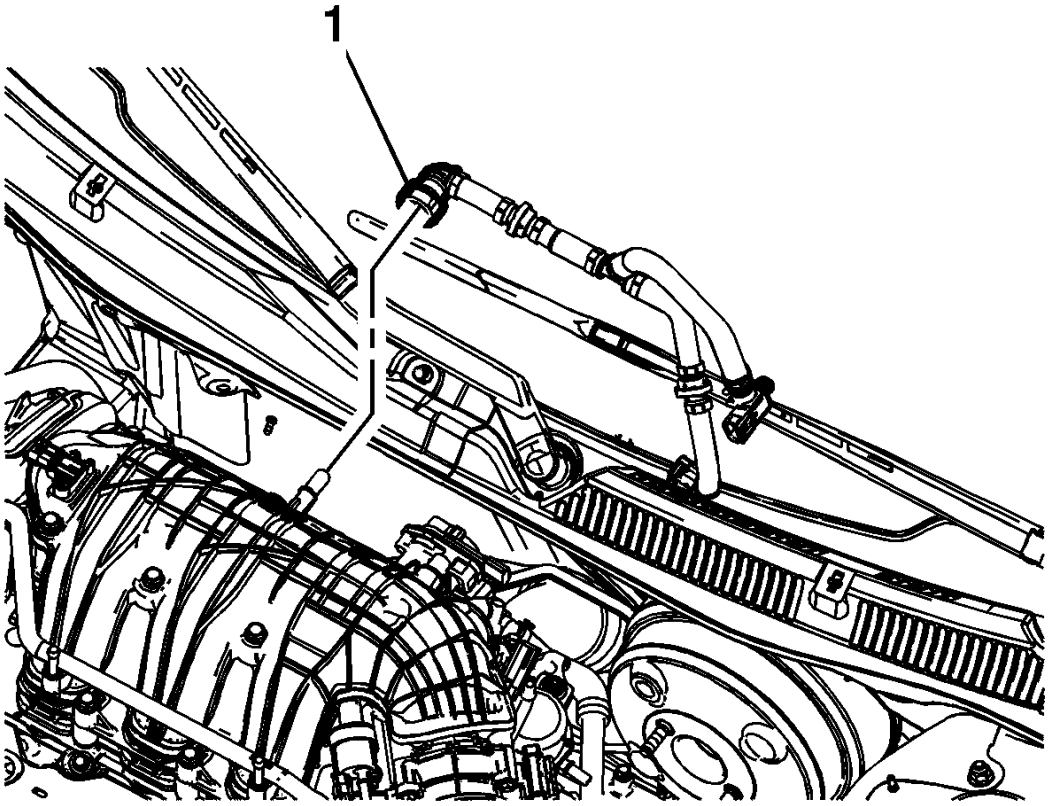


Fig. 65: Power Brake Booster Vacuum Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

1. Install the power brake booster vacuum hose and install the quick connect (1) to the intake manifold fitting.

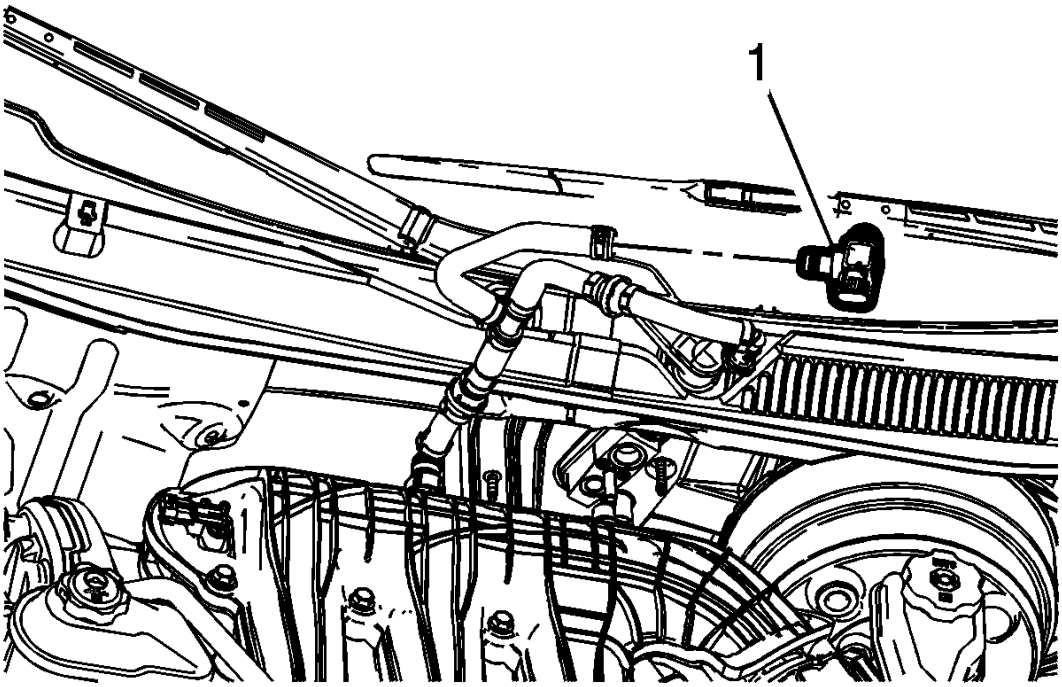


Fig. 66: Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If necessary, a small amount of denatured alcohol may be used as a lubricant for installation.**

2. If removed, compress the clamp and install the power brake booster vacuum sensor (1). to the power brake booster vacuum hose.

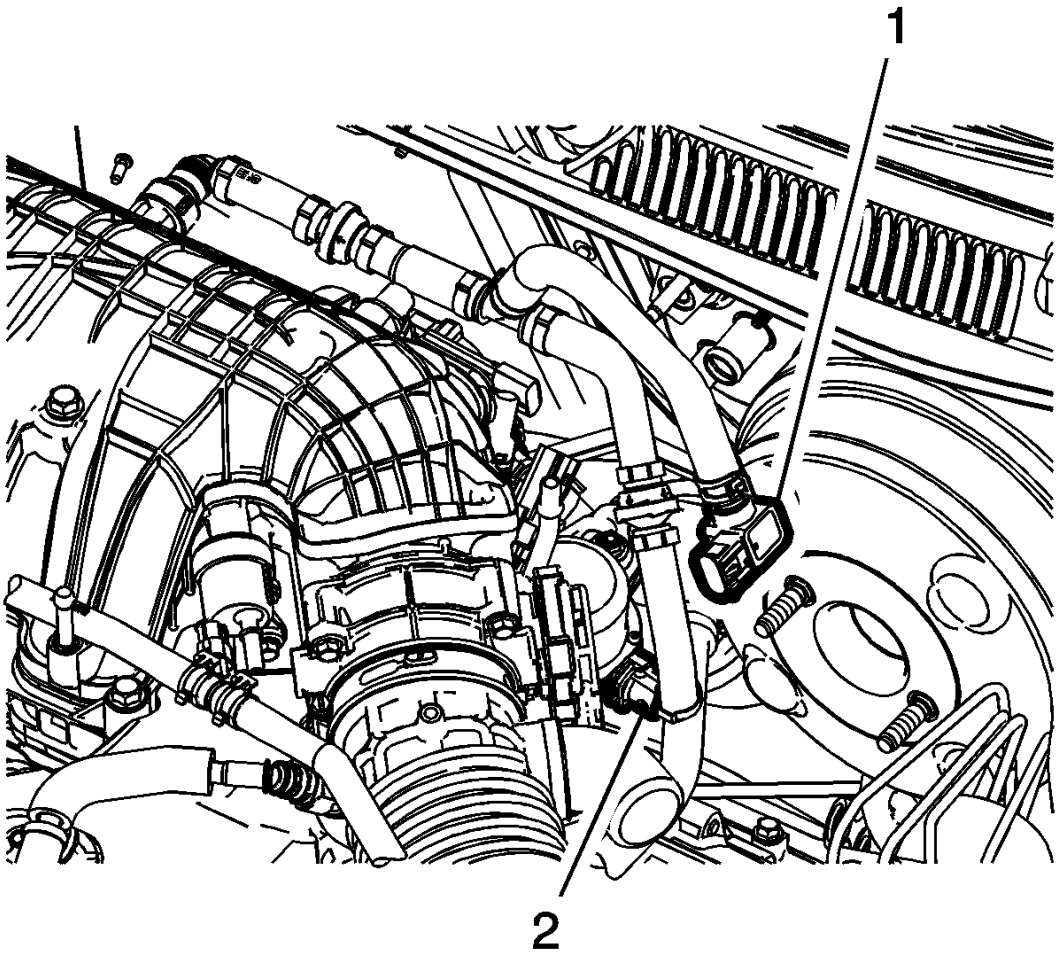


Fig. 67: Power Brake Booster Vacuum Sensor And Power Brake Vacuum Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If necessary, a small amount of denatured alcohol may be used as a lubricant for installation.**

3. Install the power brake booster vacuum sensor (1) to the power vacuum brake booster.
4. Connect the power brake booster vacuum hose quick connect (2) to the power brake booster pump.
5. Connect the power brake booster vacuum sensor electrical connector.
6. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

POWER BRAKE BOOSTER VACUUM SENSOR REPLACEMENT

Removal Procedure

1. Turn the ignition to the OFF position.
2. Apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.

3. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
4. Disconnect the power brake booster vacuum sensor electrical connector.

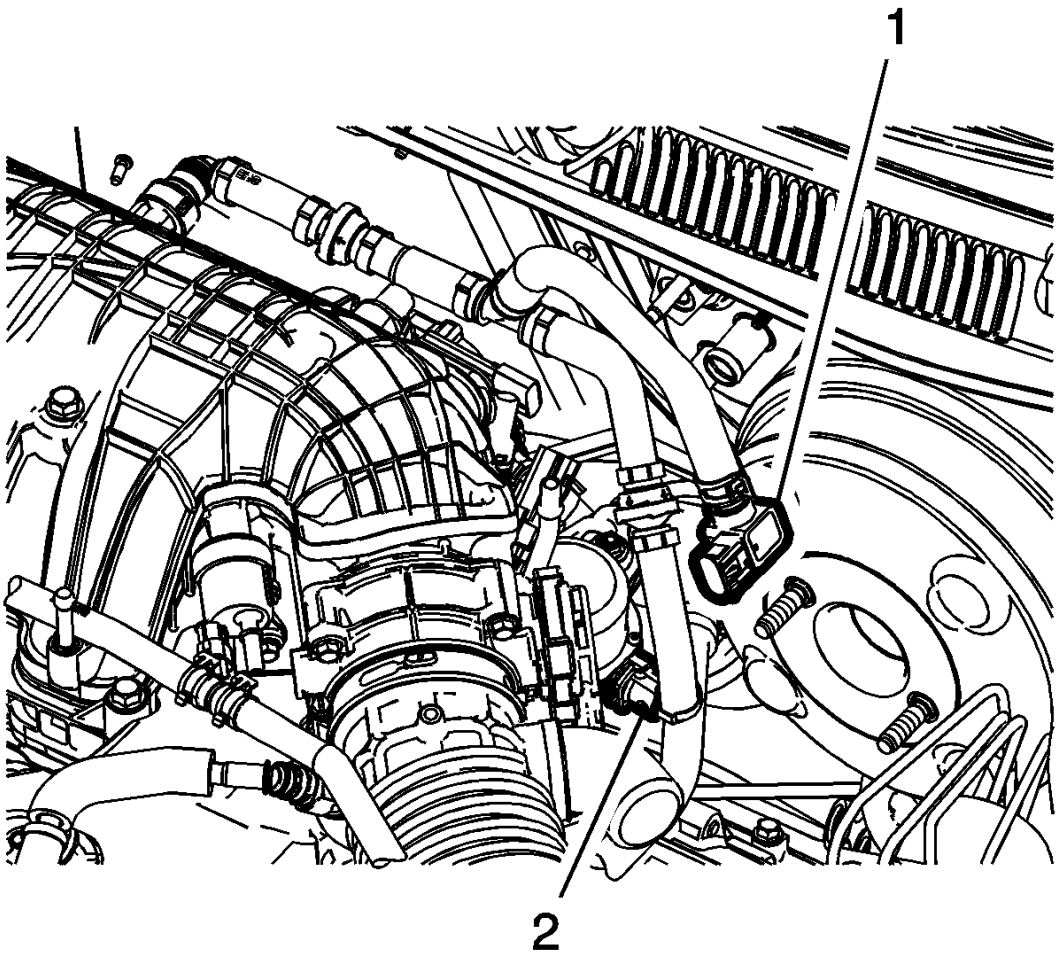


Fig. 68: Power Brake Booster Vacuum Sensor And Power Brake Vacuum Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

5. Remove the power brake booster vacuum sensor (1) from the power vacuum brake booster.
6. Disconnect the power brake booster vacuum hose quick connect (2) from the power brake booster pump.

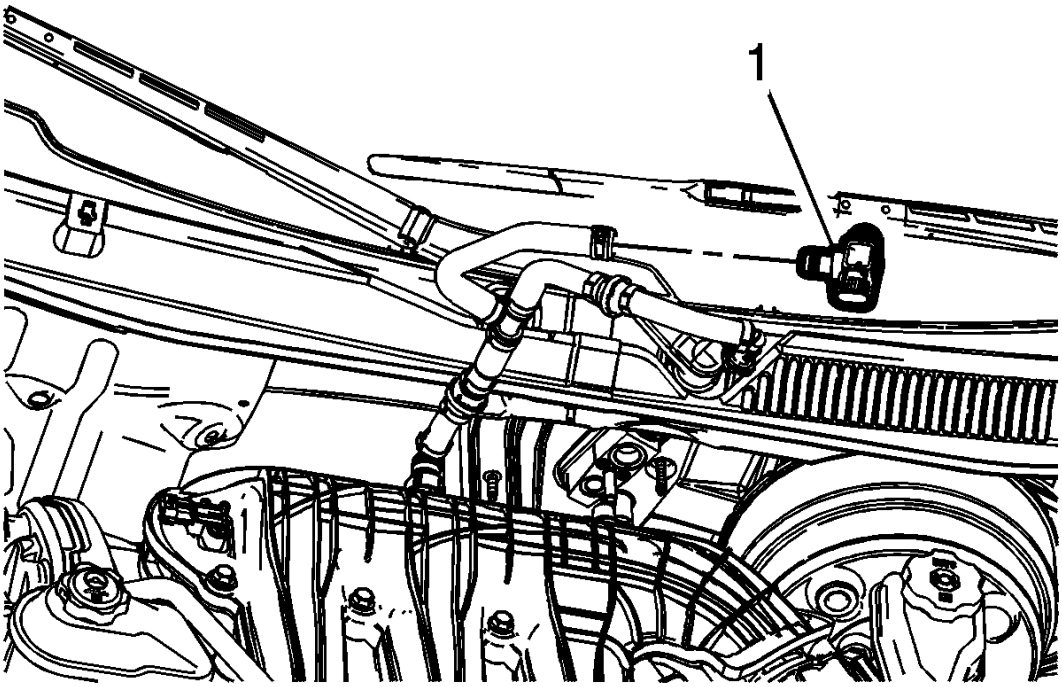


Fig. 69: Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS COMPANY

7. Rotate the power brake booster vacuum hose assembly upward, compress the clamp and remove the power brake booster vacuum sensor (1) from the power brake booster vacuum hose.

Installation Procedure

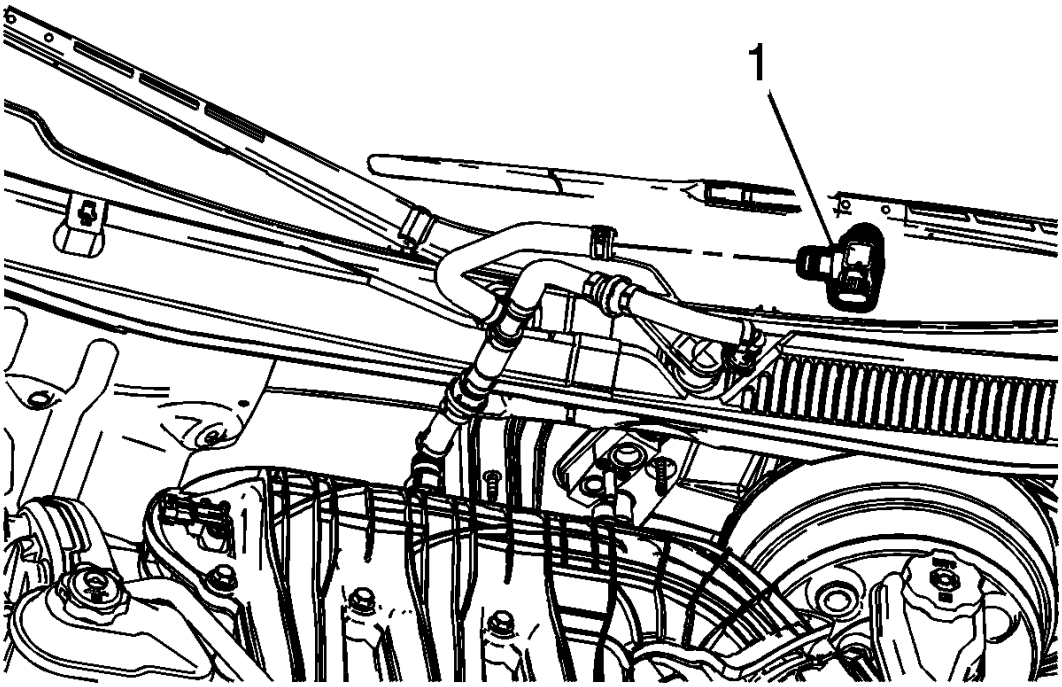


Fig. 70: Power Brake Booster Vacuum Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If necessary, a small amount of denatured alcohol may be used as a lubricant for installation.**

1. Compress the clamp and install the power brake booster vacuum sensor (1). to the power brake booster vacuum hose.

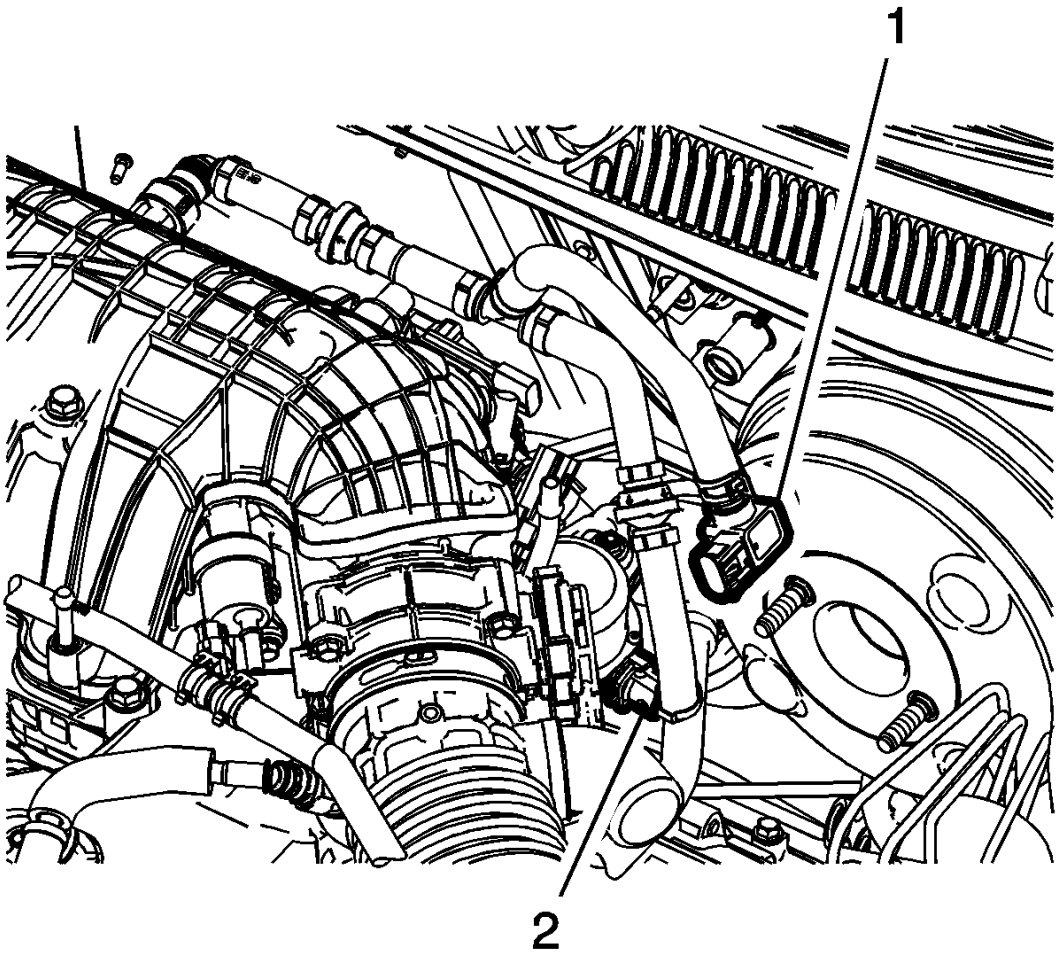


Fig. 71: Power Brake Booster Vacuum Sensor And Power Brake Vacuum Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If necessary, a small amount of denatured alcohol may be used as a lubricant for installation.**

2. Install the power brake booster vacuum sensor (1) to the power vacuum brake booster.
3. Connect the power brake booster vacuum hose quick connect (2) to the power brake booster pump.
4. Connect the power brake booster vacuum sensor electrical connector.
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

POWER BRAKE BOOSTER AUXILIARY PUMP REPLACEMENT

Removal Procedure

1. Turn the ignition to the OFF position.
2. Apply and release the brake pedal several times until the brake pedal becomes firm to deplete the power vacuum brake booster vacuum reserve.

3. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
4. Disconnect the power brake booster vacuum sensor electrical connector.

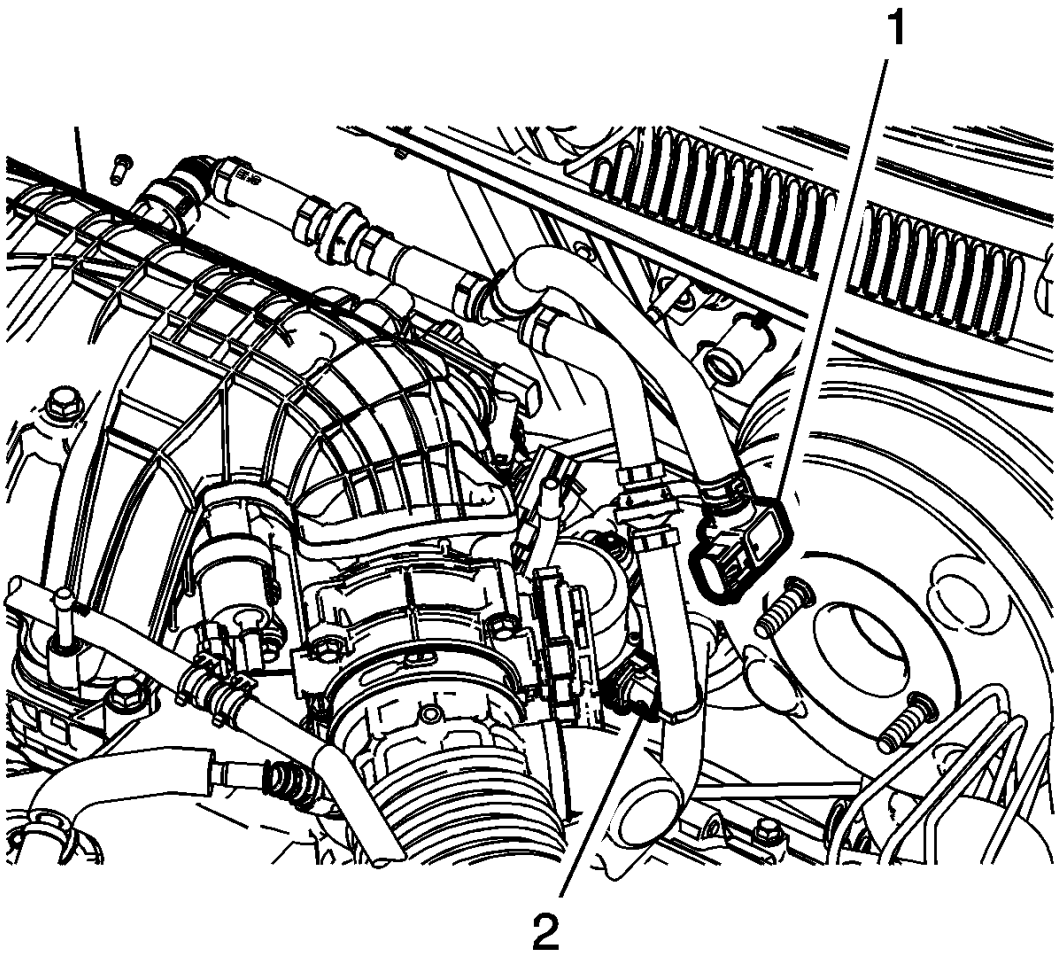


Fig. 72: Power Brake Booster Vacuum Sensor And Power Brake Vacuum Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

5. Remove the power brake booster vacuum sensor (1) from the power vacuum brake booster.
6. Disconnect the power brake booster vacuum hose quick connect (2) from the power brake booster pump.
7. Position the power brake booster vacuum hose aside.

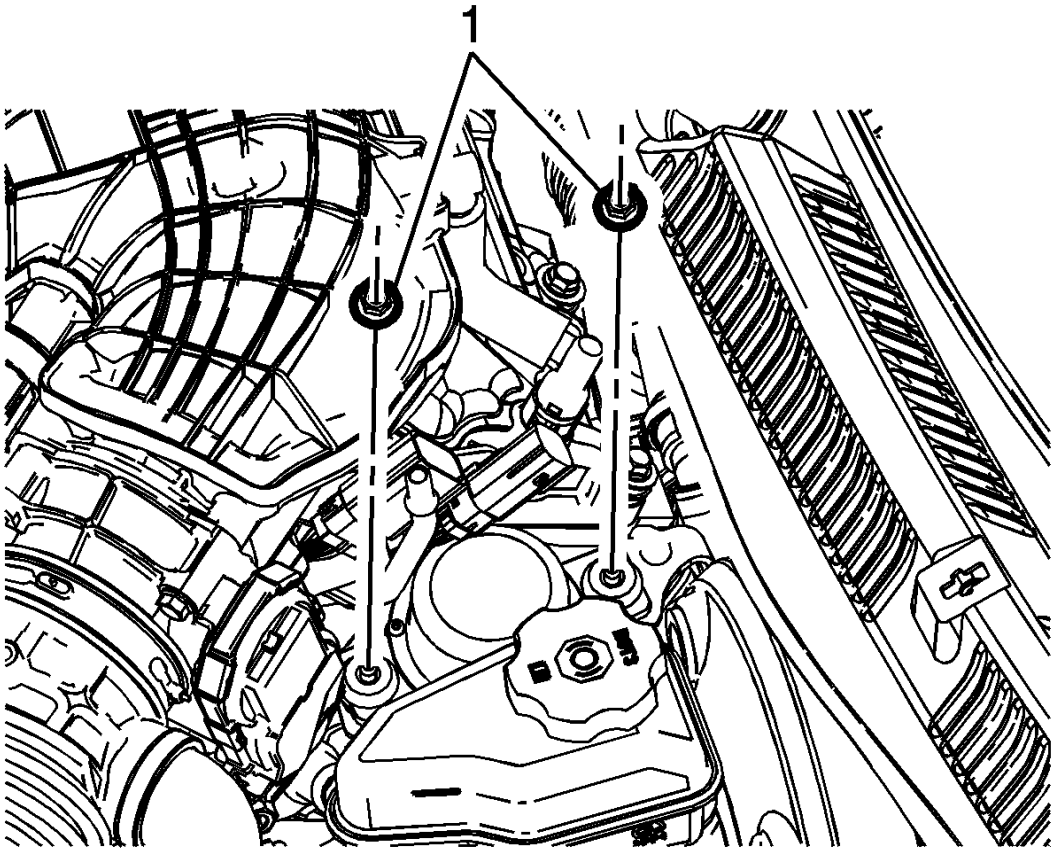


Fig. 73: Power Brake Booster Pump Nuts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the power brake booster pump nuts (1).

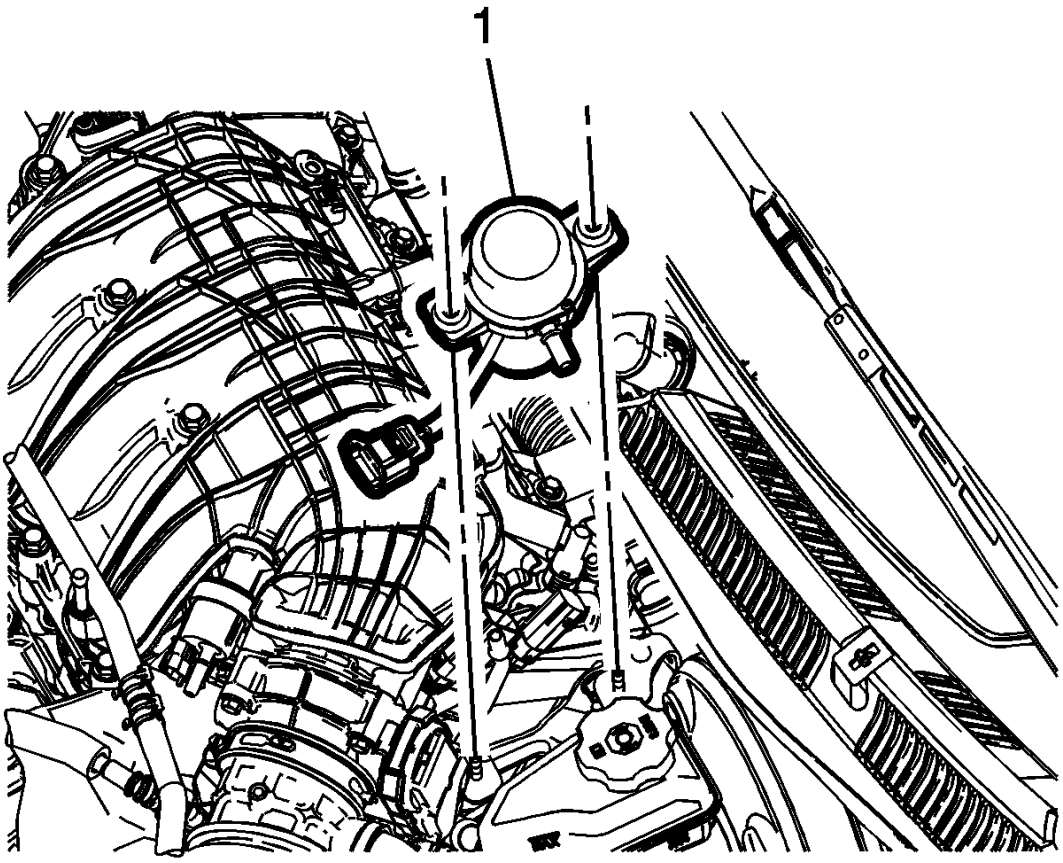


Fig. 74: Power Brake Booster Pump
Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the power brake booster pump electrical connector.
10. Remove the power brake booster pump (1).

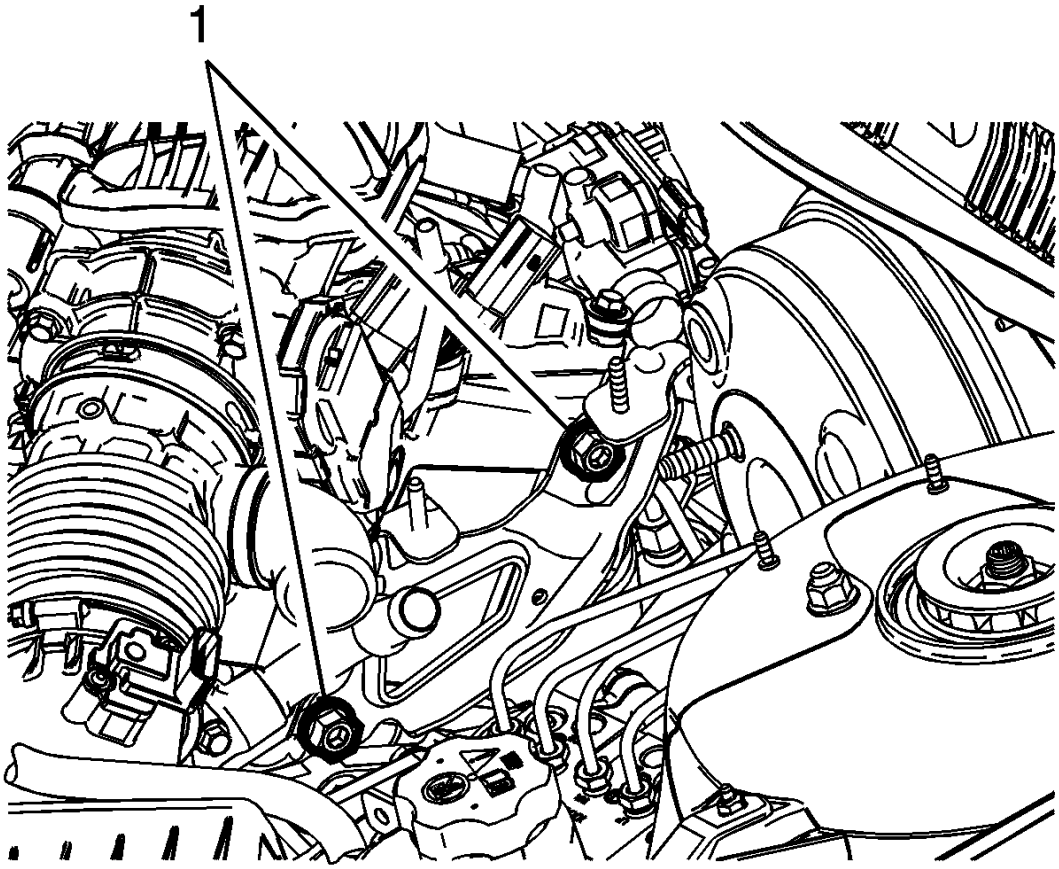


Fig. 75: Power Brake Booster Pump Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

11. If necessary, remove the power brake booster pump bracket bolts (1).

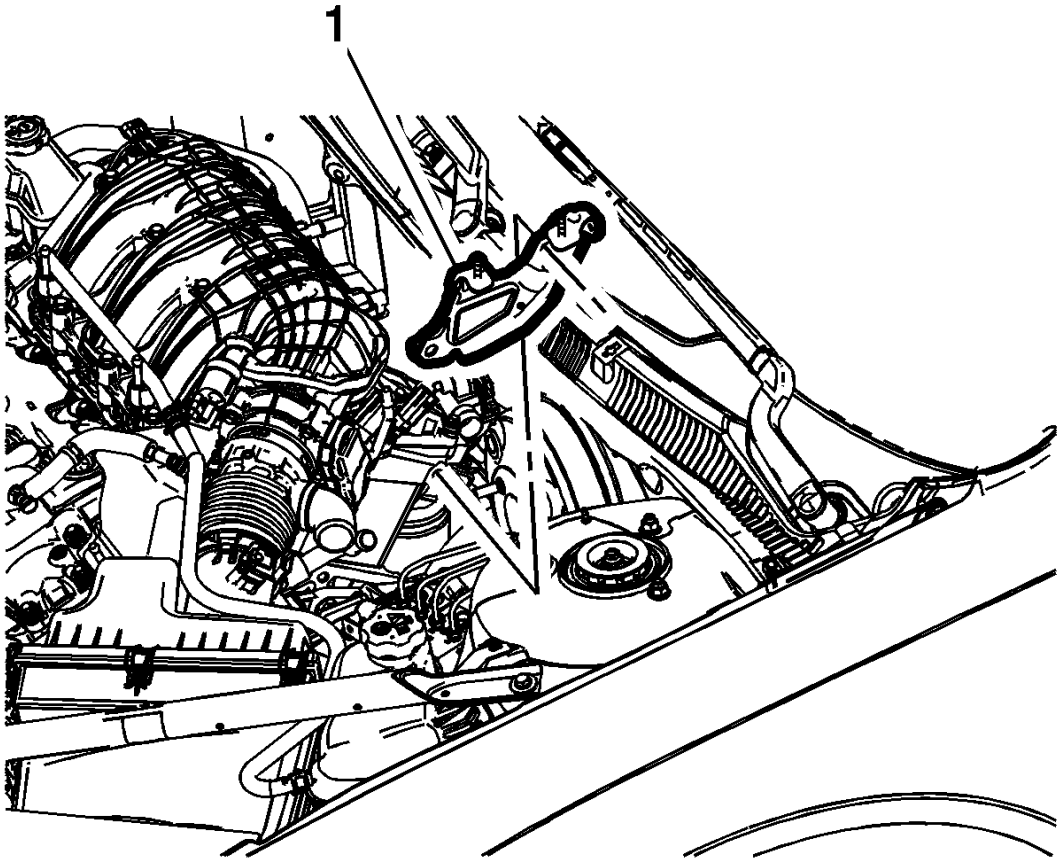


Fig. 76: Power Brake Booster Pump Bracket
Courtesy of GENERAL MOTORS COMPANY

12. If necessary, remove the power brake booster pump bracket (1).

Installation Procedure

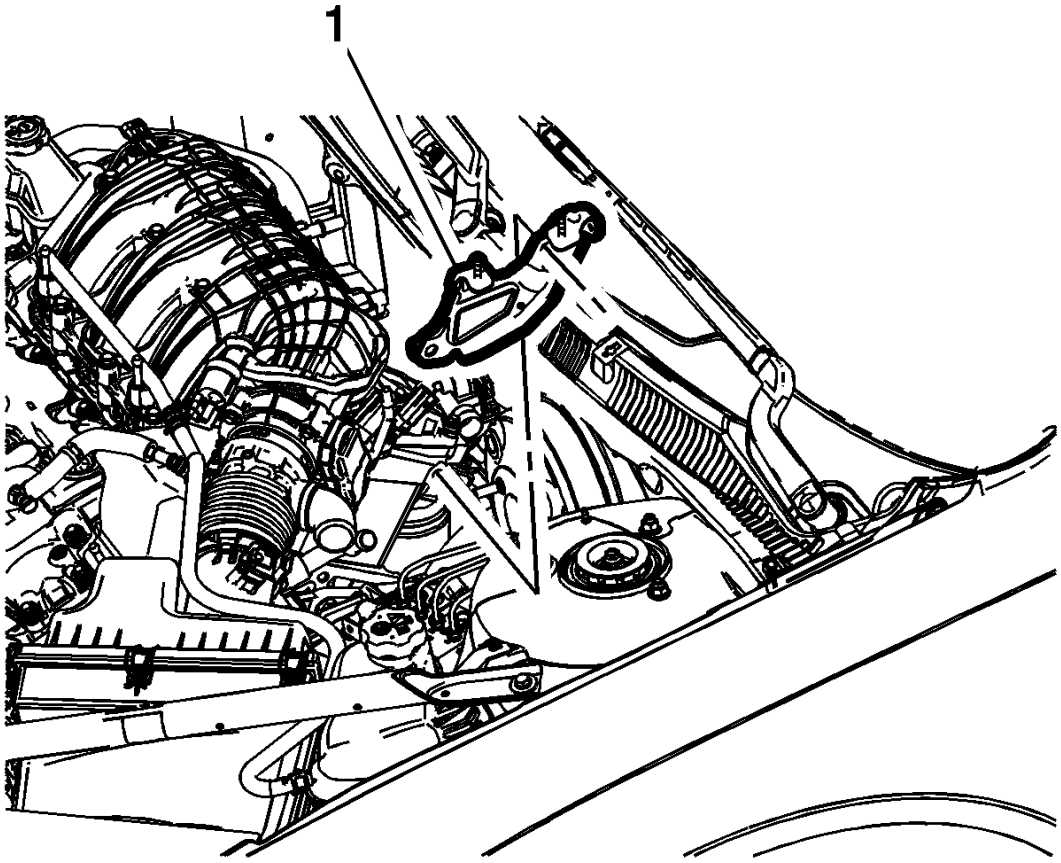


Fig. 77: Power Brake Booster Pump Bracket
Courtesy of GENERAL MOTORS COMPANY

1. If removed, install the power brake booster pump bracket (1).

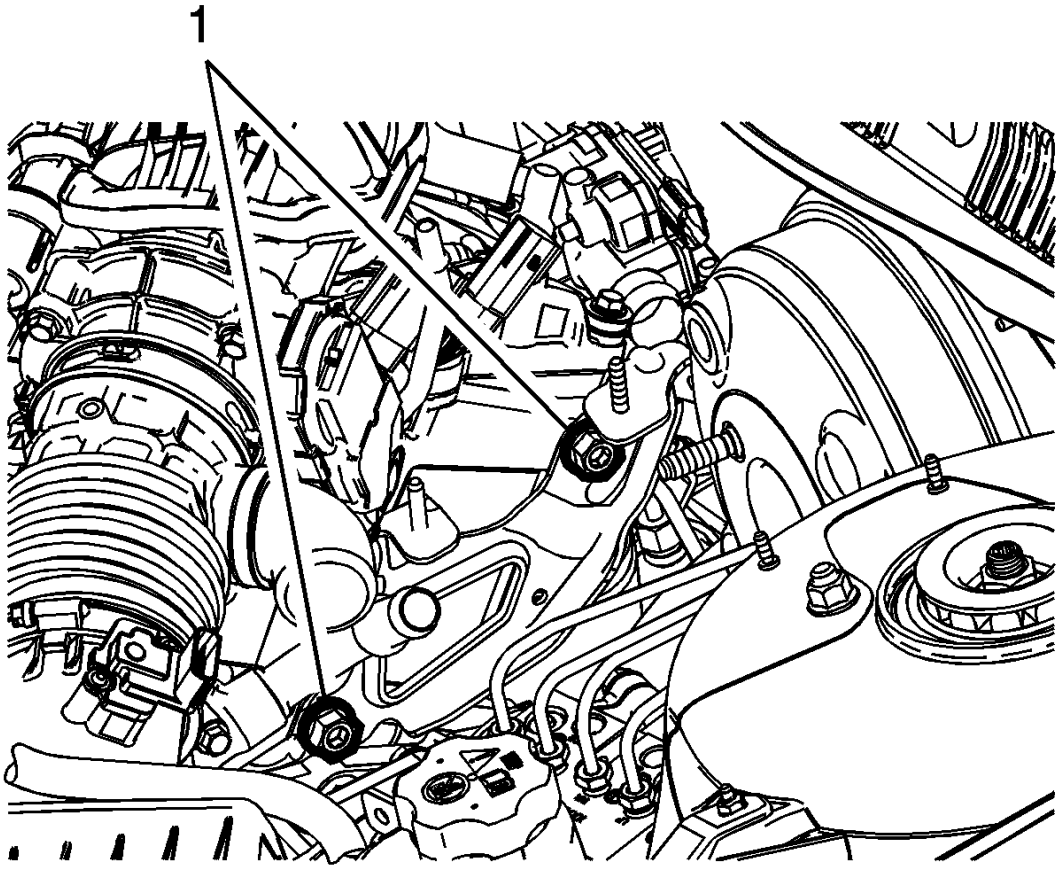


Fig. 78: Power Brake Booster Pump Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. If removed, install the power brake booster pump bracket bolts (1) and tighten to 58 N.m (43 lb ft).

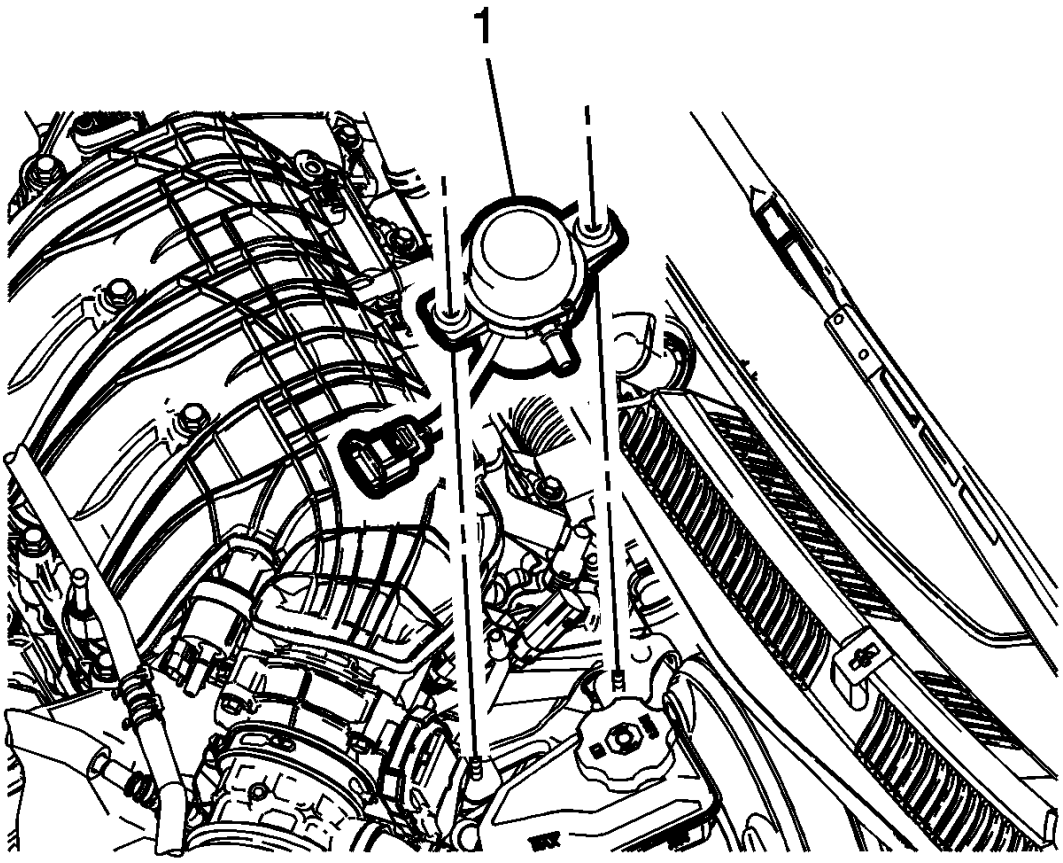


Fig. 79: Power Brake Booster Pump
Courtesy of GENERAL MOTORS COMPANY

3. Install the power brake booster pump (1).
4. Connect the power brake booster pump electrical connector.

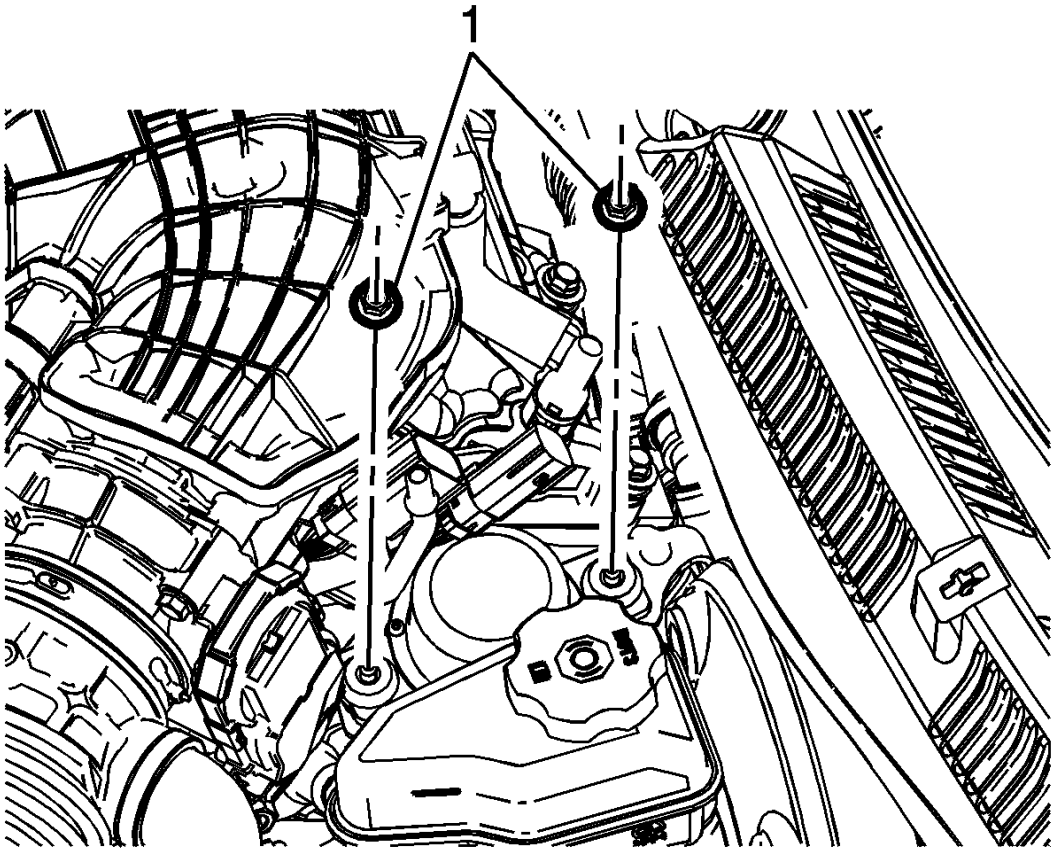


Fig. 80: Power Brake Booster Pump Nuts
Courtesy of GENERAL MOTORS COMPANY

5. Install the power brake booster pump nuts (1) and tighten to 9 N.m (80 lb in).

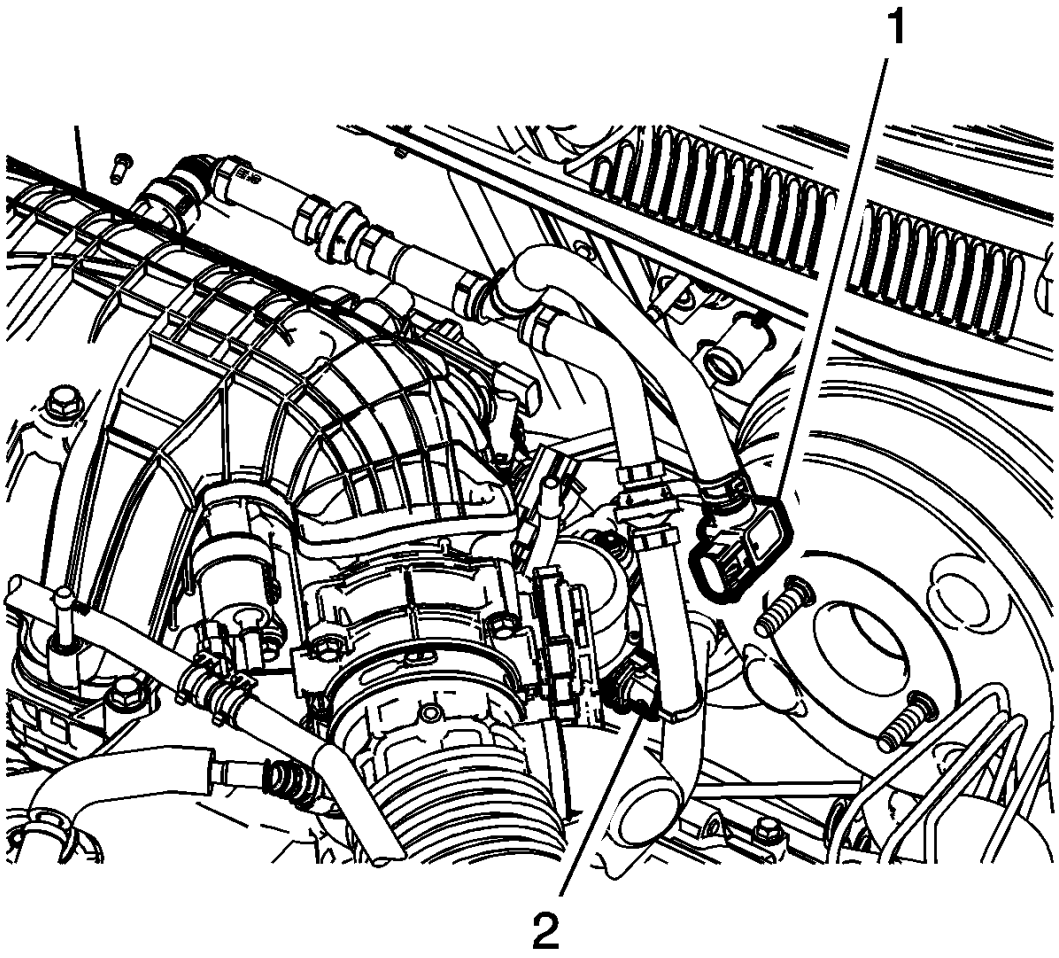


Fig. 81: Power Brake Booster Vacuum Sensor And Power Brake Vacuum Booster Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If necessary, a small amount of denatured alcohol may be used as a lubricant for installation.**

6. Install the power brake booster vacuum sensor (1) to the power vacuum brake booster.
7. Connect the power brake booster vacuum hose quick connect (2) to the power brake booster pump.
8. Connect the power brake booster vacuum sensor electrical connector.
9. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

DESCRIPTION AND OPERATION

BRAKE ASSIST SYSTEM DESCRIPTION AND OPERATION

System Component Description

The brake assist system consists of the following:

Brake Pedal

Receives, multiplies and transfers brake system input force from driver.

Brake Pedal Pushrod

Transfers multiplied input force received from brake pedal to brake booster.

Vacuum Brake Booster

Uses source vacuum to decrease effort required by driver when applying brake system input force.
At rest, source vacuum is applied to both sides of the vacuum diaphragm for single boosters, or to both sides of each of the diaphragms for tandem boosters. Return springs maintain the booster in a rest position.
When brake system input force is applied, vacuum to the rear of the diaphragm(s) is cut off, and air at atmospheric pressure is admitted in its place. This provides a decrease in brake pedal effort required.
When input force is removed, vacuum again replaces atmospheric pressure within the booster.

Vacuum Source

Supplies force used by vacuum brake booster to decrease brake pedal effort.
The primary source for vacuum is typically the vehicle's internal combustion engine. Some vehicles may use a vacuum pump to ensure and adequate supply of vacuum under various operating conditions, such as during cold start-up, heavy throttle, and high altitude.

Vacuum Pump Relay

Vehicles equipped with a vacuum pump will typically be equipped with a relay used to provide voltage to the vacuum pump motor, when commanded by the powertrain controller.

Vacuum Monitoring System

Provides a feedback voltage signal relative to the amount of vacuum available for the vacuum power brake booster.
This typically consists of a vacuum sensor mounted either into the power vacuum brake booster, integrated with the vacuum check valve, or in-line within the vacuum hose. The sensor feedback is typically monitored by the powertrain control module(s).

Vacuum Source Control

If equipped with a system to monitor available levels of vacuum for the brake assist system, the powertrain control module(s) typically perform the primary monitoring function.
The powertrain controller will typically monitor the feedback signal of a vacuum sensor, as it relates to available vacuum at the vacuum power brake booster. The powertrain controller uses the information to make sure available vacuum remains above predetermined levels. If additional vacuum is required, the powertrain controller may reactivate engine cylinders, if equipped, or command a vacuum pump ON, if equipped, and/or may alter the operation of various other engine controls and devices, as necessary.

Vacuum Source Delivery System

Enables delivery and retention of source vacuum for vacuum brake booster.

This typically consists of a vacuum check valve and a vacuum hose or pipe. If a vacuum pump is used, additional check valves may be used.

System Operation

Brake system input force from the driver is multiplied by the brake pedal and transferred by the pedal pushrod to the hydraulic brake master cylinder. Effort required to apply the brake system is reduced by the operation of the vacuum brake booster.

When brake system force is applied, vacuum to the rear of the diaphragm(s) is cut off, and air at atmospheric pressure is admitted in its place. The vacuum acts to pull the diaphragm(s) forward, while the atmospheric pressure acts to push from behind. As a result, the amount of effort required by the driver is reduced. When input force is removed, vacuum again replaces atmospheric pressure within the vacuum power brake booster to help return the booster to rest. Return springs maintain the system in a rest position.

If the vehicle is equipped with a vacuum monitoring system, the powertrain control module(s) typically will alter powertrain functions and/or command the vacuum pump ON, if equipped, to provide for the vacuum needs of the brake assist system, as operating conditions warrant.

BRAKE BOOSTER VACUUM ASSIST DESCRIPTION AND OPERATION

System Component Description

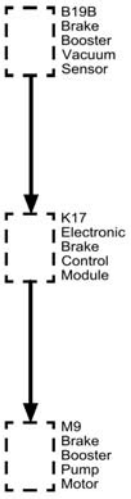


Fig. 82: Hydraulic Brake Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
B19B	B19B Brake Booster Vacuum Sensor
K17	K17 Electronic Brake Control Module
M9	M9 Brake Booster Pump Motor

The brake booster vacuum assist system consists of the following:

Brake Booster Auxiliary Vacuum Pump (electric or mechanical)

The brake booster vacuum pump is a secondary vacuum supply to the brake booster used to maintain sufficient vacuum for brake assist.

Brake Booster Vacuum Sensor

The vacuum sensor is used to measure the level of vacuum available in the brake booster. The electronic brake control module supplies a 5 V reference and a low reference circuit to the brake booster vacuum sensor. The vacuum sensor is located in the brake booster or vacuum hose. The brake booster vacuum sensor supplies a voltage signal in relation to the pressure in the brake booster to the electronic brake control module.

Electronic Brake Control Module

The electronic brake control module monitors the vacuum in the brake booster using the brake booster vacuum sensor. When the vacuum within the system drops the electronic brake control module turns ON the brake booster auxiliary vacuum pump.

Vacuum Brake Booster

When brake system input force is applied, air at atmospheric pressure is admitted to the rear of both vacuum diaphragms, providing a decrease in brake pedal effort required. When input force is removed, vacuum replaces the atmospheric pressure within the booster. The booster uses source vacuum to decrease the effort required by driver when applying the brake.

Vacuum Source

Vacuum is supplied by the engine vacuum or by the brake booster auxiliary vacuum pump (electric or mechanical).

System Operation

The electric pump can be switched on and off by the electronic brake control module based on the required vacuum. Pressure variations during braking can be measured, and the pump can be activated to generate additional vacuum if required to increase the braking force.

BRAKE FLUID AND BRAKE FLUID HANDLING

WARNING: Brake fluid may irritate eyes and skin. In case of contact, take the following actions:

- **Eye contact-rinse thoroughly with water.**

- **Skin contact-wash with soap and water.**
- **If ingested-consult a physician immediately.**

WARNING: **Use only Delco Supreme 11, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT 3 brake fluid from a clean, sealed container. Do not use fluid from an open container that may be contaminated with water. Improper or contaminated fluid could result in damage to components, or loss of braking, with possible injury.**

CAUTION: **When filling the master cylinder, use only Delco Supreme 11, GM P/N 12377967 (Canadian P/N 992667), or equivalent DOT 3 brake fluid. Do not use a container which has been used for petroleum based fluids, or a container which is wet with water. Petroleum based fluids will cause swelling and distortion of rubber parts in the hydraulic brake system, and water will mix with brake fluid, lowering the boiling point. Keep all fluid containers capped to prevent contamination.**

CAUTION: **Brake fluid will damage electrical connections and painted surfaces. Use shop cloths, suitable containers, and fender covers to prevent brake fluid from contacting these areas. Always re-seal and wipe off brake fluid containers to prevent spills.**

CAUTION: **Avoid spilling brake fluid on any of the vehicle's painted surfaces, wiring, cables or electrical connectors. Brake fluid will damage paint and electrical connections. If any fluid is spilled on the vehicle, immediately flush the area with water to minimize the potential for damage.**

CAUTION: **Power steering fluid, engine oil, brake fluid, or any mineral based fluids cannot be mixed. If brake seals contact power steering fluid or steering seals contact brake fluid, seal damage will result.**

NOTE:

- **Do not reuse the brake fluid collected during the hydraulic brake system bleeding.**
- **Always store brake fluid in a closed container.**
- **Reseal brake fluid containers immediately after use.**
- **Do not use brake fluid left in an open container.**
- **Do not use brake fluid left in an improperly sealed container.**
- **Do not use the following fluids in the hydraulic brake system:**
  - **Power steering fluid**
  - **Automatic transmission fluid**
  - **DOT 5 silicone hydraulic brake fluid**

BRAKE WARNING SYSTEM DESCRIPTION AND OPERATION

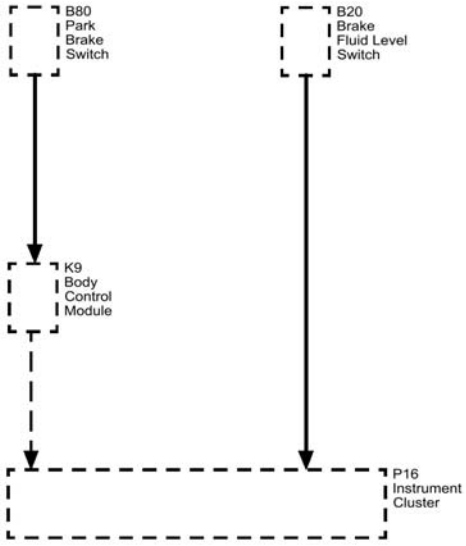


Fig. 83: Hydraulic Brakes Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
B80	B80 Park Brake Switch
B20	B20 Brake Fluid Level Switch
K9	K9 Body Control Module
P16	P16 Instrument Cluster

Brake

The instrument panel cluster (IPC) illuminates the BRAKE indicator when any of the following occurs:

- The body control module (BCM) detects that the park brake is applied and sends serial data message to illuminate indicator.
- The IPC detects a low brake fluid condition.
- The electronic brake control module (EBCM) detects a malfunction with the antilock brake system (ABS). The IPC receives a serial data message from the EBCM requesting illumination.
- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 5 seconds.

Check Brake Fluid

The IPC illuminates the CHECK BRAKE FLUID indicator in the driver information center (DIC) and sends a

serial data message in order to activate an audible warning when the IPC detects that the brake fluid level is below the normal operating range.

HYDRAULIC BRAKE SYSTEM DESCRIPTION AND OPERATION

System Component Description

The hydraulic brake system consists of the following:

Hydraulic Brake Master Cylinder Fluid Reservoir

Contains supply of brake fluid for the hydraulic brake system.

Hydraulic Brake Master Cylinder

Converts mechanical input force into hydraulic output pressure.
Hydraulic output pressure is distributed from the master cylinder through two hydraulic circuits, supplying diagonally-opposed wheel apply circuits.

Hydraulic Brake Pressure Balance Control System

Regulates brake fluid pressure delivered to hydraulic brake wheel circuits, in order to control the distribution of braking force.
Pressure balance control is achieved through dynamic rear proportioning (DRP), which is a function of the ABS modulator. Refer to **ABS Description and Operation** for specific information on the operation of DRP.

Hydraulic Brake Pipes and Flexible Brake Hoses

Carries brake fluid to and from hydraulic brake system components.

Hydraulic Brake Wheel Apply Components

Converts hydraulic input pressure into mechanical output force.

System Operation

Mechanical force is converted into hydraulic pressure by the master cylinder, regulated to meet braking system demands by the pressure balance control system, and delivered to the hydraulic brake wheel circuits by the pipes and flexible hoses. The wheel apply components then convert the hydraulic pressure back into mechanical force which presses linings against rotating brake system components.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

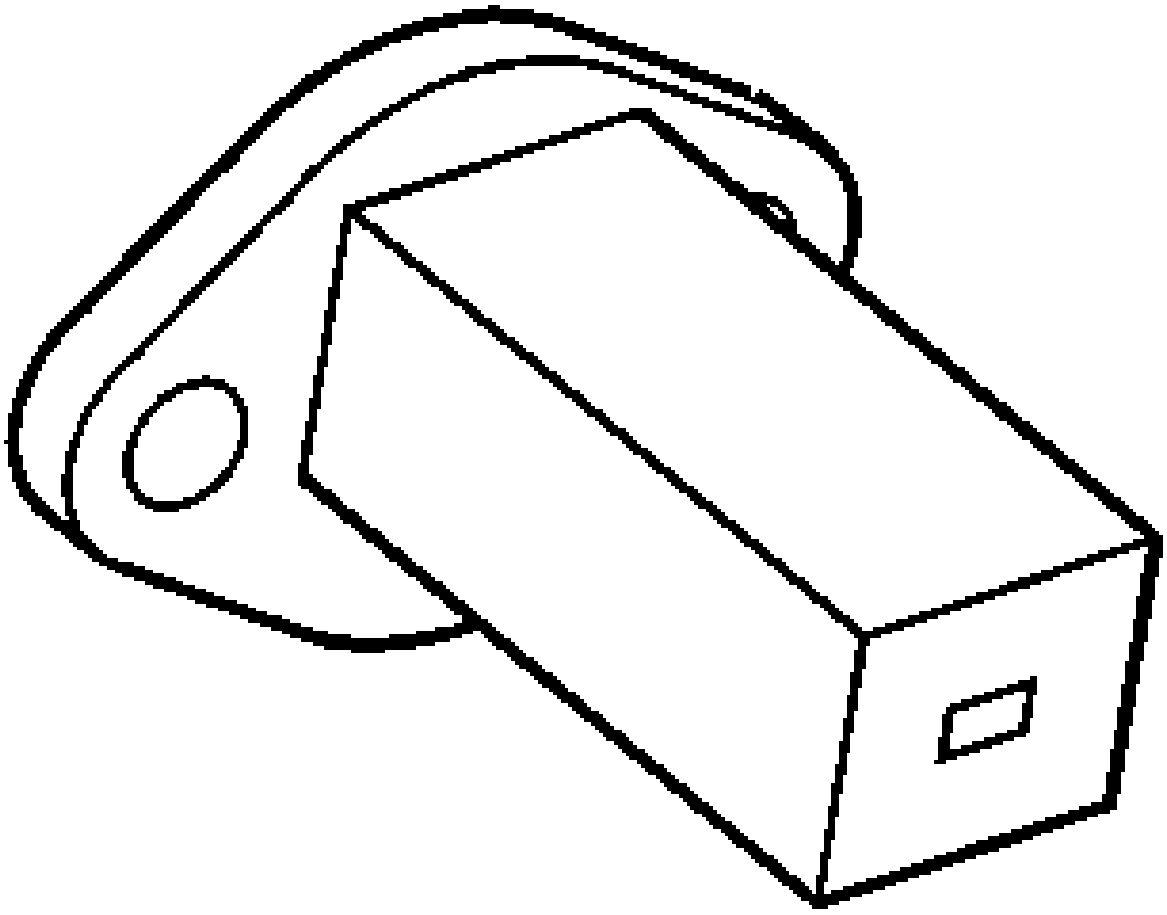
Illustration	Tool Number/ Description
	J 22805-C Brake Booster Holder

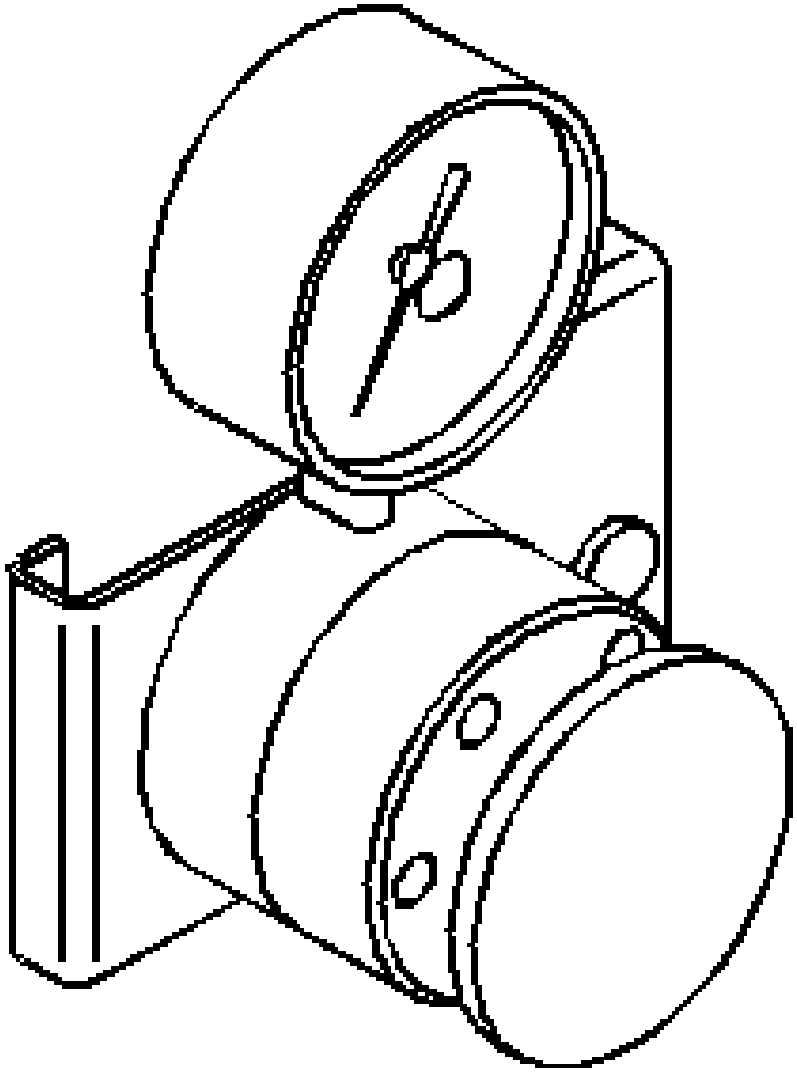
Illustration	Tool Number/ Description
	J 28662 Brake Pedal Effort Gauge

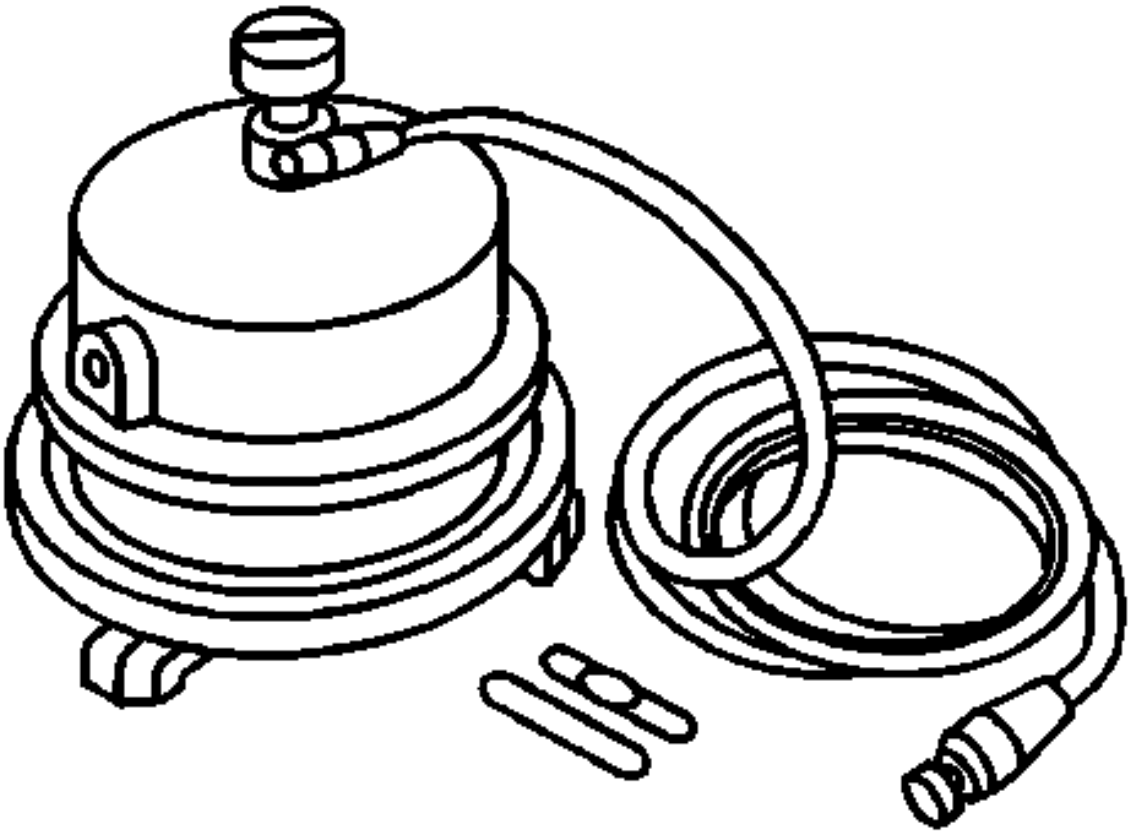
Illustration	Tool Number/ Description
	J 29532 Diaphragm Pressure Bleeder

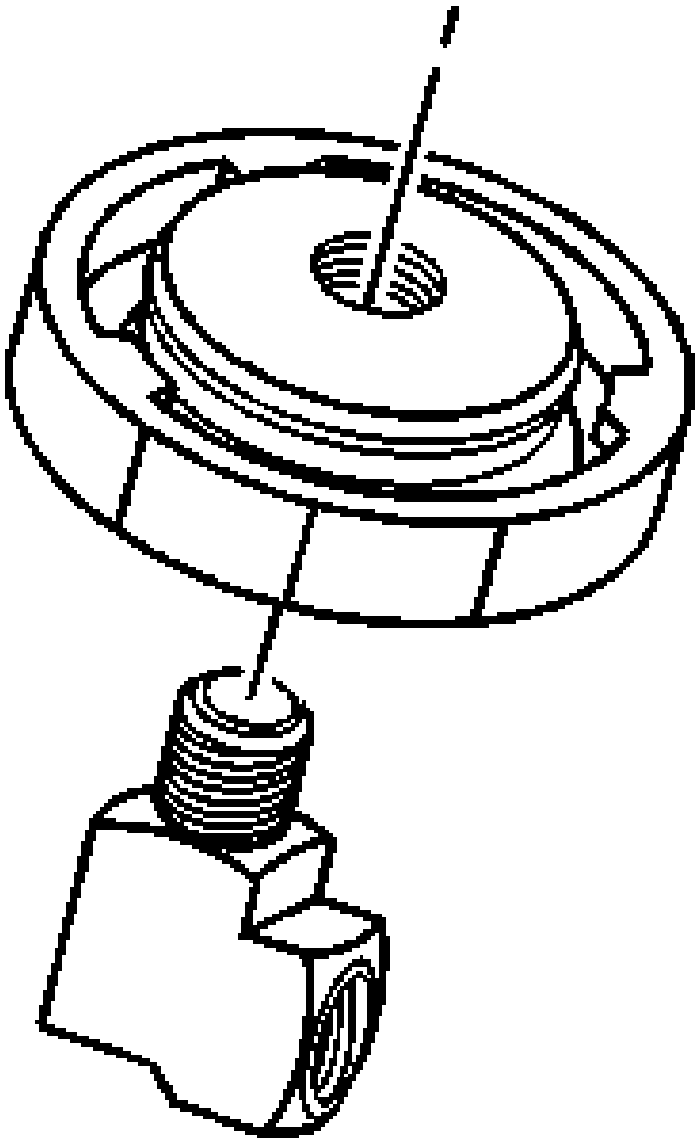
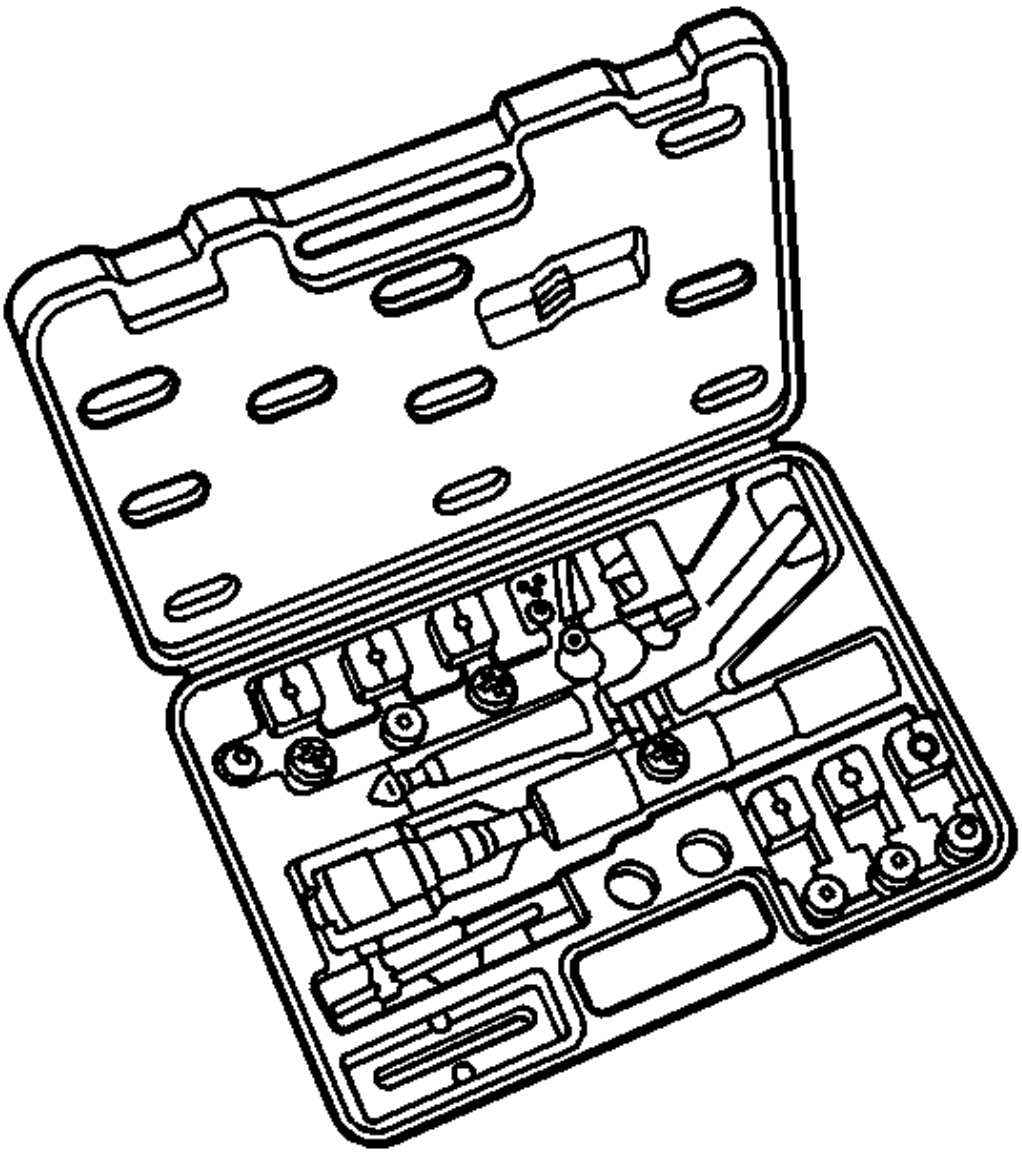
Illustration	Tool Number/ Description
	J 35589-A Brake Pressure Bleeder Adapter

Illustration	Tool Number/ Description
	J 45405 Pipe Flaring Tool Kit

Article GUID: A00737168

Brakes

Park Brake - Impala Limited

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Park Brake Cable Bracket Bolt	14 N.m	124 lb in
Park Brake Pedal Assembly Nut	25 N.m	18 lb ft
Park Brake Warning Lamp Switch Bolt	3 N.m	26 lb in

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - PARK BRAKE

IMPORTANT: Review the system operation in order to familiarize yourself with the system functions.

Refer to **Park Brake System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the park brake system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

Park Brake Will Not Hold or Release

PARK BRAKE WILL NOT HOLD OR RELEASE

Step	Action	Yes	No
1	Were you sent here from the Park Brake Symptom table?	Go to **Step 2**	Go to **Symptoms - Park Brake**
2	Inspect the park brake system for proper operation. Refer to **Park Brake System Diagnosis**. Did you find and correct a condition?	Go to **Step 5**	Go to **Step 3**
3	Inspect the disc brake system for proper operation. Refer to **Disc Brake System Diagnosis** . Did you find and correct a condition?	Go to **Step 5**	Go to **Step 4**
4	Inspect the hydraulic brake system for proper operation. Refer to **Hydraulic Brake System**	Go to **Step 5**	Go to **Symptoms - Park Brake**

Step	Action	Yes	No
	Diagnosis . Did you find and correct a condition?		
5	Road test the vehicle in order to confirm proper operation. Refer to **Brake System Vehicle Road Test** . Is the condition still present?	Go to **Step 2**	System OK

PARK BRAKE SYSTEM DIAGNOSIS

Step	Action	Yes	No
DEFINITION: This diagnostic table is designed to diagnose ONLY the mechanical components of the PARK brake system in order to determine if the PARK brake system is operating properly. You will be directed by the appropriate Symptom table to go to other brake system diagnostic tables as appropriate.			
1	Were you sent here from a Hydraulic Brake Symptom table?	Go to **Step 4**	Go to **Step 2**
2	Were you sent here from a Park Brake Symptom table?	Go to **Step 4**	Go to **Step 3**
3	1. Raise and support the vehicle with the rear axle supported by jack stands. Refer to **Lifting and Jacking the Vehicle** . 2. With the park brake RELEASED, attempt to rotate the rear wheels to check the rear brakes for a significant amount of drag. Do the rear brakes have a significant amount of drag?	Go to **Step 7**	Go to **Step 4**
4	1. Apply the park brake. 2. Attempt to rotate the rear wheels to check the rear brakes for a significant amount of drag. Do the rear brakes have a significant amount of drag?	Go to **Step 12**	Go to **Step 5**
5	Visually inspect the park brake cable connections and the cables that are accessible on the UNDERSIDE of the vehicle for disconnections and/or damage. Were any of the park brake cables disconnected and/or damaged?	Go to **Step 6**	Go to **Step 7**
6	Reconnect or replace the park brake cables as necessary. Refer to **Parking Brake Front Cable Replacement**, or **Parking Brake Rear Cable Replacement (Z7U)**. Did you complete the repair and/or replacement?	Go to **Step 12**	-
7	1. Disconnect the rear park brake cables from the equalizer and from the brake caliper piston apply levers. Refer to **Parking Brake Rear Cable Replacement (Z7U)**. 2. Have an assistant apply and maintain the caliper piston apply lever to apply the caliper piston.	Go to **Step 9**	Go to **Step 8**

Step	Action	Yes	No
	3. Attempt to rotate the rear wheels to check the rear brakes for a significant amount of drag. 4. Release the caliper piston apply lever. 5. Repeat steps 2-4 for the opposite caliper piston apply lever. 6. Rotate the rear wheels to check the brake for a significant reduction of drag. Did the brake calipers apply and release properly?		
8	Replace the appropriate rear brake caliper. Refer to **Rear Brake Caliper Replacement** . Did you complete the replacement?	Go to **Step 12**	-
9	With the aid of an assistant, apply and release the parking brake while observing the cables for free movement. Did the park brake cables move freely?	Go to **Step 11**	Go to **Step 10**
10	Replace any of the park brake cables inspected that do not have free movement. Refer to **Parking Brake Front Cable Replacement**, or **Parking Brake Rear Cable Replacement (Z7U)**. Did you complete the replacement?	Go to **Step 12**	-
11	Inspect the park brake lever pedal assembly for proper operation and replace if necessary. Refer to **Parking Brake Lever Pedal Assembly Replacement**. Did you complete the replacement?	Go to **Step 12**	-
12	Install or connect any components that were removed or disconnected during diagnosis. Did you complete the operation?	Park Brake System OK	-

PARKING BRAKE SHOE INSPECTION

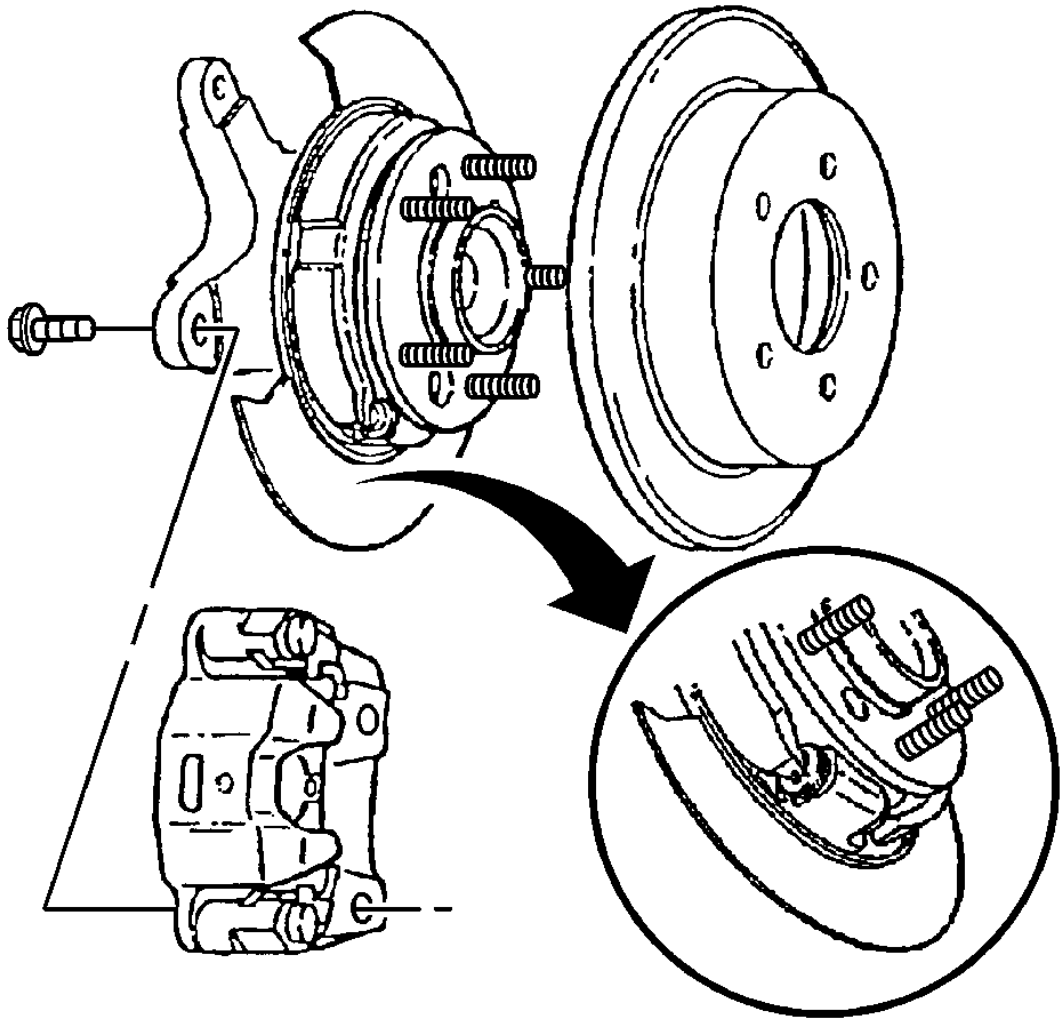


Fig. 1: Identifying Rear Brake Components
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Brake Fluid Irritant Warning .**

CAUTION: **Refer to Brake Fluid Effects on Paint and Electrical Components Caution .**

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the rear brake caliper bracket with the rear brake caliper. Refer to **Rear Brake Caliper Bracket Replacement** .
4. Remove the rear brake rotor. Refer to **Rear Brake Rotor Replacement** .
5. Inspect the park brake shoe and lining. If it exhibits any of the following conditions, then it requires replacement :
    - Excessive wear indicated by the park brake lining being worn down to the shoe
    - Brake lining cracking
    - Oil or fluid contamination of the brake lining

6. Install the rear brake rotor. Refer to **Rear Brake Rotor Replacement** .
7. Install the rear brake caliper with the rear brake caliper bracket. Refer to **Rear Brake Caliper Bracket Replacement** .
8. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
9. Lower the vehicle.

REPAIR INSTRUCTIONS

PARKING BRAKE LEVER PEDAL ASSEMBLY REPLACEMENT

Special Tools

J 37043 Parking Brake Cable Release Tool

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

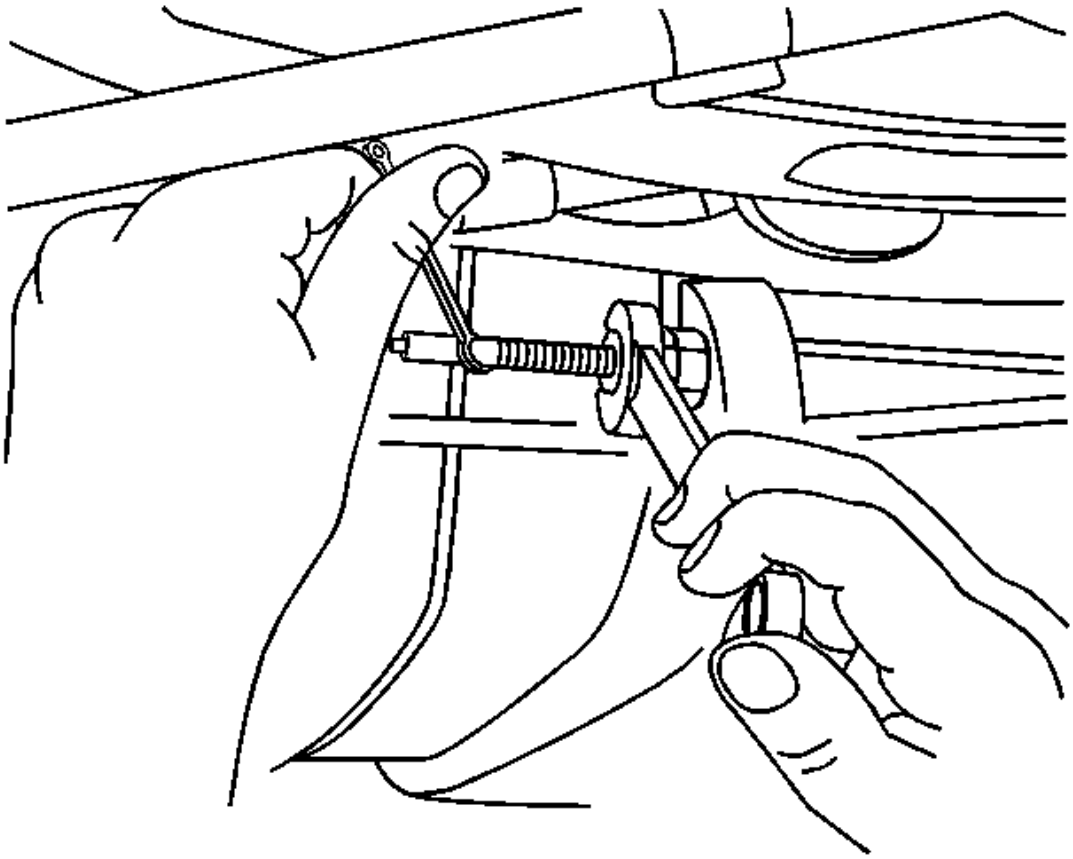


Fig. 2: Adjusting Park Brake Tension At Equalizer Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Relieve the cable tension at the park brake equalizer.

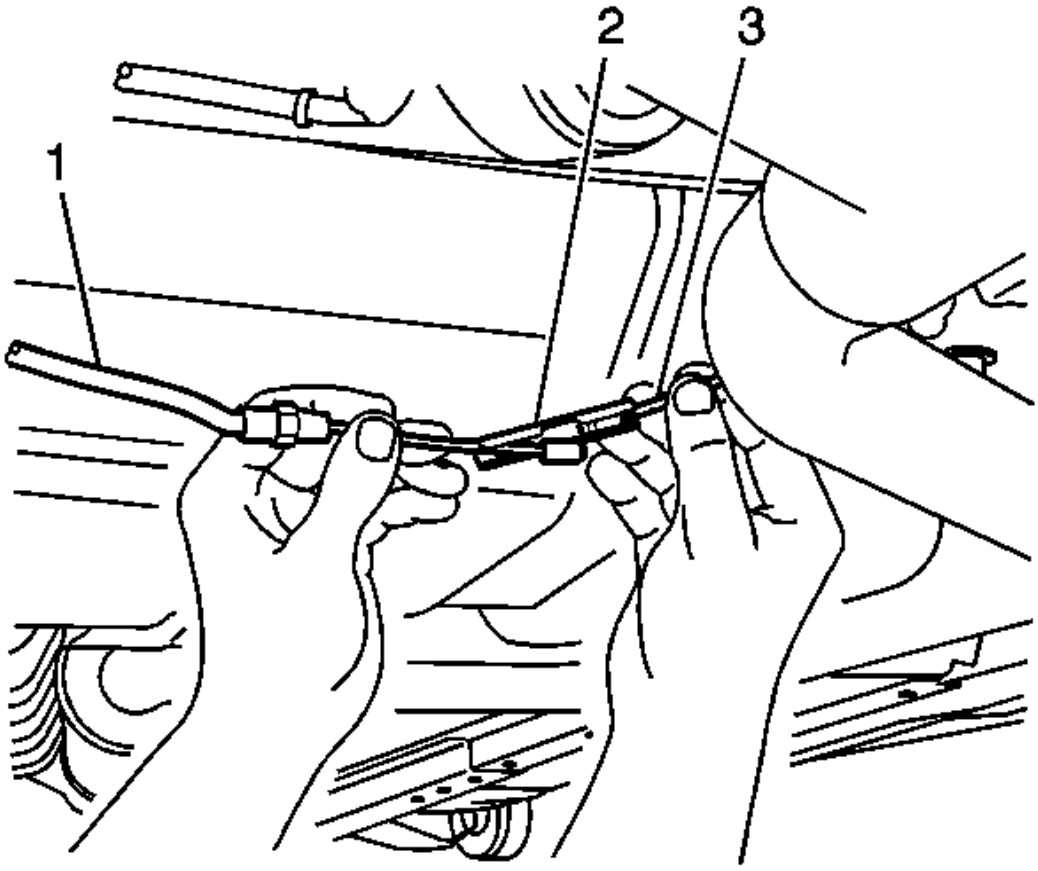


Fig. 3: View Of Front Brake Cable Connected To Right Rear Cable
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the front cable from the connector (2).
4. Lower the vehicle.
5. Remove the left side closeout/insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .
6. Remove the left side front carpet retainers. Refer to **Center Pillar Lower Trim Panel Replacement** .
7. Disconnect the electrical connector at the park brake switch.

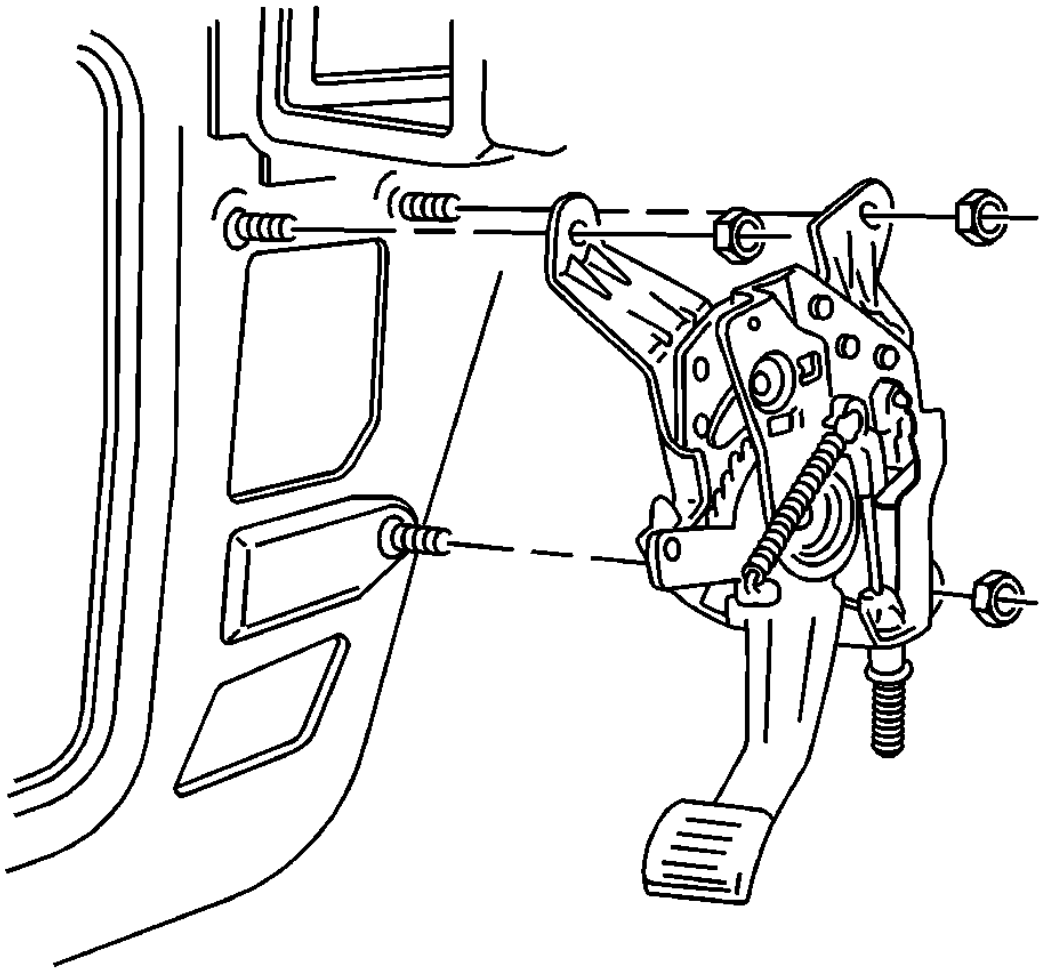


Fig. 4: Park Brake Pedal Assembly
Courtesy of GENERAL MOTORS COMPANY

8. Remove the 3 park brake pedal assembly retraining nuts from the body mounting studs.

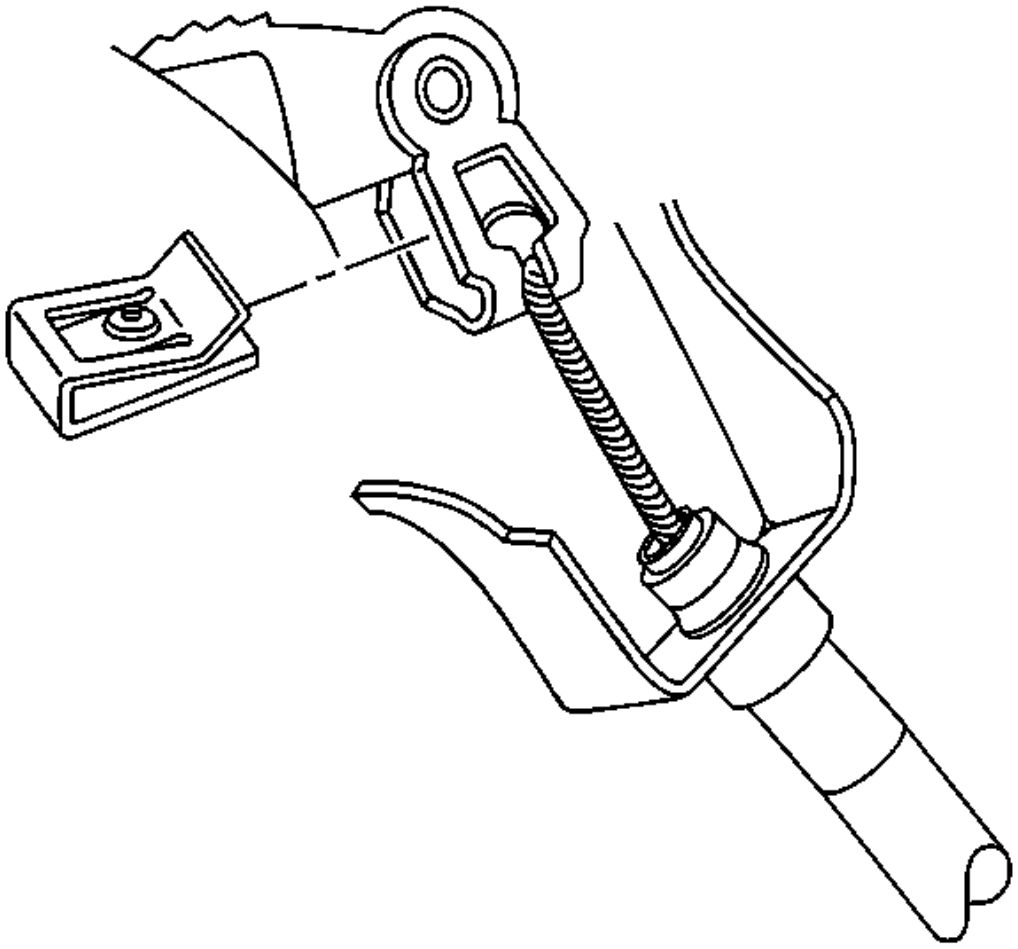


Fig. 5: View Of Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

9. Remove the retaining clip and disconnect the cable button from the clevis.
10. Use the **J 37043** parking brake cable release tool to release and remove cable from the bracket on the pedal assembly.
11. Remove the park brake pedal assembly.

Installation Procedure

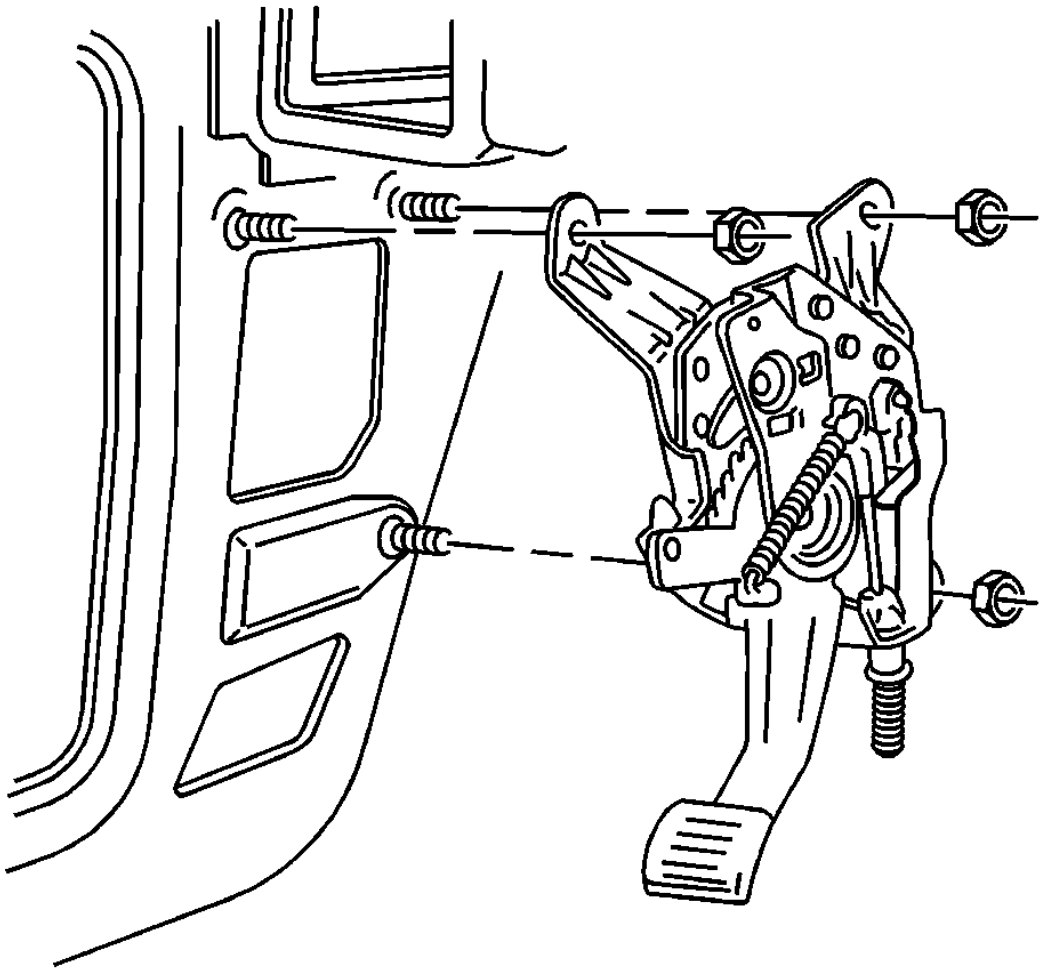


Fig. 6: Park Brake Pedal Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the park brake assembly onto the body mounting studs.

CAUTION: Refer to Fastener Caution .

2. Install the 3 park brake pedal assembly retaining nuts.

Tighten

Tighten the nuts to 25 N.m (18 lb ft).

3. Install the front park brake cable into the bracket on the park brake pedal assembly.

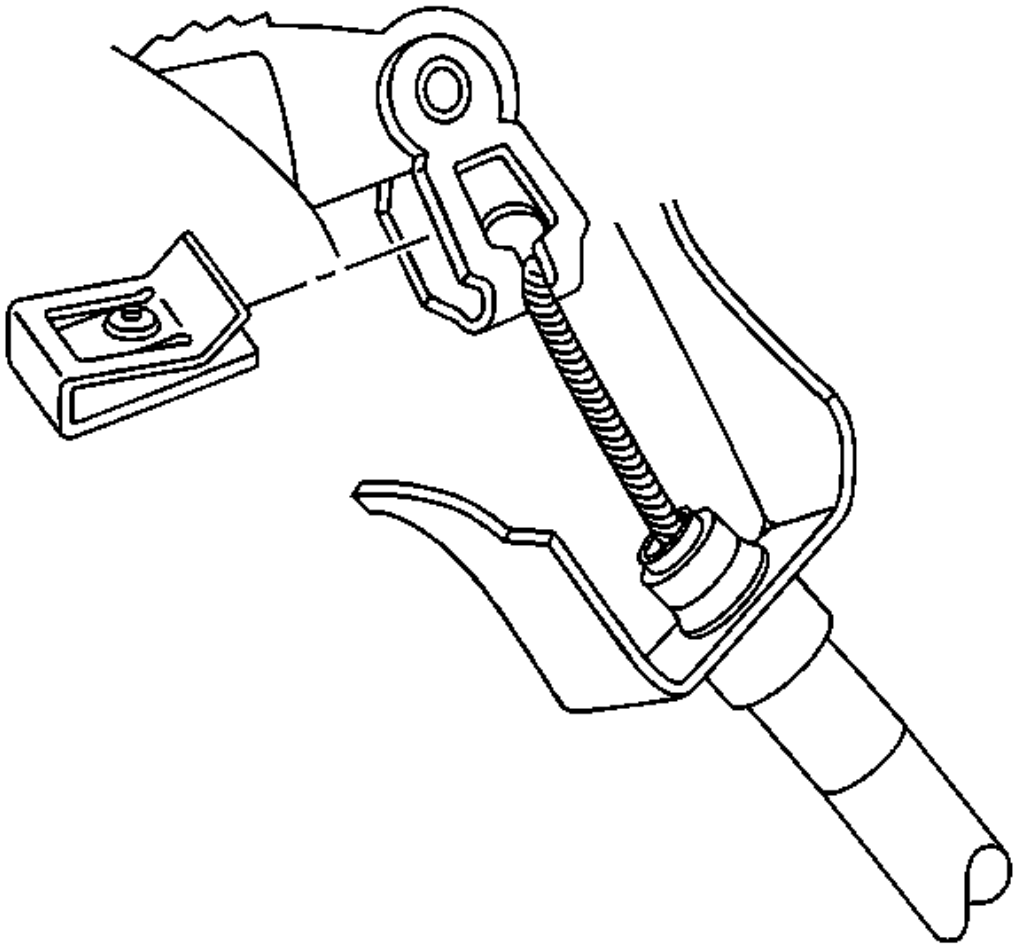


Fig. 7: View Of Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

4. Insert the cable button into the clevis and install the retaining clip.
5. Connect the electrical connector to the park brake switch.
6. Reposition the carpeting properly.
7. Install the left side carpet retainers and the lower center pillar trim panel on the left side. Refer to **Center Pillar Lower Trim Panel Replacement** .
8. Install the left side closeout/insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .
9. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
10. Install the front park brake cable through the park brake cable guides.

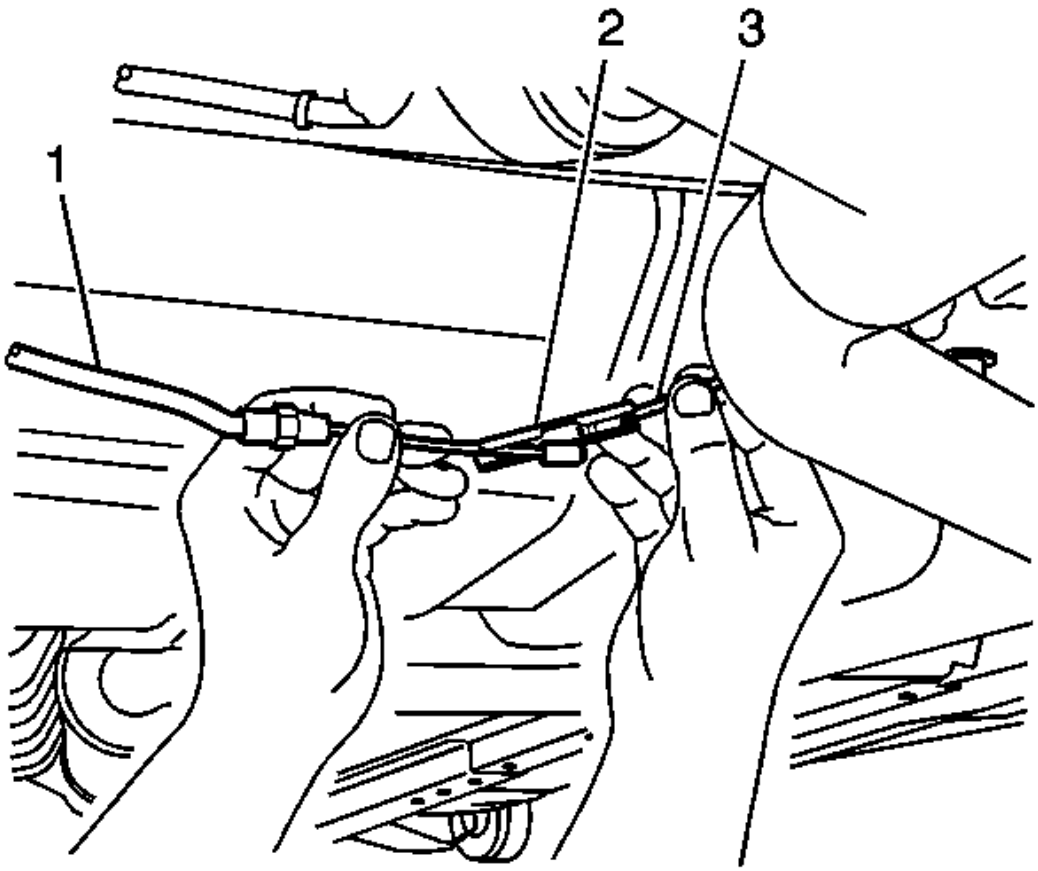


Fig. 8: View Of Front Brake Cable Connected To Right Rear Cable
Courtesy of GENERAL MOTORS COMPANY

11. Connect the front park brake cable (1) to the rear cable (3) at the connector clip (2).

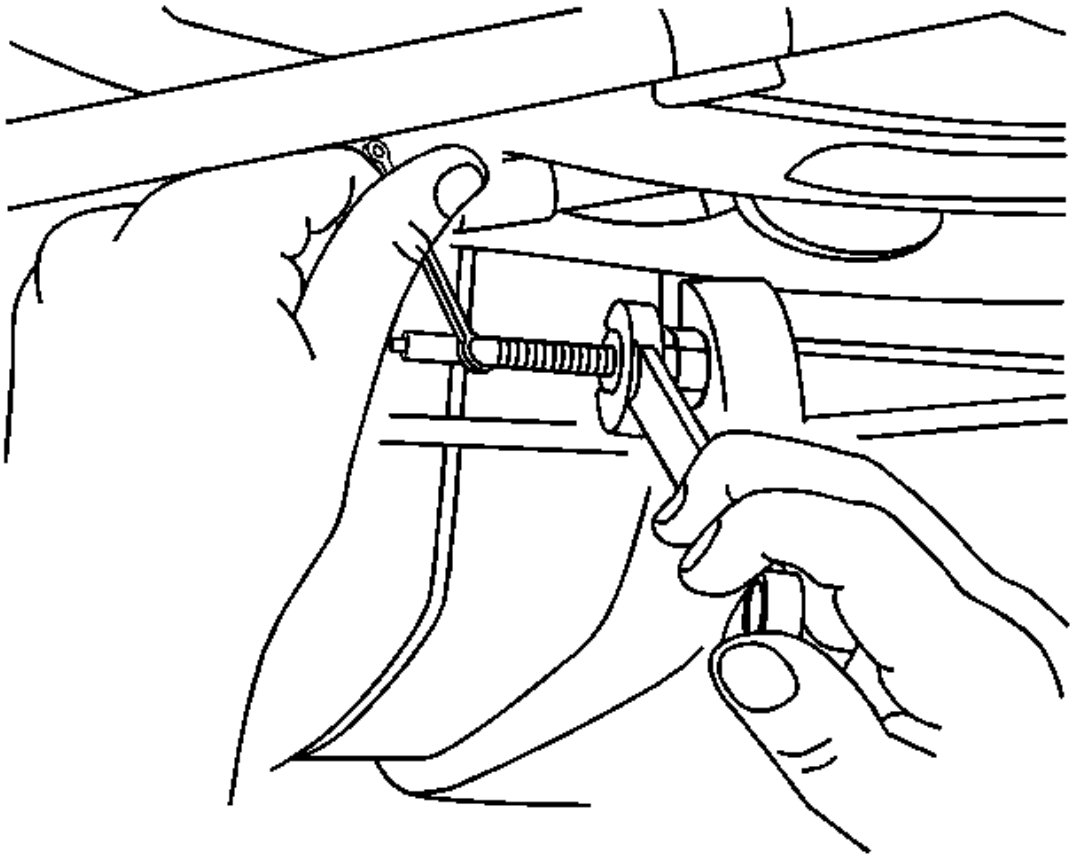


Fig. 9: Adjusting Park Brake Tension At Equalizer Assembly
Courtesy of GENERAL MOTORS COMPANY

12. Tighten the nut on the equalizer in order to remove slack in the cable.
13. Lower the vehicle.

PARKING BRAKE INDICATOR SWITCH REPLACEMENT

Removal Procedure

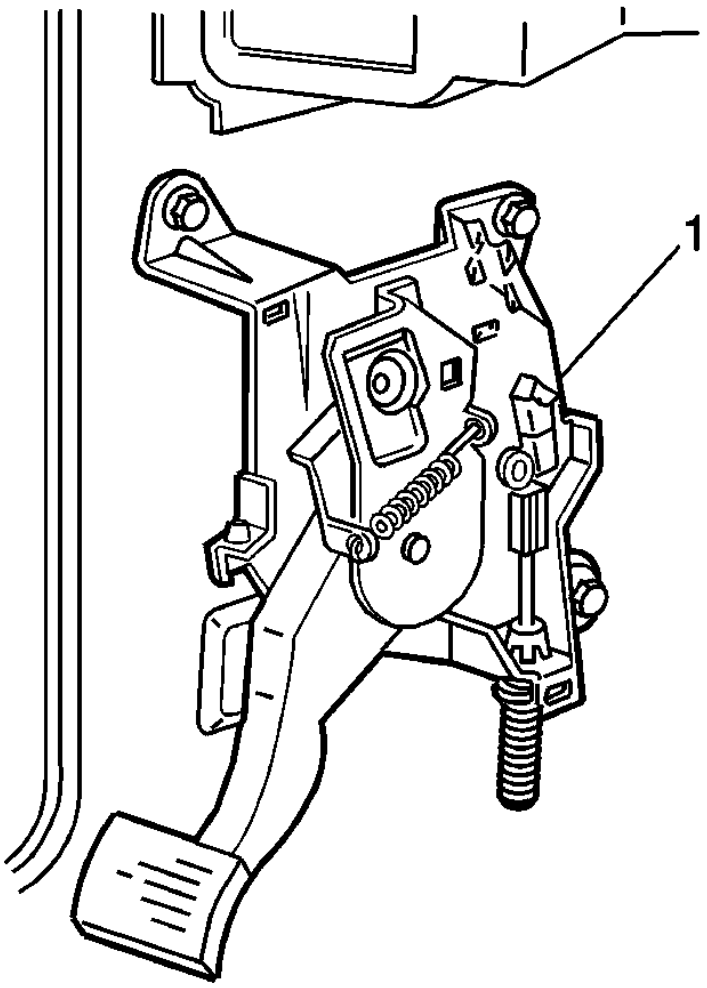


Fig. 10: Parking Brake Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left side instrument panel insulator.
2. Remove the left carpet retainers. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala)** .
3. Disconnect the electrical connector from the switch.
4. Remove the mounting screw.
5. Remove the parking brake indicator switch (1).

Installation Procedure

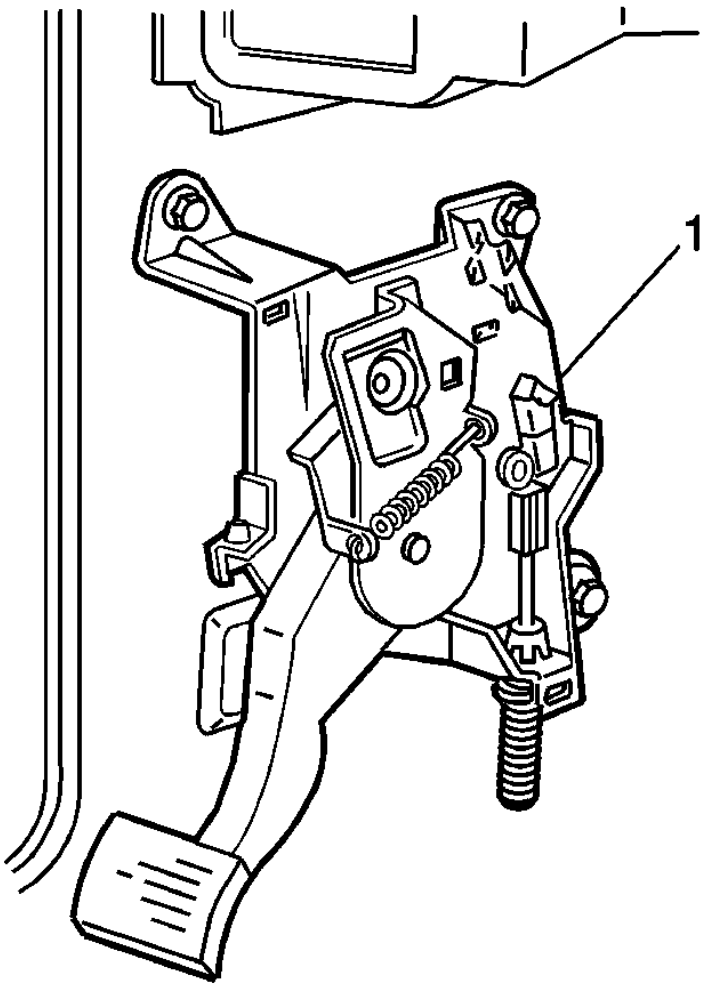


Fig. 11: Parking Brake Indicator Switch
Courtesy of GENERAL MOTORS COMPANY

1. Install the parking brake indicator switch (1).

   CAUTION: Refer to Fastener Caution .

2. Install the mounting screw.

   Tighten

   Tighten the mounting screw to 3 N.m (26 lb in).

3. Connect the electrical connector to the switch.

   Check the operation of the switch.

4. Install the left carpet retainers. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala)** .
5. Install the left side instrument panel insulator.

PARKING BRAKE FRONT CABLE REPLACEMENT

Tools Required

J 37043 Parking Brake Cable Release Tool

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

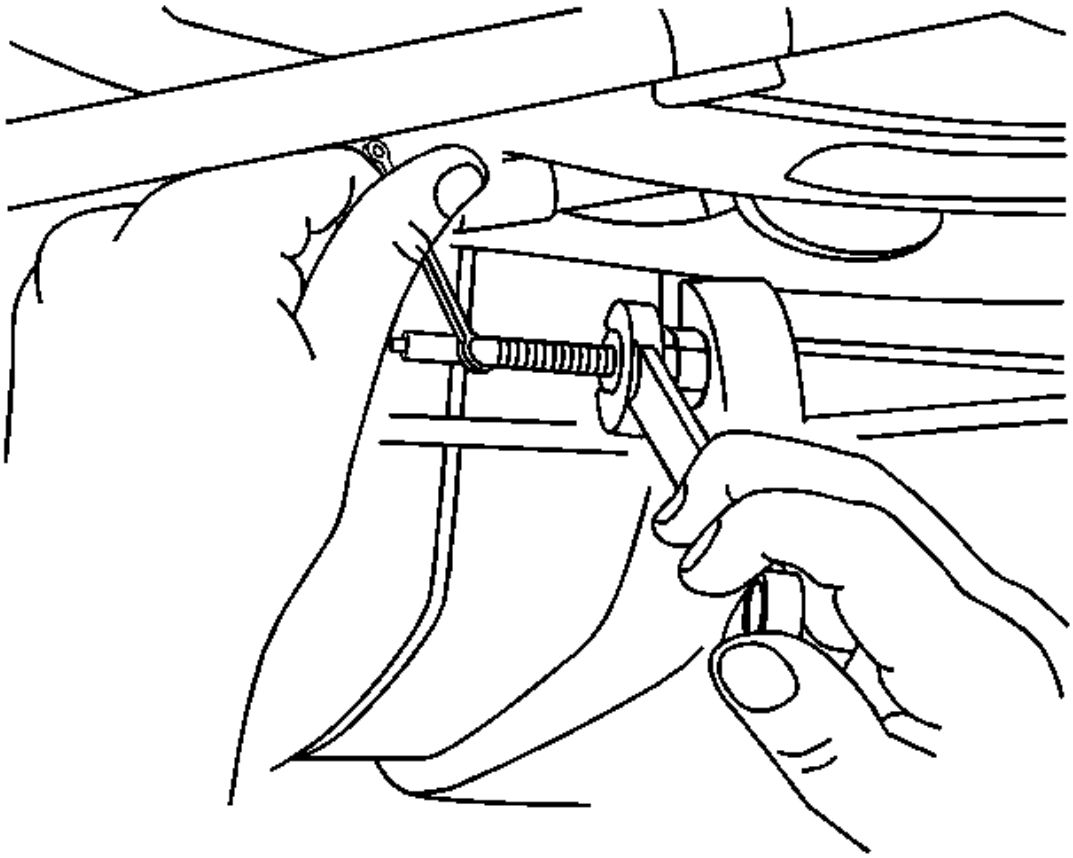


Fig. 12: Adjusting Park Brake Tension At Equalizer Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Relieve the cable tension at the park brake equalizer.

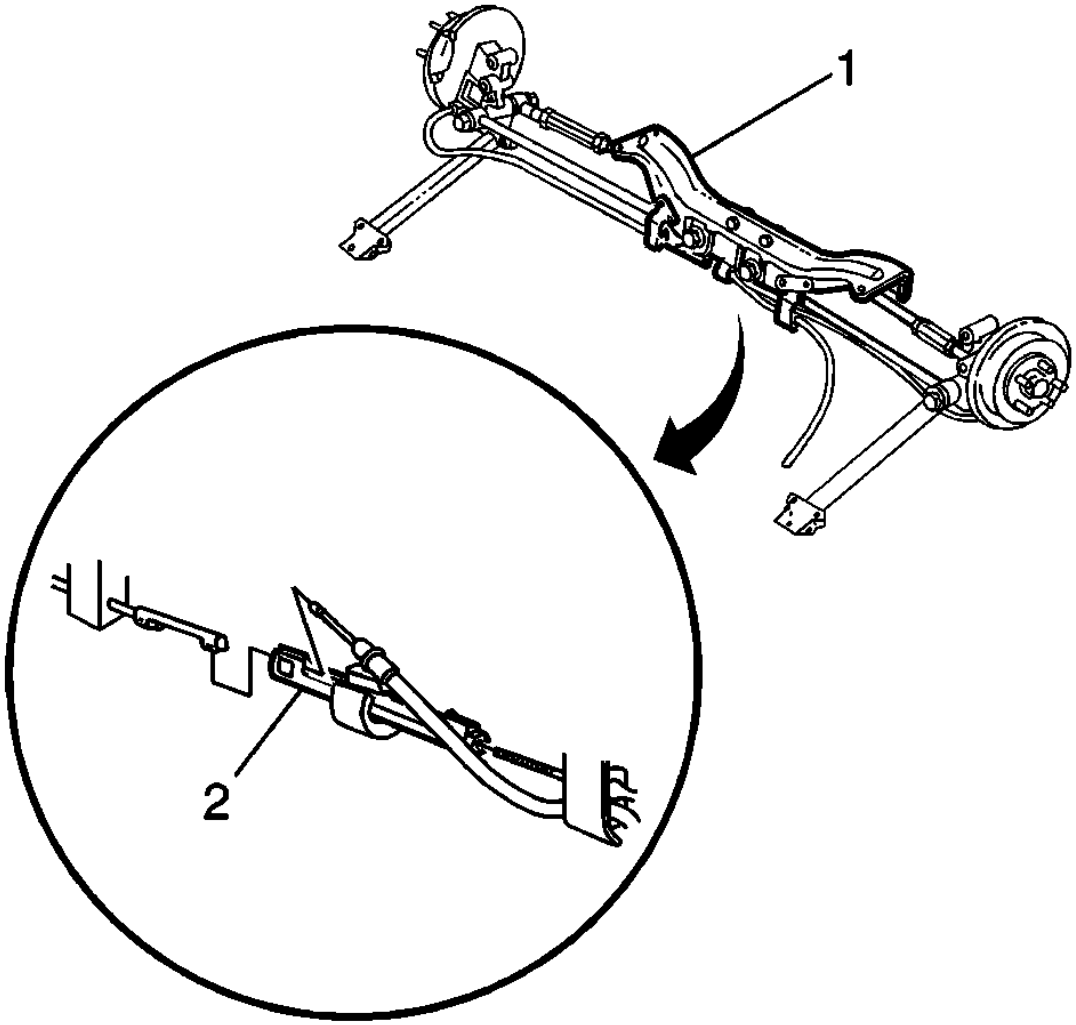


Fig. 13: View Of Parking Brake Adjustment
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the front cable from the connector (2).

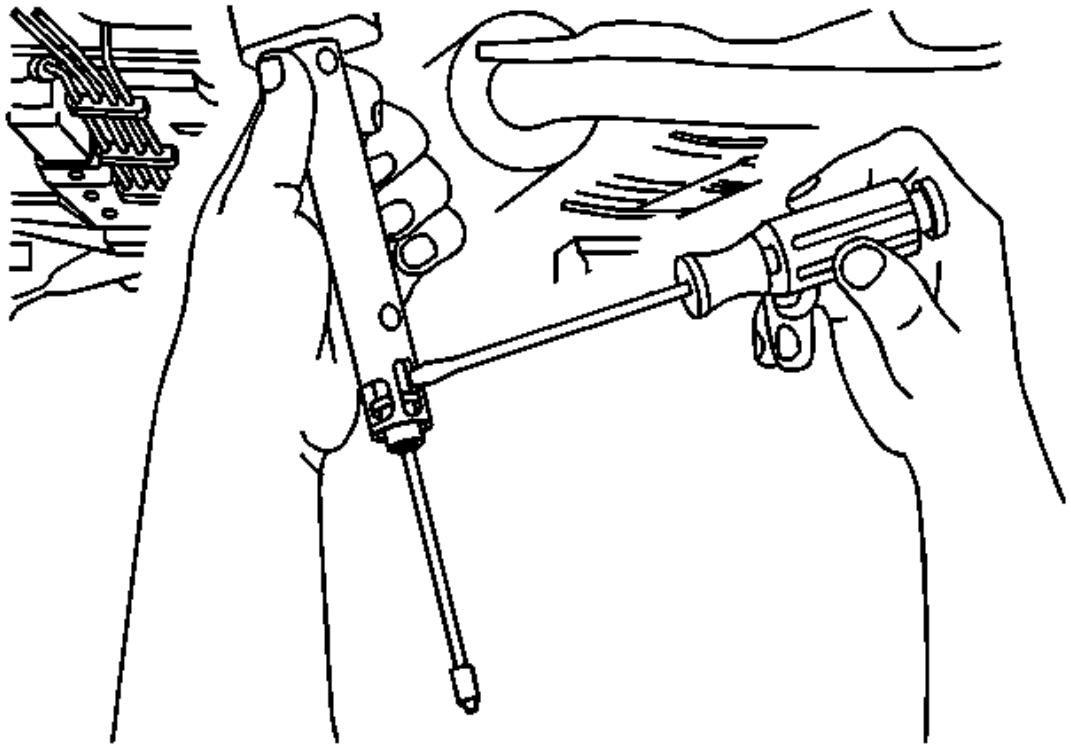


Fig. 14: Equalizer Assembly And Front Park Brake Cable
Courtesy of GENERAL MOTORS COMPANY

4. Remove the front cable from the equalizer.
5. Remove the front cable from the cable guides.
6. Lower the vehicle.
7. Remove the left side closeout/insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .
8. Remove the lower center pillar panel on the left side and the left side carpet retainers. Refer to **Center Pillar Lower Trim Panel Replacement** .
9. Fold back the carpeting in order to gain access to the front park brake cable.

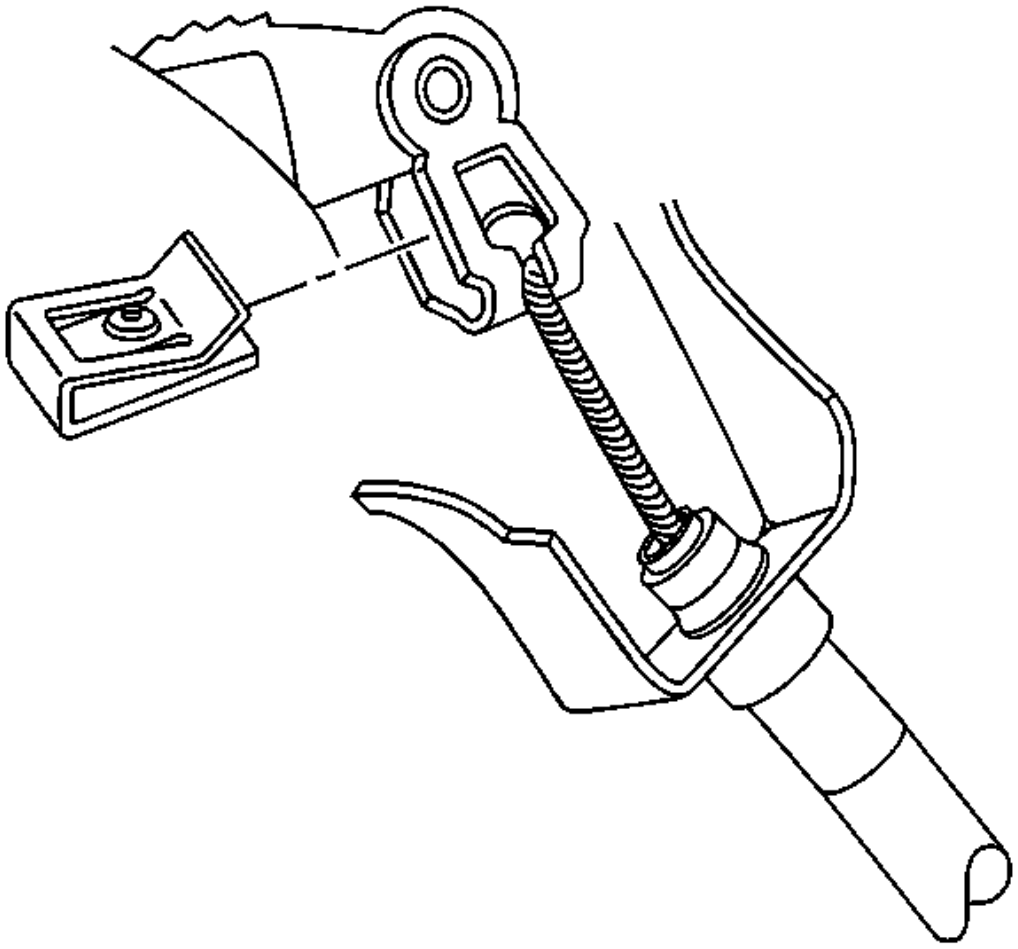


Fig. 15: View Of Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

10. Remove the retaining clip and disconnect the cable from the clevis.
11. Use the **J 37043** parking brake cable release tool to release the retainer holding cable to the bracket on the pedal assembly.
12. Remove the front cable from the vehicle.

Note routing of the cable for installation.

Installation Procedure

1. Install the front cable into the vehicle as noted in the removal procedure.
2. Install the front park brake cable into the bracket on the park brake pedal assembly.

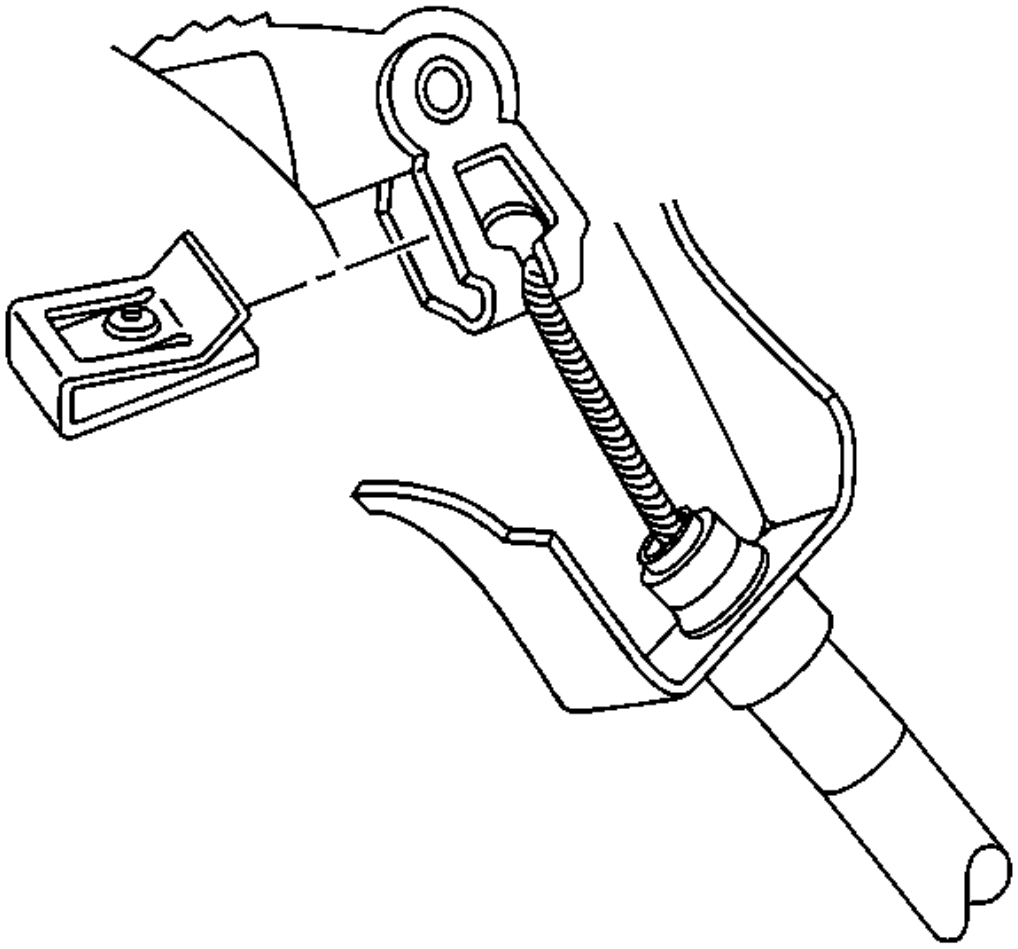


Fig. 16: View Of Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

3. Insert the cable button end into the clevis and install the retaining clip.
4. Reposition the carpeting properly.
5. Install the left side carpet retainers and the lower center pillar trim panel on the left side . Refer to **Center Pillar Lower Trim Panel Replacement** .
6. Install the left side closeout/insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .
7. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
8. Install the front park brake cable through the park brake cable guides.
9. Install the front park brake cable into the equalizer.

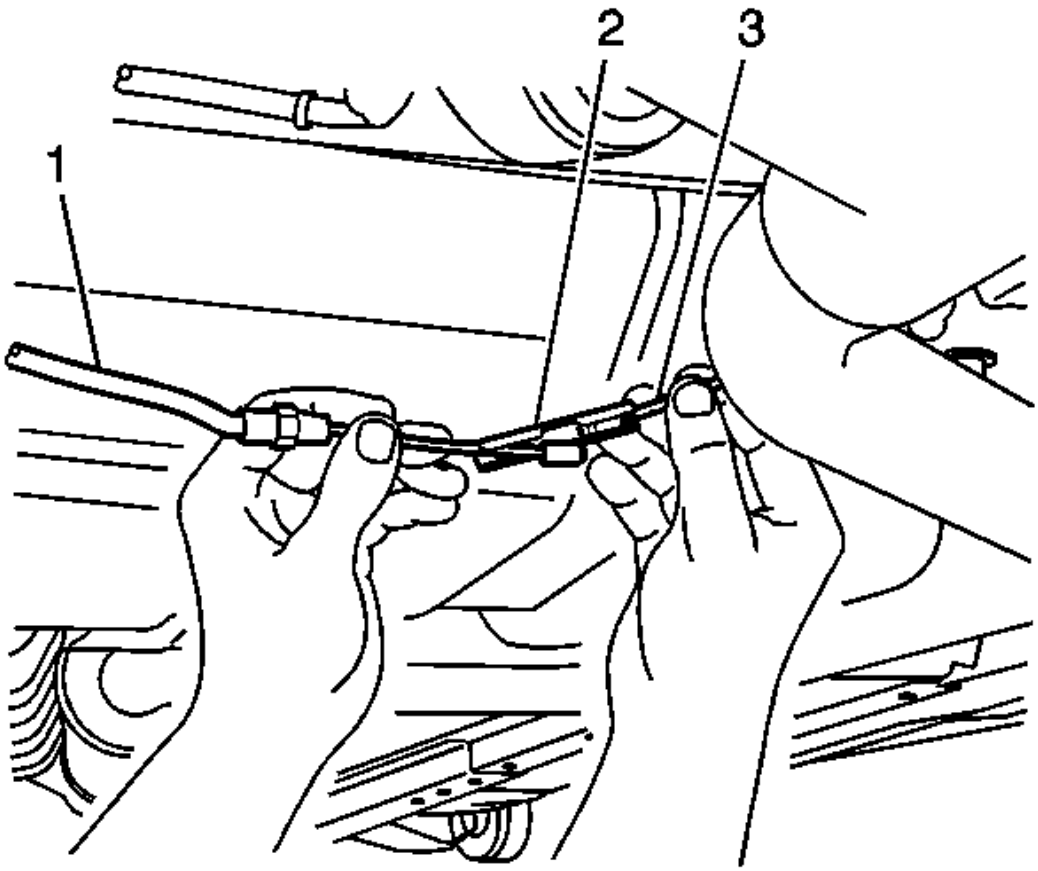


Fig. 17: View Of Front Brake Cable Connected To Right Rear Cable
Courtesy of GENERAL MOTORS COMPANY

10. Connect the front park brake cable (1) to the rear cable (3) at the connector clip (2).

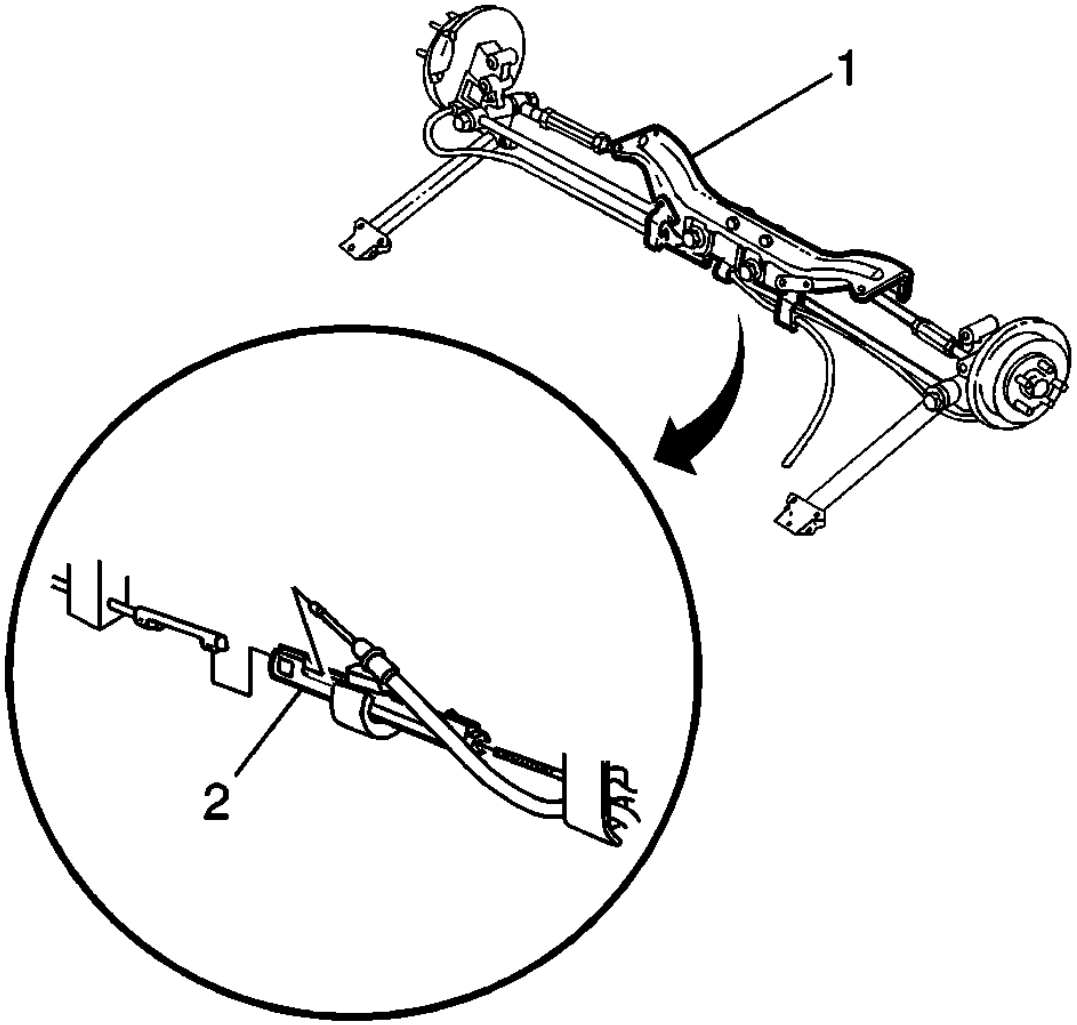


Fig. 18: View Of Parking Brake Adjustment
Courtesy of GENERAL MOTORS COMPANY

11. Tighten the nut on the equalizer (2) in order to remove slack in the cable.
12. Lower the vehicle.

PARKING BRAKE REAR CABLE REPLACEMENT (Z7U)

Special Tools

J 37043 Parking Brake Cable Release Tool

Removal Procedure

WARNING: Refer to Brake Fluid Irritant Warning .

CAUTION: Refer to Brake Fluid Effects on Paint and Electrical Components Caution .

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

2. Relieve the park brake cable tension at the equalizer.
3. Disconnect the front cable from the rear cable that is to be replaced.

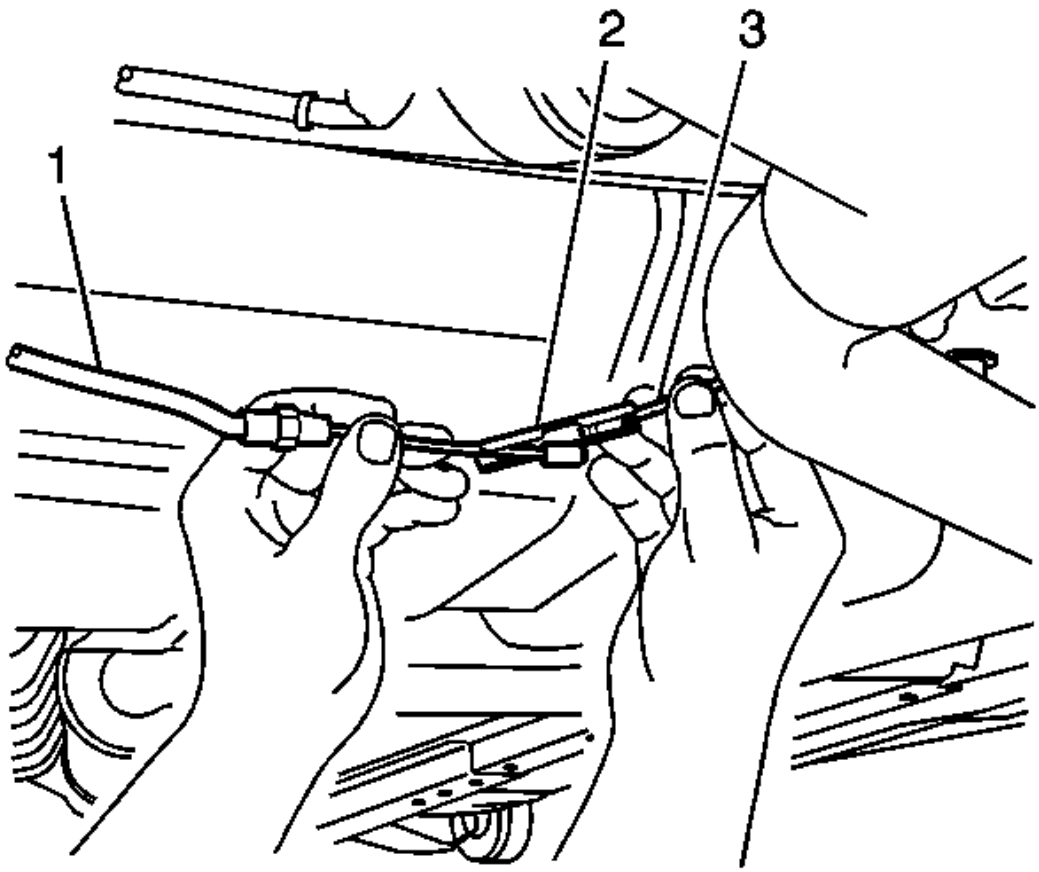


Fig. 19: View Of Front Brake Cable Connected To Right Rear Cable
Courtesy of GENERAL MOTORS COMPANY

- For the right rear cable, disconnect the cable (3) from the clip (2).
- For the left rear cable, fully remove the equalizer nut from the equalizer stud, which is part of the left rear cable.

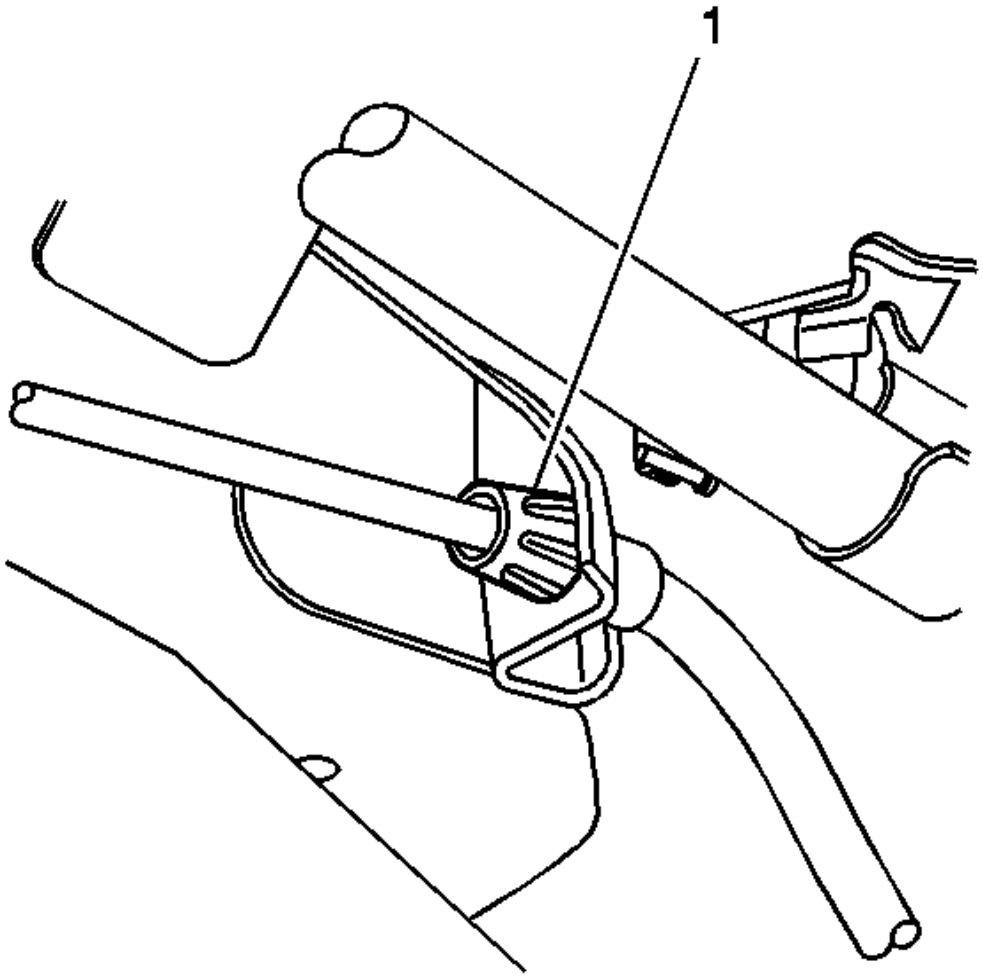


Fig. 20: Rear Park Brake Cable To Support Bracket Retainer (Z7U)
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the retainer (1) that holds the cable to the support bracket. Use the **J 37043** parking brake cable release tool to release the retainer.

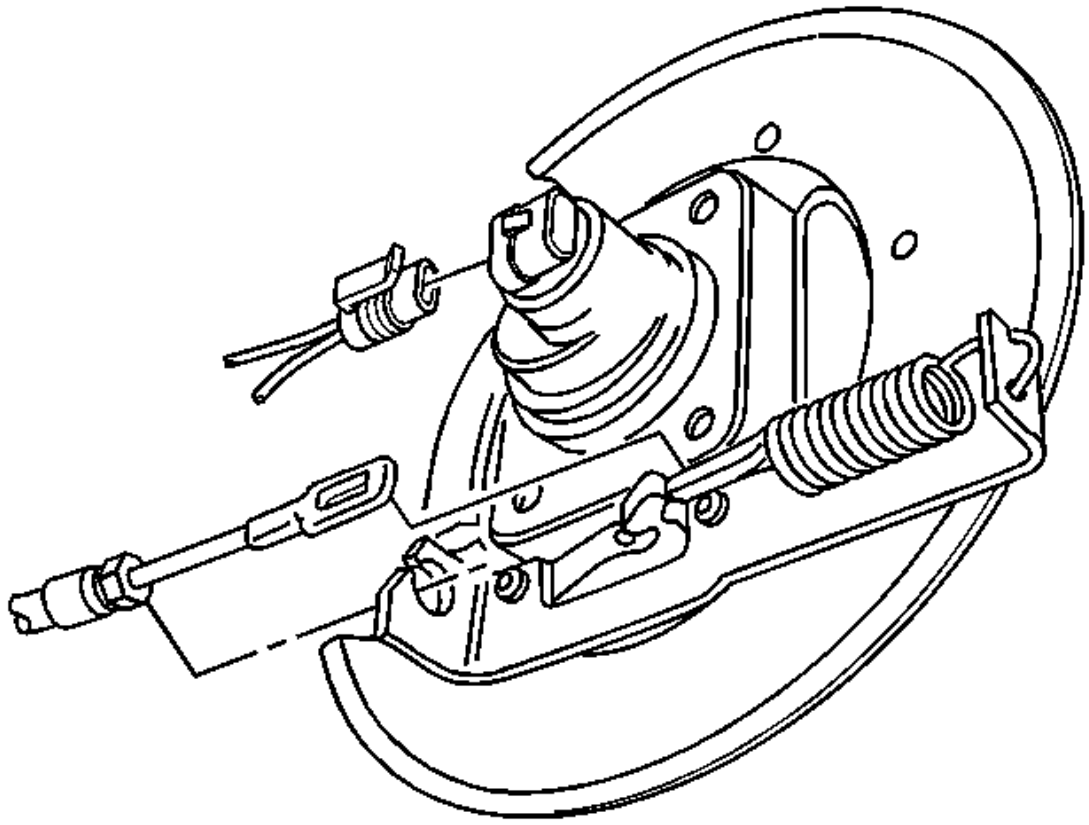


Fig. 21: View Of Rear Park Brake Cable & Wheel Speed Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the park brake cable from the actuator lever.
6. Remove cable retaining pin from the support bracket and remove the park brake cable.

Installation Procedure

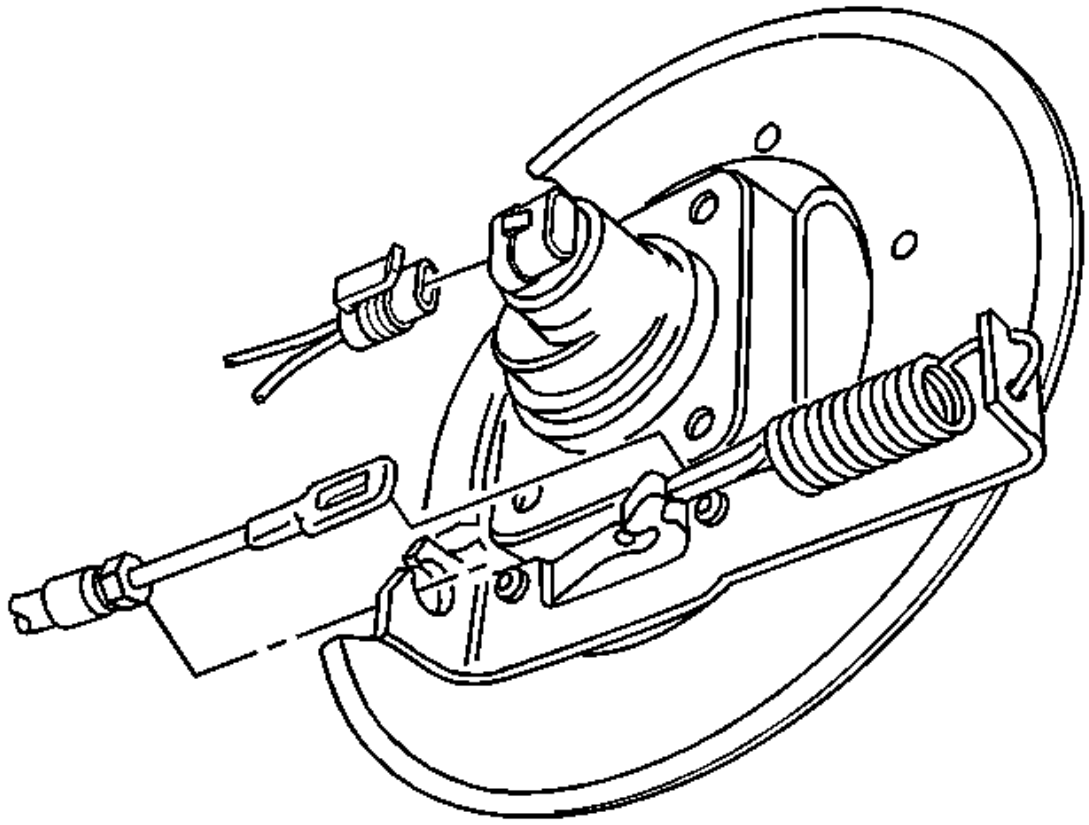


Fig. 22: View Of Rear Park Brake Cable & Wheel Speed Sensor Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Position the park brake cable into the support bracket and install the cable retaining pin.
2. Install the park brake cable to the actuator lever.

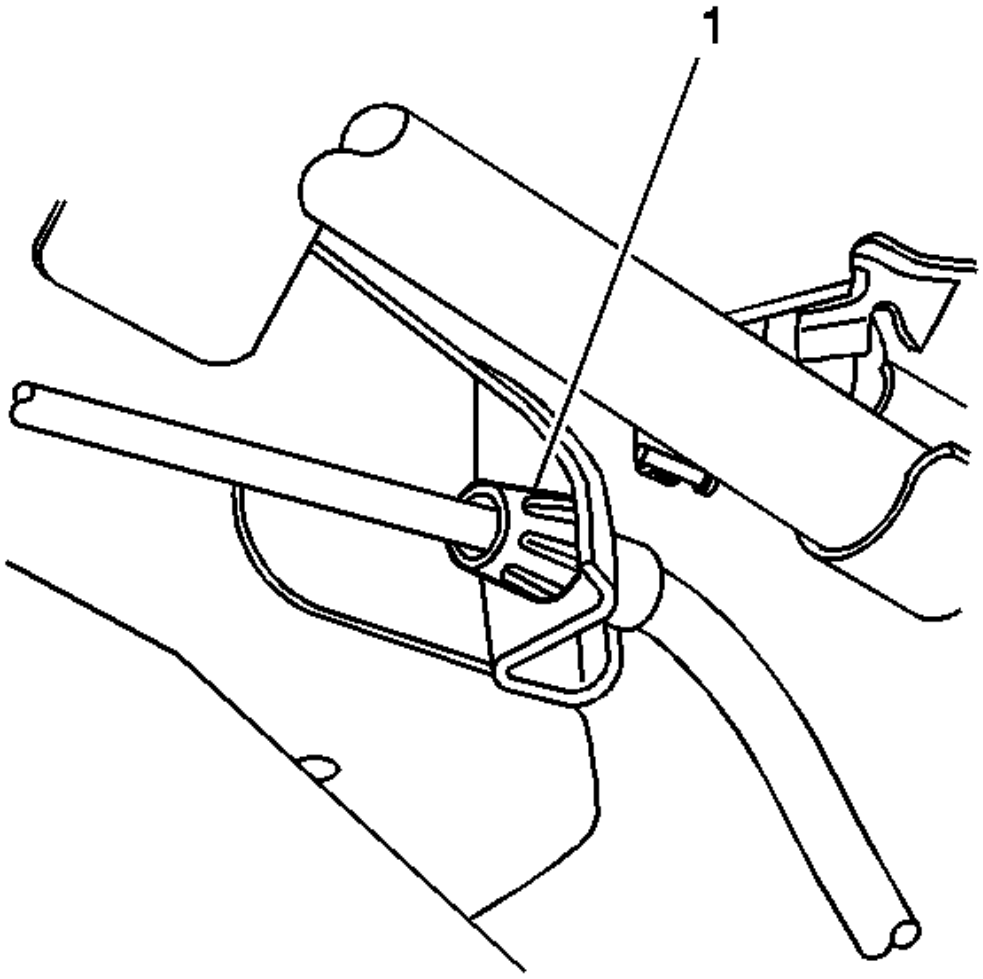


Fig. 23: Rear Park Brake Cable To Support Bracket Retainer (Z7U)
Courtesy of GENERAL MOTORS COMPANY

3. Connect the retainer (1) that holds the cable to the support bracket.
4. Connect the rear cable to the front cable.

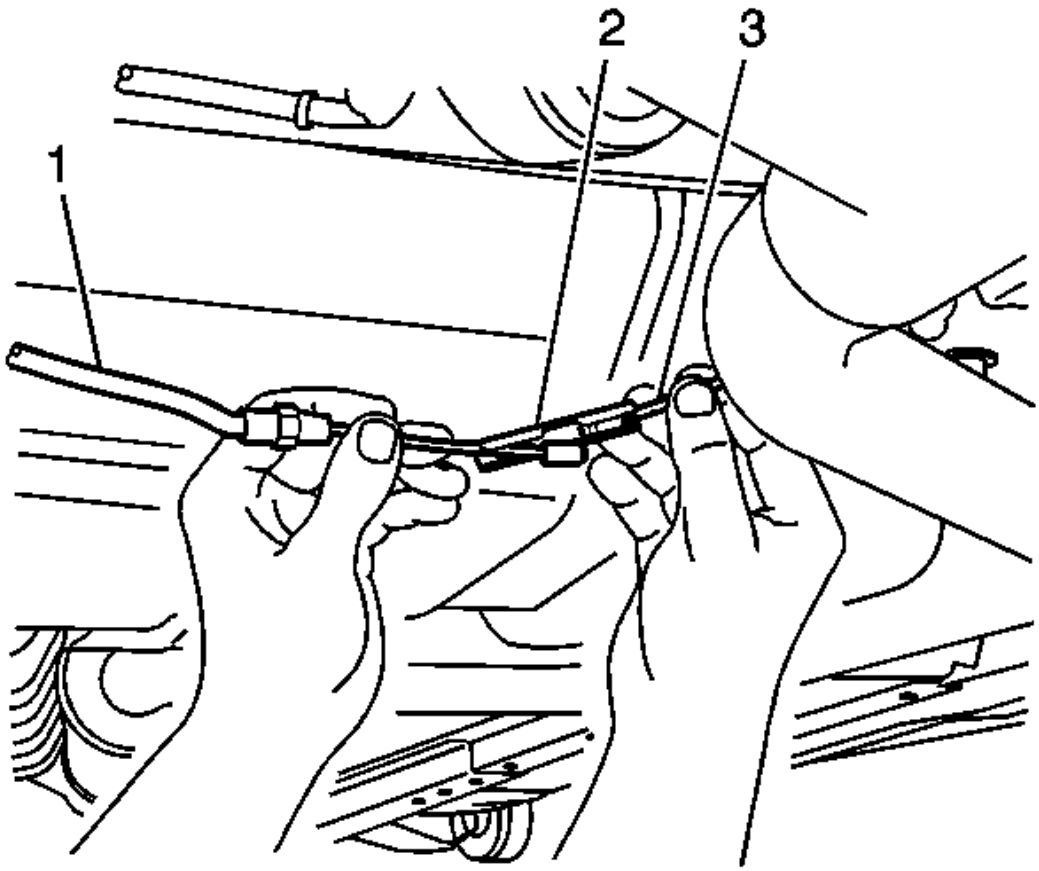


Fig. 24: View Of Front Brake Cable Connected To Right Rear Cable
Courtesy of GENERAL MOTORS COMPANY

- For the right rear cable, connect the cable (3) to the clip (2).
- For the left rear cable, install the equalizer stud to the equalizer nut, which is part of the equalizer assembly.

5. Adjust the park brake. Refer to **Parking Brake Adjustment**.
6. Lower the vehicle.

PARKING BRAKE CABLE EQUALIZER REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

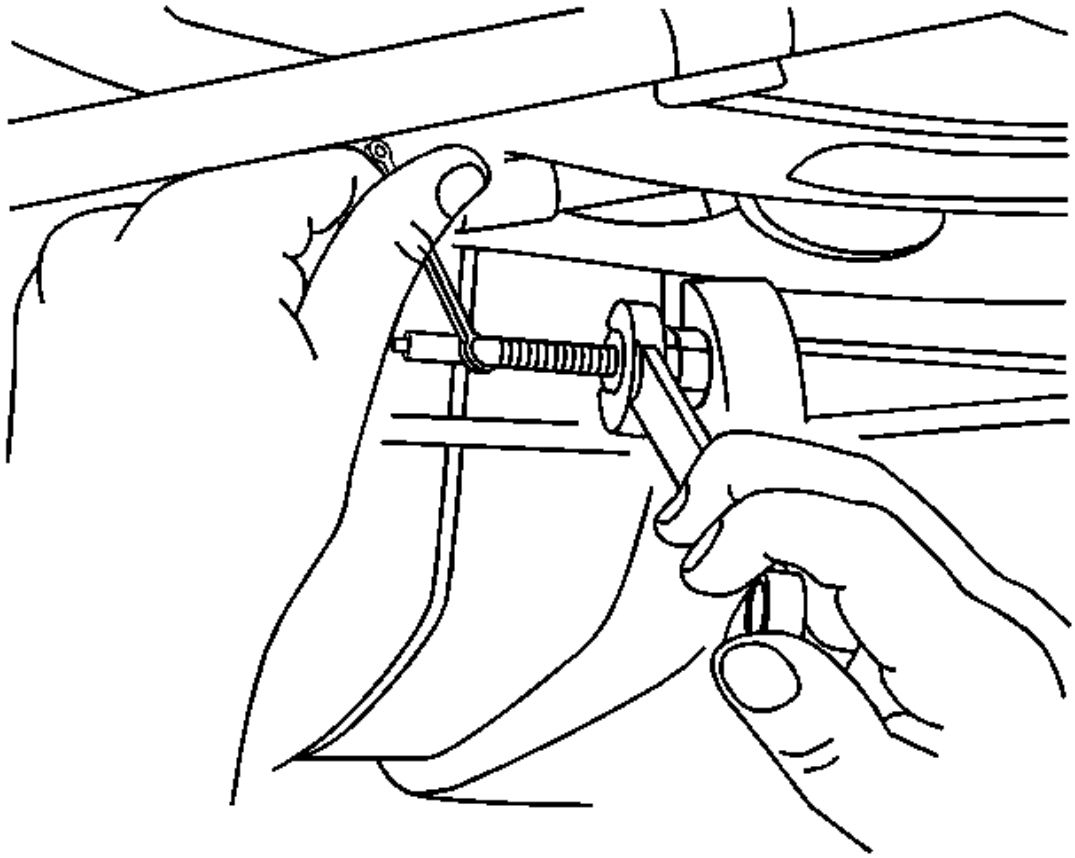


Fig. 25: Adjusting Park Brake Tension At Equalizer Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the left rear park brake cable and adjustment stud assembly from the equalizer assembly by removing the equalizer nut from the adjustment stud.

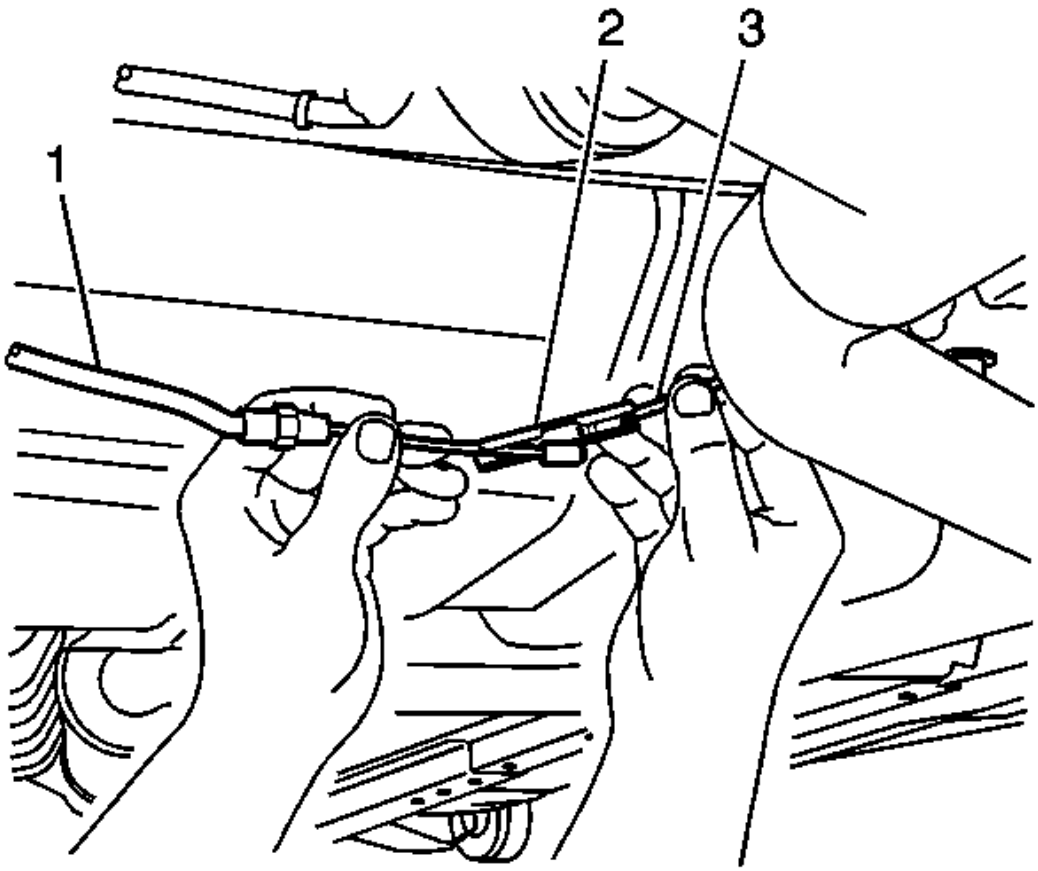


Fig. 26: View Of Front Brake Cable Connected To Right Rear Cable
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the front park brake cable (1) from the right rear cable (3) at the connector clip (2).

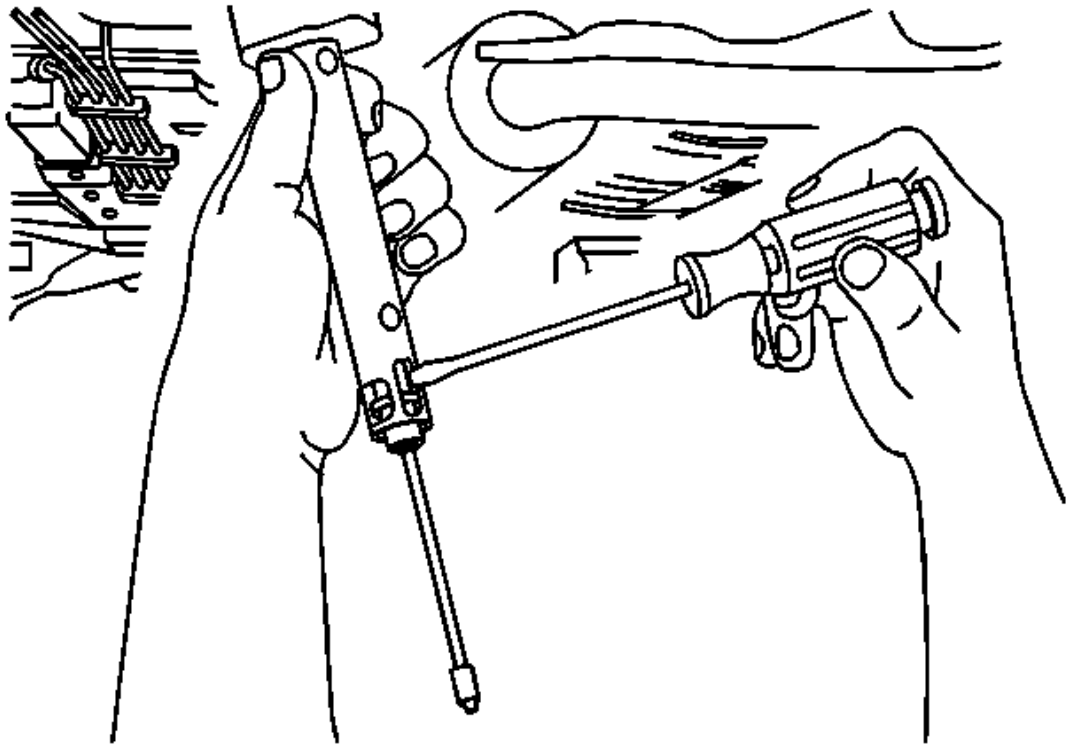


Fig. 27: Equalizer Assembly And Front Park Brake Cable
Courtesy of GENERAL MOTORS COMPANY

4. Remove the equalizer assembly from the front park brake cable. Insert a flat-bladed tool into the equalizer and lightly twist to reposition the equalizer retaining tab. This will release the assembly from the cable.

Installation Procedure

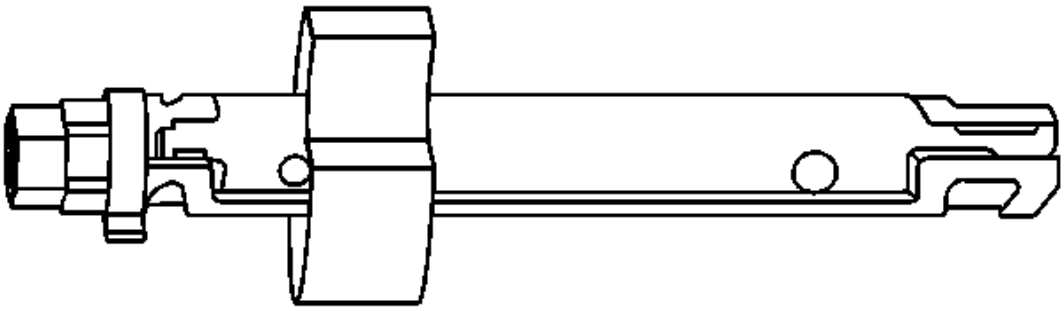


Fig. 28: View Of Equalizer Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the equalizer assembly to the front park brake cable.

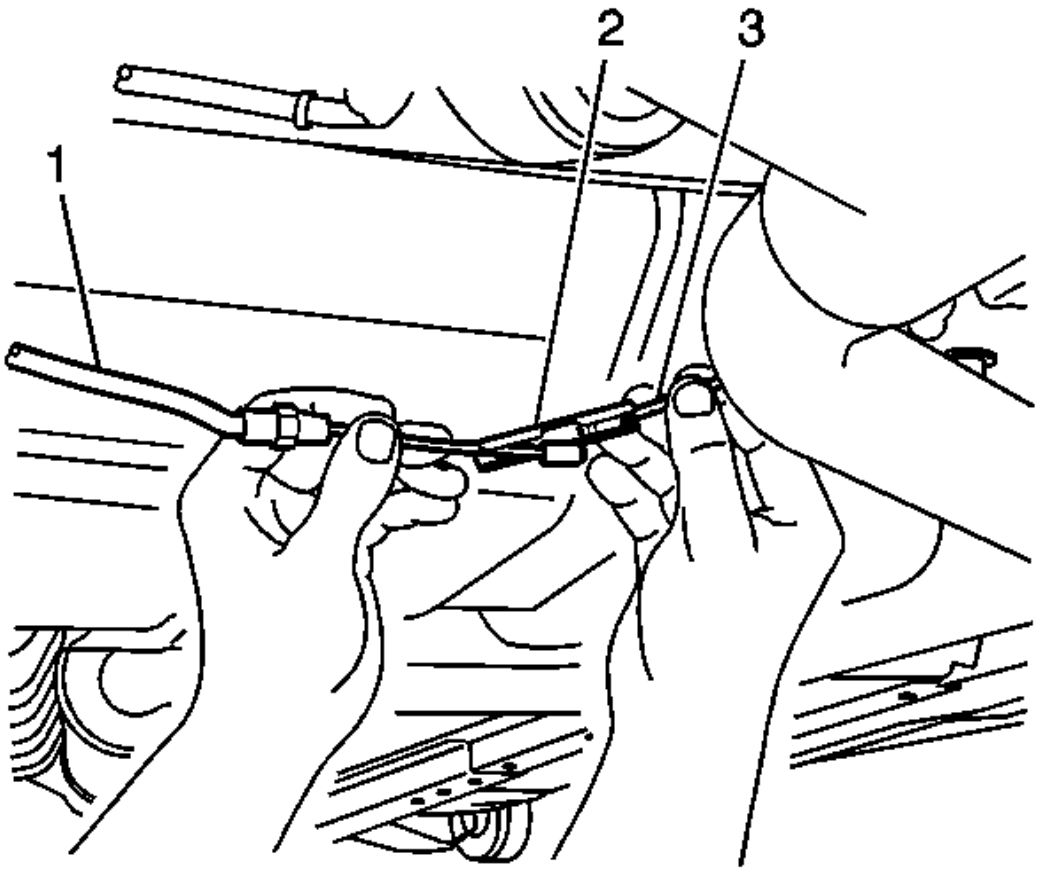


Fig. 29: View Of Front Brake Cable Connected To Right Rear Cable
Courtesy of GENERAL MOTORS COMPANY

2. Connect the front brake cable (1) to the right rear cable (3) at the connector clip (2).
3. Connect the left rear brake cable and adjustment stud assembly to the equalizer assembly by installing the adjustment stud to the equalizer nut.
4. Adjust the Park Brake System. Refer to **Parking Brake Adjustment**.
5. Lower the vehicle.

PARKING BRAKE ADJUSTMENT

WARNING: Refer to Brake Dust Warning .

Adjustment of manual adjustment park brake cable system is necessary whenever the rear brake cables have been disconnected. A need for park brake cable adjustment is indicated if the hydraulic brake system operates with good reserve, but a firm park brake pedal feel cannot be achieved with less than one full stroke of the park brake pedal.

1. Apply and release the park brake 4 times.

2. Park brake light should be illuminated after park brake has been depressed slightly.
3. Check park brake pedal assembly for full release by turning the ignition on and inspecting PARK BRAKE warning light. Light should be off. If PARK BRAKE warning light is on and park brake appears to be fully released, pull the pedal back by hand and continue with the adjustment procedure.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Check park brake levers on rear calipers. Levers should be against the stops on the caliper housing. If levers are not against stops, check for binding in rear brake cables and position levers against stops.
6. Tighten park brake cable at equalizer until either the left or right lever begins to move off stop.
7. Loosen adjustment at equalizer until the lever which has moved off the stop, as in step 5, is again resting fully against stops. Loosen tension at equalizer until the cables feel slightly loose to the touch. Cables should not sag under their own weight.
8. Operate park brake several times to check adjustment. A firm pedal feel should be obtained by depressing the pedal less than one full stroke.
9. Inspect left and right caliper levers. Both levers must be resting on stops after adjustment of parking brake.
10. Check the operation of the park brake. Refer to **Park Brake System Description and Operation**.
11. To achieve optimal performance ensure cables are not over-tensioned at the equalizer.

DESCRIPTION AND OPERATION

PARK BRAKE SYSTEM DESCRIPTION AND OPERATION

System Component Description

The park brake system consists of the following:

Park Brake Pedal Assembly

Receives and transfers park brake system apply input force from driver to park brake cable system. Releases applied park brake system when depressed again.

Park Brake Cables

Transfers input force received from park brake pedal, through park brake cable equalizer, to park brake apply lever.

Park Brake Cable Equalizer

Evenly distributes input force to both the left and right park brake units.
Threaded park brake cable equalizers are also used to remove slack in park brake cables.

Park Brake Apply Lever

Multiplies and transfers input force to park brake actuator.

Park Brake Actuator/Adjuster

Uses multiplied input force from apply lever to expand park brake shoe toward the friction surface of the

drum-in-hat portion of the rear brake rotor.
Threaded park brake actuators are also used to control clearance between the park brake shoe and the friction surface of the drum-in-hat portion of the rear brake rotor.

Park Brake Shoe

Applies mechanical output force from park brake actuator to friction surface of the drum-in-hat portion of the rear brake rotor.

System Operation

Park brake apply input force is received by the park brake pedal assembly being depressed, transferred and evenly distributed, through the park brake cables and the park brake cable equalizer, to the left and right park brake apply levers. The park brake apply levers multiply and transfer the apply input force to the park brake actuators which expand the park brake shoe toward the friction surface of the drum-in-hat portion of the rear brake rotor in order to prevent the rotation of the rear tire and wheel assemblies. The park brake pedal assembly releases an applied park brake system when it is depressed again.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

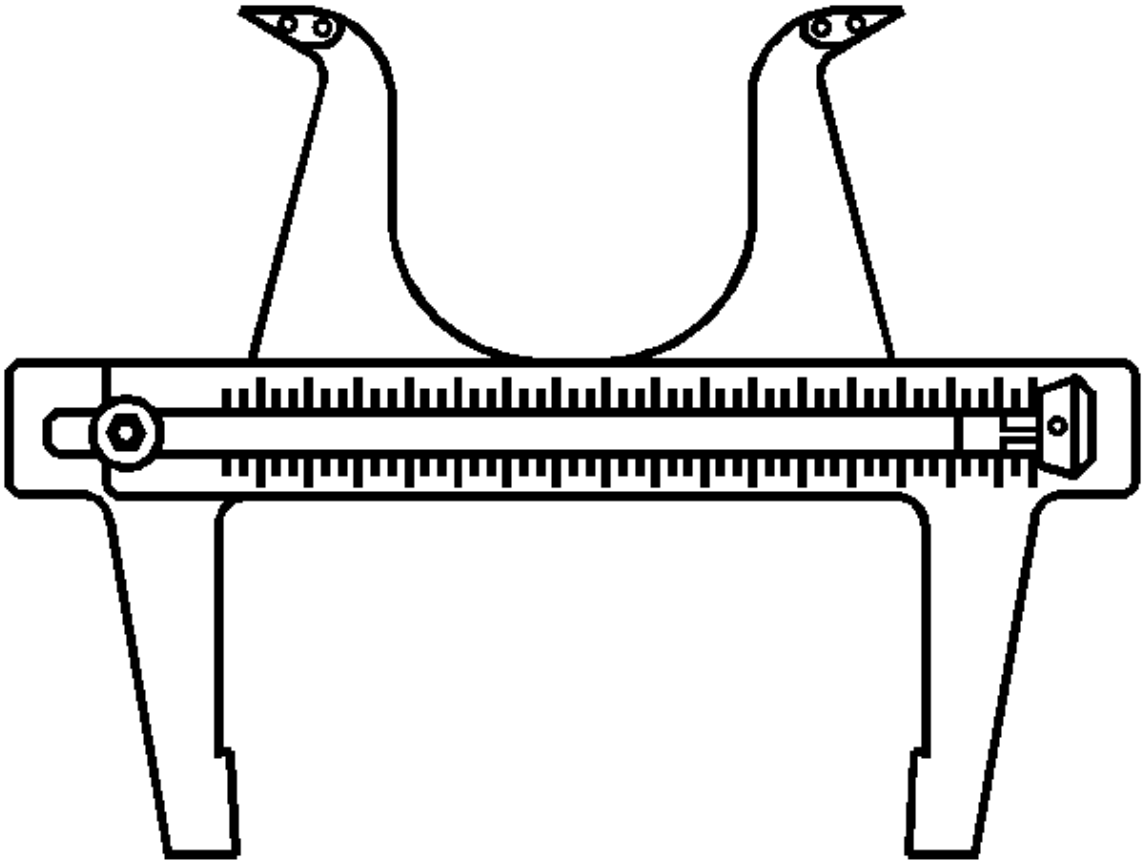
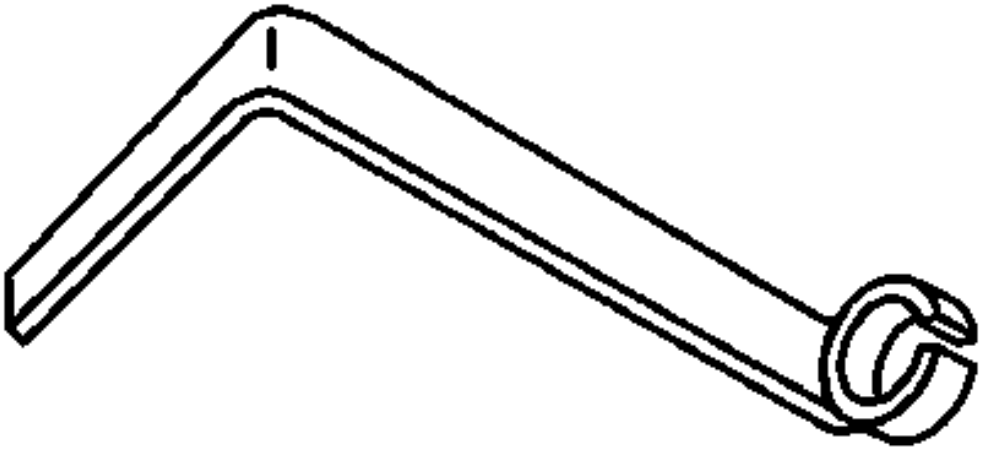
Illustration	Tool Number/ Description
	J 21177-A Drum-to-Brake Shoe Clearance Gauge

Illustration	Tool Number/ Description
	J 37043 Parking Brake Cable Release Tool

Article GUID: A00737216

COMMON SPECS AND PROCEDURES INDEX

IMPALA LIMITED COMMON SPECS AND PROCEDURES

System	Specification/Procedure
Air Conditioning	
Service	REFRIGERANT SYSTEM SPECIFICATIONS
Torque	Manual - FASTENER SPECIFICATIONS
Axle Nut/Hub Nut	
Front	155 lb ft (210 N.m)
Rear	N/A
Battery	NA
Brakes	
Bleeding Sequence	**Manual** - RIGHT REAR, LEFT REAR, RIGHT FRONT, LEFT FRONT. See HYDRAULIC BRAKE SYSTEM BLEEDING (MANUAL) . **Pressure** - RIGHT REAR, LEFT REAR, RIGHT FRONT, LEFT FRONT. See HYDRAULIC BRAKE SYSTEM BLEEDING (PRESSURE) .
Disc Brakes	
Service Specifications	DISC BRAKE COMPONENT SPECIFICATIONS
Torque	FASTENER SPECIFICATIONS
Charging	
Generator	NA
Torque	FASTENER SPECIFICATIONS
Drive Belts	
Adjustment	Serpentine belt used, not adjustable
Drive Belt Routing	See figure under DRIVE BELT REPLACEMENT .
Engine Cooling	
General Service Specifications	N/A
Radiator Cap Pressure	Pressure stamped on cap
Thermostat R & I	
3.6L	ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT
Water Pump R & I	
3.6L	WATER PUMP REPLACEMENT
Engine Mechanical	
3.6L	

System	Specification/Procedure
Compression	No cylinder reading should be less than 965 kPa (140 psi). The lowest reading should not be less than 70 percent of the highest reading. See **ENGINE COMPRESSION TEST**
Oil Pressure	Minimum @ Idle - 69 kPa (10 psi) Minimum @ 2,000 RPM - 138 kPa (20 psi)
Overhaul	**ENGINE MECHANICAL SPECIFICATIONS**
Torque	**FASTENER SPECIFICATIONS**
Fluid Specifications	See FLUIDS under MAINTENANCE/FLUIDS tab. From within Manager or Service Writer, click the "30/60/90 Interval" or "Maint." button.
Flywheel/Flex Plate/Drive Plate Torque	**Automatic Transmission** **First Pass** - 22 lb ft (30 N.m) **Final Pass** - additional 45 Degrees
Fuel System	
Pressure Specification (3.6L)	**Not Running** - 345-690 kPa (50-100 psi)
Fuel Pressure Test Procedure	See **CIRCUIT/SYSTEM VERIFICATION**
Fuel Filter Location	Fuel filter is part of the fuel tank fuel pump module.
Fuel Filter R & I	**FUEL TANK FUEL PUMP MODULE REPLACEMENT**
Ignition	
Firing Order & Cylinder Identification	**FIRING ORDER & CYLINDER IDENTIFICATION**
Ignition Wires (Resistance)	Individual Ignition Coil/Module Assemblies
Ignition Wires (Routing)	
3.6L	Coil on plug.
Spark Plug	
3.6L (Refer to Electronic Parts Catalog)	
Gap	0.0375-0.0433 in (0.95-1.10 mm)
Torque	13 lb ft (18 N.m)
Starting	
Starter	N/A
Torque	**FASTENER SPECIFICATIONS**
Wheel Alignment	
Adjustment Specifications	**WHEEL ALIGNMENT SPECIFICATIONS**
Torque	**FASTENER SPECIFICATIONS**
Wheel & Tire	
Wheel Lug Nut Torque	**Aluminum Wheels** - 93 lb ft (126 N.m) **Steel Wheels** - 103 lb ft (140 N.m) For tightening sequence, see Wheel Nut Tightening Sequence figure under **INSTALLATION PROCEDURE** .

Article GUID: A00739410

DTC INDEX

Impala

ANTILOCK BRAKE SYSTEM - DIAGNOSTIC TROUBLE CODES

ANTILOCK BRAKE SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC C0035-C0050	Wheel Speed Sensor
DTC C0110	Pump Motor
DTC C0131	Antilock Brake System (ABS) Traction Control System (TCS) Pressure
DTC C0161	Antilock Brake System (ABS) Brake Switch
DTC C0179	System Thermal Temperature High
DTC C0186	Lateral Accelerometer
DTC C0196	Yaw Rate
DTC C0201	Antilock Brake System (ABS) Enable Relay
DTC C0242 or P0856	TCS Malfunction/Traction Control Torque Request
DTC C0245	Wheel Speed Sensor
DTC C0292	VSES Combination Sensor
DTC C0558	Calibration Data Not Programmed/Learned
DTC C0561	System Disabled Information Stored
DTC C0563	Calibration Read Only Memory (ROM) Checksum Error
DTC C0710	Steering Position Signal

AUTOMATIC TRANSMISSION - 6T70 - DIAGNOSTIC TROUBLE CODES

AUTOMATIC TRANSMISSION - 6T70 - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC P0601-P0604 or P062F	Control Module Memory
DTC P0634	Control Module Overtemperature
DTC P0658 or P0659	Actuator High Control Circuit Group 1
DTC P0667, P0668, or P0669	Control Module Temperature Sensor
DTC P06AC-P06AE	Control Module Power Up Temperature Sensor
DTC P0711-P0713	Transmission Fluid Temperature Sensor
DTC P0716 or P0717	Input Speed Sensor
DTC P0722 or P0723	Output Speed Sensor
DTC P0741 or P0742	Torque Converter Clutch (TCC) System Stuck
DTC P0751 or P0752	Shift Solenoid Valve 1 Performance - Stuck
DTC P0756	Shift Solenoid Valve 2 Performance - Stuck
DTC P0776 or P0777	Pressure Control Solenoid Valve 2 Stuck
DTC P0796 or P0797	Pressure Control Solenoid Valve 3 Stuck

DTC	Description
DTC P0815, P0816, or P0826	Upshift/Downshift Switch
DTC P0842 or P0843	Transmission Fluid Pressure Switch 1
DTC P0851	Park/Neutral Position Switch
DTC P0872 or P0873	Transmission Fluid Pressure Switch
DTC P0877 or P0878	Transmission Fluid Pressure Switch 4
DTC P0961-P0963	Line Pressure Control Solenoid Valve
DTC P0965-P0967	Pressure Control Solenoid Valve 2
DTC P0969-P0971	Pressure Control Solenoid Valve 3
DTC P0973 or P0974	Shift Solenoid Valve 1
DTC P0976 or P0977	Shift Solenoid Valve 2
DTC P0989 or P0990	Transmission Fluid Pressure Switch 5
DTC P1761	Up and Down Shift Switch
DTC P182E or P1915	Internal Mode Switch
DTC P2714 or P2715	Pressure Control Solenoid Valve 4 Stuck
DTC P2719-P2721	Pressure Control Solenoid Valve 4
DTC P2723 or P2724	Pressure Control Solenoid Valve 5 Stuck
DTC P2728-P2730	Pressure Control Solenoid Valve 5
DTC P2762, P2763, or P2764	Torque Converter Clutch (TCC) Pressure Control Solenoid Valve

BATTERY, CHARGING SYSTEM AND STARTING SYSTEM - DIAGNOSTIC TROUBLE CODES

BATTERY, CHARGING SYSTEM AND STARTING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563	Device Power
DTC B1405	Device Voltage Reference Output 2
DTC B1424	Device 1 Voltage
DTC B1516	Battery Current Sensor
DTC B151A	Low Battery Capacity
DTC B1527	Parasitic Load
DTC P0615, P0616, or P0617	Starter Relay
DTC P0621	Generator L-Terminal
DTC P0622	Generator F-Terminal
DTC P1668	Generator L-Terminal

BOLTED EXTERIOR BODY PANELS AND CLOSURES - DIAGNOSTIC TROUBLE CODES

BOLTED EXTERIOR BODY PANELS AND CLOSURES - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B3006	Hood Ajar Circuit

CELLULAR SYSTEM, ENTERTAINMENT SYSTEM, AND NAVIGATION SYSTEM - DIAGNOSTIC TROUBLE CODES

CELLULAR SYSTEM, ENTERTAINMENT SYSTEM, AND NAVIGATION SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B1025, B1035, B1045, or B1055	Audio Output 1-4
DTC B1259	Antenna Ground
DTC B1287	Amplifier Control Signal
DTC B1446 or B1447	Backup Power Source
DTC B2455	Cellular Phone Microphone
DTC B2470	Cellular Phone Antenna
DTC B2476 or B2482	Cellular Phone Select Service Switch
DTC B2485	Wireless Communication Antenna

CRUISE CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

CRUISE CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C	Cruise Control Malfunction - Cruise Control Switch
DTC P0571	Cruise Control Brake Switch
DTC P0572 or P0573	Brake Switch
DTC P0575	Cruise Control Switch Signal Message Counter
DTC P0703	Brake Switch Signal Message Counter

DATA COMMUNICATION SYSTEM - DIAGNOSTIC TROUBLE CODES

DATA COMMUNICATION SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B1000	ECU Performance/Side Object Detection
DTC B1001	Option Configuration
DTC B1016	VIN Not Programmed
DTC B101D	Electronic Control Unit Hardware
DTC B101E	Electronic Control Unit Software
DTC C0550	Electronic Control Unit
DTC U0020	Low Speed CAN Communication Bus
DTC U0073 or U2100	Communication Bus
DTC U0100-U02FF	Control Module
DTC U1814	Powertrain High Speed Communication

DTC	Description
DTC U1826 or U1827	Lost Communication Module
DTC U2099	High Speed Communication

ENGINE CONTROLS/FUEL - 3.6L (LFX) - DIAGNOSTIC TROUBLE CODES

ENGINE CONTROLS/FUEL - 3.6L (LFX) - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095	Camshaft Position Actuator Solenoid Valve
DTC P0011, P0014, P0021, or P0024	Camshaft Position System
DTC P0016, P0017, P0018, or P0019	Camshaft Position Not Plausible
DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, or P0161	HO2S Heater (LFX)
DTC P0068 or P1101	Air Flow
DTC P0089, P00C6, P228C, or P228D	Fuel Pressure
DTC P0090-P0092, P00C8, P00C9, or P00CA	Fuel Pressure
DTC P0096 or P0111	Intake Air Temperature (IAT) Sensor
DTC P0097, P0098, or P0099	Intake Air Temperature (IAT) Sensor
DTC P00F4-P00F6	Intake Air Humidity Sensor
DTC P0101	Mass Air Flow (MAF) Sensor
DTC P0102 or P0103	Mass Air Flow (MAF) Sensor
DTC P0106	Manifold Absolute Pressure (MAP) Senso
DTC P0107 or P0108	Manifold Absolute Pressure (MAP) Sensor
DTC P0112, P0113, or P0114	Intake Air Temperature (IAT) Sensor 1
DTC P0116	Engine Coolant Temperature (ECT) Sensor
DTC P0117, P0118, or P0119	Engine Coolant Temperature (ECT) Sensor
DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135	Throttle Position Sensor
DTC P0128	Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature
DTC P0131, P0132, P0134, P0137, P0138, P0140, P0151, P0152, P0154, P0157, P0158, or P0160	HO2S Circuit Voltage/Insufficient Activity
DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D, or P2270-P2273	HO2S Slow Response (LFX)
DTC P0171, P0172, P0174, or P0175	Fuel Trim System Lean/Rich
DTC P0178	Fuel Composition Sensor
DTC P0179	Fuel Composition Sensor Circuit High Frequency
DTC P018B-P018D	Fuel Pressure Sensor (Chassis Control Module)
DTC P0191	Fuel Rail Pressure Sensor
DTC P0192 or P0193	Fuel Rail Pressure Senso

DTC	Description
DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277	Cylinder Injector Control
DTC P0231, P0232, or P023F	Fuel Pump Control Circuit (Chassis Control Module)
DTC P025A	Fuel Pump Control Module (Chassis Control Module)
DTC P0300-P0306	Cylinder Misfire
DTC P0315	Crankshaft Position System Variation
DTC P0324, P0326, P0331, P06B6, or P06B7	Knock Sensor
DTC P0325, P0327, P0328, P0330, P0332, or P0333	Knock Sensor
DTC P0335 or P0336	Crankshaft Position Sensor
DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391	Camshaft Position Sensor
DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316	Ignition Coil 1-6
DTC P0420 or P0430	Catalyst System Low Efficiency
DTC P0442	Evaporative Emission (EVAP) System Small Leak Detected
DTC P0443, P0458, or P0459	Evaporative Emission (EVAP) Purge Solenoid Valve
DTC P0446	Evaporative Emission (EVAP) Vent System
DTC P0449, P0498, or P0499	Evaporative Emission (EVAP) Vent Solenoid Valve
DTC P0451-P0454	Fuel Tank Pressure Sensor
DTC P0455	Evaporative Emission (EVAP) System Large Leak Detected
DTC P0496	Evaporative Emission (EVAP) System Flow During Non-Purge
DTC P0506 or P0507	Idle Speed
DTC P050D	Cold Start Rough Idle
DTC P05CC-P05CF	Cold Start Intake Camshaft Position System
DTC P057B-P057D	Brake Pedal Position Sensor
DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B	Control Module Memory/Control Module Processor/Control Module Power Off Timer (ECM)
DTC P0628	Fuel Pump Enable Circuit
DTC P0641 or P06A6	5V Reference (Chassis Control Module)
DTC P0641, P0651, P0697, or P06A3	5 V Reference (ECM)
DTC P0650, P263A, or P263B	Malfunction Indicator Lamp
DTC P0685-P0687, P0689, P0690, or P1682	Engine Controls Ignition Relay
DTC P069E	Fuel Pump Control Module Requested MIL
DTC P0700	Transmission Control Module Requested MIL
DTC P1248-P124D	Cylinder Injector High Control Circuit

DTC	Description
DTC P1255 or P064A	Fuel Pump Control Module/Module (Chassis Control Module)
DTC P135A or P135B	Ignition Coil Supply Voltage
DTC P1400	Cold Start Emission Reduction Control System
DTC P150C	Transmission Control Module Engine Speed Request Signal Message Counter
DTC P1516, P2101, P2119, or P2176	Throttle Actuator Control
DTC P163A	Control Module Fuel Pressure Regulator
DTC P2096 or P2098	Post Catalyst Fuel Trim System Low
DTC P2097 or P2099	Post Catalyst Fuel Trim System
DTC P2122, P2123, P2127, P2128, or P2138	Accelerator Pedal Position (APP) Sensor
DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F	Cylinder 1-6 Injector High Control Circuit
DTC P2199	Intake Air Temperature (IAT) Sensors
DTC P219A or P219B	Fuel Trim Cylinder Balance
DTC P2227-P2230	Barometric Pressure (BARO) Senso
DTC P2269	Water in Fuel
DTC P2544	Transmission Torque Request Signal Message Counter
DTC P2635	Fuel Pump Flow Performance (Chassis Control Module)

ENGINE COOLING SYSTEM - DIAGNOSTIC TROUBLE CODES

ENGINE COOLING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC P0480, P0481, P0691, P0692, P0693, or P0694	Cooling Fan Relay
DTC P1258	Engine Coolant Overtemperature

FIXED AND MOVEABLE WINDOWS - DIAGNOSTIC TROUBLE CODES

FIXED AND MOVEABLE WINDOWS - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B0283	Electric Rear Defrost Circuit

HORN SYSTEM - DIAGNOSTIC TROUBLE CODES

HORN SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B2750	Horn Relay Coil

HVAC SYSTEM - MANUAL - DIAGNOSTIC TROUBLE CODES

HVAC SYSTEM - MANUAL - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B0158	Outside Air Temperature Sensor
DTC B0223, B0233, B0248, B0268, B0408, B0418, or B0428	Recirculate Position/Air Flow Control/Temperature Control
DTC B3933	Air Conditioning Evaporator Temperature Sensor
DTC B393B	Air Conditioning Compressor Valve
DTC P0532 or P0533	Air Conditioning A/C Refrigerant Pressure Sensor
DTC P0645, P0646, or P0647	Air Conditioning (A/C) Compressor Clutch Relay

HYDRAULIC BRAKE SYSTEM - DIAGNOSTIC TROUBLE CODES

HYDRAULIC BRAKE SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC C0267	Low Brake Fluid
DTC C027B	Auxiliary Brake Booster Pump Malfunction
DTC C1100	Brake Booster Vacuum Sensor
DTC P258A-P258D	Vacuum Pump/Vacuum Pump Relay

IMMOBILIZER SYSTEM - DIAGNOSTIC TROUBLE CODES

IMMOBILIZER SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B302A	Telematic Requested Immobilization
DTC B3031	Security System Controller In Learn Mode
DTC B3055	No Transponder Modulation or No Transponder
DTC B3060	Unprogrammed Transponder Identification Code
DTC B3935	Transponder Authentication
DTC B3976	Unconfigured Transponder/Vehicle Configuration
DTC P0513	Theft Deterrent Key
DTC P0633	Theft Deterrent Key Not Programmed
DTC P1629	Theft Deterrent Fuel Enable Signal
DTC P162B	Remote Vehicle Speed Limiting Signal Message Counter
DTC P1631	Theft Deterrent Fuel Enable Signal
DTC P1632	Theft Deterrent Fuel Disable Signal

INSTRUMENT PANEL SYSTEM DISPLAYS AND GAUGES - DIAGNOSTIC TROUBLE CODES

INSTRUMENT PANEL SYSTEM DISPLAYS AND GAUGES - DIAGNOSTIC TROUBLE CODES

DTC	Description

DTC	Description
DTC B3567	Driver Information Center Select Switch
DTC P0461	Fuel Level Sensor
DTC P0462	Fuel Level Sensor
DTC P0463	Fuel Level Sensor
DTC P0464	Fuel Level Sensor 1
DTC P0520	ECM Requesting EOP Indicator Turned ON

KEYLESS ENTRY SYSTEM AND REMOTE FUNCTIONS - DIAGNOSTIC TROUBLE CODES

KEYLESS ENTRY SYSTEM AND REMOTE FUNCTIONS - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B2976	Driver Door Ajar
DTC B3125, B3130, or B3135	Front/Driver Door Only Unlock/All Door Lock/Unlock
DTC B3265	Trunk Release

LIGHTING SYSTEM - DIAGNOSTIC TROUBLE CODES

LIGHTING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B1395	Device Voltage Output 1
DTC B2530	Front Fog Lamp
DTC B2545	Backup Lamps
DTC B2575	Headlamp Control
DTC B257A	Headlamp Switch Input Signal Mismatch
DTC B2580	Headlamp High Beam Control
DTC B2585	Park Lamp Control
DTC B2600	Daytime Running Lam
DTC B261A	Passenger Compartment Dimming 4 Circuit
DTC B2610	Passenger Compartment Dimming 1
DTC B2615	Passenger Compartment Dimming 2
DTC B2625	Display Dimming Pulse Width Modulation (PWM)
DTC B2645	Ambient Light Sensor
DTC B2652	Passenger Compartment Dimming 3
DTC B3445 or B3884	Stop Lamp/Center High Mounted Stop Lamp (CHMSL)
DTC B3600	Passenger Compartment Dimming Request
DTC C0277 or C0890	Brake Pedal Position Sensor
DTC C0297	Brake Applied Output Circuit

POWER DOOR LOCK SYSTEM AND RELEASE SYSTEMS - DIAGNOSTIC

TROUBLE CODES

POWER DOOR LOCK SYSTEM AND RELEASE SYSTEMS - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B1008	Calibration Data Not Programmed
DTC B3105	Keyless Entry System Key Fobs Not Programmed
DTC B3109, B3110, B3111, or B3112	Keyless Entry Transmitter Battery 1-4

SEAT HEATING SYSTEM AND SEAT COOLING SYSTEM - DIAGNOSTIC TROUBLE CODES

SEAT HEATING SYSTEM AND SEAT COOLING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B1395	Device Voltage Reference
DTC B1925 or B2170	Seat Heater Sensor
DTC B2345	Seat Heater Disable
DTC B2425 or B2430	Seat Heater Cushion Circuit
DTC B2508 or B2509	Seat Heater Relay

SECONDARY AND CONFIGURABLE CUSTOMER CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

SECONDARY AND CONFIGURABLE CUSTOMER CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B1529	Device Voltage Reference
DTC B3622	Steering Wheel Controls

SHIFT LOCK CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

SHIFT LOCK CONTROL SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B2705	Gearshift Unlock Circuit

SUPPLEMENTAL INFLATABLE RESTRAINT SYSTEM - DIAGNOSTIC TROUBLE CODES

SUPPLEMENTAL INFLATABLE RESTRAINT SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B0012 or B0013	Steering Wheel Air Bag Deployment Loop
DTC B0014, B0021, B0031, or B0038	Seat Side Air Bag Deployment Loop
DTC B0015, B001A, B001B, or B0022	Seat Belt Anchor Pretensioner Deployment
DTC B0016, B0018, B0023, or B0025	Roof Rail Air Bag Deployment Loop
DTC B0019 or B0020	Instrument Panel Air Bag Deployment Loop

DTC	Description
DTC B0052	Deployment Commanded
DTC B0055	Side Air Bag Deployment Commanded
DTC B0056-B0058	Air Bag/Pretensioner Suppressed
DTC B0074	Passenger Presence Sensor
DTC B0081	Passenger Presence Module
DTC B0083-B0088	Front/Front Side Impact Sensor
DTC B1001	SDM Option Configuration Error (SDM)
DTC B1001	Option Configuration Error (PPS)
DTC B1019	SDM System Configuration Error
DTC B101D, B101E, or B1089	Air Bag Deployment Loop Invalid
DTC B1370	Device Ignition 1 Circuit

TIRE PRESSURE MONITORING SYSTEM - DIAGNOSTIC TROUBLE CODES

TIRE PRESSURE MONITORING SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC C0569	System Configuration Error
DTC C0750, C0755, C0760, or C0765	Low Tire Pressure Sensor Signal
DTC C0775	Low Tire Pressure System Sensors Not Learned

WIPER SYSTEM AND WASHER SYSTEM - DIAGNOSTIC TROUBLE CODES

WIPER SYSTEM AND WASHER SYSTEM - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B3715	Front Wiper Relay Control Circuit
DTC B3873	Front Washer Relay Control Circuit
DTC B3875	Wiper High Speed Control Relay
DTC B3922	Windshield Wiper Low Speed Signal Circuit

WIRING SYSTEMS AND POWER MANAGEMENT - DIAGNOSTIC TROUBLE CODES

WIRING SYSTEMS AND POWER MANAGEMENT - DIAGNOSTIC TROUBLE CODES

DTC	Description
DTC B0005	In Park Signal Circuit
DTC B1370-B1379, B1380-B1389, or B1440-B1443	Ignition Device
DTC B1428	Ignition Switched Power Relay 1
DTC B1475	Retained Accessory Power
DTC P2534 or P2535	Ignition On/Start Switch
DTC P2537	Ignition Accessory Switch

DOOR COMPONENT VIEWS

DRIVER DOOR COMPONENTS

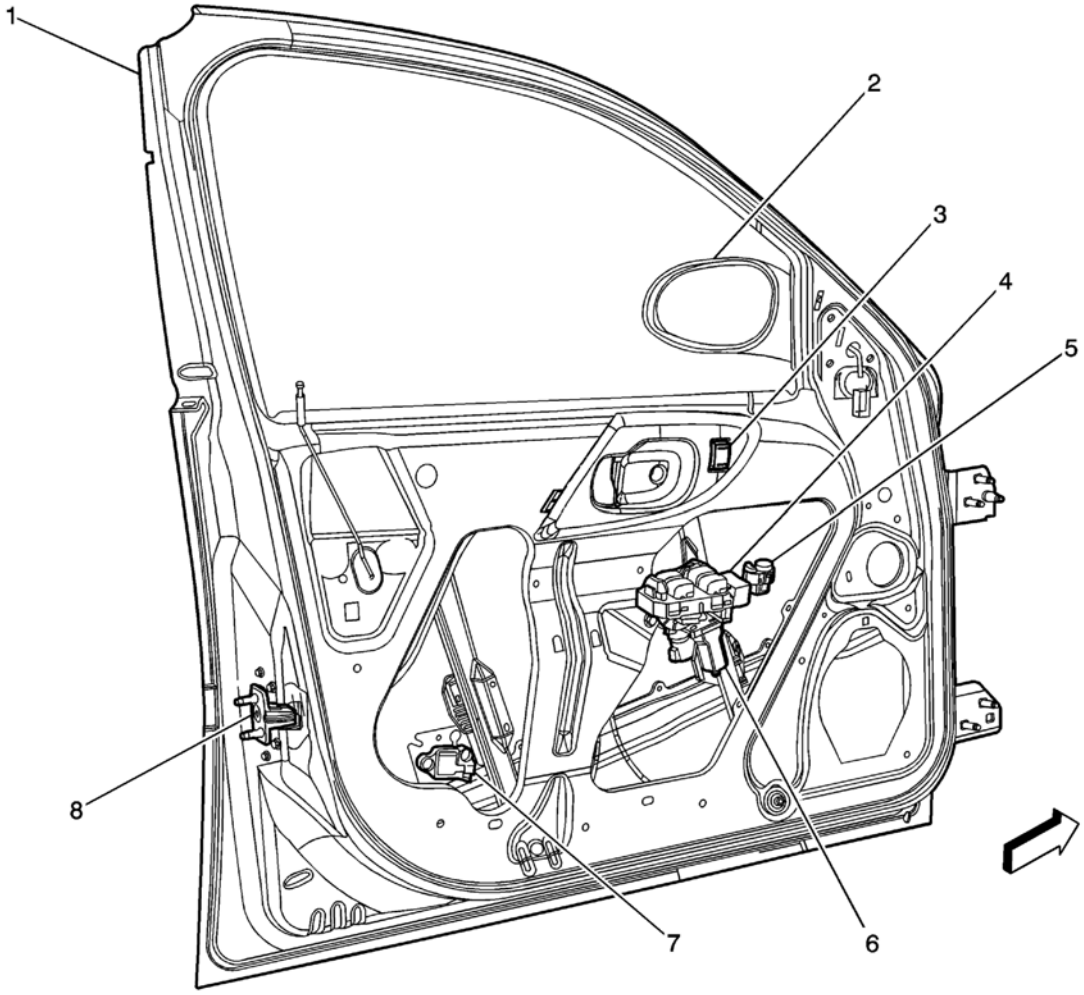


Fig. 1: Driver Door
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	Outside Rearview Mirror- Driver
3	Door Lock Switch- Driver
4	Window Switch- Driver
5	Outside Rearview Mirror (ISRVM) Switch
6	Window Motor- Driver

Callout	Component Name
7	Inflatable Restraint Side Impact Sensor (SIS)- Left
8	Door Lock- Driver

PASSENGER DOOR COMPONENTS

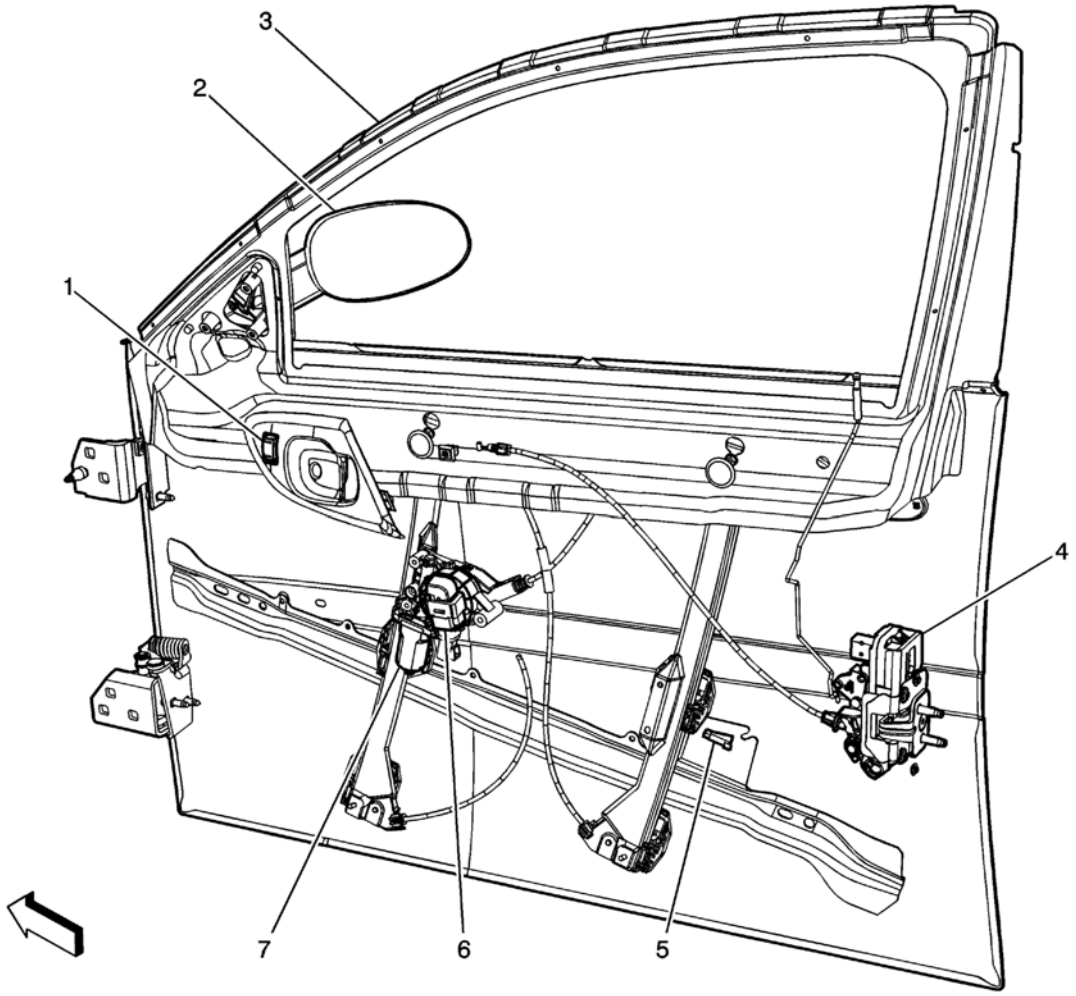


Fig. 2: Identifying Passenger Door
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Lock Switch- Passenger
2	Outside Rearview Mirror- Passenger
3	Door Frame
4	Door Lock- Passenger
5	Inflatable Restraint Side Impact Sensor (SIS)- Right
6	Window Switch- Passenger
7	Window Motor- Passenger

LEFT REAR DOOR COMPONENTS

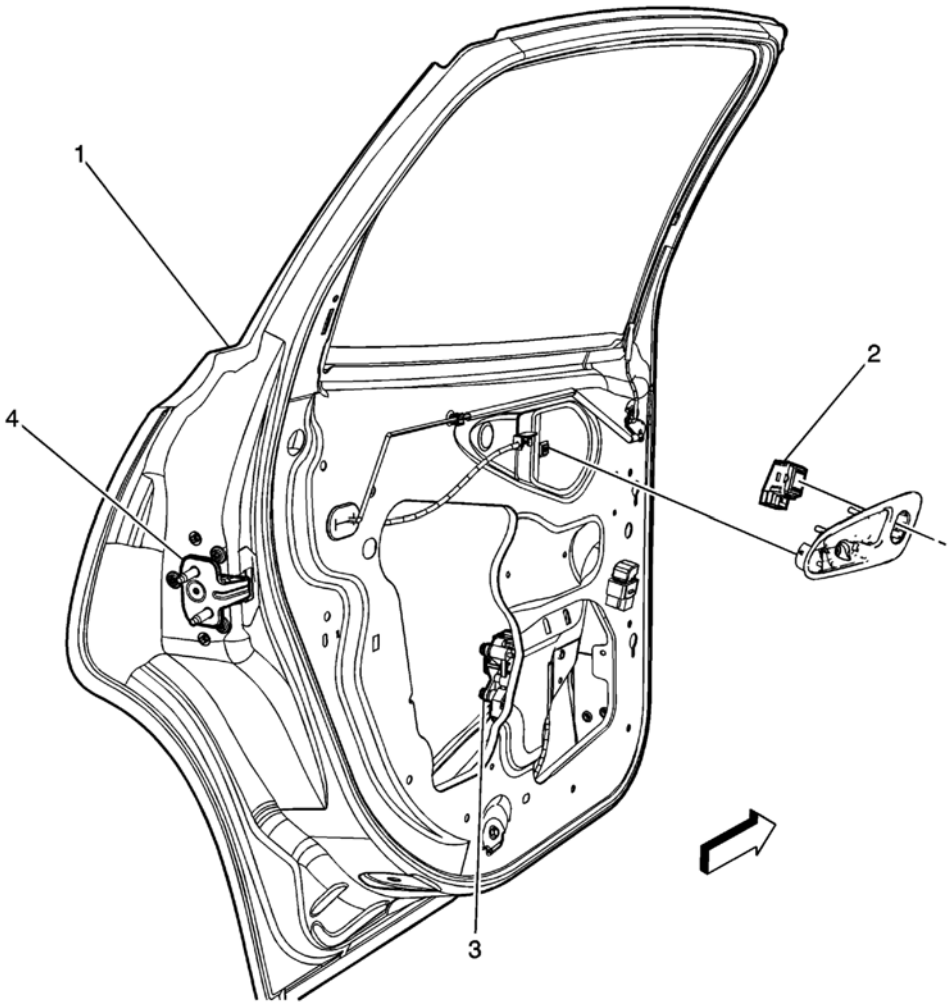


Fig. 3: View Of LR Door
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	Window Switch
3	Window Motor
4	Door Lock

RIGHT REAR DOOR COMPONENTS

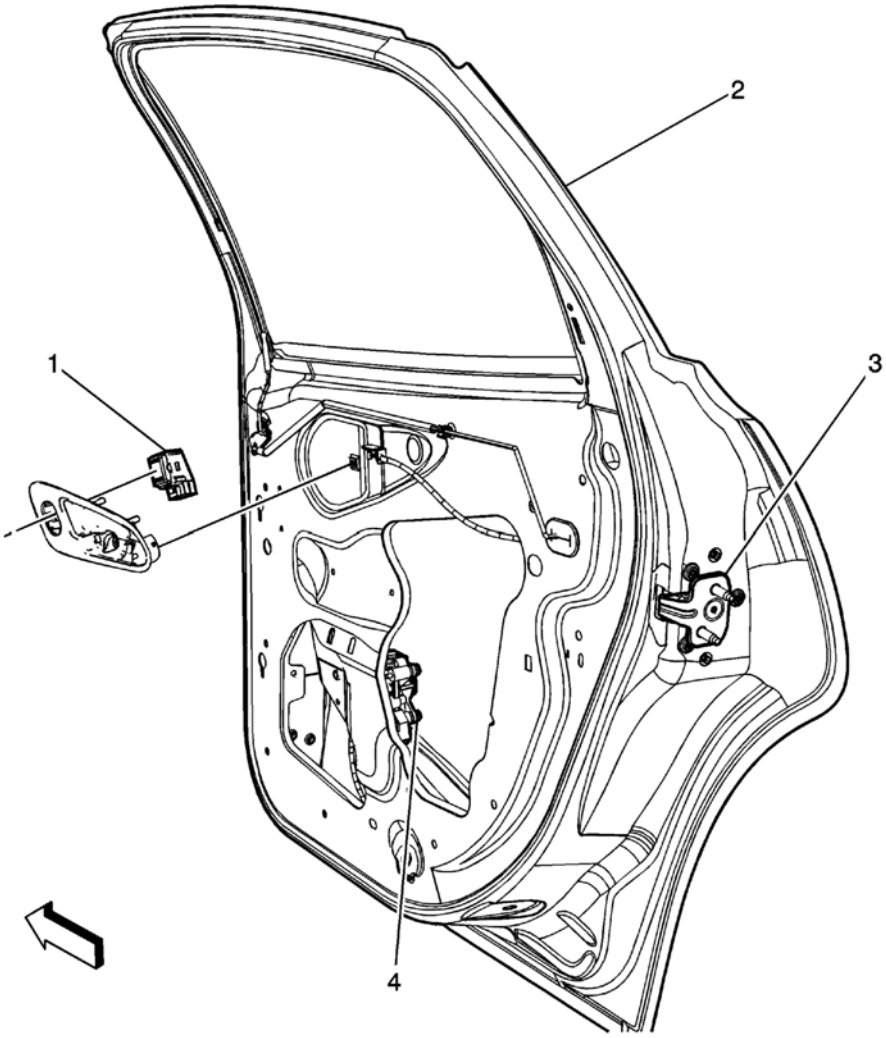


Fig. 4: View Of RR Door
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Window Switch
2	Door Frame
3	Door Lock
4	Window Motor

Article GUID: A00737221

ELECTRICAL CENTER IDENTIFICATION VIEWS

FUSE BLOCK - UNDERHOOD LABEL

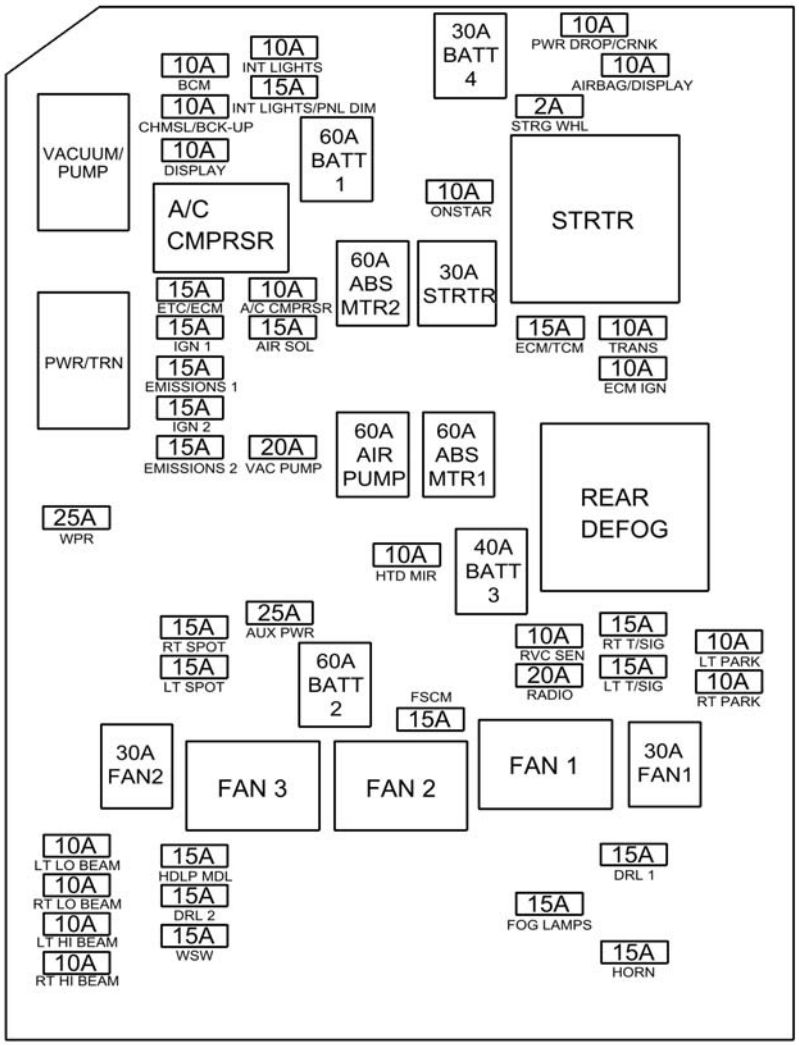


Fig. 1: Fuse Block -- Underhood Label
Courtesy of GENERAL MOTORS COMPANY

Fuse Block - Underhood Label Usage

Fuse And Relay Description	Rating	Circuits
A/C CMPRSR Fuse	10A	A/C Compressor Clutch
ABS MTR1 Fuse	60A	Electronic Brake Control Module (EBCM)
ABS MTR2 Fuse	60A	Electronic Brake Control Module (EBCM)

Fuse And Relay Description	Rating	Circuits
AIRBAG/DISPLAY Fuse	10A	Instrument Panel Cluster (IPC), HVAC Control Module, Inflatable Restraint Passenger Air Bag On/Off Indicator, and Inflatable Restraint Sensing and Diagnostic Module (SDM)
AUX PWR Fuse	25A	Accessory Power Outlet - I/P 1 and Accessory Power Outlet - I/P 2
BATT 1 Fuse	60A	CNSTR, XM, AMP, AUX Fuses, and Trunk Relay
BATT 2 Fuse	60A	HTD/SEAT, AIRBAG, PWR/MIR, S/ROOF, DR/LCK Fuses, PWR/SEAT Circuit Breaker, and RAP Relay
BATT 3 Fuse	40A	Rear Window Defogger Grid
BATT 4 Fuse	30A	Blower Motor Control Module
BCM Fuse	10A	Body Control Module (BCM), Ignition Switch, and Theft Deterrent Module (TDM)
CHMSL/BCK-UP Fuse	10A	Body Control Module (BCM)
DISPLAY Fuse	10A	Data Link Connector (DLC), Remote Control Door Lock Receiver (RCDLR), Instrument Panel Cluster (IPC), and HVAC Control Module
DRL 1 Fuse	15A	DRL 2 Fuse
DRL 2 Fuse	15A	LT LO BEAM Fuse, RT LO BEAM Fuse
ECM IGN Fuse	10A	Engine Control Module (ECM)
ECM/TCM Fuse	15A	Engine Control Module (ECM) and Transmission Control Module (TCM)
EMISSIONS 1 Fuse	15A	Heated Oxygen Sensor (HO2S) 1, Heated Oxygen Sensor (HO2S) 2, and Evaporative Emission (EVAP) Canister Purge Solenoid Valve
EMISSIONS 2 Fuse	15	Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor, Valve Lifter Oil Manifold (VLOM) Assembly (LZG), Secondary Air Injection (AIR) Pump Relay (NU3), Secondary Air Injection (AIR) Solenoid Relay (NU3), A/C CMPRSR Relay, FAN 1 Relay, FAN 2 Relay, and FAN 3 Relay
ETC/ECM Fuse	15A	Engine Control Module (ECM)
FAN1 Fuse	30A	FAN 1 Relay
FAN2 Fuse	30A	FAN 3 Relay
FOG LAMPS Fuse	15A	Fog Lamp - Left Front and Fog Lamp - Right Front
FSCM Fuse	15A	Fuel Pump Flow Control Module
HDLP MDL Fuse	15A	C122 or Emergency Vehicle Headlamp Flasher (6J7)
HORN Fuse	15A	Horn Assembly
HTD MIR Fuse	10A	Outside Rearview Mirror - Driver and Outside Rearview Mirror - Passenger
INJ 1 Fuse	20A	Fuel Injectors 1-6
INJ 2 Fuse	20A	Ignition Control Module
INT LIGHTS Fuse	10A	Body Control Module (BCM)
INT LTS/PNL DIM Fuse	15A	Body Control Module (BCM)

Fuse And Relay Description	Rating	Circuits
LT HI BEAM FUSE	10A	Headlamp - High Beam - Left or Emergency Vehicle Headlamp Flasher (6J7)
LT LO BEAM Fuse	10A	Headlamp - Low Beam - Left
LT PARK Fuse	10A	Marker lamp - LF, Park/Turn Signal Lamp - Left Front, Tail Lamp - Left, and Tail/Stop and Turn Signal - Left
LT SPOT Fuse (9C1, 9C3)	15A	Spot Lamp - Left (7x6, 7X7)
LT T/SIG Fuse	15A	Body Control Module (BCM)
PWR DROP/CRNK Fuse	10A	Blunt Cut Wire (9C1, 9C3)
RADIO Fuse	20A	Radio
RT HI BEAM Fuse	10A	Headlamp - High Beam - Right or Emergency Vehicle Headlamp Flasher (6J7)
RT LO BEAM Fuse	10A	Headlamp - Low Beam - Right
RT PARK Fuse	10A	Marker Lamp - RF, Park/Turn Signal Lamp - RF, Tail Lamp - Right, and Tail/Stop and Turn Signal - Right
RT SPOT Fuse (9C1, 9C3)	15A	Spot Lamp - Right (7X7)
RT T/SIG Fuse	15A	Body Control Module (BCM)
RVC SEN Fuse	10A	Body Control Module (BCM)
Spare Fuse	2A	Not Used
Spare Fuse	10A	Not Used
Spare Fuse	15A	Not Used
Spare Fuse	20A	Not Used
Spare Fuse	25A	Not Used
STRG WHL Fuse	2A	Steering Wheel Controls - Left and Steering Wheel Controls - Right
STRTR Fuse	40A	Starter
TRANS Fuse	10A	1-2 Shift Solenoid (1-2 SS) Valve, 2-3 Shift Solenoid (2-3 SS) Valve, Torque Converter Clutch (TCC) Solenoid Valve, and Transmission Control Module (TCM)
VAC PUMP Fuse	20A	Brake Booster Pump - Auxiliary
WPR Fuse	25A	WIPER PCB Relay
WSW Fuse	15A	Windshield Washer Fluid Pump
A/C CMPRSR Relay	-	A/C CMPRSR Fuse
FAN 1 Relay	-	Engine Cooling Fan - Left
FAN 2 Relay	-	Engine Cooling Fan - Right
FAN 3 Relay	-	Engine Cooling Fan - Right
PWR/TRN Relay	-	ETC/ECM, INJ 1, INJ 2, EMISSIONS 1, and EMISSIONS 2 Fuses
REAR DEFOG Relay	-	BATT 3 and HTD MIR Fuses
STRTR Relay	-	STRTR Fuse
Vacuum Pump Relay	-	VAC Pump Fuse
Relays listed below are non-serviceable Printed Circuit Board (PCB) relays and are internal to the block.		
DRL PCB Relay	-	DRL 1 Fuse

Fuse And Relay Description	Rating	Circuits
FOG LP PCB Relay	-	FOG LAMPS Fuse
HIGH BEAM PCB Relay	-	LT HI BEAM and RT HI BEAM Fuses
HORN PCB Relay	-	HORN Fuse
IGN MAIN PCB Relay	-	AIRBAG/DISPLAY, ECM IGN, PWR DROP/CRNK, and TRANS Fuses
LOW BEAM PCB Relay	-	DRL 2, LT LO BEAM, and RT LO BEAM Fuses
PARK LP PCB Relay	-	LT PARK and RT PARK Fuses
WIPER PCB Relay	-	WIPER HIGH PCB Relay
WIPER HIGH PCB Relay	-	Windshield Wiper Motor
WS WASH PCB Relay	-	WSW Fuse

FUSE BLOCK - UNDERHOOD - TOP VIEW

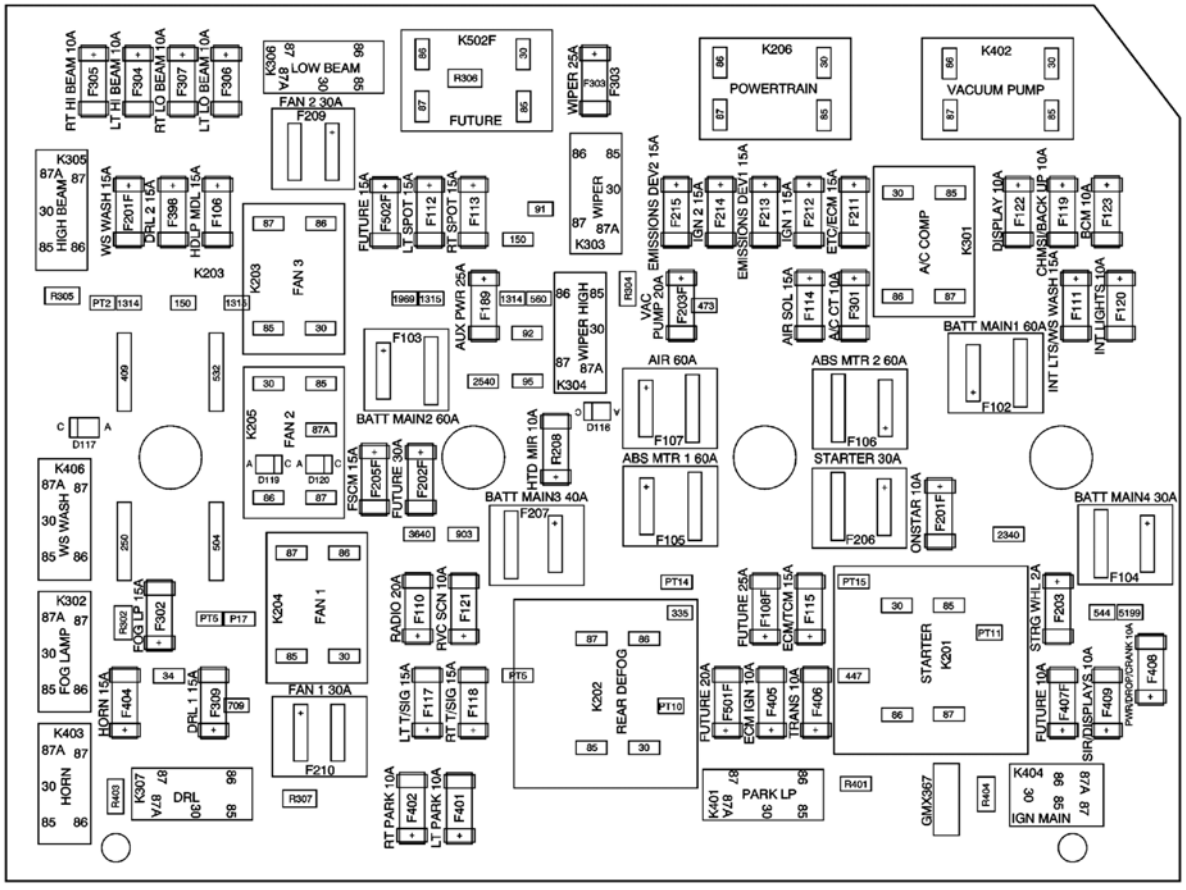


Fig. 2: Fuse Block-- Underhood-- Top View
Courtesy of GENERAL MOTORS COMPANY

FUSE BLOCK - UNDERHOOD - BOTTOM VIEW

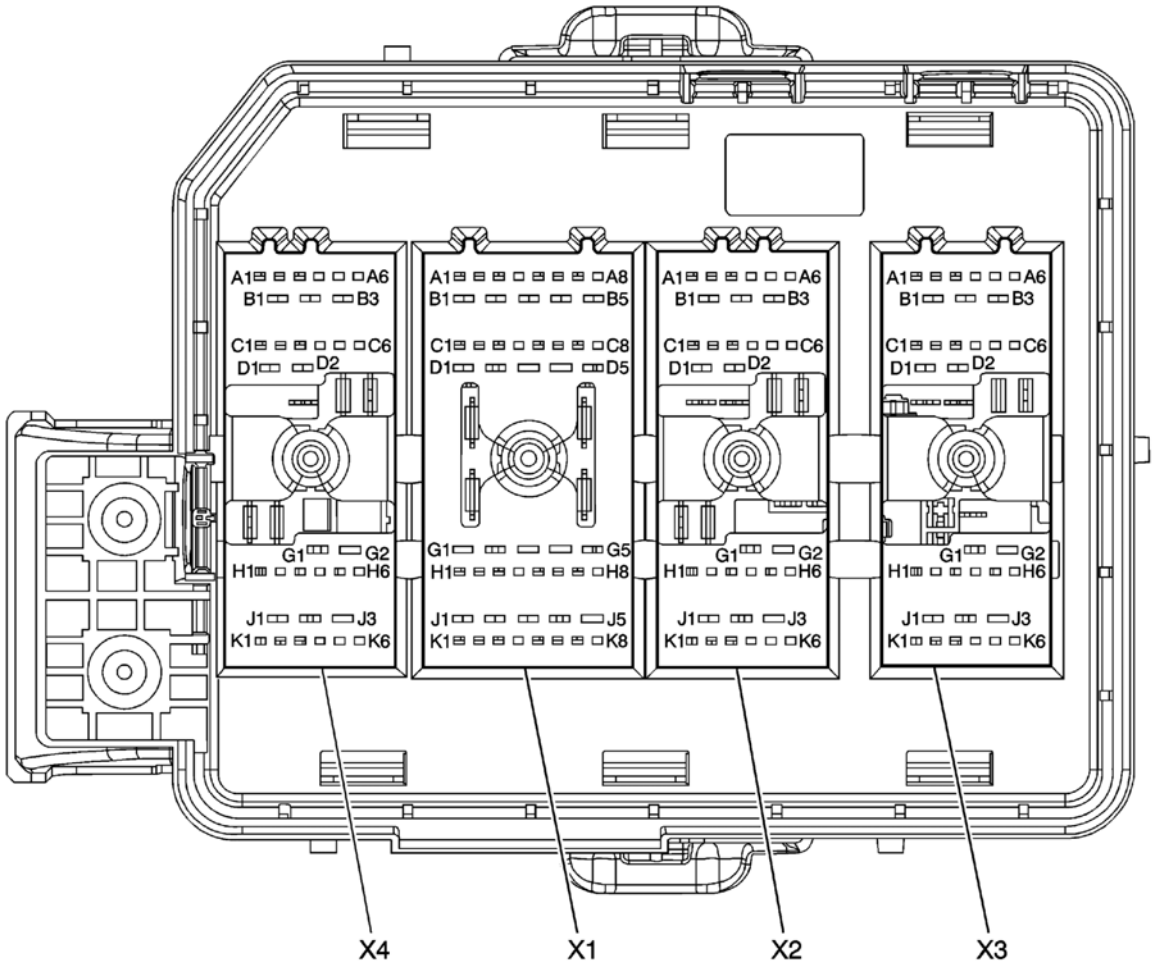


Fig. 3: Fuse Block - Underhood - Bottom View
Courtesy of GENERAL MOTORS COMPANY

FUSE BLOCK - UNDERHOOD X1

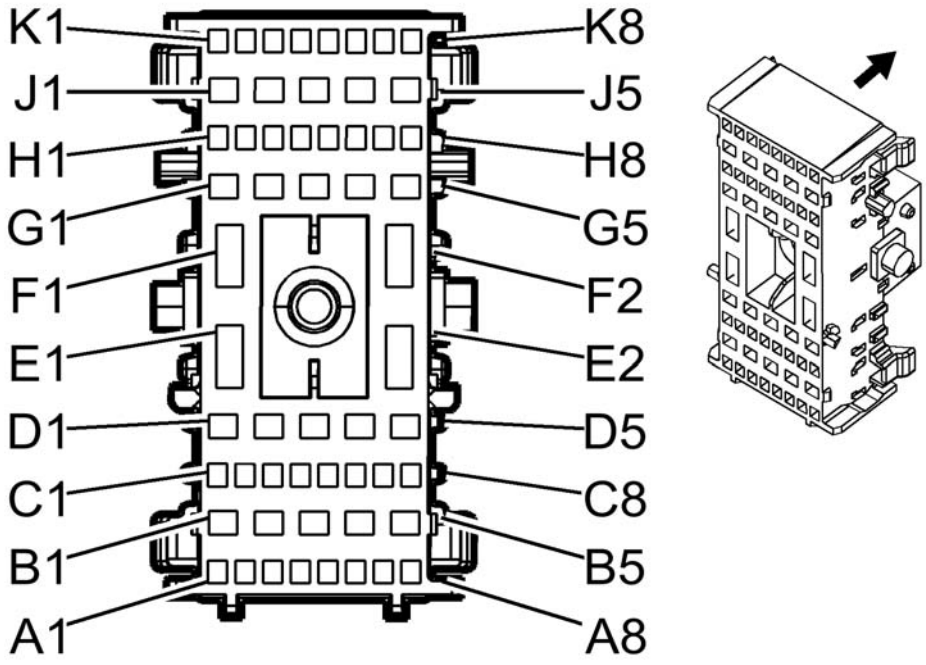


Fig. 4: Fuse Block - Underhood C1
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Engine
- OEM Connector: 15477822
- Service Connector: 19115189
- Description: 56-Way F GT 150 280 Metri-Pack 800 Series (BK)

Terminal Part Information

- Pins: A1, A5, A6, A8, C1, C2, C7, H1, H7
- Terminated Lead: 13575735
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: E/C

- Pins: B1, D1, D2, J1, J3
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pins: B2, B4
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: 2/A

- Pins: B3, B5, G2
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pins: E1, E2, F1, F2
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Pin: J2
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

Fuse Block - Underhood X1

Pin	Wire	Circuit	Function
A1	0.35 D-GN/WH	465	Fuel Pump Relay Control
A2-A4	-	-	Not Used
A5	0.5 PK/BK	5293	Ignition 1 Voltage
A6	0.35 BN	5069	PWR/TRN Relay Control
A7	-	-	Not Used
A8	0.5 PK/BK	5294	Ignition 1 Voltage
B1	0.5 PK/BK	5290	Ignition 1 Voltage
B2	0.8 PK/BK	5291	Ignition 1 Voltage
B3	0.5 PK/BK	5293	Ignition 1 Voltage
	0.5 PK/BK	5293	Ignition 1 Voltage
B4	0.8 PK/BK	5292	Ignition 1 Voltage

Pin	Wire	Circuit	Function
B5	0.8 PK/BK	5294	Ignition 1 Voltage (LZG)
	0.5 PK/BK	5294	Ignition 1 Voltage (NU3)
C1	0.35 D-GN/WH	459	A/C Compressor Clutch Relay Control
C2	0.35 BK/WH	451	Ground
C3-C6	-	-	Not Used
C7	0.35 D-BU	473	High Speed Cooling Fan Relay Control
C8	-	-	Not Used
D1	0.5 D-GN	59	A/C Compressor Clutch Supply Voltage
D2	0.5 RD/WH	2140	Battery Positive Voltage (NU3)
D3-D5	-	-	Not Used
E1	5 RD/BK	1342	Battery Positive Voltage (JL9)
E2	5 RD/BK	742	Battery Positive Voltage (NU3)
F1	3 PU	6	Starter Solenoid Crank Voltage
F2	5 RD/BK	1442	Battery Positive Voltage (without JL4)
	5 RD/BK	1442	Battery Positive Voltage (JL4)
G1	-	-	Not Used
G2	0.5 RD/WH	540	Battery Positive Voltage
	0.5 RD/WH	540	Battery Positive Voltage
G3-G5	-	-	Not Used
H1	0.35 WH	1310	EVAP Canister Vent Solenoid Control
H2-H6	-	-	Not Used
H7	0.35 D-GN	335	Low Speed Cooling Fan Relay Control
H8	-	-	Not Used
J1	0.35 YE	447	Starter Relay Coil Control
J2	0.35 PK	1339	Ignition 1 Voltage
	0.35 PK	1339	Ignition 1 Voltage
J3	0.35 PK	439	Ignition 1 Voltage
J4-J5	-	-	Not Used
K1-K8	-	-	Not Used

FUSE BLOCK - UNDERHOOD X2

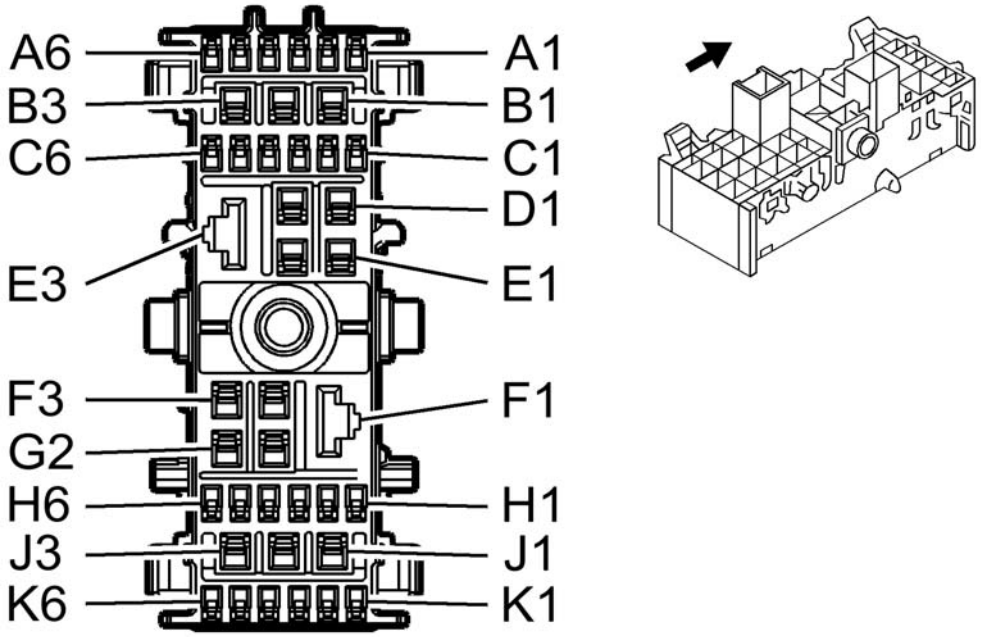


Fig. 5: Fuse Block - Underhood X2
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 13528107
- Service Connector: 88988655
- Description: 40-Way F GT 150 280 Metri-Pack 800 Series (GY)

Terminal Part Information

- Pins: A1, A5, C1, C2, C5, C6, H3, H5, H6, K2, K3
- Terminated Lead: 13575735
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: E/C

- Pins: B1, D1, D2, E1, E2, G2, J2, J3
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: 2/A

- Pin: E3
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Pin: F1
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Pin: G1
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pin: J1
- Terminated Lead: 13575754
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304713/19
- Core/Insulation Crimp: 4/4

- Pins: K5, K6
- Terminated Lead: 13575735
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: C/A

Fuse Block - Underhood X2

Pin	Wire	Circuit	Function
A1	0.35 GY	91	Wiper Relay Control
A2-A4	-	-	Not Used
A5	0.35 PK/WH	1970	Headlamp Low Beam Relay Control

Pin	Wire	Circuit	Function
A6	-	-	Not Used
B1	1 BK	150	Ground
B2	0.5 RD/WH	2740	Battery Positive Voltage (9C1, 9C3)
B3	0.5 RD/WH	2640	Battery Positive Voltage (9C1, 9C3)
C1	0.35 TN	860	Wiper High Speed Relay Control
C2	0.5 L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage
C3-C4	-	-	Not Used
C5	0.5 D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage
C6	0.35 TN/WH	1969	Headlamp High Beam Relay Control
D1	1 PU	92	Windshield Wiper Motor High Speed Control
D2	1 RD/WH	2540	Battery Positive Voltage (without Floor Console)
E1	1 D-GN	95	Windshield Wiper Motor Low Speed Control
E2	1 RD/WH	2540	Battery Positive Voltage (without Floor Console)
E3	5 RD/BK	642	Battery Positive Voltage
F1	3 PU	293	Rear Defog Element Supply Voltage
F2	-	-	Not Used
F3	0.5 RD/WH	2340	Battery Positive Voltage
G1	0.35 RD/WH	2440	Battery Positive Voltage
G2	1 RD/WH	2040	Battery Positive Voltage
H1-H2	-	-	Not Used
H3	0.35 WH	193	Rear Defog Relay Control
H4	0.5 OG	267	Heated Mirror Element Supply Voltage (DK2)
H5	0.35 D-GN/WH	1317	Fog Lamp Relay Control (T96)
H6	0.35 OG	2268	Windshield Washer Relay Control
J1	GY	901	Not Used
J2	0.8 RD/WH	440	Battery Positive Voltage
J3	0.8 RD/WH	340	Battery Positive Voltage
K1	-	-	Not Used
K2	0.35 WH	1080	Park Lamp Relay Control
K3	0.35 TN	28	Horn Relay Control
K4	0.35 D-GN/RD	6820	Exterior Lamp Flasher Signal (9C1, 9C3)
K5	0.8 PU	709	Left Park Lamp Supply Voltage
K6	0.8 BN/WH	309	Right Park Lamp Supply Voltage

FUSE BLOCK - UNDERHOOD X3

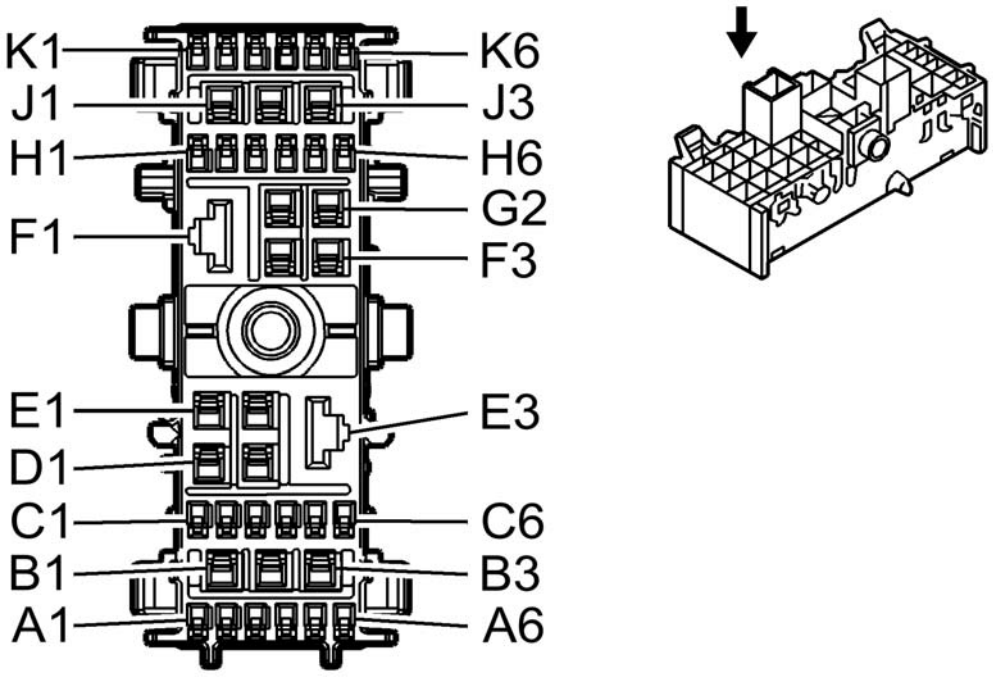


Fig. 6: Fuse Block - Underhood X3

Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 13528106
- Service Connector: 19178190
- Description: 40-Way F GT 150 280 Metri-Pack 800 Series (WH)

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	13575735	J-35616-2A (GY)	J-38125-553	12191812	19	C	A
II	13575735	J-35616-2A (GY)	J-38125-553	12191812	19	E	C
III	13575753	J-35616-4A (PU)	J-38125-553	15304711	8	2	A
IV	13575753	J-35616-4A (PU)	J-38125-553	15304711	8	E	A
V	13575756	J-35616-4A (PU)	J-38125-553	15304713	19	F	D
VI	13575753	J-35616-4A (PU)	J-38125-553	15304711	8	E	A

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
A1	-	-	-	Not Occupied	-	-
A2	0.8	YE	712	Left Headlamp Low Beam Supply Voltage	I	-
A3	0.5	TN/WH	312	Right Headlamp Low Beam Supply Voltage	II	-
A4	-	-	-	Not Occupied	-	-
A5	0.5	D-GN/WH	711	Left Headlamp High Beam Supply Voltage	II	-
A6	0.5	L-GN/BK	311	Right Headlamp High Beam Supply Voltage	II	-
B1	0.8	RD/WH	2940	Battery Positive Voltage	III	B1:9C1, 9C3
B2	0.5	GY	589	DRL Resistor Supply Voltage	IV	-
B3	-	-	-	Not Occupied	-	-
C1	0.5	D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage	II	-
C2-C4	-	-	-	Not Occupied	-	-
C5	0.5	L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage	II	-
C6	-	-	-	Not Occupied	-	-
D1	3	L-BU	409	Cooling Fan - Right Supply Voltage	V	-
D2	-	-	-	Not Occupied	-	-
E1	3	GY	532	Cooling Fan - Left Low Reference	V	-
E2	3	BK	250	E2:Ground	V	-
E3	-	-	-	Not Occupied	-	-
F1	-	-	-	Not Occupied	-	-
F2	3	WH	504	Cooling Fan - Left Supply Voltage	V	-
F3	-	-	-	Not Occupied	-	-
G1	0.5 0.5	PU PU	34 34	Front Fog Lamp Supply Voltage Front Fog Lamp Supply Voltage	VI	T96 T96
G2	-	-	-	Not Occupied	-	-
H1	-	-	-	Not Occupied	-	-
H2	0.8	OG	228	Windshield Washer Pump Control	I	-
H3-H6	-	-	-	Not Occupied	-	-
J1	0.5	GY	589	DRL Resistor Supply Voltage	-	-
J2	0.5	BN/WH	309	Right Park Lamp Supply Voltage	IV	-
J3	0.8	D-GN	29	Horn Control	III IV	-
K1	0.5	PU	709	Left Park Lamp Supply Voltage	II	-
K2	-	-	-	Not Occupied	-	-
K3	0.35	D-GN/RD	6820	Exterior Lamp Flasher Signal	II	K3:9C1, 9C3
K4-K6	-	-	-	Not Occupied	-	-

FUSE BLOCK - UNDERHOOD X4

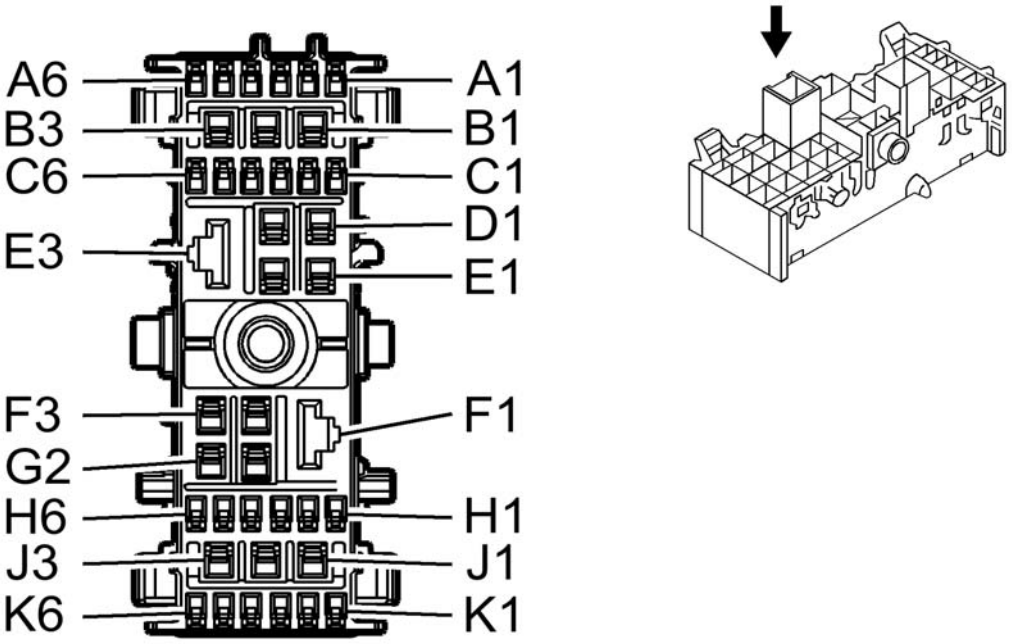


Fig. 7: Fuse Block - Underhood X4
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information • Harness Type: Instrument Panel • OEM Connector: 13528108 • Service Connector: 88988654 • Description: 40-Way F GT 150 280 Metri-Pack 800 Series (L-GY)
Terminal Part Information • Pin: A4 • Terminated Lead: 13575735 • Release Tool: J-38125-553 • Diagnostic Test Probe: J-35616-2A (GY) • Terminal/Tray: 12191812/19 • Core/Insulation Crimp: C/A • Pin: B1 • Terminated Lead: 13575753 • Release Tool: J-38125-553 • Diagnostic Test Probe: J-35616-4A (PU)

- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pins: B2, B3, F3, G1
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pins: D1, D2
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: 2/A

- Pin: E2
- Terminated Lead: 13575754
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304713/19
- Core/Insulation Crimp: 4/4

- Pin: E3
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Pin: F1
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Pins: H1, H2, H4, H6, K4
- Terminated Lead: 13575735
- Release Tool: J-38125-553

- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: E/C

Fuse Block - Underhood X4

Pin	Wire	Circuit	Function
A1-A3	-	-	Not Used
A4	0.8 RD/WH	1240	Battery Positive Voltage
A5-A6	-	-	Not Used
B1	0.35 RD/WH	1040	Battery Positive Voltage
	0.5 RD/WH	1040	Battery Positive Voltage
B2	0.5 RD/WH	1240	Battery Positive Voltage
B3	0.35 RD/WH	1840	Battery Positive Voltage
C1-C6	-	-	Not Used
D1	0.8 RD/WH	240	Battery Positive Voltage
D2	0.8 RD/WH	1640	Battery Positive Voltage
E1	-	-	Not Used
E2	2 GY	120	Fuel Pump Supply Voltage
E3	5 RD/BK	242	Battery Positive Voltage
F1	3 RD/BK	442	Battery Positive Voltage
F2	-	-	Not Used
F3	2 RD/WH	3640	Battery Positive Voltage
G1	0.35 PU/WH	1382	LED Dimming Supply
G2	-	-	Not Used
H1	0.35 YE	5199	Run/Crank Relay Coil Control
H2	0.35 PU	544	DRL PCB Relay Control
H3	-	-	Not Used
H4	0.35 PU/WH	7005	LED Dimming Supply
H5	-	-	Not Used
H6	0.35 WH	1310	EVAP Canister Vent Solenoid Control
J1-J3	-	-	Not Used
K1	0.5 PK	739	Ignition 1 Voltage (9C1, 9C3)
K2-K3	-	-	Not Used
K4	0.35 PK	1139	Ignition 1 Voltage
K5-K6	-	-	Not Used

FUSE BLOCK - I/P - LABEL

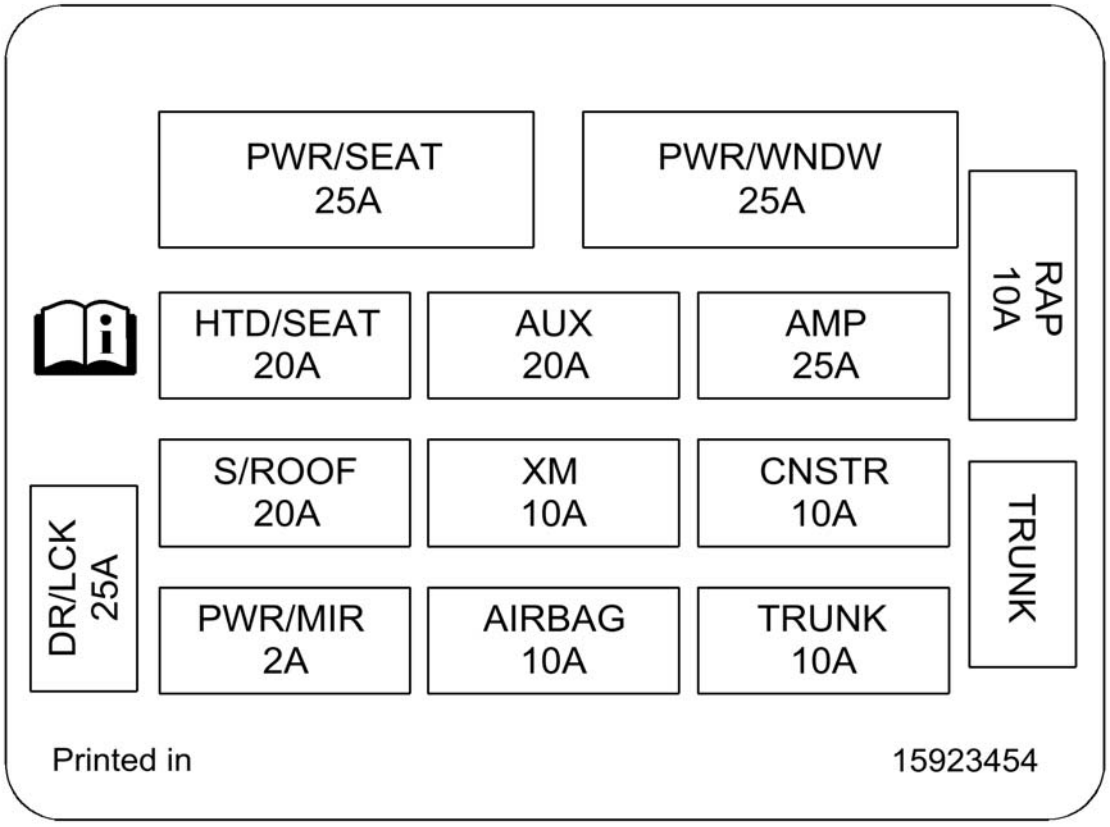


Fig. 8: Fuse Block - I/P - Label
Courtesy of GENERAL MOTORS COMPANY

Fuse Block - I/P - Label Usage

Fuse And Relay Description	Rating	Circuits
AIRBAG Fuse	10A	Inflatable Restraint Sensing and Diagnostic Module (SDM), Inflatable Restraint Front Passenger Presence System (PPS) Module
AMP Fuse	25A	Audio Amplifier
AUX Fuse	20A	Accessory Power Outlet - Center Seat, Accessory Power Outlet - Center Console 1, Accessory Power Outlet - Center Console 2, Accessory Power Outlet - Center Console Compartment
CNSTR Fuse	10A	Evaporative Emission (EVAP) Canister Vent Solenoid
DR/LCK Fuse	25A	DOOR UNLOCK PCB Relay - Driver, DOOR UNLOCK PCB Relay, and DOOR LOCK PCB Relay

Fuse And Relay Description	Rating	Circuits
HTD/SEAT Fuse	20A	Heated Seat Control Module (KA1), Emergency Vehicle Rear Compartment Lid Lamps Relay (T53)
PWR/MIR Fuse	2A	Outside Rearview Mirror Switch
RAP Fuse	10A	Automatic Transmission Shift Lock Control Solenoid (with Floor Shifter), Inside Rearview Mirror (DD6), Sunroof Motor (CF5)
S/ROOF Fuse	20A	Sunroof Motor (CF5)
TRUNK Fuse	10A	Rear Compartment Lid Release Actuator
PWR/SEAT Circuit Breaker	25A	Seat Adjuster Switch - Driver, Seat Adjuster Switch - Passenger
PWR/WNDW Circuit Breaker	25A	Window Switch - Driver, and Window Switch - Passenger
Trunk Relay	-	Trunk Fuse
XM Fuse	10A	Digital Radio Receiver (U2K)
Relays listed below are non-serviceable Printed Circuit Board (PCB) relays and are internal to the block.		
DOOR LOCK PCB Relay	-	Door Locks
DOOR UNLOCK PCB Relay	-	Door Lock - Passenger, Door Lock - Left Rear, Door Lock - Right Rear
DOOR UNLOCK PCB Relay - Driver	-	Door Lock - Driver
RAP Relay	-	RAP Fuse

FUSE BLOCK- I/P- TOP VIEW

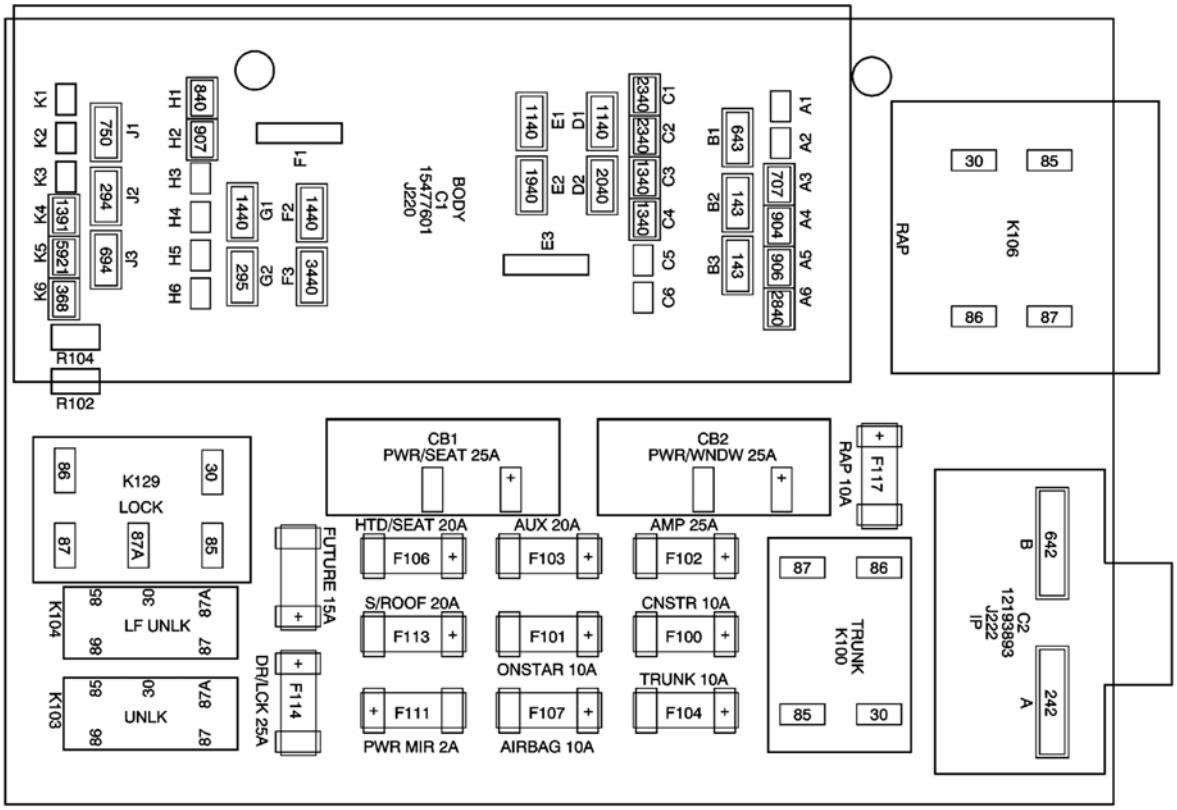


Fig. 9: Fuse Block - I/P Top View

Courtesy of GENERAL MOTORS COMPANY

FUSE BLOCK - I/P - X1

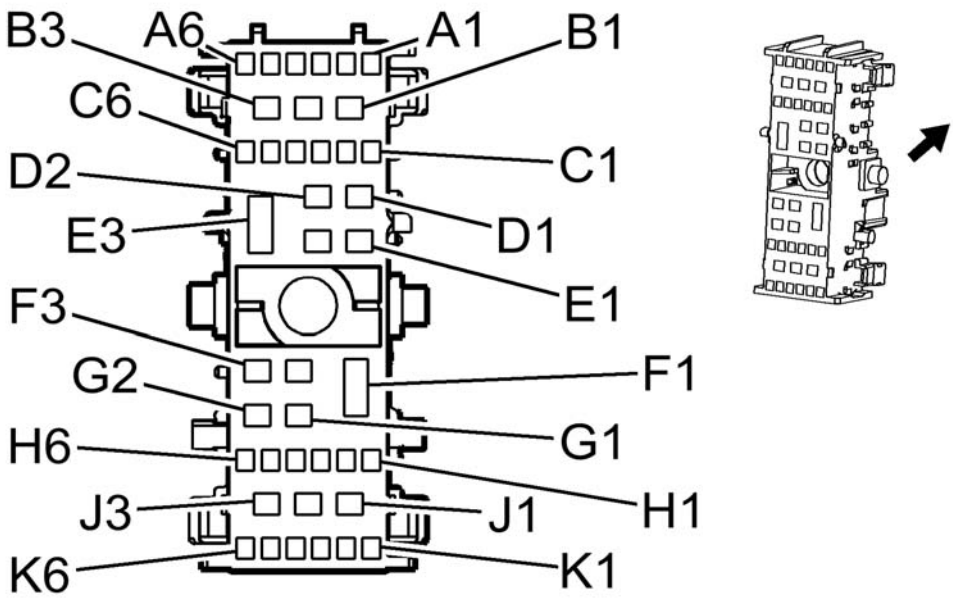


Fig. 10: Fuse Block - I/P - X1
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Body
- OEM Connector: 13552254
- Service Connector: 19178190
- Description: 40-Way F GT 150 280 Metri-Pack 800 Series (BK)

Terminal Part Information

- Pins: A3-A6, C2-C4, H1, K4-K6
- Terminated Lead: 13575735
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: E/C

- Pin: B1
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pins: B2, B3, D1, D2, E1, F3
- Terminated Lead: 13575756
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304713/19
- Core/Insulation Crimp: F/D

- Pins: E2, F2, G1, G2, J1-J3
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: 2/A

Fuse Block - I/P - X1

Pin	Wire	Circuit	Function
A1-A2	-	-	Not Used
A3	0.35 TN	707	RAP Relay Coil Supply Voltage
A4	0.35 L-BU	1344	Trunk Release Relay Control
A5	0.5 TN/WH	56	Trunk Release Motor Control
A6	0.5 RD/WH	2840	Battery Positive Voltage
B1	0.5 YE	643	Accessory Voltage (DD6, CF5)
	0.5 YE	643	Accessory Voltage (Floor Shifter without DD6)
	0.35 YE	643	Accessory Voltage (Floor Shifter with DD6)
	0.5 YE	643	Accessory Voltage (9C1, 9C3)
B2	3 YE	143	Accessory Voltage
B3	3 YE/BK	143	Accessory Voltage
C1	-	-	Not Used
C2	0.5 RD/WH	3540	Battery Positive Voltage (U2K)
C3	0.35 RD/WH	1340	Battery Positive Voltage
C4	0.5 RD/WH	1340	Battery Positive Voltage
C5-C6	-	-	Not Used
D1	3 RD/WH	1140	Battery Positive Voltage (AG1, AH5)
D2	2 RD/WH	640	Battery Positive Voltage (UQ3, U87)
E1	3 RD/WH	1140	Battery Positive Voltage (AG2)
E2	1 RD/WH	1940	Battery Positive Voltage
E3	-	-	Not Used
F1	-	-	Not Used
F2	0.8 RD/WH	1440	Battery Positive Voltage (9C1, 9C3)
F3	2 RD/WH	3440	Battery Positive Voltage (CF5)

Pin	Wire	Circuit	Function
G1	1 RD/WH	1440	Battery Positive Voltage (KA1)
G2	1 GY	295	Door Lock Actuator Lock Control
H1	0.5 RD/WH	840	Battery Positive Voltage
H2-H6	-	-	Not Used
J1	1 BK	750	Ground
J2	1 TN	294	Door Lock Actuator Unlock Control
J3	1 TN	694	Driver Door Lock Actuator Unlock Control
K1-K3	-	-	Not Used
K4	0.35 L-GN	1391	Door Lock Relay Control
K5	0.35 L-BU	5921	Door Unlock Relay Control
K6	0.35 YE	356	Driver Door Unlock Relay Control

FUSE BLOCK - I/P- X2

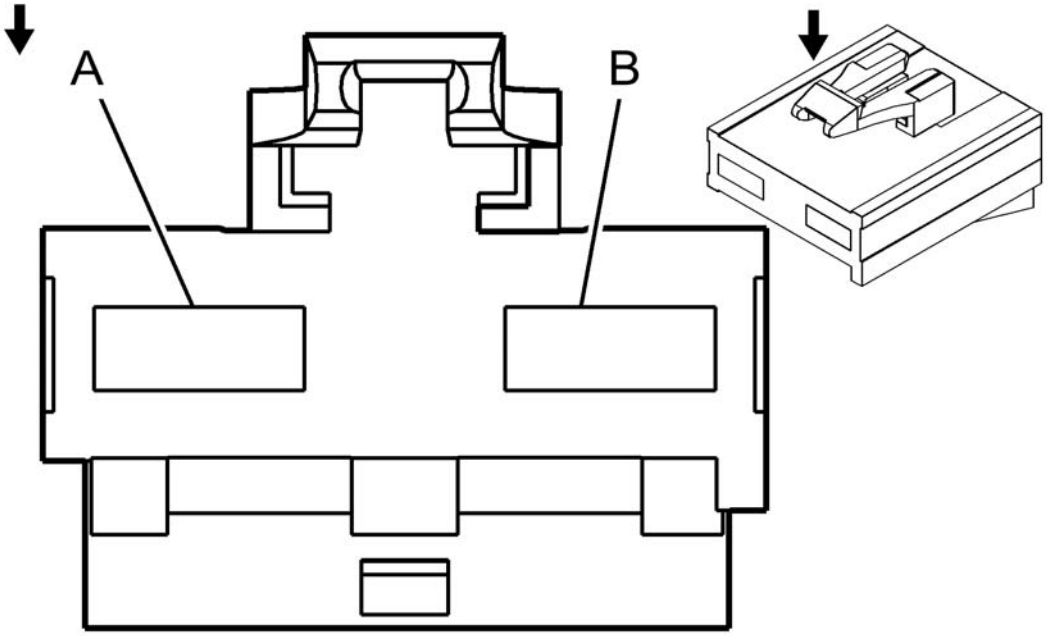


Fig. 11: Fuse Block - I/P- X2
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 13540474
- Service Connector: 19178188
- Description: 2-Way F (BK)

Terminal Part Information

- Terminated Lead: 13327105
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

Fuse Block - I/P- X2

Pin	Wire	Circuit	Function
A	5 RD/BK	242	Battery Positive Voltage
B	5 RD/BK	642	Battery Positive Voltage

FUSE HOLDER - DIGITAL VIDEO DISC (DVD) CONTROL MODULE

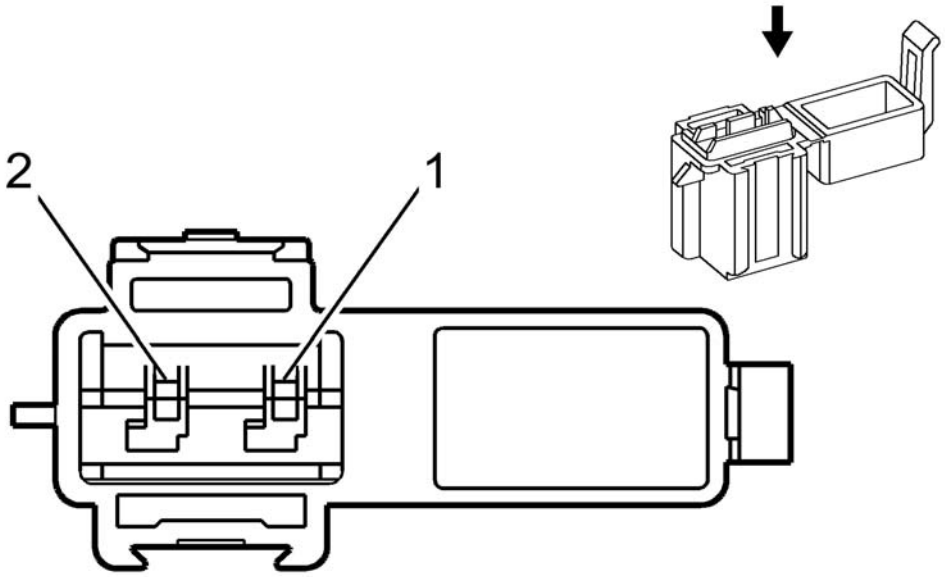


Fig. 12: Fuse Holder - Digital Video Disc (DVD) Control Module
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: SPO Accessory Power
- OEM Connector: Not Available
- Service Connector: Service by Harness - See Part Catalog
- Description: 2-Way F Fuse Holder (BK)

Terminal Part Information

- Terminal/Tray: Service by Harness- See Part Catalog
- Core/Insulation Crimp: Not Available
- Release Tool/Test Probe: Not Available

Fuse Holder - Digital Video Disc (DVD) Control Module

Pin	Wire	Circuit	Function
1	0.5 RD	739	Battery Positive Voltage
2	0.5 RD	739	Battery Positive Voltage

Article GUID: A00737211

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Front of Vehicle/Engine Compartment Component Views - Impala

FRONT OF VEHICLE/ENGINE COMPARTMENT COMPONENT VIEWS

FRONT OF THE VEHICLE COMPONENTS

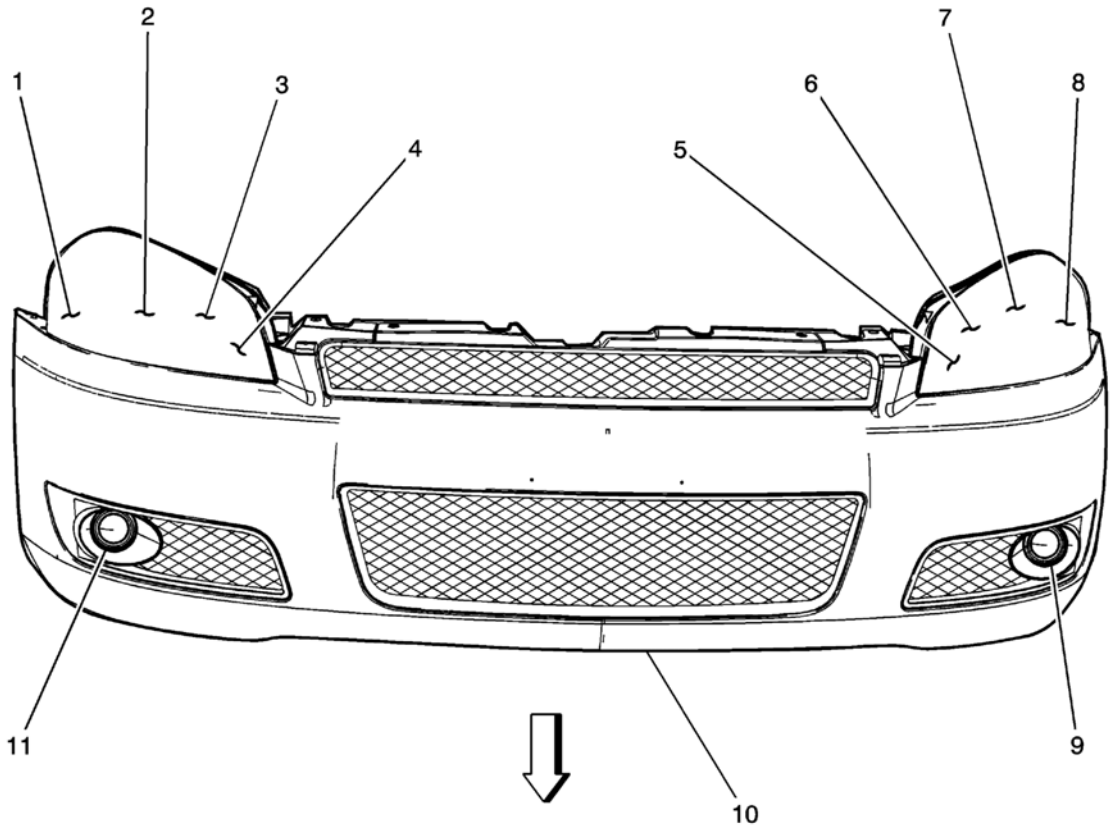


Fig. 1: Front Of The Vehicle
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Side Marker Lamp- Right Front
2	Headlamp- Right Low Beam
3	Headlamp- Right High Beam
4	Park/Turn Signal Lamp- Right
5	Park/Turn Signal Lamp- Left
6	Headlamp- Left High Beam

Callout	Component Name
7	Headlamp- Left Low Beam
8	Side Marker Lamp- Left Front
9	Fog Lamp- Left Front (T96)
10	Front Fascia
11	Fog Lamp- Right Front (T96)

RIGHT HEADLAMP ASSEMBLY COMPONENTS (9C1 OR 9C3)

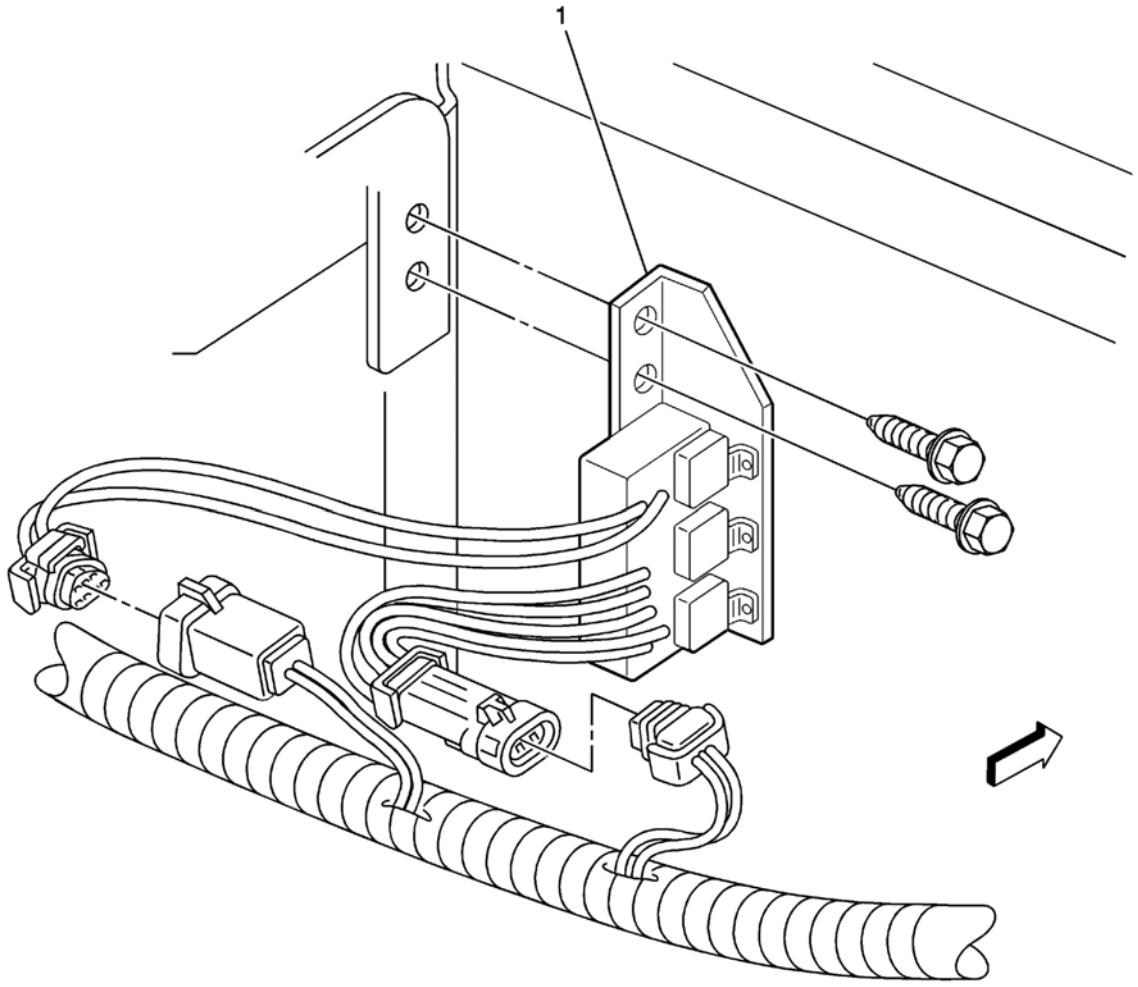


Fig. 2: Left Side Of The Right Headlamp Assembly (9C1, 9C3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Emergency Vehicle Headlamp Flasher (6J7)

A-PILLAR COMPONENTS (9C1 OR 9C3)

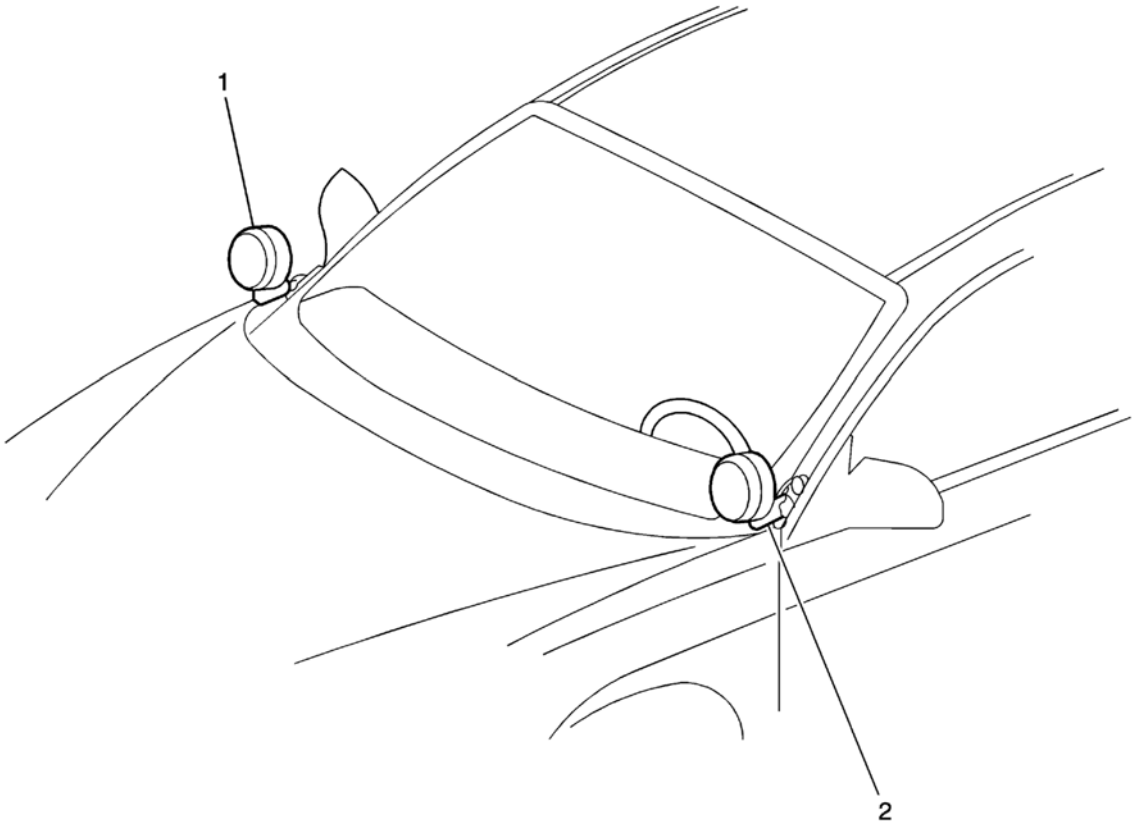


Fig. 3: Base Of A-Pillars (9C1, 9C3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Spot Lamp- Left (7X6 or 7X7)
2	Spot Lamp- Right (7X7)

UNDER THE HOOD LATCH TRIM PANEL COMPONENTS

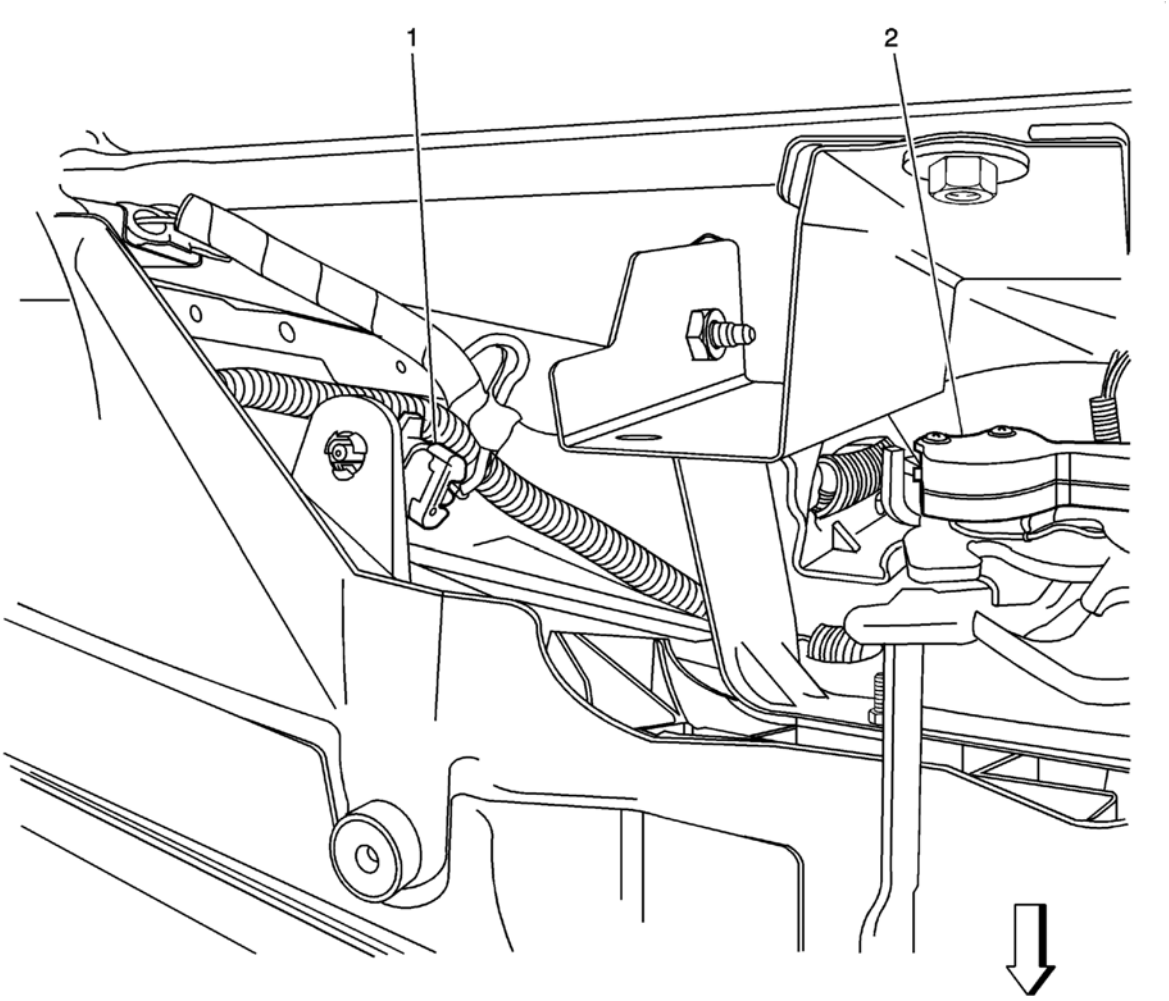


Fig. 4: Identifying Under Hood Latch Trim Panel Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Ambient Air Temperature Sensor
2	Hood Ajar Switch (AP3)

LEFT FRONT OF THE ENGINE COMPARTMENT COMPONENTS

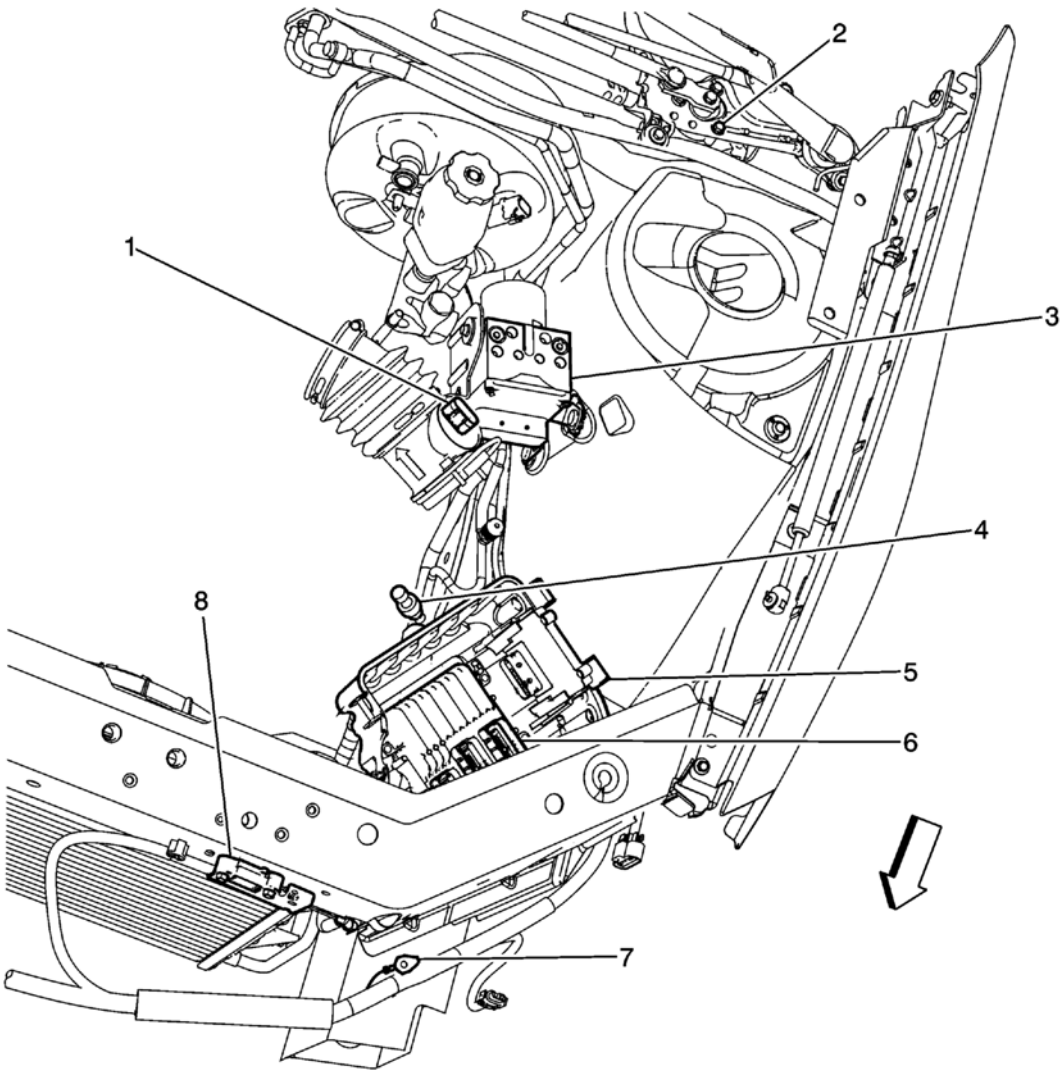


Fig. 5: Left Front of the Engine Compartment Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Multifunction Intake Air Sensor
2	Windshield Wiper Motor
3	Electronic Brake Control Module (EBCM)
4	A/C Refrigerant Pressure Sensor
5	Transmission Control Module (TCM)
6	Engine Control Module (ECM)
7	G101
8	Inflatable Restraint Front End Sensor- Left

LEFT FRONT OF THE ENGINE COMPARTMENT COMPONENTS (NU5 OR NU6)

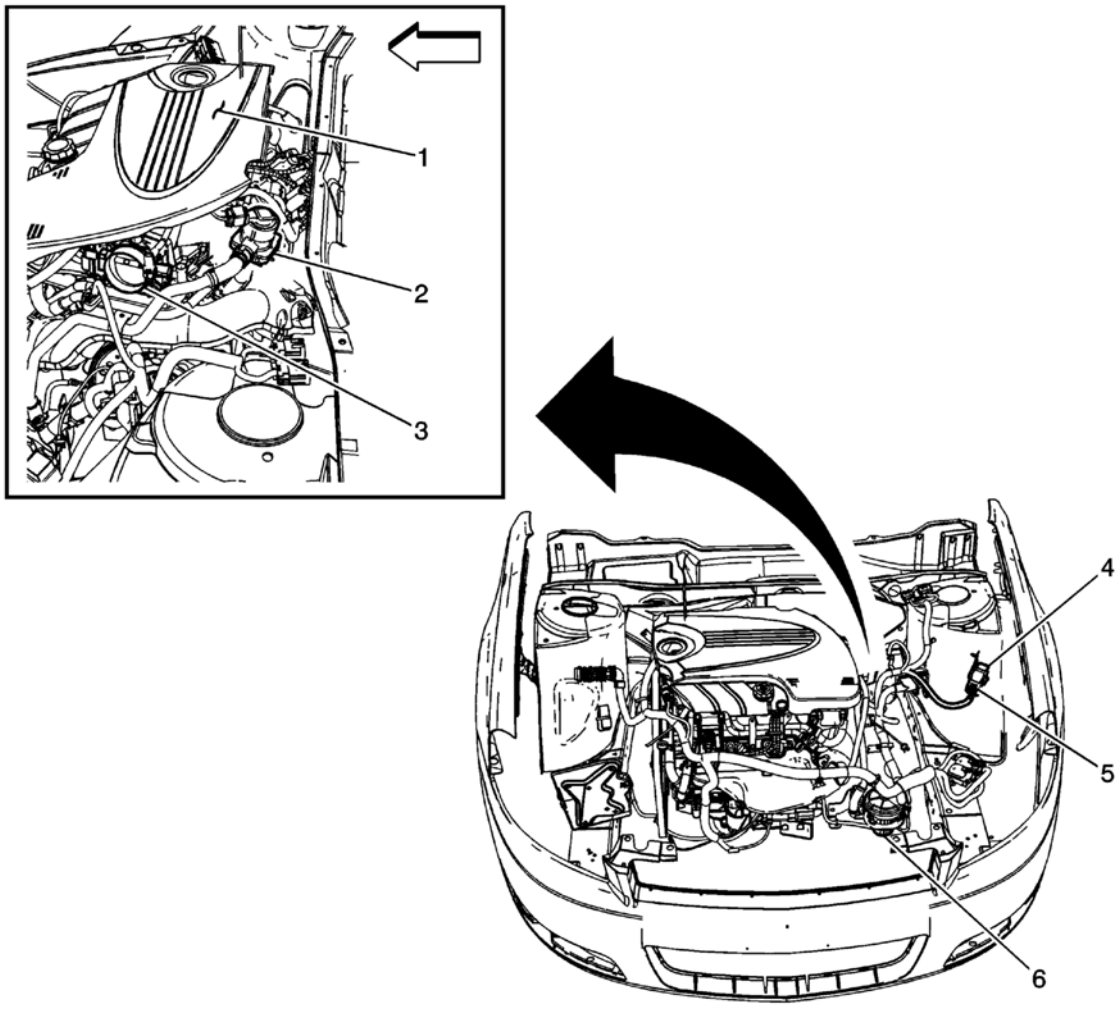


Fig. 6: Left Front of the Engine Compartment Components (NU5 or NU6)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Cover
2	Secondary Air Injection (AIR) Pump Solenoid
3	Throttle Body
4	Secondary Air Injection (AIR) Solenoid Relay
5	Secondary Air Injection (AIR) Pump Relay
6	Secondary Air Injection (AIR) Pump

LEFT REAR OF THE ENGINE COMPARTMENT COMPONENTS

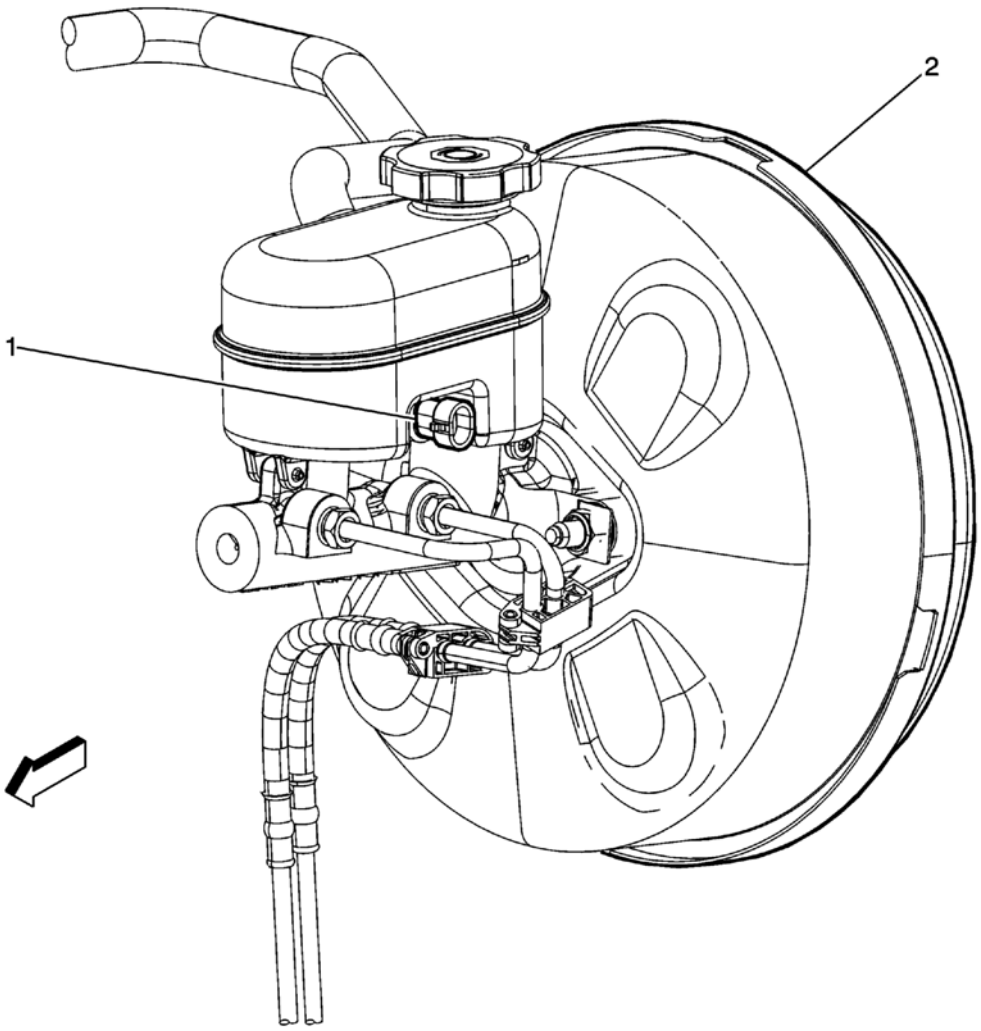


Fig. 7: Left Rear of the Engine Compartment Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Brake Fluid Level Switch
2	Brake Booster

RIGHT FRONT OF THE ENGINE COMPARTMENT COMPONENTS (1 OF 2)

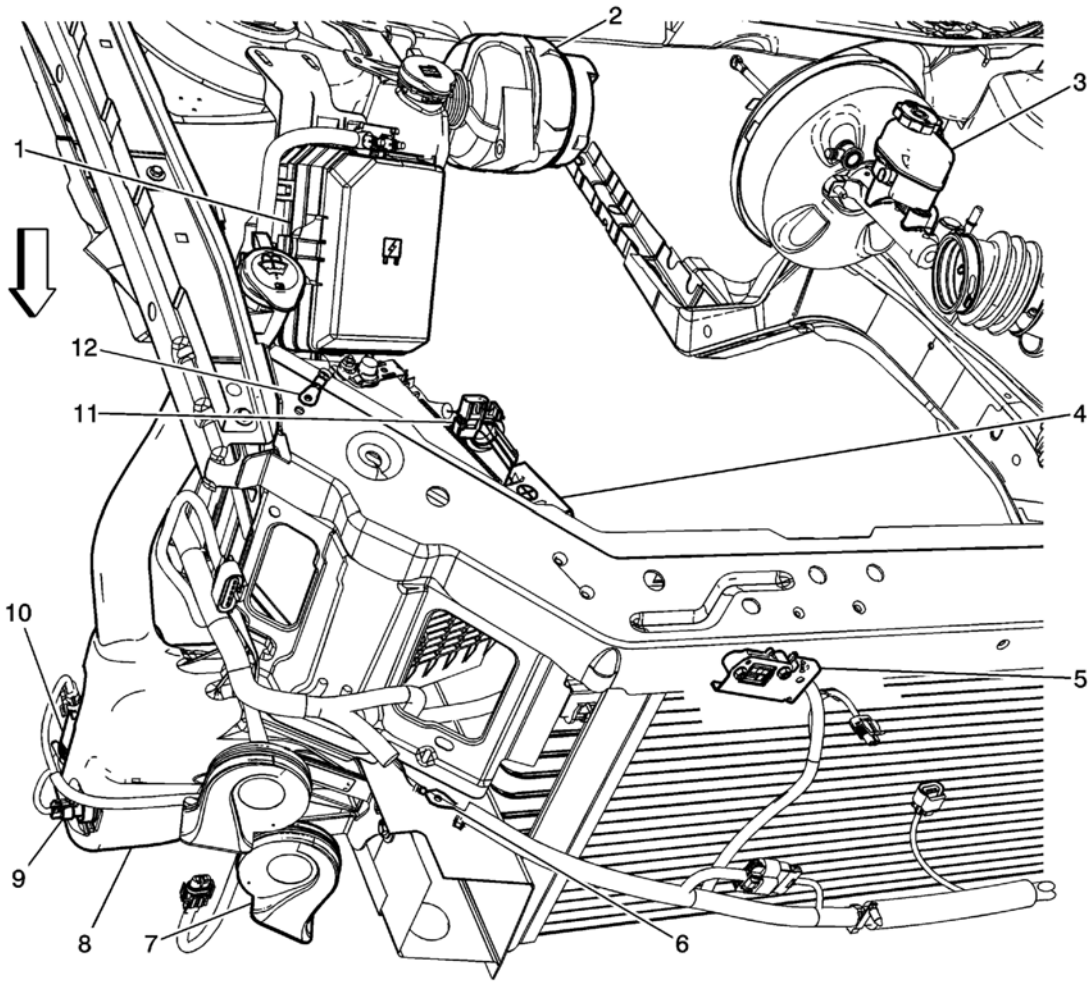


Fig. 8: Identifying RF Engine Compartment (1 of 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuse Block- Underhood
2	Generator
3	Brake Fluid Reservoir
4	Battery
5	Inflatable Restraint Front End Sensor- Right
6	G100
7	Horn Assembly
8	Windshield Washer Fluid Container
9	Windshield Washer Fluid Level Switch
10	Windshield Washer Fluid Pump
11	Battery Current Sensor
12	G102

RIGHT FRONT OF THE ENGINE COMPARTMENT COMPONENTS (2 OF 2)

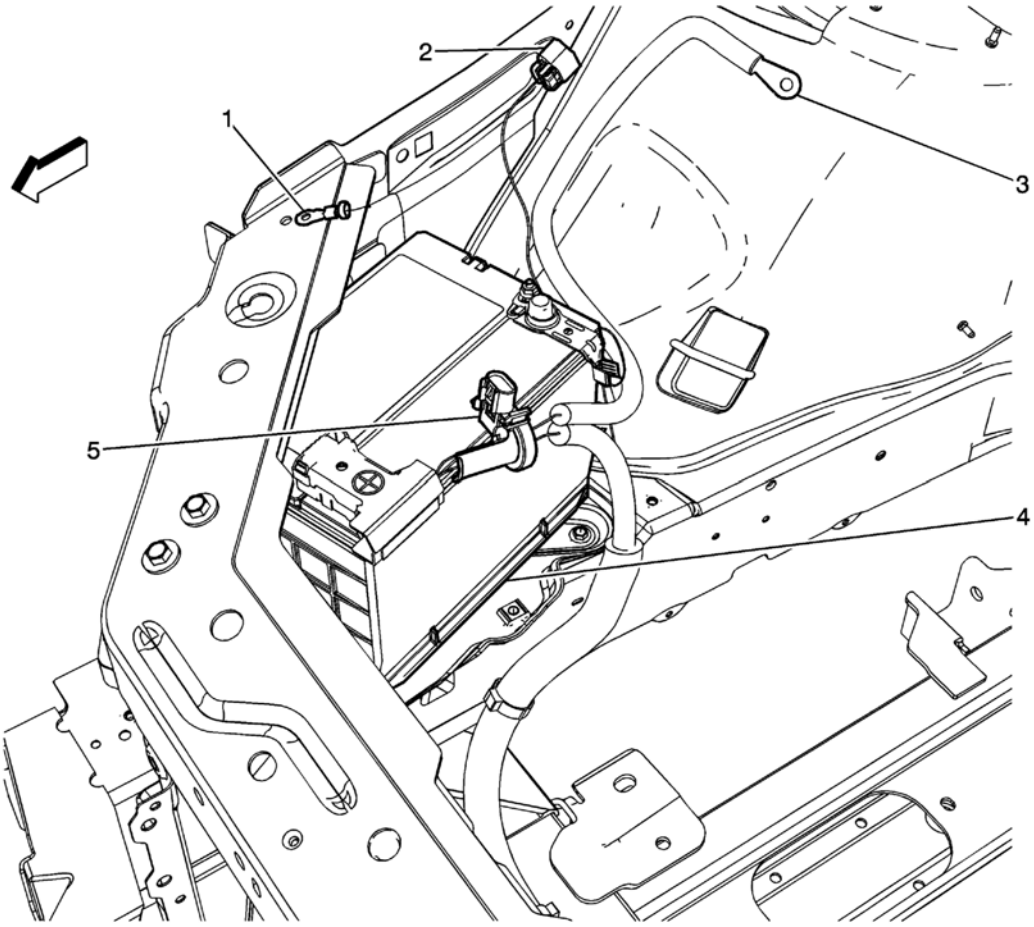


Fig. 9: Right Front of the Engine Compartment Components (2 of 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	G102
2	X105
3	Fuse Block- Underhood Positive Battery Cable Terminal
4	Battery
5	Battery Current Sensor

ENGINE COMPARTMENT COOLING COMPONENTS

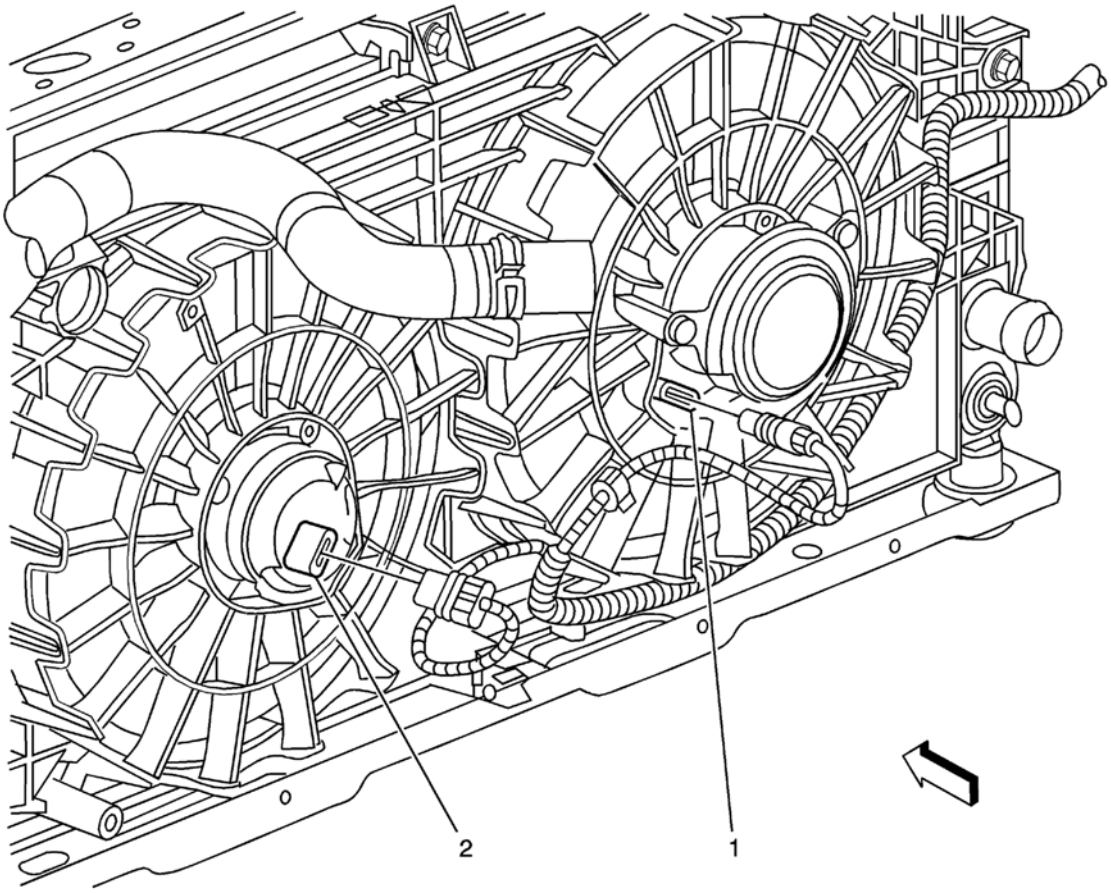


Fig. 10: Engine Compartment Cooling ComponentsBehind Radiator Component View
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Cooling Fan- Right
2	Engine Cooling Fan- Left

Article GUID: A00737229

GROUND VIEWS

G101

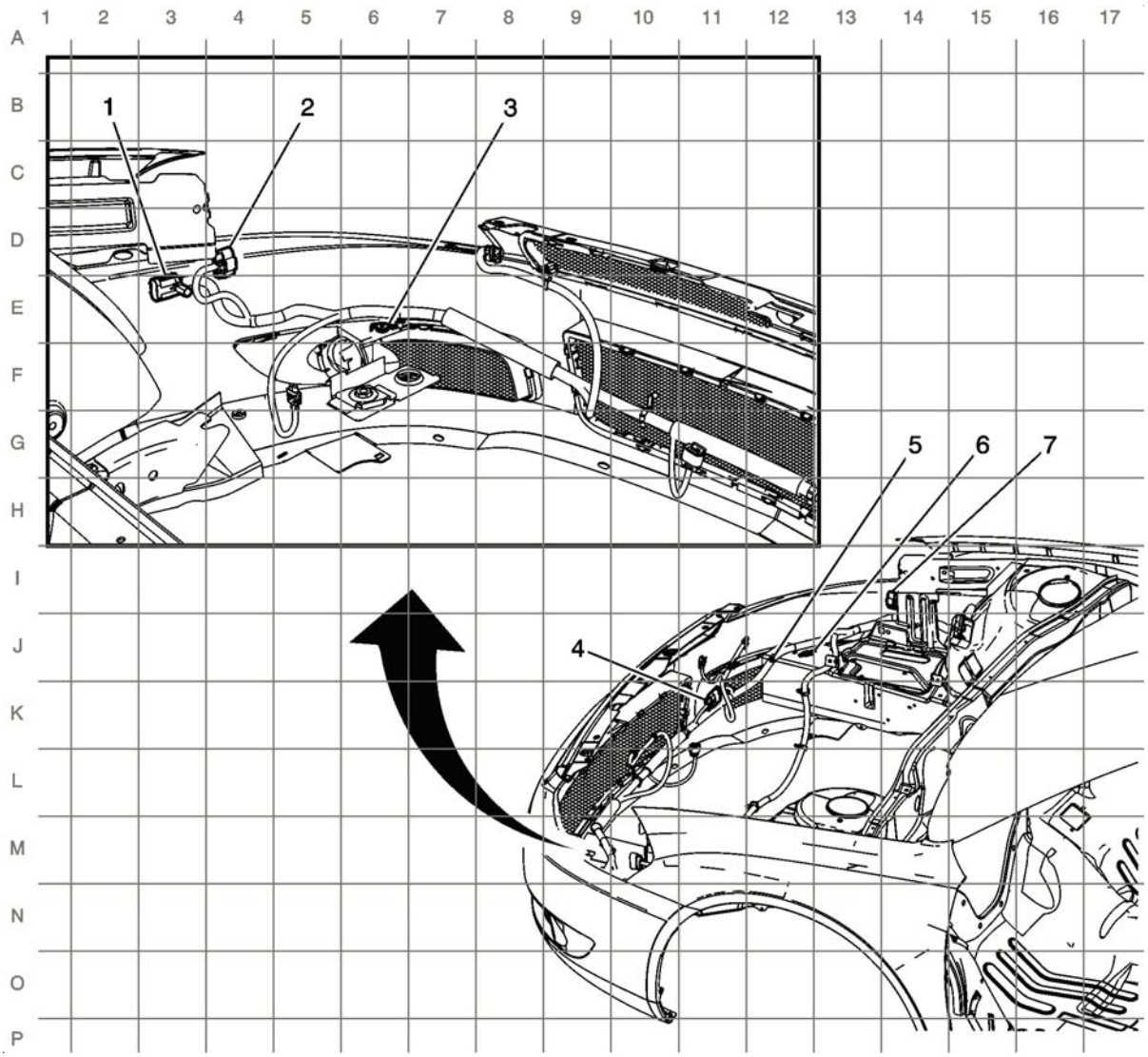


Fig. 1: Forward Lamp Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X120
2	X141
3	G101
4	X122 (9C1 or 9C3 without 6J7)
5	J124
6	G101

Callout	Component Name
7	X142

G102

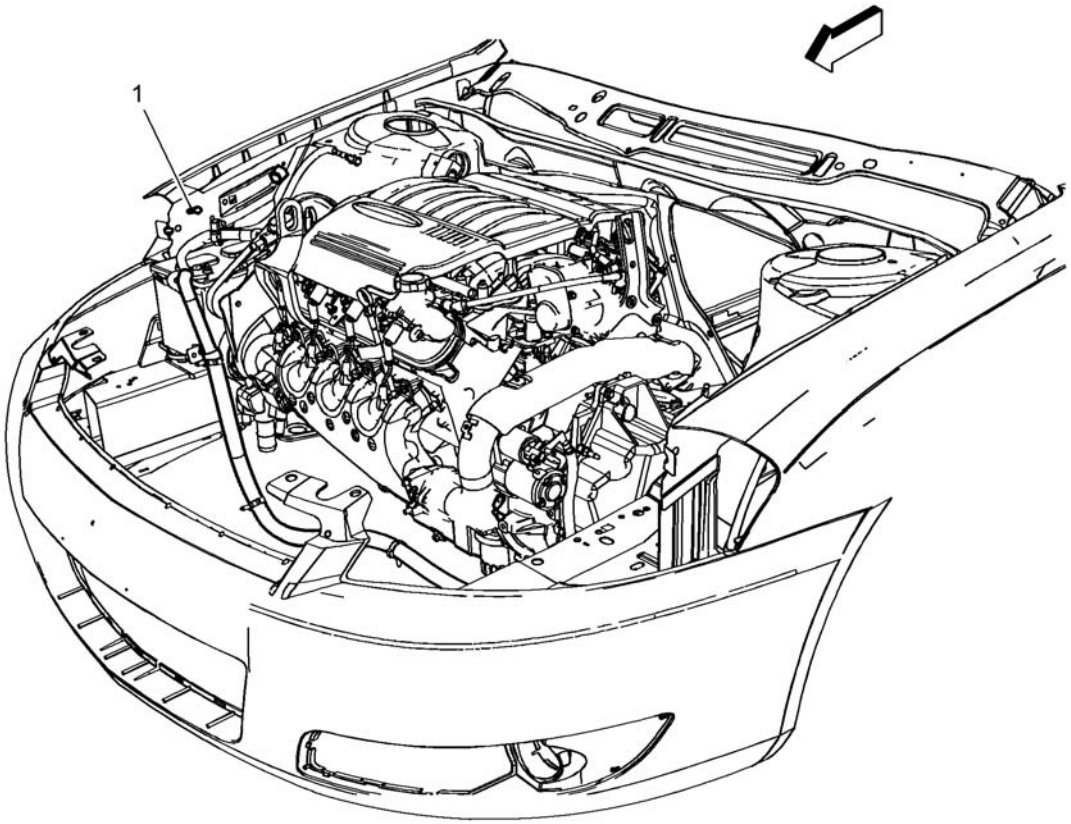


Fig. 2: G102
Courtesy of GENERAL MOTORS COMPANY

Items
1:G102

G111, G113 AND G115

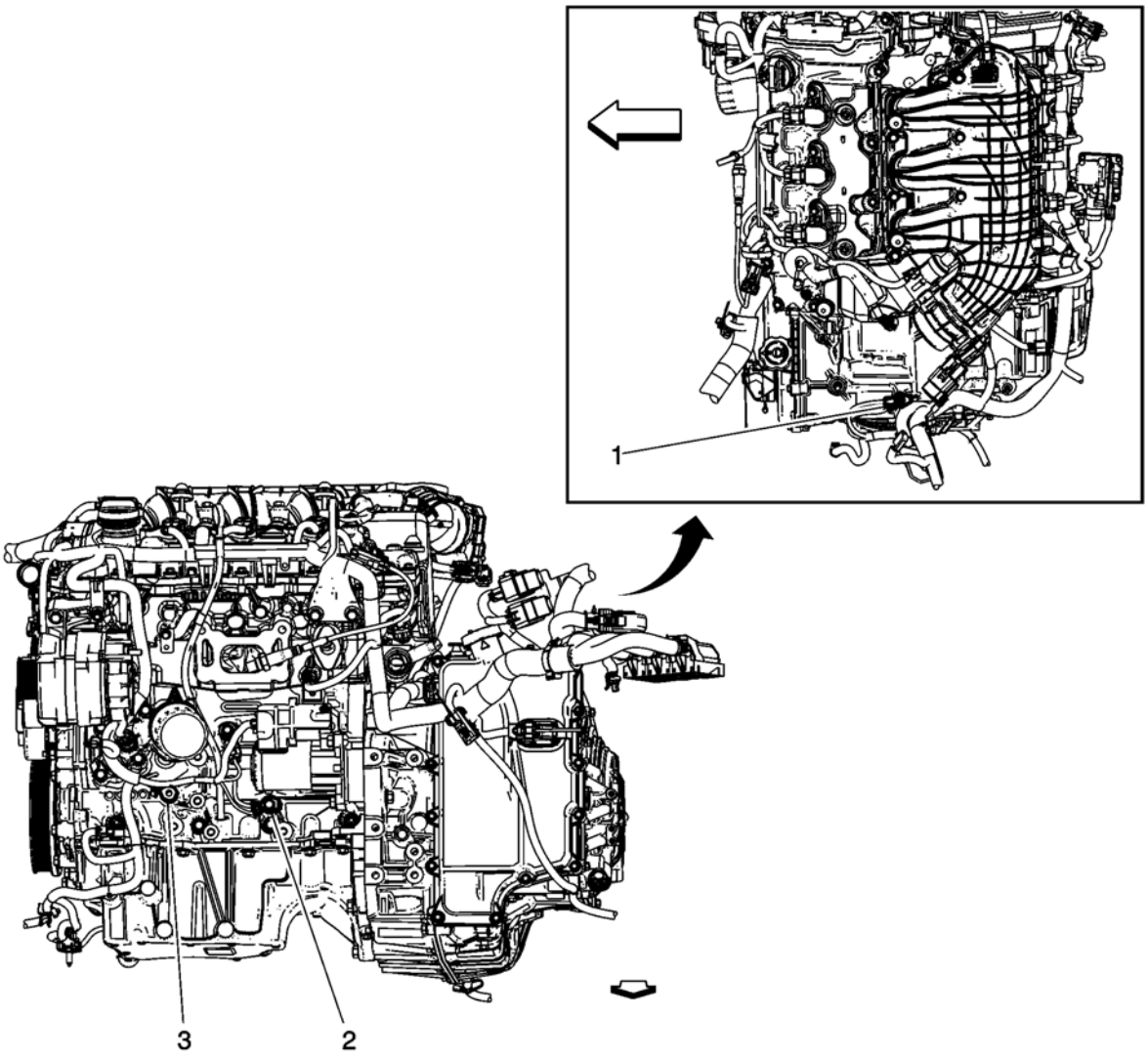


Fig. 3: G111, G113 and G115
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	G115
2	G111
3	G113

G200, G201, G202, AND G204

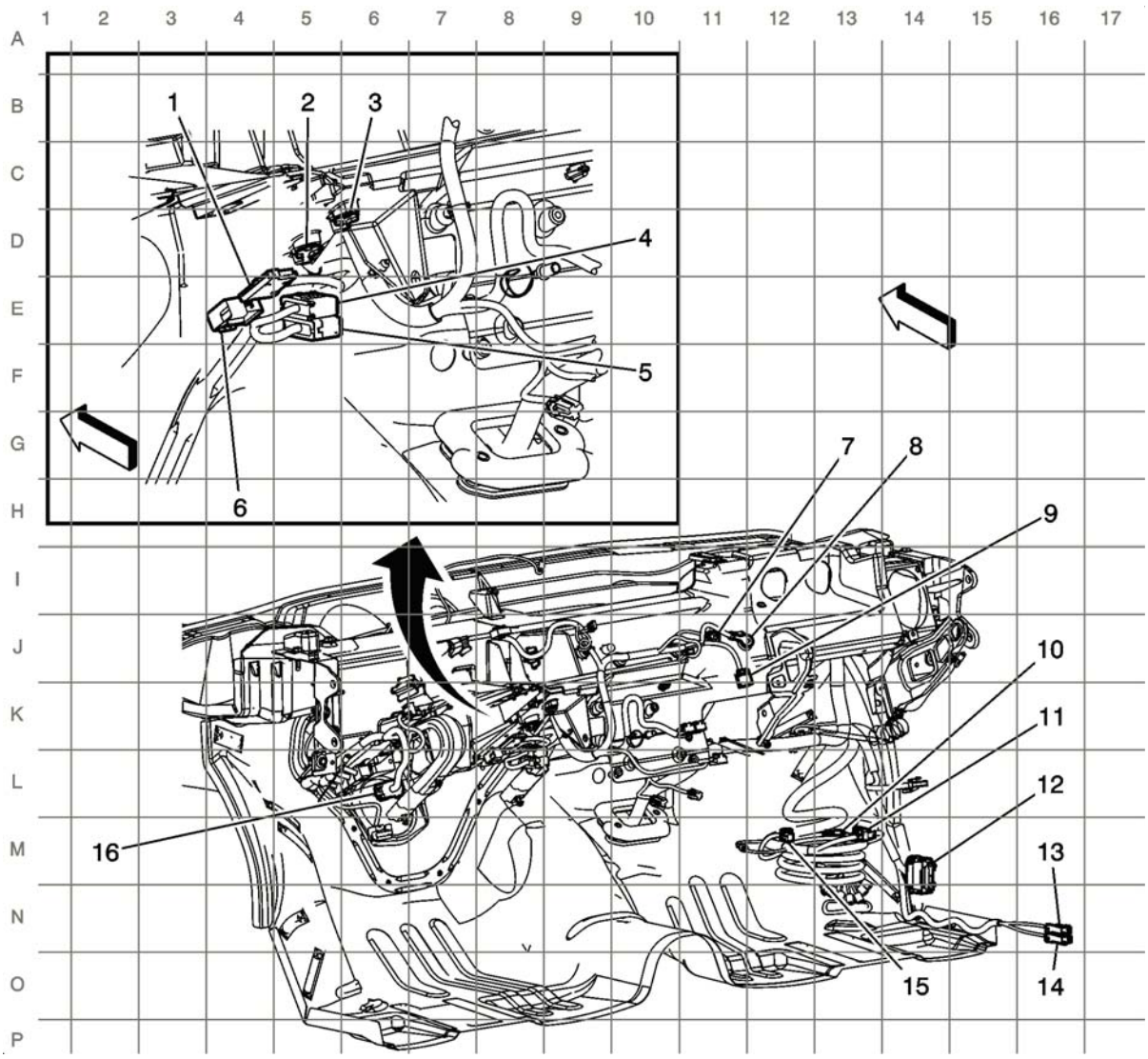


Fig. 4: Instrument Panel Harness - Instrument Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	JX205
2	G202
3	G201
4	JX206
5	JX207
6	X201
7	G200
8	G204 (9C1 or 9C3)
9	X210
10	X266 (9C1 or 9C3)
11	X267 (9C1 or 9C3)
12	X200
13	X360 (9C1 or 9C3)

Callout	Component Name
14	X362 (9C1 or 9C3)
15	X297 (9C1 or 9C3)
16	X203

G301

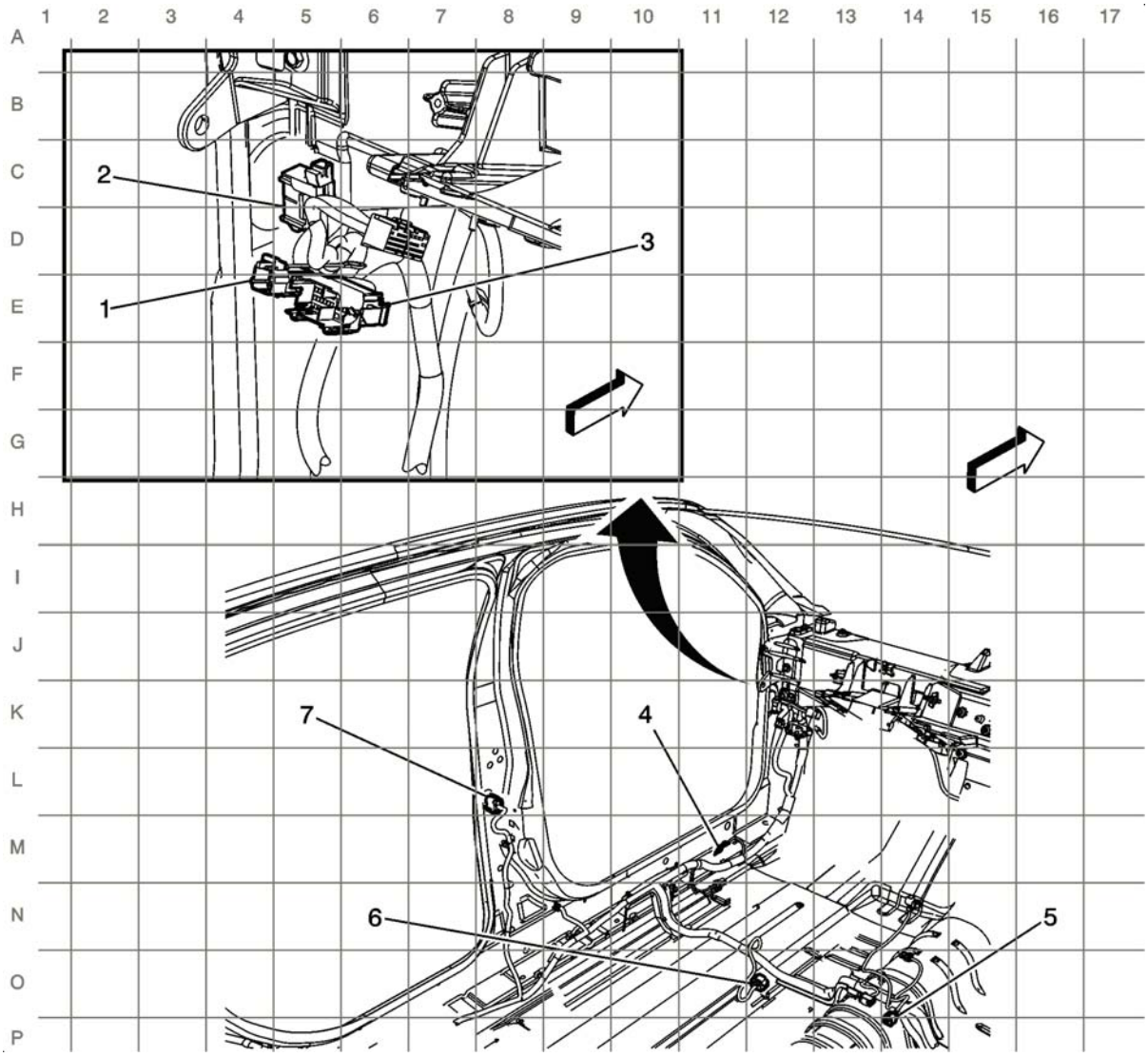


Fig. 5: Body Harness - Left Front Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X250
2	X301
3	X203
4	G301
5	X340
6	X311
7	X355

G302

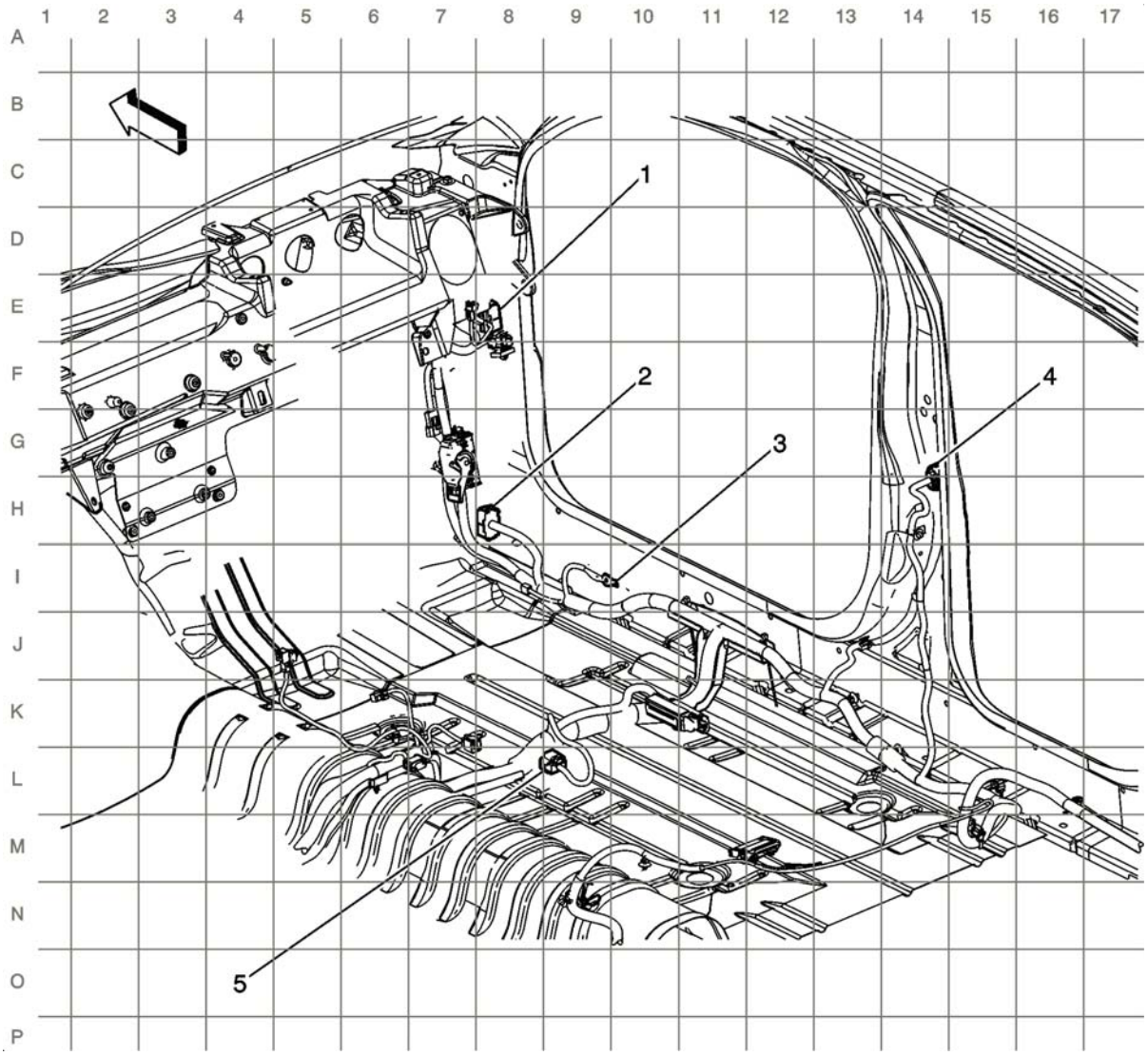


Fig. 6: Body Harness - Right Front Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X302
2	X360 (9C1 or 9C3)
3	G302
4	X356
5	X313

G403 AND G404

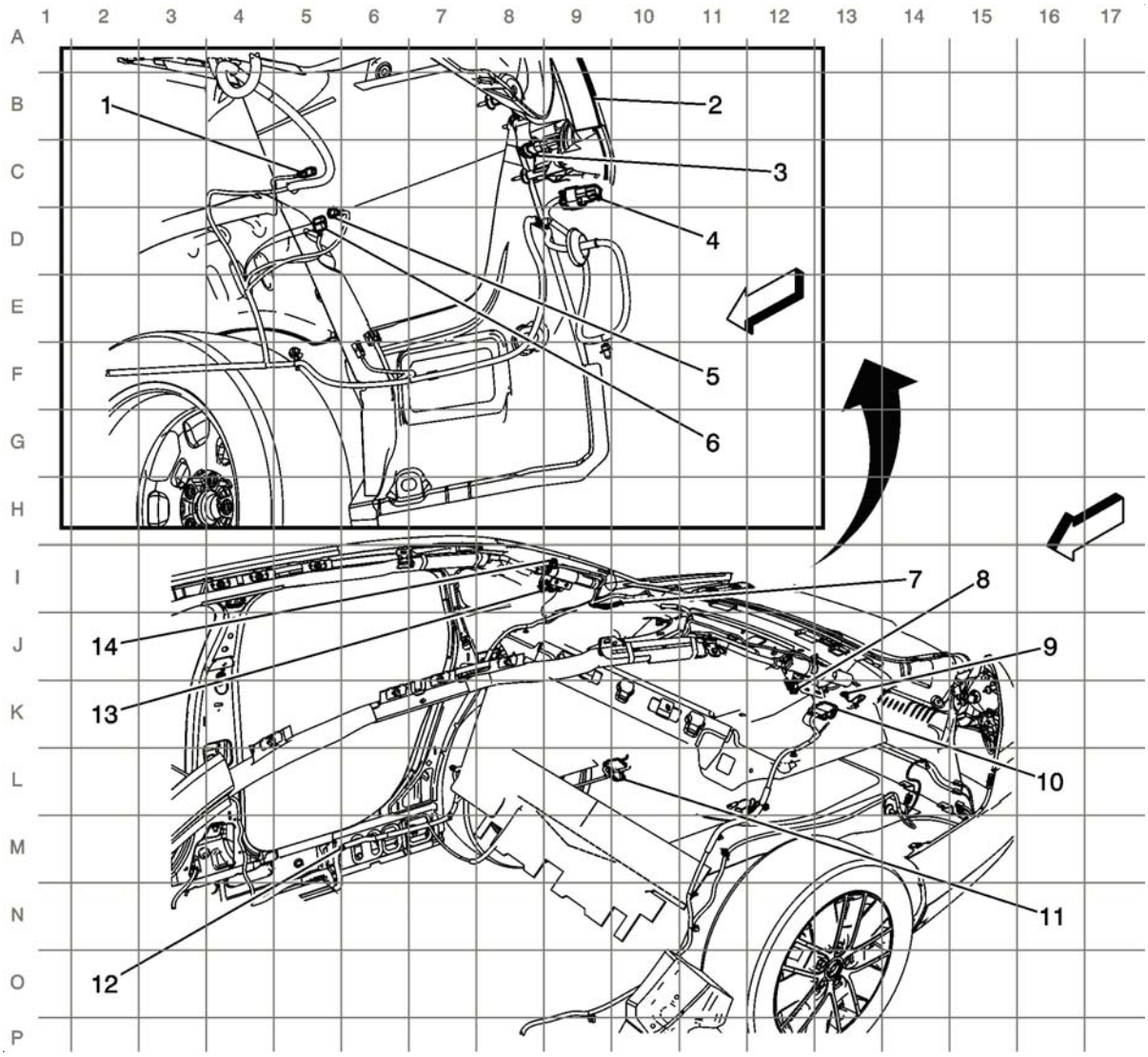


Fig. 7: Body Harness - Rear Compartment Area
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X409 (9C1 or 9C3)
2	Tail Lamp- Right
3	X402
4	X406
5	Junction Block- Rear (6J1) Positive Voltage Stud
6	Junction Block- Rear (6J1) Positive Voltage Stud
7	G404
8	X412
9	G403
10	X490
11	X405
12	J324
13	X414

Callout	Component Name
14	X322- Taped to Harness (9C1 or 9C3)

Article GUID: A00737234

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Instrument Panel/Center Console Component Views - Impala

INSTRUMENT PANEL/CENTER CONSOLE COMPONENT VIEWS

BEHIND THE INSTRUMENT PANEL COMPONENTS

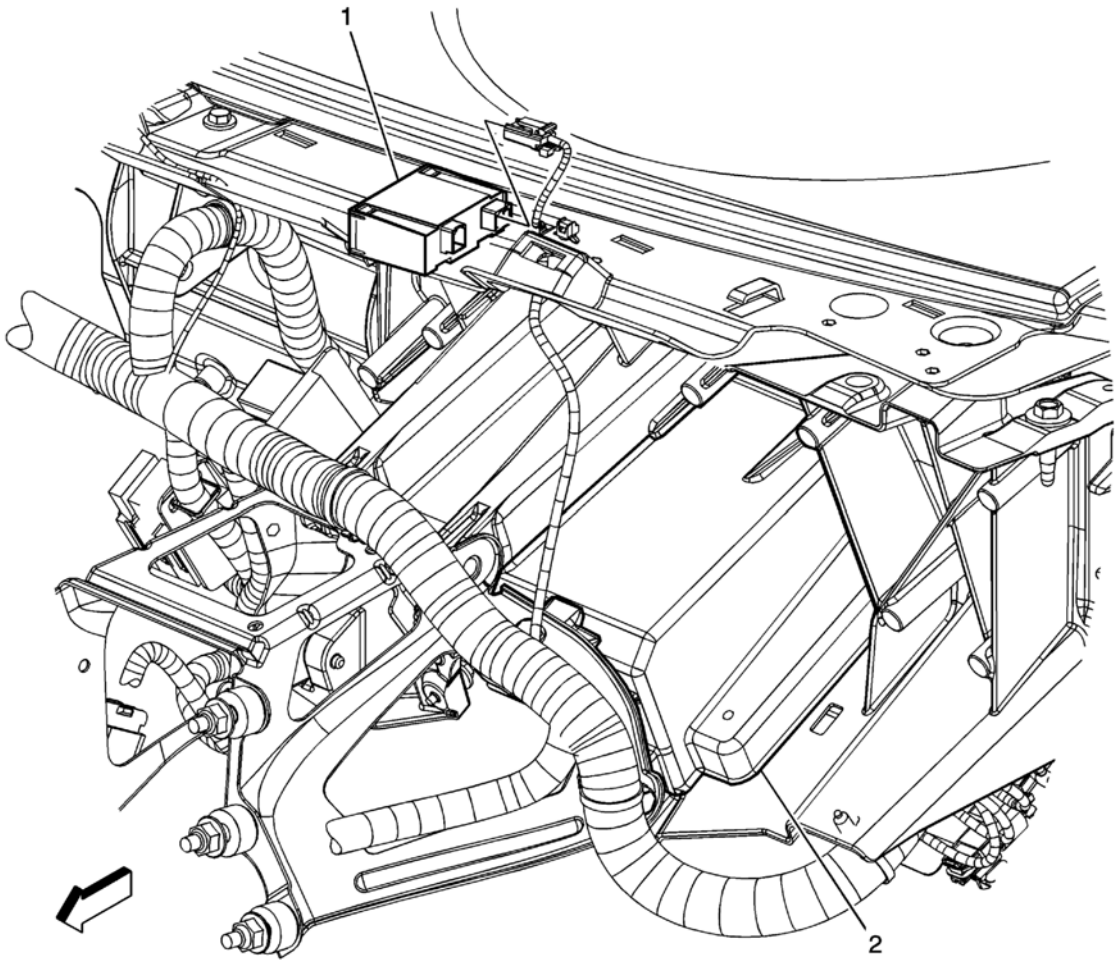


Fig. 1: Identifying Upper Center I/P Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Remote Control Door Lock Receiver (RCDLR)
2	Instrument Panel Carrier

INSTRUMENT PANEL COMPONENTS

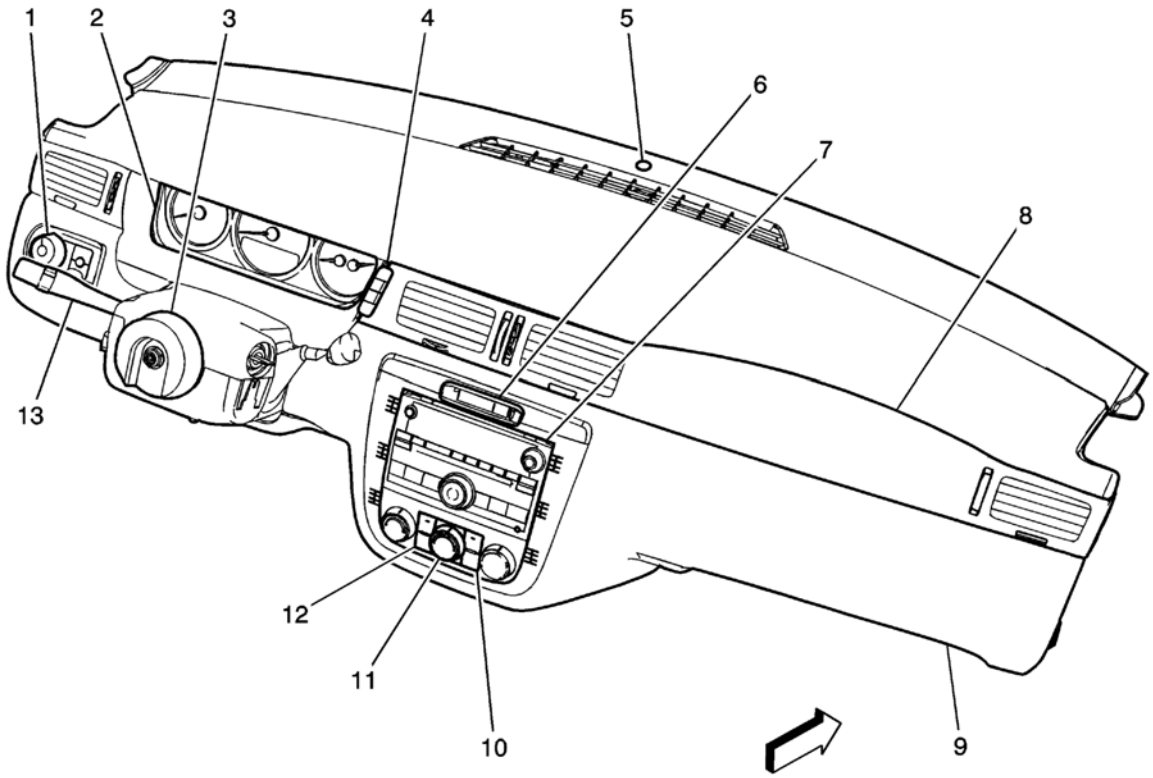


Fig. 2: Identifying I/P Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Headlamp Switch
2	Instrument Panel Cluster (IPC)
3	Inflatable Restraint Steering Wheel Module Coil
4	Driver Information Center (DIC) Switch
5	Ambient Light Sensor
6	Inflatable Restraint I/P Module Indicator
7	Radio
8	Inflatable Restraint I/P Module
9	Instrument Panel Trim Panel
10	Heated Seat Switch- Passenger (KA1)
11	HVAC Control Module
12	Heated Seat Switch- Driver (KA1)
13	Turn Signal/Multifunction Switch

BOTTOM CENTER OF THE INSTRUMENT PANEL (WITHOUT D55)

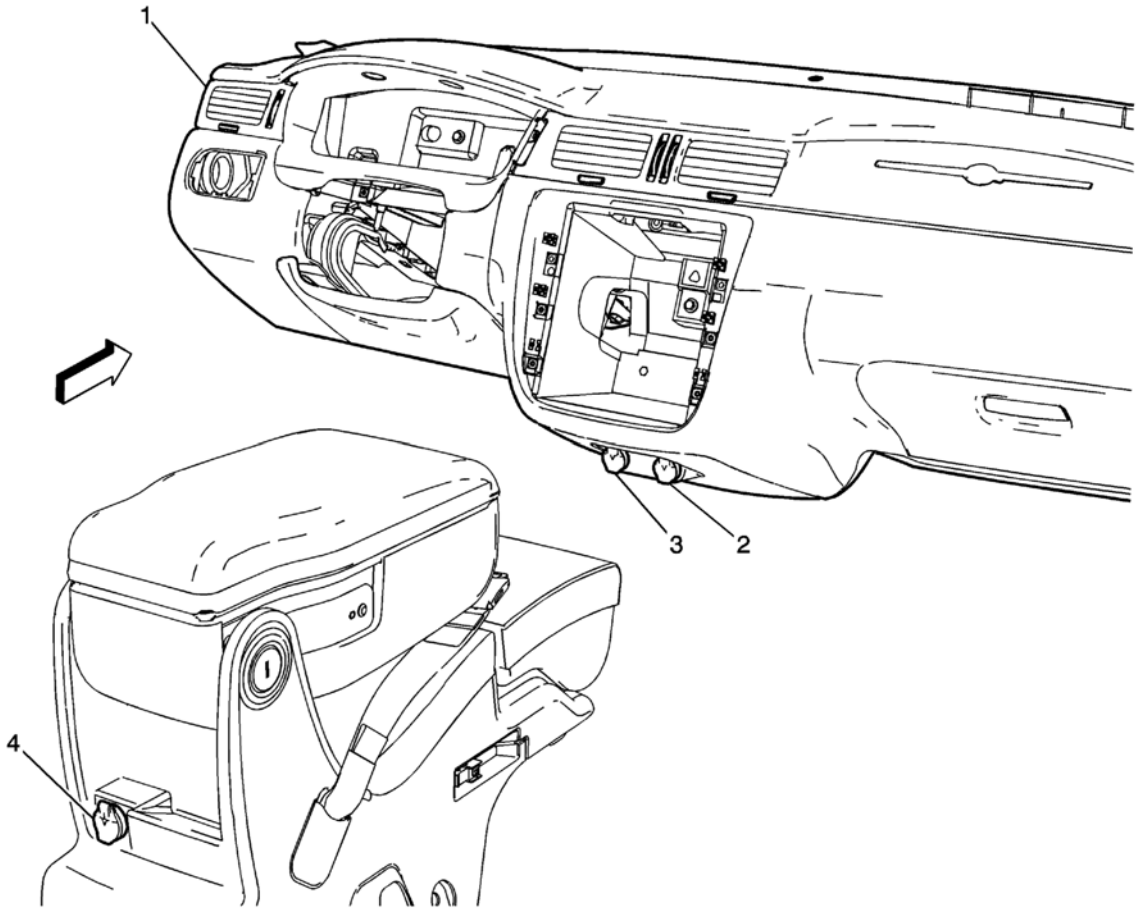


Fig. 3: Bottom Center of the Instrument Panel (without D55)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel
2	Accessory Power Outlet- I/P 2
3	Accessory Power Outlet- I/P 1
4	Accessory Power Outlet- Center Seat

CENTER CONSOLE COMPONENTS- AUXILIARY POWER OUTLETS (D55)

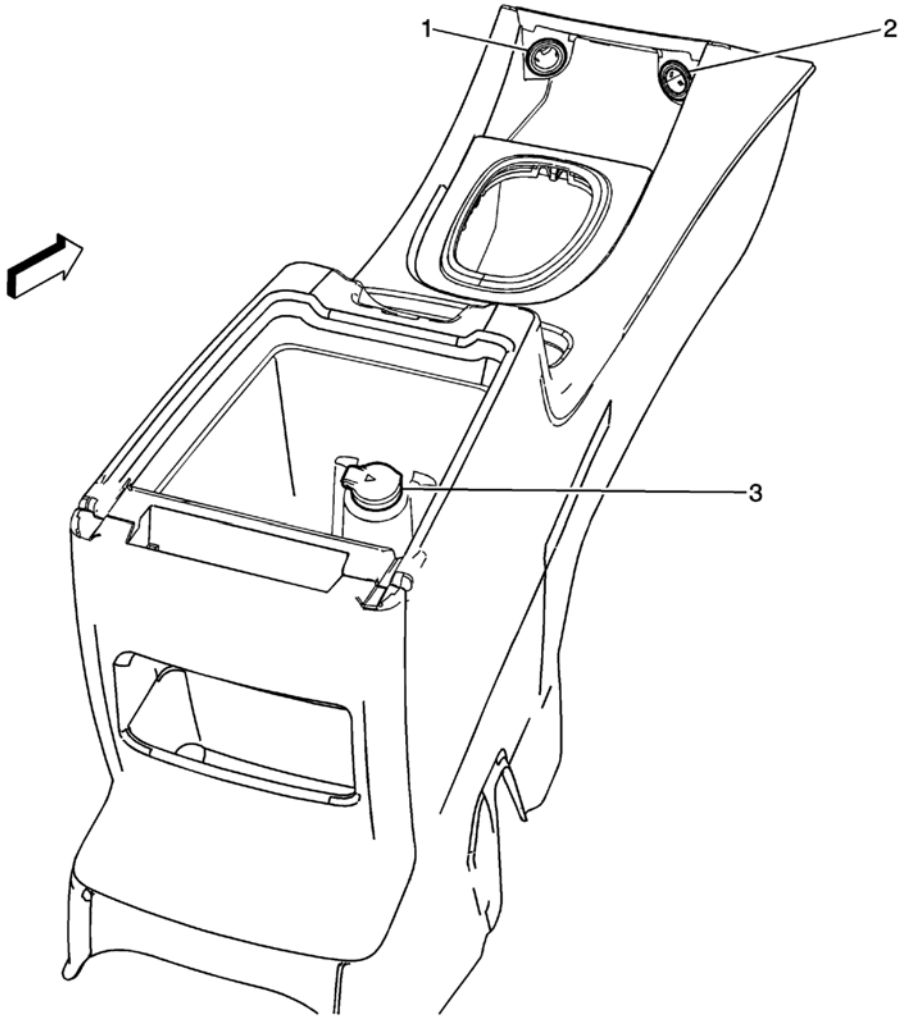


Fig. 4: Center Console Components- Auxiliary Power Outlets (D55)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Accessory Power Outlet- Center Console 1
2	Accessory Power Outlet- Center Console 2
3	Accessory Power Outlet- Center Console Compartment

CENTER CONSOLE COMPONENTS (D55)

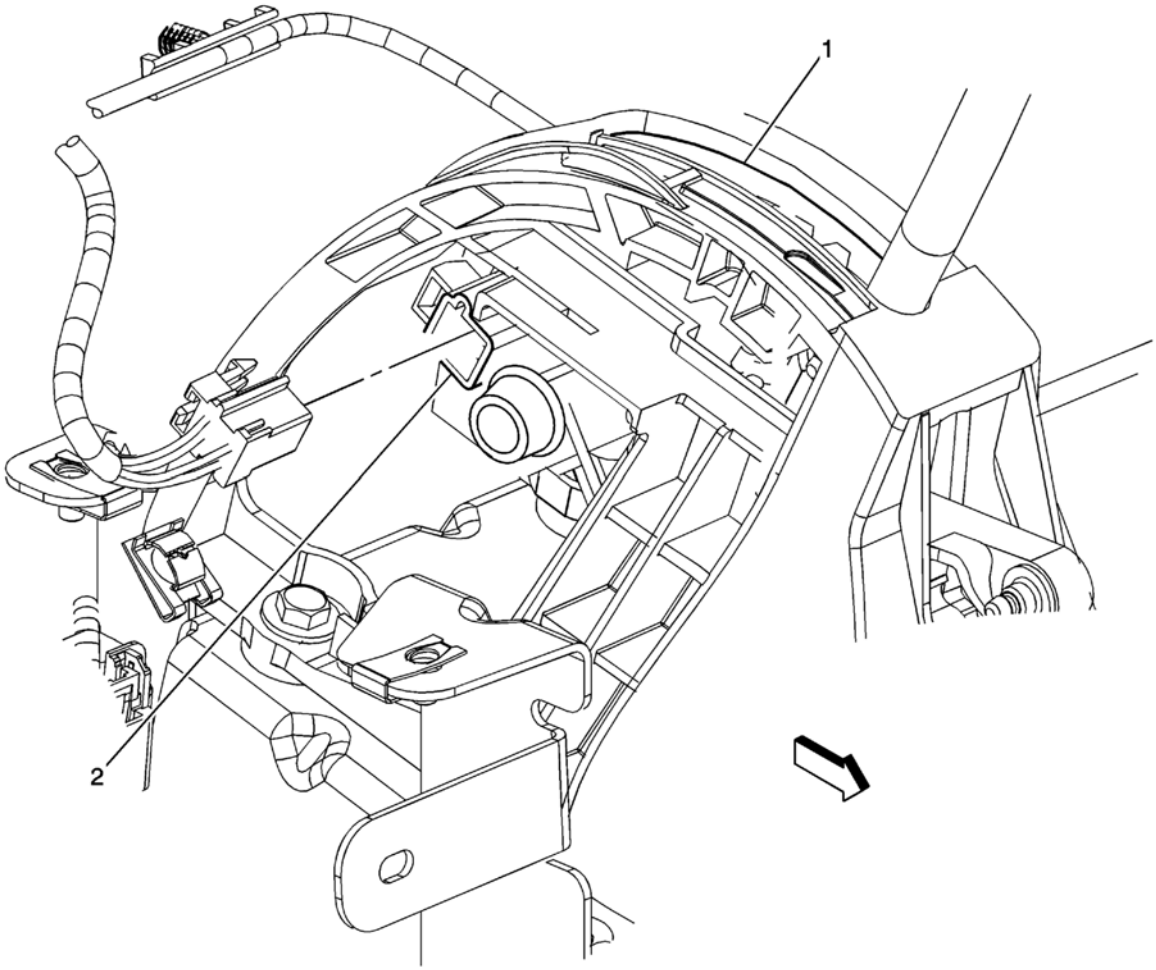


Fig. 5: Center Console Components (D55)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Floor Shifter
2	Automatic Transmission Shift Lock Control Solenoid

BELOW THE INSTRUMENT PANEL COMPONENTS- PEDAL ASSEMBLIES

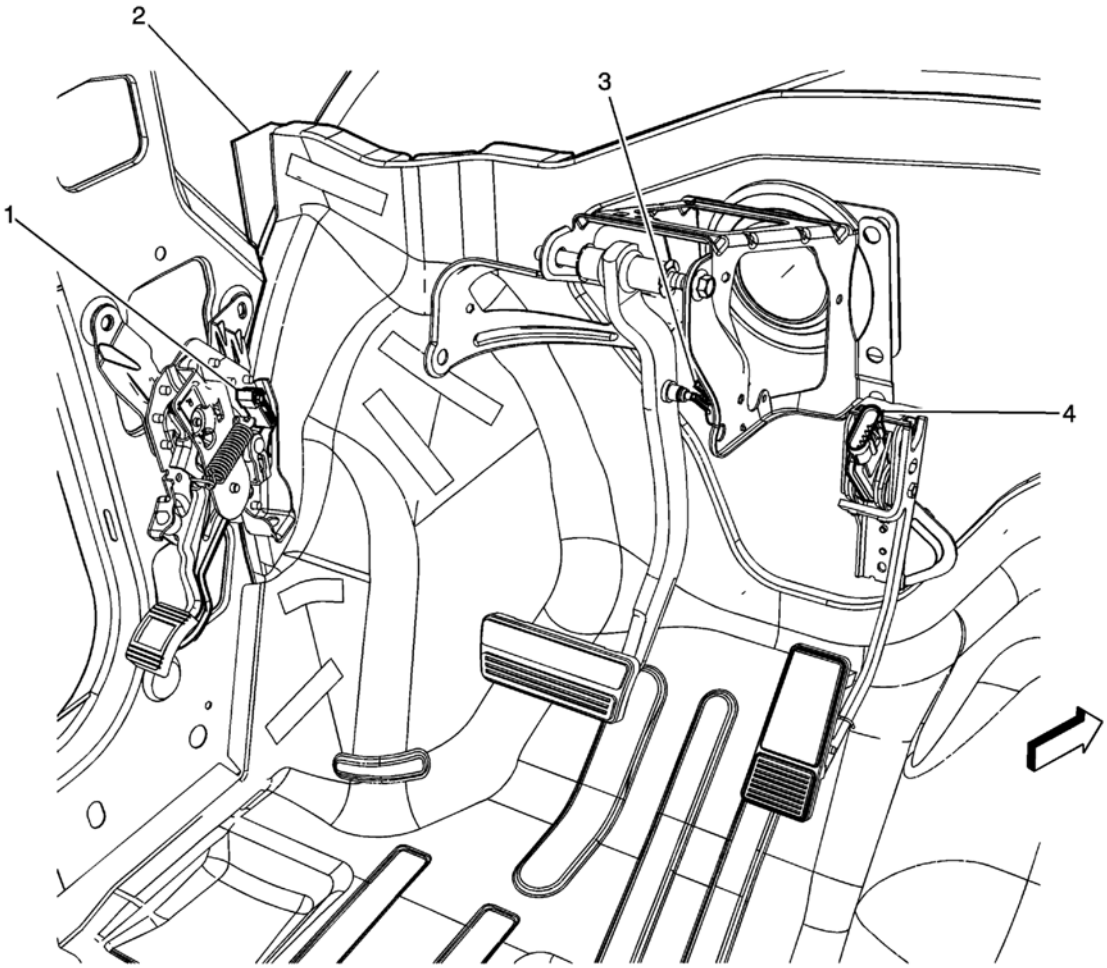


Fig. 6: Below the Instrument Panel Components- Pedal Assemblies
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Park Brake Switch
2	Dash Panel
3	Brake Pedal Position (BPP) Sensor
4	Accelerator Pedal Position (APP) Sensor

BELOW THE INSTRUMENT PANEL COMPONENTS- LEFT FRONT FOOTWELL

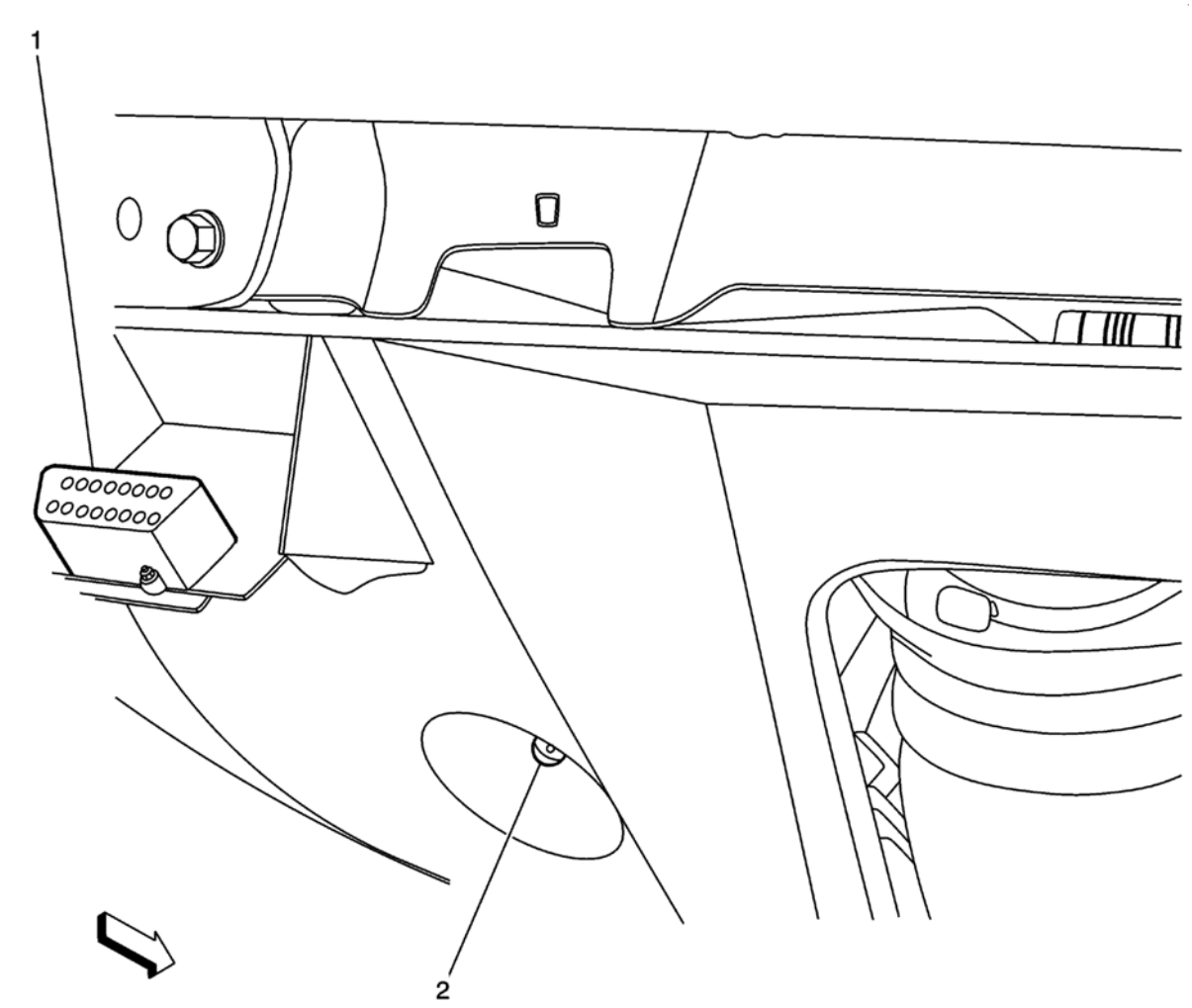


Fig. 7: Below the Instrument Panel Components- Left Front Footwell
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Data Link Connector (DLC)
2	I/P Courtesy Lamp- Left

BELOW THE INSTRUMENT PANEL COMPONENTS- RIGHT FRONT FOOTWELL

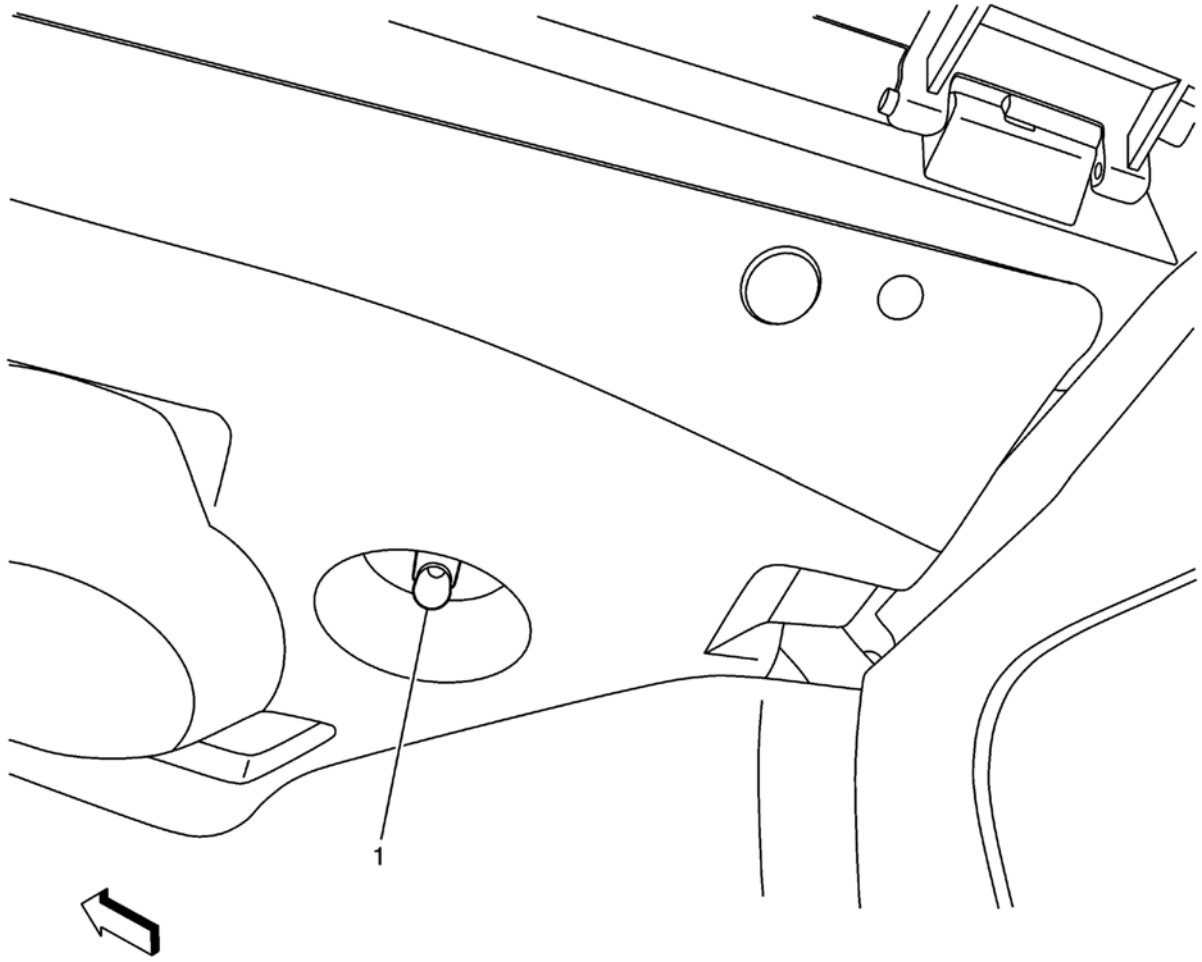


Fig. 8: Below the Instrument Panel Components- Right Front Footwell
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	I/P Courtesy Lamp- Right

STEERING WHEEL COMPONENTS

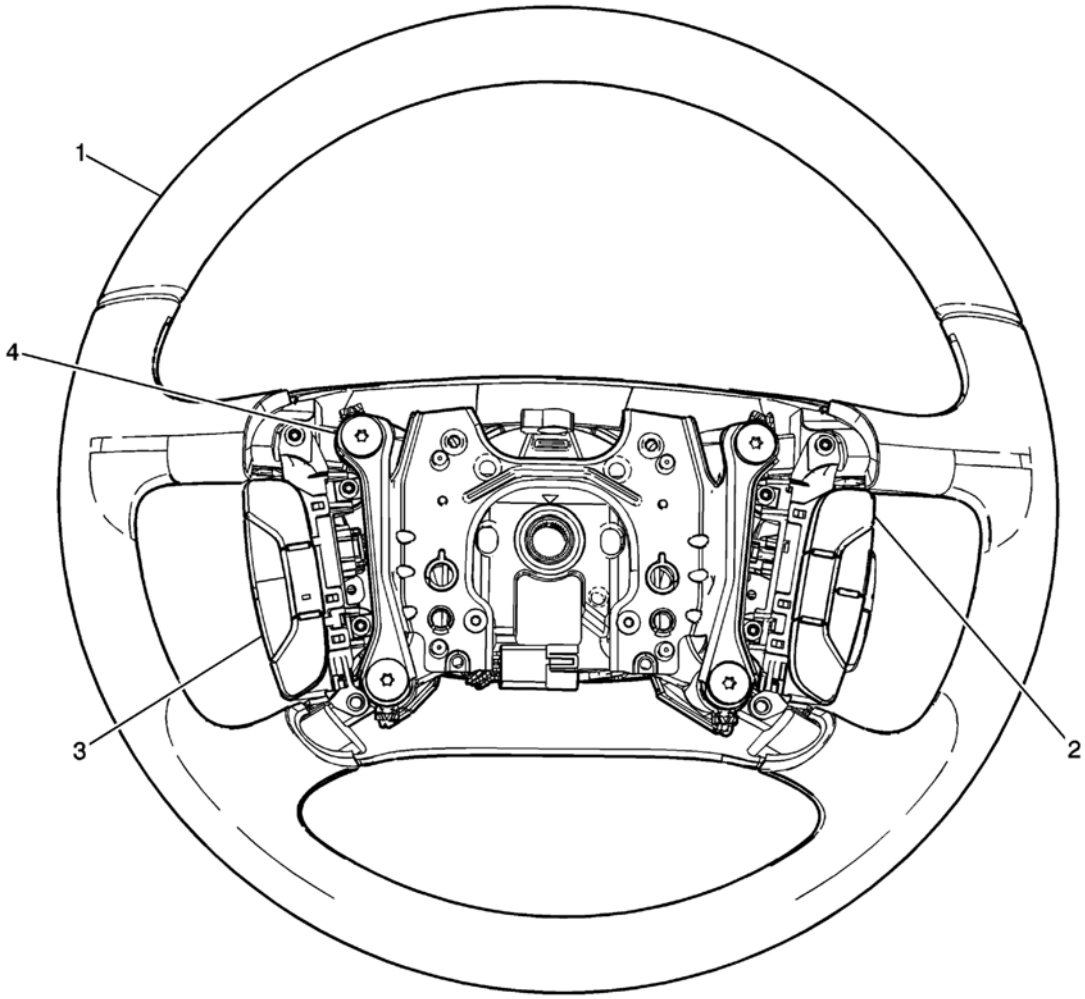


Fig. 9: View Of Steering Wheel Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Steering Wheel
2	Steering Wheel Control Switch - Right
3	Steering Wheel Control Switch - Left (UK3)
4	Horn Switch

STEERING COLUMN COMPONENTS (WITHOUT D55)

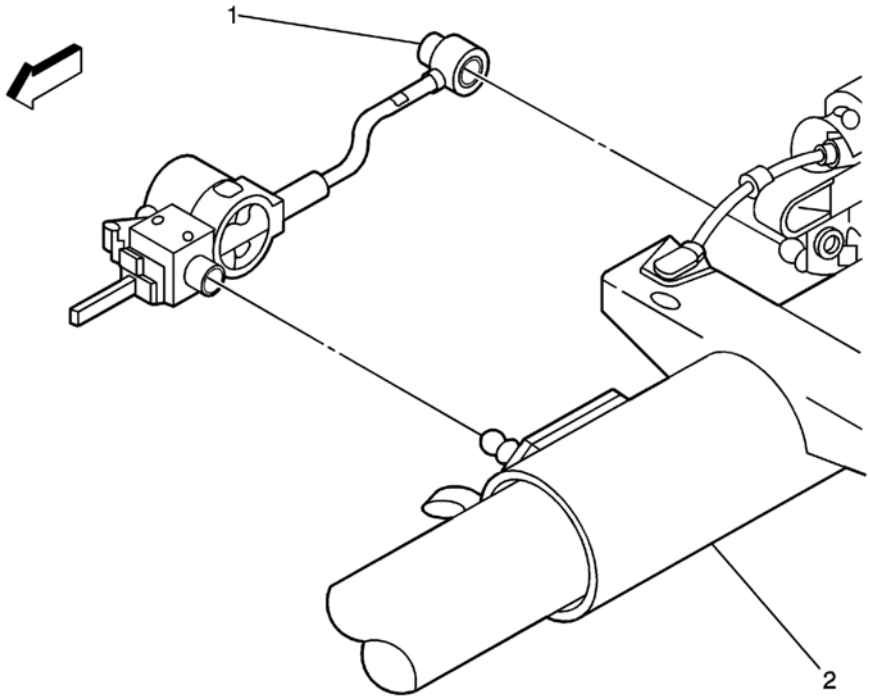


Fig. 10: Steering Column Components (without D55)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Automatic Transmission Shift Lock Control Solenoid
2	Steering Column

NEAR THE STEERING COLUMN COMPONENTS

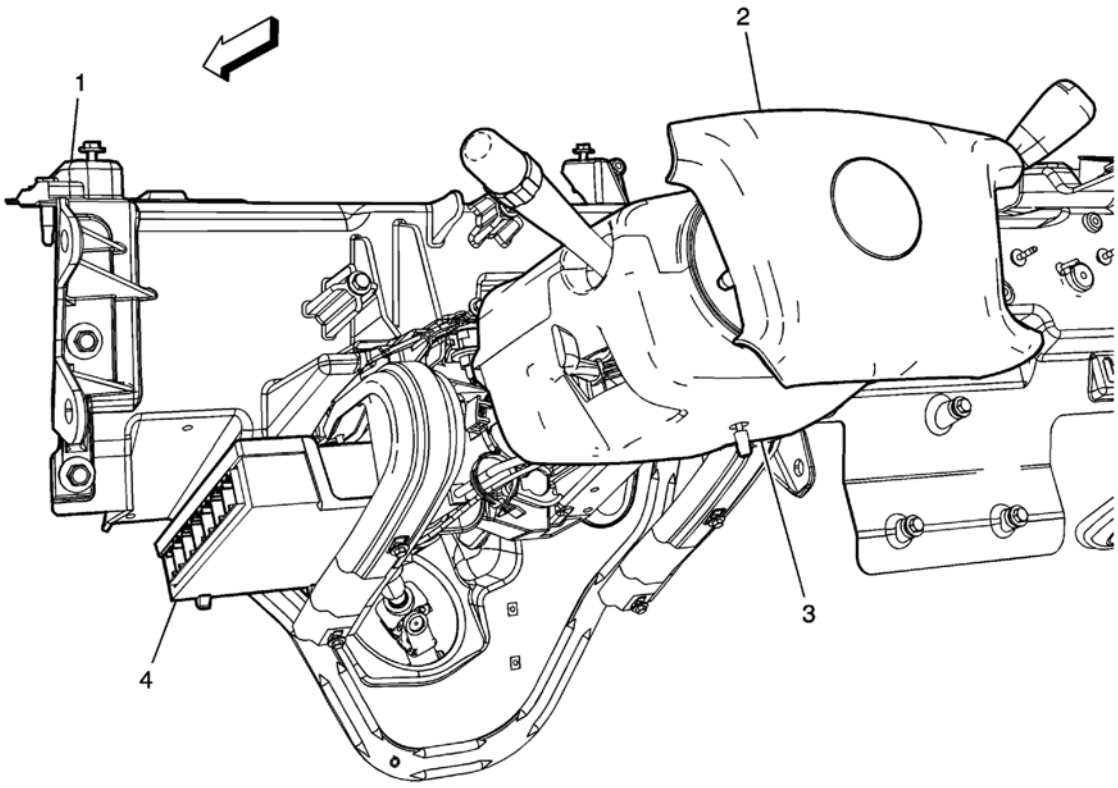


Fig. 11: Near The Steering Column
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel Carrier
2	Inflatable Restraint Steering Wheel Module
3	Steering Column
4	Body Control Module (BCM)

IN THE STEERING COLUMN COMPONENTS

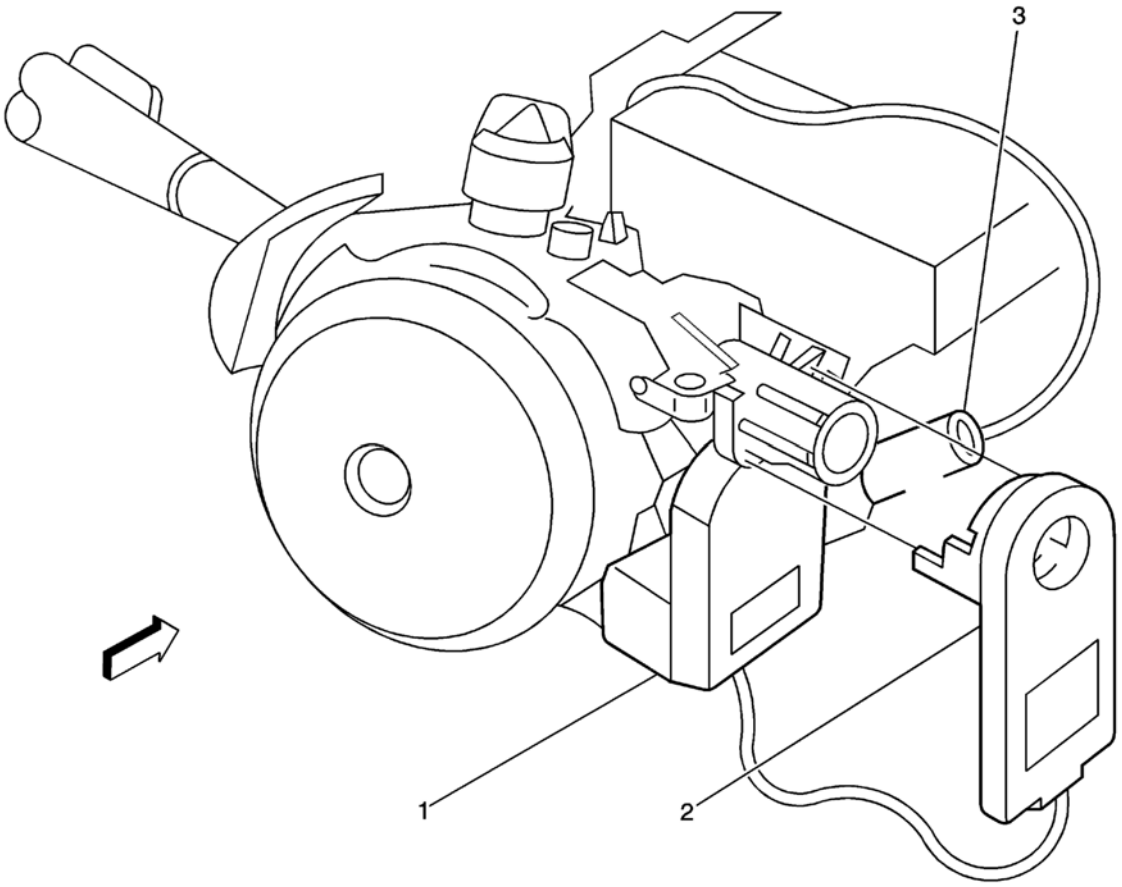


Fig. 12: In The Steering Column Component View
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Ignition Switch
2	Theft Deterrent Module (TDM)
3	Ignition Lock Cylinder Control Actuator

INTERIOR HVAC COMPONENTS

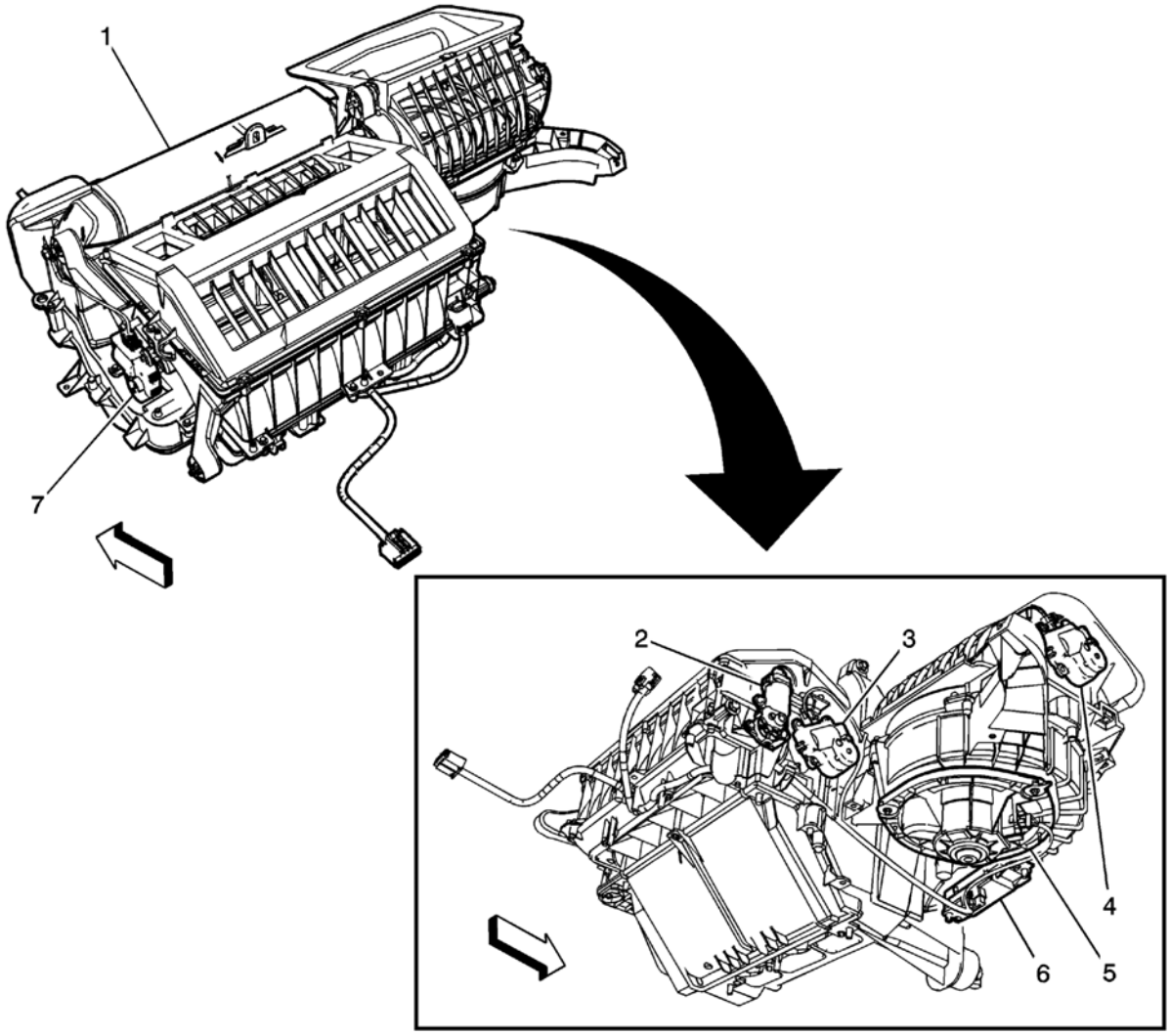


Fig. 13: Interior HVAC Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	HVAC Module
2	Mode Actuator
3	Air Temperature Actuator- Right
4	Recirculation Actuator
5	Blower Motor
6	Blower Motor Control Module
7	Air Temperature Actuator- Left

Article GUID: A00737230

LUGGAGE COMPARTMENT/REAR OF VEHICLE COMPONENT VIEWS

LUGGAGE COMPARTMENT COMPONENTS (T53)

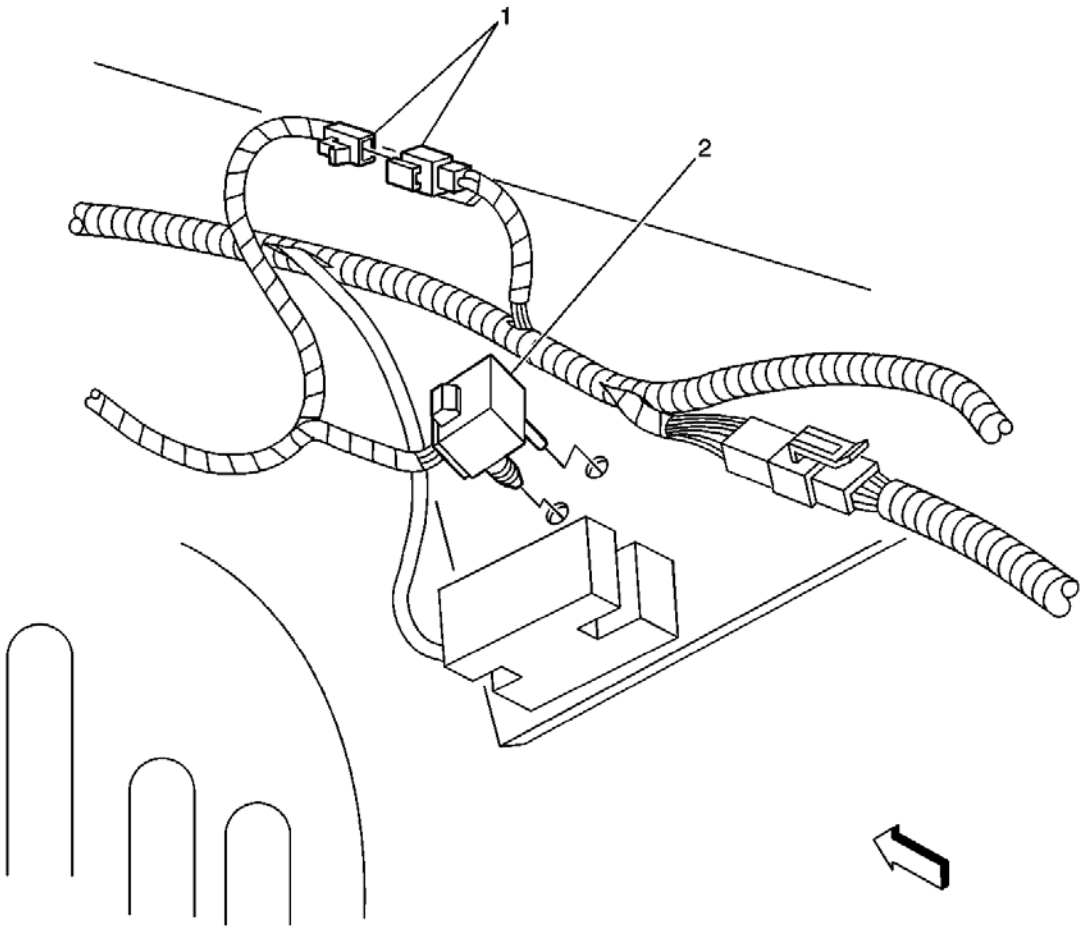


Fig. 1: Luggage Compartment Components (T53)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X409
2	Emergency Vehicle Rear Compartment Lid Lamp Relay

LEFT SIDE OF THE LUGGAGE COMPARTMENT COMPONENTS

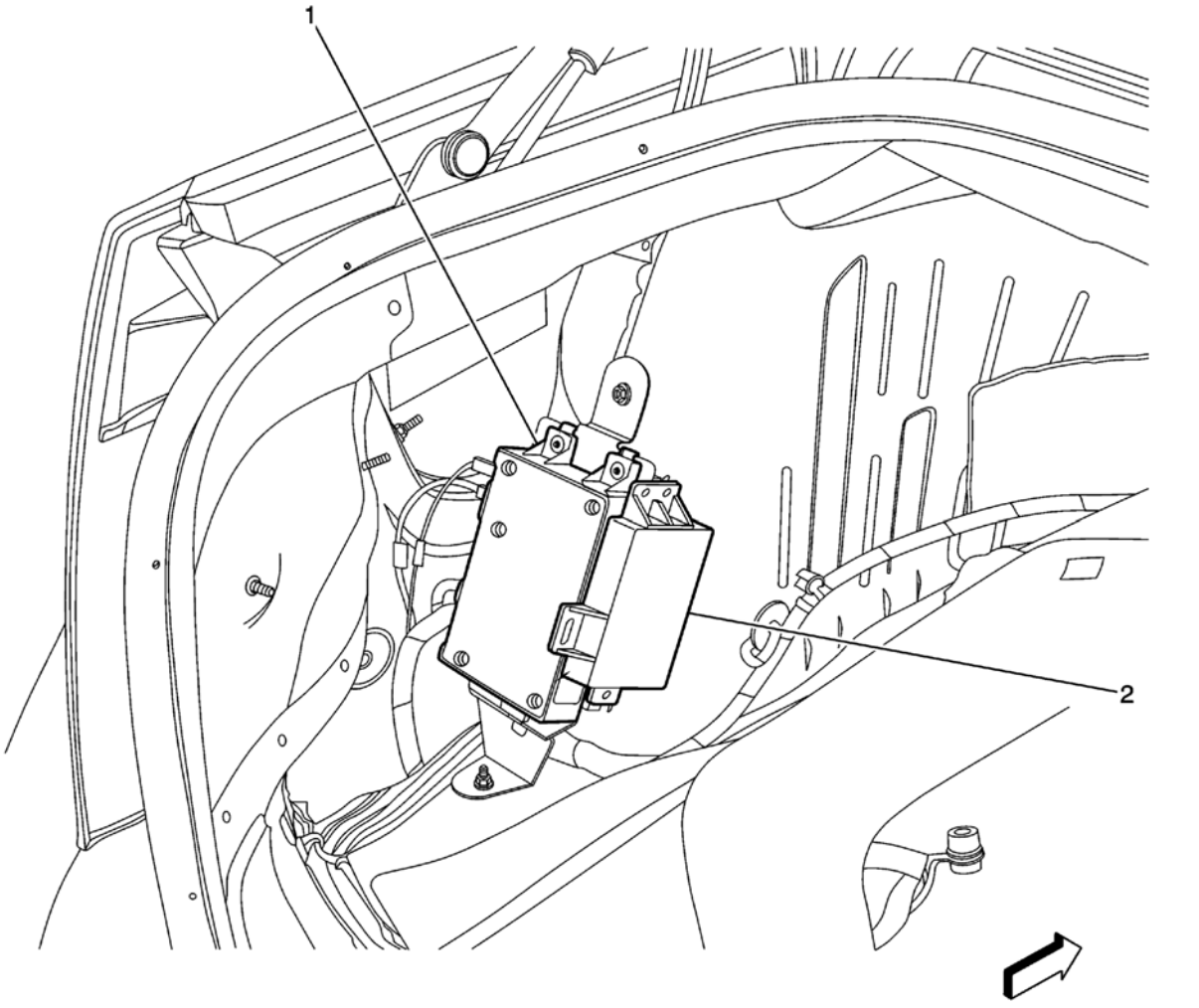


Fig. 2: Left Side of the Luggage Compartment Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Vehicle Communication Interface Module (VCIM) (UE1)
2	Vehicle Communication Interface Module (VCIM) Battery (UE1)

RIGHT SIDE OF THE LUGGAGE COMPARTMENT COMPONENTS

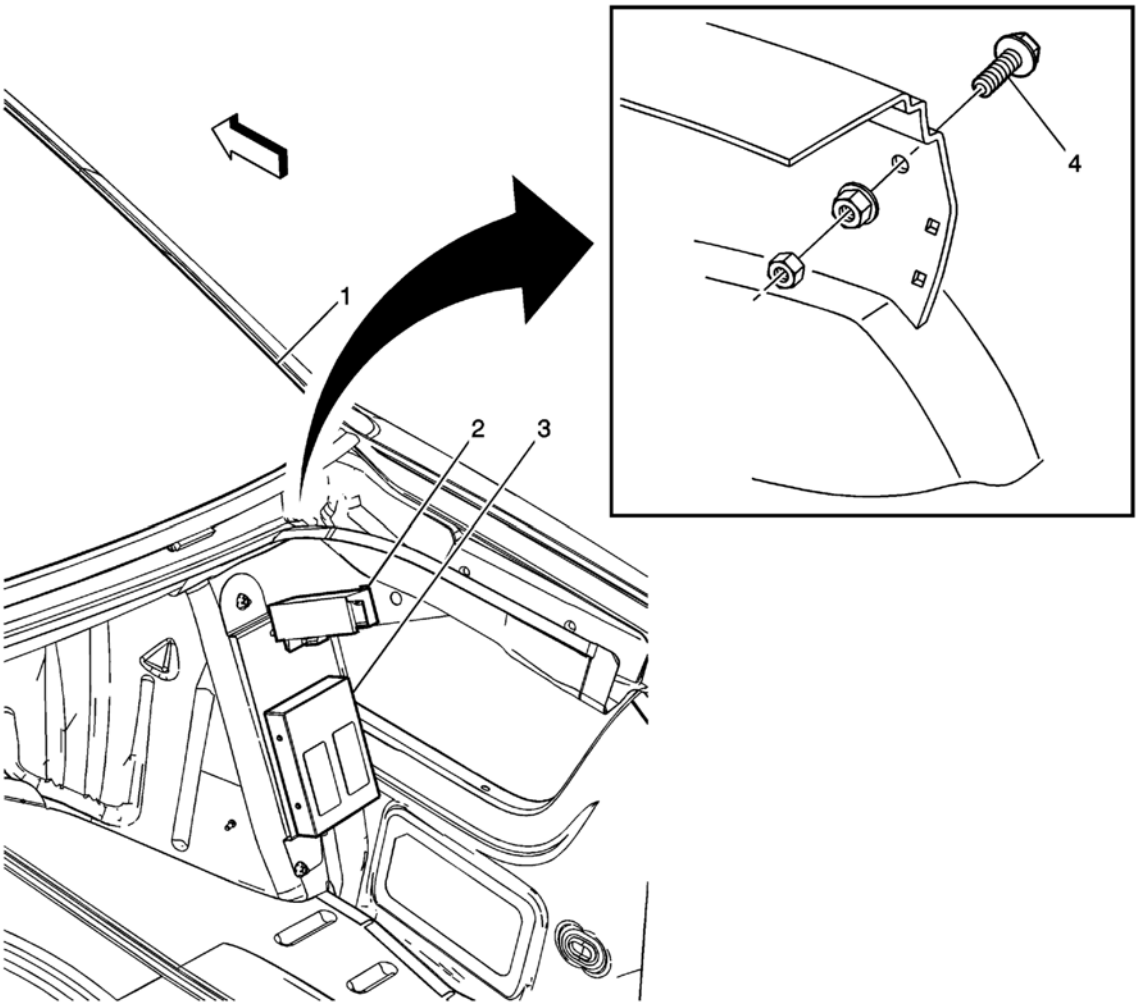


Fig. 3: Right Side Of Luggage Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Window
2	Junction Block- Rear (6J1)
3	Fuel Pump Flow Control Module
4	G405 (Provisional- UT7)

REAR COMPARTMENT LID COMPONENTS (9C1 OR 9C3)

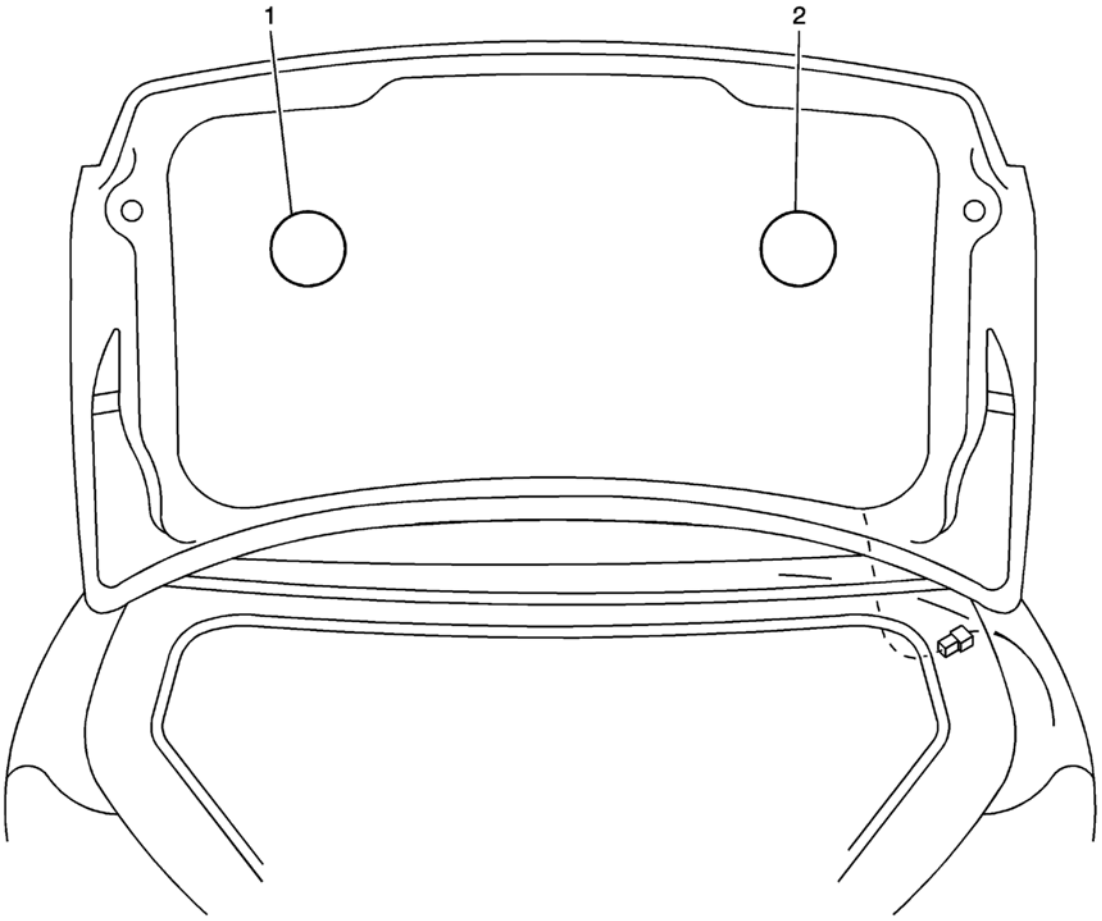


Fig. 4: Rear Compartment Lid (9C1, 9C3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Emergency Vehicle Rear Compartment Lid Lamp- Left (T53)
2	Emergency Vehicle Rear Compartment Lid Lamp- Right (T53)

REAR CENTER DECK LID COMPONENTS

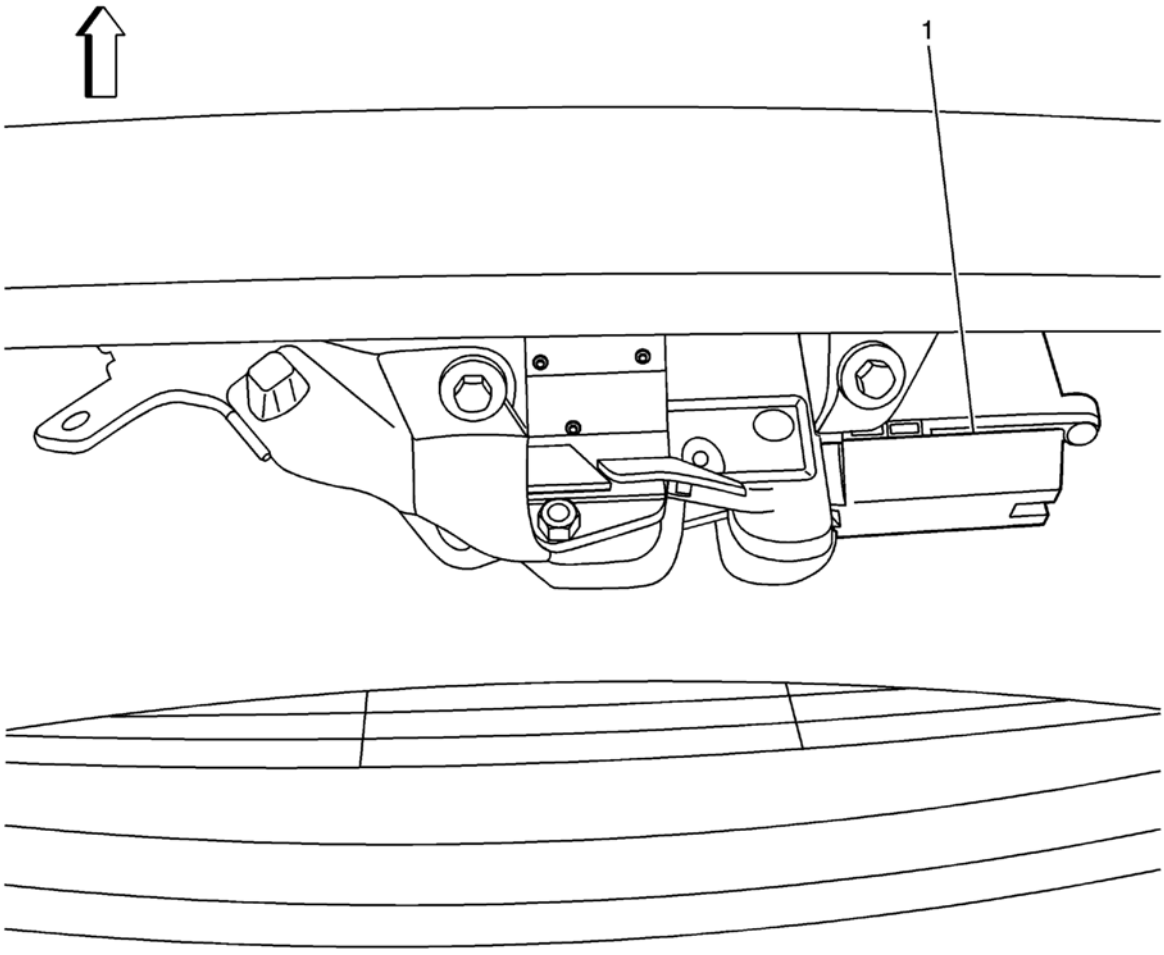


Fig. 5: View Of Rear Center Deck Lid Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Compartment Lid Release Actuator

UNDER THE REAR PACKAGE SHELF COMPONENTS

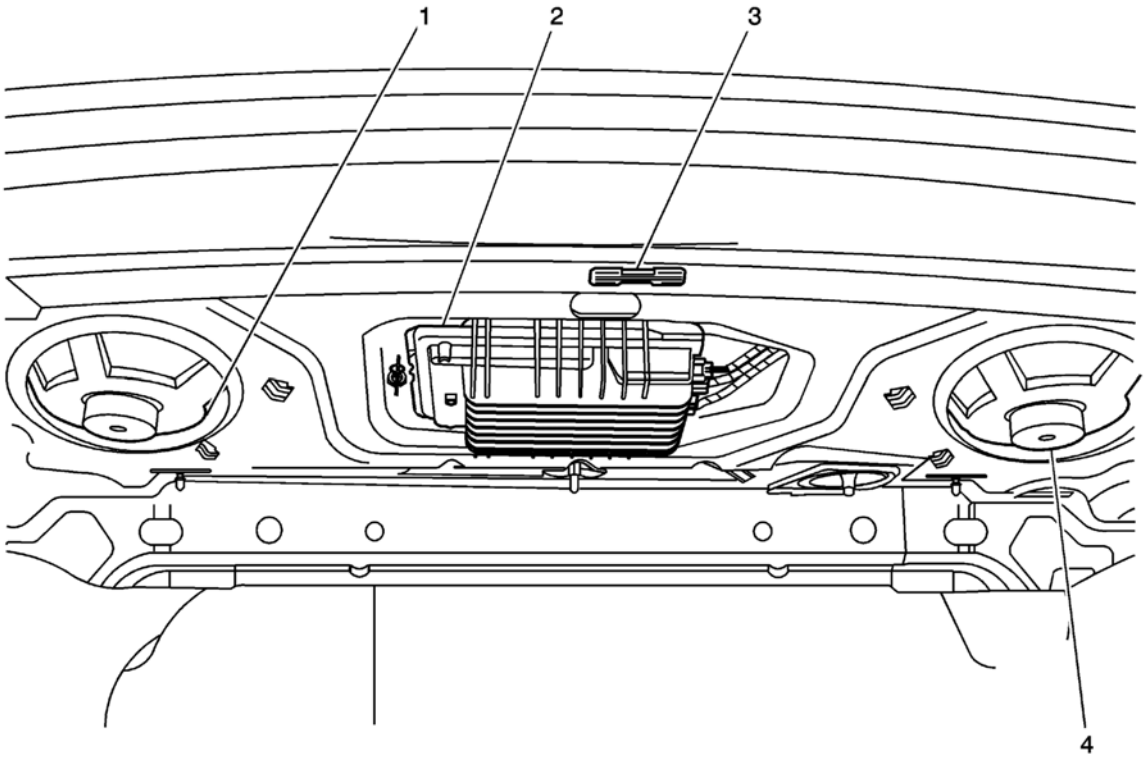


Fig. 6: Under Rear Package Shelf
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Speaker- Left Rear
2	Audio Amplifier (UQ3)
3	Rear Compartment Courtesy Lamp
4	Speaker- Right Rear

REAR OF THE VEHICLE COMPONENTS

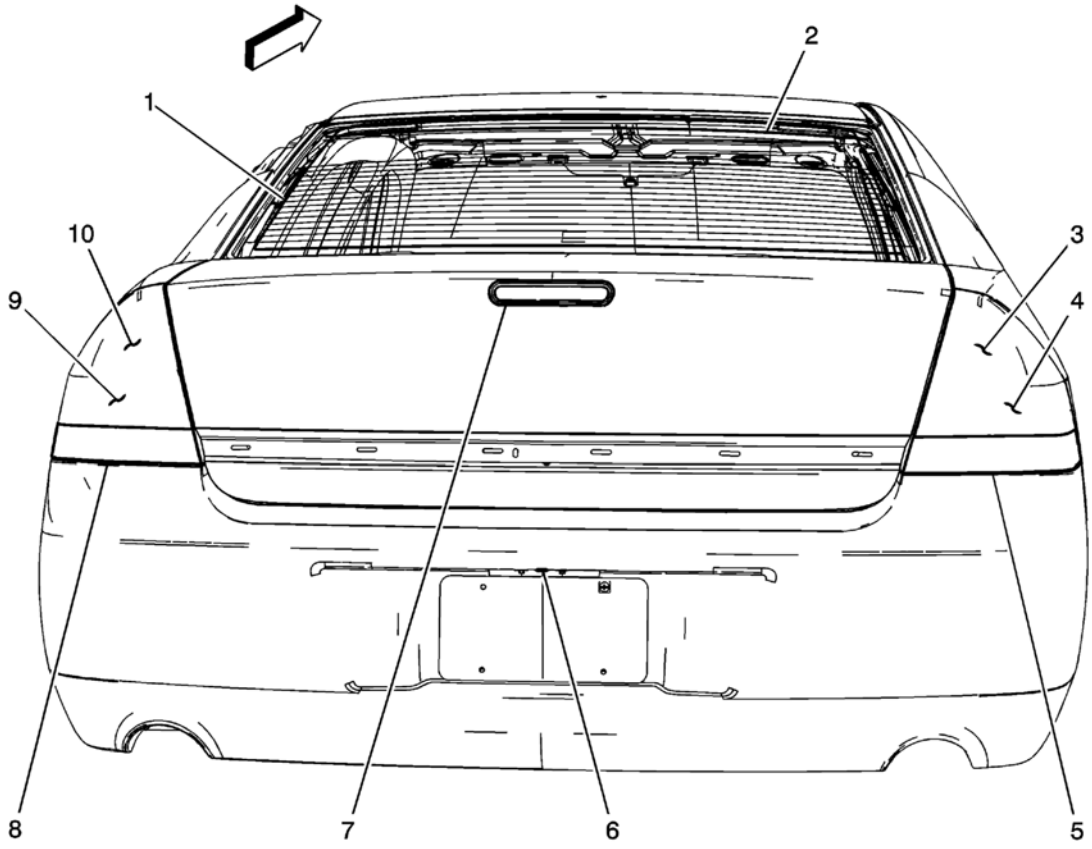


Fig. 7: Identifying Rear of the Vehicle
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Window Defogger Grid
2	Radio Rear Window Antenna
3	Tail/Stop and Turn Signal Lamp - Right
4	Tail Lamp - Right
5	Backup Lamp - Right
6	License Lamp
7	Center High Mounted Stop Lamp (CHMSL)
8	Backup Lamp - Left
9	Tail Lamp - Left
10	Tail/Stop and Turn Signal Lamp - Left

Article GUID: A00737232

MASTER ELECTRICAL COMPONENT LIST

Name	Location	Locator View	Connector End View
A/C Compressor Clutch	In the engine compartment, on the lower right front of the engine, at right side, part of the A/C compressor	Left Front of Engine Components	A/C Compressor Clutch
A/C Compressor Solenoid Valve	In the engine compartment, on the lower right front of the engine, at left side, part of the A/C compressor	Left Front of Engine Components	A/C Compressor Solenoid Valve
A/C Refrigerant Pressure Sensor	Left side of the engine compartment, mounted on the A/C line, under the air cleaner	Left Front of the Engine Compartment Components	A/C Refrigerant Pressure Sensor
Accelerator Pedal Position (APP) Sensor	In the passenger compartment, under the left side of the instrument panel, above the accelerator pedal	Below the Instrument Panel Components- Pedal Assemblies	Accelerator Pedal Position (APP) Sensor
Accessory Power Outlet - Center Console 1 (D55)	In the passenger compartment, at the left front of the center console bin, under the instrument panel	Center Console Components- Auxiliary Power Outlets (D55)	Accessory Power Outlet - Center Console 1 (D55)
Accessory Power Outlet - Center Console 2 (D55)	In the passenger compartment, at the right front of the center console bin, under the instrument panel	Center Console Components- Auxiliary Power Outlets (D55)	Accessory Power Outlet - Center Console 2 (D55)
Accessory Power Outlet - Center Console Compartment (D55)	In the passenger compartment, at the rear of the center console, in the bottom of the bin	Center Console Components- Auxiliary Power Outlets (D55)	Accessory Power Outlet - Center Console Compartment (D55)
Accessory Power Outlet - Center Seat (without D55)	In the passenger compartment, at the rear of the center front seat	Bottom Center of the Instrument Panel (without D55)	Accessory Power Outlet - Center Seat (without D55)

Name	Location	Locator View	Connector End View
Accessory Power Outlet - I/P 1 (without D55)	In the passenger compartment, behind the right side of the instrument panel, under the HVAC control module	Bottom Center of the Instrument Panel (without D55)	Accessory Power Outlet - I/P 1 (without D55)
Accessory Power Outlet - I/P 2 (without D55)	In the passenger compartment, behind the left side of the instrument panel, under the HVAC control module	Bottom Center of the Instrument Panel (without D55)	Accessory Power Outlet - I/P 2 (without D55)
Air Temperature Actuator - Left	In the passenger compartment, to the right of the accelerator pedal, behind the center of the instrument panel, on the HVAC case	Interior HVAC Components	Air Temperature Actuator - Left
Air Temperature Actuator - Right	In the passenger compartment, behind the center of the instrument panel, to the left of the instrument panel compartment, on the HVAC case	Interior HVAC Components	Air Temperature Actuator - Right
Ambient Air Temperature Sensor	In the engine compartment, in front of the radiator, just right of the center of the vehicle	Under the Hood Latch Trim Panel Components	Ambient Air Temperature Sensor
Ambient Light Sensor	In the passenger compartment, top center of the instrument panel	Instrument Panel Components	Ambient Light Sensor
Audio Amplifier (UQ3)	In the center of the rear compartment, mounted below the rear shelf panel	Radio and Speaker Components	• Audio Amplifier X1 (UQ3) • Audio Amplifier X2 (UQ3) • Audio Amplifier X3 (UQ3)
Automatic Transmission	In the engine compartment, left middle lower	Automatic Transmission Electronic Components	-
Automatic Transmission Fluid Temperature (TFT) Sensor	At the left front of the engine compartment, in the automatic	Automatic Transmission Electronic	-

Name	Location	Locator View	Connector End View
	transmission, part of the control solenoid valve assembly	Components	
Automatic Transmission Input Shaft Speed (ISS) Sensor	In the engine compartment, left middle lower, in the automatic transmission	Automatic Transmission Electronic Components	Automatic Transmission Input Shaft Speed (ISS) Sensor
Automatic Transmission Internal Mode Switch (IMS)	In the engine compartment, left middle lower, in the automatic transmission, part of the control solenoid valve assembly	Automatic Transmission Electronic Components	-
Automatic Transmission Shift Lock Control Solenoid (D55)	In the passenger compartment, under the center console, attached to the shifter lever	Center Console Components (D55)	Automatic Transmission Shift Lock Control Solenoid (D55)
Automatic Transmission Shift Lock Control Solenoid (without D55)	In the passenger compartment, attached to the right side of the steering column	Steering Column Components (without D55)	Automatic Transmission Shift Lock Control Solenoid (without D55)
Backup Lamp - Left	At the rear of the vehicle, in the bottom of the left rear tail lamp assembly	Rear of the Vehicle Components	Backup Lamp - Left
Backup Lamp - Right	At the rear of the vehicle, in the bottom of the right rear tail lamp assembly	Rear of the Vehicle Components	Backup Lamp - Right
Battery	At the right front of the engine compartment	Right Front of the Engine Compartment Components (2 of 2)	Battery Current Sensor
Battery Current Sensor	At the right front side of the engine compartment, on the positive battery cable	Right Front of the Engine Compartment Components (2 of 2)	Battery Current Sensor
Blower Motor	In the passenger compartment, behind the right side of the instrument panel, lower right side of the HVAC assembly, above foot area of the passenger floor	Interior HVAC Components	Blower Motor
Blower Motor Control Module	In the passenger compartment, behind the right side of the	Interior HVAC Components	Blower Motor Control Module

Name	Location	Locator View	Connector End View
	instrument panel, lower right side of the HVAC assembly, next to the blower motor		
Body Control Module (BCM)	In the passenger compartment, below the left side of the instrument panel, left of the steering column	Near the Steering Column Components	• Body Control Module (BCM) X1 • Body Control Module (BCM) X2 • Body Control Module (BCM) X3 • Body Control Module (BCM) X4 • Body Control Module (BCM) X5 • Body Control Module (BCM) X6 • Body Control Module (BCM) X7
Brake Fluid Level Switch	In the engine compartment, mounted under the center of the brake fluid reservoir	Left Rear of the Engine Compartment Components	Brake Fluid Level Switch
Brake Pedal Position (BPP) Sensor	In the passenger compartment, below the left side of the instrument panel, in the right side of the brake pedal bracket	Below the Instrument Panel Components- Pedal Assemblies	Brake Pedal Position (BPP) Sensor
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Exhaust	In the engine compartment, rear of the engine, at the right side	Right Rear of Engine Components	Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Exhaust
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Intake	In the engine compartment, rear of the engine, at the right side	Right Rear of Engine Components	Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Intake
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Exhaust	In the engine compartment, right side of the engine, near the front	Right Rear of Engine Components	Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Exhaust
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Intake	In the engine compartment, right side of the engine, near the front	Right Rear of Engine Components	Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Intake

Name	Location	Locator View	Connector End View
Camshaft Position (CMP) Sensor - Bank 1 Exhaust	In the engine compartment, right side of the engine, near the rear	Right Rear of Engine Components	Camshaft Position (CMP) Sensor - Bank 1 Exhaust
Camshaft Position (CMP) Sensor - Bank 1 Intake	In the engine compartment, right side of the engine, near the rear	Right Rear of Engine Components	Camshaft Position (CMP) Sensor - Bank 1 Intake
Camshaft Position (CMP) Sensor - Bank 2 Exhaust	In the engine compartment, right side of the engine, near the front	Right Rear of Engine Components	Camshaft Position (CMP) Sensor - Bank 2 Exhaust
Camshaft Position (CMP) Sensor - Bank 2 Intake	In the engine compartment, right side of the engine, near the front	Right Rear of Engine Components	Camshaft Position (CMP) Sensor - Bank 2 Intake
Cellular and Digital Radio Antenna (UE1 and/or U2K)	On the vehicle exterior, top rear center of the roof	Headliner Components- Top View	-
Cellular Telephone Microphone (UE1)	In the passenger compartment, on the headliner, near the left sunshade	-	Cellular Telephone Microphone (UE1)
Center High Mounted Stop Lamp (CHMSL)	In the rear compartment, on the upper center of the deck lid	Rear of the Vehicle Components	Center High Mounted Stop Lamp (CHMSL)
Control Solenoid Valve Assembly	In the left front of the engine compartment, in the automatic transmission	Automatic Transmission Electronic Components	• Control Solenoid Valve Assembly X1 • Control Solenoid Valve Assembly X2 • Control Solenoid Valve Assembly X3 • Control Solenoid Valve Assembly X4
Crankshaft Position (CKP) Sensor	In the engine compartment, rear of the engine, left side of the engine block	Right Rear of Engine Components	Crankshaft Position (CKP) Sensor
Data Link Connector (DLC)	In the passenger compartment, on the bottom of the instrument panel, left of the steering column	Below the Instrument Panel Components- Left Front Footwell	Data Link Connector (DLC)

Name	Location	Locator View	Connector End View
Data Link Resistor (without UE1)	In the right side luggage compartment, taped to the body harness, approximately 26 cm (10.25 in) from the fuel pump flow control module	-	-
Data Link Resistor (UE1)	In the left side luggage compartment, taped to the body harness, between the vehicle communication interface module and the vehicle communication interface module battery	-	-
Digital Radio Receiver (U2K)	In the luggage compartment, left side, above the Vehicle Communication Interface Module (VCIM)	**Radio and Speaker Components**	**Digital Radio Receiver (U2K)**
Dome/Reading Lamps	In the passenger compartment, inside center of the roof	**Headliner Components**	**Dome/Reading Lamps**
Door Lock - Driver	In the passenger compartment, in the rear of the driver door	**Driver Door Components**	• **Door Lock - Driver (UA6)** • **Door Lock - Driver (without UA6)**
Door Lock - Left Rear	In the passenger compartment, in the rear of the left rear door	**Left Rear Door Components**	**Door Lock - Left Rear**
Door Lock - Passenger	In the passenger compartment, in the rear of the passenger door	**Passenger Door Components**	**Door Lock - Passenger**
Door Lock - Right Rear	In the passenger compartment, in the rear of the right rear door	**Right Rear Door Components**	**Door Lock - Right Rear**
Door Lock Switch - Driver	In the passenger compartment, in the center of the driver door panel, near the door handle	**Driver Door Components**	**Door Lock Switch - Driver**
Door Lock Switch - Passenger	In the passenger compartment, in the center of the front	**Passenger Door Components**	**Door Lock Switch - Passenger**

Name	Location	Locator View	Connector End View
	passenger door panel, near the door handle		
Driver Information Center (DIC) Switch	In the passenger compartment, on the instrument panel, to the right of the instrument panel cluster	Instrument Panel Components	Driver Information Center (DIC) Switch
Electronic Brake Control Module (EBCM)	At the left side of the engine compartment, part of the brake pressure modulator valve, mounted to the back side of the strut tower	Left Front of the Engine Compartment Components	Electronic Brake Control Module (EBCM)
Emergency Vehicle Front Lamp Flasher (6J3)	Under the vehicle, in the right front footwell, mounted to the closeout panel	-	Emergency Vehicle Front Lamp Flasher (6J3)
Emergency Vehicle Headlamp Flasher (6J7)	At the front of the vehicle, at the left side of the right headlamp assembly	Right Headlamp Assembly Components (9C1 or 9C3)	-
Emergency Vehicle Rear Compartment Lid Lamp - Left (T53)	In the rear compartment, on the inside of the rear compartment lid	Rear Compartment Lid Components (9C1 or 9C3)	-
Emergency Vehicle Rear Compartment Lid Lamp - Right (T53)	In the rear compartment, on the inside of the rear compartment lid	Rear Compartment Lid Components (9C1 or 9C3)	-
Emergency Vehicle Rear Compartment Lid Lamp Relay (T53)	In the luggage compartment, at the upper right hand corner of the trunk opening	Luggage Compartment Components (T53)	-
Emergency Vehicle Rear Window Panel Lamp - Left (6J6)	In the rear compartment, on the left side of the package shelf	Package Shelf Components (9C1 or 9C3)	Emergency Vehicle Rear Window Panel Lamp - Left (6J6)
Emergency Vehicle Rear Window Panel Lamp - Right (6J6)	In the rear compartment, on the right side of the package shelf	Package Shelf Components (9C1 or 9C3)	Emergency Vehicle Rear Window Panel Lamp - Right (6J6)
Engine Control Module (ECM)	At the left side of the engine compartment, inside the air cleaner assembly	Left Front of the Engine Compartment Components	• Engine Control Module (ECM) X1 (LFX) • Engine Control Module (ECM) X2 (LFX) • Engine Control Module (ECM) X3 (LFX)

Name	Location	Locator View	Connector End View
Engine Coolant Temperature (ECT) Sensor	In the engine compartment, on the right front side of the cylinder head between exhaust ports 4 and 6	Left Front of Engine Components	Engine Coolant Temperature (ECT) Sensor
Engine Cooling Fan - Left	At the front of the engine compartment, mounted to the left side of the radiator	Engine Compartment Cooling Components	Engine Cooling Fan - Left
Engine Cooling Fan - Right	At the front of the engine compartment, mounted to the right side of the radiator	Engine Compartment Cooling Components	Engine Cooling Fan - Right
Engine Cooling Fan Diode - Left	In the engine compartment, near the Fuse Block - Underhood	-	-
Engine Cooling Fan Diode - Right	In the engine compartment, near the Fuse Block - Underhood	-	-
Engine Oil Pressure (EOP) Sensor	In the engine compartment, right front lower area of the engine, below the generator, above the A/C compressor	Left Front of Engine Components	Engine Oil Pressure (EOP) Switch
Evaporative Emission (EVAP) Canister Purge Solenoid Valve	In the engine compartment, right rear edge of the intake manifold	Right Rear of Engine Components	Evaporative Emission (EVAP) Canister Purge Solenoid Valve
Evaporative Emission (EVAP) Canister Vent Solenoid Valve	Under the vehicle, behind the left rear wheelhouse	Fuel Tank Components	Evaporative Emission (EVAP) Canister Vent Solenoid Valve
Evaporator Temperature Sensor	In the passenger compartment, front left of center, on left side of HVAC assembly	-	Evaporator Temperature Sensor
Fog Lamp - Left Front (T96)	At the front of the vehicle, on left front lower bumper fascia	Front of the Vehicle Components	Fog Lamp - Left Front (T96)
Fog Lamp - Right Front (T96)	At the front of the vehicle, on right front lower bumper fascia	Front of the Vehicle Components	Fog Lamp - Right Front (T96)
Fuel Injector 1	In the engine compartment, top of the engine, at number 1	Top Engine Components	Fuel Injector 1

Name	Location	Locator View	Connector End View
	cylinder intake port, below intake manifold		
Fuel Injector 2	In the engine compartment, top of the engine, at number 2 cylinder intake port, below intake manifold	**Top Engine Components**	**Fuel Injector 2**
Fuel Injector 3	In the engine compartment, top of the engine, at number 3 cylinder intake port, below intake manifold	**Top Engine Components**	**Fuel Injector 3**
Fuel Injector 4	In the engine compartment, top of the engine, at number 4 cylinder intake port, below intake manifold	**Top Engine Components**	**Fuel Injector 4**
Fuel Injector 5	In the engine compartment, top of the engine, at number 5 cylinder intake port, below intake manifold	**Top Engine Components**	**Fuel Injector 5**
Fuel Injector 6	In the engine compartment, top of the engine, at number 6 cylinder intake port, below intake manifold	**Top Engine Components**	**Fuel Injector 6**
Fuel Level Sensor	Under the vehicle, in the fuel tank, part of the Fuel Pump and Sender Assembly	**Fuel Tank Components**	-
Fuel Pressure Sensor	Under the vehicle, on the left hand side, rear of the engine compartment	-	**Fuel Pressure Sensor**
Fuel Pump and Sender Assembly	Under the vehicle, in the fuel tank	**Fuel Tank Components**	**Fuel Pump and Sender Assembly**
Fuel Pump Flow Control Module (Chassis Control Module)	In the luggage compartment, mounted to the rear of the right rear wheelhouse	**Right Side of the Luggage Compartment Components**	**Fuel Pump Flow Control Module**
Fuel Rail Pressure (FRP) Sensor	In the engine compartment, top of the engine, at the fuel rail near fuel injector 1	**Top Engine Components**	**Fuel Rail Pressure (FRP) Sensor**

Name	Location	Locator View	Connector End View
Fuel Tank Pressure (FTP) Sensor	Under the vehicle, at the top of the fuel tank, part of the fuel pump and sender assembly	**Fuel Tank Components**	**Fuel Tank Pressure (FTP) Sensor**
Fuse Block - Auxiliary (9C1 or 9C3)	In the passenger compartment, behind the instrument panel, right of the steering column, above the accelerator pedal	**Instrument Panel Harness Routing- Rear of the Instrument Panel Carrier**	-
Fuse Block - I/P	In the passenger compartment, behind the right front kick panel	**Right Front of the Passenger Compartment Components**	**Electrical Center Identification Views**
Fuse Block - Underhood	At the right side of the engine compartment, mounted to the strut tower	**Right Front of the Engine Compartment Components (1 of 2)**	**Electrical Center Identification Views**
Fusible Link (9C1 or 9C3)	In the passenger compartment, at the fuse block - underhood battery stud	**Instrument Panel Harness Routing- Engine Compartment**	-
Fusible Link (without 6J1)	In the engine compartment, near the starter, between starter and generator	-	-
Garage Door Opener (GDO) (UG1)	In the passenger compartment, front center of the headliner, above the inside rearview mirror, in the headliner console	**Headliner Components**	**Garage Door Opener (UG1)**
Generator	In the engine compartment, top right rear of the engine	**Right Front of the Engine Compartment Components (1 of 2)**	**Generator X1**
Headlamp - Left High Beam	In the left headlamp assembly	**Front of the Vehicle Components**	**Headlamp - Left High Beam**
Headlamp - Left Low Beam	At the front of the vehicle, in the left headlamp assembly	**Front of the Vehicle Components**	**Headlamp - Left Low Beam**
Headlamp - Right High Beam	At the front of the vehicle, in the right headlamp assembly	**Front of the Vehicle Components**	**Headlamp - Right High Beam**

Name	Location	Locator View	Connector End View
Headlamp - Right Low Beam	At the front of the vehicle, in the right headlamp assembly	Front of the Vehicle Components	Headlamp - Right Low Beam
Headlamp Switch	In the passenger compartment, left side of the instrument panel, left of the steering column	Instrument Panel Components	Headlamp Switch
Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 1	In the rear of the engine compartment, in the exhaust pipe near the cylinder head	Oxygen Sensors	Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 1
Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 2	In the rear of the engine compartment, after the catalytic converter	Oxygen Sensors	Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 2
Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 1	In the front of the engine compartment, in the exhaust pipe near the cylinder head	Oxygen Sensors	Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 1
Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 2	In the lower front of the engine compartment, after the catalytic converter	Oxygen Sensors	Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 2
Heated Seat Control Module (KA1)	In the passenger compartment, under the driver seat	Driver Seat Components	• Heated Seat Control Module (KA1) X1 • Heated Seat Control Module (KA1) X2 • Heated Seat Control Module (KA1) X3 • Heated Seat Control Module (KA1) X4
Heated Seat Element - Driver Back (KA1)	In the passenger compartment, under the upholstery of the driver seat back	Driver Seat Components	Heated Seat Element - Driver Back (KA1)
Heated Seat Element - Driver Cushion (KA1)	In the passenger compartment, under the upholstery of the driver seat cushion	Driver Seat Components	Heated Seat Element - Driver Cushion (KA1)
Heated Seat Element - Passenger Back (KA1)	In the passenger compartment, under the upholstery of the passenger seat back	Passenger Seat Components	Heated Seat Element - Passenger Back (KA1)

Name	Location	Locator View	Connector End View
Heated Seat Element - Passenger Cushion (KA1)	In the passenger compartment, under the upholstery of the passenger seat cushion	Passenger Seat Components	Heated Seat Element - Passenger Cushion (KA1)
High Pressure Fuel Pump (LFX)	In the engine compartment, near center middle, at the left rear of the bank 2 cylinder head	Left Front of Engine Components	G18 High Pressure Fuel Pump (LFX)
Hood Ajar Switch (AP3)	In the luggage compartment, part of the hood latch	Under the Hood Latch Trim Panel Components	Hood Ajar Switch (AP3)
Horn Assembly	At the front of the vehicle, behind the front fascia, mounted to the frame rail extension, below the right headlamp	Right Front of the Engine Compartment Components (1 of 2)	Horn Assembly
Horn Switch	In the passenger compartment, in the steering wheel, behind the inflatable restraint steering wheel module	Steering Wheel Components	Horn Switch
HVAC Control Module	In the passenger compartment, center of the instrument panel	Instrument Panel Components	• HVAC Control Module X1 • HVAC Control Module X2
I/P Courtesy Lamp - Left	In the passenger compartment, below the instrument panel, above the left footwell	Below the Instrument Panel Components- Left Front Footwell	I/P Courtesy Lamp - Left
I/P Courtesy Lamp - Right	In the passenger compartment, below the instrument panel, above the right footwell	Below the Instrument Panel Components- Right Front Footwell	I/P Courtesy Lamp - Right
Ignition Coil 1	In the engine compartment, on top of the engine, at cylinder 1	Right Rear of Engine Components	Ignition Coil 1
Ignition Coil 2	In the engine compartment, on top of the engine, at cylinder 2	Left Front of Engine Components	Ignition Coil 2
Ignition Coil 3	In the engine compartment, on top of the engine, at cylinder 3	Right Rear of Engine Components	Ignition Coil 3

Name	Location	Locator View	Connector End View
Ignition Coil 4	In the engine compartment, on top of the engine, at cylinder 4	**Left Front of Engine Components**	**Ignition Coil 4**
Ignition Coil 5	In the engine compartment, on top of the engine, at cylinder 5	**Right Rear of Engine Components**	**Ignition Coil 5**
Ignition Coil 6	In the engine compartment, on top of the engine, at cylinder 6	**Left Front of Engine Components**	**Ignition Coil 6**
Ignition Lock Cylinder Control Actuator (without D55)	In the passenger compartment, right side of the steering column	**In the Steering Column Components**	-
Ignition Switch	In the passenger compartment, right side of the steering column	**In the Steering Column Components**	**Ignition Switch**
Inflatable Restraint Front End Sensor - Left	At the left front of the vehicle, behind the front fascia, left of the hood latch	**Left Front of the Engine Compartment Components**	**Inflatable Restraint Front End Sensor - Left**
Inflatable Restraint Front End Sensor - Right	At the right front of the vehicle, behind the front fascia, right of the hood latch	**Right Front of the Engine Compartment Components (1 of 2)**	**Inflatable Restraint Front End Sensor - Right**
Inflatable Restraint Front Passenger Presence System (PPS) Module	In the passenger compartment, under the front passenger seat	**Passenger Seat Components**	**Inflatable Restraint Front Passenger Presence System (PPS) Module**
Inflatable Restraint Front Passenger Presence System (PPS) Sensor	In the passenger compartment, under the front passenger seat	**Passenger Seat Components**	-
Inflatable Restraint I/P Module	In the passenger compartment, right side of the instrument panel, above the instrument panel compartment	**Instrument Panel Components**	• **Inflatable Restraint I/P Module X1** • **Inflatable Restraint I/P Module X2**
Inflatable Restraint I/P Module Indicator	In the passenger compartment, on the instrument panel, to the right of the instrument panel cluster, above the radio	**Instrument Panel Components**	**Inflatable Restraint I/P Module Indicator**
Inflatable Restraint Roof Rail Module - Left	In the passenger compartment, mounted on	**Roof Rail Components**	**Inflatable Restraint Roof Rail Module - Left**

Name	Location	Locator View	Connector End View
	the left C-pillar, behind the trim		
Inflatable Restraint Roof Rail Module - Right	In the passenger compartment, mounted on the right C-pillar, behind the trim	Roof Rail Components	Inflatable Restraint Roof Rail Module - Right
Inflatable Restraint Sensing and Diagnostic Module (SDM)	In the passenger compartment, under the front passenger seat, under the carpet	Under the Passenger Seat Components	• Inflatable Restraint Sensing and Diagnostic Module (SDM) X1 • Inflatable Restraint Sensing and Diagnostic Module (SDM) X2
Inflatable Restraint Side Impact Module - Left	In the passenger compartment, on the left side of the driver seat back	Front Seat Airbag Components	Inflatable Restraint Side Impact Module - Left
Inflatable Restraint Side Impact Module - Right	In the passenger compartment, on the right side of the front passenger seat back	Front Seat Airbag Components	Inflatable Restraint Side Impact Module - Right
Inflatable Restraint Side Impact Sensor (SIS) - Left	In the passenger compartment, in the driver door	Driver Door Components	Inflatable Restraint Side Impact Sensor (SIS) - Left
Inflatable Restraint Side Impact Sensor (SIS) - Right	In the passenger compartment, in the front passenger door	Passenger Door Components	Inflatable Restraint Side Impact Sensor (SIS) - Right
Inflatable Restraint Steering Wheel Module	In the passenger compartment, in the center of the steering wheel	Near the Steering Column Components	• Inflatable Restraint Steering Wheel Module X1 • Inflatable Restraint Steering Wheel Module X2
Inflatable Restraint Steering Wheel Module Coil	In the passenger compartment, in the steering column, behind the steering wheel	Instrument Panel Components	• Inflatable Restraint Steering Wheel Module X1 • Inflatable Restraint Steering Wheel Module X2
Inline Fuse - Engine Cooling Fan - Left	In the engine compartment, near the Fuse Block - Underhood	-	-

Name	Location	Locator View	Connector End View
Inline Fuse - Engine Cooling Fan - Right	In the engine compartment, near the Fuse Block - Underhood	-	-
Inline Fuse - Generator (6J1)	In the engine compartment, near the starter, between the starter and the generator	-	-
Inside Rearview Mirror (ISRVM)	In the passenger compartment, top center of the windshield	**Above the Windshield Components**	• **Inside Rearview Mirror (DD6 or UE1)** • **Inside Rearview Mirror (without DD6 or UE1)**
Instrument Panel Cluster (IPC)	In the passenger compartment, left side of the instrument panel, above the steering column	**Instrument Panel Components**	**Instrument Panel Cluster (IPC)**
Junction Block - Rear (6J1)	In the rear compartment, behind the right rear wheelhouse	**Right Side of the Luggage Compartment Components**	-
Keyless Entry Antenna	In the passenger compartment, left side of the windshield, along the A-pillar	**Left Side of the Windshield Components**	-
Knock Sensor (KS) 1	In the engine compartment, rear of the engine, below the exhaust manifold, above the transmission	**Right Rear of Engine Components**	**Knock Sensor (KS) 1**
Knock Sensor (KS) 2	In the engine compartment, front of the engine, above the starter	**Left Front of Engine Components**	**Knock Sensor (KS) 2**
License Lamp	At the rear of the vehicle, center of the rear fascia, above the license plate opening	**Rear of the Vehicle Components**	**License Lamp**
Manifold Absolute Pressure (MAP) Sensor	In the engine compartment, rear near center, top left side of the intake manifold, left of the throttle body	**Right Rear of Engine Components**	**Manifold Absolute Pressure (MAP) Sensor**
Mode Actuator	In the passenger compartment, center of the instrument panel, to	**Interior HVAC Components**	**Mode Actuator**

Name	Location	Locator View	Connector End View
	the right of the radio, on the HVAC assembly		
Multifunction Intake Air Sensor	At the left front of the engine compartment, in the air cleaner duct	**Left Front of the Engine Compartment Components**	**Multifunction Intake Air Sensor**
Outside Rearview Mirror - Driver	On the vehicle exterior, upper front of the driver door	**Driver Door Components**	**Outside Rearview Mirror - Driver**
Outside Rearview Mirror - Passenger	On the vehicle exterior, upper front of the front passenger door	**Passenger Door Components**	**Outside Rearview Mirror - Passenger**
Outside Rearview Mirror Switch	In the passenger compartment, on the left front door trim panel	**Driver Door Components**	**Outside Rearview Mirror Switch**
Park Brake Switch	In the passenger compartment, below the left side of the instrument panel, part of the park brake pedal assembly	**Below the Instrument Panel Components- Pedal Assemblies**	**Park Brake Switch**
Park/Turn Signal Lamp - Left	At the front of the vehicle, in the left front headlamp assembly	**Front of the Vehicle Components**	**Park/Turn Signal Lamp - Left**
Park/Turn Signal Lamp - Right	At the front of the vehicle, in the right front headlamp assembly	**Front of the Vehicle Components**	**Park/Turn Signal Lamp - Right**
Pressure Control (PC) Solenoid Valve 1	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-
Pressure Control (PC) Solenoid Valve 2	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-
Pressure Control (PC) Solenoid Valve 3	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-

Name	Location	Locator View	Connector End View
Pressure Control (PC) Solenoid Valve 4	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	Automatic Transmission Electronic Components	-
Pressure Control (PC) Solenoid Valve 5	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	Automatic Transmission Electronic Components	-
Radio	In the passenger compartment, center of the instrument panel	Instrument Panel Components	• Radio X1 • Radio X2
Radio Antenna Module	In the passenger compartment, left of the back window	Above the Rear Seat Components	Radio Antenna Module
Radio Rear Window Antenna	At the rear of the vehicle, attached to the top of the rear window, above the rear window defogger grid	Rear of the Vehicle Components	-
Reading Lamp - Auxiliary (6C7)	In the passenger compartment, center of the roof, forward of the dome lamp	Headliner Components (9C1 or 9C3)	Reading Lamp - Auxiliary (6C7)
Rear Compartment Courtesy Lamp	In the rear compartment, in the rear deck, below the center of the rear window panel	Under the Rear Package Shelf Components	Rear Compartment Courtesy Lamp
Rear Compartment Lid Latch Release Actuator	In the rear compartment, mounted to the rear center of the deck lid, on the lid latch	Rear Center Deck Lid Components	-
Rear Window Defogger Grid	At the rear of the vehicle, on the inside rear window glass	Rear of the Vehicle Components	• Rear Window Defogger Grid X1 • Rear Window Defogger Grid X2
Recirculation Actuator	In the passenger compartment, back of the instrument panel compartment, on the	Interior HVAC Components	Recirculation Actuator

Name	Location	Locator View	Connector End View
	upper HVAC case, near the right A-pillar		
Remote Control Door Lock Receiver (RCDLR)	In the passenger compartment, on the upper center of the instrument panel, under the defroster grille panel	**Behind the Instrument Panel Components**	**Remote Control Door Lock Receiver (RCDLR)**
Seat Adjuster Motor Assembly - Driver (AG1 or AH5)	In the passenger compartment, below the driver seat	**Driver Seat Components**	**Seat Adjuster Motor Assembly - Driver (AG1, AH5)**
Seat Adjuster Motor Assembly - Passenger (AG2)	In the passenger compartment, below the front passenger seat	**Passenger Seat Components**	**Seat Adjuster Motor Assembly - Passenger (AG2)**
Seat Adjuster Switch - Driver (AG1 or AH5)	In the passenger compartment, left side of the driver seat cushion	**Driver Seat Components**	• **Seat Adjuster Switch - Driver (AG1)** • **Seat Adjuster Switch - Driver (AH5)**
Seat Adjuster Switch - Passenger (AG2)	In the passenger compartment, right side of the front passenger seat cushion	**Passenger Seat Components**	**Seat Adjuster Switch - Passenger (AG2)**
Seat Belt Pretensioner - Driver	In the passenger compartment, mounted to the left side of the driver seat, under the seat cushion	-	**Seat Belt Pretensioner - Driver**
Seat Belt Pretensioner - Passenger	In the passenger compartment, mounted to the right side of the passenger seat, under the seat cushion	-	**Seat Belt Pretensioner - Passenger**
Seat Belt Retractor Pretensioner - Driver	In the passenger compartment, mounted to the left front retractor, at the base of the B-pillar	**Left B-Pillar Components**	**Seat Belt Retractor Pretensioner - Driver**
Seat Belt Retractor Pretensioner - Passenger	In the passenger compartment, mounted to the right front retractor, at the base of the B-pillar	**Right B-Pillar Components**	**Seat Belt Retractor Pretensioner - Passenger**
Seat Belt Switch - Driver	In the passenger compartment, inside the driver seat belt buckle	-	**Seat Belt Switch - Driver**

Name	Location	Locator View	Connector End View
Seat Belt Switch - Passenger	In the passenger compartment, inside the front passenger seat belt buckle	**Passenger Seat Components**	**Seat Belt Switch - Passenger**
Seat Recline Motor - Driver (AH5)	In the passenger compartment, attached to the right side of the driver seat back	**Driver Seat Components**	**Seat Recline Motor - Driver (AH5)**
Secondary Air Injection (AIR) Pump (NU5 or NU6)	At the left front of the engine compartment, above the starter, near G111	**Left Front of the Engine Compartment Components (NU5 or NU6)**	**Secondary Air Injection (AIR) Pump (NU5/NU6)**
Secondary Air Injection (AIR) Pump Relay (NU5 or NU6)	In the engine compartment, near the mass air flow/intake air temperature sensor	**Left Front of the Engine Compartment Components (NU5 or NU6)**	**Secondary Air Injection (AIR) Pump Relay (NU5/NU6)**
Secondary Air Injection (AIR) Pump Solenoid (NU5 or NU6)	In the engine compartment, near the ignition control module	**Left Front of the Engine Compartment Components (NU5 or NU6)**	**Secondary Air Injection (AIR) Pump Solenoid Bank 1 (NU5/NU6)**
Secondary Air Injection (AIR) Pump Solenoid Relay (NU5 or NU6)	In the engine compartment, near the mass air flow/intake air temperature sensor	**Left Front of the Engine Compartment Components (NU5 or NU6)**	**Secondary Air Injection (AIR) Pump Solenoid Relay (NU5/NU6)**
Shift Solenoid (SS) Valve 1	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-
Shift Solenoid (SS) Valve 2	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-
Side Marker Lamp - Left Front	At the front of the vehicle, in the left front headlamp assembly	**Front of the Vehicle Components**	**Side Marker Lamp - Left Front**

Name	Location	Locator View	Connector End View
Side Marker Lamp - Right Front	At the front of the vehicle, in the right front headlamp assembly	Front of the Vehicle Components	Side Marker Lamp - Right Front
Speaker - Left Front	In the passenger compartment, lower front of the driver door trim panel	Radio and Speaker Components	Speaker - Left Front
Speaker - Left Front Tweeter (UQ3)	In the passenger compartment, on the left front A-pillar	Left A-Pillar Components	Speaker - Left Front Tweeter
Speaker - Left Rear	In the rear compartment, mounted in the left side of the rear package shelf	Radio and Speaker Components	• Speaker - Left Rear (UW6) • Speaker - Left Rear (UQ3)
Speaker - Right Front	In the passenger compartment, lower front of the front passenger door trim panel	Radio and Speaker Components	Speaker - Right Front
Speaker - Right Front Tweeter (UQ3)	In the passenger compartment, on the right front A-pillar	Right A-Pillar Components	Speaker - Right Front Tweeter
Speaker - Right Rear	In the rear compartment, mounted in the right side of the rear package shelf	Radio and Speaker Components	• Speaker - Right Rear (UW6) • Speaker - Right Rear (UQ3)
Spot Lamp - Left (7X6 or 7X7)	In the passenger compartment, on the left A-pillar	A-Pillar Components (9C1 or 9C3)	-
Spot Lamp - Right (7X7)	In the passenger compartment, on the right A-pillar	A-Pillar Components (9C1 or 9C3)	Spot Lamp - Right (7X7)
Starter Motor	In the engine compartment, lower front of the engine, facing the radiator, at the transmission	Left Front of Engine Components	Starter X2
Steering Angle Sensor	In the passenger compartment, at the base of the steering column	-	Steering Angle Sensor
Steering Wheel Control Switch - Left (UK3)	In the passenger compartment, on the left side of the steering wheel	Steering Wheel Components	Steering Wheel Control Switch - Left

Name	Location	Locator View	Connector End View
Steering Wheel Control Switch - Right	In the passenger compartment, on the right side of the steering wheel	**Steering Wheel Components**	**Steering Wheel Control Switch - Right (UK3)**
Sunroof Control Module (CF5)	In the passenger compartment, front center of the sunroof module, above the windshield header panel, under the headliner	**Headliner Components- Top View**	**Sunroof Control Module (CF5)**
Sunroof Switch (CF5)	In the passenger compartment, front center of the headliner, above the inside rearview mirror	**Headliner Components**	**Sunroof Switch (CF5)**
Sunshade - Left (DH6)	In the passenger compartment, mounted in the sunshade, on the left side of the windshield header	**Above the Windshield Components**	**Sunshade - Left (DH6)**
Sunshade - Right (DH6)	In the passenger compartment, mounted in the sunshade, on the right side of the windshield header	**Above the Windshield Components**	**Sunshade - Right (DH6)**
Tail Lamp - Left	At the rear of the vehicle, in the left tail lamp assembly	**Rear of the Vehicle Components**	**Tail Lamp - Left**
Tail Lamp - Right	At the rear of the vehicle, in the right tail lamp assembly	**Rear of the Vehicle Components**	**Tail Lamp - Right**
Tail/Stop and Turn Signal Lamp - Left	At the rear of the vehicle, in the left tail lamp assembly	**Rear of the Vehicle Components**	**Tail/Stop and Turn Signal Lamp - Left**
Tail/Stop and Turn Signal Lamp - Right	At the rear of the vehicle, in the right tail lamp assembly	**Rear of the Vehicle Components**	**Tail/Stop and Turn Signal Lamp - Right**
Theft Deterrent Module (TDM)	In the passenger compartment, around the ignition key cylinder housing	**In the Steering Column Components**	**Theft Deterrent Module (TDM)**
Throttle Body	In the engine compartment, top of the engine, at the intake manifold inlet	**Right Rear of Engine Components**	**Q38 Throttle Body (LFR/LFX)**

Name	Location	Locator View	Connector End View
Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Valve	In the engine compartment, left front lower, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-
Transmission Control Module (TCM)	In the engine compartment, left front lower, inside the front of the automatic transmission, part of the control solenoid valve assembly	**Left Front of the Engine Compartment Components**	-
Turn Signal/Multifunction Switch	In the passenger compartment, inside the steering column, below the inflatable restraint steering wheel module coil, on the left side	**Instrument Panel Components**	• **Turn Signal/Multifunction Switch X1** • **Turn Signal/Multifunction Switch X2** • **Turn Signal/Multifunction Switch X3**
Vehicle Communication Interface Module (VCIM) (UE1)	In the rear compartment, mounted to the rear of the left rear wheelhouse	**Left Side of the Luggage Compartment Components**	• **Vehicle Communication Interface Module (VCIM) (UE1) X1** • **Vehicle Communication Interface Module (VCIM) (UE1) X2**
Vehicle Communication Interface Module (VCIM) Battery (UE1)	At the left side of the rear compartment, attached to the side of the vehicle communication interface module	**Left Side of the Luggage Compartment Components**	**Vehicle Communication Interface Module (VCIM) Battery (UE1)**
Wheel Speed Sensor (WSS) - Left Front	Under the vehicle, inside the left front wheel hub	**Front Wheel Components**	**Wheel Speed Sensor (WSS) - Left Front**
Wheel Speed Sensor (WSS) - Left Rear	Under the vehicle, inside the left rear wheel hub	**Rear Wheel Components**	**Wheel Speed Sensor (WSS) - Left Rear**
Wheel Speed Sensor (WSS) - Right Front	Under the vehicle, inside the right front wheel hub	**Front Wheel Components**	**Wheel Speed Sensor (WSS) - Right Front**
Wheel Speed Sensor (WSS) - Right Rear	Under the vehicle, inside the right rear wheel hub	**Rear Wheel Components**	**Wheel Speed Sensor (WSS) - Right Rear**

Name	Location	Locator View	Connector End View
Window Motor - Driver	In the passenger compartment, center of the driver door, behind the door panel	Driver Door Components	Window Motor - Driver
Window Motor - Left Rear	In the passenger compartment, center of the left rear door, behind the door panel	Left Rear Door Harness Routing	Window Motor - Left Rear
Window Motor - Passenger	In the passenger compartment, center of the front passenger door, behind the door panel	Passenger Door Components	Window Motor - Passenger
Window Motor - Right Rear	In the passenger compartment, center of the right rear door, behind the door panel	Right Rear Door Harness Routing	Window Motor - Right Rear
Window Switch - Driver	In the passenger compartment, center of the driver door trim panel	Driver Door Components	• Window Switch - Driver X1 • Window Switch - Driver X2
Window Switch - Left Rear	In the passenger compartment, in the left rear inside door handle trim bezel	Left Rear Door Components	Window Switch - Left Rear
Window Switch - Passenger	In the passenger compartment, center of the front passenger door trim panel	Passenger Door Components	Window Switch - Passenger
Window Switch - Right Rear	In the passenger compartment, in the right rear inside door handle trim bezel	Right Rear Door Components	Window Switch - Right Rear
Windshield Washer Fluid Level Switch	At the right side of the engine compartment, in the lower portion of washer fluid container	Right Front of the Engine Compartment Components (1 of 2)	Windshield Washer Fluid Level Switch
Windshield Washer Fluid Pump	At the right side of the engine compartment, in the lower portion of washer fluid container	Right Front of the Engine Compartment Components (1 of 2)	Windshield Washer Fluid Pump
Windshield Wiper Motor	In the engine compartment, in the left side cowl panel, below	Left Front of the Engine Compartment	Windshield Wiper Motor

Name	Location	Locator View	Connector End View
	the air inlet screen	Components	
Yaw and Lateral Accelerometer Sensor	In the passenger compartment, mounted on the floor under the center console	-	Yaw and Lateral Accelerometer Sensor
X101 (10 cavities)	Instrument panel harness to engine harness, left rear of the engine compartment, near the brake booster, bolted to the left strut tower, next to X111	Engine Harness Routing - Left Rear	X101 I/P Harness to Engine Harness
X105 (2 cavities)	Instrument panel harness to battery cable harness, forward of the right front strut tower	Battery Cable Harness Routing (Typical)	X105 Battery Harness to I/P Harness
X111 (14 cavities)	Instrument panel harness to engine harness, left rear of the engine compartment, near the brake booster, bolted to the left strut tower, next to X101	Engine Harness Routing - Left Rear	X111 I/P Harness to Engine Harness
X115 (14 cavities)	Engine harness to instrument panel harness, left rear of the engine compartment, on the left strut tower	Engine Harness Routing - Left Rear	X115 Engine Harness to Instrument Panel Harness
X120 (10 cavities)	Instrument panel harness to forward lamp harness, left side of the engine compartment, behind the left headlamp assembly, on the frame	Forward Lamp Harness Routing	X120 I/P Harness to Forward Lamp Harness
X122 (6 cavities) (9C1 or 9C3 without 6J7)	Forward lamp harness to forward lamp harness, at the left side of the right headlamp assembly	Forward Lamp Harness Routing	X122 Forward Lamp Harness to Forward Lamp Harness (9C1/9C3 without 6J7)
X123 (4 cavities) (9C1 or 9C3)	Instrument panel harness to grille lamp jumper harness, forward of the right front strut tower	Instrument Panel Harness Routing- Engine Compartment	X123 I/P Harness to the Grille Lamp Jumper Harness (6J3)
X141 (5 cavities)	Forward lamp harness to left headlamp harness, behind the left headlamp	Forward Lamp Harness Routing	X141 Forward Lamp Harness to Left Front Headlamp Assembly Harness

Name	Location	Locator View	Connector End View
	assembly		
X142 (5 cavities)	Forward lamp harness to right headlamp harness, behind the right headlamp assembly	**Forward Lamp Harness Routing**	**X142 Forward Lamp Harness to Right Front Headlamp Assembly Harness**
X160 (12 cavities)	Engine harness to even fuel injector harness, top right left of the engine	**Engine Harness Routing - Left Rear**	**X160 Engine Harness to Even Fuel Injector Harness**
X161 (6 cavities)	Engine harness to odd fuel injector harness, top left side of engine, next to X160	**Engine Harness Routing - Left Rear**	**X161 Engine Harness to Odd Fuel Injector Harness**
X200 (40 cavities)	Body harness to instrument panel harness, behind the right front kick panel, below the instrument panel fuse panel	**Instrument Panel Harness Routing**	**X200 Body Harness to I/P Harness**
X201 (10 cavities)	Steering column harness to instrument panel harness, behind the knee bolster, to the right of the steering column	**Instrument Panel Harness Routing**	**X201 Steering Column Harness to I/P Harness**
X203 (22 cavities)	Body harness to instrument panel harness, behind the knee bolster, to the left of the steering column, behind the left instrument panel access panel, near X250	**Instrument Panel Harness Routing**	**X203 I/P Harness to Body Harness**
X208 (9C1 or 9C3)	SEO auxiliary harness to body harness, in the right front footwell	-	**X208 SEO Auxiliary Harness to Body Harness (9C1, 9C3)**
X210 (2 cavities)	Instrument panel harness to HVAC harness, on the right side of the HVAC module assembly	**HVAC Module Harness Routing**	**X210 I/P Harness to HVAC Harness**
X223 (2 cavities) (9C1 or 9C3)	Instrument panel harness to instrument panel harness, under the right side of the instrument panel, in the rear stop/turn signal supply circuits, near G301	**Left Front of the Passenger Compartment Components**	**X223 I/P Harness to I/P Harness (6J6)**

Name	Location	Locator View	Connector End View
X250 (4 cavities)	Inflatable restraint steering wheel module coil wiring harness to the body wiring harness, near X203, behind the left instrument panel access panel	**Instrument Panel Harness Routing- Lower Left**	**X250 SIR Coil to the Body Harness**
X266 (1 cavity) (6J4)	Instrument panel harness to instrument panel harness, above the right front footwell, in the horn control circuit	**Instrument Panel Harness Routing**	**X266 I/P Harness to I/P Harness (6J4)**
X268 (8 cavities) (9C1 or 9C3)	Instrument panel harness to C267B, above the right front footwell	-	**X268 I/P Harness to I/P Harness (9C1, 9C3 with WX7)**
X268 (8 cavities) (WX7)	Instrument panel harness to WX7 speaker jumper harness, above the right front footwell	-	-
X269 (8 cavities) (9C1 or 9C3)	Instrument panel harness to C267A, above the right front footwell	-	**X269 I/P Harness to I/P Harness (9C1, 9C3 with WX7)**
X269 (8 cavities) (WX7)	Instrument panel harness to WX7 speaker jumper harness, above the right front footwell	-	-
X275 (8 cavities)	Inflatable restraint steering wheel module coil harness to steering column harness, on the steering column, near the knee bolster, taped to the steering column harness	-	• **X275 SIR Coil to Steering Column Harness** • **X277 SIR Coil to Steering Column Harness**
X277 (8 cavities)	Inflatable restraint steering wheel module coil harness to steering wheel harness, behind the inflatable restraint steering wheel module	**Instrument Panel Harness Routing- Lower Left**	-
X278 (4 cavities)	Inflatable restraint instrument panel module jumper harness to body harness, behind the right instrument panel access panel	**Right Front of the Passenger Compartment Components**	**X278 Inflatable Restraint I/P Module Jumper Harness to the Body Harness**

Name	Location	Locator View	Connector End View
X297 (6 cavities) (9C1 or 9C3)	Instrument panel harness to emergency vehicle front lamps flasher harness, above the right front footwell	Instrument Panel Harness Routing	X297 I/P Harness to Grille Lamp Jumper Harness (9C1, 9C3, 6J3)
X303 (1 cavity)	Instrument panel harness to body harness, COAX connector at the right front door sill, next to G302, under the carpet	Right Front of the Passenger Compartment Components	-
X311 (12 cavities)	Body harness to driver seat harness, below the driver seat	Body Harness Routing- Left Front Passenger Compartment	X311 Body Harness to Left Front Seat Harness
X313 (12 cavities)	Body harness to front passenger seat harness, below the front passenger seat	Body Harness Routing- Right Front Passenger Compartment	X313 Body Harness to Right Front Seat Harness
X315 (4 cavities)	Driver seat harness to body harness, below the driver seat	Seat Harness Routing- Airbags and Inlines	X315 Left Front Seat Harness to Body Harness
X316 (4 cavities)	Passenger seat harness to body harness, below the passenger seat	Seat Harness Routing- Airbags and Inlines	X316 Right Front Seat Harness to Body Harness
X322 (2 cavities) (9C1 or 9C3)	Body harness to roof provision harness, in the rear compartment, near the right C-pillar	Body Harness Routing- Rear Passenger Compartment	X322 Body Harness to Roof Provision Harness (9C1, 9C3)
X340 (2 cavities) (D55)	Console harness to body harness, below the center floor console, on the left side of the floor shifter	Body Harness Routing- Left Front Passenger Compartment	X340 Console Harness to Body Harness (D55)
X340 (2 cavities) (without D55)	Body harness to auxiliary power outlet seat jumper harness, under the center of the front seat	-	X340 Body Harness to Console Harness (without D55)
X360 (1 cavity) (9C1 or 9C3)	Body harness to instrument panel harness, right side of the instrument panel, near X200	Body Harness Routing- Right Front Passenger Compartment	X360 Body Harness to I/P Harness (9C1, 9C3)
X362 (1 cavity) (9C1 or 9C3)	Body harness to instrument panel harness, right side of the instrument panel, near	G200, G201, G202, and G204	X362 Body Harness to I/P Harness (9C1, 9C3)

Name	Location	Locator View	Connector End View
	X200		
X398 (6 cavities) (CF5)	Roof harness to sunroof harness, near the right front corner of the sunroof, under the headliner, above the sunshade	Sunroof and Headliner Harness Routing	X398 Roof Harness to Sunroof Harness (CF5)
X401 (4 cavities)	Rear body harness to left tail lamp harness, below the left tail lamp assembly	Rear Fascia Harness Routing	X401 Rear Body Harness to Left Tail Lamp Harness
X402 (4 cavities)	Rear body harness to right tail lamp harness, below the right tail lamp assembly	Body Harness Routing- Rear Passenger Compartment	X402 Rear Body Harness to Right Tail Lamp Harness
X405 (16 cavities)	Rear chassis harness to body harness, forward and to the right of the spare tire well	Body Harness Routing- Rear Passenger Compartment	X405 Rear Chassis Harness to Body Harness
X406 (8 cavities)	Body harness to rear body harness, in the rear compartment, below the right tail lamp assembly, clipped on the bumper fascia	Body Harness Routing- Rear Passenger Compartment	X406 Body Harness to Rear Body Harness
X409 (2 cavities) (T53)	Emergency vehicle rear compartment lid lamps harness to body harness, between the center high mounted stop lamp and the junction block - rear	Body Harness Routing- Rear Passenger Compartment	X409 Emergency Vehicle Rear Compartment Lid Lamps Harness to Body Harness (9C1, 9C3)
X490 (18 cavities)	Headliner harness to body harness, under the left side of the rear package shelf trim panel	Sunroof and Headliner Harness Routing	X490 Headliner Harness to Body Harness
X500 (40 cavities)	Body harness to left front door harness, below the A-pillar, between the door hinges	Body Harness Routing- Left Front Passenger Compartment	X500 Body Harness to Left Front Door Harness
X503 (40 cavities)	Driver door harness to driver door trim harness, in the driver door, near the speaker - left front door	Driver Door Harness Routing	X503 Left Front Door Harness to Left Front Door Trim Harness

Name	Location	Locator View	Connector End View
X600 (40 cavities)	Body harness to right front door harness, below the A-pillar, between the door hinges	**Body Harness Routing- Right Front Passenger Compartment**	**X600 Body Harness to Right Front Door Harness**
X604 (10 cavities)	Front passenger door trim harness to front passenger door harness, near the speaker - right front	**Passenger Door Harness Routing**	**X604 Right Front Door Trim Harness to Right Front Door Harness**
X700 (9 cavities)	Body harness to left rear door harness, center of the left B-pillar	**Body Harness Routing- Left Front Passenger Compartment**	**X700 Body Harness to Left Rear Door Harness**
X800 (9 cavities)	Body harness to right rear door harness, center of the right B-pillar	**Body Harness Routing- Right Front Passenger Compartment**	**X800 Body Harness to Right Rear Door Harness**
G100	(CKTs 250, 1250) On the forward lamp harness, in back of the right headlamp assembly, on the frame	**Right Front of the Engine Compartment Components (1 of 2)**	-
G101	(CKT 1350) On the forward lamp harness, in back of the left headlamp assembly, on the frame	**G101**	-
G102	(CKT 50) Near the battery, in back of the right headlamp assembly, on the frame	**G102**	-
G111	(CKTs 51, 451) In the engine compartment, near front middle, below starter motor	**G111, G113 and G115**	-
G113	(CKT 51,1050) In the engine compartment, near front right, on the engine block, below oil filter	**G111, G113 and G115**	-
G115	(CKT 251, 350) On the transmission case, below the brake booster	**G111, G113 and G115**	-
G200	(CKT 150) Front of the instrument panel carrier, above the instrument panel compartment, to the left of the inflatable	**G200, G201, G202, and G204**	-

Name	Location	Locator View	Connector End View
	restraint instrument panel module		
G201	(CKT 1450) Front of the instrument panel carrier, behind the knee bolster, on the right side of the steering column, above G202	**G200, G201, G202, and G204**	-
G202	(CKTs 351, 1551) Front of the instrument panel carrier, behind the knee bolster, on the right side of the steering column, below G201	**G200, G201, G202, and G204**	-
G204 (9C1 or 9C3)	(CKT 2350) Right side of the instrument panel carrier, to the left of the inflatable restraint instrument panel module, next to G200	**G200, G201, G202, and G204**	-
G301	(CKT 550) Below the driver door opening, rear of the left A-pillar	**G301**	-
G302	(CKTs 750, 1751) Below the passenger front door opening, rear of the right A-pillar	**G302**	-
G303	COAX capacitance ground for the remote control door lock receiver windshield antenna, near the top of the left A-pillar, behind the trim panel	-	-
G403	(CKTs 1150, 1351) On the left side of the package shelf, near the C-pillar	**G403 and G404**	-
G404	(CKT 851) On the right side of the package shelf, near the C-pillar	**G403 and G404**	-
J100	In the engine harness, in the engine compartment, on branch to front of engine	**Engine Harness Routing - Right Front**	-

Name	Location	Locator View	Connector End View
J101	(CKT 451) Engine harness, in the engine compartment, front near middle, in main bundle between branch to ECM and branch to ECT	**Engine Harness Routing - Right Front**	-
J102	(CKT 17) Engine harness, in the engine compartment, front left on branch to ECM	**Engine Harness Routing - Right Front**	-
J103	Engine harness, in the engine compartment, front right, in branch on front of engine, near generator	**Engine Harness Routing - Right Front**	-
J109	Engine Harness, In the engine compartment, in the main bundle on left side of engine above transmission	**Engine Harness Routing - Left Rear**	-
J110	(CKT 51) In Engine Harness, In the engine compartment, in the main bundle on left side of engine above transmission	**Engine Harness Routing - Left Rear**	-
J124	(CKT 1250) On the forward lamp harness, behind the right headlamp, approximately 8 cm (3.2 in) from the breakout to G100, toward the inflatable restraint front end sensor - right	**Forward Lamp Harness Routing**	-
J126	(CKT 1250) On the right head lamp assembly harness	-	-
J127	(CKT 1350) On the left head lamp assembly harness	-	-
J128	(CKT 1250) On the right headlamp harness	-	-
J129	(CKT 1350) On the left headlamp harness	-	-

Name	Location	Locator View	Connector End View
J162	Engine Harness, In the engine compartment, rear near middle, in the main bundle between ignition coil 5 and fuel injector inlines	**Engine Harness Routing - Left Rear**	-
J163	Engine Harness, In the engine compartment, rear near middle, in the main bundle between ignition coil 5 and ignition coil 3	**Engine Harness Routing - Left Rear**	-
J164	Engine Harness, In the engine compartment, right front in the main bundle on front of the engine, between ignition coil 2 and camshaft sensors and actuators	**Engine Harness Routing - Right Front**	-
J165	Engine Harness, In the engine compartment, front near middle, in the main bundle on front of the engine, between ignition coil 6 and breakout to ECT	**Engine Harness Routing - Right Front**	-
J175	Engine Harness, In the engine compartment, in the main bundle on left side of engine above transmission	**Engine Harness Routing - Left Rear**	-
J195	(CKT 335) Located where the engine harness and cooling fan jumper harness meet	-	-
J196	(CKT 504) Located where the Engine Cooling Fan - Left and cooling fan jumper harness meet	-	-
J197	(CKT 532) Located where the Engine Cooling Fan - Left and cooling fan jumper harness meet	-	-
J198	(CKT 473) Located where the engine harness and cooling fan jumper	-	-

Name	Location	Locator View	Connector End View
	harness meet		
J199	(CKT 409) Located where the Engine Cooling Fan - Right and cooling fan jumper harness meet	-	-
J204	(CKT 4) On the steering column harness, between the body control module connector X1 and the ignition switch	-	-
J213 (UK3)	(CKT 1375) On the steering wheel harness, behind the inflatable restraint steering wheel module	-	-
J214	(CKT 1551) On the steering column harness, between X201 and the turn signal/multifunction switch	-	-
J215	(CKT 1450) In the steering wheel harness, behind the inflatable restraint steering wheel module	-	-
J231	(CKT 750) On the floor console harness, approximately 12 cm (4.75 in) from the breakout to the auxiliary power outlet - front 1, towards X340	-	-
J238	(CKT 1940) On the floor console harness, approximately 5 cm (2 in) from the breakout to X340, towards the auxiliary power outlet - front 1	-	-
J250 (9C1 or 9C3)	(CKT 502) Instrument panel harness, rear of the instrument panel carrier, approximately 15.5 cm (6.25 in) from the third breakout from the brake	**Instrument Panel Harness Routing-Splices**	-

Name	Location	Locator View	Connector End View
	pedal position sensor, toward X200		
J277	(CKT 7005) On the steering wheel harness	-	-
J303	(CKT 550) Body harness, approximately 8.5 cm (3.5 in) from the breakout to X311, toward G301	**Body Harness Routing- Passenger Compartment Splices**	-
J307	(CKT 1307) On the body harness, approximately 16.5 cm (6.5 in) from the breakout to X301, toward G301	**Body Harness Routing- Passenger Compartment Splices**	-
J308	(CKT 8) Body harness, approximately 14 cm (5.5 in) from the breakout to G301, toward X355	**Body Harness Routing- Passenger Compartment Splices**	-
J311	(CKT 1140) Body harness, approximately 10 cm (4 in) from the second breakout from X302, toward X200	-	-
J314	(CKT 294) On the body harness, approximately 16 cm (6.5 in) from the breakout to X313, toward G302	**Body Harness Routing- Passenger Compartment Splices**	-
J315	(CKT 295) On the body harness, approximately 5 cm (2 in) from the breakout to X313, toward G302	**Body Harness Routing- Passenger Compartment Splices**	-
J324	(CKT 24) On the body harness, approximately 24 cm (9.5 in) from the breakout to X405, toward X356	**Body Harness Routing- Rear Passenger Compartment**	-
J350	(CKT 5060) On the body harness, approximately 14.5 cm (5.75 in) from the breakout to G302, toward X356	**Body Harness Routing- Passenger Compartment Splices**	-
J359	(CKT 5922) On the body harness, approximately 24 cm (9.5 in) from the	**Body Harness Routing- Passenger Compartment**	-

Name	Location	Locator View	Connector End View
	breakout to X311, toward X313	**Splices**	
J364	(CKT 643) On the roof harness, approximately 10 cm (4 in) from the breakout to X398, toward the dome lamp	**Sunroof and Headliner Harness Routing**	-
J375	(CKT 750) On the body harness, approximately 30.5 cm (12.5 in) from the breakout to the seat belt pretensioner - right, toward G302	**Body Harness Routing- Passenger Compartment Splices**	-
J390	(CKT 550) On the roof harness, approximately 53 cm (21 in) from the breakout to the dome lamp, toward the inside rearview mirror	**Sunroof and Headliner Harness Routing**	-
J393	(CKT 1732) On the roof harness, approximately 38 cm (15.25 in) from the breakout to the dome lamp, toward the inside rearview mirror	**Sunroof and Headliner Harness Routing**	-
J417	(CKT 1732) On the body harness, approximately 32 cm (12.75 in) from the breakout to the seatbelt pretensioner - left, toward G301	-	-
J430	(CKT 309) On the rear body harness, approximately 14 cm (5.5 in) from the breakout to the license lamp - right, toward X406	-	-
J474 (9C1 or 9C3)	(CKT 744) On the body harness, approximately 45.5 cm (18 in) from the breakout to X409, toward the junction block - rear	-	-
J485	(CKT 850) On the rear body harness, approximately 24 cm (9.5	-	-

Name	Location	Locator View	Connector End View
	in) from the breakout to the license lamp, toward X406		
J504	(CKT 550) On the driver door trim harness, approximately 4.5 cm (1.75 in) from the breakout to the window switch, toward the door lock switch - driver	**Driver Door Harness Routing**	-
J505	(CKT 550) On the driver door harness, approximately 18.5 cm (7.25 in) from the breakout to the speaker - left front door, toward the window motor - driver	**Driver Door Harness Routing**	-
J506	(CKT 8) On the driver door trim harness, approximately 11 cm (4.25 in) from the breakout to the window switch, toward the door lock switch - driver	**Driver Door Harness Routing**	-
J604	(CKT 750) On the front passenger door harness, approximately 6 cm (2.5 in) from the breakout to the speaker - right front door, toward the window motor - front passenger	**Passenger Door Harness Routing**	-
J608	(CKT 8) On the front passenger door trim harness, approximately 6.5 cm (2.5 in) from the window switch - front passenger, toward the door lock switch - front passenger	**Passenger Door Harness Routing**	-
JX205	Clipped to the inner instrument panel structure, to the right of the steering column	**Instrument Panel Harness Routing**	**JX205**
JX206	On the instrument panel harness, near the steering	**Instrument Panel Harness Routing**	**JX206**

Name	Location	Locator View	Connector End View
	column		
JX207	On the instrument panel harness, near the steering column	**Instrument Panel Harness Routing**	**JX207**

Article GUID: A00737225

PASSENGER COMPARTMENT/ROOF COMPONENT VIEWS

LEFT FRONT OF THE PASSENGER COMPARTMENT COMPONENTS

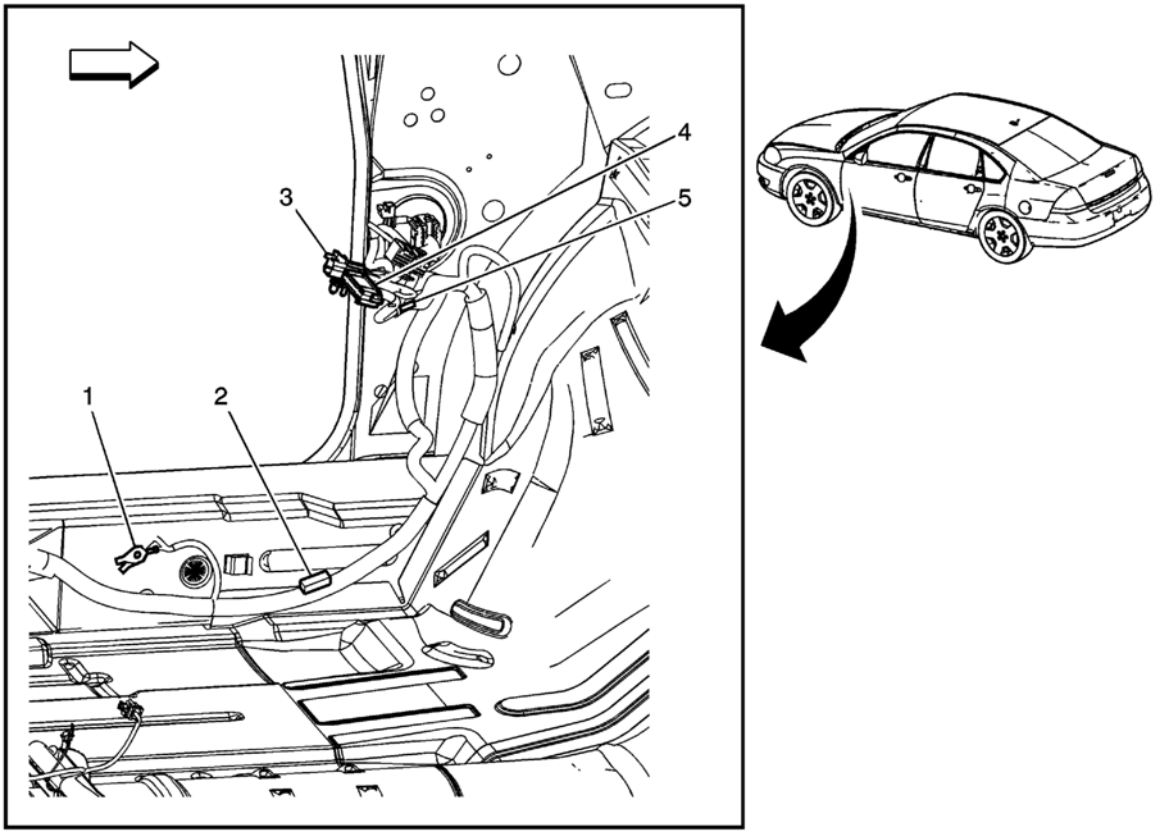


Fig. 1: Left Front of the Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	G301
2	X223- Taped to Harness (9C1 or 9C3)
3	X250
4	X203
5	Data Link Resistor- Taped to Harness (without UE1)

RIGHT FRONT OF THE PASSENGER COMPARTMENT COMPONENTS

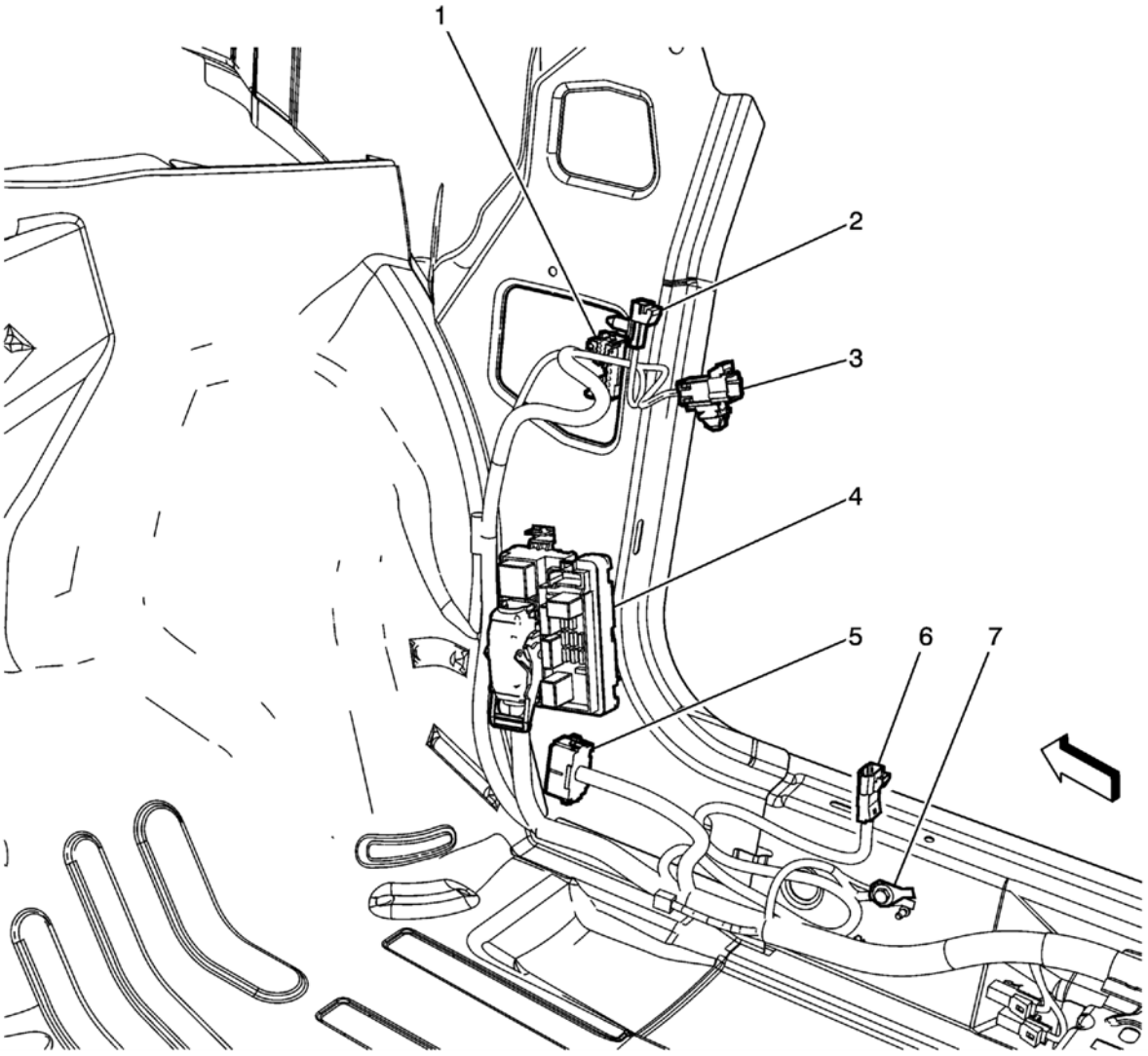


Fig. 2: Right Front of the Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X600
2	Speaker- Right Front Tweeter Connector (UQ3)
3	X278
4	Fuse Block- I/P
5	X200
6	X303
7	G302

CENTER SEAT COMPONENTS (WITHOUT D55)

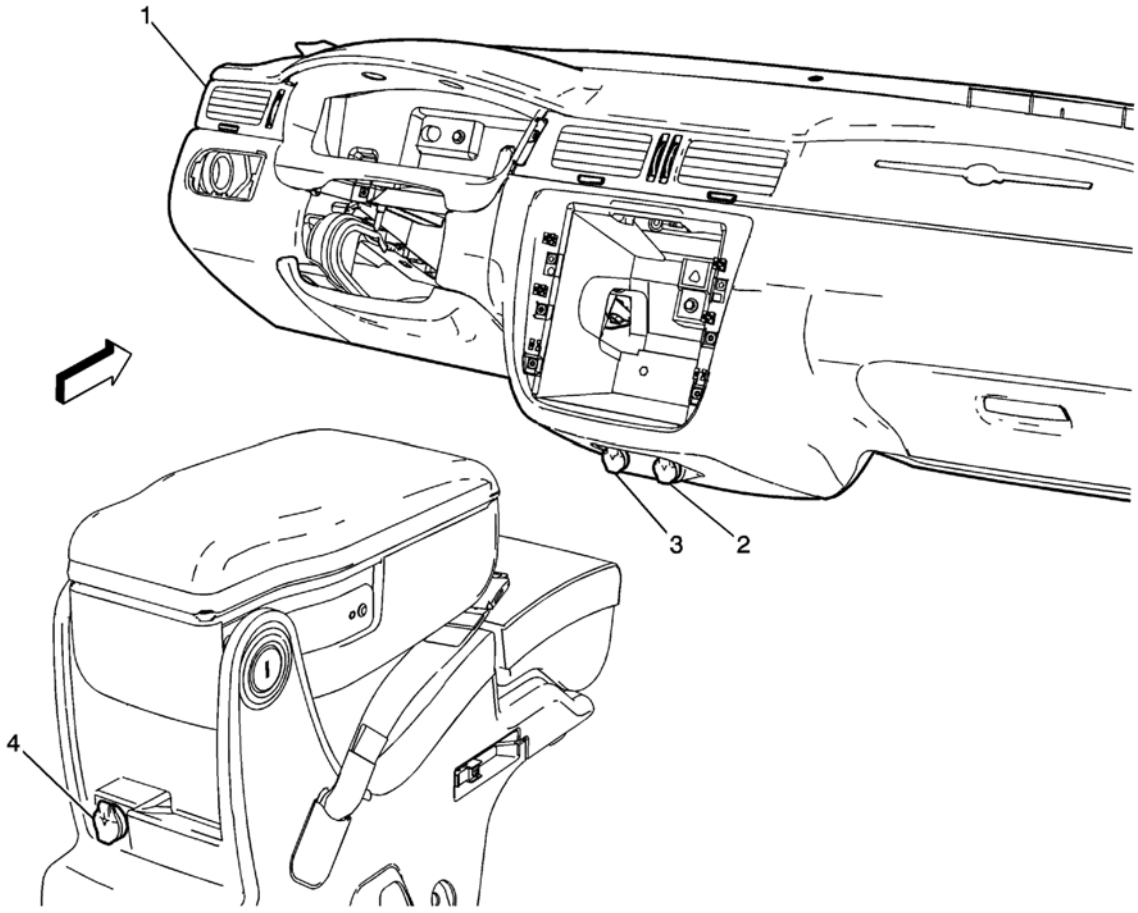


Fig. 3: Center Seat Components (without D55)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel
2	Accessory Power Outlet- I/P 2
3	Accessory Power Outlet- I/P 1
4	Accessory Power Outlet- Center Seat

HEADLINER COMPONENTS- TOP VIEW

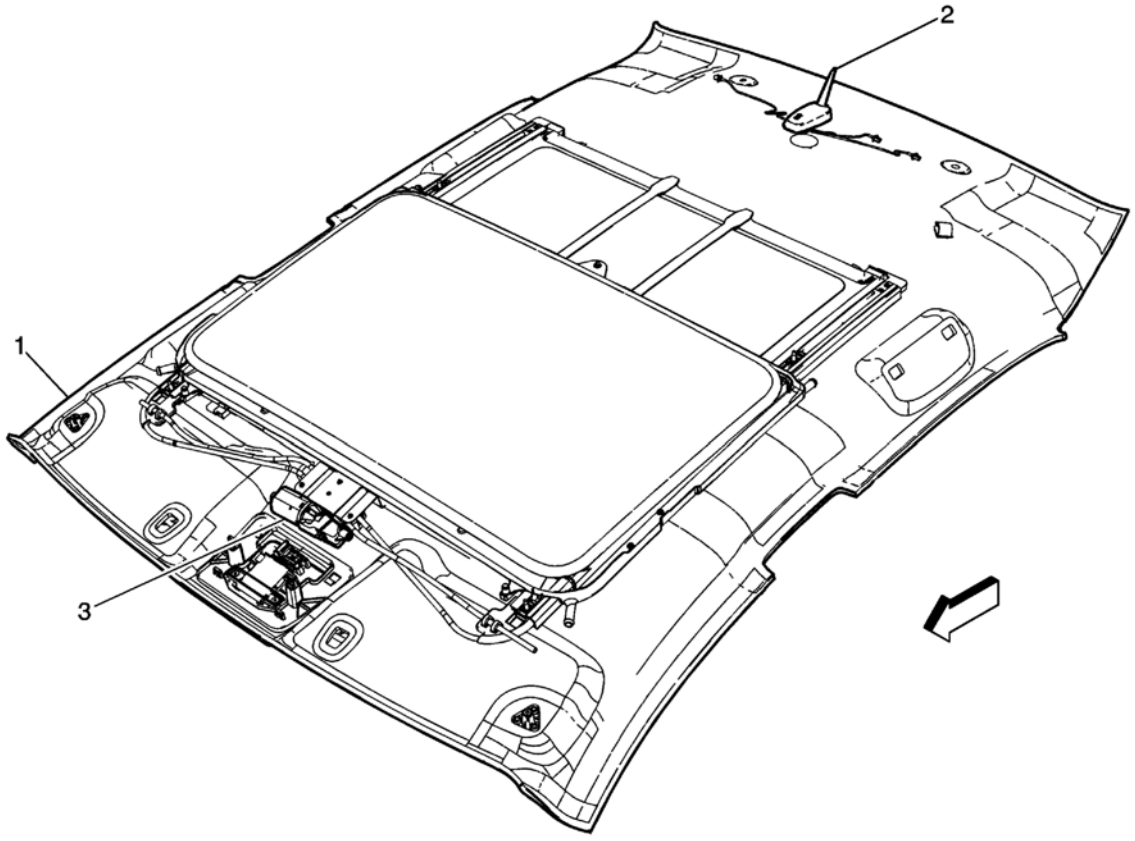


Fig. 4: Headliner Components - Top View
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Headliner
2	Cellular and Digital Radio Antenna (UE1 and/or U2K)
3	Sunroof Control Module (CF5)

HEADLINER COMPONENTS

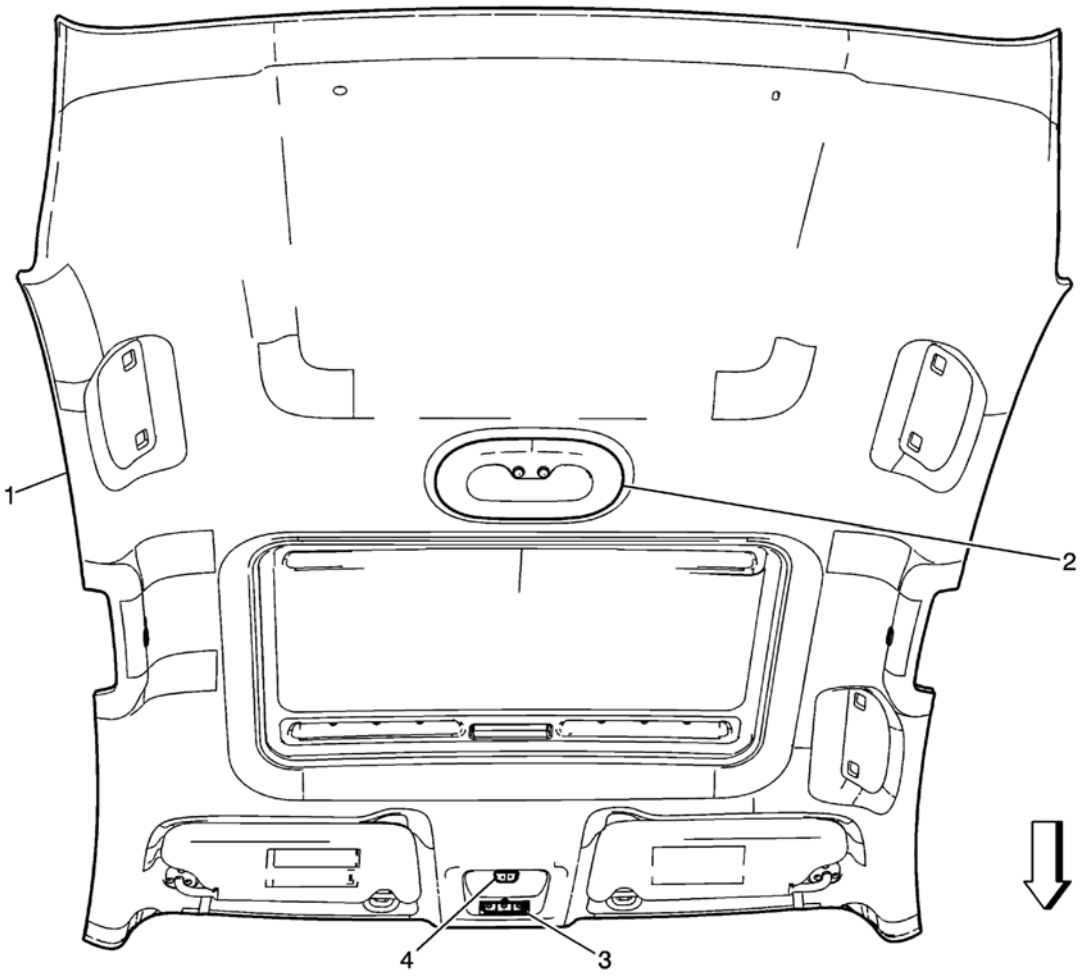


Fig. 5: Identifying Headliner Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Headliner
2	Dome/Reading Lamps
3	Garage Door Opener (GDO) (UG1)
4	Sunroof Switch (CF5)

HEADLINER COMPONENTS (9C1 OR 9C3)

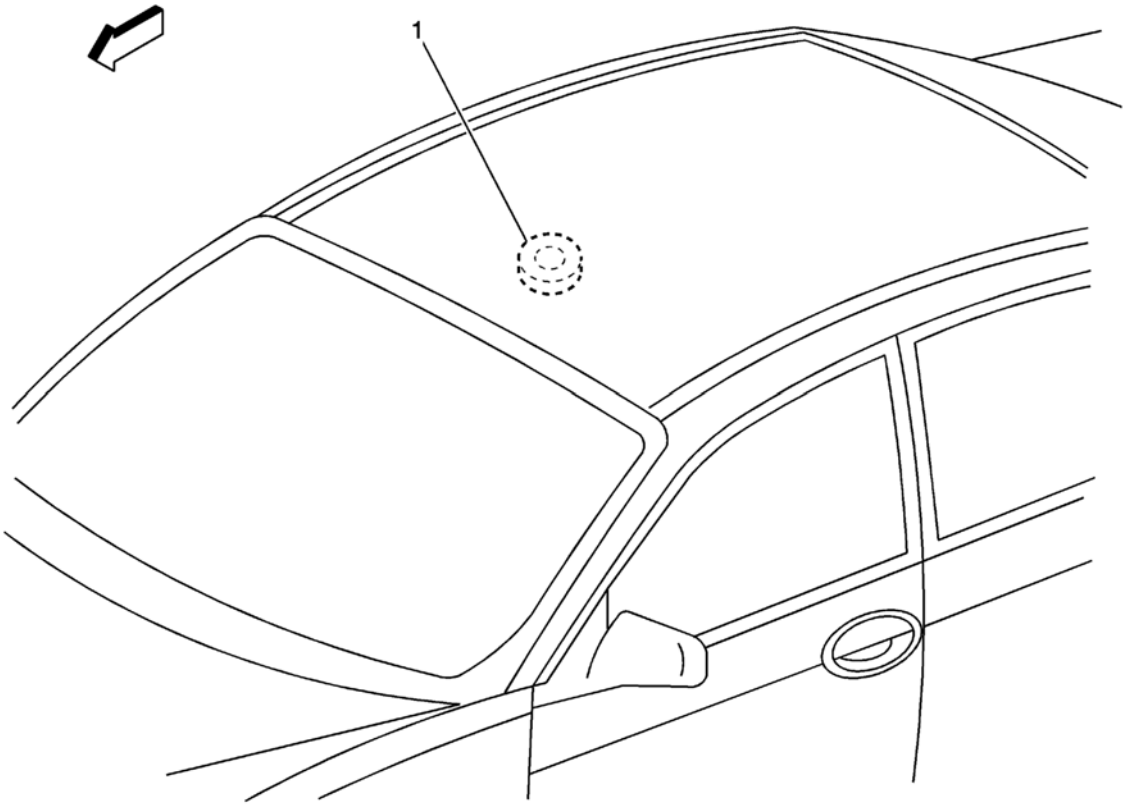


Fig. 6: Forward Headliner (9C1, 9C3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Reading Lamp - Auxiliary (6C7)

ABOVE THE WINDSHIELD COMPONENTS

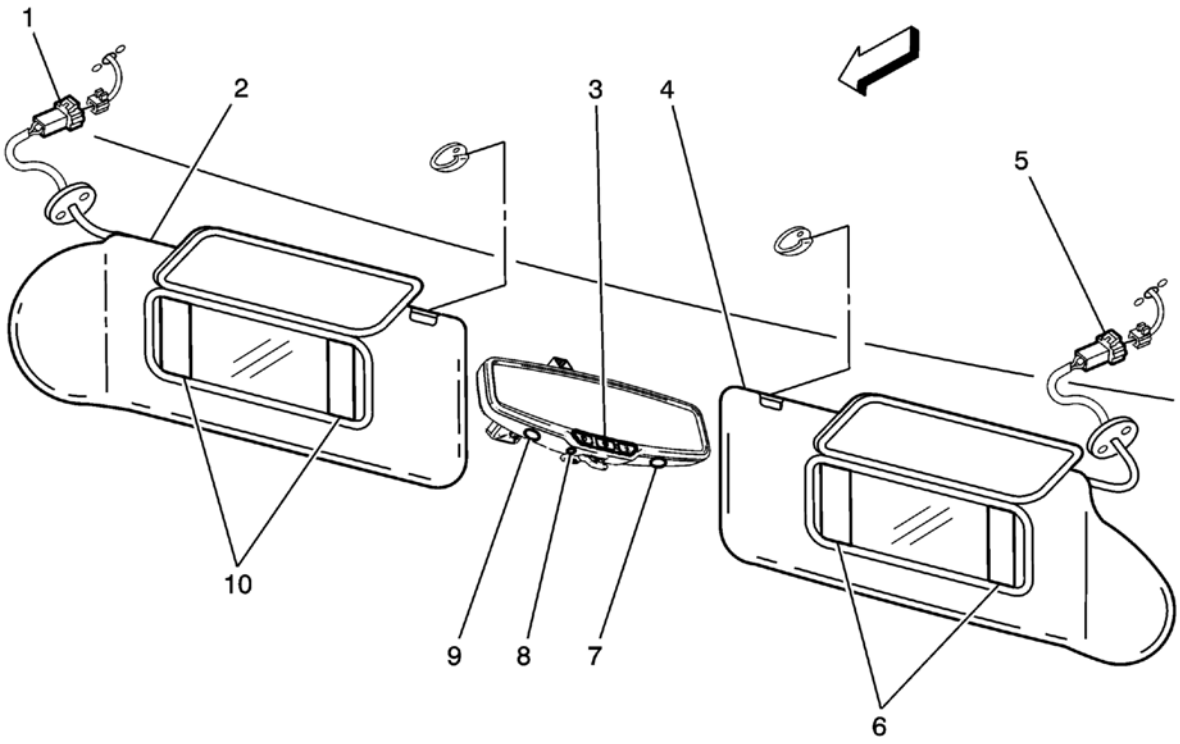


Fig. 7: Above the Windshield Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Sunshade Connector- Left (DH6)
2	Sunshade- Left (DH6)
3	OnStar Button Assembly
4	Sunshade- Right (DH6)
5	Sunshade Connector- Right (DH6)
6	Sunshade Lamps- Right
7	Reading Lamp- Right
8	Inside Rearview Mirror (ISRVM)
9	Reading Lamp- Left
10	Sunshade Lamps- Left

LEFT SIDE OF THE WINDSHIELD COMPONENTS

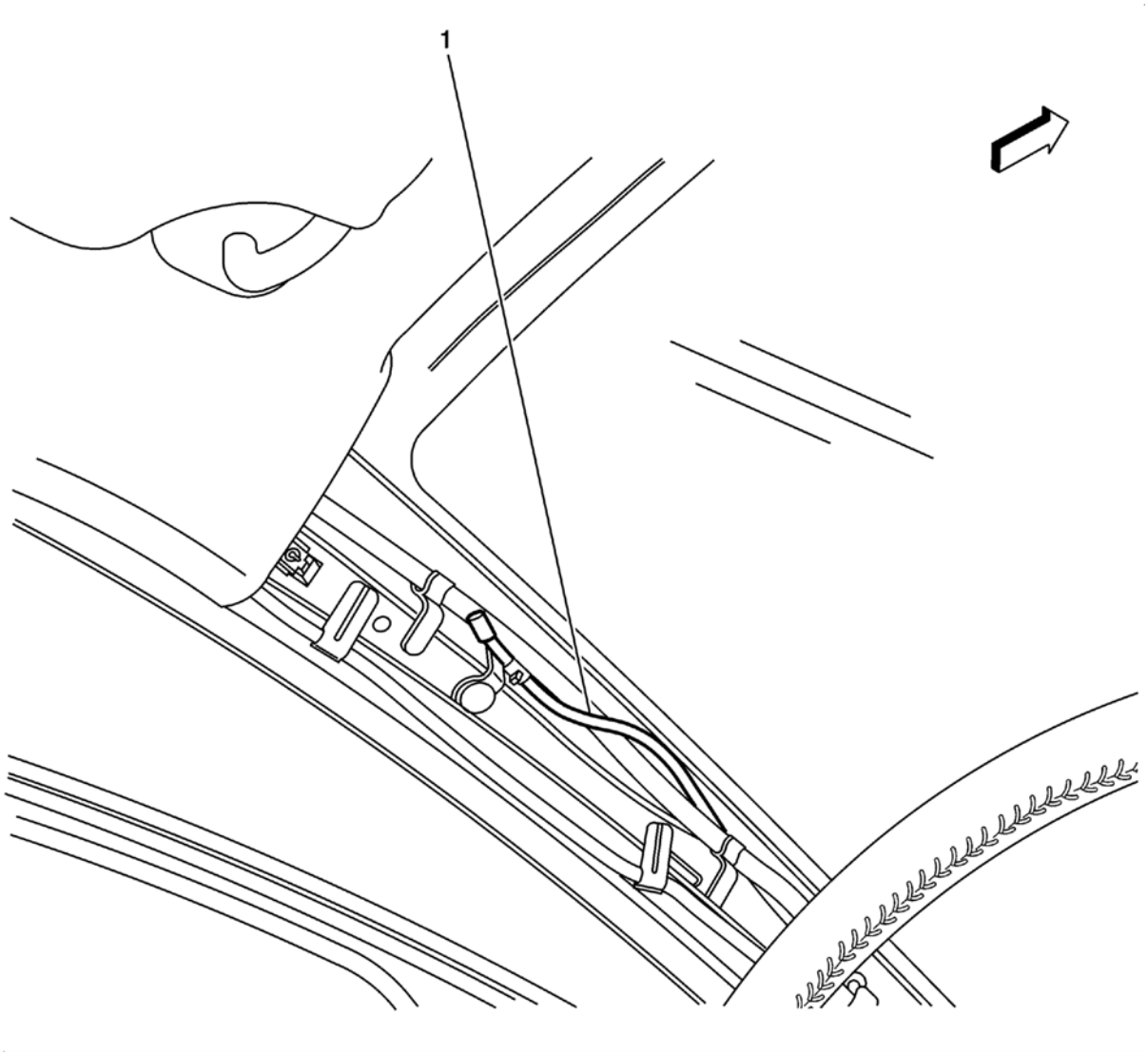


Fig. 8: Left Side of the Windshield Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Keyless Entry Antenna

LEFT A-PILLAR COMPONENTS

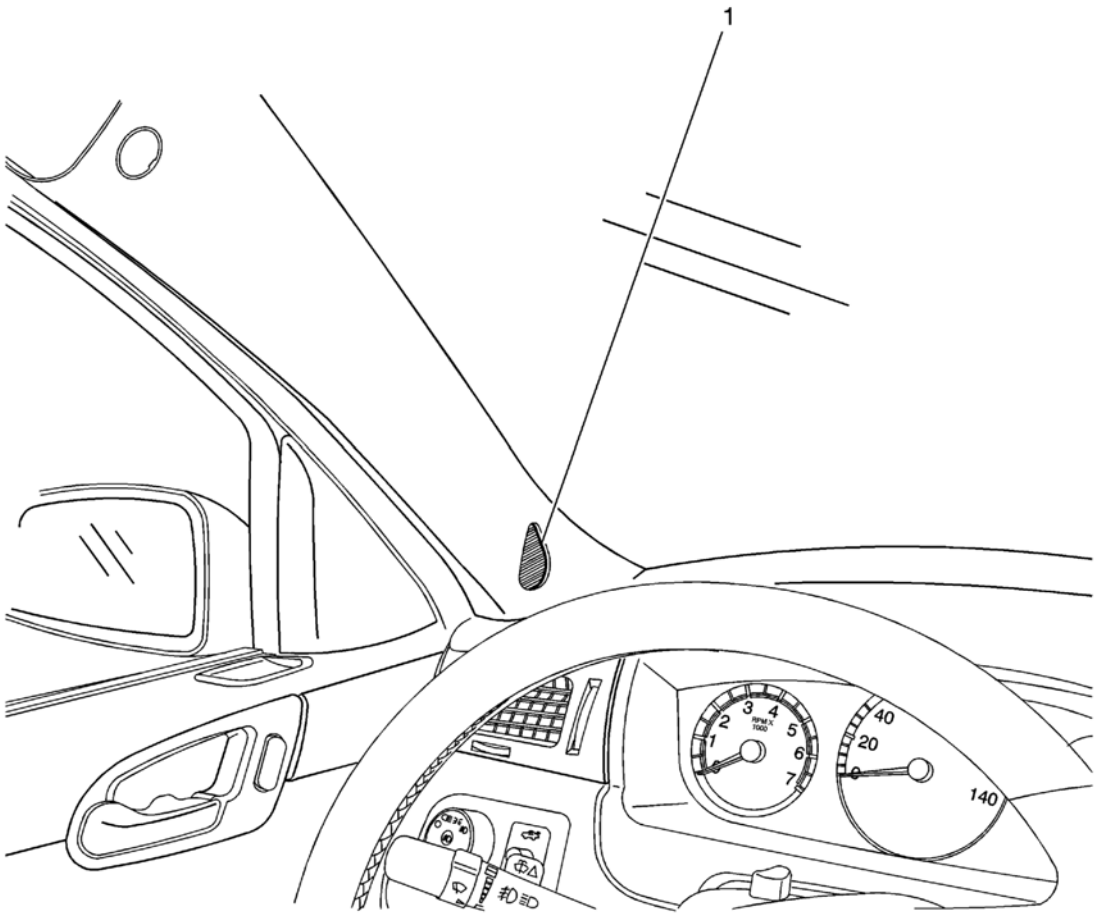


Fig. 9: Base of Left A-Pillar
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Speaker - Left Front Tweeter (UQ3)

LEFT B-PILLAR COMPONENTS

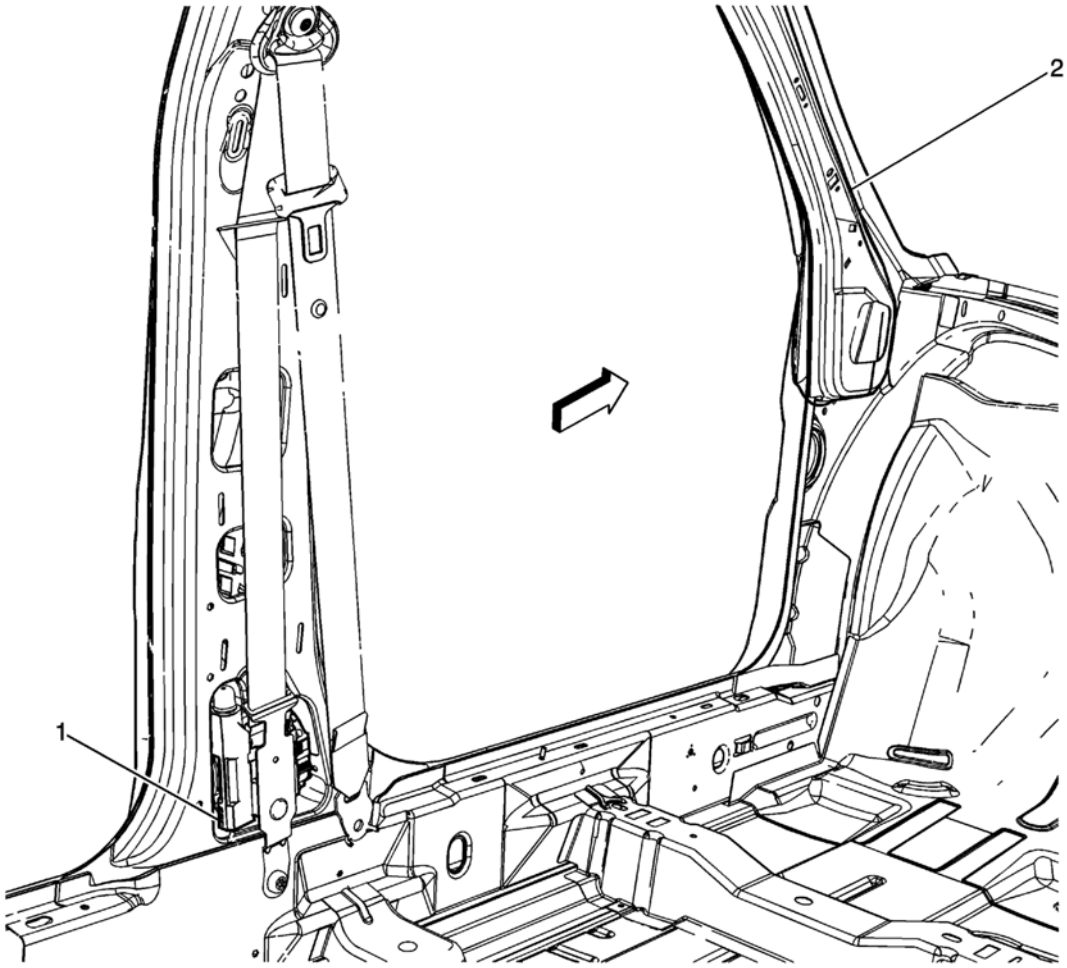


Fig. 10: On the left B-Pillar
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Belt Retractor Pretensioner - Driver
2	Left A-pillar

RIGHT A-PILLAR COMPONENTS

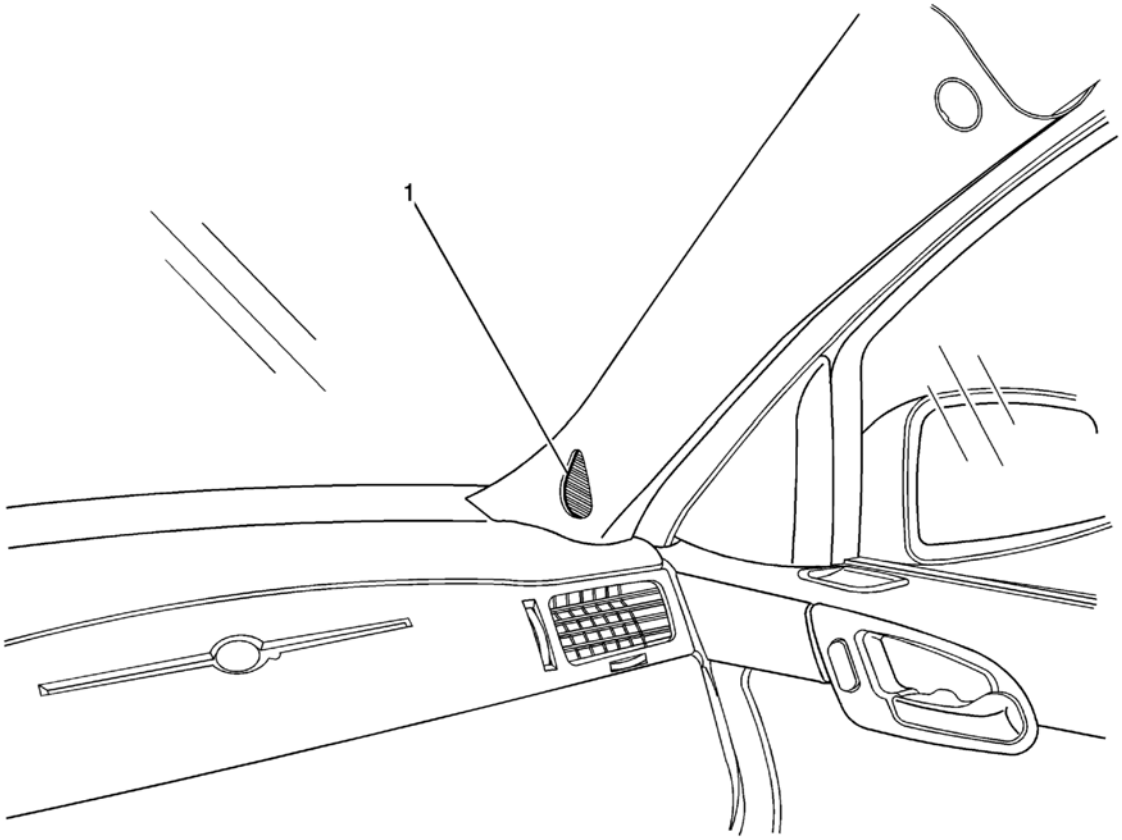


Fig. 11: Base of the Right A-Pillar
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Speaker - Right Front Tweeter (UQ3)

RIGHT B-PILLAR COMPONENTS

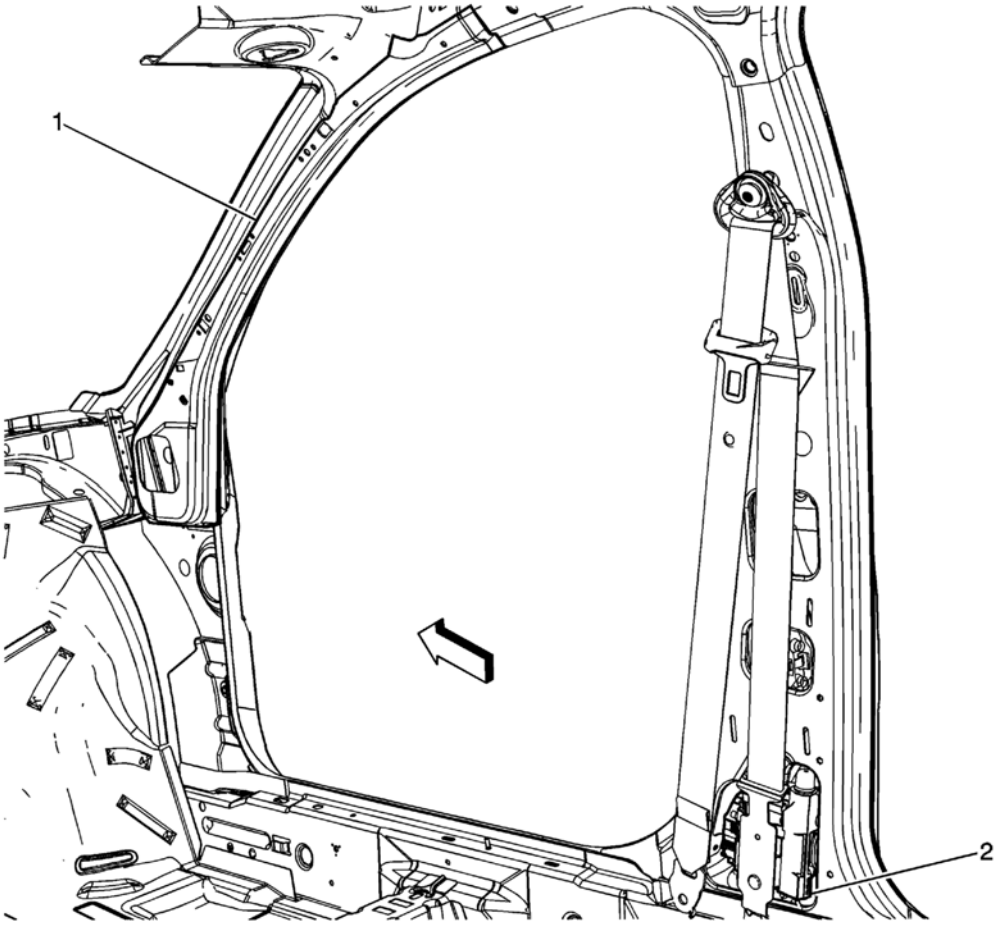


Fig. 12: On The Right B-Pillar
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Right A-pillar
2	Seat Belt Retractor Pretensioner - Passenger

ROOF RAIL COMPONENTS

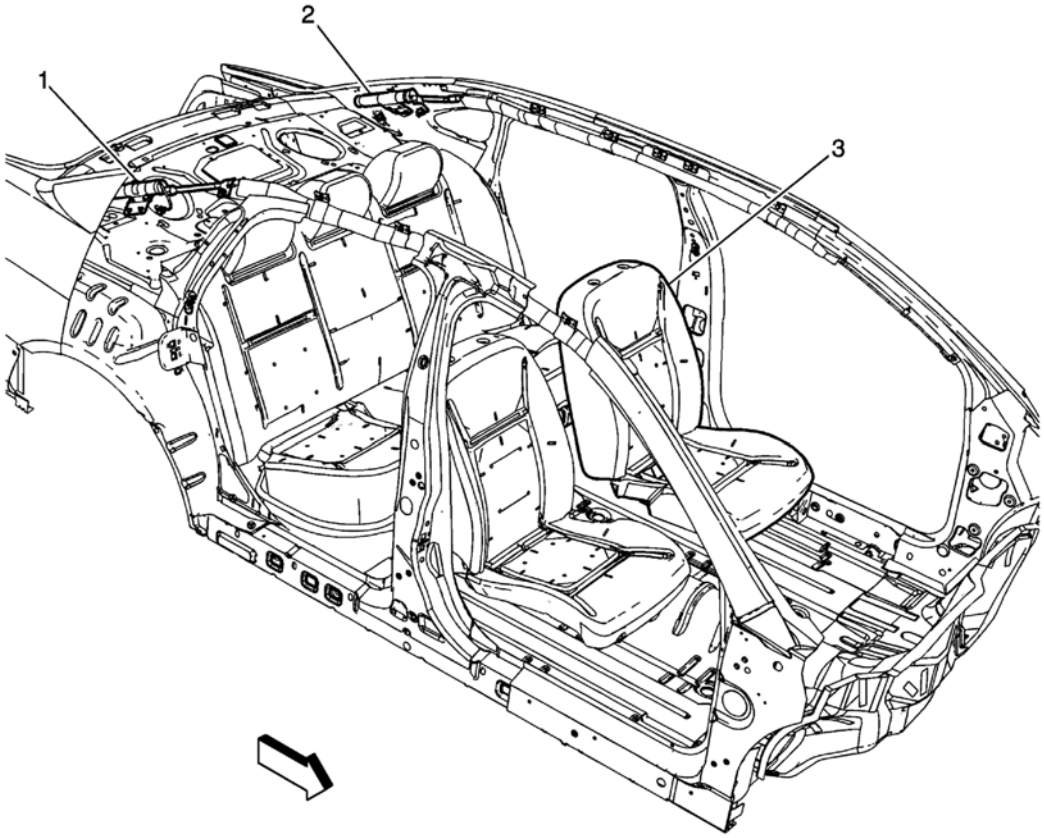


Fig. 13: Roof Rail Air Bags (AY1)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Inflatable Restraint Roof Rail Module- Right
2	Inflatable Restraint Roof Rail Module- Left
3	Driver Seat

FRONT SEAT AIRBAG COMPONENTS

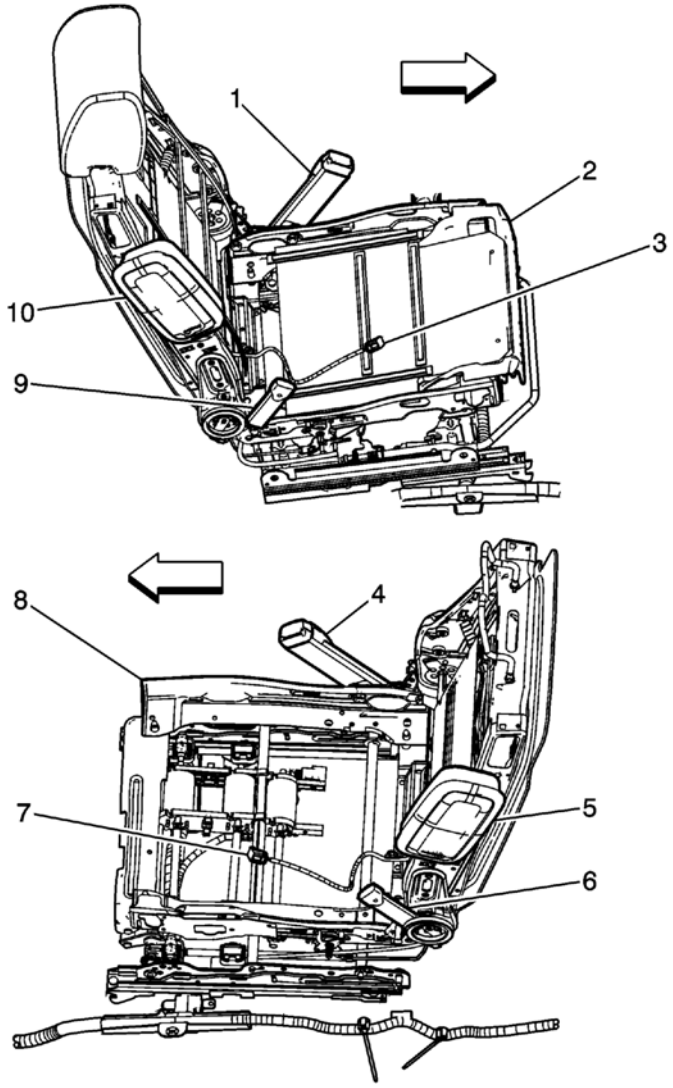


Fig. 14: Front Seat Airbag Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Belt Buckle- Passenger
2	Passenger Seat
3	X315
4	Seat Belt Buckle- Driver
5	Inflatable Restraint Side Impact Module- Left
6	Seat Belt Anchor- Driver
7	X316
8	Driver Seat
9	Seat Belt Anchor- Passenger
10	Inflatable Restraint Side Impact Module- Right

DRIVER SEAT COMPONENTS

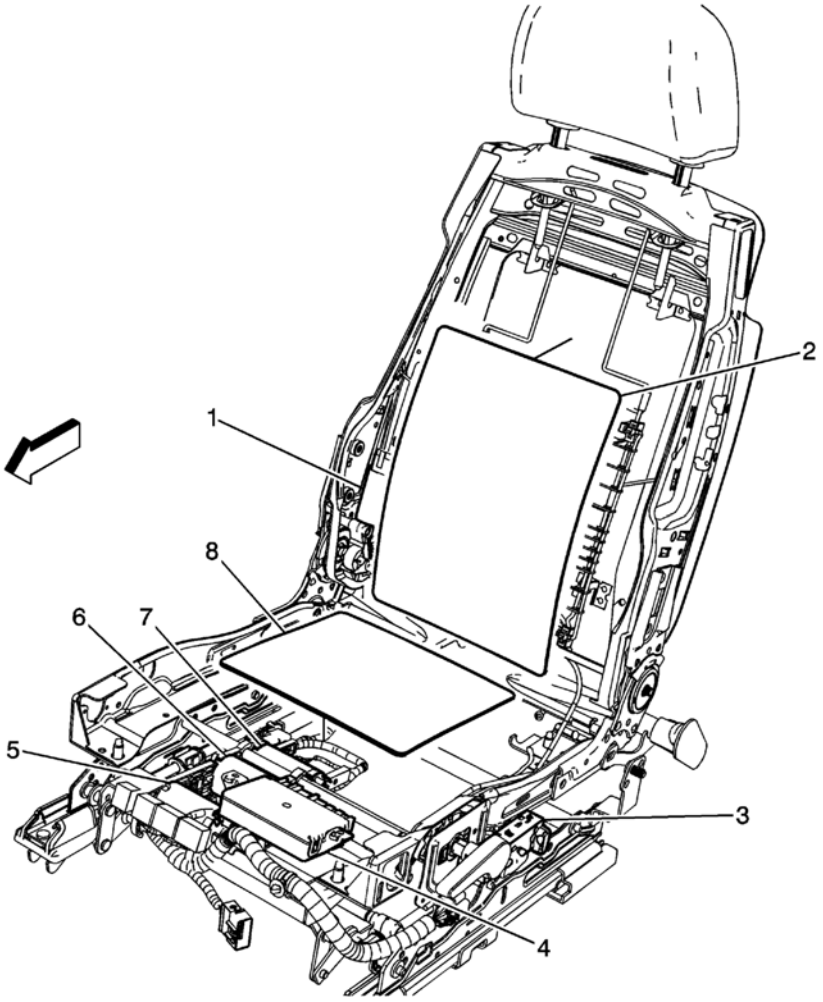


Fig. 15: Driver Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Recline Motor- Driver (AH5)
2	Heated Seat Element- Driver Back (KA1)
3	Seat Adjuster Switch- Driver (AG1 or AH5)
4	Heated Seat Control Module (KA1)
5	Horizontal Motor (Part of the Seat Adjuster Motor Assembly- Driver) (AG1 or AH5)
6	Front Vertical Motor (Part of the Seat Adjuster Motor Assembly- Driver) (AG1 or AH5)
7	Rear Vertical Motor (Part of the Seat Adjuster Motor Assembly- Driver) (AG1 or AH5)
8	Heated Seat Element- Driver Cushion (KA1)

DRIVER SEAT FRAME COMPONENTS

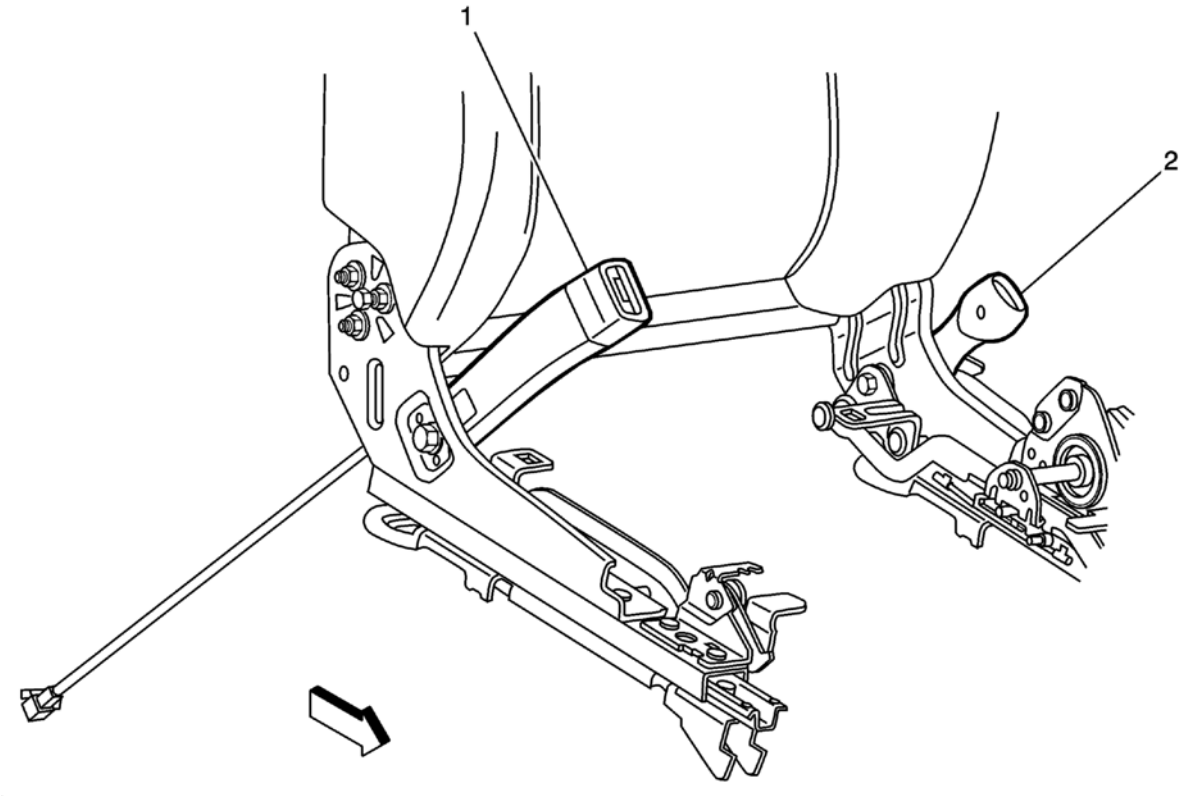


Fig. 16: Driver Seat Frame Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Belt Buckle- Driver
2	Seat Belt Anchor- Driver

PASSENGER SEAT COMPONENTS

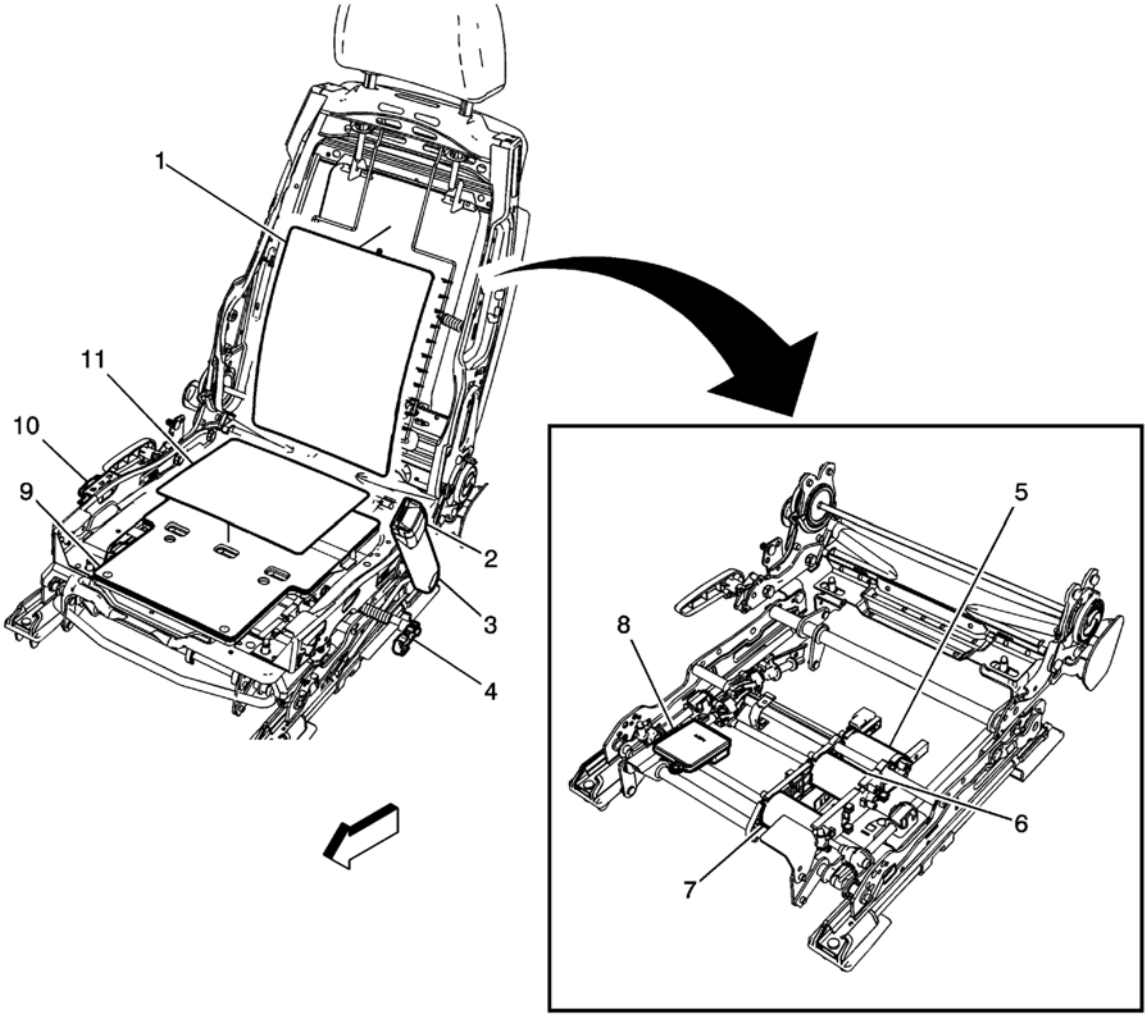


Fig. 17: View Of Passenger Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Heated Seat Element- Passenger Back (KA1)
2	Seat Belt Buckle- Passenger
3	Seat Belt Switch- Passenger
4	Seat Belt Switch- Passenger, Connector
5	Rear Vertical Motor (Part of the Seat Adjuster Motor Assembly- Passenger) (AG2)
6	Front Vertical Motor (Part of the Seat Adjuster Motor Assembly- Passenger) (AG2)
7	Horizontal Motor (Part of the Seat Adjuster Motor Assembly- Passenger) (AG2)
8	Inflatable Restraint Front Passenger Presence System (PPS) Module
9	Inflatable Restraint Front Passenger Presence System (PPS) Sensor
10	Seat Adjuster Switch- Passenger (AG2)
11	Heated Seat Element- Passenger Cushion (KA1)

UNDER THE PASSENGER SEAT COMPONENTS

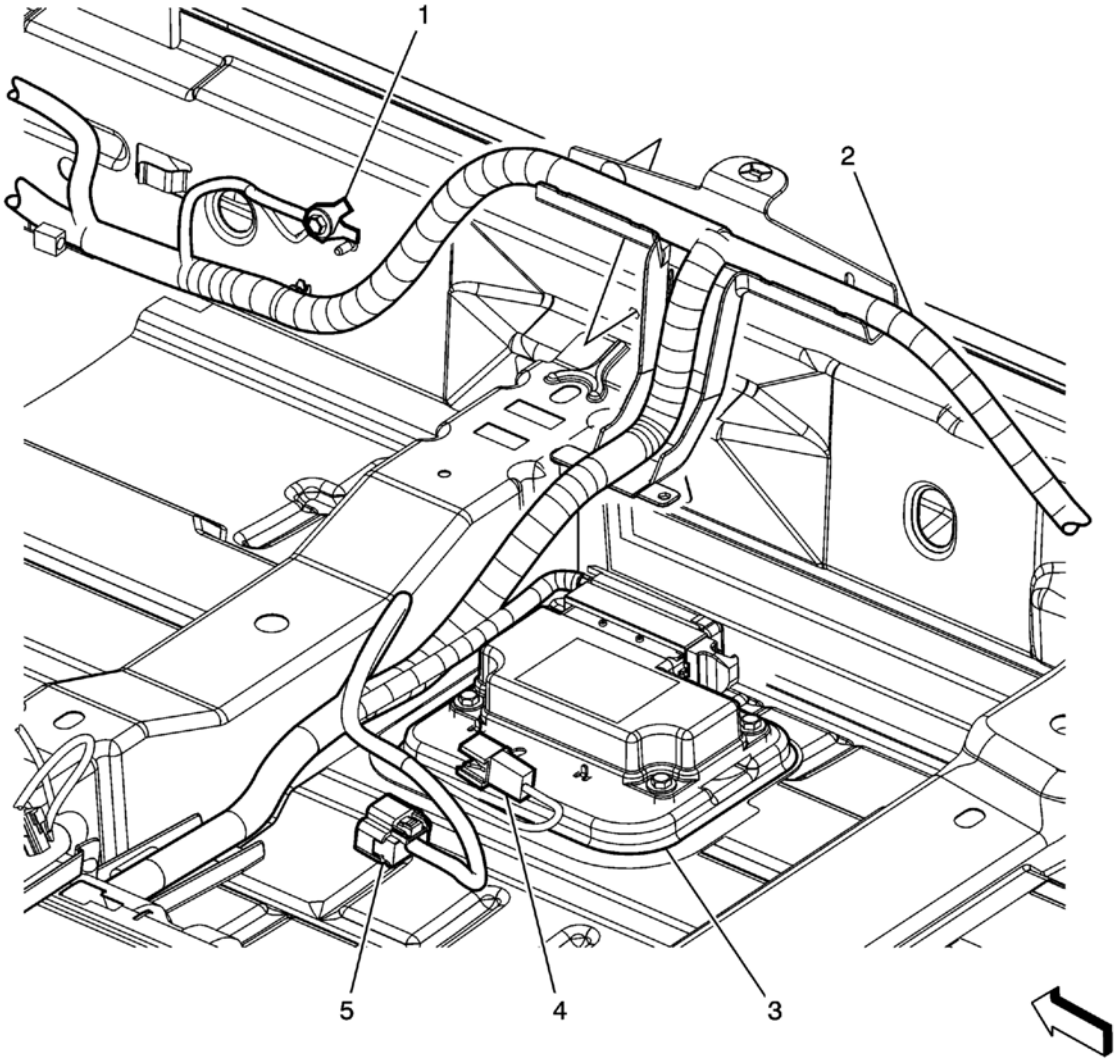


Fig. 18: Under the Passenger Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	G302
2	Body Harness
3	Inflatable Restraint Sensing and Diagnostic Module (SDM)
4	X316
5	X313

RADIO AND SPEAKER COMPONENTS

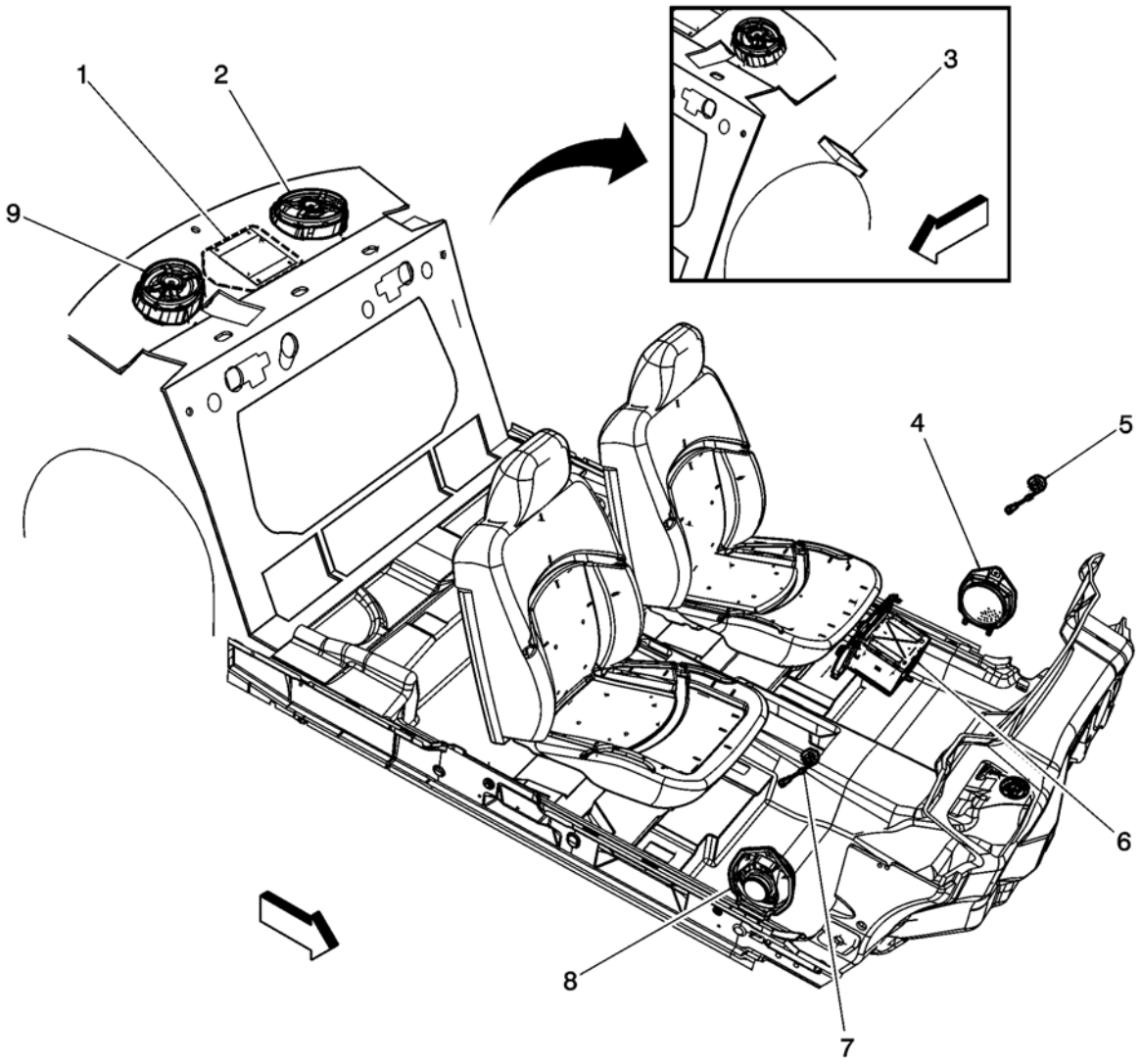


Fig. 19: Radio and Speaker Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Audio Amplifier (UQ3)
2	Speaker- Left Rear
3	Digital Radio Receiver (U2K)
4	Speaker- Left Front
5	Speaker- Left Front Tweeter (UQ3)
6	Radio
7	Speaker- Right Front Tweeter (UQ3)
8	Speaker- Right Front
9	Speaker- Right Rear

ABOVE THE REAR SEAT COMPONENTS

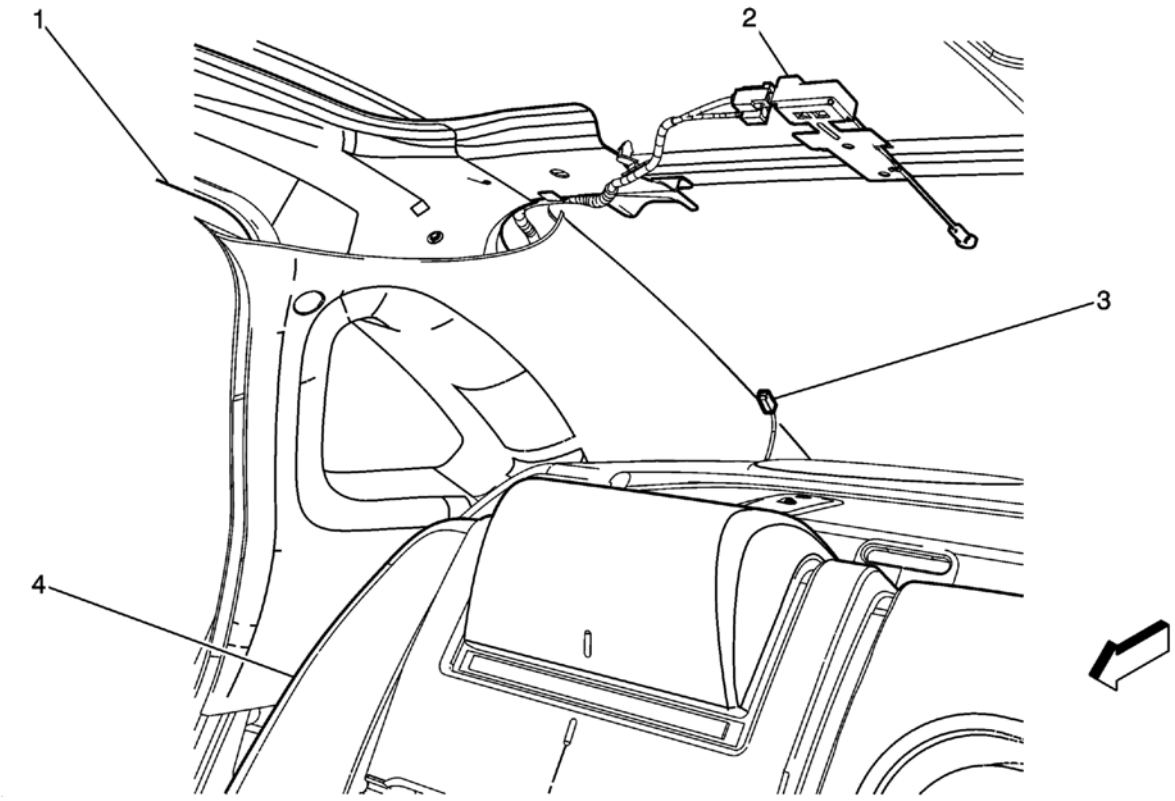


Fig. 20: Above the Rear Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Right Rear C-Pillar
2	Radio Antenna Module
3	Rear Window Defogger Grid X1
4	Rear Seat

PACKAGE SHELF COMPONENTS (9C1 OR 9C3)

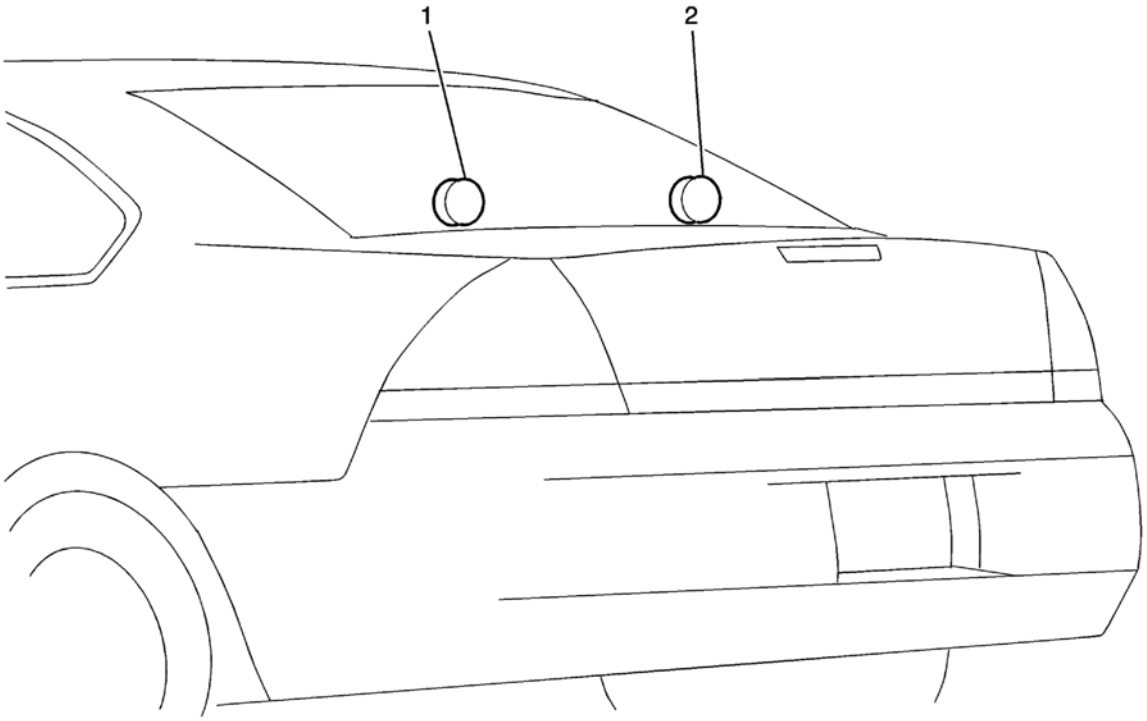


Fig. 21: On Package Shelf (9C1, 9C3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Emergency Vehicle Rear Window Panel Lamp- Left (6J6)
2	Emergency Vehicle Rear Window Panel Lamp- Right (6J6)

Article GUID: A00737231

POWERTRAIN COMPONENT VIEWS

LEFT FRONT OF ENGINE COMPONENTS

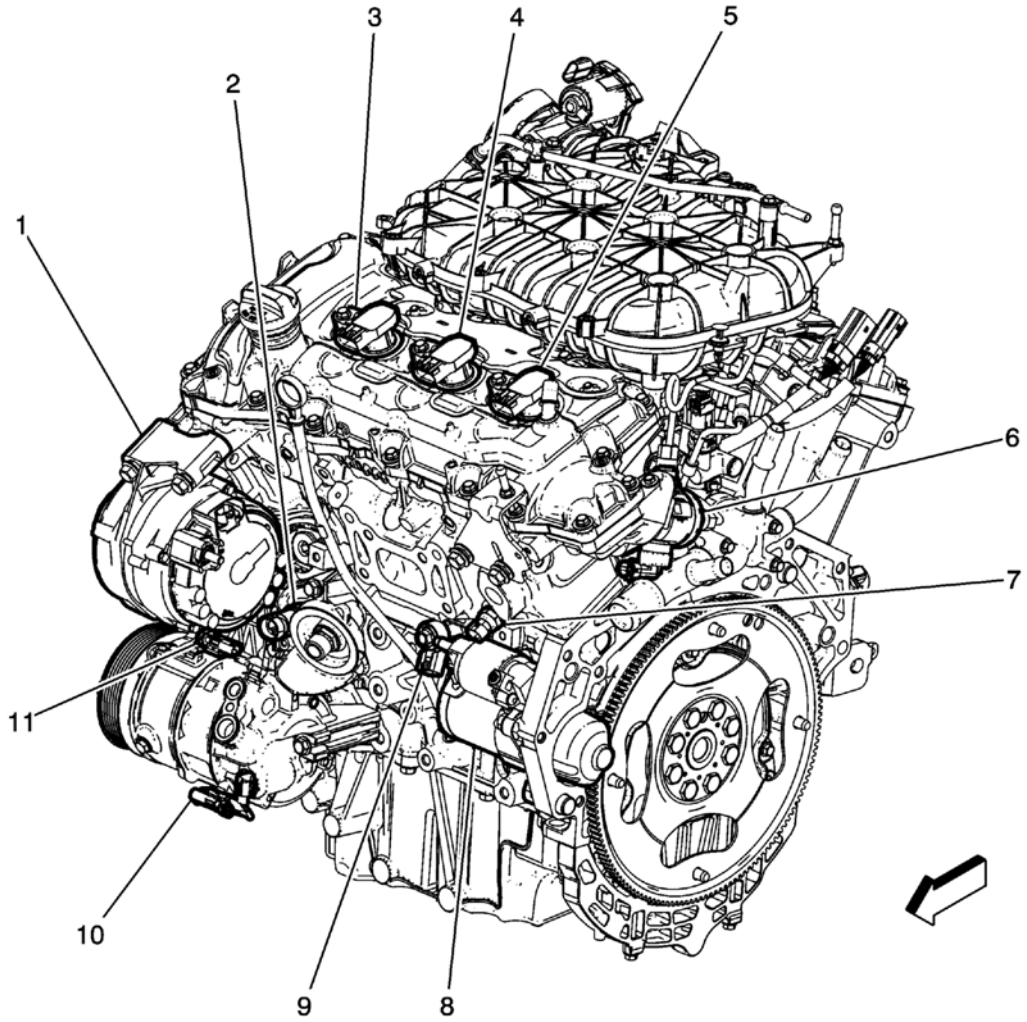


Fig. 1: Left Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Generator
2	Engine Oil Pressure (EOP) Switch
3	Ignition Coil 2
4	Ignition Coil 4
5	Ignition Coil 6
6	High Pressure Fuel Pump

Callout	Component Name
7	Engine Coolant Temperature (ECT) Sensor
8	Starter Motor
9	Knock Sensor (KS) 2
10	A/C Compressor Solenoid Valve
11	A/C Compressor Clutch

RIGHT REAR OF ENGINE COMPONENTS

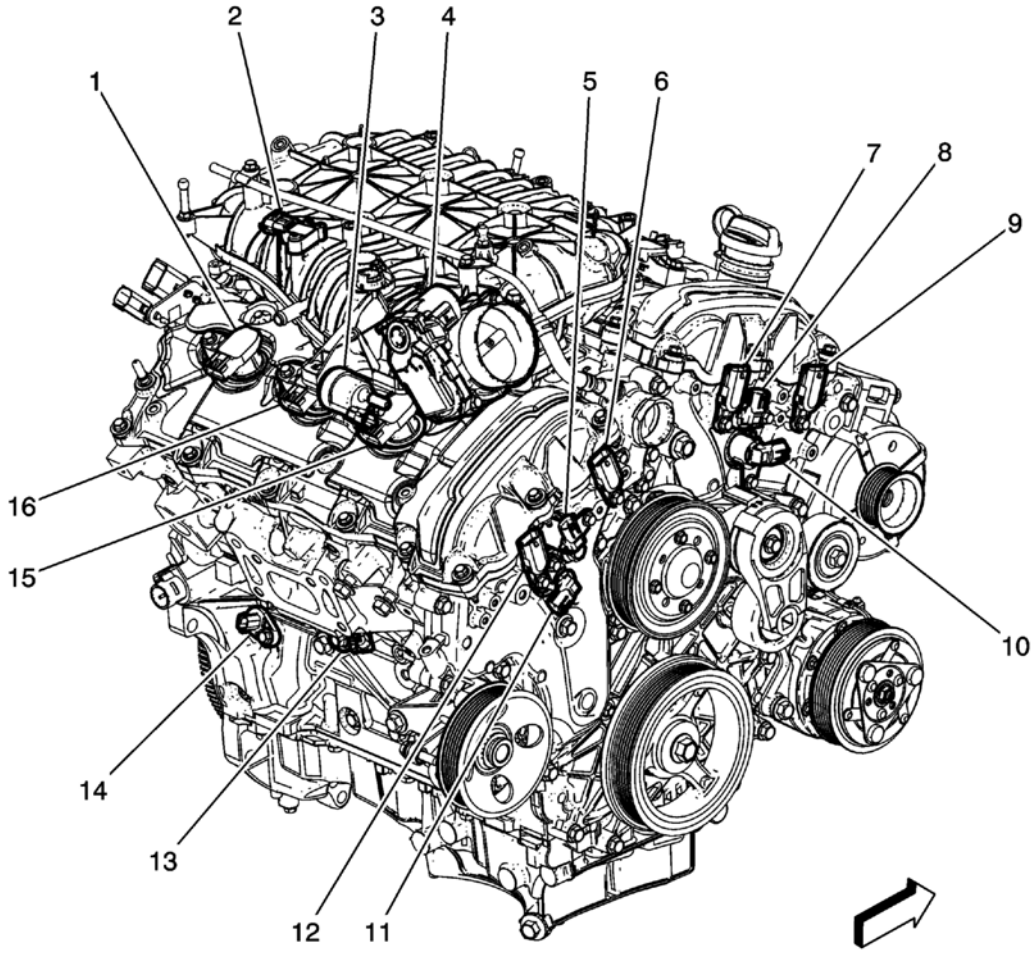


Fig. 2: Right Rear Of Engine
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Ignition Coil 5
2	Manifold Absolute Pressure (MAP) Sensor
3	Evaporative Emission (EVAP) Canister Purge Solenoid Valve
4	Throttle Body
5	Camshaft Position (CMP) Actuator Solenoid Valve- Bank 1 Intake

Callout	Component Name
6	Camshaft Position (CMP) Sensor - Bank 1 Intake
7	Camshaft Position (CMP) Sensor - Bank 2 Intake
8	Camshaft Position (CMP) Actuator Solenoid Valve- Bank 2 Intake
9	Camshaft Position (CMP) Sensor - Bank 2 Exhaust
10	Camshaft Position (CMP) Actuator Solenoid Valve- Bank 2 Exhaust
11	Camshaft Position (CMP) Actuator Solenoid Valve- Bank 1 Exhaust
12	Camshaft Position Sensor (CMP) - Bank 1 Exhaust
13	Knock Sensor (KS) 1
14	Crankshaft Position (CKP) Sensor
15	Ignition Coil 1
16	Ignition Coil 3

TOP ENGINE COMPONENTS

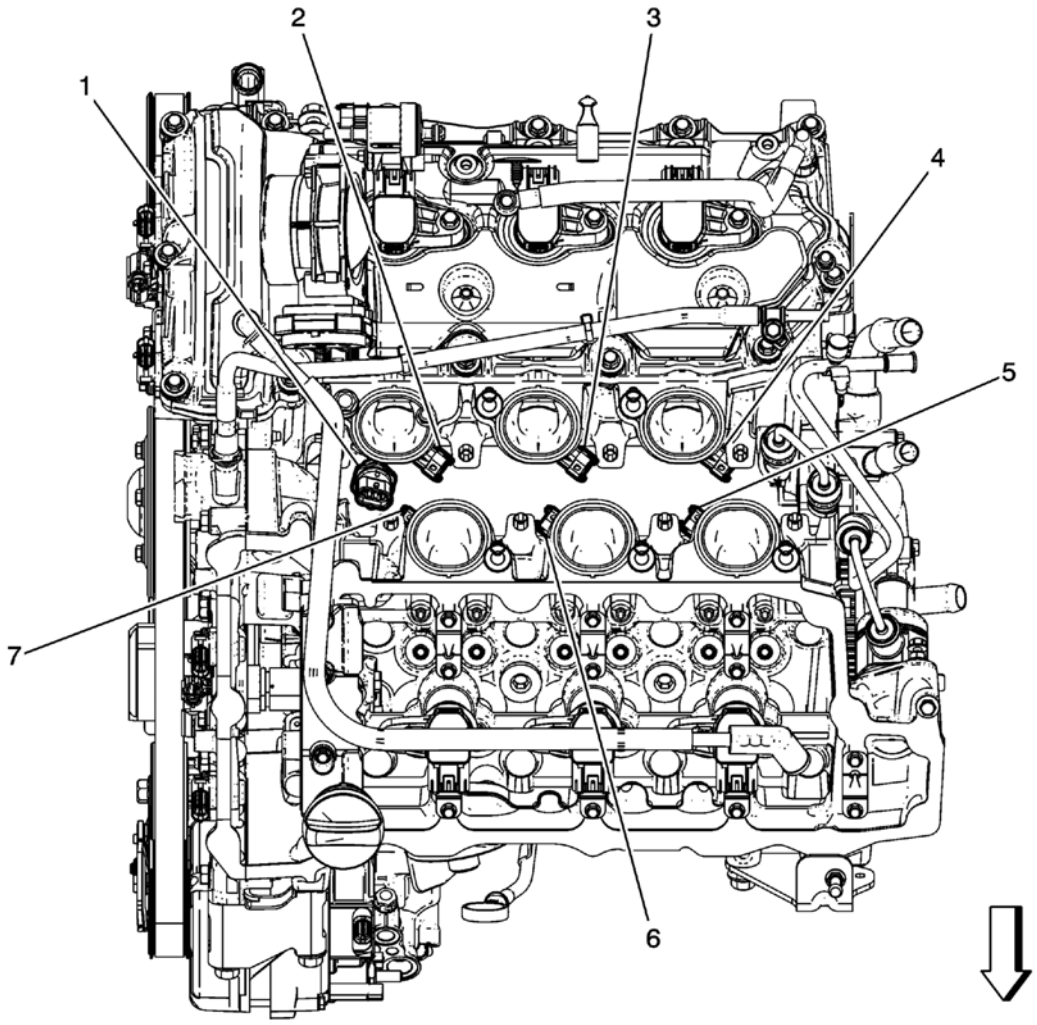


Fig. 3: Top Engine Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Rail Pressure (FRP) Sensor
2	Fuel Injector 1
3	Fuel Injector 3
4	Fuel Injector 5
5	Fuel Injector 6
6	Fuel Injector 4
7	Fuel Injector 2

OXYGEN SENSORS

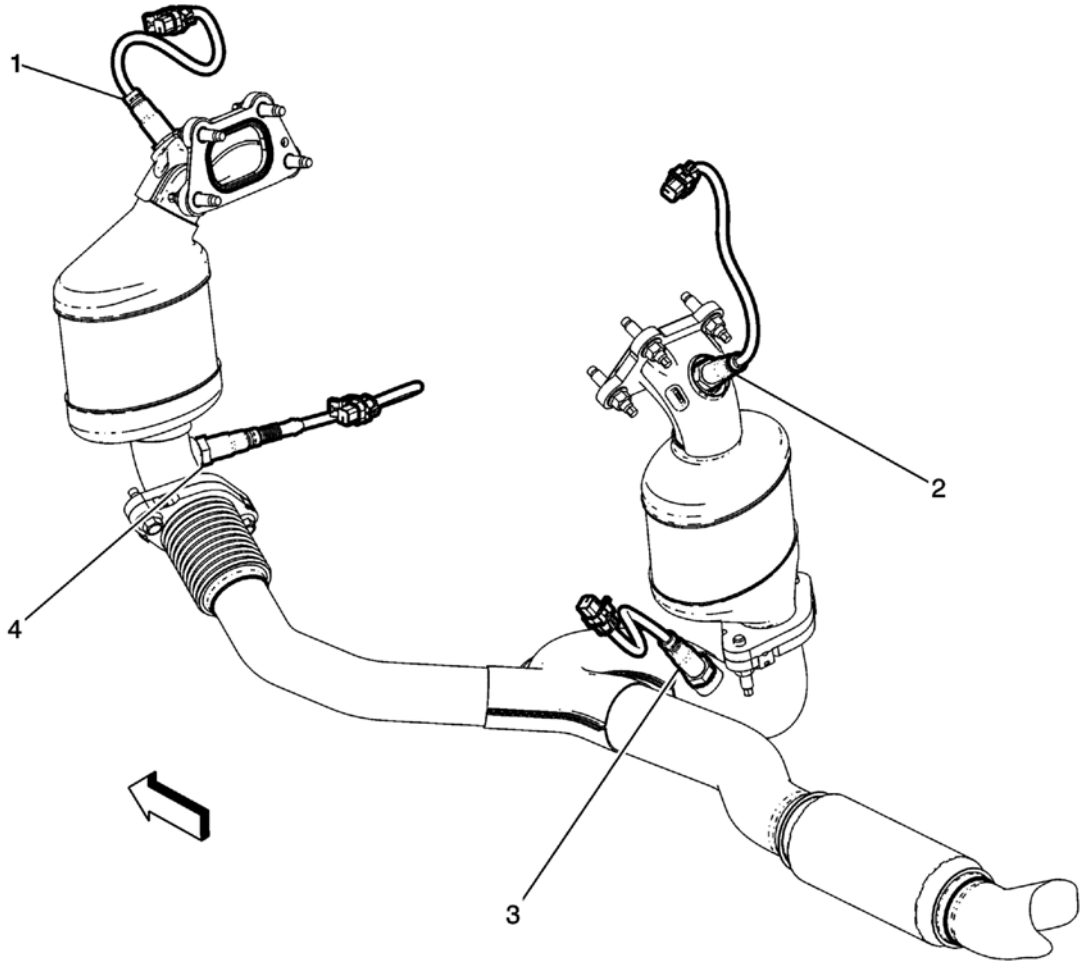


Fig. 4: Oxygen Sensors
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 1
2	Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 1
3	Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 2

Callout	Component Name
4	Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 2

AUTOMATIC TRANSMISSION ELECTRONIC COMPONENTS

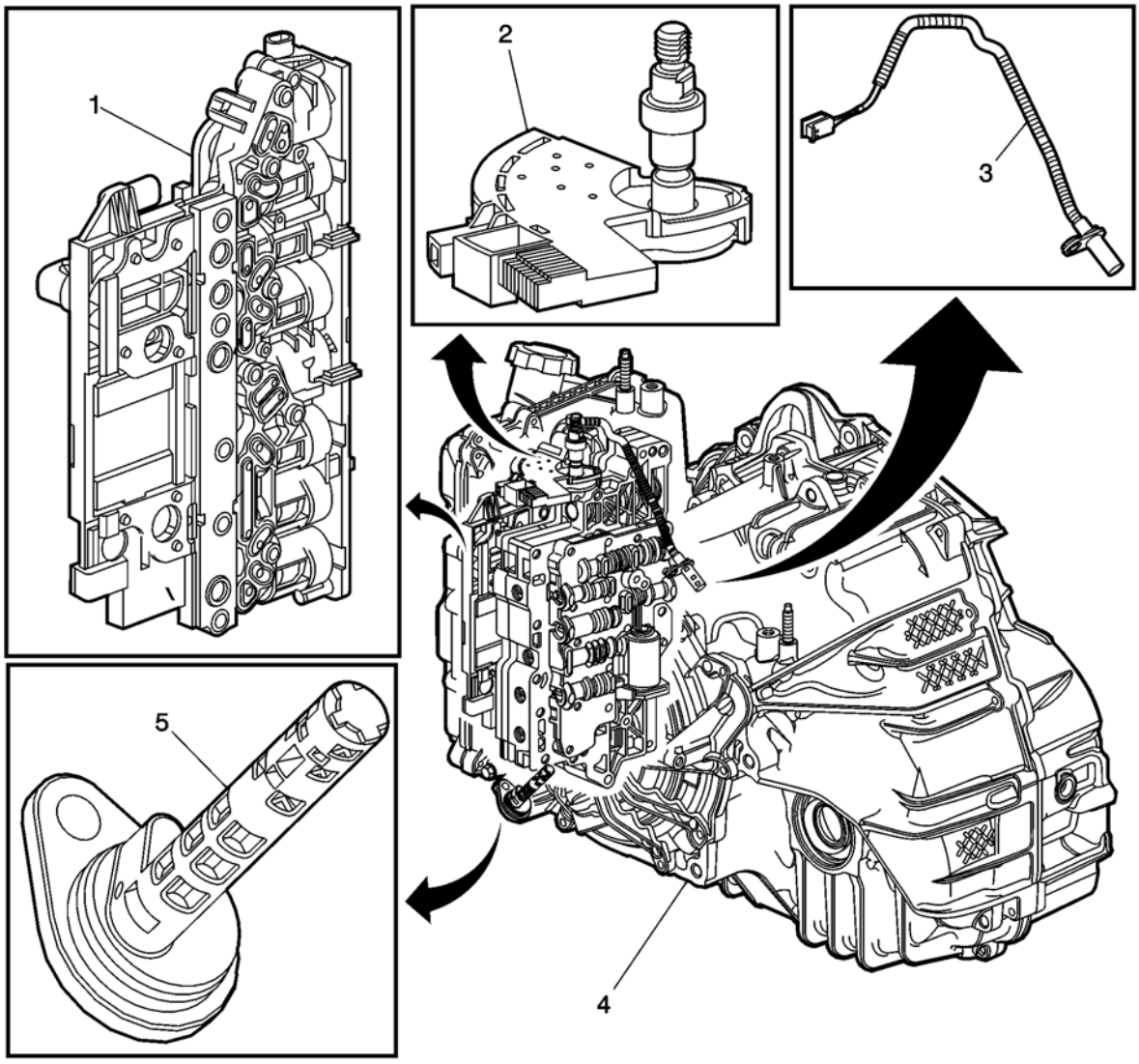


Fig. 5: Automatic Transmission Electronic Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Control Solenoid Valve Assembly
2	Automatic Transmission Internal Mode Switch (IMS)
3	Automatic Transmission Output Shaft Speed (OSS) Sensor
4	Automatic Transmission Assembly
5	Automatic Transmission Input Shaft Speed (ISS) Sensor

Article GUID: A00737228

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Wheels/Vehicle Underbody Component Views - Impala

WHEELS/VEHICLE UNDERBODY COMPONENT VIEWS

FRONT WHEEL COMPONENTS

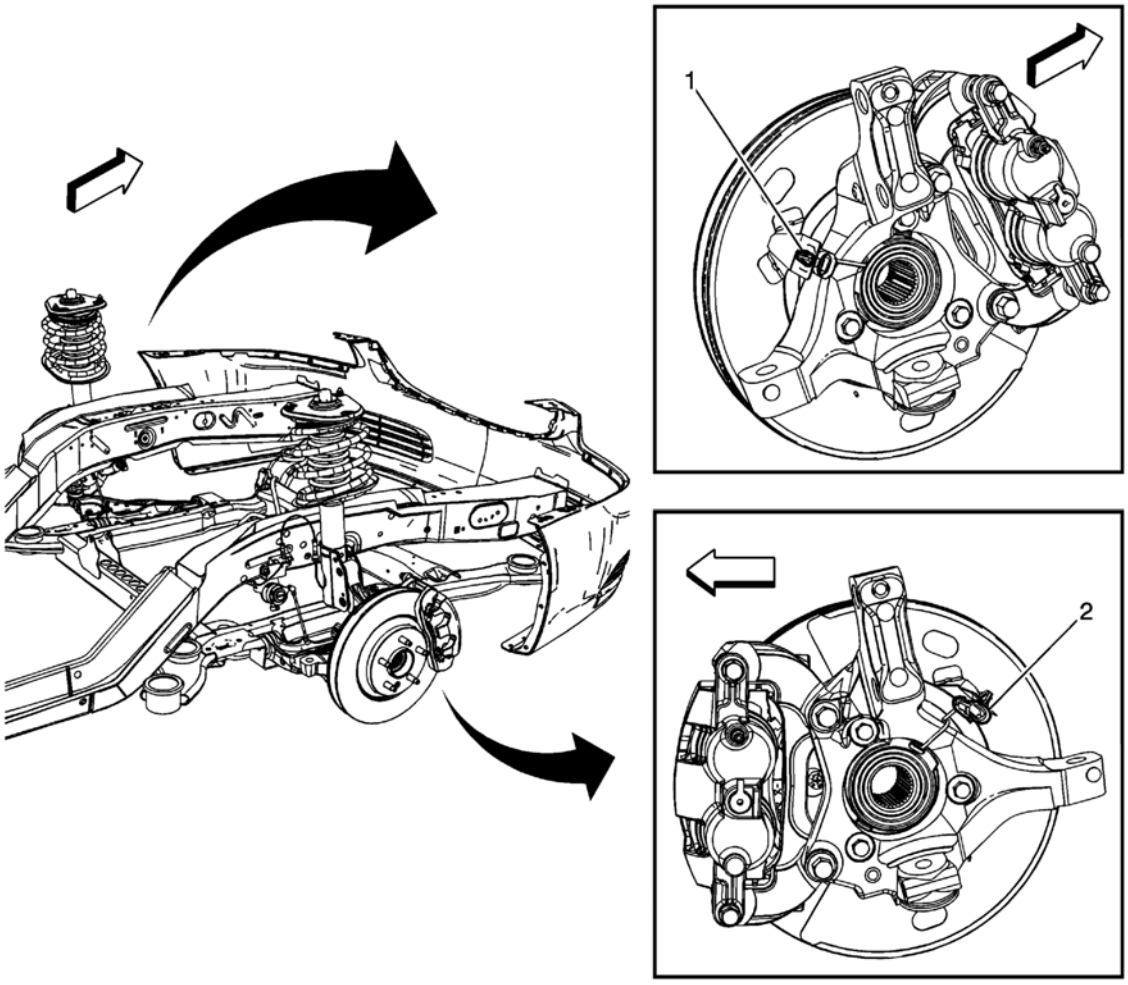


Fig. 1: Identifying Front Wheel Speed Sensors
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Wheel Speed Sensor (WSS)- Left Front
2	Wheel Speed Sensor (WSS)- Right Front

REAR WHEEL COMPONENTS

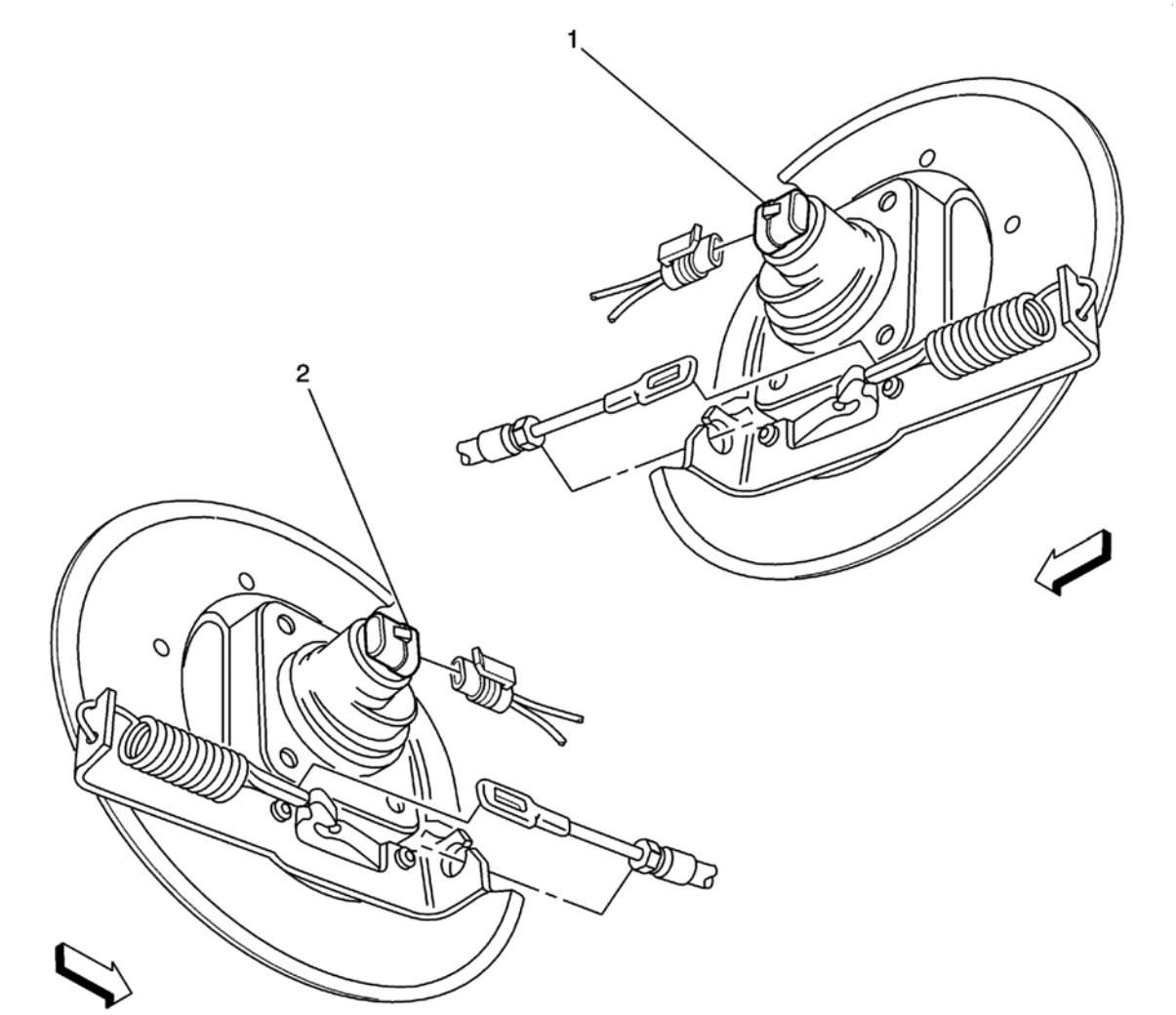


Fig. 2: Rear Wheel Speed Sensor Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Wheel Speed Sensor (WSS)- Right Rear
2	Wheel Speed Sensor (WSS)- Left Rear

UNDERBODY COMPONENTS

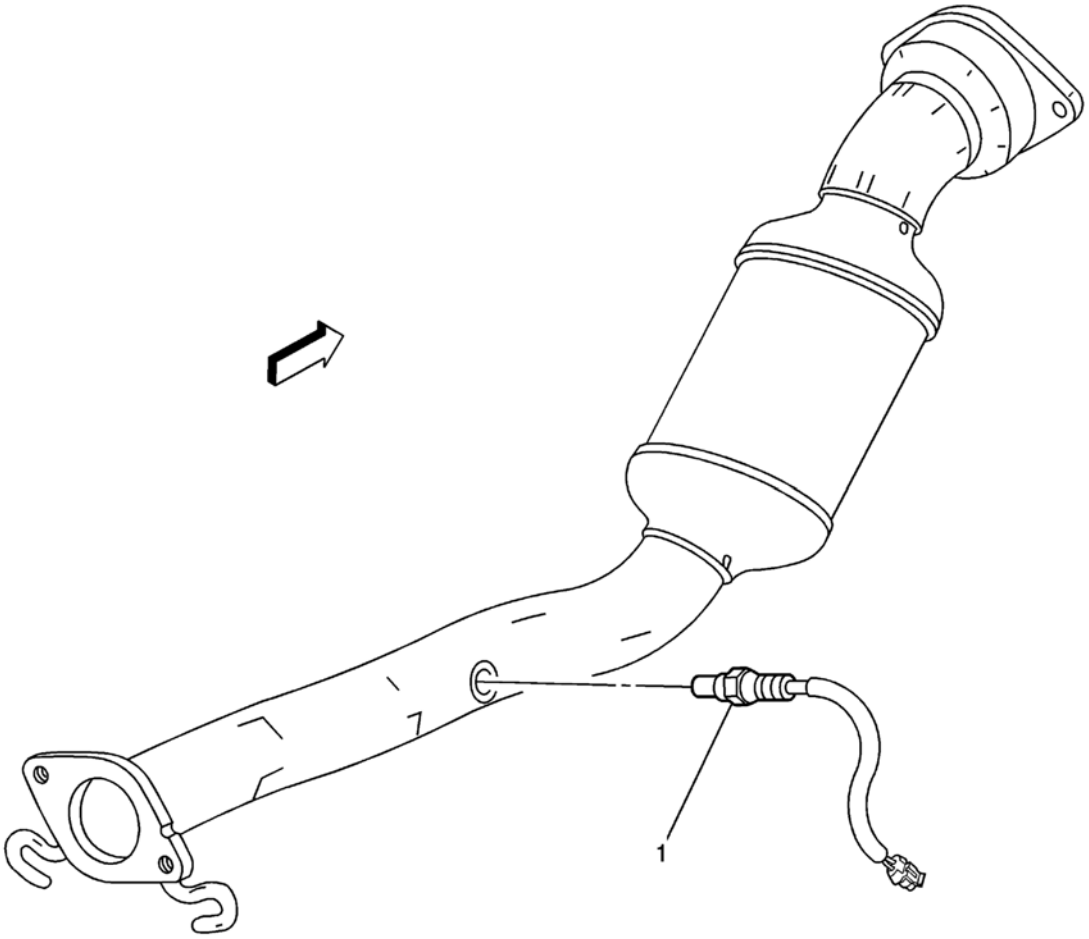


Fig. 3: Underbody Component Views
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Heated Oxygen Sensor (HO2S) 2

FUEL TANK COMPONENTS

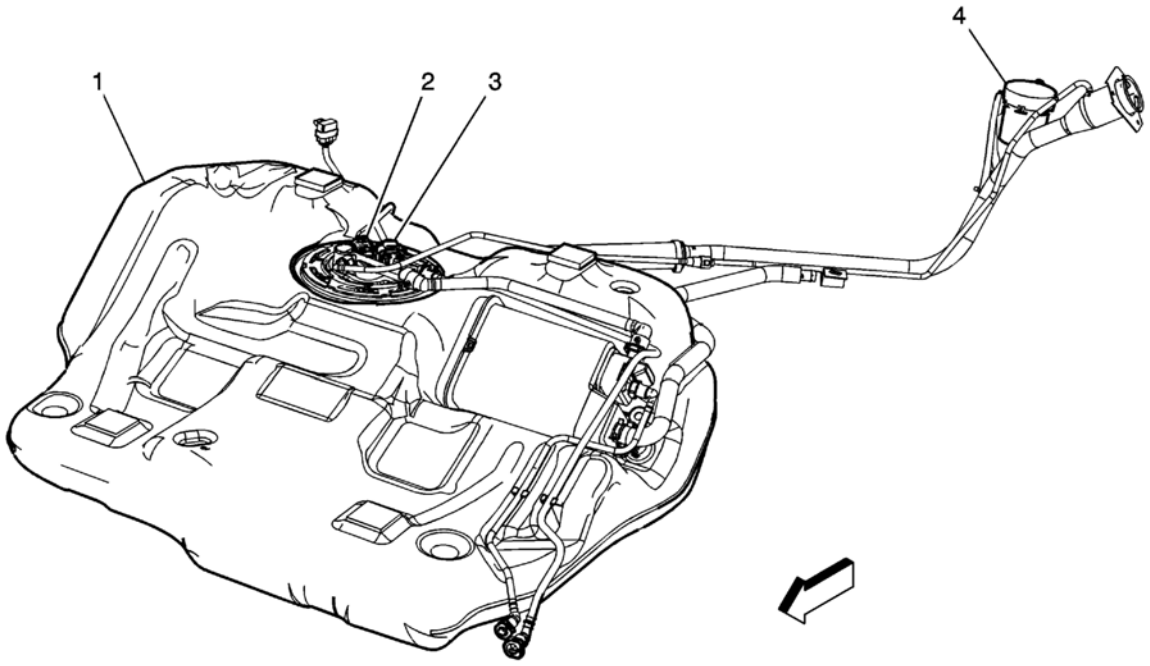


Fig. 4: Fuel Tank Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Tank
2	Fuel Pump and Sender Assembly
3	Fuel Tank Pressure (FTP) Sensor
4	Evaporative Emission (EVAP) Canister Vent Solenoid Valve

Article GUID: A00737233

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Battery Hold Down Fastener	18 N.m	13 lb ft
Battery Positive-to-Battery Positive Post Clamp	10 N.m	89 lb in
Battery Negative-to-Battery Negative Post Clamp	6 N.m	53 lb in
Battery Tray Fastener	5 N.m	44 lb in
Engine Harness Ground Terminal -to- Battery Negative Engine Ground Stud Fastener	20 N.m	15 lb ft
Generator Mounting Fasteners	58 N.m	43 lb ft
Generator Output BAT + Terminal Fastener	20 N.m	15 lb ft
Negative Battery Cable Engine Block Ground Stud/Fastener	50 N.m	37 lb ft
Negative Battery Cable Upper Tie Bar Ground Fastener	10 N.m	89 lb in
Positive Battery Cable Underhood Fuse Block Terminal Fastener	15 N.m	11 lb ft
Starter Heat Shield Fastener	5 N.m	44 lb in
Starter Mounting Fastener	58 N.m	43 lb ft
Starter Solenoid "BAT" Terminal Nut	10 N.m	89 lb in

SCHEMATIC WIRING DIAGRAMS

STARTING AND CHARGING WIRING SCHEMATICS

Starter

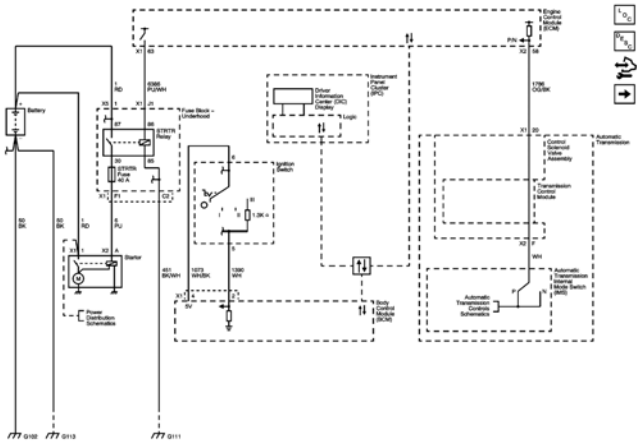


Fig. 1: Starter Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Generator

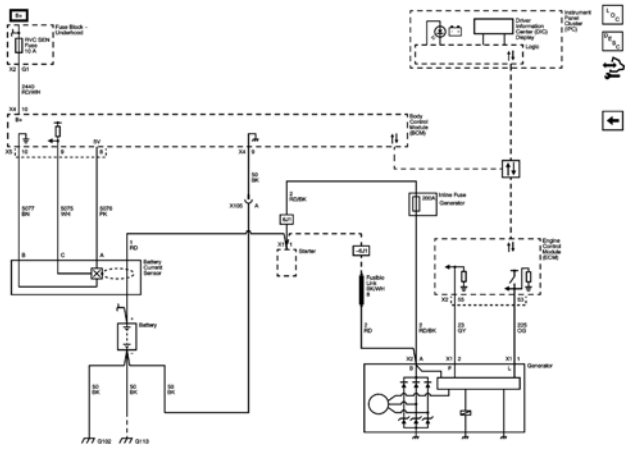


Fig. 2: Generator Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, OR P0563: DEVICE POWER

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1325 03

Device Power Circuit Voltage Below Threshold

DTC B1325 07

Device Power Circuit Voltage Above Threshold

DTC B1330 03

Device Power 2 Circuit Voltage Below Threshold

DTC B1420 00

Device Voltage 1

DTC B1424 00

Device Voltage Low

DTC B1517 03

Battery Voltage Below Threshold

DTC B1517 07

Battery Voltage Above Threshold

DTC B1517 5A

Battery Voltage Plausibility Failure

DTC C0800 03

Device Power 1 Circuit Voltage Below Threshold

DTC C0800 07

Device Power 1 Circuit Voltage Above Threshold

DTC C0800 11

Device Power 1 Circuit High Input

DTC C0800 0D

Device Power 1 Circuit High Resistance

DTC C0895 00

Device Voltage

DTC C0899 00

Device Voltage Low

DTC C0899 03

Device Voltage Low

DTC C0900 00

Device Voltage High

DTC P0560

System Voltage

DTC P0562

System Voltage Low Voltage

DTC P0563

System Voltage High Voltage

Circuit/System Description

The vehicle control modules or sensors monitor the system voltage to verify the system voltage is within the normal operating range.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The control module or sensor detects a system voltage of less than approximately 9 V for approximately 5 seconds.

Action Taken When the DTC Sets

- A driver information center message and/or warning indicator may be displayed.
- The control module may be temporarily disabled.

Conditions for Clearing the DTC

The system voltage returns to normal operating range.

Diagnostic Aids

- A high or low voltage DTC set or voltage value in multiple modules/sensors indicates a concern in the charging system.
- A possible cause of this DTC could be overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify the battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
   - **If battery voltage is less than 12.4 V or more than 12.8 V**

     Refer to **Battery Inspection/Test**.

   - **If battery voltage is between 12.4 and 12.8 V**
3. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
4. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.
   - **If the voltage is not at least 1 V greater than the voltage measured in step 1 or is greater than 15 V.**

     Refer to **Charging System Test**.

   - **If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**
5. Verify the appropriate control module scan tool B+ and ignition voltage parameters are within 1 V of the battery voltage.
   - **If not within 1 V of the battery voltage**

     Refer to Circuit/System Testing.

   - **If within 1 V of the battery voltage**
6. All OK.

Circuit/System Testing

NOTE: **Use the schematic to identify the following:**

- **Control modules the vehicle is equipped with**
- **The control module's ground, B+, and Ignition circuit terminal IDs and connectors**

NOTE: **Some control module ground circuits may require up to 20 min after the ignition is turned off before achieving a resistance reading of less than 5 Ω. In most cases the readings will drop below 20 Ω within 1 min indicating the control module is going to sleep.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connectors at the appropriate control module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between each ground circuit terminal and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the appropriate control module.

- **If the test lamp illuminates**

4. Ignition ON.
5. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ignition circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the ignition circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the appropriate control module.
   - **If the test lamp illuminates**
6. Replace the control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control module replacement, setup, and programming

DTC B1405: DEVICE VOLTAGE REFERENCE OUTPUT 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1405

Device Voltage Reference Output 2 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Current Sensor Supply Voltage	B1516	B1516	-	B1516
Battery Current Sensor Signal	B1405	B1405	-	B1405
Battery Current Sensor Low Reference	-	B1516	-	B1516

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the body control module (BCM). It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Conditions for Running the DTC

- The ignition is ON.
- The engine is running.

Conditions for Setting the DTC

The BCM detects a duty cycle of PWM input signal is less than 4 percent or more than 96 percent for more 33 seconds.

Action Taken When the DTC Sets

The DTC sets as current , no driver indication or message is displayed.

Conditions for Clearing the DTC

The DTC clears as current status when the battery sensed current returns to normal range for more than 5 seconds.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B1405

1. Ignition OFF, disconnect the harness connector at the battery current sensor.
2. Ignition OFF, test for less than 5.0 ohms between the low reference circuit terminal B and ground.
   - If greater than specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the BCM.
3. Ignition ON, test for 4.8-5.2 volts between the battery current sensor supply voltage circuit terminal A and ground.
   - If less than the specified range , test the battery current sensor supply voltage circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
   - If greater than the specified range , test the battery current sensor supply voltage circuit for a short to voltage. If the circuit tests normal, replace the BCM.
4. Ignition ON, test for 4.8-5.2 volts between the battery current sensor signal circuit terminal C and ground.
   - If less than the specified range, test the battery current sensor signal circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
   - If greater than the specified range, test the battery current sensor signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the battery current sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Battery Current Sensor Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B1424: DEVICE 1 VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1424 00

Device 1 Voltage Low

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B1424 00	B1424 00	-	-
Ground	-	B1424 00	-	-

Circuit/System Description

The theft deterrent module (TDM) monitors the battery positive (B+) voltage available to it. If the voltage at the TDM is between 6-9 V, and the voltage being reported by a serial data message is greater than 9 V, then DTC B1424 00 sets.

Conditions for Running the DTC

- The Ignition is in Accessory or Run
- The diagnostic runs every 100 milliseconds.

Conditions for Setting the DTC

- Voltage at the B+ circuit is between 6 and 9 V.
- Reported battery voltage received via serial data is valid and is greater than 9 V.
- The above conditions have been met for 2 seconds.

Action Taken When the DTC Sets

- Security Indicator turns ON.
- The driver information center (DIC) displays the SERVICE THEFT DETERRENT SYSTEM message.

Conditions for Clearing the DTC

- This DTC passes when the battery voltage at the TDM is greater than 9 V, or if the voltage reported by serial data is less than 9 V.
- A history DTC clears after 100 consecutive ignition cycles, if no failures are reported by this diagnostic.

Diagnostic Aids

A low voltage DTC in multiple modules indicates a concern in the charging system.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals.The voltage should be between 12.6 and 15.0 V.
   - If the battery voltage is not within the specified range, refer to **Charging System Test**
2. Ignition OFF, disconnect the harness connector at the theft deterrent module (TDM).
3. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 Ω between the ground circuit terminal 3 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON , verify a test lamp illuminates between the B+ circuit terminal 1 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. If the circuits test normal, replace the TDM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for TDM replacement, set up, and programming

DTC B1516: BATTERY CURRENT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1516 08

Battery Current Sensor Signal Invalid

DTC B1516 66

Battery Current Sensor Wrong Mounting Position

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Current Sensor Supply Voltage	B1516 08	B1516 08	-	B1516 08
Battery Current Sensor Signal	B1405	B1405	-	B1405
Battery Current Sensor Low Reference	-	B1516 08	-	B1516 08

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the body control module (BCM). It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Conditions for Running the DTC

- The ignition is ON.
- The engine is running.

Conditions for Setting the DTC

B1516 08

The BCM detects a duty cycle of PWM input signal is less than 4 percent or more than 96 percent for more 33 seconds.

B1516 66

The BCM detects the battery current sensor is improperly installed.

Action Taken When the DTC Sets

The DTC sets as current , no driver indication or message is displayed.

Conditions for Clearing the DTC

The DTC clears as current status when the battery sensed current returns to normal range for more than 5 seconds.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Testing

B1516 08

1. Ignition OFF, disconnect the harness connector at the battery current sensor.
2. Ignition OFF, test for less than 5.0 ohms between the low reference circuit terminal B and ground.
   - If greater than specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the BCM.
3. Ignition ON, test for 4.8-5.2 volts between the battery current sensor supply voltage circuit terminal A and ground.
   - If less than the specified range , test the battery current sensor supply voltage circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
   - If greater than the specified range , test the battery current sensor supply voltage circuit for a short to voltage. If the circuit tests normal, replace the BCM.
4. Ignition ON, test for 4.8-5.2 volts between the battery current sensor signal circuit terminal C and ground.
   - If less than the specified range, test the battery current sensor signal circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
   - If greater than the specified range, test the battery current sensor signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the battery current sensor.

B1516 66

When diagnosing B1516 66 verify that the battery current sensor is installed securely and positioned in the correct current flow direction.

- If the battery current sensor is not, remove and reinstall the sensor properly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Battery Current Sensor Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B151A: LOW BATTERY CAPACITY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B151A 58

Low Battery Capacity Detected

Circuit/System Description

The body control module (BCM) monitors the battery voltage level during an engine crank event to detect a low battery voltage condition.

Conditions for Running the DTC

The vehicle is ON

Conditions for Setting the DTC

A minimum crank battery voltage is less than the minimum crank battery voltage threshold for 16 consecutive crank events.

Action Taken When the DTC Sets

A driver information center message is displayed.

Conditions for Clearing the DTC

The DTC will clear if the minimum crank voltage is greater than the minimum crank voltage threshold during a crank event.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

- Refer to the **Battery Inspection/Test**.
- Refer to the **Charging System Test**.

DTC B1527: PARASITIC LOAD

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1527 00

Parasitic Load

Circuit/System Description

The body control module (BCM) monitors the state of charge of the electrical system.

Conditions for Running the DTC

The ignition is in Accessory or Run mode.

Conditions for Setting the DTC

The state of charge at ignition ON is 30% lower than when the engine was running and battery drain is more than 2 A.

Action Taken When the DTC Sets

There is no battery telltale illuminated or DIC message displayed.

Conditions for Clearing the DTC

- The DTC will clear if the fault does not return after 50 consecutive ignition cycles.
- The DTC will clear when run state of charge is greater than or equal to 80%.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Refer to **Battery Electrical Drain/Parasitic Load Test**.

DTC P0615, P0616, OR P0617: STARTER RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0615

Starter Relay Control Circuit

DTC P0616

Starter Relay Control Circuit Low Voltage

DTC P0617

Starter Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0616	P0615	P0617	-
Ground	-	P0615	-	-

Circuit/System Description

When the ignition switch is placed in the CRANK position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the CRANK position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch pedal is depressed or the transmission is in Park/Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter motor.

Conditions for Running the DTC

- The ignition is in the CRANK position.
- The system voltage is between 9.5-18 V.

Conditions for Setting the DTC

The ECM detects improper voltage on the control circuit of the starter relay.

Action Taken When the DTC Sets

DTC P0615, P0616, and P0617 are C type DTCs.

Conditions for Clearing the DTC

DTC P0615, P0616, and P0617 are C type DTCs.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR27 Starter Relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 85 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 87 and ground.
   - **If the test lamp does not illuminate**
   1. Ignition OFF.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify cable connection to Battery
   - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
6. Verify the test lamp turns ON and OFF when commanding the KR27 Starter Relay ON and OFF with a scan tool.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If the test lamp is always ON**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If the test lamp turns ON and OFF**
7. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30.
8. Verify the M64 Starter Motor is activated.
   - **If the M64 starter motor does not activate and the circuit fuse is good**
   1. Ignition OFF, disconnect the harness connector at the M64 starter motor.
   2. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the M64 Starter Motor.
   - **If the M64 starter motor does not activate and the circuit fuse is open**

1. Ignition OFF, disconnect the harness connector at the M64 starter motor.
2. Test for infinite resistance between the control circuit terminal X2 A and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the M64 Starter Motor.

- **If the M64 starter motor activates**

9. Test or replace the KR27 Starter Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR27 Starter Relay.
2. Test for 60-180 Ω between terminals 85 and 86.
    - **If less than 60 or greater than 180 Ω**

      Replace the relay.

    - **If between 60-180 Ω**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - **If less than infinite resistance**

      Replace the relay.

    - **If infinite resistance**
4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 Ω between terminals 30 and 87.
    - **If 2 Ω or greater**

      Replace the relay.

    - **If less than 2 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Starter Replacement**
- **Control Module References** for control module replacement, programming, and setup.

DTC P0621: GENERATOR L-TERMINAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0621

Generator L-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator turn on control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle controls the voltage regulator to turn the field circuit on and off. The ECM monitors the state of the generator turn on control circuit. The ECM should detect low voltage on the generator turn on control circuit when the ignition is ON and the engine is off, or when the charging system malfunctions. With the engine running, the ECM should detect on the generator turn on control circuit, a high voltage when the duty cycle voltage is commanded high, and a low voltage when the duty cycle voltage is commanded low.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s).
- The engine is running for the run test.

Conditions for Setting the DTC

- Ignition ON, engine OFF - The ECM detects greater than 3.5 V on the generator control circuit for 5 s.
- Engine running - The ECM detects a low voltage for 15 s on the generator control circuit when the duty cycle voltage is commanded high.
- Engine running - The ECM detects a high voltage for 15 s on the generator control circuit when the duty cycle voltage is commanded low.

Action Taken When the DTC Sets

DTC P0621 is a type C DTC.

Conditions for Clearing the DTC

- Ignition ON, engine OFF- Low voltage.
- Engine running - A control signal duty cycle is detected.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
2. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
3. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X2, B X2 or 1 X2, and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
   - **If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Test for 1 V or greater between the control circuit terminal 1 X1 and ground.
   - **If less than 1 V**
   1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the control circuit end to end.
      - If greater than 2 Ω, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If 1V or greater**
4. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module, Ignition ON
5. Test for less than 1 V between the G13 Generator control circuit terminal 1 X1 and ground.
   - **If greater than 1 V**

     Repair the short to voltage on the circuit.

   - **If 1V or less**
6. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0622: GENERATOR F-TERMINAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0622

Generator F-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings on and off. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is off, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5-99%.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s)
- Engine running at less than 3,000 RPM

Conditions for Setting the DTC

- DTC P0621 is not set
- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s), the ECM detects a PWM signal that is greater than 65% for 5 s
- Engine running at less than 3,000 RPM-The ECM detects a PWM signal that is less than 5% for 30 s

Action Taken When the DTC Sets

DTC P0622 is a type C DTC

Conditions for Clearing the DTC

- Ignition ON, Engine OFF- Low / no PWM signal detected
- Engine running - A 5-90% duty cycle is detected

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Do not have a battery charger connected during the generator testing.**

1. Engine running.
2. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is between 5-90%.
   - **If not between 5-90%**

     Refer to Circuit/System Testing.

   - **If between 5-90%**
3. Verify the scan tool Generator F-Terminal Signal parameter changes when commanding the headlamps ON and OFF.
   - **If the parameter does not change**

     Refer to Circuit/System Testing.

   - **If the parameter changes**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X2, B X2 or 1 X2, and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test or replace the G13 Generator.
   - **If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.
   - **If 5% or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit terminal 2 and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If less than 5%**
4. Install a 3 A fused jumper wire between the signal circuit terminal 2 and B+, engine running.
5. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is greater than 95%.
   - **If 95% or less**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 95%**
6. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P1668: GENERATOR L-TERMINAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1668

Generator L-Terminal Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Generator L- Terminal	P1668	P1668	P1668	-

Circuit/System Description

The engine control module (ECM) uses the generator turn ON signal circuit to control the load of the generator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON signal circuit. The ECM should detect low voltage on generator turn ON signal circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn ON signal circuit. The ECM performs tests to determine the status of the generator turn ON signal circuit.

Conditions for Running the DTC

- No generator, crankshaft position (CKP) sensors, or camshaft position (CMP) sensor DTCs are set.
- The ignition ON, engine OFF for the ignition on test.
- The engine running for the run test.

Conditions for Setting the DTC

- During the ignition ON test, the ECM detects high voltage on the generator turn on signal circuit for at least 5 seconds.
- During the RUN test, the ECM detects low voltage on the generator turn on signal circuit for at least 15 seconds.

Action Taken When the DTC Sets

DTC P1668 is a C type DTC.

Conditions for Clearing the DTC

DTC P1668 is a C type DTC.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the generator.
2. Ignition ON, test for less than 1 volt between the generator turn on signal circuit and ground.
   - If greater than the specified value, test the generator turn on signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
3. Engine Running, test for greater than 3.5 volts between the generator turn on signal and ground.
   - If less than the specified value, test the generator turn on signal circuit for a short to ground, an open/ high resistance. If the circuit tests normal, replace the ECM.
4. If the circuit tests normal, test or replace the generator.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Module References for ECM replacement, setup, and programming
- Generator Replacement

SYMPTOMS - ENGINE ELECTRICAL

NOTE: **The following steps must be completed before using the symptom tables.**

- Perform Diagnostic System Check - Vehicle before using the Symptom Tables in order to verify that all of the following are true:
  - There are no DTCs set.
  - The control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. Refer to one of the following system operations:
  - Battery Description and Operation
  - Charging System Description and Operation
  - Electrical Power Management Description and Operation
  - Starting System Description and Operation

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the starting and charging systems. Refer to Checking Aftermarket Accessories .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Battery Inspection/Test
- Battery Electrical Drain/Parasitic Load Test
- Charging System Test
- Generator Noise Diagnosis
- Starter Solenoid Does Not Click
- Starter Solenoid Clicks, Engine Does Not Crank
- Engine Cranks Slowly
- Starter Noise Diagnosis

BATTERY INSPECTION/TEST

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Aids

NOTE: **For Warranty repairs -**

You must use regionally required battery test equipment for warranty repairs.

For accurate test results the battery must be disconnected from the vehicle and the equipment connected directly to the battery posts. When setting up the equipment, select "Out of Vehicle" and then the correct battery type (Flooded, AGM or Stop/Start AGM) and rated CCA (both from the battery label) must be entered.

- **Failure to obtain the correct connections during the test may result in a failed test on a good battery.**
- **Use the Out of Vehicle test (battery disconnected with test equipment connected directly to the posts) for each battery when testing a vehicle with dual batteries.**

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 50313 Battery Tester

Circuit/System Testing

WARNING: Unless directed otherwise, the ignition must be OFF with the key removed, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStarÂ® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÂ® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÂ®module). Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÂ® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Verify the C1 Battery or C1B Battery - Auxiliary (if equipped) case is not cracked, broken, or damaged, which may be indicated by battery acid leakage.
   - **If there is any apparent damage**

     Replace the C1 Battery or C1B Battery - Auxiliary.

   - **If there is no damage**
2. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in **Fastener Specifications**.
   - **If the battery cables need to be cleaned or tightened**

     Clean as required and tighten as specified.

   - **If the battery cables are clean and tight**
3. Disconnect battery from the vehicle. There is no need to remove the battery from the vehicle.
4. Connect the EL-50313 directly to the battery terminal posts.
5. Select "Charging," "Diagnostic" and "Out of Vehicle" when setting up the test.
6. Select the proper battery type, Flooded, AGM or Stop/Start AGM.
7. Enter the CCA as shown on the battery label.
8. Verify the test result is not REPLACE BATTERY or BAD CELL-REPLACE

   NOTE: Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular time. The test code may occasionally repeat when you retest the same battery. More often, each test will result in a different code. Use the test code from the Out of Vehicle test.

   - **If the test result is REPLACE BATTERY or BAD CELL-REPLACE**

     Replace the C1 Battery or C1B Battery - Auxiliary.

   - **If the test result is not REPLACE BATTERY or BAD CELL-REPLACE**
9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Battery Replacement

BATTERY CHARGING

Special Tools

EL 50313 Battery Tester

For equivalent regional tools, refer to **Special Tools**.

Diagnostic Aids

- The charging area should be well ventilated.
- Do not charge a battery that appears to be frozen. Allow the battery to warm to room temperature and test it using the **EL 50313** Battery Tester before charging.
- An AGM battery may be damaged if charged to more than 14.5 V.
- A Flooded Cell battery may be damaged if charged to more than 16.5 V.
- Vehicles with dual batteries must be charged individually which will result in two printouts.

Battery State of Charge

NOTE: **Using voltage to determine the batteries state of charge is only accurate after the battery has been at rest for 24 hours. This is enough time for the acid in each cell to equalize. If the battery has been charged or discharged in the past 24 hours, the battery state of charge will only be an estimate.**

The maintenance-free batteries state of charge is estimated by reading the voltage of the battery across the battery terminals. Because the voltage is affected by current flow into or out of the battery, the engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the batteries state of charge:

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
   - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.
   - If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.
3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.

   NOTE: **The table is accurate to 10 percent only after the battery has been at rest for 12 hours.**

4. Measure the battery voltage at the battery terminals. Refer to the following table to determine the state of charge according to the estimated battery temperature:

Battery Voltage	% Charge at 0Â°C (32Â°F)	% Charge at 25Â°C (75Â°F)
12.75 V	100%	100%
12.7 V	100%	90%
12.6 V	90%	75%
12.45 V	75%	65%
12.2 V	65%	45%
12.0 V	40%	20%

Use the state of charge information as follows:

- A battery with a state of charge that is below 65 percent must always be recharged before returning it to service or continuing storage.
- A battery with a state of charge that is 65 percent or greater is generally considered to be charged enough in order to be returned to normal service or in order to continue storage. However, if the battery is being used in slow traffic or with short drive times, or if the temperature is very hot or very cold, the battery should be fully charged, to at least 90 percent, before returning it to service or continuing storage.

Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

- The battery charger capacity-The higher the charger amperage, the less time it will take to charge the battery.
- The state of charge of the battery-A completely discharged battery requires more than twice as much charging time as a half charged battery. In a discharged battery with a voltage below 11 V, the battery has a very high internal resistance and may only accept a very low current at first. Later, as the charging current causes the acid content to increase in the electrolyte, the charging current will increase. Extremely discharged batteries may not activate the reversed voltage protection in some chargers. Refer to the manufacturer's instructions for operating this circuitry.
- The temperature of the battery-The colder the battery is, the more time it takes to recharge the battery. The charging current accepted by a cold battery is very low at first. As the battery warms, the charging current will increase.

Charging Procedure

CAUTION: **Turn OFF the ignition when connecting or disconnecting the battery cables, the battery charger or the jumper cables. Failure to do so may damage the ECM/PCM or other electronic components.**

CAUTION: **Refer to Fastener Caution .**

When charging side-terminal batteries with the battery cables connected, connect the charger to the positive cable bolt and to a ground located away from the battery. When charging side-terminal batteries with the battery cables disconnected, install the battery side terminal adapters and connect the charger to the adapters.

1. Ensure that all of the battery terminal connections are clean and tight.
2. Connect the charger positive lead to the battery positive terminal on the battery or the remote jumper stud underhood.

   CAUTION: **Do not connect the negative charger lead to the housings of other vehicle electrical accessories or equipment. The action of the battery charger may damage such equipment.**

3. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery. If the negative battery cable is disconnected and a terminal adapter is being used, connect directly to the adapter.
4. Select "Charging," "PDI" and "In Vehicle" when setting up the charger.
5. Select the proper battery type, Flooded, AGM, Spiral AGM or Stop/Start AGM.
6. Enter the CCA as shown on the battery label.

BATTERY ELECTRICAL DRAIN/PARASITIC LOAD TEST

12 V Battery

The following procedure is for the 12 V battery only.

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

Components most likely to cause a parasitic draw on the vehicles battery are switches, relays, and control modules. After the ignition is turned OFF the control modules will begin to go to sleep shut OFF. All control modules do not go to sleep at the same time, some may take up to 30 min or longer after turning the ignition off before going to sleep. Other modules may periodically wake up then go back to sleep. These are all normal conditions.

Diagnostic Aids

- Rule out any possible aftermarket equipment causing an unacceptable parasitic current drain. Aftermarket accessories installed into the courtesy lamp circuit can cause the inadvertent power timer in the body control module (BCM) to keep resetting. This may cause the BCM to remain awake and cause a current drain on the battery.
- Rule out customer driving habits such as regular short trips that do not allow enough time to properly charge the battery. Refer to **Battery Description and Operation**.
- Verify that the battery and charging system are in proper working order. Refer to **Battery Charging**, and **Charging System Test**.
- A battery discharging for no apparent reason while the vehicle is parked can be caused by an intermittent draw, such as a module waking up, or a continuous draw, such as a dome light or stuck relay.
- Some systems and modules such as OnStarÂ®, and regulated voltage control, if equipped, are designed to wake up, perform a task, and go back asleep at regular intervals. Refer to **Body Control System Description and Operation** for the system or modules description and operation.
- An engine off natural vacuum evaporative test can occur if the engine control module (ECM) determines the drive cycle has met the appropriate criteria immediately after key off. The ECM will stay awake and the vent solenoid will stay energized for as long as 45 min. The typical current draw for this is about 1 A.
- Digital OnStar generation 6 and later vehicle communication interface module do not "wake up" every 10 min for the first 48 h as the generation 5 and prior. generation 6 and later vehicle communication interface module current draw is very low, less than 40 mA, so the OnStar system is left in that state for up to the first 48 h. Parasitic draw of up to 40 mA with an occasional spike as high as 80 mA through the vehicle communication interface module for the first 48 h is normal.
- Some automatic climate control systems can remain in a semi awake state for up to three hours, actual draw amounts vary by vehicle platform but are typically not greater than 50 mA.
- An extremely low mA current level is consumed by the remote keyless entry receiver for monitoring purposes, actual system wake up only occurs when the fobs for the vehicle are used. When other devices on the same remote keyless entry operating frequency are activated, such as the 4 tire pressure monitoring sensors and other vehicle FOBs in the vicinity, the remote keyless entry receiver will have a 100 mA spike. These spikes are normal and occur too briefly to have a significant effect on battery drain. Competing signals may cause remote keyless entry performance issues such as jamming but should not cause excessive battery draw.
- If an excessive current draw is not present during initial testing, continue periodic testing over a 1-2 hour period to see if the current draw increases and stays above an unacceptable level.

NOTE: **The battery specification listed below is a generic specification. Refer to the label on the original battery when testing the battery.**

- The battery run down time will vary depending on the batteries reserve capacity. If the reserve capacity is higher, then the battery run down time may be longer. If the reserve capacity is lower, then the battery run down time may be shorter. The graph below indicates roughly how many days a 690 cold cranking amperage battery with a 110 min reserve capacity starting at 80% state of charge will last with a constant current draw until it reaches 50% state of charge. Differences in battery reserve capacity and temperature will affect the results.

Current Drain	Days
25 mA	33
50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 38758 Parasitic Draw Test Switch

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

NOTE:

- **Most vehicle systems will go to sleep within 30 min but it can take up to 2 h before all systems power down allowing the parasitic draw test to pass. An occasional increase in the parasitic draw is normal as long as it returns within 1 s.**
- **Closing the door latches/ajar switch while leaving the doors open is recommended, this allows the vehicle systems to perform in a "doors closed" mode while allowing vehicle interior access that may be needed to complete the diagnostic steps.**
- **Locking doors will arm the vehicle content theft deterrent system if equipped. Failure to arm the system may cause a theft system fault to not be present during testing.**
- **There are many things that can prevent the vehicle from completely going to sleep and passing the parasitic draw test. Make sure all the conditions listed below are met before performing the parasitic current draw test.**
  - **Ignition OFF**
  - **Key out of the ignition switch - when not equipped with keyless access and start**
  - **Retained Accessory Power OFF - open and close the driver door after ignition OFF**
  - **Scan tool not communicating with a vehicle control module - in some cases it may need to be disconnected from the DLC**
  - **All access doors closed**
  - **Headlamps OFF - auto headlamps disabled**
  - **Any delay lighting OFF**
  - **If equipped with an under hood lamp disable it**

- **HVAC after blow OFF**
- **Any accessory that can work with ignition OFF inactive or OFF**
- **Wait up to 2 min or longer, after all other listed conditions are met**

Using an Inductive Pickup Probe

1. Connect an inductive pickup probe to the negative battery cable that can read down to 1 mA.
2. Ignition OFF, as the vehicle systems shut down test for less than 30 mA of parasitic current drain.
   - If greater than the specified range, refer to Circuit/System Testing.

Using the EL 38758 Parasitic Draw Test Switch

WARNING: **Refer to Battery Disconnect Warning .**

CAUTION: **When a fused jumper wire or digital multimeter is connected to the test switch terminals, always turn the test switch ON before opening any access door, turning the ignition on, or turning any accessory on. This is to prevent damaging the jumper wire or digital multimeter fuse.**

NOTE: **The switch knob on the EL 38758 switch is marked ON and OFF. When the switch knob is in the ON position, the circuit is closed and electrical current will pass through the switch. When the switch knob is in the OFF position, the circuit is open and electrical current will not pass through the switch.**

1. Ignition OFF, disconnect the battery negative cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Turn the **EL 38758** switch knob to the OFF position.
3. Install the male end of the **EL 38758** switch to the battery ground terminal.
4. Install the battery negative cable to the female end of the **EL 38758** switch.
5. Turn the **EL 38758** switch knob to the ON position.
6. Road test the vehicle and activate all of the accessories such as the radio and air conditioning.
7. Ignition OFF, connect a 10 A fused jumper wire to the test switch tool terminals.
8. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the jumper wire.
9. Check the fuse in the jumper wire. The fuse should be OK.
   - Failed: If the jumper wire fuse is blown, refer to Circuit/System Testing.
   - Passed
10. Turn the **EL 38758** switch knob to the ON position. Remove the fused jumper wire.
11. Connect a DMM set to the 10 A DC scale between the test switch tool terminals.
12. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the DMM.
13. As the vehicle systems shut down test for less than 30 mA of parasitic current drain.
    - If greater than the specified range, refer to Circuit/System Testing.

Circuit/System Testing

NOTE:

- **Removing or installing a fuse, relay, or connector, to determine the area causing high parasitic draw may wake up control modules. You must wait for the control modules to go back to sleep before retesting. It is best to install any removed or disconnected components after the diagnosis is completed.**
- **Fuses for power mode master components such as the BCM should be removed last to avoid misdiagnosis.**
- **If a scan tool is connected to the DLC, either disconnect it or subtract the scan tool current draw from the DMM reading to get the actual vehicle parasitic current draw.**

If the vehicle has an unacceptable amount of parasitic current draw, remove each fuse one at a time until the current draw falls to an acceptable level. A drop of more than 10-20 mA, when disabling a single system or circuit, is an indication of an overly high current draw that could be causing the battery drain. Refer to Power Distribution Schematics to diagnose exactly which circuit of the suspect system is causing the high parasitic drain. The following is a list of common components that could cause a high current draw:

- Stuck switch
- Stuck relay
- Control module

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for control module replacement, programming and setup

CHARGING SYSTEM TEST

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Reference Information

Description and Operation

Charging System Description and Operation

Electrical Information Reference

Testing for Intermittent Conditions and Poor Connections

Circuit/System Verification

Engine ON, observe the charge indicator on the instrument panel cluster (IPC) or message in the driver information center (DIC). The charge indicator on the IPC should be turned OFF and the DIC should not display charging system message

- If the charge indicator is not on the IPC and a charging system message is not displayed on the DIC, refer to Testing for Intermittent Conditions and Poor Connections .
- If the charge indicator is on the IPC or a charging system message is displayed on the DIC, refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition ON, verify that no generator or battery current sensor DTCs are set that would cause a charging system concern.
   - If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, measure the voltage across the battery terminals. The voltage should read 12.0 volts or greater at room temperature.
   - If not within specified value, refer to **Battery Inspection/Test**.
3. Connect a carbon pile tester to the battery.
4. Start the engine and increase the engine speed to 2,500 RPM. Observe the voltage reading on the tester. The voltage should read between 12.6 - 15.0 volts.
   - If not within specified range, replace the generator.
5. Adjust the carbon pile tester to the specified load test output value according to the C1 battery designation..
   - If not within specified value, replace the generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Generator Replacement

GENERATOR NOISE DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Aids

Noise from a generator may be due to electrical or mechanical noise. Electrical noise or magnetic whine usually varies with the electrical load placed on the generator and is a normal operating characteristic of all generators. When diagnosing a noisy generator, it is important to remember that loose or misaligned components around the generator may transmit the noise into the passenger compartment and that replacing the generator may not solve the problem.

Circuit/System Testing

1. Start the engine, verify the noise can be heard. Compare the concern to a similar vehicle.
2. Inspect the generator, generator mounting, wiring harness, heater hoses, A/C lines or other accessory equipment that may misrouted or may be the cause of the noise to be transmitted into the passenger compartment.
3. Ignition OFF, remove the engine drive belt. Verify the generator, idler pulley and tensioner pulley spin freely.
   - If any of the pulleys do not spin freely, replace the affected component.
4. Loosen all generator mounting bolts and ensure the generator is properly aligned. Tighten mounting bolts to specification, refer to **Generator Replacement**.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Drive Belt Replacement**
- **Drive Belt Tensioner Replacement**
- **Drive Belt Idler Pulley Replacement**
- **Generator Replacement**

STARTER SOLENOID DOES NOT CLICK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ terminal 87	1	1	-	-
ECM Park/ Neutral Signal	2	1	-	-
Coil Control terminal 86	-	1	3	-
Control Output terminal 30	1	1	3	-
Coil Ground terminal 85	-	1	-	-
1. No crank 2. Cranks in any gear 3. Cranks all the time				

Circuit/System Description

When the ignition switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 volts to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that no starter relay, theft deterrent, engine, or automatic transmission DTCs are set that would cause the ECM not to enable engine starting.
   - If DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
2. Ignition ON, observe the scan tool BCM Current Power Mode parameter. Place ignition switch in the crank position, the parameter should display Crank Request.
   - If not the specified value, refer to Power Mode Mismatch
3. Transmission range selector in park , verify the scan tool ECM PNP Switch and TCM IMS parameters display Park/Neutral.
   - If the TCM IMS parameter does not indicate Park/Neutral. Refer to Transmission Internal Mode Switch Logic
   - If the ECM Park/Neutral parameter does not indicate Park/Neutral. Refer to ECM Park Switch Circuit Malfunction.
4. Transmission range selector in park or neutral, attempt to start the vehicle. The starter relay should click and the engine should begin cranking.
   - If the STRTR relay does not click or the engine does not crank, refer to Starter Relay Circuit Malfunction.
5. Ignition ON, observe the scan tool ECM Crankshaft Position Sensor Active Counter is not incrementing.
   - If the Crankshaft Position Sensor Active Counter is incrementing, replace the Crankshaft Position Sensor.

Circuit/System Testing

ECM Park Switch Circuit Malfunction

1. Ignition OFF, disconnect the harness connector at the AT X1 20-Way Connector.
2. Ignition ON, install a 3A fused jumper wire between the signal circuit terminal 20 X1 and ground. Verify the scan tool ECM PNP switch parameter displays Park/Neutral.
   - If not the specified value, test the signal circuit terminal 20 X1 for an open/high resistance. If the circuit tests normal, replace the ECM.
3. If all circuits test normal, test or replace the internal mode switch (IMS).

Starter Relay Circuit Malfunction

1. Ignition OFF, disconnect the starter relay.
2. Ignition OFF, test for less than 3.0 ohms between the relay ground circuit terminal 85 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp illuminates between the relay switch B+ circuit terminal 87 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Ensure the parking brake is applied and the transmission is in PARK. Momentarily install a 40A fused jumper wire between the relay switch B+ circuit terminal 87 and the relay controlled output circuit terminal 30. The starter solenoid should engage and the engine should begin cranking.
   - If the solenoid does not engage, test the relay controlled output circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the starter motor.
5. Connect a test lamp between the relay coil control circuit terminal 86 and the relay coil ground circuit terminal 85.
6. With transmission range selector in park or neutral, cycle the ignition between the OFF and CRANK position. The test lamp should turn ON and OFF when changing between the commanded states.
   - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
   - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the starter relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Crankshaft Position Sensor Replacement
- Relay Replacement (Attached to Wire Harness) Relay Replacement (Within an Electrical Center)
- Starter Replacement
- Control Module References for ECM replacement, setup, and programming.

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ terminal 87	1	1	-	-
ECM Park/ Neutral Signal	2	1	-	-
Coil Control terminal 86	-	1	3	-
Control Output terminal 30	1	1	3	-
Coil Ground terminal 85	-	1	-	-
1. No crank 2. Cranks in any gear 3. Cranks all the time				

Circuit/System Description

When the ignition switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 volts to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that no starter relay, theft deterrent, or automatic transmission DTCs are set that would cause the ECM not to enable engine starting.
   - If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, observe the scan tool BCM Current Power Mode parameter. Place ignition switch in the crank position, the parameter should display Crank Request.
   - If not the specified value, refer to **Power Mode Mismatch**
3. Transmission range selector in park , verify the scan tool ECM PNP Switch and TCM IMS parameters display Park/Neutral.
   - If the TCM IMS parameter does not indicate Park/Neutral. Refer to **Transmission Internal Mode Switch Logic**
   - If the ECM Park/Neutral parameter does not indicate Park/Neutral. Refer to ECM Park Switch Circuit Malfunction.
4. Transmission range selector in park or neutral, attempt to start the vehicle. The starter relay should click and the engine should begin cranking.
   - If the STRTR relay does not click or the engine does not crank, refer to Starter Relay Circuit Malfunction.

Circuit/System Testing

ECM Park Switch Circuit Malfunction (4T65-E)

1. Ignition OFF, disconnect the harness connector at the AT Inline 20-Way Connector.
2. Ignition ON, install a 3A fused jumper wire between the signal circuit terminal W and ground. Verify the scan tool ECM PNP switch parameter displays Park/Neutral.
   - If not the specified value, test the signal circuit terminal W for an open/high resistance. If the circuit tests normal, replace the ECM.
3. If all circuits test normal, test or replace the internal mode switch (IMS).

Starter Relay Circuit Malfunction

1. Ignition OFF, disconnect the starter relay.
2. Ignition OFF, test for less than 3.0 ohms between the relay ground circuit terminal 85 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp illuminates between the relay switch B+ circuit terminal 87 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Ensure the parking brake is applied and the transmission is in PARK. Momentarily install a 40A fused jumper wire between the relay switch B+ circuit terminal 87 and the relay controlled output circuit terminal 30. The starter solenoid should engage and the engine should begin cranking.
   - If the solenoid does not engage, test the relay controlled output circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the starter motor.
5. Connect a test lamp between the relay coil control circuit terminal 86 and the relay coil ground circuit terminal 85.
6. With transmission range selector in park or neutral, cycle the ignition between the OFF and CRANK position. The test lamp should turn ON and OFF when changing between the commanded states.
   - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
   - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the starter relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Starter Replacement**
- **Control Module References** for ECM replacement, setup, and programming.

ENGINE CRANKS SLOWLY

Inspect the following items:

- Battery-Perform the Battery Inspection/Test. Refer to **Battery Inspection/Test**.
- Wiring-Inspect the wiring for damage. Inspect all connections to the starter motor, the solenoid, the battery, and all ground connections. Refer to:
  - **Circuit Testing**
  - **Wiring Repairs**
  - **Testing for Intermittent Conditions and Poor Connections**
  - **Connector Repairs**
- Engine-Verify that the engine is not seized.

If the battery, the wiring, and the engine are functioning properly, and the engine continues to crank slowly, replace the starter motor. Refer to **Starter Replacement**.

STARTER NOISE DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The PG starter motors are non-repairable. They have pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the

starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

Reference Information

Description and Operation

Charging System Description and Operation

Circuit/System Verification

Start the engine. Listen to the starter noise while the engine is cranking. Compare the concern to a similar vehicle.

Circuit/System Testing

1. Remove the flywheel inspection cover.
2. Inspect the flywheel for the following:
   - Loose flywheel bolts
   - Chipped gear teeth
   - Missing gear teeth
   - Bent flywheel
   - Debris in the bell housing
   - If not within specifications, remove the debris, tighten the flywheel bolts, or repair or replace the flywheel.
3. If all inspections were within specification, replace the starter motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Flywheel Replacement**
- **Starter Replacement**

REPAIR INSTRUCTIONS

BATTERY NEGATIVE CABLE DISCONNECTION AND CONNECTION

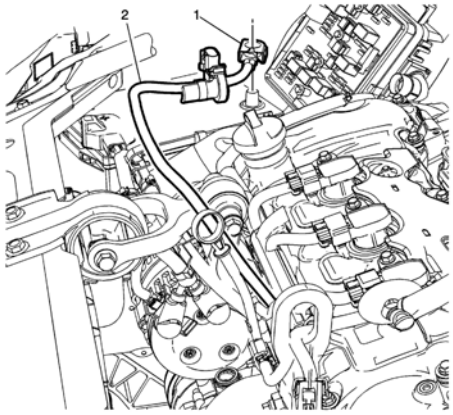


Fig. 3: Battery Negative Cable
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Battery Negative Post Clamp **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 6 N.m (53 lb in)
2	Battery Negative Cable

BATTERY CURRENT SENSOR REPLACEMENT

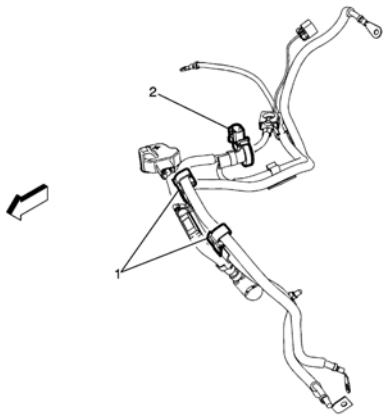


Fig. 4: Battery Current Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the battery positive and negative cable. Refer to **Battery Positive and Negative Cable Replacement**.	
1	Battery Positive and Negative Cable Retainers
2	Battery Current Sensor **Procedure** The battery current sensor is part of the battery positive and negative cable. **NOTE:** **If the battery current sensor needs to be replaced, replace the battery positive and negative cable.**

BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the underhood fuse block cover.

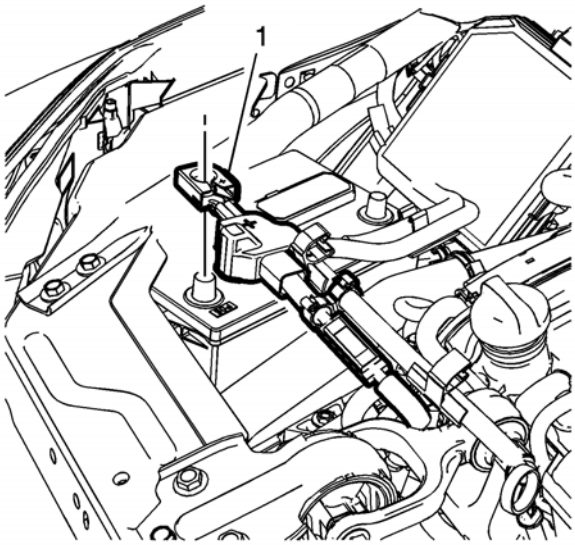


Fig. 5: Battery Positive Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Remove the protective boot on the battery positive cable.
4. Release the battery positive clamp (1) and remove the battery positive cable from the battery post.

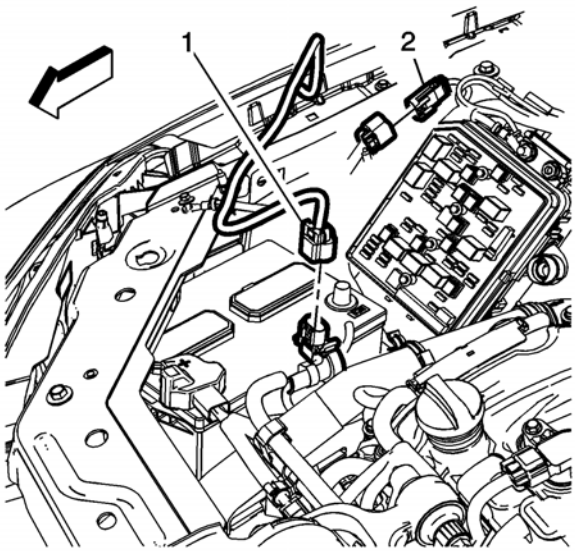


Fig. 6: Battery Current Sensor And Instrument Panel Harness Connector
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the battery current sensor (1) and the instrument panel harness connector (2), from the battery positive and negative cable harness.

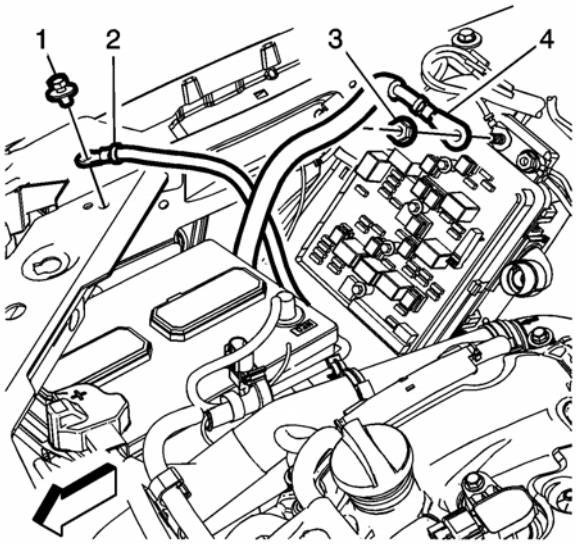


Fig. 7: Battery Negative Cable, Battery Positive Cable And Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the battery negative ground terminal fastener (1) and remove the battery negative cable (2).
7. Remove the battery positive fuse block fastener (3) and remove the battery positive cable (4).

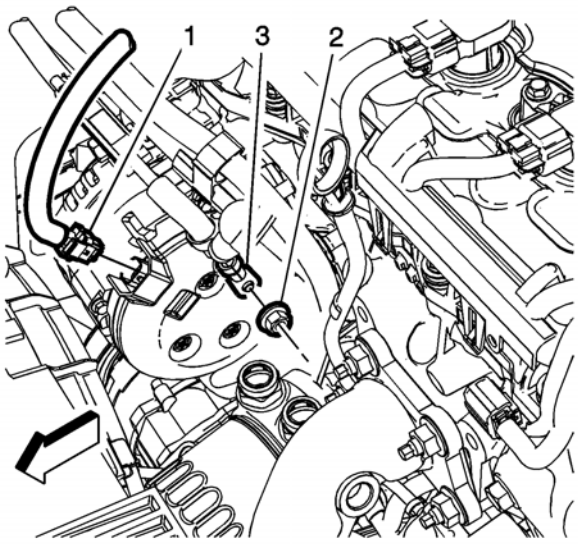


Fig. 8: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Remove the battery positive protective boot from the battery positive terminal at the back of the generator.
9. Remove the battery positive fastener (2) and the battery positive cable (3) from the generator.
10. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
11. Remove the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .

NOTE: **Do not discharge the air conditioning system.**

12. Remove the air conditioning compressor and set aside. Refer to **Air Conditioning Compressor Replacement** .

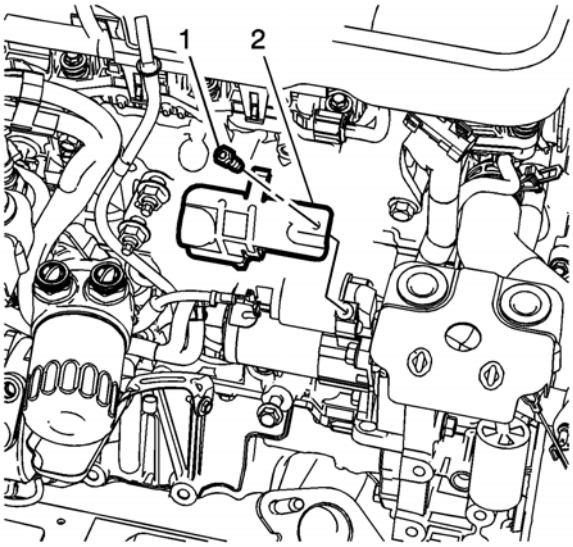


Fig. 9: Starter Heat Shield And Fastener
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the engine coolant temperature (ECT) sensor connector. Refer to **Engine Coolant Temperature Sensor Replacement** .
14. Remove the starter heat shield fastener (1) and the starter heat shield (2).

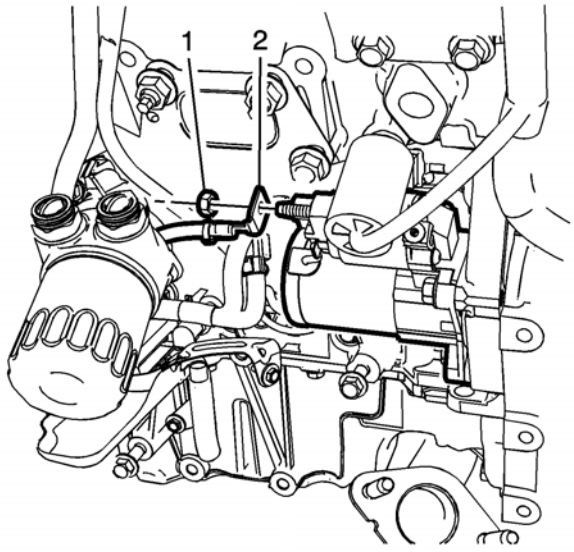


Fig. 10: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

15. Remove the starter battery positive fastener (1) and the battery positive cable (2), from the starter.

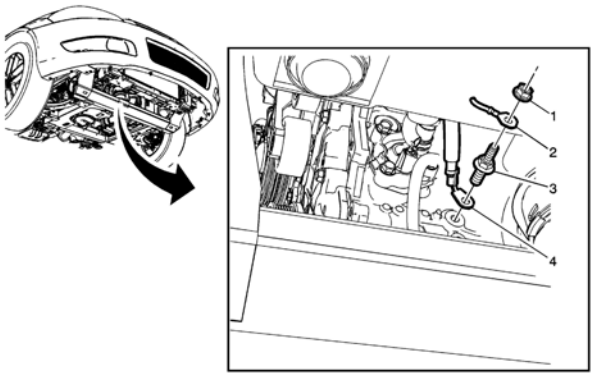


Fig. 11: Battery Negative Cable Terminal, Engine Harness Ground Terminal, Fastener And Stud
Courtesy of GENERAL MOTORS COMPANY

16. Remove the engine harness ground fastener (1) and the engine harness ground terminal (2).
17. Remove the battery negative cable ground stud (3) and the battery negative cable terminal (4) from the engine block.

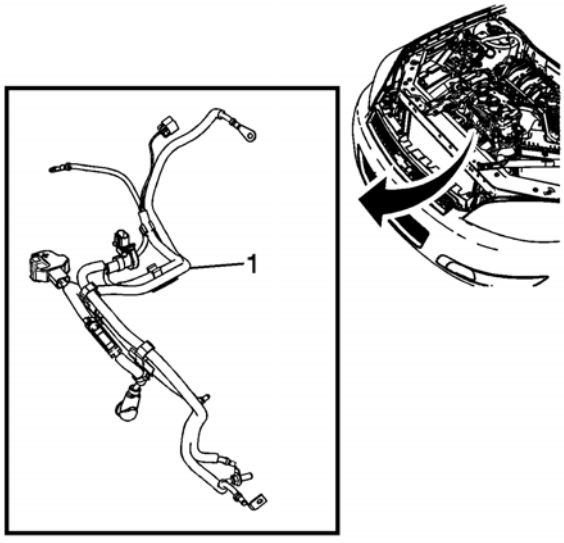


Fig. 12: Battery Positive And Negative Cable
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Observe how the battery positive and negative cable was routed within the engine compartment.**

18. Remove the battery positive and negative cable (1) from the vehicle.

Installation Procedure

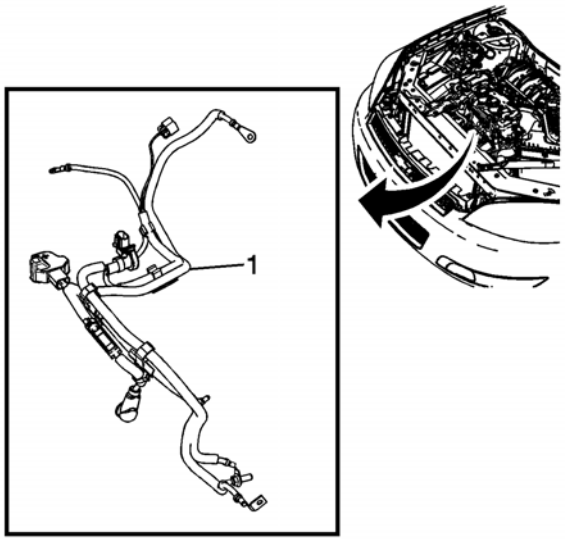


Fig. 13: Battery Positive And Negative Cable
Courtesy of GENERAL MOTORS COMPANY

1. Route the battery positive and negative cable (1) into the front engine compartment.

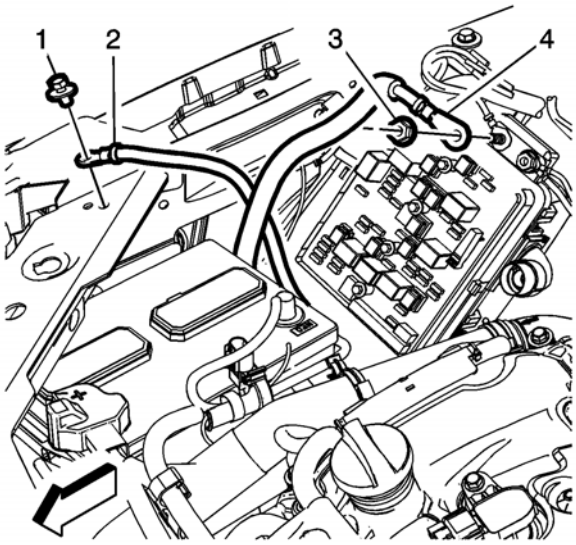


Fig. 14: Battery Negative Cable, Battery Positive Cable And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install the battery negative cable ground terminal (2) to the upper tie bar and tighten the fastener (1) to 10 N.m (89 lb in).
3. Install the battery positive cable terminal (4) to the underhood fuse block stud (1) and tighten the fastener (3) to 15 N.m (11 lb ft).
4. Install the underhood fuse block cover.

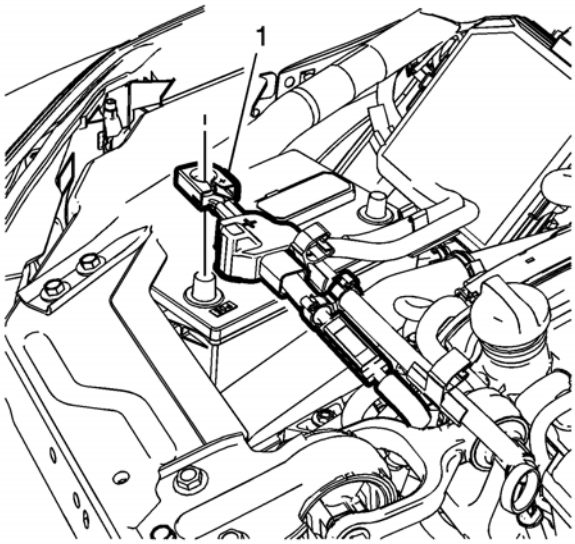


Fig. 15: Battery Positive Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Connect the battery positive cable clamp (1) to the battery post and reinstall the protective boot.

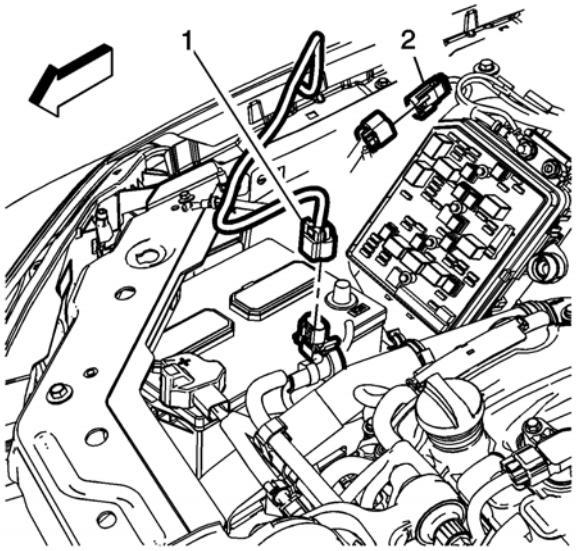


Fig. 16: Battery Current Sensor And Instrument Panel Harness Connector
Courtesy of GENERAL MOTORS COMPANY

6. Connect the battery current sensor connector (1) and the instrument panel harness connector (2).

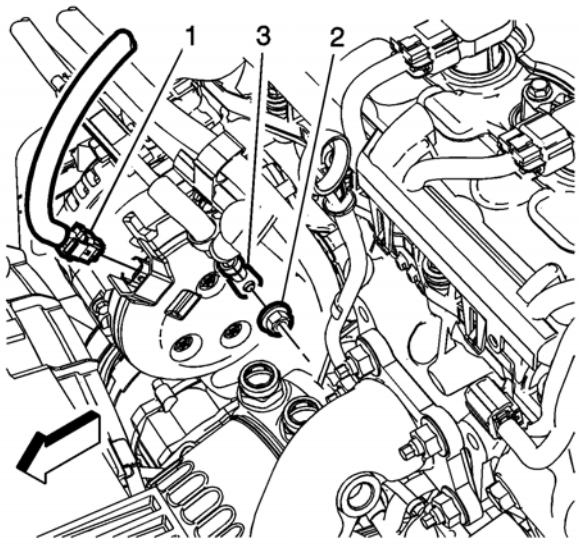


Fig. 17: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Install the battery positive terminal (3) to the back of the generator and tighten the fastener (2) to 20 N.m (15 lb ft).
8. Install the protective boot onto the generator stud.

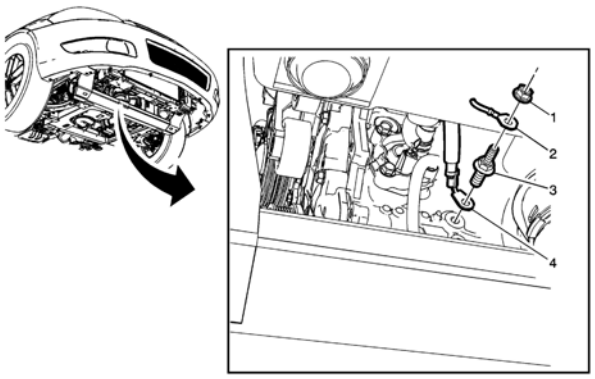


Fig. 18: Battery Negative Cable Terminal, Engine Harness Ground Terminal, Fastener And Stud
Courtesy of GENERAL MOTORS COMPANY

9. Install the battery negative cable terminal (4) and the stud (3) to the engine block. Tighten the stud (3) to 50 N.m (37 lb ft).
10. Install the engine harness terminal (2) to the stud (3) and tighten the fastener (1) to 20 N.m (15 lb ft).

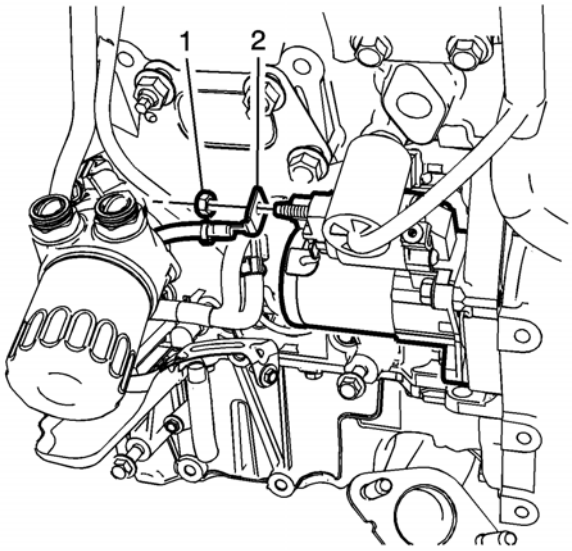


Fig. 19: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

11. Install the battery positive terminal (2) to the starter and tighten the fastener (1) to 10 N.m (89 lb in).

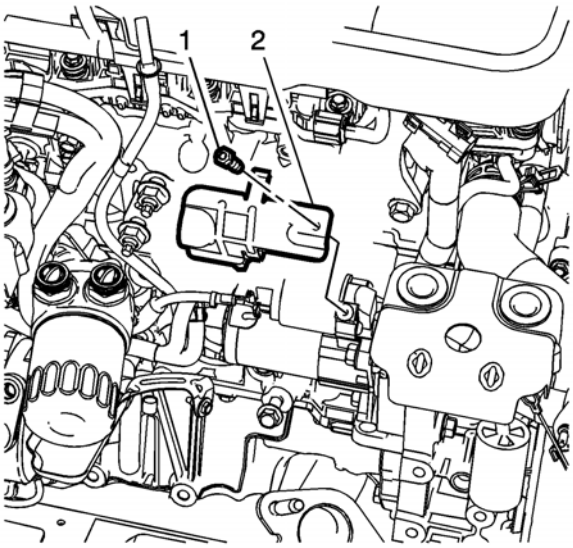


Fig. 20: Starter Heat Shield And Fastener
Courtesy of GENERAL MOTORS COMPANY

12. Install the starter heat shield (2) and tighten the fastener (1) to 5 N.m (44 lb in).
13. Connect the engine coolant temperature (ECT) sensor.
14. Install the air conditioning compressor. Refer to **Air Conditioning Compressor Replacement** .
15. Install the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
16. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the accessory wiring junction block. Refer to **Accessory Wiring Junction Block Replacement** .
3. Remove the right front diagonal brace. Refer to **Front Fender Upper Diagonal Brace Replacement** .

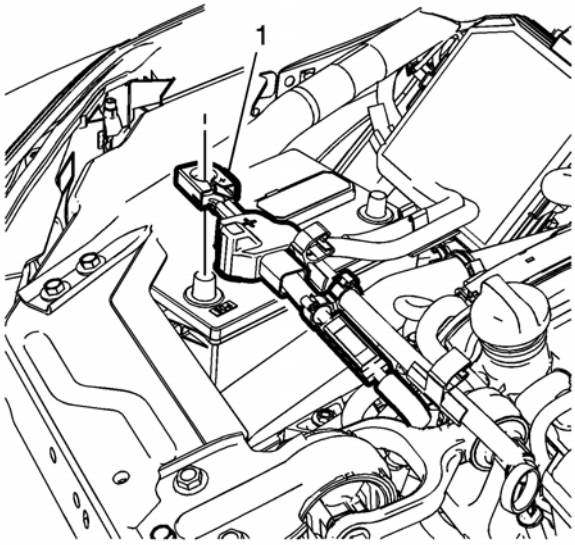


Fig. 21: Battery Positive Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Open the positive battery cable terminal cover and release the positive cable clamp (1).
5. Remove the positive battery cable from the battery.

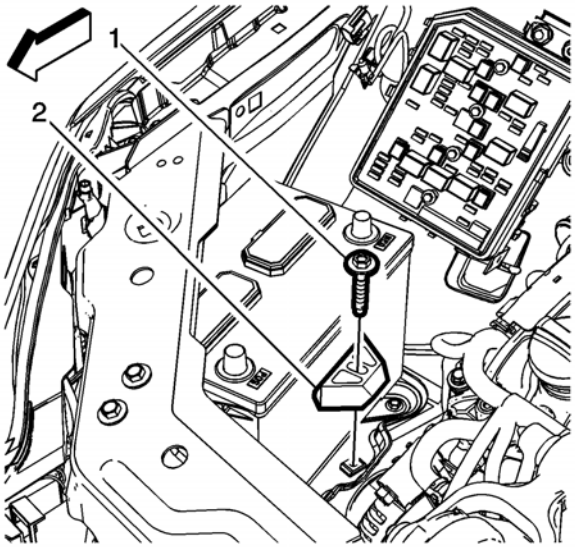


Fig. 22: Retainer And Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Remove the battery hold down fastener (1) and hold down retainer (2).

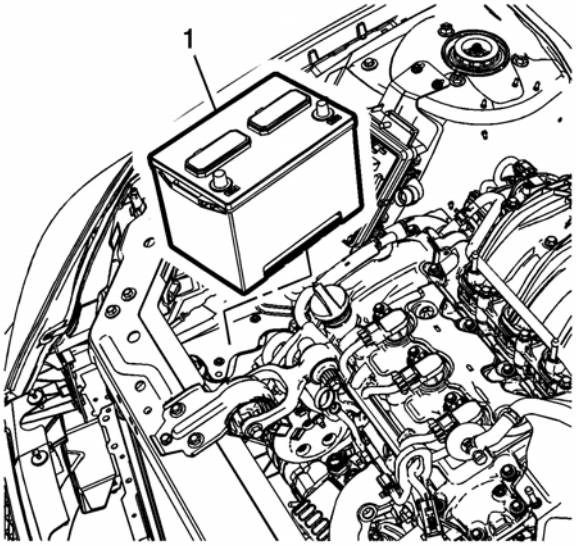


Fig. 23: Battery
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not tip the battery more than 40 degrees during removal.**

7. Remove the battery (1).

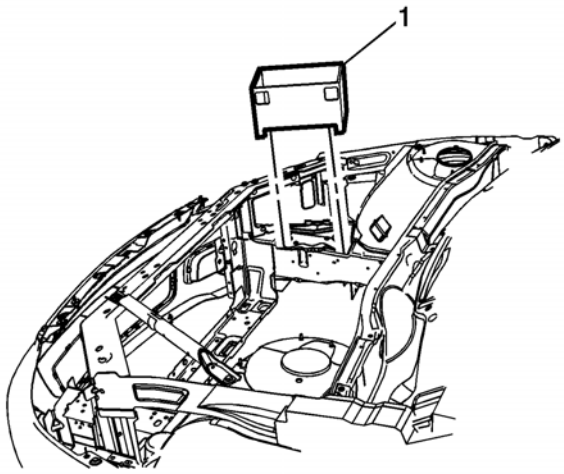


Fig. 24: Battery Insulator
Courtesy of GENERAL MOTORS COMPANY

8. Remove the battery insulator.

Installation Procedure

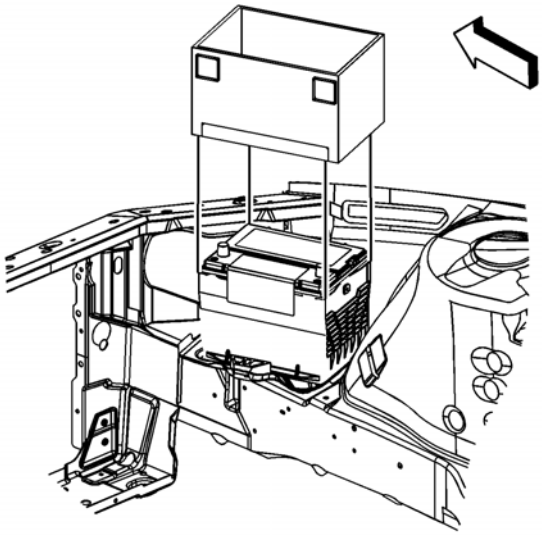


Fig. 25: View Of Battery Insulator
Courtesy of GENERAL MOTORS COMPANY

1. Install the battery insulator.

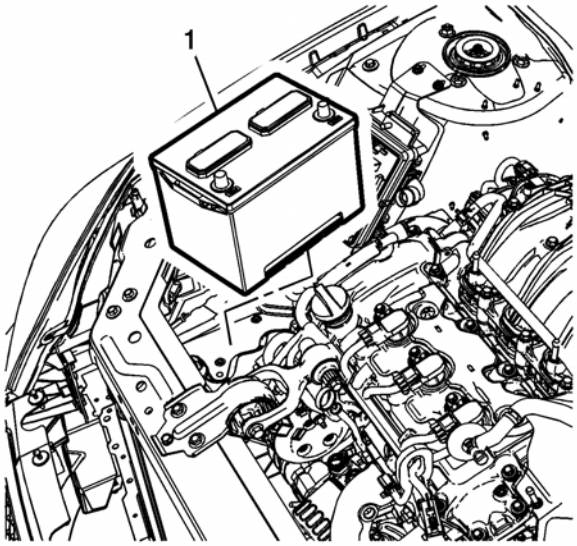


Fig. 26: Battery
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not tip the battery more than 40 degrees during installation.**

2. Install the battery (1).

CAUTION: **Refer to Fastener Caution .**

3. Install the battery hold down retainer and tighten the fastener to 18 N.m (13 lb ft).

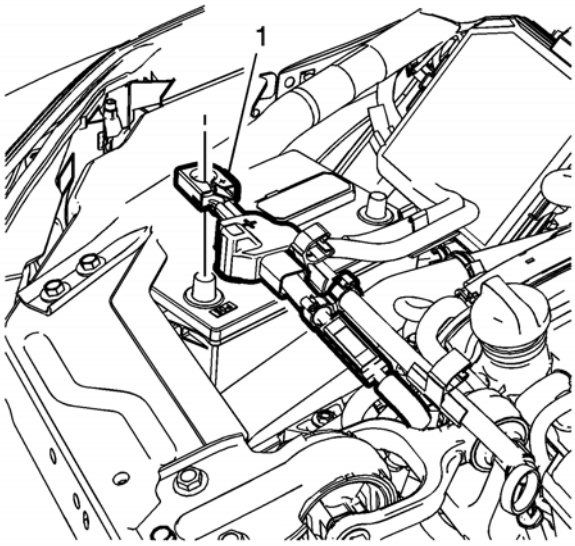


Fig. 27: Battery Positive Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Install the positive battery cable clamp (1) to the battery positive post and tighten to 10 N.m (89 lb in).
5. Install the battery positive cover.
6. Install the accessory wiring junction block. Refer to **Accessory Wiring Junction Block Replacement** .
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
8. Install the right front diagonal brace. Refer to **Front Fender Upper Diagonal Brace Replacement** .

BATTERY TRAY REPLACEMENT

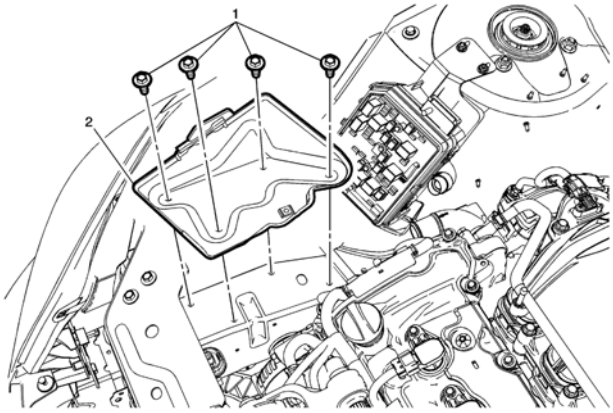


Fig. 28: Battery Tray & Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the battery.Refer to Battery Replacement	
1	Bolt (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 5 N.m (44 lb in).
2	Battery Tray **TIP:** Unclip the harness retainers from the battery tray.

STARTER REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
4. Lower the vehicle.

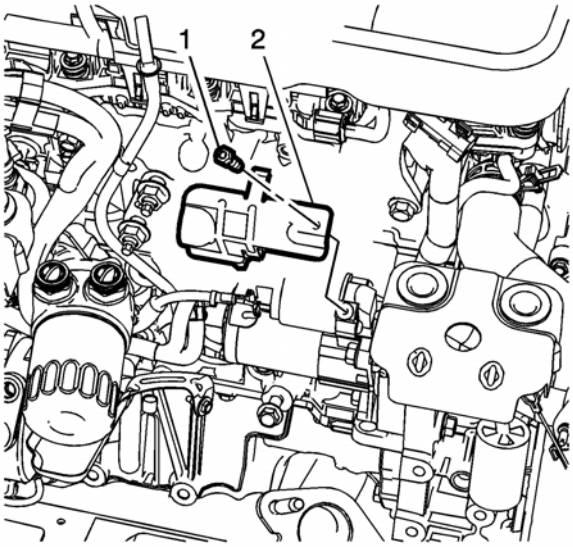


Fig. 29: Starter Heat Shield And Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine coolant temperature sensor connector. Refer to **Engine Coolant Temperature Sensor Replacement** .
6. Remove the bank 2 knock sensor. Refer to **Knock Sensor Replacement - Bank 2** .
7. Remove the starter heat shield fastener (1) and the starter heat shield (2).

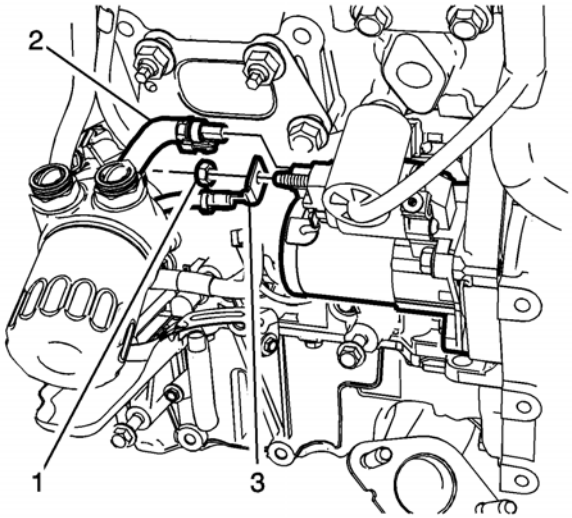


Fig. 30: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the battery positive cable fastener (1), from the starter.
9. Remove the battery positive cable (3) from the starter.

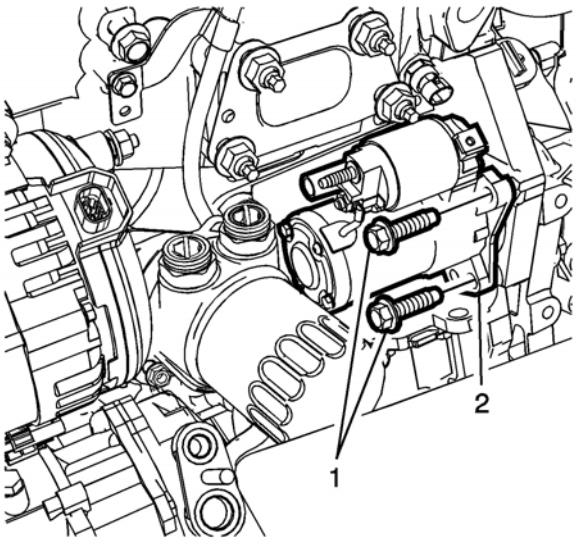


Fig. 31: Starter And Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Remove the top starter mounting fastener (1) and reposition the starter.
11. Disconnect the engine harness connector and remove the lower starter fastener (1).
12. Remove the starter (2).

Installation Procedure

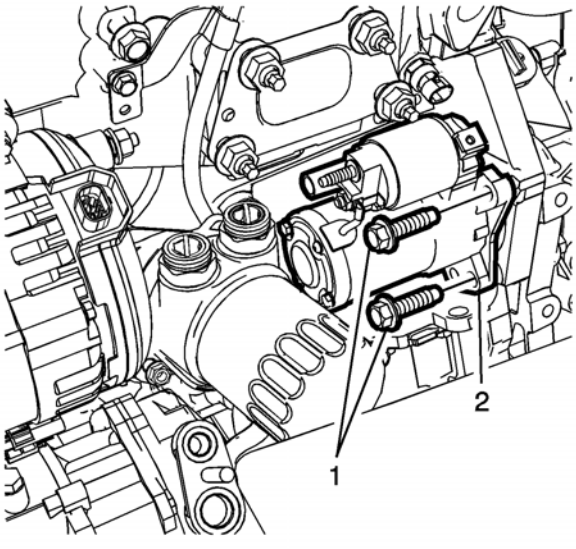


Fig. 32: Starter And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Position the starter (2), connect the engine harness connector and loosely install the top fastener (1).
2. Install the bank 2 knock sensor. Refer to **Knock Sensor Replacement - Bank 2** .

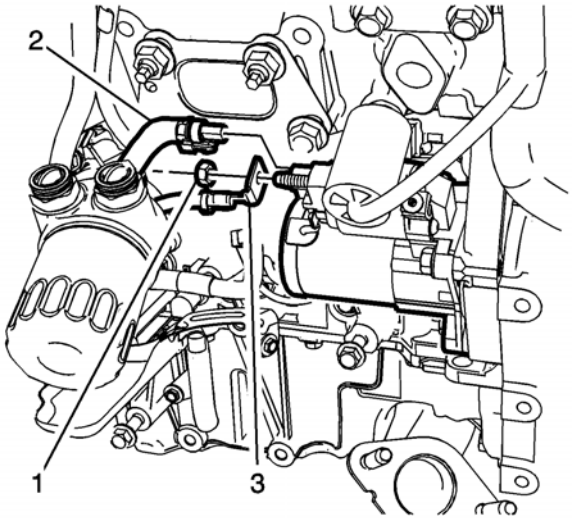


Fig. 33: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Install the battery positive cable terminal (3) to the starter.
4. Tighten the battery positive cable fastener (1) to 10 N.m (89 lb in).
5. Raise the vehicle.

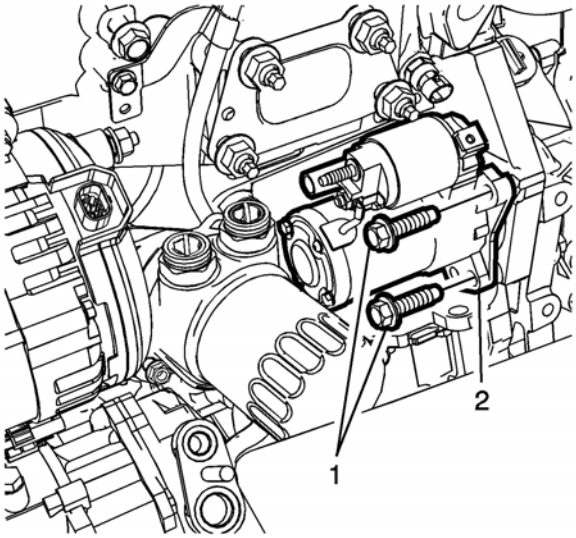


Fig. 34: Starter And Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Install the lower starter fastener (1) and tighten to 58 N.m (43 lb ft).
7. Lower the vehicle.
8. Tighten the upper starter fastener (1) to 58 N.m (43 lb ft).

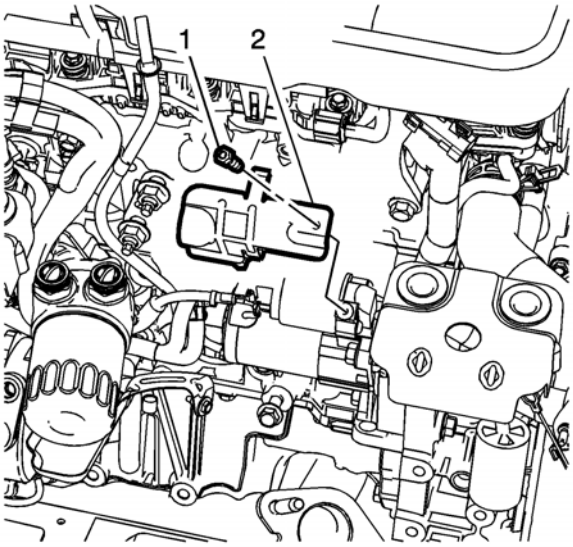


Fig. 35: Starter Heat Shield And Fastener
Courtesy of GENERAL MOTORS COMPANY

9. Install the starter heat shield (2) and tighten the starter heat shield fastener (1) to 5 N.m (44 lb in).
10. Install the engine coolant temperature sensor connector. Refer to **Engine Coolant Temperature Sensor Replacement** .
11. Install the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
12. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

GENERATOR REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement** .
3. Remove the right engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side** .

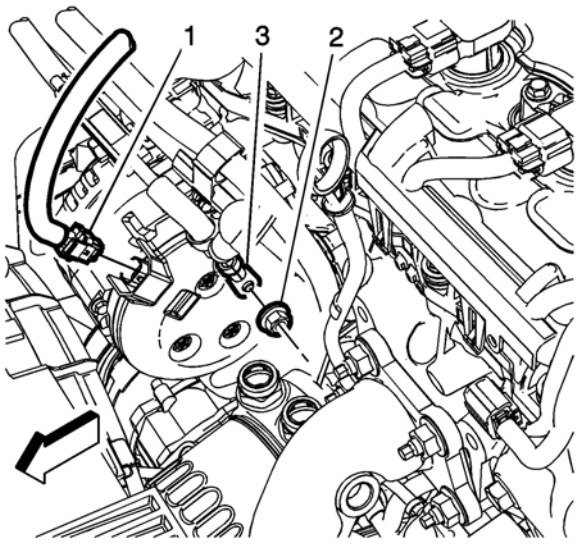


Fig. 36: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the engine harness connector (1) and remove the battery positive fastener (2).
5. Remove the battery positive cable (3).

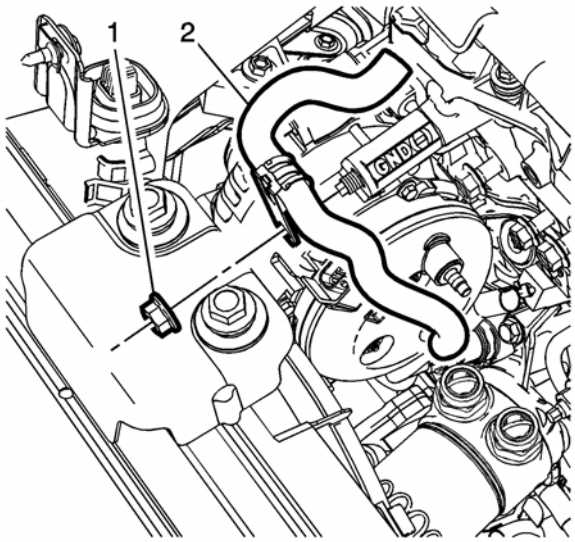


Fig. 37: Engine Harness And Generator Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Remove the generator fastener (1) and the engine harness (2), from the generator.

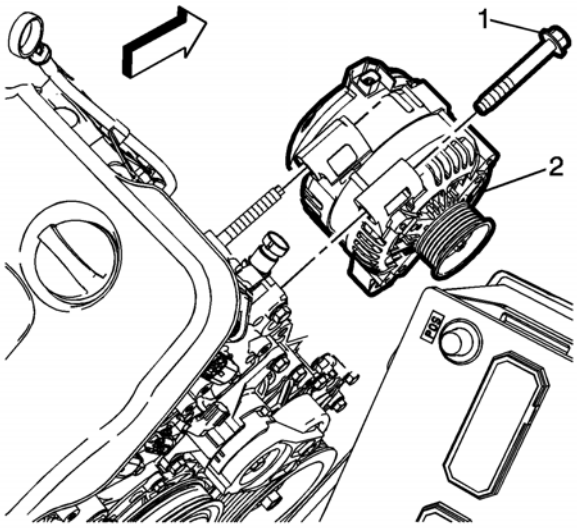


Fig. 38: Generator And Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Remove the generator mounting fastener (1) and remove the generator (2).

Installation Procedure

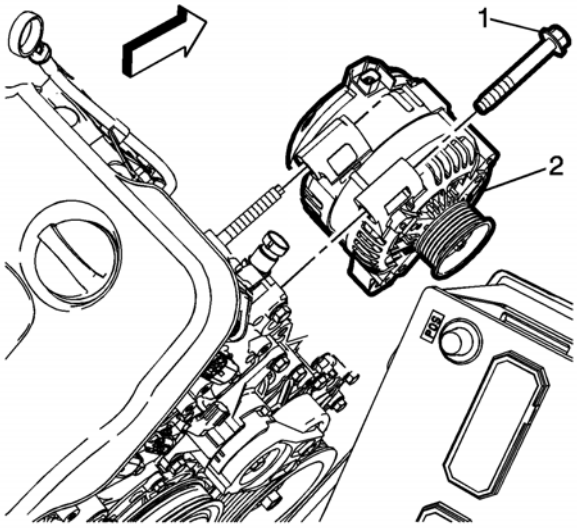


Fig. 39: Generator And Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the generator (2) and tighten the fastener (1) to 58 N.m (43 lb ft).

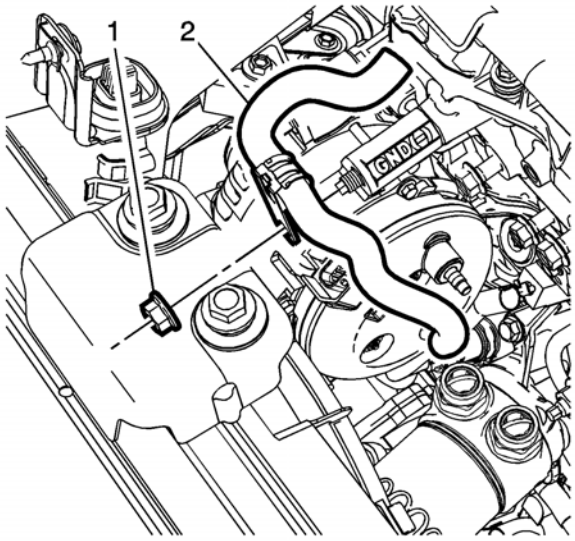


Fig. 40: Engine Harness And Generator Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Install the engine harness (2) to the generator mounting stud and tighten the fastener (1) to 58 N.m (43 lb ft).

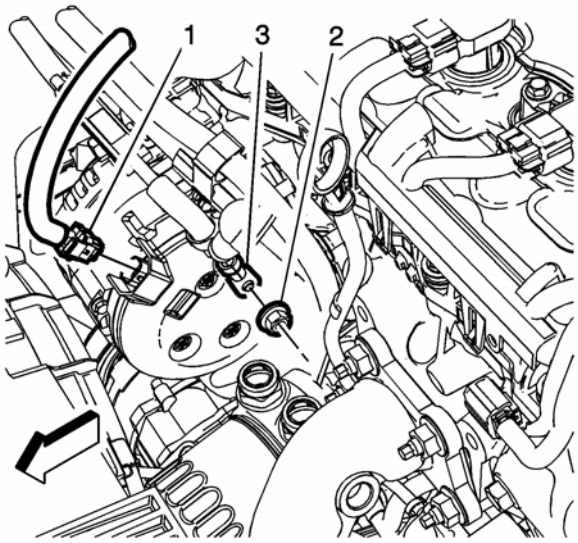


Fig. 41: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine harness connector (1) to the generator and install the battery positive terminal (3) to the generator stud. Tighten the fastener (2) to 20 N.m (15 lb ft).
4. Install the right engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side** .
5. Install the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement** .
6. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

WARNING: Batteries produce explosive gases, contain corrosive acid, and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:

- **Always shield your eyes and avoid leaning over the battery whenever possible.**
- **Do not expose the battery to open flames or sparks.**
- **Do not allow the battery electrolyte to contact the eyes or the skin. Flush immediately and thoroughly any contacted areas with water and get medical help.**
- **Follow each step of the jump starting procedure in order.**
- **Treat both the booster and the discharged batteries carefully when using the jumper cables.**

Batteries that are no longer wanted must be disposed of by an approved battery recycler and must never be thrown in the trash or sent to a landfill.

Batteries that are not part of the vehicle itself, not the battery under the hood, must only be transported on public streets for business purposes via approved hazardous material transportation procedures.

Battery storage, charging and testing facilities in repair shops must meet various requirements for ventilation, safety equipment, material segregation, etc.

The maintenance free battery is standard. There are no vent plugs in the cover. The battery is completely sealed except for 2 small vent holes in the side. These vent holes allow the small amount of gas that is produced in the battery to escape.

The battery has 3 functions as a major source of energy:

- Engine cranking
- Voltage stabilizer
- Alternate source of energy with generator overload

Battery Low Start Vehicle Message

The body control module (BCM) monitors battery positive voltage to determine battery state of charge. If one or more of the BCM battery positive voltage terminals measure less than approximately 11.6V compared to the BCM ground circuits, this message will display and four chimes may sound. Start the vehicle immediately. If the vehicle is not started and the battery continues to discharge, the climate controls, heated seats, and audio systems will shut off and the vehicle may require a jump start. These systems will function again after the vehicle is started.

Battery Ratings

A battery has 2 ratings:

- Cold cranking amperage
- Amperage hours

When a battery is replaced use a battery with similar ratings. See battery specification label on the original battery.

Amperage Hours

The amperage hour rating tells you how much amperage is available when discharged evenly over a 20 hour period. The amperage hour rating is cumulative, so in order to know how many constant amperage the battery will output for 20 h, you have to divide the amperage hour rating by 20. Example: If a battery has an amperage hour rating of 74, dividing by 20 = 3.75. Such a battery can carry a 3.75 A load for 20 hours before dropping to 10.5 V. (10.5 V is the fully discharged level, at which point the battery needs to be recharged.) A battery with an amperage hour rating of 55 will carry a 2.75 A load for 20 hours before dropping to 10.5 V.

Cold Cranking Amperage

The cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. The cold cranking amperage rating is the minimum amperage the battery must maintain for 30 seconds at -18Â°C (0Â°F) while maintaining at least 7.2 V. See battery label for the cold cranking amperage rating of this battery.

CHARGING SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management Overview

The electrical power management system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems with the battery and generator. This electrical power management system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life, and minimize the system's impact on fuel economy. The electrical power management system performs 3 functions:

- It monitors the battery voltage and estimates the battery condition.
- It takes corrective actions by boosting idle speeds, and adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during ignition-off and during ignition-on. During ignition-off the state-of-charge of the battery is determined by measuring the open-circuit voltage. The state-of-charge is a function of the acid concentration and the internal resistance of the battery, and is estimated by reading the battery open circuit voltage when the battery has been at rest for several hours.

The state-of-charge can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates state-of-charge based on adjusted net amp hours, battery capacity, initial state-of-charge, and temperature.

While running, the battery degree of discharge is primarily determined by a battery current sensor, which is integrated to obtain net amp hours.

In addition, the electrical power management function is designed to perform regulated voltage control to improve battery state-of-charge, battery life, and fuel economy. This is accomplished by using knowledge of the battery state-of-charge and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

The Charging System Description and Operation is divided into 3 sections. The first section describes the charging system components and their integration into the electrical power management. The second section describes charging system operation. The third section describes the instrument panel cluster operation of the charge indicator, driver information center messages, and voltmeter operation.

Charging System Components

Generator

The generator is a serviceable component. If there is a diagnosed failure of the generator it must be replaced as an assembly. The engine drive belt drives the generator. When the rotor is spun it induces an alternating current (AC) into the stator windings. The AC voltage is then sent through a series of diodes for rectification. The rectified voltage has been converted into a direct current (DC) for use by the vehicles electrical system to maintain electrical loads and the battery charge. The voltage regulator integral to the generator controls the output of the generator. It is not serviceable. The voltage regulator controls the amount of current provided to the rotor. If the generator has field control circuit failure, the generator defaults to an output voltage of 13.8 V.

Body Control Module (BCM)

The body control module (BCM) is a GMLAN device. It communicates with the engine control module (ECM) and the instrument panel cluster for electrical power management (electrical power management) operation. The BCM determines the output of the generator and sends the information to the ECM for control of the generator turn on signal circuit. It monitors the generator field duty cycle signal circuit information sent from the ECM for control of the generator. It monitors a battery current sensor, the battery positive voltage circuit, and estimated battery temperature to determine battery state of charge. The BCM performs idle boost.

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to either the negative or positive battery cable at the battery. The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the BCM. It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Engine Control Module (ECM)

When the engine is running, the generator turn-on signal is sent to the generator from the ECM, turning on the regulator. The generator's voltage regulator controls current to the rotor, thereby controlling the output voltage. The rotor current is proportional to the electrical pulse width supplied by the regulator. When the engine is started, the regulator senses generator rotation by detecting AC voltage at the stator through an internal wire. Once the engine is running, the regulator varies the field current by controlling the pulse width. This regulates the generator output voltage for proper battery charging and electrical system operation. The generator field duty terminal is connected internally to the voltage regulator and externally to the ECM. When the voltage regulator detects a charging system problem, it grounds this circuit to signal the ECM that a problem exists. The ECM monitors the generator field duty cycle signal circuit, and receives control decisions based on information from the BCM.

Instrument Panel Cluster

The instrument panel cluster provides the customer notification in case a concern with the charging system. There are 2 means of notification, a charge indicator and a driver information center message of SERVICE BATTERY CHARGING SYSTEM if equipped.

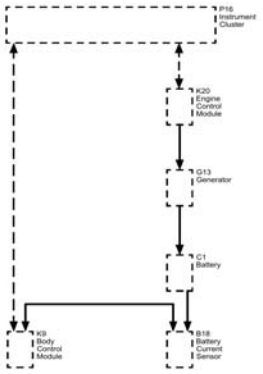


Fig. 42: Charging System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DB	Serial Data - GMLAN Low Speed
DB	Serial Data - GMLAN Low Speed
P16	P16 Instrument Cluster
K20	K20 Engine Control Module
G13	G13 Generator
C1	C1 Battery
B18	B18 Battery Current Sensor
K9	K9 Body Control Module

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 6 modes of operation and they include:

- Battery Sulfation Mode
- Charge Mode
- Fuel Economy Mode
- Headlamp Mode
- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the generator through the generator turn ON signal circuit. The ECM monitors the generator performance though the generator field duty cycle signal circuit. The signal is a pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes. The following table shows the commanded duty cycle and output voltage of the generator:

Commanded Duty Cycle	Generator Output Voltage
10%	11 V
20%	11.56 V
30%	12.12 V
40%	12.68 V
50%	13.25 V
60%	13.81 V
70%	14.37 V
80%	14.94 V
90%	15.5 V

The generator provides a feedback signal of the generator voltage output through the generator field duty cycle signal circuit to the ECM. This information is sent to the body control module (BCM). The signal is PWM signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-99 percent. Between 0-5 percent and 100 percent are for diagnostic purposes.

Battery Sulfation Mode

The BCM will enter this mode when the interpreted generator output voltage is less than 13.2 V for 45 minutes. When this condition exists the BCM will enter Charge Mode for 2-3 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

Charge Mode

The BCM will enter Charge Mode when ever one of the following conditions are met.

- The wipers are ON for more than 3 seconds.
- GMLAN (Climate Control Voltage Boost Mode Request) is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0Â°C (32Â°F).
- Battery State of Charge is less than 80 percent.
- Vehicle speed is greater than 145 km/h (90 mph)
- Current sensor fault exists.
- System voltage was determined to be below 12.56 V

When any one of these conditions is met, the system will set targeted generator output voltage to a charging voltage between 13.9-15.5 V, depending on the battery state of charge and estimated battery temperature.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the estimated battery temperature is at least 0Â°C (32Â°F) but less than or equal to 80Â°C (176Â°F), the calculated battery current is less than 15 amperes and greater than -8 amperes, and the battery state-of-charge is greater than or equal to 80 percent. Its targeted generator output voltage is the open circuit voltage of the battery and can be between 12.5-13.1 V. The

BCM will exit this mode and enter Charge Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp Mode when ever the headlamps are ON (high or low beams). Voltage will be regulated between 13.9-14.5 V.

Start Up Mode

When the engine is started the BCM sets a targeted generator output voltage of 14.5 V for 30 seconds.

Voltage Reduction Mode

The BCM will enter Voltage Reduction Mode when the calculated ambient air temperature is above 0Â°C (32Â°F). The calculated battery current is less than 1 ampere and greater than -7 amperes, and the generator field duty cycle is less than 99 percent. Its targeted generator output voltage is 12.9 V. The BCM will exit this mode once the criteria are met for Charge Mode.

Instrument Panel Cluster Operation

Charge Indicator Operation

The instrument panel cluster illuminates the charge indicator and displays a warning message in the driver information center if equipped, when the one or more of the following occurs:

- The engine control module (ECM) detects that the generator output is less than 11 V or greater than 16 V. The instrument panel cluster receives a GMLAN message from the ECM requesting illumination.
- The instrument panel cluster determines that the system voltage is less than 11 V or greater than 16 V for more than 30 seconds. The instrument panel cluster receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.
- The instrument panel cluster performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

Display Message: BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM

The BCM and the ECM will send a serial data message to the driver information center for the BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

Electrical Power Management

The electrical power management is used to monitor and control the charging system and alert the driver of possible problems within the charging system. The electrical power management system makes the most efficient use of the generator output, improves the battery state-of-charge, extends battery life, and manages system electrical loads.

The load shed operation is a means of reducing electrical loads during a low voltage or low battery state-of-charge condition.

The idle boost operation is a means of improving generator performance during a low voltage or low battery state-of-charge condition.

Each electrical power management function, either idle boost or load shed, is activated in incremental steps. For example, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate electrical power management are outlined below:

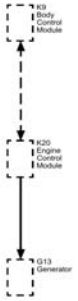


Fig. 43: Electrical Power Management Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DD	Serial Data - GMLAN High Speed
K9	K9 Body Control Module
K20	K20 Engine Control Module
G13	G13 Generator

Idle Boost and Load Shed With Current Sensor

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15Â°C (5Â°F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 Ah	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 11 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -10Â°C (14Â°F)	Greater Than 12 V	Battery has a net loss less than 0.2 Ah	First level Idle boost request cancelled
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 Ah	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 11 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 Ah	Second level Idle boost request cancelled
Load Shed 1 Start	-	-	Battery has a net loss of 4 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Load Shed 1 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12 V	Battery has a net loss of less than 2 Ah	Clear Load Shed 1
Idle Boost 3 Start	-	-	Battery has a net loss of 10 Ah	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 11 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6.0 Ah	Third level Idle boost request cancelled
Load Shed 2 Start	-	-	Battery has a net loss greater than 12 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12 V	Battery has a net loss of less than 8 Ah	Clear Load Shed 2
Load Shed 3 Start	-	Less Than 11.9 V	Battery has a net loss greater than 20 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.6 V	Battery has a net loss of less than 13 Ah	Clear Load Shed 3

Idle Boost and Load Shed Without Current Sensor (based on battery voltage)

Function	Battery Temperature Calculation	Battery Voltage Calculation	Action Taken
Idle Boost 1 Start	Less Than -15Â°C (5Â°F)	Less Than 13 V	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 12.6 V	First level Idle boost requested
Idle Boost 1 End	Greater Than -15Â°C (5Â°F)	-	First level Idle boost request cancelled
Idle Boost 1 End	-	Greater Than 13 V	First level Idle boost request cancelled
Idle Boost 2 Start	-	Less Than 12.4 V	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12.5 V	Second level Idle boost request cancelled
Load Shed 1 Start	-	Less Than 12.3 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12.4 V	Clear Load Shed 1
Idle Boost 3 Start	-	Less Than 10 V	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12.3 V	Third level Idle boost request cancelled
Load Shed 2 Start	-	Less Than 12.1 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12.2 V	Clear Load Shed 2
Load Shed 3 Start	-	Less Than 11.9 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.0 V	Clear Load Shed 3

STARTING SYSTEM DESCRIPTION AND OPERATION

The starter motors are non-repairable starter motors. They have pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened.

When the ignition switch is released from the START position, the START relay opens and battery voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, causes the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter circuit is turned off.

Circuit Description (Key Start)

When the ignition switch is placed in the Start position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the Start position. The BCM then sends a message to the engine control module (ECM) notifying it that CRANK has been requested. The ECM verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 V to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

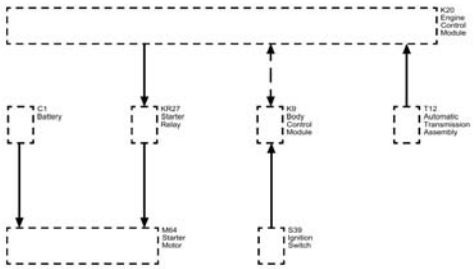


Fig. 44: Starting System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DD	Serial Data - GMLAN High Speed
K20	K20 Engine Control Module
C1	C1 Battery
KR27	KR27 Starter Relay
K9	K9 Body Control Module
T12	T12 Automatic Transmission Assembly
M64	M64 Starter Motor
S39	S39 Ignition Switch

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

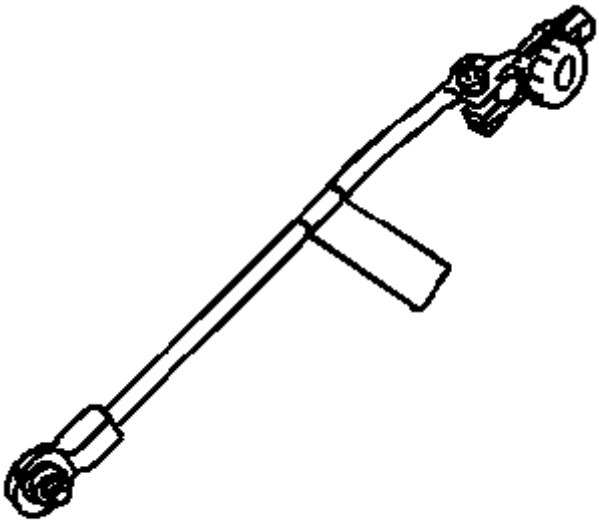
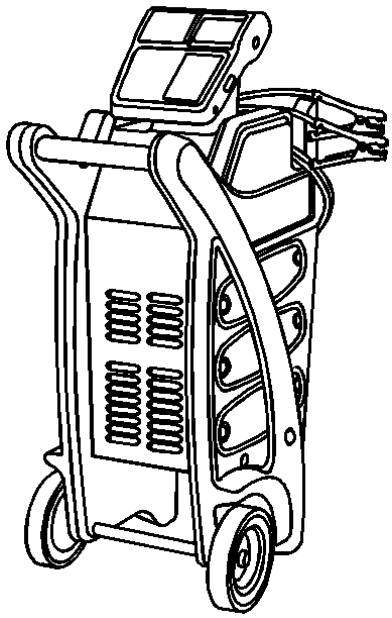
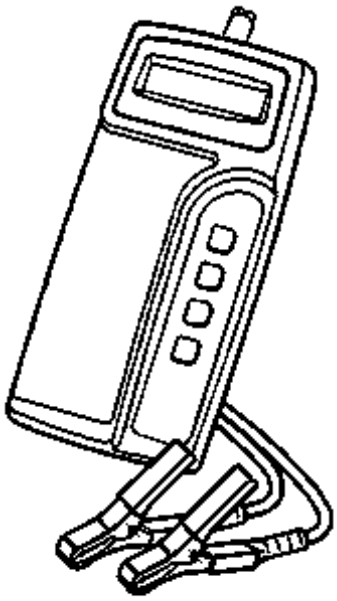
Illustration	Tool Number/Description
	EL 38758 EL 50074 J 38758 Parasitic Draw Test Switch

Illustration	Tool Number/Description
 	BC 800 W BC 800 WP EL 50313 EL 42000 EL 50076 J 42000 Battery Tester

Article GUID: A00737176

ACCESSORIES AND EQUIPMENT

Power Outlets - Impala

SCHEMATIC WIRING DIAGRAMS

CIGAR LIGHTER/POWER OUTLET WIRING SCHEMATICS

Cigar Lighter/Power Outlet

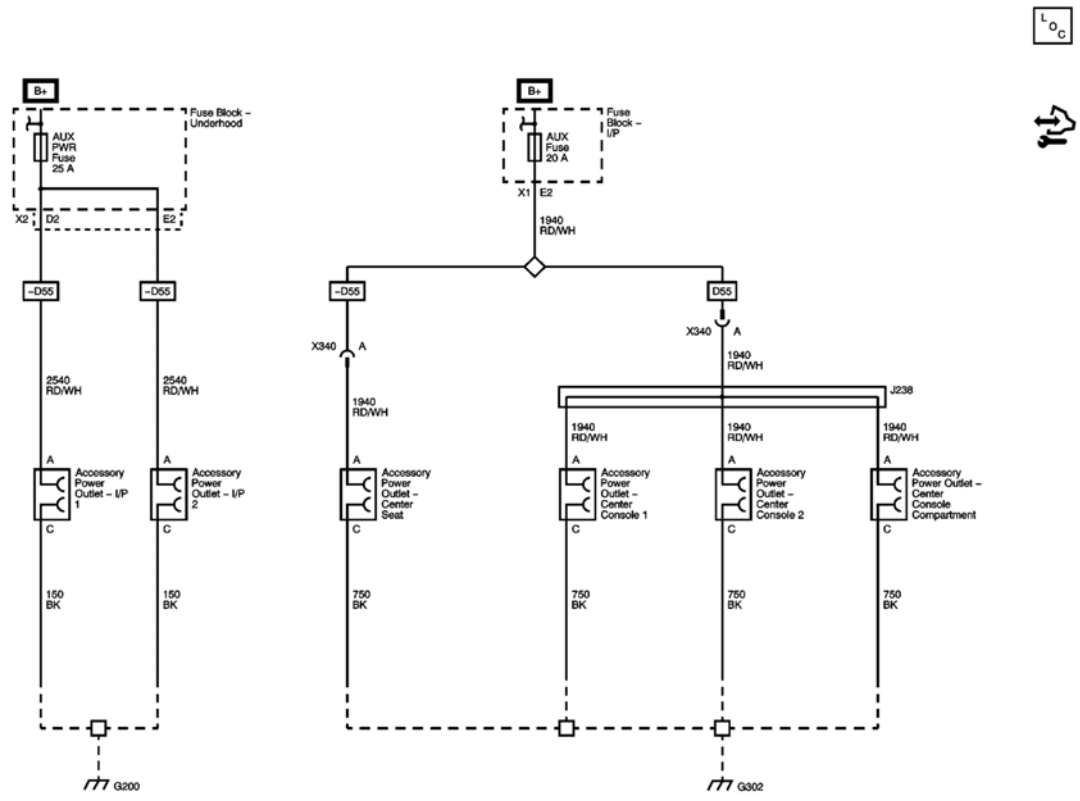


Fig. 1: Cigar Lighter/Power Outlet Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - POWER OUTLETS

Visual/Physical Inspection

- Inspect for aftermarket devices which can affect the operation of the power outlets. Refer to **Checking Aftermarket Accessories**
- Inspect the accessible system components or the visible system components for obvious damage or for obvious conditions which can cause the symptom.

Intermittent

Electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent**

Conditions and Poor Connections

Symptom List

Refer to **Power Outlet Receptacle Malfunction** in order to diagnose the system.

POWER OUTLET RECEPTACLE MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Ground	-	1	-	-
1. Accessory Power Receptacle Malfunction				

Circuit/System Description

The accessory power receptacles are supplied B+ all the time.

Reference Information

Schematic Reference

Cigar Lighter/Power Outlet Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Outlets Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate X80 accessory power receptacle.

2. Test for less than 5 Ω between the ground circuit terminal C and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminate between the B+ circuit terminal A and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, test or replace the X80 accessory power receptacle.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Cigar Lighter Receptacle or 12-Volt Accessory Power Receptacle Replacement

REPAIR INSTRUCTIONS

CIGAR LIGHTER RECEPTACLE OR 12-VOLT ACCESSORY POWER RECEPTACLE REPLACEMENT

Special Tools

J 42059 Cigar Lighter Socket Remover

Removal Procedure

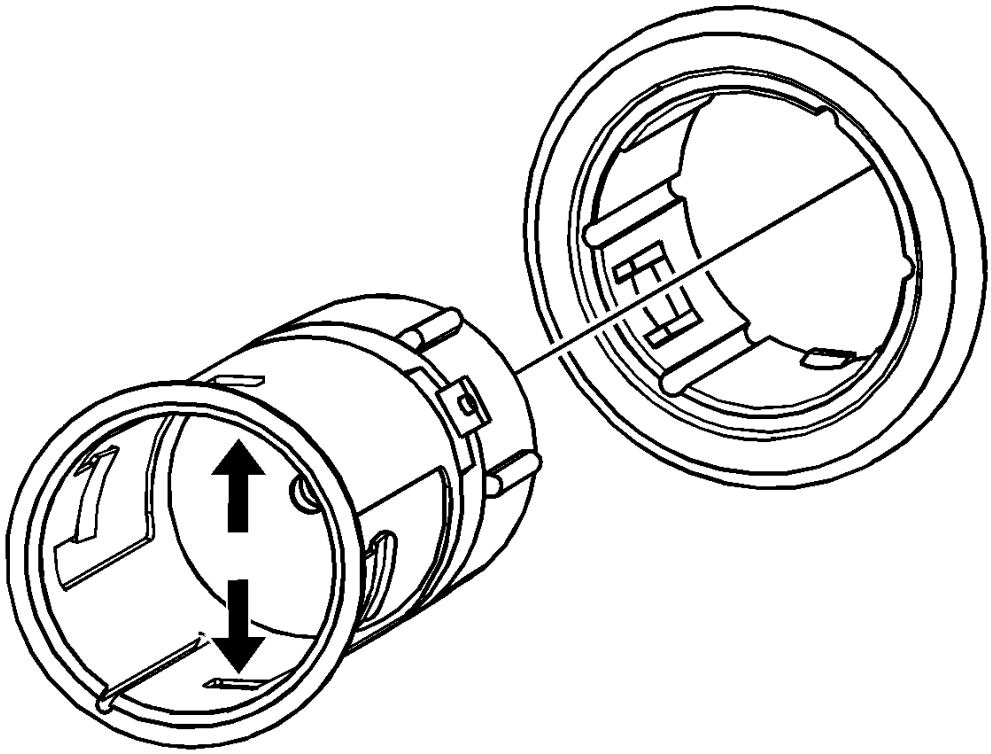


Fig. 2: View Of Cigar Lighter Socket/Accessory Power Outlet
Courtesy of GENERAL MOTORS COMPANY

1. Remove the auxiliary power outlet fuse from the fuse block.
2. Remove the receptacle:
    1. Look into the receptacle. There are two 3 mm (0.11 in) tab windows 12 mm (0.47 in) from the front of the receptacle. The **J 42059** Cigar Lighter Socket Remover pushes the plastic latches from these tab windows and the receptacle can be pulled straight out.
    2. Place one side of the "T" portion of the **J 42059** Cigar Lighter Socket Remover into the tab window. The **J 42059** Cigar Lighter Socket Remover will not fit straight into the receptacle. Angle the **J 42059** Cigar Lighter Socket Remover slightly for insertion into the receptacle.
    3. Insert the other side of the "T" into the opposite tab window.

       You must move the **J 42059** Cigar Lighter Socket Remover handle toward horizontal to engage the other tab window.

    4. Use the **J 42059** Cigar Lighter Socket Remover to pull the receptacle straight out.

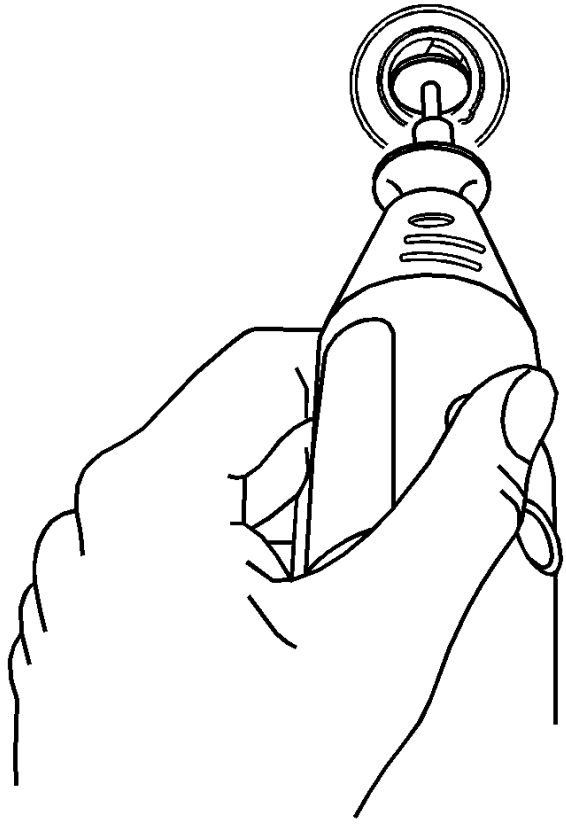


Fig. 3: Removing Cigar Housing Using Grinding Tool
Courtesy of GENERAL MOTORS COMPANY

3. If **J 42059** Cigar Lighter Socket Remover tool fails to release the lighter socket from the retainer, perform the following alternate method:
    1. Insert a small grinding tool with a cutoff wheel into the socket.
    2. Remove the plastic latches in the 3 mm (0.11 in) square windows.
    3. Use the **J 42059** Cigar Lighter Socket Remover as directed above to remove the socket.

Installation Procedure

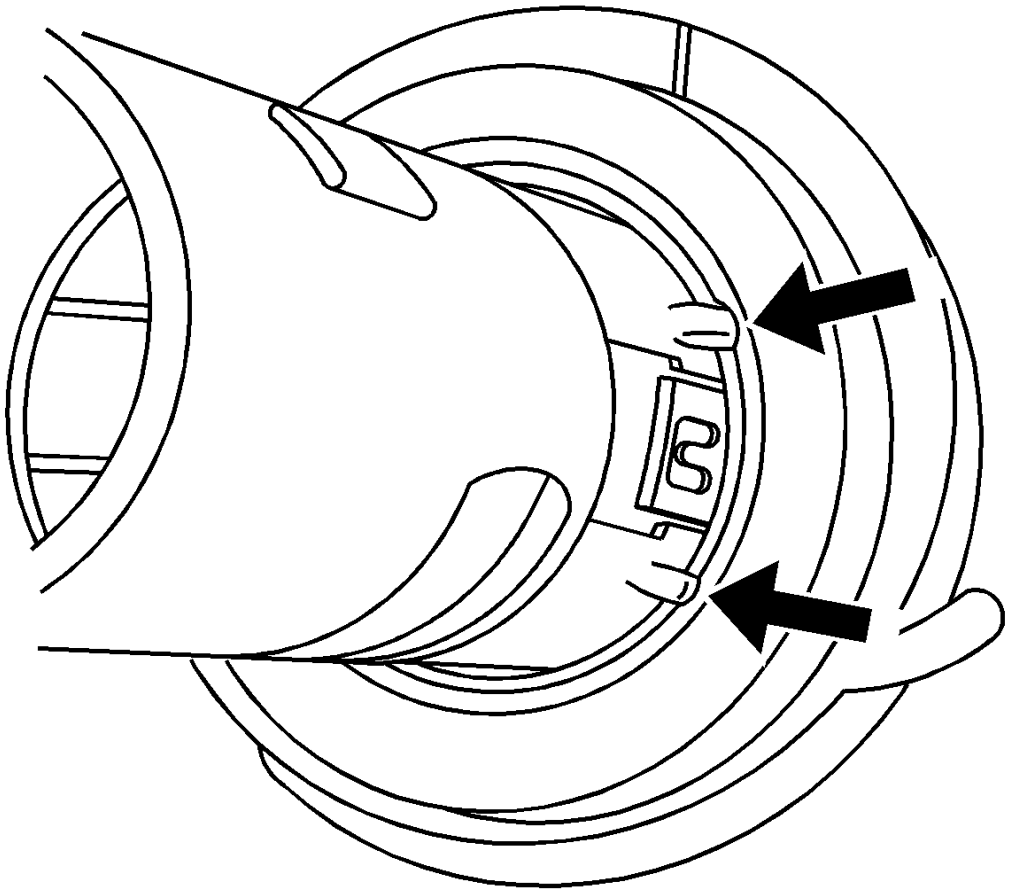


Fig. 4: View Of Receptacle Tabs & Retainer Slots
Courtesy of GENERAL MOTORS COMPANY

1. Route the connector through the retainer. Align the accessory power receptacle retainer to the slot in the opening.
2. Install the retainer by pressing into place fully seated.
3. Connect the electrical connector to the receptacle.
4. Align the tabs on the receptacle to the slots in the retainer. Install the accessory power receptacle by pressing into place until fully seated.
5. Install the accessory power receptacle fuse.

DESCRIPTION AND OPERATION

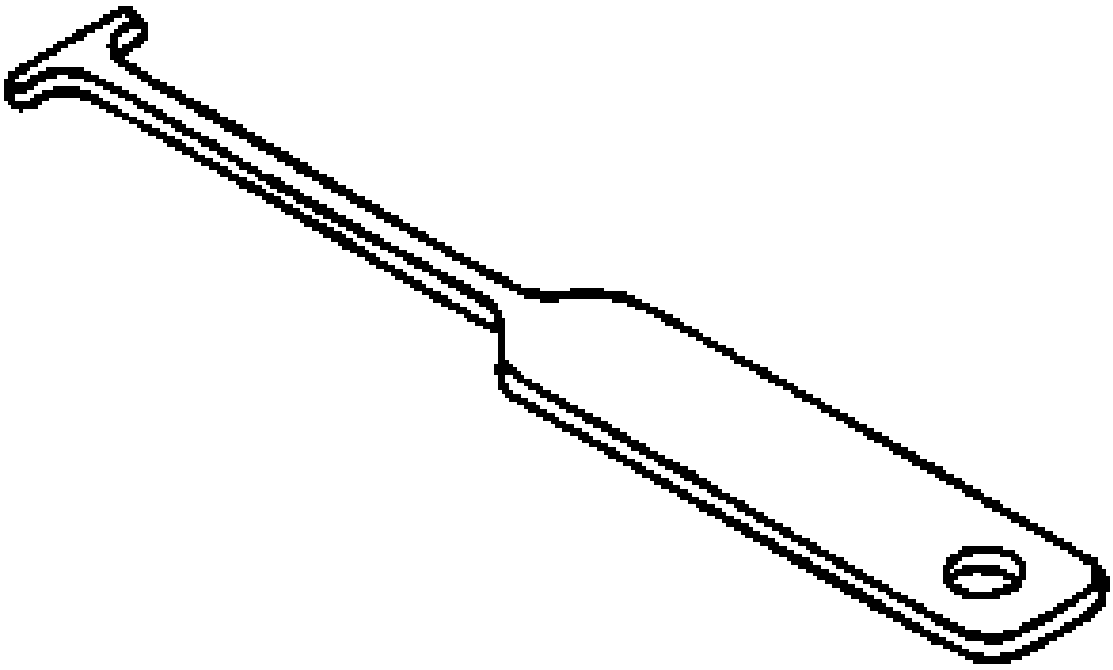
POWER OUTLETS DESCRIPTION AND OPERATION

12 Volt Power Outlet Receptacle Description and Operation

The accessory power receptacles are supplied battery voltage at all times.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	J 42059 Cigar Lighter Socket Remover

Article GUID: A00737217

SYSTEM WIRING DIAGRAMS

Chevrolet - Impala

AIR CONDITIONING

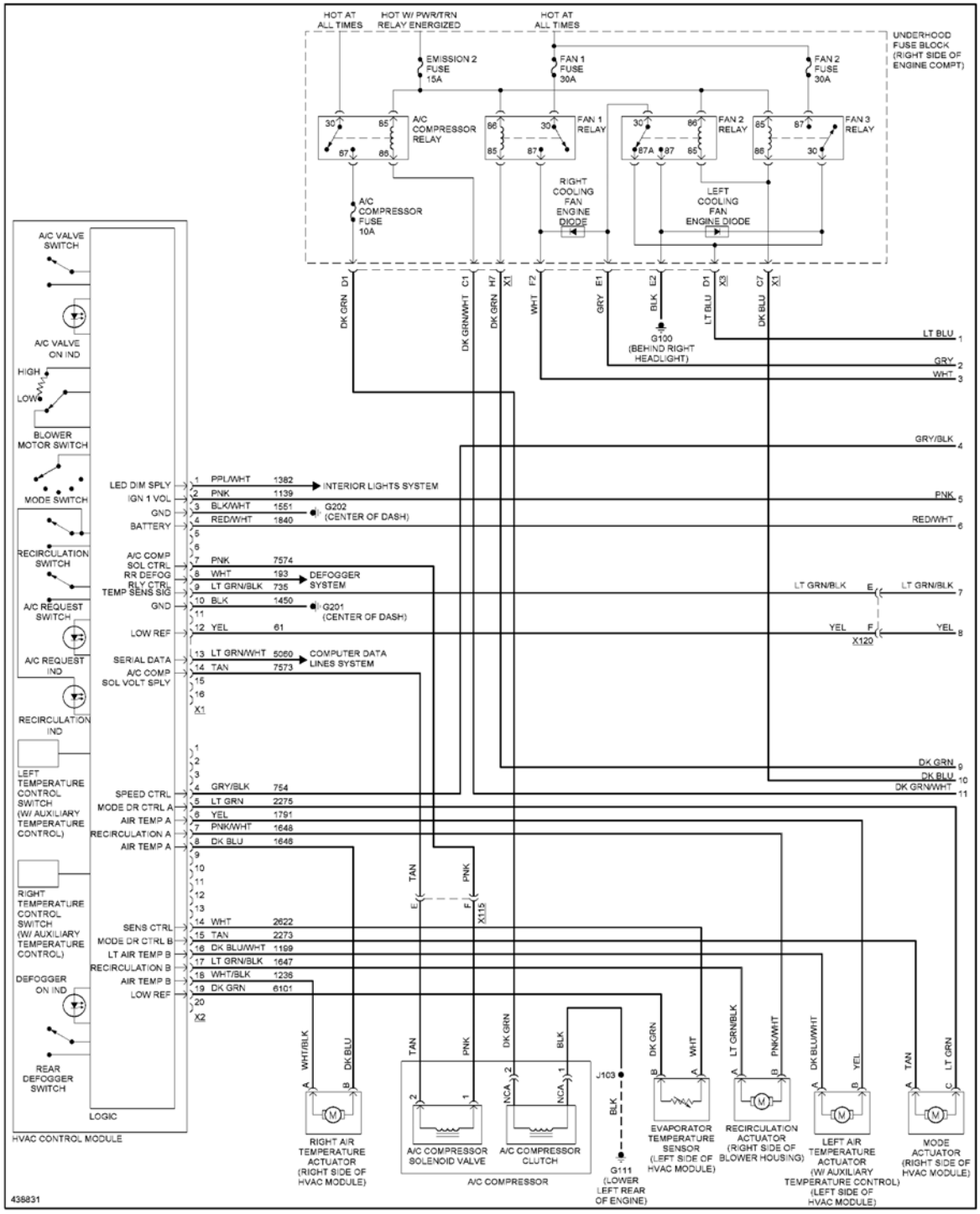


Fig. 1: Manual A/C Circuit (1 of 2)

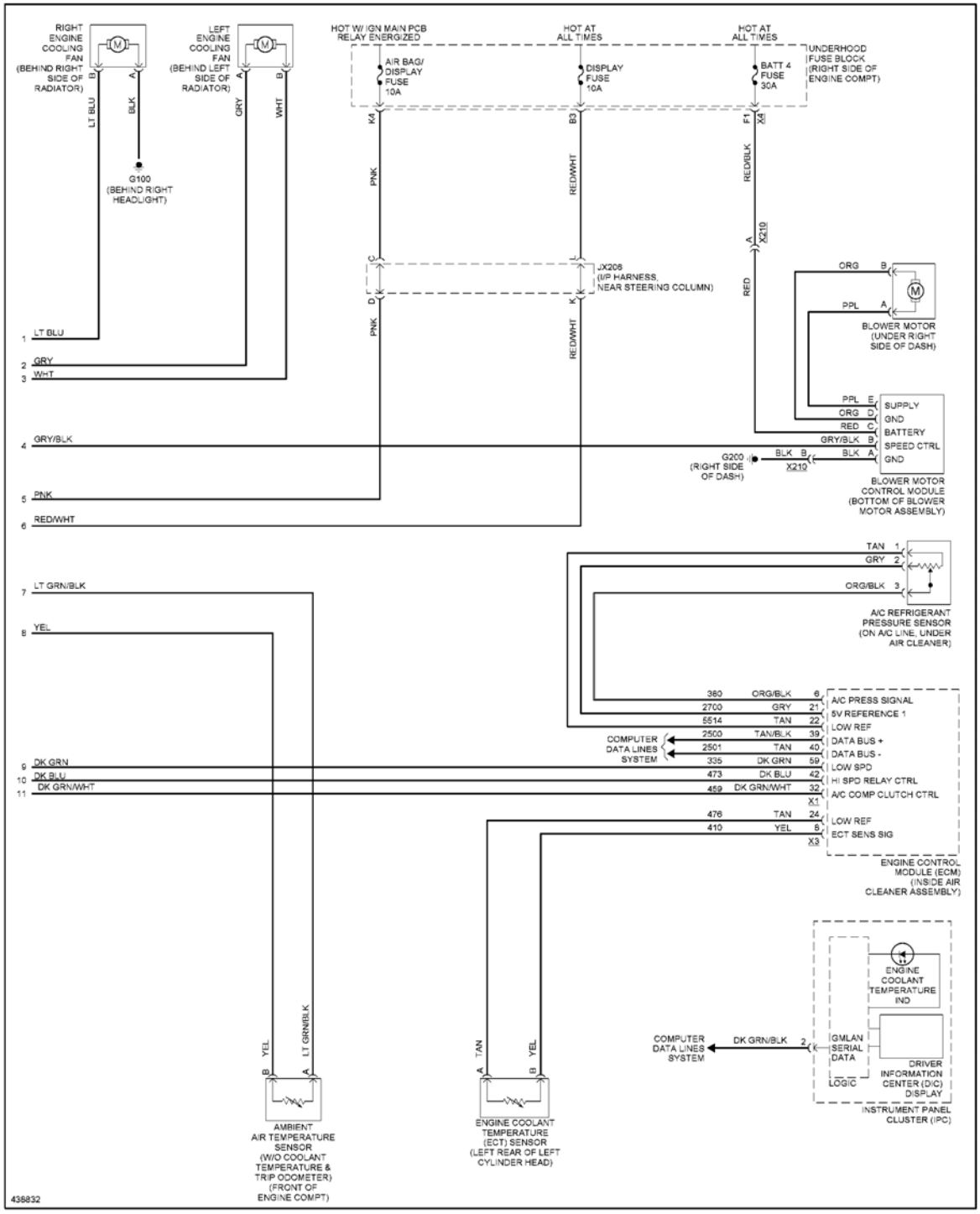


Fig. 2: Manual A/C Circuit (2 of 2)

ANTI-LOCK BRAKES

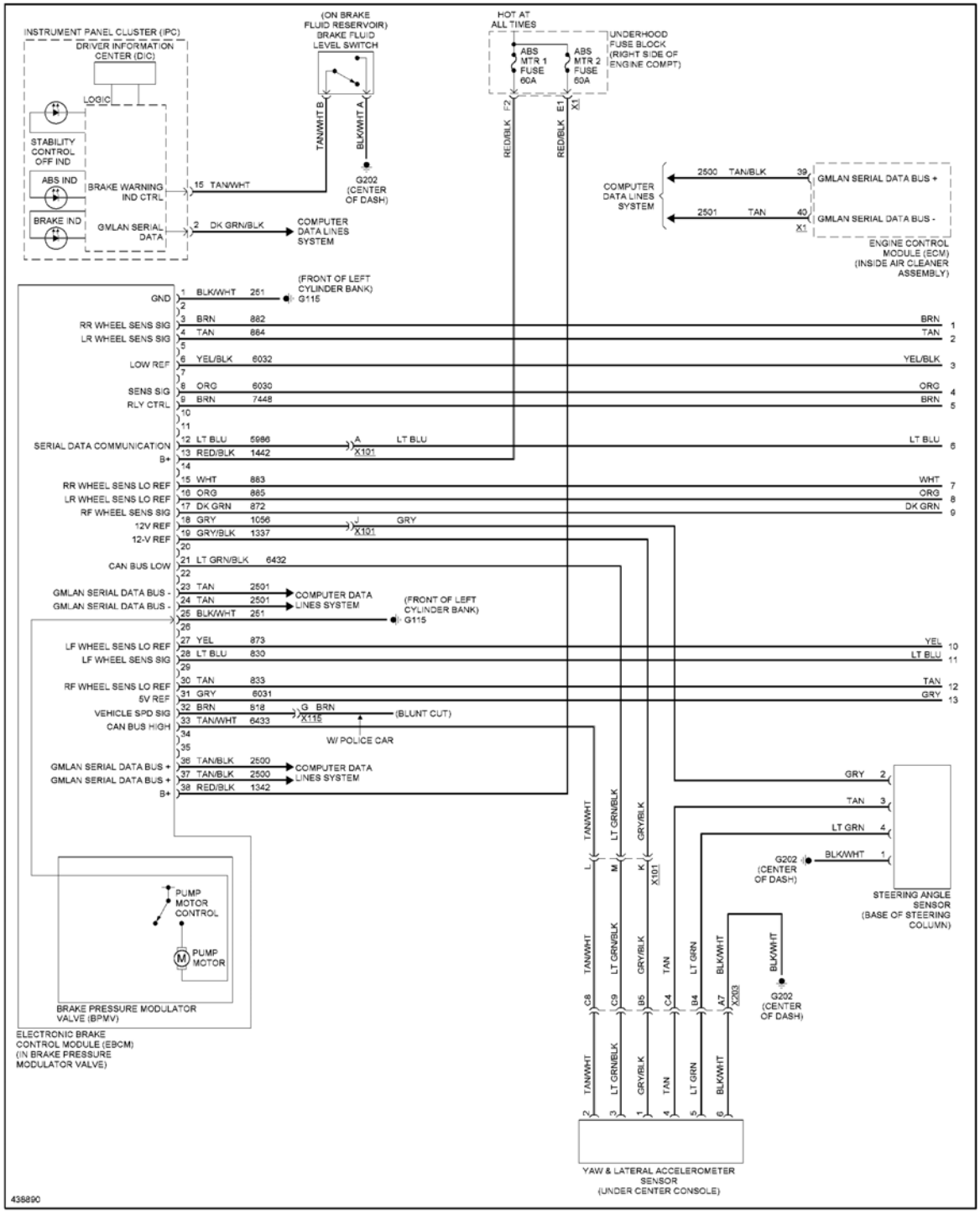


Fig. 3: Anti-lock Brakes Circuit (1 of 2)

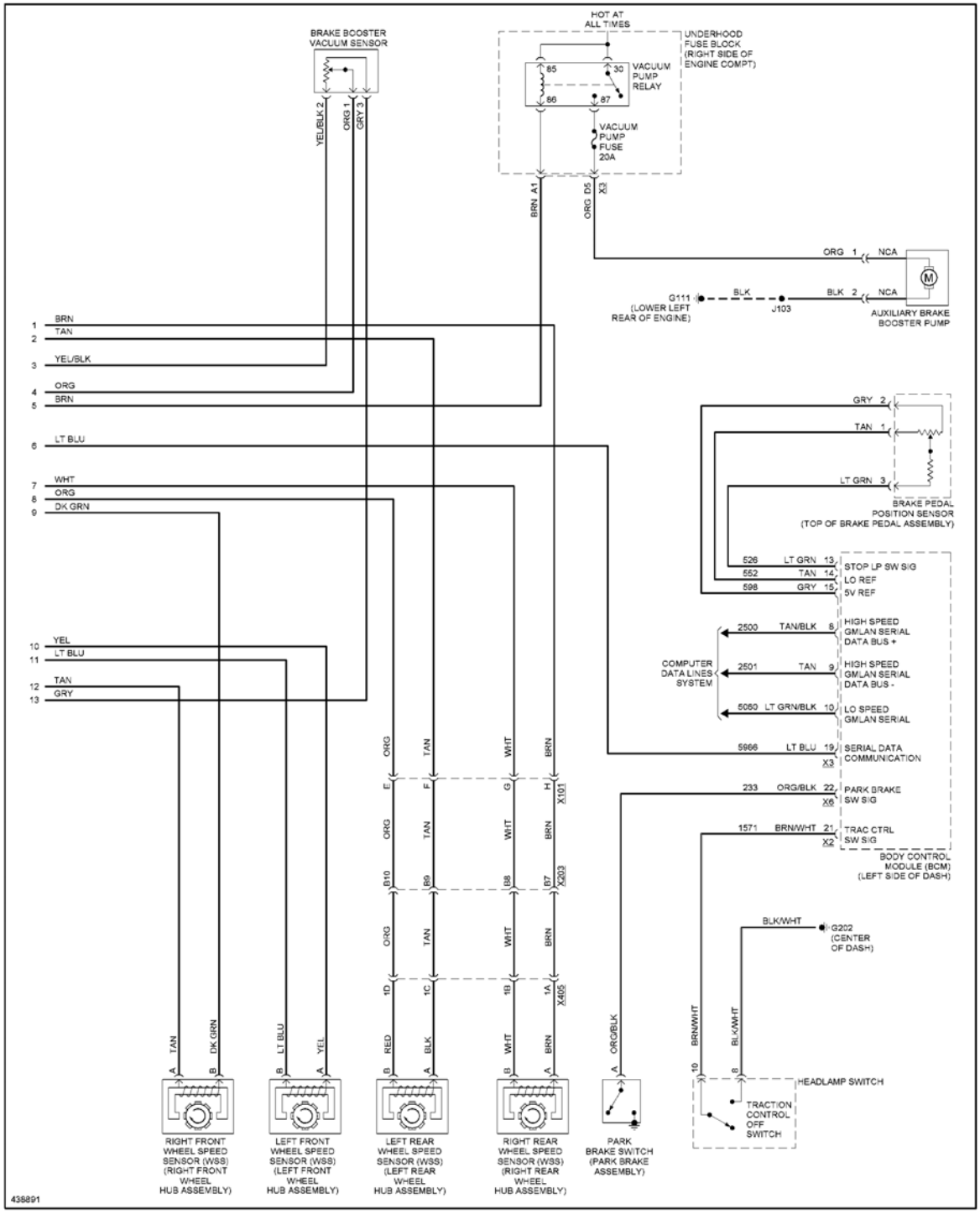


Fig. 4: Anti-lock Brakes Circuit (2 of 2)

ANTI-THEFT

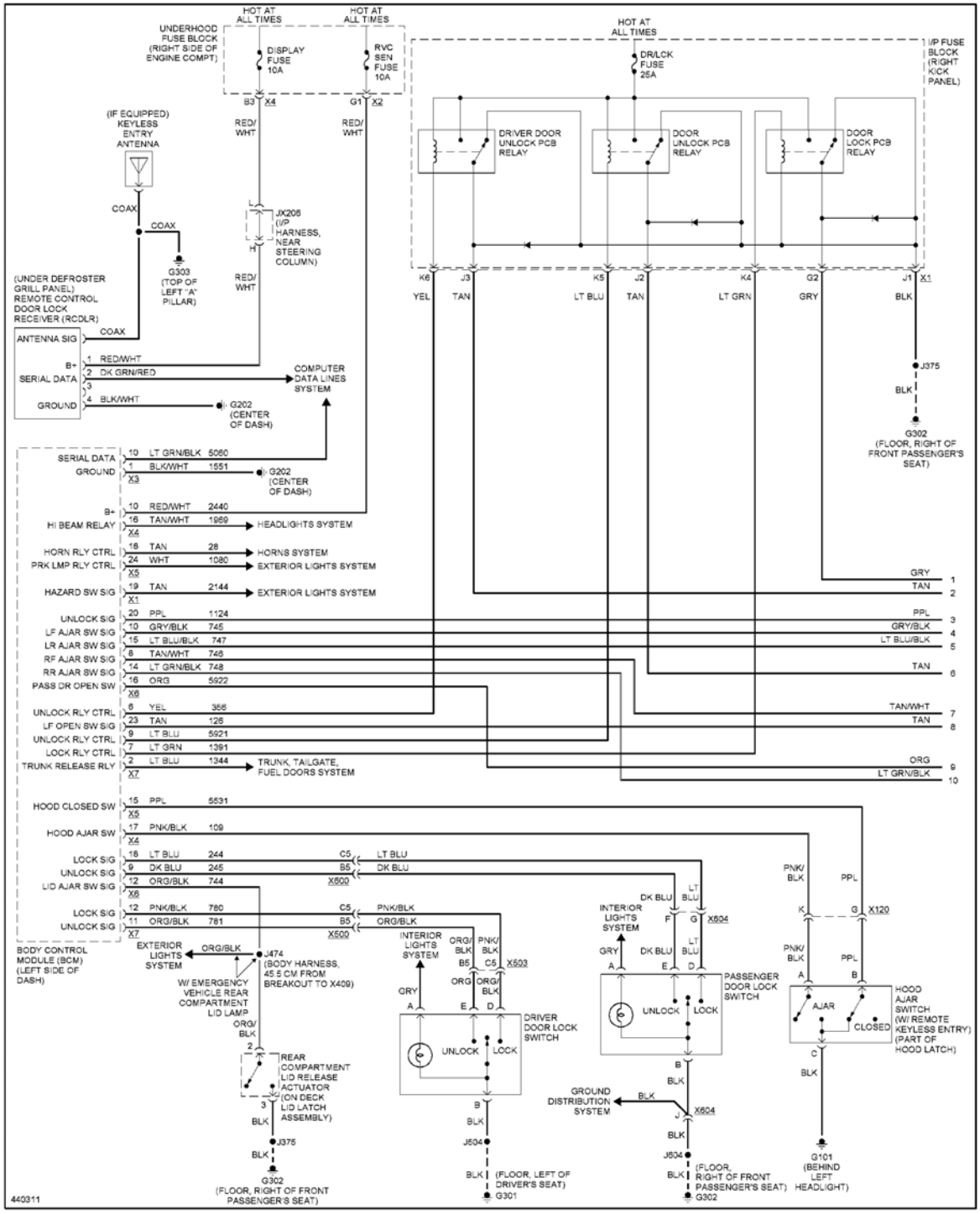


Fig. 5: Forced Entry Circuit (1 of 2)

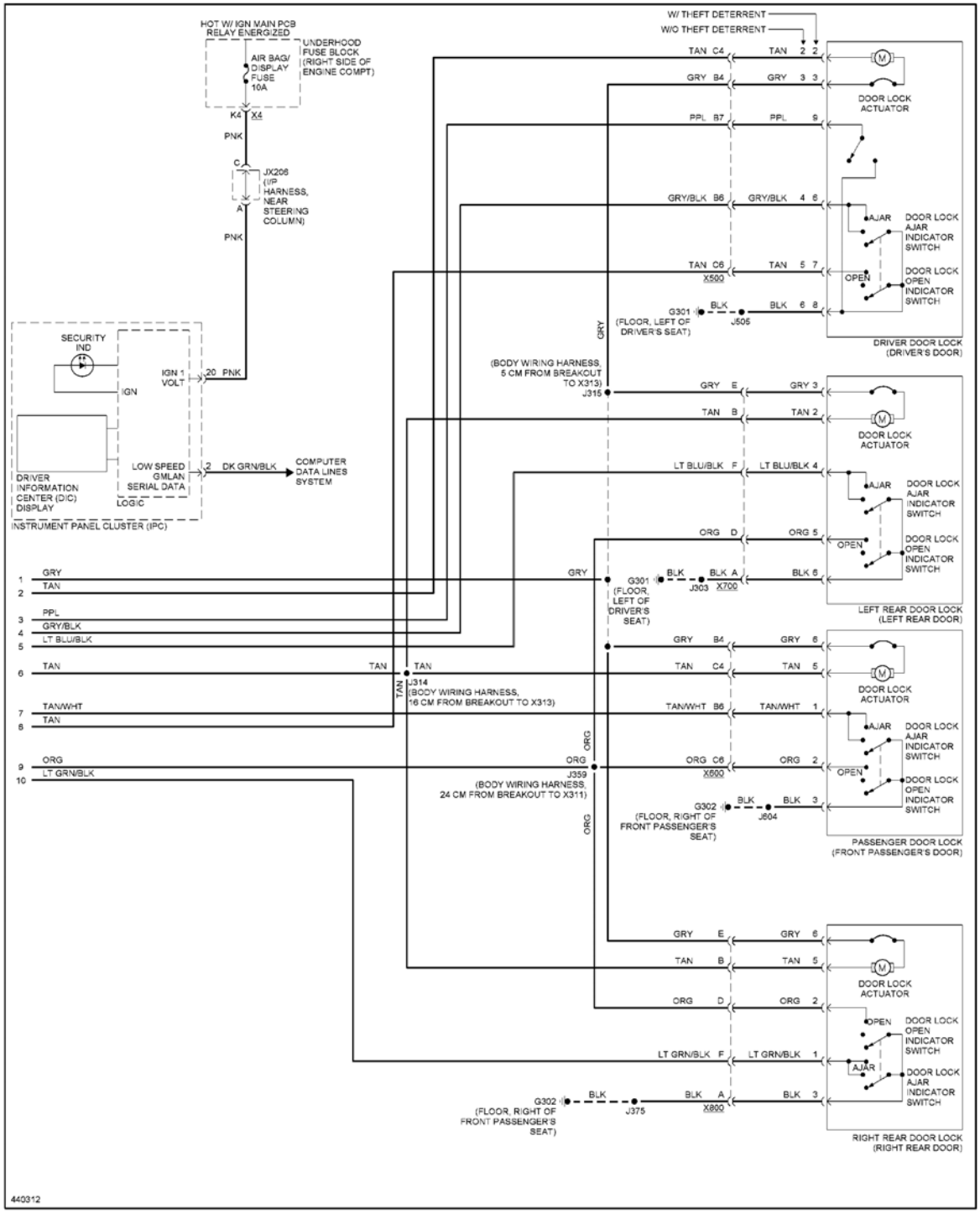


Fig. 6: Forced Entry Circuit (2 of 2)

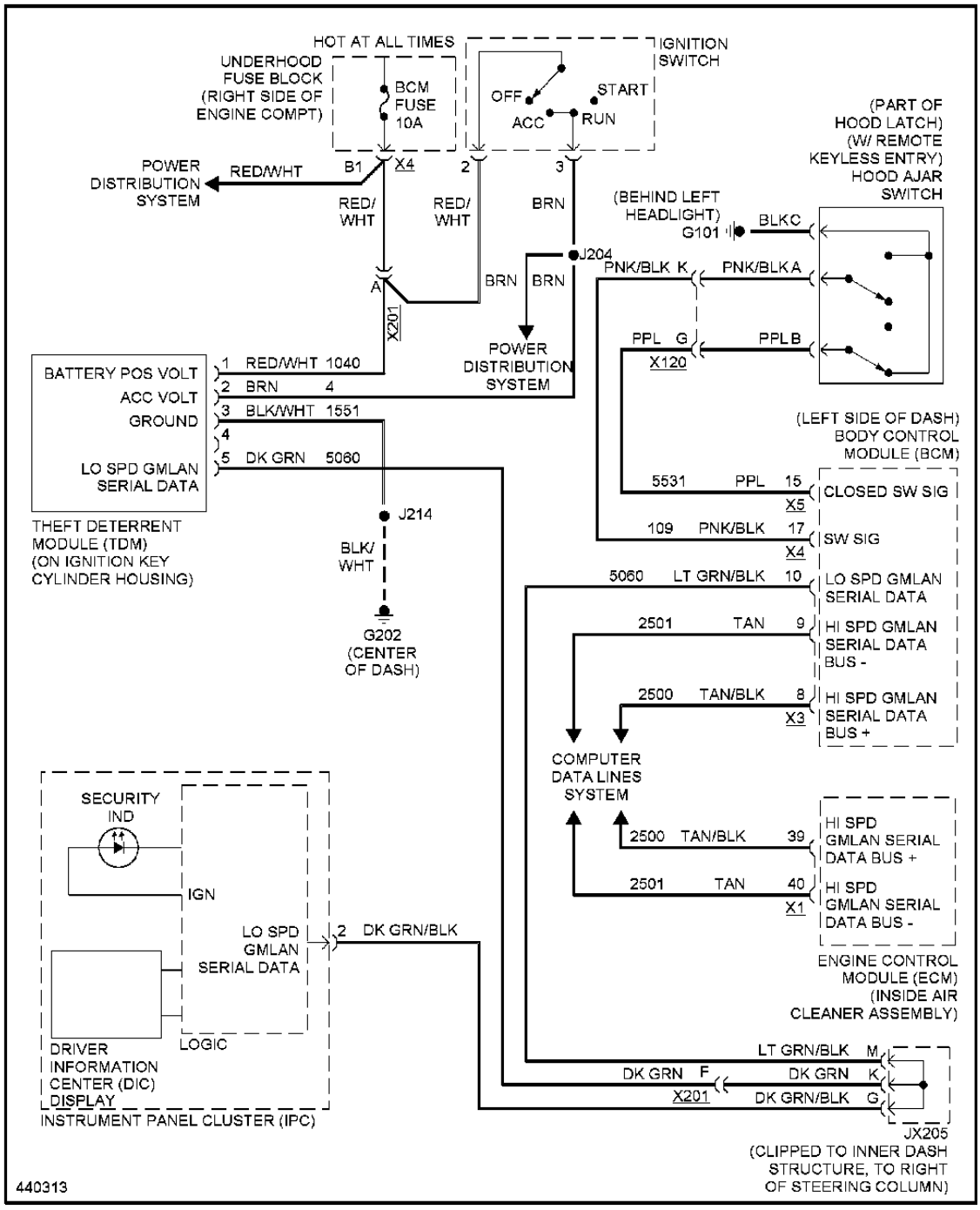


Fig. 7: Pass-Key Circuit

BODY CONTROL MODULES

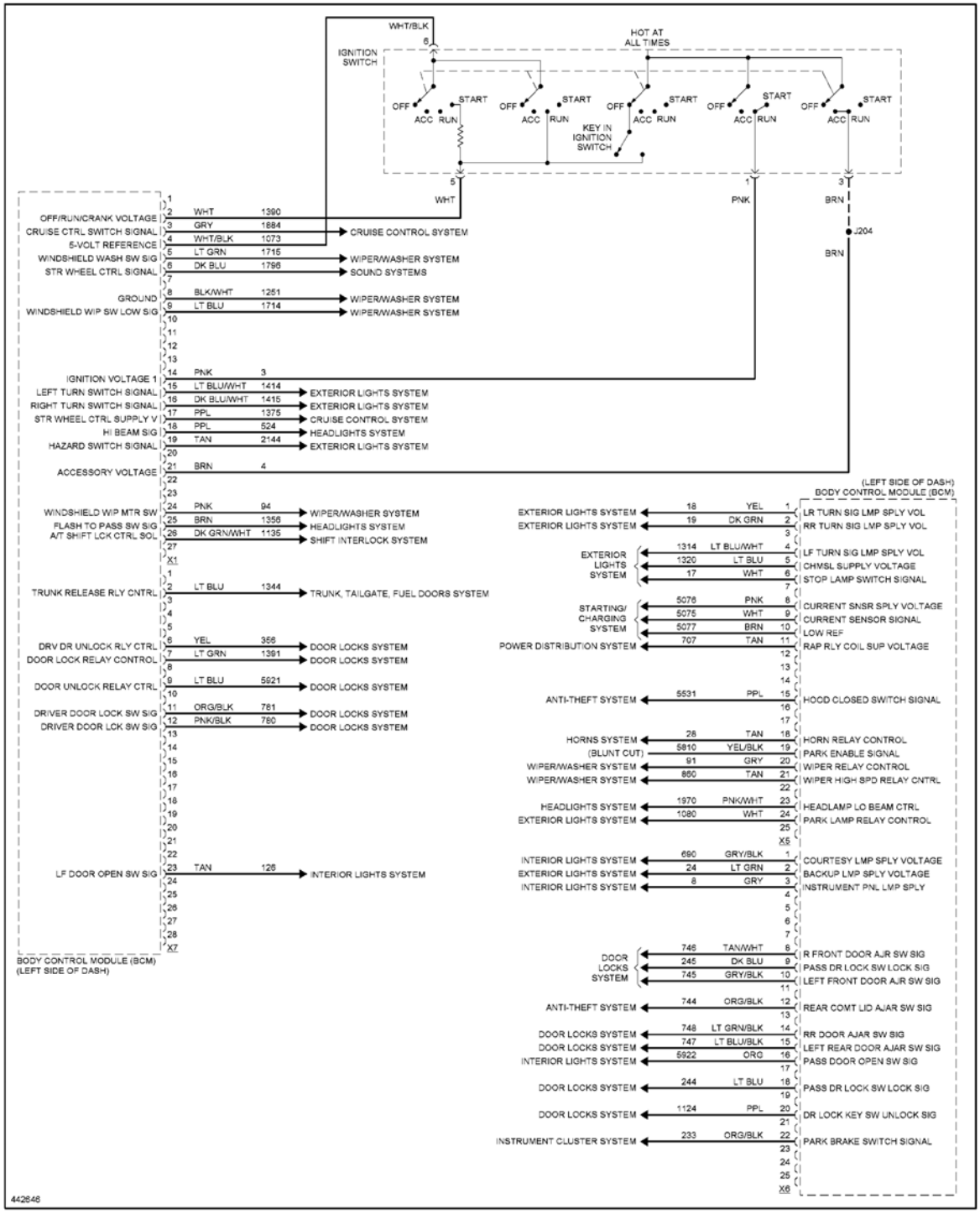


Fig. 8: Body Control Modules Circuit (1 of 2)

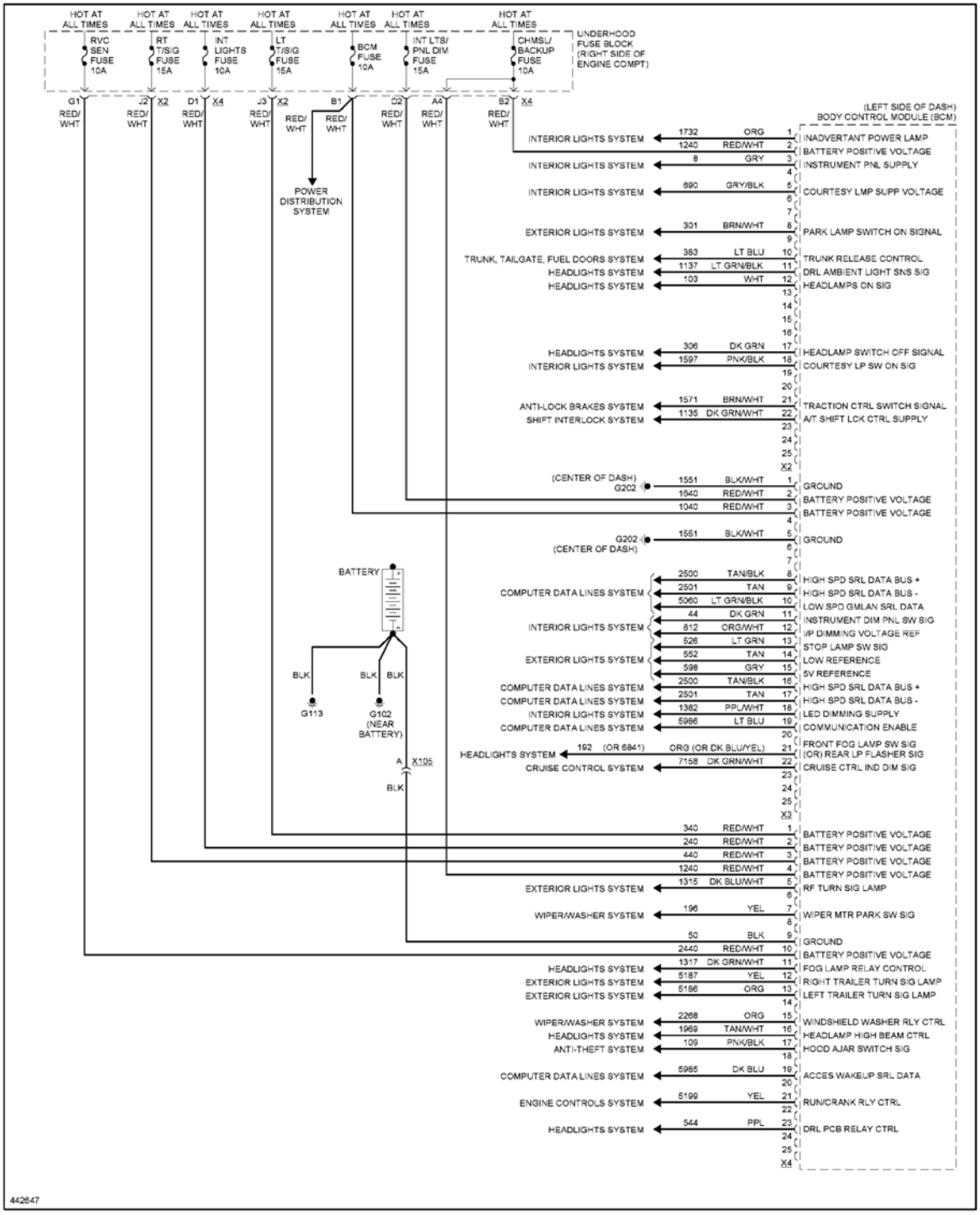


Fig. 9: Body Control Modules Circuit (2 of 2)

COMPUTER DATA LINES

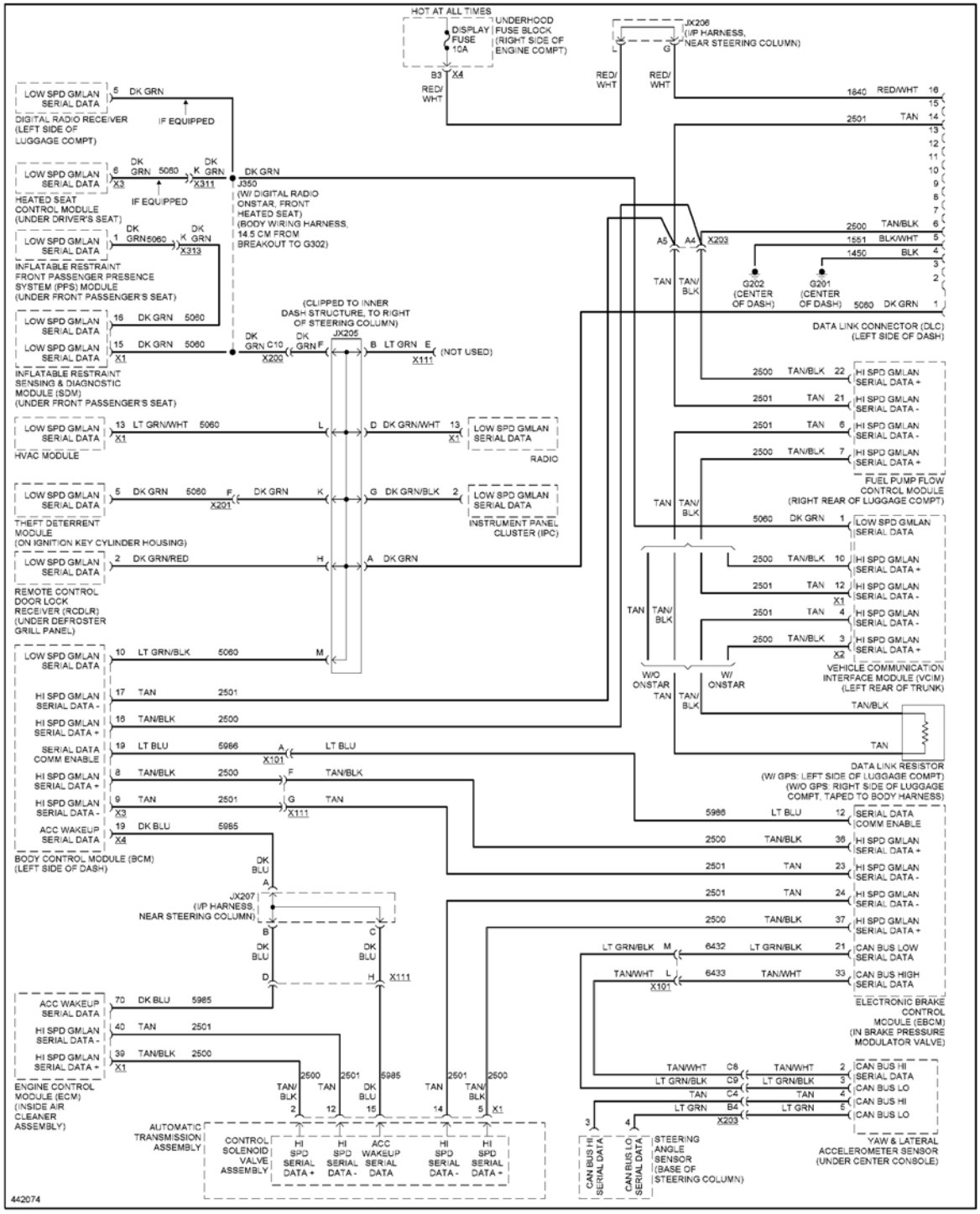


Fig. 10: Computer Data Lines Circuit

COOLING FAN

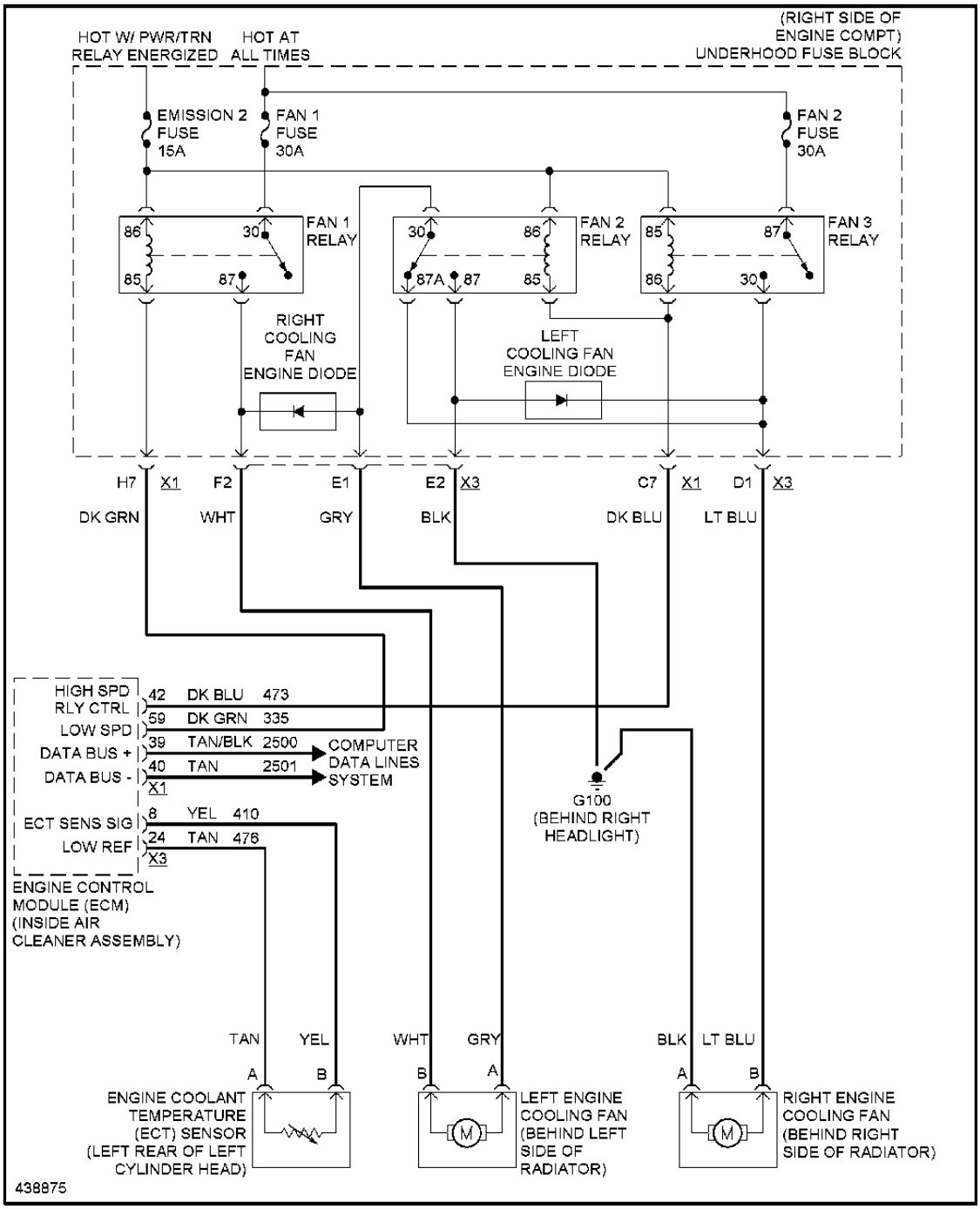


Fig. 11: Cooling Fan Circuit

CRUISE CONTROL

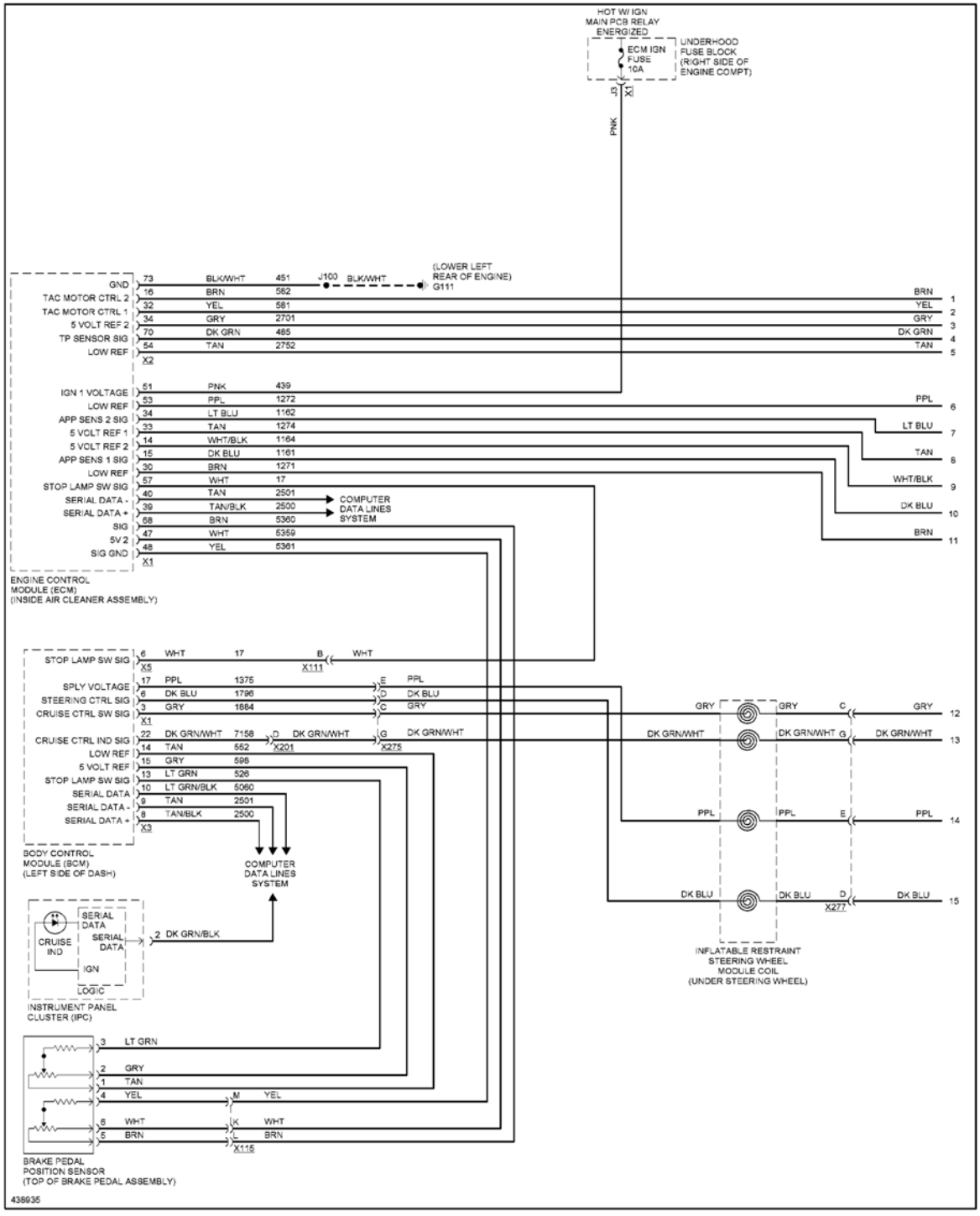


Fig. 12: Cruise Control Circuit (1 of 2)

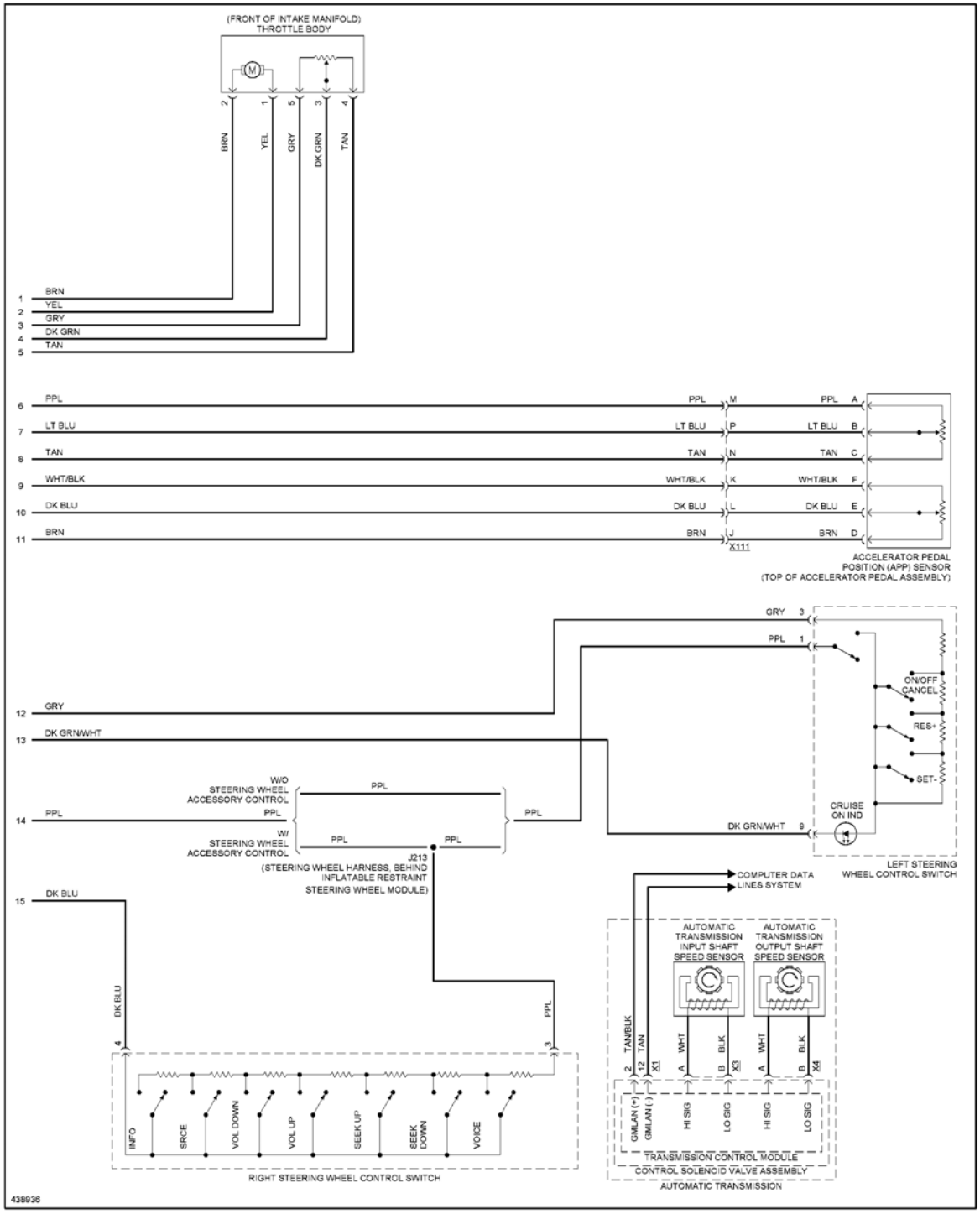


Fig. 13: Cruise Control Circuit (2 of 2)

DEFOGGERS

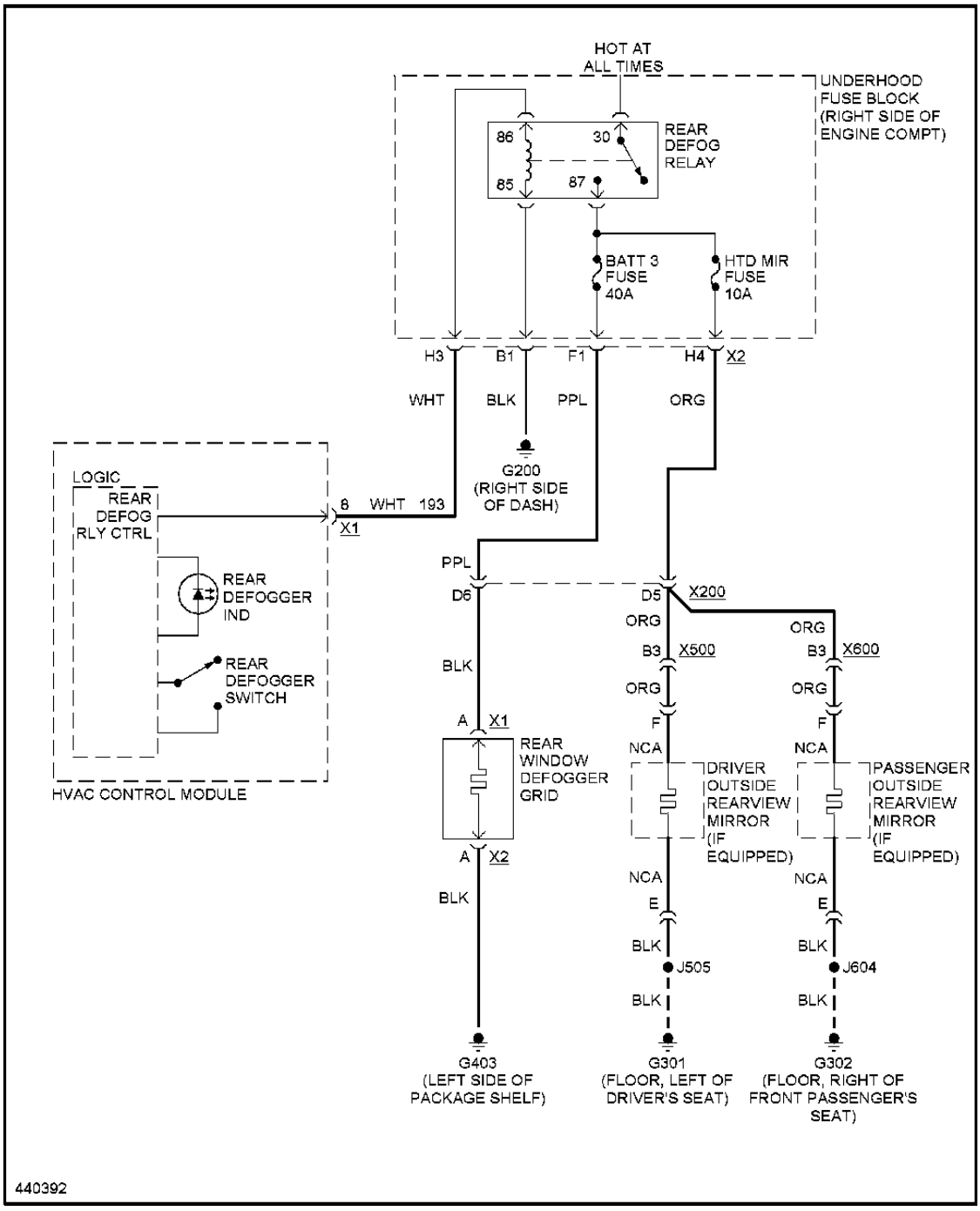


Fig. 14: Defoggers Circuit

ENGINE PERFORMANCE

3.6L VIN 3

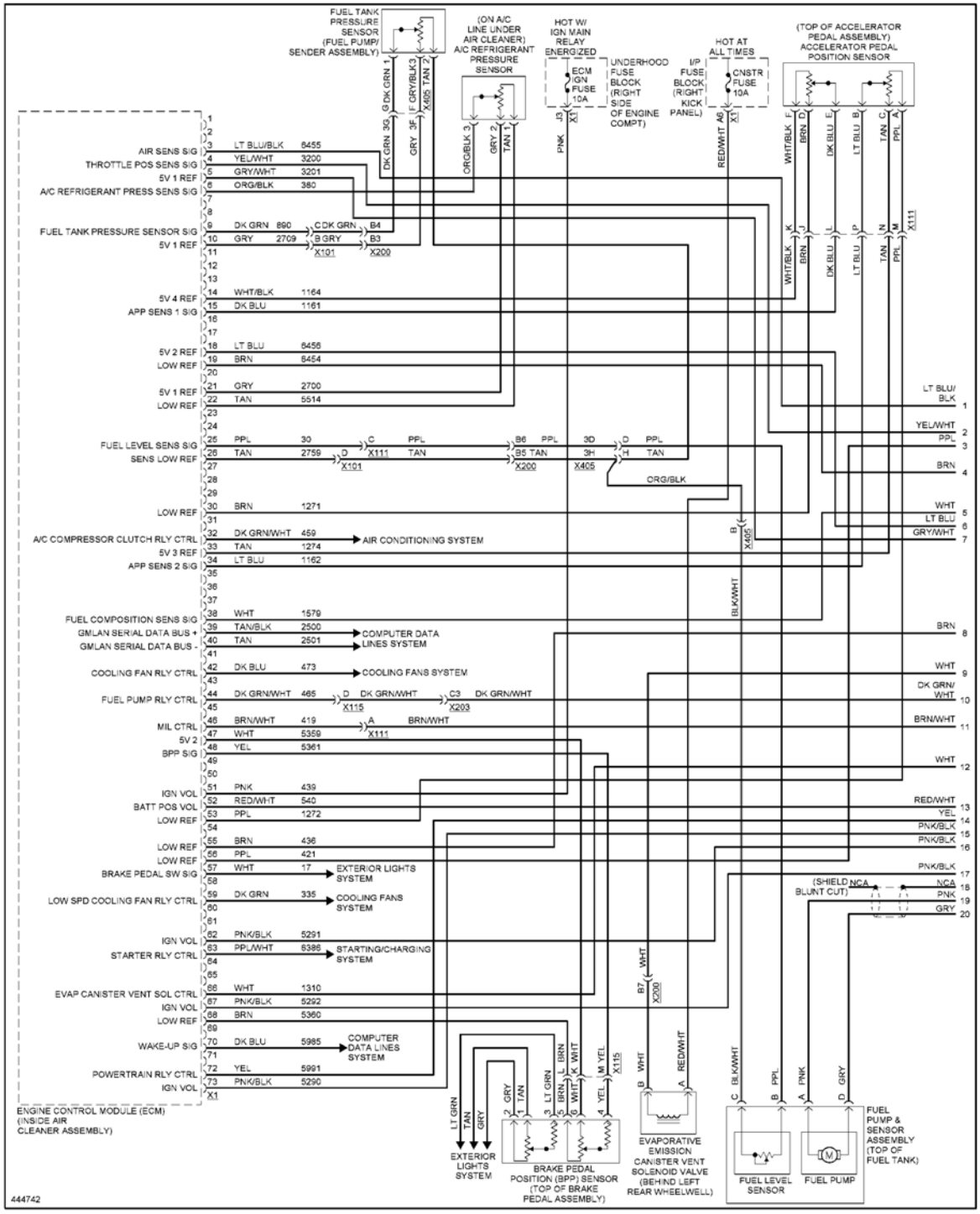


Fig. 15: 3.6L VIN 3, Engine Performance Circuit (1 of 5)

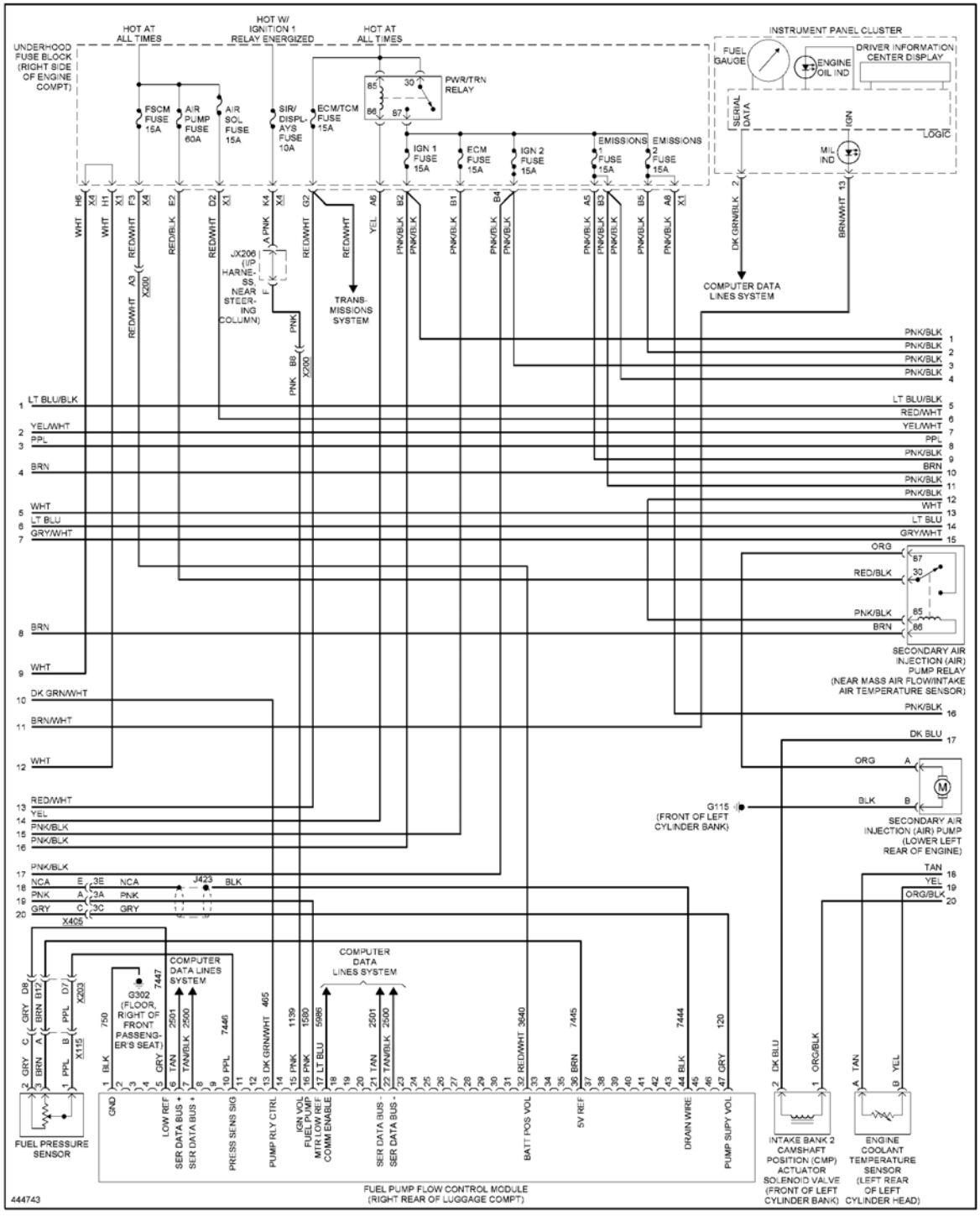


Fig. 16: 3.6L VIN 3, Engine Performance Circuit (2 of 5)

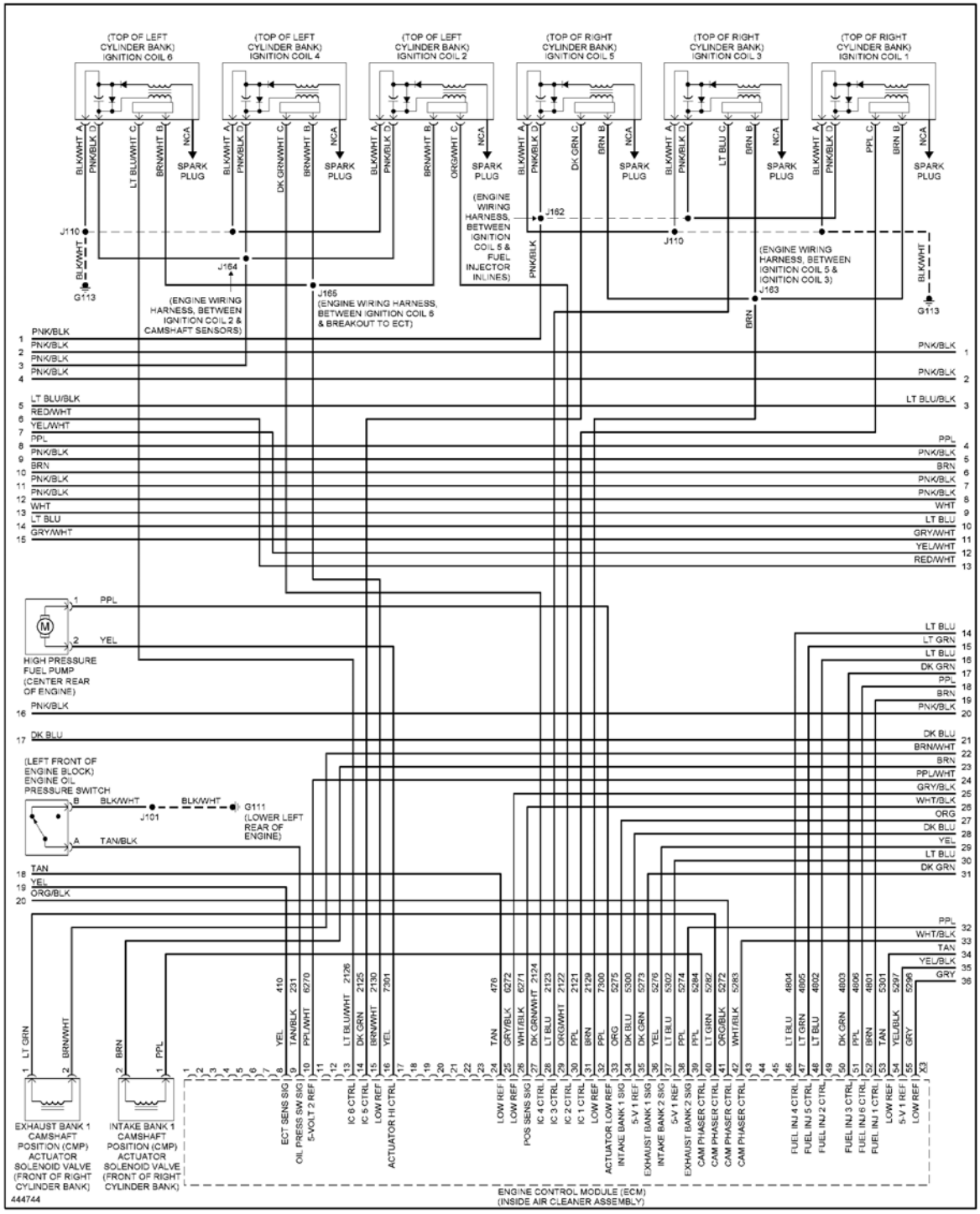


Fig. 17: 3.6L VIN 3, Engine Performance Circuit (3 of 5)

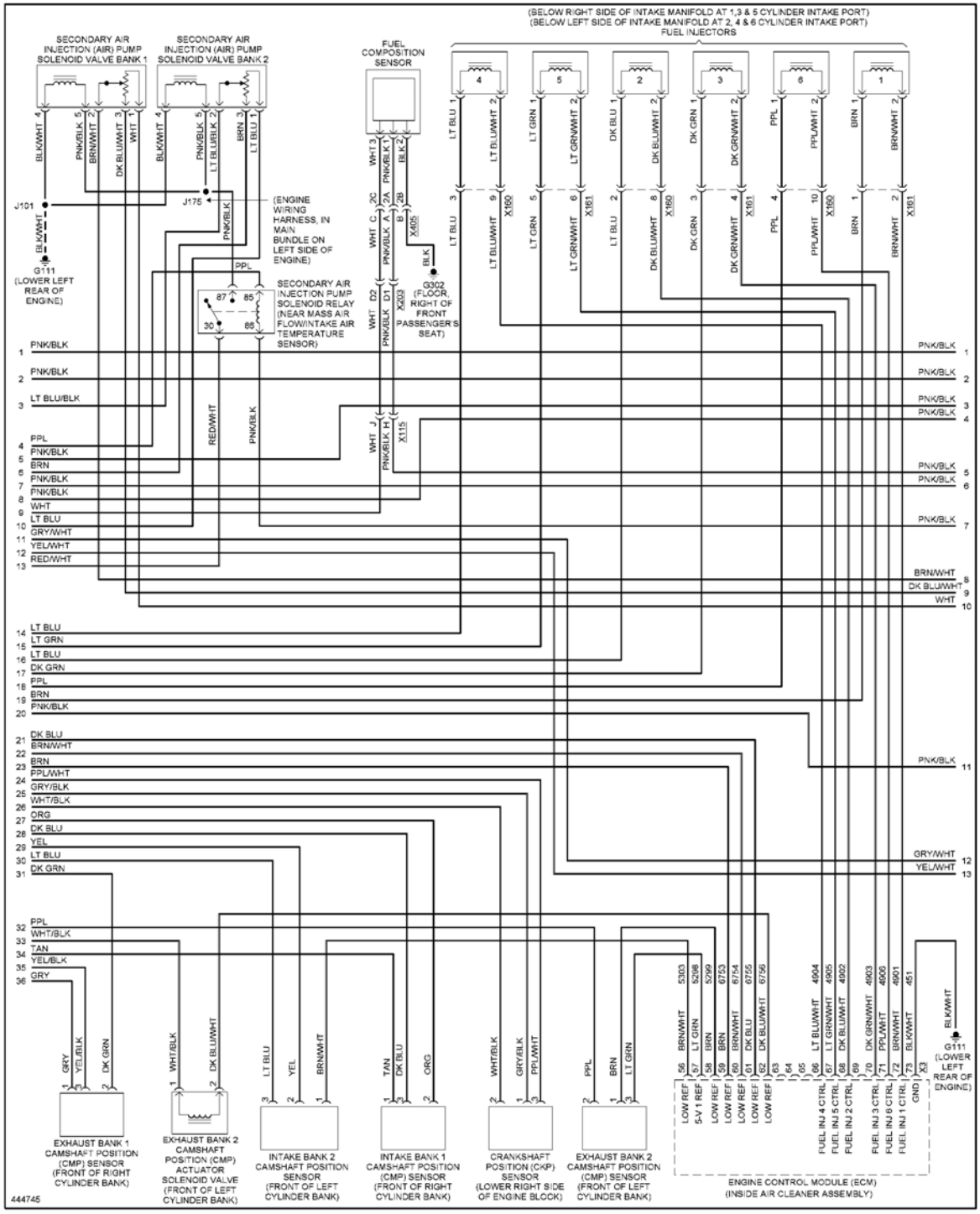


Fig. 18: 3.6L VIN 3, Engine Performance Circuit (4 of 5)

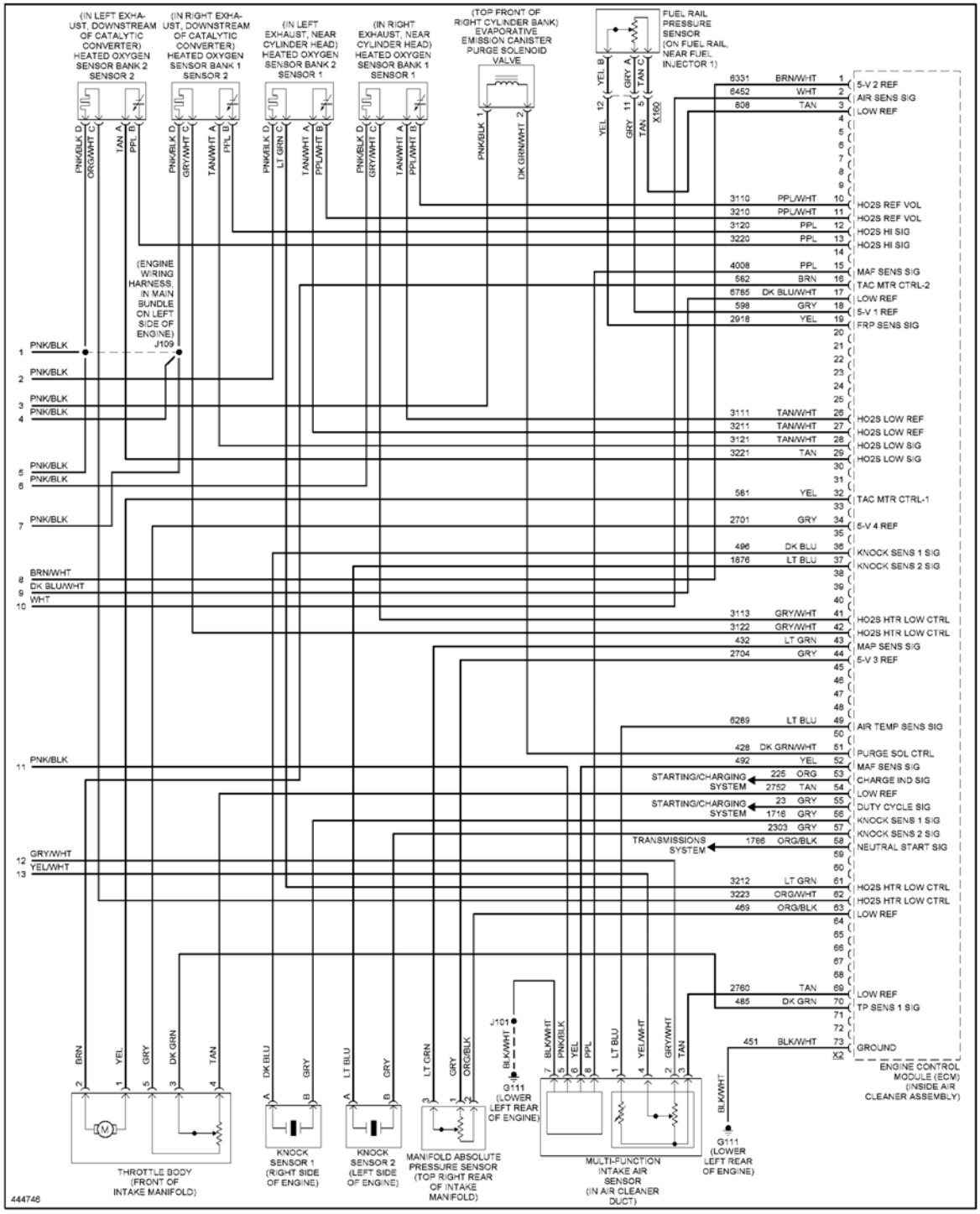


Fig. 19: 3.6L VIN 3, Engine Performance Circuit (5 of 5)

EXTERIOR LIGHTS

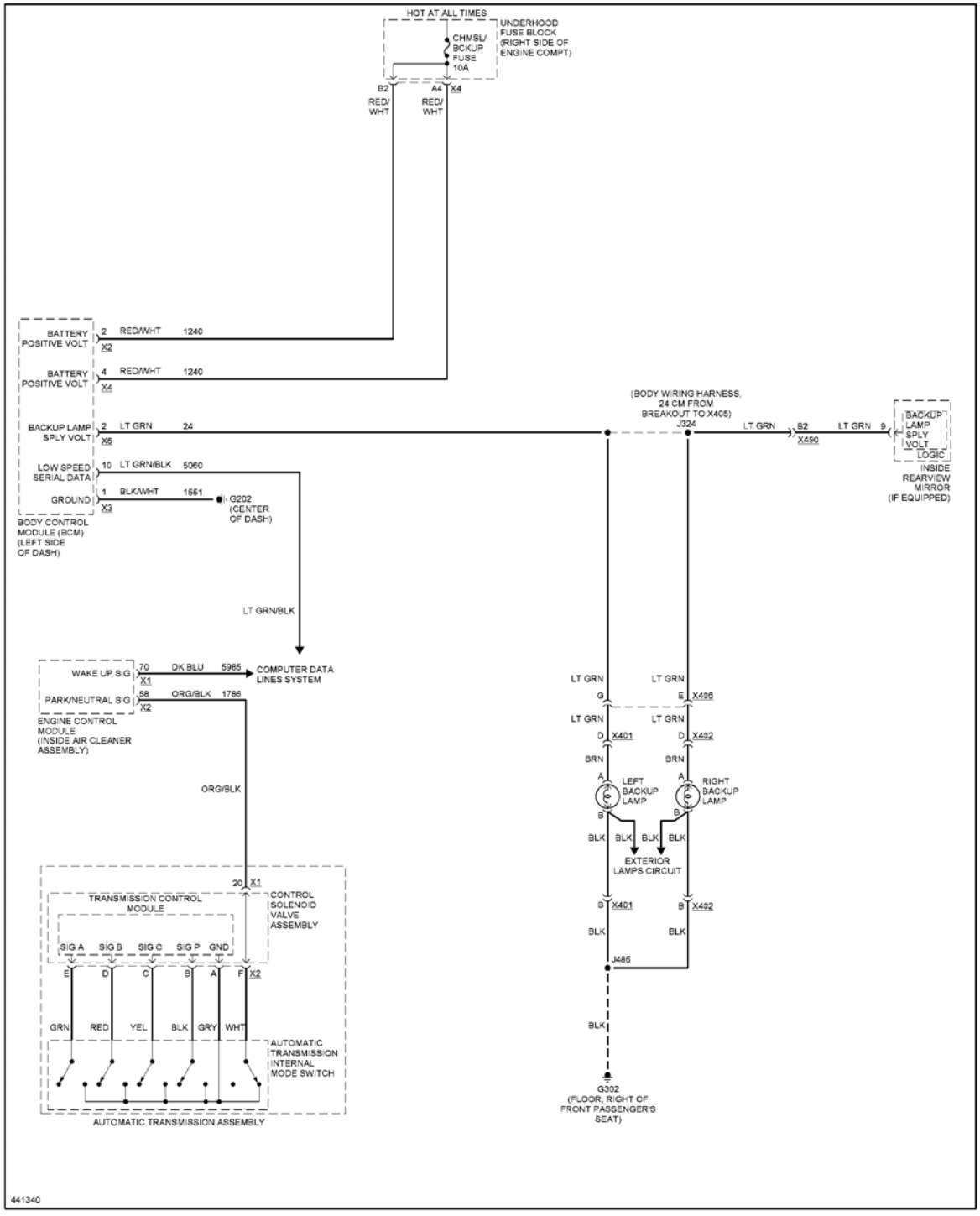


Fig. 20: Backup Lamps Circuit

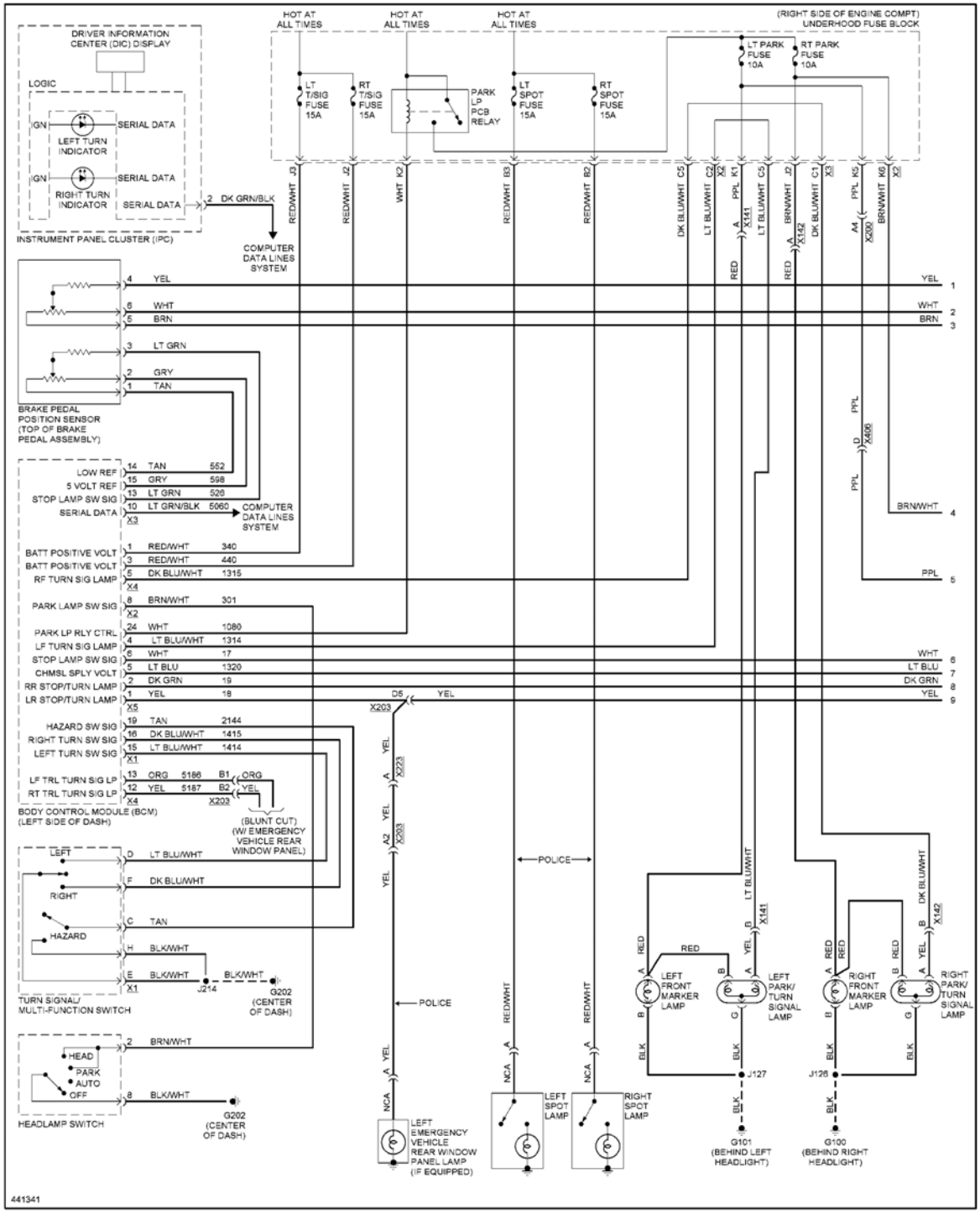


Fig. 21: Exterior Lamps Circuit (1 of 2)

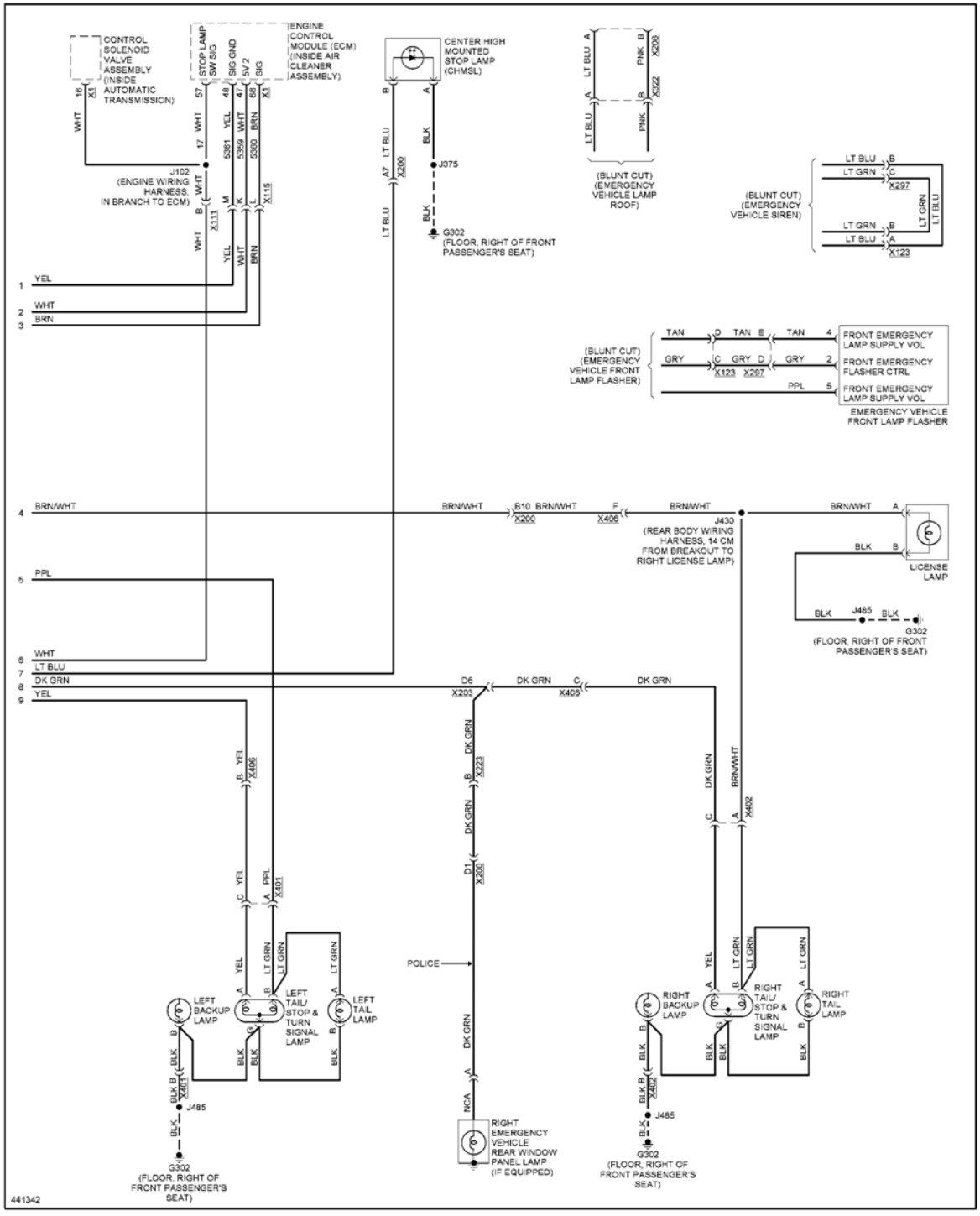


Fig. 22: Exterior Lamps Circuit (2 of 2)

GROUND DISTRIBUTION

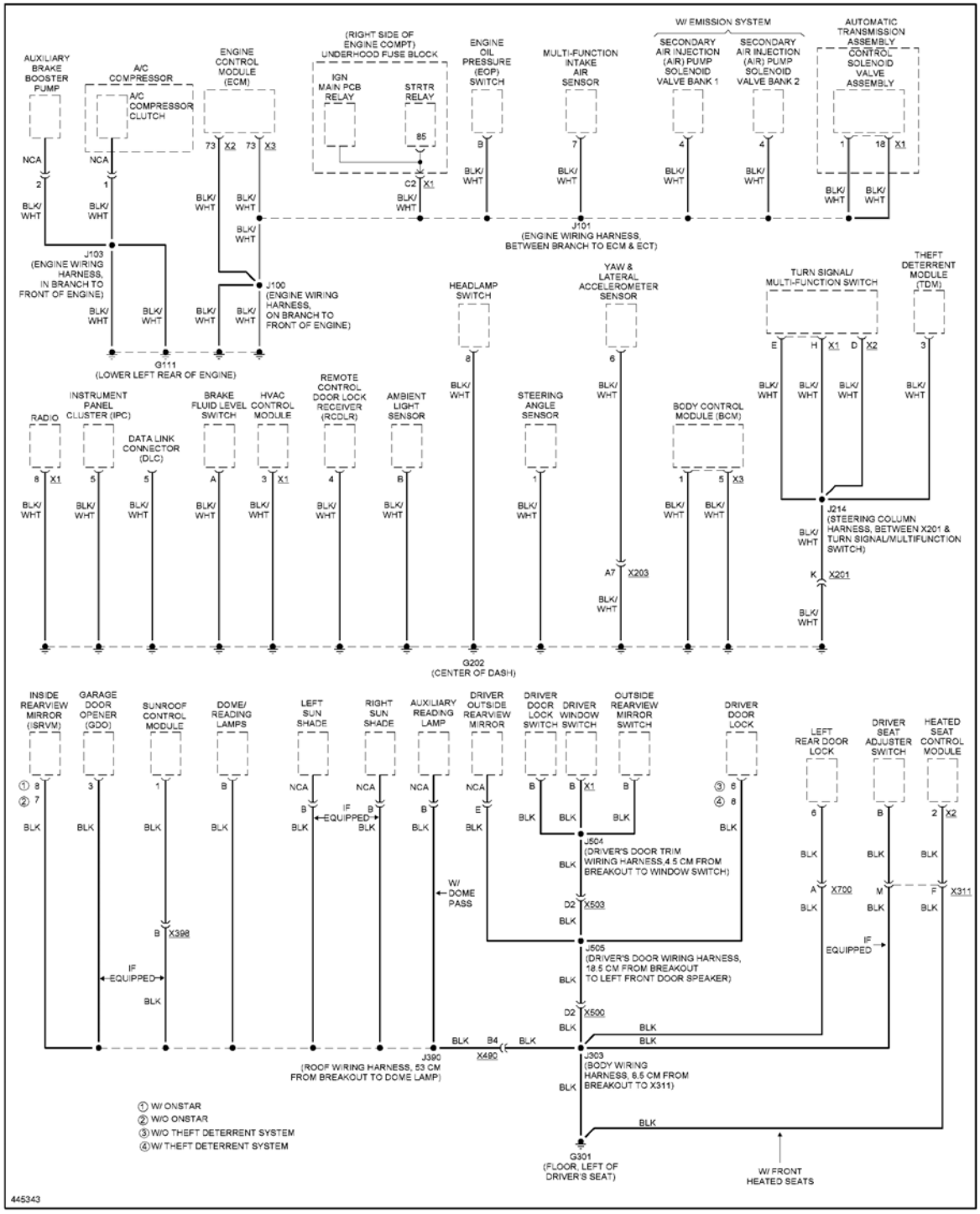


Fig. 23: Ground Distribution Circuit (1 of 3)

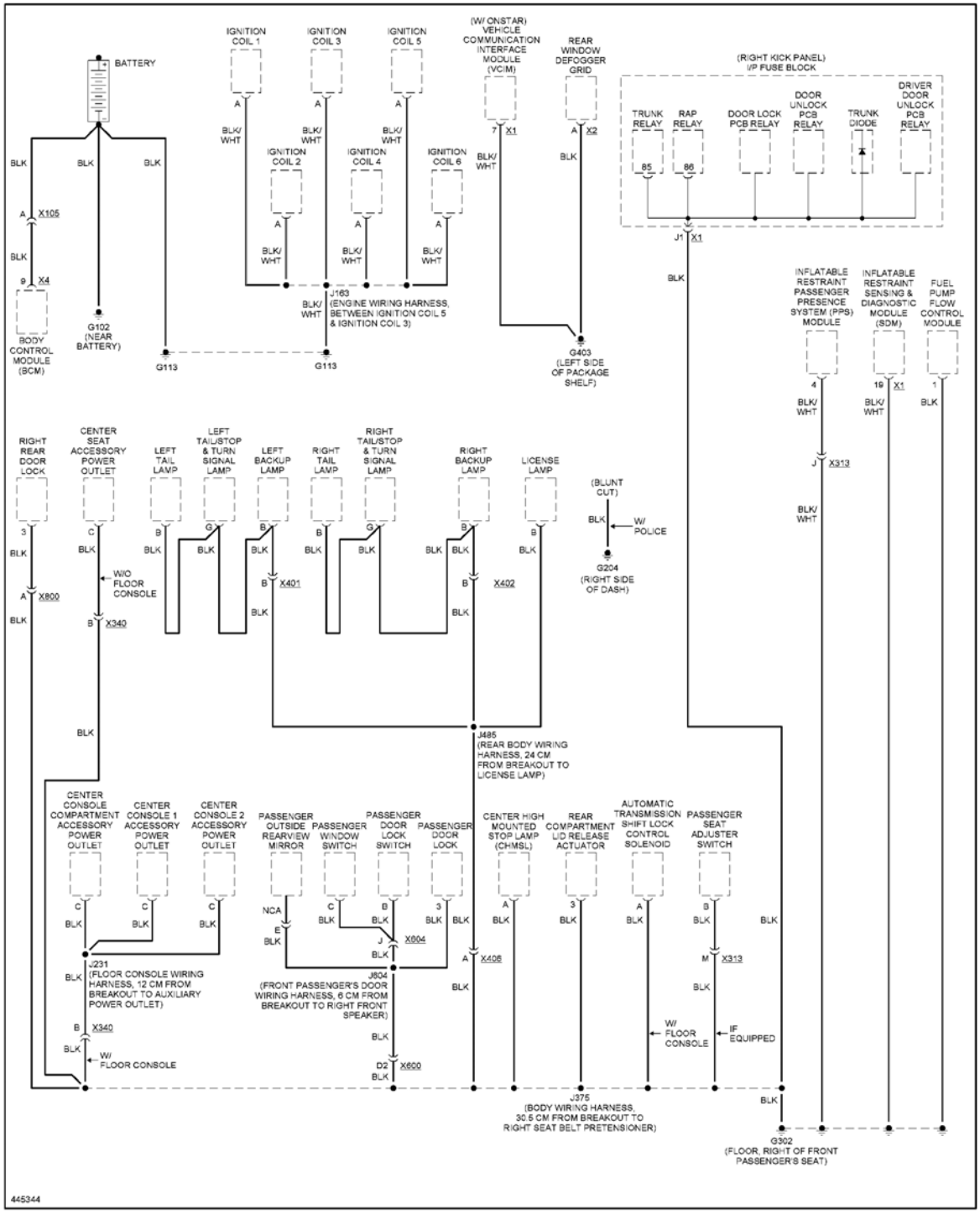


Fig. 24: Ground Distribution Circuit (2 of 3)

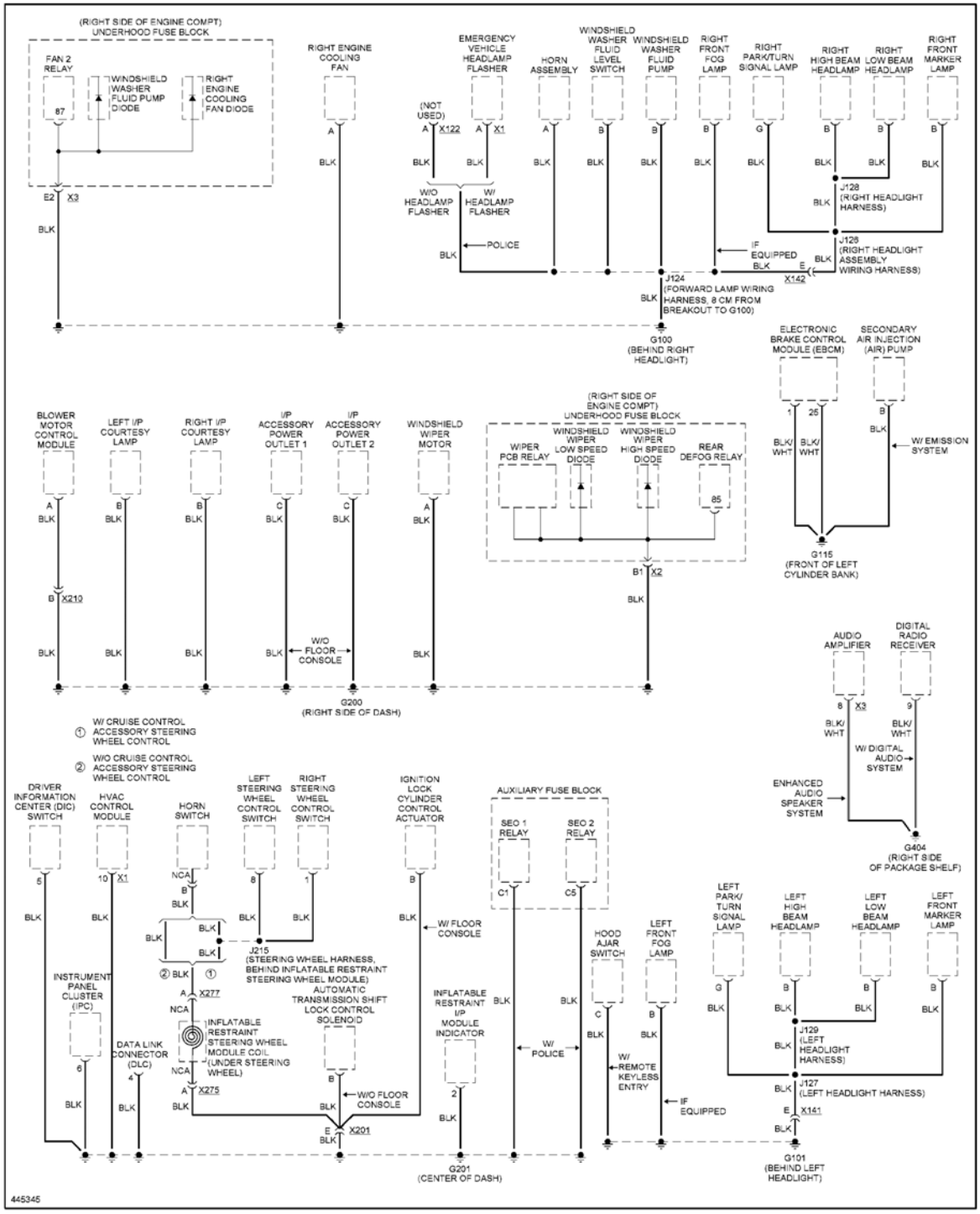


Fig. 25: Ground Distribution Circuit (3 of 3)

HEADLIGHTS

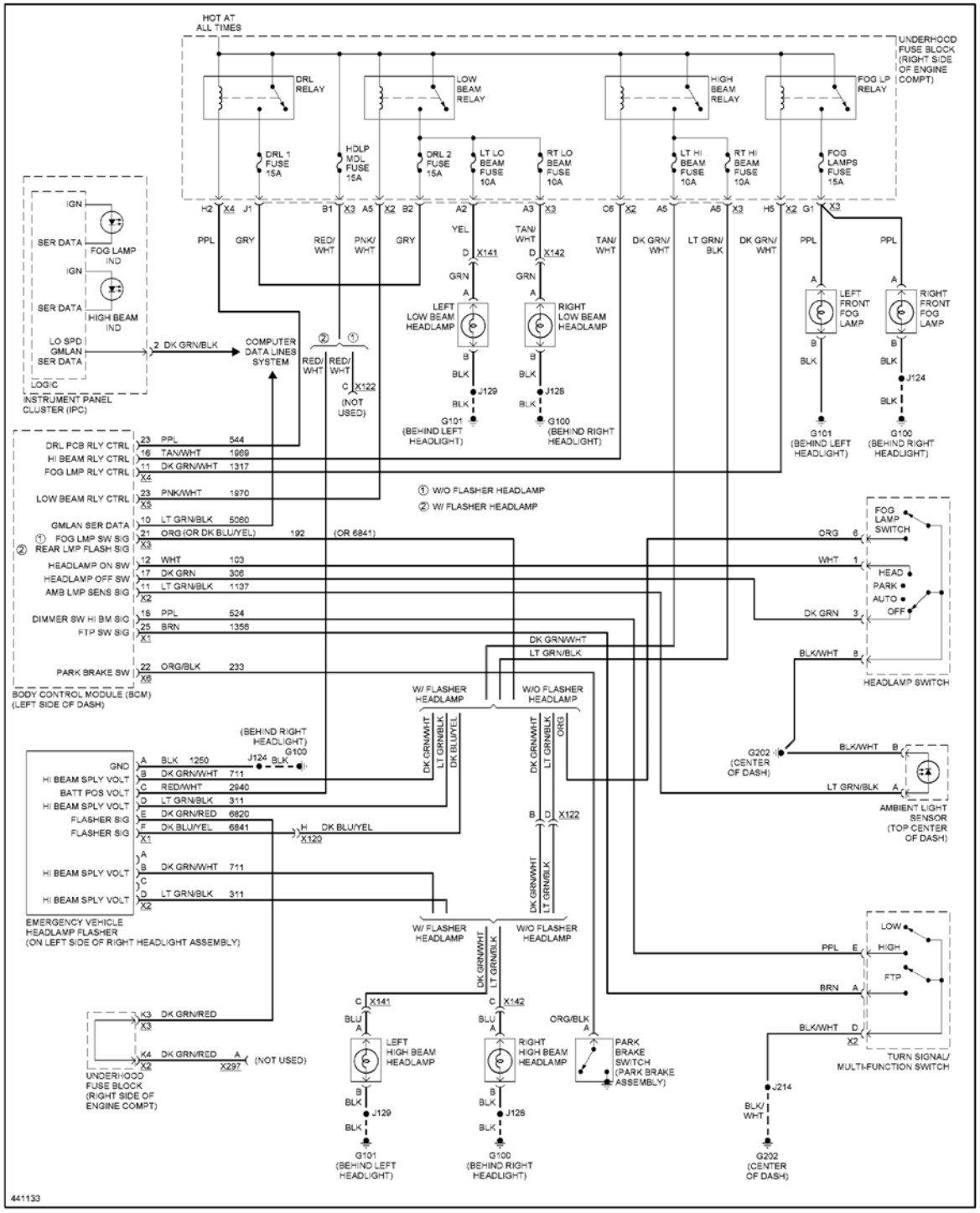


Fig. 26: Headlights Circuit, W/ Police

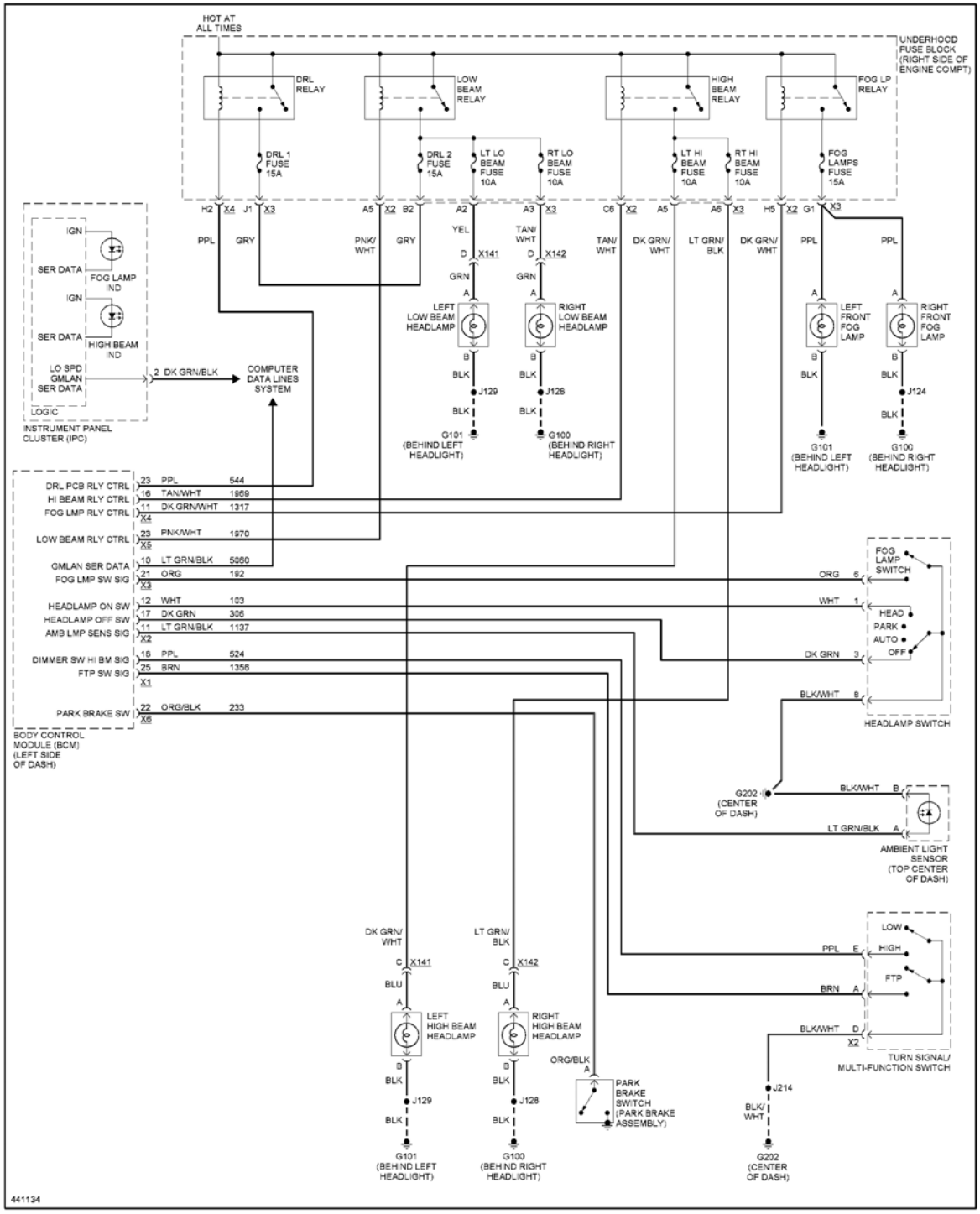


Fig. 27: Headlights Circuit, W/O Police

HORN

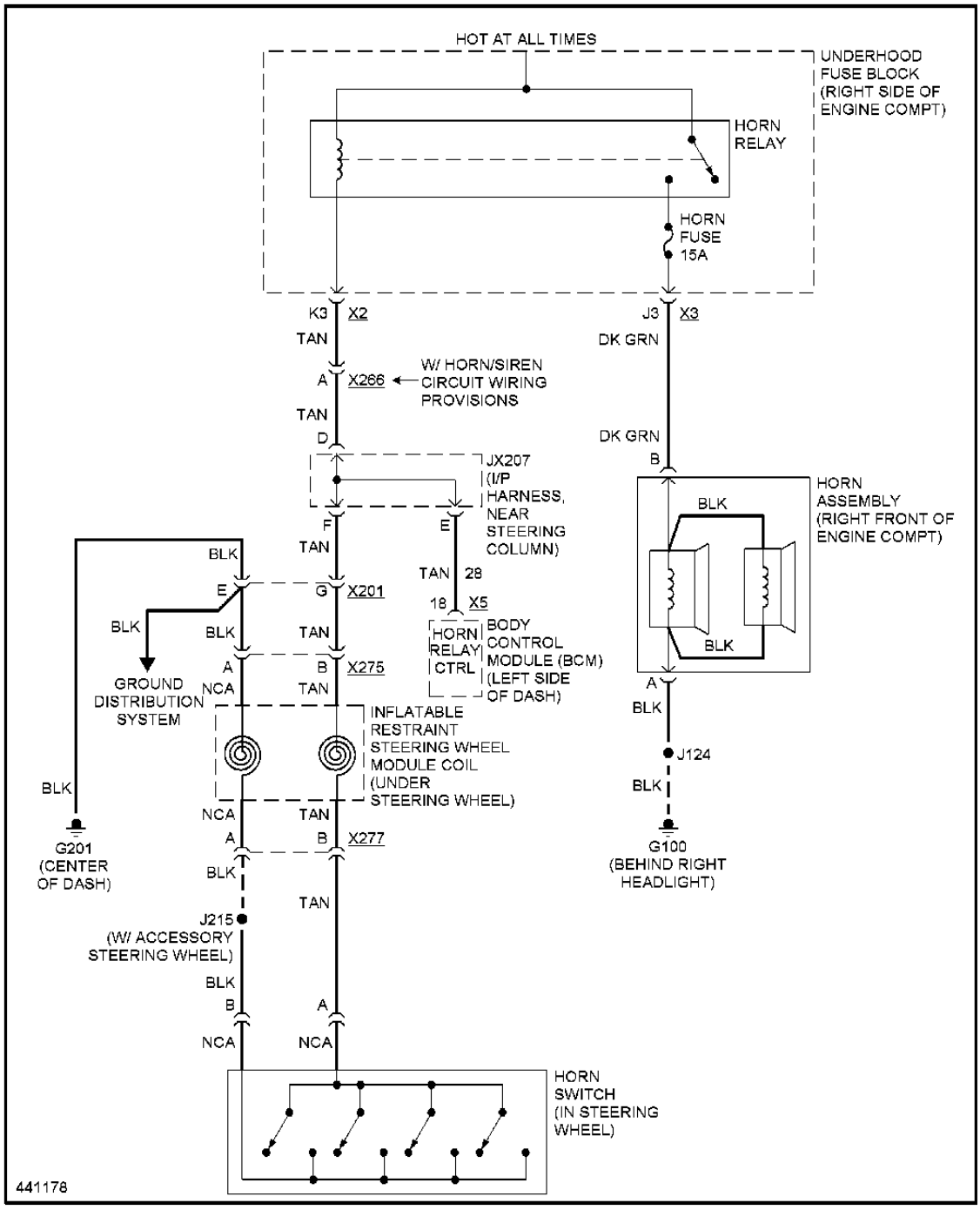


Fig. 28: Horn Circuit

INSTRUMENT CLUSTER

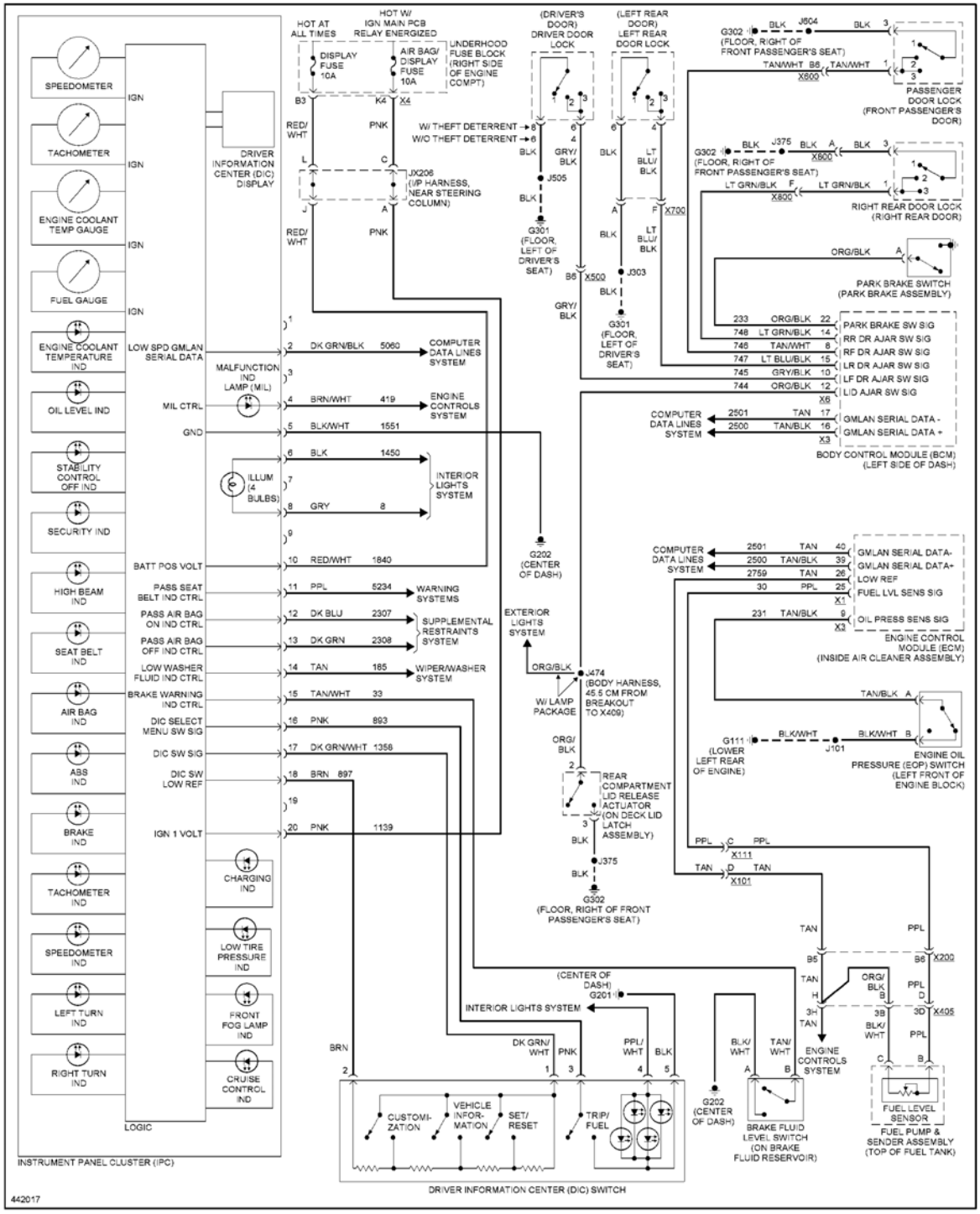


Fig. 29: Instrument Cluster Circuit

INTERIOR LIGHTS

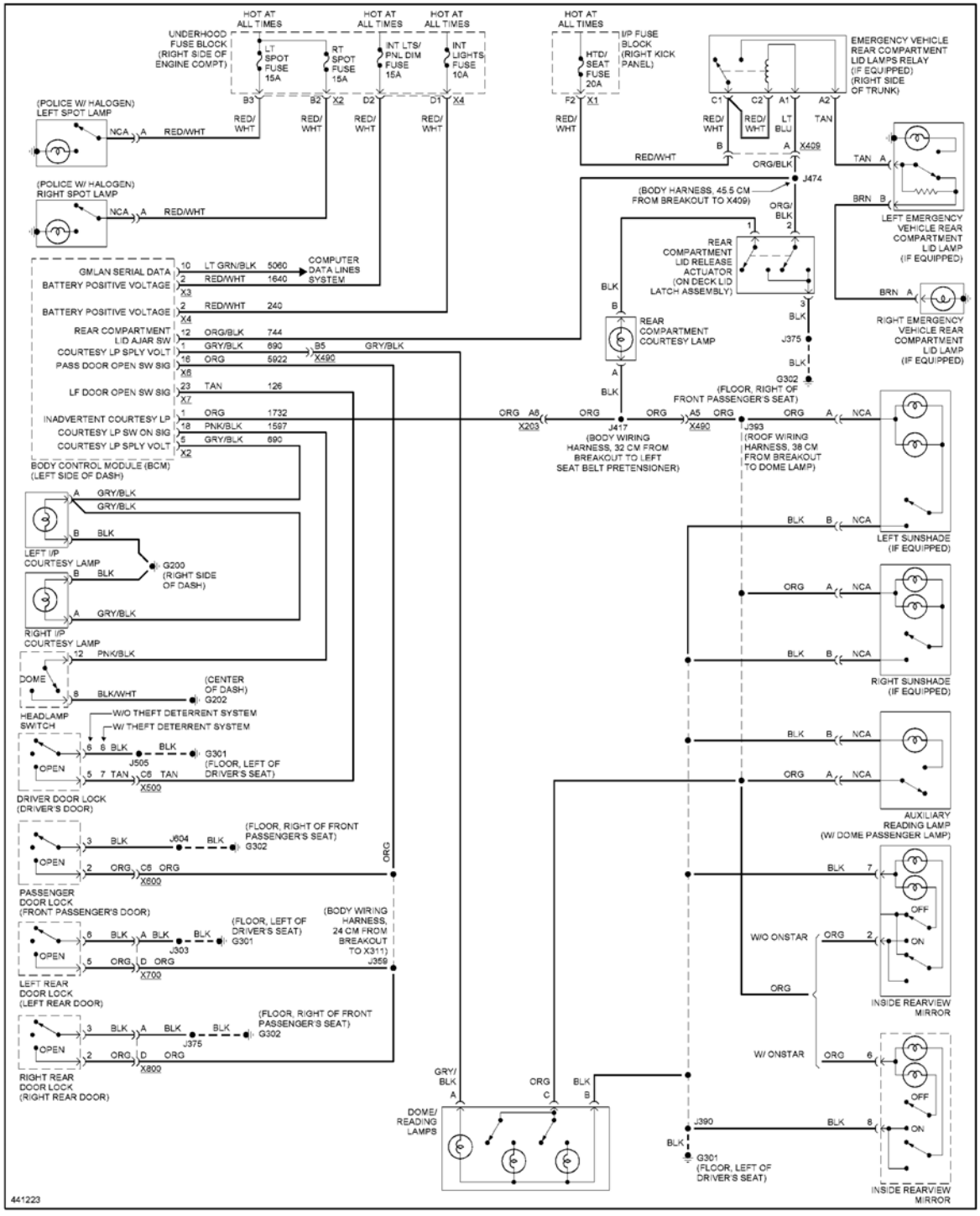


Fig. 30: Courtesy Lamps Circuit

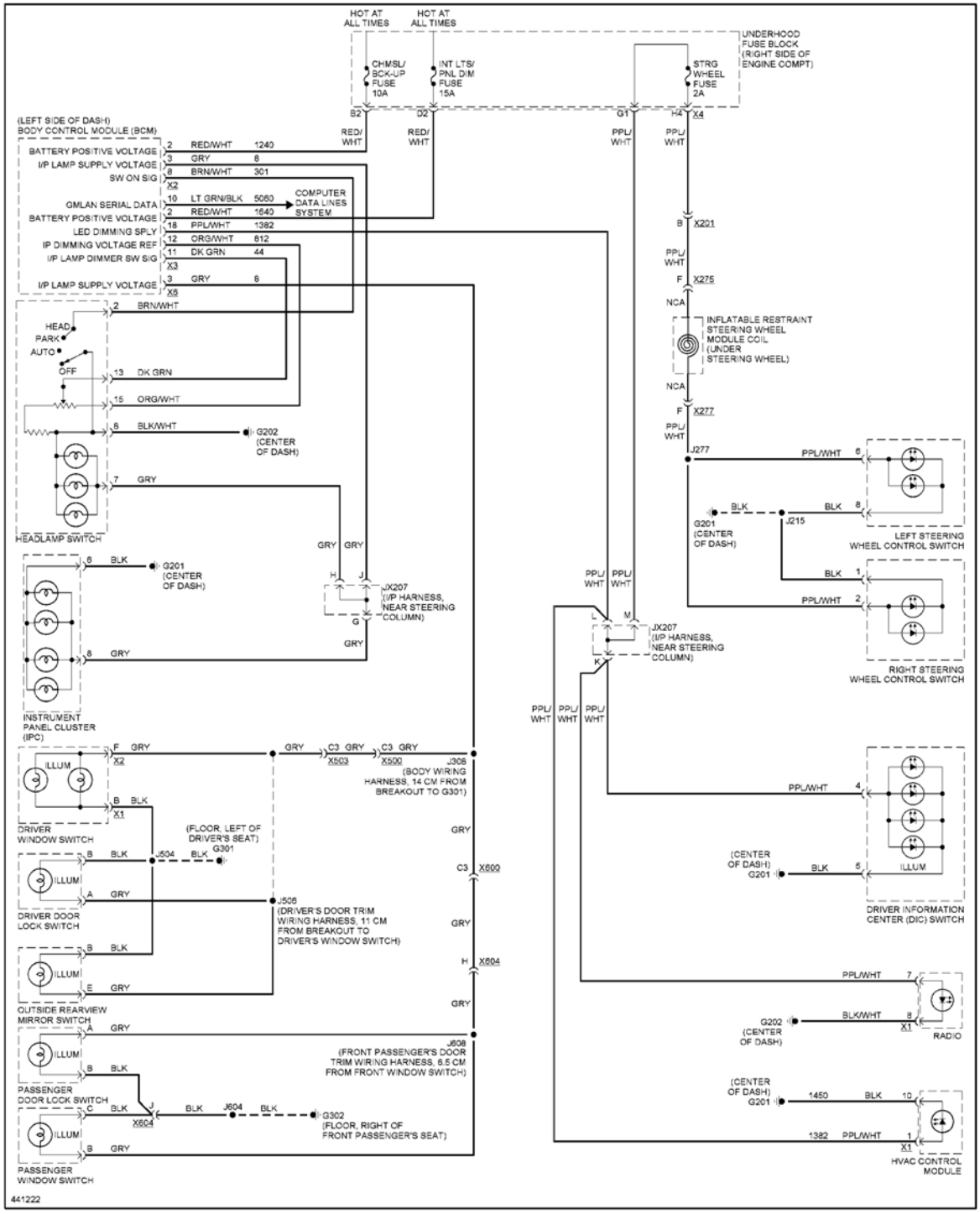


Fig. 31: Instrument Illumination Circuit

NAVIGATION

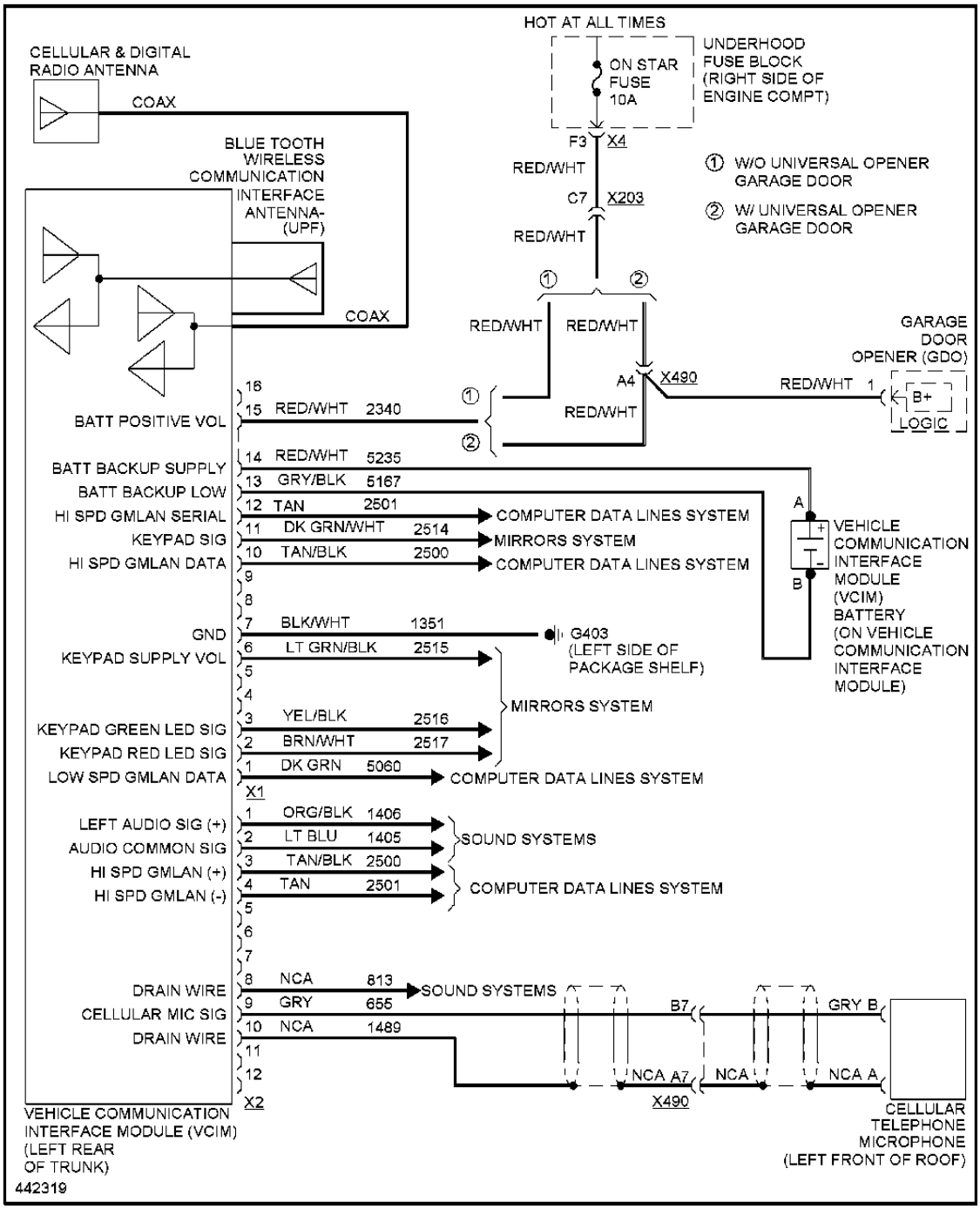


Fig. 32: Navigation Circuit

POWER DISTRIBUTION

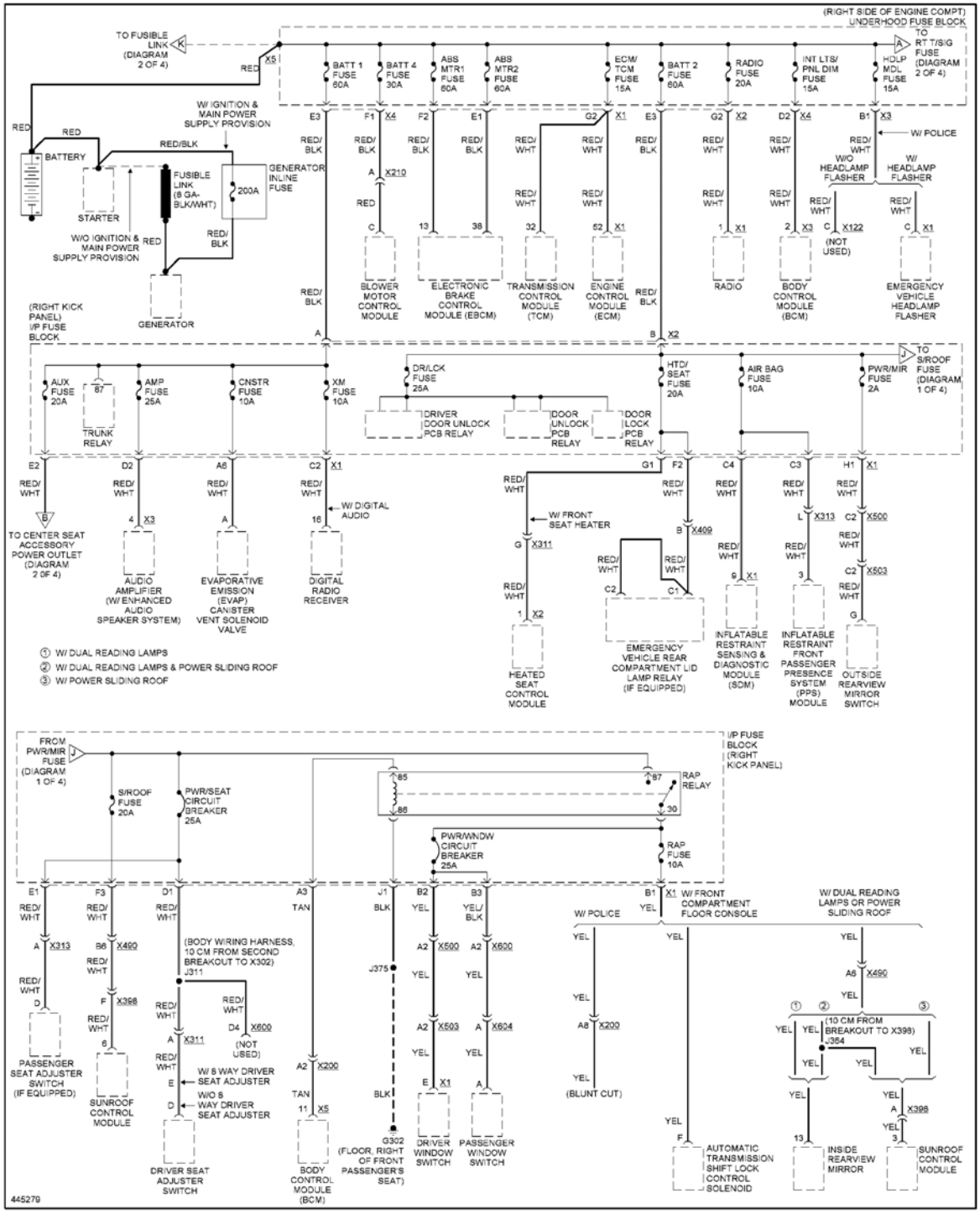


Fig. 33: Power Distribution Circuit (1 of 4)

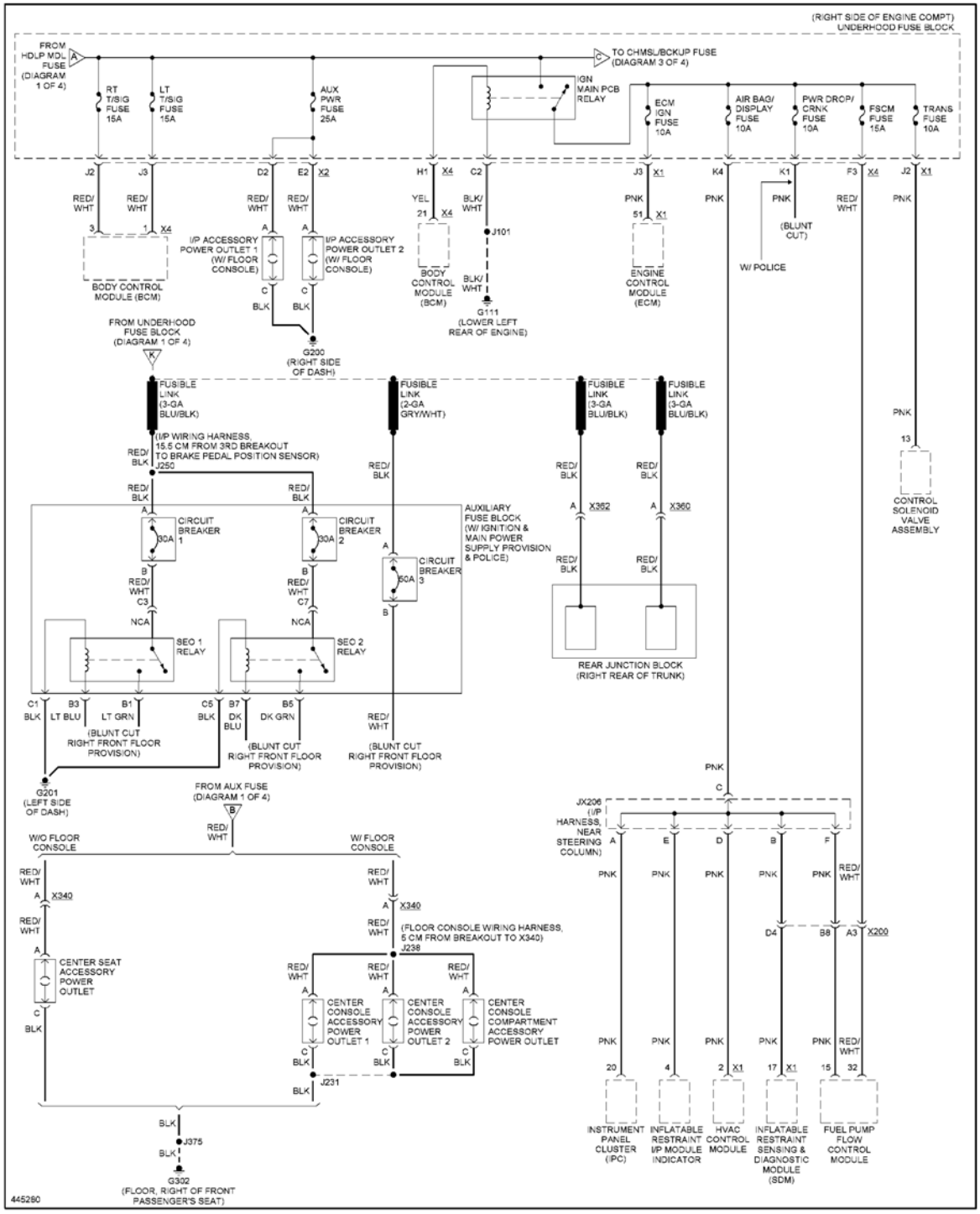


Fig. 34: Power Distribution Circuit (2 of 4)

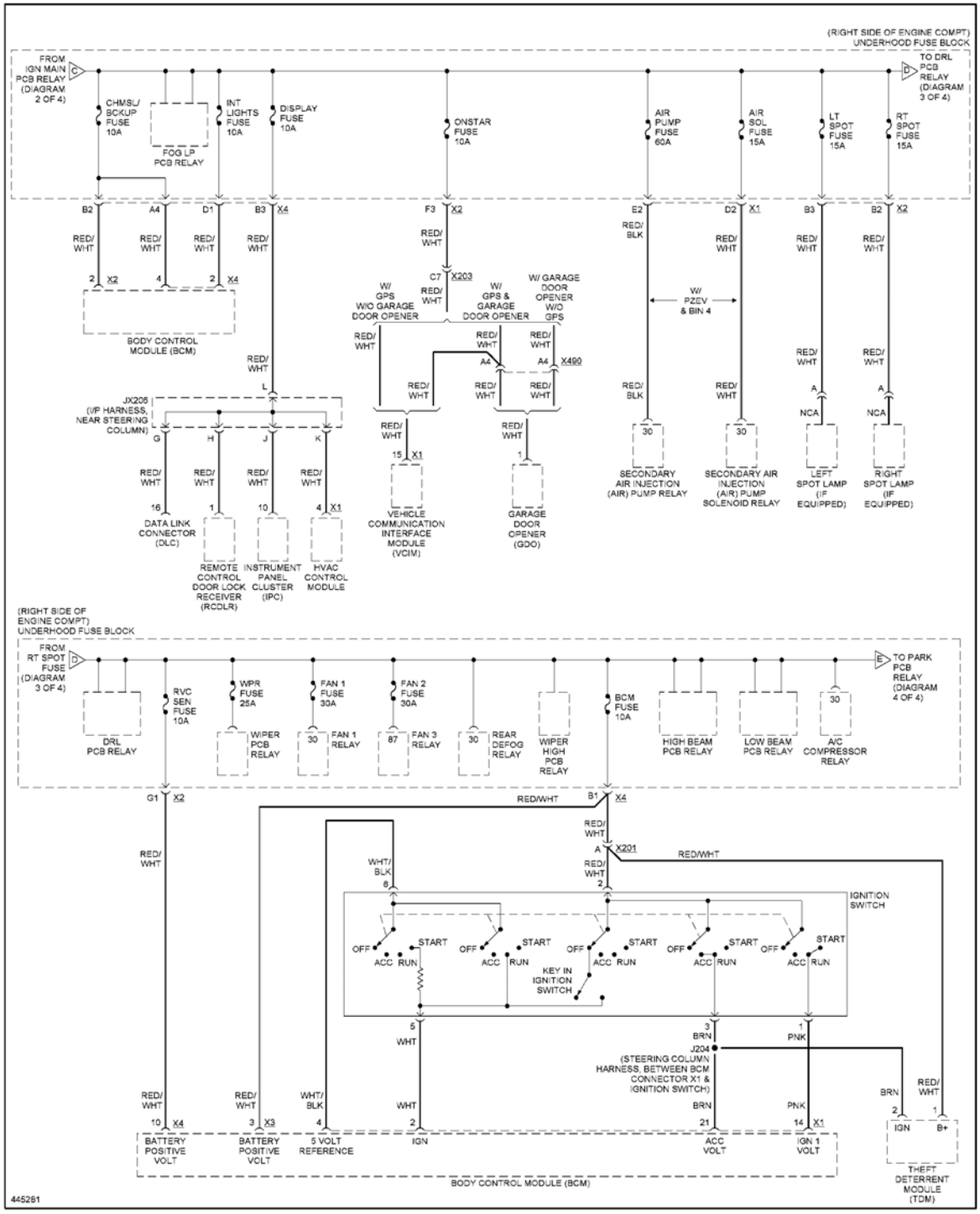


Fig. 35: Power Distribution Circuit (3 of 4)

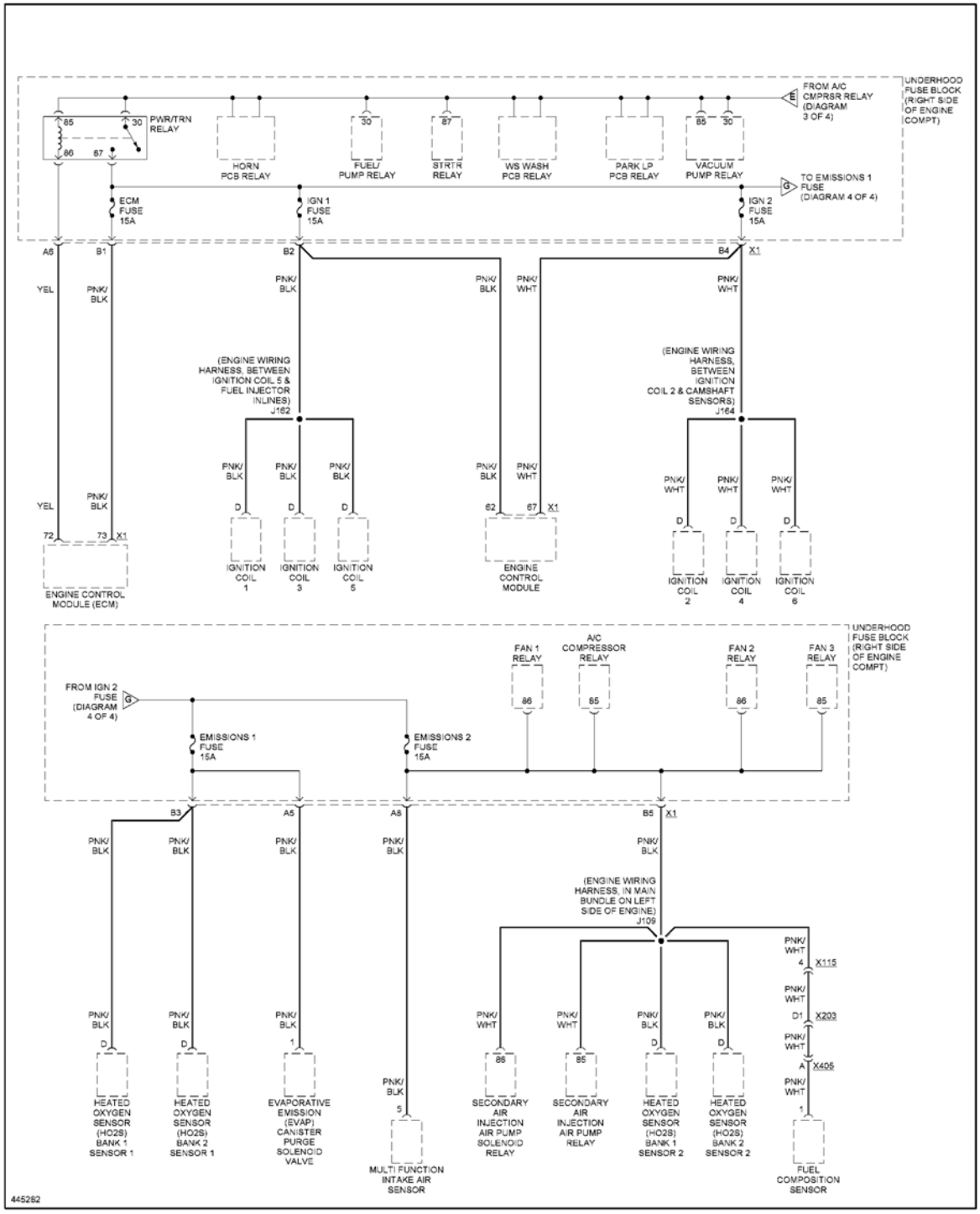


Fig. 36: Power Distribution Circuit (4 of 4)

POWER DOOR LOCKS

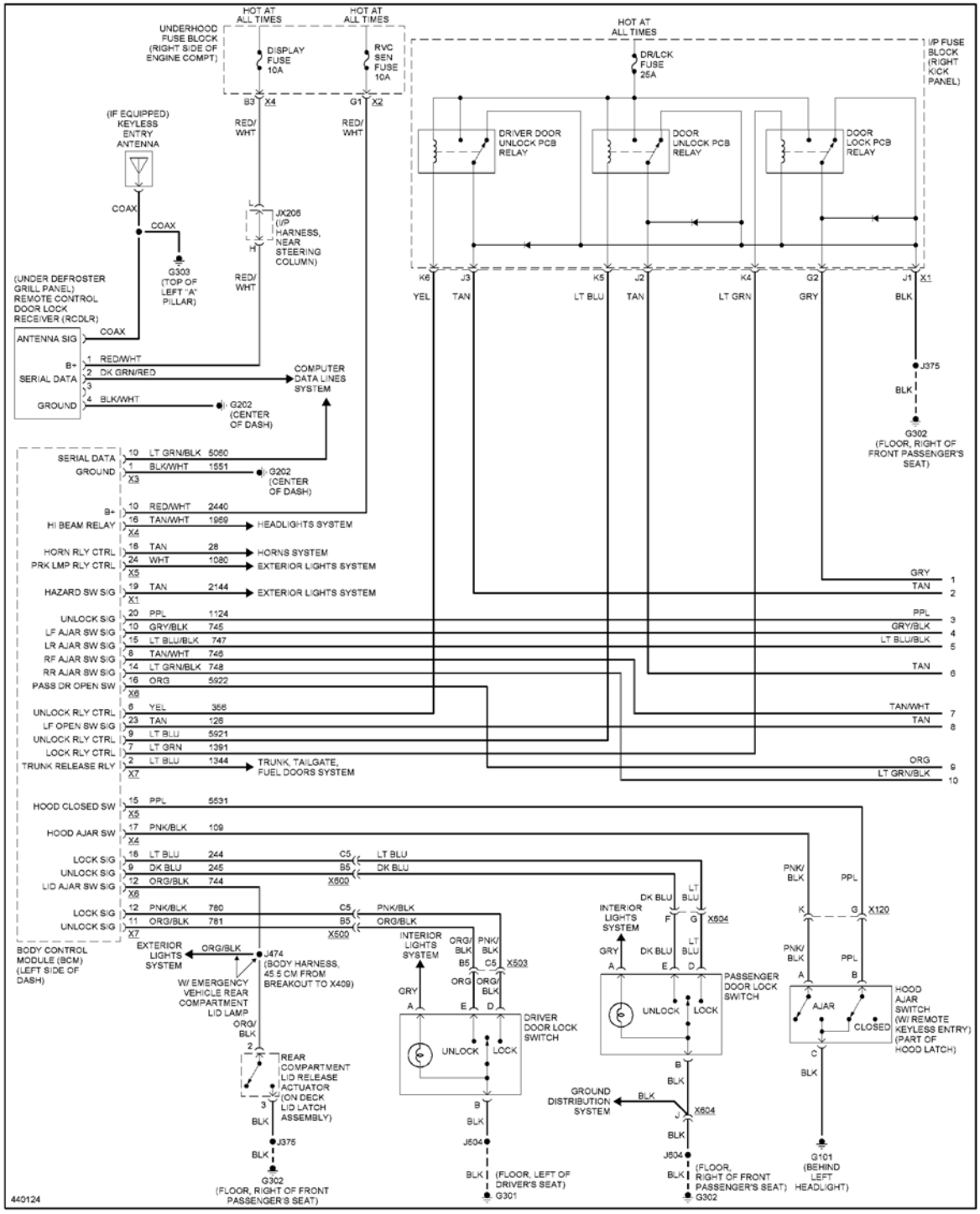


Fig. 37: Power Door Locks Circuit (1 of 2)

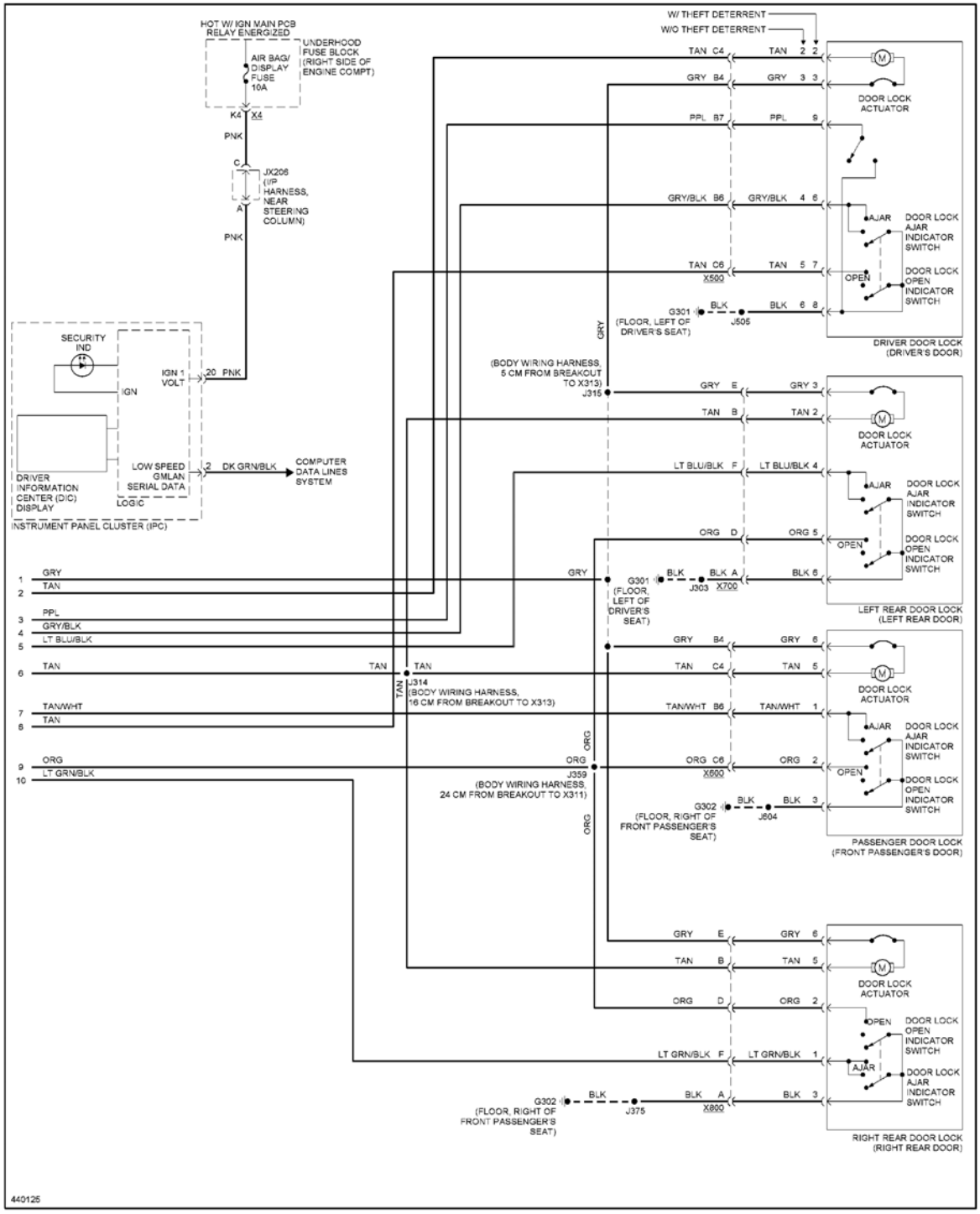


Fig. 38: Power Door Locks Circuit (2 of 2)

POWER MIRRORS

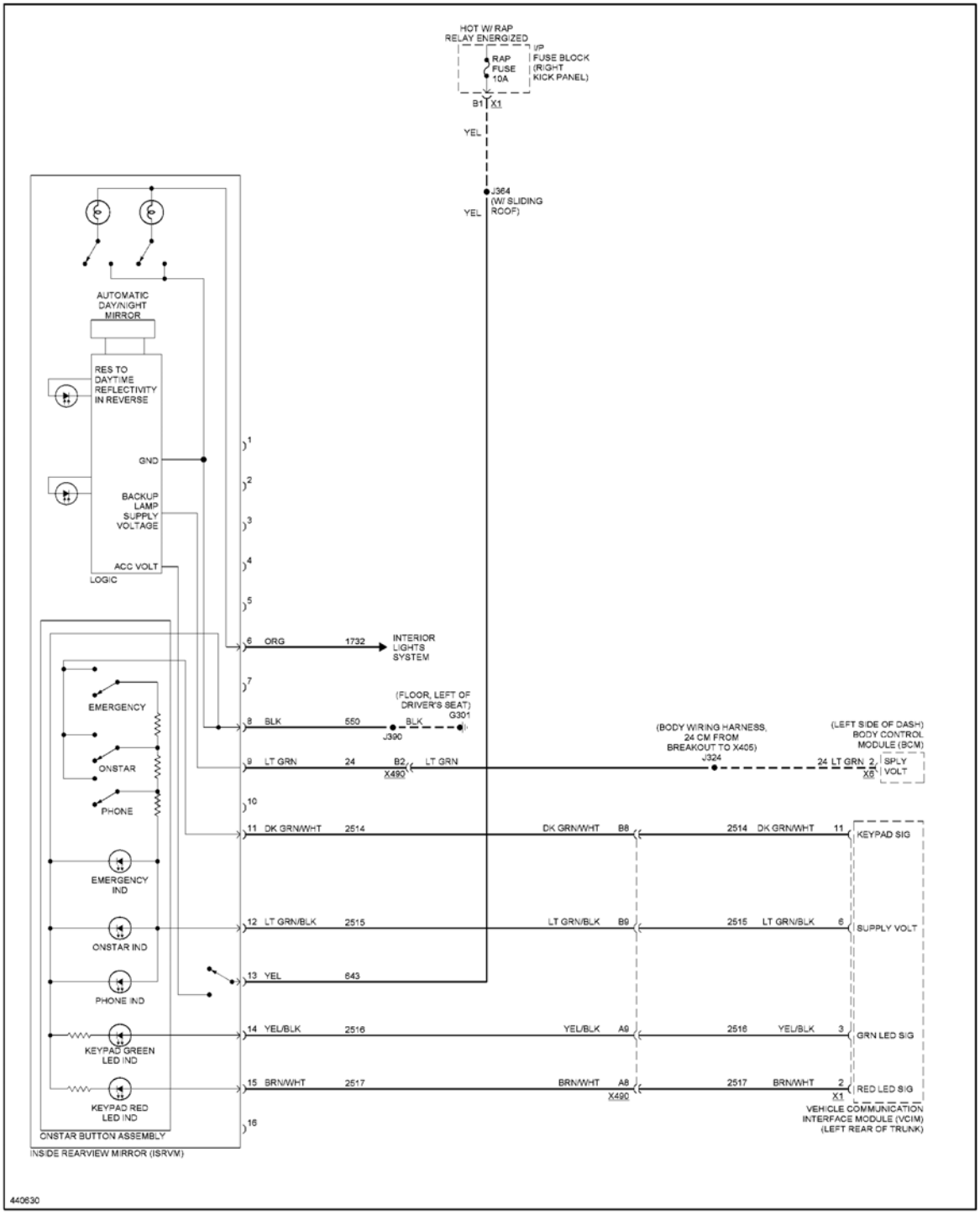


Fig. 39: Electrochromic Mirror Circuit

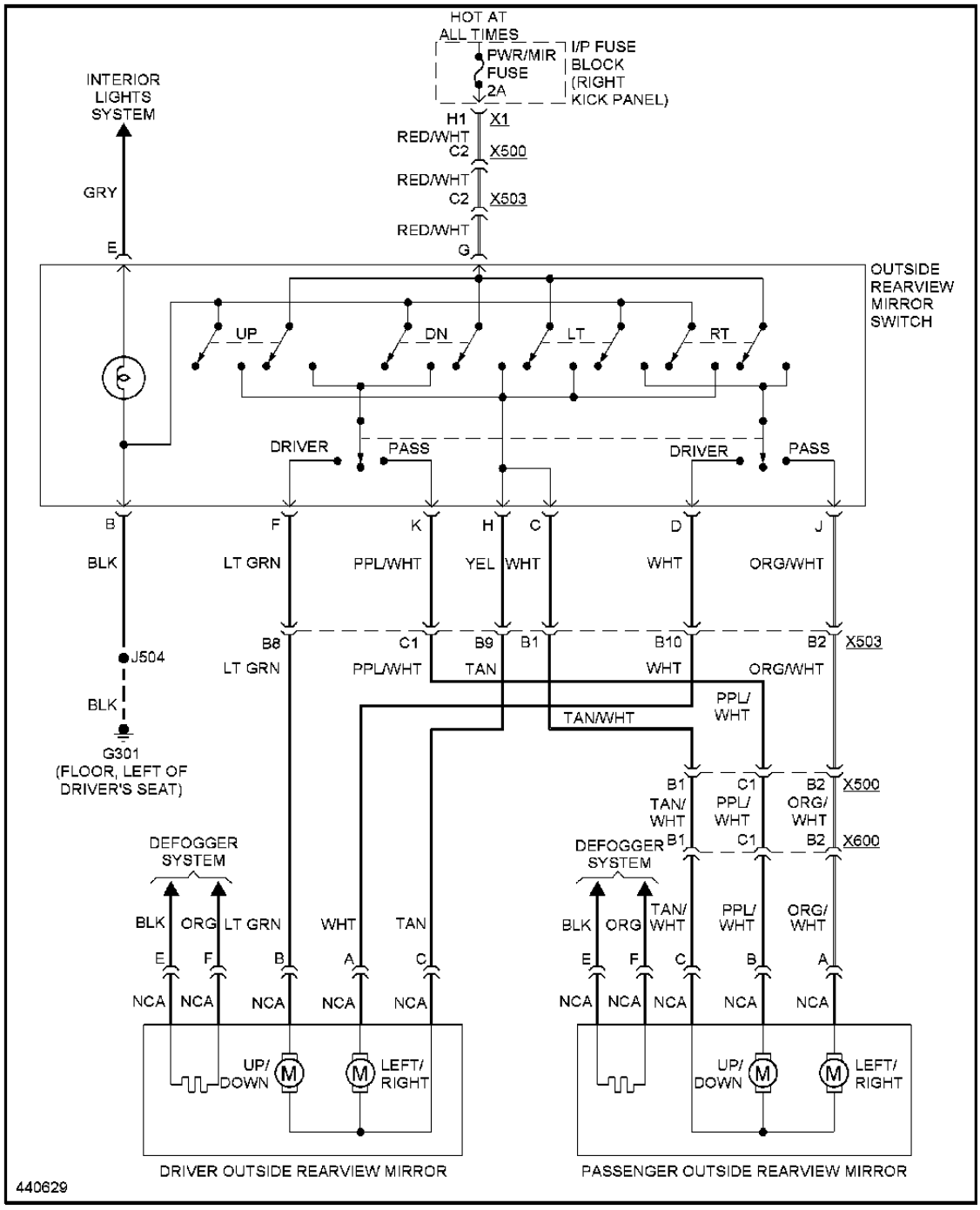


Fig. 40: Power Mirrors Circuit

POWER SEATS

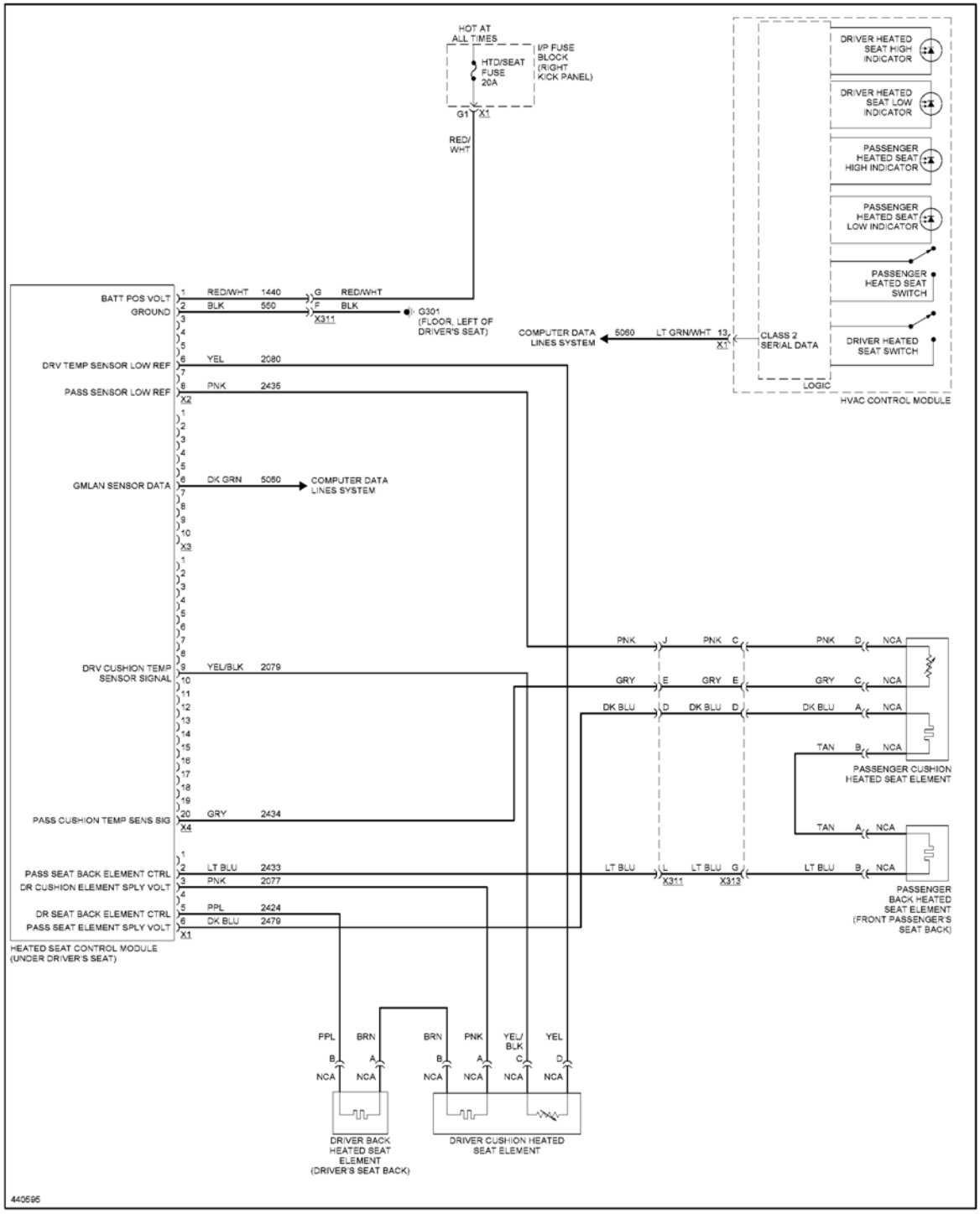


Fig. 41: Heated Seats Circuit

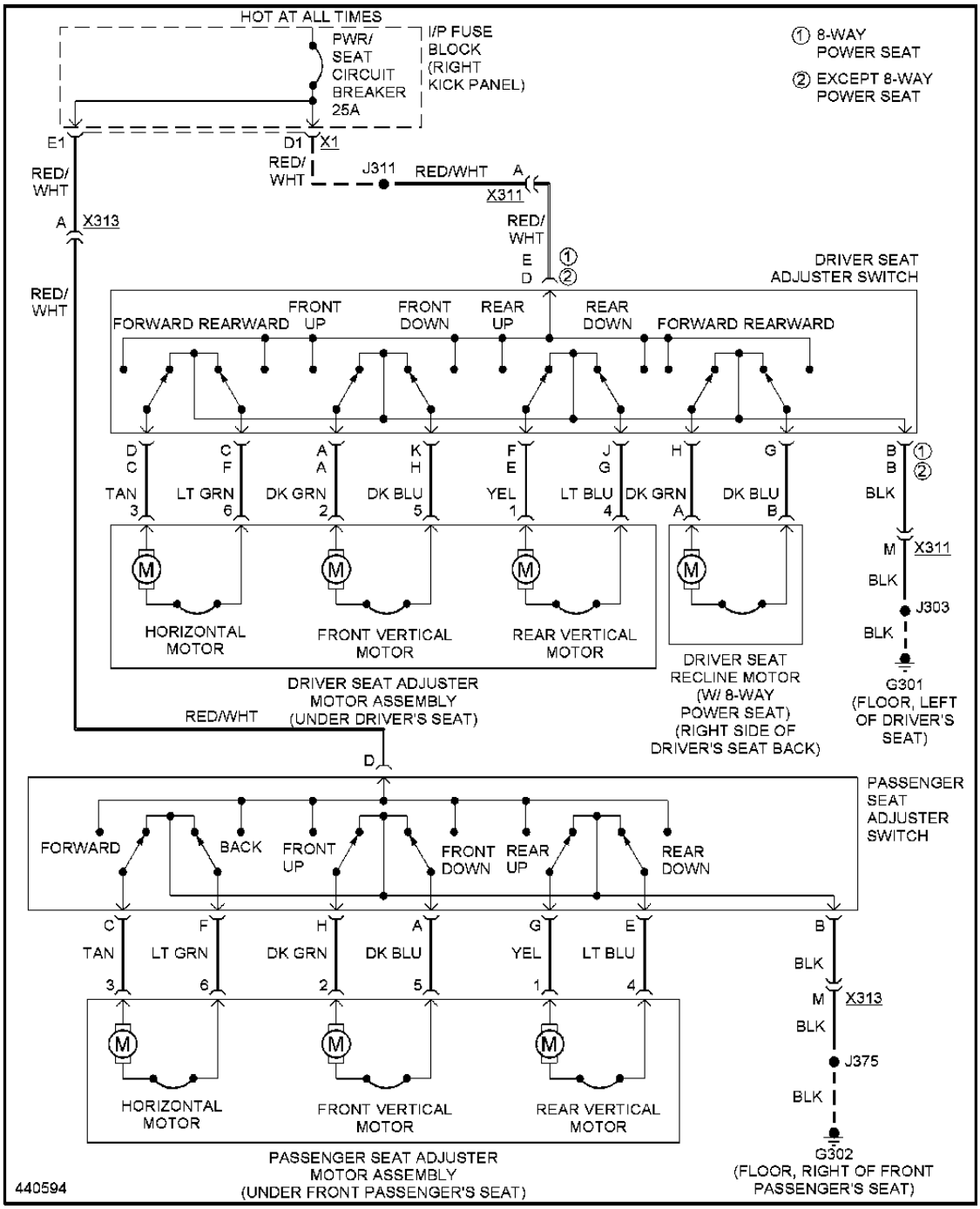


Fig. 42: Power Seat Circuit

POWER TOP/SUNROOF

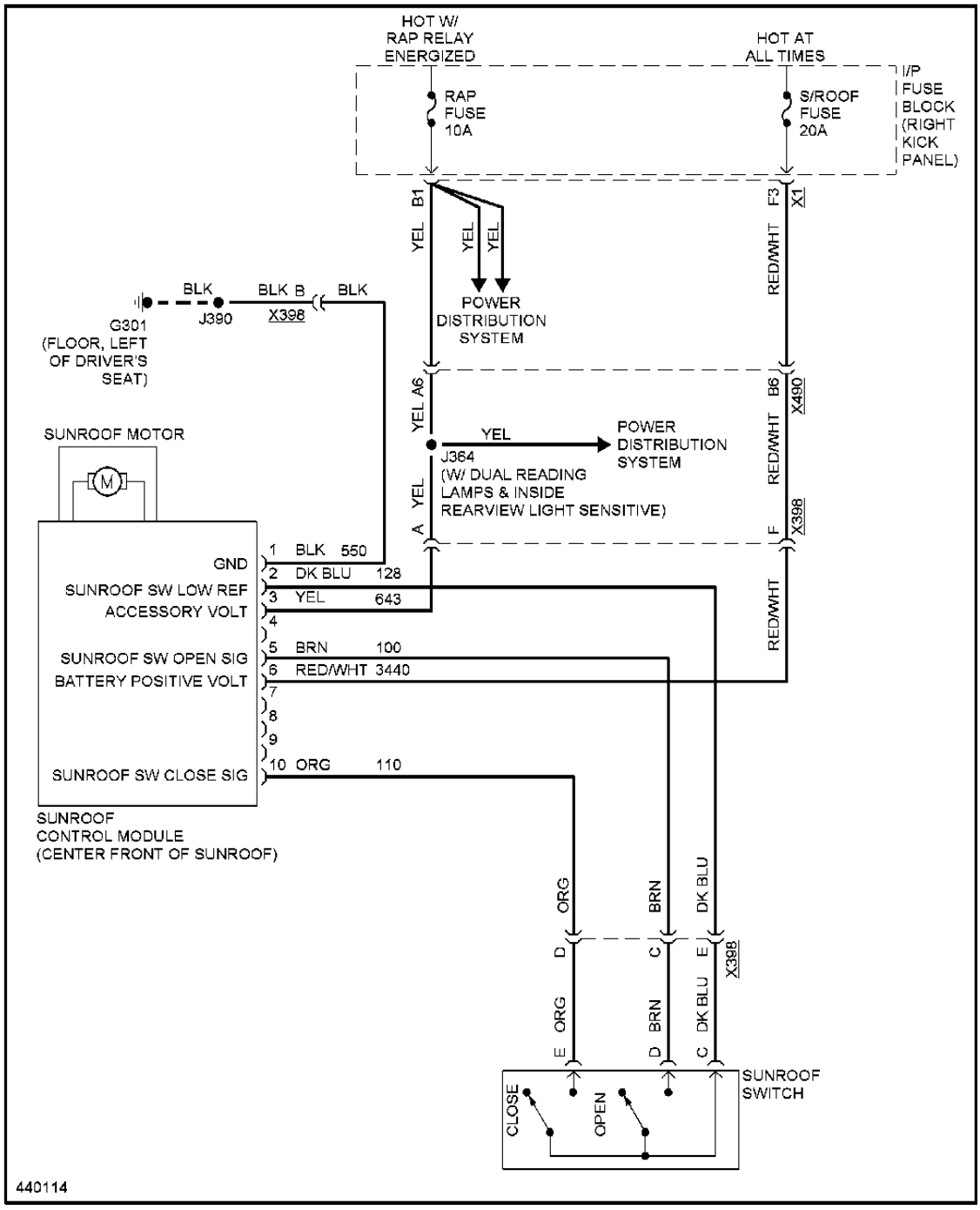


Fig. 43: Power Top/Sunroof Circuit

POWER WINDOWS

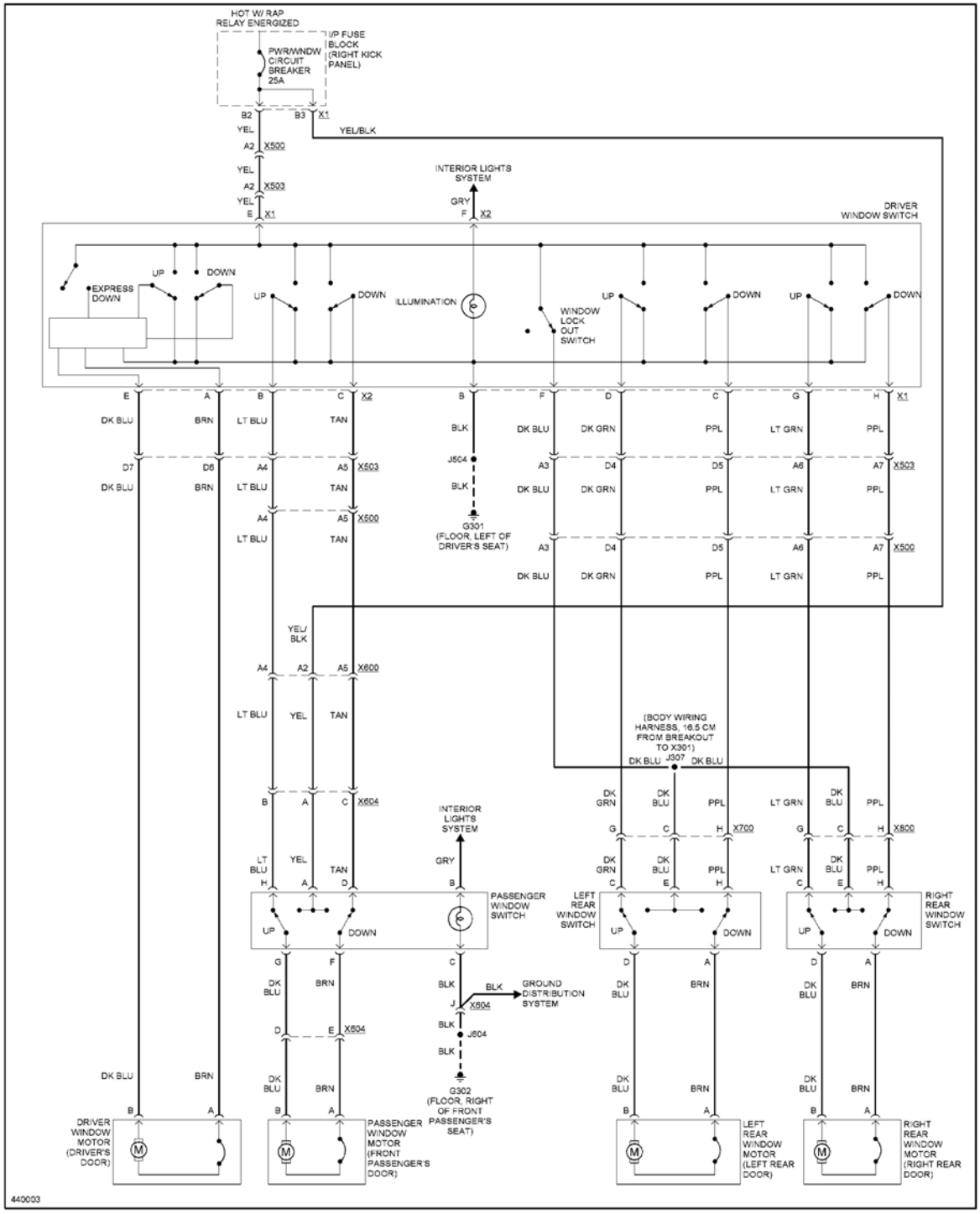


Fig. 44: Power Windows Circuit

RADIO

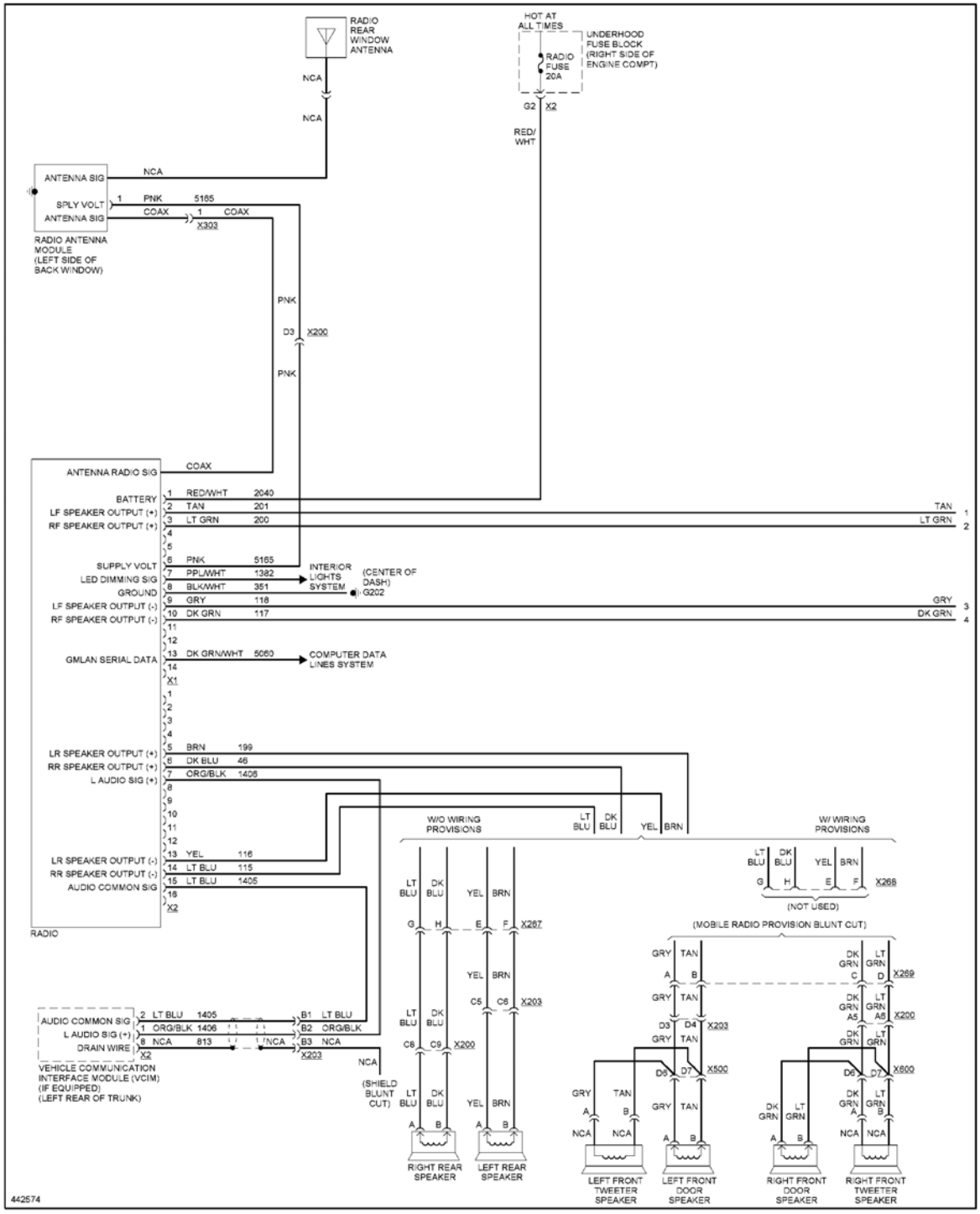


Fig. 45: Radio Circuit, Police Option (1 of 2)

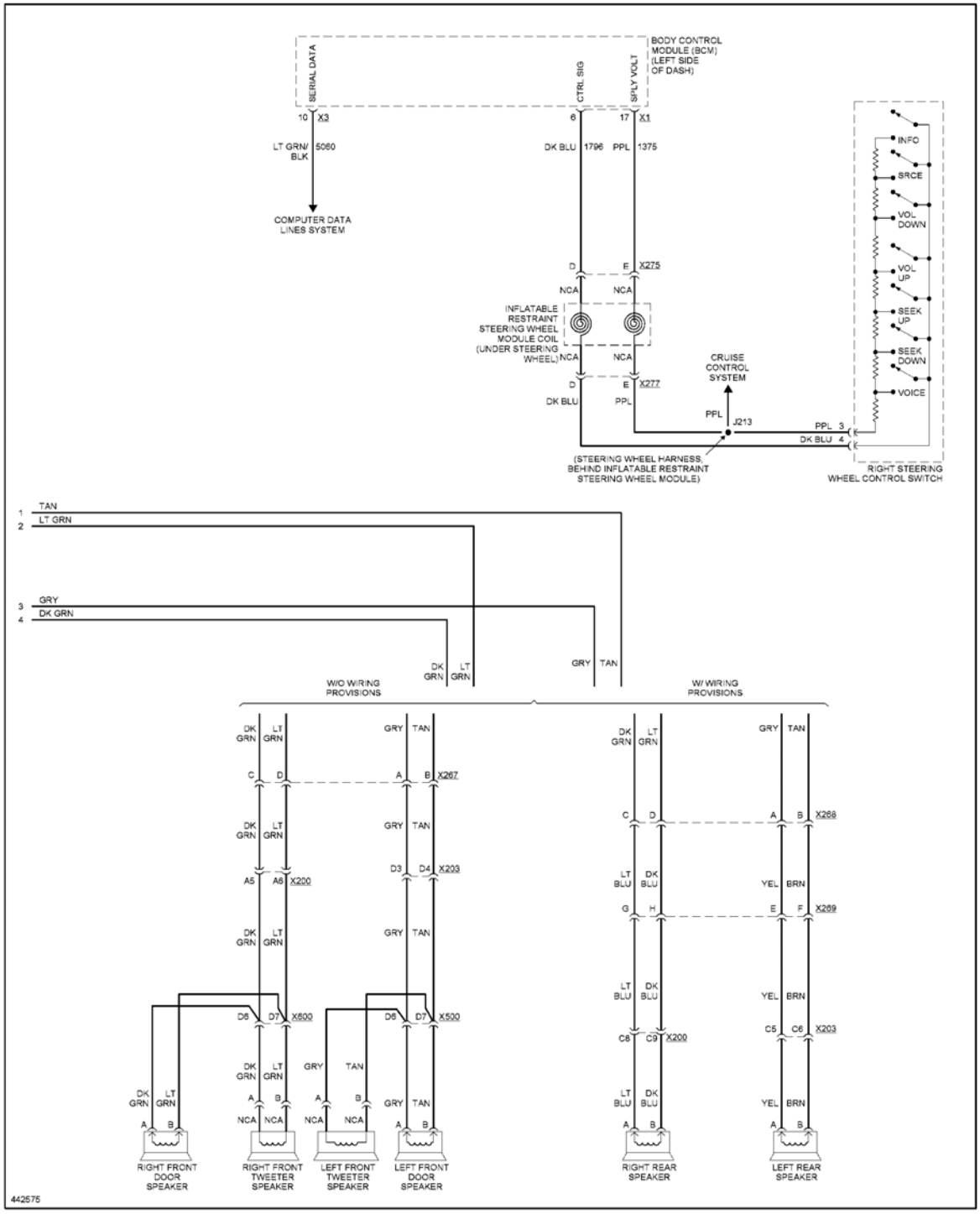


Fig. 46: Radio Circuit, Police Option (2 of 2)

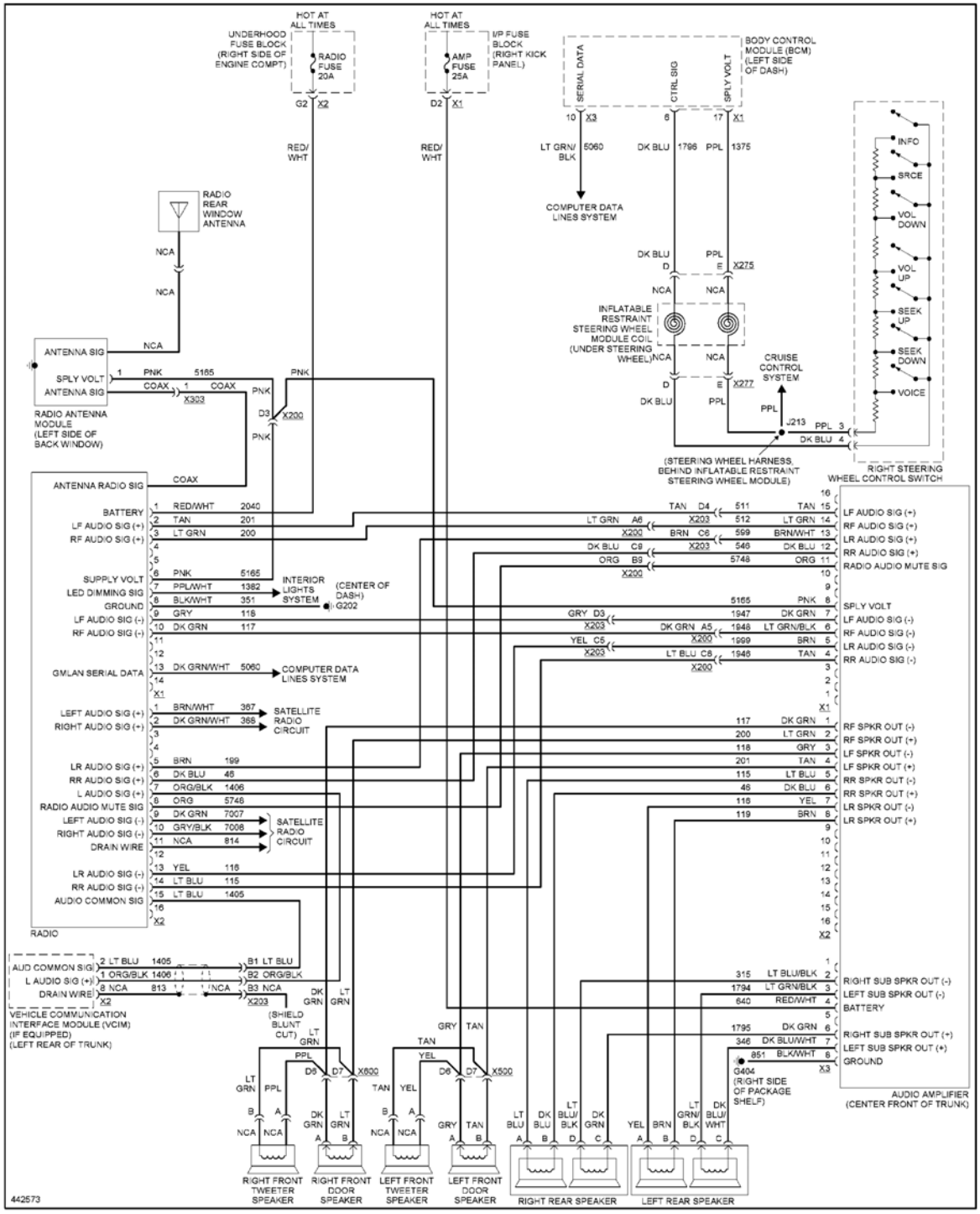


Fig. 47: Radio Circuit, W/ Amplifier

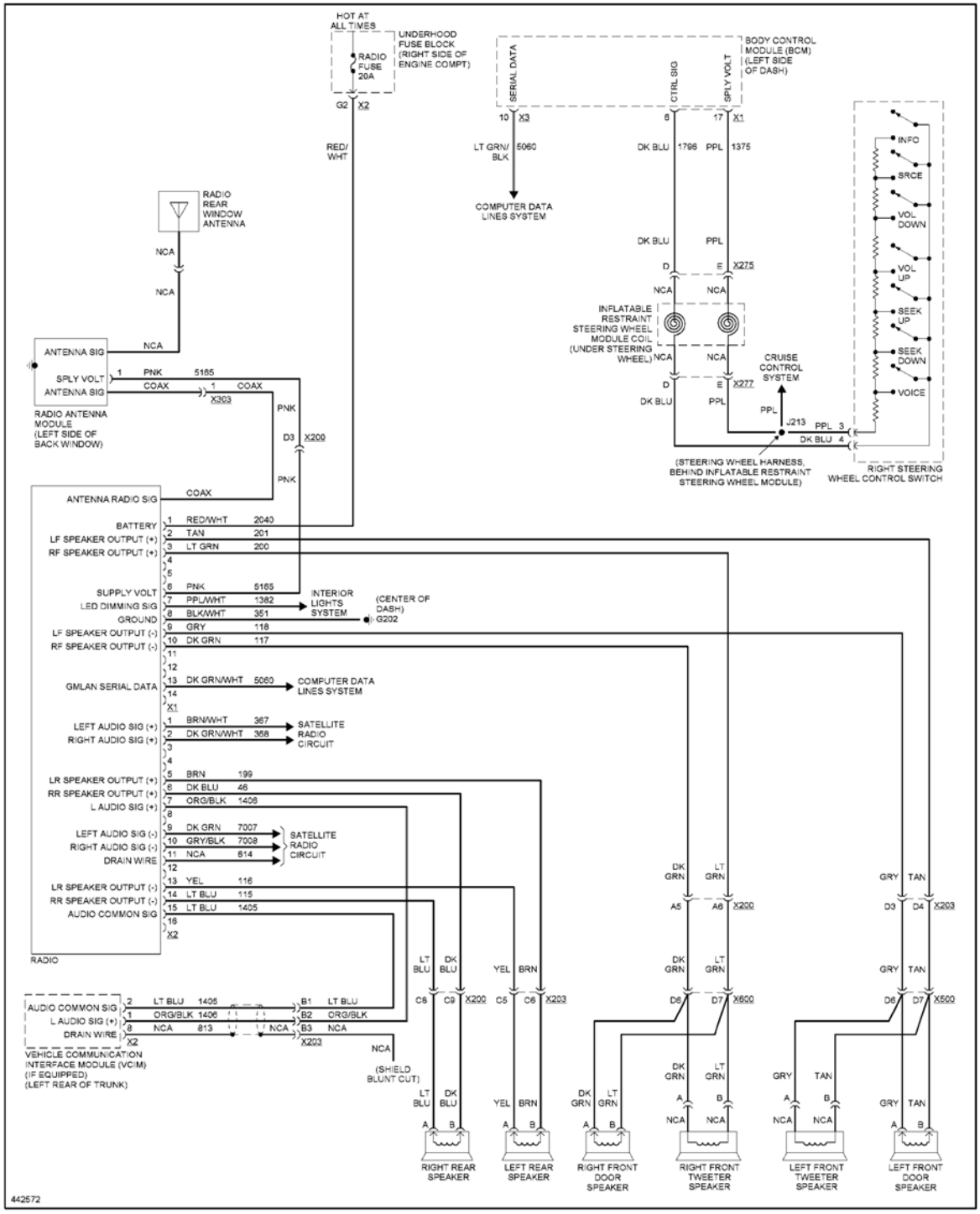


Fig. 48: Radio Circuit, W/O Amplifier

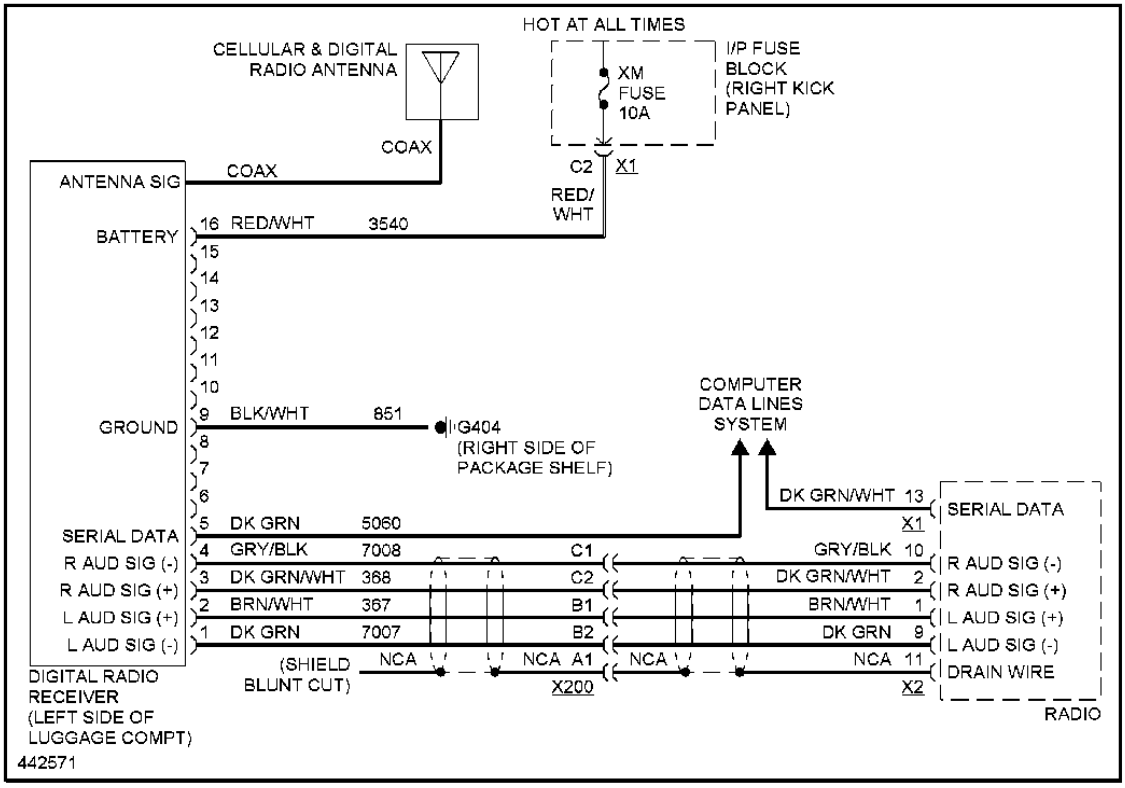


Fig. 49: Satellite Radio Circuit

SHIFT INTERLOCK

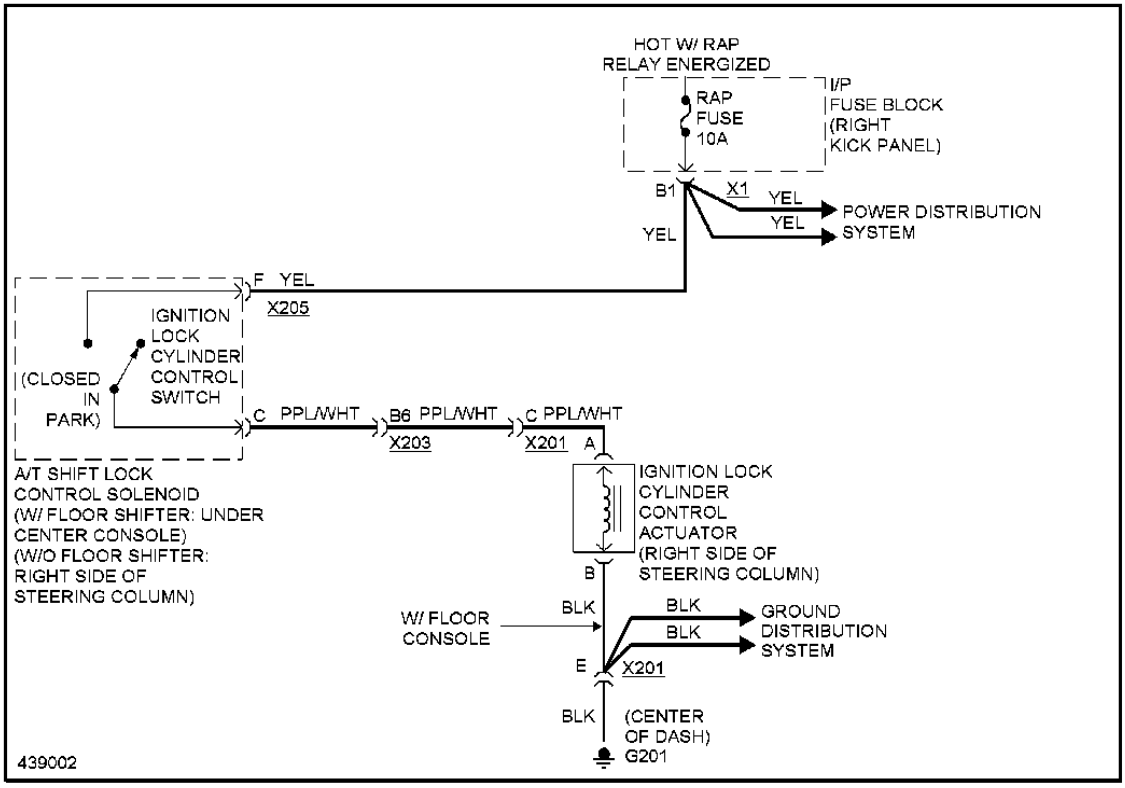


Fig. 50: Ignition Lock Solenoid Circuit

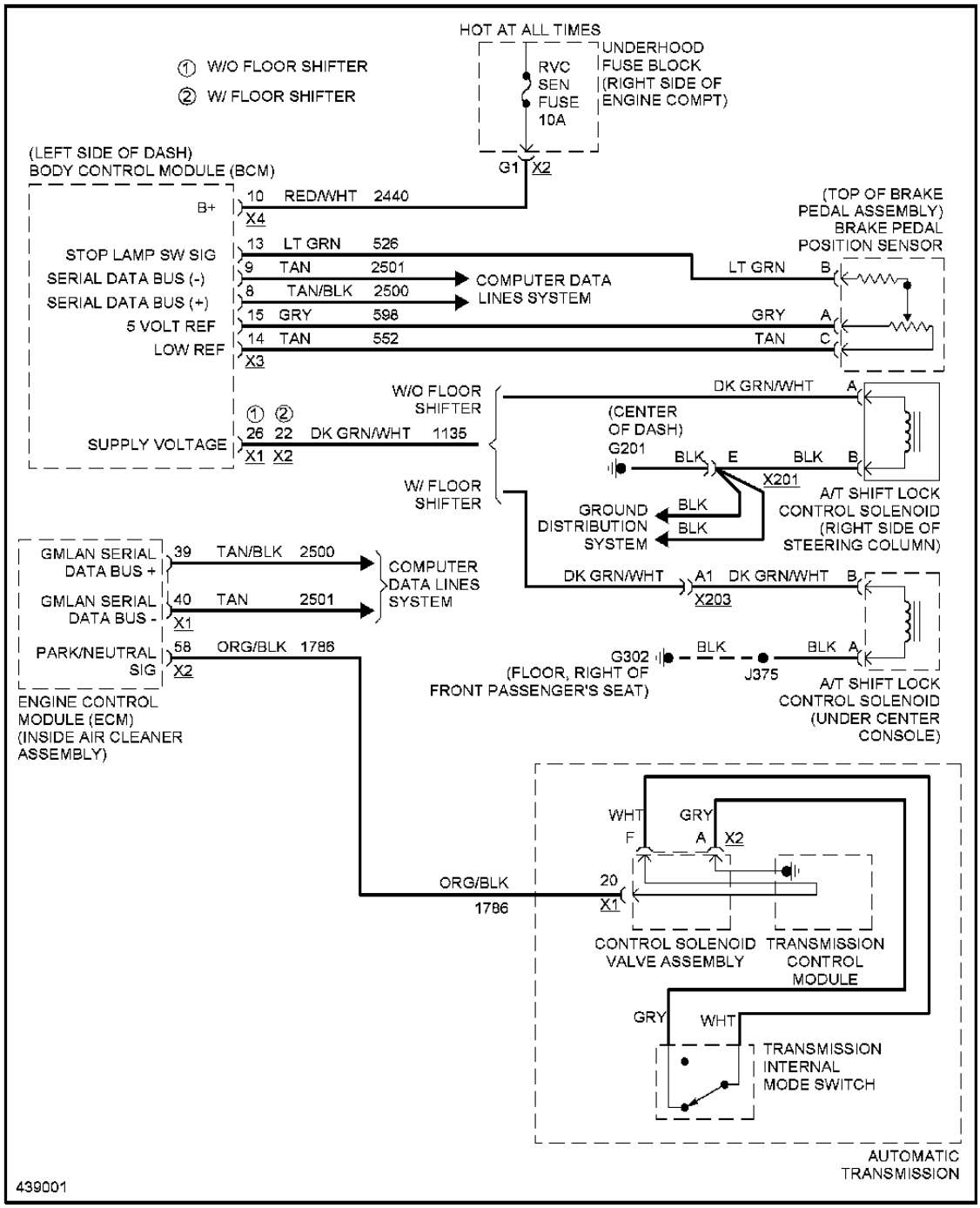


Fig. 51: Shift Interlock Circuit

STARTING/CHARGING

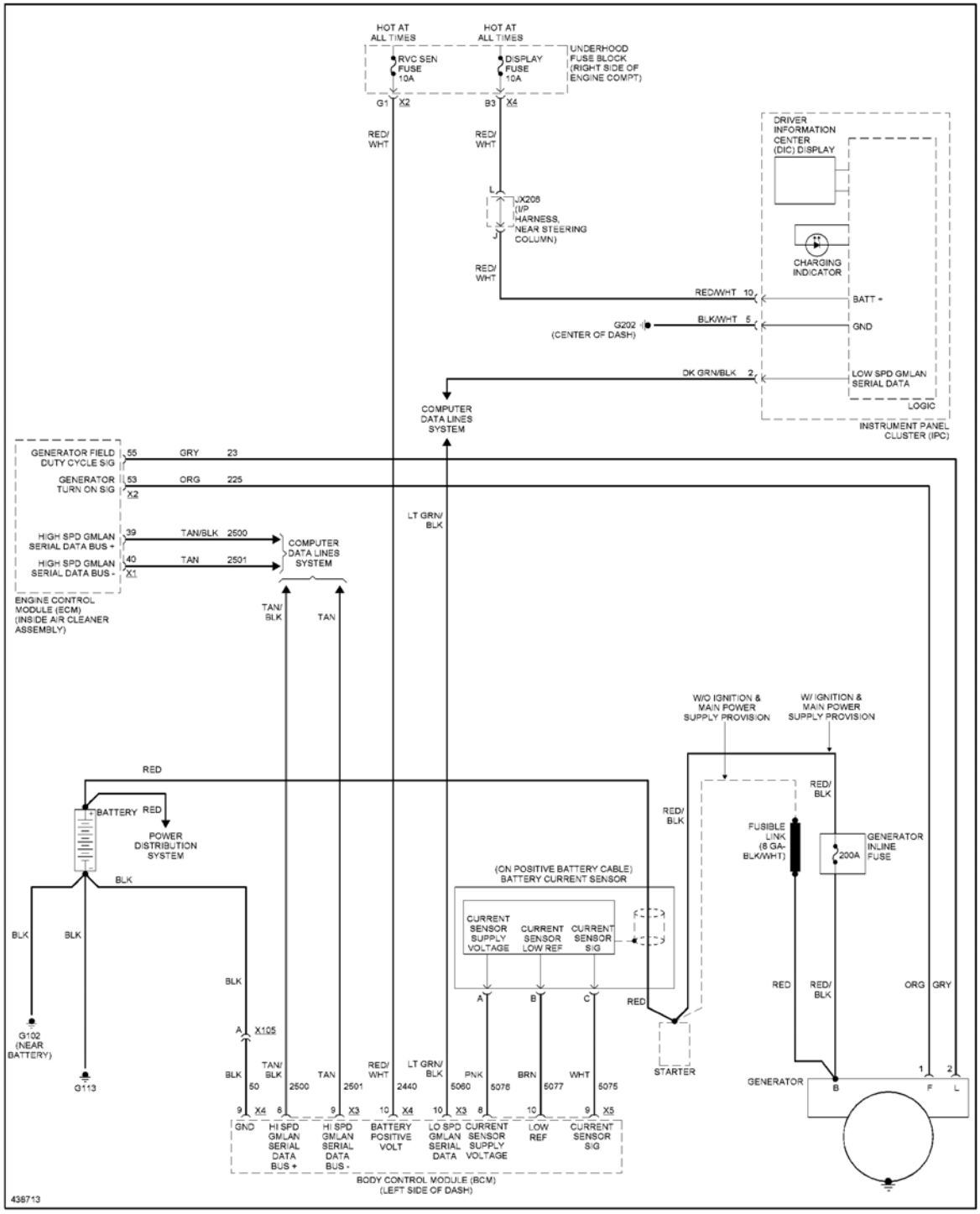


Fig. 52: Charging Circuit

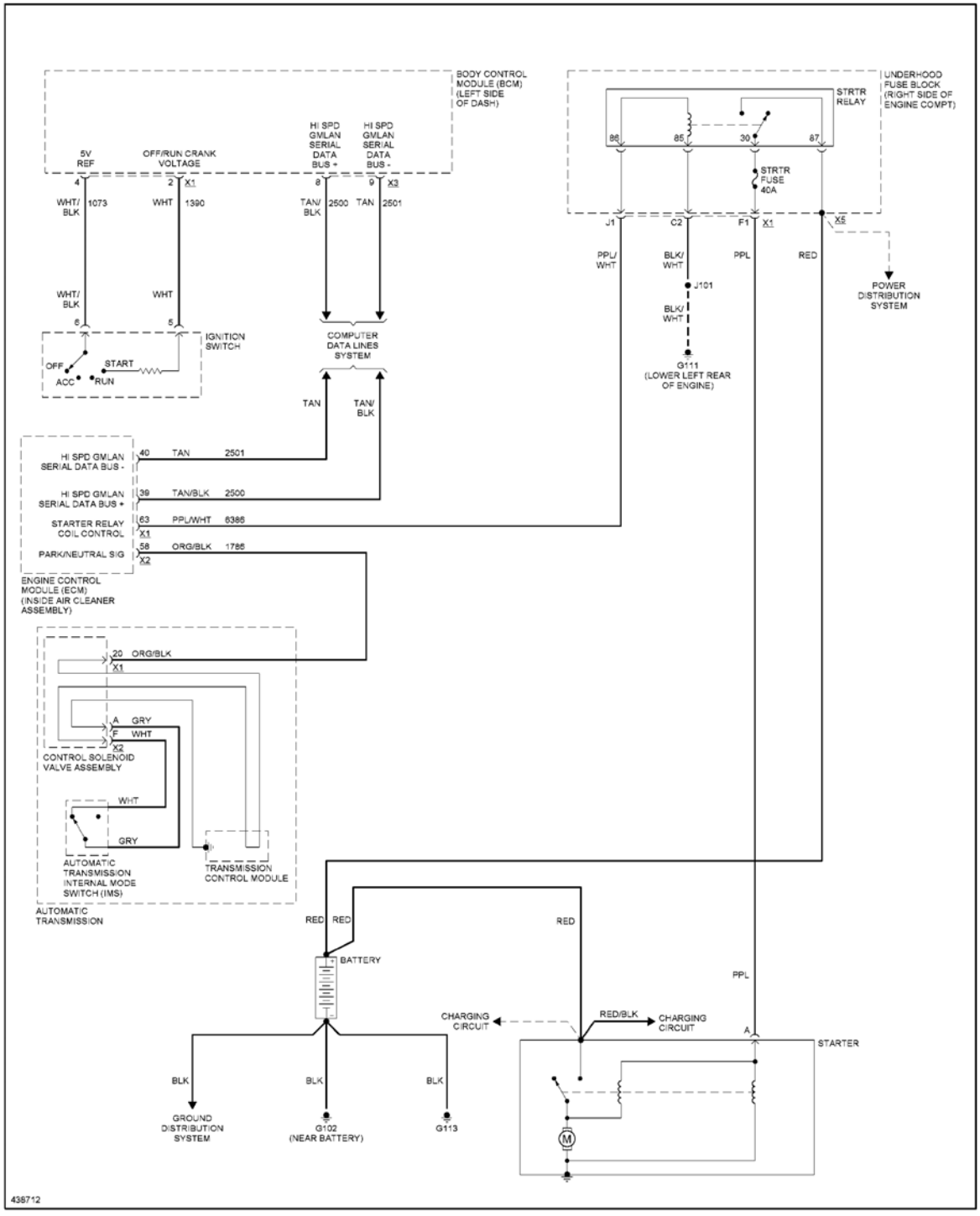


Fig. 53: Starting Circuit

SUPPLEMENTAL RESTRAINTS

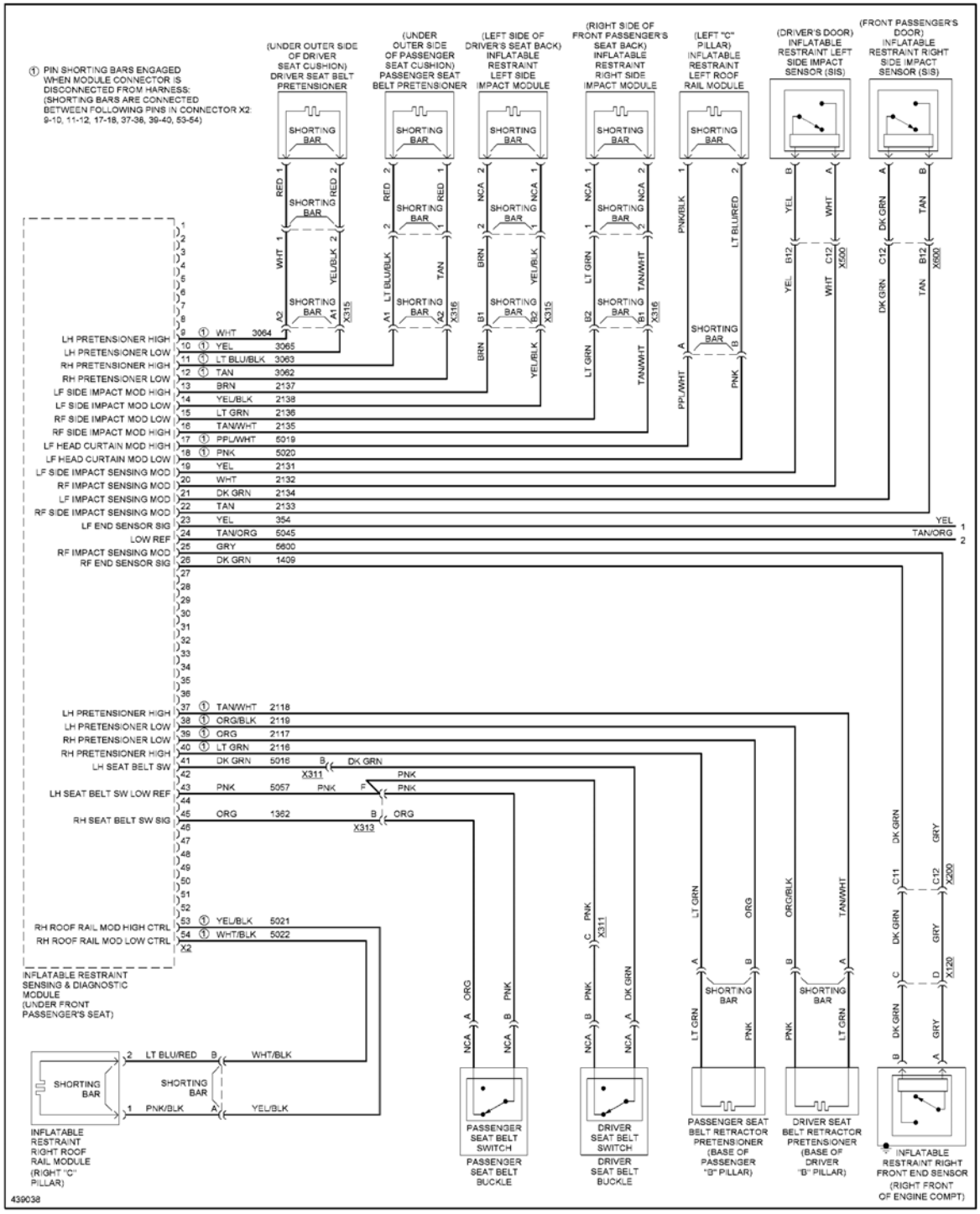


Fig. 54: Supplemental Restraints Circuit (1 of 2)

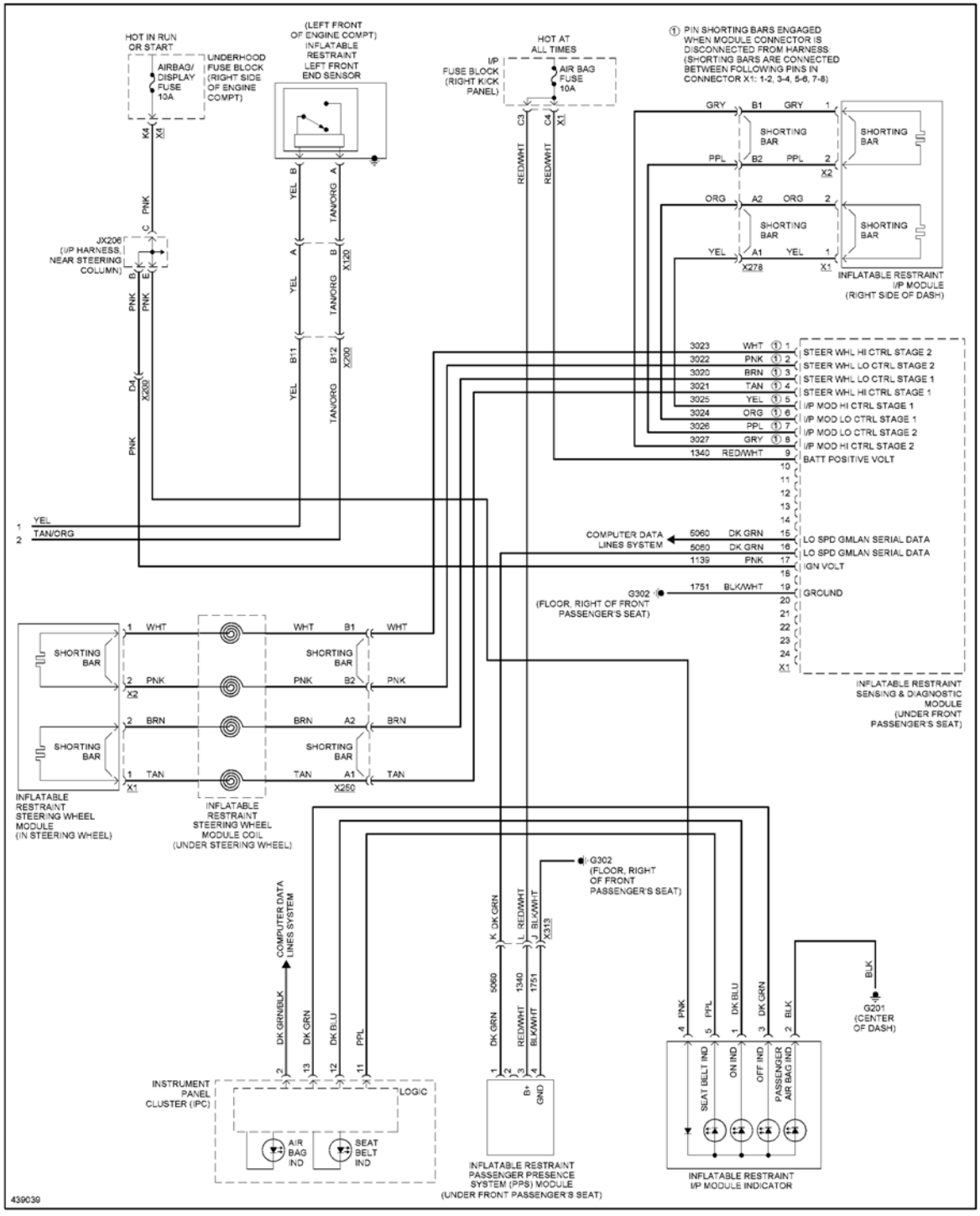


Fig. 55: Supplemental Restraints Circuit (2 of 2)

TRANSMISSION

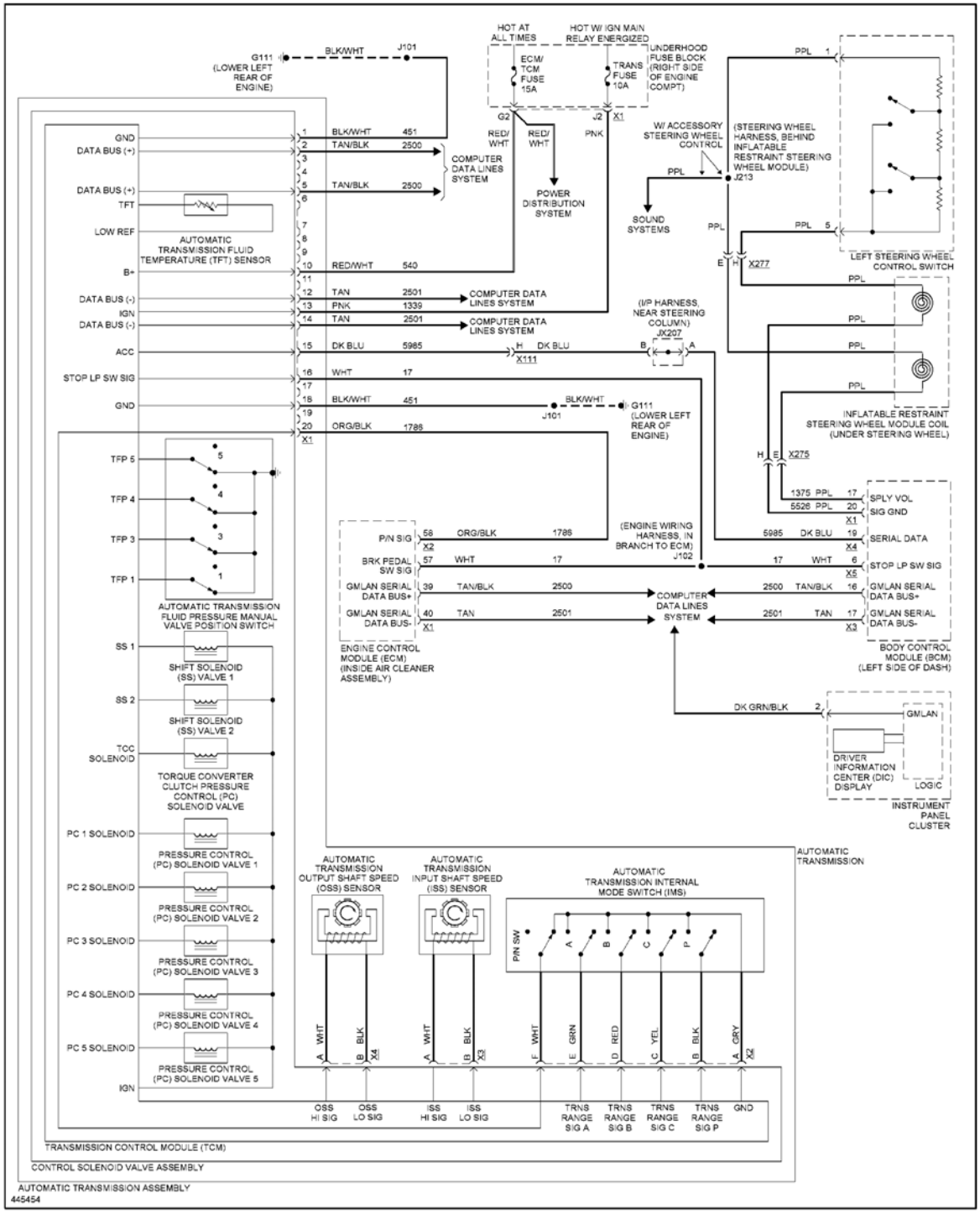


Fig. 56: Transmission Circuit

TRUNK, TAILGATE, FUEL DOOR

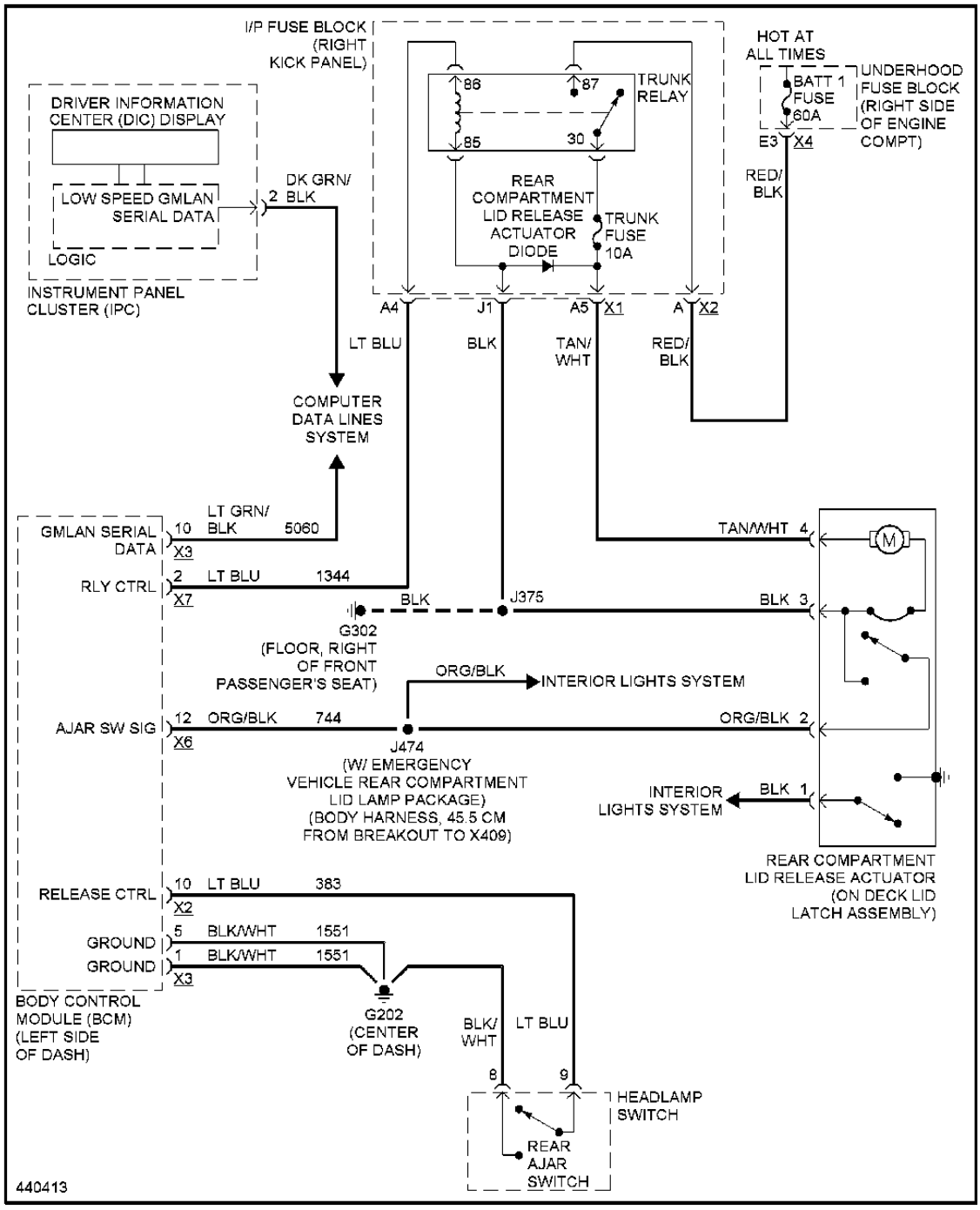


Fig. 57: Trunk Release Circuit

WARNING SYSTEMS

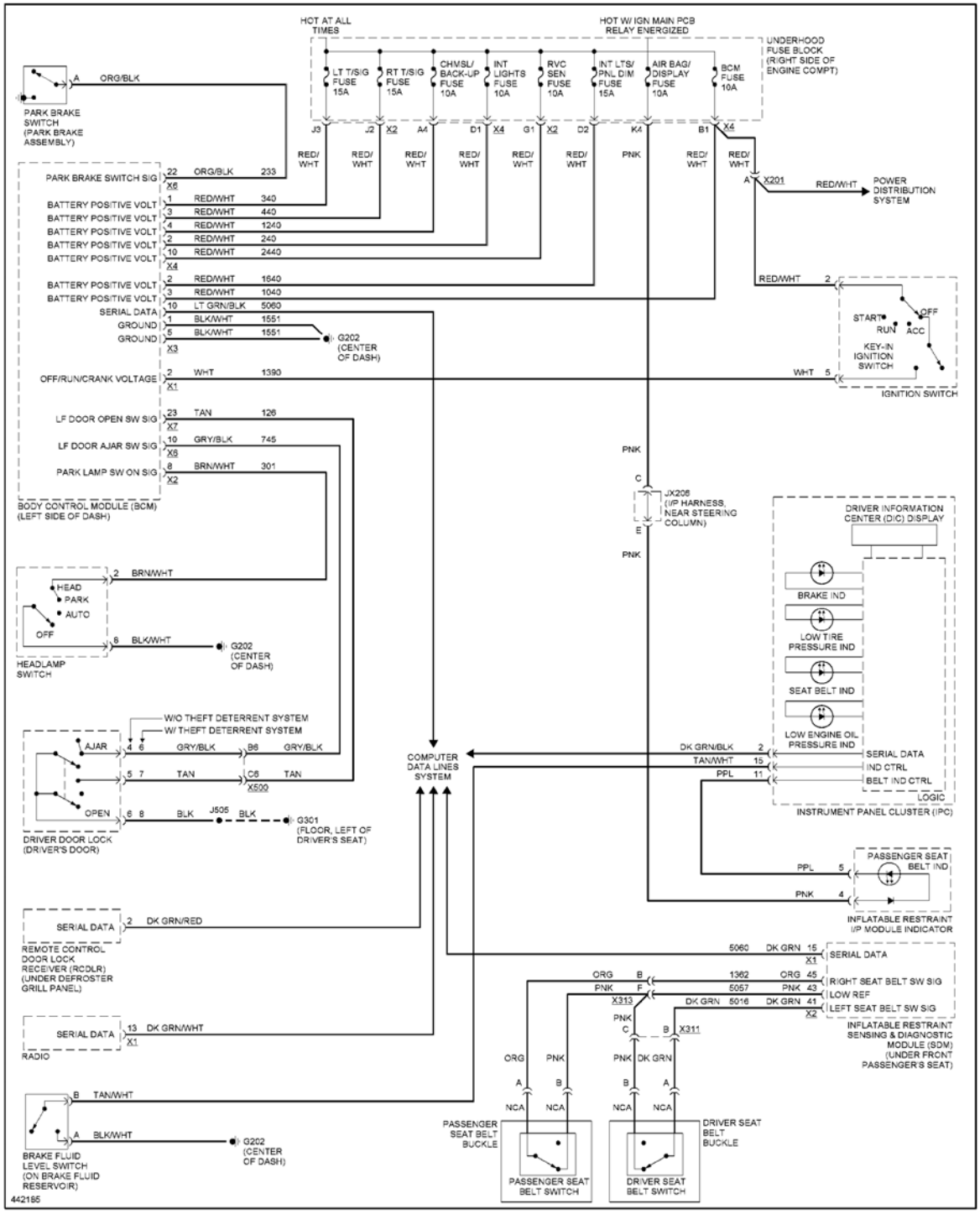


Fig. 58: Warning Systems Circuit

WIPER/WASHER

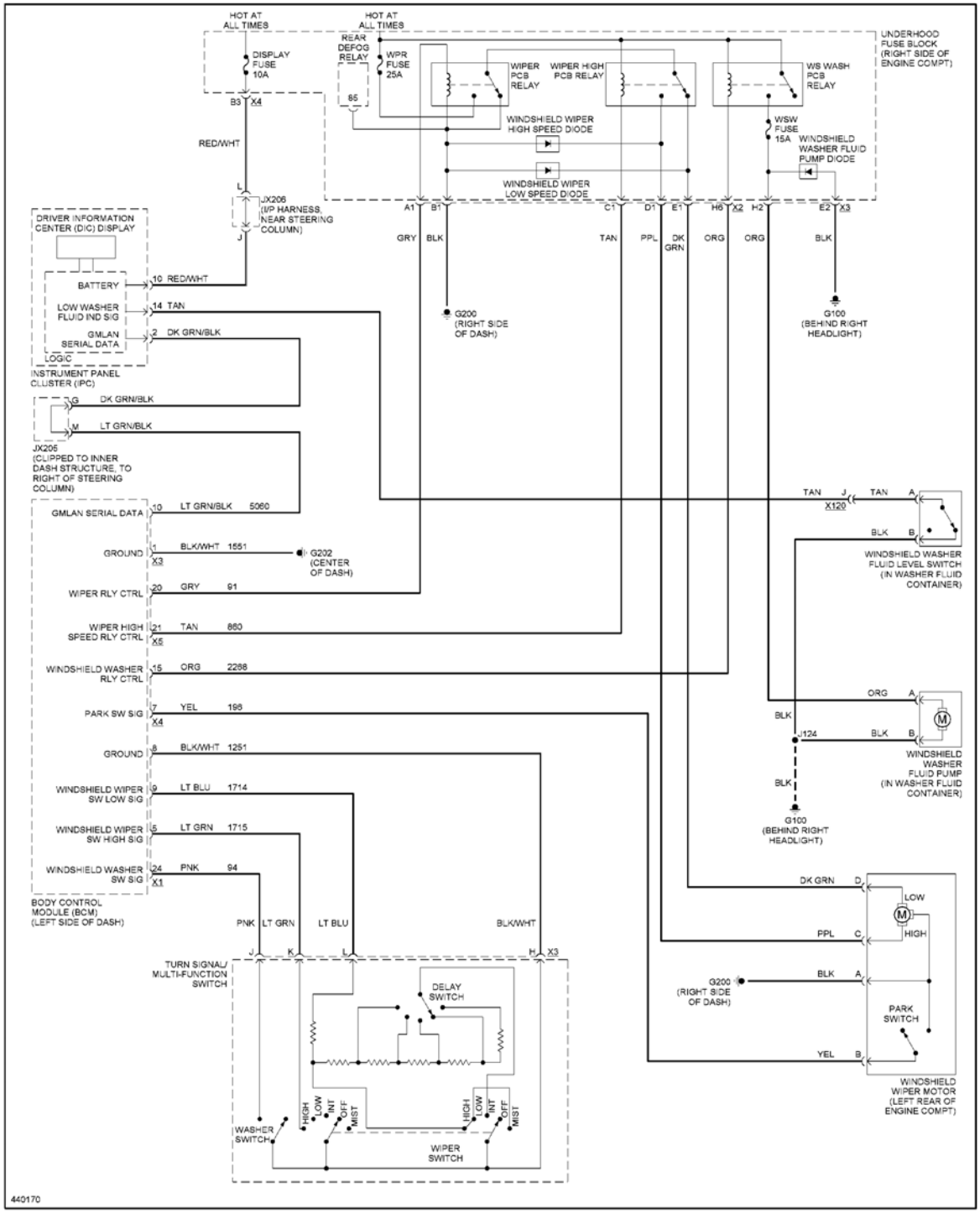


Fig. 59: Wiper/Washer Circuit

Article GUID: A00720430

COMPONENT CONNECTOR END VIEWS - INDEX

NOTE: **Component Connector end views are sorted by component name, not by connector ID (Code). Searching for component name, may help in locating appropriate connector end view.**

A00737159 - Wiring Systems and Power Management - Component Connector End Views - Sierra & Silverado

Description
A/C Compressor Clutch
A/C Compressor Solenoid Valve
A/C Refrigerant Pressure Sensor
Accelerator Pedal Position (APP) Sensor
Accessory Power Outlet - Center Console 1 (D55)
Accessory Power Outlet - Center Console 2 (D55)
Accessory Power Outlet - Center Console Compartment (D55)
Accessory Power Outlet - Center Seat (without D55)
Accessory Power Outlet - I/P 1 (without D55)
Accessory Power Outlet - I/P 2 (without D55)
Air Temperature Actuator - Left
Air Temperature Actuator - Right
Ambient Air Temperature Sensor
Ambient Light Sensor
Audio Amplifier X1 (UQ3)
Audio Amplifier X2 (UQ3)
Audio Amplifier X3 (UQ3)
Automatic Transmission Input Shaft Speed (ISS) Sensor
Automatic Transmission Shift Lock Control Solenoid (without D55)
Automatic Transmission Shift Lock Control Solenoid (D55)
Backup Lamp - Left
Backup Lamp - Right
Battery Current Sensor
Blower Motor
Blower Motor Control Module
Body Control Module (BCM) X1
Body Control Module (BCM) X2
Body Control Module (BCM) X3
Body Control Module (BCM) X4

Description
Body Control Module (BCM) X5
Body Control Module (BCM) X6
Body Control Module (BCM) X7
Brake Fluid Level Switch
Brake Pedal Position (BPP) Sensor
Camshaft Position (CMP) Sensor - Bank 1 Exhaust
Camshaft Position (CMP) Sensor - Bank 1 Intake
Camshaft Position (CMP) Sensor - Bank 2 Exhaust
Camshaft Position (CMP) Sensor - Bank 2 Intake
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Exhaust
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Intake
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Exhaust
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Intake
Cellular Telephone Microphone (UE1)
Center High Mounted Stop Lamp (CHMSL)
Circuit Breaker 1 (SEO 9C1/9C3)
Circuit Breaker 2 (SEO 9C1/9C3)
Circuit Breaker 3 (SEO 9C1/9C3)
Control Solenoid Valve Assembly X1
Control Solenoid Valve Assembly X2
Control Solenoid Valve Assembly X3
Control Solenoid Valve Assembly X4
Crankshaft Position (CKP) Sensor
Data Link Connector (DLC)
Digital Radio Receiver (U2K)
Dome/Reading Lamps
Door Lock - Driver (without UA6)
Door Lock - Driver (UA6)
Door Lock - Left Rear
Door Lock - Passenger
Door Lock - Right Rear
Door Lock Switch - Driver
Door Lock Switch - Passenger
Driver Information Center (DIC) Switch
Electronic Brake Control Module (EBCM)
Emergency Vehicle Front Lamp Flasher (6J3)
Emergency Vehicle Rear Window Panel Lamp - Left (6J6)
Emergency Vehicle Rear Window Panel Lamp - Right (6J6)
Engine Control Module (ECM) X1 (LFX)
Engine Control Module (ECM) X2 (LFX)
Engine Control Module (ECM) X3 (LFX)

Description
Engine Coolant Temperature (ECT) Sensor
Engine Cooling Fan - Left
Engine Cooling Fan - Right
Engine Oil Pressure (EOP) Switch
Evaporative Emission (EVAP) Canister Purge Solenoid Valve
Evaporative Emission (EVAP) Canister Vent Solenoid Valve
Evaporator Temperature Sensor
Fog Lamp - Left Front (T96)
Fog Lamp - Right Front (T96)
Fuel Injector 1
Fuel Injector 2
Fuel Injector 3
Fuel Injector 4
Fuel Injector 5
Fuel Injector 6
Fuel Pressure Sensor
Fuel Pump and Sender Assembly
Fuel Pump Flow Control Module
Fuel Rail Pressure (FRP) Sensor
Fuel Tank Pressure (FTP) Sensor
Garage Door Opener (UG1)
Generator X1
Headlamp - Left High Beam
Headlamp - Right High Beam
Headlamp - Left Low Beam
Headlamp - Right Low Beam
Headlamp Switch
Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 1
Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 1
Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 2
Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 2
Heated Seat Control Module (KA1) X1
Heated Seat Control Module (KA1) X2
Heated Seat Control Module (KA1) X3
Heated Seat Control Module (KA1) X4
Heated Seat Element - Driver Back (KA1)
Heated Seat Element - Driver Cushion (KA1)
Heated Seat Element - Passenger Back (KA1)
Heated Seat Element - Passenger Cushion (KA1)
G18 High Pressure Fuel Pump (LFX)
Hood Ajar Switch (AP3)

Description
Horn Assembly
Horn Switch
HVAC Control Module X1
HVAC Control Module X2
Ignition Coil 1
Ignition Coil 2
Ignition Coil 3
Ignition Coil 4
Ignition Coil 5
Ignition Coil 6
Ignition Lock Cylinder Control Actuator (D55)
Ignition Switch
Inflatable Restraint Front End Sensor - Left
Inflatable Restraint Front End Sensor - Right
Inflatable Restraint Front Passenger Presence System (PPS) Module
Inflatable Restraint I/P Module X1
Inflatable Restraint I/P Module X2
Inflatable Restraint I/P Module Indicator
Inflatable Restraint Sensing and Diagnostic Module (SDM) X1
Inflatable Restraint Sensing and Diagnostic Module (SDM) X2
Inflatable Restraint Side Impact Module - Left
Inflatable Restraint Side Impact Module - Right
Inflatable Restraint Side Impact Sensor (SIS) - Left
Inflatable Restraint Roof Rail Module - Left
Inflatable Restraint Roof Rail Module - Right
Inflatable Restraint Side Impact Sensor (SIS) - Right
Inflatable Restraint Steering Wheel Module X1
Inflatable Restraint Steering Wheel Module X2
Inside Rearview Mirror (DD6 or UE1)
Inside Rearview Mirror (without DD6 or UE1)
Instrument Panel Cluster (IPC)
I/P Courtesy Lamp - Left
I/P Courtesy Lamp - Right
Knock Sensor (KS) 1
Knock Sensor (KS) 2
License Lamp
Manifold Absolute Pressure (MAP) Sensor
Mode Actuator
Multifunction Intake Air Sensor
Outside Rearview Mirror - Driver
Outside Rearview Mirror - Passenger

Description
Outside Rearview Mirror Switch
Park Brake Switch
Park/Turn Signal Lamp - Left
Park/Turn Signal Lamp - Right
Pressure Control (PC) Solenoid Valve
Radio X1
Radio X2
Radio Antenna Module
Reading Lamp - Auxiliary (6C7)
Rear Compartment Courtesy Lamp
Rear Compartment Lid Latch
Rear Window Defogger Grid X1
Rear Window Defogger Grid X2
Recirculation Actuator
Remote Control Door Lock Receiver (RCDLR)
Seat Adjuster Motor Assembly - Driver (AG1, AH5)
Seat Adjuster Motor Assembly - Passenger (AG2)
Seat Adjuster Switch - Driver (AG1)
Seat Adjuster Switch - Driver (AH5)
Seat Adjuster Switch - Passenger (AG2)
Seat Belt Retractor Pretensioner - Driver
Seat Belt Retractor Pretensioner - Passenger
Seat Belt Pretensioner - Driver
Seat Belt Pretensioner - Passenger
Seat Belt Switch - Driver
Seat Belt Switch - Passenger
Seat Recline Motor - Driver (AH5)
Secondary Air Injection (AIR) Pump (NU5/NU6)
Secondary Air Injection (AIR) Pump Relay (NU5/NU6)
Secondary Air Injection (AIR) Pump Solenoid Bank 1 (NU5/NU6)
Secondary Air Injection (AIR) Pump Solenoid Bank 2 (NU5/NU6)
Secondary Air Injection (AIR) Pump Solenoid Relay (NU5/NU6)
Side Marker Lamp - Left Front
Side Marker Lamp - Right Front
Speaker - Left Front
Speaker - Left Front Tweeter
Speaker - Left Rear (UW6)
Speaker - Left Rear (UQ3)
Speaker - Right Front
Speaker - Right Front Tweeter
Speaker - Right Rear (UW6)

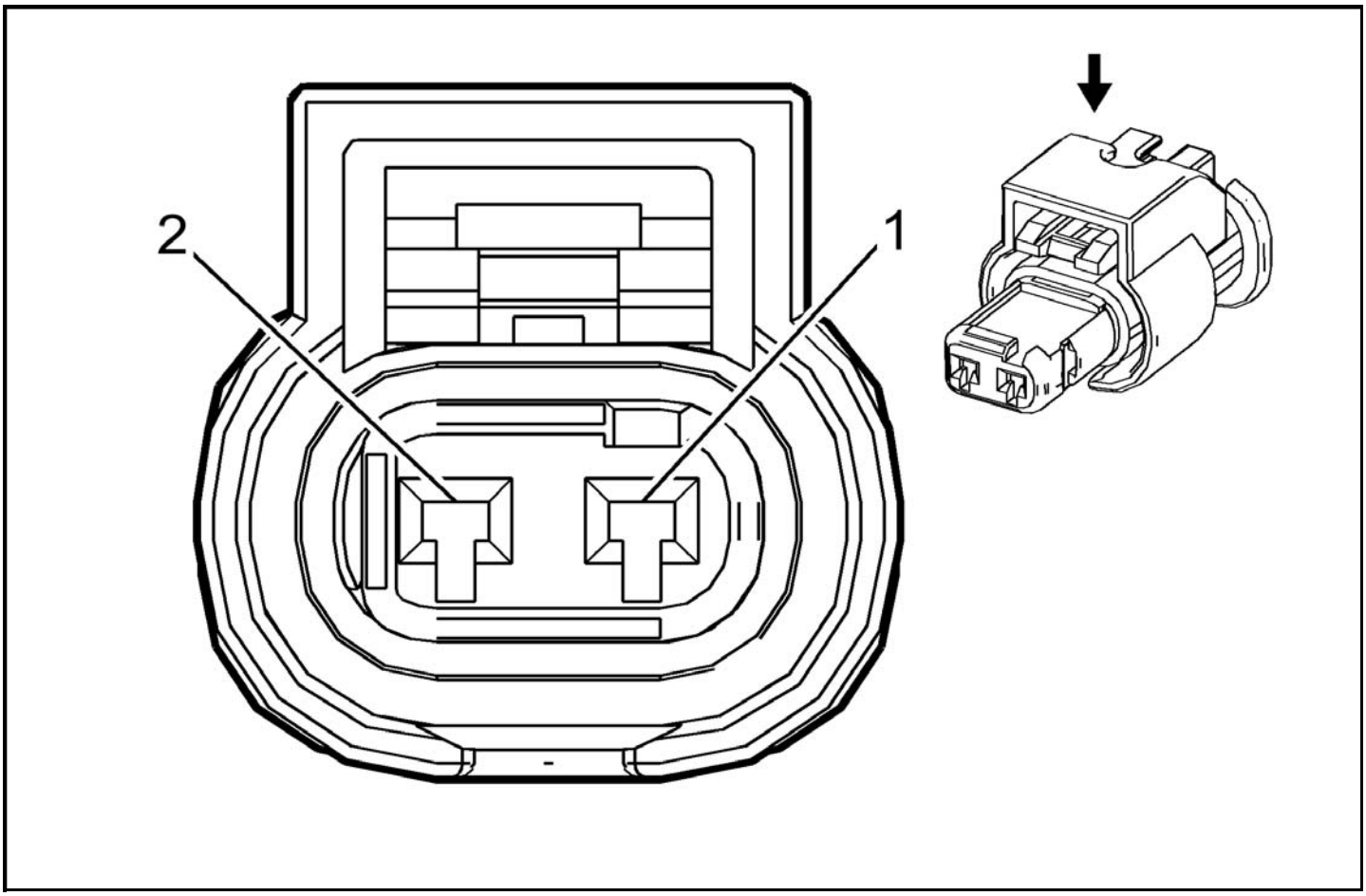
Description
Speaker - Right Rear (UQ3)
Spot Lamp - Left (7X6, 7X7)
Spot Lamp - Right (7X7)
Starter X2
Steering Angle Sensor
Steering Wheel Control Switch - Left
Steering Wheel Control Switch - Right (UK3)
Sunroof Control Module (CF5)
Sunroof Switch (CF5)
Sunshade - Left (DH6)
Sunshade - Right (DH6)
Tail Lamp - Left
Tail Lamp - Right
Tail/Stop and Turn Signal Lamp - Left
Tail/Stop and Turn Signal Lamp - Right
Theft Deterrent Module (TDM)
Q38 Throttle Body (LFR/LFX)
Turn Signal/Multifunction Switch X1
Turn Signal/Multifunction Switch X2
Turn Signal/Multifunction Switch X3
Vehicle Communication Interface Module (VCIM) (UE1) X1
Vehicle Communication Interface Module (VCIM) (UE1) X2
Vehicle Communication Interface Module (VCIM) Battery (UE1)
Vehicle Speed Sensor (VSS)
Wheel Speed Sensor (WSS) - Left Front
Wheel Speed Sensor (WSS) - Left Rear
Wheel Speed Sensor (WSS) - Right Front
Wheel Speed Sensor (WSS) - Right Rear
Window Motor - Driver
Window Motor - Left Rear
Window Motor - Passenger
Window Motor - Right Rear
Window Switch - Driver X1
Window Switch - Driver X2
Window Switch - Left Rear
Window Switch - Passenger
Window Switch - Right Rear
Windshield Washer Fluid Level Switch
Windshield Washer Fluid Pump
Windshield Wiper Motor
Yaw and Lateral Accelerometer Sensor

Article GUID: A00739509

COMPONENT CONNECTOR END VIEWS

NOTE: **Component Connector end views are sorted by component name, not by connector ID (Code). Searching for connector ID, NOT component name, may help in locating appropriate connector end view.**

A/C COMPRESSOR CLUTCH



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13761652
- Service Connector: 13577519
- Description: 2-Way F 1.2 MCP Series, Sealed (BK)

Terminal Part Information

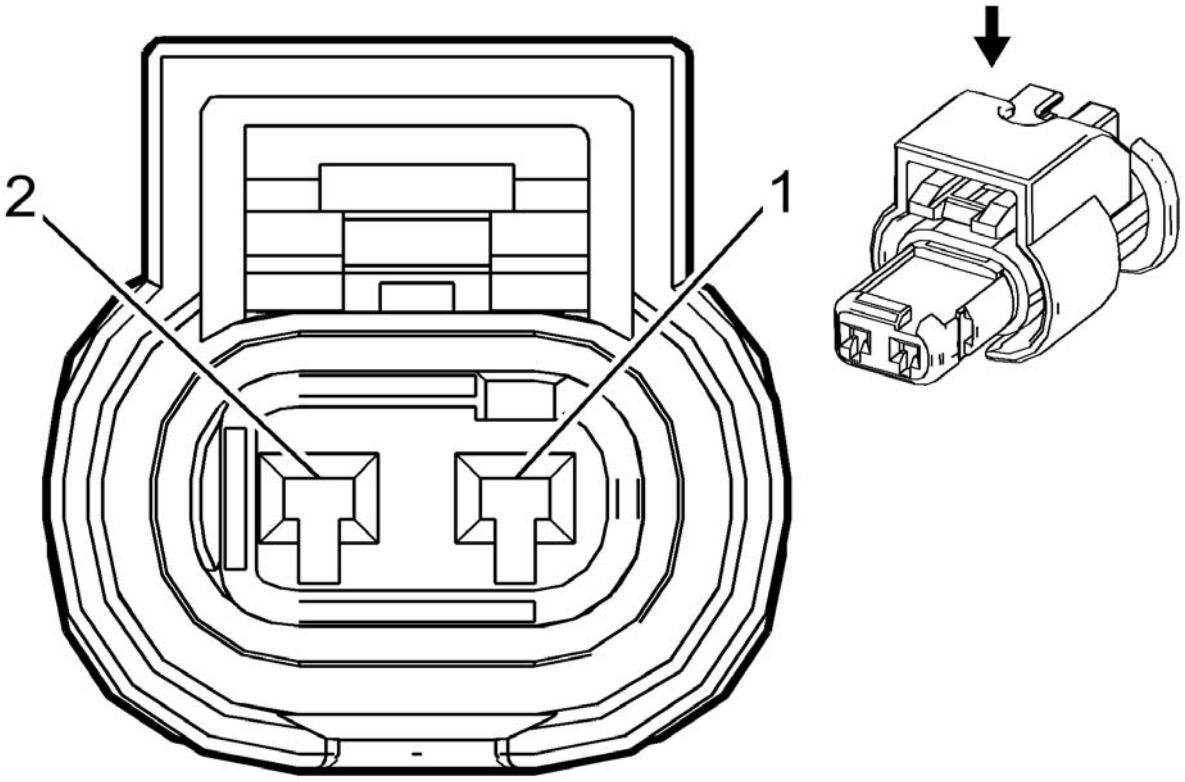
- Terminated Lead: Service by Harness - See Part Catalog
- Release Tool: J-38125-12A

- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

A/C Compressor Clutch

Pin	Wire	Circuit	Function
1	0.8 BK	1050	Ground
2	0.5 D-GN	59	A/C Compressor Clutch Supply Voltage

A/C COMPRESSOR SOLENOID VALVE



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13927762
- Service Connector: Not Available
- Description: 2-Way F 1.2 MCP Series, Sealed (BK)

Terminal Part Information

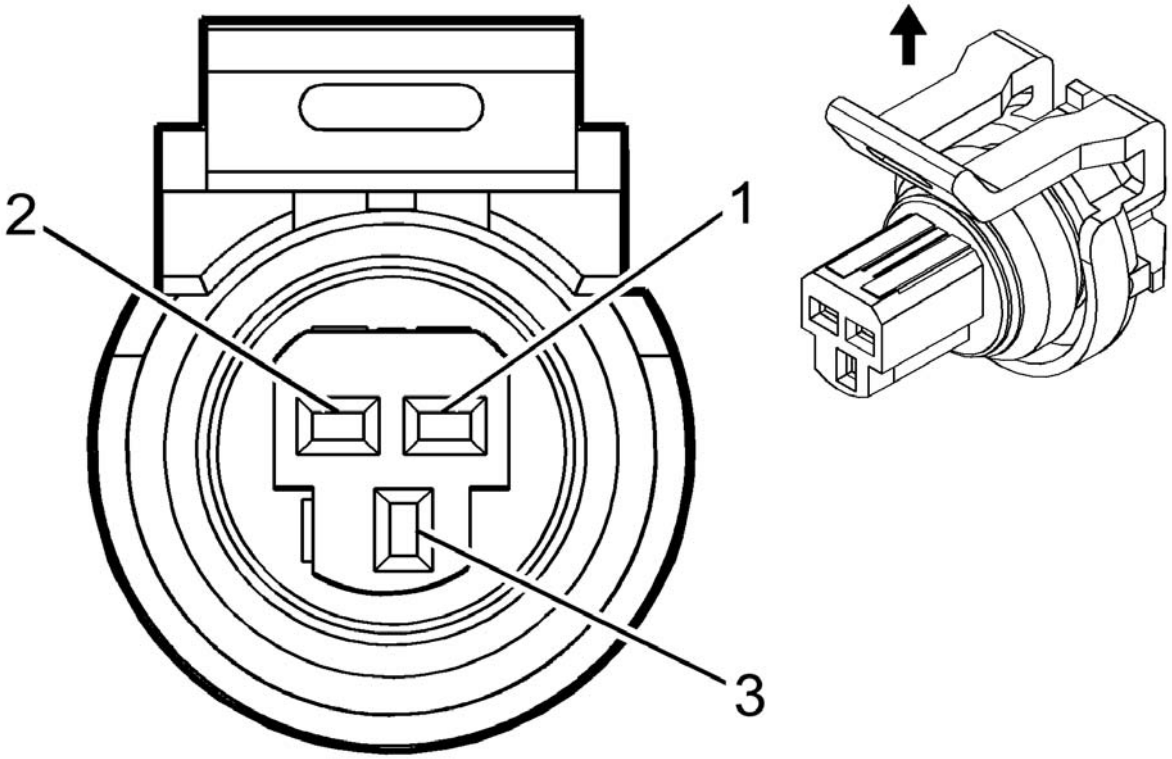
- Terminated Lead: Service by Harness- See Part Catalog

- Release Tool: Not Available
- Diagnostic Test Probe: J-35616-16 (L-GN)
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

A/C Compressor Solenoid Valve

Pin	Wire	Circuit	Function
1	0.5 PK	7574	Electric Variable Displacement Control
2	0.5 TN	7573	Electric Variable Displacement Compressor Supply

A/C REFRIGERANT PRESSURE SENSOR



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13602480
- Service Connector:88988301
- Description: 3-Way F GT 150 Series, Sealed (BK)

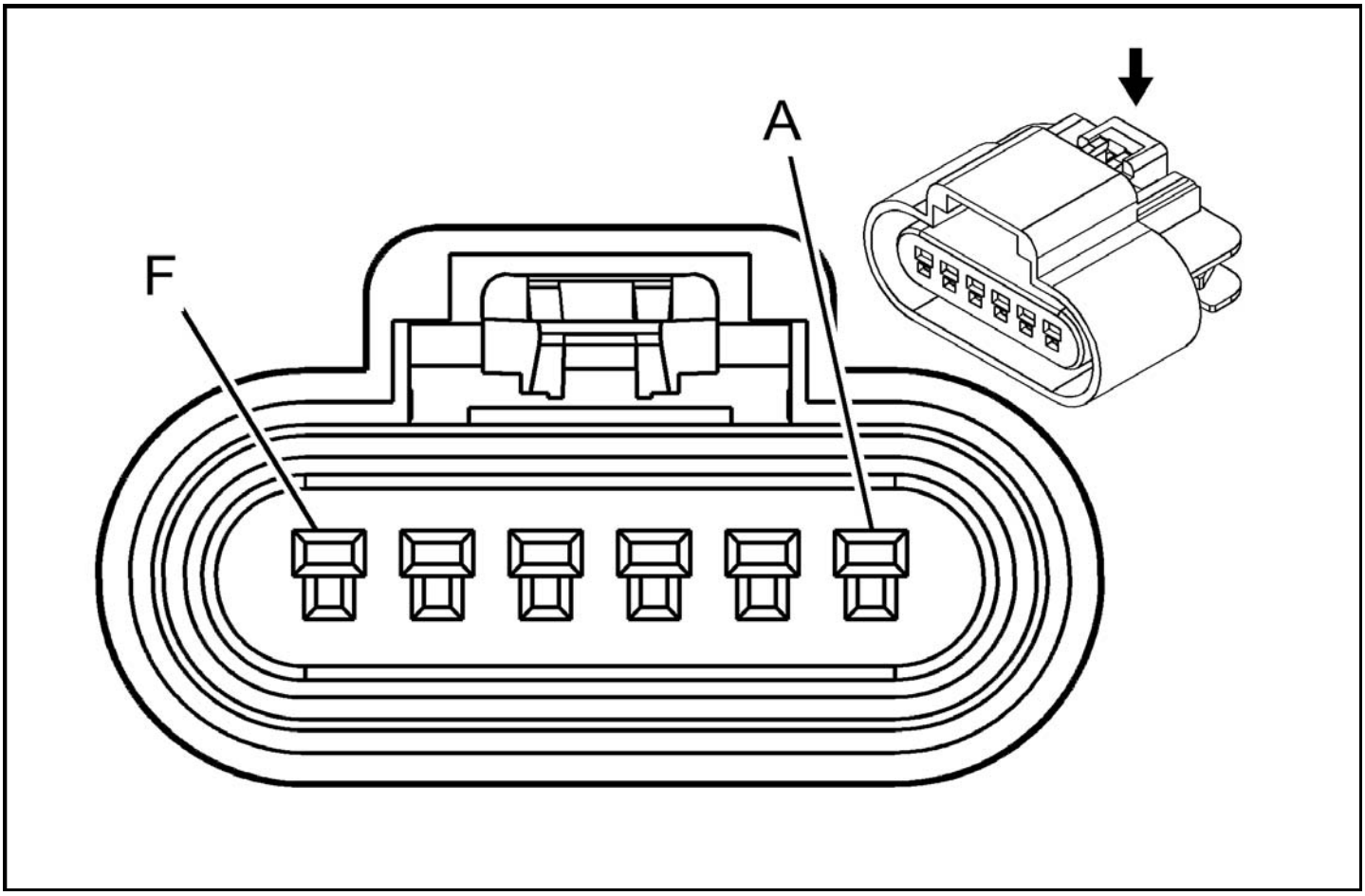
Terminal Part Information

- Terminated Lead: 13576360
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 15326267/19
- Core/Insulation Crimp: E/4

A/C Refrigerant Pressure Sensor

Pin	Wire	Circuit	Function
1	0.35 TN	5514	Low Reference
2	0.35 GY	2700	5-Volt Reference 1
3	0.35 OG/BK	380	A/C Refrigerant Pressure Sensor Signal

ACCELERATOR PEDAL POSITION (APP) SENSOR



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15326829
- Service Connector: 13584094

- Description: 6-Way F GT 150 Series, Sealed (BK)

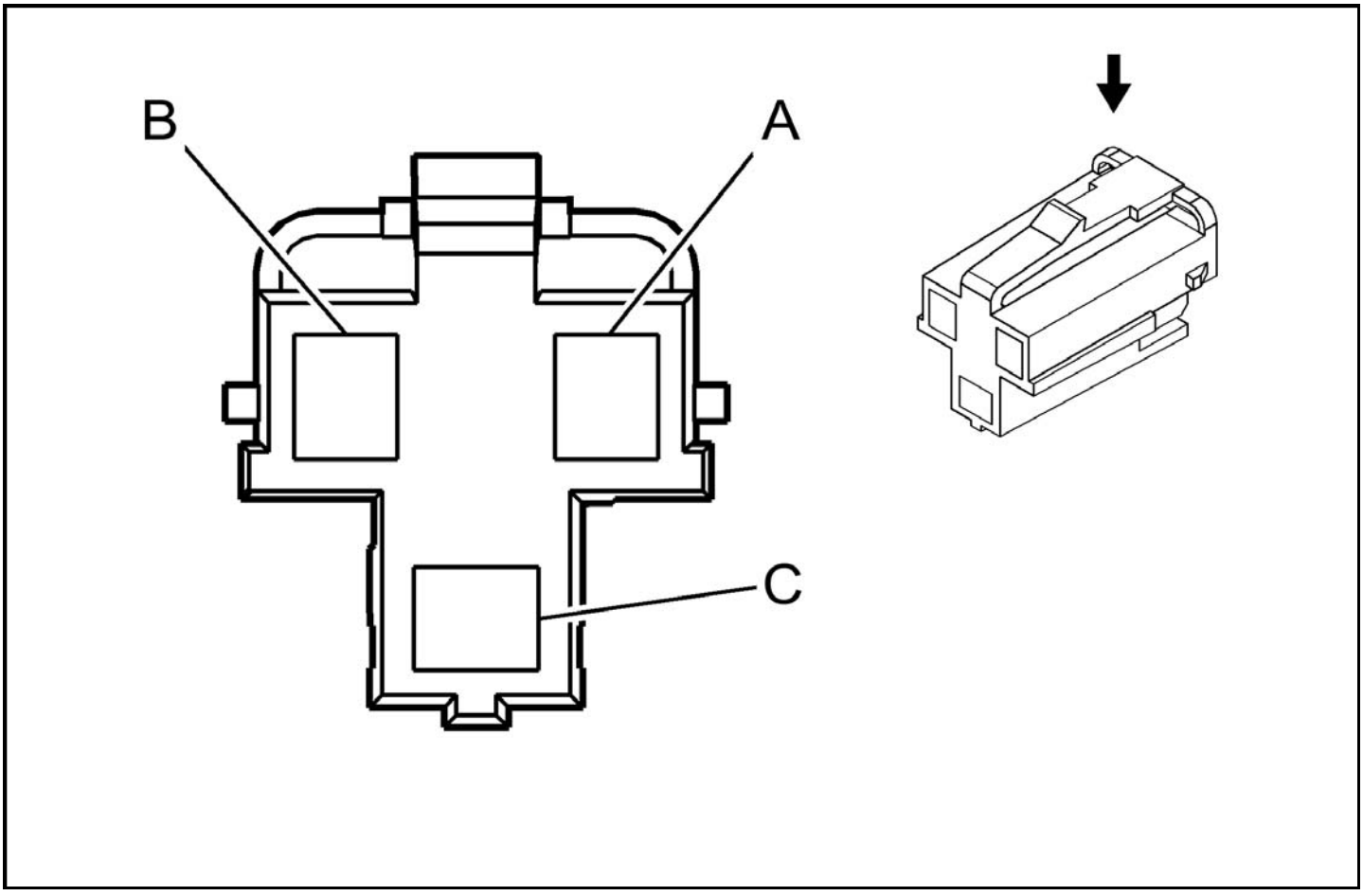
Terminal Part Information

- Terminated Lead: 13575396
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 15326427/5
- Core/Insulation Crimp: E/A

Accelerator Pedal Position (APP) Sensor

Pin	Wire	Circuit	Function
A	0.35 PU	1272	Low Reference
B	0.35 L-BU	1162	APP Sensor 2 Signal
C	0.35 TN	1274	5-Volt Reference 1
D	0.35 BN	1271	Low Reference
E	0.35 D-BU	1161	APP Sensor 1 Signal
F	0.35 WH/BK	1164	5-Volt Reference 2

ACCESSORY POWER OUTLET - CENTER CONSOLE 1 (D55)



Connector Part Information

- Harness Type: Console
- OEM Connector: 12176836
- Service Connector: 19257374
- Description: 3-Way F Metri-Pack 280 Series (GY)

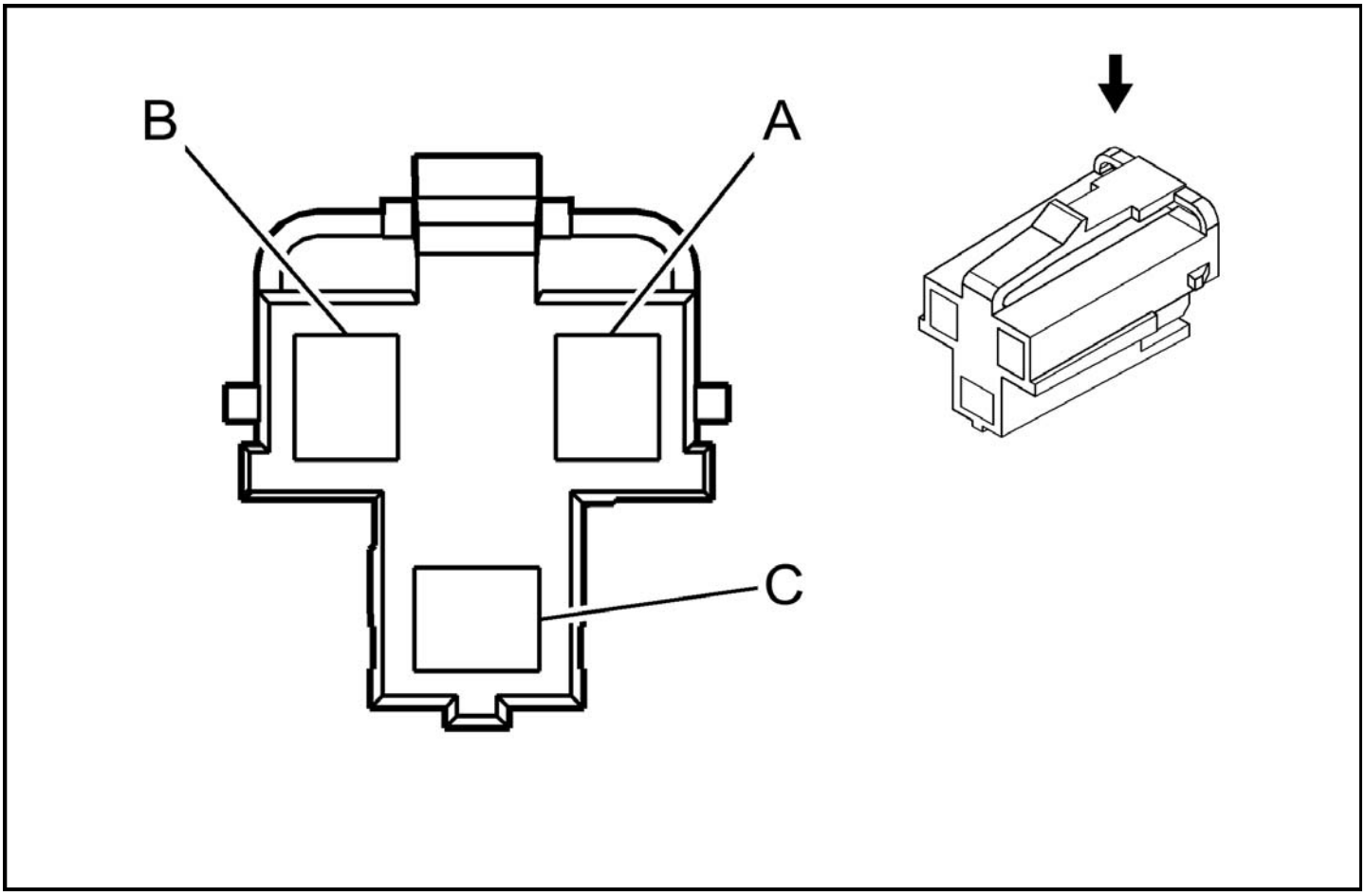
Terminal Part Information

- Terminated Lead: 13579923
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110842/4
- Core/Insulation Crimp: C/A

Accessory Power Outlet - Center Console 1 (D55)

Pin	Wire	Circuit	Function
A	1 RD/WH	1940	Battery Positive Voltage
B	-	-	Not Used
C	1 BK	750	Ground

ACCESSORY POWER OUTLET - CENTER CONSOLE 2 (D55)



Connector Part Information

- Harness Type: Console
- OEM Connector: 12176836
- Service Connector: 19257374
- Description: 3-Way F Metri-Pack 280 Series (GY)

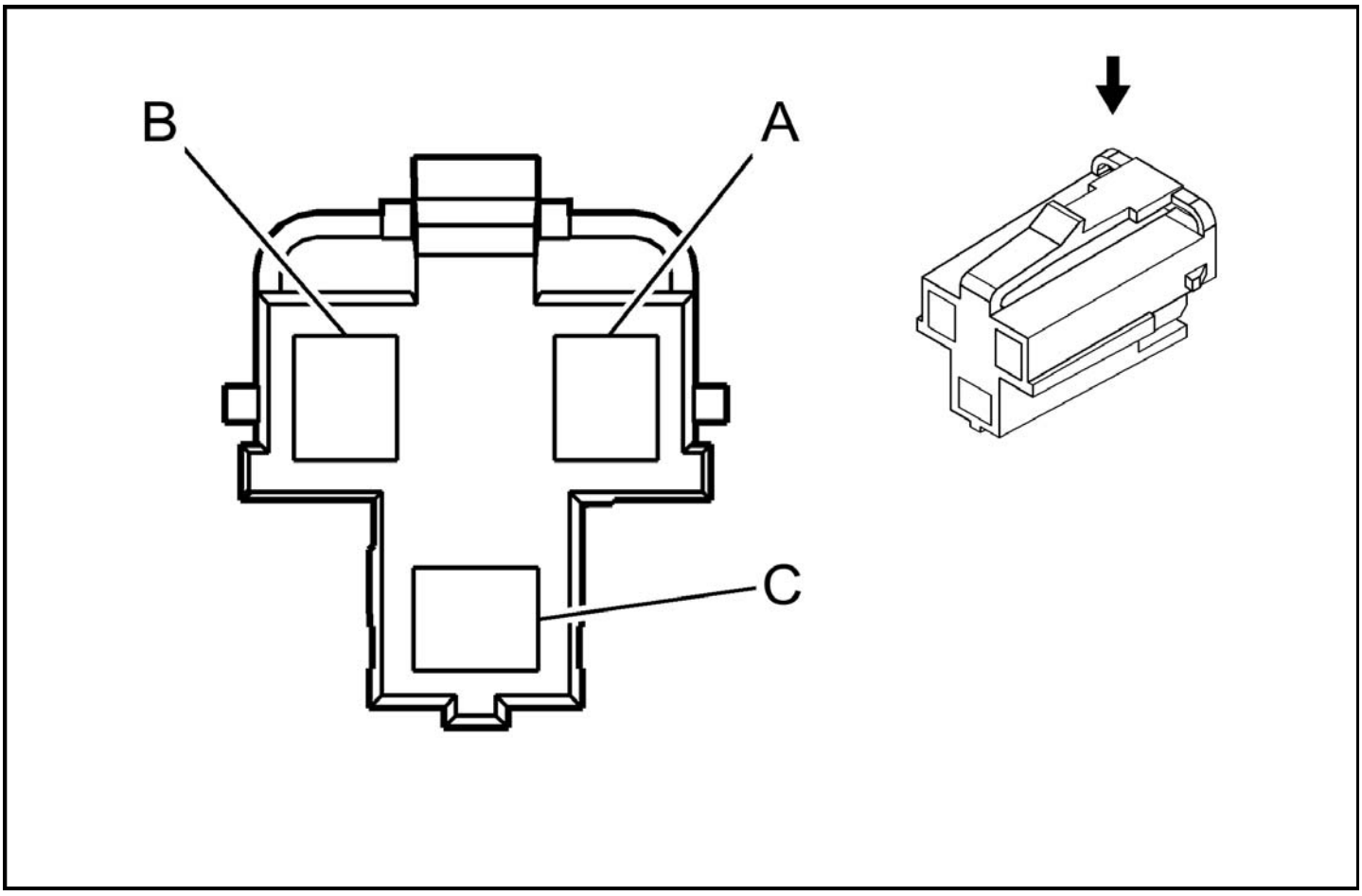
Terminal Part Information

- Terminated Lead: 13579923
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110842/4
- Core/Insulation Crimp: C/A

Accessory Power Outlet - Center Console 2 (D55)

Pin	Wire	Circuit	Function
A	1 RD/WH	1940	Battery Positive Voltage
B	-	-	Not Used
C	1 BK	750	Ground

ACCESSORY POWER OUTLET - CENTER CONSOLE COMPARTMENT (D55)



Connector Part Information

- Harness Type: Console
- OEM Connector: 12176836
- Service Connector: 19257374
- Description: 3-Way F Metri-Pack 280 Series (GY)

Terminal Part Information

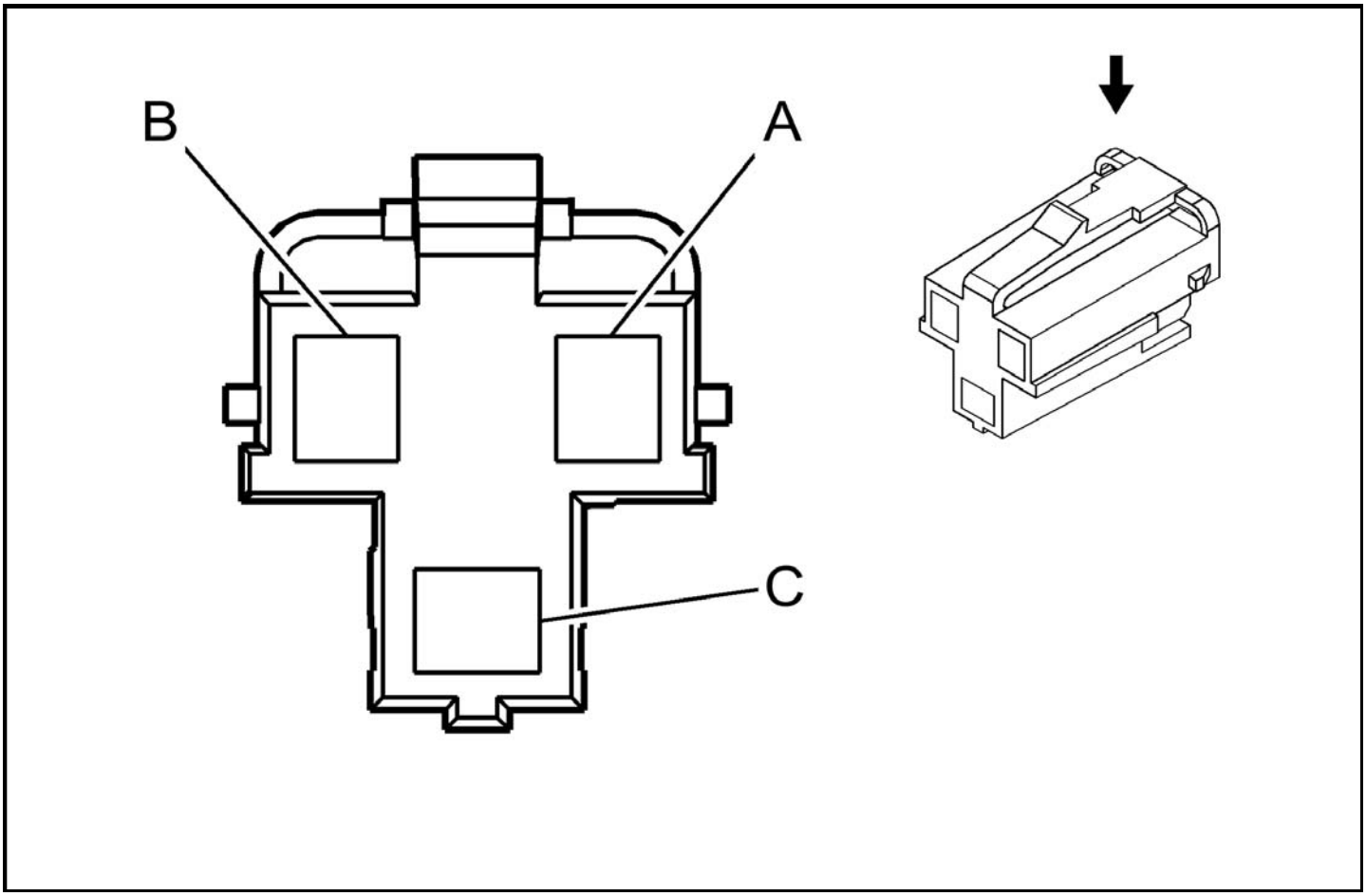
- Terminated Lead: 13579923
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110842/4
- Core/Insulation Crimp: C/A

Accessory Power Outlet - Center Console Compartment (D55)

Pin	Wire	Circuit	Function
A	1 RD/WH	1940	Battery Positive Voltage
B	-	-	Not Used

Pin	Wire	Circuit	Function
C	1 BK	750	Ground

ACCESSORY POWER OUTLET - CENTER SEAT (WITHOUT D55)



Connector Part Information

- Harness Type: Console
- OEM Connector: 12176836
- Service Connector: 19257374
- Description: 3-Way F Metri-Pack 280 Series (GY)

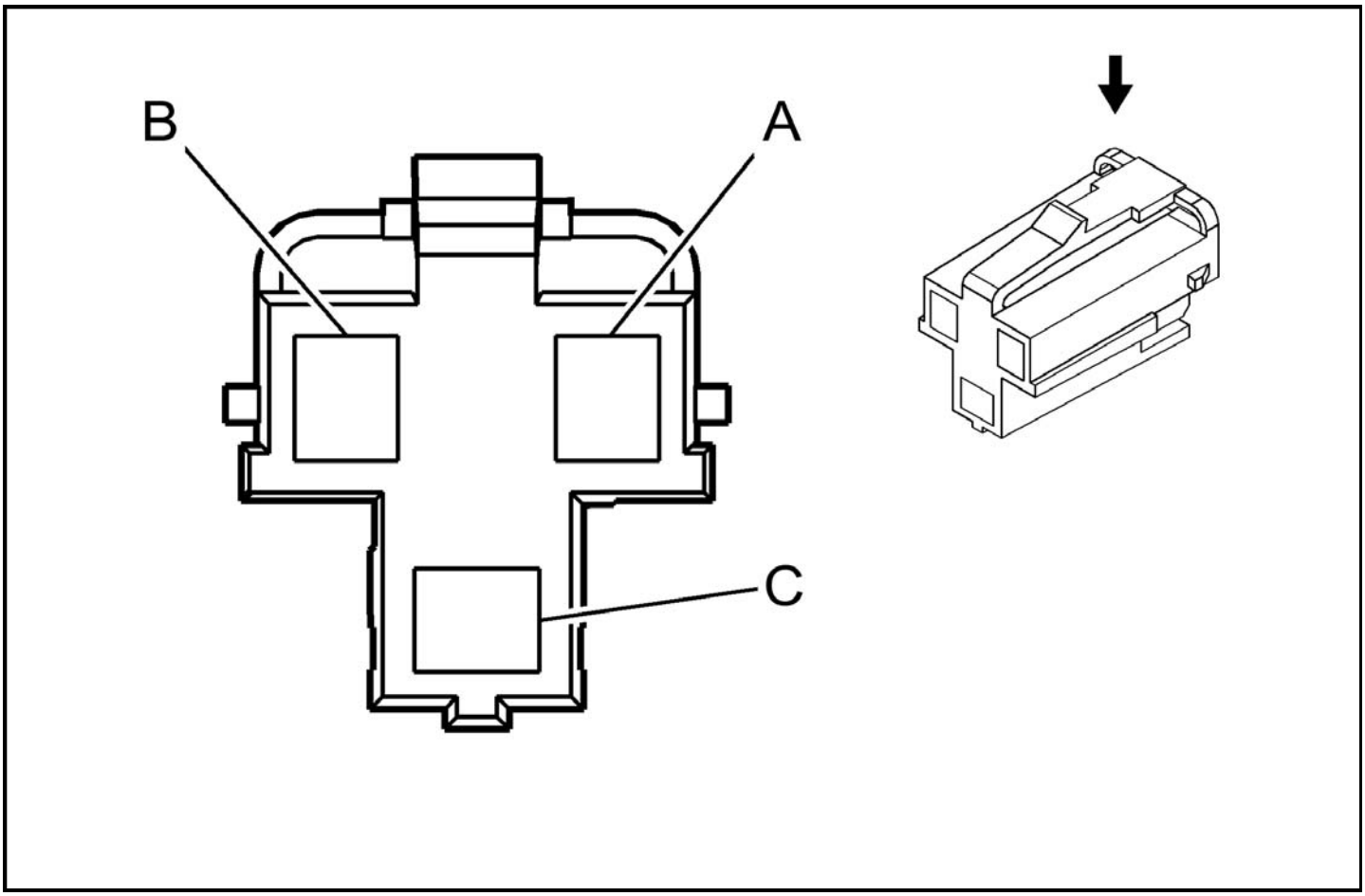
Terminal Part Information

- Terminated Lead: 13579923
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110842/4
- Core/Insulation Crimp: C/A

Accessory Power Outlet - Center Seat (without D55)

Pin	Wire	Circuit	Function
A	1 RD/WH	1940	Battery Positive Voltage
B	-	-	Not Used
C	1 BK	750	Ground

ACCESSORY POWER OUTLET - I/P 1 (WITHOUT D55)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12176836
- Service Connector: 19257374
- Description: 3-Way F Metri-Pack 280 Series (GY)

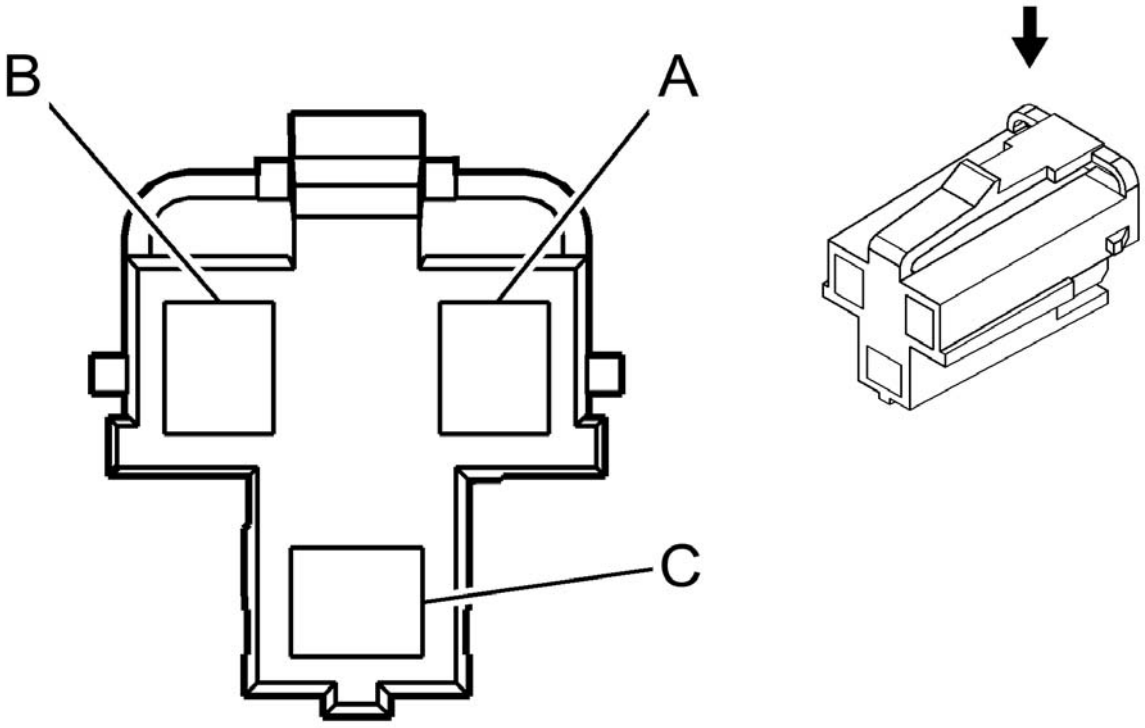
Terminal Part Information

- Terminated Lead: 13579923
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110842/4
- Core/Insulation Crimp: C/A

Accessory Power Outlet - I/P 1 (without D55)

Pin	Wire	Circuit	Function
A	1 RD/WH	2540	Battery Positive Voltage
B	-	-	Not Used
C	1 BK	150	Ground

ACCESSORY POWER OUTLET - I/P 2 (WITHOUT D55)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12176836
- Service Connector: 19257374
- Description: 3-Way F Metri-Pack 280 Series (GY)

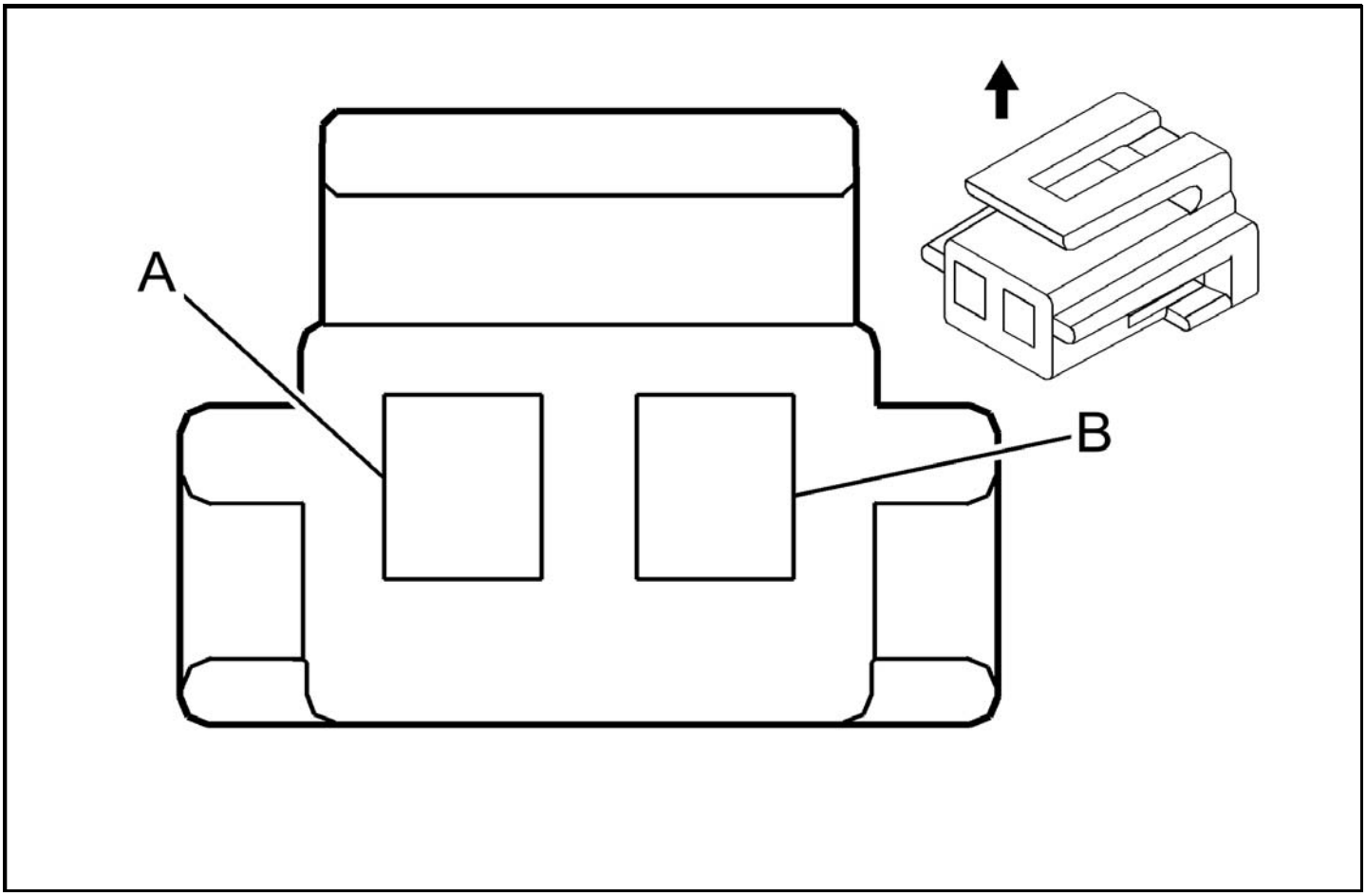
Terminal Part Information

- Terminated Lead: 13579923
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110842/4
- Core/Insulation Crimp: C/A

Accessory Power Outlet - I/P 2 (without D55)

Pin	Wire	Circuit	Function
A	1 RD/WH	2540	Battery Positive Voltage
B	-	-	Not Used
C	1 BK	150	Ground

AIR TEMPERATURE ACTUATOR - LEFT



Connector Part Information

- Harness Type: HVAC
- OEM Connector: 12059110
- Service Connector: 88953271
- Description: 2-Way F Metri-Pack 150 Series (BK)

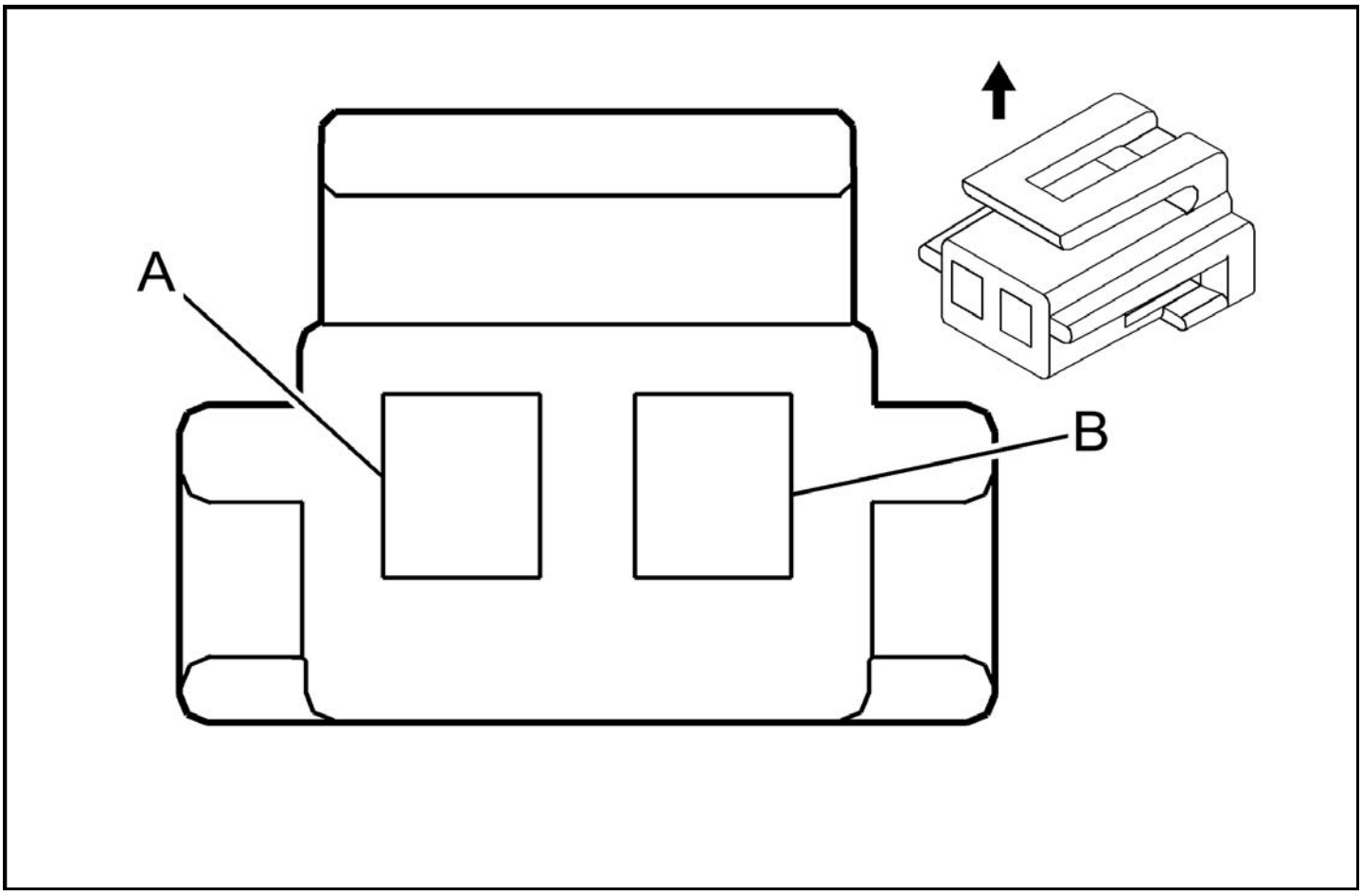
Terminal Part Information

- Terminal/Tray: 12064971/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Air Temperature Actuator - Left

Pin	Wire	Circuit	Function
A	0.35 D-BU/WH	1199	Left Air Temperature Door Control B
B	0.35 YE	1791	Left Air Temperature Door Control A

AIR TEMPERATURE ACTUATOR - RIGHT



Connector Part Information

- Harness Type: HVAC
- OEM Connector: 12059110
- Service Connector: 88953271
- Description: 2-Way F Metri-Pack 150 Series (BK)

Terminal Part Information

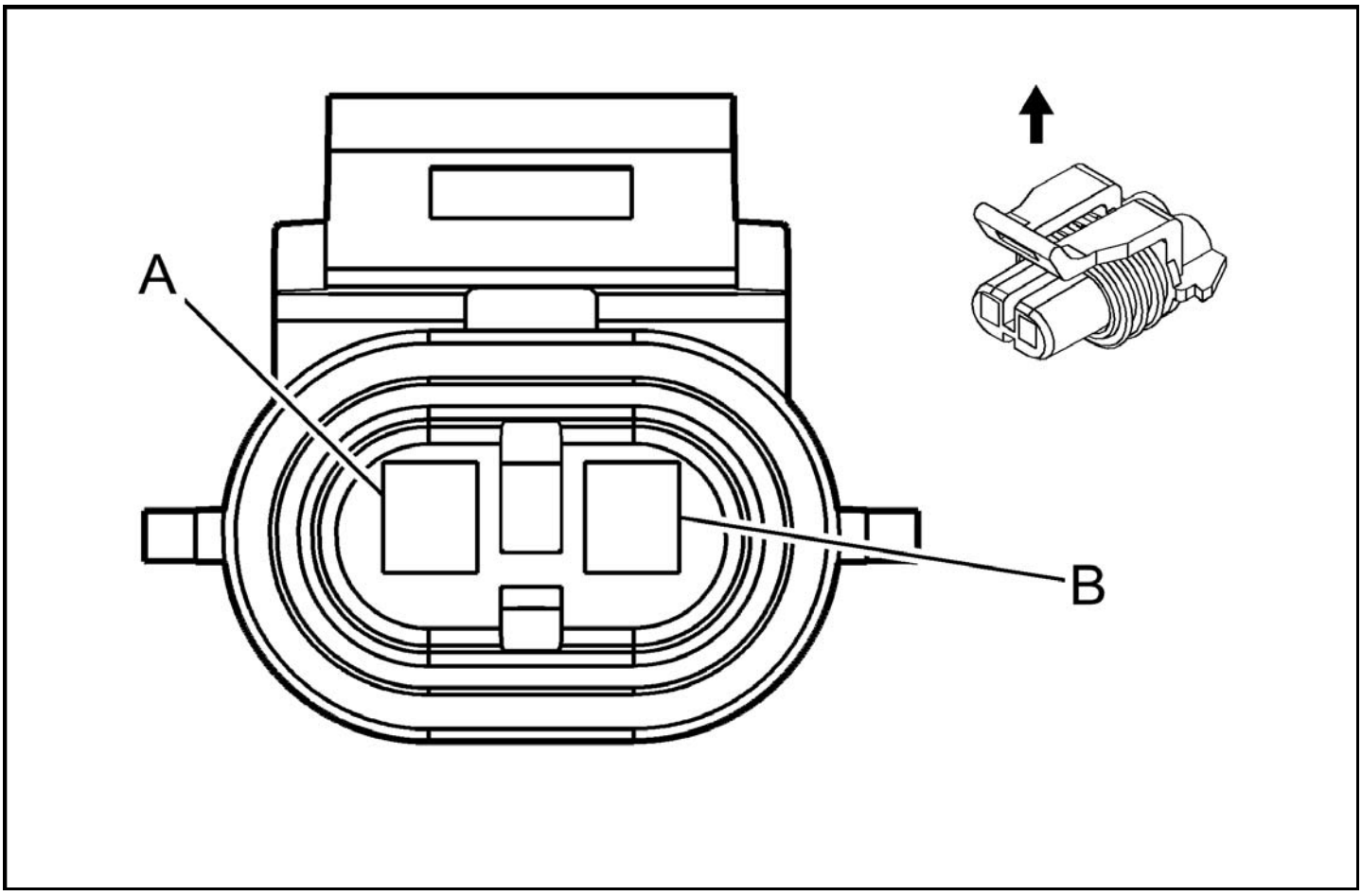
- Terminal/Tray: 12064971/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Air Temperature Actuator - Right

Pin	Wire	Circuit	Function

Pin	Wire	Circuit	Function
A	0.35 WH/BK	1236	Air Temperature Door Control B
B	0.35 D-BU	1646	Air Temperature Door Control A

AMBIENT AIR TEMPERATURE SENSOR



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 12052642
- Service Connector: 12101856
- Description: 2-Way F Metri-Pack 150 Series, Sealed (L-GN)

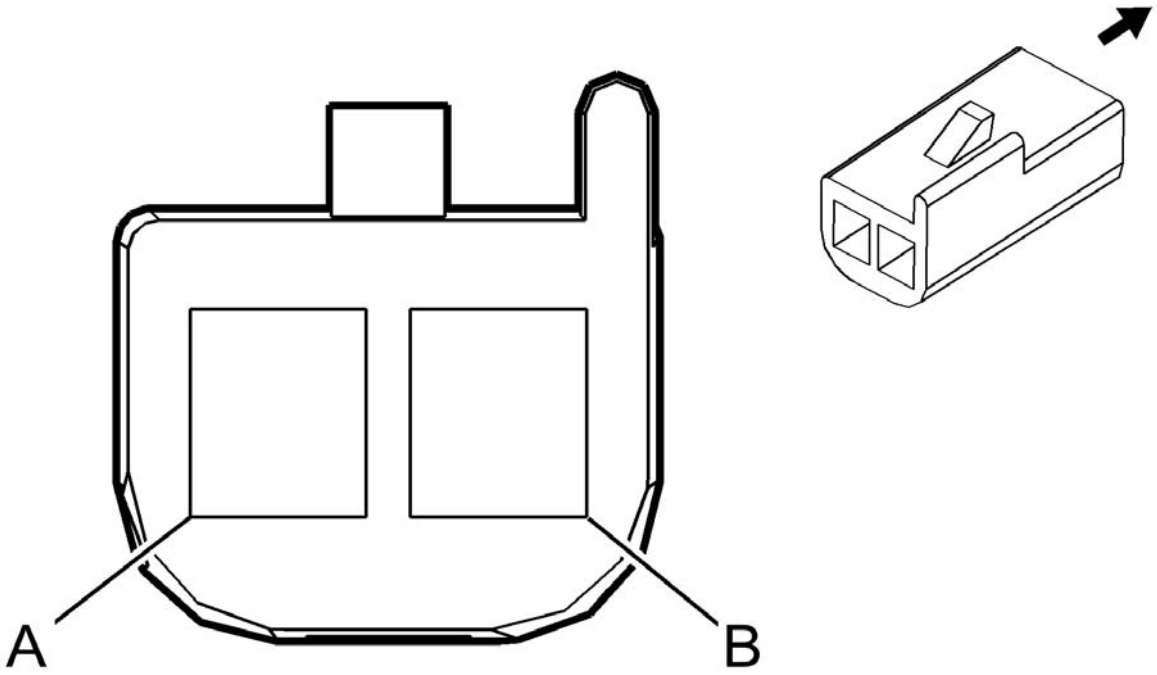
Terminal Part Information

- Terminated Lead: 13575419
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1

Ambient Air Temperature Sensor

Pin	Wire	Circuit	Function
A	0.35 L-GN/BK	735	Ambient Air Temperature Sensor Signal
B	0.35 YE	61	Low Reference

AMBIENT LIGHT SENSOR



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12047662
- Service Connector: 12085535
- Description: 2-Way F Metri-Pack 150 Series (BK)

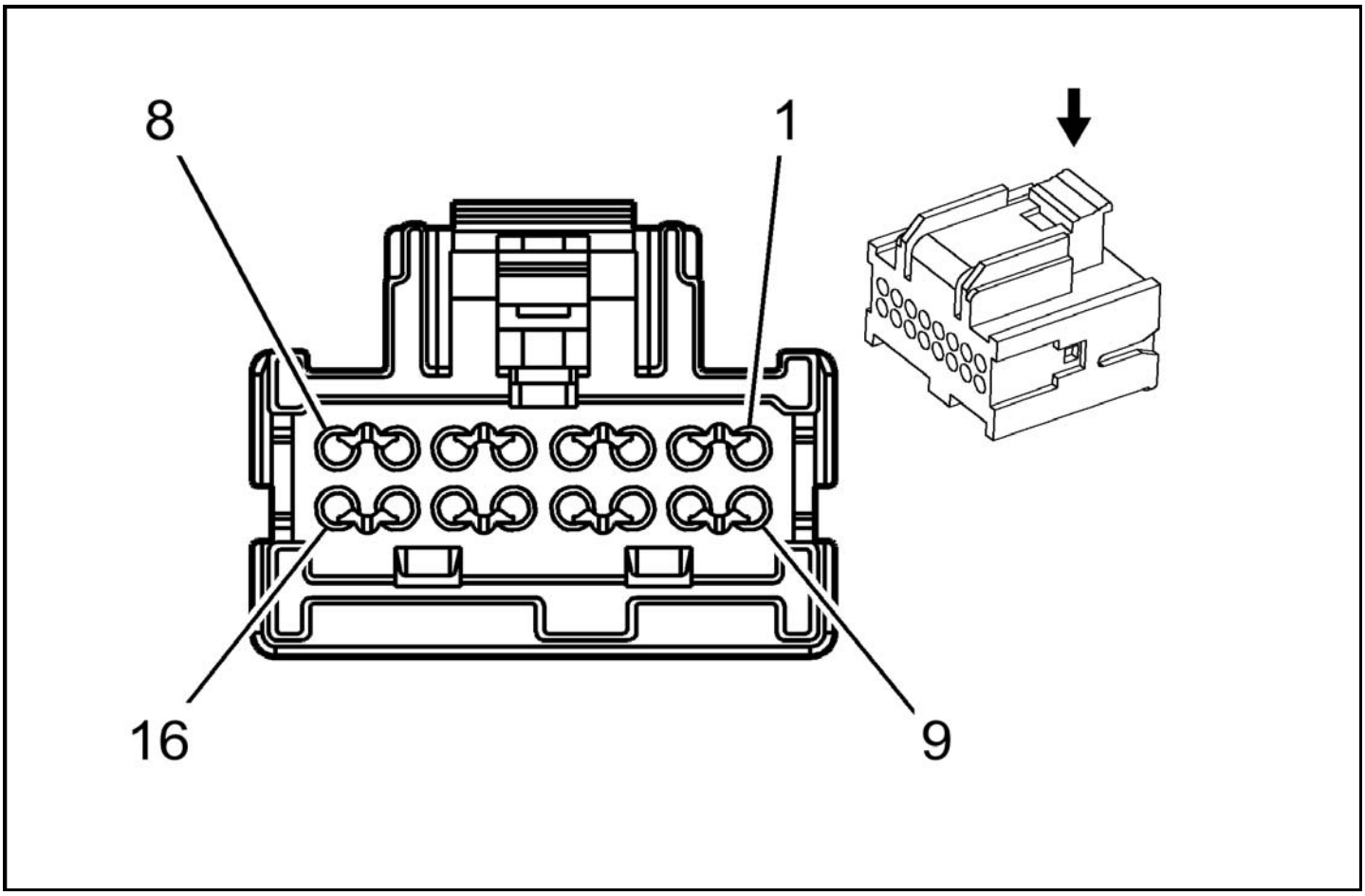
Terminal Part Information

- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Ambient Light Sensor

Pin	Wire	Circuit	Function
A	0.35 L-GN/BK	1137	DRL Ambient Light Sensor Signal
B	0.5 BK/WH	1551	Ground

AUDIO AMPLIFIER X1 (UQ3)



Connector Part Information

- Harness Type: Body
- OEM Connector: 15416970
- Service Connector: 13504130
- Description: 16-Way F Micro-Pack 64 Series (BK)

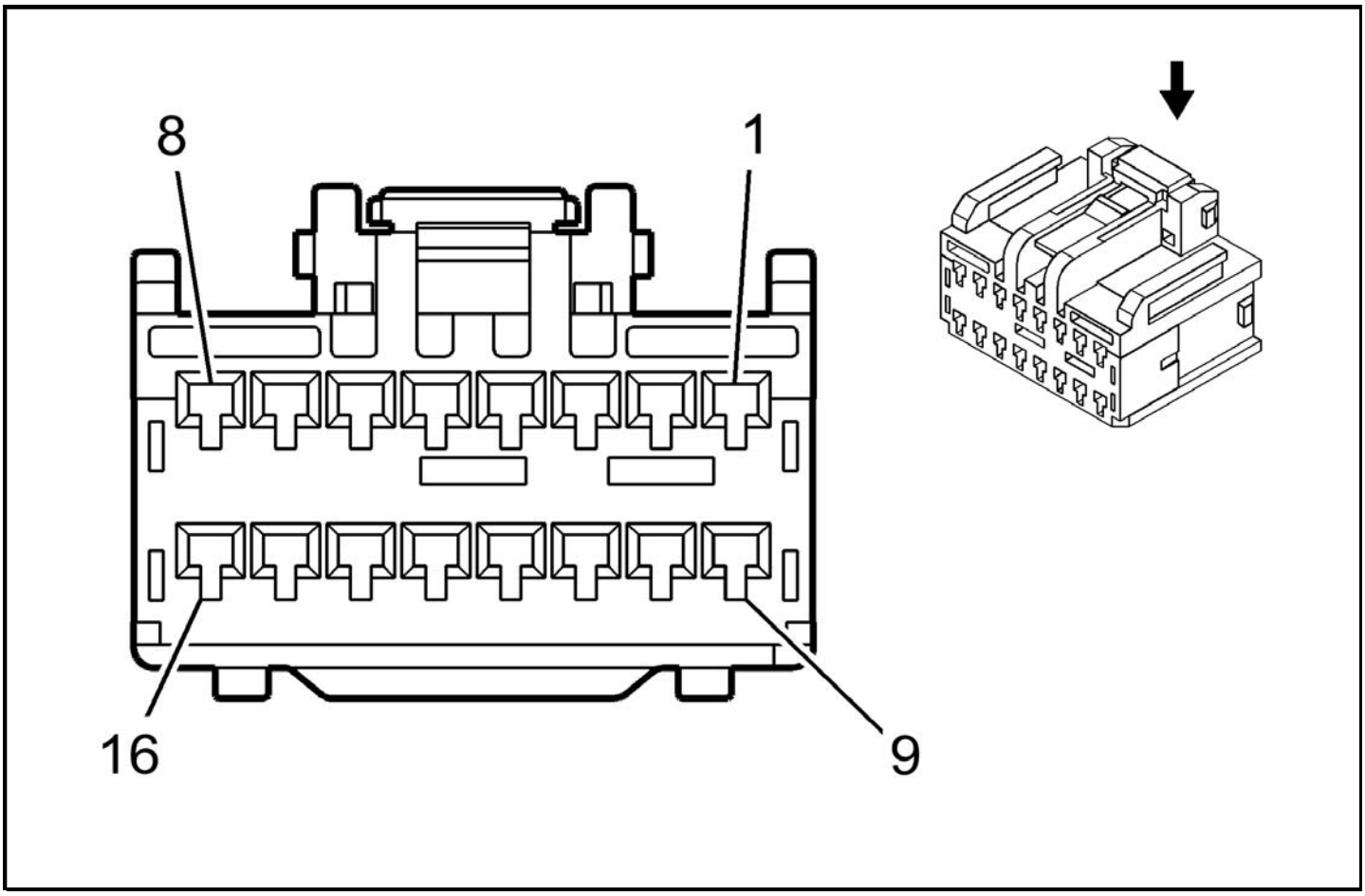
Terminal Part Information

- Terminated Lead: Service by Harness - See Part Catalog
- Release Tool: J-38125-21
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 15359541/4
- Core/Insulation Crimp: M/M

Audio Amplifier X1 (UQ3)

Pin	Wire	Circuit	Function
1-3	-	-	Not Used
4	0.5 TN	1946	Right Rear Low Level Audio Signal (-)
5	0.5 BN	1999	Left Rear Low Level Audio Signal (-)
6	0.5 L-GN/BK	1948	Right Front Low Level Audio Signal (-)
7	0.5 D-GN	1947	Left Front Low Level Audio Signal (-)
8	0.5 PK	5165	Antenna 14V Switched Supply Voltage
9-10	-	-	Not Used
11	0.35 OG	5748	Radio Audio Mute Signal
12	0.5 D-BU	546	Right Rear Low Level Audio Signal (+)
13	0.5 BN/WH	599	Left Rear Low Level Audio Signal (+)
14	0.5 L-GN	512	Right Front Low Level Audio Signal (+)
15	0.5 TN	511	Left Front Low Level Audio Signal (+)
16	-	-	Not Used

AUDIO AMPLIFIER X2 (UQ3)



Connector Part Information

- Harness Type: Body
- OEM Connector: 15489823

- Service Connector: 15134091
- Description: 16-Way F 1.5 Series (BK)

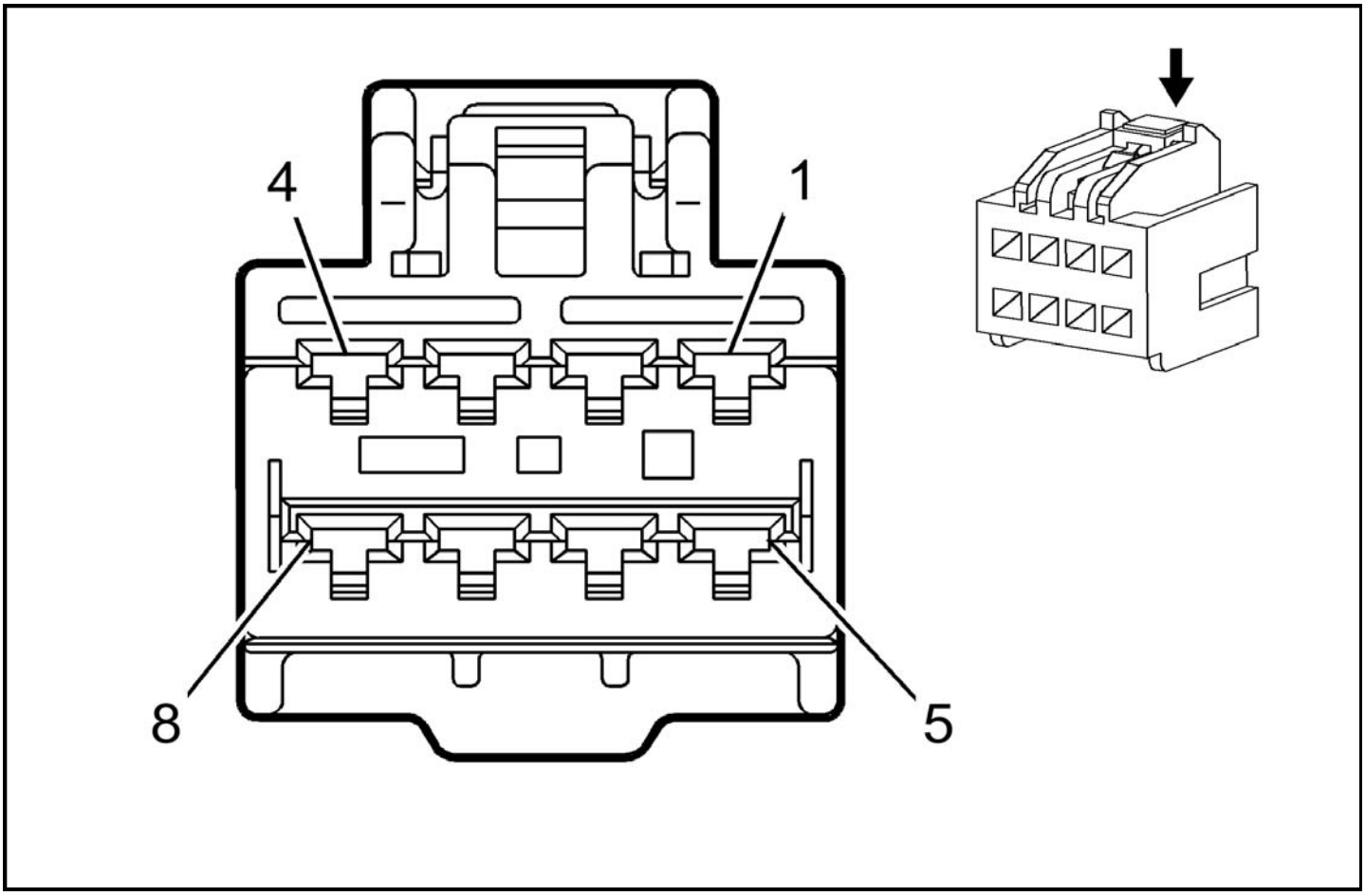
Terminal Part Information

- Terminated Lead: 13575790
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 8240-0128/22
- Core/Insulation Crimp: C/A

Audio Amplifier X2 (UQ3)

Pin	Wire	Circuit	Function
1	0.8 D-GN	117	Right Front Speaker Output (-)
2	0.8 L-GN	200	Right Front Speaker Output (+)
3	0.8 GY	118	Left Front Speaker Output (-)
4	0.8 TN	201	Left Front Speaker Output (+)
5	0.8 L-BU	115	Right Rear Speaker Output (-)
6	0.8 D-BU	46	Right Rear Speaker Output (+)
7	0.8 YE	116	Left Rear Speaker Output (-)
8	0.8 BN	199	Left Rear Speaker Output (+)
9-16	-	-	Not Used

AUDIO AMPLIFIER X3 (UQ3)



Connector Part Information

- Harness Type: Body
- OEM Connector: 15491286
- Service Connector: 13580111
- Description: 8-Way F 2.8 Series (BK)

Terminal Part Information

- Pins:2, 3, 6, 7
- Terminated Lead: 13582326
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: 8100-4444/22
- Core/Insulation Crimp: 2/A

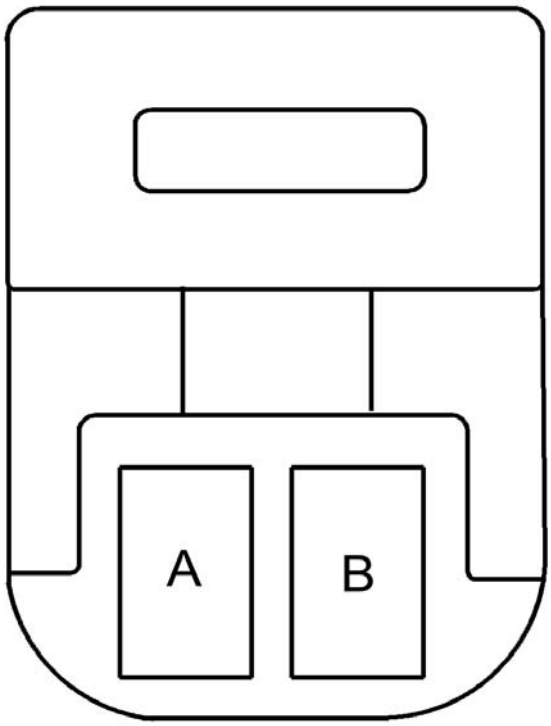
- Pins: 4, 8
- Terminated Lead: 13575578
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: 8100-4445/22

- Core/Insulation Crimp: 4/4

Audio Amplifier X3 (UQ3)

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	0.8 L-BU/BK	315	Right Subwoofer Speaker Output (-)
3	0.8 L-GN/BK	1794	Left Subwoofer Speaker Output (-)
4	2 RD/WH	640	Battery Positive Voltage
5	-	-	Not Used
6	0.8 D-GN	1795	Right Subwoofer Speaker Output (+)
7	0.8 D-BU/WH	346	Left Subwoofer Speaker Output (+)
8	2 BK/WH	851	Ground

AUTOMATIC TRANSMISSION INPUT SHAFT SPEED (ISS) SENSOR



Connector Part Information

- Harness Type: Transmission
- OEM Connector: 15473843
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F Metri-Pack 150.2 Series (CR)

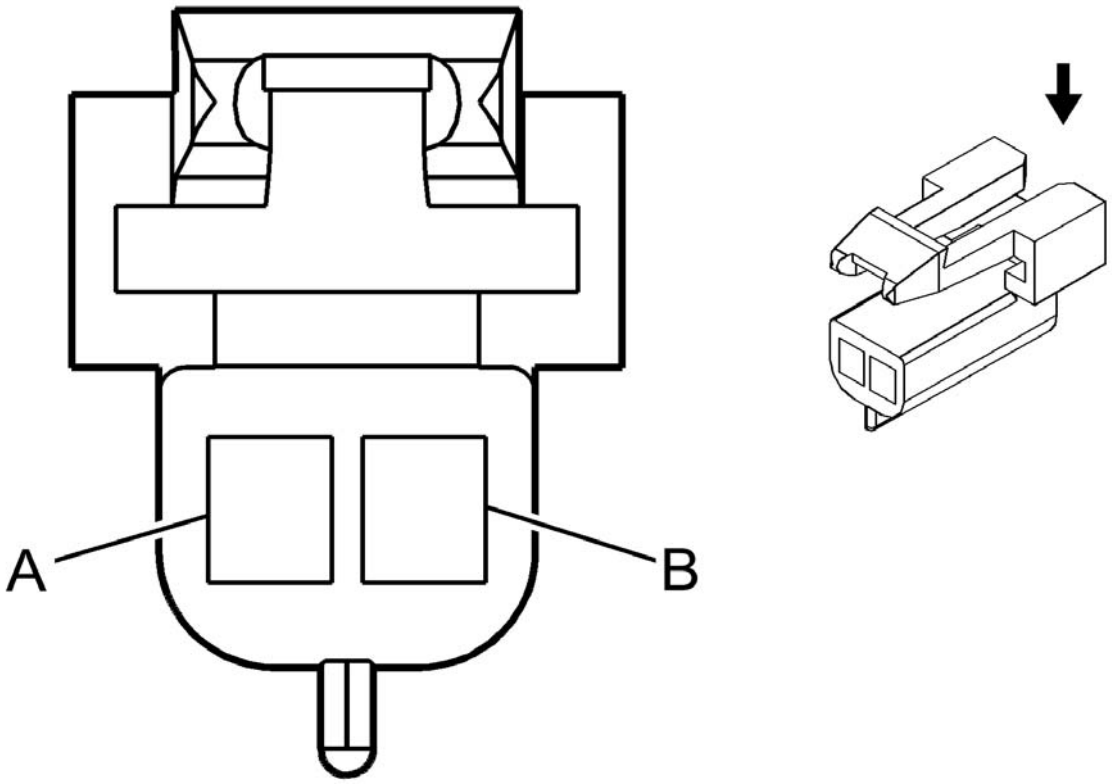
Terminal Part Information

- Terminal/Tray: 12124075/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12180559-1/J-35616-14 (GN)

Automatic Transmission Input Shaft Speed (ISS) Sensor

Pin	Wire	Circuit	Function
A	0.5 D-GN	1231	AT ISS Low Signal
B	0.5 BK	1230	AT ISS High Signal

AUTOMATIC TRANSMISSION SHIFT LOCK CONTROL SOLENOID (WITHOUT D55)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12052832
- Service Connector: 13583033
- Description: 2-Way F Metri-Pack 150 Series (BK)

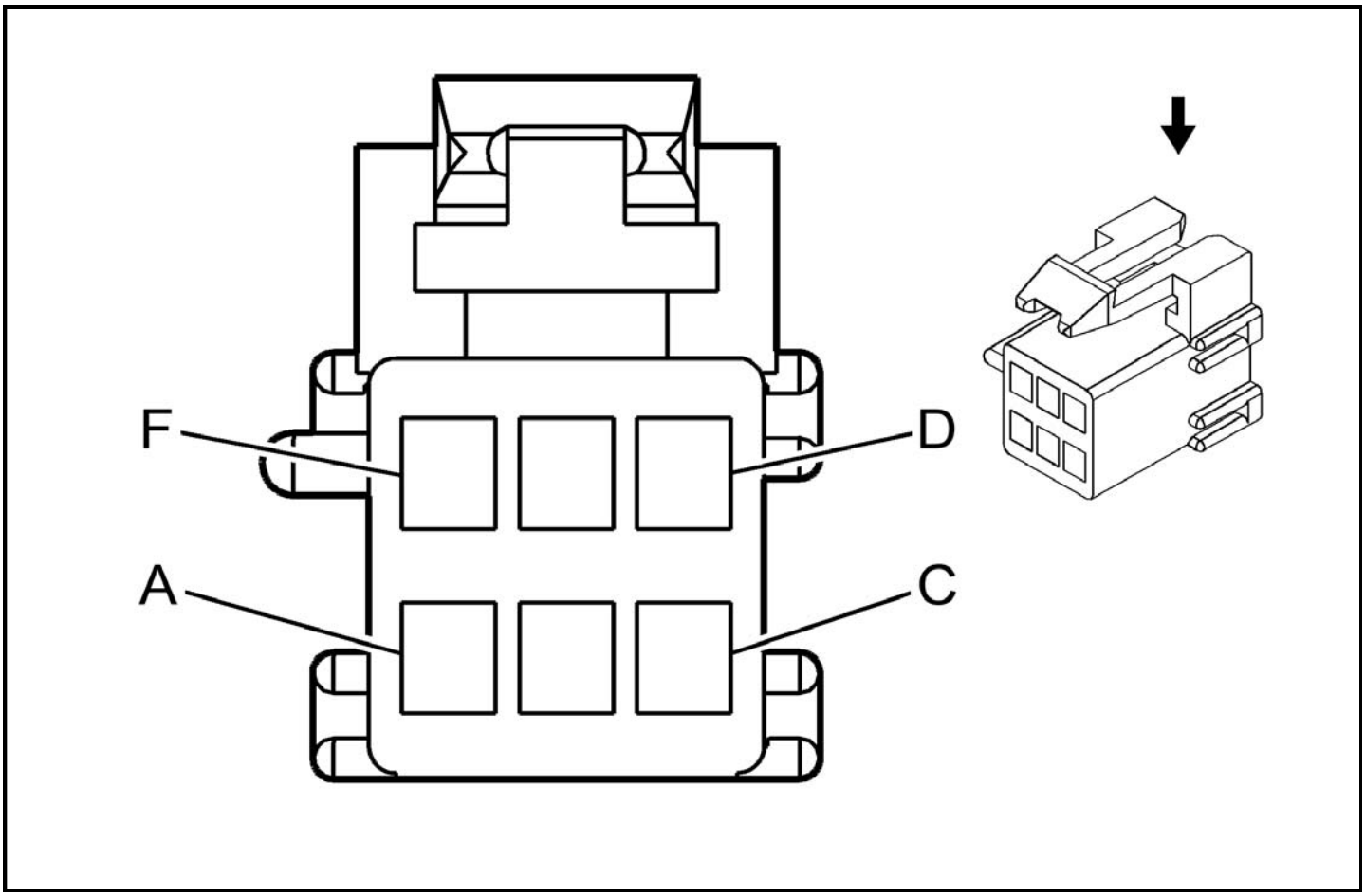
Terminal Part Information

- Terminated Lead: Service by Harness - See Part Catalog
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/2
- Core/Insulation Crimp: E/A

Automatic Transmission Shift Lock Control Solenoid (without D55)

Pin	Wire	Circuit	Function
A	0.8 D-GN/WH	1135	A/T Shift Lock Control Solenoid Supply Voltage
B	BK	1450	Ground

AUTOMATIC TRANSMISSION SHIFT LOCK CONTROL SOLENOID (D55)



Connector Part Information

- Harness Type: Body
- OEM Connector: 12064762
- Service Connector: 13583923
- Description: 6-Way F Metri-Pack 150 Series (GY)

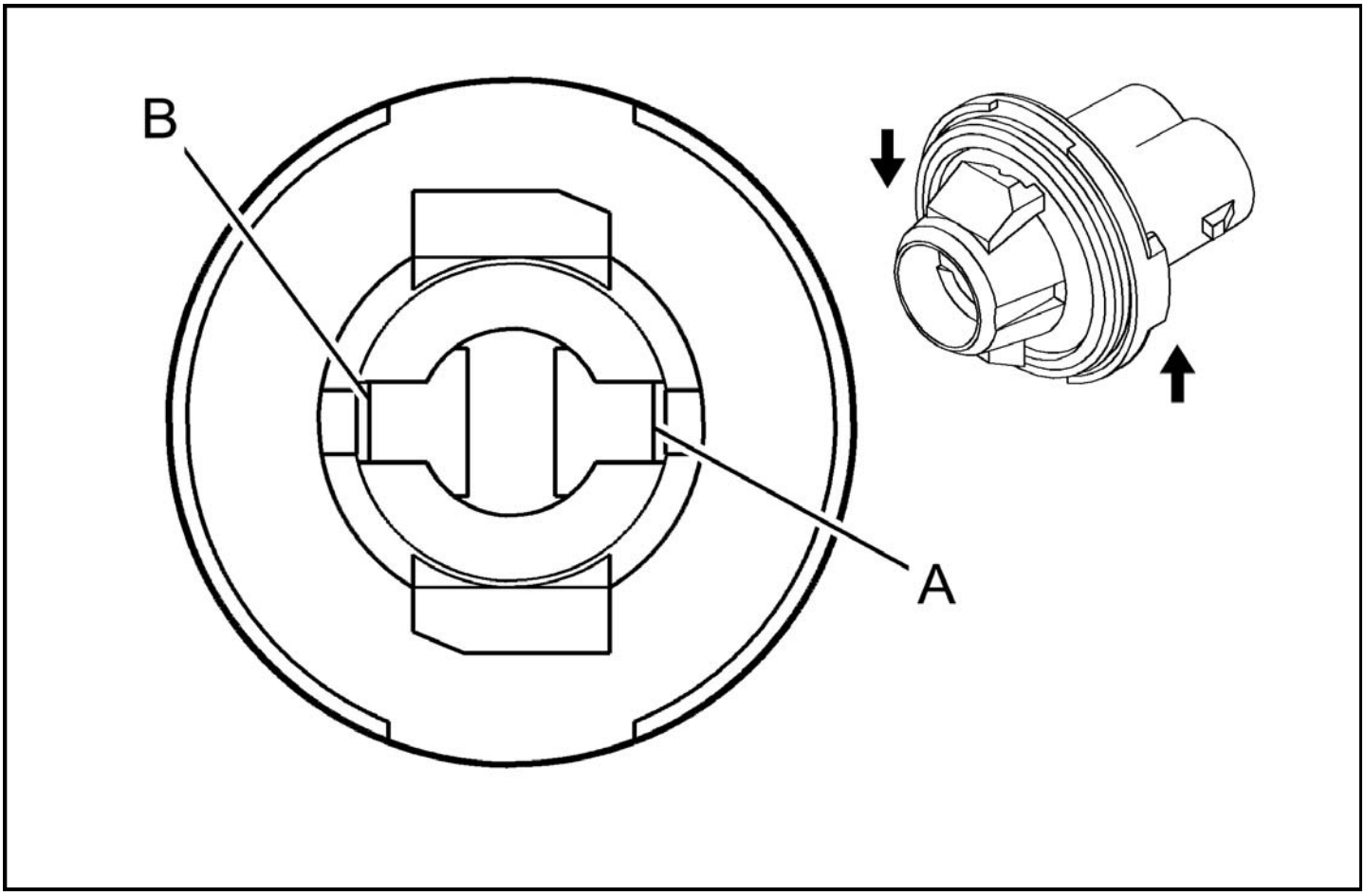
Terminal Part Information

- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Automatic Transmission Shift Lock Control Solenoid (D55)

Pin	Wire	Circuit	Function
A	0.8 BK	750	Ground
B	0.35 D-GN/WH	1135	A/T Shift Lock Control Solenoid Supply Voltage
C	0.35 PU/WH	1630	Steering Column Key Cylinder Lock Solenoid Control
D-E	-	-	Not Used
F	0.35 YE	643	Accessory Voltage

BACKUP LAMP - LEFT



Connector Part Information

- Harness Type: Left Tail Lamp
- OEM Connector: 15324946
- Service Connector: 88986416
- Description: 2-Way F Lamp Socket Wedge Base W2 (D-GY)

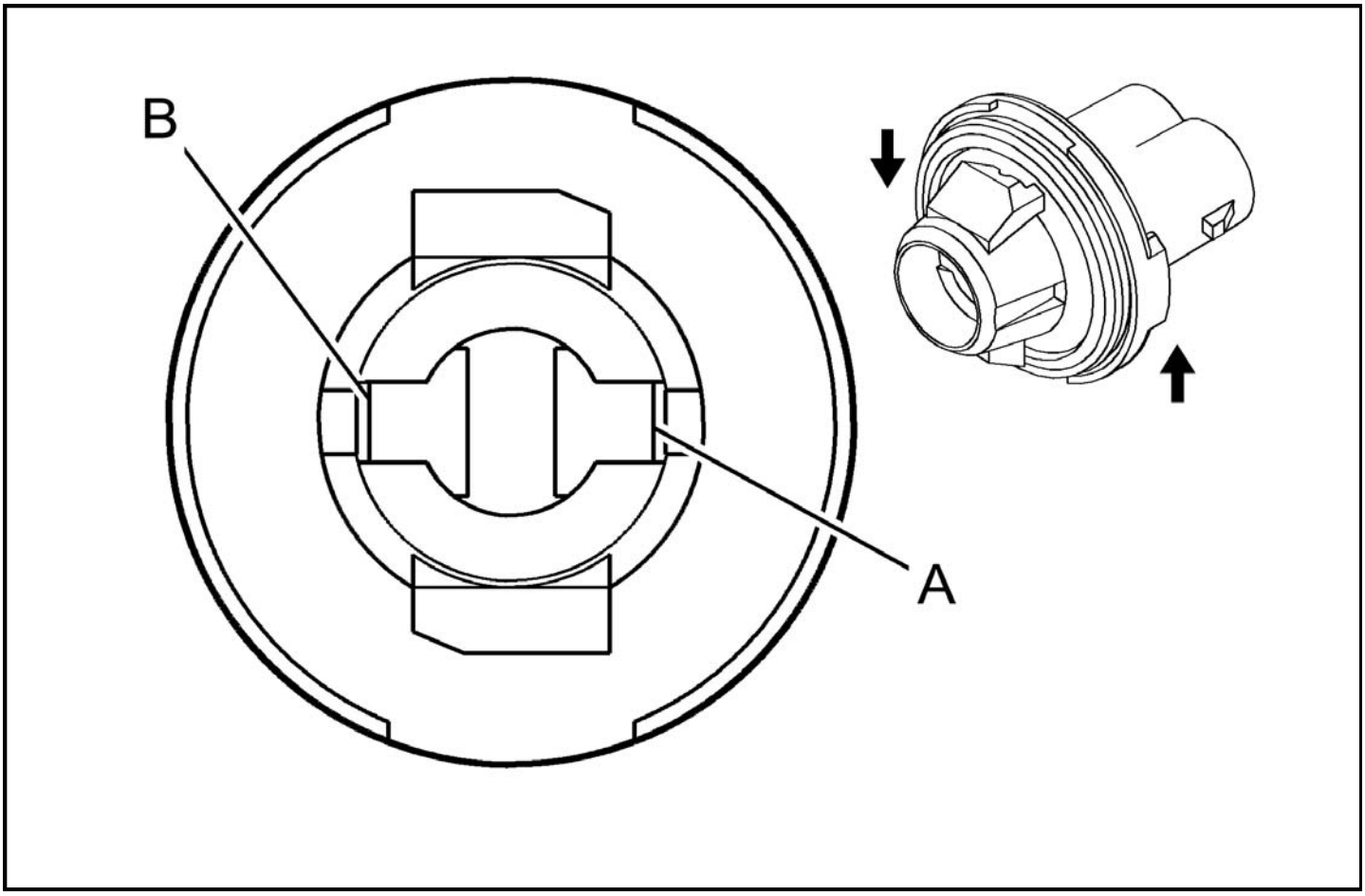
Terminal Part Information

- Terminal/Tray: 12124471/5
- Core/Insulation Crimp: 2/3
- Release Tool/Test Probe: 12094430/ Not Available

Backup Lamp - Left

Pin	Wire	Circuit	Function
A	0.5 BN	24	Backup Lamp Supply Voltage
B	0.5 BK	750	Ground
	0.5 BK	750	Ground

BACKUP LAMP - RIGHT



Connector Part Information

- Harness Type: Right Tail Lamp
- OEM Connector: 15324946
- Service Connector: 88986416
- Description: 2-Way F Lamp Socket Wedge Base W2 (D-GY)

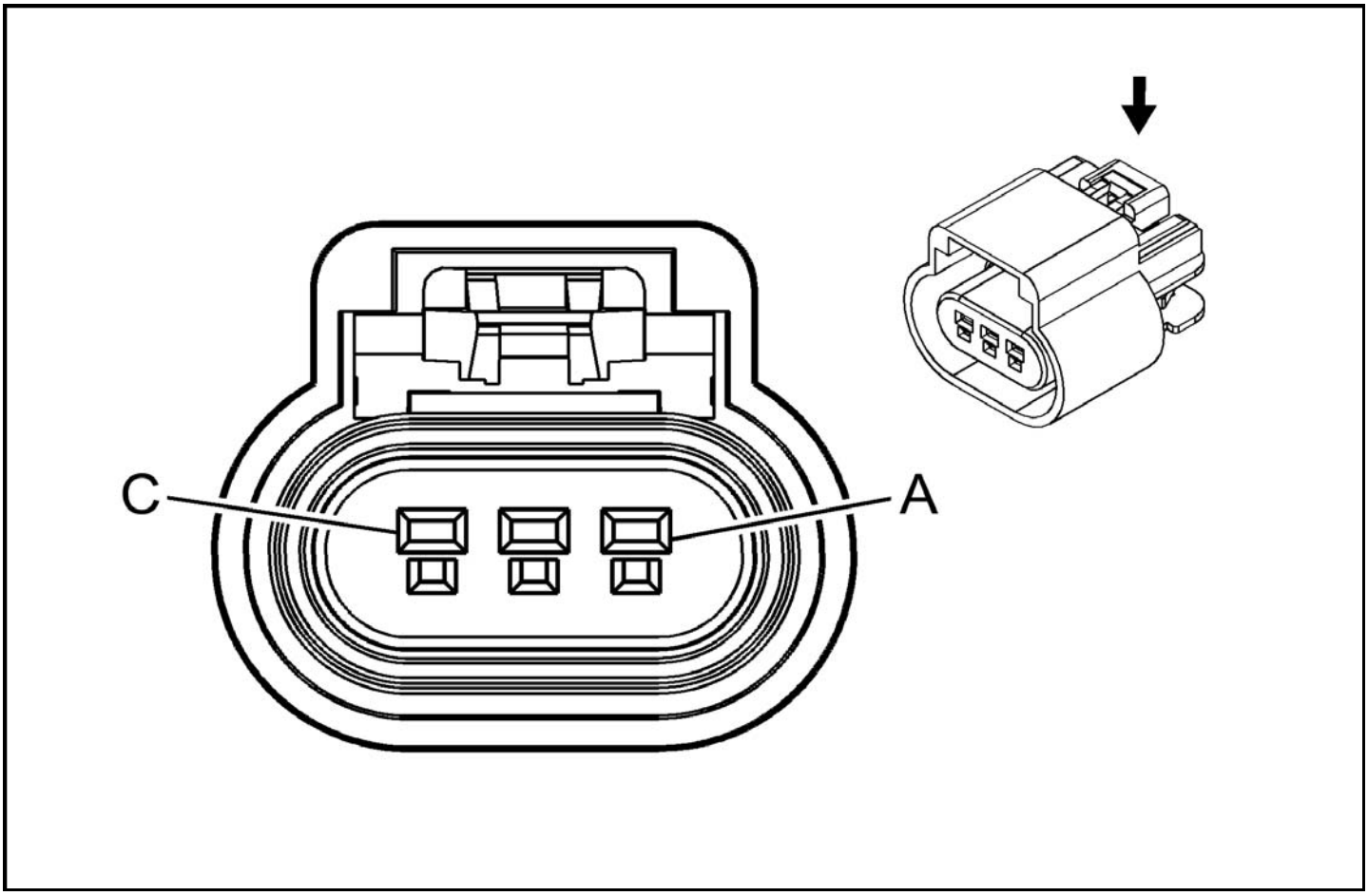
Terminal Part Information

- Terminal/Tray: 12124471/5
- Core/Insulation Crimp: 2/3
- Release Tool/Test Probe: 12094430/ Not Available

Backup Lamp - Right

Pin	Wire	Circuit	Function
A	0.5 BN	24	Backup Lamp Supply Voltage
B	0.5 BK	750	Ground
	0.5 BK	750	Ground

BATTERY CURRENT SENSOR



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15326808
- Service Connector: 13580871
- Description: 3-Way F GT 150 Series, Sealed (BK)

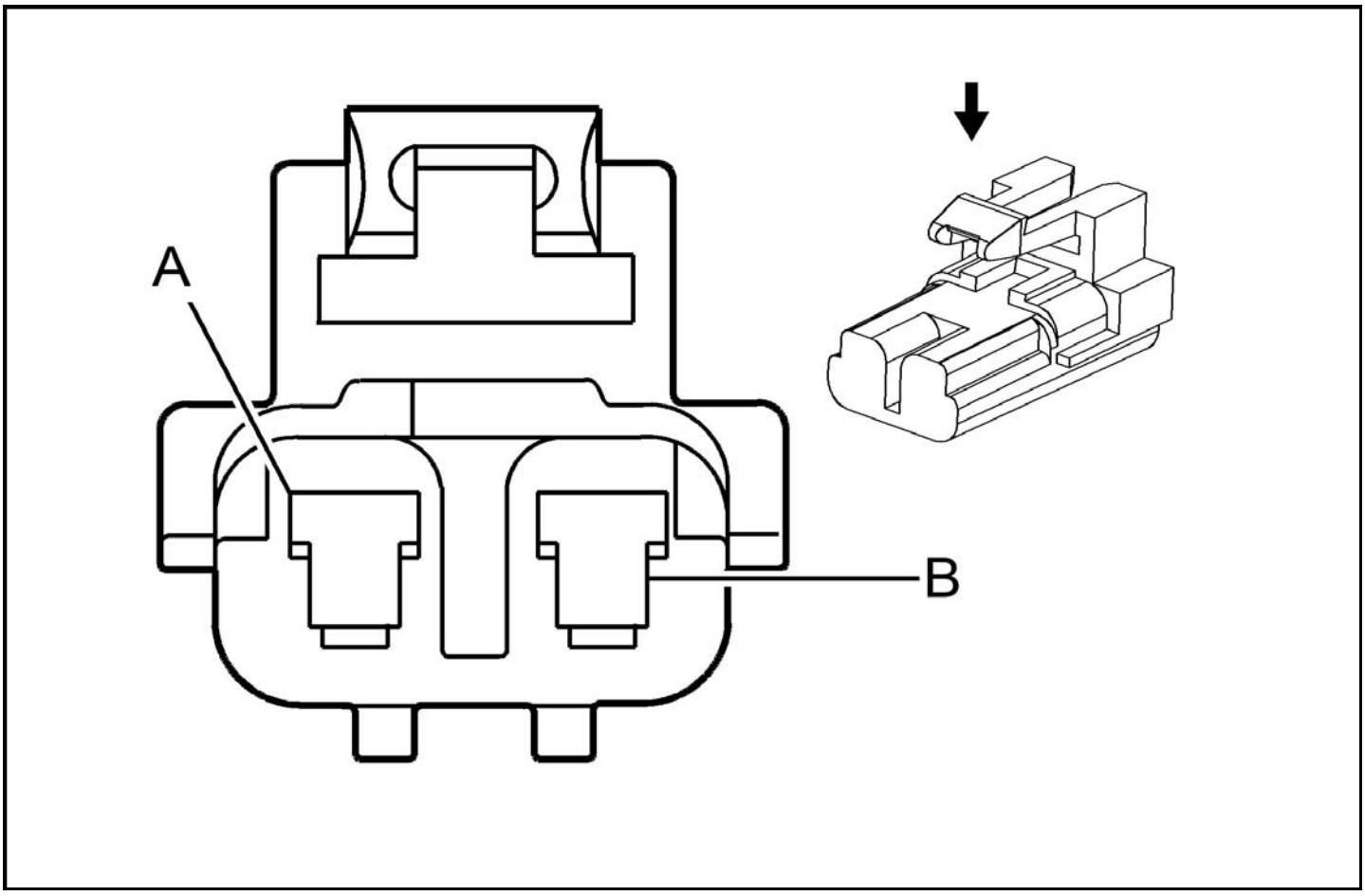
Terminal Part Information

- Terminated Lead: 13575396
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 15326427/5
- Core/Insulation Crimp: E/A

Battery Current Sensor

Pin	Wire	Circuit	Function
A	0.35 PK	5076	Current Sensor Supply Voltage
B	0.35 BN	5077	Low Reference
C	0.35 WH	5075	Current Sensor Signal

BLOWER MOTOR



Connector Part Information

- Harness Type: HVAC
- OEM Connector: 12084957
- Service Connector: 12126461
- Description: 2-Way F Metri-Pack 280 Series (BK)

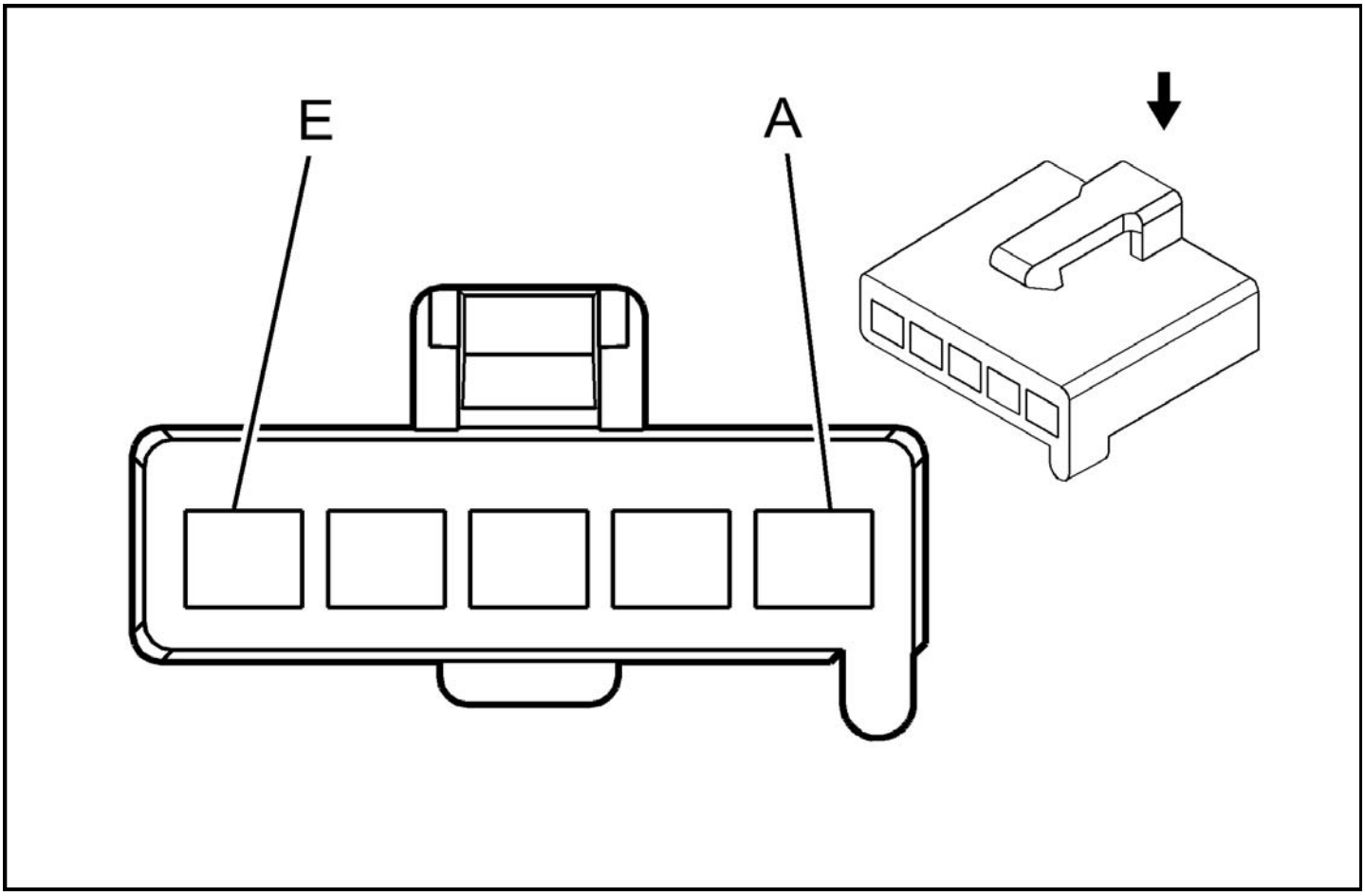
Terminal Part Information

- Terminal/Tray: 12015858/4
- Core/Insulation Crimp: F/G
- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

Blower Motor

Pin	Wire	Circuit	Function
A	3 PU	65	Blower Motor Supply Voltage
B	3 OG	5987	Ground

BLOWER MOTOR CONTROL MODULE



Connector Part Information

- Harness Type: HVAC
- OEM Connector: 12041429
- Service Connector: 12167129
- Description: 5-Way F Metri-Pack 280 Series (BK)

Terminal Part Information

- Pins: A, C, D, E
- Terminal/Tray: 12015858/4
- Core/Insulation Crimp: F/G
- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

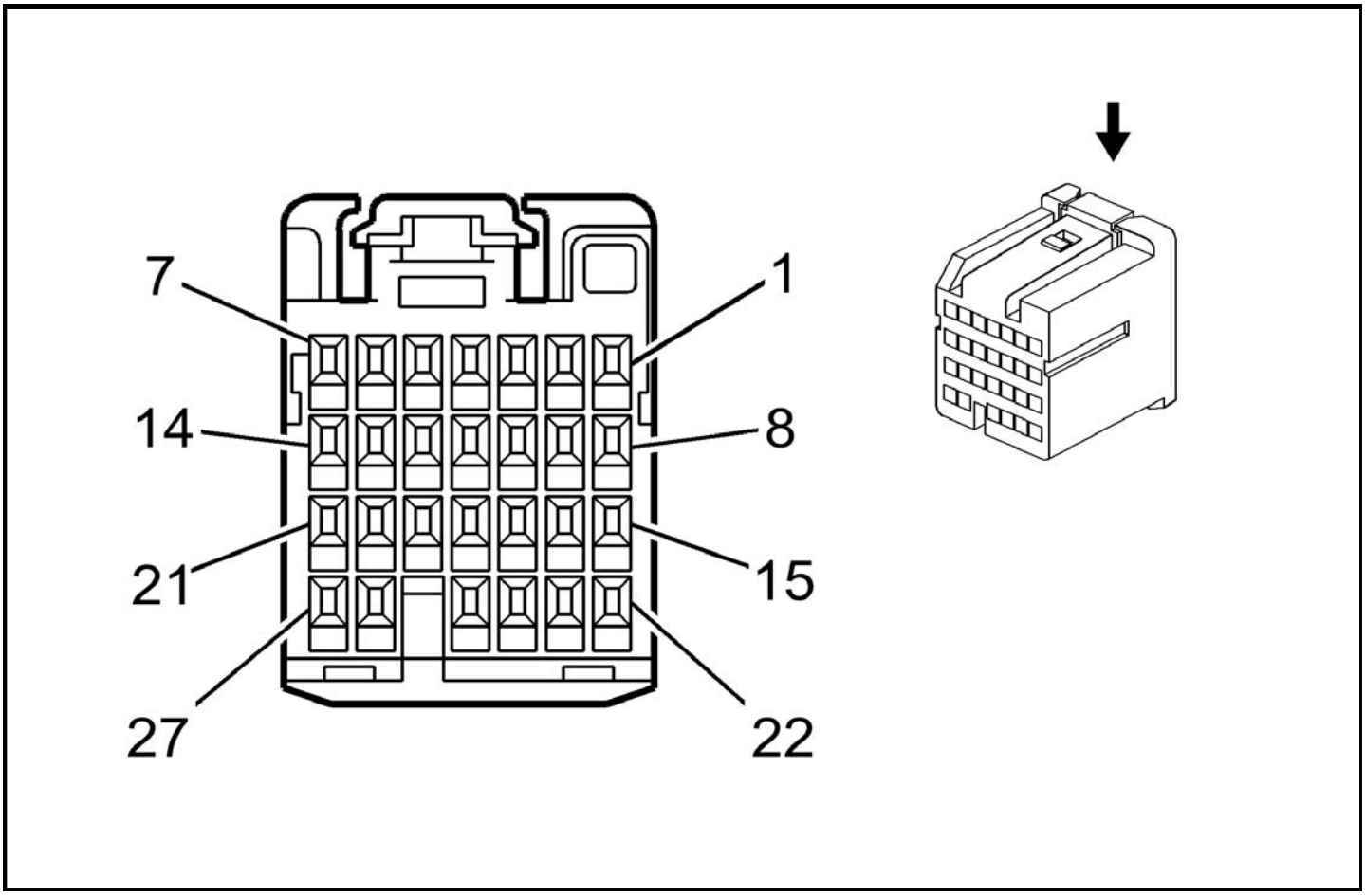
- Pins: B
- Terminal/Tray: 12034046/2
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

Blower Motor Control Module

Pin	Wire	Circuit	Function

Pin	Wire	Circuit	Function
A	3 BK	150	Ground
B	0.35 GY/BK	754	Blower Motor Speed Control
C	3 RD	442	Battery Positive Voltage
D	3 OG	5987	Ground
E	3 PU	65	Blower Motor Supply Voltage

BODY CONTROL MODULE (BCM) X1



Connector Part Information

- Harness Type: Steering Column
- OEM Connector: 15482789
- Service Connector: 88988838
- Description: 27-Way F HIT Series (L-GN)

Terminal Part Information

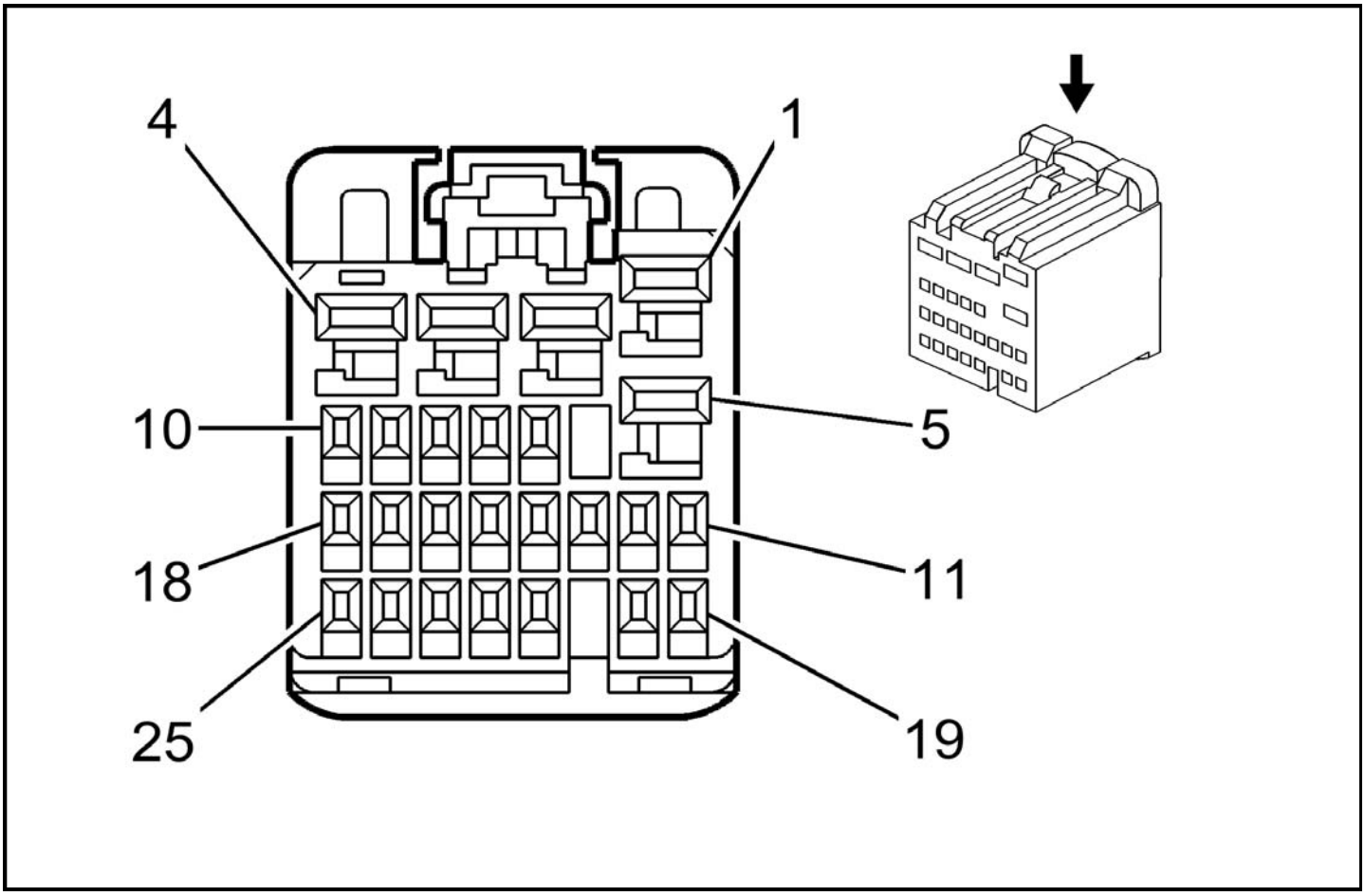
- Terminated Lead: 13575870
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SNAC3-A021T-M0.64/20

- Core/Insulation Crimp: J/J

Body Control Module (BCM) X1

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	0.35 WH	1390	Off/Run/Crank Voltage
3	0.35 GY	1884	Cruise Control Switch Signal
4	0.35 WH/BK	1073	5-Volt Reference
5	0.35 L-GN	1715	Windshield Wiper Switch High Signal
6	0.35 D-BU	1796	Steering Wheel Controls Signal
7	-	-	Not Used
8	0.35 BK/WH	1251	Ground
9	0.35 L-BU	1714	Windshield Wiper Switch Low Signal
10-13	-	-	Not Used
14	0.35 PK	3	Ignition 1 Voltage
15	0.35 L-BU/WH	1414	Left Turn Signal Switch Signal
16	0.35 D-BU/WH	1415	Right Turn Signal Switch Signal
17	0.35 PU	1375	Steering Wheel Control Supply Voltage
18	0.35 PU	524	Headlamp Dimmer Switch High Beam Signal
19	0.35 TN	2144	Hazard Switch Signal
20	-	-	Not Used
21	0.35 BN	4	Accessory Voltage
22-23	-	-	Not Used
24	0.35 PK	94	Windshield Washer Switch Signal
25	0.35 BN	1356	Flash To Pass Switch Signal
26	0.5 D-GN/WH	1135	A/T Shift Lock Control Solenoid Supply Voltage (without D55)
27	-	-	Not Used

BODY CONTROL MODULE (BCM) X2



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15482790
- Service Connector: 88988839
- Description: 25-Way F HIT Series (NA)

Terminal Part Information

- Pins: 1-3, 5
- Terminated Lead: 13327199
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: SNAC-A061T-M2.8/20
- Core/Insulation Crimp: E/A

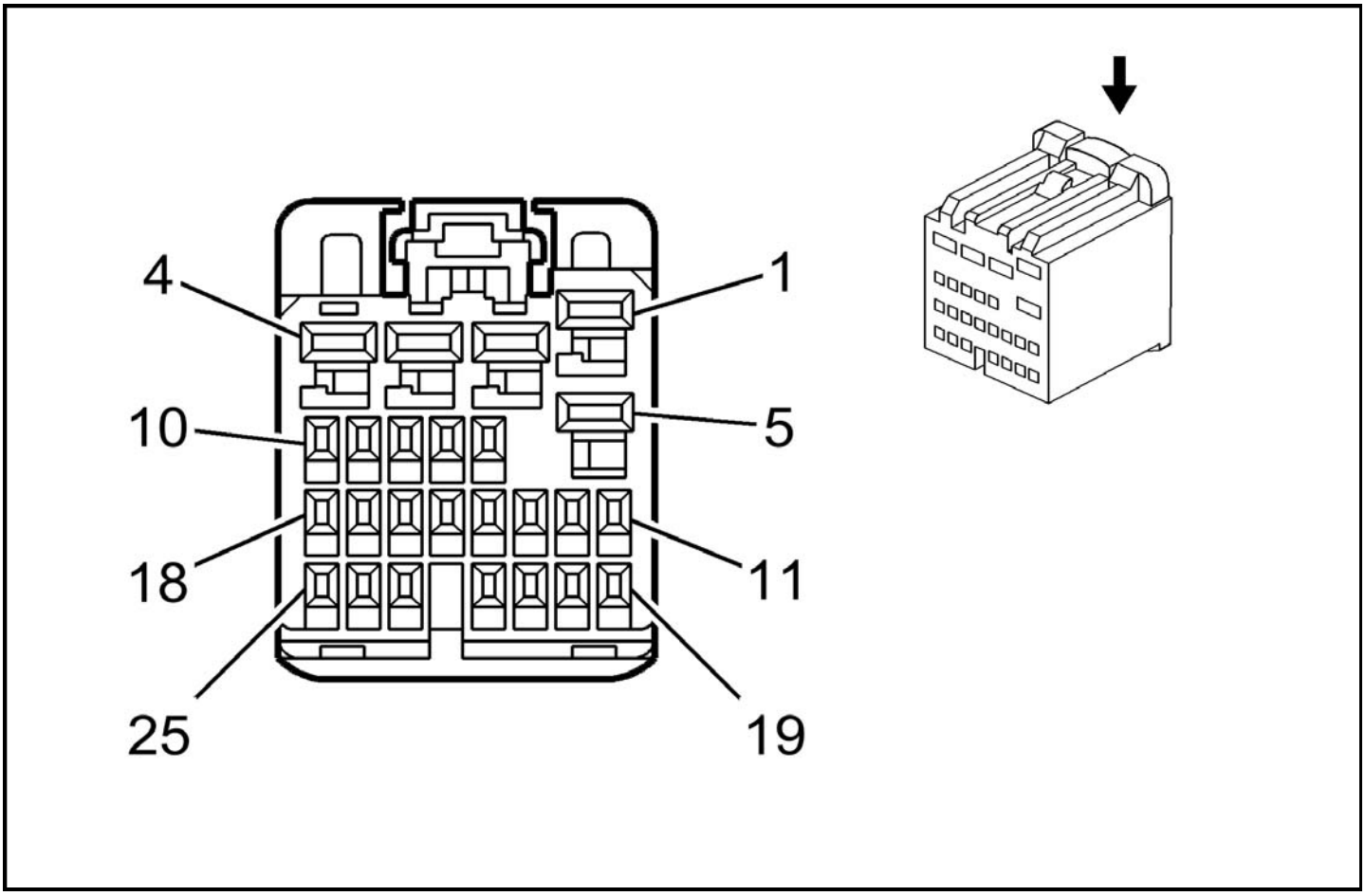
- Pins: 8, 10-12, 17, 18, 21, 22
- Terminated Lead: 13575870
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SNAC3-A021T-M0.64/20

- Core/Insulation Crimp: J/J

Body Control Module (BCM) X2

Pin	Wire	Circuit	Function
1	0.8 OG	1732	Inadvertent Power Courtesy Lamp
2	0.5 RD/WH	1240	Battery Positive Voltage
3	0.8 GY	8	Instrument Panel Lamp Supply Voltage
4	-	-	Not Used
5	0.5 GY/BK	690	Courtesy Lamp Supply Voltage
6-7	-	-	Not Used
8	0.35 BN/WH	301	Park Lamp Switch On Signal
9	-	-	Not Used
10	0.35 L-BU	383	Trunk Release Control
11	0.35 L-GN/BK	1137	DRL Ambient Light Sensor Signal
12	0.35 WH	103	Headlamp Switch Headlamps On Signal
13-16	-	-	Not Used
17	0.35 D-GN	306	Headlamps Switch Headlamps Off Signal
18	0.35 PK/BK	1597	Courtesy Lamps Switch On Signal
19-20	-	-	Not Used
21	0.35 BN/WH	1571	Traction Control Switch Signal (NW9)
22	0.35 D-GN/WH	1135	A/T Shift Lock Control Solenoid Supply Voltage (D55)
23-25	-	-	Not Used

BODY CONTROL MODULE (BCM) X3



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15482791
- Service Connector: 88988840
- Description: 25-Way F HIT Series (L-BU)

Terminal Part Information

- Pins: 1-3, 5
- Terminated Lead: 13327199
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: SNAC-A061T-M2.8/20
- Core/Insulation Crimp: E/A

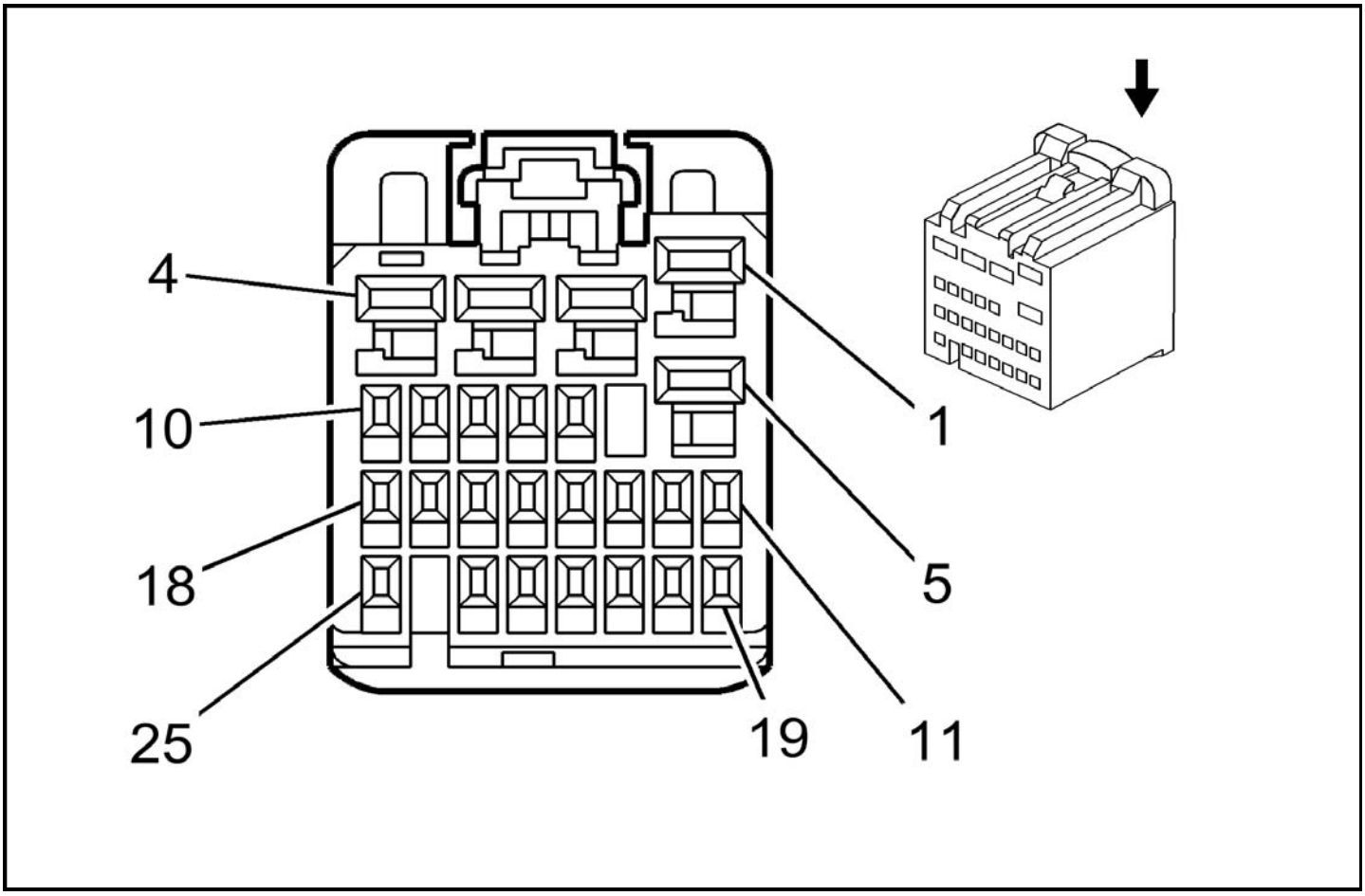
- Pins: 8-22
- Terminated Lead: 13575870
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SNAC3-A021T-M0.64/20

- Core/Insulation Crimp: J/J

Body Control Module (BCM) X3

Pin	Wire	Circuit	Function
1	0.8 BK/WH	1551	Ground
2	0.8 RD/WH	1640	Battery Positive Voltage
3	0.5 RD/WH	1040	Battery Positive Voltage
4	-	-	Not Used
5	0.8 BK/WH	1551	Ground
6-7	-	-	Not Used
8	0.35 TN/BK	2500	High Speed GMLAN Serial Data Bus +
9	0.35 TN	2501	High Speed GMLAN Serial Data Bus -
10	0.35 L-GN/BK	5060	Low Speed GMLAN Serial Data
11	0.35 D-GN	44	Instrument Panel Lamps Dimmer Switch Signal
12	0.35 OG/WH	812	I/P Dimming Voltage Reference
13	0.35 L-GN	526	Stop Lamp Switch Signal
14	0.35 TN	552	Low Reference
15	0.35 GY	598	5-Volt Reference
16	0.35 TN/BK	2500	High Speed GMLAN Serial Data Bus +
17	0.35 TN	2501	High Speed GMLAN Serial Data Bus -
18	0.35 PU/WH	1382	LED Dimming Supply
19	0.35 L-BU	5986	Serial Data Communication Enable
20	-	-	Not Used
21	0.35 OG	192	Front Fog Lamp Switch Signal (T96)
	0.5 D-BU/YE	6841	Rear Lamp Flasher Signal (9C1, 9C3)
22	0.35 D-GN/WH	7158	Cruise Control Indicator Dimming Signal
23-25	-	-	Not Used

BODY CONTROL MODULE (BCM) X4



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15482792
- Service Connector: 88988841
- Description: 25-Way F HIT Series (BK)

Terminal Part Information

- Pins: 1-5
- Terminated Lead: 13327199
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: SNAC-A061T-M2.8/20
- Core/Insulation Crimp: E/A

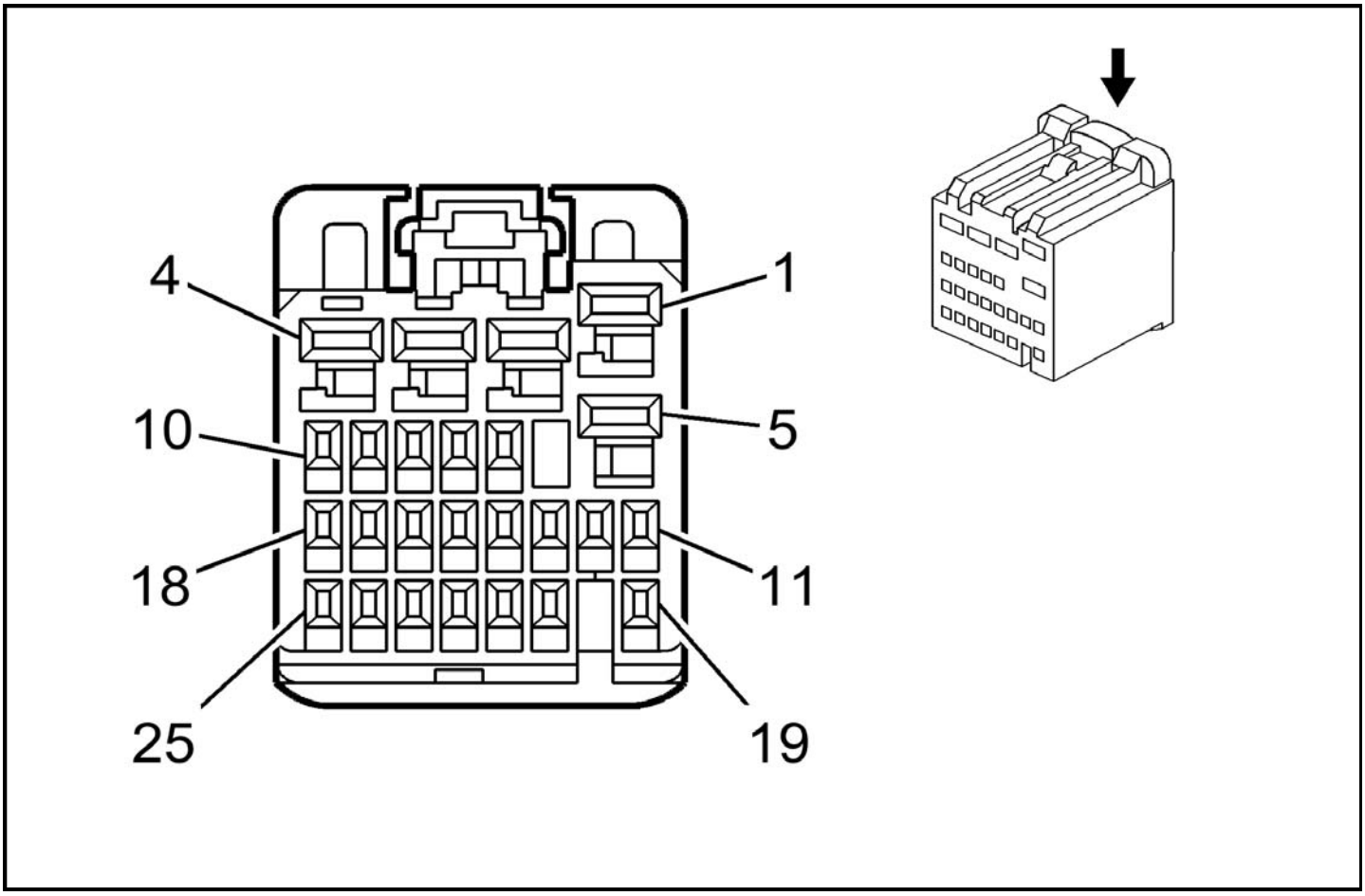
- Pins: 7, 9-11, 15-17, 19, 21, 23
- Terminated Lead: 13575870
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SNAC3-A021T-M0.64/20

- Core/Insulation Crimp: J/J

Body Control Module (BCM) X4

Pin	Wire	Circuit	Function
1	0.8 RD/WH	340	Battery Positive Voltage
2	0.8 RD/WH	240	Battery Positive Voltage
3	0.8 RD/WH	440	Battery Positive Voltage
4	0.8 RD/WH	1240	Battery Positive Voltage
5	0.5 D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage
6	-	-	Not Used
7	0.35 YE	196	Windshield Wiper Motor Park Switch Signal
8	-	-	Not Used
9	0.5 BK	50	Ground
10	0.35 RD/WH	2440	Battery Positive Voltage
11	0.35 D-GN/WH	1317	Fog Lamp Relay Control (T96)
12	0.35 YE	5187	Right Trailer Turn Signal Lamp (6J6)
13	0.35 OG	5186	Left Trailer Turn Signal Lamp (6J6)
14	-	-	Not Used
15	0.35 OG	2268	Windshield Washer Relay Control
16	0.35 TN/WH	1969	Headlamp High Beam Relay Control
17	0.35 PK/BK	109	Hood Ajar Switch Signal
18	-	-	Not Used
19	0.35 D-BU	5985	Accessory Wakeup Serial Data
20	-	-	Not Used
21	0.35 YE	5199	Run/Crank Relay Coil Control
22	-	-	Not Used
23	0.35 PU	544	DRL PCB Relay Control
24-25	-	-	Not Used

BODY CONTROL MODULE (BCM) X5



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15480179
- Service Connector: 88988837
- Description: 25-Way F HIT Series (BN)

Terminal Part Information

- Pins: 1, 2, 4, 5
- Terminated Lead: 13327199
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: SNAC-A061T-M2.8/20
- Core/Insulation Crimp: E/A

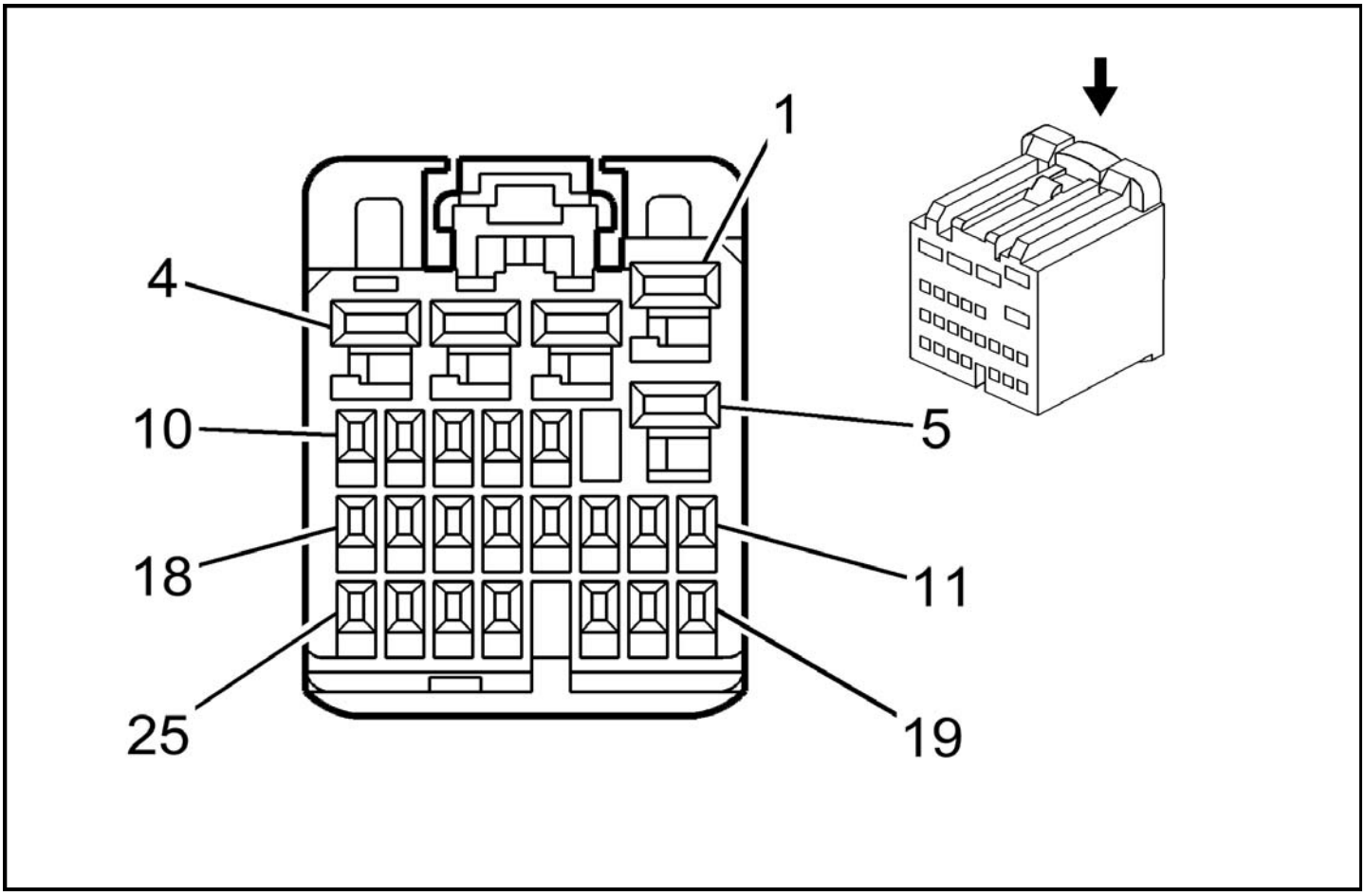
- Pins: 6, 8, 9, 11, 15, 18, 20, 21, 23, 24
- Terminated Lead: 13575870
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SNAC3-A021T-M0.64/20

- Core/Insulation Crimp: J/J

Body Control Module (BCM) X5

Pin	Wire	Circuit	Function
1	0.5 YE	18	Left Rear Stop/Turn Lamp Supply Voltage
2	0.5 D-GN	19	Right Rear Stop/Turn Lamp Supply Voltage
3	-	-	Not Used
4	0.5 L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage
5	0.5 L-BU	1320	CHMSL Supply Voltage
6	0.5 WH	17	Stop Lamp Switch Signal
7	-	-	Not Used
8	0.35 PK	5076	Current Sensor Supply Voltage
9	0.35 WH	5075	Current Sensor Signal
10	0.35 BN	5077	Low Reference
11	0.35 TN	707	RAP Relay Coil Supply Voltage
12-14	-	-	Not Used
15	0.35 PU	5531	Hood Closed Switch Signal (AP3, AP8)
16-17	-	-	Not Used
18	0.35 TN	28	Horn Relay Control
19	0.5 YE/BK	5810	Park Enable Signal (6J1)
20	0.35 GY	91	Wiper Relay Control
21	0.35 TN	860	Wiper High Speed Relay Control
22	-	-	Not Used
23	0.35 PK/WH	1970	Headlamp Low Beam Relay Control
24	0.35 WH	1080	Park Lamp Relay Control
25	-	-	Not Used

BODY CONTROL MODULE (BCM) X6



Connector Part Information

- Harness Type: Body
- OEM Connector: 15482793
- Service Connector: 88988842
- Description: 25-Way F HIT Series (PK)

Terminal Part Information

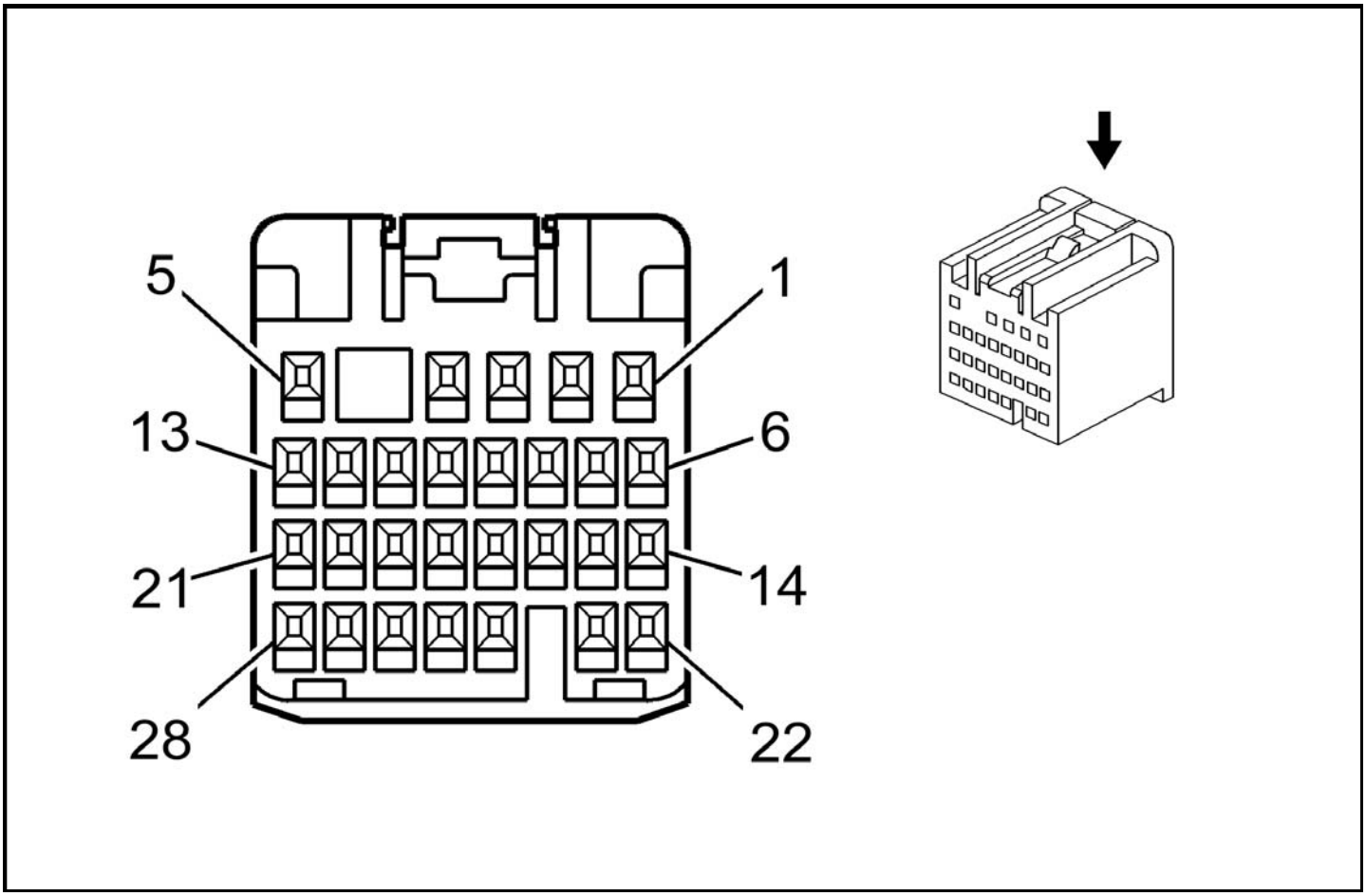
- Terminated Lead: 13575870
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SNAC3-A021T-M0.64/20
- Core/Insulation Crimp: J/J

Body Control Module (BCM) X6

Pin	Wire	Circuit	Function
1	0.8 GY/BK	690	Courtesy Lamp Supply Voltage
2	0.8 L-GN	24	Backup Lamp Supply Voltage
3	0.5 GY	8	Instrument Panel Lamp Supply Voltage
4-7	-	-	Not Used

Pin	Wire	Circuit	Function
8	0.35 TN/WH	746	Right Front Door Ajar Switch Signal
9	0.35 D-BU	245	Passenger Door Lock Switch Unlock Signal
10	0.35 GY/BK	745	Left Front Door Ajar Switch Signal
11	-	-	Not Used
12	0.5 OG/BK	744	Rear Compartment Lid Ajar Switch Signal
13	-	-	Not Used
14	0.35 L-GN/BK	748	Right Rear Door Ajar Switch Signal
15	0.35 L-BU/BK	747	Left Rear Door Ajar Switch Signal
16	0.35 OG	5922	Passenger Door Open Switch Signal
17	-	-	Not Used
18	0.35 L-BU	244	Passenger Door Lock Switch Lock Signal
19	-	-	Not Used
20	0.35 PU	1124	Door Lock Key Switch Unlock Signal (without 9C1, 9C3)
21	-	-	Not Used
22	0.5 OG/BK	233	Park Brake Switch Signal
23-25	-	-	Not Used

BODY CONTROL MODULE (BCM) X7



Connector Part Information

- Harness Type: Body
- OEM Connector: 15466053
- Service Connector: 88988806
- Description: 28-Way F HIT Series (GY)

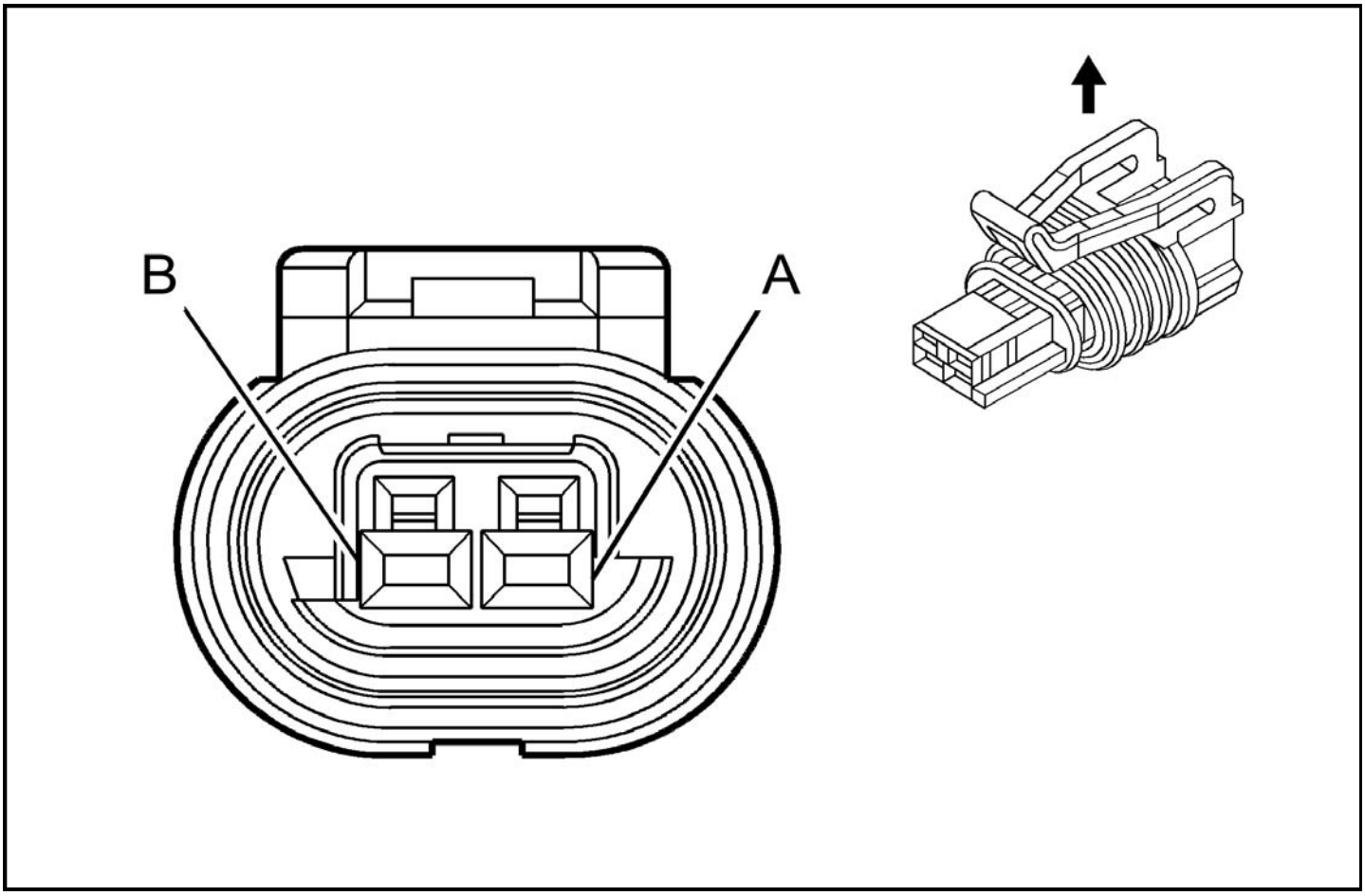
Terminal Part Information

- Terminated Lead: 13575870
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SNAC3-A021T-M0.64/20
- Core/Insulation Crimp: J/J

Body Control Module (BCM) X7

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	0.35 L-BU	1344	Trunk Release Relay Control
3-5	-	-	Not Used
6	0.35 YE	356	Driver Door Unlock Relay Control
7	0.35 L-GN	1391	Door Lock Relay Control
8	-	-	Not Used
9	0.35 L-BU	5921	Door Unlock Relay Control
10	-	-	Not Used
11	0.35 OG/BK	781	Driver Door Lock Switch Unlock Signal
12	0.35 PK/BK	780	Driver Door Lock Switch Lock Signal
13-22	-	-	Not Used
23	0.35 TN	126	Left Front Door Open Switch Signal
24-28	-	-	Not Used

BRAKE FLUID LEVEL SWITCH



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15449028
- Service Connector: 88987993
- Description: 2-Way F GT 150 Series, Sealed (BK)

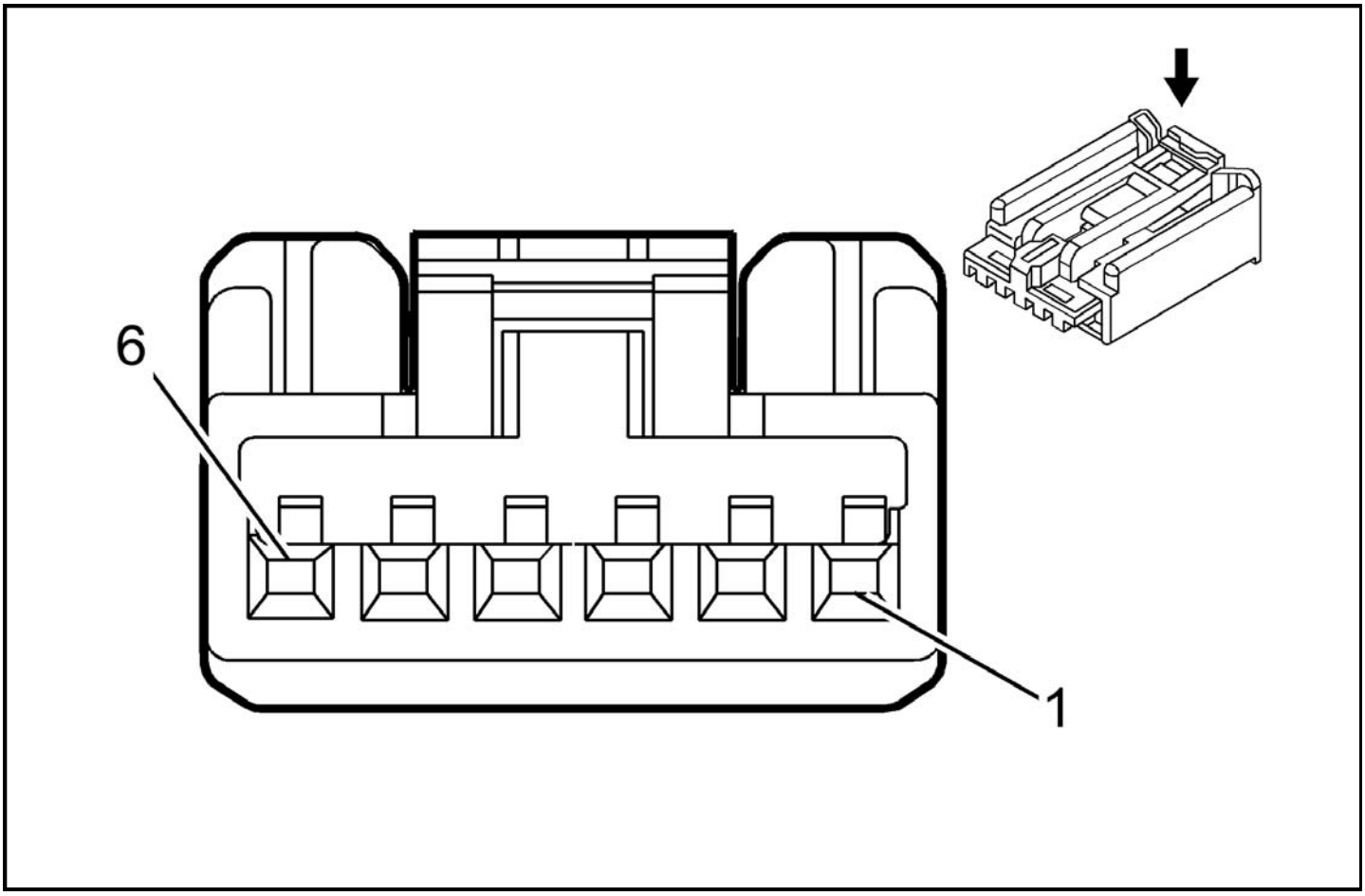
Terminal Part Information

- Terminated Lead: 13576360
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 15326267/19
- Core/Insulation Crimp: E/4

Brake Fluid Level Switch

Pin	Wire	Circuit	Function
A	0.5 BK/WH	1551	Ground
B	0.35 TN/WH	33	Brake Warning Indicator Control

BRAKE PEDAL POSITION (BPP) SENSOR



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 13595476
- Service Connector: 19167753
- Description: 6-Way F AIT II Series (BK)

Terminal Part Information

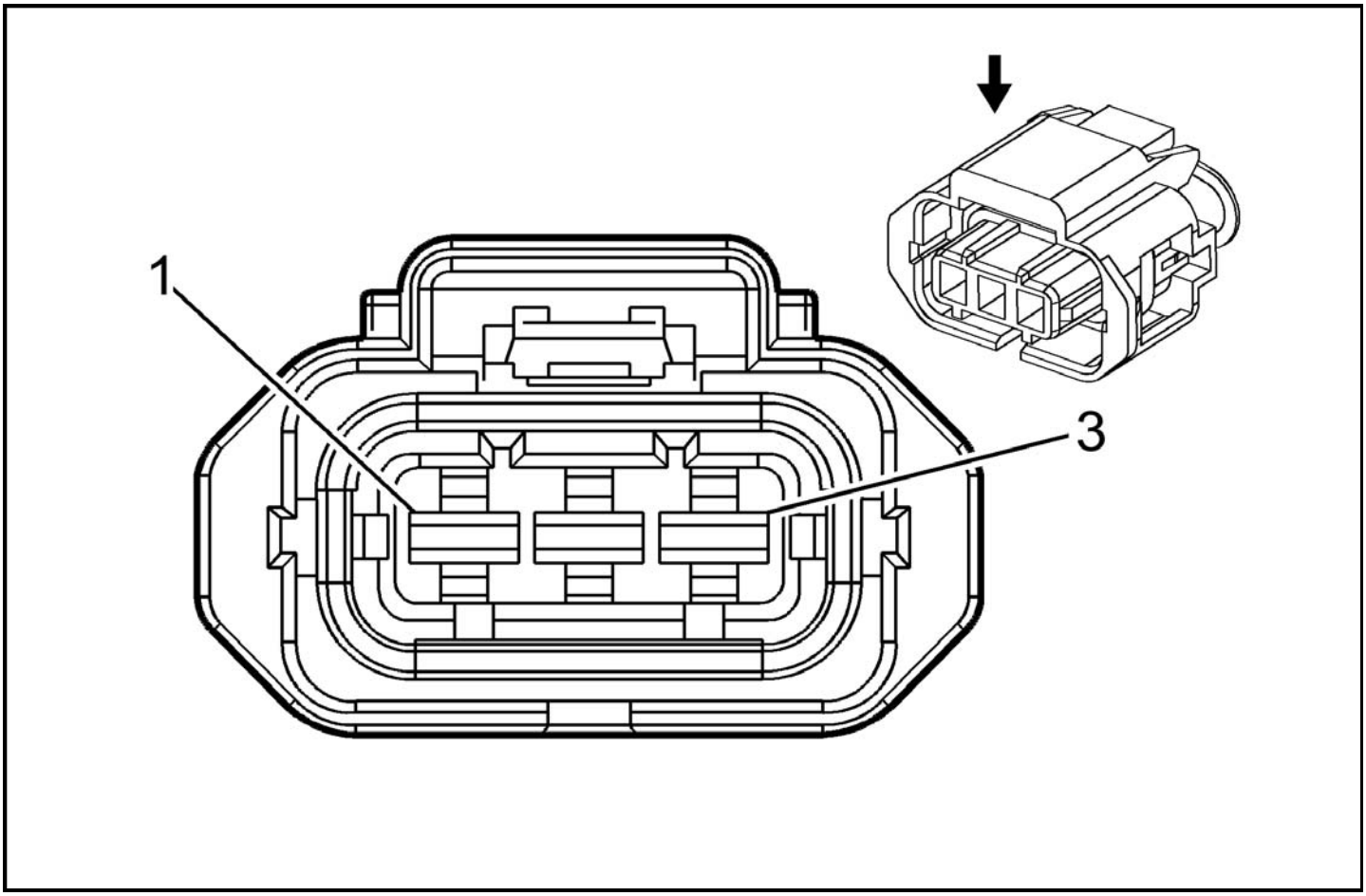
- Terminated Lead: Pins 1-3 - 13327119
- Terminated Lead: Pins 4-6 -13575867
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SAIT-A03T-M064/14
- Core/Insulation Crimp: P/P

Brake Pedal Position (BPP) Sensor

Pin	Wire	Circuit	Function
1	0.35 TN	552	Low Reference
2	0.35 GY	598	5-Volt Reference
3	0.35 L-GN	526	Stop Lamp Switch Signal

Pin	Wire	Circuit	Function
4	0.5 BN	5361	Brake Apply Sensor Signal
5	0.5 BN	5360	Low Reference
6	0.5 WH	5359	Brake Apply Sensor Supply Voltage

CAMSHAFT POSITION (CMP) SENSOR - BANK 1 EXHAUST



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15345983
- Service Connector: 13580231
- Description:3-Way F 2.8 Junior Power Timer Series, Sealed (GY)

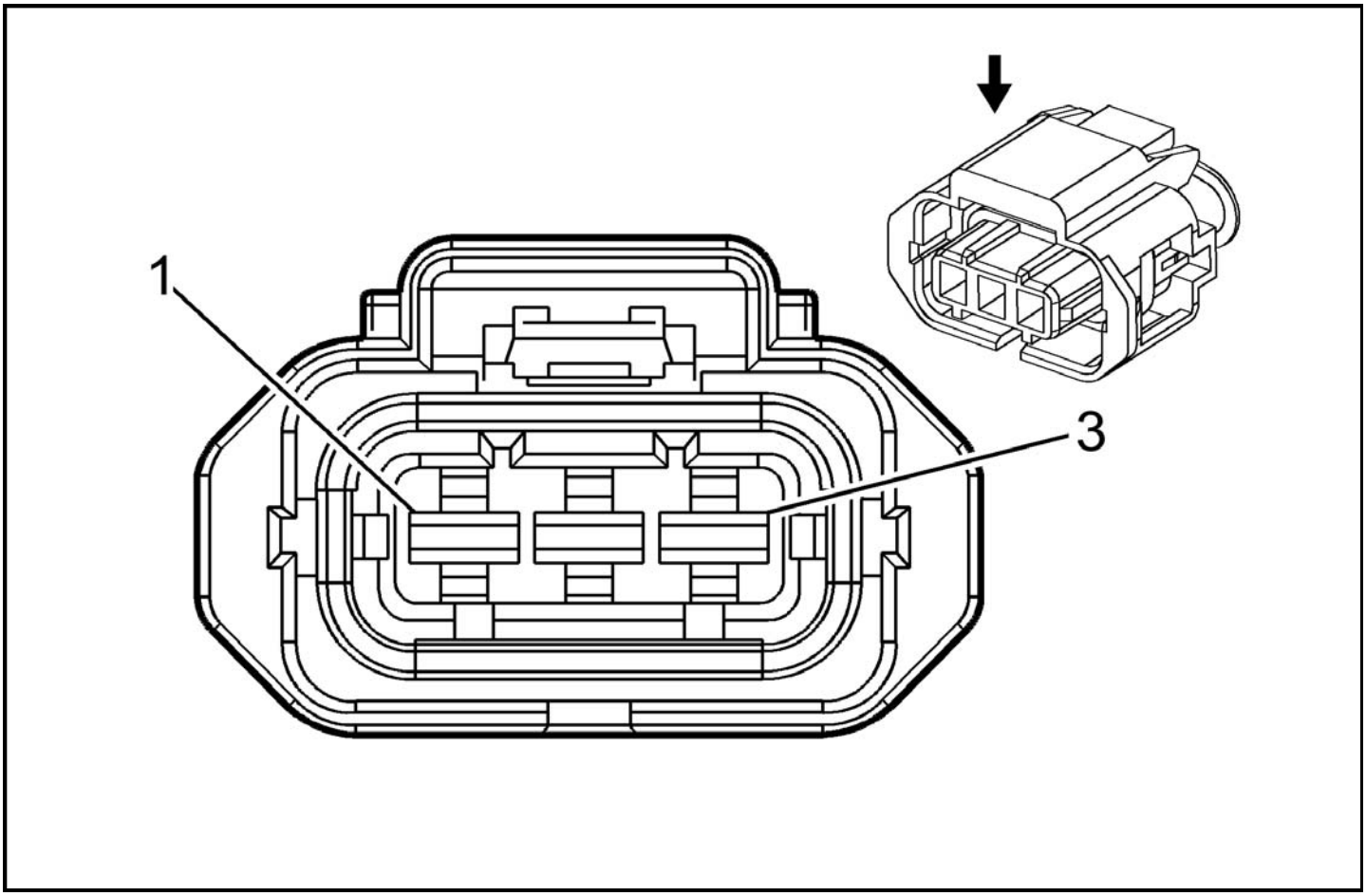
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-561
- Diagnostic Test Probe: J-35616-35 (VT)
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available

Camshaft Position (CMP) Sensor - Bank 1 Exhaust

Pin	Wire	Circuit	Function
1	0.5 GY	5296	Low Reference
2	0.5 D-GN	5273	Camshaft Position Sensor- Exhaust Bank 1 Signal
3	0.5 YE/BK	5297	5-Volt 1 Reference

CAMSHAFT POSITION (CMP) SENSOR - BANK 1 INTAKE



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15345983
- Service Connector: 13580231
- Description: 3-Way F 2.8 Junior Power Timer Series, Sealed (GY)

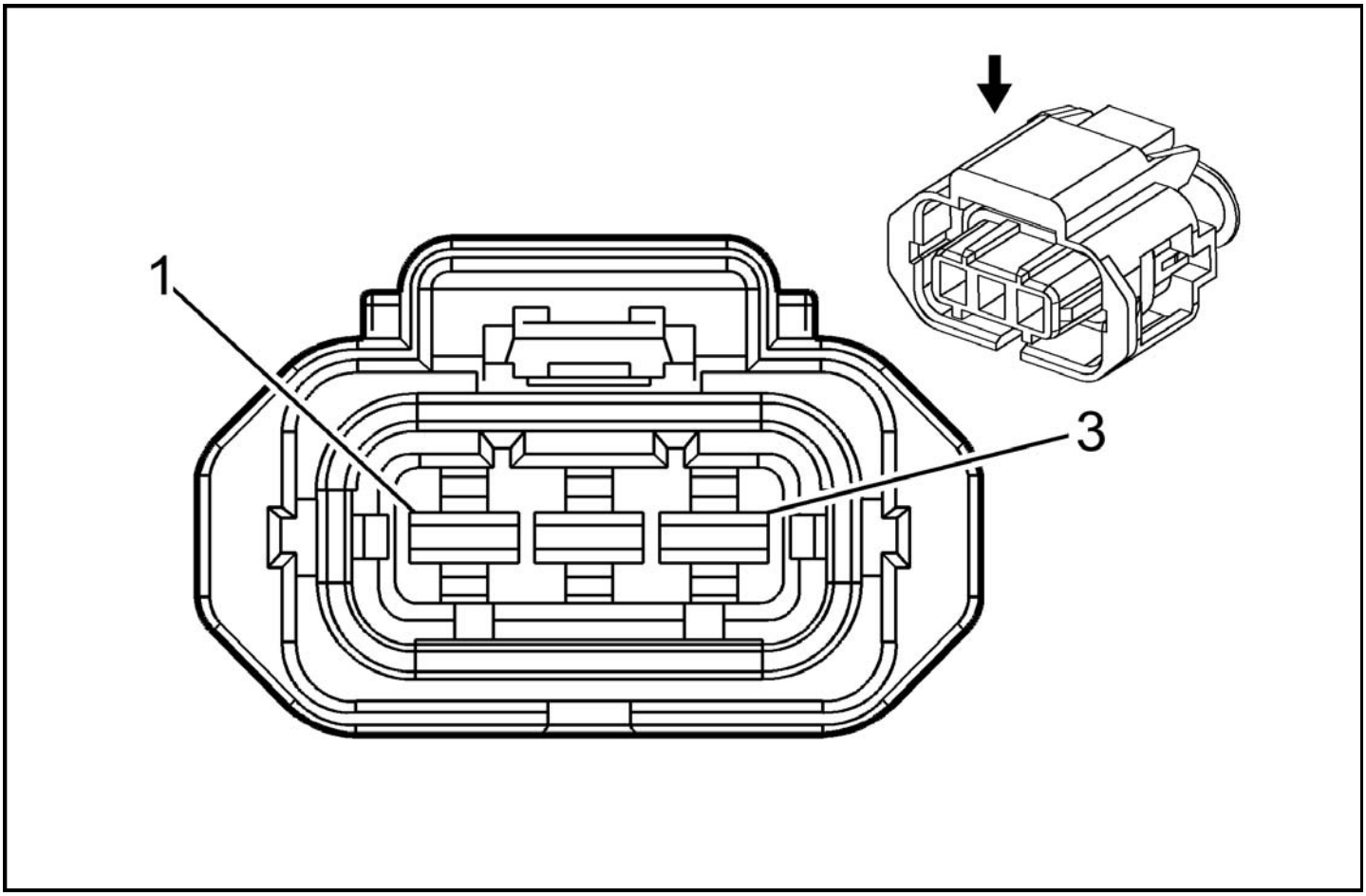
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-561
- Diagnostic Test Probe: J-35616-35 (VT)
- Release Tool: Not Available

Camshaft Position (CMP) Sensor - Bank 1 Exhaust

Pin	Wire	Circuit	Function
1	0.5 GY	5296	Low Reference
2	0.5 D-GN	5273	Camshaft Position Sensor- Exhaust Bank 1 Signal
3	0.5 YE/BK	5297	5-Volt 1 Reference

CAMSHAFT POSITION (CMP) SENSOR - BANK 1 INTAKE



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15345983
- Service Connector: 13580231
- Description: 3-Way F 2.8 Junior Power Timer Series, Sealed (GY)

Terminal Part Information

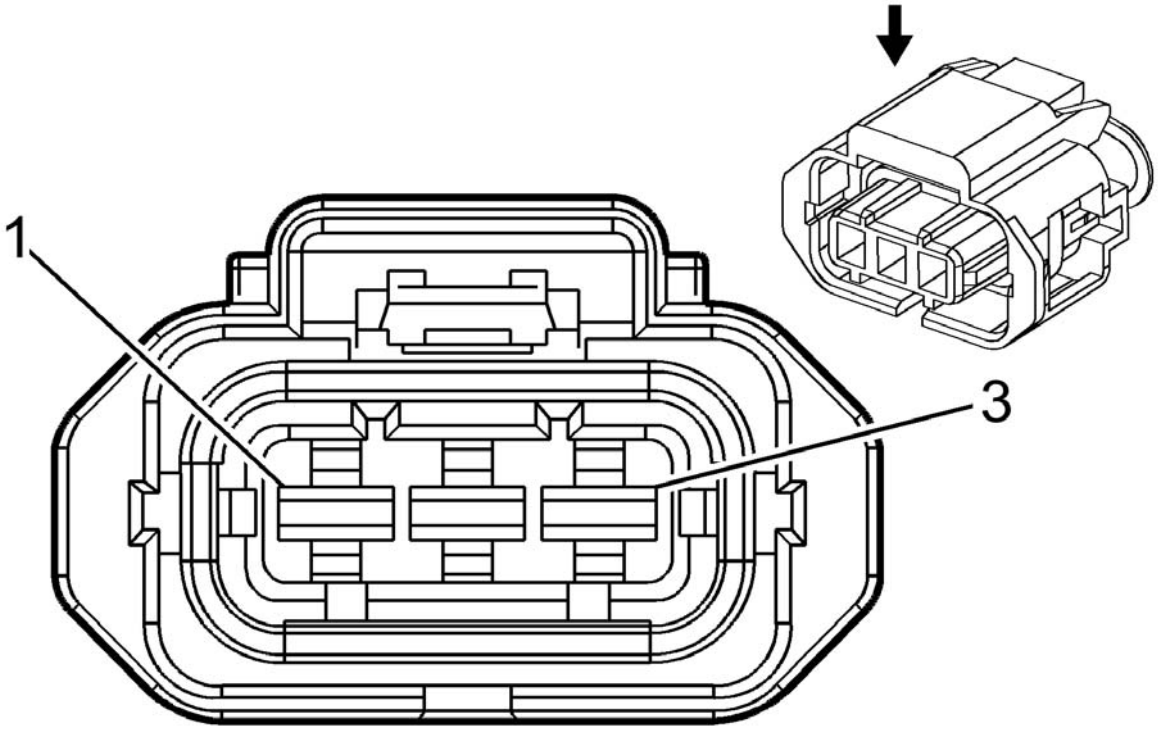
- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-561
- Diagnostic Test Probe: J-35616-35 (VT)
- Release Tool: Not Available

- Diagnostic Test Probe: Not Available

Camshaft Position (CMP) Sensor - Bank 1 Intake

Pin	Wire	Circuit	Function
1	0.5 TN	5301	Low Reference
2	0.5 OG	5275	Camshaft Position (CMP) Sensor- Intake Bank 1 Signal
3	0.5 D-BU	5300	5-Volt 1 Reference

CAMSHAFT POSITION (CMP) SENSOR - BANK 2 EXHAUST



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15345983
- Service Connector: 13580231
- Description: 3-Way F 2.8 Junior Power Timer Series, Sealed (GY)

Terminal Part Information

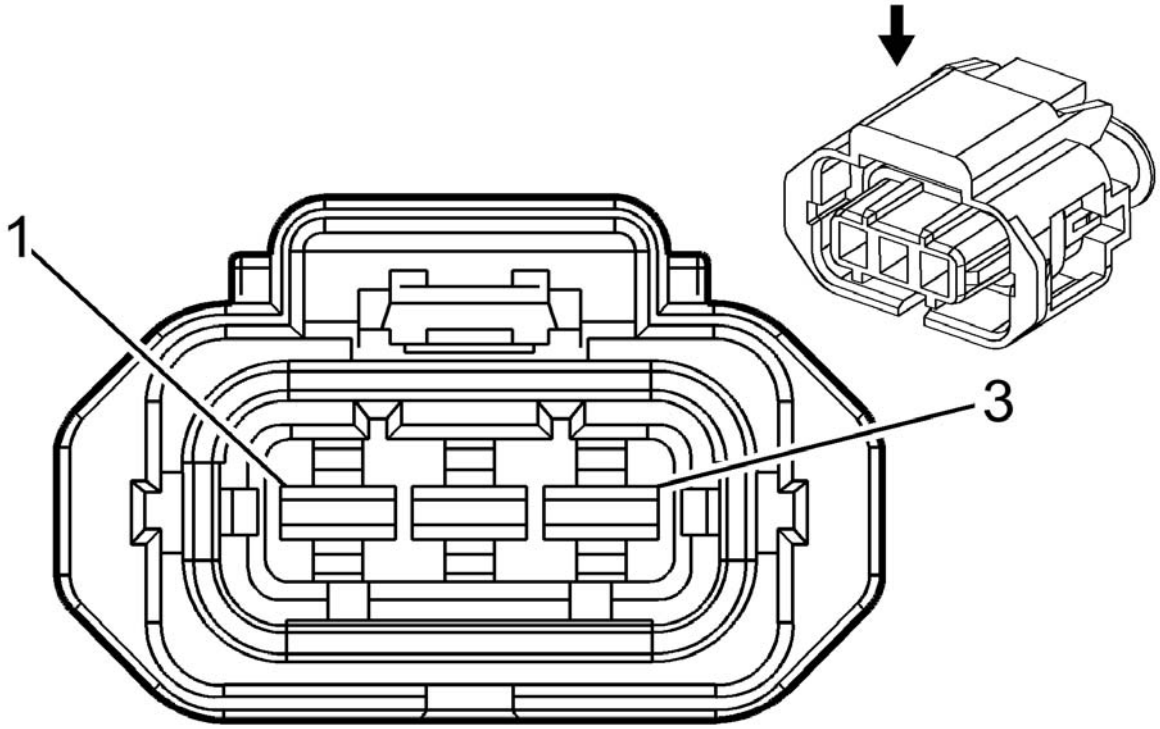
- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-561

- Diagnostic Test Probe: J-35616-35 (VT)
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available

Camshaft Position (CMP) Sensor - Bank 2 Exhaust

Pin	Wire	Circuit	Function
1	0.5 BN	5299	Low Reference
2	0.5 PU	5274	Camshaft Position (CMP) Sensor- Exhaust Bank 2 Signal
3	0.5 L-GN	5298	5-Volt 1 Reference

CAMSHAFT POSITION (CMP) SENSOR - BANK 2 INTAKE



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15345983
- Service Connector: 13580231
- Description: 3-Way F 2.8 Junior Power Timer Series, Sealed (GY)

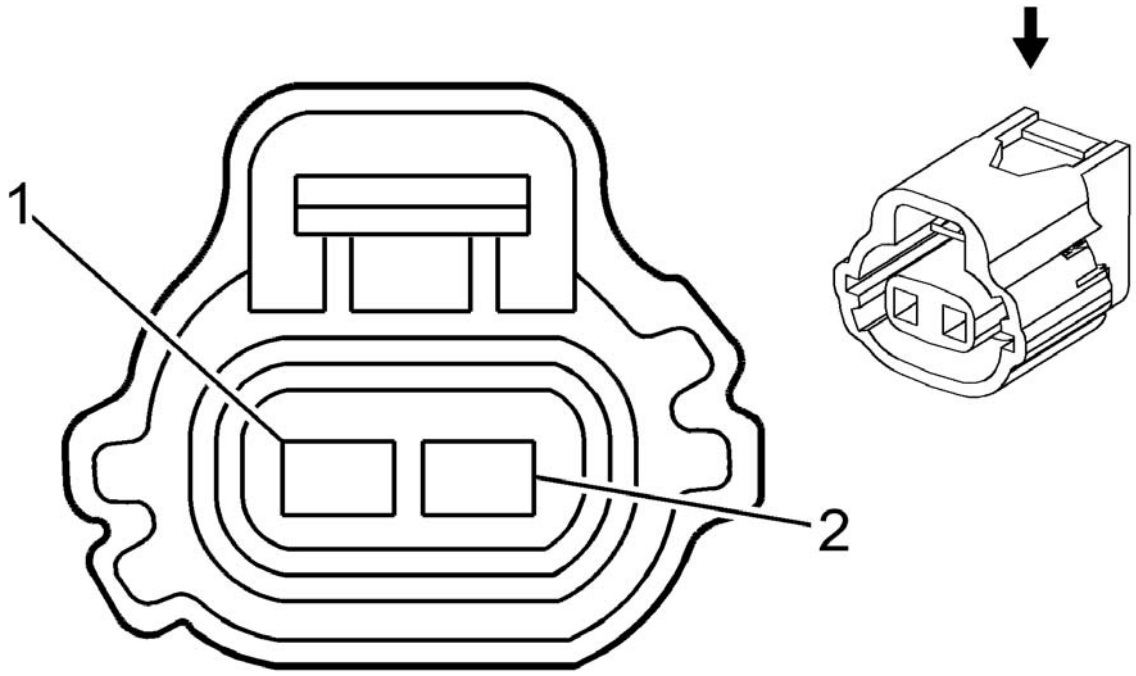
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-561
- Diagnostic Test Probe: J-35616-35 (VT)
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available

Camshaft Position (CMP) Sensor - Bank 2 Intake

Pin	Wire	Circuit	Function
1	0.5 BN/WH	5303	Low Reference
2	0.5 YE	5276	Camshaft Position (CMP) Sensor- Intake Bank 2 Signal
3	0.5 L-BU	5302	5-Volt 1 Reference

CAMSHAFT POSITION (CMP) ACTUATOR SOLENOID VALVE - BANK 1 EXHAUST



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15411401

- Service Connector: 89047244
- Description:2-Way F 090 Series, Sealed (GY)

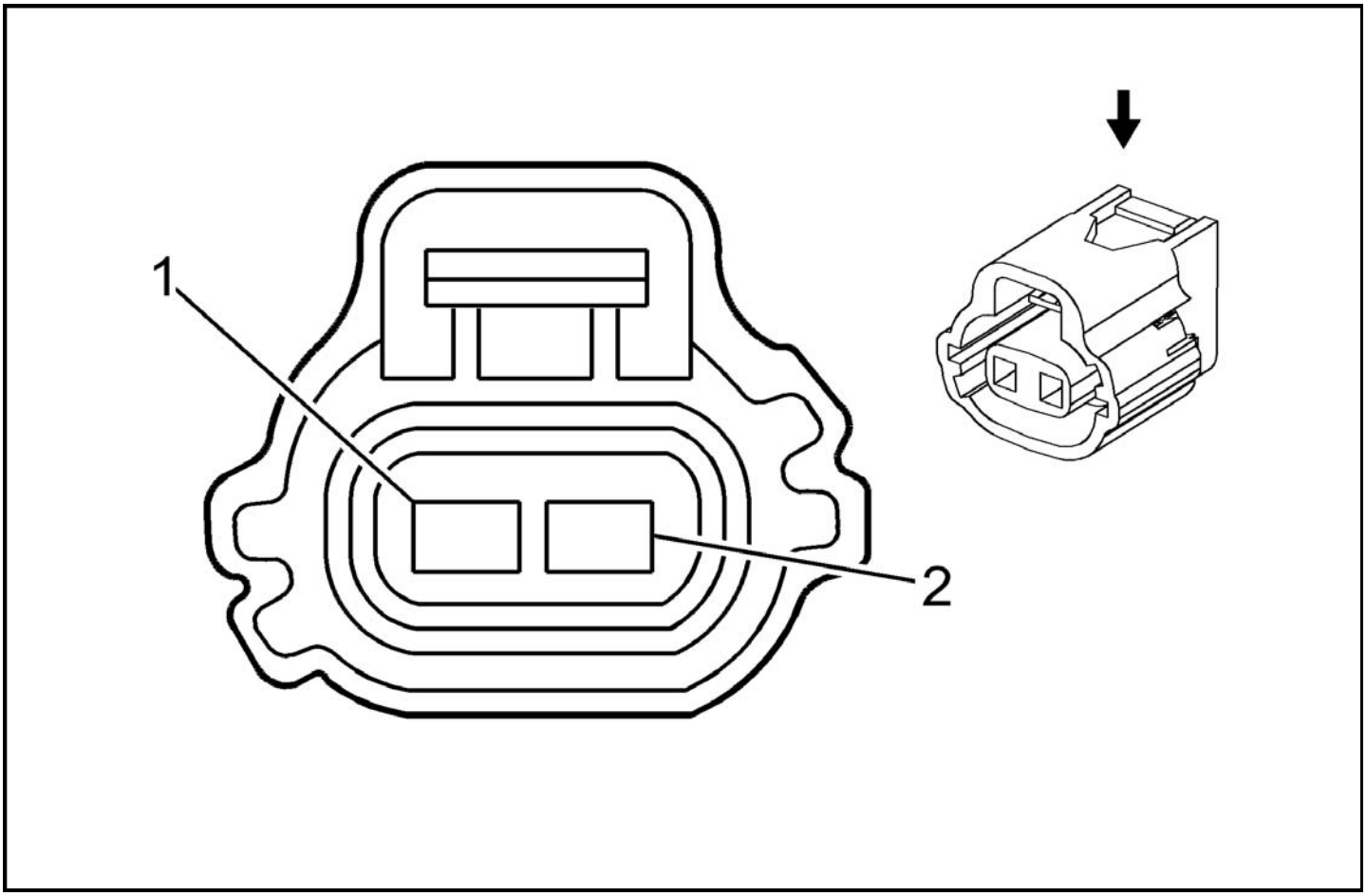
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-552
- Diagnostic Test Probe: J-35616-18 (BK)
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Exhaust

Pin	Wire	Circuit	Function
1	0.5 L-GN	5282	Camshaft Phaser Exhaust Solenoid (1)
2	0.5 BN/WH	6754	Low Reference

CAMSHAFT POSITION (CMP) ACTUATOR SOLENOID VALVE - BANK 1 INTAKE



Connector Part Information

- Harness Type: Engine

- OEM Connector: 15411401
- Service Connector: 89047244
- Description: 2-Way F 090 Series, Sealed (GY)

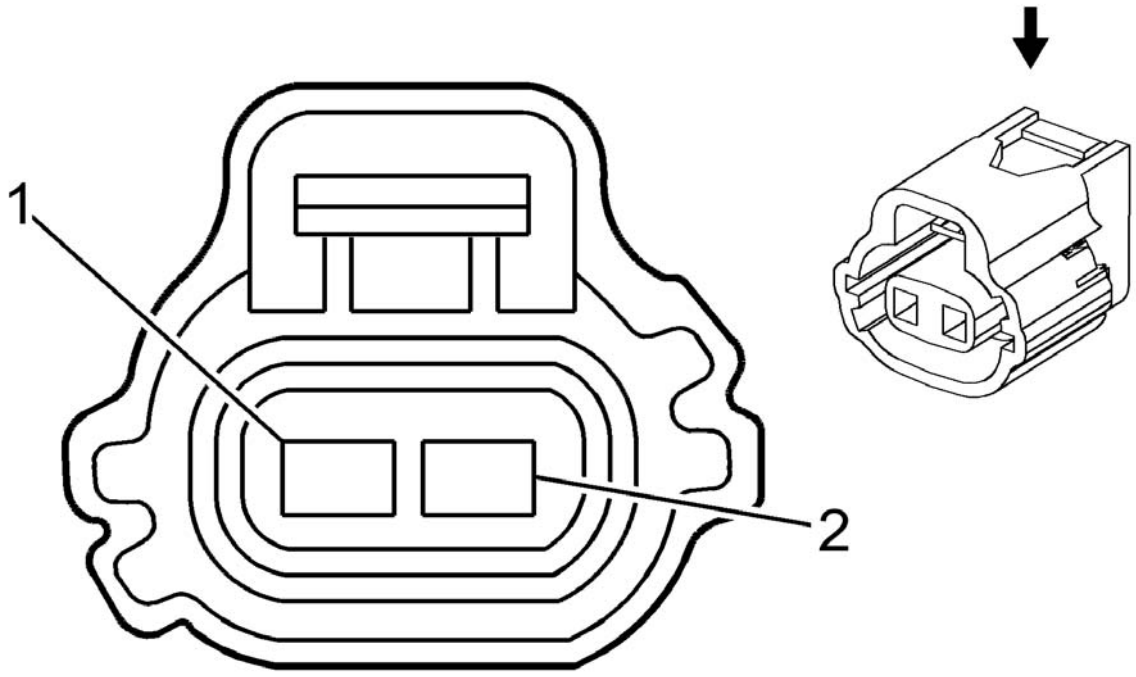
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-552
- Diagnostic Test Probe: J-35616-18 (BK)
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Intake

Pin	Wire	Circuit	Function
1	0.5 PU	5284	Camshaft Phaser Intake Solenoid (1)
2	0.5 BN	6753	Low Reference

CAMSHAFT POSITION (CMP) ACTUATOR SOLENOID VALVE - BANK 2 EXHAUST



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15411401
- Service Connector: 89047244
- Description: 2-Way F 090 Series, Sealed: (GY)

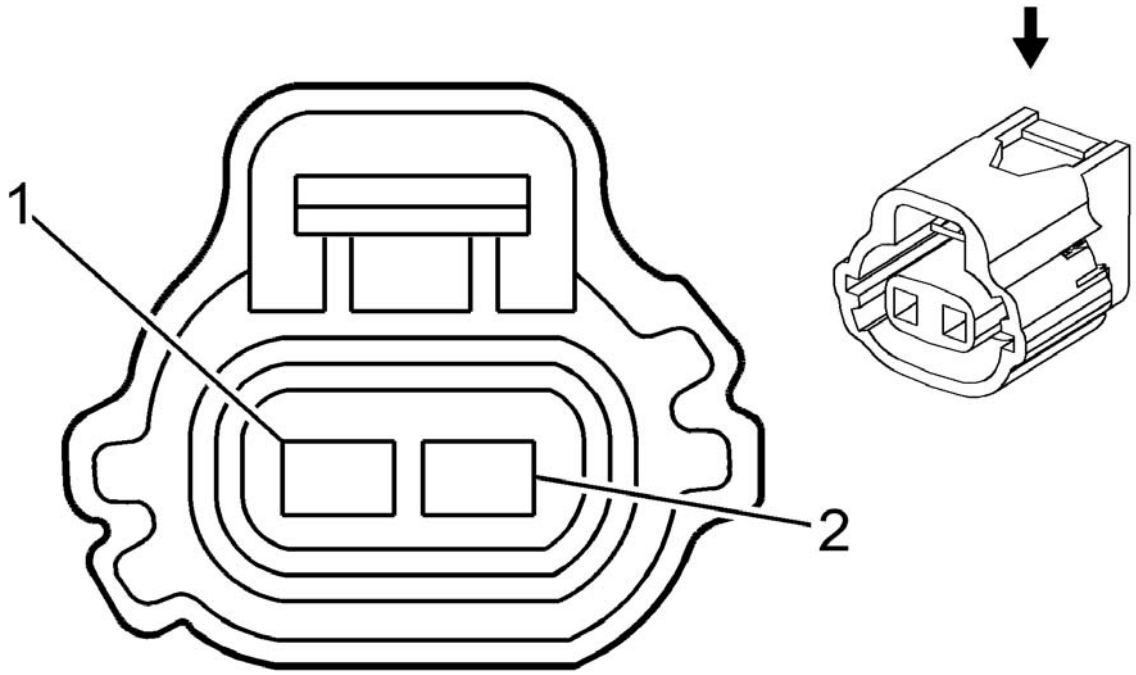
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-552
- Diagnostic Test Probe: J-35616-18 (BK)
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Exhaust

Pin	Wire	Circuit	Function
1	0.5 WH/BK	5283	Cam Phaser Control
2	0.5 D-BU/WH	6756	Low Reference

CAMSHAFT POSITION (CMP) ACTUATOR SOLENOID VALVE - BANK 2 INTAKE



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15411401
- Service Connector: 89047244
- Description: 2-Way F 090 Series, Sealed (GY)

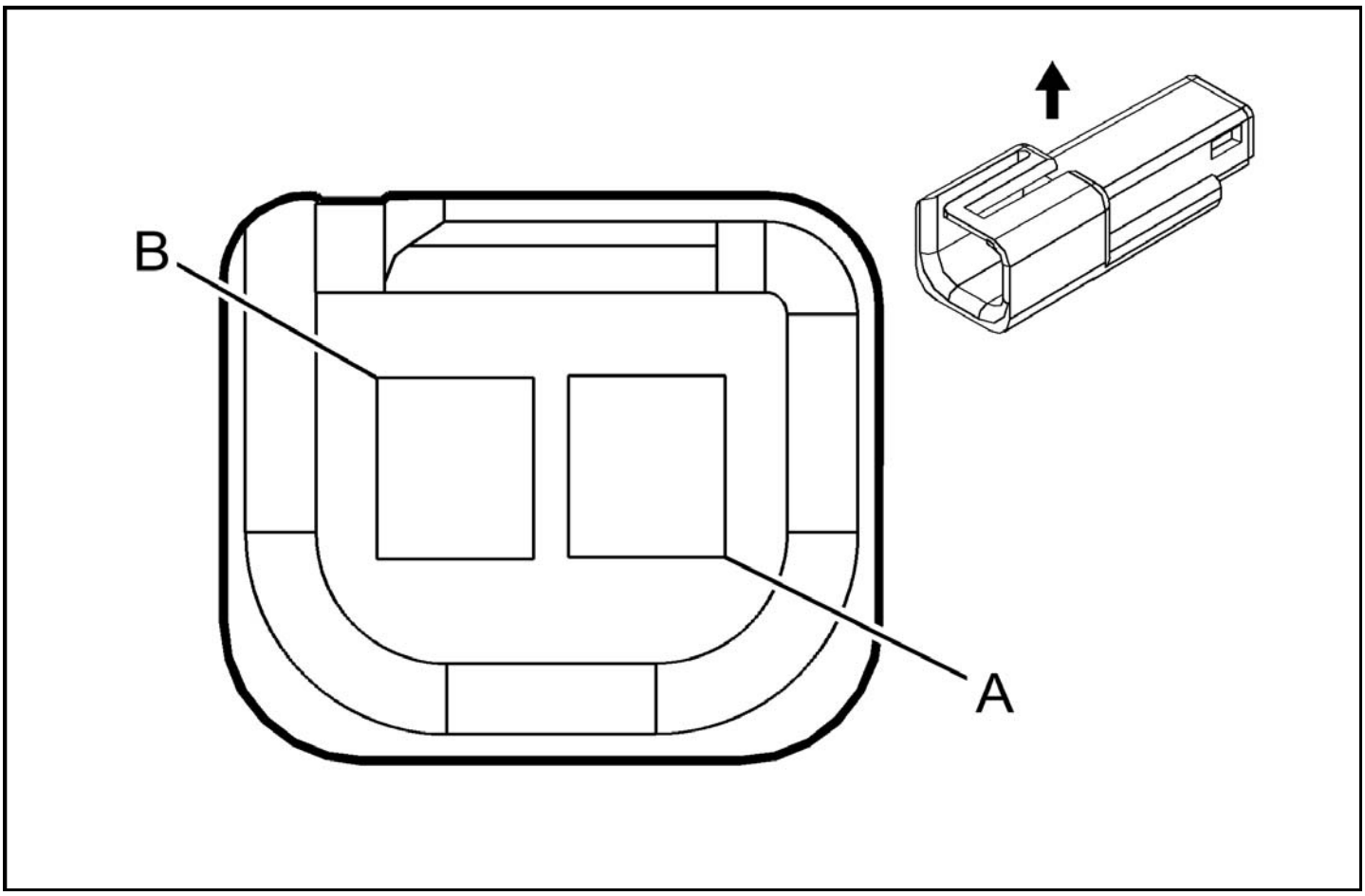
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-552
- Diagnostic Test Probe: J-35616-18 (BK)
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Intake

Pin	Wire	Circuit	Function
1	0.5 TN/BK	6397	Cam Phaser Control
2	0.5 D-BU	6755	Low Reference

CELLULAR TELEPHONE MICROPHONE (UE1)



Connector Part Information

- Harness Type: Headliner
- OEM Connector: 12047663
- Service Connector: 13584278
- Description: 2-Way M Metri-Pack 150 Series (BK)

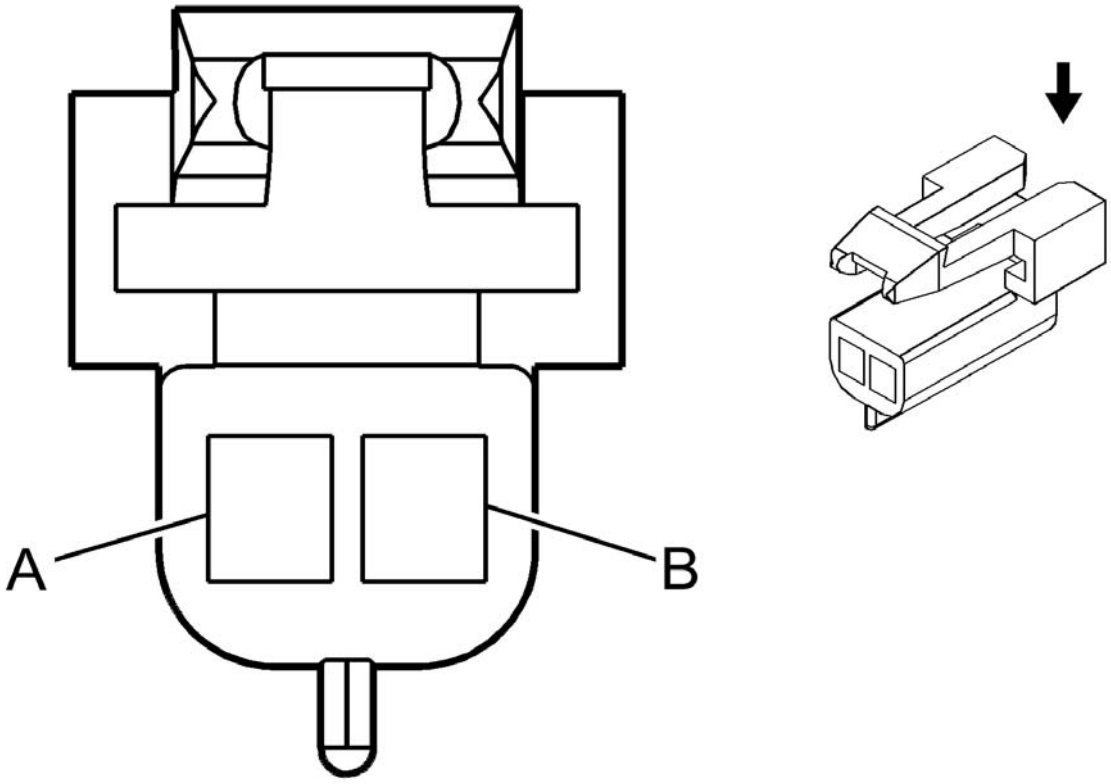
Terminal Part Information

- Terminated Lead: 13575462
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/C
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-3 (GY)

Cellular Telephone Microphone (UE1)

Pin	Wire	Circuit	Function
A	0.35 BARE	1489	Drain Wire
B	0.35 GY	655	Cellular Microphone Signal

CENTER HIGH MOUNTED STOP LAMP (CHMSL)



Connector Part Information

- Harness Type: Body
- OEM Connector: 12052832
- Service Connector: 13583033
- Description: 2-Way F Metri-Pack 150 Series (BK)

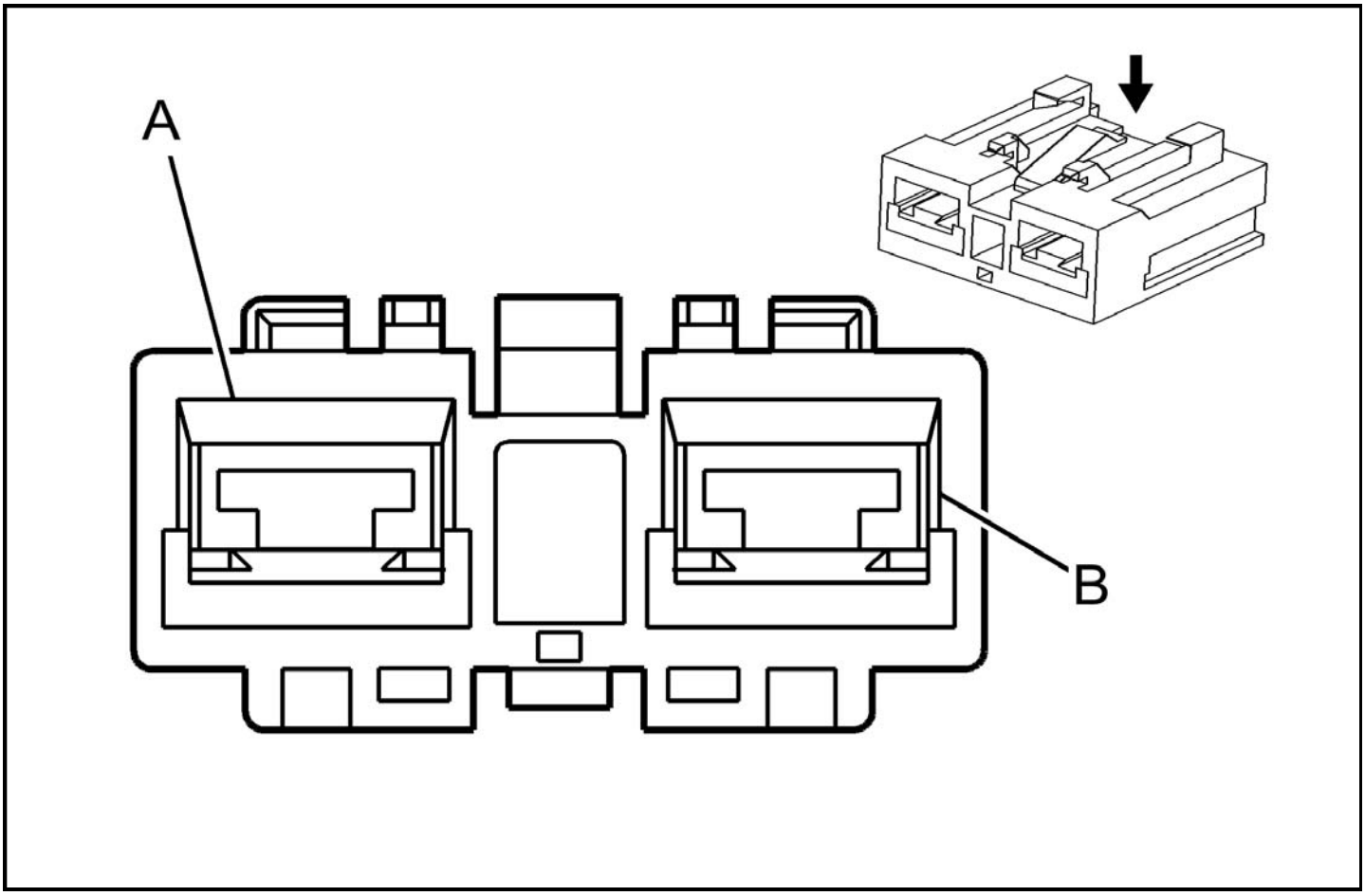
Terminal Part Information

- Terminated Lead: Service by Harness - See Part Catalog
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/2
- Core/Insulation Crimp: E/C

Center High Mounted Stop Lamp (CHMSL)

Pin	Wire	Circuit	Function
A	0.5 BK	750	Ground
B	0.5 L-BU	1320	CHMSL Supply Voltage

CIRCUIT BREAKER 1 (SEO 9C1/9C3)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12110057
- Service Connector: 12110057
- Description: 2-Way F MAXI (BK)

Terminal Part Information

- Pins: A
- Terminal/Tray: 12092445/18
- Core/Insulation Crimp: G/G
- Release Tool/Test Probe: 12150860/J-35616-44 (YE)

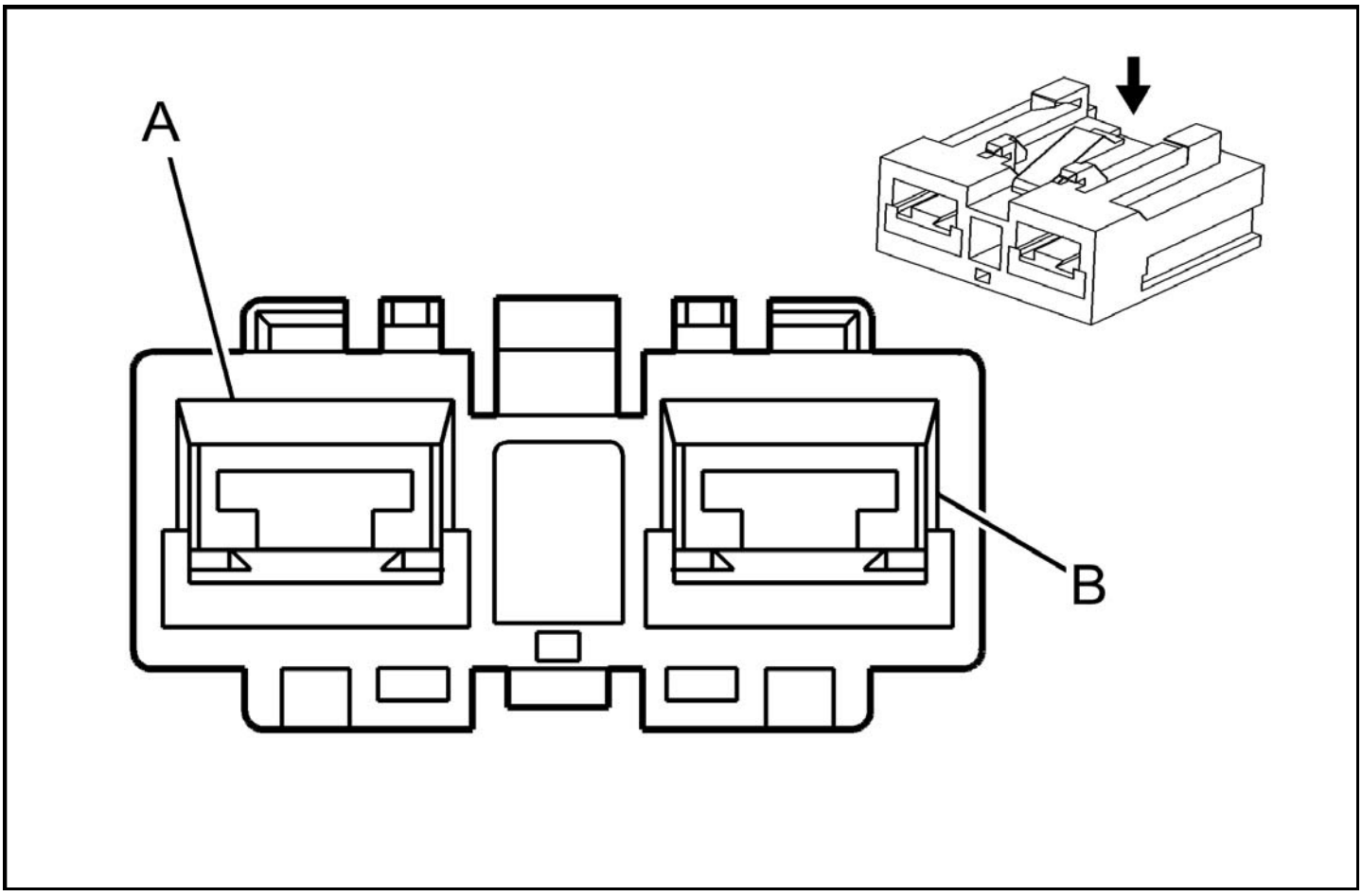
- Pins: B
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G
- Release Tool/Test Probe: 12150860/J-35616-44 (YE)

Circuit Breaker 1 (SEO 9C1/9C3)

Pin	Wire	Circuit	Function

Pin	Wire	Circuit	Function
A	8 RD/BK	502	Battery Positive Voltage
B	3 RD/WH	3040	Battery Positive Voltage

CIRCUIT BREAKER 2 (SEO 9C1/9C3)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12110057
- Service Connector: 12110057
- Description: 2-Way F MAXI (BK)

Terminal Part Information

- Pins: A
- Terminal/Tray: 12092445/18
- Core/Insulation Crimp: G/G
- Release Tool/Test Probe: 12150860/J-35616-44 (YE)

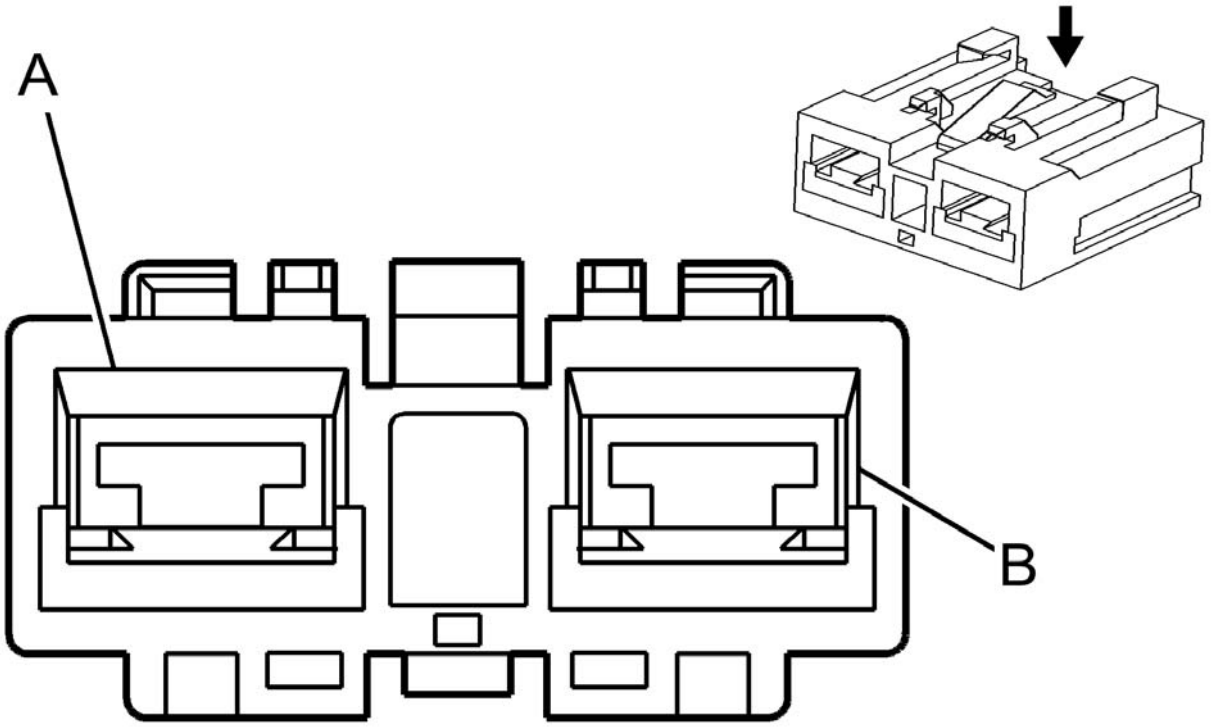
- Pins: B
- Terminal/Tray: 12110127/19

- Core/Insulation Crimp: F/G
- Release Tool/Test Probe: 12150860/J-35616-44 (YE)

Circuit Breaker 2 (SEO 9C1/9C3)

Pin	Wire	Circuit	Function
A	8 RD/BK	502	Battery Positive Voltage
B	3 RD/WH	3140	Battery Positive Voltage

CIRCUIT BREAKER 3 (SEO 9C1/9C3)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12110057
- Service Connector: 12110057
- Description: 2-Way F MAXI (BK)

Terminal Part Information

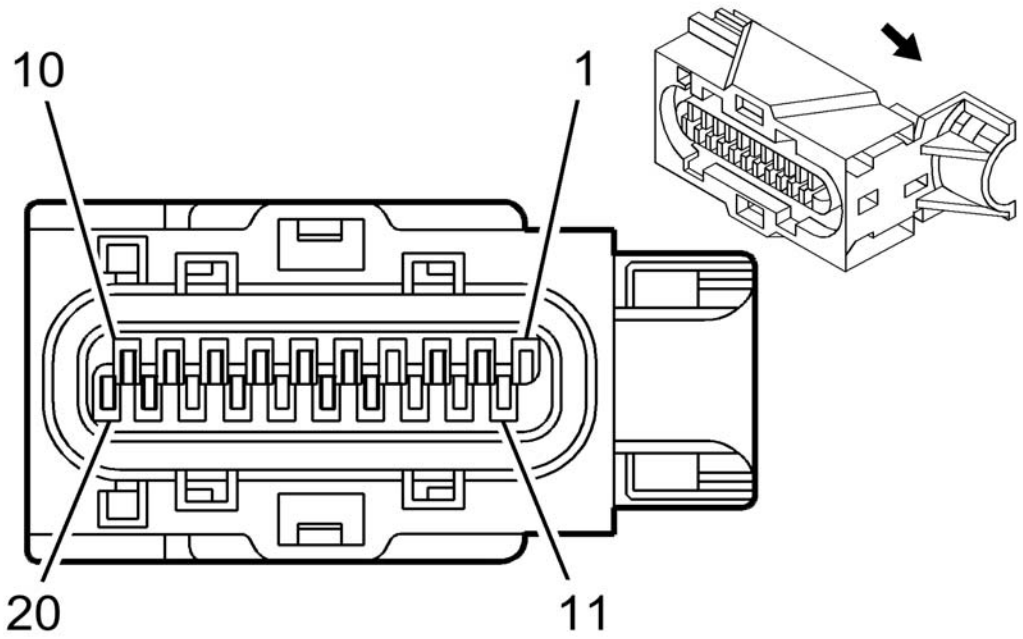
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Release Tool/Test Probe: 12150860/J-35616-44 (YE)

Circuit Breaker 3 (SEO 9C1/9C3)

Pin	Wire	Circuit	Function
A	5 RD/BK	402	Battery Positive Voltage
B	5 RD/WH	3740	Battery Positive Voltage

CONTROL SOLENOID VALVE ASSEMBLY X1



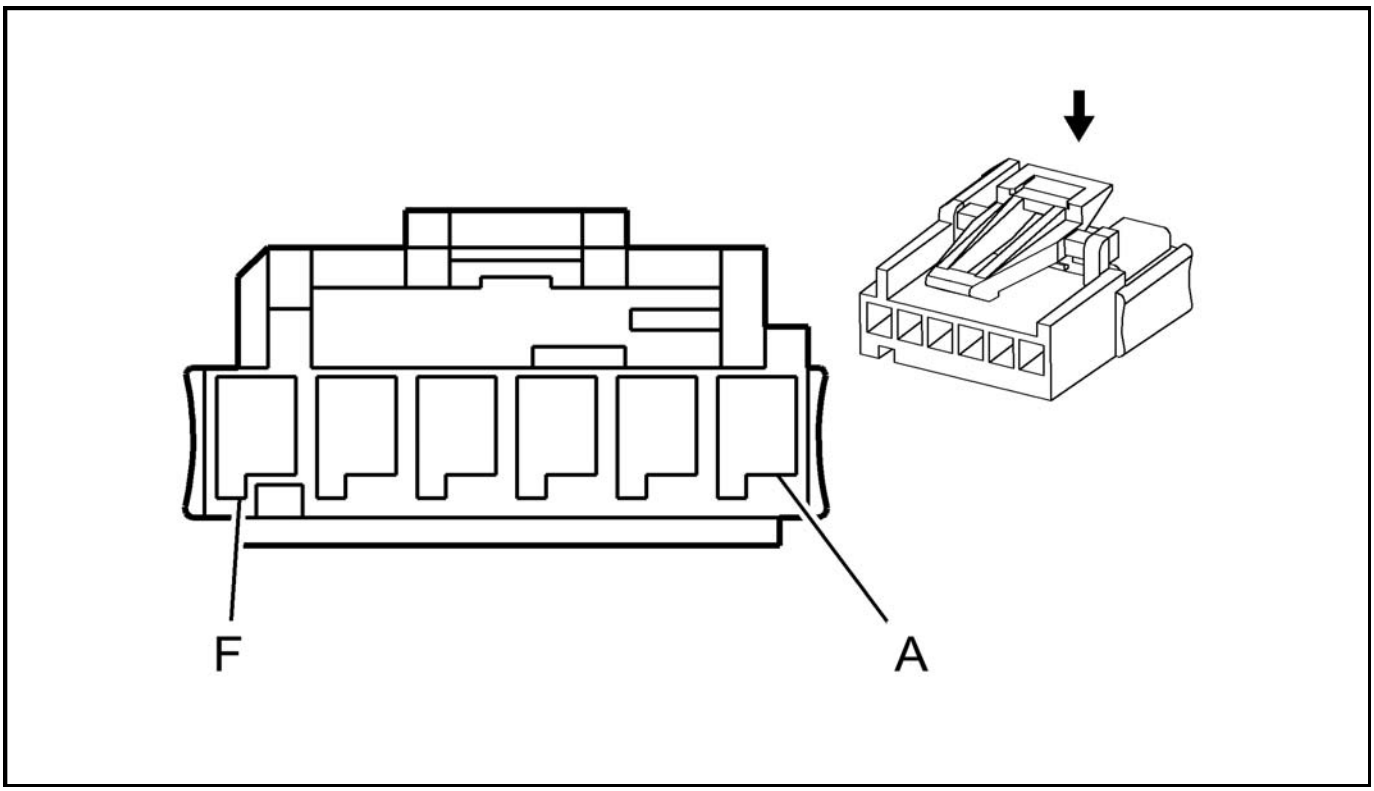
Connector Part Information	Terminal Part Information
• Harness Type: Engine • OEM Connector: 15476346 • Service Connector: 19151494 • Description: 20-Way F GT 150 Sealed (L-GY)	• Terminated Lead: Pins 1, 10, 18 - 13575400 • Terminated Lead: Pins 2, 5, 12-15 - 13575433 • Release Tool: J-38125-553 • Diagnostic Test Probe: J-35616-2A (GY) • Terminal/Tray: 15326267/19 • Core/Insulation Crimp: Pins 2, 5, 12-15 - E/4 • Core/Insulation Crimp: Pins 1, 10, 18 - E/1

Control Solenoid Valve Assembly X1

Pin	Size	Color	Circuit	Function	Option
1	0.75	BK/WH	451	Ground	-
2	0.5	TN/BK	2500	High Speed GMLAN Serial Data (+) (1)	-
3-4	-	-	-	Not Used	-

Pin	Size	Color	Circuit	Function	Option
5	0.5	TN/BK	2500	High Speed GMLAN Serial Data (+) (1)	-
6-9	-	-	-	Not Used	-
10	0.75	RD/WH	540	Battery Positive Voltage	-
11	-	-	-	Not Used	-
12	0.5	TN	2501	High Speed GMLAN Serial Data (-) (1)	-
13	0.5	PK	1339	Run/Crank Ignition 1 Voltage	-
14	0.5	TN	2501	High Speed GMLAN Serial Data (-) (1)	-
15	0.5	D-BU	5985	Accessory Wakeup Serial Data 2	-
16	0.5	WH	17	Stop Lamp Switch Signal	-
17	-	-	-	Not Used	-
18	0.75	BK/WH	451	Ground	-
19	-	-	-	Not Used	-
20	0.35	OG/BK	1786	Transmission Park/Neutral Signal (1)	-

CONTROL SOLENOID VALVE ASSEMBLY X2

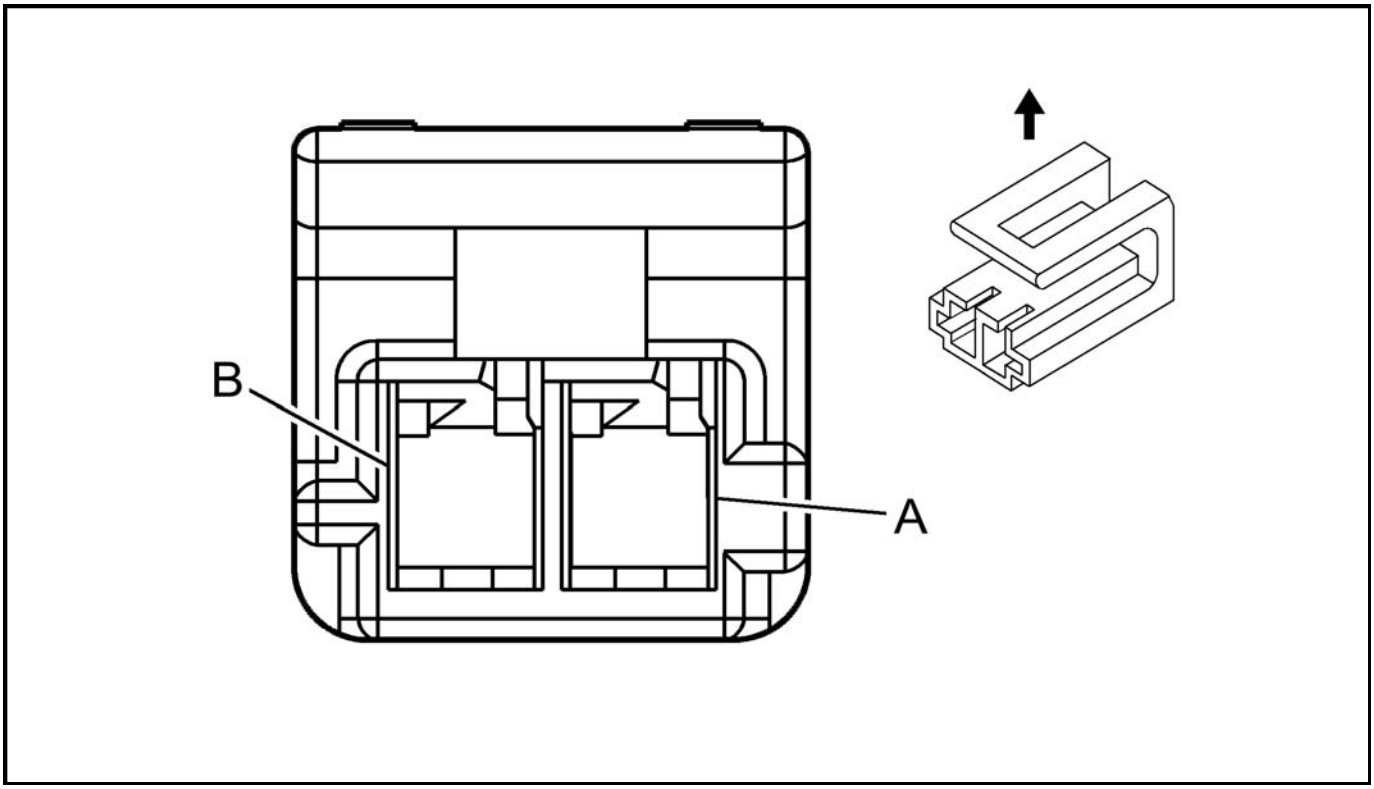


Connector Part Information	Terminal Part Information
• Harness Type: Transmission • OEM Connector: 15336500 • Service Connector: 89046635 • Description: 6-Way F Metri-Pack 150.2 Series (GN)	• Terminated Lead: Service by Harness - See Part Catalog • Release Tool: J-38125-559 • Diagnostic Test Probe: J-35616-14 (GN) • Terminal/Tray: 12124075/5 • Core/Insulation Crimp: E/C

Control Solenoid Valve Assembly X2

Pin	Size	Color	Circuit	Function	Option
A	0.5	GY	-	Low Reference	-
B	0.5	BK	-	Transmission IMS Mode Switch P bit Signal	-
C	0.5	YE	-	Transmission IMS Mode Switch C bit Signal	-
D	0.5	RD	-	Transmission IMS Mode Switch B bit Signal	-
E	0.5	GN	-	Transmission IMS Mode Switch A bit Signal	-
F	0.5	WH	-	Park/Neutral Switch Signal	-

CONTROL SOLENOID VALVE ASSEMBLY X3

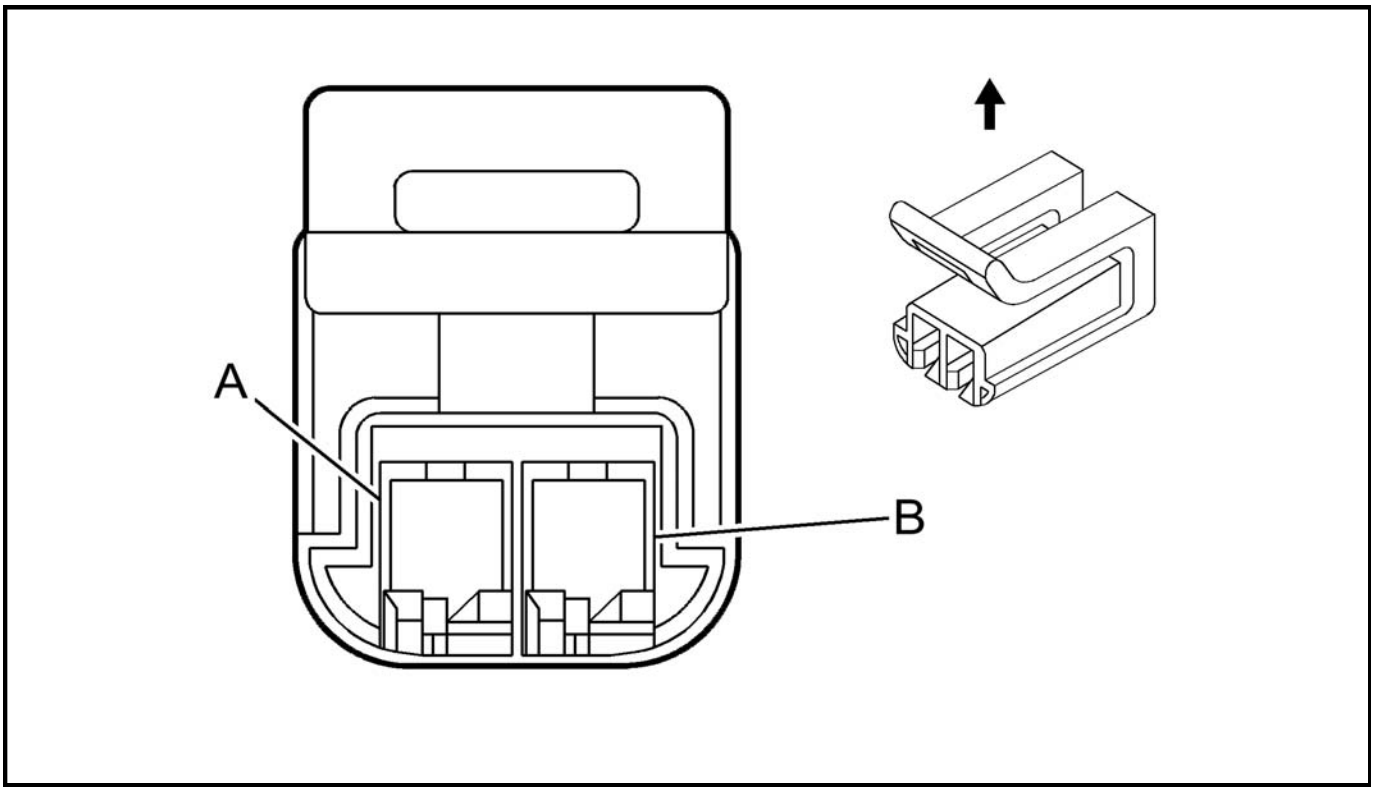


Connector Part Information	Terminal Part Information
• Harness Type: Transmission • OEM Connector: 15467085 • Service Connector: Service by Harness - See Part Catalog • Description: 2-Way F Metri-Pack 150.2 Series (L-GY)	• Terminated Lead: Service by Harness - See Part Catalog • Release Tool: J-38125-559 • Diagnostic Test Probe: J-35616-14 (GN) • Terminal/Tray: 12124075/5 • Core/Insulation Crimp: E/C

Control Solenoid Valve Assembly X3

Pin	Size	Color	Circuit	Function	Option
A	0.5	WH	-	ISS High Signal	-
B	0.5	BK	-	ISS Low Signal	-

CONTROL SOLENOID VALVE ASSEMBLY X4

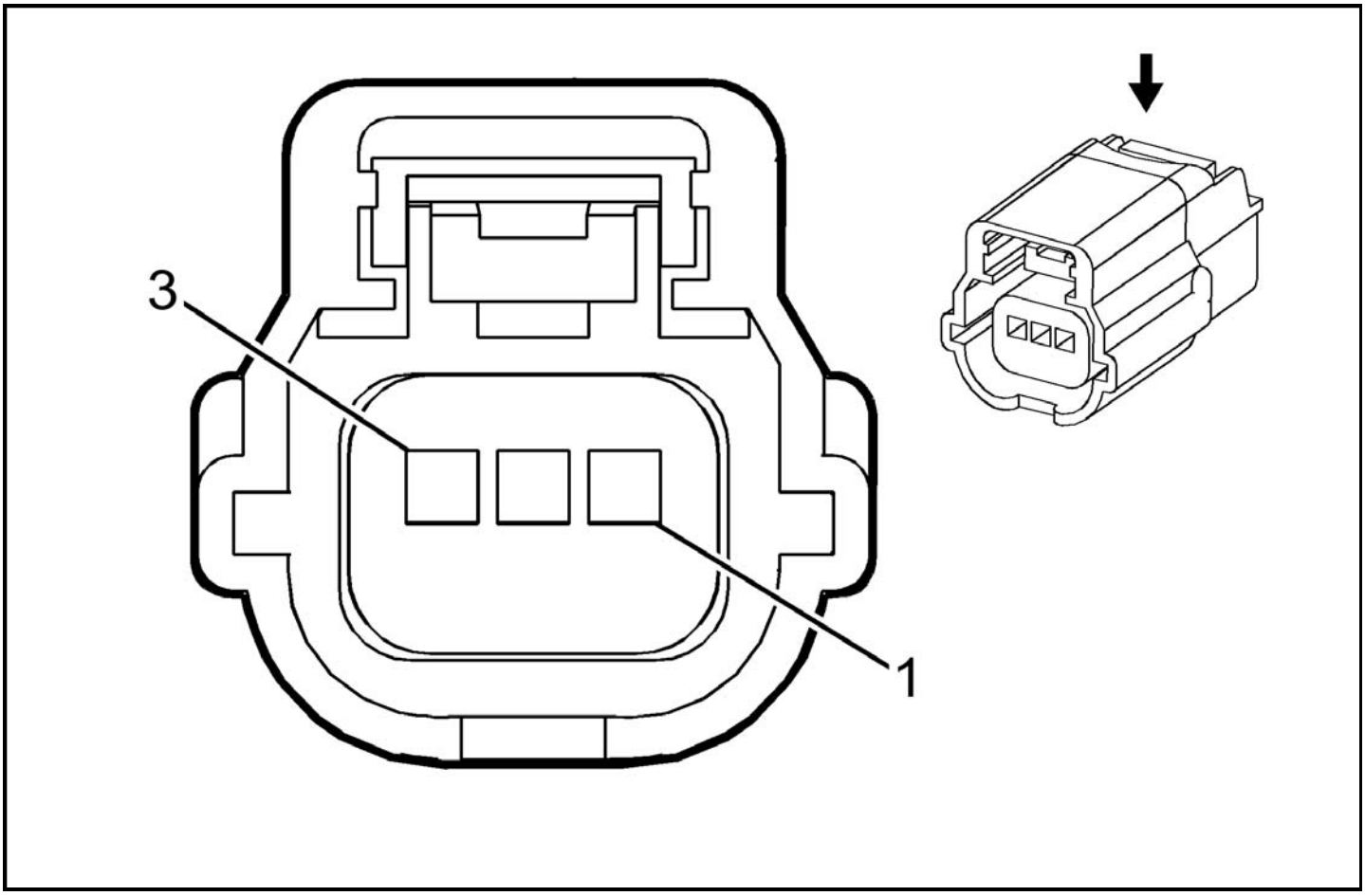


Connector Part Information	Terminal Part Information
• Harness Type: Transmission • OEM Connector: 15473844 • Service Connector: Service by Harness - See Part Catalog • Description: 2-Way F Metri-Pack 150.2 Series (L-GN)	• Terminated Lead: Service by Harness - See Part Catalog • Release Tool: J-38125-559 • Diagnostic Test Probe: J-35616-14 (GN) • Terminal/Tray: 12124075/5 • Core/Insulation Crimp: E/C

Control Solenoid Valve Assembly X4

Pin	Size	Color	Circuit	Function	Option
A	0.5	WD	-	Output Speed High Signal Output	-
B	0.5	BK	-	Output Speed Low Signal	-

CRANKSHAFT POSITION (CKP) SENSOR



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13525738
- Service Connector: 88988337
- Description: 3-Way F USCAR 064 Series, Sealed (BK)

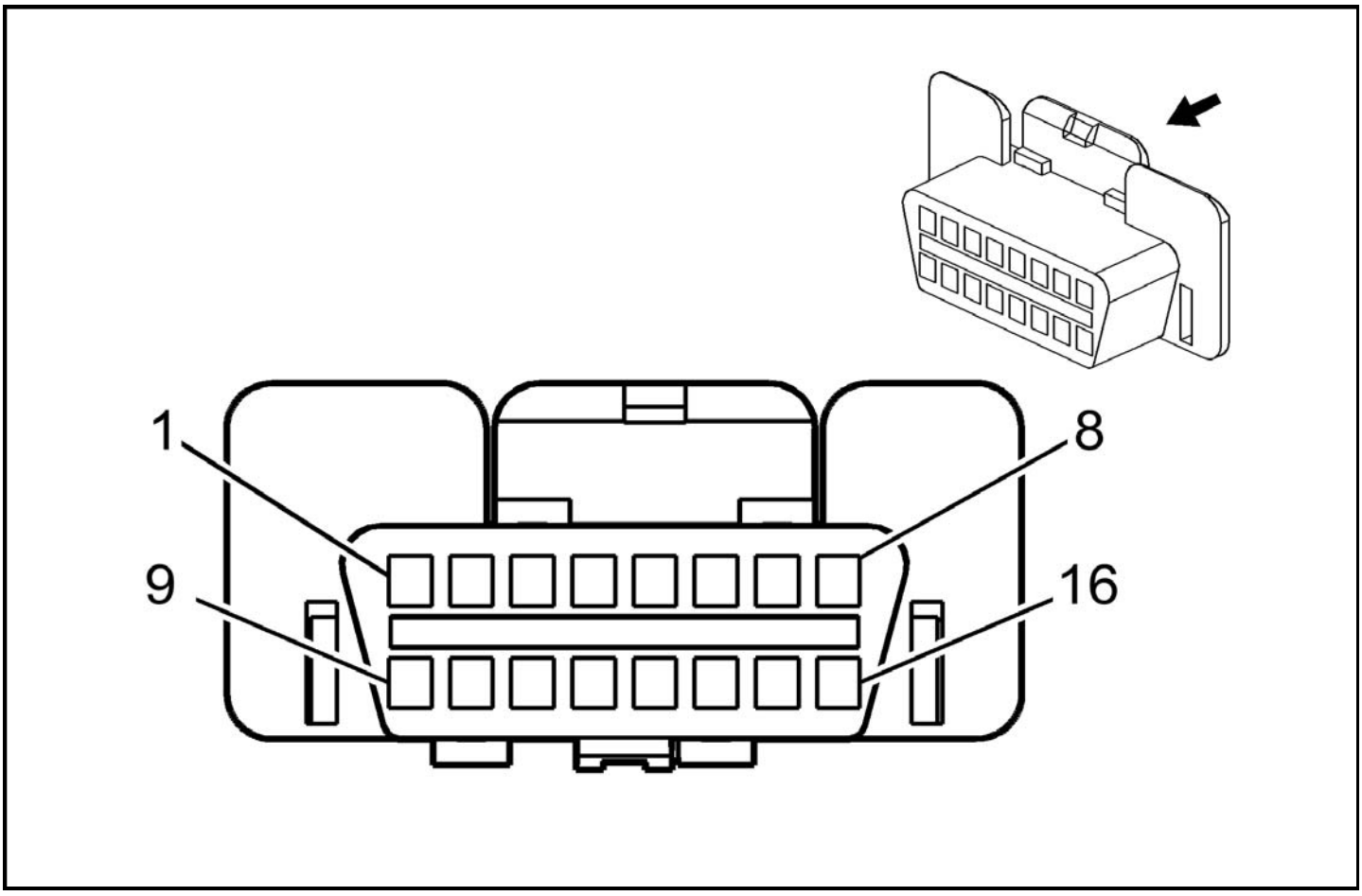
Terminal Part Information

- Terminated Lead: 13575575
- Release Tool: J-38125-213
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Crankshaft Position (CKP) Sensor

Pin	Wire	Circuit	Function
1	0.35 GY/BK	6272	Crankshaft Low reference
2	0.35 WH/BK	6271	Crankshaft Sensor Signal
3	0.35PU/WH	6270	5V Reference Voltage

DATA LINK CONNECTOR (DLC)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15488184
- Service Connector: 19115029
- Description: 16-Way F Metri-Pack 150 Series (BK)

Terminal Part Information

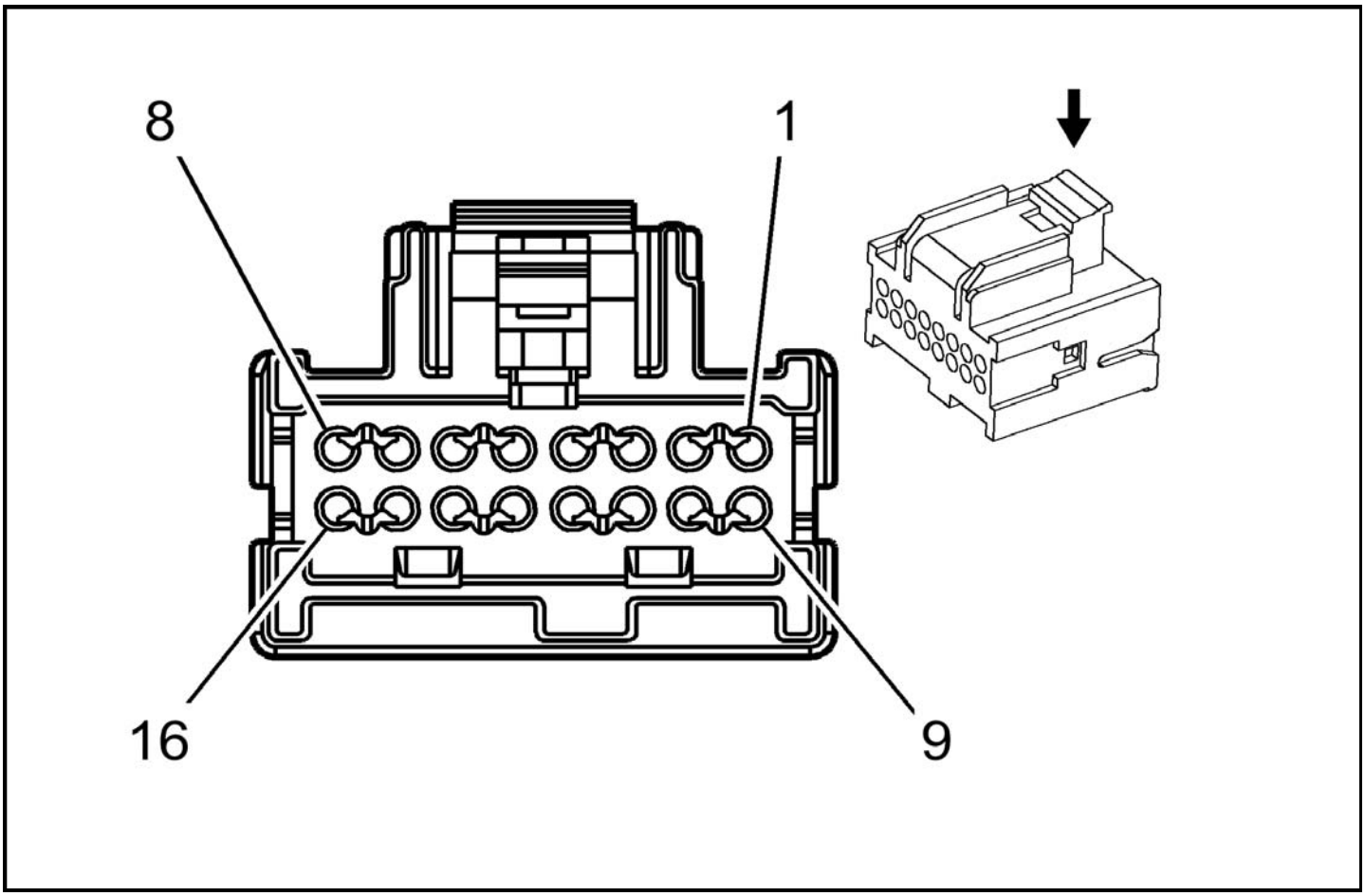
- Terminated Lead: 13575725
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 12129484/19
- Core/Insulation Crimp: E/C

Data Link Connector (DLC)

Pin	Wire	Circuit	Function
1	0.35 D-GN	5060	Low Speed GMLAN Serial Data
2-3	-	-	Not Used

Pin	Wire	Circuit	Function
4	0.5 BK	1450	Ground
5	0.5 BK/WH	1551	Ground
6	0.35 TN/BK	2500	High Speed GMLAN Serial Data Bus +
7-13	-	-	Not Used
14	0.35 TN	2501	High Speed GMLAN Serial Data Bus -
15	-	-	Not Used
16	0.5 RD/WH	1840	Battery Positive Voltage

DIGITAL RADIO RECEIVER (U2K)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15416970
- Service Connector: 13504130
- Description: 16-Way F Micro-Pack 64 Series (BK)

Terminal Part Information

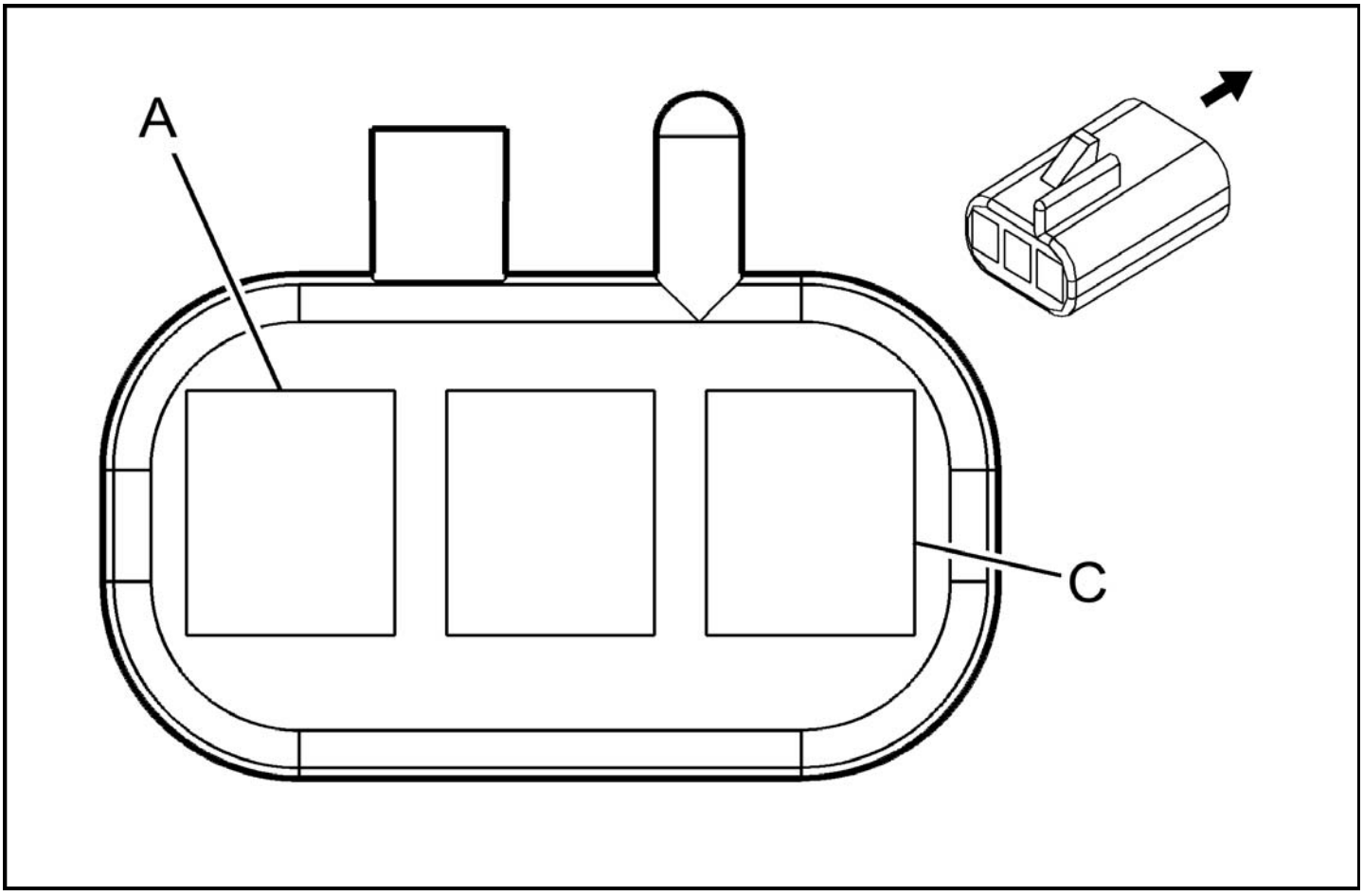
- Terminated Lead: 13575535
- Release Tool: J-38125-21

- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 15359541/4
- Core/Insulation Crimp: M/M

Digital Radio Receiver (U2K)

Pin	Wire	Circuit	Function
1	0.35 D-GN	7007	Left Audio Signal (-)
2	0.35 BN/WH	367	Left Audio Signal (+)
3	0.35 D-GN/WH	368	Right Audio Signal (+)
4	0.35 GY/BK	7008	Right Audio Signal (-)
5	0.35 D-GN	5060	Low Speed GMLAN Serial Data
6-8	-	-	Not Used
9	0.8 BK/WH	851	Ground (without UQ3)
	0.5 BK/WH	851	Ground (UQ3)
10-15	-	-	Not Used
16	0.5 RD/WH	3540	Battery Positive Voltage

DOME/READING LAMPS



Connector Part Information

- Harness Type: Headliner
- OEM Connector: 12047781
- Service Connector: 13586139
- Description: 3-Way F Metri-Pack 150 Series (BK)

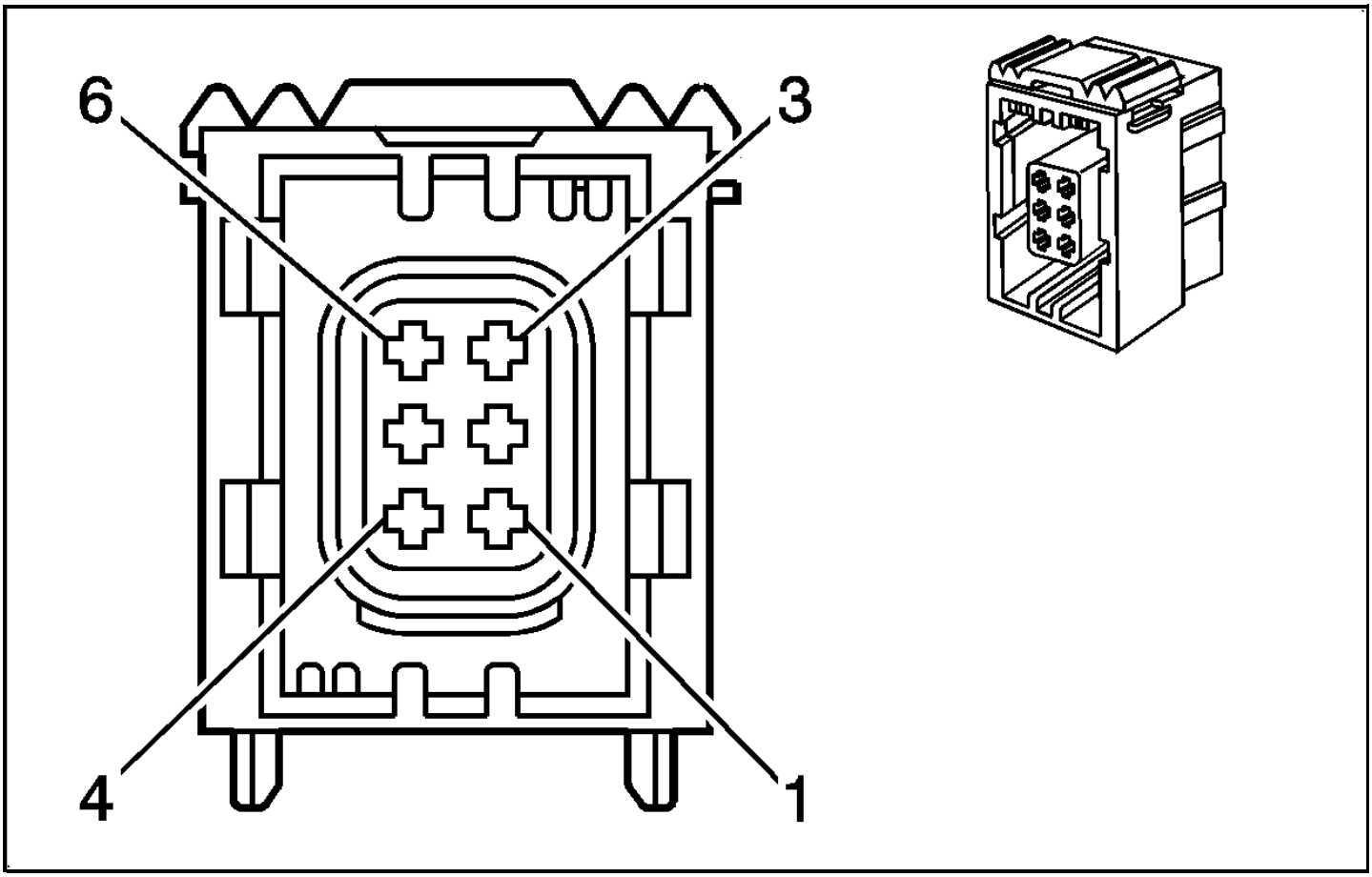
Terminal Part Information

- Terminated Lead: Service by Connector Assembly - 12101864
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/2
- Core/Insulation Crimp: E/C

Dome/Reading Lamps

Pin	Wire	Circuit	Function
A	0.5 GY/BK	690	Courtesy Lamp Supply Voltage
B	0.5 BK	550	Ground
C	0.5 OG	1732	Inadvertent Power Courtesy Lamp

DOOR LOCK - DRIVER (WITHOUT UA6)



Connector Part Information

- Harness Type: Left Front Door
- OEM Connector: 10768369
- Service Connector: 88986251
- Description: 6-Way F 1.2 Timer Series (BK)

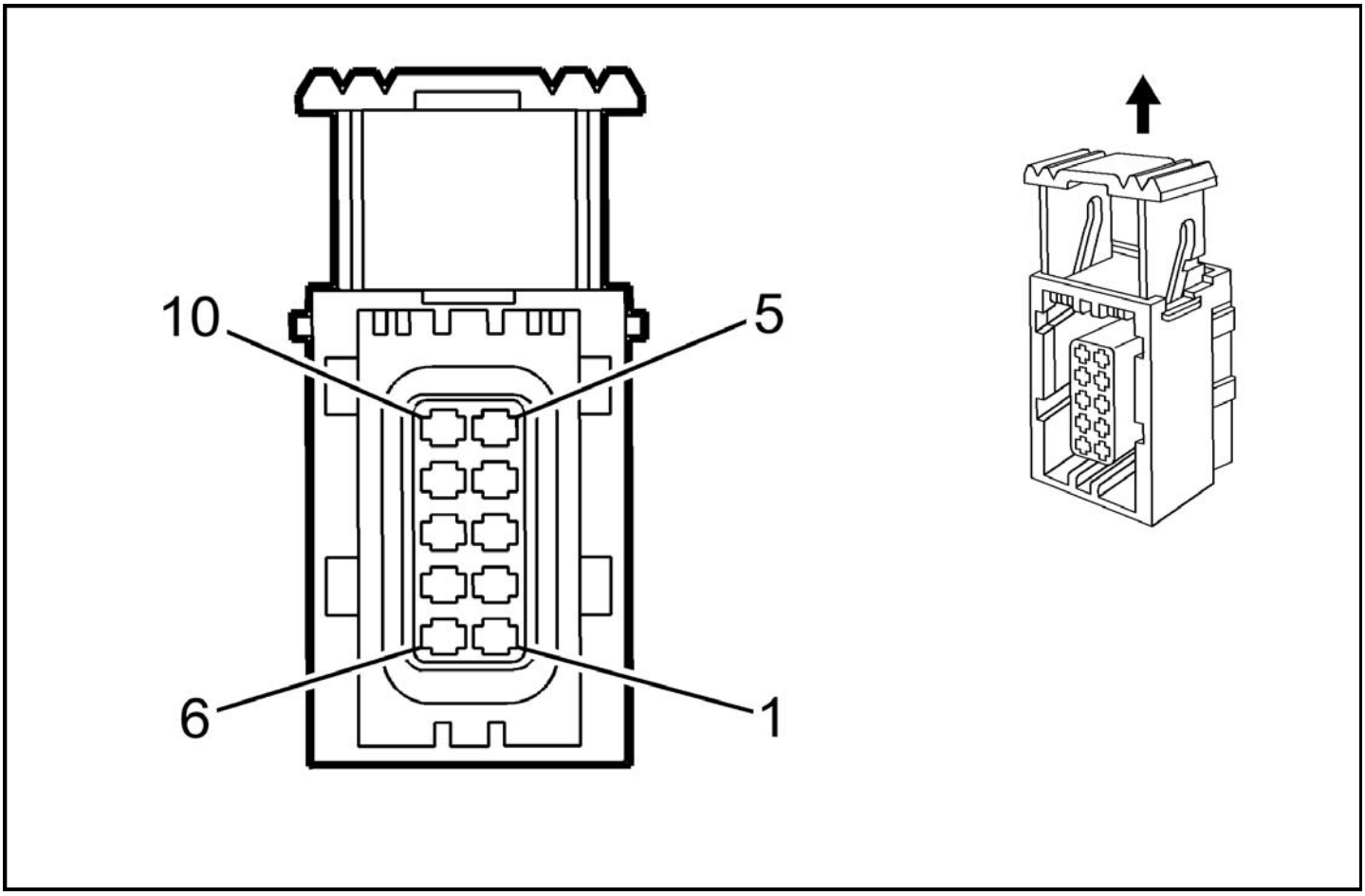
Terminal Part Information

- Terminated Lead: 13575359
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 964274-2/16
- Core/Insulation Crimp: E/1

Door Lock - Driver (without UA6)

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	1 TN	694	Driver Door Lock Actuator Unlock Control
3	1 GY	295	Door Lock Actuator Lock Control
4	0.5 GY/BK	745	Left Front Door Ajar Switch Signal
5	0.5 TN	126	Left Front Door Open Switch Signal
6	0.35 BK	550	Ground

DOOR LOCK - DRIVER (UA6)



Connector Part Information

- Harness Type: Left Front Door
- OEM Connector: 10768367
- Service Connector: 88952463
- Description: 10-Way F Sealed (BK)

Terminal Part Information

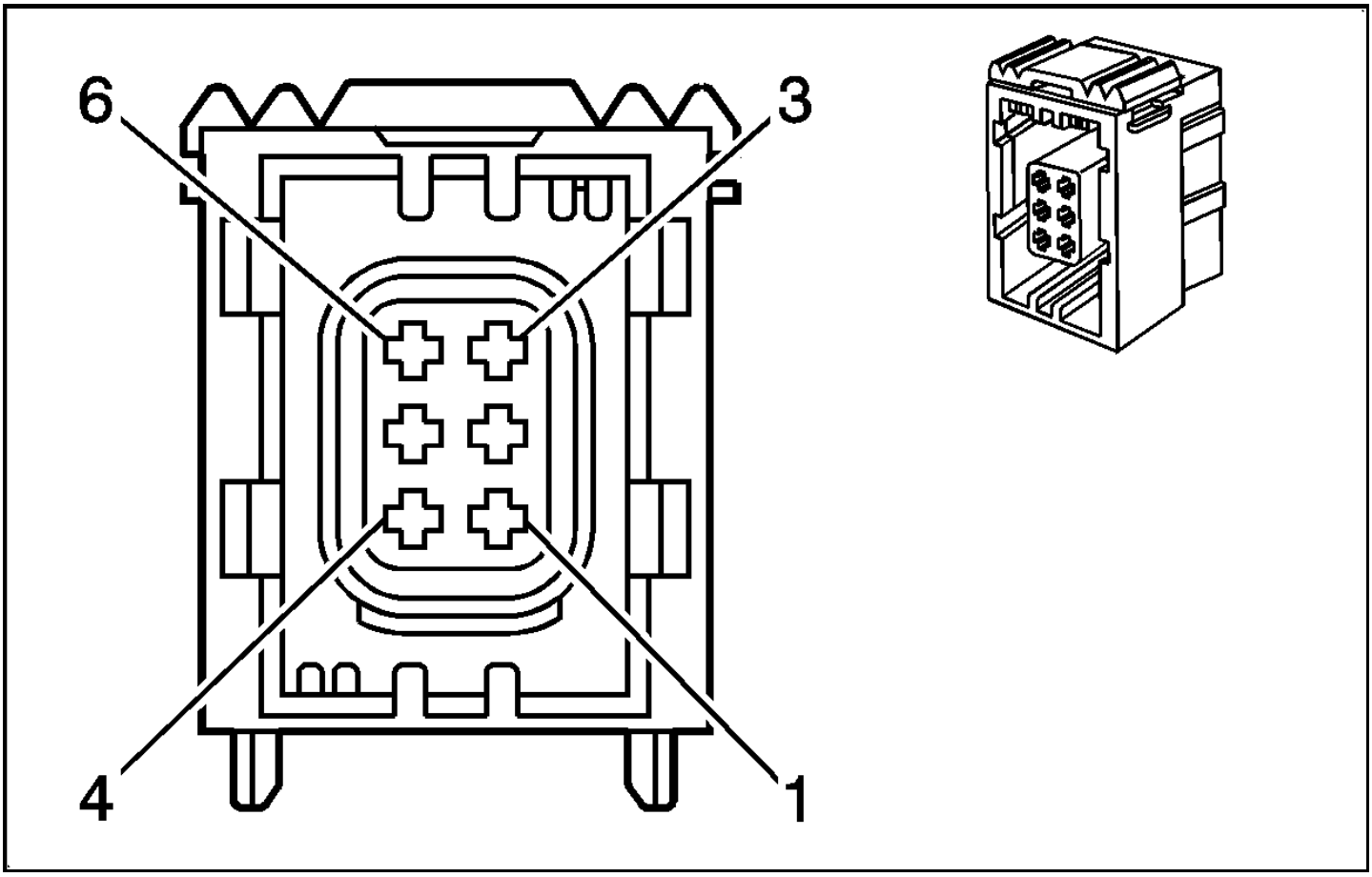
- Terminated Lead: 13575359
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 964274-2/16
- Core/Insulation Crimp: E/1

Door Lock - Driver (UA6)

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	1 TN	694	Driver Door Lock Actuator Unlock Control
3	1 GY	295	Door Lock Actuator Lock Control
4-5	-	-	Not Used

Pin	Wire	Circuit	Function
6	0.5 GY/BK	745	Left Front Door Ajar Switch Signal
7	0.5 TN	126	Left Front Door Open Switch Signal
8	0.35 BK	550	Ground
9	0.5 PU	1124	Door Lock Key Switch Unlock Signal
10	-	-	Not Used

DOOR LOCK - LEFT REAR



Connector Part Information

- Harness Type: Left Rear Door
- OEM Connector: 10768369
- Service Connector: 88986251
- Description: 6-Way F 1.2 Timer Series (BK)

Terminal Part Information

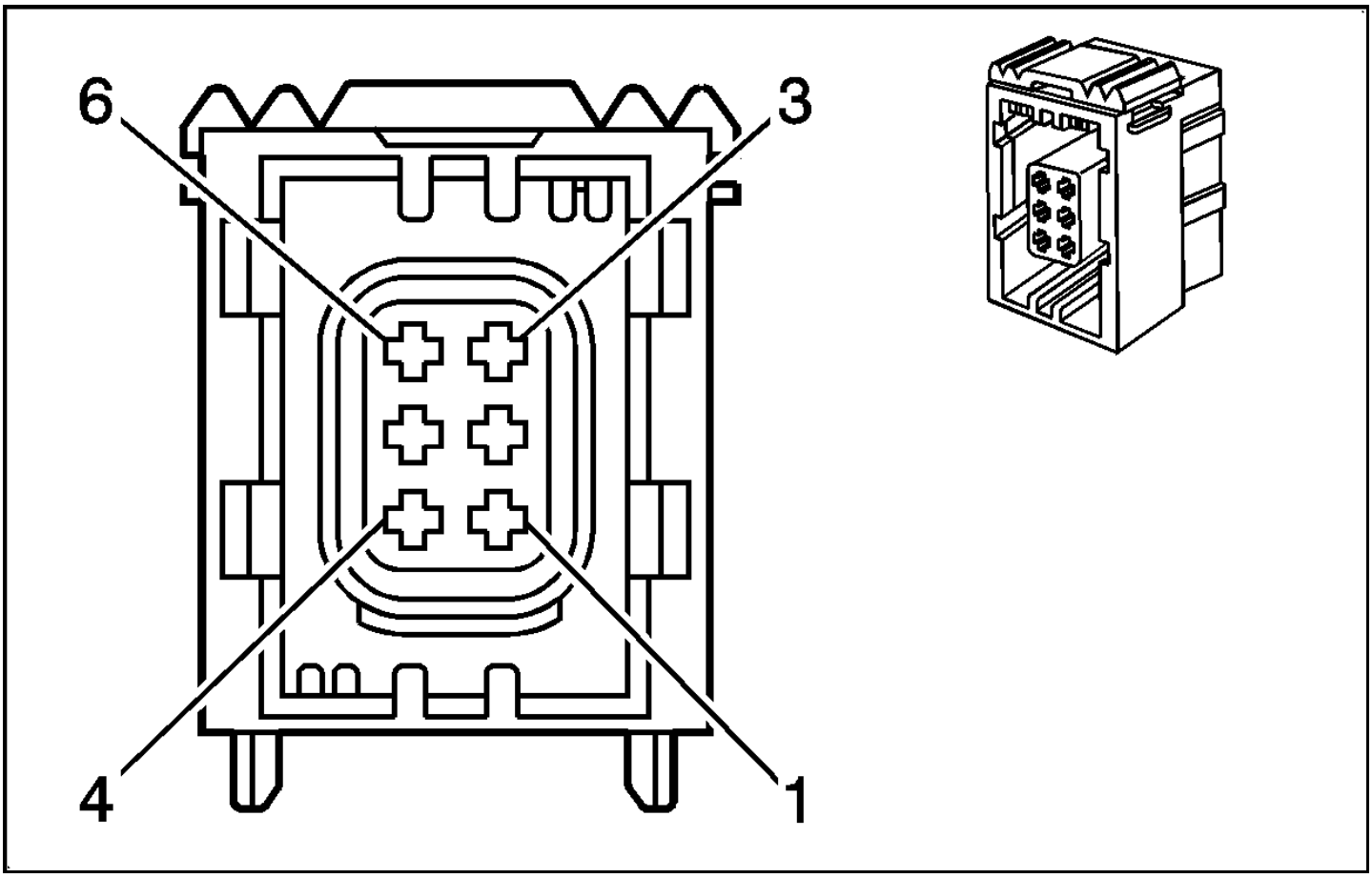
- Terminated Lead: 13575359
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 964274-2/16

- Core/Insulation Crimp: E/1

Door Lock - Left Rear

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	1 TN	294	Door Lock Actuator Unlock Control
3	1 GY	295	Door Lock Actuator Lock Control
4	0.5 L-BU/BK	747	Left Rear Door Ajar Switch Signal
5	0.5 OG	5922	Passenger Door Open Switch Signal
6	0.5 BK	550	Ground

DOOR LOCK - PASSENGER



Connector Part Information

- Harness Type: Right Front Door
- OEM Connector: 10768369
- Service Connector: 88986251
- Description: 6-Way F 1.2 Timer Series (BK)

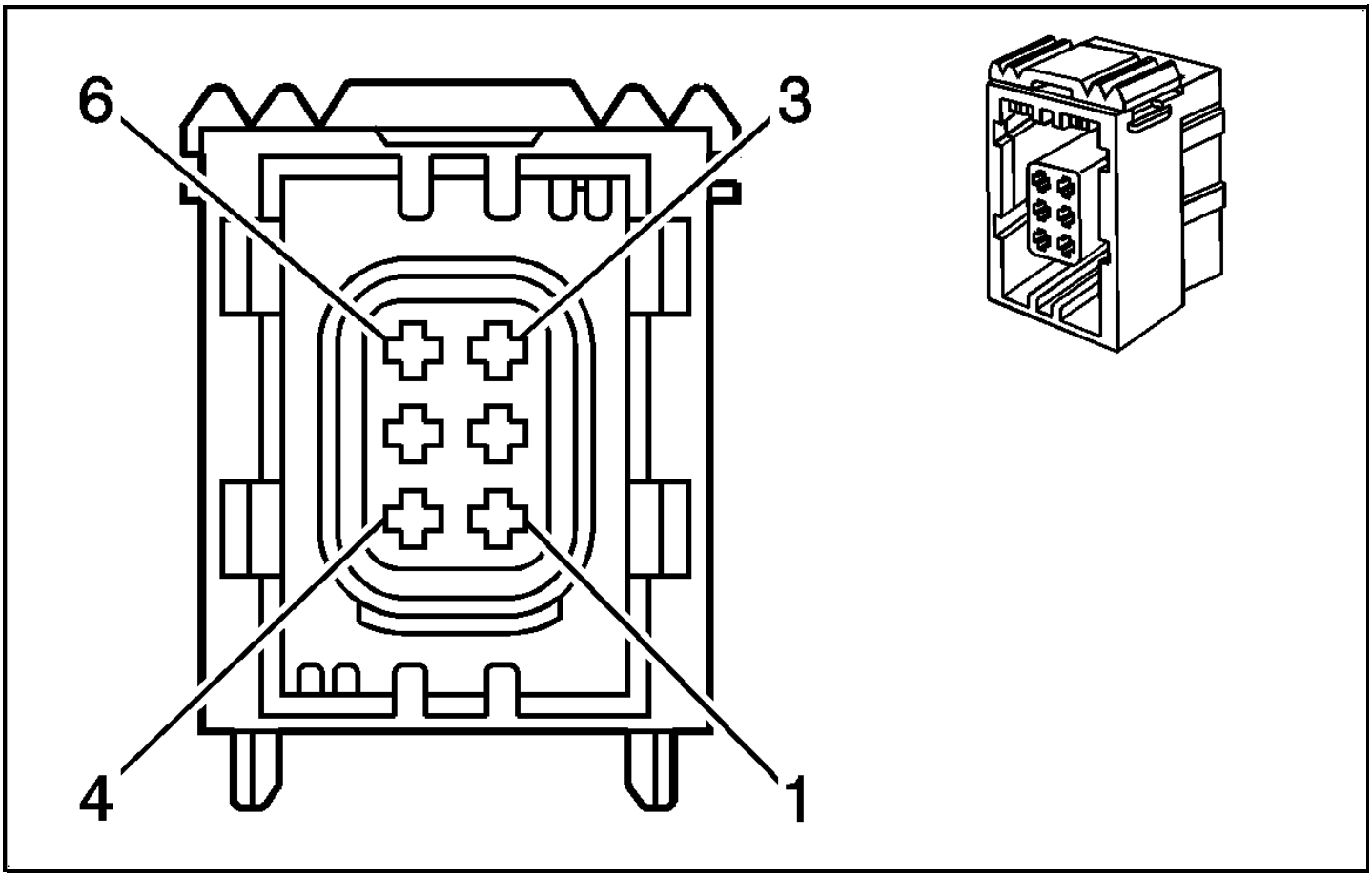
Terminal Part Information

- Terminated Lead: 13575359
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 964274-2/16
- Core/Insulation Crimp: E/1

Door Lock - Passenger

Pin	Wire	Circuit	Function
1	0.5 TN/WH	746	Right Front Door Ajar Switch Signal
2	0.5 OG	5922	Passenger Door Open Switch Signal
3	0.35 BK	750	Ground
4	-	-	Not Used
5	1 TN	294	Door Lock Actuator Unlock Control
6	1 GY	295	Door Lock Actuator Lock Control

DOOR LOCK - RIGHT REAR



Connector Part Information

- Harness Type: Right Rear Door

- OEM Connector: 10768369
- Service Connector: 88986251
- Description: 6-Way F 1.2 Timer Series (BK)

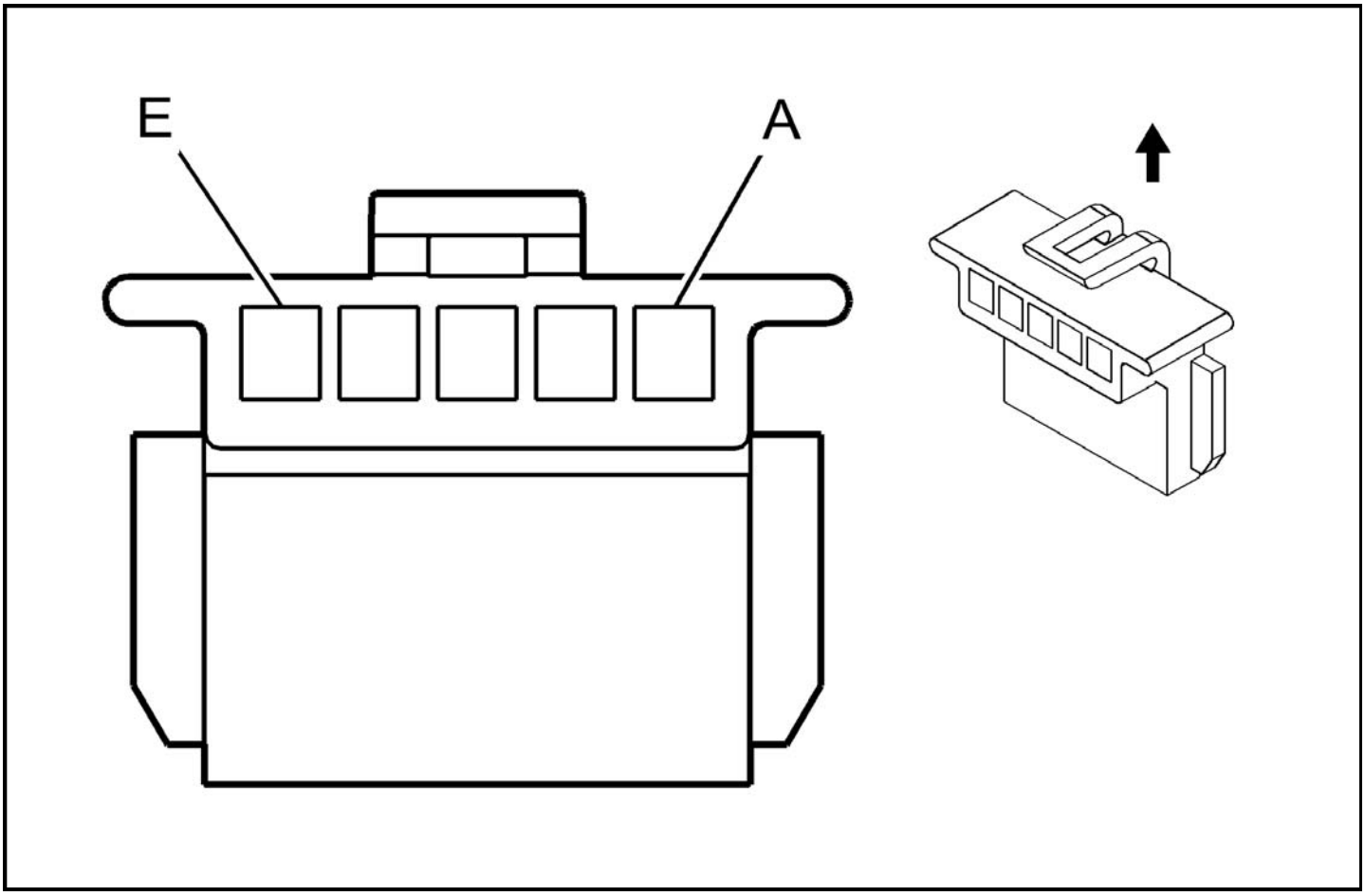
Terminal Part Information

- Terminated Lead: 13575359
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 964274-2/16
- Core/Insulation Crimp: E/1

Door Lock - Right Rear

Pin	Wire	Circuit	Function
1	0.5 L-GN/BK	748	Right Rear Door Ajar Switch Signal
2	0.5 OG	5922	Passenger Door Open Switch Signal
3	0.5 BK	750	Ground
4	-	-	Not Used
5	1 TN	294	Door Lock Actuator Unlock Control
6	1 GY	295	Door Lock Actuator Lock Control

DOOR LOCK SWITCH - DRIVER



Connector Part Information

- Harness Type: Left Front Door Trim
- OEM Connector: 12124997
- Service Connector: 12167130
- Description: 5-Way F Metri-Pack 150 Series (BK)

Terminal Part Information

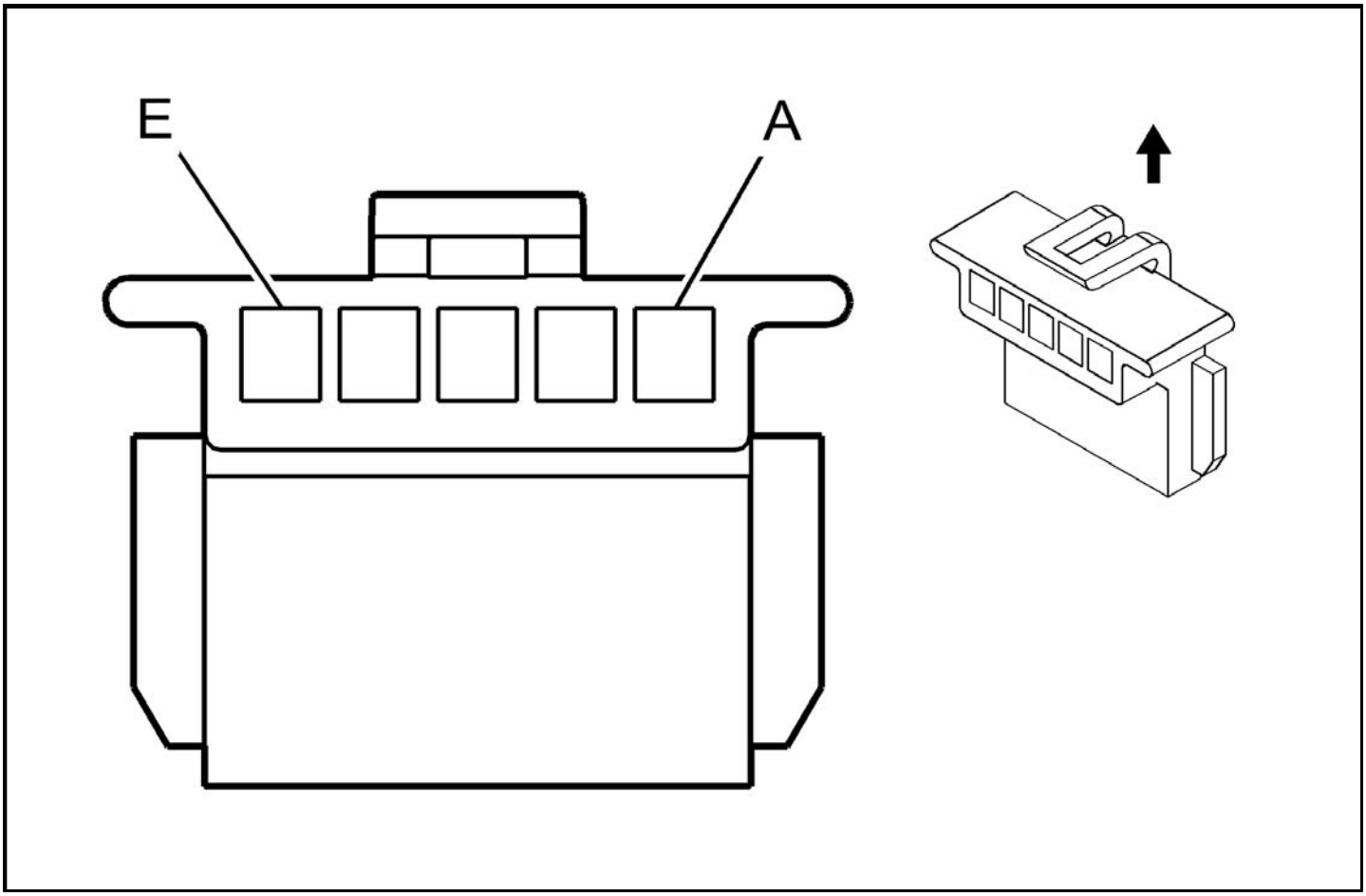
- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 12103359/18
- Core/Insulation Crimp: E/C

Door Lock Switch - Driver

Pin	Wire	Circuit	Function
A	0.35 GY	8	Instrument Panel Lamp Supply Voltage
B	0.35 BK	550	Ground
C	-	-	Not Used
D	0.35 OG/BK	780	Driver Door Lock Switch Lock Signal

Pin	Wire	Circuit	Function
E	0.35 OG	781	Driver Door Lock Switch Unlock Signal

DOOR LOCK SWITCH - PASSENGER



Connector Part Information

- Harness Type: Right Front Door
- OEM Connector: 12124997
- Service Connector: 12167130
- Description: 5-Way F Metri-Pack 150 Series (BK)

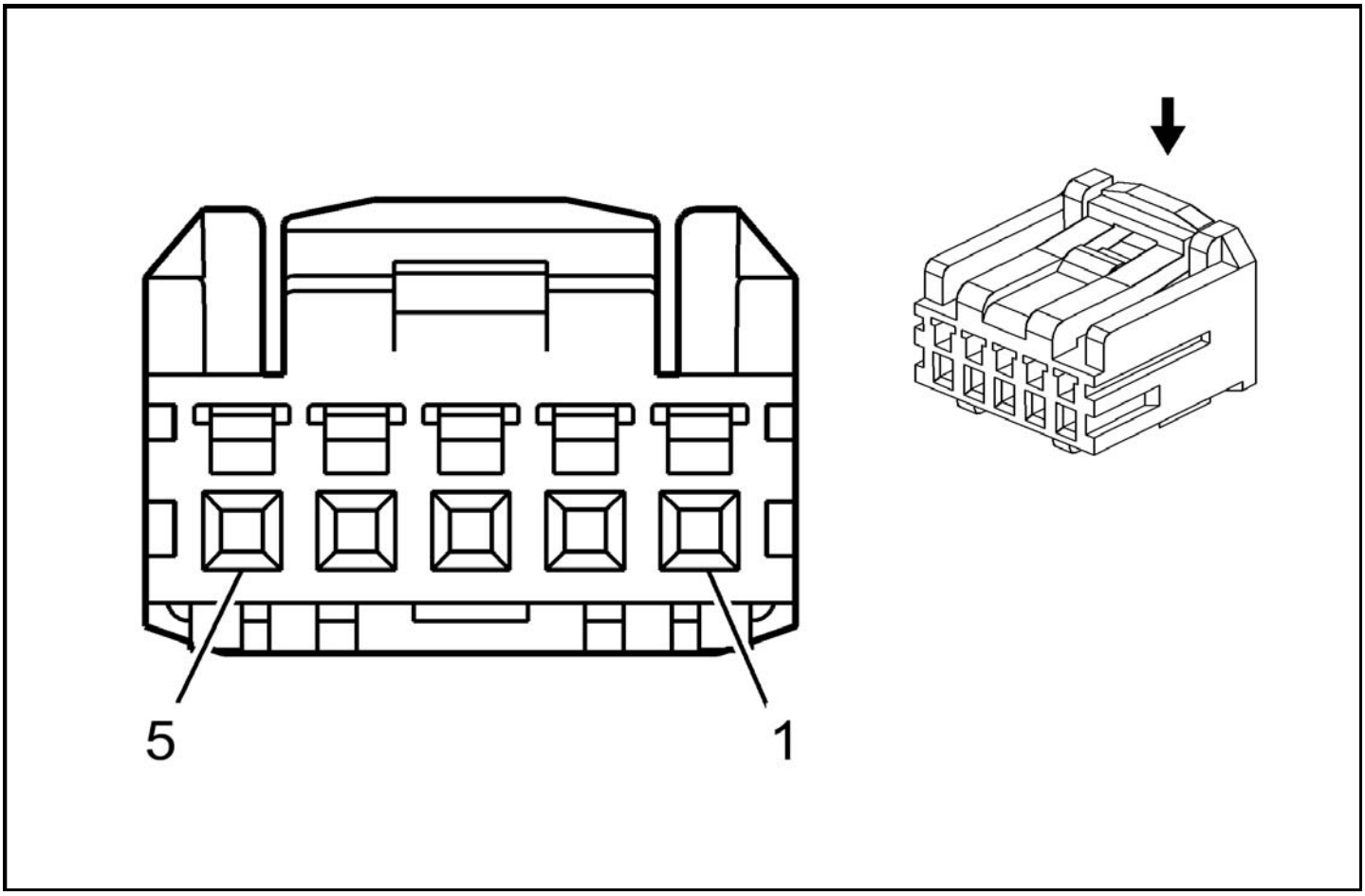
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 12103359/18
- Core/Insulation Crimp: E/C

Door Lock Switch - Passenger

Pin	Wire	Circuit	Function
A	0.35 GY	8	Instrument Panel Lamp Supply Voltage
B	0.5 BK	750	Ground
C	-	-	Not Used
D	0.35 L-BU	244	Passenger Door Lock Switch Lock Signal
E	0.35 D-BU	245	Passenger Door Lock Switch Unlock Signal

DRIVER INFORMATION CENTER (DIC) SWITCH



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15491277
- Service Connector: 88988747
- Description: 5-Way F HCM Series (BK)

Terminal Part Information

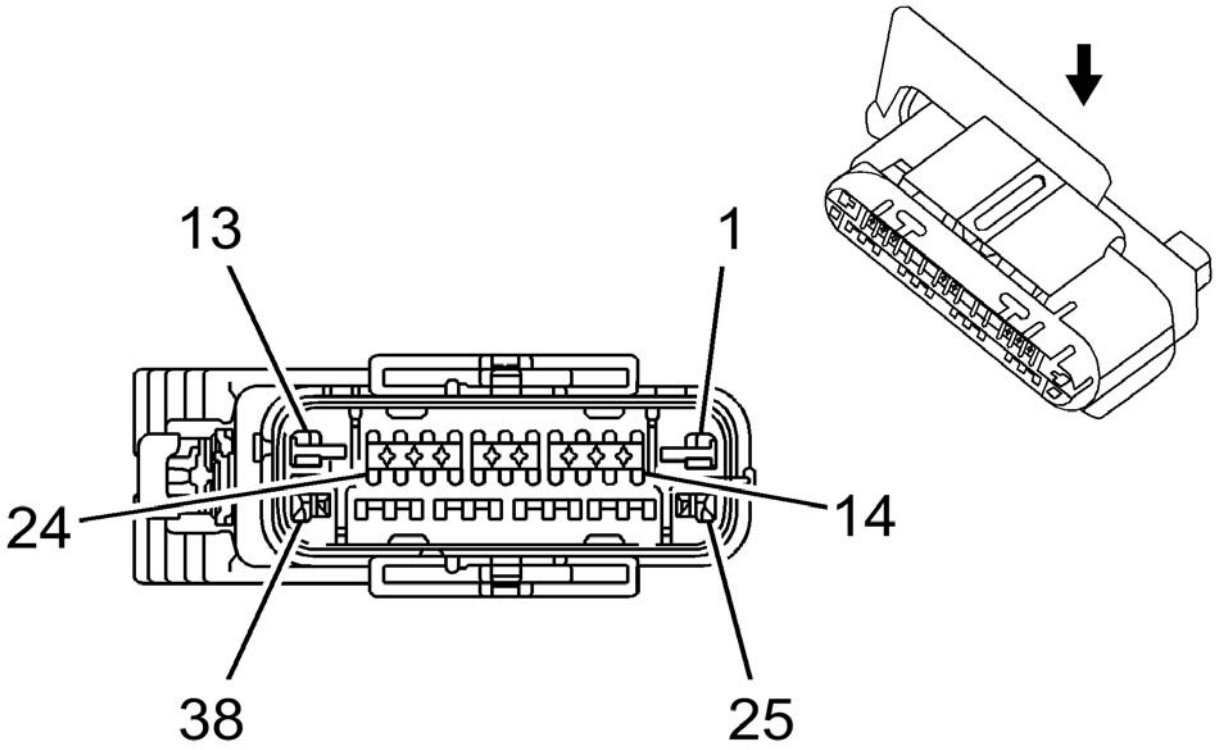
- Terminated Lead: 13575868
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SHCM-A03T-P025/20

- Core/Insulation Crimp: J/J

Driver Information Center (DIC) Switch

Pin	Wire	Circuit	Function
1	0.35 D-GN/WH	1358	DIC Switch Signal
2	0.35 BN	897	DIC Switch Low Reference
3	0.35 PK	893	DIC Select Menu Switch Signal
4	0.35 PU/WH	1382	LED Dimming Supply
5	0.5 BK	1450	Ground

ELECTRONIC BRAKE CONTROL MODULE (EBCM)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13546206
- Service Connector: 19178086
- Description: 38-Way F 250/280/6.3 Series, Sealed (BK)

Terminal Part Information

- Pin: 1

- Terminated Lead: 13581358
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-42 (RD)
- Terminal/Tray: 7116-4142-02/10
- Core/Insulation Crimp: A/3

- Pins: 3, 4, 6, 15-16, 27, 28, 31
- Terminated Lead: 13578883
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SAITS-A03T-M064/14
- Core/Insulation Crimp: 9/9

- Pins: 8, 9, 12, 17, 18, 19, 21, 23, 24, 30, 32, 33, 36, 37
- Terminated Lead: 13578883
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SAITS-A03T-M064/14
- Core/Insulation Crimp: 9/9

- Pin: 13
- Terminated Lead: 13579767
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-42 (RD)
- Terminal/Tray: 7116-4142-02/10
- Core/Insulation Crimp: D/3

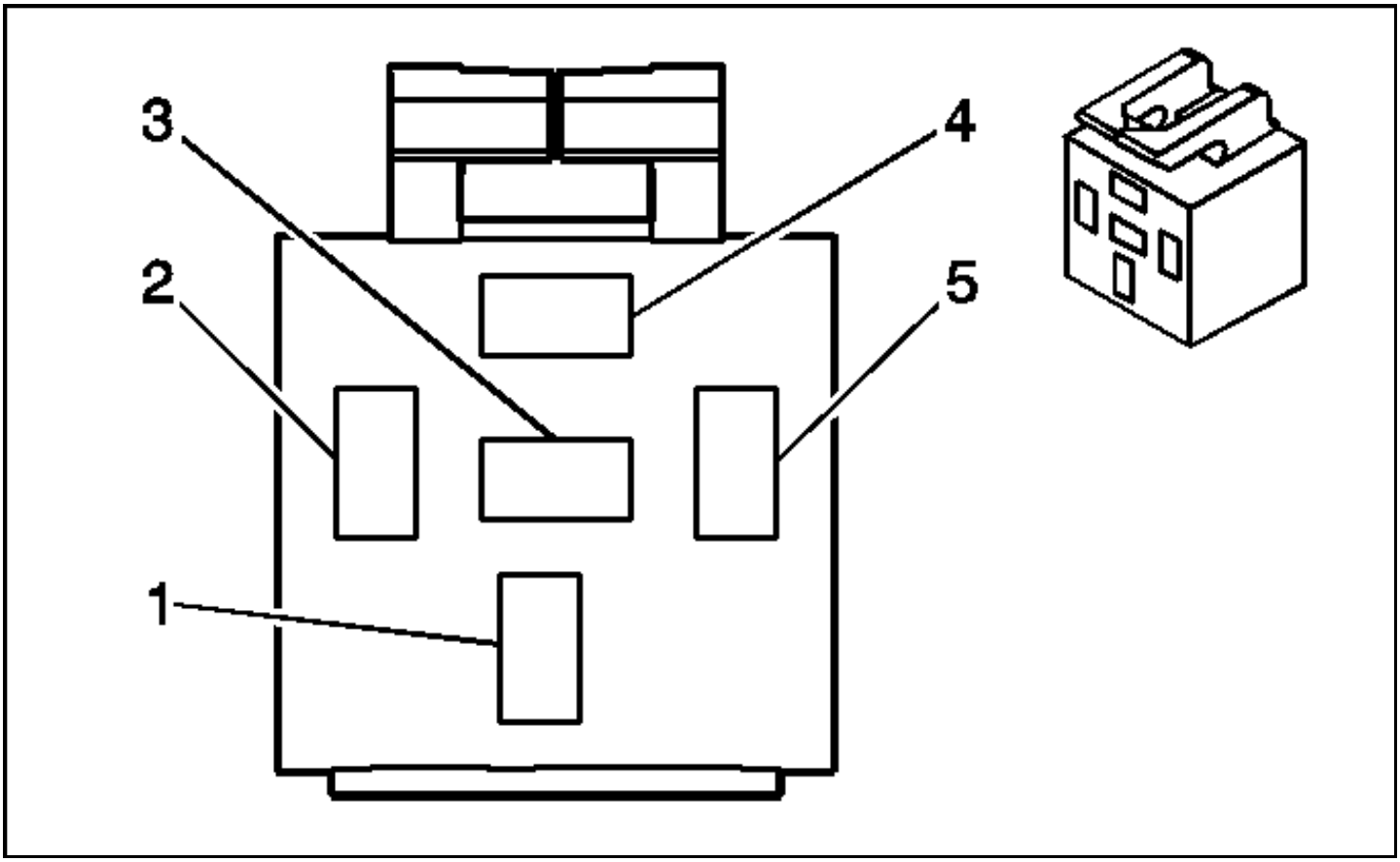
- Pin: 25
- Terminated Lead: 13575408
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15392777/23
- Core/Insulation Crimp: D/5

- Pin: 38
- Terminated Lead: 13575402
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15392777/23
- Core/Insulation Crimp: B/5

Electronic Brake Control Module (EBCM)

Pin	Wire	Circuit	Function
1	3 BK/WH	251	Ground
2	-	-	Not Used
3	0.5 BN	882	Right Rear Wheel Speed Sensor Signal
4	0.5 TN	884	Left Rear Wheel Speed Sensor Signal
5	-	-	Not Used
6	0.5 YE/BK	6032	Low Reference
7	-	-	Not Used
8	0.5 OG	6030	Brake Vacuum Sensor Signal
9	0.35 BN	7448	Vacuum Assist Pump Relay, Relay Coil Control
10-11	-	-	Not Used
12	0.35 L-BU	5986	Serial Data Communication Enable
13	5 RD/BK	1442	Battery Positive Voltage
14	-	-	Not Used
15	0.5 WH	883	Low Reference
16	0.5 OG	885	Low Reference
17	0.5 D-GN	872	Right Front Wheel Speed Sensor Signal
18	0.35 GY	1056	Steering Wheel Position Sensor 12V Reference Voltage
19	0.35 GY/BK	1337	12-Volt Reference
20	-	-	Not Used
21	0.35 L-GN/BK	6432	CAN Bus Low Serial Data
22	-	-	Not Used
23	0.35 TN	2501	High Speed GMLAN Serial Data Bus -
24	0.35 TN	2501	High Speed GMLAN Serial Data Bus -
25	3 BK/WH	251	Ground
26	-	-	Not Used
27	0.5 YE	873	Low Reference
28	0.5 L-BU	830	Left Front Wheel Speed Sensor Signal
29	-	-	Not Used
30	0.5 TN	833	Low Reference
31	0.5 GY	6031	5 Volt Reference
32	0.5 BN	818	Vehicle Speed Signal (9C1 or 9C3)
33	0.35 TN/WH	6433	CAN Bus High Serial Data
34-35	-	-	Not Used
36	0.35 TN/BK	2500	High Speed GMLAN Serial Data Bus +
37	0.35 TN/BK	2500	High Speed GMLAN Serial Data Bus +
38	5 RD/BK	1342	Battery Positive Voltage

EMERGENCY VEHICLE FRONT LAMP FLASHER (6J3)



Connector Part Information

- Harness Type: 6J3 Jumper
- OEM Connector: 12034003
- Service Connector: Service by Harness - See Part Catalog
- Description: 5-Way F Metri-Pack 630 Series (BK)

Terminal Part Information

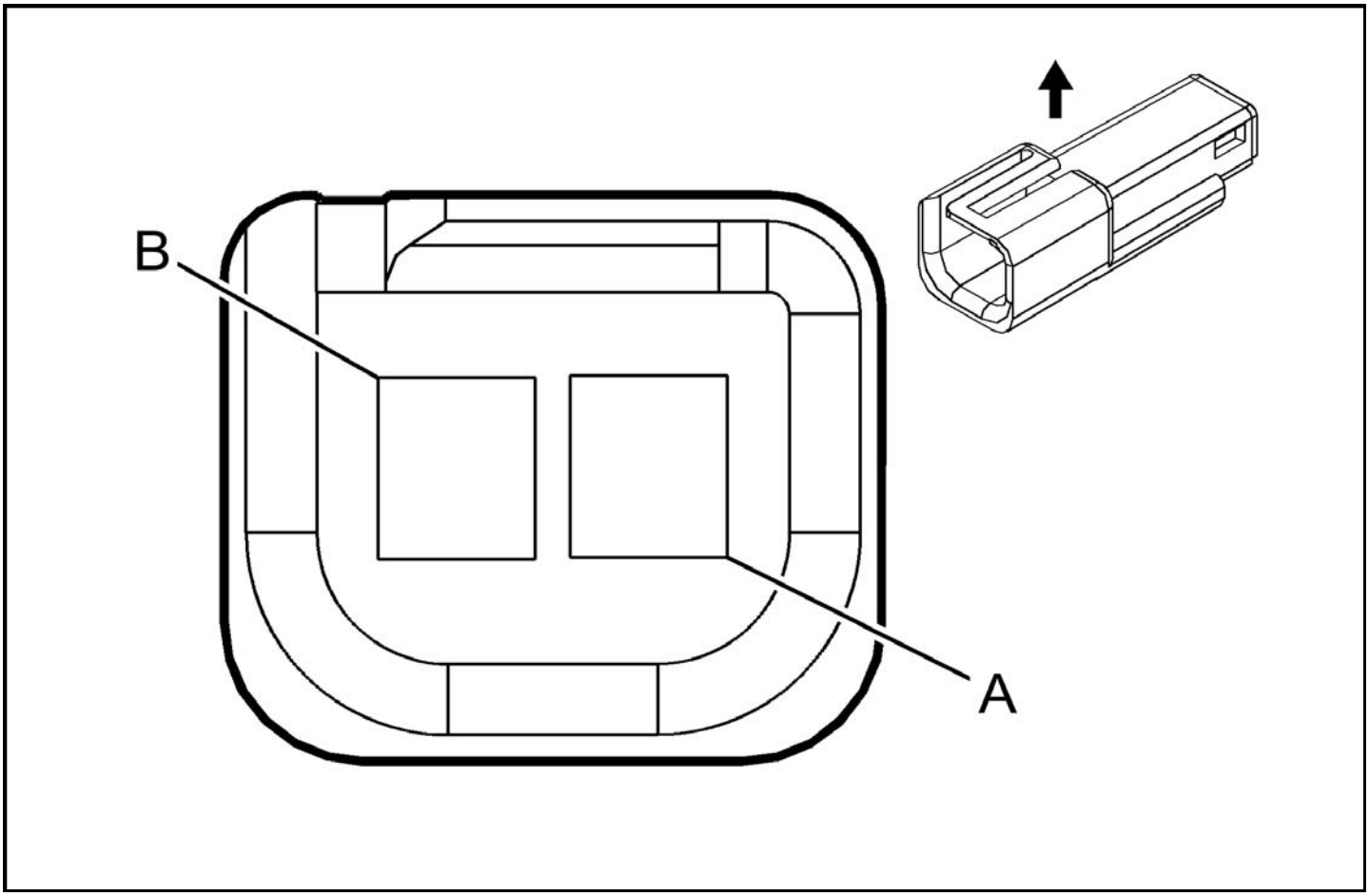
- Terminated Lead: Service by Harness - See Part Catalog
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Emergency Vehicle Front Lamp Flasher (6J3)

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	1.0 GY	6838	Front Emergency Flasher Control
3	-	-	Not Used
4	1.0 TN	6835	Front Emergency Lamp Supply Voltage

Pin	Wire	Circuit	Function
5	1.0 PU	6834	Front Emergency Lamp Flasher Supply Voltage

EMERGENCY VEHICLE REAR WINDOW PANEL LAMP - LEFT (6J6)



Connector Part Information

- Harness Type: Body
- OEM Connector: 12047663
- Service Connector: 13584278
- Description: 2-Way M Metri-Pack 150 Series (BK)

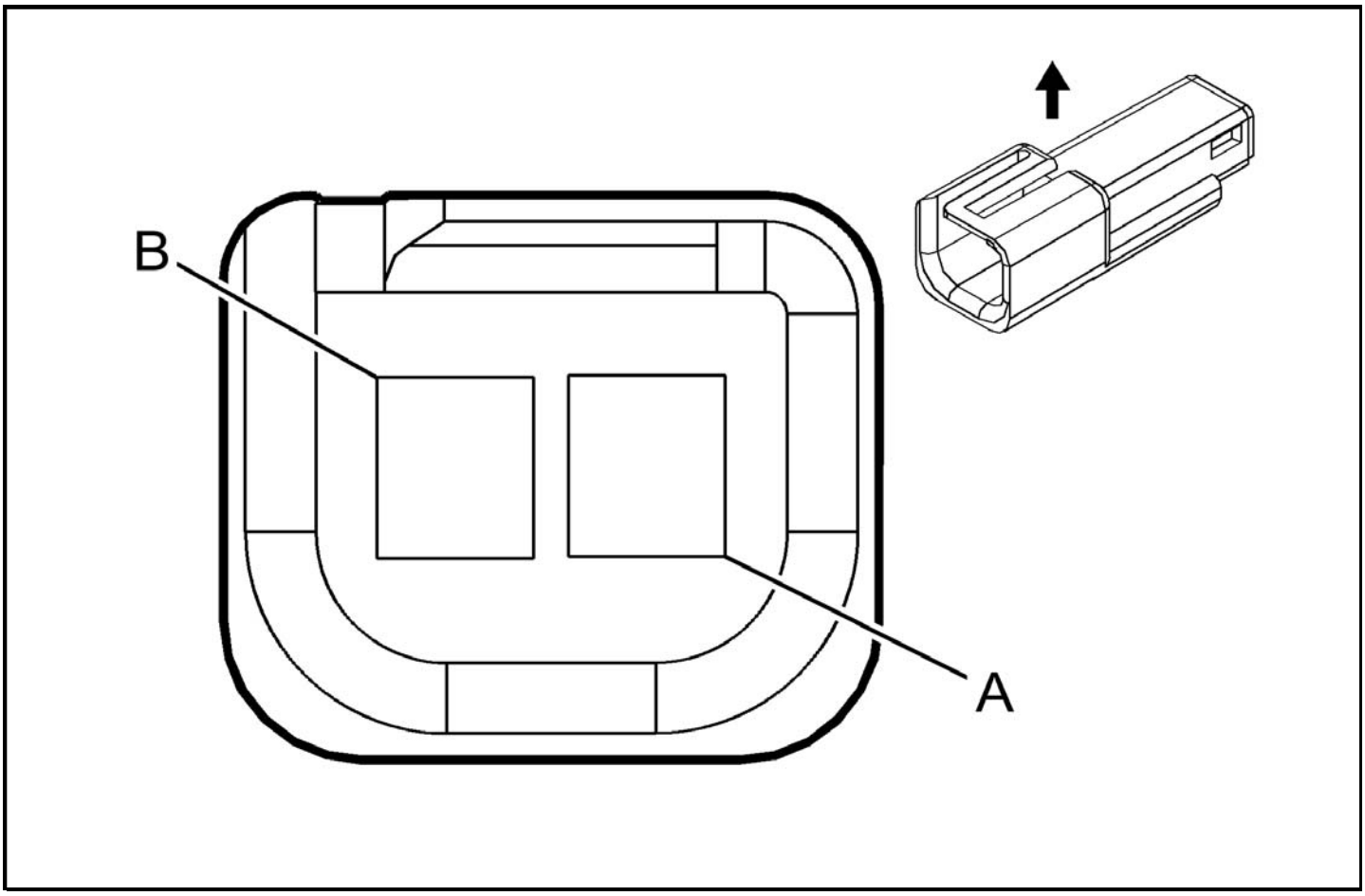
Terminal Part Information

- Terminated Lead: 13505668
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/A

Emergency Vehicle Rear Window Panel Lamp - Left (6J6)

Pin	Wire	Circuit	Function
A	0.8 YE	18	Left Rear Stop/Turn Lamp Supply Voltage
B	-	-	Not Used

EMERGENCY VEHICLE REAR WINDOW PANEL LAMP - RIGHT (6J6)



Connector Part Information

- Harness Type: Body
- OEM Connector: 12047663
- Service Connector: 13584278
- Description: 2-Way M Metri-Pack 150 Series (BK)

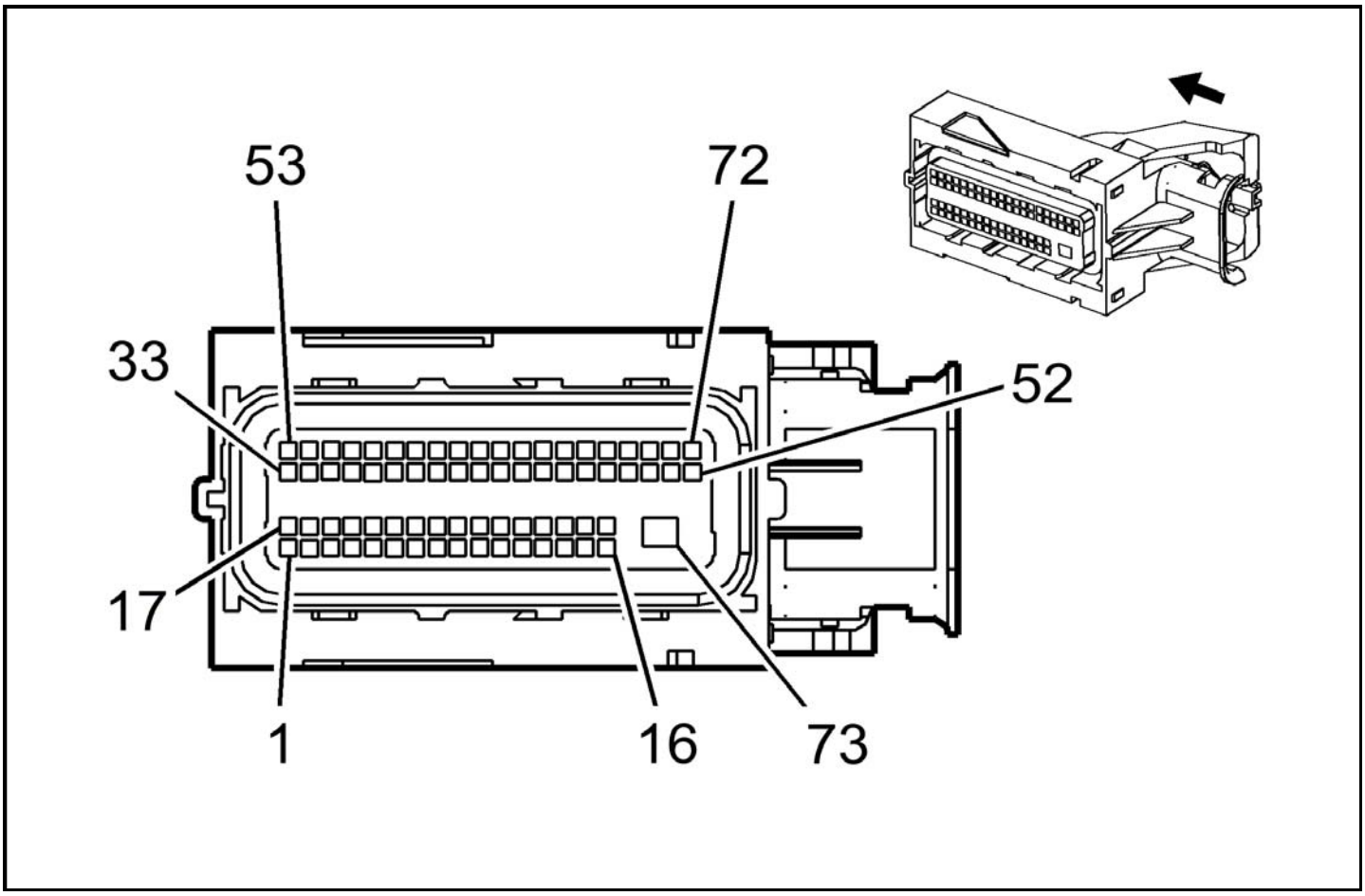
Terminal Part Information

- Terminated Lead: 13505668
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/A

Emergency Vehicle Rear Window Panel Lamp - Right (6J6)

Pin	Wire	Circuit	Function
A	0.8 D-GN	19	Right Rear Stop/Turn Lamp Supply Voltage
B	-	-	Not Used

ENGINE CONTROL MODULE (ECM) X1 (LFX)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13611938
- Service Connector: 13574782
- Description: 73-Way F 0.64, 2.8 Series, Sealed (BK with BU Terminal Position Assurance Lock)

Terminal Part Information

- Pins: 3-5, 6, 9, 10, 14, 15, 18, 19, 21, 22, 25, 26, 30, 32-34, 38-40, 42, 44, 46-48, 51-53, 55-59, 62, 63, 66-68, 70, 72
- Terminated Lead: 13575812
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 33467-0003

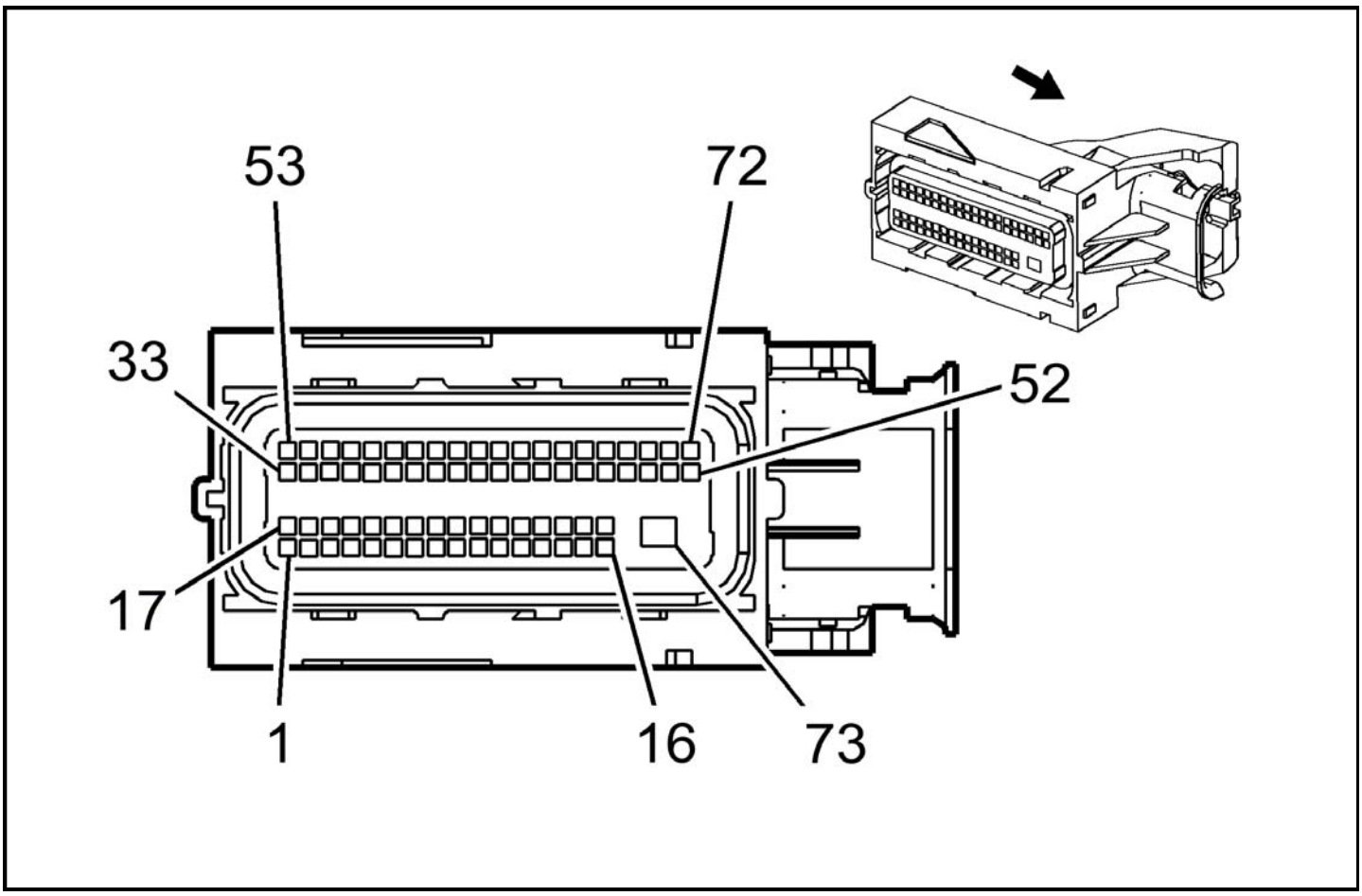
- Core/Insulation Crimp: Not Available
- Pin: 73
- Terminated Lead: 13575797
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: 7116-4152-02/9
- Core/Insulation Crimp: A/5

Engine Control Module (ECM) X1 (LFX)

Pin	Wire	Circuit	Function
1-2	-	-	Not Available
3	0.5 L-BU/BK	6455	Air Pressure Sensor Signal (NU6)
4	0.35 YE/WH	3200	Intake Air Pressure Sensor Signal
5	0.35 GY/WH	3201	5-Volt 1 Reference
6	0.5 OG/BK	380	A/C Refrigerant Pressure Sensor Signal
7-8	-	-	Not Available
9	0.5 D-GN	890	Fuel Tank Vapor Temperature Sensor Signal
10	0.5 GY	2709	5-Volt 1 Reference
11-13	-	-	Not Available
14	0.35 WH/BK	1164	5-Volt 4 Reference
15	0.5 D-BU	1161	APP Sensor 1 Signal
16-17	-	-	Not Available
18	0.5 L-BU	6456	Air Injection Reaction Pump Sensor #2 Supply Voltage
19	0.5 BN	6454	Air Injection Reaction Pump Sensor #2 Supply Voltage
20	-	-	Not Used
21	0.35 GY	2700	5-Volt 1 Reference
22	0.35 TN	5514	Low Reference
23-24	-	-	Not Available
25	03.5 PU	30	Fuel Level Sensor 1 Signal
26	0.35 TN	2759	Sensor Low Reference
27-29	-	-	Not Available
30	0.35 BN	1271	Low Reference
31	-	-	Not Available
32	0.35 D-GN/WH	459	A/C Compressor Clutch Relay Control
33	0.35 TN	1274	5-Volt 3 Reference
34	0.35 L-BU	1162	APP Sensor 2 Signal
35-37	-	-	Not Available
38	0.5 WH	1579	Fuel Temperature/Composition Signal (FHS)
39	0.35 TN/BK	2500	High Speed GMLAN Serial Data Bus +

Pin	Wire	Circuit	Function
40	0.35 TN	2501	High Speed GMLAN Serial Data Bus -
41	-	-	Not Available
42	0.5 D-BU	473	High Speed Cooling Fan Relay Control
43	-	-	Not Available
44	0.35 D-GN/WH	465	Fuel Pump Relay Control
45	-	-	Not Available
46	0.35 BN/WH	419	MIL Control
47	0.35 WH	5359	5-Volt Reference
48	0.35 YE	5361	Stop Lamp Switch Signal
49-50	-	-	Not Available
51	0.35 PK	439	Ignition Voltage
52	0.5 RD/WH	540	Battery Positive Voltage
53	0.35 PU	1272	Low Reference
54	-	-	Not Available
55	0.35 BN	436	AIR Pump Relay Control (NU6)
56	0.5 PU	421	AIR Solenoid Supply Voltage (NU6)
57	0.5 WH	17	Brake Pedal Switch Signal
58	-	-	Not Available
59	0.35 D-GN	335	Low Speed Cooling Fan Relay Control
60-61	-	-	Not Available
62	0.5 PK/BK	5291	Ignition Voltage
63	0.35 PU/WH	6386	Starter Relay Control
64-65	-	-	Not Available
66	0.35 WH	1310	EVAP Canister Vent Solenoid Control
67	0.5 PK/BK	5292	Ignition Voltage
68	0.5 BN	5360	Low Reference
69	-	-	Not Available
70	0.5 D-BU	5985	Serial Data Wake-Up Signal
71	-	-	Not Available
72	0.35 YE	5991	Powertrain Relay Control
73	2.5 PK/BK	5290	Ignition Voltage

ENGINE CONTROL MODULE (ECM) X2 (LFX)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15499466
- Service Connector: 88988931
- Description: 73-Way F 0.64/2.8 Series, Sealed (BK with BK Terminal Position Assurance Lock)

Terminal Part Information

- Pins: 1-3, 10-13, 15-19, 26-29, 32, 34, 36, 37, 41-44, 49, 51-58, 61-63, 69, 70
- Terminated Lead: 13575812
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 33467-0003
- Core/Insulation Crimp: Not Available

- Pin: 73
- Terminated Lead: 13575797
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: 7116-4152-02/9

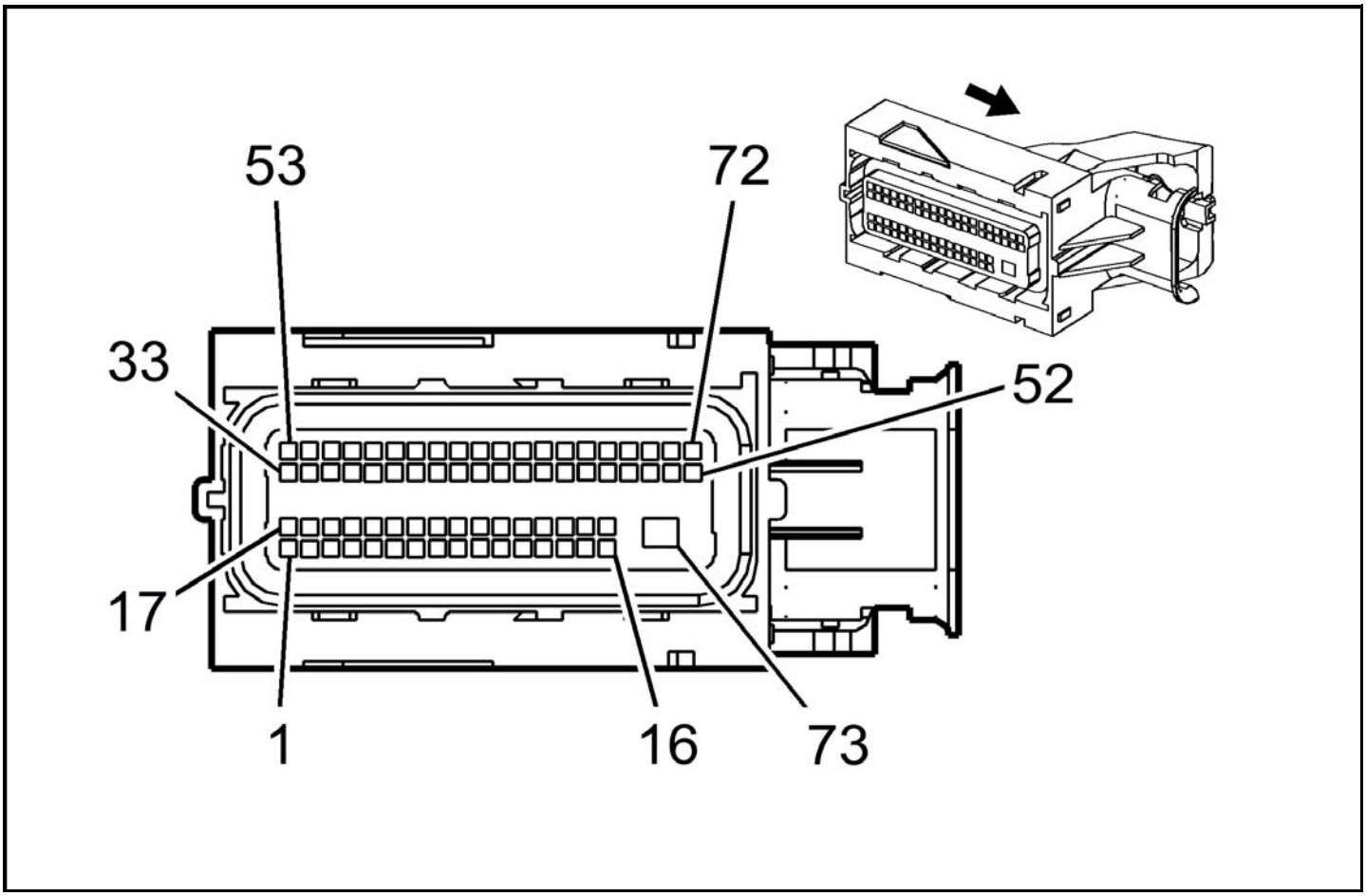
- Core/Insulation Crimp: A/5

Engine Control Module (ECM) X2 (LFX)

Pin	Wire	Circuit	Function
1	0.5 BN/WH	6331	Air Pressure Sensor Signal (NU6)
2	0.5 WH	6452	Air Pressure Sensor 5-Volt Reference (NU6)
3	0.5 TN	808	Low Reference
4-9	-	-	Not Available
10	0.5 PU/WH	3110	HO2S Reference Voltage (Bank 1 Sensor 1)
11	0.5 PU/WH	3210	HO2S Reference Voltage (Bank 2 Sensor 1)
12	0.5 PU	3120	HO2S High Signal (Bank 1 Sensor 2)
13	0.5 PU	3220	HO2S High Signal (Bank 2 Sensor 2)
14	-	-	Not Available
15	0.35 PU	4008	Humidity Sensor Signal
16	0.5 BN	582	TAC Motor Control
17	0.5 D-BU/WH	6785	Low Reference (NU6)
18	0.5 GY	598	5-Volt 1 Reference
19	0.5 YE	2918	FRP Sensor Signal
20-25	-	-	Not Available
26	0.5 TN/WH	3111	HO2S Low Reference (Bank 1 Sensor 1)
27	0.5 TN/WH	3211	HO2S Low Reference (Bank 2 Sensor 1)
28	0.5 TN/WH	3121	HO2S Low Signal (Bank 1 Sensor 2)
29	0.5 TN	3221	HO2S Low Signal (Bank 2 Sensor 2)
30-31	-	-	Not Available
32	0.5 YE	581	TAC Motor Control
33	-	-	Not Available
34	0.5 GY	2701	5-Volt 4 Reference
35	-	-	Not Available
36	0.5 D-BU	496	Knock Sensor (KS) 1 Signal
37	0.5 L-BU	1876	Knock Sensor (KS) 2 Signal
38-40	-	-	Not Available
41	0.5 GY/WH	3113	HO2S Heater Low Control (Bank 1 Sensor 1)
42	0.5 GY/WH	3122	HO2S Heater Low Control (Bank 1 Sensor 2)
43	0.5 L-GN	432	MAP Sensor Signal
44	0.5 GY	2704	5-Volt 3 Reference
45-48	-	-	Not Available
49	0.35 L-BU	6289	Intake Air Temperature Sensor Signal
50	-	-	Not Available
51	0.35 D-GN/WH	428	EVAP Canister Purge Solenoid Control
52	0.35 YE	492	MAF Sensor Signal

Pin	Wire	Circuit	Function
53	0.5 OG	225	Charge Indicator Control/Charge Indicator Signal
54	0.5 TN	2752	Low Reference
55	0.5 GY	23	Generator Field Duty Cycle Signal
56	0.5 GY	1716	Knock Sensor (KS) 1 Signal
57	0.5 GY	2303	Knock Sensor (KS) 2 Signal
58	0..35 OG/BK	1786	Clutch Start Neutral Start Signal
59-60	-	-	Not Available
61	0.5 L-GN	3212	HO2S Heater Low Control (Bank 2 Sensor 1)
62	0.5 OG/WH	3223	HO2S Heater Low Control (Bank 2 Sensor 2)
63	0.5 OG/BK	469	Low Reference
64-68	-	-	Not Available
69	0.5 TN	2760	Low Reference
70	0.5 D-GN	485	TP Sensor 1 Signal
71-72	-	-	Not Available
73	2.5 BK/WH	451	Ground

ENGINE CONTROL MODULE (ECM) X3 (LFX)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13820146
- Service Connector: 13574948
- Description: 73-Way F 0.64/2.8 Series (BK)

Terminal Part Information

- Pins: 8-10, 13-16, 24-42, 46-48, 50-62, 66-68, 70-72
- Terminated Lead: 13575812
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 33467-0003
- Core/Insulation Crimp: Not Available

- Pins: 73
- Terminated Lead: 13575797
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: 7116-4152-02/9
- Core/Insulation Crimp: A/5

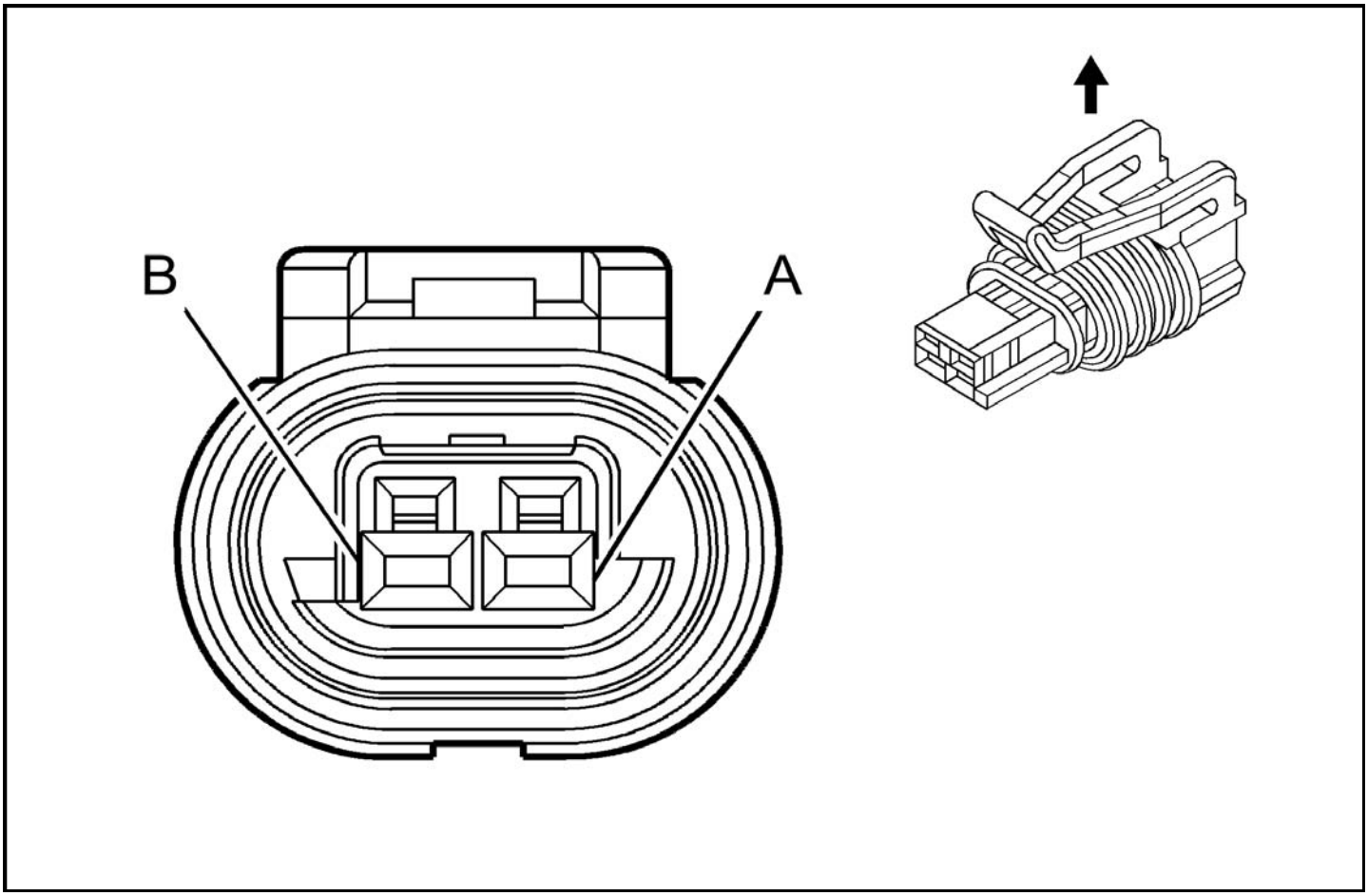
Engine Control Module (ECM) X3 (LFX)

Pin	Wire	Circuit	Function
1-7	-	-	Not Available
8	0.5 YE	410	ECT Sensor Signal
9	0.5 TN/BK	231	Oil Pressure Switch Signal
10	0.5 PU/WH	6270	5-Volt 2 Reference
11-12	-	-	Not Available
13	0.5 L-BU/WH	2126	IC 6 Control
14	0.5 D-GN	2125	IC 5 Control
15	0.5 BN/WH	2130	Low Reference
16	0.5 YE	7301	High Pressure Fuel Pump Actuator High Control
17-22	-	-	Not Available
23	-	-	Not Available
24	0.5 TN	476	Low Reference
25	0.5 GY/BK	6272	Low Reference
26	0.5 WH/BK	6271	Crankshaft Position Sensor Signal
27	0.5 D-GN/WH	2124	IC 4 Control
28	0.5 L-BU	2123	IC 3 Control

Pin	Wire	Circuit	Function
29	0.5 OG/WH	2122	IC 2 Control
30	0.5 PU	2121	IC 1 Control
31	0.5 BN	2129	Low Reference
32	0.5 PU	7300	High Pressure Fuel Pump Actuator Low Control
33	0.5 OG	5275	Camshaft Position (CMP) Sensor - Intake Bank 1 Signal
34	0.5 D-BU	5300	5-Volt 1 Reference
35	0.5 D-GN	5273	Camshaft Position (CMP) Sensor - Exhaust Bank 1 Signal
36	0.5 YE	5276	Camshaft Position (CMP) Sensor - Intake Bank 2 Signal
37	0.5 L-BU	5302	5-Volt 1 Reference
38	0.5 PU	5274	Camshaft Position (CMP) Sensor - Exhaust Bank 2 Signal
39	0.5 PU	5284	Cam Phaser Control Intake Bank 1
40	0.5 L-GN	5282	Cam Phaser Control Exhaust Bank 1
41	0.5 OG/BK	5272	Cam Phaser Control Intake Bank 2
42	0.5 WH/BK	5283	Cam Phaser Control Exhaust Bank 2
43-45	-	-	Not Available
46	0.8 L-BU	4804	Fuel Injector 4 Control
47	0.8 L-GN	4805	Fuel Injector 5 Control
48	0.8 D-BU	4802	Fuel Injector 2 Control
49	-	-	Not Available
50	0.8 D-GN	4803	Fuel Injector 3 Control
51	0.8 PU	4806	Fuel Injector 6 Control
52	0.8 BN	4801	Fuel Injector 1 Control
53	0.5 TN	5301	Low Reference
54	0.5 YE/BK	5297	5-Volt 1 Reference
55	0.5 GY	5296	Low Reference
56	0.5 BN/WH	5303	Low Reference
57	0.5 L-GN	5298	5-Volt 1 Reference
58	0.5 BN	5299	Low Reference
59	0.5 BN	6753	Low Reference
60	0.5 BN/WH	6754	Low Reference
61	0.5 D-BU	6755	Low Reference
62	0.5 D-BU/WH	6756	Low Reference
63-65	-	-	Not Available
66	0.75 L-BU/WH	4904	Fuel Injector 4 Control
67	0.75 L-GN/WH	4905	Fuel Injector 5 Control
68	0.75 D-BU/WH	4902	Fuel Injector 2 Control
69	-	-	Not Available

Pin	Wire	Circuit	Function
70	0.75 D-GN/WH	4903	Fuel Injector 3 Control
71	0.75 PU/WH	4906	Fuel Injector 6 Control
72	0.75 BN/WH	4901	Fuel Injector 1 Control
73	2.5 BK/WH	451	Ground

ENGINE COOLANT TEMPERATURE (ECT) SENSOR



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15449028
- Service Connector: 88987993
- Description: 2-Way F GT 150 Series, Sealed (BK)

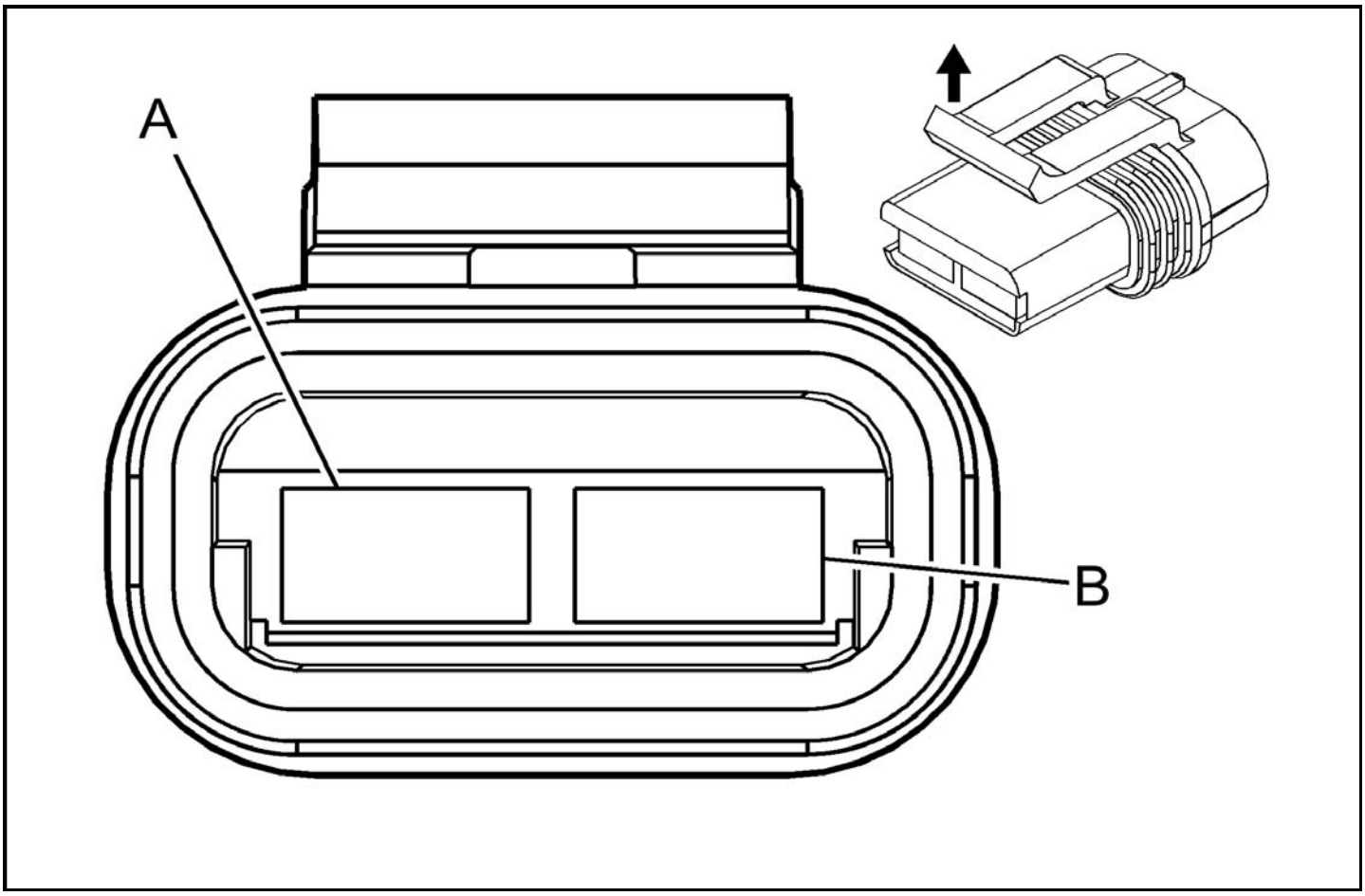
Terminal Part Information

- Terminated Lead: 13576360
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 15326267/19
- Core/Insulation Crimp: E/4

Engine Coolant Temperature (ECT) Sensor

Pin	Wire	Circuit	Function
A	0.5 OG/BK	469	Low Reference
B	0.5 YE	410	ECT Sensor Signal

ENGINE COOLING FAN - LEFT



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 12033769
- Service Connector: 12101917
- Description: 2-Way F Metri-Pack 630 Series, Sealed, Pull To Seat (BK)

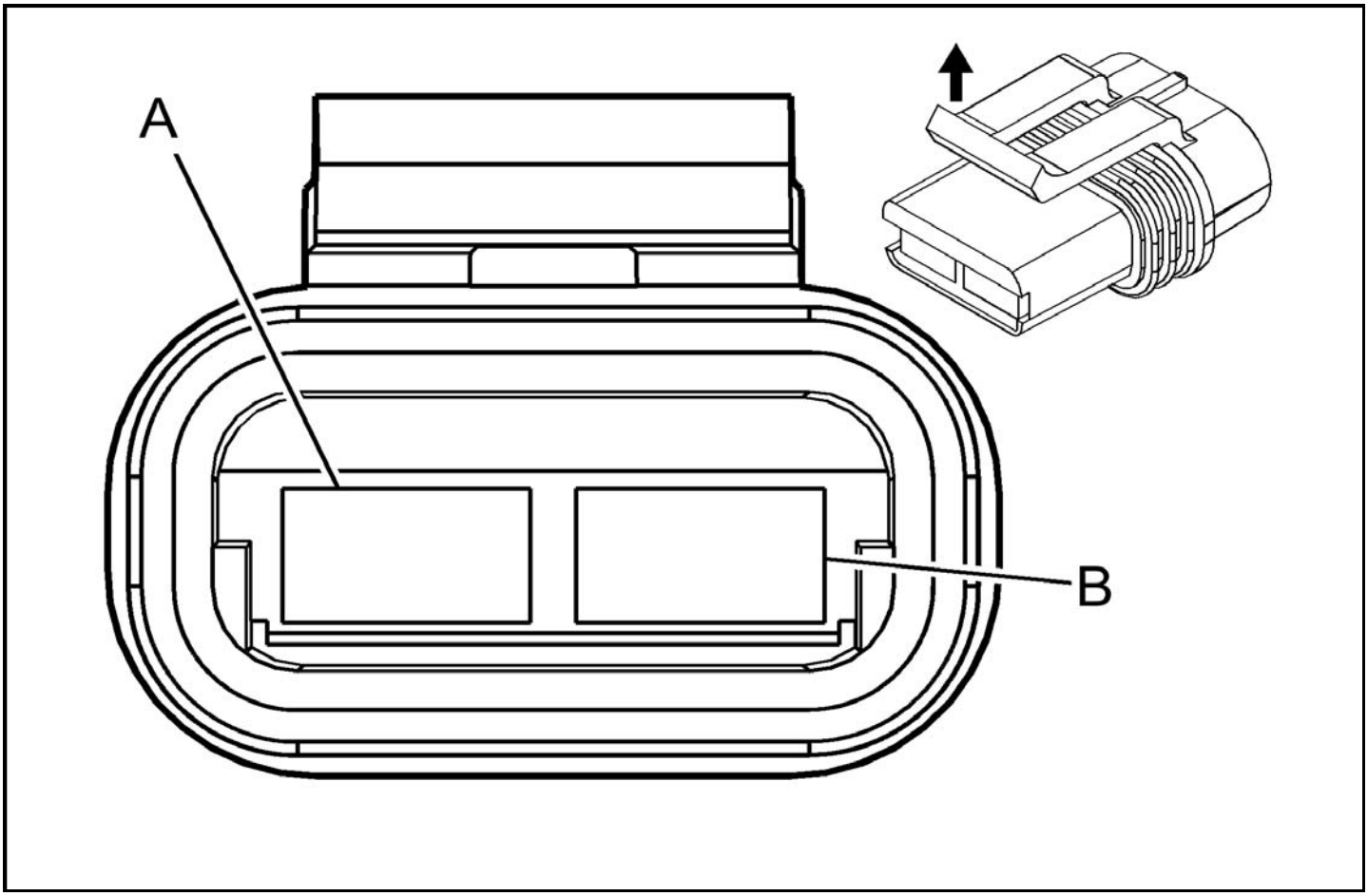
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-42 (RD)
- Terminal/Tray: 12033997/8
- Core/Insulation Crimp: D/B

Engine Cooling Fan - Left

Pin	Wire	Circuit	Function
A	3 GY	532	Cooling Fan Low Reference
B	3 WH	504	Cooling Fan Motor Supply Voltage

ENGINE COOLING FAN - RIGHT



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 12033769
- Service Connector: 12101917
- Description: 2-Way F Metri-Pack 630 Series, Sealed, Pull To Seat (BK)

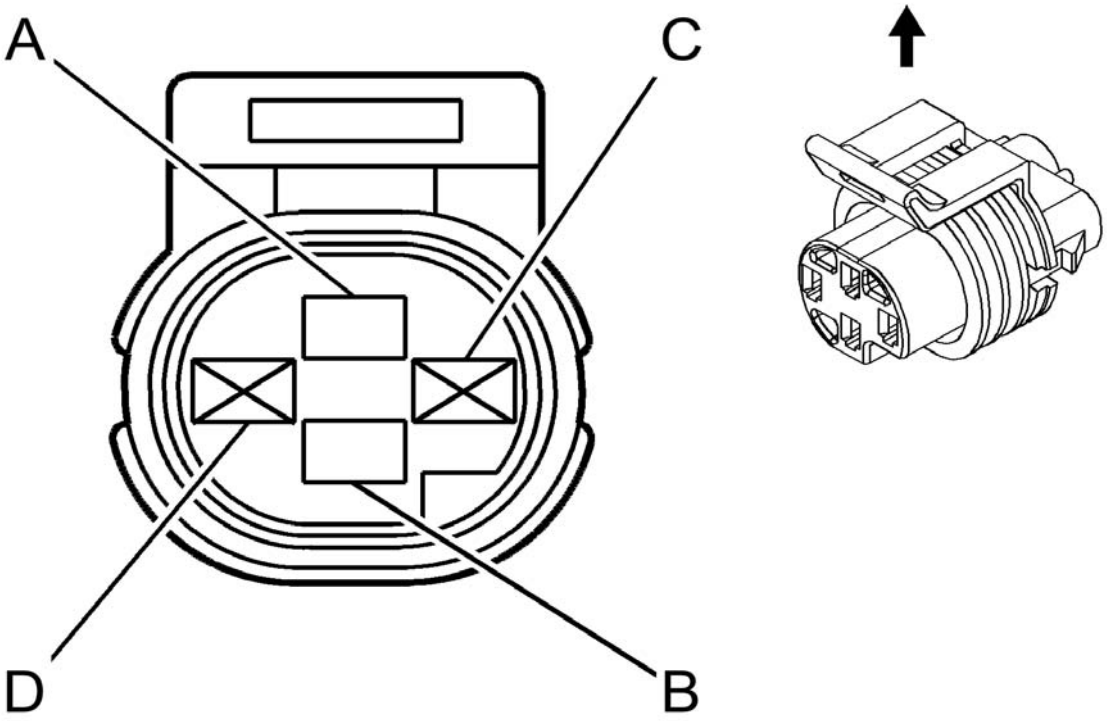
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-42 (RD)
- Terminal/Tray: 12033997/8
- Core/Insulation Crimp: D/B

Engine Cooling Fan - Right

Pin	Wire	Circuit	Function
A	3 BK	250	Ground
B	3 L-BU	409	Cooling Fan Motor Supply Voltage

ENGINE OIL PRESSURE (EOP) SWITCH



Connector Part Information

- Harness Type: Engine
- OEM Connector: 12065400
- Service Connector: 13585859
- Description: 4-Way F Metri-Pack 150 Series (L-GN)

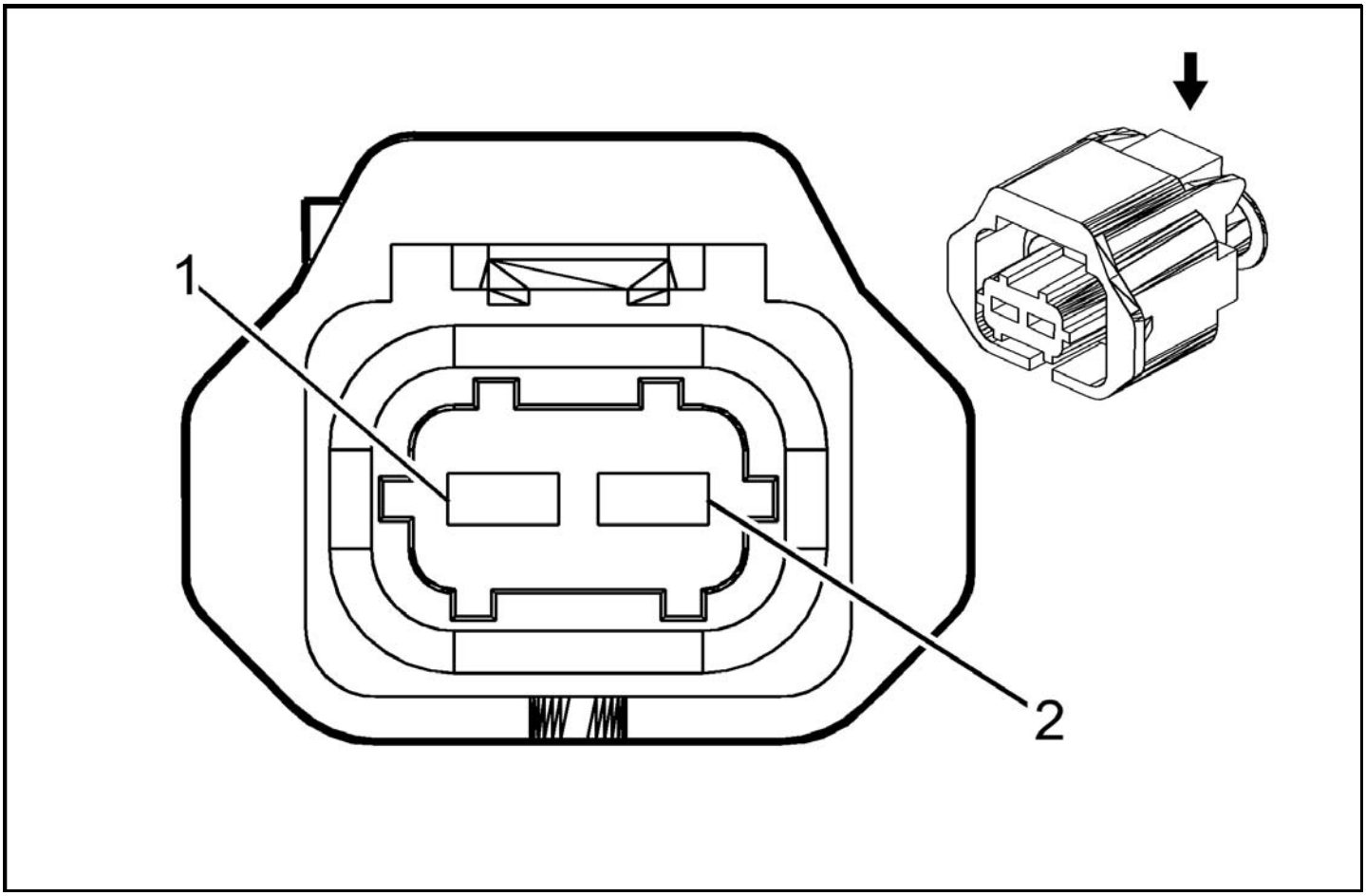
Terminal Part Information

- Terminated Lead: 13575427
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1

Engine Oil Pressure (EOP) Switch

Pin	Wire	Circuit	Function
A	0.5 TN/BK	231	Oil Pressure Signal
B	0.5 BK/WH	451	Ground
C-D	-	-	Not Available

EVAPORATIVE EMISSION (EVAP) CANISTER PURGE SOLENOID VALVE



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15397337
- Service Connector: 13355748
- Description: 2-Way F Power Timer Series (BK)

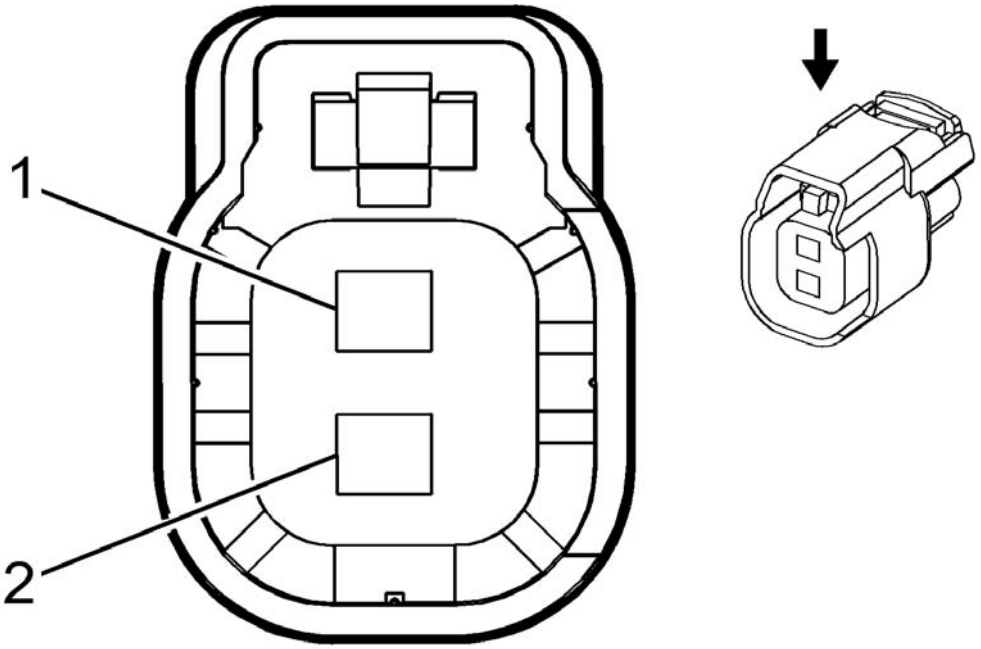
Terminal Part Information

- Terminated Lead: 13581346
- Release Tool: J-38125-36
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: 4-964286-1/16
- Core/Insulation Crimp: E/1

Evaporative Emission (EVAP) Canister Purge Solenoid Valve

Pin	Wire	Circuit	Function
1	0.5 PK/BK	5293	Ignition 1 Voltage
2	0.35 D-GN/WH	428	EVAP Canister Purge Solenoid Control

EVAPORATIVE EMISSION (EVAP) CANISTER VENT SOLENOID VALVE



Connector Part Information

- Harness Type: Body
- OEM Connector: 13771883
- Service Connector: 13579002
- Description: 2-Way F 1.5 Series, Sealed (BK)

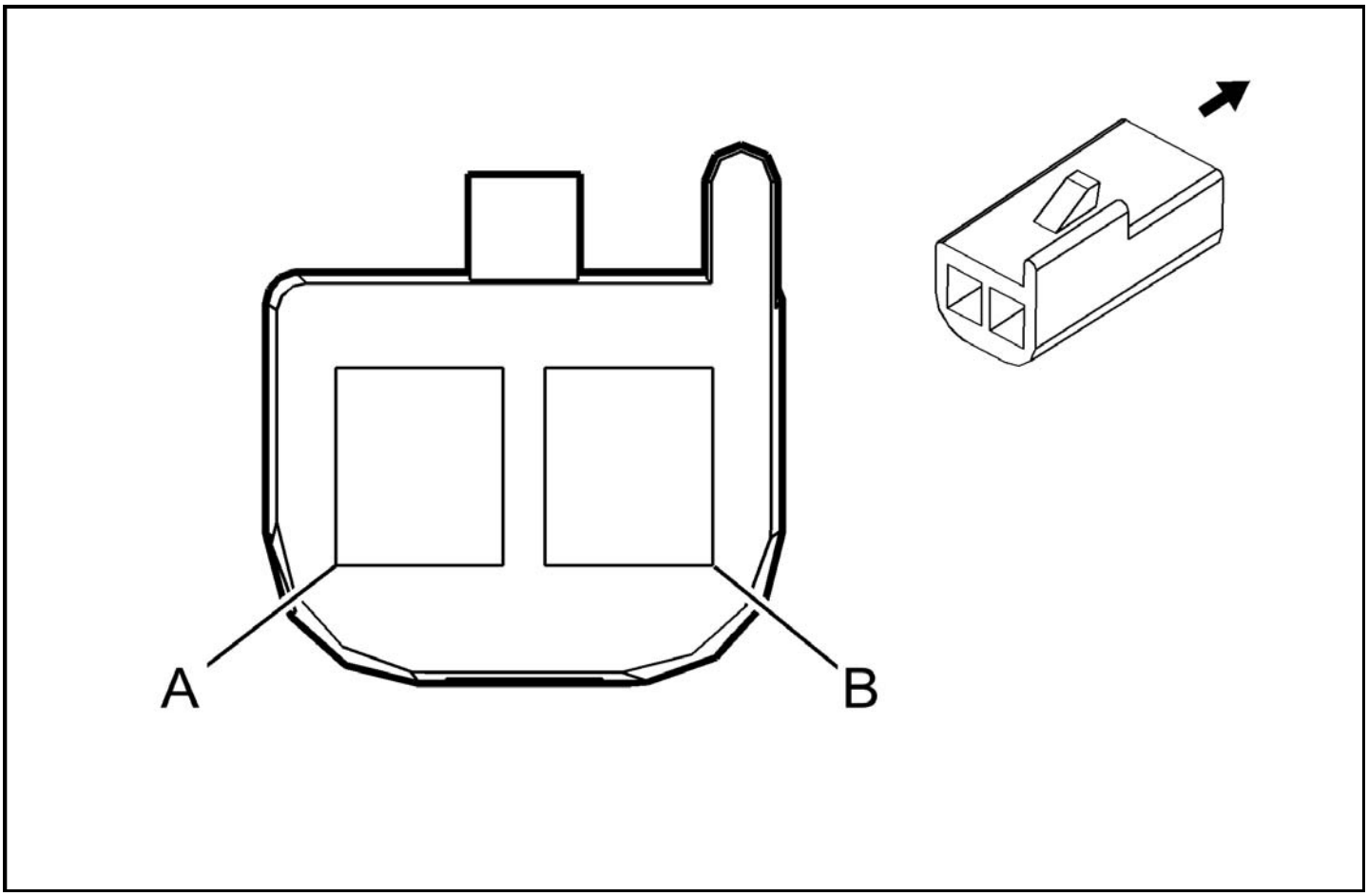
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-217
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: Not Stocked in Kit/NA
- Core/Insulation Crimp: 7/7

Evaporative Emission (EVAP) Canister Vent Solenoid Valve

Pin	Wire	Circuit	Function
1	0.35 WH	1310	EVAP Canister Vent Solenoid Control
2	0.5 RD/WH	2840	Battery Positive Voltage

EVAPORATOR TEMPERATURE SENSOR



Connector Part Information

- Harness Type: HVAC
- OEM Connector: 12047662
- Service Connector: Service by Harness - See Part Catalog
- Description: 2-Way F Metri-Pack 150 Series (BK)

Terminal Part Information

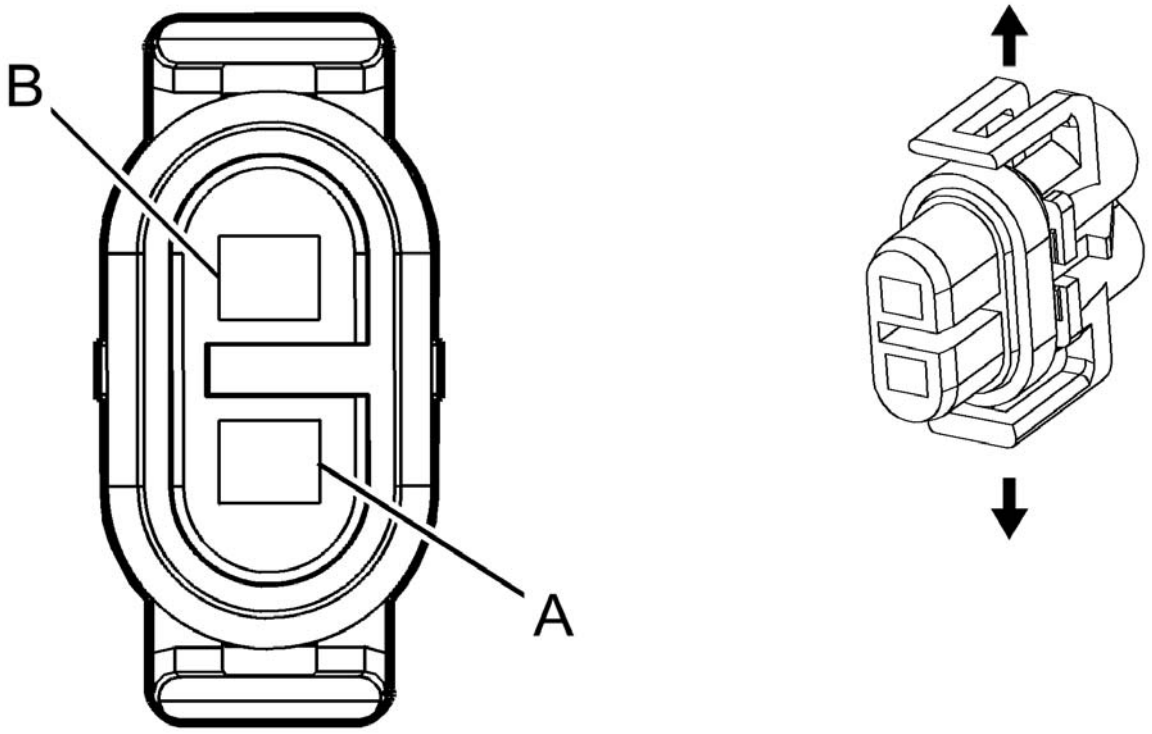
- Terminal/Tray: Service by Harness - See Part Catalog
- Core/Insulation Crimp: Service by Harness - See Part Catalog
- Release Tool/Test Probe: Service by Harness - See Part Catalog

Evaporator Temperature Sensor

Pin	Wire	Circuit	Function

Pin	Wire	Circuit	Function
A	0.35 WH	2622	Front Frost Sensor Control
B	0.35 D-GN	6101	Low Reference

FOG LAMP - LEFT FRONT (T96)



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 13511639
- Service Connector: 13584255
- Description: 2-Way F Metri-Pack 280 Series, Sealed (BU)

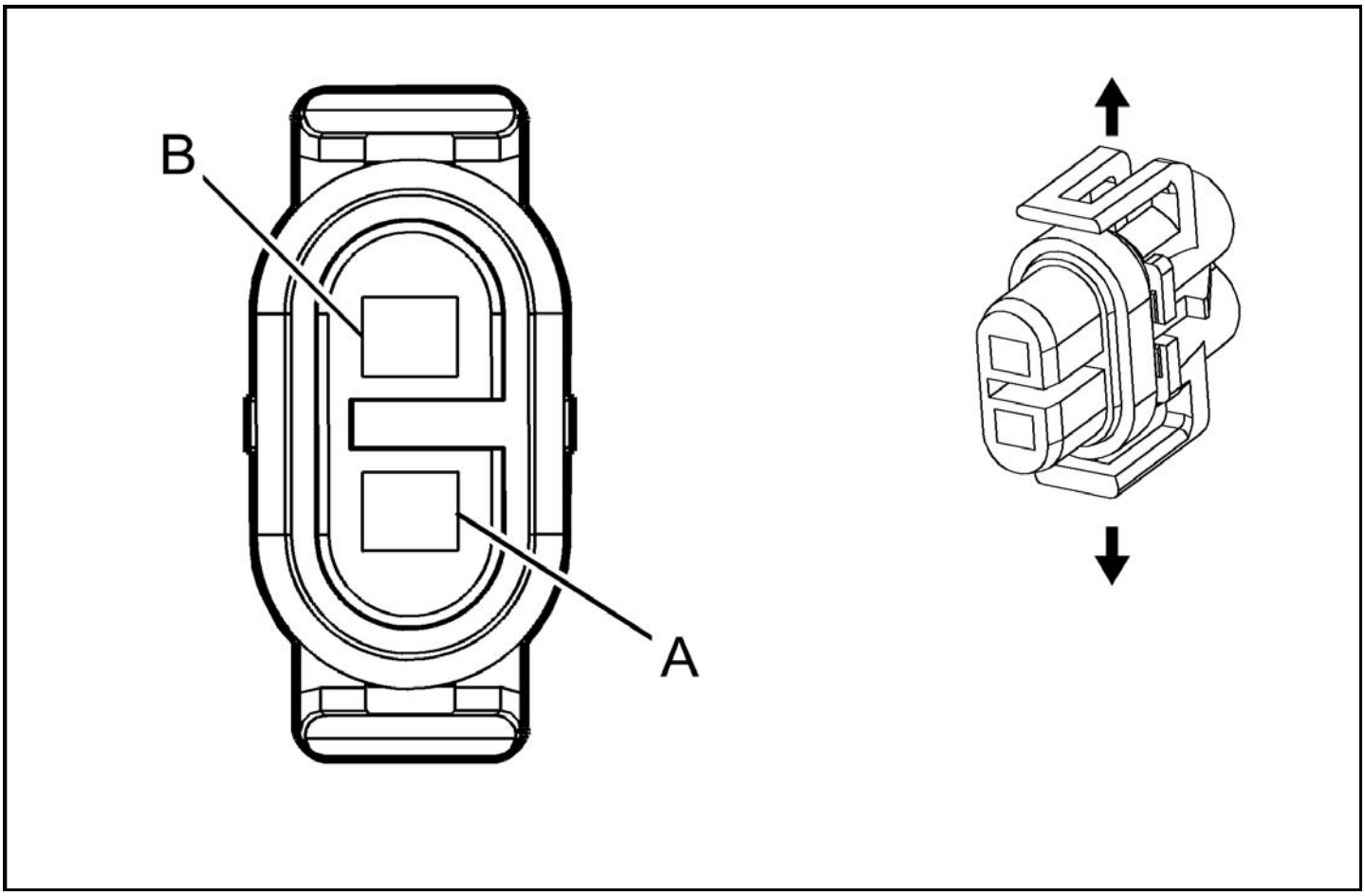
Terminal Part Information

- Terminated Lead: 13575418
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12077411/2
- Core/Insulation Crimp: 2/5

Fog Lamp - Left Front (T96)

Pin	Wire	Circuit	Function
A	0.5 PU	34	Front Fog Lamp Supply Voltage
B	0.5 BK	1350	Ground

FOG LAMP - RIGHT FRONT (T96)



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 13511639
- Service Connector: 13584255
- Description: 2-Way F Metri-Pack 280 Series, Sealed (BU)

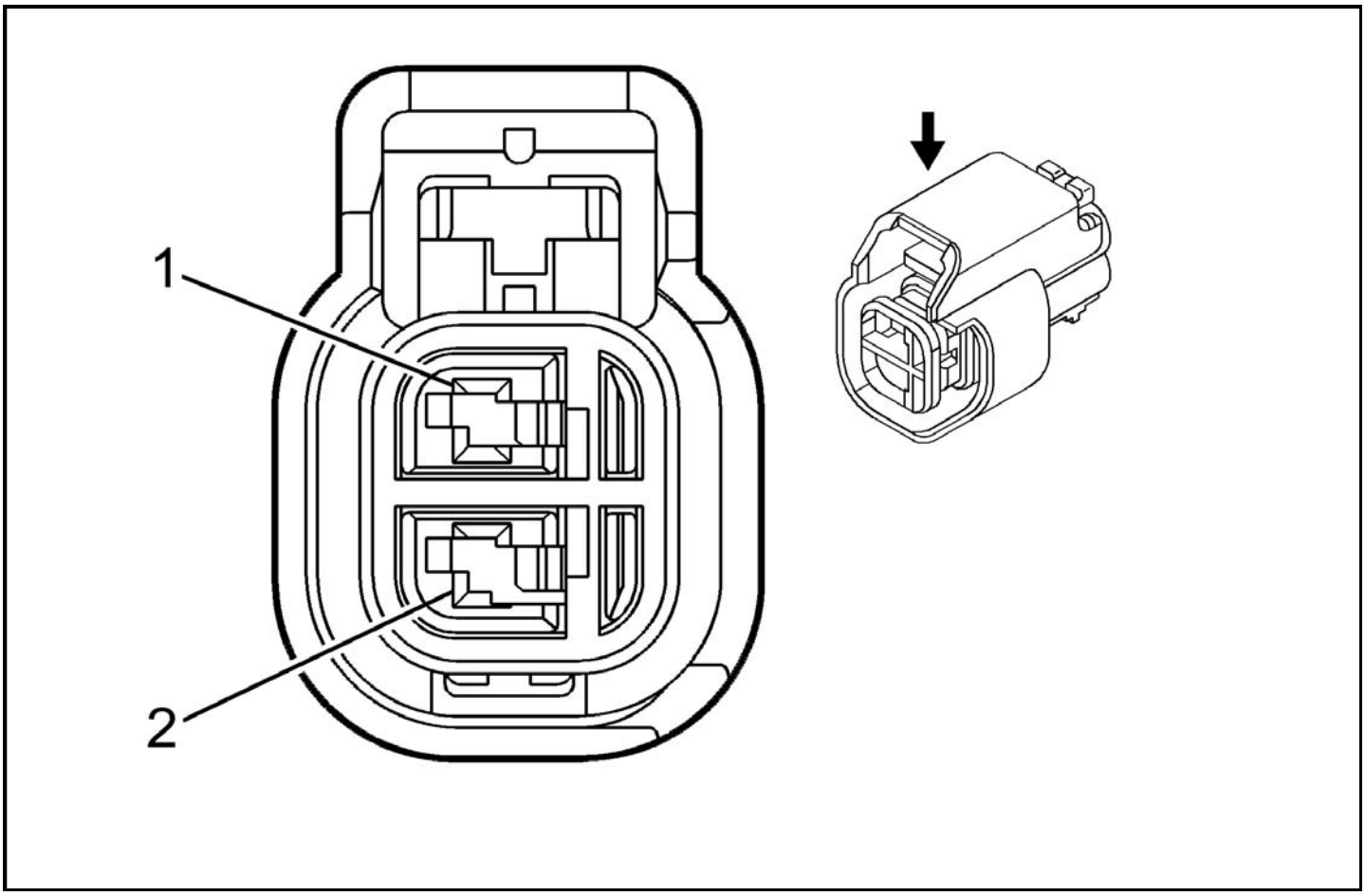
Terminal Part Information

- Terminated Lead: 13575418
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12077411/2
- Core/Insulation Crimp: 2/5

Fog Lamp - Right Front (T96)

Pin	Wire	Circuit	Function
A	0.5 PU	34	Front Fog Lamp Supply Voltage
B	0.5 BK	1250	Ground

FUEL INJECTOR 1



Connector Part Information

- Harness Type: Odd Fuel Injector
- OEM Connector: E-2157
- Service Connector: 88988054
- Description: 2-Way F Sleeve Assembly Wire Connector (BK)

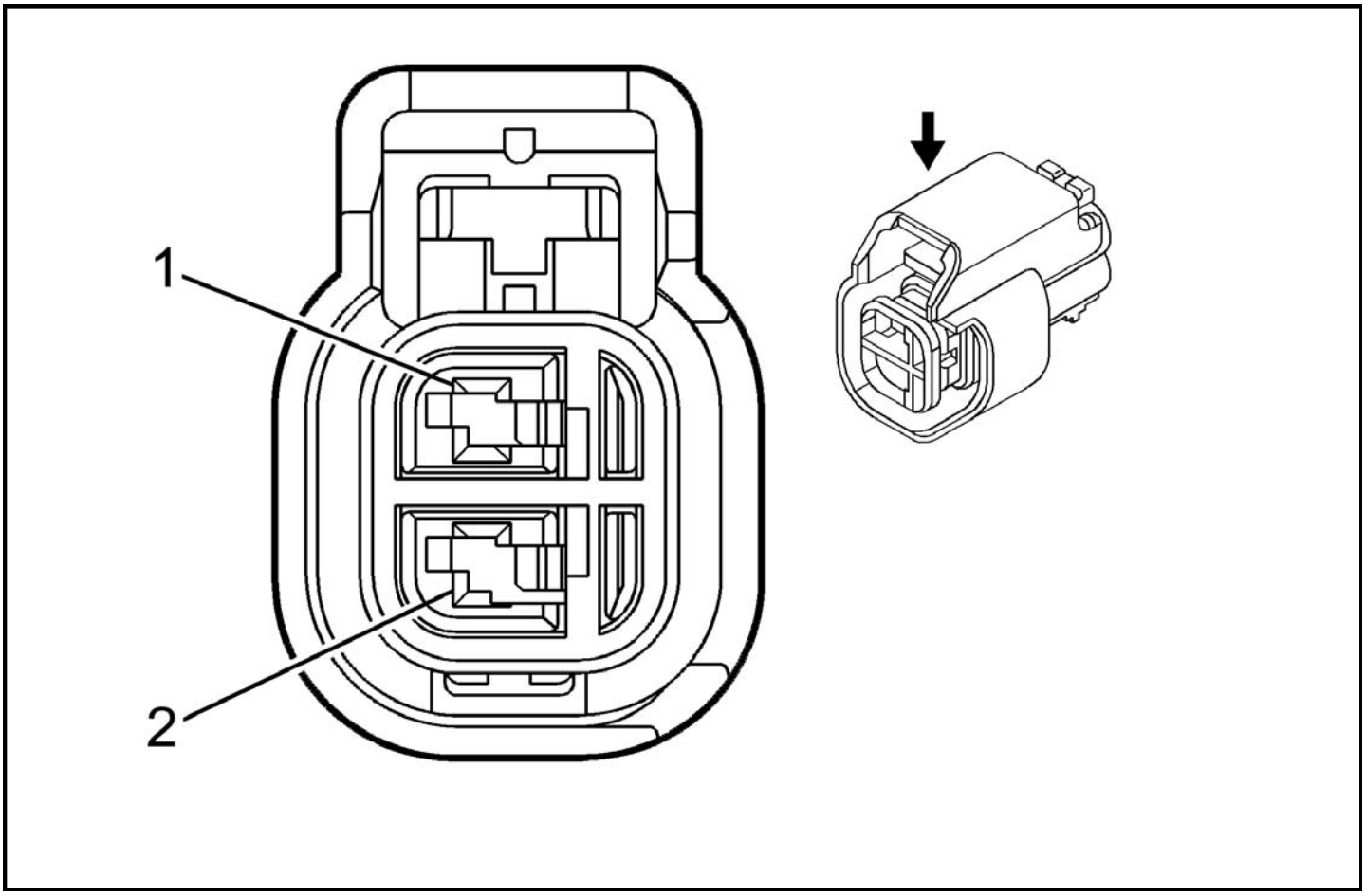
Terminal Part Information

- Terminated Lead: Service by Harness - See Part Catalog
- Terminal/Tray: 7116-4103-08/9
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-11A/J-35616-2A (GY)

Fuel Injector 1

Pin	Wire	Circuit	Function
1	0.8 BN	4801	Direct Fuel Injector (DFI) High Voltage Control Cylinder 1
2	0.8 BN/WH	4901	Direct Fuel Injector (DFI) High Voltage Supply Cylinder 1

FUEL INJECTOR 2



Connector Part Information

- Harness Type: Even Fuel Injector
- OEM Connector: E-2157
- Service Connector: 88988054
- Description: 2-Way F Sleeve Assembly Wire Connector (BK)

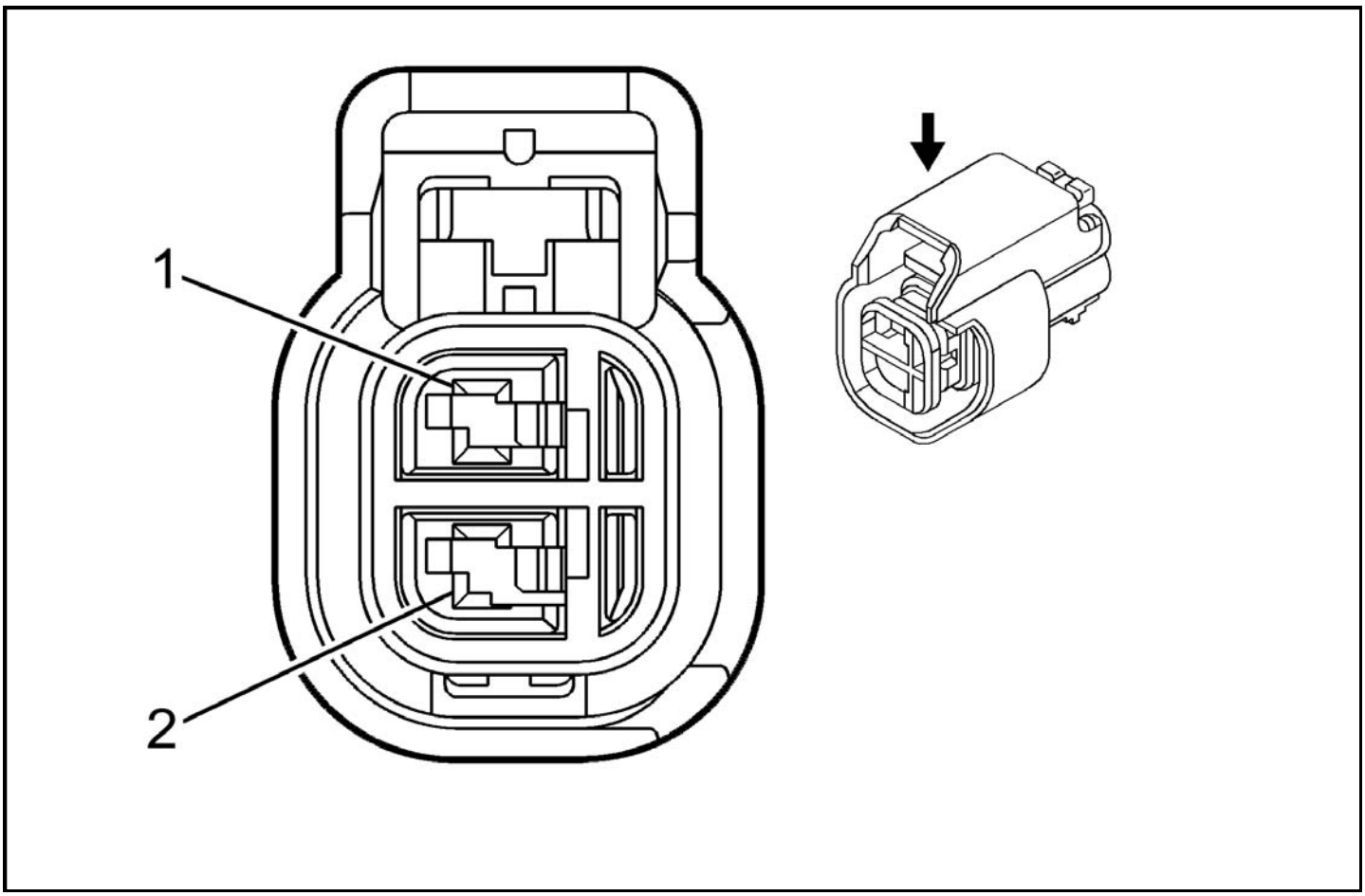
Terminal Part Information

- Terminated Lead: Service by Harness - See Part Catalog
- Terminal/Tray: 7116-4103-08/9
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-11A/J-35616-2A (GY)

Fuel Injector 2

Pin	Wire	Circuit	Function
1	0.8 D-BU	4802	Direct Fuel Injector (DFI) High Voltage Control Cylinder 2
2	0.8 D-BU/WH	4902	Direct Fuel Injector (DFI) High Voltage Supply Cylinder 2

FUEL INJECTOR 3



Connector Part Information

- Harness Type: Odd Fuel Injector
- OEM Connector: E-2157
- Service Connector: 88988054
- Description: 2-Way F Sleeve Assembly Wire Connector (BK)

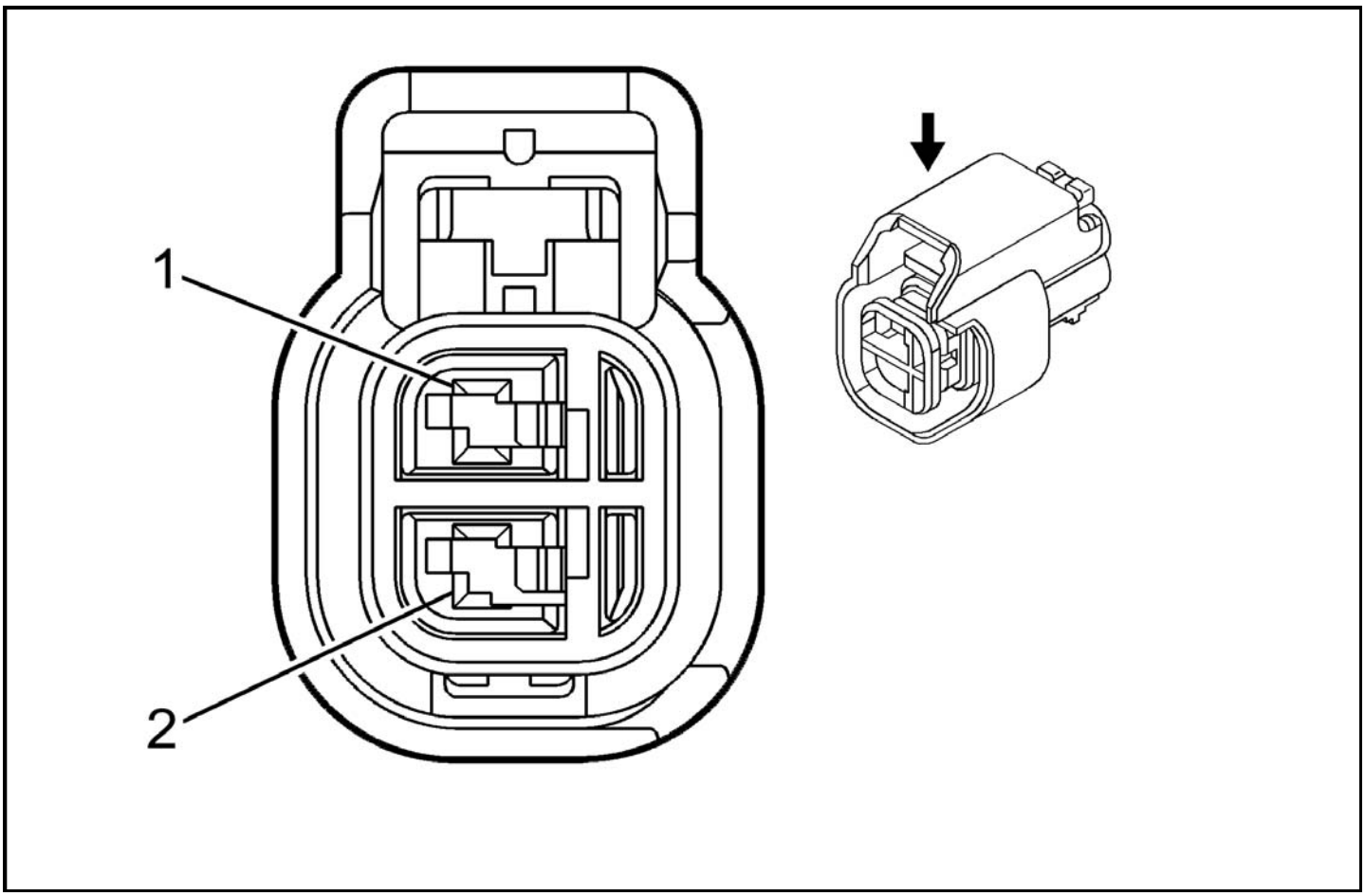
Terminal Part Information

- Terminated Lead: Service by Harness - See Part Catalog
- Terminal/Tray: 7116-4103-08/9
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-11A/J-35616-2A (GY)

Fuel Injector 3

Pin	Wire	Circuit	Function
1	0.8 D-GN	4803	Direct Fuel Injector (DFI) High Voltage Control Cylinder 3
2	0.8 D-GN/WH	4903	Direct Fuel Injector (DFI) High Voltage Supply Cylinder 3

FUEL INJECTOR 4



Connector Part Information

- Harness Type: Even Fuel Injector
- OEM Connector: E-2157
- Service Connector: 88988054
- Description: 2-Way F Sleeve Assembly Wire Connector (BK)

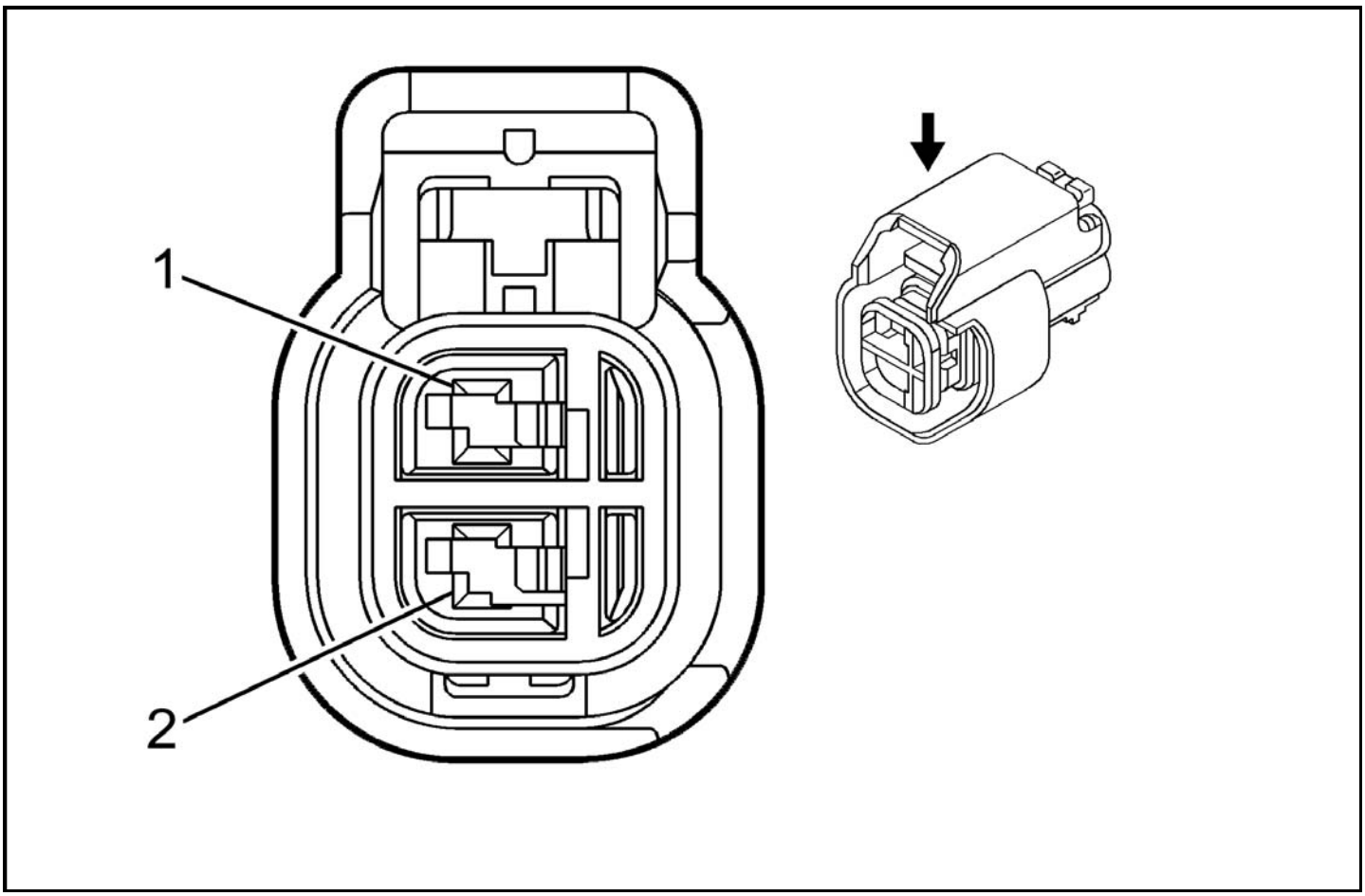
Terminal Part Information

- Terminated Lead: Service by Harness - See Part Catalog
- Terminal/Tray: 7116-4103-08/9
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-11A/J-35616-2A (GY)

Fuel Injector 4

Pin	Wire	Circuit	Function
1	0.8 L-BU	4804	Direct Fuel Injector (DFI) High Voltage Control Cylinder 4
2	0.8 L-BU/WH	4904	Direct Fuel Injector (DFI) High Voltage Supply Cylinder 4

FUEL INJECTOR 5



Connector Part Information

- Harness Type: Odd Fuel Injector
- OEM Connector: E-2157
- Service Connector: 88988054
- Description: 2-Way F Sleeve Assembly Wire Connector (BK)

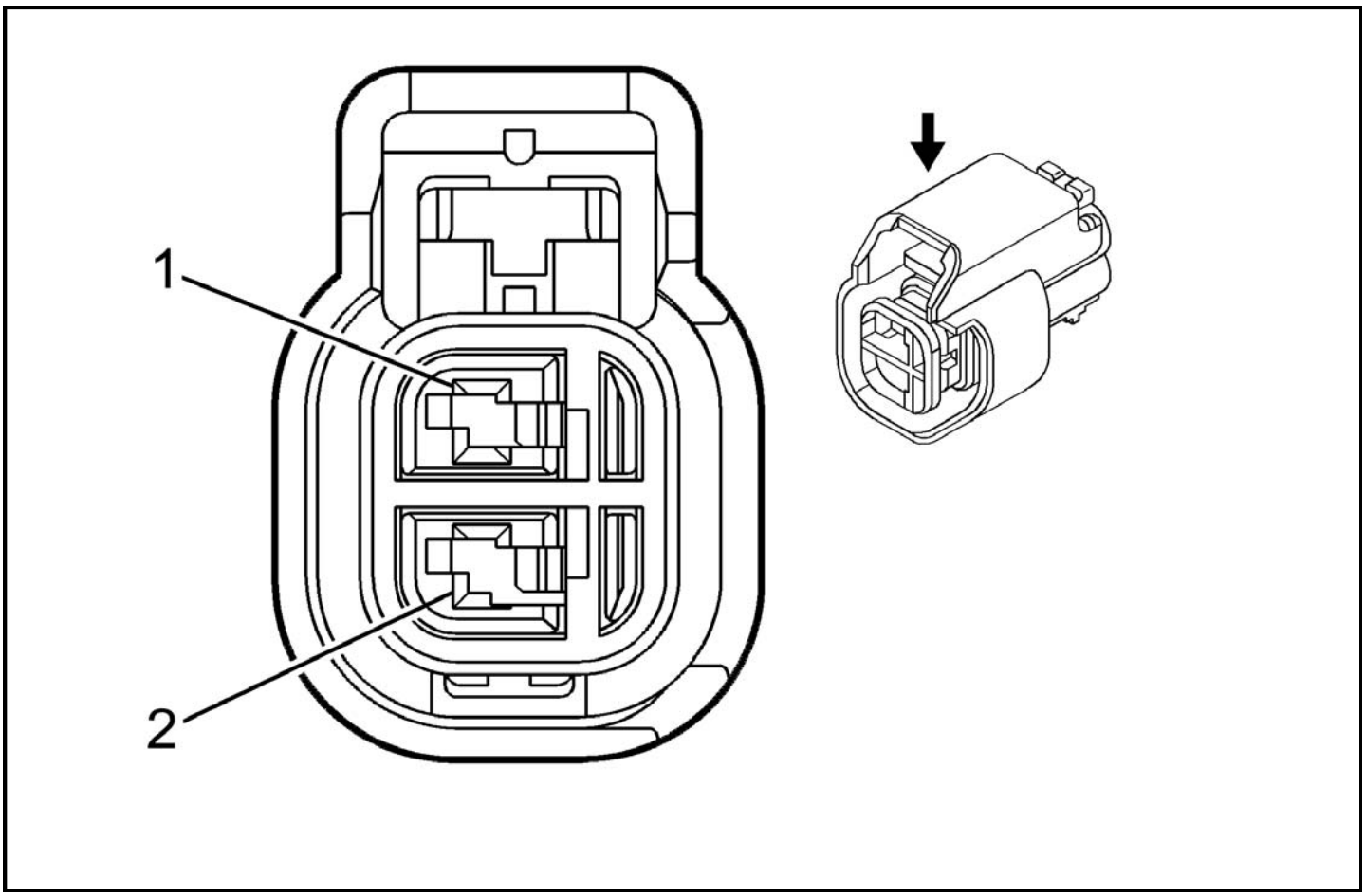
Terminal Part Information

- Terminated Lead: Service by Harness - See Part Catalog
- Terminal/Tray: 7116-4103-08/9
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-11A/J-35616-2A (GY)

Fuel Injector 5

Pin	Wire	Circuit	Function
1	0.8 L-GN	4805	Direct Fuel Injector (DFI) High Voltage Control Cylinder 5
2	0.8 L-GN/WH	4905	Direct Fuel Injector (DFI) High Voltage Supply Cylinder 5

FUEL INJECTOR 6



Connector Part Information

- Harness Type: Even Fuel Injector
- OEM Connector: E-2157
- Service Connector: 88988054
- Description: 2-Way F Sleeve Assembly Wire Connector (BK)

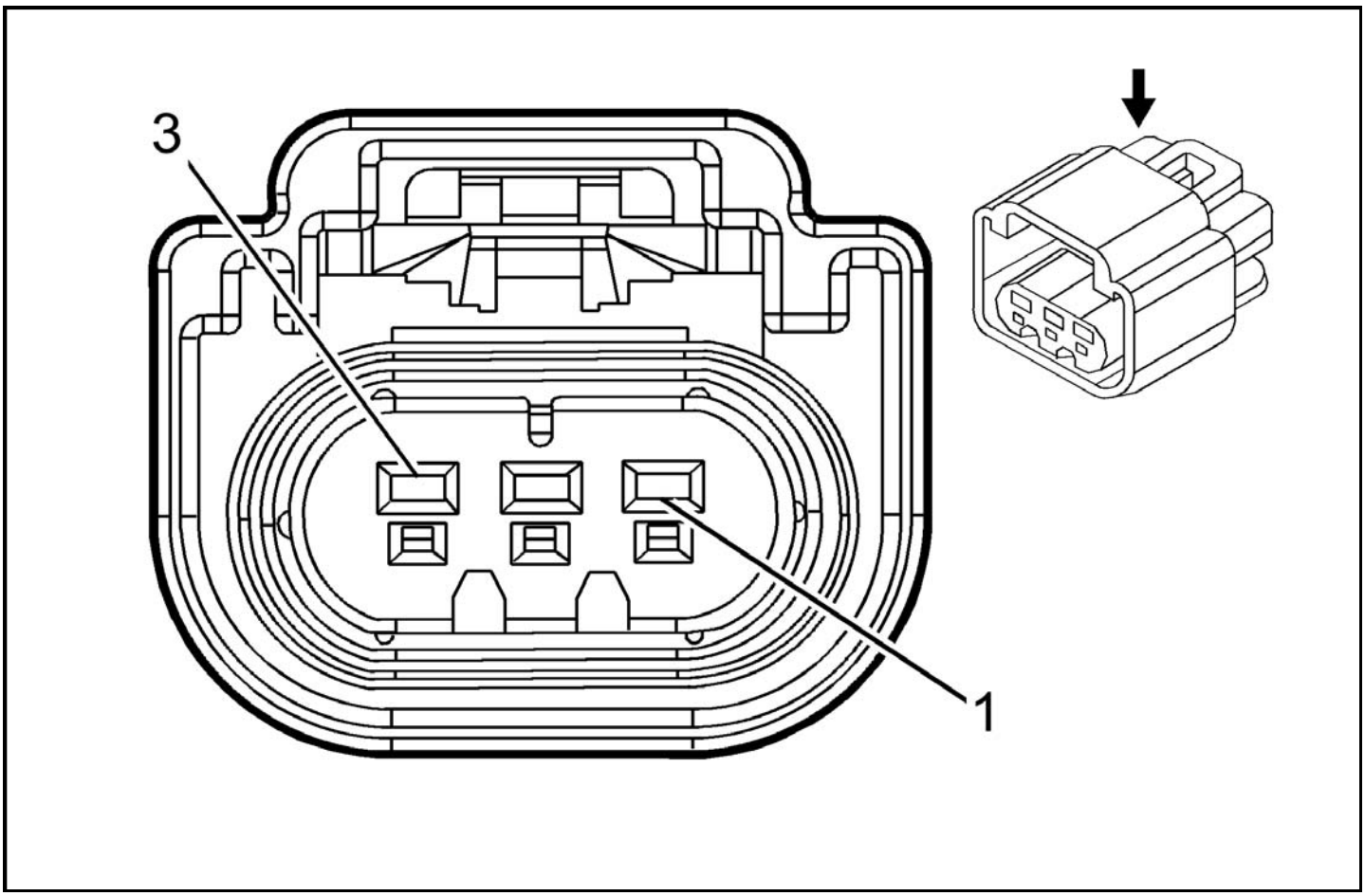
Terminal Part Information

- Terminated Lead: Service by Harness - See Part Catalog
- Terminal/Tray: 7116-4103-08/9
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-11A/J-35616-2A (GY)

Fuel Injector 6

Pin	Wire	Circuit	Function
1	0.8 PU	4806	Direct Fuel Injector (DFI) High Voltage Control Cylinder 6
2	0.8 PU/WH	4906	Direct Fuel Injector (DFI) High Voltage Supply Cylinder 6

FUEL PRESSURE SENSOR



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13511131
- Service Connector: 19168035
- Description: 3-Way F GT 150 Series, Sealed (BK)

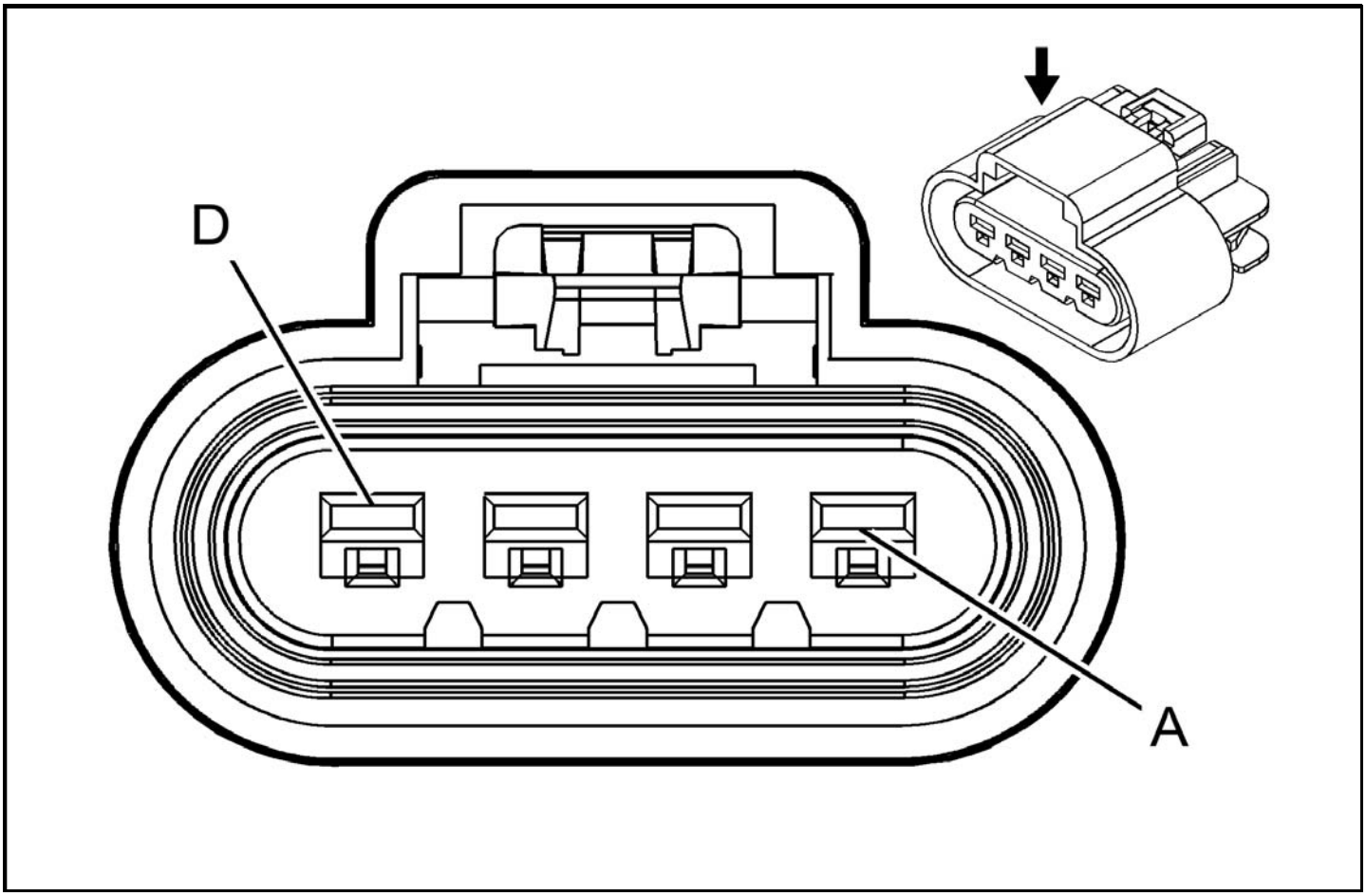
Terminal Part Information

- Terminal/Tray: 12191818/8
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: J-38125-553/J-35616-2A (GY)

Fuel Pressure Sensor

Pin	Wire	Circuit	Function
1	0.5 PU	7446	Fuel Line Pressure Sensor Signal
2	0.5 GY	7447	Low Reference
3	0.5 BN	7445	5V Reference

FUEL PUMP AND SENDER ASSEMBLY



Connector Part Information

- Harness Type: Rear Chassis
- OEM Connector: 15326631
- Service Connector: 13580864
- Description: 4-Way F GT 280 5.8 Series, Sealed (BK)

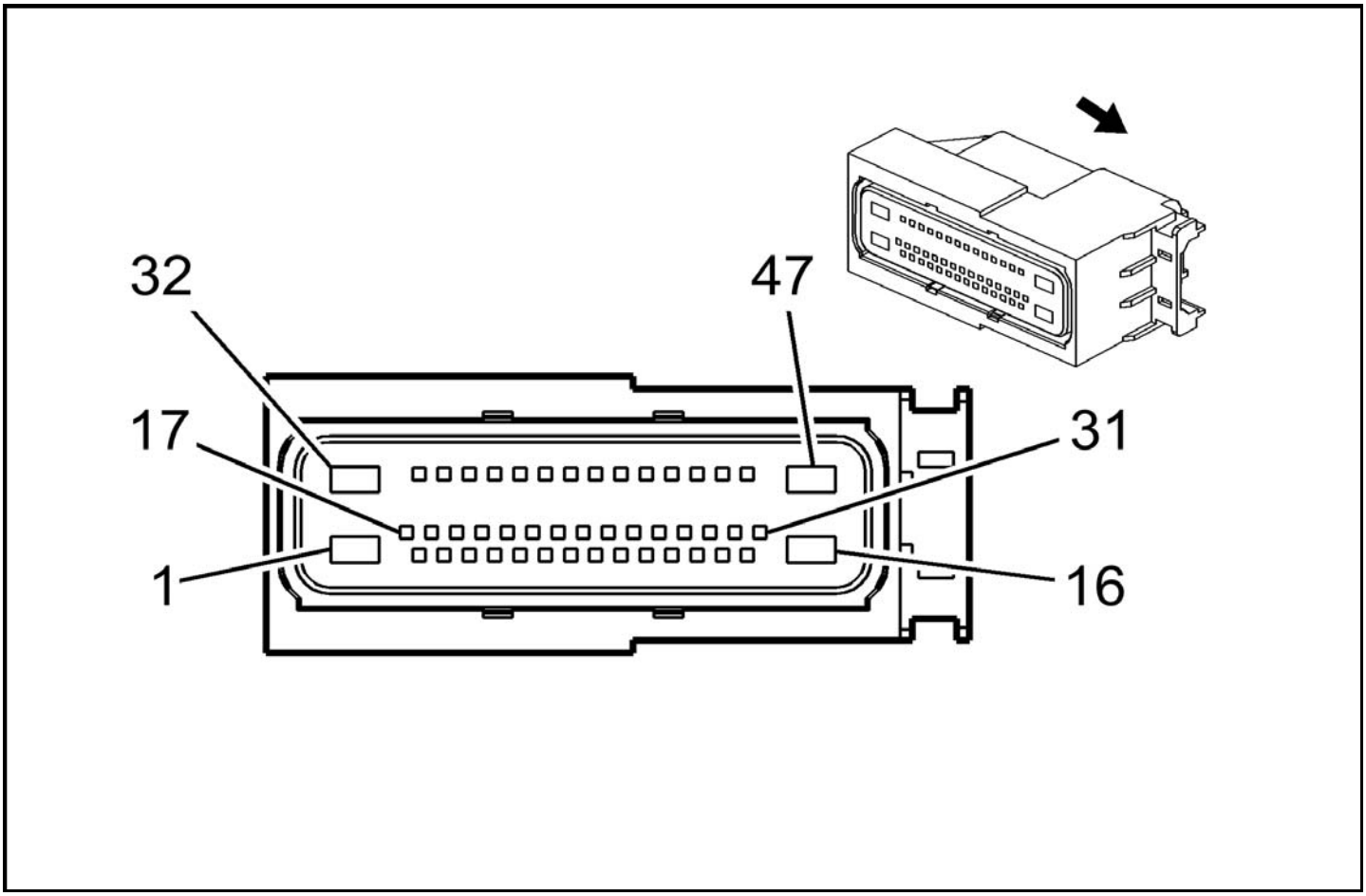
Terminal Part Information

- Terminated Lead: 13575405
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304719/19
- Core/Insulation Crimp: 2/5

Fuel Pump and Sender Assembly

Pin	Wire	Circuit	Function
A	2 PK	1580	Fuel Pump Ground
B	0.5 PU	30	Fuel Level Sensor Signal
C	0.35 BK/WH	510	Low Reference
D	2 GY	120	Fuel Pump Supply Voltage

FUEL PUMP FLOW CONTROL MODULE



Connector Part Information

- Harness Type: Body
- OEM Connector: 19153034
- Service Connector: 89047377
- Description: 47-Way F ASG Series (BK)

Terminal Part Information

- Pins: 1, 16, 32, 47
- Terminated Lead: 13327187
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-42 (RD)

- Terminal/Tray: 15476168/5
- Core/Insulation Crimp: F/3

- Pins: 5-7, 10, 13, 17, 21, 22, 36, 44
- Terminated Lead: 13576387
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SAITS-A03T-M064/14
- Core/Insulation Crimp: 9/9

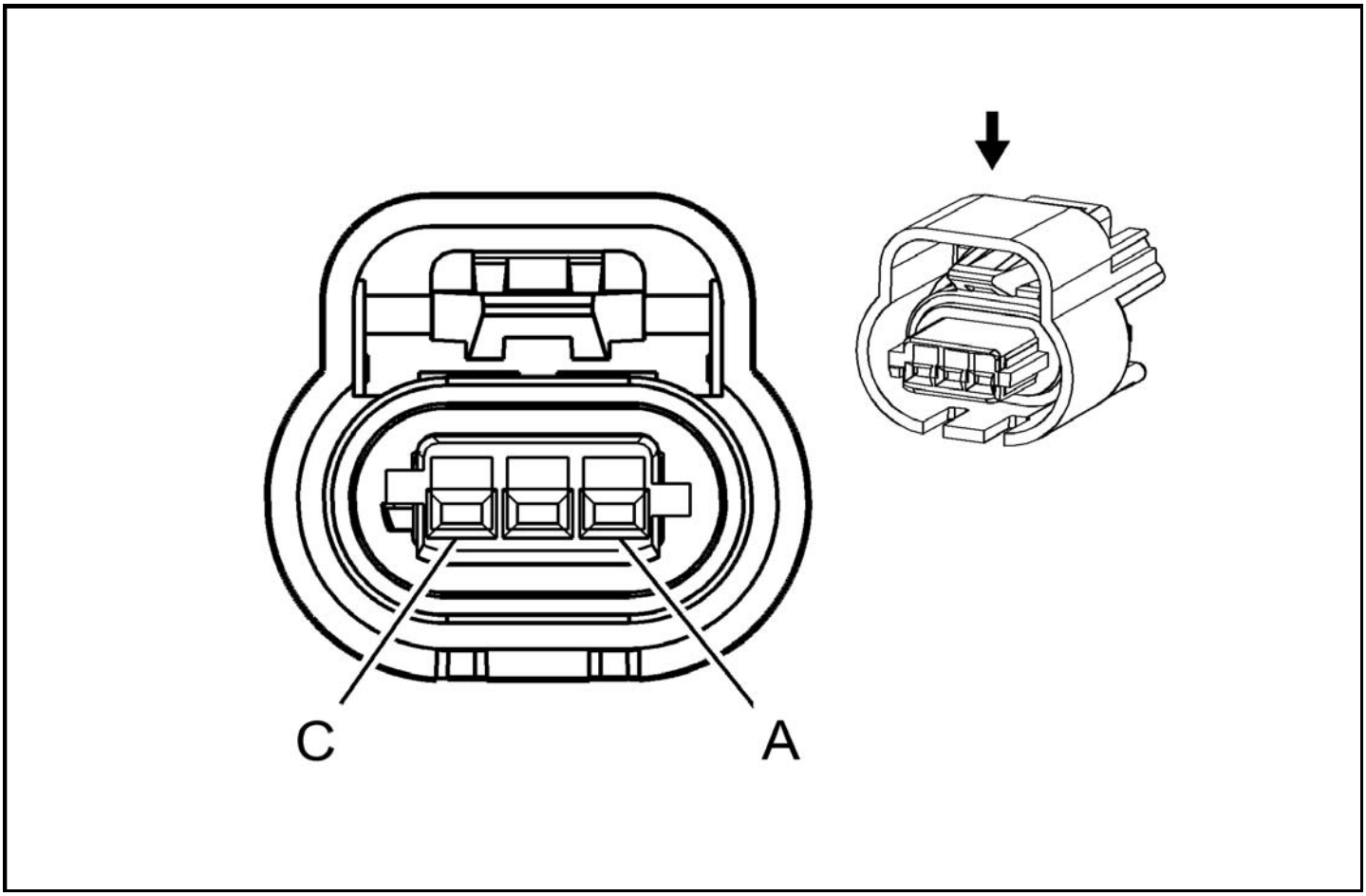
- Pins: 15
- Terminated Lead: 13576388
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SAITS-A03T-M064/14
- Core/Insulation Crimp: 9/9

Fuel Pump Flow Control Module

Pin	Wire	Circuit	Function
1	2 BK	750	Ground
2-4	-	-	Not Available
5	0.35 GY	7447	Fuel Pressure Sensor Low Reference
6	0.35 TN	2501	High Speed GMLAN Serial Data Bus-
7	0.35 TN/BK	2500	High Speed GMLAN Serial Data Bus+
8-9	-	-	Not Available
10	0.5 PU	7446	Fuel Pressure Sensor Signal
11-12	-	-	Not Available
13	0.5 D-GN/WH	465	Fuel Pump Relay Control - Primary
14	-	-	Not Available
15	0.5 PK	339	Ignition 1 Voltage
16	2 PK	1580	Fuel Pump Ground
17	0.35 L-BU	5986	Serial Data Communication Enable
18-20	-	-	Not Available
21	0.35 TN	2501	High Speed GMLAN Serial Data Bus-
22	0.35 TN/BK	2500	High Speed GMLAN Serial Data Bus+
23-31	-	-	Not Available
32	2 RD/WH	3640	Battery Positive Voltage
33-35	-	-	Not Available
36	0.5 BN	7445	Fuel Pressure Sensor 5V Reference
37-43	-	-	Not Available
44	0.5 BARE	7444	Drain Wire
45-46	-	-	Not Available

Pin	Wire	Circuit	Function
47	2 GY	120	Fuel Pump Supply Voltage

FUEL RAIL PRESSURE (FRP) SENSOR



Connector Part Information

- Harness Type: Even Fuel Injector
- OEM Connector: 15326556
- Service Connector: 88953359
- Description: 3-Way F GT 150 Series, Sealed (BK)

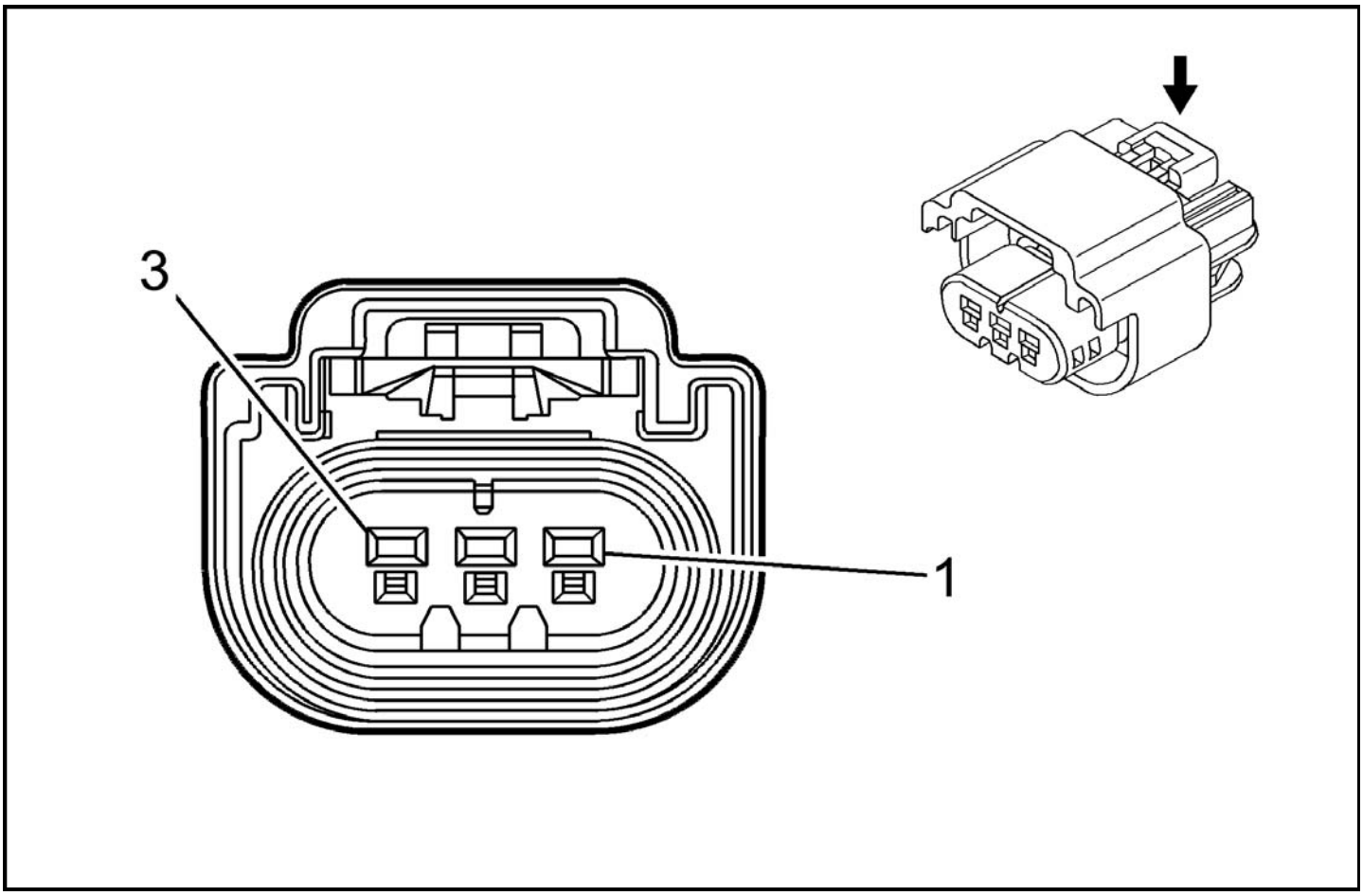
Terminal Part Information

- Terminated Lead: 13576362
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 15326267/19
- Core/Insulation Crimp: E/4

Fuel Rail Pressure (FRP) Sensor

Pin	Wire	Circuit	Function
A	0.5 GY	598	5-Volt Reference 1
B	0.5 YE	2918	Fuel Rail Pressure Sensor Signal
C	0.5 TN	808	Low Reference

FUEL TANK PRESSURE (FTP) SENSOR



Connector Part Information

- Harness Type: Rear Chassis
- OEM Connector: 13522407
- Service Connector: 19179274
- Description: 3-Way F GT 150 Series, Sealed (BK)

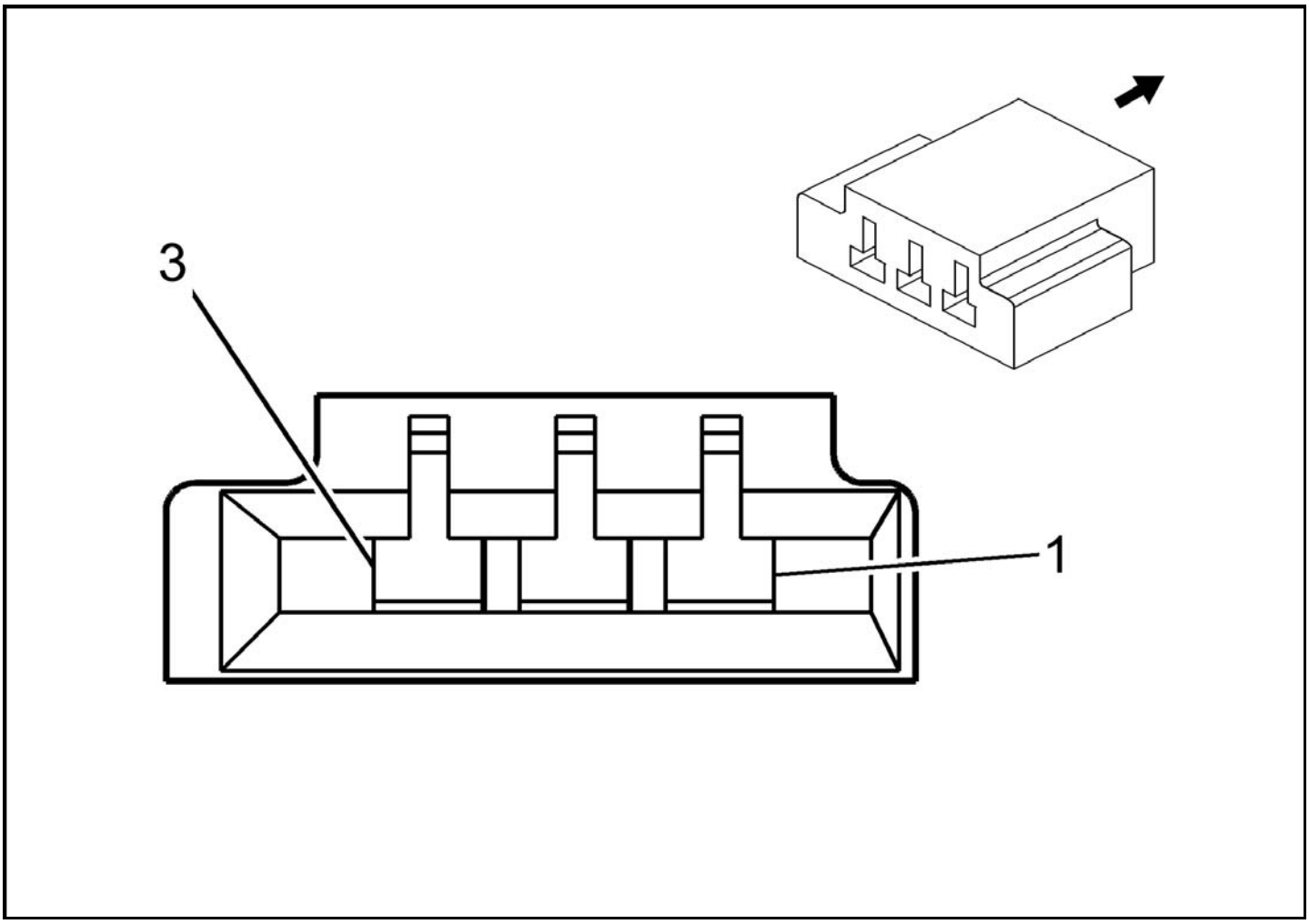
Terminal Part Information

- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Fuel Tank Pressure (FTP) Sensor

Pin	Wire	Circuit	Function
1	0.35 D-GN	890	Fuel Tank Pressure Sensor Signal
2	0.35 TN	2759	Low Reference
3	0.35 GY	416	5-Volt Reference 1

GARAGE DOOR OPENER (UG1)



Connector Part Information

- Harness Type: Headliner
- OEM Connector: 12162335
- Service Connector: 13505907
- Description: 3-Way F P/C Series (NA)

Terminal Part Information

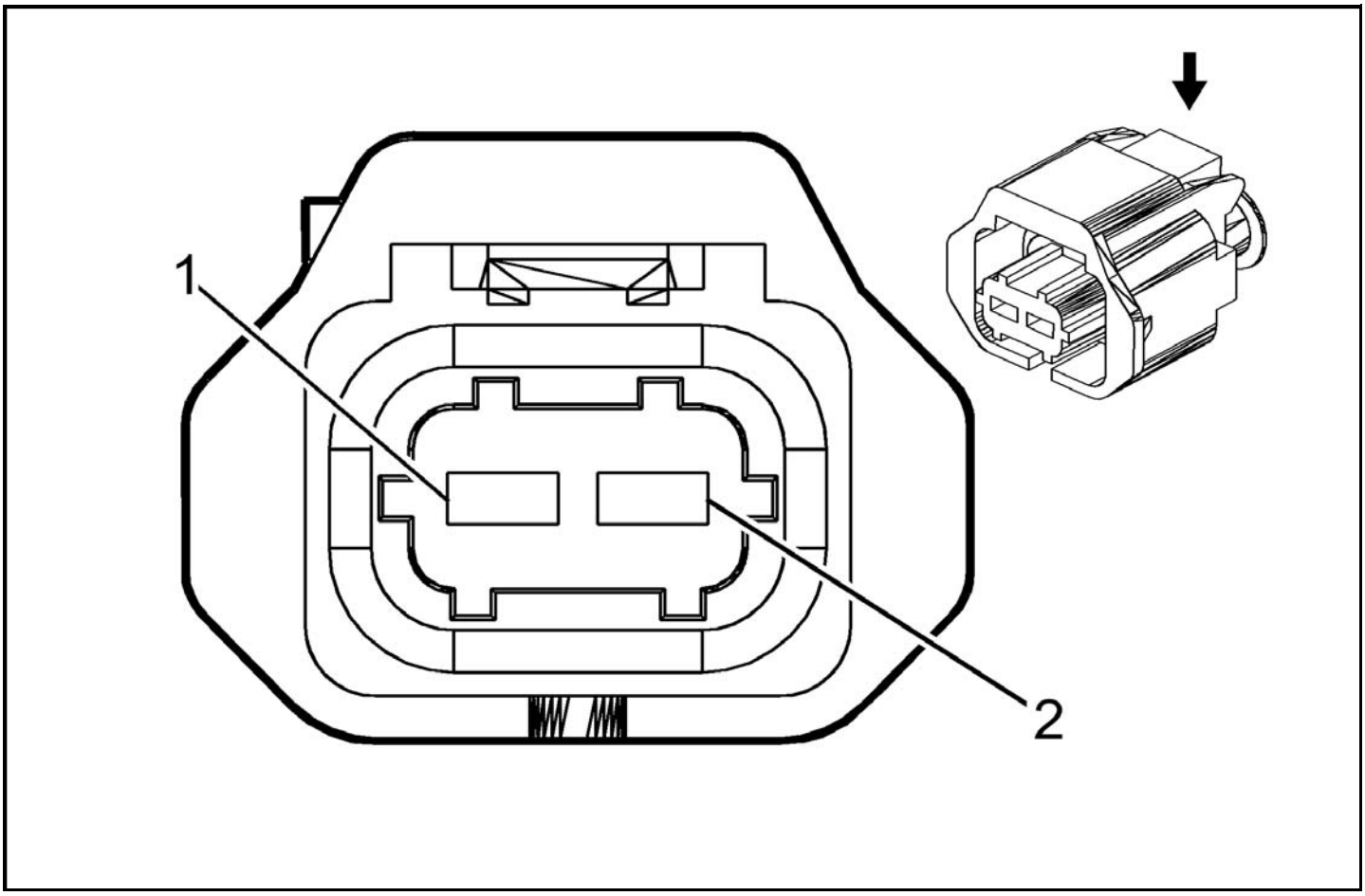
- Terminated Lead: Service by Connector Assembly - 13505907
- Release Tool: J-38125-213
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 08-50-0115/20

- Core/Insulation Crimp: E/C

Garage Door Opener (UG1)

Pin	Wire	Circuit	Function
1	0.35 RD/WH	2340	Battery Positive Voltage
2	-	-	Not Used
3	0.35 BK	550	Ground

GENERATOR X1



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15397337
- Service Connector: 13355748
- Description: 2-Way F Power Timer Series (BK)

Terminal Part Information

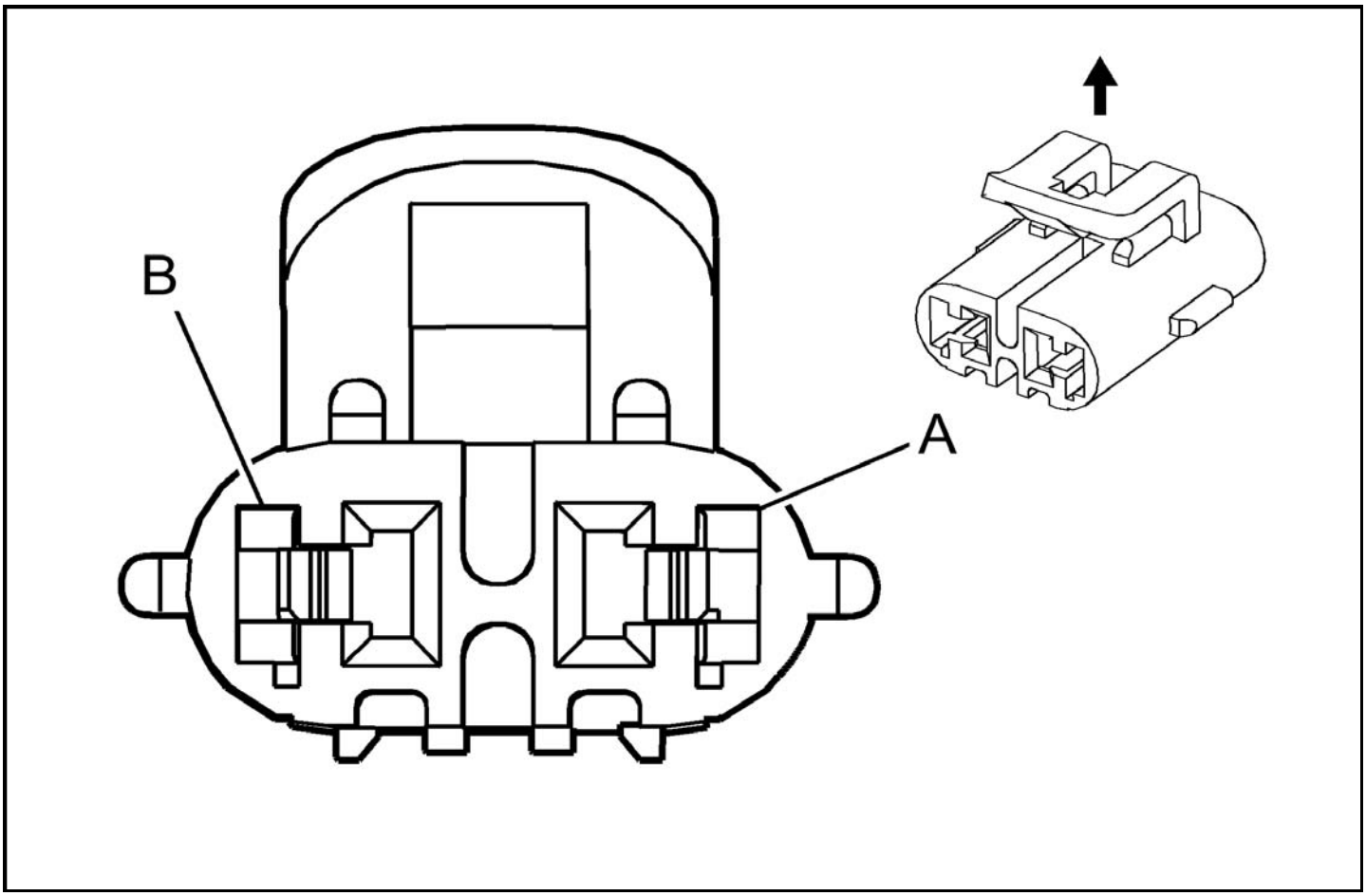
- Terminated Lead: 13575440
- Release Tool: J-38125-36

- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: 4-964286-1/16
- Core/Insulation Crimp: E/1

Generator X1

Pin	Wire	Circuit	Function
1	0.5 OG	225	Generator Turn On Signal
2	0.5 GY	23	Generator Field Duty Cycle Signal

HEADLAMP - LEFT HIGH BEAM



Connector Part Information

- Harness Type: Left Front Headlamp Assembly
- OEM Connector: H9
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F (BK)

Terminal Part Information

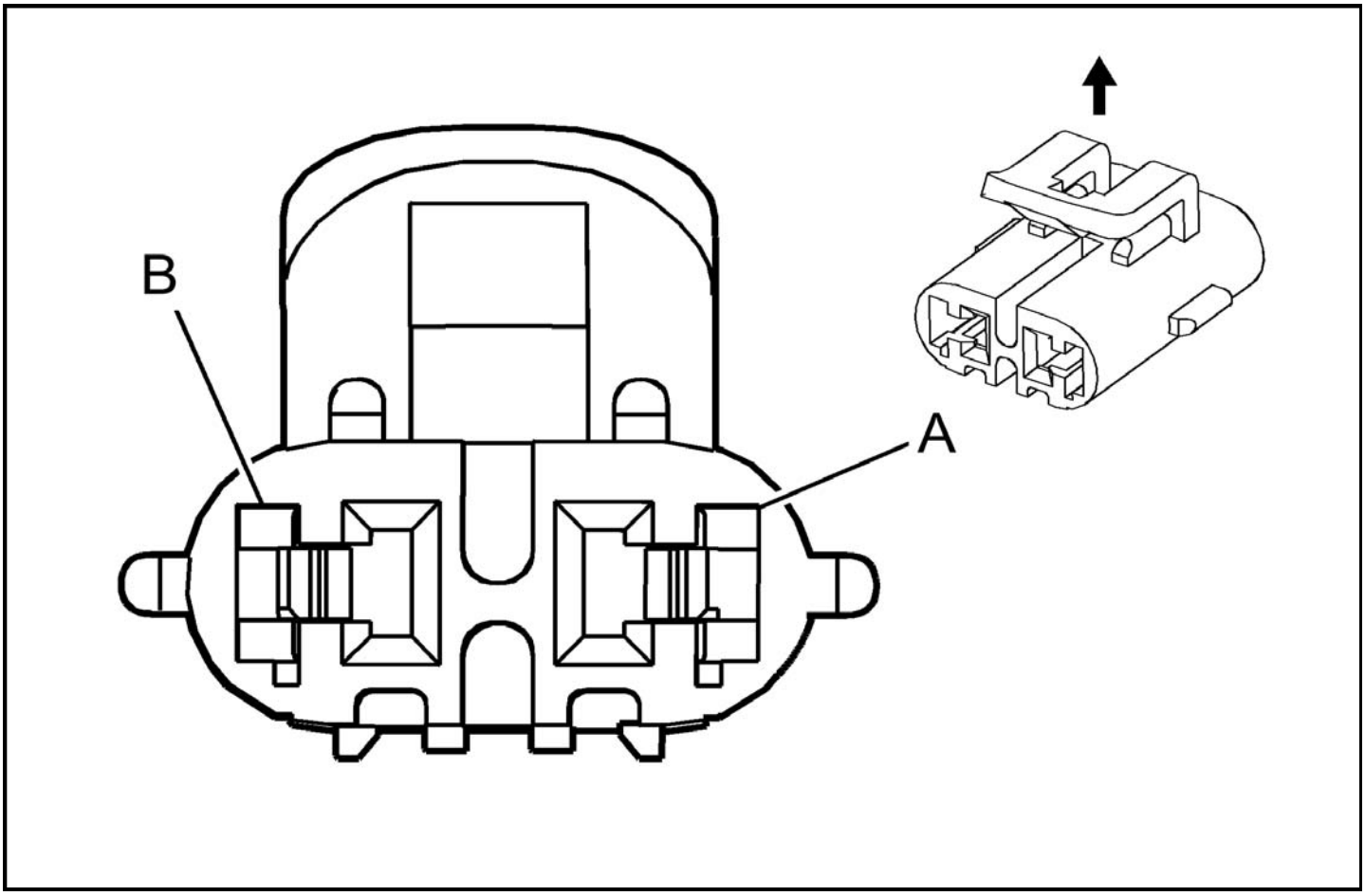
- Terminated Lead: Service by Harness- See Part Catalog

- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Headlamp - Left High Beam

Pin	Wire	Circuit	Function
A	0.8 BU	711	Left Headlamp High Beam Supply Voltage
B	0.8 BK	1350	Ground

HEADLAMP - RIGHT HIGH BEAM



Connector Part Information

- Harness Type: Right Front Headlamp Assembly
- OEM Connector: H9
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F (BK)

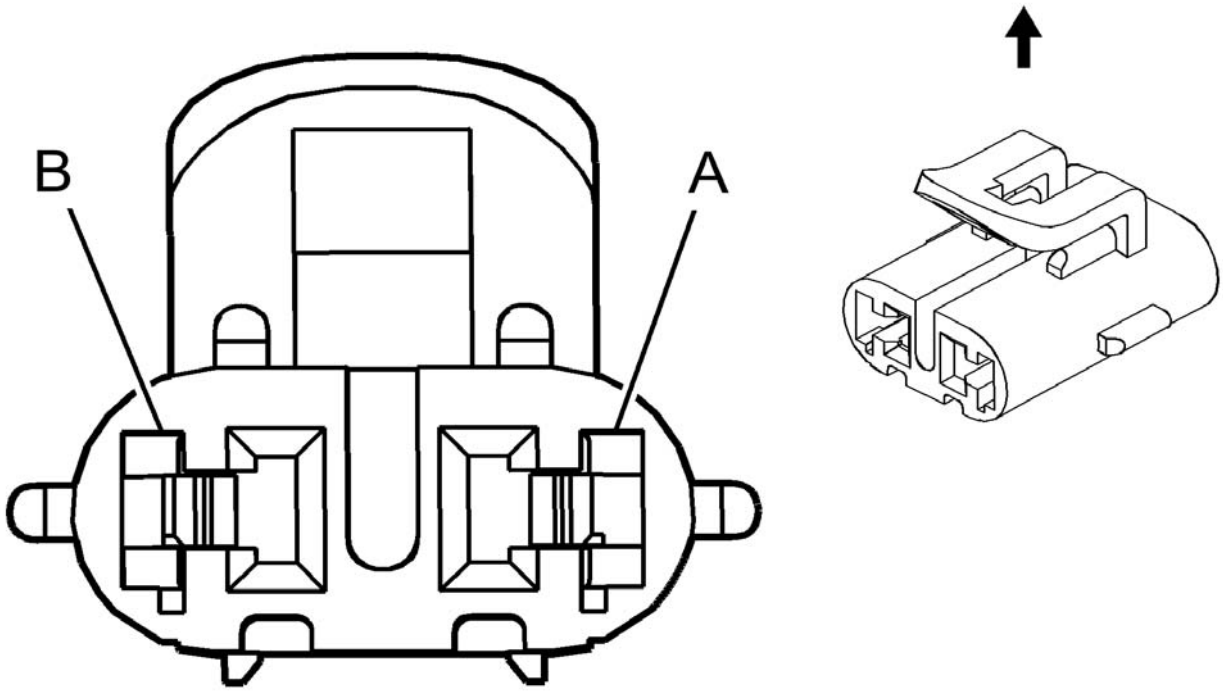
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Headlamp - Right High Beam

Pin	Wire	Circuit	Function
A	0.8 BU	311	Right Headlamp High Beam Supply Voltage
B	0.8 BK	1250	Ground

HEADLAMP - LEFT LOW BEAM



Connector Part Information

- Harness Type: Left Front Headlamp Assembly
- OEM Connector: H11
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F (WH)

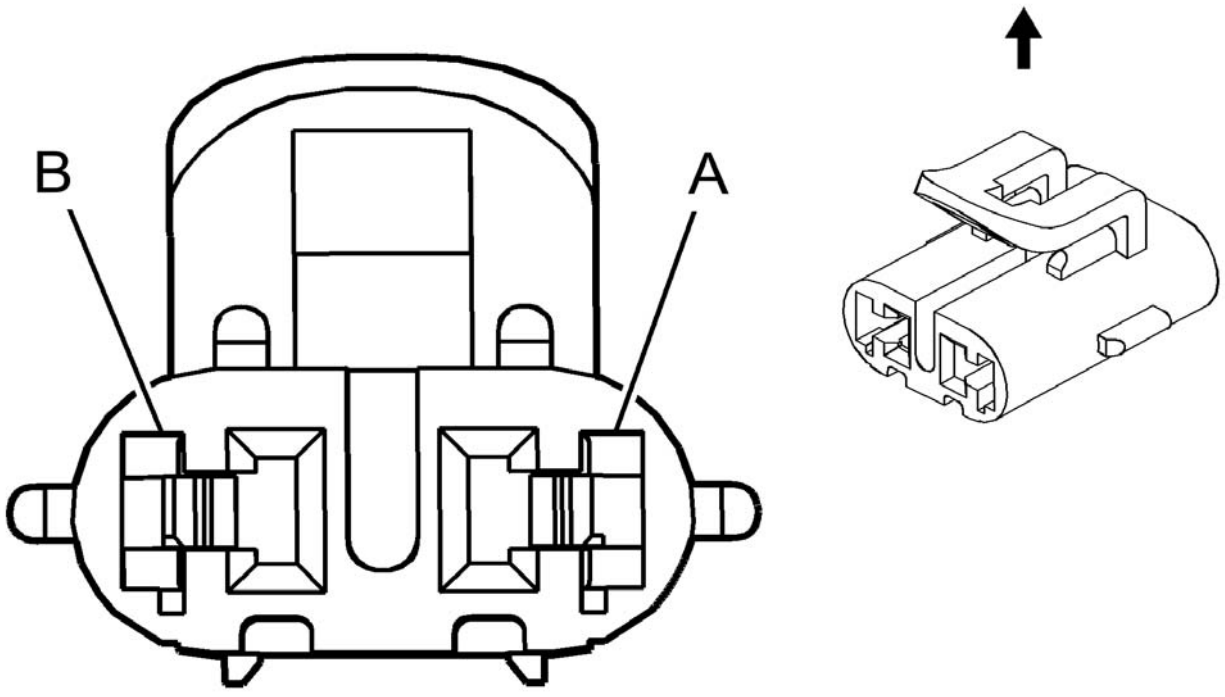
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Headlamp - Left Low Beam

Pin	Wire	Circuit	Function
A	0.8 GN	712	Left Headlamp Low Beam Supply Voltage
B	0.8 BK	1350	Ground

HEADLAMP - RIGHT LOW BEAM



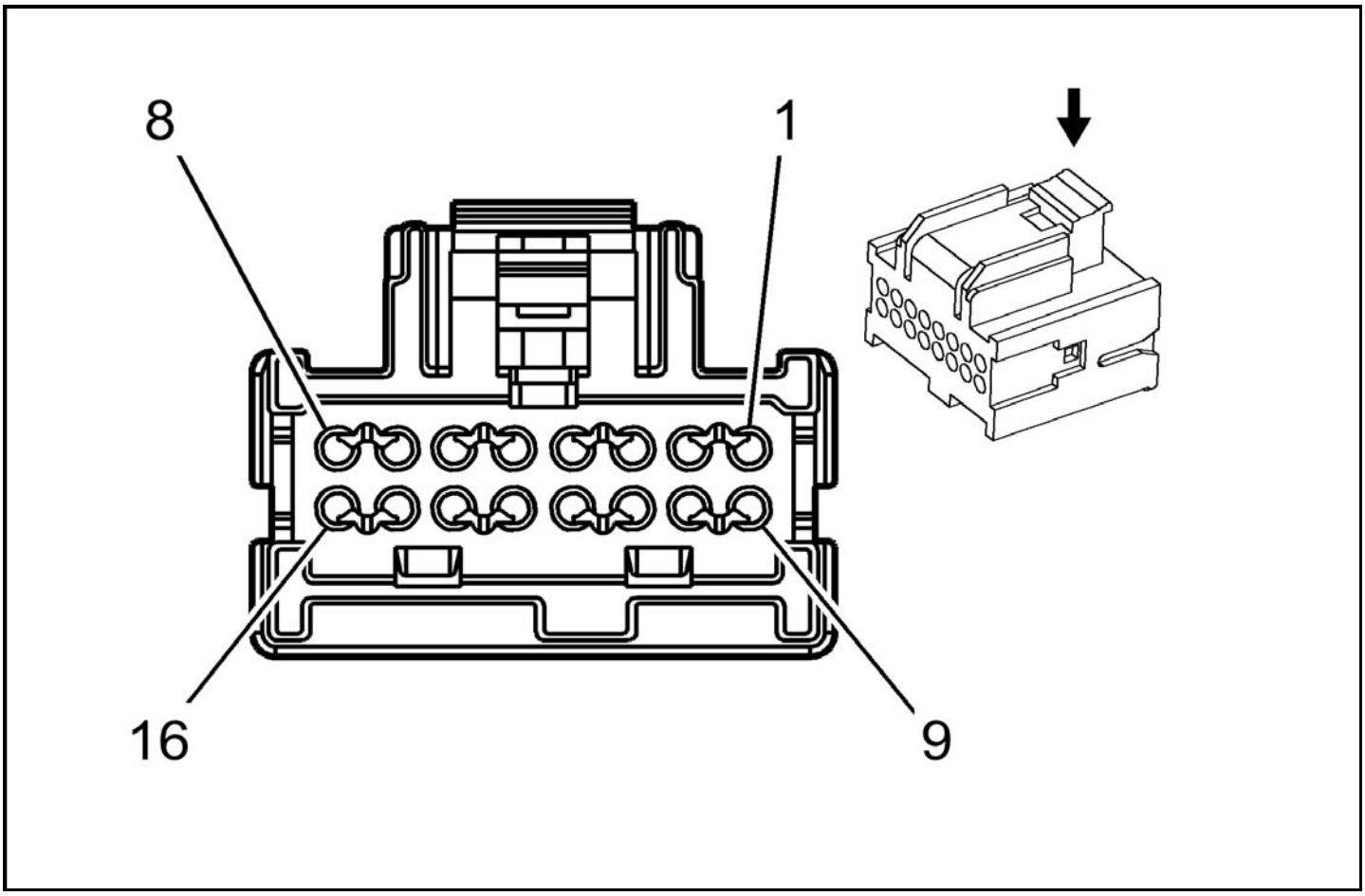
Connector Part Information

- Harness Type: Right Front Headlamp Assembly
- OEM Connector: H11
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F (WH)

Headlamp - Right Low Beam

Pin	Wire	Circuit	Function
A	0.8 GN	312	Right Headlamp Low Beam Supply Voltage
B	0.8 BK	1250	Ground

HEADLAMP SWITCH



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15416970
- Service Connector: 13504130
- Description: 16-Way F Micro-Pack 64 Series (BK)

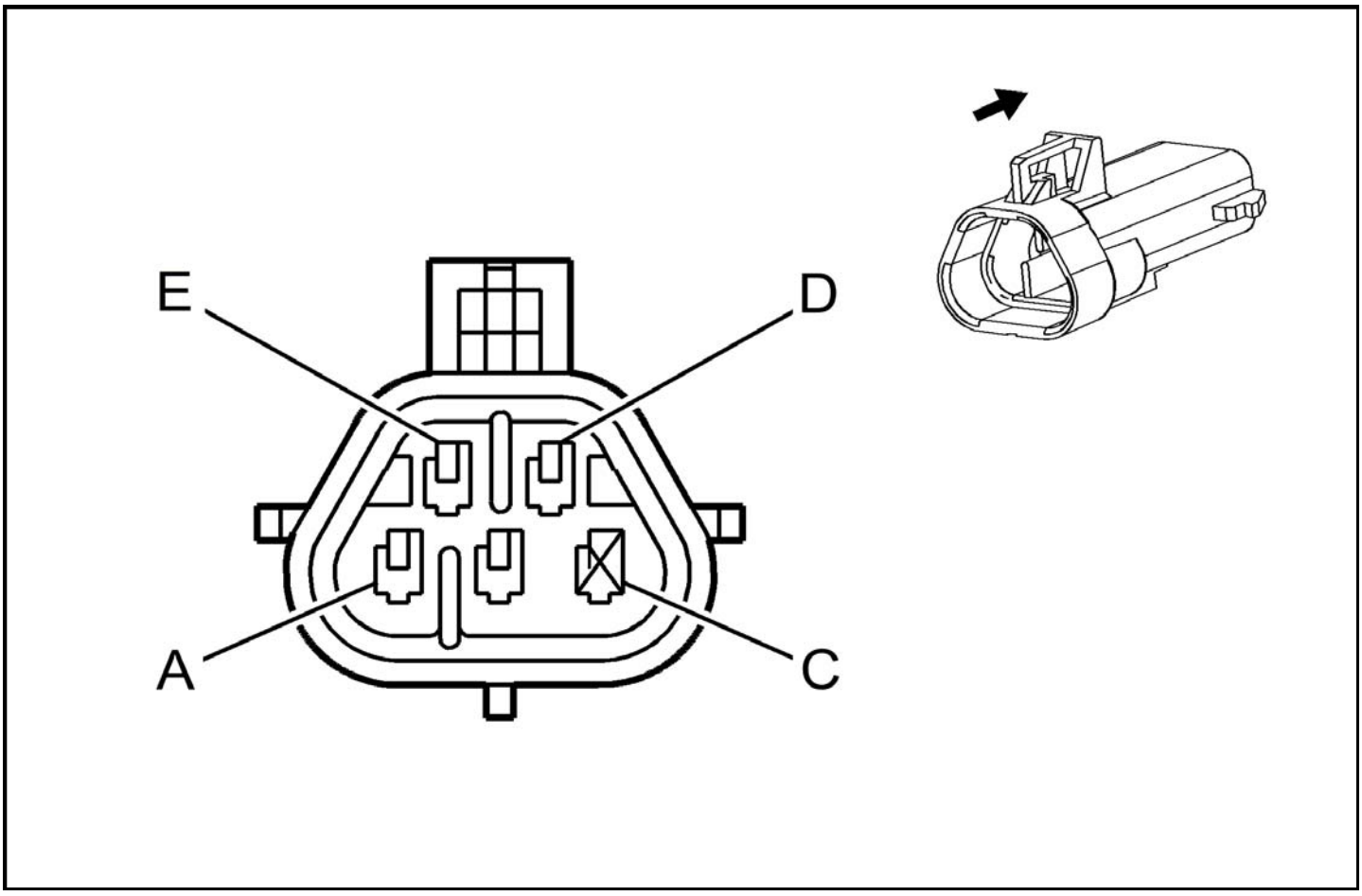
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-21
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 15359541/4
- Core/Insulation Crimp: M/M

Headlamp Switch

Pin	Wire	Circuit	Function
1	0.35 WH	103	Headlamp Switch Headlamps On Signal
2	0.35 BN/WH	301	Park Lamp Switch On Signal
3	0.35 D-GN	306	Headlamp Switch Headlamps Off Signal
4-5	-	-	Not Used
6	0.35 OG	192	Front Fog Lamp Switch Signal (T96)
7	0.35 GY	8	Instrument Panel Lamp Supply Voltage
8	0.5 BK/WH	1551	Ground
9	0.35 L-BU	383	Trunk Release Control
10	0.35 BN/WH	1571	Traction Control Switch Signal
11	-	-	Not Used
12	0.35 PK/BK	1597	Courtesy Lamps Switch On Signal
13	0.35 D-GN	44	Instrument Panel Lamps Dimmer Switch Signal
14	-	-	Not Used
15	0.35 OG/WH	812	IP Dimming Voltage Reference
16	-	-	Not Used

HEATED OXYGEN SENSOR (HO2S) - BANK 1 SENSOR 1



Connector Part Information

- Harness Type: Engine
- OEM Connector: 12092839
- Service Connector: 1358584
- Description: 5-Way M Metri-Pack 150 Series, Sealed (BK)

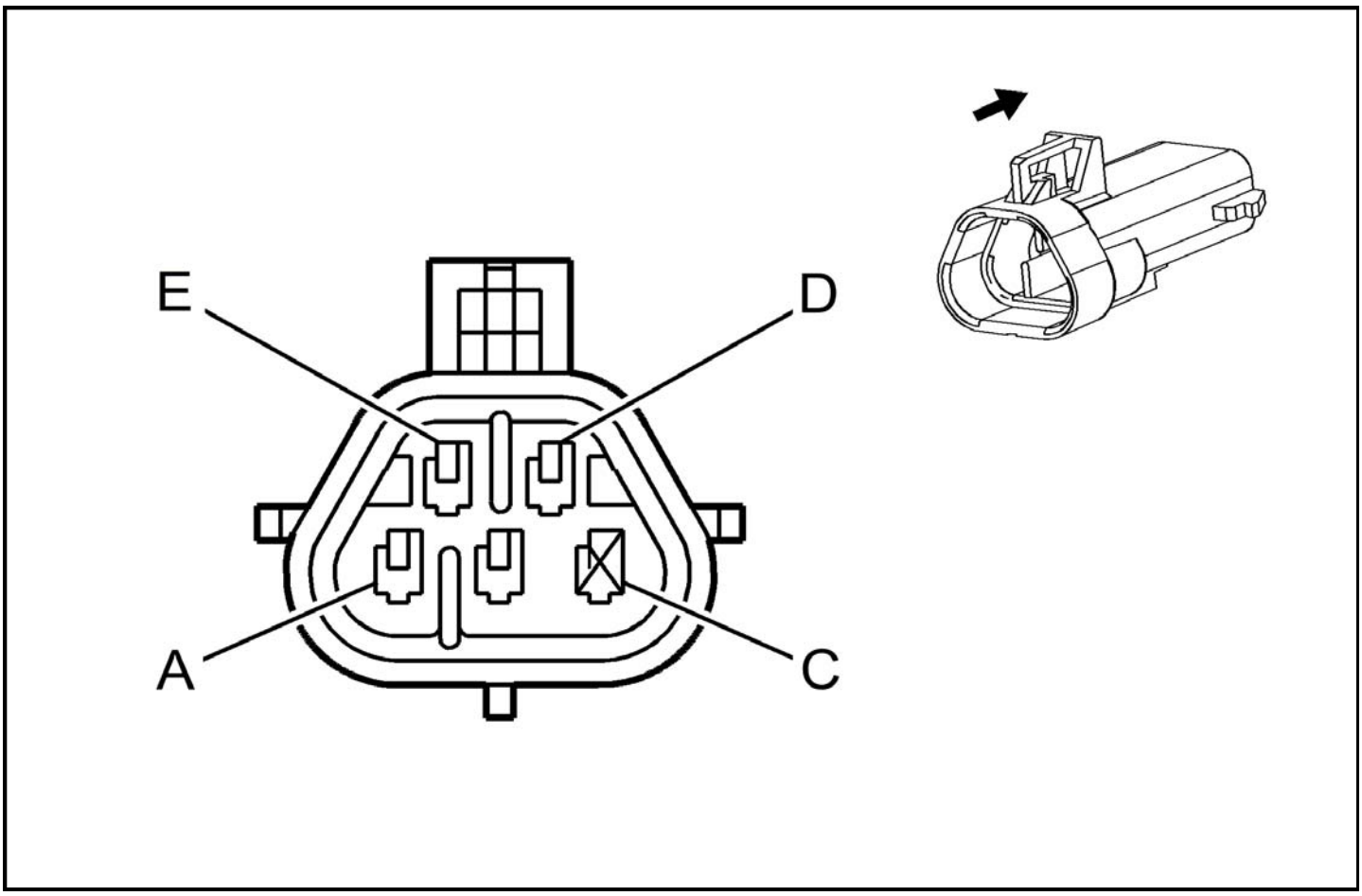
Terminal Part Information

- Terminated Lead: 13575420
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12045773/2
- Core/Insulation Crimp: E/1

Heated Oxygen Sensor (HO2S) -Bank 1 Sensor 1

Pin	Wire	Circuit	Function
A	0.5 TN/WH	3111	HO2S Low Reference (Bank 1 Sensor 1)
B	0.5 PU/WH	3110	HO2S Reference Voltage (Bank 1 Sensor 1)
C	-	-	Not Used
D	0.5 PK/BK	5293	Ignition Voltage
E	0.5 GY/WH	3113	HO2S Heater Low Control (Bank 1 Sensor 1)

HEATED OXYGEN SENSOR (HO2S) - BANK 2 SENSOR 1



Connector Part Information

- Harness Type: Engine
- OEM Connector: 12092839
- Service Connector: 1358584
- Description: 5-Way M Metri-Pack 150 Series, Sealed (BK)

Terminal Part Information

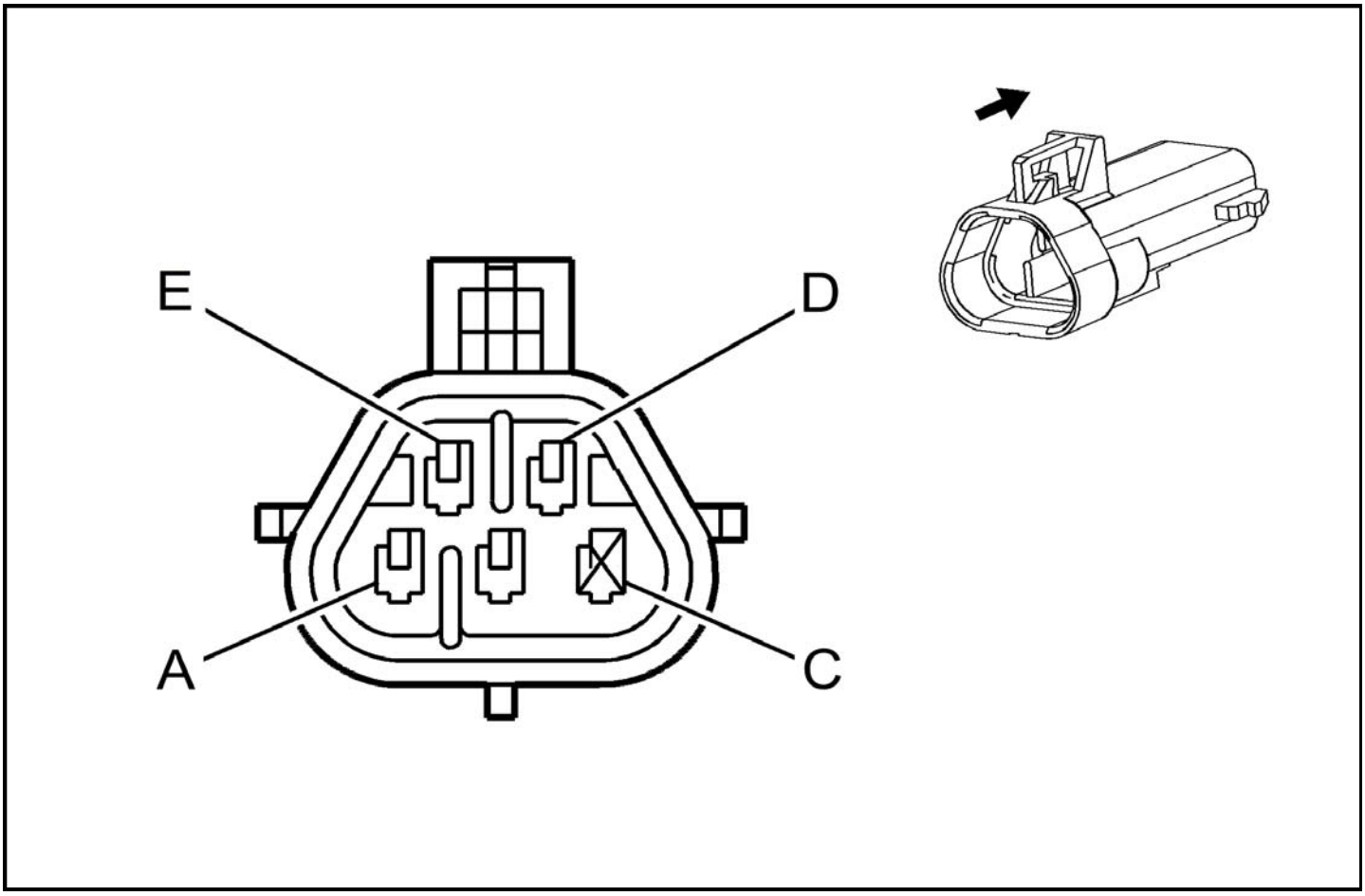
- Terminated Lead: 13575420
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12045773/2
- Core/Insulation Crimp: E/1

Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 1

Pin	Wire	Circuit	Function
A	0.5 TN/WH	3211	HO2S Low Reference (Bank 2 Sensor 1)
B	0.5 PU/WH	3210	HO2S Reference Voltage (Bank 2 Sensor 1)
C	-	-	Not Used
D	0.5 PK/BK	5293	Ignition Voltage

Pin	Wire	Circuit	Function
E	0.5 L-GN	3212	HO2S Heater Low Control (Bank 2 Sensor 1)

HEATED OXYGEN SENSOR (HO2S) - BANK 1 SENSOR 2



Connector Part Information

- Harness Type: Engine
- OEM Connector: 12092839
- Service Connector: 1358584
- Description: 5-Way M Metri-Pack 150 Series, Sealed (BK)

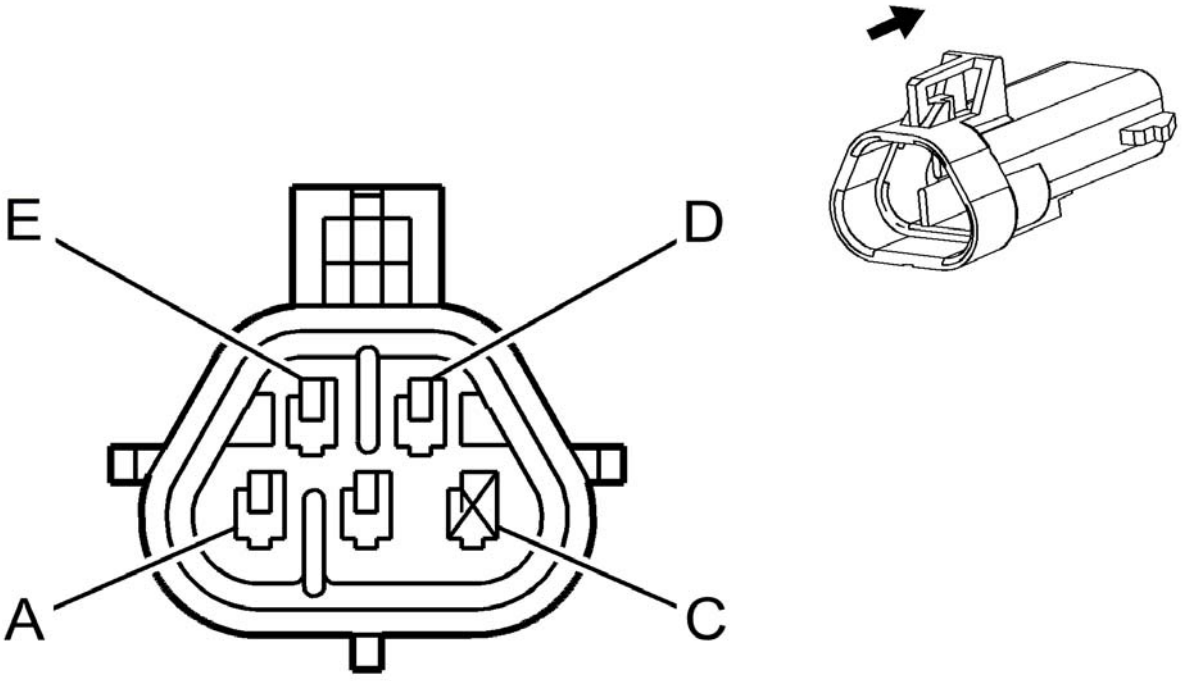
Terminal Part Information

- Terminated Lead: 13575420
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12045773/2
- Core/Insulation Crimp: E/1

Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 2

Pin	Wire	Circuit	Function
A	0.5 TN/WH	3121	HO2S Low Signal (Bank 1 Sensor 2)
B	0.5 PU	3120	HO2S High Signal (Bank 1 Sensor 2)
C	-	-	Not Used
D	0.5 PK/BK	5294	Battery Positive Voltage
E	0.5 GY/WH	3122	HO2S Heater Low Control (Bank 1 Sensor 2)

HEATED OXYGEN SENSOR (HO2S) - BANK 2 SENSOR 2



Connector Part Information

- Harness Type: Engine
- OEM Connector: 12092839
- Service Connector: 1358584
- Description: 5-Way M Metri-Pack 150 Series, Sealed (BK)

Terminal Part Information

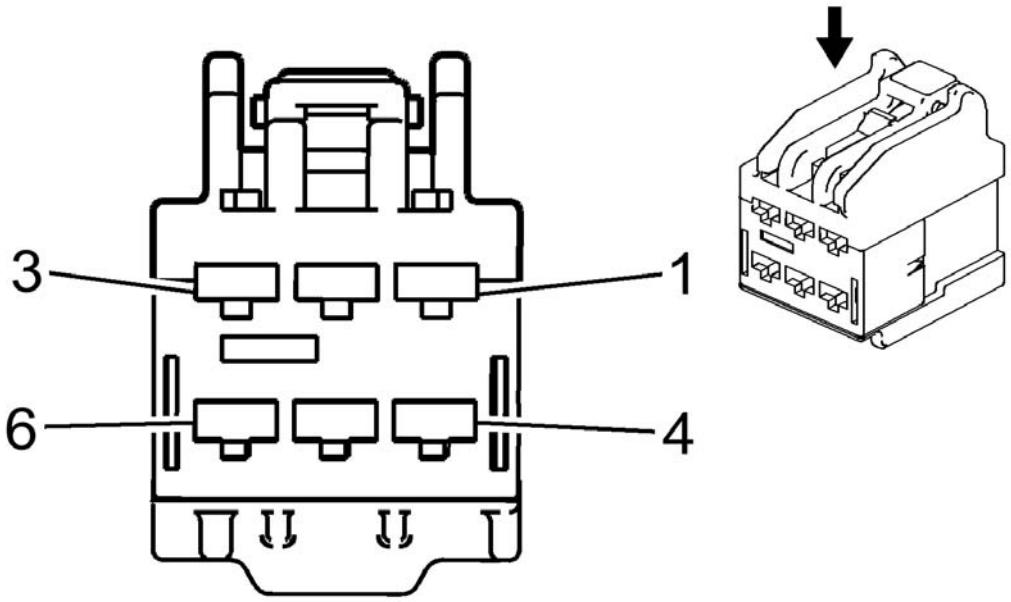
- Terminated Lead: 13575420
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)

- Terminal/Tray: 12045773/2
- Core/Insulation Crimp: E/1

Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 2

Pin	Wire	Circuit	Function
A	0.5 TN	3221	HO2S Low Signal (Bank 2 Sensor 2)
B	0.5 PU	3220	HO2S High Signal (Bank 2 Sensor 2)
C	-	-	Not Used
D	0.5 PK/BK	5294	Battery Positive Voltage
E	0.5 OG/WH	3223	HO2S Heater Low Control (Bank 2 Sensor 2)

HEATED SEAT CONTROL MODULE (KA1) X1



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 15486524
- Service Connector: Service by Harness - See Part Catalog
- Description: 6-Way F 2.8 mm Sumitomo (BN)

Terminal Part Information

- Terminal/Tray: 8100-4444/22
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-4A (PU)

Heated Seat Control Module (KA1) X1

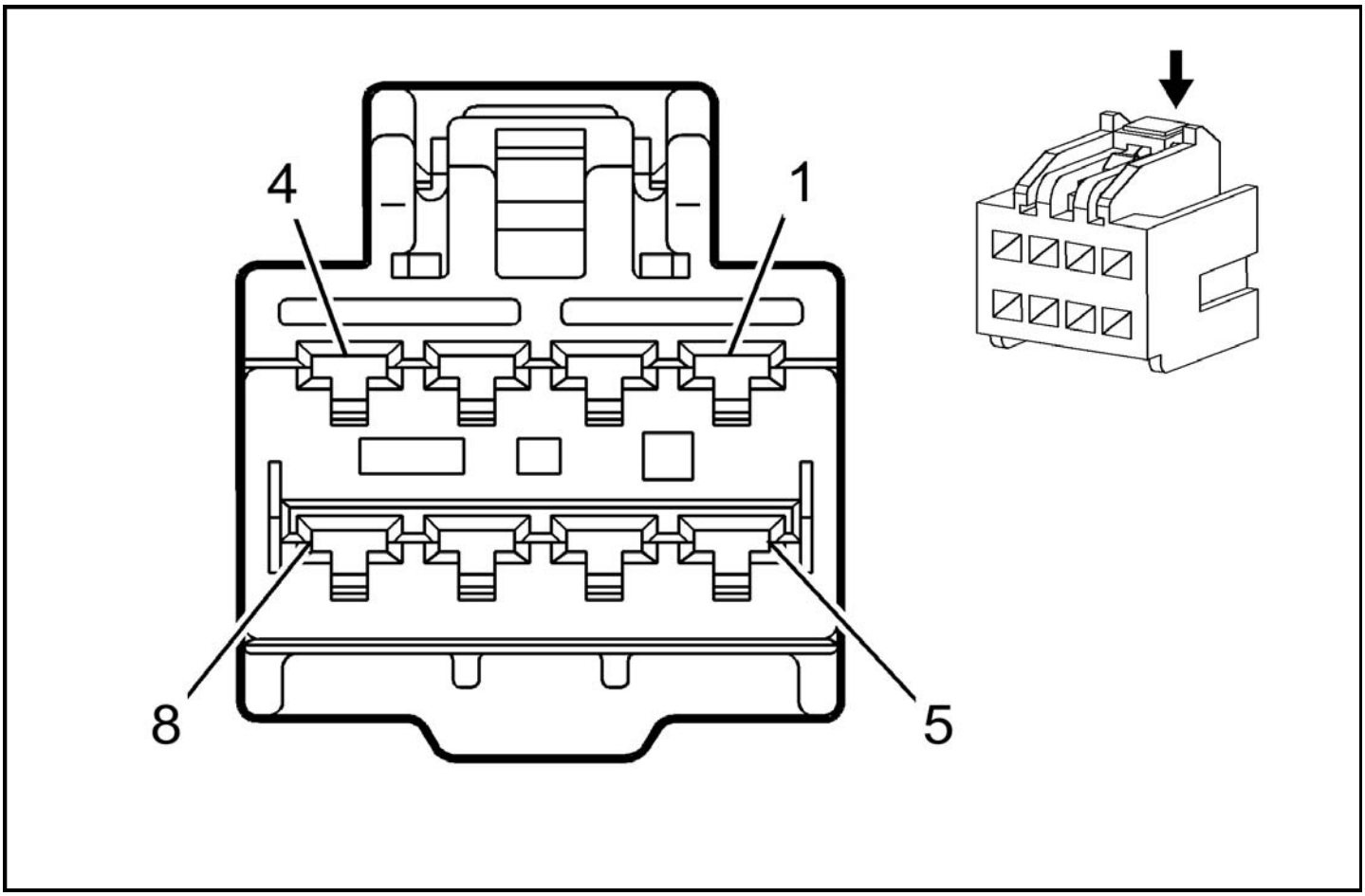
Pin	Wire	Circuit	Function
1	-	-	Not Used
2	0.8 L-BU	2433	Passenger Heated Seat Back Element Control
3	0.8 PK	2077	Driver Heated Seat Cushion Element Supply Voltage
4	-	-	Not Used
5	0.8 PU	2424	Driver Heated Seat Back Element Control
6	0.8 D-BU	2479	Passenger Heated Seat Element Supply Voltage

Article GUID: A00737159

COMPONENT CONNECTOR END VIEWS

NOTE: **Component Connector end views are sorted by component name, not by connector ID (Code). Searching for connector ID, NOT component name, may help in locating appropriate connector end view.**

HEATED SEAT CONTROL MODULE (KA1) X2



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 15491286
- Service Connector: 13580111
- Description: 8-Way F Receptacle 2.8 (BK)

Terminal Part Information

- Pins: 1, 2
- Terminal/Tray: 8100-4444/22

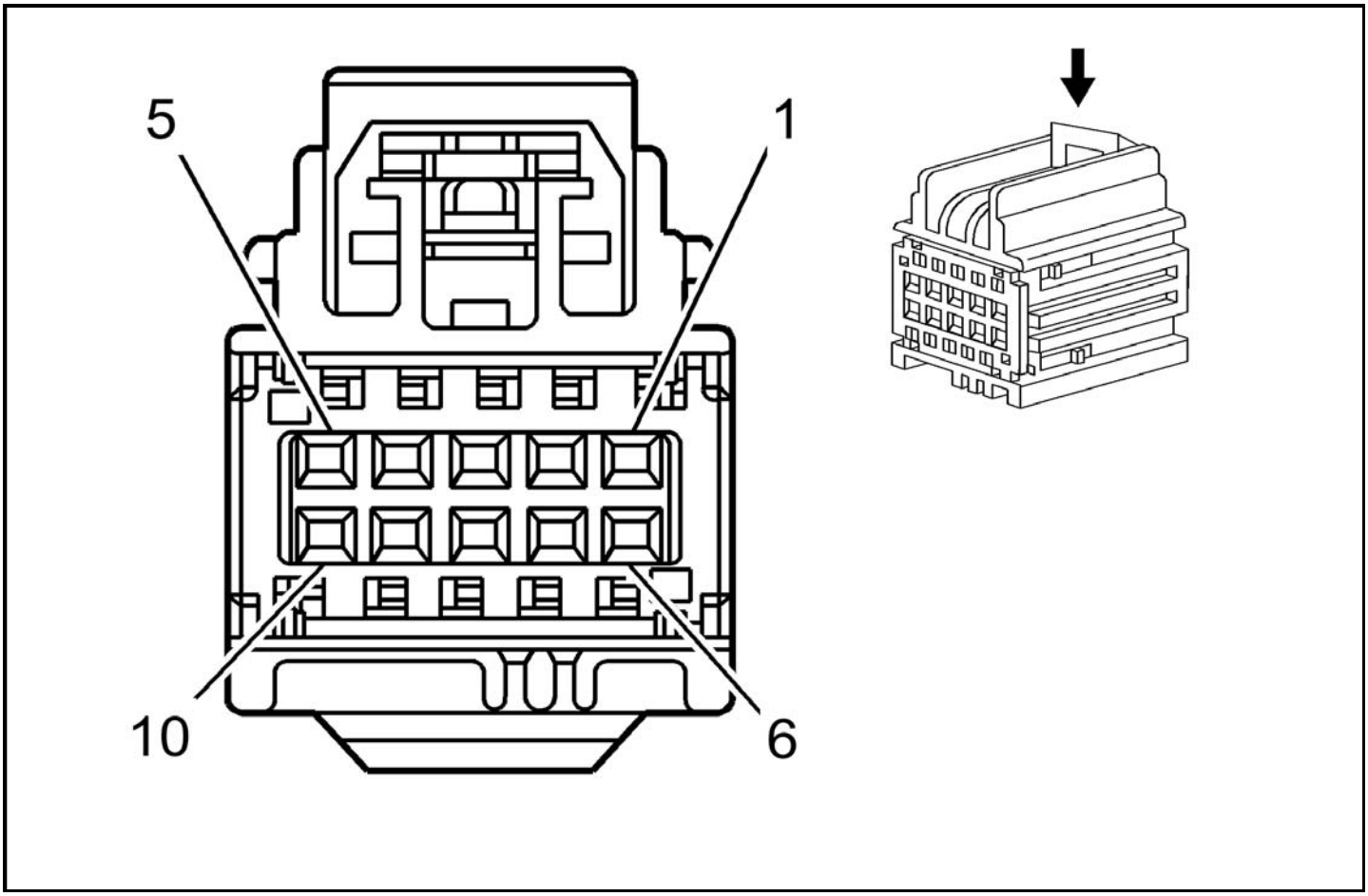
- Core/Insulation Crimp: 2/A
- Release Tool/Test Probe: 15315247/J-35616-4A (PU)

- Pins: 6, 8
- Terminal/Tray: 8100-4443/22
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-4A (PU)

Heated Seat Control Module (KA1) X2

Pin	Wire	Circuit	Function
1	1 RD/WH	1440	Battery Positive Voltage
2	1 BK	550	Ground
3-5	-	-	Not Used
6	0.35 YE	2080	Driver Heated Seat Cushion Temperature Sensor Low Reference
7	-	-	Not Used
8	0.35 PK	2435	Passenger Heated Seat Cushion Temperature Sensor Low Reference

HEATED SEAT CONTROL MODULE (KA1) X3



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 15491259
- Service Connector: 15127042
- Description: 10-Way F 0.64 YESC Kaizen Series (BK)

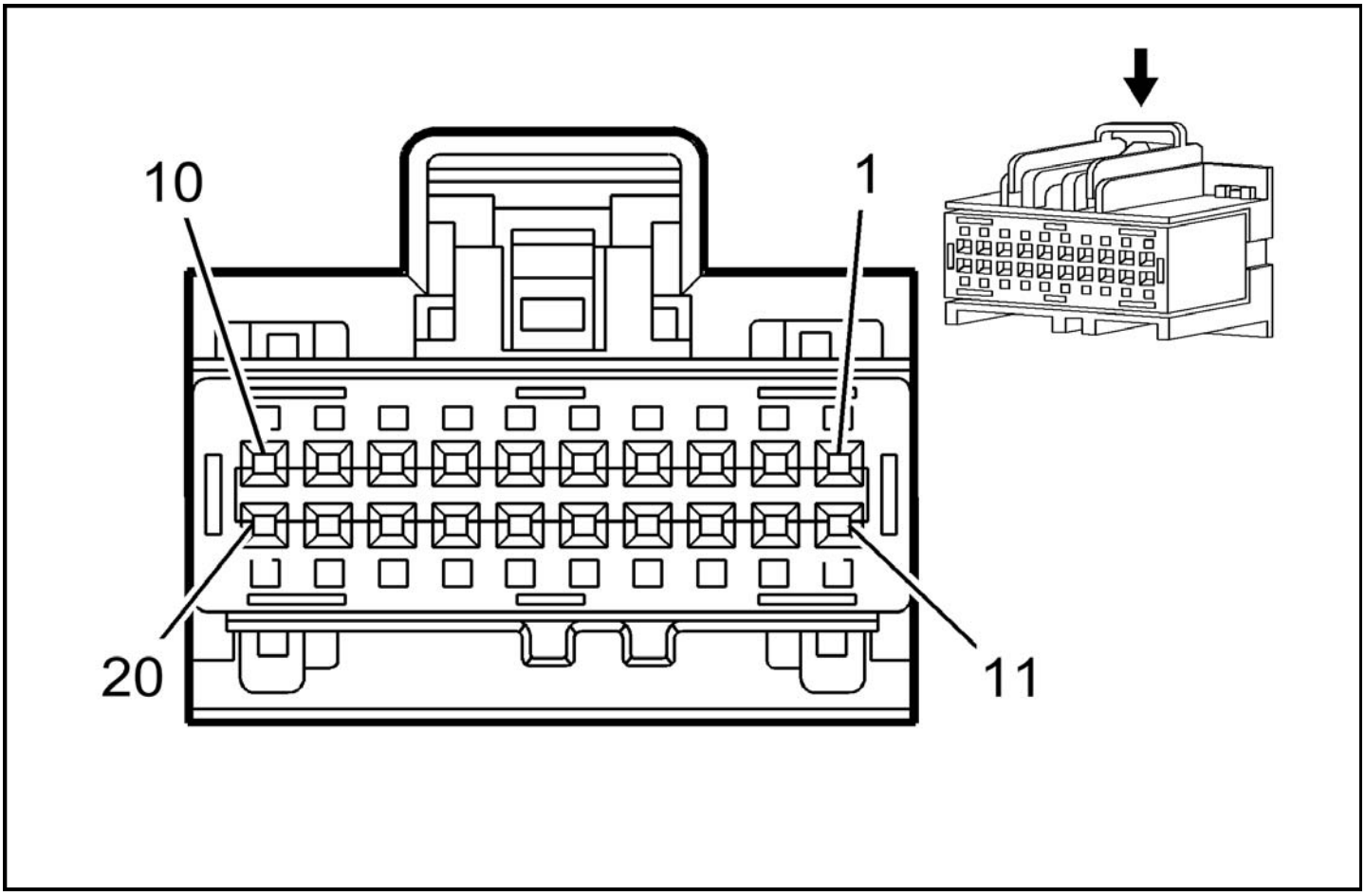
Terminal Part Information

- Terminal/Tray: SAIT-A03T-M064/14
- Core/Insulation Crimp: P/P
- Release Tool/Test Probe: J-38125-215A/J-35616-64B (L-BU)

Heated Seat Control Module (KA1) X3

Pin	Wire	Circuit	Function
1-5	-	-	Not Used
6	0.35 D-GN	5060	Low Speed GMLAN Serial Data
7-10	-	-	Not Used

HEATED SEAT CONTROL MODULE (KA1) X4



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 15489824
- Service Connector: 15126711
- Description: 20-Way F 64 Series (BK)

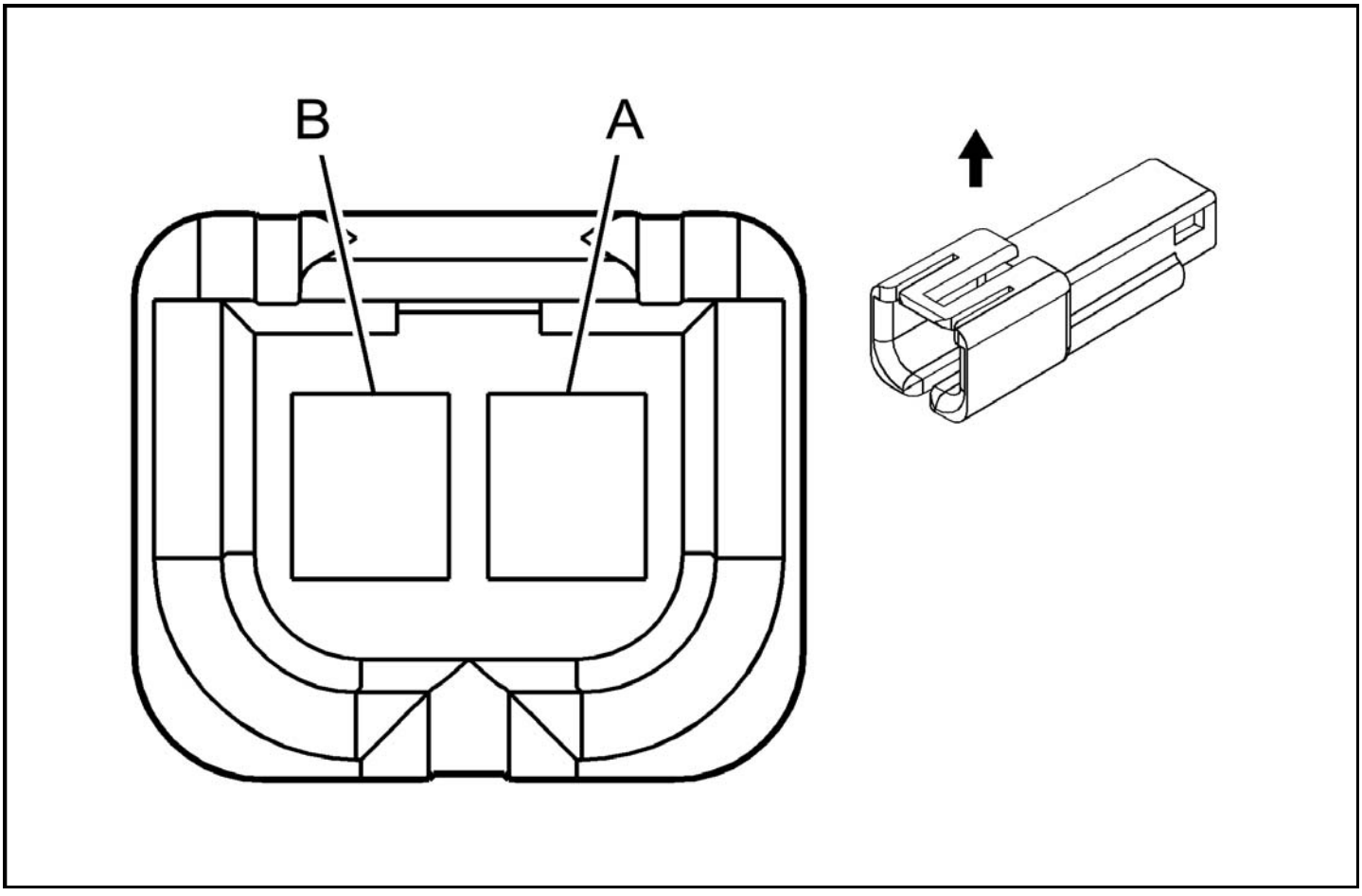
Terminal Part Information

- Terminal/Tray: SAIT-A03T-M064/14
- Core/Insulation Crimp: P/P
- Release Tool/Test Probe: J-38125-215A/J-35616-64B (L-BU)

Heated Seat Control Module (KA1) X4

Pin	Wire	Circuit	Function
1-8	-	-	Not Used
9	0.35 YE/BK	2079	Heated Seat Cushion Temperature Sensor Signal
10-19	-	-	Not Used
20	0.35 GY	2434	Passenger Heated Seat Cushion Temperature Sensor Signal

HEATED SEAT ELEMENT - DRIVER BACK (KA1)



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 12064778
- Service Connector: 12126020
- Description: 2-Way M Metri-Pack 150 Series (L-GN)

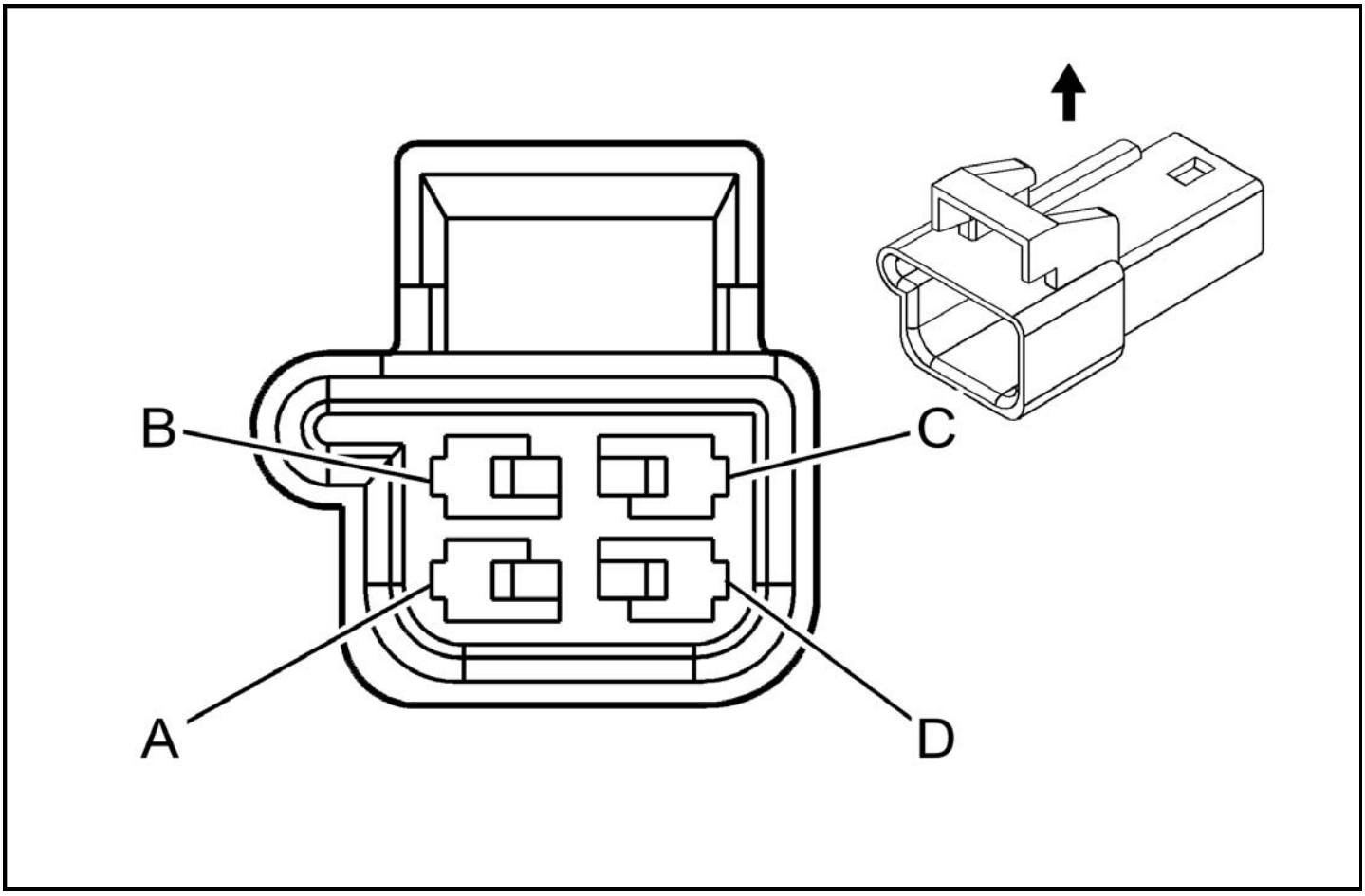
Terminal Part Information

- Terminated Lead: 13505668
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/A

Heated Seat Element - Driver Back (KA1)

Pin	Wire	Circuit	Function
A	0.8 BN	2432	Driver Heated Seat Back Element Supply Voltage
B	0.8 PU	2424	Driver Heated Seat Back Element Control

HEATED SEAT ELEMENT - DRIVER CUSHION (KA1)



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 12066496
- Service Connector: Service by Harness - See Part Catalog
- Description: 4-Way M Metri-Pack 150 Series (BK)

Terminal Part Information

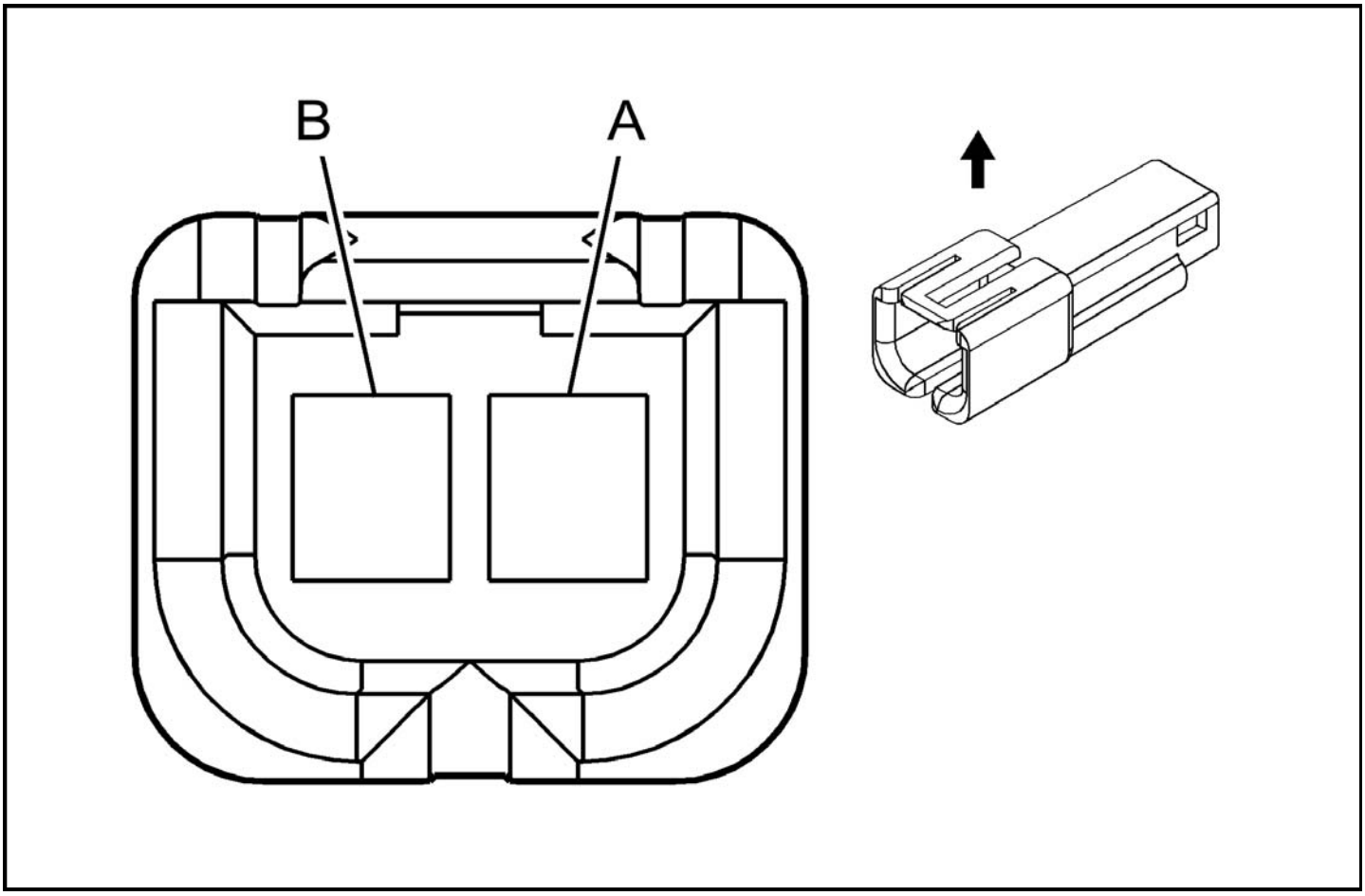
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: Pins A, B- E/A
- Core/Insulation Crimp: Pins C, D- E/C
- Release Tool/Test Probe: 12094429/J-35616-3 (GY)

Heated Seat Element - Driver Cushion (KA1)

Pin	Wire	Circuit	Function
A	0.8 PK	2077	Heated Seat Cushion Element Supply Voltage
B	0.8 BN	2432	Driver Heated Seat Back Element Supply Voltage
C	0.35 YE/BK	2079	Heated Seat Cushion Temperature Sensor Signal

Pin	Wire	Circuit	Function
D	0.35 YE	2080	Driver Heated Seat Cushion Temperature Sensor Low Reference

HEATED SEAT ELEMENT - PASSENGER BACK (KA1)



Connector Part Information

- Harness Type: Right Front Seat
- OEM Connector: 12064778
- Service Connector: 12126020
- Description: 2-Way M Metri-Pack 150 Series (L-GN)

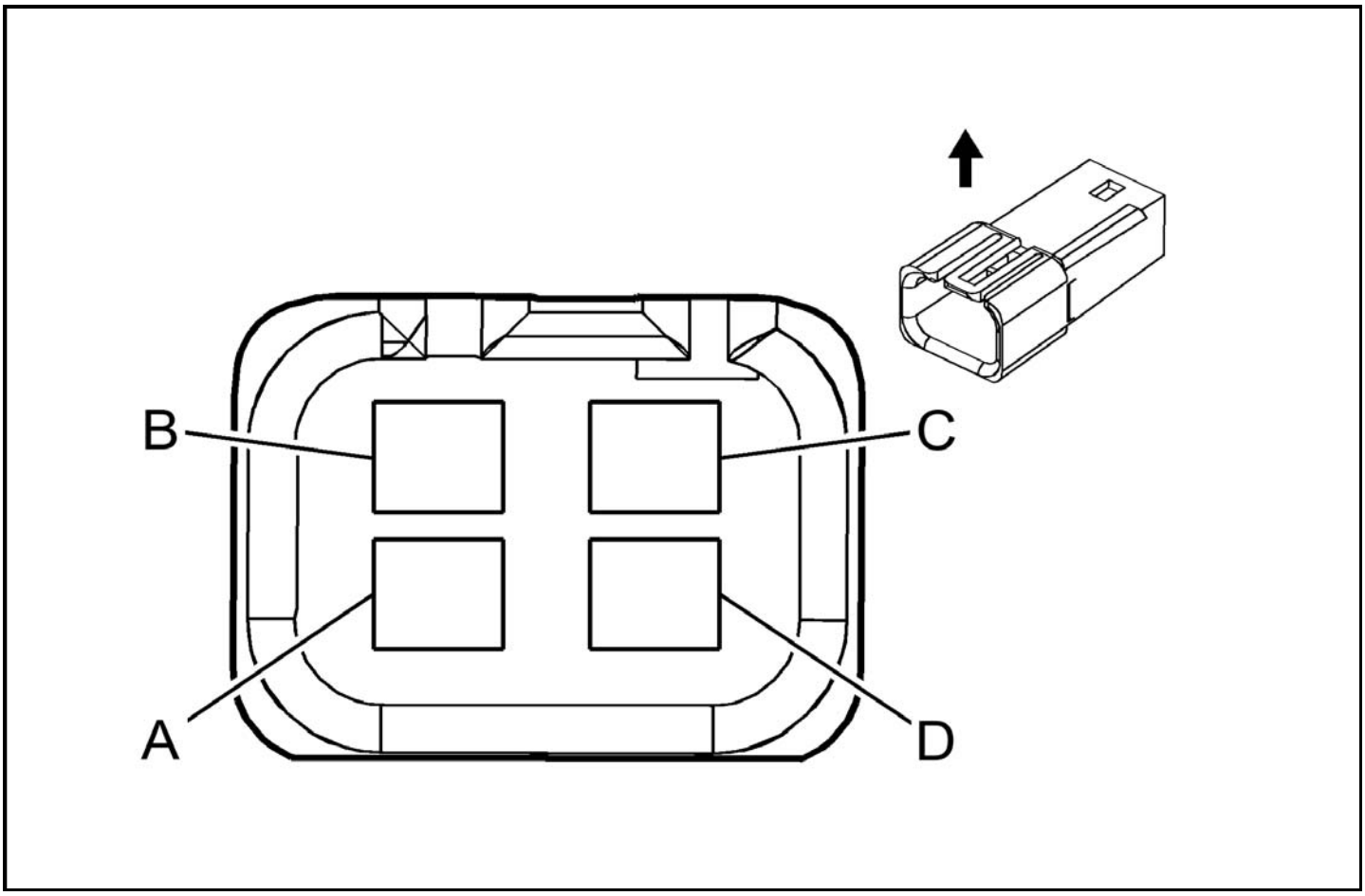
Terminal Part Information

- Terminated Lead: 13505668
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/A

Heated Seat Element - Passenger Back (KA1)

Pin	Wire	Circuit	Function
A	0.8 TN	2481	Passenger Heated Seat Back Element Supply Voltage
B	0.8 L-BU	2433	Passenger Heated Seat Back Element Control

HEATED SEAT ELEMENT - PASSENGER CUSHION (KA1)



Connector Part Information

- Harness Type: Right Front Seat
- OEM Connector: 12066498
- Service Connector: 12085536
- Description: 4-Way F Metri-Pack 150 (BK)

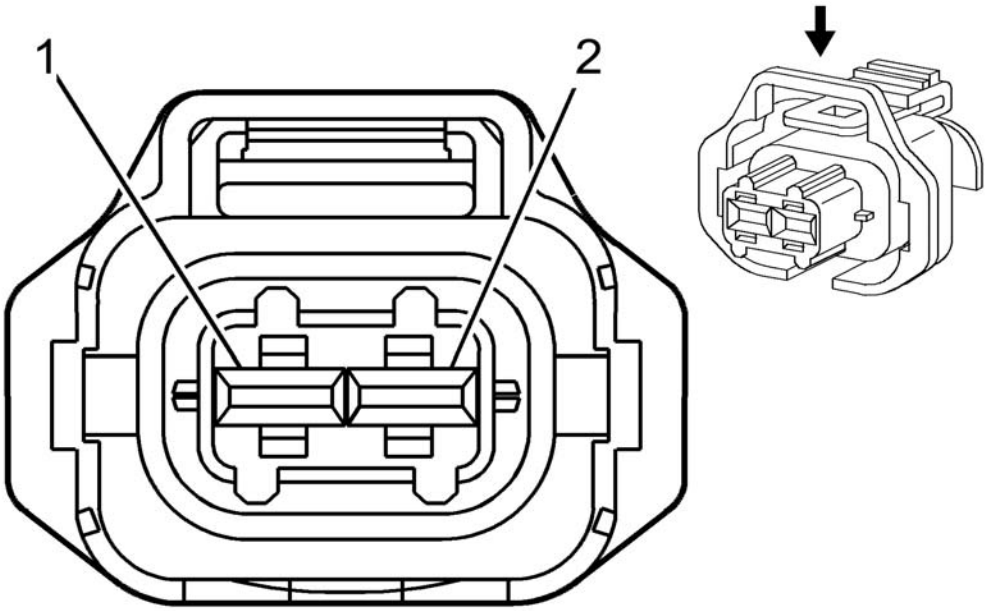
Terminal Part Information

- Terminated Lead: 13505668
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/A

Heated Seat Element - Passenger Cushion (KA1)

Pin	Wire	Circuit	Function
A	0.8 D-BU	2479	Passenger Heated Seat Element Supply Voltage
B	0.8 TN	2481	Passenger Heated Seat Back Element Supply Voltage
C	0.35 GY	2434	Passenger Heated Seat Cushion Temperature Sensor Signal
D	0.35 PK	2435	Passenger Heated Seat Cushion Temperature Sensor Low Reference

G18 HIGH PRESSURE FUEL PUMP (LFX)



Connector Part Information

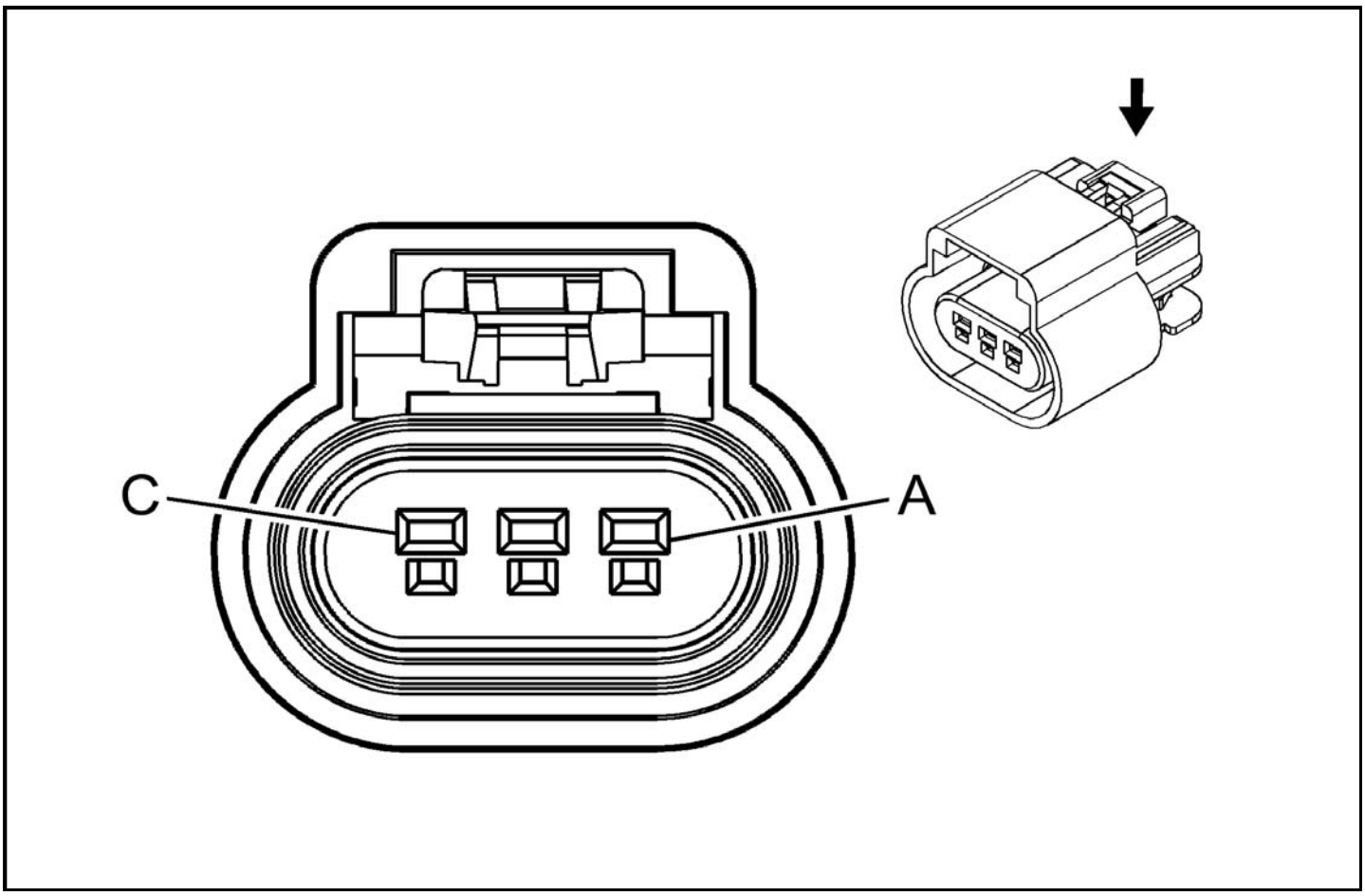
- Harness Type: Engine
- OEM Connector: 15397337
- Service Connector: 13355745
- Description: 2-Way F 2.8 Power Timer Series, Sealed (BK)

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	Not Available	J-35616-35 (VT)	J-38125-36	4-964286-1	4	E	1

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	1	PU	7300	High Pressure Fuel Pump Actuator Low Control	I	-
2	1	YE	7301	High Pressure Fuel Pump Actuator High Control	I	-

HOOD AJAR SWITCH (AP3)



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 13519047
- Service Connector: 13580871
- Description: 3-Way F GT 150 Series, Sealed (BK)

Terminal Part Information

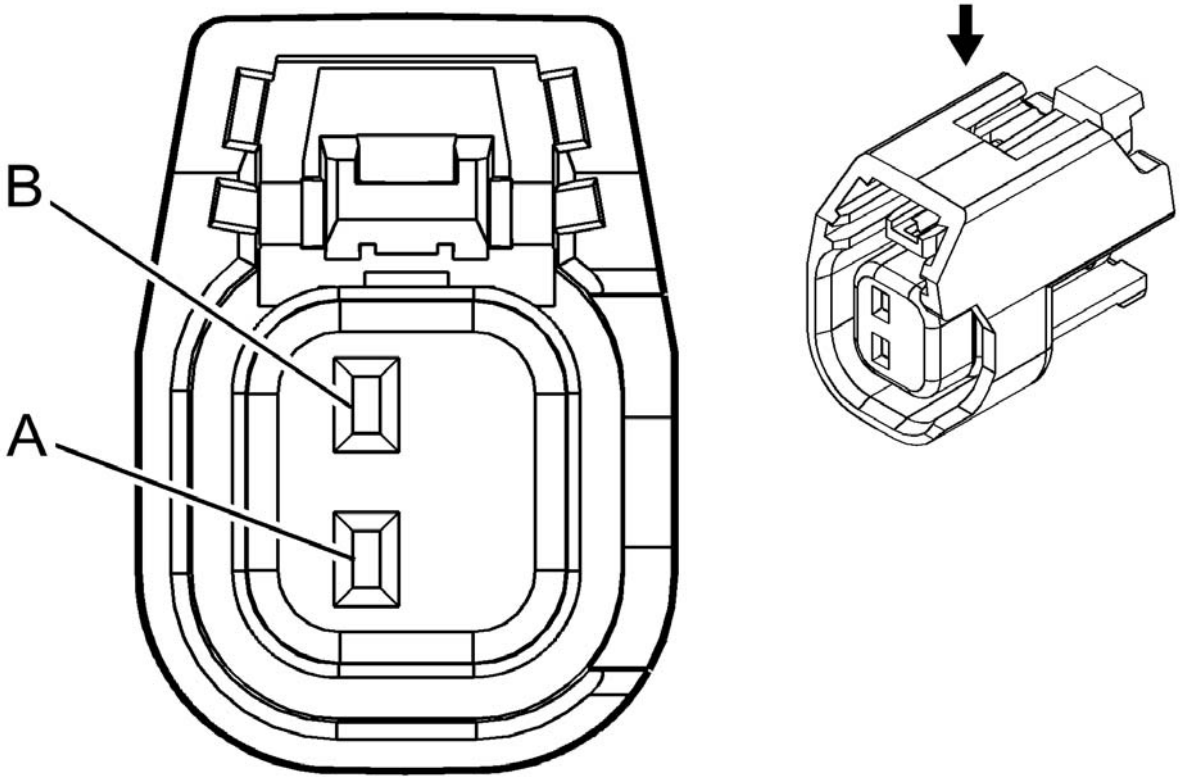
- Terminated Lead: 13327112
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8

- Core/Insulation Crimp: E/1

Hood Ajar Switch (AP3)

Pin	Wire	Circuit	Function
A	0.35 PK/BK	109	Hood Ajar Switch Signal
B	0.35 PU	5531	Hood Closed Switch Signal
C	0.35 BK	1350	Ground

HORN ASSEMBLY



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 15419715
- Service Connector: 13580876
- Description: 2-Way F GT 150 Series, Sealed (GY)

Terminal Part Information

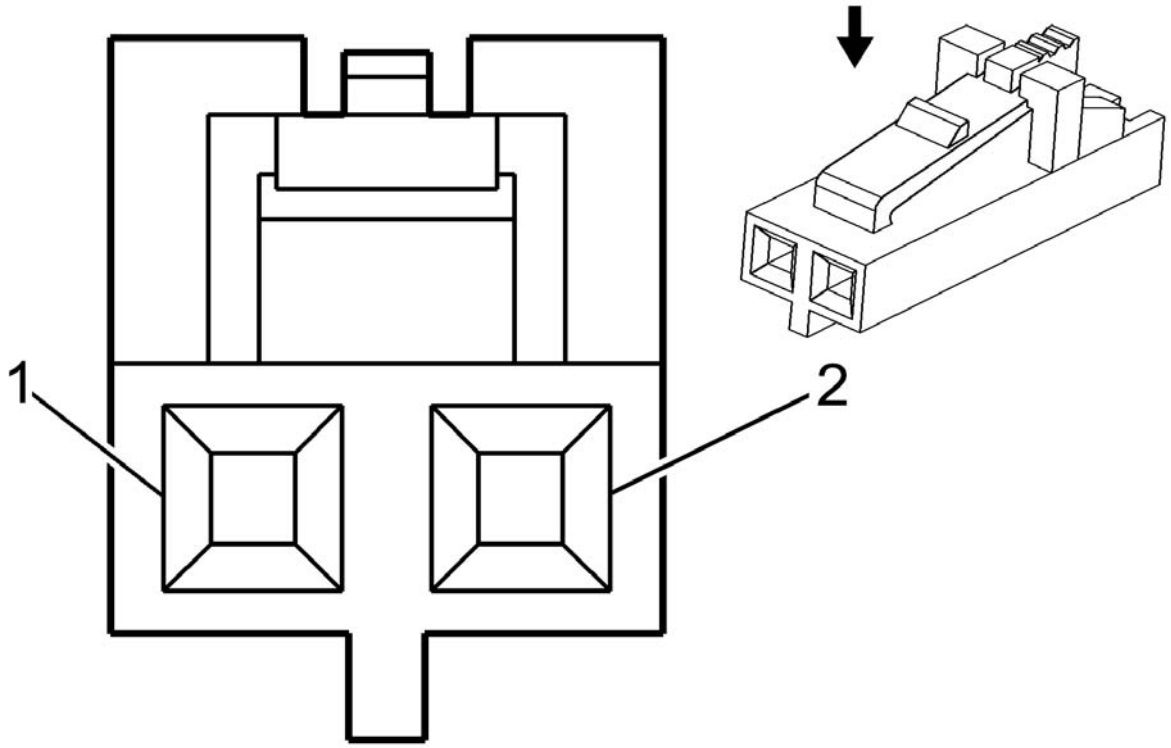
- Terminated Lead: 12191818
- Release Tool: J-38125-553

- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/1

Horn Assembly

Pin	Wire	Circuit	Function
A	0.5 BK	1250	Ground
B	0.8 D-GN	29	Horn Control

HORN SWITCH



Connector Part Information

- Harness Type: Steering Wheel
- OEM Connector: 50-57-9402
- Service Connector: 15306026
- Description: 2-Way F C/Grid/SL 70066G Series (BK)

Terminal Part Information

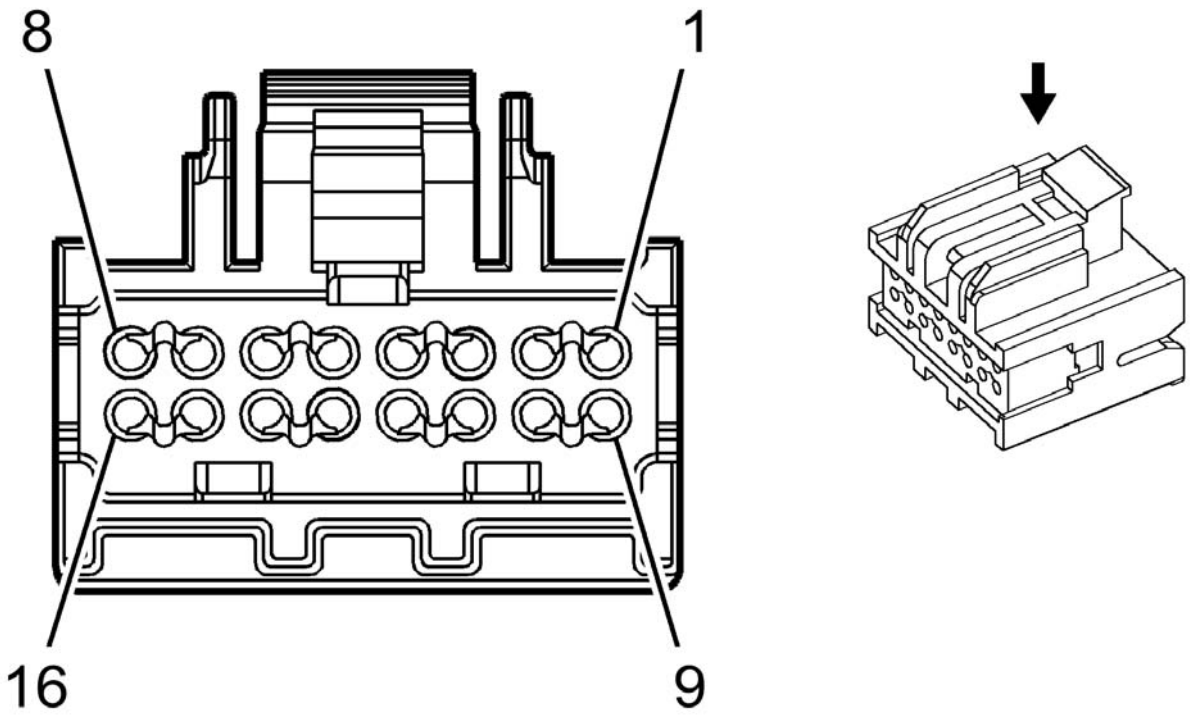
- Terminated Lead: Service by Harness- See Part Catalog

- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Horn Switch

Pin	Wire	Circuit	Function
1	0.35 TN	28	Horn Relay Control
2	0.35 BK	1450	Ground

HVAC CONTROL MODULE X1



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15429808
- Service Connector: 88988804
- Description: 16-Way F Mirco-Pack 64 Series (BU)

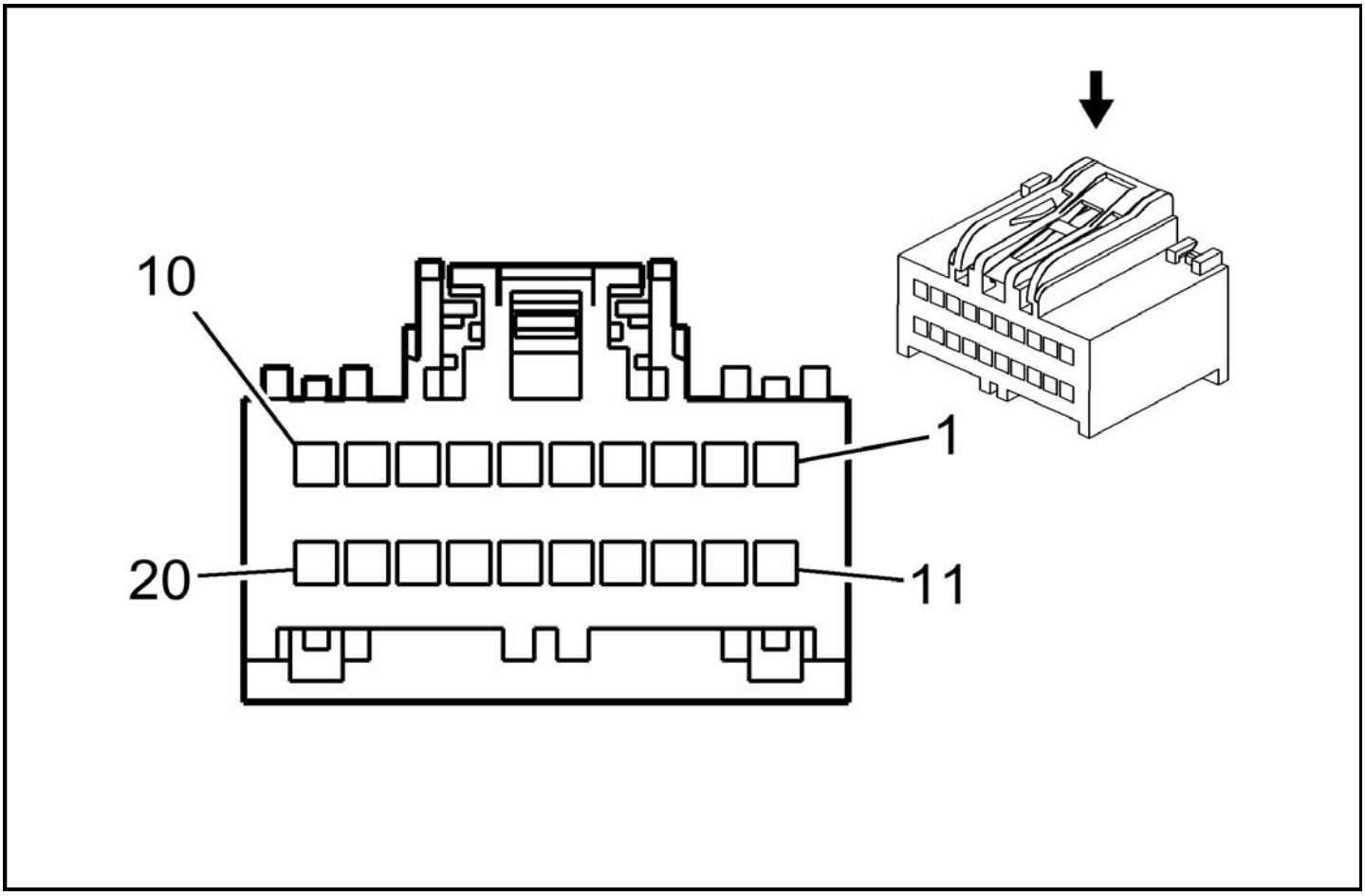
Terminal Part Information

- Terminated Lead: 13575535
- Release Tool: J-38125-21
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 15359541/4
- Core/Insulation Crimp: M/M

HVAC Control Module X1

Pin	Wire	Circuit	Function
1	0.35 PU/WH	1382	LED Dimming Supply
2	0.35 PK	1139	Ignition 1 Voltage
3	0.5 BK/WH	1551	Ground
4	0.35 RD/WH	1840	Battery Positive Voltage
5-6	-	-	Not Used
7	0.5 PK	7574	A/C Compressor Solenoid Control
8	0.35 WH	193	Rear Defog Relay Control
9	0.35 L-GN/BK	735	Ambient Air Temperature Sensor Signal
10	0.5 BK	1450	Ground
11	-	-	Not Used
12	0.35 YE	61	Low Reference
13	0.35 L-GN/WH	5060	Low Speed GMLAN Serial Data
14	0.5 TN	7573	A/C Compressor Solenoid Voltage Supply
15-16	-	-	Not Used

HVAC CONTROL MODULE X2



Connector Part Information

- Harness Type: HVAC
- OEM Connector: 15491304
- Service Connector: 15126710
- Description: 20-Way F USCAR 64 Series (GY)

Terminal Part Information

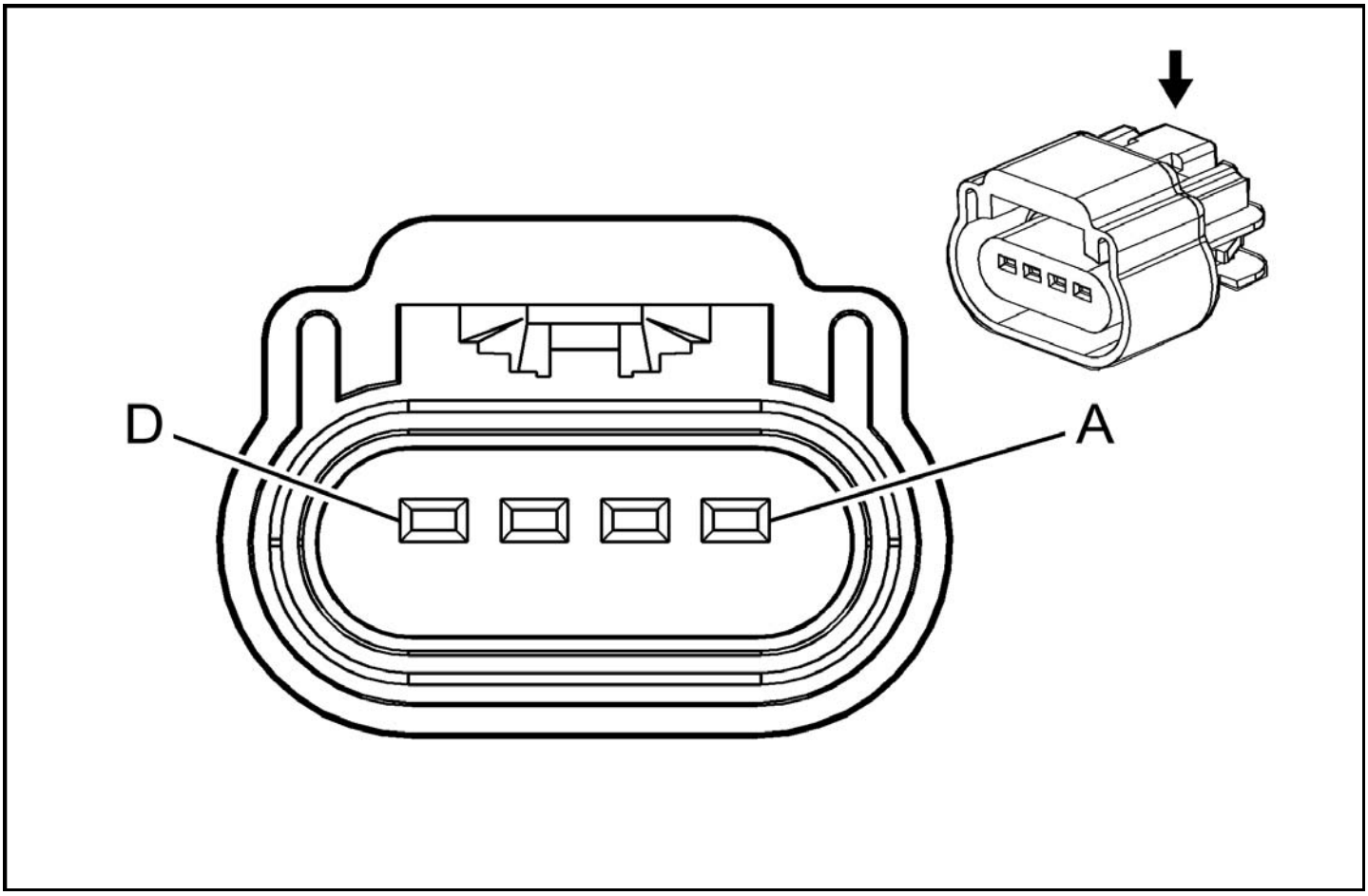
- Terminal/Tray: SAIT-A03T-M064/14
- Core/Insulation Crimp: P/P
- Release Tool/Test Probe: J-38125-215A/J-35616-64B (L-BU)

HVAC Control Module X2

Pin	Wire	Circuit	Function
1-3	-	-	Not Used
4	0.35 GY/BK	754	Blower Motor Speed Control
5	0.35 L-GN	2275	Mode Door Control A
6	0.35 YE	1791	Left Air Temperature Door Control A
7	0.35 PK/WH	1648	Recirculation Door Control A
8	0.35 D-BU	1646	Air Temperature Door Control A

Pin	Wire	Circuit	Function
9-13	-	-	Not Used
14	0.35 WH	2622	Front Frost Sensor Control
15	0.35 TN	2273	Mode Door Control B
16	0.35 D-BU/WH	1199	Left Air Temperature Door Control B
17	0.35 L-GN/BK	1647	Recirculation Door Control B
18	0.35 WH/BK	1236	Air Temperature Door Control B
19	0.35 D-GN	6101	Low Reference
20	-	-	Not Used

IGNITION COIL 1



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15466325
- Service Connector: 13585847
- Description: 4-Way F GT 150 Series, Sealed (BK)

Terminal Part Information

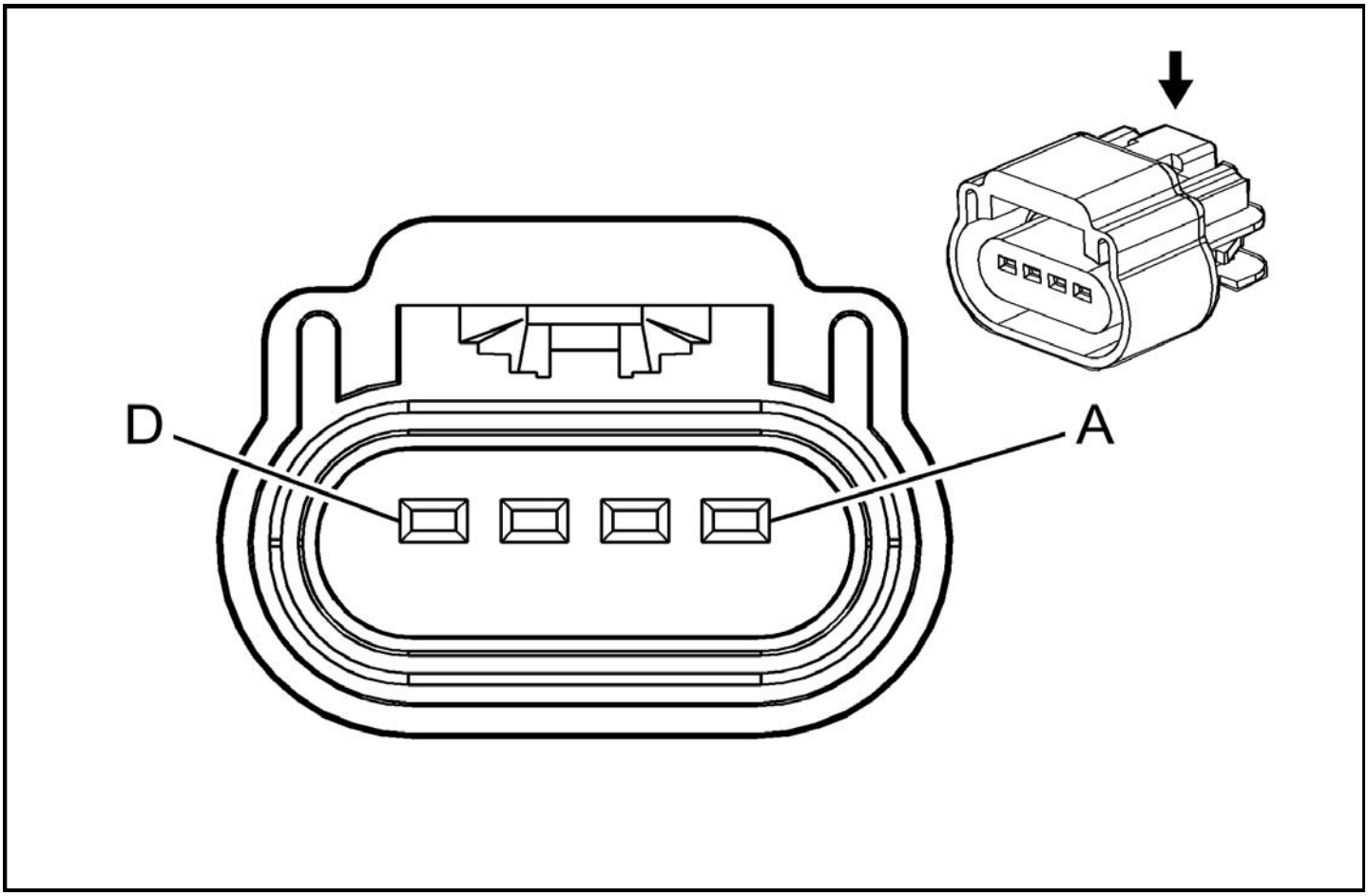
- Terminated Lead: Pins A, D- 13327113

- Terminated Lead: Pins B, C- 13578912
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: Pins A, D- 2/1
- Core/Insulation Crimp: Pins B, C- E/1

Ignition Coil 1

Pin	Wire	Circuit	Function
A	1 BK/WH	51	Ground
B	0.5 BN	2129	Low Reference
C	0.5 PU	2121	IC 1 Control
D	1 PK/BK	5291	Ignition Voltage

IGNITION COIL 2



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15466325
- Service Connector: 13585847

- Description: 4-Way F GT 150 Series, Sealed (BK)

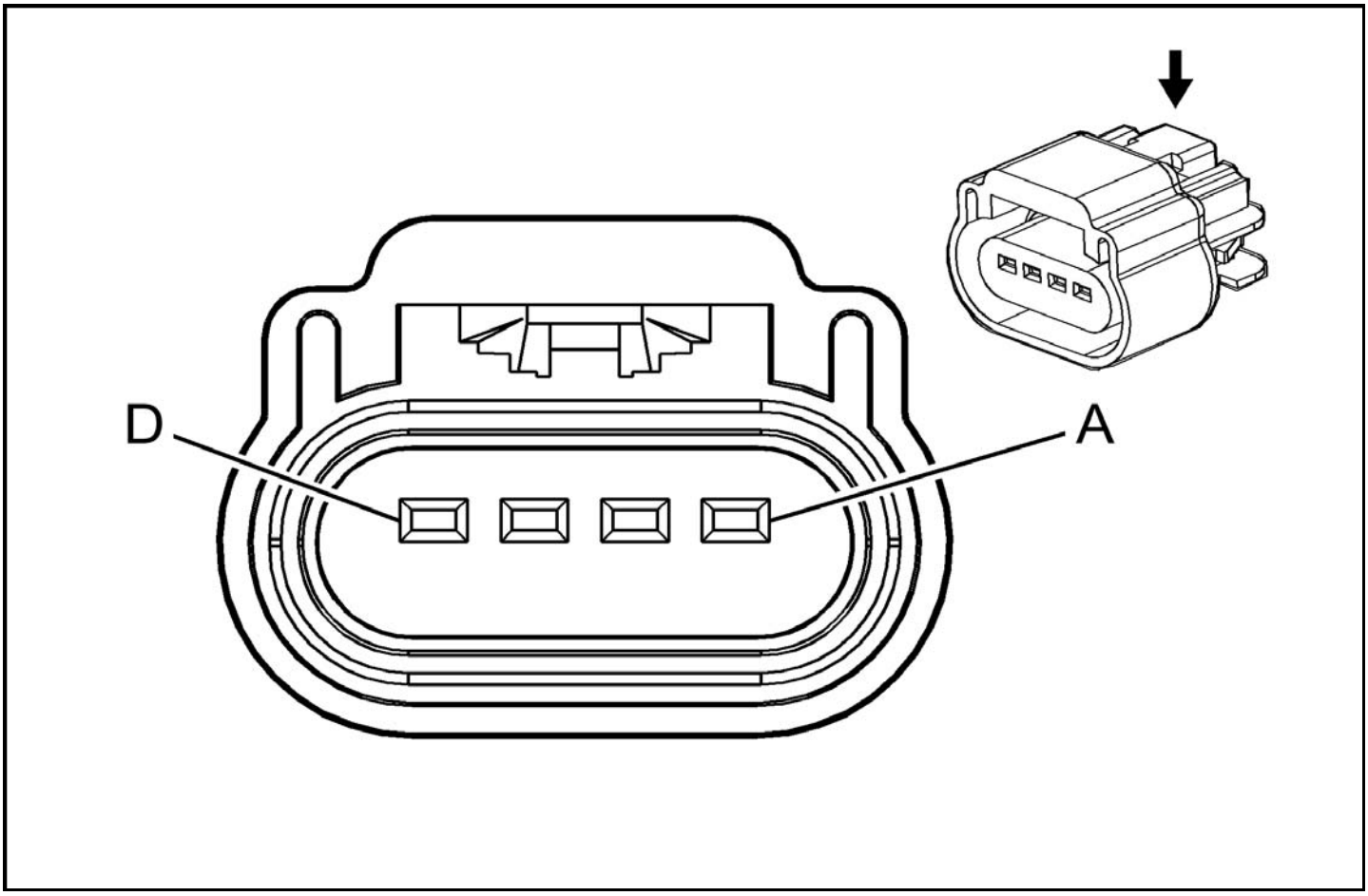
Terminal Part Information

- Terminated Lead: Pins A, D- 13327113
- Terminated Lead: Pins B, C- 13578912
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: Pins A, D- 2/1
- Core/Insulation Crimp: Pins B, C- E/1

Ignition Coil 2

Pin	Wire	Circuit	Function
A	1 BK/WH	51	Ground
B	0.5 BN/WH	2130	Low Reference
C	0.5 OG/WH	2122	IC 2 Control
D	1 PK/BK	5292	Ignition Voltage

IGNITION COIL 3



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15466325
- Service Connector: 13585847
- Description: 4-Way F GT 150 Series, Sealed (BK)

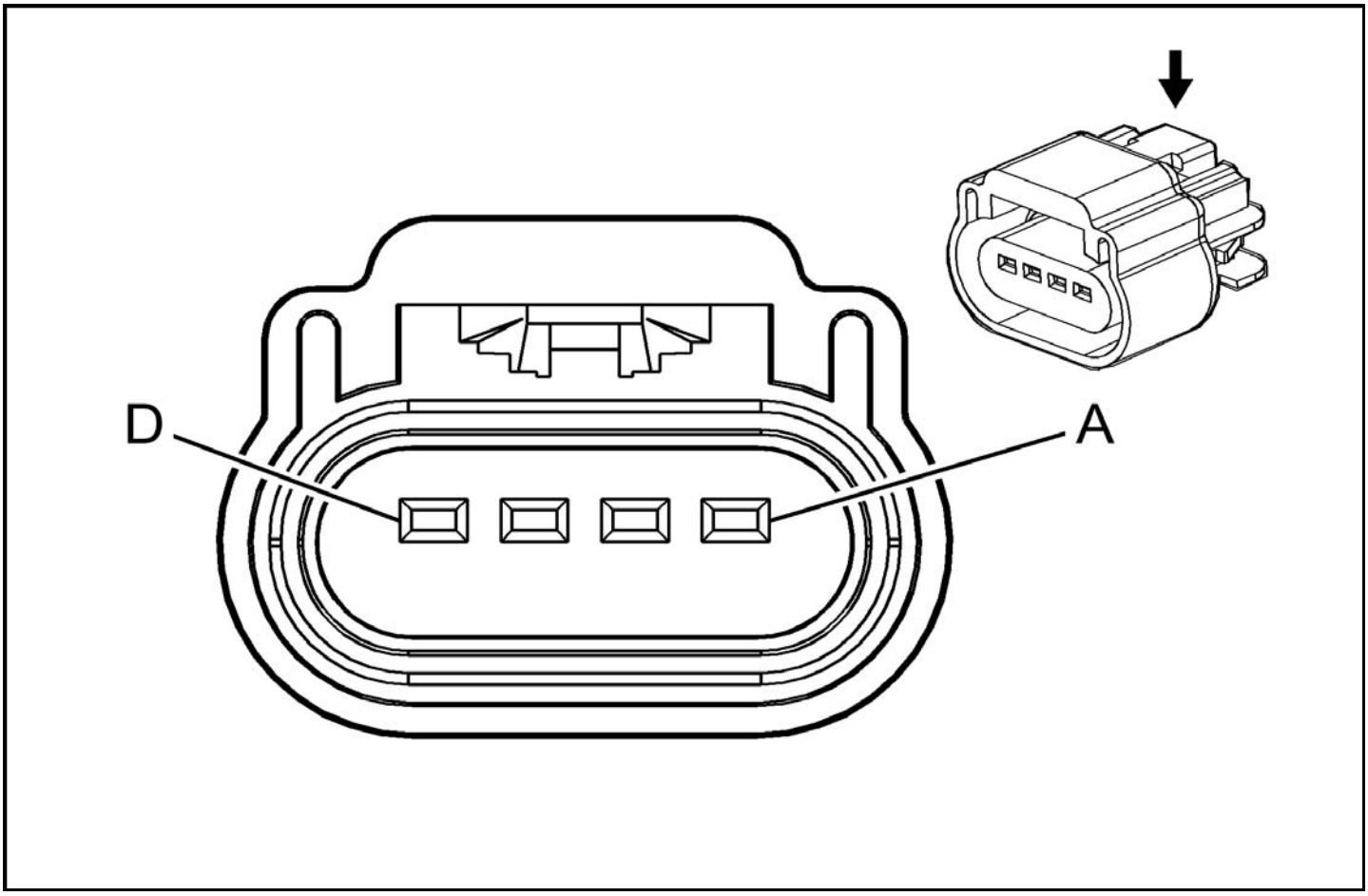
Terminal Part Information

- Terminated Lead: Pins A, D- 13327113
- Terminated Lead: Pins B, C- 13578912
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: Pins A, D- 2/1
- Core/Insulation Crimp: Pins B, C- E/1

Ignition Coil 3

Pin	Wire	Circuit	Function
A	1 BK/WH	51	Ground
B	0.5 BN	2129	Low Reference
C	0.5 L-BU	2123	IC 3 Control
D	1 PK/BK	5291	Ignition Voltage

IGNITION COIL 4



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15466325
- Service Connector: 13585847
- Description: 4-Way F GT 150 Series, Sealed (BK)

Terminal Part Information

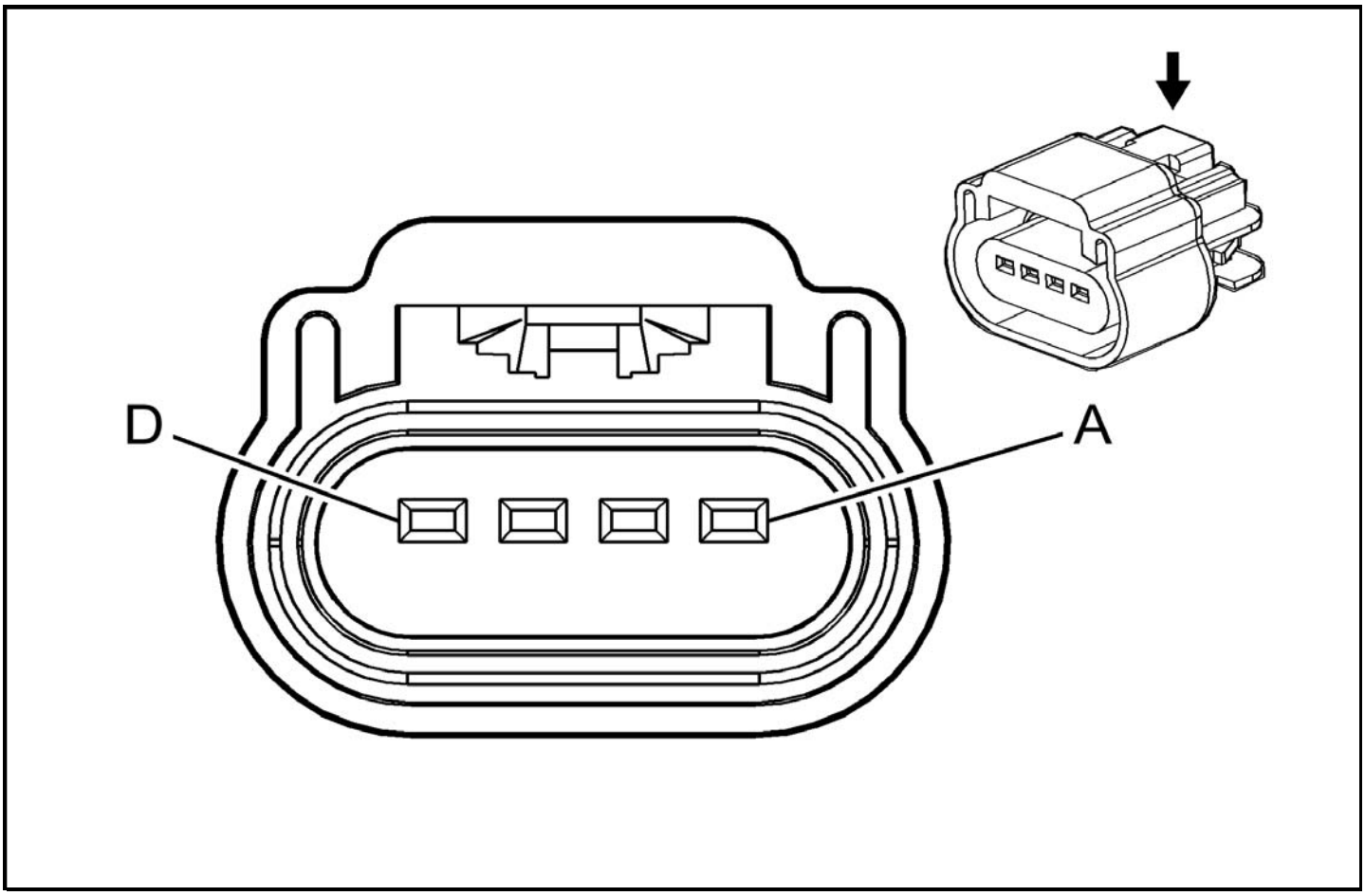
- Terminated Lead: Pins A, D- 13327113
- Terminated Lead: Pins B, C- 13578912
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: Pins A, D- 2/1
- Core/Insulation Crimp: Pins B, C- E/1

Ignition Coil 4

Pin	Wire	Circuit	Function
A	1 BK/WH	51	Ground
B	0.5 BN/WH	2130	Low Reference

Pin	Wire	Circuit	Function
C	0.5 D-GN/WH	2124	IC 4 Control
D	1 PK/BK	5292	Ignition Voltage

IGNITION COIL 5



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15466325
- Service Connector: 13585847
- Description: 4-Way F GT 150 Series, Sealed (BK)

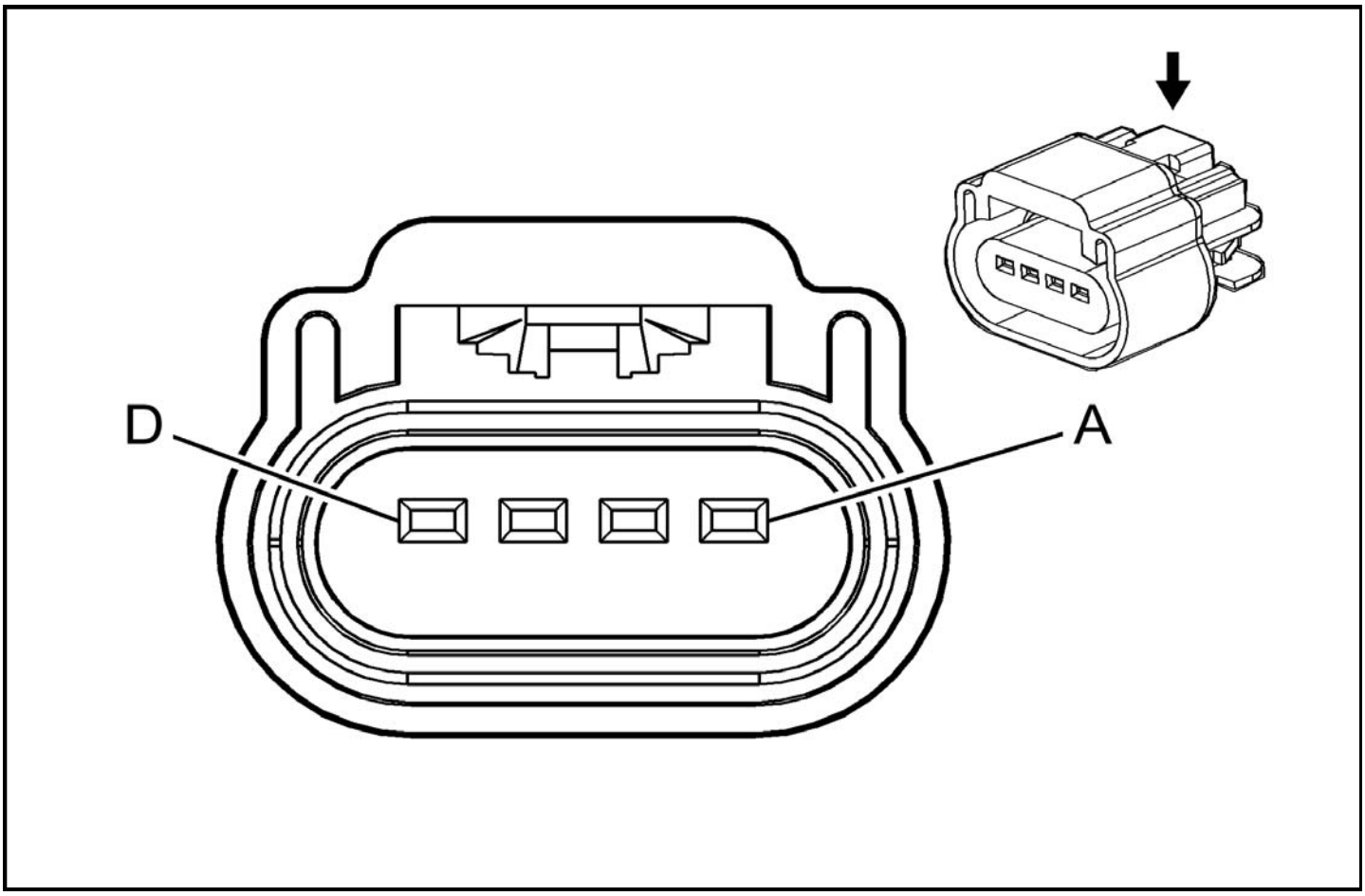
Terminal Part Information

- Terminated Lead: Pins A, D- 13327113
- Terminated Lead: Pins B, C- 13578912
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: Pins A, D- 2/1
- Core/Insulation Crimp: Pins B, C- E/1

Ignition Coil 5

Pin	Wire	Circuit	Function
A	1 BK/WH	51	Ground
B	0.5 BN	2129	Low Reference
C	0.5 D-GN	2125	IC 5 Control
D	1 PK/BK	5291	Ignition Voltage

IGNITION COIL 6



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15466325
- Service Connector: 13585847
- Description: 4-Way F GT 150 Series, Sealed (BK)

Terminal Part Information

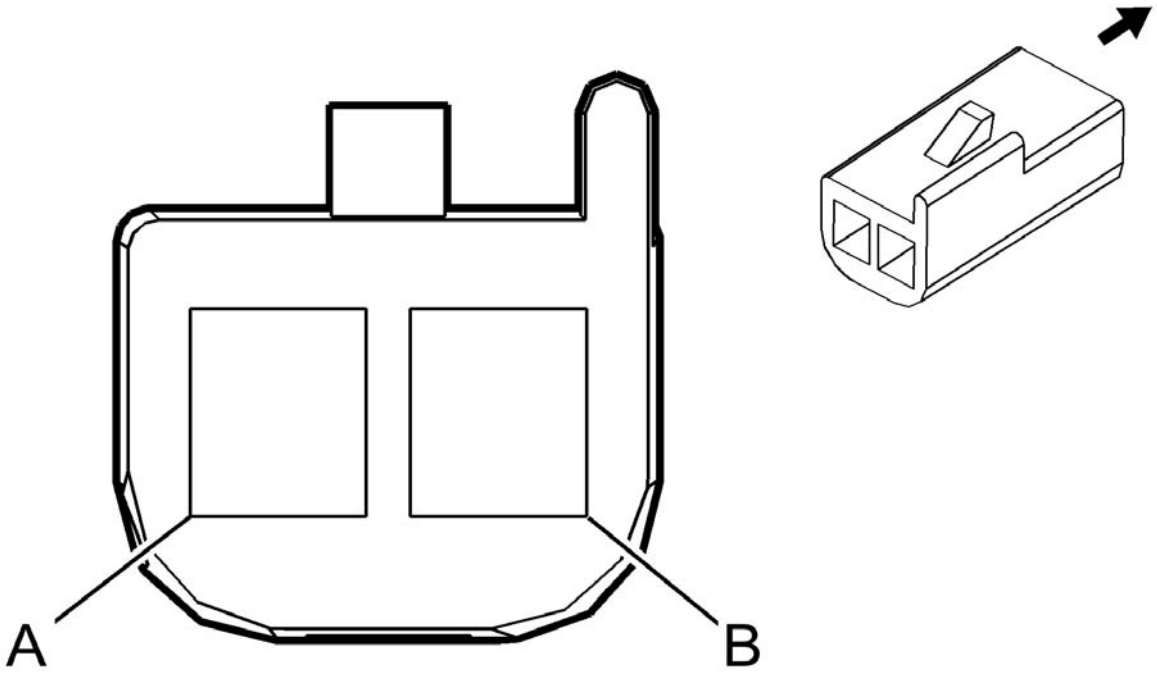
- Terminated Lead: Pins A, D- 13327113
- Terminated Lead: Pins B, C- 13578912
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)

- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: Pins A, D- 2/1
- Core/Insulation Crimp: Pins B, C- E/1

Ignition Coil 6

Pin	Wire	Circuit	Function
A	1 BK/WH	51	Ground
B	0.5 BN/WH	2130	Low Reference
C	0.5 L-BU/WH	2126	IC 6 Control
D	1 PK/BK	5292	Ignition Voltage

IGNITION LOCK CYLINDER CONTROL ACTUATOR (D55)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12047662
- Service Connector: 12085535
- Description: 2-Way F Metri-Pack 150 Series (BK)

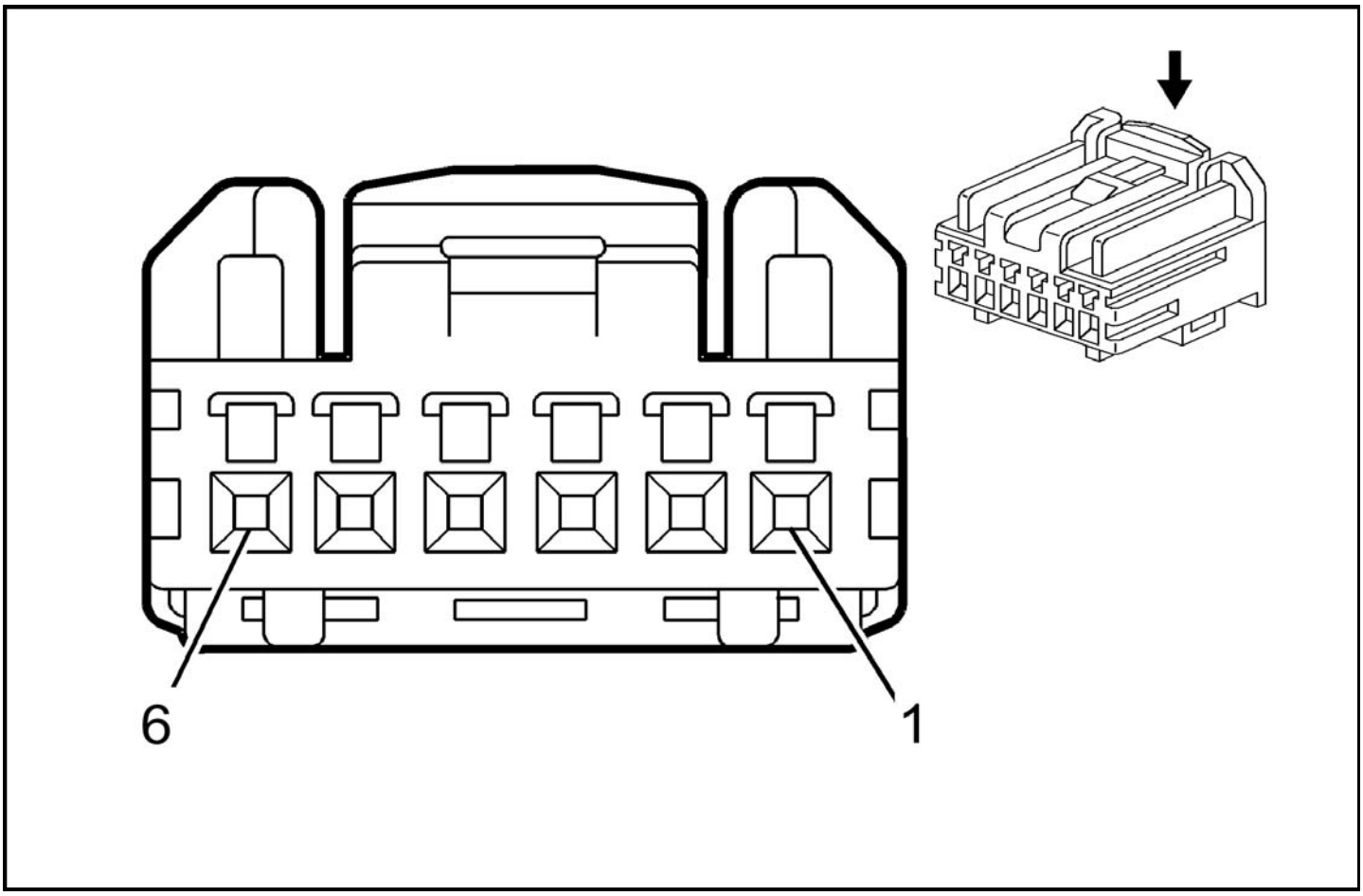
Terminal Part Information

- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Ignition Lock Cylinder Control Actuator (D55)

Pin	Wire	Circuit	Function
A	0.35 PU/WH	1630	Steering Column Key Cylinder Lock Solenoid Control
B	0.35 BK	1450	Ground

IGNITION SWITCH



Connector Part Information

- Harness Type: Steering Column
- OEM Connector: 15484551
- Service Connector: 19153174

- Description: 6-Way F HCM Series (BK)

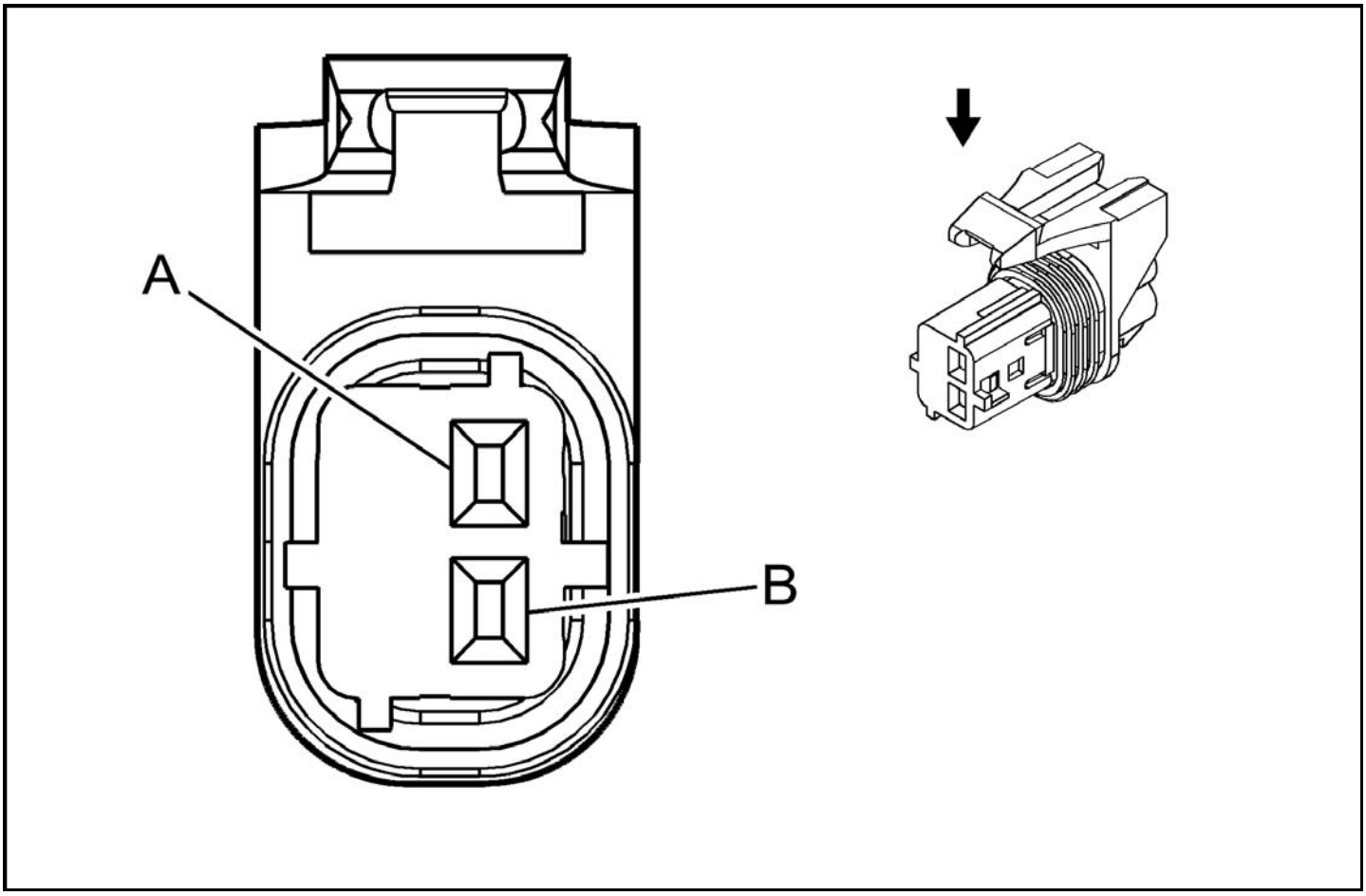
Terminal Part Information

- Terminated Lead: 13575868
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SHCM-A03T-P025/20
- Core/Insulation Crimp: J/J

Ignition Switch

Pin	Wire	Circuit	Function
1	0.35 PK	3	Ignition 1 Voltage
2	0.35 RD/WH	1040	Battery Positive Voltage
3	0.35 BN	4	Accessory Voltage
4	-	-	Not Used
5	0.35 WH	1390	Off/Run/Crank Voltage
6	0.35 WH/BK	1073	5-Volt Reference

INFLATABLE RESTRAINT FRONT END SENSOR - LEFT



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 15356723
- Service Connector: 15306439
- Description: 2-Way F GT 150 Series, Sealed (YE)

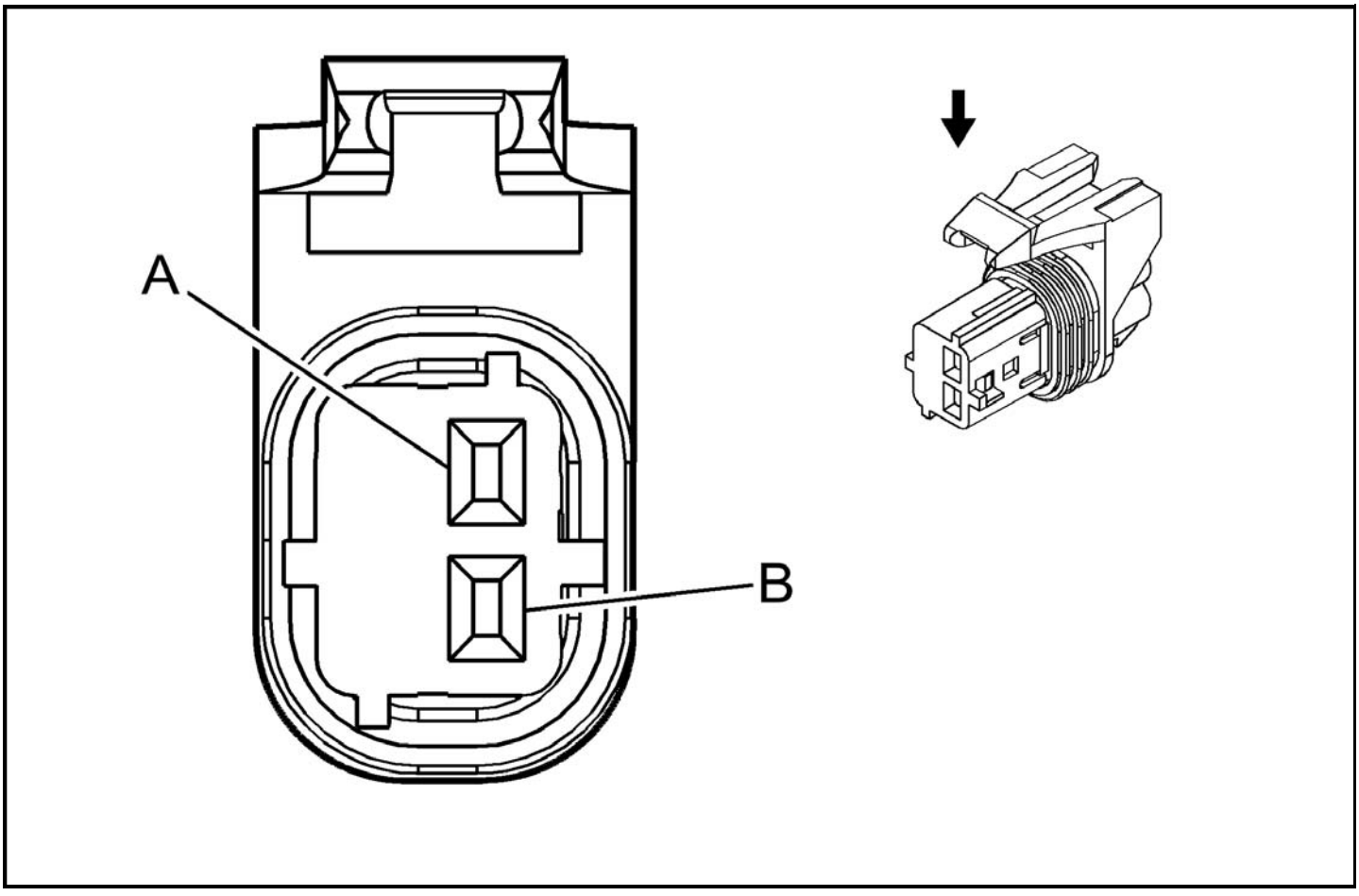
Terminal Part Information

- Terminated Lead: 13327113
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: 2/1

Inflatable Restraint Front End Sensor - Left

Pin	Wire	Circuit	Function
A	0.8 TN/OG	5045	Discriminating Sensor- Left- Low Reference
B	0.8 YE	354	Discriminating Sensor- Left- Signal

INFLATABLE RESTRAINT FRONT END SENSOR - RIGHT



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 15356723
- Service Connector: 15306439
- Description: 2-Way F GT 150 Series, Sealed (YE)

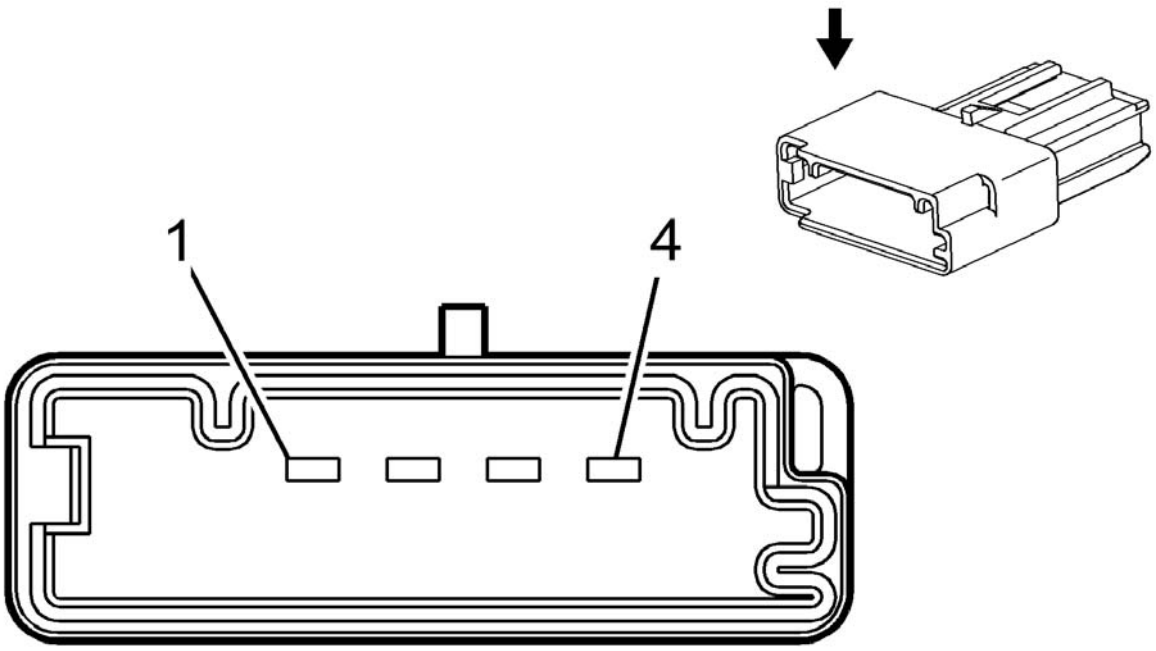
Terminal Part Information

- Terminated Lead: 13327113
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: 2/1

Inflatable Restraint Front End Sensor - Right

Pin	Wire	Circuit	Function
A	0.8 GY	5600	Discriminating Sensor- Right- Low Reference
B	0.8 D-GN	1409	Discriminating Sensor- Right- Signal

INFLATABLE RESTRAINT FRONT PASSENGER PRESENCE SYSTEM (PPS) MODULE



Connector Part Information

- Harness Type: Right Front Seat
- OEM Connector: 13640937
- Service Connector: Service by Harness - See Part Catalog
- Description: 4-Way M Low Profile 1.5 Series (BK)

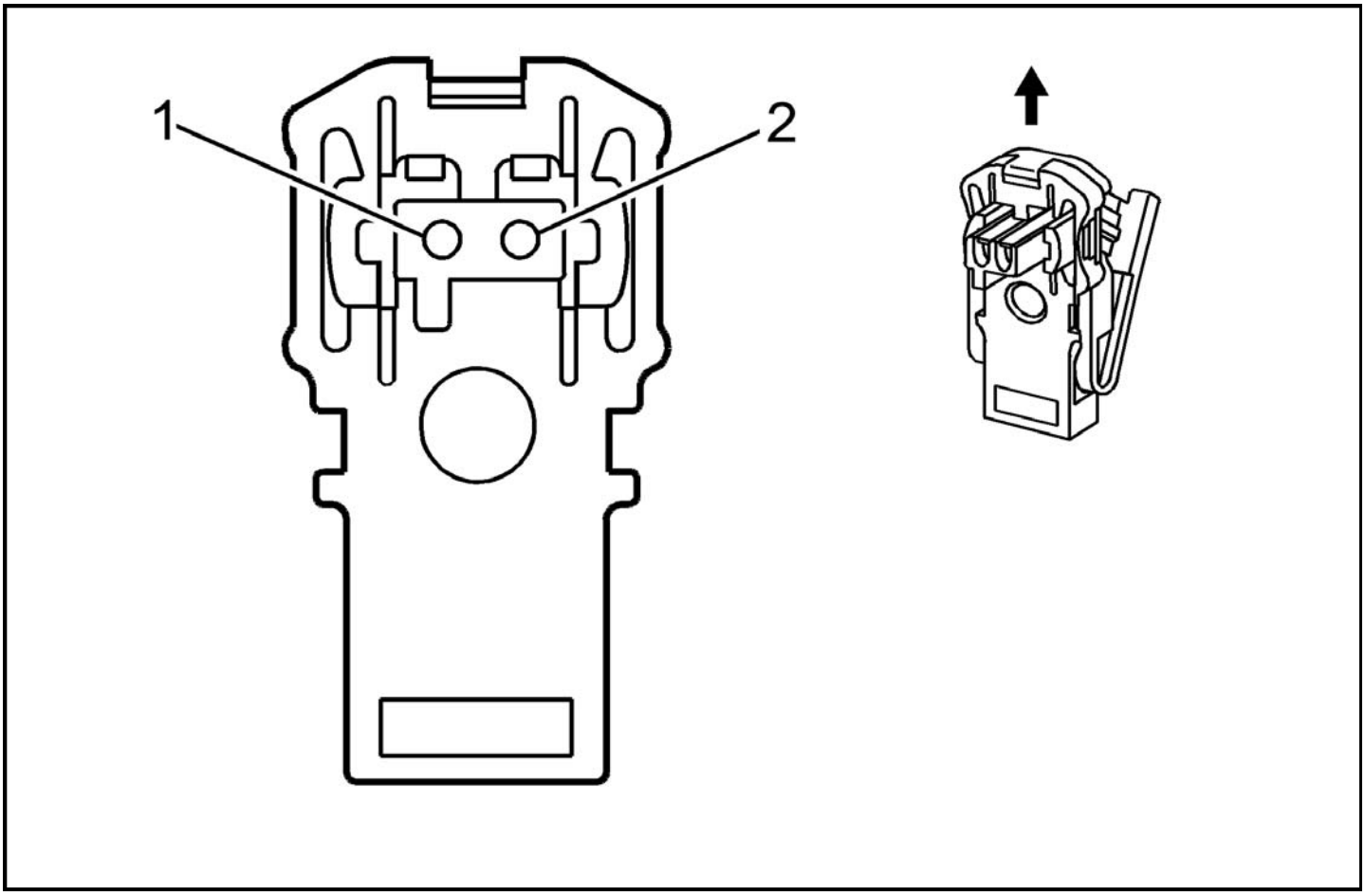
Terminal Part Information

- Terminated Lead: 13575502
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 15304702/19
- Core/Insulation Crimp: E/C

Inflatable Restraint Front Passenger Presence System (PPS) Module

Pin	Wire	Circuit	Function
1	0.35 D-GN	5060	Low Speed GMLAN Serial Data
2	-	-	Not Used
3	0.35 RD/WH	1340	Battery Positive Voltage
4	0.35 BK/WH	1751	Ground

INFLATABLE RESTRAINT I/P MODULE X1



Connector Part Information

- Harness Type: Inflatable Restraint Jumper
- OEM Connector: 54561236
- Service Connector: Service by Harness - See Part Catalog
- Description: 2-Way F AMP (WH with YE Lock)

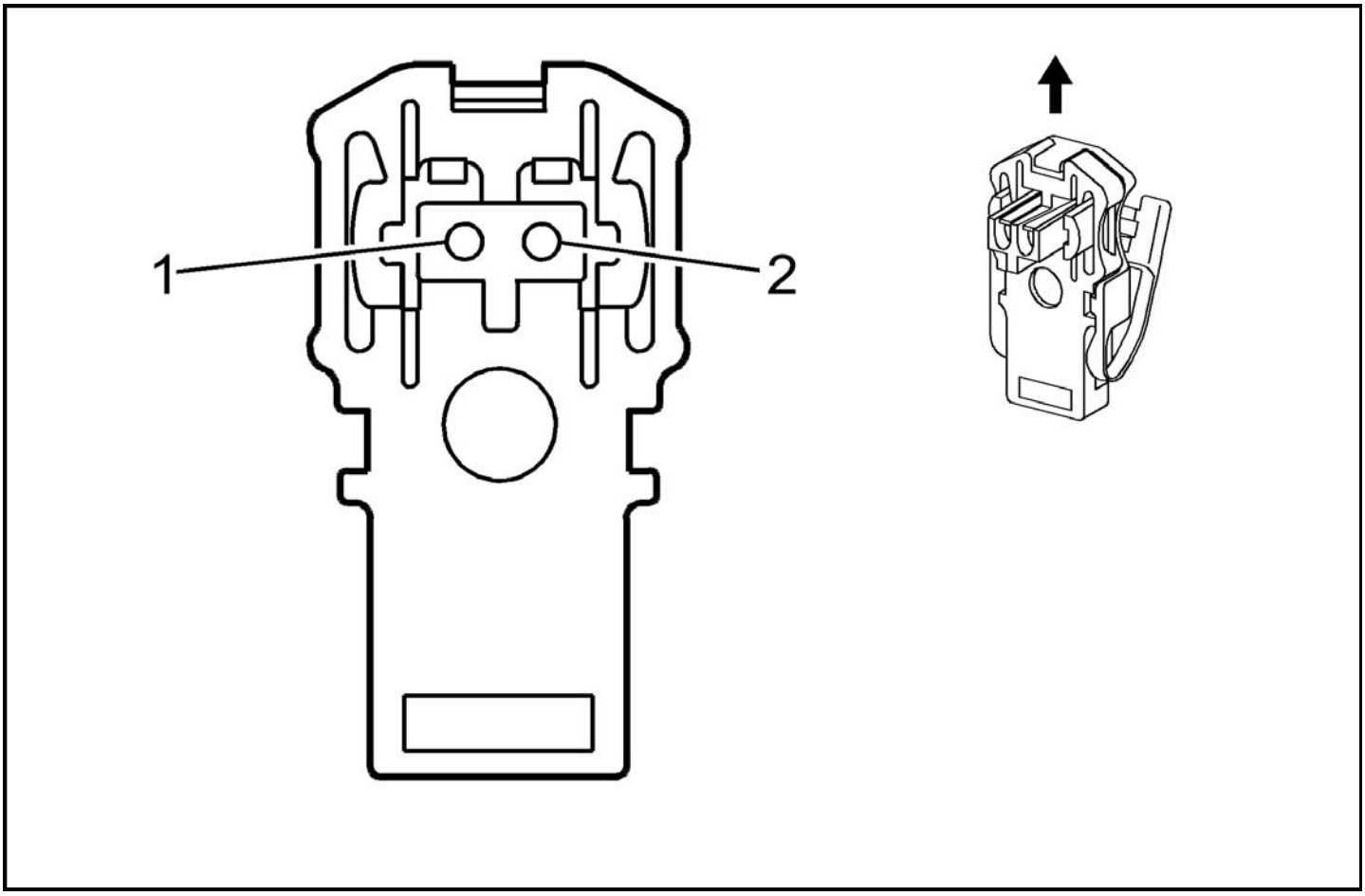
Terminal Part Information

- Terminal/Tray: Service with Pigtail
- Core/Insulation Crimp: Not Available
- Release Tool/Test Probe: Not Available

Inflatable Restraint I/P Module X1

Pin	Wire	Circuit	Function
1	0.35 YE	3025	I/P Module- Stage 1- High Control
2	0.35 OG	3024	I/P Module- Stage 1- Low Control

INFLATABLE RESTRAINT I/P MODULE X2



Connector Part Information

- Harness Type: Inflatable Restraint Jumper
- OEM Connector: 54560222
- Service Connector: Service by Harness - See Part Catalog
- Description: 2-Way F AMP (PK with YE Lock)

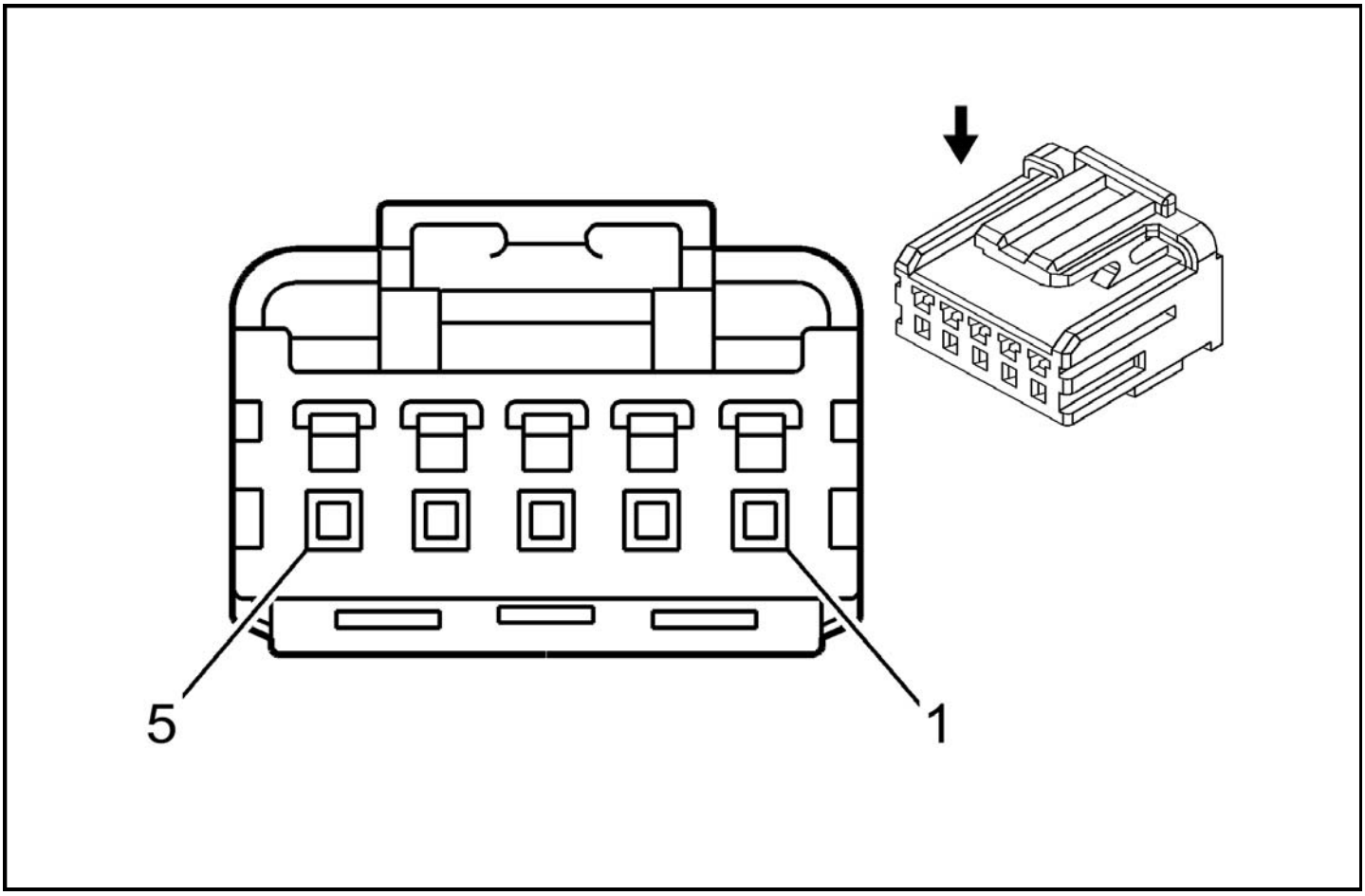
Terminal Part Information

- Terminal/Tray: Service with Pigtail
- Core/Insulation Crimp: Not Available
- Release Tool/Test Probe: Not Available

Inflatable Restraint I/P Module X2

Pin	Wire	Circuit	Function
1	0.35 GY	3027	I/P Module- Stage 2- High Control
2	0.35 PU	3026	I/P Module- Stage 2- Low Control

INFLATABLE RESTRAINT I/P MODULE INDICATOR



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15398877
- Service Connector: 88988112
- Description: 5-Way F HCM Series (NA)

Terminal Part Information

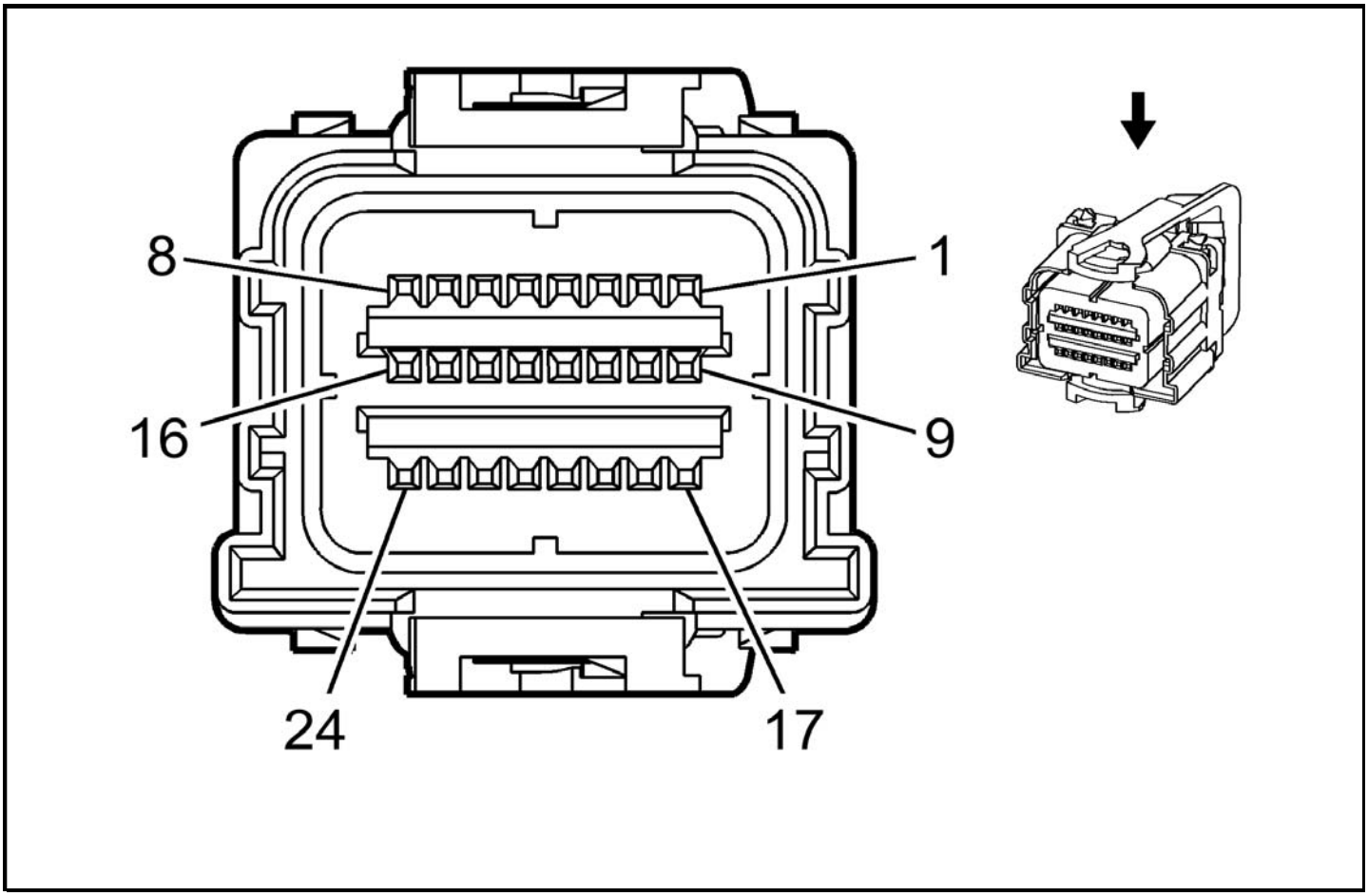
- Terminated Lead: 13575868
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SHCM-A03T-P025/20
- Core/Insulation Crimp: J/J

Inflatable Restraint I/P Module Indicator

Pin	Wire	Circuit	Function
1	0.35 D-BU	2307	Passenger Air Bag On Indicator Control
2	0.5 BK	1450	Ground
3	0.35 D-GN	2308	Passenger Air Bag Off Indicator Control
4	0.35 PK	1139	Ignition 1 Voltage

Pin	Wire	Circuit	Function
5	0.35 PU	5234	Passenger Seat Belt Indicator Control

INFLATABLE RESTRAINT SENSING AND DIAGNOSTIC MODULE (SDM) X1



Connector Part Information

- Harness Type: Body
- OEM Connector: 13608103
- Service Connector: 13580843
- Description: 24-Way F Kaizen 0.64 Series, Sealed (YE)

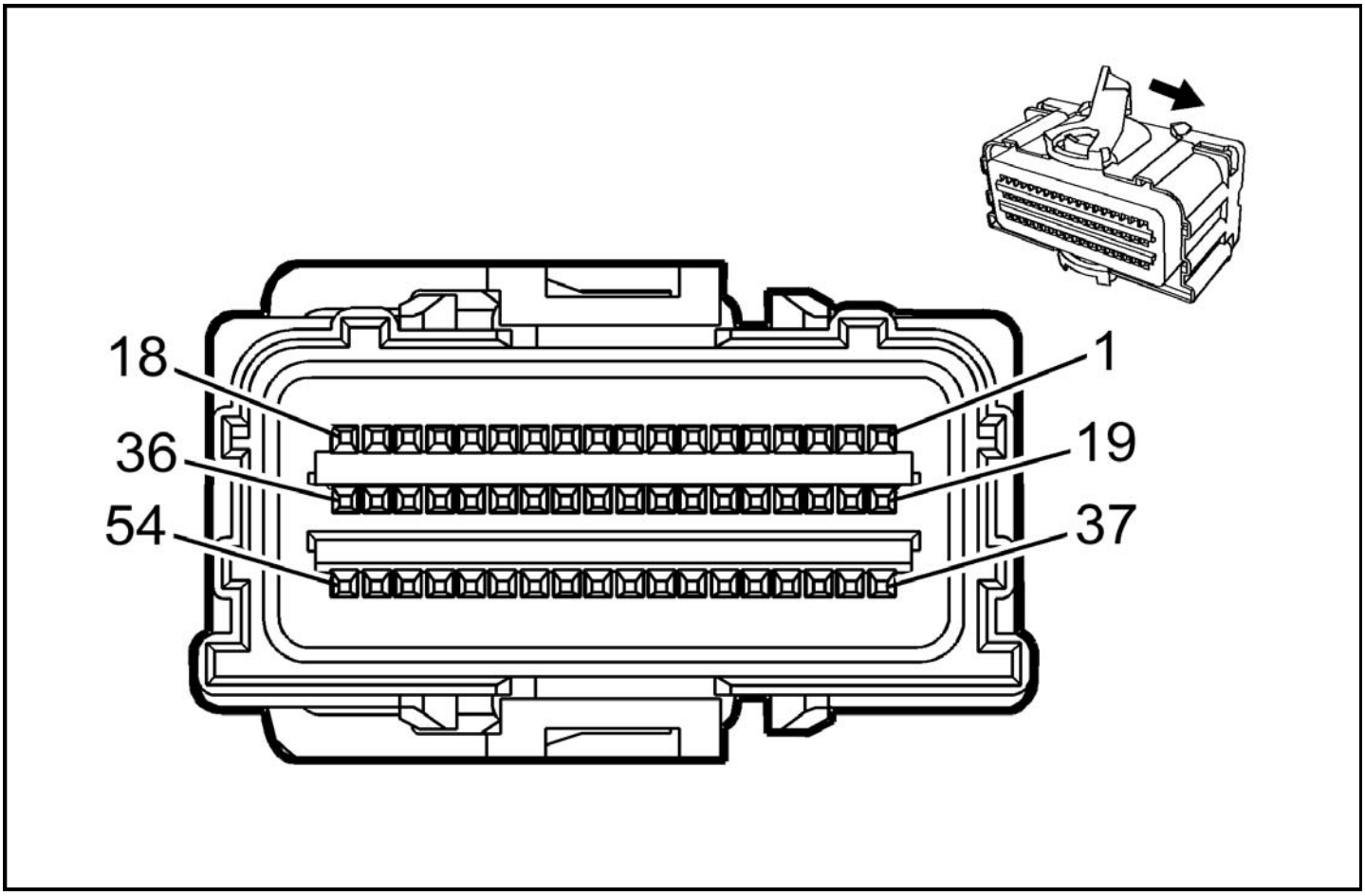
Terminal Part Information

- Terminated Lead: 13575852
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 7116-5231-08//A
- Core/Insulation Crimp: Not Available

Inflatable Restraint Sensing and Diagnostic Module (SDM) X1

Pin	Wire	Circuit	Function
1	0.35 WH	3023	Steering Wheel Module Stage 2 High Control
2	0.35 PK	3022	Steering Wheel Module Stage 2 Low Control
3	0.35 BN	3020	Steering Wheel Module Stage 2 Low Control
4	0.35 TN	3021	Steering Wheel Module Stage 2 High Control
5	0.35 YE	3025	I/P Module Stage 1 High Control
6	0.35 OG	3024	I/P Module Stage 1 Low Control
7	0.35 PU	3026	I/P Module Stage 2 Low Control
8	0.35 GY	3027	I/P Module Stage 2 High Control
9	0.35 RD	1340	Battery Positive Voltage
10-14	-	-	Not Available
15	0.35 D-GN	5060	Low Speed GM LAN Serial Data
16	0.35 D-GN	5060	Low Speed GM LAN Serial Data
17	0.5 PK	1139	Ignition Voltage
18	-	-	Not Available
19	0.5 BK	1751	Ground
20-24	-	-	Not Available

INFLATABLE RESTRAINT SENSING AND DIAGNOSTIC MODULE (SDM) X2



Connector Part Information

- Harness Type: Body
- OEM: 13715984
- Service: 13580845
- Description: 54-Way F 0.64 Series, Sealed (YE)

Terminal Part Information

- Terminated Lead: 13580076
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

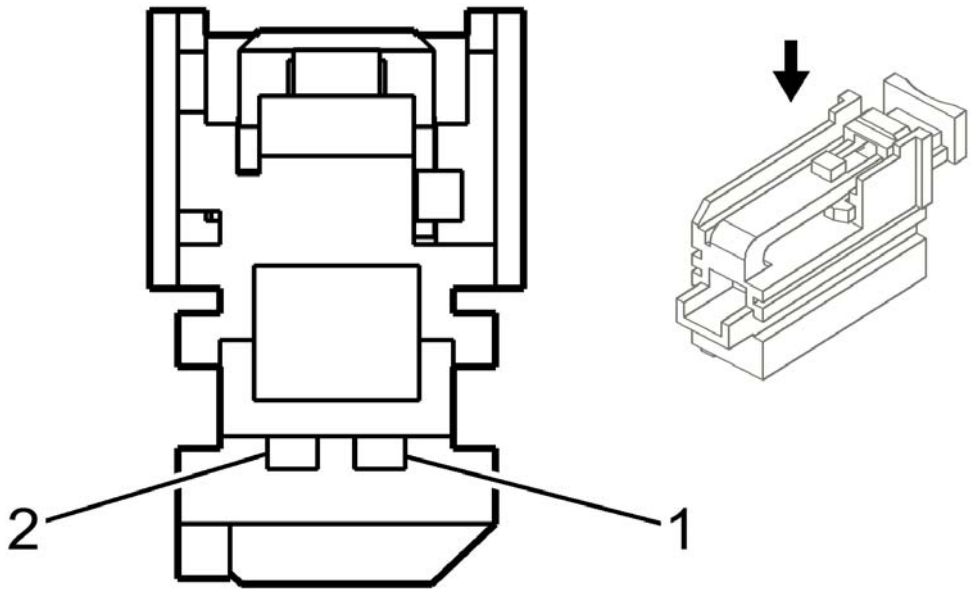
Inflatable Restraint Sensing and Diagnostic Module (SDM) X2

Pin	Wire	Circuit	Function
1-8	-	-	Not Available
9	0.35 WH	3064	Driver Seat Belt Buckle Pretensioner High Control

Pin	Wire	Circuit	Function
10	0.35 YE	3065	Driver Seat Belt Buckle Pretensioner Low Control
11	0.35 L-BU/BK	3063	Passenger Seat Belt Buckle Pretensioner Low Control
12	0.35 TN	3062	Passenger Seat Belt Buckle Pretensioner High Control
13	0.35 BN	2137	Left Front Side Impact Module High Control
14	0.35 YE/BK	2138	Left Front Side Impact Module Low Control
15	0.35 L-GN	2136	Right Front Side Impact Module Low Control
16	0.35 TN/WH	2135	Right Front Side Impact Module High Control
17	0.5 PU/WH	5019	Left Front Head Curtain Module High Control
18	0.5 PK	5020	Left Front Head Curtain Module Low Control
19	0.35 YE	2131	Left Front Side Impact Sensing Module Supply Voltage
20	0.35 WH	2132	Left Front Side Impact Sensing Module Signal
21	0.35 D-GN	2134	Right Front Side Impact Sensing Module Signal
22	0.35 TN	2133	Right Front Side Impact Sensing Module Supply Voltage
23	0.35 YE	354	Left Front Discriminating Sensor Signal
24	0.35 TN/OG	5045	Left Front Discriminating Sensor Low Reference
25	0.35 GY	5600	Right Front Side Impact Sensing Module Signal
26	0.35 D-GN	1409	Right Front Side Impact Sensing Module Signal
27-36	-	-	Not Available
37	0.35 TN/WH	2118	Driver Seat Belt Pretensioner High Control
38	0.35 OG/BK	2119	Driver Seat Belt Pretensioner Low Control
39	0.35 OG	2117	Passenger Seat Belt Pretensioner Low Control
40	0.35 L-GN	2116	Passenger Seat Belt Pretensioner High Control
41	0.35 D-GN	5016	Driver Seat Belt Switch Signal
42	-	-	Not Available
43	0.35 PK	5057	Seat Position Switch Low Reference
44	-	-	Not Available
45	0.35 OG	1362	Seat Belt Switch Signal

Pin	Wire	Circuit	Function
46-52	-	-	Not Available
53	0.5 YE/BK	5021	Right Front Head Curtain Module High Control
54	0.5 WH/BK	5022	Right Front Head Curtain Module Low Control

INFLATABLE RESTRAINT SIDE IMPACT MODULE - LEFT



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 13647550
- Service Connector: 19208396
- Description: 2-Way F 0.64 Series Unsealed (YE)

Terminal Part Information

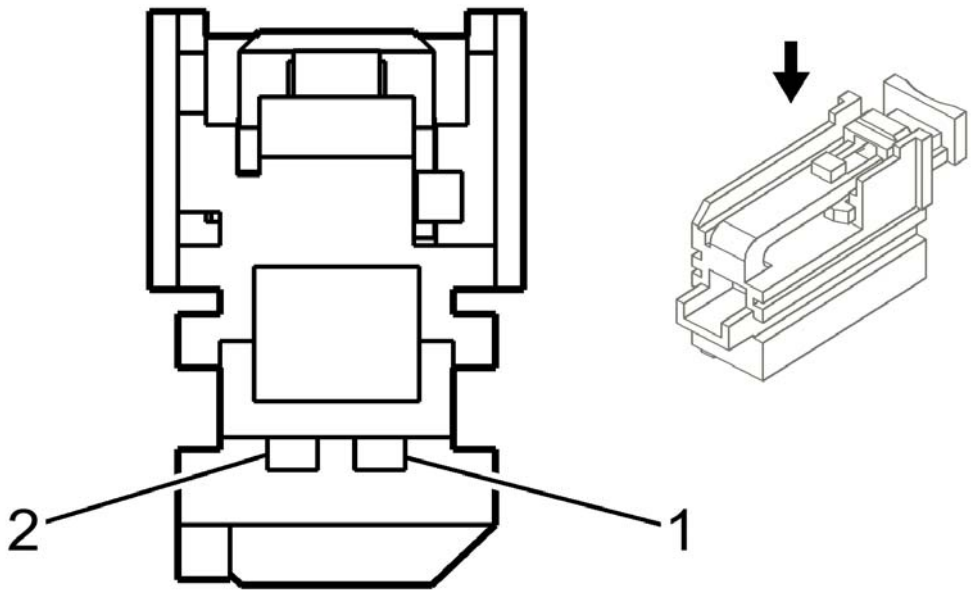
- Terminated Lead: 13575867
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SAIT-A03T-M064/14

- Core/Insulation Crimp: P/P

Inflatable Restraint Side Impact Module - Left

Pin	Wire	Circuit	Function
1	0.5 YE/BK	2138	Left Front Side Impact Module- Low Control
2	0.5 BN	2137	Left Front Side Impact Module- High Control

INFLATABLE RESTRAINT SIDE IMPACT MODULE - RIGHT



Connector Part Information

- Harness Type: Right Front Seat
- OEM Connector: 13647550
- Service Connector: 19208396
- Description: 2-Way F 0.64 Series Unsealed (YE)

Terminal Part Information

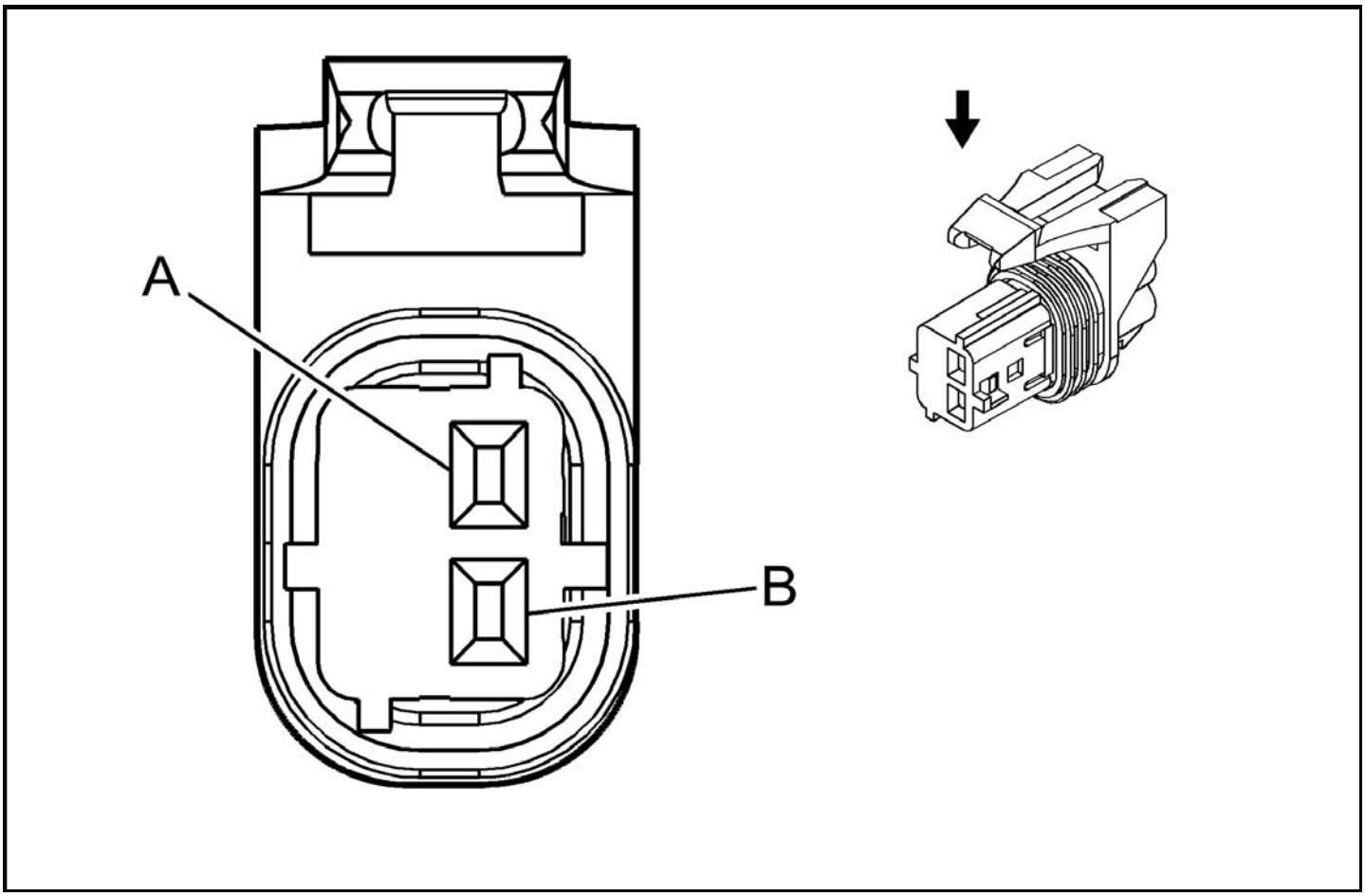
- Terminated Lead: 13575867
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)

- Terminal/Tray: SAIT-A03T-M064/14
- Core/Insulation Crimp: P/P

Inflatable Restraint Side Impact Module - Right

Pin	Wire	Circuit	Function
1	0.5 L-GN	2136	Right Front Side Impact Module- Low Control
2	0.5 TN/WH	2135	Right Front Side Impact Module- High Control

INFLATABLE RESTRAINT SIDE IMPACT SENSOR (SIS) - LEFT



Connector Part Information

- Harness Type: Left Front Door
- OEM Connector: 15356723
- Service Connector: 15306439
- Description: 2-Way F GT 150 Series, Sealed (YE)

Terminal Part Information

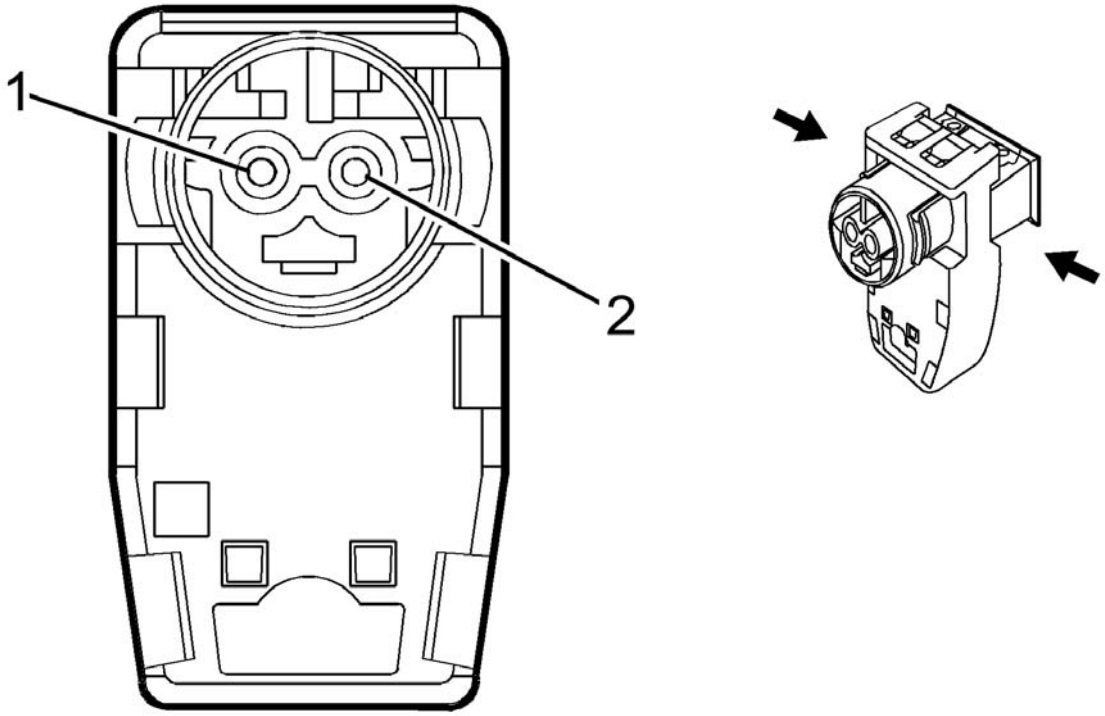
- Terminated Lead: 13327113

- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: 2/1

Inflatable Restraint Side Impact Sensor (SIS) - Left

Pin	Wire	Circuit	Function
A	0.5 WH	2132	Side Impact Sensing Module- Left- Signal
B	0.5 YE	2131	Side Impact Sensing Module- Left- Voltage

INFLATABLE RESTRAINT ROOF RAIL MODULE - LEFT



Connector Part Information

- Harness Type: Body
- OEM Connector: 13849513
- Service Connector: 13584260
- Description: 2-Way F 0.64 GET Series (BK w/ YE cover)

Terminal Part Information

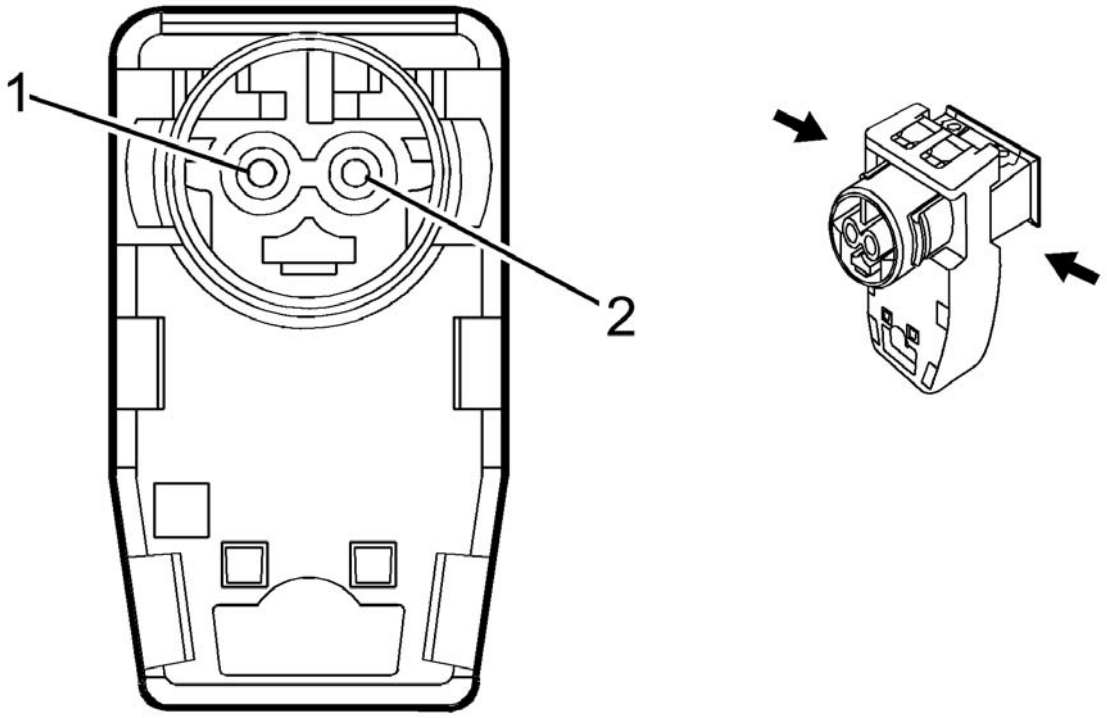
- Terminated Lead: Service by Connector Assembly - 13584260

- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Inflatable Restraint Roof Rail Module - Left

Pin	Wire	Circuit	Function
1	0.5 PU/WH	5019	Left Front Head Curtain Module High Control
2	0.5 PK	5020	Left Front Head Curtain Module Low Control

INFLATABLE RESTRAINT ROOF RAIL MODULE - RIGHT



Connector Part Information

- Harness Type: Body
- OEM Connector: 13806185
- Service Connector: 19118723
- Description: 2-Way F 0.64 GET Series (BK w/ YE cover)

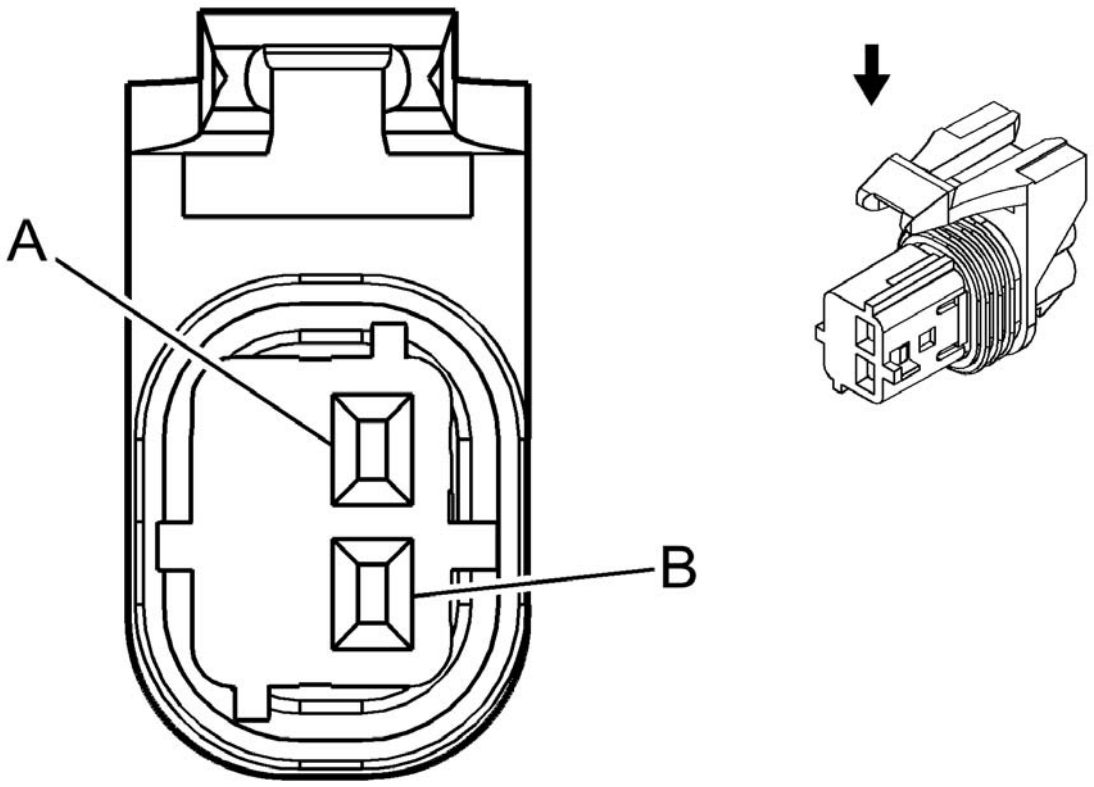
Terminal Part Information

- Terminated Lead: Service by Connector Assembly - 19118723
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Inflatable Restraint Roof Rail Module - Right

Pin	Wire	Circuit	Function
1	0.5 YE/BK	5021	Right Front Head Curtain Module High Control
2	0.5 WH/BK	5022	Right Front Head Curtain Module Low Control

INFLATABLE RESTRAINT SIDE IMPACT SENSOR (SIS) - RIGHT



Connector Part Information

- Harness Type: Right Front Door
- OEM Connector: 15356723

- Service Connector: 15306439
- Description: 2-Way F GT 150 Series, Sealed (YE)

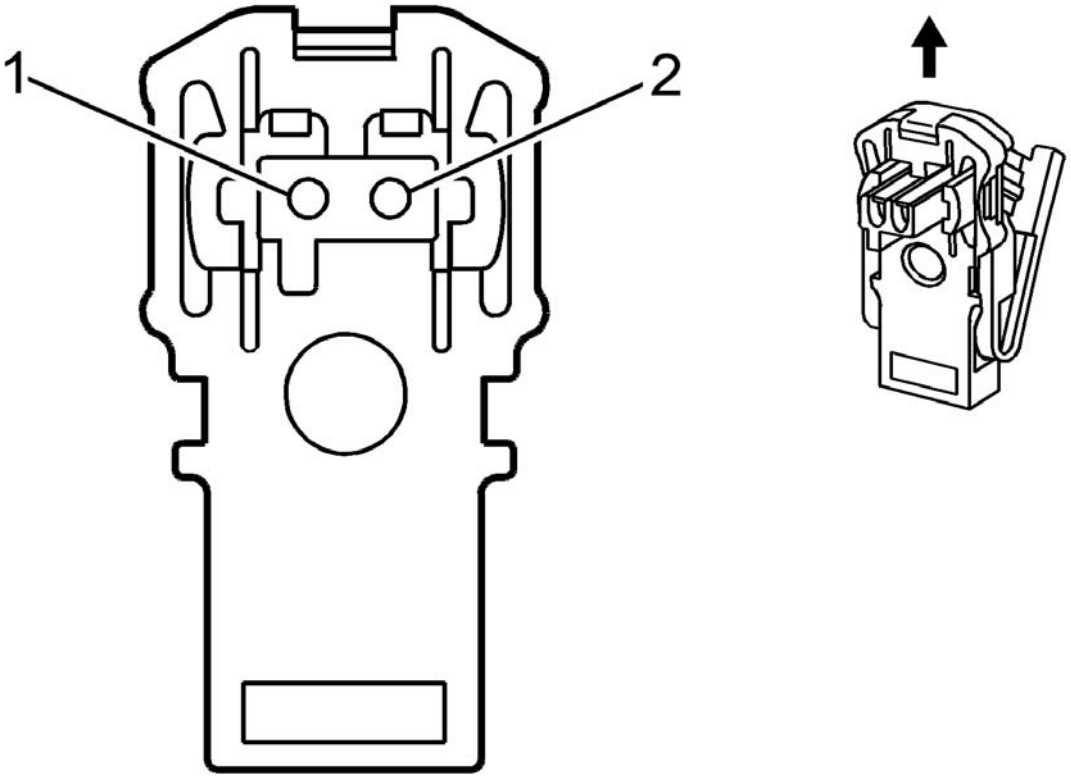
Terminal Part Information

- Terminated Lead: 13327113
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: 2/1

Inflatable Restraint Side Impact Sensor (SIS) - Right

Pin	Wire	Circuit	Function
A	0.5 D-GN	2134	Side Impact Sensing Module- Right- Signal
B	0.5 TN	2133	Side Impact Sensing Module- Right- Voltage

INFLATABLE RESTRAINT STEERING WHEEL MODULE X1



Connector Part Information

- Harness Type: SIR Coil

- OEM Connector: 54561236
- Service Connector: Service by Harness - See Part Catalog
- Description: 2-Way F AMP (WH with YE Lock)

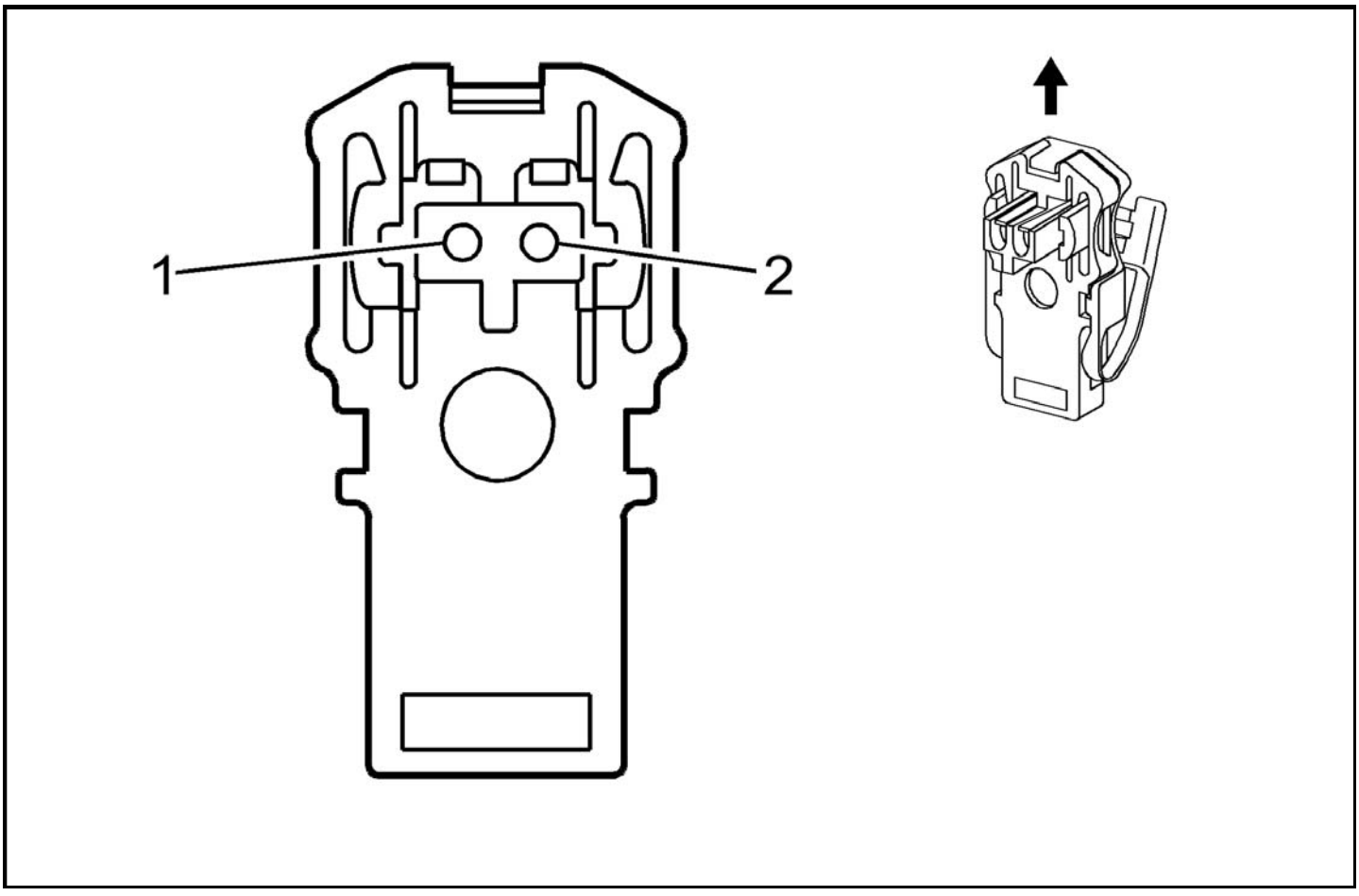
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Inflatable Restraint Steering Wheel Module X1

Pin	Wire	Circuit	Function
1	0.5 TN	3021	Steering Wheel Module- Stage 1- High Control
2	0.5 BN	3020	Steering Wheel Module- Stage 1- Low Control

INFLATABLE RESTRAINT STEERING WHEEL MODULE X2



Connector Part Information

- Harness Type: SIR Coil
- OEM Connector: 54560222
- Service Connector: 13586139
- Description: 2-Way F AMP (PK with YE Lock)

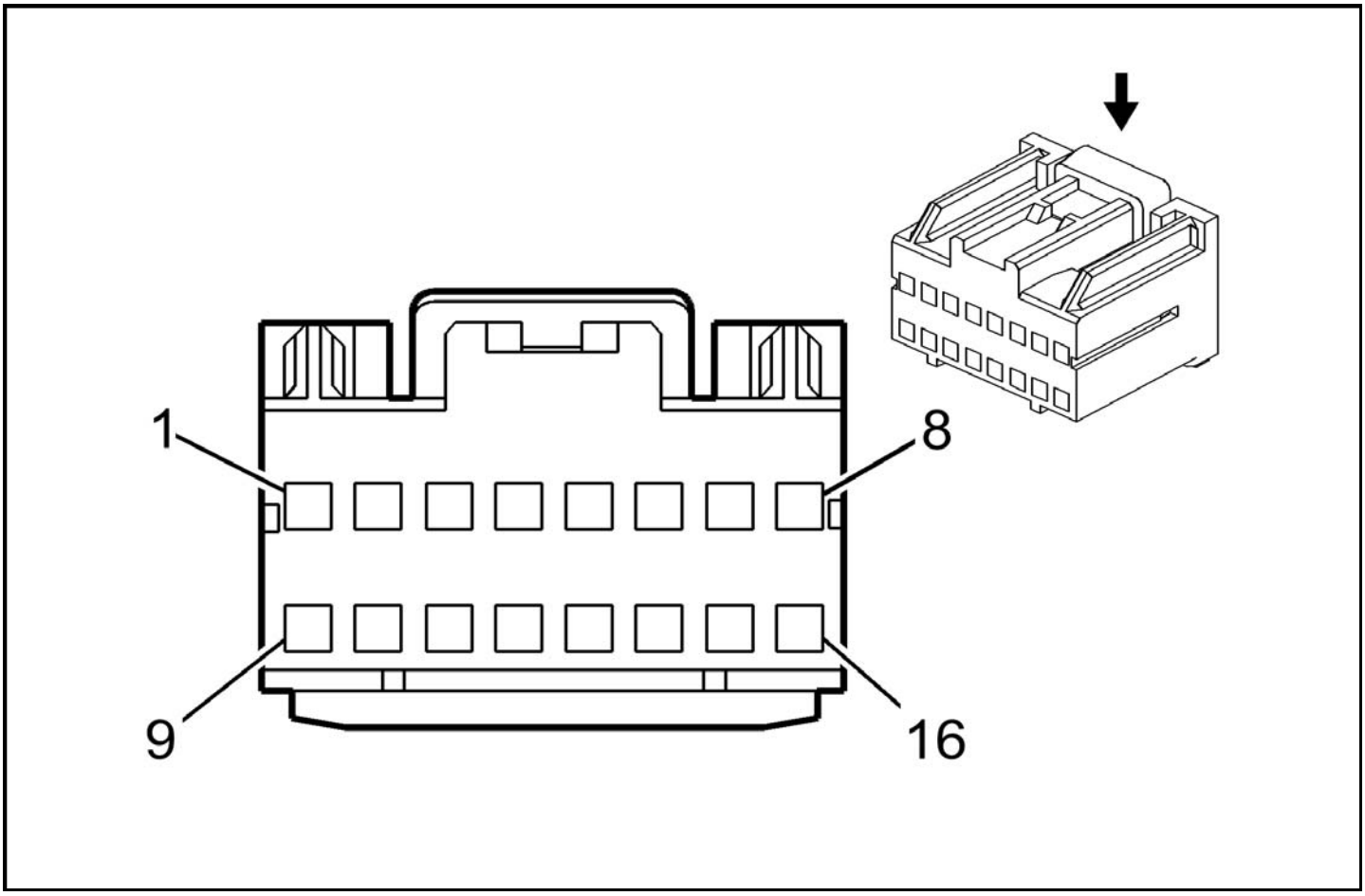
Terminal Part Information

- Terminal/Tray: Service with Pigtail
- Core/Insulation Crimp: Not Available
- Release Tool/Test Probe: Not Available

Inflatable Restraint Steering Wheel Module X2

Pin	Wire	Circuit	Function
1	0.5 WH	3023	Steering Wheel Module- Stage 2- High Control
2	0.5 PK	3022	Steering Wheel Module- Stage 2- Low Control

INSIDE REARVIEW MIRROR (DD6 OR UE1)



Connector Part Information

- Harness Type: Headliner
- OEM Connector: 15441350
- Service Connector: 15306351
- Description: 16-Way F Micro-Pack 100A Series (BK)

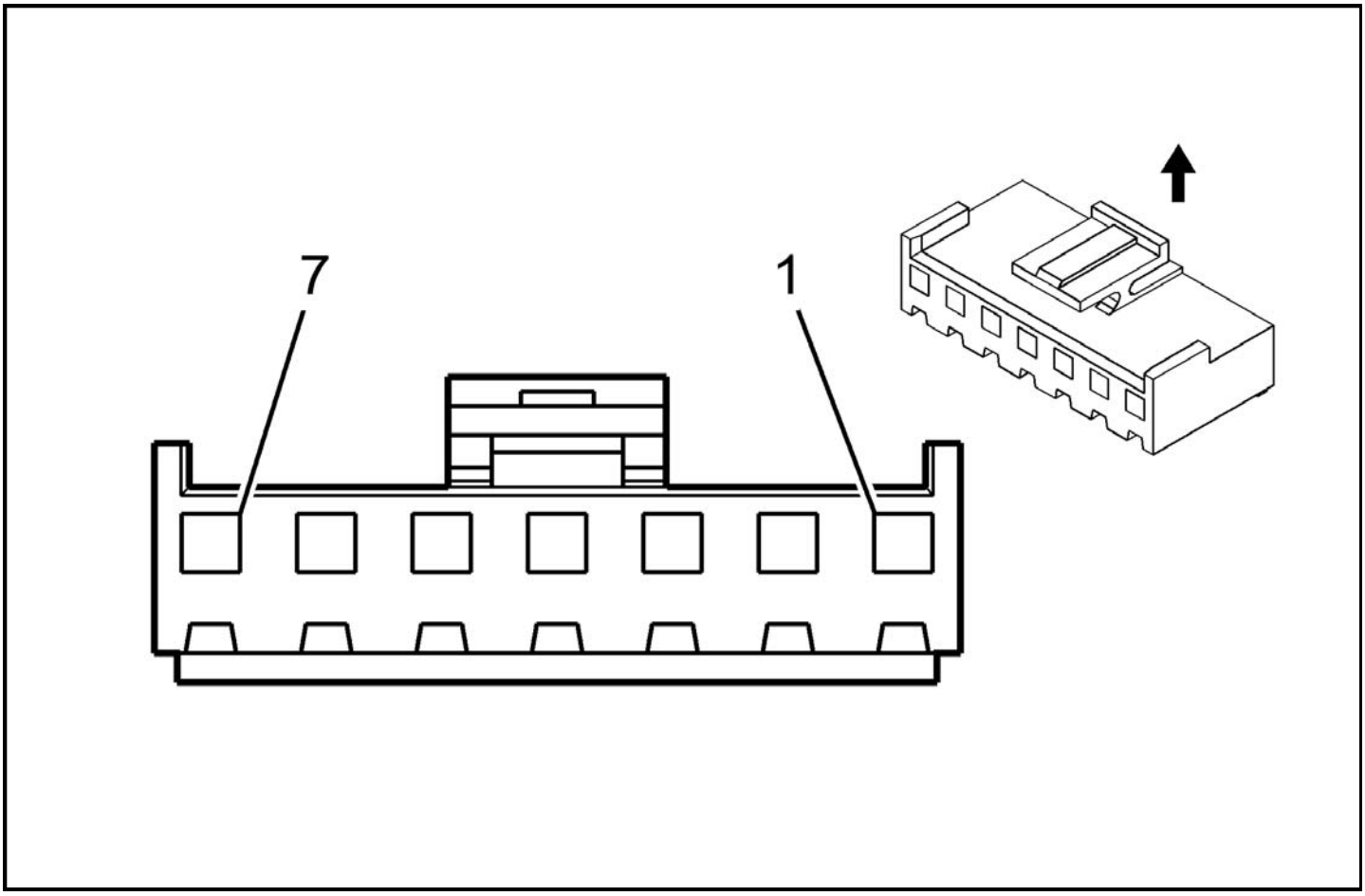
Terminal Part Information

- Terminated Lead: 13575548
- Release Tool: J-38125-559
- Diagnostic Test Probe: J-35616-16 (L-GN)
- Terminal/Tray: 15445905/23
- Core/Insulation Crimp: J/J

Inside Rearview Mirror (DD6 or UE1)

Pin	Wire	Circuit	Function
1-5	-	-	Not Used
6	0.5 OG	1732	Inadvertent Power Courtesy Lamp
7	-	-	Not Used
8	0.5 BK	550	Ground
9	0.5 L-GN	24	Backup Lamp Supply Voltage
10	-	-	Not Used
11	0.35 D-GN/WH	2514	Keypad Signal
12	0.35 L-GN/BK	2515	Keypad Supply Voltage
13	0.5 YE	643	Accessory Voltage
14	0.35 YE/BK	2516	Keypad Green LED Signal
15	0.35 BN/WH	2517	Keypad Red LED Signal
16	-	-	Not Used

INSIDE REARVIEW MIRROR (WITHOUT DD6 OR UE1)



Connector Part Information

- Harness Type: Headliner
- OEM Connector: 12124782
- Service Connector: 15306078
- Description: 7-Way F VH Series (BK)

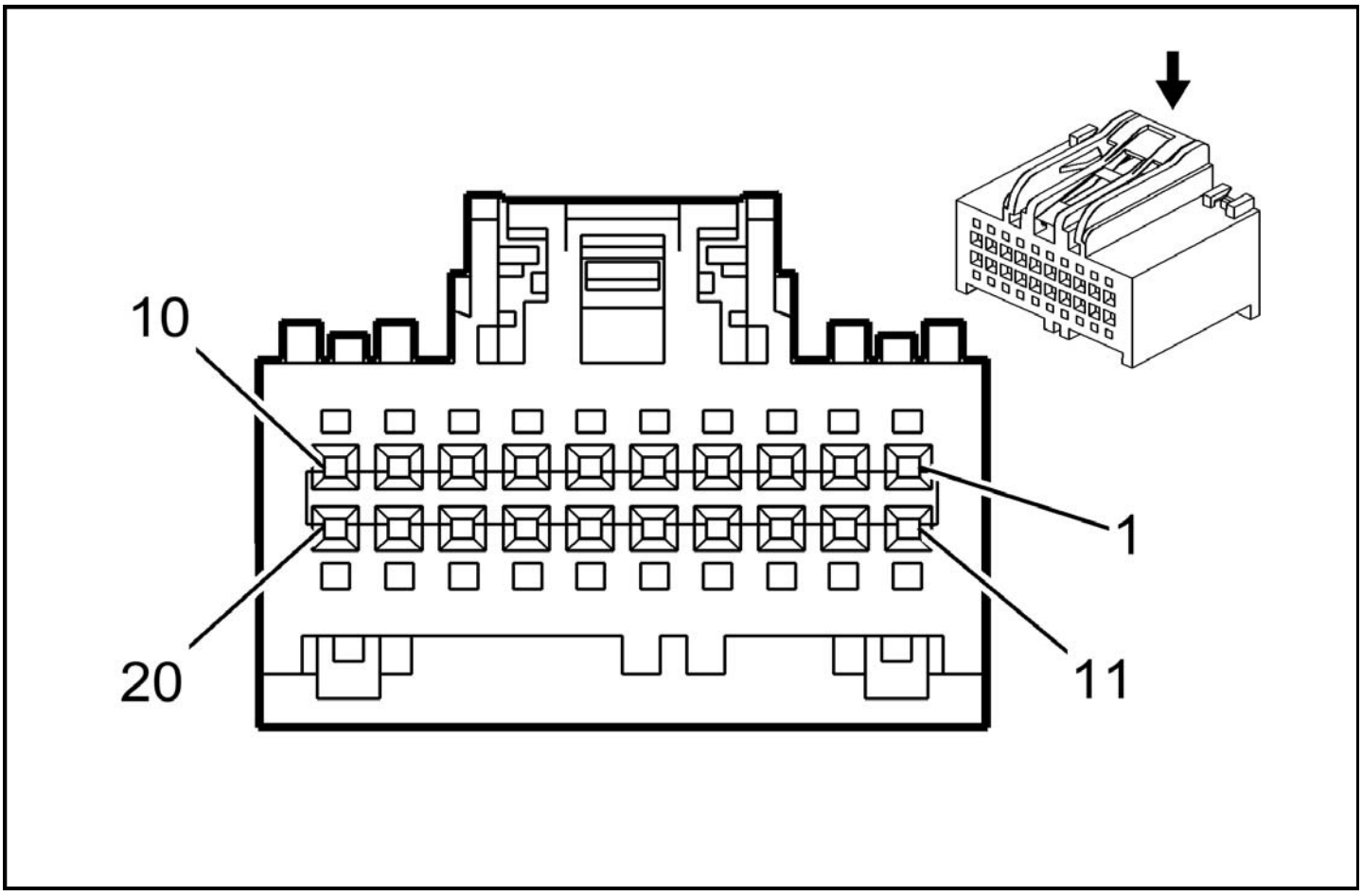
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-18 (BK)
- Terminal/Tray: SVH-21T-P1.1/20
- Core/Insulation Crimp: E/2

Inside Rearview Mirror (without DD6 or UE1)

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	0.5 OG	1732	Inadvertent Power Courtesy Lamp
3-6	-	-	Not Used
7	0.5 BK	550	Ground

INSTRUMENT PANEL CLUSTER (IPC)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15489824
- Service Connector: 15126711
- Description: 20-Way F 64 Series (BK)

Terminal Part Information

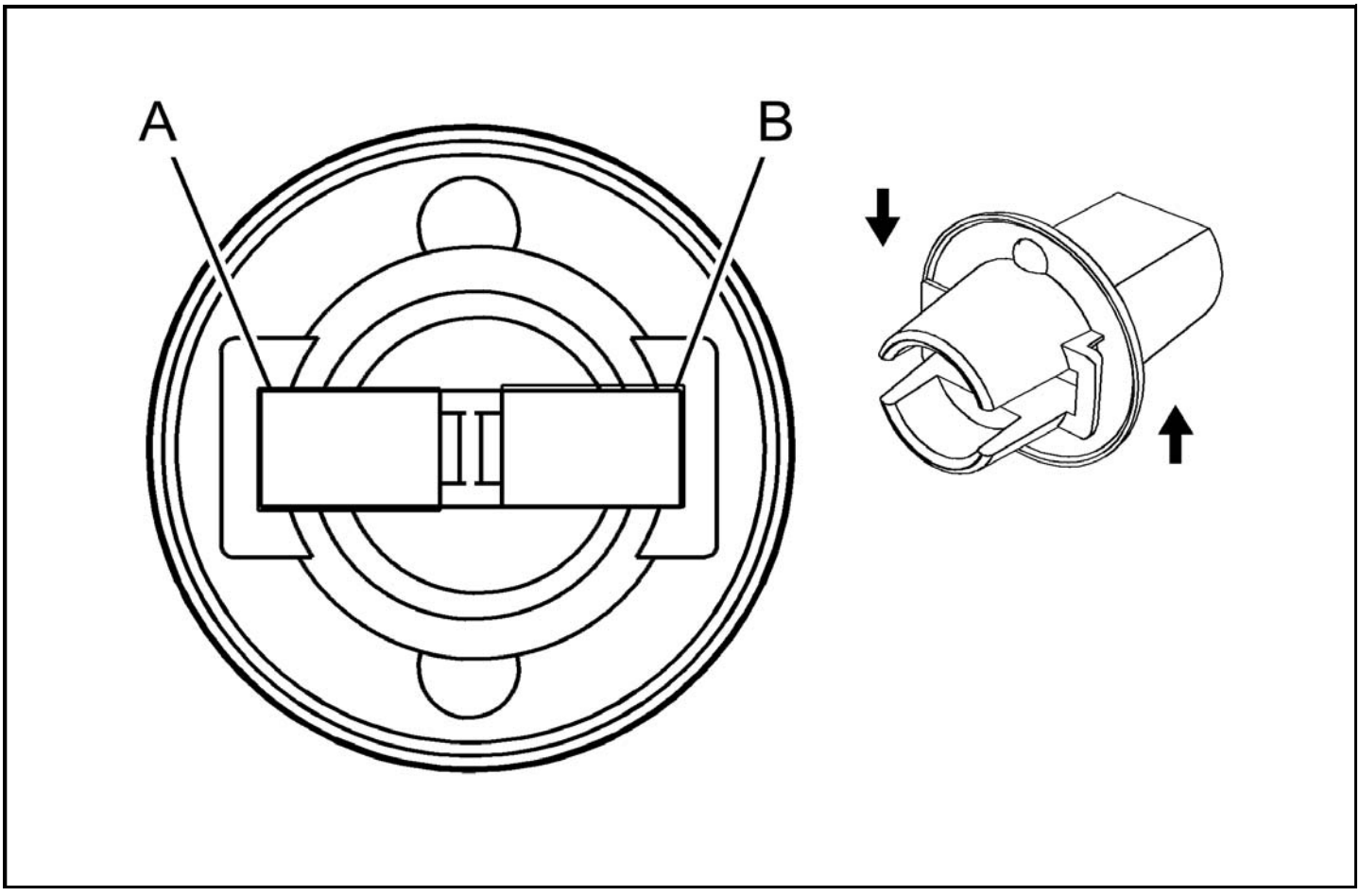
- Terminated Lead: 13575845
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SAIT-A03T-M064/14
- Core/Insulation Crimp: P/P

Instrument Panel Cluster (IPC)

Pin	Wire	Circuit	Function
1	-	-	Not Used
2	0.35 D-GN/BK	5060	Low Speed GMLAN Serial Data

Pin	Wire	Circuit	Function
3	-	-	Not Used
4	0.35 BN/WH	419	MIL Control
5	0.5 BK/WH	1551	Ground
6	0.5 BK	1450	Ground
7	-	-	Not Used
8	0.35 GY	8	Instrument Panel Lamp Supply Voltage
9	-	-	Not Used
10	0.35 RD/WH	1840	Battery Positive Voltage
11	0.35 PU	5234	Passenger Seat Belt Indicator Control
12	0.35 D-BU	2307	Passenger Air Bag On Indicator Control
13	0.35 D-GN	2308	Passenger Air Bag Off Indicator Control
14	0.35 TN	185	Low Washer Fluid Indicator Control
15	0.35 TN/WH	33	Brake Warning Indicator Control
16	0.35 PK	893	DIC Select Menu Switch Signal
17	0.35 D-GN/WH	1358	DIC Switch Signal
18	0.35 BN	897	DIC Switch Low Reference
19	-	-	Not Used
20	0.35 PK	1139	Ignition 1 Voltage

I/P COURTESY LAMP - LEFT



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12084388
- Service Connector: 12159671
- Description: 2-Way F Lamp Socket Connectors, Bulb Bases, Type W-2 (BK)

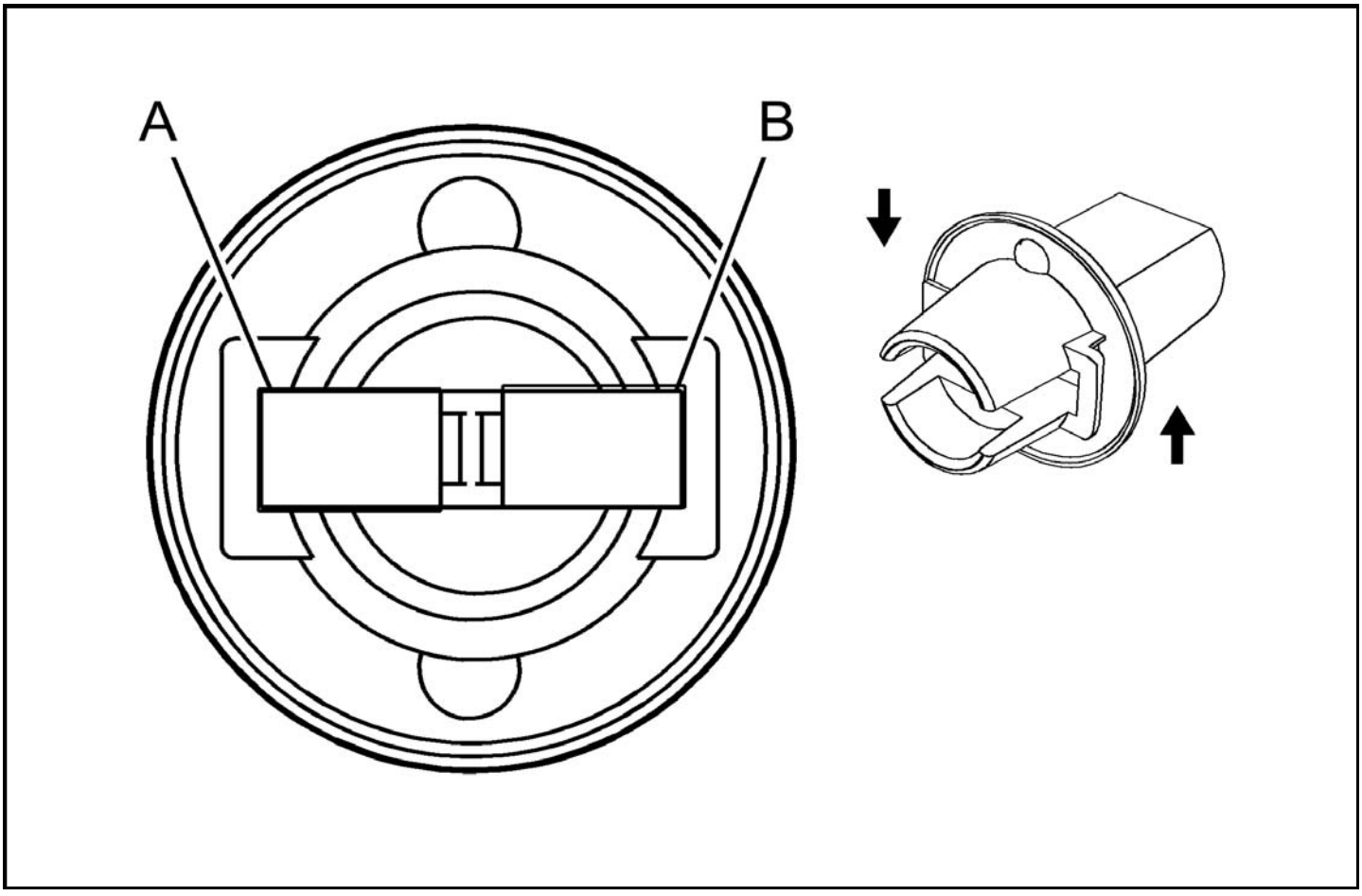
Terminal Part Information

- Terminated Lead: Service with Pigtail
- Terminal/Tray: Service with Pigtail
- Core/Insulation Crimp: Not Available
- Release Tool/Test Probe: Not Available

I/P Courtesy Lamp - Left

Pin	Wire	Circuit	Function
A	0.5 GY/BK	690	Courtesy Lamp Supply Voltage
	0.5 GY/BK	690	Courtesy Lamp Supply Voltage
B	0.35 BK	150	Ground

I/P COURTESY LAMP - RIGHT



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12084388
- Service Connector: 12159671
- Description: 2-Way F Lamp Socket Connectors, Bulb Bases, Type W-2 (BK)

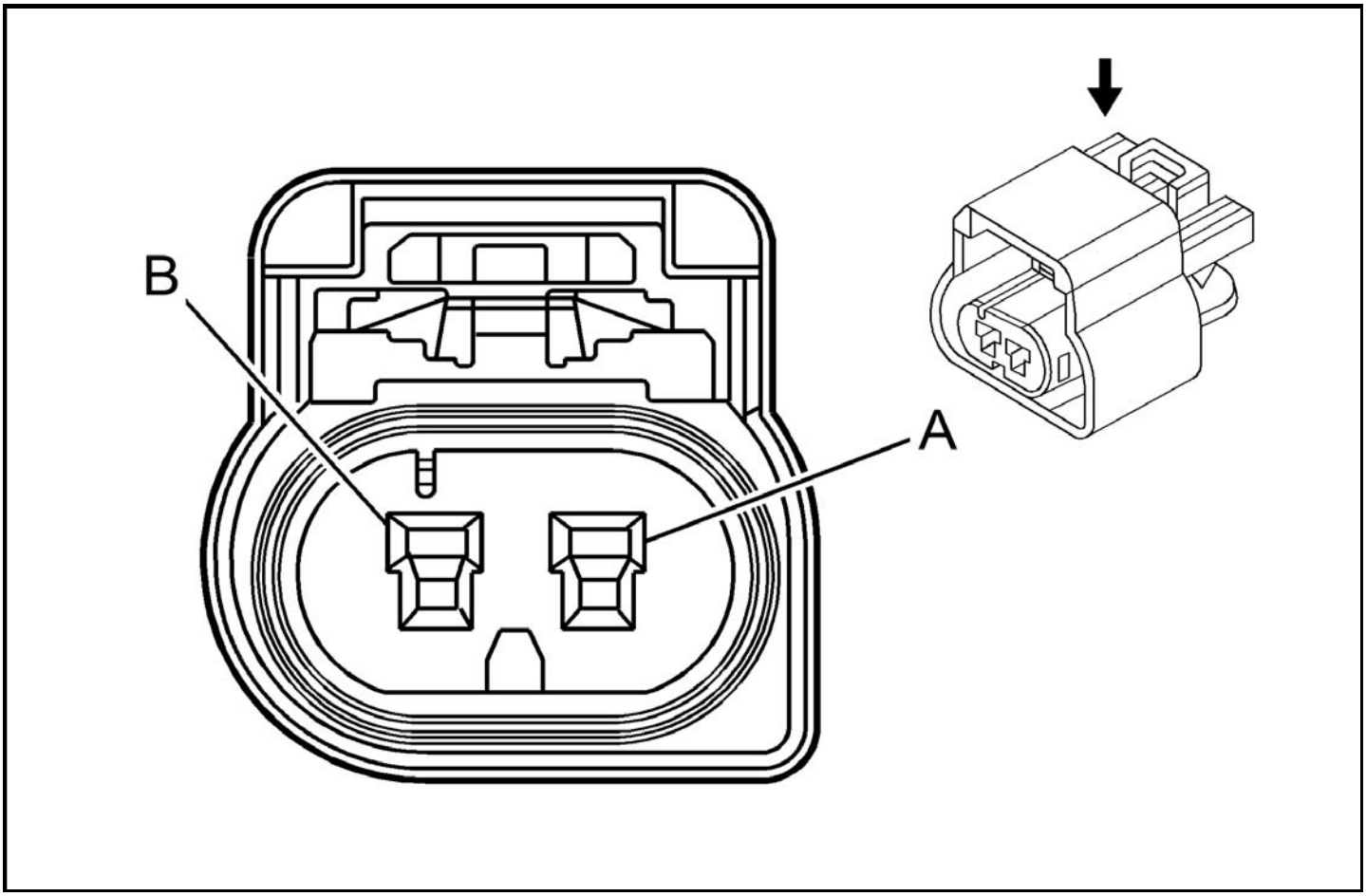
Terminal Part Information

- Terminated Lead: Service with Pigtail
- Terminal/Tray: Service with Pigtail
- Core/Insulation Crimp: Not Available
- Release Tool/Test Probe: Not Available

I/P Courtesy Lamp - Right

Pin	Wire	Circuit	Function
A	0.5 GY/BK	690	Courtesy Lamp Supply Voltage
B	0.35 BK	150	Ground

KNOCK SENSOR (KS) 1



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15374222
- Service Connector: 13580877
- Description: 2-Way F GT 150 Sealed (NA)

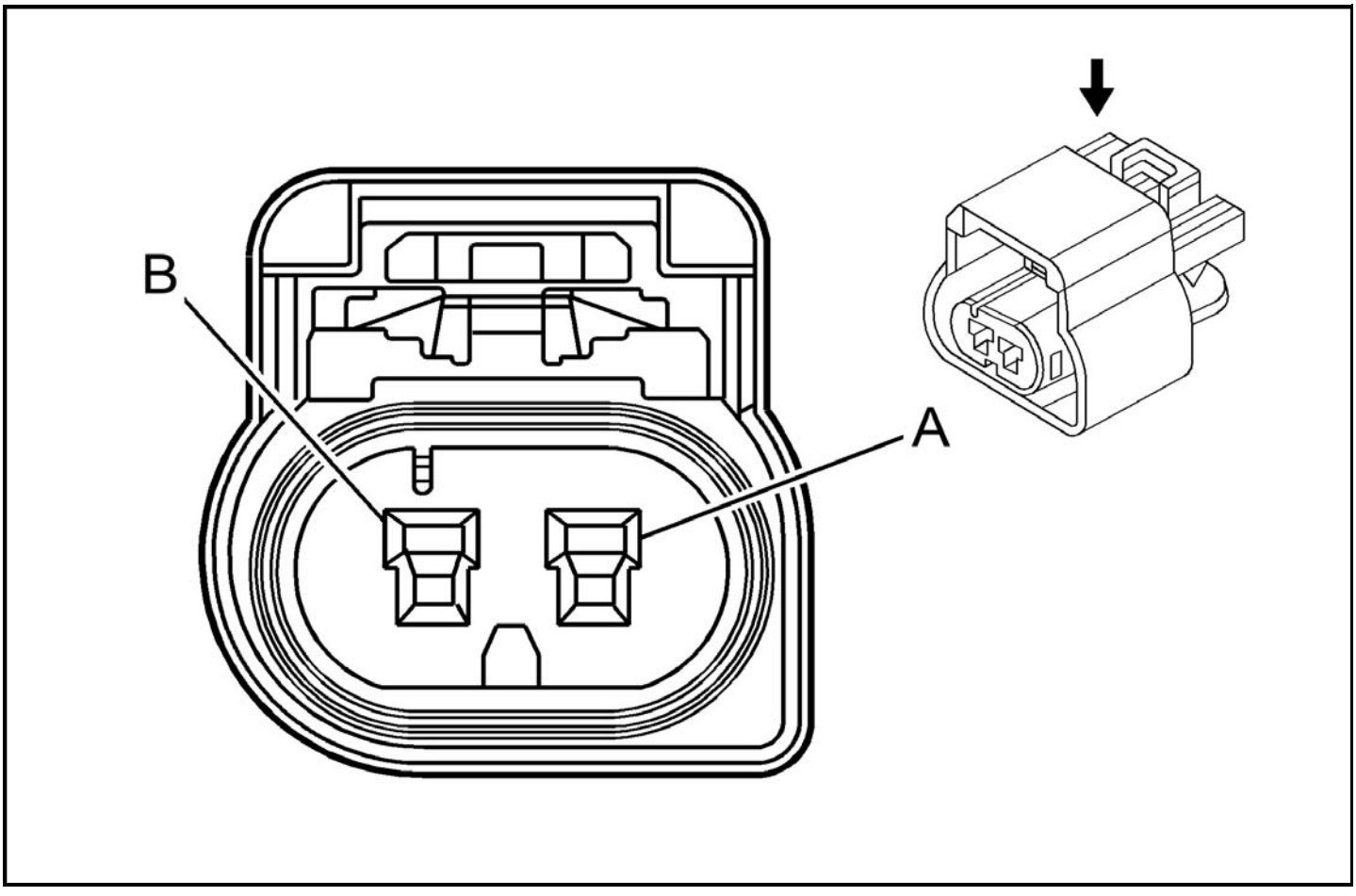
Terminal Part Information

- Terminated Lead: 13575396
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 15326427/5
- Core/Insulation Crimp: E/A

Knock Sensor (KS) 1

Pin	Wire	Circuit	Function
A	0.5 D-BU	496	KS 1 Signal
B	0.5 GY	1716	KS 1 Signal

KNOCK SENSOR (KS) 2



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15374222
- Service Connector: 13580877
- Description: 2-Way F GT 150 Sealed (NA)

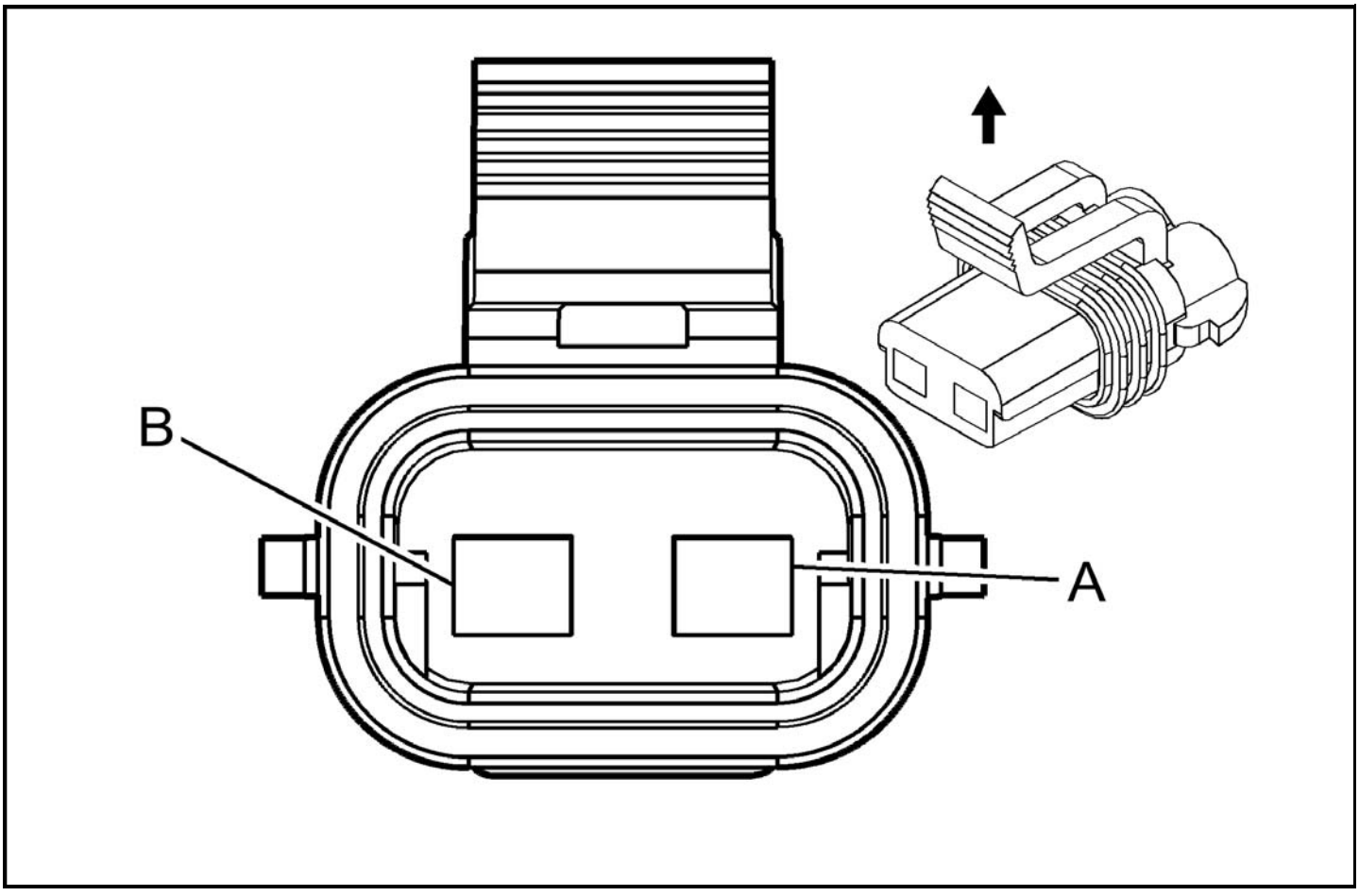
Terminal Part Information

- Terminated Lead: 13575396
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 15326427/5
- Core/Insulation Crimp: E/A

Knock Sensor (KS) 2

Pin	Wire	Circuit	Function
A	0.5 L-BU	1876	KS 2 Signal
B	0.5 GY	2303	KS 2 Signal

LICENSE LAMP



Connector Part Information

- Harness Type: Rear Body
- OEM Connector: 15300027
- Service Connector: 12101855
- Description: 2-Way F Metri-Pack 280 Series, Sealed (BK)

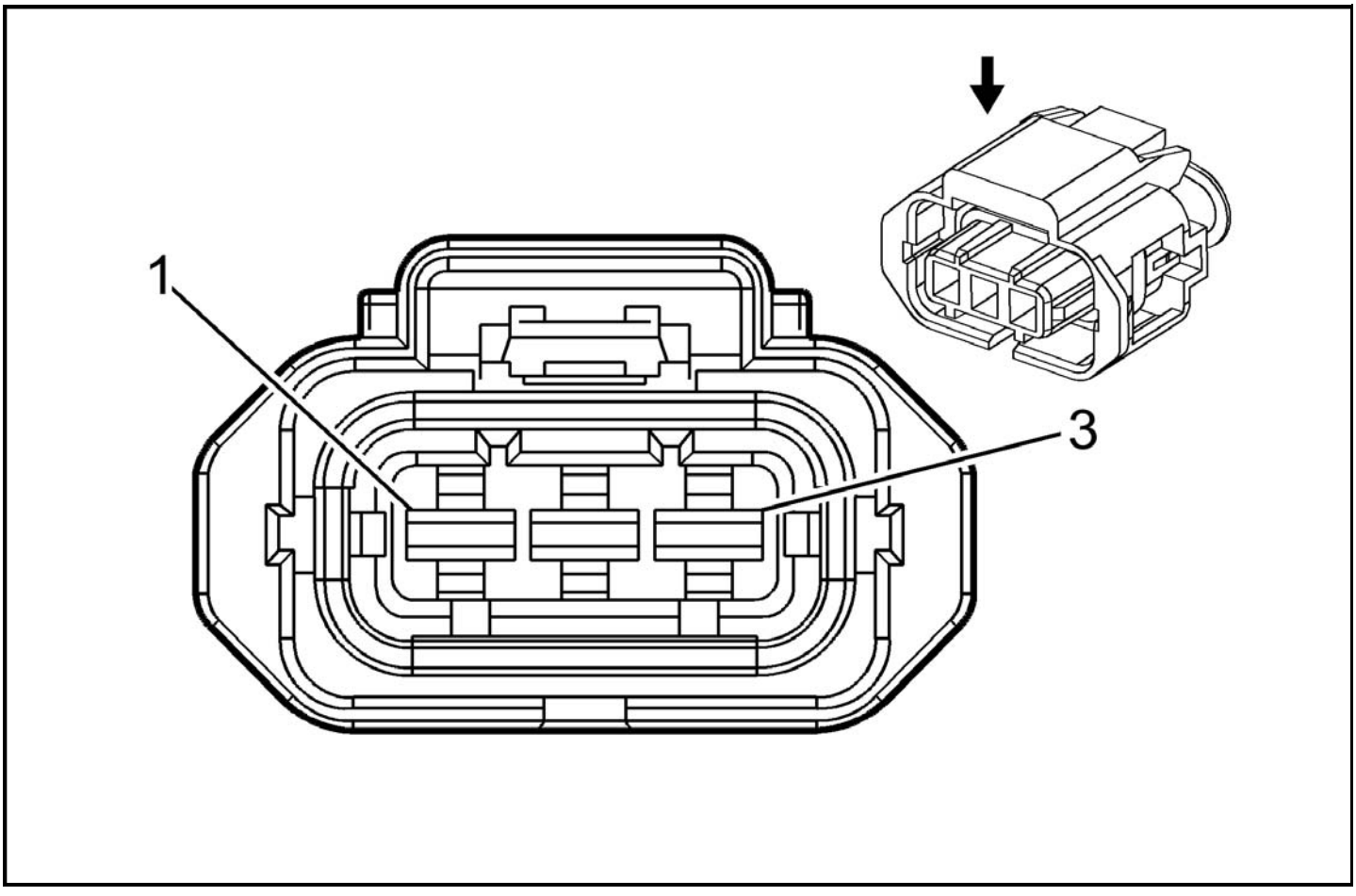
Terminal Part Information

- Terminated Lead: 13575418
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12077411/2
- Core/Insulation Crimp: 2/5

License Lamp

Pin	Wire	Circuit	Function
A	0.5 BN/WH	309	Right Park Lamp Supply Voltage
B	0.5 BK	850	Ground

MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15397338
- Service Connector: 13585845
- Description: 3-Way F 2.8 Timer Series, Sealed (BK)

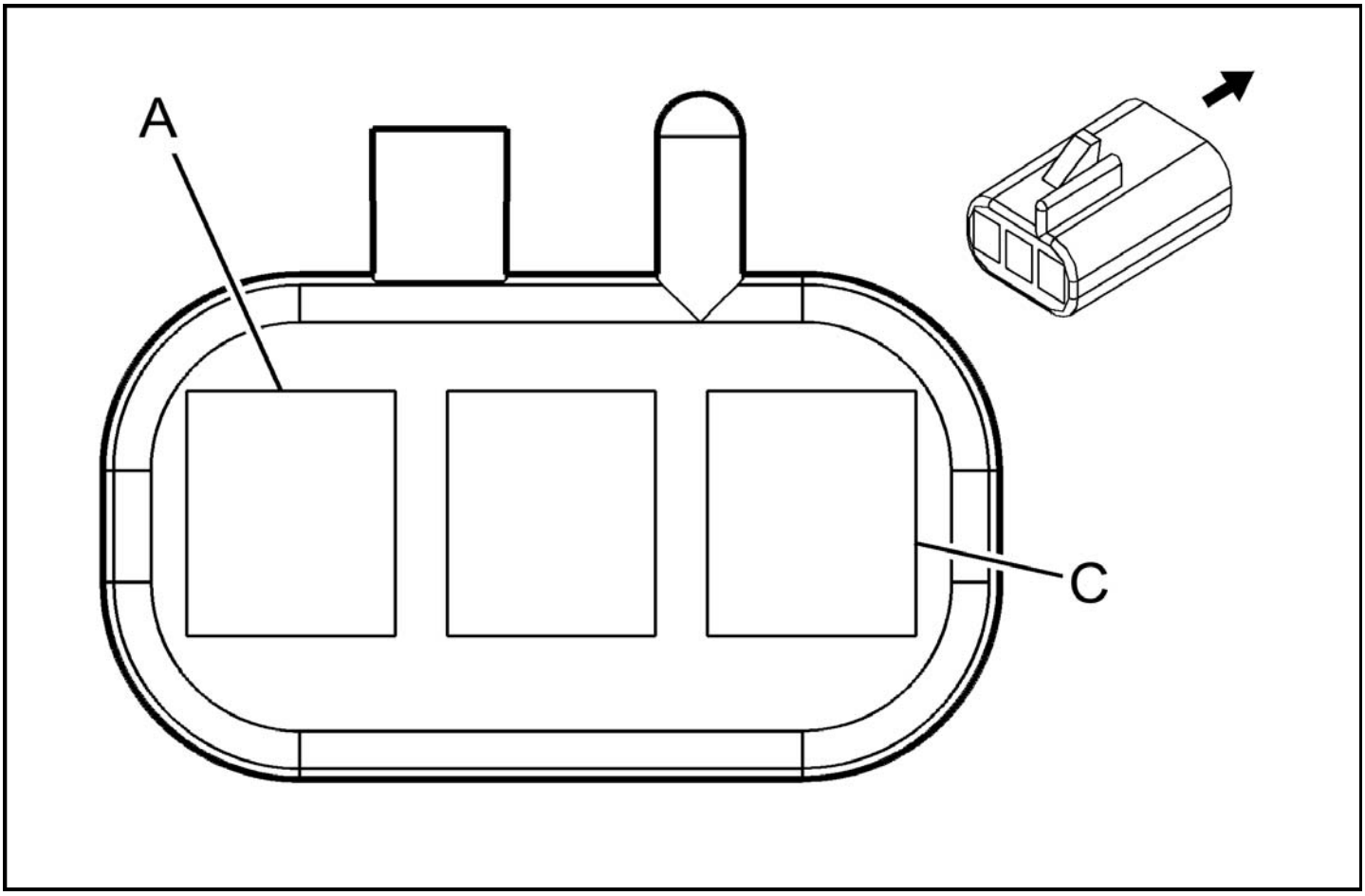
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Manifold Absolute Pressure (MAP) Sensor

Pin	Wire	Circuit	Function
1	0.5 GY	2704	5-Volt Reference 3
2	0.5 OG/BK	469	Low Reference
3	0.5 L-GN	432	MAP Sensor Signal

MODE ACTUATOR



Connector Part Information

- Harness Type: HVAC
- OEM Connector: 12047781
- Service Connector: 12101864
- Description: 3-Way F Metri-Pack 150 Series (BK)

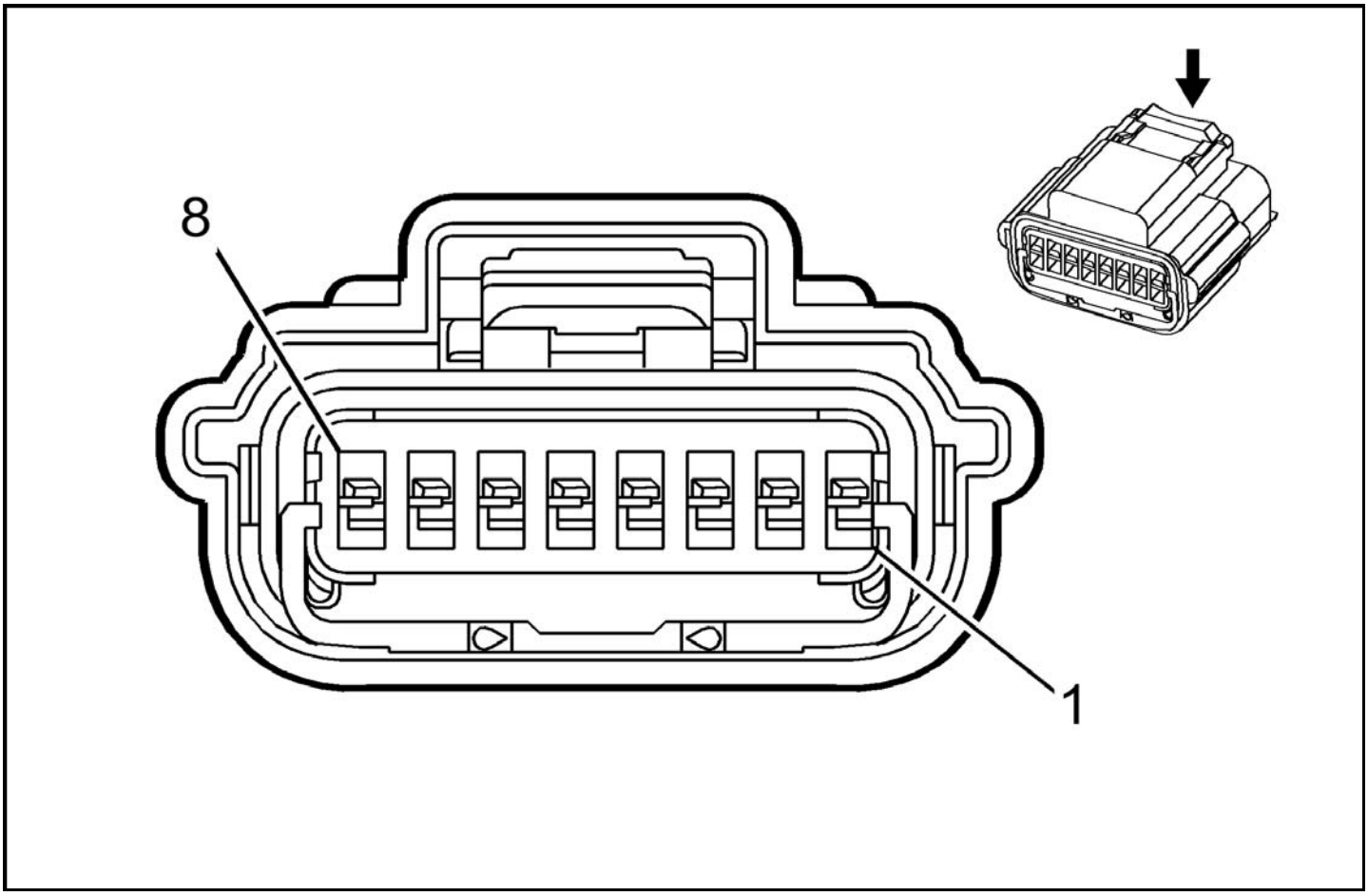
Terminal Part Information

- Terminal/Tray: 12064971/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Mode Actuator

Pin	Wire	Circuit	Function
A	0.35 TN	2273	Mode Door Control B
B	-	-	Not Used
C	0.35 L-GN	2275	Mode Door Control A

MULTIFUNCTION INTAKE AIR SENSOR



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13774439
- Service Connector: 13583440
- Description: 8-Way F 064 Series, Sealed (BK)

Terminal Part Information

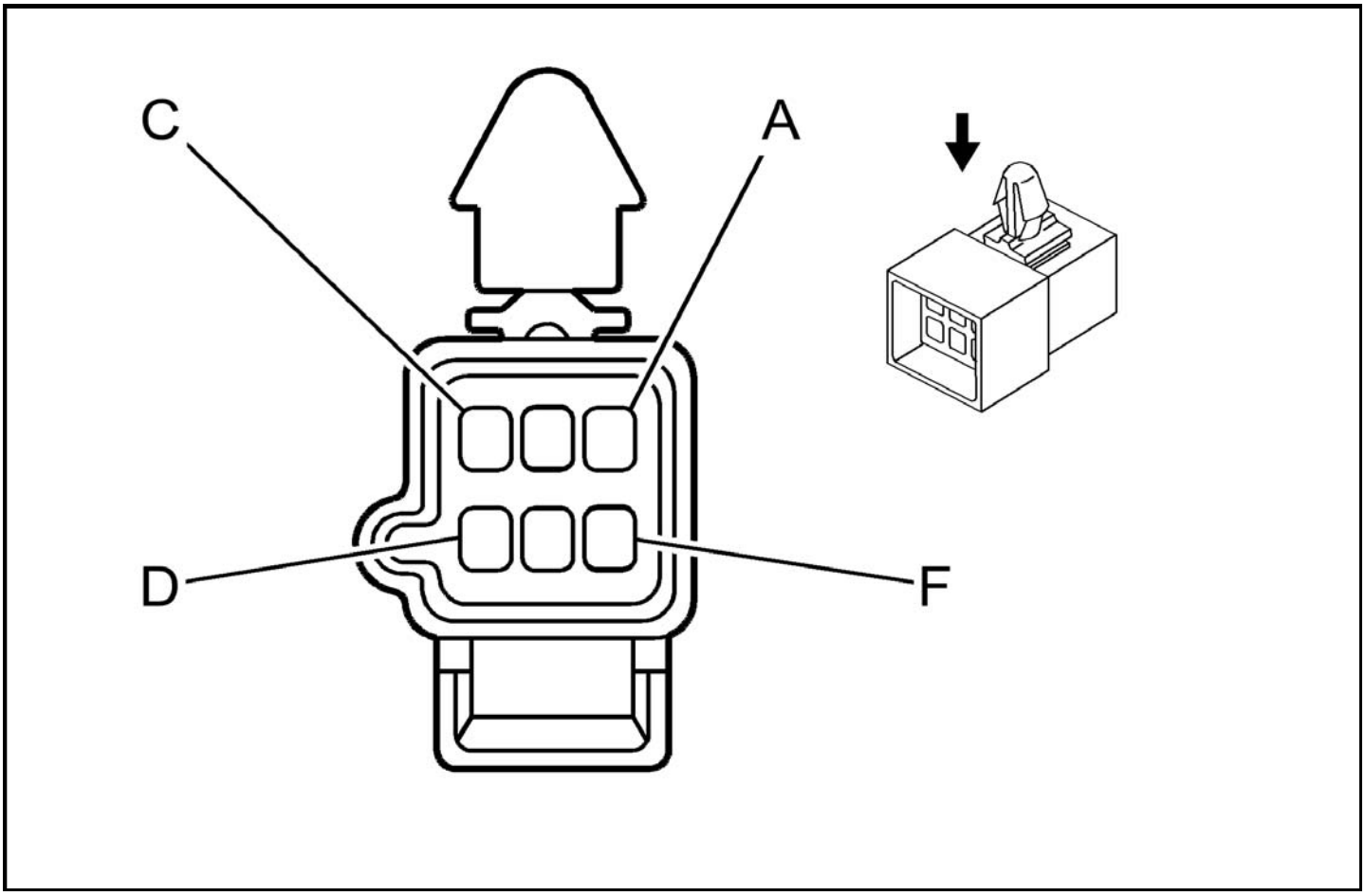
- Terminated Lead: Pins 1-4, 6-8 - 13575864
- Terminated Lead: Pin 5 - 13575865
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SAIT-A03GF-M064/27
- Core/Insulation Crimp: P/P

Multifunction Intake Air Sensor

Pin	Wire	Circuit	Function
1	0.35 L-BU	6289	Induction Air Temperature Sensor Signal
2	0.35 GY	3201	5 Volt Reference 1
3	0.35 TN	2760	Low Reference

Pin	Wire	Circuit	Function
4	0.35 YE/WH	3200	Throttle Inlet Absolute Pressure Sensor Signal
5	0.5 PK/BK	5294	Powertrain Main Relay Fused Supply (5)
6	0.35 YE	492	Mass Air Flow Sensor Signal
7	0.35 BK/WH	451	Ground
8	0.35 PU	4008	Humidity Sensor Signal

OUTSIDE REARVIEW MIRROR - DRIVER



Connector Part Information

- Harness Type: Left Front Door
- OEM Connector: 12065781
- Service Connector: 12101876
- Description: 6-Way M Metri-Pack 150 Series (GY)

Terminal Part Information

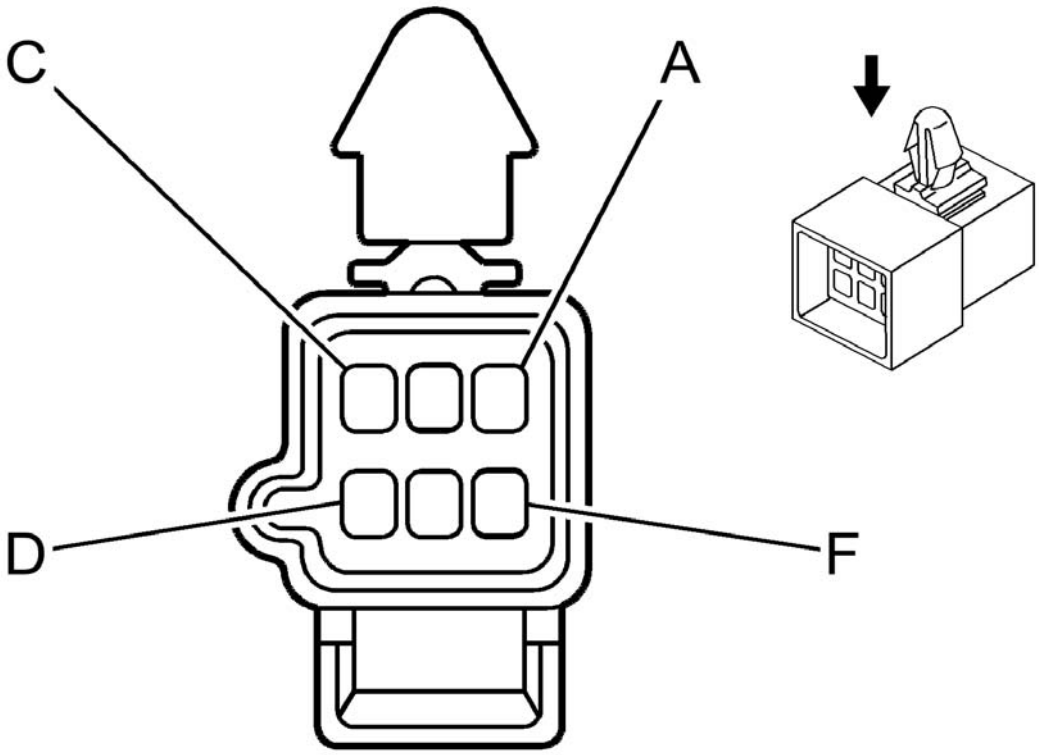
- Terminated Lead: 13575462
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2

- Core/Insulation Crimp: E/C

Outside Rearview Mirror - Driver

Pin	Wire	Circuit	Function
A	0.5 WH	81	Driver Mirror Motor Right Control
B	0.5 L-GN	89	Driver Mirror Motor Down Control
C	0.5 TN	329	Driver Mirror Motor Supply Voltage
D	-	-	Not Used
E	0.5 BK	550	Ground
F	0.5 OG	267	Heated Mirror Element Supply Voltage

OUTSIDE REARVIEW MIRROR - PASSENGER



Connector Part Information

- Harness Type: Right Front Door
- OEM Connector: 12065781
- Service Connector: 12101876
- Description: 6-Way M Metri-Pack 150 Series (GY)

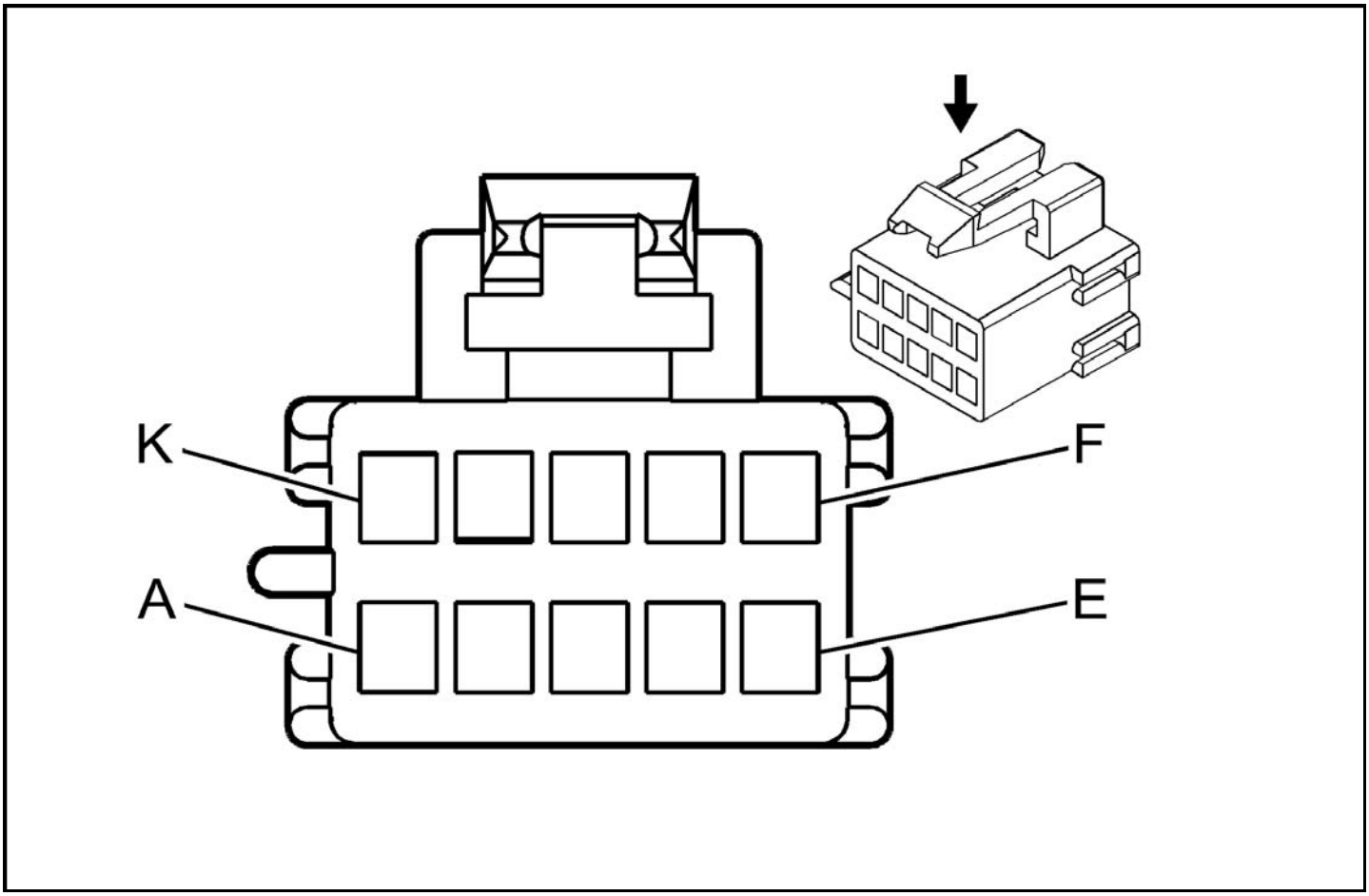
Terminal Part Information

- Terminated Lead: 13575462
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/C

Outside Rearview Mirror - Passenger

Pin	Wire	Circuit	Function
A	0.5 OG/WH	881	Passenger Mirror Motor Right Control
B	0.5 PU/WH	889	Passenger Mirror Motor Down Control
C	0.5 TN/WH	330	Passenger Mirror Motor Supply Voltage
D	-	-	Not Used
E	0.5 BK	750	Ground
F	0.5 OG	267	Heated Mirror Element Supply Voltage

OUTSIDE REARVIEW MIRROR SWITCH



Connector Part Information

- Harness Type: Left Front Door Trim
- OEM Connector: 12064769
- Service Connector: 12101762
- Description: 10-Way F Metri-Pack 150 Series (NA)

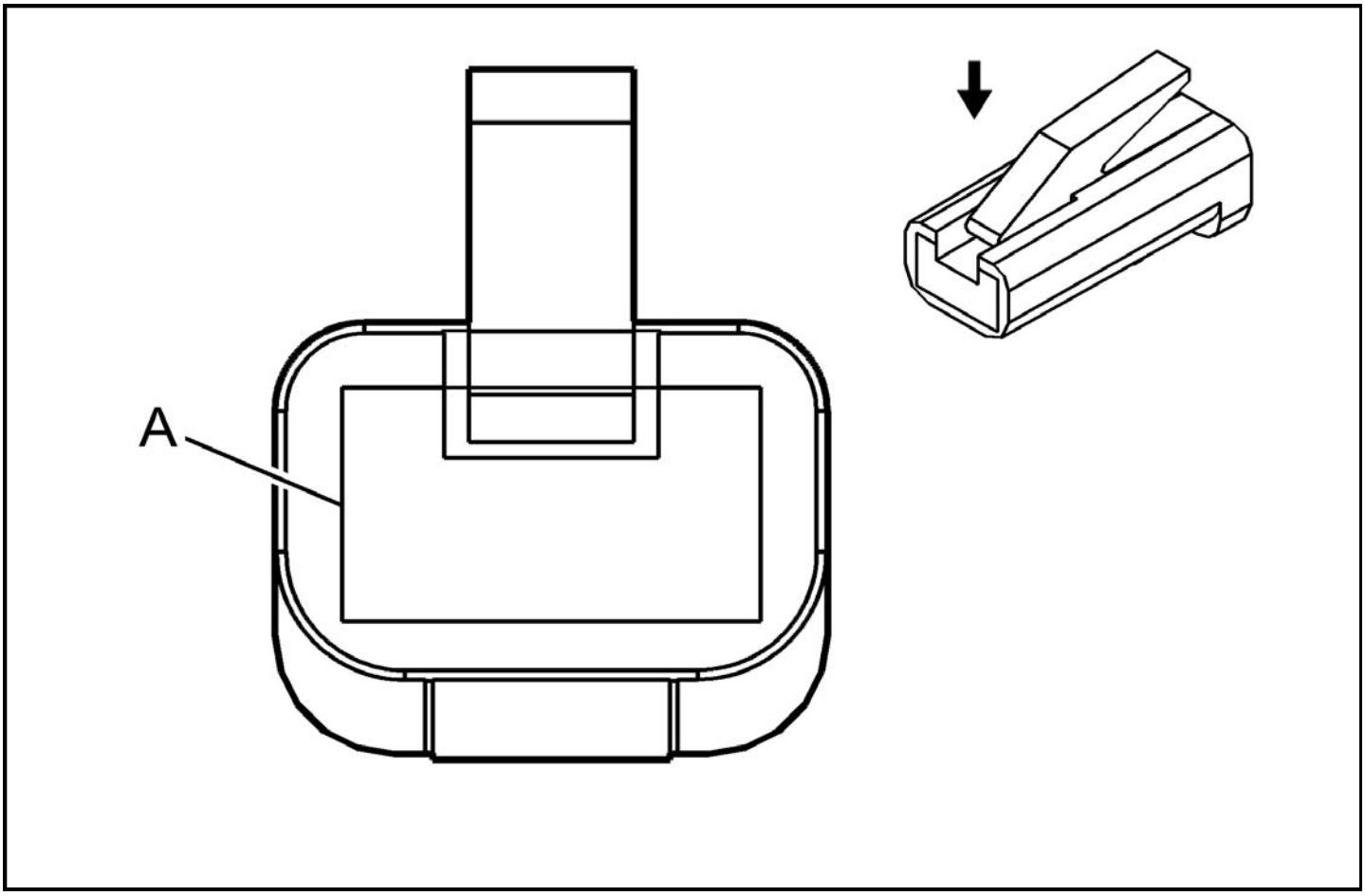
Terminal Part Information

- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Outside Rearview Mirror Switch

Pin	Wire	Circuit	Function
A	-	-	Not Used
B	0.35 BK	550	Ground
C	0.5 WH	330	Passenger Mirror Motor Supply Voltage
D	0.35 WH	81	Driver Mirror Motor Right Control
E	0.35 GY	8	Instrument Panel Lamp Supply Voltage
F	0.35 L-GN	89	Driver Mirror Motor Down Control
G	0.35 RD/WH	840	Battery Positive Voltage
H	0.35 YE	329	Driver Mirror Motor Supply Voltage
J	0.5 OG/WH	881	Passenger Mirror Motor Right Control
K	0.5 PU/WH	889	Passenger Mirror Motor Down Control

PARK BRAKE SWITCH



Connector Part Information

- Harness Type: Body
- OEM Connector: 12004267
- Service Connector: 12102561
- Description: 1-Way F 56 Series Lock Type (BK)

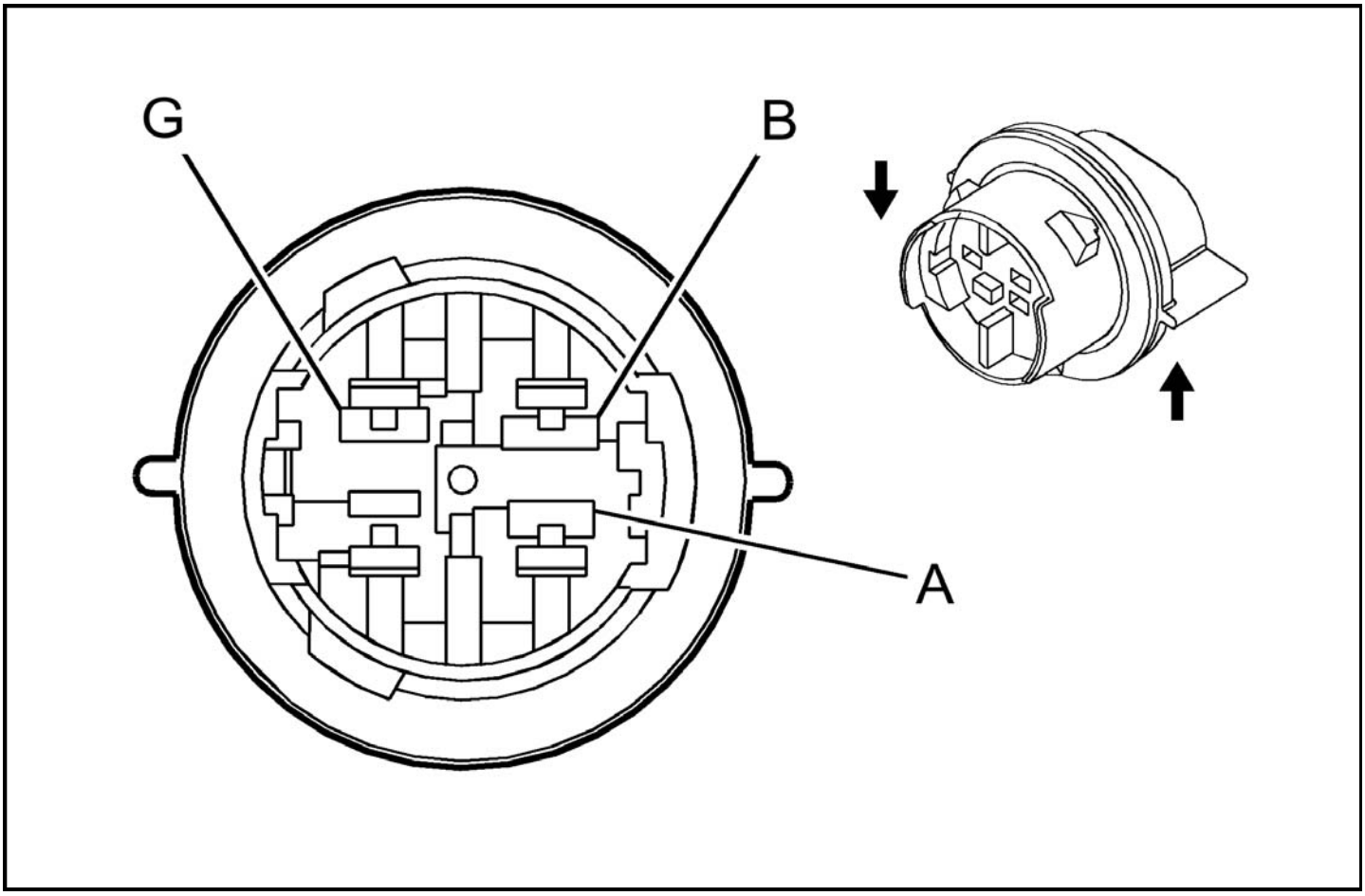
Terminal Part Information

- Terminated Lead: Service by Connector Assembly - 12102561
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-42 (RD)
- Terminal/Tray: 12124515/1
- Core/Insulation Crimp: C/D

Park Brake Switch

Pin	Wire	Circuit	Function
A	0.5 OG/BK	233	Park Brake Switch Signal

PARK/TURN SIGNAL LAMP - LEFT



Connector Part Information

- Harness Type: Left Front Headlamp Assembly
- OEM Connector: 16530873
- Service Connector: Service by Harness - See Part Catalog
- Description: 3-Way F Lamp Socket (WH)

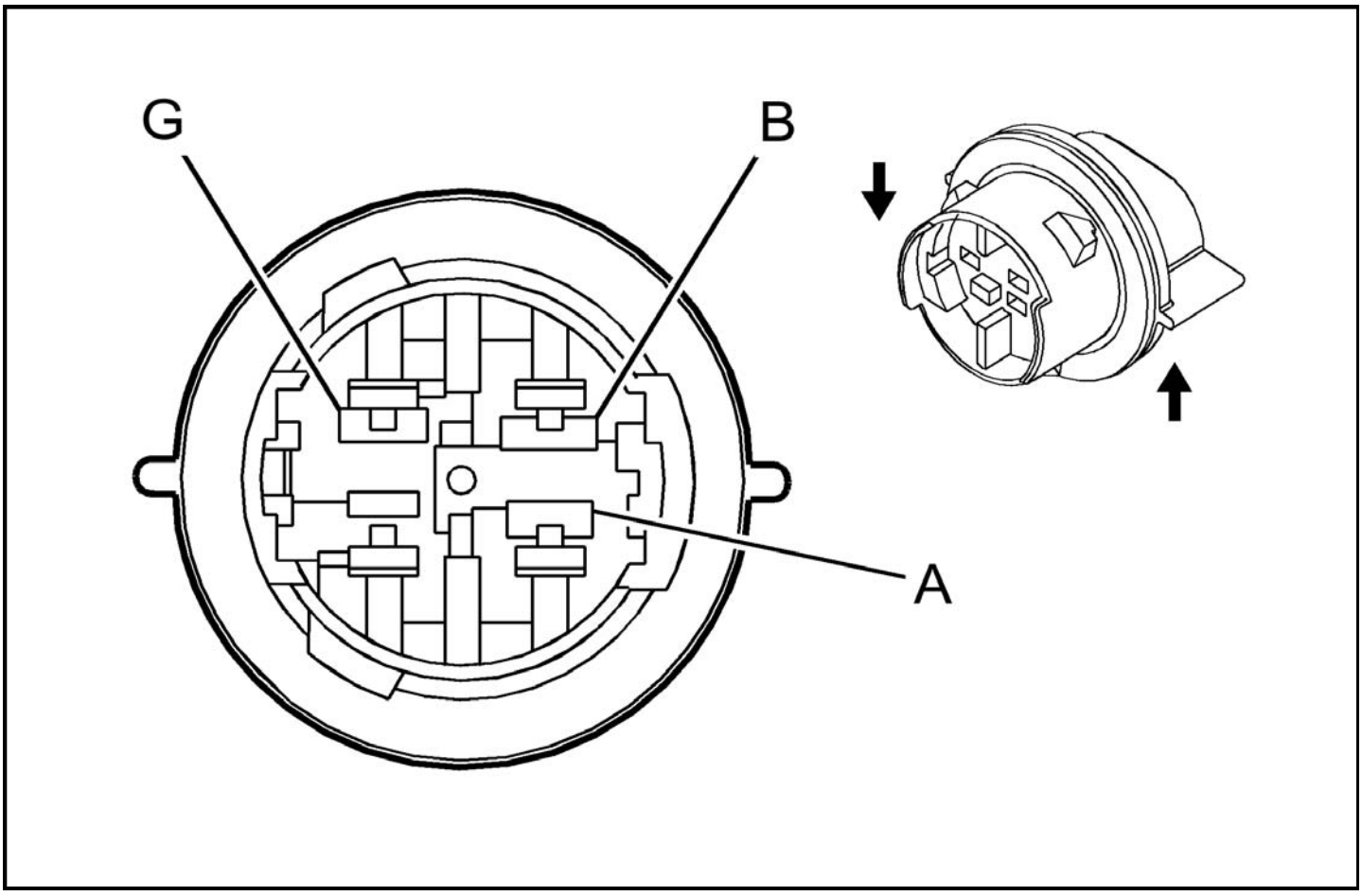
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Park/Turn Signal Lamp - Left

Pin	Wire	Circuit	Function
A	0.8 YE	1314	Left Front Turn Signal Lamp Supply Voltage
B	0.8 RD	709	Left Park Lamp Supply Voltage
G	0.8 BK	1350	Ground

PARK/TURN SIGNAL LAMP - RIGHT



Connector Part Information

- Harness Type: Right Front Headlamp Assembly
- OEM Connector: 16530873
- Service Connector: Service by Harness - See Part Catalog
- Description: 3-Way F Lamp Socket (WH)

Terminal Part Information

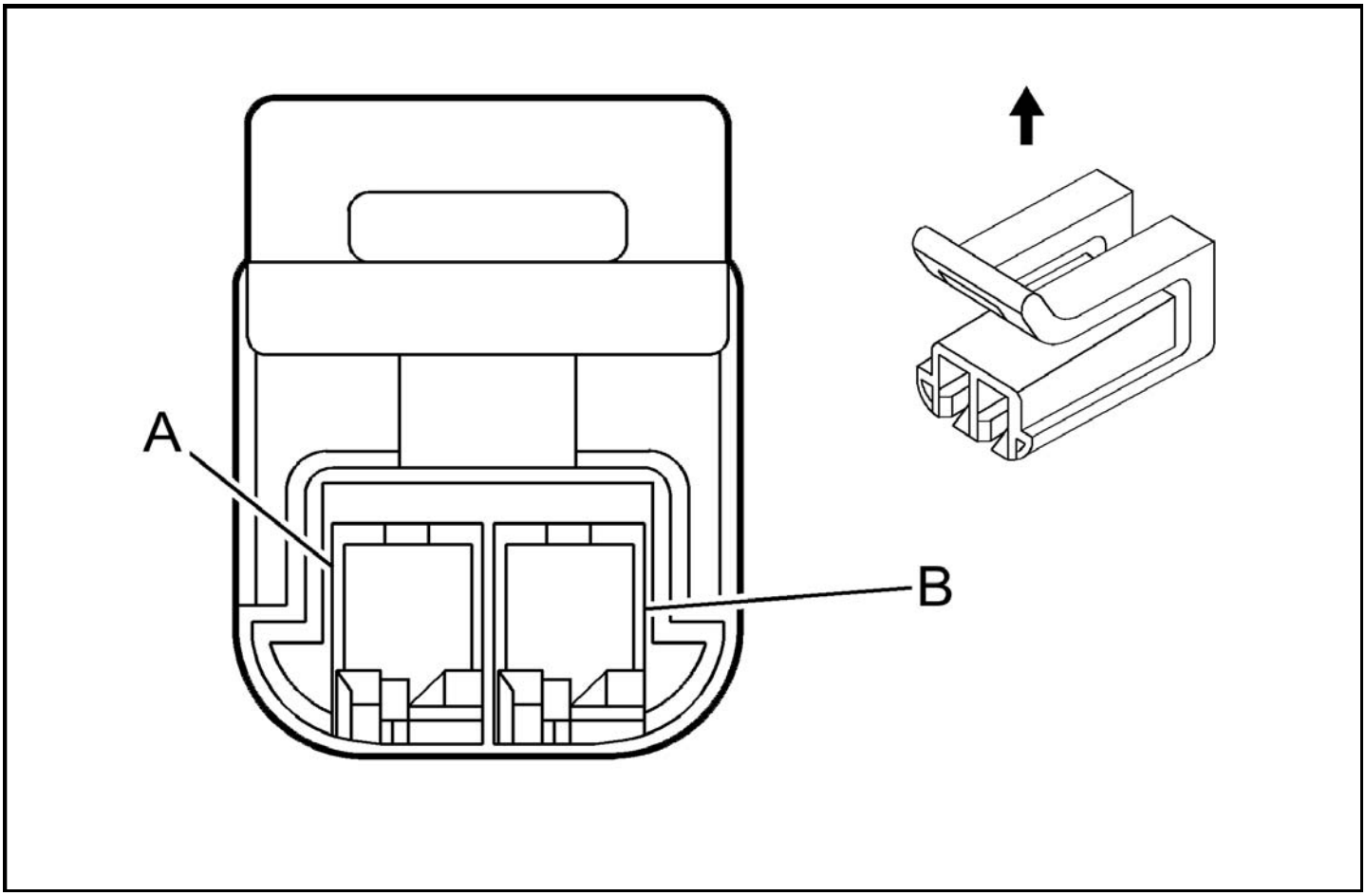
- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Park/Turn Signal Lamp - Right

Pin	Wire	Circuit	Function
A	0.8 YE	1315	Right Front Turn Signal Lamp Supply Voltage
B	0.8 RD	309	Right Park Lamp Supply Voltage

Pin	Wire	Circuit	Function
G	0.8 BK	1250	Ground

PRESSURE CONTROL (PC) SOLENOID VALVE



Connector Part Information

- Harness Type: Transmission
- OEM Connector: 15466861
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F Metri-Pack 150.2 Series (GY)

Terminal Part Information

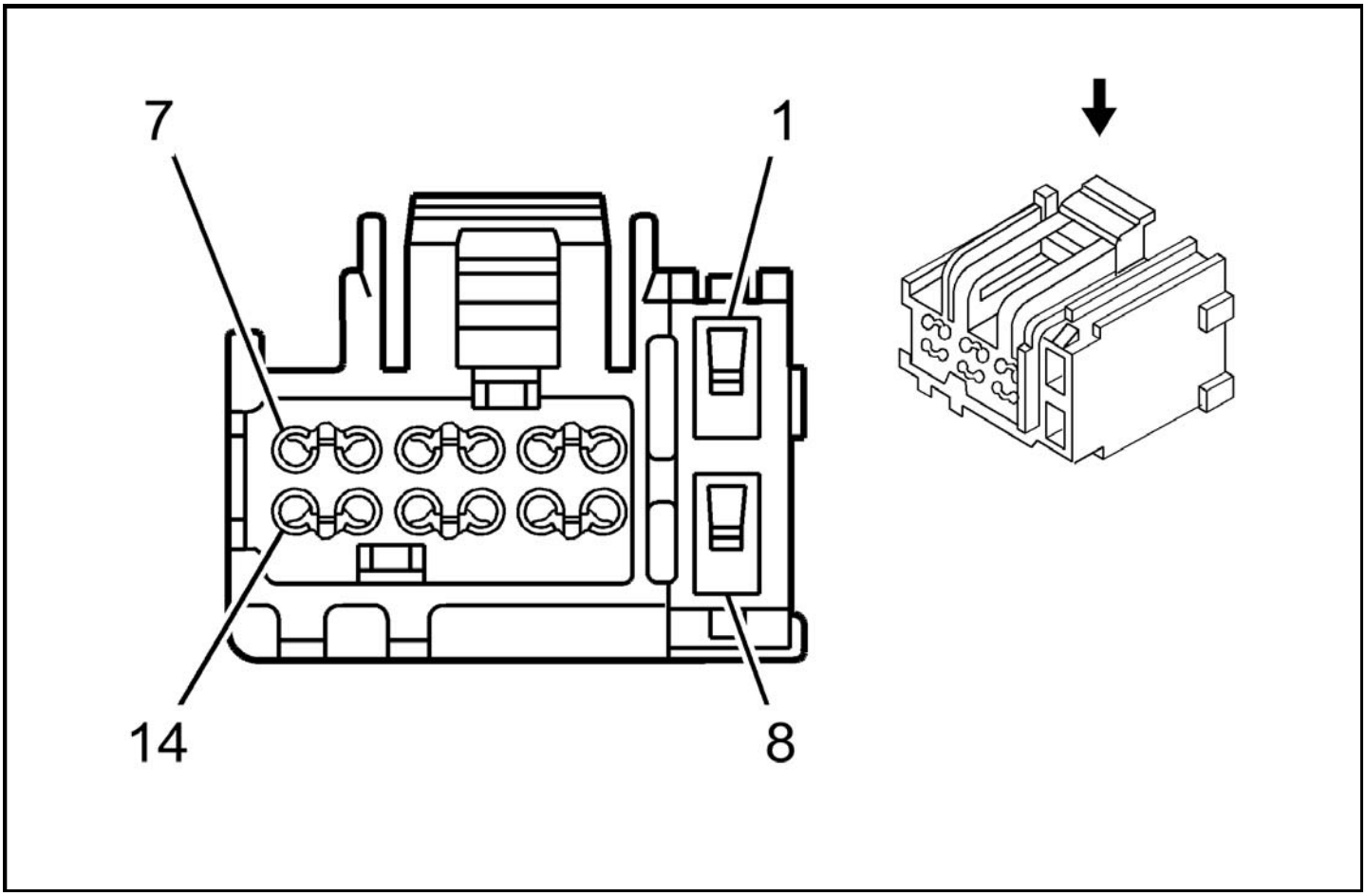
- Terminal/Tray: 12124075/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12180559-1/J-35616-14 (GN)

Pressure Control (PC) Solenoid Valve

Pin	Wire	Circuit	Function
A	0.5 PU	1228	PC Solenoid Valve High Control

Pin	Wire	Circuit	Function
B	0.5 L-BU	1229	PC Solenoid Valve Low Control

RADIO X1



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15488568
- Service Connector: 88988743
- Description: 14-Way F GT 150 Micro 64 Series (BK)

Terminal Part Information

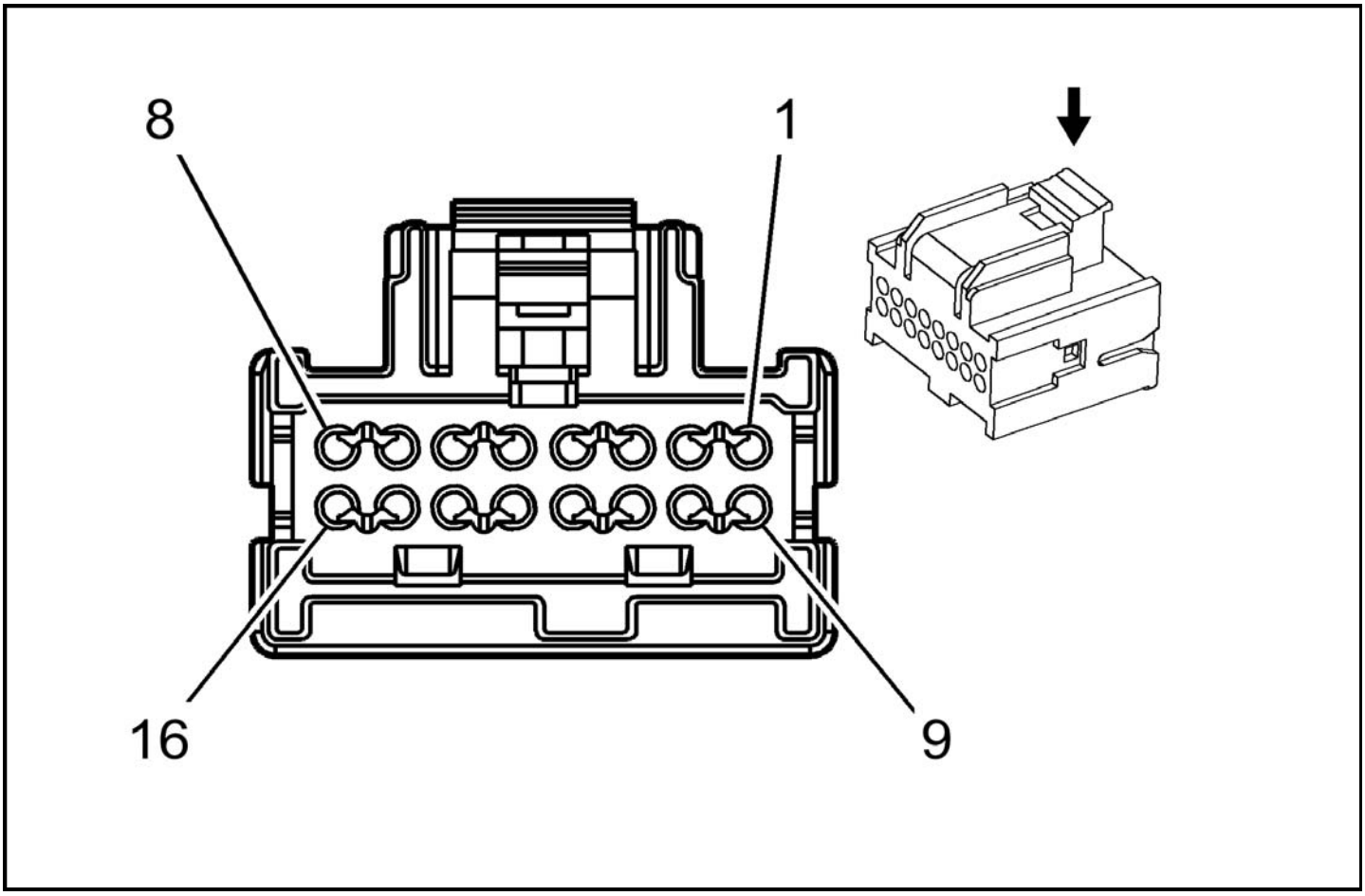
- Pins: 1, 8
- Terminated Lead: 13575735
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: C/A
- Pins: 2-6, 9-14

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-21
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 15359541/4
- Core/Insulation Crimp: M/M

Radio X1

Pin	Wire	Circuit	Function
1	1 RD/WH	2040	Battery Positive Voltage
2	0.8 TN	201	Left Front Speaker Output (+) (UW6, 9C1, 9C3)
			Left Front Low Level Audio Signal (+) (UQ3)
3	0.8 L-GN	200	Right Front Speaker Output (+) (UW6, 9C1, 9C3)
			Right Front Low Level Audio Signal (+) (UQ3)
4-5	-	-	Not Used
6	0.35 PK	5165	Antenna 14V Switched Supply Voltage
7	-	-	Not Used
8	1 BK/WH	351	Ground
9	0.8 GY	118	Left Front Speaker Output (-) (UW6, 9C1, 9C3)
			Left Front Low Level Audio Signal (-) (UQ3)
10	0.8 D-GN	117	Right Front Speaker Output (-) (UW6, 9C1, 9C3)
			Right Front Low Level Audio Signal (-) (UQ3)
11-12	-	-	Not Used
13	0.35 D-GN/WH	5060	Low Speed GMLAN Serial Data
14	-	-	Not Used

RADIO X2



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 13568238
- Service Connector: 13504130
- Description: 16-Way F Micro 64 Series Sealed (BK)

Terminal Part Information

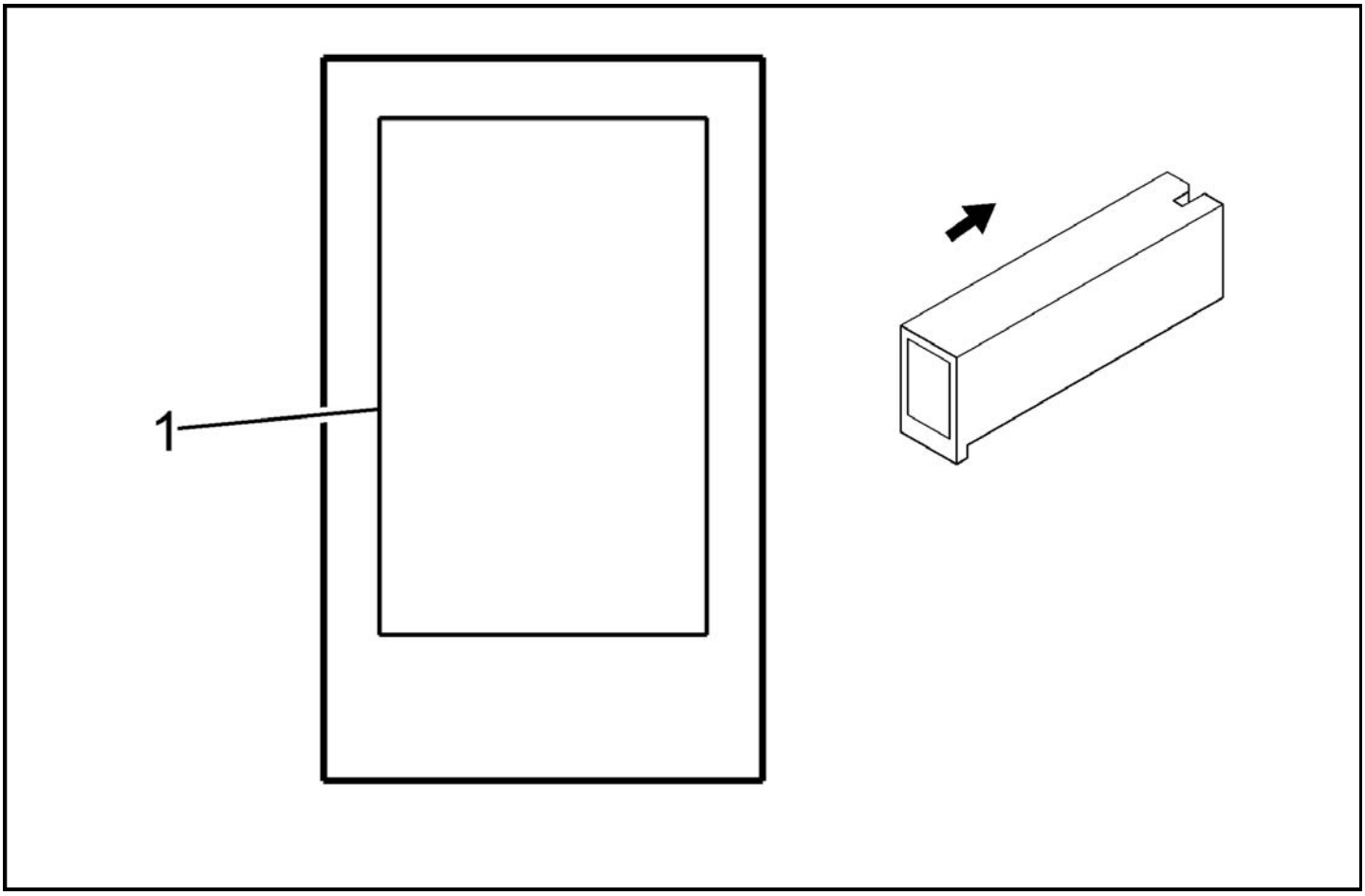
- Terminated Lead: 13575535
- Release Tool: J-38125-21
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 15359541/4
- Core/Insulation Crimp: M/M

Radio X2

Pin	Wire	Circuit	Function
1	0.35 BN/WH	367	Left Audio Signal (+) (U2K)
2	0.35 D-GN/WH	368	Right Audio Signal (+) (U2K)
3-4	-	-	Not Used

Pin	Wire	Circuit	Function
5	0.8 BN	199	Left Rear Speaker Output (+) (UW6, 9C1, 9C3)
			Left Rear Low Level Audio Signal (+) (UQ3)
6	0.8 D-BU	46	Right Rear Speaker Output (+) (UW6, 9C1, 9C3)
			Right Rear Low Level Audio Signal (+) (UQ3)
7	0.35 OG/BK	1406	Left Audio Signal (+) (UE1)
8	0.35 OG	5748	Radio Audio Mute Signal (UQ3)
9	0.35 D-GN	7007	Left Audio Signal (-) (U2K)
10	0.35 GY/BK	7008	Right Audio Signal (-) (U2K)
11	0.35 BARE	814	Drain Wire (U2K)
12	-	-	Not Used
13	0.8 YE	116	Left Rear Speaker Output (-) (UW6, 9C1, 9C3)
			Left Rear Low Level Audio Signal (-) (UQ3)
14	0.8 L-BU	115	Right Rear Speaker Output (-) (UW6, 9C1, 9C3)
			Right Rear Low Level Audio Signal (-) (UQ3)
15	0.35 L-BU	1405	Audio Common Signal (UE1)
16	-	-	Not Used

RADIO ANTENNA MODULE



Connector Part Information

- Harness Type: Body
- OEM Connector: 15368970
- Service Connector: 89046641
- Description: 1-Way F Positive Lock 187 Series (BK)

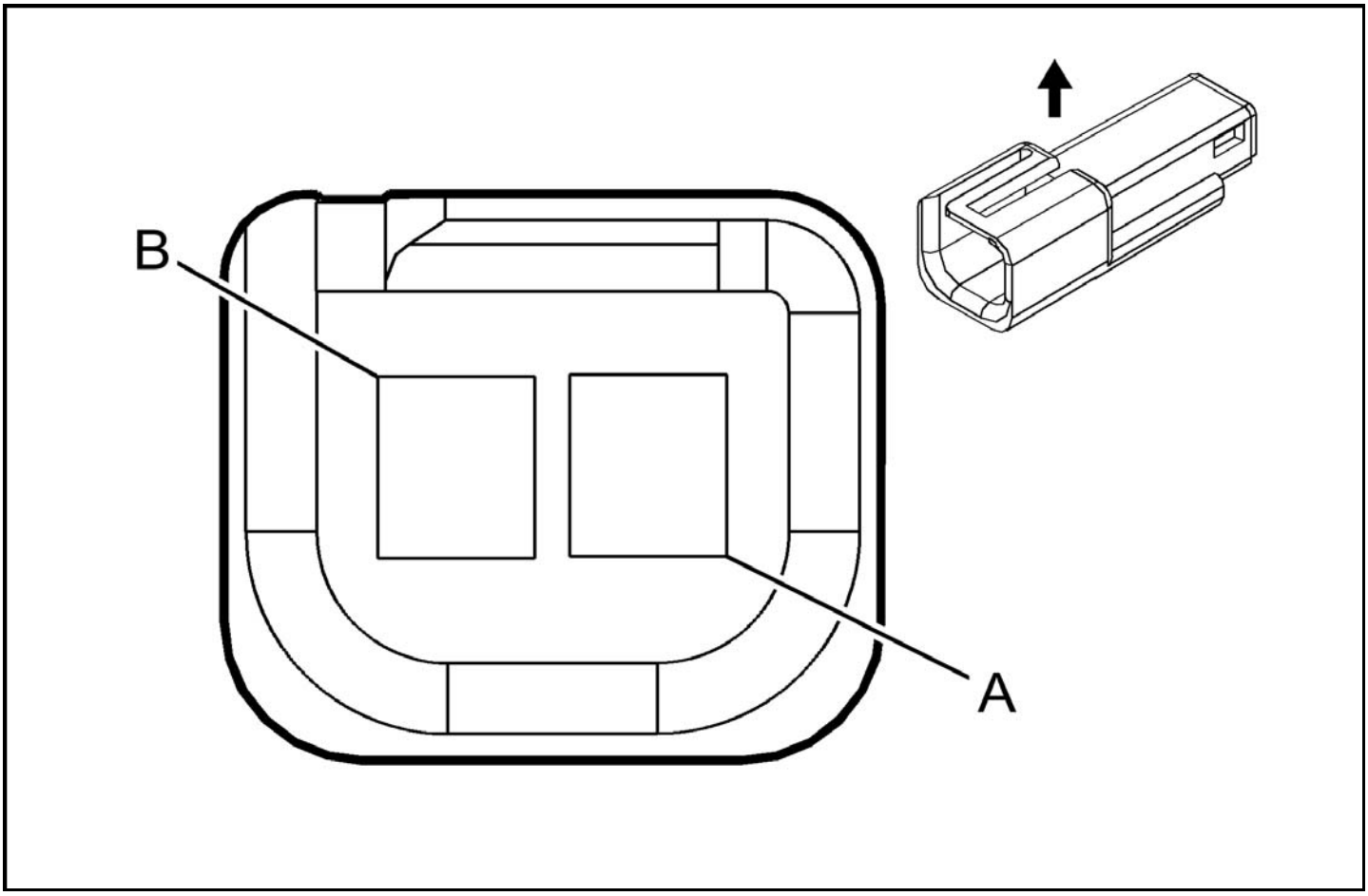
Terminal Part Information

- Terminated Lead: Service by Connector Assembly - 89046641
- Release Tool: J-38125-218
- Diagnostic Test Probe: J-35616-40 (BU)
- Terminal/Tray: 170325-1/24
- Core/Insulation Crimp: E/A

Radio Antenna Module

Pin	Wire	Circuit	Function
1	0.5 PK	5165	Antenna 14V Switched Supply Voltage

READING LAMP - AUXILIARY (6C7)



Connector Part Information

- Harness Type: Headliner
- OEM Connector: 12047663
- Service Connector: 13584278
- Description: 2-Way M Metri-Pack 150 Series (BK)

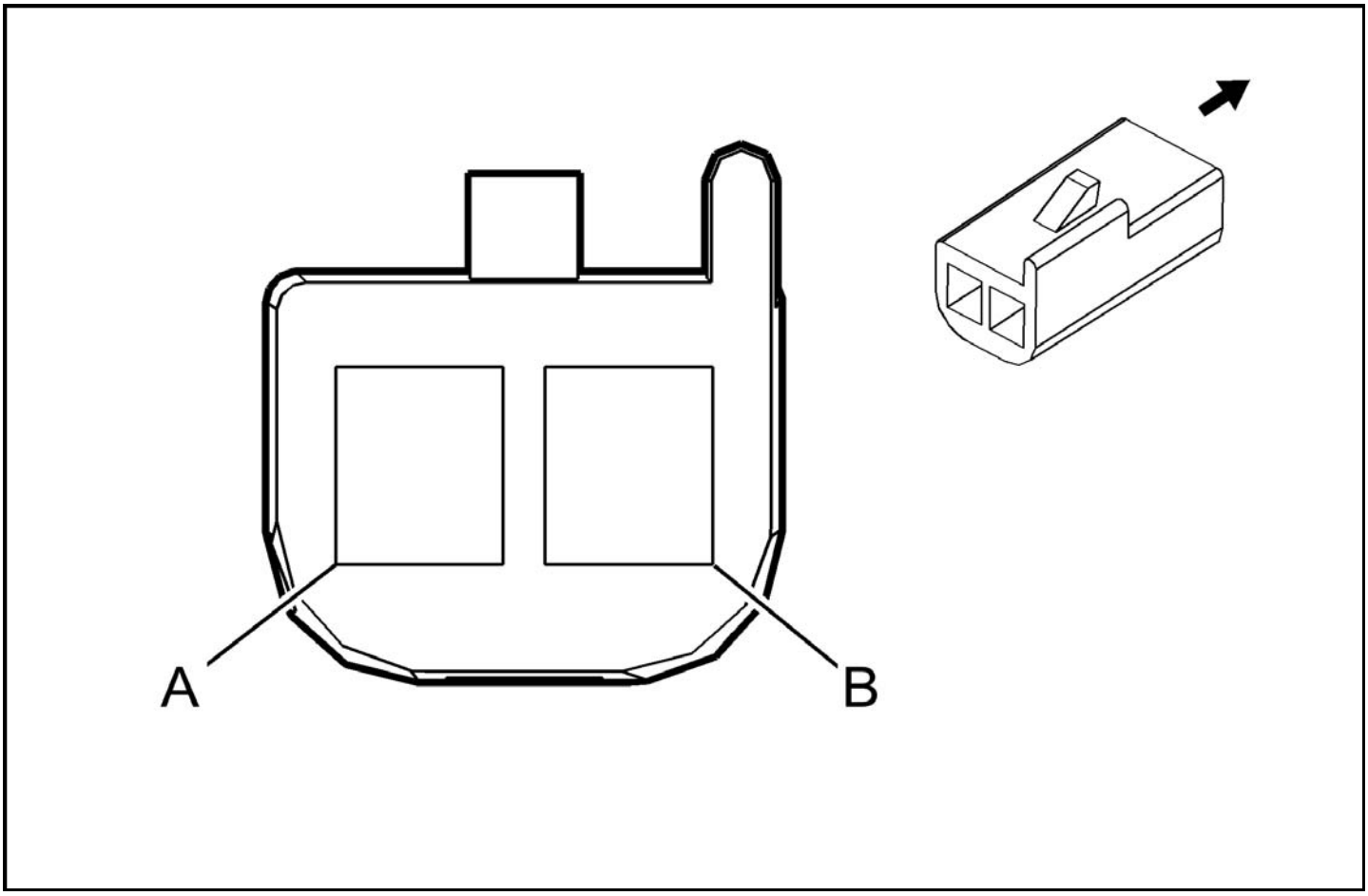
Terminal Part Information

- Terminated Lead: 13575462
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/C

Reading Lamp - Auxiliary (6C7)

Pin	Wire	Circuit	Function
A	0.5 OG	1732	Inadvertent Power Courtesy Lamp
B	0.5 BK	550	Ground

REAR COMPARTMENT COURTESY LAMP



Connector Part Information

- Harness Type: Body
- OEM Connector: 12047662
- Service Connector: 12085535
- Description: 2-Way F Metri-Pack 150 Series (BK)

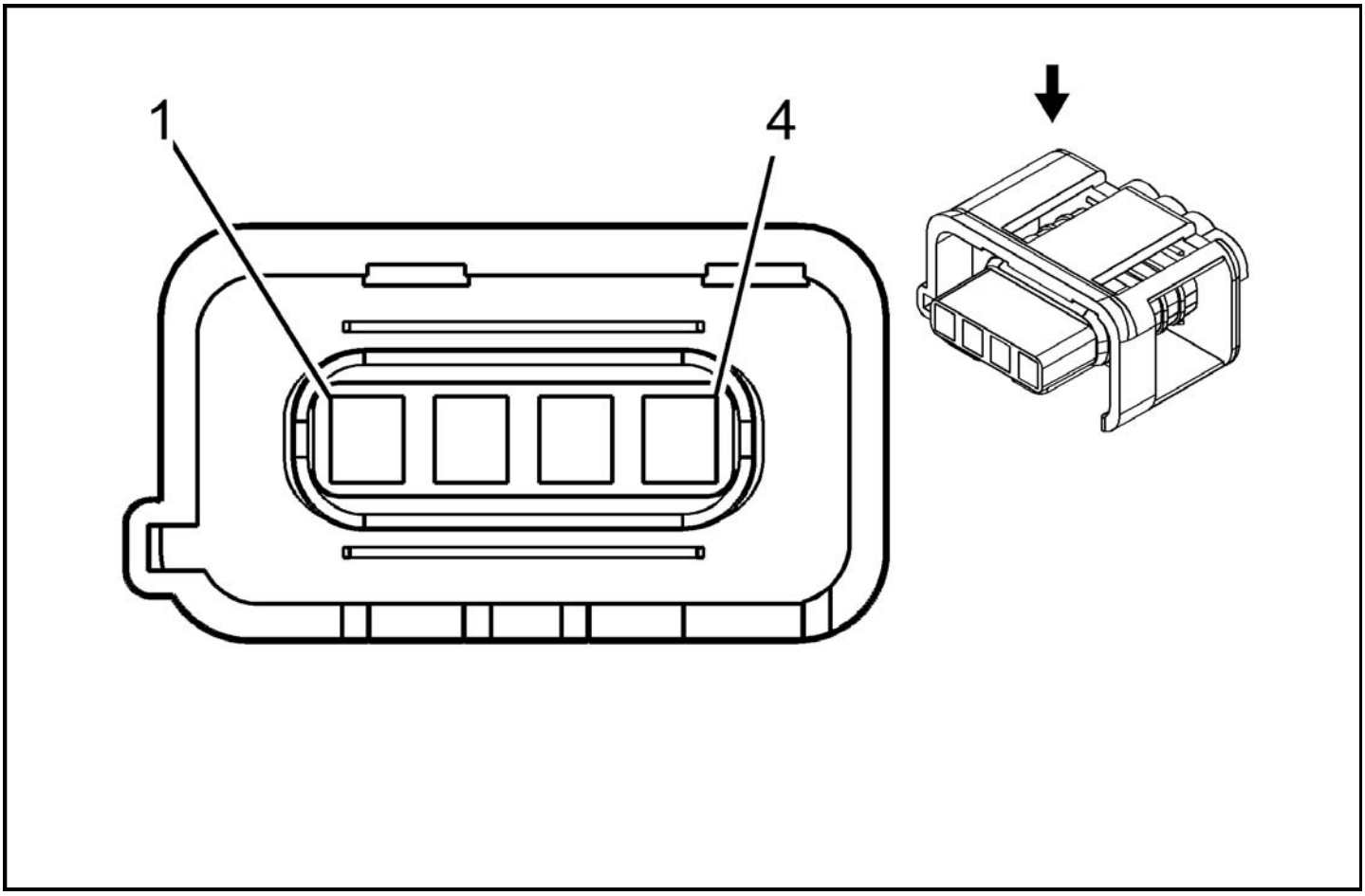
Terminal Part Information

- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Rear Compartment Courtesy Lamp

Pin	Wire	Circuit	Function
A	0.8 BK	1732	Inadvertent Power Courtesy Lamp
B	0.5 BK	737	Rear Compartment Lamp Control

REAR COMPARTMENT LID LATCH



Connector Part Information

- Harness Type: Body
- OEM Connector: 15489982
- Service Connector: 88988815
- Description: 4-Way F Micro Timer Series, Sealed (BK)

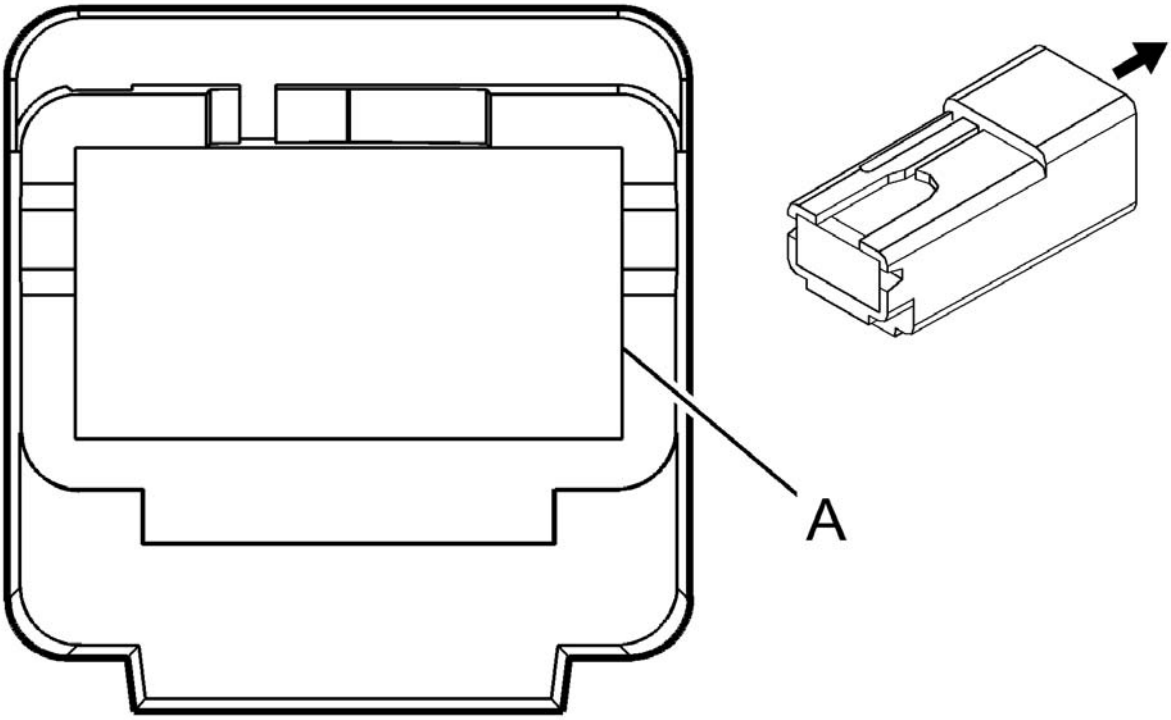
Terminal Part Information

- Terminated Lead: 13575359
- Release Tool: J-38125-560
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 964274-2/16
- Core/Insulation Crimp: E/1

Rear Compartment Lid Latch

Pin	Wire	Circuit	Function
1	0.5 BK	737	Rear Compartment Lamp Control
2	0.5 OG/BK	744	Rear Compartment Lid Ajar Switch Signal
3	0.5 BK	750	Ground
4	0.5 TN/WH	56	Trunk Release Motor Control

REAR WINDOW DEFOGGER GRID X1



Connector Part Information

- Harness Type: Headliner
- OEM Connector: 12092133
- Service Connector: 13580869
- Description: 1-Way F Metri-Pack 630 Series Self Lock (BK)

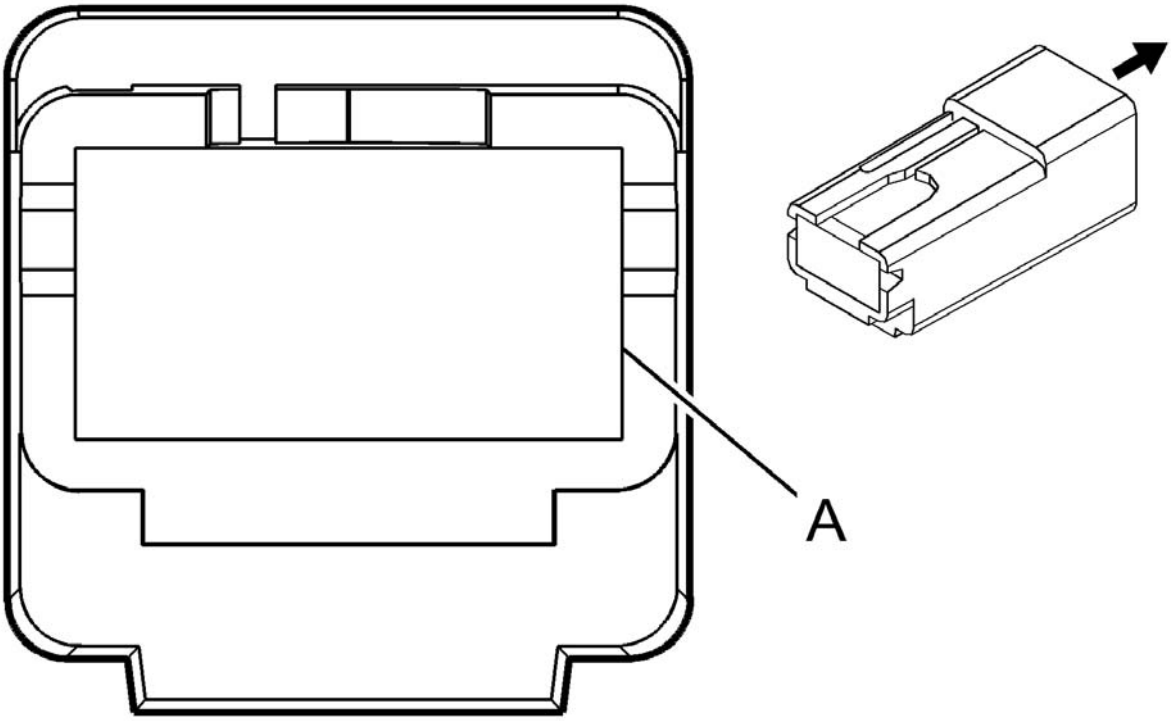
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-42 (RD)
- Terminal/Tray: 12034110/18
- Core/Insulation Crimp: F/G

Rear Window Defogger Grid X1

Pin	Wire	Circuit	Function
A	3 BK	293	Rear Defog Element Supply Voltage

REAR WINDOW DEFOGGER GRID X2



Connector Part Information

- Harness Type: Body
- OEM Connector: 12092133
- Service Connector: 13580869
- Description: 1-Way F Metri-Pack 630 Series Self Lock (BK)

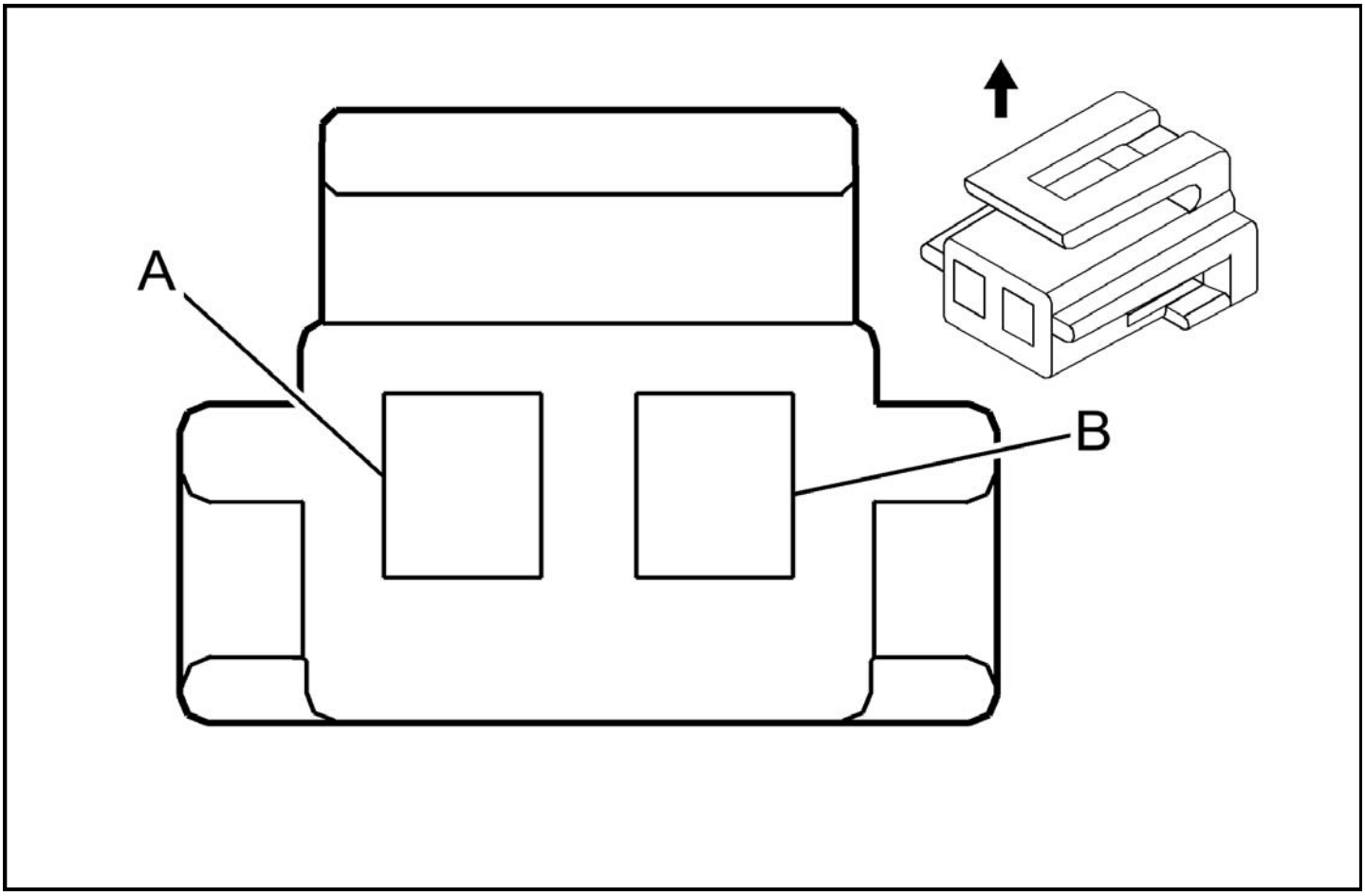
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-42 (RD)
- Terminal/Tray: 12034110/18
- Core/Insulation Crimp: F/G

Rear Window Defogger Grid X2

Pin	Wire	Circuit	Function
A	5 BK	1150	Ground

RECIRCULATION ACTUATOR



Connector Part Information

- Harness Type: HVAC
- OEM Connector: 12059110
- Service Connector: 88953271
- Description: 2-Way F Metri-Pack 150 Series (BK)

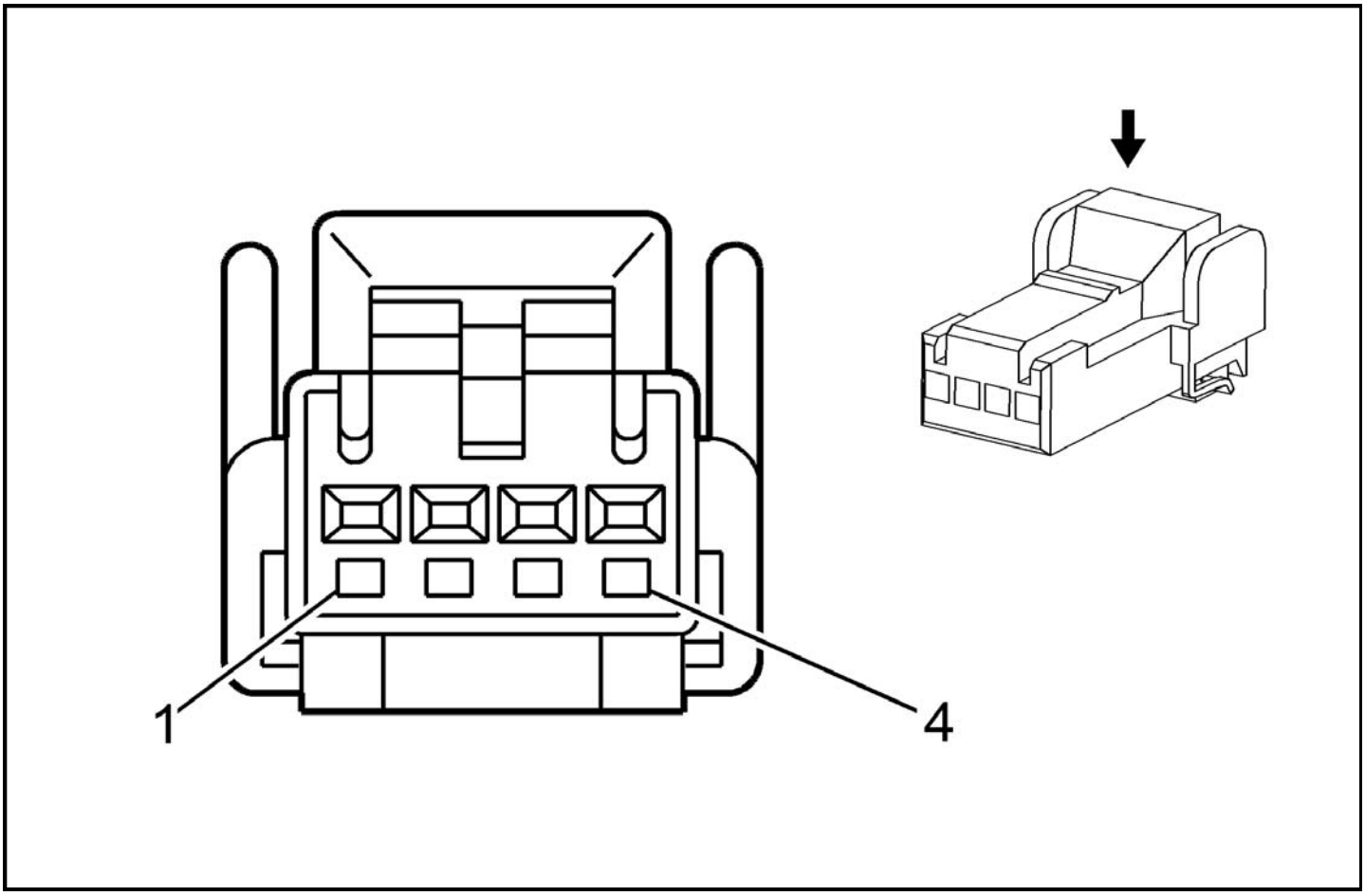
Terminal Part Information

- Terminal/Tray: 12064971/5
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Recirculation Actuator

Pin	Wire	Circuit	Function
A	0.35 L-GN/BK	1647	Recirculation Door Control B
B	0.35 PK/WH	1648	Recirculation Door Control A

REMOTE CONTROL DOOR LOCK RECEIVER (RCDLR)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15462684
- Service Connector: 13585474
- Description: 4-Way F ILAG5 Series (GN)

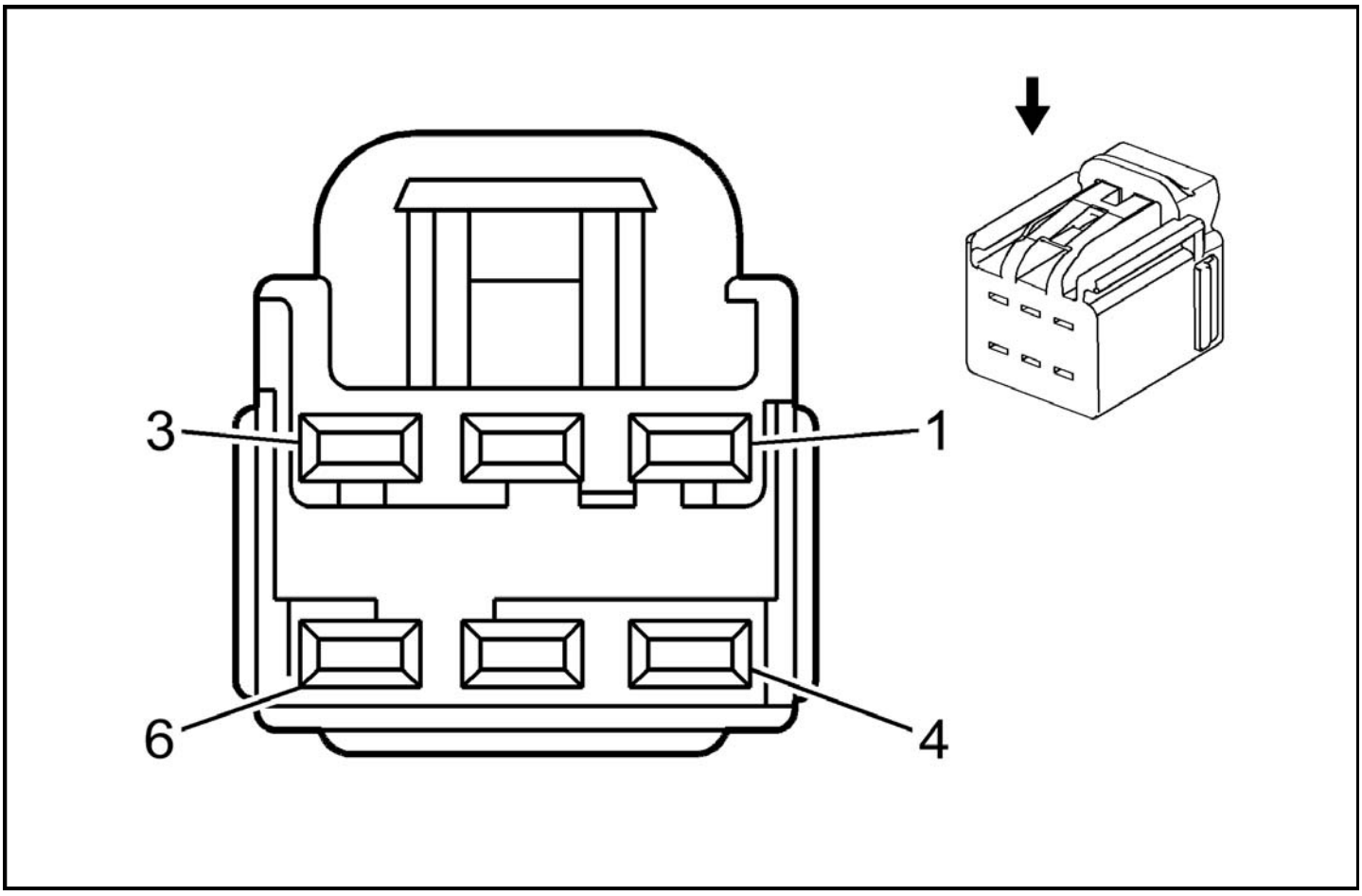
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-211
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: IL-AG5-C1-5000/20
- Core/Insulation Crimp: J/J

Remote Control Door Lock Receiver (RCDLR)

Pin	Wire	Circuit	Function
1	0.35 RD/WH	1840	Battery Positive Voltage
2	0.35 D-GN/RD	5060	Low Speed GMLAN Serial Data
3	-	-	Not Used
4	0.5 BK/WH	1551	Ground

SEAT ADJUSTER MOTOR ASSEMBLY - DRIVER (AG1, AH5)



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 10847014
- Service Connector: 19153175
- Description: 6-Way F Kaizen YESC Series (L-GY)

Terminal Part Information

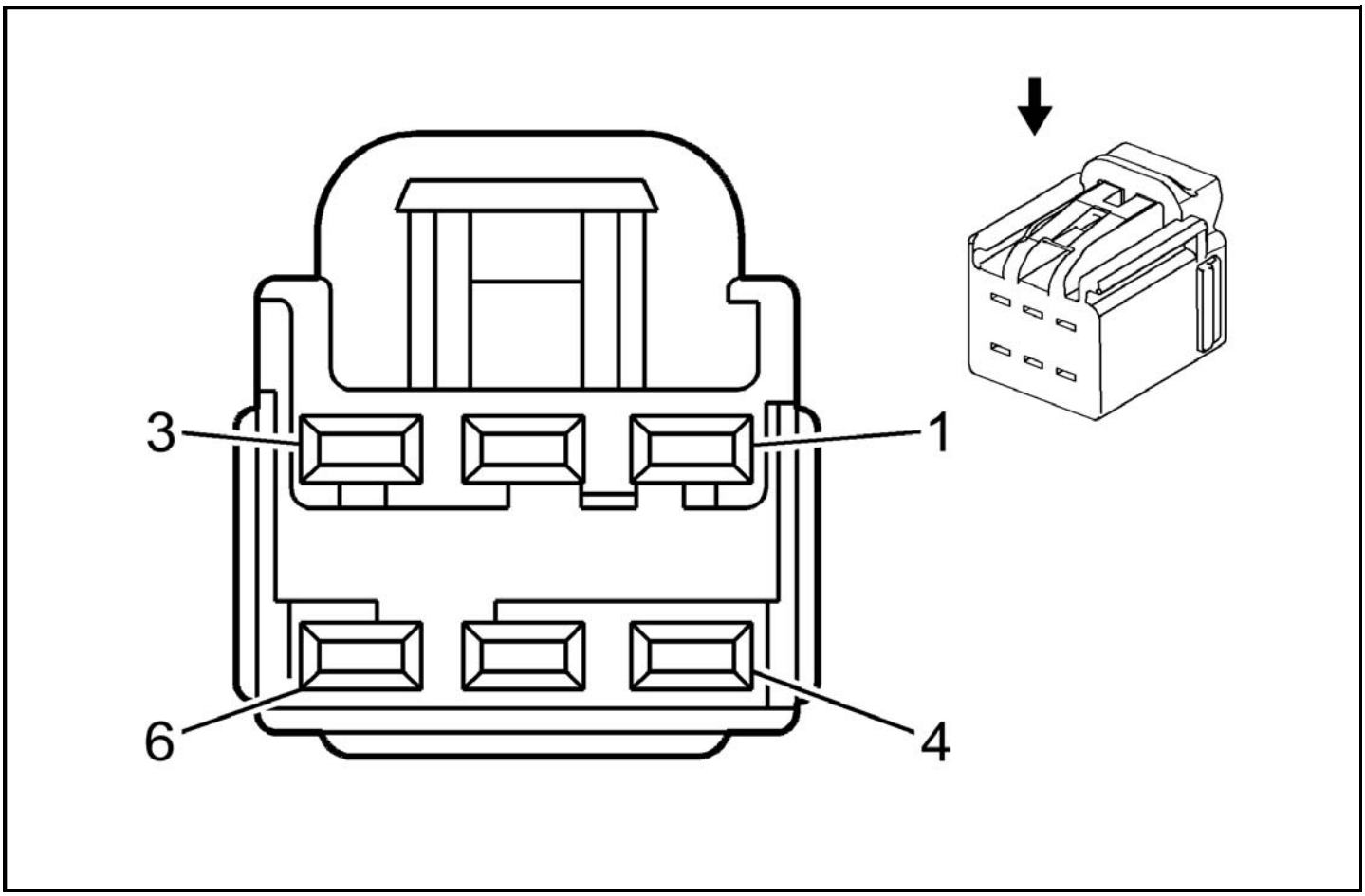
- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: 7116-4112-02/9
- Core/Insulation Crimp: C/D

Seat Adjuster Motor Assembly - Driver (AG1, AH5)

Pin	Wire	Circuit	Function
1	3 YE	282	Driver Seat Rear Vertical Motor Up Control
2	3 D-GN	286	Driver Seat Front Vertical Motor Up Control

Pin	Wire	Circuit	Function
3	3 TN	285	Driver Seat Horizontal Motor Forward Control
4	3 L-BU	283	Driver Seat Rear Vertical Motor Down Control
5	3 D-BU	287	Driver Seat Front Vertical Motor Down Control
6	3 L-GN	284	Driver Seat Horizontal Motor Rearward Control

SEAT ADJUSTER MOTOR ASSEMBLY - PASSENGER (AG2)



Connector Part Information

- Harness Type: Passenger Seat Harness
- OEM Connector: 10847014
- Service Connector: 19153175
- Description: 6-Way F Kaizen YESC Series (L-GY)

Terminal Part Information

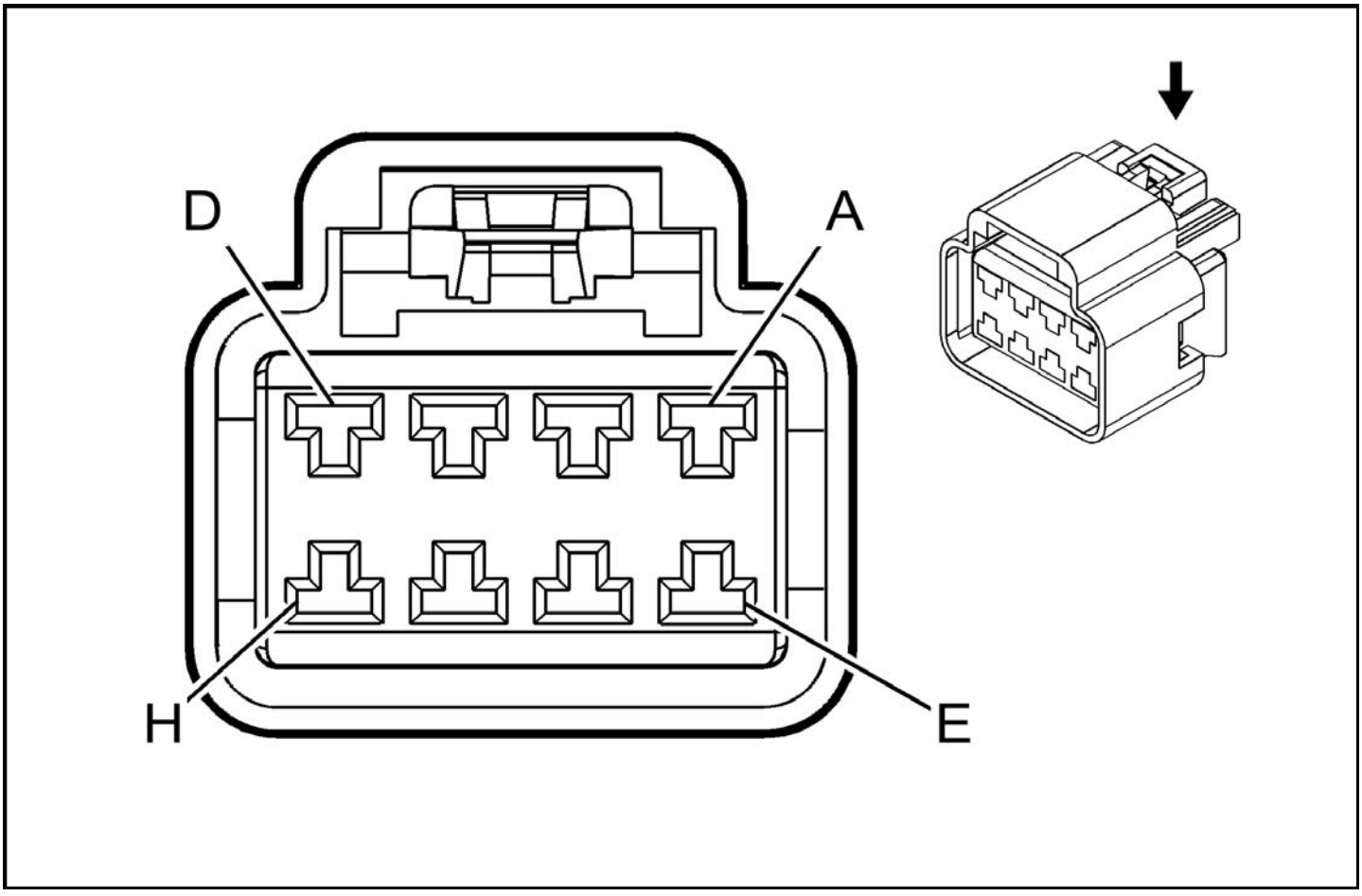
- Terminated Lead: Service by Harness- See Part Catalog

- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-35 (VT)
- Terminal/Tray: 7116-4112-02/9
- Core/Insulation Crimp: C/D

Seat Adjuster Motor Assembly - Passenger (AG2)

Pin	Wire	Circuit	Function
1	3 YE	282	Passenger Seat Rear Vertical Motor Up Control
2	3 D-GN	286	Passenger Seat Front Vertical Motor Up Control
3	3 TN	285	Passenger Seat Horizontal Motor Forward Control
4	3 L-BU	283	Passenger Seat Rear Vertical Motor Down Control
5	3 D-BU	287	Passenger Seat Front Vertical Motor Down Control
6	3 L-GN	284	Passenger Seat Horizontal Motor Rearward Control

SEAT ADJUSTER SWITCH - DRIVER (AG1)



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 15459914
- Service Connector: 19153751
- Description: 8-Way F GT 280 Series (BK)

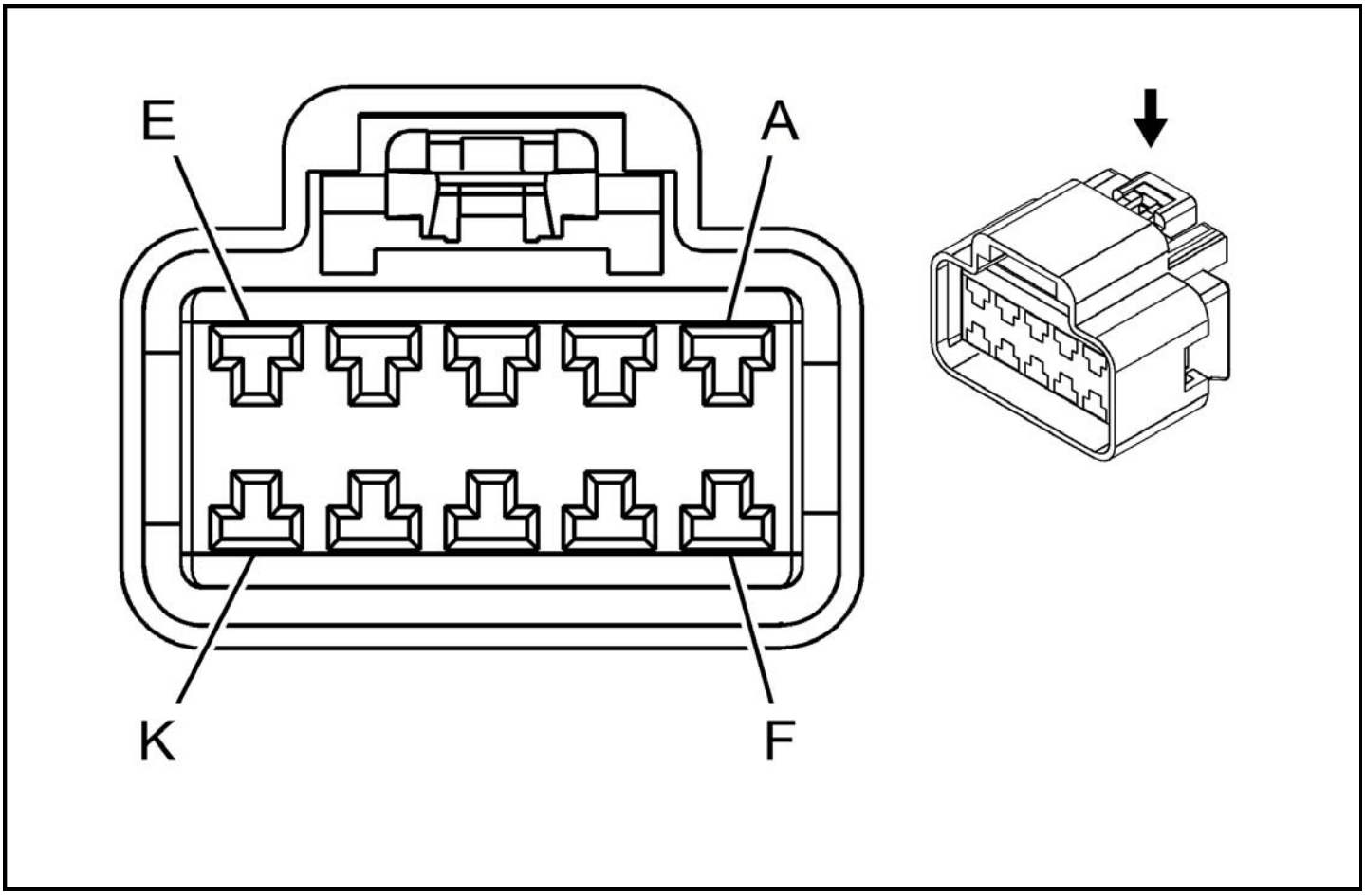
Terminal Part Information

- Terminated Lead: 13575756
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304713/19
- Core/Insulation Crimp: F/D

Seat Adjuster Switch - Driver (AG1)

Pin	Wire	Circuit	Function
A	3 D-GN	286	Driver Seat Front Vertical Motor Up Control
B	3 BK	550	Ground
C	3 TN	285	Driver Seat Horizontal Motor Forward Control
D	3 RD/WH	1140	Battery Positive Voltage
E	3 YE	282	Driver Seat Rear Vertical Motor Up Control
F	3 L-GN	284	Driver Seat Horizontal Motor Rearward Control
G	3 L-BU	283	Driver Seat Rear Vertical Motor Down Control
H	3 D-BU	287	Driver Seat Front Vertical Motor Down Control

SEAT ADJUSTER SWITCH - DRIVER (AH5)



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 15326931
- Service Connector: 15306309
- Description: 10-Way F GT 280 Series (BK)

Terminal Part Information

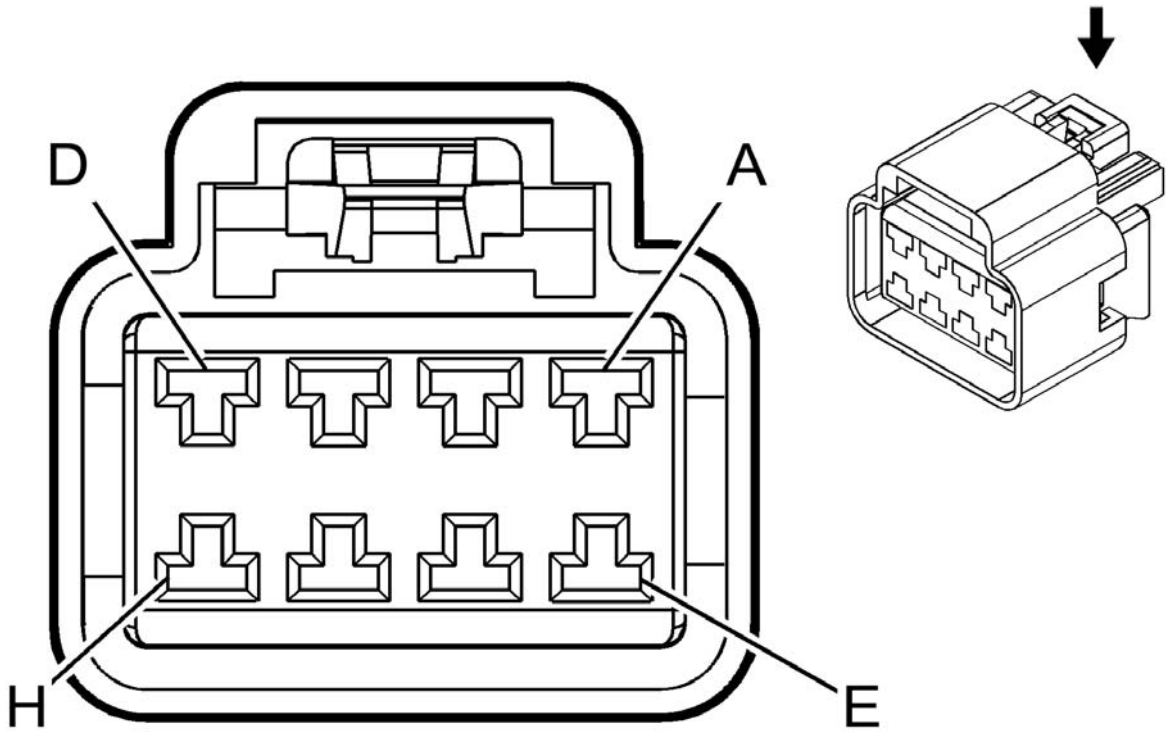
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

Seat Adjuster Switch - Driver (AH5)

Pin	Wire	Circuit	Function
A	3 D-GN	286	Driver Seat Front Vertical Motor Up Control
B	3 BK	550	Ground
C	3 L-GN	284	Driver Seat Horizontal Motor Rearward Control

Pin	Wire	Circuit	Function
D	3 TN	285	Driver Seat Horizontal Motor Forward Control
E	3 RD/WH	1140	Battery Positive Voltage
F	3 YE	282	Driver Seat Rear Vertical Motor Up Control
G	3 D-BU	77	Driver Seat Recline Motor Rearward Control
H	3 D-GN	76	Driver Seat Recline Motor Forward Control
J	3 L-BU	283	Driver Seat Rear Vertical Motor Down Control
K	3 D-BU	287	Driver Seat Front Vertical Motor Down Control

SEAT ADJUSTER SWITCH - PASSENGER (AG2)



Connector Part Information

- Harness Type: Right Front Seat
- OEM Connector: 15459914
- Service Connector: 19153751
- Description: 8-Way F GT 280 Series (BK)

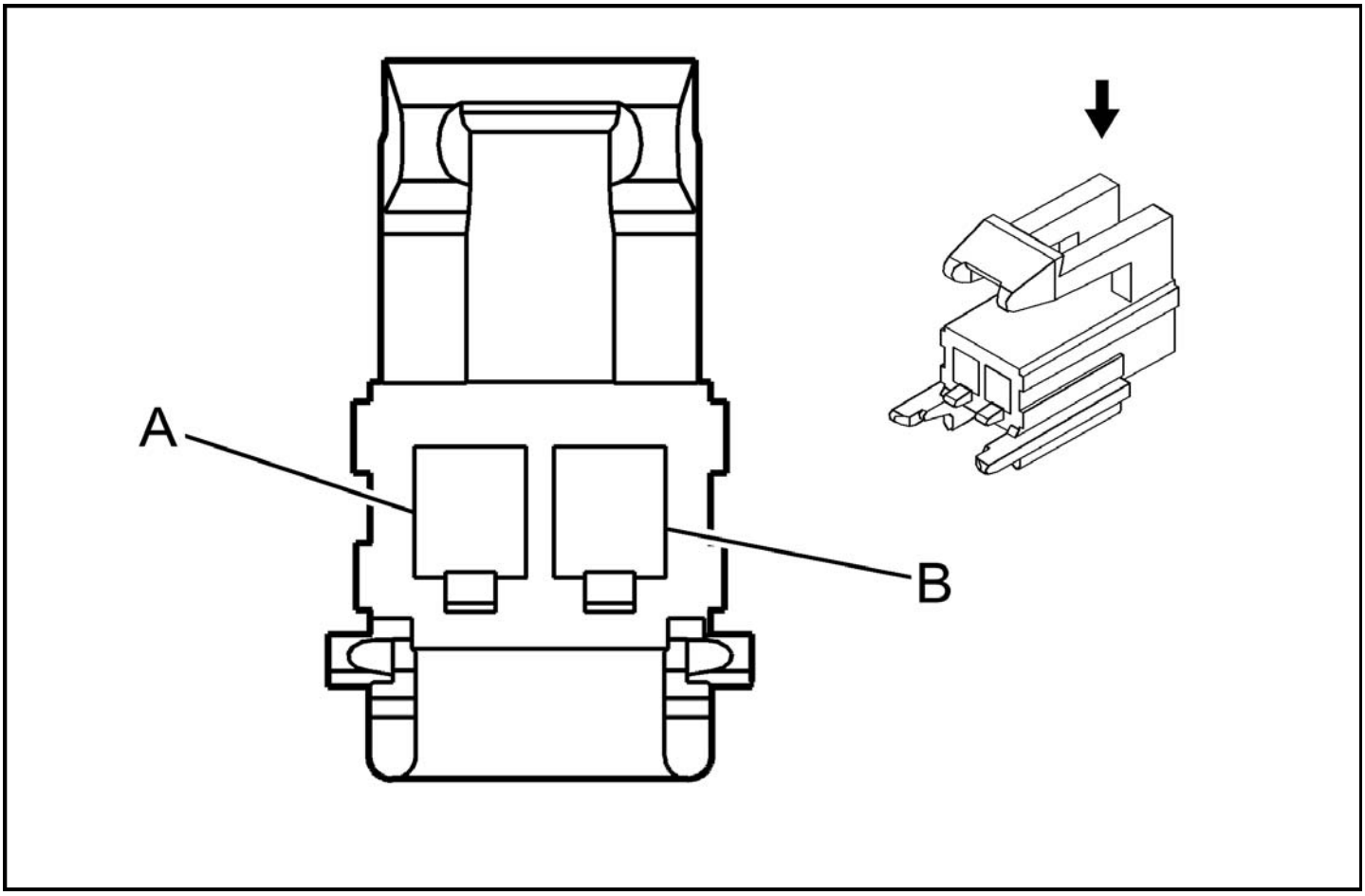
Terminal Part Information

- Terminated Lead: 13575756
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304713/19
- Core/Insulation Crimp: F/D

Seat Adjuster Switch - Passenger (AG2)

Pin	Wire	Circuit	Function
A	3 D-BU	287	Passenger Seat Front Vertical Motor Down Control
B	3 BK	750	Ground
C	3 TN	285	Passenger Seat Horizontal Motor Forward Control
D	3 RD/WH	1140	Battery Positive Voltage
E	3 L-BU	283	Passenger Seat Rear Vertical Motor Down Control
F	3 L-GN	284	Passenger Seat Horizontal Motor Rearward Control
G	3 YE	282	Passenger Seat Rear Vertical Motor Up Control
H	3 D-GN	286	Passenger Seat Front Vertical Motor Up Control

SEAT BELT RETRACTOR PRETENSIONER - DRIVER



Connector Part Information

- Harness Type: Body
- OEM Connector: 12110505
- Service Connector: 15306044
- Description: 2-Way F Metri-Pack 150 Series (YE)

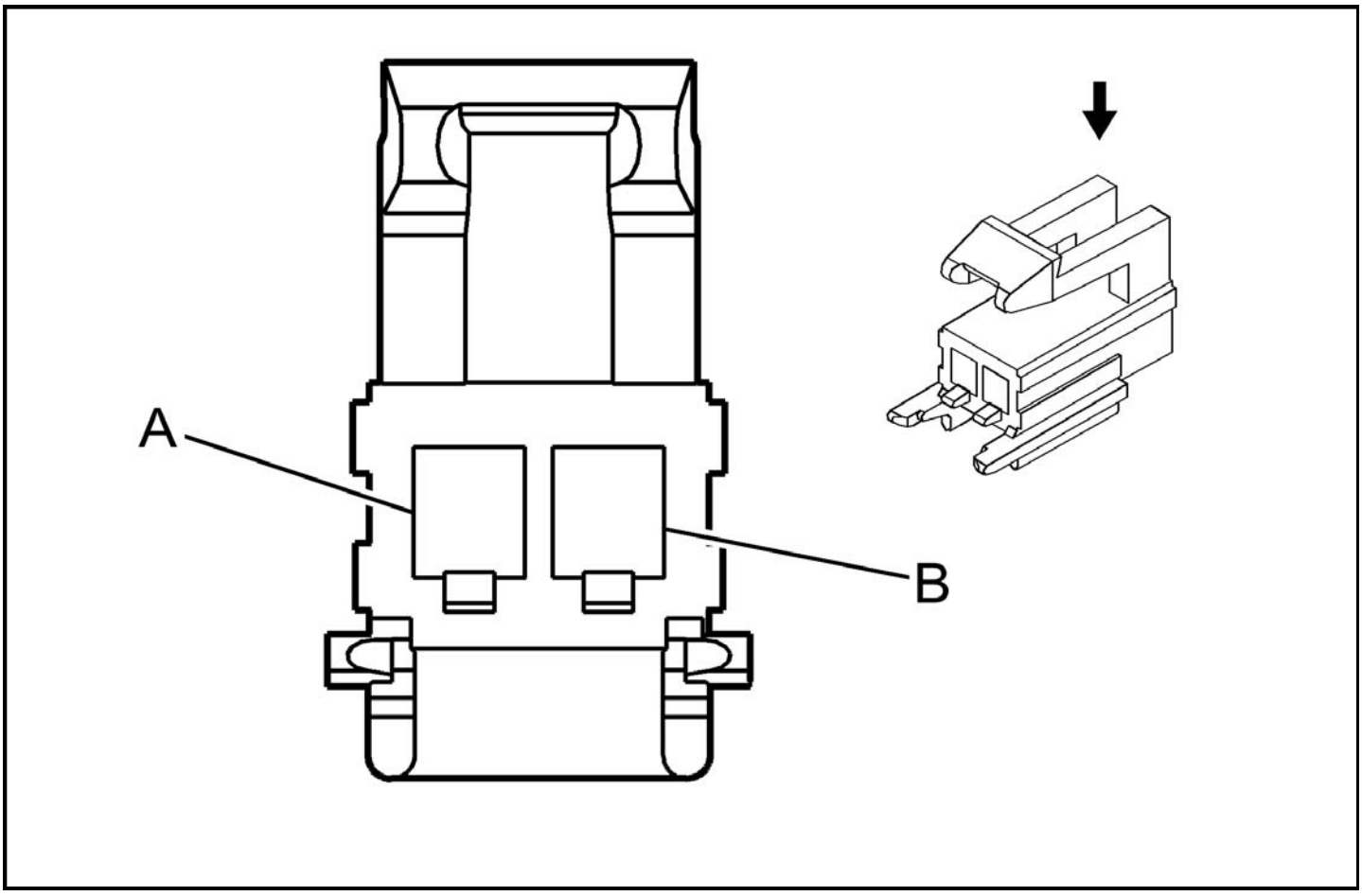
Terminal Part Information

- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Seat Belt Retractor Pretensioner - Driver

Pin	Wire	Circuit	Function
A	0.35 TN/WH	2118	Seat Belt Retractor Pretensioner- Driver- High Control
B	0.35 OG/BK	2119	Seat Belt Retractor Pretensioner- Driver- Low Control

SEAT BELT RETRACTOR PRETENSIONER - PASSENGER



Connector Part Information

- Harness Type: Body
- OEM Connector: 12110505
- Service Connector: 15306044
- Description: 2-Way F Metri-Pack 150 Series (YE)

Terminal Part Information

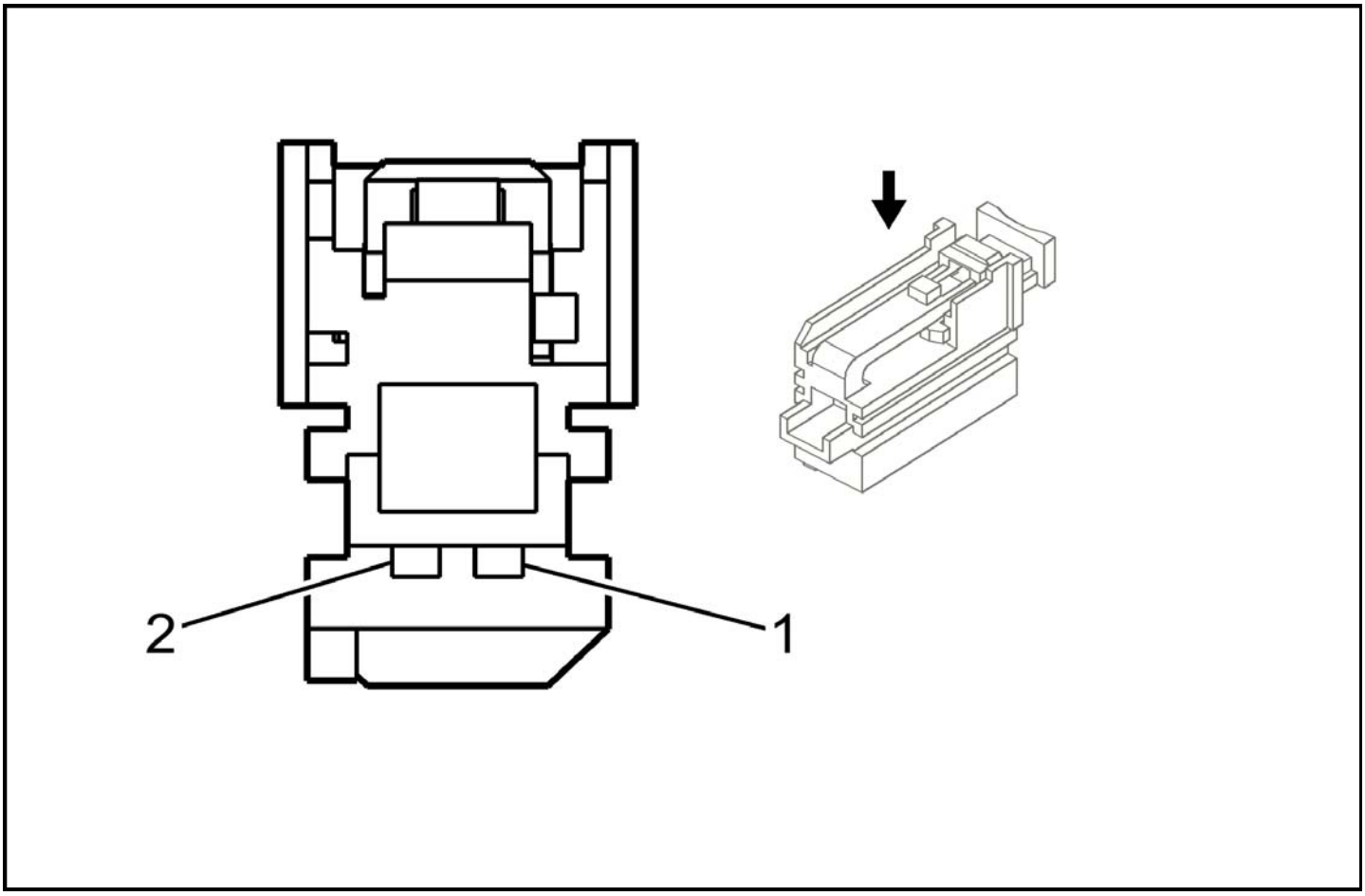
- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Seat Belt Retractor Pretensioner - Passenger

Pin	Wire	Circuit	Function
A	0.35 L-GN	2116	Seat Belt Retractor Pretensioner - Passenger - High Control

Pin	Wire	Circuit	Function
B	0.35 OG	2117	Seat Belt Retractor Pretensioner - Passenger - Low Control

SEAT BELT PRETENSIONER - DRIVER



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 13676743
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F 0.64 Series (YE)

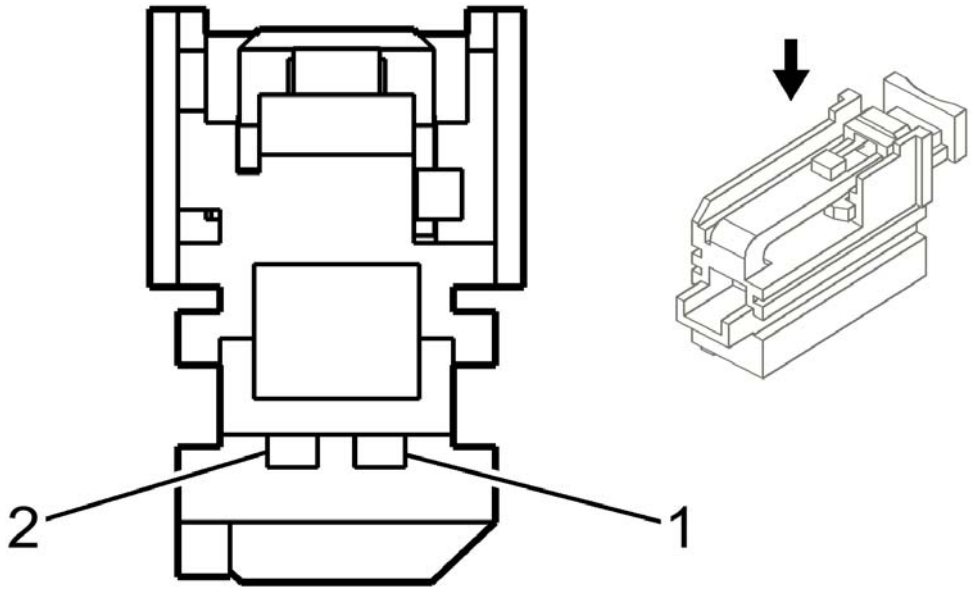
Terminal Part Information

- Terminated Lead: 13575867
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SAIT-A03T-M064/14
- Core/Insulation Crimp: P/P

Seat Belt Pretensioner - Driver

Pin	Wire	Circuit	Function
1	0.5 WH	3064	Seat Belt Pretensioner- Driver- High Control
2	0.5 YE/BK	3065	Seat Belt Pretensioner- Driver- Low Control

SEAT BELT PRETENSIONER - PASSENGER



Connector Part Information

- Harness Type: Right Front Seat
- OEM Connector: 13676743
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F 0.64 Series (YE)

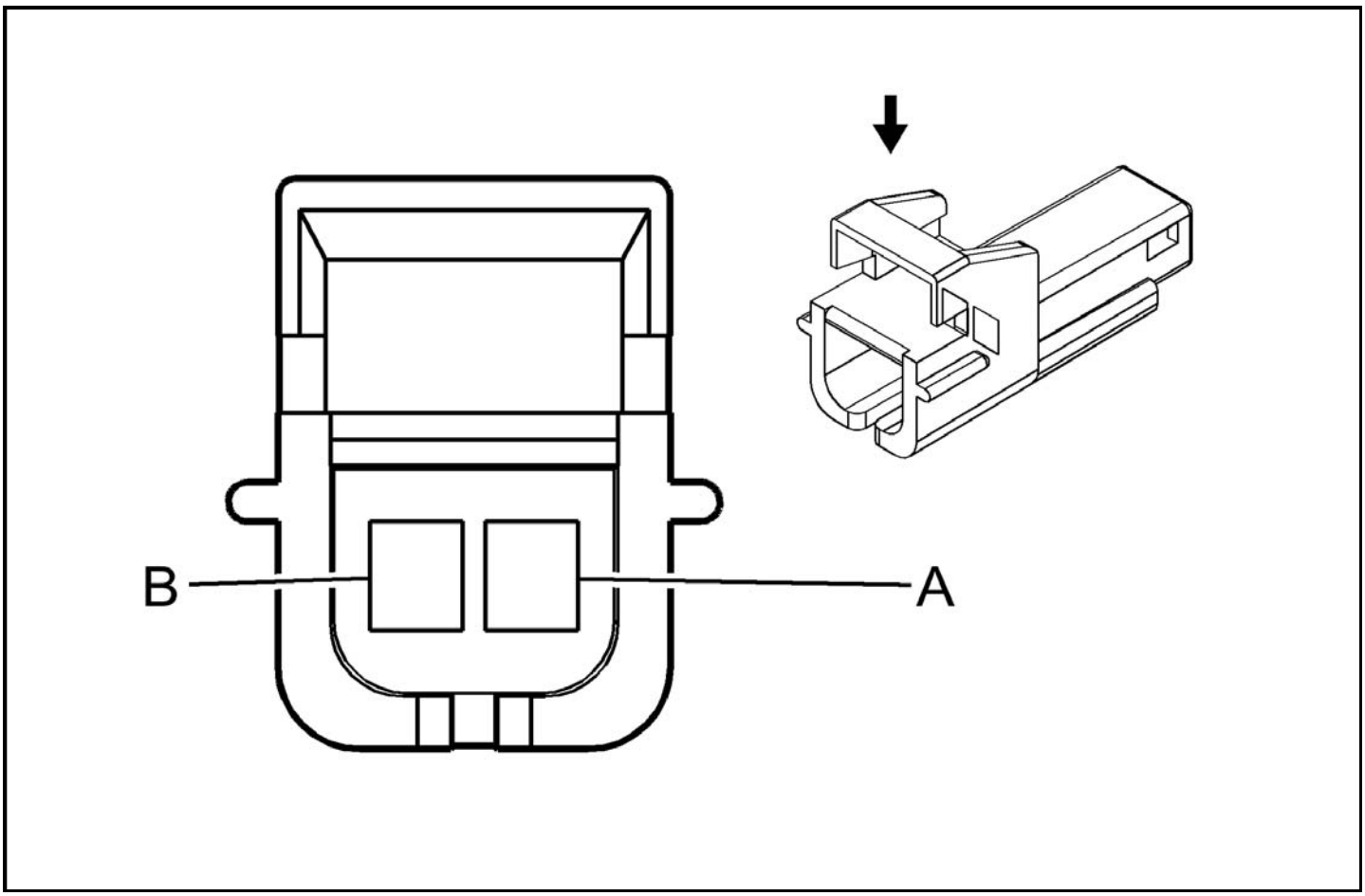
Terminal Part Information

- Terminated Lead: 13575867
- Release Tool: J-38125-215A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: SAIT-A03T-M064/14
- Core/Insulation Crimp: P/P

Seat Belt Pretensioner - Passenger

Pin	Wire	Circuit	Function
1	0.5 TN	3062	Seat Belt Pretensioner- Passenger- High Control
2	0.5 L-BU/BK	3063	Seat Belt Pretensioner- Passenger- Low Control

SEAT BELT SWITCH - DRIVER



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 12124451
- Service Connector: 12117275
- Description: 2-Way M Metri-Pack 150 Series (BK)

Terminal Part Information

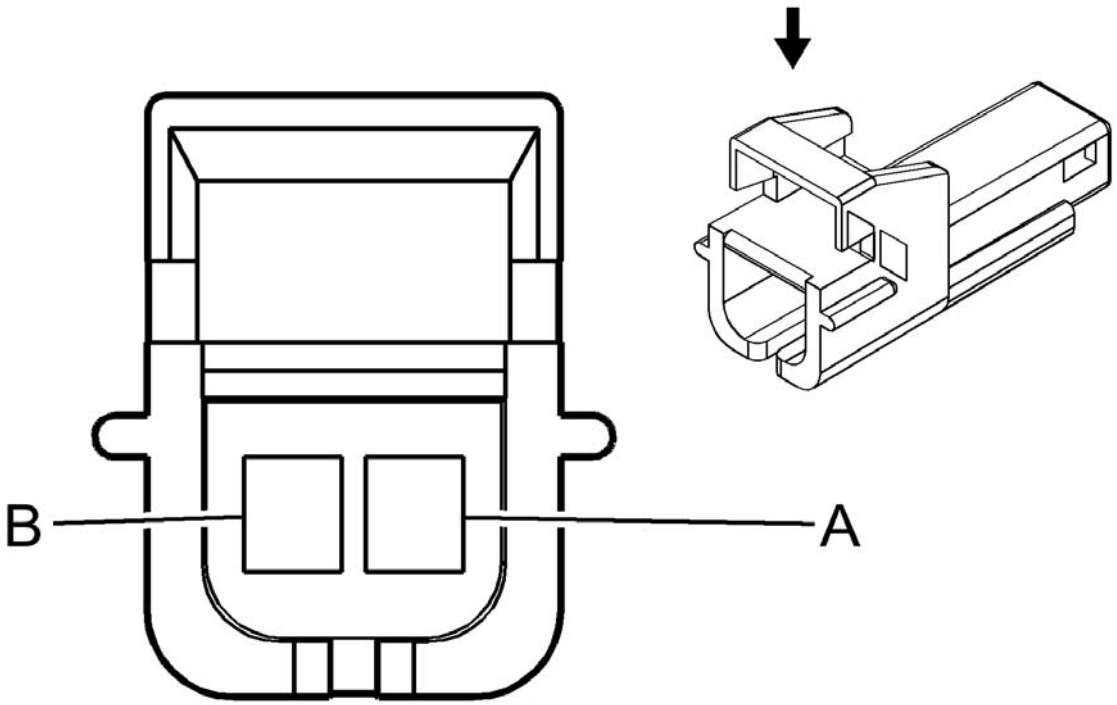
- Terminated Lead: 13575462
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2

- Core/Insulation Crimp: E/C

Seat Belt Switch - Driver

Pin	Wire	Circuit	Function
A	0.35 D-GN	5016	Seat Belt Switch- Left- Signal
B	0.35 PK	5057	Low Reference

SEAT BELT SWITCH - PASSENGER



Connector Part Information

- Harness Type: Right Front Seat
- OEM Connector: 12124451
- Service Connector: 12117275
- Description: 2-Way M Metri-Pack 150 Series (BK)

Terminal Part Information

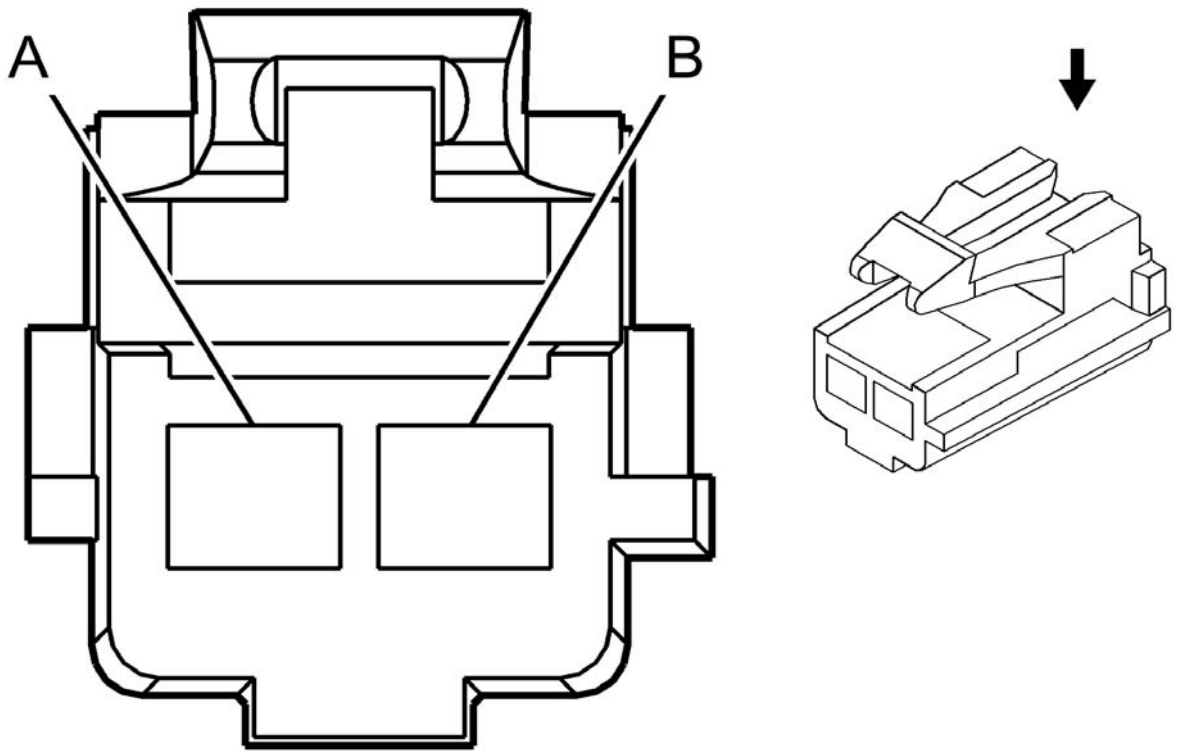
- Terminated Lead: 13575462
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)

- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/C

Seat Belt Switch - Passenger

Pin	Wire	Circuit	Function
A	0.35 OG	1362	Seat Belt Switch- Right- Signal
B	0.35 PK	5057	Low Reference

SEAT RECLINE MOTOR - DRIVER (AH5)



Connector Part Information

- Harness Type: Left Front Seat
- OEM Connector: 12129081
- Service Connector: 12129081
- Description: 2-Way F Metri-Pack 280 Series, Flexlock (BK)

Terminal Part Information

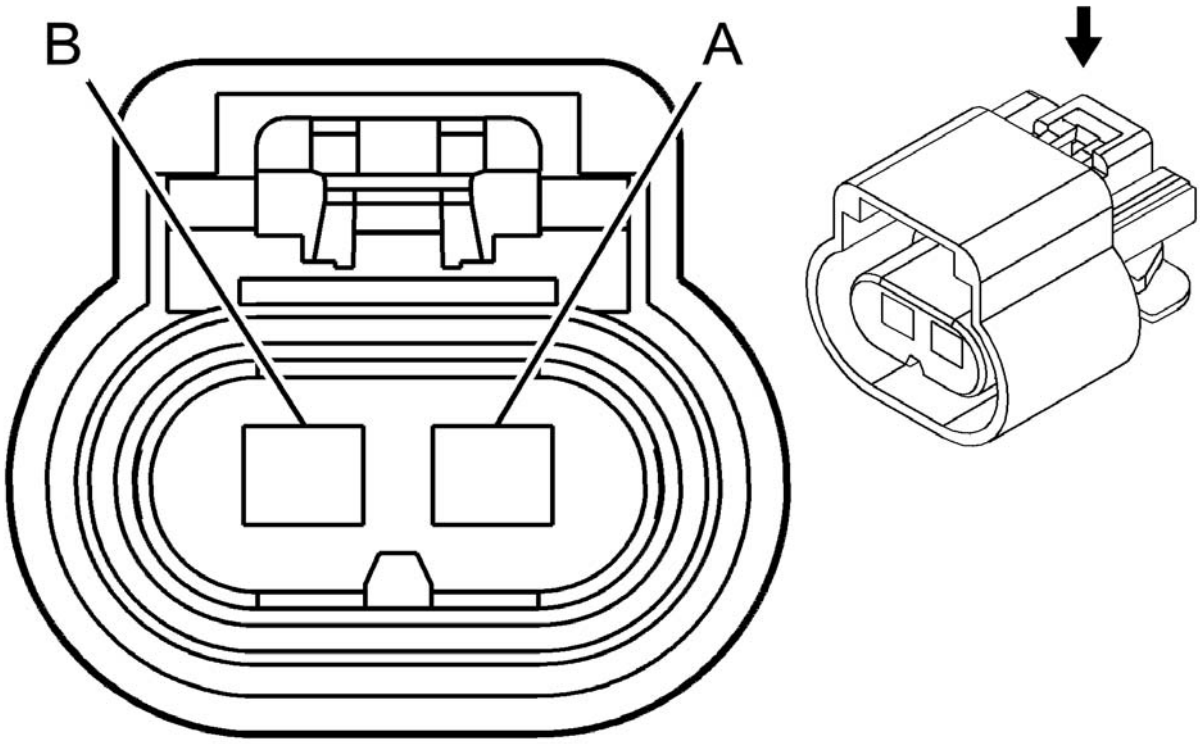
- Terminal/Tray: 12110842/4
- Core/Insulation Crimp: F/G

- Release Tool/Test Probe: 15315247/J-35616-4A (PU)

Seat Recline Motor - Driver (AH5)

Pin	Wire	Circuit	Function
A	3 D-GN	76	Driver Seat Recline Motor Forward Control
B	3 D-BU	77	Driver Seat Recline Motor Rearward Control

SECONDARY AIR INJECTION (AIR) PUMP (NU5/NU6)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 13518845
- Service Connector: 88988942
- Description: 2-Way F GT 280 Series, Sealed (BK)

Terminal Part Information

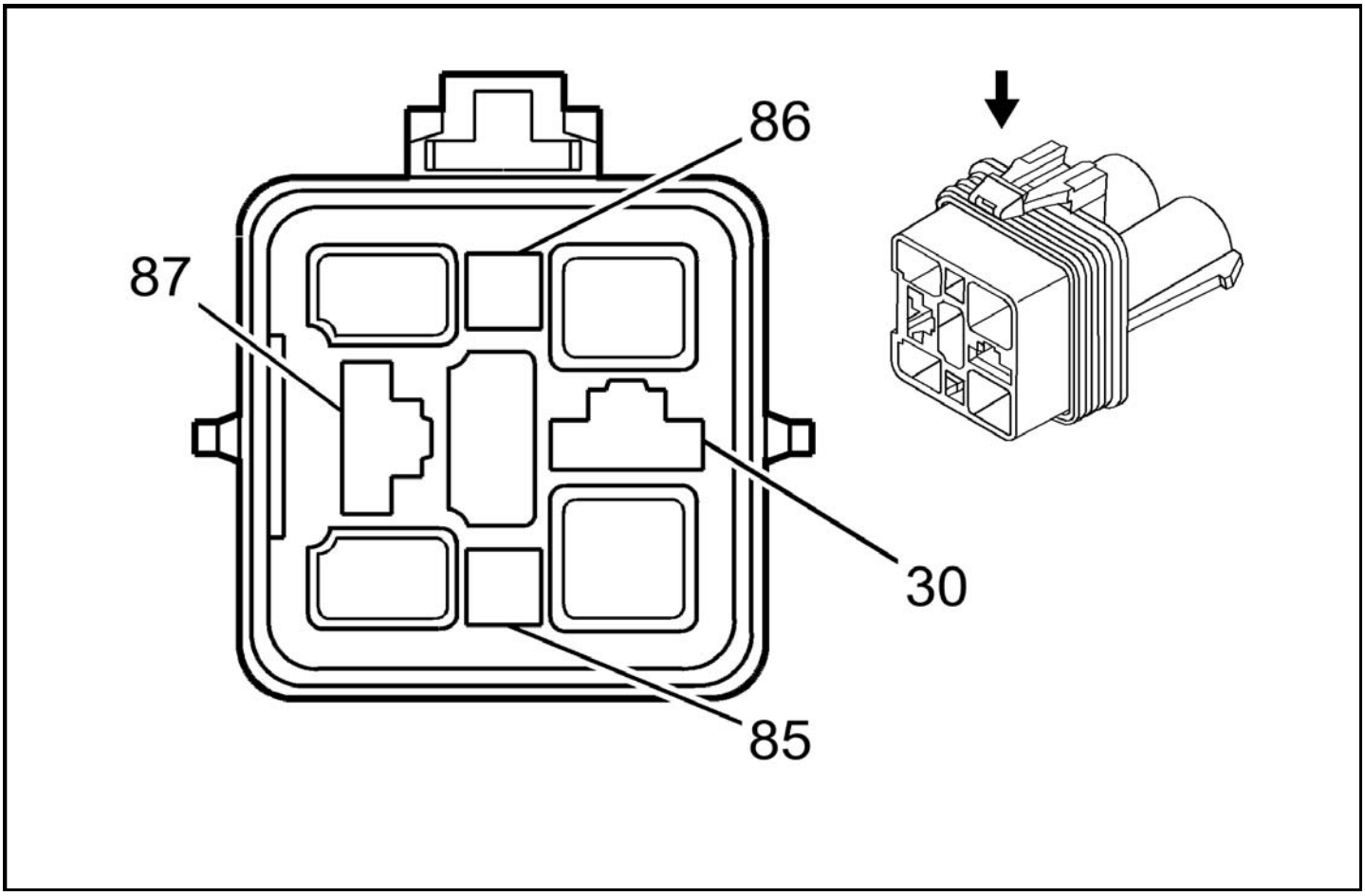
- Terminated Lead: 13575402
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)

- Terminal/Tray: 15392777/23
- Core/Insulation Crimp: B/5

Secondary Air Injection (AIR) Pump (NU5/NU6)

Pin	Wire	Circuit	Function
A	5 OG	78	AIR Pump Supply Voltage
B	5 BK	350	Ground

SECONDARY AIR INJECTION (AIR) PUMP RELAY (NU5/NU6)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15336745
- Service Connector: 15306331
- Description: 4-Way F GR 280 Series, Metri-Pack 800 Series, Sealed (GY)

Terminal Part Information

- Pins: 30, 87
- Terminated Lead: Service by Harness- See Part Catalog

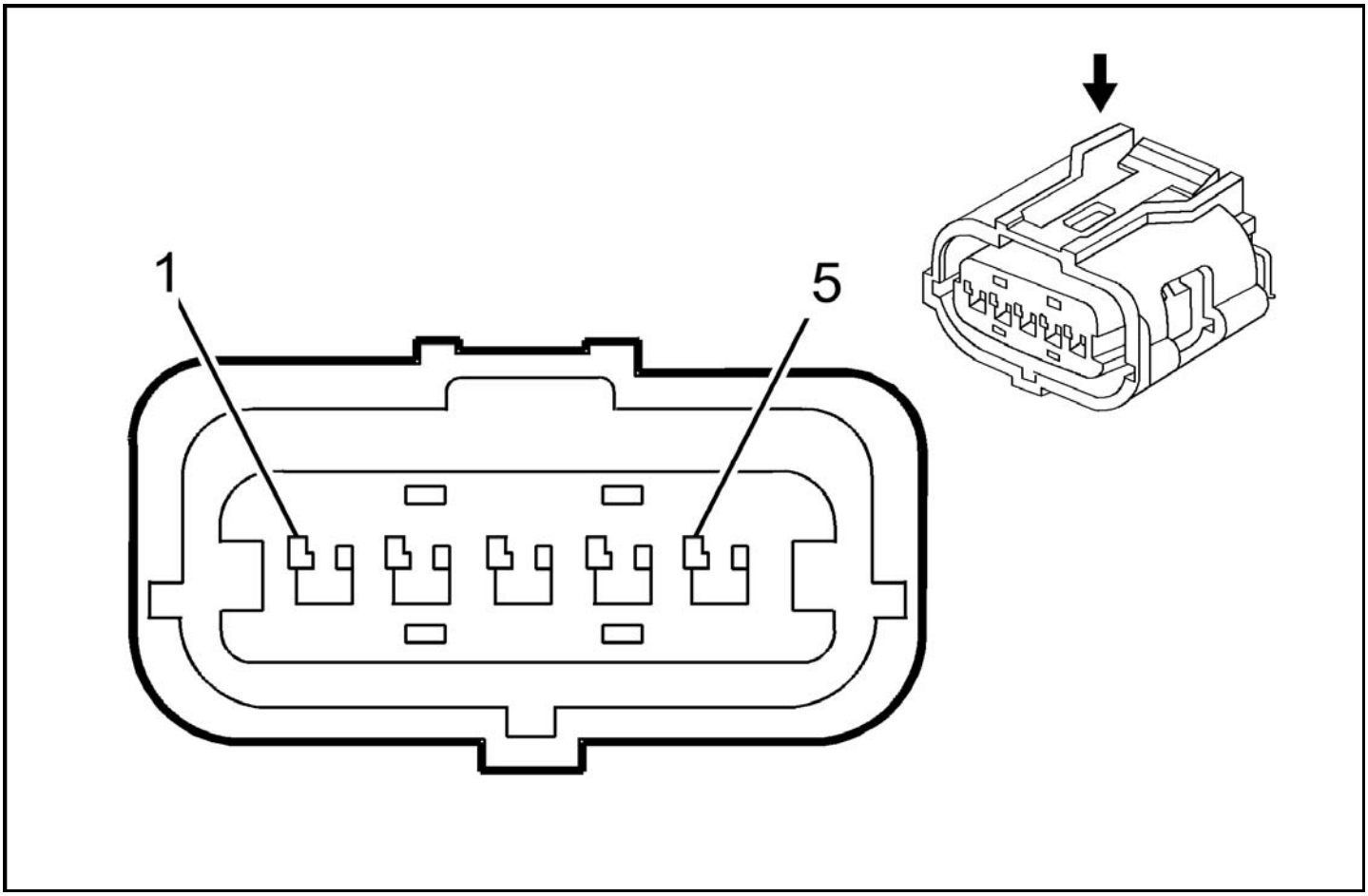
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 15336748/20
- Core/Insulation Crimp: G/F/3

- Pins: 85, 86
- Terminated Lead: 13575406
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304719/19
- Core/Insulation Crimp: E/5

Secondary Air Injection (AIR) Pump Relay (NU5/NU6)

Pin	Wire	Circuit	Function
30	5 RD/BK	742	Battery Positive Voltage
85	0.5 PK/BK	5294	Ignition 1 Voltage
86	0.35 BN	436	AIR Pump Relay Control
87	5 OG	78	AIR Pump Supply Voltage

SECONDARY AIR INJECTION (AIR) PUMP SOLENOID BANK 1 (NU5/NU6)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15443141
- Service Connector: 19151506
- Description: 5-Way F TS Series, Sealed (BK)

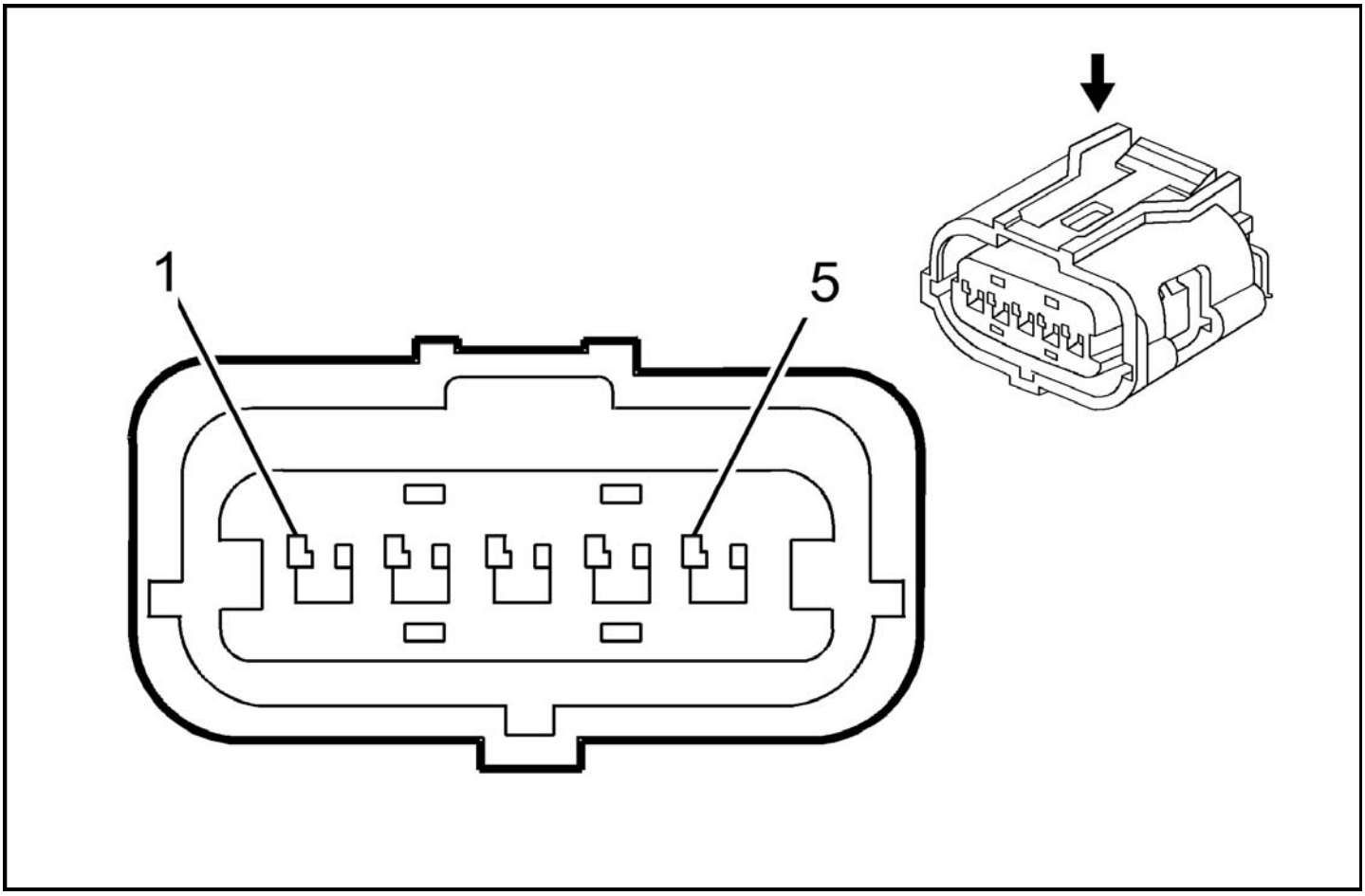
Terminal Part Information

- Terminated Lead: Service by Connector Assembly - 19151506
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp : Not Available

Secondary Air Injection (AIR) Pump Solenoid Bank 1 (NU5/NU6)

Pin	Wire	Circuit	Function
1	0.5 WH	6452	Air Injection Reaction Pump Sensor Supply Voltage
2	0.5 BN/WH	6331	Air Injection Reaction Pump Pressure Sensor Signal
3	0.5 D-BU/WH	6785	Air Injection Reaction Control Valve #1 Low Reference
4	0.5 BK/WH	451	Signal Ground
5	PK/BK	415	Air Injection Reaction Solenoid Supply Voltage

SECONDARY AIR INJECTION (AIR) PUMP SOLENOID BANK 2 (NU5/NU6)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 15443141
- Service Connector: 19151506
- Description:5-Way F TS Series, Sealed (BK)

Terminal Part Information

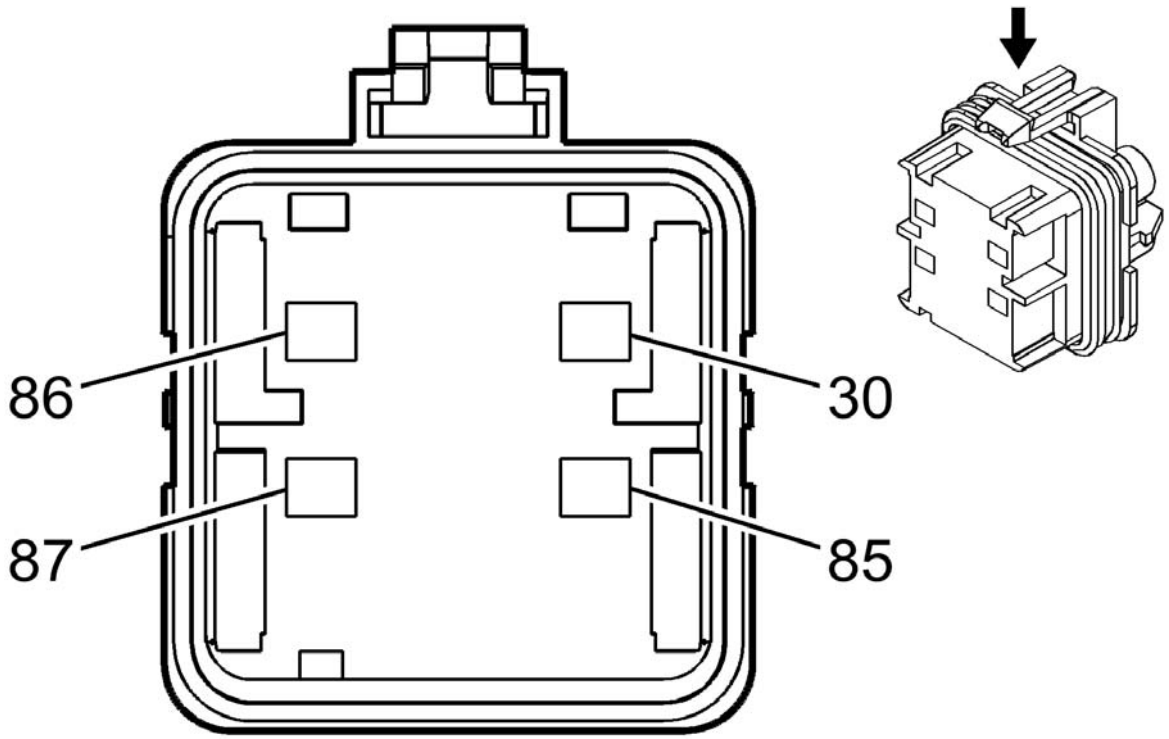
- Terminated Lead: Not Available
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray : Not Available
- Core/Insulation Crimp: Not Available

Secondary Air Injection (AIR) Pump Solenoid Bank 2 (NU5/NU6)

Pin	Wire	Circuit	Function
1	0.5 L-BU	6456	Air Injection Reaction Pump Sensor #2 Supply Voltage
2	0.5 L-BU/BK	6455	Air Injection Reaction Pump Sensor #2 Signal

Pin	Wire	Circuit	Function
3	0.5 BN	6454	Air Injection Reaction Pump Sensor #2 Ground
4	0.5 BK/WH	451	Signal Ground
5	PK/BK	415	Air Injection Reaction Solenoid Supply Voltage

SECONDARY AIR INJECTION (AIR) PUMP SOLENOID RELAY (NU5/NU6)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 12129716
- Service Connector: 13580863
- Description: 4-Way F Metri-Pack 280 Series, Flexlock (GY)

Terminal Part Information

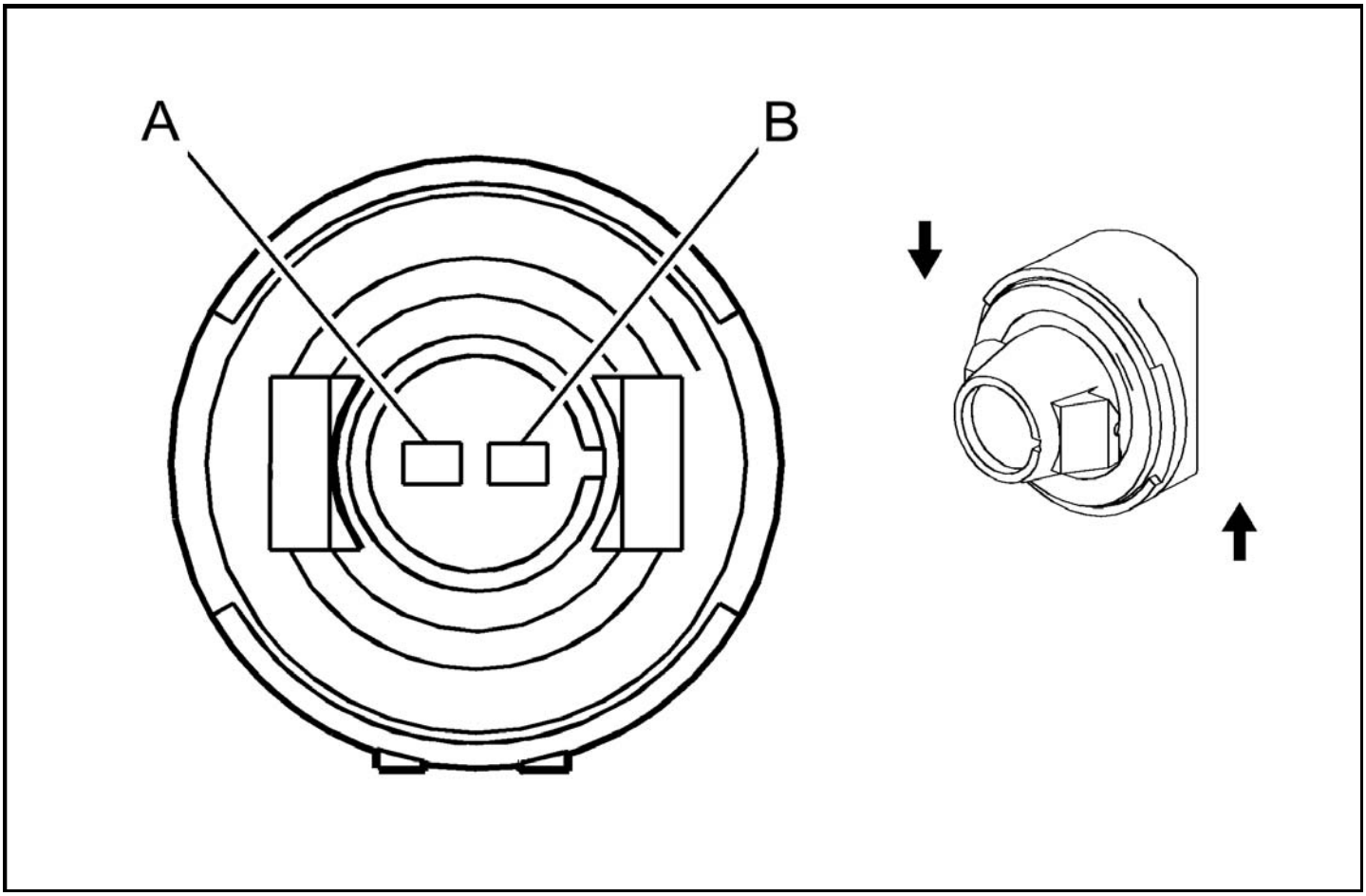
- Terminated Lead: Service by Connector Assembly - 13580863
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110847/4

- Core/Insulation Crimp: E/5

Secondary Air Injection (AIR) Pump Solenoid Relay (NU5/NU6)

Pin	Wire	Circuit	Function
30	0.5 RD/WH	2140	Battery Positive Voltage
85	0.35 PK/BK	429	AIR Solenoid Control
86	0.5 PK/BK	5294	Ignition 1 Voltage
87	0.5 PU	421	AIR Solenoid Supply Voltage

SIDE MARKER LAMP - LEFT FRONT



Connector Part Information

- Harness Type: Left Front Headlamp Assembly
- OEM Connector: 16530674
- Service Connector: Service by Harness - See Part Catalog
- Description: 2-Way F Socket (GY)

Terminal Part Information

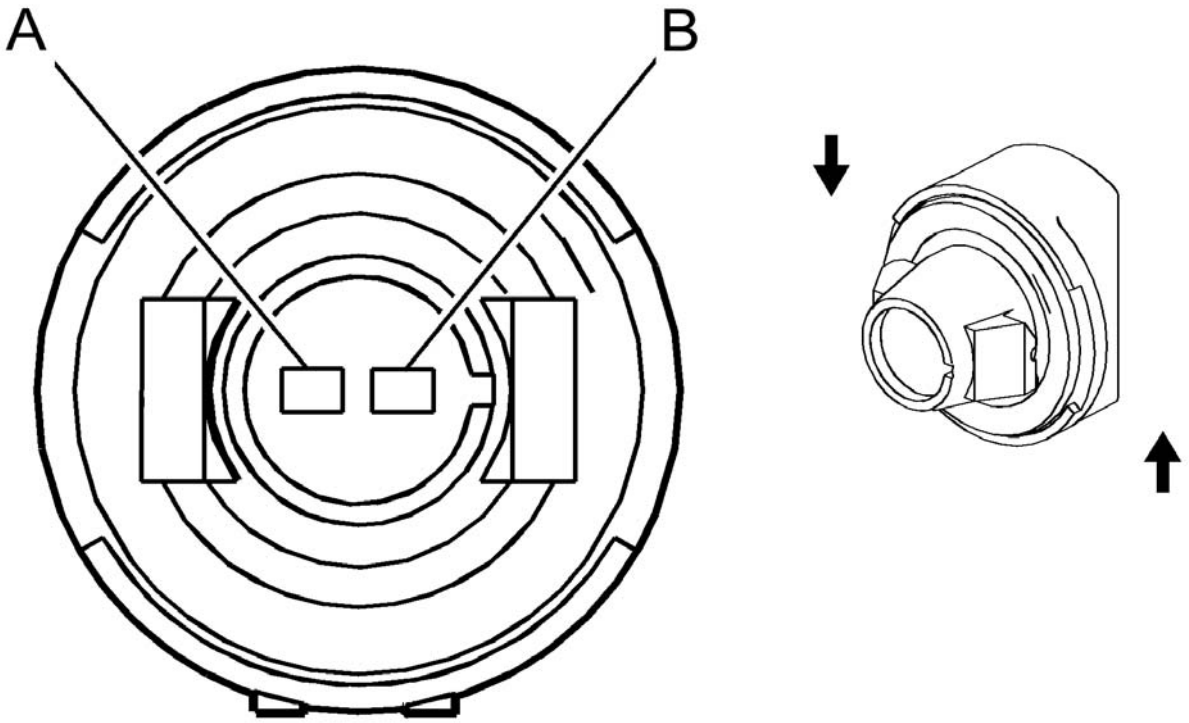
- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: Not Available

- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Side Marker Lamp - Left Front

Pin	Wire	Circuit	Function
A	0.8 RD	709	Left Park Lamp Supply Voltage
	0.8 RD	709	Left Park Lamp Supply Voltage
B	0.8 BK	1350	Ground

SIDE MARKER LAMP - RIGHT FRONT



Connector Part Information

- Harness Type: Right Front Headlamp Assembly
- OEM Connector: 16530674
- Service Connector: Service by Harness - See Part Catalog
- Description: 2-Way F Socket (GY)

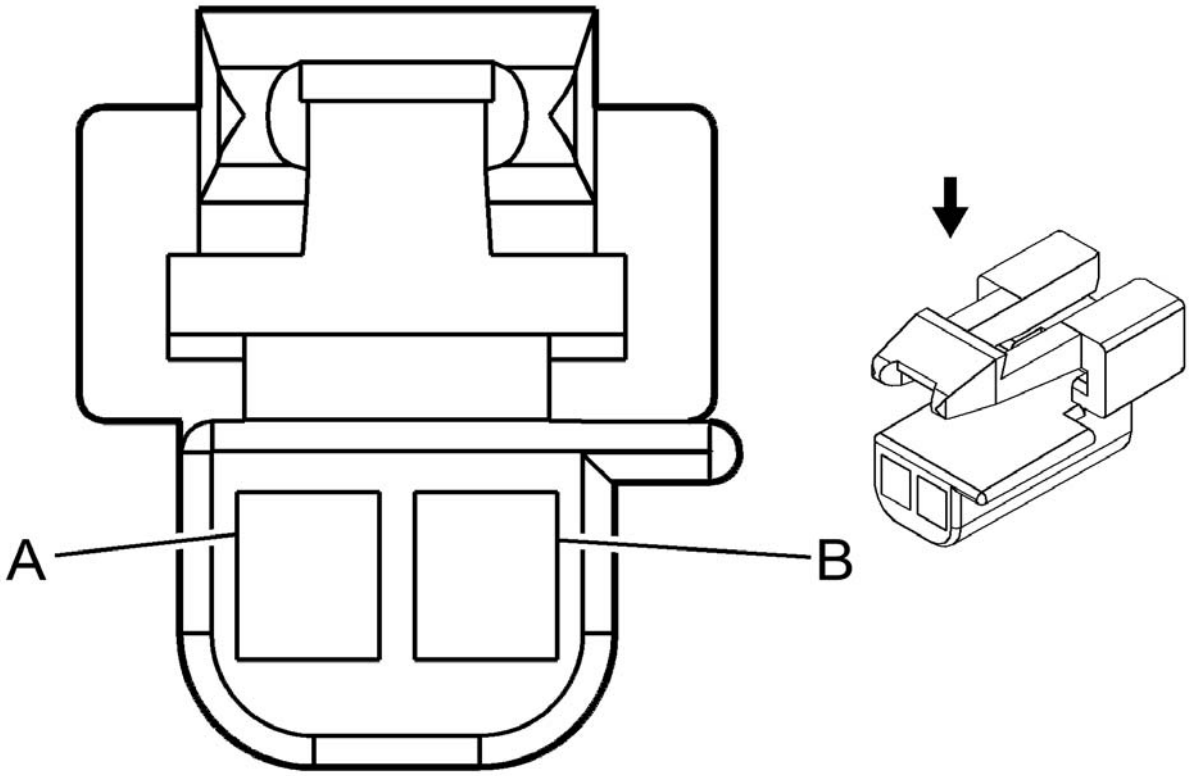
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Side Marker Lamp - Right Front

Pin	Wire	Circuit	Function
A	0.8 RD	309	Right Park Lamp Supply Voltage
	0.8 RD	309	Right Park Lamp Supply Voltage
B	0.8 BK	1250	Ground

SPEAKER - LEFT FRONT



Connector Part Information

- Harness Type: Left Front Door
- OEM Connector: 12064867
- Service Connector: 88987981
- Description: 2-Way F Metri-Pack 150 Series (NA)

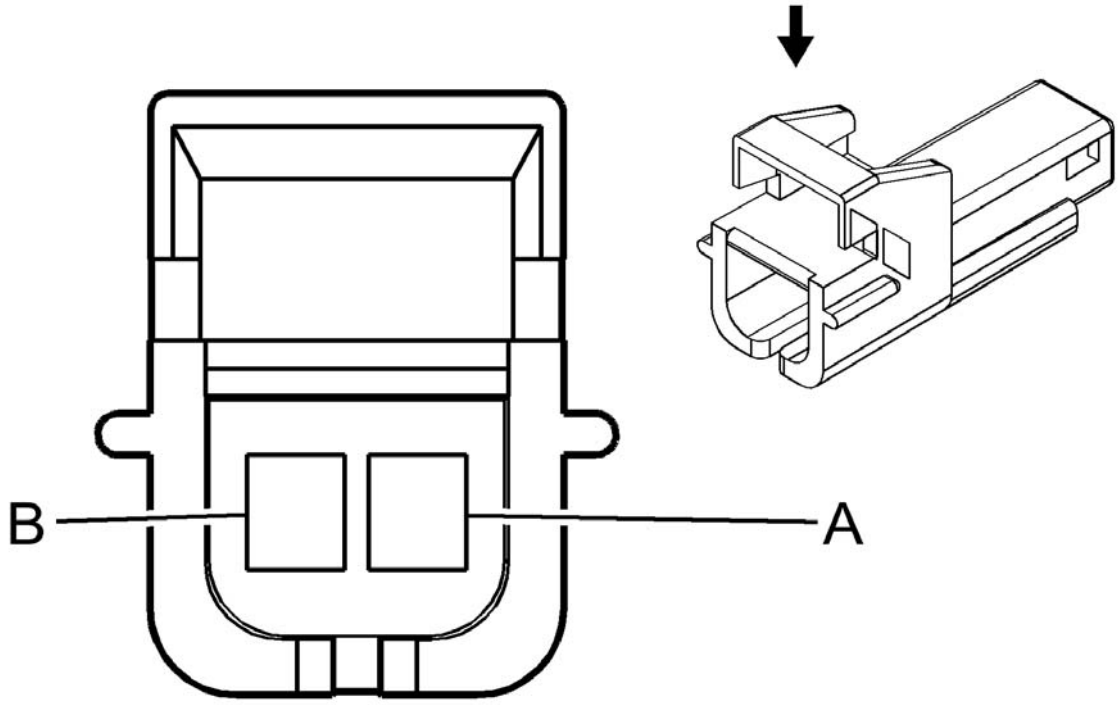
Terminal Part Information

- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Speaker - Left Front

Pin	Wire	Circuit	Function
A	0.5 GY	118	Left Front Speaker Output (-)
B	0.5TN	201	Left Front Speaker Output (+)

SPEAKER - LEFT FRONT TWEETER



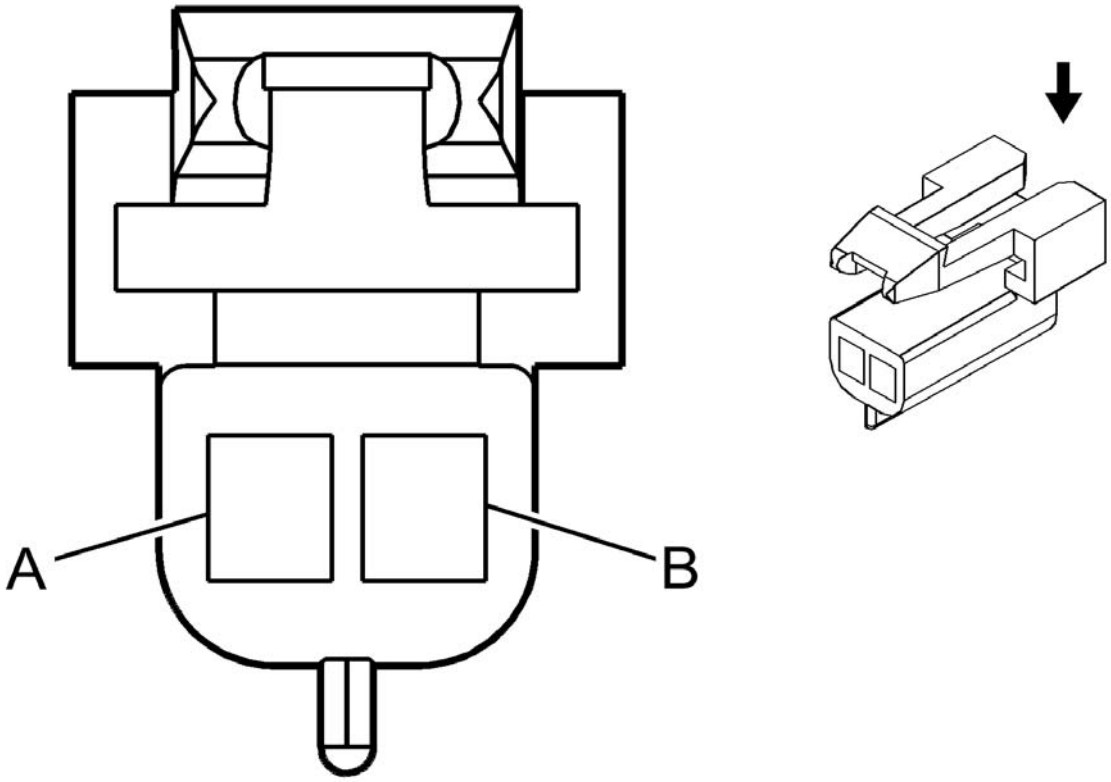
Connector Part Information

- Harness Type: Body
- OEM Connector: 15393225
- Service Connector: 12117275
- Description: 2-Way F (BK)

Speaker - Left Front Tweeter

Pin	Wire	Circuit	Function
A	0.8 GY	118	Left Front Speaker Output (-) (UW6)
	0.8 YE	1956	Left Front Speaker Output (-) (UQ3)
B	0.8 TN	201	Left Front Speaker Output (+) (UW6)
	0.8 TN	1856	Left Front Speaker Output (+) (UQ3)

SPEAKER - LEFT REAR (UW6)



Connector Part Information

- Harness Type: Body
- OEM Connector: 12052832
- Service Connector: 13583033
- Description: 2-Way F Metri-Pack 150 Series (BK)

Terminal Part Information

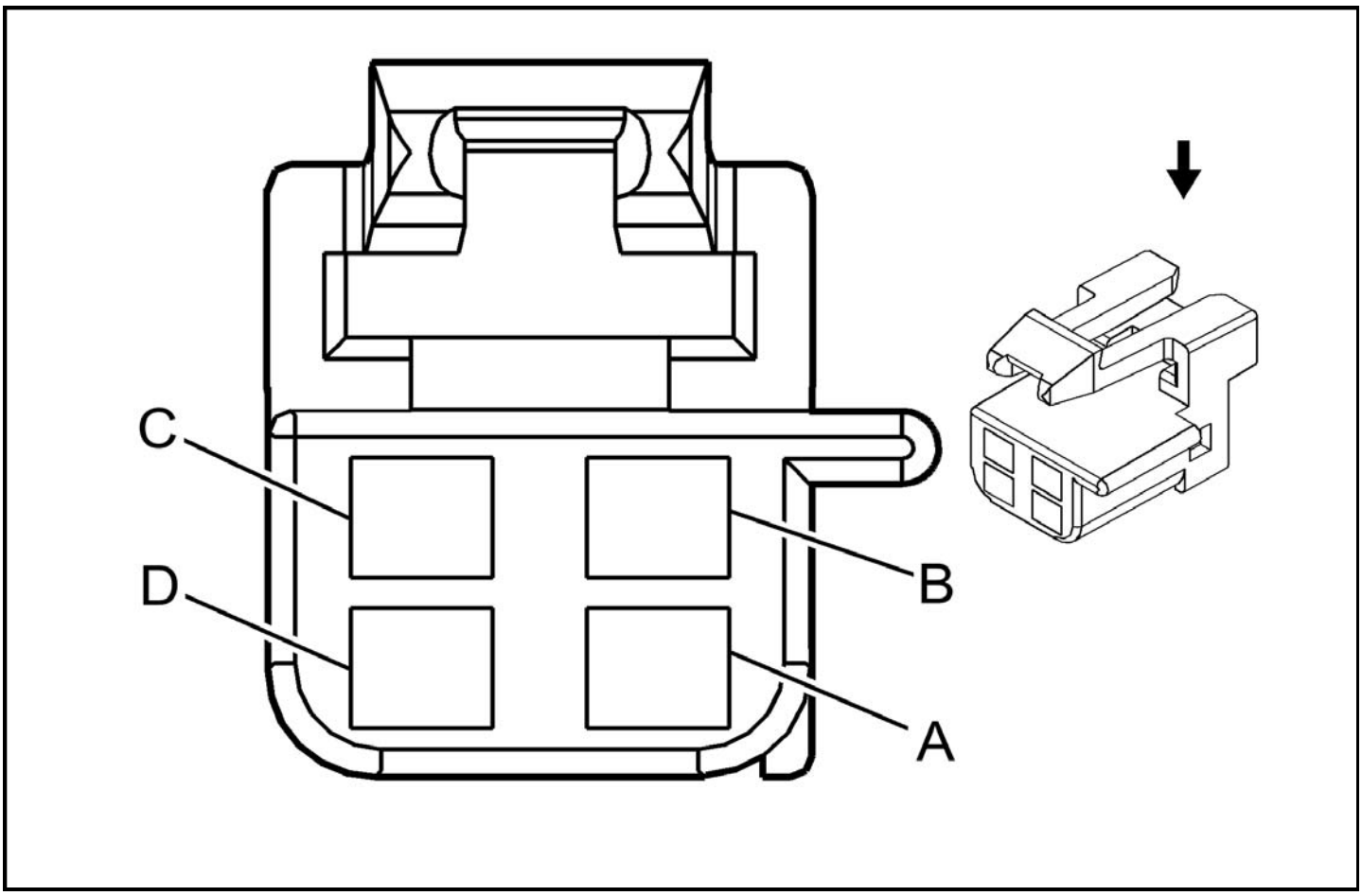
- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/2

- Core/Insulation Crimp: E/A

Speaker - Left Rear (UW6)

Pin	Wire	Circuit	Function
A	0.8 YE	116	Left Rear Speaker Output (-)
B	0.8 BN	199	Left Rear Speaker Output (+)

SPEAKER - LEFT REAR (UQ3)



Connector Part Information

- Harness Type: Body
- OEM Connector: 12064760
- Service Connector: 13584477
- Description: 4-Way F Metri-Pack 150 Series (BK)

Terminal Part Information

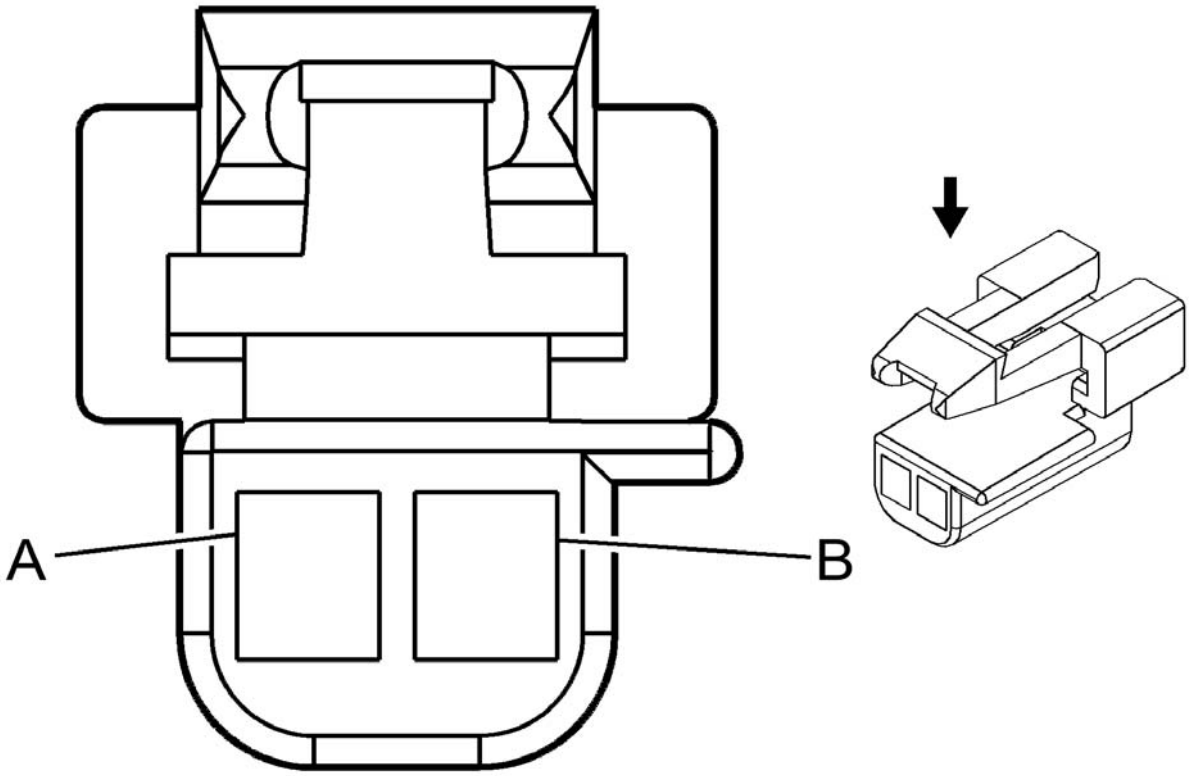
- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)

- Terminal/Tray: 15326030/2
- Core/Insulation Crimp: E/A

Speaker - Left Rear (UQ3)

Pin	Wire	Circuit	Function
A	0.8 YE	116	Left Rear Speaker Output (-)
B	0.8 BN	199	Left Rear Speaker Output (+)
C	0.8 D-BU/WH	346	Left Subwoofer Speaker Output (+)
D	0.8 L-GN/BK	1794	Left Subwoofer Speaker Output (-)

SPEAKER - RIGHT FRONT



Connector Part Information

- Harness Type: Right Front Door
- OEM Connector: 12064867
- Service Connector: 88987981
- Description: 2-Way F Metri-Pack 150 Series (NA)

Terminal Part Information

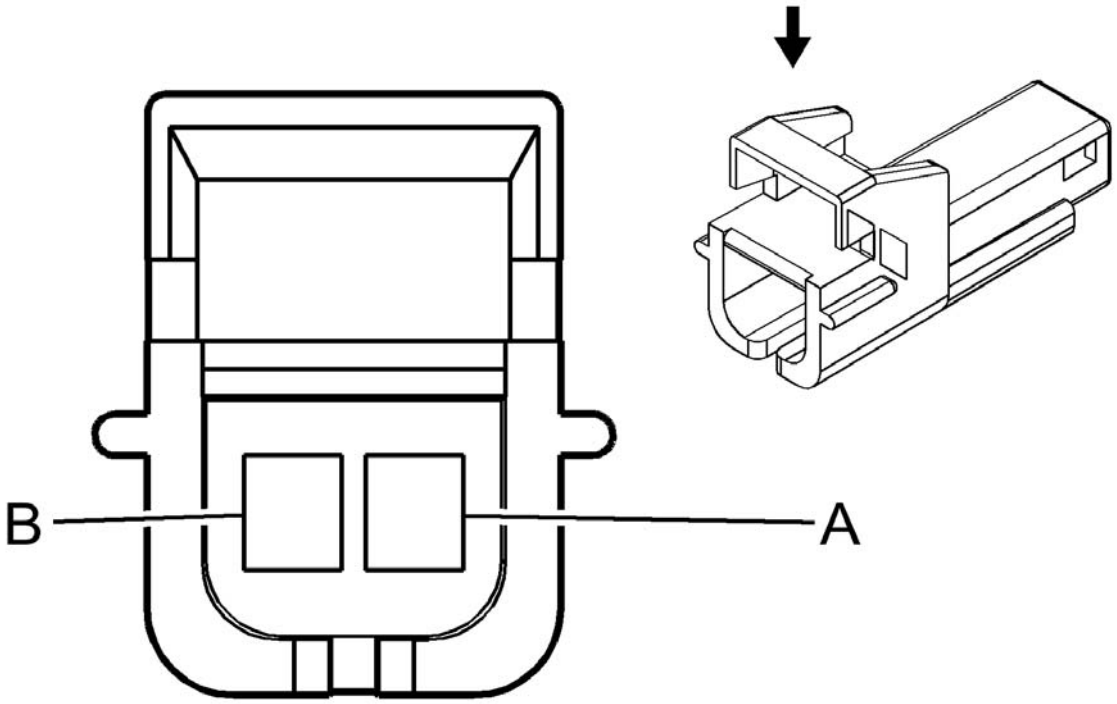
- Terminated Lead: 13575464

- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Speaker - Right Front

Pin	Wire	Circuit	Function
A	0.5 D-GN	117	Right Front Speaker Output (-)
B	0.5 L-GN	200	Right Front Speaker Output (+)

SPEAKER - RIGHT FRONT TWEETER



Connector Part Information

- Harness Type: Body
- OEM Connector: 15393225
- Service Connector: 12117275
- Description: 2-Way F (BK)

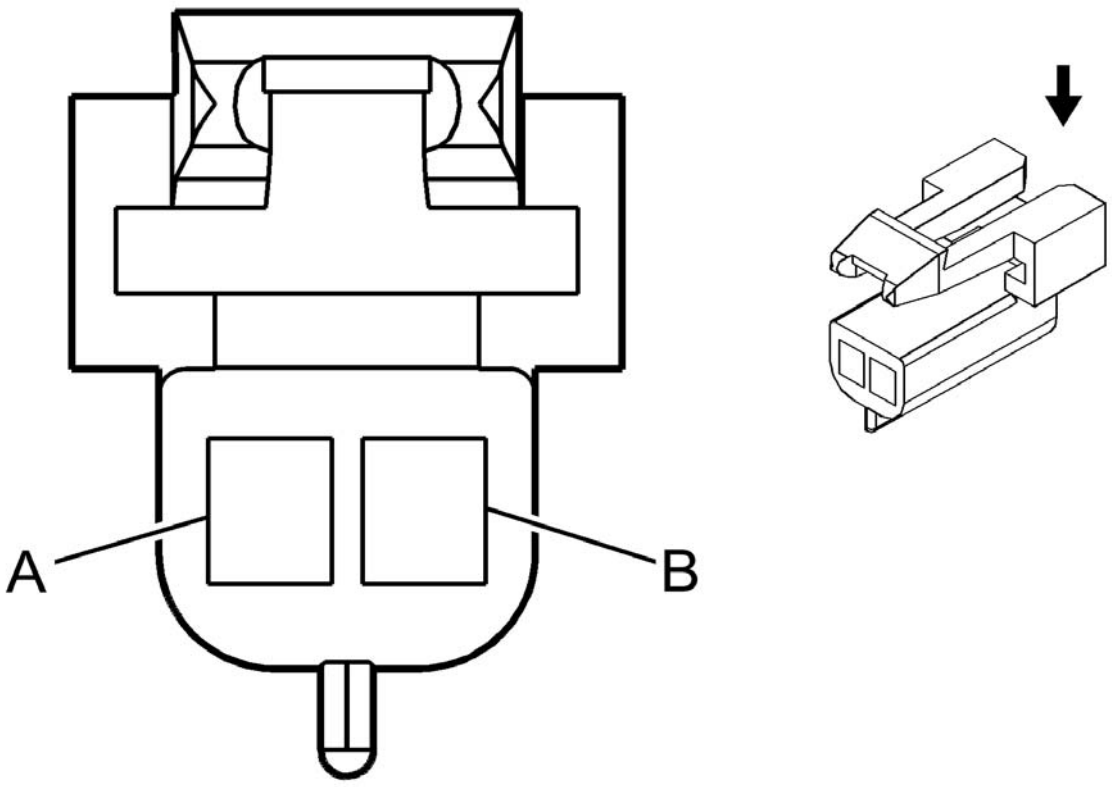
Terminal Part Information

- Terminated Lead: 13505668
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/A

Speaker - Right Front Tweeter

Pin	Wire	Circuit	Function
A	0.8 D-GN	117	Right Front Speaker Output (-) (UW6)
	0.8 PU	1952	Right Front Speaker Output (-) (UQ3)
B	0.8 L-GN	200	Right Front Speaker Output (+) (UW6)
	0.8 L-GN	1852	Right Front Speaker Output (+) (UQ3)

SPEAKER - RIGHT REAR (UW6)



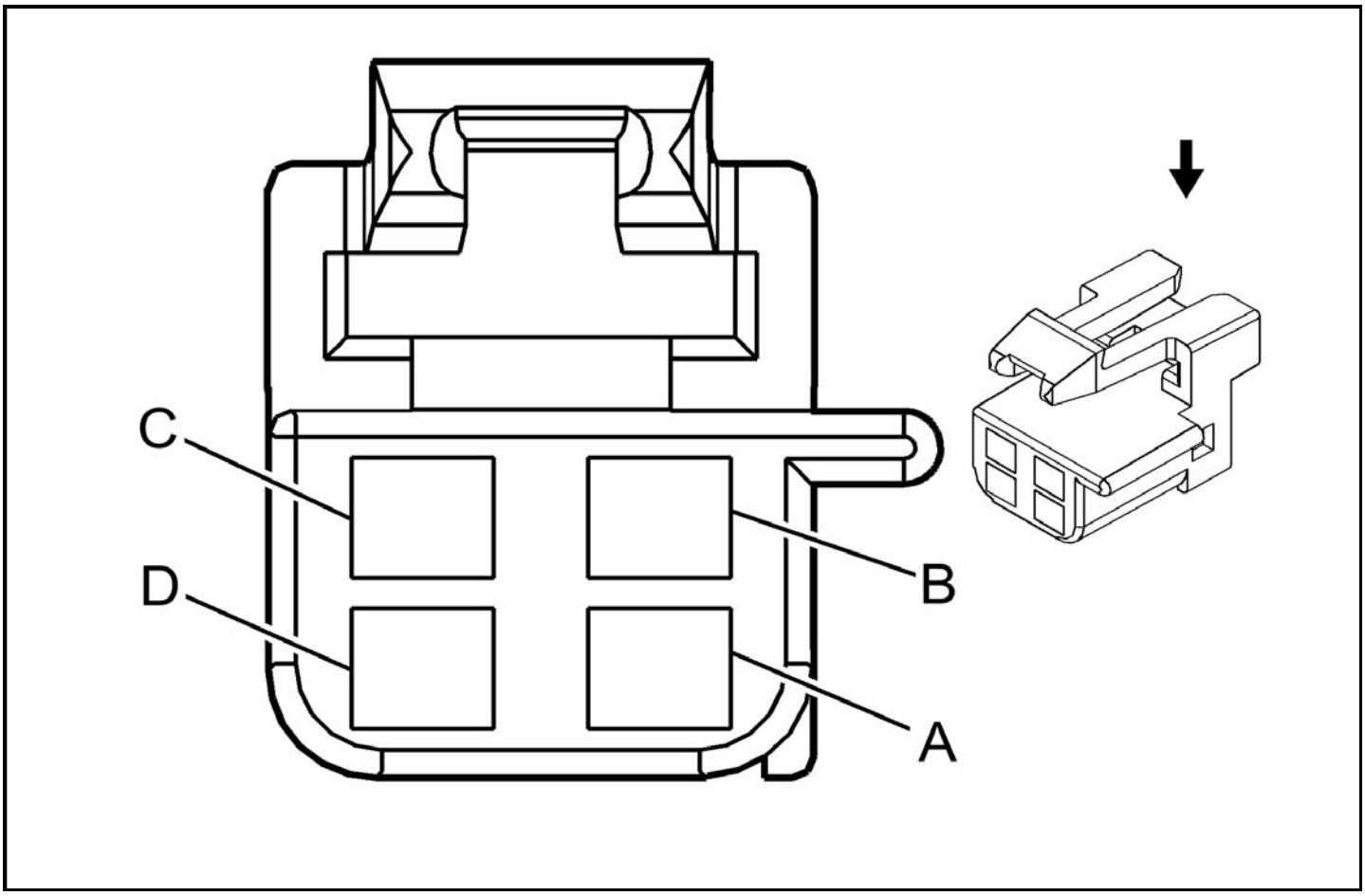
Connector Part Information

- Harness Type: Body
- OEM Connector: 12052832
- Service Connector: 13583033
- Description: 2-Way F Metri-Pack 150 Series (BK)

Speaker - Right Rear (UW6)

Pin	Wire	Circuit	Function
A	0.8 L-BU	115	Right Rear Speaker Output (-)
B	0.8 D-BU	46	Right Rear Speaker Output (+)

SPEAKER - RIGHT REAR (UQ3)



Connector Part Information

- Harness Type: Body
- OEM Connector: 12064760
- Service Connector: 13584477
- Description: 4-Way F Metri-Pack 150 Series (BK)

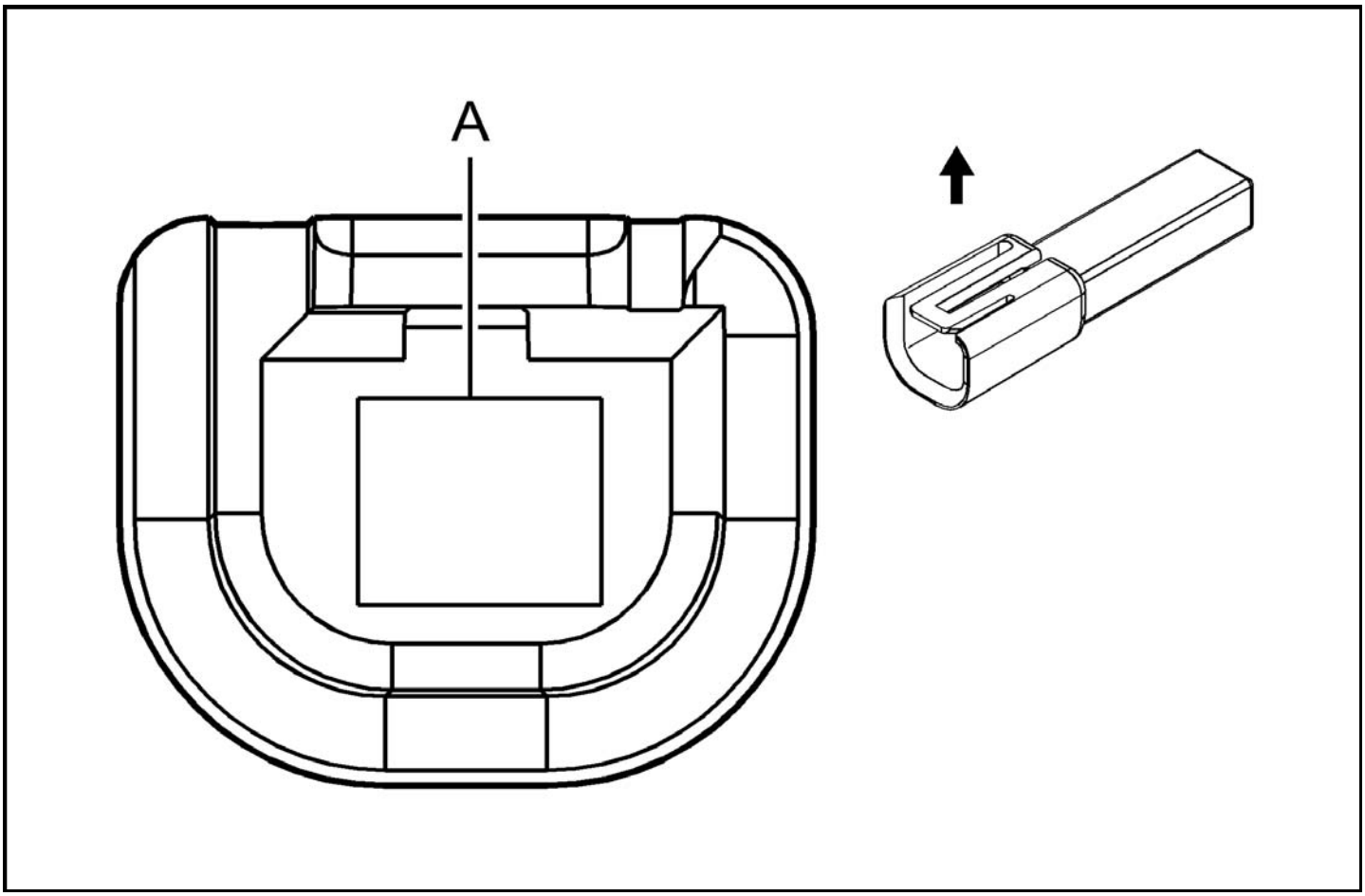
Terminal Part Information

- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/2
- Core/Insulation Crimp: E/A

Speaker - Right Rear (UQ3)

Pin	Wire	Circuit	Function
A	0.8 L-BU	115	Right Rear Speaker Output (-)
B	0.8 D-BU	46	Right Rear Speaker Output (+)
C	0.8 D-GN	1795	Right Subwoofer Speaker Output (+)
D	0.8 L-BU/BK	315	Right Subwoofer Speaker Output (-)

SPOT LAMP - LEFT (7X6, 7X7)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12047683
- Service Connector: 12101828
- Description: 1-Way M Metri-Pack 150 Series (BK)

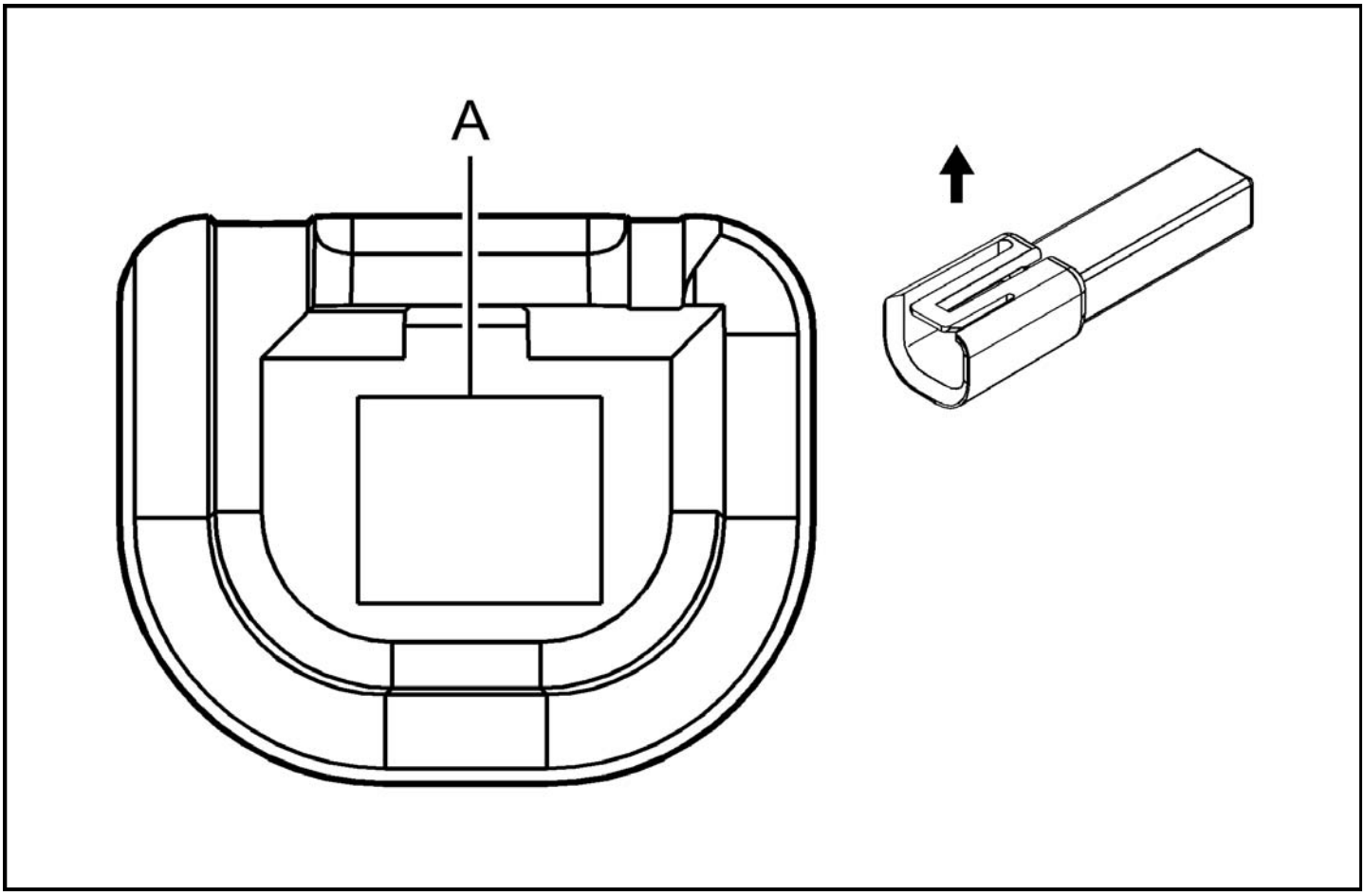
Terminal Part Information

- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-3 (GY)

Spot Lamp - Left (7X6, 7X7)

Pin	Wire	Circuit	Function
A	0.5 RD/WH	2640	Battery Positive Voltage

SPOT LAMP - RIGHT (7X7)



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12047683
- Service Connector: 12101828
- Description: 1-Way M Metri-Pack 150 Series (BK)

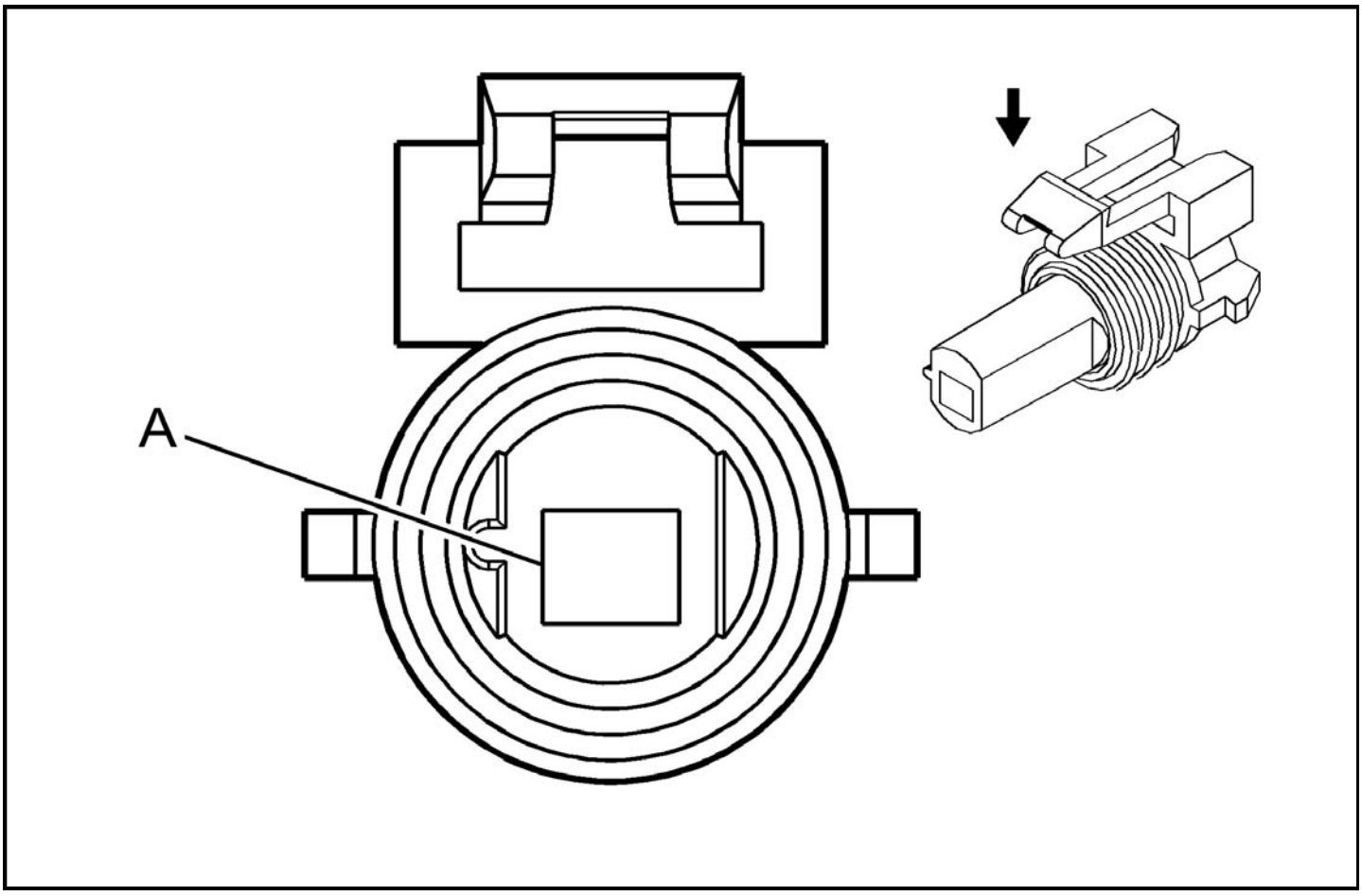
Terminal Part Information

- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094429/J-35616-3 (GY)

Spot Lamp - Right (7X7)

Pin	Wire	Circuit	Function
A	0.5 RD/WH	2740	Battery Positive Voltage

STARTER X2



Connector Part Information

- Harness Type: Engine
- OEM Connector: 12089916
- Service Connector: 13584479
- Description: 1-Way F Metri-Pack 280 Series, Sealed (BK)

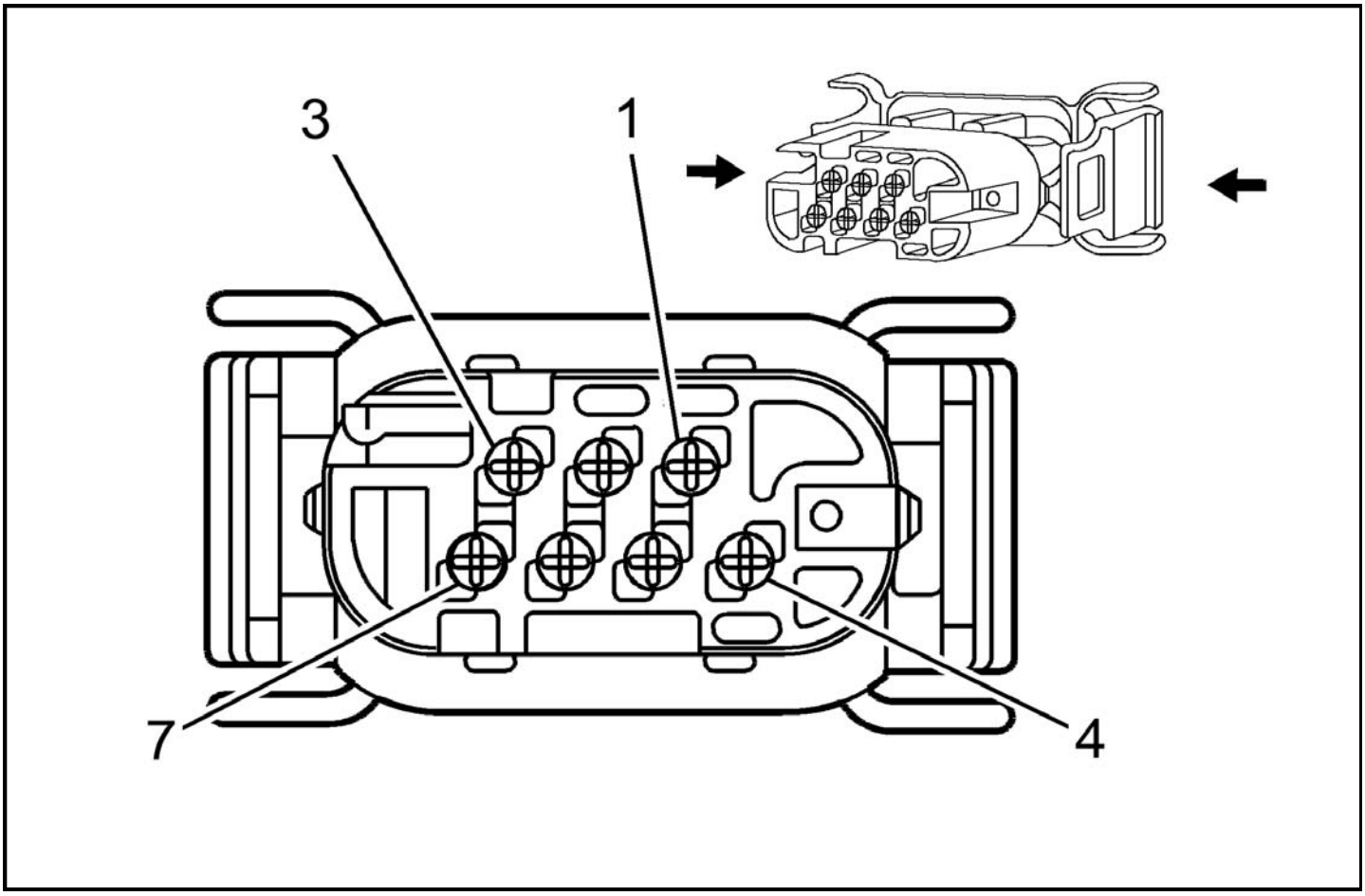
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12077413/4
- Core/Insulation Crimp: F/5

Starter X2

Pin	Wire	Circuit	Function
A	3 PU	6	Starter Solenoid Crank Voltage

STEERING ANGLE SENSOR



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15324351
- Service Connector: 88987967
- Description: 7-Way F 0.6 Series (BK)

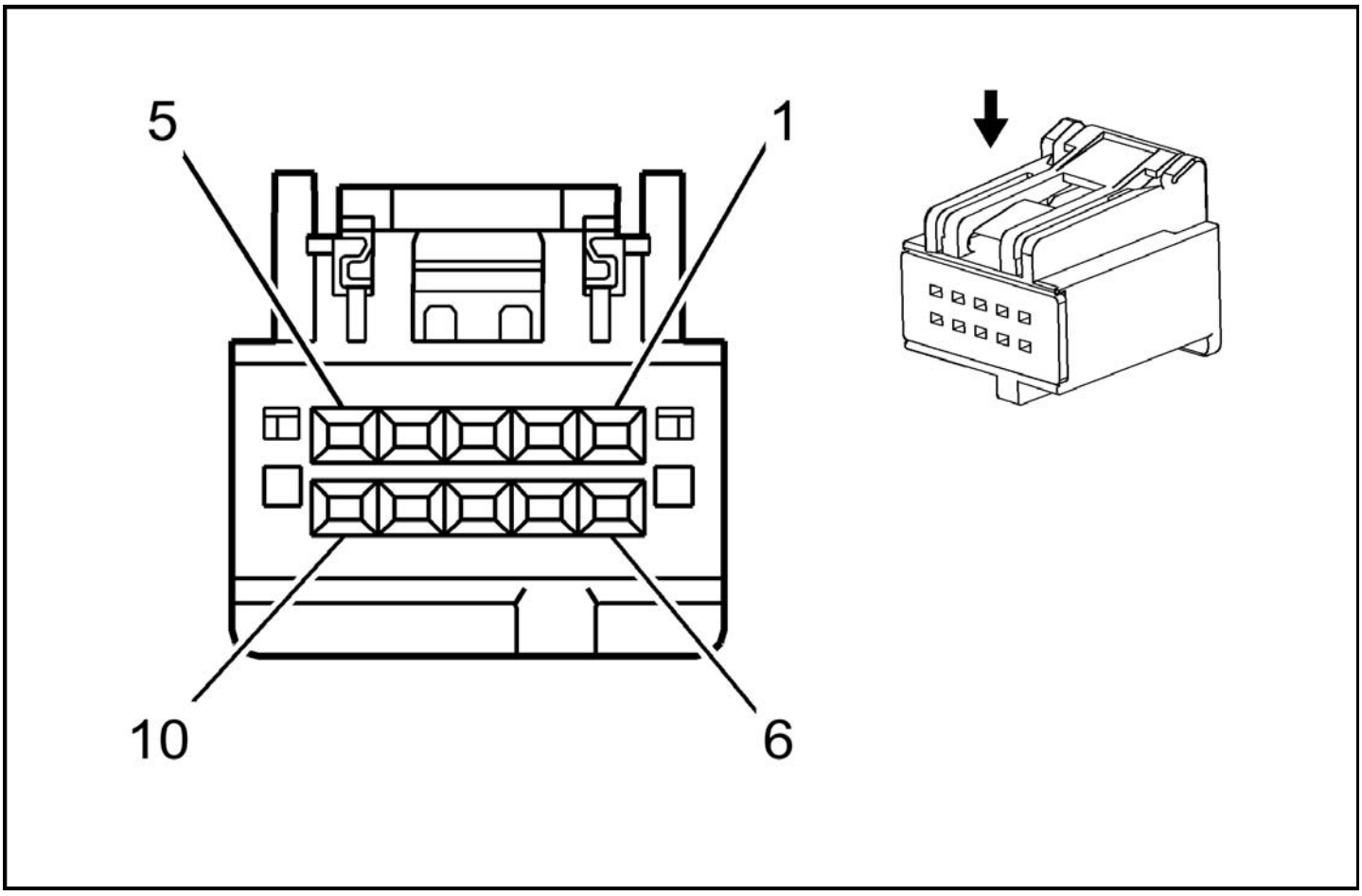
Terminal Part Information

- Terminal/Tray: 1928498014/17
- Core/Insulation Crimp: N/N
- Release Tool/Test Probe: J-38125-560/J-35616-64B (L-BU)

Steering Angle Sensor

Pin	Wire	Circuit	Function
1	0.35 BK/WH	1551	Ground
2	0.35 WH	1056	Steering Wheel Position Sensor 12V Reference Voltage
3	0.35 TN	6433	CAN Bus High Serial Data
4	0.35 L-GN	6432	CAN Bus Low Serial Data
5-7	-	-	Not Used

STEERING WHEEL CONTROL SWITCH - LEFT



Connector Part Information

- Harness Type: Steering Wheel
- OEM Connector: 30700-1100
- Service Connector: Service by Harness - See Part Catalog
- Description: 10-Way F H-DAC 64 Series (GY)

Terminal Part Information

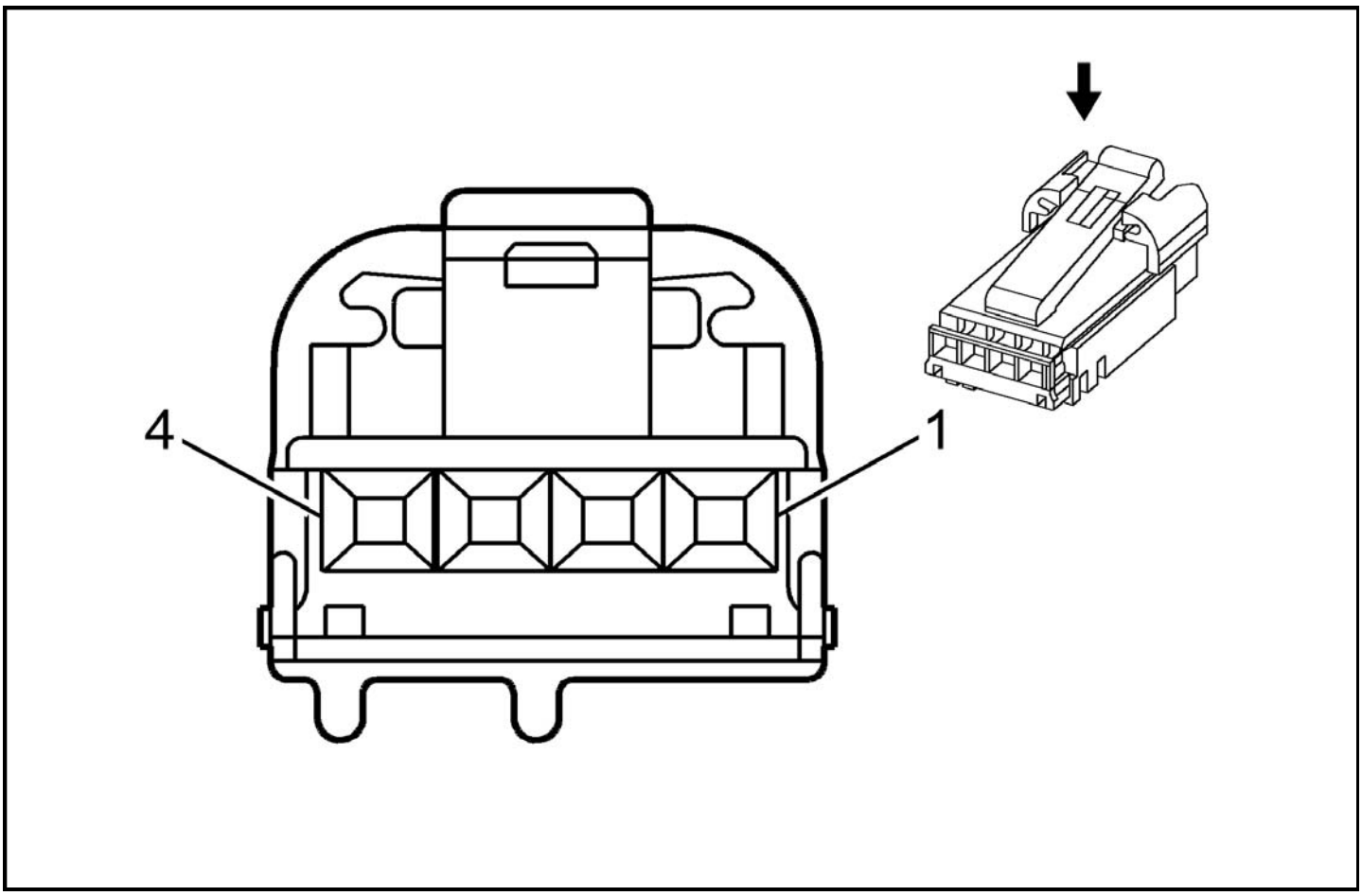
- Terminated Lead: Service by Harness - See Part Catalog
- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Steering Wheel Control Switch - Left

Pin	Wire	Circuit	Function
1	0.35 PU	1375	Steering Wheel Control Supply Voltage

Pin	Wire	Circuit	Function
2	-	-	Not Used
3	0.35 GY	1884	Cruise Control Switch Signal
4-5	-	-	Not Used
6	0.35 PU/WH	7005	LED Dimming Supply
7	-	-	Not Used
8	0.35 BK	1450	Ground
9	0.35 D-GN/WH	7158	Cruise Control Indicator Dimming Signal
10	-	-	Not Used

STEERING WHEEL CONTROL SWITCH - RIGHT (UK3)



Connector Part Information

- Harness Type: Steering Wheel
- OEM Connector: 31068-1010
- Service Connector: 19153195
- Description: 4-Way F H-DAC 64 Series (BK)

Terminal Part Information

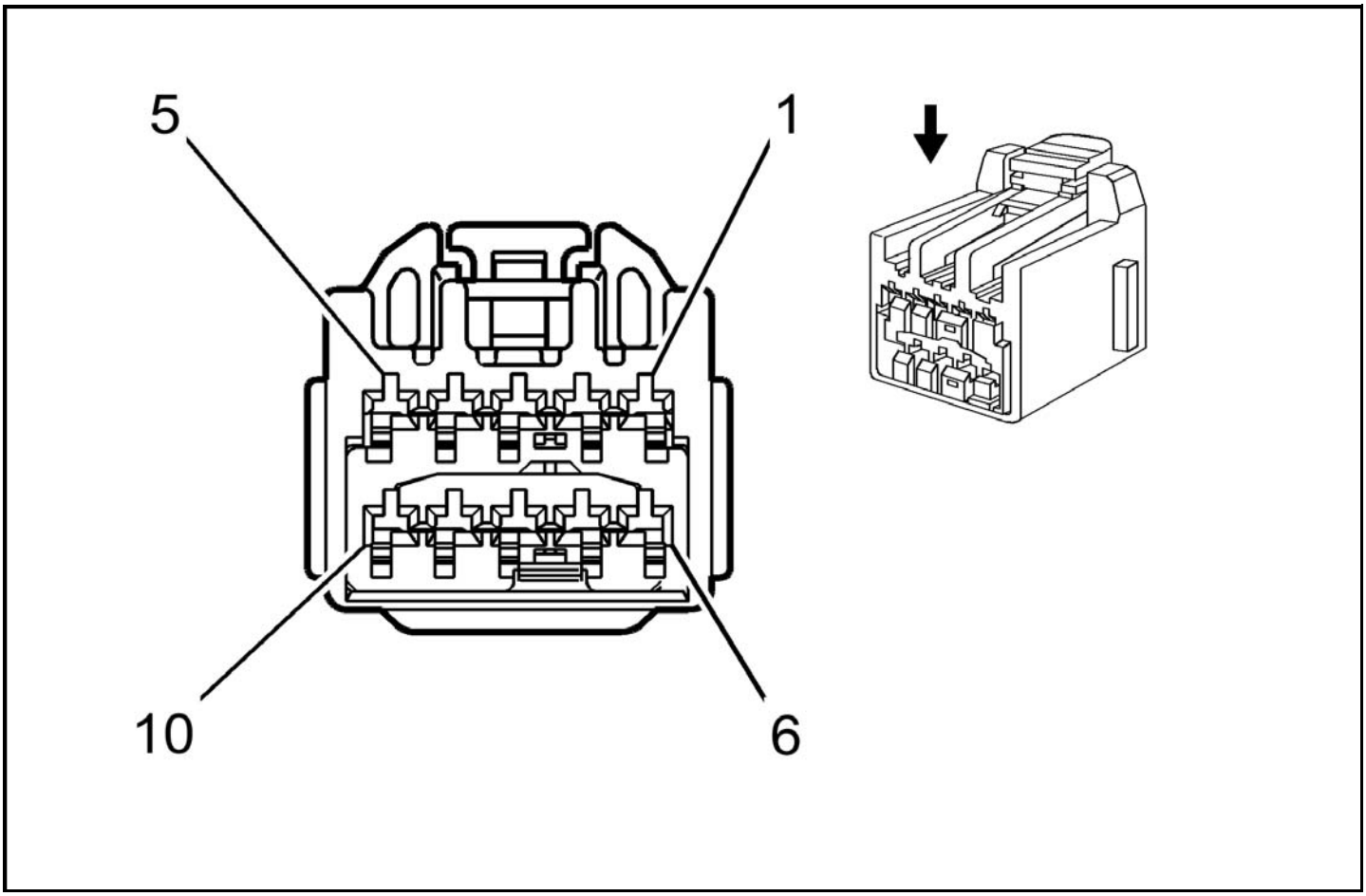
- Terminated Lead: Service by Harness- See Part Catalog

- Release Tool: Not Available
- Diagnostic Test Probe: Not Available
- Terminal/Tray: Not Available
- Core/Insulation Crimp: Not Available

Steering Wheel Control Switch - Right (UK3)

Pin	Wire	Circuit	Function
1	0.35 BK	1450	Ground
2	0.35 PU/WH	7005	LED Dimming Supply
3	0.35 PU	1375	Steering Wheel Control Supply Voltage
4	0.35 D-BU	1796	Steering Wheel Controls Signal

SUNROOF CONTROL MODULE (CF5)



Connector Part Information

- Harness Type: Sunroof
- OEM Connector: 7283-5909-40
- Service Connector: Service by Harness - See Part Catalog
- Description: 10-Way F 1.5 Series (L-GY)

Terminal Part Information

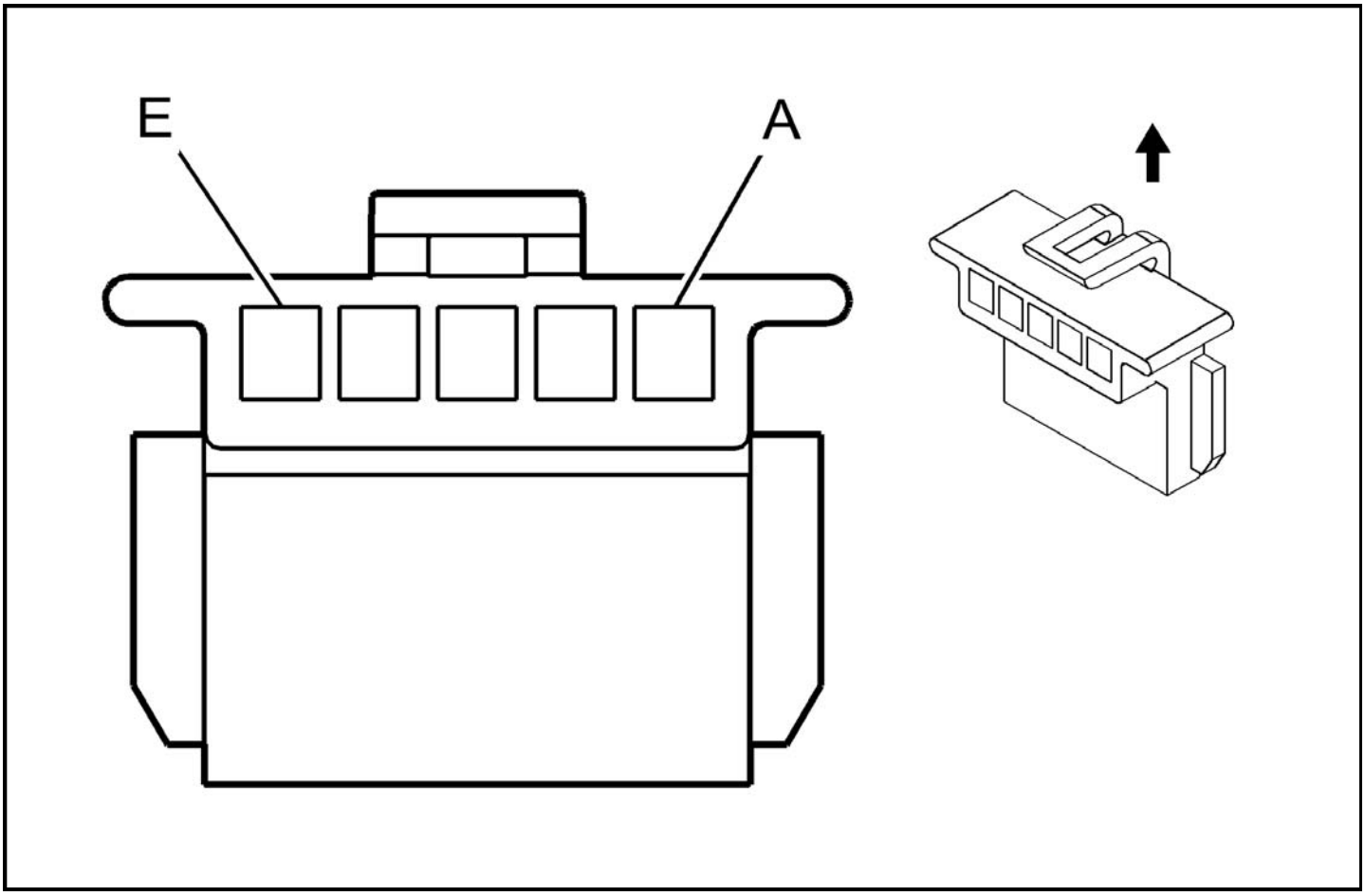
- Pins: 1, 6
- Terminal/Tray: 7116-4101-08/9
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

- Pins: 2, 3, 5, 10
- Terminal/Tray: 7116-4100-08/9
- Core/Insulation Crimp: E/C
- Release Tool/Test Probe: 12094430/J-35616-2A (GY)

Sunroof Control Module (CF5)

Pin	Wire	Circuit	Function
1	1 BK	550	Ground
2	0.5 D-BU	128	Sunroof Switch Low Reference
3	0.5 YE	643	Accessory Voltage
4	-	-	Not Used
5	0.5 BN	100	Sunroof Switch Open Signal
6	1 RD/WH	3440	Battery Positive Voltage
7-9	-	-	Not Used
10	0.5 OG	110	Sunroof Switch Close Signal

SUNROOF SWITCH (CF5)



Connector Part Information

- Harness Type: Headliner
- OEM Connector: 12124997
- Service Connector: 12167130
- Description: 5-Way F Metri-Pack 150 Series (BK)

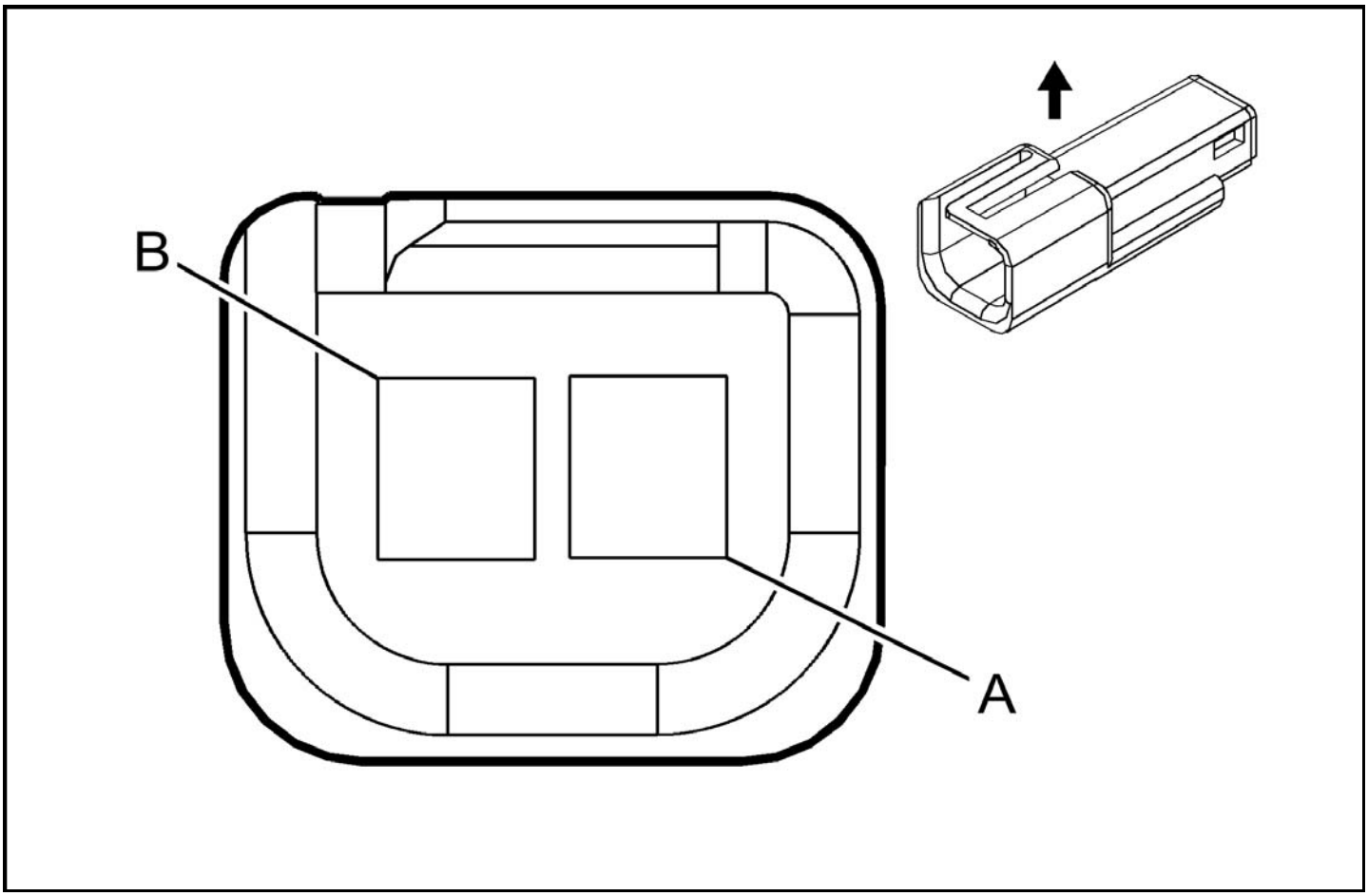
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 12103359/18
- Core/Insulation Crimp: E/C

Sunroof Switch (CF5)

Pin	Wire	Circuit	Function
A-B	-	-	Not Used
C	0.35 D-BU	128	Sunroof Switch Low Reference
D	0.35 BN	100	Sunroof Switch Open Signal
E	0.35 OG	110	Sunroof Switch Close Signal

SUNSHADE - LEFT (DH6)



Connector Part Information

- Harness Type: Headliner
- OEM Connector: 12047663
- Service Connector: 13584278
- Description: 2-Way M Metri-Pack 150 Series (BK)

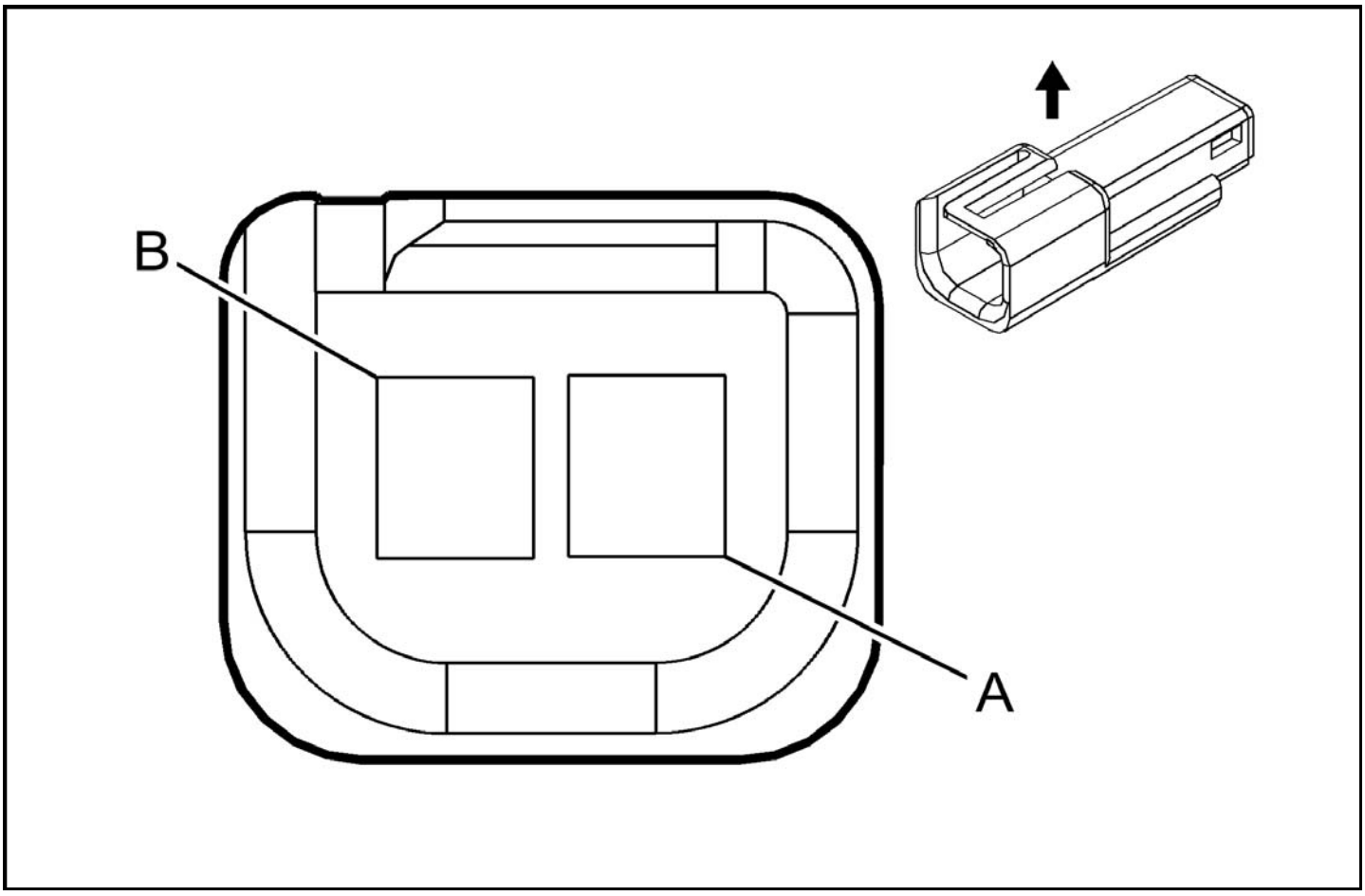
Terminal Part Information

- Terminated Lead: 13575462
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/C

Sunshade - Left (DH6)

Pin	Wire	Circuit	Function
A	0.5 OG	1732	Inadvertent Power Courtesy Lamp
B	0.5 BK	550	Ground

SUNSHADE - RIGHT (DH6)



Connector Part Information

- Harness Type: Headliner
- OEM Connector: 12047663
- Service Connector: 13584278
- Description: 2-Way M Metri-Pack 150 Series (BK)

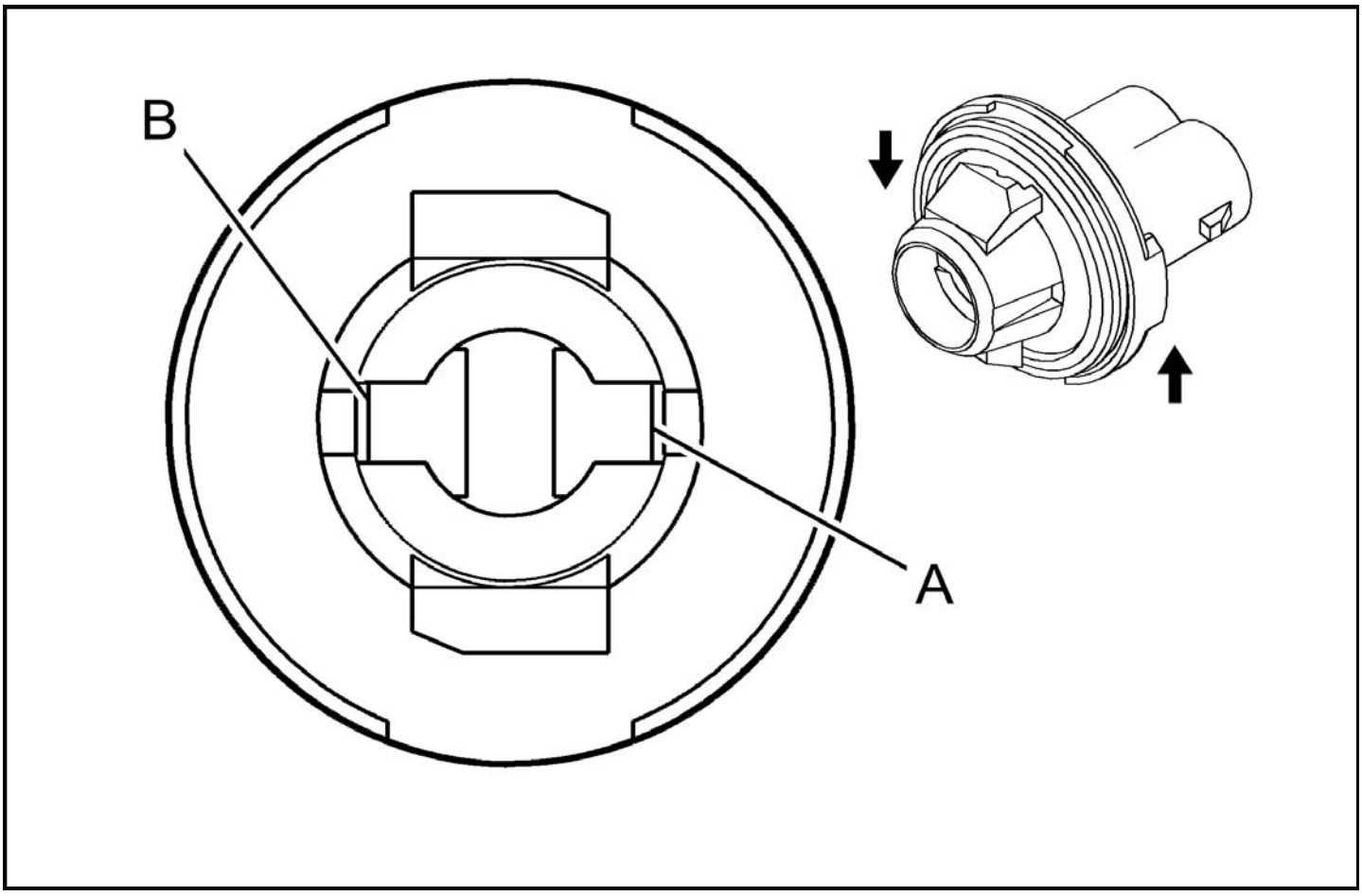
Terminal Part Information

- Terminated Lead: 13575462
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-3 (GY)
- Terminal/Tray: 12047581/2
- Core/Insulation Crimp: E/C

Sunshade - Right (DH6)

Pin	Wire	Circuit	Function
A	0.5 OG	1732	Inadvertent Power Courtesy Lamp
B	0.5 BK	550	Ground

TAIL LAMP - LEFT



Connector Part Information

- Harness Type: Left Tail Lamp
- OEM Connector: 15324946
- Service Connector: 88986416
- Description: 2-Way F Lamp Socket Wedge Base W2 (D-GY)

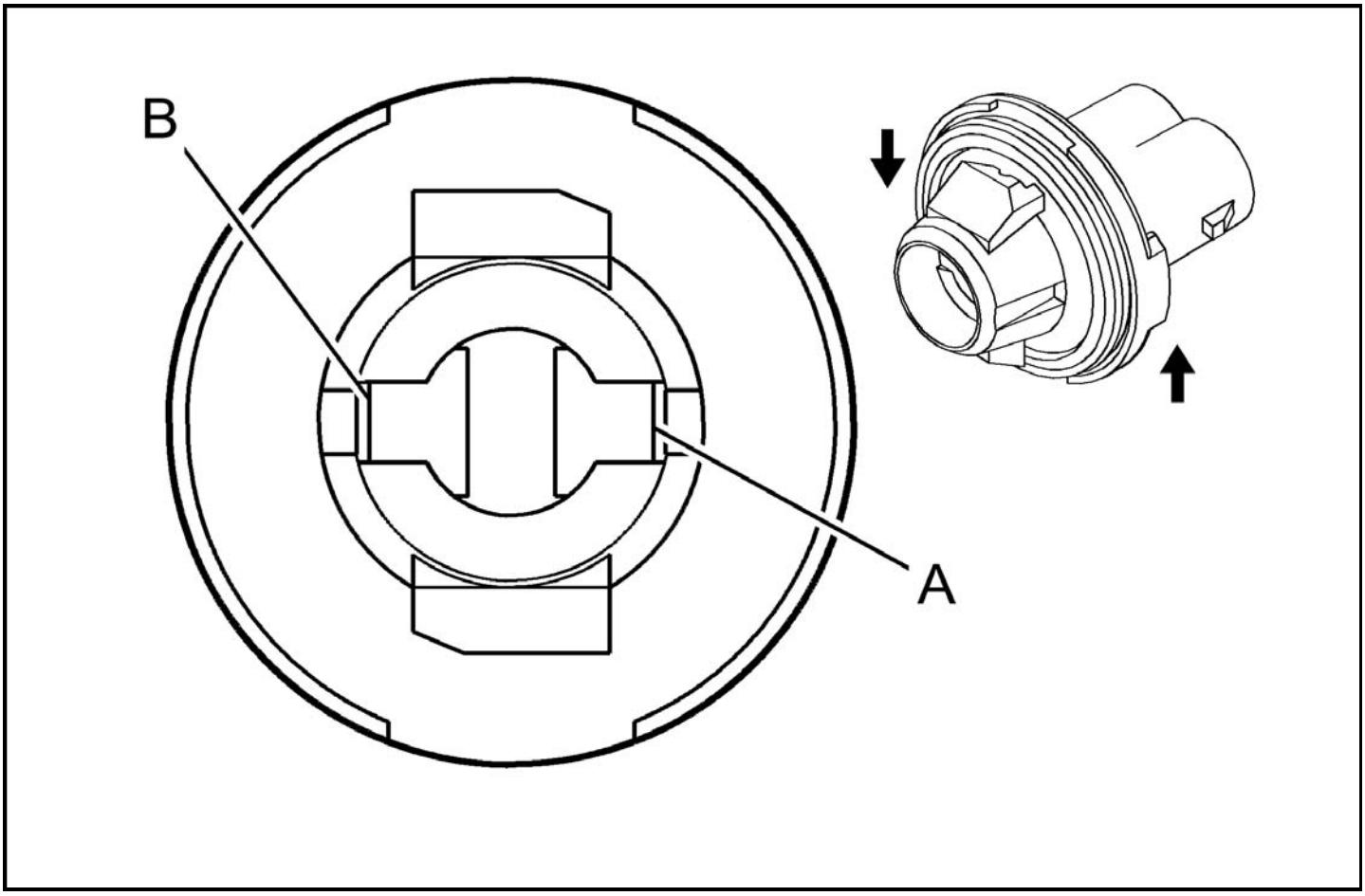
Terminal Part Information

- Terminal/Tray: 12124471/5
- Core/Insulation Crimp: 2/3
- Release Tool/Test Probe: 12094430/ Not Available

Tail Lamp - Left

Pin	Wire	Circuit	Function
A	0.5 L-GN	709	Left Park Lamp Supply Voltage
B	0.5 BK	750	Ground

TAIL LAMP - RIGHT



Connector Part Information

- Harness Type: Right Tail Lamp
- OEM Connector: 15324946
- Service Connector: 88986416
- Description: 2-Way F Lamp Socket Wedge Base W2 (D-GY)

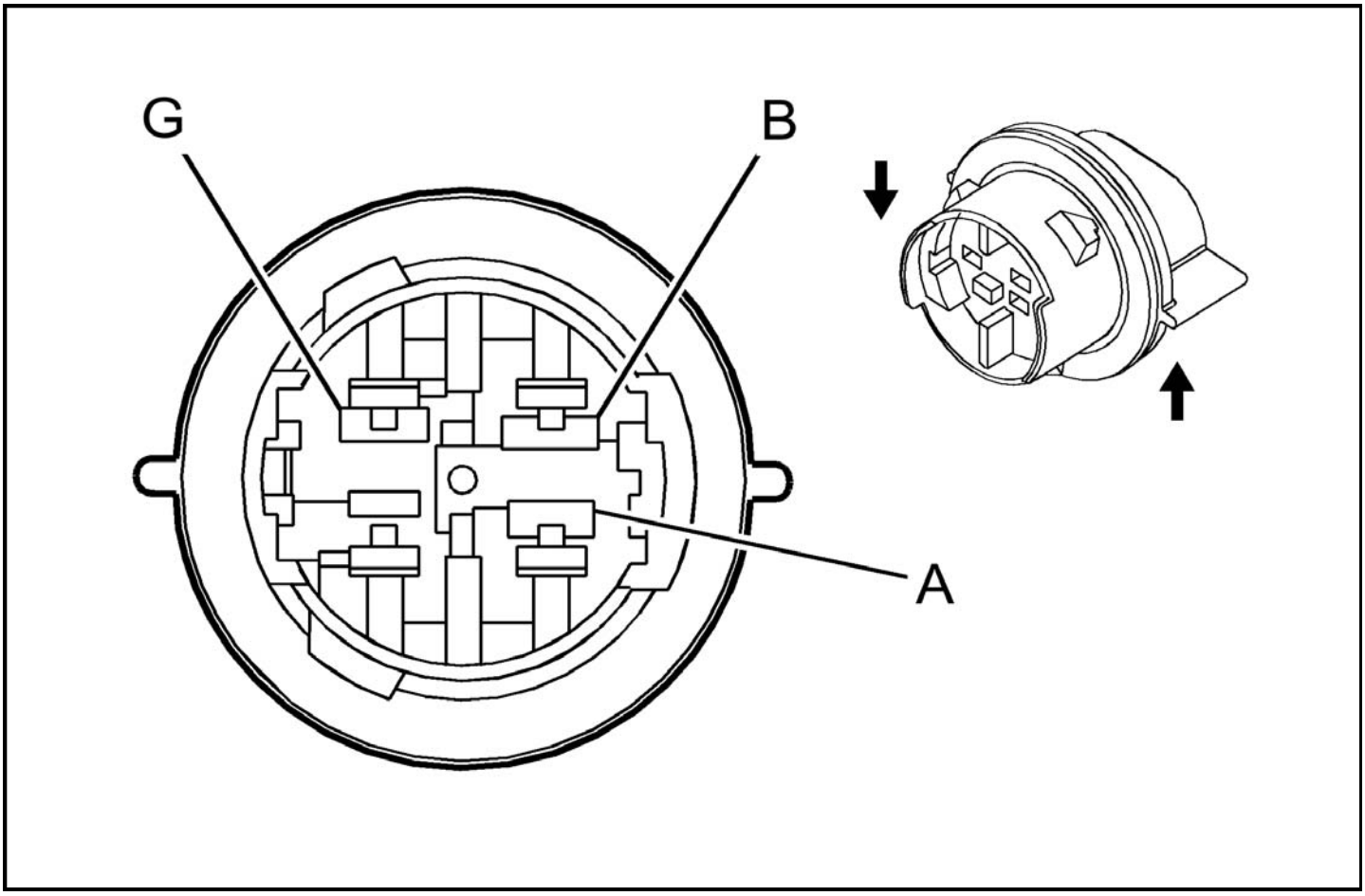
Terminal Part Information

- Terminal/Tray: 12124471/5
- Core/Insulation Crimp: 2/3
- Release Tool/Test Probe: 12094430/ Not Available

Tail Lamp - Right

Pin	Wire	Circuit	Function
A	0.5 L-GN	309	Left Park Lamp Supply Voltage
B	0.5 BK	750	Ground

TAIL/STOP AND TURN SIGNAL LAMP - LEFT



Connector Part Information

- Harness Type: Left Tail Lamp
- OEM Connector: 16530873
- Service Connector: Service by Harness - See Part Catalog
- Description: 3-Way F Lamp Socket Wedge Base W3 Right angle (NA)

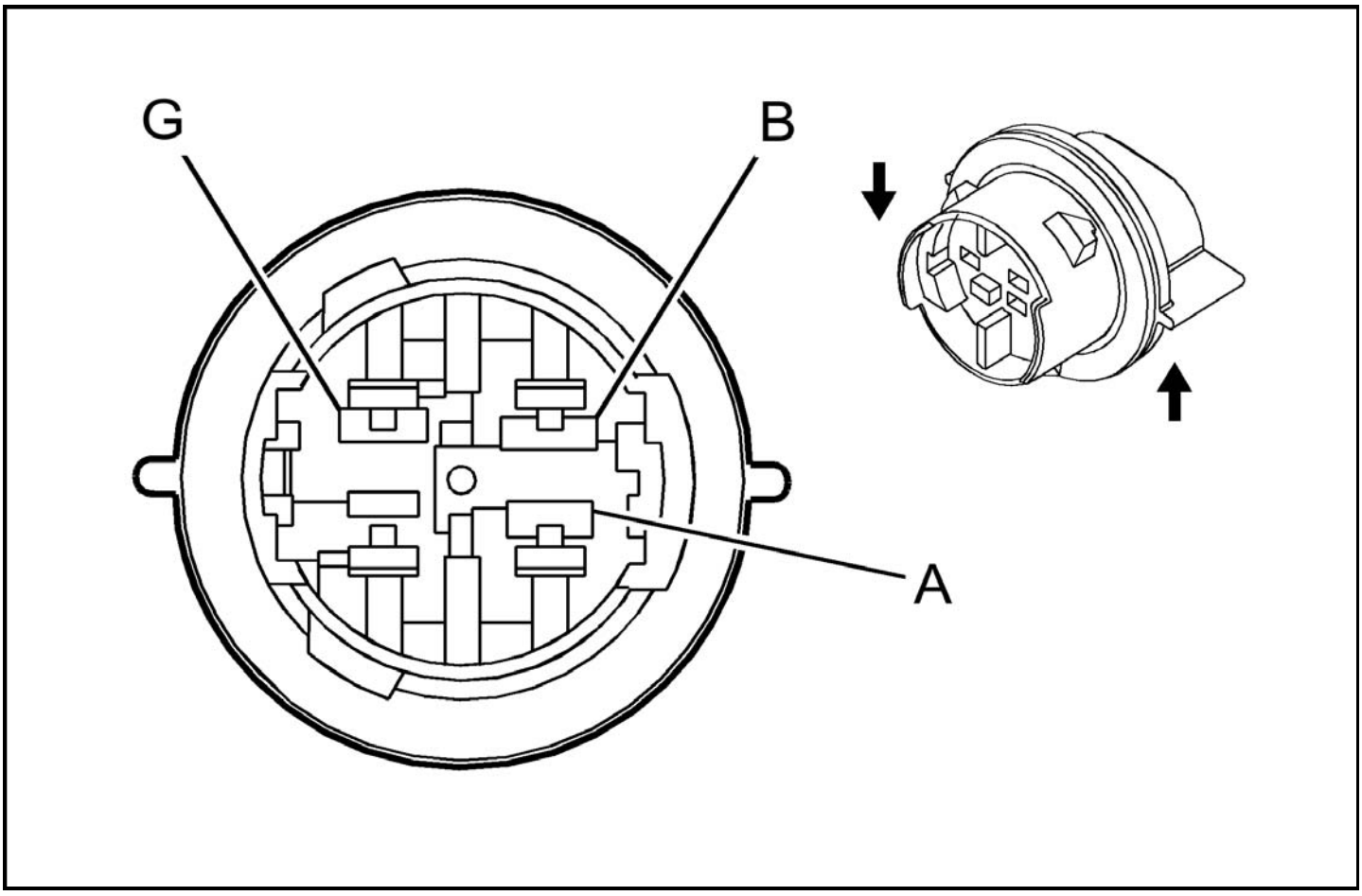
Terminal Part Information

- Terminal/Tray: 12066638/5
- Core/Insulation Crimp: 2/5
- Release Tool/Test Probe: 12180559-1/J-35616-4A (PU)

Tail/Stop and Turn Signal Lamp - Left

Pin	Wire	Circuit	Function
A	0.5 YE	18	Left Rear Stop/Turn Lamp Supply Voltage
B	0.5 L-GN	709	Left Park Lamp Supply Voltage
	0.5 L-GN	709	Left Park Lamp Supply Voltage
G	0.5 BK	750	Ground
	0.5 BK	750	Ground

TAIL/STOP AND TURN SIGNAL LAMP - RIGHT



Connector Part Information

- Harness Type: Right Tail Lamp
- OEM Connector: 16530873
- Service Connector: Service by Harness - See Part Catalog
- Description: 3-Way F Lamp Socket Wedge Base W3 Right angle (NA)

Terminal Part Information

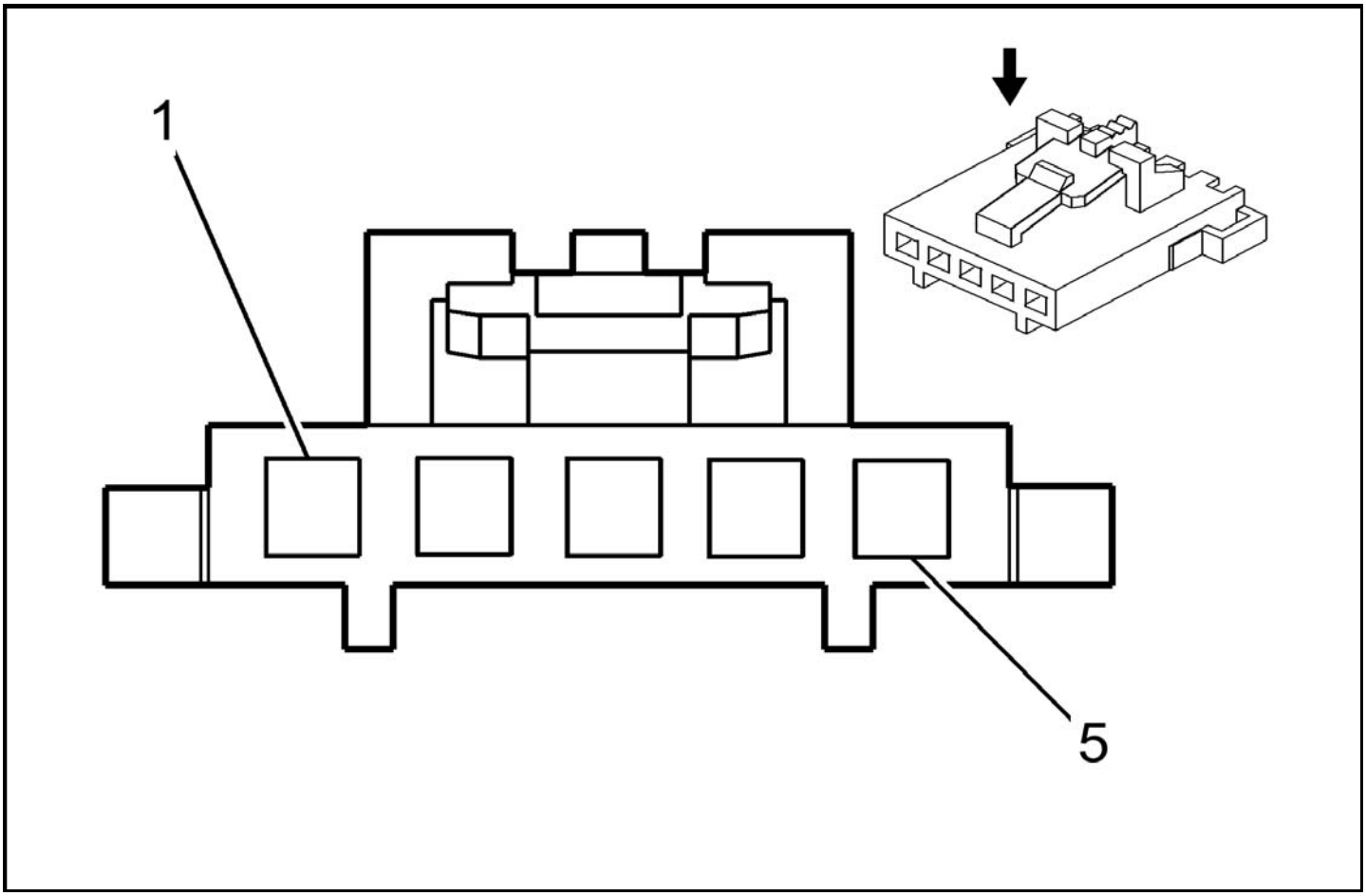
- Terminal/Tray: 12066638/5
- Core/Insulation Crimp: 2/5
- Release Tool/Test Probe: 12180559-1/J-35616-4A (PU)

Tail/Stop and Turn Signal Lamp - Right

Pin	Wire	Circuit	Function
A	0.5 YE	19	Right Rear Stop/Turn Lamp Supply Voltage
B	0.5 L-GN	309	Right Park Lamp Supply Voltage
	0.5 L-GN	309	Right Park Lamp Supply Voltage
G	0.5 BK	750	Ground

Pin	Wire	Circuit	Function
	0.5 BK	750	Ground

THEFT DETERRENT MODULE (TDM)



Connector Part Information

- Harness Type: Steering Column
- OEM Connector: 15383337
- Service Connector: 88988353
- Description: 5-Way F SL Series (BK)

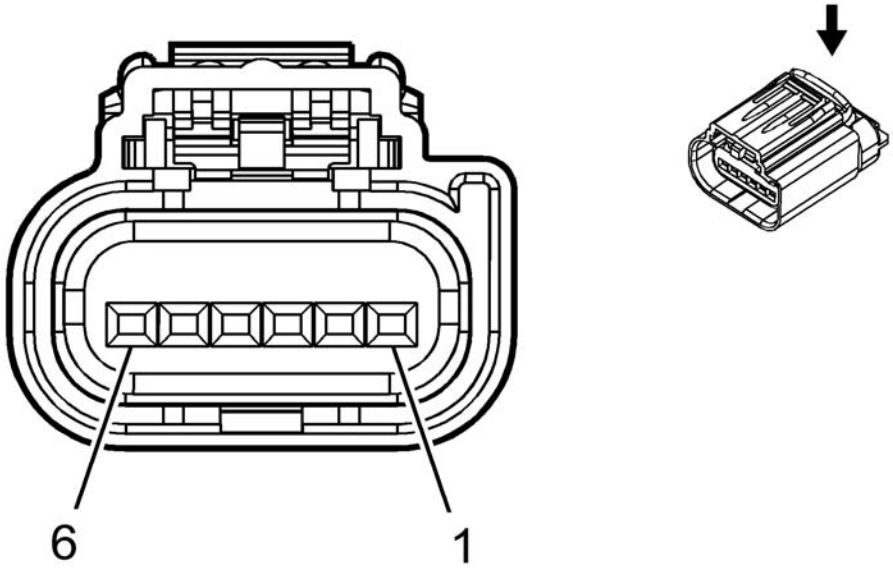
Terminal Part Information

- Terminated Lead: Service by Connector Assembly - 88988353
- Release Tool: J-38125-213
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 16-02-1110/20
- Core/Insulation Crimp: H/H

Theft Deterrent Module (TDM)

Pin	Wire	Circuit	Function
1	0.35 RD/WH	1040	Battery Positive Voltage
2	0.35 BN	4	Accessory Voltage
3	0.35 BK/WH	1551	Ground
4	-	-	Not Used
5	0.35 D-GN	5060	Low Speed GMLAN Serial Data

Q38 THROTTLE BODY (LFR/LFX)



Connector Part Information

- Harness Type: Engine
- OEM Connector: 1-1419168-1
- Service Connector: 13580980
- Description: 6-Way F 0.64 GET Series, Sealed (BK)

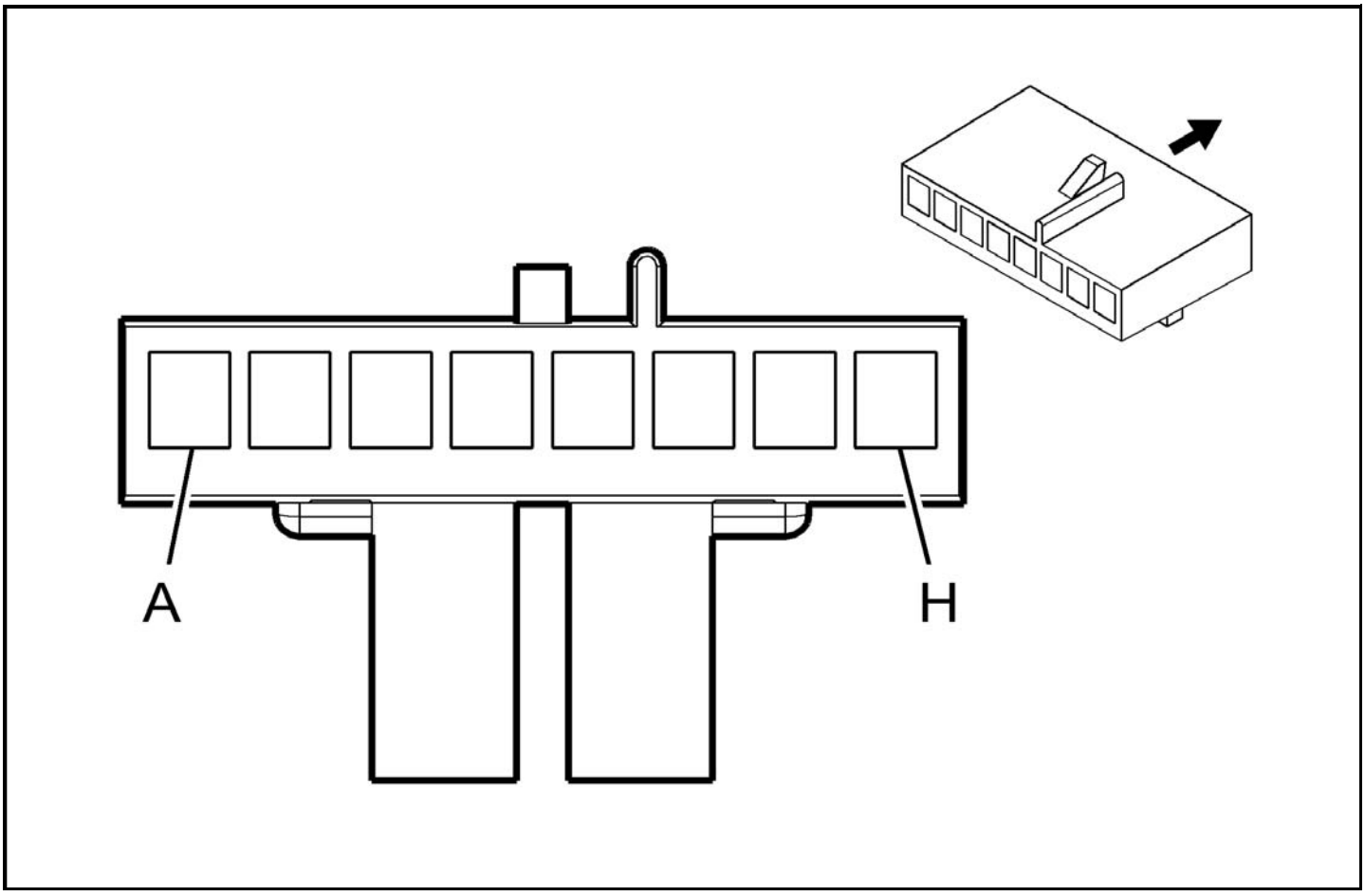
Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray Name	Core Crimp	Insulation Crimp
I	Not Required	J-35616-64B (LT BU)	Not Required	Not Required	Not Required	Not Required	Not Required

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
1	0.5	YE	581	Throttle Actuator Control Open	I	-

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
2	0.5	BN	582	Throttle Actuator Control Close	I	-
3	0.5	D-GN	485	Throttle Position Sensor Signal (1)	I	-
4	0.5	TN	2752	Throttle Position Sensor Low Reference	I	-
5	0.5	GY	2701	Throttle Position Sensor 5 Volt Reference	I	-
6	-	-	-	Not Occupied	-	-

TURN SIGNAL/MULTIFUNCTION SWITCH X1



Connector Part Information

- Harness Type: Steering Column
- OEM Connector: 12064862
- Service Connector: 12126438
- Description: 8-Way F Metri-Pack 150 Series (BK)

Terminal Part Information

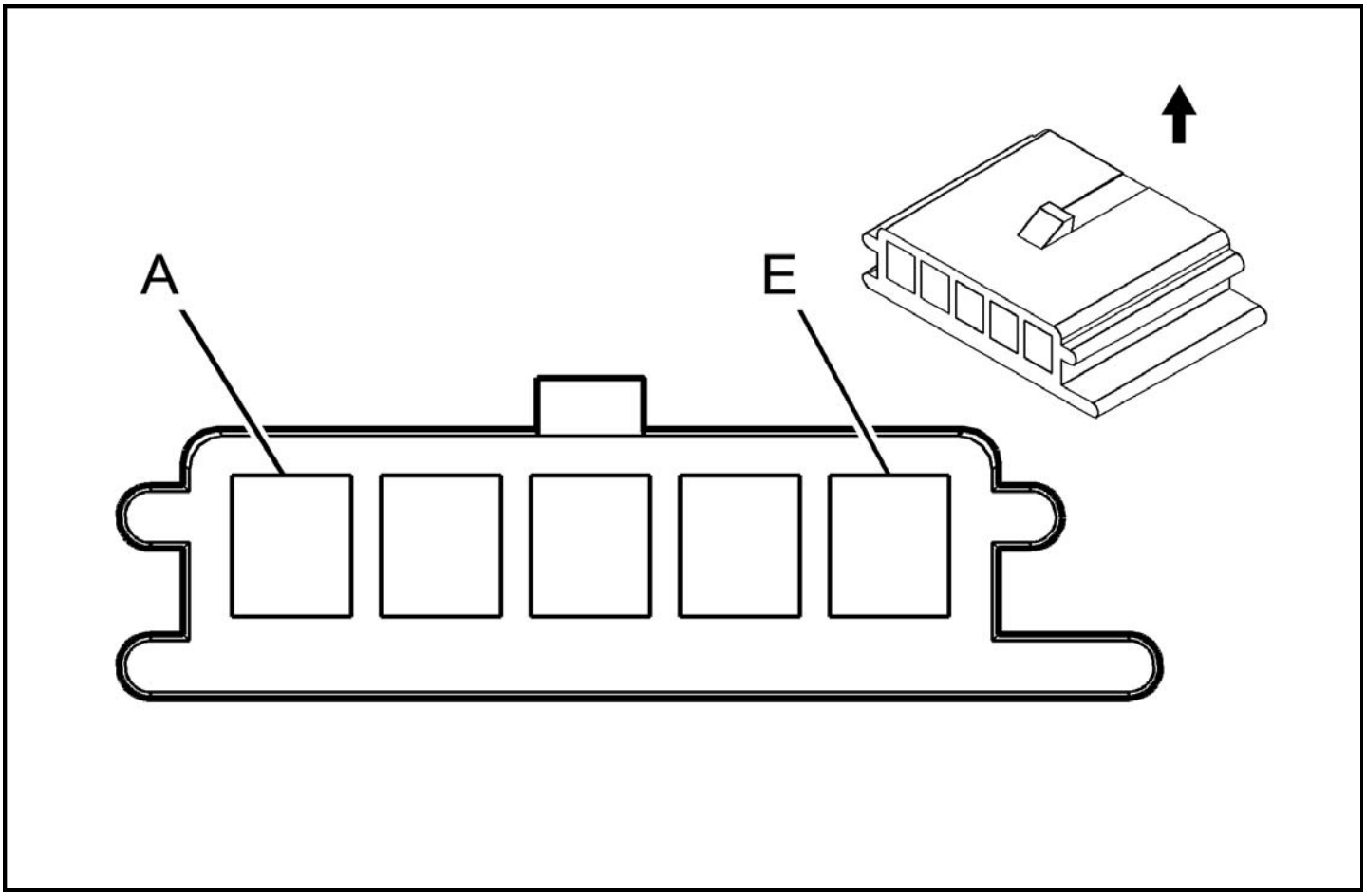
- Terminated Lead: 13575464

- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Turn Signal/Multifunction Switch X1

Pin	Wire	Circuit	Function
A-B	-	-	Not Used
C	0.35 TN	2144	Hazard Switch Signal
D	0.35 L-BU/WH	1414	Left Turn Signal Switch Signal
E	0.35 BK/WH	1551	Ground
F	0.35 D-BU/WH	1415	Right Turn Signal Switch Signal
G	-	-	Not Used
H	0.35 BK/WH	1551	Ground

TURN SIGNAL/MULTIFUNCTION SWITCH X2



Connector Part Information

- Harness Type: Steering Column
- OEM Connector: 12059800

- Service Connector: 15306169
- Description: 5-Way F Metri-Pack 150 Series (BK)

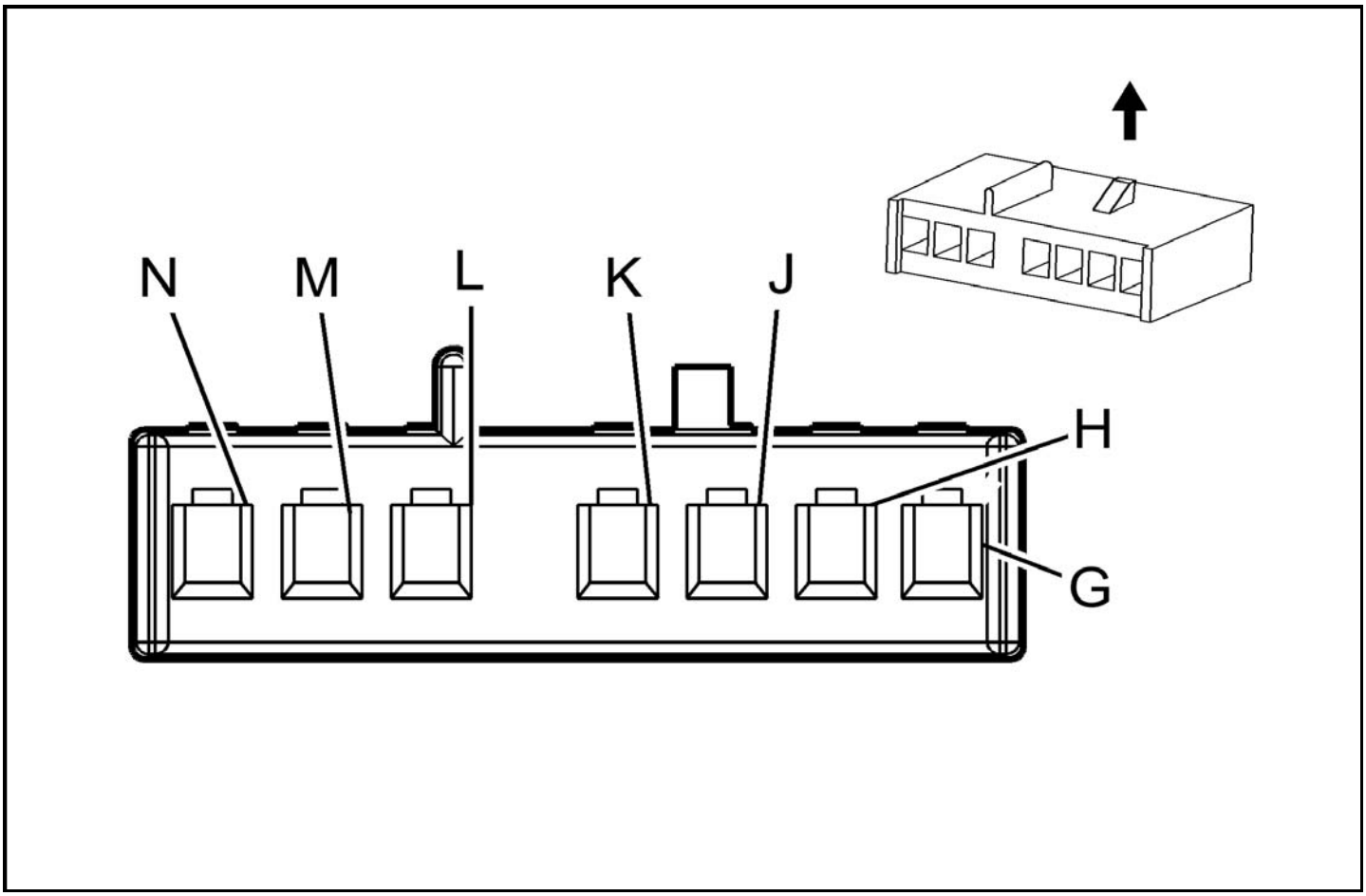
Terminal Part Information

- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Turn Signal/Multifunction Switch X2

Pin	Wire	Circuit	Function
A	0.35 BN	1356	Flash To Pass Switch Signal
B-C	-	-	Not Used
D	0.35 BK/WH	1551	Ground
E	0.35 PU	524	Headlamp Dimmer Switch High Beam Signal

TURN SIGNAL/MULTIFUNCTION SWITCH X3



Connector Part Information

- Harness Type: Steering Column
- OEM Connector: 15339058
- Service Connector: Service by Harness - See Part Catalog
- Description: 7-Way F Metri-Pack 150 Series (GY)

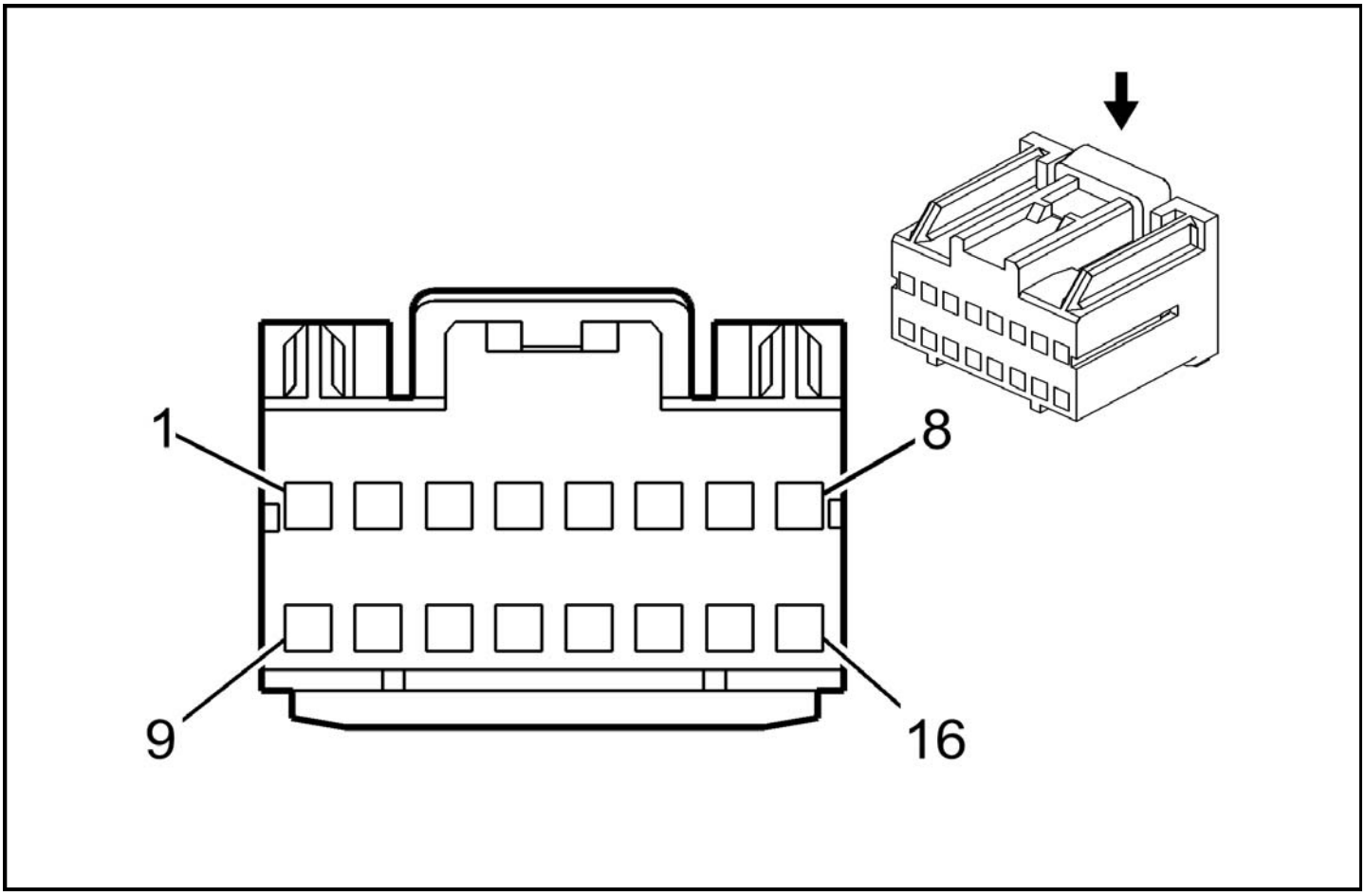
Terminal Part Information

- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Turn Signal/Multifunction Switch X3

Pin	Wire	Circuit	Function
G	-	-	Not Used
H	0.35 BK/WH	1251	Ground
J	0.35 PK	94	Windshield Washer Switch Signal
K	0.35 L-GN	1715	Windshield Wiper Switch High Signal
L	0.35 L-BU	1714	Windshield Wiper Switch Low Signal
M-N	-	-	Not Used

VEHICLE COMMUNICATION INTERFACE MODULE (VCIM) (UE1) X1



Connector Part Information

- Harness Type: Body
- OEM Connector: 15441350
- Service Connector: 15306351
- Description: 16-Way F Micro-Pack 100A Series (BK)

Terminal Part Information

- Pins: 1-3, 6, 8-15
- Terminated Lead: 13575546
- Release Tool: J-38125-559
- Diagnostic Test Probe: J-35616-16 (L-GN)
- Terminal/Tray: 15445905/23
- Core/Insulation Crimp: J/J

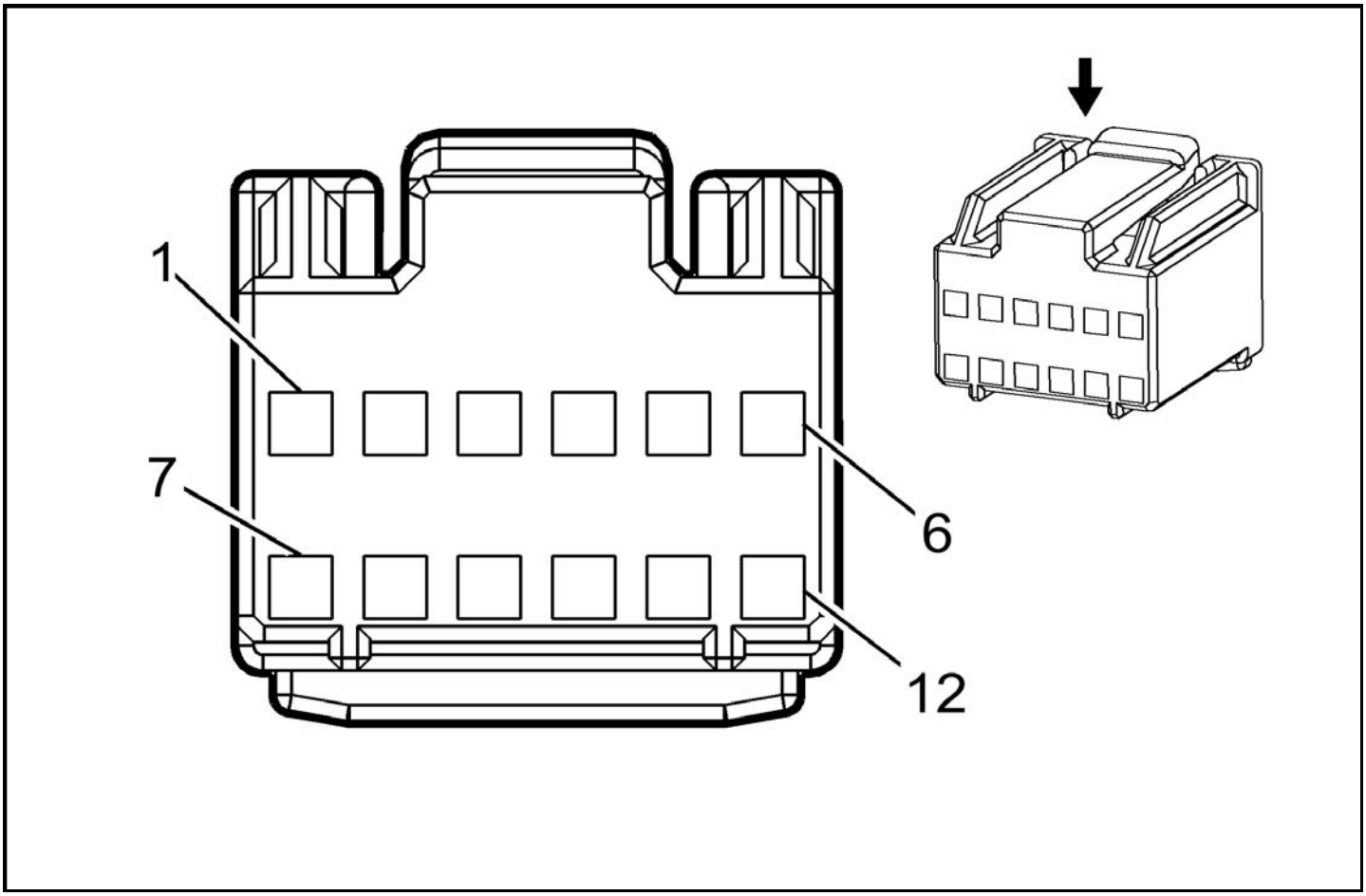
- Pins: 7
- Terminated Lead: 13575548
- Release Tool: J-38125-559
- Diagnostic Test Probe: J-35616-16 (L-GN)
- Terminal/Tray: 15445905/23

- Core/Insulation Crimp: K/K

Vehicle Communication Interface Module (VCIM) (UE1) X1

Pin	Wire	Circuit	Function
1	0.35 D-GN	5060	Low Speed GMLAN Serial Data
2	0.35 BN/WH	2517	Keypad Red LED Signal
3	0.35 YE/BK	2516	Keypad Green LED Signal
4-5	-	-	Not Used
6	0.35 L-GN/BK	2515	Keypad Supply Voltage
7	0.8 WH	1351	Ground
8-9	-	-	Not Used
10	0.35 TN/BK	2500	High Speed GMLAN Serial Data Bus +
11	0.35 D-GN/WH	2514	Keypad Signal
12	0.35 TN	2501	High Speed GMLAN Serial Data Bus -
13	0.5 GY/BK	5167	Battery Backup Low Reference
14	0.5 RD/WH	5235	Battery Backup Supply Voltage
15	0.5 RD/WH	2340	Battery Positive Voltage
16	-	-	Not Used

VEHICLE COMMUNICATION INTERFACE MODULE (VCIM) (UE1) X2



Connector Part Information

- Harness Type: Body
- OEM Connector: 15431365
- Service Connector: 88952886
- Description: 12-Way F Micro-Pack 100A Series (NA)

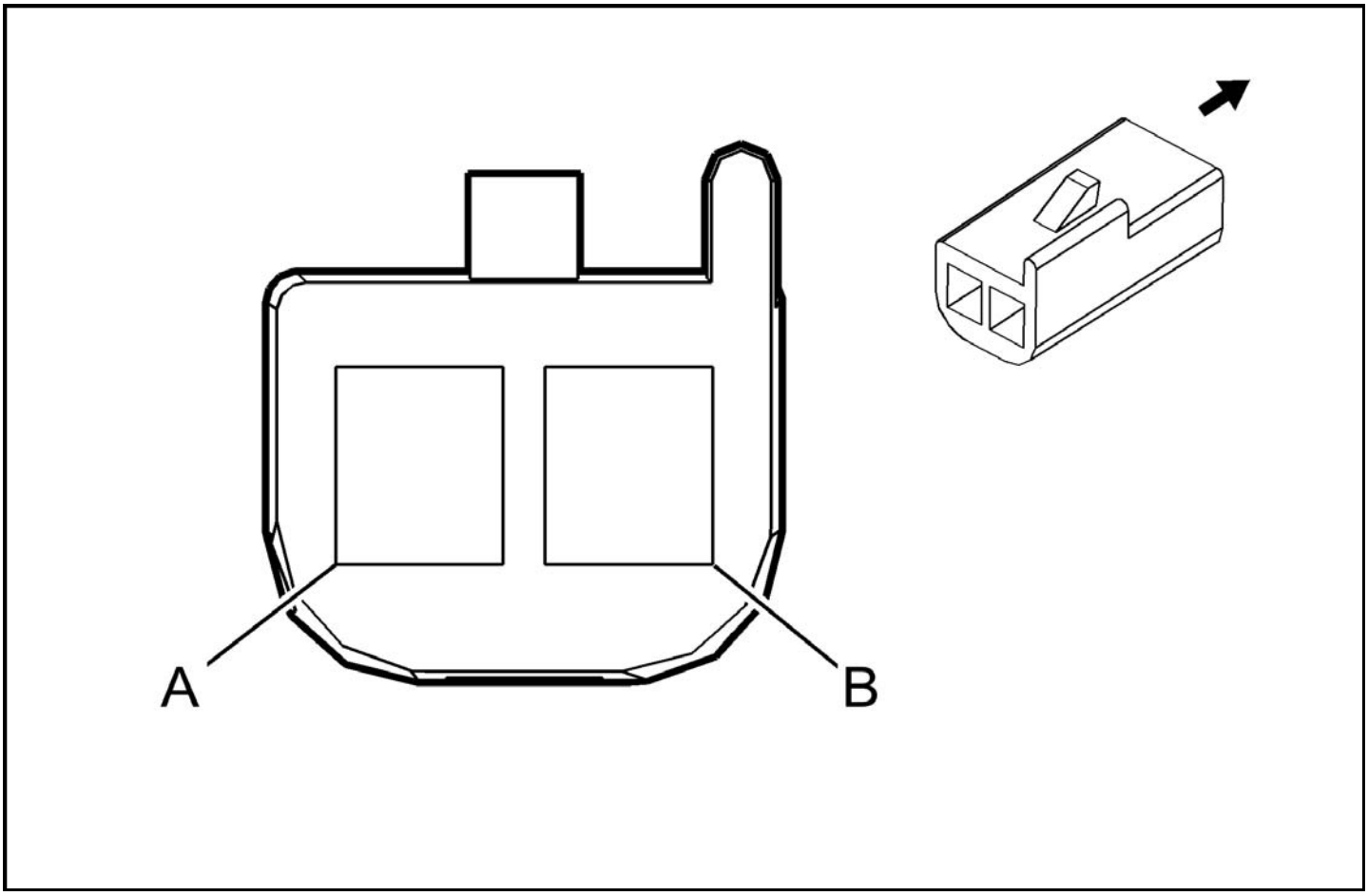
Terminal Part Information

- Terminated Lead: 13575548
- Release Tool: J-38125-559
- Diagnostic Test Probe: J-35616-16 (L-GN)
- Terminal/Tray: 15445905/23
- Core/Insulation Crimp: J/J

Vehicle Communication Interface Module (VCIM) (UE1) X2

Pin	Wire	Circuit	Function
1	0.35 OG/BK	1406	Left Audio Signal (+)
2	0.35 L-BU	1405	Audio Common Signal
3	0.35 TN/BK	2500	High Speed GMLAN Serial Data Bus +
4	0.35 TN	2501	High Speed GMLAN Serial Data Bus -
5-7	-	-	Not Used
8	0.35 BARE	813	Drain Wire
9	0.35 GY	655	Cellular Microphone Signal
10	0.35 BARE	1489	Drain Wire
11-12	-	-	Not Used

VEHICLE COMMUNICATION INTERFACE MODULE (VCIM) BATTERY (UE1)



Connector Part Information

- Harness Type: Body
- OEM Connector: 12047662
- Service Connector: 12085535
- Description: 2-Way F Metri-Pack 150 Series (BK)

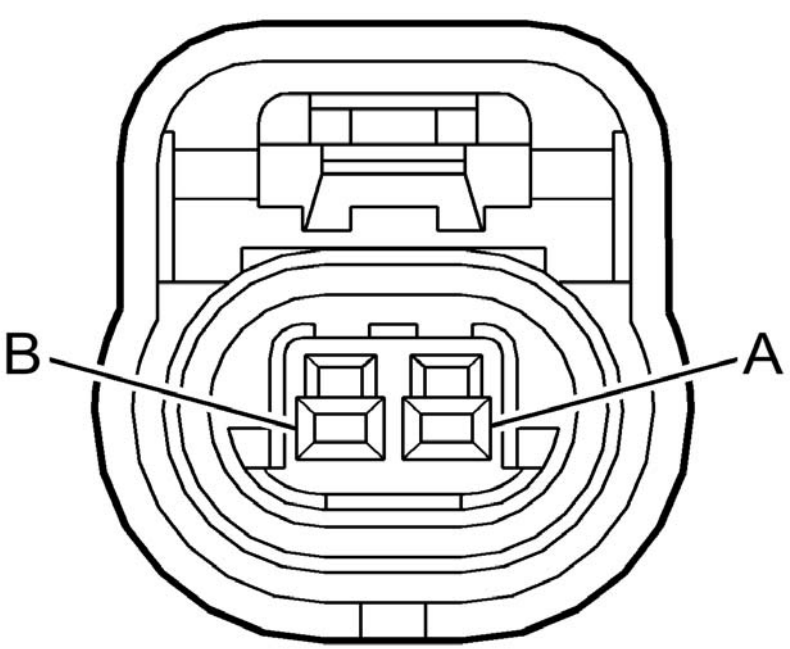
Terminal Part Information

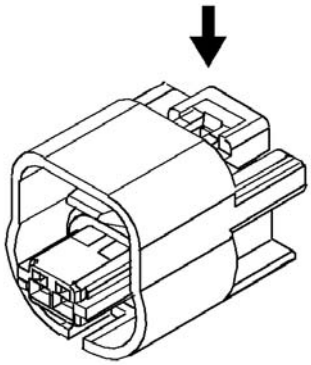
- Terminated Lead: 13575464
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 15326030/5
- Core/Insulation Crimp: E/C

Vehicle Communication Interface Module (VCIM) Battery (UE1)

Pin	Wire	Circuit	Function
A	0.5 RD/WH	5235	Battery Backup Supply Voltage
B	0.5 GY/BK	5167	Battery Backup Low Reference

VEHICLE SPEED SENSOR (VSS)





Connector Part Information

- Harness Type: Engine
- OEM Connector: 15336004
- Service Connector: 19178093
- Description: 2-Way F GT 150 Series, Sealed (BK)

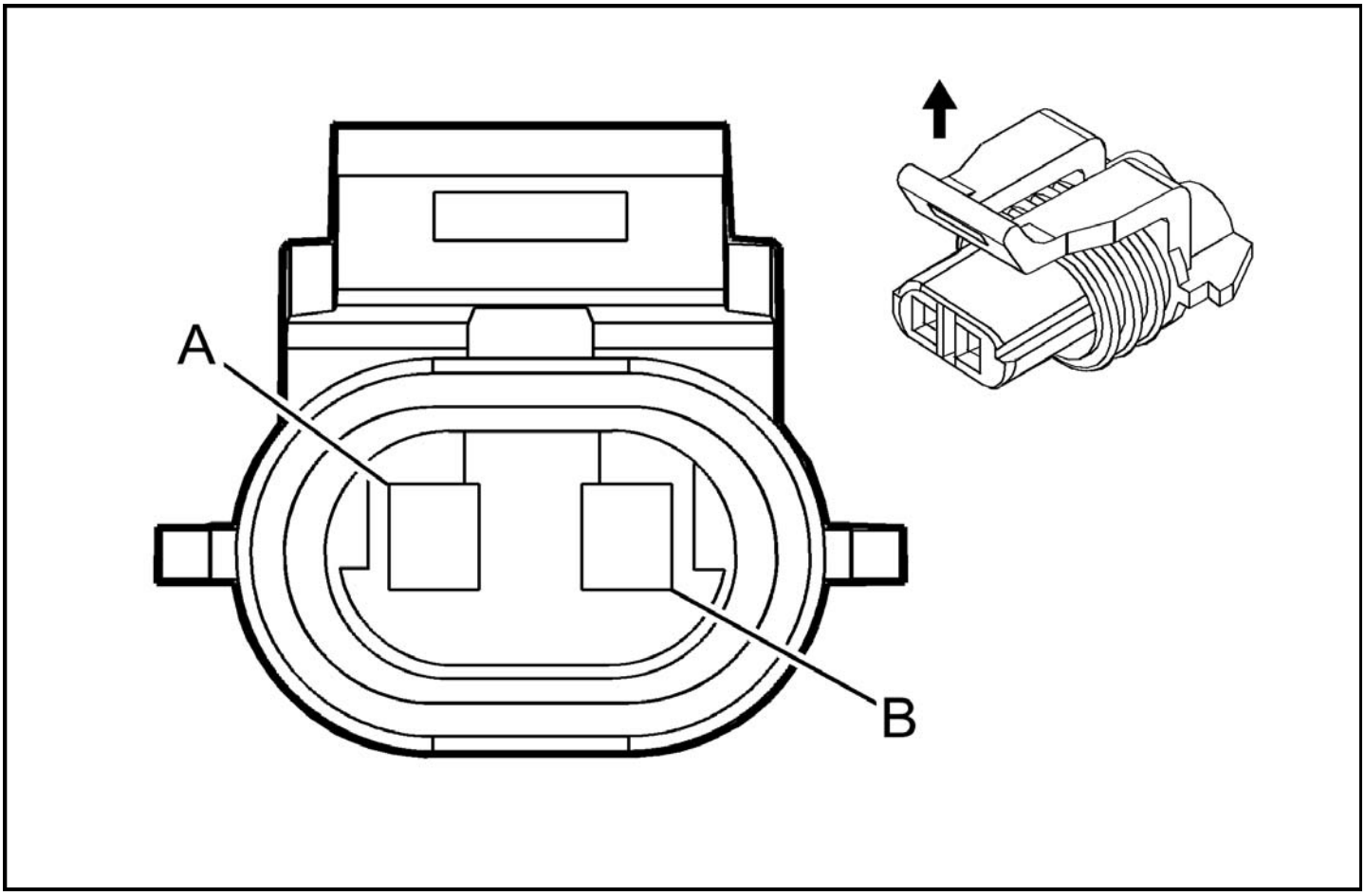
Terminal Part Information

- Terminated Lead: 13576360
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 15326267/19
- Core/Insulation Crimp: E/4

Vehicle Speed Sensor (VSS)

Pin	Wire	Circuit	Function
A	0.35 PU	401	Signal Low- Front
B	0.35 YE	400	Signal High- Front

WHEEL SPEED SENSOR (WSS) - LEFT FRONT



Connector Part Information

- Harness Type: Engine
- OEM Connector: 12052644
- Service Connector: 10340314
- Description: 2-Way F Metri-Pack 150 Series, Sealed (GY)

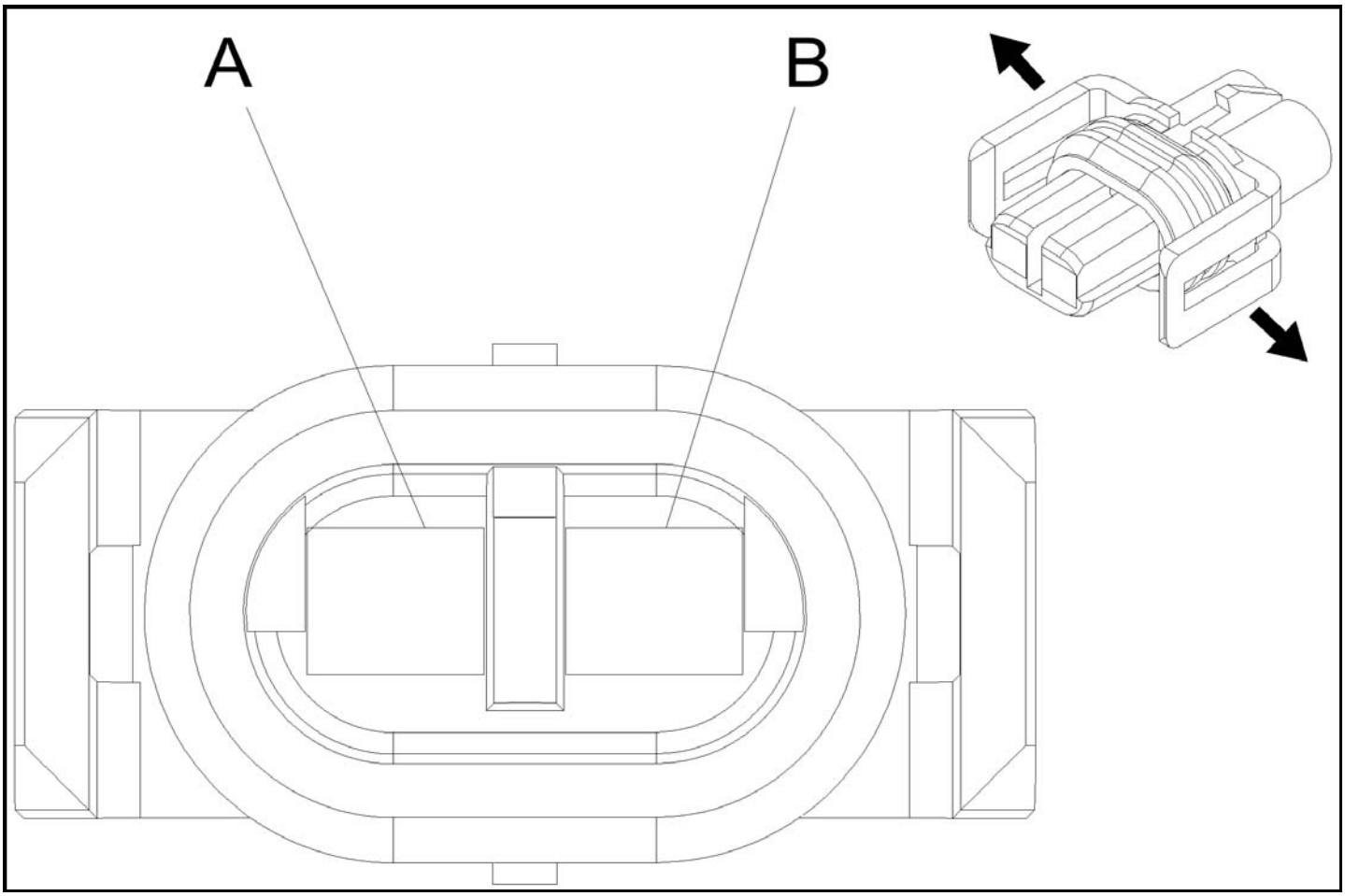
Terminal Part Information

- Terminated Lead: 13575419
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1

Wheel Speed Sensor (WSS) - Left Front

Pin	Wire	Circuit	Function
A	0.5 YE	873	Left Front Wheel Speed Sensor Low Reference
B	0.5 L-BU	830	Left Front Wheel Speed Sensor Signal

WHEEL SPEED SENSOR (WSS) - LEFT REAR



Connector Part Information

- Harness Type: Rear Chassis
- OEM Connector: 15305168
- Service Connector: 12167117
- Description: 2-Way F Metri-Pack 150 Series (GY)

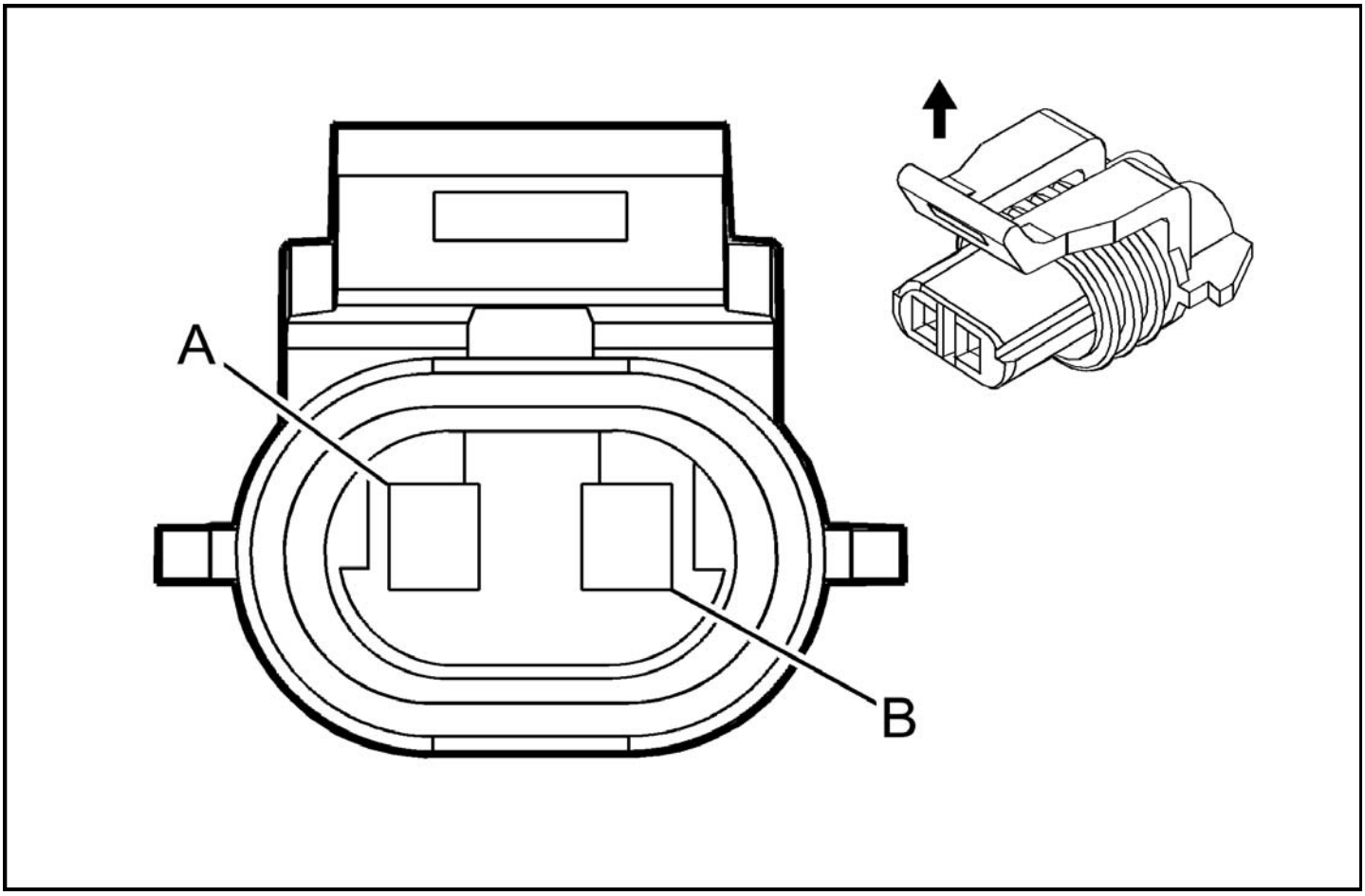
Terminal Part Information

- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Wheel Speed Sensor (WSS) - Left Rear

Pin	Wire	Circuit	Function
A	0.5 BK	884	Left Rear Wheel Speed Sensor Signal
B	0.5 RD	885	Left Rear Wheel Speed Sensor Low Reference

WHEEL SPEED SENSOR (WSS) - RIGHT FRONT



Connector Part Information

- Harness Type: Engine
- OEM Connector: 12052644
- Service Connector: 10340314
- Description: 2-Way F Metri-Pack 150 Series, Sealed (GY)

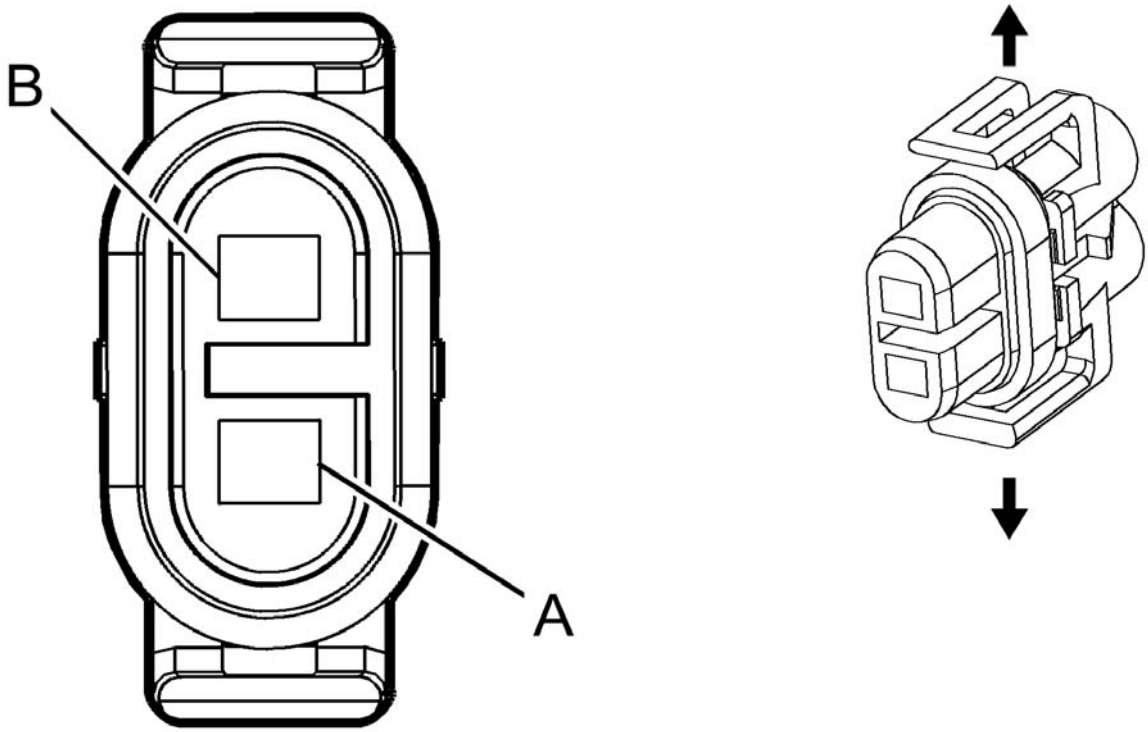
Terminal Part Information

- Terminated Lead: 13575419
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1

Wheel Speed Sensor (WSS) - Right Front

Pin	Wire	Circuit	Function
A	0.5 TN	833	Right Front Wheel Speed Sensor Low Reference
B	0.5 D-GN	872	Right Front Wheel Speed Sensor Signal

WHEEL SPEED SENSOR (WSS) - RIGHT REAR



Connector Part Information

- Harness Type: Rear Chassis
- OEM Connector: 15305168
- Service Connector: 12167117
- Description: 2-Way F Metri-Pack 150 Series (GY)

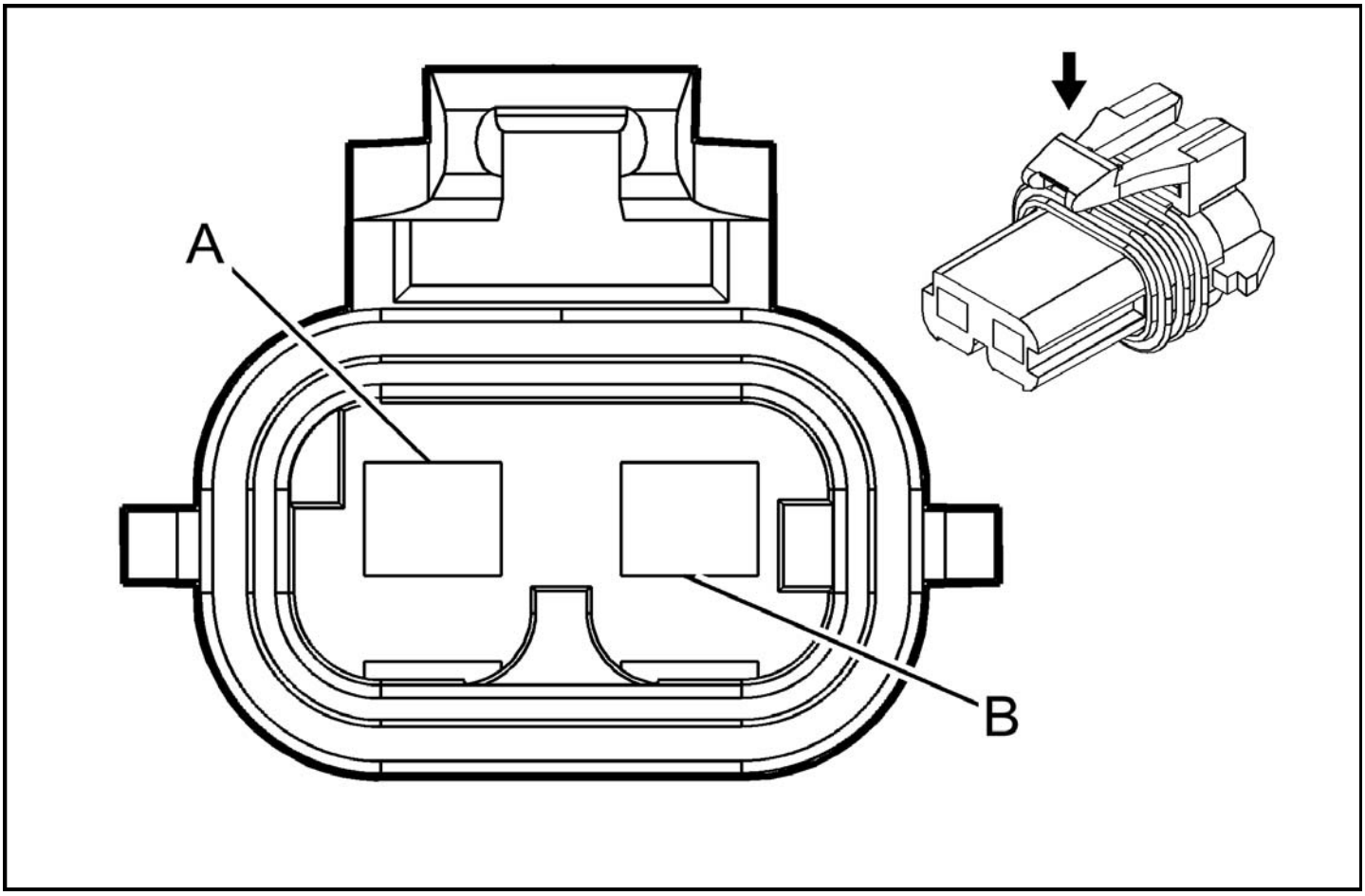
Terminal Part Information

- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12094429/J-35616-14 (GN)

Wheel Speed Sensor (WSS) - Right Rear

Pin	Wire	Circuit	Function
A	0.5 BN	882	Right Rear Wheel Speed Sensor Signal
B	0.5 WH	883	Right Rear Wheel Speed Sensor Low Reference

WINDOW MOTOR - DRIVER



Connector Part Information

- Harness Type: Left Front Door
- OEM Connector: 15497548
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F Metri-Pack 280 Series, Flexlock, Sealed (GY)

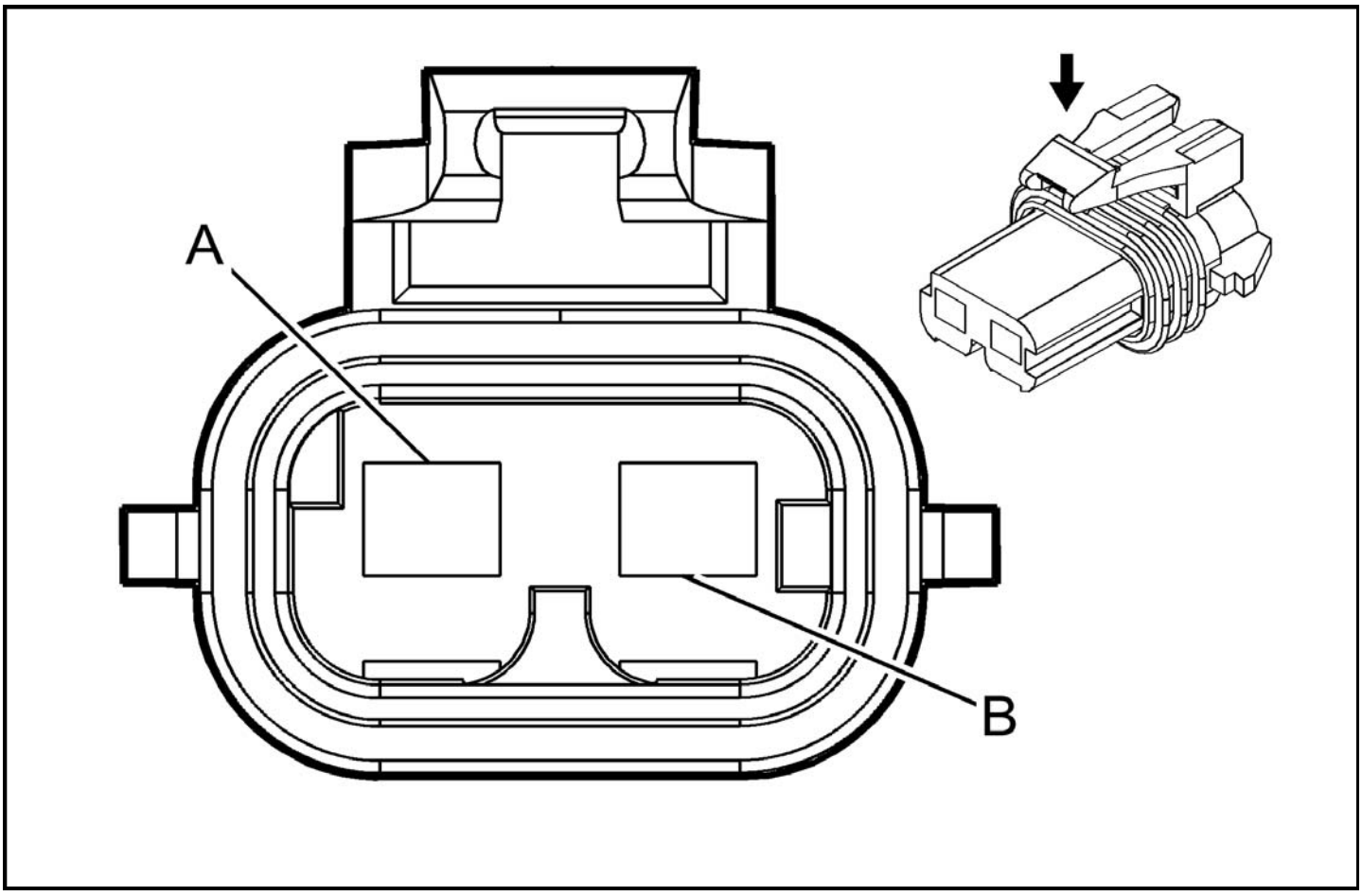
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110845/4
- Core/Insulation Crimp: A/5

Window Motor - Driver

Pin	Wire	Circuit	Function
A	2 BN	165	Power Window Motor Left Front Down Control
B	2 D-BU	164	Power Window Motor Left Front Up Control

WINDOW MOTOR - LEFT REAR



Connector Part Information

- Harness Type: Left Rear Door
- OEM Connector: 15497548
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F Metri-Pack 280 Series, Flexlock, Sealed (GY)

Terminal Part Information

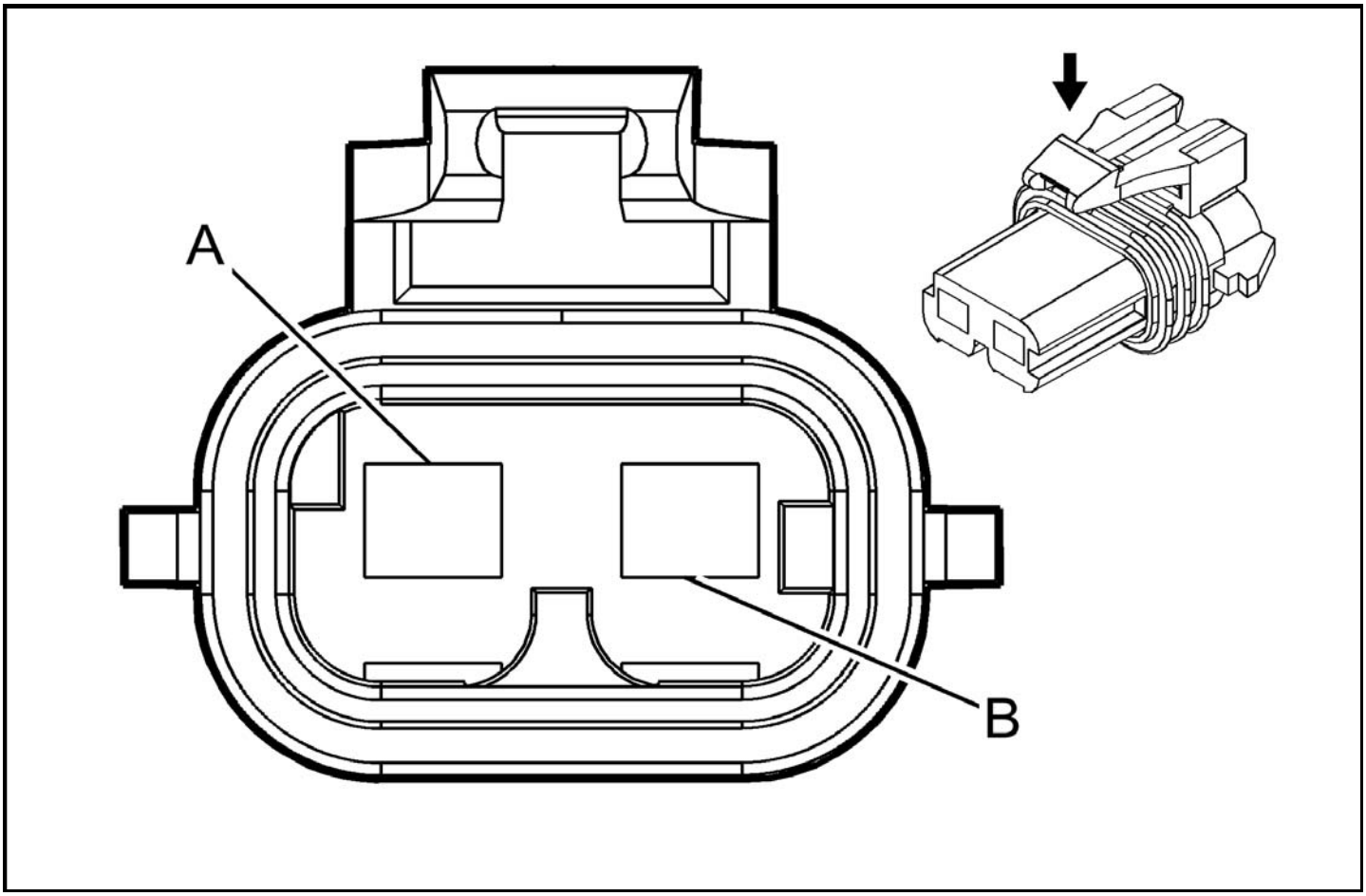
- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110845/4
- Core/Insulation Crimp: A/5

Window Motor - Left Rear

Pin	Wire	Circuit	Function
A	3 BN	669	Power Window Motor Left Rear Down Control

Pin	Wire	Circuit	Function
B	3 D-BU	668	Power Window Motor Left Rear Up Control

WINDOW MOTOR - PASSENGER



Connector Part Information

- Harness Type: Right Front Door
- OEM Connector: 15497548
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F Metri-Pack 280 Series, Flexlock, Sealed (GY)

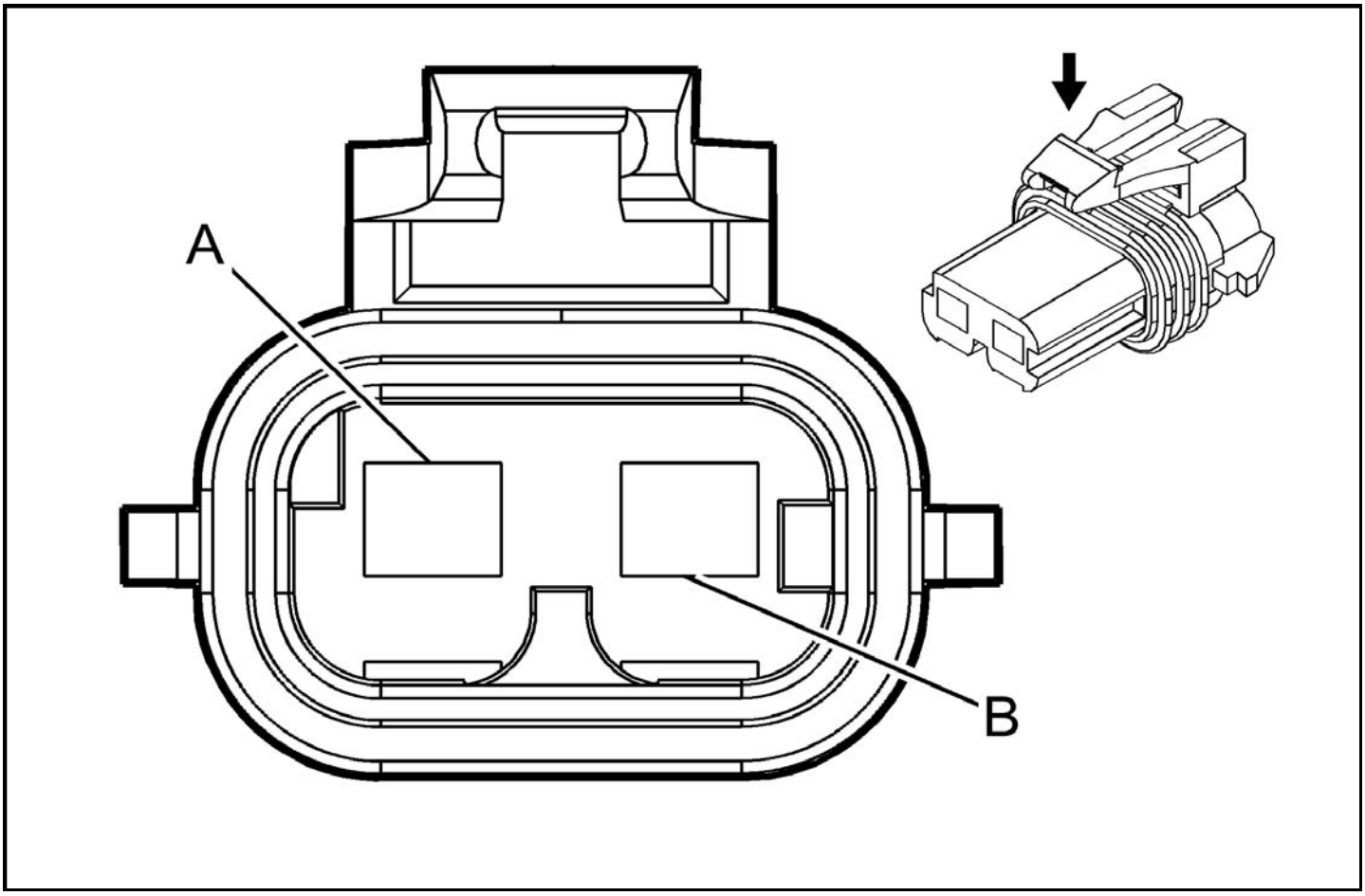
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110845/4
- Core/Insulation Crimp: A/5

Window Motor - Passenger

Pin	Wire	Circuit	Function
A	3 BN	667	Power Window Motor Right Front Down Control
B	3 D-BU	666	Power Window Motor Right Front Up Control

WINDOW MOTOR - RIGHT REAR



Connector Part Information

- Harness Type: Right Rear Door
- OEM Connector: 15497548
- Service Connector: Service by Harness- See Part Catalog
- Description: 2-Way F Metri-Pack 280 Series, Flexlock, Sealed (GY)

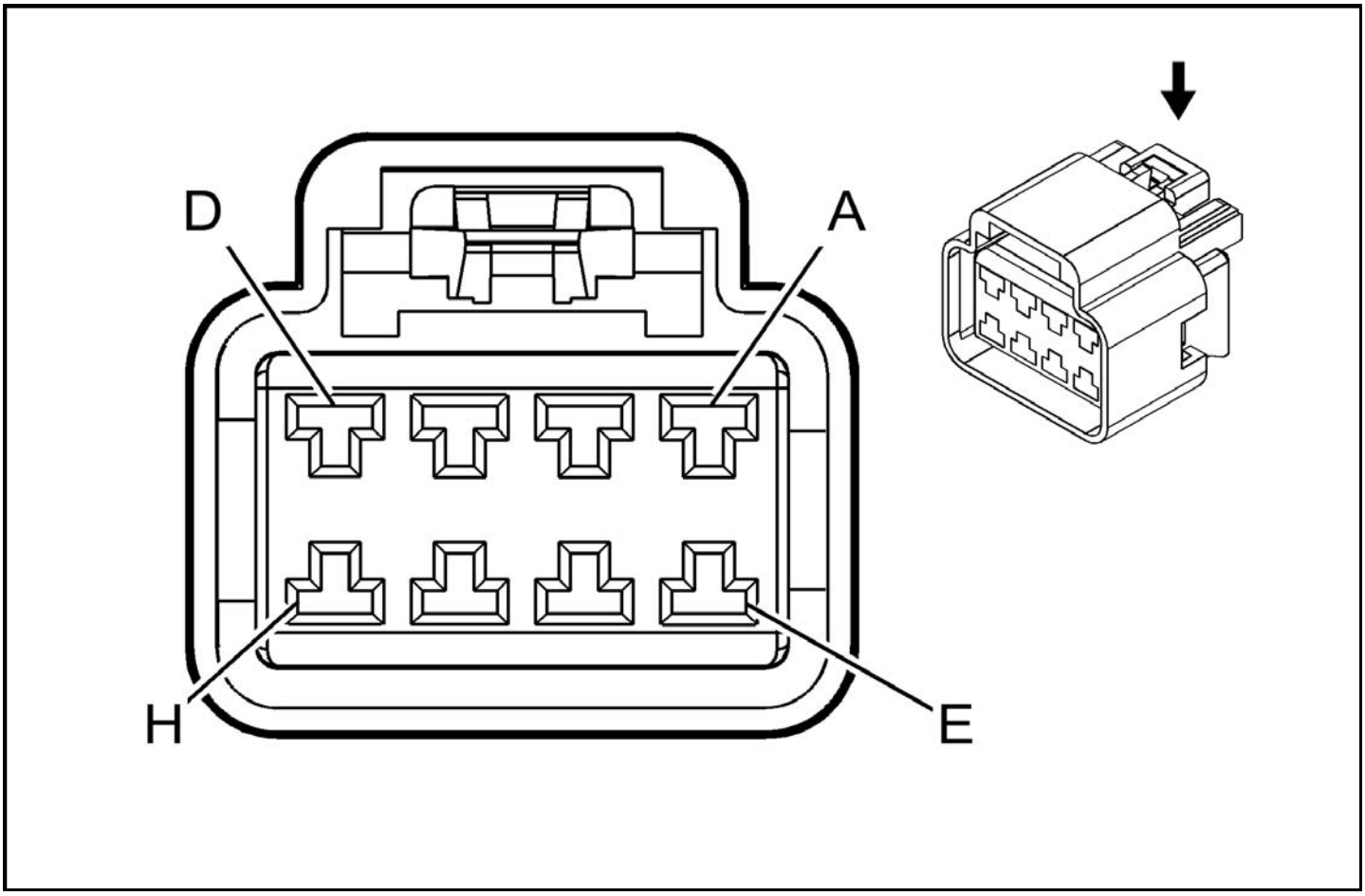
Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110845/4
- Core/Insulation Crimp: A/5

Window Motor - Right Rear

Pin	Wire	Circuit	Function
A	3 BN	671	Power Window Motor Right Rear Down Control
B	3 D-BU	670	Power Window Motor Right Rear Up Control

WINDOW SWITCH - DRIVER X1



Connector Part Information

- Harness Type: Left Front Door Trim
- OEM Connector: 15326924
- Service Connector: 19153751
- Description: 8-Way F GT 280 Series (BK)

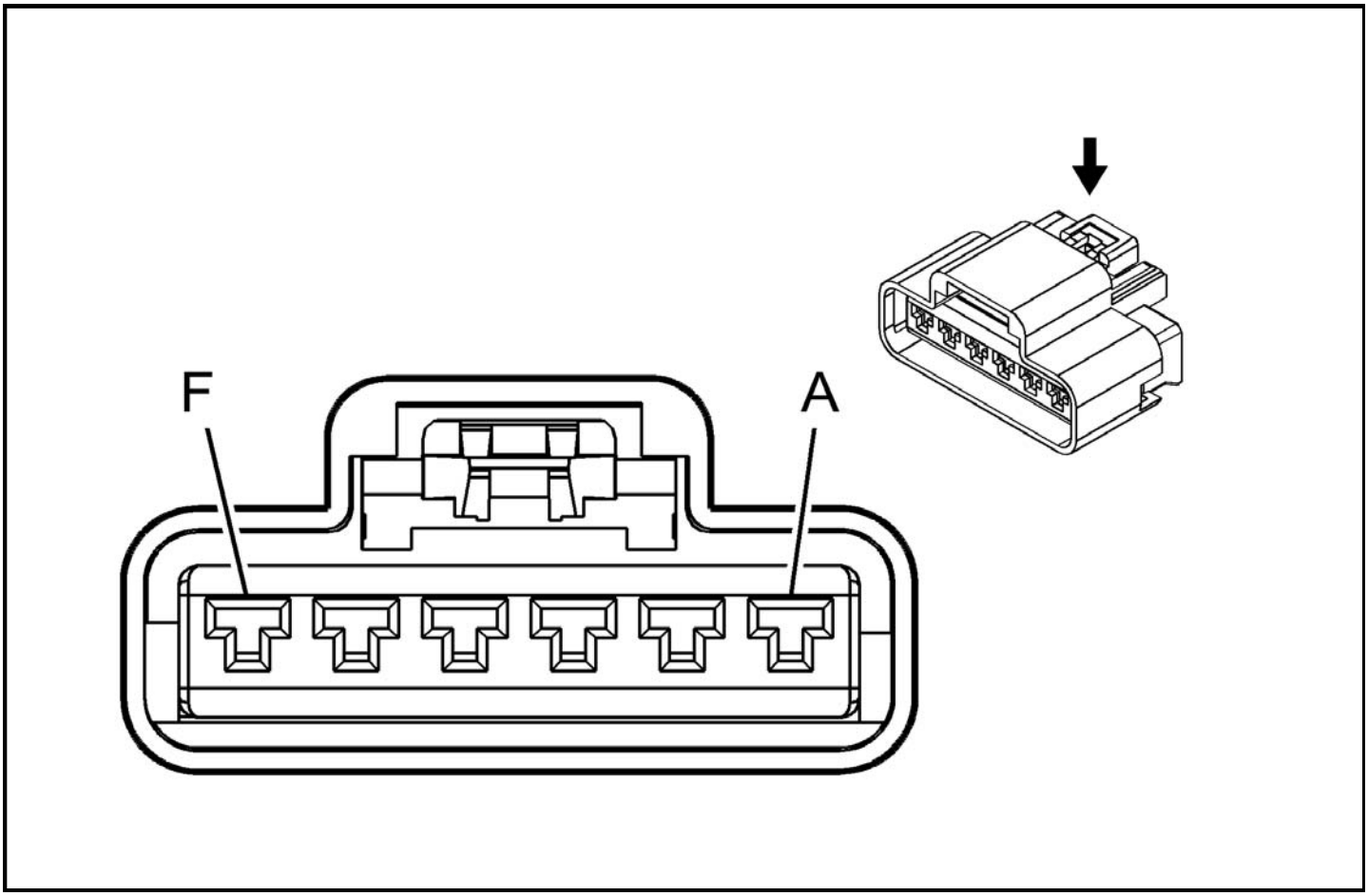
Terminal Part Information

- Terminated Lead: 13575754
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304713/19
- Core/Insulation Crimp: 4/4

Window Switch - Driver X1

Pin	Wire	Circuit	Function
A	-	-	Not Used
B	2 BK	550	Ground
C	2 PU	169	Power Window Master Switch Left Rear Down Signal
D	2 D-GN	168	Power Window Master Switch Left Rear Up Signal
E	2 YE	143	Accessory Voltage
F	2 D-BU	1307	Power Window Master Switch Lockout Signal
G	2 L-GN	170	Power Window Master Switch Right Rear Up Signal
H	2 PU	171	Power Window Master Switch Right Rear Down Signal

WINDOW SWITCH - DRIVER X2



Connector Part Information

- Harness Type: Left Front Door Trim
- OEM Connector: 15326900
- Service Connector: 13580860

- Description: 6-Way F GT 280 Series (BK)

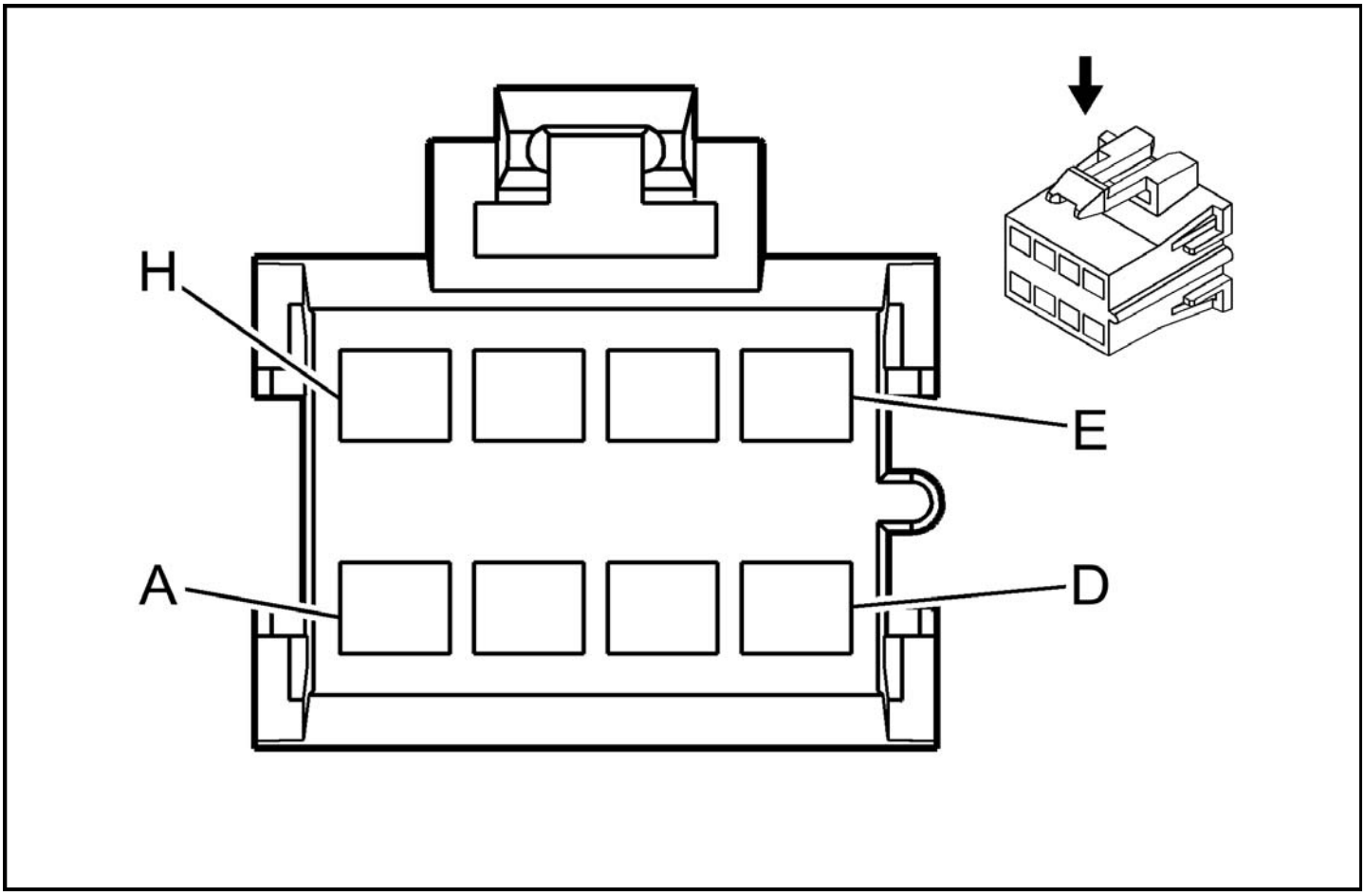
Terminal Part Information

- Terminated Lead: 13575754
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304713/19
- Core/Insulation Crimp: 4/4

Window Switch - Driver X2

Pin	Wire	Circuit	Function
A	2 BN	165	Power Window Motor Left Front Down Control
B	2 L-BU	166	Power Window Master Switch Right Front Up Signal
C	2 TN	167	Power Window Master Switch Right Front Down Signal
D	-	-	Not Used
E	2 D-BU	164	Power Window Motor Left Front Up Control
F	0.35 GY	8	Instrument Panel Lamp Supply Voltage

WINDOW SWITCH - LEFT REAR



Connector Part Information

- Harness Type: Left Rear Door
- OEM Connector: 12064998
- Service Connector: 15306189
- Description: 8-Way F Metri-Pack 280 Series (BK)

Terminal Part Information

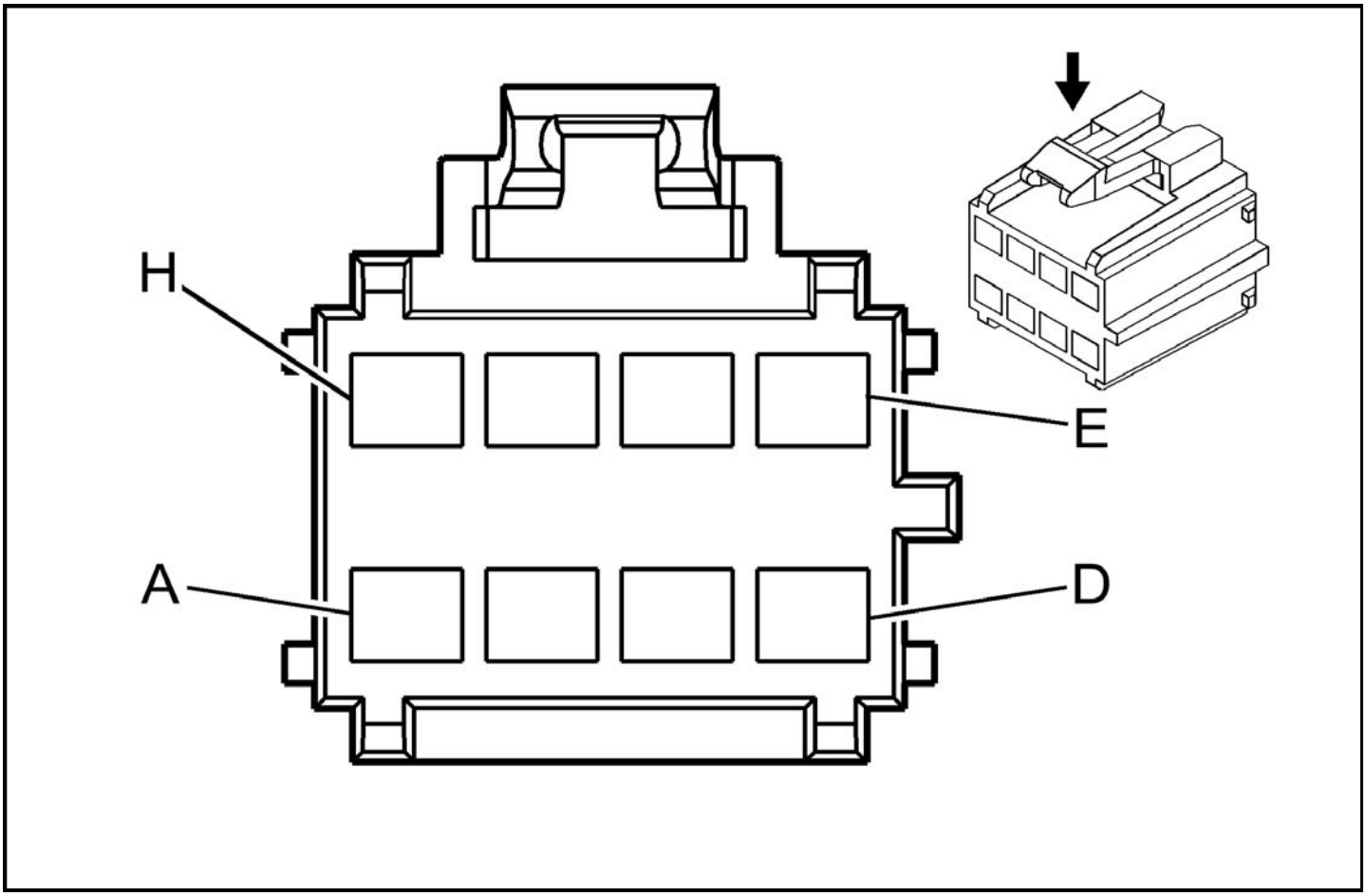
- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12015858/4
- Core/Insulation Crimp: F/G

Window Switch - Left Rear

Pin	Wire	Circuit	Function
A	3 BN	669	Power Window Motor Left Rear Down Control
B	-	-	Not Used

Pin	Wire	Circuit	Function
C	3 D-GN	168	Power Window Master Switch Left Rear Up Signal
D	3 D-BU	668	Power Window Motor Left Rear Up Control
E	3 D-BU	1307	Power Window Master Switch Lockout Signal
F-G	-	-	Not Used
H	3 PU	169	Power Window Master Switch Left Rear Down Signal

WINDOW SWITCH - PASSENGER



Connector Part Information

- Harness Type: Right Front Door
- OEM Connector: 12191825
- Service Connector: 15306048
- Description: 8-Way F Metri-Pack 280 Series (BN)

Terminal Part Information

- Pins: A, D, F, G, H

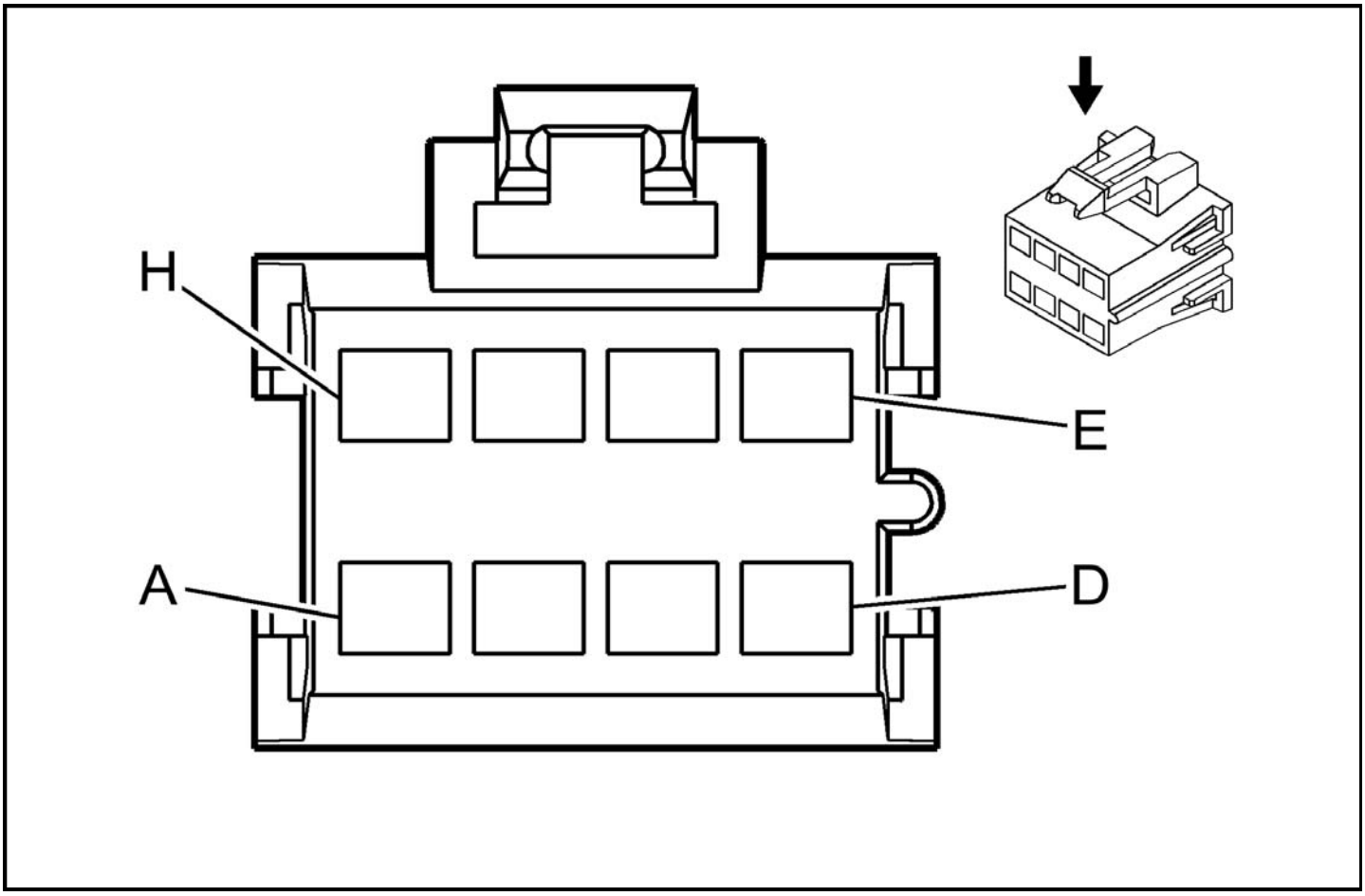
- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: Not Available

- Pins: B, C
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

Window Switch - Passenger

Pin	Wire	Circuit	Function
A	3 YE	143	Accessory Voltage
B	0.35 GY	8	Instrument Panel Lamp Supply Voltage
C	0.5 BK	750	Ground
D	3 TN	167	Power Window Master Switch Right Front Down Signal
E	-	-	Not Used
F	3 BN	667	Power Window Motor Right Front Down Control
G	3 D-BU	666	Power Window Motor Right Front Up Control
H	3 L-BU	166	Power Window Master Switch Right Front Up Signal

WINDOW SWITCH - RIGHT REAR



Connector Part Information

- Harness Type: Right Rear Door
- OEM Connector: 12064998
- Service Connector: 15306189
- Description: 8-Way F Metri-Pack 280 Series (BK)

Terminal Part Information

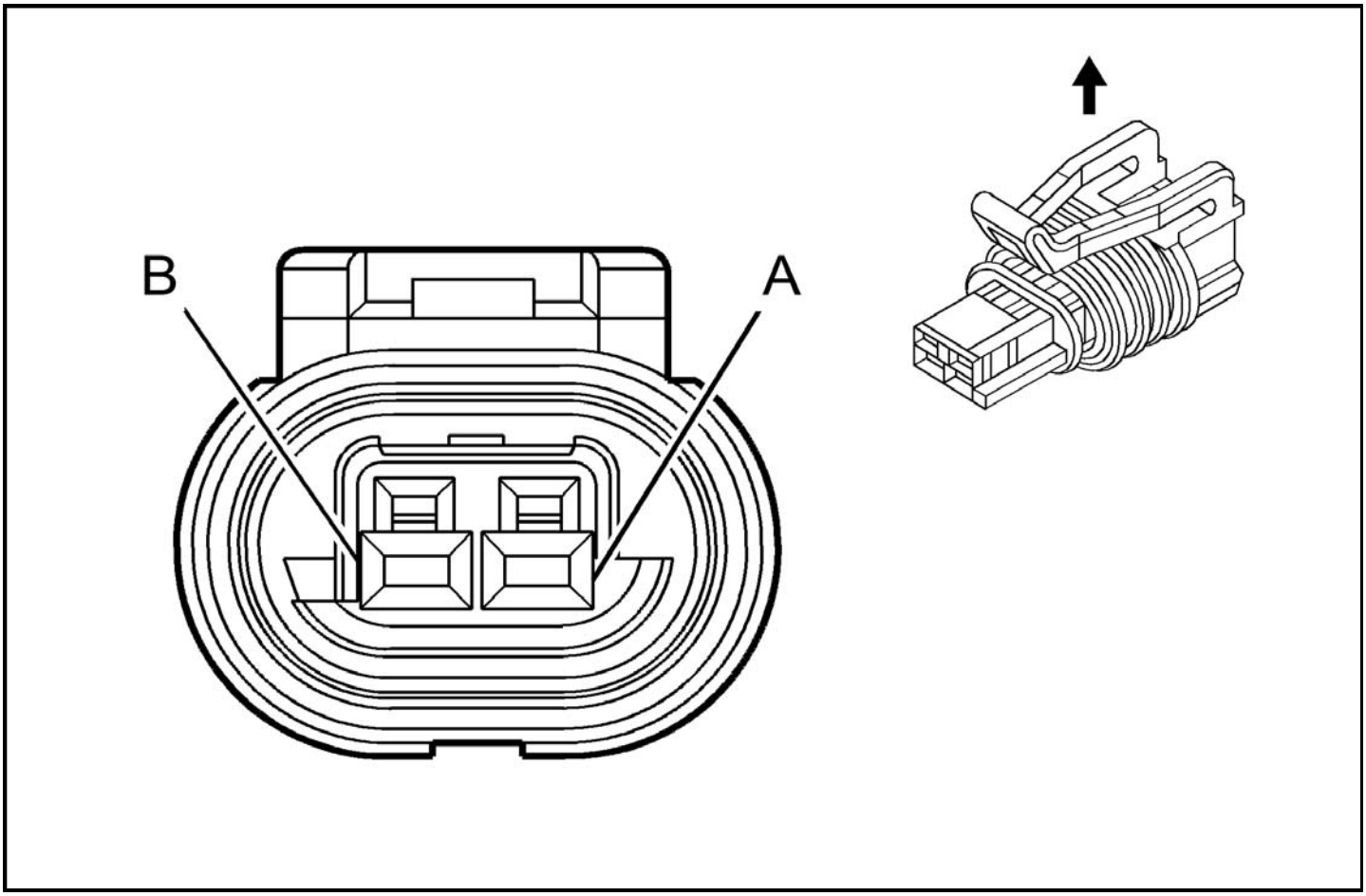
- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-11A
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12015858/4
- Core/Insulation Crimp: F/G

Window Switch - Right Rear

Pin	Wire	Circuit	Function
A	3 BN	671	Power Window Motor Right Rear Down Control
B	-	-	Not Used

Pin	Wire	Circuit	Function
C	3 L-GN	170	Power Window Master Switch Right Rear Up Signal
D	3 D-BU	670	Power Window Motor Right Rear Up Control
E	3 D-BU	1307	Power Window Master Switch Lockout Signal
F-G	-	-	Not Used
H	3 PU	171	Power Window Master Switch Right Rear Down Signal

WINDSHIELD WASHER FLUID LEVEL SWITCH



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 15449028
- Service Connector: 88987993
- Description: 2-Way F GT 150 Series, Sealed (BK)

Terminal Part Information

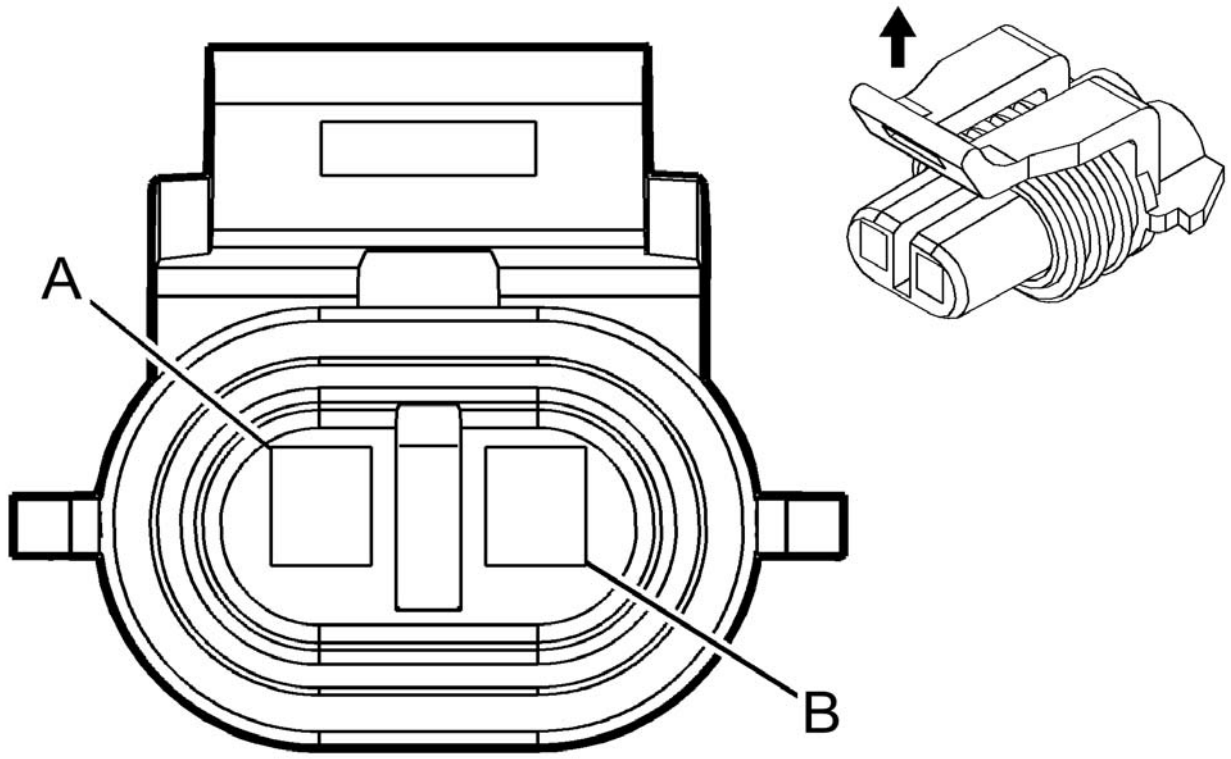
- Terminated Lead: 13576360

- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 15326267/19
- Core/Insulation Crimp: E/4

Windshield Washer Fluid Level Switch

Pin	Wire	Circuit	Function
A	0.35 TN	185	Low Washer Fluid Indicator Signal
B	0.5 BK	1250	Ground

WINDSHIELD WASHER FLUID PUMP



Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 12052641
- Service Connector: 13586114
- Description: 2-Way F Metri-Pack 150 Series (BK)

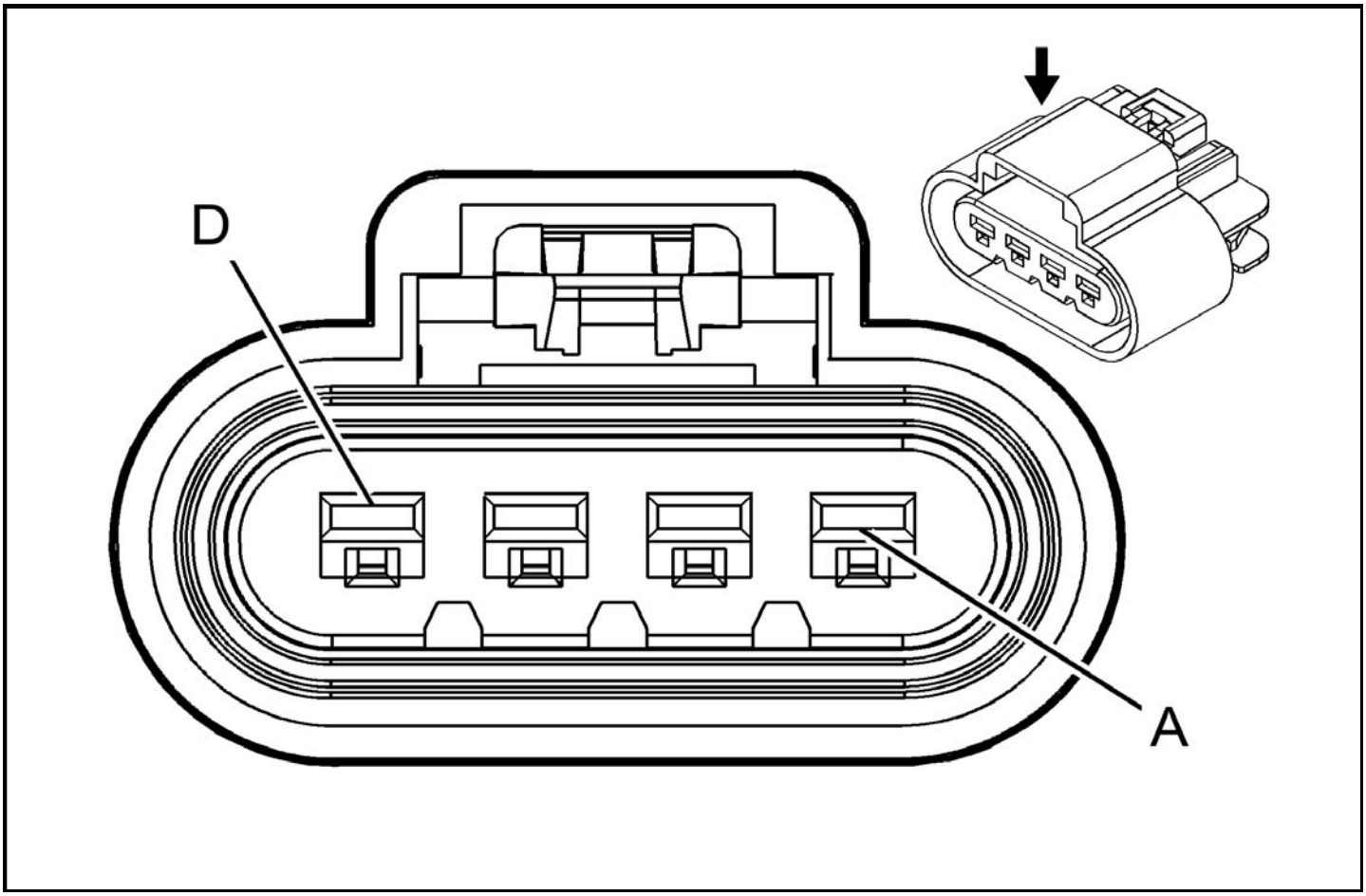
Terminal Part Information

- Terminated Lead: 13575427
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1

Windshield Washer Fluid Pump

Pin	Wire	Circuit	Function
A	0.8 OG	228	Windshield Washer Pump Control
B	0.8 BK	1250	Ground

WINDSHIELD WIPER MOTOR



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15326631
- Service Connector: 13580864
- Description: 4-Way F GT 280 5.8 Series, Sealed (BK)

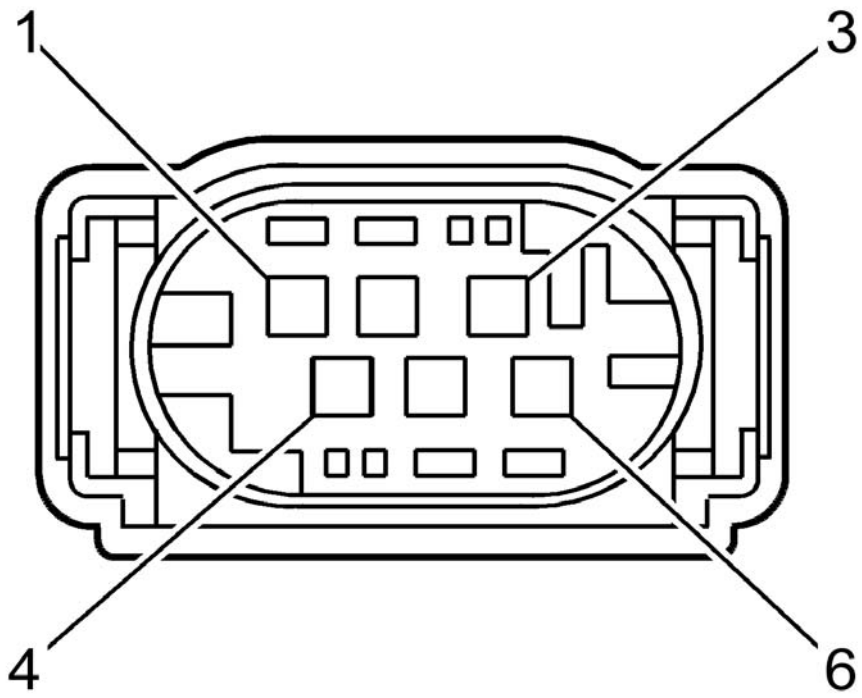
Terminal Part Information

- Terminated Lead: 13575405
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304719/19
- Core/Insulation Crimp: 2/5

Windshield Wiper Motor

Pin	Wire	Circuit	Function
A	1 BK	150	Ground
B	0.35 YE	196	Windshield Wiper Motor Park Switch Signal
C	1 PU	92	Windshield Wiper Motor High Speed Control
D	1 D-GN	95	Windshield Wiper Motor Low Speed Control

YAW AND LATERAL ACCELEROMETER SENSOR



Connector Part Information

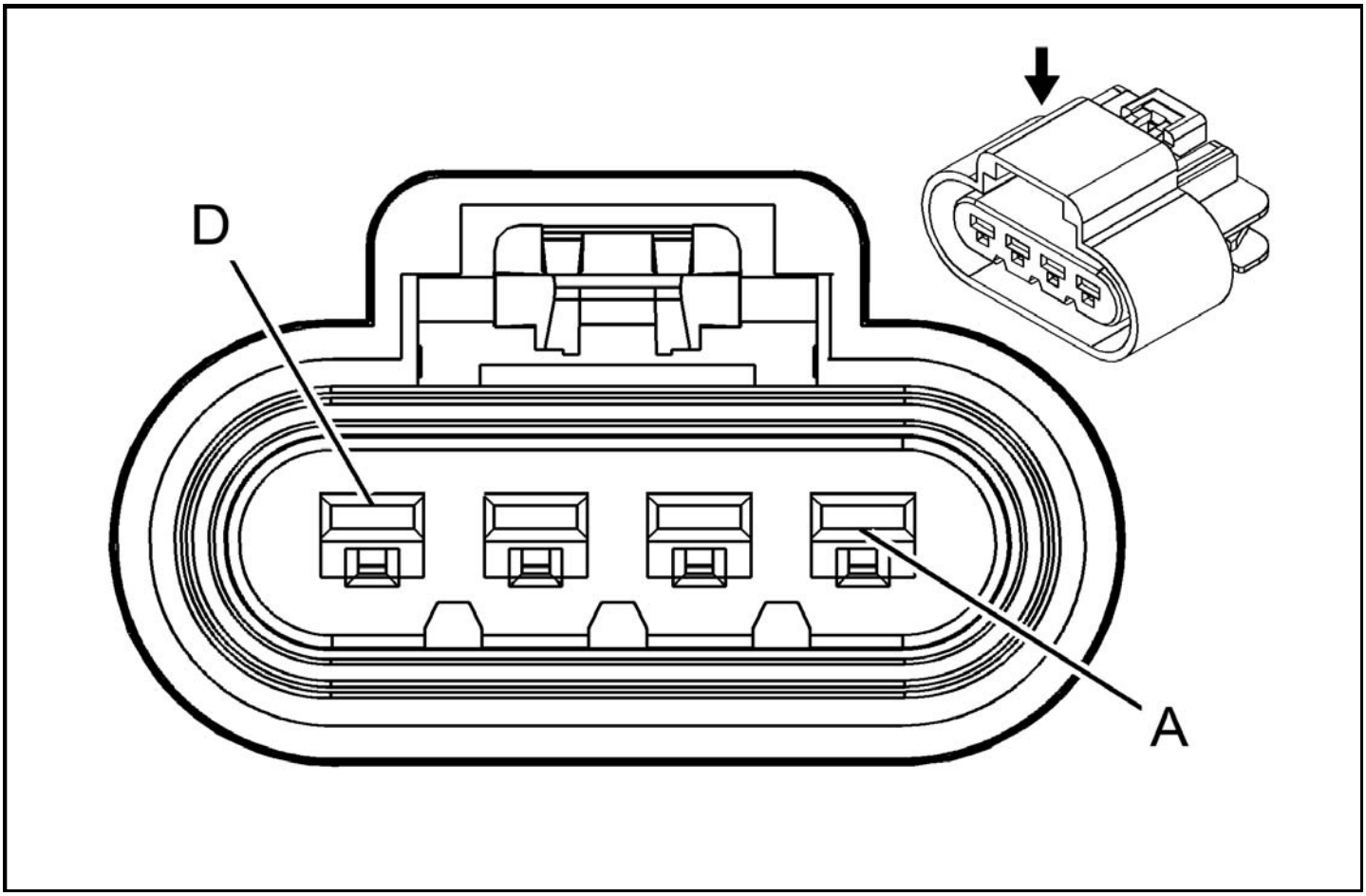
- Harness Type: Body
- OEM Connector: 15355474

- Terminated Lead: 13575427
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-14 (GN)
- Terminal/Tray: 12048074/2
- Core/Insulation Crimp: E/1

Windshield Washer Fluid Pump

Pin	Wire	Circuit	Function
A	0.8 OG	228	Windshield Washer Pump Control
B	0.8 BK	1250	Ground

WINDSHIELD WIPER MOTOR



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15326631
- Service Connector: 13580864
- Description: 4-Way F GT 280 5.8 Series, Sealed (BK)

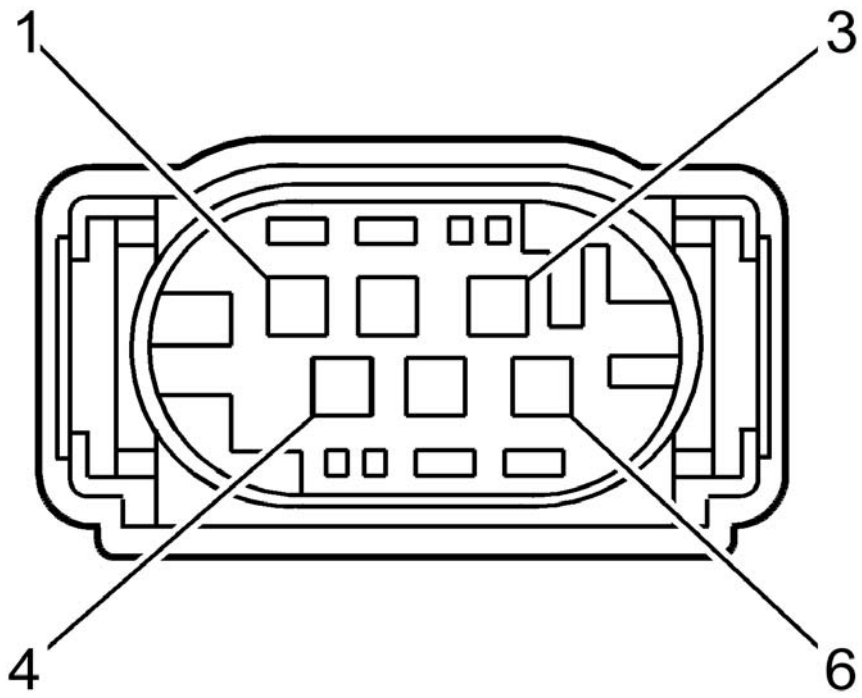
Terminal Part Information

- Terminated Lead: 13575405
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304719/19
- Core/Insulation Crimp: 2/5

Windshield Wiper Motor

Pin	Wire	Circuit	Function
A	1 BK	150	Ground
B	0.35 YE	196	Windshield Wiper Motor Park Switch Signal
C	1 PU	92	Windshield Wiper Motor High Speed Control
D	1 D-GN	95	Windshield Wiper Motor Low Speed Control

YAW AND LATERAL ACCELEROMETER SENSOR



Connector Part Information

- Harness Type: Body
- OEM Connector: 15355474

- Service Connector: 15306420
- Description: 6-Way F 0.64 MQS Series, Sealed (BK)

Terminal Part Information

- Terminated Lead: Service by Harness- See Part Catalog
- Release Tool: J-38125-12A
- Diagnostic Test Probe: J-35616-64B (L-BU)
- Terminal/Tray: 962885-5/15
- Core/Insulation Crimp: 6/6

Yaw and Lateral Accelerometer Sensor

Pin	Wire	Circuit	Function
1	0.35 GY/BK	1337	12-Volt Reference
2	0.35 TN/WH	6433	CAN Bus High Serial Data
3	0.35 L-GN/BK	6432	CAN Bus Low Serial Data
4	0.35 TN	6433	CAN Bus High Serial Data
5	0.35 L-GN	6432	CAN Bus Low Serial Data
6	0.35 BK/WH	1551	Ground

Article GUID: A00737160

DOOR COMPONENT VIEWS

DRIVER DOOR COMPONENTS

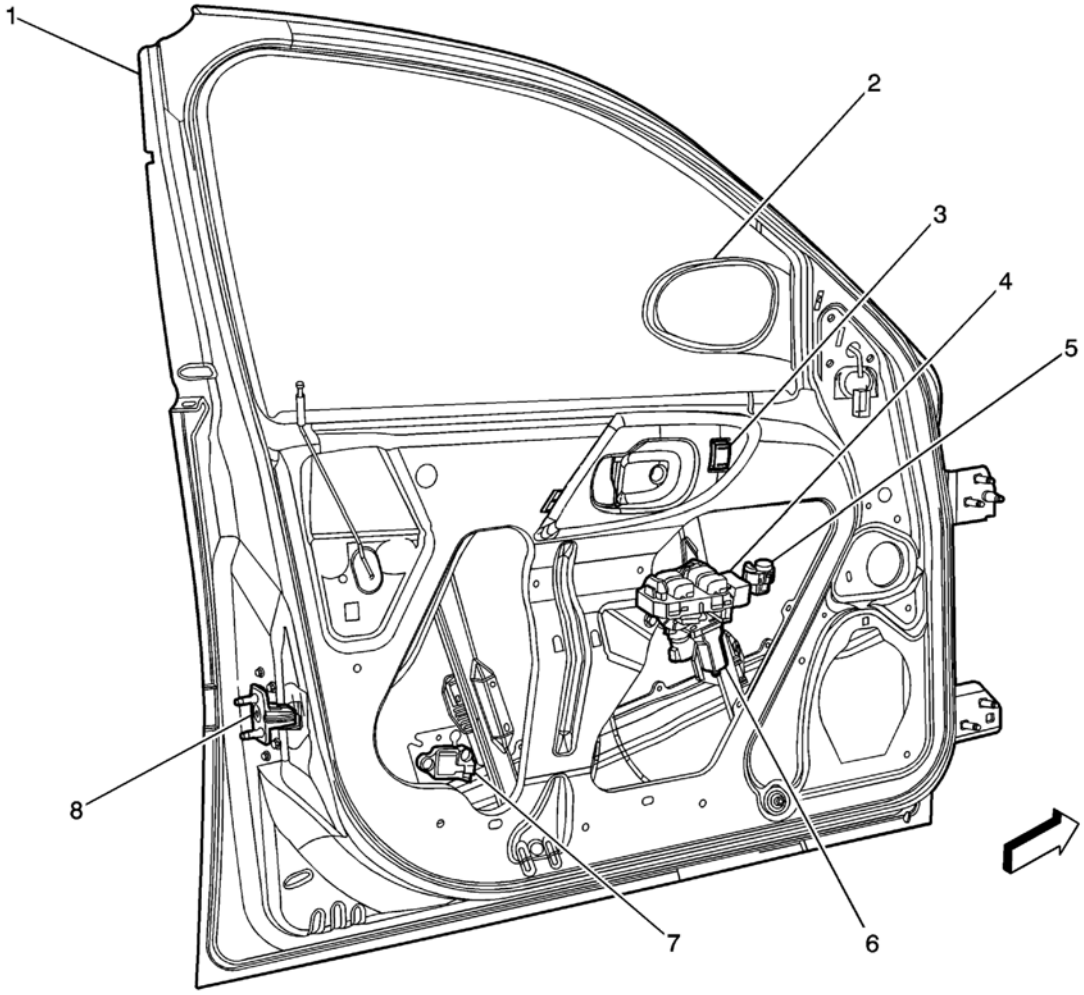


Fig. 1: Driver Door
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	Outside Rearview Mirror- Driver
3	Door Lock Switch- Driver
4	Window Switch- Driver
5	Outside Rearview Mirror (ISRVM) Switch
6	Window Motor- Driver

Callout	Component Name
7	Inflatable Restraint Side Impact Sensor (SIS)- Left
8	Door Lock- Driver

PASSENGER DOOR COMPONENTS

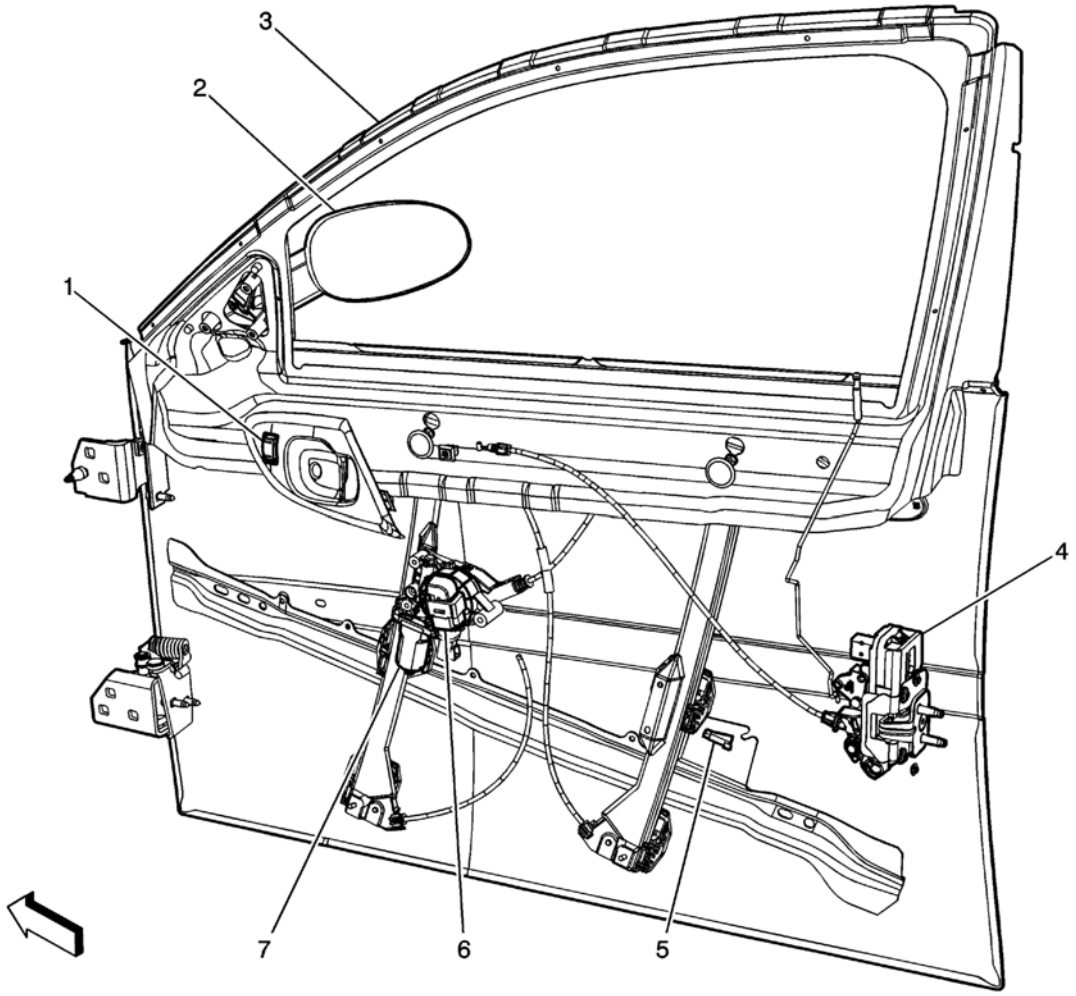


Fig. 2: Identifying Passenger Door
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Lock Switch- Passenger
2	Outside Rearview Mirror- Passenger
3	Door Frame
4	Door Lock- Passenger
5	Inflatable Restraint Side Impact Sensor (SIS)- Right
6	Window Switch- Passenger
7	Window Motor- Passenger

LEFT REAR DOOR COMPONENTS

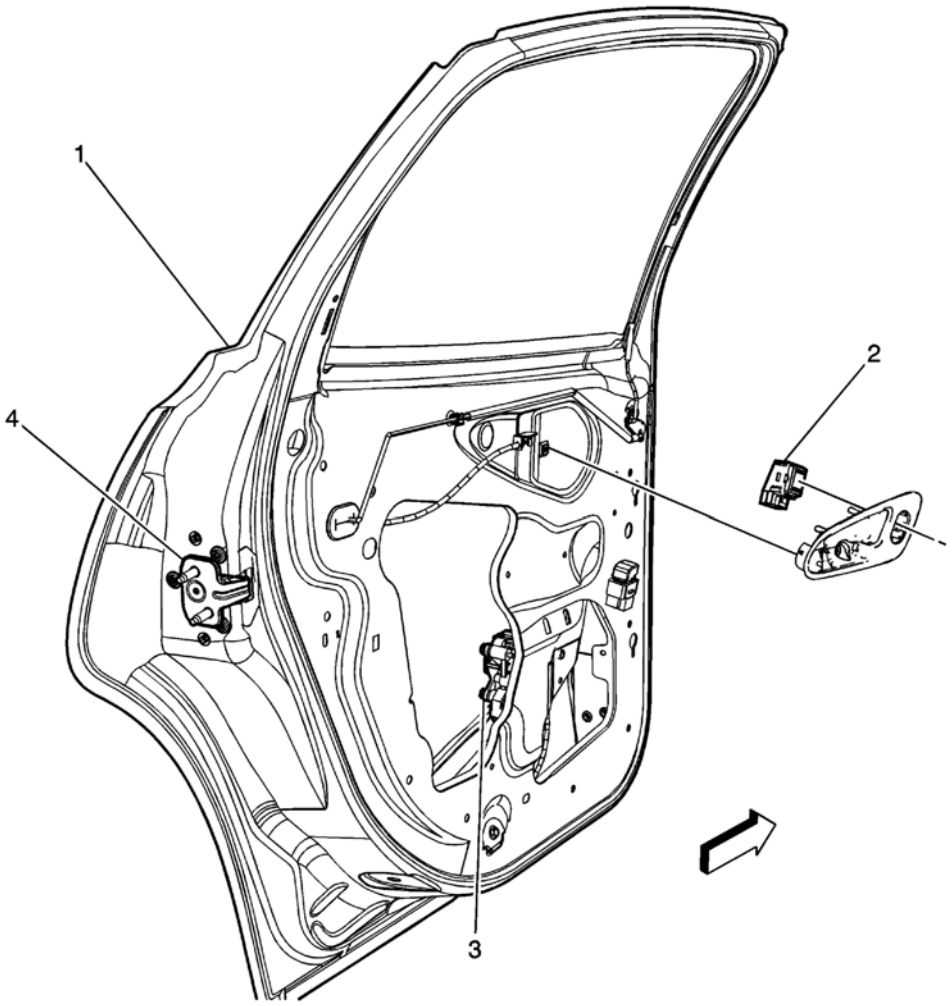


Fig. 3: View Of LR Door
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	Window Switch
3	Window Motor
4	Door Lock

RIGHT REAR DOOR COMPONENTS

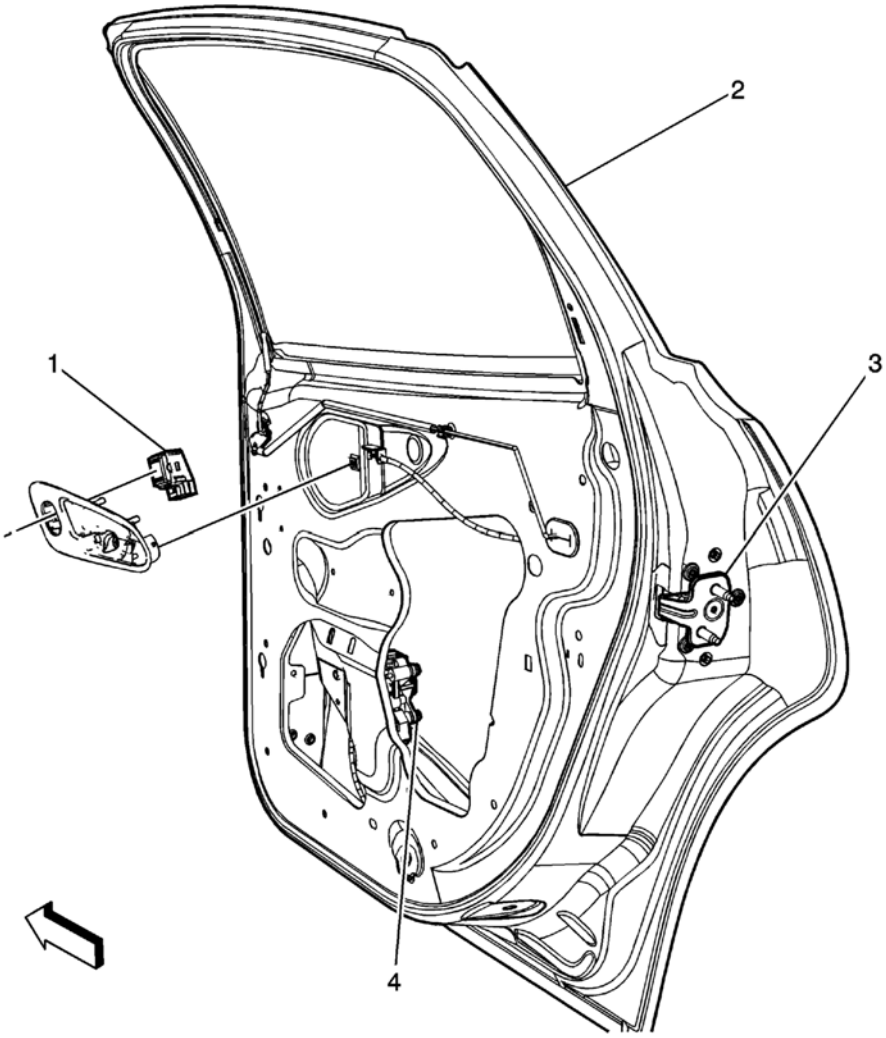


Fig. 4: View Of RR Door
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Window Switch
2	Door Frame
3	Door Lock
4	Window Motor

Article GUID: A00737221

ELECTRICAL CENTER IDENTIFICATION VIEWS

FUSE BLOCK - UNDERHOOD LABEL

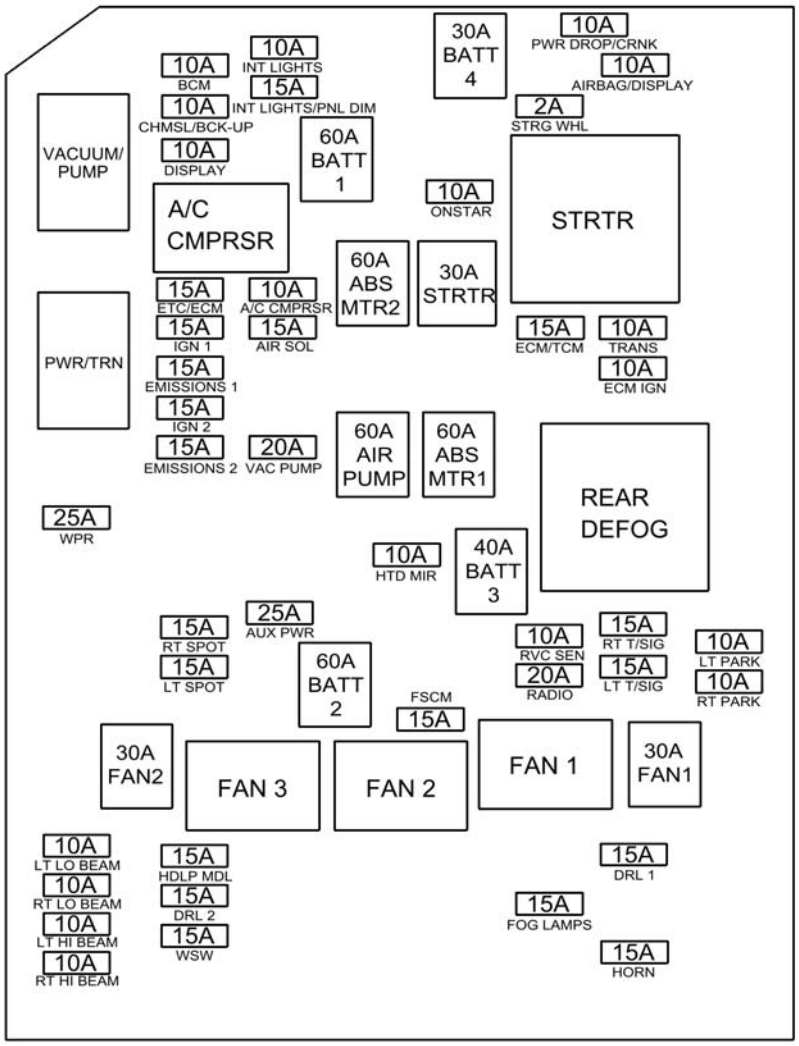


Fig. 1: Fuse Block -- Underhood Label
Courtesy of GENERAL MOTORS COMPANY

Fuse Block - Underhood Label Usage

Fuse And Relay Description	Rating	Circuits
A/C CMPRSR Fuse	10A	A/C Compressor Clutch
ABS MTR1 Fuse	60A	Electronic Brake Control Module (EBCM)
ABS MTR2 Fuse	60A	Electronic Brake Control Module (EBCM)

Fuse And Relay Description	Rating	Circuits
AIRBAG/DISPLAY Fuse	10A	Instrument Panel Cluster (IPC), HVAC Control Module, Inflatable Restraint Passenger Air Bag On/Off Indicator, and Inflatable Restraint Sensing and Diagnostic Module (SDM)
AUX PWR Fuse	25A	Accessory Power Outlet - I/P 1 and Accessory Power Outlet - I/P 2
BATT 1 Fuse	60A	CNSTR, XM, AMP, AUX Fuses, and Trunk Relay
BATT 2 Fuse	60A	HTD/SEAT, AIRBAG, PWR/MIR, S/ROOF, DR/LCK Fuses, PWR/SEAT Circuit Breaker, and RAP Relay
BATT 3 Fuse	40A	Rear Window Defogger Grid
BATT 4 Fuse	30A	Blower Motor Control Module
BCM Fuse	10A	Body Control Module (BCM), Ignition Switch, and Theft Deterrent Module (TDM)
CHMSL/BCK-UP Fuse	10A	Body Control Module (BCM)
DISPLAY Fuse	10A	Data Link Connector (DLC), Remote Control Door Lock Receiver (RCDLR), Instrument Panel Cluster (IPC), and HVAC Control Module
DRL 1 Fuse	15A	DRL 2 Fuse
DRL 2 Fuse	15A	LT LO BEAM Fuse, RT LO BEAM Fuse
ECM IGN Fuse	10A	Engine Control Module (ECM)
ECM/TCM Fuse	15A	Engine Control Module (ECM) and Transmission Control Module (TCM)
EMISSIONS 1 Fuse	15A	Heated Oxygen Sensor (HO2S) 1, Heated Oxygen Sensor (HO2S) 2, and Evaporative Emission (EVAP) Canister Purge Solenoid Valve
EMISSIONS 2 Fuse	15	Mass Air Flow (MAF)/Intake Air Temperature (IAT) Sensor, Valve Lifter Oil Manifold (VLOM) Assembly (LZG), Secondary Air Injection (AIR) Pump Relay (NU3), Secondary Air Injection (AIR) Solenoid Relay (NU3), A/C CMPRSR Relay, FAN 1 Relay, FAN 2 Relay, and FAN 3 Relay
ETC/ECM Fuse	15A	Engine Control Module (ECM)
FAN1 Fuse	30A	FAN 1 Relay
FAN2 Fuse	30A	FAN 3 Relay
FOG LAMPS Fuse	15A	Fog Lamp - Left Front and Fog Lamp - Right Front
FSCM Fuse	15A	Fuel Pump Flow Control Module
HDLP MDL Fuse	15A	C122 or Emergency Vehicle Headlamp Flasher (6J7)
HORN Fuse	15A	Horn Assembly
HTD MIR Fuse	10A	Outside Rearview Mirror - Driver and Outside Rearview Mirror - Passenger
INJ 1 Fuse	20A	Fuel Injectors 1-6
INJ 2 Fuse	20A	Ignition Control Module
INT LIGHTS Fuse	10A	Body Control Module (BCM)
INT LTS/PNL DIM Fuse	15A	Body Control Module (BCM)

Fuse And Relay Description	Rating	Circuits
LT HI BEAM FUSE	10A	Headlamp - High Beam - Left or Emergency Vehicle Headlamp Flasher (6J7)
LT LO BEAM Fuse	10A	Headlamp - Low Beam - Left
LT PARK Fuse	10A	Marker lamp - LF, Park/Turn Signal Lamp - Left Front, Tail Lamp - Left, and Tail/Stop and Turn Signal - Left
LT SPOT Fuse (9C1, 9C3)	15A	Spot Lamp - Left (7x6, 7X7)
LT T/SIG Fuse	15A	Body Control Module (BCM)
PWR DROP/CRNK Fuse	10A	Blunt Cut Wire (9C1, 9C3)
RADIO Fuse	20A	Radio
RT HI BEAM Fuse	10A	Headlamp - High Beam - Right or Emergency Vehicle Headlamp Flasher (6J7)
RT LO BEAM Fuse	10A	Headlamp - Low Beam - Right
RT PARK Fuse	10A	Marker Lamp - RF, Park/Turn Signal Lamp - RF, Tail Lamp - Right, and Tail/Stop and Turn Signal - Right
RT SPOT Fuse (9C1, 9C3)	15A	Spot Lamp - Right (7X7)
RT T/SIG Fuse	15A	Body Control Module (BCM)
RVC SEN Fuse	10A	Body Control Module (BCM)
Spare Fuse	2A	Not Used
Spare Fuse	10A	Not Used
Spare Fuse	15A	Not Used
Spare Fuse	20A	Not Used
Spare Fuse	25A	Not Used
STRG WHL Fuse	2A	Steering Wheel Controls - Left and Steering Wheel Controls - Right
STRTR Fuse	40A	Starter
TRANS Fuse	10A	1-2 Shift Solenoid (1-2 SS) Valve, 2-3 Shift Solenoid (2-3 SS) Valve, Torque Converter Clutch (TCC) Solenoid Valve, and Transmission Control Module (TCM)
VAC PUMP Fuse	20A	Brake Booster Pump - Auxiliary
WPR Fuse	25A	WIPER PCB Relay
WSW Fuse	15A	Windshield Washer Fluid Pump
A/C CMPRSR Relay	-	A/C CMPRSR Fuse
FAN 1 Relay	-	Engine Cooling Fan - Left
FAN 2 Relay	-	Engine Cooling Fan - Right
FAN 3 Relay	-	Engine Cooling Fan - Right
PWR/TRN Relay	-	ETC/ECM, INJ 1, INJ 2, EMISSIONS 1, and EMISSIONS 2 Fuses
REAR DEFOG Relay	-	BATT 3 and HTD MIR Fuses
STRTR Relay	-	STRTR Fuse
Vacuum Pump Relay	-	VAC Pump Fuse
Relays listed below are non-serviceable Printed Circuit Board (PCB) relays and are internal to the block.		
DRL PCB Relay	-	DRL 1 Fuse

Fuse And Relay Description	Rating	Circuits
FOG LP PCB Relay	-	FOG LAMPS Fuse
HIGH BEAM PCB Relay	-	LT HI BEAM and RT HI BEAM Fuses
HORN PCB Relay	-	HORN Fuse
IGN MAIN PCB Relay	-	AIRBAG/DISPLAY, ECM IGN, PWR DROP/CRNK, and TRANS Fuses
LOW BEAM PCB Relay	-	DRL 2, LT LO BEAM, and RT LO BEAM Fuses
PARK LP PCB Relay	-	LT PARK and RT PARK Fuses
WIPER PCB Relay	-	WIPER HIGH PCB Relay
WIPER HIGH PCB Relay	-	Windshield Wiper Motor
WS WASH PCB Relay	-	WSW Fuse

FUSE BLOCK - UNDERHOOD - TOP VIEW

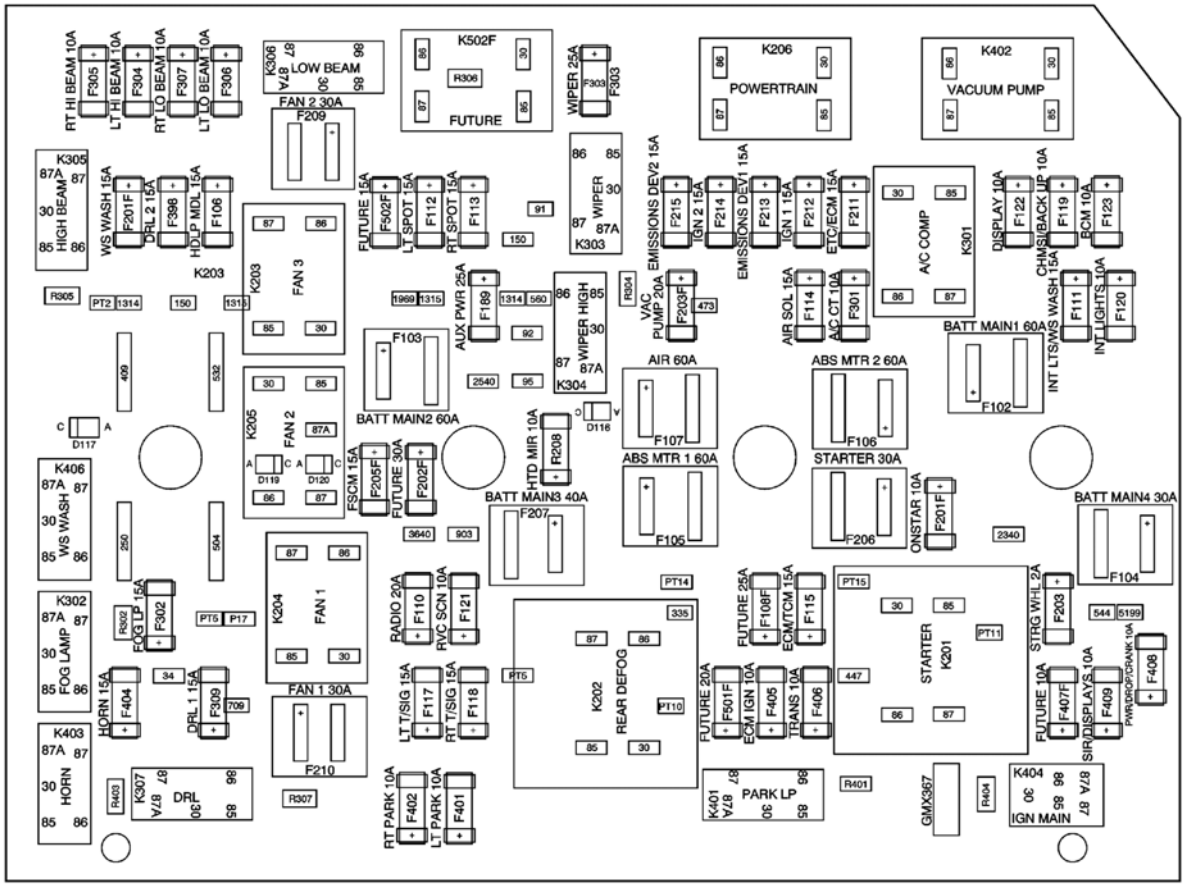


Fig. 2: Fuse Block-- Underhood-- Top View
Courtesy of GENERAL MOTORS COMPANY

FUSE BLOCK - UNDERHOOD - BOTTOM VIEW

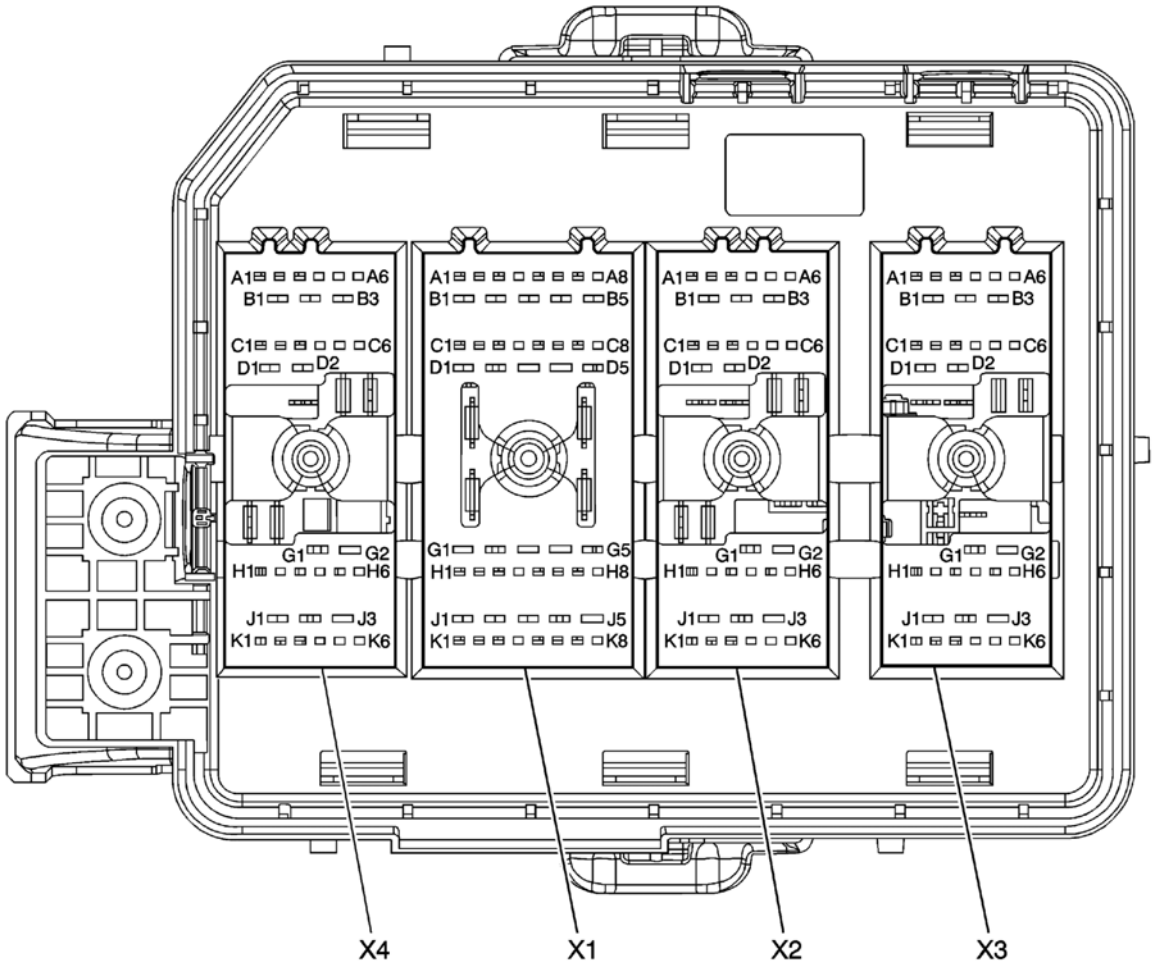


Fig. 3: Fuse Block - Underhood - Bottom View
Courtesy of GENERAL MOTORS COMPANY

FUSE BLOCK - UNDERHOOD X1

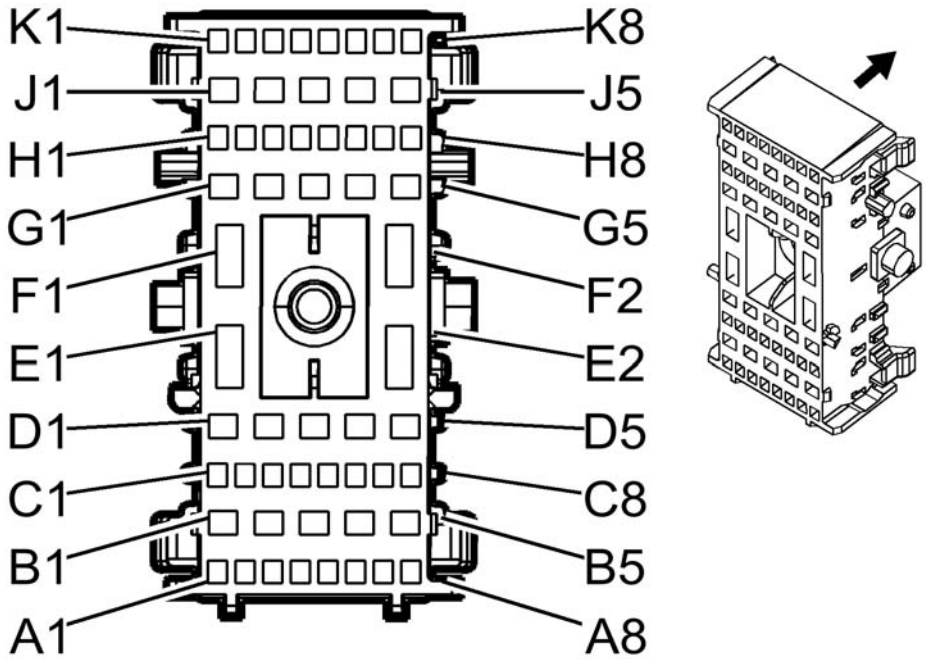


Fig. 4: Fuse Block - Underhood C1
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Engine
- OEM Connector: 15477822
- Service Connector: 19115189
- Description: 56-Way F GT 150 280 Metri-Pack 800 Series (BK)

Terminal Part Information

- Pins: A1, A5, A6, A8, C1, C2, C7, H1, H7
- Terminated Lead: 13575735
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: E/C

- Pins: B1, D1, D2, J1, J3
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pins: B2, B4
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: 2/A

- Pins: B3, B5, G2
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pins: E1, E2, F1, F2
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Pin: J2
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

Fuse Block - Underhood X1

Pin	Wire	Circuit	Function
A1	0.35 D-GN/WH	465	Fuel Pump Relay Control
A2-A4	-	-	Not Used
A5	0.5 PK/BK	5293	Ignition 1 Voltage
A6	0.35 BN	5069	PWR/TRN Relay Control
A7	-	-	Not Used
A8	0.5 PK/BK	5294	Ignition 1 Voltage
B1	0.5 PK/BK	5290	Ignition 1 Voltage
B2	0.8 PK/BK	5291	Ignition 1 Voltage
B3	0.5 PK/BK	5293	Ignition 1 Voltage
	0.5 PK/BK	5293	Ignition 1 Voltage
B4	0.8 PK/BK	5292	Ignition 1 Voltage

Pin	Wire	Circuit	Function
B5	0.8 PK/BK	5294	Ignition 1 Voltage (LZG)
	0.5 PK/BK	5294	Ignition 1 Voltage (NU3)
C1	0.35 D-GN/WH	459	A/C Compressor Clutch Relay Control
C2	0.35 BK/WH	451	Ground
C3-C6	-	-	Not Used
C7	0.35 D-BU	473	High Speed Cooling Fan Relay Control
C8	-	-	Not Used
D1	0.5 D-GN	59	A/C Compressor Clutch Supply Voltage
D2	0.5 RD/WH	2140	Battery Positive Voltage (NU3)
D3-D5	-	-	Not Used
E1	5 RD/BK	1342	Battery Positive Voltage (JL9)
E2	5 RD/BK	742	Battery Positive Voltage (NU3)
F1	3 PU	6	Starter Solenoid Crank Voltage
F2	5 RD/BK	1442	Battery Positive Voltage (without JL4)
	5 RD/BK	1442	Battery Positive Voltage (JL4)
G1	-	-	Not Used
G2	0.5 RD/WH	540	Battery Positive Voltage
	0.5 RD/WH	540	Battery Positive Voltage
G3-G5	-	-	Not Used
H1	0.35 WH	1310	EVAP Canister Vent Solenoid Control
H2-H6	-	-	Not Used
H7	0.35 D-GN	335	Low Speed Cooling Fan Relay Control
H8	-	-	Not Used
J1	0.35 YE	447	Starter Relay Coil Control
J2	0.35 PK	1339	Ignition 1 Voltage
	0.35 PK	1339	Ignition 1 Voltage
J3	0.35 PK	439	Ignition 1 Voltage
J4-J5	-	-	Not Used
K1-K8	-	-	Not Used

FUSE BLOCK - UNDERHOOD X2

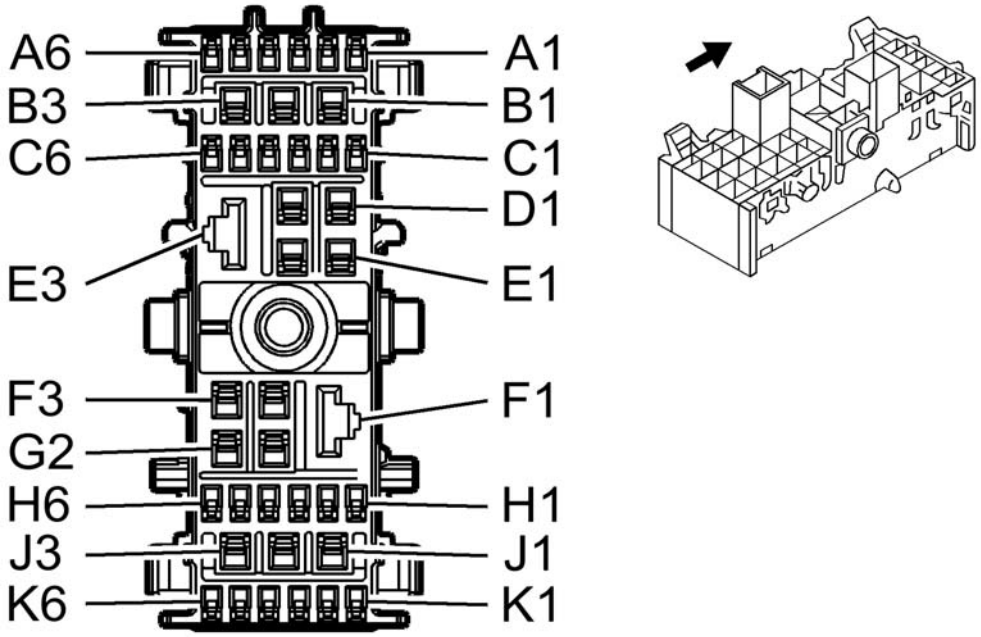


Fig. 5: Fuse Block - Underhood X2
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 13528107
- Service Connector: 88988655
- Description: 40-Way F GT 150 280 Metri-Pack 800 Series (GY)

Terminal Part Information

- Pins: A1, A5, C1, C2, C5, C6, H3, H5, H6, K2, K3
- Terminated Lead: 13575735
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: E/C

- Pins: B1, D1, D2, E1, E2, G2, J2, J3
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: 2/A

- Pin: E3
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Pin: F1
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Pin: G1
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pin: J1
- Terminated Lead: 13575754
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304713/19
- Core/Insulation Crimp: 4/4

- Pins: K5, K6
- Terminated Lead: 13575735
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: C/A

Fuse Block - Underhood X2

Pin	Wire	Circuit	Function
A1	0.35 GY	91	Wiper Relay Control
A2-A4	-	-	Not Used
A5	0.35 PK/WH	1970	Headlamp Low Beam Relay Control

Pin	Wire	Circuit	Function
A6	-	-	Not Used
B1	1 BK	150	Ground
B2	0.5 RD/WH	2740	Battery Positive Voltage (9C1, 9C3)
B3	0.5 RD/WH	2640	Battery Positive Voltage (9C1, 9C3)
C1	0.35 TN	860	Wiper High Speed Relay Control
C2	0.5 L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage
C3-C4	-	-	Not Used
C5	0.5 D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage
C6	0.35 TN/WH	1969	Headlamp High Beam Relay Control
D1	1 PU	92	Windshield Wiper Motor High Speed Control
D2	1 RD/WH	2540	Battery Positive Voltage (without Floor Console)
E1	1 D-GN	95	Windshield Wiper Motor Low Speed Control
E2	1 RD/WH	2540	Battery Positive Voltage (without Floor Console)
E3	5 RD/BK	642	Battery Positive Voltage
F1	3 PU	293	Rear Defog Element Supply Voltage
F2	-	-	Not Used
F3	0.5 RD/WH	2340	Battery Positive Voltage
G1	0.35 RD/WH	2440	Battery Positive Voltage
G2	1 RD/WH	2040	Battery Positive Voltage
H1-H2	-	-	Not Used
H3	0.35 WH	193	Rear Defog Relay Control
H4	0.5 OG	267	Heated Mirror Element Supply Voltage (DK2)
H5	0.35 D-GN/WH	1317	Fog Lamp Relay Control (T96)
H6	0.35 OG	2268	Windshield Washer Relay Control
J1	GY	901	Not Used
J2	0.8 RD/WH	440	Battery Positive Voltage
J3	0.8 RD/WH	340	Battery Positive Voltage
K1	-	-	Not Used
K2	0.35 WH	1080	Park Lamp Relay Control
K3	0.35 TN	28	Horn Relay Control
K4	0.35 D-GN/RD	6820	Exterior Lamp Flasher Signal (9C1, 9C3)
K5	0.8 PU	709	Left Park Lamp Supply Voltage
K6	0.8 BN/WH	309	Right Park Lamp Supply Voltage

FUSE BLOCK - UNDERHOOD X3

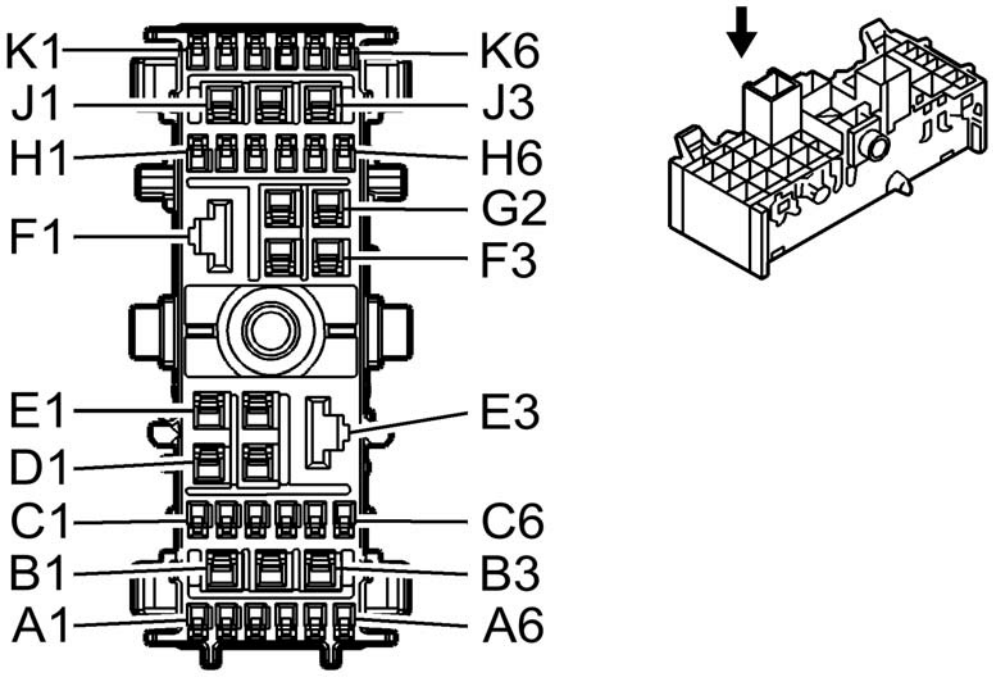


Fig. 6: Fuse Block - Underhood X3

Connector Part Information

- Harness Type: Forward Lamp
- OEM Connector: 13528106
- Service Connector: 19178190
- Description: 40-Way F GT 150 280 Metri-Pack 800 Series (WH)

Terminal Part Information

Terminal Type ID	Terminated Lead	Diagnostic Test Probe	Terminal Removal Tool	Service Terminal	Tray	Core Crimp	Insulation Crimp
I	13575735	J-35616-2A (GY)	J-38125-553	12191812	19	C	A
II	13575735	J-35616-2A (GY)	J-38125-553	12191812	19	E	C
III	13575753	J-35616-4A (PU)	J-38125-553	15304711	8	2	A
IV	13575753	J-35616-4A (PU)	J-38125-553	15304711	8	E	A
V	13575756	J-35616-4A (PU)	J-38125-553	15304713	19	F	D
VI	13575753	J-35616-4A (PU)	J-38125-553	15304711	8	E	A

Pin	Size	Color	Circuit	Function	Terminal Type ID	Option
A1	-	-	-	Not Occupied	-	-
A2	0.8	YE	712	Left Headlamp Low Beam Supply Voltage	I	-
A3	0.5	TN/WH	312	Right Headlamp Low Beam Supply Voltage	II	-
A4	-	-	-	Not Occupied	-	-
A5	0.5	D-GN/WH	711	Left Headlamp High Beam Supply Voltage	II	-
A6	0.5	L-GN/BK	311	Right Headlamp High Beam Supply Voltage	II	-
B1	0.8	RD/WH	2940	Battery Positive Voltage	III	B1:9C1, 9C3
B2	0.5	GY	589	DRL Resistor Supply Voltage	IV	-
B3	-	-	-	Not Occupied	-	-
C1	0.5	D-BU/WH	1315	Right Front Turn Signal Lamp Supply Voltage	II	-
C2-C4	-	-	-	Not Occupied	-	-
C5	0.5	L-BU/WH	1314	Left Front Turn Signal Lamp Supply Voltage	II	-
C6	-	-	-	Not Occupied	-	-
D1	3	L-BU	409	Cooling Fan - Right Supply Voltage	V	-
D2	-	-	-	Not Occupied	-	-
E1	3	GY	532	Cooling Fan - Left Low Reference	V	-
E2	3	BK	250	E2:Ground	V	-
E3	-	-	-	Not Occupied	-	-
F1	-	-	-	Not Occupied	-	-
F2	3	WH	504	Cooling Fan - Left Supply Voltage	V	-
F3	-	-	-	Not Occupied	-	-
G1	0.5 0.5	PU PU	34 34	Front Fog Lamp Supply Voltage Front Fog Lamp Supply Voltage	VI	T96 T96
G2	-	-	-	Not Occupied	-	-
H1	-	-	-	Not Occupied	-	-
H2	0.8	OG	228	Windshield Washer Pump Control	I	-
H3-H6	-	-	-	Not Occupied	-	-
J1	0.5	GY	589	DRL Resistor Supply Voltage	-	-
J2	0.5	BN/WH	309	Right Park Lamp Supply Voltage	IV	-
J3	0.8	D-GN	29	Horn Control	III IV	-
K1	0.5	PU	709	Left Park Lamp Supply Voltage	II	-
K2	-	-	-	Not Occupied	-	-
K3	0.35	D-GN/RD	6820	Exterior Lamp Flasher Signal	II	K3:9C1, 9C3
K4-K6	-	-	-	Not Occupied	-	-

FUSE BLOCK - UNDERHOOD X4

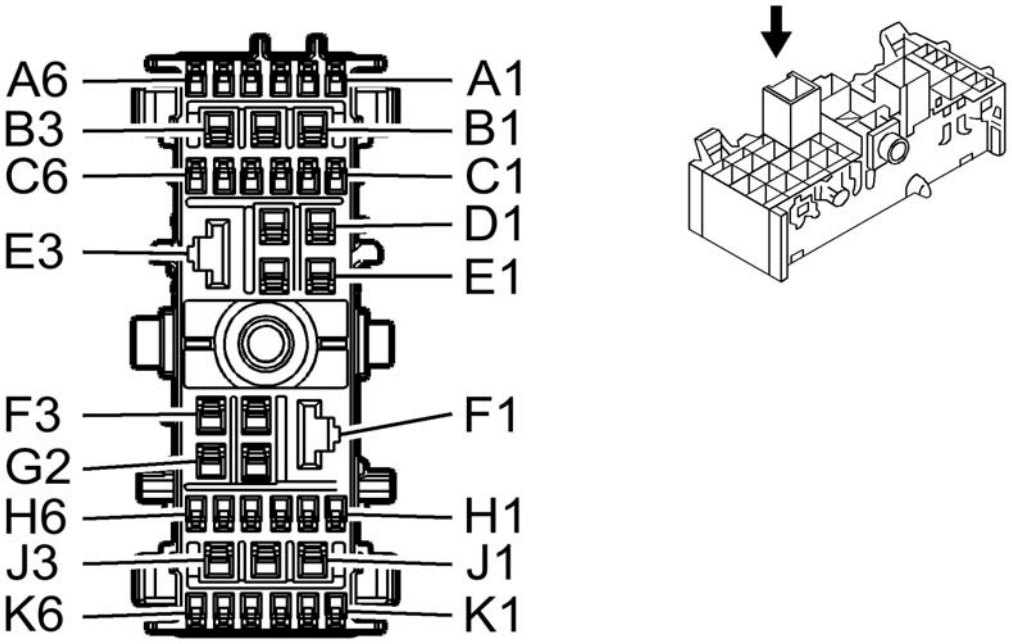


Fig. 7: Fuse Block - Underhood X4
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information • Harness Type: Instrument Panel • OEM Connector: 13528108 • Service Connector: 88988654 • Description: 40-Way F GT 150 280 Metri-Pack 800 Series (L-GY)
Terminal Part Information • Pin: A4 • Terminated Lead: 13575735 • Release Tool: J-38125-553 • Diagnostic Test Probe: J-35616-2A (GY) • Terminal/Tray: 12191812/19 • Core/Insulation Crimp: C/A • Pin: B1 • Terminated Lead: 13575753 • Release Tool: J-38125-553 • Diagnostic Test Probe: J-35616-4A (PU)

- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pins: B2, B3, F3, G1
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pins: D1, D2
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: 2/A

- Pin: E2
- Terminated Lead: 13575754
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304713/19
- Core/Insulation Crimp: 4/4

- Pin: E3
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Pin: F1
- Terminated Lead: 13575718
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

- Pins: H1, H2, H4, H6, K4
- Terminated Lead: 13575735
- Release Tool: J-38125-553

- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: E/C

Fuse Block - Underhood X4

Pin	Wire	Circuit	Function
A1-A3	-	-	Not Used
A4	0.8 RD/WH	1240	Battery Positive Voltage
A5-A6	-	-	Not Used
B1	0.35 RD/WH	1040	Battery Positive Voltage
	0.5 RD/WH	1040	Battery Positive Voltage
B2	0.5 RD/WH	1240	Battery Positive Voltage
B3	0.35 RD/WH	1840	Battery Positive Voltage
C1-C6	-	-	Not Used
D1	0.8 RD/WH	240	Battery Positive Voltage
D2	0.8 RD/WH	1640	Battery Positive Voltage
E1	-	-	Not Used
E2	2 GY	120	Fuel Pump Supply Voltage
E3	5 RD/BK	242	Battery Positive Voltage
F1	3 RD/BK	442	Battery Positive Voltage
F2	-	-	Not Used
F3	2 RD/WH	3640	Battery Positive Voltage
G1	0.35 PU/WH	1382	LED Dimming Supply
G2	-	-	Not Used
H1	0.35 YE	5199	Run/Crank Relay Coil Control
H2	0.35 PU	544	DRL PCB Relay Control
H3	-	-	Not Used
H4	0.35 PU/WH	7005	LED Dimming Supply
H5	-	-	Not Used
H6	0.35 WH	1310	EVAP Canister Vent Solenoid Control
J1-J3	-	-	Not Used
K1	0.5 PK	739	Ignition 1 Voltage (9C1, 9C3)
K2-K3	-	-	Not Used
K4	0.35 PK	1139	Ignition 1 Voltage
K5-K6	-	-	Not Used

FUSE BLOCK - I/P - LABEL

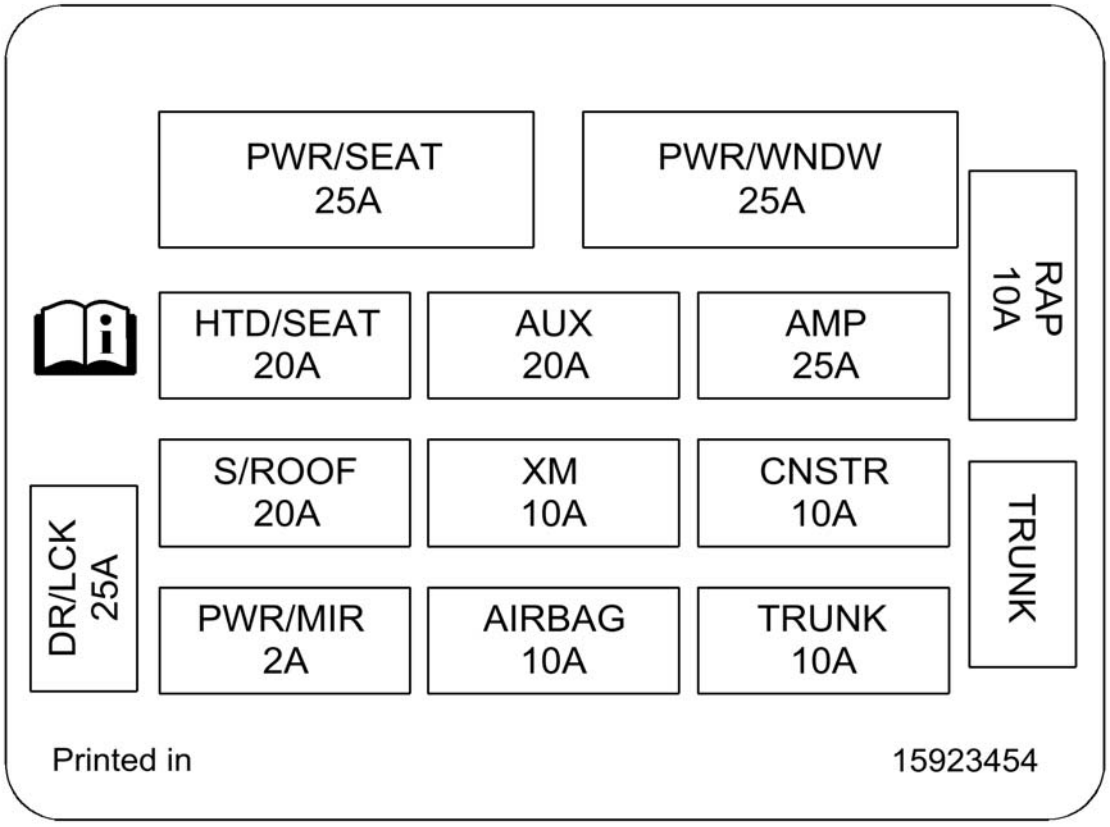


Fig. 8: Fuse Block - I/P - Label
Courtesy of GENERAL MOTORS COMPANY

Fuse Block - I/P - Label Usage

Fuse And Relay Description	Rating	Circuits
AIRBAG Fuse	10A	Inflatable Restraint Sensing and Diagnostic Module (SDM), Inflatable Restraint Front Passenger Presence System (PPS) Module
AMP Fuse	25A	Audio Amplifier
AUX Fuse	20A	Accessory Power Outlet - Center Seat, Accessory Power Outlet - Center Console 1, Accessory Power Outlet - Center Console 2, Accessory Power Outlet - Center Console Compartment
CNSTR Fuse	10A	Evaporative Emission (EVAP) Canister Vent Solenoid
DR/LCK Fuse	25A	DOOR UNLOCK PCB Relay - Driver, DOOR UNLOCK PCB Relay, and DOOR LOCK PCB Relay

Fuse And Relay Description	Rating	Circuits
HTD/SEAT Fuse	20A	Heated Seat Control Module (KA1), Emergency Vehicle Rear Compartment Lid Lamps Relay (T53)
PWR/MIR Fuse	2A	Outside Rearview Mirror Switch
RAP Fuse	10A	Automatic Transmission Shift Lock Control Solenoid (with Floor Shifter), Inside Rearview Mirror (DD6), Sunroof Motor (CF5)
S/ROOF Fuse	20A	Sunroof Motor (CF5)
TRUNK Fuse	10A	Rear Compartment Lid Release Actuator
PWR/SEAT Circuit Breaker	25A	Seat Adjuster Switch - Driver, Seat Adjuster Switch - Passenger
PWR/WNDW Circuit Breaker	25A	Window Switch - Driver, and Window Switch - Passenger
Trunk Relay	-	Trunk Fuse
XM Fuse	10A	Digital Radio Receiver (U2K)
Relays listed below are non-serviceable Printed Circuit Board (PCB) relays and are internal to the block.		
DOOR LOCK PCB Relay	-	Door Locks
DOOR UNLOCK PCB Relay	-	Door Lock - Passenger, Door Lock - Left Rear, Door Lock - Right Rear
DOOR UNLOCK PCB Relay - Driver	-	Door Lock - Driver
RAP Relay	-	RAP Fuse

FUSE BLOCK- I/P- TOP VIEW

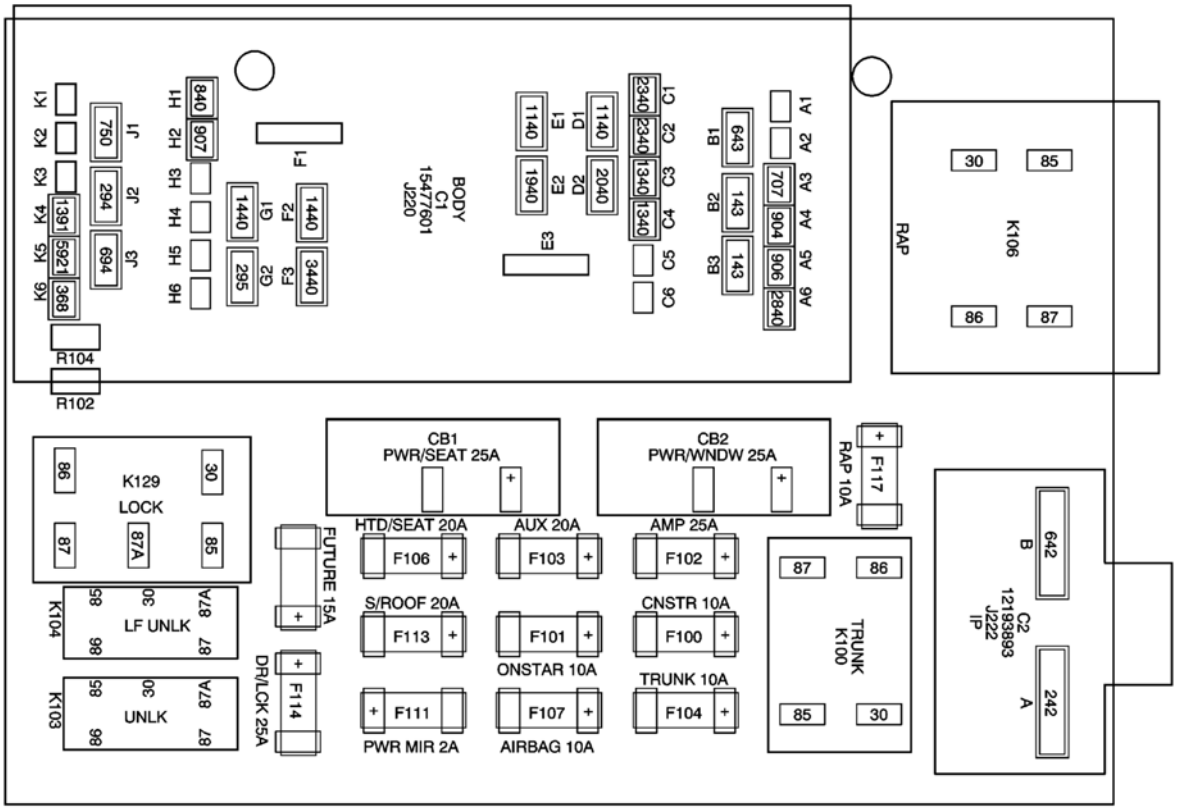


Fig. 9: Fuse Block - I/P Top View

Courtesy of GENERAL MOTORS COMPANY

FUSE BLOCK - I/P - X1

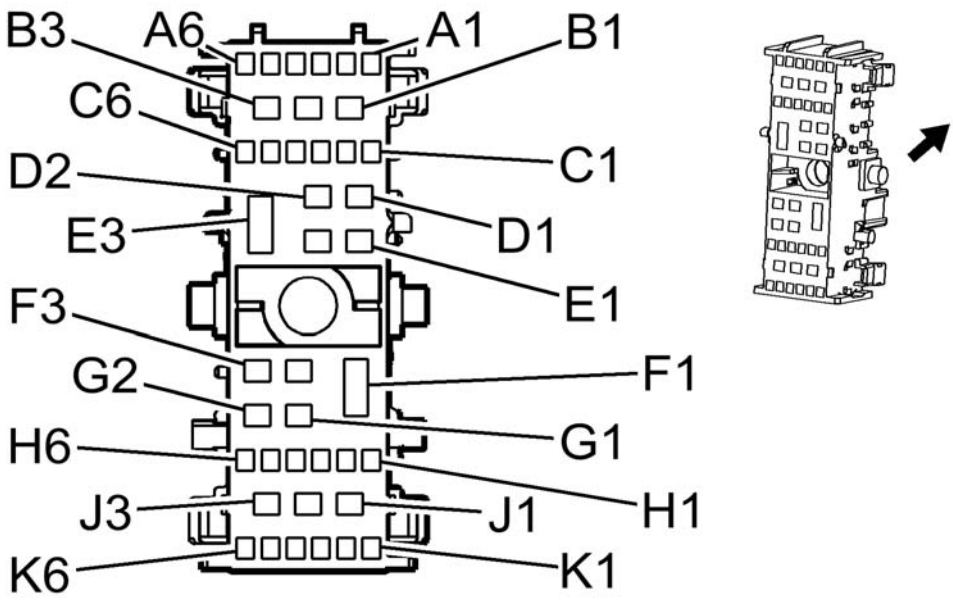


Fig. 10: Fuse Block - I/P - X1
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Body
- OEM Connector: 13552254
- Service Connector: 19178190
- Description: 40-Way F GT 150 280 Metri-Pack 800 Series (BK)

Terminal Part Information

- Pins: A3-A6, C2-C4, H1, K4-K6
- Terminated Lead: 13575735
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: E/C

- Pin: B1
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: E/A

- Pins: B2, B3, D1, D2, E1, F3
- Terminated Lead: 13575756
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304713/19
- Core/Insulation Crimp: F/D

- Pins: E2, F2, G1, G2, J1-J3
- Terminated Lead: 13575753
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 15304711/8
- Core/Insulation Crimp: 2/A

Fuse Block - I/P - X1

Pin	Wire	Circuit	Function
A1-A2	-	-	Not Used
A3	0.35 TN	707	RAP Relay Coil Supply Voltage
A4	0.35 L-BU	1344	Trunk Release Relay Control
A5	0.5 TN/WH	56	Trunk Release Motor Control
A6	0.5 RD/WH	2840	Battery Positive Voltage
B1	0.5 YE	643	Accessory Voltage (DD6, CF5)
	0.5 YE	643	Accessory Voltage (Floor Shifter without DD6)
	0.35 YE	643	Accessory Voltage (Floor Shifter with DD6)
	0.5 YE	643	Accessory Voltage (9C1, 9C3)
B2	3 YE	143	Accessory Voltage
B3	3 YE/BK	143	Accessory Voltage
C1	-	-	Not Used
C2	0.5 RD/WH	3540	Battery Positive Voltage (U2K)
C3	0.35 RD/WH	1340	Battery Positive Voltage
C4	0.5 RD/WH	1340	Battery Positive Voltage
C5-C6	-	-	Not Used
D1	3 RD/WH	1140	Battery Positive Voltage (AG1, AH5)
D2	2 RD/WH	640	Battery Positive Voltage (UQ3, U87)
E1	3 RD/WH	1140	Battery Positive Voltage (AG2)
E2	1 RD/WH	1940	Battery Positive Voltage
E3	-	-	Not Used
F1	-	-	Not Used
F2	0.8 RD/WH	1440	Battery Positive Voltage (9C1, 9C3)
F3	2 RD/WH	3440	Battery Positive Voltage (CF5)

Pin	Wire	Circuit	Function
G1	1 RD/WH	1440	Battery Positive Voltage (KA1)
G2	1 GY	295	Door Lock Actuator Lock Control
H1	0.5 RD/WH	840	Battery Positive Voltage
H2-H6	-	-	Not Used
J1	1 BK	750	Ground
J2	1 TN	294	Door Lock Actuator Unlock Control
J3	1 TN	694	Driver Door Lock Actuator Unlock Control
K1-K3	-	-	Not Used
K4	0.35 L-GN	1391	Door Lock Relay Control
K5	0.35 L-BU	5921	Door Unlock Relay Control
K6	0.35 YE	356	Driver Door Unlock Relay Control

FUSE BLOCK - I/P- X2

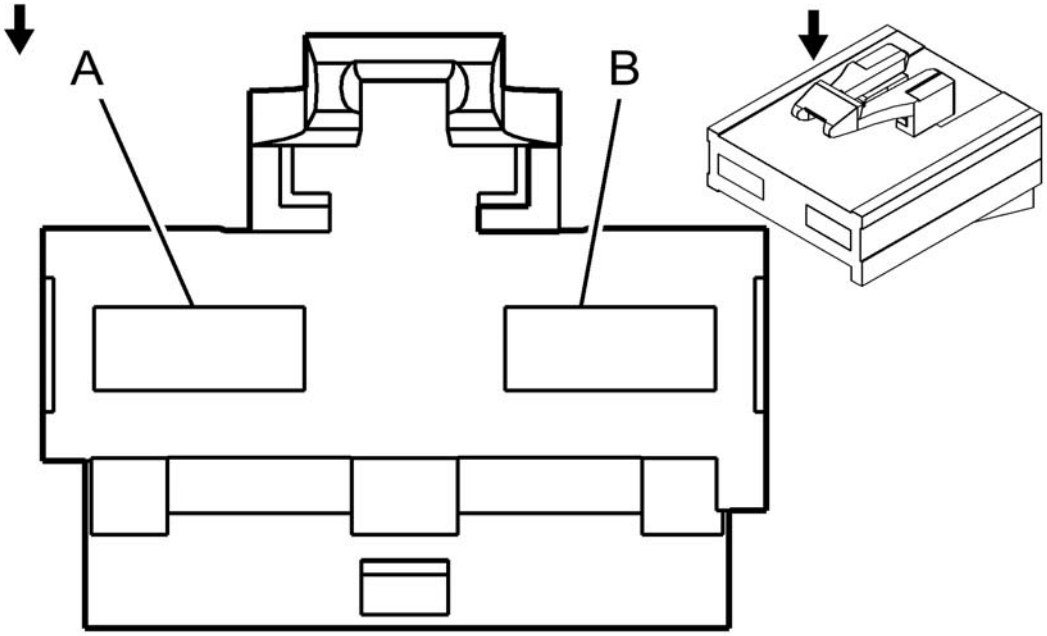


Fig. 11: Fuse Block - I/P- X2
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 13540474
- Service Connector: 19178188
- Description: 2-Way F (BK)

Terminal Part Information

- Terminated Lead: 13327105
- Release Tool: J-38125-558
- Diagnostic Test Probe: J-35616-44 (YE)
- Terminal/Tray: 12110127/19
- Core/Insulation Crimp: F/G

Fuse Block - I/P- X2

Pin	Wire	Circuit	Function
A	5 RD/BK	242	Battery Positive Voltage
B	5 RD/BK	642	Battery Positive Voltage

FUSE HOLDER - DIGITAL VIDEO DISC (DVD) CONTROL MODULE

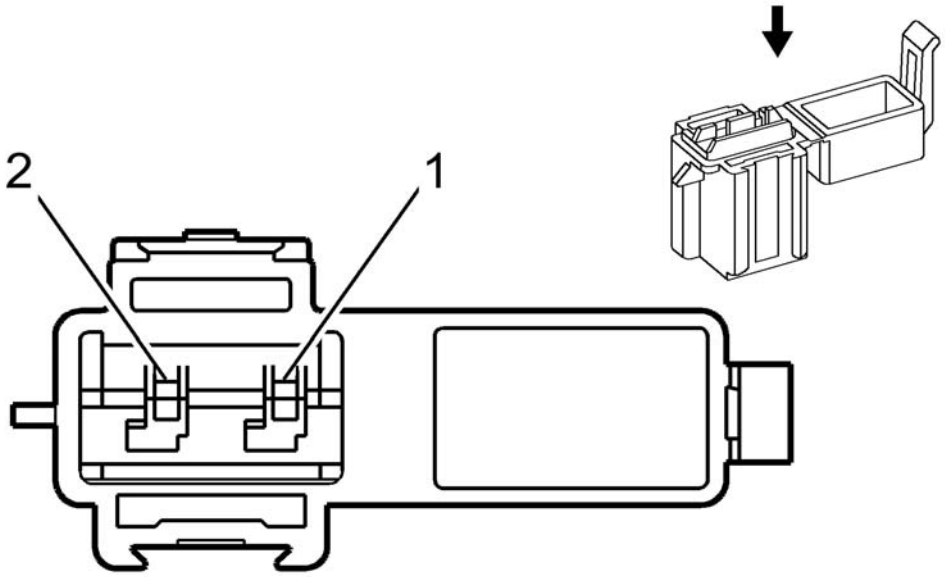


Fig. 12: Fuse Holder - Digital Video Disc (DVD) Control Module
Courtesy of GENERAL MOTORS COMPANY

Connector Part Information

- Harness Type: SPO Accessory Power
- OEM Connector: Not Available
- Service Connector: Service by Harness - See Part Catalog
- Description: 2-Way F Fuse Holder (BK)

Terminal Part Information

- Terminal/Tray: Service by Harness- See Part Catalog
- Core/Insulation Crimp: Not Available
- Release Tool/Test Probe: Not Available

Fuse Holder - Digital Video Disc (DVD) Control Module

Pin	Wire	Circuit	Function
1	0.5 RD	739	Battery Positive Voltage
2	0.5 RD	739	Battery Positive Voltage

Article GUID: A00737211

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Front of Vehicle/Engine Compartment Component Views - Impala

FRONT OF VEHICLE/ENGINE COMPARTMENT COMPONENT VIEWS

FRONT OF THE VEHICLE COMPONENTS

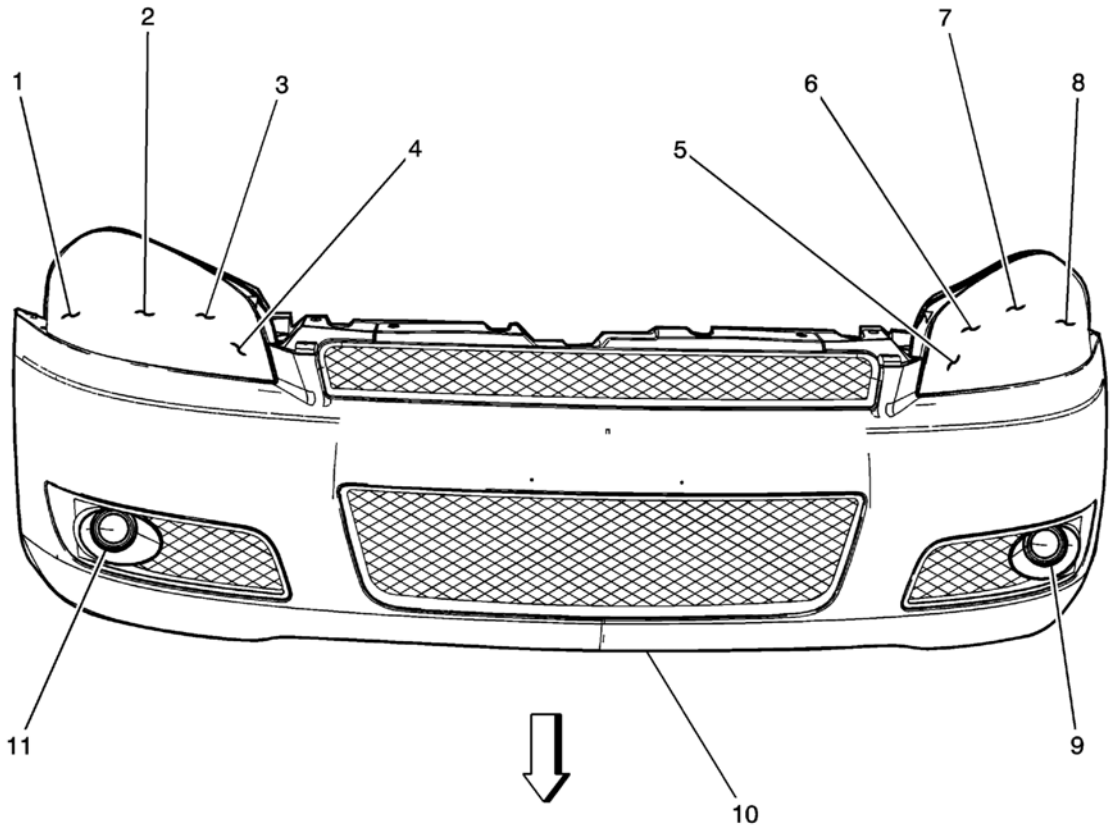


Fig. 1: Front Of The Vehicle
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Side Marker Lamp- Right Front
2	Headlamp- Right Low Beam
3	Headlamp- Right High Beam
4	Park/Turn Signal Lamp- Right
5	Park/Turn Signal Lamp- Left
6	Headlamp- Left High Beam

Callout	Component Name
7	Headlamp- Left Low Beam
8	Side Marker Lamp- Left Front
9	Fog Lamp- Left Front (T96)
10	Front Fascia
11	Fog Lamp- Right Front (T96)

RIGHT HEADLAMP ASSEMBLY COMPONENTS (9C1 OR 9C3)

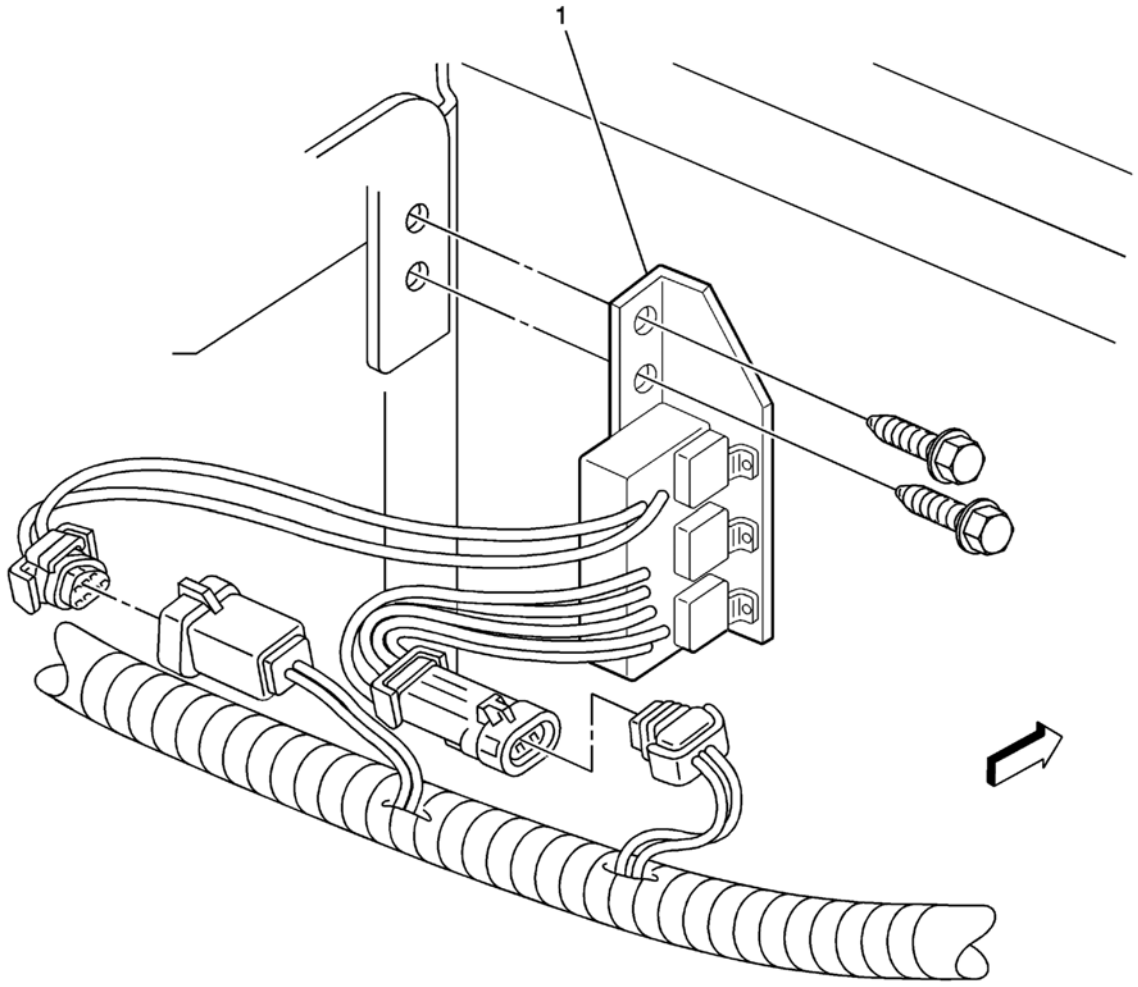


Fig. 2: Left Side Of The Right Headlamp Assembly (9C1, 9C3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Emergency Vehicle Headlamp Flasher (6J7)

A-PILLAR COMPONENTS (9C1 OR 9C3)

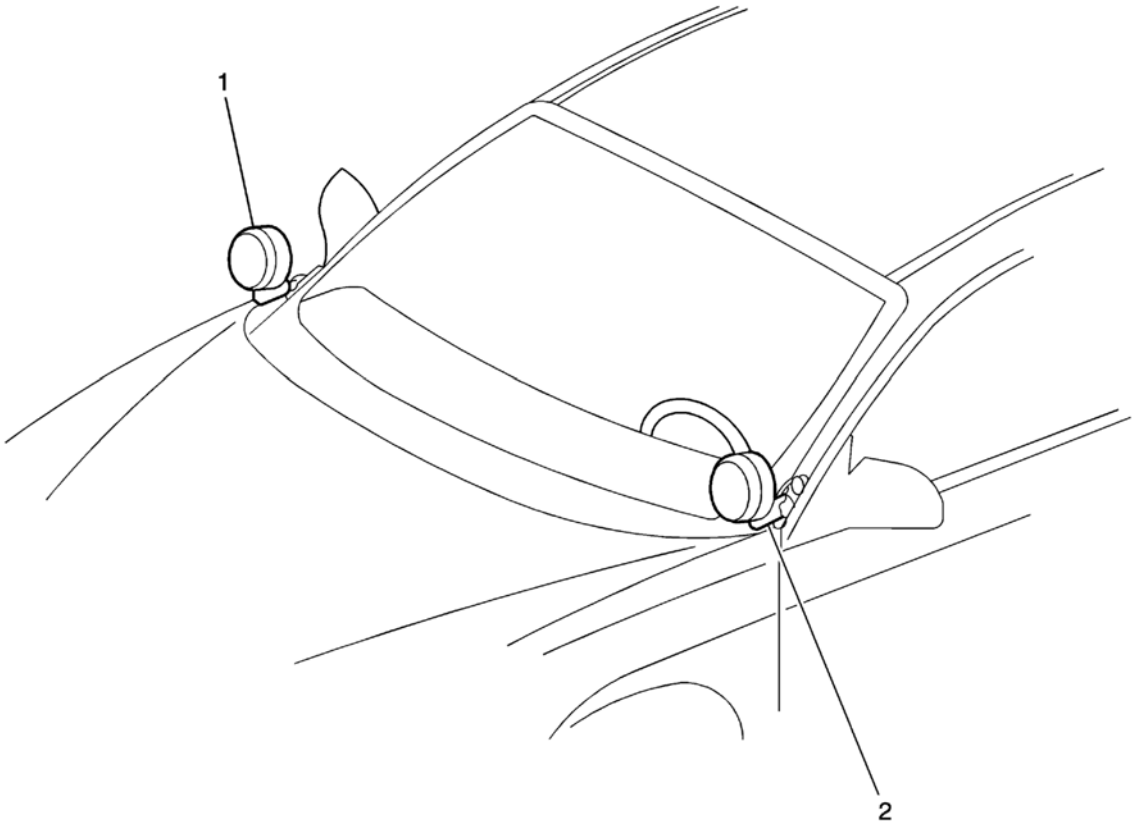


Fig. 3: Base Of A-Pillars (9C1, 9C3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Spot Lamp- Left (7X6 or 7X7)
2	Spot Lamp- Right (7X7)

UNDER THE HOOD LATCH TRIM PANEL COMPONENTS

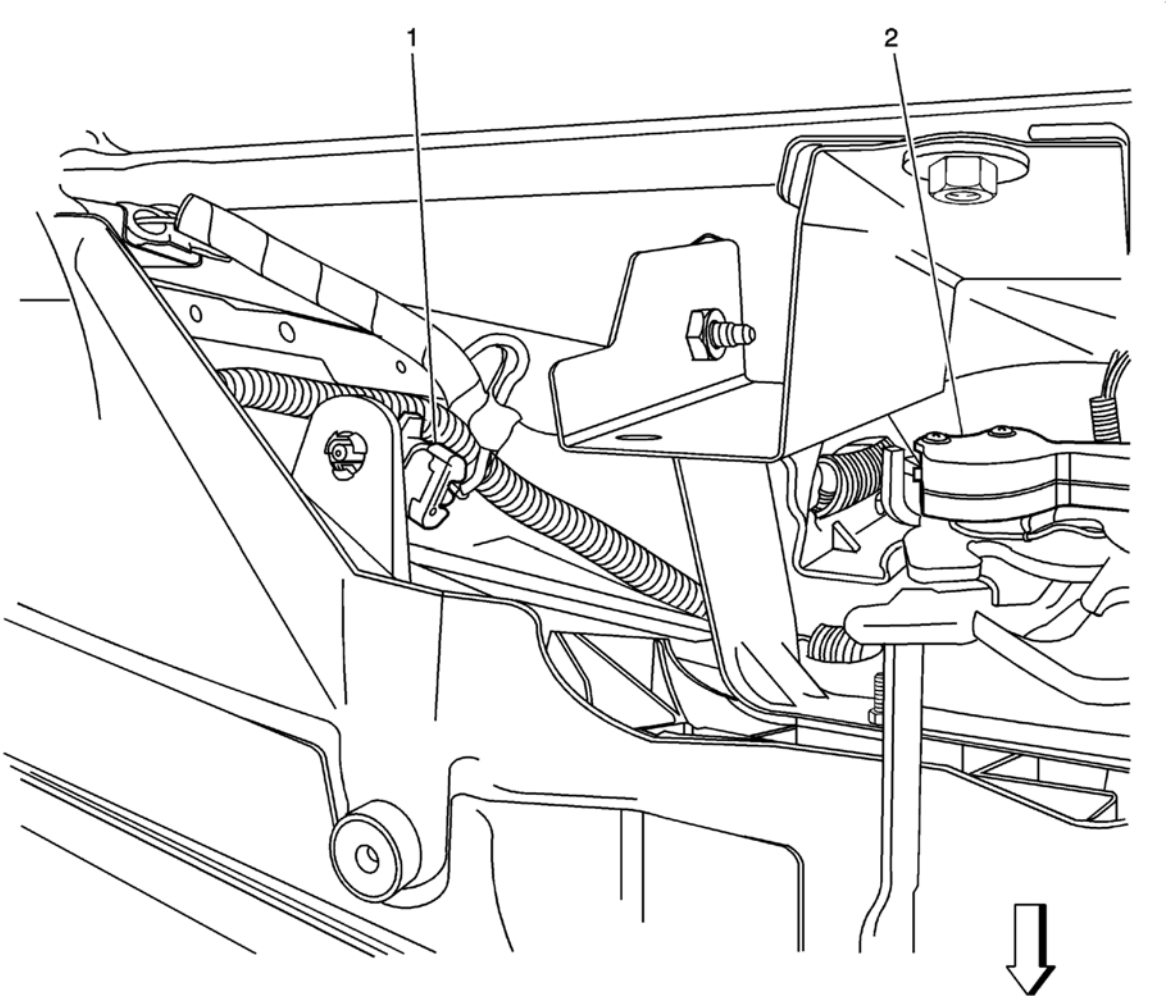


Fig. 4: Identifying Under Hood Latch Trim Panel Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Ambient Air Temperature Sensor
2	Hood Ajar Switch (AP3)

LEFT FRONT OF THE ENGINE COMPARTMENT COMPONENTS

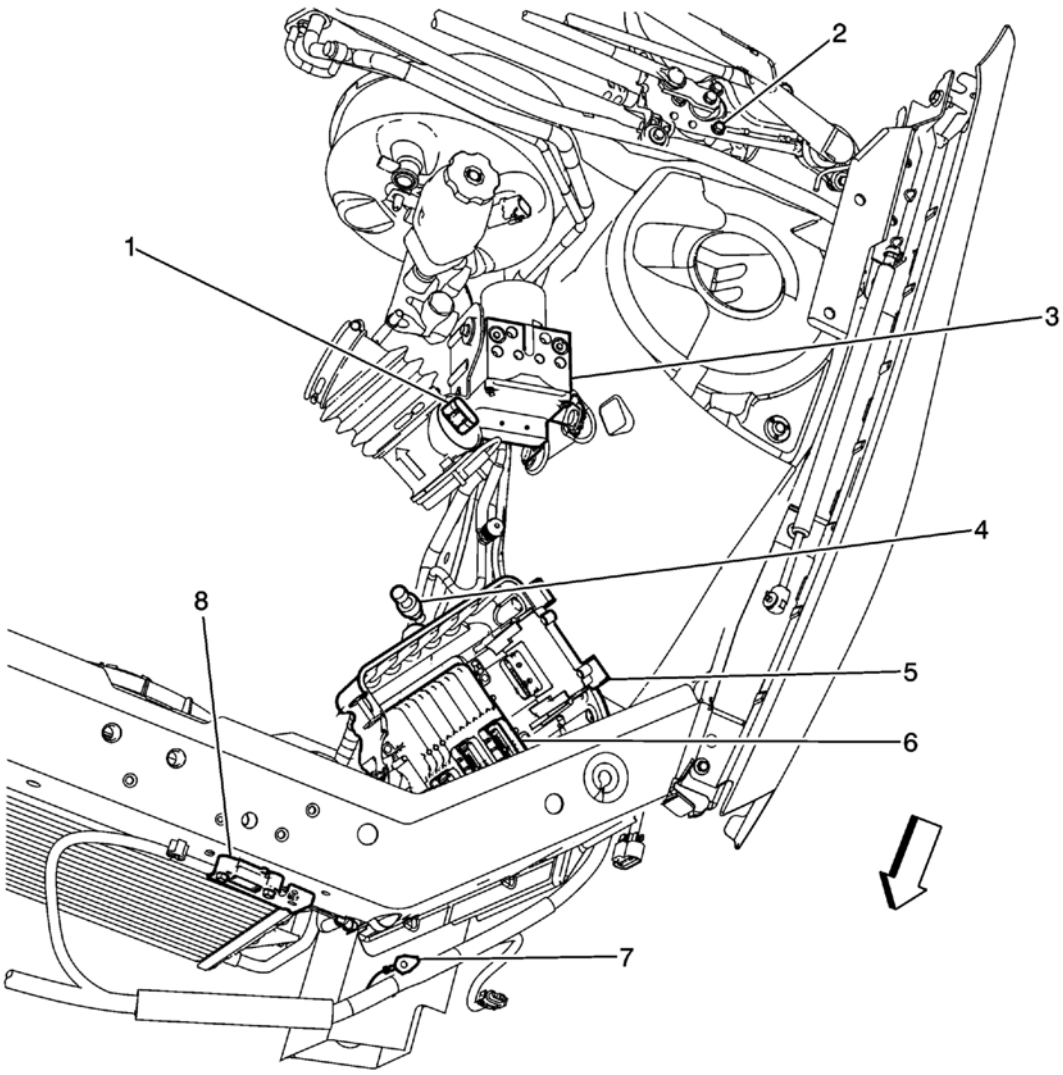


Fig. 5: Left Front of the Engine Compartment Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Multifunction Intake Air Sensor
2	Windshield Wiper Motor
3	Electronic Brake Control Module (EBCM)
4	A/C Refrigerant Pressure Sensor
5	Transmission Control Module (TCM)
6	Engine Control Module (ECM)
7	G101
8	Inflatable Restraint Front End Sensor- Left

LEFT FRONT OF THE ENGINE COMPARTMENT COMPONENTS (NU5 OR NU6)

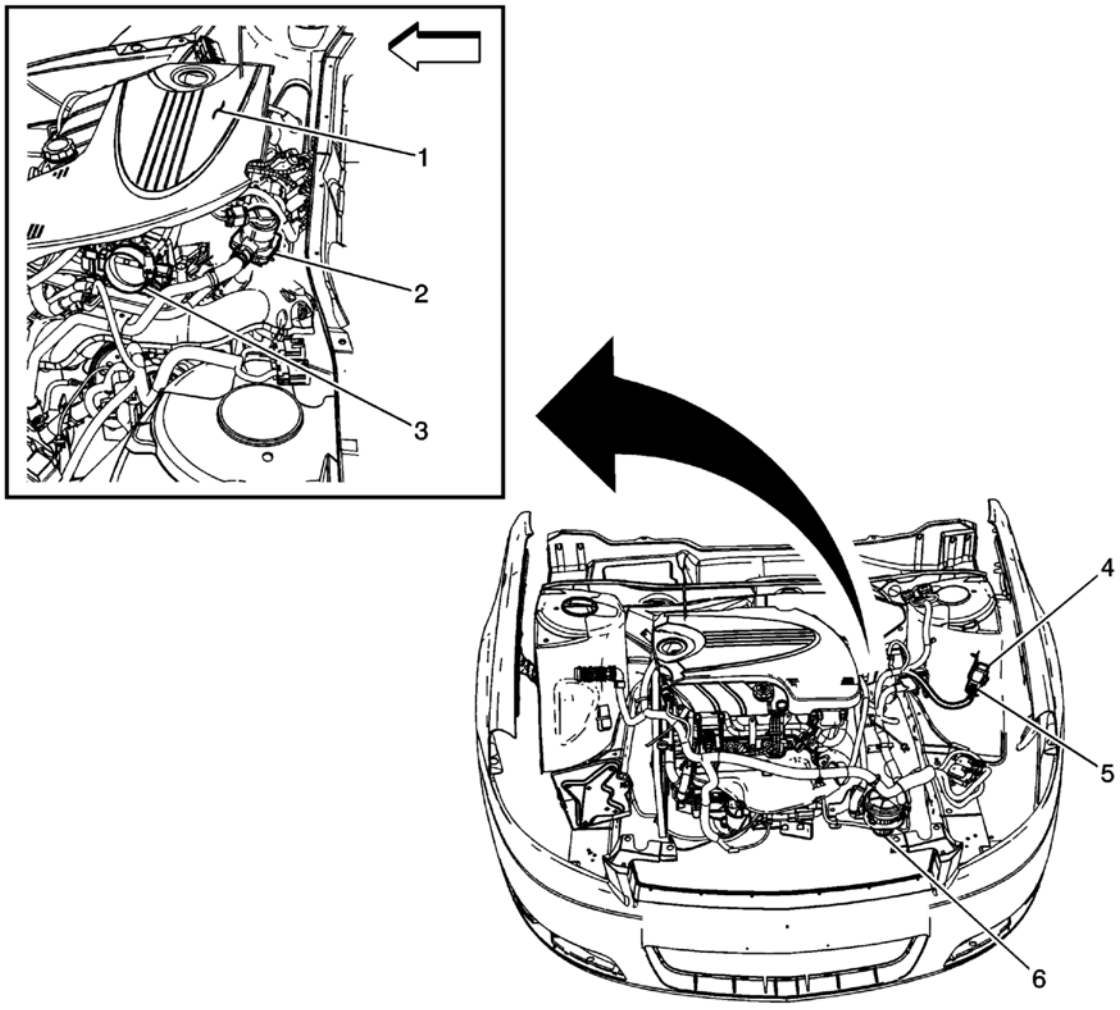


Fig. 6: Left Front of the Engine Compartment Components (NU5 or NU6)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Cover
2	Secondary Air Injection (AIR) Pump Solenoid
3	Throttle Body
4	Secondary Air Injection (AIR) Solenoid Relay
5	Secondary Air Injection (AIR) Pump Relay
6	Secondary Air Injection (AIR) Pump

LEFT REAR OF THE ENGINE COMPARTMENT COMPONENTS

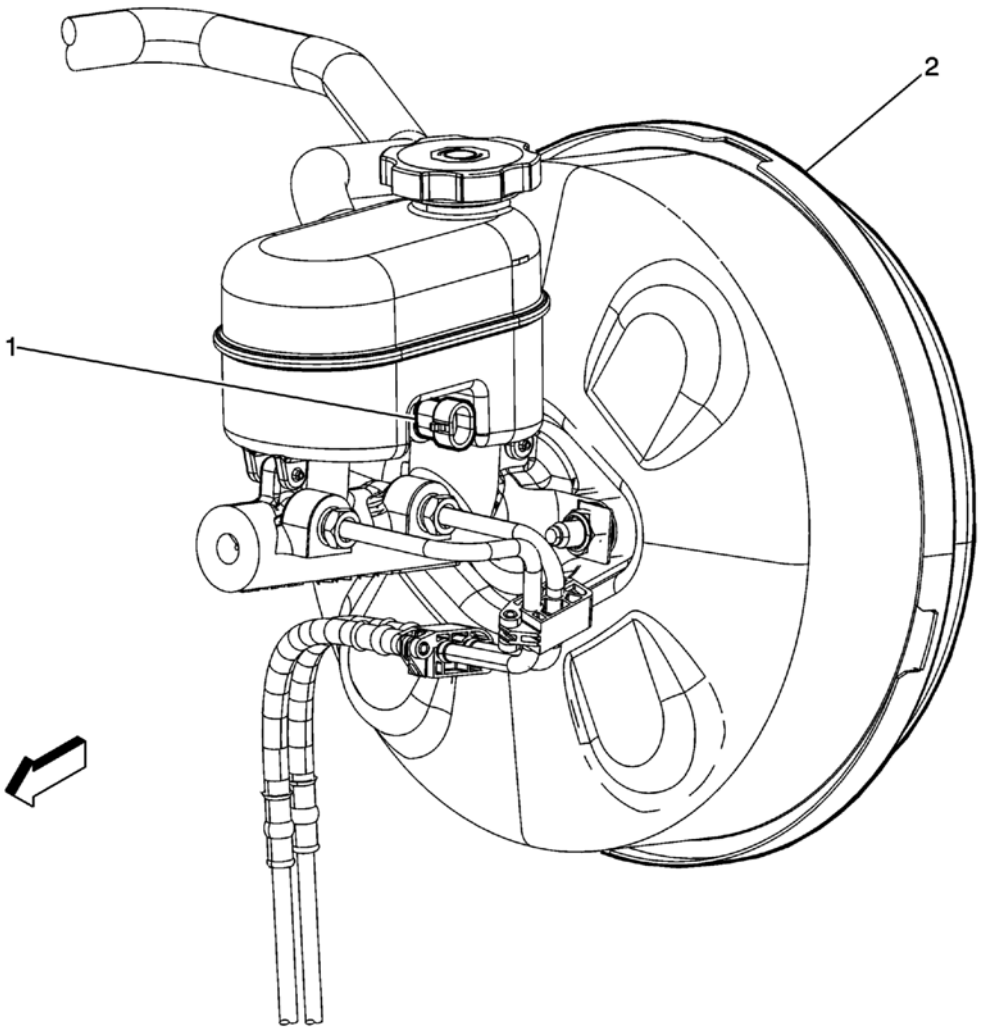


Fig. 7: Left Rear of the Engine Compartment Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Brake Fluid Level Switch
2	Brake Booster

RIGHT FRONT OF THE ENGINE COMPARTMENT COMPONENTS (1 OF 2)

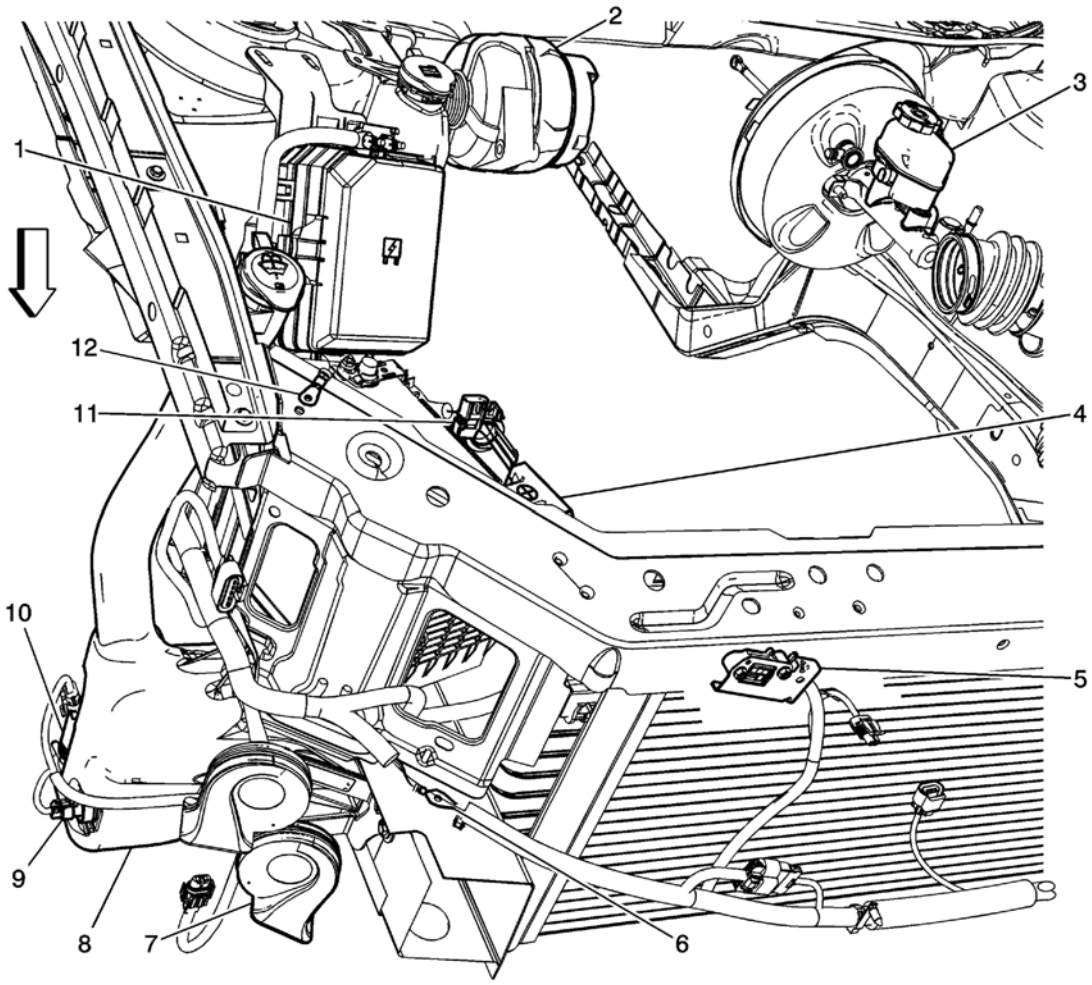


Fig. 8: Identifying RF Engine Compartment (1 of 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuse Block- Underhood
2	Generator
3	Brake Fluid Reservoir
4	Battery
5	Inflatable Restraint Front End Sensor- Right
6	G100
7	Horn Assembly
8	Windshield Washer Fluid Container
9	Windshield Washer Fluid Level Switch
10	Windshield Washer Fluid Pump
11	Battery Current Sensor
12	G102

RIGHT FRONT OF THE ENGINE COMPARTMENT COMPONENTS (2 OF 2)

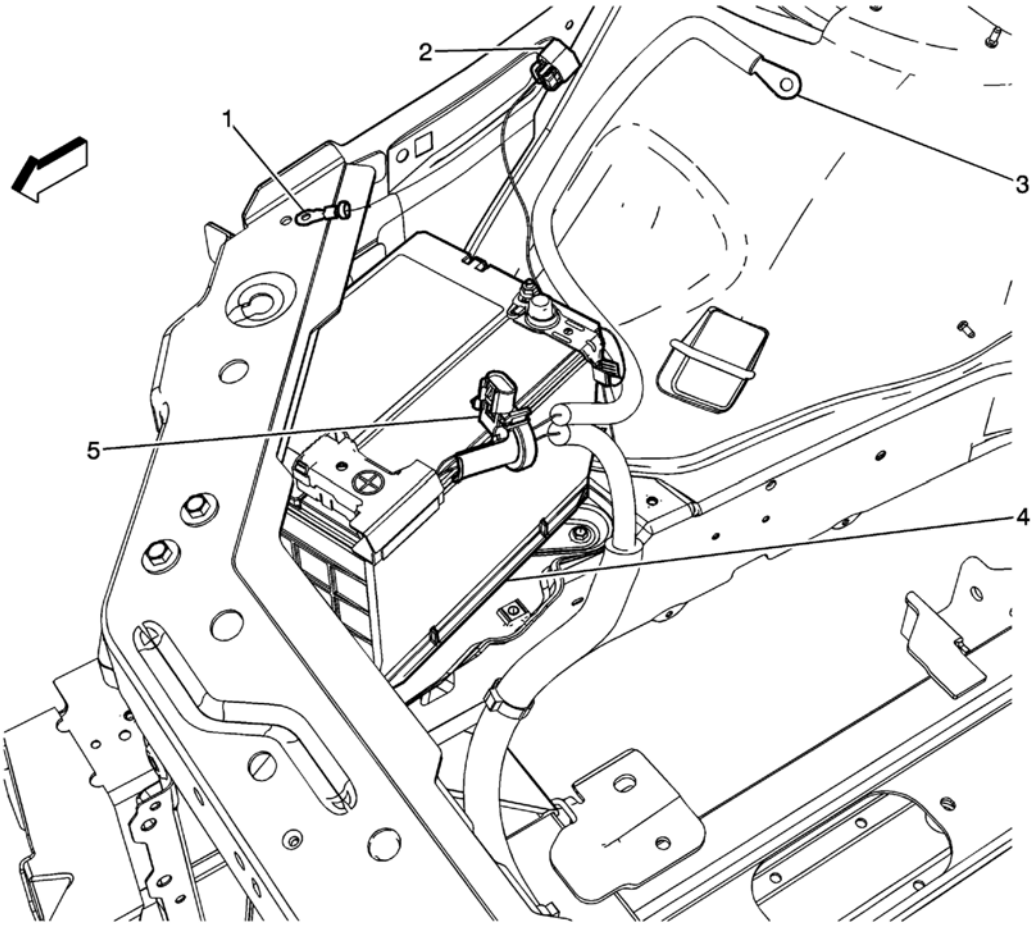


Fig. 9: Right Front of the Engine Compartment Components (2 of 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	G102
2	X105
3	Fuse Block- Underhood Positive Battery Cable Terminal
4	Battery
5	Battery Current Sensor

ENGINE COMPARTMENT COOLING COMPONENTS

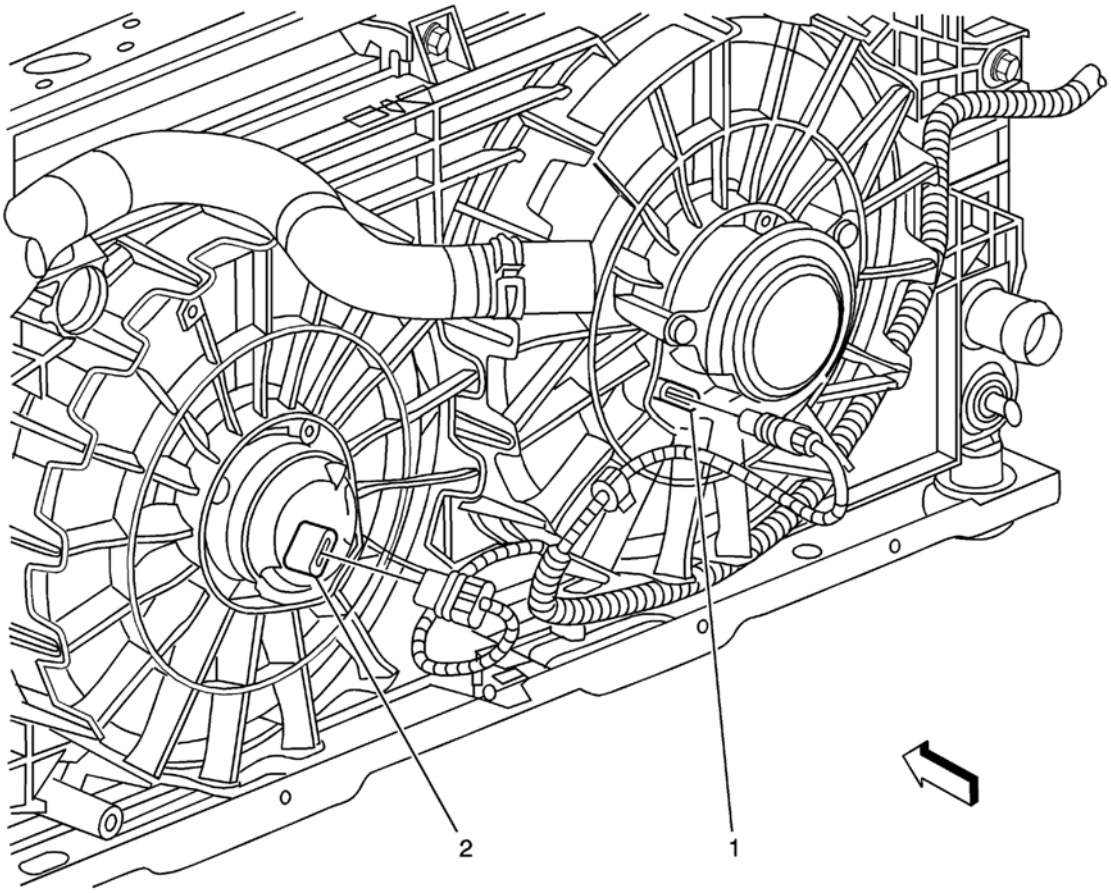


Fig. 10: Engine Compartment Cooling ComponentsBehind Radiator Component View
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Cooling Fan- Right
2	Engine Cooling Fan- Left

Article GUID: A00737229

GROUND VIEWS

G101

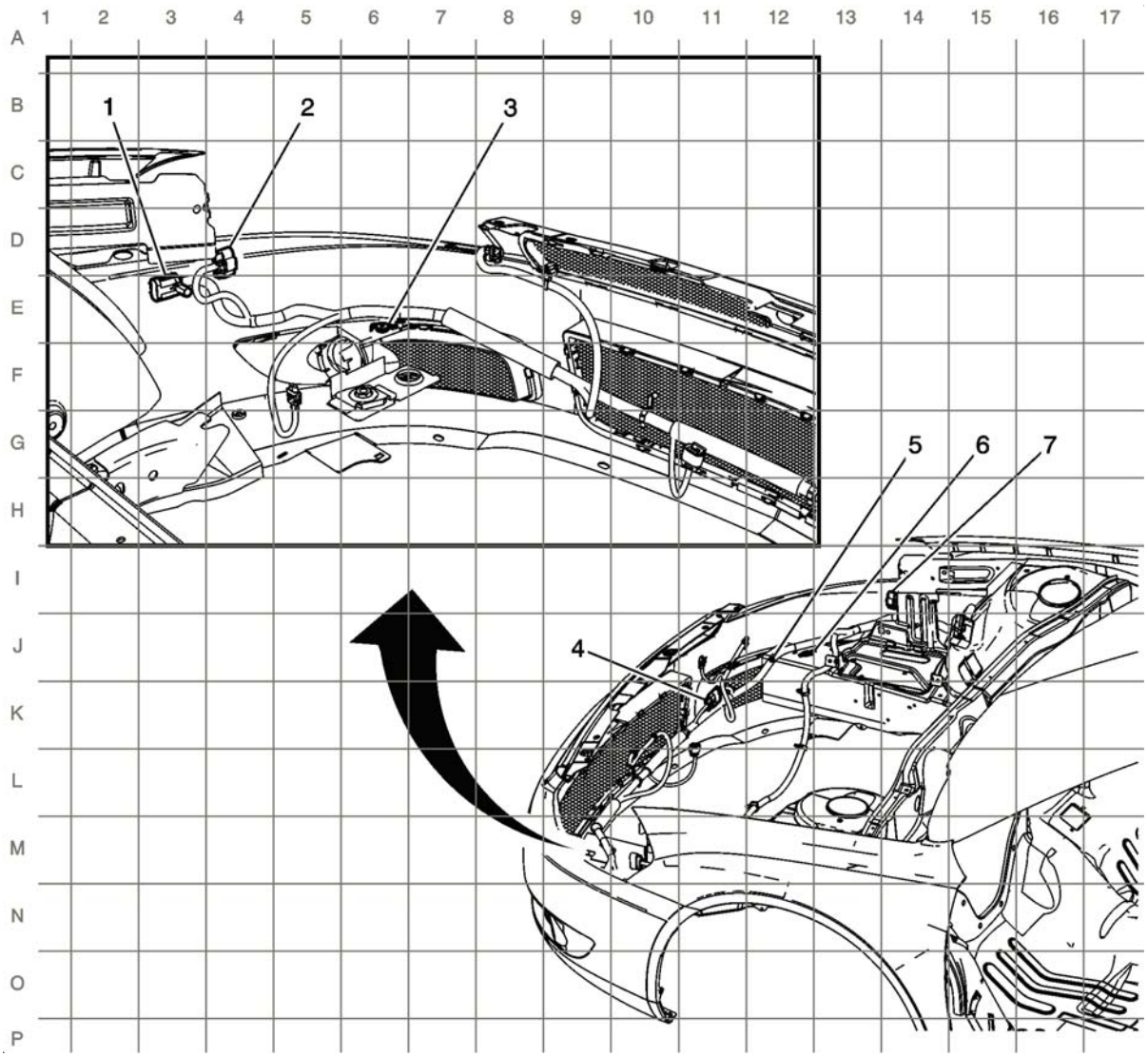


Fig. 1: Forward Lamp Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X120
2	X141
3	G101
4	X122 (9C1 or 9C3 without 6J7)
5	J124
6	G101

Callout	Component Name
7	X142

G102

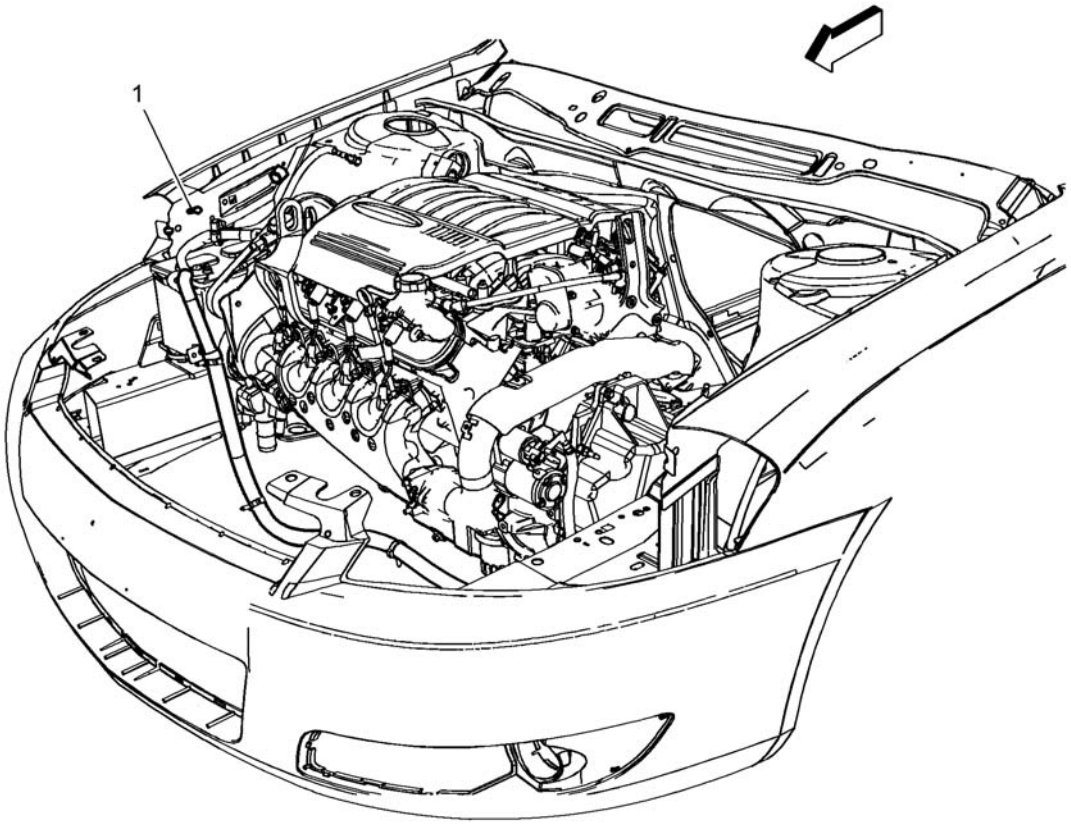


Fig. 2: G102
Courtesy of GENERAL MOTORS COMPANY

Items
1:G102

G111, G113 AND G115

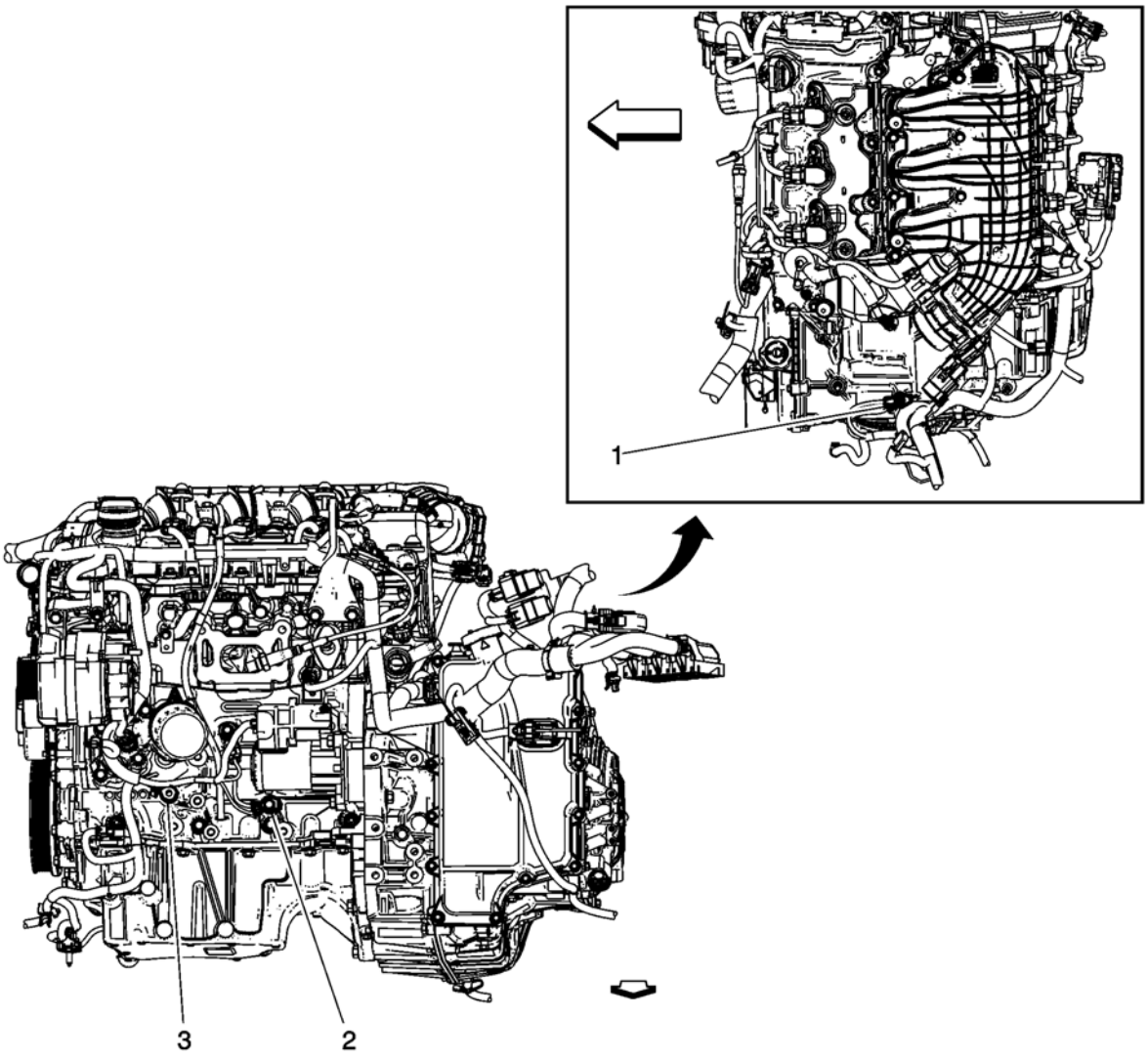


Fig. 3: G111, G113 and G115
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	G115
2	G111
3	G113

G200, G201, G202, AND G204

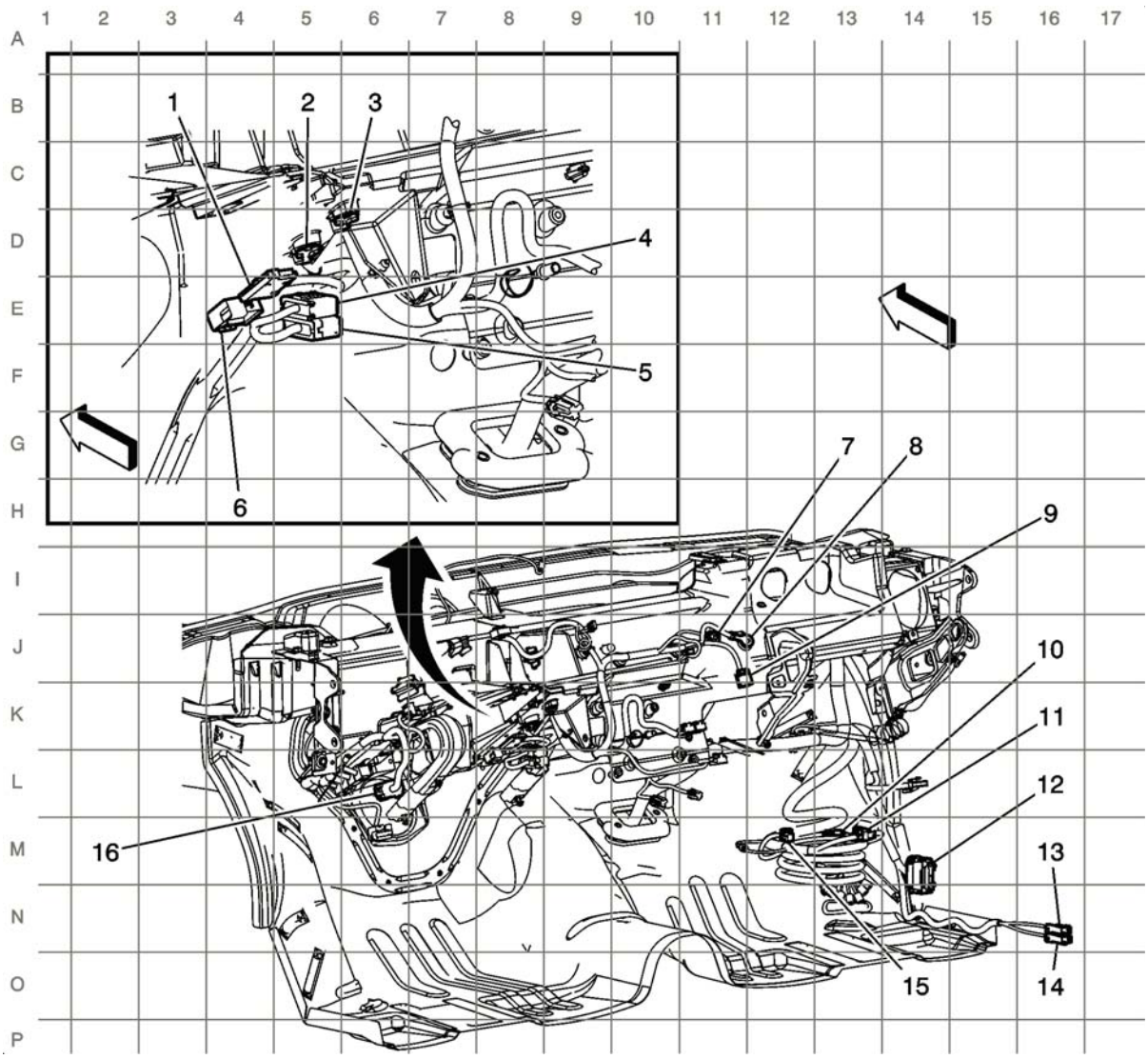


Fig. 4: Instrument Panel Harness - Instrument Panel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	JX205
2	G202
3	G201
4	JX206
5	JX207
6	X201
7	G200
8	G204 (9C1 or 9C3)
9	X210
10	X266 (9C1 or 9C3)
11	X267 (9C1 or 9C3)
12	X200
13	X360 (9C1 or 9C3)

Callout	Component Name
14	X362 (9C1 or 9C3)
15	X297 (9C1 or 9C3)
16	X203

G301

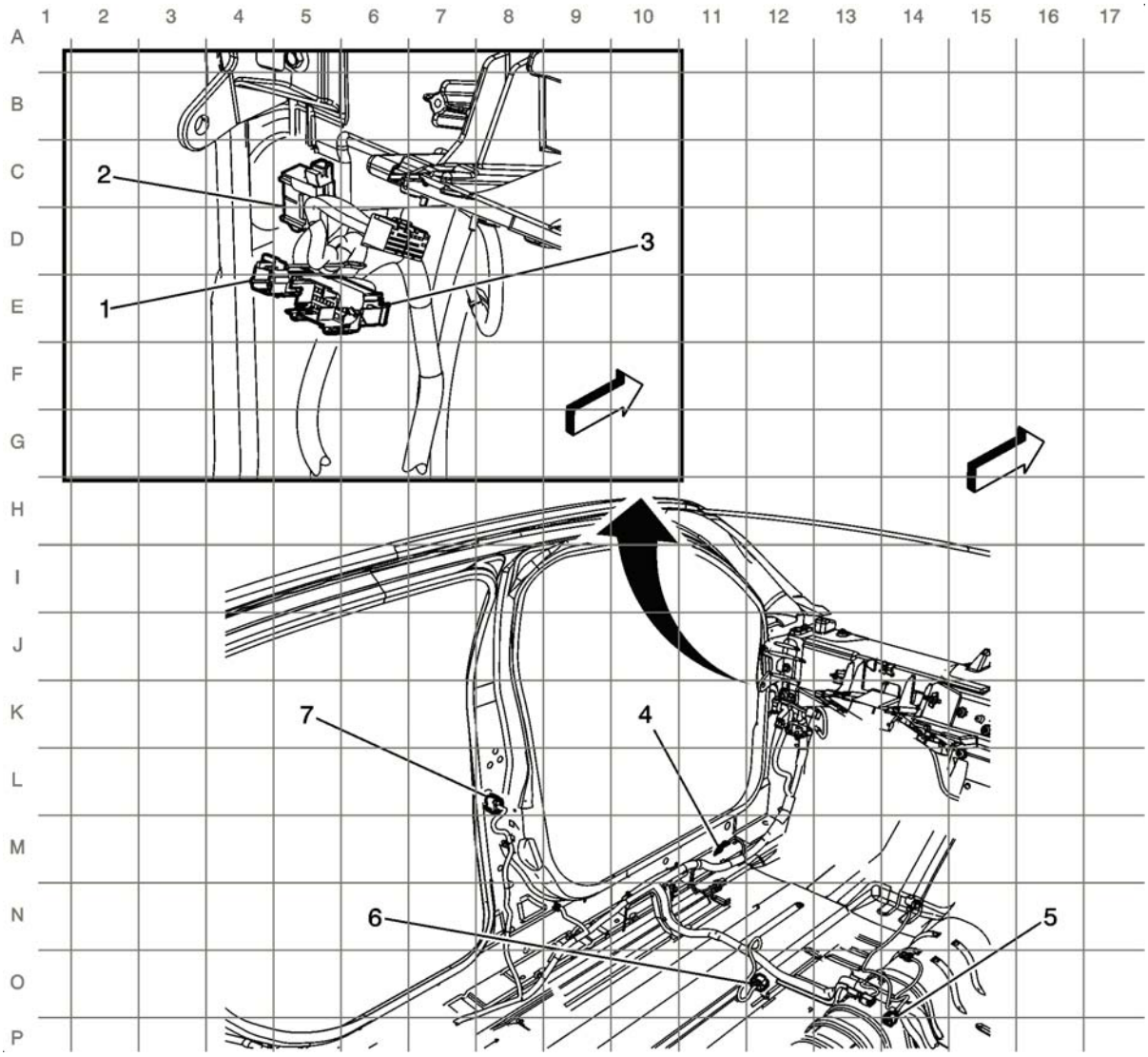


Fig. 5: Body Harness - Left Front Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X250
2	X301
3	X203
4	G301
5	X340
6	X311
7	X355

G302

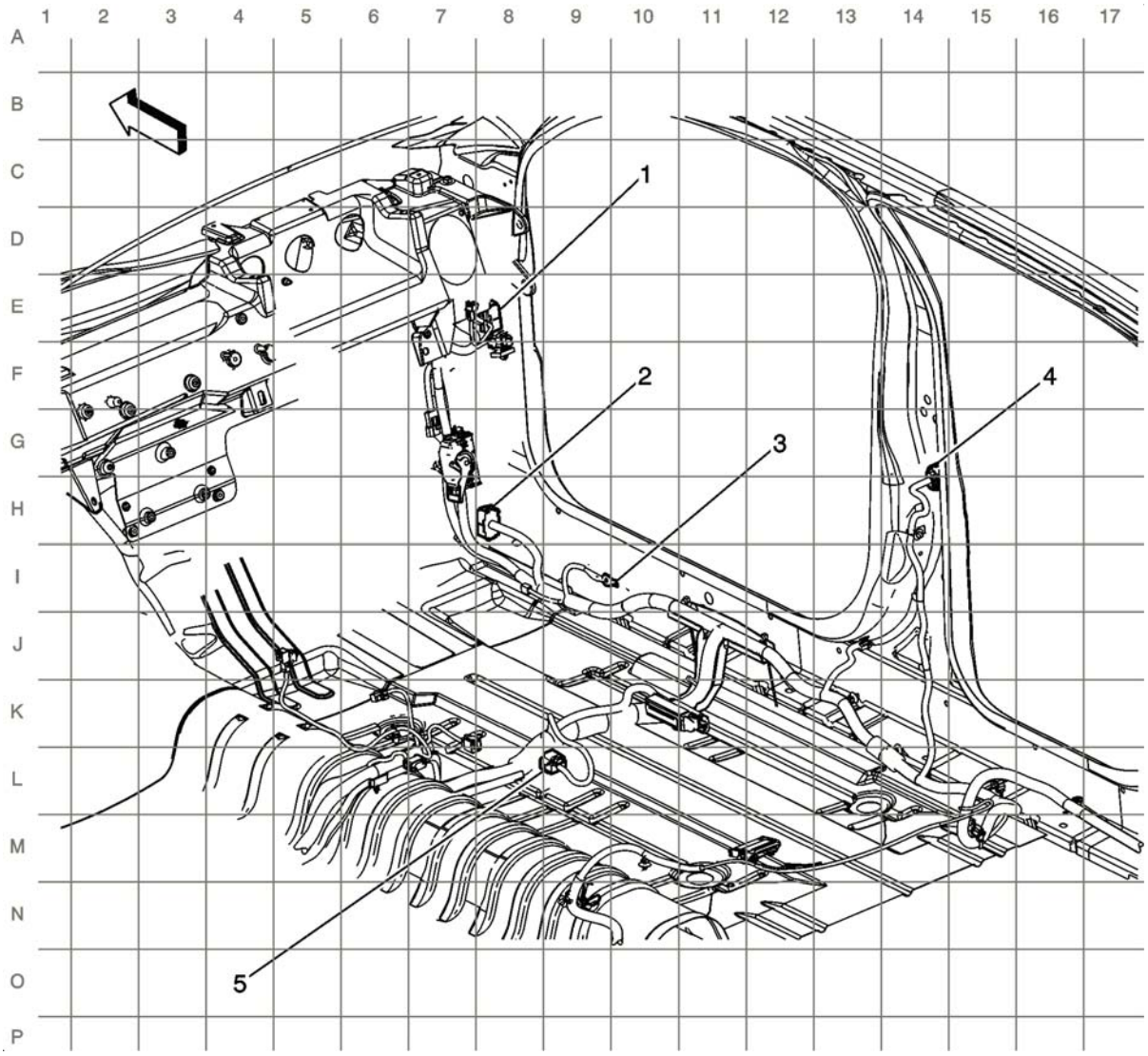


Fig. 6: Body Harness - Right Front Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X302
2	X360 (9C1 or 9C3)
3	G302
4	X356
5	X313

G403 AND G404

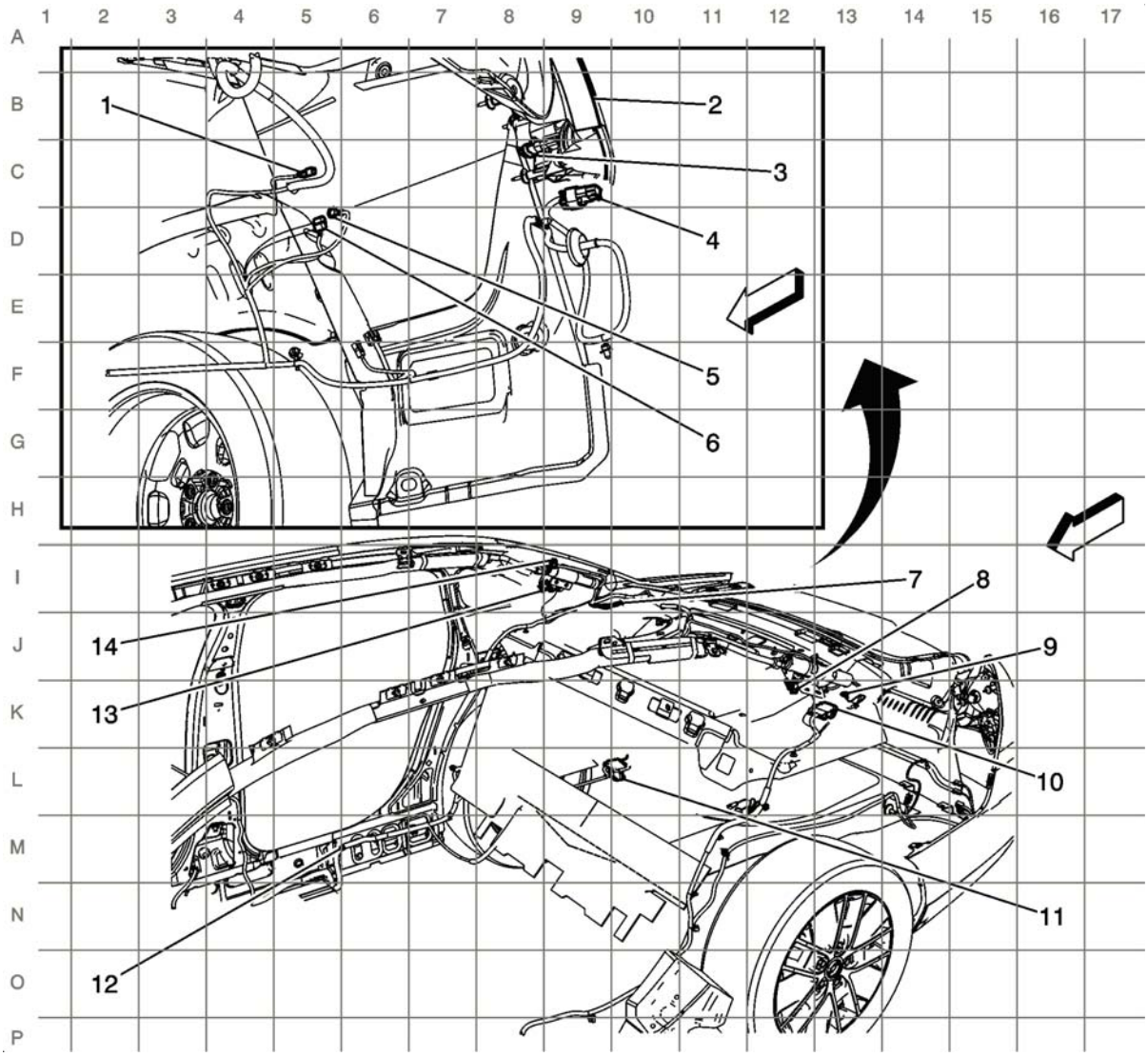


Fig. 7: Body Harness - Rear Compartment Area
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X409 (9C1 or 9C3)
2	Tail Lamp- Right
3	X402
4	X406
5	Junction Block- Rear (6J1) Positive Voltage Stud
6	Junction Block- Rear (6J1) Positive Voltage Stud
7	G404
8	X412
9	G403
10	X490
11	X405
12	J324
13	X414

Callout	Component Name
14	X322- Taped to Harness (9C1 or 9C3)

Article GUID: A00737234

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Instrument Panel/Center Console Component Views - Impala

INSTRUMENT PANEL/CENTER CONSOLE COMPONENT VIEWS

BEHIND THE INSTRUMENT PANEL COMPONENTS

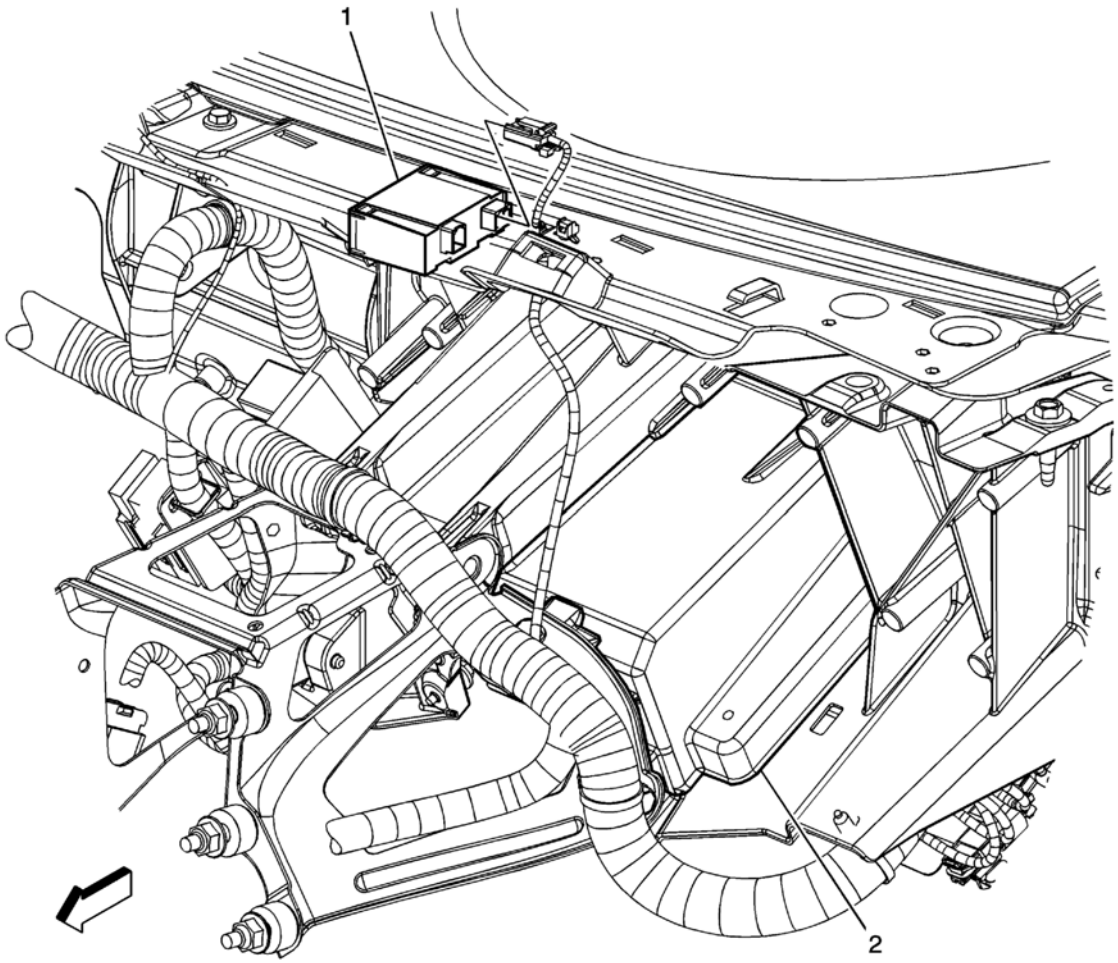


Fig. 1: Identifying Upper Center I/P Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Remote Control Door Lock Receiver (RCDLR)
2	Instrument Panel Carrier

INSTRUMENT PANEL COMPONENTS

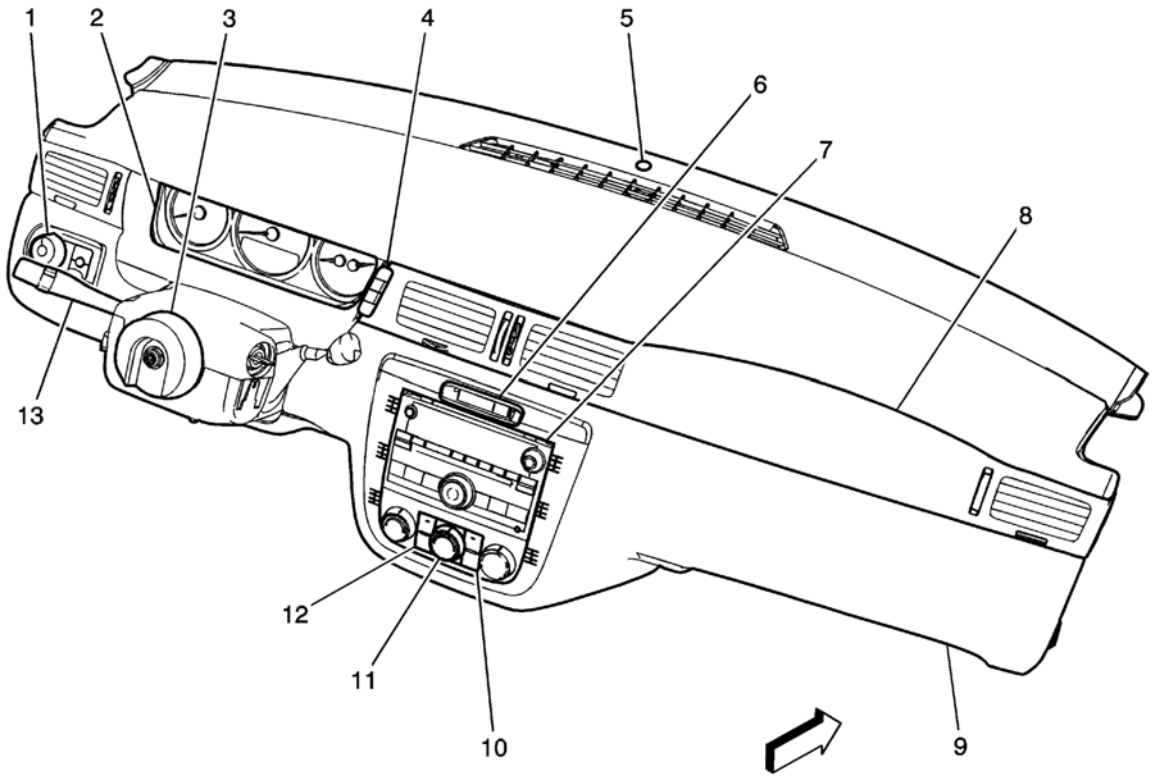


Fig. 2: Identifying I/P Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Headlamp Switch
2	Instrument Panel Cluster (IPC)
3	Inflatable Restraint Steering Wheel Module Coil
4	Driver Information Center (DIC) Switch
5	Ambient Light Sensor
6	Inflatable Restraint I/P Module Indicator
7	Radio
8	Inflatable Restraint I/P Module
9	Instrument Panel Trim Panel
10	Heated Seat Switch- Passenger (KA1)
11	HVAC Control Module
12	Heated Seat Switch- Driver (KA1)
13	Turn Signal/Multifunction Switch

BOTTOM CENTER OF THE INSTRUMENT PANEL (WITHOUT D55)

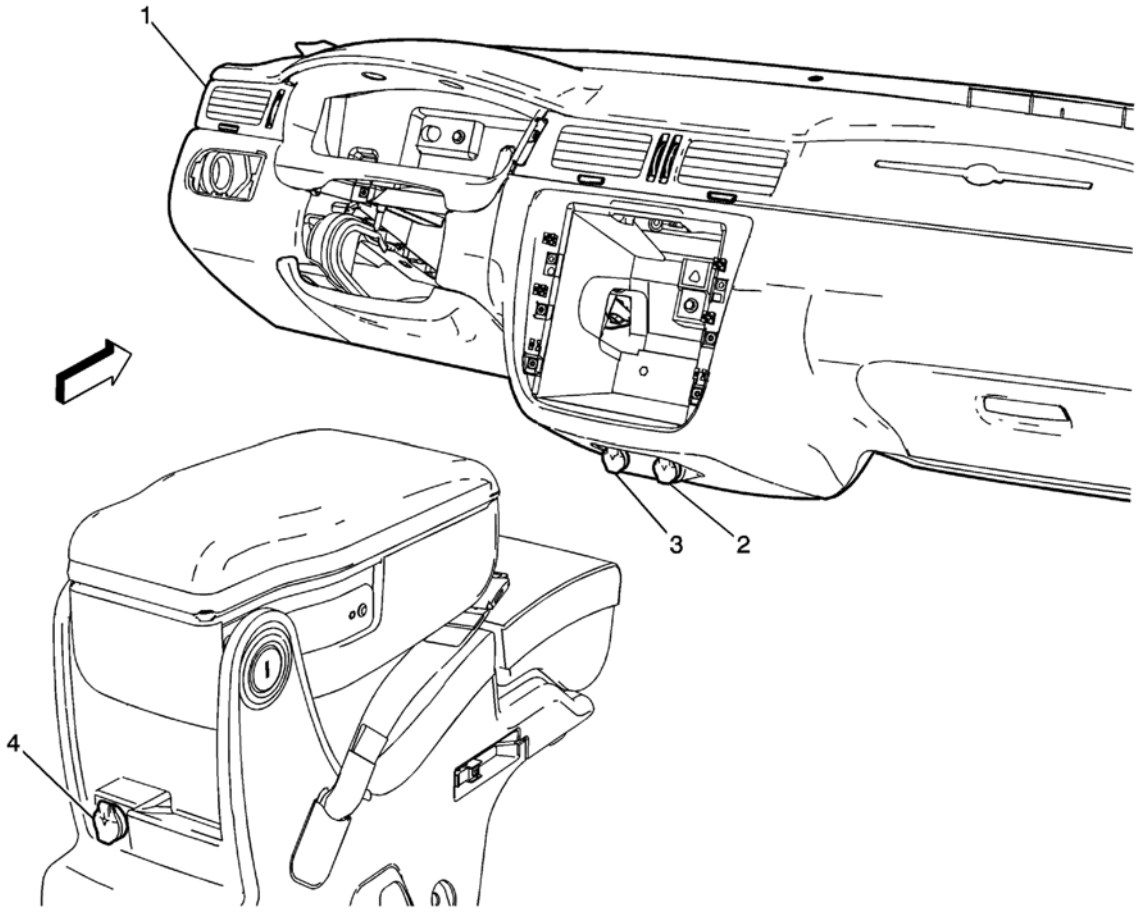


Fig. 3: Bottom Center of the Instrument Panel (without D55)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel
2	Accessory Power Outlet- I/P 2
3	Accessory Power Outlet- I/P 1
4	Accessory Power Outlet- Center Seat

CENTER CONSOLE COMPONENTS- AUXILIARY POWER OUTLETS (D55)

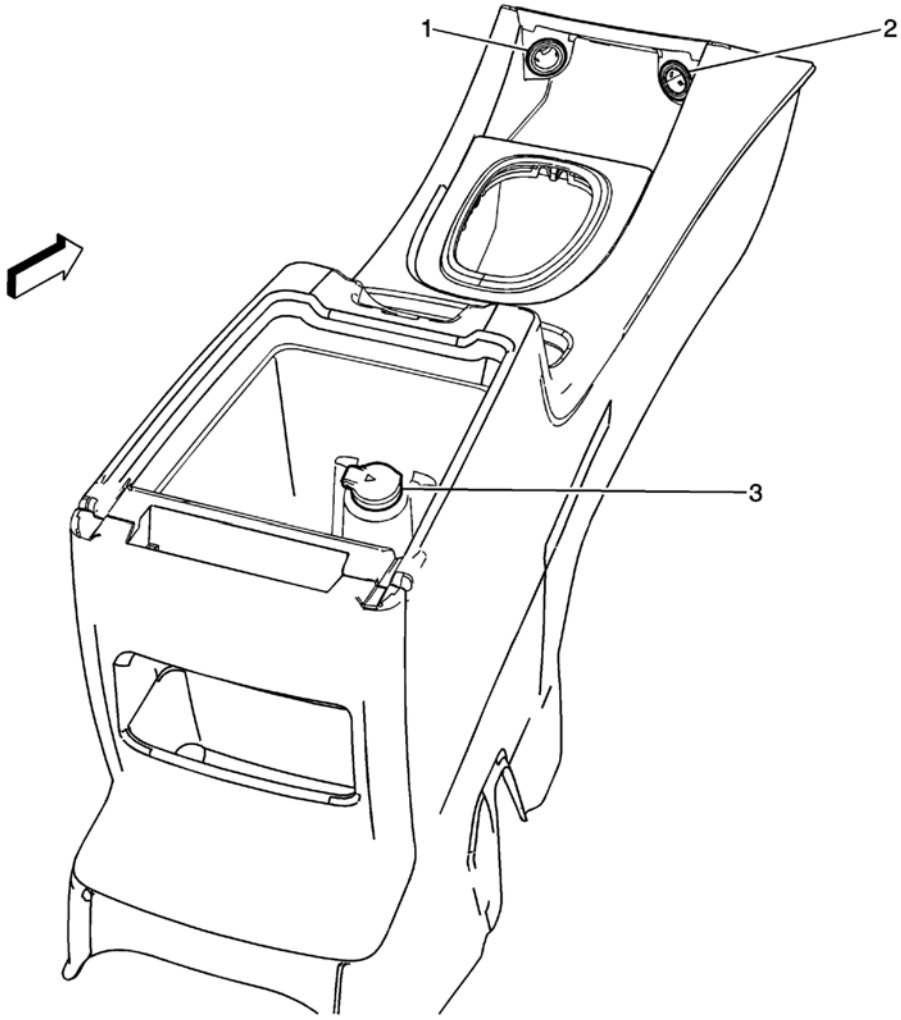


Fig. 4: Center Console Components- Auxiliary Power Outlets (D55)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Accessory Power Outlet- Center Console 1
2	Accessory Power Outlet- Center Console 2
3	Accessory Power Outlet- Center Console Compartment

CENTER CONSOLE COMPONENTS (D55)

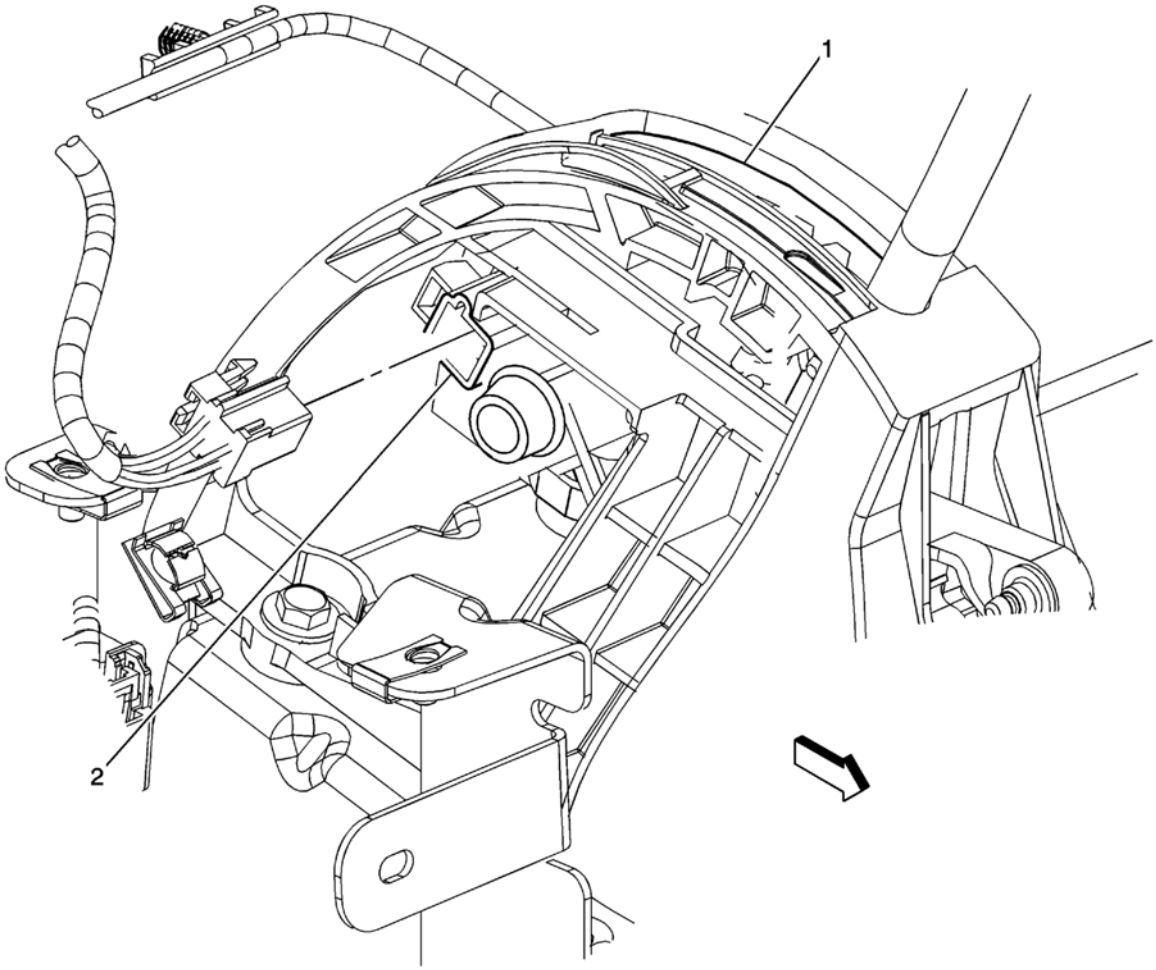


Fig. 5: Center Console Components (D55)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Floor Shifter
2	Automatic Transmission Shift Lock Control Solenoid

BELOW THE INSTRUMENT PANEL COMPONENTS- PEDAL ASSEMBLIES

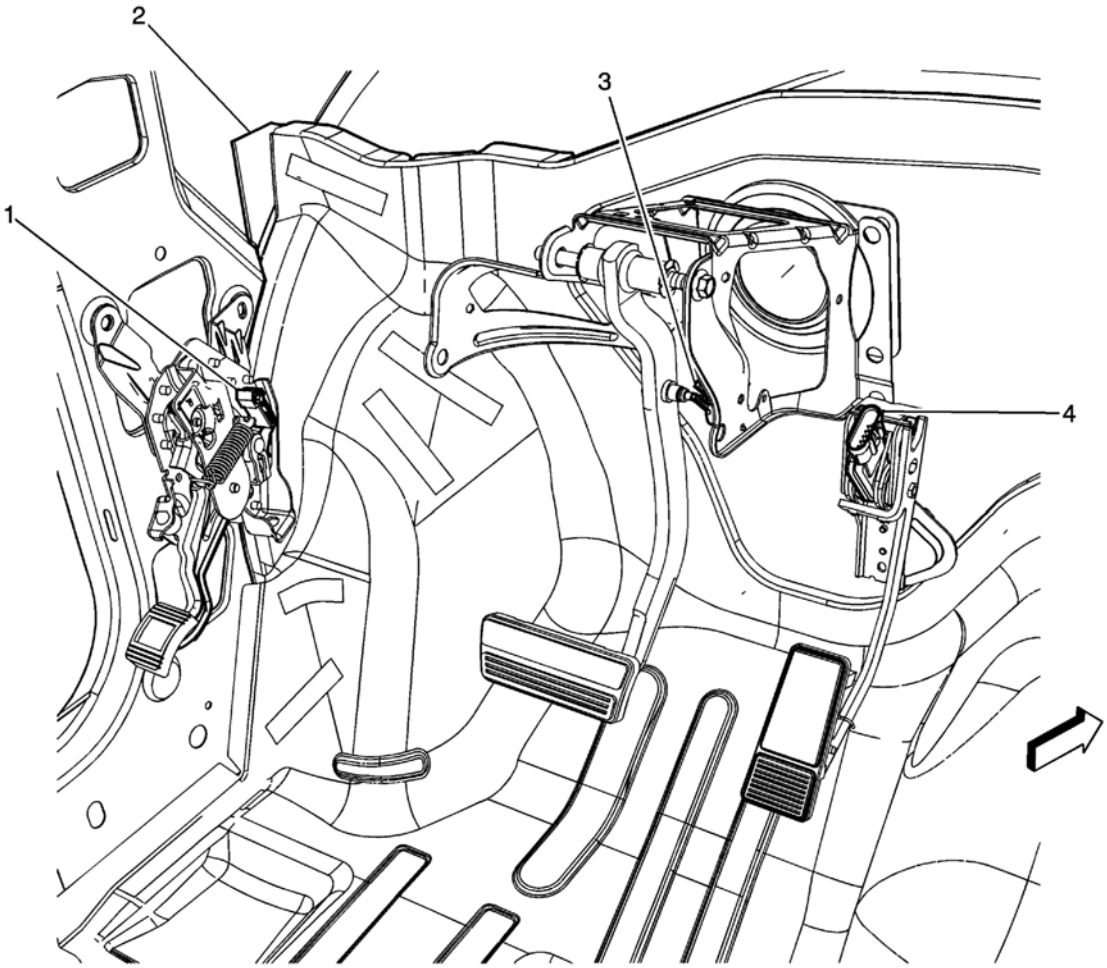


Fig. 6: Below the Instrument Panel Components- Pedal Assemblies
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Park Brake Switch
2	Dash Panel
3	Brake Pedal Position (BPP) Sensor
4	Accelerator Pedal Position (APP) Sensor

BELOW THE INSTRUMENT PANEL COMPONENTS- LEFT FRONT FOOTWELL

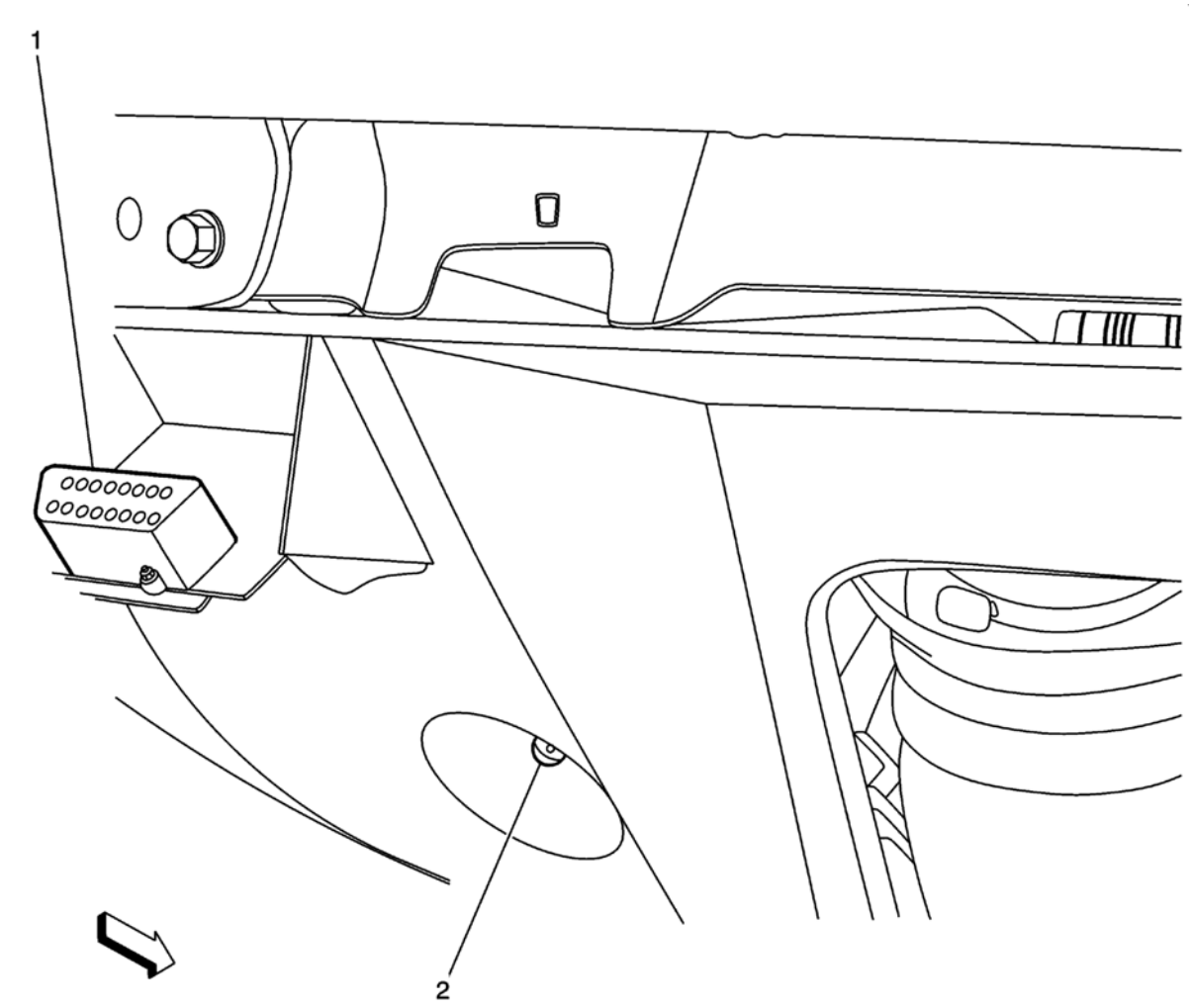


Fig. 7: Below the Instrument Panel Components- Left Front Footwell
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Data Link Connector (DLC)
2	I/P Courtesy Lamp- Left

BELOW THE INSTRUMENT PANEL COMPONENTS- RIGHT FRONT FOOTWELL

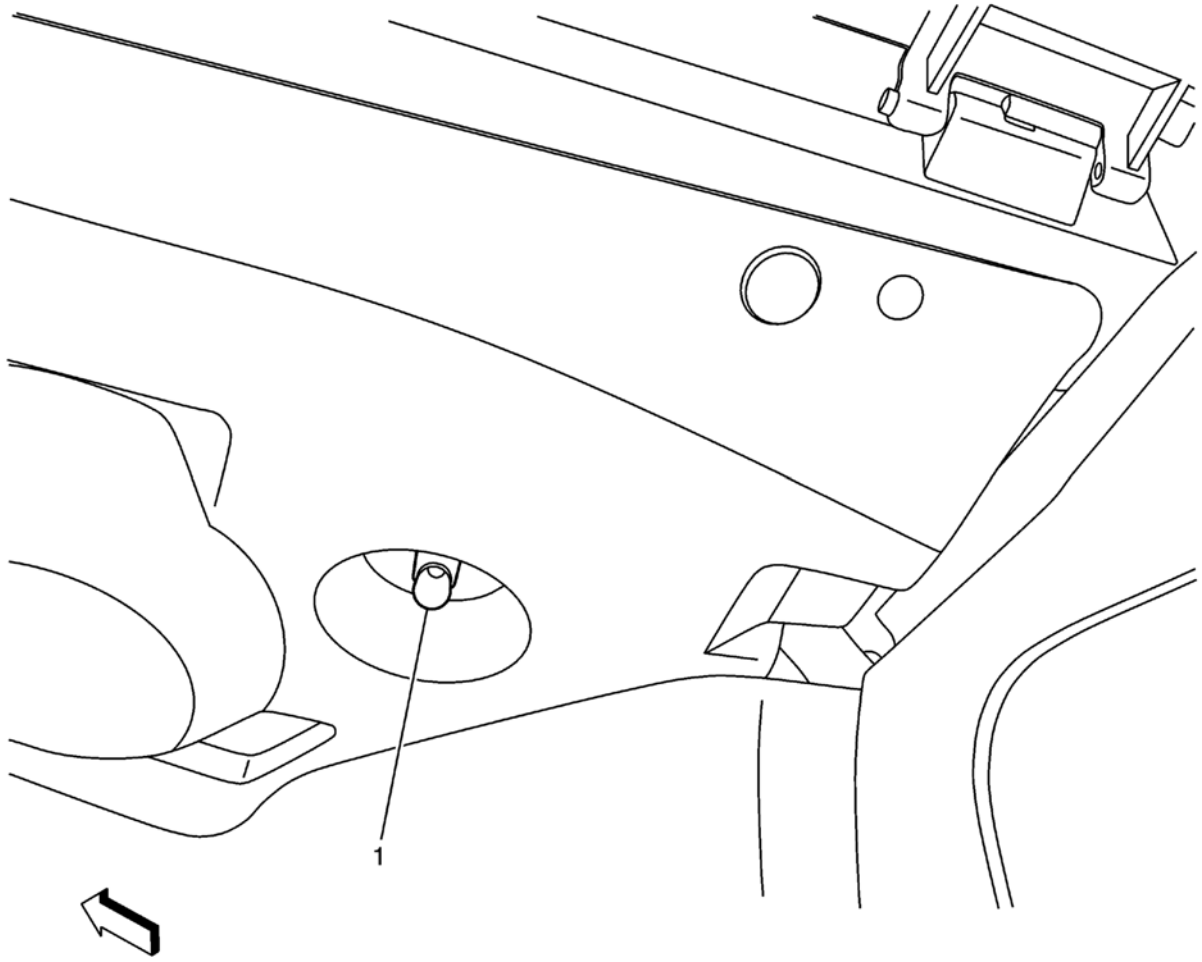


Fig. 8: Below the Instrument Panel Components- Right Front Footwell
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	I/P Courtesy Lamp- Right

STEERING WHEEL COMPONENTS

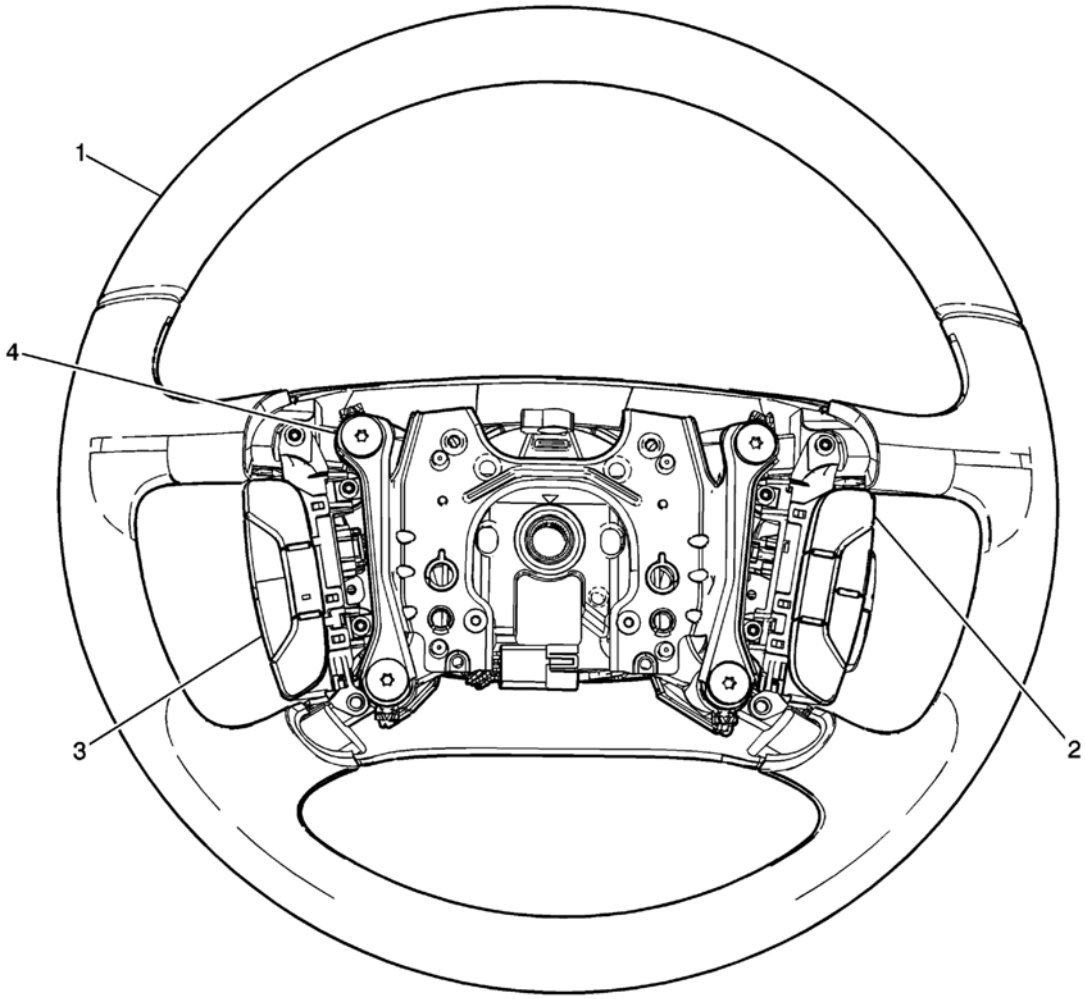


Fig. 9: View Of Steering Wheel Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Steering Wheel
2	Steering Wheel Control Switch - Right
3	Steering Wheel Control Switch - Left (UK3)
4	Horn Switch

STEERING COLUMN COMPONENTS (WITHOUT D55)

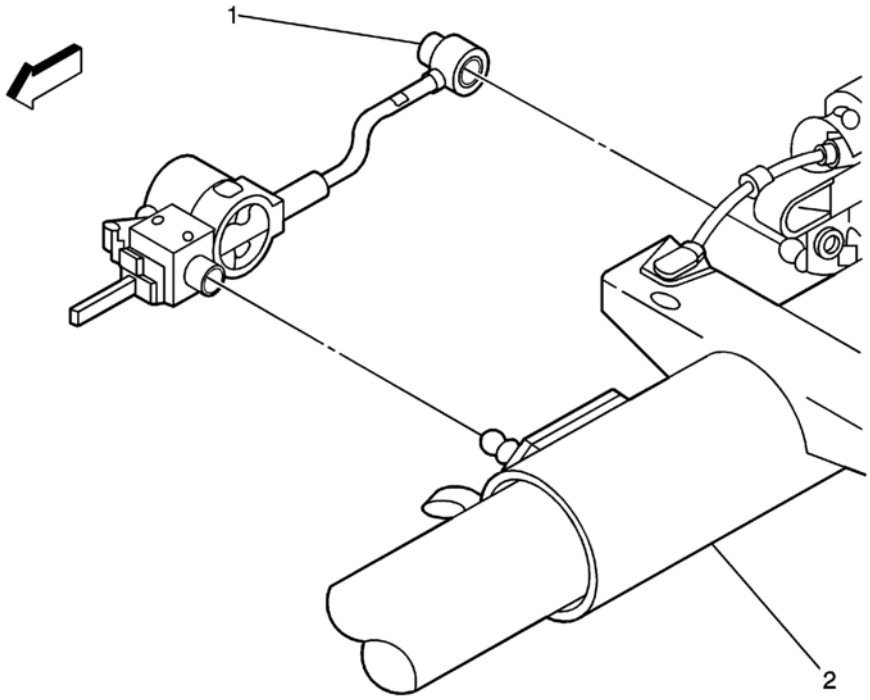


Fig. 10: Steering Column Components (without D55)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Automatic Transmission Shift Lock Control Solenoid
2	Steering Column

NEAR THE STEERING COLUMN COMPONENTS

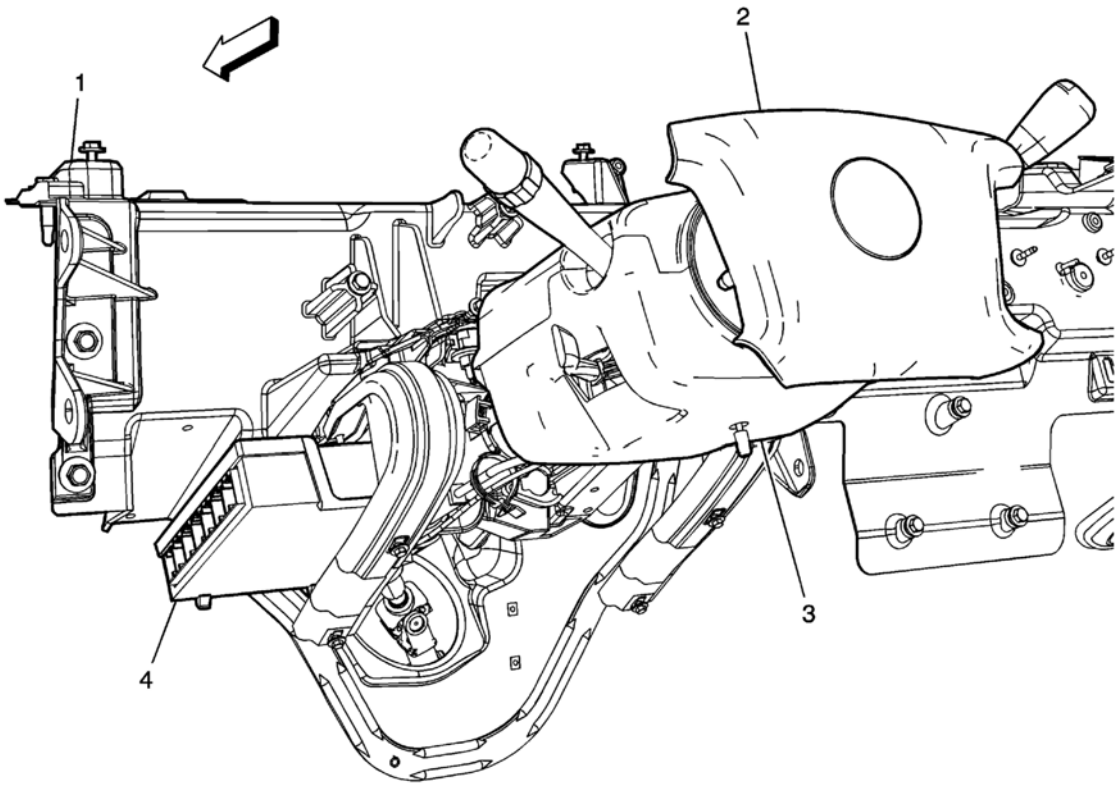


Fig. 11: Near The Steering Column
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel Carrier
2	Inflatable Restraint Steering Wheel Module
3	Steering Column
4	Body Control Module (BCM)

IN THE STEERING COLUMN COMPONENTS

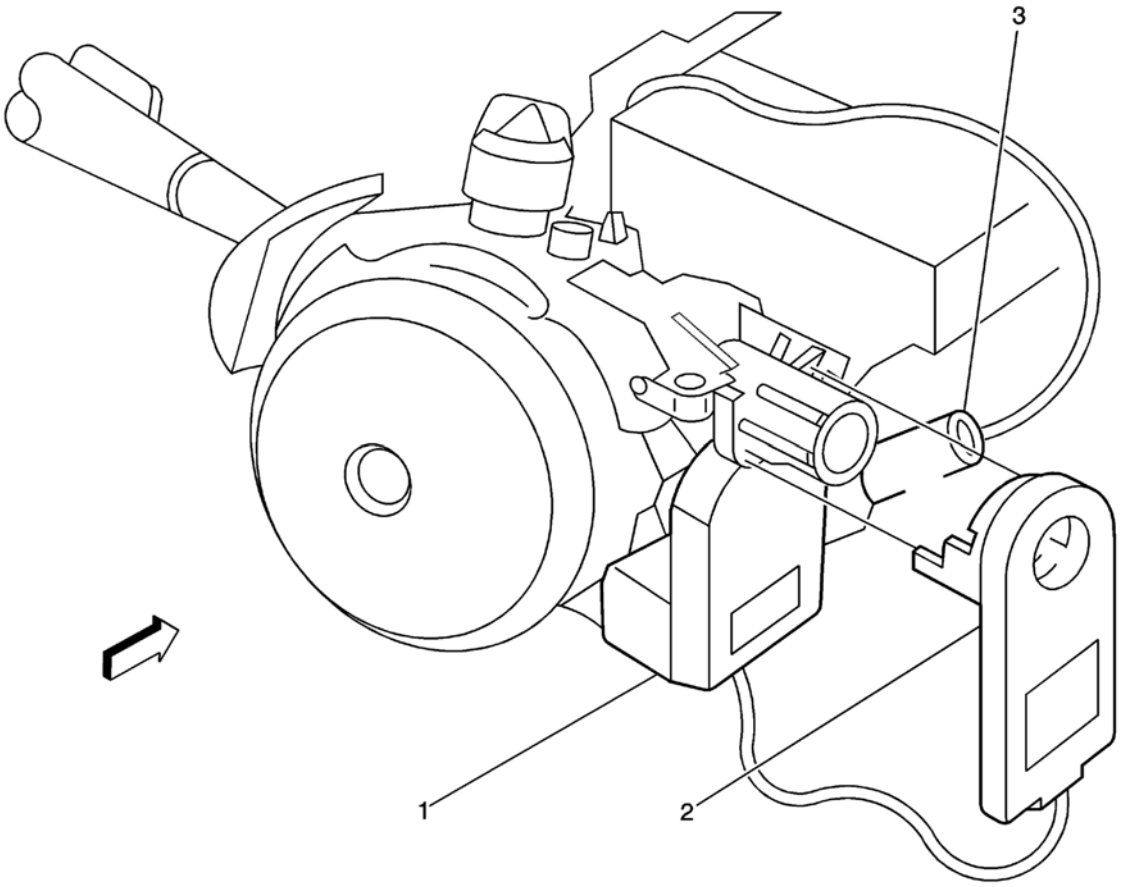


Fig. 12: In The Steering Column Component View
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Ignition Switch
2	Theft Deterrent Module (TDM)
3	Ignition Lock Cylinder Control Actuator

INTERIOR HVAC COMPONENTS

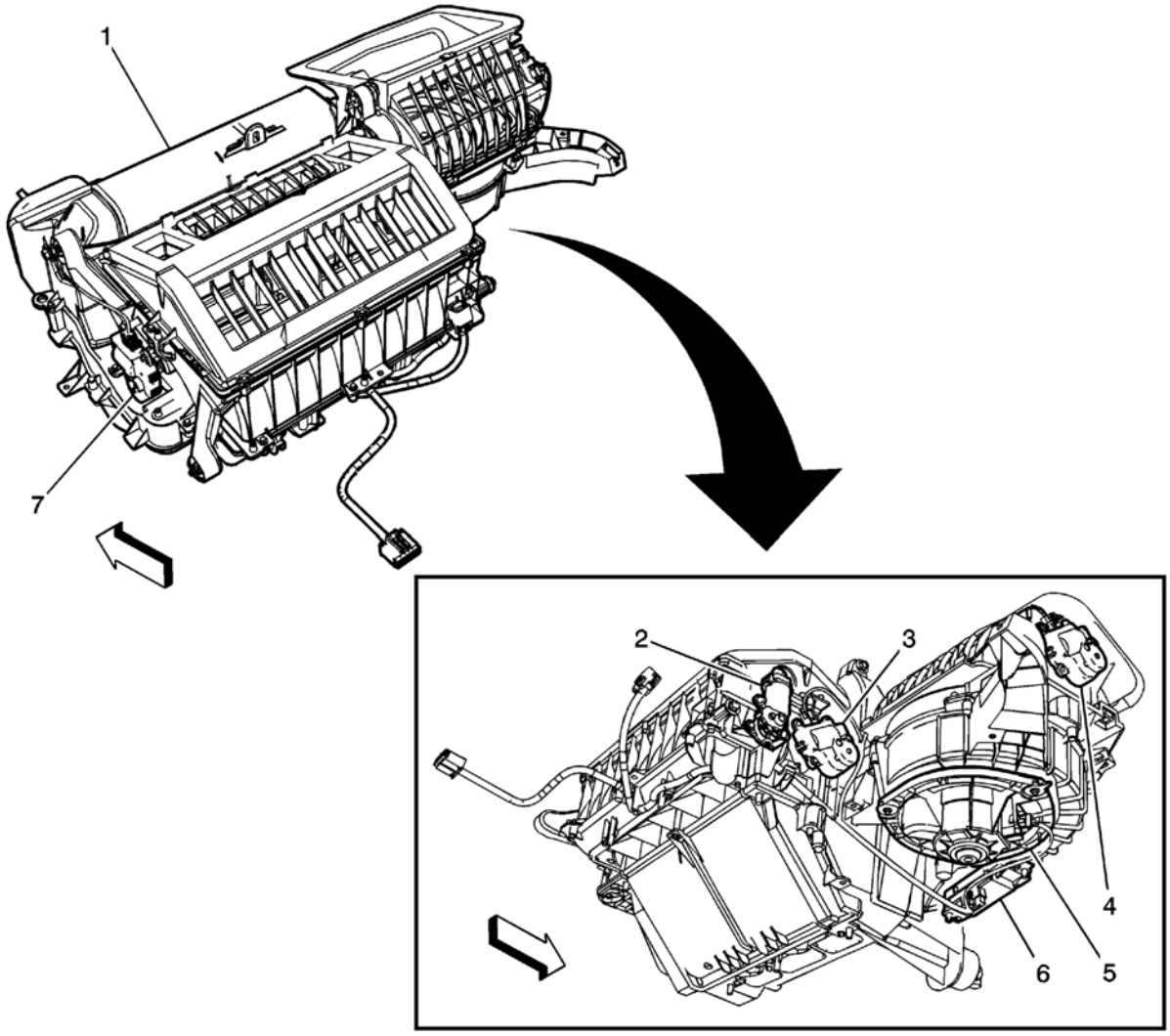


Fig. 13: Interior HVAC Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	HVAC Module
2	Mode Actuator
3	Air Temperature Actuator- Right
4	Recirculation Actuator
5	Blower Motor
6	Blower Motor Control Module
7	Air Temperature Actuator- Left

Article GUID: A00737230

LUGGAGE COMPARTMENT/REAR OF VEHICLE COMPONENT VIEWS

LUGGAGE COMPARTMENT COMPONENTS (T53)

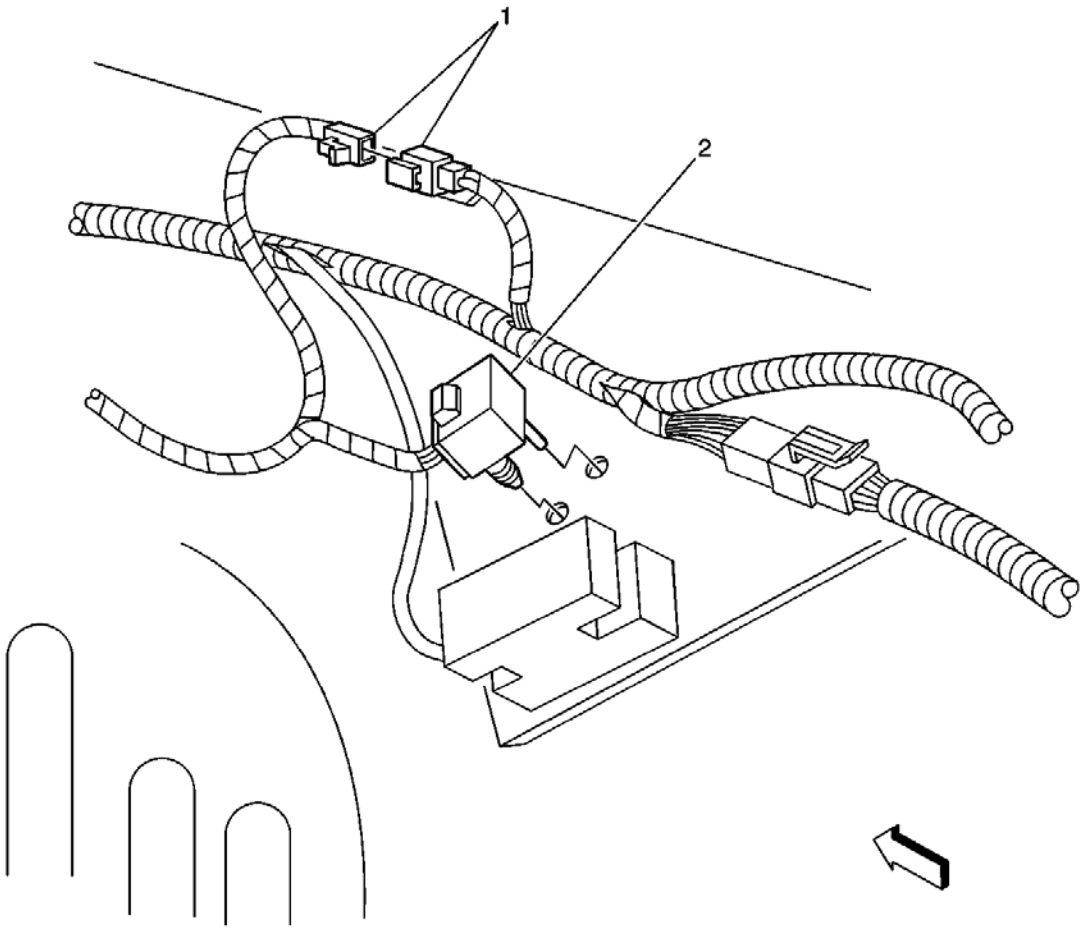


Fig. 1: Luggage Compartment Components (T53)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X409
2	Emergency Vehicle Rear Compartment Lid Lamp Relay

LEFT SIDE OF THE LUGGAGE COMPARTMENT COMPONENTS

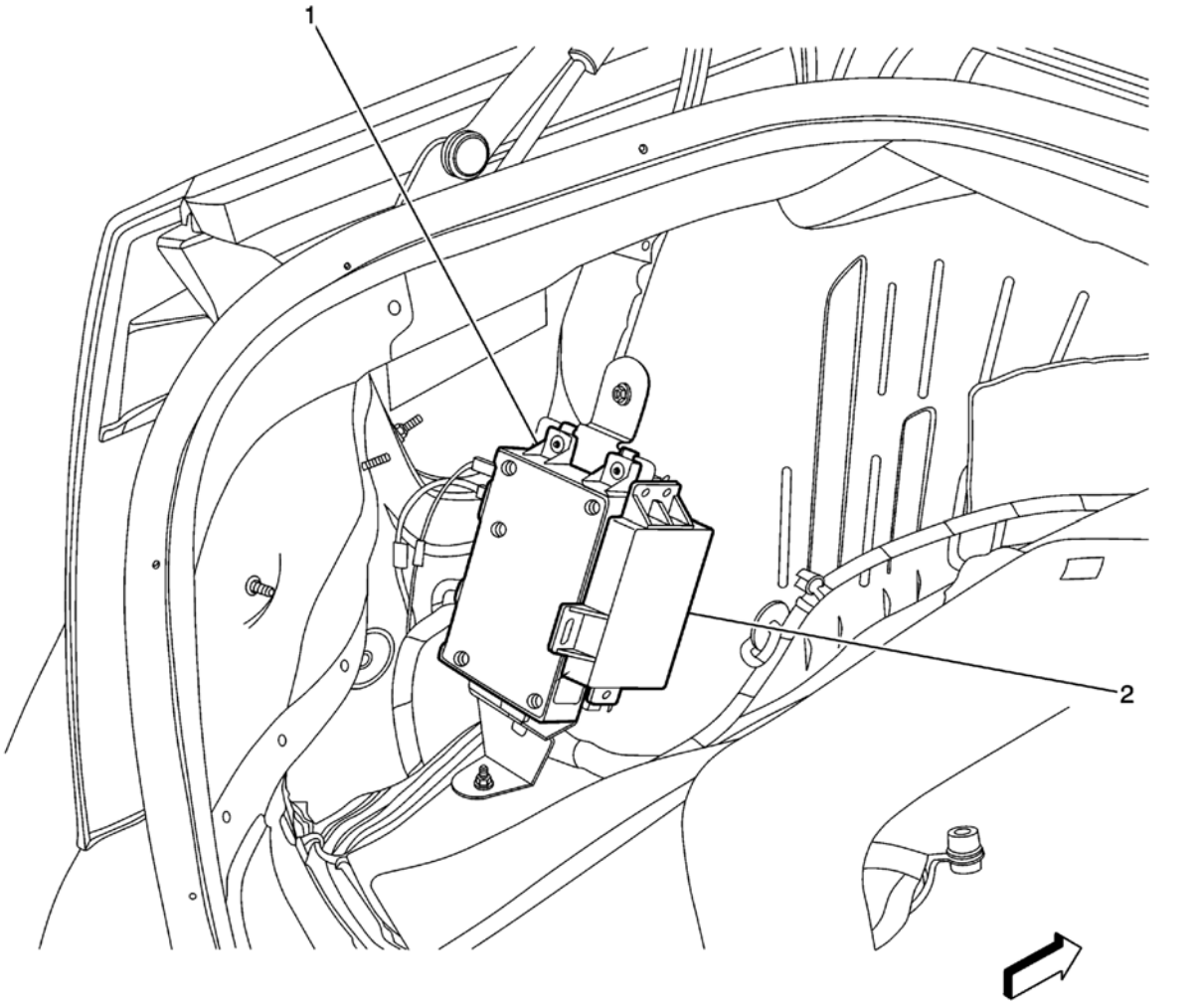


Fig. 2: Left Side of the Luggage Compartment Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Vehicle Communication Interface Module (VCIM) (UE1)
2	Vehicle Communication Interface Module (VCIM) Battery (UE1)

RIGHT SIDE OF THE LUGGAGE COMPARTMENT COMPONENTS

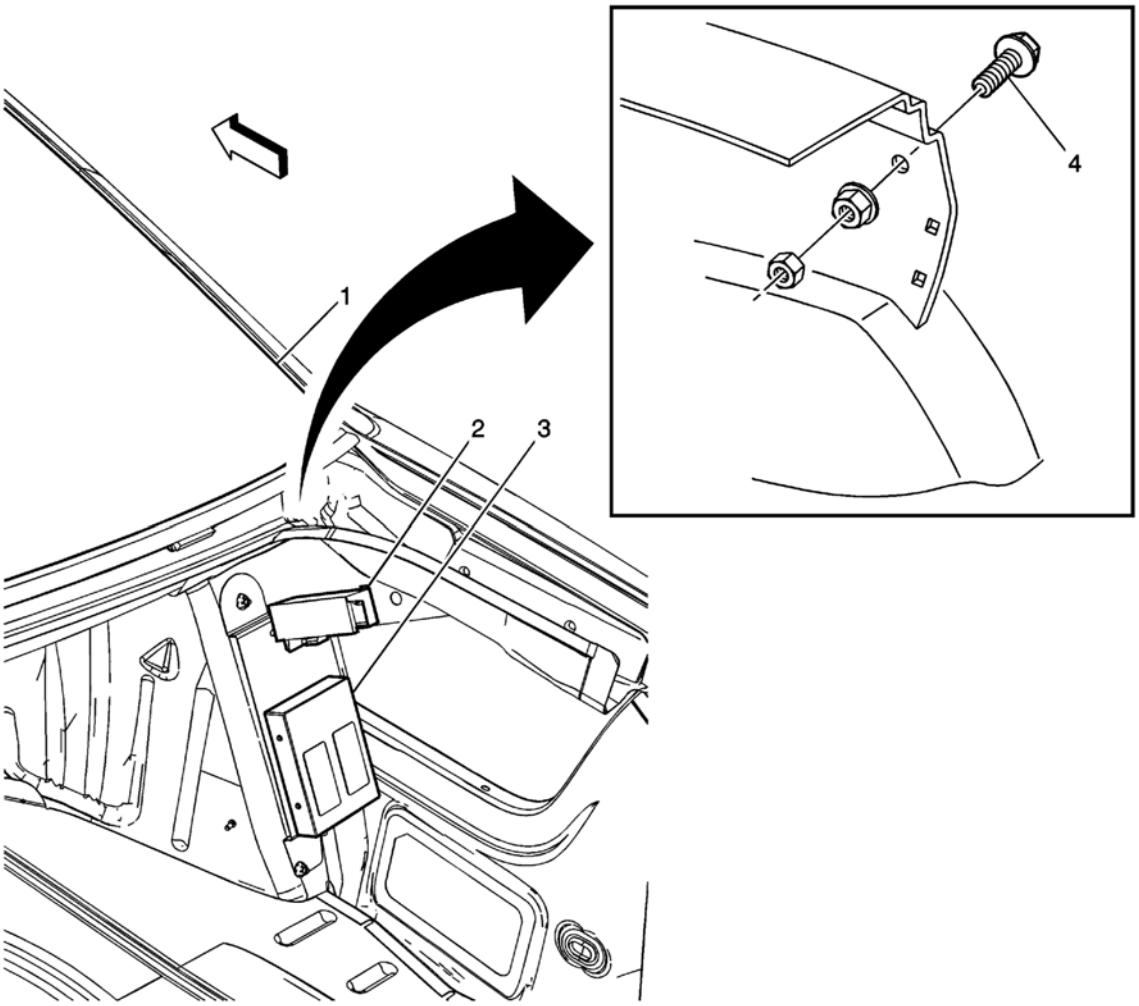


Fig. 3: Right Side Of Luggage Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Window
2	Junction Block- Rear (6J1)
3	Fuel Pump Flow Control Module
4	G405 (Provisional- UT7)

REAR COMPARTMENT LID COMPONENTS (9C1 OR 9C3)

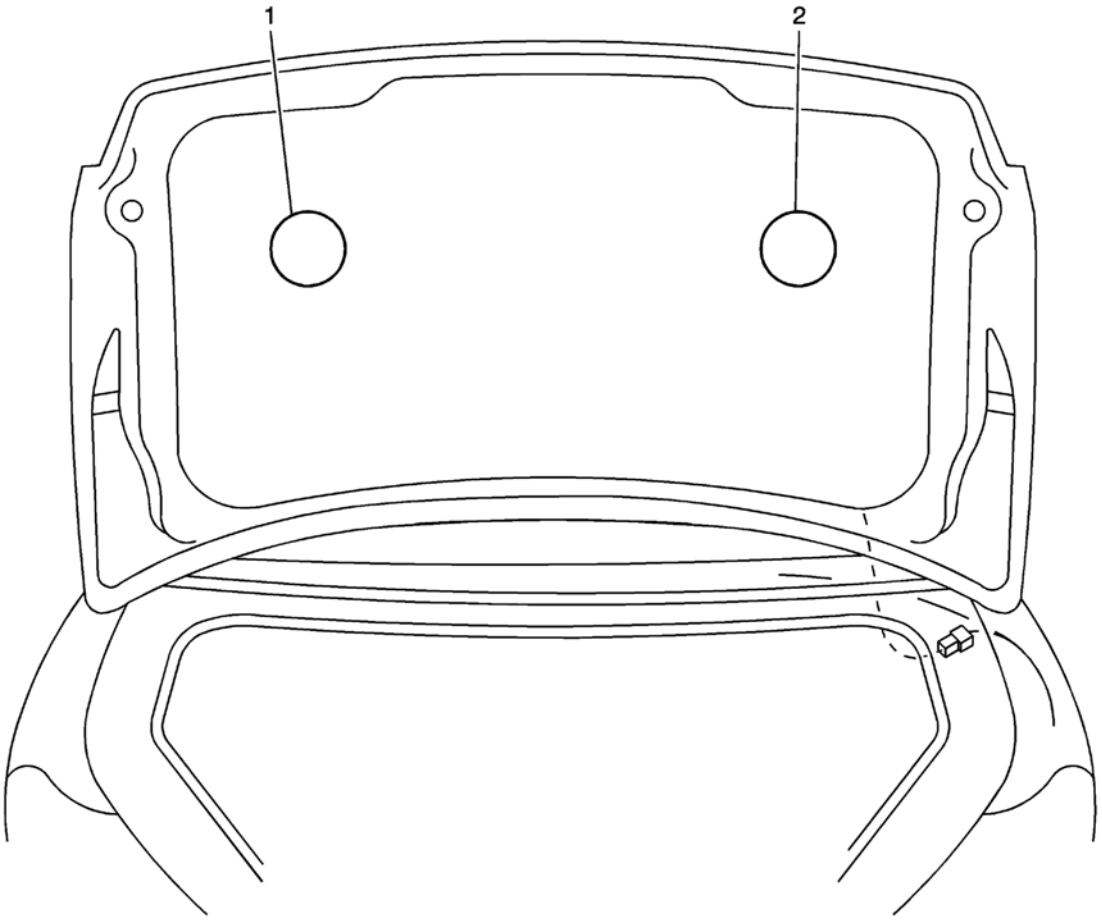


Fig. 4: Rear Compartment Lid (9C1, 9C3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Emergency Vehicle Rear Compartment Lid Lamp- Left (T53)
2	Emergency Vehicle Rear Compartment Lid Lamp- Right (T53)

REAR CENTER DECK LID COMPONENTS

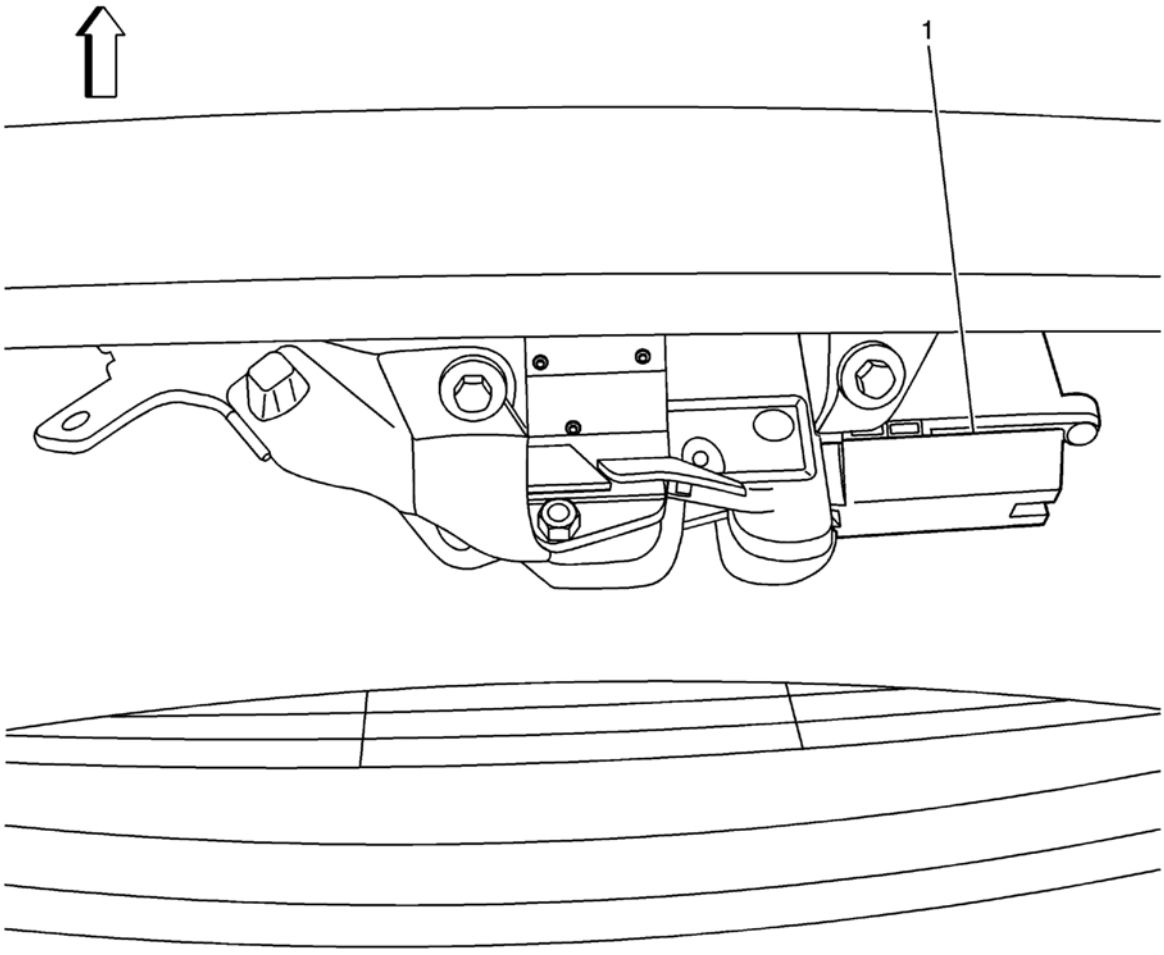


Fig. 5: View Of Rear Center Deck Lid Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Compartment Lid Release Actuator

UNDER THE REAR PACKAGE SHELF COMPONENTS

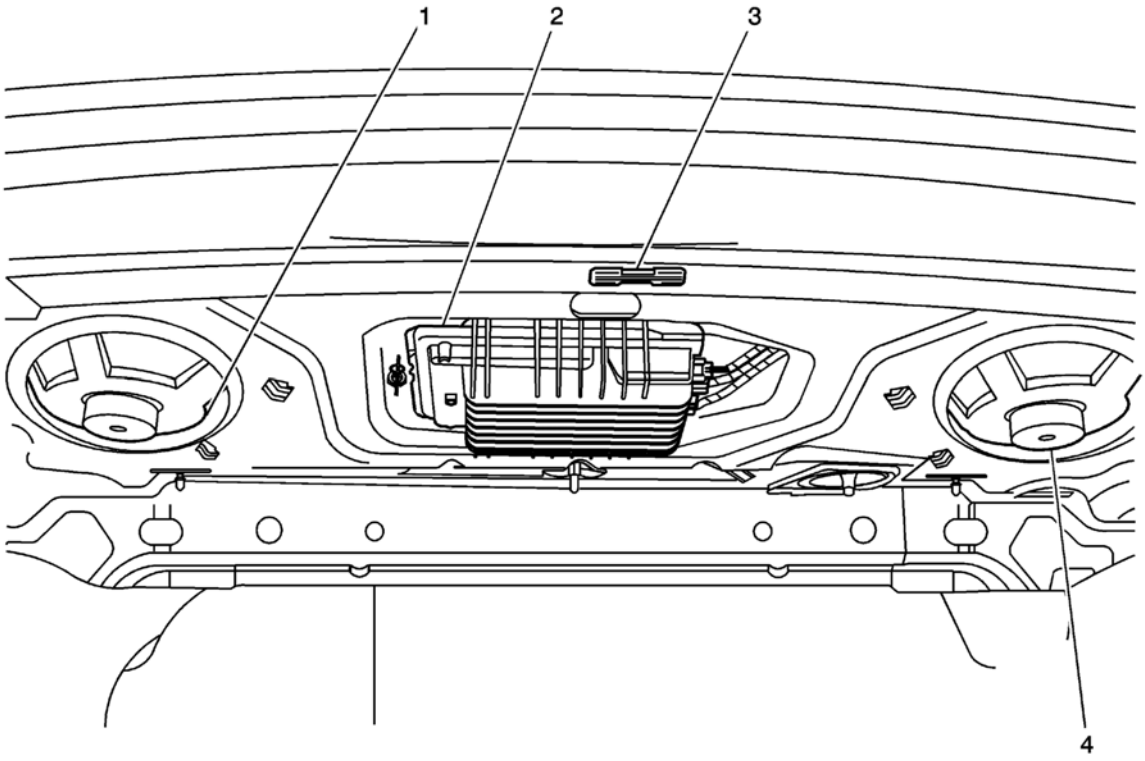


Fig. 6: Under Rear Package Shelf
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Speaker- Left Rear
2	Audio Amplifier (UQ3)
3	Rear Compartment Courtesy Lamp
4	Speaker- Right Rear

REAR OF THE VEHICLE COMPONENTS

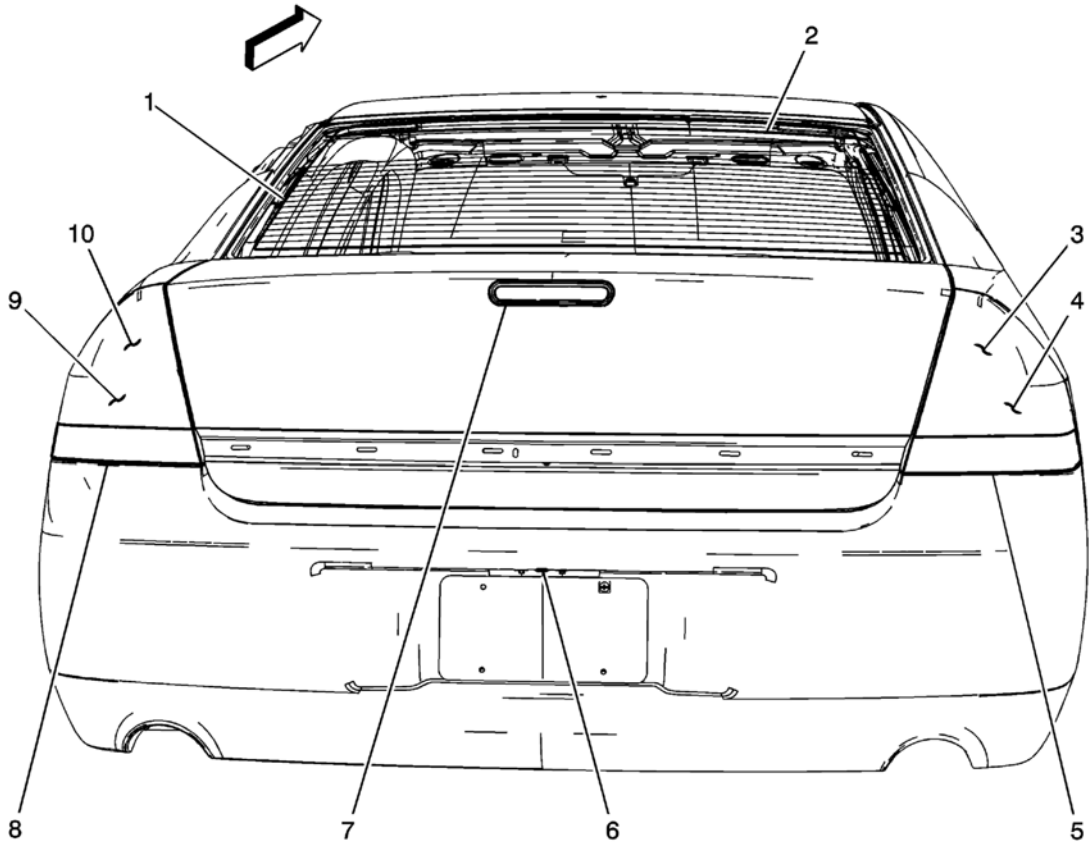


Fig. 7: Identifying Rear of the Vehicle
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear Window Defogger Grid
2	Radio Rear Window Antenna
3	Tail/Stop and Turn Signal Lamp - Right
4	Tail Lamp - Right
5	Backup Lamp - Right
6	License Lamp
7	Center High Mounted Stop Lamp (CHMSL)
8	Backup Lamp - Left
9	Tail Lamp - Left
10	Tail/Stop and Turn Signal Lamp - Left

Article GUID: A00737232

MASTER ELECTRICAL COMPONENT LIST

Name	Location	Locator View	Connector End View
A/C Compressor Clutch	In the engine compartment, on the lower right front of the engine, at right side, part of the A/C compressor	Left Front of Engine Components	A/C Compressor Clutch
A/C Compressor Solenoid Valve	In the engine compartment, on the lower right front of the engine, at left side, part of the A/C compressor	Left Front of Engine Components	A/C Compressor Solenoid Valve
A/C Refrigerant Pressure Sensor	Left side of the engine compartment, mounted on the A/C line, under the air cleaner	Left Front of the Engine Compartment Components	A/C Refrigerant Pressure Sensor
Accelerator Pedal Position (APP) Sensor	In the passenger compartment, under the left side of the instrument panel, above the accelerator pedal	Below the Instrument Panel Components- Pedal Assemblies	Accelerator Pedal Position (APP) Sensor
Accessory Power Outlet - Center Console 1 (D55)	In the passenger compartment, at the left front of the center console bin, under the instrument panel	Center Console Components- Auxiliary Power Outlets (D55)	Accessory Power Outlet - Center Console 1 (D55)
Accessory Power Outlet - Center Console 2 (D55)	In the passenger compartment, at the right front of the center console bin, under the instrument panel	Center Console Components- Auxiliary Power Outlets (D55)	Accessory Power Outlet - Center Console 2 (D55)
Accessory Power Outlet - Center Console Compartment (D55)	In the passenger compartment, at the rear of the center console, in the bottom of the bin	Center Console Components- Auxiliary Power Outlets (D55)	Accessory Power Outlet - Center Console Compartment (D55)
Accessory Power Outlet - Center Seat (without D55)	In the passenger compartment, at the rear of the center front seat	Bottom Center of the Instrument Panel (without D55)	Accessory Power Outlet - Center Seat (without D55)

Name	Location	Locator View	Connector End View
Accessory Power Outlet - I/P 1 (without D55)	In the passenger compartment, behind the right side of the instrument panel, under the HVAC control module	Bottom Center of the Instrument Panel (without D55)	Accessory Power Outlet - I/P 1 (without D55)
Accessory Power Outlet - I/P 2 (without D55)	In the passenger compartment, behind the left side of the instrument panel, under the HVAC control module	Bottom Center of the Instrument Panel (without D55)	Accessory Power Outlet - I/P 2 (without D55)
Air Temperature Actuator - Left	In the passenger compartment, to the right of the accelerator pedal, behind the center of the instrument panel, on the HVAC case	Interior HVAC Components	Air Temperature Actuator - Left
Air Temperature Actuator - Right	In the passenger compartment, behind the center of the instrument panel, to the left of the instrument panel compartment, on the HVAC case	Interior HVAC Components	Air Temperature Actuator - Right
Ambient Air Temperature Sensor	In the engine compartment, in front of the radiator, just right of the center of the vehicle	Under the Hood Latch Trim Panel Components	Ambient Air Temperature Sensor
Ambient Light Sensor	In the passenger compartment, top center of the instrument panel	Instrument Panel Components	Ambient Light Sensor
Audio Amplifier (UQ3)	In the center of the rear compartment, mounted below the rear shelf panel	Radio and Speaker Components	• Audio Amplifier X1 (UQ3) • Audio Amplifier X2 (UQ3) • Audio Amplifier X3 (UQ3)
Automatic Transmission	In the engine compartment, left middle lower	Automatic Transmission Electronic Components	-
Automatic Transmission Fluid Temperature (TFT) Sensor	At the left front of the engine compartment, in the automatic	Automatic Transmission Electronic	-

Name	Location	Locator View	Connector End View
	transmission, part of the control solenoid valve assembly	Components	
Automatic Transmission Input Shaft Speed (ISS) Sensor	In the engine compartment, left middle lower, in the automatic transmission	Automatic Transmission Electronic Components	Automatic Transmission Input Shaft Speed (ISS) Sensor
Automatic Transmission Internal Mode Switch (IMS)	In the engine compartment, left middle lower, in the automatic transmission, part of the control solenoid valve assembly	Automatic Transmission Electronic Components	-
Automatic Transmission Shift Lock Control Solenoid (D55)	In the passenger compartment, under the center console, attached to the shifter lever	Center Console Components (D55)	Automatic Transmission Shift Lock Control Solenoid (D55)
Automatic Transmission Shift Lock Control Solenoid (without D55)	In the passenger compartment, attached to the right side of the steering column	Steering Column Components (without D55)	Automatic Transmission Shift Lock Control Solenoid (without D55)
Backup Lamp - Left	At the rear of the vehicle, in the bottom of the left rear tail lamp assembly	Rear of the Vehicle Components	Backup Lamp - Left
Backup Lamp - Right	At the rear of the vehicle, in the bottom of the right rear tail lamp assembly	Rear of the Vehicle Components	Backup Lamp - Right
Battery	At the right front of the engine compartment	Right Front of the Engine Compartment Components (2 of 2)	Battery Current Sensor
Battery Current Sensor	At the right front side of the engine compartment, on the positive battery cable	Right Front of the Engine Compartment Components (2 of 2)	Battery Current Sensor
Blower Motor	In the passenger compartment, behind the right side of the instrument panel, lower right side of the HVAC assembly, above foot area of the passenger floor	Interior HVAC Components	Blower Motor
Blower Motor Control Module	In the passenger compartment, behind the right side of the	Interior HVAC Components	Blower Motor Control Module

Name	Location	Locator View	Connector End View
	instrument panel, lower right side of the HVAC assembly, next to the blower motor		
Body Control Module (BCM)	In the passenger compartment, below the left side of the instrument panel, left of the steering column	Near the Steering Column Components	• Body Control Module (BCM) X1 • Body Control Module (BCM) X2 • Body Control Module (BCM) X3 • Body Control Module (BCM) X4 • Body Control Module (BCM) X5 • Body Control Module (BCM) X6 • Body Control Module (BCM) X7
Brake Fluid Level Switch	In the engine compartment, mounted under the center of the brake fluid reservoir	Left Rear of the Engine Compartment Components	Brake Fluid Level Switch
Brake Pedal Position (BPP) Sensor	In the passenger compartment, below the left side of the instrument panel, in the right side of the brake pedal bracket	Below the Instrument Panel Components- Pedal Assemblies	Brake Pedal Position (BPP) Sensor
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Exhaust	In the engine compartment, rear of the engine, at the right side	Right Rear of Engine Components	Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Exhaust
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Intake	In the engine compartment, rear of the engine, at the right side	Right Rear of Engine Components	Camshaft Position (CMP) Actuator Solenoid Valve - Bank 1 Intake
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Exhaust	In the engine compartment, right side of the engine, near the front	Right Rear of Engine Components	Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Exhaust
Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Intake	In the engine compartment, right side of the engine, near the front	Right Rear of Engine Components	Camshaft Position (CMP) Actuator Solenoid Valve - Bank 2 Intake

Name	Location	Locator View	Connector End View
Camshaft Position (CMP) Sensor - Bank 1 Exhaust	In the engine compartment, right side of the engine, near the rear	Right Rear of Engine Components	Camshaft Position (CMP) Sensor - Bank 1 Exhaust
Camshaft Position (CMP) Sensor - Bank 1 Intake	In the engine compartment, right side of the engine, near the rear	Right Rear of Engine Components	Camshaft Position (CMP) Sensor - Bank 1 Intake
Camshaft Position (CMP) Sensor - Bank 2 Exhaust	In the engine compartment, right side of the engine, near the front	Right Rear of Engine Components	Camshaft Position (CMP) Sensor - Bank 2 Exhaust
Camshaft Position (CMP) Sensor - Bank 2 Intake	In the engine compartment, right side of the engine, near the front	Right Rear of Engine Components	Camshaft Position (CMP) Sensor - Bank 2 Intake
Cellular and Digital Radio Antenna (UE1 and/or U2K)	On the vehicle exterior, top rear center of the roof	Headliner Components- Top View	-
Cellular Telephone Microphone (UE1)	In the passenger compartment, on the headliner, near the left sunshade	-	Cellular Telephone Microphone (UE1)
Center High Mounted Stop Lamp (CHMSL)	In the rear compartment, on the upper center of the deck lid	Rear of the Vehicle Components	Center High Mounted Stop Lamp (CHMSL)
Control Solenoid Valve Assembly	In the left front of the engine compartment, in the automatic transmission	Automatic Transmission Electronic Components	• Control Solenoid Valve Assembly X1 • Control Solenoid Valve Assembly X2 • Control Solenoid Valve Assembly X3 • Control Solenoid Valve Assembly X4
Crankshaft Position (CKP) Sensor	In the engine compartment, rear of the engine, left side of the engine block	Right Rear of Engine Components	Crankshaft Position (CKP) Sensor
Data Link Connector (DLC)	In the passenger compartment, on the bottom of the instrument panel, left of the steering column	Below the Instrument Panel Components- Left Front Footwell	Data Link Connector (DLC)

Name	Location	Locator View	Connector End View
Data Link Resistor (without UE1)	In the right side luggage compartment, taped to the body harness, approximately 26 cm (10.25 in) from the fuel pump flow control module	-	-
Data Link Resistor (UE1)	In the left side luggage compartment, taped to the body harness, between the vehicle communication interface module and the vehicle communication interface module battery	-	-
Digital Radio Receiver (U2K)	In the luggage compartment, left side, above the Vehicle Communication Interface Module (VCIM)	**Radio and Speaker Components**	**Digital Radio Receiver (U2K)**
Dome/Reading Lamps	In the passenger compartment, inside center of the roof	**Headliner Components**	**Dome/Reading Lamps**
Door Lock - Driver	In the passenger compartment, in the rear of the driver door	**Driver Door Components**	• **Door Lock - Driver (UA6)** • **Door Lock - Driver (without UA6)**
Door Lock - Left Rear	In the passenger compartment, in the rear of the left rear door	**Left Rear Door Components**	**Door Lock - Left Rear**
Door Lock - Passenger	In the passenger compartment, in the rear of the passenger door	**Passenger Door Components**	**Door Lock - Passenger**
Door Lock - Right Rear	In the passenger compartment, in the rear of the right rear door	**Right Rear Door Components**	**Door Lock - Right Rear**
Door Lock Switch - Driver	In the passenger compartment, in the center of the driver door panel, near the door handle	**Driver Door Components**	**Door Lock Switch - Driver**
Door Lock Switch - Passenger	In the passenger compartment, in the center of the front	**Passenger Door Components**	**Door Lock Switch - Passenger**

Name	Location	Locator View	Connector End View
	passenger door panel, near the door handle		
Driver Information Center (DIC) Switch	In the passenger compartment, on the instrument panel, to the right of the instrument panel cluster	Instrument Panel Components	Driver Information Center (DIC) Switch
Electronic Brake Control Module (EBCM)	At the left side of the engine compartment, part of the brake pressure modulator valve, mounted to the back side of the strut tower	Left Front of the Engine Compartment Components	Electronic Brake Control Module (EBCM)
Emergency Vehicle Front Lamp Flasher (6J3)	Under the vehicle, in the right front footwell, mounted to the closeout panel	-	Emergency Vehicle Front Lamp Flasher (6J3)
Emergency Vehicle Headlamp Flasher (6J7)	At the front of the vehicle, at the left side of the right headlamp assembly	Right Headlamp Assembly Components (9C1 or 9C3)	-
Emergency Vehicle Rear Compartment Lid Lamp - Left (T53)	In the rear compartment, on the inside of the rear compartment lid	Rear Compartment Lid Components (9C1 or 9C3)	-
Emergency Vehicle Rear Compartment Lid Lamp - Right (T53)	In the rear compartment, on the inside of the rear compartment lid	Rear Compartment Lid Components (9C1 or 9C3)	-
Emergency Vehicle Rear Compartment Lid Lamp Relay (T53)	In the luggage compartment, at the upper right hand corner of the trunk opening	Luggage Compartment Components (T53)	-
Emergency Vehicle Rear Window Panel Lamp - Left (6J6)	In the rear compartment, on the left side of the package shelf	Package Shelf Components (9C1 or 9C3)	Emergency Vehicle Rear Window Panel Lamp - Left (6J6)
Emergency Vehicle Rear Window Panel Lamp - Right (6J6)	In the rear compartment, on the right side of the package shelf	Package Shelf Components (9C1 or 9C3)	Emergency Vehicle Rear Window Panel Lamp - Right (6J6)
Engine Control Module (ECM)	At the left side of the engine compartment, inside the air cleaner assembly	Left Front of the Engine Compartment Components	• Engine Control Module (ECM) X1 (LFX) • Engine Control Module (ECM) X2 (LFX) • Engine Control Module (ECM) X3 (LFX)

Name	Location	Locator View	Connector End View
Engine Coolant Temperature (ECT) Sensor	In the engine compartment, on the right front side of the cylinder head between exhaust ports 4 and 6	Left Front of Engine Components	Engine Coolant Temperature (ECT) Sensor
Engine Cooling Fan - Left	At the front of the engine compartment, mounted to the left side of the radiator	Engine Compartment Cooling Components	Engine Cooling Fan - Left
Engine Cooling Fan - Right	At the front of the engine compartment, mounted to the right side of the radiator	Engine Compartment Cooling Components	Engine Cooling Fan - Right
Engine Cooling Fan Diode - Left	In the engine compartment, near the Fuse Block - Underhood	-	-
Engine Cooling Fan Diode - Right	In the engine compartment, near the Fuse Block - Underhood	-	-
Engine Oil Pressure (EOP) Sensor	In the engine compartment, right front lower area of the engine, below the generator, above the A/C compressor	Left Front of Engine Components	Engine Oil Pressure (EOP) Switch
Evaporative Emission (EVAP) Canister Purge Solenoid Valve	In the engine compartment, right rear edge of the intake manifold	Right Rear of Engine Components	Evaporative Emission (EVAP) Canister Purge Solenoid Valve
Evaporative Emission (EVAP) Canister Vent Solenoid Valve	Under the vehicle, behind the left rear wheelhouse	Fuel Tank Components	Evaporative Emission (EVAP) Canister Vent Solenoid Valve
Evaporator Temperature Sensor	In the passenger compartment, front left of center, on left side of HVAC assembly	-	Evaporator Temperature Sensor
Fog Lamp - Left Front (T96)	At the front of the vehicle, on left front lower bumper fascia	Front of the Vehicle Components	Fog Lamp - Left Front (T96)
Fog Lamp - Right Front (T96)	At the front of the vehicle, on right front lower bumper fascia	Front of the Vehicle Components	Fog Lamp - Right Front (T96)
Fuel Injector 1	In the engine compartment, top of the engine, at number 1	Top Engine Components	Fuel Injector 1

Name	Location	Locator View	Connector End View
	cylinder intake port, below intake manifold		
Fuel Injector 2	In the engine compartment, top of the engine, at number 2 cylinder intake port, below intake manifold	**Top Engine Components**	**Fuel Injector 2**
Fuel Injector 3	In the engine compartment, top of the engine, at number 3 cylinder intake port, below intake manifold	**Top Engine Components**	**Fuel Injector 3**
Fuel Injector 4	In the engine compartment, top of the engine, at number 4 cylinder intake port, below intake manifold	**Top Engine Components**	**Fuel Injector 4**
Fuel Injector 5	In the engine compartment, top of the engine, at number 5 cylinder intake port, below intake manifold	**Top Engine Components**	**Fuel Injector 5**
Fuel Injector 6	In the engine compartment, top of the engine, at number 6 cylinder intake port, below intake manifold	**Top Engine Components**	**Fuel Injector 6**
Fuel Level Sensor	Under the vehicle, in the fuel tank, part of the Fuel Pump and Sender Assembly	**Fuel Tank Components**	-
Fuel Pressure Sensor	Under the vehicle, on the left hand side, rear of the engine compartment	-	**Fuel Pressure Sensor**
Fuel Pump and Sender Assembly	Under the vehicle, in the fuel tank	**Fuel Tank Components**	**Fuel Pump and Sender Assembly**
Fuel Pump Flow Control Module (Chassis Control Module)	In the luggage compartment, mounted to the rear of the right rear wheelhouse	**Right Side of the Luggage Compartment Components**	**Fuel Pump Flow Control Module**
Fuel Rail Pressure (FRP) Sensor	In the engine compartment, top of the engine, at the fuel rail near fuel injector 1	**Top Engine Components**	**Fuel Rail Pressure (FRP) Sensor**

Name	Location	Locator View	Connector End View
Fuel Tank Pressure (FTP) Sensor	Under the vehicle, at the top of the fuel tank, part of the fuel pump and sender assembly	**Fuel Tank Components**	**Fuel Tank Pressure (FTP) Sensor**
Fuse Block - Auxiliary (9C1 or 9C3)	In the passenger compartment, behind the instrument panel, right of the steering column, above the accelerator pedal	**Instrument Panel Harness Routing- Rear of the Instrument Panel Carrier**	-
Fuse Block - I/P	In the passenger compartment, behind the right front kick panel	**Right Front of the Passenger Compartment Components**	**Electrical Center Identification Views**
Fuse Block - Underhood	At the right side of the engine compartment, mounted to the strut tower	**Right Front of the Engine Compartment Components (1 of 2)**	**Electrical Center Identification Views**
Fusible Link (9C1 or 9C3)	In the passenger compartment, at the fuse block - underhood battery stud	**Instrument Panel Harness Routing- Engine Compartment**	-
Fusible Link (without 6J1)	In the engine compartment, near the starter, between starter and generator	-	-
Garage Door Opener (GDO) (UG1)	In the passenger compartment, front center of the headliner, above the inside rearview mirror, in the headliner console	**Headliner Components**	**Garage Door Opener (UG1)**
Generator	In the engine compartment, top right rear of the engine	**Right Front of the Engine Compartment Components (1 of 2)**	**Generator X1**
Headlamp - Left High Beam	In the left headlamp assembly	**Front of the Vehicle Components**	**Headlamp - Left High Beam**
Headlamp - Left Low Beam	At the front of the vehicle, in the left headlamp assembly	**Front of the Vehicle Components**	**Headlamp - Left Low Beam**
Headlamp - Right High Beam	At the front of the vehicle, in the right headlamp assembly	**Front of the Vehicle Components**	**Headlamp - Right High Beam**

Name	Location	Locator View	Connector End View
Headlamp - Right Low Beam	At the front of the vehicle, in the right headlamp assembly	Front of the Vehicle Components	Headlamp - Right Low Beam
Headlamp Switch	In the passenger compartment, left side of the instrument panel, left of the steering column	Instrument Panel Components	Headlamp Switch
Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 1	In the rear of the engine compartment, in the exhaust pipe near the cylinder head	Oxygen Sensors	Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 1
Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 2	In the rear of the engine compartment, after the catalytic converter	Oxygen Sensors	Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 2
Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 1	In the front of the engine compartment, in the exhaust pipe near the cylinder head	Oxygen Sensors	Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 1
Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 2	In the lower front of the engine compartment, after the catalytic converter	Oxygen Sensors	Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 2
Heated Seat Control Module (KA1)	In the passenger compartment, under the driver seat	Driver Seat Components	• Heated Seat Control Module (KA1) X1 • Heated Seat Control Module (KA1) X2 • Heated Seat Control Module (KA1) X3 • Heated Seat Control Module (KA1) X4
Heated Seat Element - Driver Back (KA1)	In the passenger compartment, under the upholstery of the driver seat back	Driver Seat Components	Heated Seat Element - Driver Back (KA1)
Heated Seat Element - Driver Cushion (KA1)	In the passenger compartment, under the upholstery of the driver seat cushion	Driver Seat Components	Heated Seat Element - Driver Cushion (KA1)
Heated Seat Element - Passenger Back (KA1)	In the passenger compartment, under the upholstery of the passenger seat back	Passenger Seat Components	Heated Seat Element - Passenger Back (KA1)

Name	Location	Locator View	Connector End View
Heated Seat Element - Passenger Cushion (KA1)	In the passenger compartment, under the upholstery of the passenger seat cushion	Passenger Seat Components	Heated Seat Element - Passenger Cushion (KA1)
High Pressure Fuel Pump (LFX)	In the engine compartment, near center middle, at the left rear of the bank 2 cylinder head	Left Front of Engine Components	G18 High Pressure Fuel Pump (LFX)
Hood Ajar Switch (AP3)	In the luggage compartment, part of the hood latch	Under the Hood Latch Trim Panel Components	Hood Ajar Switch (AP3)
Horn Assembly	At the front of the vehicle, behind the front fascia, mounted to the frame rail extension, below the right headlamp	Right Front of the Engine Compartment Components (1 of 2)	Horn Assembly
Horn Switch	In the passenger compartment, in the steering wheel, behind the inflatable restraint steering wheel module	Steering Wheel Components	Horn Switch
HVAC Control Module	In the passenger compartment, center of the instrument panel	Instrument Panel Components	• HVAC Control Module X1 • HVAC Control Module X2
I/P Courtesy Lamp - Left	In the passenger compartment, below the instrument panel, above the left footwell	Below the Instrument Panel Components- Left Front Footwell	I/P Courtesy Lamp - Left
I/P Courtesy Lamp - Right	In the passenger compartment, below the instrument panel, above the right footwell	Below the Instrument Panel Components- Right Front Footwell	I/P Courtesy Lamp - Right
Ignition Coil 1	In the engine compartment, on top of the engine, at cylinder 1	Right Rear of Engine Components	Ignition Coil 1
Ignition Coil 2	In the engine compartment, on top of the engine, at cylinder 2	Left Front of Engine Components	Ignition Coil 2
Ignition Coil 3	In the engine compartment, on top of the engine, at cylinder 3	Right Rear of Engine Components	Ignition Coil 3

Name	Location	Locator View	Connector End View
Ignition Coil 4	In the engine compartment, on top of the engine, at cylinder 4	**Left Front of Engine Components**	**Ignition Coil 4**
Ignition Coil 5	In the engine compartment, on top of the engine, at cylinder 5	**Right Rear of Engine Components**	**Ignition Coil 5**
Ignition Coil 6	In the engine compartment, on top of the engine, at cylinder 6	**Left Front of Engine Components**	**Ignition Coil 6**
Ignition Lock Cylinder Control Actuator (without D55)	In the passenger compartment, right side of the steering column	**In the Steering Column Components**	-
Ignition Switch	In the passenger compartment, right side of the steering column	**In the Steering Column Components**	**Ignition Switch**
Inflatable Restraint Front End Sensor - Left	At the left front of the vehicle, behind the front fascia, left of the hood latch	**Left Front of the Engine Compartment Components**	**Inflatable Restraint Front End Sensor - Left**
Inflatable Restraint Front End Sensor - Right	At the right front of the vehicle, behind the front fascia, right of the hood latch	**Right Front of the Engine Compartment Components (1 of 2)**	**Inflatable Restraint Front End Sensor - Right**
Inflatable Restraint Front Passenger Presence System (PPS) Module	In the passenger compartment, under the front passenger seat	**Passenger Seat Components**	**Inflatable Restraint Front Passenger Presence System (PPS) Module**
Inflatable Restraint Front Passenger Presence System (PPS) Sensor	In the passenger compartment, under the front passenger seat	**Passenger Seat Components**	-
Inflatable Restraint I/P Module	In the passenger compartment, right side of the instrument panel, above the instrument panel compartment	**Instrument Panel Components**	• **Inflatable Restraint I/P Module X1** • **Inflatable Restraint I/P Module X2**
Inflatable Restraint I/P Module Indicator	In the passenger compartment, on the instrument panel, to the right of the instrument panel cluster, above the radio	**Instrument Panel Components**	**Inflatable Restraint I/P Module Indicator**
Inflatable Restraint Roof Rail Module - Left	In the passenger compartment, mounted on	**Roof Rail Components**	**Inflatable Restraint Roof Rail Module - Left**

Name	Location	Locator View	Connector End View
	the left C-pillar, behind the trim		
Inflatable Restraint Roof Rail Module - Right	In the passenger compartment, mounted on the right C-pillar, behind the trim	Roof Rail Components	Inflatable Restraint Roof Rail Module - Right
Inflatable Restraint Sensing and Diagnostic Module (SDM)	In the passenger compartment, under the front passenger seat, under the carpet	Under the Passenger Seat Components	• Inflatable Restraint Sensing and Diagnostic Module (SDM) X1 • Inflatable Restraint Sensing and Diagnostic Module (SDM) X2
Inflatable Restraint Side Impact Module - Left	In the passenger compartment, on the left side of the driver seat back	Front Seat Airbag Components	Inflatable Restraint Side Impact Module - Left
Inflatable Restraint Side Impact Module - Right	In the passenger compartment, on the right side of the front passenger seat back	Front Seat Airbag Components	Inflatable Restraint Side Impact Module - Right
Inflatable Restraint Side Impact Sensor (SIS) - Left	In the passenger compartment, in the driver door	Driver Door Components	Inflatable Restraint Side Impact Sensor (SIS) - Left
Inflatable Restraint Side Impact Sensor (SIS) - Right	In the passenger compartment, in the front passenger door	Passenger Door Components	Inflatable Restraint Side Impact Sensor (SIS) - Right
Inflatable Restraint Steering Wheel Module	In the passenger compartment, in the center of the steering wheel	Near the Steering Column Components	• Inflatable Restraint Steering Wheel Module X1 • Inflatable Restraint Steering Wheel Module X2
Inflatable Restraint Steering Wheel Module Coil	In the passenger compartment, in the steering column, behind the steering wheel	Instrument Panel Components	• Inflatable Restraint Steering Wheel Module X1 • Inflatable Restraint Steering Wheel Module X2
Inline Fuse - Engine Cooling Fan - Left	In the engine compartment, near the Fuse Block - Underhood	-	-

Name	Location	Locator View	Connector End View
Inline Fuse - Engine Cooling Fan - Right	In the engine compartment, near the Fuse Block - Underhood	-	-
Inline Fuse - Generator (6J1)	In the engine compartment, near the starter, between the starter and the generator	-	-
Inside Rearview Mirror (ISRVM)	In the passenger compartment, top center of the windshield	**Above the Windshield Components**	• **Inside Rearview Mirror (DD6 or UE1)** • **Inside Rearview Mirror (without DD6 or UE1)**
Instrument Panel Cluster (IPC)	In the passenger compartment, left side of the instrument panel, above the steering column	**Instrument Panel Components**	**Instrument Panel Cluster (IPC)**
Junction Block - Rear (6J1)	In the rear compartment, behind the right rear wheelhouse	**Right Side of the Luggage Compartment Components**	-
Keyless Entry Antenna	In the passenger compartment, left side of the windshield, along the A-pillar	**Left Side of the Windshield Components**	-
Knock Sensor (KS) 1	In the engine compartment, rear of the engine, below the exhaust manifold, above the transmission	**Right Rear of Engine Components**	**Knock Sensor (KS) 1**
Knock Sensor (KS) 2	In the engine compartment, front of the engine, above the starter	**Left Front of Engine Components**	**Knock Sensor (KS) 2**
License Lamp	At the rear of the vehicle, center of the rear fascia, above the license plate opening	**Rear of the Vehicle Components**	**License Lamp**
Manifold Absolute Pressure (MAP) Sensor	In the engine compartment, rear near center, top left side of the intake manifold, left of the throttle body	**Right Rear of Engine Components**	**Manifold Absolute Pressure (MAP) Sensor**
Mode Actuator	In the passenger compartment, center of the instrument panel, to	**Interior HVAC Components**	**Mode Actuator**

Name	Location	Locator View	Connector End View
	the right of the radio, on the HVAC assembly		
Multifunction Intake Air Sensor	At the left front of the engine compartment, in the air cleaner duct	**Left Front of the Engine Compartment Components**	**Multifunction Intake Air Sensor**
Outside Rearview Mirror - Driver	On the vehicle exterior, upper front of the driver door	**Driver Door Components**	**Outside Rearview Mirror - Driver**
Outside Rearview Mirror - Passenger	On the vehicle exterior, upper front of the front passenger door	**Passenger Door Components**	**Outside Rearview Mirror - Passenger**
Outside Rearview Mirror Switch	In the passenger compartment, on the left front door trim panel	**Driver Door Components**	**Outside Rearview Mirror Switch**
Park Brake Switch	In the passenger compartment, below the left side of the instrument panel, part of the park brake pedal assembly	**Below the Instrument Panel Components- Pedal Assemblies**	**Park Brake Switch**
Park/Turn Signal Lamp - Left	At the front of the vehicle, in the left front headlamp assembly	**Front of the Vehicle Components**	**Park/Turn Signal Lamp - Left**
Park/Turn Signal Lamp - Right	At the front of the vehicle, in the right front headlamp assembly	**Front of the Vehicle Components**	**Park/Turn Signal Lamp - Right**
Pressure Control (PC) Solenoid Valve 1	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-
Pressure Control (PC) Solenoid Valve 2	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-
Pressure Control (PC) Solenoid Valve 3	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-

Name	Location	Locator View	Connector End View
Pressure Control (PC) Solenoid Valve 4	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	Automatic Transmission Electronic Components	-
Pressure Control (PC) Solenoid Valve 5	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	Automatic Transmission Electronic Components	-
Radio	In the passenger compartment, center of the instrument panel	Instrument Panel Components	• Radio X1 • Radio X2
Radio Antenna Module	In the passenger compartment, left of the back window	Above the Rear Seat Components	Radio Antenna Module
Radio Rear Window Antenna	At the rear of the vehicle, attached to the top of the rear window, above the rear window defogger grid	Rear of the Vehicle Components	-
Reading Lamp - Auxiliary (6C7)	In the passenger compartment, center of the roof, forward of the dome lamp	Headliner Components (9C1 or 9C3)	Reading Lamp - Auxiliary (6C7)
Rear Compartment Courtesy Lamp	In the rear compartment, in the rear deck, below the center of the rear window panel	Under the Rear Package Shelf Components	Rear Compartment Courtesy Lamp
Rear Compartment Lid Latch Release Actuator	In the rear compartment, mounted to the rear center of the deck lid, on the lid latch	Rear Center Deck Lid Components	-
Rear Window Defogger Grid	At the rear of the vehicle, on the inside rear window glass	Rear of the Vehicle Components	• Rear Window Defogger Grid X1 • Rear Window Defogger Grid X2
Recirculation Actuator	In the passenger compartment, back of the instrument panel compartment, on the	Interior HVAC Components	Recirculation Actuator

Name	Location	Locator View	Connector End View
	upper HVAC case, near the right A-pillar		
Remote Control Door Lock Receiver (RCDLR)	In the passenger compartment, on the upper center of the instrument panel, under the defroster grille panel	**Behind the Instrument Panel Components**	**Remote Control Door Lock Receiver (RCDLR)**
Seat Adjuster Motor Assembly - Driver (AG1 or AH5)	In the passenger compartment, below the driver seat	**Driver Seat Components**	**Seat Adjuster Motor Assembly - Driver (AG1, AH5)**
Seat Adjuster Motor Assembly - Passenger (AG2)	In the passenger compartment, below the front passenger seat	**Passenger Seat Components**	**Seat Adjuster Motor Assembly - Passenger (AG2)**
Seat Adjuster Switch - Driver (AG1 or AH5)	In the passenger compartment, left side of the driver seat cushion	**Driver Seat Components**	• **Seat Adjuster Switch - Driver (AG1)** • **Seat Adjuster Switch - Driver (AH5)**
Seat Adjuster Switch - Passenger (AG2)	In the passenger compartment, right side of the front passenger seat cushion	**Passenger Seat Components**	**Seat Adjuster Switch - Passenger (AG2)**
Seat Belt Pretensioner - Driver	In the passenger compartment, mounted to the left side of the driver seat, under the seat cushion	-	**Seat Belt Pretensioner - Driver**
Seat Belt Pretensioner - Passenger	In the passenger compartment, mounted to the right side of the passenger seat, under the seat cushion	-	**Seat Belt Pretensioner - Passenger**
Seat Belt Retractor Pretensioner - Driver	In the passenger compartment, mounted to the left front retractor, at the base of the B-pillar	**Left B-Pillar Components**	**Seat Belt Retractor Pretensioner - Driver**
Seat Belt Retractor Pretensioner - Passenger	In the passenger compartment, mounted to the right front retractor, at the base of the B-pillar	**Right B-Pillar Components**	**Seat Belt Retractor Pretensioner - Passenger**
Seat Belt Switch - Driver	In the passenger compartment, inside the driver seat belt buckle	-	**Seat Belt Switch - Driver**

Name	Location	Locator View	Connector End View
Seat Belt Switch - Passenger	In the passenger compartment, inside the front passenger seat belt buckle	**Passenger Seat Components**	**Seat Belt Switch - Passenger**
Seat Recline Motor - Driver (AH5)	In the passenger compartment, attached to the right side of the driver seat back	**Driver Seat Components**	**Seat Recline Motor - Driver (AH5)**
Secondary Air Injection (AIR) Pump (NU5 or NU6)	At the left front of the engine compartment, above the starter, near G111	**Left Front of the Engine Compartment Components (NU5 or NU6)**	**Secondary Air Injection (AIR) Pump (NU5/NU6)**
Secondary Air Injection (AIR) Pump Relay (NU5 or NU6)	In the engine compartment, near the mass air flow/intake air temperature sensor	**Left Front of the Engine Compartment Components (NU5 or NU6)**	**Secondary Air Injection (AIR) Pump Relay (NU5/NU6)**
Secondary Air Injection (AIR) Pump Solenoid (NU5 or NU6)	In the engine compartment, near the ignition control module	**Left Front of the Engine Compartment Components (NU5 or NU6)**	**Secondary Air Injection (AIR) Pump Solenoid Bank 1 (NU5/NU6)**
Secondary Air Injection (AIR) Pump Solenoid Relay (NU5 or NU6)	In the engine compartment, near the mass air flow/intake air temperature sensor	**Left Front of the Engine Compartment Components (NU5 or NU6)**	**Secondary Air Injection (AIR) Pump Solenoid Relay (NU5/NU6)**
Shift Solenoid (SS) Valve 1	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-
Shift Solenoid (SS) Valve 2	At the left front of the engine compartment, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-
Side Marker Lamp - Left Front	At the front of the vehicle, in the left front headlamp assembly	**Front of the Vehicle Components**	**Side Marker Lamp - Left Front**

Name	Location	Locator View	Connector End View
Side Marker Lamp - Right Front	At the front of the vehicle, in the right front headlamp assembly	Front of the Vehicle Components	Side Marker Lamp - Right Front
Speaker - Left Front	In the passenger compartment, lower front of the driver door trim panel	Radio and Speaker Components	Speaker - Left Front
Speaker - Left Front Tweeter (UQ3)	In the passenger compartment, on the left front A-pillar	Left A-Pillar Components	Speaker - Left Front Tweeter
Speaker - Left Rear	In the rear compartment, mounted in the left side of the rear package shelf	Radio and Speaker Components	• Speaker - Left Rear (UW6) • Speaker - Left Rear (UQ3)
Speaker - Right Front	In the passenger compartment, lower front of the front passenger door trim panel	Radio and Speaker Components	Speaker - Right Front
Speaker - Right Front Tweeter (UQ3)	In the passenger compartment, on the right front A-pillar	Right A-Pillar Components	Speaker - Right Front Tweeter
Speaker - Right Rear	In the rear compartment, mounted in the right side of the rear package shelf	Radio and Speaker Components	• Speaker - Right Rear (UW6) • Speaker - Right Rear (UQ3)
Spot Lamp - Left (7X6 or 7X7)	In the passenger compartment, on the left A-pillar	A-Pillar Components (9C1 or 9C3)	-
Spot Lamp - Right (7X7)	In the passenger compartment, on the right A-pillar	A-Pillar Components (9C1 or 9C3)	Spot Lamp - Right (7X7)
Starter Motor	In the engine compartment, lower front of the engine, facing the radiator, at the transmission	Left Front of Engine Components	Starter X2
Steering Angle Sensor	In the passenger compartment, at the base of the steering column	-	Steering Angle Sensor
Steering Wheel Control Switch - Left (UK3)	In the passenger compartment, on the left side of the steering wheel	Steering Wheel Components	Steering Wheel Control Switch - Left

Name	Location	Locator View	Connector End View
Steering Wheel Control Switch - Right	In the passenger compartment, on the right side of the steering wheel	**Steering Wheel Components**	**Steering Wheel Control Switch - Right (UK3)**
Sunroof Control Module (CF5)	In the passenger compartment, front center of the sunroof module, above the windshield header panel, under the headliner	**Headliner Components- Top View**	**Sunroof Control Module (CF5)**
Sunroof Switch (CF5)	In the passenger compartment, front center of the headliner, above the inside rearview mirror	**Headliner Components**	**Sunroof Switch (CF5)**
Sunshade - Left (DH6)	In the passenger compartment, mounted in the sunshade, on the left side of the windshield header	**Above the Windshield Components**	**Sunshade - Left (DH6)**
Sunshade - Right (DH6)	In the passenger compartment, mounted in the sunshade, on the right side of the windshield header	**Above the Windshield Components**	**Sunshade - Right (DH6)**
Tail Lamp - Left	At the rear of the vehicle, in the left tail lamp assembly	**Rear of the Vehicle Components**	**Tail Lamp - Left**
Tail Lamp - Right	At the rear of the vehicle, in the right tail lamp assembly	**Rear of the Vehicle Components**	**Tail Lamp - Right**
Tail/Stop and Turn Signal Lamp - Left	At the rear of the vehicle, in the left tail lamp assembly	**Rear of the Vehicle Components**	**Tail/Stop and Turn Signal Lamp - Left**
Tail/Stop and Turn Signal Lamp - Right	At the rear of the vehicle, in the right tail lamp assembly	**Rear of the Vehicle Components**	**Tail/Stop and Turn Signal Lamp - Right**
Theft Deterrent Module (TDM)	In the passenger compartment, around the ignition key cylinder housing	**In the Steering Column Components**	**Theft Deterrent Module (TDM)**
Throttle Body	In the engine compartment, top of the engine, at the intake manifold inlet	**Right Rear of Engine Components**	**Q38 Throttle Body (LFR/LFX)**

Name	Location	Locator View	Connector End View
Torque Converter Clutch (TCC) Pressure Control (PC) Solenoid Valve	In the engine compartment, left front lower, in the automatic transmission, part of the control solenoid valve assembly	**Automatic Transmission Electronic Components**	-
Transmission Control Module (TCM)	In the engine compartment, left front lower, inside the front of the automatic transmission, part of the control solenoid valve assembly	**Left Front of the Engine Compartment Components**	-
Turn Signal/Multifunction Switch	In the passenger compartment, inside the steering column, below the inflatable restraint steering wheel module coil, on the left side	**Instrument Panel Components**	• **Turn Signal/Multifunction Switch X1** • **Turn Signal/Multifunction Switch X2** • **Turn Signal/Multifunction Switch X3**
Vehicle Communication Interface Module (VCIM) (UE1)	In the rear compartment, mounted to the rear of the left rear wheelhouse	**Left Side of the Luggage Compartment Components**	• **Vehicle Communication Interface Module (VCIM) (UE1) X1** • **Vehicle Communication Interface Module (VCIM) (UE1) X2**
Vehicle Communication Interface Module (VCIM) Battery (UE1)	At the left side of the rear compartment, attached to the side of the vehicle communication interface module	**Left Side of the Luggage Compartment Components**	**Vehicle Communication Interface Module (VCIM) Battery (UE1)**
Wheel Speed Sensor (WSS) - Left Front	Under the vehicle, inside the left front wheel hub	**Front Wheel Components**	**Wheel Speed Sensor (WSS) - Left Front**
Wheel Speed Sensor (WSS) - Left Rear	Under the vehicle, inside the left rear wheel hub	**Rear Wheel Components**	**Wheel Speed Sensor (WSS) - Left Rear**
Wheel Speed Sensor (WSS) - Right Front	Under the vehicle, inside the right front wheel hub	**Front Wheel Components**	**Wheel Speed Sensor (WSS) - Right Front**
Wheel Speed Sensor (WSS) - Right Rear	Under the vehicle, inside the right rear wheel hub	**Rear Wheel Components**	**Wheel Speed Sensor (WSS) - Right Rear**

Name	Location	Locator View	Connector End View
Window Motor - Driver	In the passenger compartment, center of the driver door, behind the door panel	Driver Door Components	Window Motor - Driver
Window Motor - Left Rear	In the passenger compartment, center of the left rear door, behind the door panel	Left Rear Door Harness Routing	Window Motor - Left Rear
Window Motor - Passenger	In the passenger compartment, center of the front passenger door, behind the door panel	Passenger Door Components	Window Motor - Passenger
Window Motor - Right Rear	In the passenger compartment, center of the right rear door, behind the door panel	Right Rear Door Harness Routing	Window Motor - Right Rear
Window Switch - Driver	In the passenger compartment, center of the driver door trim panel	Driver Door Components	• Window Switch - Driver X1 • Window Switch - Driver X2
Window Switch - Left Rear	In the passenger compartment, in the left rear inside door handle trim bezel	Left Rear Door Components	Window Switch - Left Rear
Window Switch - Passenger	In the passenger compartment, center of the front passenger door trim panel	Passenger Door Components	Window Switch - Passenger
Window Switch - Right Rear	In the passenger compartment, in the right rear inside door handle trim bezel	Right Rear Door Components	Window Switch - Right Rear
Windshield Washer Fluid Level Switch	At the right side of the engine compartment, in the lower portion of washer fluid container	Right Front of the Engine Compartment Components (1 of 2)	Windshield Washer Fluid Level Switch
Windshield Washer Fluid Pump	At the right side of the engine compartment, in the lower portion of washer fluid container	Right Front of the Engine Compartment Components (1 of 2)	Windshield Washer Fluid Pump
Windshield Wiper Motor	In the engine compartment, in the left side cowl panel, below	Left Front of the Engine Compartment	Windshield Wiper Motor

Name	Location	Locator View	Connector End View
	the air inlet screen	Components	
Yaw and Lateral Accelerometer Sensor	In the passenger compartment, mounted on the floor under the center console	-	Yaw and Lateral Accelerometer Sensor
X101 (10 cavities)	Instrument panel harness to engine harness, left rear of the engine compartment, near the brake booster, bolted to the left strut tower, next to X111	Engine Harness Routing - Left Rear	X101 I/P Harness to Engine Harness
X105 (2 cavities)	Instrument panel harness to battery cable harness, forward of the right front strut tower	Battery Cable Harness Routing (Typical)	X105 Battery Harness to I/P Harness
X111 (14 cavities)	Instrument panel harness to engine harness, left rear of the engine compartment, near the brake booster, bolted to the left strut tower, next to X101	Engine Harness Routing - Left Rear	X111 I/P Harness to Engine Harness
X115 (14 cavities)	Engine harness to instrument panel harness, left rear of the engine compartment, on the left strut tower	Engine Harness Routing - Left Rear	X115 Engine Harness to Instrument Panel Harness
X120 (10 cavities)	Instrument panel harness to forward lamp harness, left side of the engine compartment, behind the left headlamp assembly, on the frame	Forward Lamp Harness Routing	X120 I/P Harness to Forward Lamp Harness
X122 (6 cavities) (9C1 or 9C3 without 6J7)	Forward lamp harness to forward lamp harness, at the left side of the right headlamp assembly	Forward Lamp Harness Routing	X122 Forward Lamp Harness to Forward Lamp Harness (9C1/9C3 without 6J7)
X123 (4 cavities) (9C1 or 9C3)	Instrument panel harness to grille lamp jumper harness, forward of the right front strut tower	Instrument Panel Harness Routing- Engine Compartment	X123 I/P Harness to the Grille Lamp Jumper Harness (6J3)
X141 (5 cavities)	Forward lamp harness to left headlamp harness, behind the left headlamp	Forward Lamp Harness Routing	X141 Forward Lamp Harness to Left Front Headlamp Assembly Harness

Name	Location	Locator View	Connector End View
	assembly		
X142 (5 cavities)	Forward lamp harness to right headlamp harness, behind the right headlamp assembly	**Forward Lamp Harness Routing**	**X142 Forward Lamp Harness to Right Front Headlamp Assembly Harness**
X160 (12 cavities)	Engine harness to even fuel injector harness, top right left of the engine	**Engine Harness Routing - Left Rear**	**X160 Engine Harness to Even Fuel Injector Harness**
X161 (6 cavities)	Engine harness to odd fuel injector harness, top left side of engine, next to X160	**Engine Harness Routing - Left Rear**	**X161 Engine Harness to Odd Fuel Injector Harness**
X200 (40 cavities)	Body harness to instrument panel harness, behind the right front kick panel, below the instrument panel fuse panel	**Instrument Panel Harness Routing**	**X200 Body Harness to I/P Harness**
X201 (10 cavities)	Steering column harness to instrument panel harness, behind the knee bolster, to the right of the steering column	**Instrument Panel Harness Routing**	**X201 Steering Column Harness to I/P Harness**
X203 (22 cavities)	Body harness to instrument panel harness, behind the knee bolster, to the left of the steering column, behind the left instrument panel access panel, near X250	**Instrument Panel Harness Routing**	**X203 I/P Harness to Body Harness**
X208 (9C1 or 9C3)	SEO auxiliary harness to body harness, in the right front footwell	-	**X208 SEO Auxiliary Harness to Body Harness (9C1, 9C3)**
X210 (2 cavities)	Instrument panel harness to HVAC harness, on the right side of the HVAC module assembly	**HVAC Module Harness Routing**	**X210 I/P Harness to HVAC Harness**
X223 (2 cavities) (9C1 or 9C3)	Instrument panel harness to instrument panel harness, under the right side of the instrument panel, in the rear stop/turn signal supply circuits, near G301	**Left Front of the Passenger Compartment Components**	**X223 I/P Harness to I/P Harness (6J6)**

Name	Location	Locator View	Connector End View
X250 (4 cavities)	Inflatable restraint steering wheel module coil wiring harness to the body wiring harness, near X203, behind the left instrument panel access panel	**Instrument Panel Harness Routing- Lower Left**	**X250 SIR Coil to the Body Harness**
X266 (1 cavity) (6J4)	Instrument panel harness to instrument panel harness, above the right front footwell, in the horn control circuit	**Instrument Panel Harness Routing**	**X266 I/P Harness to I/P Harness (6J4)**
X268 (8 cavities) (9C1 or 9C3)	Instrument panel harness to C267B, above the right front footwell	-	**X268 I/P Harness to I/P Harness (9C1, 9C3 with WX7)**
X268 (8 cavities) (WX7)	Instrument panel harness to WX7 speaker jumper harness, above the right front footwell	-	-
X269 (8 cavities) (9C1 or 9C3)	Instrument panel harness to C267A, above the right front footwell	-	**X269 I/P Harness to I/P Harness (9C1, 9C3 with WX7)**
X269 (8 cavities) (WX7)	Instrument panel harness to WX7 speaker jumper harness, above the right front footwell	-	-
X275 (8 cavities)	Inflatable restraint steering wheel module coil harness to steering column harness, on the steering column, near the knee bolster, taped to the steering column harness	-	• **X275 SIR Coil to Steering Column Harness** • **X277 SIR Coil to Steering Column Harness**
X277 (8 cavities)	Inflatable restraint steering wheel module coil harness to steering wheel harness, behind the inflatable restraint steering wheel module	**Instrument Panel Harness Routing- Lower Left**	-
X278 (4 cavities)	Inflatable restraint instrument panel module jumper harness to body harness, behind the right instrument panel access panel	**Right Front of the Passenger Compartment Components**	**X278 Inflatable Restraint I/P Module Jumper Harness to the Body Harness**

Name	Location	Locator View	Connector End View
X297 (6 cavities) (9C1 or 9C3)	Instrument panel harness to emergency vehicle front lamps flasher harness, above the right front footwell	Instrument Panel Harness Routing	X297 I/P Harness to Grille Lamp Jumper Harness (9C1, 9C3, 6J3)
X303 (1 cavity)	Instrument panel harness to body harness, COAX connector at the right front door sill, next to G302, under the carpet	Right Front of the Passenger Compartment Components	-
X311 (12 cavities)	Body harness to driver seat harness, below the driver seat	Body Harness Routing- Left Front Passenger Compartment	X311 Body Harness to Left Front Seat Harness
X313 (12 cavities)	Body harness to front passenger seat harness, below the front passenger seat	Body Harness Routing- Right Front Passenger Compartment	X313 Body Harness to Right Front Seat Harness
X315 (4 cavities)	Driver seat harness to body harness, below the driver seat	Seat Harness Routing- Airbags and Inlines	X315 Left Front Seat Harness to Body Harness
X316 (4 cavities)	Passenger seat harness to body harness, below the passenger seat	Seat Harness Routing- Airbags and Inlines	X316 Right Front Seat Harness to Body Harness
X322 (2 cavities) (9C1 or 9C3)	Body harness to roof provision harness, in the rear compartment, near the right C-pillar	Body Harness Routing- Rear Passenger Compartment	X322 Body Harness to Roof Provision Harness (9C1, 9C3)
X340 (2 cavities) (D55)	Console harness to body harness, below the center floor console, on the left side of the floor shifter	Body Harness Routing- Left Front Passenger Compartment	X340 Console Harness to Body Harness (D55)
X340 (2 cavities) (without D55)	Body harness to auxiliary power outlet seat jumper harness, under the center of the front seat	-	X340 Body Harness to Console Harness (without D55)
X360 (1 cavity) (9C1 or 9C3)	Body harness to instrument panel harness, right side of the instrument panel, near X200	Body Harness Routing- Right Front Passenger Compartment	X360 Body Harness to I/P Harness (9C1, 9C3)
X362 (1 cavity) (9C1 or 9C3)	Body harness to instrument panel harness, right side of the instrument panel, near	G200, G201, G202, and G204	X362 Body Harness to I/P Harness (9C1, 9C3)

Name	Location	Locator View	Connector End View
	X200		
X398 (6 cavities) (CF5)	Roof harness to sunroof harness, near the right front corner of the sunroof, under the headliner, above the sunshade	Sunroof and Headliner Harness Routing	X398 Roof Harness to Sunroof Harness (CF5)
X401 (4 cavities)	Rear body harness to left tail lamp harness, below the left tail lamp assembly	Rear Fascia Harness Routing	X401 Rear Body Harness to Left Tail Lamp Harness
X402 (4 cavities)	Rear body harness to right tail lamp harness, below the right tail lamp assembly	Body Harness Routing- Rear Passenger Compartment	X402 Rear Body Harness to Right Tail Lamp Harness
X405 (16 cavities)	Rear chassis harness to body harness, forward and to the right of the spare tire well	Body Harness Routing- Rear Passenger Compartment	X405 Rear Chassis Harness to Body Harness
X406 (8 cavities)	Body harness to rear body harness, in the rear compartment, below the right tail lamp assembly, clipped on the bumper fascia	Body Harness Routing- Rear Passenger Compartment	X406 Body Harness to Rear Body Harness
X409 (2 cavities) (T53)	Emergency vehicle rear compartment lid lamps harness to body harness, between the center high mounted stop lamp and the junction block - rear	Body Harness Routing- Rear Passenger Compartment	X409 Emergency Vehicle Rear Compartment Lid Lamps Harness to Body Harness (9C1, 9C3)
X490 (18 cavities)	Headliner harness to body harness, under the left side of the rear package shelf trim panel	Sunroof and Headliner Harness Routing	X490 Headliner Harness to Body Harness
X500 (40 cavities)	Body harness to left front door harness, below the A-pillar, between the door hinges	Body Harness Routing- Left Front Passenger Compartment	X500 Body Harness to Left Front Door Harness
X503 (40 cavities)	Driver door harness to driver door trim harness, in the driver door, near the speaker - left front door	Driver Door Harness Routing	X503 Left Front Door Harness to Left Front Door Trim Harness

Name	Location	Locator View	Connector End View
X600 (40 cavities)	Body harness to right front door harness, below the A-pillar, between the door hinges	**Body Harness Routing- Right Front Passenger Compartment**	**X600 Body Harness to Right Front Door Harness**
X604 (10 cavities)	Front passenger door trim harness to front passenger door harness, near the speaker - right front	**Passenger Door Harness Routing**	**X604 Right Front Door Trim Harness to Right Front Door Harness**
X700 (9 cavities)	Body harness to left rear door harness, center of the left B-pillar	**Body Harness Routing- Left Front Passenger Compartment**	**X700 Body Harness to Left Rear Door Harness**
X800 (9 cavities)	Body harness to right rear door harness, center of the right B-pillar	**Body Harness Routing- Right Front Passenger Compartment**	**X800 Body Harness to Right Rear Door Harness**
G100	(CKTs 250, 1250) On the forward lamp harness, in back of the right headlamp assembly, on the frame	**Right Front of the Engine Compartment Components (1 of 2)**	-
G101	(CKT 1350) On the forward lamp harness, in back of the left headlamp assembly, on the frame	**G101**	-
G102	(CKT 50) Near the battery, in back of the right headlamp assembly, on the frame	**G102**	-
G111	(CKTs 51, 451) In the engine compartment, near front middle, below starter motor	**G111, G113 and G115**	-
G113	(CKT 51,1050) In the engine compartment, near front right, on the engine block, below oil filter	**G111, G113 and G115**	-
G115	(CKT 251, 350) On the transmission case, below the brake booster	**G111, G113 and G115**	-
G200	(CKT 150) Front of the instrument panel carrier, above the instrument panel compartment, to the left of the inflatable	**G200, G201, G202, and G204**	-

Name	Location	Locator View	Connector End View
	restraint instrument panel module		
G201	(CKT 1450) Front of the instrument panel carrier, behind the knee bolster, on the right side of the steering column, above G202	**G200, G201, G202, and G204**	-
G202	(CKTs 351, 1551) Front of the instrument panel carrier, behind the knee bolster, on the right side of the steering column, below G201	**G200, G201, G202, and G204**	-
G204 (9C1 or 9C3)	(CKT 2350) Right side of the instrument panel carrier, to the left of the inflatable restraint instrument panel module, next to G200	**G200, G201, G202, and G204**	-
G301	(CKT 550) Below the driver door opening, rear of the left A-pillar	**G301**	-
G302	(CKTs 750, 1751) Below the passenger front door opening, rear of the right A-pillar	**G302**	-
G303	COAX capacitance ground for the remote control door lock receiver windshield antenna, near the top of the left A-pillar, behind the trim panel	-	-
G403	(CKTs 1150, 1351) On the left side of the package shelf, near the C-pillar	**G403 and G404**	-
G404	(CKT 851) On the right side of the package shelf, near the C-pillar	**G403 and G404**	-
J100	In the engine harness, in the engine compartment, on branch to front of engine	**Engine Harness Routing - Right Front**	-

Name	Location	Locator View	Connector End View
J101	(CKT 451) Engine harness, in the engine compartment, front near middle, in main bundle between branch to ECM and branch to ECT	**Engine Harness Routing - Right Front**	-
J102	(CKT 17) Engine harness, in the engine compartment, front left on branch to ECM	**Engine Harness Routing - Right Front**	-
J103	Engine harness, in the engine compartment, front right, in branch on front of engine, near generator	**Engine Harness Routing - Right Front**	-
J109	Engine Harness, In the engine compartment, in the main bundle on left side of engine above transmission	**Engine Harness Routing - Left Rear**	-
J110	(CKT 51) In Engine Harness, In the engine compartment, in the main bundle on left side of engine above transmission	**Engine Harness Routing - Left Rear**	-
J124	(CKT 1250) On the forward lamp harness, behind the right headlamp, approximately 8 cm (3.2 in) from the breakout to G100, toward the inflatable restraint front end sensor - right	**Forward Lamp Harness Routing**	-
J126	(CKT 1250) On the right head lamp assembly harness	-	-
J127	(CKT 1350) On the left head lamp assembly harness	-	-
J128	(CKT 1250) On the right headlamp harness	-	-
J129	(CKT 1350) On the left headlamp harness	-	-

Name	Location	Locator View	Connector End View
J162	Engine Harness, In the engine compartment, rear near middle, in the main bundle between ignition coil 5 and fuel injector inlines	**Engine Harness Routing - Left Rear**	-
J163	Engine Harness, In the engine compartment, rear near middle, in the main bundle between ignition coil 5 and ignition coil 3	**Engine Harness Routing - Left Rear**	-
J164	Engine Harness, In the engine compartment, right front in the main bundle on front of the engine, between ignition coil 2 and camshaft sensors and actuators	**Engine Harness Routing - Right Front**	-
J165	Engine Harness, In the engine compartment, front near middle, in the main bundle on front of the engine, between ignition coil 6 and breakout to ECT	**Engine Harness Routing - Right Front**	-
J175	Engine Harness, In the engine compartment, in the main bundle on left side of engine above transmission	**Engine Harness Routing - Left Rear**	-
J195	(CKT 335) Located where the engine harness and cooling fan jumper harness meet	-	-
J196	(CKT 504) Located where the Engine Cooling Fan - Left and cooling fan jumper harness meet	-	-
J197	(CKT 532) Located where the Engine Cooling Fan - Left and cooling fan jumper harness meet	-	-
J198	(CKT 473) Located where the engine harness and cooling fan jumper	-	-

Name	Location	Locator View	Connector End View
	harness meet		
J199	(CKT 409) Located where the Engine Cooling Fan - Right and cooling fan jumper harness meet	-	-
J204	(CKT 4) On the steering column harness, between the body control module connector X1 and the ignition switch	-	-
J213 (UK3)	(CKT 1375) On the steering wheel harness, behind the inflatable restraint steering wheel module	-	-
J214	(CKT 1551) On the steering column harness, between X201 and the turn signal/multifunction switch	-	-
J215	(CKT 1450) In the steering wheel harness, behind the inflatable restraint steering wheel module	-	-
J231	(CKT 750) On the floor console harness, approximately 12 cm (4.75 in) from the breakout to the auxiliary power outlet - front 1, towards X340	-	-
J238	(CKT 1940) On the floor console harness, approximately 5 cm (2 in) from the breakout to X340, towards the auxiliary power outlet - front 1	-	-
J250 (9C1 or 9C3)	(CKT 502) Instrument panel harness, rear of the instrument panel carrier, approximately 15.5 cm (6.25 in) from the third breakout from the brake	**Instrument Panel Harness Routing-Splices**	-

Name	Location	Locator View	Connector End View
	pedal position sensor, toward X200		
J277	(CKT 7005) On the steering wheel harness	-	-
J303	(CKT 550) Body harness, approximately 8.5 cm (3.5 in) from the breakout to X311, toward G301	**Body Harness Routing- Passenger Compartment Splices**	-
J307	(CKT 1307) On the body harness, approximately 16.5 cm (6.5 in) from the breakout to X301, toward G301	**Body Harness Routing- Passenger Compartment Splices**	-
J308	(CKT 8) Body harness, approximately 14 cm (5.5 in) from the breakout to G301, toward X355	**Body Harness Routing- Passenger Compartment Splices**	-
J311	(CKT 1140) Body harness, approximately 10 cm (4 in) from the second breakout from X302, toward X200	-	-
J314	(CKT 294) On the body harness, approximately 16 cm (6.5 in) from the breakout to X313, toward G302	**Body Harness Routing- Passenger Compartment Splices**	-
J315	(CKT 295) On the body harness, approximately 5 cm (2 in) from the breakout to X313, toward G302	**Body Harness Routing- Passenger Compartment Splices**	-
J324	(CKT 24) On the body harness, approximately 24 cm (9.5 in) from the breakout to X405, toward X356	**Body Harness Routing- Rear Passenger Compartment**	-
J350	(CKT 5060) On the body harness, approximately 14.5 cm (5.75 in) from the breakout to G302, toward X356	**Body Harness Routing- Passenger Compartment Splices**	-
J359	(CKT 5922) On the body harness, approximately 24 cm (9.5 in) from the	**Body Harness Routing- Passenger Compartment**	-

Name	Location	Locator View	Connector End View
	breakout to X311, toward X313	**Splices**	
J364	(CKT 643) On the roof harness, approximately 10 cm (4 in) from the breakout to X398, toward the dome lamp	**Sunroof and Headliner Harness Routing**	-
J375	(CKT 750) On the body harness, approximately 30.5 cm (12.5 in) from the breakout to the seat belt pretensioner - right, toward G302	**Body Harness Routing- Passenger Compartment Splices**	-
J390	(CKT 550) On the roof harness, approximately 53 cm (21 in) from the breakout to the dome lamp, toward the inside rearview mirror	**Sunroof and Headliner Harness Routing**	-
J393	(CKT 1732) On the roof harness, approximately 38 cm (15.25 in) from the breakout to the dome lamp, toward the inside rearview mirror	**Sunroof and Headliner Harness Routing**	-
J417	(CKT 1732) On the body harness, approximately 32 cm (12.75 in) from the breakout to the seatbelt pretensioner - left, toward G301	-	-
J430	(CKT 309) On the rear body harness, approximately 14 cm (5.5 in) from the breakout to the license lamp - right, toward X406	-	-
J474 (9C1 or 9C3)	(CKT 744) On the body harness, approximately 45.5 cm (18 in) from the breakout to X409, toward the junction block - rear	-	-
J485	(CKT 850) On the rear body harness, approximately 24 cm (9.5	-	-

Name	Location	Locator View	Connector End View
	in) from the breakout to the license lamp, toward X406		
J504	(CKT 550) On the driver door trim harness, approximately 4.5 cm (1.75 in) from the breakout to the window switch, toward the door lock switch - driver	**Driver Door Harness Routing**	-
J505	(CKT 550) On the driver door harness, approximately 18.5 cm (7.25 in) from the breakout to the speaker - left front door, toward the window motor - driver	**Driver Door Harness Routing**	-
J506	(CKT 8) On the driver door trim harness, approximately 11 cm (4.25 in) from the breakout to the window switch, toward the door lock switch - driver	**Driver Door Harness Routing**	-
J604	(CKT 750) On the front passenger door harness, approximately 6 cm (2.5 in) from the breakout to the speaker - right front door, toward the window motor - front passenger	**Passenger Door Harness Routing**	-
J608	(CKT 8) On the front passenger door trim harness, approximately 6.5 cm (2.5 in) from the window switch - front passenger, toward the door lock switch - front passenger	**Passenger Door Harness Routing**	-
JX205	Clipped to the inner instrument panel structure, to the right of the steering column	**Instrument Panel Harness Routing**	**JX205**
JX206	On the instrument panel harness, near the steering	**Instrument Panel Harness Routing**	**JX206**

Name	Location	Locator View	Connector End View
	column		
JX207	On the instrument panel harness, near the steering column	**Instrument Panel Harness Routing**	**JX207**

Article GUID: A00737225

PASSENGER COMPARTMENT/ROOF COMPONENT VIEWS

LEFT FRONT OF THE PASSENGER COMPARTMENT COMPONENTS

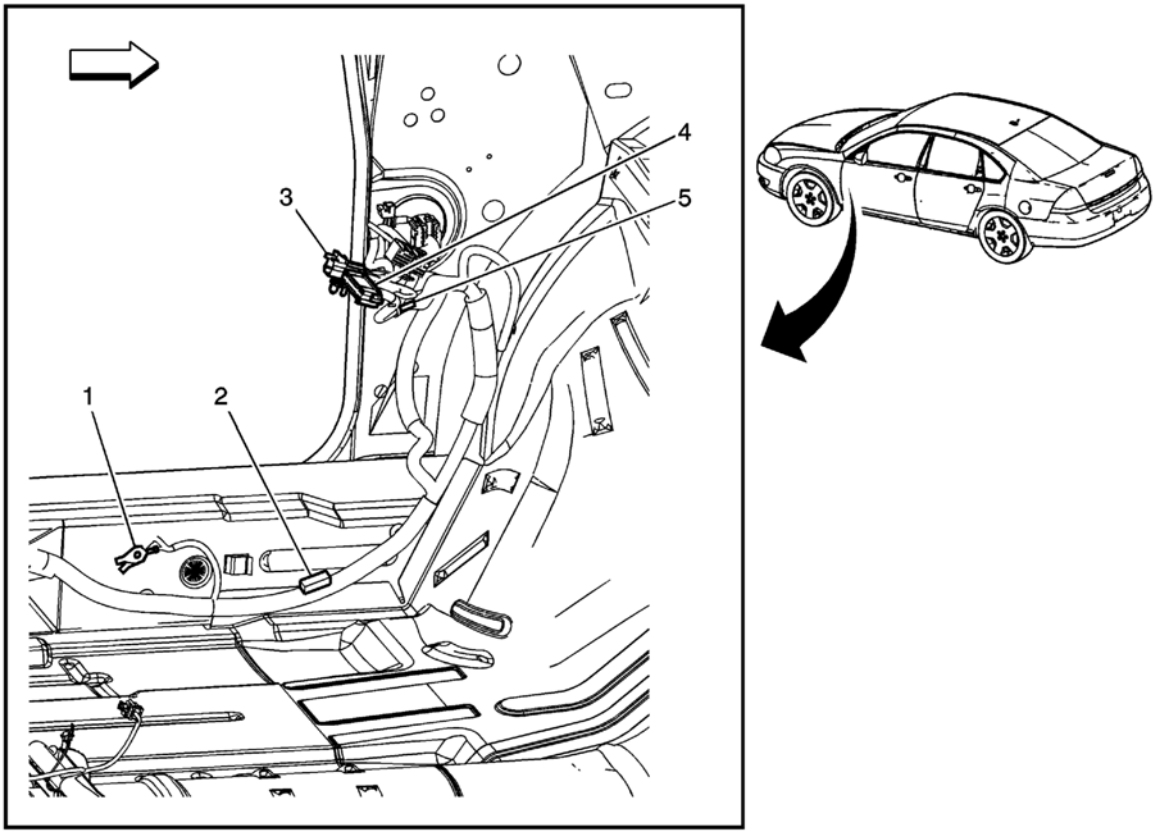


Fig. 1: Left Front of the Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	G301
2	X223- Taped to Harness (9C1 or 9C3)
3	X250
4	X203
5	Data Link Resistor- Taped to Harness (without UE1)

RIGHT FRONT OF THE PASSENGER COMPARTMENT COMPONENTS

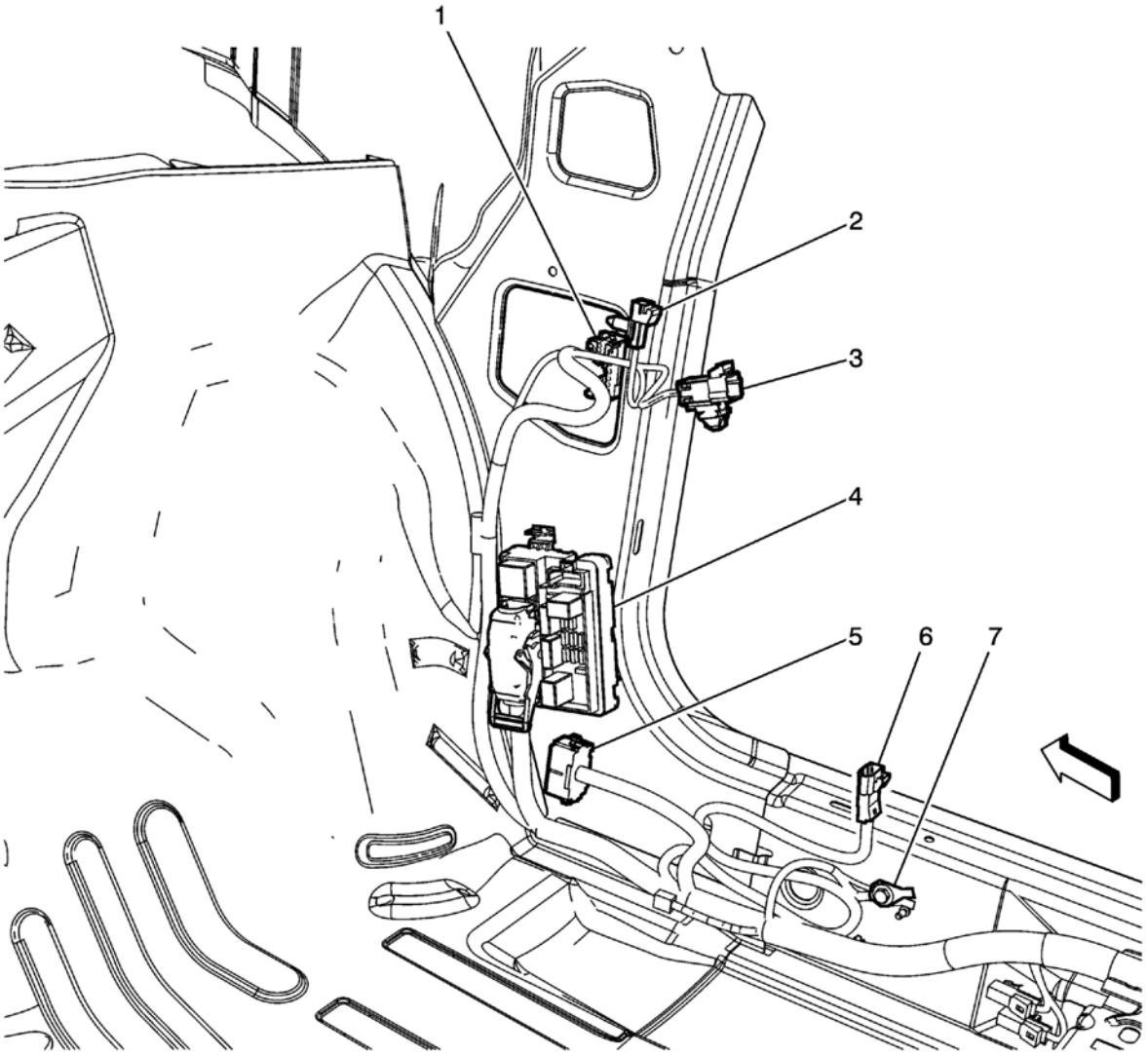


Fig. 2: Right Front of the Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X600
2	Speaker- Right Front Tweeter Connector (UQ3)
3	X278
4	Fuse Block- I/P
5	X200
6	X303
7	G302

CENTER SEAT COMPONENTS (WITHOUT D55)

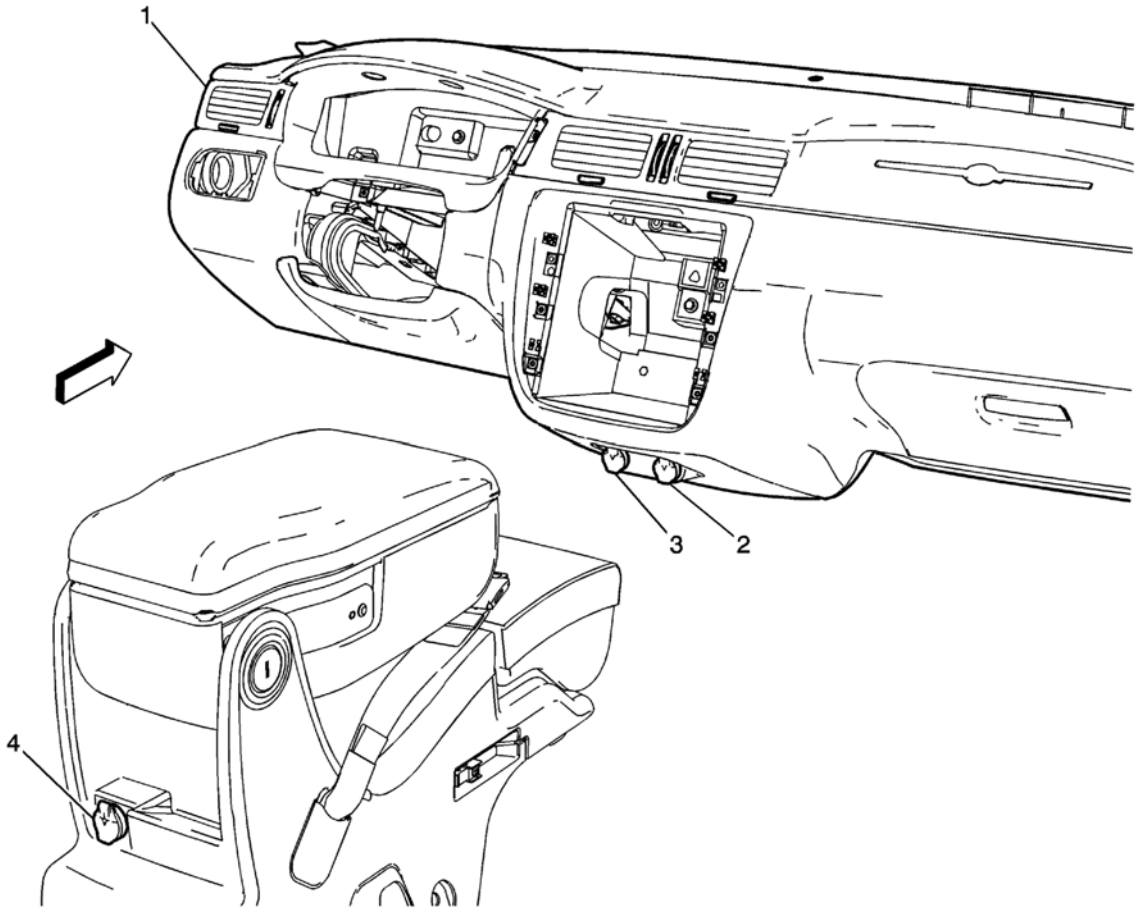


Fig. 3: Center Seat Components (without D55)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Instrument Panel
2	Accessory Power Outlet- I/P 2
3	Accessory Power Outlet- I/P 1
4	Accessory Power Outlet- Center Seat

HEADLINER COMPONENTS- TOP VIEW

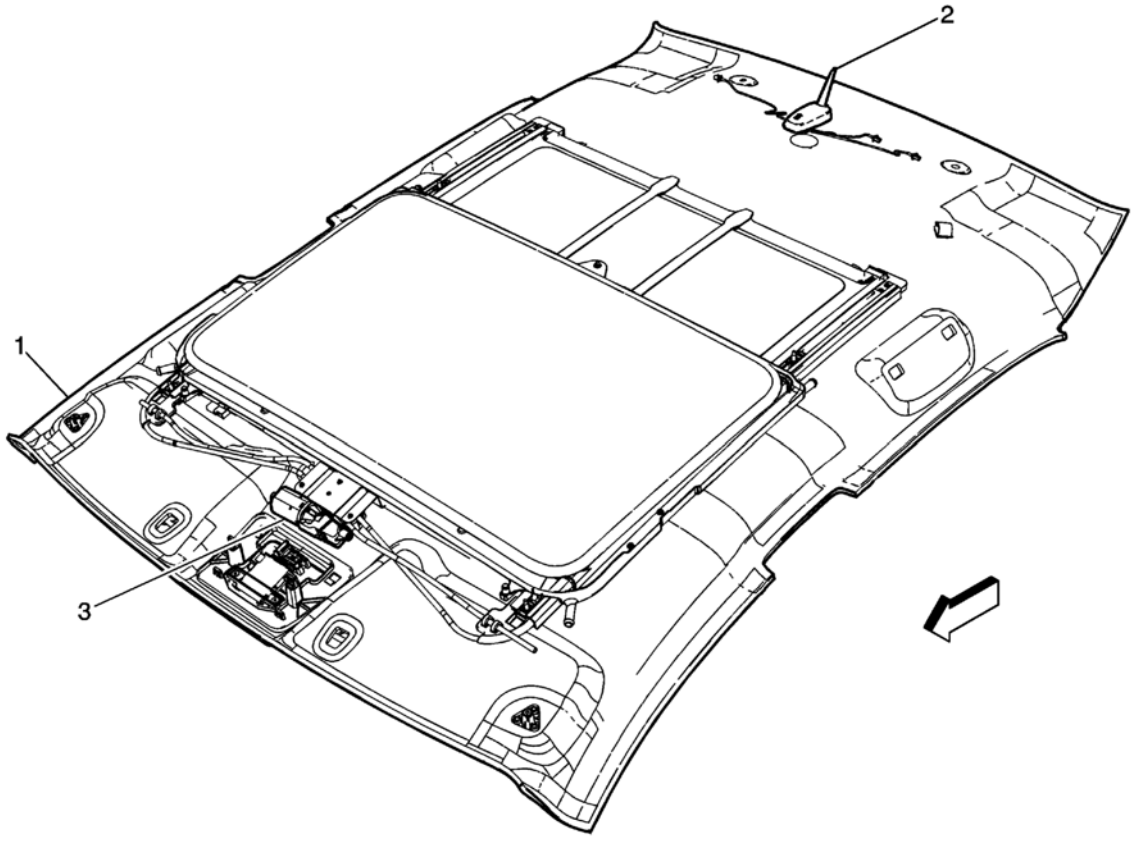


Fig. 4: Headliner Components - Top View
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Headliner
2	Cellular and Digital Radio Antenna (UE1 and/or U2K)
3	Sunroof Control Module (CF5)

HEADLINER COMPONENTS

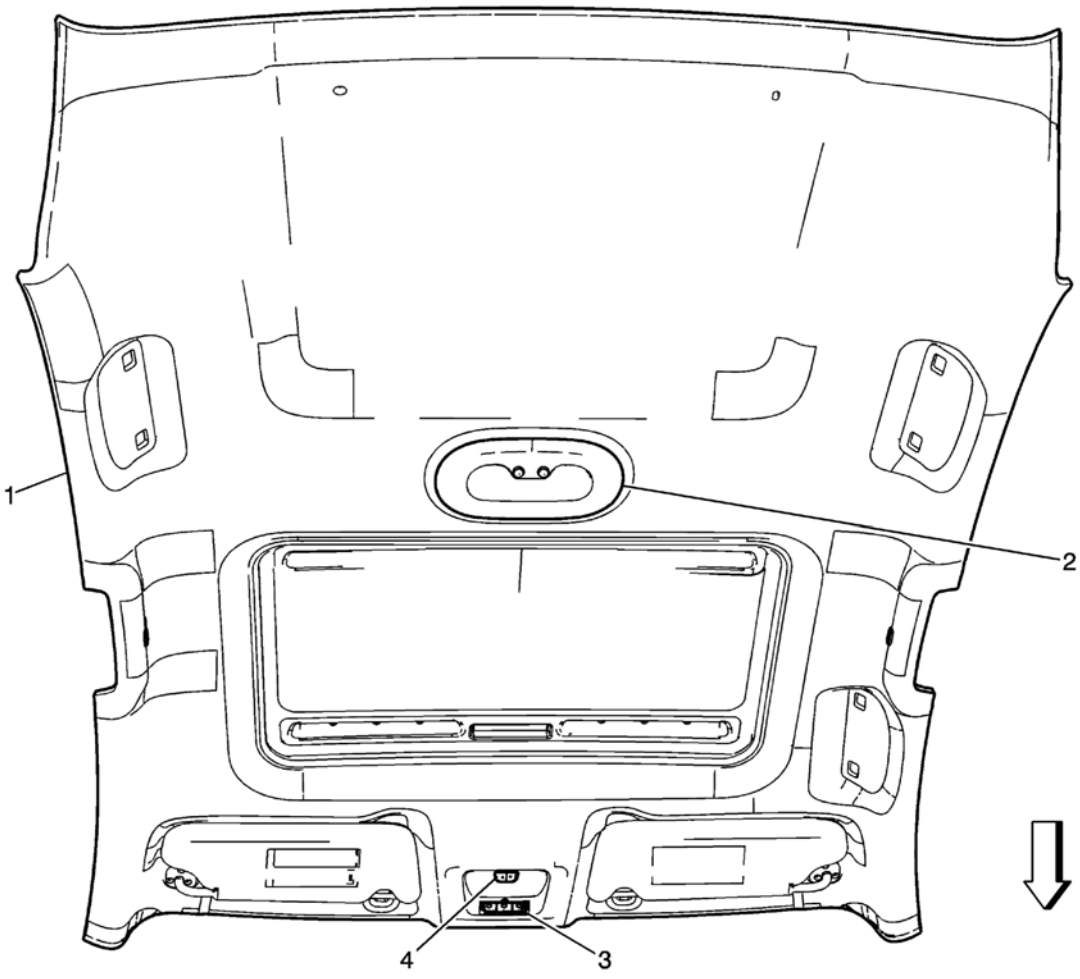


Fig. 5: Identifying Headliner Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Headliner
2	Dome/Reading Lamps
3	Garage Door Opener (GDO) (UG1)
4	Sunroof Switch (CF5)

HEADLINER COMPONENTS (9C1 OR 9C3)

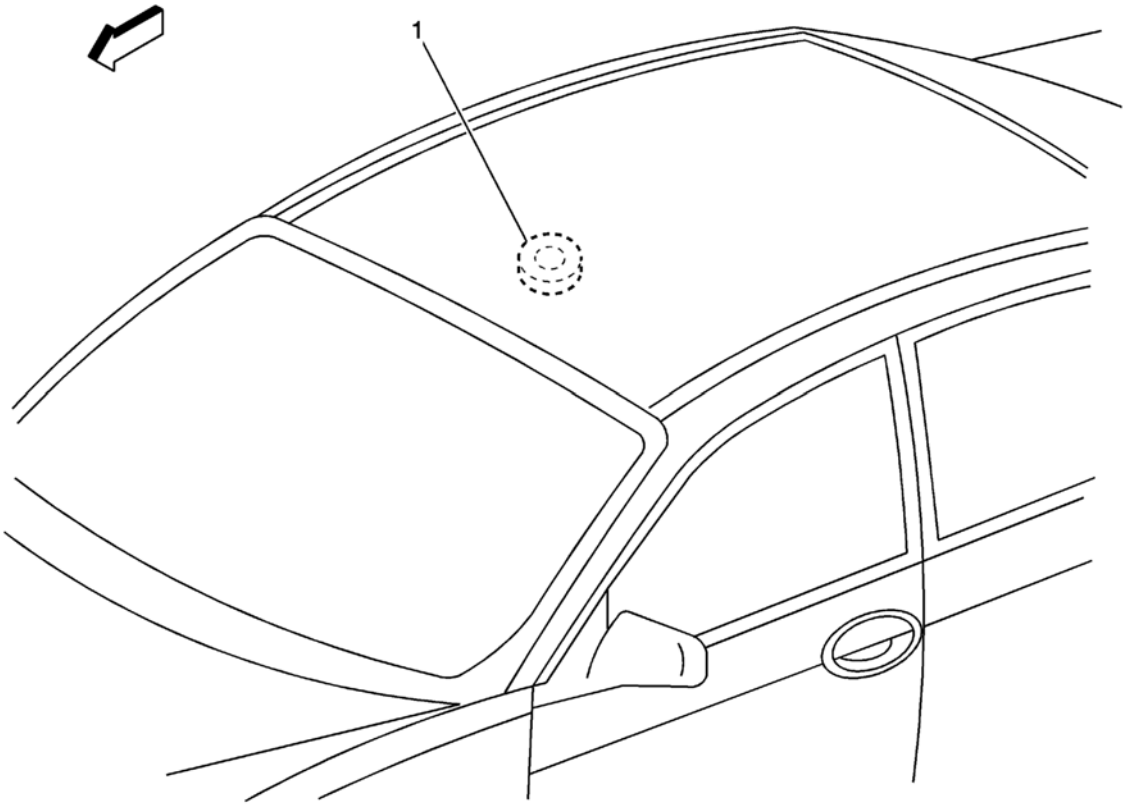


Fig. 6: Forward Headliner (9C1, 9C3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Reading Lamp - Auxiliary (6C7)

ABOVE THE WINDSHIELD COMPONENTS

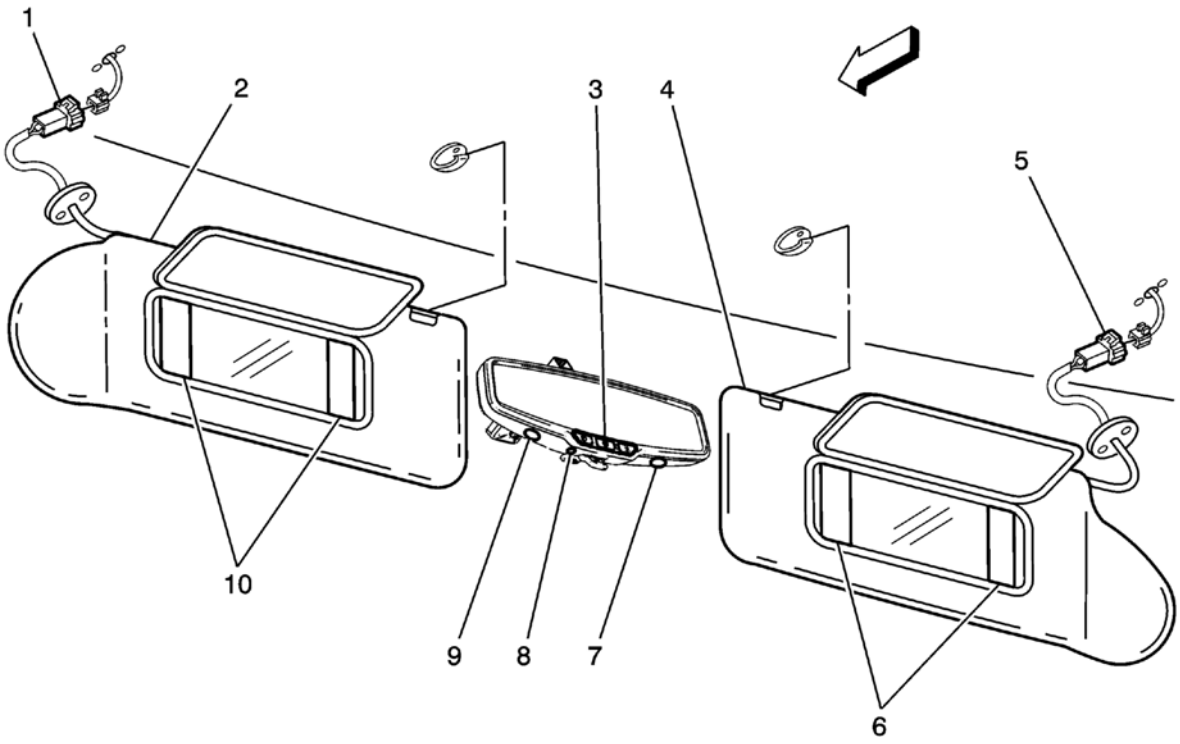


Fig. 7: Above the Windshield Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Sunshade Connector- Left (DH6)
2	Sunshade- Left (DH6)
3	OnStar Button Assembly
4	Sunshade- Right (DH6)
5	Sunshade Connector- Right (DH6)
6	Sunshade Lamps- Right
7	Reading Lamp- Right
8	Inside Rearview Mirror (ISRVM)
9	Reading Lamp- Left
10	Sunshade Lamps- Left

LEFT SIDE OF THE WINDSHIELD COMPONENTS

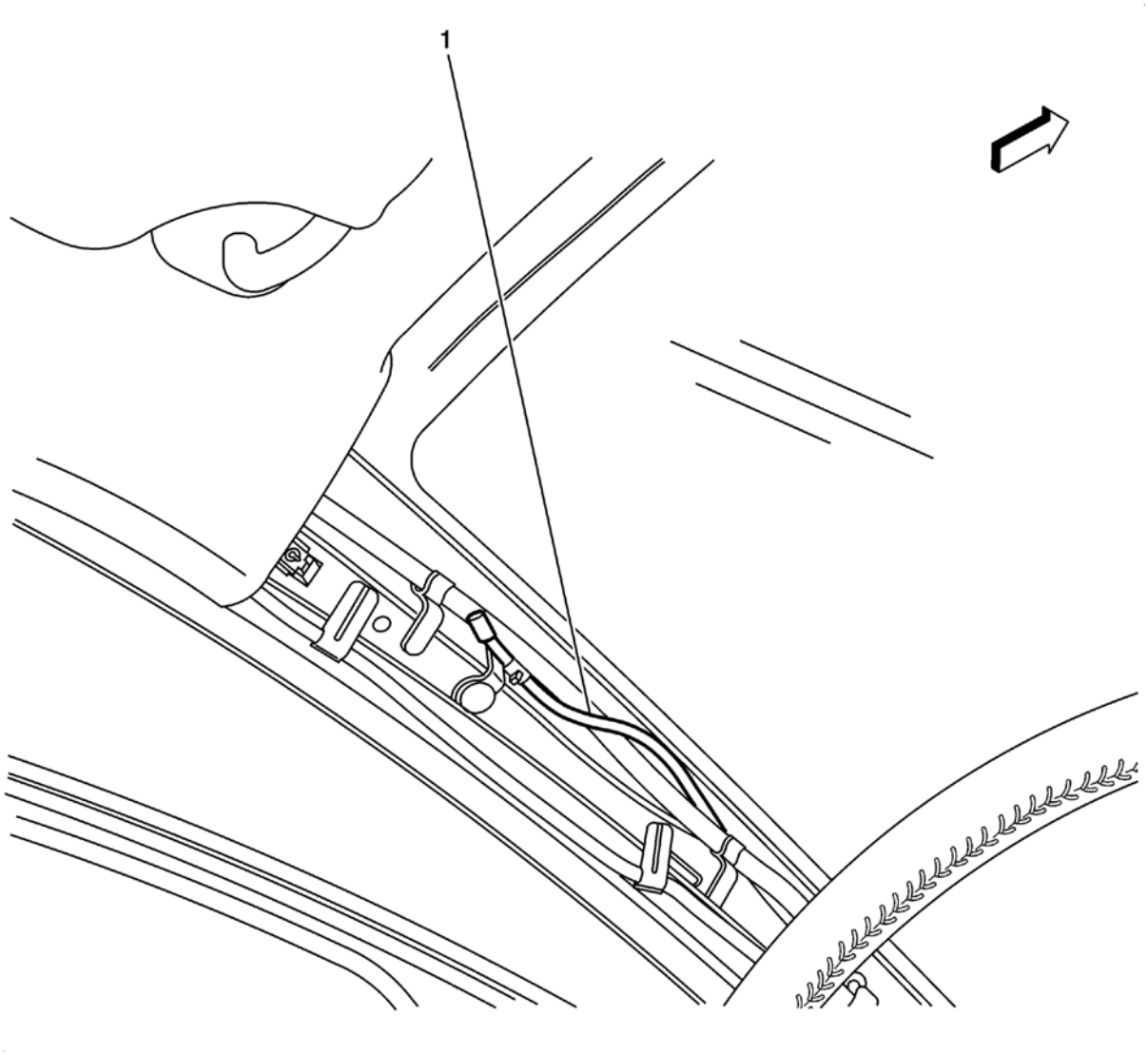


Fig. 8: Left Side of the Windshield Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Keyless Entry Antenna

LEFT A-PILLAR COMPONENTS

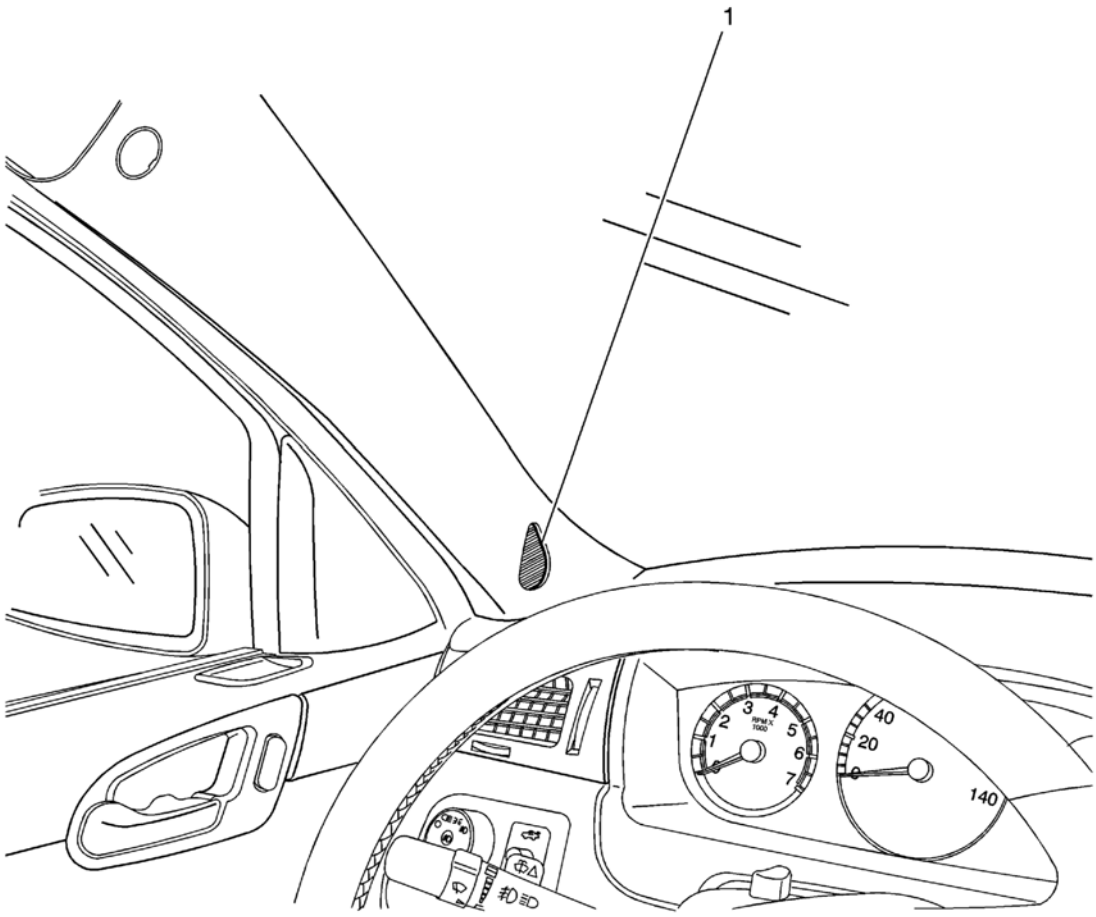


Fig. 9: Base of Left A-Pillar
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Speaker - Left Front Tweeter (UQ3)

LEFT B-PILLAR COMPONENTS

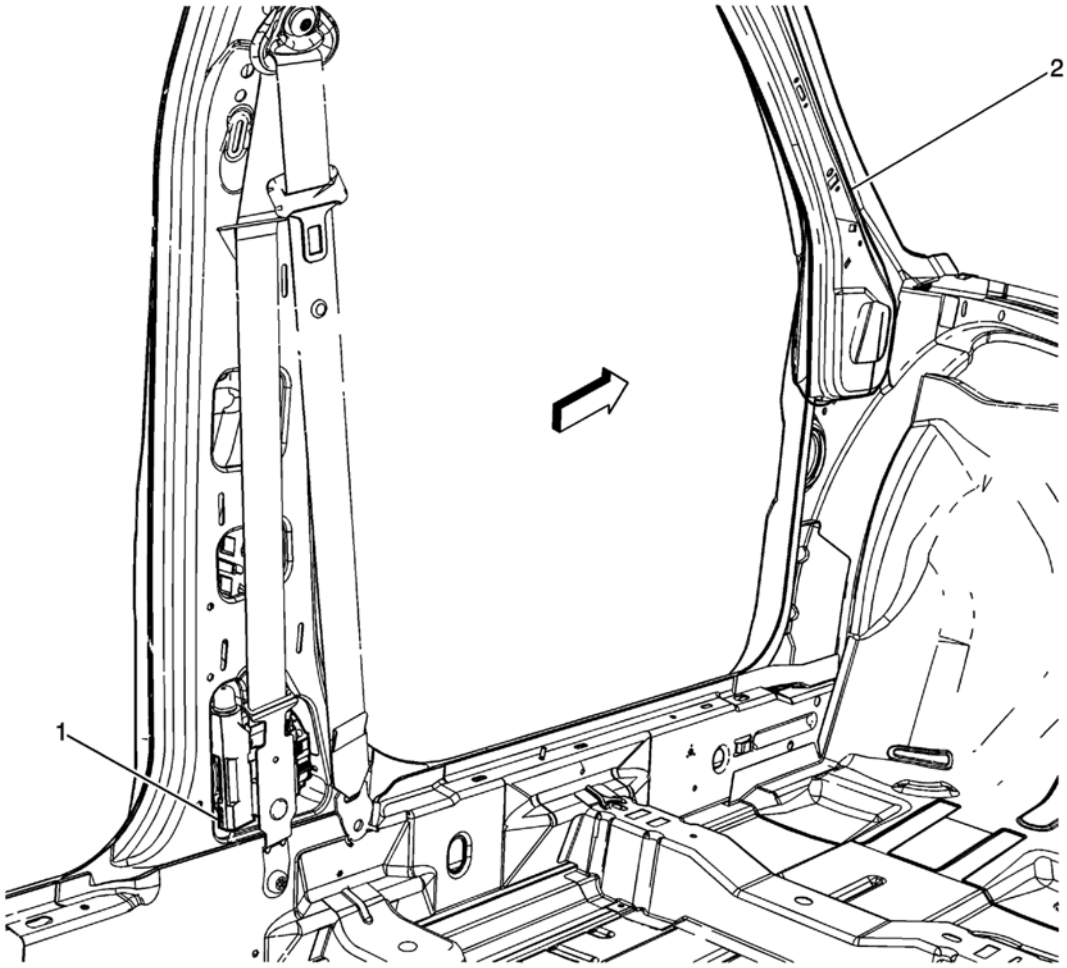


Fig. 10: On the left B-Pillar
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Belt Retractor Pretensioner - Driver
2	Left A-pillar

RIGHT A-PILLAR COMPONENTS

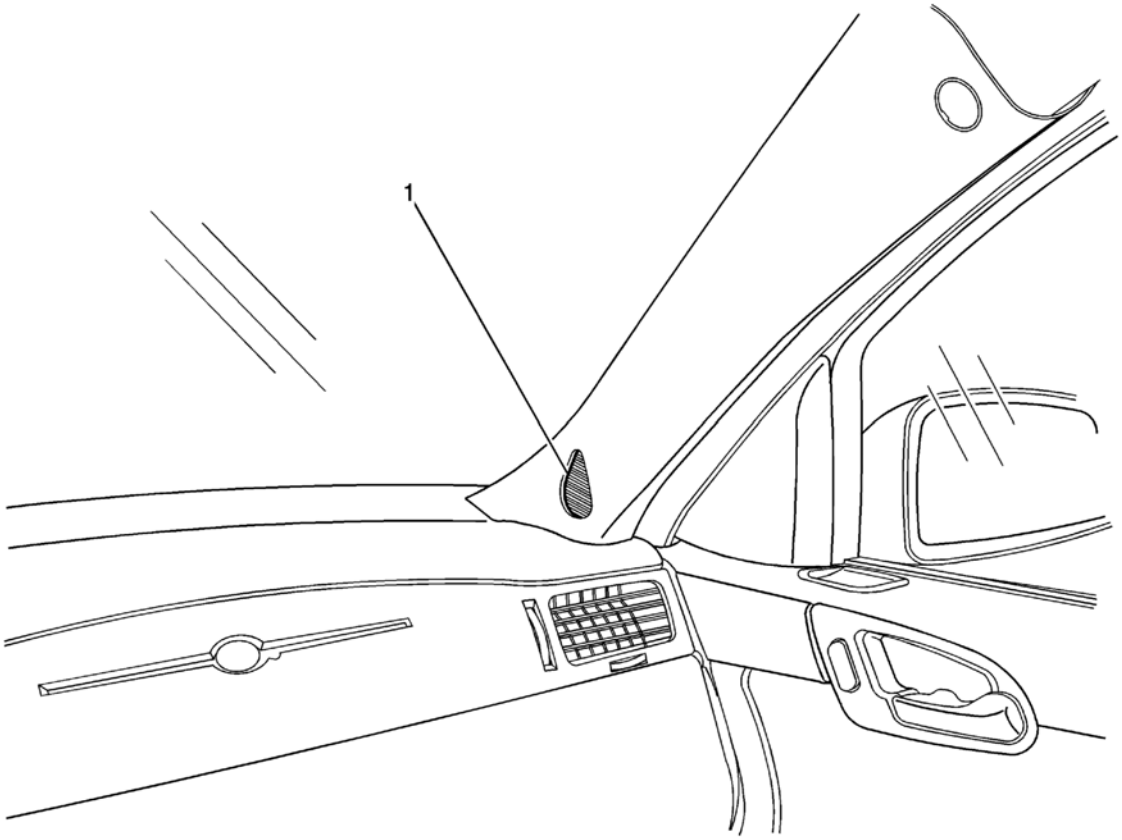


Fig. 11: Base of the Right A-Pillar
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Speaker - Right Front Tweeter (UQ3)

RIGHT B-PILLAR COMPONENTS

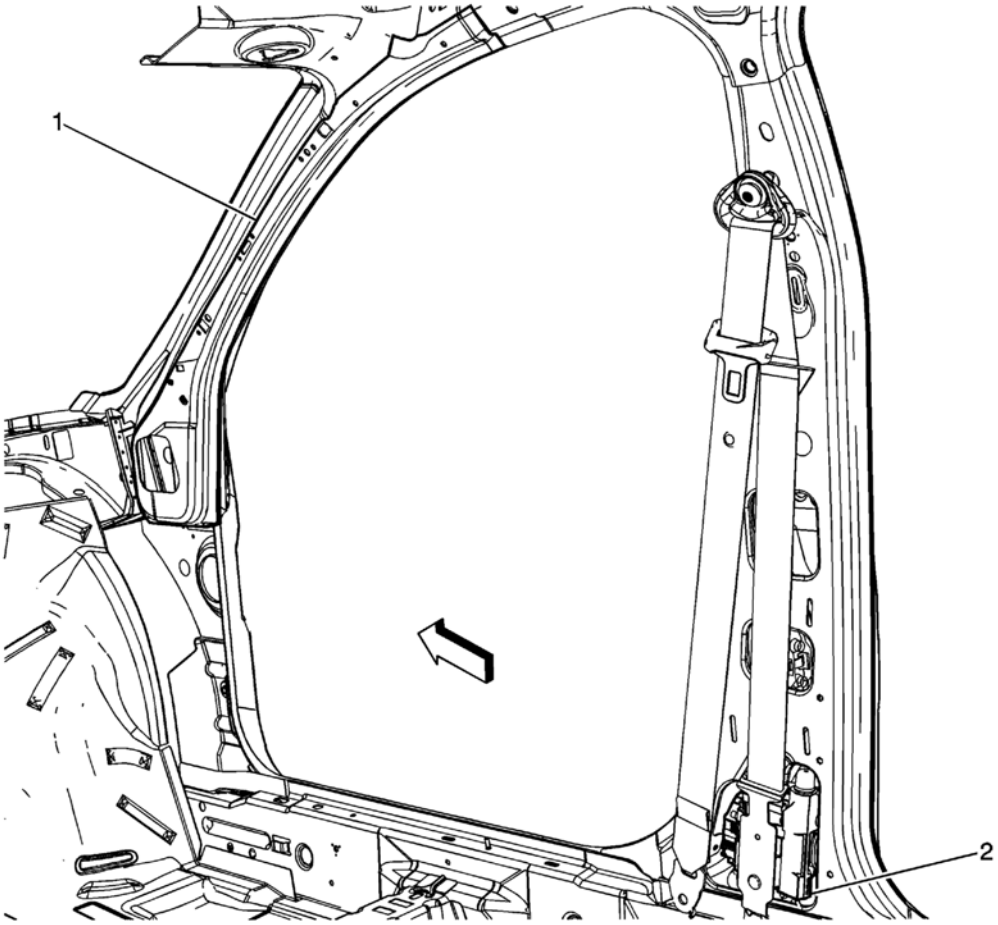


Fig. 12: On The Right B-Pillar
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Right A-pillar
2	Seat Belt Retractor Pretensioner - Passenger

ROOF RAIL COMPONENTS

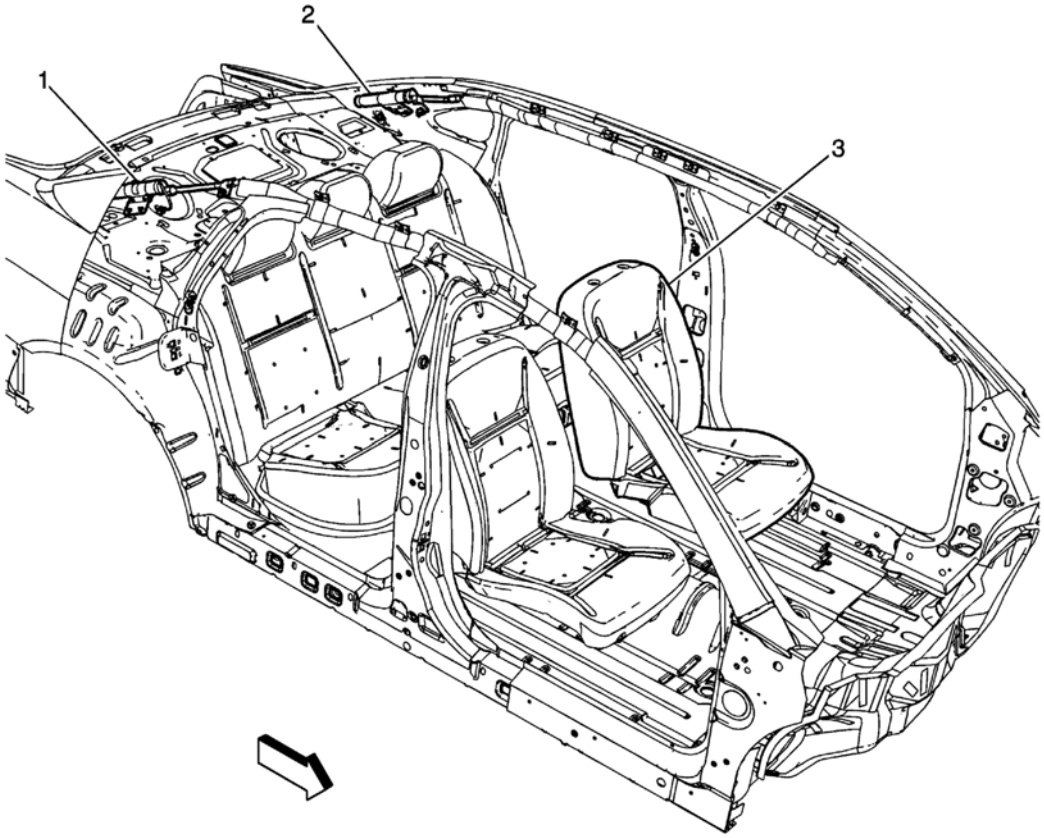


Fig. 13: Roof Rail Air Bags (AY1)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Inflatable Restraint Roof Rail Module- Right
2	Inflatable Restraint Roof Rail Module- Left
3	Driver Seat

FRONT SEAT AIRBAG COMPONENTS

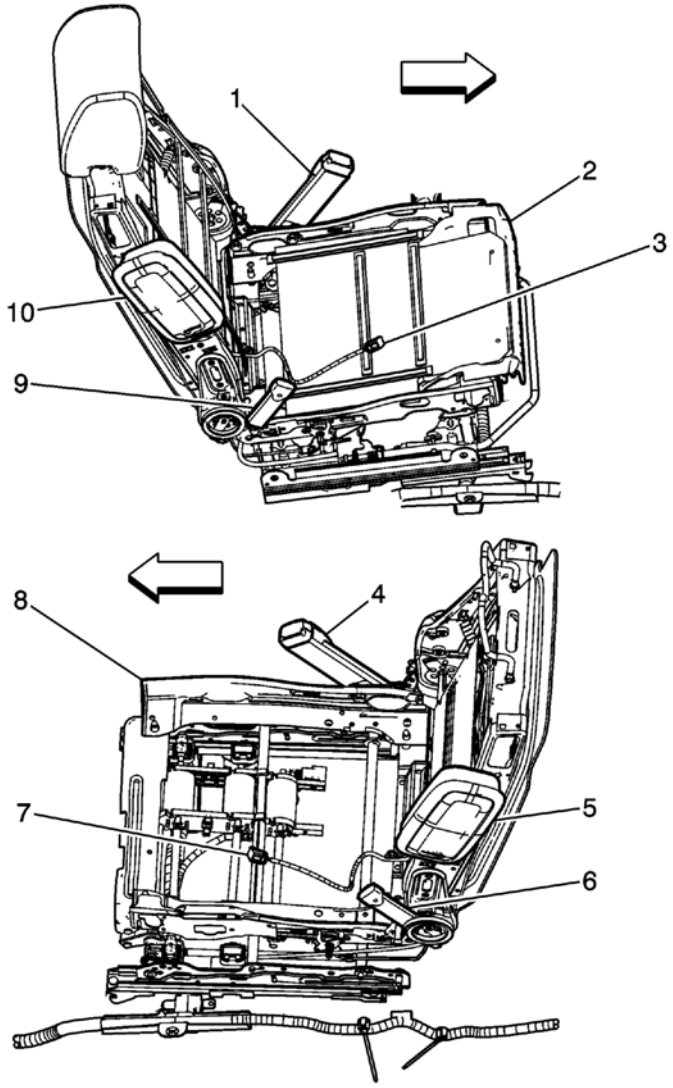


Fig. 14: Front Seat Airbag Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Belt Buckle- Passenger
2	Passenger Seat
3	X315
4	Seat Belt Buckle- Driver
5	Inflatable Restraint Side Impact Module- Left
6	Seat Belt Anchor- Driver
7	X316
8	Driver Seat
9	Seat Belt Anchor- Passenger
10	Inflatable Restraint Side Impact Module- Right

DRIVER SEAT COMPONENTS

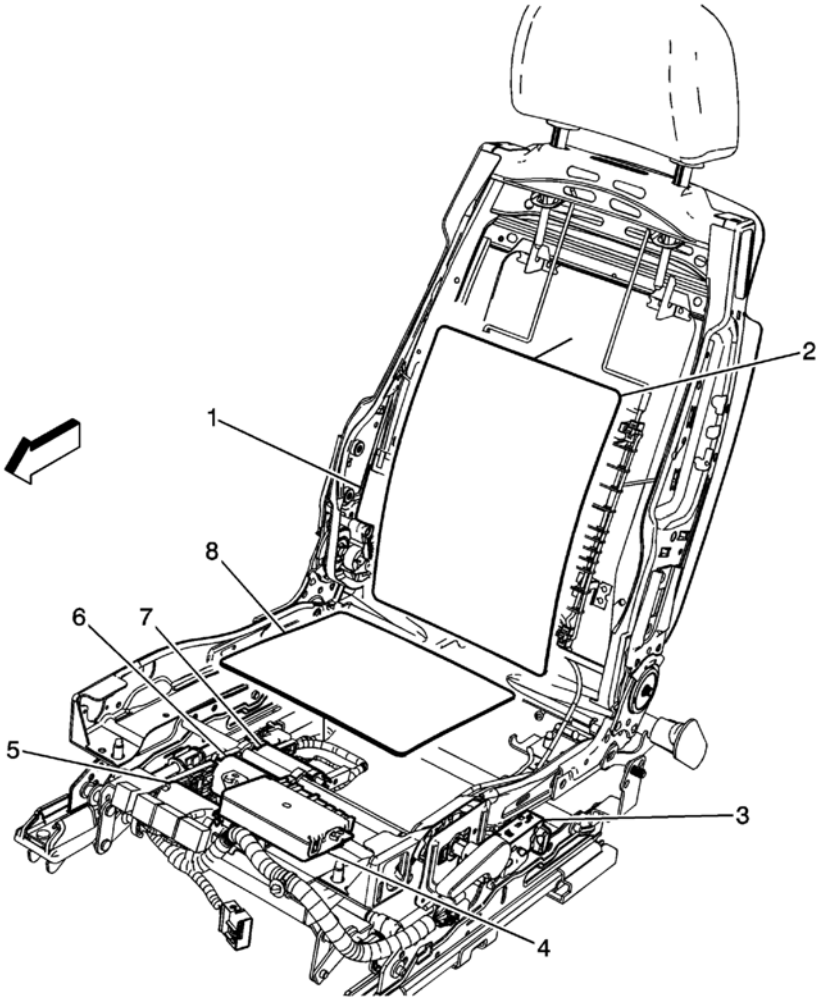


Fig. 15: Driver Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Recline Motor- Driver (AH5)
2	Heated Seat Element- Driver Back (KA1)
3	Seat Adjuster Switch- Driver (AG1 or AH5)
4	Heated Seat Control Module (KA1)
5	Horizontal Motor (Part of the Seat Adjuster Motor Assembly- Driver) (AG1 or AH5)
6	Front Vertical Motor (Part of the Seat Adjuster Motor Assembly- Driver) (AG1 or AH5)
7	Rear Vertical Motor (Part of the Seat Adjuster Motor Assembly- Driver) (AG1 or AH5)
8	Heated Seat Element- Driver Cushion (KA1)

DRIVER SEAT FRAME COMPONENTS

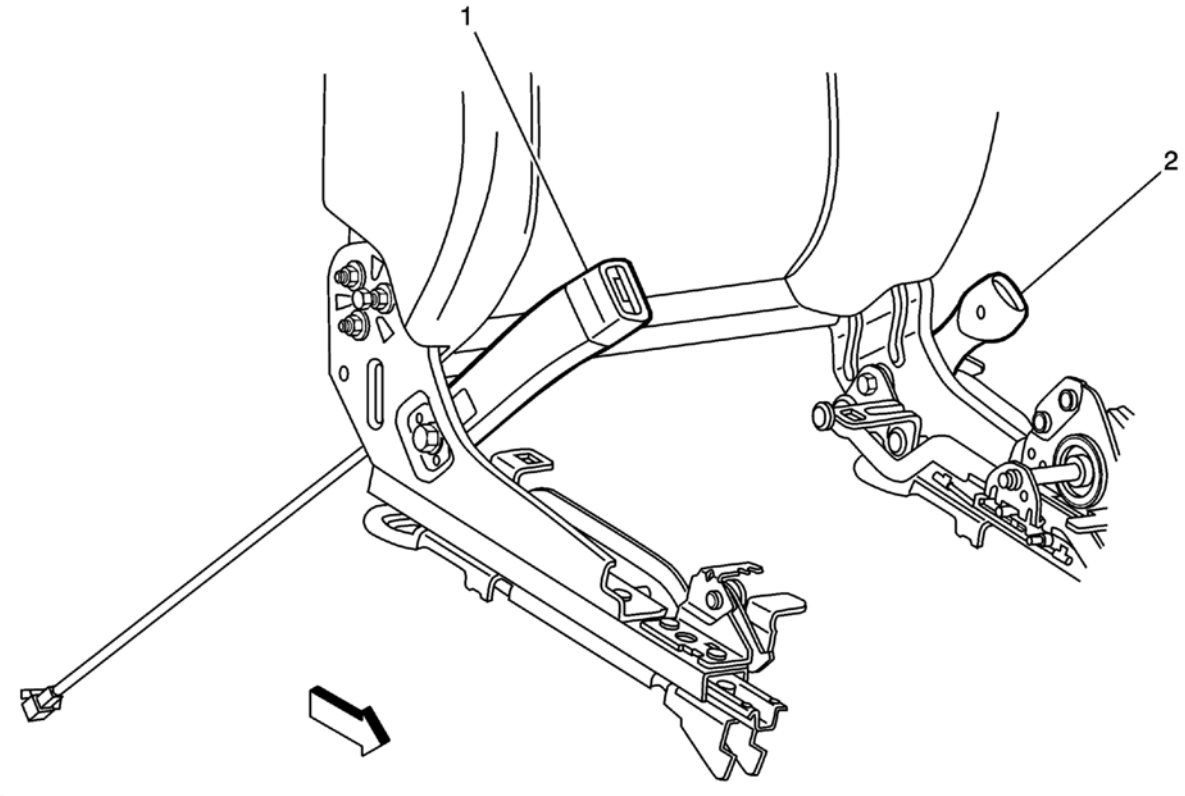


Fig. 16: Driver Seat Frame Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Belt Buckle- Driver
2	Seat Belt Anchor- Driver

PASSENGER SEAT COMPONENTS

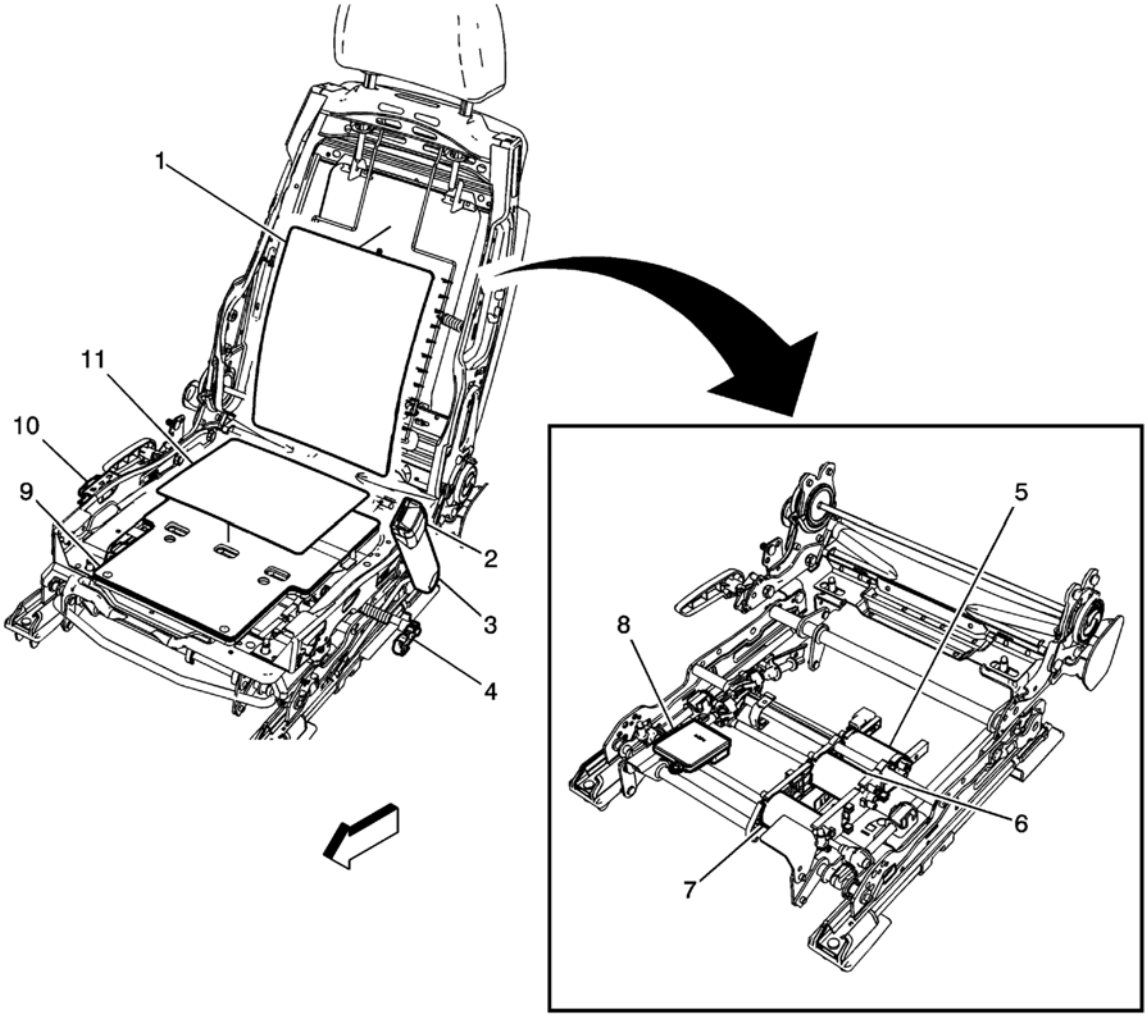


Fig. 17: View Of Passenger Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Heated Seat Element- Passenger Back (KA1)
2	Seat Belt Buckle- Passenger
3	Seat Belt Switch- Passenger
4	Seat Belt Switch- Passenger, Connector
5	Rear Vertical Motor (Part of the Seat Adjuster Motor Assembly- Passenger) (AG2)
6	Front Vertical Motor (Part of the Seat Adjuster Motor Assembly- Passenger) (AG2)
7	Horizontal Motor (Part of the Seat Adjuster Motor Assembly- Passenger) (AG2)
8	Inflatable Restraint Front Passenger Presence System (PPS) Module
9	Inflatable Restraint Front Passenger Presence System (PPS) Sensor
10	Seat Adjuster Switch- Passenger (AG2)
11	Heated Seat Element- Passenger Cushion (KA1)

UNDER THE PASSENGER SEAT COMPONENTS

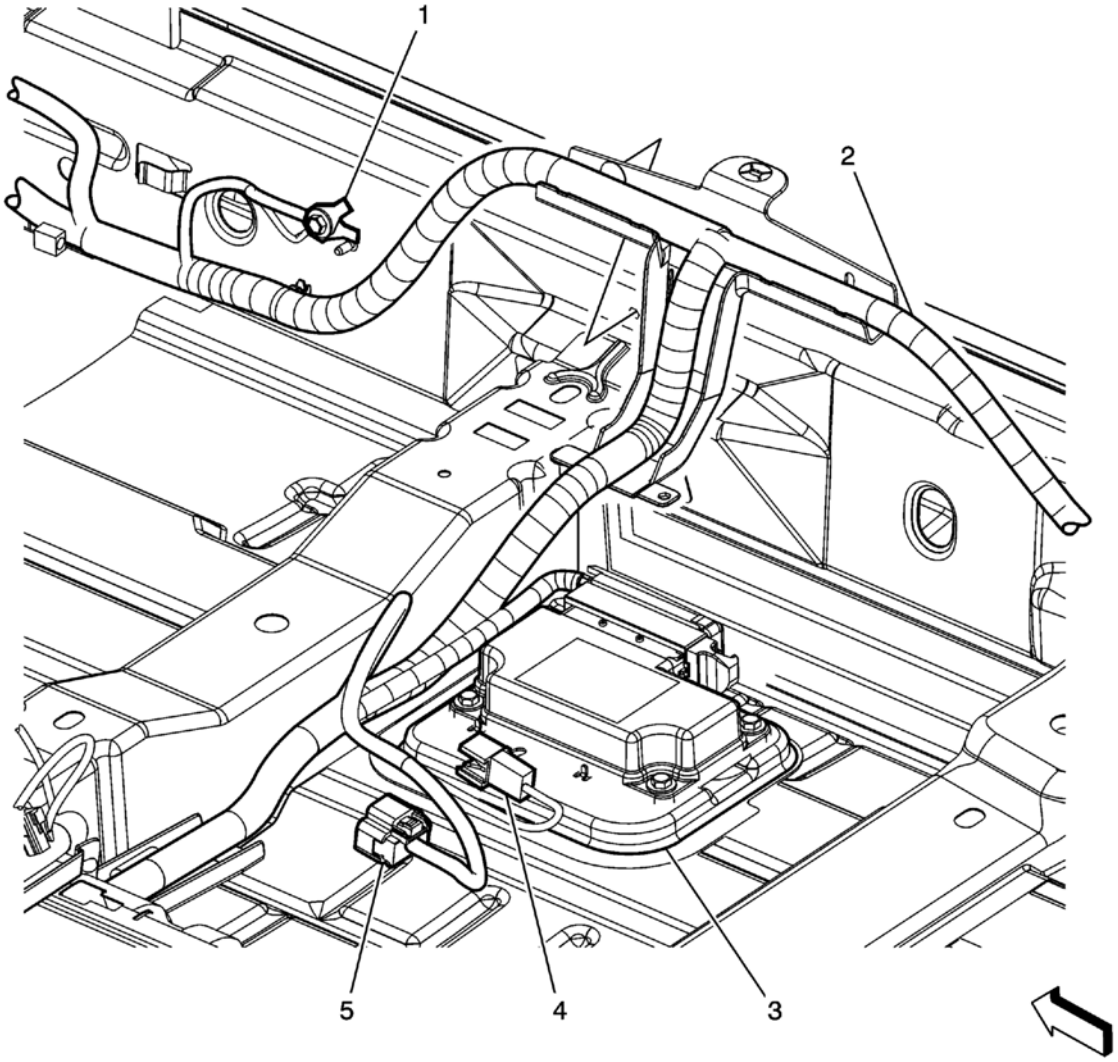


Fig. 18: Under the Passenger Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	G302
2	Body Harness
3	Inflatable Restraint Sensing and Diagnostic Module (SDM)
4	X316
5	X313

RADIO AND SPEAKER COMPONENTS

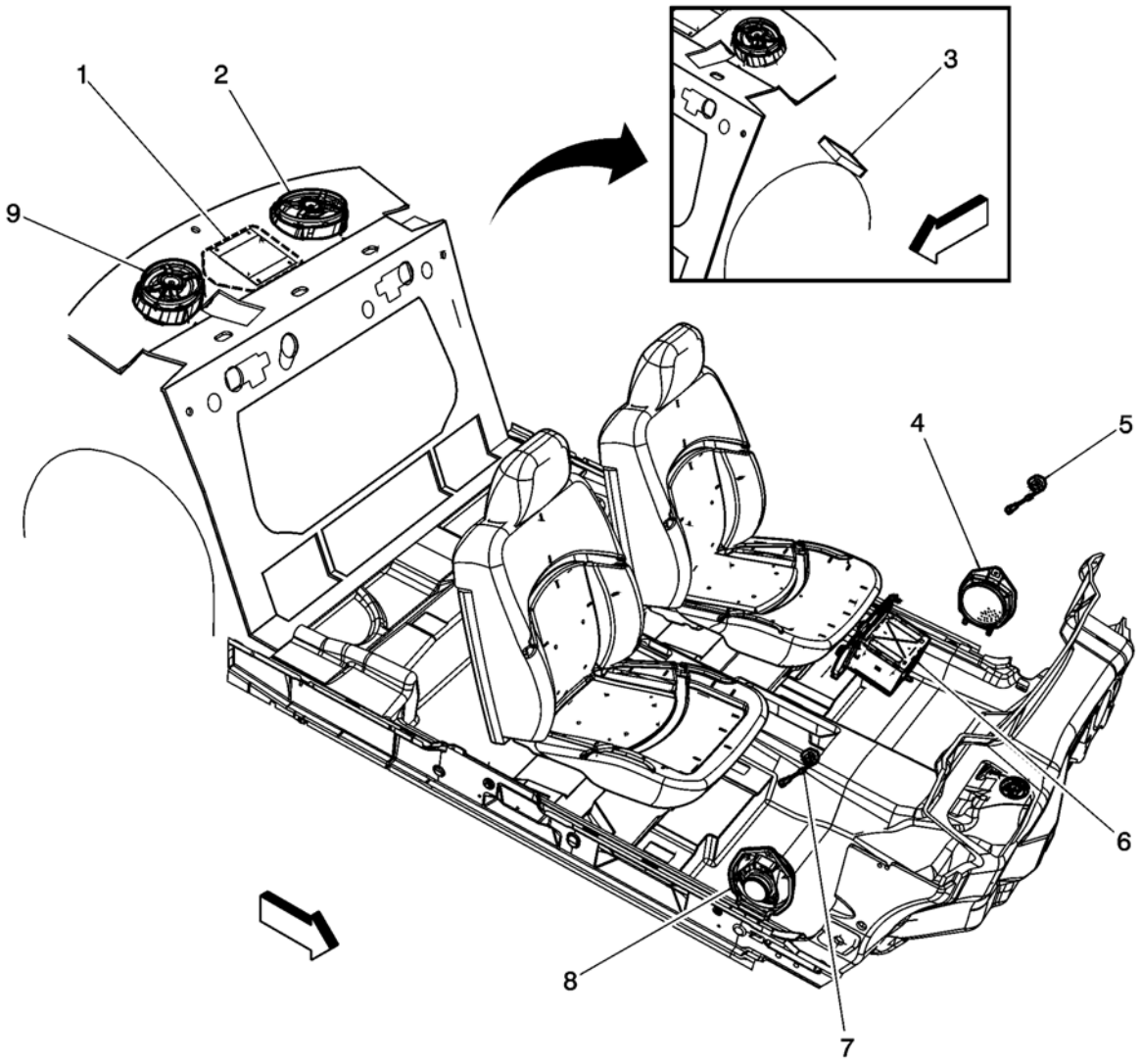


Fig. 19: Radio and Speaker Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Audio Amplifier (UQ3)
2	Speaker- Left Rear
3	Digital Radio Receiver (U2K)
4	Speaker- Left Front
5	Speaker- Left Front Tweeter (UQ3)
6	Radio
7	Speaker- Right Front Tweeter (UQ3)
8	Speaker- Right Front
9	Speaker- Right Rear

ABOVE THE REAR SEAT COMPONENTS

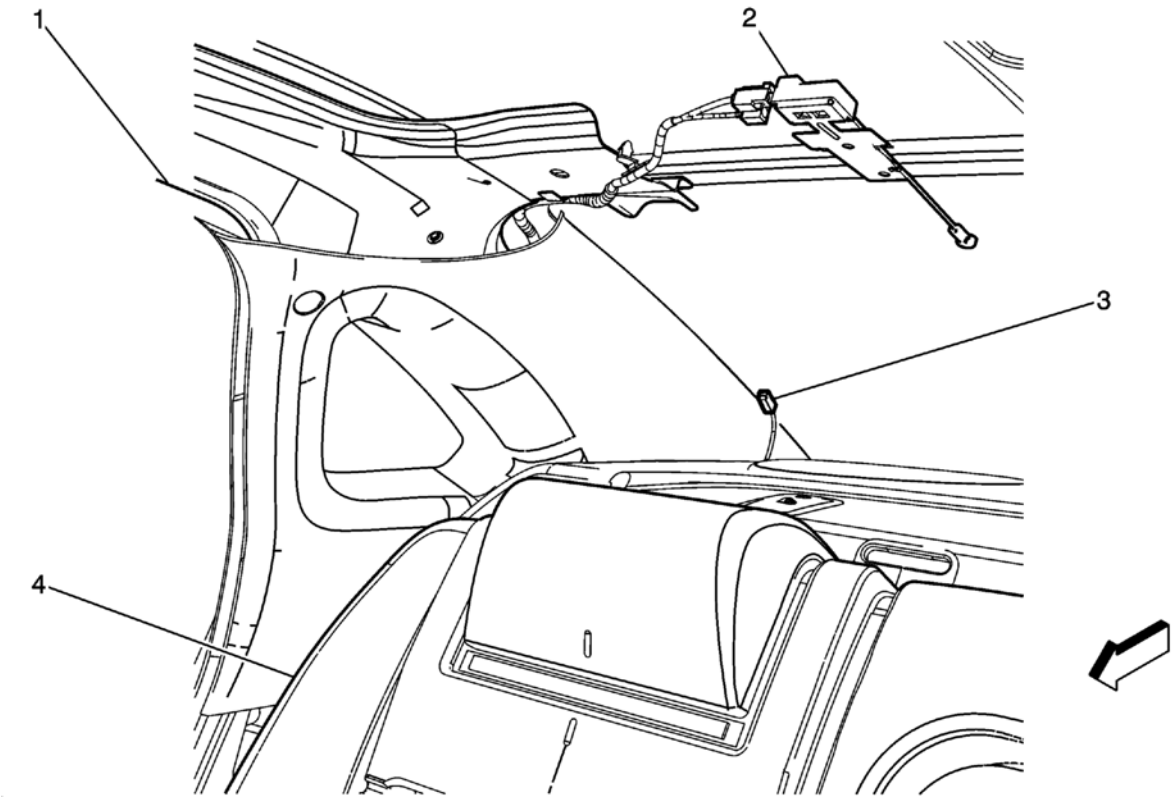


Fig. 20: Above the Rear Seat Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Right Rear C-Pillar
2	Radio Antenna Module
3	Rear Window Defogger Grid X1
4	Rear Seat

PACKAGE SHELF COMPONENTS (9C1 OR 9C3)

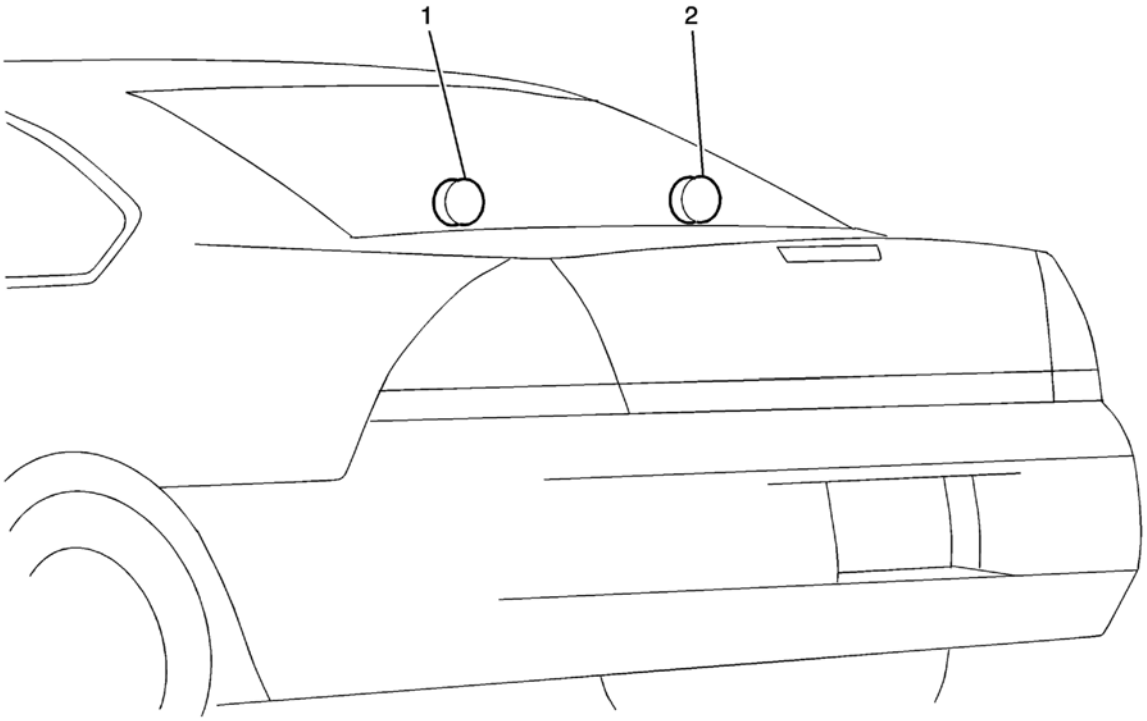


Fig. 21: On Package Shelf (9C1, 9C3)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Emergency Vehicle Rear Window Panel Lamp- Left (6J6)
2	Emergency Vehicle Rear Window Panel Lamp- Right (6J6)

Article GUID: A00737231

POWERTRAIN COMPONENT VIEWS

LEFT FRONT OF ENGINE COMPONENTS

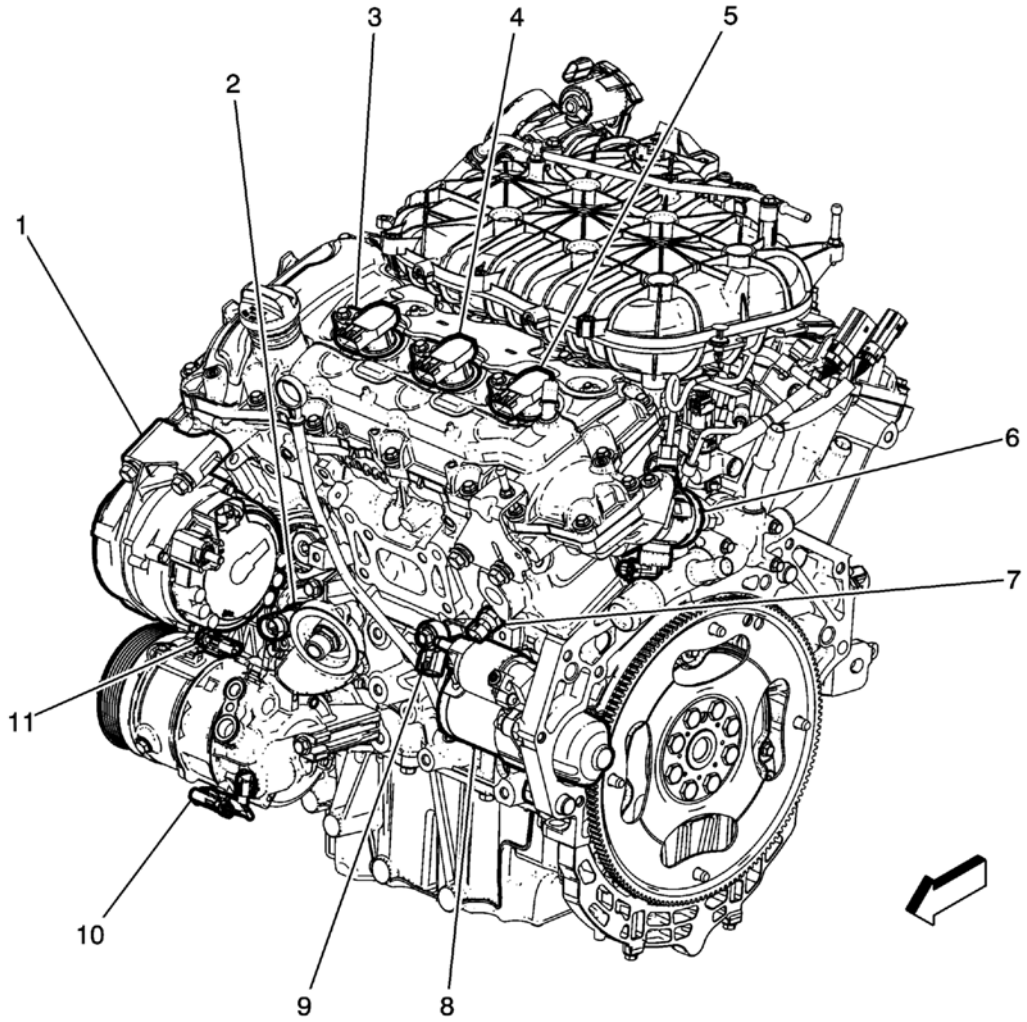


Fig. 1: Left Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Generator
2	Engine Oil Pressure (EOP) Switch
3	Ignition Coil 2
4	Ignition Coil 4
5	Ignition Coil 6
6	High Pressure Fuel Pump

Callout	Component Name
7	Engine Coolant Temperature (ECT) Sensor
8	Starter Motor
9	Knock Sensor (KS) 2
10	A/C Compressor Solenoid Valve
11	A/C Compressor Clutch

RIGHT REAR OF ENGINE COMPONENTS

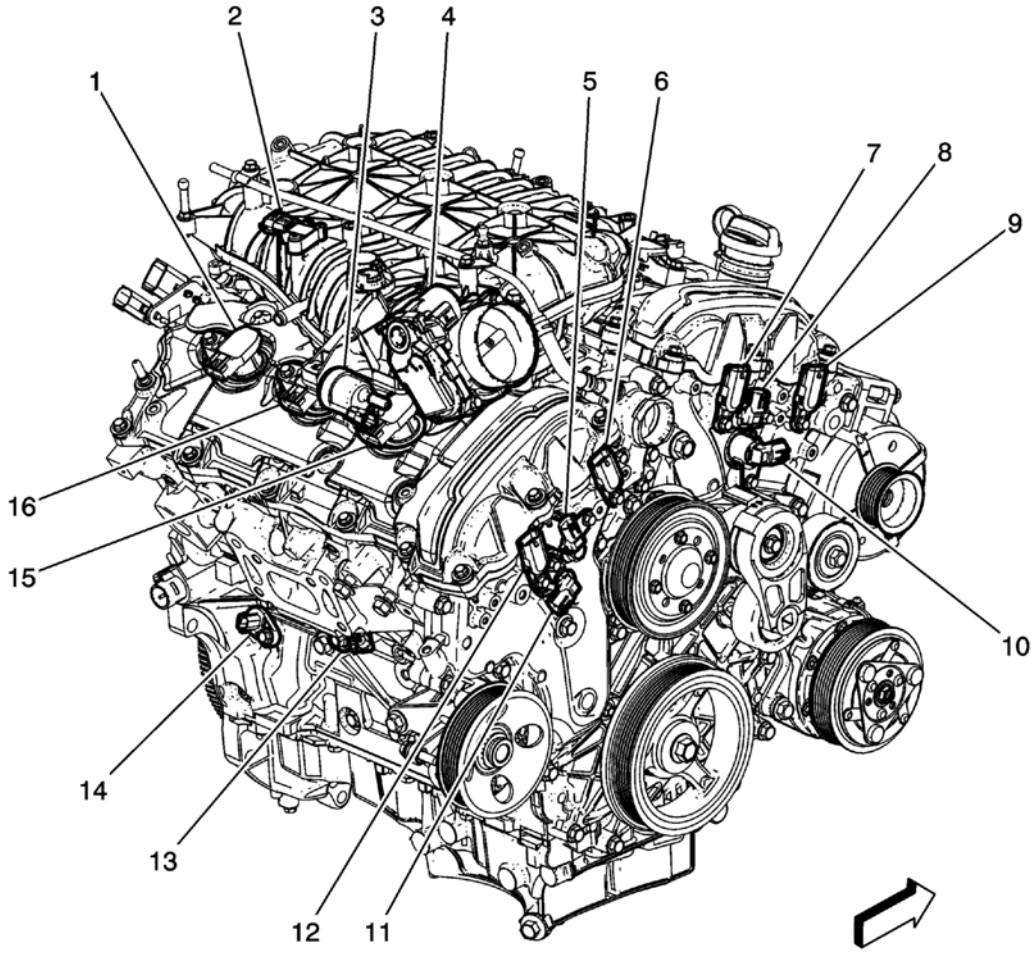


Fig. 2: Right Rear Of Engine
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Ignition Coil 5
2	Manifold Absolute Pressure (MAP) Sensor
3	Evaporative Emission (EVAP) Canister Purge Solenoid Valve
4	Throttle Body
5	Camshaft Position (CMP) Actuator Solenoid Valve- Bank 1 Intake

Callout	Component Name
6	Camshaft Position (CMP) Sensor - Bank 1 Intake
7	Camshaft Position (CMP) Sensor - Bank 2 Intake
8	Camshaft Position (CMP) Actuator Solenoid Valve- Bank 2 Intake
9	Camshaft Position (CMP) Sensor - Bank 2 Exhaust
10	Camshaft Position (CMP) Actuator Solenoid Valve- Bank 2 Exhaust
11	Camshaft Position (CMP) Actuator Solenoid Valve- Bank 1 Exhaust
12	Camshaft Position Sensor (CMP) - Bank 1 Exhaust
13	Knock Sensor (KS) 1
14	Crankshaft Position (CKP) Sensor
15	Ignition Coil 1
16	Ignition Coil 3

TOP ENGINE COMPONENTS

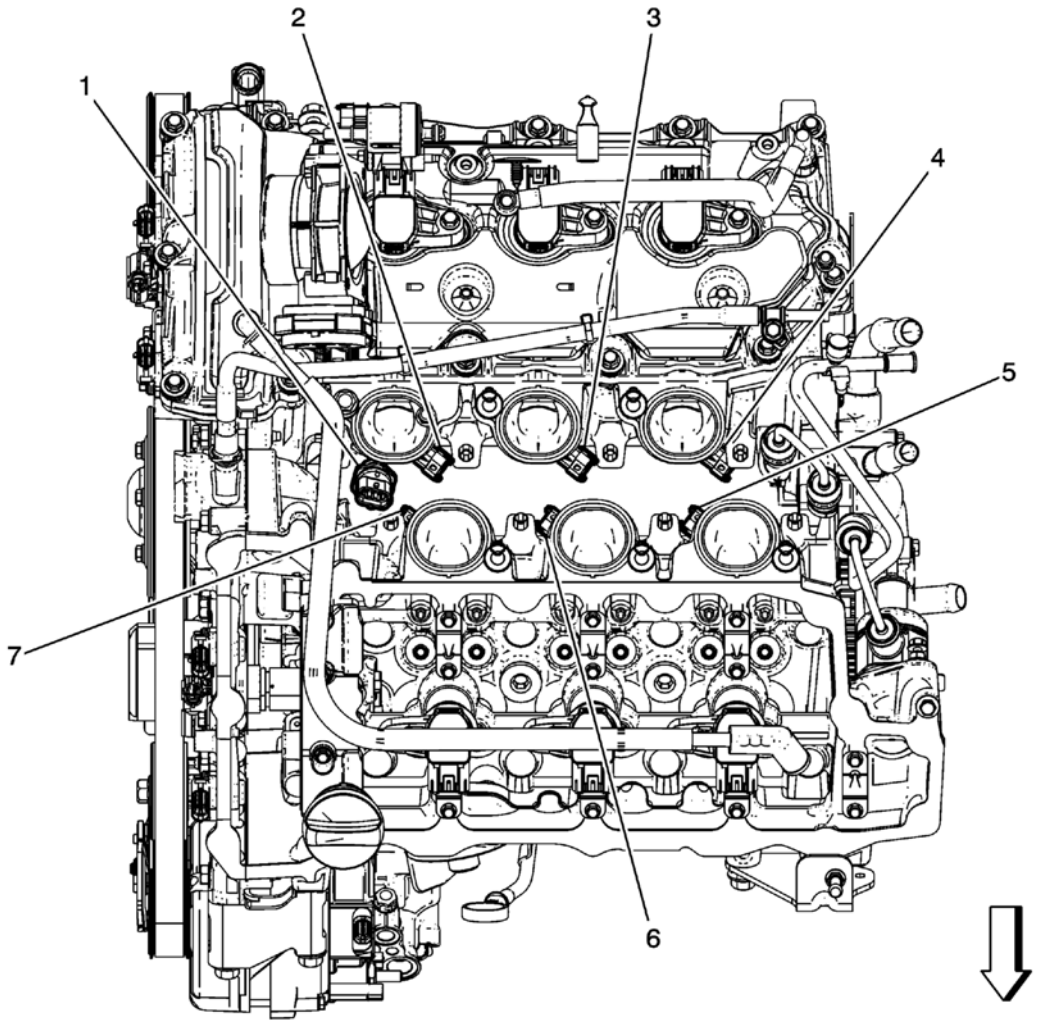


Fig. 3: Top Engine Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Rail Pressure (FRP) Sensor
2	Fuel Injector 1
3	Fuel Injector 3
4	Fuel Injector 5
5	Fuel Injector 6
6	Fuel Injector 4
7	Fuel Injector 2

OXYGEN SENSORS

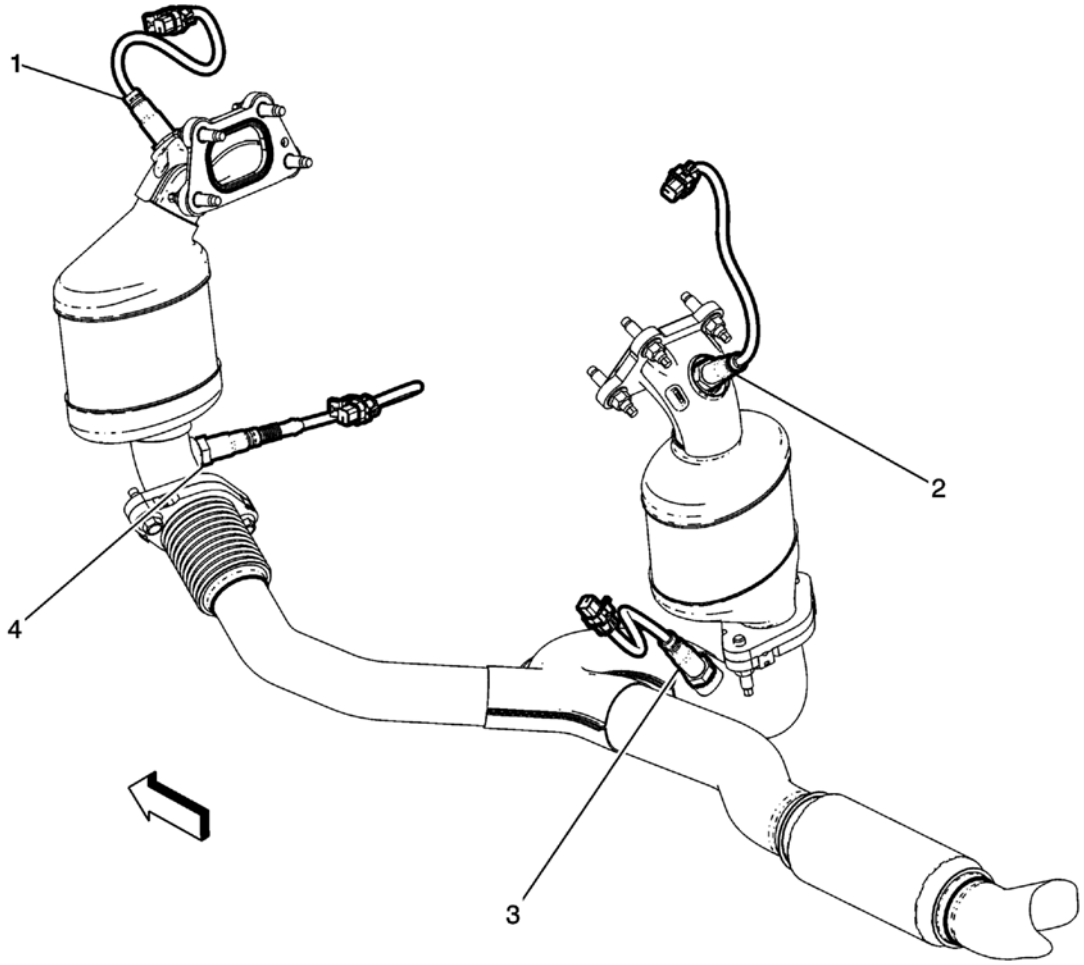


Fig. 4: Oxygen Sensors
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 1
2	Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 1
3	Heated Oxygen Sensor (HO2S) - Bank 1 Sensor 2

Callout	Component Name
4	Heated Oxygen Sensor (HO2S) - Bank 2 Sensor 2

AUTOMATIC TRANSMISSION ELECTRONIC COMPONENTS

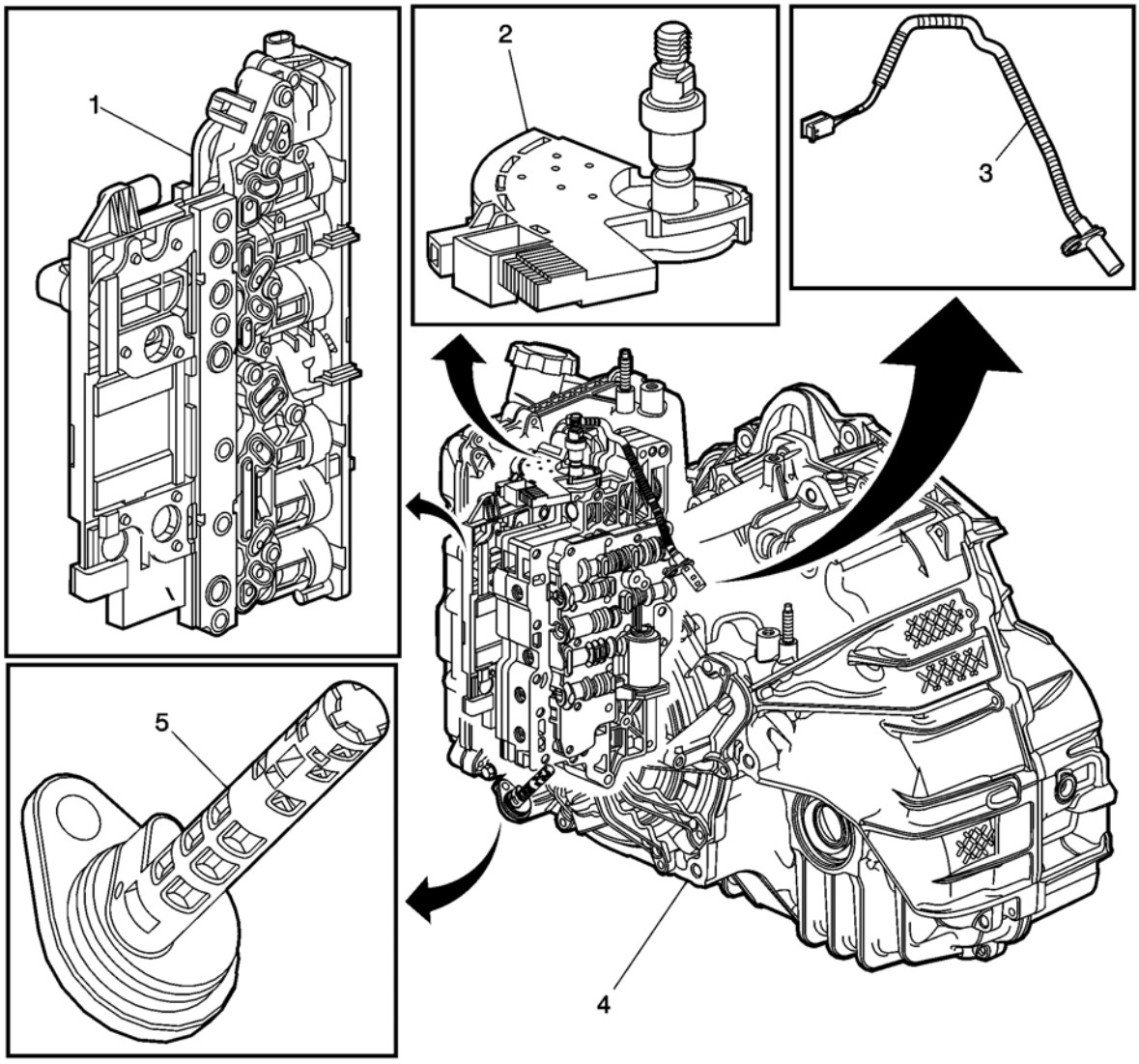


Fig. 5: Automatic Transmission Electronic Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Control Solenoid Valve Assembly
2	Automatic Transmission Internal Mode Switch (IMS)
3	Automatic Transmission Output Shaft Speed (OSS) Sensor
4	Automatic Transmission Assembly
5	Automatic Transmission Input Shaft Speed (ISS) Sensor

Article GUID: A00737228

ELECTRICAL

Wiring Systems and Power Management - Component Locator - Wheels/Vehicle Underbody Component Views - Impala

WHEELS/VEHICLE UNDERBODY COMPONENT VIEWS

FRONT WHEEL COMPONENTS

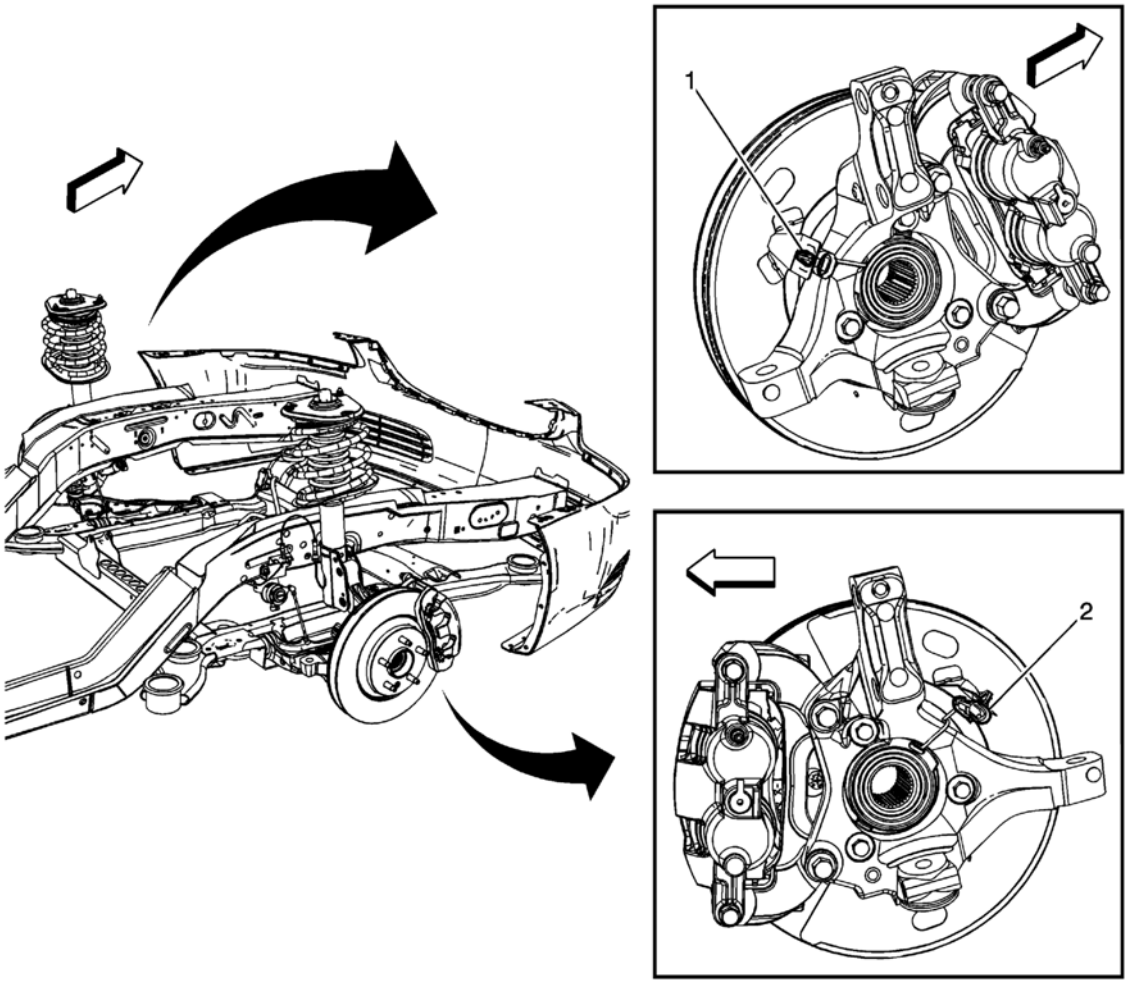


Fig. 1: Identifying Front Wheel Speed Sensors
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Wheel Speed Sensor (WSS)- Left Front
2	Wheel Speed Sensor (WSS)- Right Front

REAR WHEEL COMPONENTS

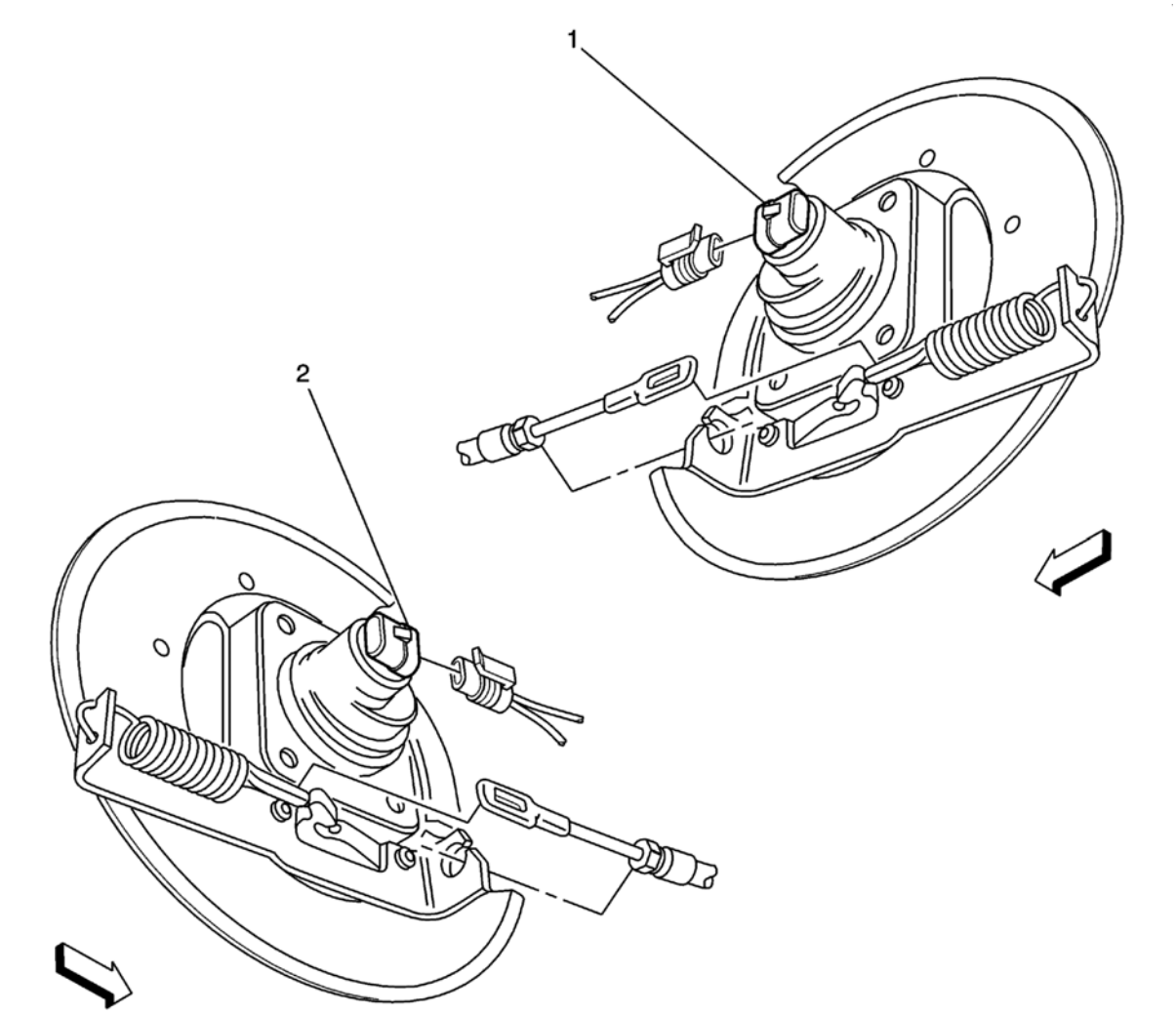


Fig. 2: Rear Wheel Speed Sensor Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Wheel Speed Sensor (WSS)- Right Rear
2	Wheel Speed Sensor (WSS)- Left Rear

UNDERBODY COMPONENTS

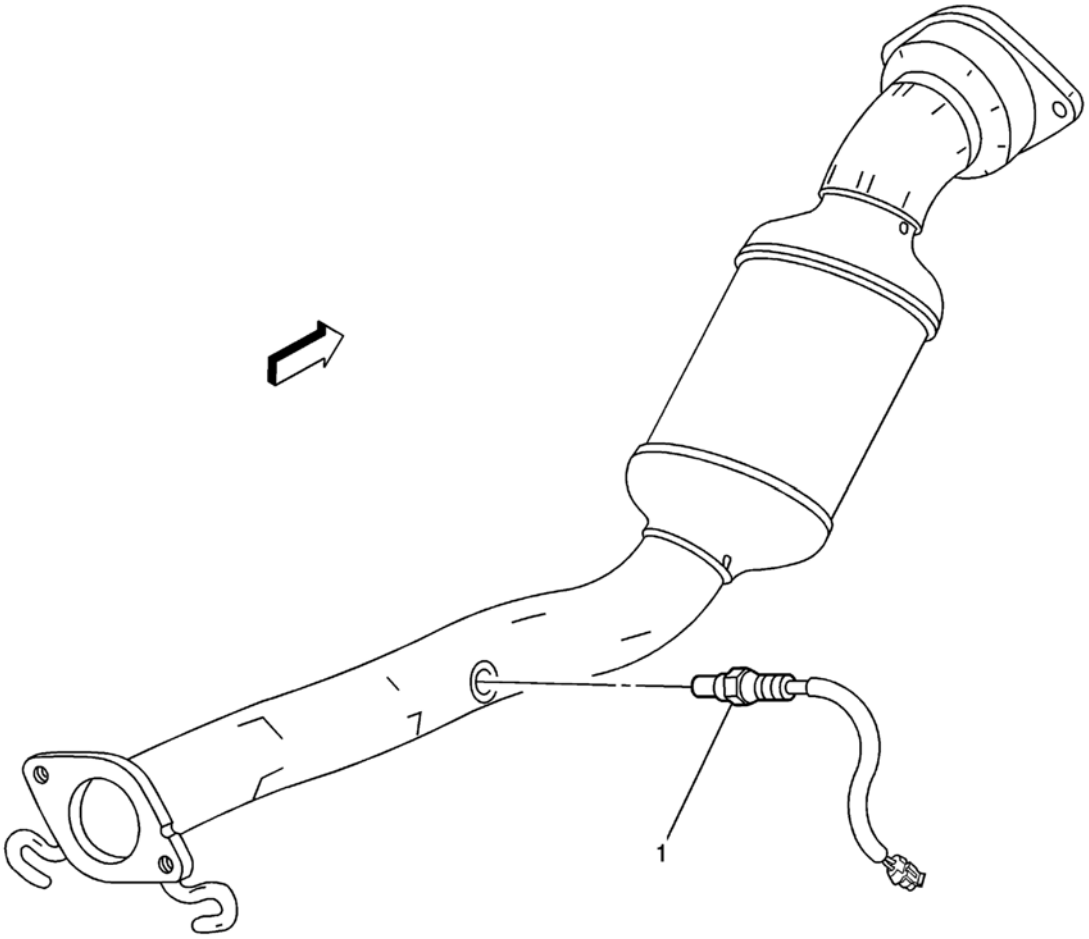


Fig. 3: Underbody Component Views
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Heated Oxygen Sensor (HO2S) 2

FUEL TANK COMPONENTS

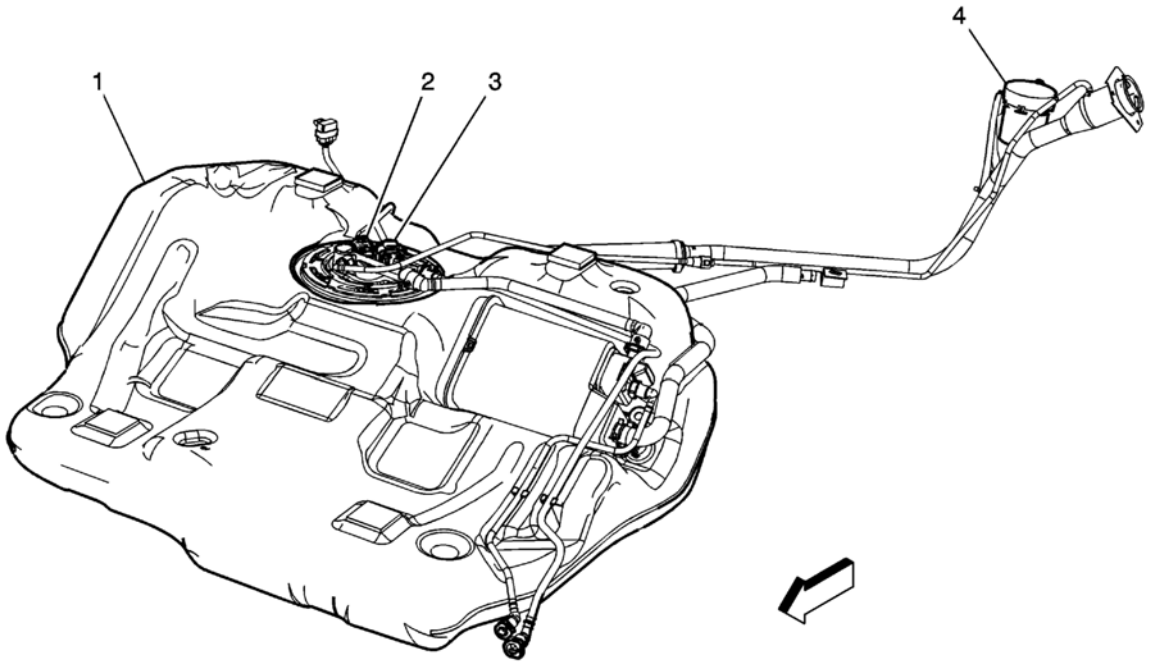


Fig. 4: Fuel Tank Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Tank
2	Fuel Pump and Sender Assembly
3	Fuel Tank Pressure (FTP) Sensor
4	Evaporative Emission (EVAP) Canister Vent Solenoid Valve

Article GUID: A00737233

DESCRIPTION AND OPERATION

ELECTRONIC PARK LOCK DESCRIPTION AND OPERATION

If the vehicle is equipped with automatic transmission and a floor mounted console gear shift, it has an electronic park lock system (EPL). The EPL system purpose is to prevent the ignition key from being turned to the OFF position when the transmission is in any position other than PARK and the vehicle may still be moving. The EPL system consists of an ignition lock cylinder solenoid, and a park position switch that is located in the A/T shift lock control switch. The ignition lock cylinder solenoid contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the Park position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

POWER MODE DESCRIPTION AND OPERATION

Serial Data Power Mode Master

Power to many of this vehicles circuits is controlled by the module that is designated the power mode master (PMM). This vehicles PMM is the body control module (BCM). The BCM has multiple B+ circuits that feed into it. Each of those circuits are partitioned within the controller to drive certain outputs of the vehicle's body functions. An open or short in any one of the B+ circuits may induce multiple codes/or a section of non-functionality within the BCM with the rest of the BCM functioning normally. In this case it is useful to refer to the power distribution schematics to determine if the non-functional partition of the controller shares a common B+ circuit. The ignition switch is a low current switch with multiple discrete ignition switch signals to the PMM for determination of the power mode that will be sent over the serial data circuits to the other modules that need this information. The PMM will also activate relays and other direct outputs of the PMM as needed. The PMM determines which power mode (Off, Accessory, Run, Crank Request) is required, and reports this information to other modules via serial data. Modules which have switched voltage inputs may operate in a default mode if the PMM serial data message does not match what the individual module can see from its own connections.

The PMM receives ignition switch signals to identify the operators desired power mode. The PMM Power Mode Parameters table below illustrates the correct state of these input parameters (circuits) in correspondence to the ignition switch position:

PMM Power Mode Parameters

Ignition Switch Position	Power Mode Transmitted	Ignition Off / Run / Crank (Off / Run Crank voltage circuit)	Ignition Accessory / Run (Accessory voltage circuit)	Ignition Run / Crank (Ignition 1 Voltage circuit)
Off Key Out	Off	Key Out/ACC	Inactive	Inactive
Off Key IN	Off	Key In/Off	Inactive	Inactive
Accessory	Accessory	Key Out/ACC	Active	Inactive
Run	Run	Run	Active	Active

Ignition Switch Position	Power Mode Transmitted	Ignition Off / Run / Crank (Off / Run Crank voltage circuit)	Ignition Accessory / Run (Accessory voltage circuit)	Ignition Run / Crank (Ignition 1 Voltage circuit)
Start	Crank Request	Crank	Inactive	Active

Relay Controlled Power Mode

The body control module (BCM) uses the discrete ignition switch inputs Off/Run/Crank Voltage, Accessory Voltage, and Ignition 1 Voltage, to distinguish the correct power mode. The BCM, after determining the desired power mode, will activate the appropriate relays for that power mode.

The RAP relay remains on for a timed period after the Ignition key is removed. Refer to **Retained Accessory Power Description and Operation** for more information on the retained accessory power (RAP) function.

BCM Awake/Sleep States

The body control module (BCM) is able to control or perform all of the BCM functions in the awake state. The BCM enters the sleep state when active control or normal monitoring of system functions has stopped and a time limit has passed. The BCM must detect certain wake-up inputs before entering the awake state. The BCM monitors for these inputs during the sleep state.

The BCM will enter the awake state if any of the following wake-up inputs are detected:

- Activity on the serial data line.
- Detection of a battery reconnect.
- Any door open signal.
- Headlamps ON.
- Key-in-ignition.
- Ignition ON.
- Park lamps ON.
- Keyless entry or remote start message.

The BCM will enter a sleep state when all of the following conditions exist:

- The ignition switch is OFF, key out.
- No activity exists on the serial data line.
- No outputs are commanded.
- No delay timers are actively counting.
- No wake-up inputs are present.

If all these conditions are met, the BCM will enter a low power or sleep condition.

RETAINED ACCESSORY POWER DESCRIPTION AND OPERATION

Retained Accessory Power (RAP)

The retained accessory power (RAP) system allows certain vehicle functions to operate for a specific amount of

time after the ignition switch is turned OFF. The body control module (BCM) monitors the ignition switch position, battery condition, and each door ajar switch status to determine whether RAP should be initiated or terminated. RAP is controlled with two different methods; serial data and relay control. Some modules receive a RAP message from the BCM over the serial data circuits. Serial data controlled RAP is deactivated as required by their modules RAP power mode operation. Other subsystems are activated directly by the BCM through a RAP relay. Components and systems that are active in RAP are also activated anytime the ignition is any position other than OFF regardless of the door switch signals.

Relay Controlled RAP

The BCM keeps the RAP relay energized during all power modes, except Off-Awake and Crank. The relay is also energized for approximately 10 minutes after shutting the ignition OFF and removing the key, providing no door is opened.

Relay controlled RAP will end when one of the following conditions is met:

- The BCM receives an input from any door ajar or open switch indicating the opening of any door after the ignition key is out of the ignition.

  IMPORTANT: If the BCM is receiving any door ajar or open signal from those switches when the ignition key is turned OFF, RAP will not initiate.

- The BCM internal timer for the RAP expires after approximately 10 minutes.
- The BCM detects a decrease in battery capacity below a prescribed limit.

Systems powered by the RAP relay during the RAP power mode are as follows:

- A/T shift lock control solenoid assembly (w/ floor shifter)
- Power window circuit breaker
- RAP fuse
  - Inside rearview mirror (DD6)
  - Sunroof (CF5)

Serial Data Controlled RAP

RAP systems controlled by serial data are as follows:

Radio

Radio RAP activation/termination is the same as relay operation with 1 exception; the only door switch that will turn off the radio during RAP is the driver door open switch.

Vehicle Communication Interface Module (VCIM) (OnstarÂ®)

VCIM RAP activation/termination is the same as radio operation with 1 exception; if there is an active call when the ignition key is turned off the VCIM will remain in RAP mode, and keep the radio in RAP mode until the call is terminated.

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B0005: IN PARK SIGNAL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B0005 00

In Park Signal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Park Enable Signal Circuit	B0005	1	-	-
1. Will cause symptom related to SEO device (6J1).				

Circuit/System Description

The park enable signal circuit is a voltage output from the body control module (BCM) only when the vehicle is not in the PARK position. This circuit is for the control of a SEO device relay when equipped with RPO 6J1.

Conditions for Running the DTC

- The system voltage is between 9-16 volts.
- The DTC can only set when the output is actively being requested by the module.

Conditions for Setting the DTC

The DTC will set only when the module requests the output and there is a short to ground for greater than 5 seconds.

Action Taken When the DTC Sets

The module output driver will be shut down and not supply voltage to the circuit.

Conditions for Clearing the DTC

- The current DTC will clear when the malfunction is no longer present.

- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Reference Information

Schematic Reference

Upfitter Provision Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Refer to Owner's Manual Supplement - Chevrolet Impala Police Package - Special Equipment Options - Special Equipment Options Standard with Impala Police Package - Description and Operation - Wiring Provisions for 12-Volt Battery Power Supply.

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the SEO relay controlled by the park enable signal circuit.
2. Connect a test lamp between the park enable signal circuit and battery positive voltage.
3. Ignition ON, transmission in the PARK position. Verify the test lamp does not illuminate.
    - If the test lamp illuminates, test for a short to ground on the park enable signal circuit. If the circuit tests normal and the DTC is current, replace the BCM.
4. If the circuit tests normal and the DTC is current, test or replace the SEO relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for module replacement, setup, and programming

DTC B1370-B1379, B1380-B1389, OR B1440-B1443: IGNITION DEVICE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1370 01

Device Ignition 1 (ON and START) Circuit Short to Battery

DTC B1370 06

Device Ignition 1 (ON and START) Circuit Short to Ground or Open

DTC B1380 01

Device Ignition ACCESSORY Circuit Short to Battery

DTC B1380 06

Device Ignition ACCESSORY Circuit Short to Ground or Open

DTC B1440 00

Power Mode Master Input Circuits Mismatch

DTC B1441 01

Device Ignition OFF, RUN, and CRANK Circuit Short to Battery

DTC B1441 06

Device Ignition OFF, RUN, and CRANK Circuit Short to Ground or Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ - Terminal 2	B1370 06, B1380 06, B1440 00, U0100-U0299, 2, 4	B1370 06, B1380 06, B1440 00, U0100-U0299	-	-
Ignition - Terminal 3	B1370 06, B1380 06, U0100-U0299, 2, 4	B1380 06, 1	B1380 01, P1629, 1	-
Ignition - Terminal 1	B1370 06, B1380 06, U0100-U0299, 2, 4	B1370 06, 1	B1370 01, U0100-U0299, 1, 2	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition - Terminal 5	B1370 06, B1380 06, B1440 00, U0100-U0299, 2, 4	B1440 00, B1441 06, 1	B1441 01, 1	-
Ignition voltage - BCM terminal 21, X4	B1428, 3	B1370 06	-	-
Accessory Wakeup Serial Data, BCM Terminal 19, X4	U1814, 3	U0100-U0299, P0513 00	-	-

1. Power Mode Mismatch
2. Scan Tool Does Not Communicate
3. This circuit is a pass through circuit in the BCM and will cause the B+ circuit fuse to open.
4. This circuit/condition will cause the B+ circuit fuse to open, and may cause a no start condition.

Circuit/System Description

The vehicle power mode master (PMM) is the body control module (BCM). The ignition switch is a low current switch with multiple discrete ignition switch signals to the PMM for determination of the power mode. The PMM receives the ignition switch signals, and additionally a reference voltage signal from the BCM, through the ignition switch, and back to the BCM. There are redundancies within the PMM system that can allow operation of certain subsystems when there are faults in the ignition switch circuits. Other information such as serial data input from other modules and DTCs is also used to determine what power mode signals and information is transmitted by the PMM. The BCM logic uses all this information to identify the operator's desired power mode and activate specific discrete signals, and serial data messages for the operation of different subsystems as necessary. Other modules which have switched voltage inputs may operate in a default mode if the PMM serial data message does not match what the individual module can detect from its own connections.

The PMM will activate relays and other direct outputs of the PMM as needed according to the calculated power mode. Some relays controlled by the BCM are switched ignition voltage outputs that are pass through circuits within the BCM directly from the ignition switch. If these circuits short to ground, the B+ circuit fuse to the ignition switch will open.

Conditions for Running the DTC

B1370 01

Ignition switch is in the OFF or ACC positions.

B1370 06, B1380 01, B1441 01, B1441 06

Ignition switch is in the START position.

B1380 06, B1440

Ignition switch is in the RUN position.

Conditions for Setting the DTC

B1370 01

Ignition circuit is shorted to voltage.

B1370 06

- Ignition 1 voltage circuit is open.
- B+ circuit of the ignition switch is open or shorted to ground.

B1380 01

Accessory circuit is shorted to voltage.

B1380 06

- Accessory voltage circuit is open.
- B+ circuit of the ignition switch is open or shorted to ground.

B1440

BCM senses an open or short to voltage on the off/run/crank circuit when both ignition accessory/run and ignition run/crank parameters are active.

BCM senses an open on the B+ circuit to the ignition switch while the engine is running. An open on the B+ circuit can be caused by a short to ground on any of the circuits listed below:

- B+
- Accessory
- Run/crank ignition voltage BCM terminal 19, X4
- Off/run/crank

B1441 01

Off/run/crank circuit is shorted to voltage.

B1441 06

Off/run/crank circuit is open.

Actions Taken When the DTC Sets

- The BCM operates in a fail-safe power mode dependent on the last valid power mode detected and the state of the engine run flag data on the serial data communications circuits.
- The other modules on the vehicle operate in a fail-safe power mode dependent on the last valid power mode transmitted by the BCM and the state of the engine run flag on the serial data communications circuits.

Conditions for Clearing the DTC

A current DTC clears when the malfunction is no longer present.

Diagnostic Aids

- A short to ground in the ignition circuit of the run crank relay will cause an open fuse to the ignition switch. DTC B1428 should be current.
- The power modes and controls are determined using BCM logic. Comparing the Body Control Module Power Mode data display parameters listed in Circuit/System Verification to the scan tool values of the vehicle will determine if there is a power mode fault.

Reference Information

Schematic Reference

- **Power Distribution Schematics**
- **Power Moding Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the following DTCs are not set: U1814, B1428.
   - If either of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. With a scan tool, access BCM, Power Mode data display list and compare all parameters listed with the corresponding ignition key position. The PMM Power Mode Parameters table below illustrates the correct state of these input parameters in correspondence to the ignition switch position. The circuits which the individual parameters are related to are in parentheses.

PMM Power Mode Parameters

Ignition Switch Position	Current Power Mode	Ignition Off/Run /Crank (Ignition Switch,	Ignition Accessory/Run (Ignition Switch,	Ignition Run/Crank (Ignition Switch,

		Terminal 5)	Terminal 3)	Terminal 1)
Off Key Out	Off	Key Out/ACC	Inactive	Inactive
Off Key IN	Off	Key In/Off	Inactive	Inactive
Accessory	Accessory	Key Out/ACC	Active	Inactive
Run	Run	Run	Active	Active
Start	Crank Request	Crank	Inactive	Active

Circuit/System Testing

IMPORTANT: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Connect a test lamp between each fuse test terminal of the ignition switch B+ circuit fuse and ground. The test lamp should illuminate.
   - If the test lamp does not illuminate, test the circuits listed below for a short to ground. If all circuits test OK, replace the BCM.
   - B+ terminal 2
   - Ignition terminal 1
   - Ignition terminal 3
   - Ignition terminal 5
   - Ignition, BCM terminal 21, X4
2. Disconnect the harness connector at the ignition switch.
3. Connect a test lamp between the B+ circuit terminal 2 and ground. The test lamp should illuminate.
   - If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.

   IMPORTANT: The ignition switch component test must be performed before proceeding with this test to verify the integrity of the switch.

4. Perform the ignition switch component test. Verify the switch passes the test.
   - If the ignition switch does not test normal, replace the ignition switch.
5. Disconnect the X 1 harness connector at the BCM, test for less than 1.0 V between the following ignition circuit terminals of the BCM and ground.
   - terminal 2
   - terminal 4
   - terminal 14
   - terminal 21
   - If greater than specified, test the circuit for a short to voltage.
6. Test for less than 1.0 Ω between the BCM and the ignition switch on the circuits listed below:
   - Ignition terminal 4, X1 and ignition switch terminal 6
   - Ignition terminal 2, X1 and ignition switch terminal 5
   - Ignition terminal 21, X1 and ignition switch terminal 3
   - Ignition terminal 14, X1 and ignition switch terminal 1

- If greater than specified, test the circuit for open/high resistance

7. If all circuits test normal, replace the BCM.

Component Testing

Ignition Switch

1. Ignition OFF, disconnect the harness connector at the ignition switch.
2. Verify the resistance between the terminals listed below match for each ignition switch position.
   - If not the specified value, replace the ignition switch.

Resistance Test

Ignition Switch Position	Terminals 1 and 2	Terminals 2 and 3	Terminals 2 and 5	Terminals 2 and 6	Terminals 5 and 6
Off Key Out	Infinite	Infinite	Infinite	Infinite	Infinite
Off Key IN	Infinite	Infinite	< 5.0 Ω	Infinite	Infinite
Accessory	Infinite	< 5.0 Ω	Infinite	Infinite	Infinite
Run	< 5.0 Ω	< 5.0 Ω	Infinite	Infinite	< 5.0 Ω
Start	< 5.0 Ω	Infinite	Infinite	Infinite	1275-1325 Ω

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition and Start Switch Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B1428: IGNITION SWITCHED POWER RELAY 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1428 00

Ignition Switched Power Relay 1 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Run/Crank Relay Coil Control	B1428 00	1	2	-
1. No Start. SIR system will retain DTC B1370 06 as current. 2. Vehicle will start and continue to run after the ignition key is removed.				

Circuit/System Description

The body control module (BCM) controls the IGN MAIN PCB relay through the run/crank relay coil control circuit by applying voltage to the circuit. The IGN MAIN PCB relay is energized when the ignition switch is in ON or START, or when a remote start is requested.

Conditions for Running the DTC

- The system voltage is between 9-16 volts.
- The DTC can only run when the output is activated.

Conditions for Setting the DTC

The DTC will set only when the output is activated and there is a short to ground in the run/crank relay coil control circuit.

Action Taken When the DTC Sets

The module output driver will be shut down and not supply voltage to the run/crank relay coil control circuit.

Conditions for Clearing the DTC

- The current DTC will clear when the module request for the output is removed or the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Use the DMM MIN/MAX function to capture/locate intermittent conditions.
- Short to voltage in the run/crank relay coil control circuit will cause the malfunction indicator lamp (MIL) to illuminate with the ignition key OFF, and the engine will remain running if started and the ignition key is removed.

Reference Information

Schematic Reference

- **Body Control System Schematics**
- **Power Distribution Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- **Circuit Testing**

- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X4 harness connector at the BCM.
2. Test for greater than 70 ohms of resistance between the BCM run/crank relay coil control circuit terminal 21 and ground.
    - If less than specified, test the control circuit for a short to ground. If the circuit tests normal, replace the underhood fuse block.
3. If the circuit tests normal, test or replace the BCM.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Refer to Control Module References for BCM replacement, setup, and programming
- Accessory Wiring Junction Block Replacement

DTC B1475: RETAINED ACCESSORY POWER

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC B1475 00

Retained Accessory Power Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
RAP Relay Coil Supply Voltage	B1475 00	1	1	-
1. Retained Accessory Power (RAP) Malfunction				

Circuit/System Description

The body control module (BCM) controls the RAP relay through the rap relay coil supply voltage circuit by applying voltage to the coil side of the relay. The RAP relay is energized when any of the following conditions are true:

- Ignition switch is in ACC or ON.
- The vehicle was remote started.
- The vehicle is in RAP mode.

Conditions for Running the DTC

- The system voltage is between 9-16 volts.
- The DTC can only set when the output is actively being requested by the module.

Conditions for Setting the DTC

The DTC will set only when the module requests the output and there is a short to ground in the rap relay coil supply voltage circuit.

Action Taken When the DTC Sets

The module output driver will be shut down and not supply voltage to the circuit.

Conditions for Clearing the DTC

- The current DTC will clear when the module request for the output is removed or the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold of 50, without a repeat of the malfunction.

Diagnostic Aids

- Use the DMM MIN/MAX function to capture/locate intermittent conditions.
- The radio RAP mode is separate function and will still operate properly.
- The ignition switch will not return to the OFF position if the RAP relay does not energize.

Reference Information

Schematic Reference

- **Body Control System Schematics**
- **Power Distribution Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Testing

1. Ignition OFF, disconnect the Rap relay.
2. Connect a test lamp between the relay coil control circuit terminal and ground.
3. Cycle the ignition ON and OFF. The test lamp should turn ON and OFF when changing ignition switch positions.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the BCM.
4. If the test lamp illuminates normal, test or replace the Rap relay.

Component Testing

Rap Relay Test

1. Ignition OFF, disconnect the RAP relay.
2. Test for 70-110 ohms of resistance between terminals 85 and 86.
    - If the resistance is not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If less than infinite, replace the relay.
4. Install a 20-amp fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 5 ohms of resistance between terminals 30 and 87.
    - If greater than 5 ohms, replace the relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for BCM replacement, setup, and programming
- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

DTC P2534 OR P2535: IGNITION ON/START SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2534

Ignition On/Start Switch Circuit Low Voltage

DTC P2535

Ignition On/Start Switch Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P2534	P2534	P2535	-
Ground	-	P2534	-	-

Circuit/System Description

The transmission control module (TCM) samples the system voltage on the Ignition 1 voltage circuit every 0.1 s. Lower than normal voltage may be inadequate to operate the transmission control solenoids properly. Improper solenoid operation may cause erratic transmission operation, which may result in internal damage.

Conditions for Running the DTC

P2534

The TCM ignition voltage signal is valid, with the ignition ON.

P2535

The TCM ignition voltage signal is valid, with the ignition OFF.

Conditions for Setting the DTC

P2534

The TCM detects 6 V or less on the ignition voltage circuit, with the ignition turned ON.

P2535

The TCM detects greater than 6 V or greater on the ignition voltage circuit, with the ignition turned OFF.

Action Taken When the DTC Sets

P2534

- DTC P2534 is a Type A DTC.
- The TCM turns the high side driver OFF.
- The TCM turns OFF all solenoids.
- The TCM commands maximum line pressure.
- The TCM freezes transmission adaptive functions.
- The TCM commands the TCC OFF.
- The TCM allows the vehicle to operate in transmission protection mode.

- The TCM disables Tap up and Tap down functions.

P2535

DTC P2535 is a Type A DTC.

Conditions for Clearing the DTC

DTCs P2534 and P2535 are Type A DTCs.

Diagnostic Aids

If all circuits test normal, ensure the transmission pass through connector and harness terminals are clean and not damaged, and the charging system is functioning correctly.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the scan tool TCM Ignition Voltage Signal parameter is between 12.6-15 V.
    - **If not between 12.6-15 V**

Refer to Circuit/System Testing.

- **If between 12.6-15 V**

3. Verify that the DTC does not set by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections**.

Circuit/System Testing

1. Ignition OFF, and all vehicle systems OFF, disconnect the X1 harness connector at the T12 Automatic Transmission Assembly.
2. Test for less than 10 Ω between ground circuit terminal 1 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
3. Test for less than 10 Ω between ground circuit terminal 18 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
4. Ignition ON.
5. Verify a test lamp illuminates between B+ circuit terminal 10 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 2 Ω in the B+ circuit end to end
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
   - **If the test lamp illuminates**
6. Ignition OFF.
7. Test for less than 1 V between the ignition circuit terminal 13 and ground.

- **If 1 V or greater**

  Repair the short to voltage on the circuit.

- **If less than 1 V**

8. Ignition ON.
9. Verify a test lamp illuminates between ignition circuit terminal 13 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 2 Ω in the ignition circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, refer to **Power Mode Mismatch**.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp.
   2. Test for infinite resistance between the ignition circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
   - **If the test lamp illuminates**
10. Replace the K71 Transmission Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for transmission control module replacement, programming, and setup.

DTC P2537: IGNITION ACCESSORY SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P2537

Ignition Accessory Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
IGN	P2537	P2537	-
Ground	-	P2537	-

Circuit/System Description

The transmission control module (TCM) continuously monitors the voltage on the Ignition Accessory/Run circuit from the body control module (BCM). When the ignition is in the Accessory or Run position, the BCM sends a 12 V wake up signal to the TCM. This wake up signal allows the TCM to power up and start functioning before the engine is started.

Conditions for Running the DTC

The ignition is in the Accessory or Run position.

Conditions for Setting the DTC

The TCM detects the Ignition Accessory/Run circuit is less than 6 V for 1 minute.

Action Taken When the DTC Sets

DTC P2537 is a Type C DTC.

Conditions for Clearing the DTC

DTC P2537 is a Type C DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-10 Jumper Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition in the ACCESSORY position.
2. Verify the scan tool BCM Accessory Relay Command parameter is Active.
   - **If the parameter is not Active**

     Refer to **Power Mode Mismatch**.

   - **If the parameter is Active**
3. Ignition ON.
4. Verify the scan tool BCM Accessory Relay Command parameter is Active.
   - **If the parameter is not Active**

     Refer to **Power Mode Mismatch**.

   - **If the parameter is Active**
5. Ignition ON, clear all DTCs in the K9 Body Control Module and the Transmission Control Module, ignition OFF for 2 min.
6. Engine Running for 1 min with the transmission in Park.
7. Verify DTC P2537 is not set in the Transmission Control Module.
   - **If DTC P2537 is set**

     Refer to Circuit/System Testing.

   - **If DTC P2537 is not set**
8. After performing the above steps, verify that the DTC does not set by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections**.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the T12 Automatic Transmission Assembly. Install the **DT-47825-10** Jumper harness to the X1 vehicle wire harness connector.
2. Ignition ON.
3. Verify a test lamp illuminates between the ignition circuit terminal 15 and ground.
   - **If the test lamp does not illuminate.**

1. Ignition OFF remove the test lamp, disconnect the X4 harness connector at the K9 Body Control Module.
2. Test for infinite resistance between the ignition circuit and ground.
    - If less than infinite resistance, repair the short to ground in the circuit.
    - If infinite resistance
3. Test for less than 2 Ω on the ignition circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K9 Body Control Module.

- **If the test lamp illuminates**

4. Replace the K71 Transmission Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for body control module or transmission control module replacement, programming, and setup.

SYMPTOMS - WIRING SYSTEMS

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
    - There are no DTCs set.
    - The control modules can communicate via the serial data links.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to:
    - **Power Mode Description and Operation**
    - **Retained Accessory Power Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the systems. Refer to **Checking Aftermarket Accessories**.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Power Mode Mismatch**

- **Retained Accessory Power Malfunction**

IGNITION CAN/CANNOT BE TURNED OFF WITH TRANSMISSION IN ANY GEAR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	1	1	-	-
Control	1	1	2	-
Ground	-	1	-	-
1. Ignition key will not turn to OFF with vehicle in park. 2. Ignition key will turn to OFF with vehicle out of park.				

Circuit/System Description

If the vehicle is equipped with automatic transmission and a floor mounted console gear shift, it has an electronic park lock system. The electronic park lock system purpose is to prevent the ignition key from being turned to the OFF position when the transmission is in any position other than PARK and the vehicle may still be moving. The electronic park lock system consists of an ignition lock cylinder solenoid, and a park position switch that is located in the A/T shift lock control switch. The ignition lock cylinder solenoid contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when it is not energized. The park position switch receives voltage from the body control module (BCM) when the ignition is turned ON. When the transmission shift selector is in PARK, the park position switch closes and energizes the key capture solenoid actuator retracting the pin, allowing the ignition switch to be turned OFF. If vehicle power is lost, power is lost to the ignition switch, the ignition switch has a fault, and/or the transmission is not in the Park position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

Diagnostic Aids

- Verify that the transmission shift selector indicator matches the position of the gear shift lever while selecting between the Park, Reverse, Drive and Low positions.
- Lost power to the ignition switch or a faulty ignition switch can prevent the ignition key from turning to the lock position and prevent ignition key removal from the column.

Reference Information

Schematic Reference

Ignition Lock Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Park Lock Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Circuit/System Verification

1. Ignition OFF, gear shift selector in PARK, ignition ON.
2. Verify that S39 Ignition Switch can be rotated to the ON position.
   - **If the ignition switch cannot be rotated to the ON position and Ignition Key Cannot Be Inserted, Rotated, or Removed from the Ignition Lock Cylinder has NOT been performed**

     Refer to **Ignition Key Cannot Be Inserted, Rotated, or Removed from the Ignition Lock Cylinder**.

   - **If the ignition switch can not be rotated to the ON position and Ignition Key Cannot Be Inserted, Rotated, or Removed from the Ignition Lock Cylinder has been performed**

     Refer to Circuit/System Testing.

   - **If the ignition switch can be rotated to the ON position**
3. Ignition ON, gear shift selector in NEUTRAL, ignition OFF.
4. Verify that the S39 Ignition Switch cannot be rotated to the LOCK position.
   - **If the ignition switch can be rotated to the LOCK position and Ignition Key Cannot Be Inserted, Rotated, or Removed from the Ignition Lock Cylinder has NOT been performed**

     Refer to **Ignition Key Cannot Be Inserted, Rotated, or Removed from the Ignition Lock Cylinder**.

   - **If the ignition switch can be rotated to the LOCK position and Ignition Key Cannot Be Inserted, Rotated, or Removed from the Ignition Lock Cylinder has been performed**

     Refer to Circuit/System Testing.

   - **If the ignition switch cannot be rotated to the LOCK position**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the Ignition Lock Cylinder Control Actuator. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 10 Ω between the ground circuit terminal B and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 10 Ω**
3. Ignition ON
4. Verify that a test lamp illuminates between the Ignition terminal A and ground with the gear shift selector in PARK.
    - **If the test lamp does not illuminate and the Ignition fuse is good**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the Ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, refer to **Power Mode Mismatch**.
    - **If the test lamp does not illuminate and the Ignition fuse is open**
    1. Ignition OFF, remove the test lamp.
    2. Test for infinite resistance between the ignition circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the Ignition Lock Cylinder Control Actuator
    - **If the test lamp illuminates**
5. Verify that a test lamp does not illuminate between the ignition terminal A and ground with the gear shift selector in NEUTRAL .
    - **If the test lamp illuminates**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the Automatic Transmission Shift Lock Control Solenoid, ignition ON.
        - **If the test lamp illuminates**

          Repair the short to voltage on the ignition circuit

        - **If the test lamp does not illuminate**
6. Test or replace the Automatic Transmission shift lock Control Solenoid.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Transmission Control Replacement**
- **Ignition Lock Cylinder Replacement**
- **Control Module References** for Body Control Module replacement, programming, and setup

POWER MODE MISMATCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1370 01

Device Ignition 1 (ON and START) Circuit Short to Battery

DTC B1370 06

Device Ignition 1 (ON and START) Circuit Short to Ground or Open

DTC B1380 01

Device Ignition ACCESSORY Circuit Short to Battery

DTC B1380 06

Device Ignition ACCESSORY Circuit Short to Ground or Open

DTC B1440 00

Power Mode Master Input Circuits Mismatch

DTC B1441 01

Device Ignition OFF, RUN, and CRANK Circuit Short to Battery

DTC B1441 06

Device Ignition OFF, RUN, and CRANK Circuit Short to Ground or Open

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ - Terminal 2	B1370 06, B1380 06, B1440 00, U0100-U0299, 2, 4	B1370 06, B1380 06, B1440 00, U0100-U0299	-	-
Ignition - Terminal 3	B1370 06, B1380 06, U0100-U0299, 2, 4	B1380 06, 1	B1380 01, P1629, 1	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition - Terminal 1	B1370 06, B1380 06, U0100-U0299, 2, 4	B1370 06, 1	B1370 01, U0100-U0299, 1, 2	-
Ignition - Terminal 5	B1370 06, B1380 06, B1440 00, U0100-U0299, 2, 4	B1440 00, B1441 06, 1	B1441 01, 1	-
Ignition voltage - BCM terminal 21, X4	B1428, 3	B1370 06	-	-
Accessory Wakeup Serial Data, BCM Terminal 19, X4	U1814, 3	U0100-U0299, P0513 00	-	-

1. Power Mode Mismatch
2. Scan Tool Does Not Communicate
3. This circuit is a pass through circuit in the BCM and will cause the B+ circuit fuse to open.
4. This circuit/condition will cause the B+ circuit fuse to open, and may cause a no start condition.

Circuit/System Description

The vehicle power mode master (PMM) is the body control module (BCM). The ignition switch is a low current switch with multiple discrete ignition switch signals to the PMM for determination of the power mode. The PMM receives the ignition switch signals, and additionally a reference voltage signal from the BCM, through the ignition switch, and back to the BCM. There are redundancies within the PMM system that can allow operation of certain subsystems when there are faults in the ignition switch circuits. Other information such as serial data input from other modules and DTCs is also used to determine what power mode signals and information is transmitted by the PMM. The BCM logic uses all this information to identify the operator's desired power mode and activate specific discrete signals, and serial data messages for the operation of different subsystems as necessary. Other modules which have switched voltage inputs may operate in a default mode if the PMM serial data message does not match what the individual module can detect from its own connections.

The PMM will activate relays and other direct outputs of the PMM as needed according to the calculated power mode. Some relays controlled by the BCM are switched ignition voltage outputs that are pass through circuits within the BCM directly from the ignition switch. If these circuits short to ground, the B+ circuit fuse to the ignition switch will open.

Conditions for Running the DTC

B1370 01

Ignition switch is in the OFF or ACC positions.

B1370 06, B1380 01, B1441 01, B1441 06

Ignition switch is in the START position.

B1380 06, B1440

Ignition switch is in the RUN position.

Conditions for Setting the DTC

B1370 01

Ignition circuit is shorted to voltage.

B1370 06

- Ignition 1 voltage circuit is open.
- B+ circuit of the ignition switch is open or shorted to ground.

B1380 01

Accessory circuit is shorted to voltage.

B1380 06

- Accessory voltage circuit is open.
- B+ circuit of the ignition switch is open or shorted to ground.

B1440

BCM senses an open or short to voltage on the off/run/crank circuit when both ignition accessory/run and ignition run/crank parameters are active.

BCM senses an open on the B+ circuit to the ignition switch while the engine is running. An open on the B+ circuit can be caused by a short to ground on any of the circuits listed below:

- B+
- Accessory
- Run/crank ignition voltage BCM terminal 19, X4
- Off/run/crank

B1441 01

Off/run/crank circuit is shorted to voltage.

B1441 06

Off/run/crank circuit is open.

Actions Taken When the DTC Sets

- The BCM operates in a fail-safe power mode dependent on the last valid power mode detected and the state of the engine run flag data on the serial data communications circuits.
- The other modules on the vehicle operate in a fail-safe power mode dependent on the last valid power

mode transmitted by the BCM and the state of the engine run flag on the serial data communications circuits.

Conditions for Clearing the DTC

A current DTC clears when the malfunction is no longer present.

Diagnostic Aids

- A short to ground in the ignition circuit of the run crank relay will cause an open fuse to the ignition switch. DTC B1428 should be current.
- The power modes and controls are determined using BCM logic. Comparing the Body Control Module Power Mode data display parameters listed in Circuit/System Verification to the scan tool values of the vehicle will determine if there is a power mode fault.

Reference Information

Schematic Reference

- **Power Distribution Schematics**
- **Power Moding Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Power Mode Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that the following DTCs are not set: U1814, B1428.
   - If either of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. With a scan tool, access BCM, Power Mode data display list and compare all parameters listed with the corresponding ignition key position. The PMM Power Mode Parameters table below illustrates the correct state of these input parameters in correspondence to the ignition switch position. The circuits which the individual parameters are related to are in parentheses.

PMM Power Mode Parameters

Ignition Switch Position	Current Power Mode	Ignition Off/Run /Crank (Ignition Switch, Terminal 5)	Ignition Accessory/Run (Ignition Switch, Terminal 3)	Ignition Run/Crank (Ignition Switch, Terminal 1)
Off Key Out	Off	Key Out/ACC	Inactive	Inactive
Off Key IN	Off	Key In/Off	Inactive	Inactive
Accessory	Accessory	Key Out/ACC	Active	Inactive
Run	Run	Run	Active	Active
Start	Crank Request	Crank	Inactive	Active

Circuit/System Testing

IMPORTANT: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.

1. Connect a test lamp between each fuse test terminal of the ignition switch B+ circuit fuse and ground. The test lamp should illuminate.
   - If the test lamp does not illuminate, test the circuits listed below for a short to ground. If all circuits test OK, replace the BCM.
   - B+ terminal 2
   - Ignition terminal 1
   - Ignition terminal 3
   - Ignition terminal 5
   - Ignition, BCM terminal 21, X4
2. Disconnect the harness connector at the ignition switch.
3. Connect a test lamp between the B+ circuit terminal 2 and ground. The test lamp should illuminate.
   - If the test lamp does not illuminate, test the B+ circuit for an open/high resistance.

   IMPORTANT: The ignition switch component test must be performed before proceeding with this test to verify the integrity of the switch.

4. Perform the ignition switch component test. Verify the switch passes the test.
   - If the ignition switch does not test normal, replace the ignition switch.
5. Disconnect the X 1 harness connector at the BCM, test for less than 1.0 V between the following ignition circuit terminals of the BCM and ground.
   - terminal 2
   - terminal 4
   - terminal 14
   - terminal 21
   - If greater than specified, test the circuit for a short to voltage.
6. Test for less than 1.0 Ω between the BCM and the ignition switch on the circuits listed below:
   - Ignition terminal 4, X1 and ignition switch terminal 6

- Ignition terminal 2, X1 and ignition switch terminal 5
- Ignition terminal 21, X1 and ignition switch terminal 3
- Ignition terminal 14, X1 and ignition switch terminal 1
- If greater than specified, test the circuit for open/high resistance

7. If all circuits test normal, replace the BCM.

Component Testing

Ignition Switch

1. Ignition OFF, disconnect the harness connector at the ignition switch.
2. Verify the resistance between the terminals listed below match for each ignition switch position.
   - If not the specified value, replace the ignition switch.

Resistance Test

Ignition Switch Position	Terminals 1 and 2	Terminals 2 and 3	Terminals 2 and 5	Terminals 2 and 6	Terminals 5 and 6
Off Key Out	Infinite	Infinite	Infinite	Infinite	Infinite
Off Key IN	Infinite	Infinite	< 5.0 Ω	Infinite	Infinite
Accessory	Infinite	< 5.0 Ω	Infinite	Infinite	Infinite
Run	< 5.0 Ω	< 5.0 Ω	Infinite	Infinite	< 5.0 Ω
Start	< 5.0 Ω	Infinite	Infinite	Infinite	1275-1325 Ω

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition and Start Switch Replacement**
- **Control Module References** for BCM replacement, setup, and programming

RETAINED ACCESSORY POWER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
RAP Relay Coil Control	B1475, 1	1	2	-
Battery Positive Voltage	3	4	2	-
Accessory Voltage (Relay Output)	3	4	2	-
Ground (RAP Relay)	-	1	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
1. All relay controlled RAP functions inoperative. 2. Relay RAP remains on past the timer limit after key out and will not turn off when a vehicle door is opened. 3. Partial relay controlled RAP functions inoperative with open fuse. 4. Partial relay controlled RAP functions inoperative with fuse OK.				

Circuit/System Description

The retained accessory power (RAP) system allows specific vehicle functions to operate after the ignition is turned OFF for a predetermined time. The RAP relay is located in the instrument panel (I/P) fuse block. The relay accessory voltage (output) feeds the RAP fuse and the PWR/WNDW circuit breaker within the I/P fuse block. Relay RAP is controlled by the BCM using inputs from the door ajar switches to determine control of the relay when the ignition is turned OFF. Radio RAP is controlled by a serial data message from the BCM using inputs from the driver door open switch. Refer to **Retained Accessory Power Description and Operation** for more detail on subsystems using RAP.

Diagnostic Aids

- The radio RAP function is a separate RAP function controlled by serial data and the specific module. These functions are not effected by the BCM RAP relay circuits.
- A short to ground or open/high resistance in the RAP relay switched voltage circuits will cause only part of the RAP functions to be inoperative. Diagnose these symptoms within the respective system sections.
- A short to voltage on the RAP relay control or switched voltage circuits would cause the RAP function to remain on past the designated time.
- A stuck relay switch could cause a RAP always on, or a RAP inoperative condition.

Reference Information

Schematic Reference

- **Power Distribution Schematics**
- **Power Moding Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Retained Accessory Power Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Verification

IMPORTANT: Battery voltage must remain above 9.6 V for RAP to operate properly.

Radio RAP

1. With all passenger doors closed, observe the courtesy lamps while opening and closing the driver door. The courtesy lamps should illuminate when the door is opened and turn off approximately 30 seconds after closing the door.
    - If the courtesy lamp operation is incorrect from the drivers door, refer to **Courtesy Lamps Malfunction** .
2. If courtesy lamp operation is correct, and the radio is the only RAP concern, replace the radio.

Relay RAP

1. Ignition ON, observe the appropriate scan tool parameters listed below while opening and closing each vehicle door. The reading should change between Door Closed/Door Ajar.

    Parameter

    - Driver Door Ajar Sw.
    - Left Rear Door Ajar Sw.
    - Passenger Door Ajar Sw.
    - Right Rear Door Ajar Sw.
    - If any parameter does not change as specified, refer to **Door Ajar Indicator Malfunction** .
2. Command the scan tool Accy/RAP Relay OFF. Attempt to operate any RAP relay controlled component within 5 seconds. The component should not operate.
3. Command the scan tool Accy/RAP Relay ON. Attempt to operate any RAP relay controlled component within 5 seconds. The component should operate.
4. Ignition ON, all doors closed. Observe the scan tool parameter Accy/RAP Relay Command. Ignition OFF, key removed, the reading should be ON for approximately 10 minutes then change to OFF.
    - If the parameter does not respond as specified, replace the BCM.

Circuit/System Testing

1. Ignition OFF, disconnect the RAP Relay.
2. Test for less than 2 ohms of resistance between ground circuit terminal and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between relay coil control circuit terminal and ground.

4. With the driver and passenger doors open, cycle the ignition key ON and OFF. The test lamp should turn ON and OFF when cycling the ignition switch.
    - If the test lamp remains ON all the time, test the relay coil control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp remains OFF all the time, test the relay coil control circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the BCM.
5. Connect a test lamp between the relay accessory voltage circuit terminal and ground. The test lamp should not illuminate.
    - If the test lamp illuminates, test the accessory voltage circuit for a short to voltage.
6. If all circuits test normal, test or replace the RAP relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the RAP relay.
2. Test for 70-110 ohms of resistance between terminals 85 and 86.
    - If the resistance is not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If not the specified value, replace the relay.
4. Install a 20 amp fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2.0 ohms of resistance between terminals 30 and 87.
    - If greater than the specified range, replace the relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for module replacement, setup, and programming

GENERAL ELECTRICAL DIAGNOSIS

Basic Knowledge Required

Without a basic knowledge of electricity, it will be difficult to use the diagnostic procedures contained in the service manual. You should understand the basic theory of electricity, and know the meaning of voltage (V), current (A), and resistance (Ω). You should also be able to read and understand a wiring diagram, as well as understand what happens in a circuit with an open or a shorted wire.

CHECKING AFTERMARKET ACCESSORIES

WARNING: Refer to SIR Warning .

Do not connect aftermarket accessories into the SIR circuits, all such circuits are indicated on circuit diagrams with the SIR symbol.

Always check for aftermarket accessories (non-OEM) as the first step in diagnosing electrical problems. If the vehicle is so equipped, disconnect the system to verify that these add-on accessories are not the cause of the problems.

Possible causes of vehicle problems related to aftermarket accessories include:

- Power feeds connected to points other than the battery
- Antenna location
- Transceiver wiring located too close to vehicle electronic modules or wiring
- Poor shielding or poor connectors on antenna feed line
- Check for recent service bulletins detailing installation guidelines for aftermarket accessories.

CIRCUIT TESTING

The Circuit Testing section contains the following diagnostic testing information. Using this information along with the diagnostic procedures will identify the cause of the electrical malfunction.

- **Using Connector Test Adapters**
- **Probing Electrical Connectors**
- **Troubleshooting with a Digital Multimeter**
- **Troubleshooting with a Test Lamp**
- **Using Fused Jumper Wires**
- **Measuring Voltage**
- **Measuring Voltage Drop**
- **Measuring Frequency**
- **Testing Ground and Low Reference Circuits**
- **Testing for Continuity**
- **Testing for Short to Ground**
- **Testing for a Short to Voltage**
- **Testing for Intermittent Conditions and Poor Connections**
- **Inducing Intermittent Fault Conditions**
- **Testing for Electrical Intermittents**
- **Scan Tool Snapshot Procedure**
- **Circuit Protection - Fuses**
- **Circuit Protection - Circuit Breakers**
- **Circuit Protection - Fusible Links**

USING CONNECTOR TEST ADAPTERS

Special Tools

EL-35616 Terminal Test Probe Kit

For equivalent regional tools, refer to Special Tools .

WARNING: **This procedure should not be performed on high voltage circuits. Performing this procedure on high voltage circuits may result in serious injury or death.**

CAUTION: **Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616-F GM Approved Terminal Release Tool Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.**

When using the J-35616-F GM Approved Terminal Release Tool Kit , ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616-F GM Approved Terminal Release Tool Kit label on the inside of the J-35616-F GM Approved Terminal Release Tool Kit for the correct adapter along with the connector end view for terminal size.

PROBING ELECTRICAL CONNECTORS

Special Tools

EL-35616 Terminal Test Probe Kit

For equivalent regional tools, refer to Special Tools .

WARNING: **This procedure should not be performed on high voltage circuits. Performing this procedure on high voltage circuits may result in serious injury or death.**

NOTE: **Always be sure to reinstall the connector position assurance (CPA) and terminal position assurance (TPA) when reconnecting connectors or replacing terminals.**

Front probe

Disconnect the connector and probe the terminals from the mating side (front) of the connector.

CAUTION: **Refer to Test Probe Caution .**

NOTE: **When probing female 0.64 terminals, it is important to use the correct adapter. There have been some revisions to the test adapter for 0.64 terminals. The proper adapter for 0.64 terminals is the J-35616-64B which has a gold terminal and a black wire between the base and tip. Failure to use the proper test adapter may result in damage to the terminal being tested and improper**

diagnosis.

NOTE: **The proper adapter for probing the terminals for fuses, relays, or diodes in an electrical center is J-35616-35. Using any other tool or adapter may damage the terminal being tested.**

Refer to the following table as a guide in selecting the correct test adapter for front probing connectors:

Test Adapter	Description
J-35616-2A	150 Male Probe Adapter (gray)
J-35616-3	150 Female Probe Adapter (gray)
J-35616-4A	280 Male Probe Adapter (purple)
J-35616-5	280 Female Probe Adapter (purple)
J-35616-6	100W Male (round) Probe Adapter (brown)
J-35616-7	100W Female (round) Probe Adapter (brown)
J-35616-8	Weather Pack Male Probe Adapter (orange)
J-35616-9	Weather Pack Female Probe Adapter (orange)
J-35616-10	100W Male (round) Probe Adapter (green)
J-35616-11	100W Female (round) Probe Adapter (green)
J-35616-12	130 Male Probe Adapter (blue)
J-35616-13	130 Female Probe Adapter (blue)
J-35616-14	150 Male Probe Adapter (green)
J-35616-16	100 Male Probe Adapter (lt green)
J-35616-17	100 Female Probe Adapter (lt green)
J-35616-18	220 Male Probe Adapter (black)
J-35616-19	220 Female Probe Adapter (black)
J-35616-21	950 Female Probe Adapter (red)
J-35616-22	950 Male Probe Adapter (red)
J-35616-31	500 Male Probe Adapter (orange)
J-35616-32	500 Female Probe Adapter (orange)
J-35616-33	160/180 Male Probe Adapter (yellow)
J-35616-34	160/180 Female Probe Adapter (yellow)
J-35616-35	280 Male Probe Adapter (violet)
J-35616-40	480 Male Probe Adapter (dk blue)
J-35616-41	480 Female Probe Adapter (dk blue)
J-35616-42	630 Male Probe Adapter (red)
J-35616-43	630 Female Probe Adapter (red)
J-35616-44	800 Male Probe Adapter (yellow)
J-35616-45	800 Female Probe Adapter (yellow)
J-35616-54	280 Male (round) Probe Adapter (tan)
J-35616-55	280 Female (round) Probe Adapter (tan)
J-35616-64B	0.64 Male Probe Adapter (lt blue)
J-35616-65B	0.64 Female Probe Adapter (lt blue)

Test Adapter	Description
J-35616-66	150 Male (round) Probe Adapter (yellow)
J-35616-67	150 Female (round) Probe Adapter (yellow)

Backprobe

NOTE:

- **Backprobe connector terminals only when specifically required in diagnostic procedures.**
- **Do not backprobe a sealed (Weather PackÂ®) connector, less than a 280 series Metri-Pack connector, a Micro-Pack connector, or a flat wire connector.**
- **Backprobing can be a source of damage to connector terminals. Use care in order to avoid deforming the terminal, either by forcing the test probe too far into the cavity or by using too large of a test probe.**
- **After backprobing any connector, inspect for terminal damage. If terminal damage is suspected, test for proper terminal contact.**

Do not disconnect the connector and probe the terminals from the harness side (back) of the connector.

TROUBLESHOOTING WITH A DIGITAL MULTIMETER

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to Special Tools .

WARNING: **High voltage circuits should only be tested using a digital multimeter (DMM) and test leads with at least a CAT III rating, such as the J 39200-A Digital Multimeter. Failure to follow the procedures may result in serious injury or death.**

CAUTION: **Refer to Test Probe Caution .**

Digital Multimeter (DMM) Basic Requirements

Service information is validated using digital multimeters that meet or exceed the following requirements. Using a multimeter that does not meet these basic requirements may give inaccurate readings which could lead to an incorrect diagnosis.

Display and Settings

1. Four digits displayed
2. Voltage, current, resistance, frequency, diode test settings, and min-max function
3. Display positive and negative values

Voltage

1. Have at least 10 M Ω input impedance
2. Test a DC voltage range of 0.1-1000 V.
3. Test an AC voltage range of 0.1-1000 V.

Current

1. Test a DC current range of 0.1µA-10 A.
2. Test an AC current range of 0.1µA-10 A.

Resistance

Test a resistance range of 0.1 Ω-40 MΩ and displays infinite for a value greater than 40 M Ω (O.L. (Over-load))

Frequency

Test for a frequency range of 0.5 HZ-199 K HZ

Diode Test

1. Apply at least 2 mA when performing the diode bias test
2. Display the break over voltage drop (0-3 V) of a forward biased diode
3. Display infinite (O.L. (Over-load)) when a diode is reverse biased

Min-Max Readings

1. Can update at a 25 ms sample rate
2. Saves and displays minimum and maximum values

NOTE: **Circuits which include any solid state control modules, such as the engine control module (ECM), should only be tested with a 10 megohm or higher impedance digital multimeter such as the EL-39200.**

The DMM instruction manual is a good source of information and should be read thoroughly upon receipt of the DMM as well as kept on hand for future reference.

A DMM should be used instead of a test lamp in order to test for voltage in high impedance circuits. While a test lamp shows whether voltage is present if the impedance is low enough, a DMM indicates how much voltage is present. In other words, if there is not enough current, the test lamp will not illuminate even though voltage is present.

The ohmmeter function on a DMM shows how much resistance exists between 2 points along a circuit. Low resistance in a circuit means good continuity.

NOTE: **Disconnect the power feed from the suspect circuit when measuring resistance with a DMM. This prevents incorrect readings. DMMs apply such a small voltage to measure resistance that the presence of voltages can upset a resistance reading.**

Diodes and solid state components in a circuit can cause a DMM to display a false reading. To find out if a

component is affecting a measurement take a reading once, then reverse the leads and take a second reading. If the readings differ the solid state component is affecting the measurement.

Following are examples of the various methods of connecting the DMM to the circuit to be tested:

- Probe both ends of the connector and either hold the leads in place while manipulating the connector or tape the leads to the harness for continuous monitoring while you perform other operations or test driving. Refer to **Probing Electrical Connectors**.
- Disconnect the harness at both ends of the suspected circuit where it connects either to a component or to other harnesses.
- If the system that is being diagnosed has a specified pinout or breakout box, it may be used in order to simplify connecting the DMM to the circuit or for testing multiple circuits quickly.

TROUBLESHOOTING WITH A TEST LAMP

Special Tools

EL-35616-200 Test Light - Probe Kit

For equivalent regional tools, refer to Special Tools .

WARNING: This procedure should not be performed on high voltage circuits. Performing this procedure on high voltage circuits may result in serious injury or death.

CAUTION: Refer to Test Probe Caution .

A test lamp can simply and quickly test a low impedance circuit for voltage. A digital multimeter (DMM) should be used instead of a test lamp in order to test for voltage in high impedance circuits. While a test lamp shows whether voltage is present if the impedance is low enough, a DMM indicates how much voltage is present. In other words, if there is not enough current, the test lamp will not illuminate even though voltage is present.

The **EL-35616-200** kit is Micro-Pack compatible and comprised of a 12 V light bulb with an attached pair of leads.

To properly operate this tool use the following procedures.

When testing for voltage:

1. Attach one lead to ground.
2. Touch the other lead to various points along the circuit where voltage should be present.
3. When the bulb illuminates, there is voltage at the point being tested.

When testing for ground:

1. Attach one lead to battery positive voltage.
2. Touch the other lead to various points along the circuit where ground should be present.
3. When the bulb illuminates, there is ground at the point being tested.

USING FUSED JUMPER WIRES

Special Tools

EL 35616-20F Fused Jumper Wire

For equivalent regional tools, refer to Special Tools .

NOTE: **A fused jumper may not protect solid state components from being damaged.**

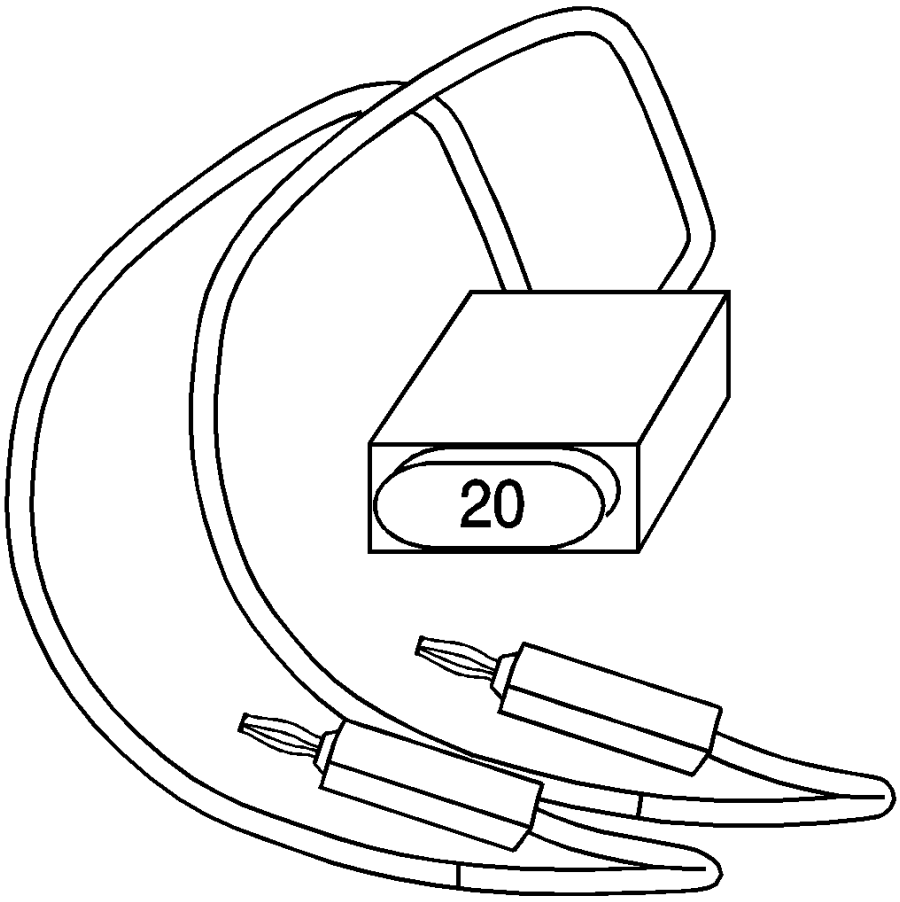


Fig. 1: Fused Jumper Wire
Courtesy of GENERAL MOTORS COMPANY

The **EL 35616-20F** Fused Jumper Wire includes banana jack connectors that provide adaptation to most connectors without damage. This fused jumper wire is supplied with a 20 A fuse which may not be suitable for some circuits. Do not use a fuse with a higher rating than the fuse that protects the circuit being tested.

MEASURING VOLTAGE

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to Special Tools .

WARNING: **Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:**

- **Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedure exactly as written may result in serious injury or death.

CAUTION: **Refer to Test Probe Caution .**

The following procedure measures the voltage at a selected point in a circuit.

1. Disconnect the electrical harness connector for the circuit being tested, if necessary.
2. Enable the circuit and/or system being tested. Use the following methods:
   - Turn ON the ignition, with the engine OFF.
   - Turn ON the engine.
   - Turn ON the circuit and/or system with a scan tool in Output Controls.
   - Turn ON the switch for the circuit and/or system being tested.
3. Select the V (AC) or V (DC) position on the digital multimeter (DMM).
4. Connect the positive lead of the DMM to the point of the circuit to be tested.
5. Connect the negative lead of the DMM to a good ground.
6. The DMM displays the voltage measured at that point.

MEASURING VOLTAGE DROP

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to Special Tools .

CAUTION: **Refer to Test Probe Caution .**

The following procedure determines the difference in voltage potential between 2 points.

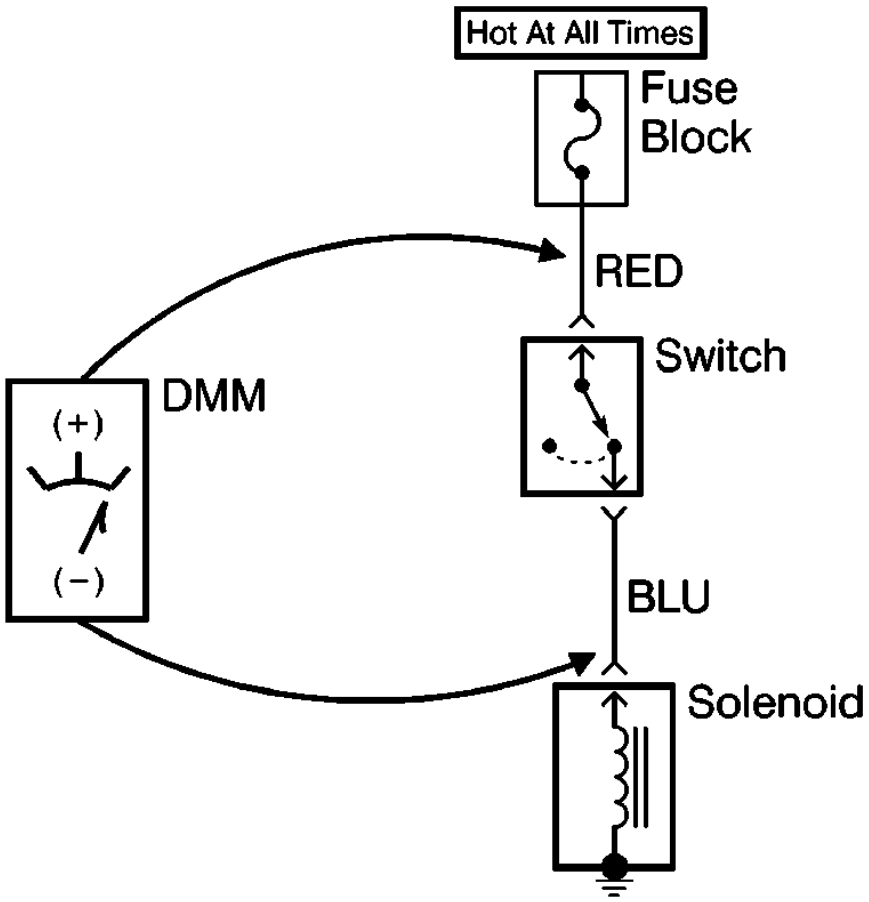


Fig. 2: Measuring Voltage Drop
Courtesy of GENERAL MOTORS COMPANY

1. Set the Digital Multimeter (DMM) to the V (DC) position.
2. Connect the positive lead of the DMM to one point of the circuit to be tested.
3. Connect the negative lead of the DMM to the other point of the circuit.
4. Operate the circuit.
5. The DMM displays the difference in voltage between the 2 points.

MEASURING FREQUENCY

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to Special Tools .

CAUTION: **Refer to Test Probe Caution .**

The following procedure determines the frequency of a signal.

NOTE: **Connecting the Digital Multimeter (DMM) to the circuit before pressing the Hz button will allow the DMM to autorange to an appropriate range.**

1. Apply power to the circuit.
2. Set the DMM to the V (AC) position.
3. Connect the positive lead of the DMM to the circuit to be tested.
4. Connect the negative lead of the DMM to a good ground.
5. Set to Hz on the DMM.
6. The DMM will display the frequency measured.

TESTING GROUND AND LOW REFERENCE CIRCUITS

Because a test lamp can light with up to 200 Ω in a ground or low reference circuit they are not recommended to be used for this type of test. A low impedance test lamp can light and indicate the circuit is good when there is as much as 20-30 Ω present, while a high impedance test lamp can light with up to 200 Ω present in the circuit. This is why the Digital Multi-Meter (DMM) is used when validating a ground or low reference circuit continuity.

When using the DMM there are many vehicle conditions that can affect the ground and low reference continuity testing. If these conditions are not met, a ground or low reference circuit test can fail on a good circuit. This may cause longer diagnosis time and incorrect component replacement.

Any current flow through a ground or low reference circuit, while being tested, will skew the DMM continuity reading, or display a reading higher than when there is no current flowing. Performing a ground or low reference circuit continuity test, in reference to the vehicles battery negative terminal, will have the highest risk of failing a good ground or low reference circuit test than any other ground reference point. The best ground test points would be a control module housing (if the control modules housing is metal and grounded), under dash metal frame work, engine block, or body ground studs (other than where the negative battery cable is attached).

A typical DMM ground or low reference circuit continuity reading can be as high as 100 Ω with the ignition ON, and drop to 15-25 Ω after the ignition is turned OFF. The reading will drop below 10 Ω after 30-40 seconds, then below 5 Ω after 60 seconds. Once the vehicle completely goes to sleep (generally 3-10 minutes) the reading will drop below 0.3 Ω.

The following list of conditions may need to be met to ensure a valid continuity reading on a ground or low reference circuit:

- Ignition OFF
- Key out of the ignition switch (when not equipped with keyless entry and remote start)
- Retained Accessory Power (RAP) OFF (open and close the driver door after ignition OFF)
- Battery charger set at a 2 A or less charge rate
- Scan tool not communicating with any vehicle control module (in some cases it may need to be disconnected from the DLC)
- All entry doors closed

- Headlamps OFF (auto headlamps disabled)
- Any delay lighting OFF
- HVAC after blow OFF
- Any accessory that can work when the ignition is OFF
- Wait up to 60 seconds (after all other listed conditions are met)

Activating the DOOR LOCK function with a key fob can greatly reduce the time to achieve a valid ground or low reference continuity test result.

TESTING FOR CONTINUITY

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to Special Tools .

WARNING: **This procedure should not be performed on high voltage circuits. Performing this procedure on high voltage circuits may result in serious injury or death.**

CAUTION: **Refer to Test Probe Caution .**

The following procedures verify good continuity in a circuit.

With a Digital Multimeter (DMM)

1. Set the DMM to the Ω position.
2. Disconnect the power feed (i.e. fuse, control module) from the suspect circuit.
3. Disconnect the load.
4. Select the MIN MAX function on the DMM.
5. Connect one lead of the DMM to one end of the circuit to be tested.
6. Connect the other lead of the DMM to the other end of the circuit.
7. If the DMM displays low or no resistance, the circuit has good continuity.

With a Test Lamp

NOTE: **Only use the test lamp procedure on low impedance power and ground circuits.**

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to one end of the circuit to be tested.
4. Connect the other lead of the test lamp to battery positive voltage.
5. Connect the other end of the circuit to ground.
6. If the test lamp illuminates (full intensity), then the circuit has good continuity.

TESTING FOR SHORT TO GROUND

WARNING: **This procedure should not be performed on high voltage circuits. Performing this procedure on high voltage circuits may result in serious injury or death.**

CAUTION: **Refer to Test Probe Caution .**

The following procedures test for a short to ground in a circuit.

With a Digital Multimeter (DMM)

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Set the rotary dial of the DMM to the Ω position.
4. Connect one lead of the DMM to one end of the circuit to be tested.
5. Connect the other lead of the DMM to a good ground.
6. If the DMM does NOT display infinite resistance (OL), there is a short to ground in the circuit.

With a Test Lamp

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Connect one lead of the test lamp to battery positive voltage.
4. Connect the other lead of the test lamp to one end of the circuit to be tested.
5. If the test lamp illuminates, there is a short to ground in the circuit.

Fuse Powering Several Loads

1. Review the system schematic and locate the fuse that is open.
2. Open the first connector or switch leading from the fuse to each load.
3. Connect a DMM across the fuse terminals (be sure that the fuse is powered).
    - When the DMM displays voltage the short is in the wiring leading to the first connector or switch.
    - If the DMM does not display voltage refer to the next step.
4. Close each connector or switch until the DMM displays voltage in order to find which circuit is shorted.

TESTING FOR A SHORT TO VOLTAGE

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to Special Tools .

WARNING: **This procedure should not be performed on high voltage circuits. Performing this procedure on high voltage circuits may result in serious injury or death.**

CAUTION: **Refer to Test Probe Caution .**

The following procedure tests for a short to voltage in a circuit.

1. Remove the power feed (i.e. fuse, control module) from the suspect circuit.
2. Disconnect the load.
3. Set the digital multimeter (DMM) to the V (DC) position.
4. Connect the positive lead of the DMM to one end of the circuit to be tested.
5. Connect the negative lead of the DMM to a good ground.
6. Turn ON the ignition and operate all accessories.
7. If the voltage measured is greater than 1 V, there is a short to voltage in the circuit.

TESTING FOR INTERMITTENT CONDITIONS AND POOR CONNECTIONS

Special Tools

EL-35616 Terminal Test Probe Kit

For equivalent regional tools, refer to Special Tools .

WARNING: This procedure should not be performed on high voltage circuits. Performing this procedure on high voltage circuits may result in serious injury or death.

When the condition is not currently present, but is indicated in DTC history, the cause may be intermittent. An intermittent may also be the cause when there is a customer complaint, but the symptom cannot be duplicated. Refer to the Symptom Table of the system that is suspect of causing the condition before trying to locate an intermittent condition.

Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the following items:

- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connector
- Poor terminal to wire connection-Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself, and corrosion in the wire to terminal contact area, etc.
- Pierced or damaged insulation can allow moisture to enter the wiring causing corrosion. The conductor can corrode inside the insulation, with little visible evidence. Look for swollen and stiff sections of wire in the suspect circuits.
- Wiring which has been pinched, cut, or its insulation rubbed through may cause an intermittent open or short as the bare area touches other wiring or parts of the vehicle.
- Wiring that comes in contact with hot or exhaust components
- Refer to **Inducing Intermittent Fault Conditions** in order to duplicate the conditions required, in order to verify the customer concern.
- Refer to **Testing for Electrical Intermittents** for test procedures to detect intermittent open, high resistance, short to ground, and short to voltage conditions.
- Refer to **Scan Tool Snapshot Procedure** for advanced intermittent diagnosis and Vehicle Data Recorder operation.

Testing for Terminal Fretting

Some intermittent conditions can be caused by wire terminal fretting corrosion. Fretting corrosion is a build-up of insulating, oxidized wear debris that can form when there is a small motion between electrical contacts. The oxidized wear debris can pile up enough at the electrical contact spots that the electrical resistance across the connection increases. Movement between the contacting surfaces as small as 10 to 100 microns can cause fretting. To put this in perspective, a sheet of paper is about 100 microns thick, so fretting motion is small and hard to see. Vibration and thermal expansion/contraction are the main sources that create fretting motion. Since vehicles vibrate and can experience large temperature swings, they are a good source for fretting motion. Tin, copper, nickel, and iron surfaces are all susceptible to fretting corrosion. Fretting corrosion can be difficult to see but it looks like small, dark smudges on the terminals contact surface.

To correct a fretting condition disconnect the suspect connector and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to both sides of the connector terminals. Then reconnect the connector and wipe away any excess lubricant. This will correct the additional terminal contact resistance due to the terminal fretting corrosion.

Testing for Proper Terminal Contact

It is important to test terminal contact at the component and any inline connectors before replacing a suspect component. Mating terminals must be inspected to ensure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination may be caused by the connector halves being improperly connected. A missing or damaged connector seal, damage to the connector itself, or exposing the terminals to moisture and dirt can also cause contamination. Contamination, usually in the underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

Deformation is caused by probing the mating side of a connector terminal without the proper adapter. Always use the **EL-35616** kit when probing connectors. Other causes of terminal deformation are improperly joining the connector halves, or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact causing an open or intermittently open circuit.

Testing for Proper Terminal Contact in Bussed Electrical Centers (BEC)

It is very important to use the correct test adapter when testing for proper terminal contact of fuses and relays in a bussed electrical center (BEC). Use **EL-35616** kit to test for proper terminal contact. Failure to use **EL-35616** kit can result in improper diagnosis of the bussed electrical center.

Follow the procedure below in order to test terminal contact:

1. Separate the connector halves.
2. Visually inspect the connector halves for contamination. Contamination may result in a white or green build-up within the connector body or between terminals. This causes high terminal resistance, intermittent contact, or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety: terminals, seals, and connector body.
3. Using an equivalent male terminal/terminated lead, verify that the retention force is significantly different between a known good terminal and the suspect terminal. Replace the female terminal in question.

Flat Wire Connectors

There are no serviceable parts for flat wire connectors on the harness side or the component side.

Follow the procedure below in order to test terminal contact:

1. Remove the component in question.
2. Visually inspect each side of the connector for signs of contamination. Avoid touching either side of the connector as oil from your skin may be a source of contamination as well.
3. Visually inspect the terminal bearing surfaces of the flat wire circuits for splits, cracks, or other imperfections that could cause poor terminal contact. Visually inspect the component side connector to ensure that all of the terminals are uniform and free of damage or deformation.
4. Insert the appropriate adapter from the on the flat wire harness connector in order to test the circuit in question.

Control Module/Component Voltage and Grounds

Poor voltage or ground connections can cause widely varying symptoms.

- Test all control module voltage supply circuits. Many vehicles have multiple circuits supplying voltage to a control module. Other components in the system may have separate voltage supply circuits that may also need to be tested. Inspect connections at the module/component connectors, fuses, and any intermediate connections between the voltage source and the module/component. A test lamp or a DMM may indicate that voltage is present, but neither tests the ability of the circuit to carry sufficient current. Operate the component to test the ability of the circuit to carry sufficient current. Refer to **Circuit Testing**, and **Power Distribution Schematics** .
- Test all control module ground and system ground circuits. The control module may have multiple ground circuits. Other components in the system may have separate grounds that may also need to be tested. Inspect grounds for clean and tight connections at the grounding point. Inspect the connections at the component and in splice packs, where applicable. Operate the component to test the ability of the circuit to carry sufficient current. Refer to **Circuit Testing**, and **Ground Distribution Schematics** .

Temperature Sensitivity

- An intermittent condition may occur when a component/connection reaches normal operating temperature. The condition may occur only when the component/connection is cold, or only when the component/connection is hot.
- Freeze Frame, Failure Records, Snapshot, or Vehicle Data Recorder data may help with this type of intermittent condition, where applicable.
- If the intermittent is related to heat, review the data for a relationship with the following:
  - High ambient temperatures
  - Underhood/engine generated heat
  - Circuit generated heat due to a poor connection, or high electrical load
  - Higher than normal load conditions, towing, etc.
- If the intermittent is related to cold, review the data for the following:
  - Low ambient temperatures-In extremely low temperatures, ice may form in a connection or component. Inspect for water intrusion.
  - The condition only occurs on a cold start.

    - The condition goes away when the vehicle warms up.
- Information from the customer may help to determine if the trouble follows a pattern that is temperature related.
- If temperature is suspected of causing an intermittent fault condition, attempt to duplicate the condition. Refer to **Inducing Intermittent Fault Conditions** in order to duplicate the conditions required.

Electromagnetic Interference and Electrical Noise

Some electrical components/circuits are sensitive to electromagnetic interference (EMI) or other types of electrical noise. Inspect for the following conditions:

- A mis-routed harness that is too close to high voltage/high current devices such as secondary ignition components, motors, generator, etc .-These components may induce electrical noise on a circuit that could interfere with normal circuit operation.
- Electrical system interference caused by a malfunctioning relay, or a control module driven solenoid or switch - These conditions can cause a sharp electrical surge. Normally, the condition will occur when the malfunctioning component is operating.
- Improper installation of non-factory or aftermarket add on accessories such as lights, 2-way radios, amplifiers, electric motors, remote starters, alarm systems, cell phones, etc. - These accessories may create interference in other circuits while operating and the interference would disappear when the accessory is not operating. Refer to **Checking Aftermarket Accessories**.
- Test for an open diode across the A/C compressor clutch and for other open diodes. Some relays may contain a clamping diode.
- The generator may be allowing AC noise into the electrical system.

Incorrect Control Module

- There are only a few situations where reprogramming a control module is appropriate:
    - A new service control module is installed.
    - A control module from another vehicle is installed.
    - Revised software/calibration files have been released for this vehicle.

NOTE: **DO NOT re-program the control module with the SAME software/calibration files that are already present in the control module. This is not an effective repair for any type of concern.**

- Verify that the control module contains the correct software/calibration. If incorrect programming is found, reprogram the control module with the most current software/calibration. Refer to **Control Module References** for replacement, setup, and programming.

INDUCING INTERMITTENT FAULT CONDITIONS

Special Tools

J-25070 Heat Gun

For equivalent regional tools, refer to Special Tools .

Many intermittent open or shorted circuits are affected by harness/connector movement that is caused by vibration, engine torque, bumps/rough pavement, etc. In order to duplicate the customer's concern, it may be necessary to manipulate the wiring harness if the malfunction appears to be vibration related. Manipulation of a circuit can consist of a wide variety of actions, including:

- Wiggling the harness
- Disconnecting a connector and reconnecting
- Stressing the mechanical connection of a connector
- Pulling on the harness or wire in order to identify a separation/break inside the insulation
- Relocating a harness or wires

All these actions should be performed with some goal in mind. For instance, with a scan tool connected, wiggling the wires may uncover a faulty input to the control module. The snapshot option would be appropriate here. Refer to **Scan Tool Snapshot Procedure**. Another option is, with the component commanded ON and OFF by the scan tool, to move related connectors and wiring and observe the component operation. With the engine running, move related connectors and wiring while monitoring engine operation. If harness or connector movement affects the data displayed, component/system operation, or engine operation, inspect and repair the harness/connections as necessary.

You may need to load the vehicle in order to duplicate the concern. This may require the use of weights, floor jacks, jackstands, frame machines, etc. In these cases you are attempting to duplicate the concern by manipulating the suspension or frame. This method is useful in finding harnesses that are too short and their connectors pull apart enough to cause a poor connection. A DMM set to the Min/Max mode and connected to the suspect circuit while testing can yield desirable results. Refer to **Testing for Electrical Intermittents**.

Certainly, using the senses of sight, smell, and hearing while manipulating the circuit can provide good results as well.

There may be instances where circuit manipulation alone will not meet the required criteria for the fault condition to appear. In such cases it may be necessary to expose the suspect circuit to other conditions while manipulating the harness. Such conditions would include high moisture conditions, along with exceptionally high or low temperatures. The following discusses how to expose the circuit to these kinds of conditions.

High Temperature Conditions

If the complaint tends to be heat related, you can simulate the condition using the **J-25070** heat gun.

Using the heat gun, you can heat up the suspected area or component. Manipulate the harnesses under high temperature conditions while monitoring the scan tool or DMM to locate the fault condition.

The high temperature condition may be achieved simply by test driving the vehicle at normal operating temperature. If a heat gun is unavailable, consider this option to enhance your diagnosis. This option does not allow for the same control, however.

Low Temperature Conditions

Depending on the nature of the fault condition, placing a fan in front of the vehicle while the vehicle is in the shade can have the desired effect.

If this is unsuccessful, use local cooling treatments such as ice or a venturi type nozzle (one that provides hot or cold air). This type of tool is capable of producing air stream temperatures down to -18Â°C (0Â°F) from one end and +71Â°C (160Â°F) from the other. This is ideally suited for localized cooling needs. In addition, circuit cooling spray can be used to cool down a component or circuit.

Once the vehicle, component, or harness has been sufficiently cooled, manipulate the harness or components in an effort to duplicate the concern.

Duplicating Failure Conditions

- If none of the previous tests are successful, attempt to duplicate and/or capture the failure conditions.
- Freeze Frame/Failure Records data, where applicable, contains the conditions that were present when the DTC set.
    1. Review and record Freeze Frame/Failure Records data.
    2. Clear the DTCs using the scan tool.
    3. Turn the key to OFF and wait 15 seconds.
    4. Operate the vehicle under the same conditions that were noted in Freeze Frame/Failure Records data, as closely as possible. The vehicle must also be operating within the Conditions for Running the DTC. Refer to Conditions for Running the DTC in the supporting text if a DTC is being diagnosed.
    5. Monitor DTC Status for the DTC being tested. The scan tool will indicate Ran, when the enabling conditions have been satisfied long enough for the DTC to run. The scan tool will also indicate whether the DTC passed or failed.
- An alternate method is to drive the vehicle with the DMM connected to a suspected circuit. An abnormal reading on the DMM when the concern occurs, may help you locate the concern.

TESTING FOR ELECTRICAL INTERMITTENTS

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to Special Tools .

WARNING: This procedure should not be performed on high voltage circuits. Performing this procedure on high voltage circuits may result in serious injury or death.

Perform the following procedures while wiggling the harness from side to side. Continue this at convenient points (about 6 inches apart) while watching the test equipment.

- **Testing for Short to Ground**
- **Testing for Continuity**
- **Testing for a Short to Voltage**

If the fault is not identified, perform the procedure below using the MIN MAX feature on the **EL-39200** DMM. This feature allows you to manipulate the circuit without having to watch the DMM . The DMM will generate an audible tone when a change is detected.

NOTE: **The DMM must be used in order to perform the following procedure since the DMM can monitor current, resistance or voltage while recording the minimum (MIN), and maximum (MAX) values measured.**

1. Connect the DMM to both sides of a suspected connector (still connected), or from one end of a suspected circuit to the other. Refer to **Troubleshooting with a Digital Multimeter** for information on connecting the DMM to the circuit.
2. Set the rotary dial of the DMM to the V (AC) or V (DC) position.
3. Press the range button of the DMM in order to select the desired voltage range.

NOTE: **The 100 ms RECORD mode is the length of time an input must stay at a new value in order to record the full change.**

4. Select the MIN MAX function of the DMM. The DMM displays the 100 ms RECORD and emits an audible tone (beep).
5. Simulate the condition that is potentially causing the intermittent connection, either by wiggling the connections or the wiring, test driving, or performing other operations. Refer to **Inducing Intermittent Fault Conditions**.
6. Listen for the audible Min Max Alert which indicates that a new minimum or maximum value has been recorded.
7. Press the MIN MAX button until the MAX value is displayed and note the value.
8. Press the MIN MAX button until the MIN value is displayed and note the value.
9. Determine the difference between the MIN and MAX values.
    - If the variation between the recorded MIN and MAX voltage values is 1 V or greater an intermittent open or high resistance condition exists. Repair the condition as necessary.
    - If the variation between the recorded MIN and MAX voltage values is less than 1 V an intermittent open or high resistance condition does not exist.

SCAN TOOL SNAPSHOT PROCEDURE

Reviewing Stored Data in Global Diagnostic System (GDS)

Overview

A snapshot is a recording of what a control module on the vehicle was receiving for information while the snapshot is being made. A snapshot is used to analyze the data during the time a vehicle condition is current. In GDS 2 there is not a traditional snapshot as there has been in the past. GDS 2 saves all past VIN and diagnostic data for future viewing. GDS 2 automatically records data whenever the user views Module Diagnostics, Vehicle Diagnostics and/or Systems Diagnostics. Module Diagnostics includes DTC Data, Identification Information, Data Display, Control Functions and Configuration/Reset Functions. Vehicle Diagnostics includes Vehicle Wide DTCs. Systems Diagnostics includes Inspection/Maintenance Status and Inspection/Maintenance Information.

Reviewing Stored Data

The Review Stored Data function allows viewing and playing of previously recorded vehicle data. This information can be used in analysis of vehicle problems and detection of trigger error conditions. The graph

function can be used to compare multiple parameters to see if a component is functioning properly. Recorded sessions can be selected for viewing by the following two methods:

- From the Home Page, click on Review Stored Data. In the Review Stored Data page, highlight a vehicle in the Sessions screen located in the upper pane and highlight the desired Stored Data in the lower pane, then click the Review button.
- The user can view stored data without ending a current on-vehicle diagnostic session by clicking the Vehicle Menu button (when active) or Back button until the Session Manager is displayed in the menu. This is used when a user is viewing live data and wants the quickest way to review the data. Click on the Session Manager button. Highlight the desired Stored Data in the lower pane and click the Review button.

Stored Data Review Selections

The following information can be selected in the tabs at the top of the screen:

- Graphical Data Display - Allows a detailed review of parameter data. The buttons on the right side modify the graph data
- Diagnostic Data Display - Displays incoming information from the file. The current value of the parameters is displayed on the screen.
- Line Graph - Allows selected locked parameters to be graphed with parameters overlaid for data comparison. The current value of the parameters is displayed on the screen. Use the buttons on the right side to modify the graph data.
- Bookmarks - If bookmarks are present, this displays the Type, Description and Time of automatic and manually generated bookmarks.
- System Information - Displays the GDS 2 Software Version and MDI Serial Number used when the session was recorded.
- Selected Vehicle Configuration - Displays vehicle identifiers, such as transmission type, for the vehicle selected on the Stored Data Review screen in the Sessions field.
- RPO - Displays vehicle build information.

Graphical Data Display

On the Graphical Data Display tab there are multiple selections at the top of the page. The selections available are:

- Create Report - Opens and internet browser page where a data display report can be printed or saved for future reference.
- Unit Switch - Toggles graph units between English and metric.
- Lock - When a parameter is selected, clicking the lock button locks a selected parameter for viewing in the Line Graph tab. In the Line Graph tab, locked parameters are isolated and overlaid for data comparison.
- Up Arrow - Click the up arrow to move a highlighted parameter up a position on the list.
- Down Arrow - Click the down arrow to move a highlighted parameter down a position on the list.
- Save As - This selection is available in the Graphical Data Display and Diagnostic Data Display tabs. This allows the user to export the graph data to a worksheet for in depth analysis and to timestamp data.

Review Stored Data Functions

To review the session there are buttons at the bottom of the window to control the cursor. From left to right the buttons are:

- Insert Bookmark - This button allows the user to insert bookmarks anywhere along the timeline. This provision allows the user to record notes regarding the inserted bookmark.
- Return Bookmark - This button moves the cursor to the previous bookmark.
- Back - This button moves the cursor back 1 frame.
- Timeline Slider Control - This allows the user to slide and select any position on the Timeline required.
- Forward - This button moves the cursor forward 1 frame.
- Forward Bookmark - This button moves the cursor forward 1 bookmark.
- Bookmarks - Allows the user to toggle bookmark visibility ON and OFF.

Graphical Preference Selections

The vertical side bar on the right side of the screen in the Graphical Data Display and Line Graph tabs toggles the Graphical Selection Panel from hidden to visible. The graphical preference selections available are:

- Reset - Resets the graph display back to the initial standard GDS 2 setting.
- Grid Line Toggle - This toggle reverses the current state of showing or removing grid lines.
- Hash Mark Toggle - This toggle reverses the current state of showing or removing data acquisition points or hash marks.
- Horizontal Graph Compression - Compresses the scale of the graph horizontally.
- Horizontal Graph Expansion - Expands the scale of the graph horizontally.
- Vertical Graph Compression - Compresses the scale of the graph vertically.
- Vertical Graph Expansion - Expands the scale of the graph vertically.
- Move Centerline of Graph Up - Moves the centerline of the graph up incrementally.
- Move Centerline of Graph Down - Moves the centerline of the graph down incrementally.

CIRCUIT PROTECTION - FUSES

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to Special Tools .

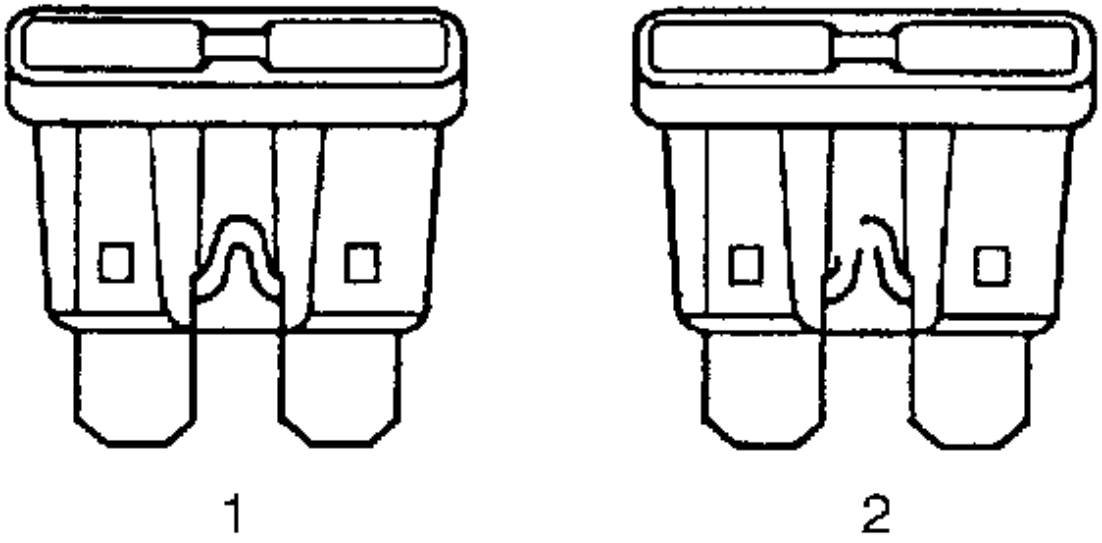


Fig. 3: Identifying Open Fuse Element
Courtesy of GENERAL MOTORS COMPANY

The fuse is the most common method of an automotive wiring circuit protection. Whenever there is an excessive amount of current flowing through a circuit the fusible element will melt and create an open or incomplete circuit. Fuses are a one time protection device and must be replaced each time the circuit is overloaded. To determine if a fuse is open, remove the suspected fuse and examine if the element in the fuse is broken (2). If not broken (1), also check for continuity using a Digital Multimeter (DMM) or a continuity tester. If the element is broken or continuity is suspect, replace the fuse with one of equal current rating.

Fuse Types

Current Rating Amperes	Color
Auto Fuses, Mini Fuses	
2	Gray
3	Violet
5	Tan

Current Rating Amperes	Color
7.5	Brown
10	Red
15	Blue
20	Yellow
25	White or Natural
30	Green
Maxi Fuses	
20	Yellow
30	Light Green
40	Orange or Amber
60	Blue
50	Red
J-Case Fuses	
20	Blue
30	Pink
40	Green
50	Red
60	Yellow
Midi Fuses	
80	Black
Mega Fuses	
100	Black
150	Black
200	Black

CIRCUIT PROTECTION - CIRCUIT BREAKERS

A circuit breaker is a protective device that is designed to open the circuit when a current load is in excess of the rated breaker capacity. If there is a short or other type of overload condition in the circuit, the excessive current will open the circuit between the circuit breaker terminals. Two types of circuit breakers are used.

Circuit Breaker

This type opens when excessive current passes through it for a period of time. It closes again after a few seconds, and if the cause of the high current is still present, it will open again. The circuit breaker will continue to cycle open and closed until the condition causing the high current is removed.

Positive Temperature Coefficient (PTC) Circuit Breaker

This type greatly increases its resistance when excessive current passes through it. The excessive current heats the PTC device, as the device heats its resistance increases. Eventually the resistance gets so high that the circuit is effectively open. Unlike the ordinary circuit breaker the PTC unit will not reset until the circuit is opened, by removing the voltage from its terminals. Once the voltage is removed the circuit breaker will re-close within a second or 2.

CIRCUIT PROTECTION - FUSIBLE LINKS

Special Tools

EL-39200 Digital Multimeter (DMM)

For equivalent regional tools, refer to Special Tools .

NOTE: **When repairing a fusible link, fusible links cut longer than 225 mm (approximately 9 in) will not provide sufficient overload protection.**

Fusible link is wire designed to melt and break continuity when excessive current is applied. It is often located between or near the battery and starter or electrical center. Use a continuity tester or a Digital Multimeter (DMM) at each end of the wire containing the fusible link in order to determine if it is broken. If broken, it must be replaced with fusible link of the same gauge size.

WIRING REPAIRS

The Wiring Repairs section contains the following types of wiring repair information. Using these elements together will make wiring repair faster and easier:

- **Testing for Intermittent Conditions and Poor Connections**
- **Flat Wire Repairs**
- **GMLAN and Media Oriented Systems Transport (MOST) Wiring Repairs**
- **High Temperature Wiring Repairs**
- **Heated Oxygen Sensor Wiring Repairs**
- **Splicing Copper Wire Using Splice Sleeves**
- **Splicing Twisted or Shielded Cable**
- **Splicing Inline Harness Diodes**
- **SIR/SRS Wiring Repairs**

REPAIRING DAMAGED WIRE INSULATION

WARNING: **In order to reduce the risk of personal injury, loss of high voltage isolation to ground and higher system impedance, do not attempt to repair any HV wiring, connector, or terminal that is damaged. High voltage coaxial type cables are not repairable. Never attempt to repair a coaxial type cable. The entire cable/harness or component must be replaced. In order to maintain system integrity and personal safety, never attempt to repair any high voltage wiring, cables, or terminals. Performing this procedure on high voltage circuits may result in serious injury or death.**

If the wire insulation has been chafed, or broken, enough to show the conductive portion of the wire, and the wire is not damaged, determine the length of insulation that needs to be repaired. If the repair is less than 280 mm (11 in), cut the wire within the damaged area. Then slide the appropriate heat shrink tubing (listed below) over the wire, and repair the wire by splicing the wires together. Refer to **Splicing Copper Wire Using Splice Sleeves**. Once the wire is spliced together slide heat shrink tubing over the damaged area and apply heat to seal

the repaired wire.

If the wire is damaged, or the damaged area is larger than 280 mm (11 in), then replace the damaged wire by splicing in a new section of wire. Refer to **Splicing Copper Wire Using Splice Sleeves**.

GM Part Number	Diameter		Description	Color	Length	
	Metric	English			Metric	English
12355003	9.5 mm^2	0.375 in	Tubing, Shrink 3/8	Black	305 mm^2	12 in
12355005	12.7 mm^2	0.5 in	Tubing, Shrink 1/2	Black	305 mm^2	12 in
12355011	19.1 mm^2	0.75 in	Tubing, Shrink 3/4	Black	305 mm^2	12 in
12355008	25.4 mm^2	1.0 in	Tubing, Shrink 1.00	Black	305 mm^2	12 in

Wire Size Conversion

Metric Wire Sizes (mm^2)	AWG Sizes
0.13	26
0.20	24
0.32	22
0.52	20
0.82	18
1.31	16
2.09	14
3.30	12
5.27	10
8.35	8
13.3	6

COAXIAL CABLE REPAIRS

The GM global coaxial (coax) cable repair strategy uses coaxial cables, connectors and jumpers to repair coaxial cables. The intent is to install the new service cable in vehicle, but removal of the old cable is not necessary. There are several repair scenarios:

- New cables, jumpers, and connector housing are required.
- Only new cables are required while it is possible to reuse the existing connector housing in vehicle. A jumper may or may not be needed.
- Only new connector housing are required, while it is possible to reuse the existing cable in the vehicle.
- A new cable would need to be installed from source to destination and by-pass the inline connector in some cases when an inline connector is unrepairable (Example: a cracked male end of a 1-way connector).

Coaxial Cable Kits

Four different kits will be available to repair coaxial cables. Components of each kit cannot be ordered separately from the kit.

- **Communication Interface Module Antenna Cable Kit** (Kit # 13581174) is used to repair Cellular coaxial cables. This kit uses RG58 low loss coaxial cables that are available in four lengths. The coaxial cables can be attached together in various lengths to closely match the length of the faulty/damaged coaxial cable.
- **Digital Radio and Vehicle Locator Antenna Coaxial Cable Kit** (Kit # 13581173) is used to repair XM and GPS coaxial cables. For vehicles that have a combined GPS and Cellular/OnStar signal on one cable, use Kit # 13581174. This kit uses RG316 low loss coaxial cables that are available in three lengths. The coaxial cables can be attached together in various lengths to closely match the length of the faulty/damaged coaxial cable.
- **Digital Radio, Mobile Telephone and Vehicle Locator Antenna Coaxial Cable Kit** (Kit # 19119056) is used with OnStar, XM, and GPS cables. This kit consists of jumpers and connectors. The jumpers are used to adapt different types of connectors together (to attach 2-way and 3-way connector onto the long 7, 5, and 3 foot cables). The connectors are used to replace existing connectors. The 1-way and 2-way connectors in the kit are in water-blue color (different than what the vehicle is built with) and are non-keyed (universal fit). The 3-way connectors in the kit are in the same color as in the vehicle.
- **Communication Interface Module Antenna Cable Kit** (Kit # 22803854) is used for the OnStar module on some vehicles built before the 2011 model year.

Coaxial Cable Repair Kits

<table>
<tr><th colspan="2">Repair Kit Name</th><th>Description</th></tr>
<tr><td colspan="2" rowspan="4">Communication Interface Module Antenna Cable Kit (Kit # 13581174)</td><td>RG58 coaxial cable with female/female connectors - 7ft/2.1m</td></tr>
<tr><td>RG58 coaxial cable with female/male connectors - 5ft/1.5m</td></tr>
<tr><td>RG58 coaxial cable with female/male connectors - 3.5ft/1.1m</td></tr>
<tr><td>RG58 coaxial cable with female/male connectors - 3.5ft/1.1m</td></tr>
<tr><td colspan="2" rowspan="3">Digital Radio and Vehicle Locator Antenna Coaxial Cable Kit (Kit # 13581173)</td><td>RG316 coaxial cable with female/female connectors - 7ft/2.1m</td></tr>
<tr><td>RG316 coaxial cable with female/male connectors - 5ft/1.5m</td></tr>
<tr><td>RG316 coaxial cable with female/male connectors - 3.5ft/1.1m</td></tr>
<tr><td rowspan="4">Digital Radio, Mobile Telephone and Vehicle Locator Antenna Coaxial Cable Kit (Kit # 19119056)</td><td rowspan="4">3-way Gen 1 sub-kit</td><td>1-way to 3-way Gen 1 jumper for female connector - Part # 13581154 - 4in/10cm
1-way to 3-way Gen 1 jumper for male connector - Part # 19119052 - 4in/10cm</td></tr>
<tr><td>White female connector</td></tr>
<tr><td>White male connector</td></tr>
</table>

Repair Kit Name		Description
		Blue female connector
		Blue male connector
	3-way Gen 2 sub-kit	1-way to 3-way Gen 2 jumper for female connector - Part # 13581155 - 4in/10cm 1-way to 3-way Gen 2 jumper for male connector - Part # 19119058 - 4in/10cm
		Tan female connector
		Tan male connector
		Gray female connector
		Gray male connector
	2-way Gen 1 sub-kit	1-way to 2-way Gen 1 jumper for female connector - Part # 13581156 - 4in/10cm
		Water-blue female connector
	2-way Gen 2 sub-kit (wide)	1-way to 2-way Gen 2 jumper for female connector - Part # 13581157 - 4in/10cm
		1-way to 2-way Gen 2 jumper for male connector - Part # 13581158 - 4in/10cm
		Water-blue female connector
		Water-blue male connector
	2-way Gen 2 and 3 sub-kit (narrow)	1-way to 2-way Gen 2 and 3 jumper for female connector - Part # 13582468 - 4in/10cm
		Use the 1-way to 2-way Gen 2 jumper for female connector 19119058 - 4in/10cm from the 2-way Gen 2 sub-kit.
		Water-blue female connector
		Water-blue male connector
	Right-angle jumper with water-blue universal 1-way connector - 4in/10cm	
Communication Interface Module Antenna Cable Kit (Kit # 22803854)		1-way to mini UHF jumper - 4in/10cm

Connector Housing Repair Procedure

The connector housings (available in Digital Radio, Mobile Telephone and Vehicle Locator Antenna Coaxial Cable Kit) are available for 1-way housings, 2-way housings and 3-way housings. Determine the connector housing required:

1-way housing

No change to the service coaxial cable is necessary in order to install the new coaxial cable into the vehicle.

2-way housing

A 4-inch jumper is required.

1. Determine the appropriate generation (1, 2, or 3) and/or size (12.7mm or 8mm) of the 2-way housing that is in the vehicle.
2. Remove the faulty/damaged coaxial cable from the 2-way connector housing by removing the terminal position assurance (TPA) from the connector housing and then slide the cable out of the connector.

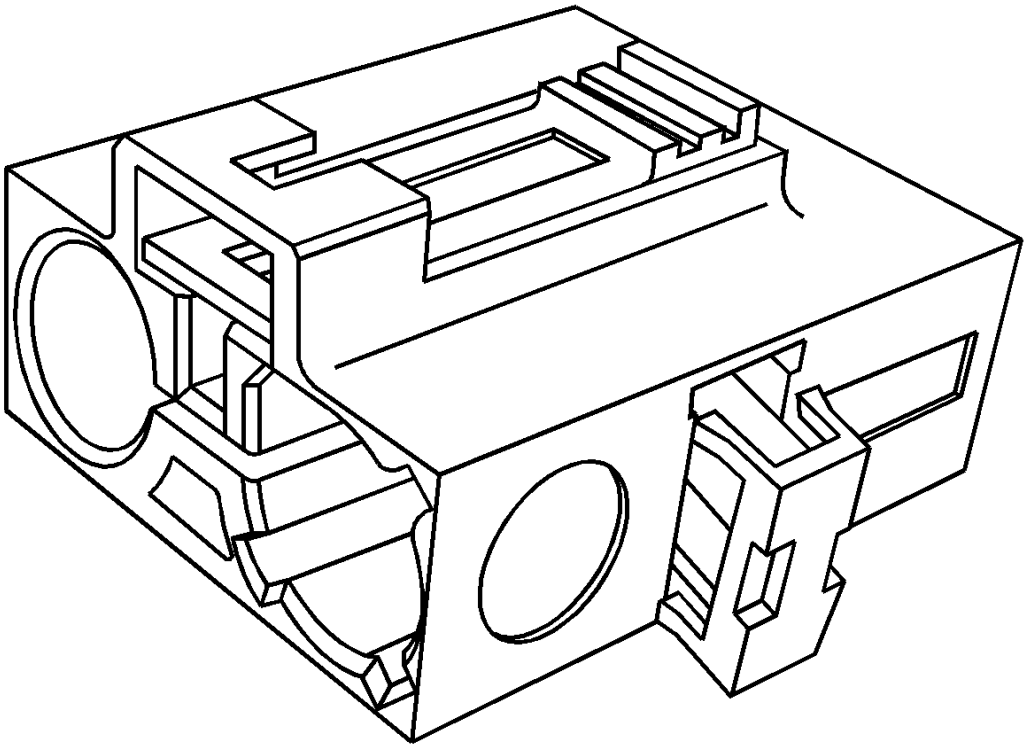


Fig. 4: Connector Housing
Courtesy of GENERAL MOTORS COMPANY

3. Install the new service coaxial cable into the vehicle. Use the 4-inch jumper for the appropriate 2-way connector housing to connect the new service coaxial cable to the connector housing.
4. If the issue is found to be the connector housing and not cable, a new connector housing may be installed while reusing all other components.

3-way housing

A 4-inch jumper is required.

1. Determine the appropriate generation (1 or 2) and keyed 3-way connector housing based on the connector housing color.
2. Note the locations of each of the cables in 3-way housing, as it is important for new cables be placed in the appropriate terminal location in the new connector. The connector housing colors are not interchangeable.
3. Remove the faulty/damaged coaxial cable from the 3-way connector housing by using a pair of side/diagonal cutters to nip and break away the housing.

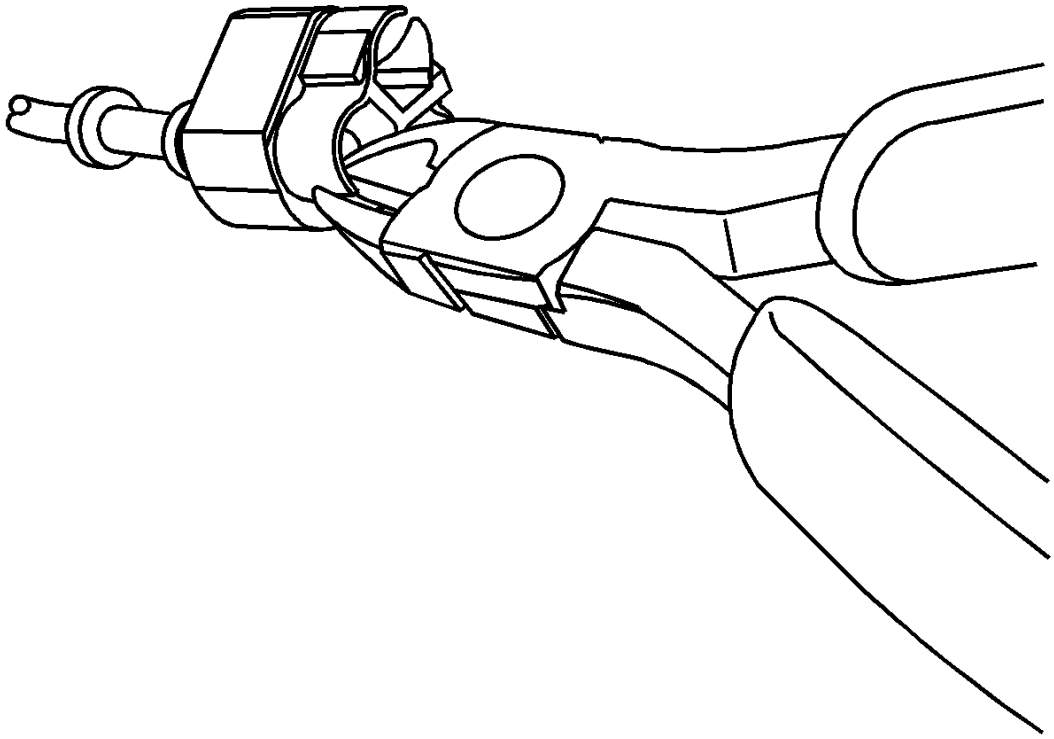


Fig. 5: Using Side/Diagonal Cutters To Nip And Break Away Connector Housing
Courtesy of GENERAL MOTORS COMPANY

4. Use caution not to damage the conductive ends of the coaxial cables inside the connector housing. Do not bend or force the terminal out or it could be damaged.

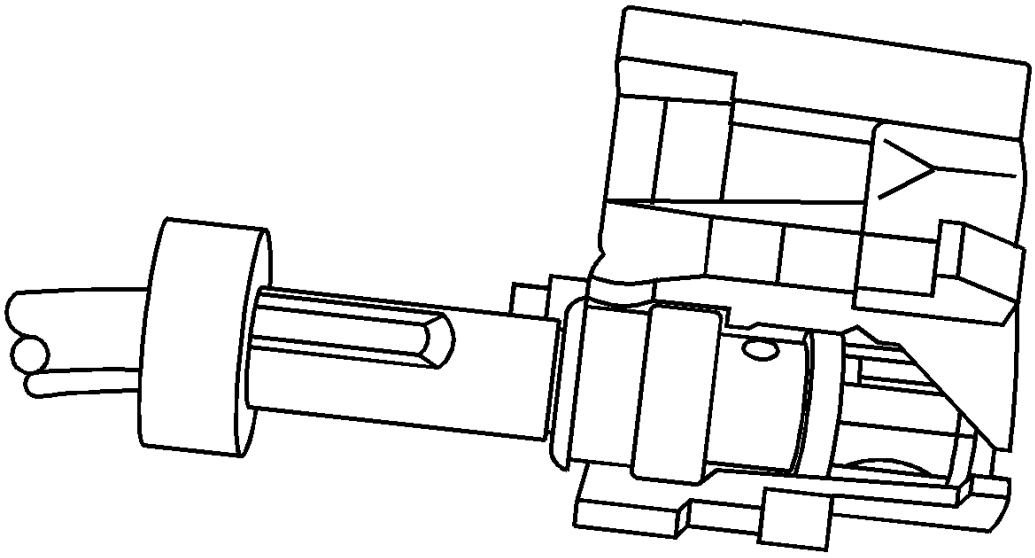


Fig. 6: Connecting New Service Coaxial Cable To New 3-Way Connector Housing
Courtesy of GENERAL MOTORS COMPANY

5. Install the new service coaxial cable into the vehicle. Use the 4-inch jumper for the appropriate color 3-way connector housing to connect the new service coaxial cable to the new 3-way connector housing.
6. If the issue is found to be the connector housing and not cable, a new connector housing may be installed while reusing all other components.

Coaxial Cable Repair Procedure

1. Identify the faulty/damaged coaxial cable.
2. Disconnect the faulty/damaged coaxial cable and leave it in the vehicle.
3. Identify the type of coaxial cable to be replaced and match up with the appropriate pieces to repair the damaged coaxial cable. Match up the type of coaxial cable, cable length and connector types. In some cases there may be extra length of cable left over.

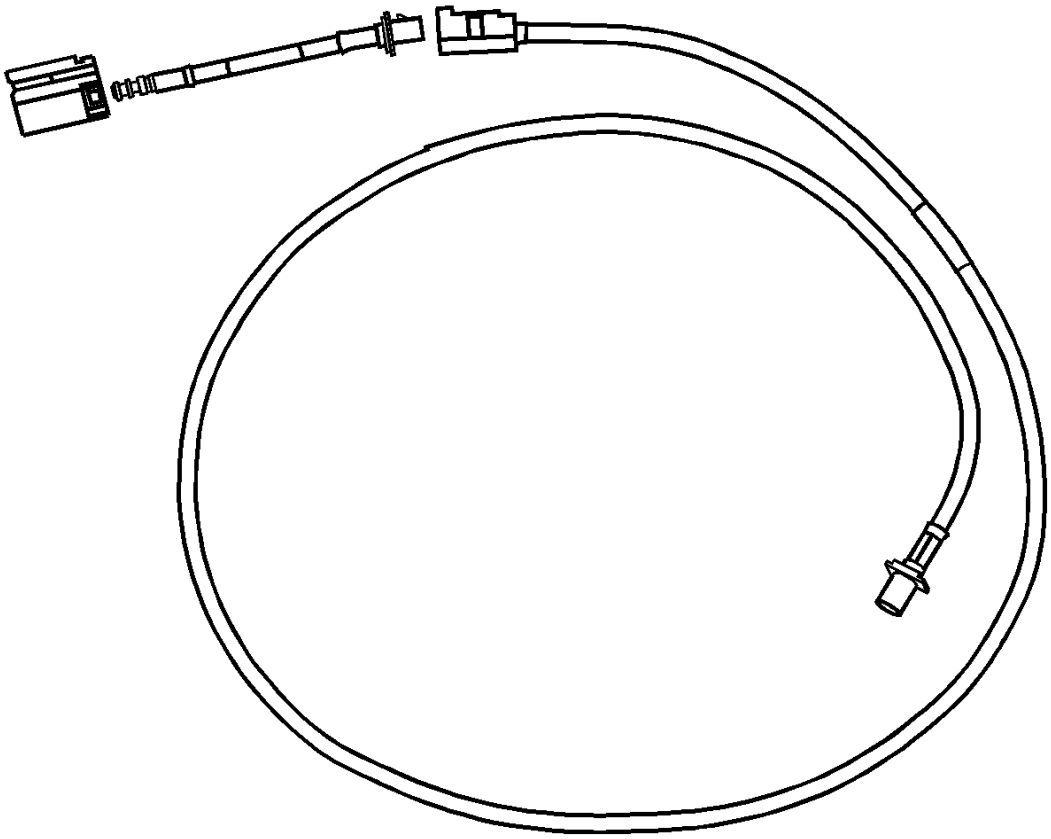


Fig. 7: Coaxial Cable
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Avoid routing the new coaxial cable near sharp edges that can damage the new coaxial cable.**

4. Install the new coaxial cable in the vehicle.

   Use tie-straps to attach the new service coaxial cable to existing harnesses or brackets. Use felt tape/foam to reduce rattles, as necessary.

   NOTE: **To avoid permanent damage, do not pinch the cable or bend it tighter than a 2 inch (5 centimeter) radius.**

5. Remove the faulty/damaged connectors, if applicable.
6. Install new connectors or jumpers, as needed. Refer to Connector Housing Repair Procedure.
7. Verify the repair by operating the system with the engine running.

FLAT WIRE REPAIRS

The flat wire within the flex wiring harness is not serviceable. If an open or short exists within the flex wiring harness the complete harness must be replaced.

FOLDED-OVER WIRE REPAIR

Special Tools

- **EL-38125-10** Splice Sleeve Crimping Tool (non GMNA)
- **J-38125-5A** Ultra Torch Special Tool
- **J-38125-8** Splice Sleeve Crimping Tool (GMNA)

For equivalent regional tools, refer to Special Tools .

The GM global wire repair strategy uses connector assemblies (pigtails) and terminated leads to repair wiring harnesses.

To reduce and manage GM Service Parts proliferation, the service pigtails and terminated leads are designed with the largest wire gauge size that can be held by either the terminal or the connector housing.

The folded over wire repair technique, in which the copper wire strands are folded over before being installed into a splice sleeve, allows the service part to be used when repairing a smaller gauge size wire in a vehicle. This technique has passed all GM testing standards.

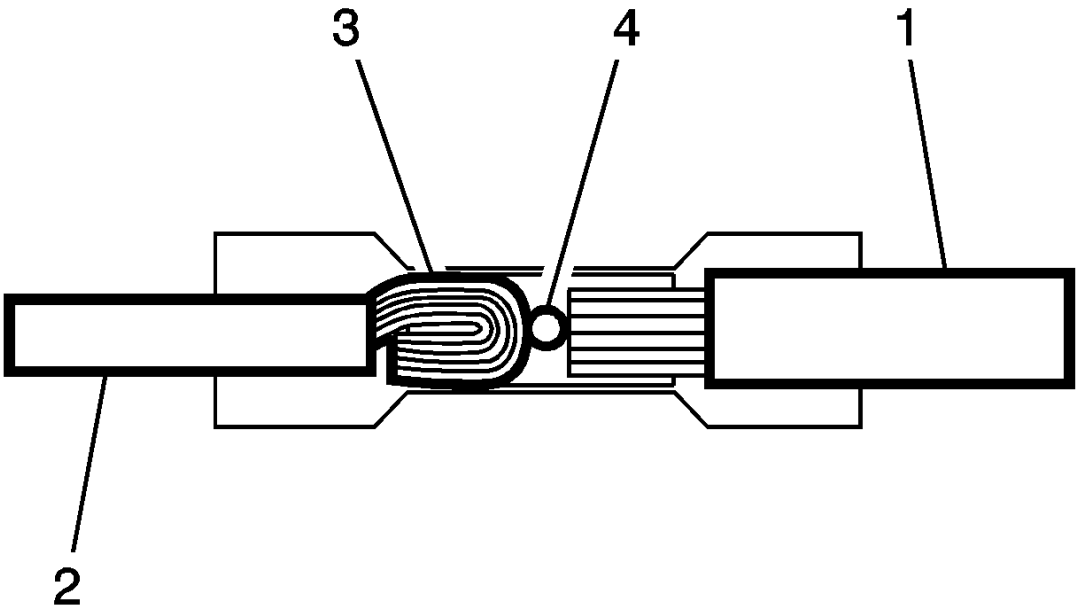


Fig. 8: View Of Stripped Wires In Splice Sleeve Connector
Courtesy of GENERAL MOTORS COMPANY

The larger harness size wires (1) will be placed in one side of the splice sleeve and match the splice sleeve closely in size. The wires are moved into the splice sleeve until they hit the stop (4) in the splice sleeve. The smaller harness size wires (2) will be placed in the other side of the splice sleeve. The smaller harness size wires will be folded over (3) to match up with the splice sleeve size.

Use the folded over wire repair for:

NOTE: **Increasing the amount of copper strands in the smaller gauge size will allow for a better crimp**

- Splicing wires of 0.35 mm or less (22, 24, 26 gauge sizes)

NOTE: **Vehicle side needs to be of same or less gauge size (not greater than the service part's gauge size)**

- Splicing wires of different gauges

Use the Service Information (SI) connector end-views to determine:

- Gauge size of wiring harness
- Recommended Repair: Terminated Lead or Pigtail

The following table lists the acceptable variance within the gauge size

Folded-Over Wire Selection Table

Harness Wire Gauge		**Connector Assembly (Pigtail) or Terminated Lead Wire Gauge Size**			
-		Salmon Color Splice Sleeve		Blue Color Splice Sleeve	Yellow Color Splice Sleeve
Metric	-	0.35 mm	0.5-0.8 mm	1.0-2.0 mm	3.0-5.0 mm
-	Wire Gauge (AWG)	22	20-18	16-14	12-10
0.13 mm	26	Fold Over Wire	Fold Over Wire	Fold Over Wire	Not Acceptable
0.22 mm	24	Fold Over Wire	Fold Over Wire	Fold Over Wire	Not Acceptable
0.35 mm	22	Fold Over Wire	Fold Over Wire	Fold Over Wire	Not Acceptable
0.5 mm	20	Not Acceptable	Wire to Wire	Fold Over Wire	Not Acceptable
0.75 mm	-	Not Acceptable	Wire to Wire	Fold Over Wire	Not Acceptable
0.8 mm	18	Not Acceptable	Wire to Wire	Fold Over Wire	Not Acceptable
1.0 mm	16	Not Acceptable	Wire to Wire	Fold Over Wire	Not Acceptable
1.5 mm	-	Not Acceptable	Not Acceptable	Wire to Wire	Fold Over Wire
2.0 mm	14	Not Acceptable	Not Acceptable	Wire to Wire	Fold Over Wire
2.5 mm	-	Not Acceptable	Not Acceptable	Wire to Wire	Fold Over Wire
3.0-5.0 mm	12-10	Not Acceptable	Not Acceptable	Not Acceptable	Wire to Wire

Example

For an IP Harness of 0.22 mm (24 gauge on left side of table) wire size, the SI connector end-view recommends a pigtail with leads of 0.8 mm (18 gauge on the top of the table) with a salmon colored DuraSeal splice sleeve of 0.5-1.0 mm (20-16 gauge).

Follow these steps to use the folded over wire (1) technique on an IP Harness.

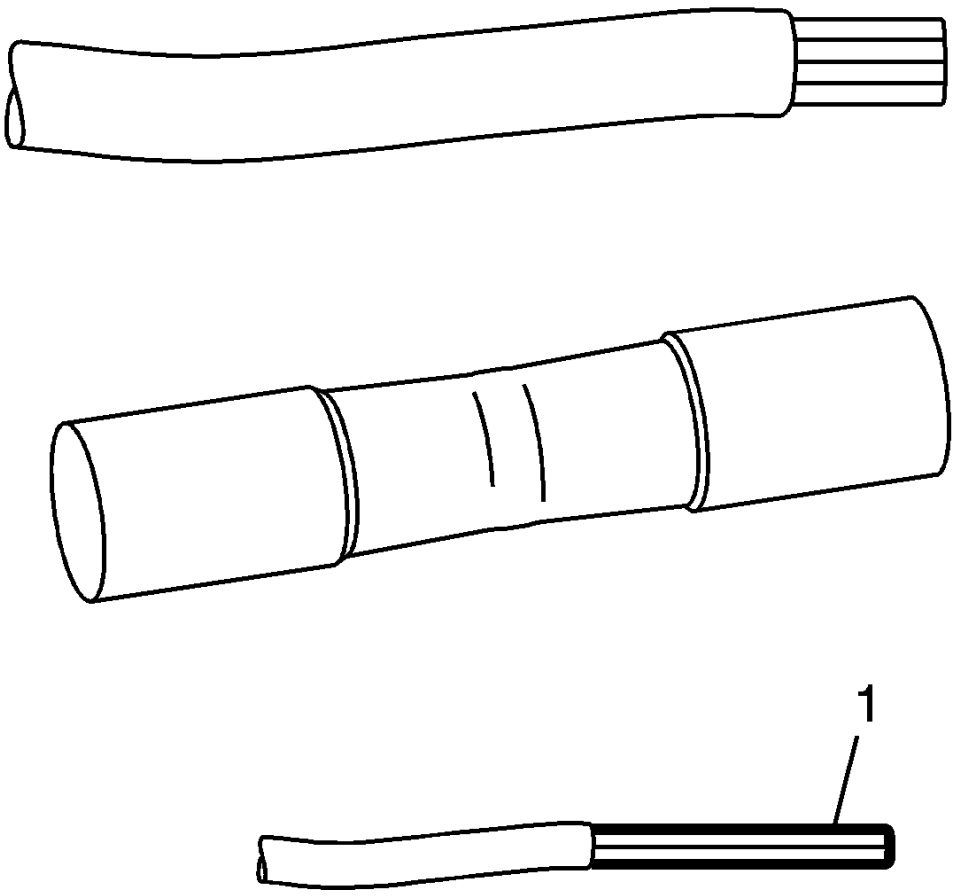


Fig. 9: View Of Stripped Wires
Courtesy of GENERAL MOTORS COMPANY

Strip twice the amount of insulation on the smaller (1) wire (IP Harness is the lower wire) than normally required. Normally, the terminated leads have 5 mm of insulation stripped off the wire.

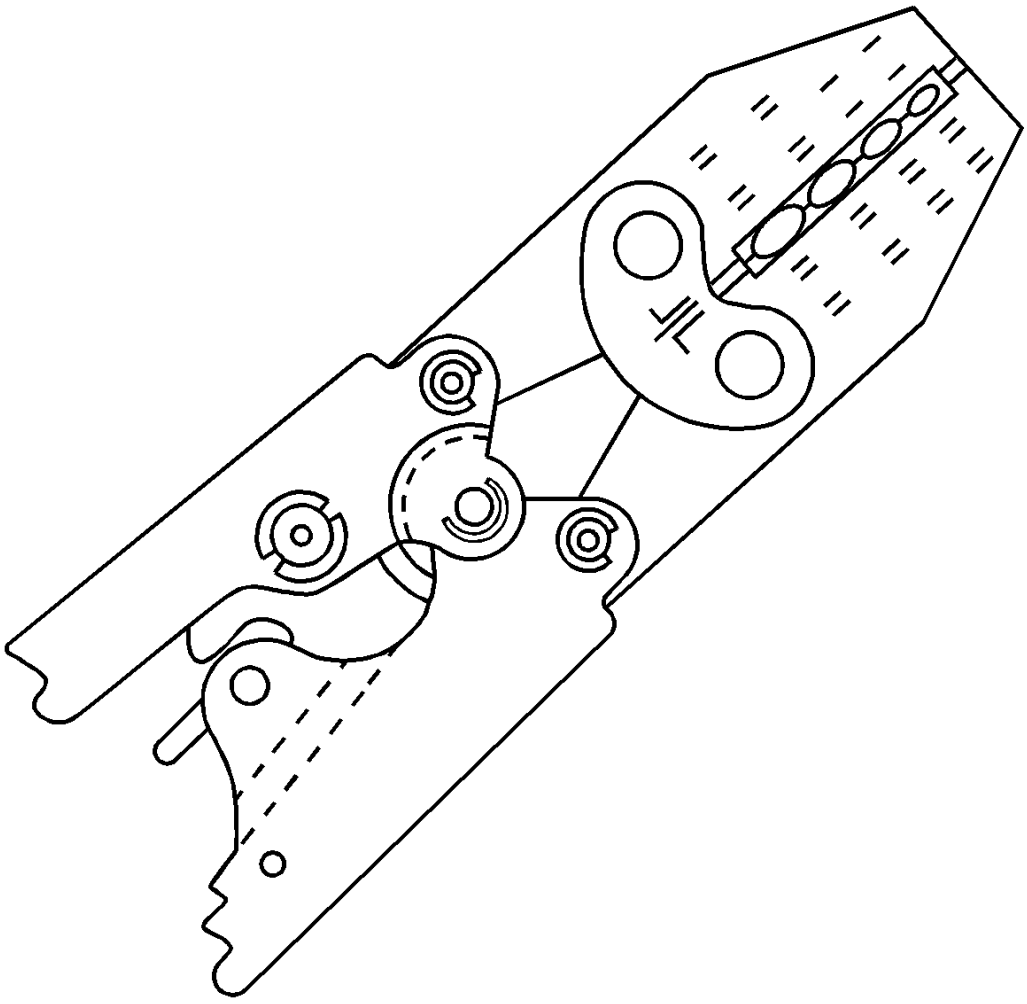


Fig. 10: Splice Sleeve Crimping Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use EL-38125-10 splice sleeve crimping tool (non GMNA) or J-38125-8 splice sleeve crimping tool (GMNA).**

1. For wiring repair, refer to **Splicing Copper Wire Using Splice Sleeves**.

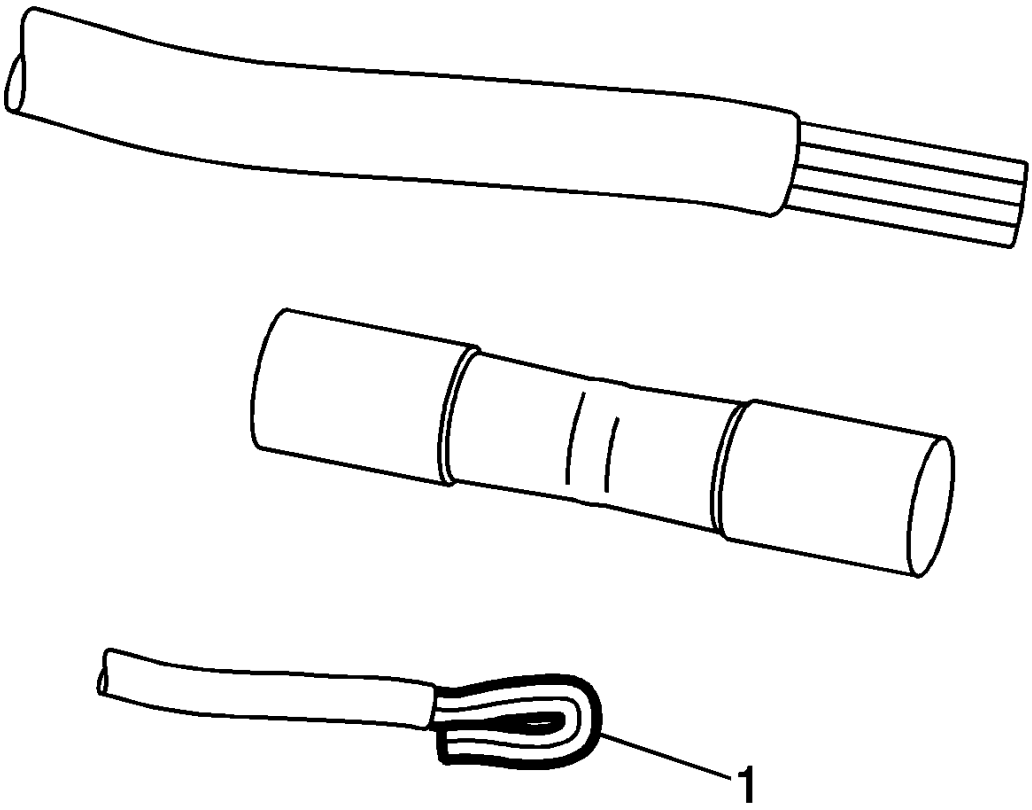


Fig. 11: View Of Twisted And Folded Wire To Length
Courtesy of GENERAL MOTORS COMPANY

2. Twist the wires before you fold them over to prevent the wire strands from opening up. Fold over the copper wire strands of the smaller (1) gauge wire so that it is the same length as the non-folded wire.

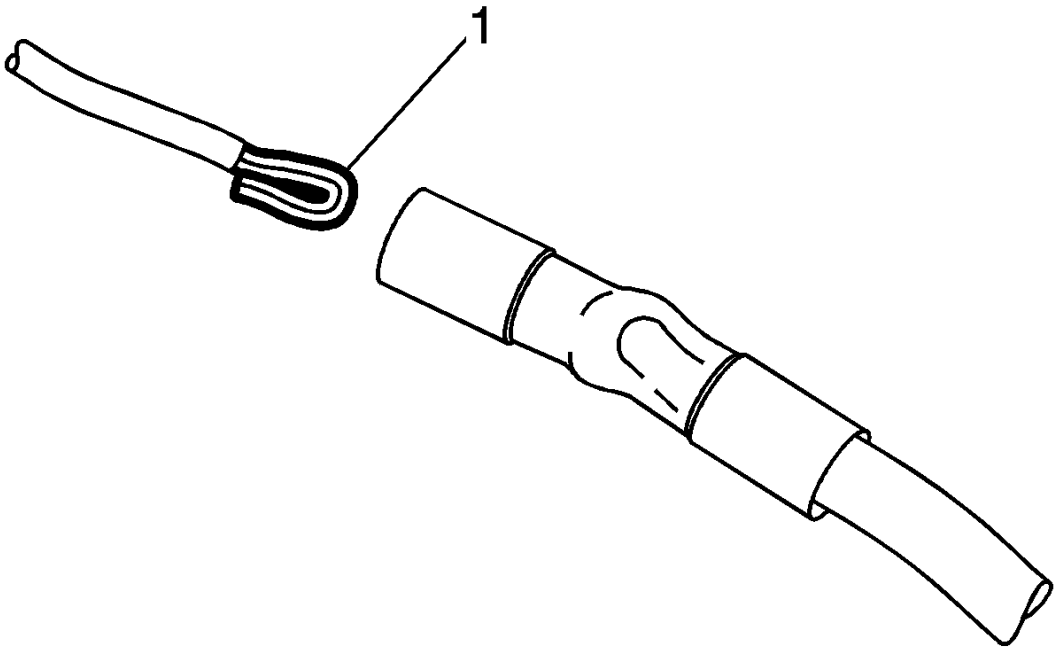


Fig. 12: View Of Folded Wire & Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

3. Insert the folded over wire (1) into the splice sleeve.

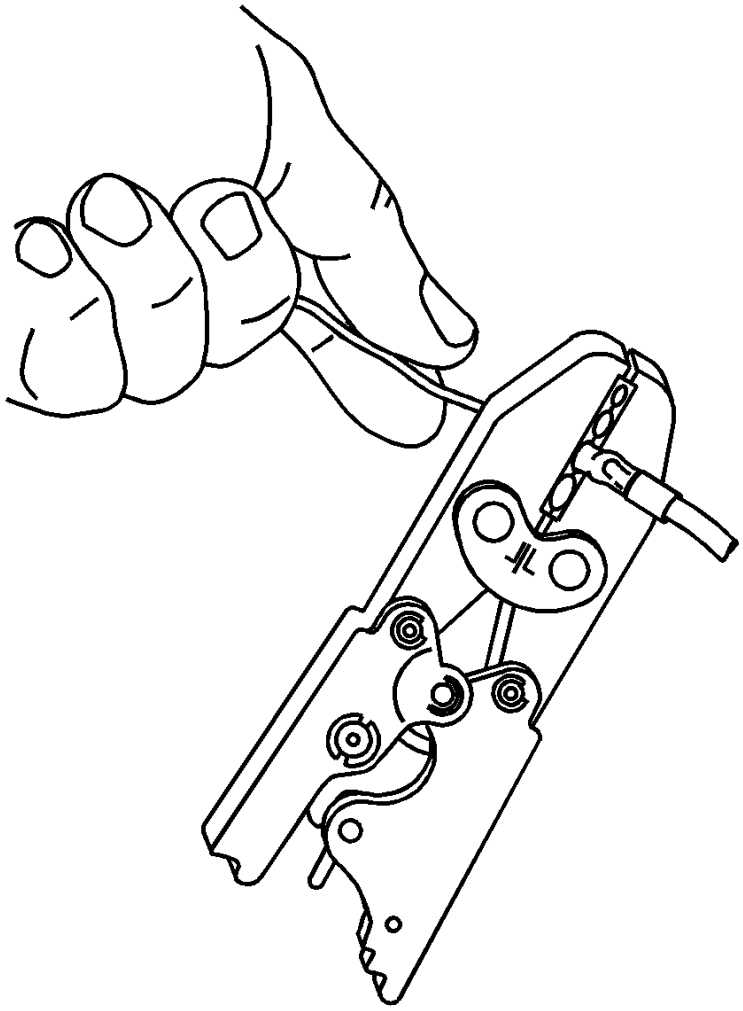


Fig. 13: Crimping The Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

4. Use the proper crimp tool to crimp the splice sleeve to the smaller wire (harness side of repair). Complete the crimp as usual (using the heat tool to shrink the tube).

HIGH TEMPERATURE WIRING REPAIRS

NOTE: **All wiring repairs need to be 200 mm from the heat zone. Areas of consideration would be any area located near the exhaust manifolds, catalytic converter, exhaust pipes, and turbocharged engines.**

Items Required

- DuraSeal splice sleeves to crimp and seal connections
- High temperature SCT1 shrink tubing to protect the splice sleeves
- Terminated leads or pigtails
- The correct tools to remove the terminals from the connectors

Use high temperature bulk wire rated at 150Â°C (302Â°F) continuous temperature of the same or larger gauge

size as the original wire when repair damage wire. Also replace any reflective tape that you remove during the repair.

High Temperature Wiring

Wiring that is exposed to high temperatures, 135Â°C (275Â°F) or higher, for prolonged periods of time may use materials i.e. wires, connectors, and shielding that has a higher heat rating than typical wiring. When making a repair in a high temperature area observe the following:

- Use high temperature bulk wire rated at 150Â°C (302Â°F) continuous temperature to replace any damaged wire.
- Replace any heat shielding that is removed.
- Cover any DuraSeal splice sleeves with SCT1 shrink tubing.
- After making a wiring repair, ensure that the location of the wiring is not moved closer to the heat source.

Identifying High Temperature Wiring

NOTE: **High temperature areas would be areas located near exhaust manifolds, catalytic converters, exhaust pipes, and turbocharged engines.**

Wiring that is exposed to high temperature, 135Â°C (275Â°F) or higher, for prolonged periods of time need special considerations when making wiring repairs. Areas that may be exposed to higher temperatures can be identified by heat resistant materials that are being used in those areas. These materials may include heat reflective tape, moon tape, and high temperature shrink tubing. Also conduit and other protective coverings may be used. Because conduit or similar coverings are used throughout the vehicle regardless of the temperature, it may be necessary for the technician to determine if an area is exposed to excessive heat before making a wiring repair.

HEATED OXYGEN SENSOR WIRING REPAIRS

CAUTION: **Do not solder repairs under any circumstances as this could result in the air reference being obstructed.**

If the heated oxygen sensor pigtail wiring, connector, or terminal is damaged the entire oxygen sensor assembly must be replaced. Do not attempt to repair the wiring, connector, or terminals. In order for the sensor to function properly it must have a clean air reference. This clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors or terminals could result in the obstruction of the air reference and degrade oxygen sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor, causing poor performance. Also, the sensor pigtail and harness wires must not be damaged in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Neither the sensor nor vehicle lead wires should be bent sharply or kinked. Sharp bends, kinks, etc., could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire (where applicable). Vehicles that utilize the

ground wire sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will also cause poor engine performance.

- To prevent damage due to water intrusion, be sure that the peripheral seal remains intact on the vehicle harness connector.

SPLICING COPPER WIRE USING SPLICE SLEEVES

Special Tools

- **EL-38125-10** Splice Sleeve Crimping Tool
- **EL-38125-5** Ultra Torch Special Tool
- DuraSeal splice sleeves, in order to repair the SIR/SRS wiring

For equivalent regional tools, refer to Special Tools .

WARNING: **In order to reduce the risk of personal injury, loss of high voltage isolation to ground and higher system impedance, do not attempt to repair any HV wiring, connector, or terminal that is damaged. High voltage coaxial type cables are not repairable. Never attempt to repair a coaxial type cable. The entire cable/harness or component must be replaced. In order to maintain system integrity and personal safety, never attempt to repair any high voltage wiring, cables, or terminals. Performing this procedure on high voltage circuits may result in serious injury or death.**

NOTE: **If the wiring harness internal to the transmission is damaged, the wiring harness must be replaced. The use of splice sleeves in an attempt to repair the internal transmission wires, connectors, or terminals could result in performance issues.**

NOTE: **Do not splice wires in Door Harness Grommets.**

NOTE:

- **Use only DuraSeal splice sleeves. Other splice sleeves may not protect the splice from moisture or provide a good electrical connection.**
- **For wire Gauge smaller than .5 mm (18 gauge) refer to Folded-Over Wire Repair**

Use DuraSeal splice sleeves to form a one-to-one splice on all types of insulation except high voltage and specialty cables. Use DuraSeal splice sleeves where there are special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using DuraSeal splice sleeves.

Splice Sleeve Color	Crimp Tool Nest Color		Wire Gauge mm^2 / (AWG)
	3 Crimp Nests	4 Crimp Nests	
Salmon (Yellow-Pink) 19168446	Red (1) or Red/Green (1)	Red (2)	0.5-0.8/(18-20)
Blue 19168447	Blue (2)	Blue (3)	1.0-2.6/(14-16)

Splice Sleeve Color	Crimp Tool Nest Color		Wire Gauge mm^2 / (AWG)
	3 Crimp Nests	4 Crimp Nests	
Yellow 19168448	Yellow (3)	Yellow (4)	3.0-5.0/(10-12)

NOTE: **You must perform the following procedures in the listed order. Repeat the procedure if any wire strands are damaged. You must obtain a clean strip with all of the wire strands intact.**

1. Open the harness by removing any tape:
   - Use a sewing seam ripper, available from sewing supply stores, in order to cut open the harness in order to avoid wire insulation damage.
   - Use the DuraSeal splice sleeves on all types of insulation except Tefzel and coaxial.
   - Do not use the crimp and DuraSeal splice sleeve to form a splice with more than 2 wires coming together.
2. Cut as little wire off the harness as possible. You may need the extra length of wire in order to change the location of a splice.

   Adjust splice locations so that each splice is at least 40 mm (1.5 in) away from the other splices, harness branches, or connectors.

3. Strip the insulation:
   - When adding a length of wire to the existing harness, use the same size wire as the original wire.
   - Perform one of the following items in order to find the correct wire size:
     - Find the wire on the schematic and convert to regional wiring gauge size.
     - If you are unsure of the wire size, begin with the largest opening in the wire stripper and work down until achieving a clean strip of the insulation.
   - Strip approximately 5.0 mm (0.20 in) of insulation from each wire to be spliced.
   - Do not nick or cut any of the strands. Inspect the stripped wire for nicks or cut strands.
   - If the wire is damaged, repeat this procedure after removing the damaged section.
4. For high temperature wiring, slide a section of high temperature SCT1 shrink tubing down the length of wire to be spliced. Ensure that the shrink tubing will not interfere with the splice procedure.
5. Select the proper DuraSeal splice sleeve according to the wire size. Refer to the above table at the beginning of the repair procedure for the color coding of the DuraSeal splice sleeves and the crimp tool nests.

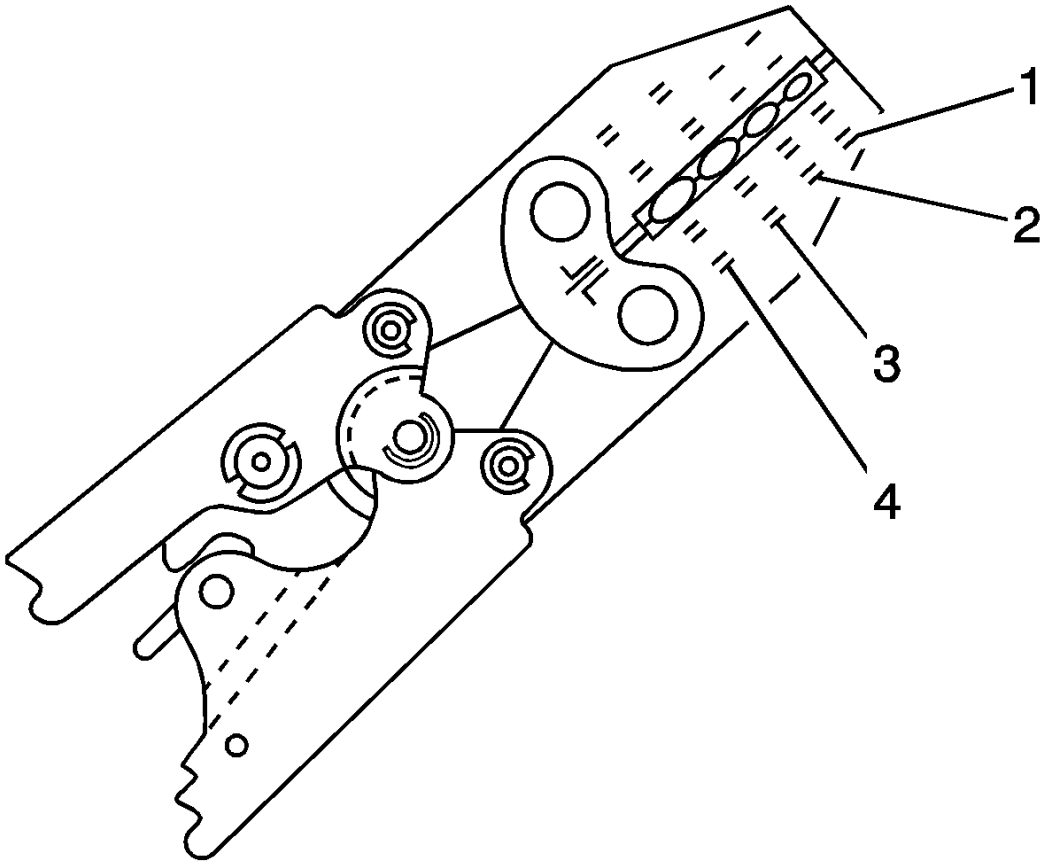


Fig. 14: Crimping Tool
Courtesy of GENERAL MOTORS COMPANY

6. The **EL-38125-10** splice sleeve crimping tool has four crimp nests. The largest crimp nest (4) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (3) is used for crimping 14 and 16 gauge wires. The third largest crimp nest (2) is used for crimping 18 and 20 gauge wires. The smallest crimp nest (1) is used for crimping 22 to 26 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.

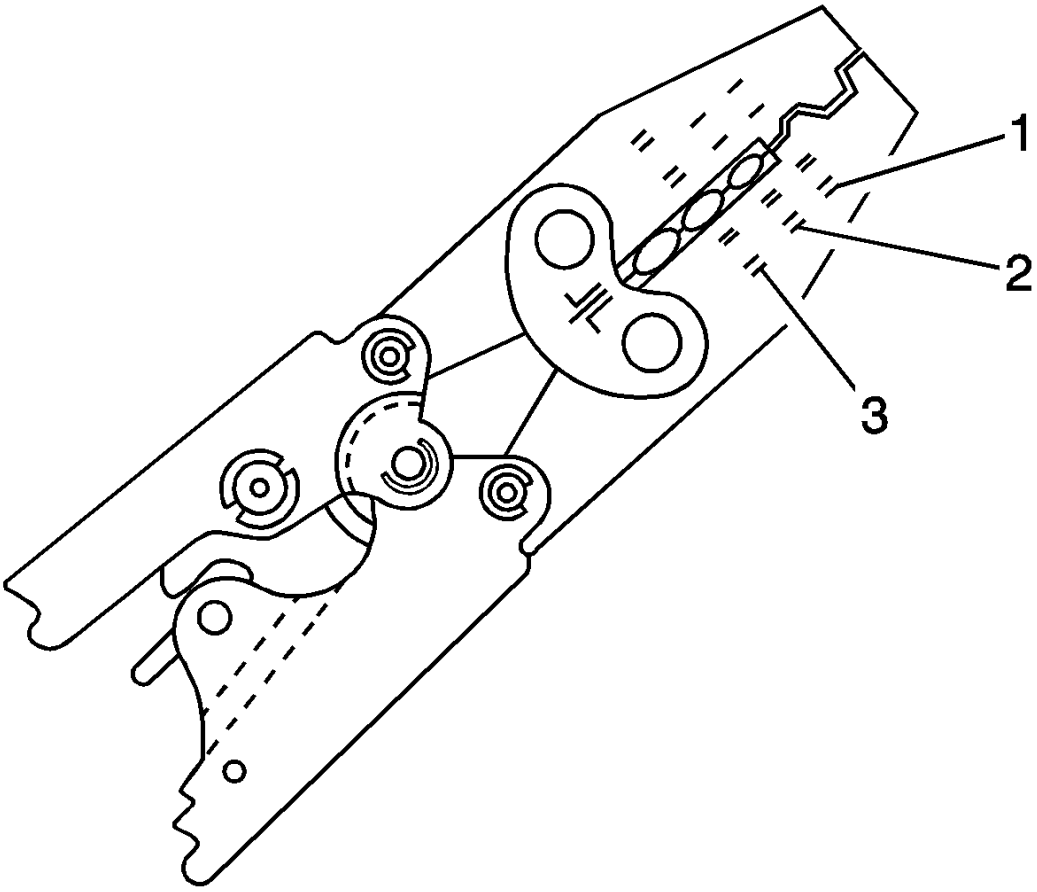


Fig. 15: Identifying Splice Crimp Tool Nests Terminal Identification
Courtesy of GENERAL MOTORS COMPANY

7. The **J-38125-8** splice sleeve crimping tool has three crimp nests. The largest crimp nest (3) is used for crimping 10 and 12 gauge wires. The second largest crimp nest (2) is used for crimping 14 and 16 gauge wires. The smallest crimp nest (1) is used for crimping 18 to 20 gauge wires. The crimp nests are referenced in the table (farther above) under the crimp tool nest color.
8. Use the splice sleeve crimp tool in order to position the DuraSeal splice sleeve in the proper color nest of the splice sleeve crimp tool. For the four crimp nest tool, use the three largest crimp nests to crimp the splice sleeves. For the three crimp nest tool, use all three crimp nests to crimp the splice sleeves. Use the four and three crimp tool diagrams (above) and the table (farther above) to match the splice sleeve with the correct crimp nest. The crimp tool diagram callout numbers match the numbers in the table (under crimp tool nest color).

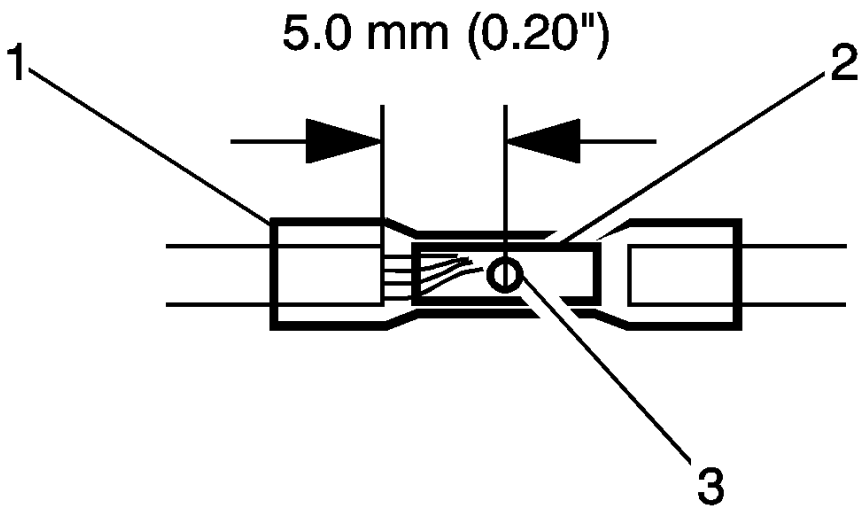


Fig. 16: Identifying Duraseal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

9. Place the DuraSeal splice sleeve in the nest. Ensure that the crimp falls midway between the end of the barrel and the stop. The sleeve has a stop (3) in the middle of the barrel (2) in order to prevent the wire (1) from going further. Close the hand crimper handles slightly in order to firmly hold the DuraSeal splice sleeve in the proper nest.

Fig. 17: Crimped Duraseal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

10. Insert the wire into the splice sleeve barrel until the wire hits the barrel stop.
11. Tightly close the handles of the crimp tool until the crimper handles open when released.

    The crimper handles will not open until you apply the proper amount of pressure to the DuraSeal splice sleeve. Repeat steps 4 and 6 for the opposite end of the splice.

Fig. 18: Crimped Duraseal Splice Sleeve
Courtesy of GENERAL MOTORS COMPANY

12. Using the EL-38125-5 ultra torch, apply heat to the crimped area of the barrel.
13. Start in the middle and gradually move the heat barrel to the open ends of the tubing:
    - The tubing will shrink completely as the heat is moved along the insulation.
    - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

High Temperature Wiring Repairs

Use the following procedures to perform high temperature wiring repairs:

1. Center the high temperature SCT1 shrink tube over the DuraSeal splice sleeve.
2. Using the EL-38125-5 ultra torch, apply heat to the high temperature heat shrink tubing.
3. Gradually move the heat from the center to the open end of the tubing:

- The tubing will shrink completely as the heat is moved along the insulation.
- A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

4. Replace any reflective tape and clips that may have been removed during the repair.

SPLICING TWISTED OR SHIELDED CABLE

WARNING: In order to reduce the risk of personal injury, loss of high voltage isolation to ground and higher system impedance, do not attempt to repair any HV wiring, connector, or terminal that is damaged. High voltage coaxial type cables are not repairable. Never attempt to repair a coaxial type cable. The entire cable/harness or component must be replaced. In order to maintain system integrity and personal safety, never attempt to repair any high voltage wiring, cables, or terminals. Performing this procedure on high voltage circuits may result in serious injury or death.

Twisted/shielded cable is used in order to protect wiring from electrical noise. Two-conductor cable of this construction is used between the radio and the Delco-BoseÂ® speaker/amplifier units and other applications where low level, sensitive signals must be carried. Follow the instructions below in order to repair the twisted/shielded cable.

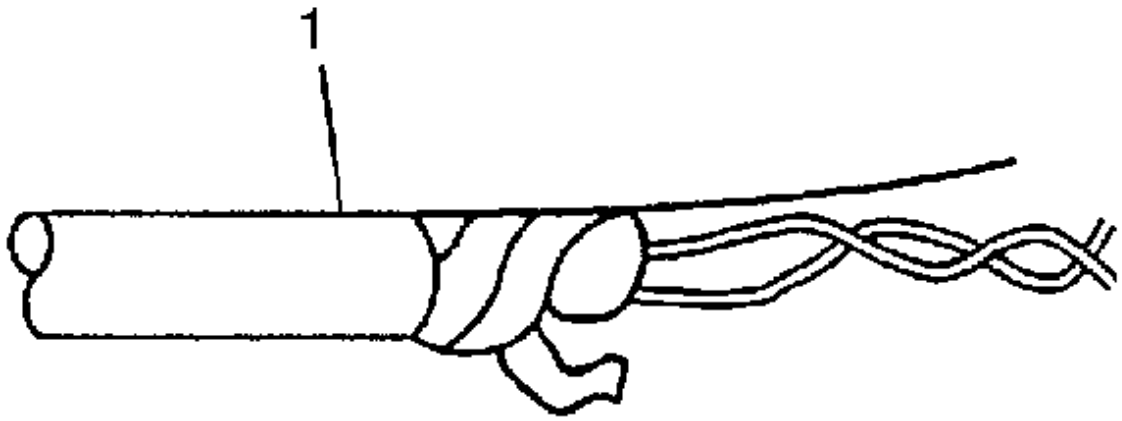


Fig. 19: View Of Outer Wiring Jacket
Courtesy of GENERAL MOTORS COMPANY

1. Remove the outer jacket (1). Use care not to cut into the drain wire of the mylar tape.
2. Unwrap the tape. Do not remove the tape. Use the tape in order to rewrap the twisted conductors after the splice is made.

Fig. 20: Preparing The Splice
Courtesy of GENERAL MOTORS COMPANY

3. Prepare the splice. Untwist the conductors and follow the instructions for **Splicing Copper Wire Using Splice Sleeves**. Staggering the splices by 65 mm (2.5 in) is recommended.

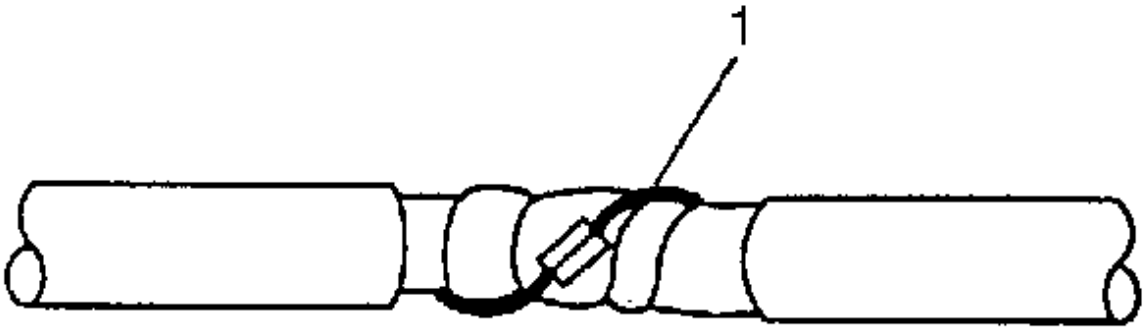


Fig. 21: Identifying Diode On Wire
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Apply the mylar tape with the aluminum side inward. This ensures good electrical contact with the drain wire.**

4. Re-assemble the cable.
    - Rewrap the conductors with the mylar tape. If the mylar tape is damaged, use 3M product AL-36FR to replace the damaged mylar tape.
    - Use caution not to wrap the drain wire in the tape (1).
    - Follow the splicing instructions for copper wire and splice the drain wire.
    - Wrap the drain wire around the conductors and tape with electrical tape to replace the outer insulation.

Fig. 22: View Of Repaired Wire Covered With Electrical Tape
Courtesy of GENERAL MOTORS COMPANY

5. Tape over the entire cable. Use a winding motion when you apply the tape.

SPLICING INLINE HARNESS DIODES

Many vehicle electrical systems use a diode to isolate circuits and protect the components from voltage spikes. When installing a new diode use the following procedure.

1. Open the harness.
    - If the harness is taped, remove the tape.
    - To avoid wiring insulation damage, use a sewing seam ripper (available from sewing supply stores) in order to cut open the harness.
    - If the harness has a black plastic conduit, pull out the diode.
2. If the diode is taped to the harness, remove all of the tape.

3. Check and record the current flow direction and orientation of diode.
4. Remove the inoperative diode from the harness with a suitable soldering tool.

NOTE: **If the diode is located next to a connector terminal remove the terminal(s) from the connector to prevent damage from the soldering tool.**

5. Carefully strip away a section of insulation next to the old soldered portion of the wire(s). Do not remove any more than is needed to attach the new diode.
6. Check current flow direction of the new diode, being sure to install the diode with correct bias. Reference the appropriate service manual wiring schematic to obtain the correct diode installation position.
7. Attach the new diode to the wire(s) using 60/40 rosin core solder. Before soldering attach some heat sinks (aluminum alligator clips) across the diode wire ends to protect the diode from excessive heat. Follow the manufacturer's instruction for the soldering equipment.
8. Reinstall terminal(s) into the connector body if previously removed.

NOTE: **To prevent shorts to ground and water intrusion, completely cover all exposed wire and diode attachment points with tape.**

9. Tape the diode to the harness or connector using electrical tape.

SIR/SRS WIRING REPAIRS

NOTE: **Refer to SIR Service Precautions .**

For European Regions

CAUTION: **If the SIR/SRS wiring, connector, or terminal is damaged, the affected wiring harness must be replaced. Do not attempt to repair the wiring, connector, or terminals. Any attempt to repair the wires, connectors, or terminals could result in performance problems of the SIR/SRS System. Operations on restraint systems must only be performed by trained and qualified personnel.**

For Non-European Regions

Special Tools

Splice Sleeve Crimping Tool, refer to Special Tools .

The Supplemental Inflatable Restraint (SIR) System/Supplemental Restraint System (SRS) requires special wiring repair procedures due to the sensitive nature of the circuitry. Follow the specific procedures and instructions when working with the SIR/SRS, and the wiring components, such as connectors and terminals.

SIR/SRS Connector Repair (Plastic Body and Terminal Metal Pin)

NOTE: **Do not use the terminals in the kit in order to replace damaged SIR/SRS system terminals. Use either an SIR/SRS pigtail or a terminated lead from the SIR Repair Kit Tray.**

The terminals in the SIR/SRS system are made with a special plating. This plating provides the necessary

contact integrity for the sensitive, low energy circuits.

Pigtail repair packs are available for SIR/SRS connectors with eight or less terminals. Only the connector body is available for connectors with more than eight terminals. Terminated leads can be used to replace damaged terminals when replacing the connector body.

SIR/SRS Component Wire Pigtail Repair

NOTE: **Do not make wire, connector, or terminal repairs on components with wire pigtails.**

A wire pigtail is a wire or wires attached directly to the device, not by a connector. If a wiring pigtail is damaged, you must replace the entire component, with pigtail. The inflatable restraint steering wheel module coil is an example of a pigtail component.

SIR/SRS Wire Repair

CAUTION: **Do not install more than 2 DuraSeal splice sleeves per SIR deployment loop. A deployment loop consists of both wires from the K36 Inflatable Restraint Sensing and Diagnostic Module to the deployable component. If more than 2 DuraSeal splice sleeves are required for any SIR deployment loop, the complete circuit of the loop must be replaced. More than 2 DuraSeal splice sleeves per deployment loop may increase the resistance in the circuit causing a DTC to be set.**

NOTE: **Refer to Wiring Repairs in the service information connector end views or the vehicle schematics in order to determine the correct wire size for the circuit you are repairing. You must obtain this information in order to ensure circuit integrity.**

If any wire except the pigtail is damaged, repair the wire by splicing in a new section of wire of the same gauge size (0.5 mm, 0.8 mm, 1.0 mm etc.). Use the DuraSeal splice sleeves and the appropriate splice sleeve crimping tool. For wiring repair, refer to **Splicing Copper Wire Using Splice Sleeves**.

For connector position assurance (CPA), refer to **Connector Position Assurance Locks**.

For terminal position assurance (TPA), refer to **Terminal Position Assurance Locks**.

CONNECTOR REPAIRS

Connector Repairs contains a list of all connector repairs. The connector repairs are listed by the connector manufacturer and then by connector type. If the technician cannot identify the manufacturer of the connector, refer to Identifying Connectors below. Knowing the connector manufacturer will assist in finding the correct connector repair from the following list:

- **Connector Position Assurance Locks**
- **Terminal Position Assurance Locks**
- **AFL/EPC Connectors**
- **Bosch Connectors (BSK)Bosch Connectors (0.64)Bosch Connectors (2.8 JPT)Bosch Connectors**

(ECM)

- Delphi Connectors (Weather Pack)Delphi Connectors (Push To Seat)Delphi Connectors (Pull To Seat)Delphi Connectors (Micro-Pack 100W)Delphi Connectors (Micro .64)Delphi Connectors (12-Way)Delphi Connectors (Steering Gear)
- FCI Connectors (Lever Lock)FCI Connectors (SIR)
- FEP Connectors (Steering Gear)
- JST Connectors
- Kostal Connectors (Glow Plug Control Module)Kostal Connectors (Transmission)
- Molex ConnectorsMolex Connectors (SIR)
- Sumitomo Connectors
- Tyco/AMP Connectors (CM 42-Way)Tyco/AMP Connectors (Sensor)Tyco/AMP Connectors (0.25 Cap)Tyco/AMP Connectors (43-Way)Tyco/AMP Connectors (Door Module)Tyco/AMP Connectors (Seat)Tyco/AMP Connectors (102-Way Inline)Tyco/AMP Connectors (SIR)
- Yazaki Connectors (2-Way)Yazaki Connectors (16-Way)
- Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)

Connector Anatomy

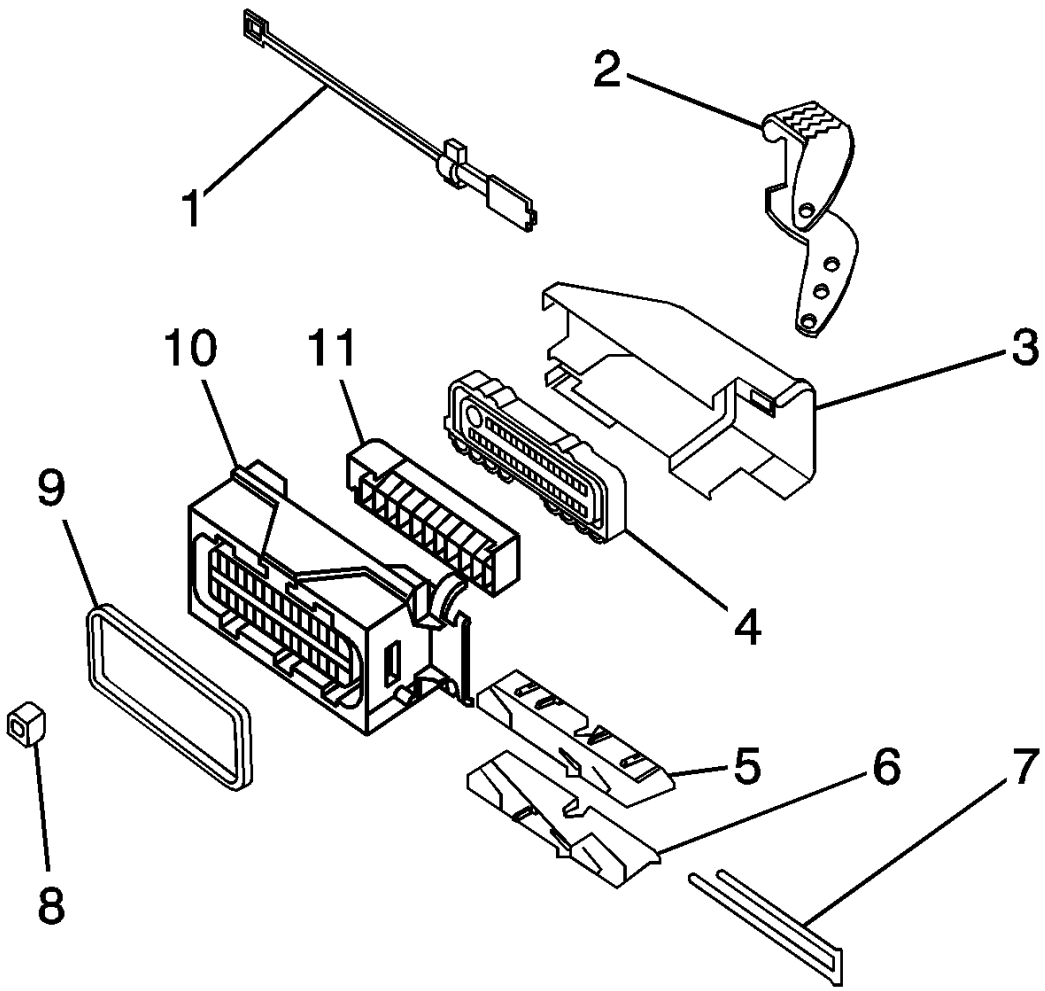


Fig. 23: Identifying Typical Connector Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Connector Positive Assurance (CPA)
2	Assist Lever
3	Wiredress Cover
4	Seal Strain/Relief
5	Slide Left Hand
6	Slide Right Hand
7	Terminal Positive Assurance (TPA)
8	Terminal Positive Assurance (TPA)
9	Connector Seal
10	Connector Housing
11	Inner Connector

Identifying Connectors

Knowing the connector manufacturer is helpful when trying to locating the correct connector repair procedure. There are many different connector designs used on GM vehicles and it is sometimes difficult to identify the connector manufacturer. The information in this document should help with the identification of connector manufactures.

The following connector manufacturers make most of the connectors found in GM vehicles:

- AFL/EPC (Alcoa Fujikura Ltd./Engineered Plastics Components)
- Bosch
- Delphi
- FCI (Framatome Connectors International)
- JAE (Japan Aviation Electronics)
- JST (Japan Solderless Terminals)
- Kostal
- Molex
- Sumitomo
- Tyco/AMP
- Yazaki

Identifying the manufacturer of a connector is often difficult. When trying to determine the manufacturer of a connector, look for specific identifying marks that are unique to that connector supplier. Most of these identify marks are hard to find or see. Check the connector carefully and refer to the information below for pictures and descriptions of connector identification markings.

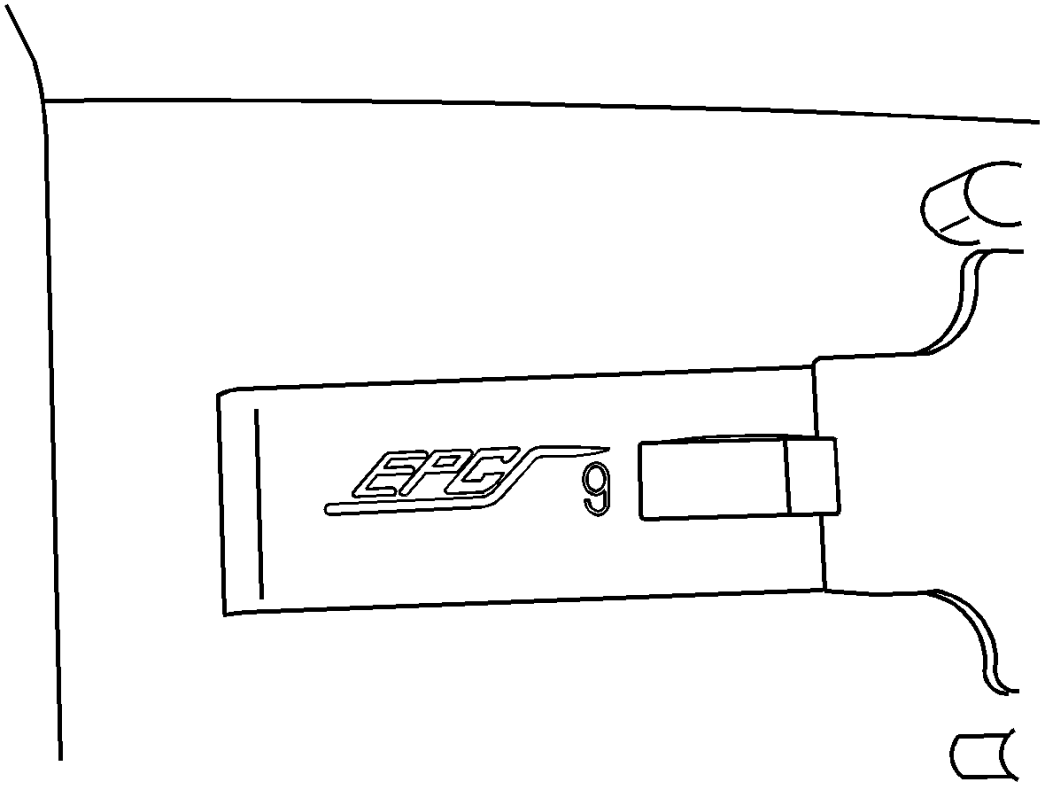


Fig. 24: View Of EPC Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- Most of AFL's connectors have EPC on their connector body. Some of the smaller connectors will not have any markings on them.

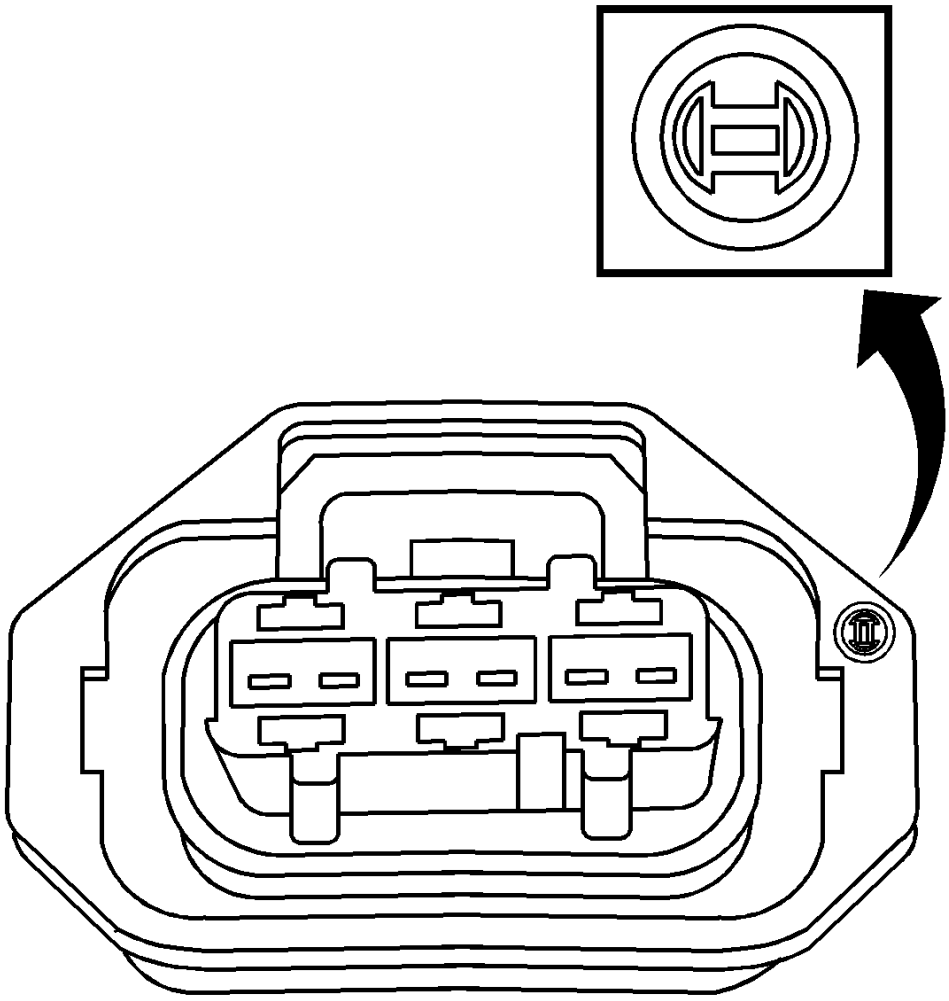


Fig. 25: View Of Bosch Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- In some cases Bosch will actually be printed on the connector. If Bosch does not appear on the connector, look for the Bosch logo. The Bosch logo is a circle with a blunted arrow inside. This logo can appear anywhere on the connector and is often very small.

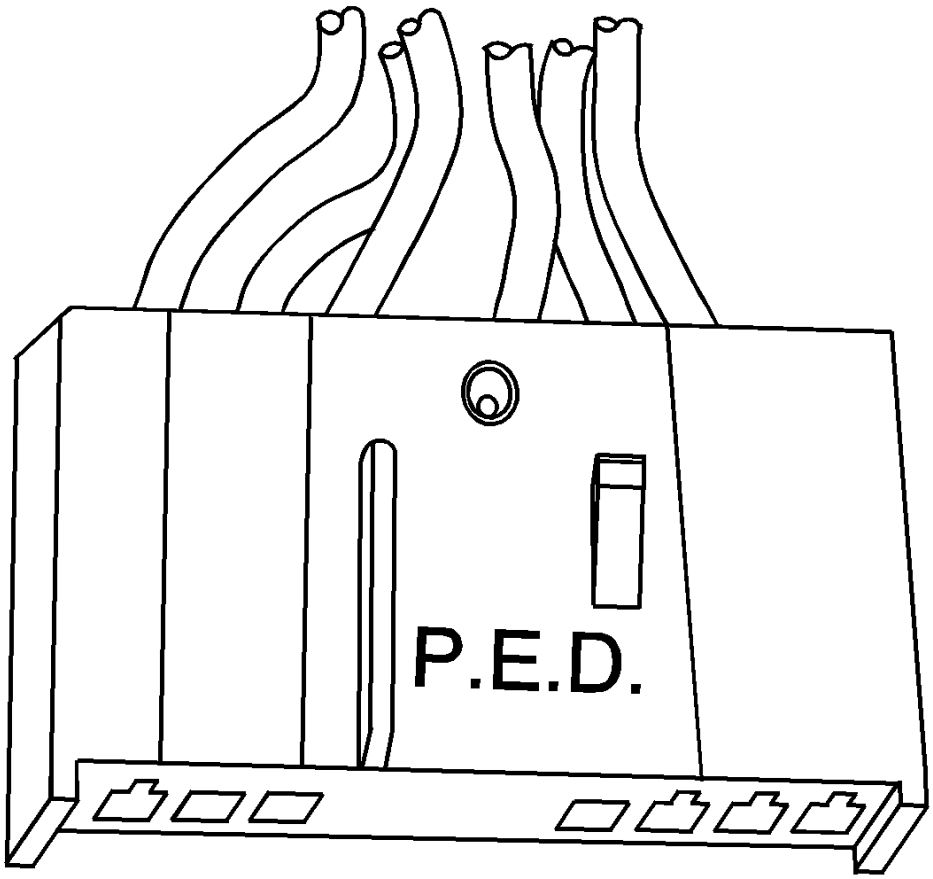


Fig. 26: View Of PED Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- In some cases Delphi will actually be printed on the connector. If Delphi is not printed on the connector, look for PED. In both cases there is no specific orientation for Delphi or PED and they can appear anywhere on the connector.

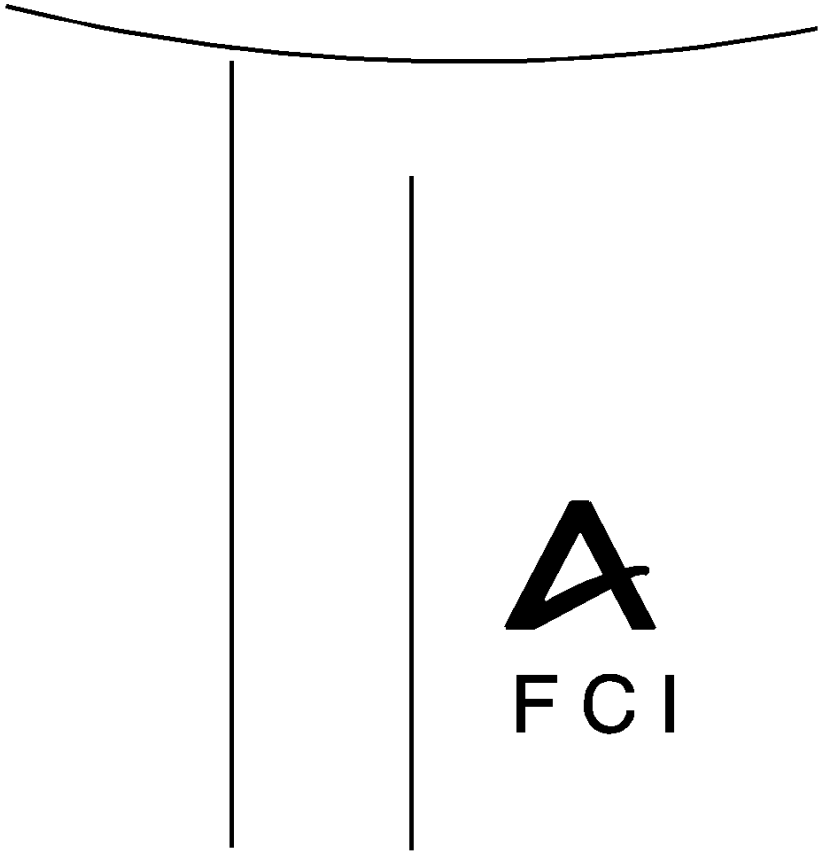


Fig. 27: View Of FCI Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- FCI connectors may have the FCI logo on their connectors. The logo is the letters FCI with an "A" above it.

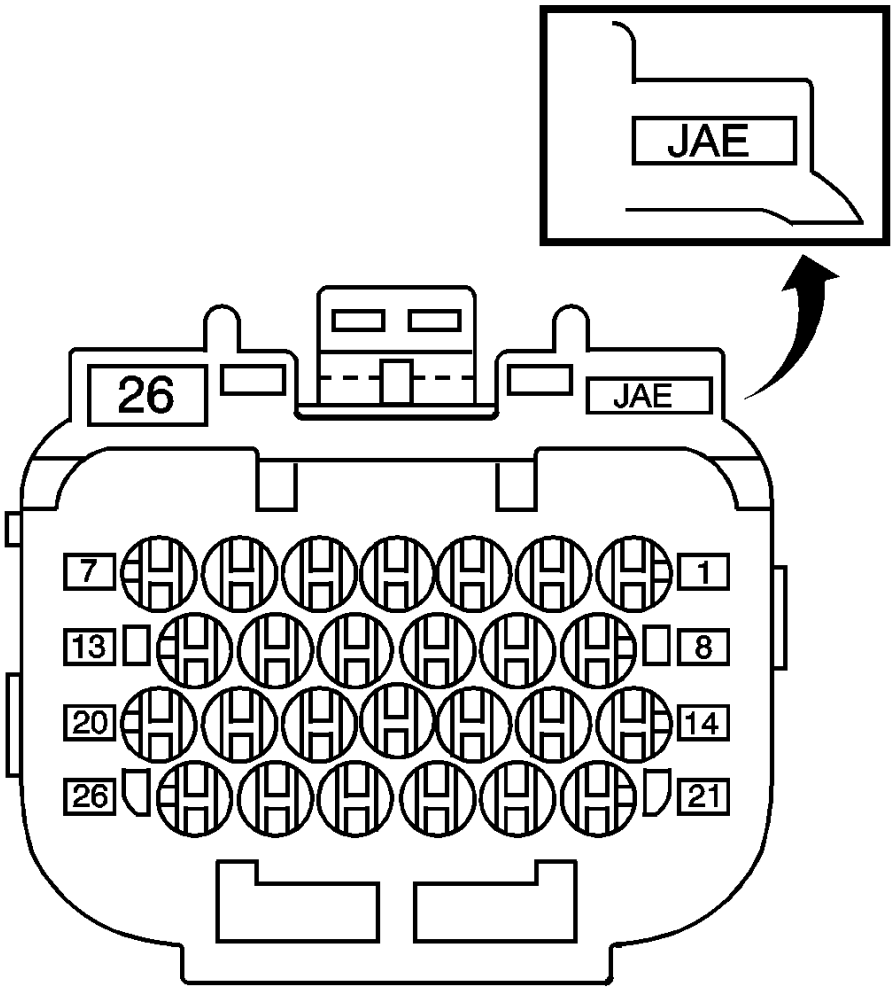


Fig. 28: View Of JAF Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- JAE connector have JAE in small letters on their connectors.

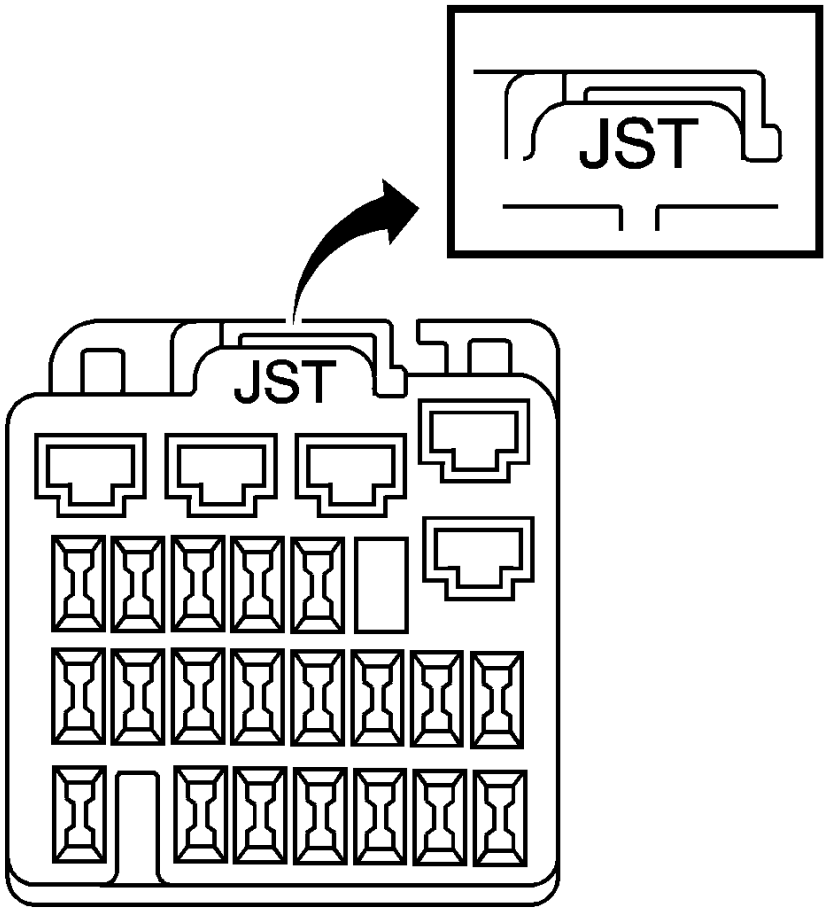


Fig. 29: View Of JST Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- JST connectors have JST in small letters on their connectors, similar to that above. The location of the logo will vary with the connector size and style.

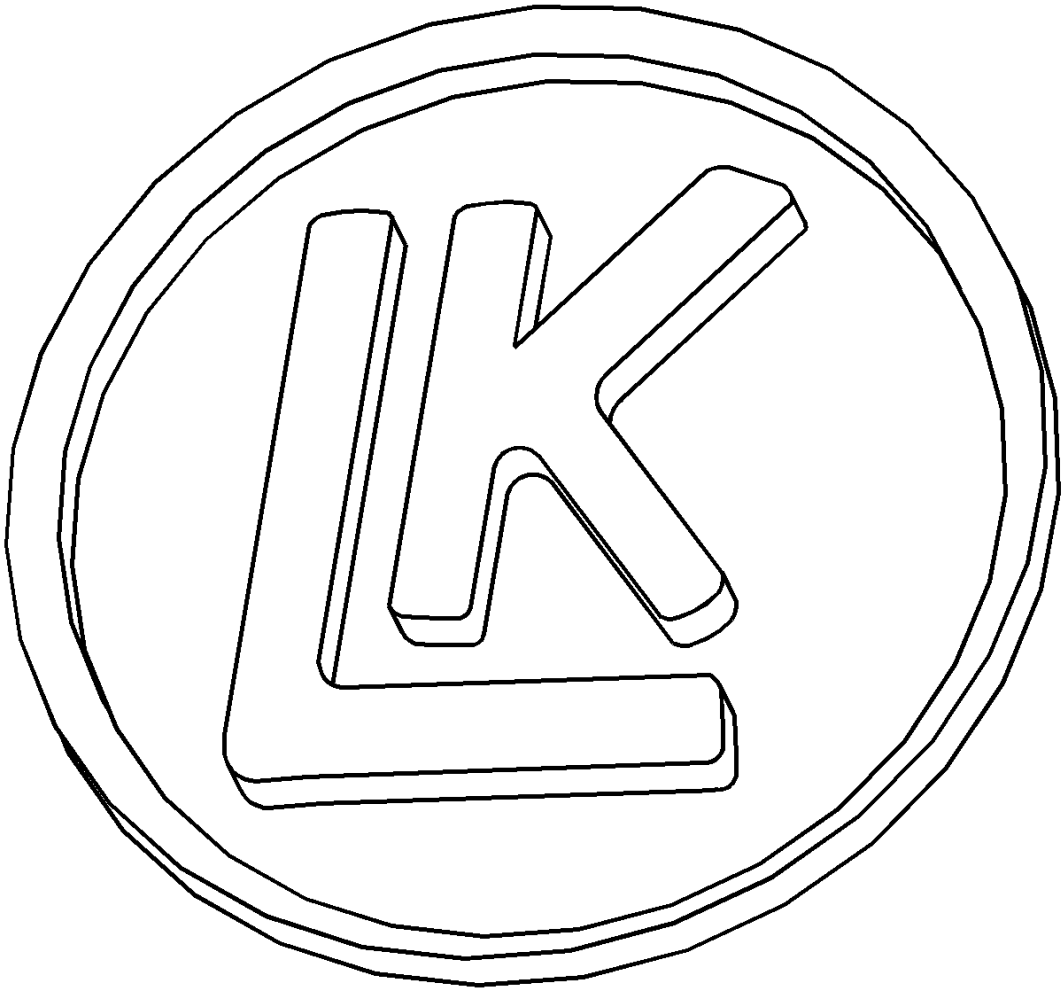


Fig. 30: View Of Kostel Connector Identifier
Courtesy of GENERAL MOTORS COMPANY

- Kostel has an "LK" with a circle around it. These connector are usually used as a transmissions connection.

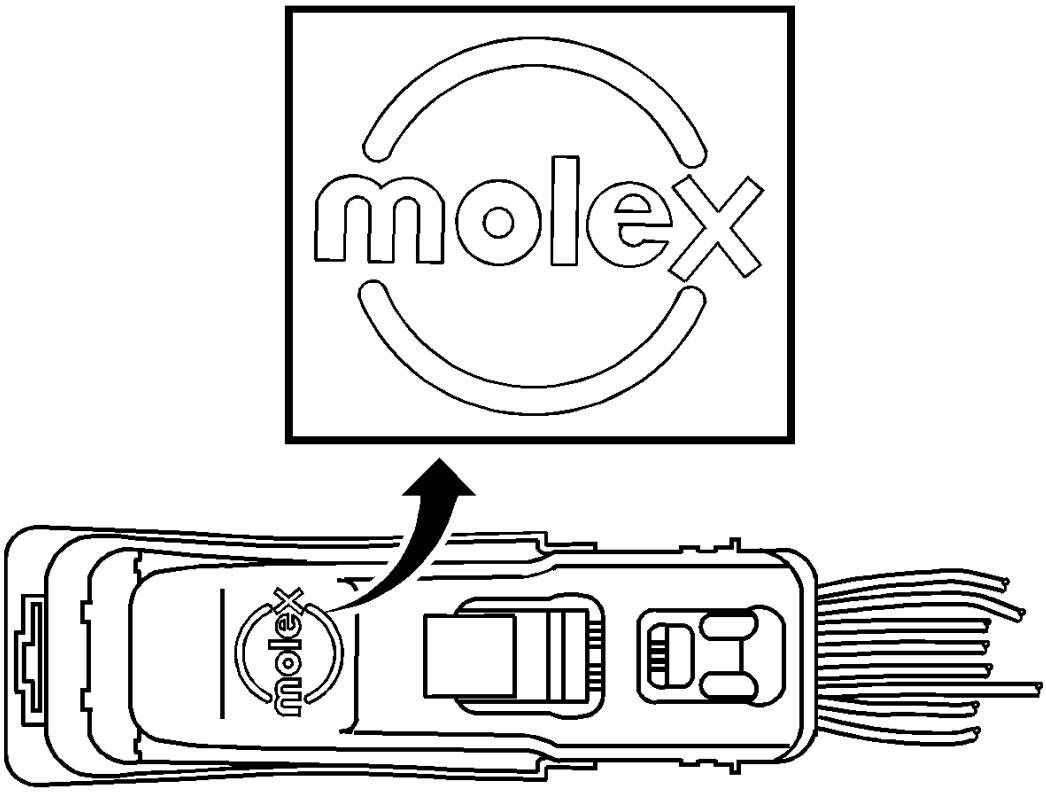


Fig. 31: View Of Molex Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

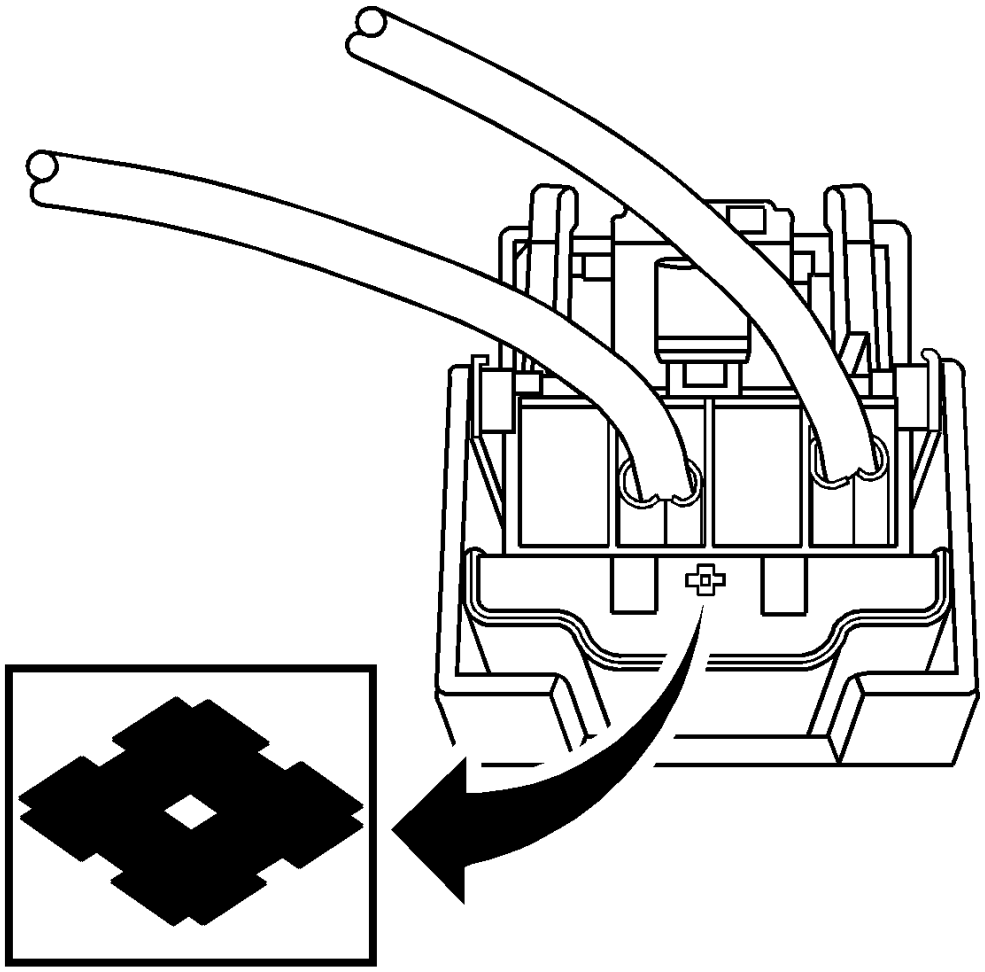


Fig. 32: View Of Sumitono Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- Most Molex connectors will have the Molex logo on the dresscover of the connector. In some cases the connectors may have MX followed by another letter. The third letter indicates where the connector was made. A connector with MXD is a Molex connector made in Detroit.

  Sumitomo has a unique symbol on their connector and possibly a part number. The symbol is similar to that of a diamond lying on its side, similar to that shown. The logo could appear anywhere but the most common place is at the wire side of the housing.

- Tyco/AMP has many different and unique connector designs. Some may or may not have identifiable marks on them.

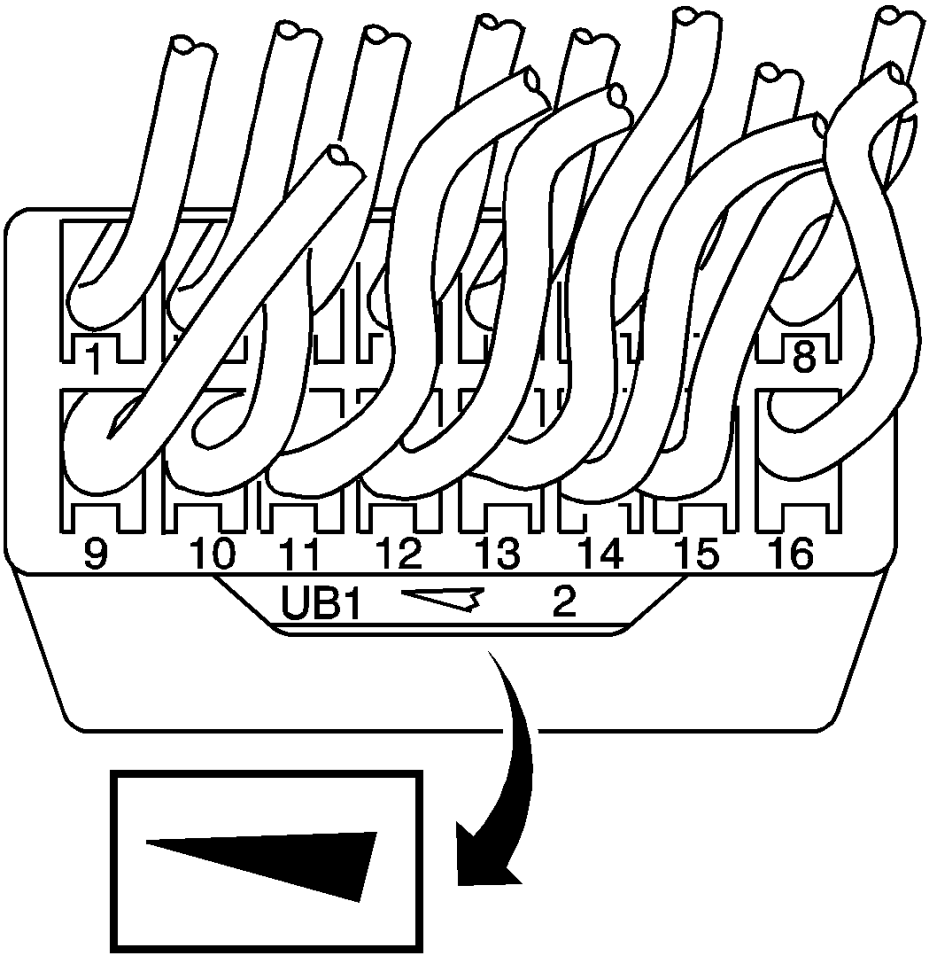


Fig. 33: View Of Yazaki Identification On Connector Body
Courtesy of GENERAL MOTORS COMPANY

- Yazaki has a wedge or arrow shape, similar to that shown.

CONNECTOR POSITION ASSURANCE LOCKS

The connector position assurance (CPA) is a small plastic insert that fits through the locking tabs of the connector. CPAs are used in various connectors throughout the vehicle. CPAs are also used in all SIR system electrical connectors. The CPA ensures that the connector halves cannot vibrate apart. You must have the CPA in place in order to ensure good contact between the mating terminals of the connector.

TERMINAL POSITION ASSURANCE LOCKS

The terminal position assurance (TPA) insert resembles the plastic combs used in the control module connectors. The TPA keeps the terminal securely seated in the connector body. Do not remove the TPA from the connector body unless you remove a terminal for replacement. If the TPA is removed, be sure to reinstall it before reconnecting the connector.

AFL/EPC CONNECTORS

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool
- **J-38125-216** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

Follow the steps below in order to remove terminals from the connector.

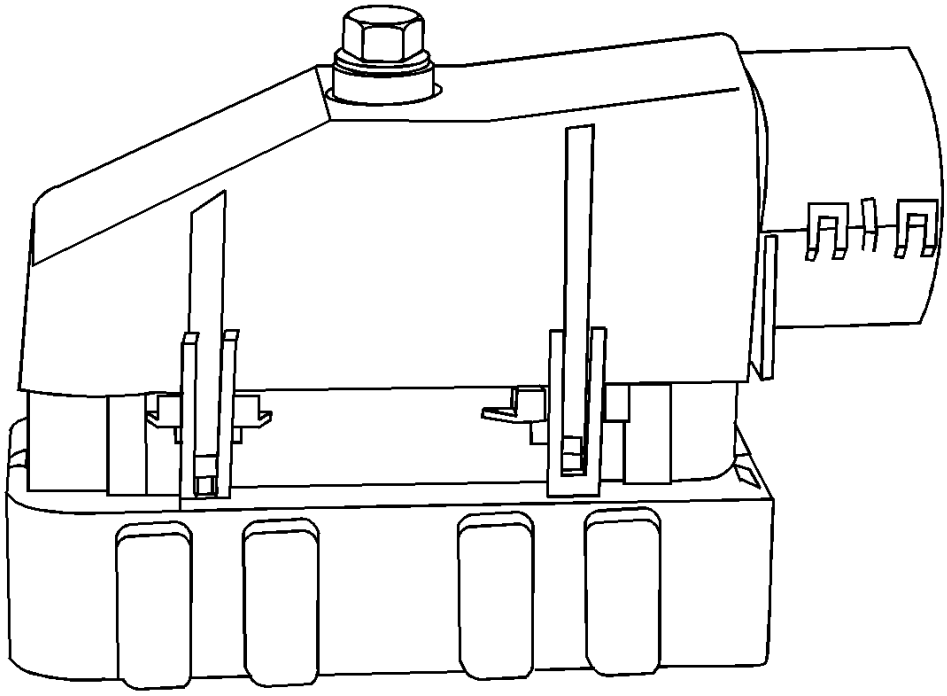


Fig. 34: View Of Bolt On Connector Cover
Courtesy of GENERAL MOTORS COMPANY

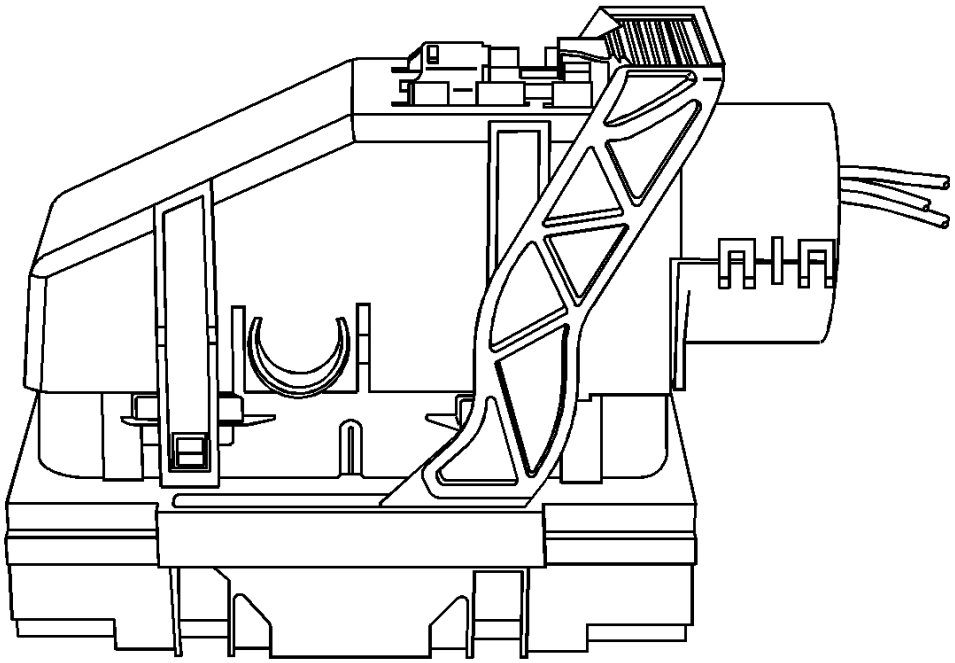


Fig. 35: Identifying Connector Position Assurance (CPA)
Courtesy of GENERAL MOTORS COMPANY

1. For connectors with a bolt in the dress cover, turn the bolt counterclockwise to remove the connector from the component.
2. Locate the connector position assurance (CPA) on the top of the wire dress cover. Slide the CPA forward.

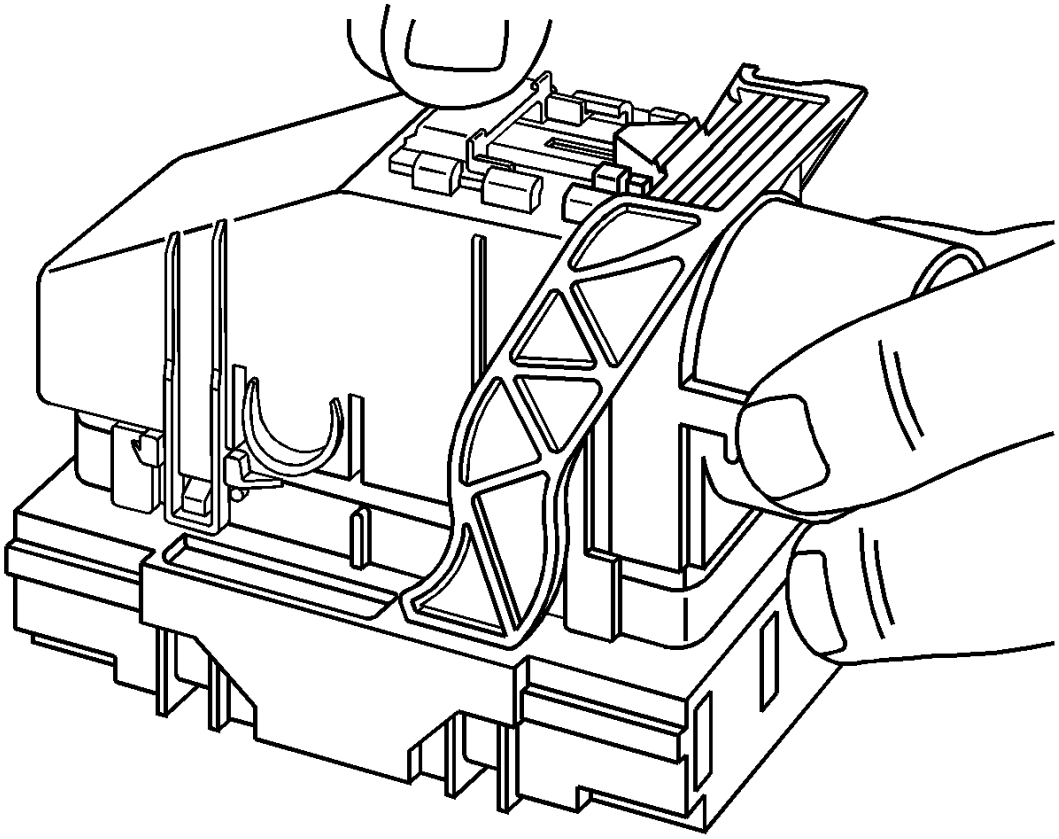


Fig. 36: Identifying Lever Lock & Lever Lock Release Tab
Courtesy of GENERAL MOTORS COMPANY

3. Slide the lever lock forward while pressing down on the lever lock release tab.

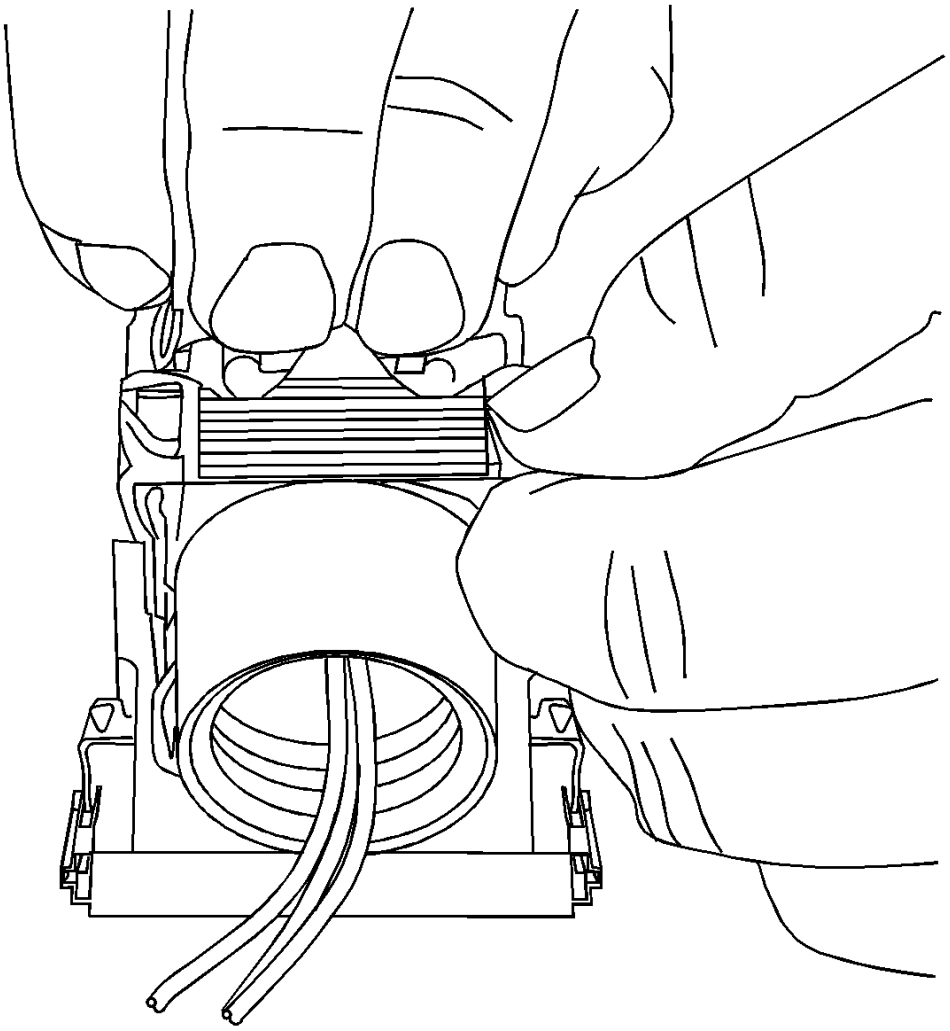


Fig. 37: View Showing Depressing Lever Lock Release Tab
Courtesy of GENERAL MOTORS COMPANY

4. View showing depressing of the lever lock release tab.

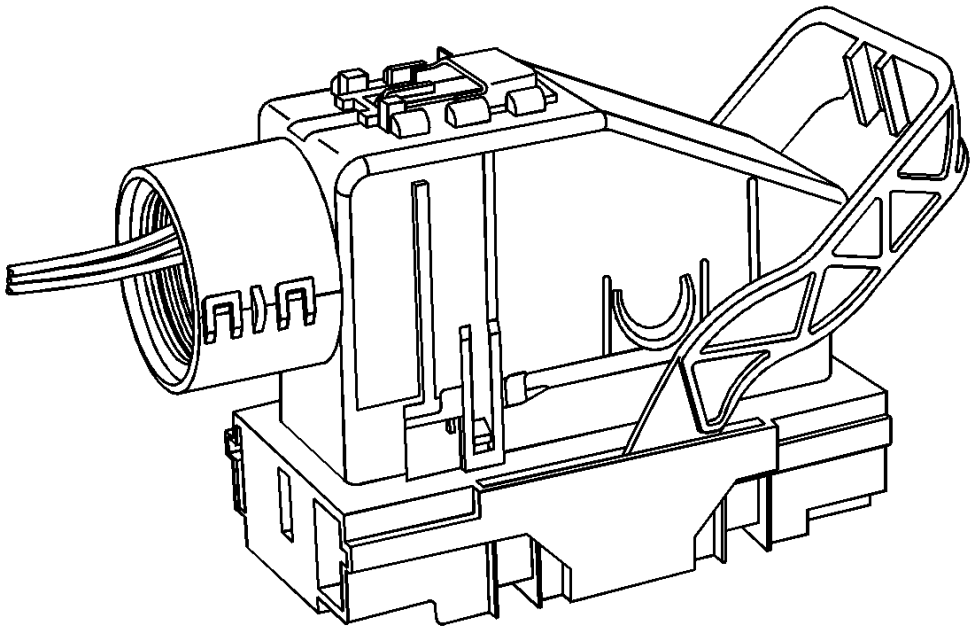


Fig. 38: View of connector in released position
Courtesy of GENERAL MOTORS COMPANY

5. View of connector in released position.
6. Disconnect the connector from the component.
7. Locate the dress cover locking tabs at the corners of the dress cover. Use a small flat-blade tool to release the locking tabs and remove the dress cover.

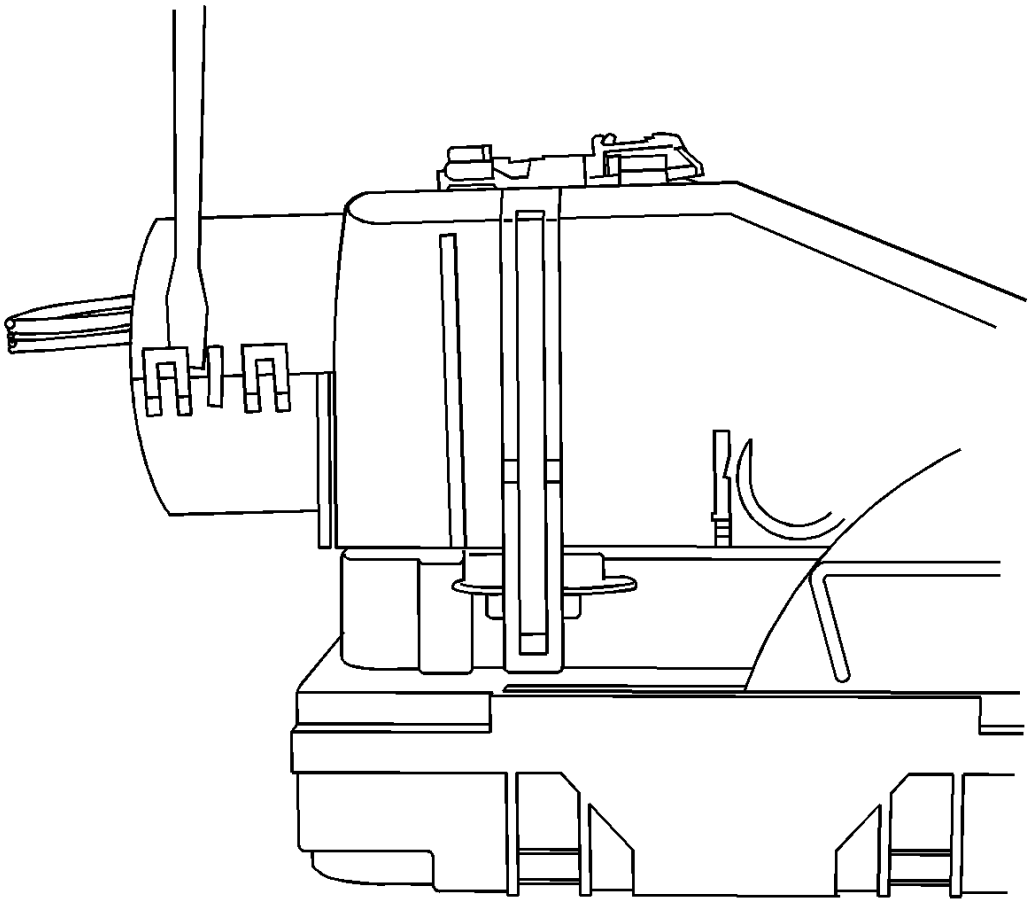


Fig. 39: View Of Connector In Released Position
Courtesy of GENERAL MOTORS COMPANY

8. Release the rear lower half of the wiredress cover.

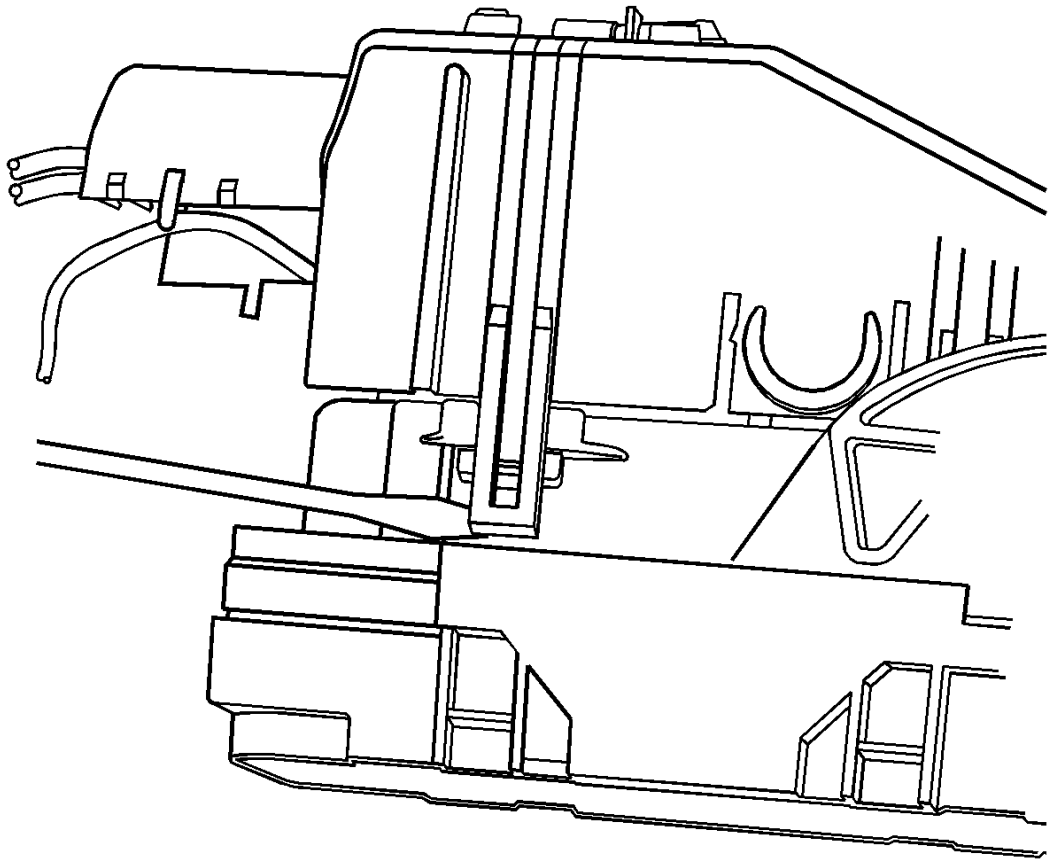


Fig. 40: Identifying Tabs Holding Wiredress Cover
Courtesy of GENERAL MOTORS COMPANY

9. Release the tabs that are holding the wiredress cover to the connector body.
10. Remove the nose piece by inserting a small flat-blade tool into the slots on both ends of the connector body. Gently pry the nose piece out of the connector. J-38125-216 can also be used to remove the nose piece.

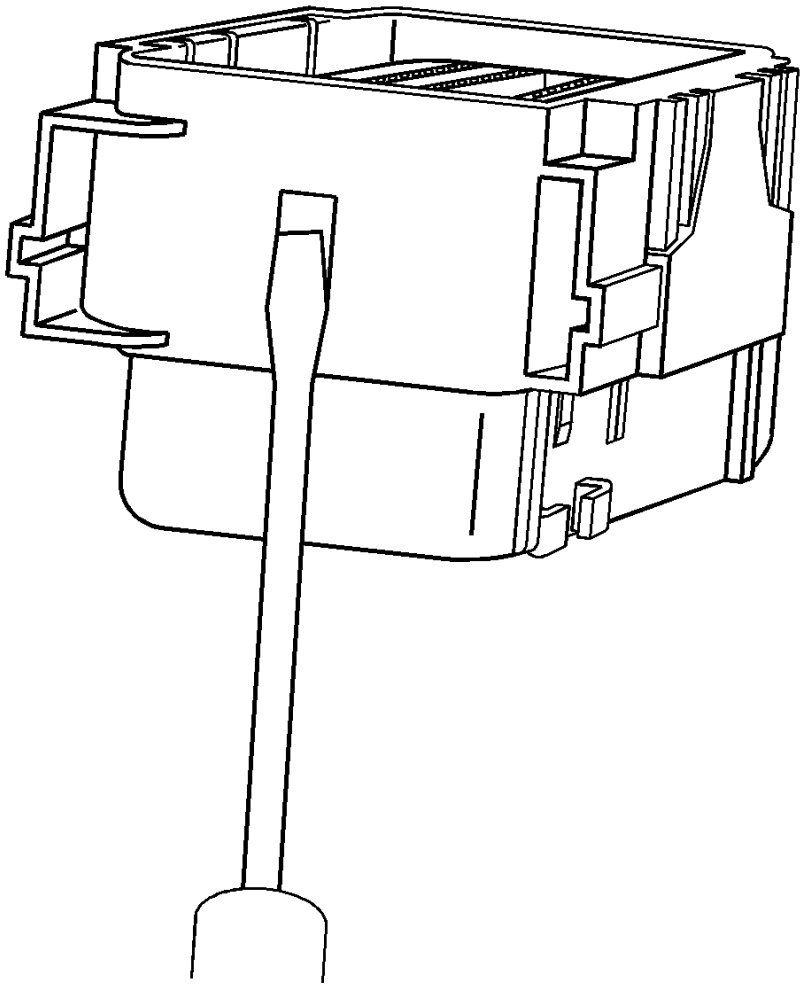


Fig. 41: Lifting Terminal Retaining Tabs
Courtesy of GENERAL MOTORS COMPANY

11. Use the J-38125-12A tool to release the terminals by lifting the terminal retaining tabs on the inside of the connector.

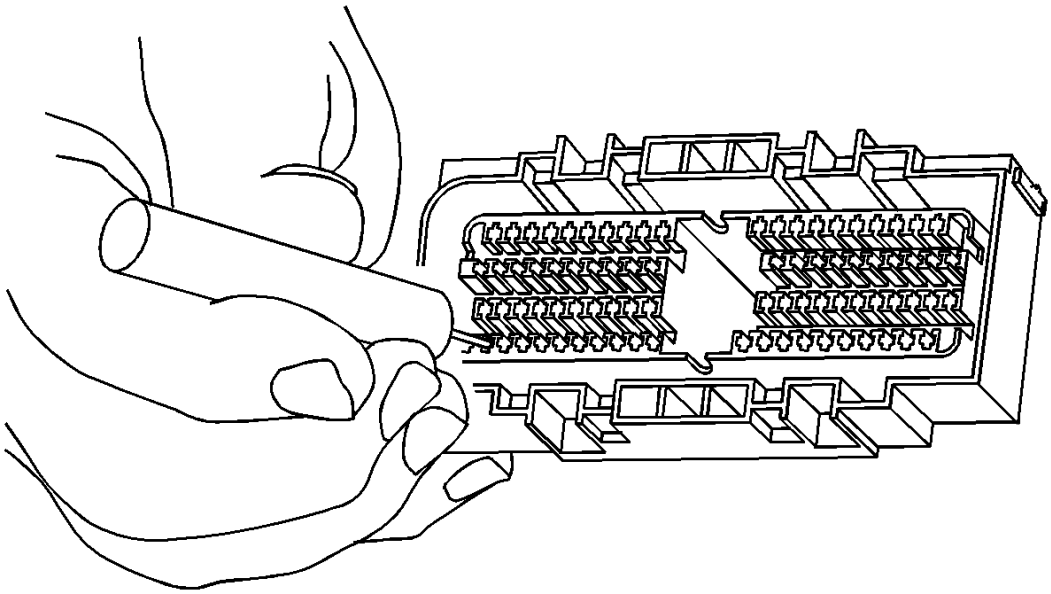


Fig. 42: Pulling Wire Out Of Back Of Connector
Courtesy of GENERAL MOTORS COMPANY

12. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
13. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
14. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

BOSCH CONNECTORS (BSK)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-561** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

1. Disconnect the connector from the component.
2. Remove the wire dress cover, if necessary.
3. Push the wire side of the terminal that is being removed toward the connector and hold it in position.

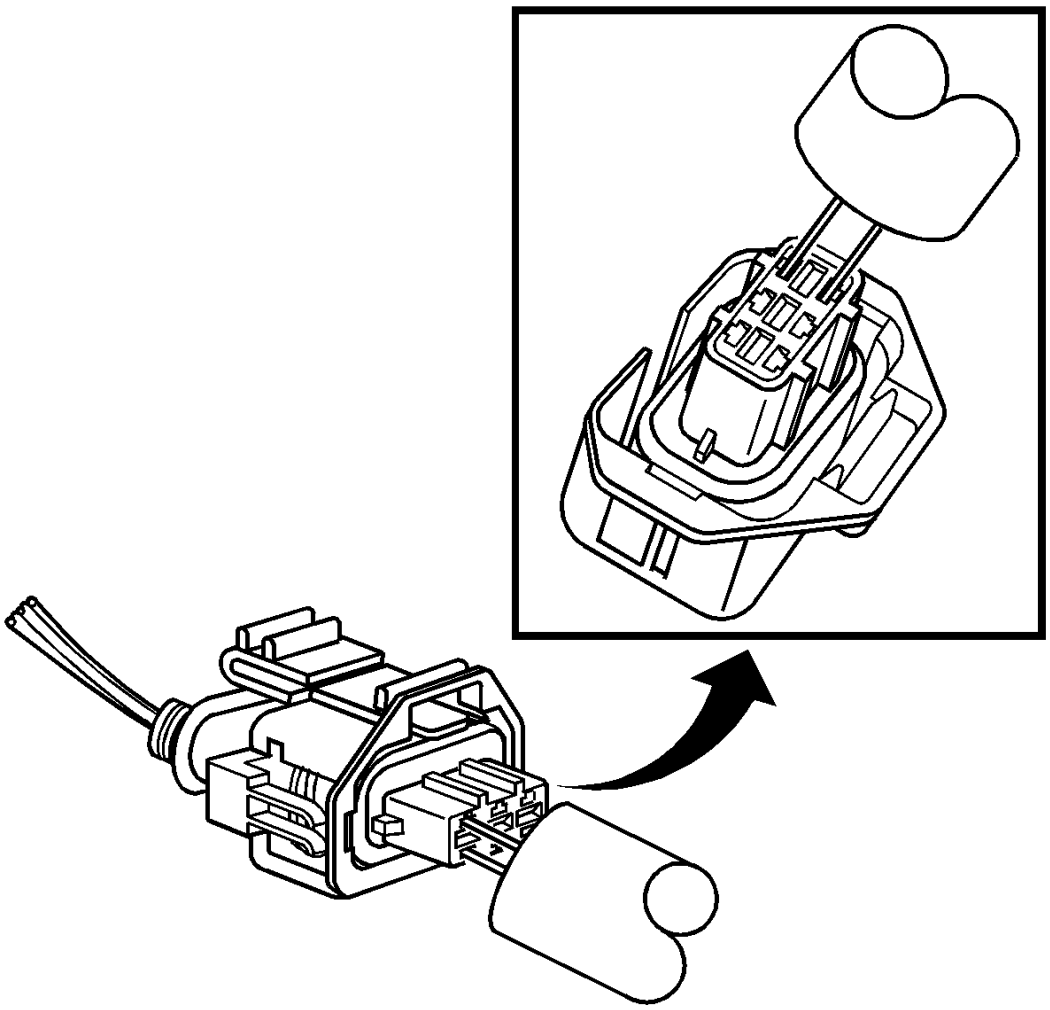


Fig. 43: View Of Bosch Connector Terminals (BSK)
Courtesy of GENERAL MOTORS COMPANY

4. Insert the J-38125-561 tool into the 2 cavities on each side of the terminal at the front of the connector and push until you feel the tool disengage the terminal retainers.
5. Carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
7. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

BOSCH CONNECTORS (0.64)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-560** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

1. Locate the lever lock on the wire dress cover. While pressing the lock, pull the lever over and past the lock until the lever is at the end of its travel.
2. Disconnect the connector from the component.
3. Pull the rubber boot that covers the wires back to expose the end of the connector dress cover.
4. Place the connector locking lever in the center of the connector.

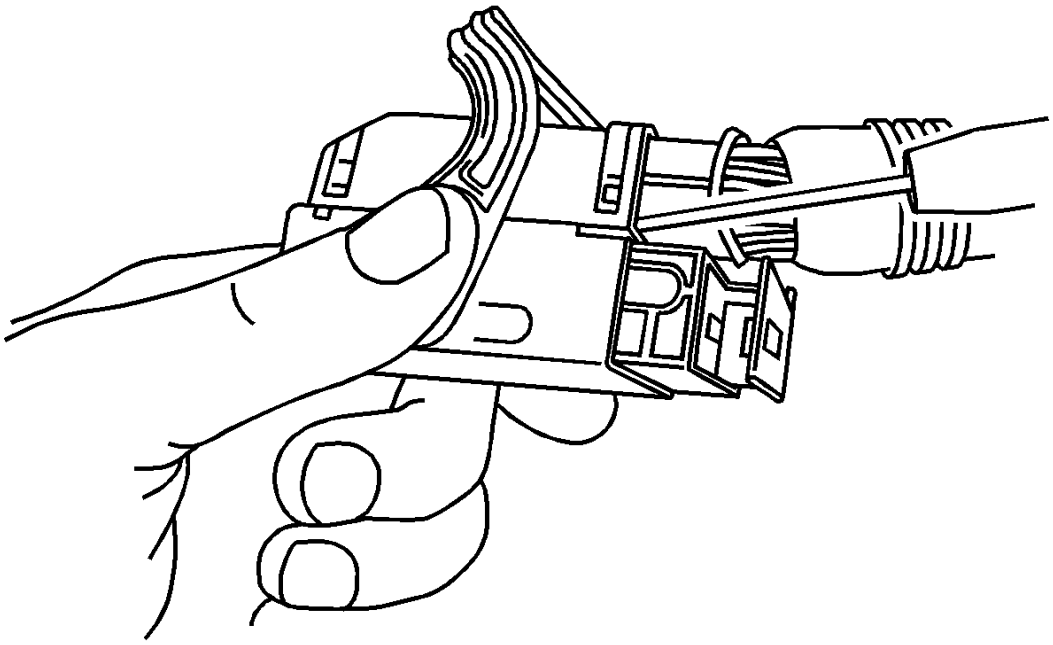


Fig. 44: View Of Flat-Bladed Tool Being Inserted Between Cover & Connector Body
Courtesy of GENERAL MOTORS COMPANY

5. Locate the 2 dress cover locking tabs that are on the wire end of the connector. Insert a small flat-bladed

tool between the cover and connector body and pry up.

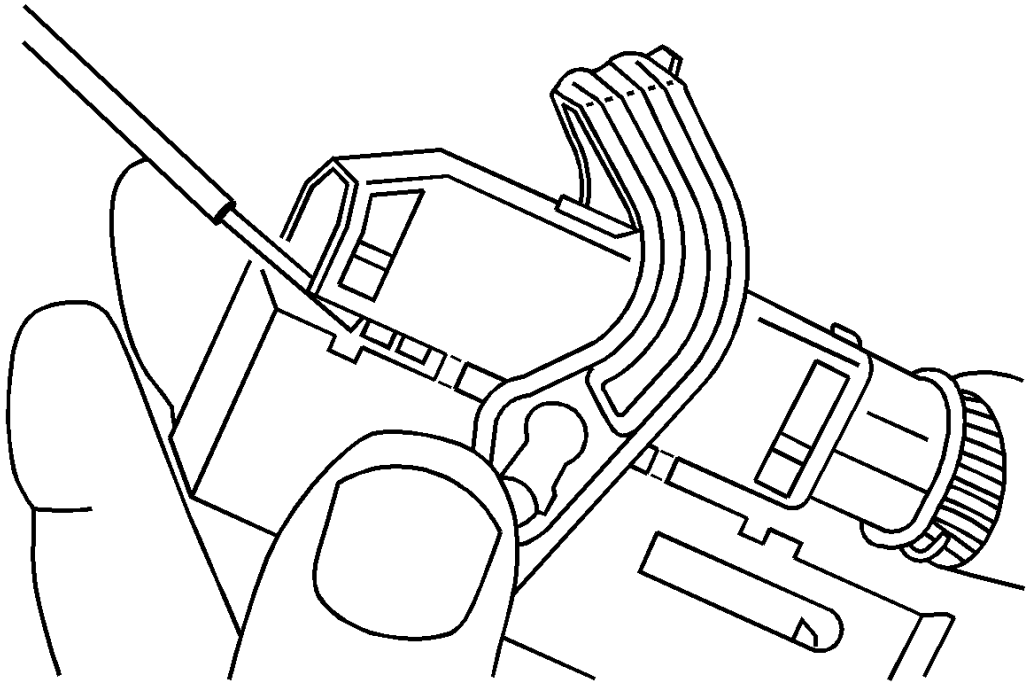


Fig. 45: View Of Flat-Bladed Tool Between Cover & Connector End
Courtesy of GENERAL MOTORS COMPANY

6. Locate the 2 dress cover locking tabs located on the opposite side of the connector. Insert a small flat-bladed tool between the cover at the connector end and pry up.
7. Remove the dress cover.
8. Cut the tie wrap on the wire bundle.

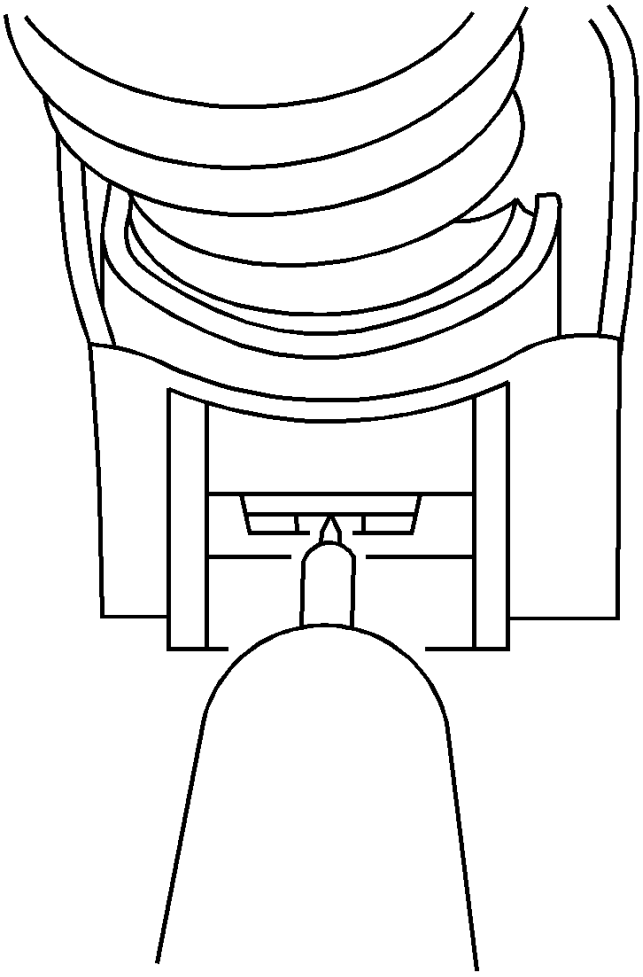


Fig. 46: View Of Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

9. Remove the terminal position assurance (TPA) by inserting a small flat-bladed tool into the small slot in the end of the slider and pushing on the TPA until it comes out of the connector. When the TPA exits the opposite side of the connector, gasp the TPA and pull it completely out of the connector.
10. Push the wire side of the terminal that is being removed toward the connector and hold it in position.

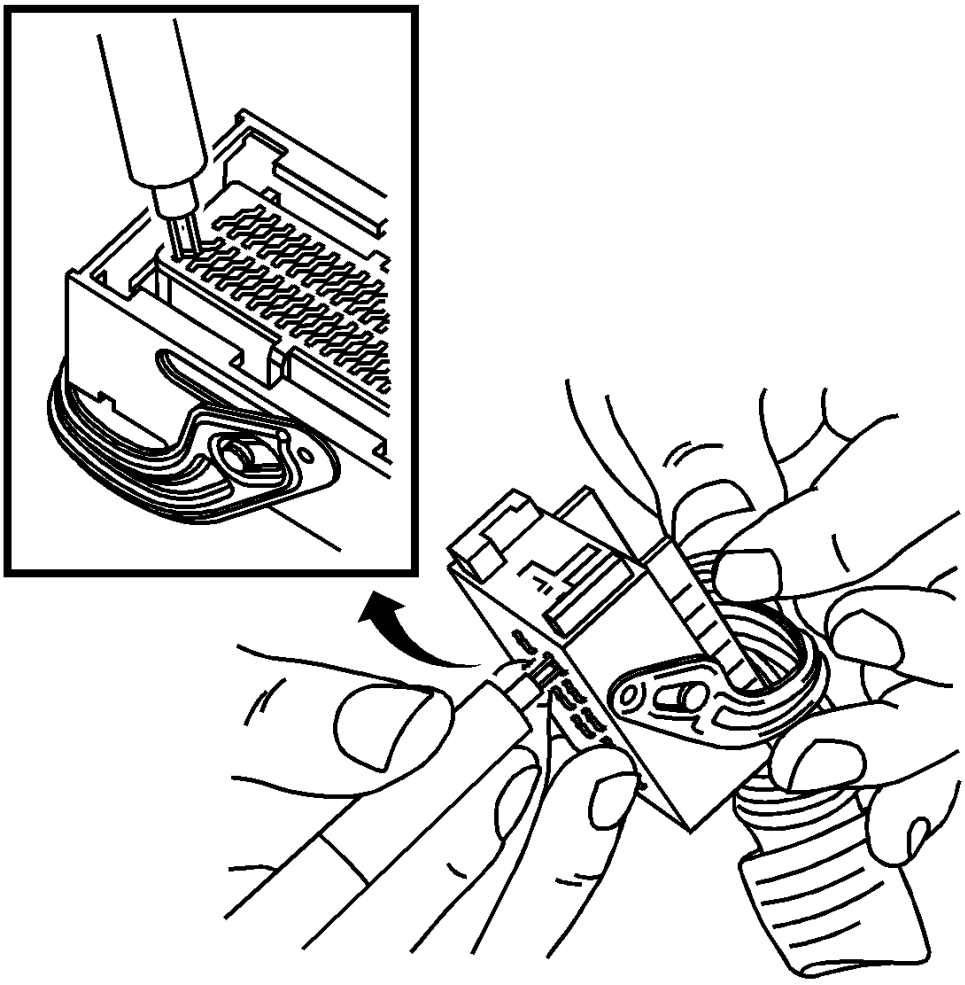


Fig. 47: Pulling Terminal Out Of Connector
Courtesy of GENERAL MOTORS COMPANY

11. Insert the J-38125-560 into the 2 triangular cavities on each side of the terminal at the front of the connector.
12. Carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.
13. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
14. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminal Insertion Procedure

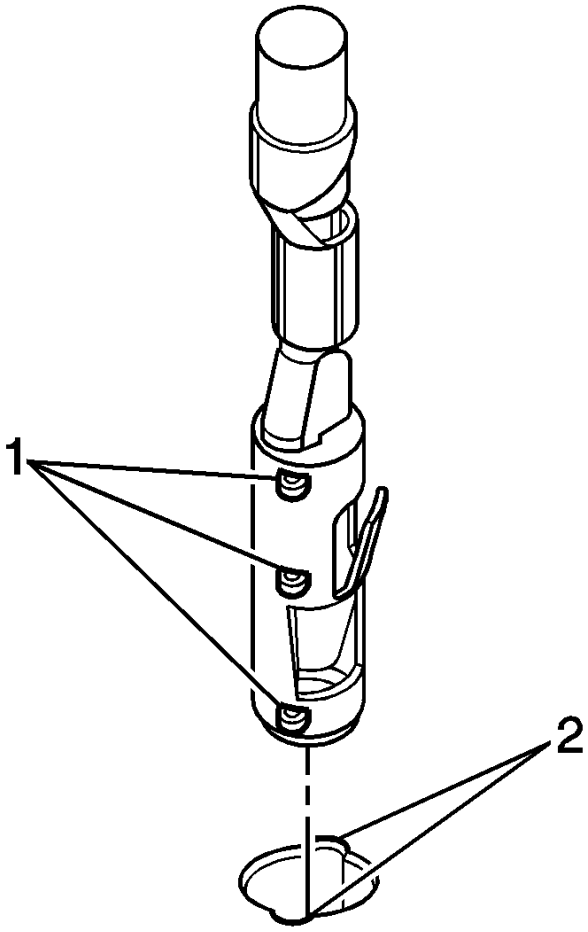


Fig. 48: Aligning Coding Lugs With Connector Coding Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Prior to installation the terminal must be aligned so the (1) coding lugs align with the (2) coding grooves on the connector.
2. Once the terminal is aligned, slide the terminal into the cavity until the retainer has engaged in the cavity of the connector.
3. Slide the TPA in the connector body and seat it using a small flat bladed tool. The TPA is seated when it is flush with the contact housing.
4. Secure the wires to the connector body using a tie wrap and replace the dress cover and grommet.

BOSCH CONNECTORS (2.8 JPT)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-557** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

1. Pull out the slider on the connector position assurance (CPA) until it is at the end of its travel.
2. Disconnect the connector from the component.
3. Remove the wire dress cover, if necessary.
4. Push the wire side of the terminal that is being removed toward the connector and hold it in position.

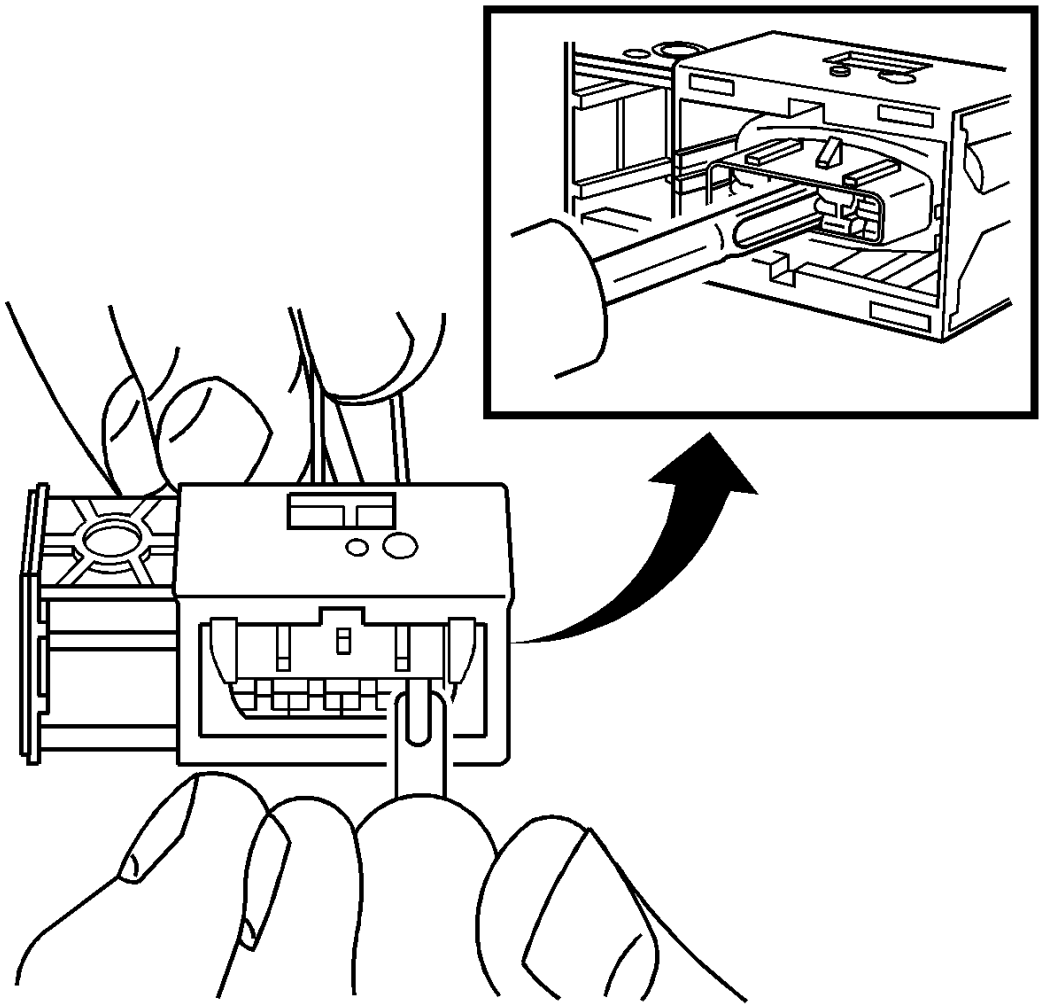


Fig. 49: View Of Bosch Connector Terminals (2.8 JPT)
Courtesy of GENERAL MOTORS COMPANY

5. Insert the J-38125-557 into the 2 cavities on each side of the terminal at the front of the connector and push until you feel the tool disengage the terminal retainers.
6. Carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.
7. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
8. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and

reconnect the connector bodies.

BOSCH CONNECTORS (ECM)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-213** Terminal Release Tool
- **J-38125-556** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

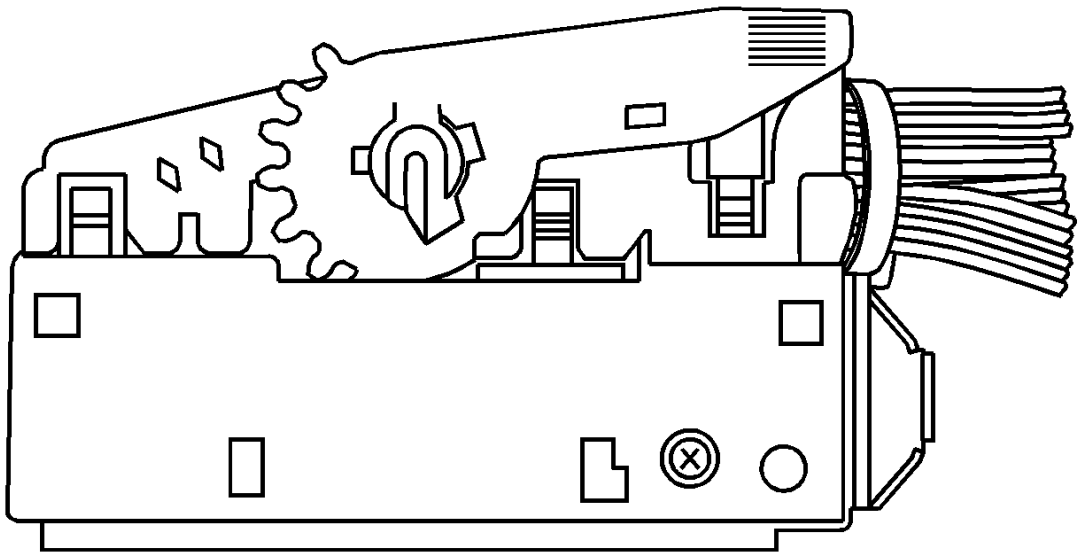


Fig. 50: View Of Bosch Connectors
Courtesy of GENERAL MOTORS COMPANY

1. Locate the assist lever on the top of the connector. Move the assist lever to the forward position.

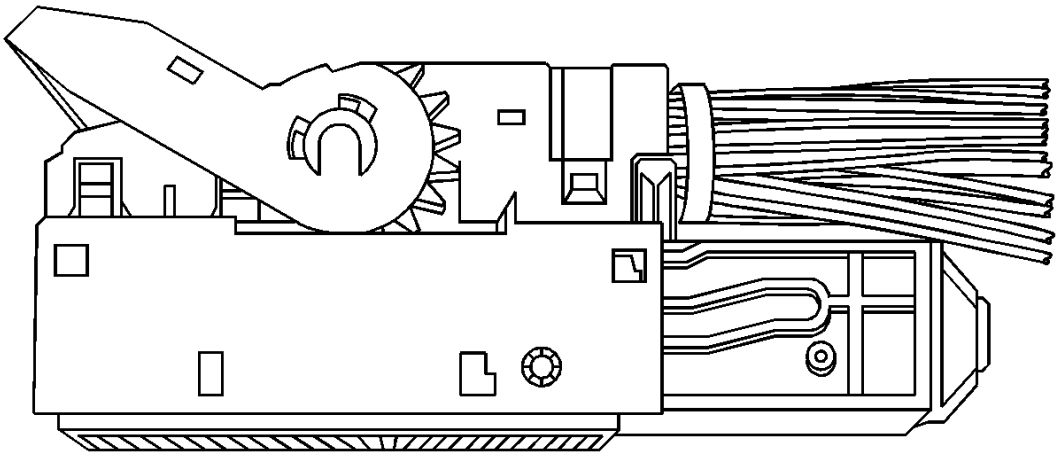


Fig. 51: Identifying Assist Lever In Forward Position
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the connector from the component.

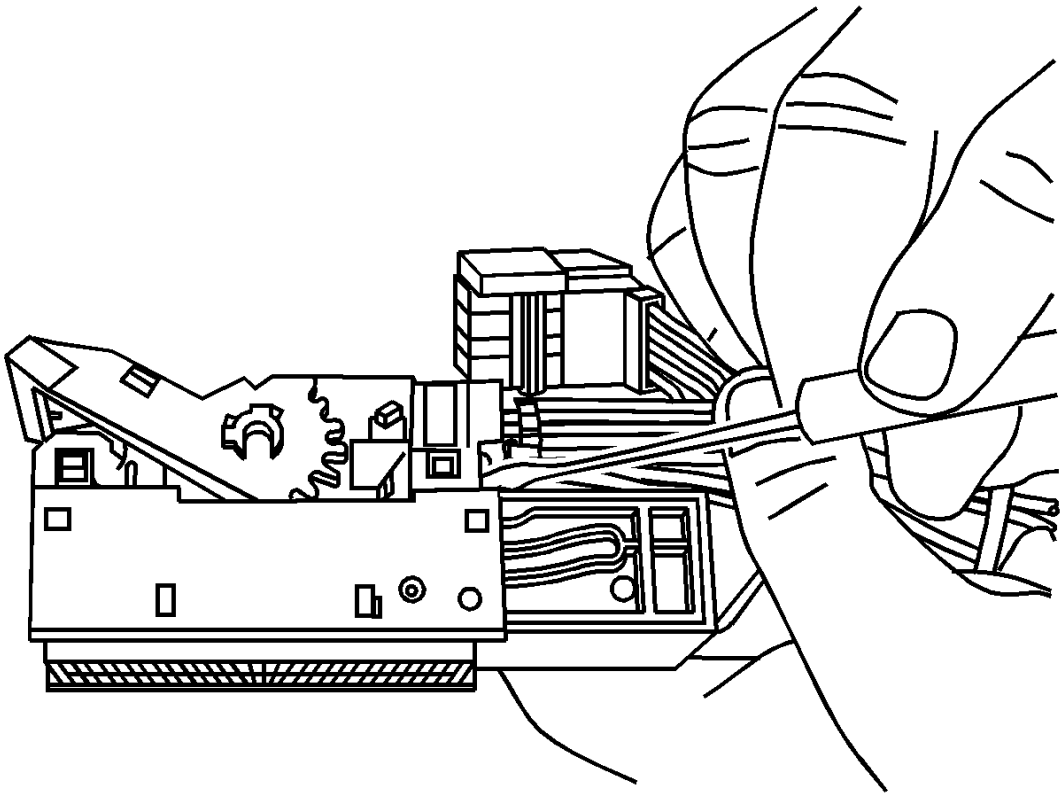


Fig. 52: View Of Releasing Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Locate the dress cover locking tabs at the corners of the connector. Use a small flat-blade tool to release the locking tabs and remove the dress cover.

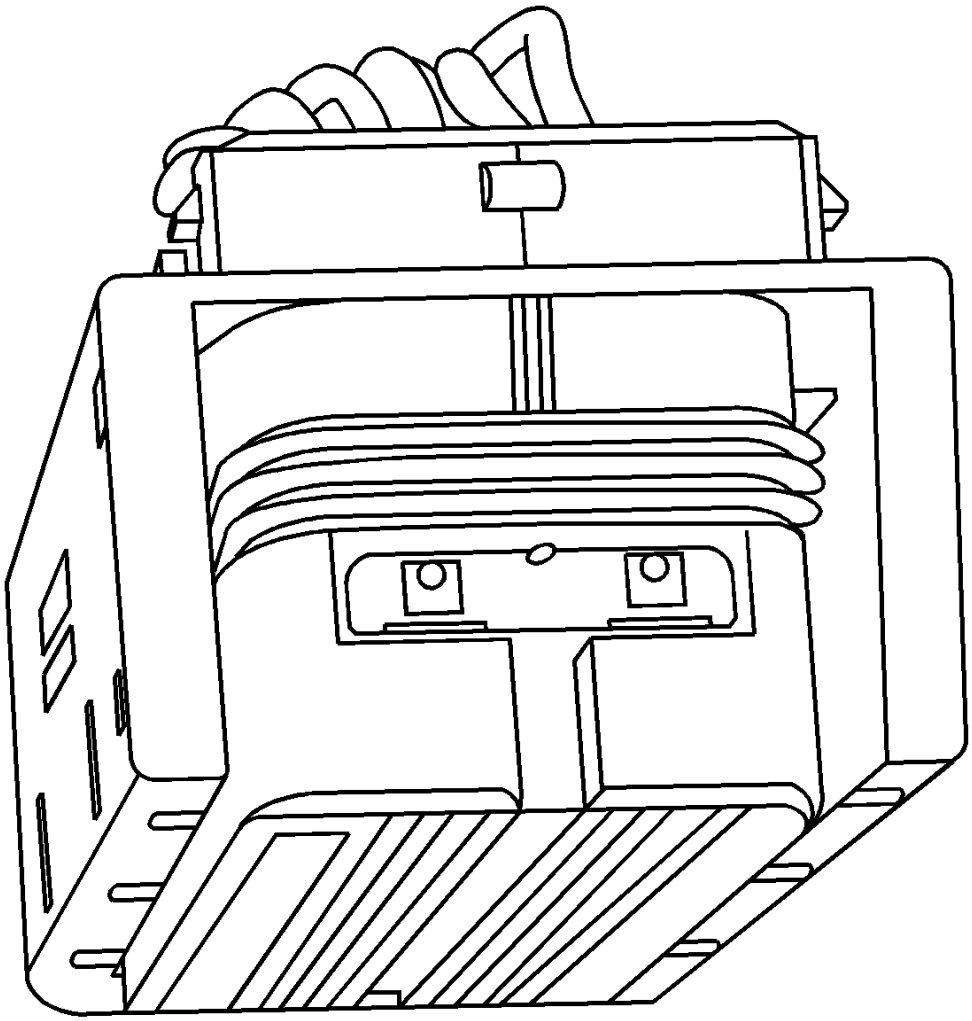


Fig. 53: View Of Terminal Positive Assurance (TPA) Connector
Courtesy of GENERAL MOTORS COMPANY

4. The terminal positive assurance (TPA) is located in the front of the connector.

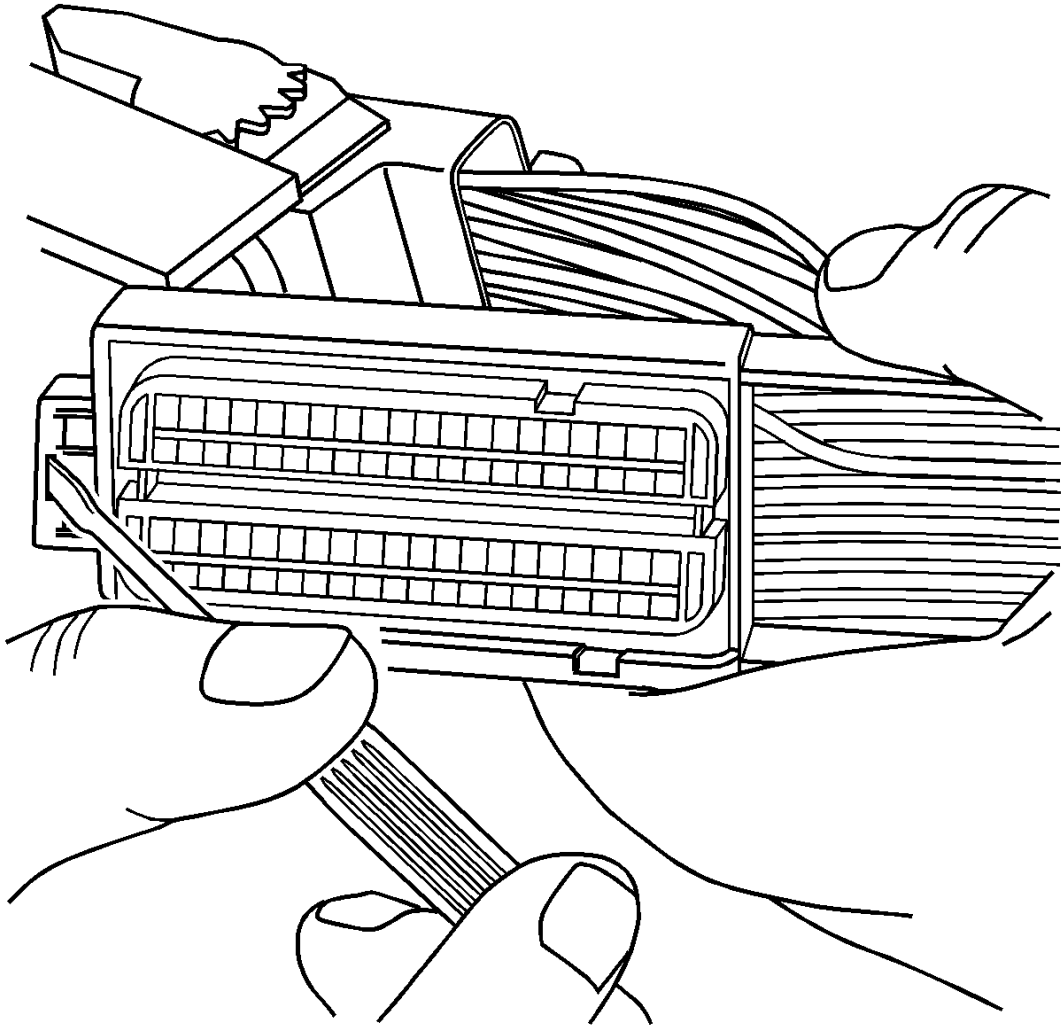


Fig. 54: View Of Removing TPA From Connector
Courtesy of GENERAL MOTORS COMPANY

5. Use a small flat-blade tool to remove TPA from the connector.

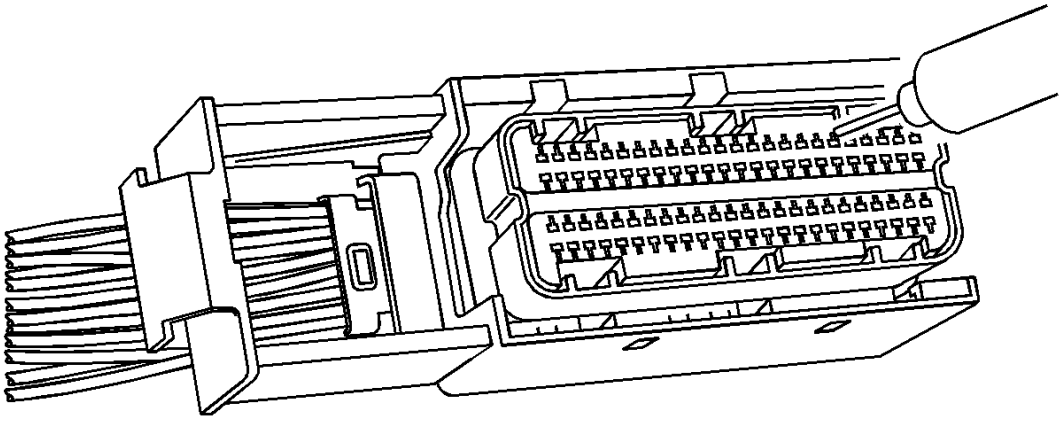


Fig. 55: View Of Special Tools And Terminals
Courtesy of GENERAL MOTORS COMPANY

6. Use the J-38125-213 or the J-38125-556 tool to release the terminals by inserting the tool into the terminal release cavity.
7. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
8. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
9. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

NOTE: **Ensure that the dress cover and connector body are both in the released position before reassembling. Failure to do so may cause damage to the connector and component.**

10. Reconnect the connector bodies.

DELPHI CONNECTORS (WEATHER PACK)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-10A** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

The following is the proper procedure for the repair of Weather PackÂ® Connectors.

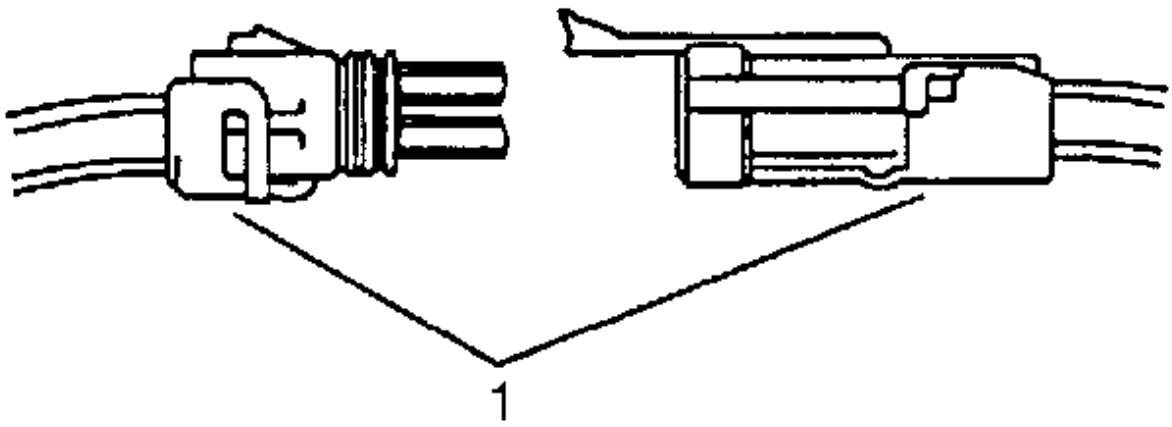


Fig. 56: View Of Connector Halves
Courtesy of GENERAL MOTORS COMPANY

1. Separate the connector halves (1).
2. Open the secondary lock. A secondary lock aids in terminal retention and is usually molded to the

connector (1).

3. Grasp the wire and push the terminal to the forward most position. Hold the wire in this position.

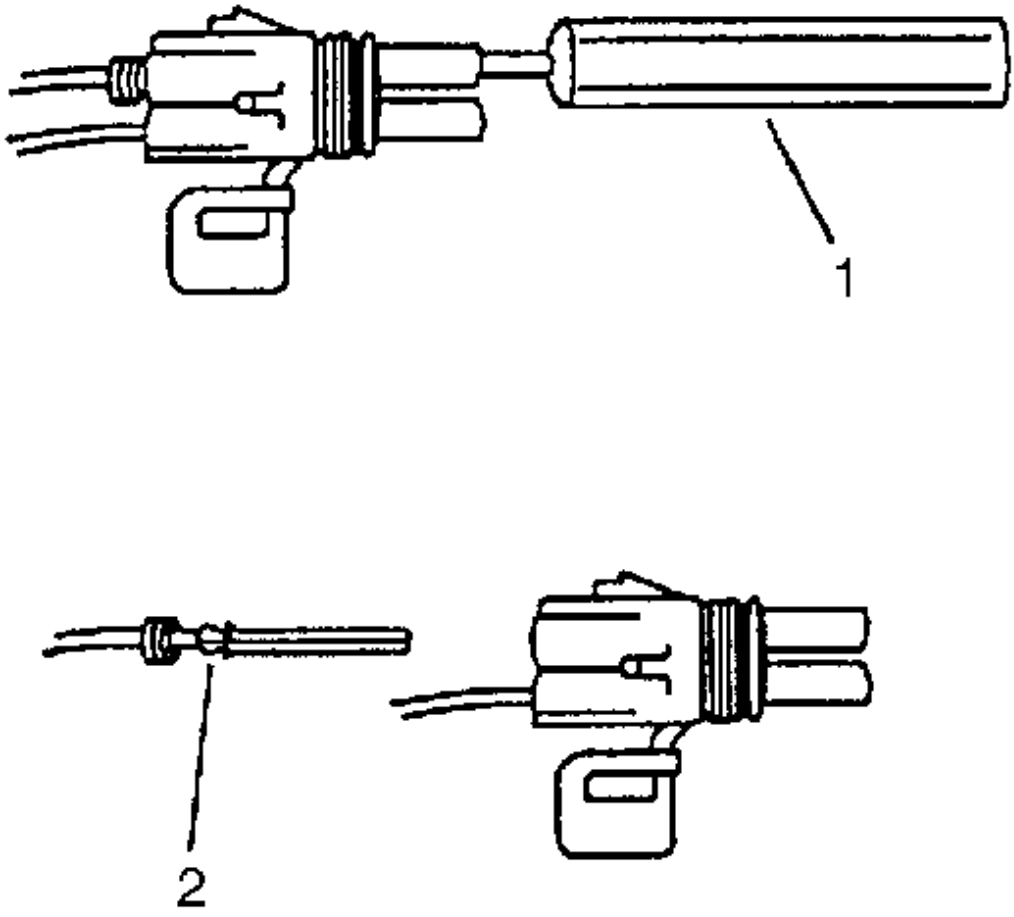


Fig. 57: Identifying Removal Tool & Terminal
Courtesy of GENERAL MOTORS COMPANY

4. Insert the Weather PackÂ® terminal removal tool J-38125-10A into the front (mating end) of the connector cavity until it rests on the cavity shoulder (1).
5. Gently pull on the wire to remove the terminal through the back of the connector (2).

NOTE: **Never use force to remove a terminal from a connector.**

6. Inspect the terminal and connector for damage. Repair as necessary. Refer to **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)**.
7. Reform the lock tang (2) and reset terminal in connector body.
8. Close secondary locks and join connector halves.

9. Verify that circuit is complete and working satisfactorily.
10. Perform system check.
11. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
12. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

DELPHI CONNECTORS (PUSH TO SEAT)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

Follow the steps below in order to repair push to seat connectors.

1. Remove the terminal position assurance (TPA) device, the connector position assurance (CPA) device, and/or the secondary lock.

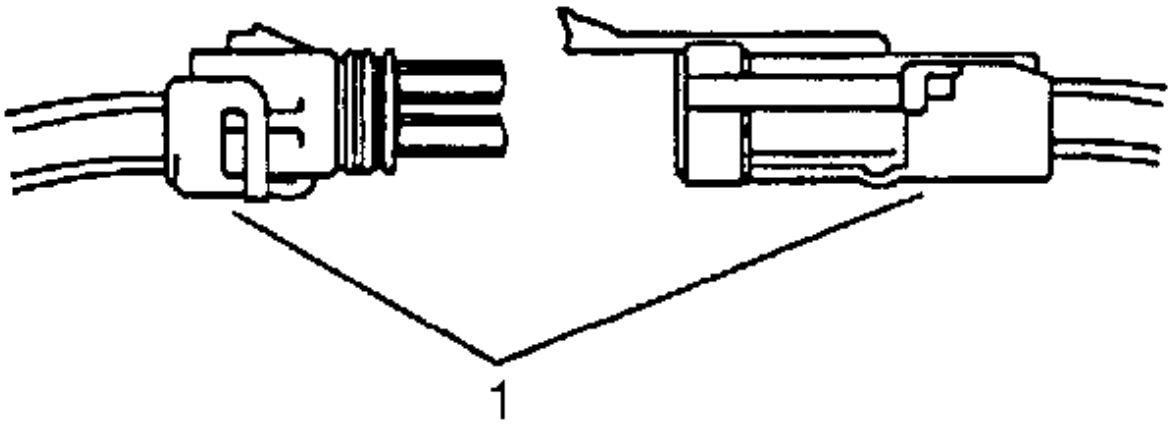


Fig. 58: View Of Connector Halves
Courtesy of GENERAL MOTORS COMPANY

2. Separate the connector halves (1).

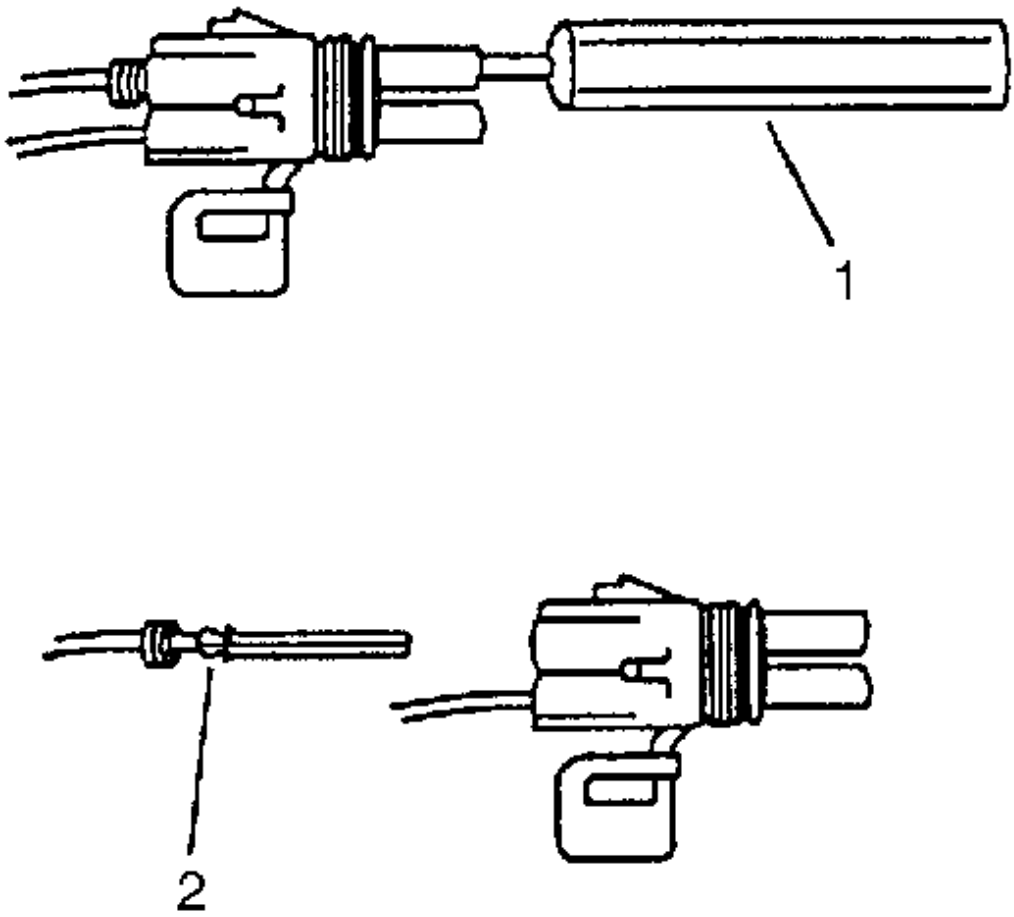


Fig. 59: Identifying Removal Tool & Terminal
Courtesy of GENERAL MOTORS COMPANY

3. Use the proper pick or removal tool (1) in order to release the terminal.
4. Gently pull the cable and the terminal (2) out of the back of the connector.

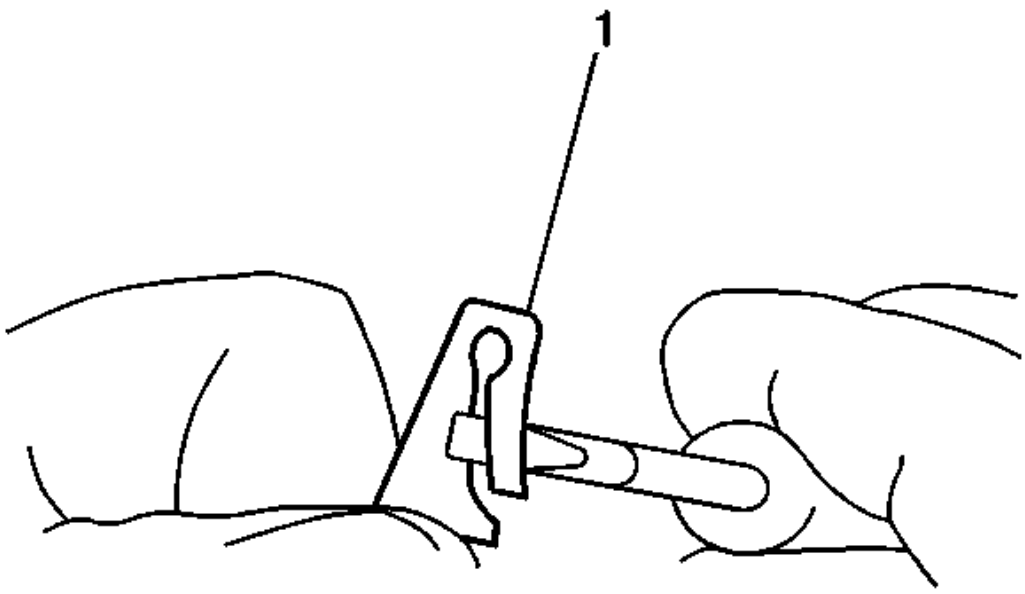


Fig. 60: Identifying Locking Device
Courtesy of GENERAL MOTORS COMPANY

5. Re-form the locking device if you are going to reuse the terminal (1).
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
7. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminal Insertion Procedure

1. In order to reuse a terminal or lead assembly, refer to **Wiring Repairs**.
2. Ensure that the cable seal is kept on the terminal side of the splice.
3. Insert the lead from the back until it catches.
4. Install the TPA, CPA, and/or the secondary locks.

DELPHI CONNECTORS (PULL TO SEAT)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

If the terminal is visibly damaged or is suspected of having a faulty connection, the terminal should be replaced.

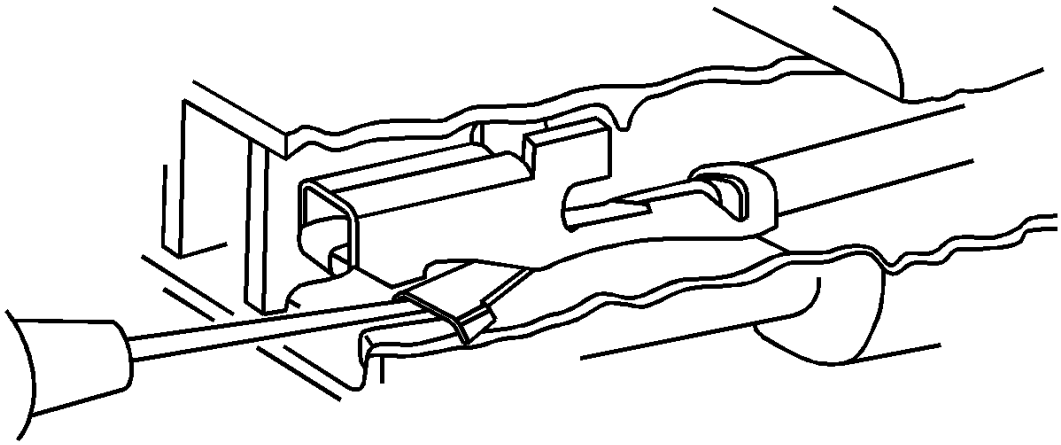


Fig. 61: Aligning Removal Tool - Delphi (Pull To Seat)
Courtesy of GENERAL MOTORS COMPANY

Follow the steps below in order to repair pull-to-seat connectors:

1. Remove the connector position assurance (CPA) device and/or the secondary lock.
2. Disconnect the connector from the component or separate the connectors for in-line connectors.
3. Remove the terminal position assurance (TPA) device.
4. Review the connector end view to determine the proper test probe and release tool.
5. Insert the release tool into the front of the connector body.
6. Grasp the wire at the back of the connector body and gently push the terminal out the front of the

connector body.

7. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
8. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminal Insertion Procedure

1. Align the terminal and pull the wire from the back of the connector in order to seat the terminal.
2. If the connector is outside of the passenger compartment, apply dielectric grease to the connector.
3. Install the TPA, CPA, and/or the secondary locks.

DELPHI CONNECTORS (MICRO-PACK 100W)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

There are 2 styles of Micro-Pack 100W connectors. These connectors are very similar but use different terminals and have some minor physical differences also.

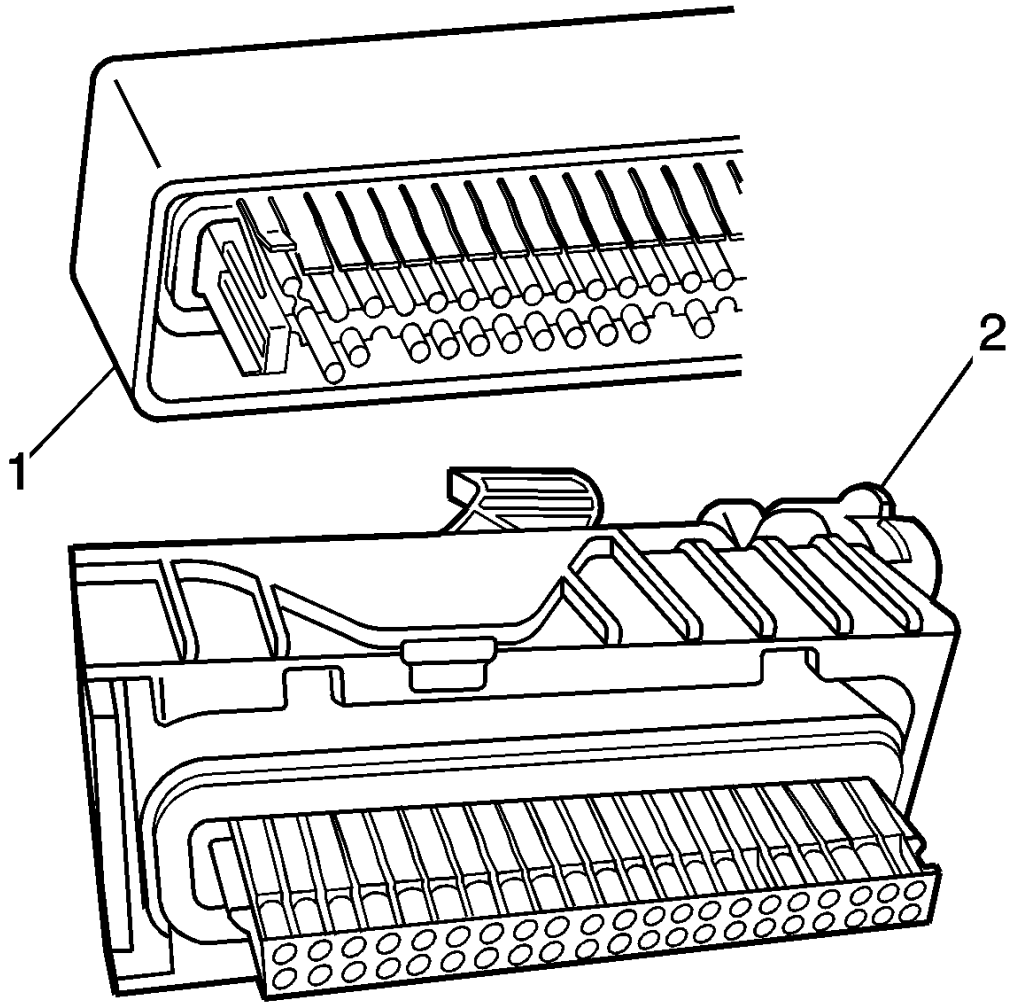


Fig. 62: Identifying Micro-Pack 100W First & Second Connector Designs
Courtesy of GENERAL MOTORS COMPANY

The first connector design of the Micro-Pack 100W (1) has a white connector interface that holds the terminals. The second design of the Micro-Pack 100W (2) has a gray interface to hold the terminals. Also, the first design has terminal cavities that are further apart (3 mm centerline) and offset from the other row of terminal cavities in the connector. The second design has terminals cavities that are closer together (2.54 mm centerline) and aligned vertically. One other way to identify the second design is the thin strip of material that runs along the outside of the cavities.

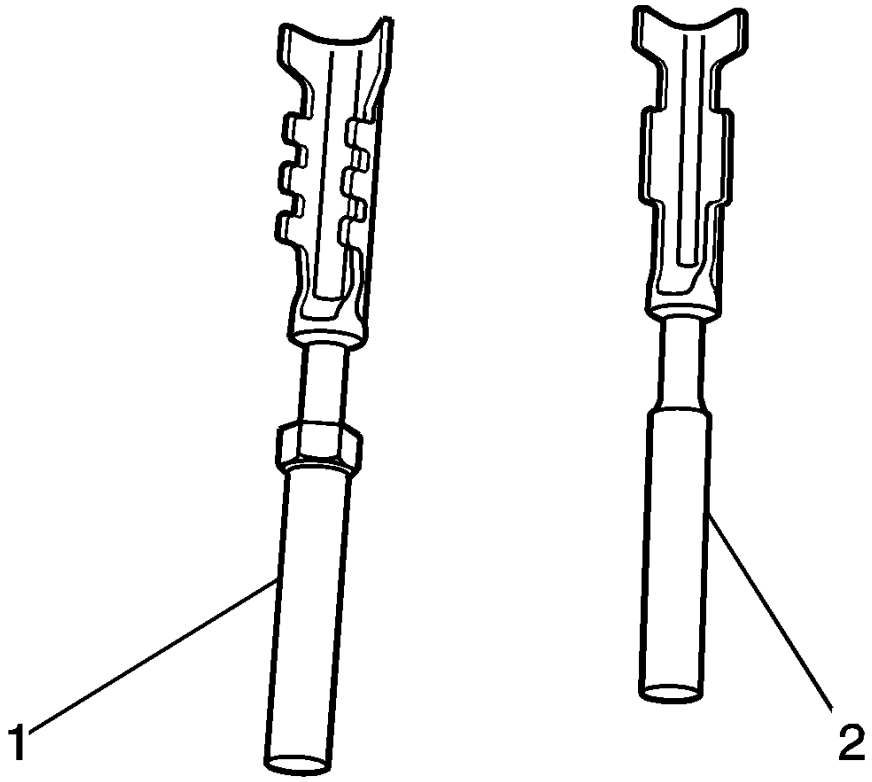


Fig. 63: Identifying Micro-Pack 100W Short & Long Terminals
Courtesy of GENERAL MOTORS COMPANY

NOTE: **There are 2 styles of Micro-Pack 100W terminals which are very similar. Ensure that you have the correct terminal before crimping the new terminal to the wire. The first design connector uses the longer terminal (1) that has a raised area in front of the recess in the terminal. The second design connector uses the shorter terminal without the raised area.**

Follow the steps below in order to remove terminals from Micro-Pack 100W connectors. Some Micro-Pack 100W connector disassembly procedures will vary. Use this procedure as a guide.

1. Disconnect the connector from the component.

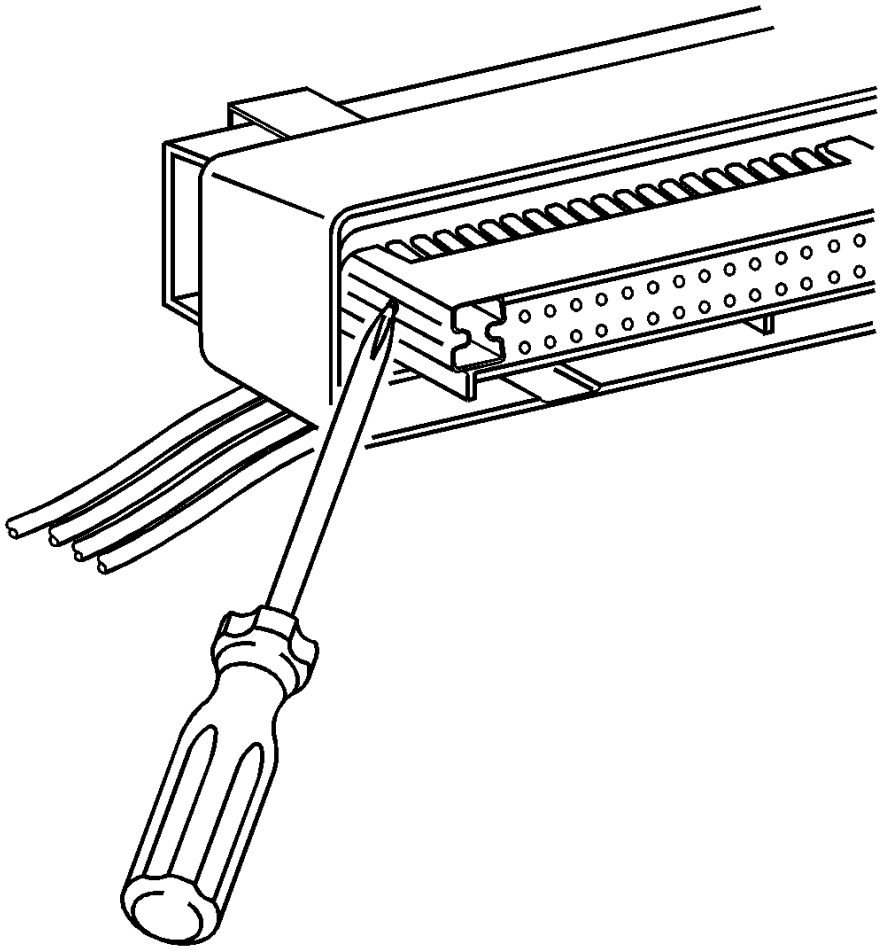


Fig. 64: Locating Nose Piece Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

2. Locate the nose piece locking tabs that are positioned on the side of the connector nose piece. The connector nose piece acts as a terminal positive assurance (TPA) and may be referred to as such.

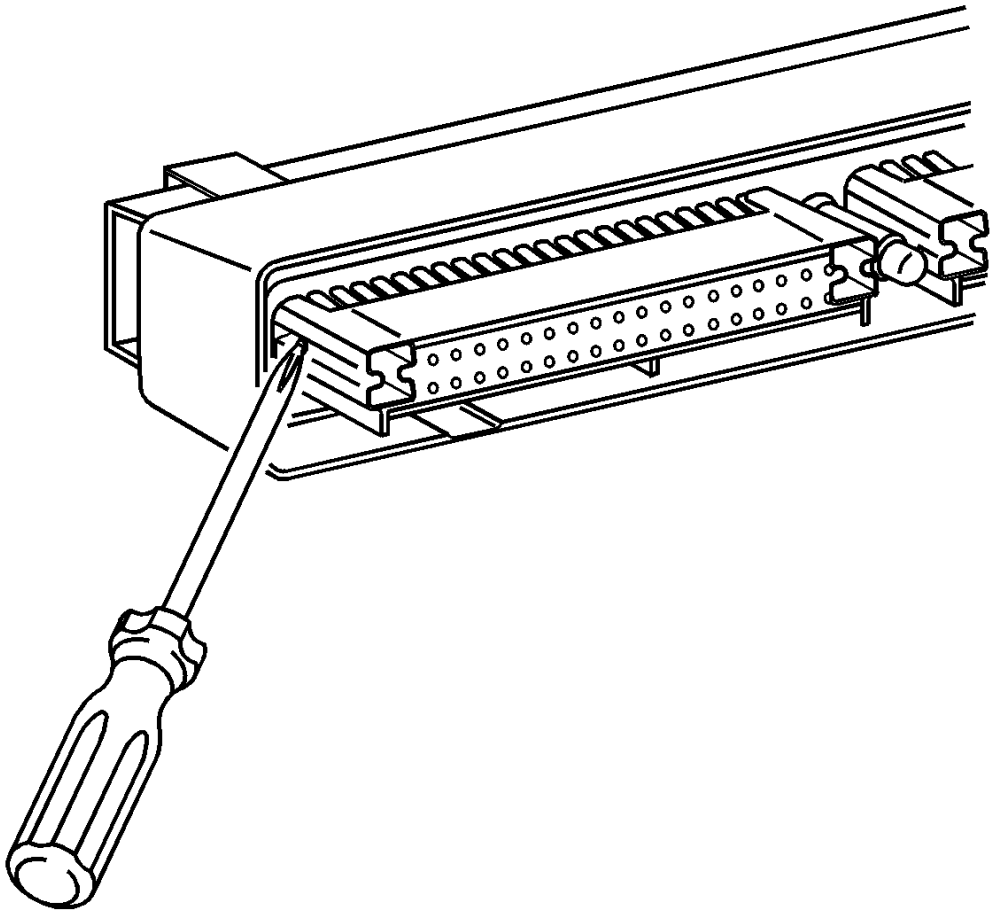


Fig. 65: Loosening Nose Piece Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Use a small flat-blade tool to push in one of the locking tabs while gently pulling on the same side of the nose piece.
4. Repeat the procedure for the other locking tab and remove the nose piece.
5. Remove the wire dress cover. The following is a general procedure for wire dress cover removal. Use this procedure as a guide, some dress cover removal procedures may vary.

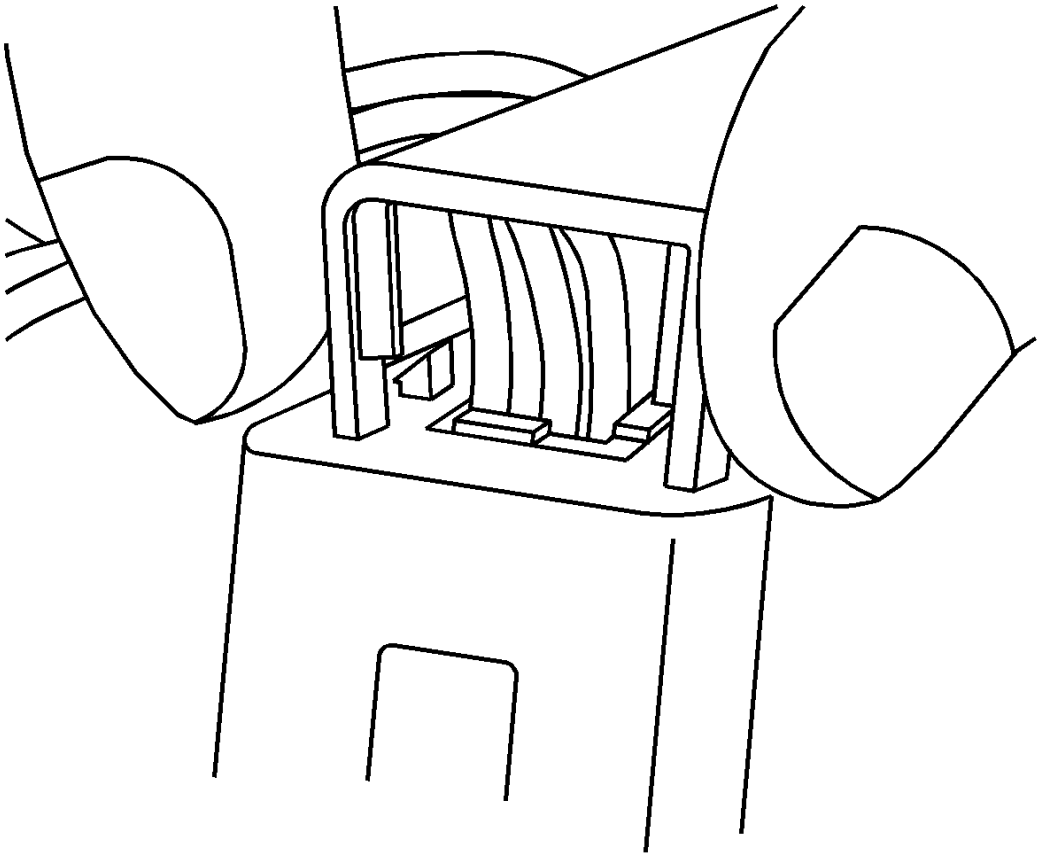


Fig. 66: Squeezing Cover Locking Legs
Courtesy of GENERAL MOTORS COMPANY

6. Use fingers to squeeze the 2 locking legs of the cover.

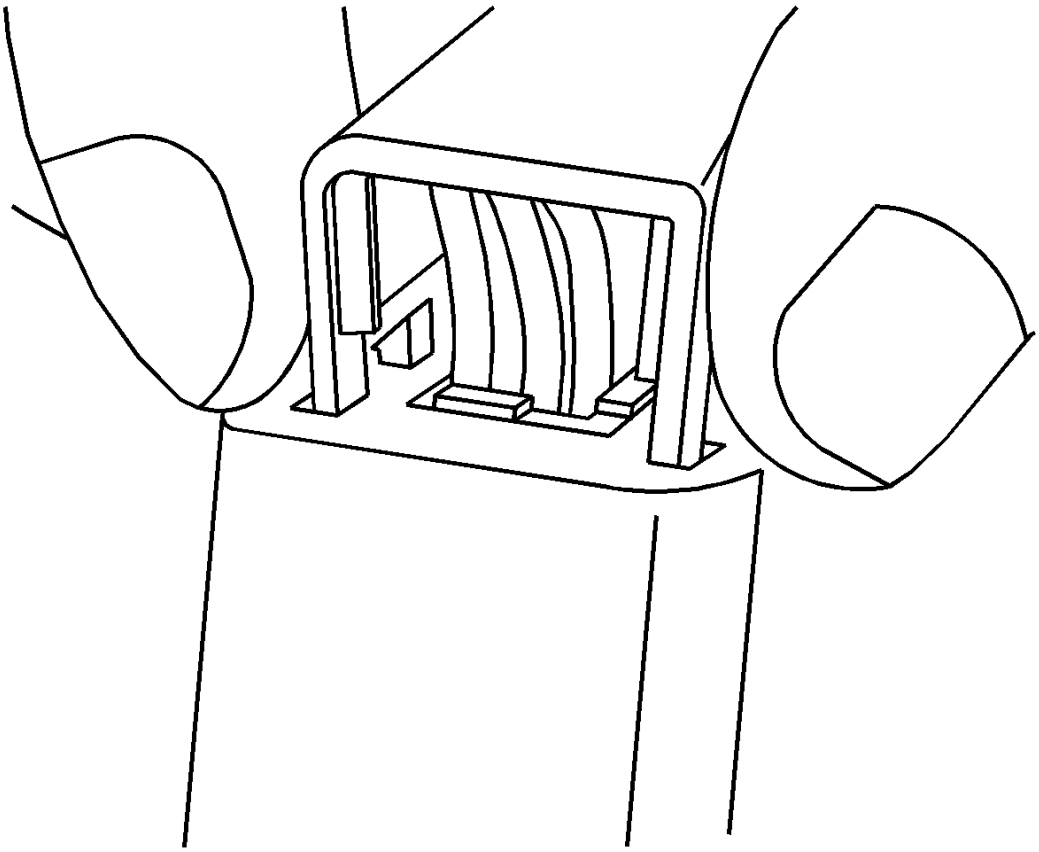


Fig. 67: Unseating Locking Leg
Courtesy of GENERAL MOTORS COMPANY

7. Apply pressure and gently rock the cover until one locking leg is unseated.

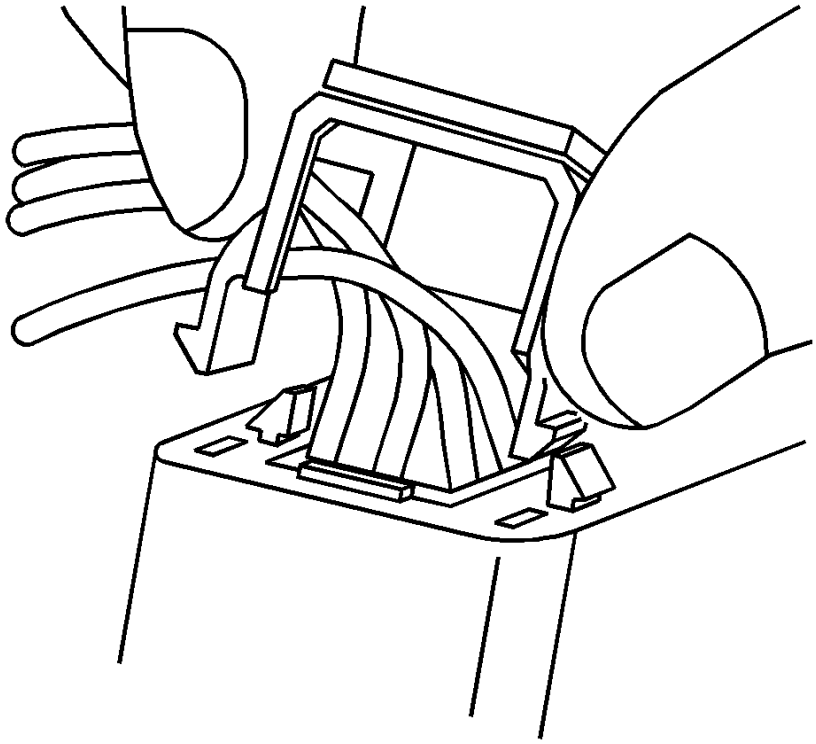


Fig. 68: Removing Cover
Courtesy of GENERAL MOTORS COMPANY

8. Continue to apply pressure and rock the cover until the second locking leg is unseated. Repeat procedure for the other side of the dress cover and remove the cover.

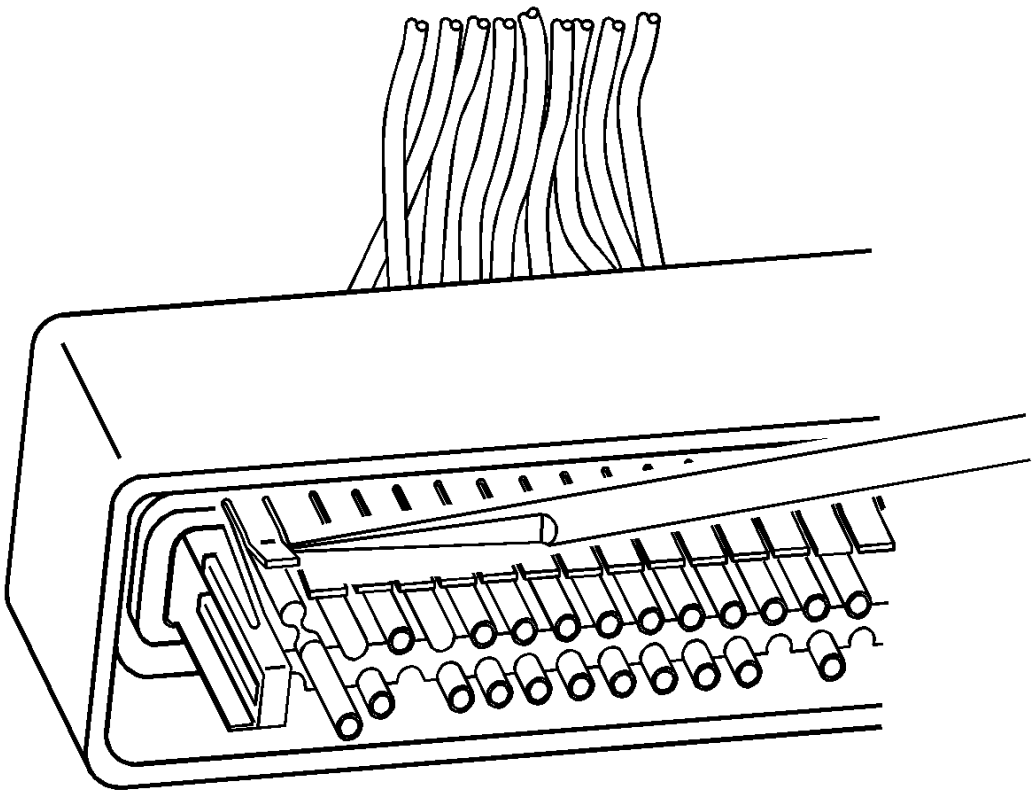


Fig. 69: Identifying Terminal Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

9. Use J-38125-12A to gently lift the terminal retaining tab while gently pulling the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
10. If the terminal is severely bent or damaged, it may be possible on some connectors to push the wire out of the front of the connector instead of pulling it through. This will prevent damage to the internal seals of the connector. Once the terminal is pushed out of the connector, cut the wire as close to the terminal as possible and pull the wire through the connector.
11. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
12. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminal Insertion Procedure

After the terminal is crimped to the wire perform the following procedure in order to replace Micro-Pack 100 terminals.

1. Slide the new terminal into the correct cavity at the back of the connector.

2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Ensure that the terminal is locked in place by gently pulling on the wire.
3. To assemble the connector, reverse the Terminal Removal Procedure.

DELPHI CONNECTORS (MICRO .64)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-21** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

Follow the steps below in order to remove terminals from Micro .64 connectors.

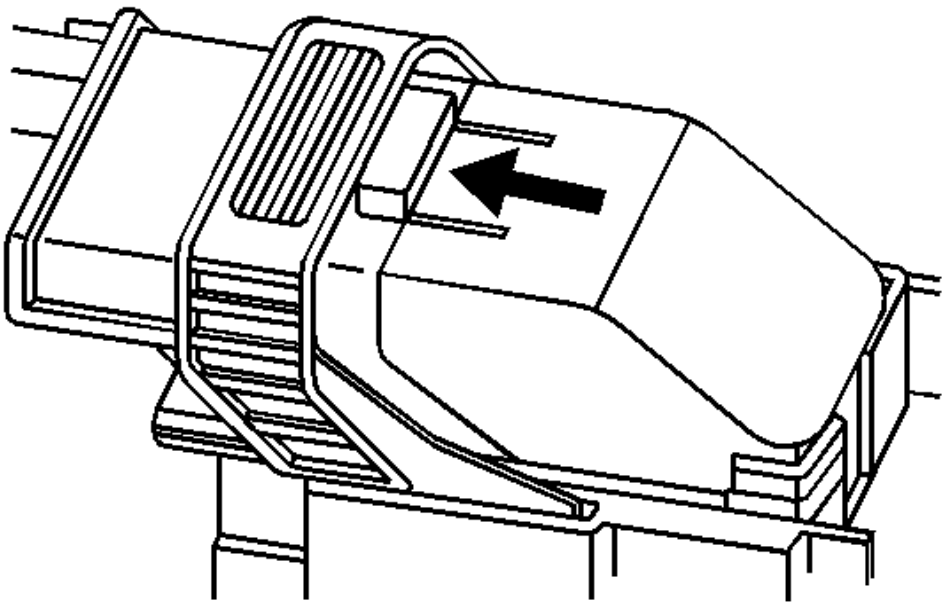


Fig. 70: Identifying Wire Dress Cover Lever Lock
Courtesy of GENERAL MOTORS COMPANY

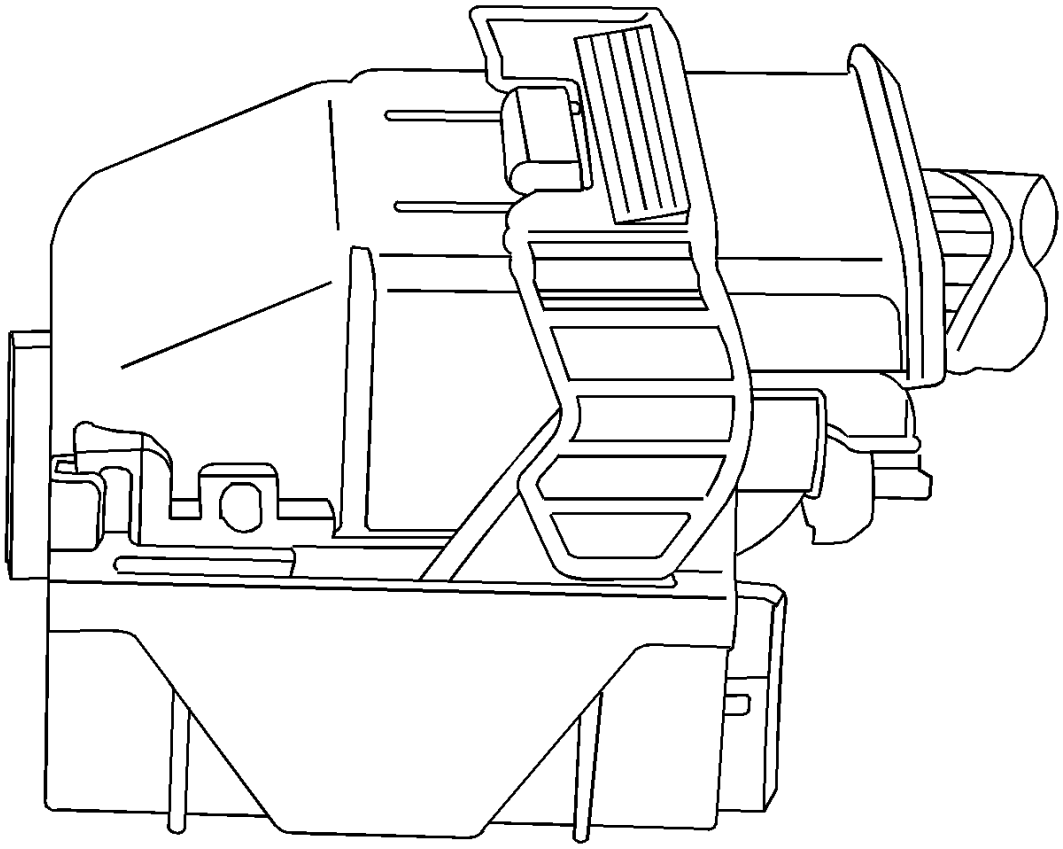


Fig. 71: View Of Typical Micro 64 Connector
Courtesy of GENERAL MOTORS COMPANY

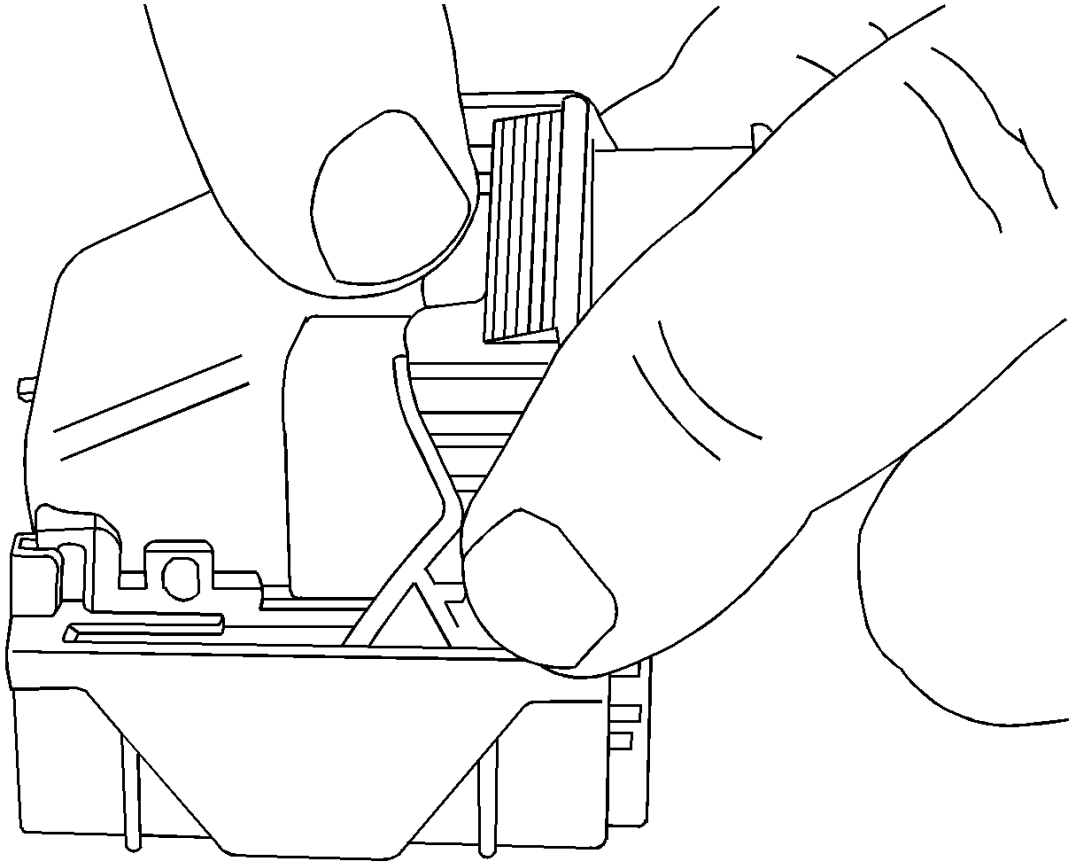


Fig. 72: Depressing Lock And Pulling Lever
Courtesy of GENERAL MOTORS COMPANY

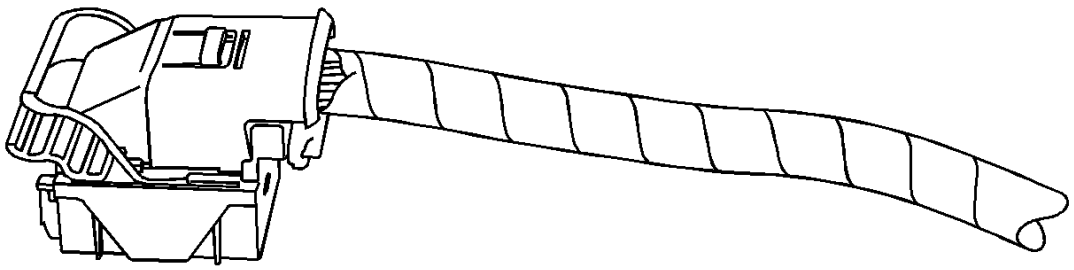


Fig. 73: View Of Connector When Released From Component
Courtesy of GENERAL MOTORS COMPANY

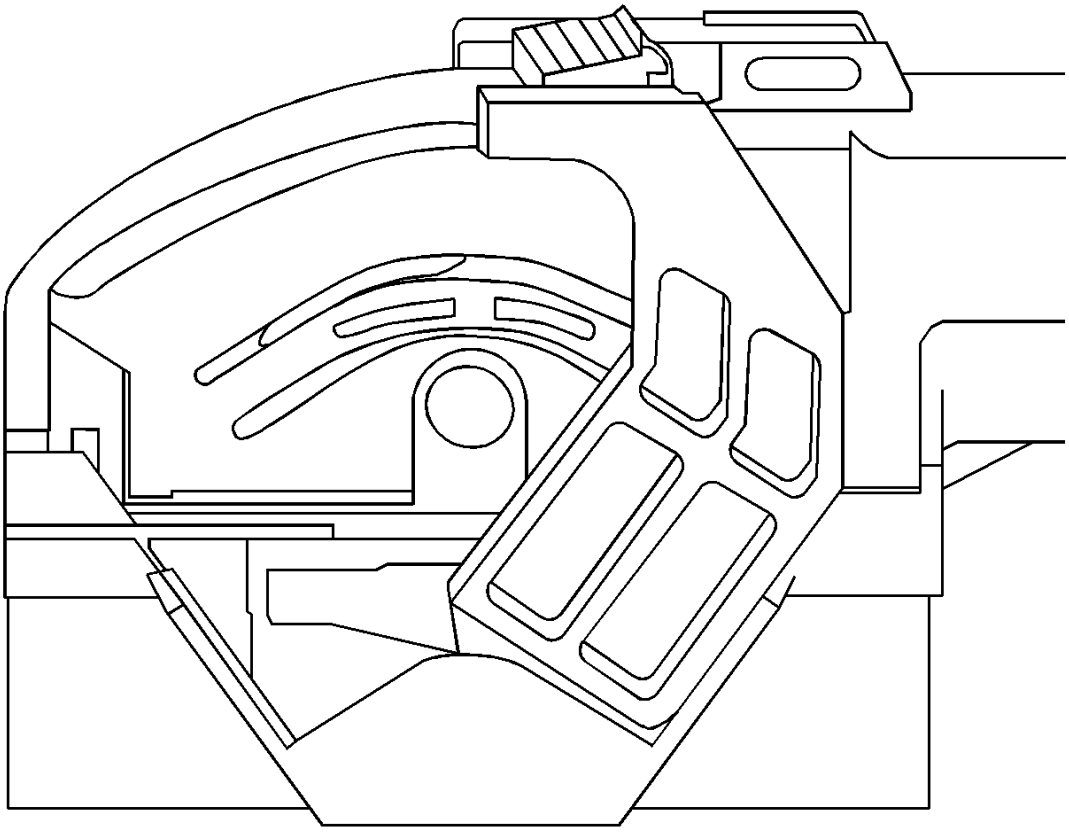


Fig. 74: View Of Another Type Of Micro 64 Connector
Courtesy of GENERAL MOTORS COMPANY

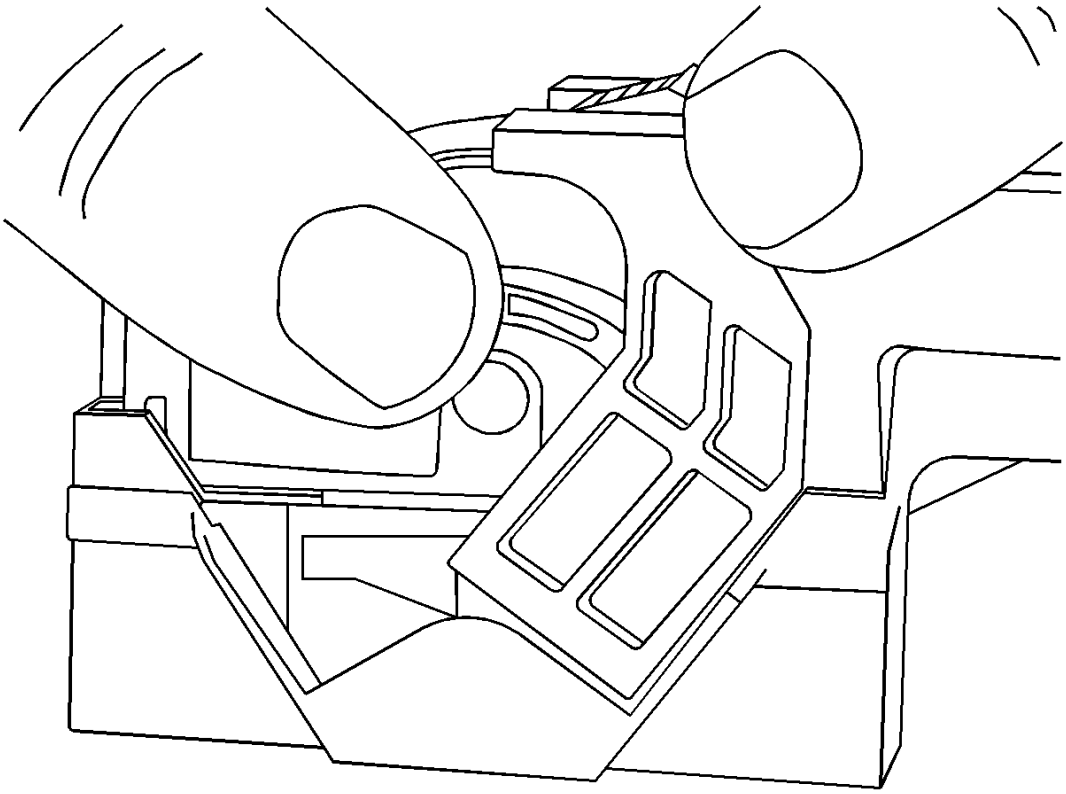


Fig. 75: Locating Locks On Both Sides Of Wiredress Cover
Courtesy of GENERAL MOTORS COMPANY

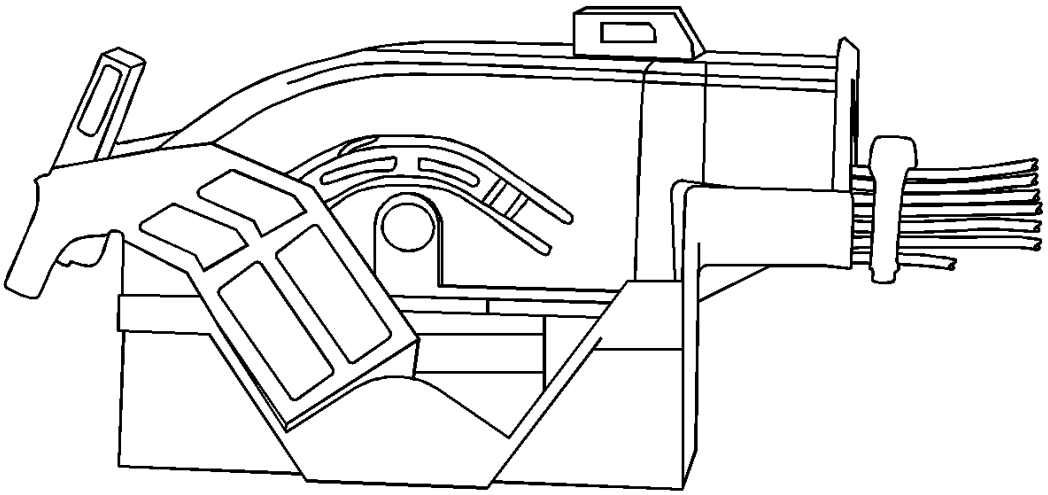


Fig. 76: View Of Connector When Released From Component
Courtesy of GENERAL MOTORS COMPANY

1. Locate the lever lock on the wire dress cover. While depressing the lock, pull the lever over and past the lock. The lever lock may be located on the top or sides of the wire dress cover.

   View of a typical Micro 64 connector.

   Depress the lock and pull the lever over and past the lock.

   View of the connector when released from the component.

   View of another type of Micro 64 connector.

   Depress the locks that are located on both sides of the wire dress cover and pull the lever over and past the locks.

   View of the connector when released from the component.

2. Disconnect the connector from the component.

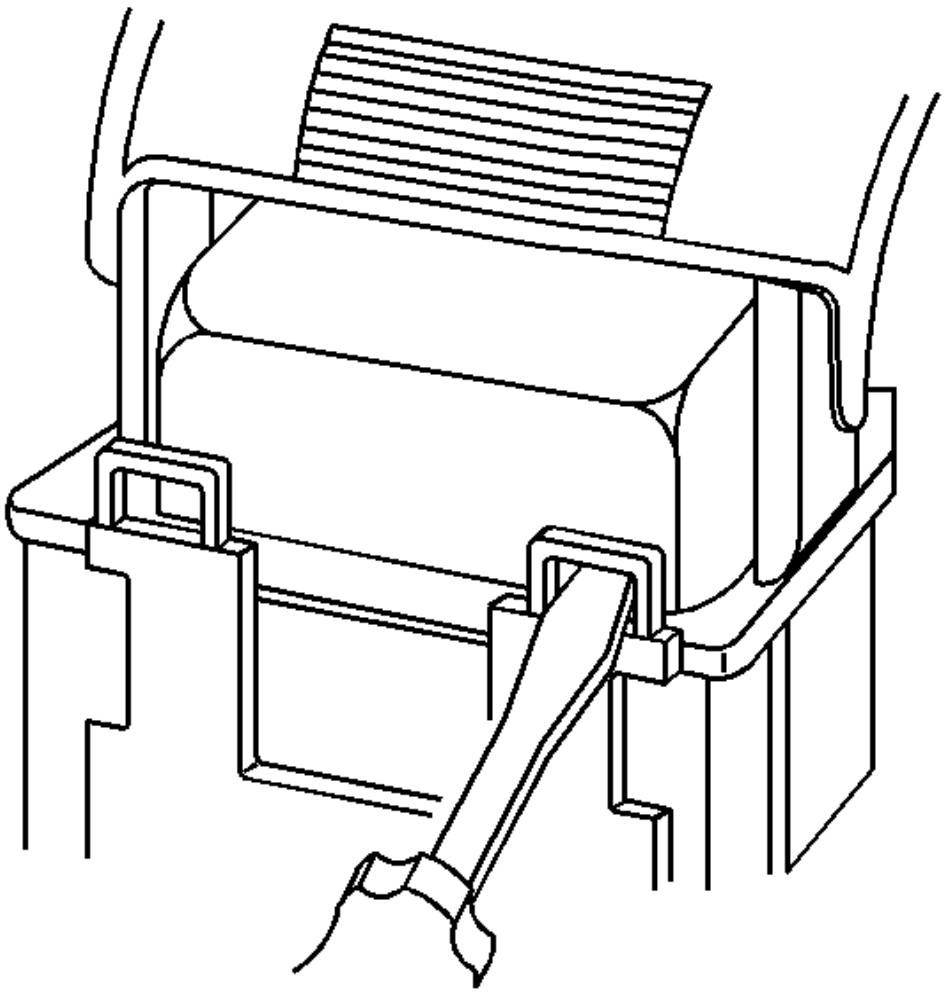


Fig. 77: View Of Releasing Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Locate the dress cover locking tabs at the front of the connector. Using a small flat-blade tool push down on one of the locking tabs and pull the cover up until the dress cover releases. Repeat this procedure for the other locking tab.
4. Once the front 2 locks are unlocked, lift the front of the dress cover and pull it forward.

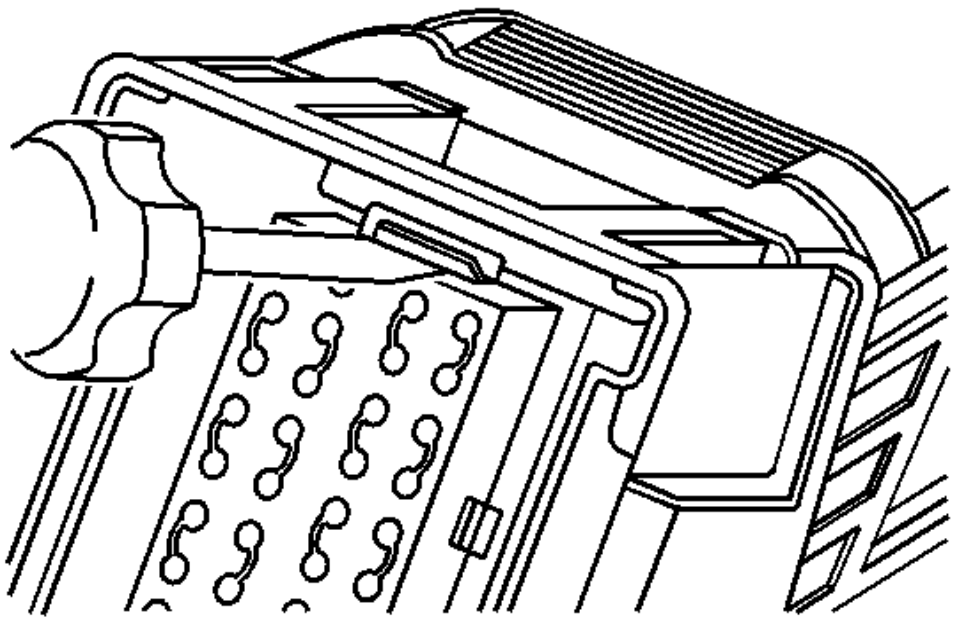


Fig. 78: View Of Removing Terminal Position Assurance
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always use care when removing a terminal position assurance (TPA) in order to avoid damaging it.**

5. Remove the TPA by inserting a small flat-blade tool into the small slot on the TPA and pushing down until the TPA releases. Gently pry the TPA out of the connector.

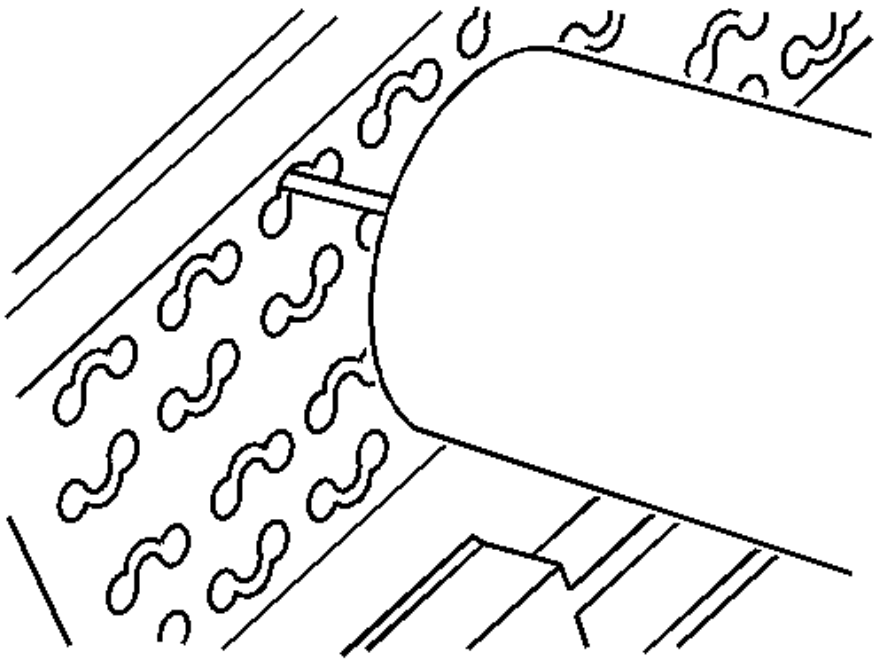


Fig. 79: Identifying Terminal Release Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Be careful not to angle or rock the J-38125-21 tool when inserting it into the connector or the tool may break.**

6. Insert the J-38125-21 tool into the round canal between the terminals cavities at the front of the connector.

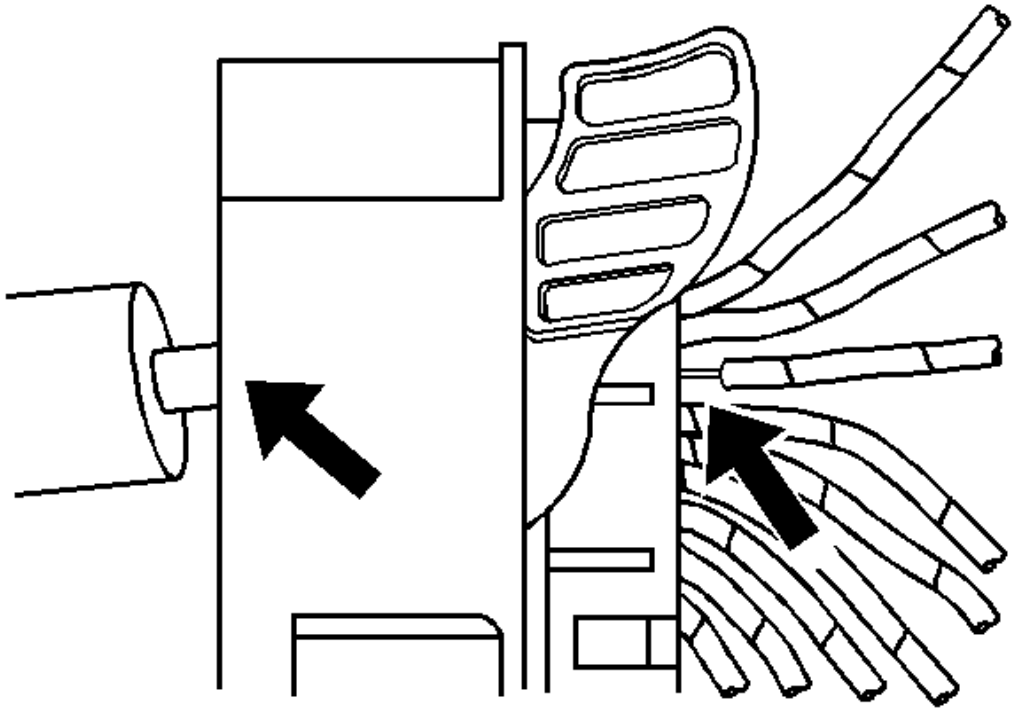


Fig. 80: Removing Wire From Back Of Connector
Courtesy of GENERAL MOTORS COMPANY

7. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
8. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
9. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

DELPHI CONNECTORS (12-WAY)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

Follow the steps below in order to remove terminals from the connector.

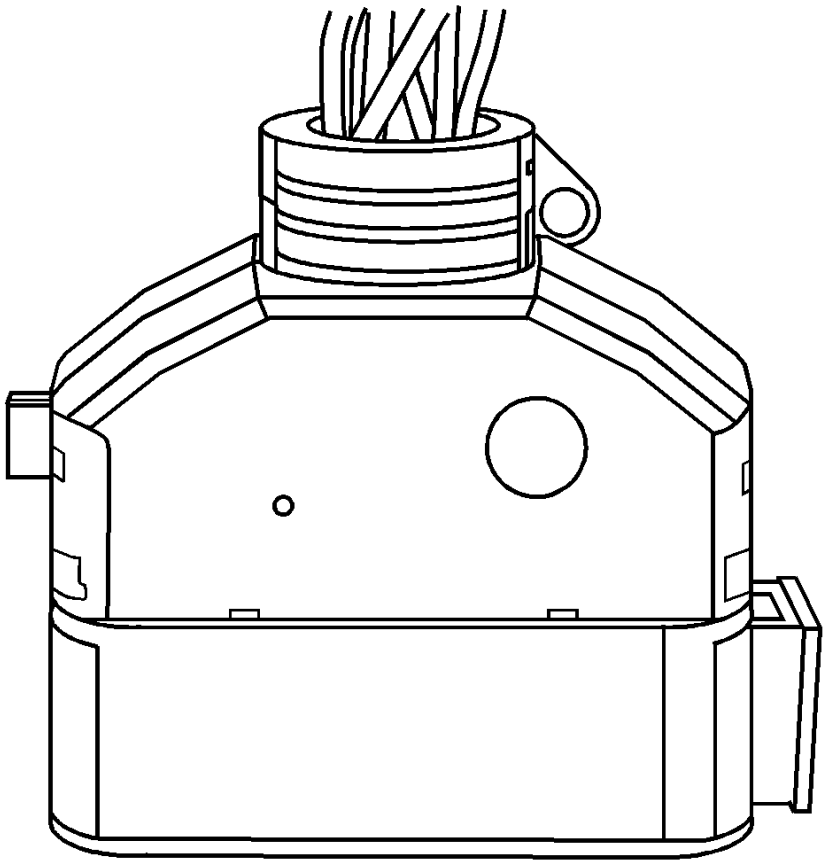


Fig. 81: Identifying Lever Lock
Courtesy of GENERAL MOTORS COMPANY

1. Locate the lever lock on the wire dress cover. Remove the connector position assurance (CPA) and slide the lever lock away from the connector body.
2. Disconnect the connector from the component.

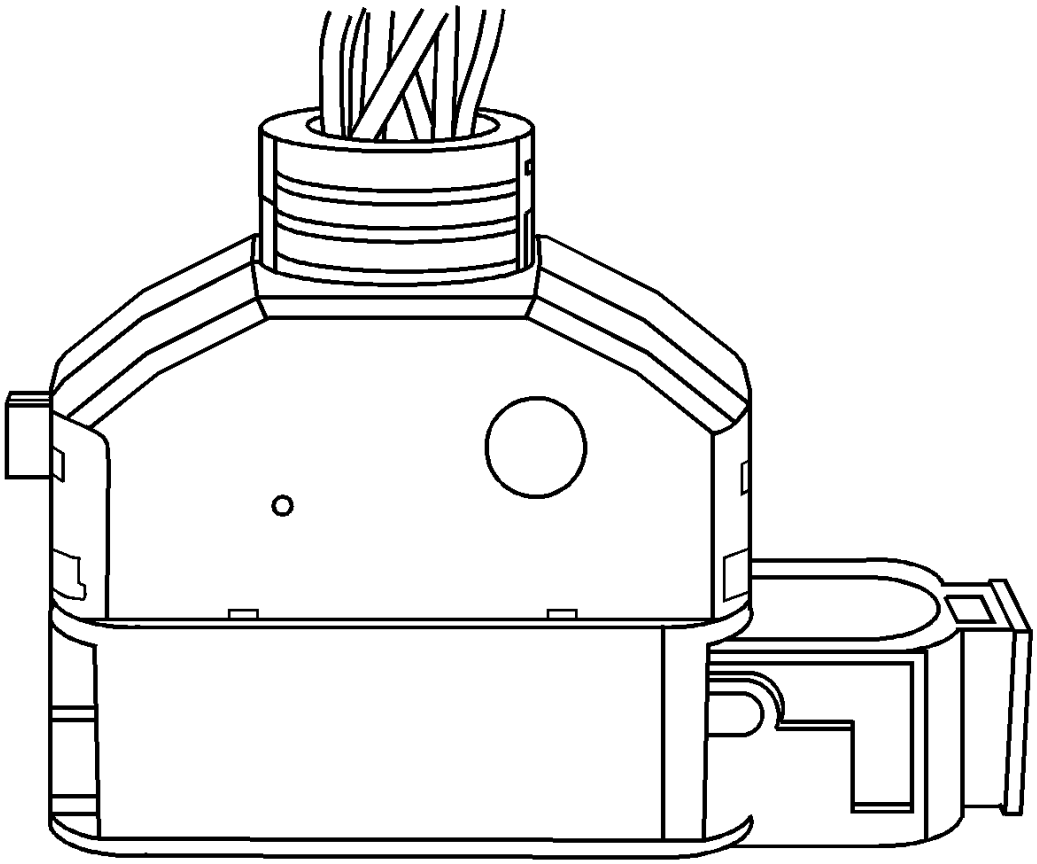


Fig. 82: Identifying Dress Cover Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Locate the dress cover locking tabs on the dress cover of the connector. Using a small flat-blade tool release all of the locking tabs.

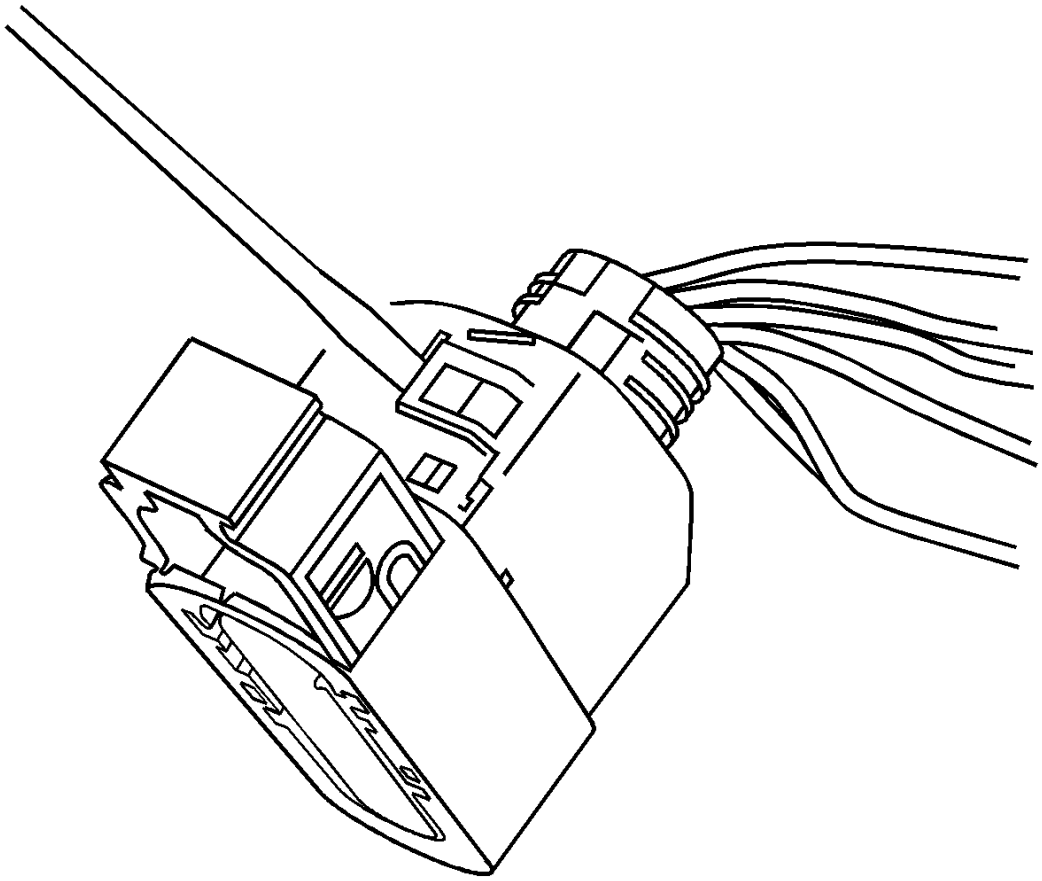


Fig. 83: Identifying Lower Wire Dress Cover Locking Tab
Courtesy of GENERAL MOTORS COMPANY

4. Release the lower wire dress cover locking tab.

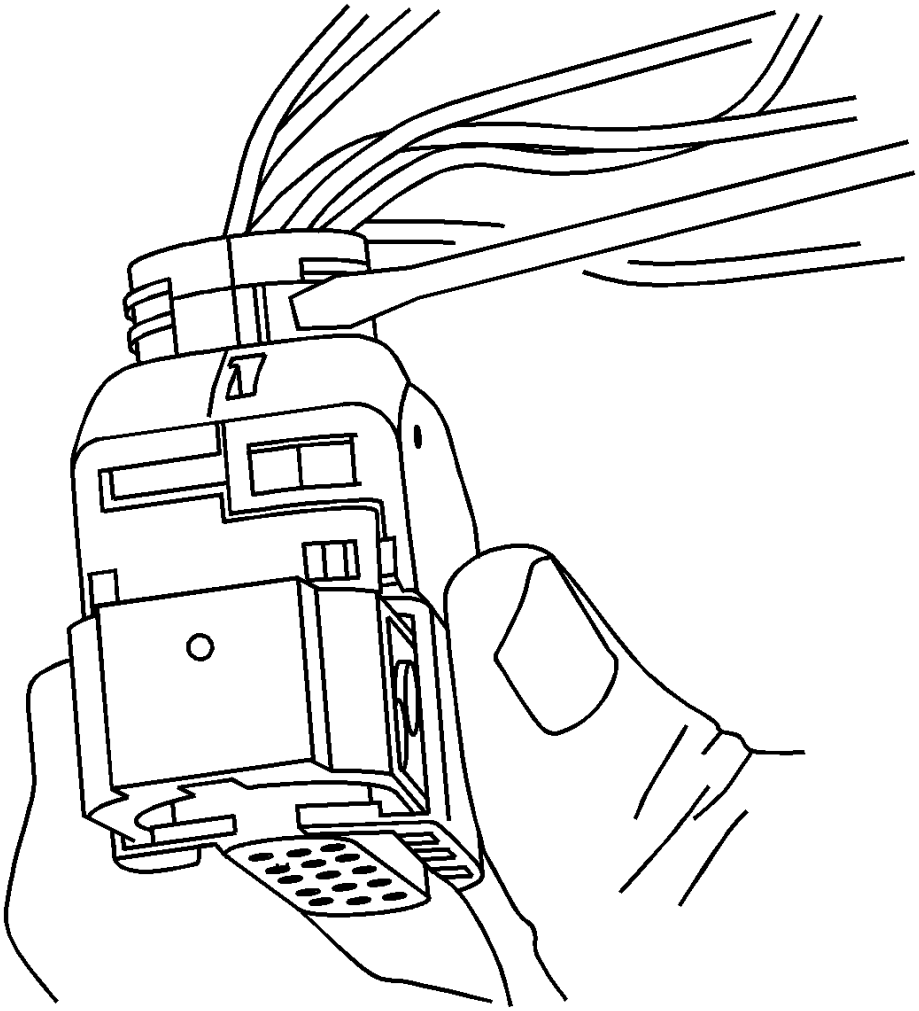


Fig. 84: Identifying Upper Wire Dress Cover Locking Tab
Courtesy of GENERAL MOTORS COMPANY

5. Release the upper wire dress cover locking tab.
6. Once the locks are unlocked, lift the dress cover off.

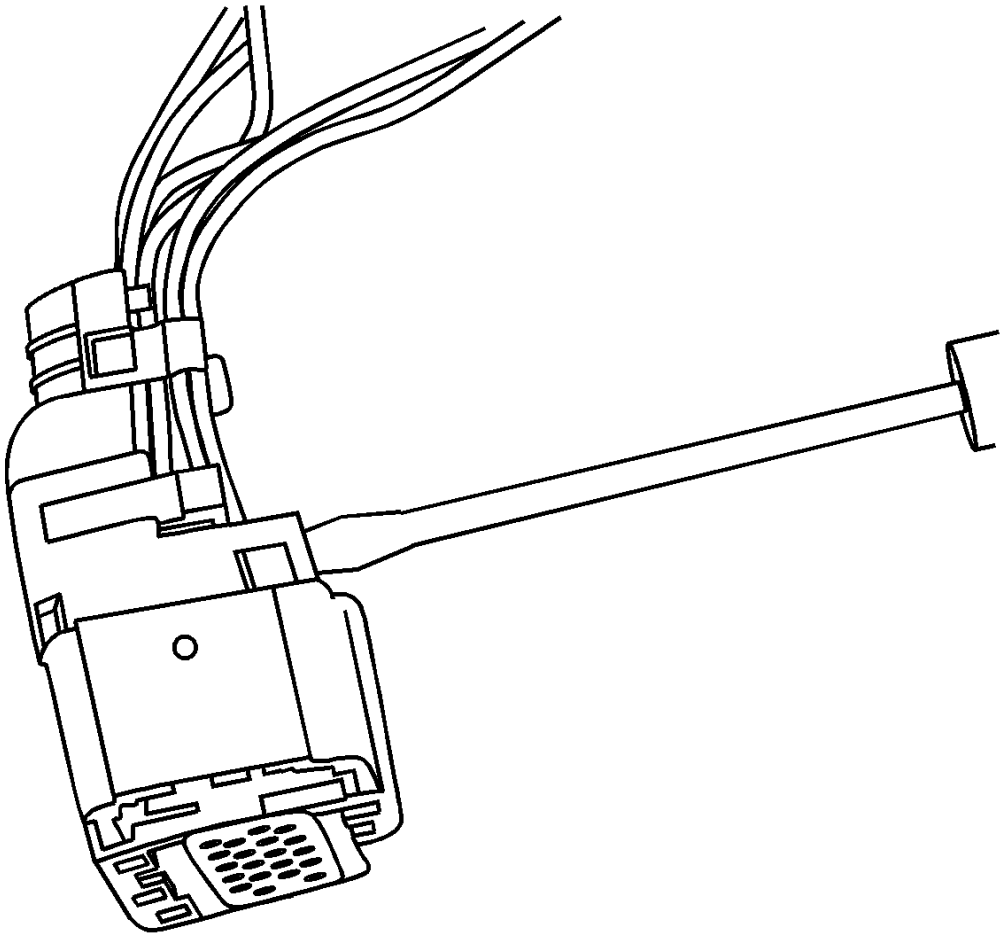


Fig. 85: View Of TPA Being Pried Out Of Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always use care when removing a terminal position assurance (TPA) in order to avoid damaging it.**

7. Remove the TPA by inserting a small flat-blade tool into the locking tabs on both sides of the TPA . Gently pry the TPA out of the connector.

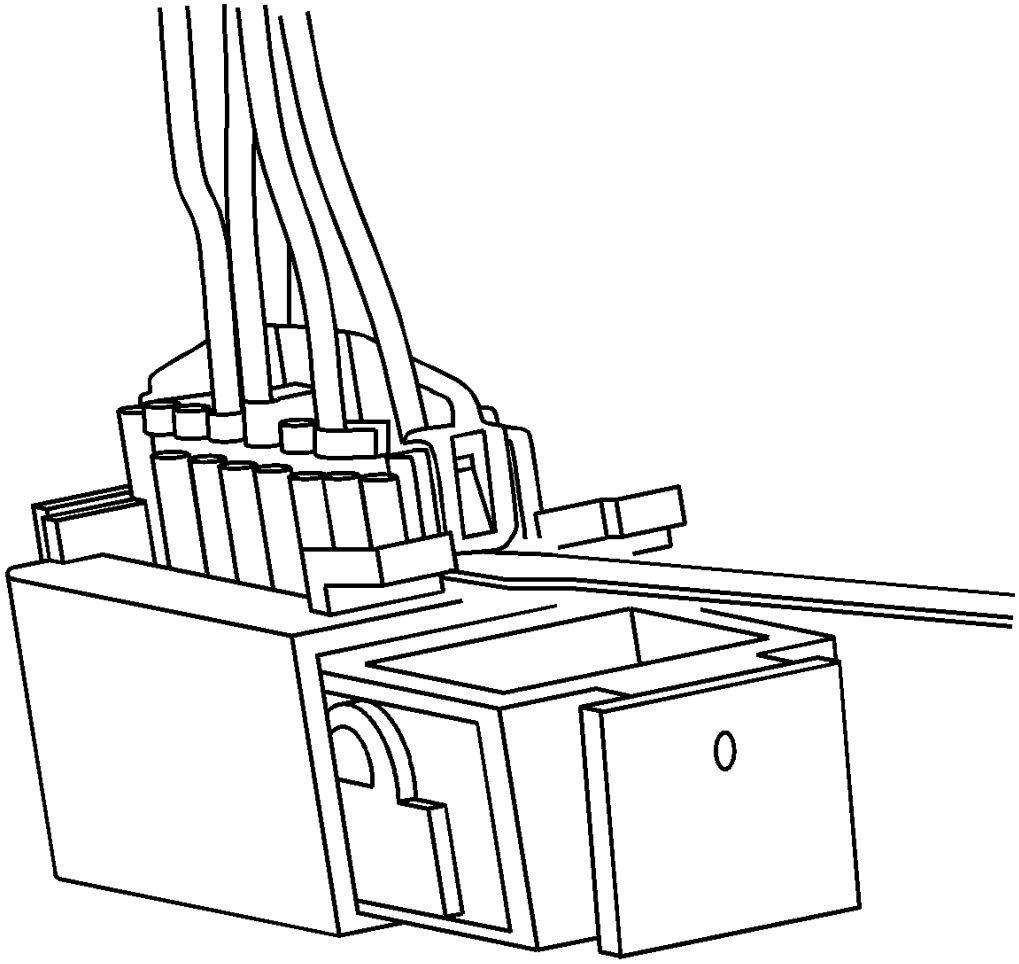


Fig. 86: Removing Nose Piece
Courtesy of GENERAL MOTORS COMPANY

8. Remove the nose piece by inserting a small flat-blade tool into the locking tabs on both sides of the nose piece. Gently pry the nose piece out of the connector.

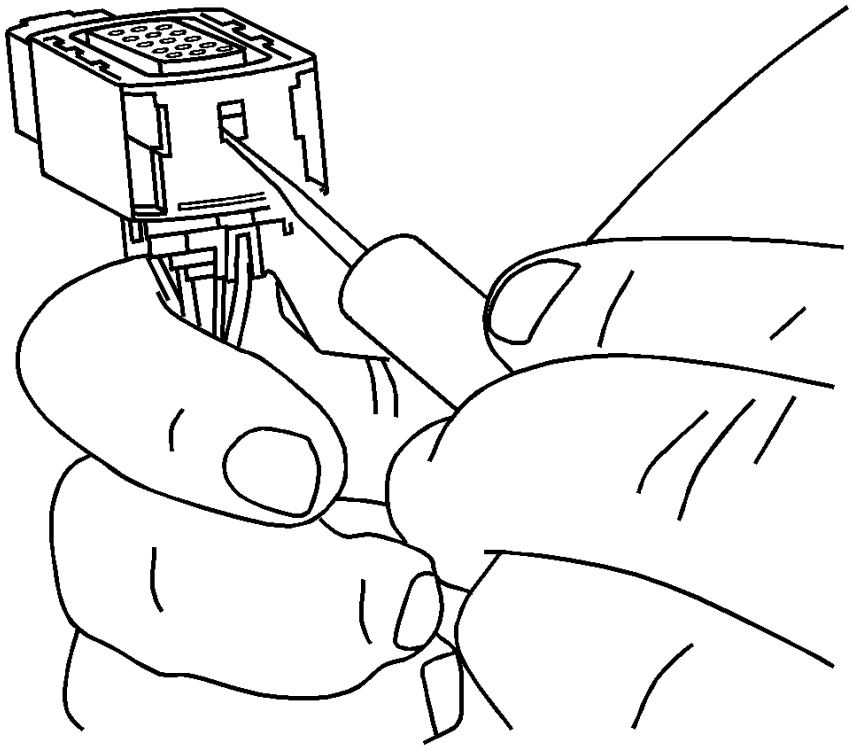


Fig. 87: Inserting Special Tool Into Terminal Release Cavity
Courtesy of GENERAL MOTORS COMPANY

9. Insert the J-38125-12A tool to release the terminals by inserting the tool into the terminal release cavity.

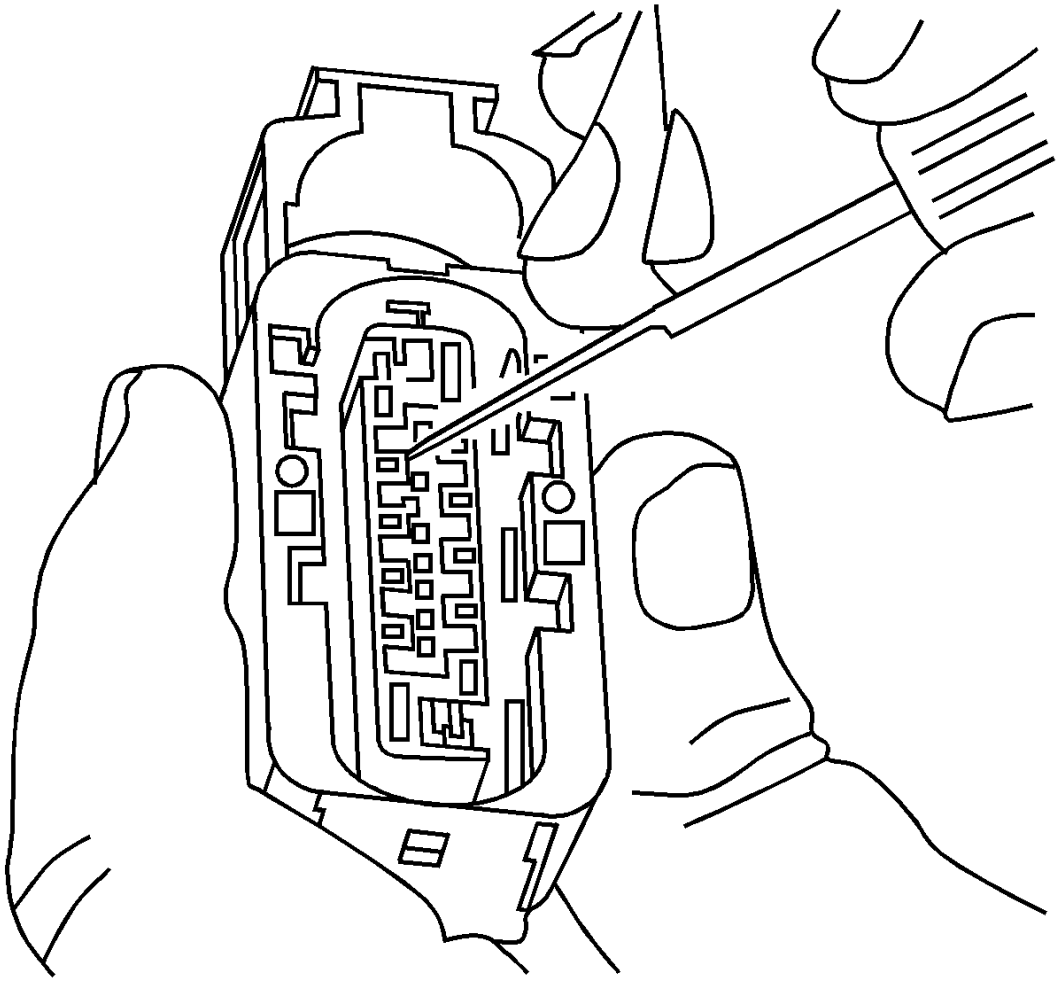


Fig. 88: Pulling Wire Out Of Back Of Connector
Courtesy of GENERAL MOTORS COMPANY

10. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
11. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
12. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

DELPHI CONNECTORS (STEERING GEAR)

Removal Procedure

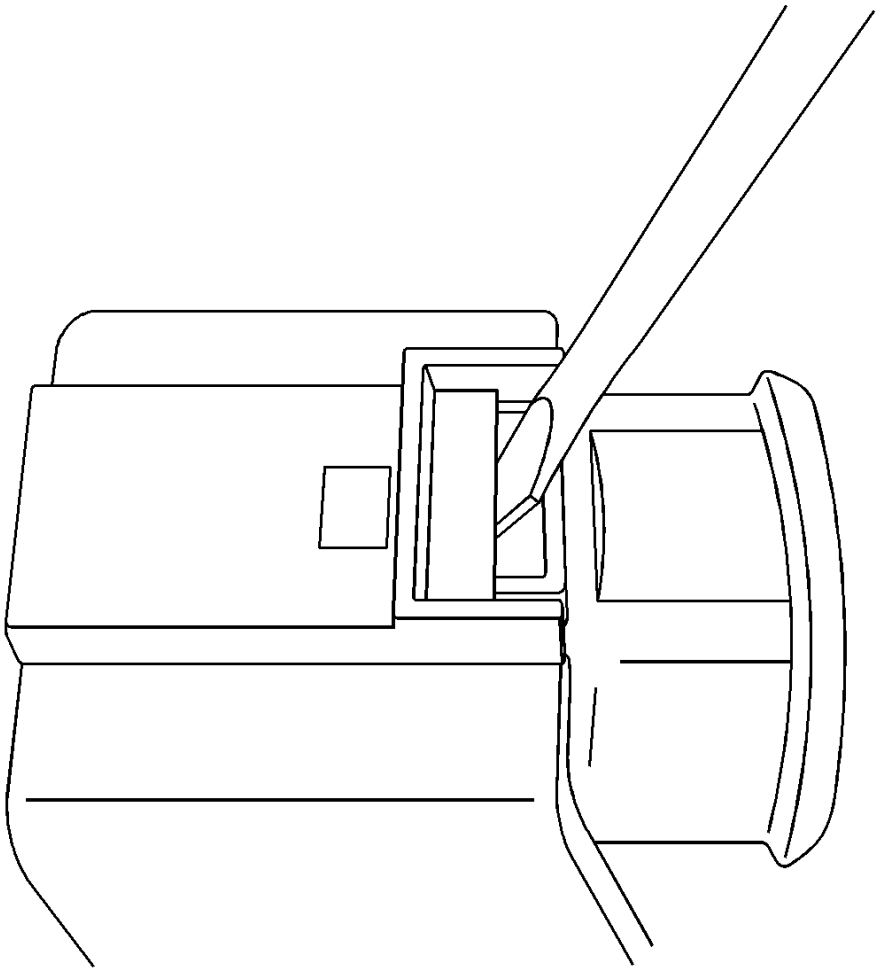


Fig. 89: Releasing Locking Tab On Connector
Courtesy of GENERAL MOTORS COMPANY

1. Use a small flat-bladed tool to release the locking tab on the connector.

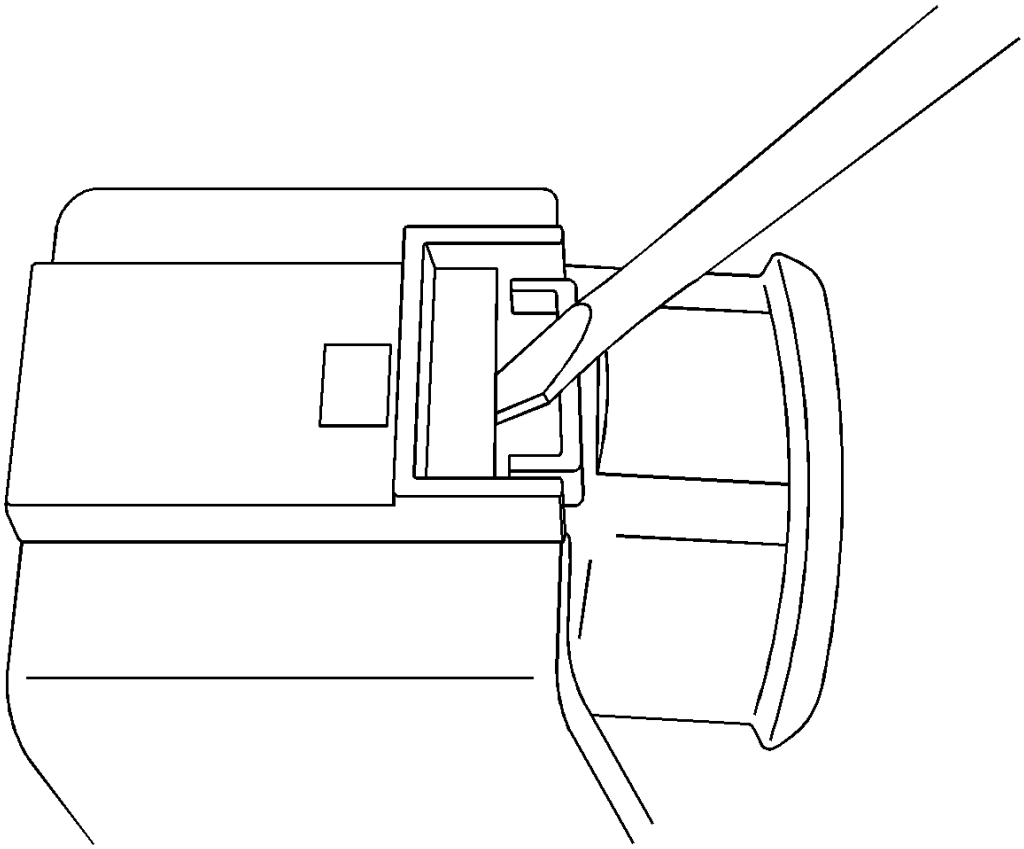


Fig. 90: Releasing Connector
Courtesy of GENERAL MOTORS COMPANY

2. Push down the locking tab to release the connector. The small flat-bladed tool may need to be pushed down and angled back slightly to depress the locking tab. Pull on the connector body while releasing the locking tab to disconnect the connector.

FCI CONNECTORS (LEVER LOCK)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-556** Terminal Release Tool
- **J-38125-560** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

Follow the steps below in order to remove terminals from the connector.

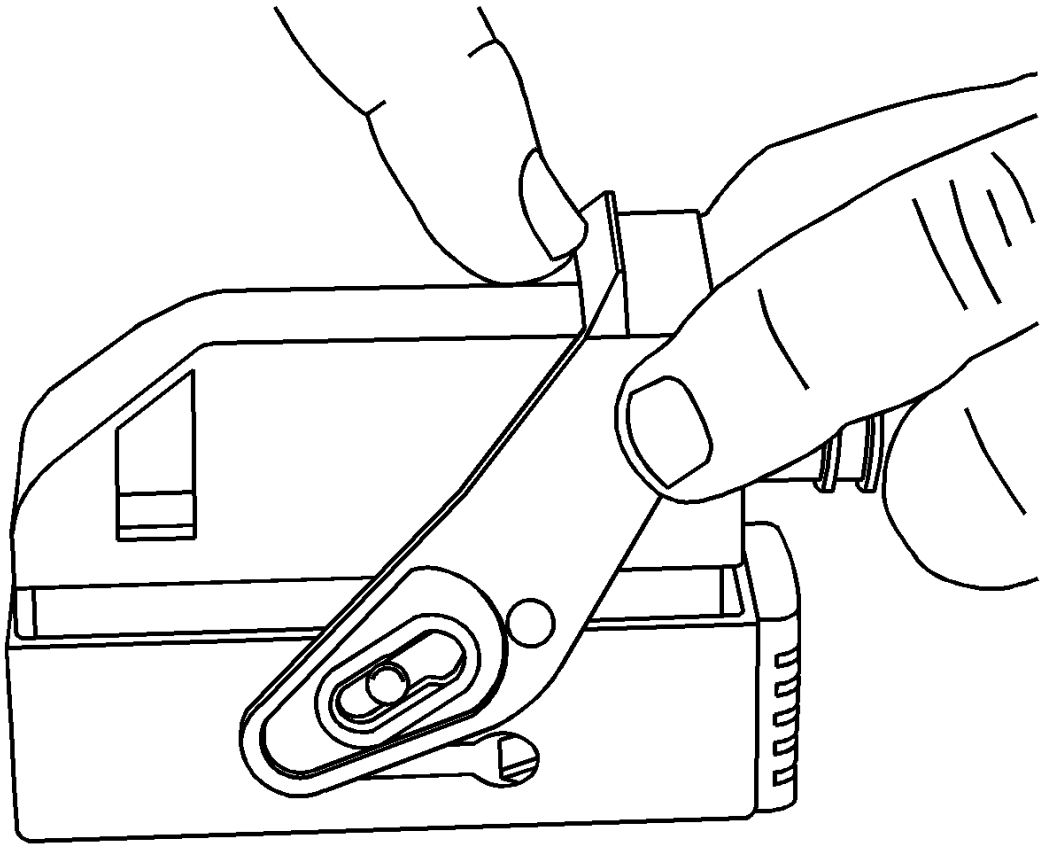


Fig. 91: Identifying Release Tab
Courtesy of GENERAL MOTORS COMPANY

1. Slide the lever lock forward while pressing down on the lever lock release tab.
2. The release tab is located on the top of the wiredress cover.

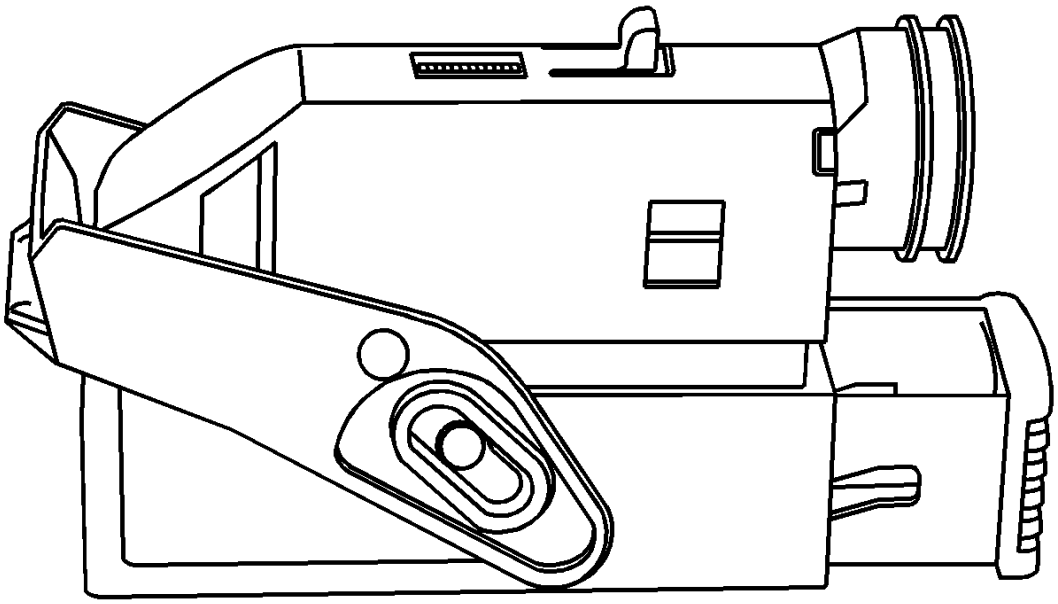


Fig. 92: View Of Connector In Released Position
Courtesy of GENERAL MOTORS COMPANY

3. View of connector in released position.
4. Disconnect the connector from the component.
5. Locate the dress cover locking tabs at the corners of the dress cover. Use a small flat-blade tool to release the locking tabs and remove the dress cover.

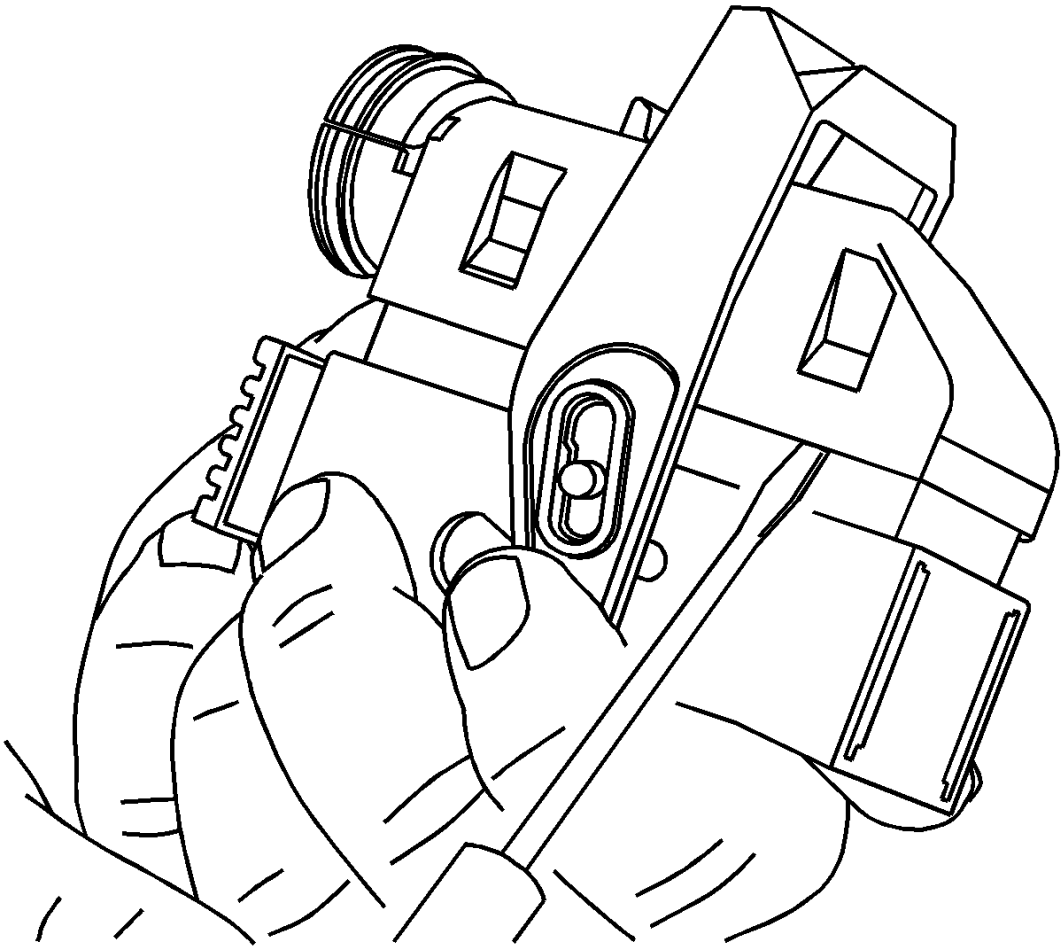


Fig. 93: View Of Sliding Terminal Position Assurance (TPA) Up One Notch
Courtesy of GENERAL MOTORS COMPANY

6. Use a small flat-blade tool to slide the terminal position assurance (TPA) up one notch on both ends of the connector. The TPA is located underneath the wire dress cover.

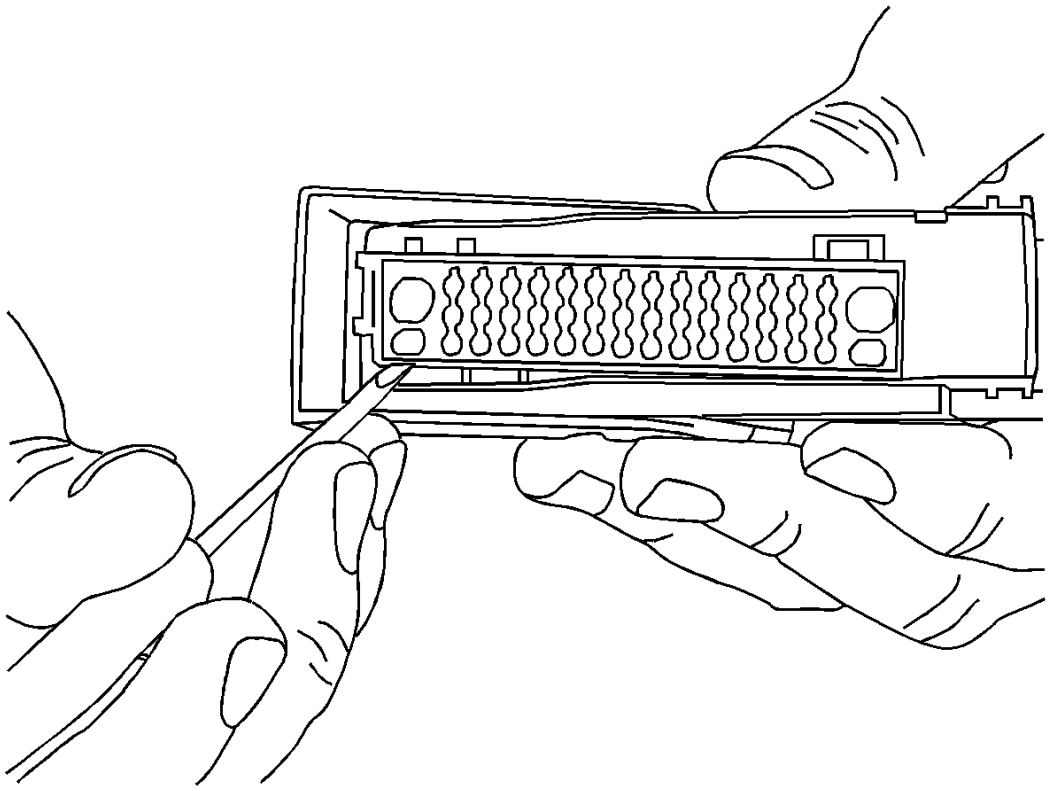


Fig. 94: View Of Releasing Terminals
Courtesy of GENERAL MOTORS COMPANY

7. For the larger terminals insert the J-38125-556 tool to release the terminals by inserting the tool into the terminal release cavity. For the smaller terminals insert the J-38125-560 tool to release the terminals by inserting the tool into the terminal release cavity.

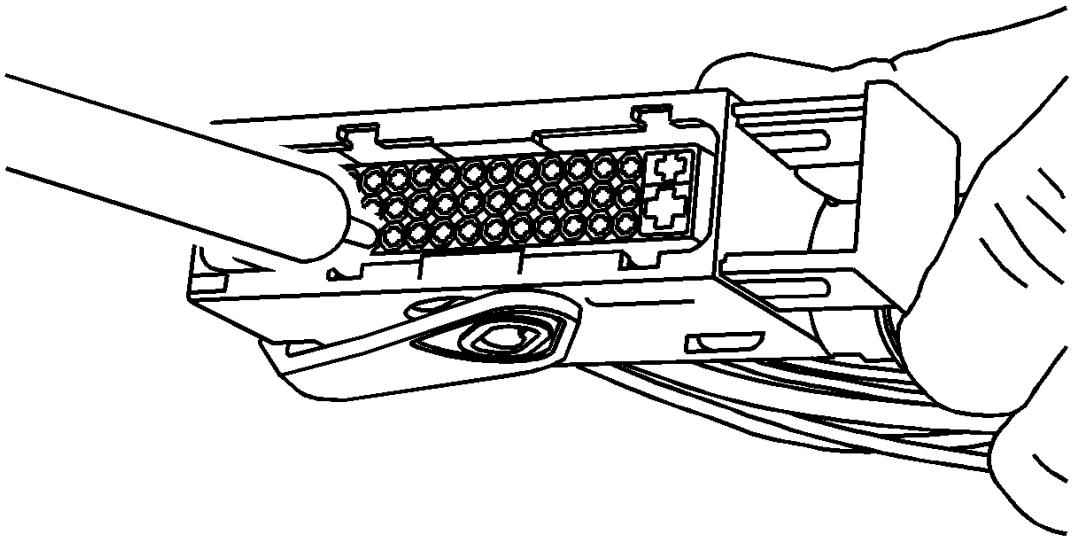


Fig. 95: View Of Wire Being Pulled Out Of Back Of Connector While Holding Removal Tool In Place
Courtesy of GENERAL MOTORS COMPANY

8. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
9. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
10. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

FCI CONNECTORS (SIR)

Removal Procedure

NOTE: **The orange or yellow connector position assurance (CPA) must be released first to disconnect or to connect the connector.**

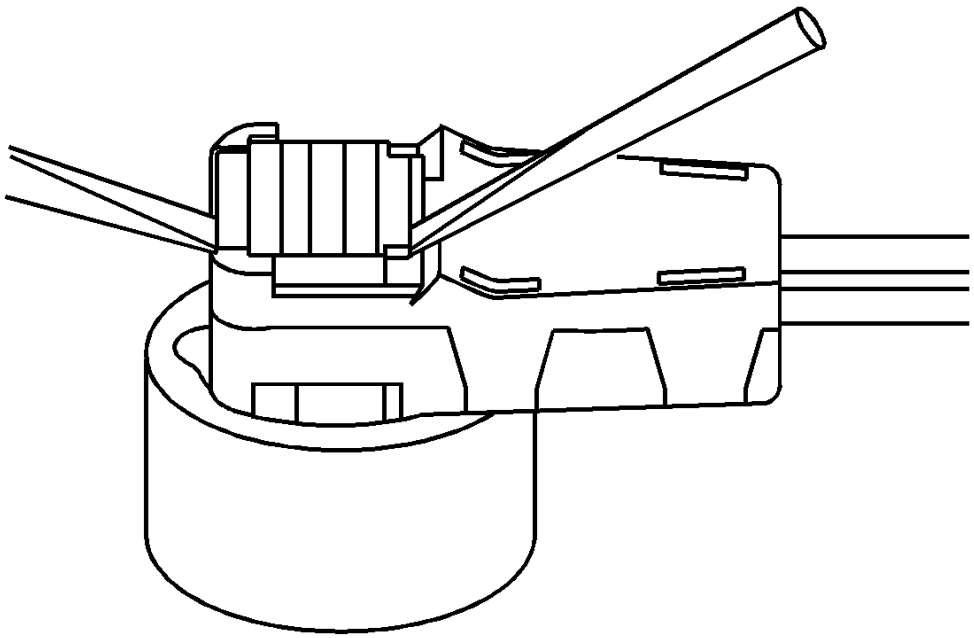


Fig. 96: Lifting Orange CPA
Courtesy of GENERAL MOTORS COMPANY

1. Lift the orange or yellow CPA vertically (avoid lifting on an angle to the connector) approximately 4 mm to release the connector. Use a small flat-bladed tool to help release the CPA. The CPA may also be released manually without any tools.

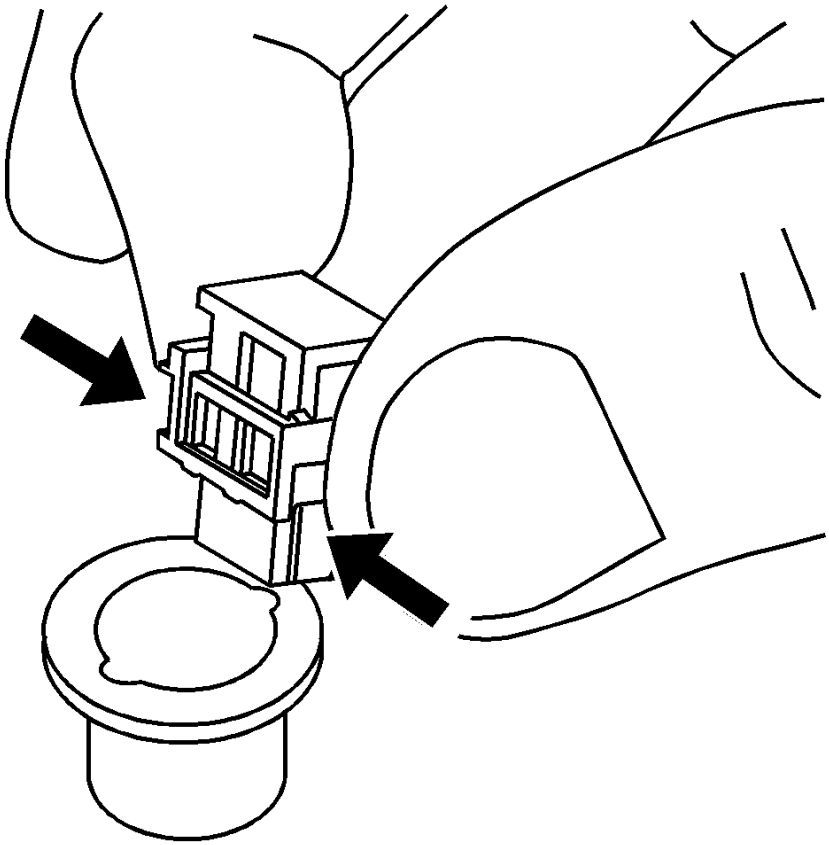


Fig. 97: Grabbing Connector On Both Sides
Courtesy of GENERAL MOTORS COMPANY

2. Grab the connector on both sides and lift vertically to disconnect the connector.

Installation Procedure

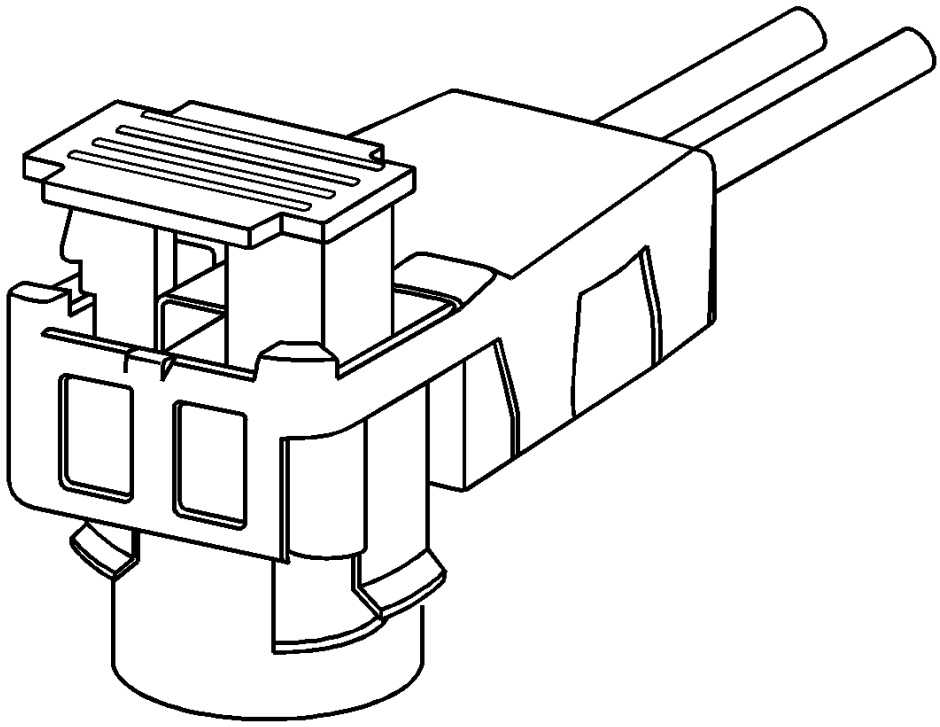


Fig. 98: Lifting Orange CPA
Courtesy of GENERAL MOTORS COMPANY

1. The CPA should be approximately 4 mm above the yellow cover before installing the connector. If not, use a small flat-bladed tool to help release the CPA. The CPA may also be released manually without any tools.

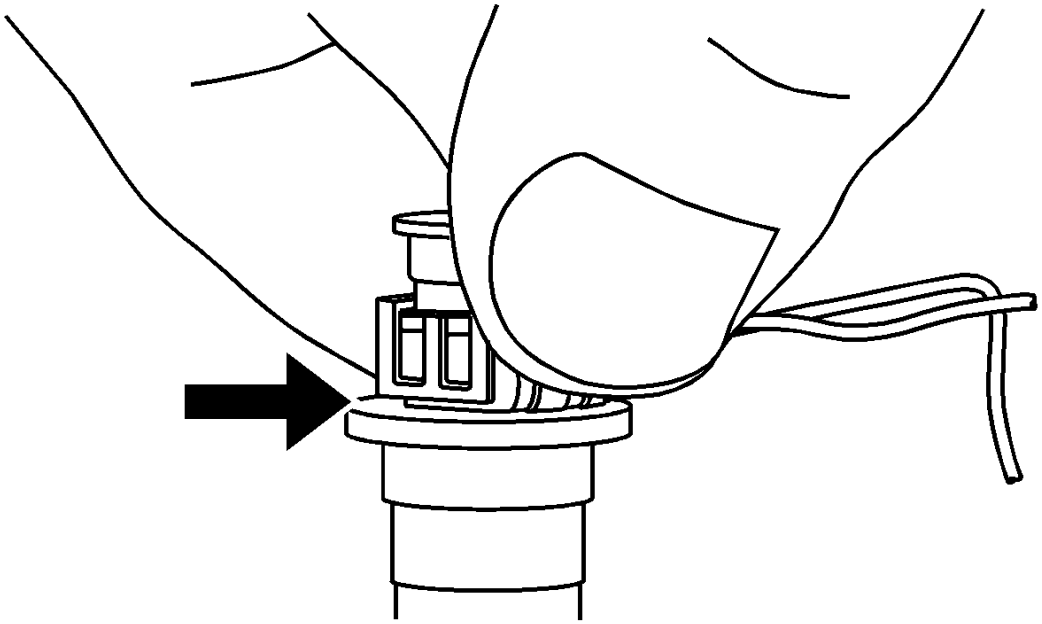


Fig. 99: Seating Connector Sub-Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Line up the connector key tabs with the initiator key slots. Grab the connector on both sides and push down into the initiator connector sub assembly until fully seated.

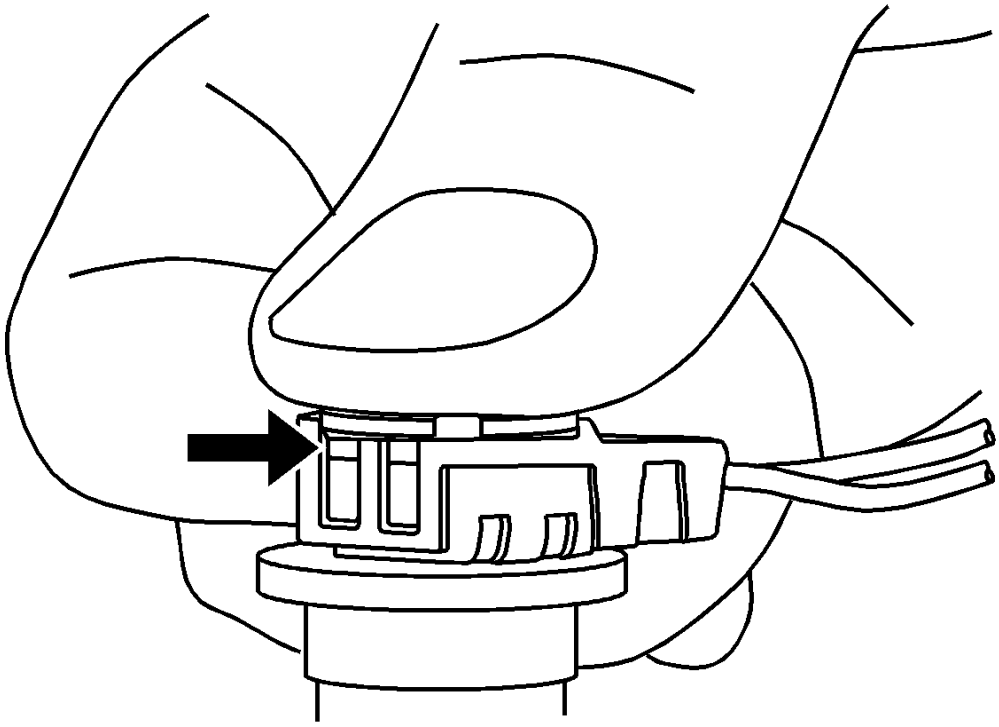


Fig. 100: Pushing CPA Down
Courtesy of GENERAL MOTORS COMPANY

3. After the connector is fully seated, push the CPA down with your thumb until the CPA is touching the yellow cover on the connector.

FEP CONNECTORS (STEERING GEAR)

Removal Procedure

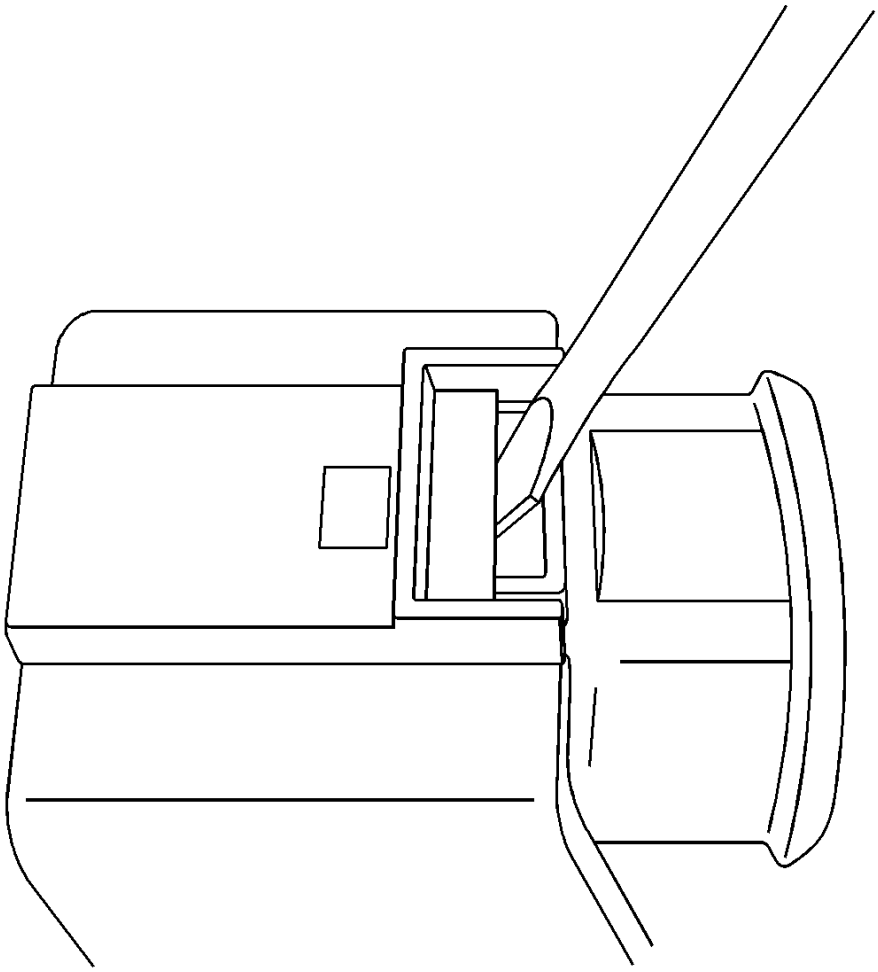


Fig. 101: Releasing Locking Tab On Connector
Courtesy of GENERAL MOTORS COMPANY

1. Use a flat-bladed tool to release the locking tab on the connector.

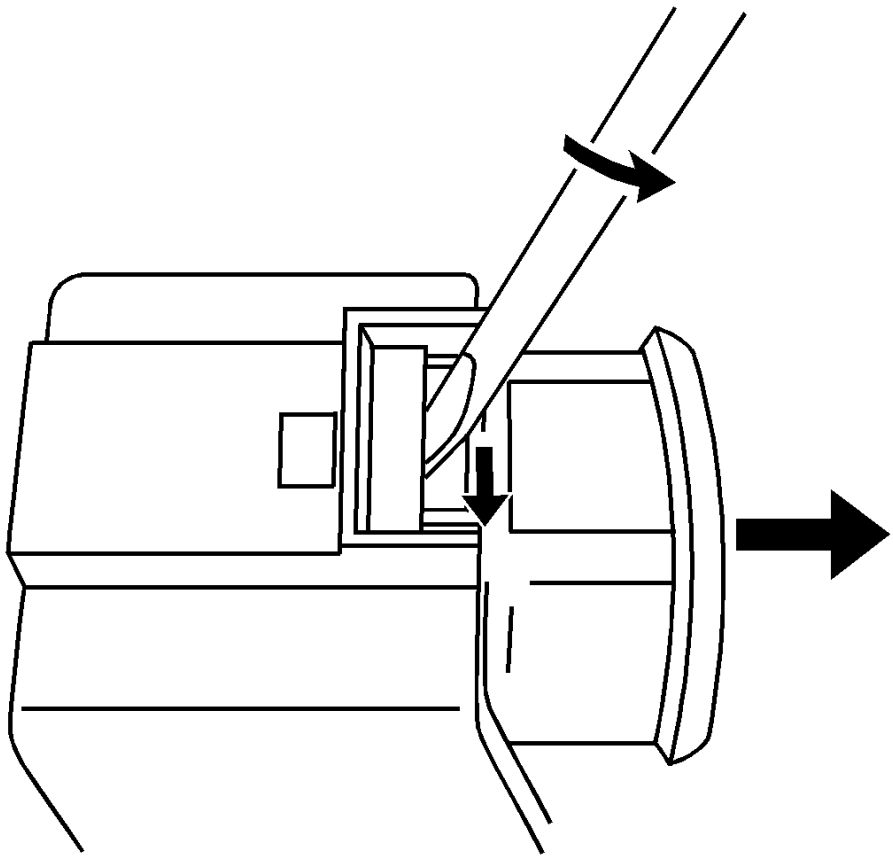


Fig. 102: Twisting Flat-Bladed Tool To Push Top Of Locking Tab Inward
Courtesy of GENERAL MOTORS COMPANY

2. Option 1: Twist the flat-bladed tool to push the top of the locking tab inward while pulling the connector body out.

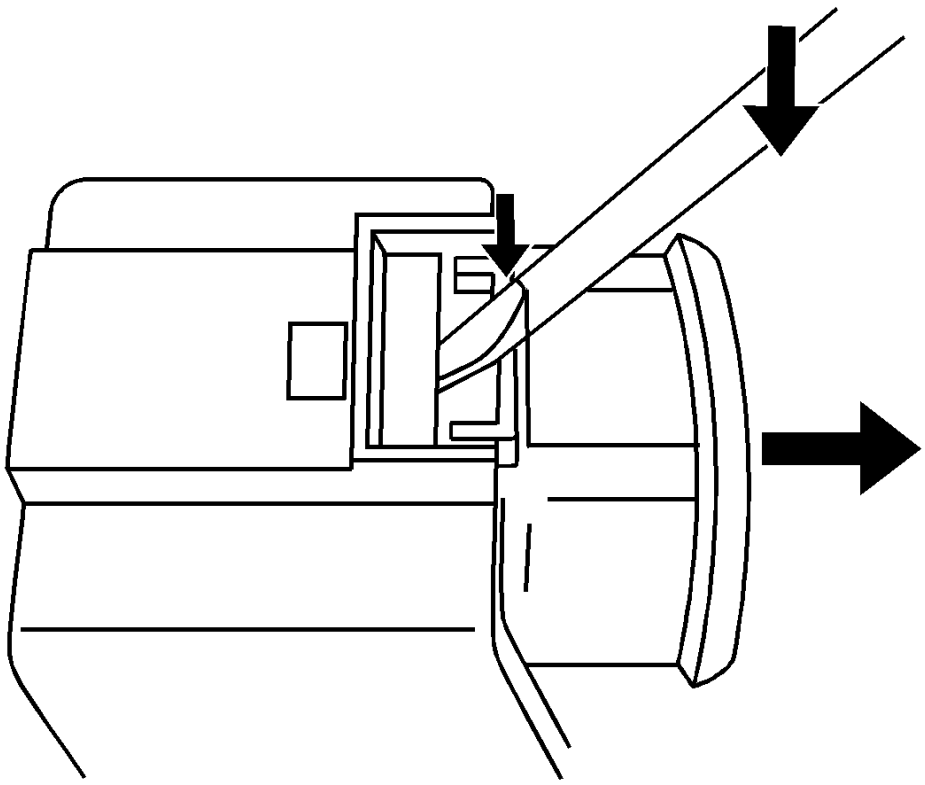


Fig. 103: Using Flat-Bladed Tool To Depress Locking Tab
Courtesy of GENERAL MOTORS COMPANY

3. Option 2: Pry using the flat-bladed tool to depress the locking tab while pulling the connector body out.

JST CONNECTORS

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-553** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

The JST connector family consists of seven unique connector housings differentiated by color and keying. This connector family is designed to use both 0.64 and 2.8 sized terminals.

JST BCM Connector

GM Service Part #	Color
88988806	Gray
88988837	Brown
88988838	Lt Green
88988839	Natural
88988840	Lt Blue
88988841	Black
88988842	Pink

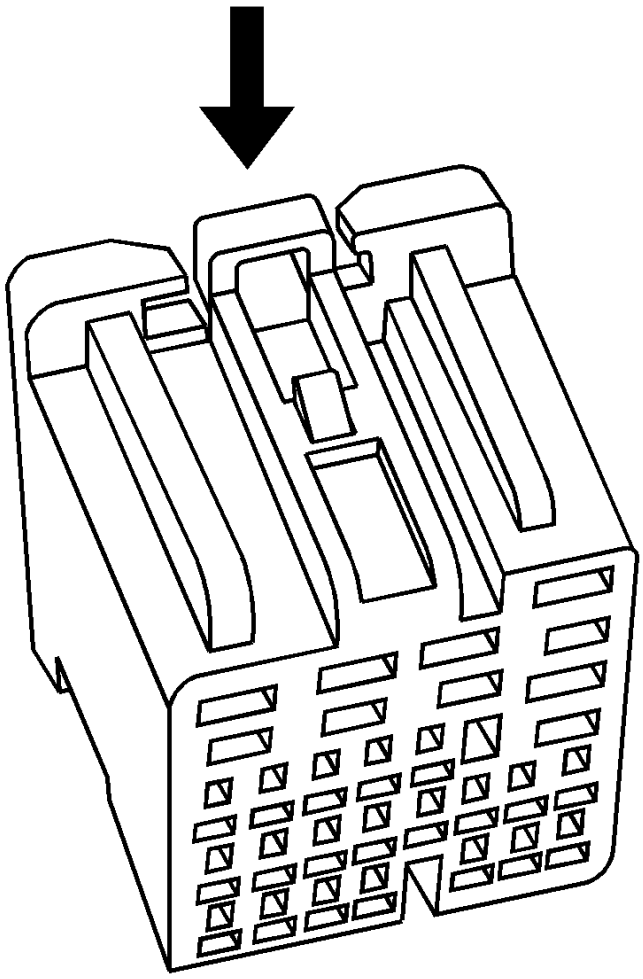


Fig. 104: Identifying Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

1. While depressing the lock, remove the connector from the component.

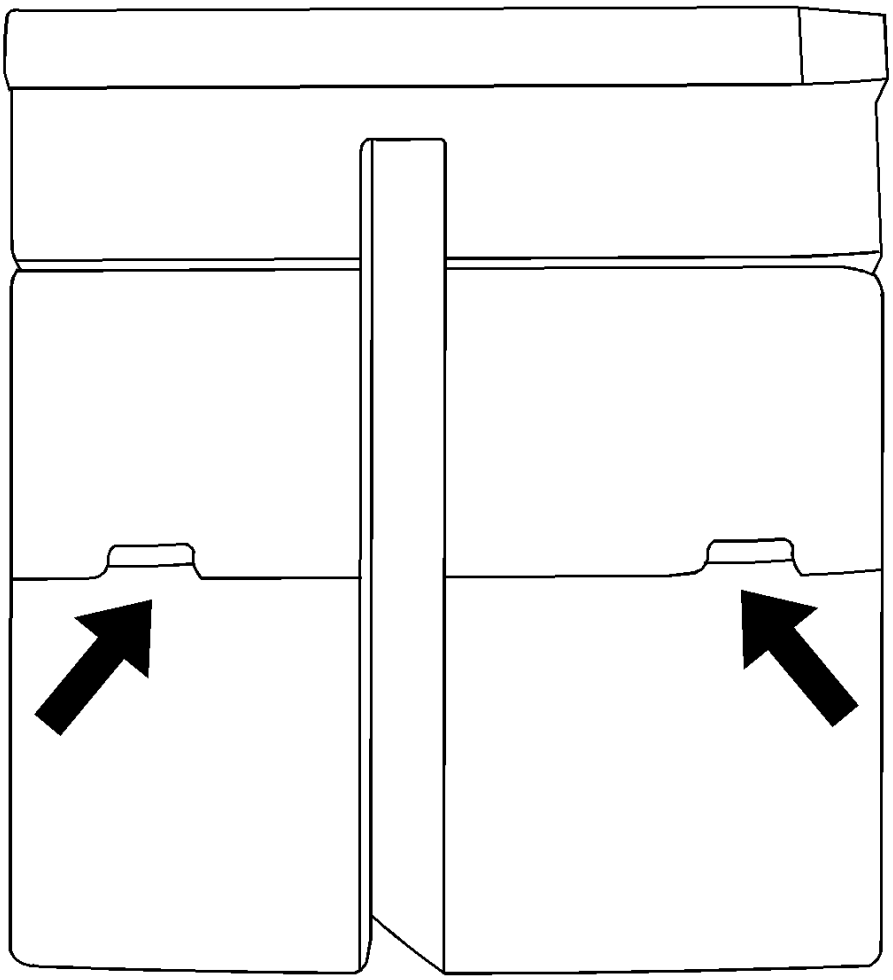


Fig. 105: Identifying TPA On Both Sides Of Connector
Courtesy of GENERAL MOTORS COMPANY

2. Unlock the terminal position assurance (TPA):
    - Position connector as shown (above) and locate TPA staging cavities.

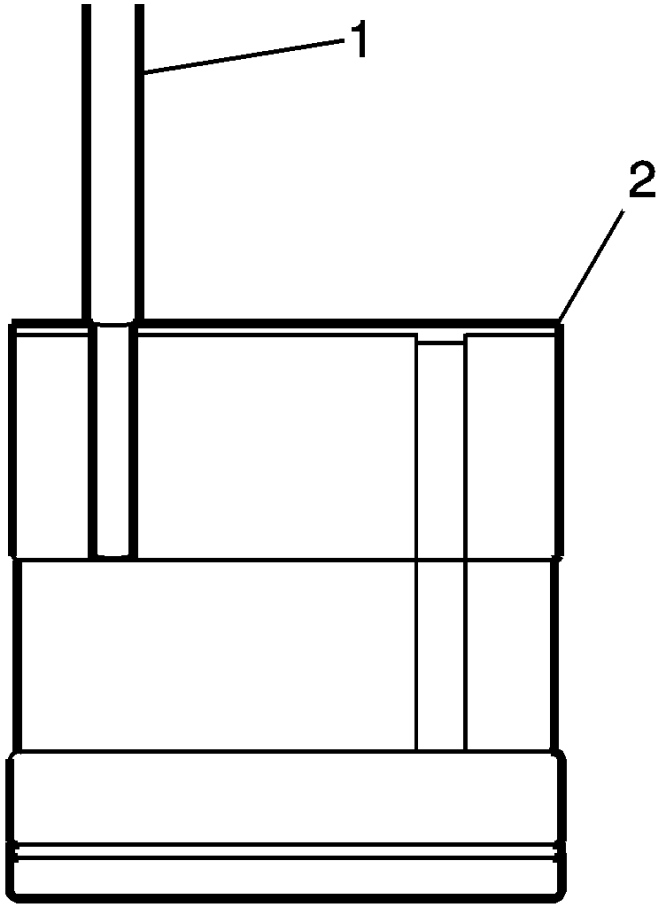


Fig. 106: Terminal Release Tool
Courtesy of GENERAL MOTORS COMPANY

- Using connector terminal release tool J-38125-553 (1) lift the TPA into the staged position. Perform this step on both sides of the TPA.

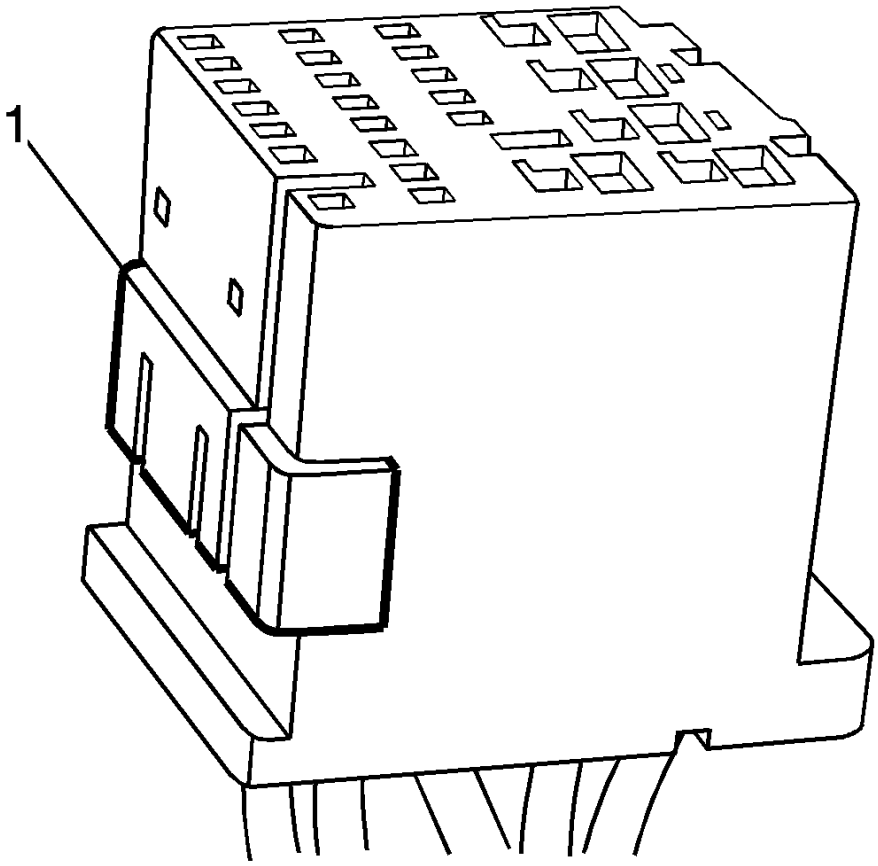


Fig. 107: TPA In Staged Position
Courtesy of GENERAL MOTORS COMPANY

- You will feel the TPA click into place when fully extended into the staged position. The figure above shows the TPA (1) in the staged position.

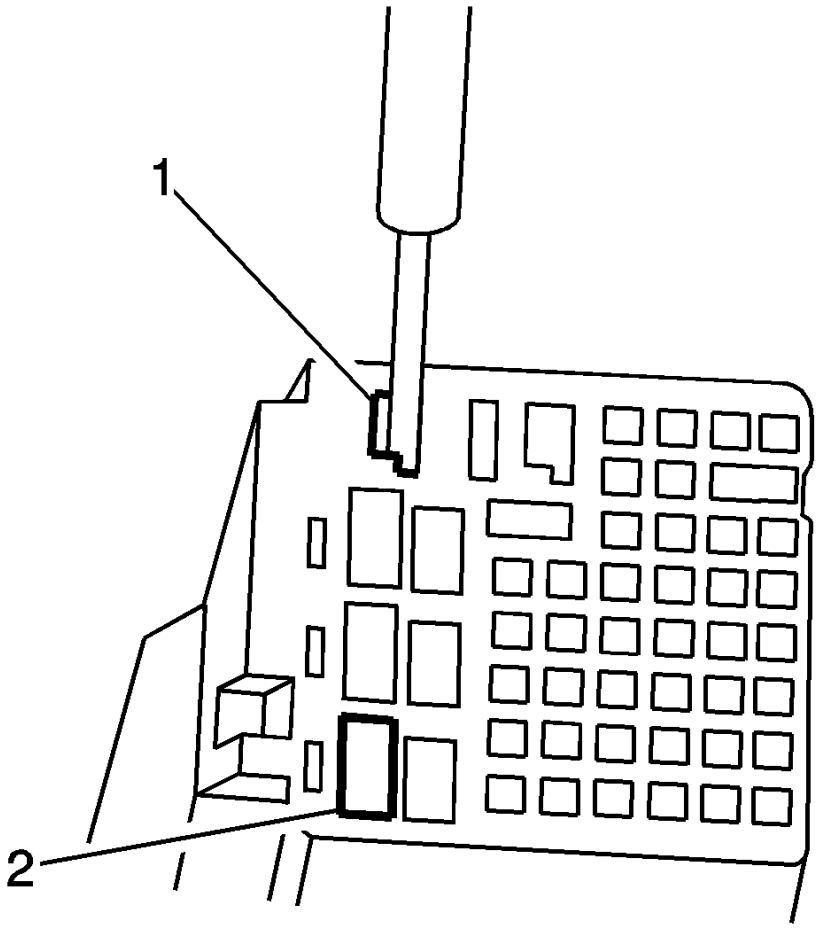


Fig. 108: Connector Terminal Release Tool
Courtesy of GENERAL MOTORS COMPANY

3. Release the terminal from the connector:
    - Position the connector as shown (above) and locate the terminal release entry canal (1) of the suspect terminal.
    - Insert the connector terminal release tool J-38125-553 into the entry canal with the angled side of the tool facing the connector wall containing cavity 4 (2).

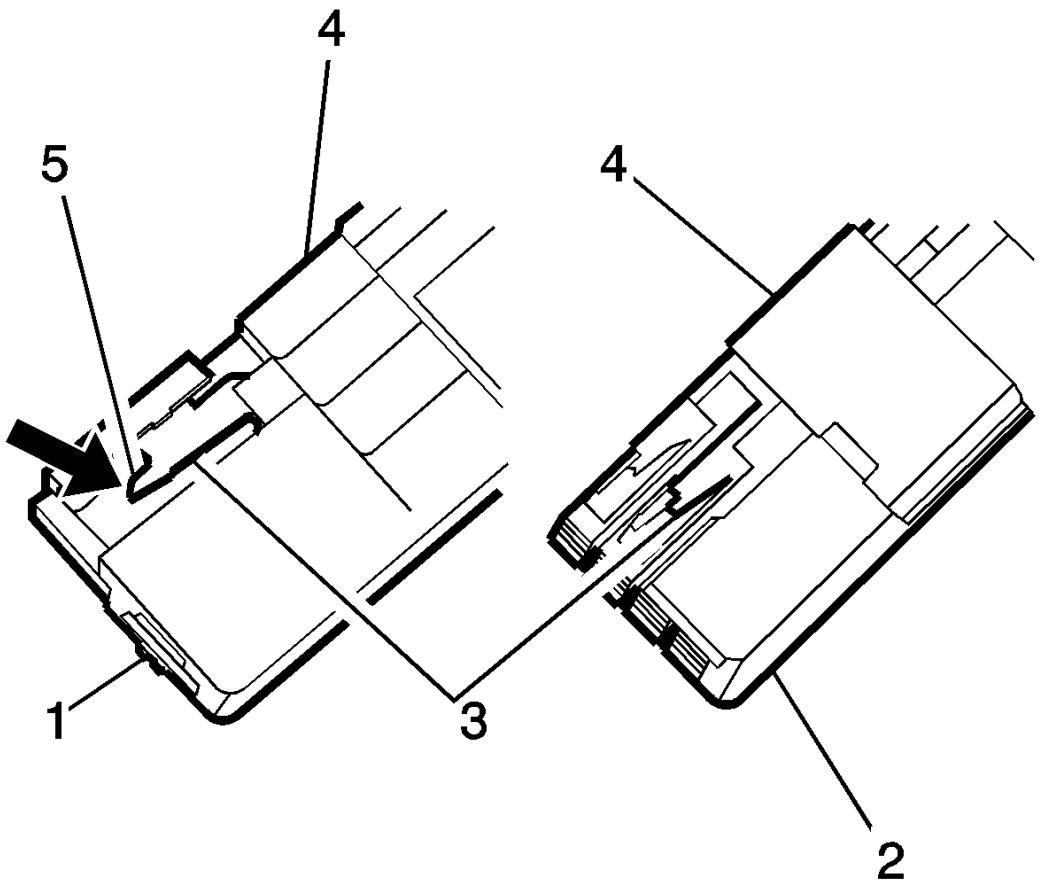


Fig. 109: Connector Lance And TPA
Courtesy of GENERAL MOTORS COMPANY

- The cavity on the left (1) is a 2.8 mm^2 cavity and the cavity on the right (2) is a 0.64 mm^2 cavity.
- Place the tip of the connector terminal release tool onto the connector lance (3) and deflect the lance to the right (5) to release the lock. Hold this released position.
- Holding the lance in the released position, slightly pull on the suspect terminal to remove it from the connector housing. The side TPA (4) is a secondary lock.

4. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
5. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

KOSTAL CONNECTORS (GLOW PLUG CONTROL MODULE)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit

- **J-38125-24** Terminal Release Tool
- **J-38125-560** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

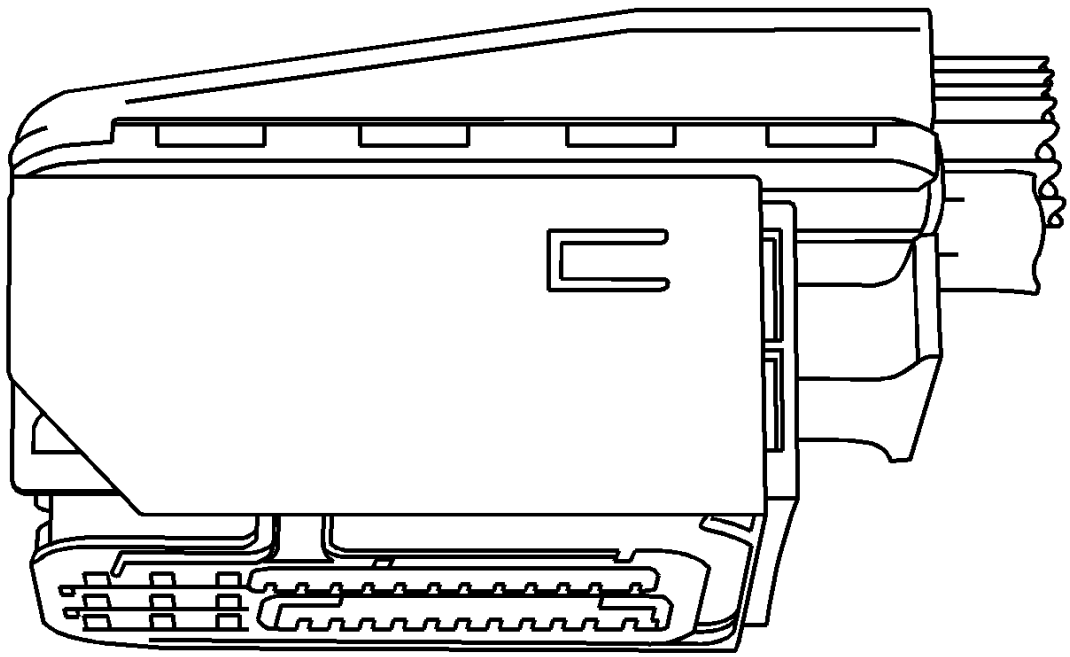


Fig. 110: View Of Typical Kostal Connector
Courtesy of GENERAL MOTORS COMPANY

View of typical connector.

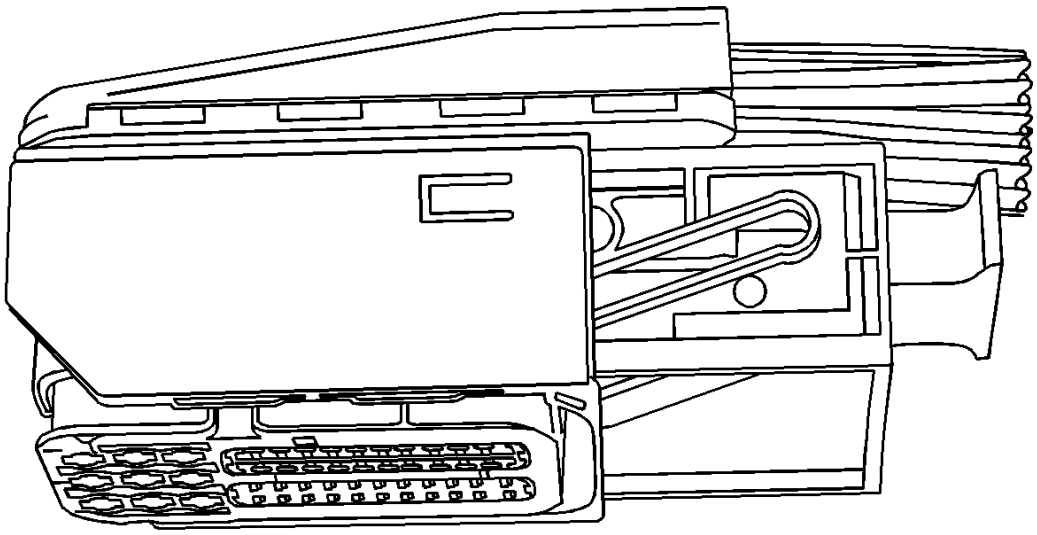


Fig. 111: View Of Connector In Released Position
Courtesy of GENERAL MOTORS COMPANY

View of connector in released position.

1. Locate the assist lever at the back of the connector. Move the assist lever to the rear position.
2. Disconnect the connector from the component.

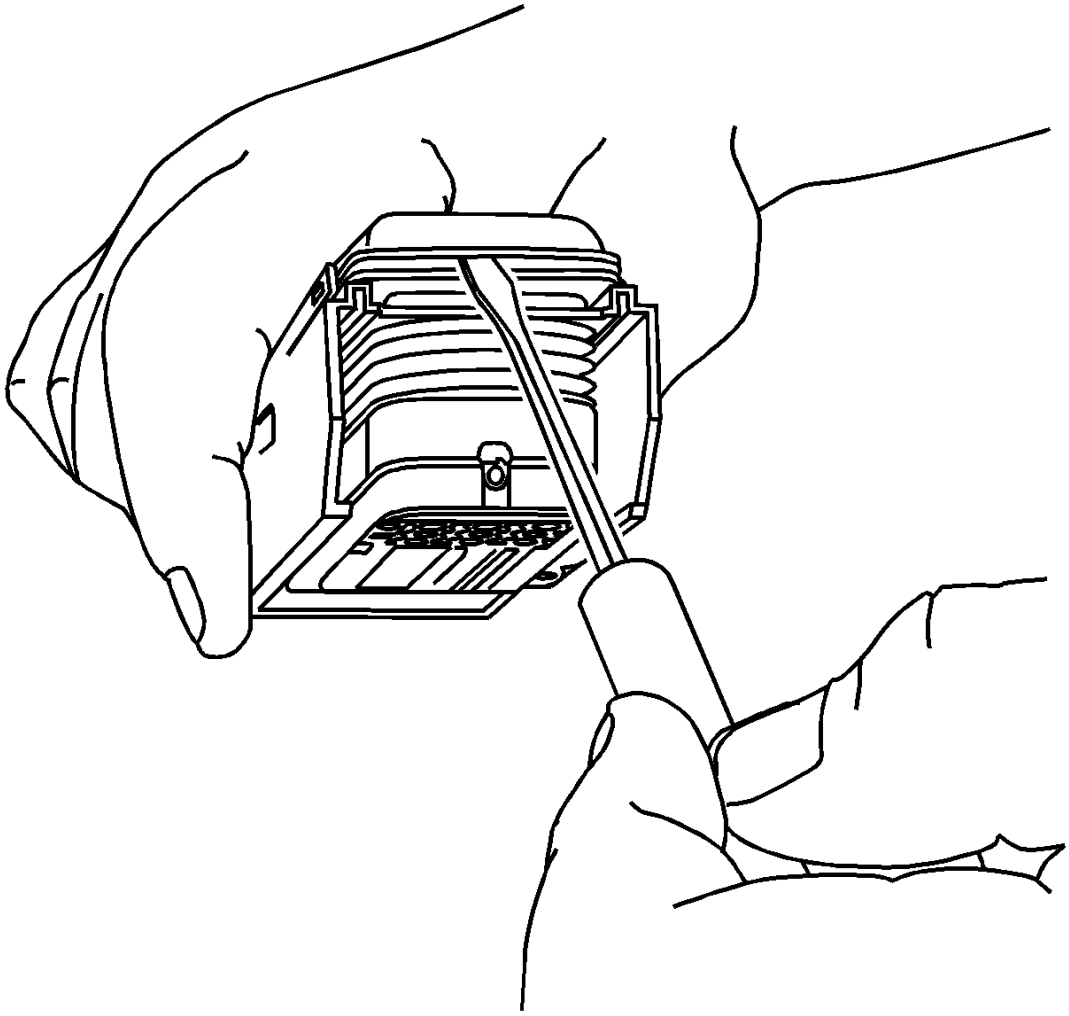


Fig. 112: Using Small Flat-Blade Tool To Remove Dress Cover
Courtesy of GENERAL MOTORS COMPANY

3. Use a small flat-blade tool to remove the dress cover.

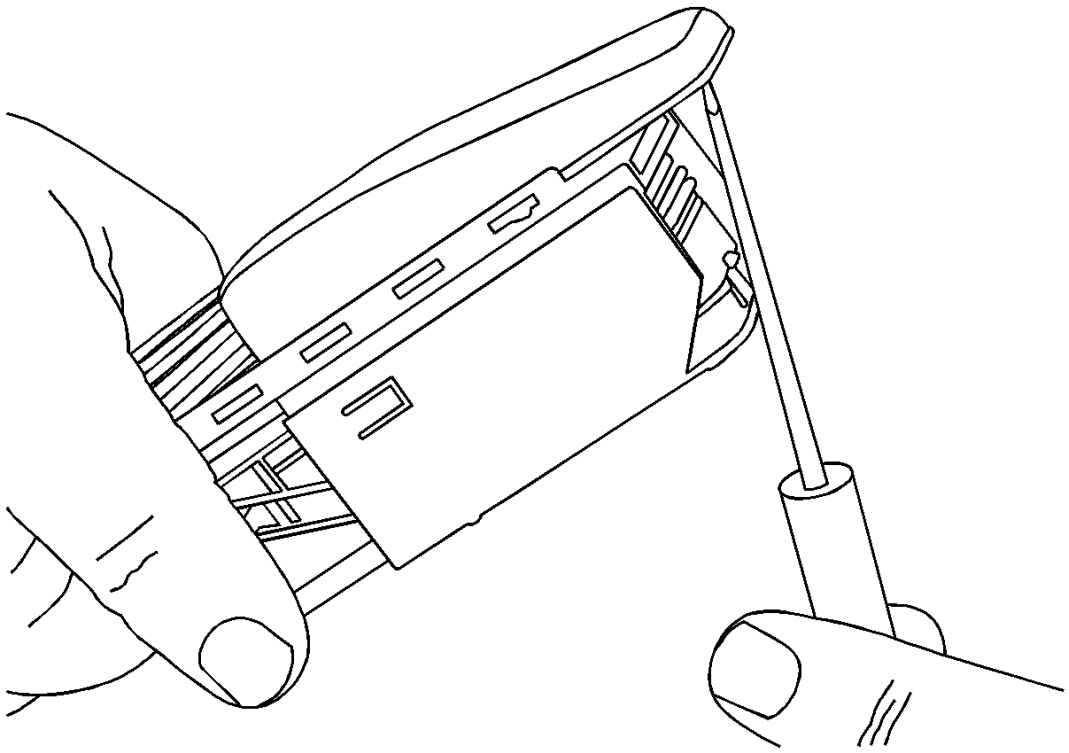


Fig. 113: Sliding Dress Cover Forward & Off Of Kostal Connector (Glow Plug Control Module)
Courtesy of GENERAL MOTORS COMPANY

4. Slide the dress cover forward and off of the connector.

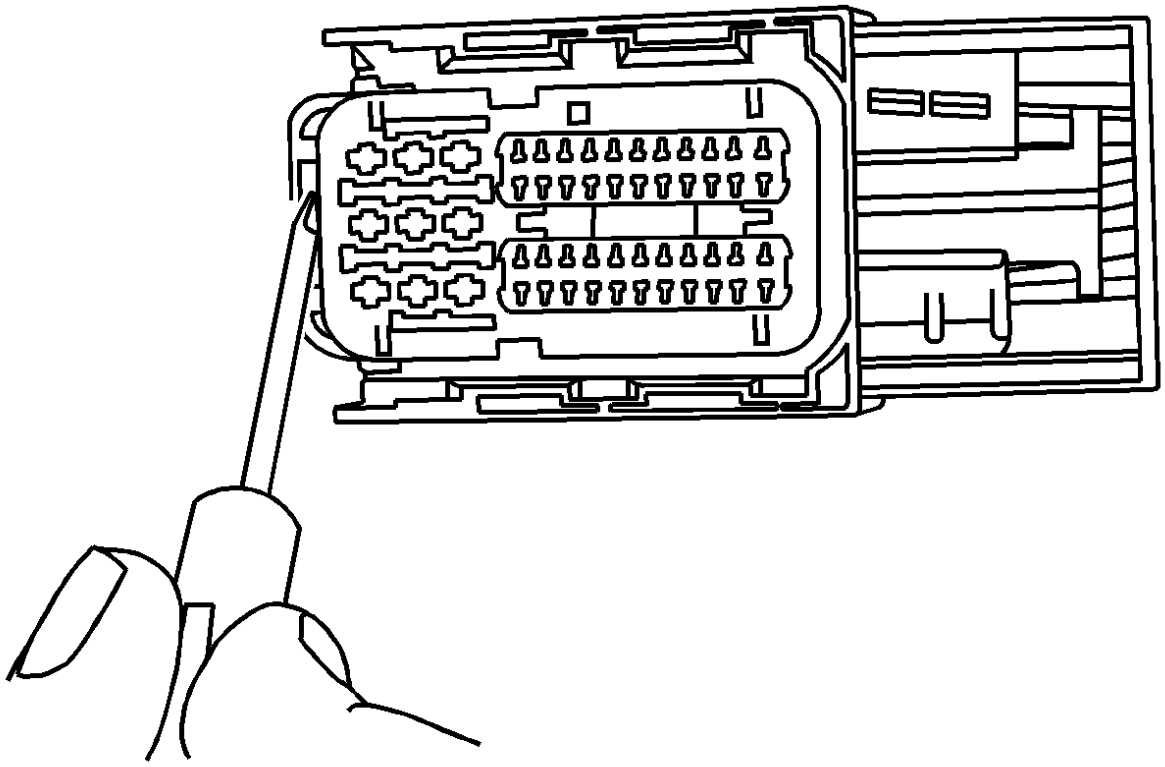


Fig. 114: Locating TPA In Front & Rear Of Connector
Courtesy of GENERAL MOTORS COMPANY

5. The terminal positive assurance (TPA) is located in the front and rear of the connector.

NOTE: **The front TPA cannot be removed from the connector. Only move it to the preset position.**

6. Use a small flat-blade tool to move the front TPA to the preset position, outboard approximately 0.125 in. (3 mm).

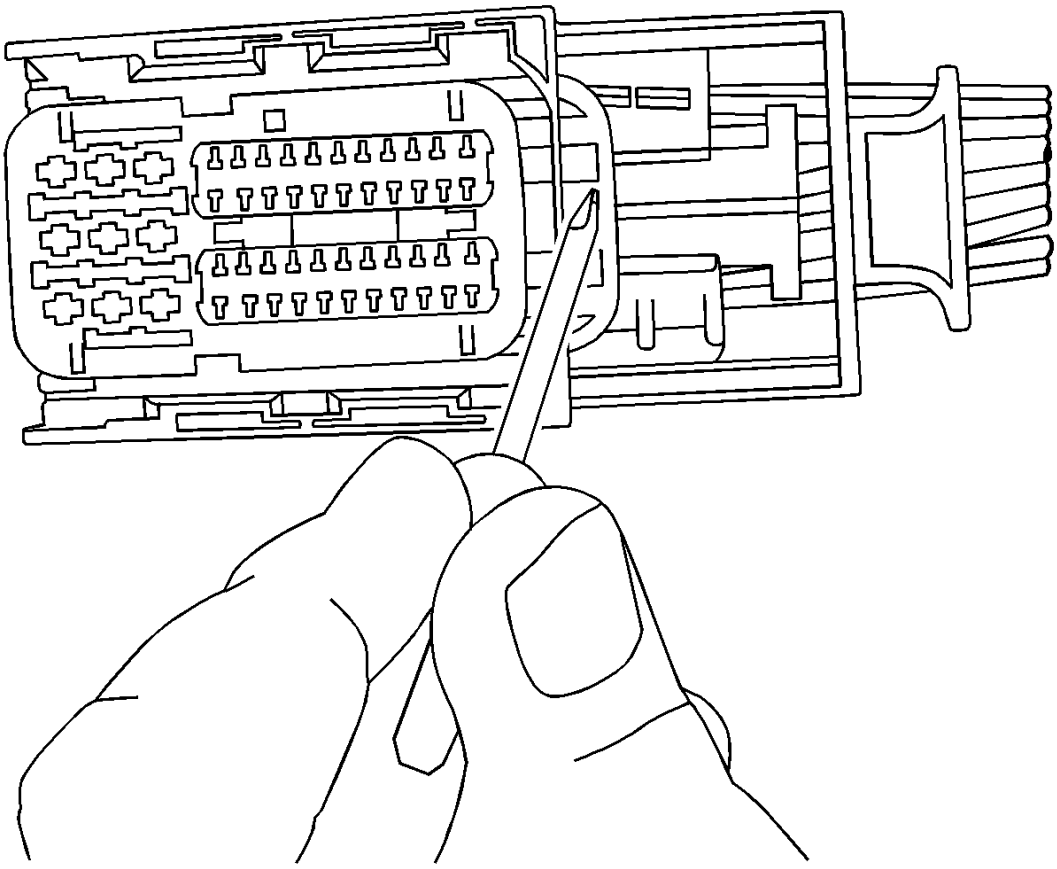


Fig. 115: Using Small Flat-Blade Tool To Remove Rear TPA
Courtesy of GENERAL MOTORS COMPANY

7. Use a small flat-blade tool to completely remove the rear TPA from the connector.

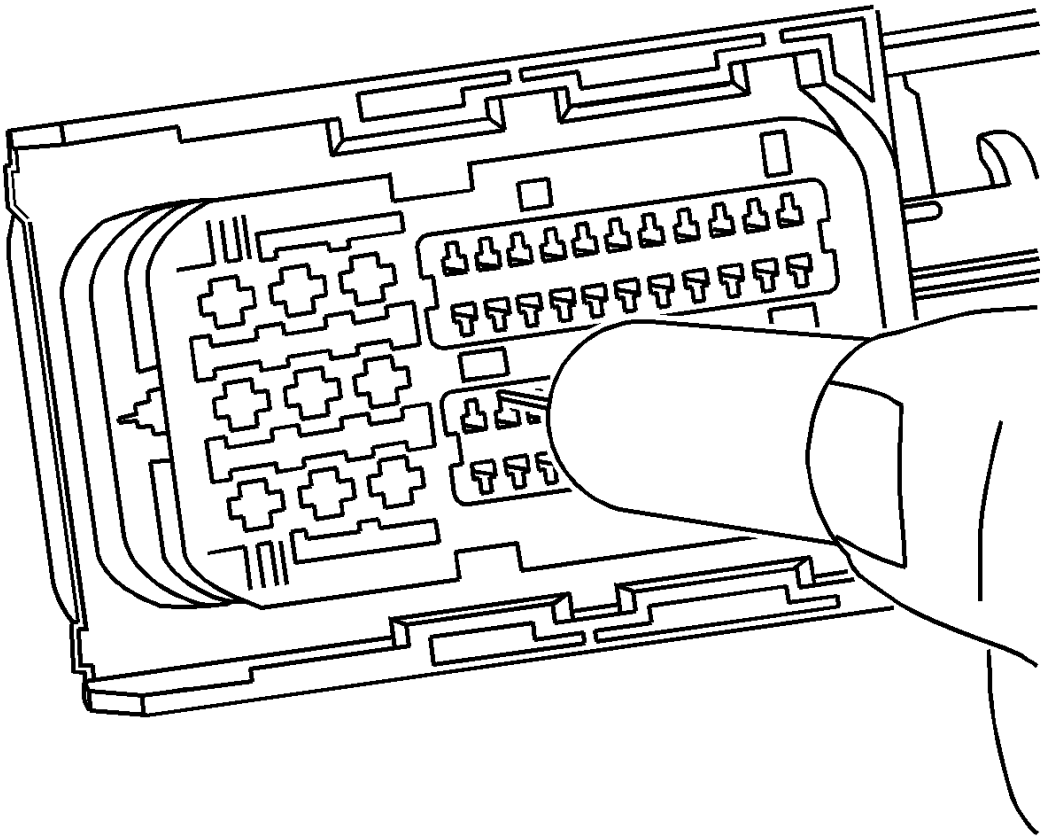


Fig. 116: Using Special Tool To Release Terminals
Courtesy of GENERAL MOTORS COMPANY

8. Use the J-38125-24 or the J-38125-560 tool to release the terminals by inserting the tool into the terminal release cavity.
9. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
10. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.

KOSTAL CONNECTORS (TRANSMISSION)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-28** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

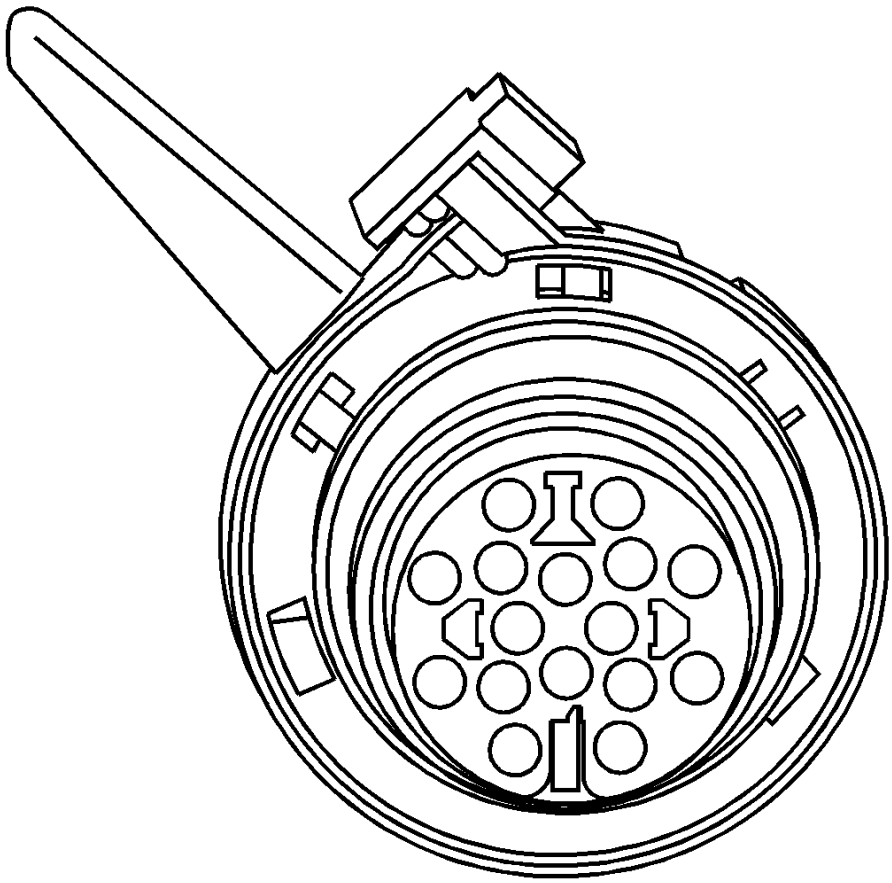


Fig. 117: View Of Connector & Lock
Courtesy of GENERAL MOTORS COMPANY

1. While depressing the lock, twist and remove the connector from the component.

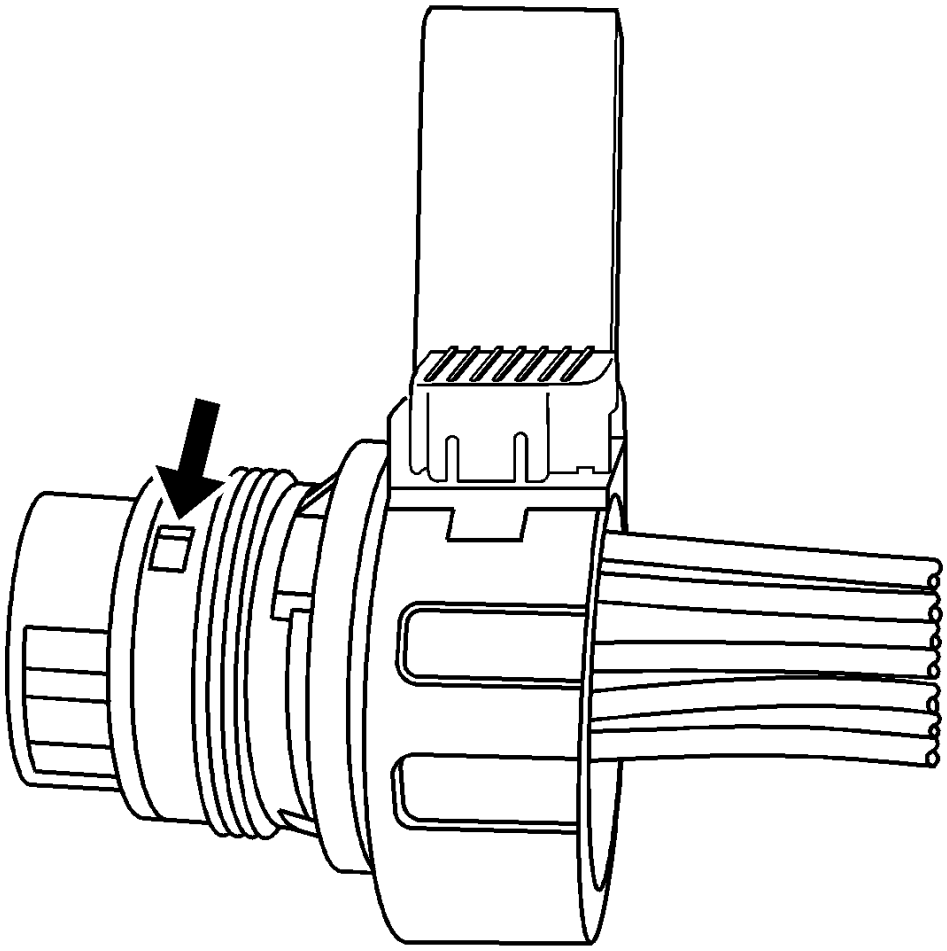


Fig. 118: View Of Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

2. Locate the terminal position assurance (TPA).

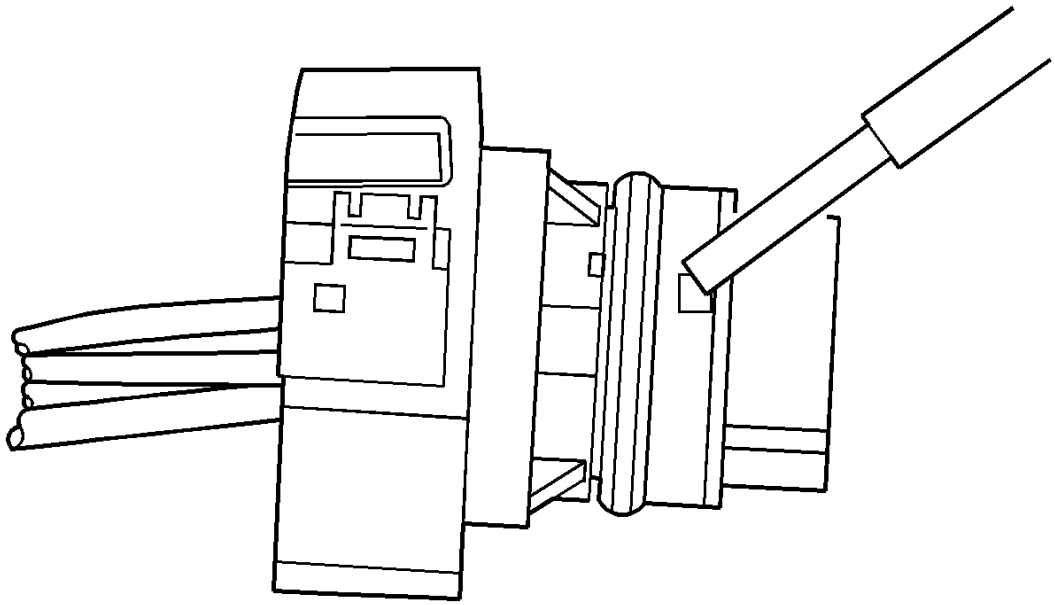


Fig. 119: View Of TPA & Flat-Bladed Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The TPA cannot be removed from the connector while there are terminals present in the connector body.**

3. Use a small flat-blade tool to push the TPA until it bottoms out.

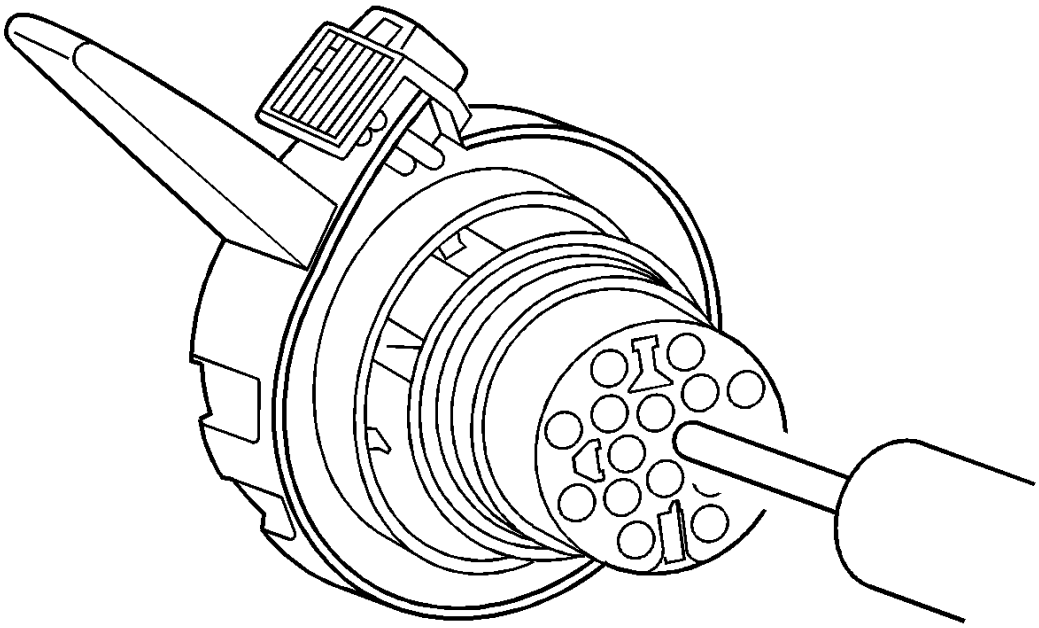


Fig. 120: Releasing Terminals
Courtesy of GENERAL MOTORS COMPANY

4. Use the J-38125-28 tool to release the terminals by inserting the tool into the terminal cavity as shown in the graphic.
5. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.

Terminal Insertion Procedure

After the terminal is replaced, perform the following procedure in order to insert the terminal.

1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Ensure that the terminal is locked in place by gently pulling on the wire.

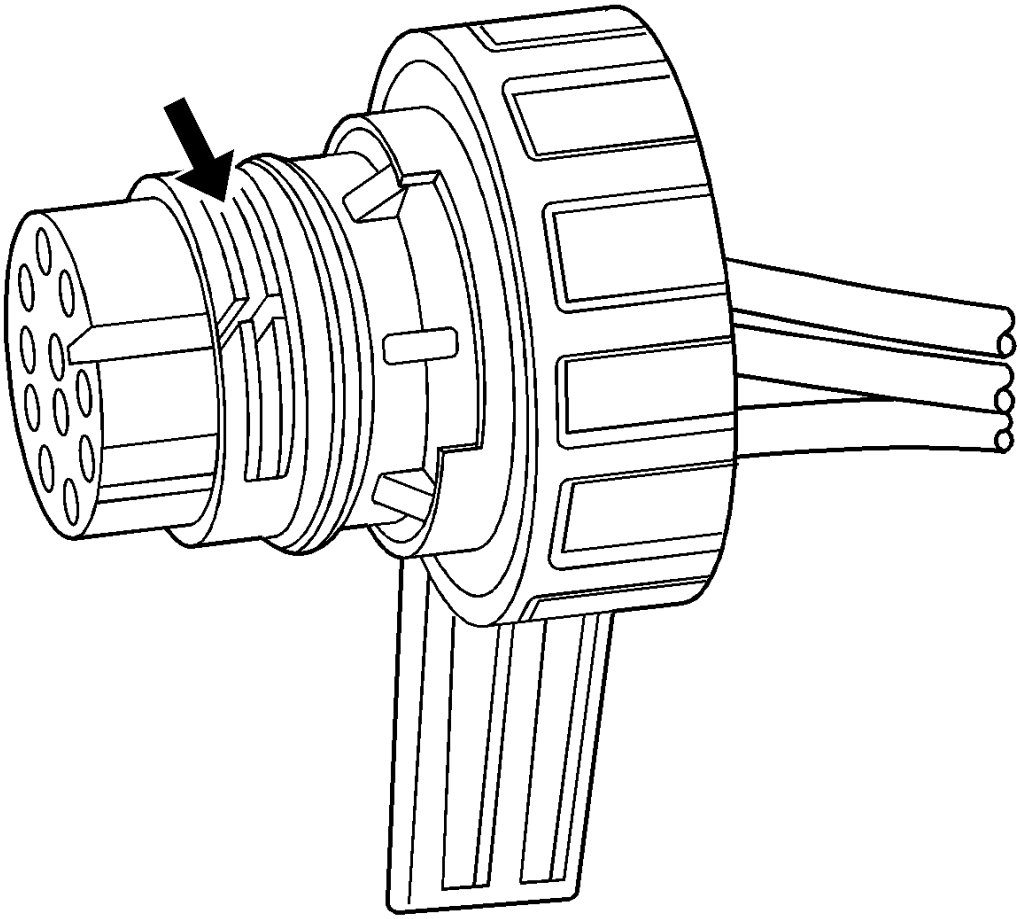


Fig. 121: Locating Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

3. Locate the TPA.

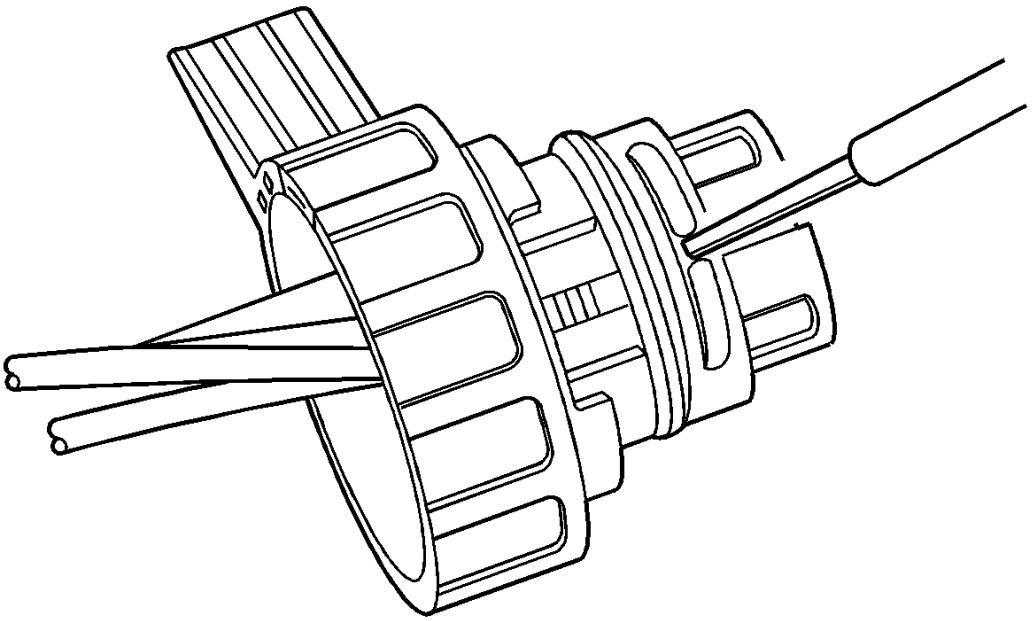


Fig. 122: View Of TPA & Flat-Bladed Tool
Courtesy of GENERAL MOTORS COMPANY

4. Use a small flat-blade tool to push the TPA until it bottoms out.

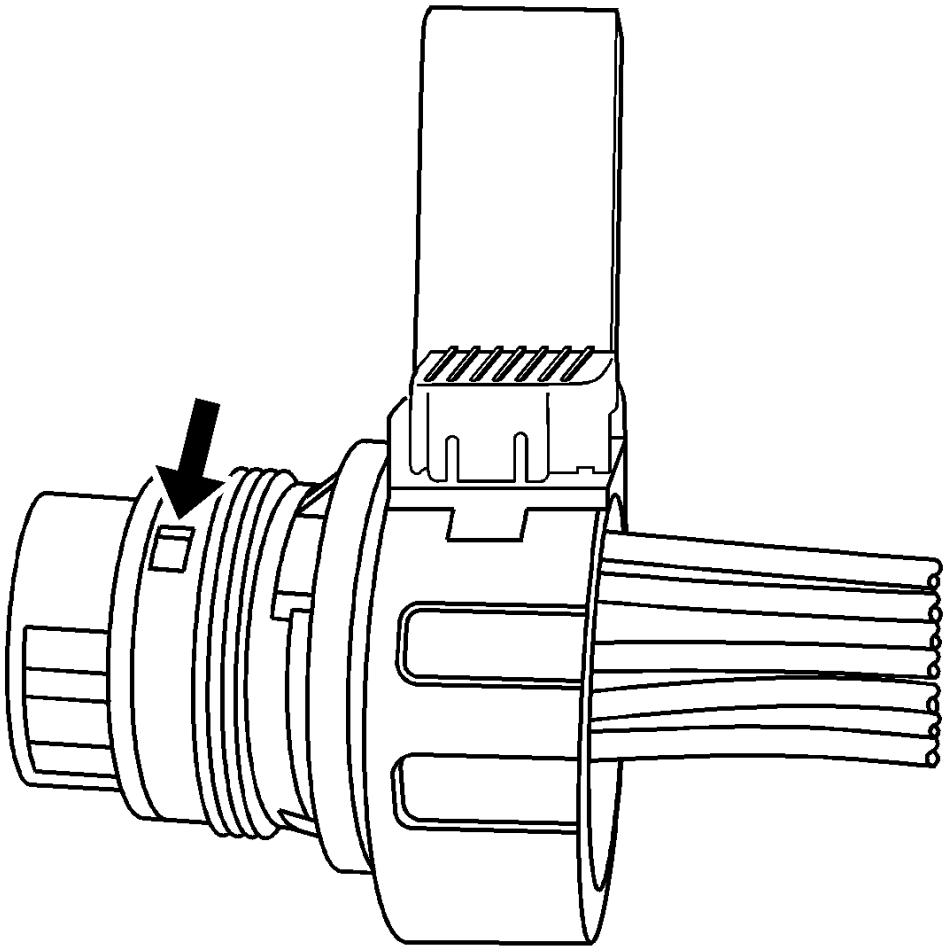


Fig. 123: View Of Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

5. Ensure the TPA is fully seated. The TPA should be centered and flush with the connector body when viewed.

MOLEX CONNECTORS

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-213** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

1. Locate the connector position assurance (CPA) on the top of the wire dress cover. Slide the CPA forward.

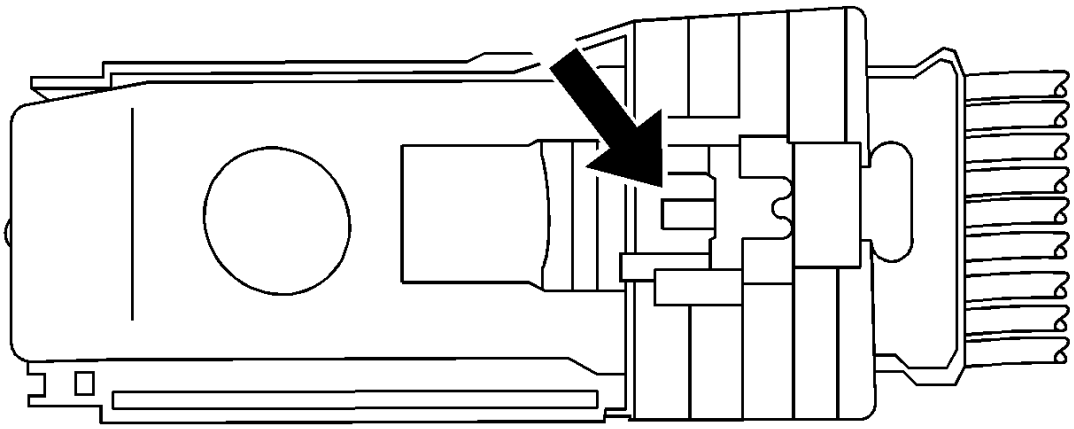


Fig. 124: Identifying Lever Lock Release Tab
Courtesy of GENERAL MOTORS COMPANY

2. Slide the lever lock forward while pressing down on the lever lock release tab.

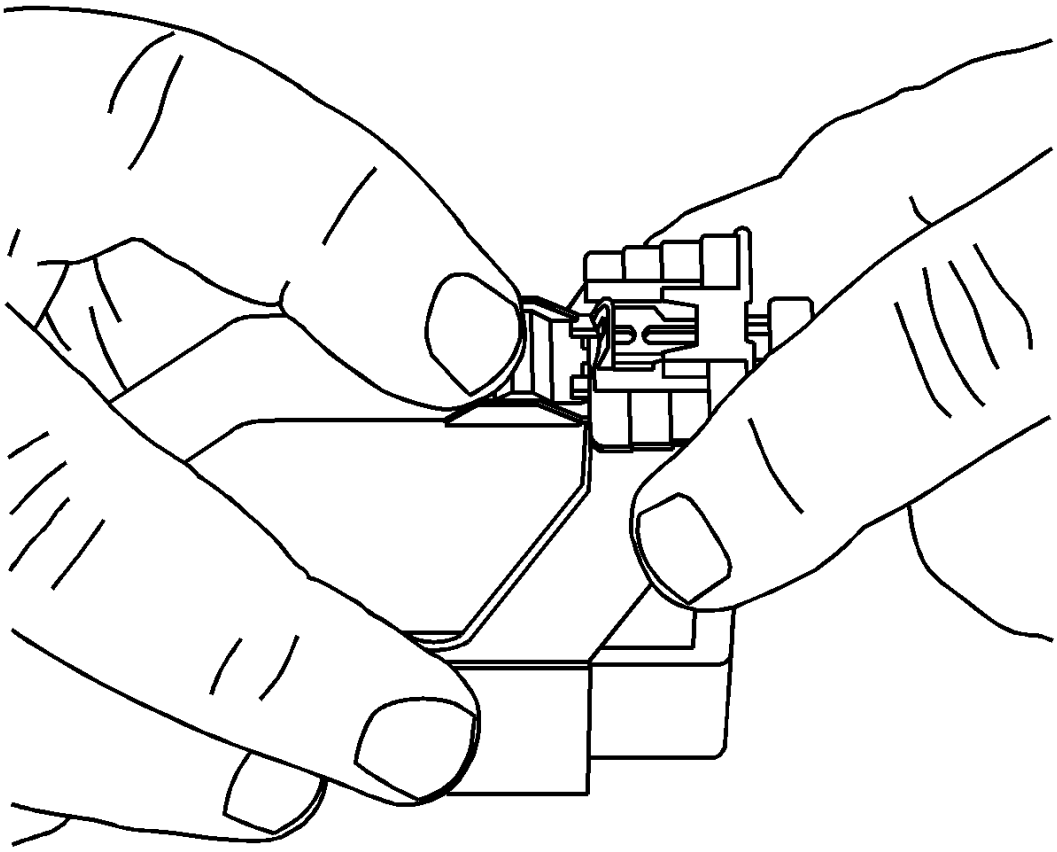


Fig. 125: View Of Lever In Full Forward Position
Courtesy of GENERAL MOTORS COMPANY

3. The lever should be in the full forward position.

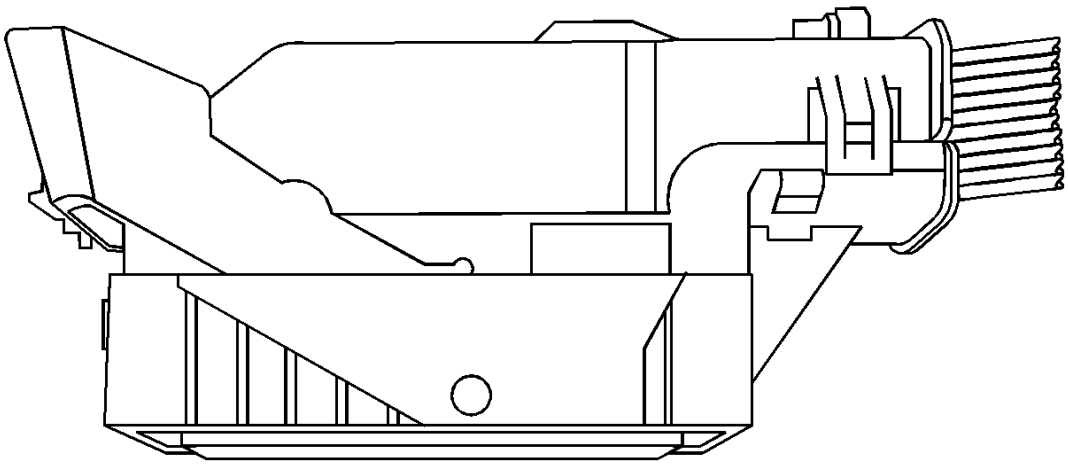


Fig. 126: View Of CPA Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the connector from the component.

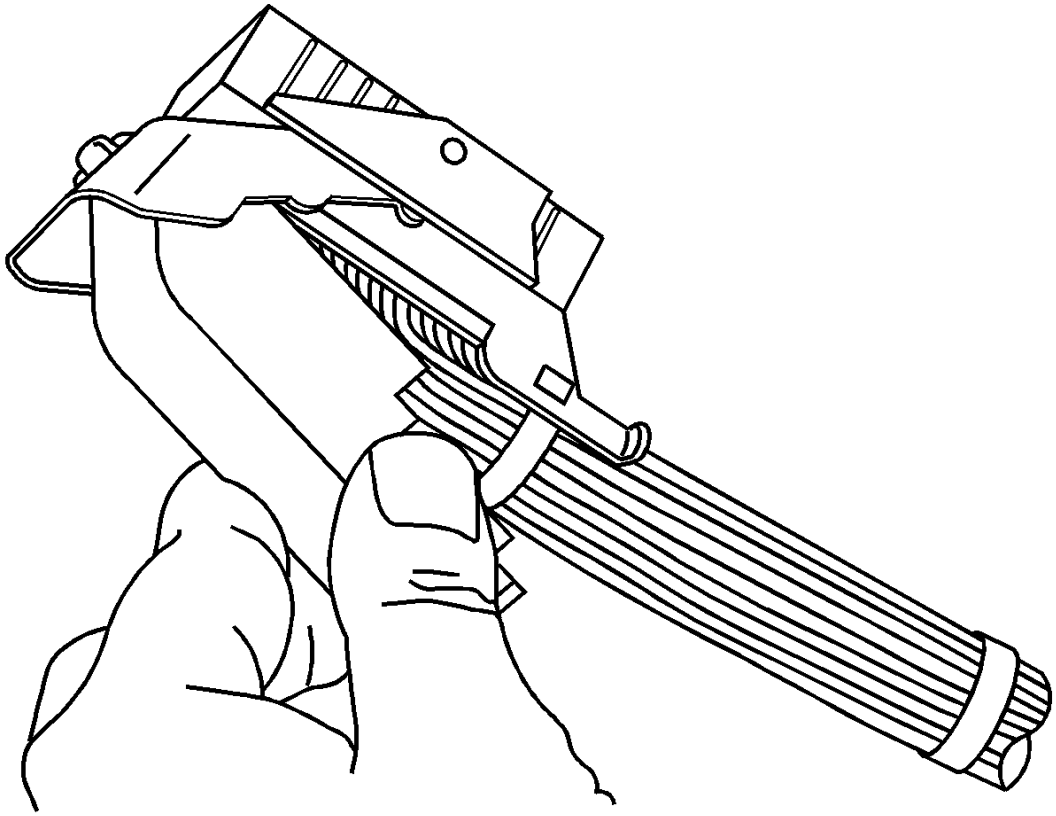


Fig. 127: View Of Dress Cover
Courtesy of GENERAL MOTORS COMPANY

5. Remove the dress cover by using a flat bladed tool to release the dress cover locking tabs and lift up on the dress cover.
6. Cut the tie wrap that holds the wires to the connector body.

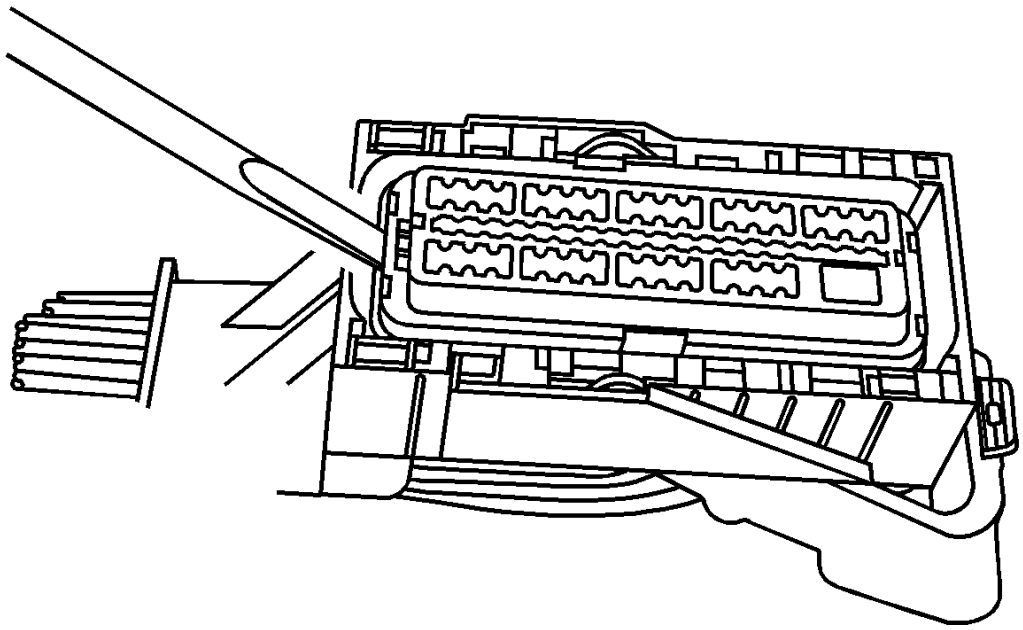


Fig. 128: Prying One Side Of Nose Piece
Courtesy of GENERAL MOTORS COMPANY

7. Use a small flat-blade tool to pry one side of the nose piece up to the pre-stage position. When the nose piece is in the pre-staged position, the nose piece will be raised above the connector body the length of the step in the nose piece.

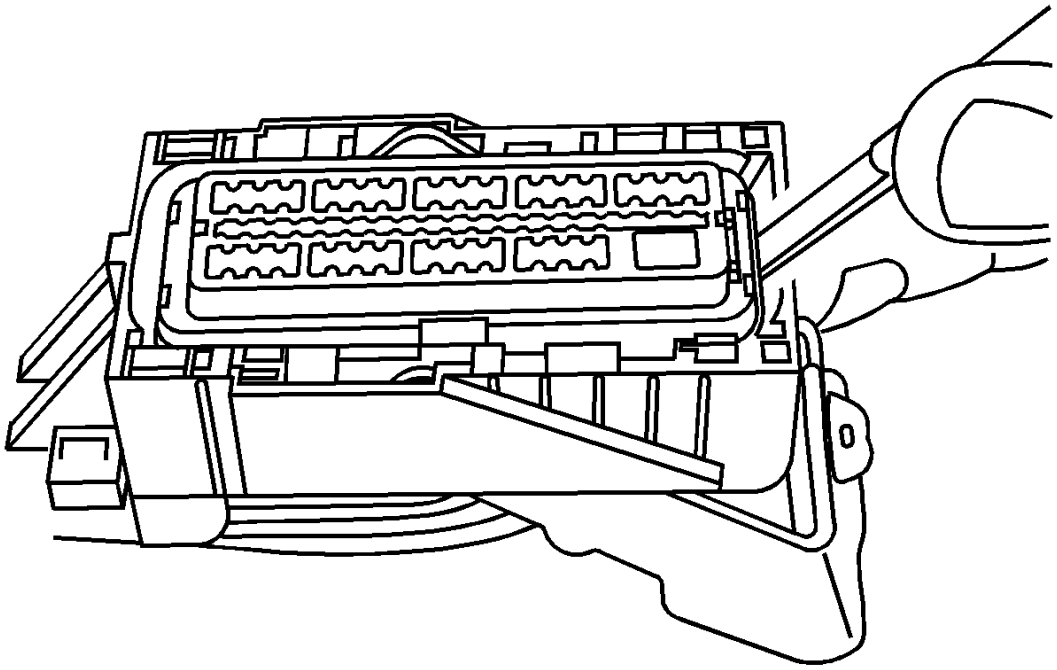


Fig. 129: Prying Side Of Nose Piece
Courtesy of GENERAL MOTORS COMPANY

8. Use a small flat-blade tool to pry the other side of the piece to the pre-stage position. If the nose piece is higher than the first step in the nose piece, gently push down on the nose piece until it meets with resistance from the connector body, you should feel the nose piece click into position.

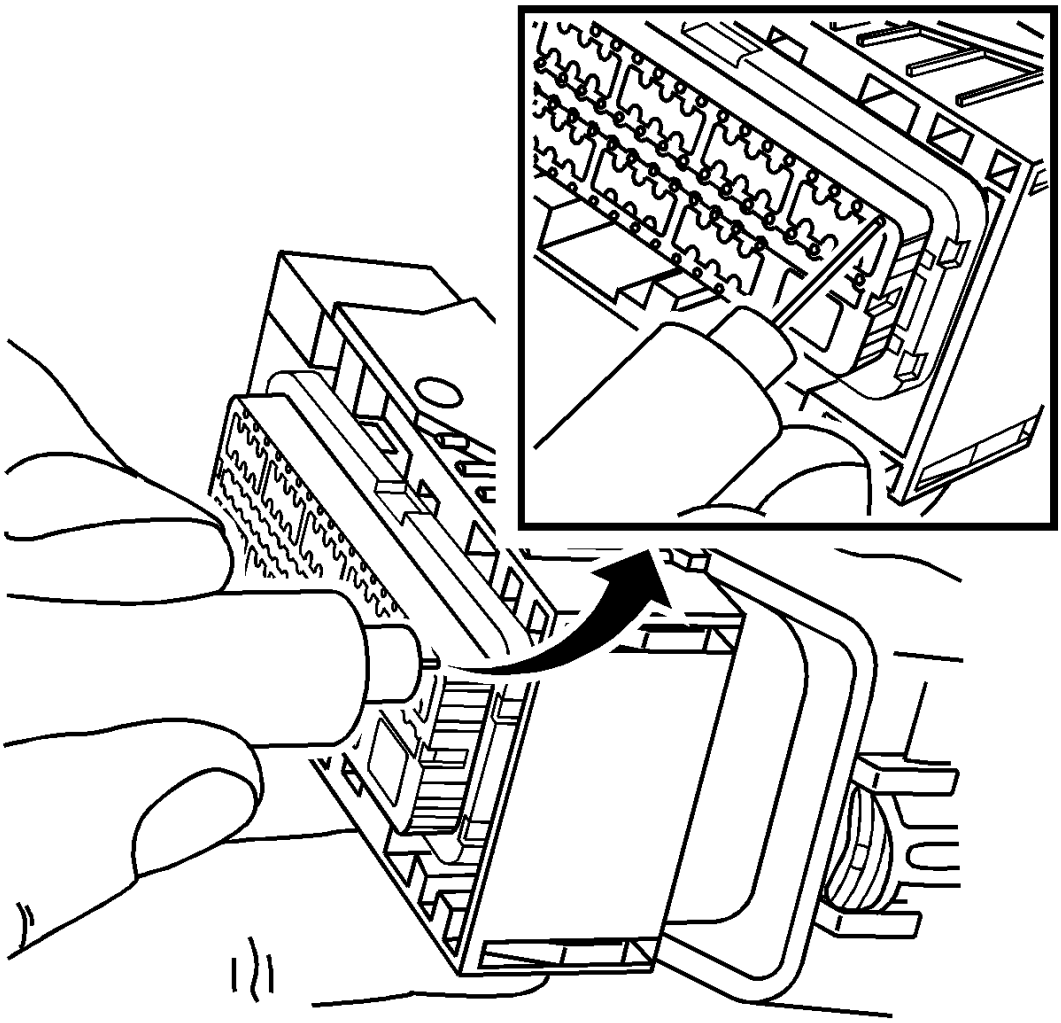


Fig. 130: Releasing Terminal
Courtesy of GENERAL MOTORS COMPANY

9. Insert the J-38125-213 into the small terminal release hole on the nose piece and gently pull on the back of the wire.
10. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
11. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminated Lead Repair

1. Remove the terminal.
2. Find the appropriate terminated lead.
3. Use the appropriate splice sleeves depending on the gauge size.
4. Refer to **Splicing Copper Wire Using Splice Sleeves**.

Terminal Insertion Procedure

After the terminal is replaced, perform the following procedure in order to insert the terminal.

1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Insure that the terminal is locked in place by gently pulling on the wire.
3. To assemble the connector, reverse the connector disassembly procedure.

MOLEX CONNECTORS (SIR)

Removal Procedure

NOTE: **The orange or yellow connector position assurance (CPA) must be released first to disconnect or to connect the connector.**

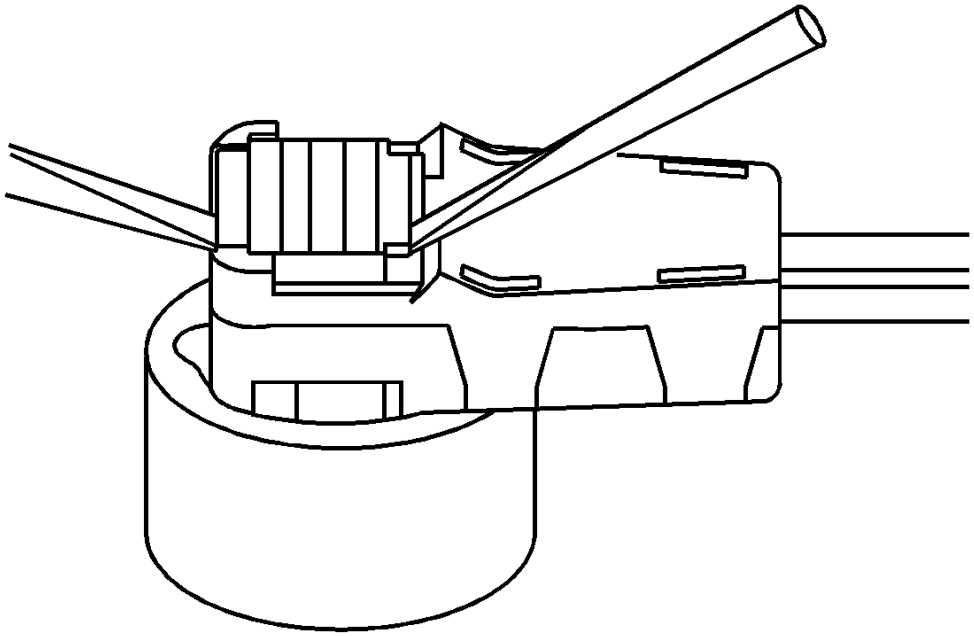


Fig. 131: Lifting Orange CPA
Courtesy of GENERAL MOTORS COMPANY

1. Lift the orange or yellow CPA vertically (avoid lifting on an angle to the connector) approximately 4 mm to release the connector. Use a small flat-bladed tool to help release the CPA. The CPA may also be released manually without any tools.

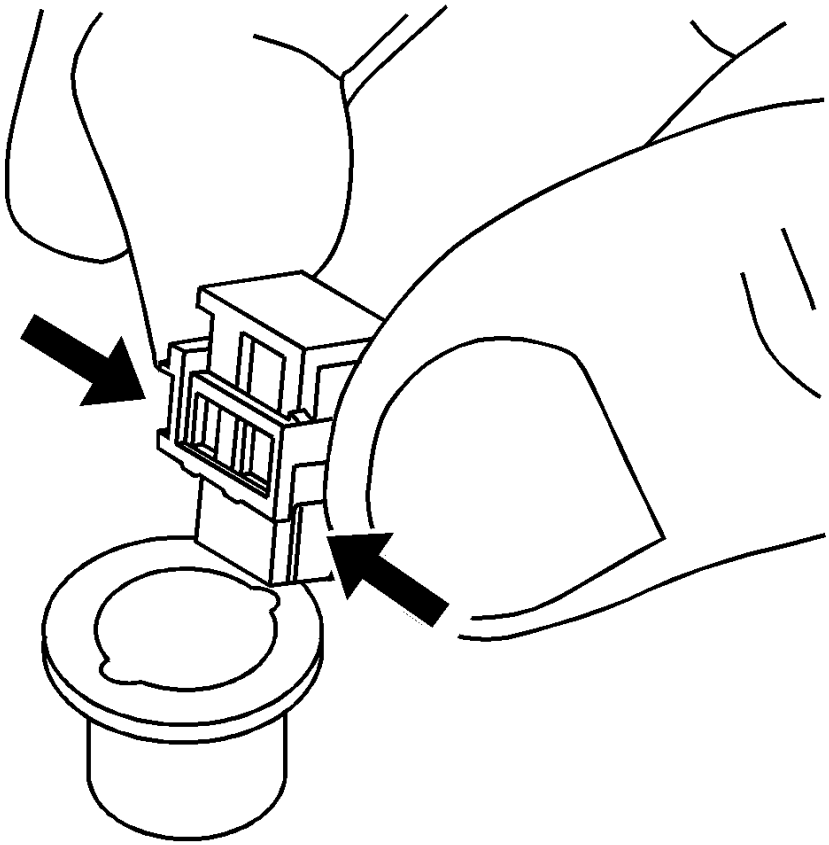


Fig. 132: Grabbing Connector On Both Sides
Courtesy of GENERAL MOTORS COMPANY

2. Grab the connector on both sides and lift vertically to disconnect the connector.

Installation Procedure

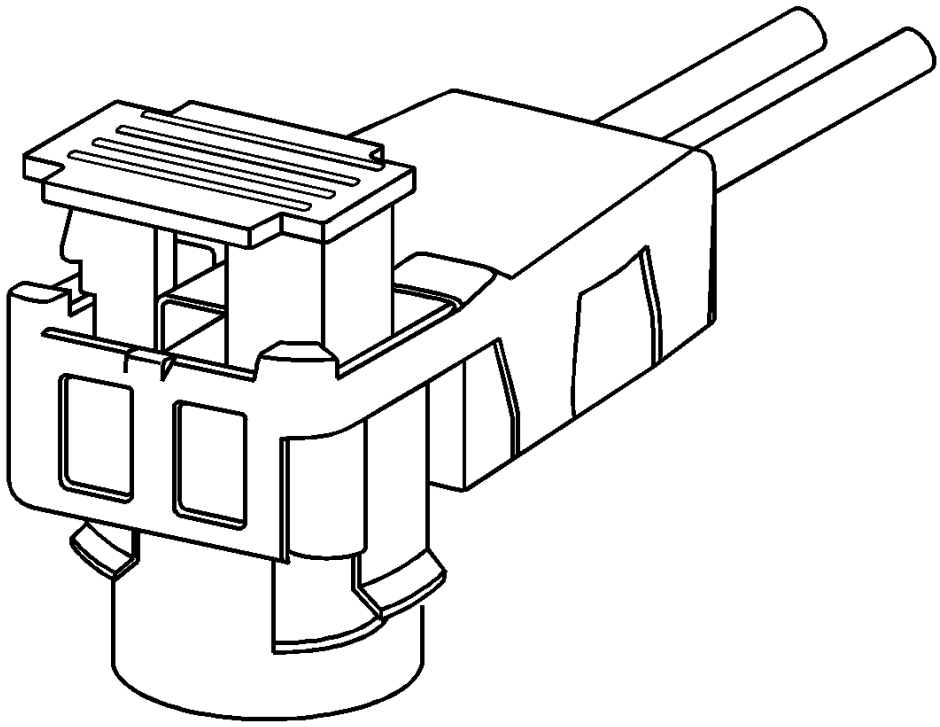


Fig. 133: Lifting Orange CPA
Courtesy of GENERAL MOTORS COMPANY

1. The CPA should be approximately 4 mm above the yellow cover before installing the connector. If not, use a small flat-bladed tool to help release the CPA. The CPA may also be released manually without any tools.

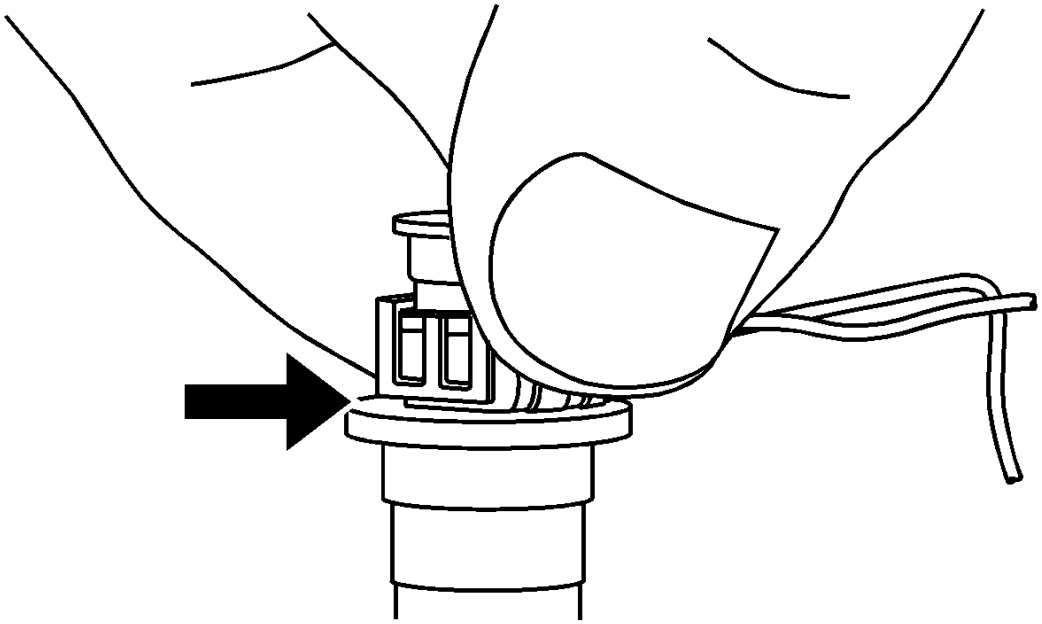


Fig. 134: Seating Connector Sub-Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Line up the connector key tabs with the initiator key slots. Grab the connector on both sides and push down into the initiator connector sub assembly until fully seated.

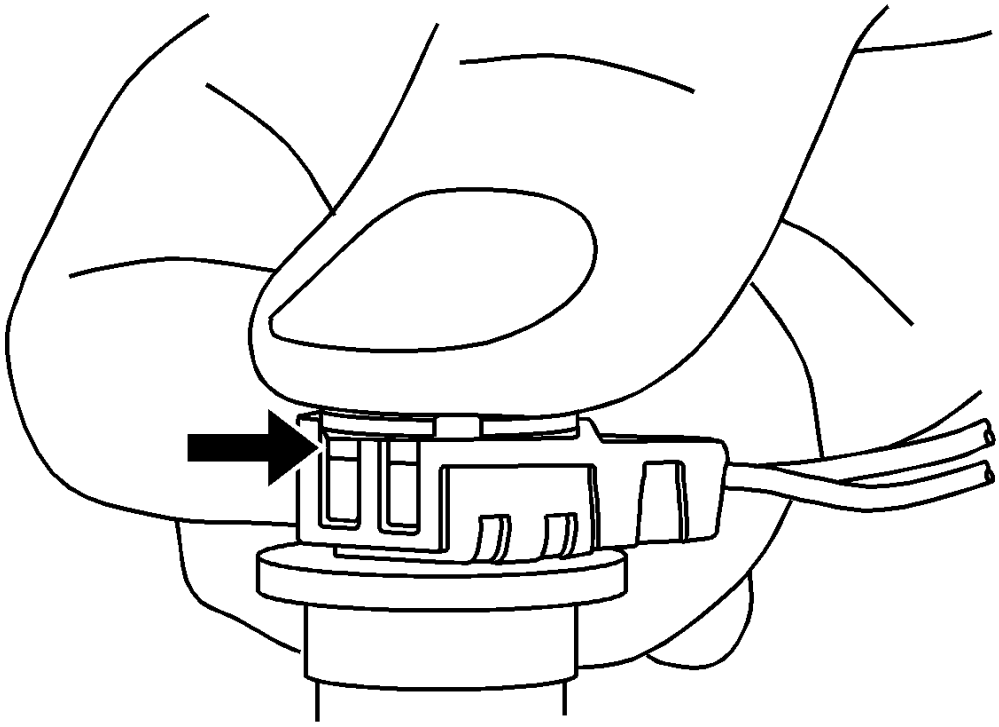


Fig. 135: Pushing CPA Down
Courtesy of GENERAL MOTORS COMPANY

3. After the connector is fully seated, push the CPA down with your thumb until the CPA is touching the yellow cover on the connector.

SUMITOMO CONNECTORS

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool
- **J-38125-552** Terminal Release Tool
- **J-38125-553** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

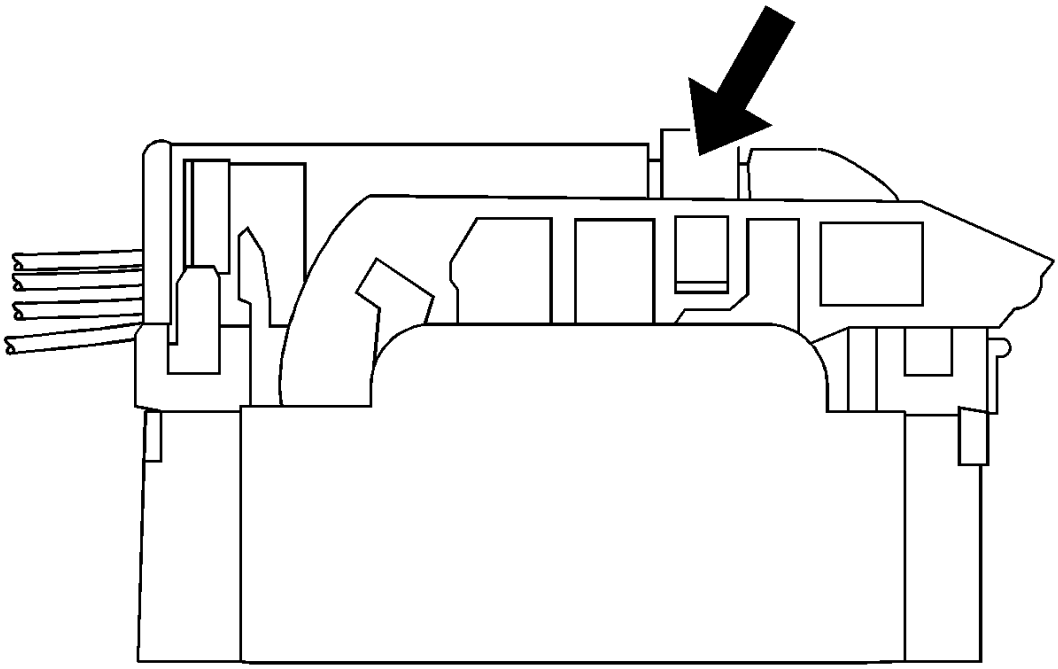


Fig. 136: Identifying Lever Lock
Courtesy of GENERAL MOTORS COMPANY

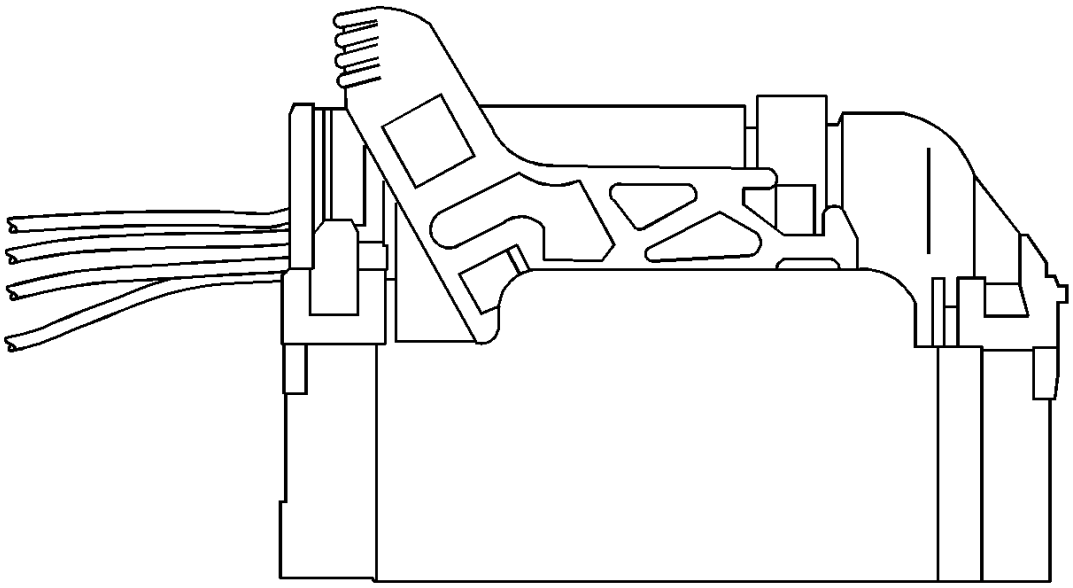


Fig. 137: View Of Lever Lock In Forward Position
Courtesy of GENERAL MOTORS COMPANY

1. Slide the lever lock forward while pressing down on the lever lock release tab.
2. Disconnect the connector from the component.

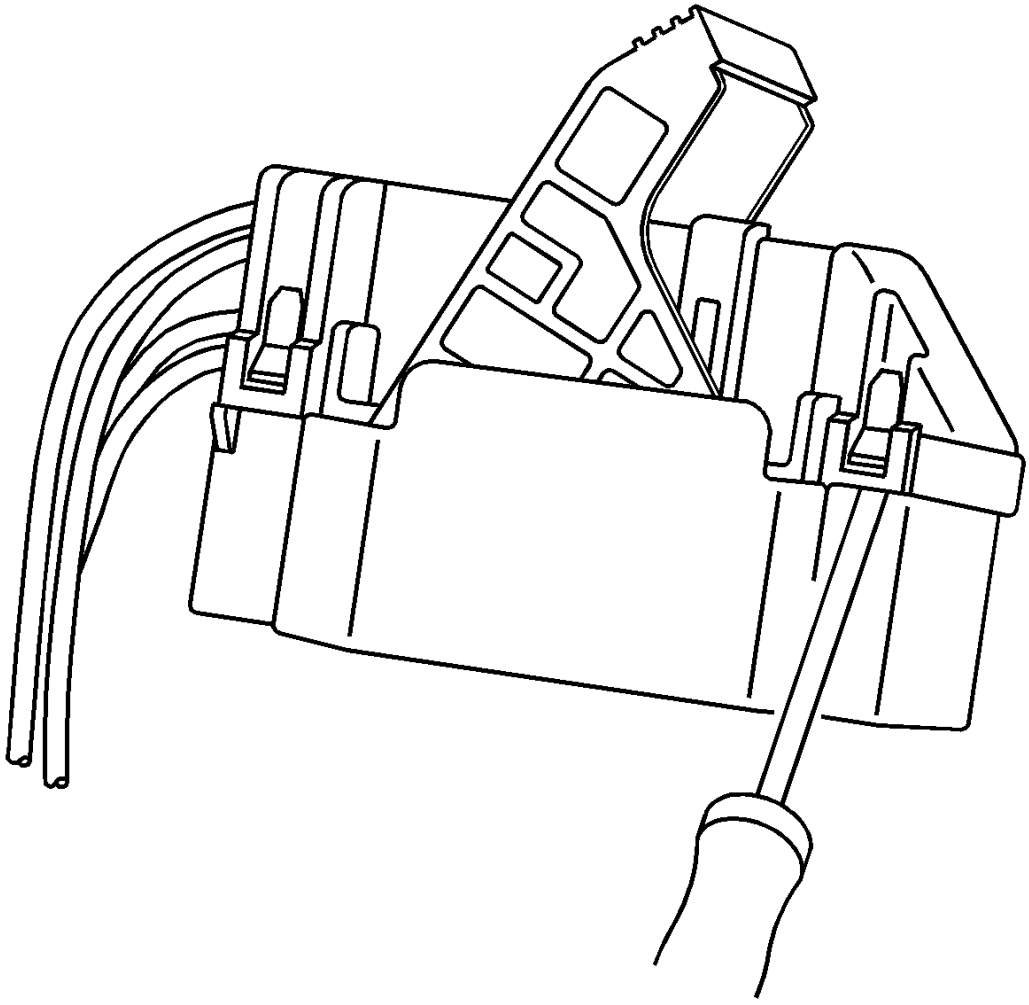


Fig. 138: View Of Connector Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Remove the dress cover by using a flat-blade tool to release the connector locking tabs and pulling off the dress cover.

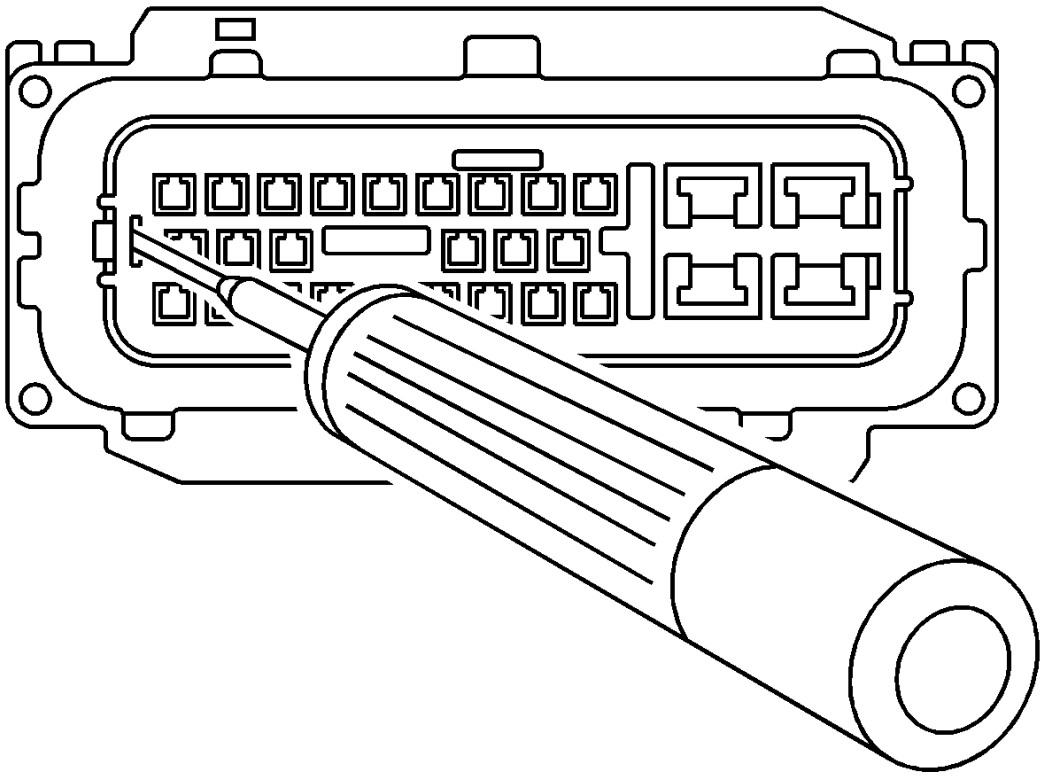


Fig. 139: Identifying Nose Piece Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

4. Relieve the tension on the nose piece retainers by inserting J-38125-12A into the single retainer slot on the end of the nose piece and gently prying out the locking tab. Repeat the process for both of the nose piece locking tabs on the opposite side of the nose piece.

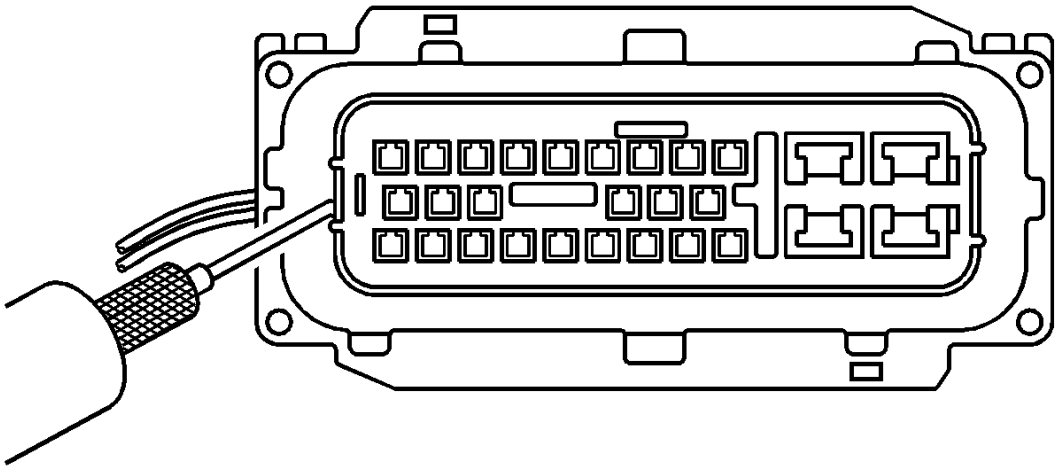


Fig. 140: Pulling Up One End Of Nose Piece (1st Side)
Courtesy of GENERAL MOTORS COMPANY

5. Once the nose piece retainers are relaxed, use the J-38125-552 to pull up the nose piece by hooking the tool under the nose piece and pulling up. The nose piece should raise slightly.

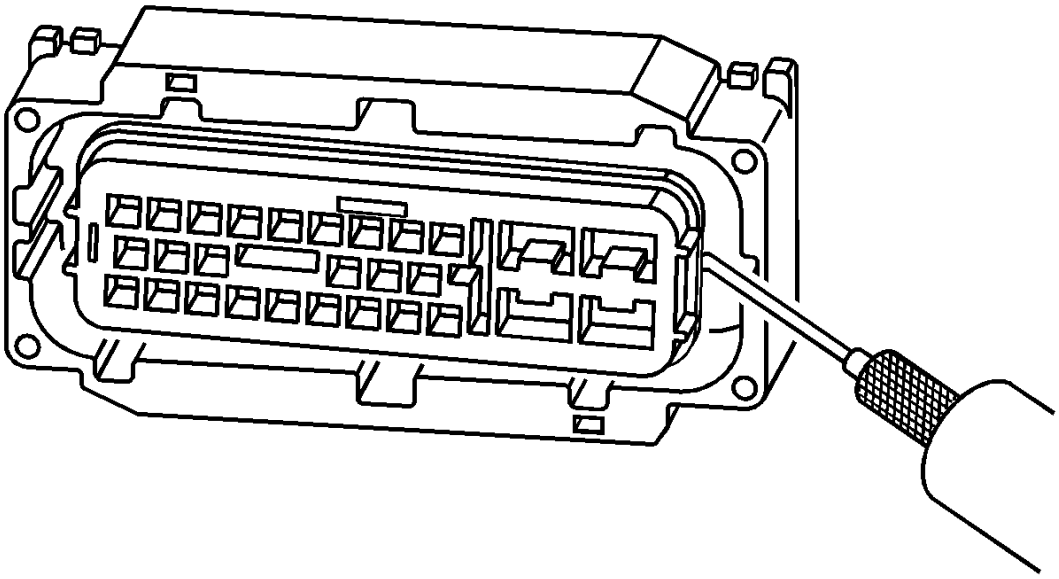


Fig. 141: Pulling Up One End Of Nose Piece (2nd Side)
Courtesy of GENERAL MOTORS COMPANY

6. On the opposite side of the nose piece, use the J-38125-552 pull up the nose piece by hooking the tool under the nose piece and pulling up. The nose piece should release completely. If the nose piece does not come off, repeat the procedure on the opposite side.

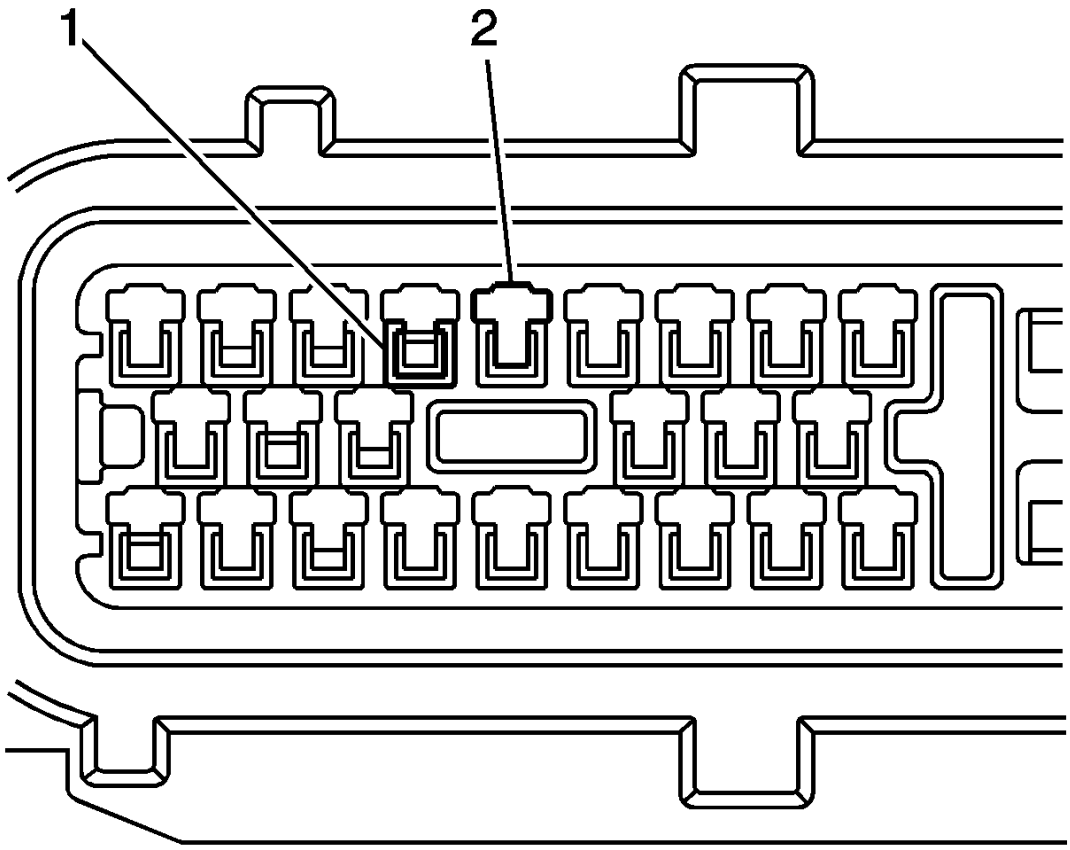


Fig. 142: View Of Terminal & Entry Canal
Courtesy of GENERAL MOTORS COMPANY

7. The illustration above identifies the entry canal where the terminal release tool will be inserted, and the terminal cavity.
    - Terminal (1)
    - Entry Canal (2)

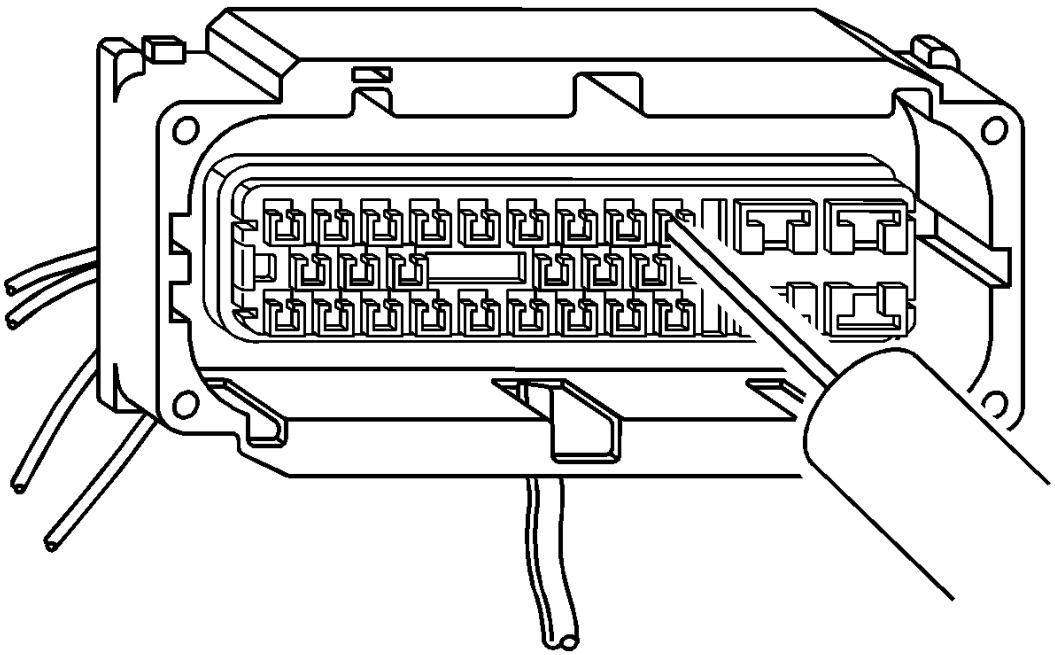


Fig. 143: Inserting Tool Into Entry Canal
Courtesy of GENERAL MOTORS COMPANY

8. Insert the J-38125-553 tool into the entry canal and pry up on the terminal retainer. The terminal retainer is a small plastic piece on the top of the terminal. The terminal retainer must be held up while the terminal is pulled out of the connector.

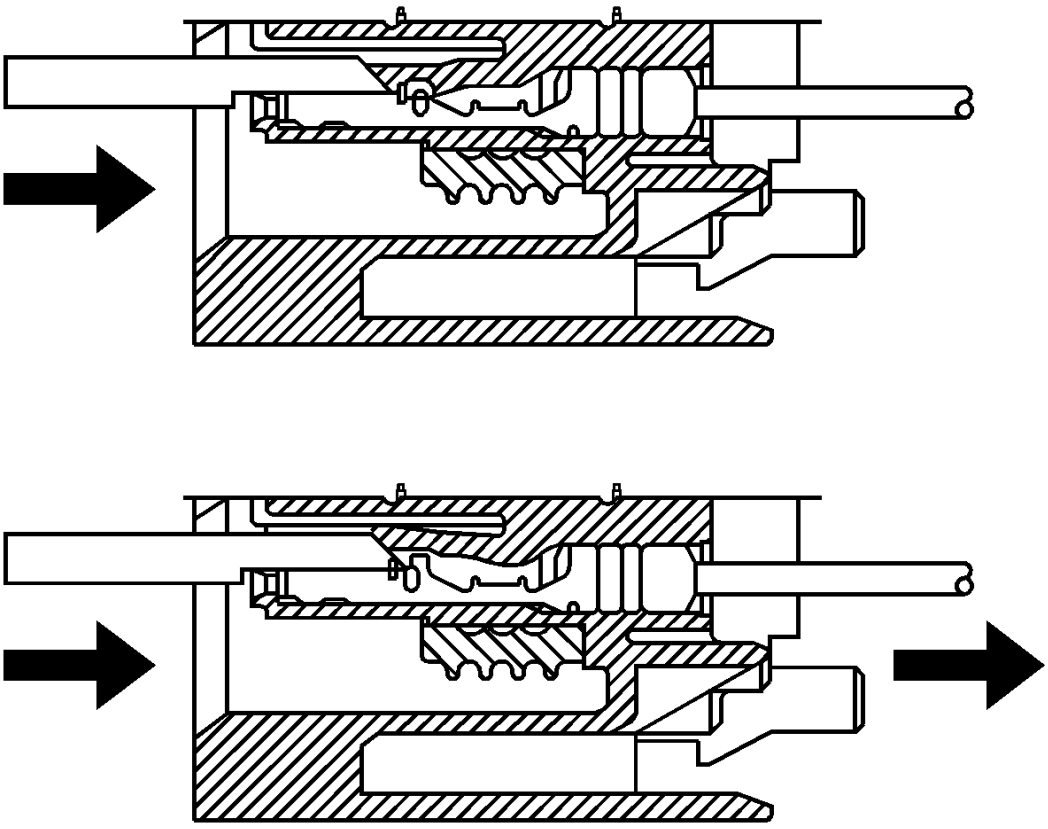


Fig. 144: Cutaway View Of Connector
Courtesy of GENERAL MOTORS COMPANY

9. The illustration shows a cutaway view of the connector to aid the technician in releasing the terminal retainer.
10. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
11. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

Terminal Insertion Procedure

After the terminal is replaced, perform the following procedure in order to insert the terminal.

1. Slide the new terminal into the correct cavity at the back of the connector.
2. Push the terminal into the connector until it locks into place. The new terminal should be even with the other terminals. Ensure that the terminal is locked in place by gently pulling on the wire.
3. To assemble the connector, reverse the connector disassembly procedure.

TYCO/AMP CONNECTORS (CM 42-WAY)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

1. Locate the connector position assurance (CPA) on the connector body and pull the CPA out. The CPA is on the wire harness side of connector.
2. Disconnect the connector from the component.

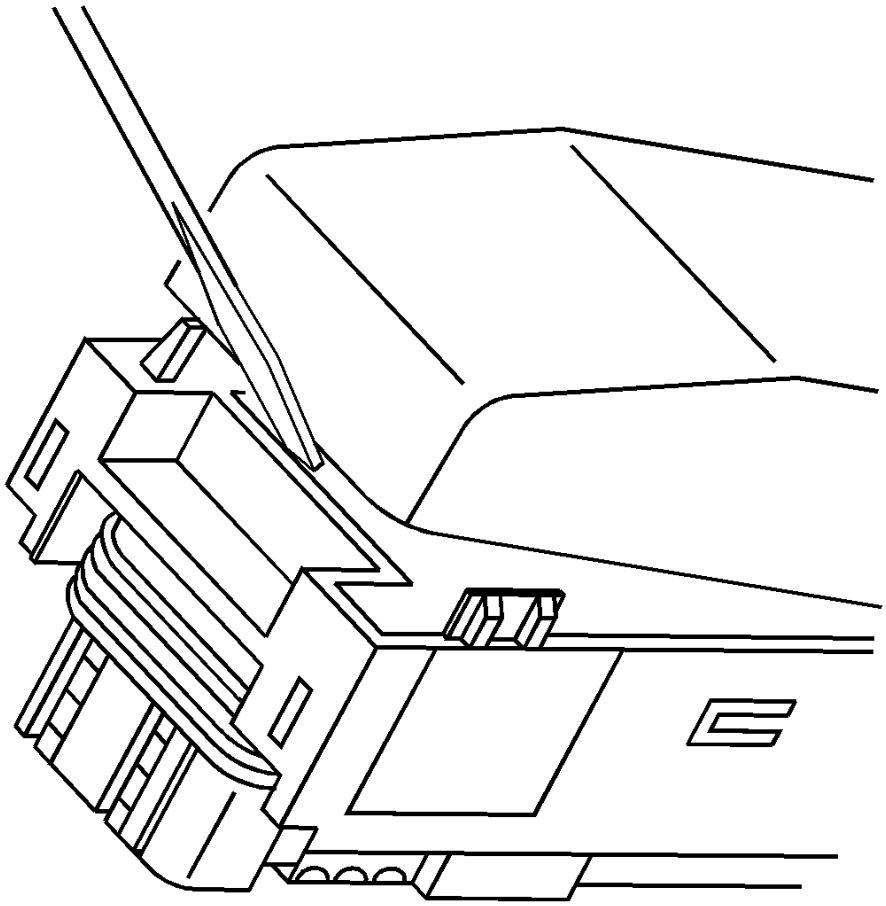


Fig. 145: View Of Dress Cover
Courtesy of GENERAL MOTORS COMPANY

3. Use a small flat-bladed tool to gently pry off the dress cover by inserting the tool under the cover opposite the harness side and prying up.
4. Remove the cover.

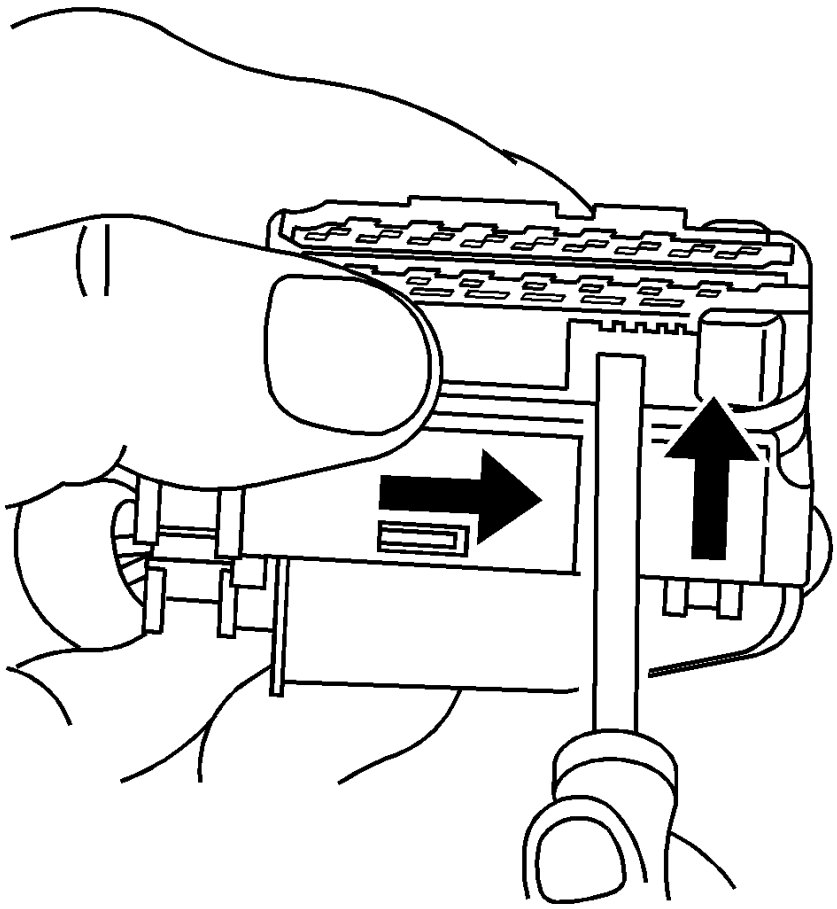


Fig. 146: View Of Terminal Position Assurance (TPA)
Courtesy of GENERAL MOTORS COMPANY

5. Using a small flat-bladed tool, push on the side of the nose piece retainer while pushing the nose piece forward with your thumb. This will release the terminal position assurance (TPA).

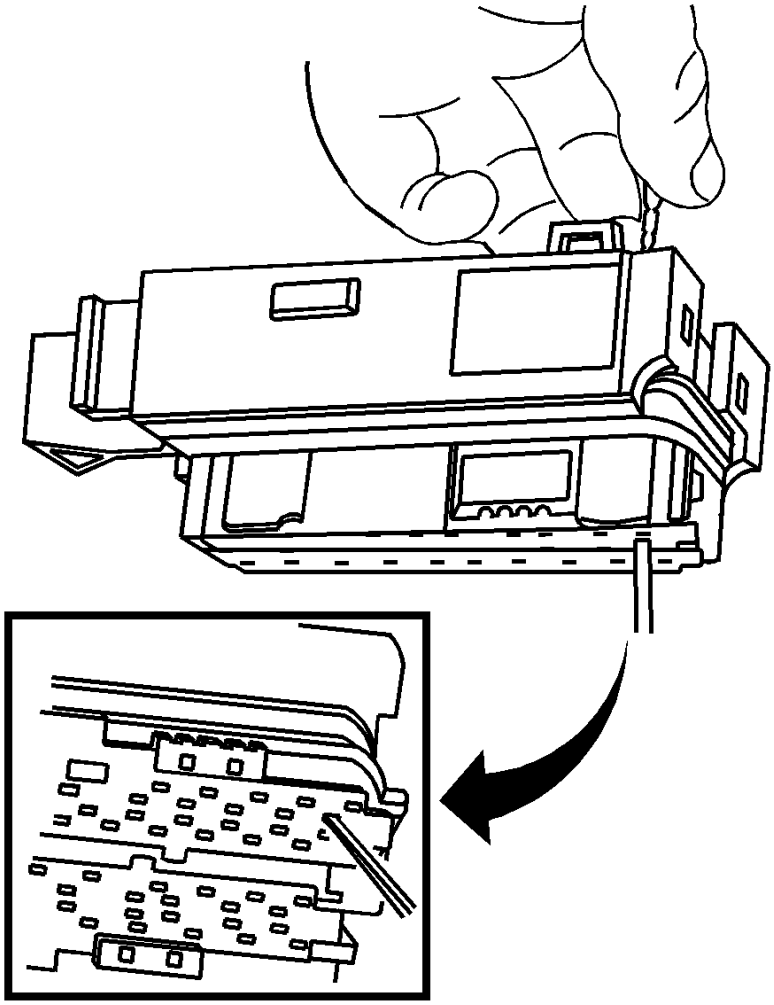


Fig. 147: Inserting Special Tool Into Terminal Release Cavity
Courtesy of GENERAL MOTORS COMPANY

6. Insert the **J-38125-12A** tool into the corresponding terminal release cavity. The release cavities are the 2 center rows of cavities on one half of the connector.

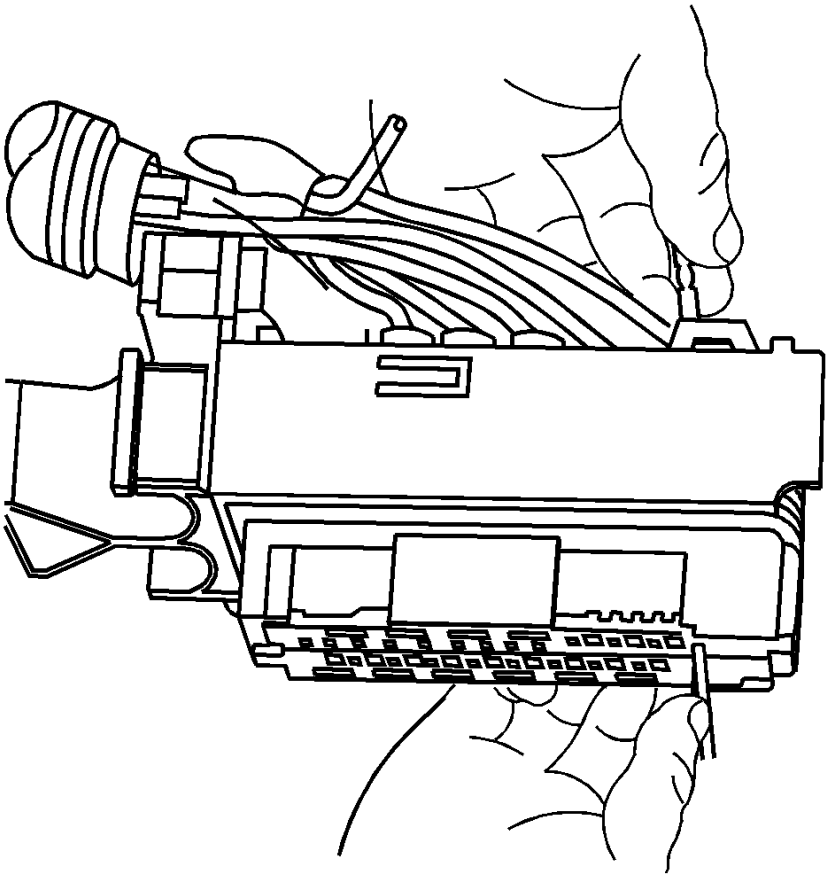


Fig. 148: Identifying Special Tool & Release Cavity
Courtesy of GENERAL MOTORS COMPANY

7. Pressing the **J-38125-12A** tool in the release cavity of the terminal you are removing, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
8. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
9. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (SENSOR)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-11A** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

1. Disconnect the connector from the component.

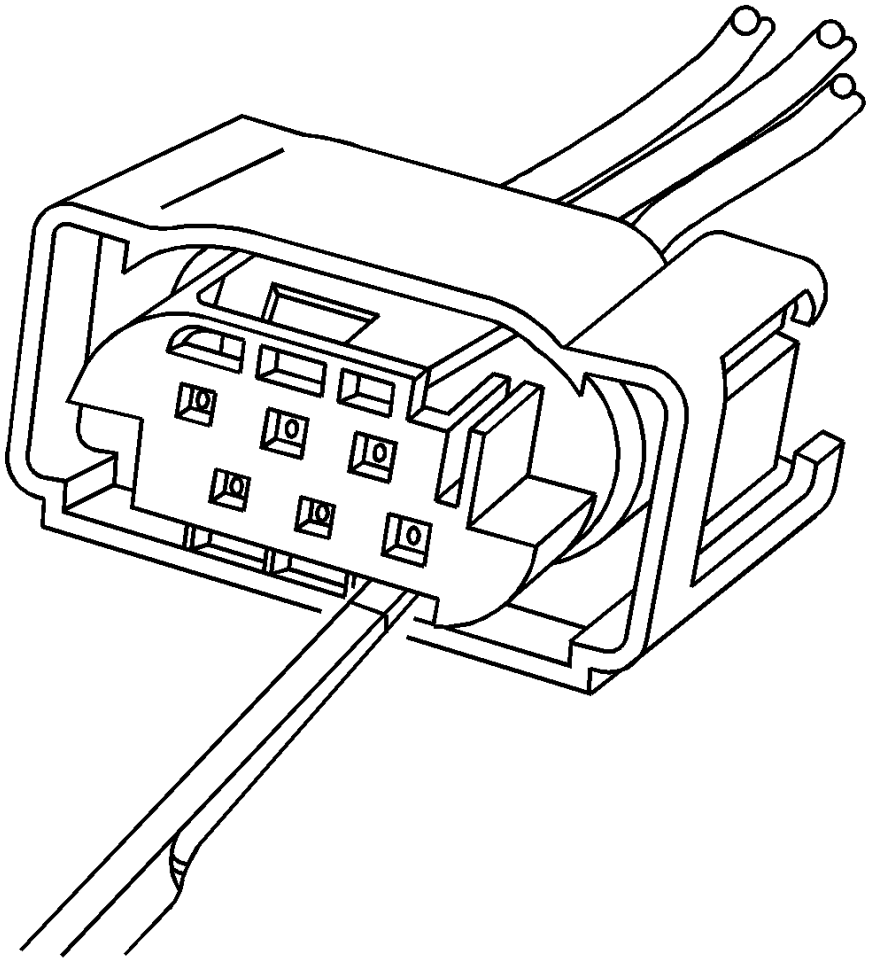


Fig. 149: View Of Inserting Special Tool Into Lower Right Face Cavity
Courtesy of GENERAL MOTORS COMPANY

2. Insert the J-38125-11A tool into the cavity on the lower right hand face of the connector until the terminal release tang access panel slides over.

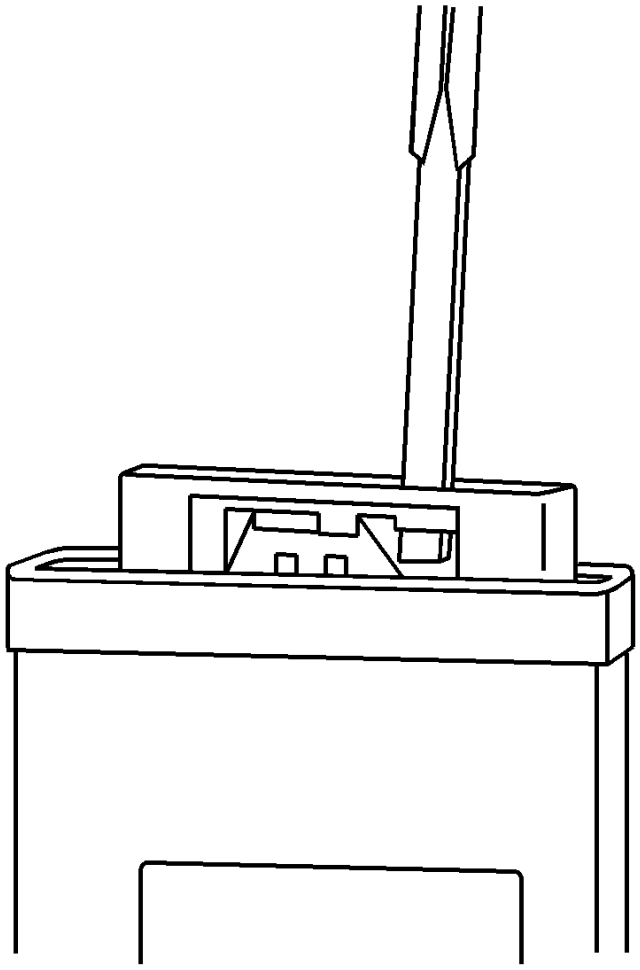


Fig. 150: Pushing Wire Side Of Terminal Toward Connector
Courtesy of GENERAL MOTORS COMPANY

3. Ensure that the terminal release tang access panel is in the correct location to access the terminals.
4. Push the wire side of the terminal that is being removed toward the connector and hold it in position.

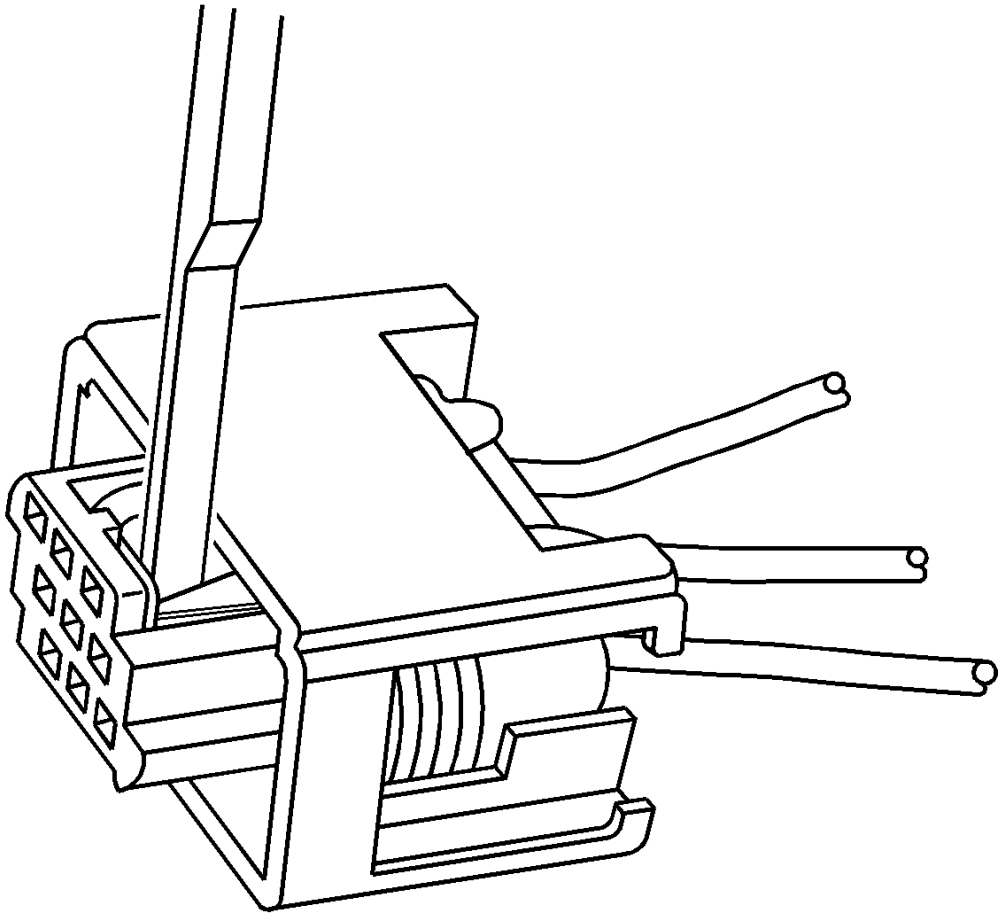


Fig. 151: View Of Inserting Tool Into Terminal Release Tang Access Slot (Sensor)
Courtesy of GENERAL MOTORS COMPANY

5. Insert the J-38125-11A into the terminal release tang access slot located behind the access panel of the connector and press down on the terminal while carefully pulling the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
7. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (0.25 CAP)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-24** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

1. Disconnect the connector from the component by pressing down on the connector position assurance (CPA).

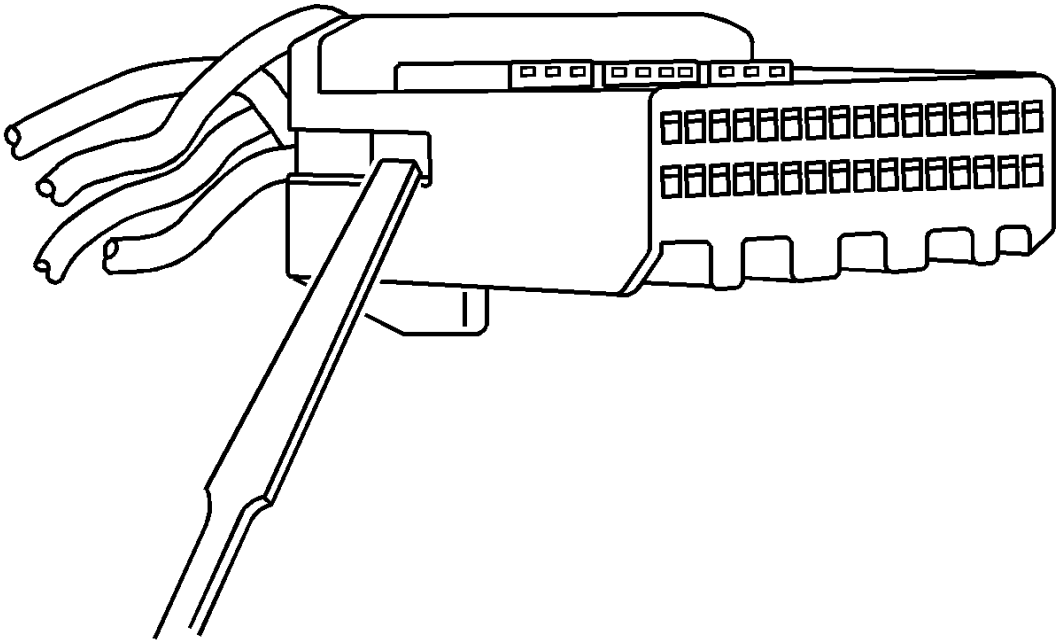


Fig. 152: Releasing TPA Using Small Flat-Bladed Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The TPA on this connector cannot be removed unless the terminals are removed first. The TPA will come out of the connector body, but only slightly. When the TPA is slightly raised the terminals can be removed. Using excessive force to remove the TPA with the terminals still in the connector will damage the connector.**

2. Use a small flat-bladed tool to release the terminal position assurance (TPA) by inserting the tool in the small recess on the side of the connector and pushing up until the TPA releases from the connector body. The TPA should raise just slightly. Do not try to remove the TPA.
3. Repeat the process for the other side of the connector.

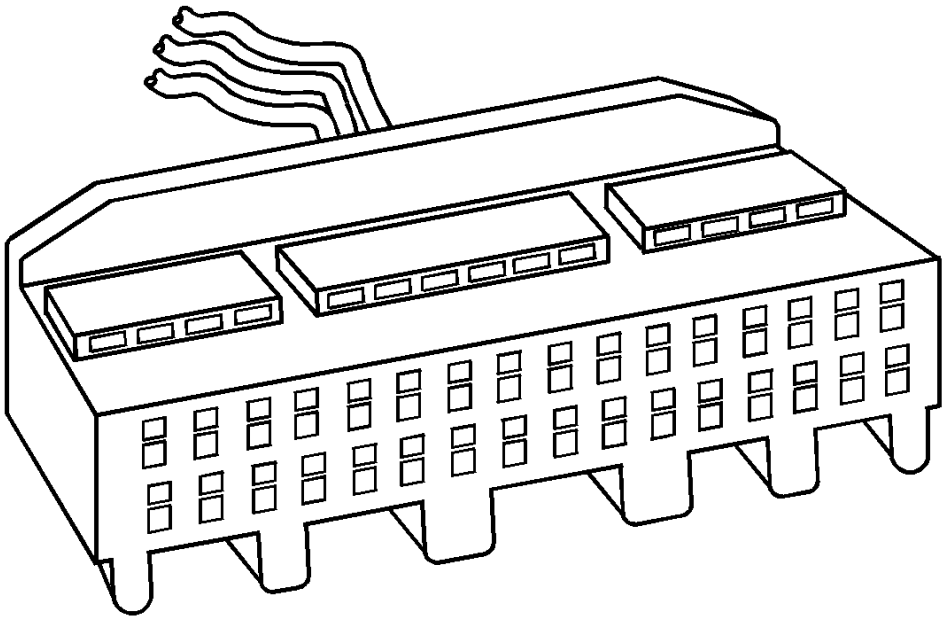


Fig. 153: View Of Terminal Position Assurance
Courtesy of GENERAL MOTORS COMPANY

4. Ensure that the TPA is in the proper position to remove the terminals.

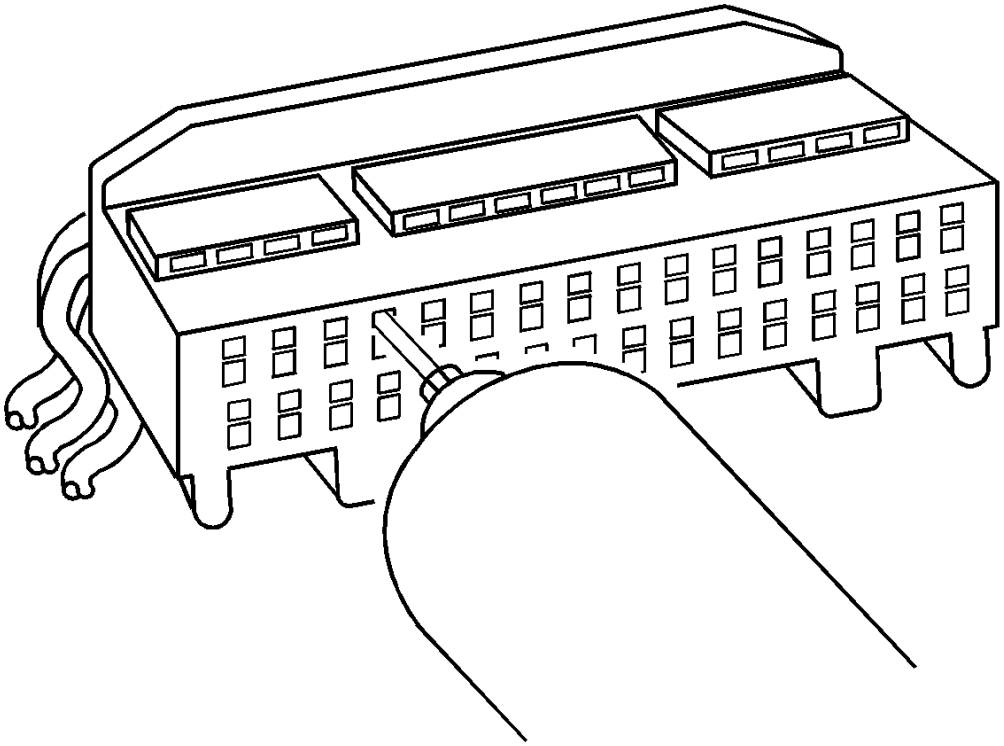


Fig. 154: Identifying Special Tool & Release Cavity
Courtesy of GENERAL MOTORS COMPANY

5. While pushing the terminal forward, insert the J-38125-24 in the release cavity above the terminal you are removing, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
7. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (43-WAY)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool
- **J-38125-13A** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

Follow the steps below in order to remove terminals from the connector.

1. Locate the lever lock on the wire dress cover. Slide the lever lock away from the connector body.
2. Disconnect the connector from the component.
3. Locate the dress cover locking tabs on the dress cover of the connector. Using a small flat-bladed tool release all of the locking tabs.
4. Once the locks are unlocked, lift the dress cover off.

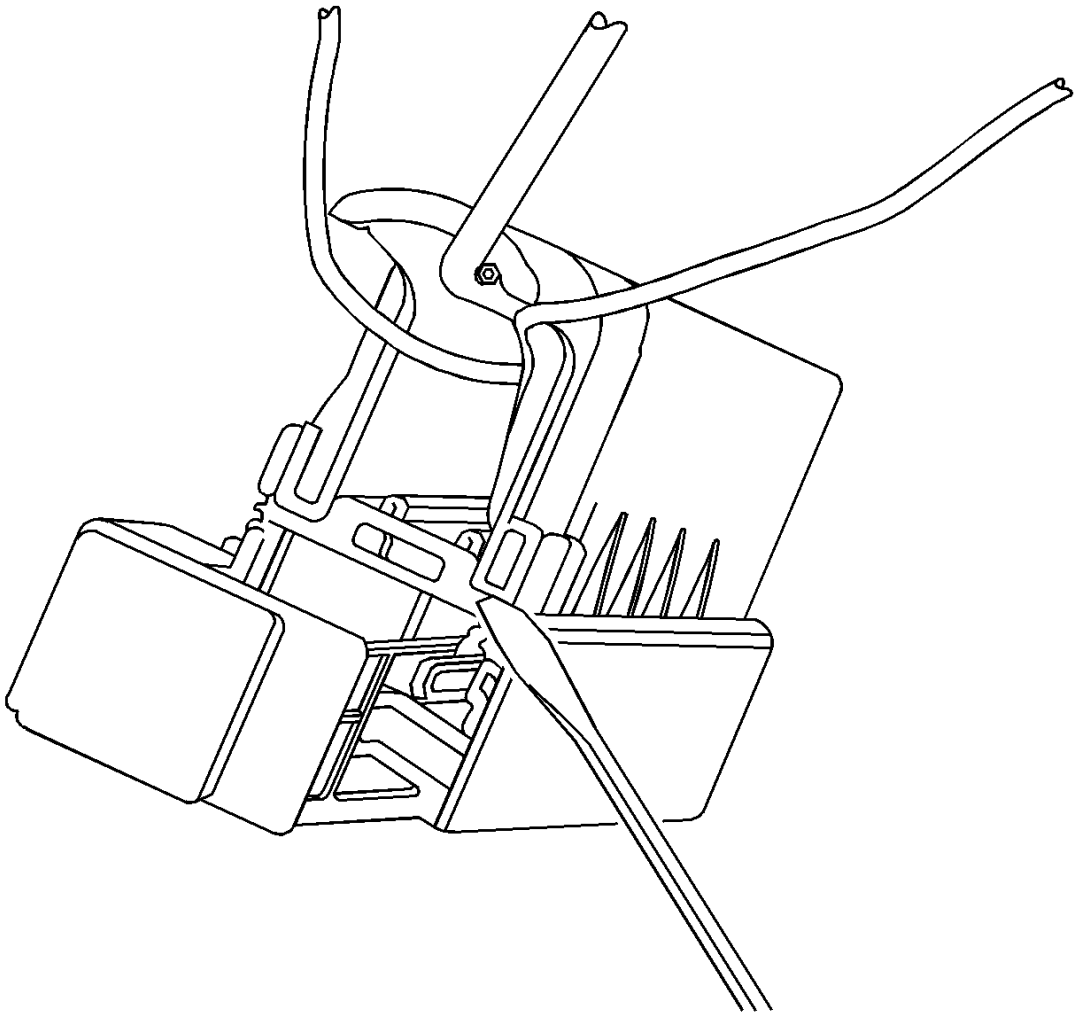


Fig. 155: Releasing TPA
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always use care when removing a terminal position assurance (TPA) in order to avoid damaging it.**

5. Release the TPA by inserting a small flat-bladed tool into the blue locking tabs on both ends of the connector. Gently slide the TPA up to the released position on both ends.

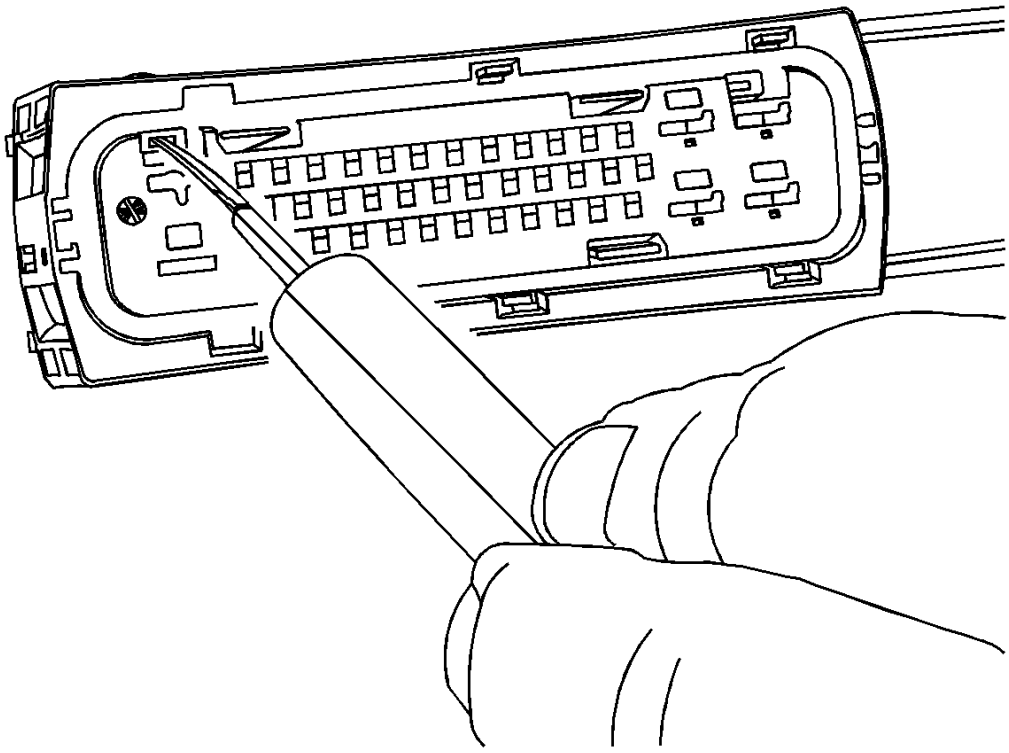


Fig. 156: View Of Inserting Tool Into Terminal Release Cavity
Courtesy of GENERAL MOTORS COMPANY

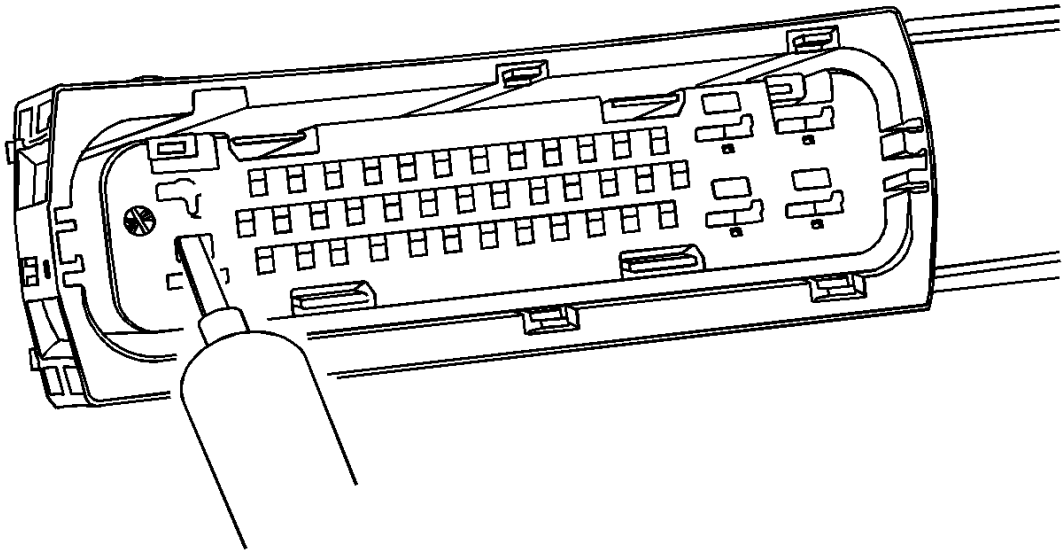


Fig. 157: View Of Release Tool Being Used For Larger Terminals
Courtesy of GENERAL MOTORS COMPANY

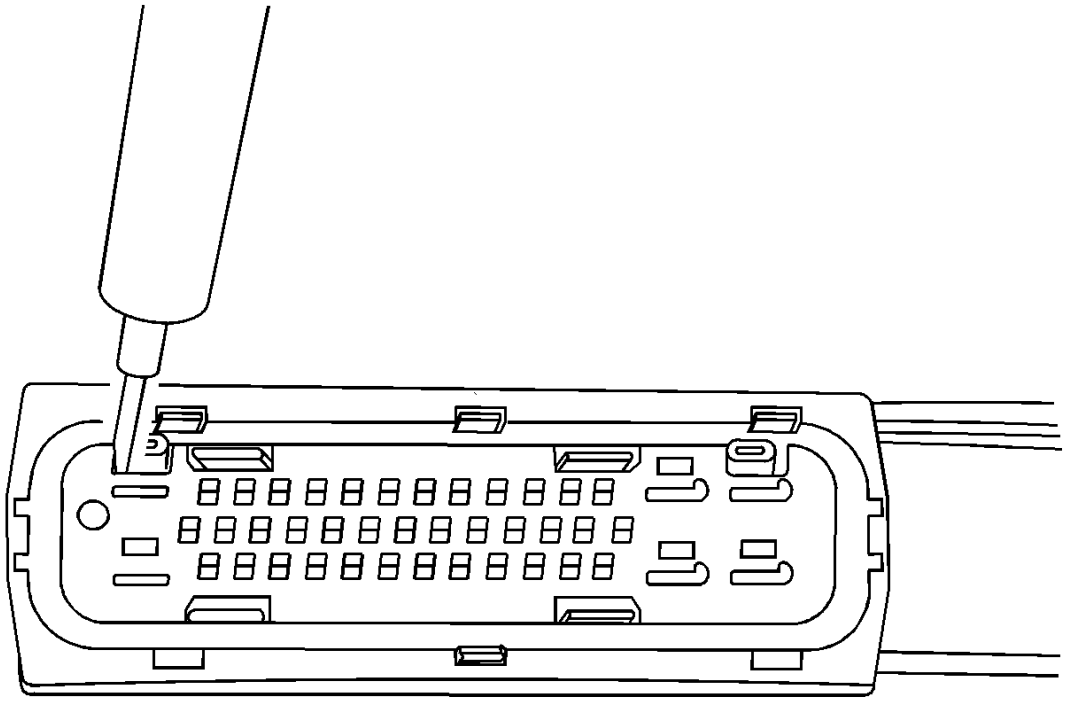


Fig. 158: View Of Release Tool Being Used For Larger Terminals
Courtesy of GENERAL MOTORS COMPANY

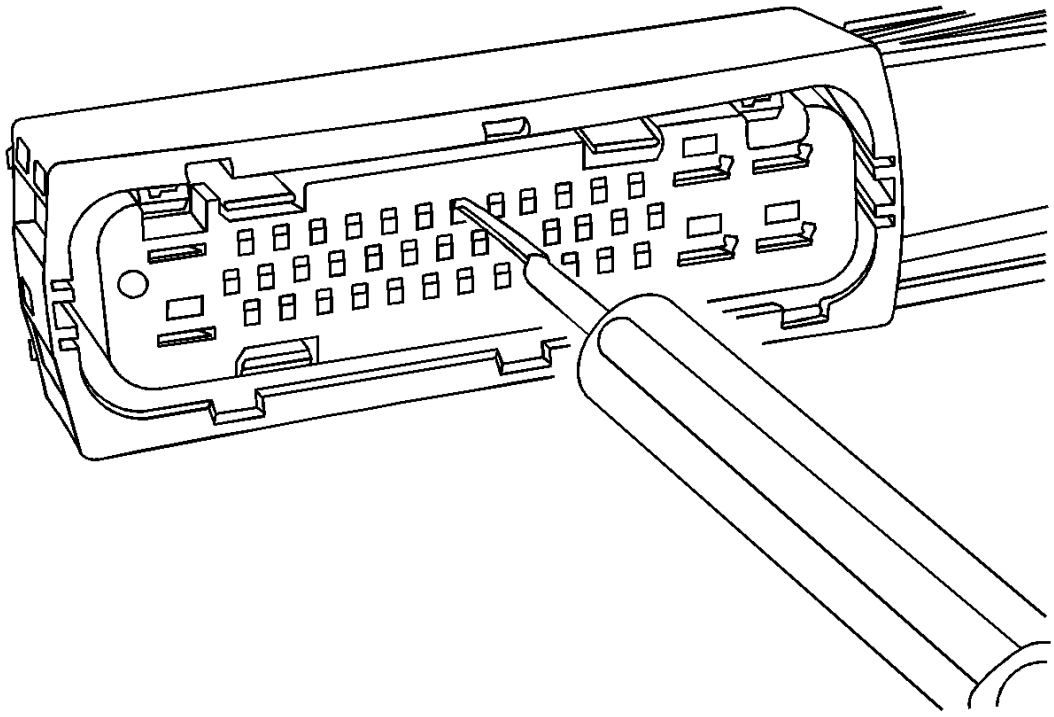


Fig. 159: View Of Release Tool Being Used For Smaller Terminals
Courtesy of GENERAL MOTORS COMPANY

6. For the larger terminals insert the **J-38125-13A** tool to release the terminals by inserting the tool into the terminal release cavity. For the smaller terminals insert the **J-38125-12A** tool to release the terminals by inserting the tool into the terminal release cavity.

   View of the release tool being used for the larger terminals.

   View of the release tool being used for the larger terminals.

   View of the release tool being used for the smaller terminals.

7. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
8. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
9. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (DOOR MODULE)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-12A** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

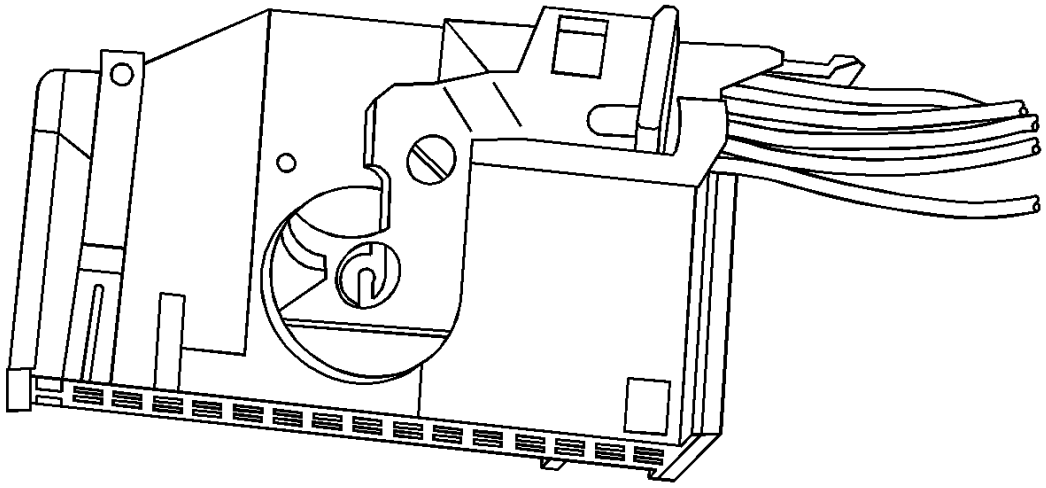


Fig. 160: Side View Of Tyco/AMP Connector
Courtesy of GENERAL MOTORS COMPANY

Side view of connector.

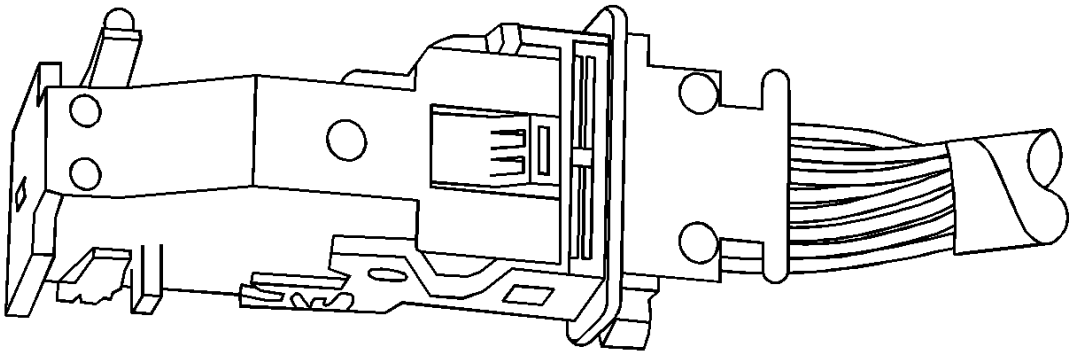


Fig. 161: Top View Of Tyco/AMP Connector
Courtesy of GENERAL MOTORS COMPANY

View of top of connector.

1. Locate the assist lever and lock on the top of the connector.

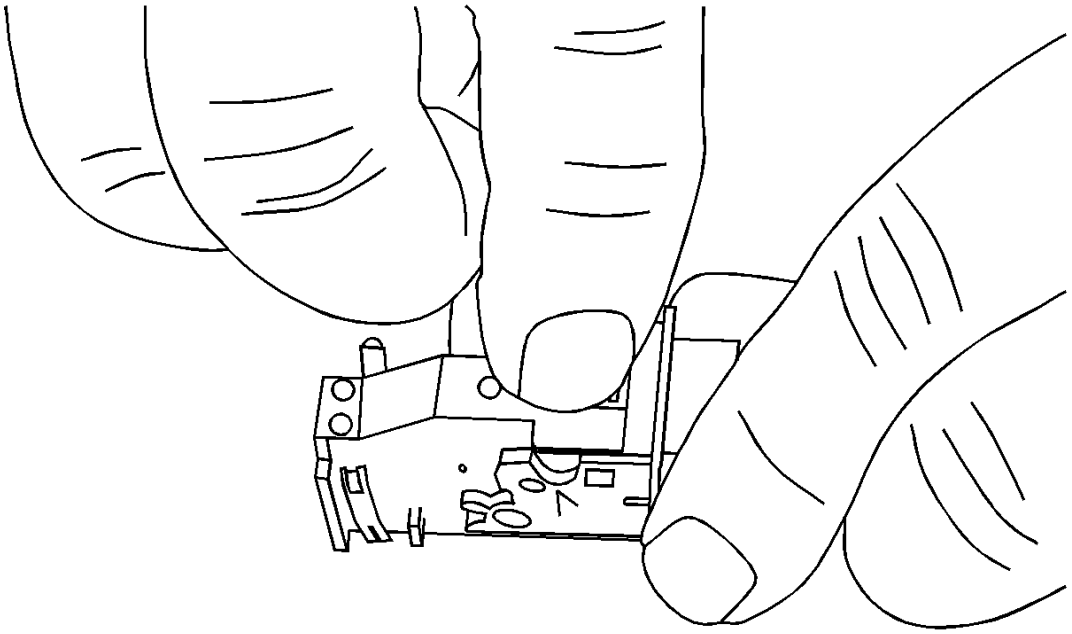


Fig. 162: View Of Depressing Lock & Pulling Assist Lever
Courtesy of GENERAL MOTORS COMPANY

2. While depressing the lock, pull the lever over and past the lock.

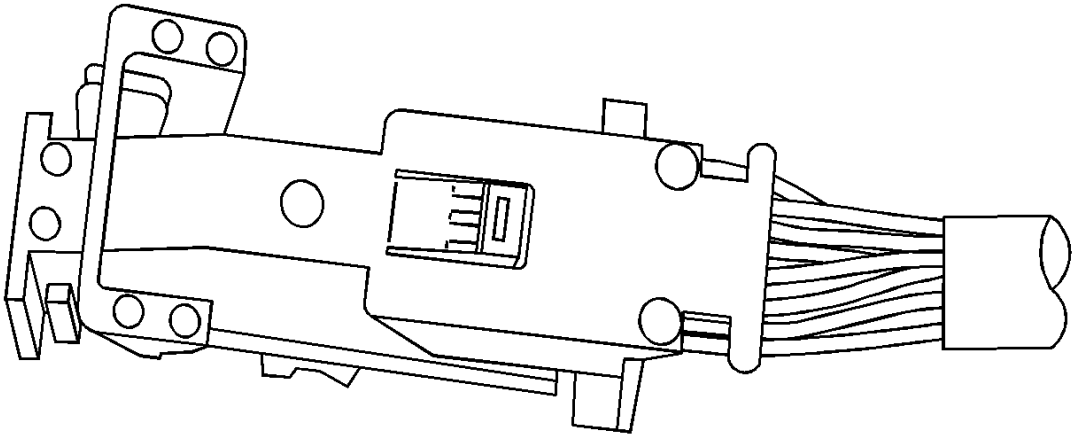


Fig. 163: View Of Component Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the connector from the component.

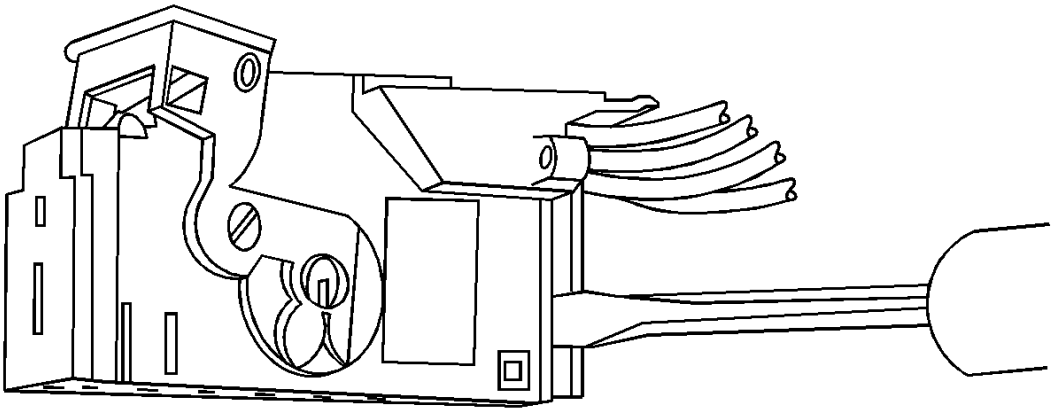


Fig. 164: Identifying Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

4. Locate the dress cover locking tabs at the rear of the connector. Use a small flat-blade tool to release the locking tabs. Repeat this procedure for the other locking tab.

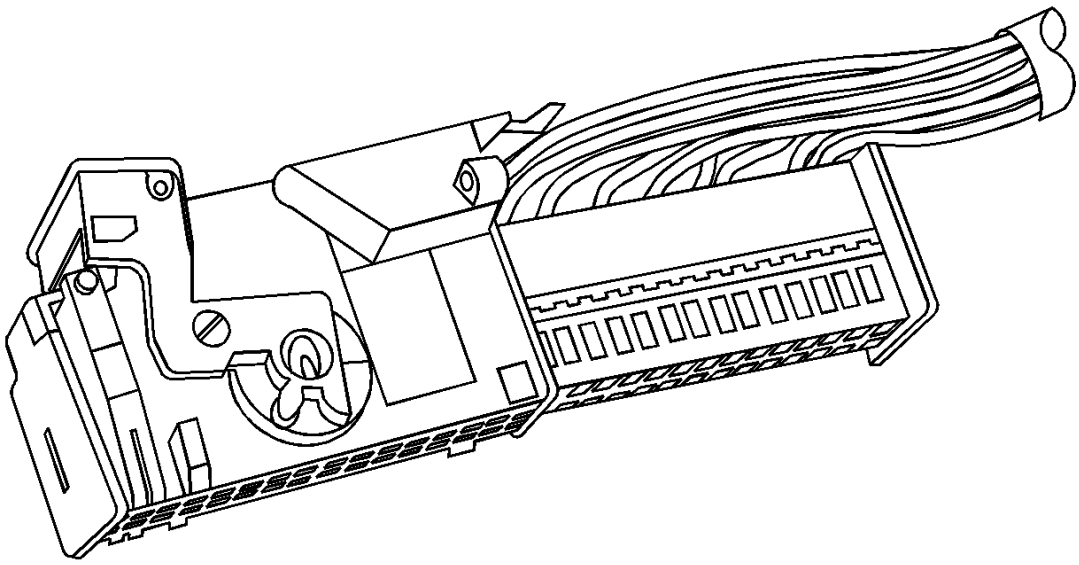


Fig. 165: Sliding Inner Connector Out Of Connector Housing
Courtesy of GENERAL MOTORS COMPANY

5. Once the locking tabs are unlocked, slide the inner connector out of the rear of the connector housing.

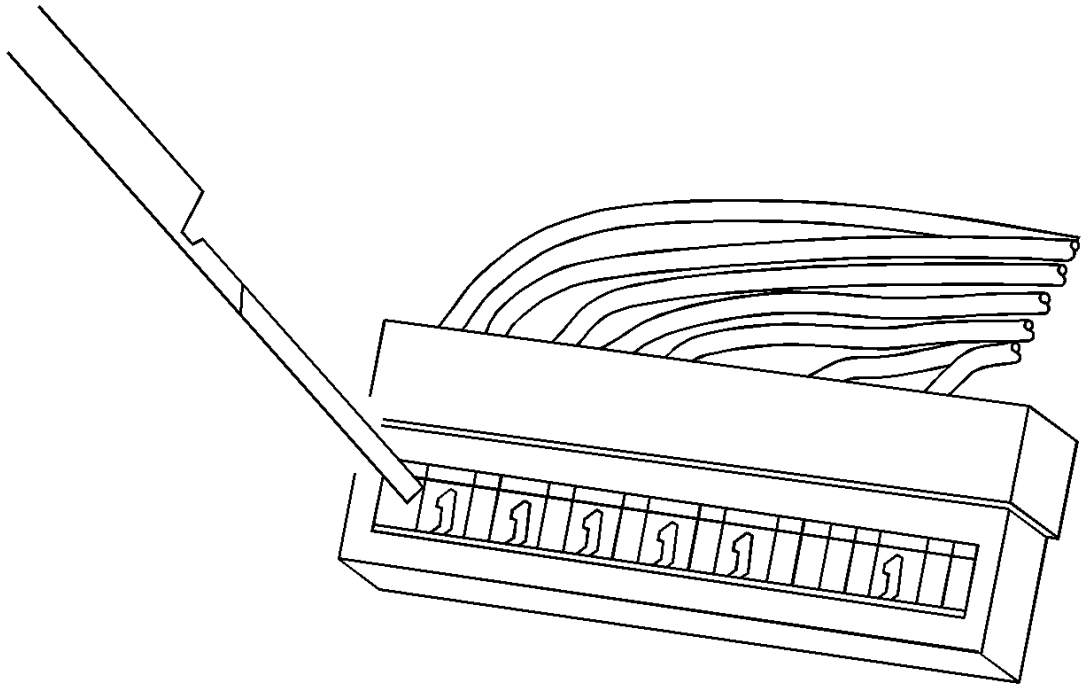


Fig. 166: Using Special Tool To Release Terminals
Courtesy of GENERAL MOTORS COMPANY

6. Use the J-38125-12A tool to release the terminals by pressing on the tang.
7. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
8. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
9. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (SEAT)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-11A** Terminal Release Tool
- **J-38125-212** Terminal Release Tool

- **J-38125-556** Terminal Release Tool
- **J-38125-560** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

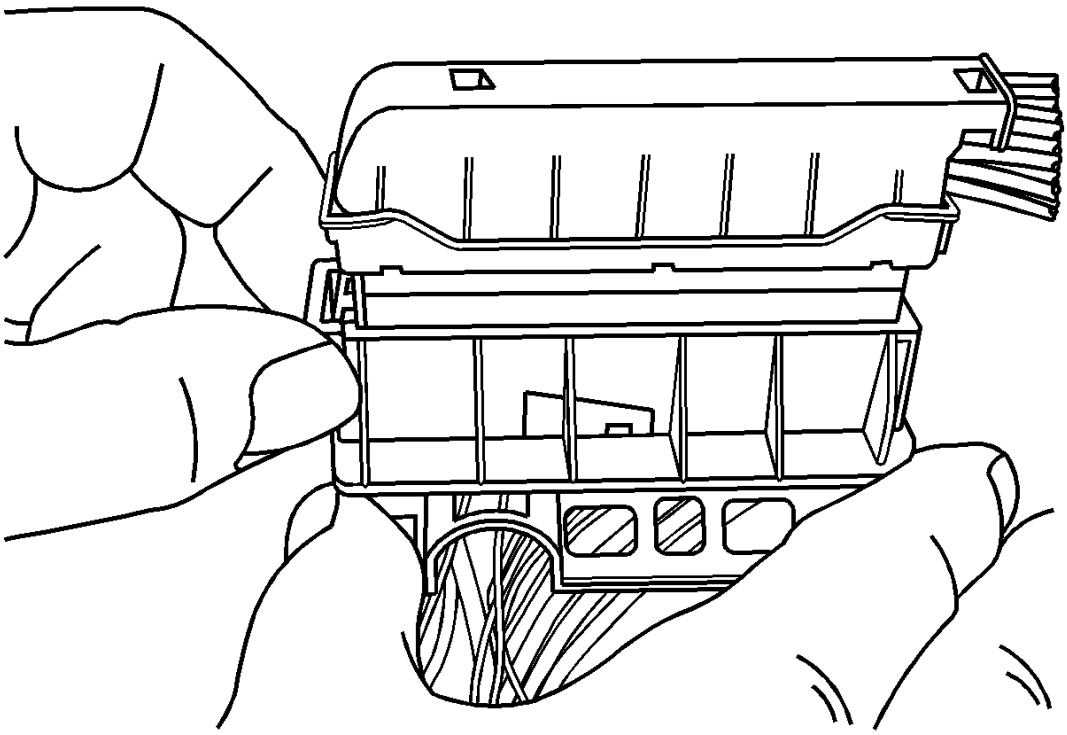


Fig. 167: Locating Locking Slide Lever
Courtesy of GENERAL MOTORS COMPANY

1. Grasp the locking slide lever and pull outward from the end of the connector.

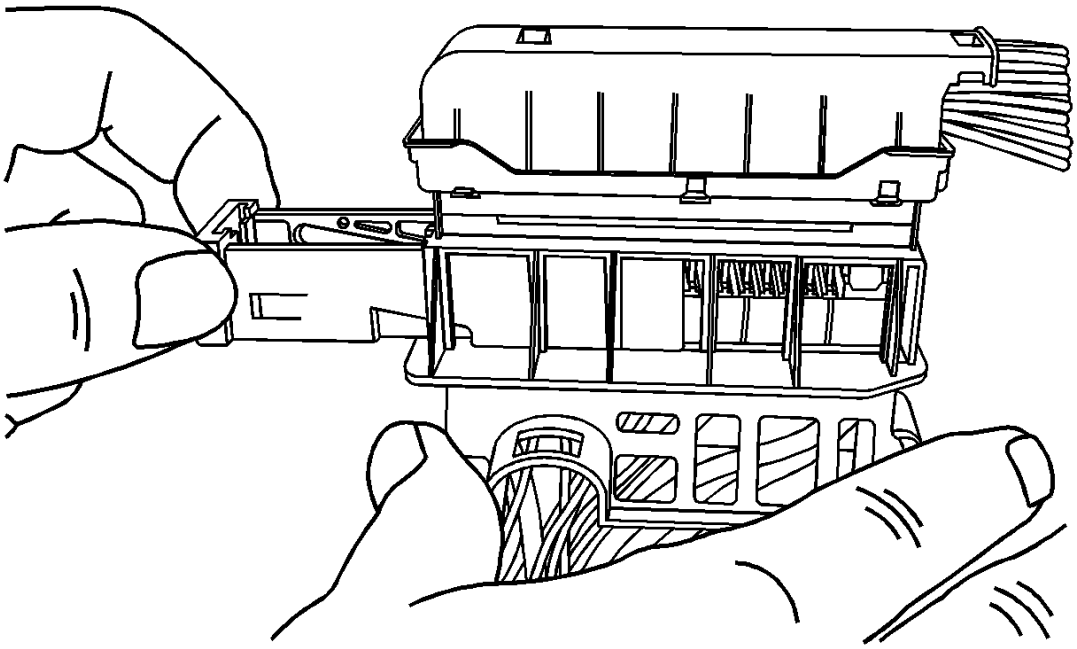


Fig. 168: Pulling Slide Lever Out Of Mating Connector
Courtesy of GENERAL MOTORS COMPANY

2. As the slide lever is pulled out the mating connector is lifted from the seated position.

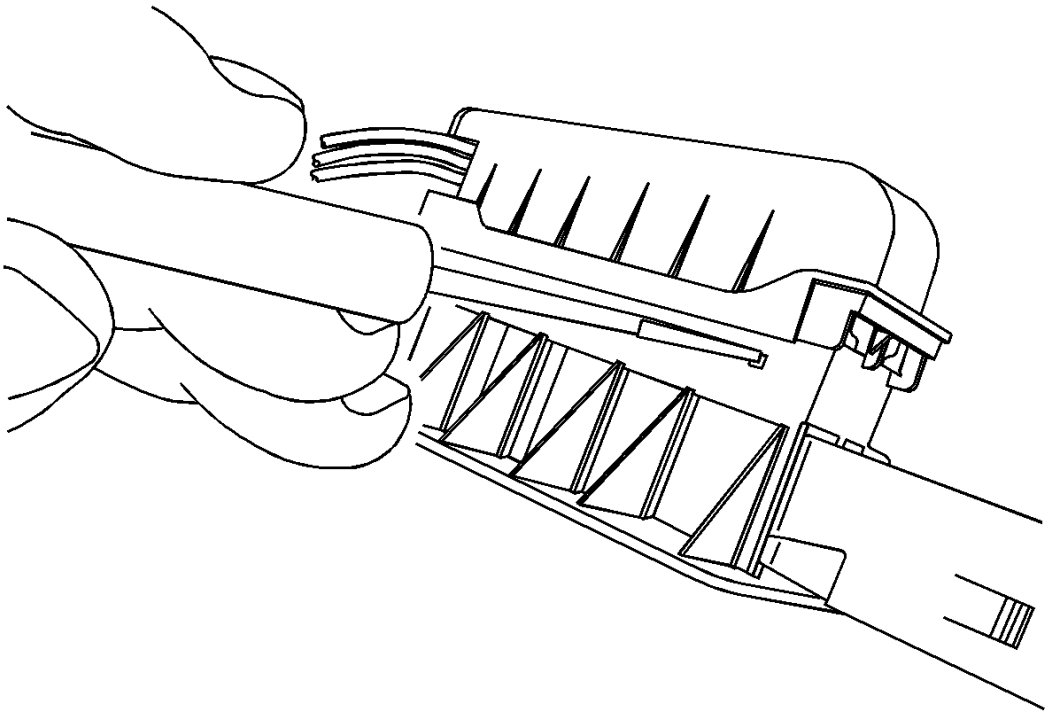


Fig. 169: Pushing TPA Tabs Into Connector Body
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Terminal position assurance (TPA) is keyed and can only be inserted in one direction.**

3. Using terminal release tool J-38125-11A or equivalent, push the TPA tabs into the connector body.

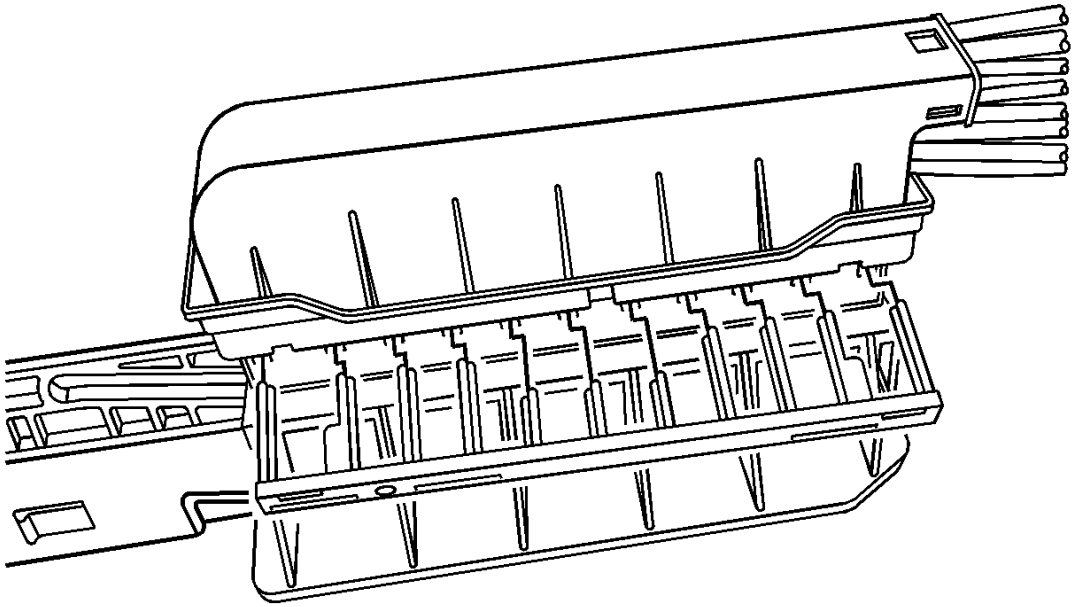


Fig. 170: Pulling TPA From Connector Body
Courtesy of GENERAL MOTORS COMPANY

4. Pull the TPA from the connector body.

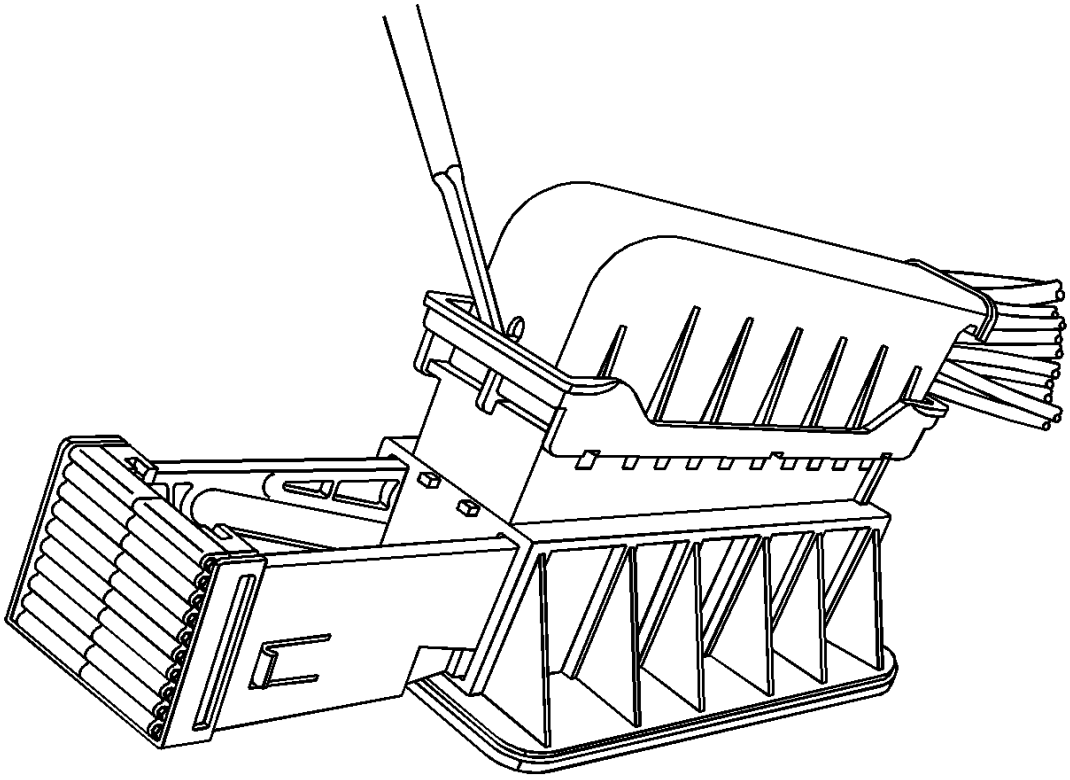


Fig. 171: Releasing Connector Wire Dress Cover Locking Tab
Courtesy of GENERAL MOTORS COMPANY

5. Using terminal release tool J-38125-11A or equivalent, release the connector wire dress cover locking tab.

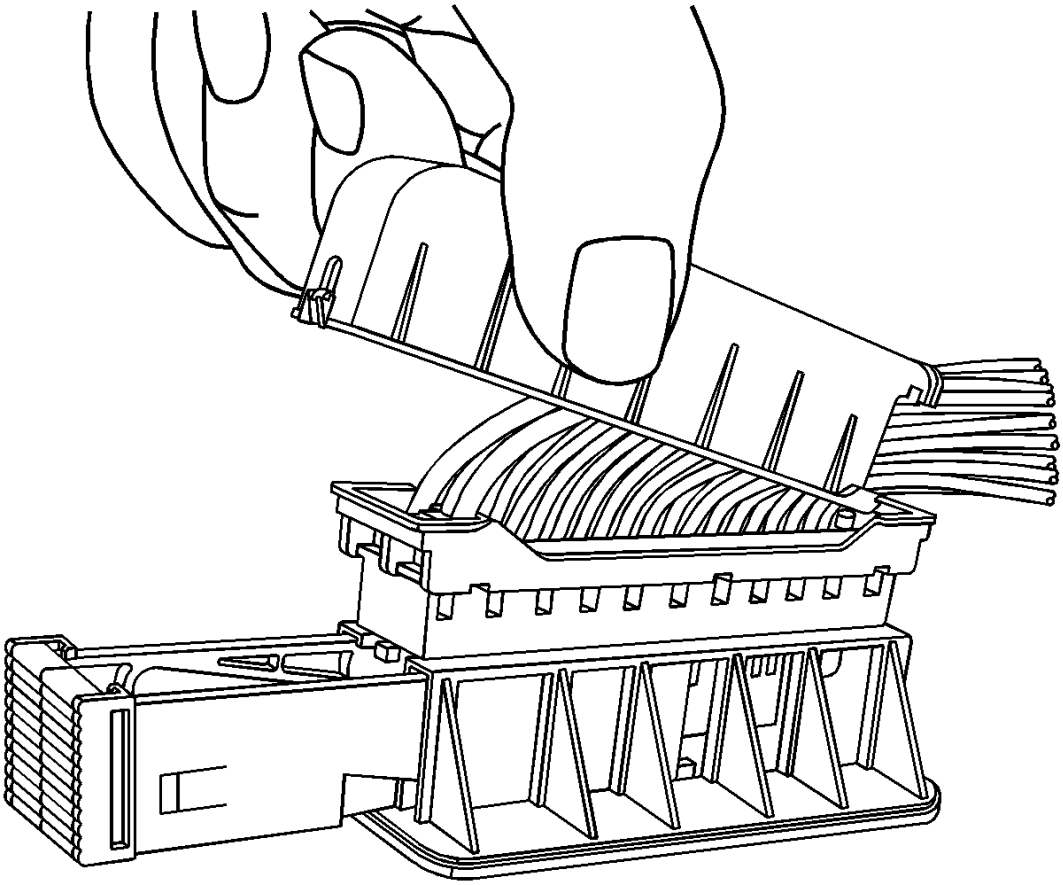


Fig. 172: Lifting Connector Wire Dress Cover From Connector Body
Courtesy of GENERAL MOTORS COMPANY

6. With the lock tab released, lift the connector wire dress cover from the connector body.

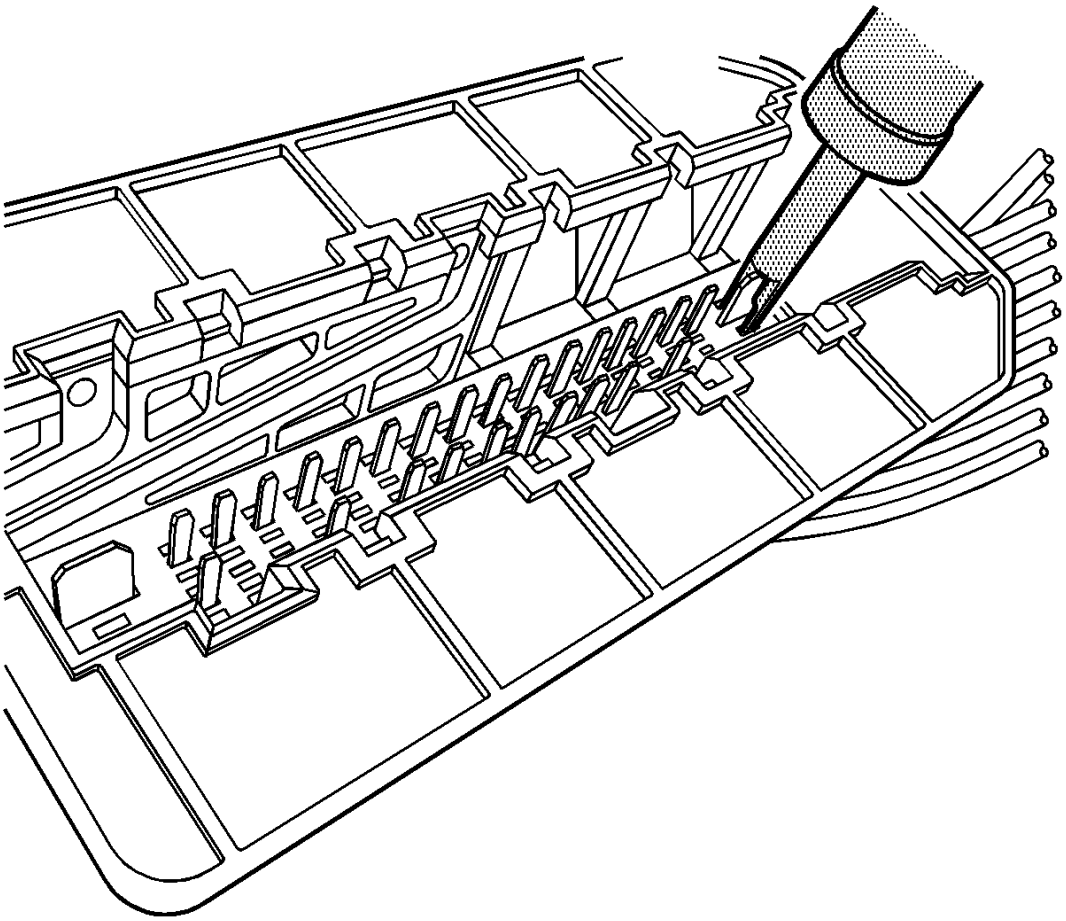


Fig. 173: Using Terminal Release Tool
Courtesy of GENERAL MOTORS COMPANY

7. Using terminal release tool J-38125-212, press the prongs into the holes each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.

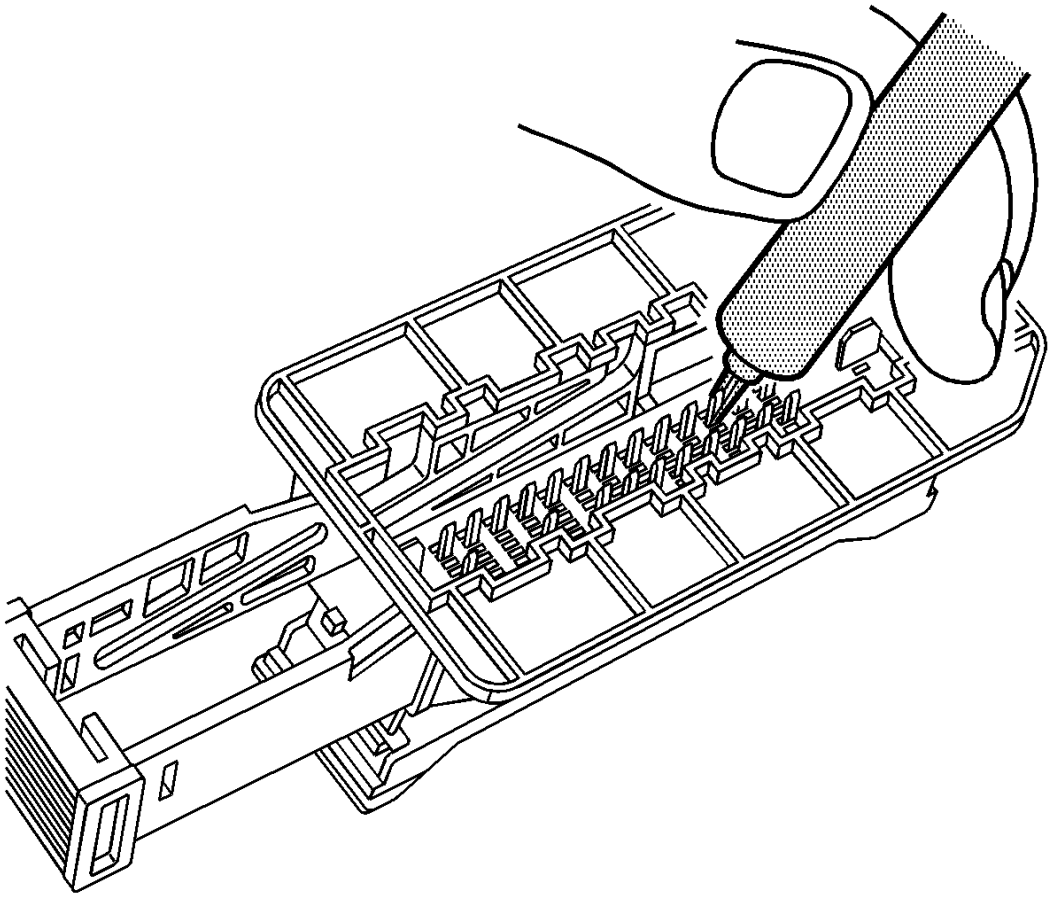


Fig. 174: Using Terminal Release Tool
Courtesy of GENERAL MOTORS COMPANY

8. Using terminal release tool J-38125-560, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.

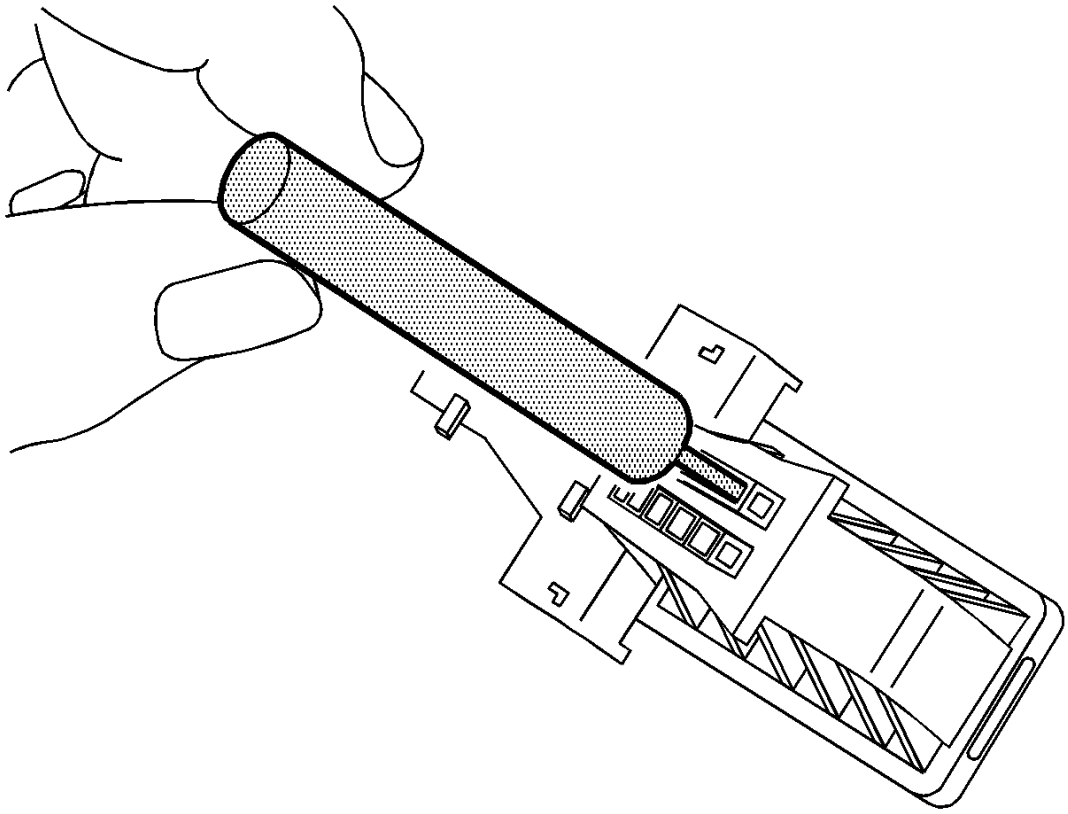


Fig. 175: Using Terminal Release Tool
Courtesy of GENERAL MOTORS COMPANY

9. Using terminal release tool J-38125-556, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.
10. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
11. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (102-WAY INLINE)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-11A** Terminal Release Tool
- **J-38125-212** Terminal Release Tool
- **J-38125-216** Terminal Release Tool

- **J-38125-221** Terminal Release Tool
- **J-38125-560** Terminal Release Tool
- **J-38125-566** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

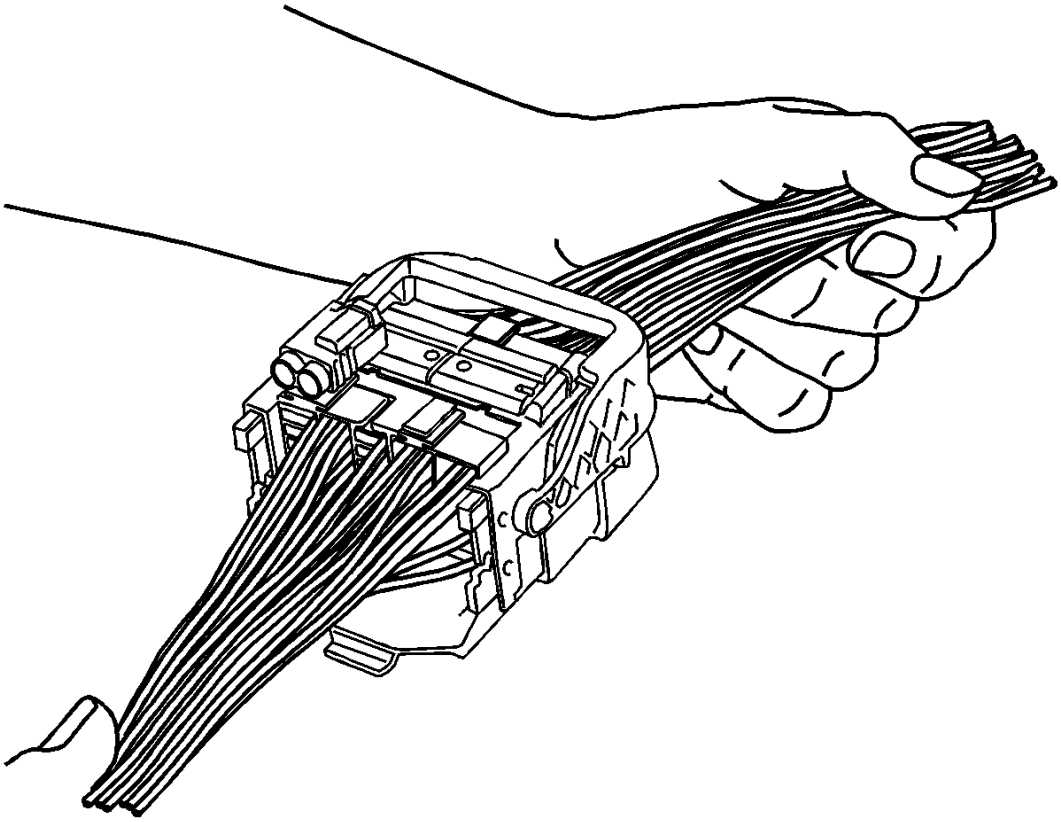


Fig. 176: View Of Typical Connector In Assembled Position
Courtesy of GENERAL MOTORS COMPANY

View of a typical connector in the assembled position.

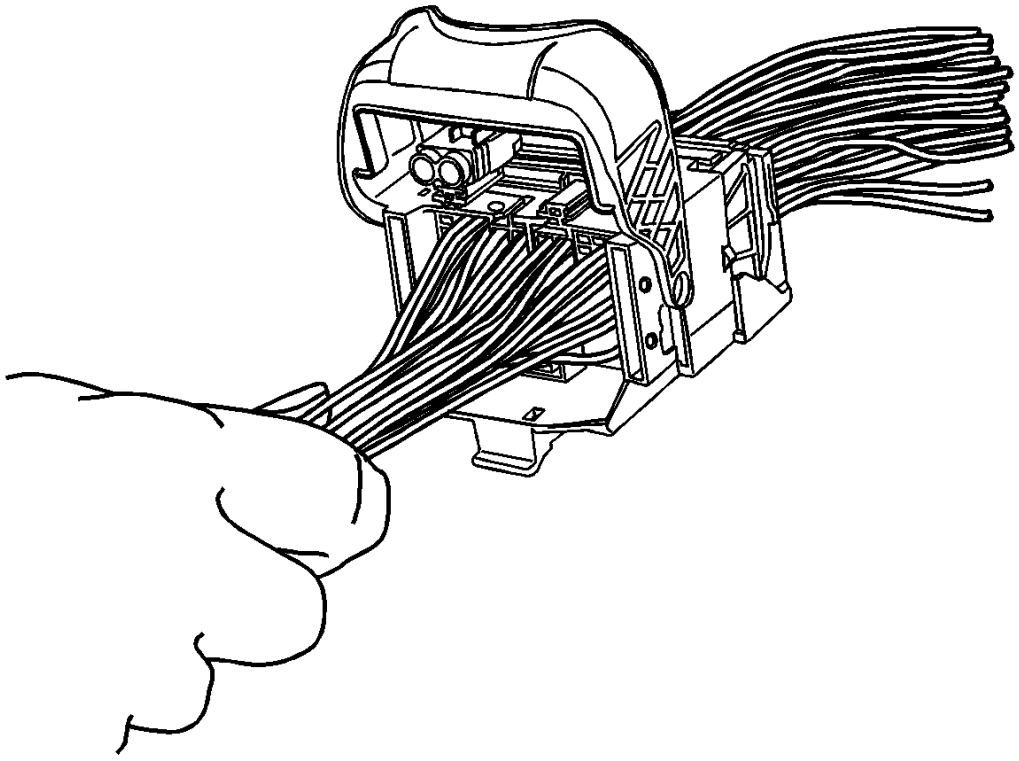


Fig. 177: View Of Locking Lever At 90 Degrees From Connector Body
Courtesy of GENERAL MOTORS COMPANY

1. Pull the locking lever to the 90 degree position from the connector body.

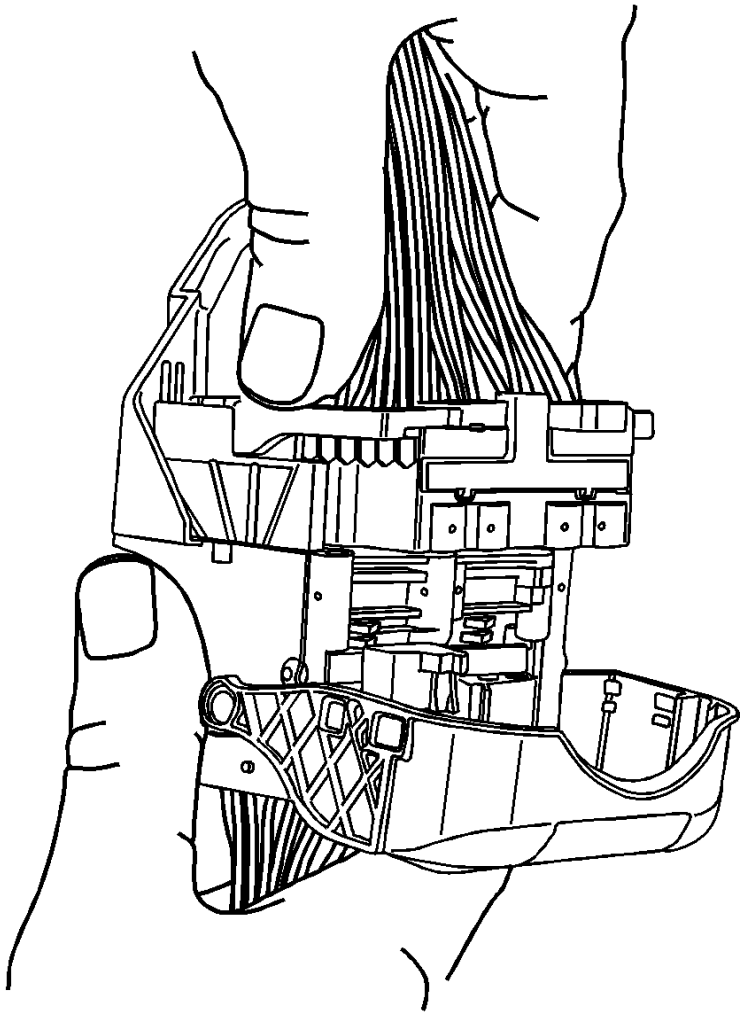


Fig. 178: Assembled View Of Connector - Tyco/AMP (102-Way Inline)
Courtesy of GENERAL MOTORS COMPANY

2. With the locking lever in the 90 degree position and the male connector body separated, it can be slid outward for removal.

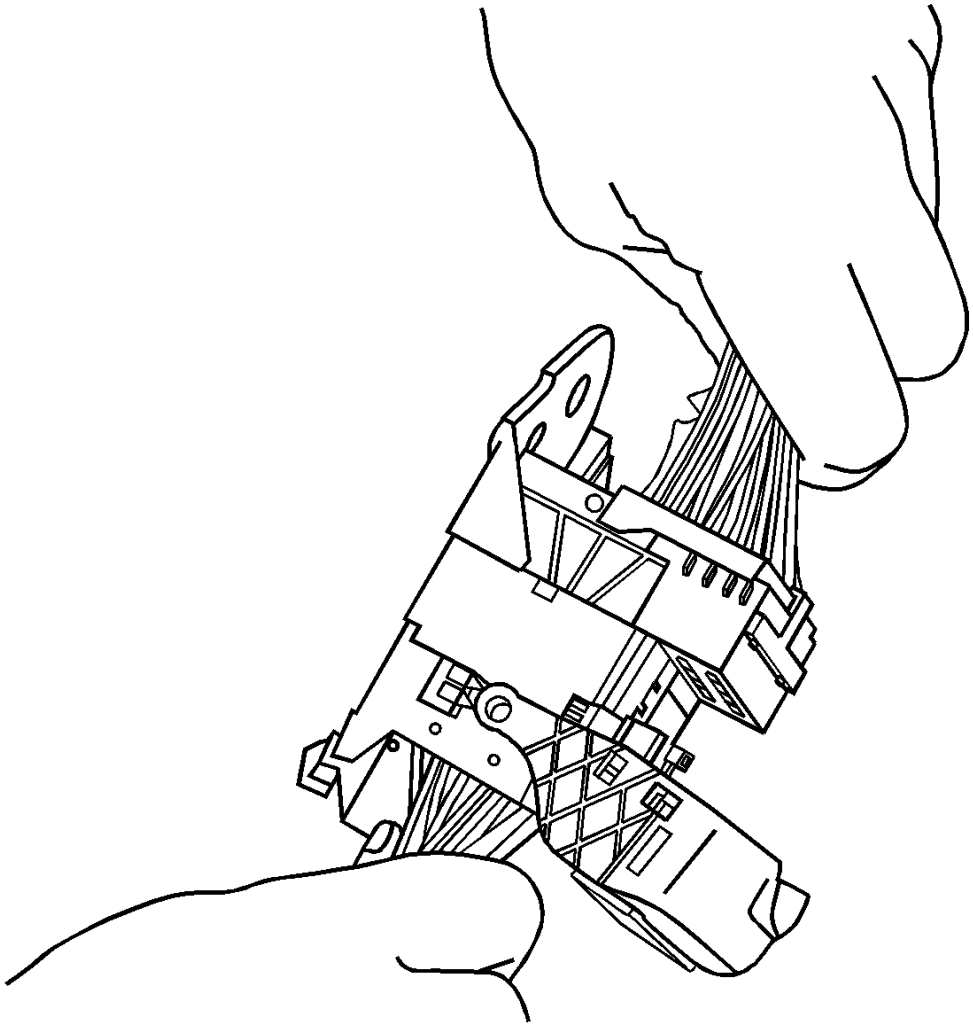


Fig. 179: Sliding Male Connector Body Away From Guide Plates
Courtesy of GENERAL MOTORS COMPANY

3. Slide the male connector body out away from the guide plates.

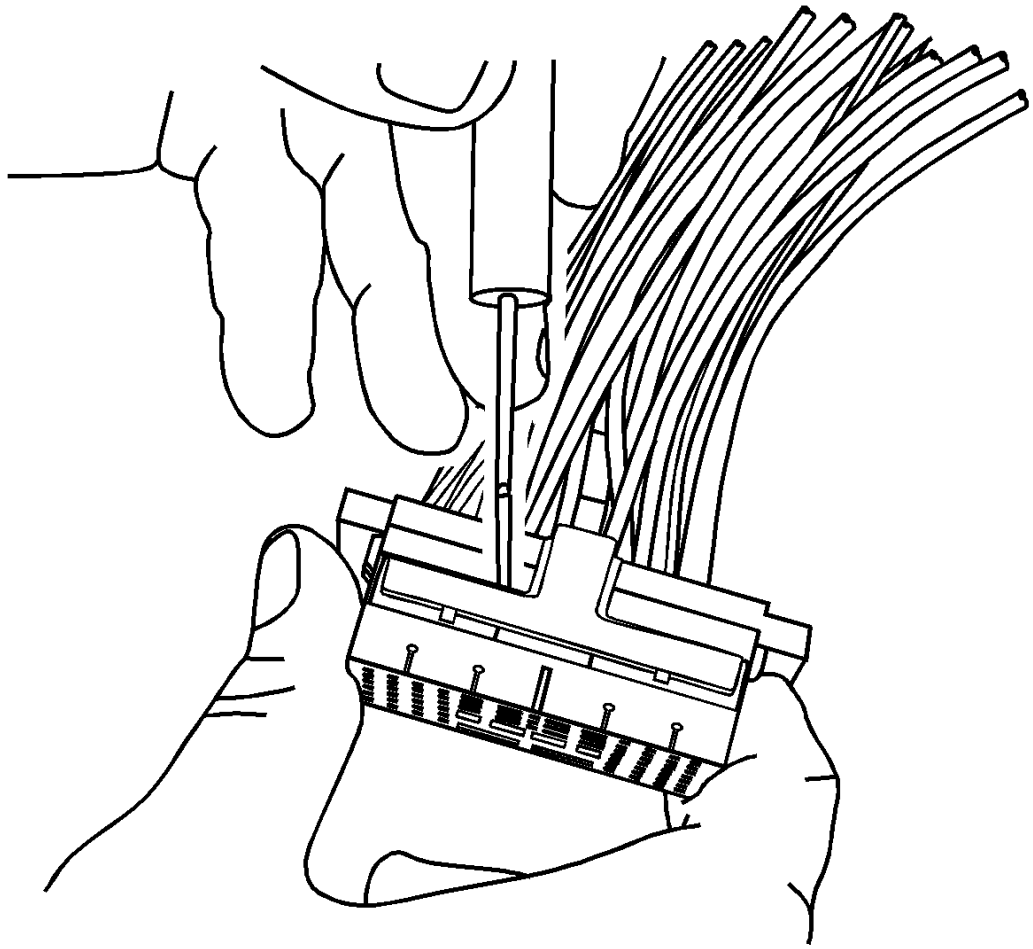


Fig. 180: View of Terminal Release Tool And TPA
Courtesy of GENERAL MOTORS COMPANY

NOTE: **During assembly the terminal position assurance (TPA) will not fully seat if any terminal is not fully seated.**

4. Using terminal release tool J-38125-11A or equivalent, remove the TPA from the connector body.

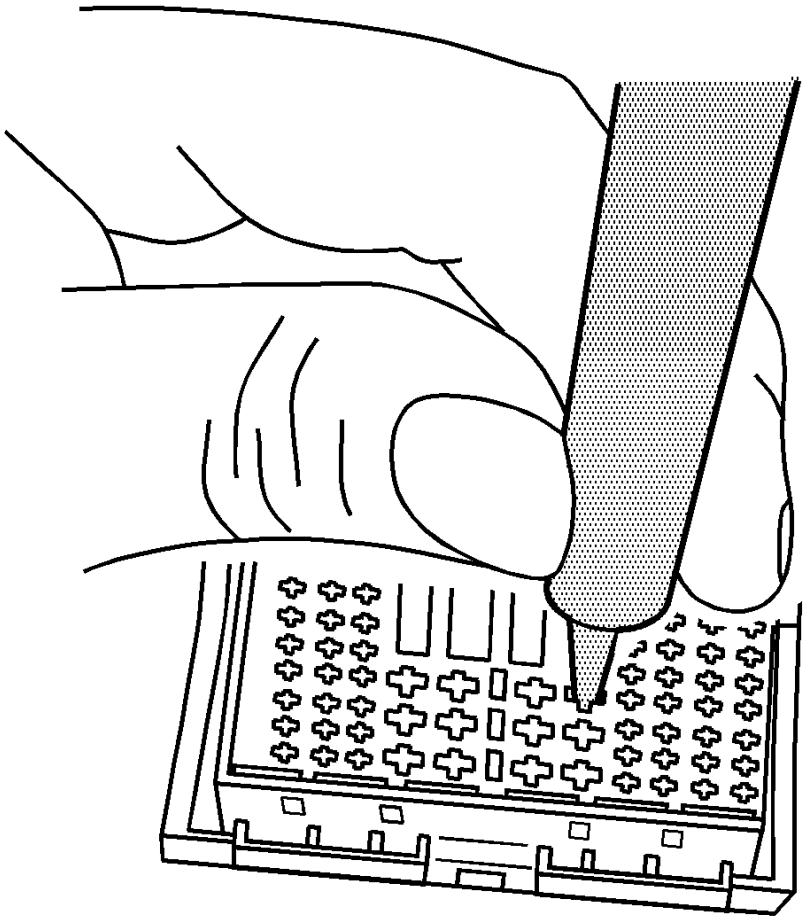


Fig. 181: Releasing Lock Tabs
Courtesy of GENERAL MOTORS COMPANY

5. Using terminal release tool J-38125-566, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.

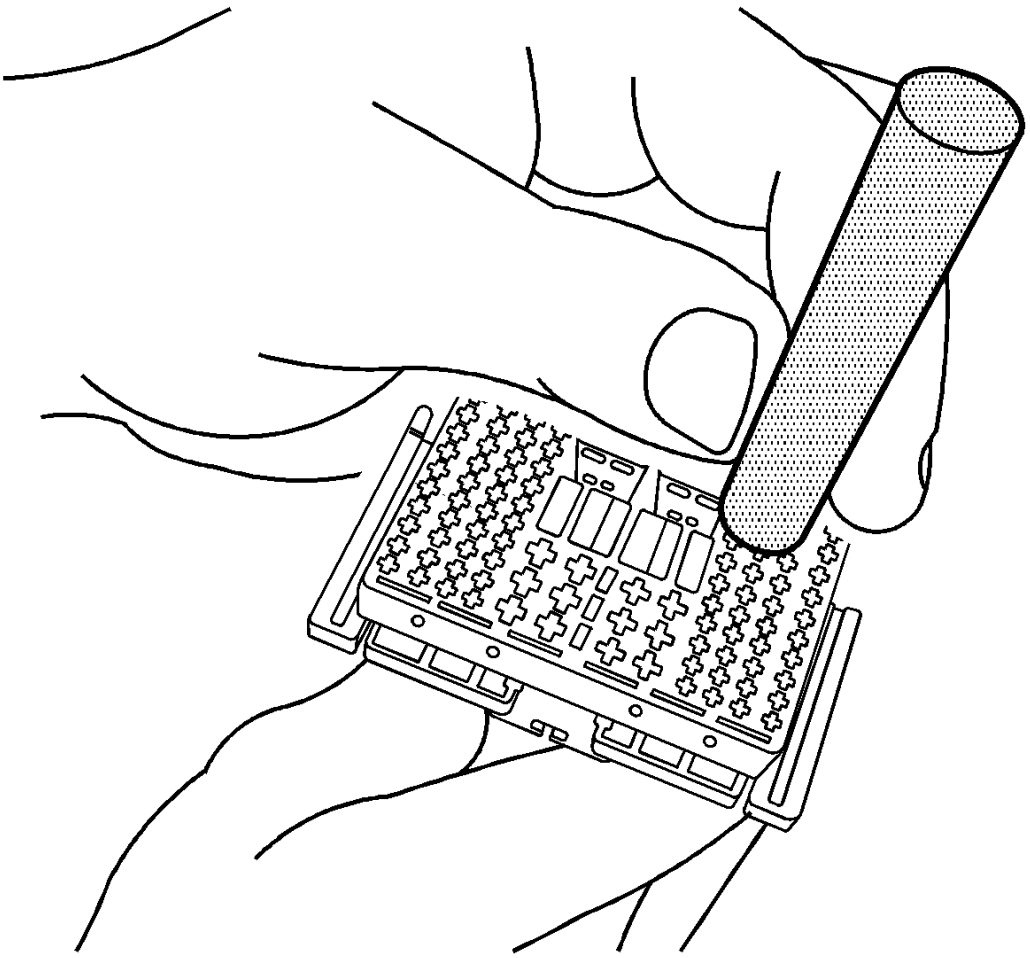


Fig. 182: Using Terminal Release Tool
Courtesy of GENERAL MOTORS COMPANY

6. Using terminal release tool J-38125-560, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.

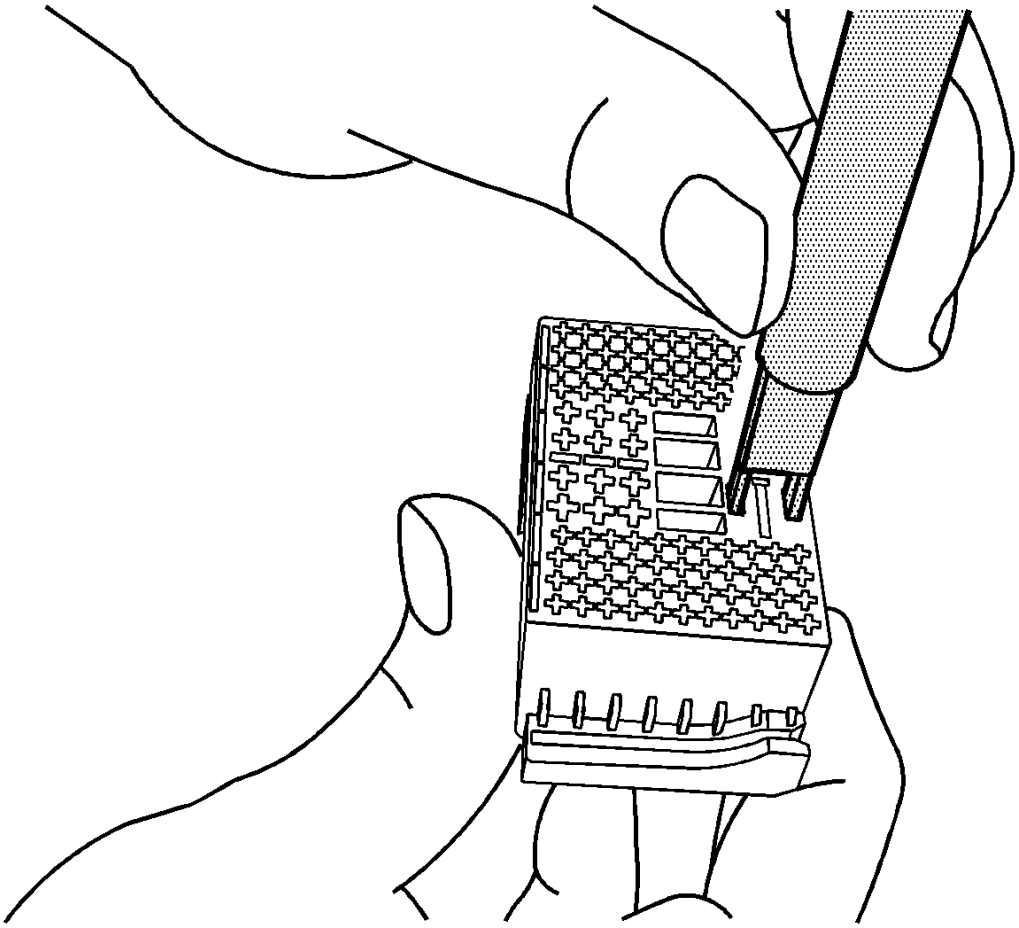


Fig. 183: Releasing Lock Tabs - Tyco/AMP (102-Way Inline)
Courtesy of GENERAL MOTORS COMPANY

7. Using terminal release tool J-38125-221, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.

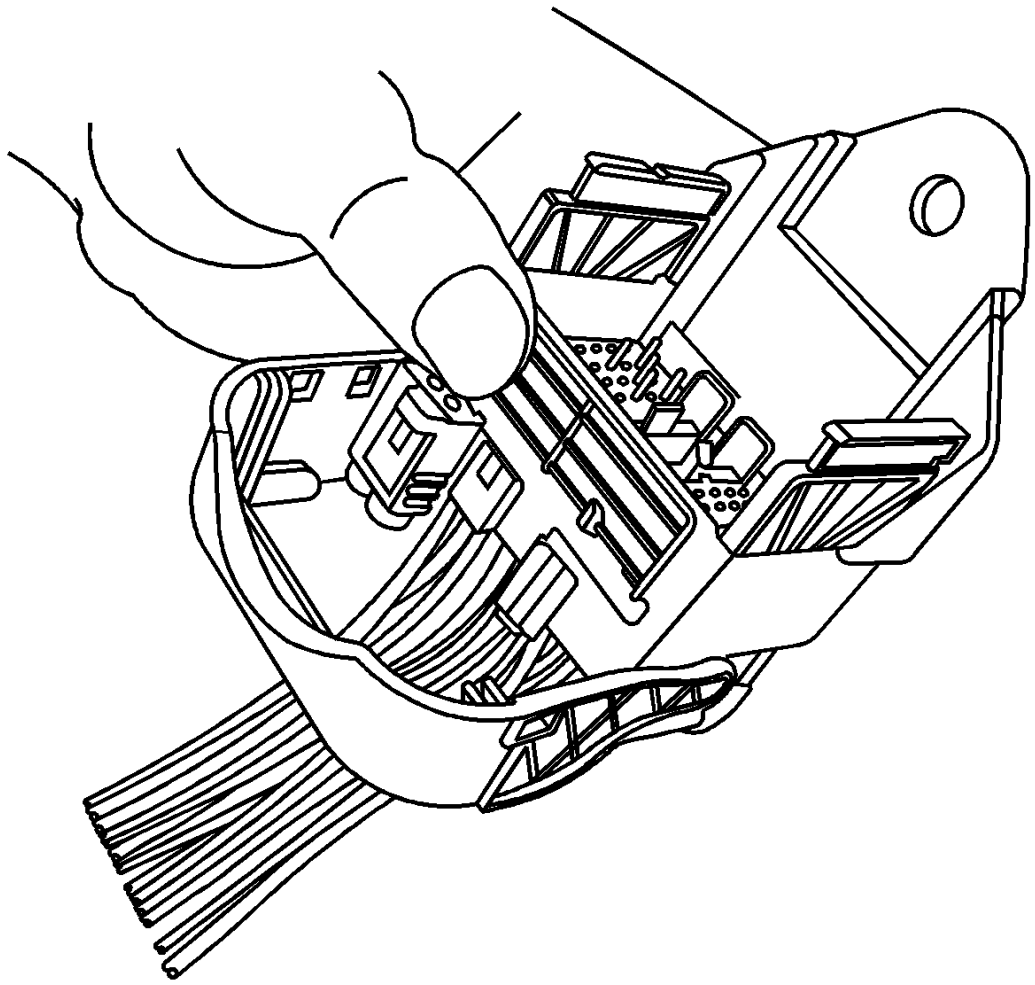


Fig. 184: View Of Female Connector Body - Tyco/AMP (102-Way Inline)
Courtesy of GENERAL MOTORS COMPANY

8. The female connector body may have an additional connector hooked to the edge of the body. Use terminal release tool J-38125-11A or equivalent to release the locking tab and slide the connector off the female body.

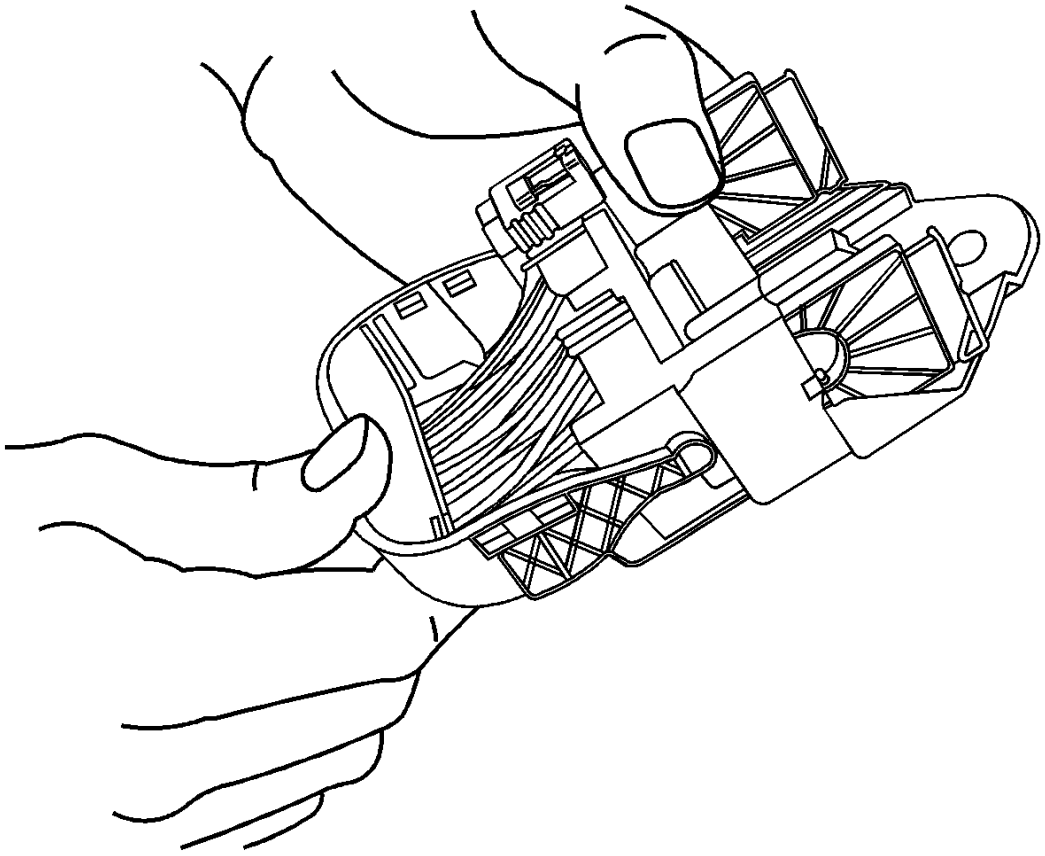


Fig. 185: Moving Locking Lever
Courtesy of GENERAL MOTORS COMPANY

9. Move the locking lever 180 degrees from the connected position.

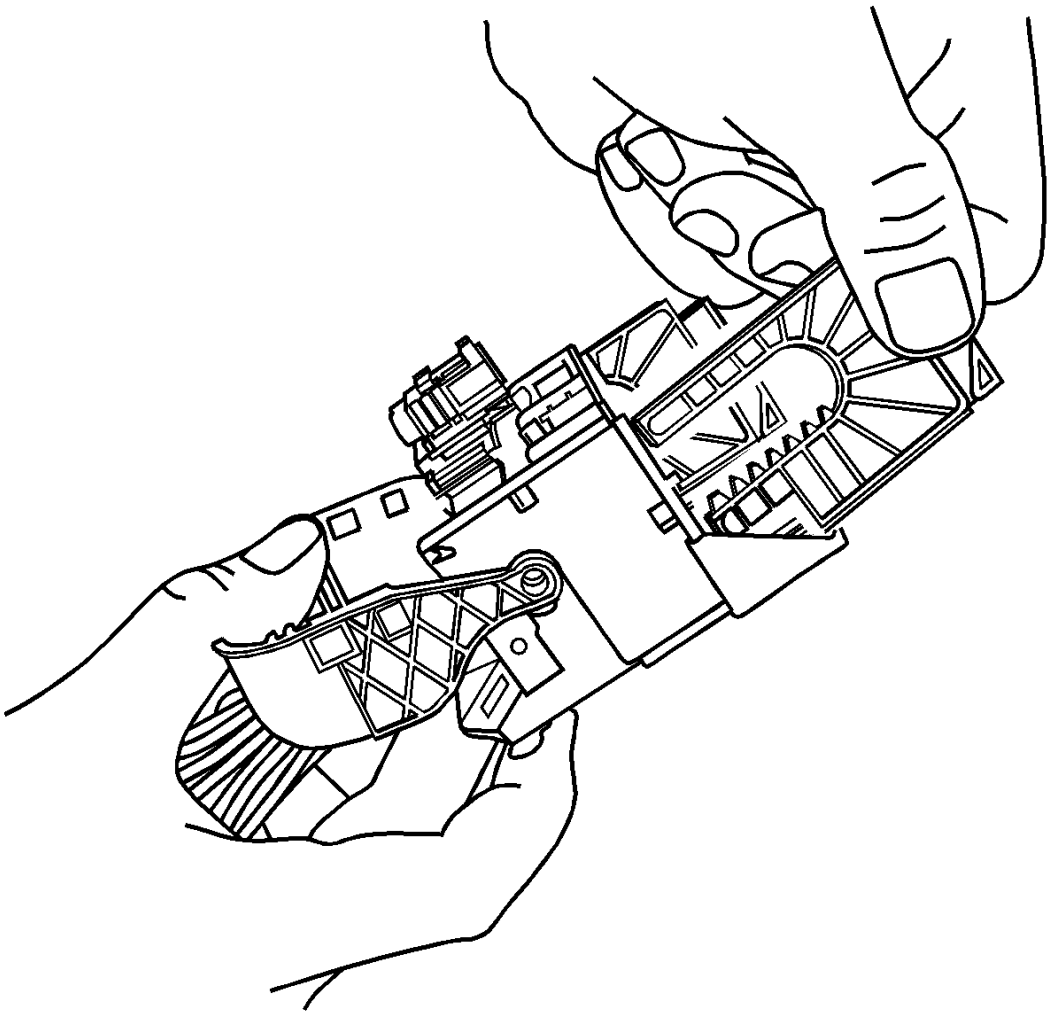


Fig. 186: Removing Guide Plates From Connector Body
Courtesy of GENERAL MOTORS COMPANY

10. With the locking lever in the 180 degree position the guide plates can be removed from the connector body.

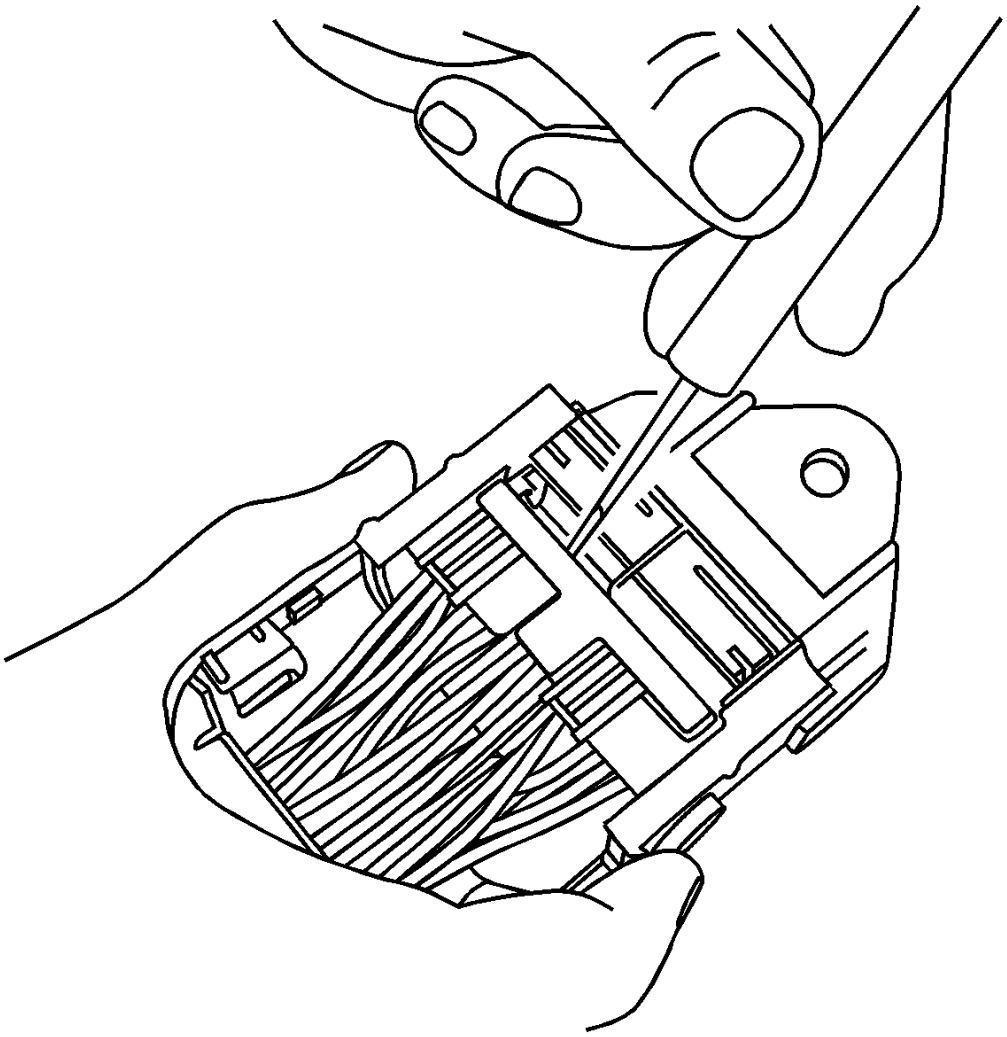


Fig. 187: Removing TPA
Courtesy of GENERAL MOTORS COMPANY

NOTE: **During assembly the TPA will not fully seat if any terminal is not fully seated.**

11. Using terminal release tool J-38125-11A or equivalent, remove the TPA from the connector body.

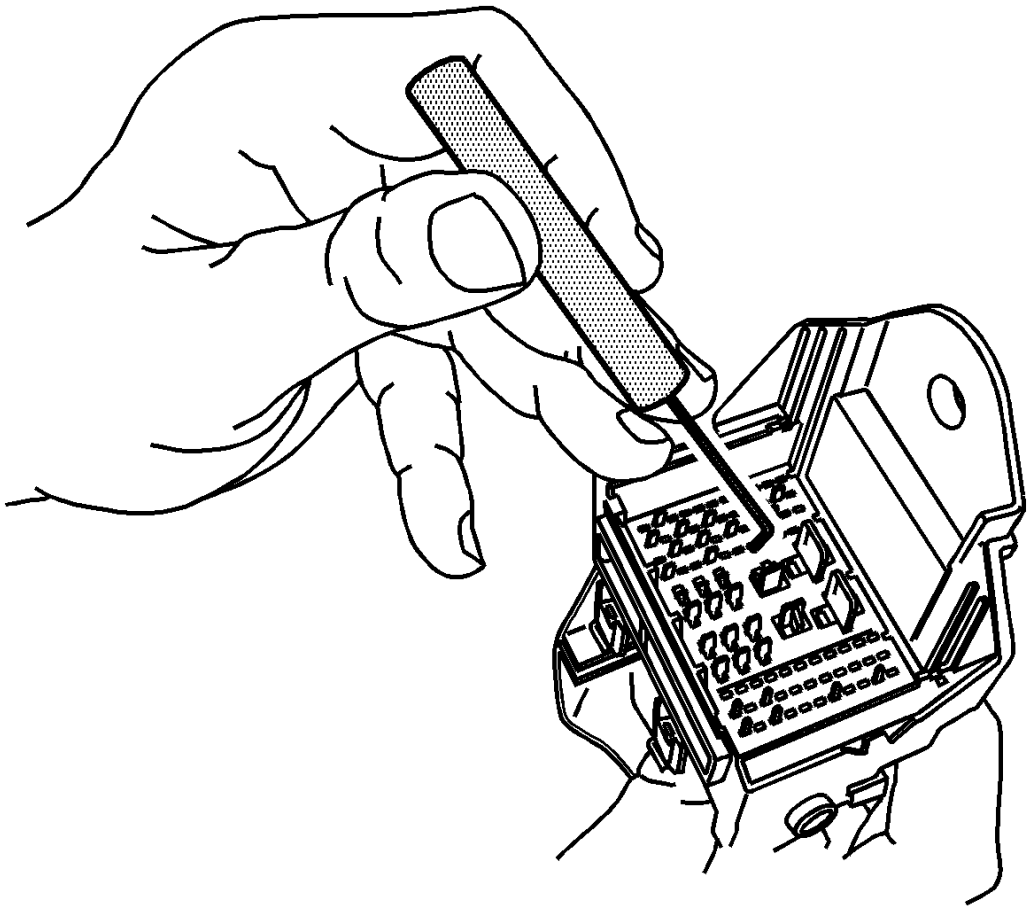


Fig. 188: Lifting Terminal Plate Past The Terminals
Courtesy of GENERAL MOTORS COMPANY

12. Using terminal release tool J-38125-216, lift the terminal plate past the terminals and out of the connector body cavity.

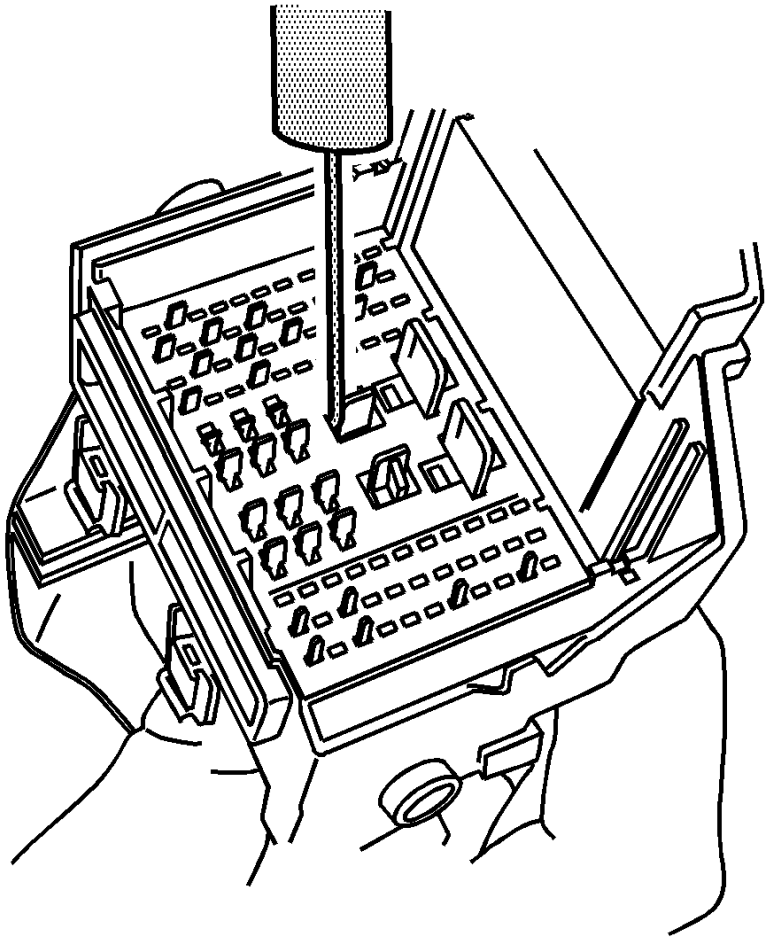


Fig. 189: View Of Terminal Plate
Courtesy of GENERAL MOTORS COMPANY

13. Terminal plate will bind slightly on each corner.

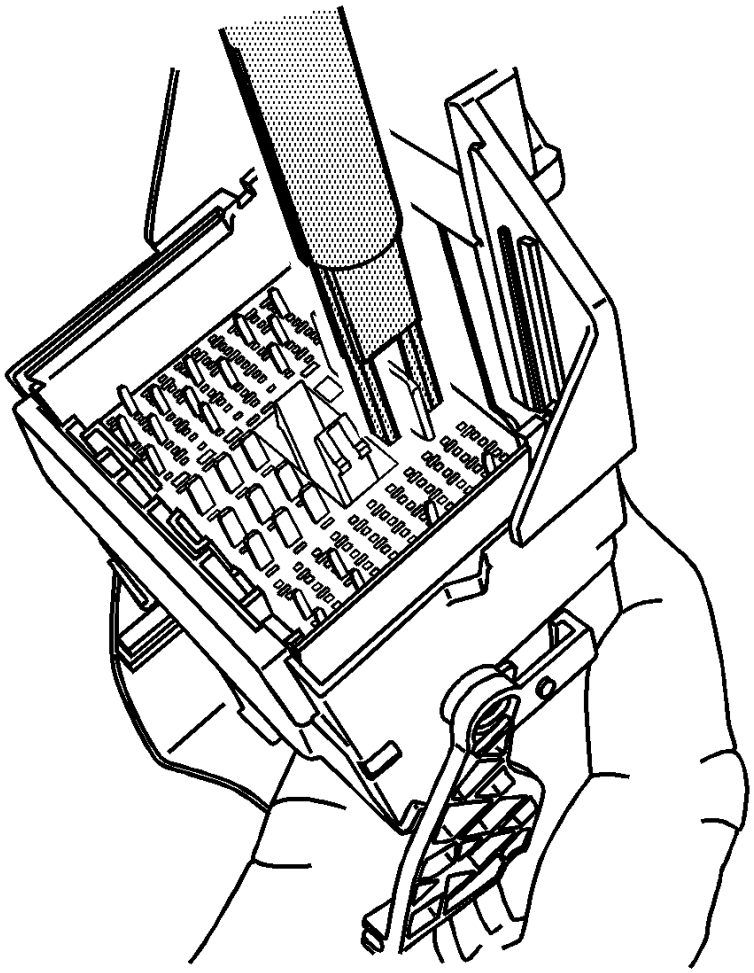


Fig. 190: Releasing Lock Tabs
Courtesy of GENERAL MOTORS COMPANY

14. Using terminal release tool J-38125-221, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.

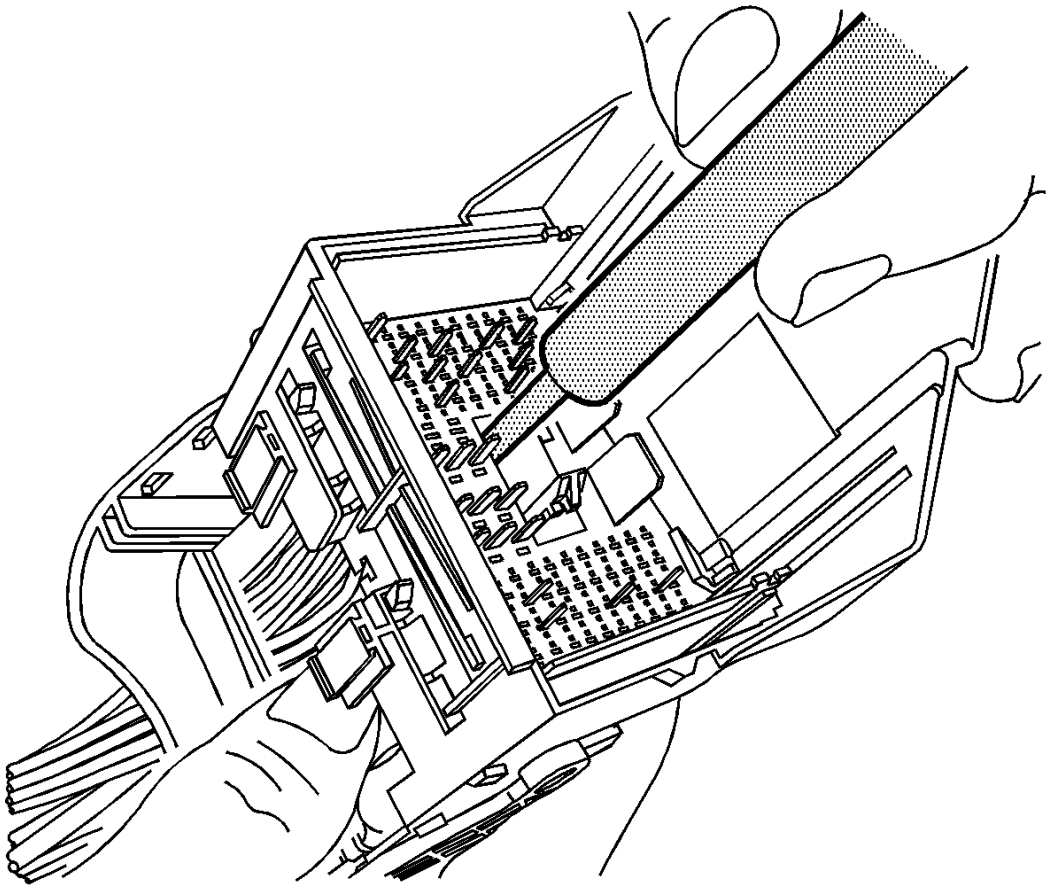


Fig. 191: View of Pressing Prongs On Each Side Of Terminal
Courtesy of GENERAL MOTORS COMPANY

15. Using terminal release tool J-38125-212, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.

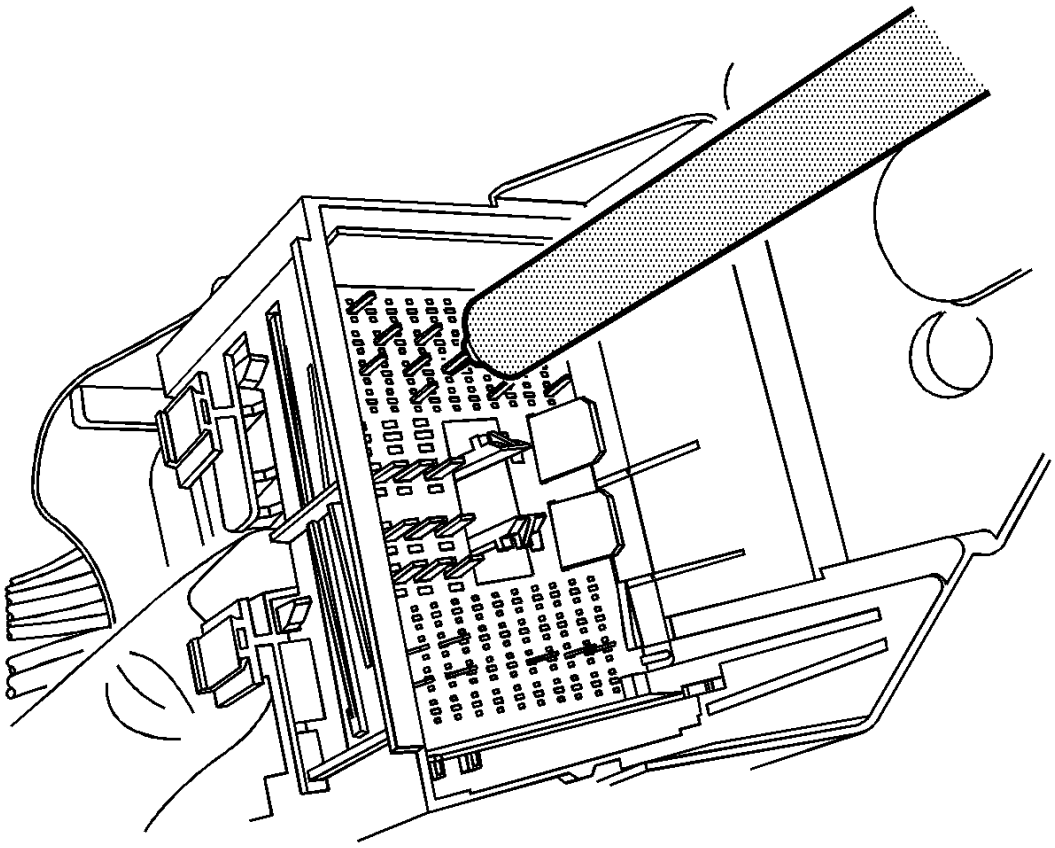


Fig. 192: Pressing Prongs On Each Side Of Terminal - Tyco/AMP (102-Way Inline)
Courtesy of GENERAL MOTORS COMPANY

16. Using terminal release tool J-38125-560, press the prongs into the holes on each side of the terminal to be removed to release the lock tabs and pull the terminal out of the connector body.

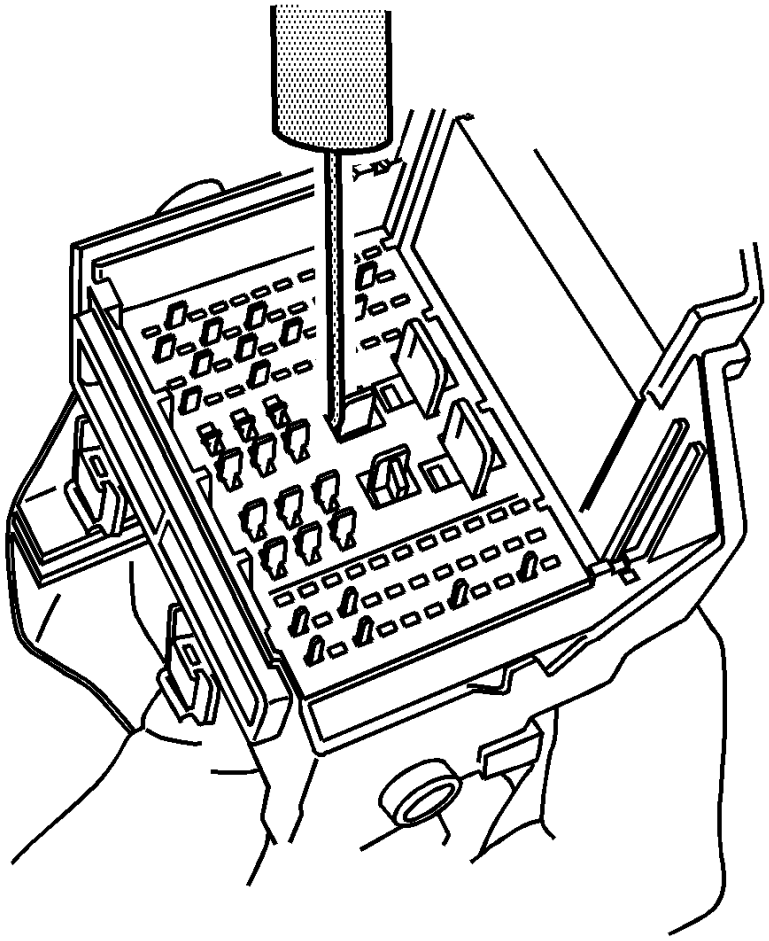


Fig. 193: View Of Terminal Plate
Courtesy of GENERAL MOTORS COMPANY

17. Press the terminal plate back into the female connector to the preset position. The plate will bind slightly on each corner.

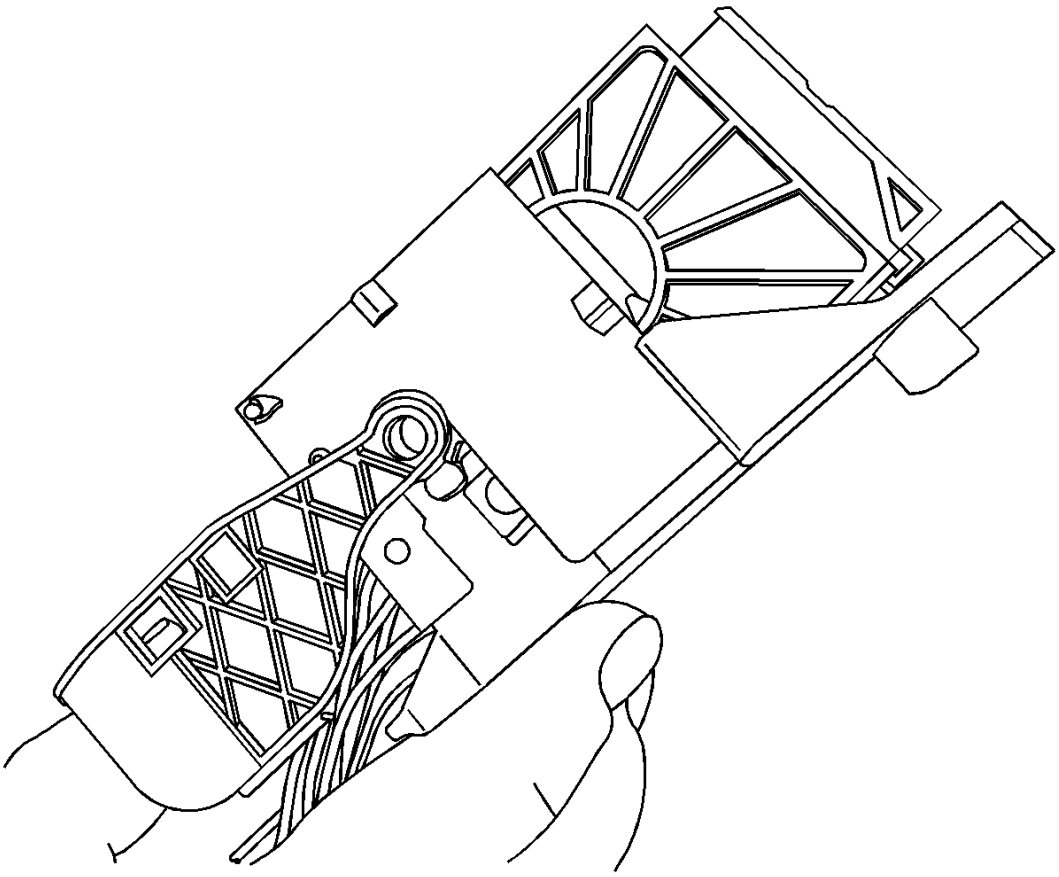


Fig. 194: Aligning Guide Plates To Mesh With Locking Lever Gears
Courtesy of GENERAL MOTORS COMPANY

18. With the locking lever in the 180 degree position, align the guide plates to mesh with the gears on the locking lever.

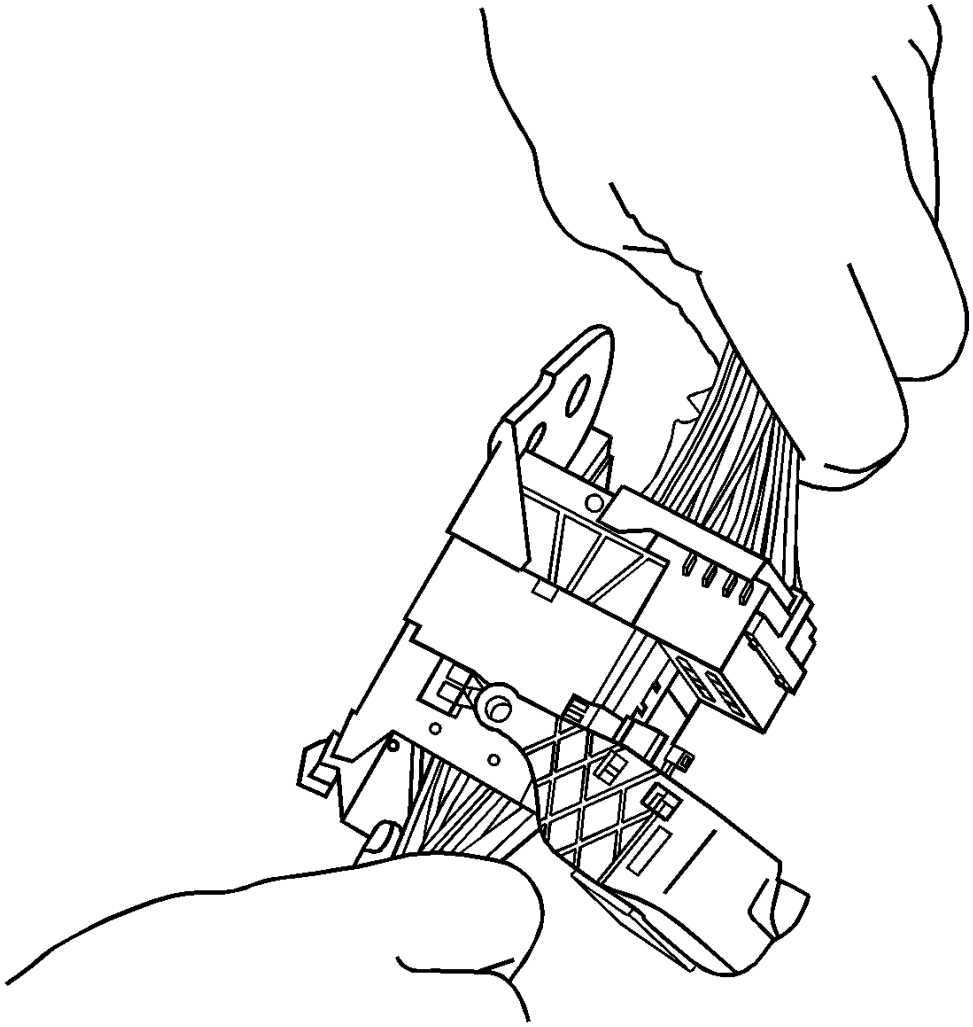


Fig. 195: Sliding Male Connector Body Away From Guide Plates
Courtesy of GENERAL MOTORS COMPANY

19. Slide the male connector body back inward toward the guide plates.

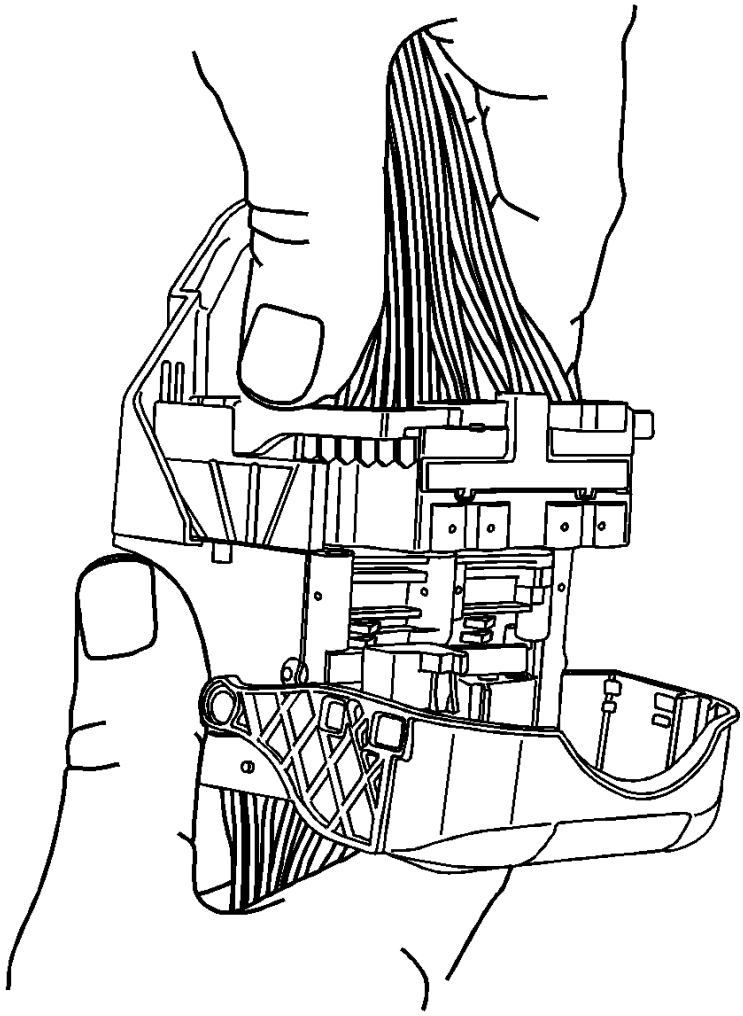


Fig. 196: Assembled View Of Connector - Tyco/AMP (102-Way Inline)
Courtesy of GENERAL MOTORS COMPANY

20. With the locking lever in the 90 degree position and the male connector body connected, it can be slid inward for assembly.

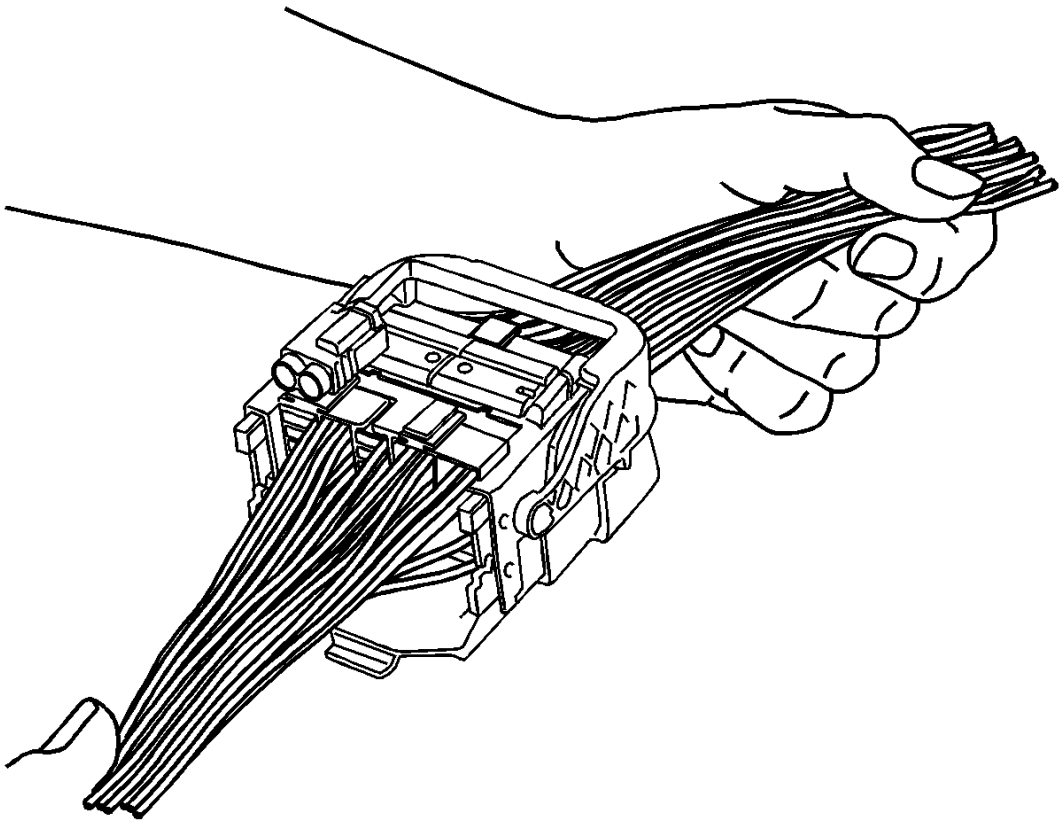


Fig. 197: View Of Typical Connector In Assembled Position
Courtesy of GENERAL MOTORS COMPANY

21. Move the lever into the locked position or in the assembled position. This will pull the male connector down into the female connector.
22. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
23. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

TYCO/AMP CONNECTORS (SIR)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-11A** Terminal Release Tool
- **J-38125-215A** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Removal Procedure

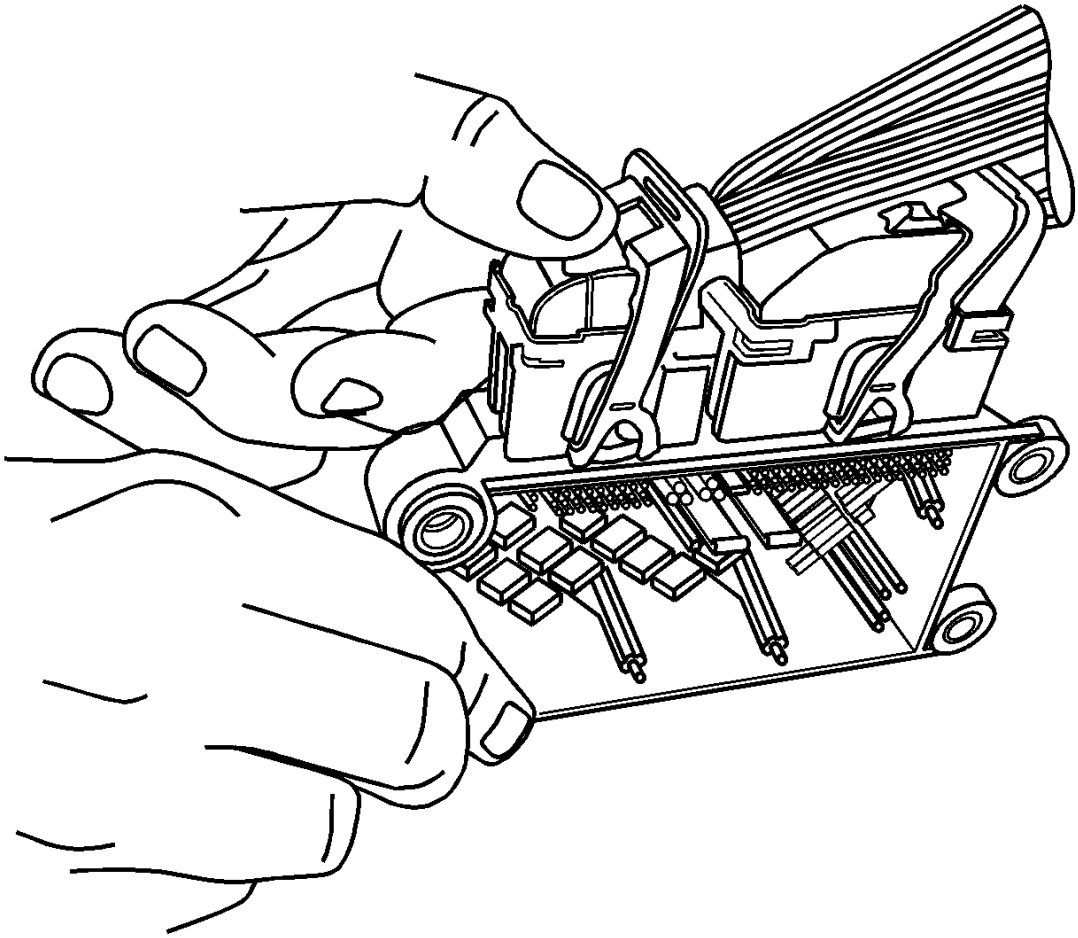


Fig. 198: Sliding Red CPA Away From Connector Lever
Courtesy of GENERAL MOTORS COMPANY

1. Using your thumbs press down and slide the red CPA away from the connector lever.

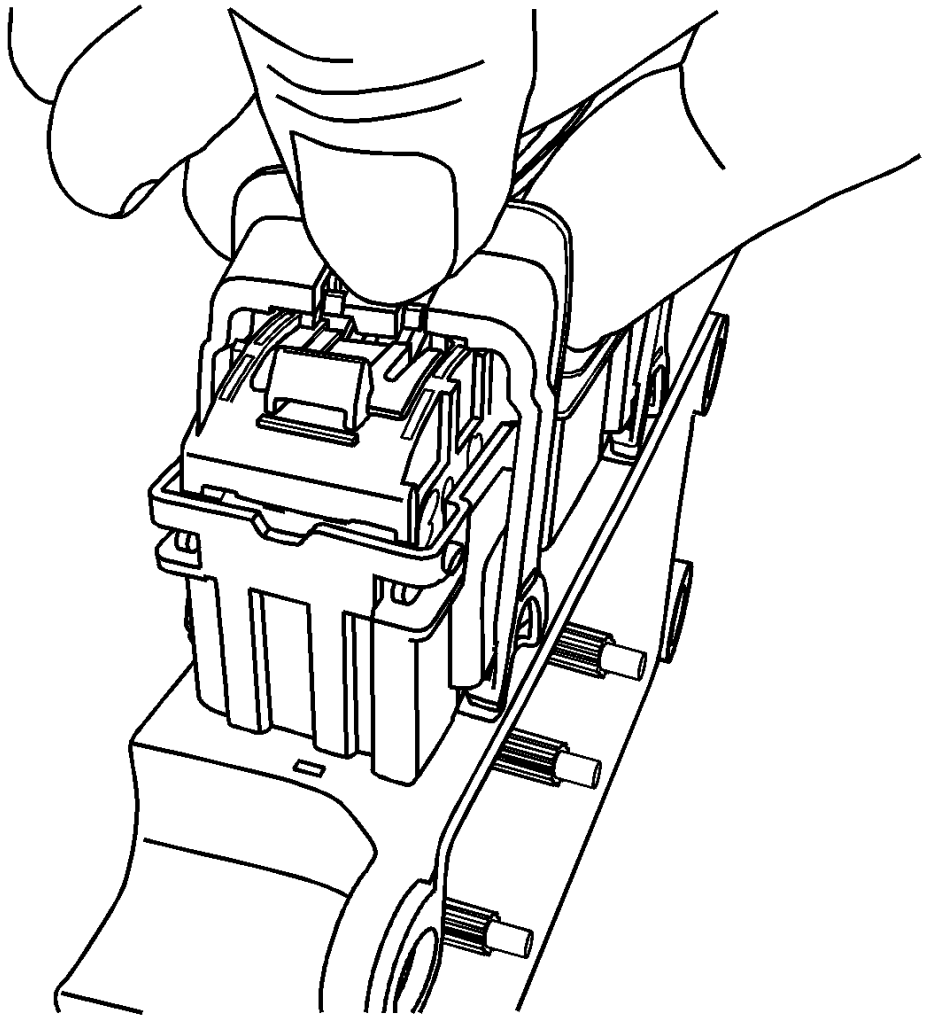


Fig. 199: Pressing Down On Locking Tab - Tyco/AMP Connectors (SIR)
Courtesy of GENERAL MOTORS COMPANY

2. Using your thumb press down on the locking tab and move the lever to the released position.

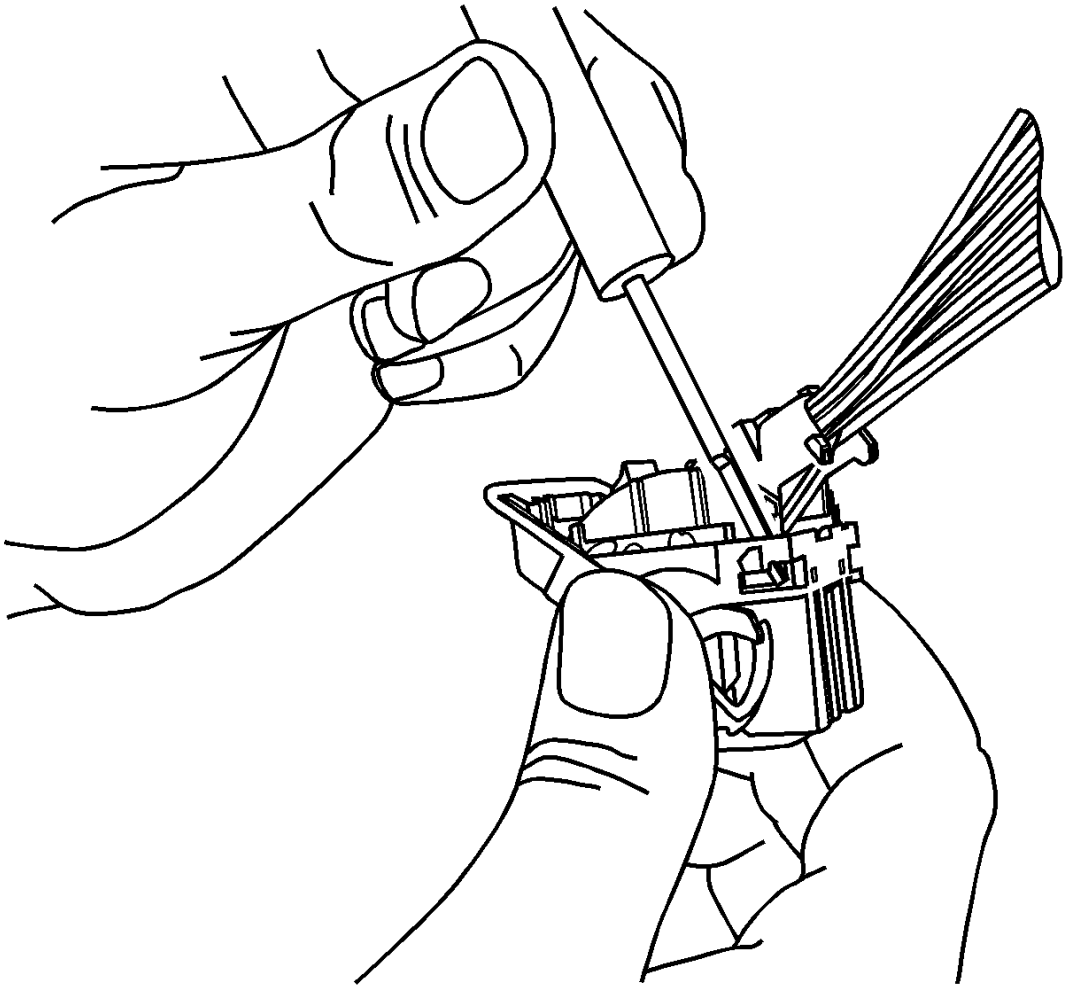


Fig. 200: Releasing Wire Dress Cover Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

3. Using terminal tool J-38125-11A or equivalent, release the wire dress cover locking tabs.

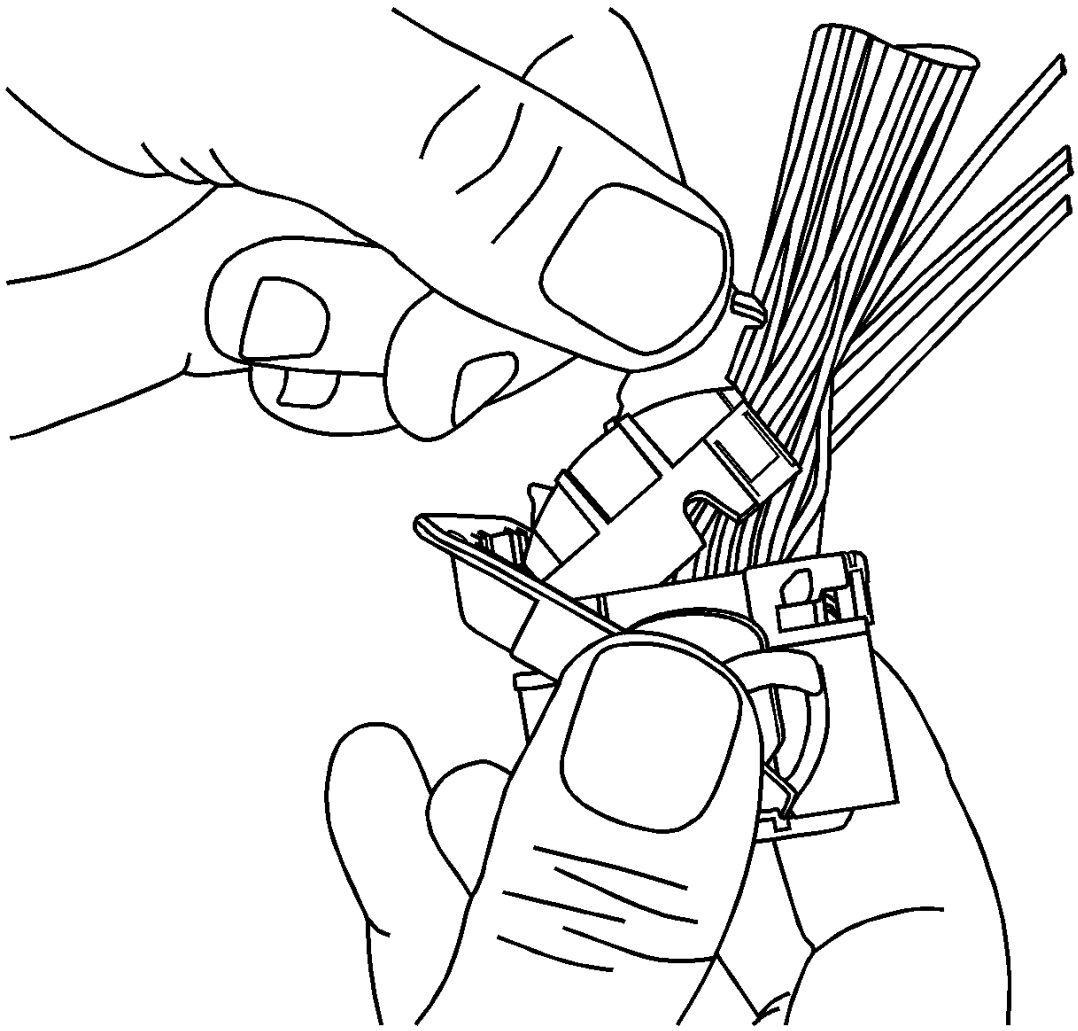


Fig. 201: Pivoting Connector Wire Dress Cover
Courtesy of GENERAL MOTORS COMPANY

4. Pivot connector wire dress cover while removing from the connector body.

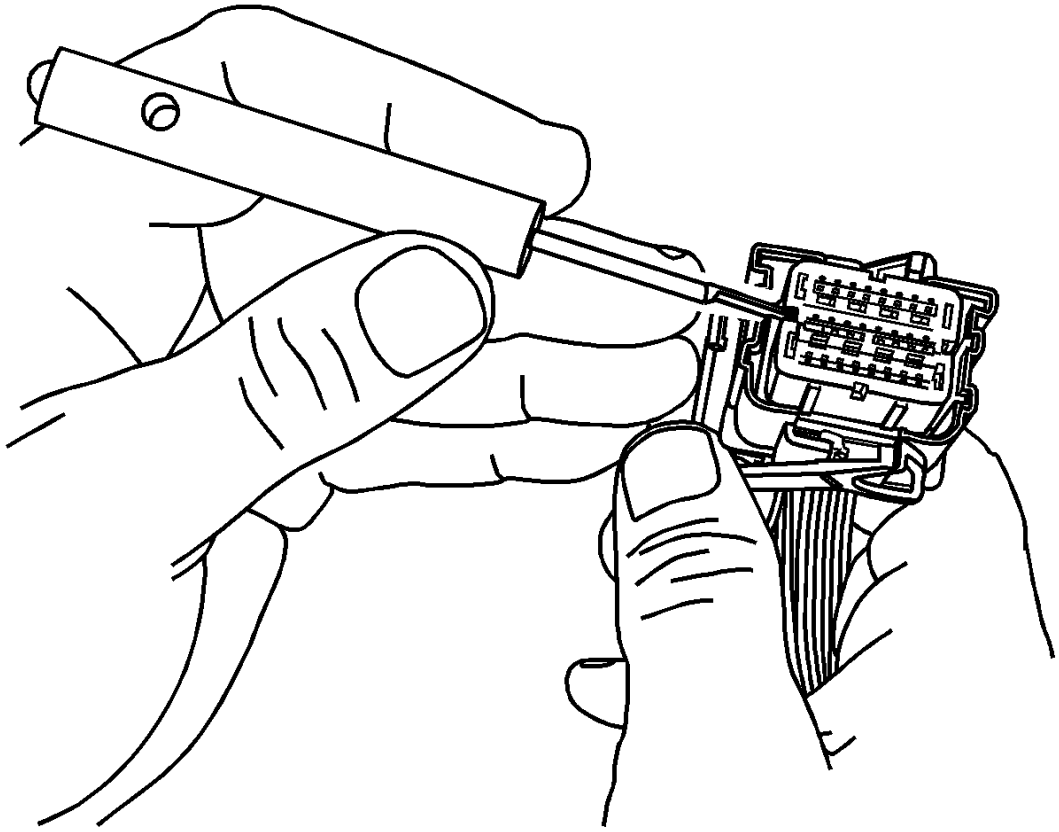


Fig. 202: Removing TPA
Courtesy of GENERAL MOTORS COMPANY

5. Using terminal tool J-38125-11A or equivalent, remove the TPA by lifting straight off the connector body.

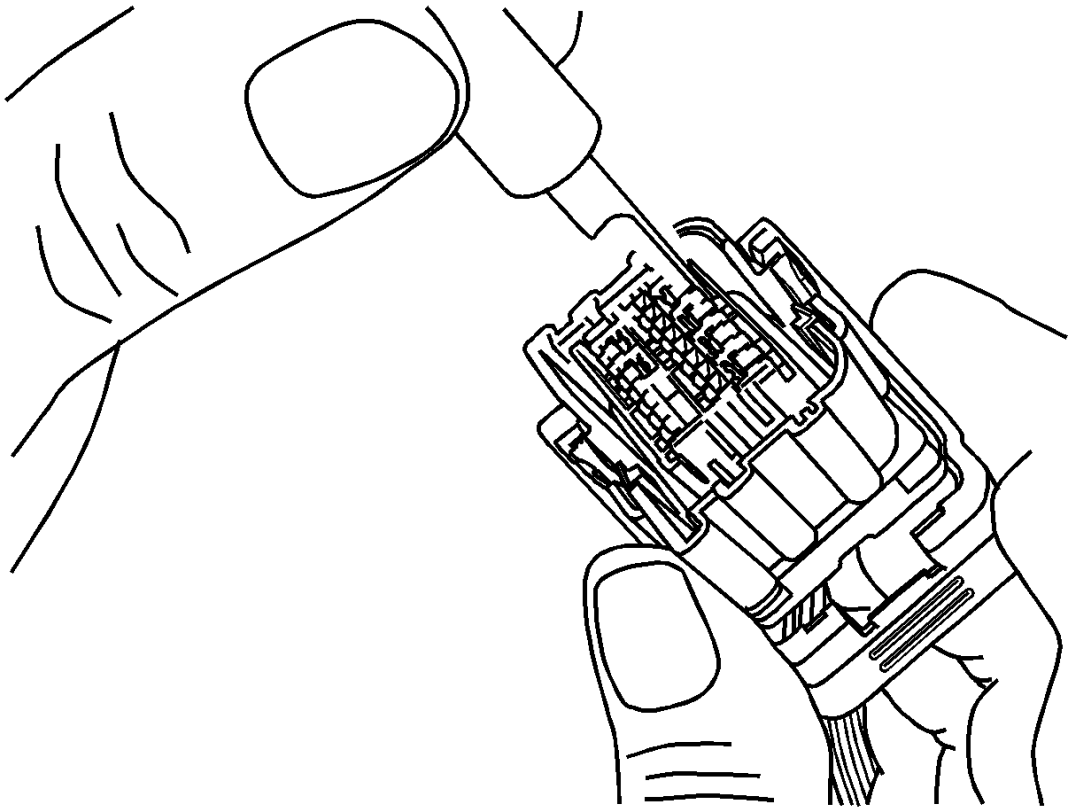


Fig. 203: View of Terminal Release Tool & Rear of Connector Body
Courtesy of GENERAL MOTORS COMPANY

6. Using terminal release tool J-38125-215A, place the tip of the tool on the outside edge next to the terminal and depress the lock tab and remove the rear of the connector body.

Terminal Repair Procedure

Use the appropriate terminal and crimper in order to replace the terminal.

YAZAKI CONNECTORS (2-WAY)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-553** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

Terminal Removal Procedure

1. Disconnect the connector from the component.

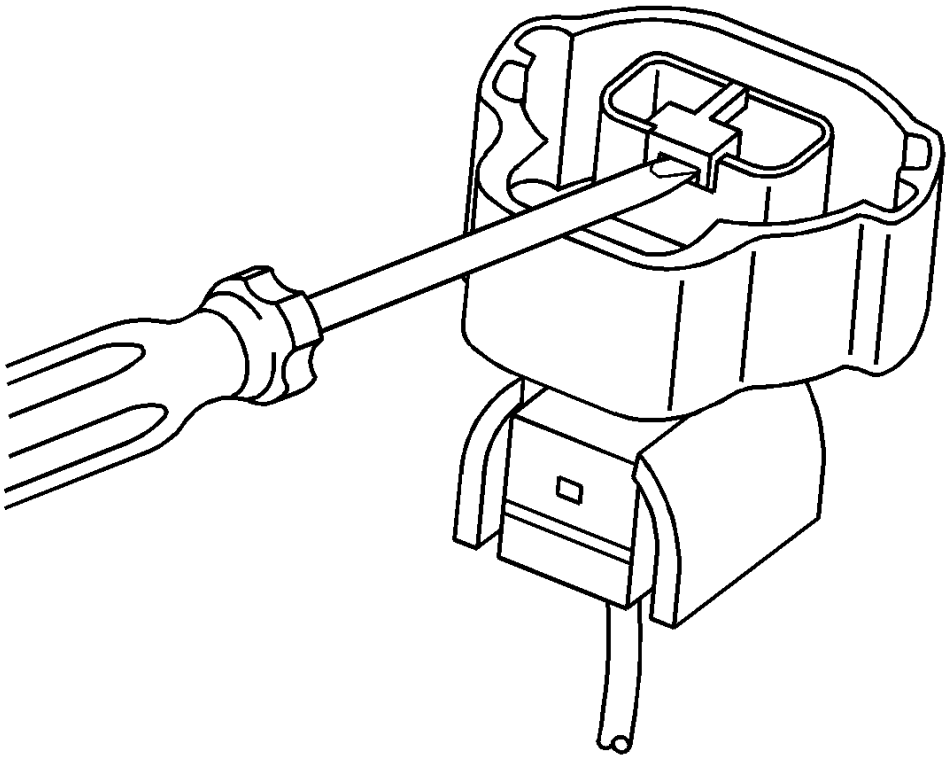


Fig. 204: Identifying Terminal Position Assurance (Yakazi)
Courtesy of GENERAL MOTORS COMPANY

2. Insert a small flat-blade tool in the slot below the front loaded terminal position assurance (TPA) and pry up.
3. Remove the TPA by pulling it out of the connector.
4. Push the wire side of the terminal that is being removed toward the connector and hold it in position.

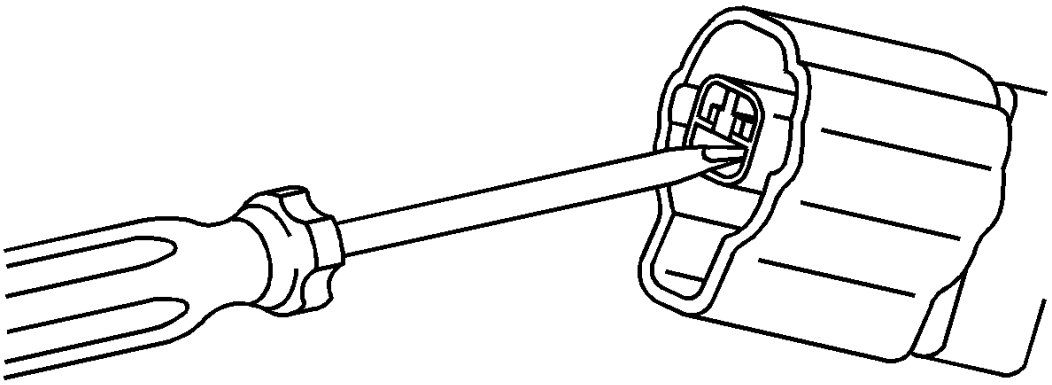


Fig. 205: View Of Inserting Tool Into Terminal Cavity (Yakazi)
Courtesy of GENERAL MOTORS COMPANY

5. Insert the J-38125-553 on a slight upward angle into the cavity below the terminal to be removed. Ensure that the pointed on the end of the tool is facing the bottom of the terminal and it stays in contact with the terminal until it stops on the plastic terminal retainer.

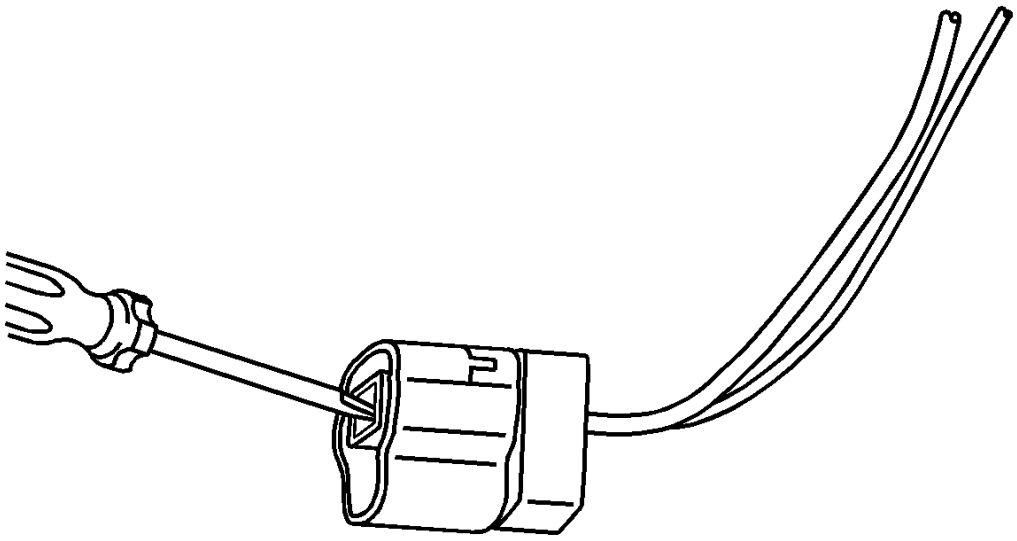


Fig. 206: View Of Pulling Terminal Out Of Connector (Yakazi)
Courtesy of GENERAL MOTORS COMPANY

6. Gently pry the plastic terminal retainer down and carefully pull the terminal out of the connector. Always remember never use force when pulling a terminal out of a connector. If the terminal is difficult to remove, repeat the entire procedure.
7. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
8. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

YAZAKI CONNECTORS (16-WAY)

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **J-38125-215** Terminal Release Tool

For equivalent regional tools, refer to Special Tools .

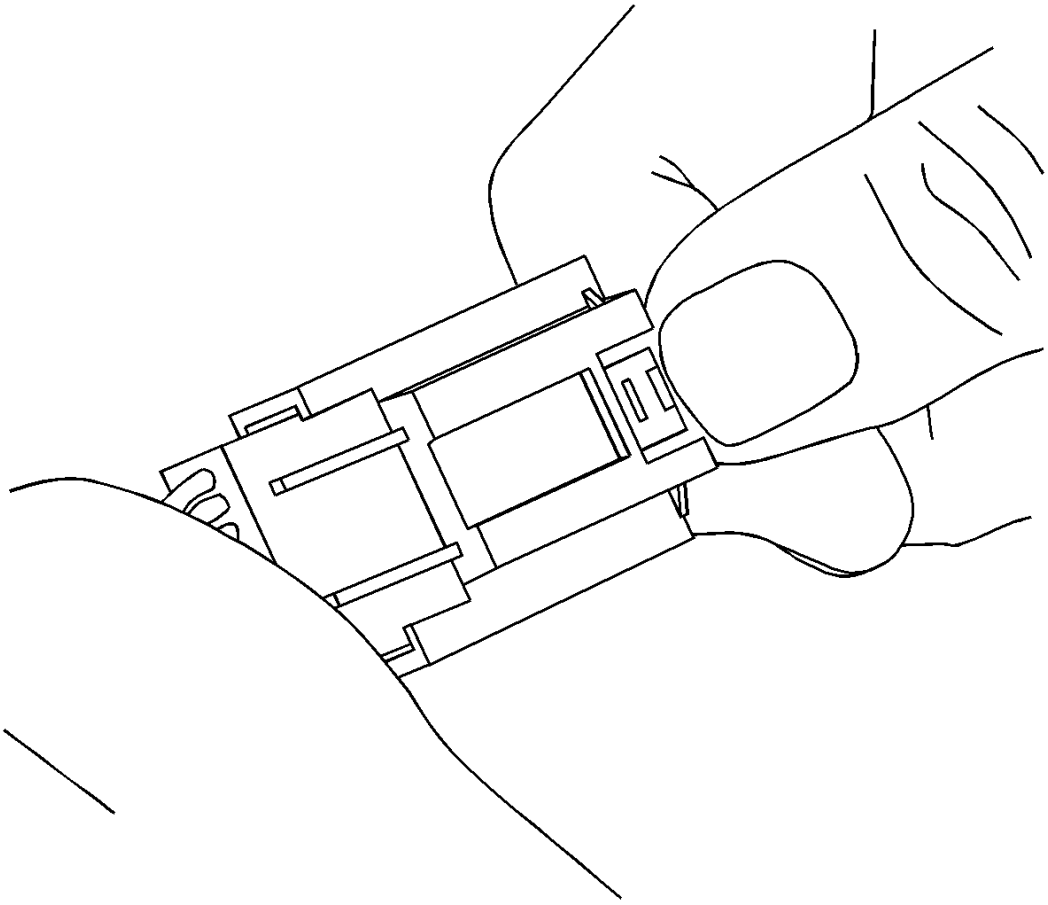


Fig. 207: Pulling Two Connector Halves Apart
Courtesy of GENERAL MOTORS COMPANY

1. While depressing the lock, pull the two connector halves apart.

NOTE: **The terminal position assurance (TPA) is fragile and may break if not done carefully.**

2. Use a small flat-blade tool to very carefully push the TPA towards the face of the connector on both sides of the connector.

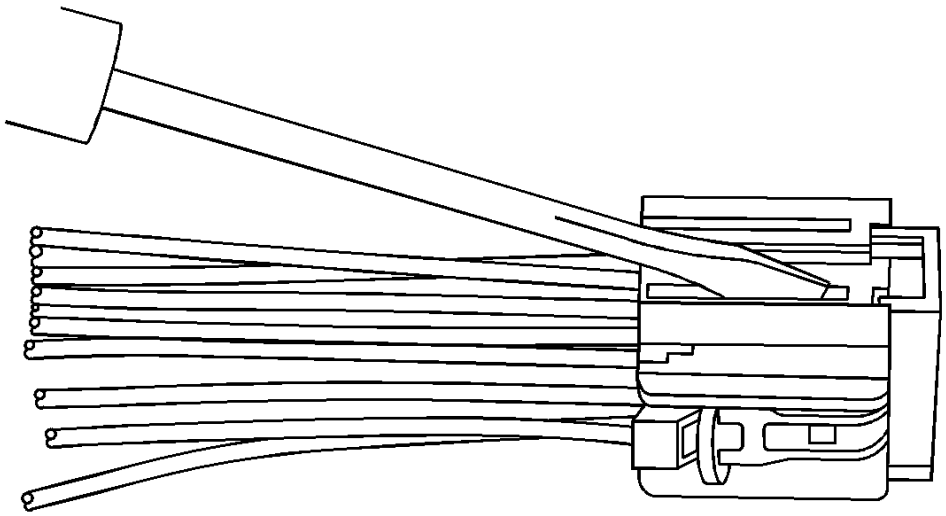


Fig. 208: View Of Male Connector Half & Female Terminals
Courtesy of GENERAL MOTORS COMPANY

3. View of the male half of the connector with female terminals.

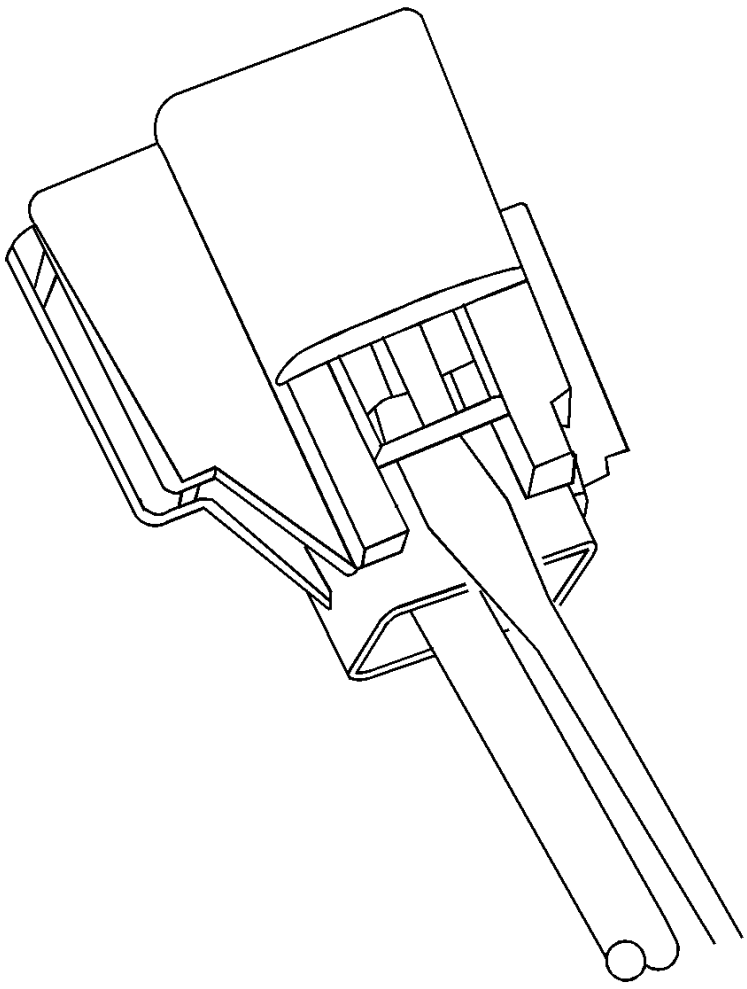


Fig. 209: View Of Female Half Of Connector With Male Terminals
Courtesy of GENERAL MOTORS COMPANY

4. View of the female half of the connector with male terminals.
5. Use the J-38125-215 tool to release the terminals by inserting the tool into the terminal release cavity.

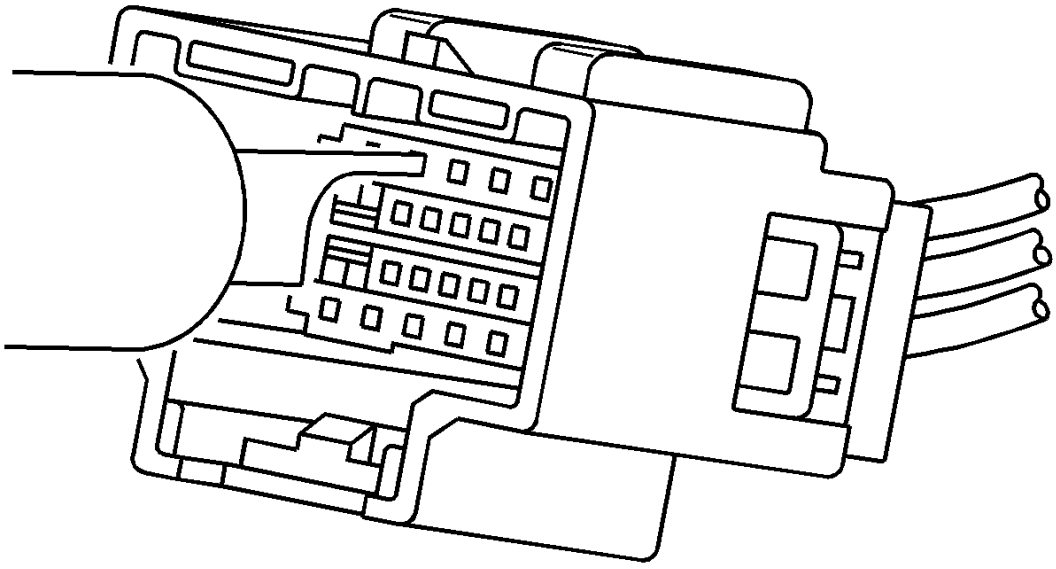


Fig. 210: Using Removal Tool On Female Half Of Connector
Courtesy of GENERAL MOTORS COMPANY

6. View of the female half of the connector with male terminals.

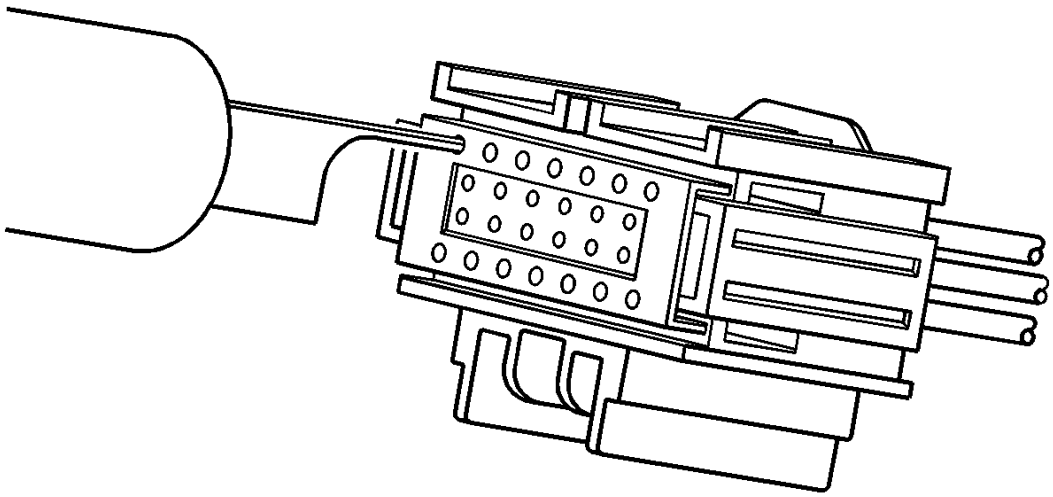


Fig. 211: Using Removal Tool On Male Half Of Connector
Courtesy of GENERAL MOTORS COMPANY

7. View of the male half of the connector with female terminals.
8. While holding the removal tool in place, gently pull the wire out of the back of the connector. Always remember never use force when pulling a terminal out of a connector.
9. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
10. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

REPAIRING CONNECTOR TERMINALS (TERMINATED LEAD REPAIR)

Special Tools

EL-38125-10 Splice Sleeve Crimp Tool

For equivalent regional tools, refer to Special Tools .

NOTE: **All repairs near the engine manifold, turbo engine and all exhaust pipes should**

follow the High Temperature Wiring Repairs procedures.

For high temperature wiring repairs, refer to **High Temperature Wiring Repairs**.

Terminated leads are terminals that are crimped onto wires. The terminated lead can be used throughout the vehicle since it is designed for temperatures up to 150Â°C. The length of the wire is 450 mm.

1. Use the connector end view to identify the correct terminated lead.
2. The terminated lead package should include a DuraSeal splice sleeve. If not, use the chart to in Splicing Copper Wire Using Splice Sleeves to identify the correct DuraSeal splice sleeve, refer to **Splicing Copper Wire Using Splice Sleeves**.

REPAIRING CONNECTOR TERMINALS (TERMINAL REPAIR)

Special Tools

- **J-38125-580** Terminal Repair Kit
- **J-38125-6** Crimp Tool
- **J-38125-7** Crimp Tool
- **J-38125-8** Crimp Tool
- **J-38125-64** Crimp Tool
- **J-38125-101** Crimp Tool
- **J-38125-641** Crimp Tool
- **J-38125-642** Crimp Tool
- **J-38125-643** Crimp Tool

For equivalent regional tools, refer to Special Tools .

Use the following repair procedures to repair each type of terminal:

- For push to seat terminals, refer to **Delphi Connectors (Weather Pack)Delphi Connectors (Push To Seat)Delphi Connectors (Pull To Seat)Delphi Connectors (Micro-Pack 100W)Delphi Connectors (Micro .64)Delphi Connectors (12-Way)Delphi Connectors (Steering Gear)**.
- For pull to seat terminals, refer to **Delphi Connectors (Weather Pack)Delphi Connectors (Push To Seat)Delphi Connectors (Pull To Seat)Delphi Connectors (Micro-Pack 100W)Delphi Connectors (Micro .64)Delphi Connectors (12-Way)Delphi Connectors (Steering Gear)**.

NOTE: **The first step for all terminal repairs is to find the connector end view in SI.**

Cable Seal Terminals

1. Cut off the terminal between the core and the insulation crimp to minimize any wire loss.
2. Remove the old seal.
3. Apply the correct cable seal, per the wire gauge size, from the kit. Slide the seal back along the wire to enable removal of the insulation.
4. To minimize wire loss, remove only the insulation required.

5. Using the connector end view, determine the correct crimp tool and crimp jaw.
6. Align the seal with the end of the cable insulation.
7. Position the stripped wire and seal in the terminal.
8. Hand Crimp the core wings first.
9. Hand Crimp the insulation wings around the seal and the cable.

Unsealed Terminals

1. Cut off the terminal between the core and the insulation crimp to minimize any wire loss.
2. To minimize wire loss, remove only the insulation required.
3. Position the stripped wire in the terminal.
4. Hand Crimp the core wings first.
5. Hand Crimp the insulation wings around the cable.

Micro-Pack 100W Size Terminal

The Micro-Pack 100W connectors have small terminals that are difficult to handle and hold when crimping. In order to aid the technician when crimping these terminals, a new crimping tool was developed. The J 38125-101 (W jaw) crimping tool was developed to crimp Micro-Pack 100W terminals. The J 38125-101 (W jaw) crimping tool has a terminal holding block that will hold the terminal in place while the terminal is being crimped. After the terminal is removed from the connector perform the following procedure in order to repair Micro-Pack 100 terminals.

1. Cut the wire as close to the terminal as possible.

NOTE: **After cutting the damaged terminal from the wire, determine if the remaining wire is long enough to reach the connector without putting a strain on the wire. If the wire is not long enough, splice a small length of the same gauge wire to the existing wire, then crimp the new terminal on the added wire.**

2. Strip 5 mm (3/16 in) of insulation from the wire.

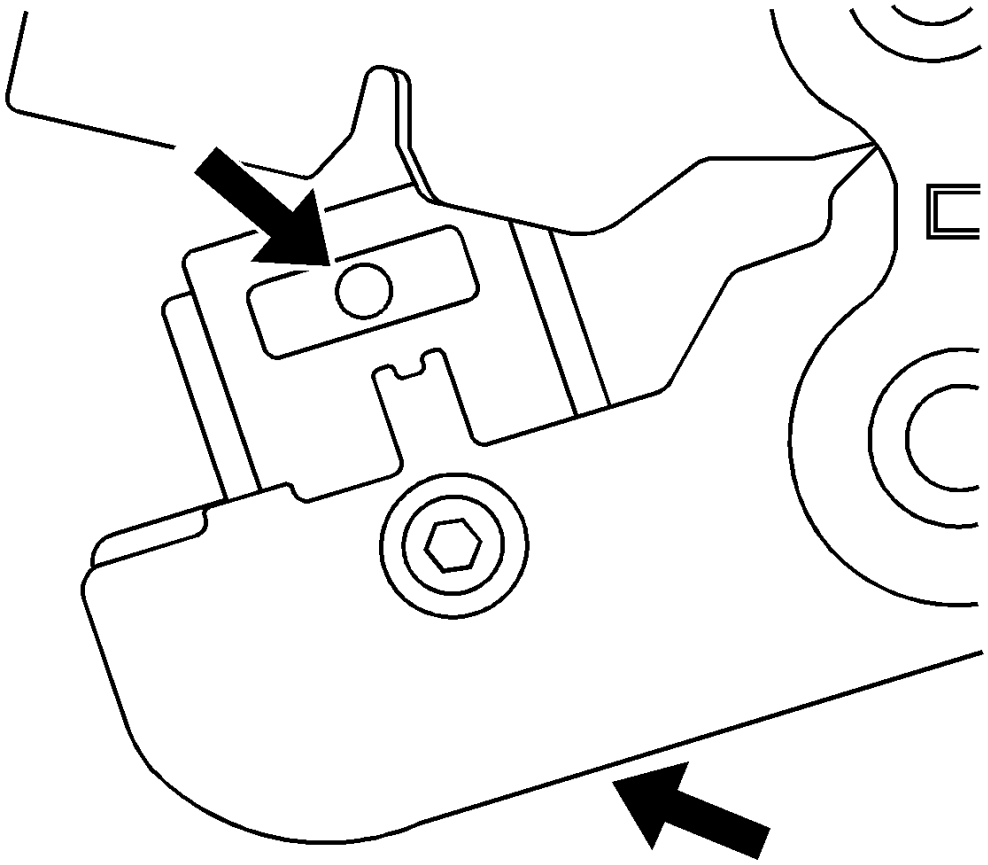


Fig. 212: Identifying Crimping Tool Spring Loaded Locator
Courtesy of GENERAL MOTORS COMPANY

3. Depress the spring loaded locator of the J 38125-101 (W jaw) crimping tool until the terminal holder is completely visible.

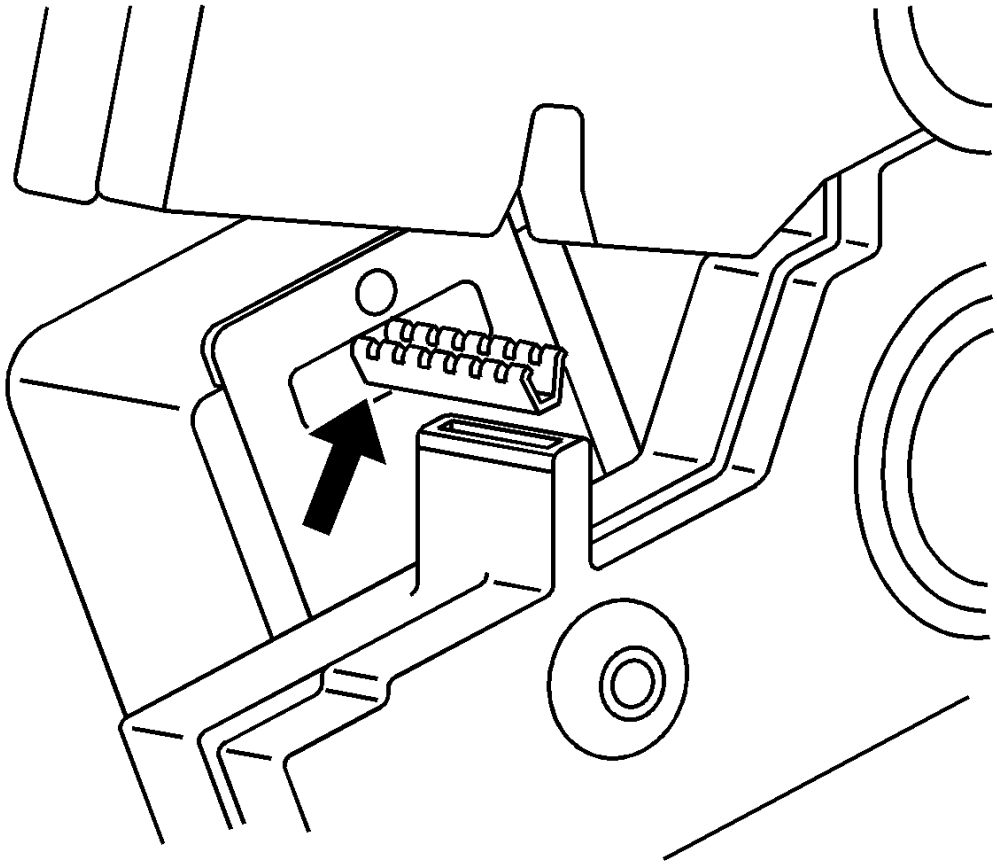


Fig. 213: Locating Terminal In Crimping Tool
Courtesy of GENERAL MOTORS COMPANY

4. Insert the terminal into the crimp tool until the core wings are flush with the anvil on the crimp tool. Be sure that the wings are pointed toward the crimp tool former and release the spring locator. The locator will hold the terminal in place. Inspect the alignment of the terminal wings with the crimp tool former. If the terminal wings are wider than the crimp tool former, remove the terminal and bend the terminal wings in slightly.
5. Place stripped wire into terminal.
6. Crimp the new terminal to the wire. If a jam occurs, press the emergency release to open applicator.

Micro 0.64 Size Terminal

The Micro 64 connectors have small terminals that are difficult to handle and hold when crimping. In order to aid the technician when crimping these terminals, a new crimping tool was developed. The J 38125-64 (M jaw) was developed to crimp Micro 64 terminals. The J-38125-64 crimping tool has a terminal holding block that will hold the terminal in place while the terminal is being crimped. The J-38125-64 crimping tool is also designed to crimp both the wire and the insulation at the same time.

After the terminal is removed from the connector perform the following procedure in order to repair Micro 64

terminals.

NOTE: **After cutting the damaged terminal from the wire, determine if the remaining wire is long enough to reach the connector without putting a strain on the wire. If the wire is not long enough, splice a small length of the same gauge wire to the existing wire, then crimp the new terminal on the added wire.**

1. Cut the wire as close to the damaged terminal as possible.
2. Strip 5 mm (3/16 in) of insulation from the wire.

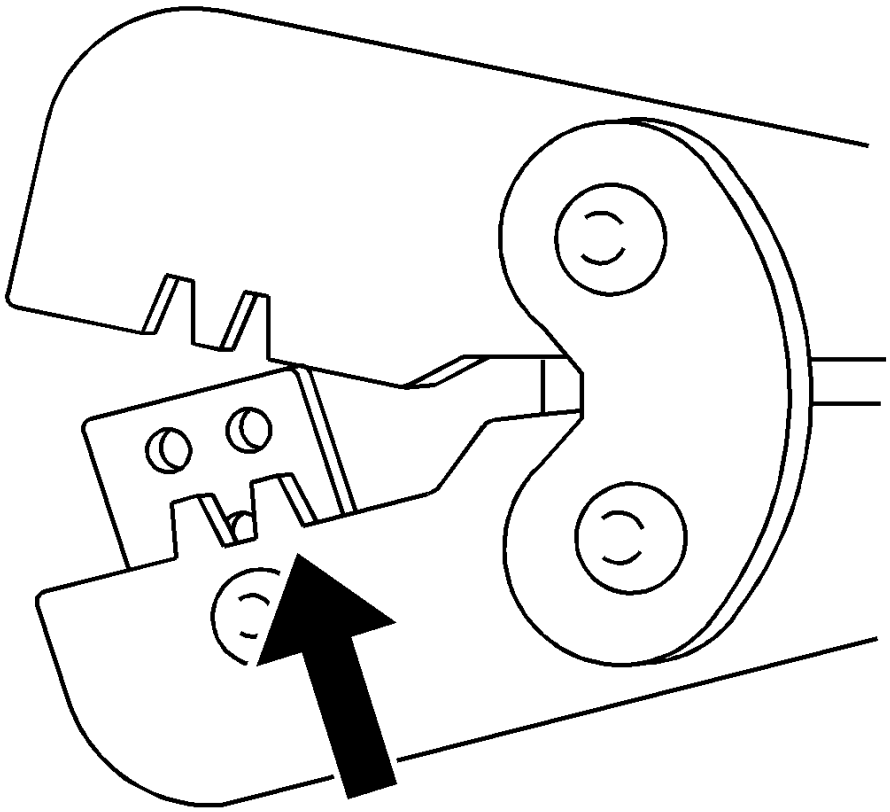


Fig. 214: Identifying Crimping Tool Spring Loaded Locator
Courtesy of GENERAL MOTORS COMPANY

3. Depress the spring loaded locator of the crimping tool until the terminal holder is completely visible.

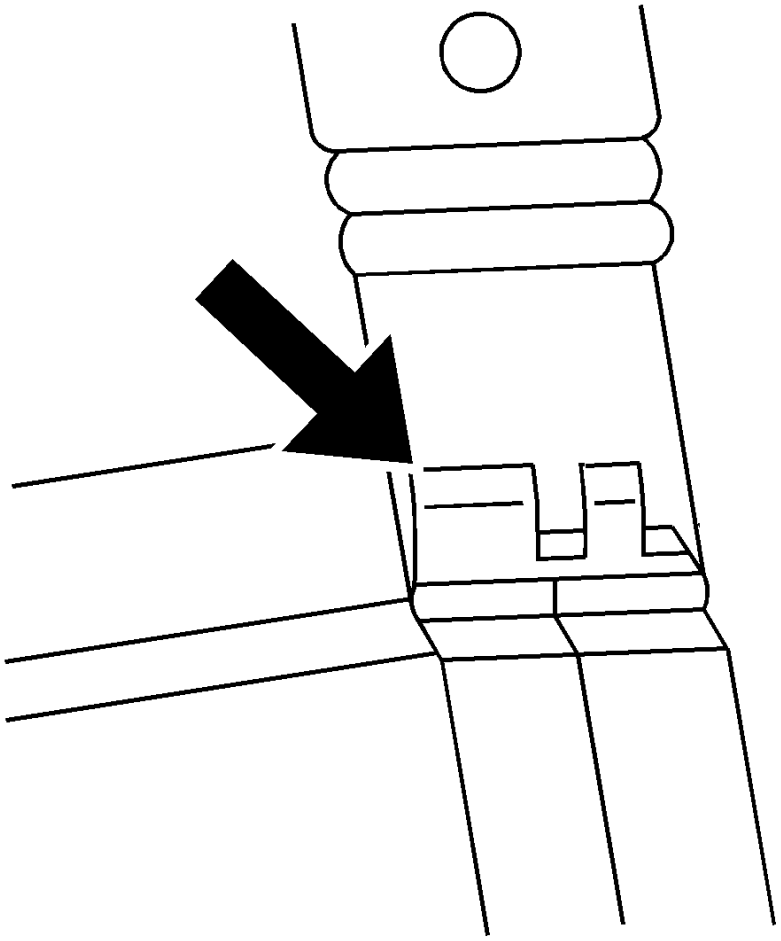


Fig. 215: Identifying Terminal Holder
Courtesy of GENERAL MOTORS COMPANY

4. Insert terminal into the appropriate terminal holder until it hits bottom and stops. The correct terminal holder is determined by the wire size. Also ensure that the terminals wings are pointing towards the former on the tool and the release locator.
5. Insert the stripped cable into the terminal. Insulation should be visible on both sides of the terminal insulation wings.
6. Compress the handles until the ratchet automatically releases.
7. Place the terminal into the appropriate cavity and assemble the connector.

TERMINAL REMOVAL

Special Tools

- **EL-38125-550** Terminal Release Tool Kit
- **EL-38125-580** Terminal Release Tool Kit
- **EL-35616** Terminal Test Probe Kit

For equivalent regional tools, refer to Special Tools .

NOTE: **All repairs near the engine manifold, turbo engine and all exhaust pipes should follow the High Temperature Wiring Repair procedures.**

1. Find the appropriate connector end view within the connector end view section. The connector end view has the following information:
   - Diagnostic probe tool
   - Terminal release tool
   - Terminal/terminated lead part numbers

   NOTE: **Not using the proper test kit probe may cause damage to the terminal(s) that are probed.**

2. Determine if a terminal is damaged.
   1. Locate the diagnostic probe tool from the connector end view. The connector end view describes the color and part number to help the technician find and use the correct tool.
   2. Connect the probe tool to the Digital Multimeter.
   3. Insert the probe tool into the cavity and follow the procedures from the **Troubleshooting with a Digital Multimeter**.
3. Disconnect the connector body to perform the repair.
4. Use the following procedure to remove the terminal from the connector body.

   NOTE: **Several procedures for specific connector bodies are called out in the Wiring Repairs section.**

   1. The terminal position assurance (TPA) and connector position assurance (CPA) should be removed before releasing the terminal for the connector body.
   2. Look at the connector end view to locate the cavity of the damaged terminal and find the proper terminal release tool from the terminal release tool kit.

      NOTE: **Using the incorrect terminal release tool can damage the connector body.**

      NOTE: **Some terminals have a lever that must be disengaged before the terminal can be released.**

   3. Insert the terminal release tool into the cavity.

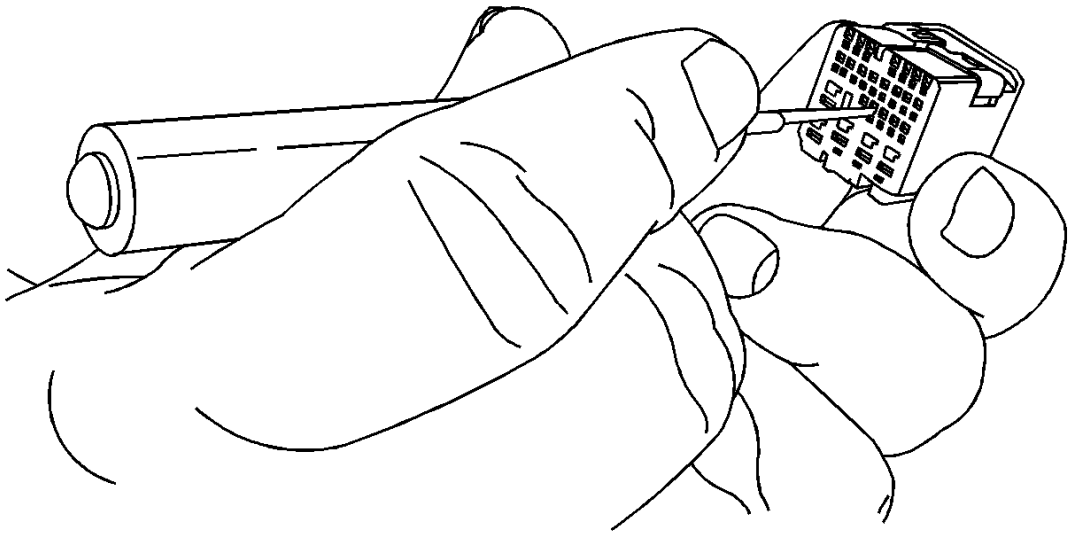


Fig. 216: Gently Pulling Wire Out Of Back Of Connector
Courtesy of GENERAL MOTORS COMPANY

5. Gently pull the wire out of the back of the connector.
6. Repair the terminal by following the **Repairing Connector Terminals (Terminated Lead Repair)Repairing Connector Terminals (Terminal Repair)** procedure.
7. Insert the repaired terminal back into the cavity. Repeat the diagnostic procedure to verify the repair and reconnect the connector bodies.

IGNITION KEY CANNOT BE INSERTED, ROTATED, OR REMOVED FROM THE IGNITION LOCK CYLINDER

Step	Action	Yes	No
1	1. Ensure the transmission shift lever is in the PARK position and the steering column is NOT in the locked position. 2. Verify the ignition key cannot be removed from the ignition lock cylinder.	Go to **Step 4**	Go to **Step 2**

Step	Action	Yes	No
	Can the ignition key be removed from the ignition lock cylinder?		
2	Verify the ignition key cannot be turned to the OFF position. Can the ignition key be turned to the OFF position?	Go to **Step 3**	Go to **Step 7**
3	Verify the ignition key cannot be removed from the ignition lock cylinder. Can the ignition key be removed from the ignition lock cylinder?	Go to **Step 7**	Go to **Step 12**
4	Verify the ignition key cannot be fully inserted and rotated without sticking in any position. Can the ignition key be fully inserted into the ignition lock cylinder and be rotated without sticking in any position?	Go to **Step 7**	Go to **Step 5**
5	Inspect for an incorrect, worn, or damaged ignition key. Is the ignition key incorrect, worn, or damaged?	Go to **Step 10**	Go to **Step 6**
6	Inspect the ignition key. Clean the entire middle groove area of the ignition key. Can the cleaned key be fully inserted into the ignition lock cylinder and be rotated without sticking in any position?	Go to **Step 13**	Go to **Step 12**
7	Verify the adjustment of the shift control cable. Refer to **Range Selector Lever Cable Adjustment** . Can the ignition key be turned to the OFF position and be removed?	Go to **Step 13**	Go to **Step 8**
8	Attempt to override the ignition lock solenoid on the ignition and start switch housing. Can the ignition key be turned to the OFF position and be removed?	Go to **Step 9**	Go to **Step 12**
9	Inspect the electrical system for improper operation. Refer to **Ignition Can/Cannot Be Turned Off with Transmission in Any Gear**, and to **Testing for Intermittent Conditions and Poor Connections**. Can the ignition key be turned to the OFF position and be removed?	Go to **Step 13**	Go to **Step 11**
10	Replace the ignition key. Refer to **Replacing Keys (North America except Canada)** **Replacing Keys (Canada)** . Did you complete the repair?	Go to **Step 13**	-
11	Replace the floor shifter. Refer to **Transmission Control Replacement** . Did you complete the repair?	Go to **Step 13**	-
12	Replace the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement** . Did you complete the repair?	Go to **Step 13**	-

Step	Action	Yes	No
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

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Article GUID: A00737161

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Battery Positive Cable and Nut	4.7 N.m	42 lb in
Fuse Block Fuse Holder Nut - MIDI-Fuse	4.7 N.m	42 lb in
Ground Fastener M6 Nut	9 N.m	80 lb in
Ground Fastener M6 Nut - Repair	8 N.m	71 lb in
Ground Fastener M7 Bolt	9 N.m	80 lb in
Ground Fastener M8 Nut	22 N.m	16 lb ft
Ground Fastener M10 Nut	45 N.m	33 lb ft
Positive Battery Cable Lead Nut	10 N.m	89 lb in
Underhood Junction Block Connector Bolts	6 N.m	53 lb in

Article GUID: A00737226

REPAIR INSTRUCTIONS

GMLAN AND MEDIA ORIENTED SYSTEMS TRANSPORT (MOST) WIRING REPAIRS

Special Tools

- **EL-38125-10** Splice Sleeve Crimping Tool
- DuraSeal splice sleeves
- A wire stripping tool

For equivalent regional tools, refer to Special Tools .

The DuraSeal splice sleeves have the following 2 critical features:

- A special heat shrink sleeve environmentally seals the splice. The heat shrink sleeve contains a sealing adhesive inside.
- A cross hatched (knurled) core crimp provides necessary contact integrity for the sensitive, low energy circuits.

The GM Local Area Network (GMLAN) System requires special wiring repair procedures due to the sensitive nature of the circuitry. Follow the specific procedures and instructions when working on GMLAN connectors and terminals.

GMLAN Repairs

NOTE: **When making a repair to any GMLAN network, the original wire length after the repair must be the same length as before the repair. If the network is a twisted pair, the twist must be maintained after the repair is completed.**

GMLAN has 2 types of networks, low speed and high speed. Low speed GMLAN has a single wire and works at slow speeds. High speed GMLAN has 2 wires in a twisted pair and works at higher speeds. For more information on GMLAN, refer to **Data Link Communications Description and Operation** .

GMLAN Connector Terminal Repair

NOTE: **A terminated lead can be used to replace damaged connector terminals for both high speed and low speed GMLAN systems. When making a connector terminal repair on a GMLAN high speed system with twisted pair wires, do not untwist the wires more than necessary to make the repair.**

If the individual terminals are damaged on any GMLAN connection, use the appropriate connector repair procedure in order to repair the terminal. Refer to **Connector Repairs** for the appropriate connector repair procedure.

GMLAN Wire Repair

NOTE: **Refer to Wiring Repairs in the service information connector end views or the vehicle schematics in order to determine the correct wire size for the circuit you are repairing. You must obtain this information in order to ensure circuit integrity.**

If any wire except the pigtail is damaged, repair the wire by splicing in a new section of wire of the same gauge size (0.5 mm^2 , 0.8 mm^2 , 1.0 mm^2 etc.). Use the DuraSeal splice sleeves and **EL-38125-10** tool. For wiring repair, refer to **Splicing Copper Wire Using Splice Sleeves** .

Media Oriented Systems Transport (MOST) Wiring Repair

NOTE: **If harness repair/analysis is performed, MOST bus Twist Pair unshielded wire should be 0.35 mm^2 (22 AWG) wire with at least one twist per each 1 45/64 inch (45 mm) and must not be untwisted for more than 3 15/16 of an inch (10 cm).**

The following conditions need to be met to ensure a valid continuity:

- Untwisted length for all MOST 50 circuits at each wire harness connector should be no longer 50 mm max (25 mm preferred).
- When wire repairs are made, a minimum 25 twists/meter for all MOST 50 circuits.
- MOST 50 has specific receive and transmit I/O.

The transmit of one module is connected to receive of the next module in ring topology.

RELAY REPLACEMENT (ATTACHED TO WIRE HARNESS)

Removal Procedure

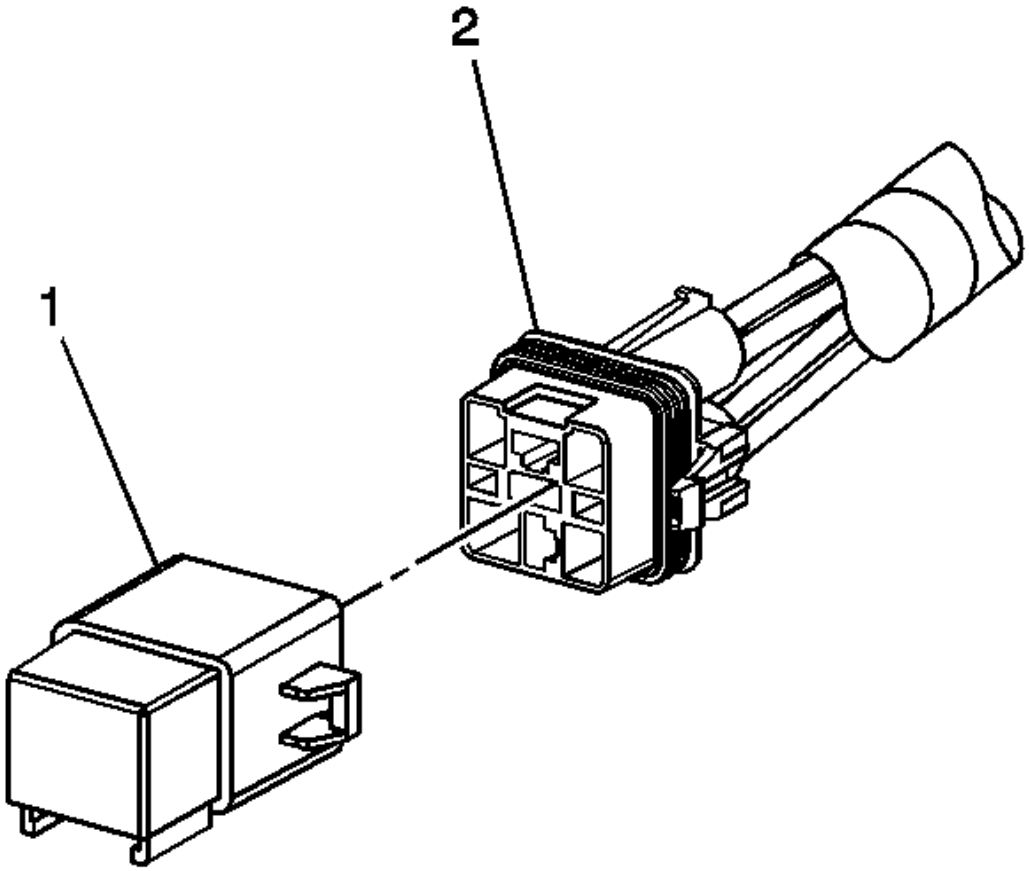


Fig. 1: Identifying Relay & Wire Harness Connector
Courtesy of GENERAL MOTORS COMPANY

1. Locate the relay. Refer to the **Master Electrical Component List** to locate the relay in the vehicle.
2. Remove any fasteners which hold the relay in place.
3. Remove any connector position assurance (CPA) devices or secondary locks.

NOTE: **Use care when removing a relay in a wiring harness when the relay is secured by fasteners or tape.**

4. Separate the relay (1) from the wire harness connector (2).

Installation Procedure

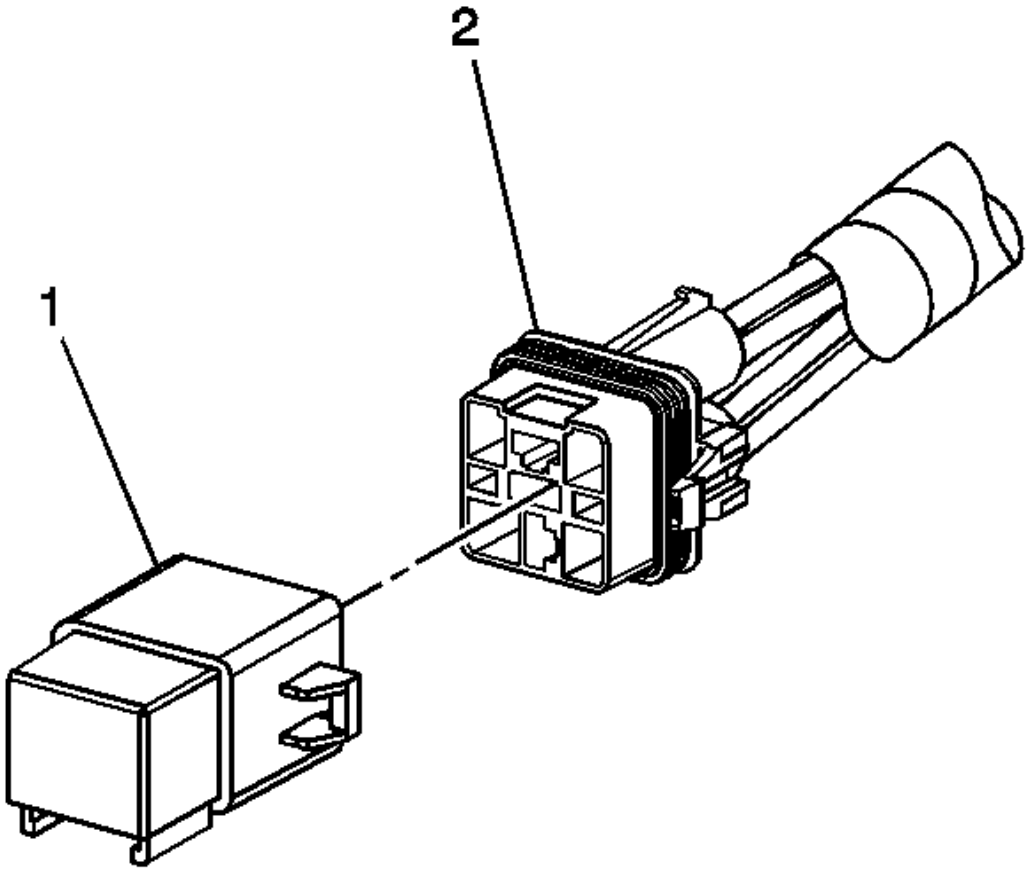


Fig. 2: Identifying Relay & Wire Harness Connector
Courtesy of GENERAL MOTORS COMPANY

1. Connect the relay (1) to the wire harness connector (2).
2. Install any connector position assurance (CPA) devices or secondary locks.
3. Install the relay using any fasteners or tape that originally held the relay in place.

RELAY REPLACEMENT (WITHIN AN ELECTRICAL CENTER)

Special Tools

EL-43244 Relay Puller Pliers

Removal Procedure

1. Remove the electrical center cover.

NOTE:

- **Always note the orientation of the relay.**
- **If equipped with a notch style relay; observe the location of the notch on the old relay to verify the new relay is installed with the notch in**

the same location.

- **Ensure that the electrical center is secure, as not to put added stress on the wires or terminals.**

2. Locate the relay. Refer to **Electrical Center Identification Views** to locate the electrical center where the relay exists.

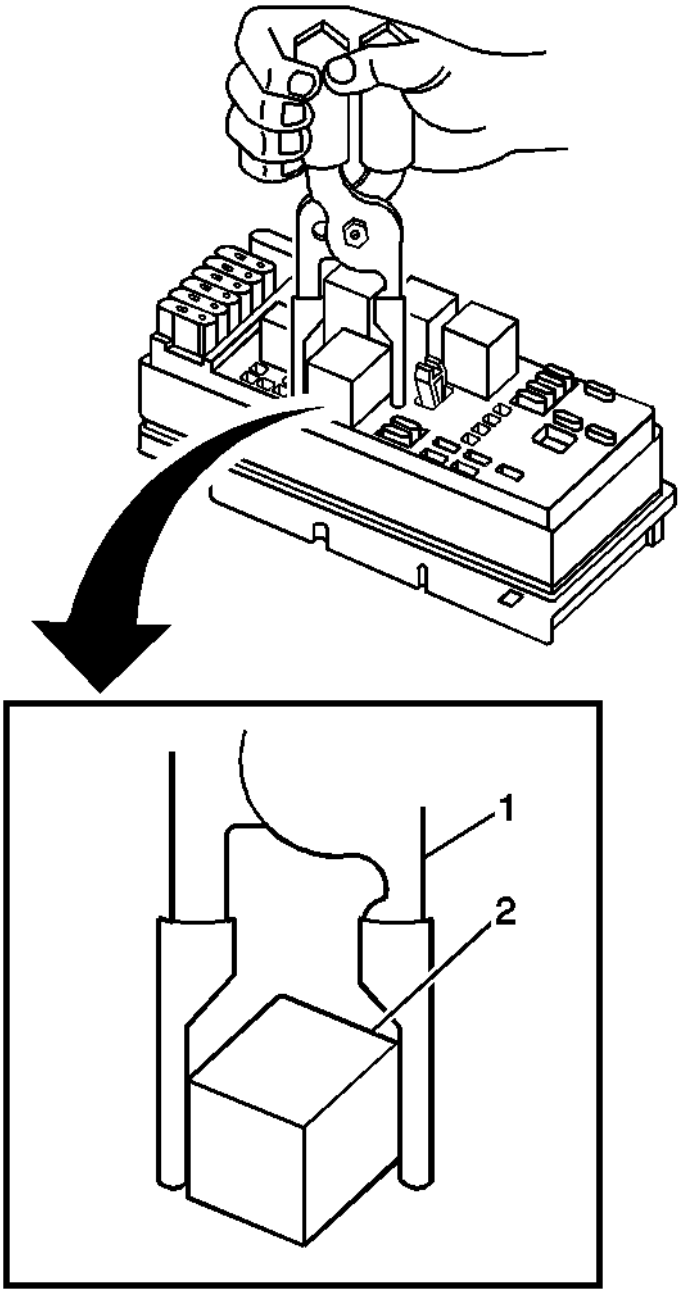


Fig. 3: Removing/Installing Relay
Courtesy of GENERAL MOTORS COMPANY

3. Using the EL-43244 (1) position the tool on opposing corners of the relay (2).

CAUTION: Use EL-43244 to pull the relay straight out from the electrical center terminals. The use of pliers or a flat bladed tool could damage the electrical center.

4. Remove the relay (2) from the electrical center.

Installation Procedure

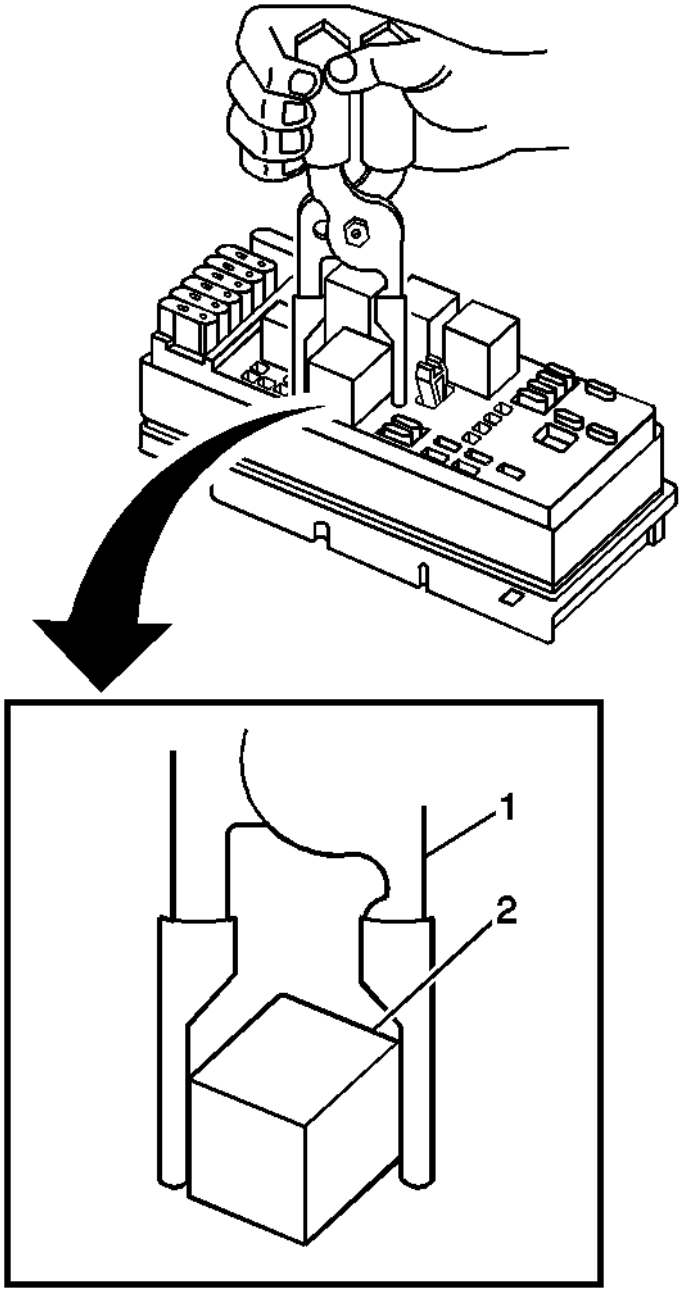


Fig. 4: Removing/Installing Relay
Courtesy of GENERAL MOTORS COMPANY

1. Install the relay (2) in the same position as removed.
2. Install the electrical center cover.

GROUND REPAIR

Electrical Grounds

Proper electrical system function relies on secure, positive, corrosion-free ground connections. Loose, stripped, or corroded connections increase the possibility of improper system function and loss of module communication. These conditions may also lead to unnecessary repairs and component replacements.

In general, electrical ground connections are accomplished using one, or a combination of, three attachment methods:

- Welded M6 stud and nut
- Welded M6 nut and bolt
- Welded M8 nut and bolt

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

Determine which attachment method is used, and carry out the appropriate repair.

M6 Weld Stud Replacement

1. Select a location adjacent the damaged or missing M6 ground stud having 20 mm (0.79 in) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the M6 rivet stud flange.
2. Using GM approved residue-free solvent or equivalent, remove any grease from the repair site and allow to dry.

   NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

3. Drill a 10 mm (0.40 in) diameter hole through the panel.
4. Carefully remove paint and primer from the area surrounding the rivet stud flange until bare metal is visible.

   CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

5. Select a replacement conductive M6 rivet stud. Refer to GM parts catalog for the correct part number and application.
6. Using a rivet stud installer, install the replacement conductive M6 rivet stud.
7. Ensure the new rivet stud is securely fastened, with no detectable movement.

   NOTE: The rivet stud and surrounding panel area must be properly refinished prior to the installation of the ground terminal and nut to maintain positive electrical grounding.

8. Completely wrap the threads of the rivet stud with painters tape or equivalent.
9. Refinish the repair area using an anti-corrosion primer.
10. Allow the refinished repair area to cure sufficiently before removing the protective material applied to the

rivet stud threads.

11. Remove the painters tape or equivalent from the rivet stud threads.
12. Using GM approved residue-free solvent or equivalent, thoroughly clean the rivet stud threads to remove any adhesive and allow to dry.
13. Carefully remove any corrosion from the electrical ground wire terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
14. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new conductive M6 rivet stud threads.
15. Install the ground terminal to the new rivet stud.
16. Select a new, conductive M6 nut. Refer to GM parts catalog for the correct part number and application.

CAUTION: Refer to Fastener Caution .

17. Install the M6 nut and tighten to 8 (71 lb in).
18. Check for proper system operation.

M6 Weld Nut

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the M6 weld nut at the electrical ground location is damaged or stripped, a new, conductive self-threading M7 bolt may be used to secure the ground terminal. Refer to GM parts catalog for the correct part number and application.
2. Using GM approved residue-free solvent or equivalent, remove any grease from the surface surrounding the weld nut and allow to dry.
3. Remove any loose metal particles from the damaged or stripped weld nut with a stiff brush.
4. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new, conductive, self-threading M7 bolt threads.
5. Carefully remove any corrosion from the electrical ground terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
6. Install the electrical ground terminal to the new, conductive M7 bolt.

CAUTION: Refer to Fastener Caution .

7. Install the M7 bolt and tighten to 9 (80 lb in).
8. Check for proper system operation.

M6 Weld Nut (Alternative Repair)

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the electrical ground location is accessible from both sides of the panel, a conductive M6 bolt and a conductive M6 nut may be used to secure the electrical ground terminal. Refer to GM parts catalog for

the correct part number and application.

2. Select a location adjacent the damaged M6 weld nut having 20 mm (0.79) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the new electrical ground site.
3. Using GM approved residue-free solvent or equivalent, remove any grease from the surface surrounding the ground location and allow to dry.

NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

4. Drill a 10 mm (0.40 in) diameter hole through the panel.
5. Carefully remove paint and primer from the area surrounding the new ground site until bare metal is visible.
6. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new, conductive M6 bolt threads.
7. Carefully remove any corrosion from the electrical ground terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
8. Install the electrical ground terminal and new, conductive M6 bolt to the ground location.

CAUTION: Refer to Fastener Caution .

9. Install the conductive M6 nut and tighten to 8 (71 lb in).

NOTE: The repair area must be properly refinished to maintain positive electrical grounding.

10. Refinish the repair area using an anti-corrosion primer.
11. Check for proper system operation.

M8 Weld Nut

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the M8 weld nut electrical ground location is accessible from both sides of the panel, a conductive M8 bolt and a conductive M8 nut may be used to secure the ground terminal. Refer to GM parts catalog for the correct part numbers and application.
2. Select a location adjacent to M8 weld nut having 20 mm (0.79 in) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the new electrical ground site.
3. Using GM approved residue-free solvent or equivalent, remove any grease from the surface surrounding the ground location and allow to dry.

NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

4. Drill a 10 mm (0.40 in) diameter hole through the panel.
5. Carefully remove paint and primer from the area surrounding the new ground site until bare metal is

visible.

6. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new, conductive M8 bolt threads.
7. Carefully remove any corrosion from the electrical ground terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
8. Install the electrical ground terminal and new, conductive M8 bolt to the ground location.

CAUTION: Refer to Fastener Caution .

9. Install the conductive M8 nut and tighten to 22 (16 lb ft).

NOTE: The repair area must be properly refinished to maintain positive electrical grounding.

10. Refinish the repair area using an anti-corrosion primer.
11. Check for proper system operation.

M8 Weld Nut (Alternative Repair)

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. If the M8 weld nut electrical ground location is not accessible from both sides of the panel, a conductive M6 rivet stud and a conductive M6 nut may be used to secure the ground terminal. Refer to GM parts catalog for the correct part numbers and application.
2. Select a location adjacent the damaged M8 weld nut having 20 mm (0.79 in) clearance behind the panel surface and 20 mm (0.79 in) clearance surrounding the new, conductive M6 rivet stud flange.
3. Using GM approved residue-free solvent or equivalent, remove any grease from the repair site and allow to dry.

NOTE: Ensure 20 mm (0.79 in) clearance is maintained behind the panel to be drilled.

4. Drill a 10 mm (0.40 in) diameter hole through the panel.
5. Carefully remove paint and primer from the area surrounding the rivet stud flange until bare metal is visible.
6. Using a rivet stud installer, install the replacement conductive M6 rivet stud.
7. Ensure the new rivet stud is securely fastened, with no detectable movement.

NOTE: The rivet stud and surrounding panel area must be properly refinished prior to the installation of the ground terminal and nut to maintain positive electrical grounding.

8. Completely wrap the threads of the rivet stud with painters tape or equivalent.
9. Refinish the repair area using an anti-corrosion primer.
10. Allow the refinished repair area to cure sufficiently before removing the protective material applied to the

rivet stud threads.

11. Remove the painters tape or equivalent from the rivet stud threads.
12. Using GM approved residue-free solvent or equivalent, thoroughly clean the rivet stud threads to remove any adhesive and allow to dry.
13. Carefully remove any corrosion from the electrical ground wire terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
14. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the new conductive M6 rivet stud threads.
15. Install the ground terminal to the new, conductive M6 rivet stud.

CAUTION: Refer to Fastener Caution .

16. Install the conductive M6 nut and tighten to 8 (71 lb in).
17. Check for proper system operation.

Securing Loose Electrical Ground Connections

If the electrical ground connection is loose and the ground attachments are not damaged, properly securing the loose electrical ground may be all that is necessary. Carry out the following procedure to secure loose electrical ground connections.

CAUTION: Use GM approved replacement fasteners with conductive finish for electrical ground repair.

1. Using GM approved residue-free solvent or equivalent, thoroughly clean the ground stud threads and allow to dry.
2. Carefully remove any corrosion from the electrical ground wire terminal. Refer to **Testing for Intermittent Conditions and Poor Connections** .
3. Using a small brush, apply Dielectric Lubricant GM P/N 12377900 (Canadian P/N 10953529) to the ground stud threads.
4. Install the ground wire terminal to the ground stud.

CAUTION: Refer to Fastener Caution .

5. Install the ground stud nut.
   - M6 ground stud nut: Tighten to 9 (80 lb in)
   - M8 ground stud nut: Tighten to 22 (16 lb ft)
   - M10 ground stud nut: Tighten to 45 (33 lb ft)
6. Check for proper system operation.

FRONT COMPARTMENT FUSE BLOCK FUSE REPLACEMENT (MIDI-FUSE)

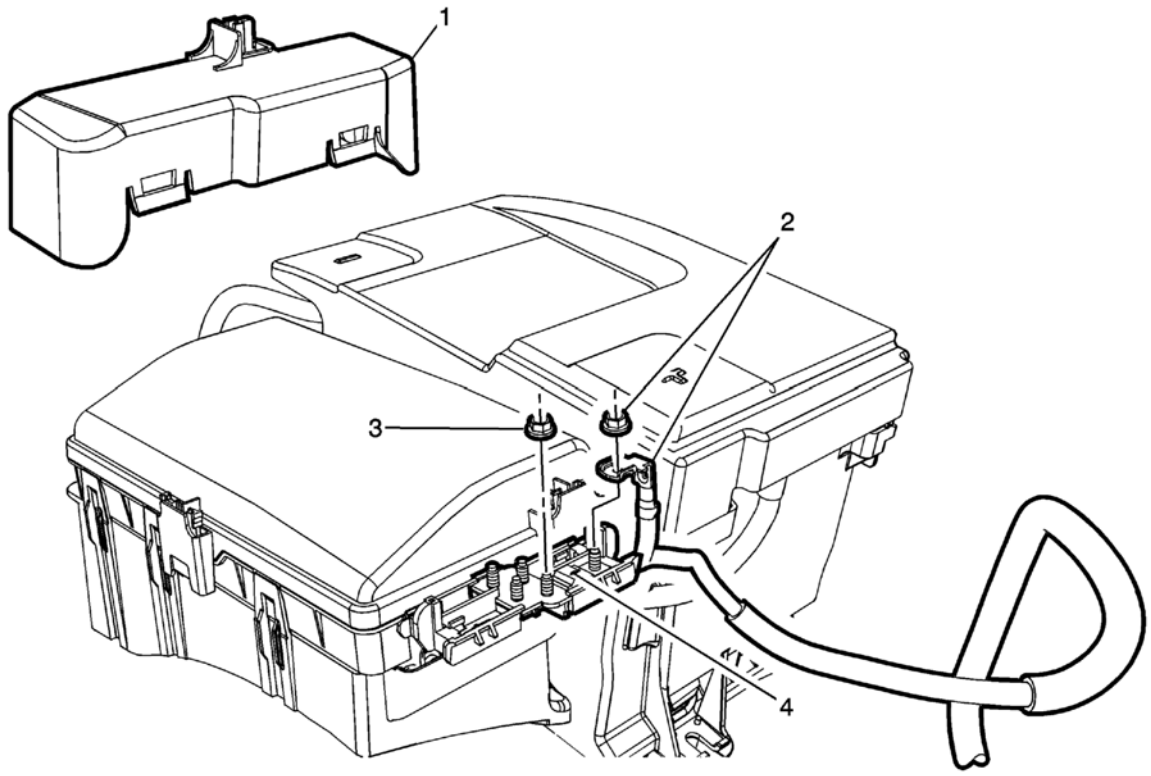


Fig. 5: Front Compartment Fuse Block Fuse (MIDI-Fuse)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection** .	
1	Fuse Block Fuse Cover
2	Battery Positive Cable and Nut **CAUTION:** **Refer to** **Fastener Caution** . **Procedure** Disconnect the battery positive cable(s) from the fuse. **Tighten** 4.7 (42 lb in)
3	Fuse Block Fuse Holder Nut - MIDI-Fuse **Tighten** 4.7 (42 lb in)
4	Fuse Block Fuse - MIDI-Fuse

INSTRUMENT PANEL ELECTRICAL CENTER OR JUNCTION BLOCK REPLACEMENT - RIGHT

SIDE (IMPALA LIMITED)

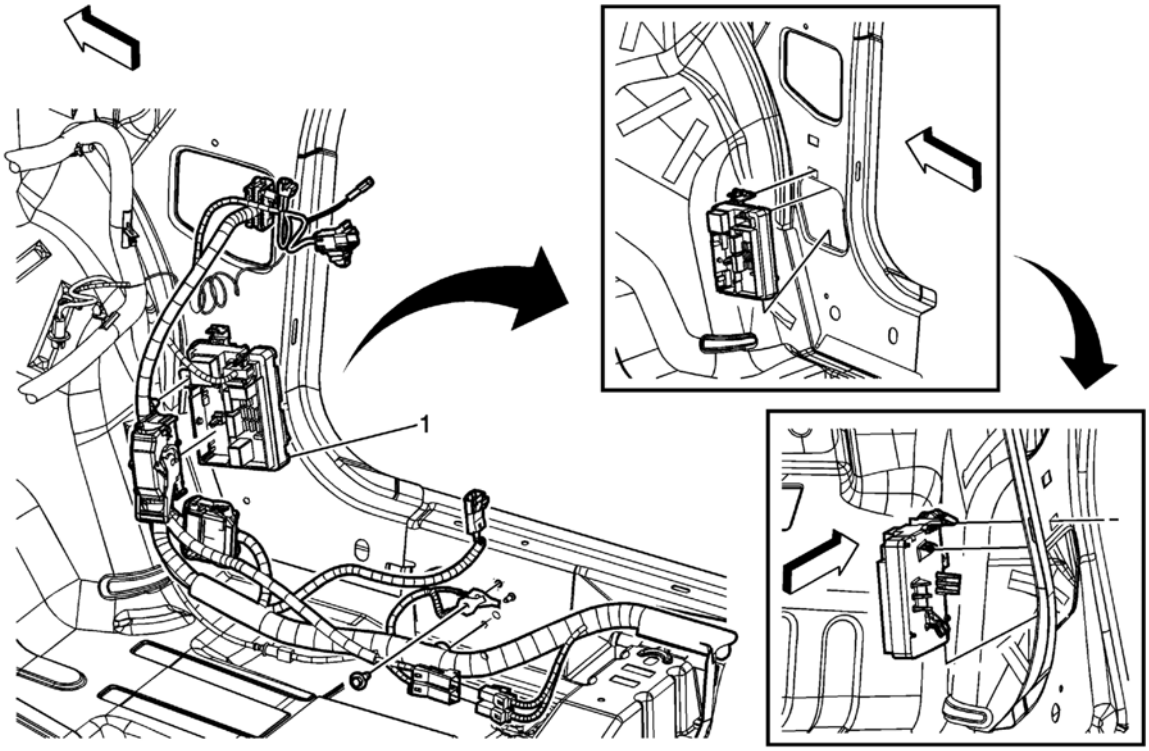


Fig. 6: Exploded View Of Junction Block - Right Side (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications** . **Preliminary Procedure** Remove right side carpet retainer. Refer to **Front Side Door Opening Floor Carpet Retainer Replacement (Impala Limited)** .	
1	Body and I/P Wiring Harness Junction Block 1. Pull back carpet to reveal junction block. 2. Press release tab to pull block out.

ACCESSORY WIRING JUNCTION BLOCK REPLACEMENT

Removal Procedure

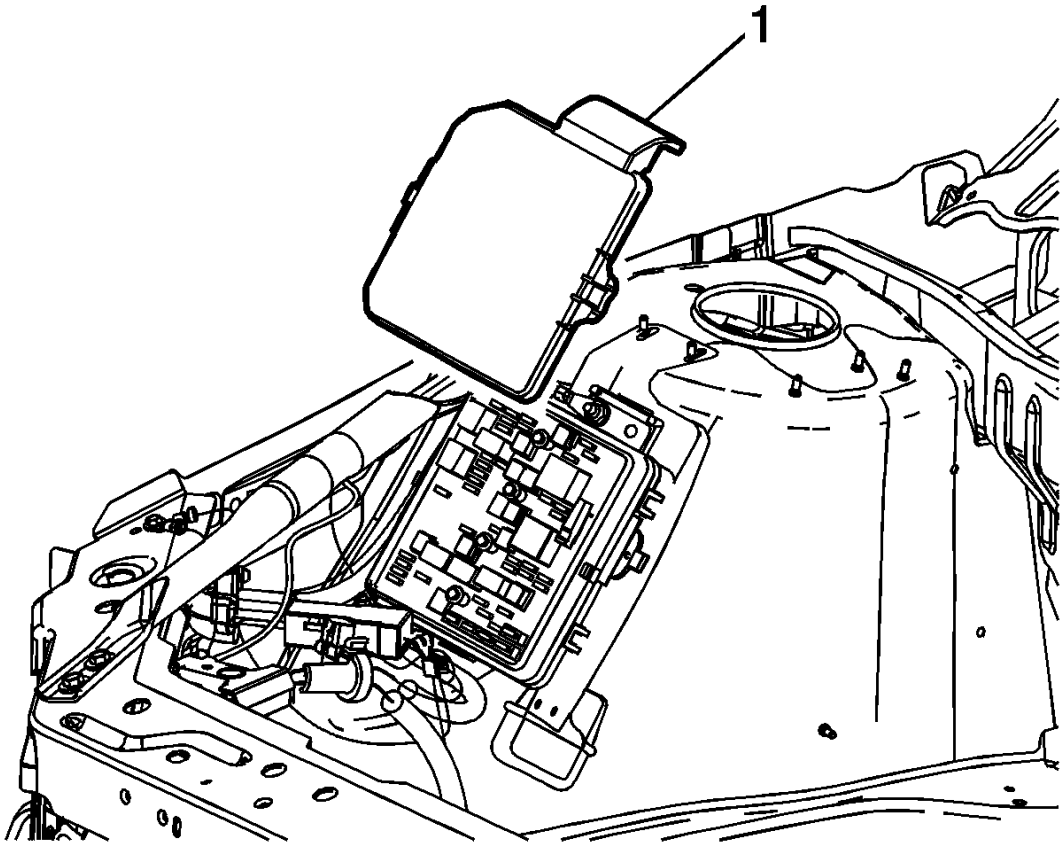


Fig. 7: Identifying Electrical Center Cover
Courtesy of GENERAL MOTORS COMPANY

1. Remove the electrical center cover (1).
2. Disconnect the positive battery cable from junction box. Refer to **Battery Positive and Negative Cable Replacement** .

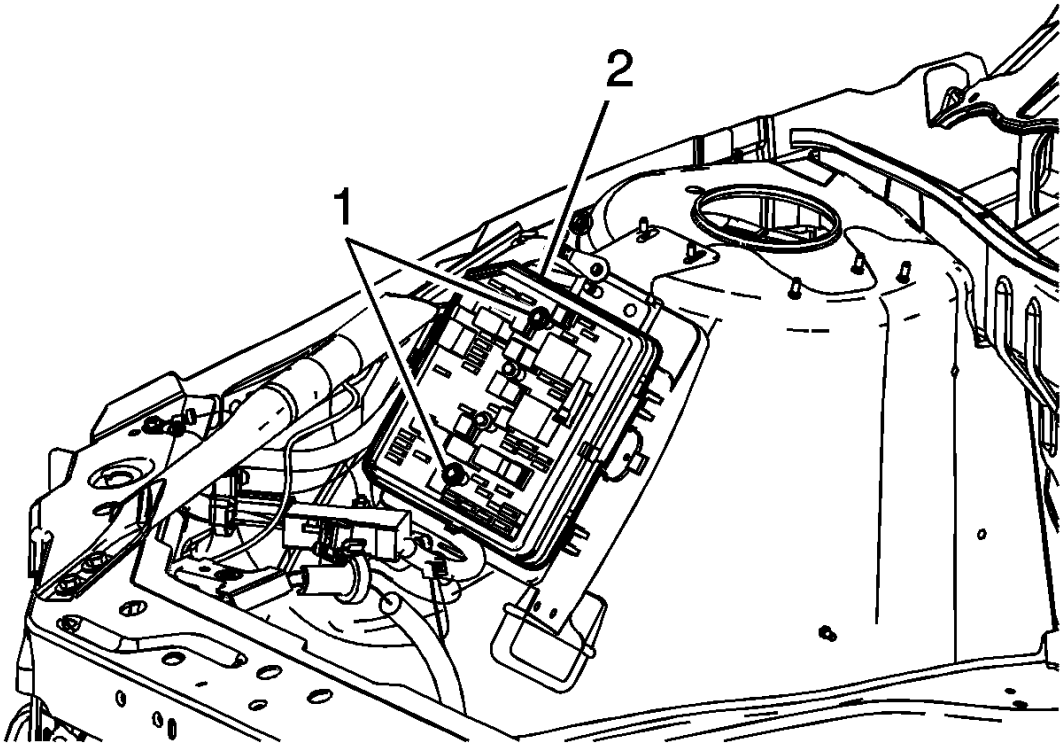


Fig. 8: Identifying Fasteners & Electrical Center Board
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fasteners (1) securing the electrical center board (2).
4. Unlock the tabs on the electrical center board.
5. Lift up on the electrical center board.

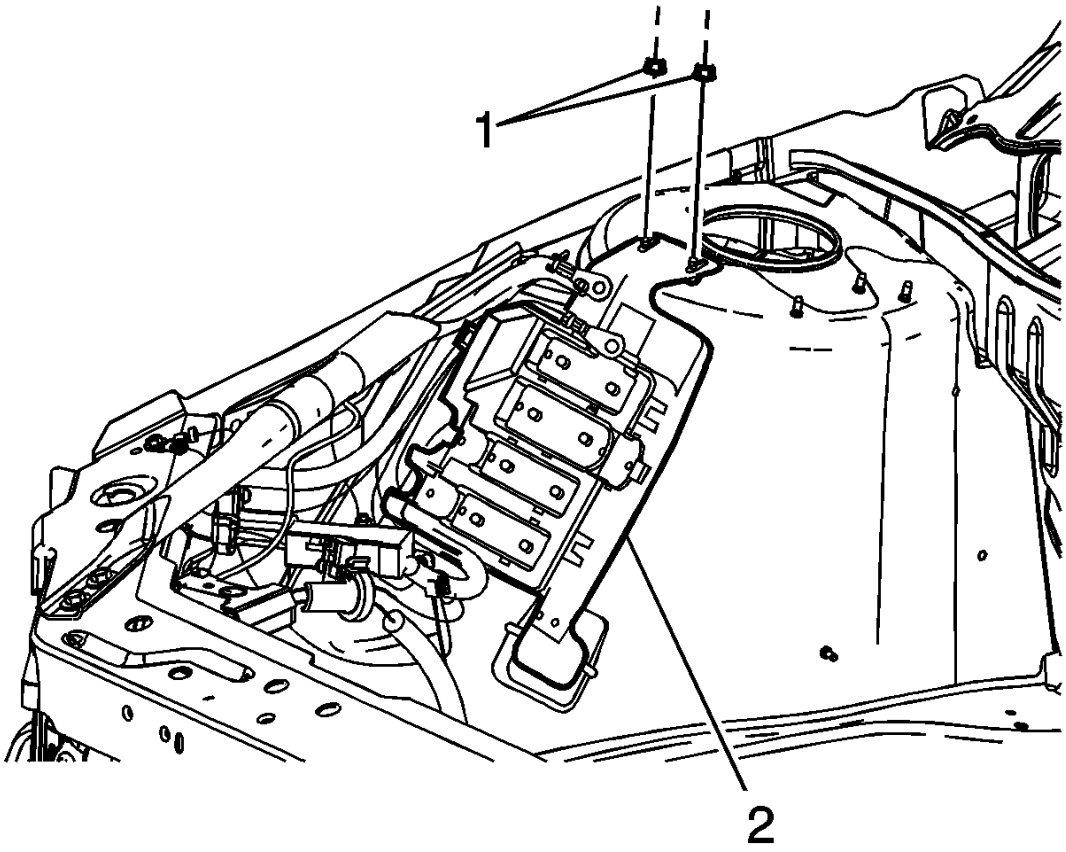


Fig. 9: Identifying Fasteners & Electrical Center Bracket
Courtesy of GENERAL MOTORS COMPANY

6. Remove the fasteners (1) securing the electrical center bracket (2) to vehicle.

Installation Procedure

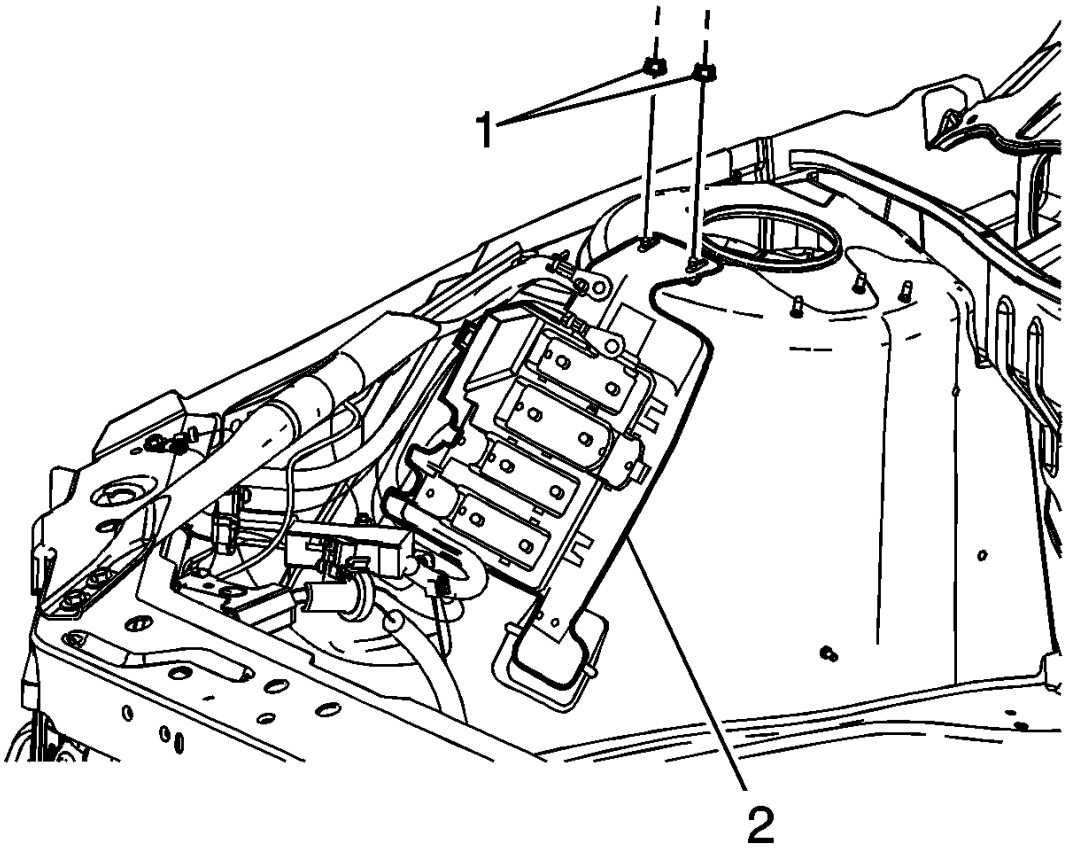


Fig. 10: Identifying Fasteners & Electrical Center Bracket
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install fasteners (1) securing the electrical center (2) to vehicle.

   Tighten

   Tighten the fasteners to 10 N.m (86 lb in).

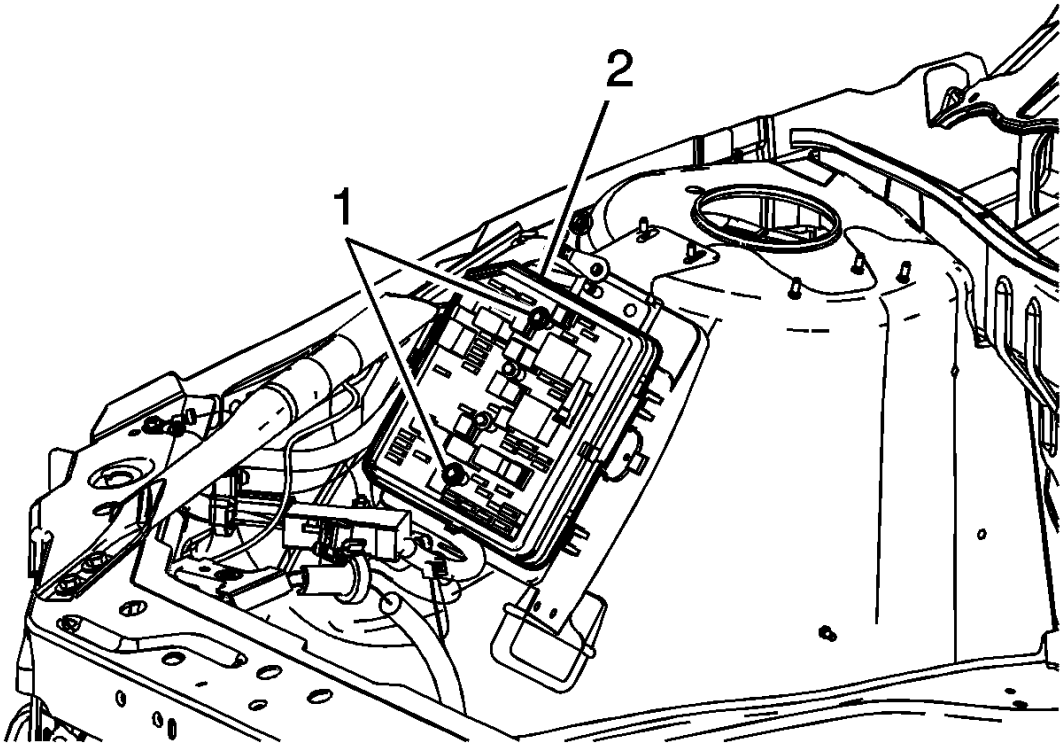


Fig. 11: Identifying Fasteners & Electrical Center Board
Courtesy of GENERAL MOTORS COMPANY

2. Install the fasteners (1) securing the electrical center board (2).

   Tighten

   Tighten the fasteners to 7 N.m (62 lb in).

3. Connect the positive battery cable. Refer to **Battery Positive and Negative Cable Replacement** .

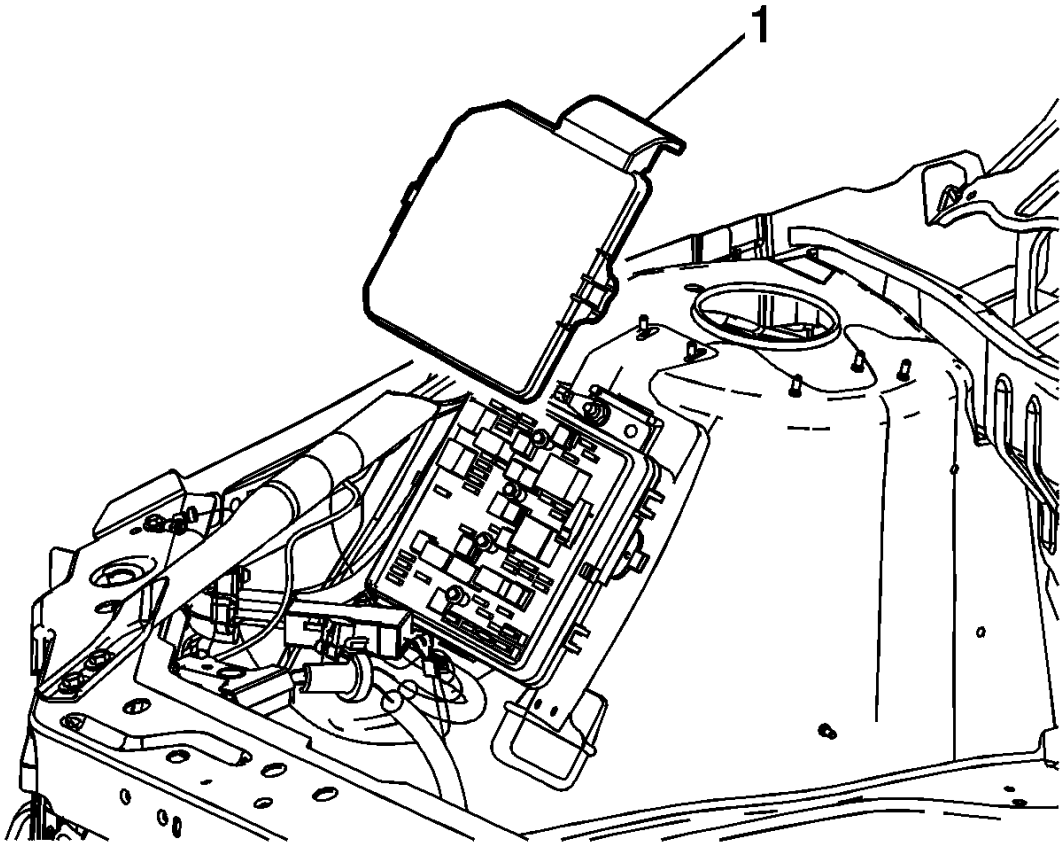


Fig. 12: Identifying Electrical Center Cover
Courtesy of GENERAL MOTORS COMPANY

4. Install the electrical center cover (1).

IGNITION LOCK CYLINDER REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

WARNING: Refer to SIR Warning .

2. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
3. Remove the tilt lever. Refer to **Steering Column Tilt Wheel Release Lever Replacement** .
4. Remove the steering wheel. Refer to **Steering Wheel Replacement** .
5. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement** .
6. Rotate the ignition lock cylinder to the crank position.

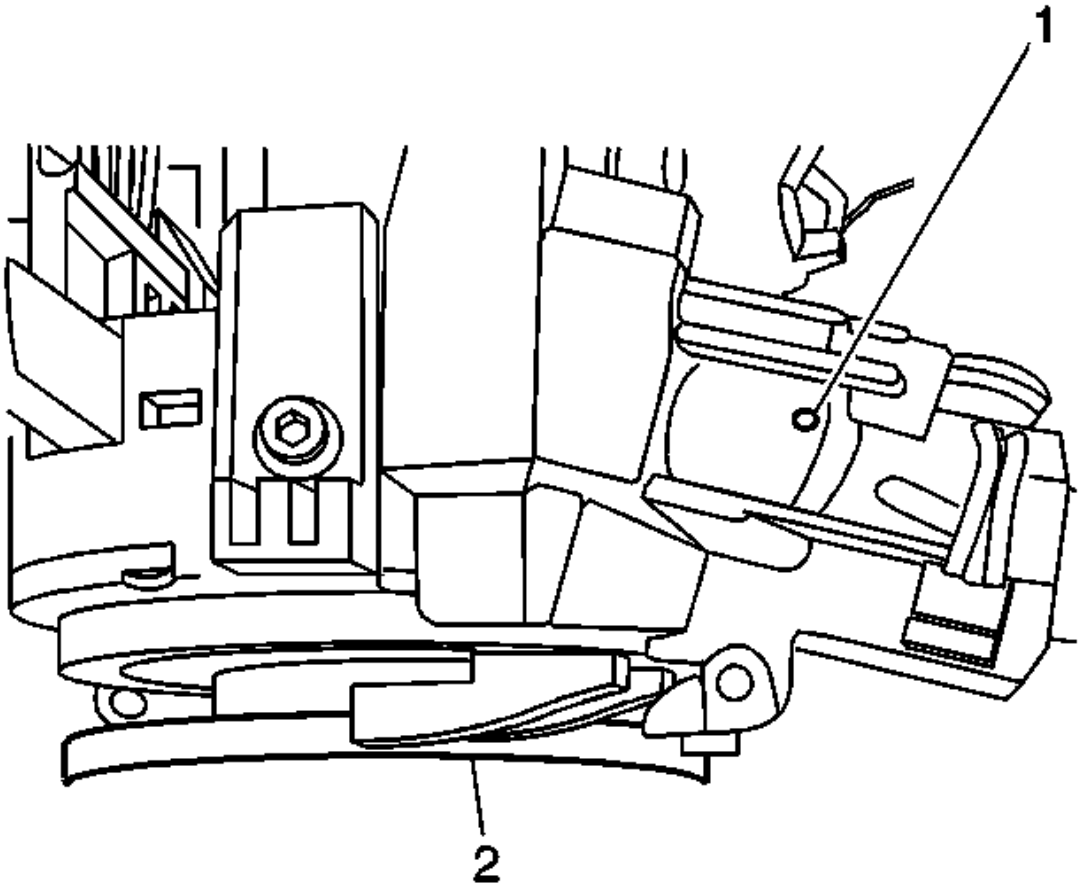


Fig. 13: Locating Ignition Lock Cylinder Release Access Hole
Courtesy of GENERAL MOTORS COMPANY

7. Use a suitable tool in order to push down and hold the lock cylinder retaining pin through the access hole (1) in the ignition lock cylinder case .
8. Release the ignition lock cylinder to the run position.

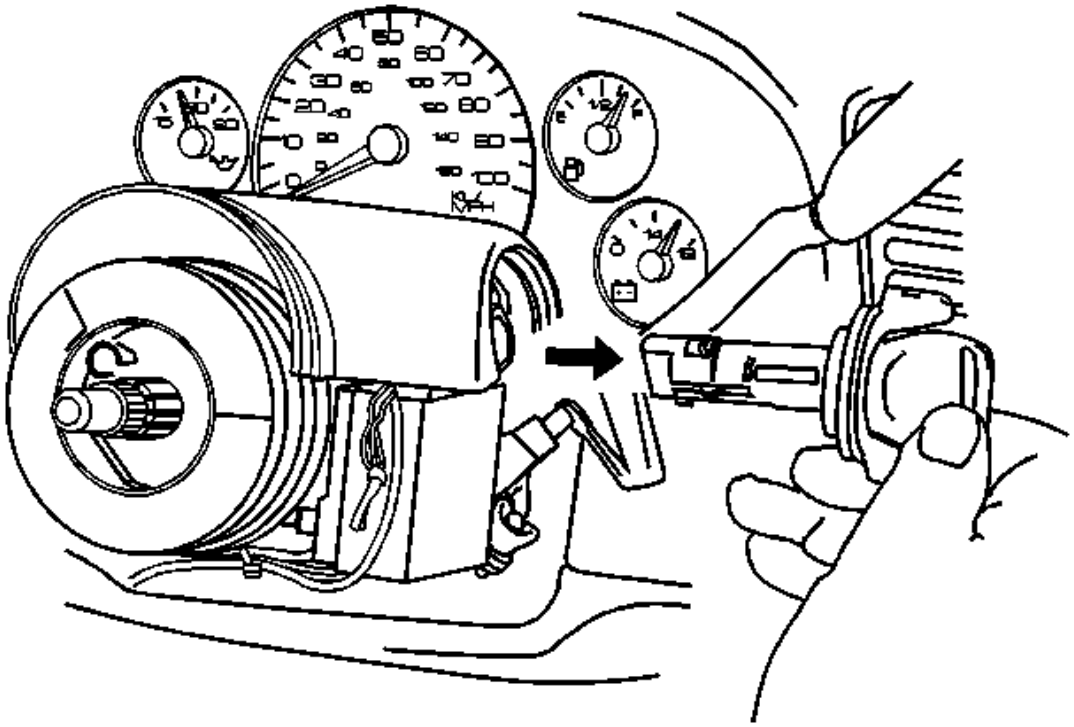


Fig. 14: View of Ignition Lock Cylinder, Ignition Lock Cylinder Case Assembly, and Steering Column

Courtesy of GENERAL MOTORS COMPANY

9. Remove the ignition lock cylinder from the steering column.

Installation Procedure

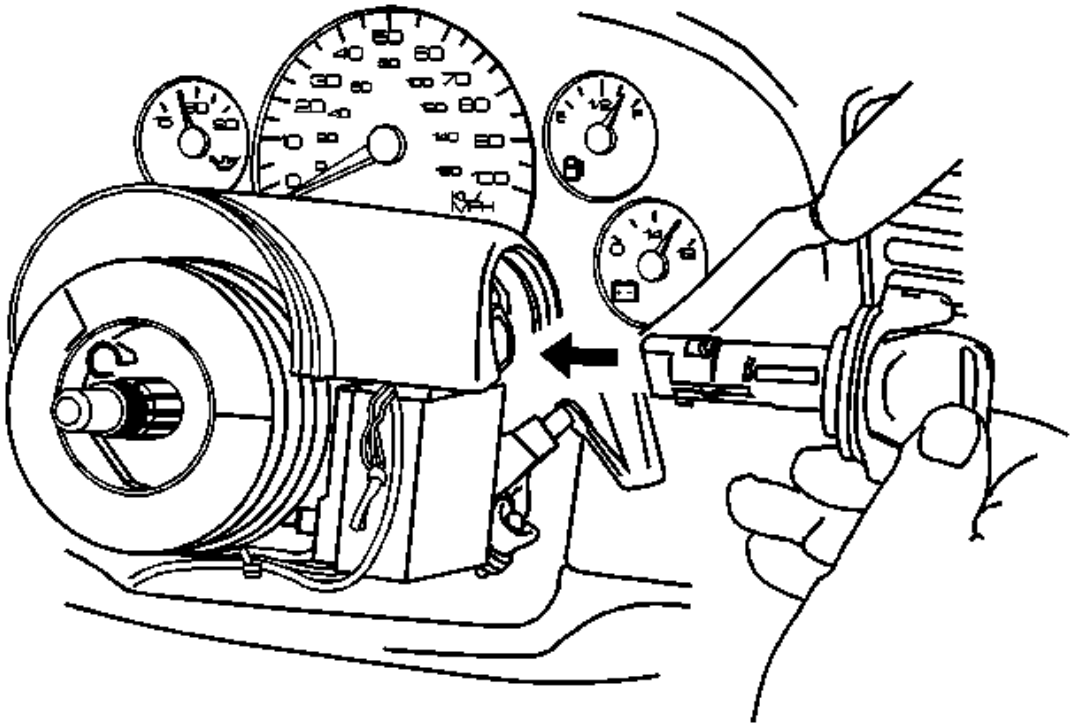


Fig. 15: View of Ignition Cylinder Lock, Ignition Lock Cylinder Case Assembly and Upper Steering Column

Courtesy of GENERAL MOTORS COMPANY

1. Align the lock cylinder retaining pin with the access hole in the ignition lock cylinder case.
2. Push the ignition lock cylinder into the ignition lock cylinder case. Ensure the lock cylinder retaining pin engages the access hole.
3. Install the steering column trim covers. Refer to **Steering Column Trim Cover Replacement** .
4. Install the steering wheel. Refer to **Steering Wheel Replacement** .
5. Install the tilt lever. Refer to **Steering Column Tilt Wheel Release Lever Replacement** .
6. Enable the SIR system. Refer to **SIR Disabling and Enabling** .
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

IGNITION AND START SWITCH REPLACEMENT

Removal Procedure

WARNING: Refer to SIR Warning .

1. Disable the SIR system **SIR Disabling and Enabling** .
2. Remove the upper and lower trim covers. Refer to **Steering Column Trim Cover Replacement** .
3. Remove the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement**.

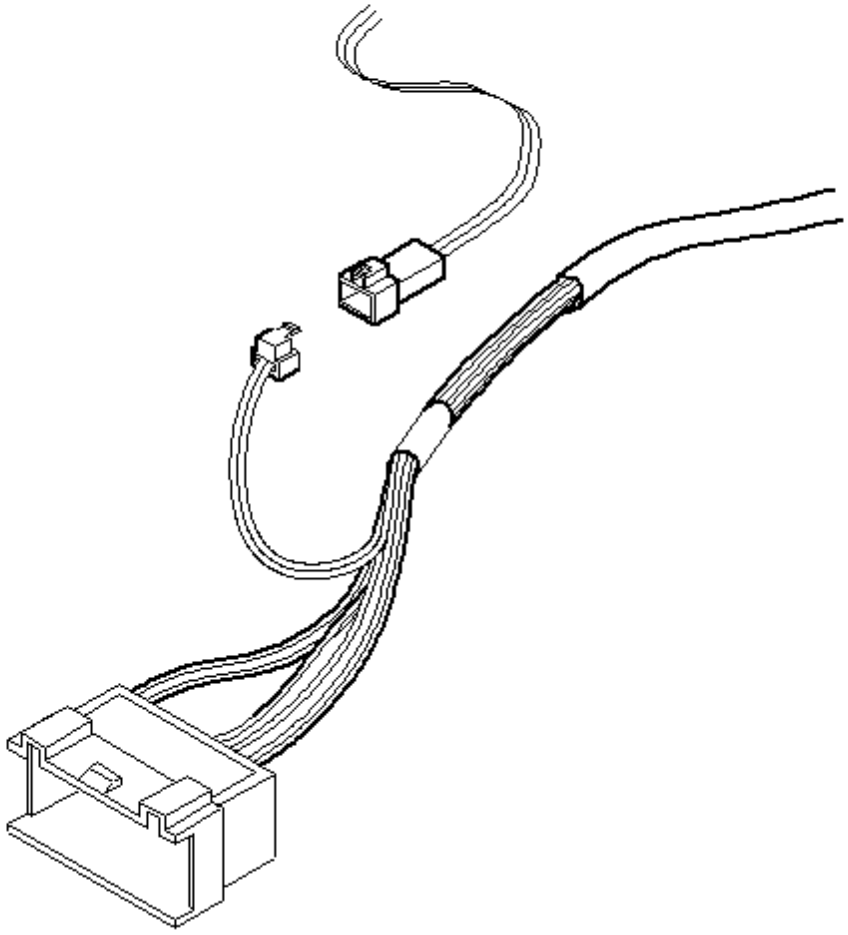


Fig. 16: Theft Deterrent Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the theft deterrent control module connector.
5. Disconnect the fused jumper assembly connector.

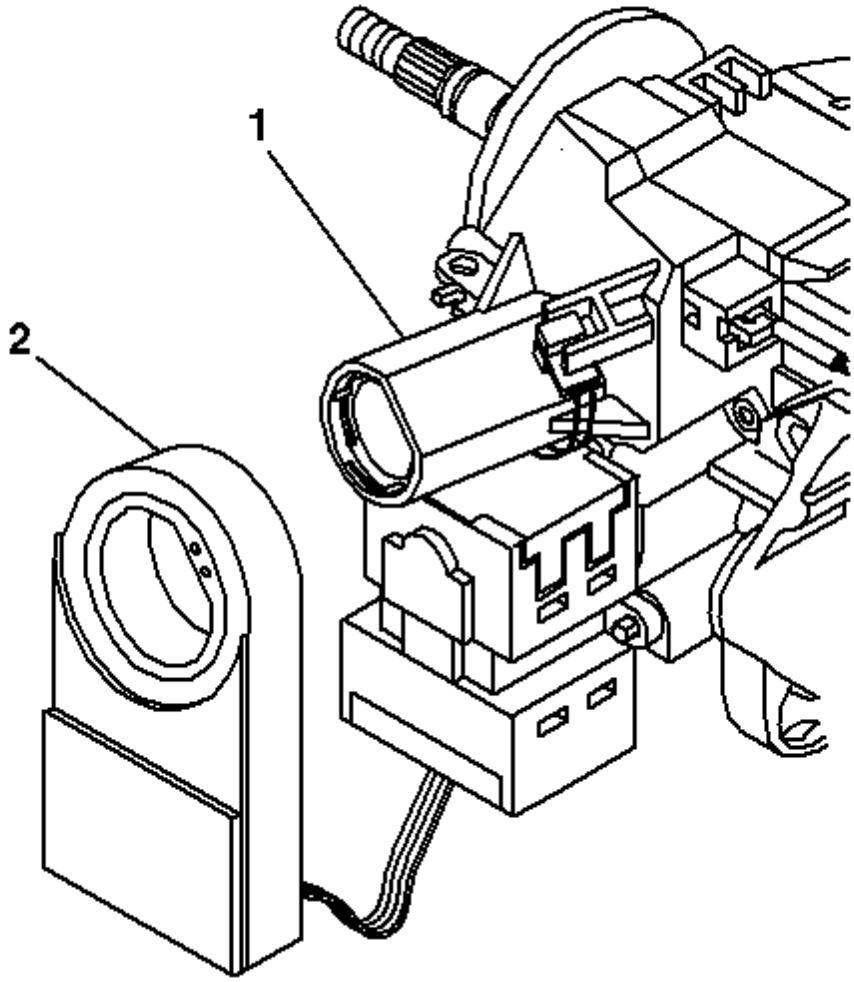


Fig. 17: Locating Theft Deterrent Module & Ignition Lock Cylinder Case Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Slide the theft deterrent control module (2) from the ignition lock cylinder case (1).

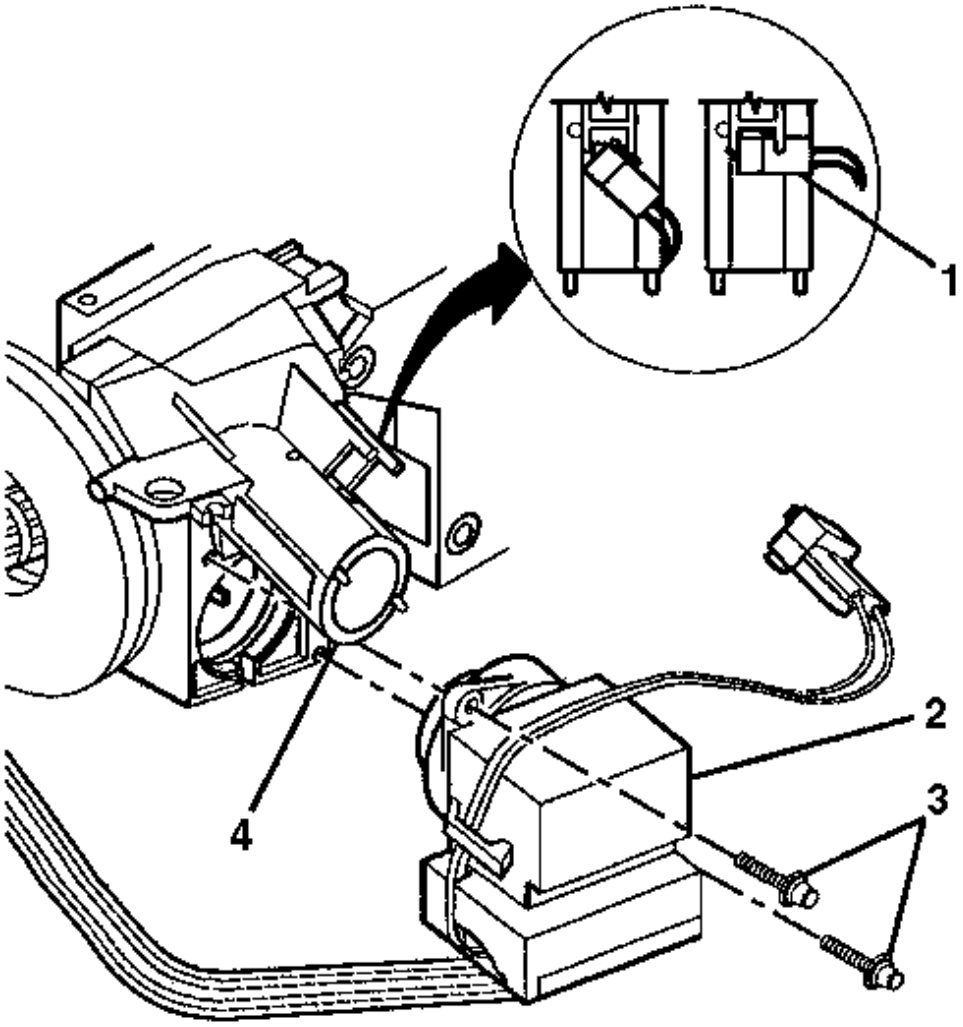


Fig. 18: Key Alarm Connector To/From Ignition Lock Cylinder Case
Courtesy of GENERAL MOTORS COMPANY

7. Remove the key alarm connector (1) from the ignition lock cylinder case (4).
8. Remove the 2 tapping screws (3) from the ignition switch assembly (2).

Installation Procedure

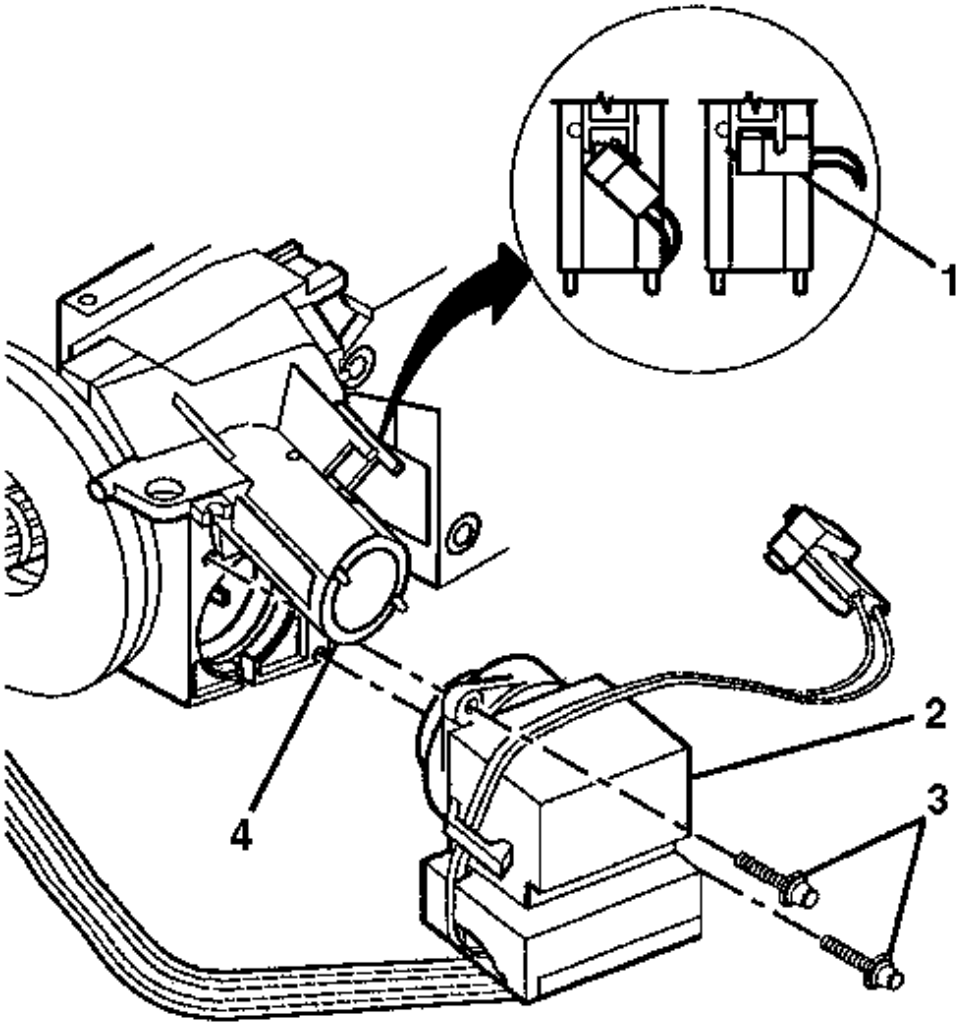


Fig. 19: Key Alarm Connector To/From Ignition Lock Cylinder Case
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the ignition switch assembly (2) and secure by using 2 tapping screws (3).

   Tighten

   Tighten the screws to 7 N.m (62 lb in).

2. Install the ignition switch assembly connector (1) onto the ignition lock cylinder case (4).

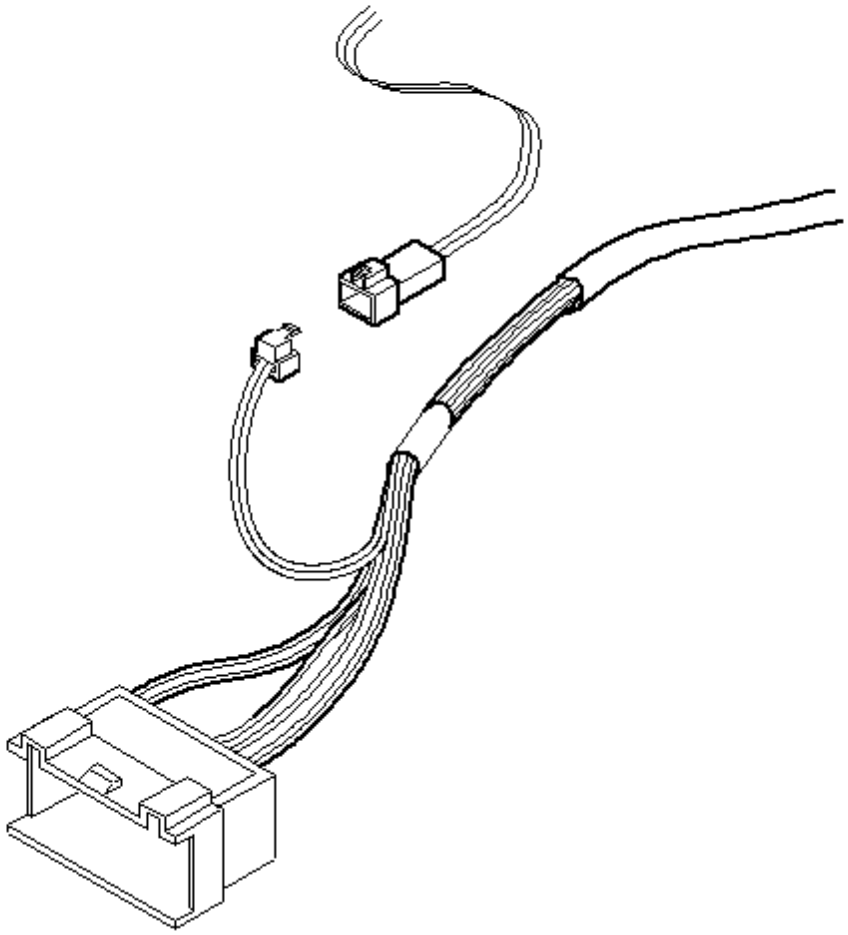


Fig. 20: Theft Deterrent Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

3. Connect the theft deterrent control module connector.
4. Connect the fused jumper assembly connector.

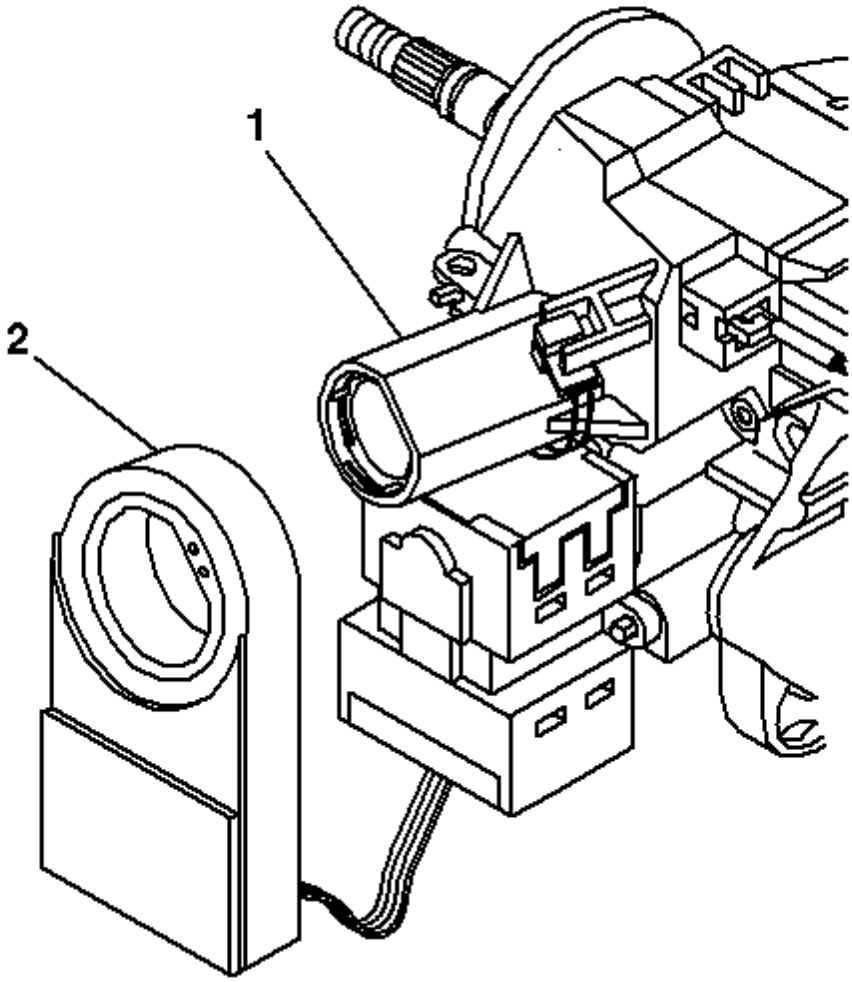


Fig. 21: Locating Theft Deterrent Module & Ignition Lock Cylinder Case Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Install the theft deterrent control module (2) onto the ignition lock cylinder case (1).
6. Install the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement**.
7. Install the upper and lower trim covers. Refer to **Steering Column Trim Cover Replacement** .
8. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

IGNITION LOCK CYLINDER CASE REPLACEMENT

Removal Procedure

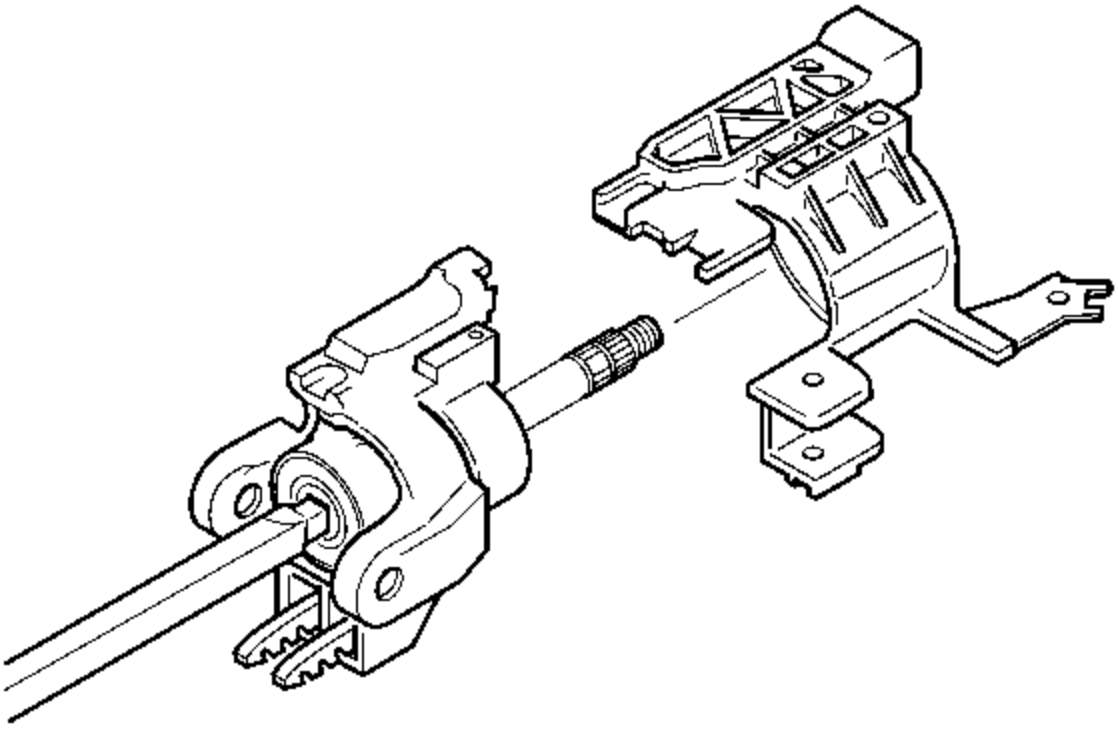


Fig. 22: View Of Turn Signal Switch Housing & Steering Column Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to SIR Warning .

1. Disable the SIR system. Refer to **SIR Disabling and Enabling** .
2. Remove the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement**.
3. Remove the ignition switch. Refer to **Ignition and Start Switch Replacement**.
4. Remove the steering column tilt head components. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement** .
5. Remove the turn signal switch housing. Refer to **Turn Signal Switch Housing Replacement** .
6. Remove the turn signal and multifunction switch assembly only. Refer to **Turn Signal Multifunction Switch Replacement** .

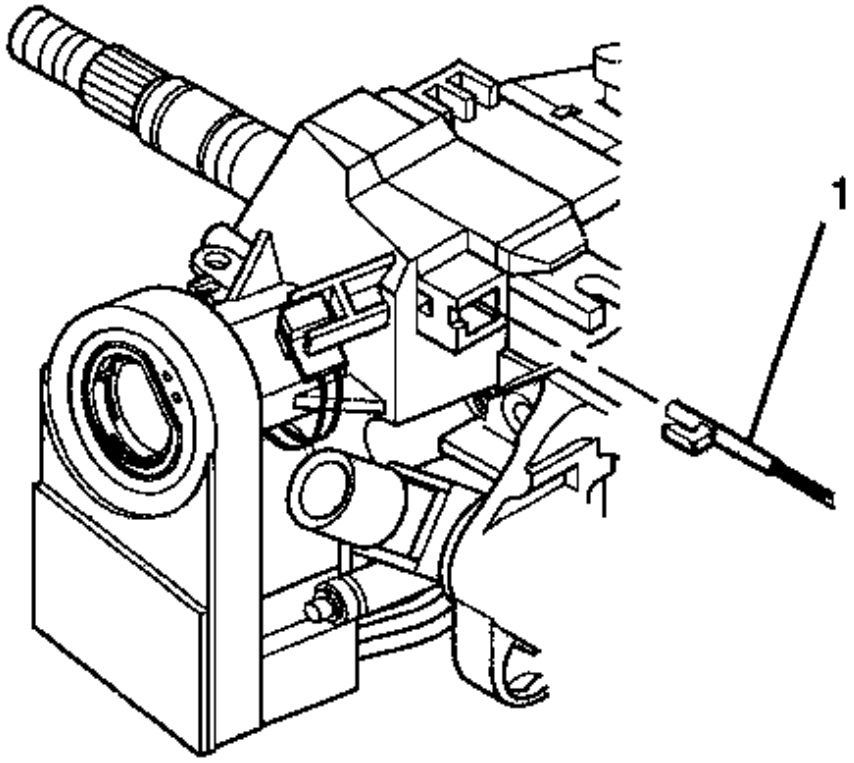


Fig. 23: Identifying Park Lock Cable At Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

7. Remove the park lock cable assembly (1) from the ignition lock cylinder case in the following way:
    1. Use a small blade to push against the locking tab on the end of the park lock cable assembly (1).
    2. Disconnect the park lock cable assembly (1) from the ignition lock cylinder case.

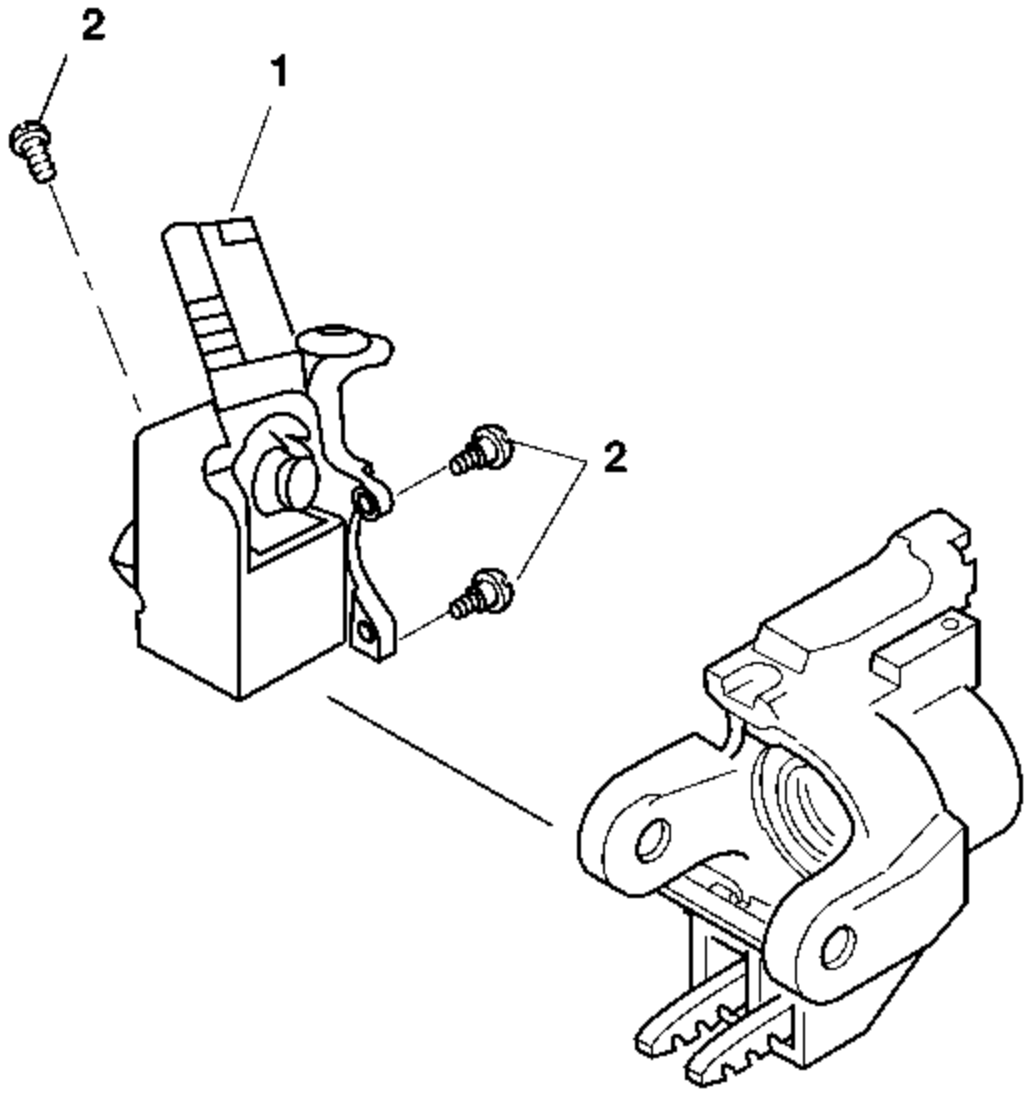


Fig. 24: View Of Ignition Lock Cylinder Case Assembly & Screws
Courtesy of GENERAL MOTORS COMPANY

8. Remove the 3 TORXÂ® screws (2) from the ignition lock cylinder case (1).
9. Remove the ignition lock cylinder case (1) from the steering column tilt head assembly.

Installation Procedure

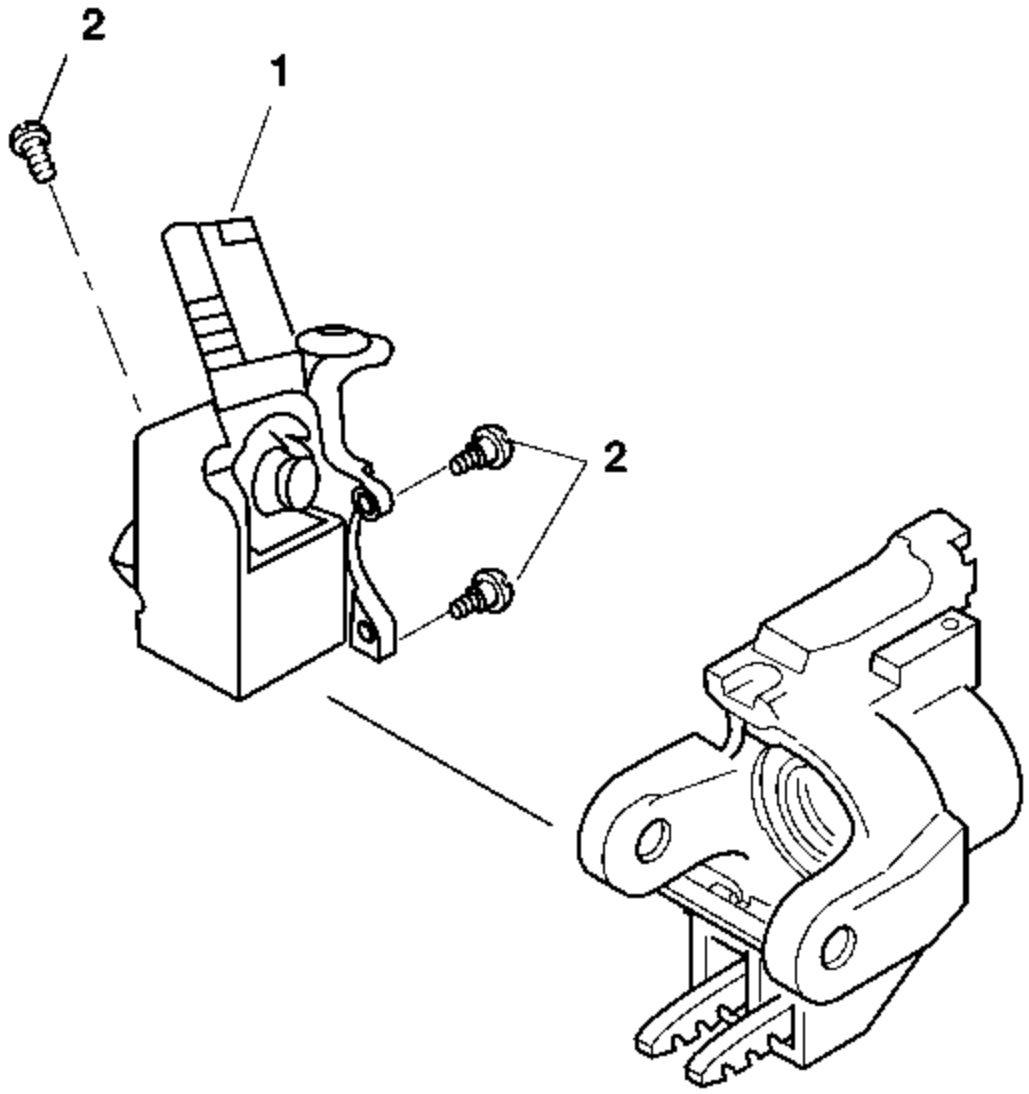


Fig. 25: View Of Ignition Lock Cylinder Case Assembly & Screws
Courtesy of GENERAL MOTORS COMPANY

1. Align the ignition lock cylinder case (1) with the steering column tilt head assembly.

CAUTION: Refer to Fastener Caution .

2. Screw the 3 TORXÂ® screws (2) into the ignition lock cylinder case (1).

Tighten

Tighten the 3 TORXÂ® screws to 7 N.m (62 lb in).

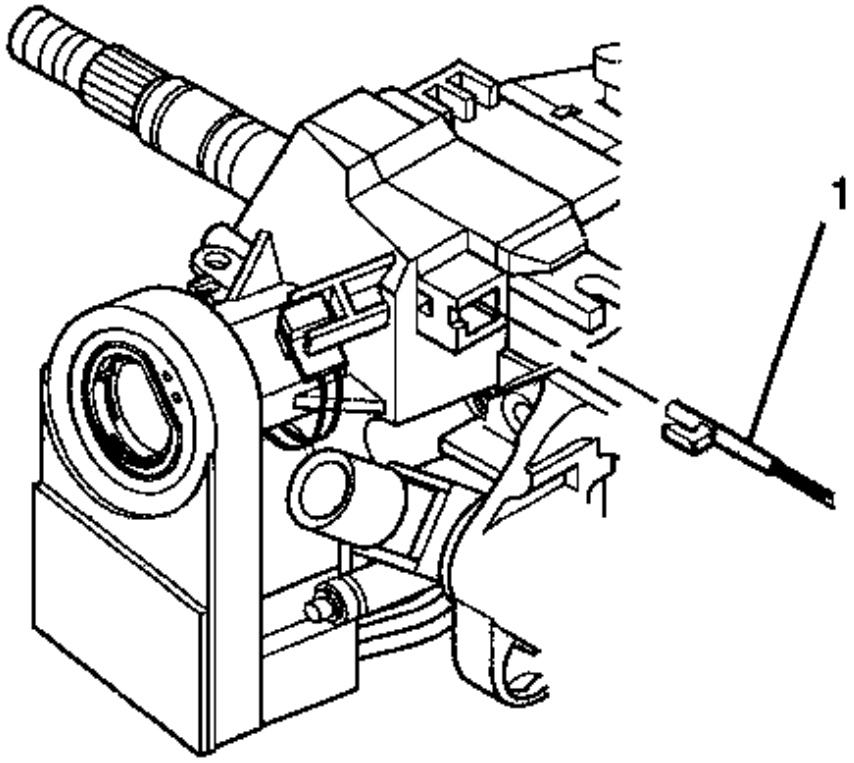


Fig. 26: Identifying Park Lock Cable At Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

3. Press the locking tab on the end of the park lock cable assembly (1) into the slot in the ignition lock cylinder case.

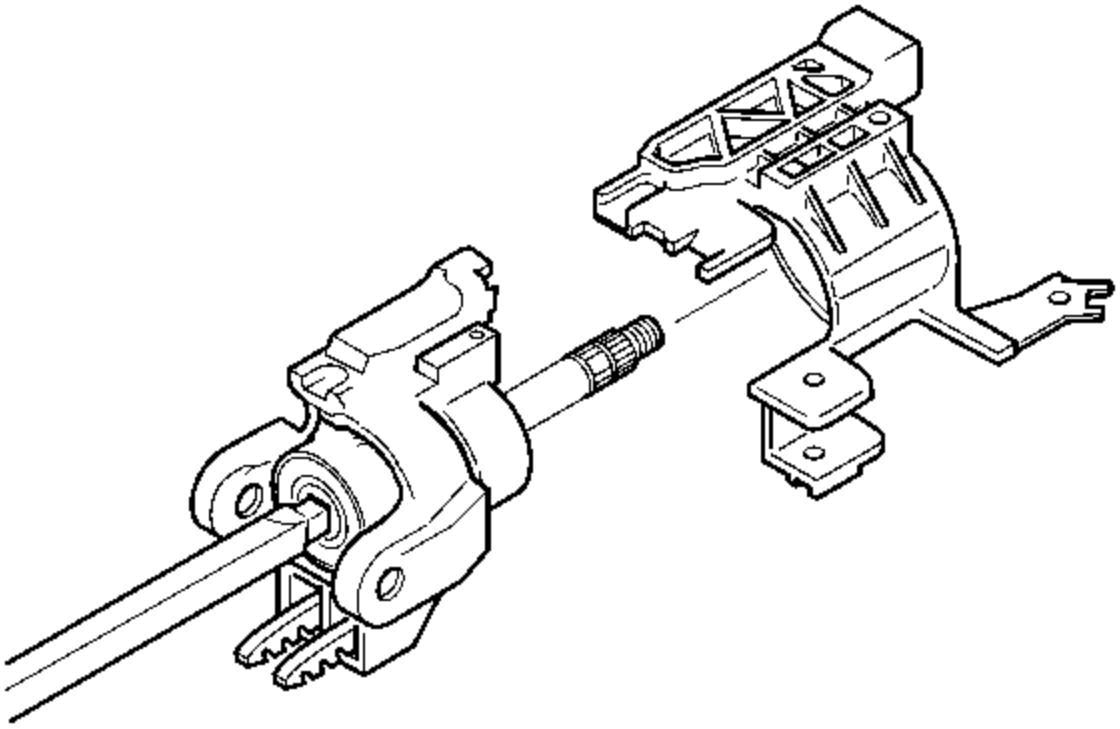


Fig. 27: View Of Turn Signal Switch Housing & Steering Column Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Press the turn signal switch housing firmly against the steering column tilt head in order for the screws from the turn signal and multifunction switch assembly to align.**

4. Install the turn signal switch housing. Refer to **Turn Signal Switch Housing Replacement** .
5. Install the turn signal and multifunction switch assembly only. Refer to **Turn Signal Multifunction Switch Replacement** .
6. Install the steering column tilt head components. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement** .
7. Install the ignition switch only. Refer to **Ignition and Start Switch Replacement**.
8. Install the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement**.
9. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

Article GUID: A00737178

WIRING HARNESS ROUTING DIAGRAMS AND SCHEMATIC WIRING DIAGRAMS

WIRING HARNESS ROUTING VIEWS

Forward Lamp Harness Routing

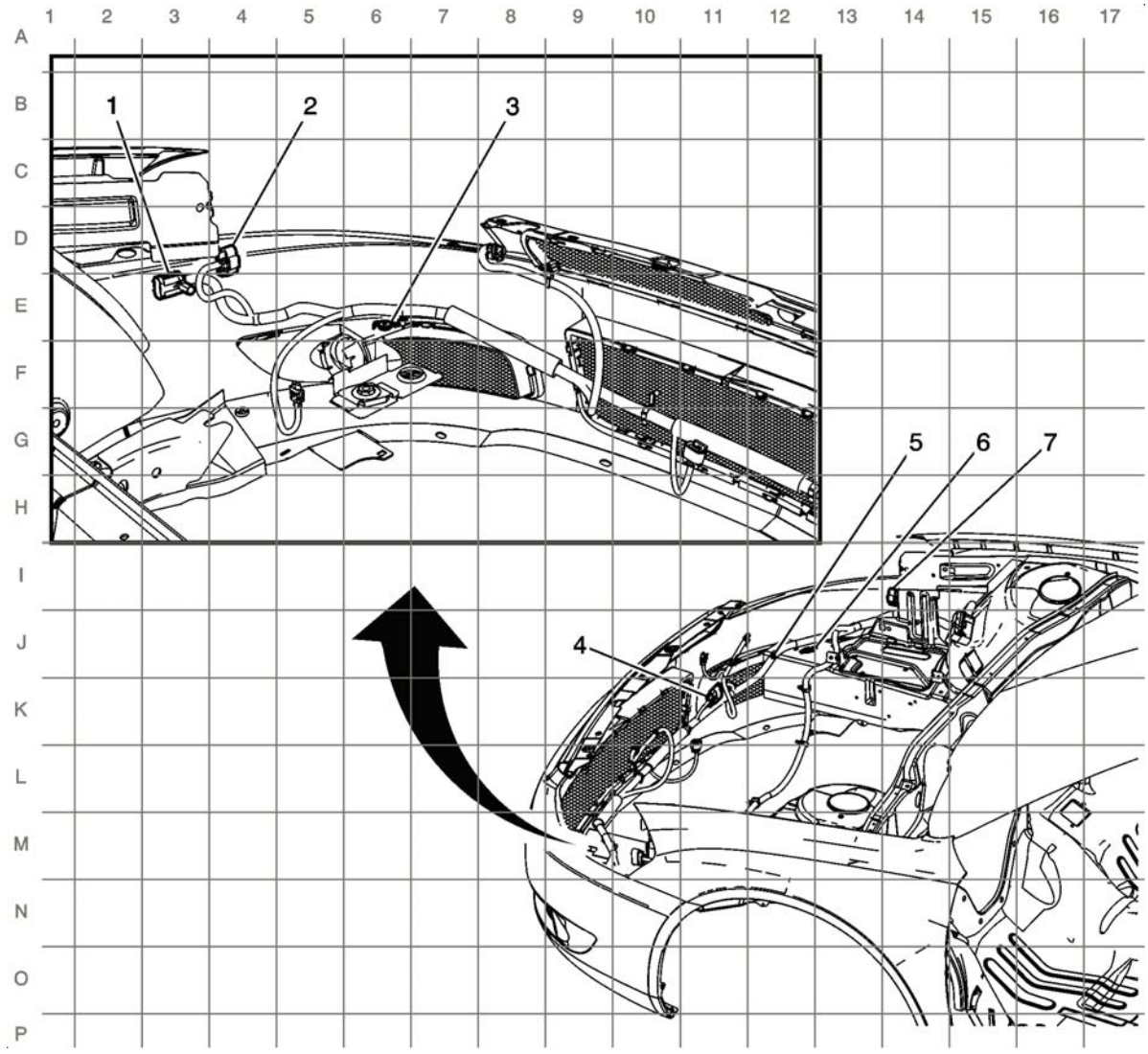


Fig. 1: Forward Lamp Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X120
2	X141
3	G101

Callout	Component Name
4	X122 (9C1 or 9C3 without 6J7)
5	J124
6	G101
7	X142

Engine Harness Routing - Right Front

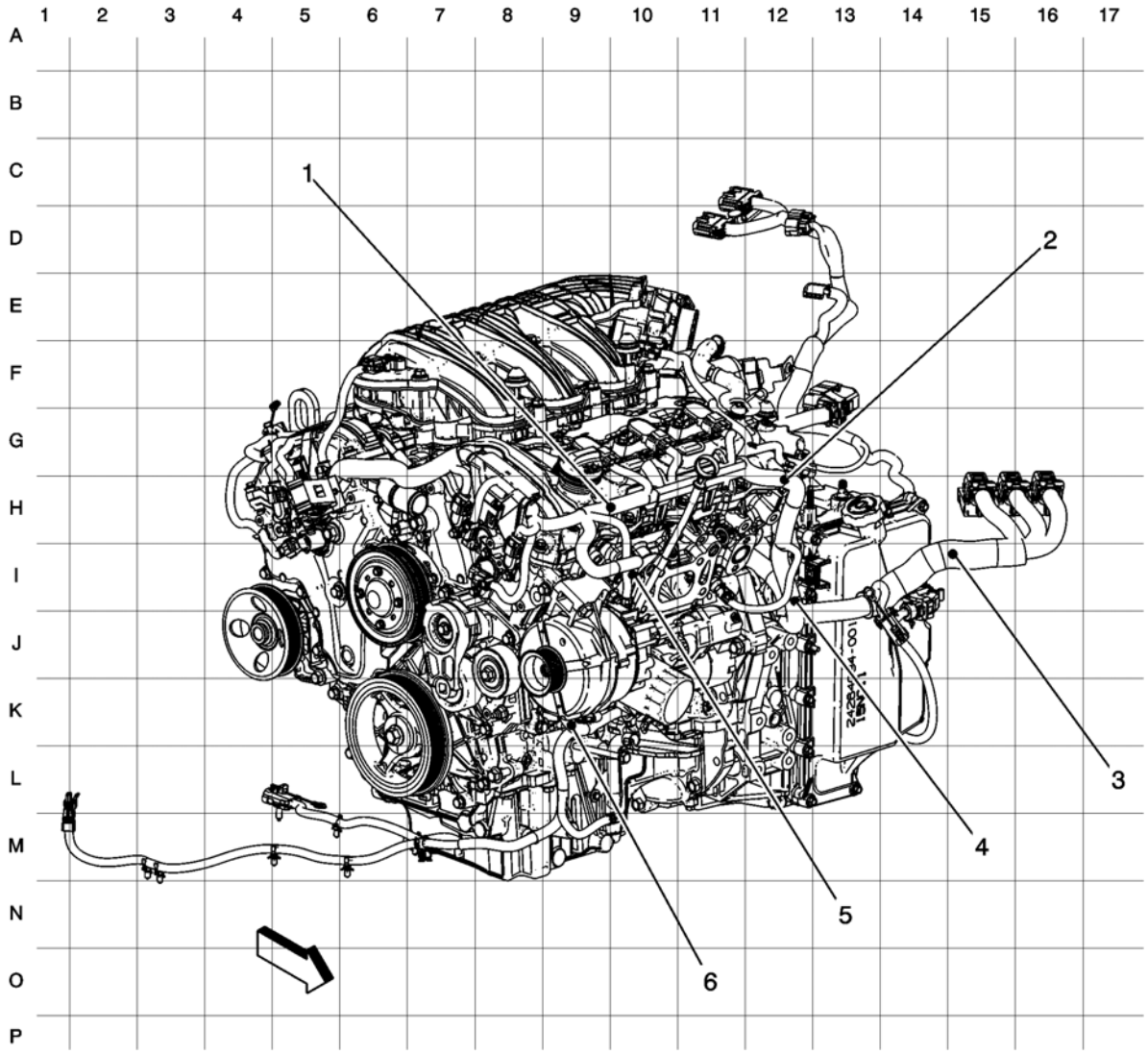


Fig. 2: Engine Harness Routing Diagram -- Right Front
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	J164
2	J165
3	J102
4	J101
5	J100
6	J103

Engine Harness Routing - Left Rear

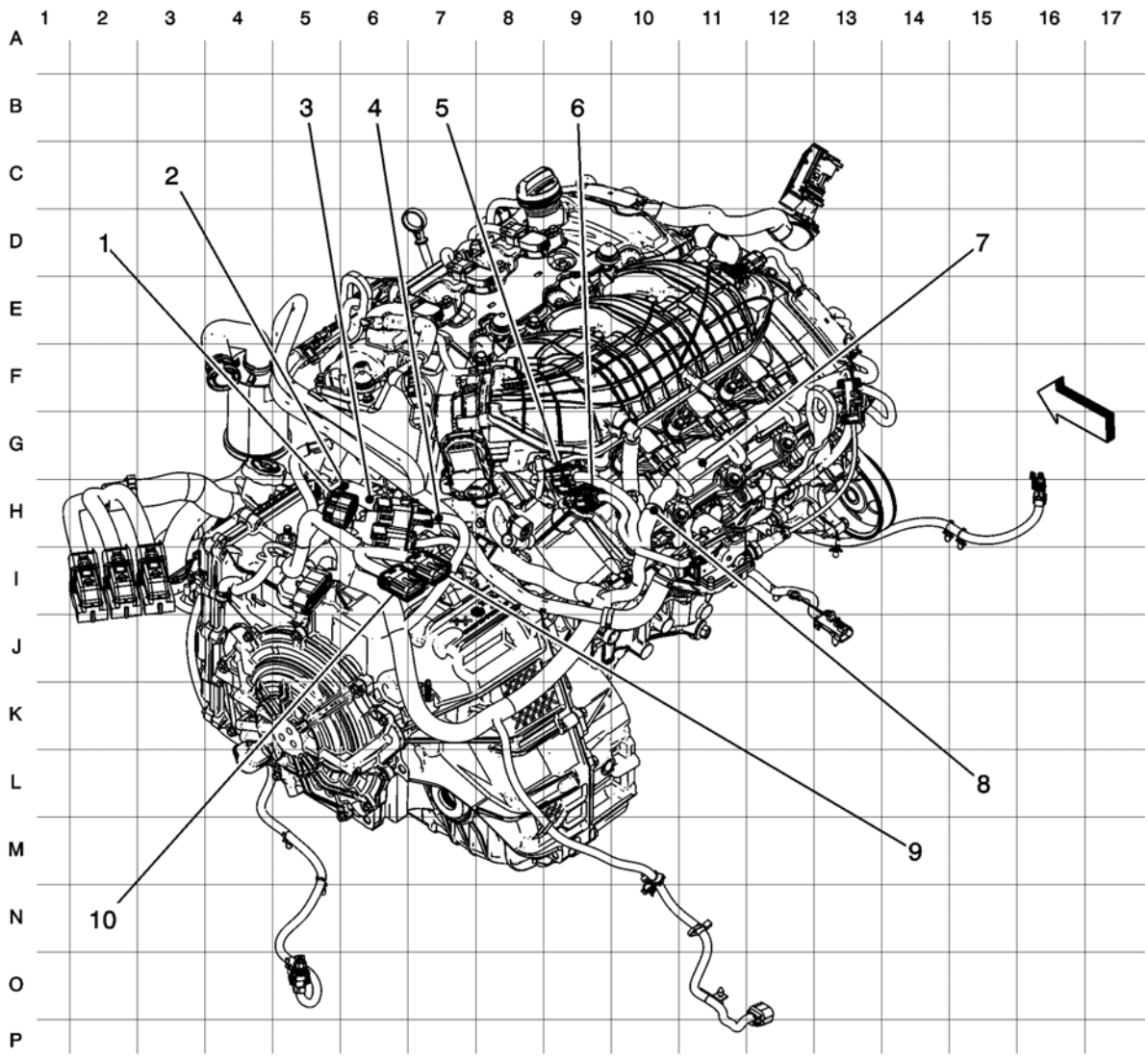


Fig. 3: Engine Harness Routing Diagram -- Left Rear
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X115
2	J110
3	J175
4	J109
5	X160
6	X161
7	J163
8	J162
9	X111
10	X101

Battery Cable Harness Routing (Typical)

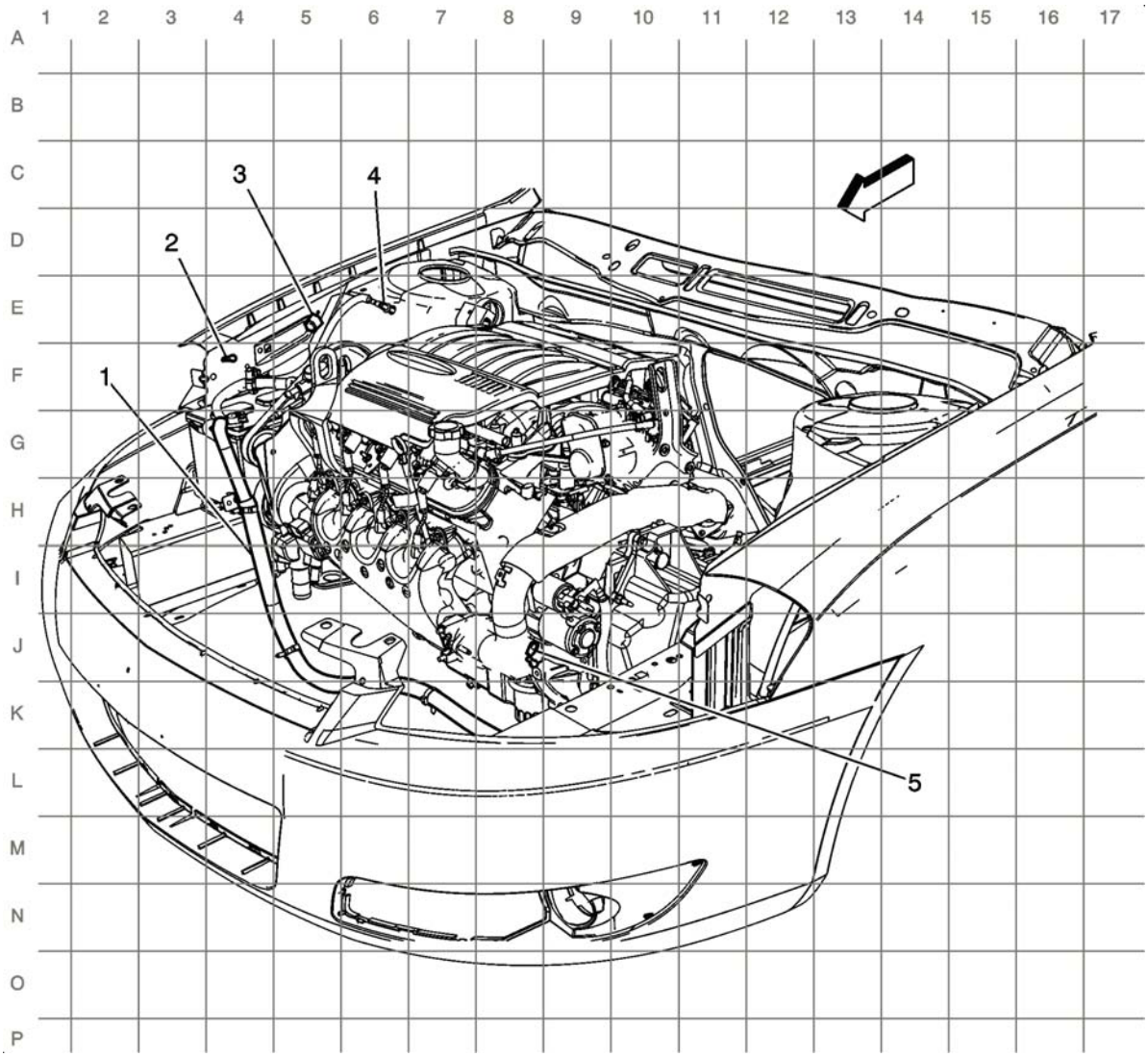


Fig. 4: Battery Cables (Typical)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Battery Cables
2	G102
3	X105
4	Positive Voltage Stud
5	G111

HVAC Module Harness Routing

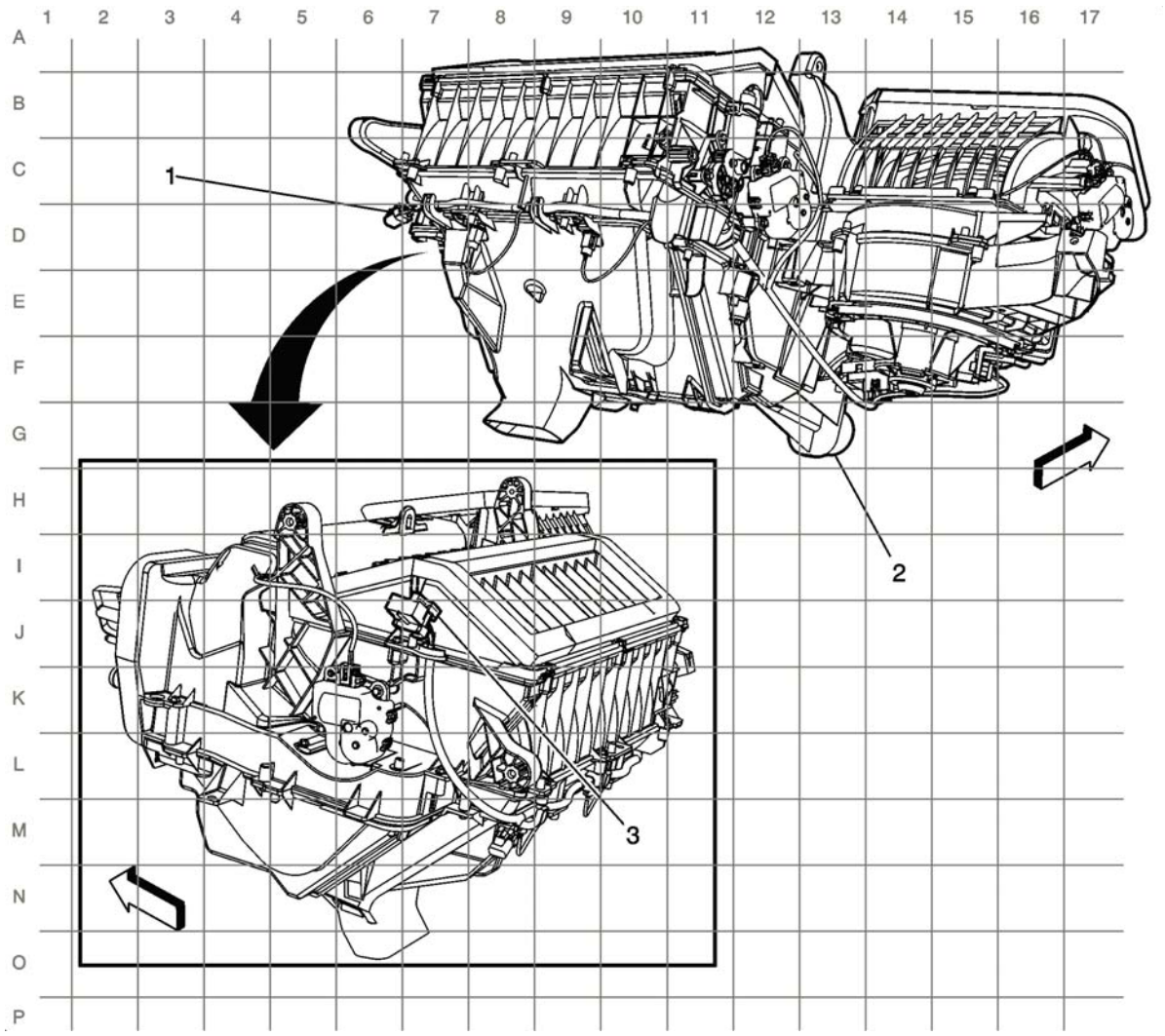


Fig. 5: HVAC Module Wiring
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X210
2	HVAC Module
3	HVAC Control Module- X2

Instrument Panel Harness Routing

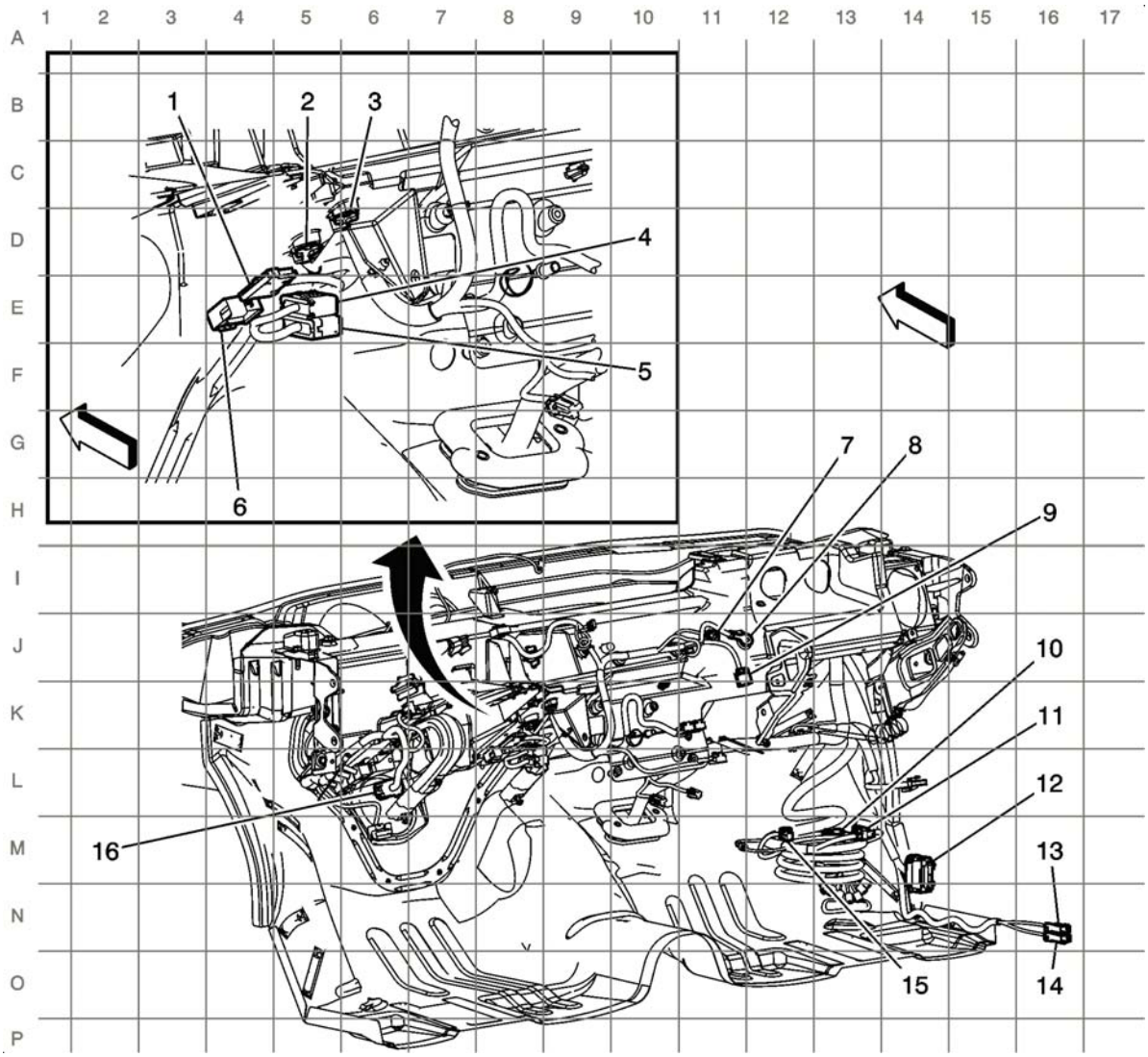


Fig. 6: Instrument Panel Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	JX205
2	G202
3	G201
4	JX206
5	JX207
6	X201
7	G200
8	G204 (9C1, 9C3)
9	X210
10	X266 (9C1, 9C3)
11	X267 (9C1, 9C3)
12	X200
13	X360 (9C1, 9C3)
14	X362 (9C1, 9C3)

Callout	Component Name
15	X297 (9C1, 9C3)
16	X203

Instrument Panel Harness Routing- Lower Left

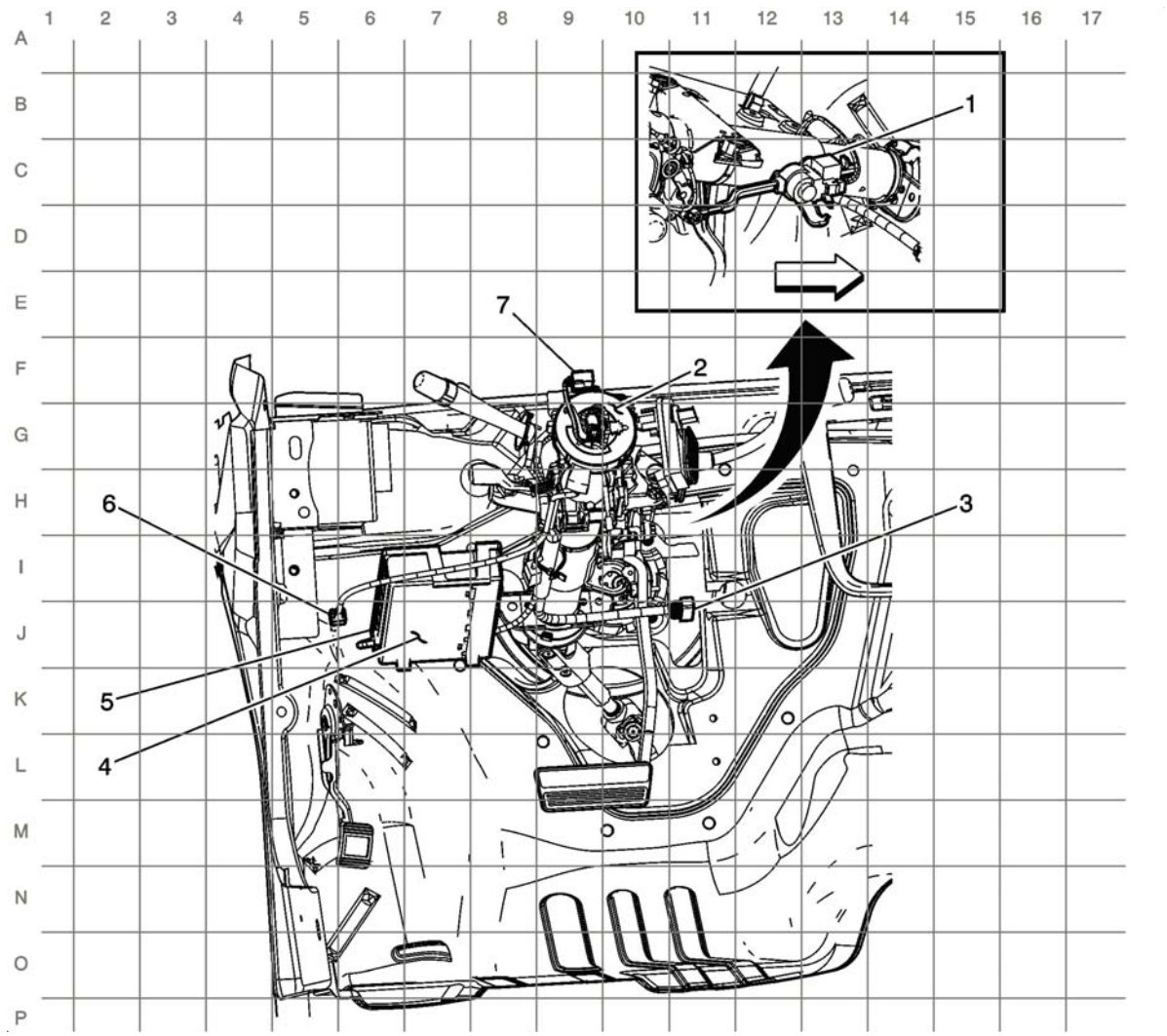


Fig. 7: Instrument Panel Harness- Lower Left
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Ignition Lock Cylinder Control Actuator
2	Inflatable Restraint Steering Wheel Module Coil
3	X201
4	Body Control Module (BCM)
5	Body Control Module (BCM) X1
6	X250
7	X277

Instrument Panel Harness Routing- Rear of the Instrument Panel Carrier

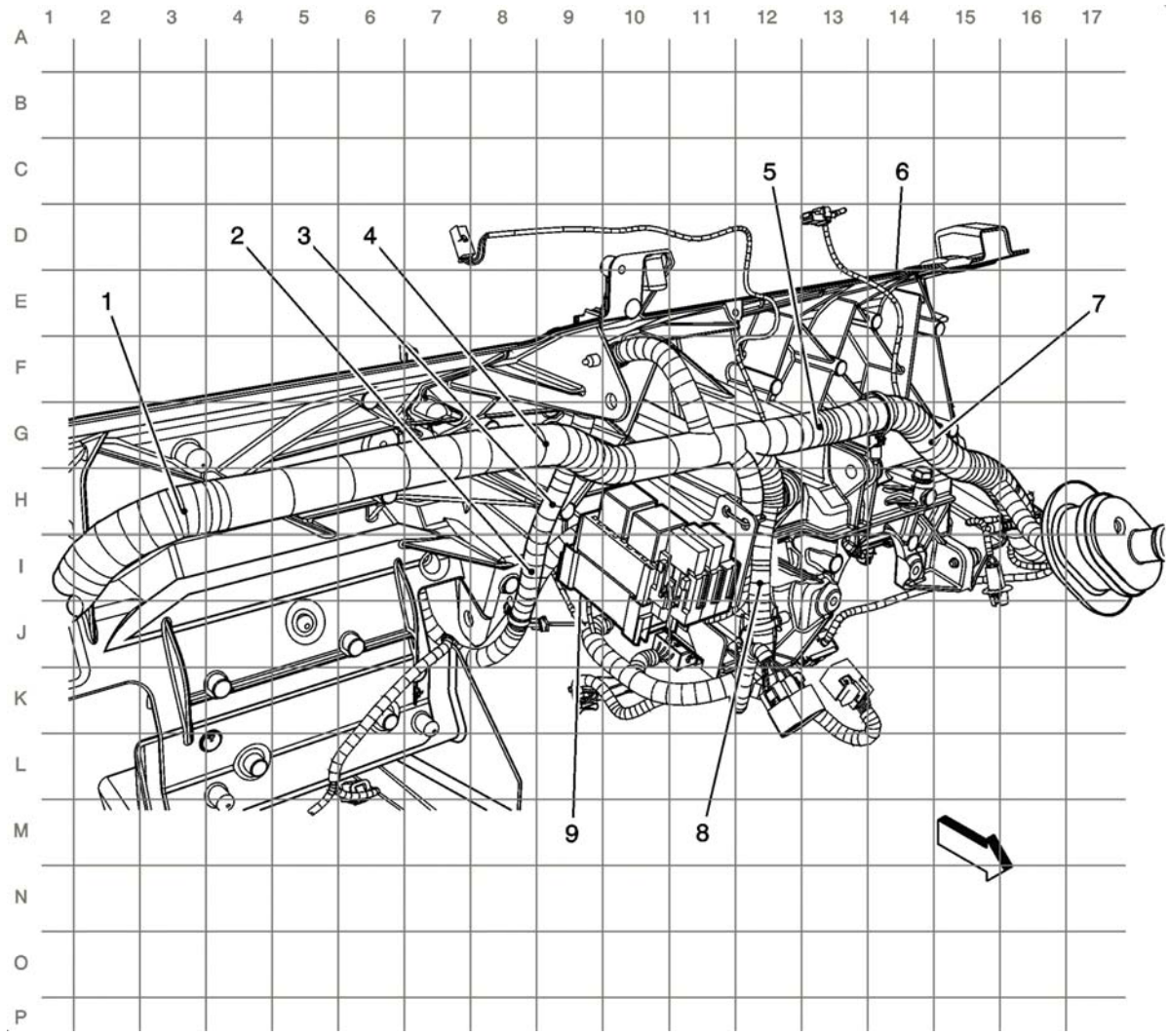


Fig. 8: I/P Harness - Rear of the I/P Carrier
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	J282
2	J203
3	J239
4	J250
5	J218
6	Instrument Panel Carrier
7	J259
8	J269
9	Fuse Block- Auxiliary (9C1/9C3)

Instrument Panel Harness Routing- Engine Compartment

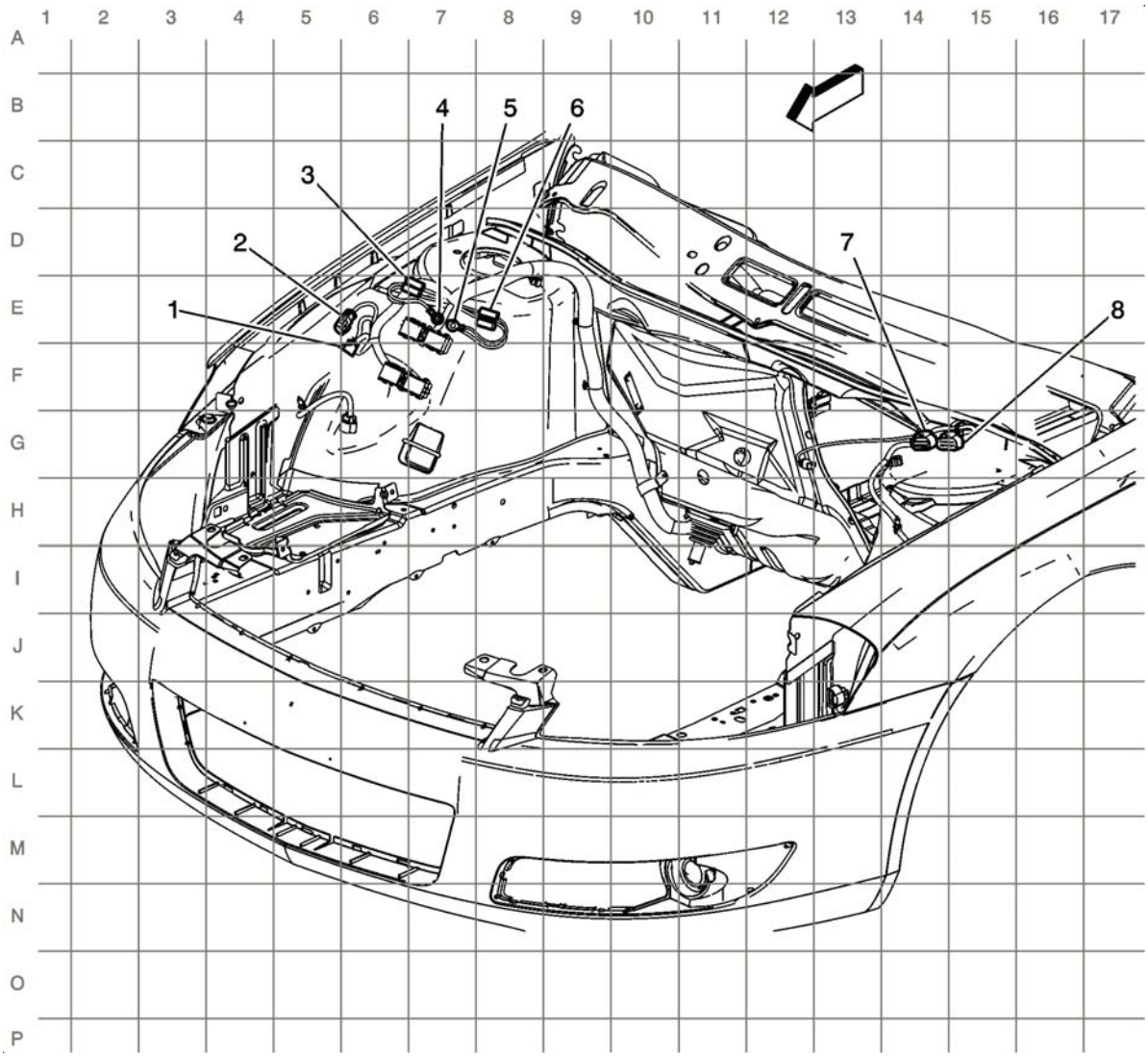


Fig. 9: Instrument Panel Harness - Engine Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X123 (9C1 or 9C3)
2	X105
3	Fusible Link (9C1 or 9C3)
4	Positive Battery Voltage Stud (Fuse Block)
5	Positive Battery Voltage Stud (Fuse Block)
6	Fusible Link (9C1 or 9C3)
7	X101
8	X111

Instrument Panel Harness Routing- Splices

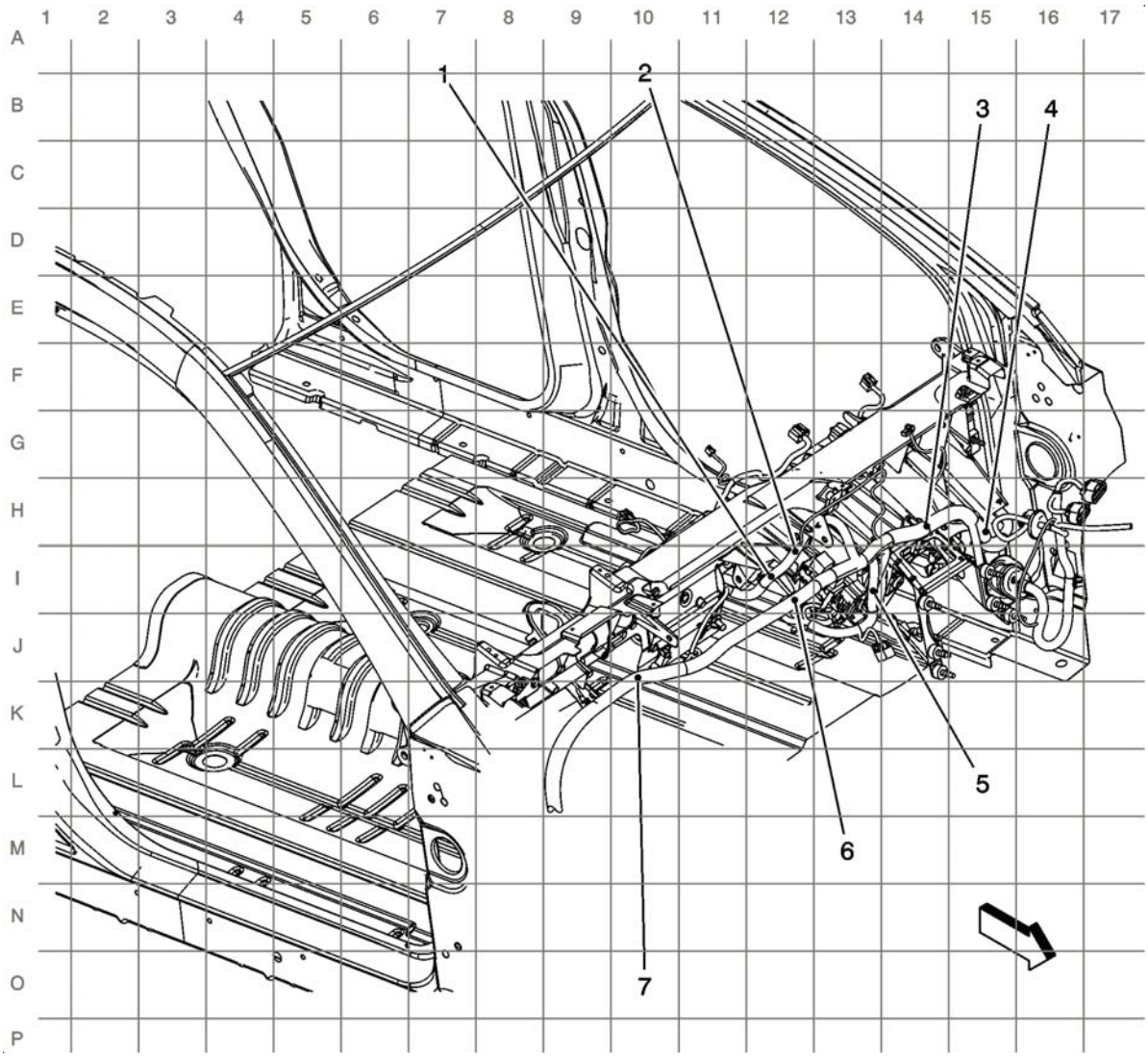


Fig. 10: Instrument Panel Harness Splices
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	J203
2	J239
3	J218
4	J259
5	J269
6	J250
7	J282

Sunroof and Headliner Harness Routing

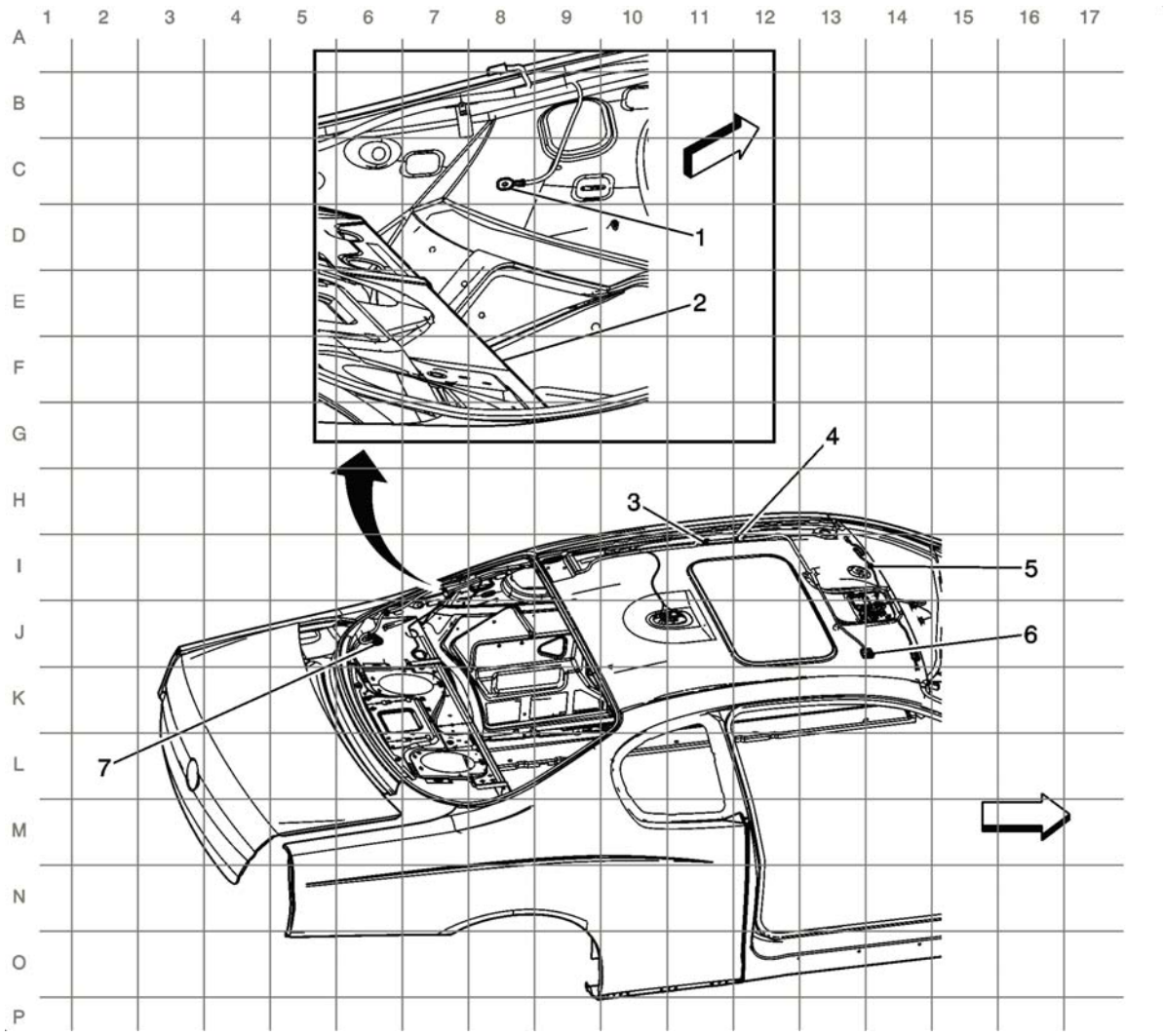


Fig. 11: Sunroof and Headliner Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	G403
2	Rear Shelf
3	J393
4	J390
5	J364
6	X398 (CF5)
7	X490

Body Harness Routing- Passenger Compartment Splices

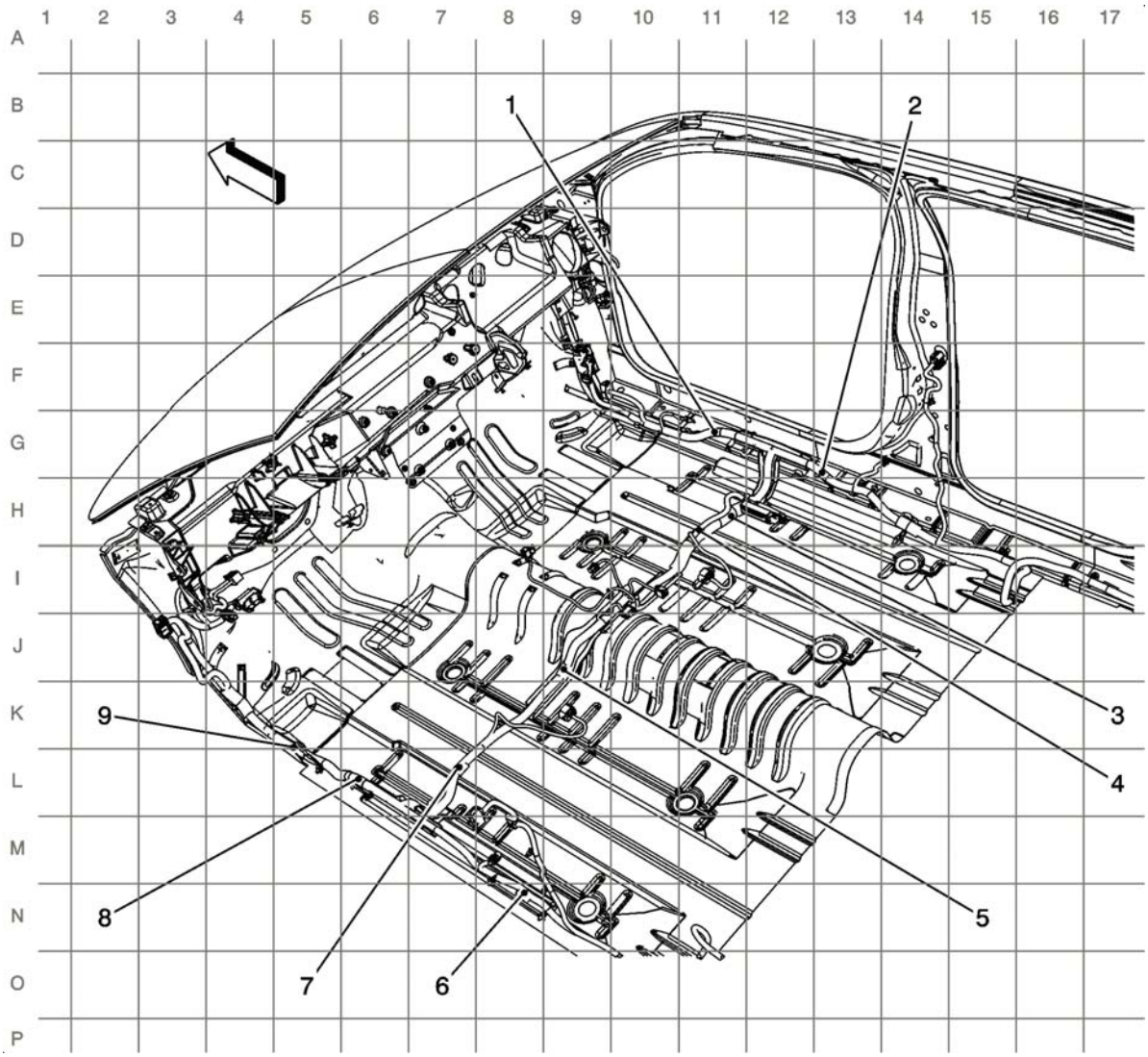


Fig. 12: Body Harness - Passenger Compartment Splices
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	J350
2	J375
3	J314
4	J315
5	J359
6	J332
7	J303
8	J308
9	J307

Body Harness Routing- Left Front Passenger Compartment

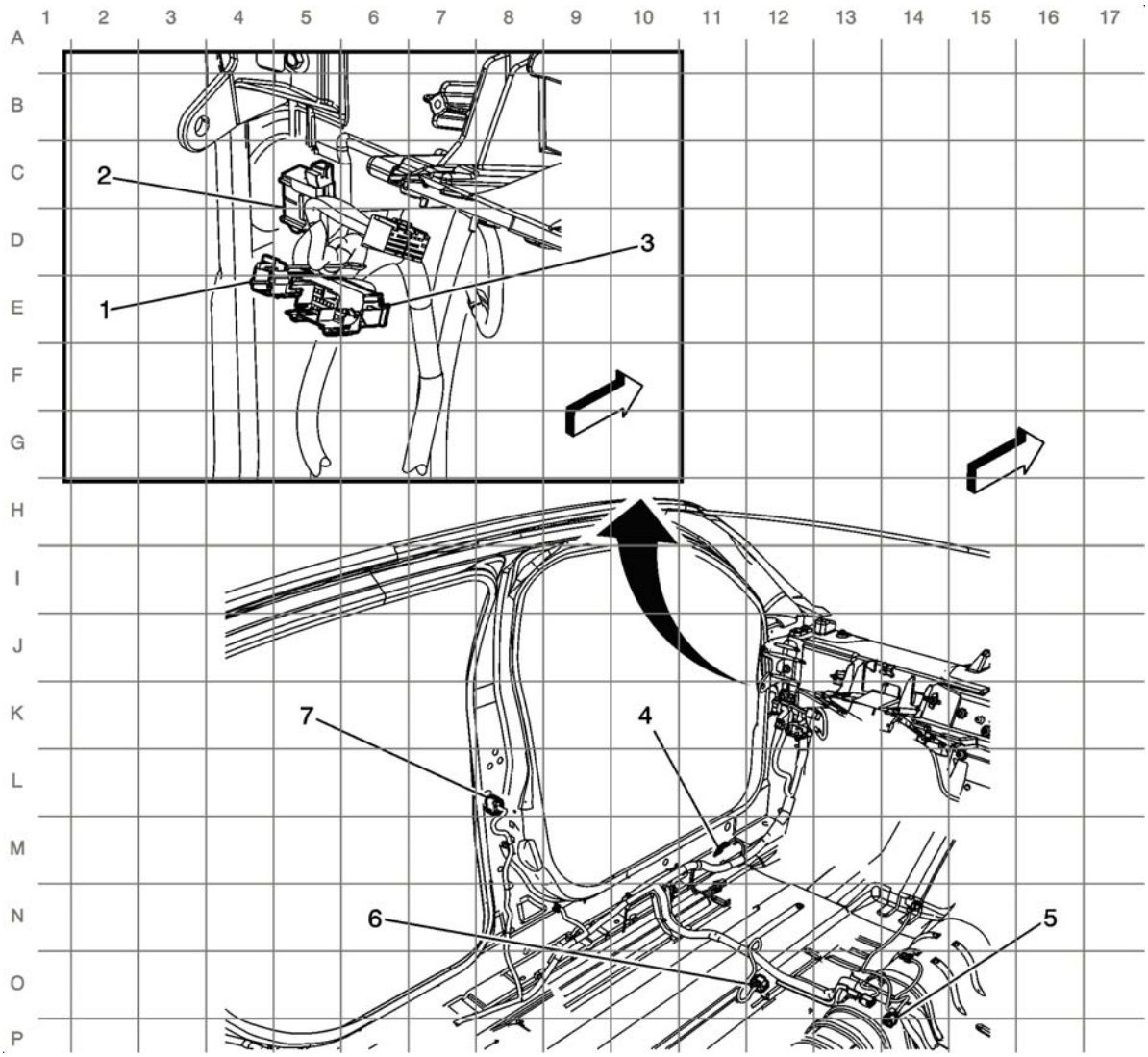


Fig. 13: Body Harness - Left Front Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X250
2	X500
3	X203
4	G301
5	X340
6	X311
7	X700

Body Harness Routing- Right Front Passenger Compartment

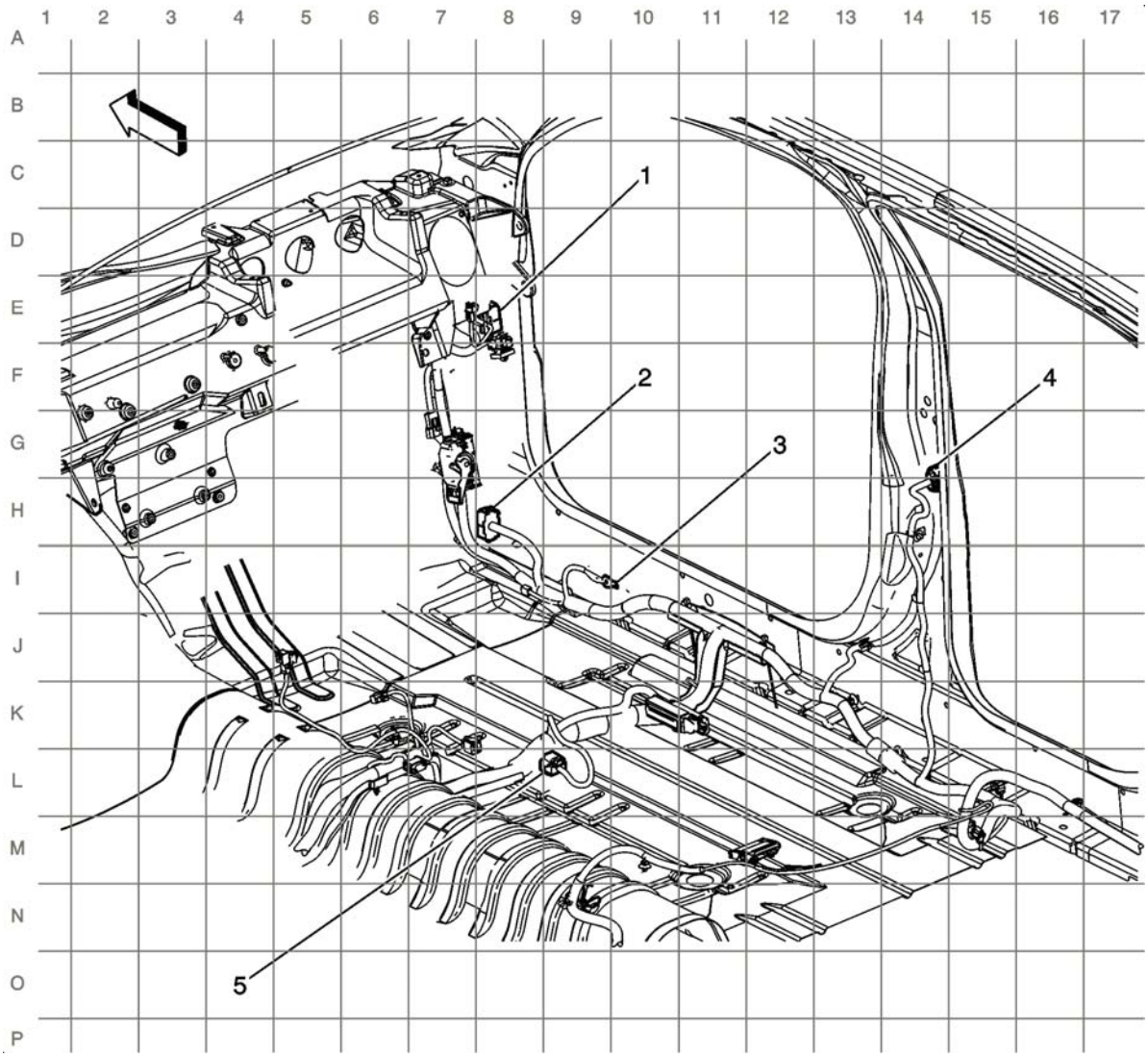


Fig. 14: Body Harness - Right Front Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X600
2	X360 (9C1 or 9C3)
3	G302
4	X800
5	X313

Body Harness Routing- Rear Passenger Compartment

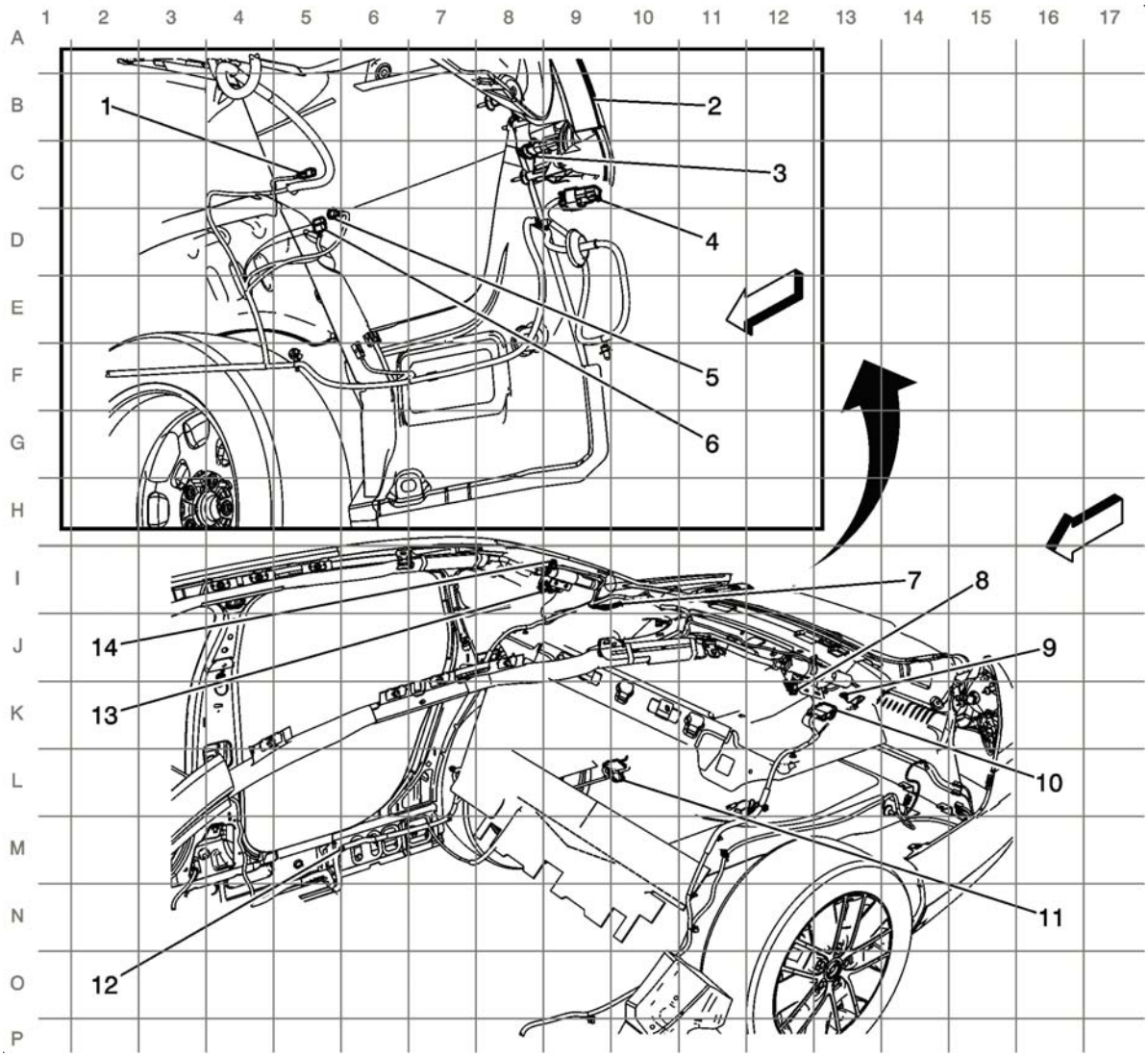


Fig. 15: Body Harness - Rear Compartment Area
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X409 (9C1 or 9C3)
2	Tail Lamp- Right
3	X402
4	X406
5	Junction Block- Rear (6J1) Positive Voltage Stud
6	Junction Block- Rear (6J1) Positive Voltage Stud
7	G404
8	X412
9	G403
10	X490
11	X405
12	J324
13	X414
14	X322- Taped to Harness (9C1 or 9C3)

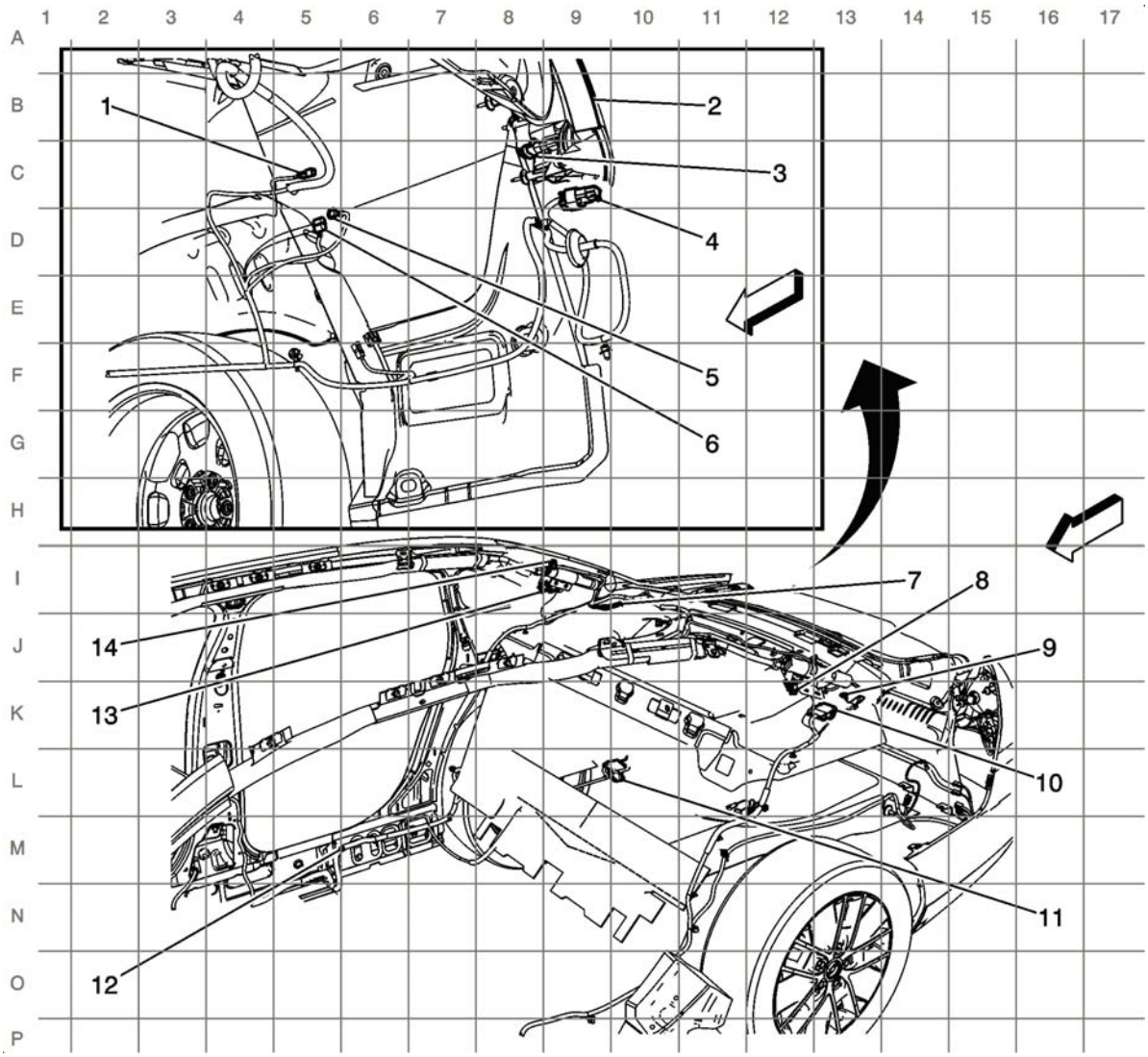


Fig. 15: Body Harness - Rear Compartment Area
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X409 (9C1 or 9C3)
2	Tail Lamp- Right
3	X402
4	X406
5	Junction Block- Rear (6J1) Positive Voltage Stud
6	Junction Block- Rear (6J1) Positive Voltage Stud
7	G404
8	X412
9	G403
10	X490
11	X405
12	J324
13	X414
14	X322- Taped to Harness (9C1 or 9C3)

Seat Harness Routing- Airbags and Inlines

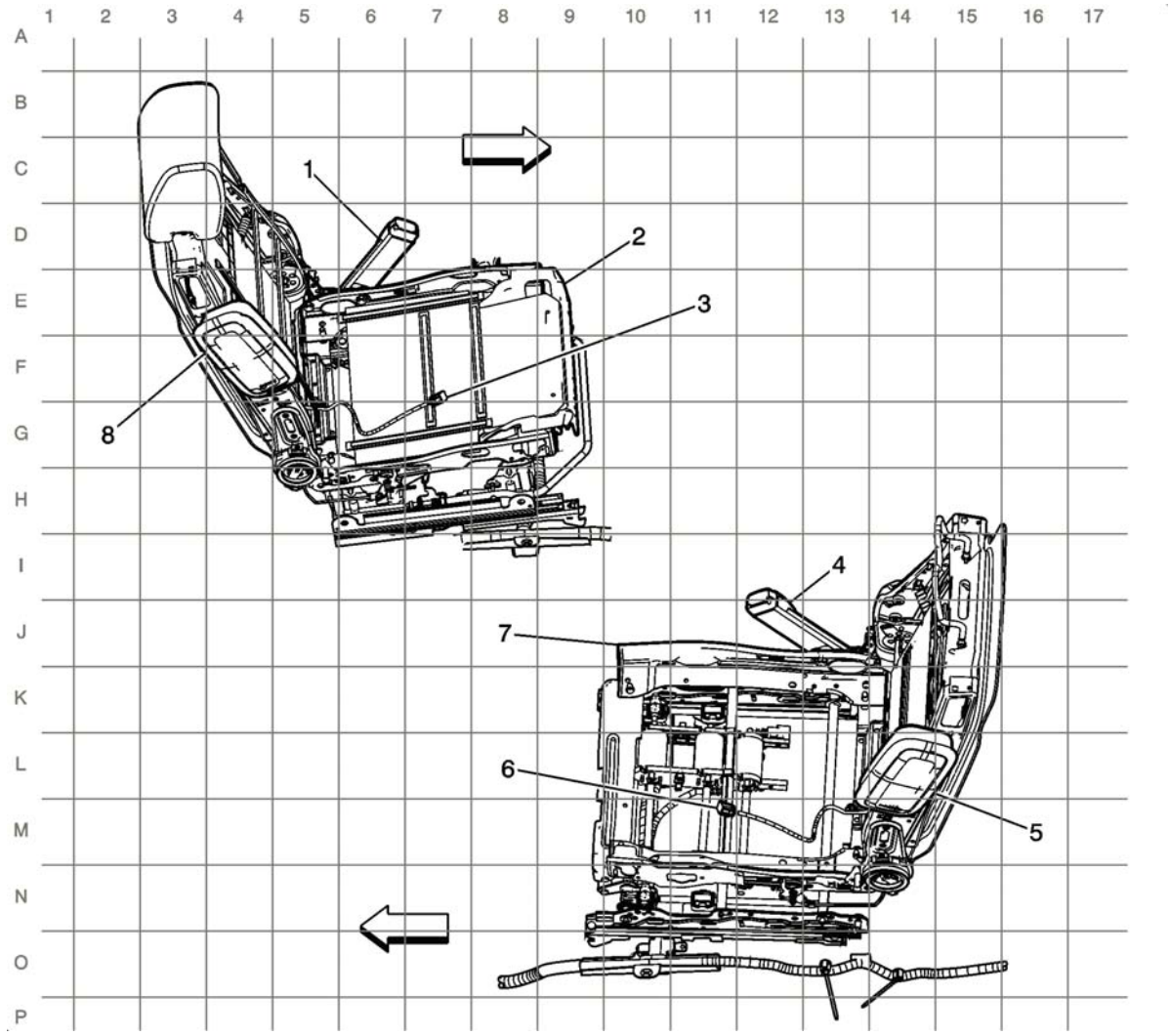


Fig. 16: Front Seat Airbag Inlines
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Belt Buckle- Passenger
2	Passenger Seat
3	X316
4	Seat Belt Buckle- Driver
5	Inflatable Restraint Side Impact Module- Left
6	X315
7	Driver Seat
8	Inflatable Restraint Side Impact Module- Right

Driver Door Harness Routing

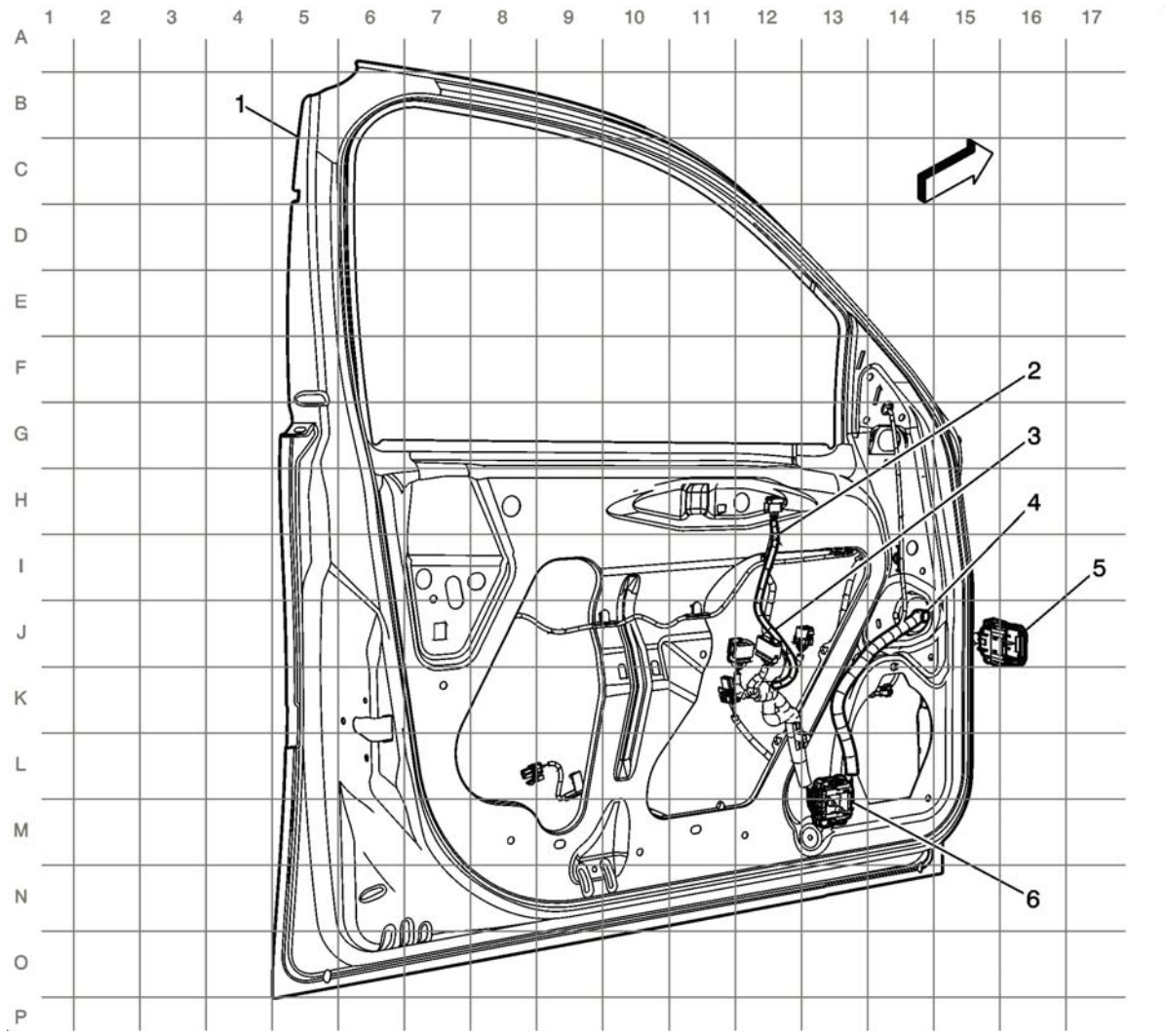


Fig. 17: Driver Door Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	J506
3	J504
4	J505
5	X500
6	X503

Passenger Door Harness Routing

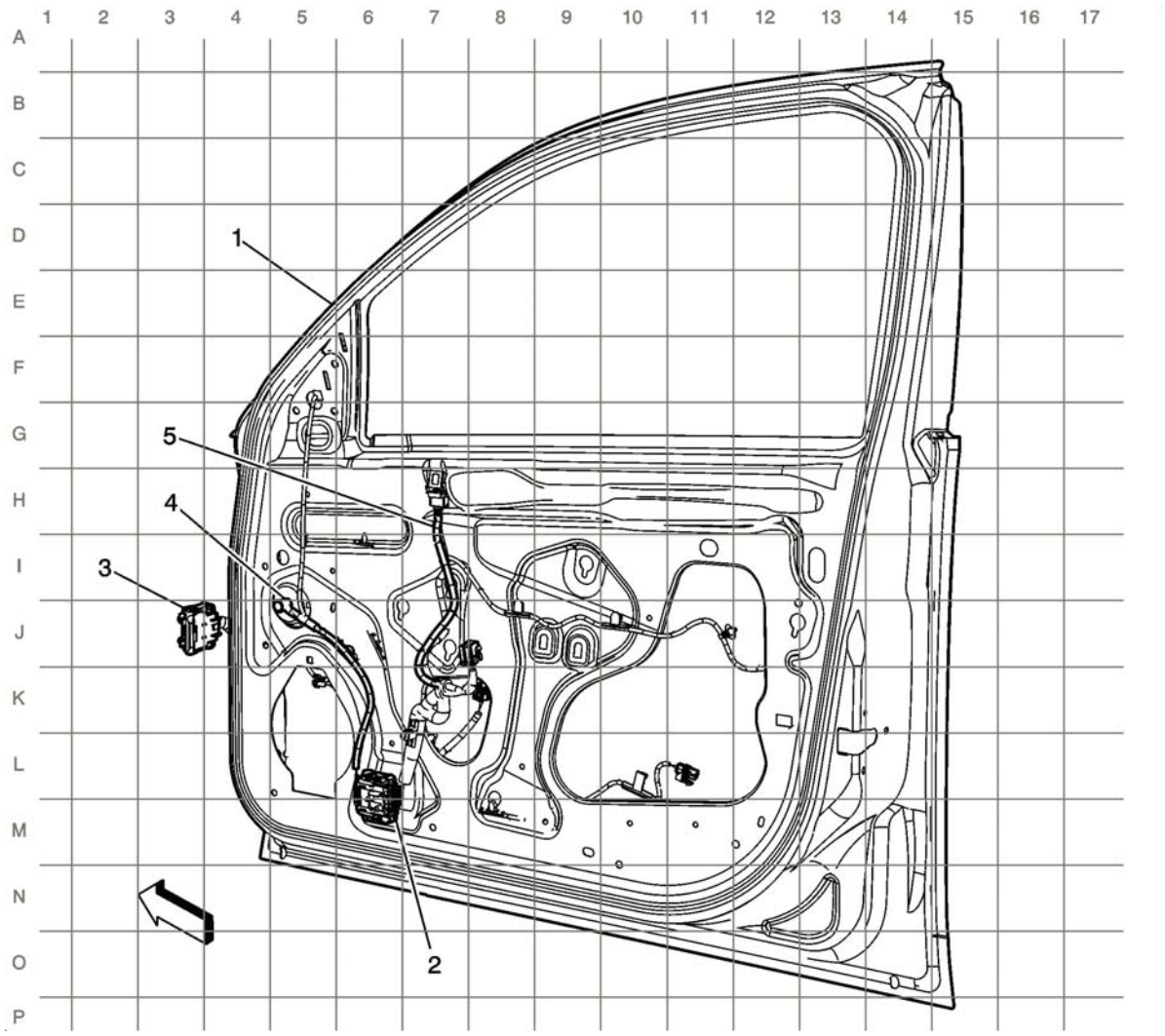


Fig. 18: Passenger Door Harnesses
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	X604
3	X600
4	J604
5	J608

Left Rear Door Harness Routing

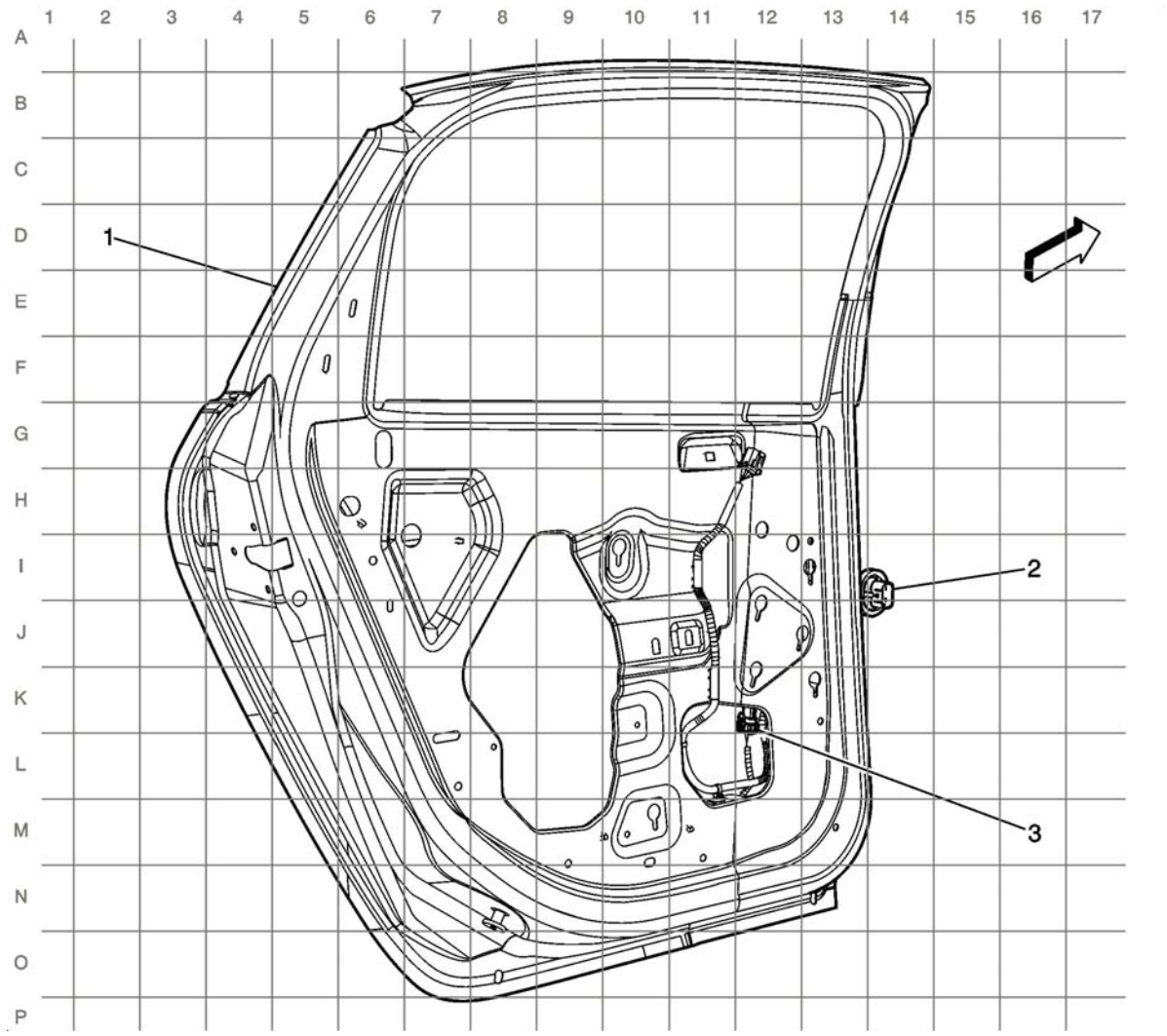


Fig. 19: Left Rear Door Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	X700
3	Window Motor- Left Rear Connector

Right Rear Door Harness Routing

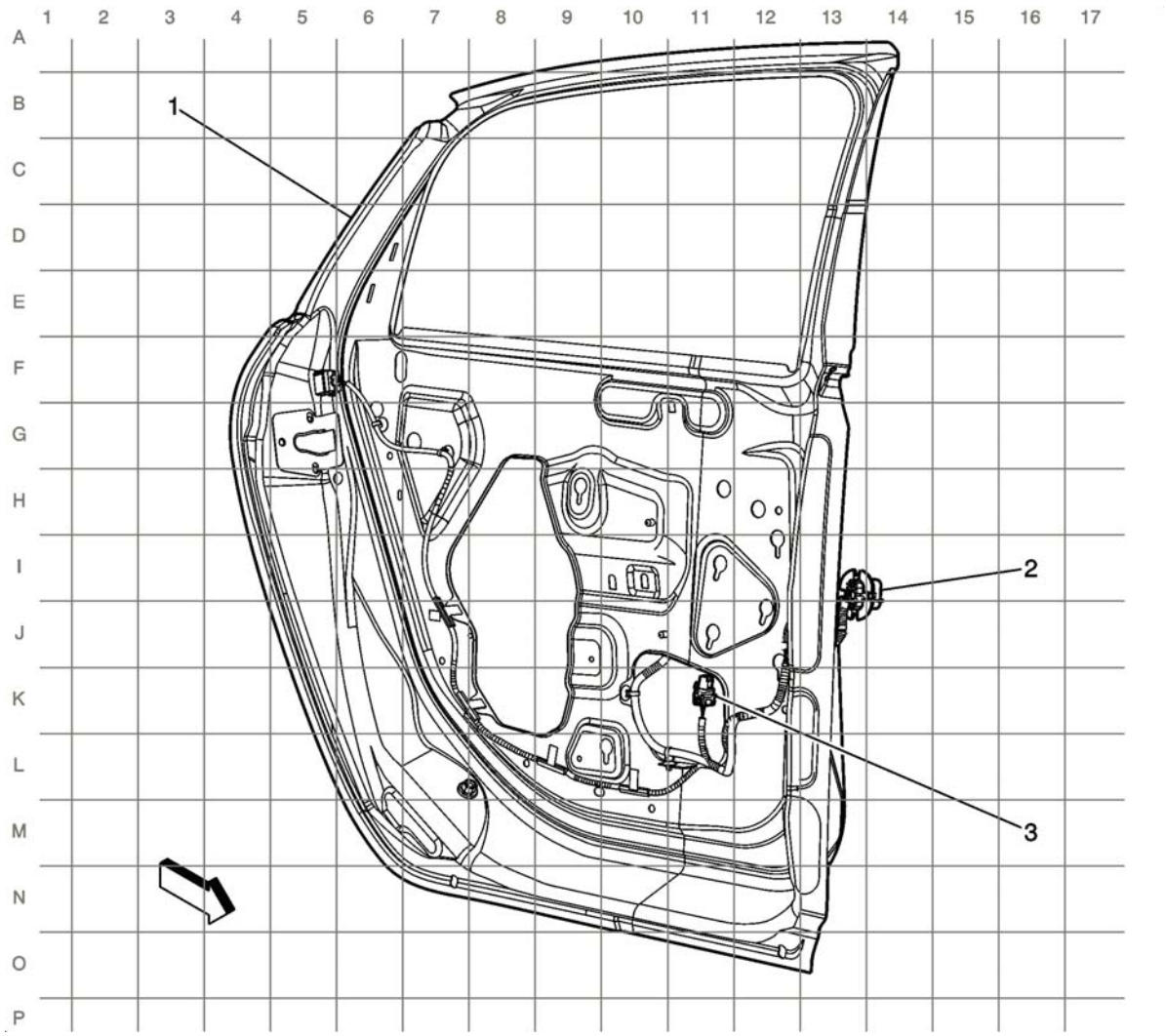


Fig. 20: Right Rear Door Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	X800
3	Window Motor- Right Rear Connector

Rear Compartment Lid Harness Routing

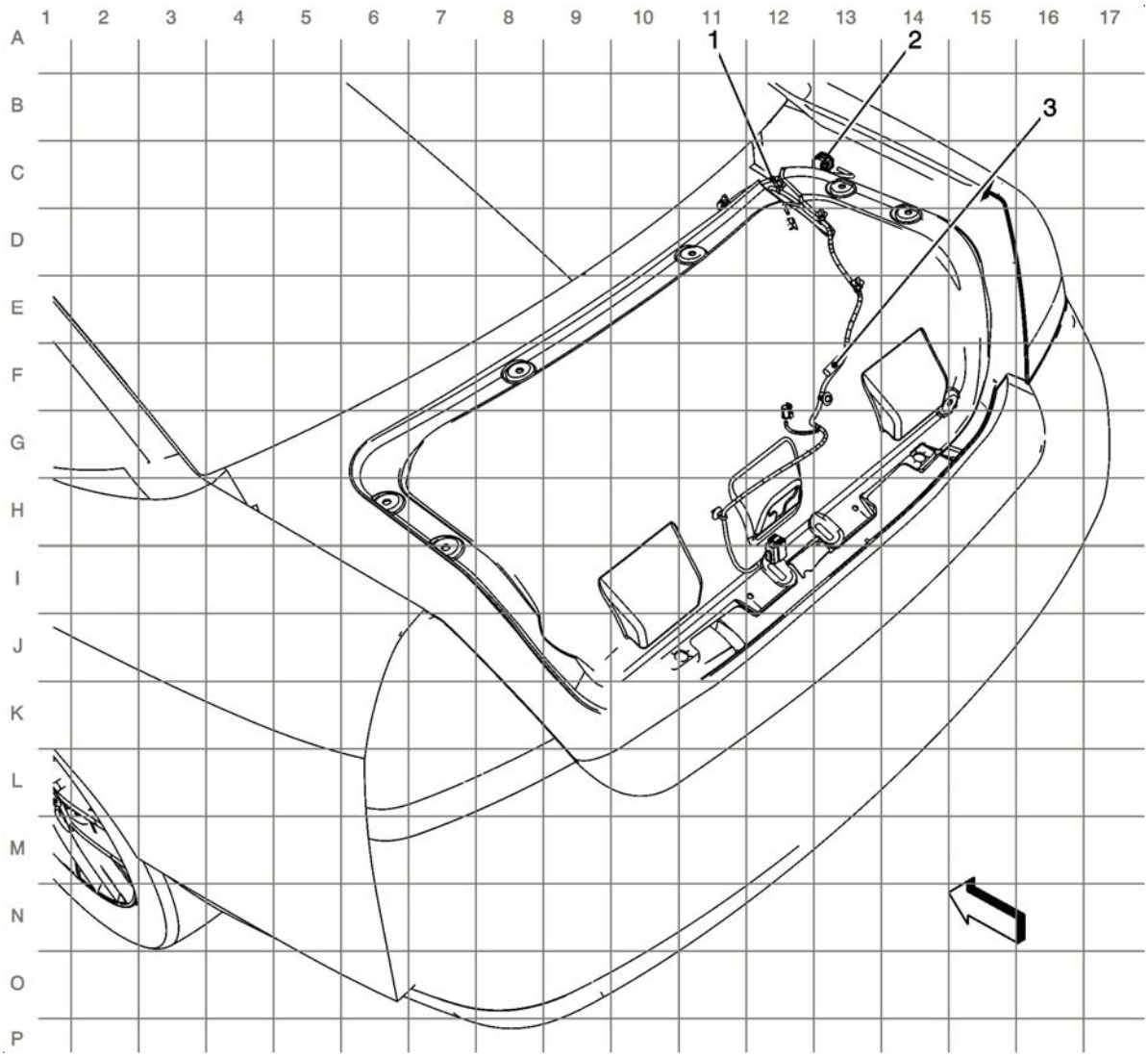


Fig. 21: Rear Compartment Lid
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	J902
2	X430
3	J901

Rear Fascia Harness Routing

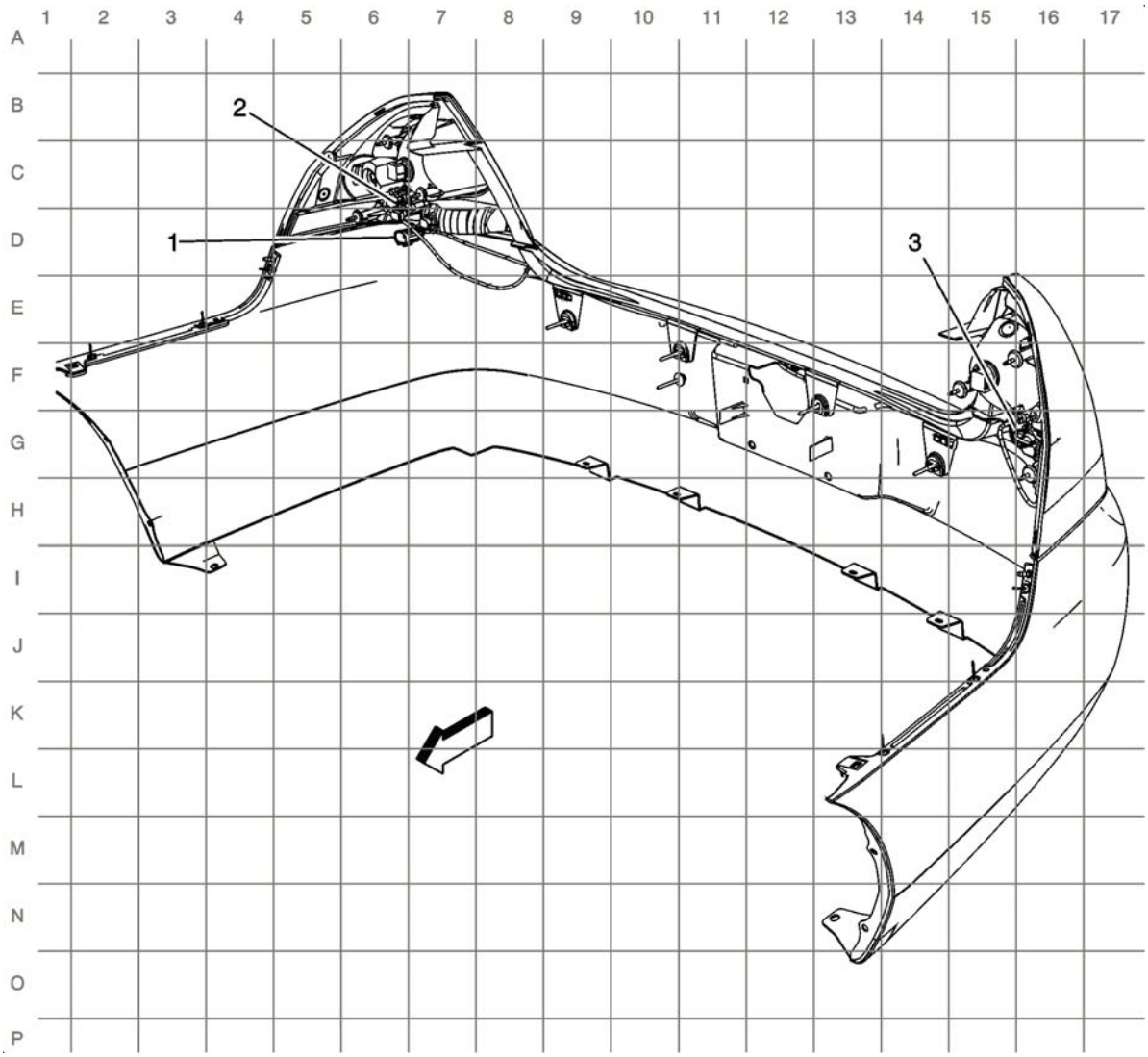


Fig. 22: Rear Fascia
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X406
2	X402
3	X401

WIRING SCHEMATIC DIAGRAMS

Electrical Schematic Symbols

Voltage Indicators

Symbol	Description

Symbol	Description
	Battery Voltage

Symbol	Description
	Ignition Switch- Off Position

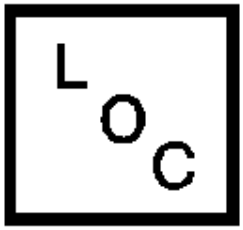
Symbol	Description
	Ignition Switch-Accessory Position

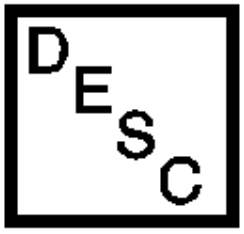
Symbol	Description
	Ignition Switch- Run Position

Symbol	Description
	Ignition Switch-Start Position

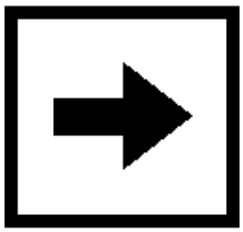
General Icons

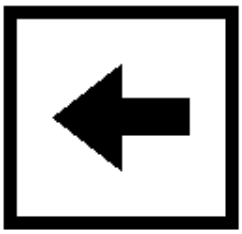
Symbol	Description

Symbol	Description
	Master Component List Icon This icon is used on the schematic to link to the Master Electrical Component List.

Symbol	Description
	Description and Operation Icon This icon is used on the schematic to link to the Description and Operation of that particular system.

Symbol	Description
	Computer Programming Icon This icon is used on the schematic to link to Control Module References, which identifies which components need programming upon replacement.

Symbol	Description
	Next Schematic Page Icon This icon is used on the schematic to navigate to the next schematic in the subsystem.

Symbol	Description
	Previous Schematic Page Icon This icon is used on the schematic to navigate to the previous schematic in the subsystem.

Symbol	Description
	Supplemental Inflatable Restraint (SIR) or Supplemental Restraint System (SRS) Icon This icon is used to alert the technician that the system contains SIR/SRS components that require certain precautions before servicing.

Symbol	Description
	Information Icon This icon is used to alert the technician that there is additional information that will aid in servicing a system.

Symbol	Description
	Danger Icon This icon is intended to alert the technician that a component within the system contains labeling with the same icon. This icon is used when a source component has potential for 60 volts DC or greater or has potential for 42 volts AC or greater.

Symbol	Description
	High Voltage Icon This icon is intended to alert the technician that a component within the system contains labeling with the same icon. This icon is used when a component/circuit has potential for 60 volts DC or greater or has potential for 42 volts AC or greater.

Symbol	Description
	Caution Icon This icon is used to advise the technician to use caution when servicing this component. This icon may be used when a component/circuit has a voltage range potential between 30-60 volts DC or 15-42 volts AC.

Symbol	Description
	Functional Serial Data Communication This icon is used to show the technician that the serial data circuit detail is shown incomplete. It also provides an active link to the Data Communication Schematics were the circuit is shown complete.

Switch Position Icons

Symbol	Description

Symbol	Description
	Generic Up Arrows

Symbol	Description
	Generic Down Arrows

Symbol	Description
	Generic Left Arrows

Symbol	Description
   	Generic Right Arrows

Symbol	Description
	Generic Express Down Arrows

Symbol	Description
	On/Off Icon

Symbol	Description
	Generic Lock Icon

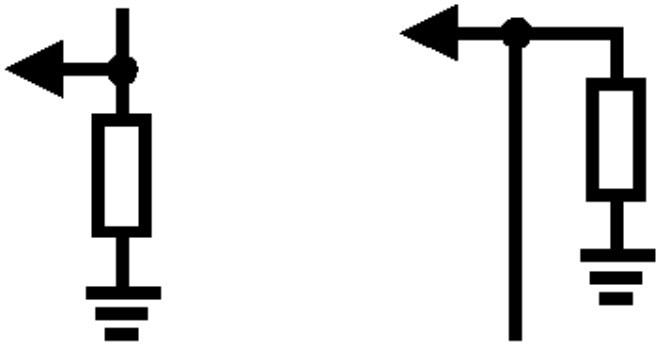
Symbol	Description
	Generic Unlock Icon

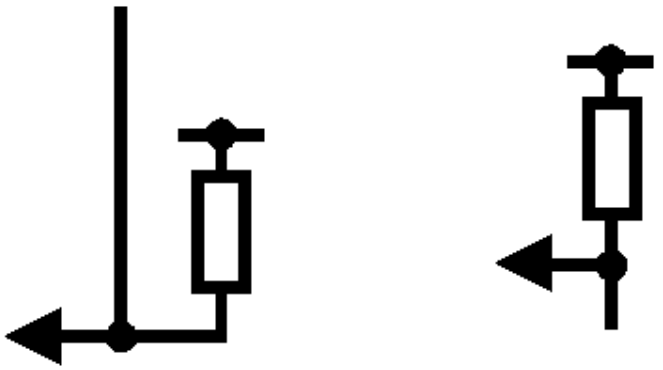
Symbol	Description
	Generic Window Switch Positions- 4 Door

Symbol	Description
	Generic Window Switch Positions- 2 Door

Module Circuit Function Icons

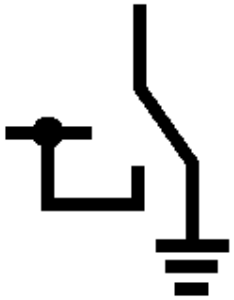
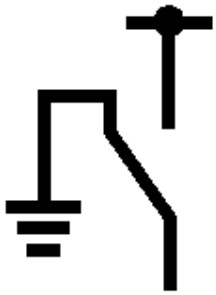
Symbol	Description

Symbol	Description
	I/O Pull-Down Resistors (-)

Symbol	Description
	I/O Pull-Up Resistors (+)

Symbol	Description
	I/O High-Side Drive Switch (+)

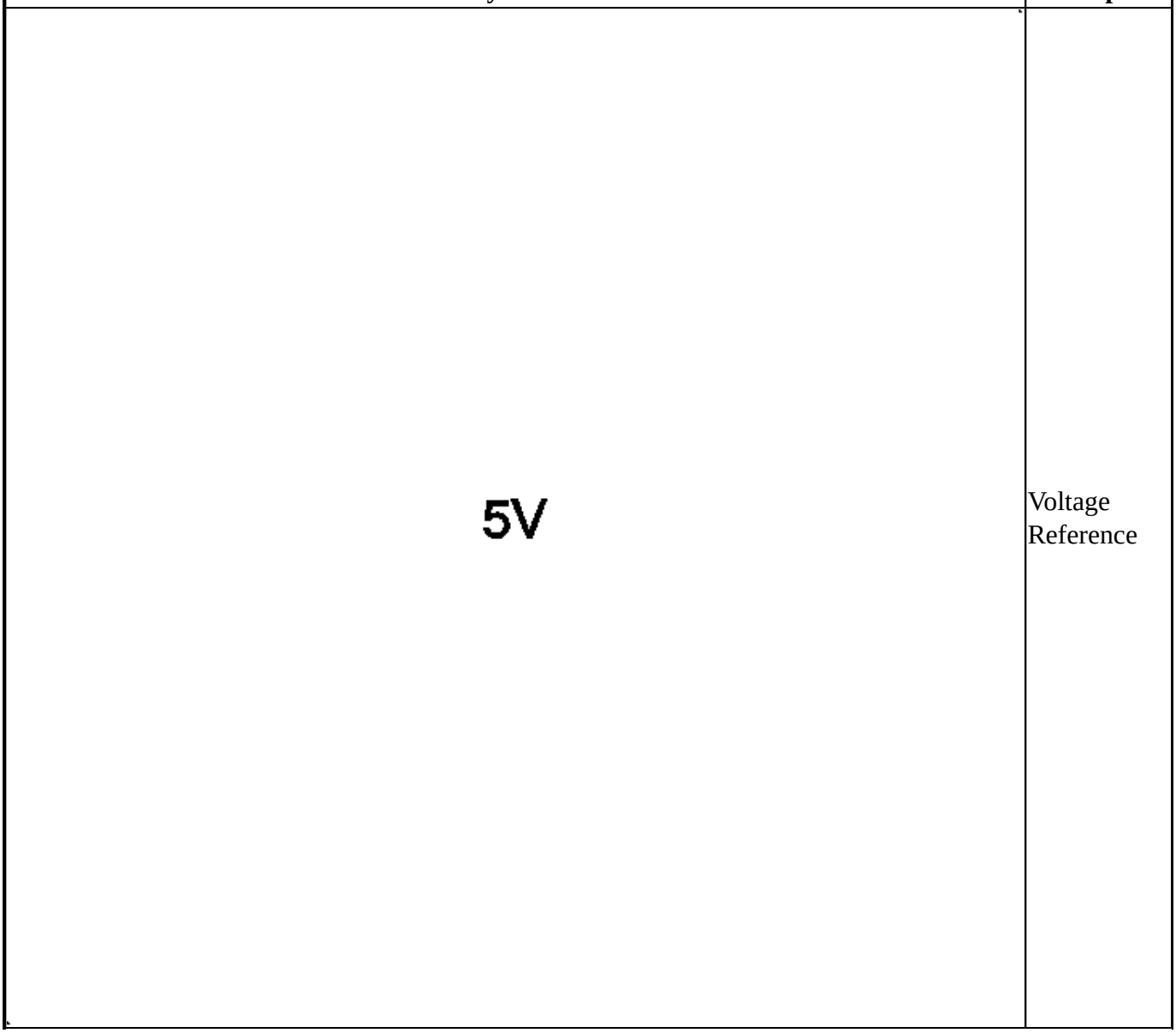
Symbol	Description
	I/O Low-Side Drive Switch (+)

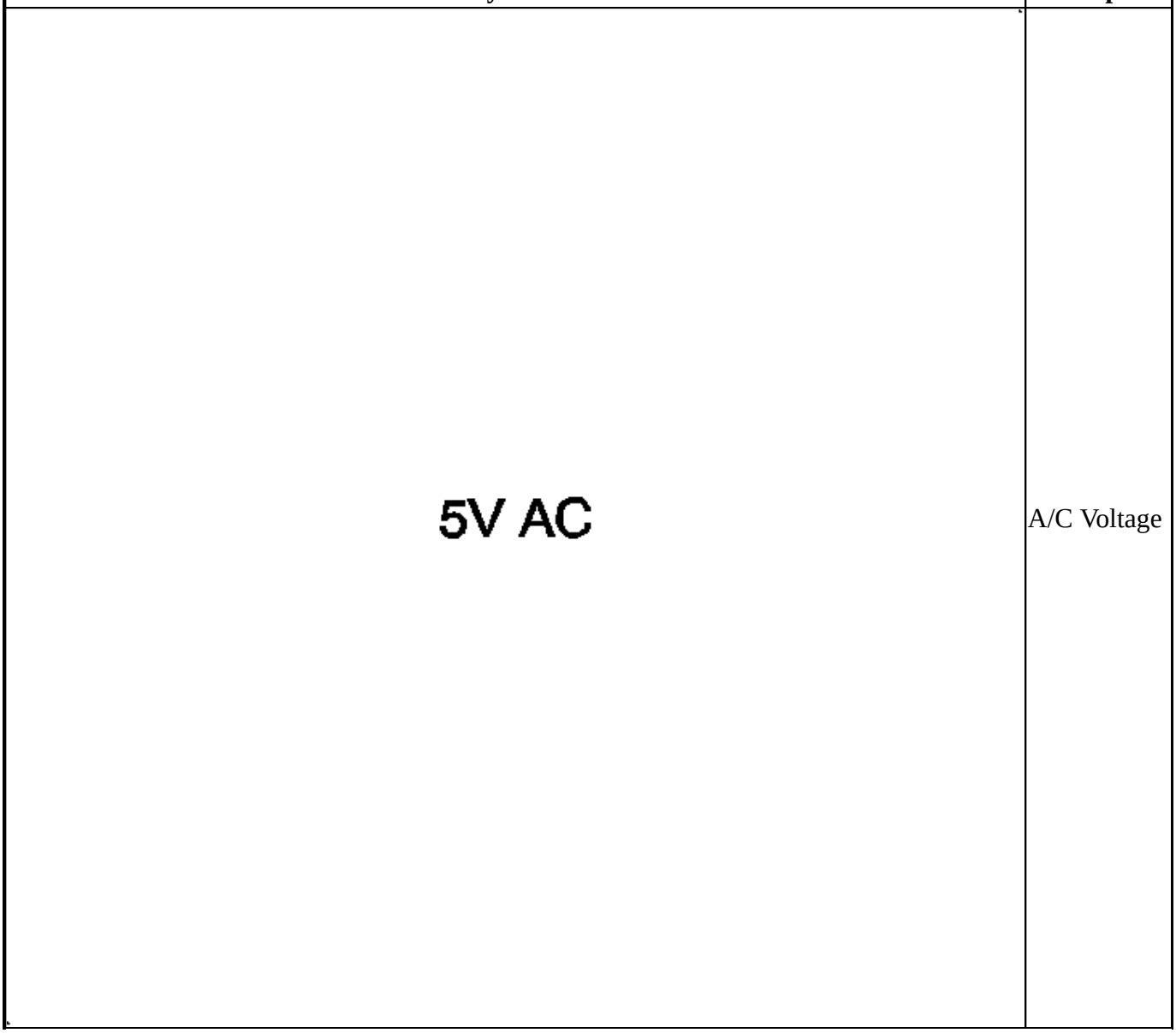
Symbol	Description
 	I/O Bidirectional Switch (+/-)

Symbol	Description
	Pulse-Width Modulation Symbol

Symbol	Description
B+	Battery Voltage

Symbol	Description
IGN	Ignition Voltage

Symbol	Description
	Voltage Reference

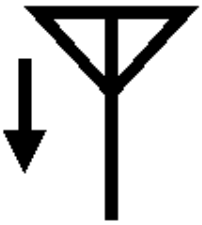
Symbol	Description
	A/C Voltage

Symbol	Description
	Low Reference

Symbol	Description
	Ground

Symbol	Description
	Serial Data

Symbol	Description
	Antenna Signal- In

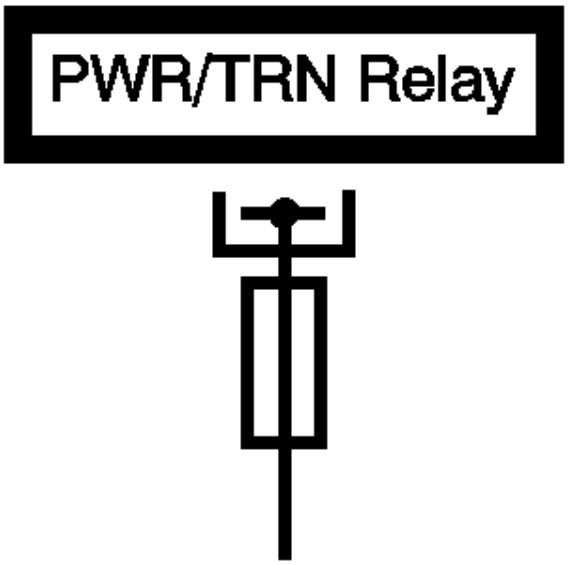
Symbol	Description
	Antenna Signal- Out

Symbol	Description
	Brake Apply

Harness Components

Symbol	Description

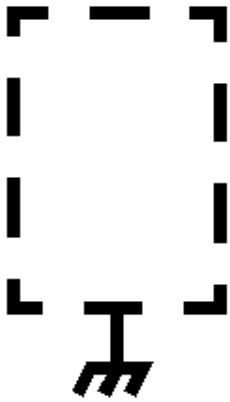
Symbol	Description
	Fuse

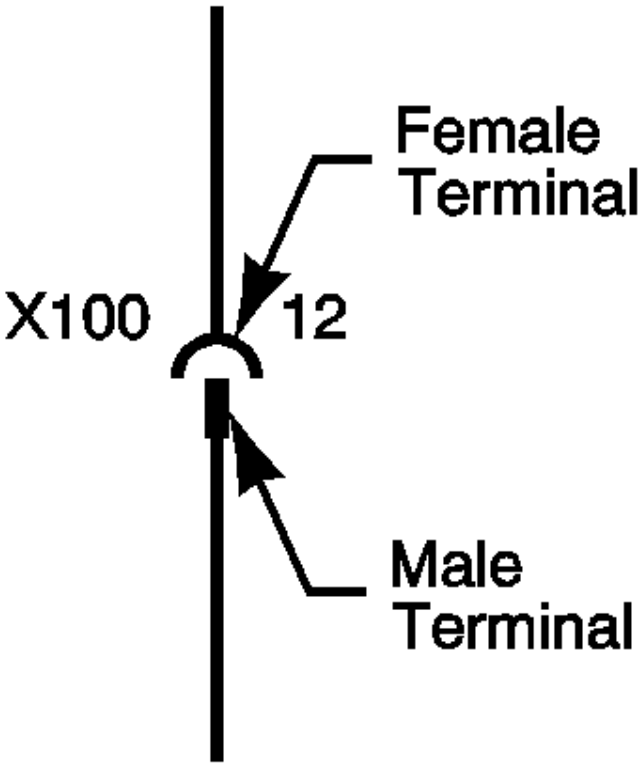
Symbol	Description
	Fuse Supplied by a Relay

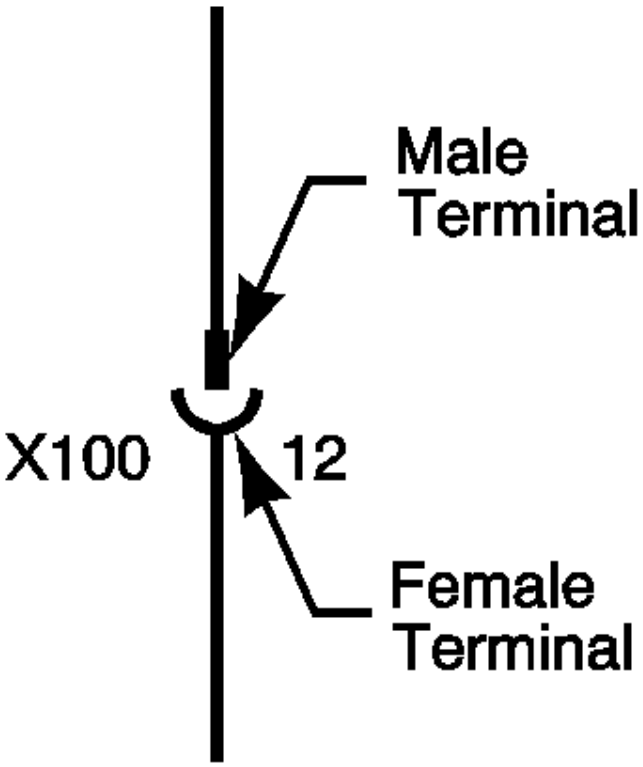
Symbol	Description
	Circuit Breaker

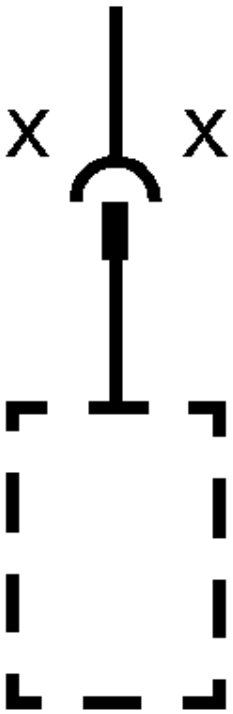
Symbol	Description
	Fusible Link

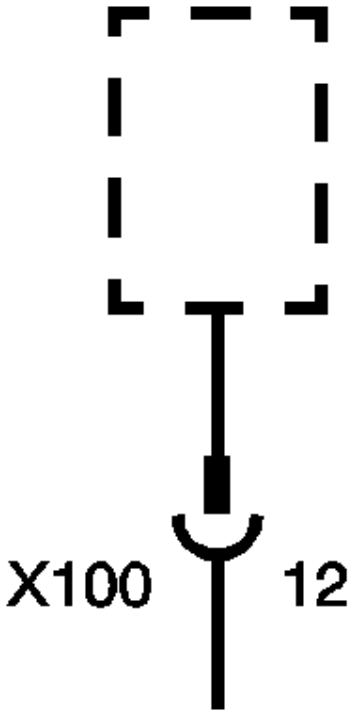
Symbol	Description
	Ground

Symbol	Description
	Case Ground

Symbol	Description
	Inline Harness Connector

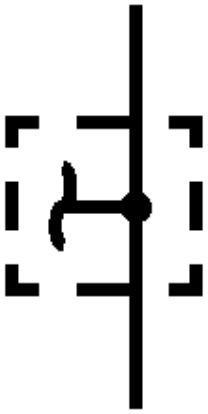
Symbol	Description
	Inline Harness Connector

Symbol	Description
	Pigtail Connection

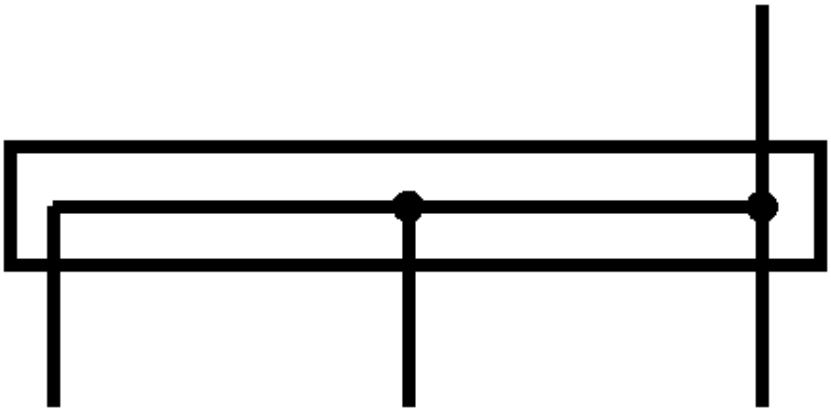
Symbol	Description
	Pigtail Connection

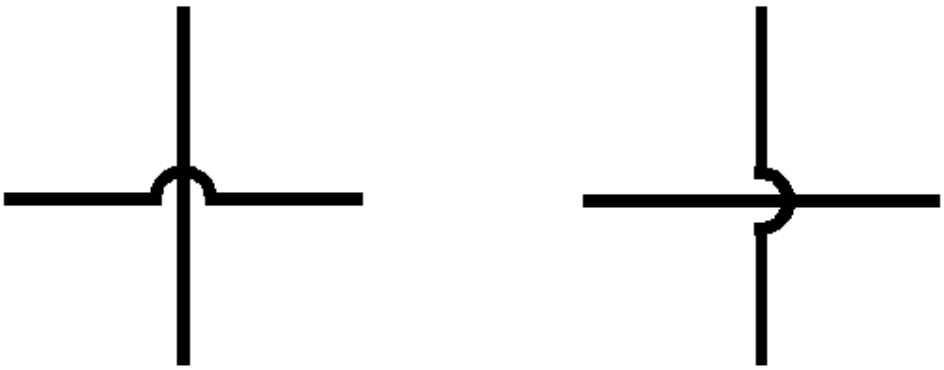
Symbol	Description
	Provisional or Diagnostic Connector

Symbol	Description
	Blunt Cut Wire

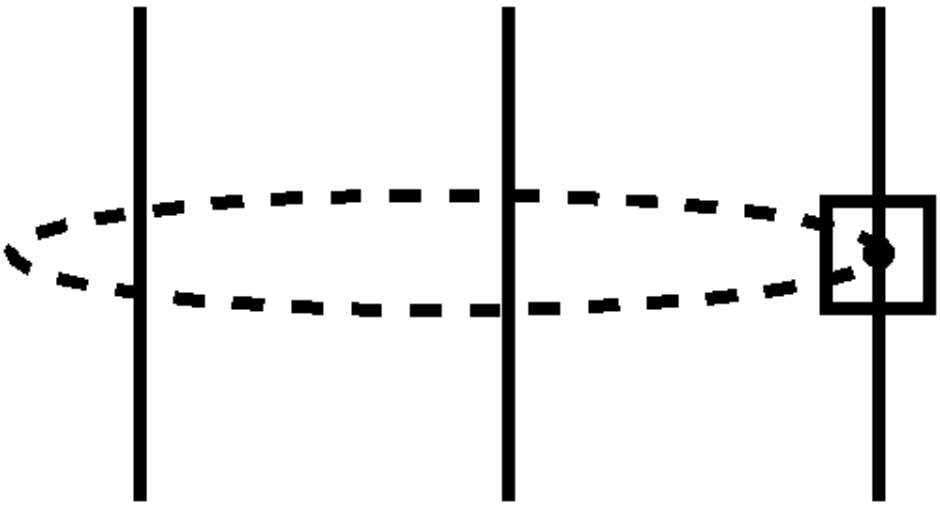
Symbol	Description
	Incomplete Physical Splice

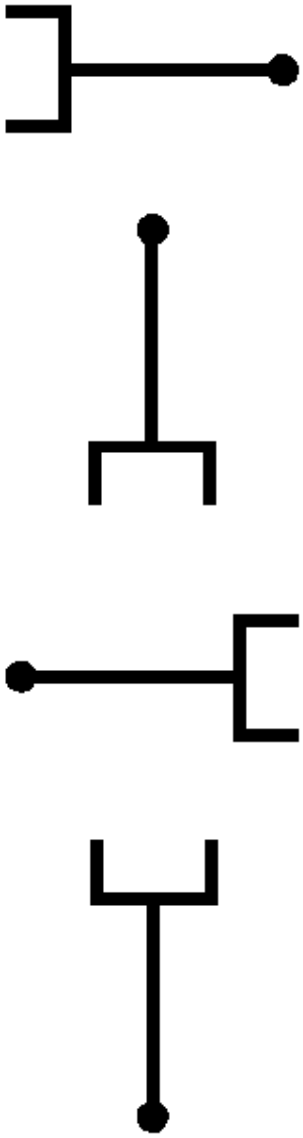
Symbol	Description
	Complete Physical Splice- 2 Wires

Symbol	Description
	Complete Physical Splice- 3 or more wires

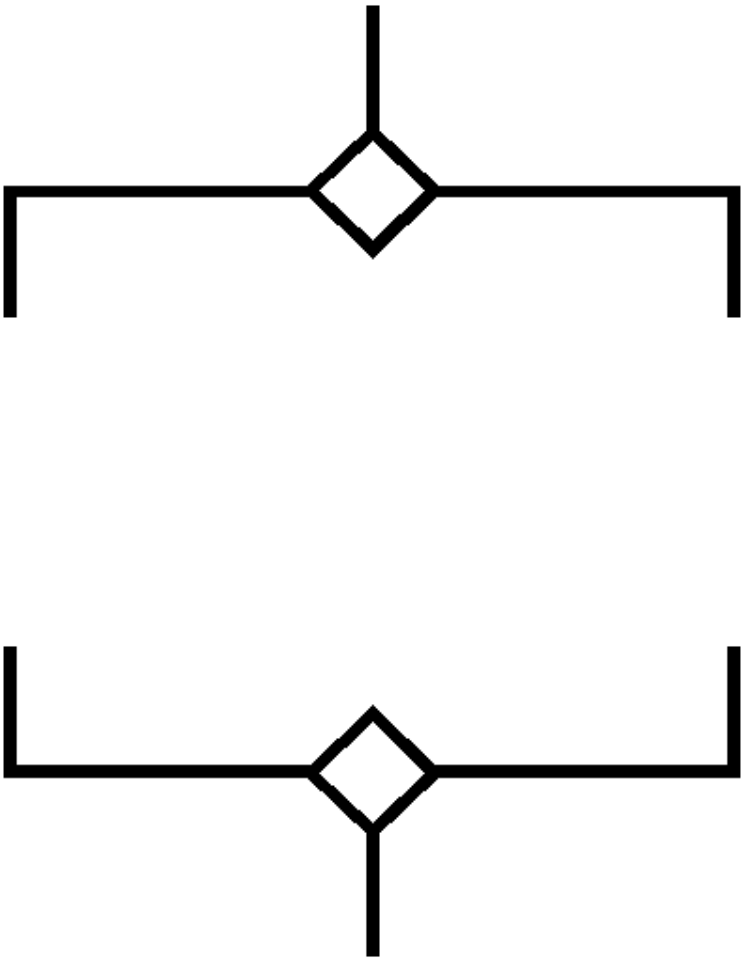
Symbol	Description
	Wire Crosses

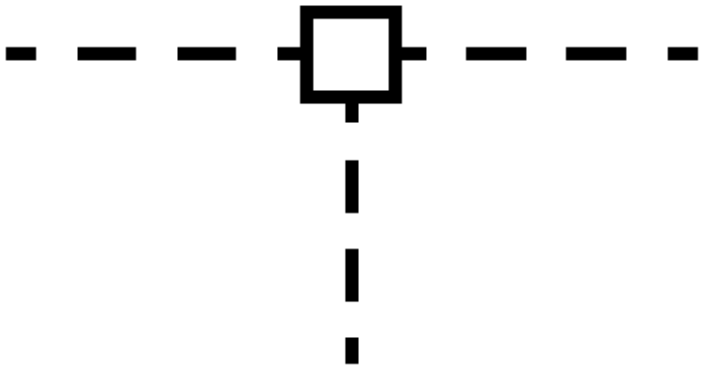
Symbol	Description
	Twisted Wires

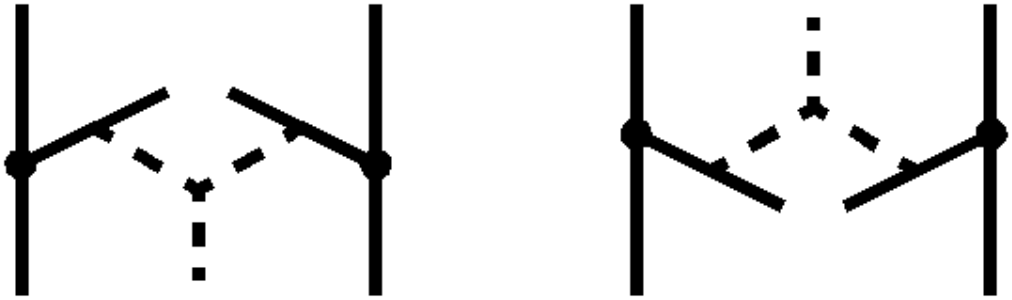
Symbol	Description
	Shield

Symbol	Description
	Circuit References

Symbol	Description
	Circuit Continuation Arrowheads

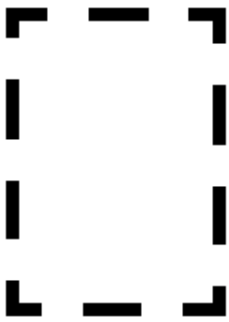
Symbol	Description
	Option Breakpoint

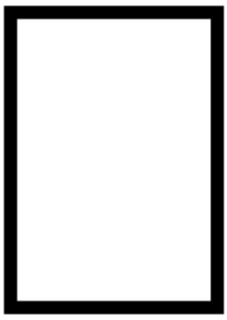
Symbol	Description
	Ground Circuit Connection

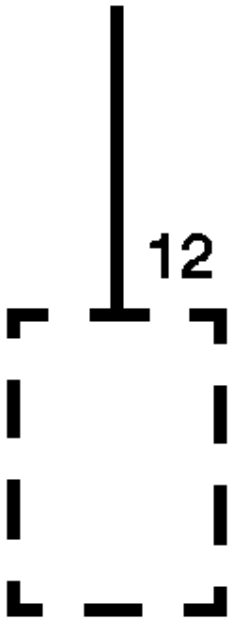
Symbol	Description
	Connector Shorting Clip

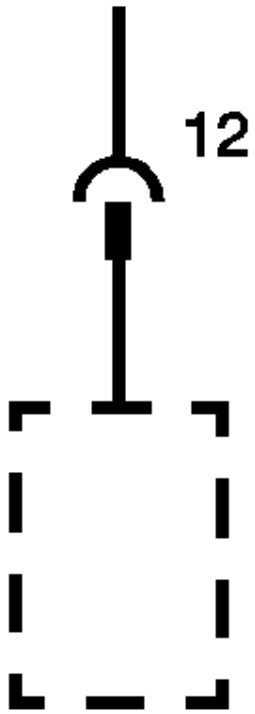
Component Parts

Symbol	Description

Symbol	Description
	Partial Component When a component is represented in a dashed box, the component or its wiring is not shown in its entirety.

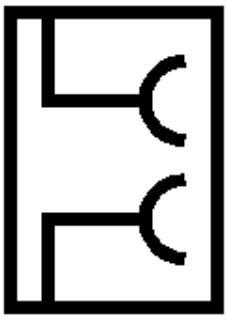
Symbol	Description
	Entire Component When a component is represented in a solid box the component or its wiring is shown in its entirety.

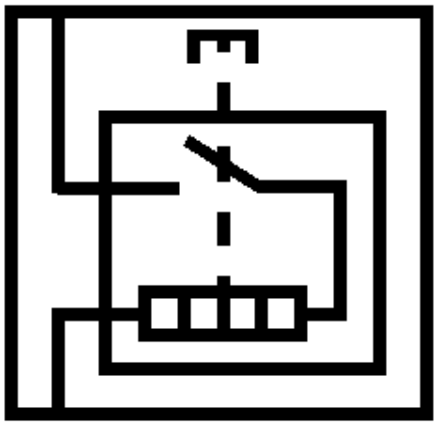
Symbol	Description
	Connector Directly Attached to Component

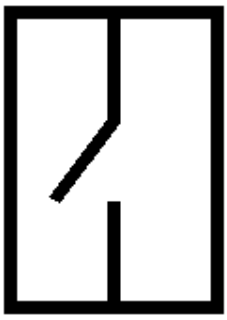
Symbol	Description
	Pigtail Connector

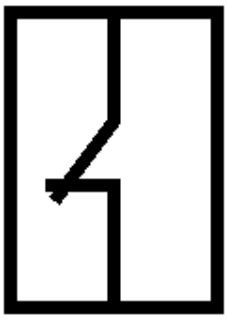
Switches and Relays

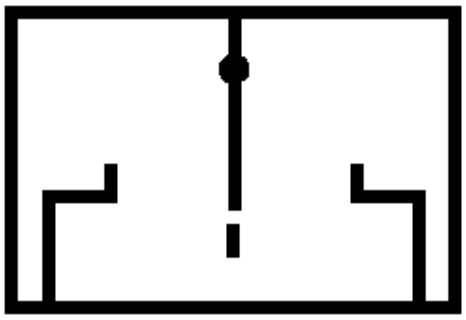
Symbol	Description

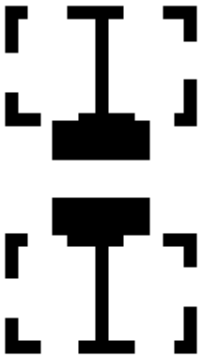
Symbol	Description
	Accessory Power Outlet

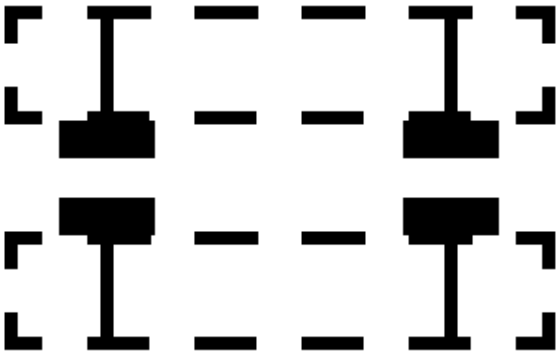
Symbol	Description
	Cigar Lighter

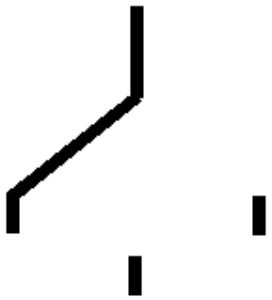
Symbol	Description
	Switch- 2 Position Normally Open

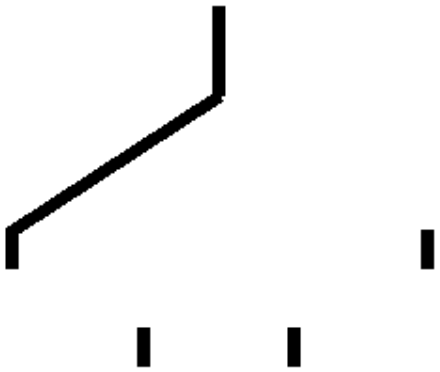
Symbol	Description
	Switch- 2 Position Normally Closed

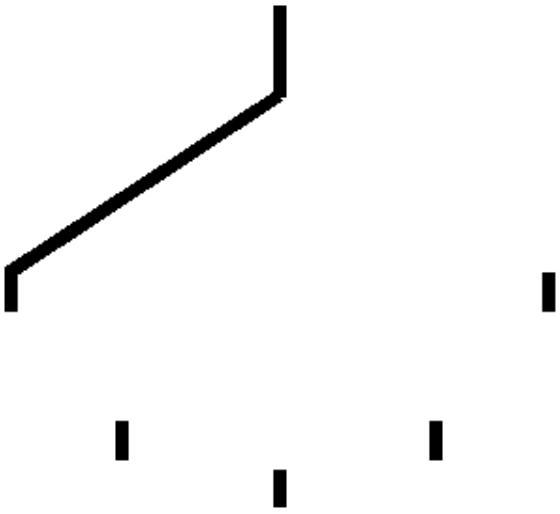
Symbol	Description
	Switch-Rocker

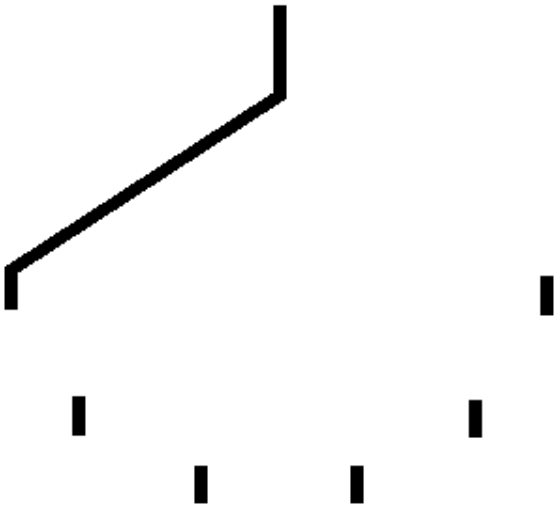
Symbol	Description
	Switch-Contact Plate (1 Wire)

Symbol	Description
	Switch-Contact Plate (2 Wire)

Symbol	Description
	Switch- 3 Position

Symbol	Description
	Switch- 4 Position

Symbol	Description
	Switch- 5 Position

Symbol	Description
	Switch- 6 Position

Symbol	Description
	Switch Actuator-Push (Momentary)

Symbol	Description
	Switch Actuator-Push (Latching)

Symbol	Description
	Switch Actuator-Pull (Momentary)

Symbol	Description
	Switch Actuator-Pull (Latching)

Symbol	Description
	Switch Actuator-Rotate (Momentary)

Symbol	Description
	Switch Actuator-Rotate (Latching)

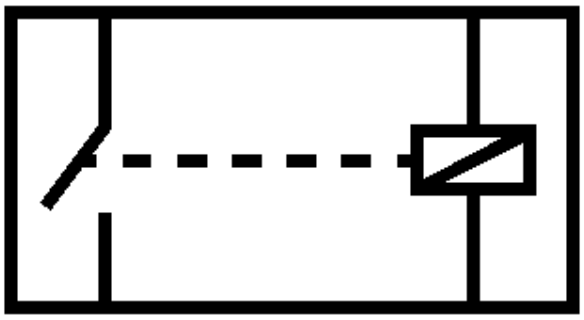
Symbol	Description
	Switch Actuator-Slide (Momentary)

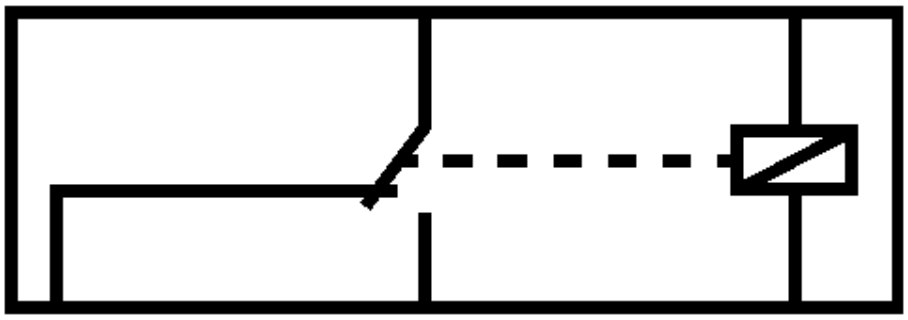
Symbol	Description
	Switch Actuator-Slide (Latching)

Symbol	Description
	Switch Actuator-Pressure (Momentary)

Symbol	Description
	Switch Actuator-Temperature (Momentary)

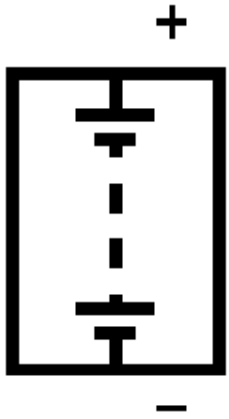
Symbol	Description
	Switch Actuator-Volume (Latching)

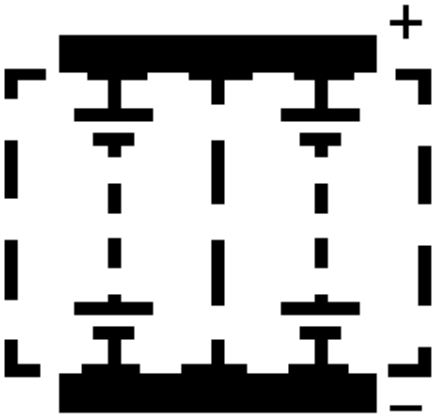
Symbol	Description
	4-Pin Single Pole/Throw Relay- Normally Open

Symbol	Description
	5-Pin Relay-Normally Closed

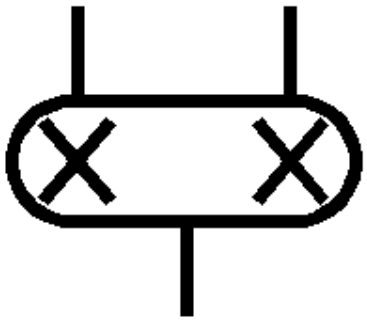
Devices and Sensors

Symbol	Description

Symbol	Description
	Battery

Symbol	Description
	Battery Assembly-Hybrid

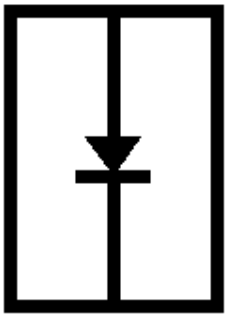
Symbol	Description
	Single Filament Light Bulb

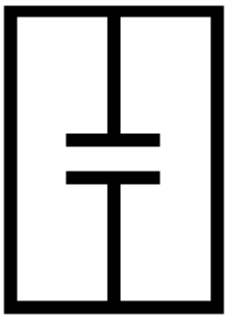
Symbol	Description
	Double Filament Light Bulb

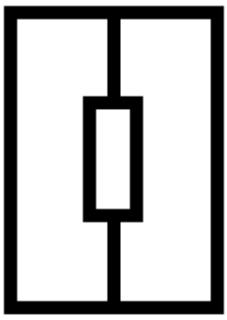
Symbol	Description
	Light Emitting Diode (LED)

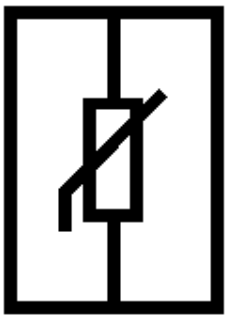
Symbol	Description
	Photo Sensor

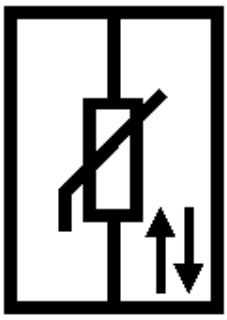
Symbol	Description
	Gauge

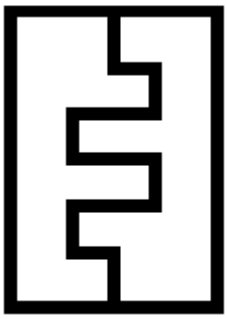
Symbol	Description
	Diode

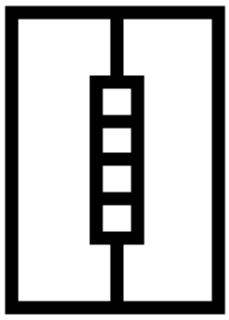
Symbol	Description
	Capacitor

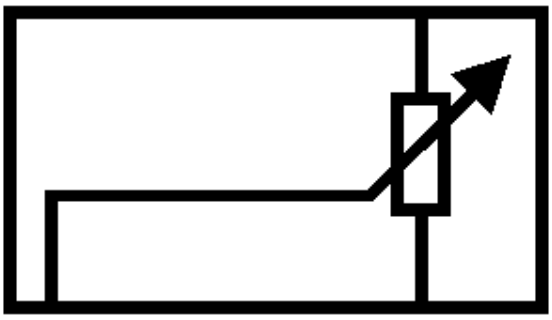
Symbol	Description
	Resistor

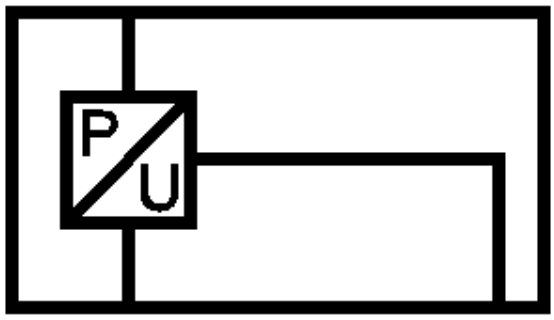
Symbol	Description
	Variable Resistor

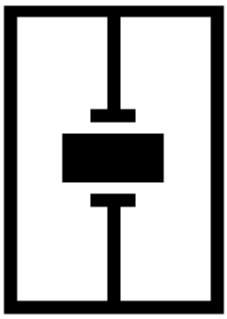
Symbol	Description
	Variable Resistor-NTC

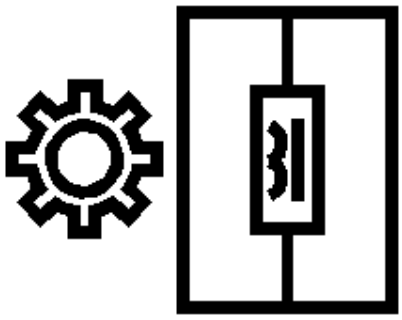
Symbol	Description
	Breakable Wire

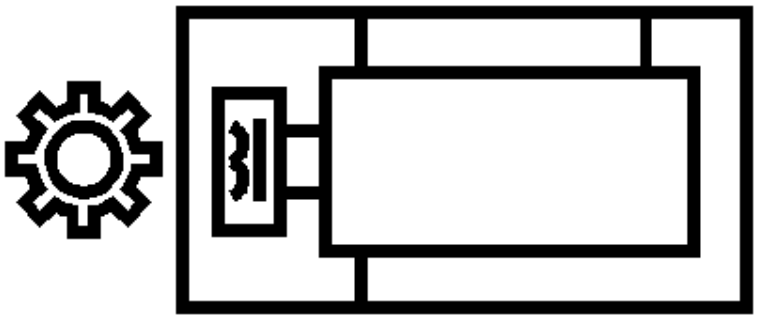
Symbol	Description
	Heating Element

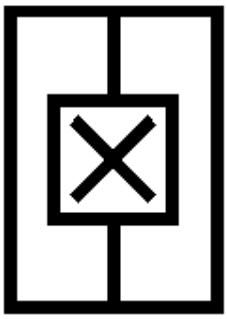
Symbol	Description
	Position Sensor

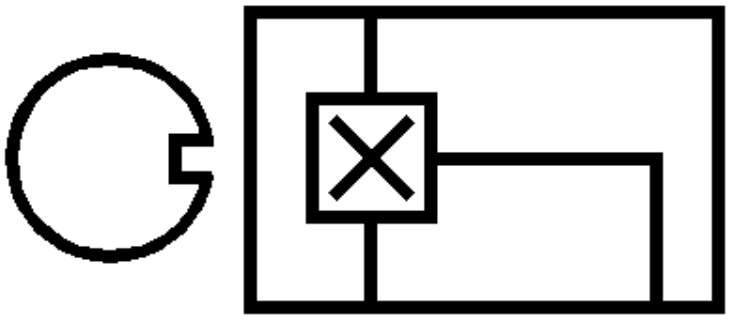
Symbol	Description
	Pressure Sensor

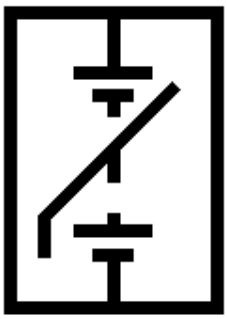
Symbol	Description
	Knock Sensor

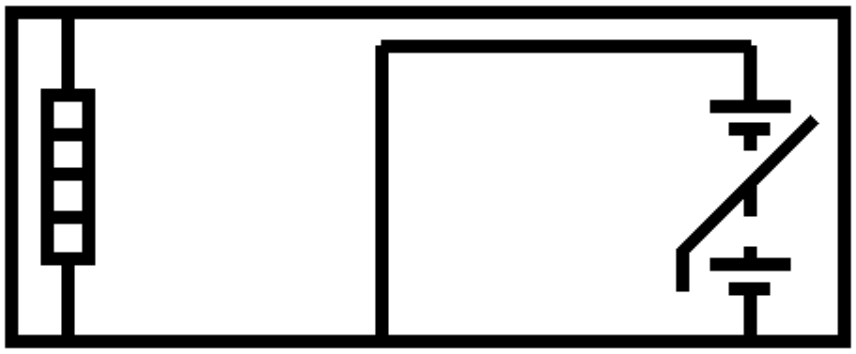
Symbol	Description
	Inductive Type Sensor-2-Wire

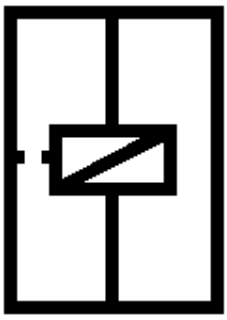
Symbol	Description
	Inductive Type Sensor- 3-Wire

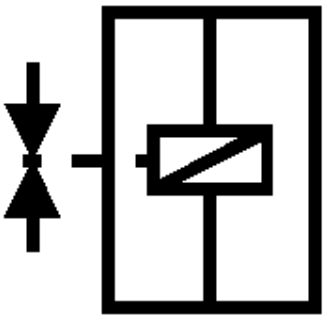
Symbol	Description
	Hall Effect Sensor- 2-Wire

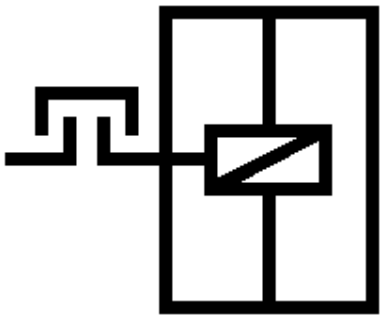
Symbol	Description
	Hall Effect Sensor- 3-Wire

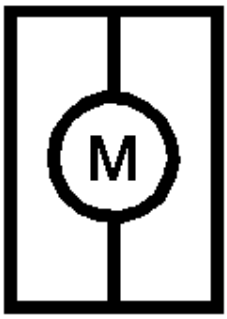
Symbol	Description
	Oxygen Sensor-2-Wire

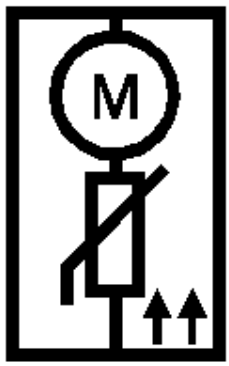
Symbol	Description
	Heated Oxygen Sensor-4-Wire

Symbol	Description
	Solenoid-Actuator

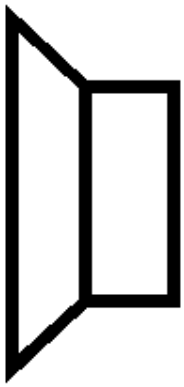
Symbol	Description
	Solenoid-Valve

Symbol	Description
	Clutch

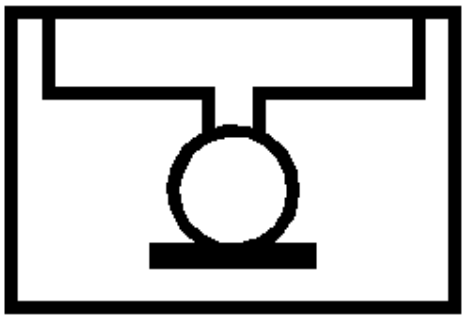
Symbol	Description
	Motor

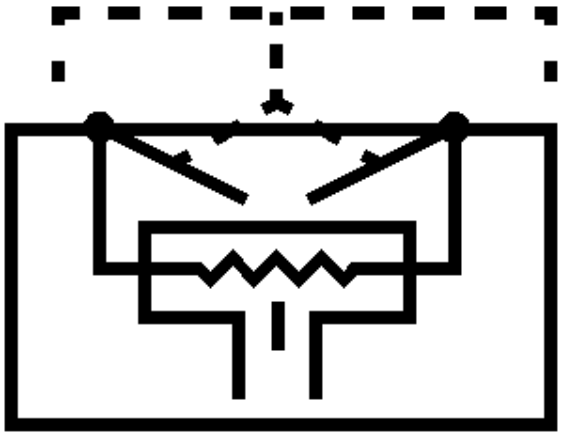
Symbol	Description
	Motor with PTC

Symbol	Description
	Antenna

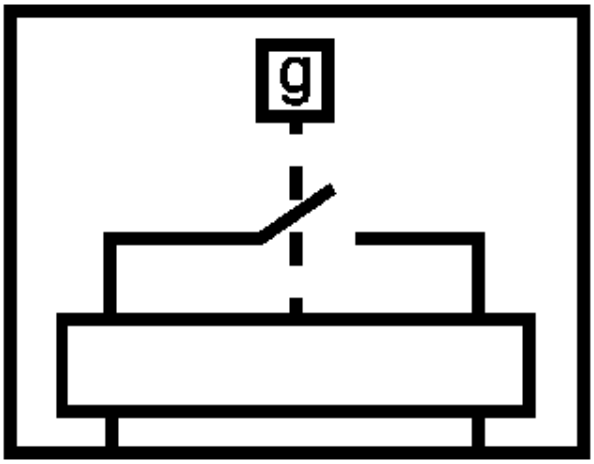
Symbol	Description
	Speaker

Symbol	Description
	Horn

Symbol	Description
	Microphone

Symbol	Description
	Airbag

Symbol	Description
	SIR Coil

Symbol	Description
	SIR Impact Sensor

Vehicle Zoning Strategy

All grounds, in-line connectors, and splices have identifying numbers that correspond to where they are located in the vehicle. The following table explains the numbering system.

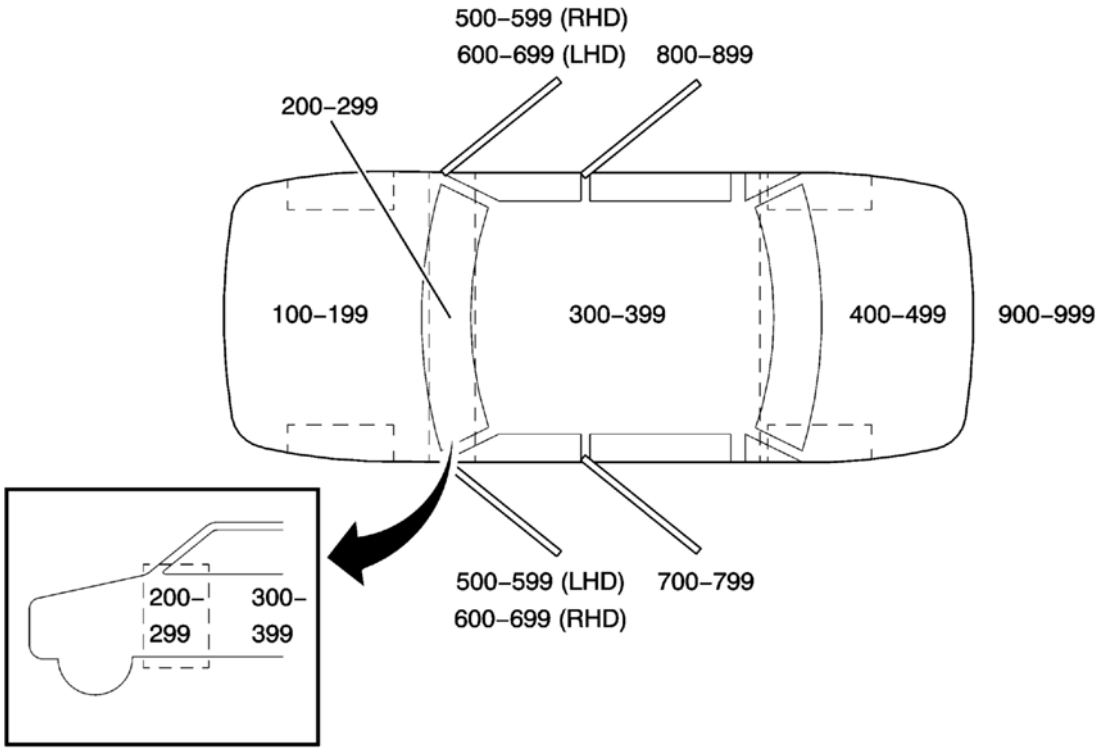


Fig. 23: Passenger Car Zoning View
Courtesy of GENERAL MOTORS COMPANY

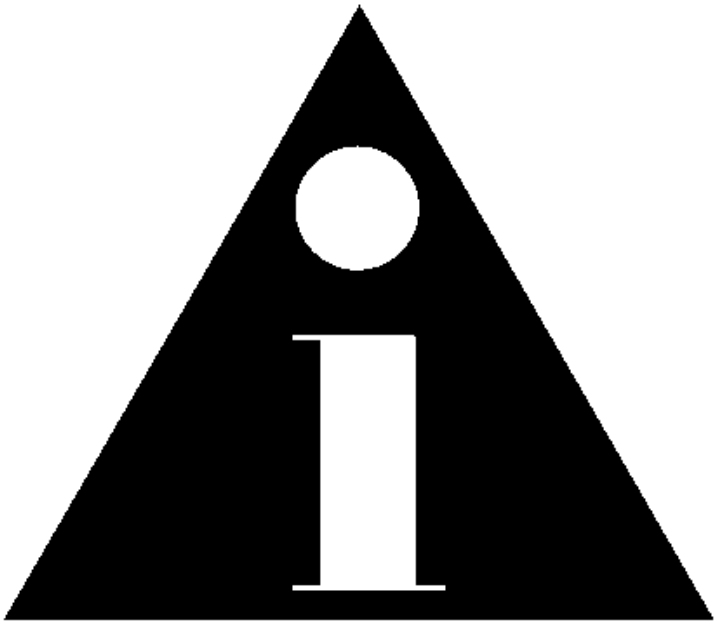
Callout Numbers	Zone Description
100-199	Engine compartment (all forward of the instrument panel)
200-299	Within the instrument panel area (between the bulkhead and the front plane of the instrument panel)
300-399	Passenger compartment (from instrument panel to the back of the rear seats)
400-499	Luggage compartment (from the back of the rear seats to the rear of the vehicle)
500-599	Inline harness connectors to or within the driver door
600-699	Inline harness connectors to or within the front passenger door
700-799	Inline harness connectors to or within the left rear door
800-899	Inline harness connectors to or within the right rear door
900-999	Inline harness connectors to or within the luggage compartment lid or hatch

Master Electrical Schematic Icons

Icon	Icon Definition

Icon	Icon Definition
	WARNING: **When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Refer to SIR Disabling and Enabling . Failure to observe the correct procedure could cause deployment of the SIR components, personal injury, or unnecessary SIR system repairs.**
	NOTE: **Twisted-pair wires provide an effective shield that helps protect sensitive electronic components from electrical interference.** **In order to prevent electrical interference from degrading the performance of the connected components, you must maintain the proper specification**

Icon	Icon Definition
	when making any repairs to the twisted-pair wires shown : • **The wires must be twisted a minimum of 9 turns per 31 cm (12 in) as measured anywhere along the length of the wires.** • **The outside diameter of the twisted wires must not exceed 6.0 mm (0.25 in).**

Icon	Icon Definition
	**NOTE:** **The following component has pin numbers that are known to have been changed during production by the wiring harness supplier.** • **JX206 The following lists what cavities are bussed to battery positive voltage and ignition 1 voltage: Pins A, B, C, D, E, and F are all attached to the ignition 1 voltage bus while pins G, H, J, K, and L are all attached to the battery positive**

Icon	Icon Definition

Power Distribution Schematics

Fuse Block- Underhood Bussing

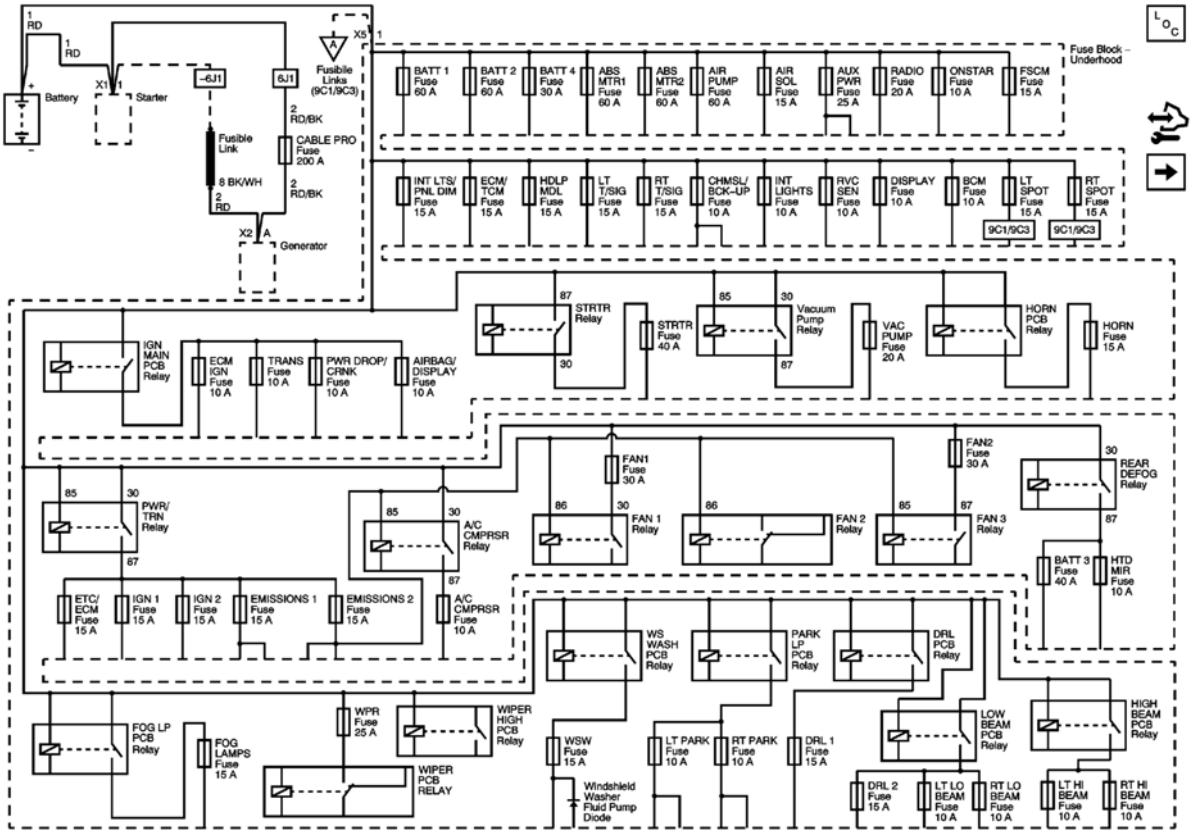


Fig. 24: Fuse Block Wiring Schematic -- Underhood Bussing
Courtesy of GENERAL MOTORS COMPANY

SEO (9C1 or 9C3)

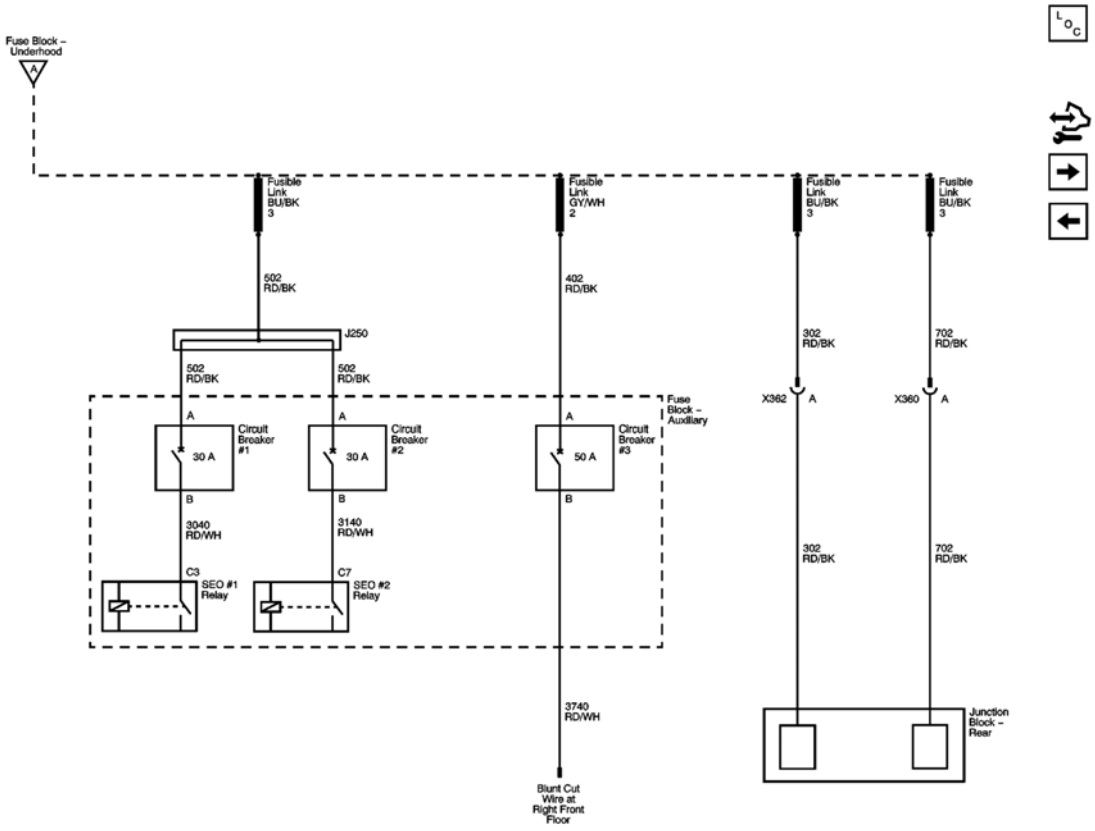


Fig. 25: SEO Wiring Schematic (9C1 or 9C3)

Courtesy of GENERAL MOTORS COMPANY

Ignition Switch

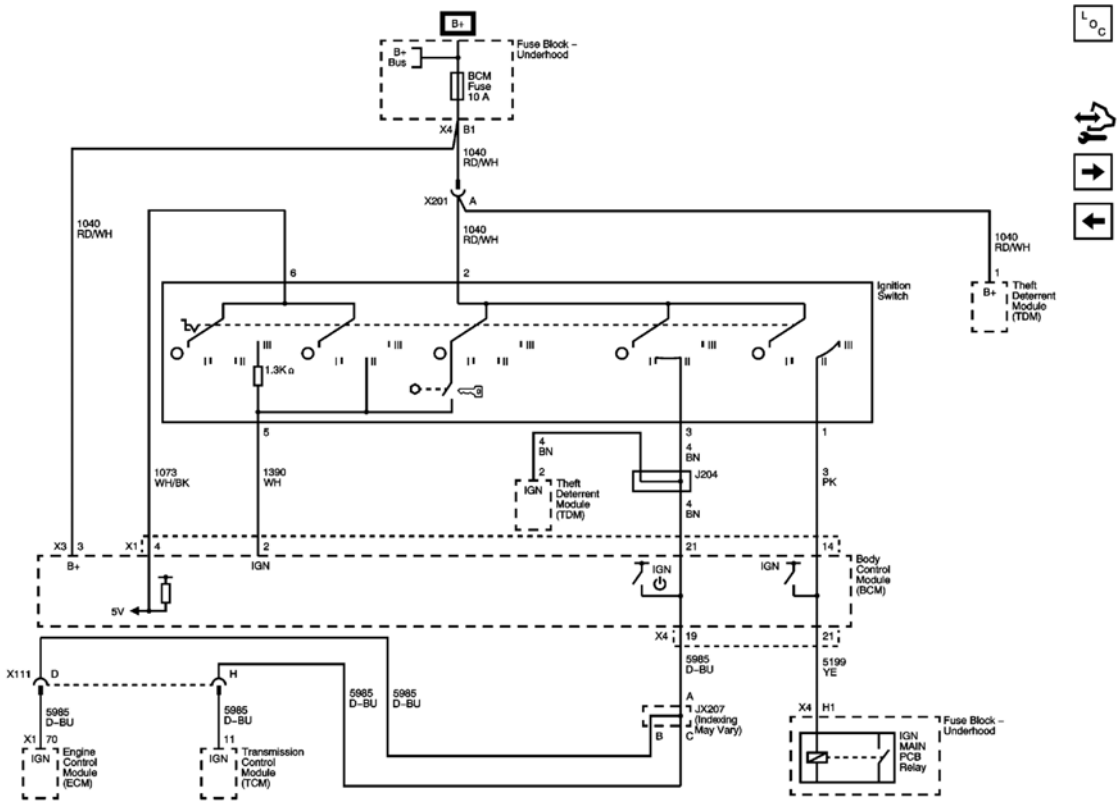


Fig. 26: Ignition Switch Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

AMP, AUX, BATT 1, CNSTR, TRUNK, XM Fuses

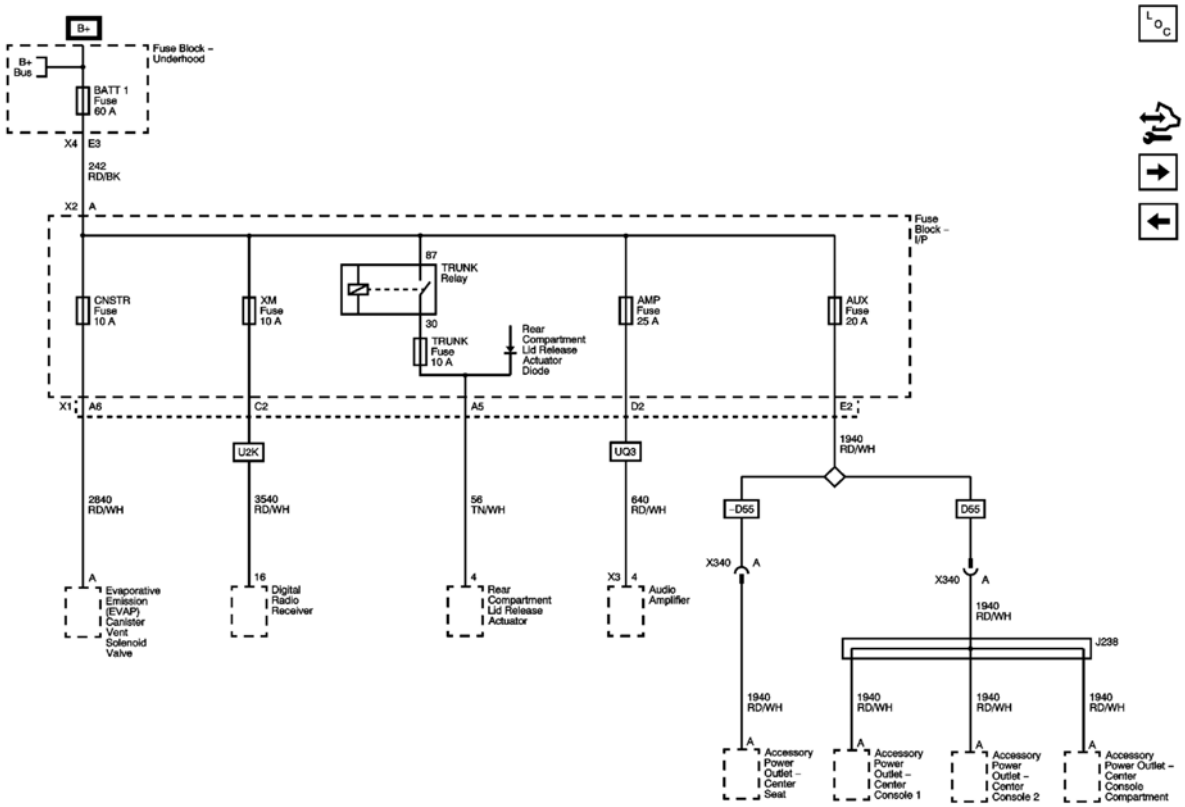


Fig. 27: AMP, AUX, BATT 1, CNSTR, TRUNK, XM Fuses Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

AIRBAG, BATT 2, HTD/SEAT, PWR/MIR Fuses, and PWR/SEAT Circuit Breaker

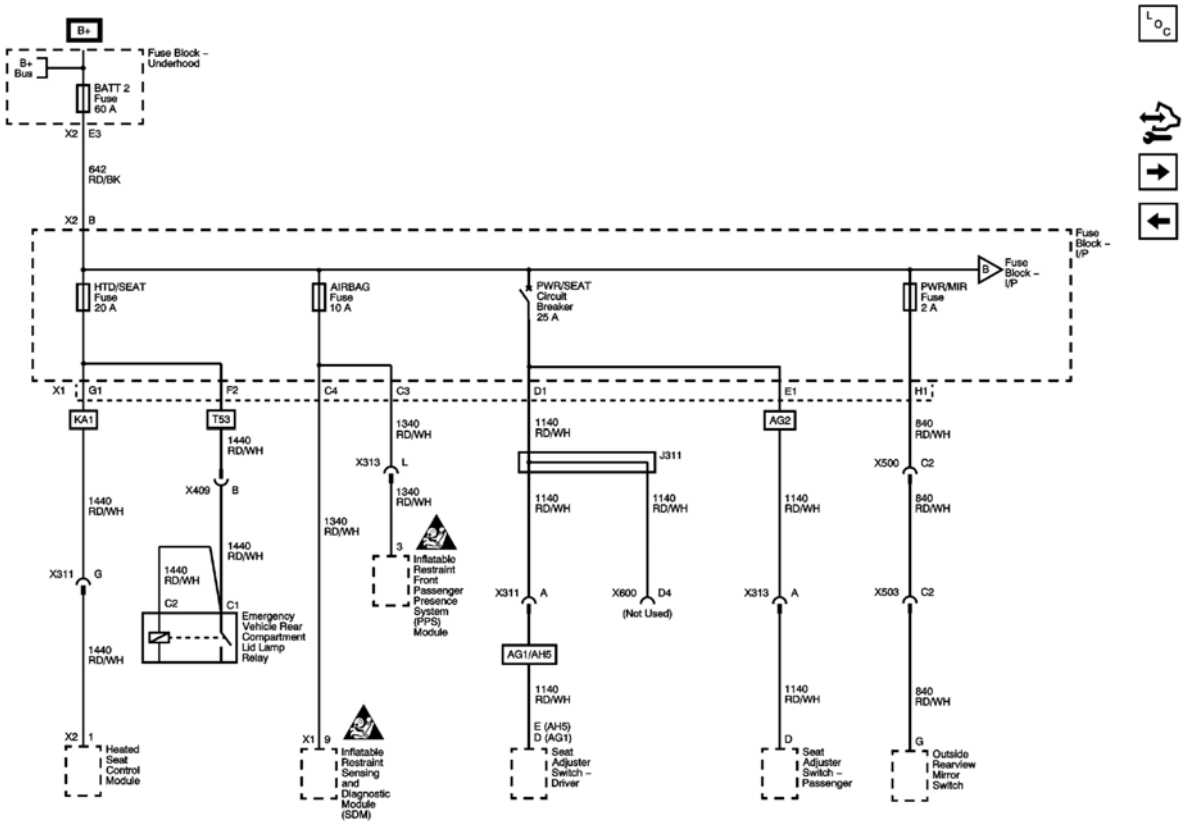


Fig. 28: AIRBAG, BATT 2, HTD/SEAT, PWR/MIR Fuses, and PWR/SEAT Circuit Breaker Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

DR/LCK, RAP, S/ROOF Fuses

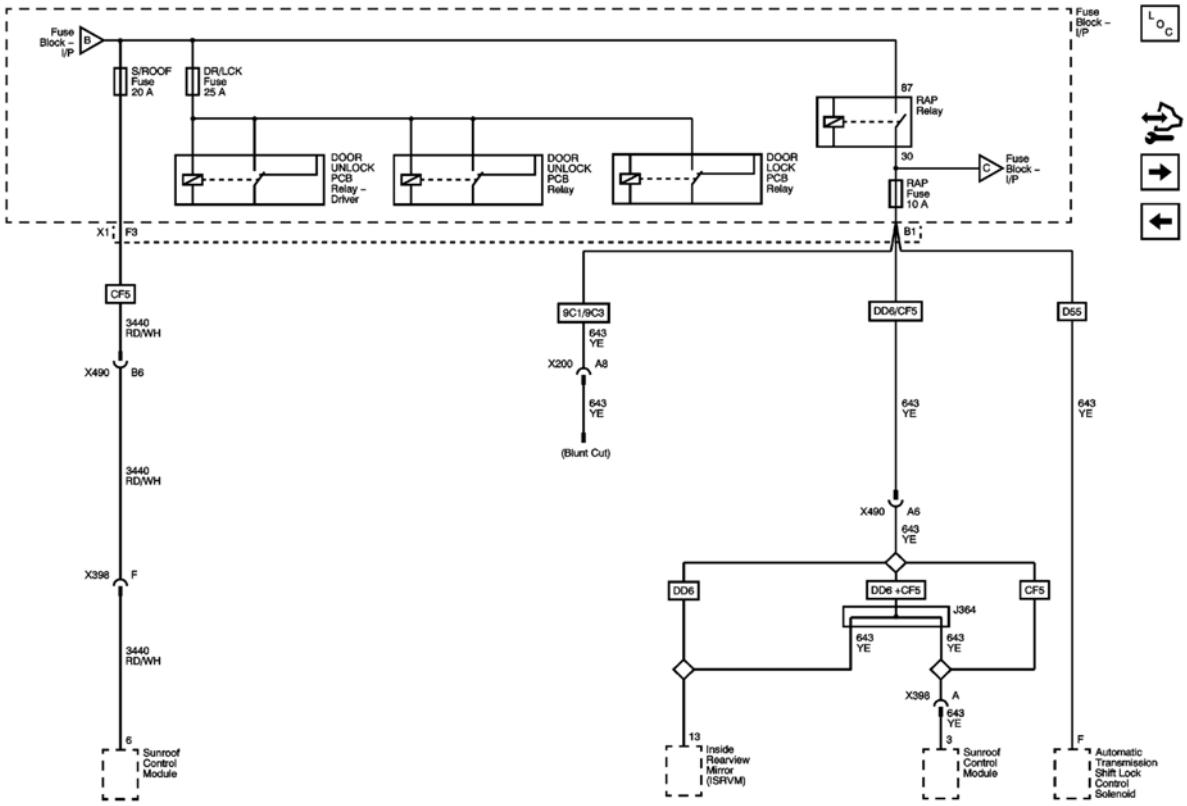


Fig. 29: DR/LCK, RAP, S/ROOF Fuses Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

ABS MTR1, ABS MTR2, AIR PUMP, AIR SOL, AUX PWR, BATT 4, Radio Fuses, and PWR/WNDW Circuit Breaker

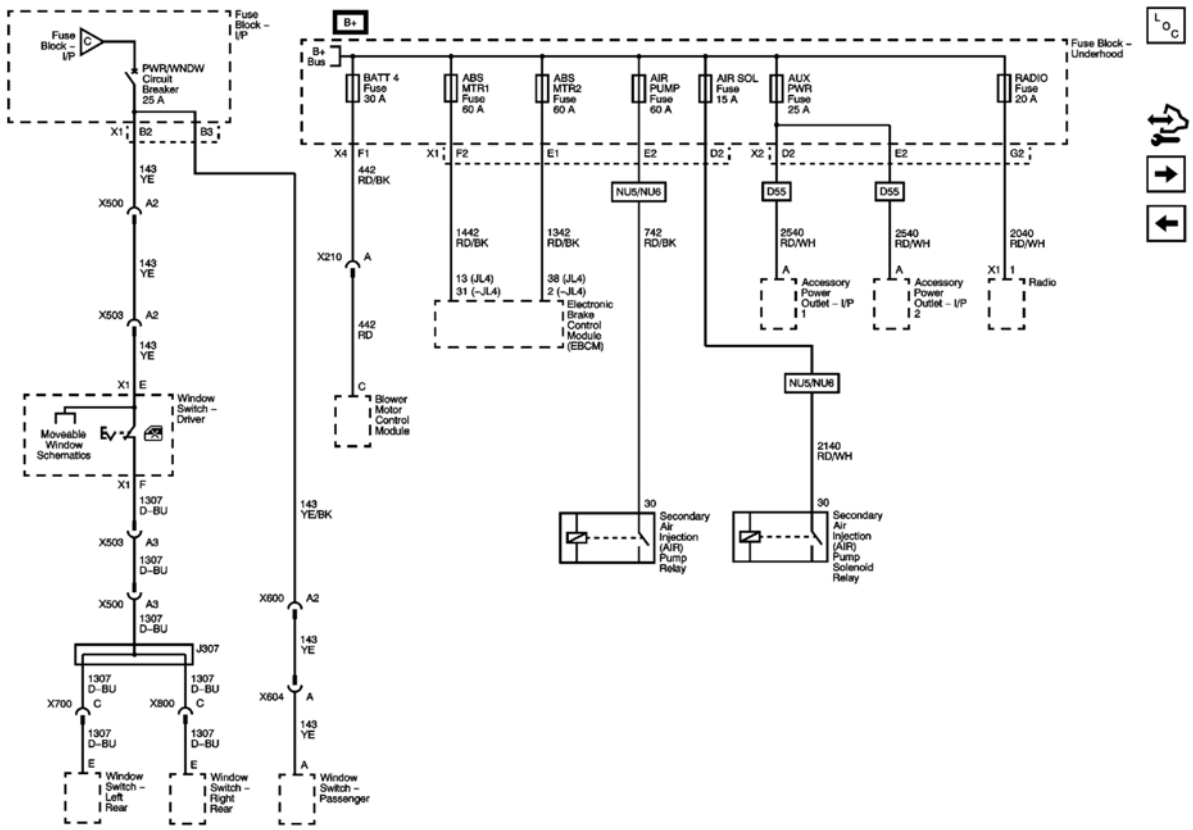


Fig. 30: ABS MTR1, ABS MTR2, AIR PUMP, AIR SOL, AUX PWR, BATT 4, Radio Fuses, and PWR/WNDW Circuit Breaker Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

CHMSL/BCK-UP, ECM/TCM, INT LIGHTS, INT LTS/PNL DIM, LT T/SIG, ONSTAR, RT T/SIG, and RVC SEN Fuses

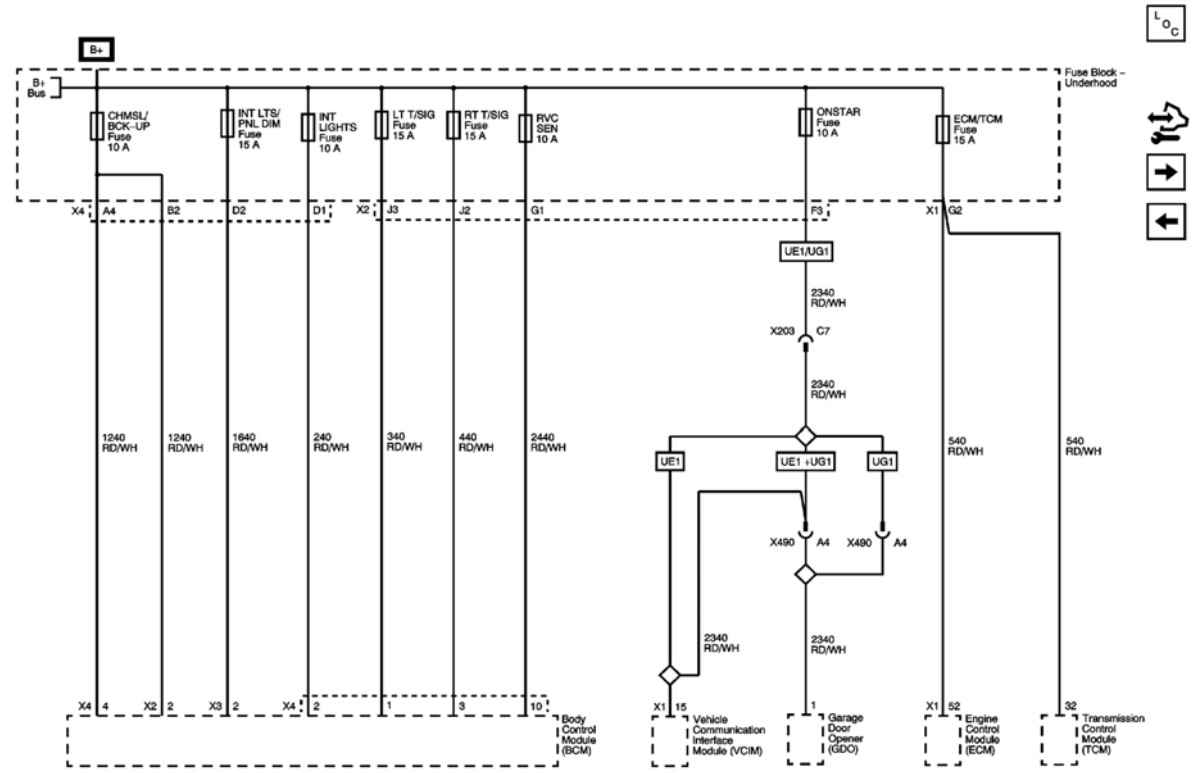


Fig. 31: CHMSL/BCK-UP, ECM/TCM, INT LIGHTS, INT LTS/PNL DIM, LT T/SIG, ONSTAR, RT T/SIG, and RVC SEN Fuses Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DISPLAY, HDLP MDL, LT SPOT, and RT SPOT Fuses

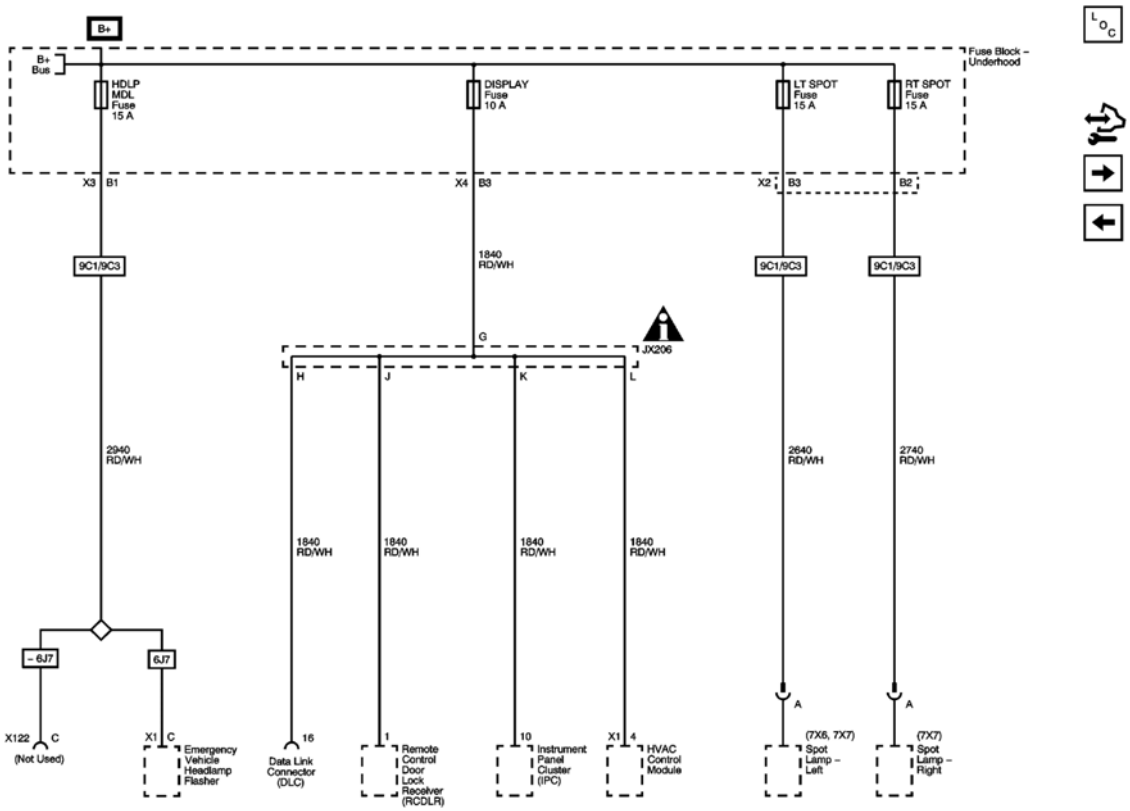


Fig. 32: DISPLAY, HDLP MDL, LT SPOT, and RT SPOT Fuses Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

AIRBAG/DISPLAY, ECM IGN, FUEL/PUMP, HORN, PWR DROP/CRNK, STRTR, and TRANS Fuses

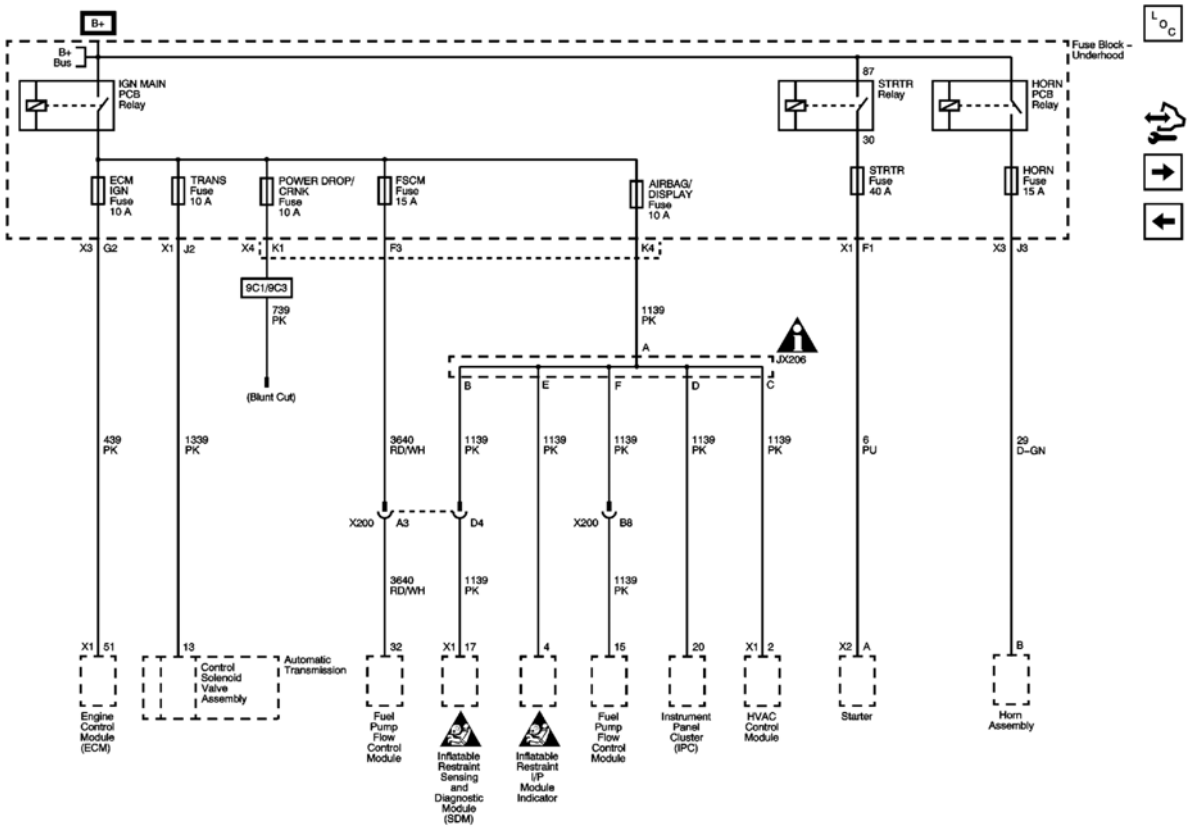


Fig. 33: AIRBAG/DISPLAY, ECM IGN, FUEL/PUMP, HORN, PWR DROP/CRNK, STRTR, and TRANS Fuses Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

ETC/ECM, IGN 1, and IGN 2 Fuses

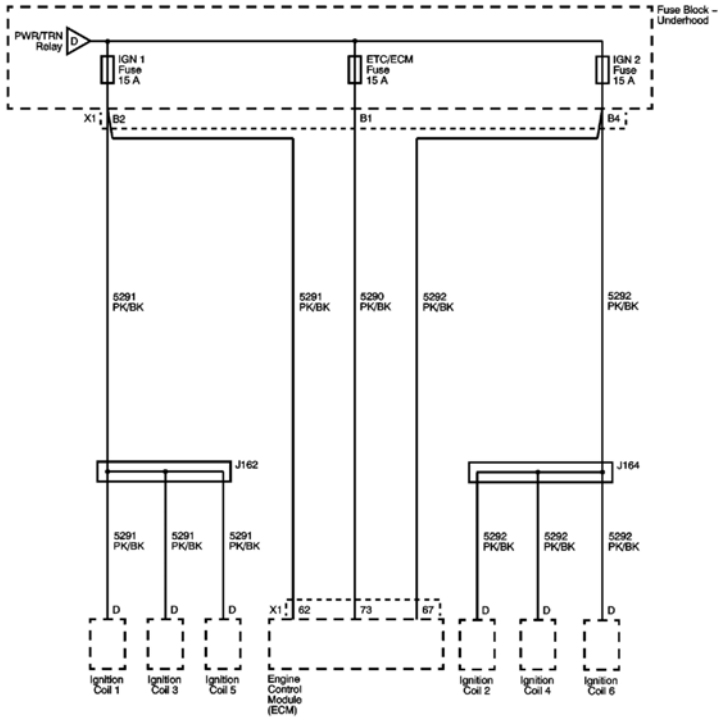


Fig. 34: ETC/ECM, IGN 1, and IGN 2 Fuses Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

A/C CMPRSR, EMISSIONS 1, and EMISSIONS 2 Fuses

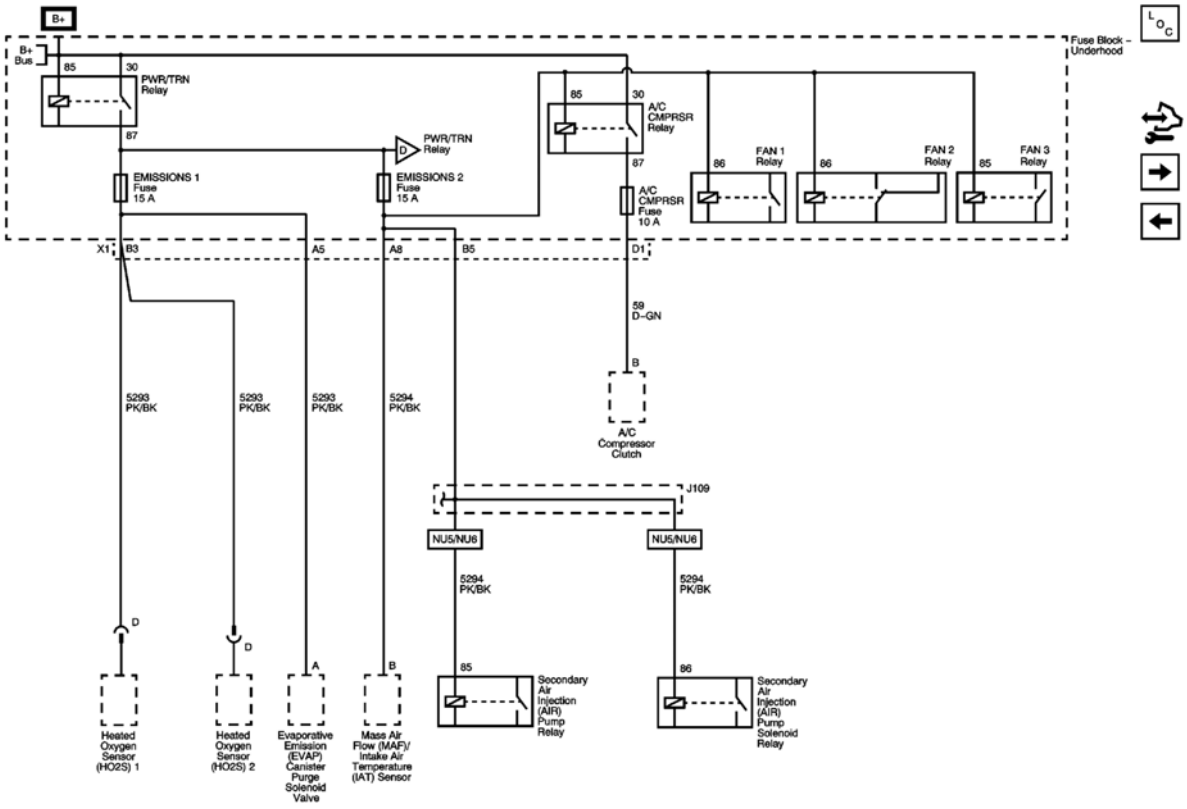


Fig. 35: A/C CMPRSR, EMISSIONS 1, and EMISSIONS 2 Fuses Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

BATT 3, FOG LAMPS, HTD MIR, LT PARK, RT PARK, and WSW Fuses

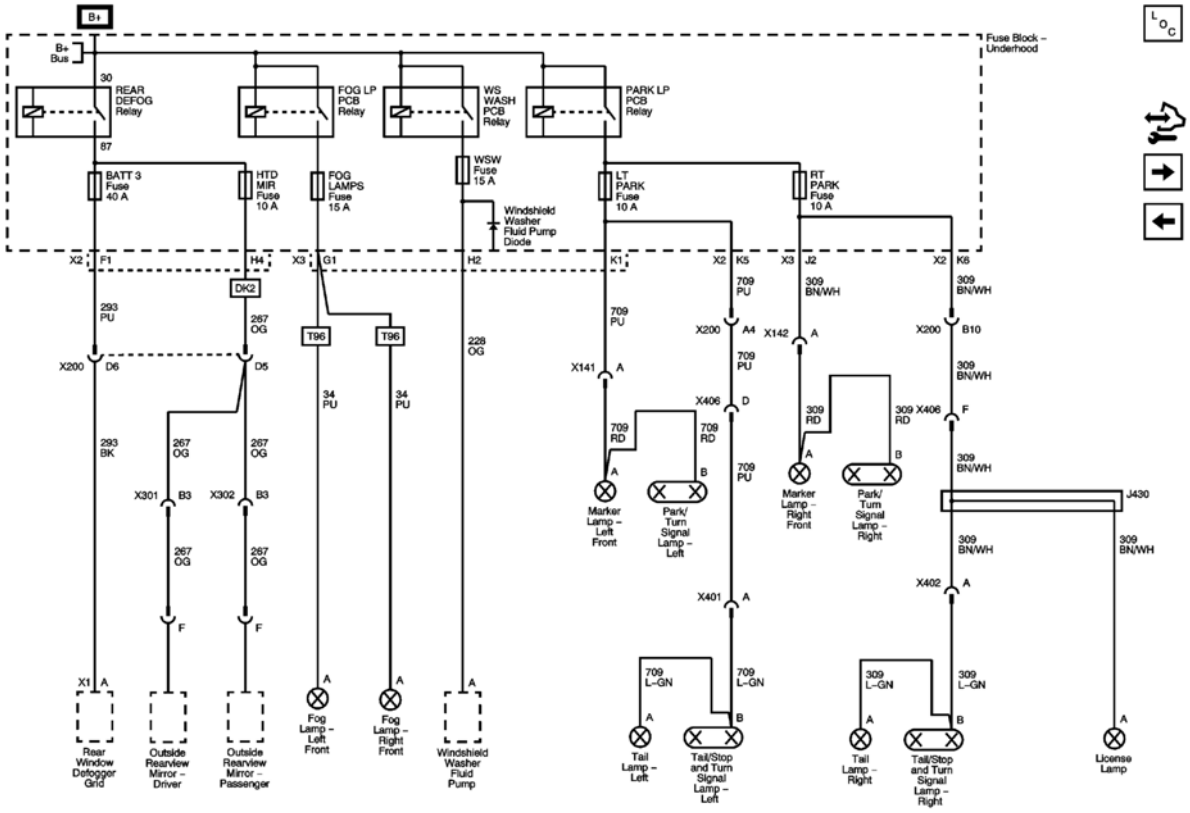


Fig. 36: BATT 3, FOG LAMPS, HTD MIR, LT PARK, RT PARK, and WSW Fuses Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DRL 1, DRL 2, LT HI BEAM, LT LO BEAM, RT HI BEAM, RT LO BEAM, and STRG WHL Fuses

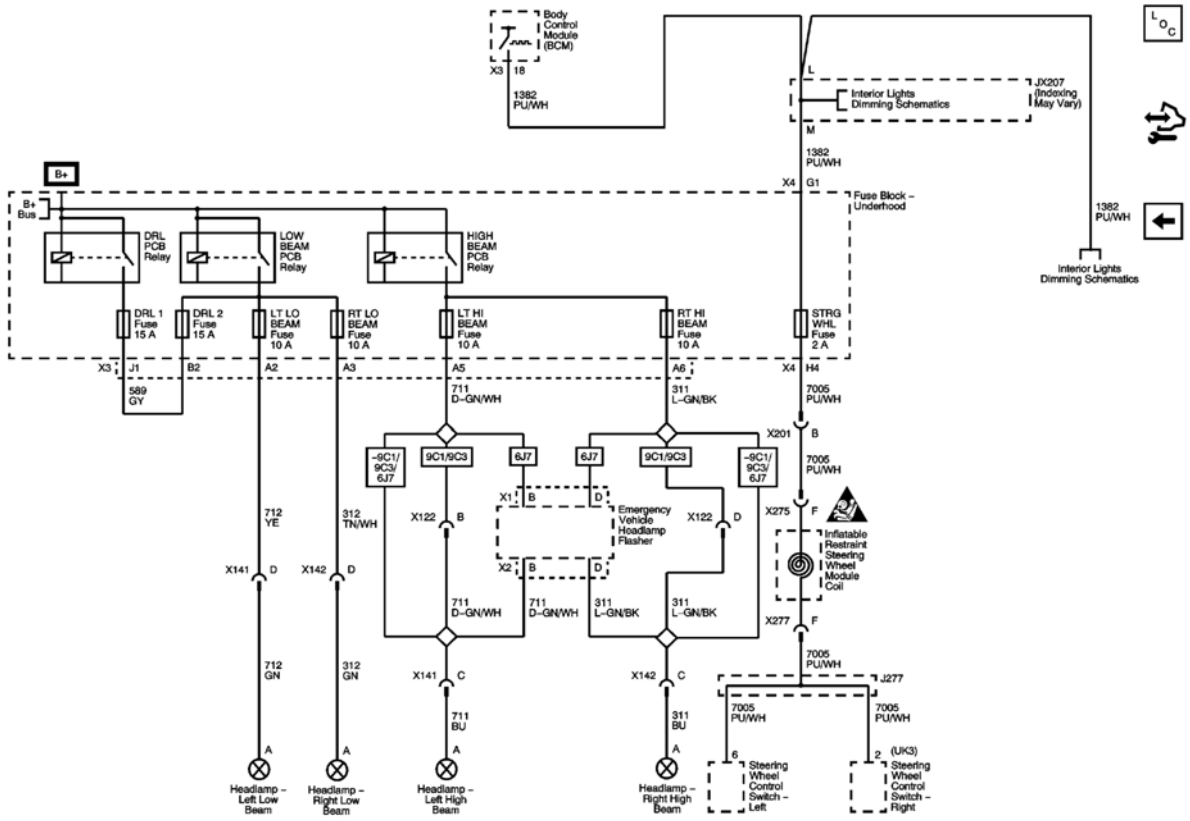


Fig. 37: DRL 1, DRL 2, LT HI BEAM, LT LO BEAM, RT HI BEAM, RT LO BEAM, and STRG WHL Fuses Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

Power Moding Schematics

RAP Fuse Circuits

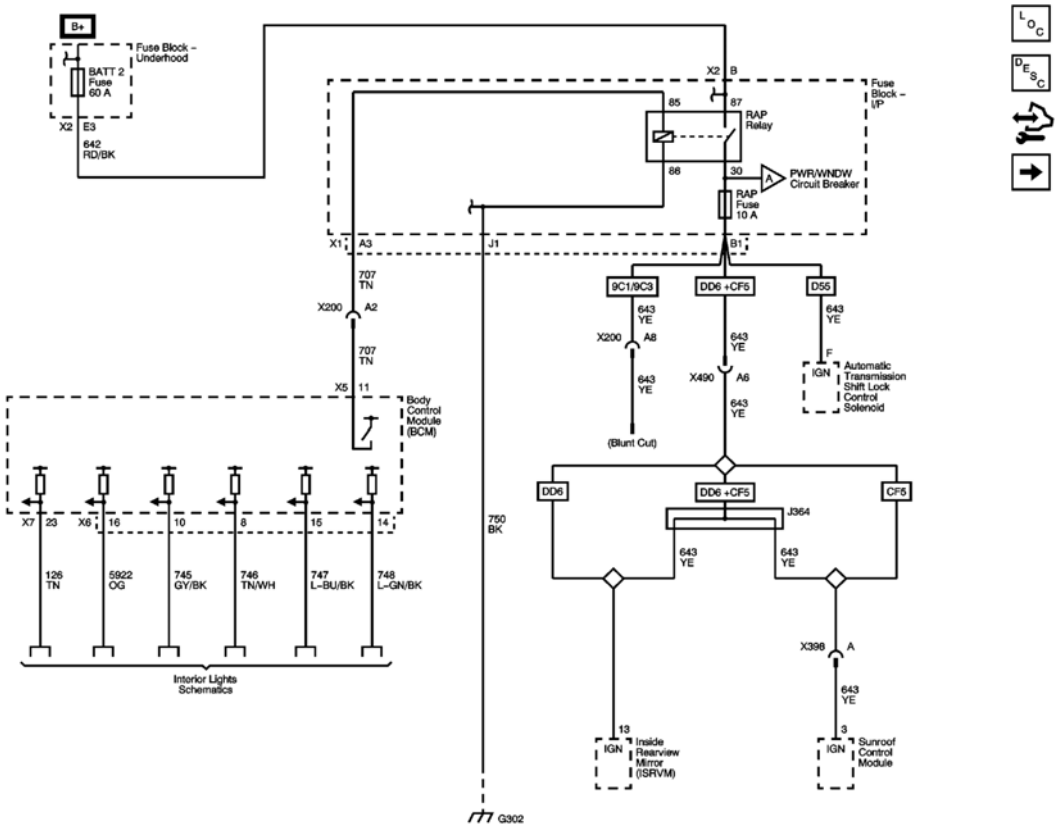


Fig. 38: RAP Fuse Circuits Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

Power Window Circuits

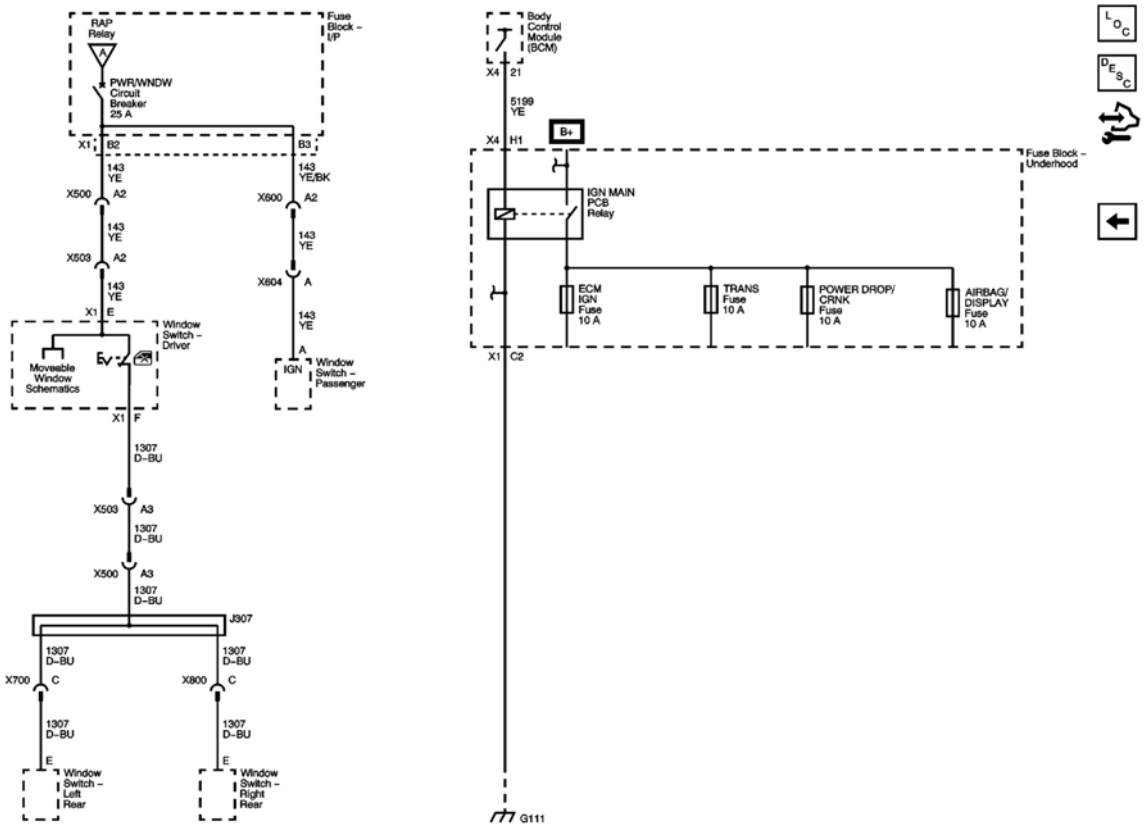


Fig. 39: Power Window Circuits Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Ignition Lock Schematics

Ignition Lock

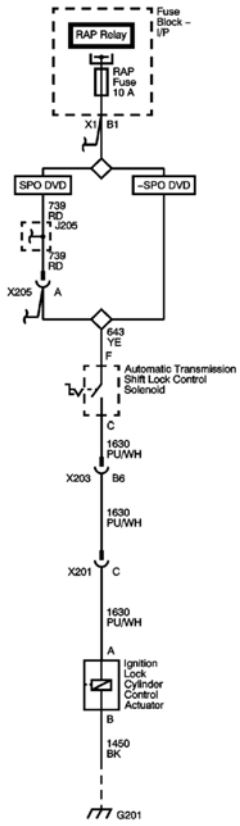


Fig. 40: Ignition Lock Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Ground Distribution Schematics

G100

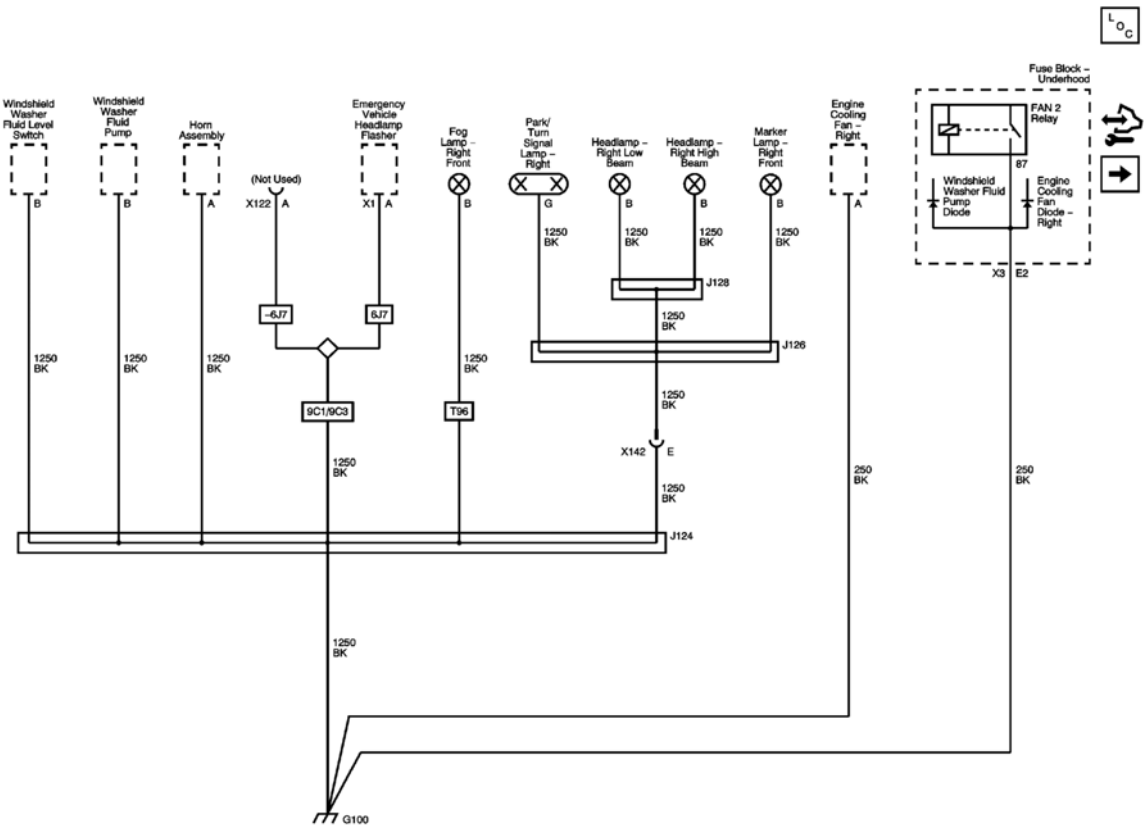


Fig. 41: G100 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

G101, G102, and G111

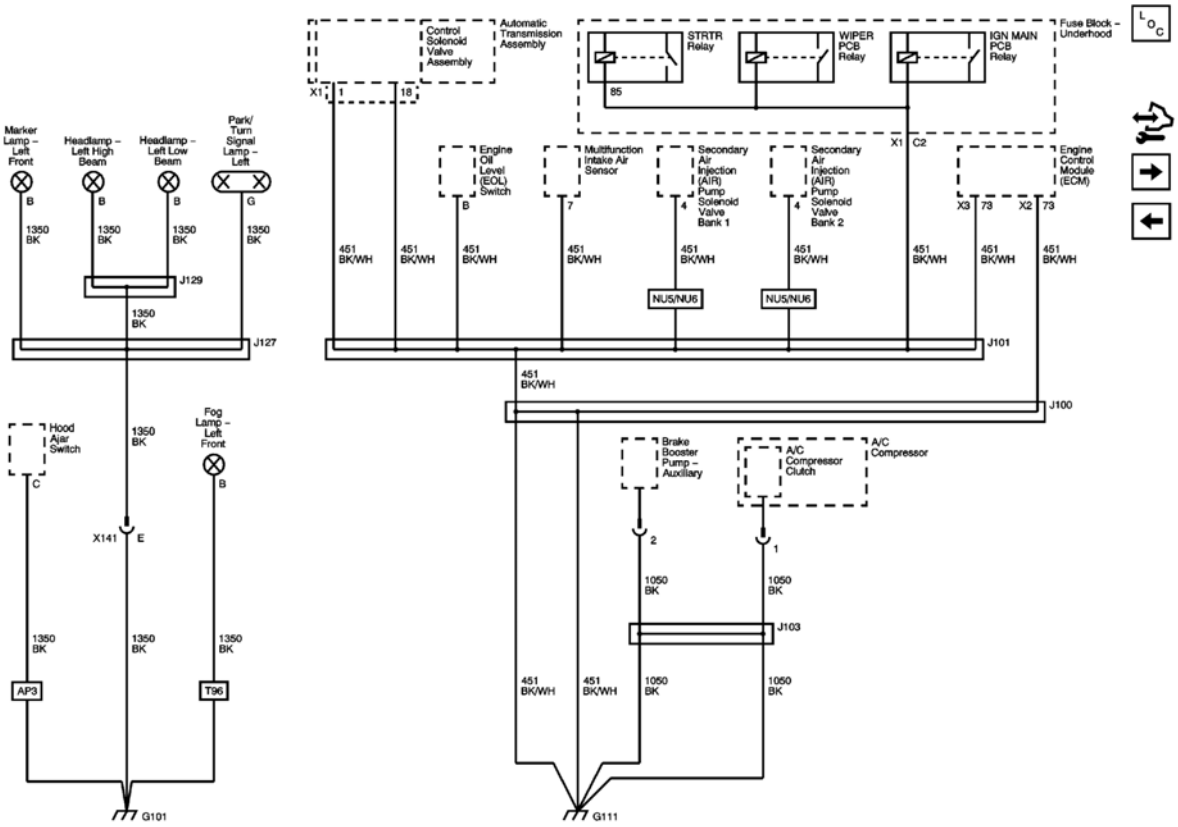


Fig. 42: G101, G102, and G111 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

G112 and G115

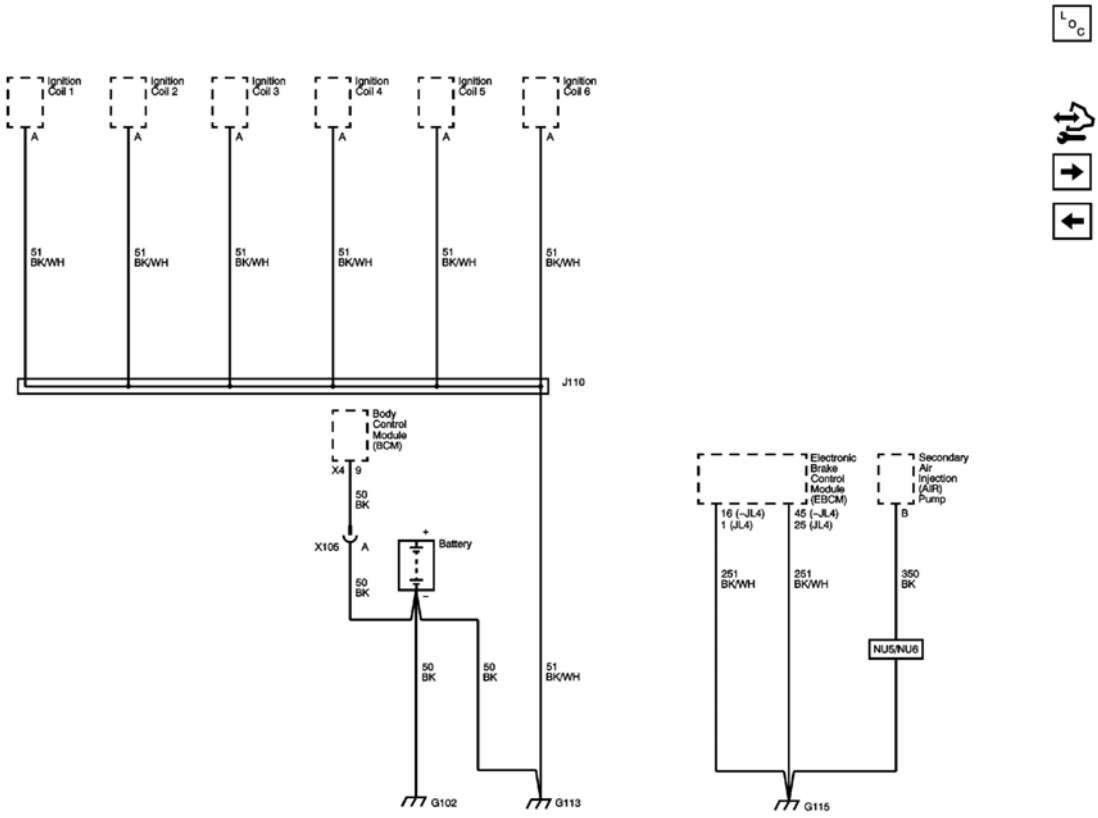


Fig. 43: G112 and G115 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

G200

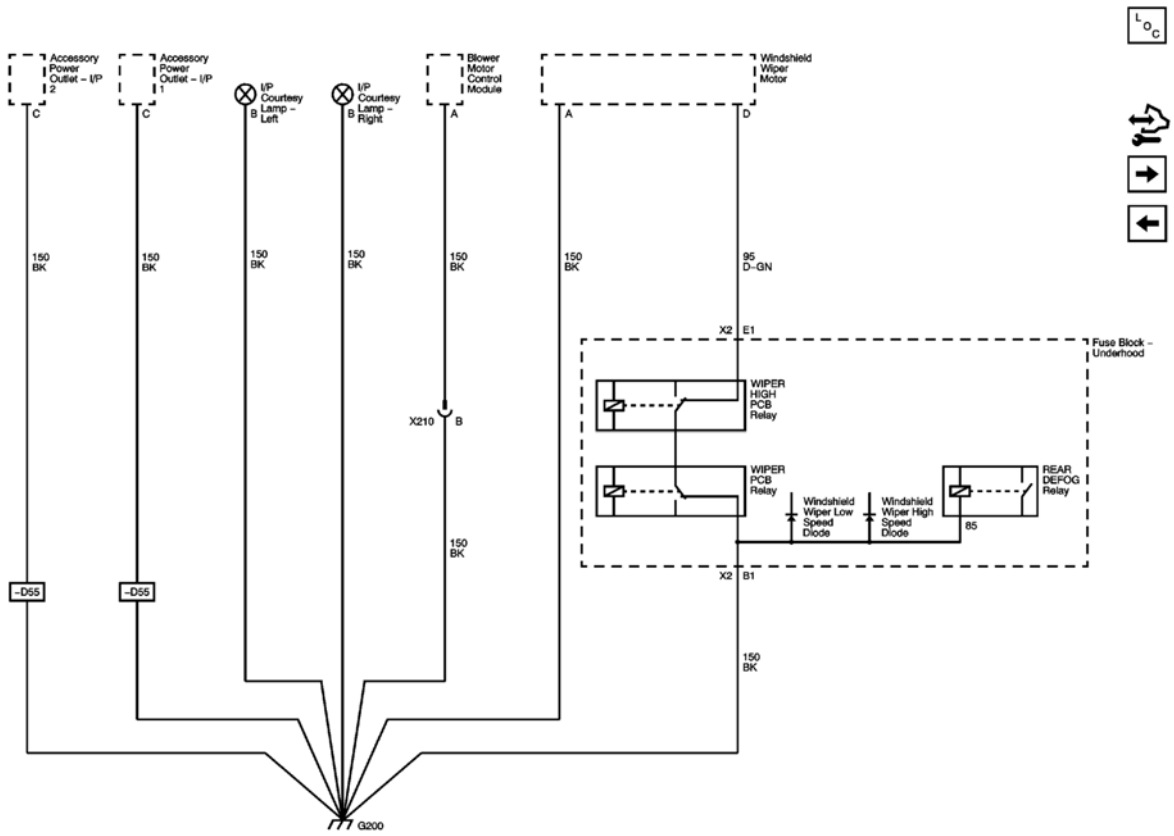


Fig. 44: G200 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

G201

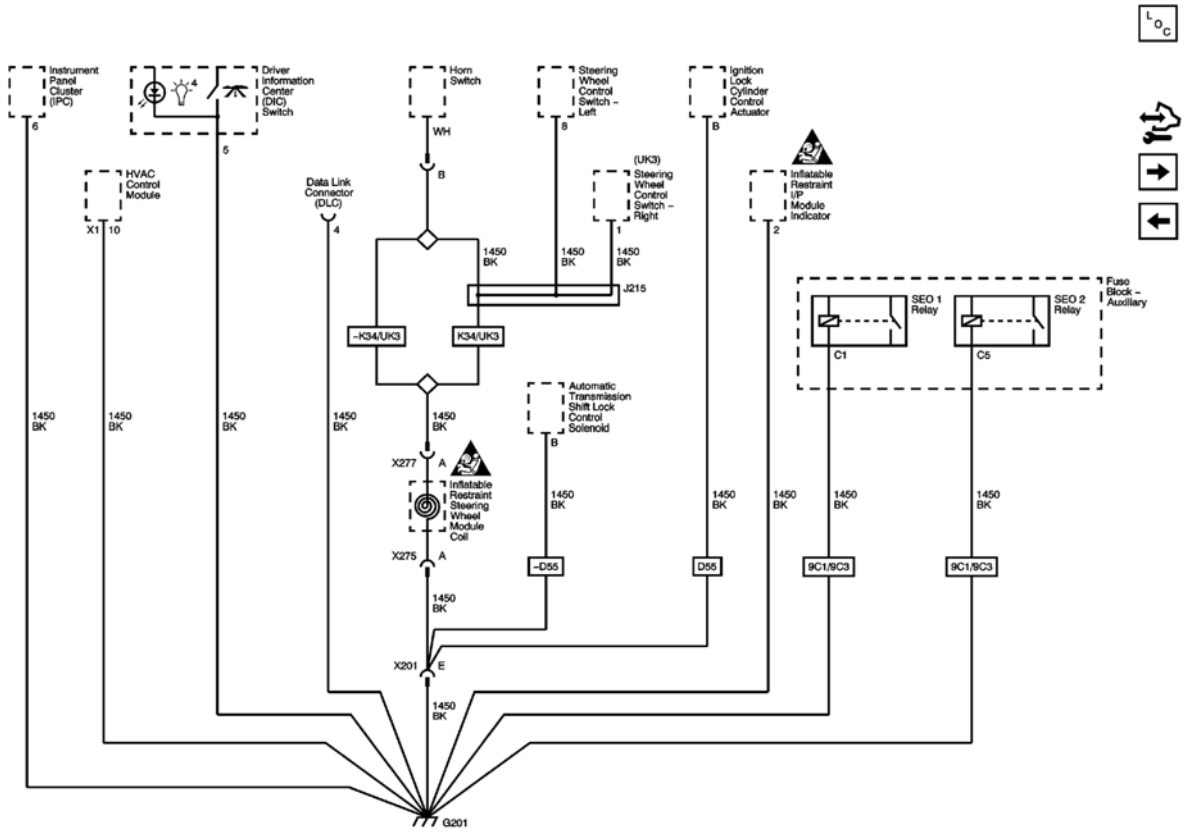


Fig. 45: G201 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

G202 and G204

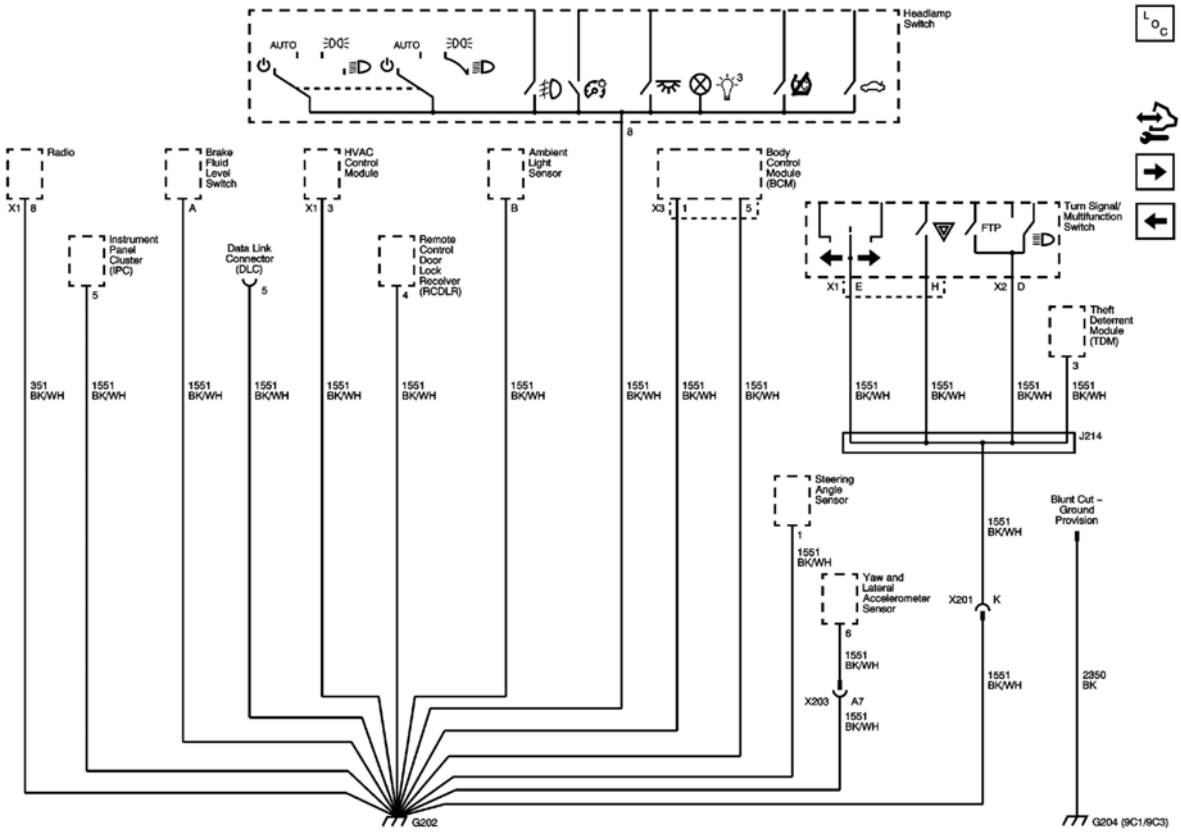


Fig. 46: G202 and G204 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

G301

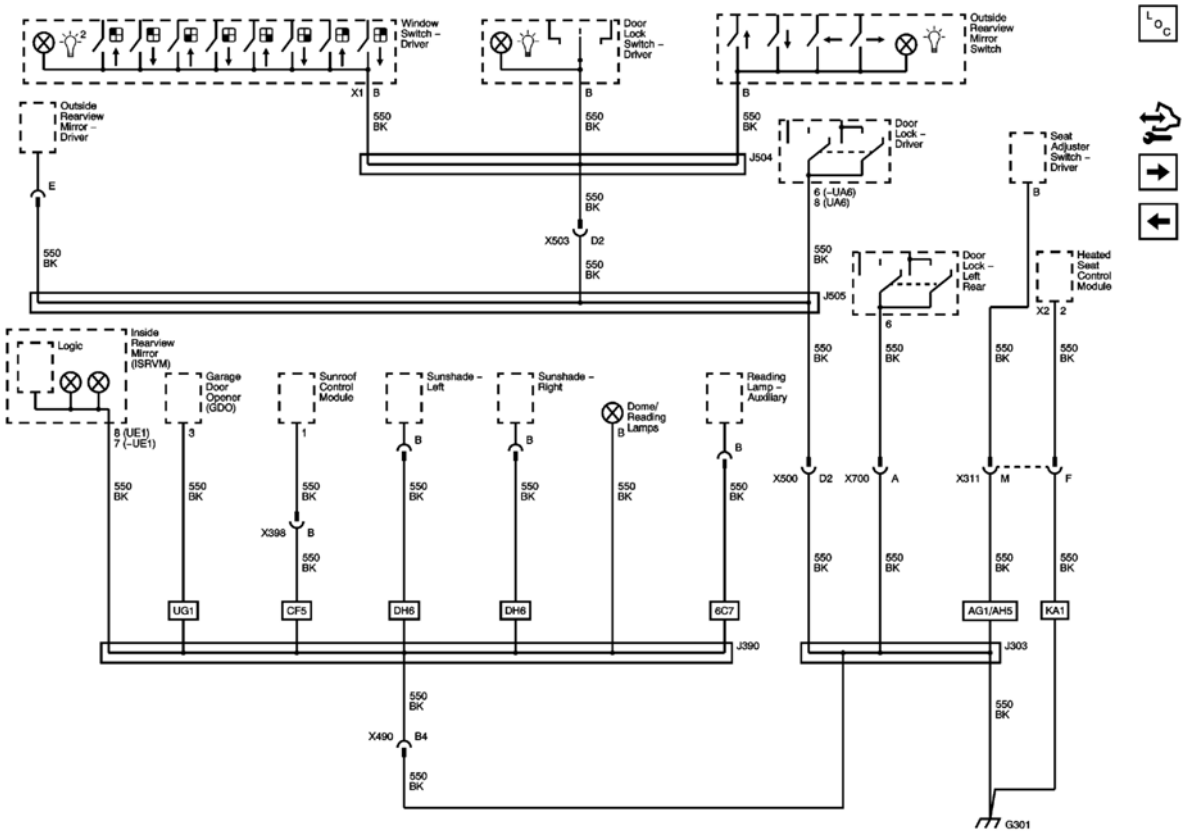


Fig. 47: G301 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

G302 (1 of 2)

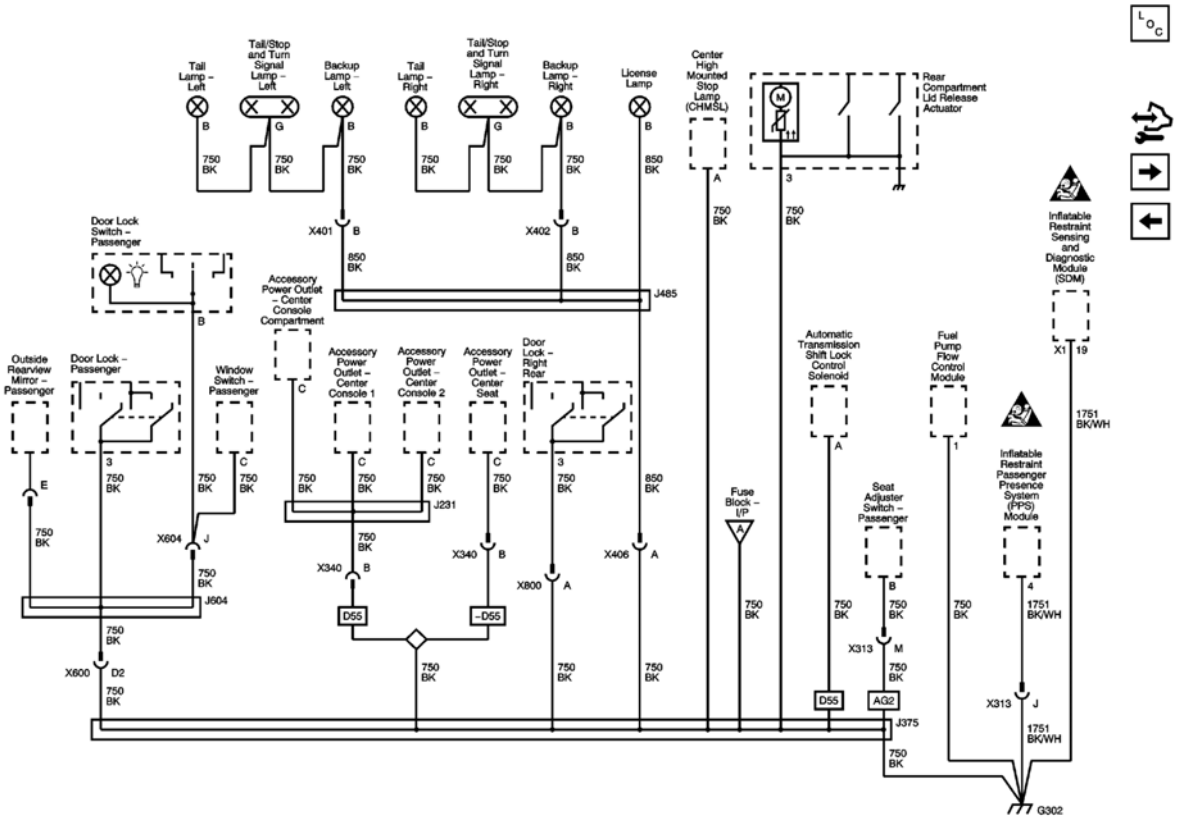


Fig. 48: G302 Wiring Schematic (1 of 2)

Courtesy of GENERAL MOTORS COMPANY

G302 (2 of 2)

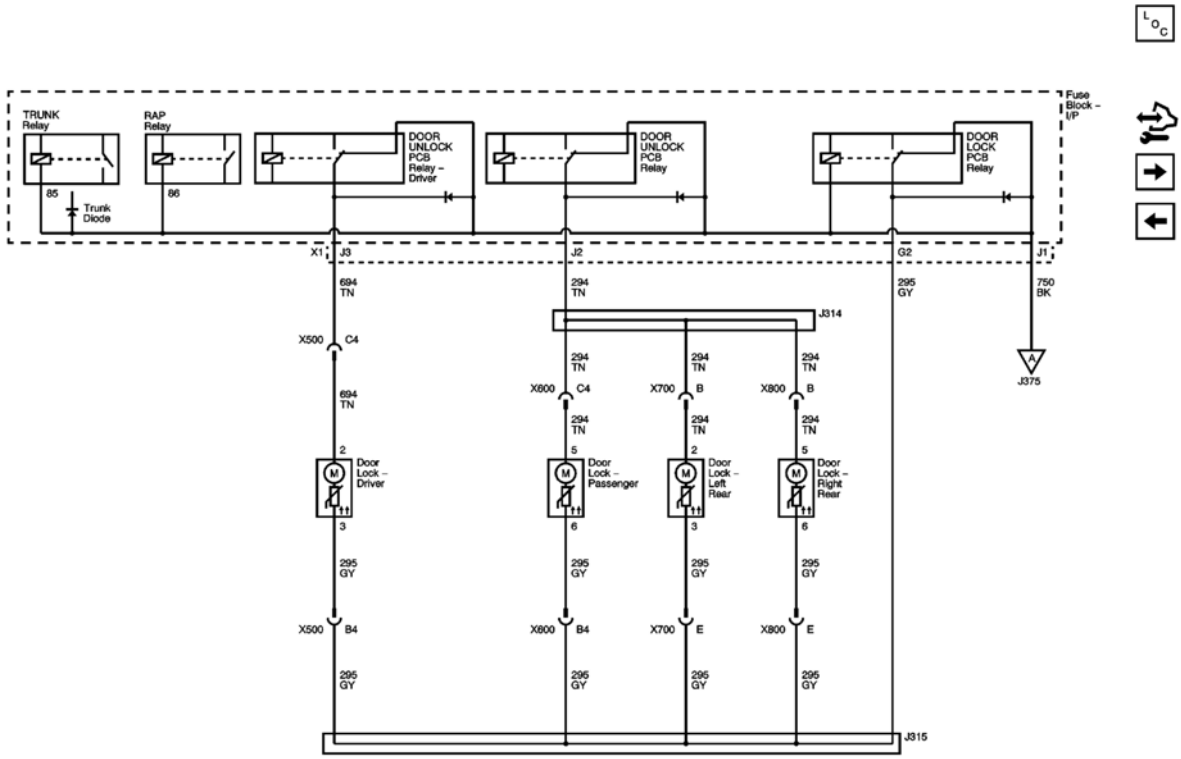


Fig. 49: G302 Wiring Schematic (2 of 2)

Courtesy of GENERAL MOTORS COMPANY

G403 and G404

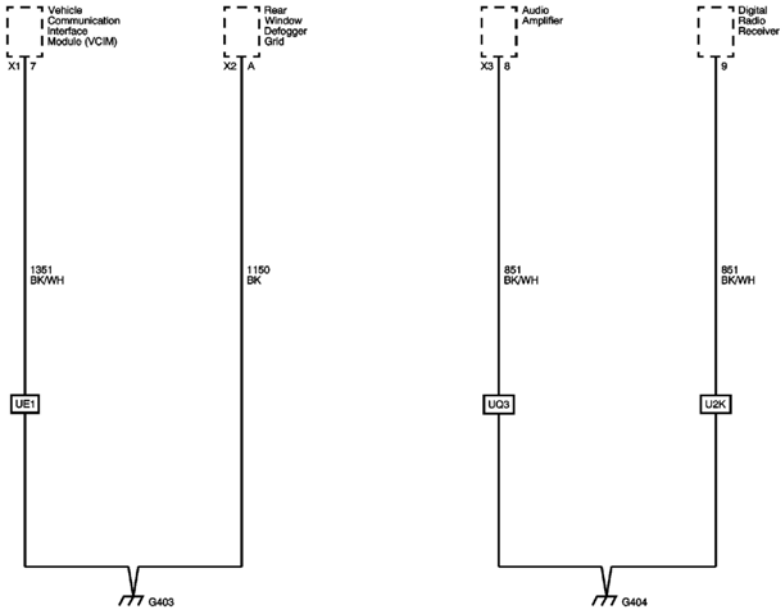


Fig. 50: G403 and G404 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Upfitter Provision Schematics

6J1

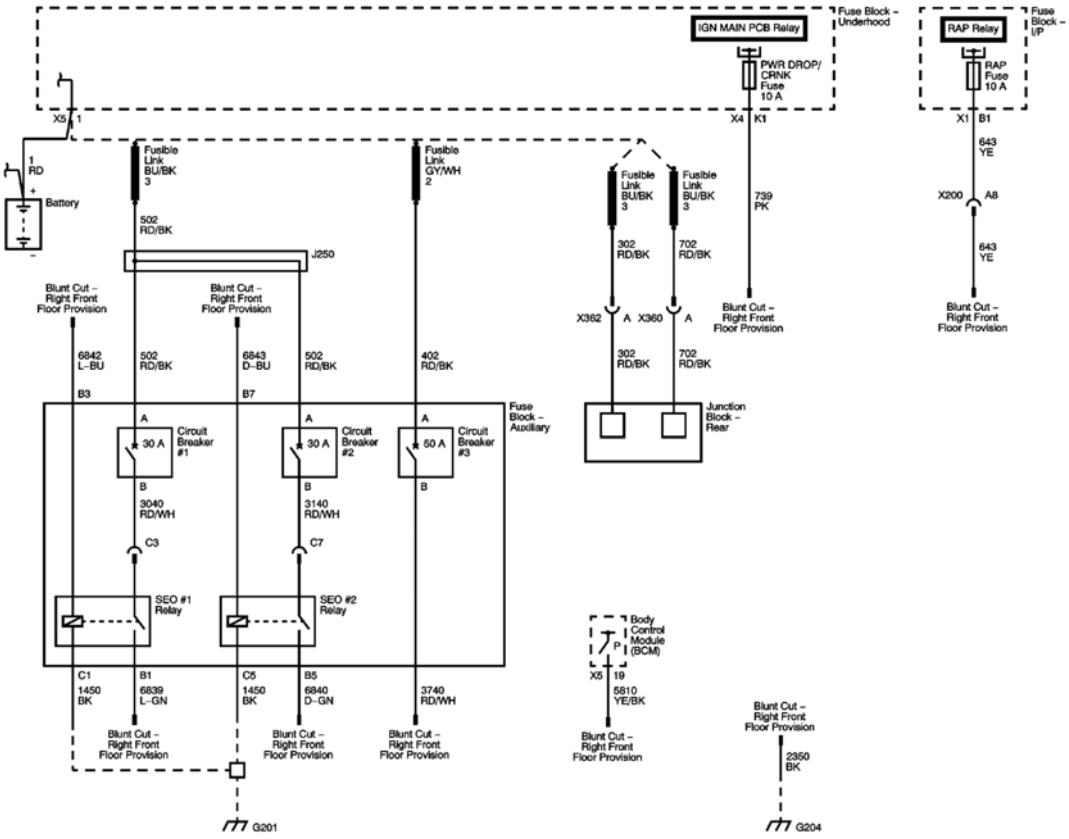


Fig. 51: 6J1 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

6J3, 6J6, 6F5, and 6C8

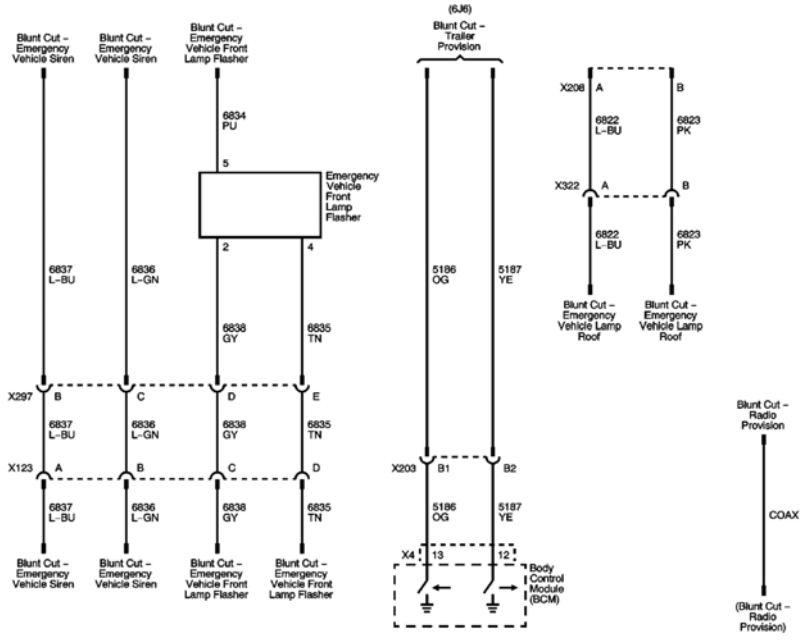
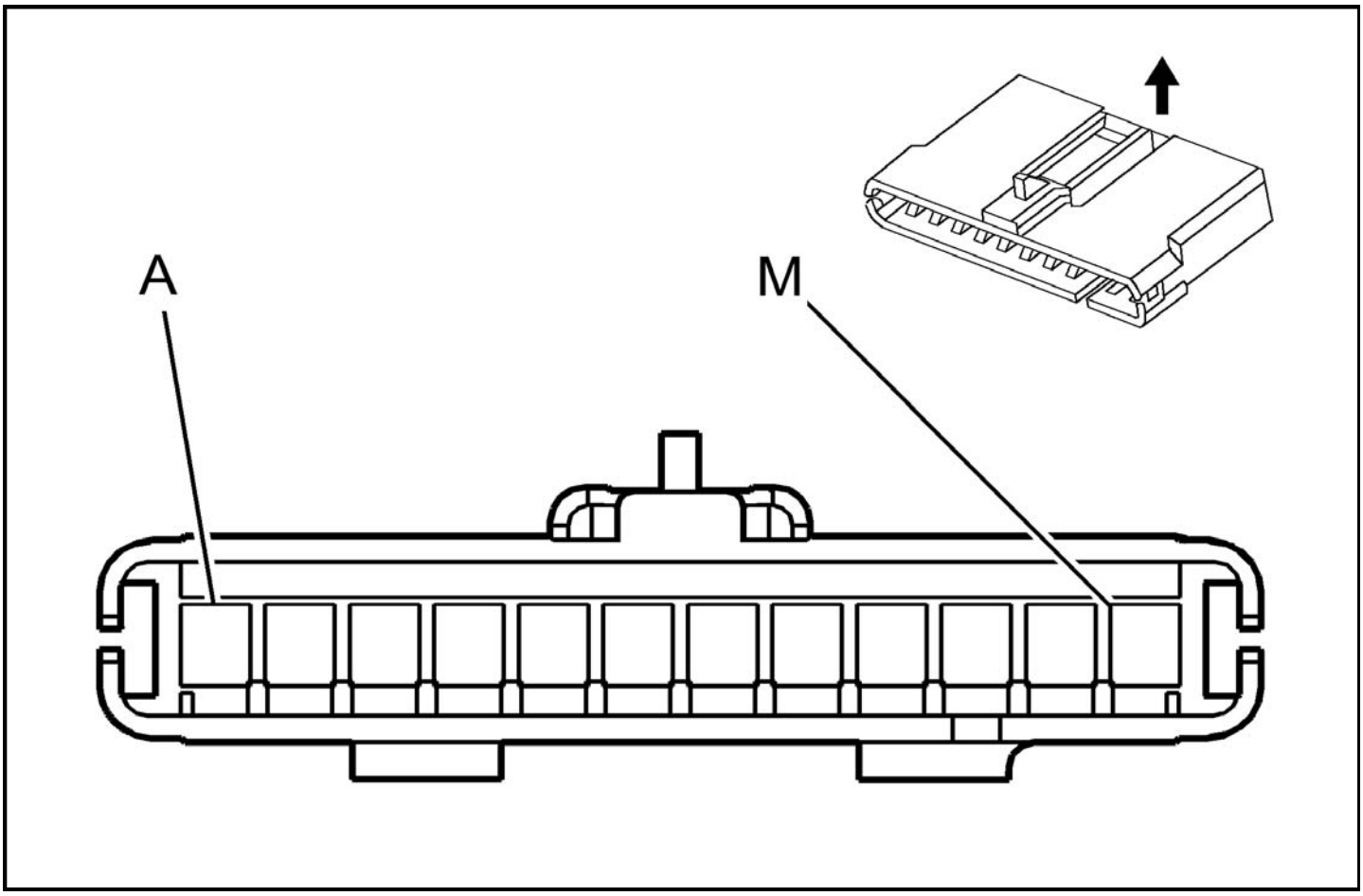


Fig. 52: 6J3, 6J6, 6F5, and 6C8 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Article GUID: A00737210

SPLICE PACK CONNECTOR END VIEWS

JX205



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12191216
- Service Connector: 15305914
- Description: 12-Way F GT 150 Series (L-GY)

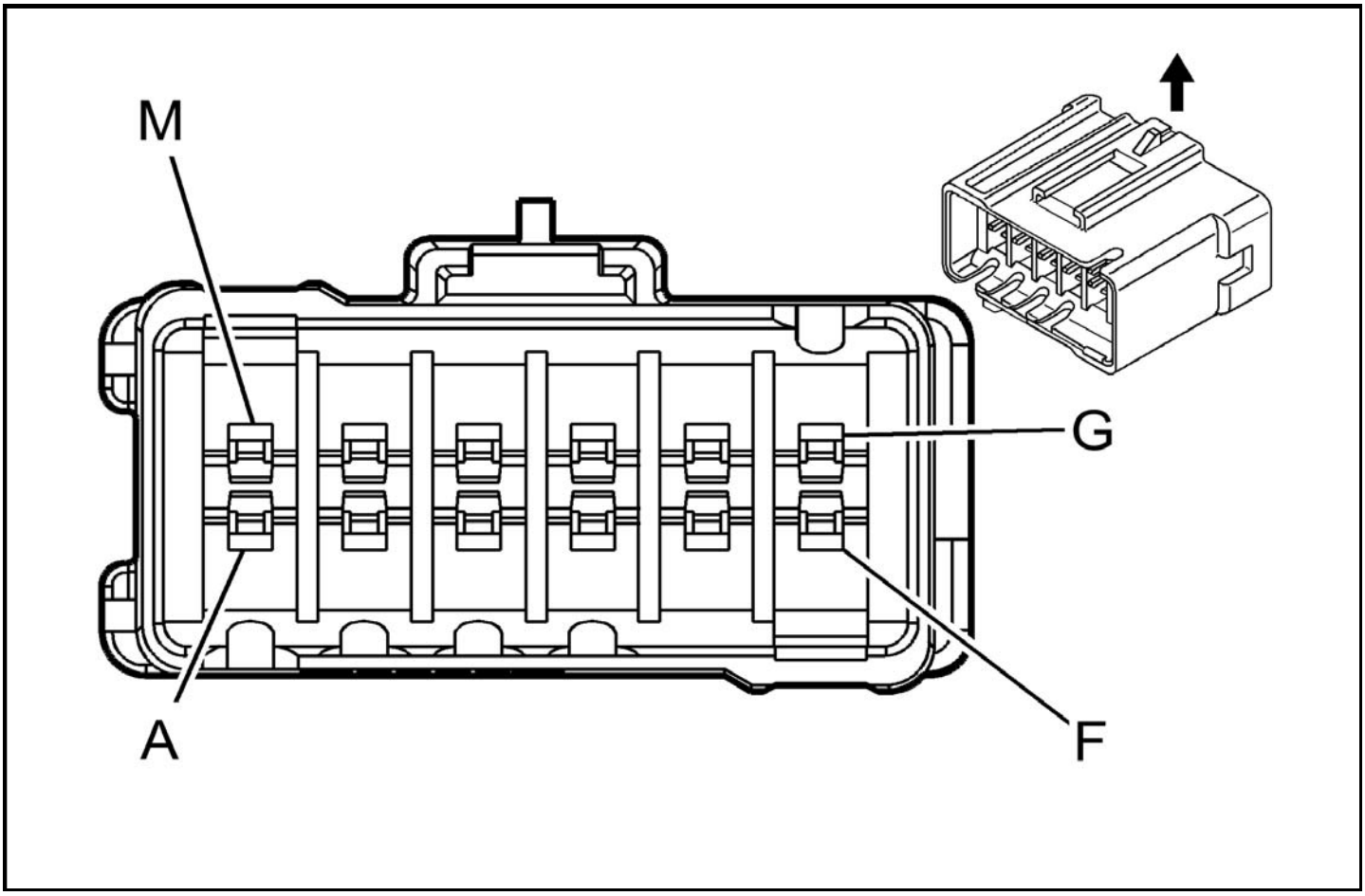
Terminal Part Information

- Terminated Lead: 13575735
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-2A (GY)
- Terminal/Tray: 12191812/19
- Core/Insulation Crimp: E/C

JX205

Pin	Wire	Circuit	Function
A	0.35 D-GN	5060	Low Speed GMLAN Serial Data
B	0.35 L-GN	5060	Low Speed GMLAN Serial Data
C	-	-	Not Used
D	0.35 D-GN/WH	5060	Low Speed GMLAN Serial Data
E	-	-	Not Used
F	0.35 D-GN	5060	Low Speed GMLAN Serial Data
G	0.35 D-GN/BK	5060	Low Speed GMLAN Serial Data
H	0.35 D-GN/RD	5060	Low Speed GMLAN Serial Data
J	-	-	Not Used
K	0.35 D-GN	5060	Low Speed GMLAN Serial Data
L	0.35 L-GN/WH	5060	Low Speed GMLAN Serial Data
M	0.35 L-GN/BK	5060	Low Speed GMLAN Serial Data

JX206



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 15305288
- Service Connector: 12167610

- Description: 12-Way F Metri-Pack 280 (BK)
- Indexing may vary

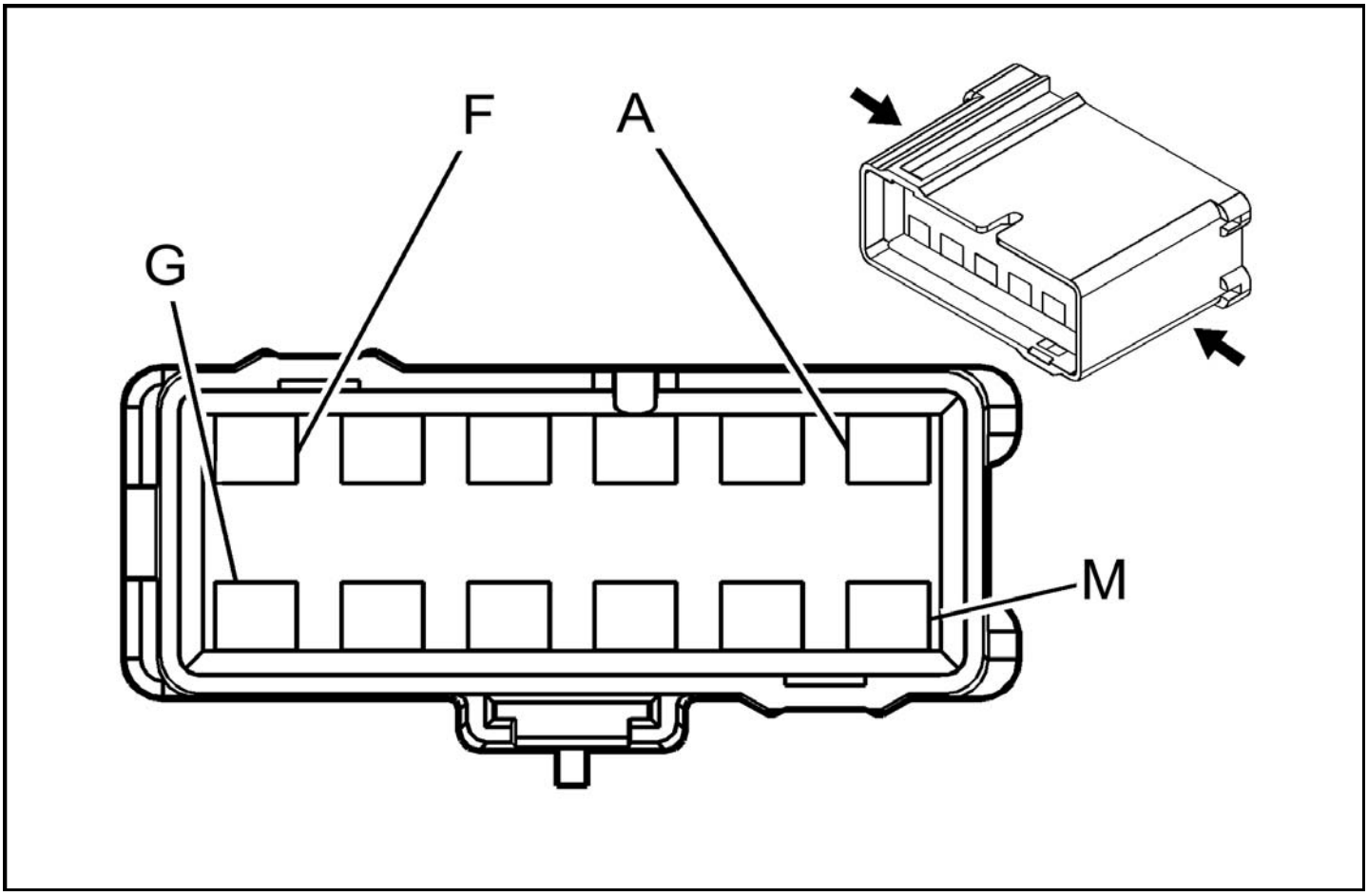
Terminal Part Information

- Terminated Lead: 13575721
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110844/4
- Core/Insulation Crimp: E/A

JX206

Pin	Wire	Circuit	Function
A	0.35 PK	1139	Ignition 1 Voltage
B	0.35 PK	1139	Ignition 1 Voltage
C	0.35 PK	1139	Ignition 1 Voltage
D	0.35 PK	1139	Ignition 1 Voltage
E	0.35 PK	1139	Ignition 1 Voltage
F	0.35 PK	1139	Ignition 1 Voltage
G	0.5 RD/WH	1840	Battery Positive Voltage
H	0.35 RD/WH	1840	Battery Positive Voltage
J	0.35 RD/WH	1840	Battery Positive Voltage
K	0.35 RD/WH	1840	Battery Positive Voltage
L	0.35 RD/WH	1840	Battery Positive Voltage
M	-	-	Not Used

JX207



Connector Part Information

- Harness Type: Instrument Panel
- OEM Connector: 12176473
- Service Connector: 12167611
- Description: 12-Way F Metri-Pack 280 Series (BK)

Terminal Part Information

- Terminated Lead: 13575721
- Release Tool: J-38125-553
- Diagnostic Test Probe: J-35616-4A (PU)
- Terminal/Tray: 12110844/4
- Core/Insulation Crimp: E/A

JX207

Pin	Wire	Circuit	Function
A	0.35 D-BU	5985	Accessory Wakeup Serial Data
B	0.35 D-BU	5985	Accessory Wakeup Serial Data
C	0.35 D-BU	5985	Accessory Wakeup Serial Data
D	0.35 TN	28	Horn Relay Control

Pin	Wire	Circuit	Function
E	0.35 TN	28	Horn Relay Control
F	0.35 TN	28	Horn Relay Control
G	0.35 GY	8	Instrument Panel Lamp Supply Voltage
H	0.35 GY	8	Instrument Panel Lamp Supply Voltage
J	0.8 GY	8	Instrument Panel Lamp Supply Voltage
K	0.35 PU/WH	1382	LED Dimming Supply
	0.35 PU/WH	1382	LED Dimming Supply
L	0.35 PU/WH	1382	LED Dimming Supply
	0.35 PU/WH	1382	LED Dimming Supply
M	0.35 PU/WH	1382	LED Dimming Supply

Article GUID: A00737199

EMISSION APPLICATIONS

Impala

Engine & Fuel System	(1) Emission Control Systems & Devices	EGR Test No.
2.5L (153") 4-Cyl. DI	**PCV, (2) EVAP, TWC, FR, (2) SPK, (3) HO2S, AIR, CEC, (2) MIL,** EVAP-CPCSV, EVAP-CVCSV, EVAP-RV/FTPS, EVAP-VC, FF-CKV	...
3.6L (217") V6 DI	**PCV, (2) EVAP, (3) TWC, FR, (2) SPK, (4) HO2S, CEC, (2) MIL,** EVAP-CPCSV, EVAP-CVCSV, EVAP-FVTS, EVAP-ORVR, EVAP-VC	...

(1) Major emission control systems and devices are listed in bold type; components and other related devices are listed in light type.

(2) PCM-controlled.

(3) Equipped with 2.

(4) Equipped with 4.

Article GUID: A00617326

EMISSION CONTROL ABBREVIATIONS

Gasoline & Diesel

"A"

A/C

Air Conditioning

A/C-ISUS

A/C Idle Speed-Up Solenoid

A/F

Air/Fuel

AAI

Air Assist Injector

ACL

Air Cleaner (Thermostatic Air Cleaner)

ACL-BMS

ACL Bimetallic Sensor

ACL-CKV

ACL Check Valve

ACL-DV

ACL Delay Valve

ACL-ESC

Electronic Spark Control

ACL-PVS

ACL Ported Vacuum Switch

ACL-RDV

ACL Reverse Delay Valve

ACL-RDVS

ACL Reverse Delay Valve (Single)

ACL-TCV

ACL Thermal Control Valve

ACL-TS

ACL Temperature Sensor

ACL-TSOV

ACL Temperature Sensor Override Valve

ACL-TVS

ACL Thermal Vacuum Switch

ACL-TVV

ACL Thermal Vacuum Valve

ACL-VCDV

ACL Vacuum Control Delay Valve

ACL-VCV

ACL Vacuum Control Valve

ACL-VM

ACL Vacuum Motor

ACL-WP

ACL Wax Pellet Type Motor

ADS

Anti-Dieseling Solenoid

AFR

Air/Fuel Ratio Sensor

AFS

Air/Fuel Ratio Sensor

AIH

Air Intake Heaters

AIH-TS

AIH Temperature Sensor

AIR

Air Injection System

AIS

Air Injection System

AIS-ACV

AIS Air Control Valve

AIS-AF

Air Injection System Air Filter

AIS-AMV

AIS Air Management Valve

AIS-ASV

AIS Air Switching Valve

AIS-BPV

AIS By-Pass Valve

AIS-CC

AIS Computer Controlled

AIS-CKV

AIS Check Valve

AIS-CSV

AIS Control Solenoid Valve

AIS-CV

AIS Combination Valve

AIS-DV

AIS Diverter Valve

AIS-IMCV

AIS Intake Manifold Change-Over Valve

AIS-MCV

AIS Manifold Change-Over Valve

AIS-OWV

AIS One Way Valve

AIS-PAF

AIS Pulse Air Feeder

AIS-PM

AIS Pump Motor

AIS-PV

AIS Pneumatic Valve

AIS-RV

AIS Relief Valve

AIS-SAV

AIS Secondary Air Valve

AIS-SOL

AIS Solenoid

AIS-SV

AIS Solenoid Valve

AIS-VCV

AIS Vacuum Control Valve

AIS-VSV

AIS Vacuum Switching Valve

AIS-VT

AIS Vacuum Tank

AIS-VCV

AIS Vacuum Control Valve

AIS-VSV

AIS Vacuum Switching Valve

AIV

Air Injection Valve

AIV-SOL

Air Injection Valve Solenoid

ALVW

Adjusted Loaded Vehicle Weight

AMV

Air Management Valve

AP

Air Pump Injection System

AP-ABV

Air Pump Air Bypass Valve

AP-ACV

AP Air Control Valve

AP-AMV

AP Air Management Valve

AP-ASRV

AP Air Switching Relief Valve

AP-ASS

AP Air Switching Solenoid

AP-ASV

AP Air Switching Valve

AP-BP

AP By-Pass Valve

AP-BPV

AP By-Pass Valve

AP-CKV

AP Check Valve

AP-CS

AP Control Solenoid

AP-CV

AIR Cut-Off Valve

AP-DCTO

AP Dual Coolant Temperature Override

AP-DLY

AP Delay Valve

AP-DV

AP Diverter Valve

AP-EADV

AP Electric Air Control Diverter Valve

AP-EAMR

AP Electric Air Management Relay

AP-EAMS

AP Electric Air Management Solenoid

AP-EAP

AP Electric Air Pump

AP-EC

AP Electromagnetic Clutch

AP-ERLY

AP Electric Air Pump Relay

AP/PAIR

Pulsed Secondary Air Injection

AP-RDV

AP Reed Valve

AP-RV

AP Relief Valve

AP-SOL

AP Solenoid

AP-SOV

AP Shut-Off Valve

AP-SV

AP Solenoid Valve

AP-SWV

AP Switchover Valve

AP-TV

AP Transmitting Valve

AP-VCS

AP Vacuum Control Solenoid

AP-VCSV

AP Vacuum Controlled Air Shut-Off Valve

AP-VCV

AP Vacuum Control Valve

AP-VSV

AP Vacuum Switching Valve

A/T

Automatic Transmission

ATCV

Air Temperature Control Valve

"B"

BP/EGR

Backpressure EGR System

BP/EGR-BPS

BP/EGR Backpressure Sensor

BP/EGR-BPT

BP/EGR Backpressure Transducer

BP/EGR-BPV

BP/EGR Backpressure Valve

BP/EGR-BS

BP/EGR Bleed Solenoid

BP/EGR-BVSV

BP/EGR Bimetallic Vacuum Switching Valve

BP/EGR-C

BP/EGR Controller

BP/EGR-CLR

BP/EGR Cooler

BP/EGR-CS

BP/EGR Control Solenoid

BP/EGR-CTO

BP/EGR Coolant Temperature Override

BP/EGR-CV

BP/EGR Control Valve

BP/EGR-DCTO

BP/EGR Dual Coolant Temperature Override

BP/EGR-DS

BP/EGR Diagnostic Solenoid

BP/EGR-DSOL

BP/EGR Duty Solenoid

BP/EGR-DTVSW

BP/EGR Distributor Thermal Vacuum Switch

BP/EGR-DV

BP/EGR Delay Valve

BP/EGR-EET

BP/EGR Electric Transducer

BP/EGR-EPV

BP/EGR External Pressure Valve

BP/EGR-FDV

BP/EGR Forward Delay Valve

BP/EGR-LCV

BP/EGR Vacuum Control Valve

BP/EGR-LC

BP/EGR Load Control Valve

BP/EGR-OVS

BP/EGR Orifice Valve Sensing

BP/EGR-PS

BP/EGR Position Sensor

BP/EGR-PT

BP/EGR Pressure Tranducer

BP/EGR-PVS

BP/EGR Ported Vacuum Switch

BP/EGR-RES

BP/EGR Reservoir

BP/EGR-RST

BP/EGR Restrictor

BP/EGR-SOL

BP/EGR Solenoid

BP/EGR-TCTVS

BP/EGR Torque Converter Thermal Vacuum Switch

BP/EGR-TCV

BP/EGR Thermal Control Valve

BP/EGR-TCVLV

BP/EGR Temperature Control Valve

BP/EGR-T

BP/EGR Temperature Sensor

BP/EGR-TS

BP/EGR Temperature Sensor

BP/EGR-TVC

BP/EGR Thermal Control Valve

BP/EGR-TVS

BP/EGR Thermal Vacuum Switch

BP/EGR-TVV

BP/EGR Thermal Vacuum Valve

BP/EGR-VC

BP/EGR Diagnostic Valve

BP/EGR-VCV

BP/EGR Vacuum Control Valve

BP/EGR-VM

BP/EGR Vacuum Modulator

BP/EGR-VRV

BP/EGR Vacuum Regulator Valve

BP/EGR-VS

BP/EGR Vacuum Switch

BP/EGR-VSOL

BP/EGR Vent Solenoid

BP/EGR-VSV

BP/EGR Vacuum Switching Valve

"C"

C-4

Computer Controlled Catalytic Converter

CAC

Charge Air Cooler

CAS

Clean Air System

CB

Crankcase Breather

CB-VC

Crankcase Breather-Vapor Canister

CBPS

Coasting By-Pass System

CBVC

Crankcase Breather Vapor Canister

CCIEV

Coolant Controlled Idle Enrichment Valve

CCO

Computerized Engine Controls

CCS

Controlled Combustion System

CCV

Closed Crankcase Ventilation

CD-REGVLV

Crankcase Depression Regulator Valve

CDRV

Crankcase Depression Relief Valve

CEAB

Cold Engine Air Bleed

CEAB-TVS

CEAB Thermal Vacuum Switch

CEAB-TVV

CEAB Thermal Vacuum Valve

CEC

Computerized Engine Controls

CESS

Cold Engine Sensor Switch

CETS

Cold Engine Temperature Switch

CFI

Continuous Fuel Injection

CMH

Cold Mixture Heater

CNG

Compressed Natural Gas

CO

Carbon Monoxide

CO2

Carbon Dioxide

CPI

Central Port Injection

CRV

Coasting Richer Valve

CSI

Central Sequential Injection

CTAVS

Cold Temperature Activated Vacuum System

CTOX

Continous Trap Oxidizer

CVOT

Crankcase Ventilation Orifice Tube

CVOT-CKV

Crankcase Ventilation Orifice Tube Check Valve

"D"

DCLV

Deceleration Valve

DCS

Deceleration Control System

DDI

Direct Diesel Injection

DFI

Direct Diesel Injection

DI

Direct Injection

DKV

Deceleration Kick Valve

DLCV

Deceleration Mixture Control Valve

DM-TL

Diagnostic Module Tank Leakage

DMS

Dual Manifold System

DOC

Diesel Oxidation Catalyst

DOHC

Dual Overhead Cam

DPD

Dual Point Distributor

DPF

Diesel Particulate Filter

DPF/TWC

Combination Diesel Particulate Filter and Three Way Catalyst

DPFE

Differential Pressure Feedback EGR Valve

DPFEGR

Differential Pressure Feedback EGR Valve

DTM

Deceleration Throttle Modulator

"E"

EAIR

Electric Air Injection System

EAIR-DV

EAIR Diverter Valve

EC

Computerized Engine Controls

ECM

Electronic Control Module

ECU

Electronic Control Unit

EDC

Electronic Diesel Control

EDS

Electronic Diesel System

EEC

Electronic Engine Control

EFE

Early Fuel Evaporation

EFE-CKV

EFE Check Valve

EFE-CV

EFE Control Valve

EFE-DTVS

EFE Delay Thermal Vacuum Switch

EFE-HTR

EFE Heater

EFE-HCV

EFE Heat Control Valve

EFE-OTS

EFE Oil Temperature Switch

EFE-PTC

EFE Positive Temperature Coefficient (Intake Heater Grid)

EFE-PVS

EFE Ported Vacuum Switch

EFE-SOL

EFE Solenoid

EFE-TVS

EFE Thermal Vacuum Switch

EFE-TVV

EFE Thermal Vacuum Valve

EFE-VSV

EFE Vacuum Switching Valve

EFI

Electronic Fuel Injection

EFI-MA

EFI Mass Airflow Sensor

EFI-MAF

EFI Mass Airflow Sensor

EGR

Exhaust Gas Recirculation System

EGR-BCS

EGR Boost Check Solenoid

EGR-BPBV

EGR By-Pass Backpressure Valve

EGR-BPT

EGR Backpressure Transducer

EGR-BPV

EGR By-Pass Valve

EGR-BS

EGR Bleed Solenoid

EGR-BSSV

EGR Boost Sensor Solenoid Valve

EGR-BV

EGR Bypass Valve

EGR-BVSV

EGR Bimetallic Vacuum Switching Valve

EGR-C

EGR Controller

EGR-CC

EGR Coolant Controlled

EGR-CLR

EGR Cooler

EGR-VSOL

EGR Vacuum Solenoid

EGR-CKV

EGR Check Valve

EGR-CS

EGR Control Solenoid

EGR-CSOL

EGR Cut-Off Solenoid

EGR-CSV

EGR Control Solenoid

EGR-CTO

EGR Coolant Temperature Override

EGR-CTS

EGR Charge Temperature Sensor

EGR-CTSW

EGR Charge Temperature Switch

EGR-CTTS

EGR Coolant Temperature Thermoswitch

EGR-CV

EGR Control Valve

EGR-CVCV

EGR Constant Vacuum Control Valve

EGR-CVS

EGR Control Vent Solenoid

EGR-DC

EGR Digital Control

EGR-DCTO

EGR Dual Coolant Temperature Override

EGR-DPFE

Differential Pressure Feedback EGR Sensor

EGR-DPFS

EGR Differential Pressure Feedback Sensor

EGR-DS

EGR Diagnostic Solenoid

EGR-DSOL

EGR Duty Solenoid

EGR-DTVS

EGR Delay Thermal Vacuum Switch

EGR-DTVSW

EGR Distributor Thermal Vacuum Switch

EGR-DV

EGR Delay Valve

EGR-EPRS

EGR Exhaust Pressure Regulator Solenoid

EGR-EPRV

EGR Exhaust Pressure Regulator Valve

EGR-EPV

EGR External Pressure Valve

EGR/EVAP-CSV

EGR/EVAP Control Solenoid Valve

EGR-EVR

EGR Vacuum Regulator

EGR-EVRV

EGR Electronic Vacuum Regulator Valve

EGR-FDV

EGR Forward Delay Valve

EGR-FJS

EGR Floor Jet System

EGR-FPS

EGR Feedback Pressure Sensor

EGR-LCV

EGR Load Control Valve

EGR-MAP

EGR Manifold Absolute Pressure Sensor

EGR-PFE

EGR-PFE Sensor

EGR-PS

EGR Position Sensor

EGR-PSW

EGR Pulse Switch

EGR-PVS

EGR Ported Vacuum Switch

EGR-REG

EGR Regulator

EGR-RES

EGR Reservoir

EGR-RST

EGR Restrictor

EGR-SC

EGR Signal Converter

EGR-SEC

EGR, Secondary

EGR-SEN

EGR Sensor

EGR-SM

EGR Stepper Motor

EGR-SOL

EGR Solenoid

EGR-SU

EGR Switchover Valve

EGR-SUB

Sub-EGR Valve

EGR-SV

EGR Switchover Valve

EGR-SVV

EGR Solenoid Vacuum Valve

EGR-T

EGR Temperature Sensor

EGR-TC

EGR Transmission Controlled

EGR-TCTVS

EGR Torque Converter Thermal Vacuum Switch

EGR-TCV

EGR Thermal Control Valve

EGR-TCVLV

EGR Temperature Control Valve

EGR-TRANS

EGR Transducer

EGR-TS

EGR Temperature Sensor

EGR-TSW

EGR Temperature Switch

EGR-TV

EGR Thermal Valve

EGR-TVD

EGR Throttle Valve Diaphragm

EGR-TVS

EGR Thermal Vacuum Switch

EGR-TVSOL

EGR Throttle Valve Solenoid

EGR-TVV

EGR Thermal Vacuum Valve

EGR-V

EGR Valve

EGR-VA

EGR Vacuum Amplifier

EGR-VCV

EGR Vacuum Control Valve

EGR-VM

EGR Vacuum Modulator

EGR-VR

EGR Vacuum Regulator

EGR-VRS

EGR Vacuum Regulator Solenoid

EGR-VRSV

EGR Vacuum Regulator Solenoid Valve

EGR-VRV

EGR Vacuum Regulator Valve

EGR-VS

EGR Vacuum Switch

EGR-VSDV

EGR Vacuum Switch Dump Valve

EGR-VSEN

EGR Vacuum Sensor

EGR-VSOL

EGR Vent Solenoid

EGR-VSS

EGR Vacuum Switching Solenoid

EGR-VST

EGR Vacuum Surge Tank

EGR-VSV

EGR Vacuum Switching Valve

EGR-VVCS

EGR Venturi Vacuum Control System

EGRB

EGR Boost Sensor

EGRC

EGR Control Solenoid

EGRC-BPT

EGR Control Backpressure Transducer

EGRC-SV

EGR Control Solenoid Valve

EHOC

Electronically Heated Oxidation Catalyst

EHTWC

Electronically Heated Three-Way Catalyst

EI

Electronic Ignition System

EIS

Electronic Ignition System

ELB

Electronic Lean Burn

EPR

Exhaust Pressure Regulator

EPR-SOL

EPR Solenoid

ESA

Electronic Spark Advance

ESIM

Evaporative System Integrity Monitor

EVAP

Fuel Evaporative System

EVAP-AAC

EVAP Auxiliary Air Control

EVAP-BPSV

EVAP By-Pass Solenoid Valve

EVAP-BVSV

EVAP Bimetallic Vacuum Switching Valve

EVAP-CAV

EVAP Canister Air Valve

EVAP-CCV

EVAP Control Canister Close Valve

EVAP-CCVSV

EVAP Control Canister Vent Shut Valve

EVAP-CCVVSV

EVAP Closed Canister Valve Vacuum Switching Valve

EVAP-CDCV

EVAP Canister Drain Cut Valve

EVAP-CKV

EVAP Check Valve

EVAP-CPCS

EVAP Canister Purge Control Solenoid

EVAP-CPCSV

EVAP Canister Purge Control Solenoid Valve

EVAP-CPCV

EVAP Canister Purge Control Valve

EVAP-CPRV

EVAP Canister Purge Regulator Valve

EVAP-CPSV

EVAP Canister Vent Shut Valve

EVAP-CPT

EVAP Canister Purge Timer

EVAP-CPTVS

EVAP Canister Purge Thermal Vacuum Switch

EVAP-CPV

EVAP Canister Vent Valve

EVAP-CPVCSV

EVAP Canister Purge Volume Control

EVAP-CPVCV

EVAP Canister Purge Volume Control Valve

EVAP-CPVDV

EVAP Canister Purge Vacuum Delay Valve

EVAP-CPVR

EVAP Canister Purge Valve Resonator

EVAP-CS

EVAP Control Solenoid

EVAP-CSPS

EVAP Control System Pressure Sensor

EVAP-CSPV

EVAP Canister Purge Valve

EVAP-CST

EVAP Canister Surge Tank

EVAP-CSV

EVAP Control Solenoid Valve

EVAP-CT

EVAP Catch Tank

EVAP-CV

EVAP Control Solenoid Valve

EVAP-CVCS

EVAP Canister Vent Control Solenoid

EVAP-CVCSV

EVAP Canister Vent Control Solenoid Valve

EVAP-CVCV

EVAP Canister Vent Control Valve

EVAP-CVS

EVAP Canister Vent Solenoid

EVAP-CVSV

EVAP Carburetor Vent Switching Valve

EVAP-CVV

EVAP Canister Vent Valve

EVAP-DCTO

EVAP Dual Coolant Temperature Override

EVAP-DF

EVAP Drain Filter

EVAP-DPS

EVAP Differential Pressure Sensor

EVAP-DV

EVAP-Drain Valve

EVAP-ESIM

Evaporative System Integrity Monitor

EVAP-EV

EVAP Emission Valve

EVAP-FBVV

EVAP Fuel Bowl Vent Valve

EVAP-FBVS

EVAP Fuel Bowl Vent Solenoid

EVAP-FCV

EVAP Fuel Cut Valve

EVAP-FLS

EVAP Fuel Level Sensor

EVAP-FOLV

EVAP Fuel Overflow Limiter Valve

EVAP-FR/FTPS

EVAP Rollover Valve/Fuel Tank

EVAP-FS

EVAP Flow Switch

EVAP-FSV

EVAP Flow Switchover Valve

EVAP-FTCV

EVAP Tank Pressure Control Valve

EVAP-FTEV

EVAP Fuel Tank EVAP Valve

EVAP-FTPCSV

EVAP Fuel Tank Pressure Control Solenoid Valve

EVAP-FTPS

EVAP Fuel Tank Pressure Sensor

EVAP-FTS

EVAP Fuel Temperature Sensor

EVAP-FVCV

EVAP Fuel Vapor Control Valve

EVAP-FVS

EVAP Fuel Vapor Separator

EVAP-FVTS

EVAP Fuel Vapor Temperature Sensor

EVAP-FVV

EVAP Fuel Vent Valve

EVAP-FVVV

EVAP Fuel Vapor Vent Valve

EVAP-FWV

EVAP Fuel Vent Valve

EVAP-IVS

EVAP Inner Vent Solenoid

EVAP-LDAF

EVAP Leak Detection Pump Air Filter

EVAP-LDP

EVAP Leak Detection Pump

EVAP-LDPAF

EVAP Leak Detection Pump Air Filter

EVAP-LDPF

EVAP Leak Detection Pump Filter

EVAP-LDPVV

EVAP Leak Detection Pump Vent Valve

EVAP-LSEP

EVAP Liquid Separator

EVAP-NVLD

EVAP Natural Vacuum Leak Detection

EVAP-ORVR

Evaporative On-Board Refueling Vapor Recovery System

EVAP-ORVRCV

Evaporative On-Board Refueling Vapor Recovery Check Valve

EVAP-ORVRFTVRV

EVAP-ORVR Fuel Tank Vapor Recirculation

EVAP-OVCV

EVAP Outer Vent Control Valve

EVAP-OWV

EVAP One-Way Valve

EVAP-PCDV

EVAP Purge Control Diaphram Valve

EVAP-PCS

EVAP Purge Control Solenoid Valve

EVAP-PCSV

EVAP Purge Cut-Off Solenoid Valve

EVAP-PFS

EVAP Purge Flow Sensor

EVAP-PFSVVSV

EVAP Purge Flow Switching Valve Vacuum Switching Valve

EVAP-PPS

EVAP Proportional Purge Solenoid

EVAP-PR

EVAP Purge Resonator

EVAP-PRRV

EVAP Pressure Relief Rollover Valve

EVAP-PRV

EVAP Pressure Relief Valve

EVAP-PS

EVAP Purge Solenoid

EVAP-PSOL

EVAP Purge Solenoid

EVAP-PSSV

EVAP Pressure Switching Solenoid

EVAP-PSVVSV

EVAP Pressure Switching Valve Vacuum Switching Valve

EVAP-PV

EVAP Purge (Frequency) Valve

EVAP-PVS

EVAP Ported Vacuum Switch

EVAP-RV

EVAP Rollover Valve

EVAP-RV/FTPS

EVAP Rollover Valve/Fuel Tank

EVAP-RVSV

EVAP Rollover Vapor Separator Valve

EVAP-SNR

EVAP Canister Sensor

EVAP-SOL

EVAP Solenoid

EVAP-SOV

EVAP Shutoff Valve

EVAP-SSV

EVAP Shut-Off Solenoid Valve

EVAP-SV

EVAP Solenoid Valve

EVAP-TC

EVAP Trap Canister

EVAP-TS

EVAP Temperature Switch

EVAP-TPBPV

EVAP Tank Pressure By-Pass Valve

EVAP-TPCS

EVAP Tank Pressure Control Solenoid

EVAP-TPCV

EVAP Tank Pressure Control Valve

EVAP-TRWV

EVAP Tree-Way Valve

EVAP-TV

EVAP Thermal Valve

EVAP-TVS

EVAP Thermal Vacuum Switch

EVAP-TVV

EVAP Thermal Vacuum Valve

EVAP-TWV

EVAP Two-Way Valve

EVAP-VC

EVAP Vapor Canister

EVAP-VCAT

EVAP Vapor Canister Air Tank

EVAP-VCF

EVAP Vapor Canister Filter

EVAP-VCSV

EVAP Vapor Canister Shut-off Valve

EVAP-VCTV

EVAP Vacuum Control Valve

EVAP-VCV

EVAP Vacuum Canister Valve

EVAP-VCVS

EVAP Vapor Canister Vent Solenoid

EVAP-VLFR

EVAP Vent Line Flow Restrictor

EVAP-VM

EVAP Vacuum Motor

EVAP-VMV

EVAP Vapor Management Valve

EVAP-VPS

EVAP Vapor Pressure Sensor

EVAP-VPSVSV

EVAP Vapor Pressure Sensor Vacuum Switching Valve

EVAP-VS

EVAP Vacuum Sensor

EVAP-VSOL

EVAP Ventilation Solenoid

EVAP-VSOL/LDP

EVAP Ventilation Solenoid/Leak Detection Pump

EVAP-VST

EVAP Vacuum Surge Tank

EVAP-VSV

EVAP Vacuum Switching Valve

EVAP-VV

EVAP Ventilation Valve

EVRS

EGR Vacuum Regulator Solenoid

"F"

FBC

Feedback Carburetor

FCOV

Fuel Change Over Valve

FF

Flex Fuel

FF-CKV

Fuel Fill Check Valve

FF-FCV

Fuel Tank Fuel Cut-Off Valve

FF-FLVV

Fuel Tank Fill Limit Vent Valve

FFC-PVRV

Fuel Fill Cap Pressure Vacuum Relief Valve

FGOV

Fuel Gravity/Overflow Valve

FGVV

Fuel Gravity Vent Valve

FI

Fuel Injected

FICD

Fast Idle Control Device

FISR

Fast Idle Solenoid Relay

FLV

Fill Limit Valve

FLVV

Fill Limiting Vent Valve

FP-CKV

Fill Pipe Check Valve

FP-RV

Fill Pipe Rollover Valve

FR

Fill Pipe Restrictor

FT-FLVV

Fuel Tank Fill Limit Vent Valve

FT-GVV

Fuel Tank Grade Vent Valve

FT-OPRV

Fuel Tank Over Pressure Vent Valve

FT-PCV

Fuel Tank Pressure Control Valve

FT-VCV

Fuel Tank Vapor Control Valve

FT-VRV

Fuel Tank Vapor Recirculation Valve

FTCV

Fuel Tank Check Valve

FTDPS

Fuel Tank Differential Pressure Sensor

FTEV

Fuel Tank EVAP Valve

FTPS

Fuel Tank Pressure Sensor

FTT

Fuel Tank Temperature Sensor

FTTS

Fuel Tank Temperature Sensor

FTV/LSV

Fuel Tank Vapor/Liquid Seperation Valve

FTVCV

Fuel Tank Vapor Control Valve

FTVPRV

Fuel Tank Ventilation Pressure Retention Valve

FVPS

Fuel Vapor Pressure Sensor

FTVV

Fuel Tank Vent Valve

FVV

Fuel Vapor Valve

"G"

GVWR

Gross Vehicle Weight Rating

"H"

HAC

High Altitude Compensator

HAFS

Heated Air Fuel Ratio Sensor

HAI

Hot Air Intake

HAS

High Altitude System

HC

Hydrocarbons

HCAC-VSV

Hydrocarbon Absorber Catalyst Vacuum Switching Valve

HDC

Heavy Duty Cooling

HDC-CTO

HDC Coolant Temperature Override

HFM-SFI

Hot Film Engine Management SFI

HIC

Hot Idle Compensator

HIM

Heated Intake Manifold

HO

High Output

HO2S

Heated Oxygen Sensor

HP

High Performance

HP

Horsepower

HPCA

Housing Pressure Cold Advance

HSC

High Swirl Combustion

"I"

IAC

Idle Air Control Valve

IACV-SW

IACV Switch

ICOM

Idle Compensator

IDI

Indirect Diesel Injection

IES

Idle Enrichment System

IMCO

Improved Combustion System

"K"

KS

Knock Sensor

"L"

LH-SFI

Hot Wire Sequential Multiport Fuel Injection

LVFD

Liquid/Vapor Fuel Discriminator

LVW

Loaded Vehicle Weight

"M"

MD-TICS

Timing & Injection rate Control System

MDP

Manifold Differential Pressure sensor

ME-SFI

Motor Electronics Sequential Fuel Injection

MFI

Multiport Fuel Injection

MFI-MAF

MFI Mass Airflow Sensor

MFLS

Main Fuel Level Sensor

MI

Mechanical Fuel Injection

MIL

Malfunction Indicator Light

M/T

Manual Transmission

"N"

NAC

Nitrogen Oxides (NOx) Adsorbing Catalyst

NLV

Non-Linear Valve

NOS

NOx Sensor

NOx

NOx Emission Control

NOxATWC

NOx Adsorptive TWC

NOxC

Nitrogen Oxide Catalyst

NOxS

Nitrogen Oxide Sensor

NOxTWC

NOx Adsorptive TWC

NSC

Nitrogen Oxides (NOx) Storage Catalyst

"O"

OBD

On-Board Diagnostic System

PBD (F)/(P)

Full/Partial On-Board Diagnostic

OC

Oxidation Catalytic Converter

OHC

Overhead Cam

ORVR

On-Board Refueling Vapor Recovery

ORVR-COV

ORVR Cut-Off Valve

ORVR-CV

ORVR Control Valve

ORVR-FAV

ORVR Fresh Air Valve

ORVR-FMV

ORVR Flow Management Valve

ORVR-FTVCV

ORVR Fuel Tank Vapor Control Valve

ORVR-FTVRV

ORVR Fuel Tank Vapor Recirculation Valve

ORVR-FVRS

ORVR Fuel Vapor Recovery System

ORVR-FVV

ORVR Fuel Vent Valve

ORVR-LV

ORVR Leveling Valve

ORVR-OCKV

ORVR Overfill Check Valve

ORVR-RCV

ORVR Refueling Control Valve

ORVR-VCV

ORVR Vapor Cut Valve

ORVR-VRV

ORVR Vapor Recirculating Valve

ORVR-VSV

ORVR Vent Shut Valve

ORVR-VV

ORVR Vent Valve

OVCV

Outer Vent Control Valve

O2S

Oxygen Sensor

"P"

PAIR

Pulsed Secondary Air Injection

PAIR-ABV

PAIR Anti-Backfire Valve

PAIR-ACOV

PAIR Air Cut-Off Valve

PAIR-ACS

PAIR Air Control Solenoid

PAIR-ACV

PAIR Air Control Valve

PAIR-AIV

PAIR Air Injection Valve

PAIR-ASCS

PAIR Air Suction Control Solenoid

PAIR-ASOV

PAIR Air Shutoff Valve

PAIR-ASS

PAIR Air Switching Solenoid

PAIR-ASV

PAIR Air Switching Valve

PAIR-ASVL

PAIR Air Suction Valve

PAIR-AVCS

PAIR Air Valve Control Solenoid

PAIR-CSV

PAIR Control Solenoid Valve

PAIR-CKV

PAIR Check Valve

PAIR-DV

PAIR Diverter Valve

PAIR-PAF

PAIR Pulse Air Feeder

PAIR-PAV

PAIR Pulse Air Valve

PAIR-RES

PAIR Resonator

PAIR-RV

PAIR Reed Valve

PAIR-SCSV

PAIR Swirl Control Solenoid Valve

PAIR-SCV

PAIR Swirl Control Valve

PAIR-SOL

PAIR Solenoid

PAIR-VSV

PAIR Vacuum Switching Valve

PCM

Powertrain Control Module

PCV

Positive Crankcase Ventilation

PCV-DOV

PCV Dual Orifice Valve

PCV-HCB

PCV Heated Crankcase Breather

PCV-HE

PCV Heating Element

PCV-PRV

PCV Pressure Regulator Valve

PCV-SOL

PCV Solenoid

PEVR

Power Enrichment Vacuum Regulator

PPM

Parts Per Million

PTOX

Periodic Trap Oxidizer

PURCV

Purge Crankcase Ventilation

PVCS

Ported Valve Control System

PVCS-A

PVCS Actuator

PVCS-CS

PVCS Control Solenoid

PVLCS

Power Valve Control System

"R"

RC

NOx Reduction Catalyst

ROV

Rollover Valve

"S"

SAI-SV

Secondary Air Injection Shutoff Valve

SAIR-CV

Secondary Air Injection Control Valve

SC

Supercharged or Super Charger

SC MFI

Supercharged Multiport Fuel Injection

SCR

Selective Catalytic Reduction

SCSV

Swirl Control Solenoid Valve

SCV

Swirl Control Valve

SCV-A

SCV Actuator

SFI

Sequential Multiport Fuel Injection

SFI-MAF

SFI Mass Airflow Sensor

SFLS

Sub-Fuel Level Sensor

SOHC

Single Overhead Cam

SPK

Spark Controls

SPK-AVM

SPK Advance Vacuum Modulator

SPK-BVSV

SPK Bimetal Vacuum Switching Valve

SPK-CC

SPK Computer Controlled

SPK-CKV

SPK Check Valve

SPK-CSSA

SPK Cold Start Spark Advance System

SPK-CSSH

SPK Cold Start Spark Hold System

SPK-CTO

SPK Coolant Temperature Override

SPK-DAVS

SPK Distributor Vacuum Advance Solenoid

SPK-DCKV

SPK Distributor Check Valve

SPK-DCTO

SPK Dual Coolant Temperature Override

SPK-DDD

SPK Dual Diaphragm Distributor

SPK-DMV

SPK Distributor Modulator Valve

SPK-DPD

SPK Dual Point Distributor

SPK-DPVS

SPK Distributor Ported Vacuum Switch

SPK-DRCV

SPK Distributor Retard Control Valve

SPK-DRS

SPK Distributor Retard Solenoid

SPK-DSVMV

SPK Distributor Spark Vacuum Modulator Valve

SPK-DTVS

SPK Distributor Thermal Vacuum Switch

SPK-DTVV

SPK Distributor Thermal Vacuum Valve

SPK-DV

SPK Delay Valve

SPK-DVA

SPK Distributor Vacuum Advance

SPK-DVAS

SPK Distributor Vacuum Advance Solenoid

SPK-DVCS

SPK Distributor Vacuum Control Solenoid

SPK-DVCSW

SPK Distributor Vacuum Controlled Switch

SPK-DVCV

SPK Distributor Vacuum Control Valve

SPK-DVDV

SPK Distributor Vacuum Delay Valve

SPK-DVRS

SPK Distributor Vacuum Retard Switch

SPK-DVRV

SPK Distributor Vacuum Regulating Valve

SPK-DVVV

SPK Distributor Vacuum Vent Valve

SPK-EAVS

SPK Electronically Actuated Vacuum Switch

SPK-EDM

SPK Electronic Distributor Modulator

SPK-EI

SPK Electronic Ignition

SPK-ESA

SPK Electronic Spark Advance

SPK-ESC

SPK Electronic Spark Control (Retard)

SPK-ESS

SPK Electronic Spark Selection

SPK-EST

SPK Electronic Spark Timing

SPK-FDV

SPK Forward Delay Valve

SPK-HPCA

SPK Housing Pressure Cold Advance

SPK-ITCS

SPK Ignition Timing Control System

SPK-ITVS

SPK Ignition Timing Vacuum Switch

SPK-NLVR

SPK Non-Linear Vacuum Regulator

SPK-OSAC

SPK Orifice Spark Advance Control

SPK-PVA

SPK Ported Vacuum Advance

SPK-PVS

SPK Ported Vacuum Switch

SPK-RDO

SPK Retard Delay Orifice

SPK-RDV

SPK Reverse Delay Valve

SPK-RDVD

SPK Reverse Delay Valve (Dual)

SPK-RDVLV

SPK Retard Delay Valve

SPK-RDVS

SPK Reverse Delay Valve (Single)

SPK-RETS

SPK Retard Switch

SPK-SC

SPK Speed Controlled

SPK-SDV

SPK Spark Delay Valve

SPK-SOL

SPK Solenoid

SPK-SRRV

SPK Spark Relay Regulator Valve

SPK-TAVIA

SPK Temperature Activated Vacuum Ignition Advance

SPK-TCS

SPK Transmission Controlled Spark

SPK-TCSYS

SPK Timing Control System

SPK-TIDC

SPK Thermostatic Ignition Distributor Control

SPK-TV

SPK Thermal Valve

SPK-TVS

SPK Thermal Vacuum Switch

SPK-VACTO

SPK Vacuum Advance Coolant Temperature Override

SPK-VAS

SPK Vacuum Advance Solenoid

SPK-VAV

SPK Vacuum Advance Valve

SPK-VR

SPK Vacuum Retard

SPK-VRSW

SPK Vacuum Retard Switch

SPK-VSV

SPK Vacuum Switching Valve

SPK-VTCS

SPK Vacuum Timing Control System

SPL

Smoke Puff Limiter

SRI

Service Reminder Indicator

SSCA

Stepped Speed Control Actuator

SSCS

Stepped Speed Control Solenoid

STS

Service Throttle Soon Light

STVS

Secondary Throttle Valve System

SUB-HO2S

Sub-Heated Oxygen Sensor (after CAT)

SUB-O2S

Sub-Oxygen Sensor

SUB-TWC

Sub Three-Way Catalytic Converter

"T"

TAA

Turbo Air-To-Air

TAA

Throttle Actuator Assembly

TAB

Thermactor Air By-Pass

TAD

Thermactor Air Diverter

TAC

Thermostatic Air Cleaner

TBI

Throttle Body Injection

TBPCS

Throttle By-Pass Control System

TC

Turbo Charger

TCC

Torque Converter Clutch

TCCL

Torque Converter Control

TCD

Throttle Closing Dashpot

TC-DV

TC Delay Valve

TC-TVC

TC Thermal Vacuum Switch

TC-VS

TC Vacuum Switch

TD

Thermactor Diverter

TFT

Tank Fuel Temperature Sensor

THOS2

Third Heated Oxygen Sensor

TICV

Thermal Ignition Control Valve

TIV

Thermal Idle Valve

TK

Throttle Kicker

TLUC

Transmission Lock-Up Converter

TLUC-TVS

TLUC Thermal Vacuum Switch

TLUC-VS

TLUC Vacuum Switch

TM

Throttle Modulator

TOS

Throttle Opener System

TP

Throttle Positioner

TPI

Tuned Port Fuel Injection

TPV

Throttle Poppet Valve

TR

Thermal Reactor

TRC

Throttle Return Control

TRCS

Throttle Return Control Solenoid

TRCTL

Throttle Return Control Throttle Lever Actuator

TRSCV

Throttle Return Solenoid Control Valve

TRTVV

Temperature Regulator Thermal Vacuum Valve

TRVV

Transmission Vacuum Valve

TSOL

Throttle Solenoid

TVISD

Throttle Vacuum Idle Speed Diaphragm

TVM

Transmission Vacuum Modulator

TVS

Thermal Vacuum Switch

TWC

Three-Way Catalytic Converter

TWC+OC

Three-Way + Oxidation Catalytic Converter

"V"

VA

Vacuum Advance Unit

VAC-AMP

Vacuum Amplifier

VA-CTO

VA Coolant Temperature Override

VC

Vapor Canister

VCV

Vacuum Cut Valve

VCV-BV

VCV By-Pass Valve

VLFR

Vent Line Flow Restrictor/Anti-Trickle Fill Valve

"W"

WU

Warm-Up Catalyst

WU-OC

Warm-Up Oxidation Converter

WU-TWC

Warm-Up Three-Way Catalytic Converter

Article GUID: A00158541

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, OR P2095: CAMSHAFT POSITION ACTUATOR SOLENOID VALVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0010

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0013

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 1

DTC P0020

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

DTC P0023

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Bank 2

DTC P2088

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 1

DTC P2089

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 1

DTC P2090

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 1

DTC P2091

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 1

DTC P2092

Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 2

DTC P2093

Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 2

DTC P2094

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Bank 2

DTC P2095

Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Camshaft Position Actuator Solenoid Valve High Control	P0010, P0013, P0020, P0023, P2088, P2090, P2092, P2094	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023, P2089, P2091, P2093, P2095	P0011, P0014, P0021, P0024
Camshaft Position Actuator Solenoid Valve Low Reference	-	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023	-	-

Circuit/System Description

The camshaft position actuator system enables the Engine Control Module (ECM) to change the timing of the camshafts while the engine is operating. The Camshaft Position Actuator Solenoid Valve signal from the ECM is pulse width modulated (PWM). The ECM controls the Camshaft Position Actuator Solenoid Valve duty cycle by controlling the amount of solenoid valve On time. The Camshaft Position Actuator Solenoid Valve controls the advance or the retard of each camshaft. The Camshaft Position Actuator Solenoid Valve controls the oil flow that applies the pressure to advance or retard the camshafts.

The ECM controls the Camshaft Position Actuator Solenoid Valve by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The ignition switch is in the Crank or Run position.
- The ECM commanded the Camshaft Position Actuator Solenoid Valve On.
- DTCs P0010, P0013, P0020, P0023 and P2088 - P2095 run continuously when the above conditions are

met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 s.

Action Taken When the DTC Sets

DTCs P0010, P0013, P0020, P0023 and P2088 - P2095 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0010, P0013, P0020, P0023 and P2088 - P2095 are Type B DTCs.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool circuit status parameters for the component. The circuit status parameters change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **If a crankshaft or camshaft position sensor DTC is set, the Camshaft Position Actuator output control will not function.**

1. Ignition On.
2. Verify DTC P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391 is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

   - **If none of the DTCs are set**
3. Verify the scan tool parameters listed below do not display Malfunction:
   - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2
   - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2
   - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
4. Engine idling at normal operating temperature.
5. Verify the scan tool parameters listed below do not display Malfunction when commanding the appropriate scan tool Camshaft Position Actuator from 0-25Â° and back to 0Â° with a scan tool:
   - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2
   - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2
   - Intake/Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
6. Raise the engine speed to 2,000 RPM for 10 s.
7. Verify that DTC P0010, P0013, P0020, P0023 or P2088 - P2095 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

- **If none of the DTCs set**

8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
10. All OK

Circuit/System Testing

1. Ignition Off and all vehicle systems Off, disconnect the appropriate harness connector at the Q6 camshaft position actuator solenoid valve. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition Off, disconnect the harness connector at the K20 engine control module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit
        - If less than 2 Ω, replace the K20 engine control module
    - **If less than 5 Ω**
3. Ignition On.

    NOTE: **A test lamp must be used for this test. The control circuit is pulled-up to a low current voltage, 1.5-3.5 V on the control circuit is normal.**

4. Verify that a test lamp does not illuminate between the control circuit terminal 1 and ground.
    - **If the test lamp illuminates**
    1. Ignition Off, disconnect the harness connector at the K20 engine control module, ignition On.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit
        - If less than 1 V, replace the K20 engine control module
    - **If the test lamp does not illuminate**
5. Remove the test lamp.
6. Connect the DMM black lead to the control circuit terminal 1. Connect the DMM red lead to B+. Command the Camshaft Position Actuator Solenoid On and Off with a scan tool. Verify the voltage changes.
    - **If the voltage does not change**
    1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance or short to ground in the circuit.

- If less than 2 Ω, replace the K20 Engine Control Module.
- **If the voltage changes**

7. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

Component Testing

1. Ignition Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 Ω between the control terminal 1 and the low reference terminal 2.
   - **If not between 5-12 Ω**

     Replace the Q6 Camshaft Position Actuator Solenoid Valve.

   - **If between 5-12 Ω**
3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
   - **If not infinite resistance**

     Replace the Q6 Camshaft Position Actuator Solenoid Valve.

   - **If infinite resistance**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for K20 Engine Control Module replacement, programming and setup.

DTC P0011, P0014, P0021, OR P0024: CAMSHAFT POSITION SYSTEM

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0011

Intake Camshaft Position System Performance Bank 1

DTC P0014

Exhaust Camshaft Position System Performance Bank 1

DTC P0021

Intake Camshaft Position System Performance Bank 2

DTC P0024

Exhaust Camshaft Position System Performance Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Camshaft Position Actuator Solenoid Valve High Control	P0010, P0013, P0020, P0023, P2088, P2090, P2092, P2094	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023, P2089, P2091, P2093, P2095	P0011, P0014, P0021, P0024
Camshaft Position Actuator Solenoid Valve Low Reference	-	P0010, P0013, P0020, P0023	P0010, P0013, P0020, P0023	-	-

Circuit/System Description

The camshaft position actuator system enables the engine control module (ECM) to change the timing of the camshafts while the engine is operating. The camshaft position actuator solenoid signal from the ECM is pulse width modulated (PWM). The ECM controls the camshaft position actuator solenoid duty cycle by controlling the amount of solenoid On time. The camshaft position actuator solenoid controls the advance or the retard of each camshaft. The camshaft position actuator solenoid controls the oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

- DTC P0010, P0013, P0020, P0023, P0016, P0017, P0018, P0019, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391 or P2088 - P2095 is not set.
- The ignition voltage is between 11-32 V.
- The engine is running.
- The desired camshaft position is not changing greater than 4.5Â° for at least 1 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 20Â° or less than 5Â°.
- DTCs P0011, P0014, P0021, and P0024 run continuously when the above conditions are met.

Conditions for Setting the DTC

P0011 and P0021

The ECM detects the difference between the desired and actual camshaft position angle is greater than 5Â° for greater 2.5 s.

P0014 and P0024

The ECM detects the difference between the desired and actual camshaft position angle is greater than 5Â° for greater 10 s.

Action Taken When the DTC Sets

DTCs P0011, P0014, P0021, and P0024 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0011, P0014, P0021, and P0024 are Type B DTCs.

Diagnostic Aids

Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft position actuator solenoid, mechanical camshaft actuator, or timing chain can cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **The engine oil level and the oil pressure are critical to the correct operation of the camshaft position actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.**
- **The engine oil condition has a major impact on the camshaft actuator system. Debris in the oil can interfere with the camshaft position actuator solenoid and the mechanical camshaft actuator operation. Inspect for dirty or degraded crankcase oil. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.**
- **If a crankshaft or camshaft position sensor DTC is set, the Camshaft Position Actuator output control will not function.**

1. Ignition On.
2. Verify that the engine has the correct oil level and the correct oil pressure. Refer to **Oil Pressure Diagnosis and Testing** .
   - **If the oil level and the oil pressure are not correct**

     Repair as necessary

   - **If the oil level and the oil pressure are correct**

   NOTE: **If a crankshaft or camshaft position sensor DTC is set, the scan tool Camshaft Position Actuator output control will not function.**

3. Verify DTC P0016, P0017, P0018, P0019, P0335, P0336, P0338, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391 or P2088 - P2095 is not set.
   - **If any of the DTCs are set**

     If any of the DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

   - **If none of the DTCs are set**
4. Engine idling.
5. Verify the scan tool parameters are less than 2Â° in each of the commanded states when commanding the Camshaft Position Actuator from 0-20Â° and back to 0Â° with the scan tool.
   - Intake Camshaft Position Variance Bank 1
   - Exhaust Camshaft Position Variance Bank 1
   - Intake Camshaft Position Variance Bank 2

- Exhaust Camshaft Position Variance Bank 2
- **If 2Â° or greater**

  Refer to Circuit/System Testing.

- **If less than 2Â°**

6. Verify that DTC P0011, P0014, P0021 or P0024 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **If none of the DTCs set**
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
8. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
9. All OK.

Circuit/System Testing

1. Ignition Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
   - If 2 Ω or greater, repair the open/high resistance in the circuit.
   - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If less than 5 Ω**
3. Ignition On.
4. Verify that a test lamp does not illuminate between the control circuit terminal 1 and ground.
   - **If the test lamp illuminates**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.
   2. Test for less than 1 V between the control circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K20 Engine Control Module.
   - **If the test lamp does not illuminate**
5. Verify the test lamp illuminates when commanding the appropriate Camshaft Position Actuator Solenoid Valve On with a scan tool.

- **If the test lamp does not illuminate**

1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the control circuit end to end.

- If 2 Ω or greater, repair the open/high resistance or short to ground in the circuit.
- If less than 2 Ω, replace the K20 Engine Control Module.
- **If the test lamp illuminates**

6. Ignition Off, remove the Q6 Camshaft Position Actuator Solenoid Valve.
7. Verify the conditions listed below do not exist with the Q6 Camshaft Position Actuator Solenoid Valve:
    1. Torn, restricted, mis-positioned, or missing screens.
    2. Engine oil leak between the oil sealing lands of the solenoid. Inspect the lands of the solenoid for nicks.
    3. Oil seepage at the solenoid connector.

- **If a condition is found**

  Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If a condition is not found**

NOTE: **After swapping the solenoids, install jumper wires to the appropriate terminals of the harness connectors and the solenoids.**

8. Ignition Off, swap the Q6 Camshaft Position Actuator Solenoid Valve with the Q6 Camshaft Position Actuator Solenoid Valve that is operating correctly.
9. Engine idling.
10. Verify the scan tool Camshaft Position Variance parameter is less than 2Â° in each of the commanded states when commanding the Camshaft Position Actuator from 0-20Â° and back to 0Â° with a scan tool.

- **If 2Â° or greater**

  Replace the mechanical camshaft position actuator.

- **If less than 2Â°**

11. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

Component Testing

1. Ignition Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 Ω between the control terminal 1 and the low reference terminal 2.

- **If not between 5-12 Ω**

  Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If between 5-12 Ω**

3. Test for infinite resistance between each terminal and the Q6 camshaft position actuator solenoid valve housing.

- **If not infinite resistance**

  Replace the Q6 Camshaft Position Actuator Solenoid Valve.

- **If infinite resistance**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Actuator Replacement - Bank 1**
- **Camshaft Position Actuator Replacement - Bank 2**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for K20 ECM replacement, programming, and setup

DTC P0016, P0017, P0018, OR P0019: CAMSHAFT POSITION NOT PLAUSIBLE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0016

Crankshaft Position - Intake Camshaft Position Not Plausible Bank 1

DTC P0017

Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 1

DTC P0018

Crankshaft Position - Intake Camshaft Position Not Plausible Bank 2

DTC P0019

Crankshaft Position - Exhaust Camshaft Position Not Plausible Bank 2

Circuit/System Description

The engine control module (ECM) uses the crankshaft position sensor and the camshaft position sensor pulses to monitor the correlation between the crankshaft and the camshaft position.

Conditions for Running the DTC

- DTC P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0641, or P0642 is not set.
- The crankshaft and camshaft position signals are synchronized.
- The engine is cranking or running.
- The camshaft position actuator is in the parked position.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

DTC P0016, P0017, P0018, or P0019

- The ECM detects that one camshaft is mis-aligned with the crankshaft. The ECM detects one of the following conditions:
  - Bank 1 intake camshaft is greater than 9Â° advanced or 12Â° retarded in relationship to the crankshaft.
  - Bank 1 exhaust camshaft is greater than 10Â° advanced or 13Â° retarded in relationship to the crankshaft.
  - Bank 2 intake camshaft is greater than 11Â° advanced or 13Â° retarded in relationship to the crankshaft.
  - Bank 2 exhaust camshaft is greater than 9Â° advanced or 13Â° retarded in relationship to the crankshaft.
- The ECM detects that all 4 camshafts are mis-aligned with the crankshaft. The ECM detects the following conditions:
  - Bank 1 intake camshaft is greater than 9Â° advanced or 12Â° retarded in relationship to the crankshaft.
  - Bank 1 exhaust camshaft is greater than 10Â° advanced or 13Â° retarded in relationship to the crankshaft.
  - Bank 2 intake camshaft is greater than 6Â° advanced or 9Â° retarded in relationship to the crankshaft.
  - Bank 2 exhaust camshaft is greater than 7Â° advanced or 9Â° retarded in relationship to the crankshaft.

Action Taken When the DTC Sets

DTCs P0016, P0017, P0018, and P0019 are type B DTCs.

Conditions for Clearing the DTC

DTCs P0016, P0017, P0018, and P0019 are type B DTCs.

Diagnostic Aids

- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed secondary timing chain can cause this DTC to set.

- This diagnostic algorithm is designed to detect an alignment condition between a primary intermediate sprocket and the secondary timing chain or the alignment between a primary intermediate sprocket and the crankshaft. Either condition would cause the camshaft timing for both cams on one bank to be off an equal number of degrees.
- DTCs P0016, P0017, P0018, and P0019 set at the same time indicate a possible condition with the primary timing chain and the alignment between both intermediate sprockets and the crankshaft. Also, the crankshaft reluctor wheel may have moved and is no longer referenced to top dead center (TDC).
- Observing the desired and actual camshaft angle parameters with a scan tool before a DTC sets may help to isolate whether a condition is specific to one camshaft, one bank, or caused by a condition with the primary crankshaft timing.

Reference Information

Description and Operation

Camshaft Actuator System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0010, P0013, P0020, P0023, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P2088, P2089, P2090, P2091, P2092, P2093, P2094, 20095 or P25CA-P25CE is not set.
    - **If any of the DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **If none of the DTCs are set**
3. Verify the conditions below do not exist:
    - A Q6 Camshaft Position Actuator Solenoid Valve that is stuck in the full advance or retard position
    - The correct installation of the Q6 Camshaft Position Actuator Solenoid Valves
    - The correct installation of the B23 Camshaft Position Sensors
    - The correct installation of the B26 Crankshaft Position Sensor
    - A timing chain tensioner condition
    - An incorrectly installed timing chain
    - Excessive play in the timing chain
    - A timing chain that jumped teeth
    - A crankshaft reluctor wheel that has moved in relationship to top dead center (TDC) on the crankshaft

- **If a condition is found**

  Repair as necessary.

- **If no condition is found**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     A mechanical condition listed above still exists.

   - **If the DTC does not set**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust**
- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Timing Drive Components Cleaning and Inspection**
- **Crankshaft Position Sensor Replacement**
- **Timing Chain Alignment Diagram**

DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, OR P0161: HO2S HEATER (LFX)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0030

HO2S Heater Control Circuit Bank 1 Sensor 1

DTC P0031

HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 1

DTC P0032

HO2S Heater Control Circuit High Voltage Bank 1 Sensor 1

DTC P0036

HO2S Heater Control Circuit Bank 1 Sensor 2

DTC P0037

HO2S Heater Control Circuit Low Voltage Bank 1 Sensor 2

DTC P0038

HO2S Heater Control Circuit High Voltage Bank 1 Sensor 2

DTC P0050

HO2S Heater Control Circuit Bank 2 Sensor 1

DTC P0051

HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 1

DTC P0052

HO2S Heater Control Circuit High Voltage Bank 2 Sensor 1

DTC P0053

HO2S Heater Resistance Bank 1 Sensor 1

DTC P0054

HO2S Heater Resistance Bank 1 Sensor 2

DTC P0056

HO2S Heater Control Circuit Bank 2 Sensor 2

DTC P0057

HO2S Heater Control Circuit Low Voltage Bank 2 Sensor 2

DTC P0058

HO2S Heater Control Circuit High Voltage Bank 2 Sensor 2

DTC P0059

HO2S Heater Resistance Bank 2 Sensor 1

DTC P0060

HO2S Heater Resistance Bank 2 Sensor 2

DTC P0135

HO2S Heater Performance Bank 1 Sensor 1

DTC P0141

HO2S Heater Performance Bank 1 Sensor 2

DTC P0155

HO2S Heater Performance Bank 2 Sensor 1

DTC P0161

HO2S Heater Performance Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S Heater Voltage Supply	P0030, P0036, P0037, P0050, P0056, P0057, P0097, P00F4, P0102, P0132, P0135, P0138, P0141, P0152, P0155, P0158, P0161, P2199, *	P0030, P0031, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0690	P0135, P0141, P0155, P0161
HO2S Heater Control	P0030, P0031, P0036, P0037, P0050, P0051, P0053, P0054, P0056, P0057, P0059, P0060, P0135, P0141, P0155, P0161	P0030, P0036, P0050, P0056, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0030, P0032, P0036, P0038, P0050, P0052, P0056, P0058, P0132, P0134, P0135, P0138, P0140, P0141, P0152, P0154, P0155, P0158, P0160, P0161	P0135, P0141, P0155, P0161
* Opens Fuse				

Typical Scan Tool Data

HO2S Sensor 1 Current/HO2S Sensor 2 Current

Circuit	Short to Ground	Open	Short to Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 0.2-1.5 A			
HO2S Heater Low Control	0 A	0 A	0 A
HO2S Heater Voltage Supply	0 A	0 A	0.2-2 A

Circuit/System Description

Heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside the HO2S minimizes the time required for the sensors to reach operating temperature. Voltage is provided to the heater by an ignition voltage circuit through a fuse. With the engine running, ground is provided to the heater by the HO2S heater low control circuit through a low side driver within the engine control module (ECM). The ECM uses pulse width modulation (PWM) to control the HO2S heater operation to maintain a specific HO2S operating temperature range.

Conditions for Running the DTC

P0030-P0032, P0036-P0038, P0050-P0052, or P0056-P0058

- The Ignition voltage is between 11-32 V.
- The engine speed is greater than 400 RPM.
- The DTCs run continuously when the above conditions are met.

P0053, P0054, P0059, or P0060

- DTCs P0112, P0113, P0117, P0118, or P2610 are not set.
- The engine run time is greater than 20 s.
- The Ignition voltage is less than 18 V.
- The ignition is OFF for greater than 8 h.
- The engine coolant temperature (ECT) is between -30 to +45Â°C (-22 to +113Â°F) at engine start-up.
- The ECT and the intake air temperature (IAT) are within 8Â°C (14Â°F) at engine start-up.
- The DTCs run once per drive cycle when the above conditions are met.

P0135, P0141, P0155, or P0161

- DTCs P0116, P0117, P0118, P0125, or P0128 are not set.
- The Ignition voltage is between 10-32 V.
- The HO2S is at operating temperature.
- The HO2S is commanded ON.
- The DTCs run once per drive cycle when the above conditions are met for 120 s.

Conditions for Setting the DTC

P0030, P0036, P0050, or P0056

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match

for greater than 5 s.

P0031, P0037, P0051, or P0057

The engine control module detects a short to ground in the heater output low side driver circuit of the heated oxygen sensor when the heater is commanded OFF for greater than 13 s.

P0032, P0038, P0052, or P0058

The engine control module detects a short to voltage in the heater output low side driver circuit of the heated oxygen sensor when the heater is commanded ON for greater than 13 s.

P0053, P0054, P0059, or P0060

The ECM detects the HO2S heater is not within a specified resistance range at engine start-up.

P0135 or P0155

The ECM detects that the HO2S 1 heater current is greater than 3.1 amps, or less than 0.3 amps for greater than 8 s.

P0141 or P0161

The ECM detects that the HO2S 2 heater current is greater than 2.9 amps, or less than 0.3 amps for greater than 8 s.

Action Taken When the DTC Sets

DTCs P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, and P0161 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, and P0161 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the HO2S Heater Bank 1 or 2 Sensor 1 or 2 ON and OFF with a scan tool .
   - HO2S Heater Control Circuit Low Voltage Test Status Bank 1 or 2 Sensor 1 or 2
   - HO2S Heater Control Circuit Open Test Status Bank 1 or 2 Sensor 1 or 2
   - HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate B52 Heated Oxygen Sensor. Ignition ON.
2. Verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 2 Ω in the ignition circuit end to end.
   - If 2 Ω or greater, repair the open/high resistance in the circuit.
   - If less than 2 Ω, verify the fuse is OK and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the ignition circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test all components connected to the fuse and replace as necessary.
- **If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the ignition voltage circuit terminal D and the control circuit terminal C.
   - **If the test lamp illuminates**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
   - If less than infinite resistance, repair the short to ground on the circuit.
   - If infinite resistance, replace the K20 Engine Control Module.
   - **If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2 parameter is OK when commanding the HO2S Heater ON with a scan tool.
   - **If the parameter is not OK**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module. Ignition ON.
   2. Test for less than 1 V between the control circuit and ground.
   - **If the parameter is OK**

NOTE:

- **Less than 10 Ω of additional resistance on the ignition voltage circuit or control circuit may set a DTC. If there is a resistance on a circuit, the driver will remain ON and the scan tool HO2S High Voltage Test Status parameter will display OK.**
- **Performing this test may set additional DTCs.**

6. Install a 10 A fused jumper wire between the control circuit terminal C and the ignition voltage circuit terminal D.

NOTE: **This test may only be performed once per key cycle. If test is repeated, ignition OFF, allow the engine control module to shut down completely, then ignition ON.**

7. Verify the scan tool HO2S Heater Control Circuit High Voltage Test Status Bank 1 or 2 Sensor 1 or 2 parameter is Malfunction when commanding the HO2S Heater ON with a scan tool.
   - **If the parameter is not Malfunction**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the control circuit end to end.
   - If 2 Ω or greater, repair the open/high resistance in the circuit.
   - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If the parameter is Malfunction**
8. Test or replace the B52 Heated Oxygen Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S.
- **Control Module References** for ECM replacement, programming and setup

DTC P0068 OR P1101: AIR FLOW

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0068

Throttle Body Air Flow Performance

DTC P1101

Intake Air Flow System Performance

Circuit/System Description

The engine control module (ECM) compares actual air flow based on throttle position (TP) to a calculated air flow based on manifold absolute pressure (MAP) sensor, and mass air flow (MAF).

Conditions for Running the DTC

DTC P0068

- The engine speed is greater than 800 RPM.
- The ignition voltage is greater than 6.5 V.
- The throttle actuator control system is not in reduced power mode.
- The DTC runs continuously when the above conditions are met.

DTC P1101

- DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114. P0116, P0117, P0118, P0128, P0335, or P0336 are not set
- The engine speed is between 600-6,800 RPM
- The engine coolant temperature (ECT) is between -7 and +125Â°C (+19 and +257Â°F).

- The intake air temperature (IAT) sensor 1 is between -20 and +125Â°C (-4 to +257Â°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the actual air flow rate is greater than the calculated air flow.

Action Taken When the DTC Sets

- DTC P0068 is a type A DTC.
- DTC P1101 is a type B DTC.

Conditions for Clearing the DTC

- DTC P0068 is a type A DTC.
- DTC P1101 is a type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
    - **If any of the DTCs are set**

Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.

- **If none of the DTCs are set**

3. Verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90 %.
   - **90 % or greater**

     Refer to **Throttle Body Inspection and Cleaning** .

   - **If less than 90 %**
4. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
   - **If Disagree**

     Refer to **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135** for further diagnosis.

   - **If Agree**
5. Determine the current vehicle testing altitude.
6. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
   - **If the MAP Sensor parameter is not in range**

     Refer to **DTC P0106** for further diagnosis.

   - **If the MAP Sensor parameter is in range**
7. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
   1. Engine idling
   2. Perform the scan tool snapshot function.
   3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
   4. Exit from the scan tool snapshot and review the data.
   5. Observe the MAF Sensor parameter frame by frame with a scan tool.
   - **The MAF Sensor parameter does not change smoothly and gradually**

     Refer to **DTC P0101** for further diagnosis.

   - **The MAF Sensor parameter changes smoothly and gradually**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing for further diagnosis.

   - **If the DTC does not set.**
10. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Verify the integrity of the entire air induction system by verifying that none of the following conditions exist:
    - Any damaged, improperly installed, collapsed, or restricted components
    - Loose clamps, cracks, or other damage
    - An air flow restriction
    - Restricted air filter
    - Splits, kinks, leaks, or improper connections at the vacuum hoses
    - Vacuum leaks at the intake manifold, MAP sensor, and throttle body
    - Water intrusion
    - Any snow or ice buildup, in cold climates
    - Contamination of the MAF sensor element
    - Improper operation of the crankcase ventilation system-Refer to **Crankcase Ventilation System Inspection/Diagnosis** for further diagnosis.
    - Missing, restricted, or leaking exhaust components-Refer to **Symptoms - Engine Exhaust** for further diagnosis.
    - **If a condition is found**

      Repair or replace component as appropriate.

    - **If no condition is found**
2. Test the engine for a mechanical condition. Refer to **Symptoms - Engine Mechanical** for diagnosis.
    - **If a condition is found**

      Repair or replace component as appropriate.

    - **If no condition is found**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for engine control module replacement, programming, and setup.

DTC P0089, P00C6, P228C, OR P228D: FUEL PRESSURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0089

Fuel Pressure Regulator Performance

DTC P00C6

Fuel Rail Pressure Low During Engine Cranking

DTC P228C

Fuel Pressure Regulator Solenoid Control Performance - Low Pressure

DTC P228D

Fuel Pressure Regulator Control Performance - High Pressure

Circuit/System Description

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a three-lobe cam on the Bank 2 exhaust camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the engine control module (ECM) requests pressure ranging from 2 to 15 MPa (290 to 2,176 psi), depending on engine speed and load. Output drivers in the ECM provide the high pressure fuel pump actuator control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail. When the control solenoid is NOT powered, the pump operates at maximum flow rate. In the event of pump control failure, the high pressure system is protected by a relief valve in the high pressure fuel pump that prevents the pressure from exceeding 17.5 MPa (2,538 psi).

The fuel rail pressure sensor provides the feedback necessary to the ECM to control the high pressure fuel pump and the fuel injectors. This sensor is diagnosed separately from the fuel pressure control system.

The ECM monitors the fuel rail pressure sensor and the high pressure fuel pump actuator to determine if the commanded and actual pressures are within a predetermined range during engine cranking and at all times while the engine is running. The ECM also monitors the high pressure fuel pump actuator to make sure it is operating within expected limits.

Conditions for Running the DTC

P0089, P228C, or P228D

- DTC P0016, P0017, P0018, P0019, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, or P0628, is not set.
- The ignition voltage is greater than 8 V.
- The low side fuel pressure is greater than 275 kPa (40 psi).
- The engine is running.

- The DTCs run continuously when the above conditions are met for 10 s.

P00C6

- DTC P0090, P0091, P0092, P00C8, P00C9, P00CA, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, or P0628, is not set.
- The ignition voltage is more than 8 V.
- The engine coolant temperature is less than 65Â°C (149Â°F).
- The low side fuel pressure is greater than 300 kPa (44 psi).
- The diagnostic runs once for each engine start.

Conditions for Setting the DTC

P0089

The high pressure fuel pump has exceeded it's control limits. This condition exists when the high pressure fuel pump actuator command is 0Â° or greater than 240Â°. The condition exists for greater than 10 s.

P00C6

The engine control module detects that the fuel rail pressure is not rising greater than 3 MPa (435 psi) or has fallen below 2 MPa (290 psi) during engine cranking, depending on initial pressure when cranking begins.

P228C

The actual fuel rail pressure is 3 MPa (435 psi) less than the desired fuel rail pressure. The condition exists for greater than 10 s.

P228D

The actual fuel rail pressure is 3 MPa (435 psi) greater than the desired fuel rail pressure. The condition exists for greater than 10 s.

Action Taken When the DTC Sets

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C and P228D are Type A DTCs.
- A message center or an indicator displays Reduced Engine Power for P228C and P228D.

Conditions for Clearing the DTC

- DTCs P0089 and P00C6 are Type B DTCs.
- DTCs P228C and P228D are Type A DTCs.

Diagnostic Aids

- A leak in the high pressure fuel system may set a DTC.
- A faulty valve, plunger, or solenoid in the high pressure fuel pump may set a DTC. High pressure fuel pump damage will most likely be undetectable upon visual inspection.

- A restricted fuel feed pipe between the high pressure fuel pump and the fuel rail pressure sensor may set a DTC.
- Any problem with the Bank 2 exhaust cam may set fuel pressure DTCs due to the location and design of the high pressure fuel pump. If DTC P0019 or P0391 are current or in history, a cam control issue may be the root cause.
- A leaking or restricted fuel injector may set DTC P0089.
- For DTC P00C6, park the vehicle outdoors overnight and perform a start in the morning.
- A short to voltage in the crankshaft position signal circuit may set a DTC.
- As little as 2 Ω on either circuit of the high pressure fuel pump actuator will cause these DTCs to set. Test the circuits of the high pressure fuel pump actuator for a high resistance if you suspect a condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON
2. Verify DTC P0016, P0017, P0018, P0019, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0111, P0112, P0113, P0116, P0117, P0118, P0128, P0192, P0193, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, or P0628 is not set.
    - **If any of the DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

3. Engine at idle.
4. Verify the Fuel Rail Pressure Sensor parameter is between 1.9-5.0 MPa (276-725 psi).
   - **If not between 1.9-5.0 MPa (276-725 psi)**

     Refer to Circuit/System Testing.

   - **If between 1.9-5.0 MPa (276-725 psi)**
5. Verify the scan tool Fuel Rail Pressure Sensor parameter increases and decreases when commanding the Fuel Rail Pressure Control with a scan tool.
   - **If the Fuel Rail Pressure Sensor does not increase and decrease with each command**

     Refer to Circuit/System Testing.

   - **If the Fuel Rail Pressure Sensor increases and decreases with each command**

WARNING: Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.

6. Road test the vehicle and perform a wide open acceleration from a stop until the transmission shifts into second gear. On manual transmission applications, shift to second gear or stop the test near 7,000 RPM. Repeat the test at least three times.
7. Verify DTCs P0089, P00C6, P228C, and P228D do not set.
   - **If any of the DTCs set**

     Refer to Circuit/System Testing.

   - **If none of the DTCs set**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify DTCs P0089, P00C6, P228C, and P228D do not set.
   - **If any of the DTCs set**

     Refer to Circuit/System Testing.

   - **If none of the DTCs set**
10. All OK.

Circuit/System Testing

NOTE: Circuit/System Verification must be performed first or misdiagnosis may result.

1. Clear all DTCs.

WARNING: **Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.**

2. Road test the vehicle and perform a wide open acceleration from a stop until the transmission shifts into second gear. On manual transmission applications, shift to second gear or stop the test near 7,000 RPM. Repeat the test at least three times.
3. Verify the scan tool Fuel Rail Pressure Sensor parameter is between 14-17 MPa (2031-2,466 psi) while under load near 7,000 RPM.
    - **If not within the specified range**
    1. Remove the G18 High Pressure Fuel Pump.
    2. Inspect the lobes on the camshaft for unusual wear.
        - If the camshaft lobes are worn, replace the camshaft.
        - If the camshaft lobes appear normal, test or replace the G18 High Pressure Fuel Pump.
    - **If within the specified range**
4. Verify none of the conditions listed below exist:
    1. Contaminates in the fuel system, Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**
    2. A Leak in the high pressure fuel system.
    3. A restricted fuel feed pipe between the G18 High Pressure Fuel Pump and the B47B Fuel Rail Pressure Sensor.
    4. A leaking or restricted Q17 Fuel Injector, Refer to **Fuel Injector Solenoid Coil Test** , and **Fuel Injector Balance Test** .
    5. High resistance in the G18 High Pressure Fuel Pump actuator circuits.
    - **If a condition exist**

      Repair as necessary.

    - **If none of the conditions exist**
5. All OK.

Component Testing

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.

NOTE: **The DMM and test leads must be calibrated to 0 Ω in order to prevent misdiagnosis.**

2. Test for 9-11 Ω at 25Â°C (77Â°F) of resistance between G18 High Pressure Fuel Pump actuator low control circuit terminal 1 and high control circuit terminal 2.
    - **If not within the specified range**

      Replace the G18 High Pressure Fuel Pump.

    - **If within the specified range**

3. Test for infinite resistance between each G18 High Pressure Fuel Pump actuator terminal and the G18 High Pressure Fuel Pump housing/case.
    - **If less than infinite resistance**

      Replace the G18 High Pressure Fuel Pump.

    - **If infinite resistance**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Camshaft Replacement - Left Side**
- **Fuel Pump Replacement** for G18 High Pressure Fuel Pump replacement.

  NOTE: **Some vehicles do not support the Fuel Rail Pressure Relief Valve Reset procedure. Applications not supporting this procedure will return an error message stating "Parameter ID not supported. Check for proper vehicle selection."**

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

DTC P0090-P0092, P00C8, P00C9, OR P00CA: FUEL PRESSURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0090

Fuel Pressure Regulator Control Circuit

DTC P0091

Fuel Pressure Regulator Control Circuit Low Voltage

DTC P0092

Fuel Pressure Regulator Control Circuit High Voltage

DTC P00C8

Fuel Pressure Regulator High Control Circuit

DTC P00C9

Fuel Pressure Regulator High Control Circuit Low Voltage

DTC P00CA

Fuel Pressure Regulator High Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
High Pressure Fuel Pump Actuator High Control	P0091, P00C9	P0090, P00C8	P0092, P00C9, P00CA	-
High Pressure Fuel Pump Actuator Low Control	P0091, P0092, P00C9	P0090, P00C8	P0092, P00CA	-

Circuit/System Description

High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high pressure fuel pump. The high pressure fuel pump actuator is a solenoid valve. The engine control module (ECM) provides battery voltage on the actuator high control circuit and ground on the actuator low control circuit. Both circuits are controlled through output drivers within the ECM. When deactivated, both drivers are disabled. When activated, the high control circuit driver energizes the high pressure fuel pump actuator and the low control circuit driver pulse-width modulates (PWM) the low control circuit to ground. The ECM monitors the voltage on the circuits to detect a failure.

The high fuel pressure necessary for direct injection is supplied by the high pressure fuel pump. The high pressure fuel pump is mounted on the rear of the engine and is driven by a three-lobe cam on the Bank 2 exhaust camshaft. This high pressure fuel pump also regulates the fuel pressure using an actuator in the form of an internal solenoid-controlled valve. In order to keep the engine running efficiently under all operating conditions, the ECM requests pressure ranging from 2-15 MPa (290-2,176 PSI), depending on engine speed and load. Output drivers in the ECM provide the pump control circuit with a 12 V pulse-width modulated (PWM) signal, which regulates fuel pressure by closing and opening the control valve at specific times during pump strokes. This effectively regulates the portion of each pump stroke that is delivered to the fuel rail.

It is important to note that the high pressure fuel pump is a trailing-edge control system, meaning that if the control solenoid is NOT powered, the pump operates at maximum flow rate. In the event of pump control failure, the high pressure system is protected by a relief valve in the pump that prevents the pressure from exceeding 17.5 MPa (2,538 PSI).

NOTE: **The fuel rail pressure sensor is diagnosed separately from the fuel pressure control system and should not be replaced for any codes referenced in this document.**

The fuel rail pressure sensor operates on a 5 V reference circuit and it provides the feedback necessary to the ECM to control the high pressure fuel pump and the fuel injectors.

Conditions for Running the DTC

- The ignition voltage is between 11-18 V.

- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTC

P0090

- The engine control module detects an open circuit in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P0091

- The engine control module detects a short to ground in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P0092

- The engine control module detects a short to voltage in the high pressure fuel pump actuator low control circuit.
- The DTC sets when the above condition is present for 4 s.

P00C8

- The engine control module detects an open circuit in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

P00C9

- The engine control module detects a short to ground in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

P00CA

- The engine control module detects a short to voltage in the high pressure fuel pump actuator high control circuit.
- The DTC sets when the above condition is present for 4 s.

Action Taken When the DTC Sets

- DTCs P0090, P0091, P0092, P00C8, P00C9, and P00CA are Type A DTCs.
- A message center or an indicator displays Reduced Engine Power.

Conditions for Clearing the DTC

DTCs P0090, P0091, P0092, P00C8, P00C9, and P00CA are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0685, or P1682 are not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If none of the DTCs are set**
3. Verify the parameters listed below do not display Malfunction when commanding the Fuel Pressure Regulator ON and OFF with a scan tool.
   - Fuel Pressure Regulator Control Circuit High Voltage Test Status
   - Fuel Pressure Regulator Control Circuit Open Test Status
   - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
   - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
   - Fuel Pressure Regulator High Control Circuit Open Test Status
   - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump, ignition ON. It may take up to 2 min for all vehicle systems to power down.
2. Verify that a test lamp does not illuminate between the high control circuit terminal 1 and ground.
    - **If the test lamp illuminates**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the high control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If the test lamp does not illuminate**
3. Verify that a test lamp does not illuminate between the low control circuit terminal 2 and ground.
    - **If the test lamp illuminates**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the low control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If the test lamp does not illuminate**
4. Verify that a test lamp does not illuminate between the high control circuit terminal 1 and B+.
    - **If the test lamp illuminates**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the high control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If the test lamp does not illuminate**
5. Verify that a test lamp does not illuminate between the low control circuit terminal 2 and B+.
    - **If the test lamp illuminates**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the low control circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K20 Engine Control Module.

- **If the test lamp does not illuminate**

6. Remove the test lamp, connect a 3 A fused jumper wire between the high control circuit terminal 2 and ground.
7. Verify the Fuel Pressure Regulator High Control Circuit Low Voltage Test Status transitions from OK to Malfunction.
    - **If Malfunction is not displayed**
    1. Ignition OFF, remove the fused jumper, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the high control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If Malfunction is displayed**
8. Connect a 3 A fused jumper wire between the low control circuit terminal 1 and B+.
9. Verify the Fuel Pressure Regulator Control Circuit High Voltage Test Status transitions from OK to Malfunction.
    - **If Malfunction is not displayed**
    1. Ignition OFF, remove the fused jumper, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If Malfunction is displayed**
10. Test or replace the G18 High Pressure Fuel Pump.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.

NOTE: **The DMM and test leads must be calibrated to 0 Ω in order to prevent misdiagnosis.**

2. Test for 9-11 Ω between low control circuit terminal 1 and high control circuit terminal 2.
    - **If not within the specified range**

      Replace the G18 High Pressure Fuel Pump.

- **If within the specified range**

3. Test for infinite resistance between each terminal and the High Pressure Fuel Pump housing/case.
    - **If less than infinite resistance**

      Replace the G18 High Pressure Fuel Pump.

    - **If infinite resistance**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Pump Replacement** for G18 High Pressure Fuel Pump replacement.
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup.

> **NOTE:** **Some vehicles do not support the Fuel Rail Pressure Relief Valve Reset procedure. Applications not supporting this procedure will return an error message stating "Parameter ID not supported. Check for proper vehicle selection."**

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

DTC P0096 OR P0111: INTAKE AIR TEMPERATURE (IAT) SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0096

Intake Air Temperature (IAT) Sensor 2 Performance

DTC P0111

Intake Air Temperature (IAT) Sensor 1 Performance

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0113, P0114, P2199*	P0111, P2199

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Reference	-	P0111, P0113, P0114, P2199, P2229, P2230	P0113, P0114, P2199, P2227, P2229*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P0443, P2199	P0096, P0097, P00F4, P0101, P0102, P0178, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102, P0178, P2199	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F)* 10 Hz
Ground	-	-40Â°C (-40Â°F) 10 Hz	-

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

ECT Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with coolant temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The sensors listed below are integrated within the multifunction intake air sensor:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

The intake air temperature (IAT) sensor 1 is a variable resistor that changes the voltage on the engine control module (ECM) supplied 5 V signal circuit. The signal varies with inlet air temperature in the sensor bore and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 2 and the humidity sensor share the same circuit. The IAT sensor 2 signal is displayed by the scan tool as Hertz (Hz) and Â°C (Â°F).

The sensors listed below share an ECM supplied 5 V reference circuit:

- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

The sensors listed below share an ECM supplied low reference circuit:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Cold	High	High

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Warm	Low	Low

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	45 Hz	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°F)

Conditions for Running the DTCs

P0096 and P0111

- DTCs P0097, P0098, P0112, P0113, P0116, P0117, P0118, P0119, or P1682 are not set.
- The vehicle has been OFF at least 8 hours.
- Ignition voltage is at least 11 V.
- These DTCs run once per ignition cycle when the enabling conditions are met.

Conditions for Setting the DTCs

P0096

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 10Â°C (18Â°F).

  AND

- The absolute difference between ECT start-up temperature and the IAT sensor 2 start-up temperature is greater than the absolute difference between ECT start-up temperature and the IAT sensor 1 start-up temperature.
- This DTC runs once per ignition cycle when the enabling conditions are met.

P0111

- The ECM determines the absolute difference between IAT sensor 1 start-up temperature and the IAT sensor 2 start-up temperature is greater than 10Â°C (18Â°F).

  AND

- The absolute difference between ECT start-up temperature and the IAT sensor 1 start-up temperature is greater than the absolute difference between ECT start-up temperature and the IATsensor 2 start-up temperature.
- This DTC runs once per ignition cycle when the enabling conditions are met.

Action Taken When the DTC Sets

- DTC P0096 is a Type B DTC - North America and Korea.
- DTC P0096 is a Type C DTC - Except North America and Korea.
- DTC P0111 is a Type B DTC.

- The ECM commands the cooling fans ON.

Conditions for Clearing the DTCs

- DTC P0096 is a Type B DTC - North America and Korea.
- DTC P0096 is a Type C DTC - Except North America and Korea.
- DTC P0111 is a Type B DTC.

Diagnostic Aids

- With the ignition ON, when the engine is OFF and cold; properly functioning IAT sensors 1 and 2 will gradually increase the scan tool IAT Sensor 1 and 2 parameters. This is due to the heat that is generated by the multifunction intake air sensor internal heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40Â°C (-40Â°F), and there are also Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

NOTE: **To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been OFF for 8 hours or more.**

1. Ignition ON.
2. Verify the following scan tool parameters are within 10Â°C (18Â°F) of each other.
    - Start-Up IAT Sensor 1
    - IAT Sensor 2
    - Start-Up ECT
    - **If not within 10Â°C (18Â°F)**

      Refer to Circuit/System Testing.

    - **If within 10Â°C (18Â°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
    - IAT Sensor 1
    - IAT Sensor 2
    - ECT Sensor
    - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

      Refer to Circuit/System Testing.

    - **If between: -38 and +149Â°C (-36 and +300Â°F)**
4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTCs do not set.
    - **If any DTC sets**

      Refer to Circuit/System Testing.

    - **If no DTC sets**
6. All OK

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Verify none of the following conditions exist:
    - A restricted or collapsed air intake duct
    - An intake manifold leak
    - A MAP sensor seal that is leaking, missing, or damaged

- A restricted or collapsed air intake duct
- A misaligned or damaged air intake duct
- Any water intrusion in the induction system
- An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing
- **If a condition exists**

  Repair or replace component as appropriate.

- **If no condition exists**

2. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
   - **If 2 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **If less than 2 Ω**
4. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.
   - **If 2 Ω or greater**
   1. Ignition OFF. Disconnect the sensor chassis ground.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 2 Ω**
5. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
   2. Test for less than 2 Ω in the ignition voltage circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
   2. Test for infinite resistance between the ignition voltage circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
   - **If a test lamp illuminates**
6. Ignition ON, test for 4.8-5.2 V between the intake air temperature signal 1 circuit terminal 1 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

NOTE: **If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

7. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39Â°C (-38Â°F).
    - **If warmer than -39Â°C (-38Â°F).**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

    - **If colder than -39Â°C (-38Â°F).**

8. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3.
9. Verify the scan tool IAT Sensor 3 parameter is warmer than 150Â°C (302Â°F).
    - **If colder than 150Â°C (302Â°F).**

    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω, replace the K20 Engine Control Module.

- **If warmer than 150Â°C (302Â°F).**

10. Ignition ON, test for 4.8-5.2 V between the intake air temperature signal 2 circuit terminal 8 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**

      NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**
11. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
    - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
    1. Test or replace the B75C Multifunction Intake Air sensor.
    2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
    3. Verify the DTC does not set.
        - **If the DTC sets**

          Replace the K20 Engine Control Module.

        - **If the DTC does not set**
    4. All OK.
    - **EL-38522-A, Variable Signal Generator; or equivalent is available**
12. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
    - Red lead to the signal circuit terminal 8 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
13. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
    - Signal switch to 5 V
    - Duty Cycle switch to 50 % (Normal)

- Frequency switch to 30 Hz

14. Ignition ON, verify the scan tool IAT Sensor 2 parameter is between 28-32 Hz.
    - **If not between 28-32 Hz**

      Replace the K20 Engine Control Module.

    - **If between 28-32 Hz**
15. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

   NOTE: A thermometer can be used to test the sensor off the vehicle.

2. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** table for Hitachi Sensors. The resistance values should be in range of the table values.
    - **If not within the table values.**

      Replace the B75C Multifunction Intake Air sensor.

    - **If within the table values.**
3. All OK

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.
    - **If not within 5%**

      Replace the B75C Multifunction Intake Air sensor.

    - **If within 5%**
2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0097, P0098, OR P0099: INTAKE AIR TEMPERATURE (IAT) SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0097

Intake Air Temperature (IAT) Sensor 2 Circuit Low Voltage

DTC P0098

Intake Air Temperature (IAT) Sensor 2 Circuit High Voltage

DTC P0099

Intake Air Temperature (IAT) Sensor 2 Circuit Intermittent

Diagnostic Fault Information

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P0443, P2199	P0096, P0097, P00F4, P0101, P0102, P0178, P2199, P2230	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102, P0178, P2199, P2230	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F)* 10 Hz

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Ground	-	-40Â°C (-40Â°F) 10 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The sensors listed below are integrated within the mass air flow/multifunction intake air sensor:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

The IAT sensor 2 and the humidity sensor share the same circuit. The IAT sensor 2 signal is displayed by the scan tool as Hertz (Hz) and Â°C (Â°F).

The sensors listed below share an ECM supplied 5 V reference circuit:

- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

The sensors listed below share an ECM supplied low reference circuit:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Cold	High	High
Warm	Low	Low

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	45 Hz	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°F)

Conditions for Running the DTCs

P0097, P0098, and P0099

- The ignition is ON, or the engine is running.

- The Ignition voltage is at least 11 V.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P0097

NOTE: The scan tool display range is between -40 and +150Â°C (-40 and +302Â°F).

The ECM detects that the IAT sensor 2 signal is less than 13 Hz, colder than -60Â°C (-76Â°F), for greater than 5 s.

P0098

The ECM detects that the IAT sensor 2 signal is greater than 390 Hz, warmer than 150Â°C (302Â°F), for greater than 5 s.

P0099

The ECM detects that the IAT sensor 2 signal is intermittent or has abruptly changed for longer than 5 s.

Action Taken When the DTC Sets

- DTCs P0097, P0098, and P0099 are Type B DTCs - North America and Korea.
- DTCs P0097, P0098, and P0099 are Type C DTCs - Except North America and Korea.
- The ECM commands the cooling fans ON.

Conditions for Clearing the MIL/DTC

- DTCs P0097, P0098, and P0099 are Type B DTCs - North America and Korea.
- DTCs P0097, P0098, and P0099 are Type C DTCs - Except North America and Korea.

Diagnostic Aids

- With the ignition ON, the engine OFF and the engine is cold, a properly functioning IAT sensor 2 will gradually increase the scan tool IAT Sensor 2 parameter. This is due to the heat that is generated by the MAF sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40Â°C (-40Â°F), and there are also Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

NOTE: **To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been OFF for 8 hours or more.**

1. Ignition ON.
2. Verify the following scan tool parameters are within 10Â°C (18Â°F) of each other.
   - Start-Up IAT Sensor 1
   - IAT Sensor 2
   - Start-Up ECT
   - **If not within 10Â°C (18Â°F)**

     Refer to Circuit/System Testing.

   - **If within 10Â°C (18Â°F)**
3. Engine idling, verify the following scan tool parameters are between: between -38 and +149Â°C (-36 and +300Â°F).
   - IAT Sensor 1
   - IAT Sensor 2
   - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

     Refer to Circuit System Testing.

- **If between: -38 and +149Â°C (-36 and +300Â°F)**

4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
6. All OK

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Ignition OFF and all systems OFF, it may take up to for 2 min. for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
   - **If 2 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω replace the K20 Engine Control Module.
   - **If less than 2 Ω**
3. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.
   - **If 2 Ω or greater**
   1. Ignition OFF. Disconnect the sensor chassis ground.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open or high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 2 Ω**
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
   2. Test for less than 2 Ω in the ignition voltage circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
   2. Test for infinite resistance between the ignition voltage circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test all components connected to the ignition circuit, replace as necessary.

- **If a test lamp illuminates**

5. Ignition ON, test for 4.8-5.2 V between the intake air temperature sensor 2 signal circuit terminal 8 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

     NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Ignition ON, test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 4.8-5.2 V**
6. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
   - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
   1. Test or replace the B75C Multifunction Intake Air sensor.
   2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
   3. Verify the DTC does not set.
      - **If the DTC sets**

        Replace the K20 Engine Control Module.

      - **If the DTC does not set**
   4. All OK.
   - **EL-38522-A, Variable Signal Generator; or equivalent is available**
7. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
   - Red lead to the signal circuit terminal 8 at the harness connector
   - Black leads to ground
   - Battery voltage supply lead to B+

8. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
    - Signal switch to 5 V
    - Duty Cycle switch to 50 % (Normal)
    - Frequency switch to 30 Hz
9. Ignition ON, observe the scan tool IAT Sensor 2 parameter. The scan tool parameter should be between 28-32 Hz.
    - **If not between 28-32 Hz**

      Replace the K20 Engine Control Module.

    - **If between 28-32 Hz**
10. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.
    - **If not within 5%**

      Replace the B75C Multifunction Intake Air sensor.

    - **If within 5%**
2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement
- **Control Module References** for engine control module replacement, programming, and setup

DTC P00F4-P00F6: INTAKE AIR HUMIDITY SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P00F4

Intake Air Humidity Sensor Circuit Low Voltage

DTC P00F5

Intake Air Humidity Sensor Circuit High Voltage

DTC P00F6

Intake Air Humidity Sensor Circuit Erratic

Diagnostic Fault Information

Intake Air Humidity

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P0102, P0178, P0443, P00F4, P2199	P0096, P0097, P0101, P0102, P0178, P00F4, P2199	P0690	P0096, P0101, P0103
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P0102, P0178, P00F4, P2199, P2230	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

Intake Air Humidity

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient humidity and temperature; and engine bay conditions			
Ignition	0 %	0 %	-
Signal	100 %	0 %	0 %*
Ground	-	0 %	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The humidity sensor measures the ambient humidity of the air in the sensor bore. The signal varies with intake air humidity and is displayed by the scan tool as duty cycle %. The ECM applies 5 V to the circuit. The signal circuit is shared by the humidity sensor and the intake air temperature (IAT) sensor 2. Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor's internal circuits for these sensors:

- IAT sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

Conditions for Running the DTCs

P00F4, P00F5, and P00F6

- DTC P1682 is not set.
- The ignition is ON.
- The ignition voltage is at least 11 V.
- These DTCs run continuously within the enabling conditions.

Conditions for Setting the DTCs

P00F4

The ECM detects that the humidity sensor signal is less than or equal to 5 % for greater than 5 s.

P00F5

The ECM detects that the humidity sensor signal is greater than or equal to 95 % for greater than 5 s.

P00F6

The ECM detects that the humidity sensor signal is intermittent or has abruptly changed over a period of time greater than 5 s.

Action Taken When the DTC Sets

- DTCs P00F4, P00F5, and P00F6 are Type B DTCs - North America and Korea.
- DTCs P00F4, P00F5, and P00F6 are Type C DTCs - Except North America and Korea.

Conditions for Clearing the MIL/DTC

- DTCs P00F4, P00F5, and P00F6 are Type B DTCs - North America and Korea.
- DTCs P00F4, P00F5, and P00F6 are Type C DTCs - Except North America and Korea.

Diagnostic Aids

- The Intake Air Humidity Signal parameter displays the measured humidity within the air intake system and may differ from atmospheric humidity measured outside the air intake system.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the Intake Air Humidity parameter displays the value: 0 % or 100 %, and there are also IAT Sensor 2 DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

NOTE: **To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been OFF for 8 hours or more.**

1. Ignition ON.
2. Verify the following scan tool parameters are within 10Â°C (18Â°F) of each other.
    - Start-Up IAT Sensor 1
    - IAT Sensor 2
    - Start-Up ECT
    - **If not within 10Â°C (18Â°F)**

      Refer to Circuit/System Testing.

- **If within 10Â°C (18Â°F)**

3. Engine idling, verify the scan tool Intake Air Humidity parameter is between 5 and 90 %.
    - **If not between 5 and 90 %**

      Refer to Circuit/System Testing.

    - **If between 5 and 90 %**
4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTCs do not set.
    - **If any DTC sets**

      Refer to Circuit/System Testing.

    - **If no DTCs set**
6. All OK

Circuit/System Testing

1. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
    - **If 2 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.
        - If less than 2 Ω replace the K20 Engine Control Module.
    - **If less than 2 Ω**
3. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.
    - **If 2 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 2 Ω**
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
    2. Test for less than 2 Ω in the ignition voltage circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
2. Test for infinite resistance between the ignition voltage circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.

- **If a test lamp illuminates**

5. Ignition ON, test for 4.8-5.2 V between the humidity signal circuit terminal 8 and ground.
    - **If less than 4.8 V**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

    - **If greater than 5.2 V**

    NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.

    - **If between 4.8-5.2 V**

6. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
    - **EL-38522-A, Variable Signal Generator; or equivalent is not available**

    1. Test or replace the B75C Multifunction Intake Air sensor.
    2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
    3. Verify the DTC does not set.
        - **If the DTC sets**

          Replace the K20 Engine Control Module.

        - **If the DTC does not set**

    4. All OK.

    - **EL-38522-A, Variable Signal Generator; or equivalent is available**

7. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
    - Red lead to the signal circuit terminal 8 at the harness connector

- Black leads to ground
- Battery voltage supply lead to B+

8. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
    - Signal switch to 5 V
    - Frequency switch to 250 Hz
    - Duty Cycle switch to 50 % (Normal)
9. Ignition ON, observe the scan tool Intake Air Humidity parameter. The scan tool parameter should be between 45-55 %.
    - **If not between 45-55 %.**

      Replace the K20 Engine Control Module.

    - **If between 45-55 %.**
10. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Test the Intake Air Humidity Sensor by varying the air humidity in the intake duct near the sensor, while observing the scan tool Intake Air Humidity Sensor parameter. The parameter should change and be within 5-95%.
    - **If not within 5-95%, or the parameter does not change.**

      Replace the K20 Engine Control Module.

    - **If within 5-95% and the parameter does change**
2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0101: MASS AIR FLOW (MAF) SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0101

Mass Air Flow (MAF) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102, P0178, P0443, P2199	P0096, P0097, P00F4, P0101, P0102, P0178, P2199	P0690	P0096, P0101, P0103
Signal	P0102	P0102	P0102*	P0101, P0103, P1101
Ground	-	P0096, P0097, P00F4, P0102, P2199	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 2,000-10,000 Hz			
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz*
Ground	-	0 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The intake flow rationality diagnostic provides the within-range rationality check for the mass air flow (MAF), manifold absolute pressure (MAP), and the throttle position sensors. This is an explicit model-based diagnostic containing 4 separate models for the intake system.

The estimates of MAF and MAP obtained from this system of models and calculations are then compared to the actual measured values from the MAF, MAP, and the throttle position sensors and to each other to determine the appropriate DTC to fail.

Conditions for Running the DTCs

- DTCs P0102, P0103, P0107, P0108, P0111, P0112, P0113, P0114. P0116, P0117, P0118, P0128, P0335, or P0336 are not set
- The engine speed is greater than 500 RPM.
- The engine coolant temperature (ECT) is between -7 and +125Â°C (+19 and +257Â°F).
- The intake air temperature (IAT Sensor 1) is between -20 and +125Â°C (-4 and +257Â°F).
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The engine control module (ECM) detects that the actual measured air flow from the MAF, MAP, and throttle position sensors is not within range of the calculated air flow that is derived from the system of models for greater than 2 s.

Action Taken When the DTC Sets

DTC P0101 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0101 is a Type B DTC.

Diagnostic Aids

- Any type of contamination on the MAF sensor heating elements will degrade the proper operation of the sensor. Certain types of contaminants act as a heat insulator, which will impair the response of the sensor to air flow changes. Water or snow can create the opposite effect, and cause the signal to increase rapidly.
- Certain aftermarket air filters may cause this DTC to set.
- Certain aftermarket air induction systems may cause this DTC to set.
- Modifications to the air induction system may cause this DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0641, P0651, P0697, or P06A3 is not set.
   - **If any of the DTCs are set**

     Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.

   - **If none of the DTCs are set**
3. Verify the scan tool Throttle Body Idle Air Flow Compensation parameter is less than 90 %.
   - **90 % or greater**

     Refer to **Throttle Body Inspection and Cleaning** .

   - **If less than 90 %**
4. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
   - **If Disagree**

     Refer to **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135** for further diagnosis.

   - **If Agree**
5. Determine the current vehicle testing altitude.
6. Verify the scan tool MAP Sensor pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
   - **If the MAP Sensor parameter is not in range**

     Refer to **DTC P0106** for further diagnosis.

   - **If the MAP Sensor parameter is in range**
7. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
   1. Engine idling
   2. Perform the scan tool snapshot function.
   3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
   4. Exit from the scan tool snapshot and review the data.
   5. Observe the MAF Sensor parameter frame by frame with a scan tool.
   - **The MAF Sensor parameter does not change smoothly and gradually**

     Refer to Circuit/System Testing for further diagnosis.

   - **The MAF Sensor parameter changes smoothly and gradually**

8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify a DTC does not set.
    - **If the DTC sets**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

    - **If the DTC does not set**
10. All OK

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Verify the integrity of the entire air induction system by verifying that none of the following conditions exist:
    - Any damaged components
    - Improperly installed components
    - Collapsed, restricted, or damaged components
    - Loose clamps, cracks, or other damage
    - An air flow restriction
    - Restricted air filter
    - Splits, kinks, leaks, or improper connections at the vacuum hoses
    - Vacuum leaks at the intake manifold, MAP sensor, and throttle body
    - Water intrusion
    - Any snow or ice buildup, in cold climates
    - Contamination of the Multifunction Intake Air sensor element
    - **If a condition is found**

      Repair or replace component as appropriate.

    - **If no condition is found**
2. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Test for less than 2 Ω between the ground circuit terminal 7 and ground.
    - **If 2 Ω or greater**
    1. Ignition OFF. Disconnect the sensor chassis ground.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 2 Ω**
4. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
2. Test for less than 2 Ω in the ignition voltage circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
2. Test for infinite resistance between the ignition voltage circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.

- **If a test lamp illuminates**

5. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal 6 and ground.
    - **If less than 4.8 V**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

    - **If greater than 5.2 V**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.

    - **If between 4.8-5.2 V**

6. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
    - **EL-38522-A, Variable Signal Generator; or equivalent is not available**

    1. Test or replace the B75C Multifunction Intake Air sensor.
    2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
    3. Verify the DTC does not set.
        - **If the DTC sets**

          Replace the K20 Engine Control Module.

        - **If the DTC does not set**

    4. All OK.

    - **EL-38522-A, Variable Signal Generator; or equivalent is available**

7. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:

- Red lead to the signal circuit terminal 6 at the harness connector
- Black leads to ground
- Battery voltage supply lead to B+

8. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
   - Signal switch to 5 V
   - Frequency switch to 5 kHz
   - Duty Cycle switch to 50 % (Normal)
9. Engine idling, observe the scan tool MAF Sensor parameter. The scan tool MAF Sensor parameter should be between 4,950-5,050 Hz.
   - **If not between 4,950-5,050 Hz.**

     If not between 4,950-5,050 Hz, replace the K20 Engine Control Module.

   - **If between 4,950-5,050 Hz.**
10. Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement.
- **Control Module References** for ECM replacement, programming, and setup.

DTC P0102 OR P0103: MASS AIR FLOW (MAF) SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0102

Mass Air Flow (MAF) Sensor Circuit Low Frequency

DTC P0103

Mass Air Flow (MAF) Sensor Circuit High Frequency

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102,	P0096, P0097, P00F4, P0101,	P0690	P0096, P0101, P0103

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
	P0178, P0443, P2199	P0102, P0178, P2199		
Signal	P0102	P0102	P0102*	P0101, P0103, P1101
Ground	-	P0096, P0097, P00F4, P0102, P0178, P2199	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

MAF Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 2,000-10,000 Hz			
Ignition Voltage	0 Hz	0 Hz	-
Signal	0 Hz	0 Hz	0 Hz*
Ground	-	0 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The mass air flow (MAF) sensor is integrated with the multifunction intake air sensor. The MAF sensor is an air flow meter that measures the amount of air in the sensor bore. The engine control module (ECM) uses the MAF sensor signal to provide the correct fuel delivery for all engine speeds and loads. A small quantity of air entering the engine indicates a deceleration or idle condition. A large quantity of air entering the engine indicates an acceleration or high load condition.

The ECM applies 5 V to the MAF sensor on the MAF sensor signal circuit. The sensor uses the voltage to produce a variable frequency signal based on the inlet air flow through the sensor bore. The signal varies with engine load and is displayed by the scan tool as Hertz (Hz) and grams per second (g/s). Ignition voltage and ground circuits are also supplied to the multifunction intake air sensor internal circuits for these sensors:

- Intake Air Temperature (IAT) sensor 2
- Humidity sensor
- MAF sensor

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- MAF sensor
- BARO pressure sensor

Conditions for Running the DTC

- The engine is running for greater than 1 s.
- The ignition signal is greater than 10 V.
- The above conditions are met for greater than 1 s.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0102

The ECM detects that the MAF Sensor Signal is less than 800 Hz (about 0.90 g/s) for greater than 10 s.

P0103

The ECM detects that the MAF Sensor Signal parameter is greater than 14,500 Hz (about 630 g/s) for greater than 10 s.

Action Taken When the DTC Sets

DTCs P0102 and P0103 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0102 and P0103 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

1. Engine idling, observe the scan tool MAF Sensor parameter. The reading should be between 2.5-8.8 g/s.
    - **If not between 2.5-8.8 g/s**

      Refer to Circuit/System Testing.

    - **If between 2.5-8.8 g/s**
2. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
    1. Engine idling
    2. Perform the scan tool snapshot function.
    3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
    4. Exit from the scan tool snapshot and review the data.
    5. Observe the MAF Sensor parameter frame by frame with a scan tool.
    - **The MAF Sensor parameter does not change smoothly and gradually**

      Refer to Circuit/System Testing.

    - **The MAF Sensor parameter changes smoothly and gradually**
3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify a DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set.**
5. All OK

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

2. Test for less than 2 Ω between the ground circuit terminal 7 and ground.
    - **If 2 Ω or greater**
    1. Ignition OFF. Disconnect the sensor chassis ground.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the chassis ground connection.
    - **If less than 2 Ω**
3. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
    2. Test for less than 2 Ω in the ignition voltage circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
    2. Test for infinite resistance between the ignition voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
    - **If a test lamp illuminates**
4. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal 6 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**
5. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
    - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
    1. Test or replace the B75C Multifunction Intake Air sensor.

2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
3. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the K20 Engine Control Module.

    - **If the DTC does not set**
4. All OK.

- **EL-38522-A, Variable Signal Generator; or equivalent is available**

6. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
    - Red lead to the signal circuit terminal 6 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
7. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
    - Signal switch to 5 V
    - Frequency switch to 5 kHz
    - Duty Cycle switch to 50 % (Normal)
8. Engine idling, verify the scan tool MAF Sensor parameter is between 4,950-5,050 Hz.
    - **If not between 4,950-5,050 Hz.**

      If not between 4,950-5,050 Hz, replace the K20 Engine Control Module.

    - **If between 4,950-5,050 Hz.**
9. Test or replace the B75C Multifunction Intake Air sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement.
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0106: MANIFOLD ABSOLUTE PRESSURE (MAP) SENSO

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0106

Manifold Absolute Pressure (MAP) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0107, P0641	P0106, P0697	P0107	P0106, P0697	P0106, P0107
Signal	P0107	P0106, P0107	P0107	P0108*	P0106, P0107, P1101
Low Reference	-	P0106, P0108	P0106, P0108	-	P0106, P0108
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.					

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in Park or Neutral **Parameter Normal Range:** 20-48 kPa (2.9-7 PSI), varies with altitude			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)*
Low Reference	-	127 kPa (18.4 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

MAP Sensor, if equipped with Turbocharger

Circuits	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 12-225 kPa (1.7-32.6 PSI) (varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)*
Low Reference	-	255 kPa (36.9 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, barometric pressure (BARO) and if equipped, turbocharger output. A diaphragm within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance.

The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5 V reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The

ECM converts the signal voltage input to a pressure value.

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the BARO. If equipped, a turbocharger can increase the pressure above BARO, when the vehicle is operated at wide-open throttle (WOT). The lowest manifold pressure occurs when the vehicle is idling or decelerating. The ECM monitors the MAP sensor signal for pressure outside of the normal range.

Conditions for Running the DTC

- DTC P0102, P0103, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0128, P0335 or P0336 is not set.
- The engine speed is between 400-7,000 RPM.
- The intake air temperature (IAT) Sensor parameter is between -20Â° to +125Â°C (-4Â° to +257Â°F).
- The engine coolant temperature (ECT) Sensor parameter is between 69-127Â°C (156-260Â°F).
- This DTC runs continuously when the above conditions are met.

Conditions for Setting the DTCs

The ECM determines if the MAP Sensor is not within the normal operating range. It accomplishes this by running 3 different models within the software to determine the values, for greater than 0.5 S.

Action Taken When the DTC Sets

DTC P0106 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0106 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

GE-23738-A Vacuum Pump

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

1. Ignition ON, verify that DTC P0641, P0651, P0697, or P06A3 is not set.
   - **If any of the DTCs are set**

     Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.

   - **If none of the DTCs are set**
2. If you were sent here from DTC P0068, P0101, P0121, or P1101; refer to Circuit/System Testing.
3. Ignition ON, verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90%.
   - **If 90 % or greater**

     Refer to **Throttle Body Inspection and Cleaning** .

   - **If less than 90 %**
4. Verify the scan tool Throttle Position Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
   - **If Disagree**

     Refer to **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135** for further diagnosis.

   - **If Agree**
5. Determine the current vehicle testing altitude.
6. Verify the scan tool MAP Sensor parameter is within the range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
   - **If the MAP Sensor parameter is not in range**

     Refer to Circuit/System Testing.

   - **If the MAP Sensor parameter is within range**
7. Engine idling, verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 PSI) and changes with accelerator pedal input.
   - **If not between 26-52 kPa (3.8-7.5 PSI) or does not change**

     Refer to Circuit/System Testing.

   - **If between 26-52 kPa (3.8-7.5 PSI) and changes**
8. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is

increased and decreased while performing the actions listed below.

1. Engine idling
2. Perform the scan tool snapshot function.
3. Increase the engine speed slowly to 3000 RPM and then back to idle.
4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **The MAF Sensor parameter does not change smoothly and gradually**

  Refer to **DTC P0101** for further diagnosis.

- **The MAF Sensor parameter changes smoothly and gradually**

9. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
10. Verify a DTC does not set.

- **If the DTC sets**

  Refer to Circuit/System Testing.

- **If the DTC does not set**

11. All OK.

Circuit/System Testing

1. Verify the integrity of the entire air induction system and verify that none of the following conditions exist:
   - Any damaged components
   - Improper operation of turbocharger wastegate actuator or bypass valve, if equipped
   - Loose or improper installation of the turbocharger and the charge air cooler, including the flexible ductwork, if equipped
   - An air flow restriction
   - Any vacuum leak
   - Improperly routed vacuum hoses
   - In cold climates, inspect for any snow or ice buildup at the BARO port on the ECM, if equipped
   - A restriction in the MAP Sensor port or the BARO port
   - Proper operation of the Positive Crankcase Ventilation (PCV) system
   - Missing, restricted or leaking exhaust components. Refer to **Symptoms - Engine Exhaust** .
   - Engine mechanical condition; for example: low compression or incorrect timing chain installation. Refer to **Symptoms - Engine Mechanical** .
   - **If a condition is found**

     Repair or replace the component as appropriate.

   - **If no condition is found**
2. Ignition OFF, and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.

Disconnect the harness connector at the B74 Manifold Absolute Pressure Sensor.

3. Test for less than 2 Ω between the low reference circuit terminal 2 and ground.
    - **If 2 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 2 Ω**
4. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

    NOTE: **If the signal circuit is shorted to a voltage the ECM or the MAP Sensor may be damaged.**

    -
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**
5. Ignition ON, verify the scan tool MAP Sensor parameter is less than 0.5 V.
    - **If 0.5 V or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit terminal 3 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If less than 0.5 V**
6. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.
7. Ignition ON, verify the scan tool MAP Sensor voltage parameter is greater than 4.5 V.
    - **If 4.5 V or less**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Remove the jumper wire, test for infinite resistance between the signal circuit terminal 3 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open or high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 4.5 V**

8. Test or replace the B74 Manifold Absolute Pressure Sensor.

Component Testing

NOTE: **You must perform the Circuit/System Testing in order to verify the integrity of the MAP Sensor circuits before proceeding with the Component Testing.**

Skewed Sensor Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A** . Verify the scan tool MAP pressure parameter decreases between 13-21 kPa (1.8-3.0 PSI).
    - **If the parameter does not decrease between 13-21 kPa (1.8-3.0 PSI).**

      Replace the B74 Manifold Absolute Pressure Sensor.

    - **If the parameter does decrease between 13-21 kPa (1.8-3.0 PSI).**
3. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A** . Verify the scan tool MAP pressure parameter decreases between 30-38 kPa (4.4-5.5 PSI).
    - **If the parameter does not decrease between 30-38 kPa (4.4-5.5 PSI).**

      Replace the B74 Manifold Absolute Pressure Sensor.

    - **If the parameter does decrease between 30-38 kPa (4.4-5.5 PSI).**
4. All OK.

Erratic Signal Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0-15 kPa (0-4.4 in Hg) of

vacuum to the sensor with the **GE-23738-A** .

7. Verify the voltage changes, without any spikes or dropouts, between 0.2-4.9 V.
    - **If not between 0.2-4.9 V or has spikes or dropouts**

      Replace the B74 Manifold Absolute Pressure Sensor.

    - **If between 0.2-4.9 V and there are no spikes or dropouts**
8. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair

- **Manifold Absolute Pressure Sensor Replacement**
- **Control Module References** for ECM replacement, programming, and setup

DTC P0107 OR P0108: MANIFOLD ABSOLUTE PRESSURE (MAP) SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptors

DTC P0107

Manifold Absolute Pressure (MAP) Sensor Circuit Low Voltage

DTC P0108

Manifold Absolute Pressure (MAP) Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P0107, P0697	P0106, P0697	P0107	P0106, P0697	P0106, P0107
Signal	P0107	P0106, P0107	P0107	P0108*	P0106, P0107, P1101
Low Reference	-	P0106, P0108	P0106, P0108	-	P0106, P0108
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.					

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, transmission in Park or Neutral **Parameter Normal Range:** 20-48 kPa (2.9-7 PSI), varies with altitude			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	127 kPa (18.4 PSI)*
Low Reference	-	127 kPa (18.4 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

MAP Sensor, if equipped with Turbocharger

Circuits	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** 12-225 kPa (1.7 to 32.6 PSI) (Varies with altitude)			
5 V Reference	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)
Signal	0 kPa (0 PSI)	0 kPa (0 PSI)	255 kPa (36.9 PSI)*
Low Reference	-	255 kPa (36.9 PSI)	-
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit Description

The manifold absolute pressure (MAP) sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by engine speed, throttle opening, air temperature, barometric pressure (BARO) and if equipped turbocharger output. A diaphragm within the MAP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance.

The MAP sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5 V reference circuit. The ECM supplies a ground on a low reference circuit. The MAP sensor provides a signal voltage to the ECM, relative to the pressure changes, on the MAP sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Under normal operation the greatest pressure that can exist in the intake manifold is at ignition ON, engine OFF, which is equal to the BARO. If equipped, a turbocharger can increase the pressure above BARO, when the vehicle is operated at wide-open throttle (WOT). The lowest manifold pressure occurs when the vehicle is idling or decelerating. The ECM monitors the MAP sensor signal for pressure outside of the normal range.

Conditions for Running the DTC

P0107

This DTC runs continuously.

P0108

This DTC runs continuously.

Conditions for Setting the DTC

P0107

The ECM detects that the MAP Sensor voltage is less than 0.15 V for more than 13 ms.

P0108

The ECM detects that the MAP Sensor voltage is more than 4.50 V for more than 13 ms.

Action Taken When the DTC Sets

DTCs P0107 and P0108 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0107 and P0108 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

GE-23738-A Vacuum Pump

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

1. Ignition ON, verify that DTC P0641, P0651, P0697, or P06A3 is not set.
   - **If any of the DTCs are set**

     Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.

- **If none of the DTCs are set**

2. Determine the current vehicle testing altitude.
3. Verify the scan tool MAP Sensor parameter is within the range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
    - **If the MAP Sensor parameter is not in range**

      Refer to Circuit/System Testing for further diagnosis.

4. Verify the engine is equipped with a turbocharger.
    - **If not equipped with a turbocharger**

      Refer to Step 6.

    - **If equipped with a turbocharger**
5. Engine idling, verify the scan tool MAP Sensor voltage parameter is between 0.3-4.8 V and changes with accelerator pedal input.
    - **If not between 0.3-4.8 V or does not change**

      Refer to Circuit/System Testing.

    - **If between 0.3-4.8 V and changes**

      Refer to Step 7.

6. Engine idling, verify the scan tool MAP Sensor voltage parameter is between 0.2-4.5 V and changes with accelerator pedal input.
    - **If not between 0.2-4.5 V or does not change**

      Refer to Circuit/System Testing.

    - **If between 0.2-4.5 V and changes**
7. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
8. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
9. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B74 Manifold Absolute Pressure Sensor.
2. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down. Test for less than 2 Ω between the low reference circuit terminal 2 and ground.

- **If 2 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If less than 2 Ω**

3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 1 and ground.
    - **If less than 4.8 V**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

    NOTE: **If the signal circuit is shorted to a voltage the ECM or the MAP Sensor may be damaged.**

    -
    - **If greater than 5.2 V**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.

    - **If between 4.8-5.2 V**

4. Ignition ON, verify the scan tool MAP Sensor parameter is less than 0.5 V.
    - **If 0.5 V or greater**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Ignition ON, test for less than 1 V between the signal circuit terminal 3 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.

    - **If less than 0.5 V**

5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5 V reference circuit terminal 1.
6. Ignition ON, verify the scan tool MAP Sensor voltage parameter is greater than 4.5 V.
    - **If 4.5 V or less**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Remove the jumper wire, test for infinite resistance between the signal circuit terminal 3 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open or high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 4.5 V**

7. Test or replace the B74 Manifold Absolute Pressure Sensor.

Component Testing

NOTE: **You must perform the Circuit/System Testing in order to verify the integrity of the MAP Sensor circuits before proceeding with the Component Testing.**

Skewed Sensor Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor from the engine. Connect the harness to the sensor, if disconnected.
2. Ignition ON, apply 17 kPa (5.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A** . Verify the scan tool MAP Sensor pressure parameter decreases between 13-21 kPa (1.8-3.0 PSI).
    - **If the parameter does not decrease between 13-21 kPa (1.8-3.0 PSI).**

      Replace the B74 Manifold Absolute Pressure Sensor.

    - **If the parameter does decrease between 13-21 kPa (1.8-3.0 PSI).**
3. Apply 34 kPa (10.0 in Hg) of vacuum to the B74 Manifold Absolute Pressure Sensor, with the **GE-23738-A** . Verify the scan tool MAP pressure parameter decreases between 30-38 kPa (4.4-5.5 PSI).
    - **If the parameter does not decrease between 30-38 kPa (4.4-5.5 PSI).**

      Replace the B74 Manifold Absolute Pressure Sensor.

    - **If the parameter does decrease between 30-38 kPa (4.4-5.5 PSI).**
4. All OK.

Erratic Signal Test

1. Ignition OFF, remove the B74 Manifold Absolute Pressure Sensor and disconnect the harness.
2. Install a 3 A fused jumper wire between the 5 V reference circuit terminal 1 of the sensor and the sensor harness.
3. Install a jumper wire between the low reference circuit terminal 2 of the sensor and ground.
4. Install a jumper wire to the signal circuit terminal 3 of the sensor.
5. Connect a DMM between the jumper wire and ground.
6. Ignition ON, observe the DC voltage on the DMM. Slowly apply between 0-15 kPa (0-4.4 in Hg) of vacuum to the sensor with the **GE-23738-A** .
7. Verify the voltage changes, without any spikes or dropouts, between 0.2-4.9 V.

- **If not between 0.2-4.9 V or has spikes or dropouts**

  Replace the B74 Manifold Absolute Pressure Sensor.

- **If between 0.2-4.9 V and there are no spikes or dropouts**

8. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Manifold Absolute Pressure Sensor Replacement**
- **Control Module References** for ECM replacement, programming, and setup

DTC P0112, P0113, OR P0114: INTAKE AIR TEMPERATURE (IAT) SENSOR 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0112

Intake Air Temperature (IAT) Sensor 1 Circuit Low Voltage

DTC P0113

Intake Air Temperature (IAT) Sensor 1 Circuit High Voltage

DTC P0114

Intake Air Temperature (IAT) Sensor 1 Circuit Intermittent

Diagnostic Fault Information

IAT Sensor 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0113, P0114, P2199*	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199, P2227, P2228, P2229,	P0113, P0114, P2199, P2227, P2229*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running **Parameter Normal Range:** Varies with ambient temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

Circuit/System Description

The intake air temperature (IAT) sensor 1 is a variable resistor that measures the temperature of the air in the sensor bore. The engine control module (ECM) supplies 5 V to the IAT sensor 1 signal circuit and a ground for the IAT sensor 1 low reference circuit. The signal varies with inlet air temperature and is displayed by the scan tool as Â°C (Â°F).

The multifunction intake air sensor houses the following:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Mass Air Flow (MAF) sensor
- BARO pressure sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the DTCs

P0112 and P0113

- The engine run time is greater than 1 s.
- The DTCs run continuously when the above conditions are met.

P0114

- The ignition is ON or the engine is running.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTCs

P0112

The ECM detects that the IAT sensor 1 signal is warmer than 149Â°C (300Â°F) for greater than 5 s.

P0113

The ECM detects that the IAT sensor 1 signal is colder than -60Â°C (-76Â°F) for greater than 5 s.

NOTE: The scan tool display range is between -40 and +150Â°C (-40 and +302Â°F).

P0114

The ECM detects that the IAT sensor 1 signal is intermittent or has abruptly changed for greater than 5 s.

Action Taken When the DTCs Set

- DTCs P0112, P0113, and P0114 are Type B DTCs.
- The ECM commands the cooling fans ON.

Conditions for Clearing the DTCs

DTCs P0112, P0113, and P0114 are Type B DTCs.

Diagnostic Aids

With the ignition ON, the engine OFF, if the engine is cold, a properly functioning IAT sensor 1 will gradually increase the scan tool IAT Sensor 1 parameter. This is due to the heat that is generated by the MAF sensor heating elements.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been OFF for 8 hours or more.**

1. Ignition ON.
2. Verify the following scan tool parameters are within 10Â°C (18Â°F) of each other.
    - Start-Up IAT Sensor 1
    - IAT Sensor 2
    - Start-Up ECT
    - **If not within 10Â°C (18Â°F)**

      Refer to Circuit/System Testing.

    - **If within 10Â°C (18Â°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
    - IAT Sensor 1
    - IAT Sensor 2
    - ECT Sensor
    - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

      Refer to Circuit/System Testing.

    - **If between: -38 and +149Â°C (-36 and +300Â°F)**
4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTC does not set.
    - **If the DTC sets.**

      Refer to Circuit/System Testing.

    - **If the DTC does not set.**
6. All OK

Circuit/System Testing

1. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
2. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
    - **If 2 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.

- If less than 2 Ω replace the K20 engine control module.

- **If less than 2 Ω**

3. Ignition ON, test for 4.8-5.2 V between the intake air temperature sensor 1 signal circuit terminal 1 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 engine control module.
   - **If greater than 5.2 V**

     NOTE: If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.

   1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
   2. Ignition ON, test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 engine control module.
   - **If between 4.8-5.2 V**
4. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39Â°C (-38Â°F).
   - **If warmer than -39Â°C (-38Â°F).**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If colder than -39Â°C (-38Â°F).**
5. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3.
6. Verify the scan tool IAT Sensor 1 parameter is warmer than 150Â°C (302Â°F).
   - **If colder than 150Â°C (302Â°F).**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.

- If less than 1 V

3. Ignition OFF.
4. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If warmer than 150Â°C (302Â°F).**

7. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

NOTE: **A thermometer can be used to test the sensor off the vehicle.**

2. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** table for Hitachi Sensors. The resistance values should be in range of the table values.
    - **If not within the table values.**

      Replace the B75C Multifunction Intake Air sensor.

    - **If within the table values.**
3. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement.
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P0116: ENGINE COOLANT TEMPERATURE (ECT) SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptor

DTC P0116

Engine Coolant Temperature (ECT) Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118, P0119	P0118, P0119	P0116, P0128
Low Reference	-	P0118	-	P0128

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** -39 to 149Â°C (-38 to 300Â°F)			
ECT Sensor	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT sensor signal circuit and a ground for the low reference circuit.

The ECM uses this high side coolant rationality diagnostic to determine if the input from the ECT sensor is skewed warmer than normal. The internal clock of the ECM will record the amount of time the ignition is OFF. If the calibrated ignition OFF time is met at start-up, the ECM will compare the temperature difference between the ECT and the intake air temperature (IAT) to determine if the temperatures are within an acceptable operating range of each other.

Conditions for Running the DTC

- DTC P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0128, P0502, P0503, P0601, or P2610 is not set.
- The vehicle has had a minimum ignition OFF time of 8 h.
- The ignition is ON.
- The start-up IAT is warmer than -7Â°C (+19Â°F).
- The Fuel Level Sensor is greater than 2.5%.
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 30Â° C (54Â° F) warmer than the IAT sensor.

  OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 15Â° C (27Â° F) warmer than the IAT sensor, and NO engine block heater was not detected.

  OR

- The ECM detects a temperature difference at power-up that indicates that the ECT sensor is 15Â° C (27Â° F) warmer than the IAT sensor, the engine cranked for greater than 10 s without starting and NO engine block heater was not detected.

Action Taken When the DTC Sets

- DTC P0116 is a Type B DTC.
- The cooling fans will be commanded ON.
- The A/C compressor will be commanded OFF.

Conditions for Clearing the MIL/DTC

DTC P0116 is a Type B DTC.

Diagnostic Aids

- Engine coolant that is leaking through the sensor will create a high resistance short to ground. This condition results in less voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a warmer ECT.
- An IAT sensor that is skewed colder at various ambient temperatures due to greater resistance than is normal will increase the range between these two sensors. Measure and record the resistance of the IAT sensor at various ambient temperatures, then compare those measurements to the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** table.
- A slight to moderate resistance in the IAT sensor signal circuit or low reference circuit will increase the range between these two sensors. This condition results in a greater voltage on the IAT sensor signal circuit, which is interpreted by the ECM as a colder IAT.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ECT Sensor parameter is between -40 and 150Â°C (-40 and 302Â°F) and changes with engine run time.
   - **If not within the specified range or does not change**

     Refer to Circuit/System Testing.

   - **If within the specified range and changes**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the harness connector at the B34 Engine Coolant Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference terminal A or 2 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39Â°C (-38Â°F).
   - **If warmer than -39Â° C (-38Â° F)**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the K20 Engine Control Module.
   - **If colder than -39Â° C (-38Â° F)**

5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149Â°C (300Â°F).
    - **If 149Â° C (300Â° F) or colder**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If warmer than 149Â° C (300Â° F)**
7. Test or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance.
3. Verify the readings are within the range specified in the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table.
    - **If not within the specified range**

      Replace the B34 Engine Coolant Temperature Sensor.

    - **If within the specified range**
4. Test for infinite resistance between each terminal and the sensor housing.
    - **If less than infinite resistance**

      Replace the B34 Engine Coolant Temperature Sensor.

    - **If infinite resistance**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Engine Coolant Temperature Sensor Replacement**
- **Control Module References** for engine control module replacement, setup, and programming

DTC P0117, P0118, OR P0119: ENGINE COOLANT TEMPERATURE (ECT) SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0117

Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage

DTC P0118

Engine Coolant Temperature (ECT) Sensor Circuit High Voltage

DTC P0119

Engine Coolant Temperature (ECT) Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118, P0119	P0118*, P0119	P0116,P0128
Low Reference	-	P0118, P0119	-	P0128
*ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running at various operating conditions **Parameter Normal Range:** Varies with coolant temperature			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 V to the ECT sensor signal circuit and a ground for the low reference circuit. This diagnostic checks for an open, short to ground or an intermittent circuit condition between the ECM and ECT sensor.

Conditions for Running the DTC

P0117

- The ignition is ON.

  OR

- The engine is running for greater than 10 s.
- This DTC runs continuously within the enabling conditions.

P0118

- The ignition is ON.

  OR

- The engine is running for greater than 10 s.

  OR

- The engine run time is less than 10 s when the IAT is warmer than -7Â°C (19Â°F).
- This DTC runs continuously within the enabling conditions.

P0119

- No active DTCs set.
- The ignition is ON.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

P0117

The ECM detects that the ECT is warmer than 149Â°C (300Â°F) for greater than 5 s.

P0118

The ECM detects that the ECT is colder than -39Â°C (-38Â°F) for greater than 5 s.

P0119

The ECM detects that the ECT is intermittent or has abruptly changed for greater than 3 seconds.

Action Taken When the DTC Sets

- DTC P0117, P0118 and P0119 are Type B DTCs.
- The cooling fans will be commanded ON.
- The Engine Coolant Temperature Gauge is inoperative.
- The AC compressor will be commanded OFF.

Conditions for Clearing the DTC

DTC P0117, P0118 and P0119 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Cooling System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ECT Sensor parameter is between -40 and 150Â°C (-40 and 302Â°F) and changes with engine run time.
    - **If not between the specified range or does not change**

      Refer to Circuit/System Testing.

    - **If within the specified rante and changes**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the B34 Engine Coolant Temperature sensor harness connector at the sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39Â° C (-38Â° F).
    - **If warmer than -39Â° C (-38Â° F)**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If colder than -39Â° C (-38Â° F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149Â° C (300Â° F).
    - **If 149Â° C (300Â° F) or colder**
    1. Ignition OFF, remove the jumper wire, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If warmer than 149Â° C (300Â° F)**
7. Test or replace the B34 Engine Coolant Temperature Sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance.
3. Verify the readings are within the range specified in **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table.

- **If not within the specified range**

  Replace the B34 Engine Coolant Temperature Sensor.

- **If within the specified range**

4. Test for infinite resistance between each terminal and the sensor housing.
   - **If less than infinite resistance**

     Replace the B34 Engine Coolant Temperature Sensor.

   - **If infinite resistance**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Engine Coolant Temperature Sensor Replacement**
- **Control Module References** for ECM replacement, programming, and setup.

DTC P0121-P0123, P0222, P0223, P16A0-P16A2, OR P2135: THROTTLE POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0121

Throttle Position Sensor 1 Performance

DTC P0122

Throttle Position Sensor 1 Circuit Low Voltage

DTC P0123

Throttle Position Sensor 1 Circuit High Voltage

DTC P0222

Throttle Position Sensor 2 Circuit Low Voltage

DTC P0223

Throttle Position Sensor 2 Circuit High Voltage

DTC P16A0

Sensor Communication Circuit Low Voltage

DTC P16A1

Sensor Communication Circuit High Voltage

DTC P16A2

Sensor Communication Circuit Performance

DTC P2135

Throttle Position Sensors 1-2 Not Plausible

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P06A3	P0122*, P0222*, P16A0	P06A3	P0121, P16A2, P2135*
Signal	P0122*, P0222*, P16A0	P0122*, P0222*, P16A1	P0123*, P0223*, P16A1**	P0121, P16A2, P2135*
Low Reference	-	P0123*, P0223*, P16A1	-	P0121, P16A2, P2135*
* This DTC set indicates an internal throttle body condition. ** A short to voltage causes P16A1 to set. If DTC P16A0, P16A1, and P16A2 set at the same time, an intermittent circuit condition exists.				

Typical Scan Tool Data

Throttle Position Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. **Parameter Normal Range:** Throttle Position Sensor 1 3.75-4.75 V			
5 V Reference	5.0 V	5.0 V	5.0 V
Signal	5.0 V	0.0 V	0.0 V
Low Reference	-	0.0 V	-

Throttle Position Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating with the throttle closed. All accessories OFF. **Parameter Normal Range:** Throttle Position Sensor 2 0.45-0.90 V			
5 V Reference	0.0 V	0.0 V	0.0 V
Signal	0.0 V	5.0 V	5.0 V
Low Reference	-	5.0 V	-

Circuit/System Description

The throttle body assembly contains a contact-less inductive throttle position sensing element that is managed by a customized integrated circuit. The throttle position sensor is mounted within the throttle body assembly and is not serviceable. The engine control module (ECM) supplies the throttle body with a 5 V reference circuit, a low reference circuit, an H-bridge motor directional control circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the throttle body to the ECM. The throttle body cannot receive data from the ECM over the signal/serial data circuit. The throttle position sensor provides a signal voltage that changes relative to throttle blade angle. The customized integrated circuit translates the voltage based position information into serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The throttle position sensor information is transmitted between the throttle body and the ECM on the signal/serial data circuit. The ECM decodes the serial data signal into separate voltages which are displayed on a scan tool as the voltage inputs from TP sensors 1 and 2.

Conditions for Running the DTC

P0121

- DTCs P0102, P0103, P0107, P0108, P0112, P0113, P0117, P0118, P0335, or P0336 is not set.
- The engine speed is between 500-6,800 RPM.
- The engine coolant temperature (ECT) is -7 to +126Â°C (19-259Â°F).
- The intake air temperature (IAT) is -20 to +125Â°C (-4 to +257Â°F).
- The DTC runs continuously when the above conditions are met.

P0122, P0123, P0222, P0223

- DTC P06A3 is not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The DTCs run continuously when the above condition are met.

P16A0, P16A1, or P16A2

- DTC P06A3 is not set.
- The ignition is ON or the engine is operating.
- The run/crank voltage is greater than 6.41 V.
- The DTCs run continuously once the above conditions are met for greater than 1 s.

P2135

- DTCs P0122, P0123, P0222, P0223, or P06A3 are not set.
- The ignition is ON or the engine is running.
- The run/crank or powertrain relay voltage is greater than 6.41 V and reduced power is not active.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0121

The ECM detects that the throttle position sensor 1 voltage is stuck within normal operating range for greater than 1 s.

P0122

The ECM detects the throttle position sensor 1 signal voltage is less than 0.32 V for greater than 1 s.

P0123

The ECM detects the throttle position sensor 1 signal voltage is greater than 4.75 V for greater than 1 s.

P0222

The ECM detects the throttle position sensor 2 signal voltage is less than 0.25 V for greater than 1 s.

P0223

The ECM detects the throttle position sensor 2 signal voltage is greater than 4.59 V for greater than 1 s.

P16A0

The ECM detects a low voltage circuit condition on the throttle position sensor signal circuit for greater than 1 s.

P16A1

The ECM detects a high voltage circuit condition on the throttle position sensor signal circuit for greater than 1 s.

P16A2

The ECM detects an incorrect message was received over the throttle position sensor signal circuit for greater than 1 s.

P2135

The ECM detects that throttle position sensors 1 and 2 disagree greater than 7-10 percent for greater than 1 s.

Action Taken When the DTC Sets

- DTCs P0121 is a Type B DTC.
- DTCs P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 are Type A DTCs.
- The ECM commands the throttle actuator control (TAC) system to operate in a Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions, the ECM commands the engine OFF.

Conditions for Clearing the DTC

- DTCs P0121 is a Type B DTC.
- DTCs P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 are Type A DTCs.

Diagnostic Aids

- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- If the accelerator pedal is pressed to the wide open throttle position, the throttle blade angle or Throttle Position angle is limited to less than 40 percent.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **If you were sent here from DTC P0068, P0101, P0106, or P1101 refer to Circuit/System Testing.**

1. Ignition ON.
2. Verify that DTC P0601-P0606, P06A3, and P16F3 is not set.
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

   - **If a DTC is not set**
3. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
   - **If 90 % or greater**

Refer to **Throttle Body Inspection and Cleaning** .

- **If less than 90 %**

4. Verify that DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, or P2135 are not set.
   - **If DTC P0122, P0123, P0222, P0223, or P2135 are the only DTCs set**

     Replace the Q38 Throttle Body.

   - **If DTC P16A0, P16A1, or P16A2 is set with any of the DTCs**

     Refer to Circuit/System Testing.

   - **If none of the DTCs are set**
5. Verify the TP Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.
   - **If Agree is not displayed**

     Replace the Q38 Throttle Body.

   - **If Agree is displayed**
6. Verify DTC P0122, P0123, P0222, P0223, P16A0, P16A1, P16A2, and P2135 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing.

   - **If a DTC is not set**
7. Determine the current vehicle testing altitude.
8. Verify the scan tool MAP Sensor pressure parameter is within range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
   - **If the MAP Sensor pressure is not in range**

     Refer to **DTC P0106**.

   - **If the MAP Sensor pressure is within range**
9. Engine idling.
10. Verify the scan tool MAP Sensor pressure parameter is between 26-52 kPa (3.8-7.5 psi) and changes with accelerator pedal input.
    - **If not between 26-52 kPa (3.8-7.5 psi) or does not change**

      Refer to **DTC P0106**.

    - **If between 26-52 kPa (3.8-7.5 psi) and changes**
11. Verify the scan tool MAF Sensor g/s parameter changes smoothly and gradually as the engine speed is increased and decreased while performing the actions listed below.
    1. Engine idling
    2. Perform the scan tool snapshot function.

3. Increase the engine speed slowly to 3,000 RPM and then back to idle.
4. Exit from the scan tool snapshot and review the data.
5. Observe the MAF Sensor parameter frame by frame with a scan tool.

- **If the MAF Sensor parameter does not change smoothly and gradually**

  Refer to **DTC P0101**.

- **If the MAF Sensor parameter changes smoothly and gradually**

12. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
13. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
14. All OK.

Circuit/System Testing

NOTE: Disconnecting the throttle body harness connector causes additional DTCs to set.

1. Ignition OFF, and all vehicle systems OFF, disconnect the harness connector at Q38 Throttle Body. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 4 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 5 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the 5 V reference circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

5. Ignition ON.
6. Test for 4.8-5.2 V between the signal circuit terminal 3 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

7. Replace the Q38 Throttle Body.

Repair Instructions

- **Throttle Body Assembly Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
5. Ignition ON.
6. Verify the TP Sensors 1 and 2 Agree/Disagree parameter displays Agree while performing the Throttle Sweep Test with a scan tool.

- **If Agree is not displayed**

  Replace the Q38 Throttle Body.

- **If Agree is displayed**

7. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not set.
   - **If DTC sets**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

   - **If DTC does not set**
8. All OK.

DTC P0128: ENGINE COOLANT TEMPERATURE (ECT) BELOW THERMOSTAT REGULATING TEMPERATURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0128

Engine Coolant Temperature (ECT) Below Thermostat Regulating Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117, P0119	P0118	P0118	P0116, P0119, P0128
Low Reference	-	P0118, P0119	-	P0119, P0128

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine Running at various operating conditions **Parameter Normal Range:** Varies with coolant temperature within a range of -39 to 149Â°C (-38 to 300Â°F)			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)

Circuit/System Description

The engine control module (ECM) monitors the temperature of the engine coolant for engine control and enabling criteria for some diagnostics. The ECM estimates the amount of energy generated to calculate a target engine coolant temperature (ECT). If the ECT fails to reach the thermostat regulating temperature, before a predetermined amount of energy is generated engine, the DTC sets.

Conditions for Running the DTC

- DTC P0068, P0071, P0072, P0073, P0074, P0101, P0102, P0103, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P0502, P0503, P1101, P1516, P2101, or P2135 is not set.
- The start-up ECT is between -40Â° and 66Â°C (-40Â° and 151Â°F).
- The engine OFF time is greater than 30 min.
- The engine run time is between 2 and 24 min.
- The vehicle has traveled greater than 2.4 km (1.5 mi).
- The ethanol in the fuel is less than 87%.
- This DTC runs once per ignition cycle when the above conditions are met.

Conditions for Setting the DTC

- The ECM determines that the ECT has not met its calibrated target of 71Â°C (160Â°F) when the start-up ambient temperature was between 10 and 52Â°C (50 and 126Â°F), for greater than 1 s.

  OR

- The ECM determines that the ECT has not met its calibrated target of 55Â°C (131Â°F) when the start-up ambient temperature was between -7 and 10Â°C (19 and 50Â°F), for greater than 1 s.

Action Taken When the DTC Sets

- DTC P0128 is a Type B DTC.
- The engine coolant temperature gauge defaults to cold.
- The A/C is commanded OFF and inoperative.
- The cooling fans are commanded ON.

Conditions for Clearing the MIL/DTC

DTC P0128 is a Type B DTC.

Diagnostic Aids

- DTC P0128 occurring with insufficient vehicle interior heating is an indication of improper thermostat operation.
- Corrosion in the ECT sensor terminals or the ECT harness connector results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.
- A slight to moderate resistance in the ECT sensor signal circuit or low reference circuit will affect this diagnostic. This condition results in a greater voltage on the ECT sensor signal circuit, which is interpreted by the ECM as a colder ECT.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Cooling System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that DTC P0116, P0117, P0118, or P0119 is not set.
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **If a DTC is not set**
2. Verify the cooling system is filled to the correct coolant level. Refer to **Cooling System Draining and Filling** , and **Loss of Coolant** .
   - **If the coolant level is not correct**

     Repair as necessary

   - **If the coolant level is correct**
3. Engine running for 15 min with the A/C OFF, increase the engine speed to 3,000 RPM.
4. Verify the scan tool ECT Sensor parameter is greater than 80Â°C (176Â°F).
   - **If less than 80Â°C (176Â°F)**

     Replace the engine coolant thermostat.

   - **If greater than 80Â°C (176Â°F)**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the harness connector at the B34 Engine Coolant Temperature sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal A or 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 5 Ω**
3. Ignition ON.
4. Verify the scan tool ECT Sensor parameter is colder than -39Â° C (-38Â° F).
    - **If warmer than -39Â° C (-38Â° F)**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal B or 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If colder than -39Â° C (-38Â° F)**
5. Install a 3 A fused jumper wire between the signal circuit terminal B or 1 and the low reference circuit terminal A or 2.
6. Verify the scan tool ECT sensor parameter is warmer than 149Â° C (300Â° F).
    - **If 149Â° C (300Â° F) or colder**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω, replace the K20 Engine Control Module.

- **If warmer than 149Â° C (300Â° F)**

7. Test the B34 Engine Coolant Temperature Sensor.

   Refer to Component Testing.

Component Testing

1. Ignition OFF, disconnect the harness connector at the B34 Engine Coolant Temperature Sensor.
2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance.
3. Verify the readings are within the range specified in the **Temperature Versus Resistance - Engine Coolant Temperature Sensor** table.
   - **If not within the specified range**

     Replace the B34 Engine Coolant Temperature Sensor.

   - **If within the specified range**
4. Test for infinite resistance between each terminal and the sensor housing.
   - **If less than infinite resistance**

     Replace the B34 Engine Coolant Temperature Sensor.

   - **If infinite resistance**
5. Refer to **Thermostat Diagnosis** .

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Coolant Temperature Sensor Replacement**
- **Engine Coolant Thermostat Housing Replacement**
- **Control Module References** for engine control module replacement, programming and setup.

DTC P0131, P0132, P0134, P0137, P0138, P0140, P0151, P0152, P0154, P0157, P0158, OR P0160: HO2S CIRCUIT VOLTAGE/INSUFFICIENT ACTIVITY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0131

HO2S Circuit Low Voltage Bank 1 Sensor 1

DTC P0132

HO2S Circuit High Voltage Bank 1 Sensor 1

DTC P0134

HO2S Circuit Insufficient Activity Bank 1 Sensor 1

DTC P0137

HO2S Circuit Low Voltage Bank 1 Sensor 2

DTC P0138

HO2S Circuit High Voltage Bank 1 Sensor 2

DTC P0140

HO2S Circuit Insufficient Activity Bank 1 Sensor 2

DTC P0151

HO2S Circuit Low Voltage Bank 2 Sensor 1

DTC P0152

HO2S Circuit High Voltage Bank 2 Sensor 1

DTC P0154

HO2S Circuit Insufficient Activity Bank 2 Sensor 1

DTC P0157

HO2S Circuit Low Voltage Bank 2 Sensor 2

DTC P0158

HO2S Circuit High Voltage Bank 2 Sensor 2

DTC P0160

HO2S Circuit Insufficient Activity Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154,	P0132, P0134, P0138, P0140, P0152, P0154,	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B,

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
			P0158, P0160	P0158, P0160	P015C, P015D
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D

Typical Scan Tool Data

HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0.00 V	Approximately 1.9 V	Approximately 1.9 V
HO2S Low Signal	0.00 V	Approximately 1.9 V	Approximately 1.9 V

Circuit/System Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTC

P0131, P0137, P0151, or P0157

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10 percent.

- The throttle position (TP) is between 3-70 percent.
- The DTCs run continuously when the above conditions are met for 2 s.

P0132, P0138, P0152, or P0158

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine is operating in Closed Loop.
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10 percent.
- The throttle position (TP) is between 0-70 percent.
- The DTCs run continuously when the above conditions are met for 3 s.

P0134, P0140, P0154, or P0160

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The ignition voltage is between 10-32 V.
- The engine run time is greater than 150 s.
- The fuel system is in Closed Loop.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0131, P0137, P0151, or P0157

- The ECM detects that the HO2S voltage is less than 50 mV.
- The DTCs set within 50 s when the above condition is met.

P0132, P0138, P0152, or P0158

- The ECM detects that the HO2S voltage is greater than 1,050 mV.
- The DTCs set within 50 s when the above condition is met.

P0134 or P0154

- The ECM detects that the HO2S 1 voltage is between 350-550 mV.
- The HO2S heater warm-up cycle is complete.
- The DTCs set within 15 s when the above conditions are met.

P0140 or P0160

- The ECM detects that the HO2S 2 voltage is not varying.

- The HO2S heater warm-up cycle is complete.
- The DTCs set within 15 s when the above conditions are met.

Action Taken When the DTC Sets

DTCs P0131, P0132, P0134, P0137, P0138, P0140, P0151, P0152, P0154, P0157. P0158, and P0160 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0131, P0132, P0134, P0137, P0138, P0140, P0151, P0152, P0154, P0157, P0158, and P0160 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no HO2S heater DTCs are set
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If a DTC is not set**
3. Engine running.
4. Verify the scan tool HO2S Bank 1 or 2 Sensor 1 or 2 parameters are between 50-1,050 mV.
   - **If not between 50-1,050 mV**

Refer to Circuit/System Testing.

- **If between 50-1,050 mV**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate B52 Heated Oxygen Sensor harness connector. It may take up to 2 minutes for all vehicle systems to power down. Ignition ON.
2. Test for 1.7-3.0 V between the high signal circuit terminal B and ground.
   - **If less than 1.7 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the high signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the high signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 3.0 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module. Ignition ON.
   2. Test for less than 1 V between the high signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 1.7-3.0 V**
3. Verify the scan tool heated oxygen sensor Bank 1 or 2 Sensor 1 or 2 parameter is between 1.7-2.1 V
   - **If less than 1.7 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the low signal circuit terminal A and ground.
   - If less than infinite resistance, repair the short to ground on the circuit.
   - If infinite resistance, replace the K20 Engine Control Module.
   - **If between 1.7-2.1 V**
4. Connect a 3 A fused jumper wire between the high signal circuit terminal B and the low signal circuit terminal A.

NOTE: **The low signal circuit is tied to a pull-up circuit within the engine control module. A voltage of 0.0-1.10 V on the low signal circuit is normal.**

5. Verify the scan tool HO2S Bank 1 or 2 Sensor 1 or 2 parameter displays 0.0 V.
   - **If greater than 0.0 V**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module. Ignition ON.
   2. Test for less than 2 Ω in the low signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω
   3. Test for less than 1 V between the low signal circuit terminal A and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If 0.0 V**
6. Verify none of the following conditions exist:
   - Water intrusion in the B52 HO2S harness connector
   - Low or high fuel system pressure-Refer to **Fuel System Diagnosis** .
   - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks
   - Engine vacuum leaks
   - **If any of the conditions exist**

     Repair as necessary.

   - **If none of the conditions exist.**
7. Test or replace the B52 Heated Oxygen Sensor

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S.
- **Control Module References** for ECM replacement, programming and setup

DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D, OR P2270-P2273: HO2S SLOW RESPONSE (LFX)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0133

HO2S Slow Response Bank 1 Sensor 1

DTC P013A

HO2S Slow Response Rich to Lean Bank 1 Sensor 2

DTC P013B

HO2S Slow Response Lean to Rich Bank 1 Sensor 2

DTC P013C

HO2S Slow Response Rich to Lean Bank 2 Sensor 2

DTC P013D

HO2S Slow Response Lean to Rich Bank 2 Sensor 2

DTC P013E

HO2S Delayed Response Rich to Lean Bank 1 Sensor 2

DTC P013F

HO2S Delayed Response Lean to Rich Bank 1 Sensor 2

DTC P014A

HO2S Delayed Response Rich to Lean Bank 2 Sensor 2

DTC P014B

HO2S Delayed Response Lean to Rich Bank 2 Sensor 2

DTC P0153

HO2S Slow Response Bank 2 Sensor 1

DTC P015A

HO2S Delayed Response Rich to Lean Bank 1 Sensor 1

DTC P015B

HO2S Delayed Response Lean to Rich Bank 1 Sensor 1

DTC P015C

HO2S Delayed Response Rich to Lean Bank 2 Sensor 1

DTC P015D

HO2S Delayed Response Lean to Rich Bank 2 Sensor 1

DTC P2270

HO2S Signal Stuck Lean Bank 1 Sensor 2

DTC P2271

HO2S Signal Stuck Rich Bank 1 Sensor 2

DTC P2272

HO2S Signal Stuck Lean Bank 2 Sensor 2

DTC P2273

HO2S Signal Stuck Rich Bank 2 Sensor 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S High Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D
HO2S Low Signal	P0131, P0137, P0151, P0157	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0132, P0134, P0138, P0140, P0152, P0154, P0158, P0160	P0133, P013A, P013B, P013C, P013D, P013E, P013F, P014A, P014B, P0153, P015A, P015B, P015C, P015D

Typical Scan Tool Data

HO2S Sensor 1 Voltage, HO2S Sensor 2 Voltage

Circuit	Short to Ground	Open	Short to Voltage
Parameter Normal Range: 200-800 mV			
HO2S High Signal	0.00 V	1.7-2.1 V	1.7-2.1 V
HO2S Low Signal	0.00 V	1.7-2.1 V	1.7-2.1 V

Circuit/System Description

The heated oxygen sensors (HO2S) are used for fuel control and catalyst monitoring. Each HO2S compares the

oxygen content of the surrounding air with the oxygen content of the exhaust stream. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. While the engine runs, the HO2S heats up and begins to generate a voltage within a range of 0-1,000 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S voltage to determine the air-to-fuel ratio. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heat the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner.

Conditions for Running the DTC

P0133 or P0153

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine coolant temperature (ECT) is greater than 54Â°C (129Â°F).
- The intake air temperature (IAT) is warmer than -40Â°C (-40Â°F)
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine run time is greater than 60 s.
- The engine speed is between 1,000-3,000 RPM.
- The barometric (BARO) pressure is greater than 70 kPa.
- The mass airflow (MAF) is between 15-43 g/s.
- The fuel system is in Closed Loop.
- The throttle position (TP) is greater than 5%.
- The DTCs run once per drive cycle when the above conditions are met.

P013A P013C, P013E, or P014A

- Before the ECM can report DTC P013A, or P013C failed, DTCs P013E, P014A, P2270, and P2272 must run and pass.
- Before the ECM can report DTC P013E, or P014A failed, DTCs P2270 and P2272 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The Ignition voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.

- The engine run time is equal to or greater than 5 min.
- The accelerator pedal (APP) is steady.
- The torque converter clutch (TCC) is applied.
- The DTCs run once per ignition cycle, during decel fuel cut-off (DFCO), when the above conditions are met.

P013B P013D, P013F, or P014B

- Before the ECM can report DTC P013B, or P013D failed, DTCs P013A, P013C, P013E, P013F, P014A, P014B, P2270, P2271, P2272, and P2273 must run and pass.
- Before the ECM can report DTC P013F, or P014B failed, DTCs P013A, P013C, P013E, P014A, P2270, P2271, P2272, and P2273 must run and pass.
- DTCs P0030, P0036, P0053, P0054, P0101, P0102, P0103, P0106, P0107, P0108, P0120, P0121, P0122, P0123, P0131, P0132, P0133, P0134, P0135, P0137, P0138, P013A, P013B, P013E, P013F, P0140, P0141, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0442, P0443, P0446, P0449, P0455, P0496, P1133, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271, P2A00 are not set.
- The Ignition voltage is between 10-32 V.
- The learned heater resistance is valid.
- The fuel level is greater than 10%.
- The engine run time is equal to or greater than 5 min.
- The DTCs run once per ignition cycle when the above conditions are met.

P015A, P015B, P015C or P015D

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0220, P0222, P0223, P0442, P0443, P0446, P0449, P0455, P0496, P1516, P2101, P2119, P2135, P2176 are not set.
- The engine coolant temperature (ECT) is warmer than 54Â°C (129Â°F).
- The intake air temperature (IAT) is warmer than -40Â°C (-40Â°F)
- The Ignition voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine run time is greater than 60 s.
- The engine speed is between 1,025-2,325 RPM.
- The vehicle speed is between 70 km/h (44 mph).
- The mass airflow (MAF) is between 3-12 g/s.
- The fuel system is in Closed Loop.
- The DTCs run once per drive cycle when the above conditions are met.

P2270 or P2272

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203,

P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270, P2271 are not set.

- The system voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine speed is between 1,100-2,300 RPM.
- The engine airflow is between 3-11 g/s.
- The vehicle speed is between 64 km/h (39.8 mph) and 120 km/h (74 mph).
- The fuel state is in Closed Loop.
- The evaporative emission (EVAP) diagnostics are not in control of purge.
- The heated oxygen sensor heaters are ON for more than 180 s.
- The predicted catalytic converter temperature is between 600-900Â°C (1,112-1,652Â°F).
- This DTC runs once per trip when all of the above conditions have been met for 3 s.

P2271 or P2273

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0128, P013A, P013B, P013E, P013F, P0171, P0172, P0201, P0202, P0203, P0204, P0220, P0222, P0223, P0300, P0411, P0412, P0418, P1174, P1516, P2101, P2119, P2135, P2176, P2270 are not set.
- The system voltage is between 10-32 V.
- The fuel level is greater than 10%.
- The engine speed is 1,150-2,300 RPM.
- The engine airflow is between 3-11 g/s.
- The vehicle speed is between 70-120 km/h (44-74 mph).
- The fuel state is in Closed Loop.
- The EVAP is not in control of purge.
- Power take-off is not active.
- The heated oxygen sensor heaters have been on more than 180 s.
- The predicted catalyst temperature is between 500-980Â°C (1,112-1,652Â°F).
- DTCs P013A, P013E, and P2270 have run and passed.

THEN

- DFCO is active.
- The accelerator pedal position is stable.
- This DTC runs once per trip when the above conditions are met for 3 s.

Conditions for Setting the DTC

P0133, P0153, P015A, P015B, P015C or P015D

- The ECM detects that the HO2S 1 rich-to-lean or lean-to-rich average response time is greater than a calibrated value.

- The DTCs set within 60 s when the above condition is met.

P013A or P013C

The ECM detects that the accumulated mass air flow monitored during rich-to-lean transitions between 450-150 mV is greater than 75 grams.

P013B or P013D

The ECM detects that the accumulated mass air flow monitored during lean-to-rich transitions between 350-650 mV is greater than 75 grams.

P013E or P014A

The ECM detects that the HO2S voltage has not decreased below 450 mV within a calibrated value of accumulated air flow.

P013F or P014B

The ECM detects that the HO2S voltage has not increased above 350 mV within a calibrated value of accumulated air flow.

P2270 or P2272

The ECM does not detect a HO2S voltage greater than 800 mV before accumulated mass air flow exceeds a calibrated value.

P2271 or P2273

The ECM does not detect an HO2S voltage less than 100 mV before accumulated mass air flow exceeds a calibrated value.

Action Taken When the DTC Sets

- DTCs P0133, P013E, P013F, P014A, P014B, P0153, P2270, P2271, P2272, and P2273 are Type B DTCs.
- DTCs P013A, P013B, P013C, P013D, P015A, P015B, P015C, and P015D are Type A DTCs.

Conditions for Clearing the DTC

- DTCs P0133, P013E, P013F, P014A, P014B, P0153, P2270, P2271, P2272, and P2273 are Type B DTCs.
- DTCs P013A, P013B, P013C, P013D, P015A, P015B, P015C, and P015D are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no HO2S heater DTCs are set.
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If a DTC is not set**
3. Verify none of the conditions listed below exist:
   - Lean or rich fuel injectors-Refer to **Fuel Injector Solenoid Coil Test** .
   - Water intrusion in the HO2S harness connector
   - Low or high fuel system pressure-Refer to **Fuel System Diagnosis** .
   - Fuel that is contaminated-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
   - Fuel saturation of the evaporative emission (EVAP) canister
   - Exhaust leaks-Refer to **Exhaust Leakage** .
   - Engine vacuum leaks
   - Engine oil consumption-Refer to **Oil Consumption Diagnosis** .
   - Engine coolant consumption-Refer to **Loss of Coolant** .
     - **If any of the conditions exist**

       Repair as necessary.

   - **If none of the conditions exist**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Test or replace the appropriate B52 Heated Oxygen Sensor.

- **If the DTC does not set**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair .

- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- Perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S.
- **Control Module References** for ECM replacement, programming and setup

DTC P0171, P0172, P0174, OR P0175: FUEL TRIM SYSTEM LEAN/RICH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0171

Fuel Trim System Lean Bank 1

DTC P0172

Fuel Trim System Rich Bank 1

DTC P0174

Fuel Trim System Lean Bank 2

DTC P0175

Fuel Trim System Rich Bank 2

Circuit/System Description

The engine control module (ECM) controls a closed loop air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The ECM monitors the heated oxygen sensor (HO2S) signal voltage, and adjusts the fuel delivery based on the signal voltage while in Closed Loop. A change made to the fuel delivery changes the long and short term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltages. These changes fine tune the engine fueling. The long term fuel trim values change in response to trends in the short term fuel trim. The long term fuel trim makes coarse adjustments to fueling in order to re-center and restore control to short term fuel trim. The ideal fuel trim values are around 0%. A positive fuel trim value indicates that the ECM is adding fuel in order to

compensate for a lean condition. A negative fuel trim value indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition.

Conditions for Running the DTC

- DTCs P0030, P0050, P0053, P0059, P0101, P0102, P0103, P0106, P0107, P0108, P0131-P0135, P0151-P0155, P015A, P015B, P015C, P015D, P0178, P0179, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300-P0306, P0411, P0442, P0455, P0458, P0496, P0506, P0507, P1133, P1153, P1248, P1249, P124A, P124B, P124C, P124D, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P2227, P2228, P2229, P2230, or P2269 are not set.
- The engine is in Closed Loop status.
- The catalyst monitor diagnostic intrusive test, post HO2S diagnostic intrusive test, device control, and evaporative emissions leak test are not active.
- The engine coolant temperature is between -20 and +150Â°C (-4 and +302Â°F).
- The intake air temperature is between -20 and +150Â°C (-4 and +302Â°F).
- The manifold absolute pressure is between 5-255 kPa (0.7-37 PSI).
- The engine speed is between 400-6,600 RPM.
- The mass air flow is between 0.5-510 g/s.
- The barometric pressure is greater than 70 kPa (10.2 PSI).
- The fuel level is greater than 10% and no fuel level sensor fault is present.
- This diagnostic runs continuously when the above conditions have been met.

Conditions for Setting the DTC

- The average long term fuel trim weighted average value is greater or less than a calibrated value.
- The above condition is present for approximately 3 min after the Conditions for Running the DTC have been met.

Action Taken When the DTC Sets

DTCs P0171, P0172, P0174, and P0175 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0171, P0172, P0174, and P0175 are Type B DTCs.

Diagnostic Aids

- Allow the engine to reach operating temperature. With the engine running, observe the HO2S parameter with a scan tool. The HO2S value should vary from approximately 40 mV to approximately 900 mV, and respond to fueling changes.
- With the engine running at operating temperature, the normal Short Term Fuel Trim and Long Term Fuel Trim parameters should be between +10 and -10% with 0% the optimum, .
- Any un-metered air into the engine causes this DTC to set. Thoroughly inspect all areas of the engine for vacuum leaks. An un-metered air leak in the induction system or a small vacuum leak may cause the ECM to learn an incorrect Throttle Body Idle Airflow Compensation value over time. The incorrectly

learned value may cause various symptoms to occur such as rough or unstable idle speeds, and/or engine stall. If this condition is detected and repaired it will be necessary perform the scan tool Idle Learn procedure to ensure any symptoms are corrected

- A MAF sensor condition can cause this DTC without setting a MAF DTC. If there is a MAF sensor condition, the MAF sensor parameters will appear to be within range.
- Verify the air filter is the correct one for this application, the engine oil fill cap is in place and is tight, and the engine oil dip stick is fully seated.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition ON.
2. Verify no other DTCs are set.
   - **If any other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If no other DTCs are set**
3. Verify the MAP sensor pressure parameter is within the range specified for your altitude. Refer to **Altitude Versus Barometric Pressure (With LFX)** .
   - **If not within the specified range**

     Refer to **DTC P0106**.

   - **If within the specified range**

NOTE: **Fuel vapor introduced into the intake manifold during evaporative**

emission system purge can temporarily cause fuel trim parameter readings to be outside the normal range.

4. Engine running at the operating temperature, EVAP Purge Solenoid Valve Command 0%.
5. Verify the appropriate Long Term Fuel Trim Bank 1 or 2 parameter is between -26% and +38%.
    - **If greater than +38%**
    1. Ignition OFF.
    2. Verify the conditions listed below do not exist:
        - Mass air flow sensor signal skewed. If the Short Term Fuel Trim or Long Term Fuel Trim parameters for both banks changes greater than 20% when the MAF sensor is disconnected, refer to **DTC P0101**.
        - Fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
        - Missing, restricted, or leaking exhaust components. Refer to **Symptoms - Engine Exhaust** .
        - Malfunctioning fuel injectors. Refer to **Fuel Injector Solenoid Coil Test** .
        - Split, kinked, or improperly connected vacuum hoses.
        - Insufficient fuel in the tank.
        - Low fuel pressure. Refer to **Fuel System Diagnosis** .
        - Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
        - Leaks in the air induction system and the air intake ducts.
        - Missing air filter element.
        - Cracked evaporative emissions canister.
        - Evaporative pipes obstructed or leaking.
        - Leaks in the crankcase ventilation system. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
            - If a condition is found, repair as necessary.
            - If no condition is found, test the engine for a mechanical condition. Refer to **Symptoms - Engine Mechanical** .
    - **If less than -26%**
    1. Ignition OFF.
    2. Verify the conditions listed below do not exist:
        - Mass air flow (MAF) sensor signal skewed. If the Short Term Fuel Trim or Long Term Fuel Trim parameters for both banks changes greater than 20% when the MAF sensor is disconnected, refer to **DTC P0101**.
        - Fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
        - Missing, restricted, or leaking exhaust components. Refer to **Symptoms - Engine Exhaust** .
        - Malfunctioning fuel injectors. Refer to **Fuel Injector Solenoid Coil Test** .
        - Collapsed or restricted air intake duct.
        - Excessive fuel pressure. Refer to **Fuel System Diagnosis** .
        - Dirty or restricted air filter.
        - Objects blocking the throttle body.

- Improper operation of the evaporative emissions control system.
- Excessive fuel in the crankcase. Change the engine oil as necessary.
  - If a condition is found, repair as necessary.
  - If no condition is found, test the engine for a mechanical condition. Refer to **Symptoms - Engine Mechanical** .
- **If between -26% and +38%**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Perform the scan tool Fuel Trim Reset after completing the repair.

DTC P0178: FUEL COMPOSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0178

Fuel Composition Sensor Circuit Low Frequency

Circuit/System Description

Alcohol content information is supplied to the engine control module (ECM) from the fuel composition sensor. The fuel composition sensor has a battery positive circuit, a signal circuit, and a ground circuit. The fuel composition sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The signal circuit carries the ethanol percentage via the frequency signal. The ECM provides an internal pull up to 5 V on the signal circuit, and the fuel composition sensor pulls the 5 V to ground in pulses. The normal range of operating frequency is between 50-150 Hz. The microprocessor inside the sensor is capable of a certain amount of self-diagnosis. An output frequency between 180 Hz and 190 Hz indicates that the fuel is contaminated.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

The engine control module detects that the fuel composition sensor output frequency is less than 45 Hz for greater than 6 s.

Action Taken When the DTC Sets

DTC P0178 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0178 is a Type B DTC.

Diagnostic Aids

- The Fuel Composition Sensor scan tool parameter reacts immediately to any change in the fuel composition sensor circuits, but may not react long enough to set a DTC.
- An intermittent condition may not be detected because the sensor does not immediately power down and the connection may be restored before voltage drops below the operating threshold.
- If this DTC will not reset and the parameters are steady, thoroughly inspect all fuel composition sensor circuits for an intermittent open.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 44175-A** Alcohol Tester Kit
- **EL 38522-A** Variable Signal Generator

For equivalent regional tools, Refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)**

Circuit/System Verification

1. Engine running,

2. Verify the scan tool Fuel Composition Sensor parameter is between 50-150 Hz.
    - **If not between 50-150 Hz**

      Refer to Circuit/System Testing.

    - **If between 50-150 Hz**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B198 Fuel Composition Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 5 Ω**
3. Ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is OK**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is OK and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, remove the test lamp.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, replace the B198 Fuel Composition Sensor.
    - **If the test lamp illuminates**
5. Ignition ON.
6. Test for 4.8-5.2 V between the signal circuit terminal 3 and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground in the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
2. Ignition ON.
3. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

7. Ignition OFF, connect the red lead of the **EL 38522-A** Variable Signal Generator to the signal circuit terminal 3 at the B198 Fuel Composition Sensor harness connector.
8. Connect the battery voltage supply to B+, and the black lead to ground.
9. Set the **EL 38522-A** Variable Signal Generator Signal to 5 V, the Frequency to 60 Hz, and the Duty Cycle to Normal.
10. Ignition ON.
11. Clear the DTCs with a scan tool.
12. Verify the scan tool Fuel Composition Sensor parameter is at 60 Hz.
    - **If not the specified value**

      Replace the K20 Engine Control Module.

    - **If the specified value**
13. Test or replace the B198 Fuel Composition Sensor.

Component Testing

1. Test the fuel composition using the **CH 44175-A** Alcohol Tester Kit and the CH 44175-A Instruction Manual. Record the frequency.
2. Compare the special tool test frequency and the scan tool Fuel Composition Sensor frequency parameter.
3. Verify the difference between the tool and the sensor is 12 Hz or less.
    - **If greater than the specified value**

      Replace the B198 Fuel Composition Sensor.

    - **If less than the specified value**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Flexible Fuel Sensor Replacement**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup.

DTC P0179: FUEL COMPOSITION SENSOR CIRCUIT HIGH FREQUENCY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0179

Fuel Composition Sensor Circuit High Frequency

Circuit/System Description

Alcohol content information is supplied to the engine control module (ECM) from the fuel composition sensor. The fuel composition sensor has a battery positive circuit, a signal circuit, and a ground circuit. The fuel composition sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The signal circuit carries the ethanol percentage via the frequency signal. The ECM provides an internal pull up to 5 V on the signal circuit, and the fuel composition sensor pulls the 5 V to ground in pulses. The normal range of operating frequency is between 50-150 Hz. The microprocessor inside the sensor is capable of a certain amount of self-diagnosis. An output frequency between 180 Hz and 190 Hz indicates that the fuel is contaminated.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

The engine control module detects that the fuel composition sensor output frequency is between 155-185 Hz for greater than 6 s.

Action Taken When the DTC Sets

DTC P0179 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0179 is a Type B DTC.

Diagnostic Aids

A momentary slug of water in the fuel system may set this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 44175-A** Alcohol Tester Kit
- **EL 38522-A** Variable Signal Generator

For equivalent regional tools, Refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)**

Circuit/System Verification

1. Engine running,
2. Verify the scan tool Fuel Composition Sensor parameter is between 50-150 Hz.
    - **If not between 50-150 Hz**

      Refer to Circuit/System Testing.

    - **If between 50-150 Hz**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

- **If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Verify that there are no contaminants, water, or too high of a concentration of ethanol in the fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** and the **CH 44175-A** Instruction Manual.
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B198 Fuel Composition Sensor. It may take up to 2 minutes for all vehicle systems to power down.
3. Test for less than 5 Ω between the ground circuit terminal 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 5 Ω**
4. Ignition ON.
5. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is OK**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is OK and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, remove the test lamp.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, replace the B198 Fuel Composition Sensor.
    - **If the test lamp illuminates**
6. Ignition ON.
7. Test for 4.8-5.2 V between the signal circuit terminal 3 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
2. Ignition ON.
3. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

8. Ignition OFF, connect the red lead of the **EL 38522-A** Variable Signal Generator to the signal circuit terminal 3 at the B198 Fuel Composition Sensor harness connector.
9. Connect the battery voltage supply to B+, and the black lead to ground.
10. Set the **EL 38522-A** Variable Signal Generator Signal to 5 V, the Frequency to 60 Hz, and the Duty Cycle to Normal.
11. Ignition ON.
12. Clear the DTCs with a scan tool.
13. Verify the scan tool Fuel Composition Sensor parameter is at 60 Hz.
    - **If not the specified value**

      Replace the K20 Engine Control Module.

    - **If the specified value**
14. Test or replace the B198 Fuel Composition Sensor.

Component Testing

1. Test the fuel composition using the **CH 44175-A** Alcohol Tester Kit and the CH 44175-A Instruction Manual. Record the frequency.
2. Compare the special tool test frequency and the scan tool Fuel Composition Sensor frequency parameter.
3. Verify the difference between the tool and the sensor is 12 Hz or less.
    - **If greater than the specified value**

      Replace the B198 Fuel Composition Sensor.

    - **If less than the specified value**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Flexible Fuel Sensor Replacement**
- **Fuel System Cleaning**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup.

DTC P018B-P018D: FUEL PRESSURE SENSOR (CHASSIS CONTROL MODULE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P018B

Fuel Pressure Sensor Performance

DTC P018C

Fuel Pressure Sensor Circuit Low Voltage

DTC P018D

Fuel Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0641, P06A6	P018C	P018D	P06A6
Signal	P018C	P018C	P018D	P018B
Low Reference	-	P018D	-	P06A6

Circuit/System Description

The fuel pressure sensor is located on the fuel line. The fuel pressure sensor monitors the fuel pressure in the fuel line. The chassis control module monitors the voltage signal from the fuel pressure sensor.

Conditions for Running the DTC

- The engine is running.
- DTC P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The engine has been running for at least 5 seconds.

Conditions for Setting the DTC

The chassis control module does not detect a change in the fuel pressure of at least 30 kPa (4.4 psi) when the fuel pump is operating. The fuel pressure sensor performance diagnostic provides a means to detect fuel pressure sensor output that is stuck within the normal operating range of the sensor.

Action Taken When the DTC Sets

DTC P018B, P018C and P018D are Type A DTCs.

Conditions for Clearing the DTC

DTC P018B, P018C and P018D are Type A DTCs.

Diagnostic Aids

Using the failure records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the failure records can help determine how many miles since the DTC set. The fail counter and pass counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running.
2. Verify the scan tool Fuel Pressure Sensor Voltage parameter is between 0.2-4.8 V.
    - **If not between 0.2-4.8 V**

      Refer to Circuit/System Testing.

    - **If between 0.2-4.8 V**
3. All OK.

Circuit/System Testing

NOTE: **Verify that the fuel tank is not empty. Only perform this diagnostic if there is at least 2 gallons of fuel in the fuel tank. Clear the DTC, and start and run the engine. Verify that the DTC resets before proceeding with the circuit system testing. If the DTC does not reset, refer to diagnostic aids.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K38 Chassis Control Module.
    - **If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K38 Chassis Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K38 Chassis Control Module.
    - **If between 4.8-5.2 V**
5. Verify the scan tool Fuel Pressure Sensor Voltage parameter is less than 1 V.
    - **If 1 V or greater**
    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal 1 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K38 Chassis Control Module.
    - **If less than 1 V**
6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.
7. Verify the scan tool Fuel Pressure Sensor Voltage parameter is greater than 4.8 V.

- **If 4.8 V or less**

1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
2. Test for infinite resistance between the signal circuit terminal 1 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K38 Chassis Control Module.

- **If greater than 4.8 V**

8. Test or replace the B47 Fuel Pressure Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for chassis control module replacement, programming and setup

DTC P0191: FUEL RAIL PRESSURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0191

Fuel Rail Pressure Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0340, P0345, P0365, P0390, P0506, P0641, P2227	P0192	P0193, P0641, P2227, P2229	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0192, P0193	P0193	P0191
Low Reference	-	P0193	P0193	P0191

Circuit/System Description

The fuel rail pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 V reference voltage on the 5 V reference circuit and ground on the low reference circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the fuel rail pressure

sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

Conditions for Running the DTC

Condition 1

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0122, P0123, P0201-P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301-P0306, P0351-P0356, P0506, P0507, P0722, P0723, P1248, P1249, P124A, P124B, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 are not set.
- The engine is running.
- The accelerator pedal position is 0 percent for 4 s.
- The ignition voltage is greater than 11 V.
- The low side fuel pressure is greater than 275 kPa (40 psi).
- The vehicle speed is less than 1 km/h (0.62 mph).
- The diagnostic runs continuously when the above conditions are met.

Condition 2 and 3

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0122, P0123, P0201-P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301-P0306, P0351-P0356, P0506, P0507, P0722, P0723, P1248, P1249, P124A, P124B, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 are not set.
- The ignition voltage is greater than 11 V.
- The low side fuel pressure is greater than 275 kPa (40 psi).
- The desired fuel rail pressure is between 4-6 MPa (580-870 psi).
- The engine speed is between 1,000-3,000 RPM.
- The vehicle speed is greater than 30 km/h (18.64 mph).
- The diagnostic runs continuously when the above conditions are met.

Condition 4

- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P0122, P0123, P0201-P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0300, P0301-P0306, P0351-P0356, P0506, P0507, P0722, P0723, P1248, P1249, P124A, P124B, P2122, P2123, P2127, P2128, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, or P2157 are not set.
- The engine speed is greater than 2,000 RPM.
- The vehicle speed is greater than 30 km/h (18.64 mph).
- DTC P0191 runs once an ignition cycle at engine start up when the above conditions have been met.

Conditions for Setting the DTC

Condition 1

The low side fuel pressure is at least 0.8 MPa (116 psi) less than the high side fuel pressure or the high side fuel

pressure is at least 0.3 MPa (44 psi) greater than the low side fuel pressure with the high pressure fuel pump actuator commanded OFF.

The condition exists for greater than 3 s.

Condition 2

The measured fuel rail pressure is at least 2 MPa (290 psi) less than the calibrated relief pressure for greater than 3 s.

Condition 3

The difference between the desired fuel rail pressure and the actual fuel rail pressure is greater than 2 MPa (290 psi) for 3 s.

Condition 4

The difference between the measured maximum high pressure and the measured minimum high pressure is less than or equal to 0.1 MPa (14.5 psi) for greater than 10 s.

Action Taken When the DTC Sets

- DTC P0191 is a Type A DTC.
- A message center or an indicator may display Reduced Engine Power.

Conditions for Clearing the DTC

DTC P0191 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0628, P069E, or U0109 is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If none of the DTCs are set**
3. Engine at idle.
4. Verify the scan tool Fuel Rail Pressure Sensor parameter is between 1.9-5.0 MPa (276-725 psi).
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **If within the specified range**
5. Verify the scan tool Fuel Rail Pressure Sensor and Desired Fuel Rail Pressure parameters closely match.
   - **If the parameters do not match**

     Refer to Circuit/System Testing.

   - **If the parameters match**
6. Move related harnesses/connectors of the B47B Fuel Rail Fuel Pressure Sensor.
7. Verify the engine does not stumble, stall, or change engine speed.
   - **If the engine stumbles, stalls, or changes engine speed**

     Test or repair the suspected harness or connection.

   - **If the engine does not stumbles, stalls, or changes engine speed**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify DTC P0191 is not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
10. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the B47B Fuel Rail Pressure Sensor connector. It may

take up to 2 min for all vehicle systems to power down.

2. Test for less than 5 Ω between the low reference circuit terminal C and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If within 4.8-5.2 V**
5. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.
    - **If 0.02 V or greater**
    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If less than 0.02 V**
6. Connect a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal A.
7. Verify the scan tool Fuel Rail Pressure Sensor Voltage parameter is greater than 4.96 V.
    - **If 4.96 V or less**
    1. Ignition OFF, remove fused jumper, disconnect the X2 harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit terminal 12 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 4.96 V**

8. Test or replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup.

DTC P0192 OR P0193: FUEL RAIL PRESSURE SENSO

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0192

Fuel Rail Pressure Sensor Circuit Low Voltage

DTC P0193

Fuel Rail Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference Voltage	P0192, P0193, P0340, P0345, P0365, P0390, P0506, P0641, P2227	P0192	P0193, P0641, P2227, P2229	P0191
Fuel Rail Pressure Sensor Signal	P0192	P0192, P0193	P0193	P0191
Low Reference	-	P0193	P0193	P0191

Circuit/System Description

The fuel rail pressure sensor detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 V reference voltage on the 5 V reference circuit and ground on the reference ground circuit. The ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the fuel rail pressure sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is between 11-18 V.
- The DTCs run continuously within the enabling conditions.

Conditions for Setting the DTC

P0192

The engine control module detects that the fuel rail pressure sensor signal voltage is low.

P0193

The engine control module detects that the fuel rail pressure sensor signal voltage is high.

Action Taken When the DTC Sets

- DTCs P0192 and P0193 are Type A DTCs.
- A message center or an indicator may display Reduced Engine Power.

Conditions for Clearing the DTC

DTCs P0192 and P0193 are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0641, P0651, P0697, or P06A3 is not set.
   - **If any of the DTCs are set**

     Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .

   - **If none of the DTCs are set**
3. Engine running.
4. Verify the scan tool Fuel Rail Pressure Sensor parameter is between 0.25-4.75 V.
   - **If not between 0.25-4.75 V**

     Refer to Circuit/System Testing.

   - **If between 0.25-4.75 V**
5. Verify the scan tool Fuel Rail Pressure Sensor increases or decreases when commanding an increase and decrease in Fuel Rail Pressure with a scan tool.
   - **If the parameter does not change**

     Refer to Circuit/System Testing.

   - **If the parameter changes**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
8. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF, disconnect the B47B Fuel Rail Pressure Sensor connector. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal C and ground.
   - **If 5 Ω or greater**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If less than 5 Ω**

3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.

- **If less than 4.8 V**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the 5 V reference circuit and ground.
    - If less than infinite resistance, repair the short to ground in the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the 5 V reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the 5 V reference circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If within 4.8-5.2 V**

5. Verify the scan tool Fuel Rail Pressure Sensor voltage parameter is less than 0.02 V.

- **If 0.02 V or greater**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If less than 0.02 V**

6. Connect a 3 A fused jumper wire between the signal circuit terminal B and the 5 V reference circuit terminal A.
7. Verify the scan tool Fuel Rail Pressure Sensor Voltage parameter is greater than 4.96 V.

- **If 4.96 V or less**

1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 12 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 4.96 V**

8. Test or replace the B47B Fuel Rail Pressure Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup.

DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, OR P0277: CYLINDER INJECTOR CONTROL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0201

Cylinder 1 Injector Control Circuit

DTC P0202

Cylinder 2 Injector Control Circuit

DTC P0203

Cylinder 3 Injector Control Circuit

DTC P0204

Cylinder 4 Injector Control Circuit

DTC P0205

Cylinder 5 Injector Control Circuit

DTC P0206

Cylinder 6 Injector Control Circuit

DTC P0261

Cylinder 1 Injector Control Circuit Low Voltage

DTC P0262

Cylinder 1 Injector Control Circuit High Voltage

DTC P0264

Cylinder 2 Injector Control Circuit Low Voltage

DTC P0265

Cylinder 2 Injector Control Circuit High Voltage

DTC P0267

Cylinder 3 Injector Control Circuit Low Voltage

DTC P0268

Cylinder 3 Injector Control Circuit High Voltage

DTC P0270

Cylinder 4 Injector Control Circuit Low Voltage

DTC P0271

Cylinder 4 Injector Control Circuit High Voltage

DTC P0273

Cylinder 5 Injector Control Circuit Low Voltage

DTC P0274

Cylinder 5 Injector Control Circuit High Voltage

DTC P0276

Cylinder 6 Injector Control Circuit Low Voltage

DTC P0277

Cylinder 6 Injector Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Low Control Cylinder 1	P2147	P0201	P2148	P1248
High Control Cylinder 1	P0261	P0201	P0262	P1248

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Low Control Cylinder 2	P2150	P0202	P2151	P1249
High Control Cylinder 2	P0264	P0202	P0265	P1249
Low Control Cylinder 3	P2153	P0203	P2154	P124A
High Control Cylinder 3	P0267	P0203	P0268	P124A
Low Control Cylinder 4	P2156	P0204	P0270, P2157	P124B
High Control Cylinder 4	P0270, P2156	P0204	P0271, P2157	P124B
Low Control Cylinder 5	P216B	P0205	P216C	P124C
High Control Cylinder 5	P0273	P0205	P0274	P124C
Low Control Cylinder 6	P216E	P0206	P216F	P124D
High Control Cylinder 6	P0276	P0206	P0277	P124D

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the high control circuits. The ECM energizes each fuel injector by grounding the low control circuit of the fuel injector. The ECM monitors the status of the fuel injector circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is between 11-18 V.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0201, P0202, P0203, P0204, P0205, or P0206

The engine control module detects the fuel injector high voltage supply circuit or the fuel injector high voltage control circuit is open for greater than 2 s.

P0261, P0264, P0267, P0270, P0273, or P0276

The engine control module detects the fuel injector high voltage control circuit is shorted to ground for greater than 2 s.

P0262, P0265, P0268, P0271, P0274, or P0277

The engine control module detects the fuel injector high voltage control circuit is shorted to voltage for greater than 2 s.

Action Taken When the DTC Sets

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, and P0277 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, and P0277 are Type A DTCs.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test** .
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Cylinder 1-6 Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0685 or P1682 is not set.
    - **If the DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If the DTCs are not set**

3. Engine idling.
4. Verify the scan tool Cylinder 1-6 Injector Control Circuit Status parameters display OK.
    - **If any parameters do not display OK**

      Refer to Circuit/System Testing.

    - **If all parameters display OK**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277 does not set.
    - **If any DTC sets**

      Refer to Circuit/System Testing.

    - **If no DTC sets**
7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate multi-way harness connector X160 or X161, at the rear of the intake manifold, ignition ON. It may take up to 2 min for all vehicle systems to power down.
2. Verify the scan tool Cylinder 1-6 Injector Control Circuit Status parameters display Open.
    - **If Open is not displayed**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.

       NOTE: **Test on the Engine Control Module side of the multi-way harness connector.**

    2. Test for infinite resistance between the appropriate Q17 Fuel Injector low control circuit and ground.
        - If less than infinite, repair the short to ground on the circuit.
        - If infinite resistance
    3. Ignition ON.
    4. Test for less than 1 V between the Q17 Fuel Injector low control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, test or replace the K20 Engine Control Module.
    - **If Open is displayed**
3. Ignition ON, connect a test lamp between the appropriate Q17 Fuel Injector high control circuit and low control circuits.
4. Verify the appropriate Cylinder 1-6 Injector Control Circuit Status transitions from Open to OK.
    - **If OK is not displayed**

1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω on the Q17 Fuel Injector high control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω
3. Test for less than 2 Ω on the Q17 Fuel Injector low control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, test or replace the K20 Engine Control Module.

- **If OK is displayed**

NOTE: **Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.**

5. Test for 2-3 Ω between the appropriate Q17 Fuel Injector high control circuit and low control circuit.
    - **If less than 2 Ω**
    1. Disconnect the harness connector at the Q17 Fuel Injector.
    2. Test for infinite resistance between the Q17 Fuel Injector high control circuit and low control circuit.
        - If less than infinite, repair the short between the circuits.
        - If infinite resistance, test or replace the Q17 Fuel Injector.
    - **If greater than 3 Ω**
    1. Disconnect the harness connector at the Q17 Fuel Injector.
    2. Test for less the 2 Ω in the Q17 Fuel Injector high control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω
    3. Test for less the 2 Ω in the Q17 Fuel Injector low control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, test or replace the Q17 Fuel Injector.
    - **If between 2-3 Ω**
6. Test for infinite resistance between the appropriate Q17 Fuel Injector low control circuit and ground.
    - **If less than infinite resistance**
    1. Disconnect the harness connector at the Q17 Fuel Injector.
    2. Test for infinite resistance between the Q17 Fuel Injector high control circuit and ground.
        - If less than infinite, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for infinite resistance between the Q17 Fuel Injector low control circuit and ground.
        - If less than infinite, repair the short to ground on the circuit.
        - If infinite resistance, test or replace the Q17 Fuel Injector.
    - **If infinite resistance**
7. Ignition ON.

8. Test for less than 1 V between the appropriate Q17 Fuel Injector low control circuit and ground.
    - **If 1 V or greater**

      Repair the short to voltage on the circuit.

    - **If less than 1 V**
9. All OK.

Component Testing

- **Fuel Injector Solenoid Coil Test**
- **Fuel Injector Balance Test**

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Injector Replacement**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P0231, P0232, OR P023F: FUEL PUMP CONTROL CIRCUIT (CHASSIS CONTROL MODULE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0231

Fuel Pump Control Circuit Low Voltage

DTC P0232

Fuel Pump Control Circuit High Voltage

DTC P023F

Fuel Pump Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0231	P023F	P0232	P023F, P2635
Low Reference	-	P023F	-	P023F, P2635

Circuit/System Description

The engine control module (ECM) supplies voltage to the chassis control module when the ECM detects that the ignition is on. The voltage from the ECM to the chassis control module remains active for 2 s, unless the engine is in crank or run. While this voltage is being received, the chassis control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

P0231

- The ignition voltage is greater than 11 V.
- The engine is cranking or running.
- The fuel pump enable circuit is commanded ON.
- The fuel pump power module output current is less than 75 A.
- The DTC runs continuously when the conditions above are met.

P0232

- The ignition voltage is greater than 7 V.
- The fuel pump enable circuit is commanded ON.
- The DTC runs continuously when the conditions above are met.

P023F

- The ignition voltage is greater than 7 V.
- The commanded duty cycle is between 30-60 %.
- The DTC runs continuously when the conditions above are met.

Conditions for Setting the DTC

P0231

The fuel pump driver control module detects that the fuel pump current is greater than 14.48 A for 1 s.

P0232

The fuel pump driver control module detects that the fuel pump output circuit voltage is greater than 4.0 V for 1 s when the voltage should be 0 V.

P023F

The fuel pump driver control module detects that the fuel pump current is less than 1 A and the fuel pump duty cycle is approximately 30-60 % for 1 s.

Action Taken When the DTC Sets

DTCs P0231, P0232, and P023F are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0231, P0232, and P023F are Type A DTCs.

Diagnostic Aids

Using the failure records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the failure records can help determine how many miles since the DTC set. The fail counter and pass counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

On vehicles equipped with a high pressure mechanical pump on direct fuel injection engines, the vehicle may continue to run even though the pump in the fuel tank is not operating.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the fuel pump turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
    - **If the fuel pump does not turn ON and OFF**

      Refer to Circuit/System Testing.

    - **If the fuel pump turns ON and OFF**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

4. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor Assembly. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K38 Chassis Control Module.
    - **If less than 5 Ω**
3. Connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
4. Ignition ON.
5. Verify the test lamp turns ON and OFF when commanding the Fuel Pump Enable On and Off with a scan tool.
    - **If the test lamp is always OFF**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K38 Chassis Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K38 Chassis Control Module.
    - **If the test lamp is always ON**
    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K38 Chassis Control Module.
    - **If the test lamp turns ON and OFF**
6. Test or replace the A7 Fuel Pump and Level Sensor Assembly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for K38 Chassis Control Module replacement, programming, and setup

DTC P025A: FUEL PUMP CONTROL MODULE (CHASSIS CONTROL MODULE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P025A

Fuel Pump Control Module Enable Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P025A	P025A	-	P025A

Circuit/System Description

The engine control module (ECM) supplies voltage to the chassis control module when the ECM detects that the ignition is on. The voltage from the ECM to the chassis control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the chassis control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The serial data message from the ECM to the chassis control module does not agree with the state of the control enable voltage signal supplied from the ECM to the chassis control module for more than 2 seconds.

Action Taken When the DTC Sets

DTC P025A is a Type A DTC.

Conditions for Clearing the DTC

DTC P025A is a Type A DTC.

Diagnostic Aids

Beginning in the 2014 model year the K27 Fuel Pump Control Module (FPCM) will now be called the chassis control module (CCM). The component code for the chassis control module will be K38. The chassis control

module name will be used in Service Information, the Global Diagnostic System and the Service Programming System.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: **Verify that the fuel tank is not empty. Only perform this diagnostic if there is at least 2 gallons of fuel in the fuel tank. Clear the DTC, and start and run the engine. Verify that the DTC resets before proceeding with the circuit system testing. If the DTC does not reset, refer to diagnostic aids.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
2. Connect a test lamp between the control circuit terminal 20 and ground.
3. Verify the test lamp turns On and Off when commanding the fuel pump ON and OFF using the scan tool ECM fuel pump enable control function.
    - **If the test lamp is always Off**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.

- If infinite resistance

3. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If the test lamp is always On**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If the test lamp turns On and Off**

4. Test or replace the K38 Chassis Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for ECM or chassis control module replacement, programming and setup.

DTC P0300-P0306: CYLINDER MISFIRE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0300

Engine Misfire Detected

DTC P0301

Cylinder 1 Misfire Detected

DTC P0302

Cylinder 2 Misfire Detected

DTC P0303

Cylinder 3 Misfire Detected

DTC P0304

Cylinder 4 Misfire Detected

DTC P0305

Cylinder 5 Misfire Detected

DTC P0306

Cylinder 6 Misfire Detected

Circuit/System Description

The engine control module (ECM) uses information from the crankshaft position sensor and the camshaft position sensor to determine when a engine cylinder misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM can detect individual cylinder misfire events.

Extreme cylinder misfire events can cause catalytic converter damage. The malfunction indicator lamp (MIL) will flash when the conditions for catalytic converter damage are present. DTCs P0301 through P0306 correspond to cylinders 1 through 6. When the ECM detects that one or more specific cylinders are misfiring, the DTC for the respective misfiring cylinder will set and up to 2 of the corresponding fuel injectors are disabled for a minimum of 30 s. The ECM will then re-enable the fuel injector and, after approximately 200 engine revolutions, will determine if the misfire is still present. If the misfire is still present, the ECM will disable the fuel injector again repeating the process. If the misfire is not present, the fuel injector will remain enabled by the ECM. In Spark Ignition Direct Injection (SIDI) system applications, if a fuel injector fault DTC is set during a misfire event, the ECM will not re-enable the injector.

Conditions for Running the DTC

- DTC P0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0122, P0123, P0191, P0192, P0193, P0222, P0223, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0601, P0604, P0606, P0651, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2227, P2228, P2229, or P2230 is not set.
- DTC P0806, P0807, or P0808 is not set when equipped with manual transmission.
- The engine speed is less than 1,000 RPM and DTC P0315 is set.
- The engine speed is greater than 1,500 RPM.
- The crankshaft position and camshaft position sensors are synchronized.
- The engine coolant temperature (ECT) is between -7 and 130Â°C (19-266Â°F).
- If the ECT is colder than -7Â°C (19Â°F) at start-up, this diagnostic will not run until the ECT is between 21-130Â° (70-266Â°F).
- The battery voltage is between 9-32 V.
- The vehicle is not in an acceleration or deceleration condition.
- The ECM is not detecting a rough road signal.
- The fuel level is at least 11%.
- The ECM is not in fuel cut-off or deceleration fuel cut-off mode.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P0300

The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause emissions levels to exceed a predetermined value or a misfire rate high enough to cause catalyst damage.

P0301, P0302, P0303, P0304, P0305, or P0306

The ECM detects a crankshaft rotation speed variation indicating a single cylinder misfire rate sufficient to cause emissions levels to exceed mandated standards.

Action Taken When the DTC Sets

- DTCs P0300-P0306 are Type B DTCs.
- When a catalyst damaging level of misfire is present, the ECM may disable the fuel injectors for up to 2 misfiring cylinders and will flash the malfunction indicator lamp (MIL).

Conditions for Clearing the DTC

DTCs P0300-P0306 are Type B DTCs.

Diagnostic Aids

- A misfire DTC could be caused by an excessive vibration from sources other than the engine. Inspect for the conditions listed below:
  - A tire or wheel that is out of round or out of balance
  - Variable thickness brake rotors
  - An unbalanced drive shaft
  - Certain rough road conditions
  - Transmission operation
  - A damaged or defective accessory drive component or belt
- Observe misfire counters after Active Fuel Management is commanded Off for a sticking lifter.
- High resistance in the circuits of the injectors may set a misfire DTC without setting an injector DTC. Test the injector circuits of the affected cylinder(s) for a high resistance if you suspect a condition.
- If the condition is intermittent, observing the scan tool IC Circuit Test and Fuel Injector Circuit Test Status parameters may help isolate the condition. The circuit test status parameters will change from OK or Not Run to Fault/Malfunction if a condition exists.
- A condition in the heated O2 sensor (HO2S) heater control circuits may set a DTC P0300.

Reference Information

Description and Operation

- **Electronic Ignition System Description**
- **Fuel System Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL26792 HEI Spark Tester

For equivalent regional tools, refer to Special Tools (Diagnostic Tools) Special Tools (Repair Tools) .

Circuit/System Verification

NOTE: **Before starting the engine, review the freeze frame failure records data to determine if the misfire sets during a cold start or at operating temperature. If there is a cold start condition and the engine is started, the engine will need to be cooled down before the next attempt to start the engine within the fail conditions.**

1. Engine Running at normal operating temperature.
2. Verify there is no abnormal engine noise.
   - **If abnormal engine noise is present**

     Refer to Symptoms - Engine Mechanical .

   - **If abnormal engine noise is not present**
3. Perform the scan tool Crankshaft Position System Variation Learn procedure.
4. Verify no DTCs are set.
   - **If any DTCs other than P0300-P0306 are set**

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle .

   - **If DTC P0300-P0306 is set**

     Refer to Circuit/System Testing.

   - **If no DTCs are set**
5. Verify the scan tool Cylinder 1-6 Current Misfire Counter parameters do not increment.
   - **If increments**

     Refer to Circuit/System Testing.

   - **If does not increment**
6. Engine Running, perform the Cylinder Power Balance Test with a scan tool.
7. Verify the engine speed changes when each injector is disabled and then enabled.
   - **If engine speed does not change**

     Refer to Circuit/System Testing.

   - **If engine speed does change**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within

the conditions that you observed from the Freeze Frame/Failure Records data.

9. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
10. All OK.

Circuit/System Testing

1. Verify none of the conditions listed below exist:
    - Damage, carbon tracking, or fluid intrusion of the spark plug boots and/or spark plugs
    - Vacuum hose splits, kinks, and incorrect connections
    - Engine vacuum leaks
    - Crankcase ventilation system for vacuum leaks
    - Fuel pressure that is too low or too high. Refer to **Fuel System Diagnosis** .
    - Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** .
    - Exhaust system restrictions
        - **If a condition exists**

          Repair or replace as necessary.

        - **If no conditions exist**

NOTE: **An erratic or weak spark is considered a no spark condition.**

2. Ignition OFF, remove the appropriate T8 Ignition Coil and connect the **EL 26792** to the spark plug boot, engine Cranking.
3. Verify the spark output.
    - **If no output or the output is weak**

      Refer to **Electronic Ignition System Diagnosis** .

    - **If the output is good**
4. Ignition OFF.
5. Verify the conditions listed below. Refer to **Ignition System Specifications** .
    - The correct spark plug type
    - The correct spark plug gap
    - The correct spark plug torque
    - **If a condition exists**

      Repair or replace as necessary.

    - **If no conditions exist**

6. Exchange the suspect spark plug with another cylinder that is operating correctly.
7. Engine Running.
8. Verify the scan tool Cylinder 1-6 Current Misfire Counter does not increment for the cylinder where the suspect spark plug was installed.
    - **If increments**

      Replace the spark plug.

    - **If does not increment**
9. Verify the conditions listed below do not exist:
    - A lean or rich Q17 Fuel Injector-Refer to **Fuel Injector Balance Test** .
    - An engine mechanical condition-Refer to **Symptoms - Engine Mechanical** .

Repair Instructions

- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**
- **Spark Plug Replacement**

Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
3. Clear the DTCs.
4. Turn OFF the ignition for 60 s.
5. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the **Diagnostic Trouble Code (DTC) List - Vehicle** and perform the appropriate diagnostic procedure.
6. Engine Running, verify the scan tool Cylinder 1-6 Current Misfire Counter parameters do not increment.
    - If the misfire counter parameters increment, a misfire condition still exists.
7. To verify that the performance of the catalytic converter has not been affected by the condition that set this DTC, perform the Repair Verification for DTC P0420 or P0430. Refer to **DTC P0420 or P0430** .

DTC P0315: CRANKSHAFT POSITION SYSTEM VARIATION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0315

Crankshaft Position System Variation Not Learned

Circuit/System Description

The crankshaft position variation learn feature is used to calculate reference period errors caused by slight tolerance variations in the crankshaft, and the crankshaft position sensor. The calculated error allows the engine control module (ECM) to accurately compensate for reference period variations. This enhances the ability of the ECM to detect misfire events over a wider range of engine speed and load conditions.

The crankshaft position system variation compensating values are stored in ECM memory after a learn procedure has been performed and the ignition switch is turned to the OFF position for at least 30 s. If the actual variation is not within the crankshaft position system variation compensating values stored in the ECM, DTC P0300 may set.

If the crankshaft position system variation values are not stored in the ECM memory or a proper ECM power down does not occur after completing the Crankshaft Position Learn Procedure, DTC P0315 sets.

Conditions for Running the DTC

Engine is Running.

The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

The ECM detects that the crankshaft position system variation values are not stored in memory.

Action Taken When the DTC Sets

DTC P0315 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0315 is a Type A DTC.

Diagnostic Aids

This test procedure requires that the vehicle battery has passed a load test and is completely charged. Refer to **Battery Inspection/Test** .

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Perform the scan tool **Crankshaft Position System Variation Learn** procedure.

2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
3. Verify the DTC is not set.
    - **If the DTC sets**

      Replace the K20 Engine Control Module.

    - **If the DTC does not set**
4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for engine control module replacement, programming, and setup

DTC P0324, P0326, P0331, P06B6, OR P06B7: KNOCK SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0324

Knock Sensor System Performance

DTC P0326

Knock Sensor Performance Bank 1

DTC P0331

Knock Sensor Performance Bank 2

DTC P06B6

Control Module Knock Sensor Processor 1 Performance

DTC P06B7

Control Module Knock Sensor Processor 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor 1 High Signal	P0327, P06B6	P0325	P0328	P0324*, P0326**

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor 2 High Signal	P0332, P06B7	P0330	P0333	P0324*, P0331**
Knock Sensor 1 Low Signal	P0327	P0325	P0328	P0324*, P0326**
Knock Sensor 2 Low Signal	P0332	P0330	P0333	P0324*, P0331**
* Signal Performance High ** Signal Performance Low				

Circuit/System Description

The knock sensors enable the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The knock sensors produce an alternating current (AC) voltage signal that varies depending on the vibration level during engine operation. The ECM adjusts the spark timing based on the amplitude and the frequency of the two knock sensor signals. The ECM receives each knock sensor signal through a dedicated circuit. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges and monitors the normal knock sensor signal. The ECM monitors the internal knock sensor processor test circuits which perform the open circuit diagnostic.

Conditions for Running the DTCs

P0324

- Engine is running for 2 s or greater.
- Engine speed is 8,500 RPM or less.
- Engine air flow is between 200-2,000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor 1 is -40Â°C (-40Â°F) or warmer.

  AND

- Engine speed is 400 RPM or greater.

  OR

- Engine speed is 8,500 RPM or greater.

  OR

- Engine speed is 8,500 RPM or greater.

P0326 and P0331

- Engine is running for 2 s or greater.
- Engine speed is 8,500 RPM or less.
- Engine air flow is between 200-2,000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor 1 is -40Â°C (-40Â°F) or warmer.

AND

- Engine speed is 400 RPM or greater for 167 or more cumulative revolutions.

OR

- Engine speed is 8,500 RPM or greater for 100 or more cumulative revolutions.

OR

- Engine speed is 8,500 RPM or greater for 5 or more cumulative revolutions.

P06B6 and P06B7

- Engine is running for 2 s or greater.
- Engine speed is between 400-4,000 RPM for 200 or more cumulative revolutions.
- Engine air flow is between 10-2,000 mg per cylinder.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0324

The ECM detects that either knock sensor signal performance is out of the normal calibrated range due to excessive engine knock on a per cylinder basis.

P0326

The ECM detects that the knock sensor 1 signal performance is out of the normal calibrated range due to a low signal level.

P0331

The ECM detects that the knock sensor 2 signal performance is out of the normal calibrated range due to a low signal level.

P06B6 and P06B7

The ECM has detected a fault in the knock sensor processor open circuit diagnostic internal test circuit.

Action Taken When the DTCs Set

- DTCs P0324, P0326, P0331, P06B6, and P06B7 are Type B DTCs.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

Conditions for Clearing the DTCs

DTCs P0324, P0326, P0331, P06B6, and P06B7 are Type B DTCs.

Reference Information

Description and Operation

Electronic Ignition System Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine Running.
2. Verify DTC P0325, P0327, P0328, P0330, P0332, P0333, P06B6, or P06B7 is not set.
   - **If DTC P0325, P0327, P0328, P0330, P0332, or P0333 is set with P06B6 or P06B7**

     Refer to **DTC P0325, P0327, P0328, P0330, P0332, or P0333**.
   - **If only DTC P06B6 or P06B7 is set**

     Replace the K20 Engine Control Module.
   - **If none of the DTCs are set**
3. Ignition OFF.
4. Verify none of the conditions listed below exist:
   - B68 Knock Sensor or wiring harness damage.
   - Incorrect B68 Knock Sensor installation. Refer to **Fastener Specifications** .
   - B68 Knock Sensor and engine mounting surface burrs, casting flash, and foreign material.
   - Close proximity of hoses, brackets, and engine wiring.
   - Loose brackets.
   - Loose or broken accessory drive belts, brackets, components.
   - An engine mechanical condition. Refer to **Symptoms - Engine Mechanical** .
   - Contaminated or poor quality fuel.
   - **If a condition exists**

     Repair or replace as necessary.
   - **If no conditions exist**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **If the DTC sets**

     Test or replace the appropriate B68 Knock Sensor.
   - **If the DTC does not set**

6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Knock Sensor Replacement - Bank 1**
- **Knock Sensor Replacement - Bank 2**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P0325, P0327, P0328, P0330, P0332, OR P0333: KNOCK SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0325

Knock Sensor Circuit Bank 1

DTC P0327

Knock Sensor Circuit Low Voltage Bank 1

DTC P0328

Knock Sensor Circuit High Voltage Bank 1

DTC P0330

Knock Sensor Circuit Bank 2

DTC P0332

Knock Sensor Circuit Low Voltage Bank 2

DTC P0333

Knock Sensor Circuit High Voltage Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor 1 High Signal	P0327, P06B6	P0325	P0328	P0324*, P0326**
Knock Sensor 2 High Signal	P0332, P06B7	P0330	P0333	P0324*, P0331**
Knock Sensor 1 Low Signal	P0327	P0325	P0328	P0324*, P0326**

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Knock Sensor 2 Low Signal	P0332	P0330	P0333	P0324*, P0331**
* Signal Performance High ** Signal Performance Low				

Circuit/System Description

The knock sensors enable the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The knock sensors produce an alternating current (AC) voltage signal that varies depending on the vibration level during engine operation. The ECM adjusts the spark timing based on the amplitude and the frequency of the two knock sensor signals. The ECM receives each knock sensor signal through a dedicated circuit. The ECM learns a minimum knock sensor noise level for all of the engine speed ranges and monitors the normal knock sensor signal. The ECM monitors the internal knock sensor processor test circuits which perform the open circuit diagnostic.

Conditions for Running the DTCs

P0325 and P0330

- Engine is running for 2 s or greater.
- Engine speed is between 400-5,500 RPM for 100 or more cumulative revolutions.
- Engine air flow is between 10-2000 mg per cylinder.
- The engine coolant temperature (ECT) is -40Â°C (-40Â°F) or warmer.
- The intake air temperature (IAT) sensor 1 is -40Â°C (-40Â°F) or warmer.

P0327, P0328, P0332, and P0333

Engine speed is less than 8,500 RPM.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTCs

P0325

The ECM detects knock sensor 1 signal circuit is open.

P0327

The ECM detects knock sensor 1 signal circuit is shorted to ground.

P0328

The ECM detects knock sensor 1 signal circuit is shorted to voltage.

P0330

The ECM detects knock sensor 2 signal circuit is open.

P0332

The ECM detects knock sensor 2 signal circuit is shorted to ground.

P0333

The ECM detects knock sensor 2 signal circuit is shorted to voltage.

Action Taken When the DTCs Set

- DTCs P0325, P0327, P0328, P0330, P0332, and P0333 are Type B DTCs.
- The ignition timing is retarded to reduce the potential of engine damaging spark knock.

Conditions for Clearing the DTCs

DTCs P0325, P0327, P0328, P0330, P0332, and P0333 are Type B DTCs.

Diagnostic Aids

The following conditions listed below may cause a knock sensor DTC to set:

- Sensor damage.
- Knock sensor and engine mounting surface burrs, casting flash, and foreign material.
- Close proximity of hoses, brackets, and engine wiring.
- Loose brackets.
- Loose or broken accessory drive belts, brackets, components.
- An engine mechanical condition. Refer to **Symptoms - Engine Mechanical** .

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine Running.
2. Verify DTC P0325, P0327, P0328, P0330, P0332, or P0333, is not set.
   - **If the DTC is set**

     Refer to Circuit/System Testing.

   - **If the DTC is not set**
3. Verify the appropriate B68 Knock Sensor mounting bolt is properly tightened. Refer to **Fastener Specifications** .
   - **If not tightened to the correct specification**

     Repair a necessary.

   - **If tightened to the correct specification**
4. Verify the scan tool parameters listed below display No while moving the related harnesses and connectors of the B68 Knock Sensor.
   - Cylinder 1 Knock Detected
   - Cylinder 2 Knock Detected
   - Cylinder 3 Knock Detected
   - Cylinder 4 Knock Detected
   - Cylinder 5 Knock Detected
   - Cylinder 6 Knock Detected
   - **If No is not displayed**

     Repair the wiring harness or connectors.

   - **If No is displayed**
5. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the B68 Knock Sensor, ignition ON.
2. Test for 1-2 V between the low signal circuit terminal B and ground.
    - **If less than 1 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the low signal circuit terminal B and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance.
    3. Test for less than 2 Ω in the low signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the low signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 1-2 V**
3. Test for 2-4 V between the high signal circuit terminal A and ground.
    - **If less than 2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the high signal circuit terminal A and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance.
    3. Test for less than 2 Ω in the high signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 4 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the high signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 2-4 V**
4. Test or replace the B68 Knock Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Knock Sensor Replacement - Bank 1**
- **Knock Sensor Replacement - Bank 2**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P0335 OR P0336: CRANKSHAFT POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0335

Crankshaft Position Sensor Circuit

DTC P0336

Crankshaft Position Sensor Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P057C, P0335, P0651	P0335	P0651	P0336
Signal	P0335, P0506	P0335	P0335	P0336
Low Reference	-	P0335	-	P0336

Circuit/System Description

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses crankshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing, and to detect cylinder misfire.

Conditions for Running the DTC

P0335 Condition 1

- The starter is engaged and the engine control module detects camshaft position sensor pulses.

Or

- DTCs P0101, P0102 and P0103 are not set.

  And

- The airflow into the engine is greater than 3 g/s.

Condition 2

- DTC P0651 is not set.
- The engine is running and the starter is not engaged.

Condition 3

- DTCs P0365, P0366, P0641, and P0651 are not set.
- The engine is running or the starter is engaged.

P0336 Condition 1

- DTCs P0335 or P0651 are not set.
- The airflow into the engine is greater than 3 g/s.
- Engine speed is greater than 450 RPM.

Condition 2

- DTC P0651 is not set.
- The engine is running and the starter is not engaged.

Condition 3

- The starter is engaged and the engine control module detects camshaft position sensor pulses.

  Or

- DTCs P0101, P0102, and P0103 are not set.
- The airflow into the engine is greater than 3 g/s.

Condition 4

- DTCs P0365, P0366, P0641, and P0651, are not set.
- The engine is running or the starter is engaged.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0335 Condition 1

The ECM does not detect a crankshaft position sensor pulse for greater than 4 s.

Condition 2

The ECM does not detect a crankshaft position sensor pulse for greater than 1.0 s.

Condition 3

The ECM does not detect a crankshaft position sensor pulse for 2 out of 10 engine revolutions.

P0336 Condition 1

The ECM detects that 10 or more crankshaft resynchronization have occurred within 10.0 s.

Condition 2

The ECM does not detect the synchronization gap on the reluctor wheel for greater than 0.4 s.

Condition 3

The ECM does not detect the synchronization gap on the reluctor wheel for 1.5 s after the starter was engaged.

Condition 4

The ECM detects less than 51 or greater than 65 crankshaft position sensor pulses during 1 engine revolution for 8 out of 10 engine revolutions.

Action Taken When the DTC Sets

- DTCs P0335 and P0336 are Type B DTCs.
- An engine driveability issue occurs after the first failure.
- The camshaft position sensor is used to determine engine position.
- The camshaft actuators are commanded to the parked position.

Conditions for Clearing the DTC

DTCs P0335 and P0336 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0651 is not set.
   - **If the DTC is set**

     Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** .

   - **If the DTC is not set**
3. Engine running.
4. Verify the scan tool Crankshaft Position Active Counter parameter increments.
   - **If the counter does not increment**

     Refer to Circuit/System Testing.

   - **If the counter increments**
5. Verify the scan tool Crankshaft Position Resync Counter parameter displays 0 counts and the engine does not stumble or stall while moving the related harness/connectors of the B26 Crankshaft Position Sensor.
   - **If greater than 0 counts and the engine stumbles or stalls**

     Refer to Circuit/System Testing.

   - **If 0 counts and the engine does not stumble or stall**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
8. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B26 Crankshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If 2 Ω or less, replace the K20 Engine Control Module.
    - **If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**
5. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance.
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

6. Ignition OFF, connect a 3 A fused jumper wire to the signal circuit terminal 2, ignition ON.

NOTE: **Additional DTCs may set when performing this test.**

7. Verify the scan tool Crankshaft Position Sensor Active Counter parameter increments while rapidly tapping the fused jumper wire end to ground.
   - **If the counter does not increment**

     Replace the K20 Engine Control Module.

   - **If the counter increments**
8. Verify DTC P0336 is not set.
   - **If the DTC is set**

     Inspect for the conditions listed below:

   - Excessive play or looseness of the B26 Crankshaft Position Sensor or the reluctor wheel
   - Improper installation of the B26 Crankshaft Position Sensor
   - Foreign material passing between the B26 Crankshaft Position Sensor and the reluctor wheel
   - Damaged reluctor wheel
   - Excessive air gap between the B26 Crankshaft Position Sensor and the reluctor wheel
   - Engine oil for debris
   - Timing chain, tensioner, and sprockets for wear or damage
     - If any of the conditions above are found, repair as necessary.
     - If all components test normal, test or replace the B26 Crankshaft Position Sensor.
   - **If the DTC is not set**
9. Test or replace the B26 Crankshaft Position Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Crankshaft Position Sensor Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

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Article GUID: A00737213

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, OR P0391: CAMSHAFT POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0340

Intake Camshaft Position Sensor Circuit Bank 1

DTC P0341

Intake Camshaft Position Sensor Performance Bank 1

DTC P0345

Intake Camshaft Position Sensor Circuit Bank 2

DTC P0346

Intake Camshaft Position Sensor Performance Bank 2

DTC P0365

Exhaust Camshaft Position Sensor Circuit Bank 1

DTC P0366

Exhaust Camshaft Position Sensor Performance Bank 1

DTC P0390

Exhaust Camshaft Position Sensor Circuit Bank 2

DTC P0391

Exhaust Camshaft Position Sensor Performance Bank 2

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0107, P0192, P0236, P0237, P0340, P0345, P0365, P0390, P0452, P0522, P0532, P0641, P2228	P0340, P0345, P0365, P0390	P0193, P0236, P0345, P0453, P0506, P0533, P0641, P1101, P2227, P222B	-
Signal	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	P0340, P0345, P0365, P0390	P0341, P0346, P0366, P0391
Low Reference	-	P0340, P0345, P0365, P0390	-	-

Circuit/System Description

The 4 camshaft position sensors each have 3 circuits consisting of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency with 4 varying width output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM uses the cylinder 1 exhaust camshaft position sensor to determine injector and ignition system synchronization. The intake and exhaust camshaft position sensors are also used to determine camshaft to crankshaft relationship. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft to control camshaft phasing and limp-home operation.

Conditions for Running the DTC

P0340, P0345, P0365, or P0390 Condition 1

- DTCs P0101, P0102, and P0103 are not set.
- The airflow into the engine is greater than 3 g/s.

  OR

- The starter is engaged and the engine control module detects camshaft position sensor pulses.

Condition 2

- DTC P0651 is not set.
- The engine is running and the starter is not engaged.

Condition 3

- DTC P0335, P0336, P0641, or P0651 are not set.
- The crankshaft is synchronized.
- The starter is engaged.

Condition 4

- DTC P0335, P0336, P0641, or P0651 are not set.
- The crankshaft is synchronized.

P0341, P0346, P0366, or P0391 Condition 1

- DTC P0335, P0336, P0641, or P0651 are not set.
- The crankshaft is synchronized.
- The starter is engaged.

Condition 2

- DTC P0335, P0336, P0641, or P0651 are not set.
- The crankshaft is synchronized.

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0340, P0345, P0365, or P0390 Condition 1

- The ECM does not detect a camshaft position sensor pulse for greater than 5.5 s.

  OR

- The ECM does not detect a camshaft position sensor pulse for greater than 4.0 s since the time the starter has been engaged.

Condition 2

The ECM detects less than 4 camshaft position sensor pulses for greater than 3.0 s.

Condition 3

The ECM does not detect a camshaft position sensor pulse during the first 2 engine revolutions.

Condition 4

The ECM does not detect a camshaft position sensor pulse during 200 engine revolutions.

P0341, P0346, P0366, or P0391 Condition 1

- The ECM detects less than 4 camshaft position sensor pulses during 2 engine revolutions.

  OR

- The ECM detects greater than 10 camshaft position sensor pulses during 2 engine revolutions.

Condition 2

The ECM detects less than 398 or greater than 402 camshaft position sensor pulses during 200 engine revolutions.

Action Taken When the DTC Sets

- DTCs P0340, P0341, P0345, P0346, P0365, P0366, P0391, and P0390 are Type B DTCs.
- The camshaft position actuator is commanded to the Home or Parked position.
- The ignition system defaults to a failed camshaft position sensor limp home mode.

Conditions for Clearing the DTC

DTCs P0340, P0341, P0345, P0346, P0365, P0366, P0391, and P0390 are Type B DTCs.

Diagnostic Aids

- With a DTC set, the engine may crank for an extended period of time at start-up
- The exhaust camshaft position sensor is used for injector and ignition system synchronization. A stalling condition will occur if the camshaft position sensor signal is intermittent and a DTC will not set. Inspect all camshaft position sensor circuits for poor connections.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0641 or P0651 is not set.
   - **If any of the DTCs are set**

     Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)**.

   - **If none of the DTCs are set**
3. Engine running.
4. Verify the scan tool parameters listed below increment:
   - Exhaust Camshaft Position Active Counter Bank 1
   - Exhaust Camshaft Position Active Counter Bank 2
   - Intake Camshaft Position Active Counter Bank 1
   - Intake Camshaft Position Active Counter Bank 2
   - **If any counter does not increment**

     Refer to Circuit/System Testing.

   - **If all counters increment**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate B23 Camshaft Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If 2 Ω or less, replace the K20 Engine Control Module.
   - **If less than 5 Ω**
3. Ignition ON.

4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance.
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω , replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**
5. Test for 4.8-5.2 V between the signal circuit terminal 2 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance.
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**
6. Verify DTC P0341, P0346, P0366, or P0391 is not set.
    - **If any of the DTCs are set**

      Verify the conditions listed below do not exist:

    - Excessive play or looseness of the B23 Camshaft Position Sensor or the reluctor wheel
    - Improper installation of the B23 Camshaft Position Sensor
    - Foreign material passing between the B23 Camshaft Position Sensor and the reluctor wheel

- Damaged reluctor wheel
- Excessive air gap between the B23 Camshaft Position Sensor and the reluctor wheel
- Engine oil for debris
- Timing chain, tensioner, and sprockets for wear or damage
  - If a conditions exist, repair as necessary.
  - If none of the condition exist test or replace the B23 Camshaft Position Sensor.
- **If none of the DTCs are set**

7. Test or replace the B23 Camshaft Position Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust**
- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, OR P2316: IGNITION COIL 1-6

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0351

Ignition Coil 1 Control Circuit

DTC P0352

Ignition Coil 2 Control Circuit

DTC P0353

Ignition Coil 3 Control Circuit

DTC P0354

Ignition Coil 4 Control Circuit

DTC P0355

Ignition Coil 5 Control Circuit

DTC P0356

Ignition Coil 6 Control Circuit

DTC P2300

Ignition Coil 1 Control Circuit Low Voltage

DTC P2301

Ignition Coil 1 Control Circuit High Voltage

DTC P2303

Ignition Coil 2 Control Circuit Low Voltage

DTC P2304

Ignition Coil 2 Control Circuit High Voltage

DTC P2306

Ignition Coil 3 Control Circuit Low Voltage

DTC P2307

Ignition Coil 3 Control Circuit High Voltage

DTC P2309

Ignition Coil 4 Control Circuit Low Voltage

DTC P2310

Ignition Coil 4 Control Circuit High Voltage

DTC P2312

Ignition Coil 5 Control Circuit Low Voltage

DTC P2313

Ignition Coil 5 Control Circuit High Voltage

DTC P2315

Ignition Coil 6 Control Circuit Low Voltage

DTC P2316

Ignition Coil 6 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Coil 1 Control	P0300, P2300	P0300, P0351	P0300, P2301	P0300, P0351
Ignition Coil 2 Control	P0300, P2303	P0300, P0352	P0300, P2304	P0300, P0352
Ignition Coil 3 Control	P0300, P2306	P0300, P0353	P0300, P2307	P0300, P0353
Ignition Coil 4 Control	P0300, P2309	P0300, P0354	P0300, P2310	P0300, P0354
Ignition Coil 5 Control	P0300, P2312	P0300, P0355	P0300, P2313	P0300, P0355
Ignition Coil 6 Control	P0300, P2315	P0300, P0356	P0300, P2316	P0300, P0356
Ignition Coil 1 Ground	-	P0300, P0351	-	P0300, P0351
Ignition Coil 2 Ground	-	P0300, P0352	-	P0300, P0352
Ignition Coil 3 Ground	-	P0300, P0353	-	P0300, P0353
Ignition Coil 4 Ground	-	P0300, P0354	-	P0300, P0354
Ignition Coil 5 Ground	-	P0300, P0355	-	P0300, P0355
Ignition Coil 6 Ground	-	P0300, P0356	-	P0300, P0356

Circuit/System Description

The ignition system on this engine uses an individual coil for each cylinder. The engine control module (ECM) controls the spark event for each cylinder through the 6 individual ignition control circuits. When the ECM commands the ignition control circuit ON, electrical current will flow through the primary winding of the ignition coil, creating a magnetic field. When a spark event is requested, the ECM will command the ignition control circuit OFF, interrupting current flow through the primary winding. The magnetic field created by the primary winding will collapse across the secondary coil windings, producing a high voltage across the spark plug electrodes. The ECM uses information from the crankshaft position sensor, and the camshaft position sensor for sequencing and timing of the spark events. The ECM monitors each ignition control circuit for improper voltage levels.

Conditions for Running the DTC

- The engine is cranking or running.
- Ignition voltage greater than 5 V.

The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match.

Action Taken When the DTC Sets

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315 and P2316 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0351, P0352, P0353, P0354, P0355, P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315 and P2316 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 26792 HEI Spark Tester

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

1. Engine Running.
2. Verify the scan tool parameters listed below do not display Malfunction:
   - Ignition Coil 1-6 Control Circuit High Voltage Test Status
   - Ignition Coil 1-6 Control Circuit Low Voltage Test Status
   - Ignition Coil 1-6 Control Circuit Open Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTCs. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

4. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the appropriate T8 Ignition Coil. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal A and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 5 Ω**
3. Verify the scan tool Ignition Coil Control Circuit Low Voltage Test Status does not display Malfunction.
    - **If Malfunction is displayed**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the control circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If Malfunction is not displayed**
4. Verify the scan tool Ignition Coil Control Circuit High Voltage Test Status does not display Malfunction.
    - **If Malfunction is displayed**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage in the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If Malfunction is not displayed**
5. Ignition OFF, install a 3 A fused jumper wire between the control circuit terminal C and ground, engine Running.
6. Verify the scan tool Ignition Coil Control Circuit Low Voltage Test Status displays Malfunction.
    - **If Malfunction is not displayed**
    1. Ignition OFF, remove the fused jumper, and disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω, replace the K20 Engine Control Module.
- **If Malfunction is displayed**

7. Test or replace the T8 Ignition Coil.

Component Test

NOTE: **You must perform the Circuit/System Testing before proceeding with Component Testing.**

1. Ignition OFF, connect the **EL 26792** HEI spark tester to the appropriate T8 Ignition Coil.
2. Engine Running.
3. Verify the spark output of the T8 Ignition Coil.
   - **If no output or the output is weak**

     Replace the T8 Ignition Coil.

   - **If the output is normal**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0420 OR P0430: CATALYST SYSTEM LOW EFFICIENCY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0420

Catalyst System Low Efficiency Bank 1

DTC P0430

Catalyst System Low Efficiency Bank 2

Circuit/System Description

A 3-way catalytic converter (TWC) controls emissions of hydrocarbons, CO and NOx. The catalyst within the converter promotes a chemical reaction, which oxidizes the hydrocarbons and the CO that are present in the

exhaust gas. This process converts the hydrocarbons and the CO into water vapor and CO2, and reduces the NOx, converting the NOx into nitrogen. The TWC also stores oxygen. The ECM monitors this process by using a heated oxygen sensor (HO2S) that is in the exhaust stream after the TWC. The HO2S 2 produces an output signal that the ECM uses to calculate the oxygen storage capacity of the catalyst. This indicates the ability of the catalyst to convert the exhaust emissions efficiently. The ECM monitors the efficiency of the catalyst by allowing the catalyst to heat, then wait for a stabilization period while the engine is idling. The ECM then adds and removes fuel while monitoring the HO2S 2. When the catalyst is functioning properly, the HO2S 2 response to the extra fuel is slow compared to the response of the HO2S 1, which is located before the TWC. When the HO2S 2 response is near that of the HO2S 1, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

Conditions for Running the DTC

- DTC P0016, P0017, P0018, P0019, P0053, P0054, P0059, P0060, P0068, P0090, P0091, P0092, P00C8, P00C9, P00CA, P0101, P0102, P0103, P0112, P0113, P0116, P0117, P0118, P0119, P0121, P0122, P0123, P0128, P0131, P0132, P0133, P0135, P0137, P0138, P013A, P013B, P013C, P013D, P013E, P013F, P0140, P0141, P014A, P014B, P0151, P0152, P0153, P0155, P0157, P0158, P0160, P0161, P0171, P0172, P0174, P0175, P0191, P0192, P0193, P0222, P0223, P0300, P0301. P0302, P0303, P0304, P0305, P0306, P0335, P0336, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0443, P0506, P0507, P0606, P1153, P16F3, P2101, P2122, P2123, P2127, P2128, P2135, P2138, P2227, P2228, P2229, P2230, P2270, P2271, P2272, or P2273 is not set.
- Before the ECM performs the idle test, the vehicle must be driven under the following conditions:
  - The engine speed is greater than 965 RPM
  - The engine run time is greater than a calibrated value
  - Both conditions exist for greater than 15 s
- The throttle is in the rest position.
- The Intake Air Temperature (IAT) is between -20 to +250Â°C (-4 to +482Â°F).
- The ignition voltage is greater than 11 V.
- The Engine Coolant Temperature (ECT) is between 40-127Â°C (104-261Â°F).
- The Barometric Pressure (BARO) is greater than 70 kPa.
- The engine has been idling less than 50 s.
- The vehicle speed is less than 2 km/h (1 mph).
- The short term fuel trim is learned.
- The air flow into the engine is between 3-13 g/s.
- The Evaporative Emission (EVAP) purge concentration is learned.
- The catalytic converter calculated temperature is between 450-850Â°C (842-1,562Â°F).
- The engine is operating in Closed Loop.
- The transmission is not in P/N (automatic transmission only).

This diagnostic attempts one test during each valid idle period once the above conditions have been met. This diagnostic attempts up to 8 tests during each drive cycle.

Conditions for Setting the DTC

The ECM determines that the efficiency of the catalyst has degraded below a calibrated threshold.

Action Taken When the DTC Sets

DTC P0420 and P0430 are Type A DTCs.

Conditions for Clearing the DTC

DTC P0420 and P0430 are Type A DTCs.

Diagnostic Aids

Inspect for the following conditions, which may cause a catalytic converter to degrade:

- An engine misfire
- High engine oil or high coolant consumption
- Retarded spark timing
- A weak or poor spark
- A lean fuel mixture
- A rich fuel mixture
- A damaged oxygen sensor or wiring harness

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that no other DTCs are set.
    - If a DTC is set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.
2. Operate the vehicle within the Conditions for Running the DTC while observing the scan tool TWC Mon. Off Idle Test Conditions Met parameter. The parameter will change to Yes when the Off Idle Conditions have been met.
    - If not the specified value, operate the vehicle within the Off Idle Conditions.
3. When the parameter has changed to Yes and the conditions are safe, stop and idle the vehicle in gear.
4. Apply the service brake.
5. Monitor the scan tool TWC Monitor Test State parameter. When the parameter indicates Active, the TWC Monitor Test is running.
6. Continue to monitor the parameter. When the parameter indicates Inactive, the TWC Monitor Test has completed.
7. When the test has completed, the TWC Monitor Test Count parameter will increment by one and the TWC Monitor Test Result parameter will indicate Passed, Failed or No Decision.
    - If No Decision is indicated, repeat steps 2-6 until the Test Result parameter indicates Passed or

Failed.

Circuit/System Testing

1. Verify the following conditions do not exist with the appropriate catalytic converter:
    - Dents
    - Severe discoloration caused by excessive temperatures
    - Road damage
    - Internal rattles caused by damaged catalyst substrate
    - Restrictions
        - If a condition is found, replace the catalytic converter.
2. Verify the following conditions do not exist with the exhaust system:
    - Leaks
    - Physical damage
    - Loose or missing hardware
        - If a condition is found, repair the exhaust system.
3. Verify the following conditions do not exist with the appropriate B52B heated oxygen sensor 2:
    - The HO2S is not at the correct torque
    - Damage
        - If a condition is found, replace the B52B heated oxygen sensor 2 as necessary.
4. If all physical conditions test normal, test or replace the catalytic converter.

Repair Instructions

NOTE: **A new converter with less than 100 miles on it may set DTC P0420 or P0430 due to out-gassing of the internal matting. Operating the vehicle at highway speeds for approximately 1 hour may correct the condition.**

- **Exhaust Leakage**
- **Restricted Exhaust**
- **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2**
- **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2**
- Perform the HO2S Heater Learn procedure with a scan tool after replacing the Heated Oxygen Sensor.
- **Catalytic Converter Replacement - Left Side (Front)**
- **Catalytic Converter Replacement - Right Side (Rear)**

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.
3. Clear the DTCs with a scan tool.
4. Turn OFF the ignition for 60 s

5. Operate the vehicle within the Conditions for Running the DTC while observing the scan tool TWC Mon. Off Idle Test Conditions Met parameter. The parameter will change to Yes when the Off Idle Conditions have been met.
    - If not the specified value, operate the vehicle within the Off Idle Conditions.
6. When the parameter has changed to Yes and the conditions are safe, stop and idle the vehicle in gear.
7. Apply the service brake.
8. Monitor the scan tool TWC Test State parameter. When the parameter indicates Active, the TWC Monitor Test is running.
9. Continue to monitor the parameter. When the parameter indicates Inactive, the TWC Monitor Test has completed.
10. When the test has completed, the TWC Monitor Test Count parameter will increment by one and the TWC Monitor Test Result parameter will indicate Passed, Failed or No Decision.
    - If No Decision is indicated, repeat steps 5-9 until the Test Result parameter indicates Passed or Failed.
11. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not reset. If the DTC resets or another DTC is present, refer to the **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

DTC P0442: EVAPORATIVE EMISSION (EVAP) SYSTEM SMALL LEAK DETECTED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0442

Evaporative Emission (EVAP) System Small Leak Detected

Circuit/System Description

The engine off natural vacuum test is the small leak detection diagnostic for the evaporative emission (EVAP) system. This diagnostic tests the EVAP system for a small leak when the key is turned OFF and the correct conditions are met. Heat from the exhaust system is transferred into the fuel tank while the vehicle is operating. When the vehicle is turned OFF and the EVAP system is sealed a change in the fuel tank vapor temperature occurs which results in a corresponding pressure change in the fuel tank vapor space. This change is monitored by the engine control module (ECM) using the fuel tank pressure sensor input. With a leak in the system, the amount of pressure change will be less than that of a sealed system.

Conditions for Running the DTC

- DTCs P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0125, P012B, P012C, P012D, P0128, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0502, P0503, P0722, P0723, P2227, P2228, P2229, P2610 are not set.

- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant sensor (ECT) is greater than 70Â°C (158Â°F)
- No key cycle during engine off natural vacuum or test will abort.
- The fuel level is between 10-90%.
- The start-up engine coolant temperature (ECT) and the start-up intake air temperature (IAT) are within 8Â°C (14Â°F).
- The engine run time before shut-off was greater than 10 min.
- The drive distance before engine shut-off was more than 8 km (5 mi).
- The ambient air temperature at the end of the drive cycle is between 0-34Â°C (32-93Â°F).
- DTC P0442 runs once per drive cycle during the hot soak period after the ignition is turned OFF and may require up to 40 min to complete. The controller will not make more than 2 test attempts per day. The time since the last completed engine off natural vacuum test must be at least 17 h if passed or 10 h if failed.

Conditions for Setting the DTC

- The ECM detects a leak in the EVAP system that is greater than a calibrated amount.
- The ECM must complete several engine off natural vacuum tests before the diagnostic can turn the MIL on or off.

Action Taken When the DTC Sets

DTC P0442 is a Type A DTC.

Conditions for Clearing the DTC

DTC P0442 is a Type A DTC.

Diagnostic Aids

- The EVAP system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. When injecting smoke at the service port tool remove the fuel fill cap, or temporarily leave the EVAP Vent Solenoid Valve open, until smoke is observed then close the system and continue testing. If using a fuel cap adapter at the filler neck, use the **EN 41413-VLV** at the service port to allow the system to fill faster.
- To help locate intermittent leaks using the **GE 41413-A** , move all EVAP components while observing smoke with the **GE 41413-SPT** .
- Individual components can be isolated and tested using adapters in the **GE 41413-300** .
- When servicing the EVAP system, test pressure must not exceed 13 in H20 (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.
- A condition may exist where a leak in the EVAP system only exists under a vacuum condition. This type of leak may be detected by using the scan tool EVAP Purge/Seal function to create a vacuum in the EVAP system and then observe the Fuel Tank Pressure Sensor parameter for vacuum decay.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096** EVAP Service Port Access Tool
- **EN 41413-VLV** EVAP Service Port Vent Fitting
- **GE 41413-A** Evaporative Emissions System Tester (EEST)
- **GE 41413-300** EVAP Cap and Plug Kit
- **GE 41413-SPT** High Intensity White Light

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Testing

NOTE:

- **Refer to the GE 41413-A operation manual for detailed instructions in Evaporative Emission System Diagnosis.**
- **Larger volume fuel tanks and/or those with lower fuel levels may require several minutes for the floating indicator to stabilize or produce smoke from a leak.**
- **Ensure that the underbody temperature of the vehicle and the tester are similar.**

1. Disconnect the purge tube at the quick connector on the EVAP canister side of the Q12 Evaporative Emission Canister Purge Solenoid Valve and install the **CH 48096** .
2. Connect the **GE 41413-A** to the **CH 48096** .
3. Command the EVAP Purge/Seal function to System Seal or Not Venting with a scan tool to seal the EVAP system.
4. Use the flow meter on the **GE 41413-A** calibrated to 0.51 mm (0.020 in) to determine if there is a leak.
    - **If a leak is detected**
    1. Use the **GE 41413-A** to apply smoke to the EVAP system at the purge tube service port until the leak is located using the **GE 41413-SPT**
        - If leak is detected, repair or replace the affected component as necessary.
    - **If no leak is detected**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

DTC P0443, P0458, OR P0459: EVAPORATIVE EMISSION (EVAP) PURGE SOLENOID VALVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0443

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit

DTC P0458

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit Low Voltage

DTC P0459

Evaporative Emission (EVAP) Purge Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Ignition	P0443, P0458	P0443	P0690
Control	P0443, P0458	P0443, P0458	P0459, P0690

Circuit/System Description

The evaporative emission (EVAP) purge solenoid valve is used to purge fuel vapor from the EVAP canister to

the intake manifold. The EVAP purge solenoid valve is pulse width modulated (PWM). Ignition voltage is supplied directly to the EVAP purge solenoid valve. The engine control module (ECM) controls the solenoid valve by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. A scan tool will display the amount of ON time as a percentage.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.
- The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0443

The ECM detects the EVAP purge solenoid valve control circuit is open within 0.25 s.

P0458

The ECM detects the EVAP purge solenoid valve control circuit is shorted to ground within 0.25 s.

P0459

The ECM detects the EVAP purge solenoid valve control circuit is shorted to voltage within 0.25 s.

Action Taken When the DTC Sets

DTC P0443, P0458 and P0459 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0443, P0458 and P0459 are Type B DTCs.

Diagnostic Aids

- The audible clicking intensity will vary depending on mounting locations and interference with the fuel injectors clicking. You may also feel a change in the frequency of clicking.
- Verify the EVAP Purge Solenoid Valve control circuit parameters do not display Malfunction when moving the related harnesses and connectors of the Q12 Evaporative Emission Purge Solenoid Valve.
- Use a hand vacuum pump to verify the purge solenoid actually flows vacuum during the dynamic testing.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify DTC P0690 is not set.
   - **If the DTC is set**

     Refer to **DTC P0685-P0687, P0689, P0690, or P1682**

   - **If the DTC is not set**
2. Verify the control circuit status parameters listed below do not display Malfunction while commanding the EVAP Purge Solenoid Valve from 0% to 50% and back to 0% with a scan tool:
   - EVAP Purge Solenoid Valve Control Circuit Open Test Status
   - EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status
   - EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing

   - **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing

   - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve, ignition ON.
2. Verify that a test lamp illuminates between the ignition voltage circuit terminal A or 1 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, remove the test lamp.
    2. Test for infinite resistance between the ignition circuit and ground
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, test all components connected to the ignition voltage circuit for a short and replace as necessary.
    - **If the test lamp illuminates**
3. Verify that a test lamp does not illuminate between the ignition circuit terminal A or 1 and the control circuit terminal B or 2.
    - **If the test lamp illuminates**
    1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If the test lamp does not illuminate**
4. Remove the test lamp.
5. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the EVAP Purge Solenoid Valve to 50% with a scan tool.
    - **If OK is not displayed**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If OK is displayed**
6. Install a 3 A fused jumper wire between the control circuit terminal B or 2 and the ignition circuit terminal A or 1.
7. Verify the scan tool EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the EVAP Purge Solenoid Valve to 50% with a scan tool.
    - **If Malfunction is not displayed**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.

2. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω replace the K20 Engine Control Module.
- **If Malfunction is displayed**

8. Test or replace the Q12 Evaporative Emission Purge Solenoid Valve.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve.
2. Test for 10-30 Ω between the control terminal B or 2 and the ignition circuit terminal A or 1.
    - **If not between 10-30 Ω**

      Replace the Q12 Evaporative Emission Purge Solenoid Valve.

    - **If between 10-30 Ω**
3. All OK.

Dynamic Test

1. Ignition OFF, disconnect the harness connector at the Q12 Evaporative Emission Purge Solenoid Valve.
2. Install a 3 A fused jumper wire between the ignition, terminal A or 1 and 12 V. Install a jumper wire between the control terminal B or 2 and ground.
3. Verify the Evaporative Emission Purge Solenoid Valve turns on & off/clicks and flows vacuum.
    - **If it does not turn on & off/click or flow vacuum.**

      Replace the Q12 Evaporative Emission Purge Solenoid Valve.

    - **If it does turns on & off/clicks and flows vacuum.**
4. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Evaporative Emission Canister Purge Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, programming and setup

DTC P0446: EVAPORATIVE EMISSION (EVAP) VENT SYSTEM

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0446

Evaporative Emission (EVAP) Vent System Performance

Typical Scan Tool Data

Fuel Tank Pressure Sensor Signal Voltage	Fuel Tank Pressure
1.5 V	Atmospheric Pressure / BARO
Less than 1.5 V	Positive Pressure
Greater than 1.5 V	Negative Pressure / Vacuum

Circuit/System Description

This DTC tests the evaporative emission (EVAP) system for a restricted or blocked EVAP vent path that would cause excess amounts of vacuum to be developed in the EVAP system. The engine control module (ECM) commands the EVAP purge solenoid valve Open and the EVAP vent solenoid valve Closed. This allows vacuum to be applied to the EVAP system. Once a calibrated vacuum level has been reached, the ECM commands the EVAP purge solenoid valve Closed and the EVAP vent solenoid valve Open. The ECM monitors the fuel tank pressure (FTP) sensor for a decrease in vacuum. If the vacuum does not decrease to near 0 in H2O in a calibrated time, this DTC sets.

The following table illustrates the relationship between the ON and OFF states, and the OPEN or CLOSED states of the EVAP purge and vent solenoid valves.

ECM Command	EVAP Purge Solenoid Valve	EVAP Vent Solenoid Valve
ON	Open	Closed
OFF	Closed	Open

Conditions for Running the DTC

- DTC P0068, P00C8, P00C9, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0121, P0122, P0123, P0128, P0191, P0192, P0193, P0222, P0223, P0443, P0601, P0604, P0606, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2176, is not set.
- The ignition voltage is between 11-32 V.
- The start up IAT is between 4-30Â°C (39-86Â°F).
- The start up ECT is less than 35Â°C (95Â°F)
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10-90%.
- This test will start and run once per cold start for no greater than 17 min.

Conditions for Setting the DTC

NOTE: **There are two stages to setting this DTC. Stage one, prep test, then stage two test.**

- If the fuel tank pressure sensor reading is less than -3.0 kPa (-12 in) H2O of vacuum for 5 s before 6 L (1.6 gal) of purge volume.

OR

- If the fuel tank pressure sensor reading is greater than 0.62 kPa (2.5 in) H2O of pressure or less than -1.24 kPa (-5 in) H2O of vacuum for 60 s.
- After setting the DTC for the first time, 2 L (0.5 gal) of fuel must be consumed before setting the DTC for the second time.

Action Taken When the DTC Sets

DTC P0446 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0446 is a Type B DTC.

Diagnostic Aids

An intermittent condition could be caused by:

- A damaged EVAP vent housing
- A temporary blockage at the EVAP vent solenoid valve inlet
- A pinched vent hose
- A blockage in the vent system may also cause a poor fuel fill problem.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 41415-30** Fuel Tank Cap Adapter
- **GE 41413-A** Evaporative Emissions System Tester
- **GE 41415-60** Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0449 is not set.
   - **If the DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If the DTC is not set**
3. Ignition OFF, remove the fuel tank filler cap or install GE 41415-60 for capless vehicles. Ignition ON.
4. Verify the scan tool Fuel Tank Pressure Sensor voltage parameter is within 1.3-1.7 V.
   - **If not between the 1.3-1.7 V**

     Refer to P0452, P0453 within **DTC P0451-P0454**.

   - **If between the 1.3-1.7 V**
5. Install the fuel tank filler cap or remove the GE 41415-60. Engine idling at operating temperature for 5 min,
6. Verify the scan tool Fuel Tank Pressure Sensor parameter does not increase to greater than 2.5 V when commanding the EVAP Purge Solenoid Valve to 50%.
   - **If greater than 2.5 V**

     Refer to Circuit System Testing.

   - **If 2.5 V or less**
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/failure Records data.
   - **If the DTC sets**

     Refer to Circuit System Testing.

   - **If the DTC does not set**
8. All OK.

Circuit/System Testing

NOTE: Perform the Circuit/System Verification before proceeding with the Circuit/System Testing.

1. Verify a blockage or restriction does not exist in the EVAP system components listed below.
   - Evaporative Emission Vent System Hoses
   - Evaporative Emission Canister
   - Q13 Evaporative Emission Vent Solenoid Valve
   - Evaporative Emission Vent Filter
   - **If a condition exists**

     Repair or replace the component as necessary

   - **If none of the conditions exist**
2. Reconnect all previously disconnected EVAP hardware.

NOTE: Refer to the GE 41413-A operation manual for detailed instructions in Evaporative Emission System Diagnosis.

3. Remove the fuel fill cap and connect the CH 41415-30 to the fuel tank filler neck or install GE 41415-60 on capless fuel fill vehicles. Connect the GE 41413-A to the CH 41415-30 or GE 41415-60.
4. Ignition ON, command the EVAP Purge/Seal function to System Seal or Not Venting with a scan tool to seal the EVAP system.
5. Turn the nitrogen/smoke valve on the GE 41413-A to nitrogen.

NOTE: DO NOT exceed the specified value in this step. Exceeding the specified value may produce incorrect test results.

6. Use the remote switch to activate the GE 41413-A and pressurize the fuel tank to 5.0 in H20.
7. Verify the scan tool Fuel Tank Pressure Sensor parameter is 0 in H20 when commanding the EVAP Vent Solenoid Valve to OFF or Venting.
   - **If not 0 in H20**
   1. Ignition OFF
   2. Verify a blockage or a restriction does not exist in the EVAP vent hose or inlet.
      - **If a condition exists**

        Repair or replace the component as necessary

      - **If none of the conditions exist**

        Replace the Q13 Evaporative Emission Vent Solenoid Valve

   - **If 0 in H20**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

- **If the DTC sets**

  Refer to step 1 above.

- **If the DTC does not set**

9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Evaporative Emission Canister Replacement**
- **Fuel Tank Pressure Sensor Replacement (E-85)** **Fuel Tank Pressure Sensor Replacement (E-10)**

DTC P0449, P0498, OR P0499: EVAPORATIVE EMISSION (EVAP) VENT SOLENOID VALVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0449

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit

DTC P0498

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit Low Voltage

DTC P0499

Evaporative Emission (EVAP) Vent Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
B+	P0449, P0498	P0449	-
Control	P0449, P0498	P0449	P0499

Circuit/System Description

Battery voltage is supplied to the evaporative emission (EVAP) vent solenoid valve through a fuse. The engine control module (ECM) grounds the EVAP vent solenoid valve control circuit through an internal switch called a driver. The ECM monitors the status of the driver. A scan tool will display the commanded state of the EVAP vent solenoid valve as ON (Not Venting) or OFF (Venting).

Conditions for Running the DTC

The DTCs run continuously once the above conditions are met.

Conditions for Setting the DTC

P0449

The ECM detects the EVAP Vent Solenoid Valve control circuit is open within 0.25 s.

P0498

The ECM detects the EVAP Vent Solenoid Valve control circuit is shorted to ground within 0.25 s.

P0499

The ECM detects the EVAP Vent Solenoid Valve control circuit is shorted to voltage within 0.25 s.

Action Taken When the DTC Sets

DTC P0449, P0498 and P0499 are Type B DTCs.

Conditions for Clearing the DTC

DTC P0449, P0498 and P0499 are Type B DTCs.

Diagnostic Aids

- An audible click may be heard when performing verification step 2 below.
- Verify the EVAP Vent Solenoid Valve control circuit parameters do not display Malfunction when moving the related harnesses and connectors of the Q13 Evaporative Emission Vent Solenoid Valve

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the control circuit status parameters listed below do not display Malfunction while commanding the EVAP Vent Solenoid Valve to ON (Not Venting) and OFF (Venting) with a scan tool:
   - EVAP Vent Solenoid Valve Control Circuit Open Test Status
   - EVAP Vent Solenoid Valve Control Circuit Low Voltage Test Status
   - EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing

   - **If Malfunction is not displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing

   - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q13 Evaporative Emission Vent Solenoid Valve, Ignition ON,
2. Verify that a test lamp illuminates between the B+ circuit terminal A or 2 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF, remove the test lamp.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF, remove the test lamp.
2. Test for infinite resistance between the B+ circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, test all components connected to the B+ circuit for a short and replace as necessary.

- **If the test lamp illuminates**

3. Verify that a test lamp does not illuminate between the B+ circuit terminal A or 2 and the control circuit terminal B or 1.

- **If the test lamp illuminates**

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the control circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K20 Engine Control Module.

- **If the test lamp does not illuminate**

4. Remove the test lamp.
5. Verify the scan tool EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status parameter is OK when commanding the EVAP Vent Solenoid Valve to ON (Not Venting) with a scan tool.

- **If OK is not displayed**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If OK is displayed**

6. Install a 3 A fused jumper wire between the control circuit terminal B or 1 and the B+ circuit terminal A or 2.
7. Verify the scan tool EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status parameter is Malfunction when commanding the EVAP Vent Solenoid Valve to ON (Not Venting) with a scan tool.

- **If Malfunction is not displayed**

1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω replace the K20 Engine Control Module.

- **If Malfunction is displayed**

8. Test or replace the Q13 Evaporative Emission Vent Solenoid Valve.

Component Testing

1. Ignition OFF, disconnect the harness connector at the Q13 Evaporative Emission Vent Solenoid Valve.
2. Test for 10-30 Ω between the control terminal B or 1 and the B+ circuit terminal A or 2.

- **If not between 10-30 Ω**

  Replace the Q13 Evaporative Emission Vent Solenoid Valve.

- **If between 10-30 Ω**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Evaporative Emission Canister Vent Solenoid Valve Replacement**
- **Control Module References** for ECM replacement, programming and setup

DTC P0451-P0454: FUEL TANK PRESSURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0451

Fuel Tank Pressure Sensor Performance

DTC P0452

Fuel Tank Pressure Sensor Circuit Low Voltage

DTC P0453

Fuel Tank Pressure Sensor Circuit High Voltage

DTC P0454

Fuel Tank Pressure Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5 V Reference	P018C, P0192, P0452, P0522, P0532, P0641, P2227,	P0451	P0446, P0452	P018D, P0193, P0453, P0523, P0641, P2227	-

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
	P2228				
Signal	P0452	P0451	P0452, P0453	P0453	P0451, P0454
Low Reference	-	P0446, P0451	P0446, P0453, P0463	-	P0451

Typical Scan Tool Data

Fuel Tank Pressure Sensor Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF **Parameter Normal Range:** 1.3-1.7 V			
5 V Reference	0 V	0 V	4.2-5 V
Signal	0 V	0 V	5 V
Low Reference	-	4.96 V	-

Circuit/System Description

The fuel tank pressure sensor measures vapor pressure or vacuum in the evaporative emission (EVAP) system. The engine control module (ECM) supplies a 5 V reference and a low reference circuit to the fuel tank pressure sensor. The fuel tank pressure sensor signal voltage varies depending on EVAP system pressure or vacuum. The controller also uses this fuel tank pressure signal to determine atmospheric pressure for use in the engine-off small leak test, DTC P0442. Before using this signal as an atmospheric reference it must first be re-zeroed.

Conditions for Running the DTC

P0451

- DTC P0451 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- The number of times this test runs can range from 0-2 per engine-off period. The length of the test can be up to 10 min.

P0452 and P0453

DTC P0452 and P0453 run continuously when the ignition is ON.

P0454

- DTC P0454 runs only when the engine-off natural vacuum small leak test, P0442, executes.
- This test can run once per engine-off period. The length of the test can be up to 10 min.
- A refueling event is not detected. A refueling event is confirmed if the fuel level has a persistent change of 10% for 30 s during a 10 min refueling rationality test.

Conditions for Setting the DTC

P0451

This DTC will set if the controller is unable to re-zero the fuel tank pressure sensor voltage within a calibrated range during the engine-off small leak test, P0442.

P0452

The fuel tank pressure sensor voltage is less than 0.15 V for more than 10 s.

P0453

The fuel tank pressure sensor voltage is more than 4.9 V for more than 10 s.

P0454

If, during the engine-off natural vacuum small leak test, P0442, the ECM detects an abrupt fuel tank pressure signal change, other than a refueling event, this DTC will set. An abrupt change is defined as a change of greater than 0.45 in H2O in the span of 1 s but less than 1 in H2O in 12.5 ms. This test must fail twice to set this DTC.

Action Taken When the DTC Sets

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0451 and P0454 are Type A DTCs.
- DTCs P0452 and P0453 are Type B DTCs.

Diagnostic Aids

P0451 and P0454

- A restriction in the EVAP canister or vent lines could prevent fuel vapor pressure from bleeding off fast enough. If the vent system cannot bleed off pressure fast enough, the re-zero procedure may not complete successfully, which could cause this code to set.
- Ensure that the reference port on the fuel tank pressure sensor is unobstructed.
- A fuel tank pressure sensor that is skewed or does not have a linear transition from low to high may cause this code to set. Scan tool output controls, snapshot, and plot functions can help detect erratic sensor response. To test the sensor signal under vacuum conditions, use the Quick Snapshot and the Purge/Seal functions to capture data while commanding purge to 20%, then plot or review the data to look for erratic sensor operation. A similar test can be done for the pressure side of the sensor operation by applying pressure with the **GE 41413-A** while taking a snapshot or reviewing stored data.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **GE 41413-A** Evaporative Emission System Tester (EEST)
- **GE 41415-60** Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)**

Circuit/System Verification

1. Remove the fuel cap or install GE 41415-60 for capless fuel fill vehicles.
2. Ignition ON, engine OFF.
3. Verify the scan tool Fuel Tank Pressure Sensor parameter is between 1.3 and 1.7 V.
    - **If not between 1.3-1.7 V**

      Refer to Circuit/System Testing

    - **If between 1.3-1.7 V**
4. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF. Disconnect the harness connector at the B150 Fuel Tank Pressure Sensor. This may take up to 2 min, for all vehicle systems to power down. .
2. Test for less than 5 Ω of resistance between the low reference circuit terminal 2 and ground.

- **If 5 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If less than 5 Ω**

3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
    - **If less than 4.8 V**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

    - **If greater than 5.2 V**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, Ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.

    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
    - **If between 4.8-5.2 V**

5. Verify the scan tool Fuel Tank Pressure Sensor parameter is less than 0.2 V.
    - **If 0.2 V or greater**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, Ignition ON
    2. Test for less than 1 V between the signal circuit terminal 1 and ground.

    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
    - **If less than 0.2 V**

6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3.
7. Verify the scan tool Fuel Tank Pressure Sensor parameter is greater than 4.7 V.
    - **If 4.7 V or less**

    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K20 Engine Control Module.
- **If greater than 4.7 V**

8. Test or replace the B150 Fuel Tank Pressure Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for ECM replacement, programming and setup
- **Fuel Tank Pressure Sensor Replacement (E-85)** **Fuel Tank Pressure Sensor Replacement (E-10)**

DTC P0455: EVAPORATIVE EMISSION (EVAP) SYSTEM LARGE LEAK DETECTED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0455

Evaporative Emission (EVAP) System Large Leak Detected

Circuit/System Description

The engine control module (ECM) tests the evaporative emission (EVAP) system for a large leak or restrictions to the purge path in the EVAP system. When the enabling criteria has been met, the ECM commands the EVAP vent solenoid valve and purge solenoid valve ON, allowing vacuum into the EVAP system. The ECM monitors the fuel tank pressure sensor voltage to verify that the system is able to reach a calibrated level of vacuum before a calibrated amount of purge volume has passed through the system.

Conditions for Running the DTC

- DTCs P0068, P00C8, P00C9, P00CA, P0090, P0091, P0092, P0106, P0107, P0108, P0111, P0112, P0113, P0114 P0116, P0117, P0118, P0122, P0123, P0125, P0128, P0191, P0192, P0193, P0222, P0223, P06A3, P06DB, P06DE, P0A1D, P160D, P160E P1682, P16A0, P16A1, P16A2, P16F3, P1104, P127A, P127C, P127D, P15F2, P0443, P0449, P0452, P0453, P0502, P0503, P0601, P0604, P0606, P0697, P2100, P2101, P2102, P2103, P2122, P2123, P2127, P2128, P2135, P2138, P215B, P2176, P228C, P228D, U0073, U0074, U0293 or U1817 are not set.
- The ignition voltage is between 11-32 V.
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10-90%.
- The cold startup engine coolant temperature (ECT) and the startup intake air temperature (IAT) are within 8Â°C (14Â°F).
- The startup engine coolant temperature (ECT) is less than 35Â°C (95Â°F).

- The startup intake air temperature (IAT) is between 4-34Â°C (39-93Â°F).
- DTC P0455 runs once per cold start, shortly after purge is enabled followed by vent system performance test P0446.

Conditions for Setting the DTC

- The EVAP system is not able to achieve or maintain a calibrated level of vacuum less than -2.74 kPa (-11 in H20) before a calibrated amount of purge volume has passed through the system.
- After setting the DTC for the first time, 2 L (0.5 gal) of fuel must be consumed before setting the DTC for the second time.

NOTE: **The weak vacuum follow-up test and Driver Information Center message is disabled on capless fuel fill systems.**

-
- With a DTC P0455 detected a weak vacuum follow-up test (fuel cap replacement test) will run and passes if tank vacuum is greater than 2.74 kPa (11 in H20). This test will run for a maximum of 22 min. This test runs until it passes.

Action Taken When the DTC Sets

DTC P0455 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0455 is a Type B DTC.

Diagnostic Aids

- Inspect for a loose, missing, damaged, or incorrect fuel fill cap.
- On capless fuel fill systems inspect for damaged seals on the flapper valves.
- Inspect for a damaged fuel filler neck and seal surface.
- A blockage or restriction in the EVAP Purge Solenoid Valve, purge pipe, EVAP canister, or vapor pipe, can cause this DTC to set.
- The EVAP system can be filled with smoke more quickly and completely by opening the system opposite the end where the smoke is injected. For example, when injecting smoke at the service port remove the fuel fill cap, or temporarily leave the vent open, until smoke is observed, then close the system and continue testing. If using a fuel cap or capless fuel fill adapter at the filler neck, use the **J 41413-VLV** at the service port to allow the system to fill faster.
- To help locate intermittent leaks using the **GE 41413-A** , move all EVAP components while observing smoke with the **GE 41413-SPT** .
- Individual components can be isolated and tested using adapters in the **J 41413-300** .
- When servicing the EVAP system, test pressure must not exceed 13 in H20 (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.
- A condition may exist where a leak in the EVAP system only exists under a vacuum condition. This type of leak may be detected by using the scan tool Purge/Seal function to create a vacuum in the EVAP system and then observe the Fuel Tank Pressure Sensor parameter for vacuum decay.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48096** EVAP Service Access Port Tool
- **GE 41415-30** Fuel Tank Cap Adapter
- **GE 41413-A** Evaporative Emissions System Tester
- **GE 41413-SPT** High Intensity White Light
- **GE 41415-60** Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter
- **J 41413-300** EVAP Cap and Plug Kit
- **J 41413-311** EVAP Plug (Brass Nozzle)
- **J 41413-VLV** EVAP Service Port Vent Fitting

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)**

Circuit/System Testing

IMPORTANT:
- Larger volume fuel tanks and/or those with lower fuel levels may require several minutes

for the floating indicator to stabilize or produce smoke from a leak.

- Refer to the **GE 41413-A** operation manual for detailed instructions in Evaporative Emission System Diagnosis.

1. Disconnect the purge tube at the quick connector on the EVAP canister side of the Q12 Evaporative Emission Purge Solenoid Valve and install the **CH 48096** .
2. Connect the **GE 41413-A** to the vehicle EVAP service access port adapter.
3. Command the EVAP Purge/Seal function to System Seal or Not Venting with a scan tool to seal the EVAP system.
4. Verify that there is no leak in the EVAP system using the flow meter on the **GE 41413-A** , calibrated to 0.51 mm (0.020 in).
   - **If a leak is detected**
   1. Apply smoke to the EVAP system at the service access port adapter with the **GE 41413-A** .
   2. Locate the leak using the **GE 41413-SPT** .
      - When the leak is located, repair or replace the affected component as necessary.
   - **If no leak detected**

NOTE: **The steps below test for a restriction in the purge path.**

5. Connect the **GE 41413-A** nitrogen/smoke hose to the **J 41413-311** .
6. Disconnect the hose at the fuel cap end of the **GE 41415-30** and connect to the **J 41413-311** . Capless fuel fill vehicles will need to use **GE 41415-60** connected to **GE 41413-A** .
7. Install the **GE 41415-30** , filler neck end only, to the vehicle.
8. Engine idling, command the Purge/Seal function to System Seal or Not Venting with a scan tool to seal the system.
9. Command the EVAP Purge Solenoid Valve to 30% with a scan tool.
10. Verify the vacuum/pressure gauge on the **GE 41413-A** and the scan tool Fuel Tank Pressure Sensor parameter both show vacuum.
    - **If the vacuum/pressure gauge shows vacuum but the Fuel Tank Pressure Sensor parameter does not show vacuum**

      Replace the B150 Fuel Tank Pressure Sensor.

    - **If both do not show vacuum**

      Repair the restriction in the purge path.

    - **If both show vacuum**
11. Verify that the Fuel Tank Pressure Sensor parameter increases to greater than 3.2 V, and the pressure values are similar between the scan tool Fuel Tank Pressure Sensor and the vacuum/pressure gauge on the **GE 41413-A** .
    - **If not within the specified range**

Replace the B150 Fuel Tank Pressure Sensor.

- **If within the specified range**

12. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for ECM replacement, programming and setup
- **Fuel Tank Pressure Sensor Replacement (E-85)** **Fuel Tank Pressure Sensor Replacement (E-10)**

DTC P0496: EVAPORATIVE EMISSION (EVAP) SYSTEM FLOW DURING NON-PURGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0496

Evaporative Emission (EVAP) System Flow During Non-Purge

Circuit/System Description

This DTC tests for undesired intake manifold vacuum flow to the evaporative emission (EVAP) system. The engine control module (ECM) seals the EVAP system by commanding the EVAP purge solenoid valve OFF and the vent solenoid valve ON. The ECM monitors the fuel tank pressure (FTP) sensor to determine if a vacuum is being drawn on the EVAP system. If vacuum in the EVAP system is greater than a predetermined value within a predetermined time, this DTC sets.

The following table illustrates the relationship between the ON and OFF states, and the Open or Closed states of the EVAP purge and vent solenoid valves.

ECM Command	EVAP Purge Solenoid Valve	EVAP Vent Solenoid Valve
ON	Open	Closed
OFF	Closed	Open

Conditions for Running the DTC

- DTCs P0068, P00C8, P00C9, P00CA, P0090, P0091, P0092, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0122, P0123, P0125, P0128, P0191, P0192, P0193, P0222, P0223, P0601, P0604, P0606, P0697, P06A3, P06DB, P06DE, P0A1D, P1104, P127A, P127C, P127D, P15F2, P160D, P160E, P1682, P16A0, P16A1, P16A2, P16F3, P0443, P0449, P0452, P0453, P0454, P0502, P0503, P0722, P0723, P2100, P2101, P2102, P2103, P2122, P2123, P2127, P2128, P2135, P2138, P215B, P2176, P228C, P228D, U0073, U0074, U0293, U1817, are not set.
- The ignition voltage is between 11-32 V.

- The engine OFF time is greater than 48 min,
- The barometric pressure (BARO) is greater than 70 kPa.
- The fuel level is between 10-90%.
- The startup engine coolant temperature (ECT) is less than 35Â°C (95Â°F).
- The startup intake air temperature (IAT) is between 4-34Â°C (39-93Â°F).
- DTC P0496 runs once per cold start, for up to 17 min, when the above conditions are met.This test will run with the purge valve and the vent valve closed.

Conditions for Setting the DTC

The ECM detects greater than 10 in H2O vacuum for 5 s during a non-purge condition.

Action Taken When the DTC Sets

DTC P0496 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P0496 is a Type B DTC.

Diagnostic Aids

An intermittent condition could be caused by:

- An improperly installed or damaged EVAP Purge Solenoid Valve
- A temporary blockage or restriction in the EVAP Purge Solenoid Valve

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Powertrain Component View

Powertrain Component Views

Description and Operation

Evaporative Emission Control System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
2. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing

   - **If the DTC does not set**
3. All OK

Circuit/System Testing

1. Ignition ON, engine OFF.
2. Command the EVAP Purge/Seal function to System Seal or Not Venting with a scan tool to seal the EVAP system.
3. Start the engine.
4. Observe the Fuel Tank Pressure Sensor with a scan tool. The Fuel Tank Pressure Sensor parameter should be less than 1.7 V after 90 s.
   - **If not within specifications**

     Replace the Q12 Evaporative Emission Purge Solenoid Valve

   - **Within Specifications**
5. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Evaporative Emission Canister Purge Solenoid Valve Replacement

DTC P0506 OR P0507: IDLE SPEED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0506

Idle Speed Low

DTC P0507

Idle Speed High

Circuit/System Description

The throttle actuator control (TAC) motor is a DC motor that is part of the throttle body assembly. The TAC motor drives the throttle valve. The engine control module (ECM) controls the TAC motor based on throttle position sensor input. The idle speed is controlled by the ECM based on various inputs. The ECM commands the TAC motor to open or close the throttle valve in order to maintain the desired idle speed.

Conditions for Running the DTC

- DTCs P0068, P0101, P0102, P0103, P0112, P0113, P0117, P0118, P0121, P0122, P0123, P0171, P0172, P0174, P0175, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268. P0270, P0271, P0273, P0274, P0276, P0277, P0300-P0306, P0351-P0356, P0461-P0464, P0496, P0627, P0628, P0629, P0722, P1516, P2066-P2068, are not set.
- The barometric pressure (BARO) is greater than 70 kPa.
- The engine coolant temperature (ECT) is greater than 60Â°C (140Â°F).
- The engine run time is greater than 60 s.
- The ignition voltage is between 11-32 V.
- The transmission is not changing gears.
- The torque converter clutch (TCC) is not changing states.
- The intake air temperature (IAT) is warmer than -20Â°C (-4Â°F).
- The vehicle speed is less than 3 km/h (2 mph).
- The commanded engine speed is steady within 25 RPM.
- The engine is idling for greater than 5 s.
- The DTCs run when the above conditions are met.

Conditions for Setting the DTC

P0506

The actual engine speed is 94 RPM less than the desired idle speed for 10 s.

P0507

The actual engine speed is 188 RPM greater than the desired idle speed for 10 s.

Action Taken When the DTC Sets

DTCs P0506 and P0507 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P0506 and P0507 are Type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify there are no other DTCs set.
    - **If any other DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

    - **If no other DTCs are set**
3. Verify the scan tool Throttle Body Idle Airflow Compensation parameter is less than 90 %.
    - **If 90 % or greater**

      Refer to **Throttle Body Inspection and Cleaning** .

    - **If less than 90 %**

4. Engine Idling at the normal operating temperature.
5. Verify the actual Engine Speed is not 100 RPM less than the Desired Idle Speed.
    - **If 100 RPM less than the Desired Idle Speed**

      Refer to Circuit/System Testing.

    - **If 100 RPM greater than the Desired Idle Speed**
6. Verify the actual Engine Speed is not 200 RPM greater than the Desired Idle Speed.
    - **If 200 RPM greater than the Desired Idle Speed**

      Refer to Circuit/System Testing.

    - **If 200 RPM less than the Desired Idle Speed**
7. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
8. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
9. All OK

Circuit/System Testing

P0506

1. Verify the conditions listed below do not exist.
    - Restricted exhaust
    - Mechanical conditions that limits engine speed
    - Parasitic load on the engine-For example, a transmission condition, a belt driven accessory condition.
    - **If a condition is found**

      Repair as necessary.

    - **If a condition is not found**
2. All OK.

P0507

1. Verify the conditions listed below do not exist.
    - Vacuum leaks
    - A throttle valve that does not close correctly
    - Verify the correct operation of the crankcase ventilation system. Inspect for the conditions listed below:

- Improper routing of the positive crankcase ventilation (PCV) system
- Vacuum leaks in the PCV system-Refer to **Crankcase Ventilation System Inspection/Diagnosis** .

- **If a condition is found**

  Repair as necessary.

- **If a condition is not found**

2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Throttle Body Assembly Replacement

DTC P050D: COLD START ROUGH IDLE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P050D

Cold Start Rough Idle

Circuit/System Description

During a cold start, the Engine Control Module (ECM) commands dual-pulse mode during Open Loop operation to improve cold start emissions. In dual-pulse mode, the Fuel Injectors are energized twice during each injection event. As with misfire diagnosis, in dual-pulse mode the ECM monitors the crankshaft position sensor and the camshaft position sensors to calculate crankshaft rotation speed. In normal operation, optimum fuel delivery during dual-pulse mode produces a steady crankshaft rotation speed. If the variations exceed a calibrated value, the code will be set.

Conditions for Running the DTC

- DTCs P0010, P0011, P0013, P0014, P0016, P0017, P0018, P0019, P0020, P0021, P0023, P0024, P0089, P0090-P0092, P00C6, P00C8, P00C9, P00CA, P0101-P0103, P0106-P0108, P0112-P0114, P0116-P0118, P0121-P0123, P0128, P0192, P0193, P0201-P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0315, P0335, P0336, P0351-P0356, P0627-P0629, P069E, P0716, P0717, P0722, P0723, P0850-P0852, P1248, P1249, P124A, P124B, P124C, P124D, P1258, P135A, P135B, P150C, P163A, P1762, P1763, P1915, P2122, P2123, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P228C, P228D, U0109 are not set.
- The catalyst temperature is less than 100Â°C (212Â°F).

- The engine coolant temperature is warmer than 10Â°C (14Â°F).
- The barometric pressure is greater than 70 kPa.
- The engine speed is between 450-1800 RPM.
- The engine is running and a cold start has been detected.
- DTC P050D runs once per cold start.

Conditions for Setting the DTC

This DTC will set if the Engine Control Module detects variations in crankshaft rotation speed caused by the lack of adequate fuel delivery during dual-pulse mode.

Action Taken When the DTC Sets

- DTC P050D is a Type B DTC.
- The Engine Control Module disables dual pulse mode and energizes the fuel injector as it would for a warm engine.

Conditions for Clearing the DTC

DTC P050D is a Type B DTC.

Diagnostic Aids

- This DTC may be set with a misfire DTC, however the existence of this DTC is a higher priority and indicates the condition to diagnose is related to fuel and/or injectors, not the ignition/spark system.
- A restricted Fuel Injector may cause this DTC to set.
- High resistance in the circuits of the Fuel Injectors could set this DTC without setting a Fuel Injector DTC. Test the Fuel Injector circuits of the affected cylinders for a high resistance if you suspect a condition.
- A drop in system voltage during cold start may set this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: **Circuit/System Testing requires cold start. Do not start vehicle prior to connecting scan tool and preparing to evaluate the condition during engine crank.**

1. Start the engine and observe the Cylinder 1-6 Current Misfire Counters during the first 500 engine cycles. The Cylinder 1-6 Current Misfire Counters should not be incrementing.
    - **If the misfire counters are incrementing on one or more cylinders**
    1. Ignition OFF.
    2. Verify that the following conditions do not exist:
        - Fuel pressure that is too low or too high-Refer to **Fuel System Diagnosis**.
        - Contaminated fuel-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
        - If a condition exist, repair as necessary.
        - If none of the conditions exist, replace the Q17 Fuel Injectors as indicated by high misfire counts.
    - **If the misfire counters are not incrementing**
2. All OK.

Repair Instructions

- **Fuel Injection Fuel Rail Assembly Replacement - Bank 1**
- **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**

Repair Verification

NOTE: **Repair Verification requires cold start.**

1. Ignition ON, engine OFF, clear the DTCs with a scan tool.
2. Start the engine.
3. Verify the DTC does not reset.

DTC P05CC-P05CF: COLD START INTAKE CAMSHAFT POSITION SYSTEM

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P05CC

Cold Start Intake Camshaft Position System Performance Bank 1

DTC P05CD

Cold Start Intake Camshaft Position System Performance Bank 2

DTC P05CE

Cold Start Exhaust Camshaft Position System Performance Bank 1

DTC P05CF

Cold Start Exhaust Camshaft Position System Performance Bank 2

Circuit/System Description

The camshaft position actuator system enables the Engine Control Module (ECM) to change the timing of the camshafts while the engine is operating. The camshaft position actuator solenoid signal from the ECM is Pulse Width Modulated (PWM). The ECM controls the camshaft position actuator solenoid duty cycle by controlling the amount of solenoid On time. The camshaft position actuator solenoid controls the advance or the retard of each camshaft. The camshaft position actuator solenoid controls the oil flow that applies the pressure to advance or retard the camshafts.

Conditions for Running the DTC

- DTC P0010, P0016, P0017, P0018, P0019, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366, P0390 or P0391, is not set.
- The ignition voltage is greater than 11 V.
- The engine is running.
- The desired camshaft position is greater than 0 degrees.
- The desired camshaft position is not changing greater than 4.5Â° for at least 1 s.
- Both of the desired and actual camshaft position actuator values cannot be greater than 20 degrees or less than 5 degrees.
- DTCs P05CC, P05CD, P05CE, and P05CF run continuously once the above conditions are met.

Conditions for Setting the DTC

The ECM detects the difference between the desired and actual camshaft position angle is greater than 4.5 degrees for greater 1 s.

Action Taken When the DTC Sets

DTCs P05CC, P05CD, P05CE, and P05CF are type B DTCs.

Conditions for Clearing the DTC

DTCs P05CC, P05CD, P05CE, and P05CF are type B DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Camshaft Actuator System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Diagnostic Aids

- Verify the correct engine oil type and viscosity were used during recent oil changes.
- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this DTC. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain can cause this DTC to set.

Circuit/System Verification

NOTE:

- **Correct engine oil type and viscosity are critical to the performance of the camshaft position actuator system.**
- **The engine oil level and the oil pressure are critical to the correct operation of the camshaft position actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.**

- **The engine oil condition has a major impact on the camshaft actuator system. Debris in the oil can interfere with the camshaft position actuator solenoid and the mechanical camshaft actuator operation. Inspect for dirty or degraded crankcase oil. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life Remaining parameter. Advise the customer an oil change may be required.**

1. Ignition On.
2. Verify the engine has the correct oil level and the correct oil pressure.
   - **If the oil level and the oil pressure are not correct**

     Repair as necessary

   - **If the oil level and the oil pressure are correct**

NOTE: **If a crankshaft or camshaft position sensor DTC is set, the scan tool Camshaft Position Actuator output control will not function.**

3. Verify DTC P0010, P0016, P0017, P0018, P0019, P0335, P0336, P0340, P0341, P0345, P0346, P0365, P0366,P0390 or P0391, is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

   - **If none of the DTCs are set**
4. Engine idling at normal operating temperature.
5. Verify the scan tool parameters are less than 2Â° in each of the commanded states when commanding the Camshaft Position Actuator from 0Â° to maximum range and back to 0Â° with the scan tool.
   - Intake Camshaft Position Variance Bank 1
   - Exhaust Camshaft Position Variance Bank 1
   - Intake Camshaft Position Variance Bank 2
   - Exhaust Camshaft Position Variance Bank 2
   - **If 2Â° or greater**

     Refer to Circuit/System Testing.

   - **If less than 2Â°**
6. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
   - **If any DTC sets**

     Refer to Circuit/System Testing.

- **If a DTCs does not set**

7. All OK.

Circuit/System Testing

NOTE: **If debris is found on CMP screens, clean the screens and reinspect for damage. If the screens are not damaged, reinstall in the engine.**

1. Remove the Q6 Camshaft Position Actuator Solenoid Valve and verify the following conditions do not exist:
   - Torn, mis-positioned, or missing screens at the CMP actuator solenoid
   - Engine oil leak between the oil sealing lands of the CMP actuator solenoid-Inspect the lands of the CMP actuator solenoid for nicks.
   - Oil seepage at the CMP actuator solenoid connector
   - **If a condition is found**

     Replace the Q6 Camshaft Position Actuator Solenoid Valve.

   - **If no condition is found**

NOTE: **After swapping the solenoids, install jumper wires to the appropriate terminals of the harness connectors and the solenoids.**

2. Ignition Off, swap the intake or exhaust Q6 Camshaft Position Actuator Solenoid Valve with the Q6 Camshaft Position Actuator Solenoid Valve that is operating correctly.
3. Engine idling.
4. Verify the scan tool Camshaft Position Variance parameter is less than 2Â° in each of the commanded states when commanding the Camshaft Position Actuator from 0Â° to maximum range and back to 0Â° with a scan tool.
   - **If 2Â° or greater**

     Replace the mechanical camshaft position actuator.

   - **If less than 2Â°**
5. Test or replace the Q6 Camshaft Position Actuator Solenoid Valve.

Component Testing

1. Ignition Off, disconnect the harness connector at the appropriate Q6 Camshaft Position Actuator Solenoid Valve.
2. Test for 5-12 Ω between the control circuit terminal 1 and the low reference circuit terminal 2 of the Q6 Camshaft Position Actuator Solenoid Valve.
   - **If not between the specified values**

     Replace the Q6 Camshaft Position Actuator Solenoid Valve.

   - **If between the specified values**

3. Test for infinite resistance between each terminal and the Q6 Camshaft Position Actuator Solenoid Valve housing.
    - **If less than infinite resistance**

      Replace the Q6 Camshaft Position Actuator Solenoid Valve.

    - **If infinite resistance**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Camshaft Position Actuator Replacement - Bank 1**
- **Camshaft Position Actuator Replacement - Bank 2**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P057B-P057D: BRAKE PEDAL POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P057B

Brake Pedal Position Sensor Performance

DTC P057C

Brake Pedal Position Sensor Circuit Low Voltage

DTC P057D

Brake Pedal Position Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P057C	P057C	P057D	P057B

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P057C P0651	P057C	P057D, P0651	-
Low Reference	-	P057D	P057D	-

Typical Scan Tool Data

Brake Pedal Position Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON. **Normal Range:** 0.25-4.75 V			
5 V Reference	0 V	0 V	-
Signal	0 V	0 V	5 V
Low Reference	-	5 V	-

Circuit/System Description

The brake pedal position (BPP) sensor is part of the engine brake pedal override feature. The engine control module (ECM) continuously monitors the vehicle speed and the position of the brake pedal. These two main inputs, along with other ECM inputs are used to determine if the vehicle is decelerating at the proper speed and rate with the brake pedal applied. When the engine brake pedal override system is active, the ECM reduces engine torque to assist in reducing vehicle speed.

The BPP sensor is a six wire sensor, and is part of a dual brake position sensor. One BPP Sensor is used for the stop lamps and the other BPP Sensor is used for the engine brake pedal override feature. The BPP Sensor for engine brake pedal override communicates with the ECM. The ECM supplies a 5 V reference circuit, low reference circuit, and signal circuit to the BPP sensor. The BPP sensor sends a voltage signal to the ECM on the signal circuit. The voltage on the signal circuit will vary from a voltage greater than 0.25 V when the brake pedal is released to a voltage less than 4.75 V when the brake pedal is fully applied.

For information on the Stop Lamps side of the BPP Sensor, refer to **Exterior Lighting Systems Description and Operation** .

Conditions for Running the DTC

P057B

- DTCs P057C, or P057D are not set.
- Ignition voltage is greater than 10 V.
- Shift lever has been in Park at least once during key ON.
- Shift lever is not in Park.
- Vehicle speed is greater than 8 Km/h (5 mph).
- Accelerator Pedal Position is less than 5 %.
- DTC runs once per key cycle when above conditions are met.

P057C or P057D

- Ignition voltage is greater than 10 V.
- DTC runs continuously when above condition is met.

Conditions for Setting the DTC

P057B

ECM detects the BPP sensor signal is stuck in a range for greater than 1 s.

P057C

ECM detects the BPP sensor voltage is less than 0.25 V greater than 1 s.

P057D

ECM detects the BPP sensor voltage is greater than 4.75 V greater than 1 s.

Action Taken When the DTC Sets

- P057B, P057C, and P057D are Type A DTCs.
- Brake Pedal Position Sensor parameter defaults to 0 %.

Conditions for Clearing the DTC

P057B, P057C, and P057D are Type A DTCs

Reference Information

Schematic Reference

- **Engine Controls Schematics**
- **Exterior Lights Schematics**

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **The Brake Pedal Position sensor scan tool data is located in the ECM automatic transmission data list.**

1. Ignition ON.
2. Verify DTC P0641, P0651, P0697, or P06A3 is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If none of the DTCs are set**
3. Transmission in Park, and service brake pedal released.
4. Verify the scan tool Brake Pedal Position Sensor parameter in the ECM displays greater than 0.25 V.
   - **If 0.25 V or less**

     Refer to Circuit/System Testing.

   - **If greater than 0.25 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter voltage changes as the brake pedal is applied and displays less than 4.75 V when the brake pedal is fully applied.
   - **If the voltage does not change, or is greater than 4.74 V**

     Refer to Circuit/System Testing.

   - **If the voltage changes and less than 4.75 V**
6. Verify the scan tool Brake Pedal Position Sensor Learned Release Position parameter is within 0.1 V of the Brake Pedal Position Sensor parameter when the brake pedal is fully released.
   - **If difference is greater than 0.1 V**

     Perform the **Brake Pedal Position Sensor Learn** .

   - **If difference is 0.1 V or less**
7. Verify the Brake Pedal Position Sensor parameter transitions smoothly without any spikes or dropouts when slowly applying and releasing the brake pedal.
   - **If parameter does not transition smoothly or has spikes or dropouts**

     Refer to Circuit/System Testing.

   - **If parameter transitions smoothly and there are no spikes or dropouts**
8. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
9. Verify the DTC does not set.

- **If the DTC sets**

  Refer to Circuit/System Testing.

- **If the DTC does not set**

10. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B22 Brake Pedal Position Sensor. It may take up to 2 minutes for all vehicle systems to power down.

NOTE: **All terminal references are for the vehicle harness brake pedal position sensor connector.**

2. Test for less than 10 Ω between the low reference circuit terminal 5 and ground.
   - **If 10 Ω or greater**
   1. Disconnect the X1 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 6 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance.
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 4.8-5.2 V**
5. Verify the scan tool Brake Pedal Position Sensor parameter is less than 0.25 V.

- **If 0.25 V or greater**

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 0.25 V between the signal circuit terminal 4 and ground.
    - If 0.25 V or greater, repair the short to voltage on the circuit.
    - If less than 0.25 V, replace the K20 Engine Control Module.

- **If less than 0.25 V**

6. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 6.
7. Verify the scan tool Brake Pedal Position Sensor parameter is greater than 4.8 V.
    - **If 4.8 V or less**

    1. Ignition OFF, remove the jumper wire, and disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 4 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance.
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.

    - **If greater than 4.8 V**

8. Replace the B22 Brake Pedal Position Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Brake Pedal Position Sensor Replacement**
- Perform the **Brake Pedal Position Sensor Learn** following the replacement of the ECM or BPP sensor, or any repair that effects the BPP sensor alignment.
- **Control Module References** for Engine Control Module replacement, programming and setup.

DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, OR P262B: CONTROL MODULE MEMORY/CONTROL MODULE PROCESSOR/CONTROL MODULE POWER OFF TIMER (ECM)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each of the diagnostic category.

DTC Descriptors

DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P062B

Control Module Fuel Injector Control Performance

DTC P062F

Control Module Long Term Memory Performance

DTC P0630

VIN Not Programmed or Mismatched - Engine Control Module (ECM)

DTC P16F3

Control Module Redundant Memory Performance

DTC P262B

Control Module Power Off Timer Performance

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed.

Conditions for Running the DTCs

P0601, P0602, P0630

These DTCs run continuously when the ignition is ON.

P0603, P062F

These DTCs run during ECM power up.

P0604

DTC P0604 runs continuously when the ignition is ON for greater than 30 s.

P0606, P062B

- The ignition is ON.
- The system voltage is greater than 11 V.
- These DTCs run continuously when the above conditions are met.

P16F3

- The engine speed is greater than 550 RPM.
- DTCs P0101, P0102, P0103, P0106, P0107, P0108, P2227, P2228, P2229, or P2230 are not set.
- DTC P16F3 runs continuously when the above conditions are met.

P262B

DTC P262B runs during ECM power down.

Conditions for Setting the DTCs

The ECM detects an internal failure or incomplete programming for more than 10 s.

Actions Taken When the DTC Sets

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630, and P16F3 are Type A DTCs.
- DTCs P062F and P262B are Type B DTCs.

Conditions for Clearing the MIL/DTC

- DTCs P0601, P0602, P0603, P0604, P0606, P062B, P0630, and P16F3 are Type A DTCs.
- DTCs P062F and P262B are Type B DTCs.

Diagnostic Aids

Low voltage or a momentary loss of power or ground to the ECM may cause a DTC to set. Verify the following:

- The battery cables are clean and tight, and the battery is fully charged. Refer to **Battery Inspection/Test** .
- The ECM ground circuits do not have an open or high resistance.
- The ECM power circuits do not have an open, short to ground, or high resistance.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, clear the DTC information with a scan tool.
2. Verify no other DTCs are set.
    - **If any other DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

    - **If no other DTCs are set**
3. Verify DTC P0602 or P0630 is not set.
    - **If any of the DTCs are set**
    1. Program the K20 Engine Control Module. Refer to **Control Module References** .
    2. Verify DTC P0602 or P0630 is not set.
        - If any of the DTCs are set, replace the K20 Engine Control Module.
        - If none of the DTCs are set
    3. All OK.
    - **If none of the DTCs are set**
4. Verify DTC P0601, P0603, P0604, P0606, P062B, P062F, P16F3, or P262B is not set.
    - **If any of the DTCs are set**

      Replace the K20 Engine Control Module.

    - **If none of the DTCs are set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for engine control module replacement, programming, and setup.

DTC P0628: FUEL PUMP ENABLE CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0628

Fuel Pump Enable Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Pump Enable	P0628, P069E	P069E	-	-

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the chassis control module whenever the engine is cranking or running. The engine control module enables the chassis control module as long as the engine is cranking or running, and ignition system reference pulses are received. While this enable voltage is being received, the chassis control module supplies a varying voltage to the fuel tank fuel pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

- The engine speed is greater than 0 RPM.
- The ignition voltage is greater than 11 V.
- The DTCs run continuously when the conditions above are met.

Conditions for Setting the DTC

- The engine control module detects that the commanded state of the driver and the actual state of the control circuit do not match.
- The above condition is met for a minimum of 2.5 s.

Action Taken When the DTC Sets

DTC P0628 is a Type B DTC.

Conditions for Clearing the DTC

DTC P0628 is a Type B DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below display OK or Not Run when commanding the Fuel Pump Enable ON and OFF with a scan tool.
    - Fuel Pump Enable Circuit Low Voltage Test Status
    - Fuel Pump Enable Circuit Open Test Status
    - Fuel Pump Enable Circuit High Voltage Test Status
    - **If OK or Not Run are not displayed**

      Refer to Circuit/System Testing.

    - **If OK or Not Run are displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle system OFF, disconnect the harness connector at the K38 Chassis Control Module. It may take up to 2 min for all vehicle systems to power down.

2. Test for less than 1 V between the K38 Chassis Control Module enable circuit terminal 13 and ground.
    - **If 1 V or greater**
    1. Disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Test for less than 1 V between the K38 Chassis Control Module enable circuit terminal 13 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, test or replace the K20 Engine Control Module.
    - **If less than 1 V**
3. Ignition ON, command the Fuel Pump Enable ON with a scan tool.
4. Test for B+ on the enable circuit terminal 13 of the K38 Chassis Control Module.
    - **If less than B+**
    1. Disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Test for infinite between the K38 Chassis Control Module enable circuit terminal 13 and ground.
        - If less than infinite, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω on the K38 Chassis Control Module enable circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, test or replace the K20 Engine Control Module.
    - **If B+**
5. Test or replace the K38 Chassis Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for K20 Engine Control Module or K38 Chassis Control Module replacement, programming, and setup.

DTC P0641 OR P06A6: 5V REFERENCE (CHASSIS CONTROL MODULE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0641

5V Reference Circuit

DTC P06A6

5V Reference 1 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P018C, P0641, P06A6	P018C	P018D, P0641, P06A6	P06A6
Signal	P018C	P018B, P018C	P018D	P018B
Low Reference	-	P0641, P06A6	-	P06A6

Circuit/System Description

The fuel pressure sensor is located on the fuel line. The fuel pressure sensor monitors the fuel pressure in the fuel line. The chassis control module monitors the voltage signal from the fuel pressure sensor.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The chassis control module detects that the fuel pressure 5 V reference is above or below a predetermined voltage threshold.

Action Taken When the DTC Sets

DTCs P0641 and P06A6 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0641 and P06A6 are Type A DTCs.

Diagnostic Aids

Using the failure records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the failure records can help determine how many miles since the DTC set. The fail counter and pass counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B47 Fuel Pressure Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K38 Chassis Control Module.
    - **If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal 3 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K38 Chassis Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K38 Chassis Control Module.
    - **If between 4.8-5.2 V**
5. Verify the scan tool Fuel Pressure Sensor Voltage parameter is less than 1 V.
    - **If 1 V or greater**

1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit terminal 1 and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K38 Chassis Control Module.

- **If less than 1 V**

6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and the 5 V reference circuit terminal 3, wait 15 seconds.
7. Verify the scan tool Fuel Pressure Sensor Voltage parameter is greater than 4.8 V.

- **If 4.8 V or less**

1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
2. Test for infinite resistance between the signal circuit terminal 1 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K38 Chassis Control Module.

- **If greater than 4.8 V**

8. Test or replace the B47 Fuel Pressure Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for chassis control module replacement, programming and setup

DTC P0641, P0651, P0697, OR P06A3: 5 V REFERENCE (ECM)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0641

5 V Reference 1 Circuit

DTC P0651

5 V Reference 2 Circuit

DTC P0697

5 V Reference 3 Circuit

DTC P06A3

5 V Reference 4 Circuit

Circuit/System Description

The engine control module (ECM) has 4 internal 5 V reference circuits. Each internal reference circuit provides external 5 V reference circuits for more than one sensor. A short to ground or short to voltage on one external 5 V reference circuit can affect all the other components connected to the same internal 5 V reference circuit.

Conditions for Running the DTC

- Ignition voltage is greater than 6.4 V.
- DTCs P0641, P0651, P0697, and P06A3 run continuously when the above condition is met.

Conditions for Setting the DTC

The 5 V reference circuit voltage is greater or less than a predetermined threshold.

Action Taken When the DTC Sets

DTCs P0641, P0651, P0697, and P06A3 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0641, P0651, P0697, and P06A3 are Type A DTCs.

Diagnostic Aids

DTC P0641

The 5 V reference 1 circuit provides 5 V to the following sensors:

- Fuel tank pressure sensor
- Multifunction intake air sensor
- Fuel rail pressure sensor
- A/C refrigerant pressure sensor
- All four camshaft position sensors

DTC P0651

The 5 V reference 2 circuit provides 5 V to the following sensors:

- Crankshaft position sensor
- Brake pedal position sensor
- Both secondary air injection pump solenoid valves (if equipped)

DTC P0697

The 5 V reference 3 circuit provides 5 V to the following sensors:

- Manifold absolute pressure sensor
- Accelerator pedal position sensor 2

DTC P06A3

The 5 V reference 4 circuit provides 5 V to the following sensors:

- Throttle position sensor
- Accelerator pedal position sensor 1

It may be possible to locate the fault by disconnecting one component at a time from the 5 V reference circuit while viewing the 5 V Reference Circuit parameter on the scan tool. The scan tool parameter will change from Fault to OK when the source of the fault is disconnected.

If all 5 V reference components have been disconnected and a fault is still indicated, the fault may exist in the wiring harness.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the DTC information with a scan tool. DTC P0641, P0651, P0697, or P06A3 should not set.
2. Observe the circuit status parameters listed below:
    - 5 V Reference 1 Circuit Status
    - 5 V Reference 2 Circuit Status

- 5 V Reference 3 Circuit Status
- 5 V Reference 4 Circuit Status

  Each parameter should display OK.

3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

NOTE: Additional DTCs will set when disconnecting the components.

1. Ignition OFF, disconnect the harness connector of all appropriate sensors for the applicable DTC. Refer to Diagnostic Aids.
2. Ignition ON, test for 4.8-5.2 V between one of the affected 5 V reference circuits and ground.
   - If the voltage is less than the specified range, test for a short to ground on the 5 V reference circuit for each of the affected components. If all circuits test normal, replace the K20 engine control module.
   - If the voltage is greater than the specified range, test for a short to voltage on the 5 V reference circuit for each of the affected components. If all circuits test normal, replace the K20 engine control module.

NOTE: A short to voltage on the signal circuit of certain components may cause this DTC to set.

3. Connect each component associated with the affected 5 V reference circuit one at a time while monitoring the appropriate scan tool 5 V Reference Voltage parameter. Verify the voltage remains 4.8-5.2 V.
   - If not within the specified range when a component is connected, test the signal circuit of that component for a short to voltage. If the circuit tests normal, replace the component.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accelerator Pedal Position Sensor Replacement**
- **Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement**
- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake**
- **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust**
- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake**
- **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust**
- **Crankshaft Position Sensor Replacement**
- **Fuel Pressure Sensor Replacement - Fuel Injection Fuel Rail**
- **Fuel Tank Pressure Sensor Replacement (E-85)** **Fuel Tank Pressure Sensor Replacement (E-10)**
- **Manifold Absolute Pressure Sensor Replacement**
- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement**

- Secondary Air Injection Bypass Valve Replacement - Bank 2
- Secondary Air Injection Bypass Valve Replacement - Bank 1
- Throttle Body Assembly Replacement
- Control Module References for engine control module replacement, setup, and programming

DTC P0650, P263A, OR P263B: MALFUNCTION INDICATOR LAMP

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptor

DTC P0650

Malfunction Indicator Lamp (MIL) Control Circuit Open

DTC P263A

Malfunction Indicator Lamp (MIL) Control Circuit Low Voltage

DTC P263B

Malfunction Indicator Lamp (MIL) Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0650	P0650	-	-
Control	P0650, P263A*	P0650, P263A	P263B	-
* The MIL remains ON				

Circuit/System Description

The malfunction indicator lamp (MIL) illuminates to inform the driver that an emission system fault has occurred and the powertrain control system requires service. Ignition voltage is supplied directly to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit when the emission system fault occurs. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

Conditions for Running the DTC

- The engine speed is greater than 80 RPM.
- The ignition voltage is between 11-32 V.
- The DTCs run continuously when the above conditions are met .

Conditions for Setting the DTC

DTC P0650 or DTC P263A

The ECM detects low voltage during the MIL control circuit driver OFF state. This indicates either a shorted to ground or an open MIL control circuit.

DTC P263B

The ECM detects high voltage on the MIL control circuit during the driver ON state. This indicates a shorted to voltage MIL control circuit.

Action Taken When the DTC Sets

DTC P0650, P263A, and P263B are Type B DTCs.

Conditions for Clearing the DTC

DTC P0650, P263A, and P263B are Type B DTCs.

Diagnostic Aids

- If the condition is intermittent, move the related harnesses and connectors while monitoring the scan tool MIL control circuit status parameters. Perform this test with the ignition ON and the engine OFF, and with the engine running. The MIL control circuit status parameters will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.
- If the ECM detects low voltage on the MIL control circuit during the MIL control circuit driver OFF state, DTCs P0650 and DTC P263A may set simultaneously.

Reference Information

Schematic Reference

- **Engine Controls Schematics**
- **Instrument Cluster Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - The MIL Control Circuit Low Voltage Test Status
    - The MIL Control Circuit Open Test Status
    - The MIL Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **If Malfunction is not displayed**
3. Engine running.
4. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - The MIL Control Circuit Low Voltage Test Status
    - The MIL Control Circuit Open Test Status
    - The MIL Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **If Malfunction is not displayed**
5. Verify the malfunction indicator lamp turns ON and OFF when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - **If the malfunction indicator lamp does not turn ON and OFF**

      Refer to Circuit/System Testing.

    - **If the malfunction indicator lamp turns ON and OFF**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
    - **If the DTC sets**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

    - **If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Ignition OFF.
2. Disconnect the X1 harness connector at the K20 Engine Control Module.

3. Ignition ON, verify the malfunction indicator lamp does not illuminate.
    - **If the malfunction indicator lamp illuminates**
    1. Test for infinite resistance between the control circuit terminal X1 46 and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, replace the P16 Instrument Cluster.
    - **If the malfunction indicator lamp does not illuminate**
4. Connect a 3 A fused jumper wire between the control circuit terminal X1 46 and ground.
5. Verify the malfunction indicator lamp illuminates.
    - **If the malfunction indicator lamp illuminates**

      Replace the K20 Engine Control Module.

    - **If the malfunction indicator lamp does not illuminate**
    1. Test for less than 1 V between the control circuit terminal X1 46 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    2. Ignition OFF.
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω.
6. Ignition OFF, disconnect the harness connector at the instrument cluster.
7. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 20 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the ignition voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ignition voltage circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - **If the test lamp illuminates**
8. Replace the P16 Instrument Cluster.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Instrument Cluster Replacement**
- **Control Module References** for control module replacement, programming, and setup

DTC P0685-P0687, P0689, P0690, OR P1682: ENGINE CONTROLS IGNITION RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0685

Engine Controls Ignition Relay Control Circuit

DTC P0686

Engine Controls Ignition Relay Control Circuit Low Voltage

DTC P0687

Engine Controls Ignition Relay Control Circuit High Voltage

DTC P0689

Engine Controls Ignition Relay Feedback Circuit Low Voltage

DTC P0690

Engine Controls Ignition Relay Feedback Circuit High Voltage

DTC P1682

Ignition 1 Switch Circuit 2

Diagnostic Fault Information

Powertrain Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Relay Coil Supply Voltage	-	P0685, P0689, P1682	-
Relay Control Circuit	P0686, P0690	P0685, P0686, P1682	P0685, P0687, P0689, P1682
Relay Feedback Circuit	P0689, P1682	P0689, P1682	P0690

Ignition Main Relay

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Ignition 1 Signal, Ignition Main Relay	1	1	2
1. No Crank condition. 2. Engine continues to operate with ignition OFF.			

Typical Scan Tool Data

Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status - Component Commanded OFF

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded OFF **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Short Gnd test and Not Run for Short Volts test • Component ON - Not Run for Open/Short Gnd test and OK for Short Volts test			
Battery Voltage	Fault	Fault	-
Engine Controls Ignition Relay Control Circuit	Fault	Fault	Not Run

Engine Controls Ignition Relay Control Circuit Low Voltage, Open, and High Voltage Test Status - Component Commanded ON

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Component commanded ON **Parameter Normal Range:** The following illustrates the normal parameter state with no circuit conditions: • Component OFF - OK for Open/Short Gnd test and Not Run for Short Volts test • Component ON - Not Run for Open/Short Gnd test and OK for Short Volts test			
Battery Voltage	Not Run	Not Run	-
Engine Controls Ignition Relay Control Circuit	Not Run	Not Run	Fault

Circuit/System Description

There are 2 ignition voltage circuits supplied to the engine control module (ECM). One is supplied by the powertrain relay and the other is supplied by the ignition main relay. The ECM monitors and compares the ignition voltage supplied by the two relays.

Conditions for Running the DTC

P0685, P0686, P0687

- The ignition is ON.
- The ignition voltage is greater than 11 V.
- The DTC runs continuously when the above conditions are met.

P0689

- The powertrain relay is commanded ON.
- The ignition voltage is greater than 11 V.
- DTC P0685 is not set.

- The DTC runs continuously when the above conditions are met.

P0690

- The powertrain relay is commanded OFF.
- DTC P0685 is not set.
- The DTC runs continuously when the above conditions are met.

P1682

- The powertrain relay is commanded ON.
- The ignition voltage is greater than 5.5 V.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P0685

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 s.

P0686

The ECM detects a short to ground on the control circuit for greater than 2 s.

P0687

The ECM detects a short to voltage on the control circuit for greater than 2 s.

P0689

The engine controls ignition relay feedback voltage is less than 5 V for greater than 5 s.

P0690

- The ECM detects the engine controls ignition relay feedback circuit is greater than 4 V when the relay is commanded OFF.
- The condition is present for greater than 2 s.

P1682

The ECM detects that there is greater than 3 V difference between the ignition main relay signal and the powertrain relay signal circuits for less than 1 s.

Action Taken When the DTC Sets

- DTC P1682 is a Type A DTC.
- DTCs P0685, P0686, P0687, and P0690 are Type B DTCs.
- DTC P0689 is a Type C DTC.

Conditions for Clearing the DTC

- DTC P1682 is a Type A DTC.
- DTCs P0685, P0686, P0687, and P0690 are Type B DTCs.
- DTC P0689 is a Type C DTC.

Diagnostic Aids

The powertrain relay may also be labeled the engine controls ignition relay, the engine control module relay, or the main relay. The ignition main relay may also be labeled the run/crank relay, the ignition 1 relay, the ignition run relay, or the ignition relay.

Reference Information

Schematic Reference

- **Engine Controls Schematics**
- **Power Distribution Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Electrical Center Identification Views**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **A short to voltage on other components may cause DTC P0690 to set. If other DTCs are set, diagnose those DTCs first.**
- **If you were sent here from Engine Cranks But Does Not Run proceed to Circuit/System Testing.**

1. Ignition ON, observe the DTC information with a scan tool. DTC P0685, P0686, P0687, P0689, P0690, or P1682 should not set.
2. Ignition ON, observe the scan tool Ignition 1 Voltage Signal and the Engine Controls Ignition Relay

Feedback Signal parameters. There should be less than 3 V difference between the two parameters.

3. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification before proceeding with Circuit/System Testing, unless sent here from Engine Cranks But Does Not Run.

1. Ignition OFF, disconnect the powertrain relay.
2. Verify that a test lamp illuminates between ground and the relay circuit terminals listed below:
   - Terminal 85
   - Terminal 30
   - If the test lamp does not illuminate, test the relay battery voltage circuit for an open/high resistance.

NOTE: High resistance in the circuit/underhood fuse block for either the powertrain relay or the ignition main relay can cause DTC P1682 to set.

3. Ignition ON, verify that a test lamp does not illuminate between the ignition voltage circuit terminal 87 and ground.
   - If the test lamp illuminates, test the ignition voltage circuit for a short to voltage.
4. Connect a 20 A fused jumper wire between the relay switch B+ circuit terminal 30 and the relay switch ignition voltage circuit terminal 87.
5. Ignition ON, observe the scan tool Engine Controls Ignition Relay Feedback Signal parameter. The K20 Engine Control Module should communicate, and the parameter should display B+.
   - If not the specified value, or the K20 Engine Control Module does not communicate, test the ignition voltage circuit between the powertrain relay and the K20 Engine Control Module for a short to ground or for an open/high resistance. If the circuit/connections test normal, replace the K20 Engine Control Module.
6. Ignition OFF, connect a DMM set to the diode setting between control circuit terminal 86 and ground. Verify the DMM displays OL.
   - If not the specified value, test the control circuit for a short to ground. If the circuit tests normal, replace the K20 Engine Control Module.
7. Ignition ON, verify the DMM displays less than 1 V.
   - If not the specified range, test the control circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the K20 Engine Control Module.
8. If all circuits test normal, replace the powertrain relay.

Component Testing

1. Remove the powertrain relay.

NOTE: Depending on the application, the relay coil resistance will be within one of the following ranges.

2. Test for one of the following resistance specifications between terminals 85 and 86 of the powertrain relay:
    - 70-110 Ω
    - 200-250 Ω
    - If not within the specified range, replace the powertrain relay.
3. Test for infinite resistance between the following terminals of the powertrain relay:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If not the specified value, replace the powertrain relay.
4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.
    - If greater than the specified range, replace the powertrain relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for engine control module replacement, programming, and setup.

DTC P069E: FUEL PUMP CONTROL MODULE REQUESTED MIL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** Prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P069E

Fuel Pump Control Module Requested MIL Illumination

Circuit/System Description

The fuel pump control module constantly monitors the fuel pump control system for any condition which may adversely affect vehicle emissions. If a condition is detected, the fuel pump control module sets a DTC and sends a serial data message to the engine control module (ECM). The ECM sets DTC P069E to inform the technician that the fuel pump control module has set the emission related DTC. The serial data message sent by the fuel pump control module also contains a request for the ECM to illuminate the malfunction indicator lamp (MIL).

The technician can observe the DTC that was set by the fuel pump control module by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating

conditions present when the fuel pump control module DTC set.

Conditions for Running the DTC

The ignition is ON, or the engine is running for greater than 3 s.

Conditions for Setting the DTC

The ECM receives a serial data message from the fuel pump control module indicating that an emission related DTC has set in the fuel pump control module.

Action Taken When the DTC Sets

- DTC P069E is a Type A DTC.
- DTC P069E will continue to be current or active as long as the fuel pump control module is requesting MIL illumination.

Conditions for Clearing the DTC

DTC P069E is a Type A DTC.

Diagnostic Aids

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the fuel pump control module will cause the fuel pump control module to request DTC P069E to be set in the ECM.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **Do not replace the engine control module for this DTC. DTC P069E is an informational DTC.**
- **Correct any engine control and communication DTCs before diagnosing fuel pump control module DTCs.**

1. Verify there are no engine control or communication DTCs set.
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If a DTC is not set**
2. Verify there are no fuel pump control module DTCs set.
   - **If a DTC is set**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If a DTC is not set**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If the DTC does not set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

DTC P0700: TRANSMISSION CONTROL MODULE REQUESTED MIL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each of the diagnostic category.

DTC Descriptor

DTC P0700

Transmission Control Module Requested MIL Illumination

Circuit/System Description

The transmission control module (TCM) constantly monitors the transmission system for any condition which may adversely affect vehicle emissions. If a condition is detected, the TCM sets a DTC and sends a serial data message to the engine control module (ECM). The ECM sets DTC P0700 to inform the technician that the TCM has set the emission related DTC. The serial data message sent by the TCM also contains a request for the ECM to illuminate the malfunction indicator lamp (MIL).

The technician can observe the DTC that was set by the TCM by reviewing the ECM Freeze Frame records on the scan tool. The ECM Freeze Frame records also contain the engine operating conditions present when the transmission DTC set.

Conditions for Running the DTC

- The ignition is ON or the engine is operating.
- DTC P0700 runs continuously.

Conditions for Setting the DTC

The ECM receives a serial data message from the TCM indicating that an emission related DTC has set in the TCM.

Action Taken When the DTC Sets

DTC P0700 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P0700 is a Type A DTC.

Diagnostic Aids

Communication codes, U-codes, as well as powertrain codes, P-codes, set in the TCM can cause the TCM to request DTC P0700 to be set in the ECM.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **Do not replace the engine control module for this DTC. DTC P0700 is an informational DTC.**
- **Correct any engine controls and communication DTCs before diagnosing transmission control module DTCs.**

1. Verify there are no engine control or communication DTCs set.
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If a DTC is not set**
2. Verify there are no transmission control module DTCs set.
   - **If a DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If a DTC is not set**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If the DTC does not set**

5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

DTC P1248-P124D: CYLINDER INJECTOR HIGH CONTROL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1248

Cylinder 1 Injector High Control Circuit Shorted to Control Circuit

DTC P1249

Cylinder 2 Injector High Control Circuit Shorted to Control Circuit

DTC P124A

Cylinder 3 Injector High Control Circuit Shorted to Control Circuit

DTC P124B

Cylinder 4 Injector High Control Circuit Shorted to Control Circuit

DTC P124C

Cylinder 5 Injector High Control Circuit Shorted to Control Circuit

DTC P124D

Cylinder 6 Injector High Control Circuit Shorted to Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Supply Cylinder 1	P2147	P0201	P2148	P1248

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit to Control Circuit
Direct Fuel Injector High Voltage Control Cylinder 1	P0261	P0201	P0262	P1248
Direct Fuel Injector High Voltage Supply Cylinder 2	P2150	P0202	P2151	P1249
Direct Fuel Injector High Voltage Control Cylinder 2	P0264	P0202	P0265	P1249
Direct Fuel Injector High Voltage Supply Cylinder 3	P2153	P0203	P2154	P124A
Direct Fuel Injector High Voltage Control Cylinder 3	P0267	P0203	P0268	P124A
Direct Fuel Injector High Voltage Supply Cylinder 4	P2156	P0204	P2157	P124B
Direct Fuel Injector High Voltage Control Cylinder 4	P0270	P0204	P0271	P124B
Direct Fuel Injector High Voltage Supply Cylinder 5	P216B	P0205	P216C	P124C
Direct Fuel Injector High Voltage Control Cylinder 5	P0273	P0205	P0274	P124C
Direct Fuel Injector High Voltage Supply Cylinder 6	P216E	P0206	P216F	P124D
Direct Fuel Injector High Voltage Control Cylinder 6	P0276	P0206	P0277	P124D

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the injector high voltage supply circuits. The ECM energizes each fuel injector by grounding the high voltage control circuit of the fuel injector. The ECM monitors the status of the fuel injector high voltage supply circuits and the fuel injector high voltage control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is between 11-18 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

The engine control module detects the fuel injector high voltage supply circuit is shorted to the fuel injector high voltage control circuit for greater than 2 s.

Action Taken When the DTC Sets

DTCs P1248, P1249, P124A, P124B, P124C, and P124D are Type A DTCs.

Conditions for Clearing the DTC

DTCs P1248, P1249, P124A, P124B, P124C, and P124D are Type A DTCs.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test**.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Cylinder 1-6 Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0685 or P1682 is not set.
    - **If DTC P0685 or P1682 is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If DTC P0685 or P1682 is not set**

3. Engine idling.
4. Verify the scan tool Cylinder 1-6 Injector Control Circuit Status parameters display OK.
    - **If any parameters do not display OK**

      Refer to Circuit/System Testing.

    - **If all parameters display OK**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify DTC P1248, P1249, P124A, P124B, P124C, or P124D does not set.
    - **If any DTC sets**

      Refer to Circuit/System Testing.

    - **If no DTC sets**
7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate multi-way harness connector X160 or X161, at the rear of the intake manifold, ignition ON. It may take up to 2 minutes for all vehicle systems to power down.
2. Verify the scan tool Cylinder 1-6 Injector Control Circuit Status parameters display Open.
    - **If Open is not displayed**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.

       NOTE: Test on the Engine Control Module side of the multi-way harness connector.

    2. Test for infinite resistance between the appropriate Q17 Fuel Injector high voltage supply circuit and high voltage control circuit.
        - If less than infinite, repair the short between the circuits.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If Open is displayed**

NOTE: Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.

3. Ignition OFF, disconnect the harness connector at the appropriate Q17 Fuel Injector.
4. Test for infinite resistance between the appropriate Q17 Fuel Injector high voltage supply circuit and high voltage control circuit.
    - **If less than infinite resistance**

      Repair the short between the circuits.

- **If infinite resistance**

5. Test or replace the appropriate Q17 Fuel Injector.

Component Testing

- **Fuel Injector Solenoid Coil Test**
- **Fuel Injector Balance Test**

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Injector Replacement**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P1255 OR P064A: FUEL PUMP CONTROL MODULE/MODULE (CHASSIS CONTROL MODULE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P064A

Fuel Pump Control Module Performance

DTC P1255

Fuel Pump Control Module Driver High Temperature

Circuit/System Description

The engine control module (ECM) supplies voltage to the chassis control module when the ECM detects that the ignition is on. The voltage from the ECM to the chassis control module remains active for 2 seconds, unless the engine is in crank or run. While this voltage is being received, the chassis control module supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel pressure.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

The chassis control module detects an over-temperature fault.

Action Taken When the DTC Sets

DTCs P064A and P1255 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P064A and P1255 are Type A DTCs.

Diagnostic Aids

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

Beginning in the 2014 model year the K27 Fuel Pump Control Module (FPCM) will now be called the chassis control module (CCM). The component code for the chassis control module will be K38. The chassis control module name will be used in Service Information, the Global Diagnostic System and the Service Programming System.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0231, P0232 or P023F is not set.
    - **If any of the DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If none of the DTCs are set**

3. Verify that the area where the K38 Chassis Control Module is located is free of debris, clutter, or any insulating material that would cause the K38 Chassis Control Module to overheat.
    - **If any debris, clutter, or other material is found**
    1. Clear the area where the K38 Chassis Control Module is located.
    2. Clear the DTC and test drive the vehicle.
    3. Verify DTC P1255 or P064A is not set.
        - If DTC P1255 or P064A is set, replace the K38 Chassis Control Module.
        - If DTC P1255 or P064A is not set
    4. All OK.
    - **If no debris, clutter, or other material is found**
4. Clear the DTC and test drive the vehicle.
5. Verify DTC P1255 or P064A is not set.
    - **If DTC P1255 or P064A is set**

      Replace the K38 Chassis Control Module.

    - **If DTC P1255 or P064A is not set.**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for chassis control module replacement, programming and setup

DTC P135A OR P135B: IGNITION COIL SUPPLY VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P135A

Ignition Coil Supply Voltage Circuit Bank 1

DTC P135B

Ignition Coil Supply Voltage Circuit Bank 2

Diagnostic Fault Information

Circuit	Short to	Open/High	Short to	Signal

	Ground	Resistance	Voltage	Performance
Ignition Voltage	P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0351, P0352, P0353, P0354, P0355, P0356, P135A, P135B	P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0351, P0352, P0353, P0354, P0355, P0356, P135A, P135B	-	-

Circuit/System Description

The ignition system uses an individual ignition coil for each cylinder. The engine control module (ECM) monitors the ignition voltage from the fuse to the individual coils.

Conditions for Running the DTC

- The ignition is ON.
- Ignition Run/Crank and PT relay voltages are greater than 11 V

The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects less than 2.5 V on the ignition coil supply voltage circuit for greater than 313 ms.

Action Taken When the DTC Sets

DTC P135A and P135B are Type A DTCs.

Conditions for Clearing the DTC

DTC P135A and P135B are Type A DTCs.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON.
2. Verify the appropriate scan tool Ignition Coil Supply Voltage parameter displays On.
    - **If On is not displayed**

      Refer to Circuit/System Testing.

    - **If On is displayed**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
2. Connect a 3 A fused jumper wire between the control circuit terminal 72 and ground, ignition ON.
3. Verify a test lamp illuminates between the appropriate ignition circuit terminal listed below and ground.
    - Terminal 62
    - Terminal 67
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**

      NOTE: **The ignition circuit may supply voltage to other components. Make sure to test all circuits and components for a short to ground that share the ignition circuit.**

    1. Ignition OFF, remove the test lamp, and disconnect all components on the circuit.
    2. Test for infinite resistance between the ignition circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Replace the fuse, ignition ON.
4. Verify the fuse is good after connecting each of the components one at a time.
    - If the fuse opens, replace the component that opens the fuse when connected.
    - If the fuse is good, all OK.

- **If the test lamp illuminates**

4. Replace the K20 Engine Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P1400: COLD START EMISSION REDUCTION CONTROL SYSTEM

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provide an overview of each diagnostic category.

DTC Descriptor

DTC P1400

Cold Start Emission Reduction Control System

Circuit/System Description

The catalytic converter must be warmed to efficiently reduce the emissions. The cold start strategy is to reduce the amount of time it takes to warm the catalytic converter. During a cold start, the engine idle speed is elevated and spark timing is retarded to allow the catalyst to warm quickly. This diagnostic monitors the following to build an exhaust energy model:

- Engine speed
- Spark advance
- Throttle position
- Engine coolant temperature
- Engine runtime
- Park/neutral position
- Vehicle speed

The actual model is then compared to the expected exhaust energy model.

Conditions for Running the DTC

- The engine is running, and a cold start has been detected.
- Vehicle speed is less than 3 km/h (2 MPH).
- The engine is at idle with no input from the accelerator pedal.
- The calculated catalyst temperature is less than 350Â°C (662Â°F).
- Engine coolant is greater than -10Â°C (14Â°F) and less than 56Â°C (132Â°F).
- Barometric pressure is greater than 74 kPa (10.7 psi).
- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0112, P0113, P0116, P0117, P0118, P0120, P0121, P0122, P0123, P0220, P0222, P0223, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0335, P0336, P0351, P0352, P0353, P0501, P0502, P0506, P0507, P0601, P0602, P0603, P0604, P0606, P0607, P060D, P062F, P0641, P0651, P1101, P1516, P1682, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2176, P2610 are not set.
- This DTC runs for 10 s within the first 18 s of start-up, or until the calculated catalyst temperature is greater than 900Â°C (1,652Â°F). This diagnostic runs once per trip when a cold start has been determined.

Conditions for Setting the DTC

The actual exhaust energy model does not match the expected exhaust energy model.

Action Taken When the DTC Sets

DTC P1400 is a Type A DTC.

Conditions for Clearing the MIL/DTC

DTC P1400 is a Type A DTC.

Reference Information

Description and Operation

Engine Control Module Description

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Diagnostic Aids

Any loading of the engine that lowers engine RPM, such as with partial application of the clutch, A/C cycling etc., during the first 18 s of engine run time may set this DTC.

Circuit/System Verification

1. Vehicle OFF, allow the engine to cool to be within the temperatures listed in the Conditions for Running

the DTC.

2. Engine running.
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
    - **If the DTC sets**
5. Verify that the conditions listed below do not exist:
    - Damage, restriction, water intrusion or modification of the air intake system.
    - Dirty or deteriorating air filter element
    - Crankcase ventilation system for correct operation-Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
    - Vacuum leak or other un-metered air downstream of the mass air flow (MAF) sensor
    - Intake manifold leak
    - Exhaust leak
    - Water intrusion
    - Damaged, restricted, modified or enhanced exhaust system-Refer to **Symptoms - Engine Exhaust** .
    - **If any of the conditions exist**

      Repair as necessary.

    - **If none of the conditions exist**
6. Verify an engine mechanical condition does not alter the air flow into the combustion chamber. Refer to **Symptoms - Engine Mechanical** .
    - **If the DTC does not set**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

DTC P150C: TRANSMISSION CONTROL MODULE ENGINE SPEED REQUEST SIGNAL MESSAGE COUNTER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P150C

Transmission Control Module Engine Speed Request Signal Message Counter Incorrect

Circuit/System Description

To improve vehicle shift feel, the transmission control module (TCM) is constantly sending the ECM serial data messages with requests to modify engine speed or torque. These serial data messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P150C when it detects a discrepancy in the structure of this message causing its integrity to be questioned.

An intermittent fault in the controller area network (CAN) circuits will cause DTC P150C to set.

Conditions for Running the DTC

- DTCs P0506, P0507, or U0101 are not set.
- The engine is running for greater than 0.5 s.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

The ECM detects that the TCM engine speed request does not match the expected engine speed request.

Action Taken When the DTC Sets

DTC P150C is a Type B DTC.

Conditions for Clearing the DTC

DTC P150C is a Type B DTC.

Reference Information

Description and Operation

Data Link Communications Description and Operation

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **DTC P150C is an informational DTC.**
- **Diagnose all other engine control module DTCs prior to DTC P150C.**

1. Verify that no other DTCs are set except for DTC P150C.
   - **If any other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If only DTC P150C is set**

2. Replace the K71 Transmission Control Module.
3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the K20 Engine Control Module.

    - **If the DTC does not set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for ECM or TCM replacement, programming, and setup

DTC P1516, P2101, P2119, OR P2176: THROTTLE ACTUATOR CONTROL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1516

Throttle Actuator Control (TAC) Module Throttle Actuator Position Performance

DTC P2101

Throttle Actuator Position Performance

DTC P2119

Throttle Closed Position Performance

DTC P2176

Minimum Throttle Position Not Learned

Diagnostic Fault Information

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
TAC Motor Control Closed	P2101	P2101	P2101	P1516, P2101, P2176

Circuit	Short to Ground	Open or High Resistance	Short to Voltage	Signal Performance
TAC Motor Control Open	P2119	P2101	P2101	P1516, P2101, P2176

Circuit/System Description

The throttle body assembly contains a contact-less inductive throttle position sensing element that is managed by a customized integrated circuit. The throttle position (TP) sensor is mounted within the throttle body assembly and is not serviceable. The engine control module (ECM) supplies the throttle body with a 5 V reference circuit, a low reference circuit, an H-bridge motor directional control circuit, and an asynchronous signal/serial data circuit. The asynchronous signal means communication is only going from the throttle body to the ECM. The throttle body cannot receive data from the ECM over the signal/serial data circuit. The TP sensor provides a signal voltage that changes relative to throttle blade angle. The customized integrated circuit translates the voltage based position information into serial data using the Society of Automotive Engineers (SAE) J2716 Single Edge Nibble Transmission (SENT) protocol. The TP sensor information is transmitted between the throttle body and the ECM on the signal/serial data circuit. The ECM decodes the serial data signal into separate voltages which are displayed on a scan tool as the voltage inputs from TP sensors 1 and 2.

The ECM controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the TP sensor signal/serial data circuit to determine the actual throttle valve position.

Conditions for Running the DTC

P1516

- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.
- DTC P1516 runs continuously when the above conditions are met.

P2101

- DTC P1682 is not set.
- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.
- The engine is running or the following conditions are met:
  - The engine is not running.
  - The ignition voltage is greater than 11 V.
  - The TAC system is not in the Battery Saver mode.
  - The ECM is commanding the throttle.
  - The ECM has learned the minimum throttle position.
- DTC P2101 runs continuously when the above conditions are met.

P2119

- DTCs P0122, P0123, P0222, P0223, or P06A3 is not set.
- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.
- The system is not in the Battery Save mode.

- The ECM is not commanding the throttle.
- DTC P2119 runs continuously when the above conditions are met.

P2176

- The run/crank or powertrain relay voltage is greater than 6.4 V and reduced power is not active.
- DTC P2176 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P1516

The ECM detects an unstable throttle position for greater than 1 s.

P2101

- The ECM detects the actual throttle position does not match the predicted throttle position for greater than 1 s.

  OR

- The ECM detects the throttle control is driving the throttle in the incorrect direction or exceed the reduced power limit.

P2119

The ECM determines that the throttle blade did not return to the rest position within 1 s.

P2176

The ECM detects that both throttle position (TP) sensors were greater than a predetermined voltage during the minimum throttle learn procedure for greater than 2 s.

Action Taken When the DTC Sets

- DTCs P2101, and P2176 are Type A DTCs.
- DTC P1516 is a Type B DTC.
- DTC P2119 is a Type C DTC.
- The ECM commands the TAC system to operate in the Reduced Engine Power mode.
- A message center or an indicator displays Reduced Engine Power.
- Under certain conditions, the control module commands the engine OFF.

Conditions for Clearing the MIL/DTC

- DTCs P2101, and P2176 are Type A DTCs.
- DTC P1516 is a Type B DTC.
- DTC P2119 is a Type C DTC.

Diagnostic Aids

- Depending on the Start Up ECT, the Desired Throttle Position percentage maybe greater or less than the Throttle Position with the TAC motor at rest. When the ignition is initially turned ON, or when the engine is cranking or running the Desired and Actual Throttle positions should closely match.
- Inspect for a condition in which the throttle valve may have been held open. For example, ice may have formed in the throttle bore causing the throttle valve not to close.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- A low battery condition may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.

   NOTE: A low battery voltage or charging system condition may cause a DTC to set.

2. Verify DTC P0121, P0122, P0123, P0222, P0223, P0562, P0621, P0622, or P2135 is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

- **If none of the DTCs are set**

3. Verify the scan tool Throttle Body Idle Air flow Compensation parameter is less than 90 %.
   - **If 90 % or greater**

     Refer to **Throttle Body Inspection and Cleaning** .

   - **If less than 90 %**
4. Clear the DTCs with a scan tool.
5. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
6. Ignition ON.
7. Verify the scan tool TAC Motor parameter displays Enabled while slowly depressing the accelerator pedal.
   - **If Enabled is Not displayed**

     Refer to Circuit/System Testing.

   - **If Enabled is displayed**
8. Verify DTC P1516, P2101, P2119, or P2176 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing.

   - **If none of the DTCs are set**

   NOTE: **If there is a condition with the throttle body, the TAC Motor Command parameter will go to 99 % for a predetermined amount of time and then a DTC sets. Once a DTC is set, the TAC Motor Command parameter will go to 0 % and the TAC Motor parameter will display Disabled.**

9. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.
   - **If Enabled is Not displayed**

     Replace the Q38 Throttle Body assembly.

   - **If Enabled is displayed**
10. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
11. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
12. All OK

Circuit/System Testing

1. Ignition OFF.

WARNING: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

2. Verify the conditions listed below do not exist with the Q38 Throttle Body:

NOTE:

- **The rest position is defined as the actual Throttle Position percentage when the ignition is OFF or with the ignition ON for greater than 30 seconds.**
- **When the ignition is OFF, spring tension should hold the throttle plate in the rest position. You should be able to open the throttle plate to wide open throttle (WOT) or push the throttle plate to the fully closed position. In each case, the throttle plate should return to the rest position without assistance.**

- A throttle blade that is not in the rest position
- A throttle blade that is binding open or closed
- A throttle blade that is free to move open or closed without spring pressure
- **If a condition is found**

  Replace the Q38 Throttle Body.

- **If a condition is not found**

NOTE: Disconnecting the throttle body harness connector may cause additional DTCs to set.

3. Disconnect the harness connector at the Q38 Throttle Body Assembly, ignition ON.

NOTE: The test lamp may illuminate briefly when the ignition switch is turned on, but should not remain illuminated.

4. Verify that a test lamp does Not illuminate continuously between each motor control circuit listed below and ground.
   - TAC Motor Control Closed circuit terminal 1
   - TAC Motor Control Open circuit terminal 2
   - **If the test lamp is always ON**
   1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module, ignition ON
   2. Test for less than 1 V between the motor control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If the test lamp is always OFF**

5. Verify that a test lamp does not illuminate between each motor control circuit listed below and B+.
    - TAC Motor Control Closed circuit terminal 1
    - TAC Motor Control Open circuit terminal 2
    - **If the test lamp illuminates**
    1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If the test lamp does not illuminate**
6. Ignition OFF, set the DMM to the 40 V scale, select the Min/Max Recording Mode, and set the Peak Min/Max response time to 1 ms.

NOTE:

- **The test lamp must be connected to circuit before turning ignition on or incorrect diagnosis may occur.**
- **The ignition must be OFF and the ECM completely powered down before testing each circuit or a lower voltage will be recorded. It may take up to 2 min for all vehicle systems to power down.**
- **The DMM Min/Max Recording Mode and the response time of 1 ms must be reset after testing each circuit or a lower voltage will be recorded.**

7. Verify the Max voltage is within 3 V of B+ while using DMM Min/Max Recording Mode function on each control circuit listed below as the ignition is turned ON.
    - TAC Motor Control Closed circuit terminal 1
    - TAC Motor Control Open circuit terminal 2
    - **If not within 3 V of B+**
    1. Ignition OFF, disconnect the harness connector X2 at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If within 3 V of B+**
8. Replace the Q38 Throttle Body.

Repair Instructions

- **Throttle Body Assembly Replacement**
- **Control Module References** for ECM replacement, programming, and setup

Repair Verification

1. Install any components that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component is removed or replaced.

3. Clear the DTCs with a scan tool.
4. Ignition OFF and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
5. Ignition ON.
6. Verify the scan tool TAC Motor parameter displays Enabled while performing the Throttle Sweep Test with a scan tool.
    - **If Disabled**

      Test or replace the Q38 Throttle Body assembly.

    - **If Enabled**
7. If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not set again.
    - **If DTC sets**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

    - **If DTC does not set**
8. All OK

DTC P163A: CONTROL MODULE FUEL PRESSURE REGULATOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P163A

Control Module Fuel Pressure Regulator 1 Control System Circuitry Performance

Circuit/System Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM).

Conditions for Running the DTC

- The engine is running or cranking.
- The ignition voltage is between 8-18 V.
- DTC P163A runs continuously when the conditions are met for greater than 500 mS.

Conditions for Setting the DTC

The ECM detects a condition with the integrated high pressure fuel pump actuator circuits or detects the current used to drive the high pressure fuel pump actuator is out of range for greater than 4 s.

Action Taken When the DTC Sets

DTC P163A is a Type C DTC.

Conditions for Clearing the DTC

DTC P163A is a Type C DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Engine Control Module Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool parameters listed below do not display Malfunction when commanding the Fuel Pressure Regulator On and Off with a scan tool.
    - Fuel Pressure Regulator Control Circuit High Voltage Test Status
    - Fuel Pressure Regulator Control Circuit Open Test Status
    - Fuel Pressure Regulator Control Circuit Low Voltage Test Status
    - Fuel Pressure Regulator High Control Circuit High Voltage Test Status
    - Fuel Pressure Regulator High Control Circuit Open Test Status
    - Fuel Pressure Regulator High Control Circuit Low Voltage Test Status
    - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump. It may take up to 2 min for all vehicle systems to power down.
2. Verify that a test lamp does not illuminate between the high pressure fuel pump actuator low control circuit terminal 1 and B+.
   - **If the test lamp illuminates**
   1. Remove the test lamp.
   2. Disconnect the X3 harness connector at the K20 Engine Control Module.
   3. Test for infinite resistance between the low control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test or replace the K20 Engine Control Module.
   - **If the test lamp does not illuminate**
3. Ignition ON.
4. Verify a test lamp does not illuminate between the high pressure fuel pump actuator high control circuit terminal 2 and ground.
   - **If the test lamp illuminates**
   1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module. Ignition ON.
   2. Test for less than 1 V between the high control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, test or replace the K20 Engine Control Module.
   - **If the test lamp does not illuminate**
5. Verify the test lamp illuminates when the Fuel Pressure Regulator is commanded On with a scan tool.
   - **If the test lamp does not illuminate**
   1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the high control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω, test or replace the K20 Engine Control Module.

- **If the test lamp illuminates**

6. Ignition OFF, connect a test lamp between the high pressure fuel pump actuator low control circuit terminal 1 and B+. Ignition ON.
7. Verify the test lamp illuminates when the Fuel Pressure Regulator is commanded On with a scan tool.
    - **If the test lamp does not illuminate**
    1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module. Ignition ON.
    2. Test for less than 1 V between the low control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Test for less than 2 Ω in the low control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, test or replace the K20 Engine Control Module.
    - **If the test lamp illuminates**
8. Test or replace the G18 High Pressure Fuel Pump.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the G18 High Pressure Fuel Pump.

    NOTE: **The DMM and test leads must be calibrated to 0 Ω in order to prevent misdiagnosis.**

2. Test for 9-12 Ω between low control circuit terminal 1 and high control circuit terminal 2.
    - **If not within the specified range**

      Replace the G18 High Pressure Fuel Pump.

    - **If within the specified range**
3. Test for infinite resistance between each terminal and the high pressure fuel pump housing/case.
    - **If less than infinite resistance**

      Replace the G18 High Pressure Fuel Pump.

    - **If infinite resistance**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Pump Replacement** for G18 High Pressure Fuel Pump replacement
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

NOTE: **Some vehicles do not support the Fuel Rail Pressure Relief Valve Reset procedure. Applications not supporting this procedure will return an error message stating "Parameter ID not supported. Check for proper vehicle selection."**

- Perform the Fuel Rail Pressure Relief Valve Reset procedure.

DTC P2096 OR P2098: POST CATALYST FUEL TRIM SYSTEM LOW

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2096

Post Catalyst Fuel Trim System Low Limit Bank 1

DTC P2098

Post Catalyst Fuel Trim System Low Limit Bank 2

Circuit Description

Fuel trim bias is used to keep the post catalyst air/fuel ratio within a predetermined range. This allows optimal catalyst efficiency under various operating conditions. The engine control module (ECM) constantly monitors how lean or rich the fuel trim bias is commanded, to determine if the fuel trim bias is greater than a calibrated amount.

Conditions for Running the DTC

- DTC P0016, P0017, P0018, P0019, P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0131-P0135, P0137, P0138, P013A-P013F, P0140, P0141, P014A, P014B, P0151-P0155, P0157, P0158, P015A-P015D, P0160, P0161, P0178, P0179, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300-P0306, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0498, P0499, P1248, P1249, P124A, P124B, P124C, P124D, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P219A, P219B, P2227, P2228, P2229, P2230, P2269, P2270, P2271, P2272, or P2273 is not set.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 PSI).
- The manifold absolute pressure (MAP) is between 10-255 kPa (1.5-37 PSI).
- The intake air temperature (IAT) is between -20 and +150Â°C (-4 and +302Â°F).
- The engine start-up coolant temperature is warmer than -20Â°C (-4Â°F).
- The engine is in Closed Loop status.
- The fuel control intrusive diagnostics are not active.

- DTCs P2096 and P2098 run continuously when the conditions above have been met.

Conditions for Setting the DTC

The lean correction limit for a condition causing a rich air/fuel ratio has been exceeded.

Action Taken when the DTC Sets

DTCs P2096 and P2098 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2096 and P2098 are Type B DTCs.

Diagnostic Aids

- The post catalyst fuel trim diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.
- Failure to perform the scan tool Heated Oxygen Sensor Resistance Learn Reset after replacing an HO2S, clearing HO2S diagnostic trouble codes, or after battery disconnection may cause inaccurate post catalyst fuel trim readings.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other HO2S or fuel trim DTC is set.
   - **If any other HO2S or fuel trim DTC is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If no other HO2S or fuel trim DTC is set**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
4. Verify DTC P2096 or P2098 is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing.

   - **If no DTC is set**
5. All OK.

Circuit/System Testing

Verify the conditions listed below do not exist:

- Air intake duct collapsed or restricted.
- Air filter dirty or restricted.
- Objects blocking the throttle body.
- Excessive fuel in the crankcase. Change engine oil as necessary.
- Rich fuel injectors. Refer to **Fuel Injector Solenoid Coil Test**.
- High fuel system pressure. Refer to **Fuel System Diagnosis**.
- Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Fuel saturation of the evaporative emissions (EVAP) canister
- EVAP purge valve stuck open or leaking
- Restricted exhaust
- Incorrect crankcase ventilation system operation. Refer to **Crankcase Ventilation System Inspection/Diagnosis**

- **If a condition is found**

  Repair as necessary.

- **If no condition is found**

  Test fuel trim cylinder balance. Refer to **DTC P219A or P219B**.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Perform the scan tool Fuel Trim Reset after completing the repair.

DTC P2097 OR P2099: POST CATALYST FUEL TRIM SYSTEM

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2097

Post Catalyst Fuel Trim System High Limit Bank 1

DTC P2099

Post Catalyst Fuel Trim System High Limit Bank 2

Circuit Description

Fuel trim bias is used to keep the post catalyst air/fuel ratio within a predetermined range. This allows optimal catalyst efficiency under various operating conditions. The engine control module (ECM) constantly monitors how lean or rich the fuel trim bias is commanded, to determine if the fuel trim bias is greater than a calibrated amount.

Conditions for Running the DTC

- DTC P0016, P0017, P0018, P0019, P0030, P0036, P0050, P0053, P0054, P0056, P0059, P0060, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0116, P0117, P0118, P0119, P0128, P0131-P0135, P0137, P0138, P013A-P013F, P0140, P0141, P014A, P014B, P0151-P0155, P0157, P0158, P015A-P015D, P0160, P0161, P0178, P0179, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300-P0306, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0442, P0443, P0446, P0449, P0452, P0453, P0455, P0496, P0498, P0499, P1248, P1249, P124A, P124B, P124C, P124D, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P219A, P219B, P2227, P2228, P2229, P2230, P2269, P2270, P2271, P2272, or P2273 is not set.
- The barometric pressure (BARO) is greater than 70 kPa (10.2 PSI).
- The manifold absolute pressure (MAP) is between 10-255 kPa (1.5-37 PSI).
- The intake air temperature (IAT) is between -20 and +150Â°C (-4 and +302Â°F).
- The engine start-up coolant temperature is warmer than -20Â°C (-4Â°F).
- The engine is in Closed Loop status.
- The fuel control intrusive diagnostics are not active.
- DTCs P2097 and P2099 run continuously when the conditions above have been met.

Conditions for Setting the DTC

The rich correction limit for a condition causing a lean air/fuel ratio has been exceeded.

Action Taken when the DTC Sets

DTCs P2097 and P2099 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2097 and P2099 are Type B DTCs.

Diagnostic Aids

- The post catalyst fuel trim diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other HO2S or fuel trim DTC is set.
    - **If any other HO2S or fuel trim DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **If no other HO2S or fuel trim DTC is set**
3. Verify the conditions listed below do not exist:
    - Exhaust system leaks. Refer to **Symptoms - Engine Exhaust**
    - Vacuum hoses split, kinked, or improperly connected
    - Insufficient fuel in the tank
    - Leaks in the air induction system and the air intake ducts
    - Missing air filter element
    - A cracked evaporative canister
    - Evaporative pipes plugged, obstructed, or leaking
    - Leaks in the crankcase ventilation system. Refer to **Crankcase Ventilation System Inspection/Diagnosis**
    - Engine vacuum leaks
    - Low fuel system pressure. Refer to **Fuel System Diagnosis**.
    - Contaminated fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
    - Lean fuel injectors. Refer to **Fuel Injector Solenoid Coil Test**.
    - **If a condition is found**

      Repair as necessary.

    - **If no condition is found**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
5. Verify DTC P2097 or P2099 is not set.
    - **If a DTC is set**

      Refer to Circuit/System Testing.

    - **If no DTC is set**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Perform the scan tool Fuel Trim Reset after completing the repair.

DTC P2122, P2123, P2127, P2128, OR P2138: ACCELERATOR PEDAL POSITION (APP) SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2122

Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage

DTC P2123

Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage

DTC P2127

Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage

DTC P2128

Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage

DTC P2138

Accelerator Pedal Position (APP) Sensor 1-2 Correlation

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Accelerator Pedal Position (APP) Sensor 1 5 V Reference Circuit	P06A3	P2138	P2122	P06A3	P2138
Accelerator Pedal Position (APP) Sensor 2 5 V Reference Circuit	P0106, P0108, P0107, P0697	P2138	P2127	P0106, P0108, P0697	P2138
Accelerator Pedal Position (APP) Sensor 1 Signal	P2122	P2138	P2122	P2123, P2138	P2138
Accelerator Pedal Position (APP) Sensor 2 Signal	P2127	P2138	P2127	P2128, P2138	P2138
Accelerator Pedal Position (APP) Sensor 1 Low Reference	-	P2138	P2123	-	P2138
Accelerator Pedal Position (APP) Sensor 2 Low Reference	-	P2138	P2128	-	P2138

Typical Scan Tool Data

APP Sensor 1

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle. **Parameter Normal Range:** APP Sensor 1 0.88-1.08 V			
APP Sensor 1 5 V Reference	0.00 V	0.00 V	2-3 V
APP Sensor 1 Signal	0.00 V	0.00 V	4-5 V
APP Sensor 1 Low Reference	-	4-5 V	-

APP Sensor 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The engine is operating at idle. **Parameter Normal Range:** APP Sensor 2 0.39-0.59 V			
APP Sensor 2 5 V Reference	0.00 V	0.00 V	1-3 V
APP Sensor 2 Signal	0.00 V	0.00 V	2-5 V
APP Sensor 2 Low Reference	-	4-5 V	-

Circuit/System Description

The accelerator pedal assembly contains 2 accelerator pedal position (APP) sensors. The APP sensors are mounted to the accelerator pedal assembly and are not serviceable. The APP sensors provide a signal voltage that changes relative to pedal position. The engine control module (ECM) supplies each APP sensor with a 5 V reference circuit, a low reference circuit, and a signal circuit.

Both the APP sensors 1 and 2 signal percentages increase as the pedal is depressed, from approximately 0 percent at rest to above 95 percent when fully depressed.

Conditions for Running the DTC

P2122, P2123, P2127, or P2128

- DTC P06A3 or P0697 are not set.
- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 6 V.
- The ECM is not commanding reduced power.
- The DTCs run continuously when the above conditions are met.

P2138

- DTCs P06A3, P0697, P2122, P2123, P2127, or P2128 are not set.
- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 6 V.
- The ECM is not commanding reduced power.
- The DTC runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2122

The ECM detects that the APP sensor 1 voltage is less than 0.46 V for less than 1 s.

P2123

The ECM detects that the APP sensor 1 voltage is greater than 4.7 V for less than 1 s.

P2127

The ECM detects that the APP sensor 2 voltage is less than 0.32 V for less than 1 s.

P2128

The ECM detects that the APP sensor 2 voltage is greater than 2.6 V for less than 1 s.

P2138

The ECM detects that APP sensor 1 and APP sensor 2 disagree greater than 10 percent for less than 1 s.

OR

The ECM detects that both APP sensor 1 and APP sensor 2 are 5 percent greater than the learned minimum position for less than 1 s.

Action Taken When the DTC Sets

- DTCs P2122, P2123, P2127, P2128, and P2138 are type A DTCs.
- The ECM commands the TAC system to operate in a Reduced Engine Power mode.

Conditions for Clearing the DTC

DTCs P2122, P2123, P2127, P2128, and P2138 are type A DTCs.

Diagnostic Aids

- A high resistance condition on the accelerator pedal position circuits could cause a DTC to set.
- Ensure that the in-line harness connector seals are installed correctly. Improper installation could result in water intrusion into the connector and cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Throttle Actuator Control (TAC) System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0697 or P06A3 is not set.
   - **If any of the DTCs are set**

     Refer to **DTC P0641, P0651, P0697, or P06A3 (ECM)** for further diagnosis.

   - **If none of the DTCs are set**
3. Verify the APP Sensor 1 Circuit Status and APP Sensor 2 Circuit Status displays OK.
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing

   - **If OK is displayed**
4. Verify the scan tool APP Sensor 1 and 2 Agree/Disagree parameter displays Agree while performing the tests listed below:
   - Rapidly depress the accelerator pedal from the rest position to the wide open throttle position (WOT) and release pedal. Repeat the procedure several times.
   - Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times.
   - **If Disagree**

     Refer to Circuit/System Testing

   - **If Agree**
5. Verify that DTC P2122, P2123, P2127, P2128, or P2138 is not set.
   - **If any of the DTCs are set**

     Refer to Circuit/System Testing

   - **If none of the DTCs set**

6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing

    - **If the DTC does not set**
8. All OK

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B107 accelerator pedal assembly. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 5 Ω between each low reference circuit terminal listed below and ground.
    - Low reference circuit terminal 4 or A
    - Low reference circuit terminal 5 or D
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 engine control module.
    - **If less than 5 Ω**
3. Ignition ON.
4. Test for 4.8-5.2 V between each 5 V reference circuit terminal listed below and ground.
    - 5 V reference circuit terminal 1 or C
    - 5 V reference circuit terminal 2 or F
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5 V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 engine control module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the harness connector at the K20 engine control module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 engine control module.
    - **If between 4.8-5.2 V**

5. Verify each APP sensor voltage parameter is less than 0.2 V.
    - **If 0.2 V or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 engine control module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal listed below and ground.
    - APP sensor 1 signal circuit terminal 3 or E
    - APP sensor 2 signal circuit terminal 6 or B
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 engine control module.
    - **If less than 0.2 V**
6. Install a 3 A fused jumper wire between each signal circuit terminal listed below and the 5 V reference circuit terminal 1 or C.
    - APP sensor 1 signal circuit terminal 3 or E
    - APP sensor 2 signal circuit terminal 6 or B
7. Verify the scan tool APP sensor voltage parameter is greater than 4.8 V.
    - **If 4.8 V or less**
    1. Ignition OFF, disconnect the harness connector at the K20 engine control module.
    2. Test for infinite resistance between the signal circuit terminal and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 engine control module.
    - **If greater than 4.8 V**
8. Test or replace the B107 accelerator pedal assembly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Accelerator Pedal Position Sensor Replacement**
- **Control Module References** for ECM replacement, programming, and setup

DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, OR P216F: CYLINDER 1-6 INJECTOR HIGH CONTROL CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2147

Cylinder 1 Injector High Control Circuit Low Voltage

DTC P2148

Cylinder 1 Injector High Control Circuit High Voltage

DTC P2150

Cylinder 2 Injector High Control Circuit Low Voltage

DTC P2151

Cylinder 2 Injector High Control Circuit High Voltage

DTC P2153

Cylinder 3 Injector High Control Circuit Low Voltage

DTC P2154

Cylinder 3 Injector High Control Circuit High Voltage

DTC P2156

Cylinder 4 Injector High Control Circuit Low Voltage

DTC P2157

Cylinder 4 Injector High Control Circuit High Voltage

DTC P216B

Cylinder 5 Injector High Control Circuit Low Voltage

DTC P216C

Cylinder 5 Injector High Control Circuit High Voltage

DTC P216E

Cylinder 6 Injector High Control Circuit Low Voltage

DTC P216F

Cylinder 6 Injector High Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Short from Supply Circuit

				to Control Circuit
Low Control Cylinder 1	P2147	P0201	P2148	P1248
High Control Cylinder 1	P0261	P0201	P0262	P1248
Low Control Cylinder 2	P2150	P0202	P2151	P1249
High Control Cylinder 2	P0264	P0202	P0265	P1249
Low Control Cylinder 3	P2153	P0203	P2154	P124A
High Control Cylinder 3	P0267	P0203	P0268	P124A
Low Control Cylinder 4	P2156	P0204	P0270, P2157	P124B
High Control Cylinder 4	P0270, P2156	P0204	P0271, P2157	P124B
Low Control Cylinder 5	P216B	P0205	P216C	P124C
High Control Cylinder 5	P0273	P0205	P0274	P124C
Low Control Cylinder 6	P216E	P0206	P216F	P124D
High Control Cylinder 6	P0276	P0206	P0277	P124D

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the high control circuits. The ECM energizes each fuel injector by grounding the low control circuit of the fuel injector. The ECM monitors the status of the fuel injector circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Conditions for Running the DTC

- The engine is running.
- The ignition voltage is between 11-18 V.
- The DTCs run continuously when the above conditions are met.

Conditions for Setting the DTC

P2147, P2150, P2153, P2156, P216B, or P216E

The engine control module detects the fuel injector high voltage supply circuit is shorted to ground for greater than 2 s.

P2148, P2151, P2154, P2157, P216C, or P216F

The engine control module detects the fuel injector high voltage supply circuit is shorted to voltage for greater than 2 s.

Action Taken When the DTC Sets

DTCs P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, and P216F are Type A DTCs.

Conditions for Clearing the DTC

DTCs P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, and P216F are Type A DTCs.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test**.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0685 or P1682 is not set.
    - **If the DTC is set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **If the DTC does not set**
3. Engine idling.
4. Verify the scan tool Cylinder 1-6 Injector Control Circuit Status parameters display OK.

- **If OK is not displayed**

  Refer to Circuit/System Testing.

- **If OK is displayed**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F does not set.
   - **If any DTC sets**

     Refer to Circuit/System Testing.

   - **If no DTC sets**
7. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate multi-way harness connector X160 or X161, at the rear of the intake manifold, ignition ON. It may take up to 2 min for all vehicle systems to power down.
2. Verify the scan tool Cylinder 1-6 Injector Control Circuit Status parameters display Open.
   - **If Open is not displayed**
   1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.

      NOTE: **Test on the Engine Control Module side of the multi-way harness connector.**

   2. Test for infinite resistance between the appropriate Q17 Fuel Injector low control circuit and ground.
      - If less than infinite, repair the short to ground on the circuit.
      - If infinite resistance
   3. Ignition ON.
   4. Test for less than 1 V between the Q17 Fuel Injector low control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, test or replace the K20 Engine Control Module.
   - **If Open is displayed**
3. Ignition ON, connect a test lamp between the Q17 Fuel Injector high control circuit and low control circuit.
4. Verify the appropriate Cylinder 1-6 Injector Control Circuit Status transitions from Open to OK.
   - **If OK is not displayed**
   1. Ignition OFF, remove the test lamp, disconnect the X3 harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω on the Q17 Fuel Injector high control circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω

3. Test for less than 2 Ω on the Q17 Fuel Injector low control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, test or replace the K20 Engine Control Module.

- **If OK is displayed**

NOTE: **Testing for the following steps is performed on the fuel injector side of the multi-way harness connector. It may be necessary to remove the intake manifold to isolate the condition.**

5. Test for 2-3 Ω between the appropriate Q17 Fuel Injector high control circuit and low control circuit.
    - **If less than 2 Ω**
    1. Disconnect the harness connector at the Q17 Fuel Injector.
    2. Test for infinite resistance between the Q17 Fuel Injector high control circuit and low control circuit.
        - If less than infinite, repair the short between the circuits.
        - If infinite resistance, test or replace the Q17 Fuel Injector.
    - **If greater than 3 Ω**
    1. Disconnect the harness connector at the Q17 Fuel Injector.
    2. Test for less the 2 Ω in the Q17 Fuel Injector high control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω
    3. Test for less the 2 Ω in the Q17 Fuel Injector low control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, test or replace the Q17 Fuel Injector.
    - **If between 2-3 Ω**
6. Test for infinite resistance between the Q17 Fuel Injector low control circuit and ground.
    - **If less than infinite resistance**
    1. Disconnect the harness connector at the Q17 Fuel Injector.
    2. Test for infinite resistance between the Q17 Fuel Injector high control circuit and ground.
        - If less than infinite, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for infinite resistance between the Q17 Fuel Injector low control circuit and ground.
        - If less than infinite, repair the short to ground on the circuit.
        - If infinite resistance, test or replace the Q17 Fuel Injector.
    - **If infinite resistance**
7. Ignition ON.
8. Test for less than 1 V between the Q17 Fuel Injector low control circuit and ground.
    - **If 1 V or greater**

Repair the short to voltage on the circuit.

- **If less than 1 V**

9. All OK.

Component Testing

- **Fuel Injector Solenoid Coil Test**
- **Fuel Injector Balance Test**

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Injector Replacement**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

DTC P2199: INTAKE AIR TEMPERATURE (IAT) SENSORS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P2199

Intake Air Temperature (IAT) Sensors 1-2 Not Plausible

Diagnostic Fault Information

IAT 1 Sensor

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0112, P0114, P2199	P0111, P0113, P0114, P2199	P0113, P0114, P2199*	P0111, P2199
Low Reference	-	P0111, P0113, P0114, P2199, P2227, P2228, P2229	P0113, P0114, P2199, P2227, P2229*	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

IAT Sensor 2

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	P0096, P0097, P00F4, P0102,	P0096, P0097, P00F4, P0101,	P0690	P0096, P0101, P0103

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
	P0178, P0443, P2199	P0102, P0178, P2199, P2230		
Signal	P0096, P0097, P00F5, P2199	P0096, P0097, P00F4, P2199	P0096, P0097, P00F4, P2199*	P0096
Ground	-	P0096, P0097, P00F4, P0102, P0178, P2199, P2230	-	P0096, P0102
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

IAT 1 Sensor

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature; and engine bay conditions			
Signal	150Â°C (302Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
Low Reference	-	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)*
*Internal ECM or sensor damage may occur if the circuit is shorted to B+			

IAT Sensor 2

Circuit	Short to Ground	Open or High Resistance	Short to Voltage
Operating Conditions: Engine Running **Parameter Normal Range:** Varies with ambient temperature			
Ignition Voltage	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-
Signal	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F) 10 Hz	-40Â°C (-40Â°F)* 10 Hz
Ground	-	-40Â°C (-40Â°F) 10 Hz	-
*Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The sensors listed below are integrated within the mass air flow/multifunction intake air sensor:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor

- MAF sensor
- BARO pressure sensor

The intake air temperature (IAT) sensor 1 is a variable resistor that changes the voltage on the engine control module (ECM) supplied 5 V signal circuit. The signal varies with inlet air temperature in the sensor bore and is displayed by the scan tool as Â°C (Â°F). The IAT sensor 2 and the humidity sensor share the same circuit. The IAT sensor 2 signal is displayed by the scan tool as Hertz (Hz) and Â°C (Â°F).

The sensors listed below share an ECM supplied 5 V reference circuit:

- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

The sensors listed below share an ECM supplied low reference circuit:

- IAT sensor 1
- IAT sensor 2
- Humidity sensor
- Barometric pressure (BARO) sensor

IAT Sensor 1 - Temperature, Resistance, Voltage Table

IAT Sensor 1	IAT Sensor 1 Resistance	IAT Sensor 1 Signal Voltage
Cold	High	High
Warm	Low	Low

IAT Sensor 2 - Temperature, Frequency Table

IAT Sensor 2	IAT Sensor 2 Frequency	IAT Sensor 2 Temperature
Cold	45 Hz	-40Â°C (-40Â°F)
Warm	302 Hz	104Â°C (219Â°F)

Conditions for Running the DTC

- DTC P1682 is not set.
- The ignition is ON.
- Ignition voltage is at least 11 V.
- This DTC runs continuously within the enabling conditions.

Conditions for Setting the DTC

The ECM detects that the absolute difference between the IAT sensor 1 and the IAT sensor 2 temperatures is greater than 55Â°C (99Â°F) for longer than 5 s.

Action Taken When the DTC Sets

DTC P2199 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2199 is a Type B DTC.

Diagnostic Aids

- With the ignition ON, the engine OFF and the engine is cold, a properly functioning IAT sensor 2 will gradually increase the scan tool IAT Sensor 2 parameter. This is due to the heat that is generated by the multifunction intake air sensor heating elements.
- The humidity sensor and the IAT sensor 2 signals are sent to the ECM on the same circuit. If the IAT Sensor 2 parameter displays the values: 10 Hz; -40Â°C (-40Â°F), and there are Humidity Sensor DTCs, check for a circuit problem.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Powertrain Component Views

Powertrain Component Views

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38522-A Variable Signal Generator

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

NOTE: **To minimize the effects of residual engine heat and sensor internal heating elements, perform Steps 1 and 2 of this verification procedure only if the ignition has been OFF for 8 hours or more.**

1. Ignition ON.
2. Verify the following scan tool parameters are within 55Â°C (99Â°F) of each other.
    - Start-Up IAT Sensor 1
    - IAT Sensor 2
    - Start-Up ECT
    - **If not within 55Â°C (99Â°F)**

      Refer to Circuit/System Testing.

    - **If within 55Â°C (99Â°F)**
3. Engine idling, verify the following scan tool parameters are between: -38 and +149Â°C (-36 and +300Â°F).
    - IAT Sensor 1
    - IAT Sensor 2
    - ECT Sensor
    - **If not between: -38 and +149Â°C (-36 and +300Â°F)**

      Refer to Circuit System Testing.

    - **If between: -38 and +149Â°C (-36 and +300Â°F)**
4. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
5. Verify the DTC does not set.
    - **If the DTC sets.**

      Refer to Circuit/System Testing.

    - **If the DTC does not set.**
6. All OK

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Verify none of the following conditions exist:
    - A restricted or collapsed air intake duct
    - An intake manifold leak
    - A MAP sensor seal that is leaking, missing, or damaged
    - A misaligned or damaged air intake duct
    - Any water intrusion in the induction system
    - An Intake Manifold Resonator with a leaking seal, or a cracked or broken housing
    - **If a condition exists**

Repair or replace the component as appropriate.

- **If no condition exists**

2. Ignition OFF and all systems OFF, it may take up to for 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air sensor.
3. Test for less than 2 Ω between the low reference circuit terminal 3 and ground.
    - **If 2 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.
        - If less than 2 Ω replace the K20 Engine Control Module.
    - **If less than 2 Ω**
4. Ignition OFF, all vehicle systems OFF, test for less than 2 Ω between the ground circuit terminal 7 and ground.
    - **If 2 Ω or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open or high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 2 Ω**
5. Ignition ON, verify that a test lamp illuminates between the ignition circuit terminal 5 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
    2. Test for less than 2 Ω in the ignition voltage circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF, remove the test lamp and remove the fuse for the ignition voltage circuit.
    2. Test for infinite resistance between the ignition voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, test all components connected to the ignition circuit, replace as necessary.
    - **If a test lamp illuminates**
6. Ignition ON, test for 4.8-5.2 V between the intake air temperature signal 1 circuit terminal 1 and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance

3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.
- **If greater than 5.2 V**

NOTE: **If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.
- **If between 4.8-5.2 V**

7. Ignition ON, verify the scan tool IAT Sensor 1 parameter is colder than -39Â°C (-38Â°F).
    - **If warmer than -39Â°C (-38Â°F).**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit terminal 1 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If colder than -39Â°C (-38Â°F).**
8. Ignition OFF, install a 3 A fused jumper wire between the signal circuit terminal 1 and the low reference circuit terminal 3.
9. Verify the scan tool IAT Sensor 3 parameter is warmer than 150Â°C (302Â°F).
    - **If colder than 150Â°C (302Â°F).**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Ignition OFF.
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If warmer than 150Â°C (302Â°F).**
10. Ignition ON, test for 4.8-5.2 V between the Intake Air Temperature sensor 2 signal circuit terminal 8 and ground.
    - **If less than 4.8 V**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 5.2 V**

NOTE: **If the signal circuit is shorted to a voltage the engine control module or the sensor may be damaged.**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Ignition ON, test for less than 1 V between the signal circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If between 4.8-5.2 V**

11. Determine if **EL-38522-A** Variable Signal Generator or equivalent is available.
    - **EL-38522-A, Variable Signal Generator; or equivalent is not available**
    1. Test or replace the B75C Multifunction Intake Air sensor.
    2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
    3. Verify the DTC does not set.
        - **If the DTC sets**

          Replace the K20 Engine Control Module.

        - **If the DTC does not set**
    4. All OK.
    - **EL-38522-A, Variable Signal Generator; or equivalent is available**
12. Ignition OFF, connect the leads of the **EL-38522-A** Variable Signal Generator as follows:
    - Red lead to the signal circuit terminal 8 at the harness connector
    - Black leads to ground
    - Battery voltage supply lead to B+
13. Set the **EL-38522-A** Variable Signal Generator to the following specifications.
    - Signal switch to 5 V
    - Duty Cycle switch to 50 % (Normal)
    - Frequency switch to 30 Hz
14. Ignition ON, verify the scan tool IAT Sensor 2 parameter is between 28-32 Hz.
    - **If not between 28-32 Hz**

Replace the K20 Engine Control Module.

- **If between 28-32 Hz**

15. Test or replace the B75C Multifunction Intake Air sensor.

Component Testing

Multifunction Intake Air Sensor

1. Ignition OFF, disconnect the harness connector at the B75C Multifunction Intake Air sensor.

NOTE: A thermometer can be used to test the sensor off the vehicle.

2. Test the IAT sensor 1 by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the **Temperature Versus Resistance - Intake Air Temperature Sensor (Hitachi Sensor)** table for Hitachi Sensors. The resistance values should be in range of the table values.
   - **If not within the table values.**

     Replace the B75C Multifunction Intake Air sensor.

   - **If within the table values.**
3. All OK

Multifunction Intake Air Sensor

1. Test the IAT Sensor 2 by varying the sensor temperature while monitoring the air temperature with a thermometer. Compare the readings with the scan tool IAT Sensor 2 parameter. The values should be within 5%.
   - **If not within 5%**

     Replace the B75C Multifunction Intake Air sensor.

   - **If within 5%**
2. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement.
- **Control Module References** for engine control module replacement, programming, and setup

DTC P219A OR P219B: FUEL TRIM CYLINDER BALANCE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P219A

Fuel Trim Cylinder Balance Bank 1

DTC P219B

Fuel Trim Cylinder Balance Bank 2

Circuit/System Description

The Fuel Trim Cylinder Balance diagnostic detects a rich or lean cylinder to cylinder air/fuel ratio imbalance in each bank. The diagnostic monitors the pre-catalyst heated oxygen sensor (HO2S) signal's frequency and amplitude characteristics by calculating an accumulated voltage over a predetermined sample period. An imbalance is indicated when multiple samples of the accumulated voltage are consistently higher than the desired value.

Conditions for Running the DTC

- DTCs P0016, P0017, P0018, P0019, P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0119, P0122, P0123, P0128, P0201-P0206, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0300, P0301-P0306, P0340, P0341, P0345, P0346, P0365, P0366, P0390, P0391, P0442, P0455, P0458, P0496, P1248, P1249, P124A, P124B, P124C, P124D, P16A0, P16A1, P16A2, P16F3, P2101, P2135, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F are not set.
- The EVAP device controls and intrusive diagnostics are not active .
- The secondary air injection reaction pump is not on, if equipped.
- The engine overspeed protection is not active.
- Engine run time is greater than 30 s.
- The engine is in Closed Loop status for greater than 5 s.
- The fuel level is greater than 10% and no fuel level sensor fault is present.
- The system voltage is greater than 11 V.
- The engine coolant temperature (ECT) is warmer than -20Â°C (-4Â°F).
- The engine speed is between 1,600-4,000 RPM.
- The mass air flow is between 0-1,000 g/s.
- DTCs P219A and P219B run continuously when the above conditions have been met.

Conditions for Setting the DTC

Multiple samples of the pre-catalyst HO2S accumulated voltage are consistently greater than the desired value.

Action Taken When the DTC Sets

DTCs P219A and P219B are Type A DTCs.

Conditions for Clearing the MIL/DTC

DTCs P219A and P219B are Type A DTCs.

Diagnostic Aids

- The fuel trim cylinder balance diagnostic is very sensitive to heated oxygen sensor (HO2S) design. A non-OE sensor or an incorrect part number may cause a DTC to set.
- Monitoring the misfire current counters, or misfire graph, may help to isolate the cylinder that is causing the condition.
- Certain aftermarket air filters may cause a DTC to set.
- Certain aftermarket air induction systems or modifications to the air induction system may cause a DTC to set.
- Certain aftermarket exhaust system components may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify no other DTCs are set.
    - **If any other DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** for further diagnosis.

- **If no other DTCs are set**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
4. Verify DTC P219A or P219B is not set.
   - **If a DTC is set**

     Refer to Circuit/System Testing.

   - **If no DTC is set**
5. All OK.

Circuit/System Testing

1. Engine idling, transmission in Park or Neutral, verify the manifold absolute pressure (MAP) sensor parameter is between 20-48 kPa.
   - **If not within the specified range** .

     Refer to **DTC P0106** .

   - **If within the specified range**
2. Verify the conditions listed below do not exist:
   - Modified, damaged, leaking, or restricted air induction system components.
   - Vacuum leaks at the intake manifold, the throttle body, and the injector O-rings.
   - Improperly operating crankcase ventilation system. Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
   - Split, kinked, or improperly connected vacuum hoses.
   - Restricted, damaged, leaking, or modified exhaust system from the catalytic converter forward. Refer to **Symptoms - Engine Exhaust** .
   - Improperly operating fuel injectors. Refer to **Fuel Injector Solenoid Coil Test**.
   - Fuel contamination. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
   - Excessive fuel in the crankcase due to leaking injectors. Change engine oil as necessary.
   - Improperly operating ignition system. Refer to **Electronic Ignition System Diagnosis**.
   - **If a condition is found**

     Repair as necessary.

   - **If no condition is found**
3. Test the engine for any mechanical conditions such as sticking valves, lifters, etc., which could alter the flow into the combustion chamber. Refer to **Symptoms - Engine Mechanical** .

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Perform the scan tool Fuel Trim Reset after completing the repair.

DTC P2227-P2230: BAROMETRIC PRESSURE (BARO) SENSO

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2227

Barometric Pressure (BARO) Sensor Performance

DTC P2228

Barometric Pressure (BARO) Sensor Circuit Low Voltage

DTC P2229

Barometric Pressure (BARO) Sensor Circuit High Voltage

DTC P2230

Barometric Pressure (BARO) Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641, P2227, P2228	P2227, P2228	P0193, P0641, P2227, P2229	P2227
Signal	P2227, P2228	P2227, P2228	P2227, P2229	P2227
Low Reference	-	P0113, P2199, P2227, P2228, P2229	-	P2227

Typical Scan Tool Data

BARO

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On, Engine Off **Parameter Normal Range:** 56-105 kPa (8.1-15.2 psi), varies with altitude			
5 V Reference	0 kPa (0 psi)	0 kPa (0 psi)	128 kPa (18.6 psi)
Signal	0 kPa (0 psi)	0 kPa (0 psi)	128 kPa (18.6 psi)

Circuit	Short to Ground	Open	Short to Voltage
Low Reference	-	128 kPa (18.6 psi)	-

Circuit/System Description

The barometric pressure (BARO) sensor is integral to the multifunction intake air sensor and responds to changes in altitude and atmospheric conditions. This gives the ECM an indication of barometric pressure. The ECM uses this information to calculate fuel delivery. The BARO sensor provides a voltage signal to the ECM relative to the atmospheric pressure changes. The ECM monitors the BARO sensor signal for a voltage outside of the normal range.

Conditions for Running the DTC

P2227

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P2101, P2135, P2228, or P2229 is not set.
- The engine is running.

OR

- DTC P0106, P0107, P0108, P2228, P2229, P2230, or P2610 is not set and P0107, P0108, P2228, or P2229 is not pending.
- Ignition On, engine Off
- The time between the current ignition cycle and the last time the engine was running is greater than 7 min.
- DTC P2227 runs continuously when the above conditions are met.

P2228 or P2229

- The engine is running.
- The DTCs run continuously when the above condition is met .

P2230

- DTC P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0111, P0112, P0113, P0114, P0117, P0118, P0119, P0121, P0122, P0123, P0222, P0223, P2101, P2135, P2228, or P2229 is not set.
- The ignition is On.
- DTC P2230 runs continuously when the above conditions are met.

Conditions for Setting the DTC

P2227

- The engine is running.
- The ECM detects that the difference between the BARO signal and the calculated BARO is greater than

15 kPa (2.2 psi) if the vehicle has traveled at most 2.0 km (1.2 mi) since the last calculated BARO update, or the ECM detects that the difference between the BARO signal and the calculated BARO is greater than 20 kPa (2.9 psi) if the vehicle has traveled greater than 2.0 km (1.2 mi) since the last calculated BARO update.

OR

- Ignition On, engine Off
- The ECM detects that the BARO pressure is less than 50 kPa (7.3 psi) or greater than 115 kPa (16.7 psi).

P2228

The ECM detects that the BARO sensor voltage is less than 2.0 V for greater than 4 s.

P2229

The ECM detects that the BARO sensor voltage is greater than 4.5 V for greater than 4 s.

P2230

The ECM detects that the cumulative difference between BARO sensor readings, over a specific length of time, is greater than a calibrated threshold.

Action Taken When the DTC Sets

DTCs P2227, P2228, P2229, and P2230 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P2227, P2228, P2229, and P2230 are Type B DTCs.

Diagnostic Aids

Inspect the inlet port on the BARO sensor for moisture or debris and attempt to dry or clean the inlet, if contaminated.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition On.
2. Verify DTC P0106, P0107, P0108, or P0697 is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If none of the DTCs are set**
3. Verify the scan tool MAP Sensor parameter is within the range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
   - **If not within the specified range**

     Refer to **DTC P0106** .

   - **If within the specified range**
4. Verify the scan tool BARO pressure parameter is within the range specified in the **Altitude Versus Barometric Pressure (With LFX)** table.
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **If within the specified range**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed in the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Verify the conditions listed below do not exist with the B75C Multifunction Intake Air Sensor:
   - Damage
   - Restrictions in the inlet port

- **If a condition exists**

  Repair or replace the B75C Multifunction Intake Air Sensor as necessary.

- **If none of the conditions exist**

2. Ignition Off, and all vehicle systems Off, it may take up to 2 minutes for all vehicle systems to power down. Disconnect the harness connector at the B75C Multifunction Intake Air Sensor.
3. Test for less than 5 Ω between the low reference circuit terminal 3 and ground.
   - **If 5 Ω or greater**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If greater than the specified value, repair the open or high resistance in the circuit.
      - If 2 Ω or less replace the K20 Engine Control Module.
   - **If less than 5 Ω**
4. Ignition On.
5. Test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
   - **If less than 4.8 V**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the 5 V reference circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the 5 V reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.
   2. Test for less than 1 V between the 5 V reference circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 4.8-5.2 V**
6. Verify the scan tool BARO Sensor parameter is less than 0.2 V.
   - **If 0.2 V or greater**
   1. Ignition Off, disconnect the harness connector at the K20 Engine Control Module, ignition On.
   2. Test for less than 1 V between the signal circuit terminal 4 and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If less than 0.2 V**
7. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5 V reference circuit terminal 2.
8. Verify the scan tool BARO Sensor parameter is greater than 4.5 V.

- **If 4.5 V or less**

1. Ignition Off, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the signal circuit terminal 4 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If greater than 4.5 V**

9. Test or replace the B75C Multifunction Intake Air Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** for multifunction intake air sensor replacement
- **Control Module References** for engine control module replacement, programming, and setup

DTC P2269: WATER IN FUEL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P2269

Water in Fuel

Circuit/System Description

Alcohol content information is supplied to the engine control module from the fuel composition sensor. The fuel composition sensor has a battery positive circuit, a signal circuit, and a ground circuit. The fuel composition sensor uses a microprocessor inside the sensor to measure the ethanol percentage and changes the output signal accordingly. The signal circuit carries the ethanol percentage via the frequency signal. The ECM provides an internal pull up to 5 V on the signal circuit, and the fuel composition sensor pulls the 5 V to ground in pulses. The normal range of operating frequency is between 50-150 Hz. The microprocessor inside the sensor is capable of a certain amount of self-diagnosis. An output frequency between 180 Hz and 190 Hz indicates that the fuel is contaminated.

Conditions for Running the DTC

- The ignition voltage is greater than 11 V.

- The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

The engine control module detects that the fuel composition sensor output frequency is greater than 185 Hz for greater than 6 s.

Action Taken When the DTC Sets

DTC P2269 is a Type B DTC.

Conditions for Clearing the MIL/DTC

DTC P2269 is a Type B DTC.

Diagnostic Aids

A momentary slug of water in the fuel system may set this DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 44175-A** Alcohol Tester Kit
- **EL 38522-A** Variable Signal Generator

For equivalent regional tools, Refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)**

Circuit/System Verification

1. Engine running, verify the scan tool Fuel Composition Sensor parameter is between 50-150 Hz.
    - **If not between 50-150 Hz**

      Refer to Circuit/System Testing.

    - **If between 50-150 Hz**
2. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
3. Verify the DTC does not set.
    - **If DTC is set**

      Refer to Circuit/System Testing.

    - **If DTC is not set**
4. All OK.

Circuit/System Testing

1. Verify that there are no contaminants, water, or too high of a concentration of ethanol in the fuel. Refer to **Alcohol/Contaminants-in-Fuel Diagnosis** and the **CH 44175-A** Instruction Manual.
    - **If the fuel tested is not within acceptable levels**

      Refer to **Fuel System Cleaning**

    - **If the fuel tested is within acceptable levels**
2. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B198 Fuel Composition Sensor. It may take up to 2 minutes for all vehicle systems to power down.
3. Test for less than 5 Ω between the ground circuit terminal 2 and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the ground connection.
    - **If less than 5 Ω**
4. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
    - **If the test lamp does not illuminate and the fuse is not opened**
    1. Ignition OFF, remove the test lamp.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is good and voltage is supplied to the fuse.
    - **If the test lamp does not illuminate and the fuse is opened**
    1. Ignition OFF, remove the test lamp.
    2. Test for infinite resistance between the B+ circuit and ground

- If less than infinite, repair the short to ground in the circuit.
- If infinite, test all the components connected to the circuit, and repair or replace as necessary.

- **If the test lamp illuminates**

5. Ignition ON, test for 4.8-5.2 V between the signal circuit terminal 3 and ground.
   - **If less than 4.8 V**
   1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module.
   2. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, test or replace the K20 Engine Control Module.
   - **If greater than 5.2 V**
   1. Ignition OFF, disconnect the harness connector X1 at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, test or replace the K20 Engine Control Module.
   - **If within 4.8-5.2 V**
6. Ignition OFF, connect the red lead of the **EL 38522-A** Variable Signal Generator to the signal circuit terminal 3 at the B198 Fuel Composition Sensor harness connector. Connect the battery voltage supply to B+, and the black lead to ground.
7. Set the **EL 38522-A** Variable Signal Generator Signal to 5 V, the Frequency to 60 Hz, and the Duty Cycle to Normal.
8. Ignition ON.
9. Clear the DTCs with a scan tool.
10. Verify the scan tool Fuel Composition Sensor parameter is at 60 Hz.
    - **If not 60 Hz**

      Test or replace the K20 Engine Control Module.

    - **If 60 Hz**
11. Test or replace the B198 Fuel Composition Sensor.

Component Testing

1. Test the fuel composition using the **CH 44175-A** Alcohol Tester Kit and the CH 44175-A Instruction Manual. Record the frequency.
2. Compare the special tool test frequency and the scan tool Fuel Composition Sensor frequency parameter.
3. Verify the difference between the tool and the sensor is 12 Hz or less.
   - **If greater than the specified value**

     Replace the B198 Fuel Composition Sensor.

   - **If less than the specified value**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Flexible Fuel Sensor Replacement**
- **Fuel System Cleaning**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup.

DTC P2544: TRANSMISSION TORQUE REQUEST SIGNAL MESSAGE COUNTER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for a overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2544

Transmission Torque Request Signal Message Counter Incorrect

Circuit/System Description

To improve shift feel, the transmission control module (TCM) is constantly sending the engine control module (ECM) serial data messages with requests to modify engine speed or torque. These serial data messages are sent through two circuits which are part of a communication network called the controller area network (CAN). The ECM sets DTC P2544 when it detects a discrepancy in the structure of the message causing the integrity of the message to be questioned.

Conditions for Running the DTC

- The engine run time is greater than 0.5 s.
- No other CAN errors are present.

Conditions for Setting the DTC

The ECM detects that the engine speed and torque modification messages from the TCM are either corrupted or intermittently missing for greater than 4 s.

Action Taken When the DTC Sets

- DTC P2544 is a Type B DTC.
- The TCM commands maximum line pressure during shifts, which results in harsh shifts.
- The TCM freezes adaptive functions.

Conditions for Clearing the DTC

DTC P2544 is a Type B DTC.

Diagnostic Aids

An intermittent fault in the CAN circuits will cause the ECM to set DTC P2544.

Reference Information

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE:

- **DTC P2544 is an informational DTC.**
- **Diagnose all other engine control module DTCs prior to DTC P2544.**

1. Verify that no other DTCs are set except for DTC P2544.
   - **If any other DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If only DTC P2544 is set**
2. Replace the K71 Transmission Control Module.
3. Operate the vehicle within the conditions for running the DTC. You may also operate the vehicle within the conditions that you observed from the freeze frame/failure records data.
4. Verify the DTC does not set.
   - **If DTC sets**

     Replace the K20 Engine Control Module.

   - **If DTC does not set**
5. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for ECM or TCM replacement, programming, and setup

DTC P2635: FUEL PUMP FLOW PERFORMANCE (CHASSIS CONTROL MODULE)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P2635

Fuel Pump Flow Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0231	P023F	P0232	P023F, P2635
Low Reference	-	P023F	-	P023F, P2635

Circuit/System Description

The engine control module (ECM) supplies voltage to the chassis control module when the ECM detects that the ignition is on. The voltage from the ECM to the chassis control module remains active for two seconds, unless the engine is in crank or run. While this voltage is being received, the chassis control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel line pressure.

Conditions for Running the DTC

- DTC P018B, P018C, P018D, P0231, P0232, P023F, P064A, P1255 or P06A6 are not active.
- DTC P0641 has not failed this ignition cycle.
- Fuel pump control is enabled and the fuel pump control state is normal.
- The system voltage is greater than 11 V.
- The engine has been running for more than 30 seconds.
- Low fuel level warning not present.

Conditions for Setting the DTC

This DTC sets when the chassis control module detects a predetermined fuel pressure performance degradation between the desired fuel pressure and the current fuel pressure.

Action Taken When the DTC Sets

DTC P2635 is a Type B DTC.

Conditions for Clearing the DTC

DTC P2635 is a Type B DTC.

Diagnostic Aids

Using the failure records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the failure records can help determine how many miles since the DTC set. The fail counter and pass counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

On vehicles equipped with a high pressure mechanical pump on direct injection engines, the vehicle may continue to run even though the pump in the fuel tank is not operating.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: **Do not replace the chassis control module based on a history DTC P2635. The DTC P2635 may be stored but that does not indicate a failure of the chassis control module. Refer to Strategy Based Diagnosis for further history DTC diagnostics.**

1. Ignition ON.
2. Verify DTC P018B, P018C, P018D, P0231, P0232 or P023F is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If none of the DTCs are set**
3. Verify the proper fuel system pressure. Perform the fuel system pressure test, refer to **Fuel System Diagnosis**.
   - **If the fuel system pressure test is not normal**

     Replace the A7 Fuel Pump and Level Sensor Assembly.

   - **If the fuel system pressure test is normal**
4. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the A7 Fuel Pump and Level Sensor Assembly. It may take up to 2 minutes for all vehicle systems to power down.
5. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.

- **If 10 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
2. Test for less than 2 Ω in the low reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K38 Chassis Control Module.

- **If less than 10 Ω**

6. Connect a test lamp between the control circuit terminal 1 and the low reference circuit terminal 2.
7. Ignition ON.
8. Verify the test lamp turns On and Off when commanding the fuel pump On and Off using the scan tool ECM fuel pump enable control function.
    - **If the test lamp is always Off**

    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K38 Chassis Control Module.

    - **If the test lamp is always On**

    1. Ignition OFF, disconnect the harness connector at the K38 Chassis Control Module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K38 Chassis Control Module.

    - **If the test lamp turns On and Off**

9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for chassis control module replacement, programming, and setup.

SYMPTOMS - ENGINE CONTROLS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Symptoms Description

Symptoms covers conditions that are not covered by DTCs. Certain conditions can cause multiple symptoms.

These conditions are listed together under Symptoms Testing. Conditions that may only cause specific symptoms are listed separately under Additional Symptoms Testing. Perform the Symptoms Testing before using the Additional Symptoms Testing.

Symptoms Definition

Backfire

The fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Cuts Out, Misses

A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1,500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

Engine Control Module (ECM) Commanded Reduced Engine Power

The ECM illuminates the Reduced Engine Power lamp and will limit engine power under potential engine/vehicle damaging or emissions related conditions. A DTC may not be set.

Detonation/Spark Knock

A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Dieseling, Run-On

The engine continues to run after the key is turned OFF, but runs very rough.

Fuel Odor

A noticeable smell of unburned fuel.

Hard Start

The engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stall.

Hesitation, Sag, Stumble

A momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

Lack of Power, Sluggishness, or Sponginess

The engine delivers less than expected power. Little or no increase in vehicle speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy

Fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time, as previously shown by an actual road test.

Rough, Unstable, or Incorrect Idle and Stalling

The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle speed may vary. Either condition may be severe enough to stall the engine.

Surges/Chuggles

An engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

Symptoms Verification

Before using the Symptom tables, perform the following verifications:

- Verify that the malfunction indicator lamp (MIL) is operating correctly. Use the scan tool to command the lamp ON and OFF.
- Verify there are no DTCs that are stored.
- Verify that the scan tool data is within a normal operating range. Refer to **Control Module References** for scan tool information.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.

Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movements of a component. Refer to the following for a list of issues that may cause an intermittent condition:

- Moisture and water intrusion in connectors, terminals, and components
- Incomplete connector mating
- Poor terminal contact
- High circuit or component resistance-High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Wiring harness that is too short or tight
- Wire insulation that is chaffed or cut
- High or low ambient temperature
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in component or circuit due to circuit resistance, poor terminal contact, or high electrical load

- High or low system voltage
- High vehicle load conditions
- Rough road surfaces
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of aftermarket, add on accessories

Visual/Physical Check

- Verify that the control module grounds are clean, tight, and correctly located.
- Verify that the vacuum hoses are not split or kinked, and are properly connected.
- Verify that the air filter is clean and free from restrictions.
- Verify that there is no water intrusion in connectors terminals and components.
- Inspect the air intake ducts for the conditions listed below:
    - Collapsed
    - Damaged areas
    - Looseness
    - Incorrect installation
    - Leaking

      If any condition listed above has allowed non-metered air to enter the air induction system, the **Q38 Throttle Body: Throttle/Idle Learn** procedure must be performed after the repair is complete.
- Inspect for air leaks at the throttle body mounting area, the mass air flow (MAF) sensor and intake manifold sealing surfaces.
- Inspect the wiring harness for the following conditions:
    - Poor connections
    - Pinches
    - Cuts
- Inspect for loose, damaged, unseated, or missing sensors/components.
- Inspect the terminals for corrosion and correct contact.

Symptoms Testing

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Engine Control Module (ECM) Commanded Reduced Engine Power, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness /Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles

- Test/inspect the fuel system for the conditions listed below:
    - Incorrect system operation or fuel pressure-Refer to **Fuel System Diagnosis**.
    - Leaking or incorrectly operating fuel injectors-Refer to **Fuel Injector Solenoid Coil Test**.
    - Contaminated or poor quality fuel-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- Test/inspect the ignition system for the conditions listed below:
    - Spark plugs with incorrect heat range or an abnormal condition-Refer to **Spark Plug Inspection** ,

and **Ignition System Specifications** .

- Coolant or oil fouled spark plugs-Refer to **Coolant in Combustion Chamber** , or **Oil Consumption Diagnosis** for diagnosis.
- Secondary ignition system susceptible to moisture. Wet down the secondary ignition system with water from a spray bottle to help locate damaged or deteriorated components. Engine running, look/listen for arcing or misfiring as the water is applied.
- Weak spark using the **J 26792** HEI spark tester -Refer to **Electronic Ignition System Diagnosis**.

- Test/inspect for the conditions listed below:
  - Non-metered air flow into the air induction system. If a leak is found, repair as necessary. The **Q38 Throttle Body: Throttle/Idle Learn** procedure must be performed when the repair is complete.
  - Incorrectly operating transmission torque converter clutch (TCC) - The scan tool should indicate an engine speed drop when the TCC is commanded ON. Refer to **Torque Converter Diagnosis** .
  - Incorrectly operating A/C compressor
  - An engine that runs lean or rich-Observe the Fuel Trim parameters with a scan tool.
  - Slow responding heated oxygen sensors (HO2S)-The HO2S should respond quickly to different throttle positions.

    CAUTION: Refer to Heated Oxygen and Oxygen Sensor Caution .

  - Water intrusion in the HO2S connector

    NOTE: The embossed arrows on the mass air flow (MAF) sensor indicate the direction of the intake air flow. The arrows must point toward the engine.

  - Incorrect mass air flow (MAF) sensor installation. A MAF sensor that is incorrectly installed may cause a hard start. Install the MAF in the correct direction. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
  - Incorrect MAF sensor connections.
  - Engine oil contaminated by fuel
  - Split or kinked vacuum hoses-Verify that the routing and connections are correct.
  - Excessive knock sensor system spark retard activity-Observe the scan tool Knock Retard parameter for activity greater than 0Â°.
  - Electromagnetic interference (EMI) on reference circuits, which can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists.
  - Incorrectly operating crankcase ventilation valve-Refer to **Crankcase Ventilation System Inspection/Diagnosis** .
  - A stuck open evaporative emission (EVAP) canister purge solenoid.
  - A crankshaft position (CKP) sensor with an intermittent condition-Observe the scan tool Crankshaft Position Resync Counter parameter. The parameter should remain at 0 during all operating conditions, and when moving the related harnesses and connectors between the

crankshaft position sensor and the ECM.

- Test/inspect the engine cooling system for the conditions listed below:
  - A thermostat with an incorrect heat range-Refer to **Thermostat Diagnosis** .
  - Incorrect engine coolant level-If the level is low, refer to **Loss of Coolant** .

  For additional information, refer to **Symptoms - Engine Cooling**

- Test/inspect the exhaust system components for the conditions listed below:
  - Physical damage or possible internal failure
  - Restricted three-way catalytic converters

  For more information, refer to **Symptoms - Engine Exhaust** .

- Test/inspect the engine for the mechanical conditions listed below:
  - Excessive oil in the combustion chamber or leaking valve seals
  - Oil consumption
  - Incorrect cylinder compression
  - Sticking or leaking valves
  - Worn camshaft lobes
  - Incorrect valve timing
  - Worn rocker arms
  - Broken valve springs
  - Excessive carbon buildup in the combustion chambers-Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.
  - Incorrect engine parts

  For additional information, refer to **Symptoms - Engine Mechanical**

- If the above conditions do not address the symptom, refer to the additional symptoms tests.

Additional Symptoms Tests

Detonation/Spark Knock

- Test for an engine overheating condition. Refer to **Engine Overheating** .
- Verify that the engine coolant temperature (ECT) has not shifted in value. Allow the engine to run and reach operating temperature. Observe the ECT Sensor parameter with a scan tool and compare the reading to that parameter listed on the **K20 Engine Control Module: Scan Tool Information** , list. If the reading is not in the range specified in the list, test the resistance of the ECT sensor. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** , for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement** . If the sensor is within the specification, test the ECT sensor circuits for high resistance.
- Inspect for excessive carbon buildup in the combustion chambers. Clean the chambers with Top Engine Cleaner, if necessary. Follow the instructions on the can.

- If there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vehicle minimum octane requirements.

Engine Control Module (ECM) Commanded Reduced Engine Power

Under certain conditions the engine control module may limit engine power by reducing engine torque and, for some vehicles, fuel pressure as well. For most, but not all of the conditions, the engine control module will illuminate the reduced engine power lamp on the instrument cluster. If equipped with the driver information center feature, a reduced engine power message may be displayed as well. A DTC may not be set.

A repair may not be necessary. Observe the scan tool Reduced Engine Power History parameter or refer to **K20 Engine Control Module: Scan Tool Information** to determine the reason for the reduced engine power event.

Verify or inspect for the following:

- Vehicle being operated at sustained high engine speeds, or, towing heavy loads up an incline for an extended period of time, which may cause the engine oil or coolant to overheat. Inspect the airflow passageways in front of the engine for obstructions and clear away any debris or foreign material that is found. If no obstructions are found, review approved driving habits with the customer. The customer may need to operate the vehicle at a higher engine speed to improve cooling system performance, or, at a slower engine speed to reduce engine load.
- A cooling fan condition which may cause the ECM to reduce engine power. Refer to **Cooling Fan Description and Operation** , and **Cooling System Description and Operation** to verify correct operation of the cooling fan.
- Temporarily reduced engine power. Under extremely cold ambient temperatures some SIDI equipped vehicles may experience ECM commanded reduced engine power for a few minutes during engine warm-up. This would be a normal condition, noticeable only at wide open throttle, and the reduced engine power lamp would not be illuminated.
- Fuel temperature out of range too high.
- A high pressure fuel system condition. Refer to **Fuel System Diagnosis**, and **Fuel System Description** to verify high pressure fuel system pressure and operation.
- Intake air temperature out of range too high. Engine running, observe the scan tool IAT sensor parameter. The readings should be between -40Â° C and +149Â° C (-40Â° F and +300Â° F. Refer to **DTC P0112, P0113, or P0114** for additional information.
- Reduced engine power due to OnStarÂ® remote command. Verify the vehicle is not in the OnStarÂ® initiated Stolen Vehicle Slowdown mode. Refer to **OnStar Stolen Vehicle Slowdown Active** , and **Remote Vehicle Speed Limiting Description and Operation** for additional information.
- If equipped with MH7 (6T45) or MHH (6T40) automatic transmission, an incorrect learned brake pedal position (BPP) sensor. Verify the following actions have not occurred:
    - An engine control module has been replaced
    - A BPP sensor that has been replaced
    - A BPP sensor is misaligned or incorrectly installed

      If any of the above actions have occurred, the **Brake Pedal Position Sensor Learn** procedure must be performed.

Fuel Odor

- Inspect for leaking, damaged, or deteriorated fuel lines.
- Inspect for a saturated EVAP canister-Refer to **Evaporative Emission Control System Description** .
- Inspect for a condition with the internal components of the fuel tank assembly-Refer to **Fuel System Description** .

Hard Start

- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and clean, if necessary. Refer to **Throttle Body Inspection and Cleaning** .
- Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the intake air temperature (IAT) sensor value on a cold engine. The ECT and IAT sensor values should be within Â± 3Â°C (5Â°F). If the ECT sensor is out of range with the IAT sensor, test the resistance of the ECT sensor. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** , for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement** . If the sensor is within the specification, test the ECT sensor circuits for high resistance.
- Verify that the fuel system has adequate pressure for engine start-up. Observe the scan tool Fuel Pressure Sensor parameter and refer to **Fuel System Diagnosis** for correct pressure specifications.
- Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to **Crankshaft and Bearing Cleaning and Inspection** , and **Engine Mechanical Specifications** .

Hesitation, Sag, Stumble

- Test the fuel pressure. Refer to **Fuel System Diagnosis**.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
- Test the generator. Refer to **Symptoms - Engine Electrical** . Repair the charging system if the generator output voltage is less than 9 volts or more than 16 volts.
- Verify that each injector harness is connected to the correct injector.
- Inspect for excessive crankshaft endplay that will cause the crankshaft position (CKP) sensor reluctor wheel to move out of alignment with the CKP sensor. Refer to **Crankshaft and Bearing Cleaning and Inspection** , and **Engine Mechanical Specifications** .
- Test the manifold absolute pressure (MAP) sensor. Refer to **DTC P0106** .

NOTE: **The following actions may need to be repeated in order to verify an intermittent intake or exhaust camshaft actuator condition.**

- Engine warm and idling, verify the correct operation of the camshaft actuator system. Command the intake and exhaust camshaft actuator for each cylinder bank from 0 degrees to 20 degrees and back to zero while observing the appropriate scan tool Intake Camshaft Position Variance and Exhaust Camshaft Position Variance parameters. Each parameter should be less than 2 degrees in each of the commanded states.

- If any of the parameters is greater than 2 degrees, inspect the suspect camshaft actuator and camshaft actuator solenoid valve and valve bore for contamination, obstruction, and damage. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** , and **Camshaft Actuator System Description** for additional information.

Poor Fuel Economy

- Inspect for heavy loads being carried or towed
- Inspect for acceleration rate too much or too often
- Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. Inspect the throttle body and clean, if necessary. Refer to **Throttle Body Inspection and Cleaning** .
- Inspect the brake system for brake drag.
- Inspect for incorrect operation of the speedometer.
- Verify that the engine coolant temperature (ECT) has not shifted in value. Allow the engine to run and reach operating temperature. Observe the ECT Sensor parameter with a scan tool and compare the reading to the parameter listed in the **K20 Engine Control Module: Scan Tool Information** , list. If the reading is not in the range specified in the list, test the resistance of the ECT sensor. Refer to **Temperature Versus Resistance - Engine Coolant Temperature Sensor** , for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to **Engine Coolant Temperature Sensor Replacement** . If the sensor is within the specification, test the ECT sensor circuits for high resistance.
- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .

Rough, Unstable, or Incorrect Idle and Stalling

- An excessively high idle may be due to the floor mat interfering with the accelerator pedal. With this condition present, it may not be possible to shift the transmission into gear. Inspect the accelerator pedal for binding and verify that the floor mat is not interfering with the accelerator pedal movement.
- Engine idle speed may be unstable or the engine may stall if the ECM has learned an incorrect idle/airflow compensation value. A DTC may also set. Observe the scan tool Throttle Body Idle Airflow Compensation parameter. A value greater than 90% may indicate an excessive accumulation of deposits in the throttle bore. If the throttle body needs cleaning, refer to **Throttle Body Inspection and Cleaning** .

  The actions listed below may also cause the ECM to learn an incorrect idle value.

  - The engine control module has been replaced
  - The throttle body has been replaced
  - The throttle body has been cleaned but the idle learn procedure was not performed after completing the cleaning
  - The air induction system was leaking, allowing non-metered air to enter the combustion chamber. The leak was repaired but the idle learn procedure was not performed after repairing the leak

    If any of the actions listed above have occurred, the **Q38 Throttle Body: Throttle/Idle Learn** procedure must be performed.

- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
- Inspect the engine mounts. Refer to **Engine Mount Inspection**
- Inspect the intake and exhaust manifolds for casting flash.

NOTE: **The ECM uses the bank 1 exhaust camshaft position sensor to determine camshaft to crankshaft relationship in order to control fuel injector and ignition system synchronization. If the bank 1 exhaust camshaft position sensor signal to the ECM is intermittent, a stalling condition will occur and a DTC will not set.**

- Inspect all bank 1 exhaust camshaft position sensor wiring for poor connections. Start the engine and observe for engine stalling while wiggling the bank 1 exhaust camshaft position sensor wiring harness. Refer to **Inducing Intermittent Fault Conditions** for further diagnosis.

Surges/Chuggles

- Inspect the mass air flow (MAF) sensor for obstruction, contamination, and damage. Refer to **Mass Airflow Sensor with Intake Air Temperature Sensor Replacement** .
- Inspect for slow responding heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The PCM reduces the amount of fuel delivered to the engine, causing a driveability condition.
- Verify that each injector harness is connected to the correct injector.

POOR FUEL FILL QUALITY

Problem	Causes
DEFINITION: During the fueling process a continual, occasional, or no-fuel nozzle shut-off condition has occurred.	
Difficult to fill	• Fuel fill limiter vent valve stuck closed • Evaporative emission (EVAP) canister restricted • EVAP vent valve stuck closed • Hose between canister and canister vent solenoid twisted or kinked if applicable • High fuel temperature • Fuel filler hose is kinked • Faulty dispensing nozzle • Ignition switch ON, vent valve closed
Over fill	• Fill limiter vent valve stuck open or leaking • Fuel inlet check valve stuck open

Problem	Causes
Pre-mature shut-off of the fuel dispensing nozzle occurs immediately after engaging dispensing nozzle, tank empty	• Restricted vapor lines or fuel fill pipe • High fuel temperature • Inlet check valve at tank stuck closed, fill pipe full of fuel • Fuel tank full, gauge not accurate
Pre-mature shut-off of the fuel dispensing nozzle, more than 1/8 of tank capacity dispensed	• Kinked, pinched or plugged lines in fuel tank vent system • EVAP vent valve stuck closed or restricted • EVAP canister restricted • Fuel limiting vent valve stuck closed or obstruction at top of fuel tank
Fuel Spitback	• Restricted EVAP canister • High fuel temperature • Ignition switch ON, EVAP vent valve closed

MALFUNCTION INDICATOR LAMP (MIL) DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The malfunction indicator lamp (MIL) illuminates to inform the driver that an emission system fault has occurred and the powertrain control system requires service. Ignition voltage is supplied directly to the MIL. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit when the emission system fault occurs. Under normal operating conditions, the MIL should be ON only when the ignition is ON and the engine is OFF.

Diagnostic Aids

If the condition is intermittent, move the related harnesses and connectors while monitoring the scan tool MIL control circuit status parameters. Perform this test with the ignition ON and the engine OFF, and with the engine running. The MIL control circuit status parameters change from OK or Not Run to Malfunction if there is a condition with a circuit or a connection.

Reference Information

Schematic Reference

- **Engine Controls Schematics**
- **Instrument Cluster Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: Any MIL requesting DTCs that may be set should be diagnosed first.

1. Ignition ON.
2. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - The MIL Control Circuit Low Voltage Test Status
    - The MIL Control Circuit Open Test Status
    - The MIL Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing

    - **If Malfunction is not displayed**
3. Engine running.
4. Verify the parameters listed below do not display Malfunction when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - The MIL Control Circuit Low Voltage Test Status
    - The MIL Control Circuit Open Test Status
    - The MIL Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing

    - **If Malfunction is not displayed**
5. Verify the malfunction indicator lamp turns ON and OFF when commanding the Malfunction Indicator Lamp On and Off with a scan tool.
    - **If the malfunction indicator lamp does not turn ON and OFF**

      Refer to Circuit/System Testing

- **If the malfunction indicator lamp turns ON and OFF**

6. All OK.

Circuit/System Testing

1. Ignition OFF.
2. Disconnect the X1 harness connector at the K20 Engine Control Module.
3. Ignition ON, verify the malfunction indicator lamp does not illuminate.
    - **If the malfunction indicator lamp illuminates**
    1. Test for infinite resistance between the control circuit terminal X1 46 and ground.
        - If less than infinite resistance, repair the short to ground in the circuit.
        - If infinite resistance, replace the P16 Instrument Cluster.
    - **If the malfunction indicator lamp does not illuminate**
4. Connect a 3 A fused jumper wire between the control circuit terminal X1 46 and ground.
5. Verify the malfunction indicator lamp illuminates.
    - **If the malfunction indicator lamp illuminates**

      Replace the K20 Engine Control Module.

    - **If the malfunction indicator lamp does not illuminate**
    1. Test for less than 1 V between the control circuit terminal X1 46 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    2. Ignition OFF.
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω.
6. Ignition OFF, disconnect the harness connector at the instrument cluster.
7. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal 20 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the ignition voltage circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ignition voltage circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - **If the test lamp illuminates**
8. Replace the P16 Instrument Cluster.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Instrument Cluster Replacement**
- **Control Module References** for control module replacement. programming, and setup

ENGINE CRANKS BUT DOES NOT RUN

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

This Engine Cranks But Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but not start. This diagnostic directs the technician to the appropriate system diagnosis.

Diagnostic Aids

Inspect for any of the conditions listed below:

- If equipped with a key type ignition system, a partially retracted or folded over ignition key. When attempting to start the engine, the mechanical portion of the vehicle key must be locked in the fully extended position with the fob parallel to the key. Leaving the key partially retracted or folded over when starting may interrupt transponder authentication and result in an intermittent no-start condition. In such instances, DTC B3055 may also be set. If an intermittent no-start complaint is received, it may be necessary to discuss with the customer their starting habits and verify they are locking the key in the fully extended position, fob parallel to the key, before starting.
- A crankshaft position sensor condition. When this condition is present, the engine control module (ECM) uses the camshaft position sensors to determine engine speed and position. If the condition exists in the signal circuit of the sensor, the engine will go into a limp home mode after a hard restart. The ECM then calculates engine speed from one of the camshaft position sensors. However, the engine will operate with a crankshaft position sensor condition only if the ECM has stored the learned reference position of the camshafts in memory.
- An in-tank fuel pump condition. The fuel pump flow control module controls and monitors the operation of the in-tank fuel pump. If the fuel pump flow control module detects a fault, a DTC sets in the fuel pump flow control module. The fuel pump flow control module will then send a serial data message to the engine control module (ECM) requesting the illumination of the malfunction indicator lamp (MIL).
- Insufficient fuel. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid. Refer to **Fuel Injector Solenoid Coil Test** for diagnosis.
- Fuel injector ON time inadequate. When this condition is present, there may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Check all the engine data parameters with a scan tool and compare the values indicated with the expected values or the values

from a known good vehicle.

- Loose unsecured engine electrical grounds. Inspect the engine for good secure electrical grounds.
- Water or foreign material in the fuel, which can cause either a no start or a engine will not stay running condition. During freezing weather water can freeze inside the fuel system. The engine may start after 30 min in a heated repair shop. The malfunction may not recur until parked overnight in freezing temperatures. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.
- An ignition system that is susceptible to moisture. An engine that starts and runs after being brought into a warm, dry repair shop, may be susceptible to moisture. Spray water on the ignition system components and wiring while cranking the engine in order to check for an engine starting or will not stay running concern.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH 48027** Digital Pressure Gauge
- **J 26792** HEI Spark Tester

Circuit/System Verification

NOTE: **This diagnostic assumes the following:**

- **The battery is completely charged.**
- **The engine cranking speed is acceptable.**
- **There is adequate fuel in the fuel tank.**

1. Crank the engine for up tp 15 s.
2. Verify that DTC P0116, P0118, P0201-P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0335, P0336, P0513, P0601, P0602, P0603-P0606, P062B, P0627, P0628, P0629, P0633, P069E, P1631, P1649, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, or U0109 is not set.
   - **If any of the DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
   - **If none of the DTCs are set**
3. Ignition ON.
4. Verify the Security Indicator on the instrument cluster illuminates momentarily.
   - **If the security indicator stays ON or is flashing**

     Review the **Diagnostic Trouble Code (DTC) List - Vehicle** , for immobilizer system DTCs. For additional information, refer to **Immobilizer Description and Operation** .
   - **If the security indicator does not stay ON and is not flashing**
5. Verify the scan tool Engine Speed parameter displays greater than 0 RPM while cranking the engine.
   - **If 0 RPM**

     Refer to **DTC P0335 or P0336** .
   - **If greater than 0 RPM**

NOTE: **A MAF sensor circuit condition may cause an Engine Cranks But Does Not Run condition without setting a DTC.**

6. Verify that the scan tool Mass Airflow Sensor parameter displays greater than 0 Hz while cranking the engine.
   - **If 0 Hz**

     Refer to **DTC P0102 or P0103**
   - **If greater than 0 Hz**
7. Ignition OFF, connect the **J 26792** HEI Spark Tester between the spark plug boot of a T8 Ignition Coil and ground.

NOTE:
- **Perform the spark test on at least three of the cylinders.**
- **An erratic or weak spark is considered to be a no spark condition.**

8. Verify the spark tester sparks while cranking the engine.
   - **If the spark tester does not spark**

     Refer to **Electronic Ignition System Diagnosis**.
   - **If the spark tester sparks**

9. Ignition OFF, all accessories OFF.
10. Install a **CH-48027** Digital Pressure Gauge. Refer to **Fuel Pressure Gauge Installation and Removal**
11. Ignition ON, engine OFF

NOTE:

- **If the engine is too hot, high fuel pressure readings may result due to hot soak fuel boiling. Allow the engine coolant temperature to cool to less than 60Â° C (150Â° F) before attempting to verify fuel pressure.**
- **The Fuel Pump Enable may need to be commanded On a few times in order to obtain the highest possible fuel pressure.**
- **Additional DTCs may set when using the fuel pump output control.**

12. Command the Fuel Pump Enable ON several times with a scan tool.
13. Verify the fuel pressure is between 345-690 kPa (50-100 psi) while the fuel pump is running.
    - **If not within the specified range**

      Refer to **Fuel System Diagnosis**

    - **If within the specified range**

NOTE: **The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.**

14. Verify that the fuel pressure, after the fuel pump has turned OFF, decreases to 500-599 kPa (72-87 psi), and does not decrease greater than 34 kPa (5 psi) in 1 minute from that point.
    - **If not within the specified range**

      Refer to **Fuel System Diagnosis**

    - **If within the specified range**

NOTE: **Allow the vehicle to stabilize at an ambient temperature between 20-32Â° C (68-90Â° F) before performing the following step.**

15. Verify the Fuel Rail Pressure Sensor parameter is between 1.9-2.1 MPa (279-305 psi) while cranking the engine.
    - **If not within the specified range**

      Perform the Circuit/System Testing section of the **Fuel Injector Circuit Diagnosis**.

    - **If within the specified range**
16. Verify none of the conditions listed below exist:
    - Collapsed air intake duct to the throttle body
    - Restricted air filter element
    - Gas or coolant fouled spark plugs
    - A skewed engine coolant temperature (ECT) sensor-Refer to **Temperature Versus Resistance -**

Engine Coolant Temperature Sensor .

- Restricted exhaust system-Refer to **Restricted Exhaust** .
- Contaminated fuel-Refer to **Alcohol/Contaminants-in-Fuel Diagnosis**.
- An engine mechanical condition, for example, worn timing chain and gears, low compression-Refer to **Symptoms - Engine Mechanical** .
  - **If a condition exists**

    Repair as necessary.
  - **If no conditions exist**

17. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

FUEL SYSTEM DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine control module (ECM) supplies voltage to the fuel pump control module when the ECM detects that the ignition is ON. The voltage from the ECM to the fuel pump control module remains active for 2 s, unless the engine is in Crank or Run. While this voltage is being received, the fuel pump control module closes the ground switch of the fuel pump and also supplies a varying voltage to the fuel tank pump module in order to maintain the desired fuel rail pressure.

The fuel system is an electronic returnless on-demand design. A returnless fuel system reduces the internal temperature of the fuel tank by not returning hot fuel from the engine to the fuel tank. Reducing the internal temperature of the fuel tank results in lower evaporative emissions.

An electric turbine style fuel pump attaches to the primary fuel tank fuel pump module inside the fuel tank. The fuel pump supplies fuel through the fuel feed pipe to the high pressure fuel pump. The high pressure fuel pump supplies fuel to a variable-pressure fuel rail. Fuel enters the combustion chamber through precision multi-hole fuel injectors. The high pressure fuel pump, fuel rail pressure, fuel injection timing, and injection duration are controlled by the engine control module (ECM).

The primary fuel tank fuel pump module also contains a primary jet pump and a secondary jet pump. Fuel pump flow loss, caused by vapor expulsion in the pump inlet chamber, is diverted to the primary jet pump and the secondary jet pump through a restrictive orifice located on the pump cover. The primary jet pump fills the reservoir of the primary fuel tank fuel pump module. The secondary jet pump creates a venturi action which causes the fuel to be drawn from the secondary side of the fuel tank, through the fuel transfer pipe, to the primary side of the fuel tank.

Diagnostic Aids

Observe the Misfire Counters or perform the Fuel Injector Balance Test to help identify a leaking fuel injector.

Reference Information

Description and Operation

Fuel System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J-37287-FF Fuel Line Shut-Off Adapter

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

NOTE:

- **Repair all fuel system related DTCs before performing this diagnostic.**
- **Inspect the fuel system for damage or external leaks before proceeding.**
- **Verify that adequate fuel is in the fuel tank before proceeding.**
- **The Fuel Pump Enable may need to be commanded On a few times in order to obtain the highest possible fuel pressure.**
- **DO NOT perform the Fuel System Diagnosis if the engine coolant temperature is above 60Â°C (150Â°F). High fuel pressure readings may result due to hot soak fuel boiling. With the engine OFF, the fuel pressure may increase beyond the pressure relief regulator valve's setting point of 690 kPa (100 PSI) Â± 5 percent.**

1. Ignition ON, engine OFF, command the Fuel Pump Enable On several times with a scan tool.
2. Verify the Chassis Control Module Fuel Pressure Sensor parameter is between 345-690 kPa (50-100 PSI) with the fuel pump running.
    - **If less than 345 kPa (50 PSI)**

      Refer to Circuit/System Testing - Fuel Pressure Low.

    - **If greater than 690 kPa (100 PSI)**

Replace the G12 Fuel Pump.

- **If between 345-690 kPa (50-100 PSI)**

NOTE: **The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.**

3. Verify that the Chassis Control Module Fuel Pressure Sensor parameter decreases to 500-599 kPa (72-87 PSI) after the fuel pump is turned off.
   - **If the fuel pressure does not decrease to 500-599 kPa (72-87 PSI)**

     Replace the G12 Fuel Pump.

   - **If the fuel pressure decreases to 500-599 kPa (72-87 PSI)**
4. Verify the Chassis Control Module Fuel Pressure Sensor parameter does not decrease greater than 34 kPa (5 PSI) in 1 min.
   - **If the fuel pressure decreases greater than 34 kPa (5 PSI)**

     Refer to Circuit/System Testing - Fuel Pressure Leaks Down.

   - **If the fuel pressure does not decrease greater than 34 kPa (5 PSI)**
5. Engine idling.
6. Verify that the Chassis Control Module Fuel Pressure Sensor parameter is between 300-400 kPa (43-58 PSI)
   - **If less than 300 kPa (43 PSI)**

     Refer to Circuit/System Testing - Fuel Pressure Low.

   - **If greater than 400 kPa (58 PSI)**

     Replace the G12 Fuel Pump.

7. Verify the scan tool Chassis Control Module Short Term Fuel Pump Trim and the Long Term Fuel Pump Trim when multiplied together are less than 1.5.
   - **If greater than 1.5**

     Refer to Circuit/System Testing - Fuel Pressure Low.

   - **If less than 1.5**

WARNING: **Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.**

8. Verify the scan tool Chassis Control Module Fuel Pressure Sensor and the Desired Fuel Pressure are within 45 kPa (6.5 PSI) at 300 kPa (43.5 PSI) request or 60 kPa (8.7 PSI) at 400 kPa (58 PSI) request of

each other while operating the vehicle through varying loads.

- **If greater than 45 kPa (6.5 PSI) / 60 kPa (8.7 PSI)**

  Refer to Circuit/System Testing - Fuel Pressure Drops OFF.

- **If less than 45 kPa (6.5 PSI) / 60 kPa (8.7 PSI)**

9. If the fuel system components test normal, refer to **Symptoms - Engine Controls**, **Fuel Injector Solenoid Coil Test**, and **Fuel Injector Balance Test**.

Circuit/System Testing

Fuel Pressure Low

1. Verify none of the conditions listed below exist:
   - Restricted fuel feed pipe
   - Restricted or plugged strainer
   - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
   - **If a condition exist**

     Repair as necessary.

   - **If a condition does not exist**
2. Test or replace the G12 Fuel Pump.

Fuel Pressure Leaks Down

1. Ignition OFF, relieve the fuel pressure. Refer to **Fuel Pressure Relief (Without CH 48027)** **Fuel Pressure Relief (CH 48027)** **Fuel Pressure Relief (High Side)** .
2. Install the **EN-37287** Fuel Line Shut-Off Adapters between the fuel feed pipe and the fuel rail.
3. Open the valve on the **EN-37287** Fuel Line Shut-Off Adapters.
4. Ignition ON, command the Fuel Pump Enable On with a scan tool.
5. Close the valve on the **EN-37287** Fuel Line Shut-Off Adapters.
6. Verify the Chassis Control Module Fuel Rail Fuel Pressure parameter does not decrease greater than 34 kPa (5 PSI) in 1 min.
   - **If the fuel pressure drops**

     Replace the G12 Fuel Pump.

   - **If the fuel pressure does not drop**
7. Locate and replace the leaking Q17 Fuel Injector.

Fuel Pressure Drops OFF

1. Verify none of the conditions listed below exist:
   - Restricted fuel feed pipe
   - Restricted or plugged strainer

- Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
- **If a condition exist**

  Repair as necessary.

- **If a condition does not exist**

2. Test or replace the G12 Fuel Pump.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Feed Pipe Replacement**
- **Fuel Pump Fuel Feed Hose Replacement**
- **Fuel Injector Replacement**
- **Fuel Tank Fuel Pump Module Replacement** for G12 Fuel Pump replacement

FUEL INJECTOR SOLENOID COIL TEST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine control module (ECM) supplies a separate high voltage supply circuit and a high voltage control circuit for each fuel injector. The fuel injector high voltage supply circuit and the high voltage control circuit are both controlled by the ECM. The ECM energizes each fuel injector by grounding the control circuit. The ECM controls each fuel injector with 65 V. This is controlled by a boost capacitor in the ECM. During the 65 V boost phase, the capacitor is discharged through a fuel injector, allowing for initial injector opening. The fuel injector is then held open with 12 V. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Component Testing

NOTE:

- **The resistance test must be performed at the fuel injector or mis-diagnosis will occur.**
- **The DMM and test leads must be calibrated to 0 Ω in order to prevent mis-diagnosis.**

1. Ignition OFF, all vehicle system OFF, Disconnect the harness connector at the appropriate Q17 Fuel Injector. It may take up to 2 m for all vehicle systems to power down.
2. Test for 1.9-2.3 Ω at 18-23Â°C (65-75Â°F) between the high voltage supply circuit terminal 2 and the high voltage control circuit terminal 1 at the Q17 fuel injector.
   - **If not within the specified range**

     Replace the Q17 Fuel Injector.

   - **If within the specified range**
3. Test for infinite resistance between each terminal at the Q17 Fuel Injector and the Q17 Fuel Injector housing/case.
   - **If less than infinite resistance**

     Replace the Q17 Fuel Injector.

   - **If infinite resistance**
4. All OK, perform the Fuel Injector Balance Test.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Fuel Injector Replacement

FUEL INJECTOR BALANCE TEST

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Circuit/System Description

Two methods of testing fuel injector balance are available, the Active Fuel Injector Tester (AFIT) or a scan tool. The Active Fuel Injector Tester and SIDI adaptor connects to the engine control module harness connectors to test the high pressure fuel pump performance, fuel injector wiring, and fuel injector operation. The AFIT displays step by step instructions to precisely determine pressure drop of each fuel injector. The scan tool fuel

injector balance test is performed while the engine is running at idle. The scan tool pressurizes the fuel rail to a predetermined pressure before each fuel injector is pulsed for a precise amount of time allowing a measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that is recorded and used to compare each fuel injector.

Diagnostic Aids

- Monitoring the Current Misfire Counters may help to isolate the fuel injector that is causing the condition.
- Operating the vehicle over a wide temperature range may help isolate the fuel injector that is causing the condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **CH-47976** Active Fuel Injector Tester
- **CH-47976-500** Active Fuel Injection Tester (AFIT) SIDI Adapter Kit

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)**

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Fuel Remaining parameter is greater than 10%.
   - **If the Fuel Remaining parameter is less than 10%** , add fuel to the fuel tank.
   - **If the Fuel Remaining parameter is 10% or greater**
3. Verify the scan tool ECT Sensor parameter is less than 60Â°C (140Â°F).
   - **If the ECT Sensor parameter is greater than 60Â°C (140Â°F)** , allow the engine temperature to cool.
   - **If the ECT Sensor parameter is 60Â°C (140Â°F) or less**
4. Verify the battery is fully charged and all accessories are Off.
   - **If the battery is not fully charged** , charge or repair battery as necessary.

- **If the battery is fully charged**

5. Preform the appropriate Fuel Injector Balance Test in Circuit System Testing.

Circuit System Testing

Fuel Injector Balance Test with Active Fuel Injector Tester

1. Ignition OFF, all vehicle systems OFF. Install the **CH-47976** Active Fuel Injector Tester and the **CH-47976-500** Active Fuel Injection Tester (AFIT) SIDI Adapter Kit , refer to the Active Fuel Injector Tester User Guide. It may take up to 2 minutes for all vehicle systems to power down.
2. Turn ON the Active Fuel Injector Tester and select the vehicle.
3. Ignition ON, perform the Injector Test with the Active Fuel Injector Tester.
   - **If the Active Fuel Injector Tester aborts testing due to fuel pressure or fuel leak down**

     Refer to **Fuel System Diagnosis**.

   - **If the Active Fuel Injector Tester does not abort testing**
4. Compare the test results with the appropriate recommended tolerance.
   - **If any fuel injector exceeds the recommended tolerance**

     Replace the appropriate Q17 Fuel Injector(s).

   - **If all fuel injectors are within the recommended tolerance**
5. Perform **Fuel Injector Circuit Diagnosis**.

Fuel Injector Balance Test with Scan Tool

1. Ignition ON.
2. Command the Fuel Pump Enable ON with a scan tool.
3. Verify the fuel pressure is between 345-690 kPa (50-100 PSI) with the fuel pump running.
   - **If not within 345-690 kPa (50-100 PSI)**

     Refer to **Fuel System Diagnosis**.

   - **If within 345-690 kPa (50-100 PSI)**

NOTE: **The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.**

4. Verify the fuel pressure does not decrease greater than 34 kPa (5 PSI) within 1 minute.
   - **If greater than the specified value**

     Refer to **Fuel System Diagnosis**.

   - **If less than the specified value**
5. Engine idling.

6. Verify the scan tool Fuel Rail Pressure Sensor 1 parameter is between 1.9-5.0 MPa (276-725 PSI).
    - **If not between 1.9-5.0 MPa (276-725 PSI)**

      Refer to **Fuel System Diagnosis**.

    - **If between 1.9-5.0 MPa (276-725 PSI)**

NOTE: **The engine speed must be between 600-1,000 RPM to perform this test.**

7. Select the Fuel Injector Balance function within the Control Functions menu of a scan tool.
8. Select and test a Q17 Fuel Injector. Repeat for each Q17 Fuel Injector.
9. Obtain and record a pressure drop value for each Q17 Fuel Injector.
10. Add all of the individual pressure drop values except for the fuel injector suspected of being faulty. This is the total pressure drop.
11. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop.
12. Multiply the average pressure drop by 0.20. This is the acceptable variance from the average pressure drop, 20%.
13. Verify the difference between any individual pressure drop and the average pressure drop is not greater than the acceptable variance.
    - **If greater than the acceptable variance**

      Replace the Q17 Fuel Injector.

    - **If within the acceptable variance**
14. Perform **Fuel Injector Circuit Diagnosis**.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Fuel Injector Replacement

FUEL INJECTOR CIRCUIT DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Injector 1 Control +	P2147	P0201	P2148	P1248
Fuel Injector 1 Control -	P0261	P0201	P0262	P1248

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Injector 2 Control +	P2150	P0202	P2151	P1249
Fuel Injector 2 Control -	P0264	P0202	P0265	P1249
Fuel Injector 3 Control +	P2153	P0203	P2154	P124A
Fuel Injector 3 Control -	P0267	P0203	P0268	P124A
Fuel Injector 4 Control +	P2156	P0204	P2157	P124B
Fuel Injector 4 Control -	P0270	P0204	P0271	P124B
Fuel Injector 5 Control +	P216B	P0205	P216C	P124C
Fuel Injector 5 Control -	P0273	P0205	P0274	P124C
Fuel Injector 6 Control +	P216E	P0206	P216F	P124D
Fuel Injector 6 Control -	P0276	P0206	P0277	P124D

Circuit/System Description

The engine control module (ECM) supplies voltage to each fuel injector on the injector high voltage supply circuits. The ECM energizes each fuel injector by grounding the high voltage control circuit of the fuel injector. The ECM monitors the status of the injector high voltage supply circuits and the injector high voltage control circuits. When a fuel injector circuit condition is detected by the ECM, the affected fuel injector(s) is disabled.

Diagnostic Aids

- Performing the fuel injector coil test may help isolate an intermittent condition. Refer to **Fuel Injector Solenoid Coil Test**.
- If the condition is intermittent, move the related harnesses and connectors, with the engine operating, while monitoring the scan tool Injector Control Circuit Status parameters. An Injector Control Circuit Status parameter will change from OK or Not Run to Malfunction if there is a condition with the circuit or a connection.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Fuel System Description

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Do Not perform this procedure unless directed here from the Fuel Injector Balance Test.**

1. Engine idling.
2. Verify the scan tool Cylinder 1-6 Current Misfire Counter parameters do not increment.
    - **If the Cylinder 1-6 Current Misfire Counters increment**

      Refer to Circuit/System Testing.

    - **If the Cylinder 1-6 Current Misfire Counters do not increment**
3. Verify the scan tool Cylinder 1-6 Injector Control Circuit Status parameters display OK.
    - **If the Cylinder 1-6 Injector Control Circuit Status parameters do not display OK**

      Refer to Circuit/System Testing.

    - **If the Cylinder 1-6 Injector Control Circuit Status parameters display OK**
4. All OK.

Circuit/System Testing

1. Ignition OFF, all vehicle systems OFF. Disconnect the X3 harness connector at the K20 Engine Control Module. It may take up to 2 min for all vehicle systems to power down.
2. Test for infinite resistance between the appropriate Q17 Fuel Injector control + circuit and ground.
    - **If less than infinite resistance**
    1. Disconnect the harness connector of the Q17 Fuel Injector.
    2. Test for infinite resistance between the Q17 Fuel Injector control + circuit and ground.
        - If infinite resistance
    3. Test for infinite resistance between the Q17 Fuel Injector control - circuit and ground.
        - If less than infinite, repair the short to ground in the circuit.
        - If infinite, replace the Q17 Fuel Injector.
    - **If infinite resistance**
3. Ignition ON.
4. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
    - **If 1 V or greater**
    1. Disconnect the harness connector of the Q17 Fuel Injector, ignition ON.
    2. Test for less than 1 V between the Q17 Fuel Injector control + circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, repair the short to voltage on the control - circuit.
    - **If less than 1 V**
5. Ignition OFF.
6. Test for less than 3 Ω between the Q17 Fuel Injector control + circuit and control - circuit.
    - **If 3 Ω or greater**

1. Disconnect the harness connector of the Q17 Fuel Injector.
2. Test for less than 2 Ω on the control + circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω
3. Test for less than 2 Ω on the control - circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the Q17 Fuel Injector.

- **If less than 3 Ω**

7. Replace the K20 Engine Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel Injector Replacement**
- **Control Module References** for K20 Engine Control Module replacement, programming, and setup

ALCOHOL/CONTAMINANTS-IN-FUEL DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Ethanol concentrations of greater than 10% in non-blended gasoline or greater than 85% with E85 blended gasoline for flexible fuel applications can cause driveability conditions such as hesitation, lack of power, stalling, or no start. Excessive concentrations of ethanol used in vehicles not designed for it may cause fuel system corrosion, deterioration of rubber components, and fuel filter restriction.

Reference Information

Special Tools

CH 44175-A Alcohol Tester Kit , if available

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Verification

1. Remove a sample of fuel from the bottom of the fuel tank and place in a clean, clear container.

2. Place the sample on a level surface for 2 minutes.
3. Verify the sample is clear and bright in color.
    - **If the sample appears cloudy, or contaminated with water, as indicated by a water layer at the bottom of the sample**

      Refer to Circuit/System Testing - Particulate Contaminants in Fuel.

    - **If alcohol contamination is suspected**

      Refer to Circuit/System Testing - Alcohol in Fuel Testing.

    - **If the sample remains clear and bright**
4. All OK.

Circuit/System Testing

Alcohol in Fuel Testing with Special Tool, If Available

1. Test the fuel composition using **CH 44175-A** and Instruction Manual.
2. Verify no water appears in the fuel sample.
    - **If water appears in the fuel sample**

      Clean the fuel system.

    - **If no water appears in the fuel sample**
3. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
4. Verify the non-blended gasoline fuel sample does not measure greater than 15% or an E85 blended gasoline fuel sample does not measure greater than 91% ethanol.
    - **If greater than the specified value**
    1. Add fresh regular gasoline to the vehicle's fuel tank.
    2. Remove a new sample of fuel from the tank.
    3. Test the fuel composition using **CH 44175-A** and Instruction Manual.
    4. Subtract 50 from the reading on the DMM in order to obtain the percentage of alcohol in the fuel sample.
    5. Verify the non-blended gasoline fuel sample does not measure greater than 15% or an E85 blended gasoline fuel sample does not measure greater than 91% ethanol.
        - If additional testing indicates that the ethanol percentage is still above 15% for a non-blended gasoline sample, drain and replace the vehicle's fuel. Refer to **Fuel Tank Draining (E-85)** .
        - If additional testing indicates that the E85 blended gasoline sample still measures above 91%, continue adding fresh, regular gasoline until the ethanol content is 85% or less.
    - **If the specified value or less**
5. All OK.

Alcohol in Fuel Testing without Special Tool

NOTE: **This procedure is for non-blended gasoline only. If excessive alcohol content is suspected with E85 fuel add 15% tank volume of fresh, regular gasoline to the fuel tank.**

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.034 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10-15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Re-install the stopper and shake the cylinder vigorously again for 10-15 seconds.
6. Put the cylinder on a level surface for approximately 5 minutes to allow adequate liquid separation. If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be more than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5% alcohol in the fuel. The actual amount of alcohol may be somewhat more because this procedure does not extract all of the alcohol from the fuel.
7. Verify the non-blended gasoline fuel sample does not measure greater than 15%.
    - **If greater than the specified value**
    1. Add fresh regular gasoline to the vehicle's fuel tank.
    2. Remove a new sample of fuel from the tank.
    3. Test the fuel composition of the new sample.
    4. Verify the non-blended gasoline fuel sample does not measure greater than 15% .
        - If greater than the specified value, drain and replace the vehicle's fuel. Refer to **Fuel Tank Draining (E-85)** .
        - If the specified value or less, all OK.
    - **If the specified value or less**
8. All OK.

Particulate Contaminants in Fuel

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel from the bottom of the fuel tank.
2. Place the container on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination. Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles.
3. Verify there are no physical contaminants or water present in the fuel sample.
    - **If any physical contaminants or water are present**

      Clean the fuel system.

    - **If no physical contaminants or water are present**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Fuel System Cleaning**
- **Fuel Tank Draining (E-85)**

EVAPORATIVE EMISSION SYSTEM DIAGNOSIS

Special Tools

EN 41413-VLV EVAP Service Port Vent Fitting

Operating Instructions for the Evaporative Emission System Tester

Vehicle Setup

WARNING: **Refer to Fuel and Evaporative Emission Pipe Warning .**

CAUTION: **Refer to Clean, Dry, Low Pressure Gas Source Caution .**

NOTE: **When servicing the evaporative emission (EVAP) system, test pressure must not exceed 13 in H20 (0.5 PSI) as pressure in excess of this could cause system components to perform inaccurately.**

NOTE: **A large difference between the vehicle temperature and shop temperature will seriously affect the accuracy of the tests. Always allow at least 15 min for the vehicle temperature to adjust to the shop temperature. Refer to Temperature Variation Instructions for more information about vehicle versus shop temperatures.**

1. Engine OFF, open the hood. Position a large fan to blow air under the vehicle onto the fuel tank area.
2. Connect the red battery clip from the tester to the positive battery terminal.

   NOTE: **The vehicle battery must be fully charged for optimum tester performance.**

3. Connect the black battery clip from the tester to chassis ground.

Flow Meter Test - Leak Detection

CAUTION: **Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .**

1. Open the Nitrogen tank valve and turn the NITROGEN / SMOKE valve on the front control panel to NITROGEN.
2. Connect the hose to the correct test orifice on the bottom front of the tester. For orifice size, refer to the vehicle specific information found in service procedures for DTCs that relate to EVAP system leaks.
3. Press and release the remote switch to activate the tester.

NOTE: **The tester will time out after about 15 min. You may press the remote switch to reactivate the tester as desired.**

4. Position the sliding red flag on the flow meter to align with the floating indicator. When the red flag is set, press and release the remote switch to deactivate the tester.
5. Remove the hose from the test orifice and install the hose onto the vehicle. For proper connection location, and the special tool numbers for any adapters that may be required, refer to the service procedures for DTCs that relate to EVAP system leaks.
6. Ignition ON, seal the EVAP system per instructions in the service procedures for DTCs that relate to EVAP system leaks. Most systems can be sealed using a scan tool output control for the EVAP Vent Solenoid Valve, other systems require that the vent system be plugged.

NOTE:

- **Larger volume fuel tanks, and/or those with lower fuel levels, may require several minutes to fill with nitrogen.**
- **Static buildup may cause the float indicator to stick. It may be necessary to tap on the flow meter to free up the float.**
- **If fuel level is 90% or greater it will take longer to fill the system with smoke because the fuel fill tube check valve will be closed and force any smoke to pass through the on-board refueling vapor recovery pipe and orifice.**

7. Press and release the remote switch to activate the nitrogen flow and fill the system.
8. Verify the stable floating indicator position to the red flag.
    - **Above the red flag, result is unacceptable - fail**

      Go to the Smoke Procedure

    - **Below the red flag - pass. Test complete**
9. Press and release the remote switch to deactivate the tester.

Smoke Procedure - Locate the Leak

NOTE: **It is not recommended to use the tester in an outside repair bay area because wind and sunlight may affect temperature and your ability to see the smoke.**

1. Turn OFF any fans that may cause air movement around or near the vehicle.

NOTE: **Completely unwind the nitrogen/smoke hose from the bracket to optimize the tester's performance.**

2. Connect the nitrogen/smoke hose to the vehicle as directed in the service procedures. Some vehicles require that the nitrogen/smoke hose be connected at the front of the EVAP system at the EVAP service port. An adapter may be necessary. Other vehicles require the connection be made at the rear of the system using an adapter at the fuel fill cap or capless fuel fill. Consult the service procedures for DTCs that relate to EVAP system leaks for vehicle specific instructions regarding connection location and adapters.

3. Open the Nitrogen tank valve and turn the nitrogen/smoke valve on the control panel to smoke.

NOTE: **The remote switch operates on a push ON, push OFF fashion.**

4. Press and release the remote switch to activate the tester and inject smoke into the EVAP system.
5. Verify smoke has filled the EVAP system by opening the system opposite the end where smoke is injected.

NOTE:

- **When injecting smoke at the service port, remove the fuel fill cap until smoke is observed. Then close the system and continue testing.**
- **If using a special tool fuel fill cap adapter at the filler neck, vent the system at the service port, with special tool EN 41413-VLV until smoke is observed then remove the vent fitting tool and close the system to continue with the test.**
- **Inject smoke in less than 2 min cycles for optimum tester performance.**

6. Press and release the remote switch to deactivate the tester.

NOTE: **For optimum visual smoke performance, deactivate the smoke flow and allow the system pressure to drop. Allowing the smoke to exit small holes at a low flow rate greatly enhances visibility.**

7. Introduce smoke into the system for an additional 60 s. Continue introducing smoke at 15 s intervals, as necessary until leak source is identified.
8. Using a high-intensity white light, inspect the entire EVAP system path, and look for the source of the leak indicated by the exiting smoke.
    - **Smoke seen leaking**

      Repair or replace the affected component.

    - **No smoke seen leaking**
9. All OK

Temperature Variation Instructions

The Concern

Ideal circumstances for conducting the EVAP flow meter test require equal temperatures between the Nitrogen gas and the vehicle EVAP system. Significant differences in temperature between them can result in a flow or pressure change during testing, causing misleading results. Typically, the evaporative emission system tester is stored indoors, approximately 21Â°C (70Â°F). Vehicles brought in for diagnosis may have an EVAP system at significantly different temperatures.

For Example

NOTE: **With no temperature difference between the Nitrogen gas and EVAP system, the resulting vehicle EVAP system pressure will remain stable at 13 in. H2O (0.5**

PSI) once pressurized, providing no leaks are present.

When the EVAP flow meter tests are performed with significant differences in temperature between the Nitrogen gas and the vehicle EVAP system, the following results can occur:

- An increase in flow during the flow meter test can be caused by a vehicle's warm EVAP system cooling down.
- A decrease in flow during the flow meter test can be caused by a vehicle's cool EVAP system warming up.

The Solution

When working on a vehicle with significant temperature differences between the vehicle EVAP system and the Nitrogen gas, allow the vehicle EVAP system temperature to stabilize as close as possible to the temperature of the Nitrogen gas before conducting the flow meter test.

ELECTRONIC IGNITION SYSTEM DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

This ignition system uses an individual ignition coil for each cylinder. The Engine Control Module (ECM) controls the spark events by transmitting the timing pulses on the ignition control circuits to the individual ignition coil in firing order sequence.

Diagnostic Aids

- This engine application may use 2 fuses, one for each bank, to supply ignition voltage to the ignition module/coil assemblies. A good indication that a fuse is open is that all misfire counters are incrementing on one side of the engine.
- An open/high resistance on the low reference circuit to the ignition coil may cause a misfire.
- An erratic or weak spark is considered a no spark condition.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Powertrain Component Views

Description and Operation

Electronic Ignition System Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References

Special Tools

EL 26792 HEI Spark Tester

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Circuit/System Testing

NOTE: **Do not perform this diagnostic procedure unless you were sent here from a misfire DTC or the Engine Cranks But Does Not Run diagnostic.**

1. Ignition OFF and all vehicle systems OFF. Disconnect the harness connector at the appropriate T8 Ignition Coil. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 5 Ω between the ground circuit terminal A and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 5 Ω**
3. Test for less than 5 Ω between the low reference circuit terminal B and ground.
    - **If 5 Ω or greater**
    1. Ignition OFF, disconnect the X3 harness connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 5 Ω**
4. Ignition ON.

5. Verify a test lamp illuminates between the ignition circuit terminal D and ground.
    - **If the test lamp does not illuminate**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp illuminates**
6. Ignition OFF, exchange the suspect T8 Ignition Coil with the T8 Ignition Coil of a known functioning cylinder.
7. Engine Running.
8. Verify the scan tool Cylinder 1-6 Current Misfire Counter does not increment for the same cylinder that the suspect T8 Ignition Coil was removed from.
    - **If increments**

      Replace the K20 Engine Control Module.

    - **If does not increment**
9. Test or replace the T8 Ignition Coil.

Component Testing

NOTE: **You must perform the Circuit/System Testing before proceeding with Component Testing.**

1. Ignition OFF, connect the **EL 26792** to the appropriate T8 Ignition Coil.
2. Engine Running.
3. Verify the spark output of the T8 Ignition Coil.
    - **If no output or the output is weak**

      Replace the T8 Ignition Coil

    - **If the output is good**
4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Ignition Coil Replacement - Bank 1**
- **Ignition Coil Replacement - Bank 2**
- **Control Module References** for engine control module replacement, programming, and setup.

INSPECTION/MAINTENANCE SYSTEM CHECK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Description

Several states require that a vehicle pass on-board diagnostic (OBD) system tests and inspection/maintenance (I/M) emission inspections in order to renew license plates. This is accomplished by viewing the Inspection/Maintenance System Status or Data display on a scan tool. Using a scan tool, the technician can observe the I/M status in order to verify that the vehicle meets the criteria that complies with the local area requirements.

While testing in the I/M System Status mode, some DTCs may occur that are called I/M Test DTCs. An I/M Test DTC is defined as a fault code that is currently commanding the malfunction indicator lamp (MIL) ON, and is stored in non-volatile memory. The intended use of this data is to prevent vehicles from passing I/M inspection without proper repair to the vehicle. These fault codes are not erasable from any scan tool command or by disconnecting power to the controller. I/M Test DTCs are supported by all emissions related electronic control units, such as engine control modules (ECMs), transmission control modules (TCMs), fuel pump control modules, etc. An I/M Test DTC will not be stored or erased from the electronic control unit except at the end of trip processing which occurs 5 s after ignition OFF.

Conditions for Updating the I/M System Status

NOTE: **New vehicles may not report an Inspection/Maintenance System Check pass or fail status for certain post catalyst oxygen sensor or heated oxygen sensor 2 diagnostics prior to 700 miles. After replacing a catalytic converter on a vehicle with greater than 700 miles, it may require up to an additional 700 miles to prevent a false failure status.**

Each system requires at least one, and sometimes several, diagnostic tests. The results of these tests are reported by a DTC. A system monitor is complete when either all of the DTCs comprising the monitor have Run and Passed, or any one of the DTCs comprising the monitor have illuminated the MIL. Once all of the tests are completed, the Inspection/Maintenance System Status or Data will indicate YES in the Completed or Value column.

For example, when the HO2S Heater Status indicates YES, either all of the oxygen sensor heater tests have passed or one of the tests has illuminated the MIL. If the vehicle has four heated oxygen sensors, either all four heater circuit tests have passed or one of the heater circuit tests has illuminated the MIL. The Inspection/Maintenance System Status or Data will indicate NO under the Completed or Value column when any of the required tests for that system have not run. The following is a list of conditions that would set the Inspection/Maintenance System or Data indicator to NO:

- The vehicle is new from the factory and has not yet been driven through the necessary drive conditions to complete the tests.
- The battery has been disconnected or discharged below operating voltage.
- The control module power or ground has been interrupted.
- The control module has been reprogrammed.
- The control module DTCs have been cleared as part of a service procedure.

Conditions for Clearing I/M Test DTCs

1. Only the OBD II System can erase I/M Test DTCs. The OBD II system must determine that the malfunction that caused the I/M Test DTC to be stored is no longer present and is not commanding the MIL. Each of the following represents ways to clear an I/M Test DTC:
    - If the MIL goes off due to 3 passing drive cycles, and the scan tool code clear is not used, the I/M Test DTC is erased at power down of the last drive cycle.
    - If a scan tool code clear is used to turn OFF the MIL, the I/M Test DTC is not erased, therefore the DTC must PASS and not FAIL during the drive cycle. The I/M Test DTC is erased at power down of the drive cycle.
    - If the controller is reflashed/reprogrammed, all I/M Test DTCs are erased.
2. For the OBD II System to run a single drive cycle for clearing an I/M Test DTC, all of the following conditions must occur:
    - Cumulative time of engine run time greater than 600 s.
    - Cumulative vehicle operation above 41 km/h (25 mph) over 300 s.
    - Continuous vehicle idle greater than 30 s.
    - Ignition OFF for 5 s to allow the code to clear.

Monitored Emission Control Systems

The OBD II system monitors all emission control systems that are on-board, but not all vehicles need every possible emission control system. For example, a vehicle may not be equipped with secondary air injection or exhaust gas recirculation (EGR). The OBD II regulations require monitoring of the following; if equipped:

- The air conditioning system
- The catalytic converter efficiency
- Comprehensive component monitoring-Emission related inputs and outputs
- The evaporative emission (EVAP) system
- The fuel delivery system
- Heated catalyst monitoring
- Misfire monitoring
- The oxygen sensor system (O2S or HO2S)
- The oxygen sensor heater system (HO2S heater)

For the specific DTCs required for each system, refer to **Inspection/Maintenance (I/M) System DTC Table**. Systems such as misfire and comprehensive components may not be listed in a system status list. These tests run continuously and do not require an I/M System Status indicator.

Diagnostic Aids

The Inspection/Maintenance System Status or Data display provides an indication of when the control module has completed the required tests. This does not necessarily mean that the test has passed, only that a decision was made. If the diagnostic fails, a DTC will indicate the failure. If a failure indication is present for a DTC associated with one of the I/M regulated systems, it may prevent other required tests from running. For example, a DTC for the control circuit of the EVAP purge solenoid may not be listed in the

Inspection/Maintenance System DTC Table because it is a continuous test. If this DTC is set, the Active Tests for the EVAP system may not run.

The Inspection/Maintenance System Status or Data information may be useful for a technician to determine if diagnostics have run when verifying repairs.

Circuit/System Verification

1. Verify that all Inspection/Maintenance System Status or Data indicators report YES, and that no I/M Test DTCs are present.
    - **If any I/M Test DTCs are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **If no I/M Test DTCs are set**
2. All OK.

Circuit/System Testing

NOTE: **Many DTC related repairs will instruct the technician to clear the DTC information. Clearing the DTC will reset the Inspection/Maintenance System Status or Data indicators to NO. Performing the I/M Complete System Set Procedure will set each of the I/M System Status indicators to YES.**

1. Verify no I/M DTCs are present.
    - **If an I/M DTC is set that would prevent the I/M System Status tests from completing, diagnose that DTC before continuing.**

      Refer to **Inspection/Maintenance (I/M) System DTC Table**.

    - **If no I/M DTCs are set**
2. Review applicable service bulletins for software updates that would prevent the I/M System Status tests from completing.
    - **If a control module re-program or other repair is required,**

      Perform the **Inspection/Maintenance Complete System Set Procedure** after repair.

    - **If no repair is required**
3. Observe the Inspection/Maintenance System Status or Data indicators.
    - **If any Inspection/Maintenance System Status or Data indicators report NO**

      Perform the **Inspection/Maintenance Complete System Set Procedure**.

    - **If no Inspection/Maintenance System Status or Data indicators report NO**
4. All OK.

INSPECTION/MAINTENANCE COMPLETE SYSTEM SET PROCEDURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Description

The purpose of the Inspection/Maintenance (I/M) complete system set procedure is to satisfy the enable criteria necessary to execute all of the I/M readiness diagnostics and complete the trips for those particular diagnostics. When all I/M monitored diagnostic tests are completed, the I/M System Status indicators are set to YES. Perform the Inspection/Maintenance (I/M) Complete System Set Procedure if any I/M System Status indicators are set to NO.

Conditions for Meeting a Cold Start

- The ignition voltage between 10 and 15 V.
- The barometric pressure (BARO) is more than 75 kPa (10.9 PSI).
- The engine coolant temperature (ECT) at start-up is less than 42Â°C (108Â°F).
- The intake air temperature (IAT) is between 2-32Â°C (36-90Â°F).
- The engine is OFF for greater than 6 hours or the following conditions must be met:
  - The start-up IAT minus start-up ECT are within 12Â°C (22Â°F).
  - The start-up ECT minus start-up IAT are within 50Â°C (90Â°F).
- Fuel level is between 25 and 75%.

Circuit/System Verification

1. Verify that all I/M System Status indicators report YES, and that no I/M Test DTCs are present.
   - **If any I/M Test DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

   - **If no I/M Test DTCs are set**
2. All OK.

Inspection/Maintenance (I/M) System Set Procedure

1. Ensure that the vehicle meets the conditions for a cold start listed above.
   - If the EVAP I/M System Status indicator displays NO, perform the EVAP Service bay test if applicable.
2. Turn OFF all accessories; HVAC system, other electrical loads, including aftermarket/add-on equipment, etc., and open the hood.
3. Set the vehicle parking brake and ensure the vehicle is in park for automatic transmission or neutral for manual transmission.
4. Start and idle the engine for 2 min.

WARNING: Refer to Road Test Warning .

5. Close the hood, release the parking brake and Accelerate at part throttle to 72-80 km/h (45-50 MPH) with this speed maintained until the engine reaches operating temperature, 8-10 min .
6. Continue operation under these conditions for an additional 6 min.
7. Accelerate at part throttle to 90 km/h (55 MPH) with this speed maintained for 2 min.
8. Release the accelerator pedal for at least 10 s. This will allow the vehicle to enter the decel fuel cut off.

NOTE: **Do NOT touch the accelerator pedal until told to do so. A change in throttle position or an increase in engine speed may invalidate this portion of the test.**

9. Safely stop the vehicle, with the engine in drive for automatic or neutral with the clutch pedal depressed and parking brake applied for manual. Allow the vehicle to idle for 2 min.
10. Shift the vehicle to park for automatic and neutral for manual. Turn OFF the ignition and exit the vehicle. Do NOT disturb the vehicle for 45 min.
11. Observe the Inspection/Maintenance (I/M) System Status with a scan tool. All of the I/M System Status indicators should display YES.
    - If the EVAP I/M System Status indicator displays NO, turn OFF the ignition, ensure that the vehicle meets the conditions for a cold start, and repeat steps 6-11 three more times, or until the EVAP I/M System Status indicator transitions to YES. If the indicator continues to display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table** to identify the DTCs that did not run.
    - If any of the I/M System Status indicators display NO, refer to the **Inspection/Maintenance (I/M) System DTC Table** for the indicator which did not display YES. The I/M System DTC Table identifies the DTCs associated with each I/M System Status Indicator.

NOTE: **An I/M Test DTC will not be stored or erased from the ECU except at the end of trip processing, which occurs 5 s after ignition OFF.**

12. Observe the I/M Test DTC information with a scan tool. Verify there are no I/M Test DTCs present.
    - If an I/M Test DTC is set, diagnose the DTC using the **Diagnostic Trouble Code (DTC) List - Vehicle** , and refer to **Inspection/Maintenance System Check**.
13. Observe the engine DTC information with a scan tool. Verify no DTCs are present.
    - If a DTC is set, diagnose using the **Diagnostic Trouble Code (DTC) List - Vehicle** , . After repairs, perform the **Inspection/Maintenance Complete System Set Procedure** to verify no further DTCs are set.

INSPECTION/MAINTENANCE (I/M) SYSTEM DTC TABLE

System	DTCs Required to Set System Status to YES
If an I/M System Status indicator did NOT update to YES during the **Inspection/Maintenance Complete System Set Procedure** , review each indicator and reference this table to determine each DTC associated with the I/M System Status Indicator. Each DTC listed below has specific conditions that must be met for the diagnostic to run. Included within the conditions are additional DTCs, which if set, may inhibit the DTCs listed below from running. Reviewing and operating the vehicle within the Conditions for Running for each DTC listed below will allow the I/M System Status Indicators to transition to YES.	

System	DTCs Required to Set System Status to YES
Catalyst	**DTC P0420 or P0430**
EVAP	• **DTC P0442** • **DTC P0446** • **DTC P0455**
Fuel System	**DTC P219A or P219B**
Oxygen Sensor	• **DTC P0131, P0132, P0134, P0137, P0138, P0140, P0151, P0152, P0154, P0157, P0158, or P0160** • **DTC P0133, P013A-P013F, P014A, P014B, P0153, P015A-P015D, or P2270-P2273 (LFX)**
Oxygen Sensor Heater	**DTC P0030-P0032, P0036-P0038, P0050-P0054, P0056-P0060, P0135, P0141, P0155, or P0161 (LFX)**
Camshaft System	**DTC P0011, P0014, P0021, or P0024**

Article GUID: A00737204

REPAIR INSTRUCTIONS

BRAKE PEDAL POSITION SENSOR LEARN

NOTE: **Brake system does not use a brake switch, stoplight switch or brakelight switch. System uses a Brake Pedal Position Sensor to control these functions.**

Calibration Criteria

NOTE: **Do not apply the brake pedal during the brake pedal position sensor calibration procedure. Any movement of the brake pedal during this procedure will cause the calibration procedure to fail. If this occurs, the brake pedal position sensor calibration must be repeated.**

Brake pedal position sensor calibration must be performed after the brake pedal position sensor, body control module (BCM), or engine control module (ECM) have been serviced. The calibration procedure will set the brake pedal position sensor home value. This value is used by the BCM and ECM to determine the action of the driver applying the brake system and to provide this information to the vehicle subsystems via serial data.

Calibration Procedure

1. Apply the parking brake.
2. Ignition ON, engine OFF, place the transmission in the PARK position for automatic transmission or NEUTRAL position for manual transmission.
3. Install a scan tool.
4. Clear all DTCs before proceeding.
5. Navigate to the Configuration/Reset Functions menu of the BCM.
6. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.
7. Navigate to the Configuration/Reset Functions menu of the ECM.
8. Select the Learn Functions menu.
9. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.

CRANKSHAFT POSITION SYSTEM VARIATION LEARN

The Crankshaft Position Variation Learn procedure is required when the following service procedures have been performed, regardless of whether DTC P0315 is set:

- An engine replacement.
- A engine control module (ECM) replacement.
- A crankshaft balancer replacement.
- A crankshaft replacement.
- A crankshaft position sensor replacement.

- Any engine repairs which disturb the crankshaft to crankshaft position sensor relationship.

The ECM monitors certain component signals to determine if all the conditions are met to continue with the Crankshaft Position Variation Learn procedure. The scan tool only displays the condition that inhibits the procedure. The scan tool displays the signals of the components listed below:

- Crankshaft position sensors activity: If there is a crankshaft position sensor condition, refer to the applicable DTC set.
- Camshaft position sensor signal activity: If there is a camshaft position sensor signal condition, refer to the applicable DTC set.
- Engine coolant temperature (ECT): If the engine coolant temperature is not warm enough, idle the engine until the engine coolant temperature reaches the correct temperature.

1. Verify no DTCs are set.
    - **If any DTCs other than P0300-P0308, or P0315 are set**

      Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

    - **If DTC P0300-P0308, P0315, or no DTCs are set**

    NOTE: The Crankshaft Position Variation Learn may have to be repeated up to 5 times before the procedure is successful.

2. Engine Running at normal operating temperature, perform the scan tool Crankshaft Position Variation Learn procedure and follow the on screen instructions.
3. Verify the scan tool displays Test Passed Successfully when completed.
    - **If Test Passed Successfully is not displayed**

      Verify that none of the conditions listed below exist:

      - The ignition switch is in the ON position until there is insufficient system voltage.
      - An ECM power disconnect with the ignition ON that may have erased the crankshaft position system variation values and set DTC P0315.
      - Interference in the signal circuit of the crankshaft position sensor.
      - Debris between the crankshaft position sensor and the reluctor wheel.
      - A damaged or misaligned reluctor wheel.
      - Worn crankshaft main bearings.
      - Excessive crankshaft runout.
      - A damaged crankshaft.
      - If a condition is exists, repair or replace as necessary.
      - If no conditions exist, replace the K20 Engine Control Module.
    - **If Test Passed Successfully is displayed**
4. Clear all DTCs.
5. Engine Running.
6. Verify a DTC is not set.

- **If a DTC is set**

  Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

- **If a DTC is not set**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for engine control module replacement, programming, and setup.

ENGINE CONTROL MODULE REPLACEMENT

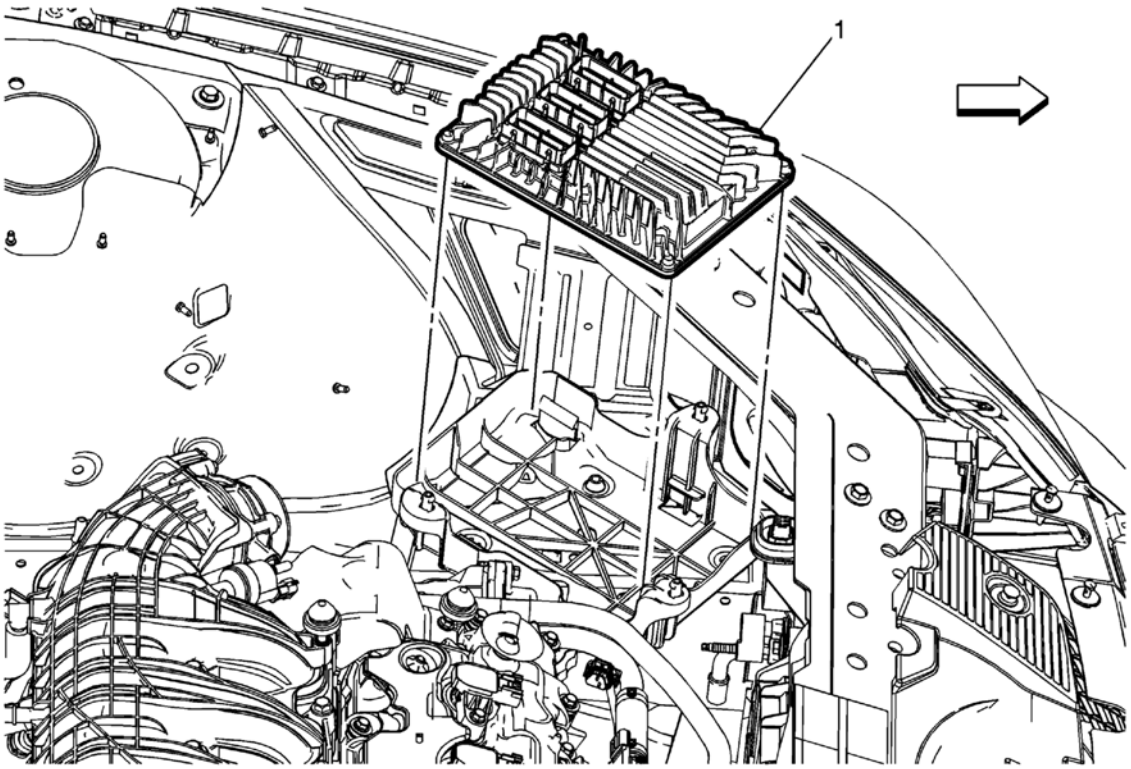


Fig. 1: Engine Control Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** . 2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**	
1	Electronic Control Module

Callout	Component Name
	WARNING: **Refer to Safety Glasses Warning .** **CAUTION:** • **Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module (battery cable, powertrain control module (PCM)/engine control module (ECM)/transaxle control module (TCM) pigtail, control module fuse, jumper cables, etc.) in order to prevent internal control module damage.** • **Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control**

Callout	Component Name
	module, using battery booster cables, or when charging the vehicle battery. • **In order to prevent any possible electrostatic discharge damage to the control module, do no touch the connector pins or the soldered components on the circuit board.** • **Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module.** • **The replacement control module must be**

Callout	Component Name
	programmed. **Procedure** 1. Disconnect the electrical connectors. 2. Release the retaining tab. 3. If replacing, program the ECM. Refer to **Control Module References** . **NOTE:** **Before removing the engine control module (ECM), use the scan tool to capture the ECM data. This captured data will then need to be restored into the NEW ECM. Refer to Control Module References .**

Q38 THROTTLE BODY: THROTTLE/IDLE LEARN

Description

The engine control module (ECM) learns the airflow through the throttle body to ensure the correct idle. The learned airflow values are stored within the ECM. These values are learned to adjust for production variation and will continuously learn during the life of the vehicle to compensate for reduced airflow due to throttle body coking. Anytime the throttle body airflow rate changes, for example due to cleaning or replacing, the values must be relearned.

An engine that had a heavily coked throttle body that has been cleaned or replaced may take several drive cycles to unlearn the coking. To accelerate the process, the scan tool has the ability to reset all learned values back to zero. A new ECM will also have values set to zero.

The idle may be unstable or a DTC may set if the learned values do not match the actual airflow.

Conditions for Running the Throttle Learn Procedure

Scan tool Idle Learn or Idle Learn Reset Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P0697, P06A3, P06D2, P1248, P1249, P124A, P124B, P1516, P16A0-P16A2, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, or P2322 are not set.
- Ignition ON, engine OFF.
- The vehicle speed sensor (VSS) is 0 km/h (0 mph).

Service Bay/On Road Learn Procedure

- DTCs P0068, P0101, P0102, P0103, P0106, P0107, P0108, P0116, P0117, P0118, P0120, P0122, P0123, P0128, P0171, P0172, P0174, P0175, P0201-P0208, P0220, P0222, P0223, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, P0277, P0279, P0280, P0282, P0283, P0300-P0308, P0351-P0358, P0496, P0601, P0604, P0606, P060D, P0641, P0651, P0697, P06A3, P06D2, P1248, P1249, P124A, P124B, P1516, P16A0-P16A2, P2101, P2119, P2120, P2122, P2123, P2125, P2127, P2128, P2135, P2138, P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, P216F, P217B, P217C, P217E, P217F, P2176, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, P2316, P2318, P2319, P2321, or P2322 are not set.
- The engine speed is between 450-4,000 RPM.
- The manifold absolute pressure (MAP) is greater than 5 kPa.
- The mass air flow (MAF) is greater than 2 g/s.
- The ignition voltage is greater than 10 volts.

Diagnostic Aids

A un-metered air leak in the induction system or a small vacuum leak may not set a DTC. If the condition goes undetected, the ECM may learn an incorrect Throttle Body Idle Airflow Compensation value over time. The incorrectly learned value may cause various symptoms to occur such as rough or unstable idle speeds, and/or engine stall. If this condition is detected and repaired it will be necessary perform the Idle Learn procedure to ensure any symptoms are corrected.

Throttle Learn

Scan Tool Idle Learn or Idle Learn Reset Procedure - Performed after the throttle body is cleaned or replaced

1. Ignition ON, engine OFF, perform the Idle Learn or Idle Learn Reset in Configuration/Reset or Module Setup.
2. Engine idling, verify the scan tool Throttle Body Idle Airflow Compensation value is equal 0% and the engine is idling at a normal idle speed.
3. Clear the DTCs and return to the diagnostic that referred you here.

Service Bay/On Road Idle Learn Procedure - Performed after the ECM is programmed or replaced

NOTE: **Do NOT perform this procedure if any DTCs are set. Refer to Diagnostic Trouble Code (DTC) List - Vehicle .**

1. Engine idling for 3 m.
2. The ECM will start to learn the new idle cells and the scan tool Desired Idle Speed should start to decrease.
3. Ignition OFF for 60 s.
4. Start and idle the engine for 3 m.
5. Verify the engine is idling normally.
    - **If the engine idle is not correct**

      NOTE: **During the drive cycle the check engine light may come on with idle speed DTCs. If idle speed codes are set, clear codes so the ECM can continue to learn.**

        1. Operate the vehicle at speeds above 70 km/h (44 mph) with several decelerations and extended idles.
        2. Verify the engine is idling normally.
            - If the engine idle is not correct.

              Ignition OFF for 60 s, repeat step 5.1.

            - If the engine idle is correct.
        3. Clear any DTCs and return to the diagnostic that referred you here.
    - **If the engine idle is correct**
6. Clear any DTCs and return to the diagnostic that referred you here.

ENGINE COOLANT TEMPERATURE SENSOR REPLACEMENT

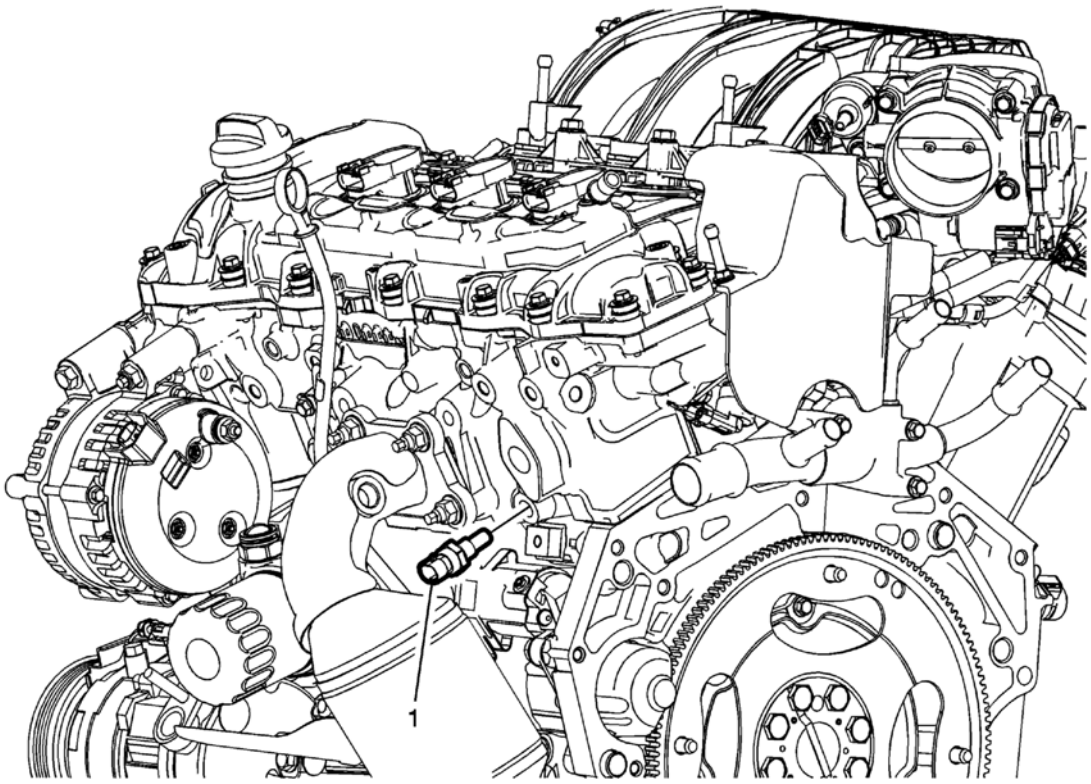


Fig. 2: Engine Coolant Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	Preliminary Procedure **Partially drain the cooling system. Refer to Cooling System Draining and Filling .**
1	Engine Coolant Temperature Sensor **CAUTION:** **Refer to Fastener Caution .** **Procedure** Disconnect the ECT sensor harness connector. **Tighten** 20 N.m (14.7 lb ft)

MASS AIRFLOW SENSOR WITH INTAKE AIR TEMPERATURE SENSOR REPLACEMENT

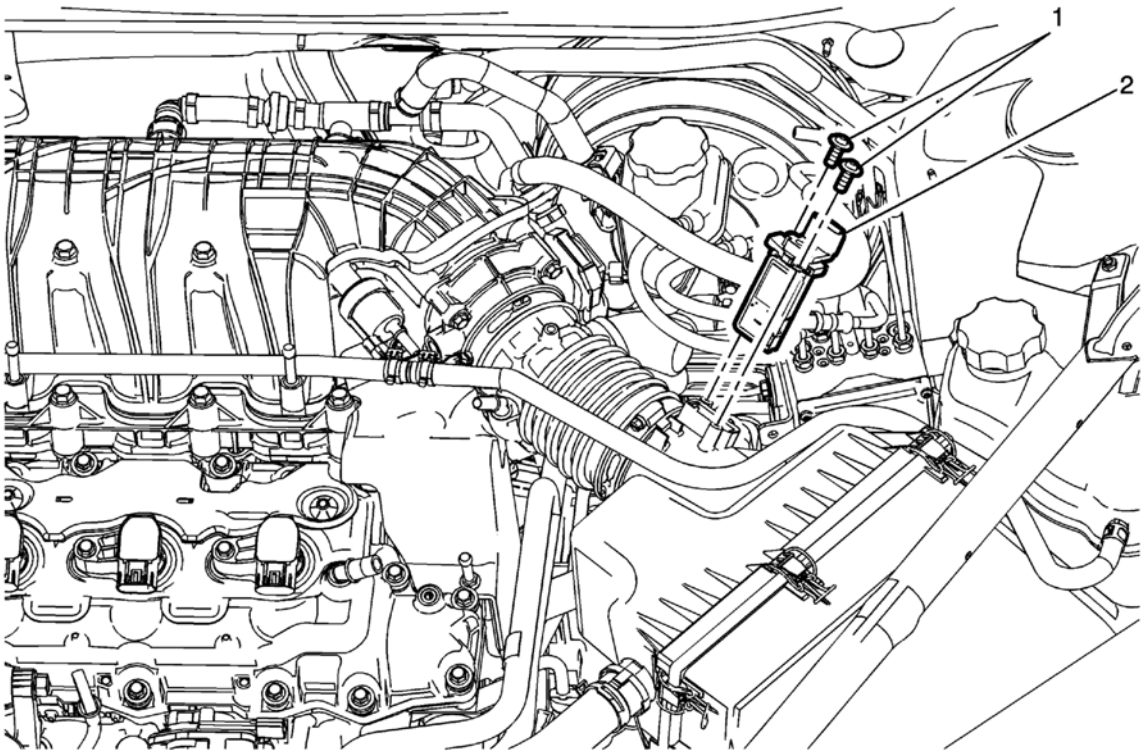


Fig. 3: Mass Airflow Sensor with Intake Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Bolt (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 3 N.m (27 lb in)
2	Mass Airflow Sensor **Procedure** Disconnect the mass airflow sensor harness connector.

MANIFOLD ABSOLUTE PRESSURE SENSOR REPLACEMENT

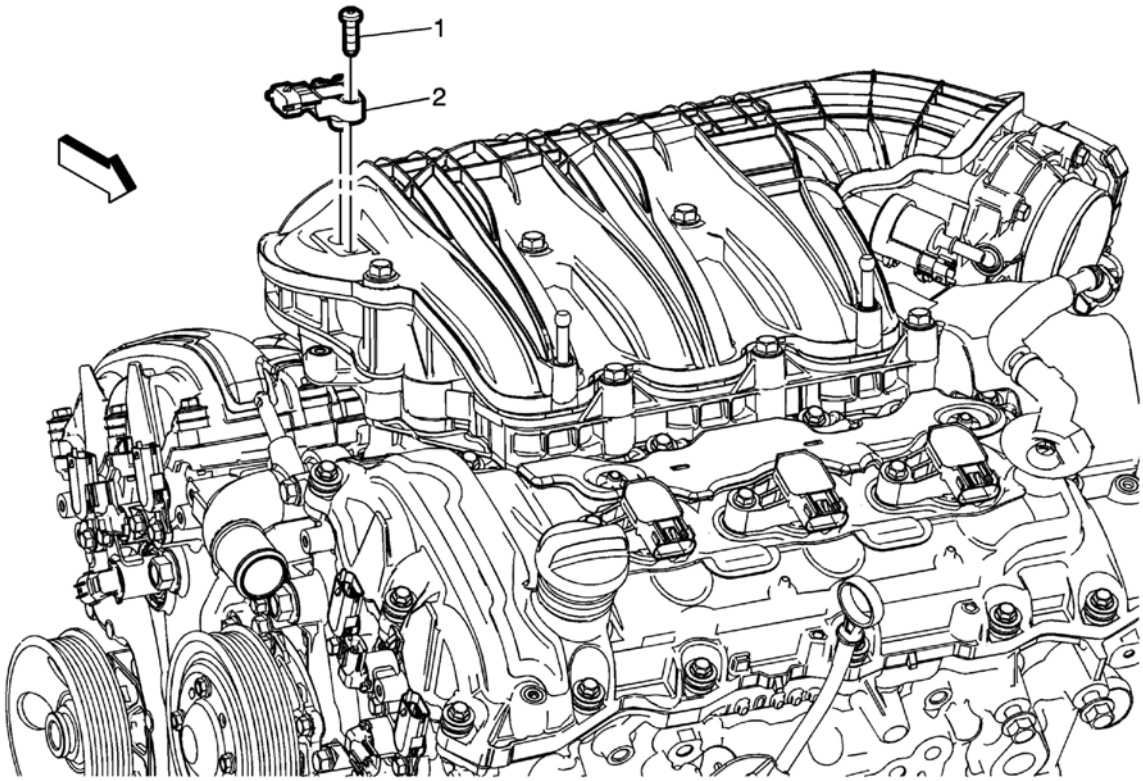


Fig. 4: Manifold Absolute Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	Preliminary Procedure **Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .**
1	Manifold Absolute Pressure Sensor Bolt. **CAUTION:** **Refer to Fastener Caution .** **Tighten** 5 N.m (44 lb in)
2	Manifold Absolute Pressure Sensor. **Procedure** Disconnect the MAP sensor harness connector.

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 1

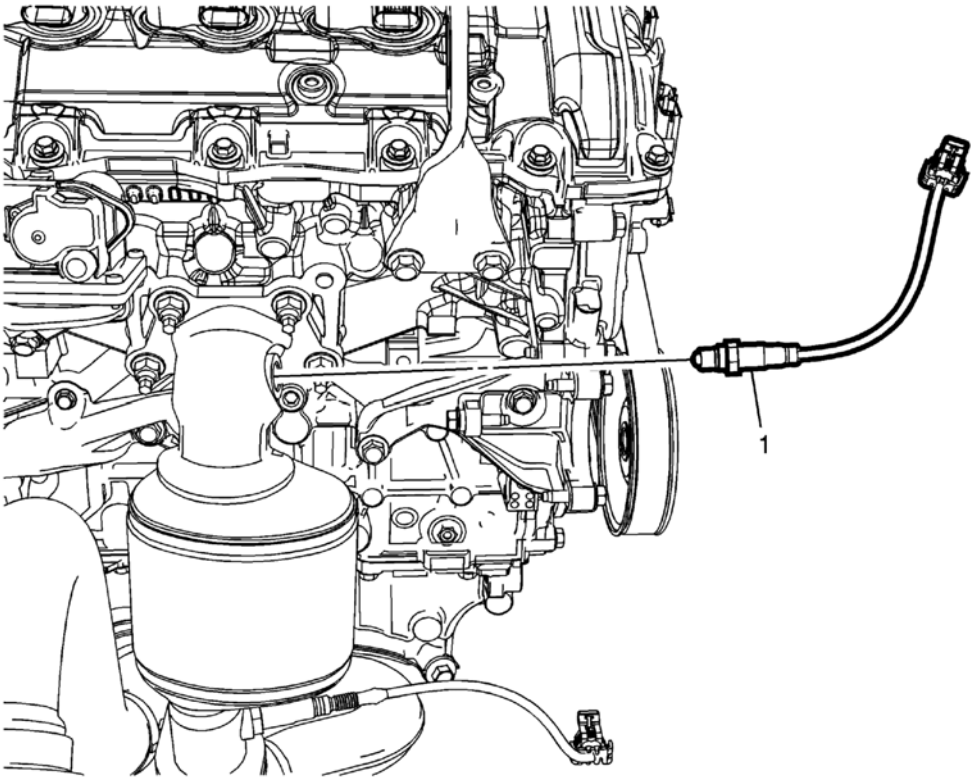


Fig. 5: Heated Oxygen Sensor - Bank 1 Sensor 1
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Heated Oxygen Sensor **CAUTION:** **Refer to Heated Oxygen and Oxygen Sensor Caution .** **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Disconnect the heated oxygen sensor harness connector. 2. If reinstalling the old sensor, coat the threads with anti-seize compound. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

Callout	Component Name
	• The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48Â°C (120Â°F). • A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation. **Tighten** 42 N.m (31 lb in)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 1 SENSOR 2

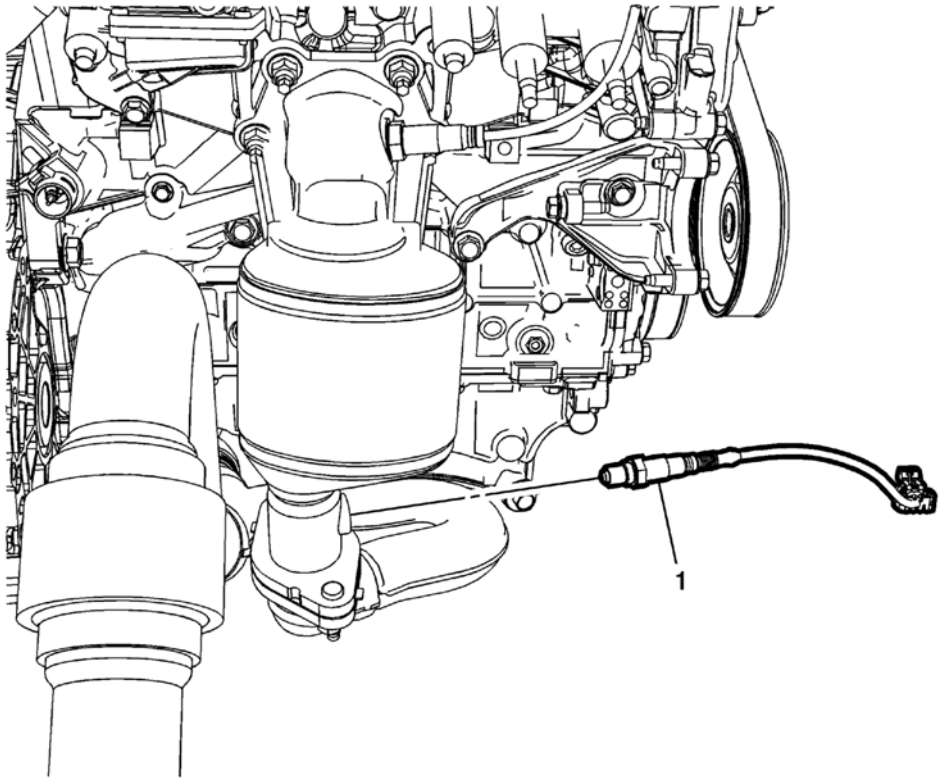


Fig. 6: Heated Oxygen Sensor - Bank 1 Sensor 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	

Callout	Component Name
1	Heated Oxygen Sensor **CAUTION:** **Refer to Heated Oxygen and Oxygen Sensor Caution .** **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Disconnect the heated oxygen sensor harness connector. 2. If reinstalling the old sensor, coat the threads with anti-seize compound. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . • The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48Â°C (120Â°F). • A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation. **Tighten** 42 N.m (31 lb in)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 1

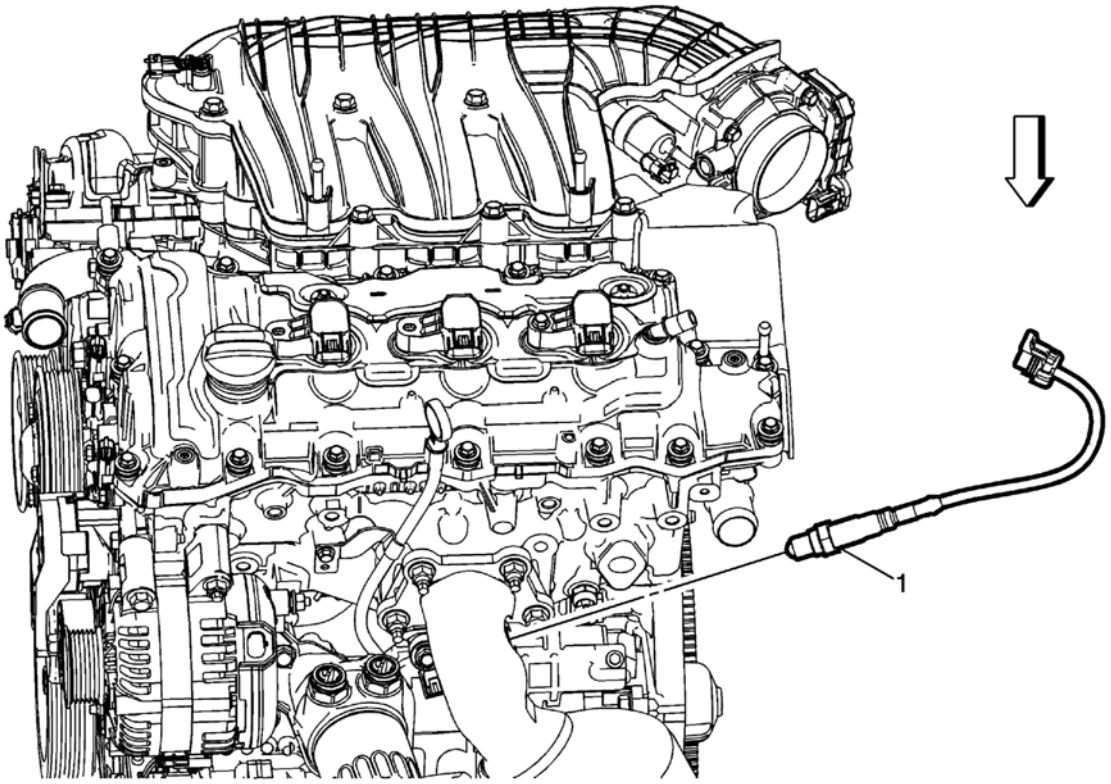


Fig. 7: Heated Oxygen Sensor - Bank 2 Sensor 1
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Heated Oxygen Sensor **CAUTION:** **Refer to Heated Oxygen and Oxygen Sensor Caution .** **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Disconnect the heated oxygen sensor harness connector. 2. If reinstalling the old sensor, coat the threads with anti-seize compound. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . • The in-line connector and louvered end must be kept clear of grease, dirt or other

Callout	Component Name
	contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48Â°C (120Â°F). • A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation. **Tighten** 42 N.m (31 lb in)

HEATED OXYGEN SENSOR REPLACEMENT - BANK 2 SENSOR 2

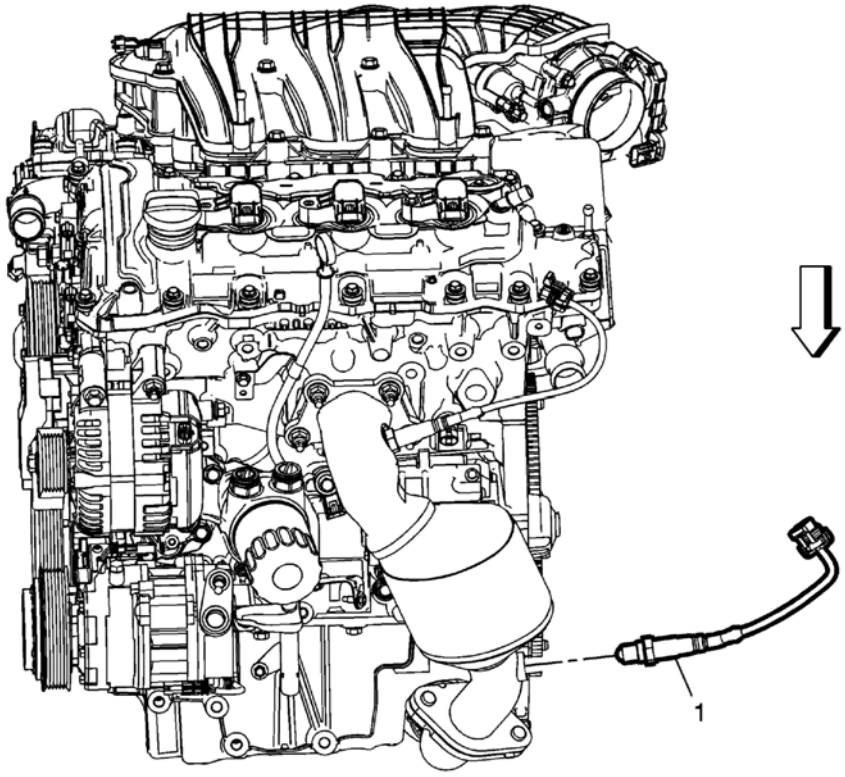


Fig. 8: Heated Oxygen Sensor - Bank 2 Sensor 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	

Callout	Component Name
1	Heated Oxygen Sensor **CAUTION:** **Refer to Heated Oxygen and Oxygen Sensor Caution .** **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Disconnect the heated oxygen sensor harness connector. 2. If reinstalling the old sensor, coat the threads with anti-seize compound. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . • The in-line connector and louvered end must be kept clear of grease, dirt or other contaminants. Avoid using cleaning solvents of any type. DO NOT drop or roughly handle the heated oxygen sensor (HO2S). • The HO2S may be difficult to remove when the engine temperature is less than 48Â°C (120Â°F). • A special anti-seize compound is used in the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before reinstallation. **Tighten** 42 N.m (31 lb in)

ACCELERATOR PEDAL POSITION SENSOR REPLACEMENT

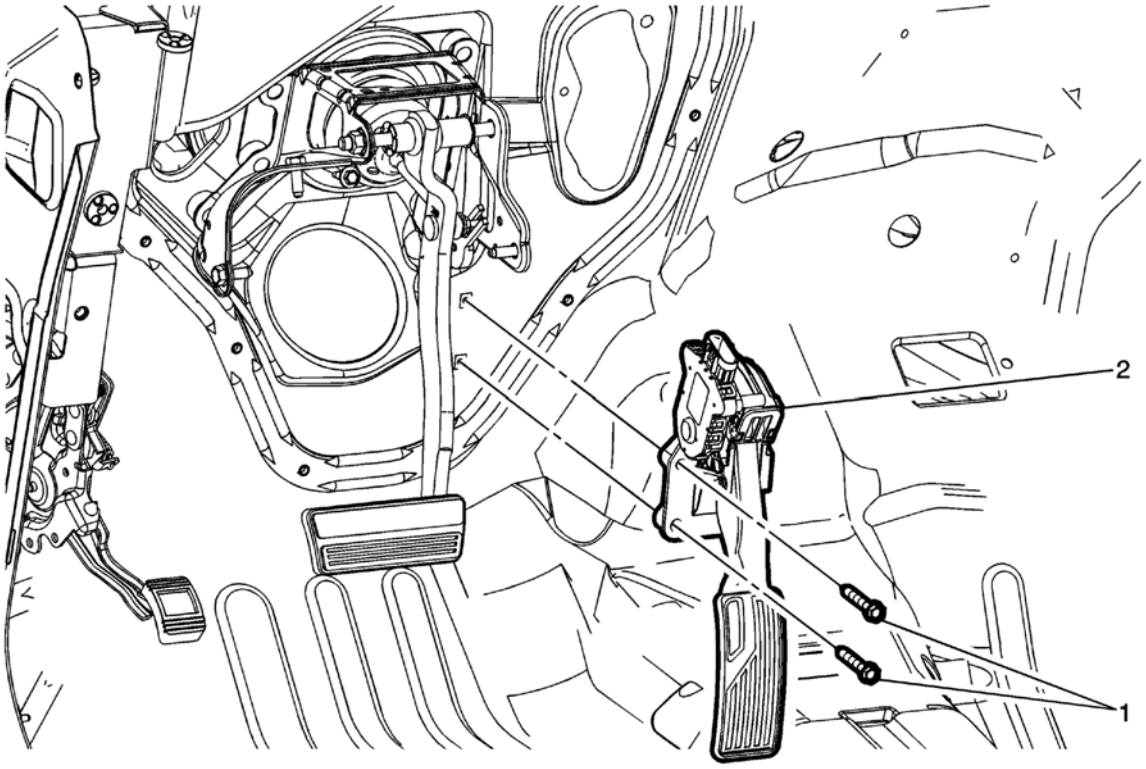


Fig. 9: Accelerator Pedal Position Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the left instrument panel (I/P) sound insulator. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** . 2. Disconnect the accelerator pedal position sensor electrical connector.	
1	Accelerator Pedal Position Sensor Bolts (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution** **Tighten** 9 N.m(80 lb in)
2	Accelerator Pedal Position Sensor

THROTTLE BODY ASSEMBLY REPLACEMENT

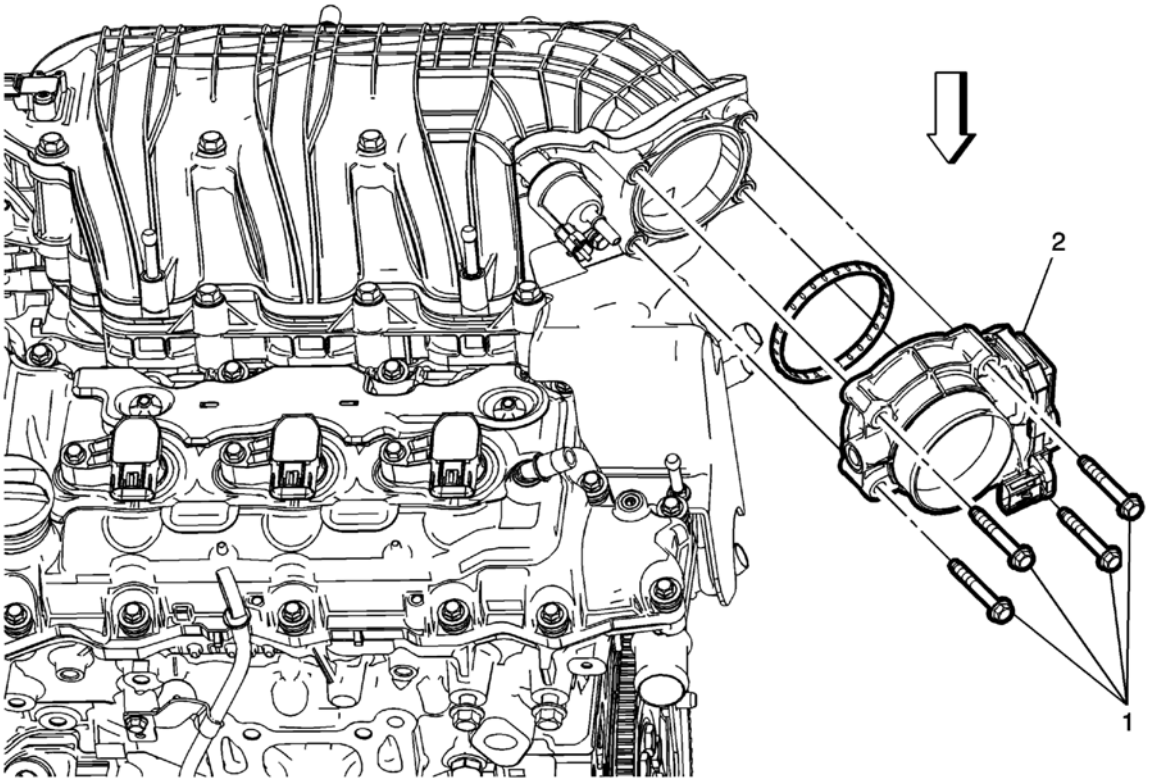


Fig. 10: Throttle Body Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures **1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement** **2. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement**	
1	Throttle Body Bolts (Qty: 4). **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Throttle Body. **Procedure** 1. Disconnect the throttle body electrical connector. 2. Install a NEW throttle body seal. 3. Perform the throttle learn procedure. Refer to **Q38 Throttle Body: Throttle/Idle**

Callout	Component Name
Preliminary Procedures **1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement** **2. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement**	
	Learn .

THROTTLE BODY INSPECTION AND CLEANING

1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

WARNING: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

CAUTION: Do not insert any tools into the throttle body bore in order to avoid damage to the throttle valve plate.

2. Inspect the throttle body bore and the throttle plate for deposits. You will need to open the throttle plate in order to inspect all surfaces.

CAUTION: Do not use any solvent that contains Methyl Ethyl Ketone (MEK). This solvent may damage fuel system components.

3. Clean the throttle body bore and the throttle plate using a clean shop towel with GM Top Engine Cleaner, P/N 1052626 or ACDelco Carburetor Tune-Up Conditioner, P/N X66-P, or an equivalent product.
4. Install the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.
5. Perform the Throttle/Idle Learn procedure. Refer to **Q38 Throttle Body: Throttle/Idle Learn**.

FUEL PRESSURE RELIEF (WITHOUT CH 48027)

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Relieving Fuel Pressure Warning .

1. If the fuel system requires repair, prevent fuel spillage by removing the fuel pump fuse. Refer to **Electrical Center Identification Views** .
2. Loosen the fuel fill cap in order to relieve the fuel tank vapor pressure.
3. Remove the engine cover, if required.
4. Remove the fuel rail service port cap.
5. Wrap a shop towel around the fuel rail service port and using a small flat-bladed tool, depress (open) the fuel rail test port valve.
6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
7. Install the fuel rail service port cap.

8. Install the engine cover, if required.
9. Tighten the fuel fill cap.

FUEL PRESSURE RELIEF (CH 48027)

Special Tools

CH-48027 Digital Pressure Gauge

WARNING: Refer to Gasoline/Gasoline Vapors Warning .

WARNING: Refer to Relieving Fuel Pressure Warning .

1. If the fuel system requires repair, prevent fuel spillage by removing the fuel pump fuse. Refer to **Electrical Center Identification Views** .

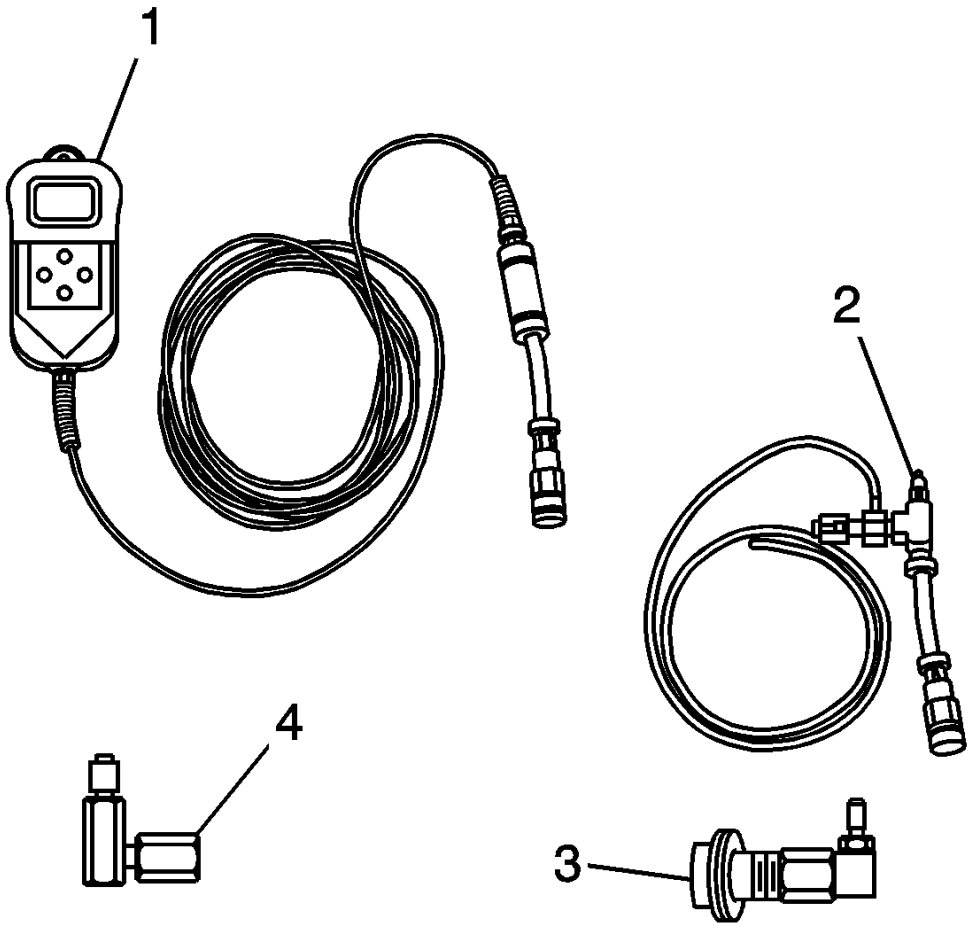


Fig. 11: View Of Digital Pressure Gauge, Special Tools & Components
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine cover, if required.

3. Loosen the fuel fill cap in order to relieve the fuel tank vapor pressure.
4. Remove the fuel rail service port cap.

WARNING: **Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.**

5. Wrap a shop towel around the fuel rail service port.
6. Connect the CH-48027-3 (4) to the fuel rail service port.
7. Connect the CH-48027-2 (2) to the CH-48027-3 (4).
8. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
9. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
10. Close the valve on the CH-48027-2 (2).
11. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.

CAUTION: **Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:**

- **The fuel pipe connections**
- **The hose connections**
- **The areas surrounding the connections**

NOTE: **If relieving the fuel pressure for the fuel pressure gauge installation and removal, it is NOT necessary to proceed with the following steps.**

12. Disconnect the CH-48027-2 (2) from the CH-48027-3 (4).
13. Disconnect the CH-48027-3 (4) from the fuel rail service port.
14. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
15. Install the fuel rail service port cap.
16. Install the engine cover, if required.
17. Tighten the fuel fill cap.

FUEL PRESSURE RELIEF (HIGH SIDE)

WARNING: **Fuel that flows out at high pressure can cause serious injury to the skin and eyes. ALWAYS depressurize the fuel system before removing components that are under high fuel pressure.**

1. Remove the fuel pump control module 20A fuse from the underhood electrical center. Refer to **Electrical Center Identification Views** .
2. Start the vehicle and allow the engine to idle until the engine stops. The engine will stop in approximately 20-30 seconds.

3. Turn the ignition OFF.

FUEL PRESSURE GAUGE INSTALLATION AND REMOVAL

Special Tools

CH-48027 Digital Pressure Gauge

Installation Procedure

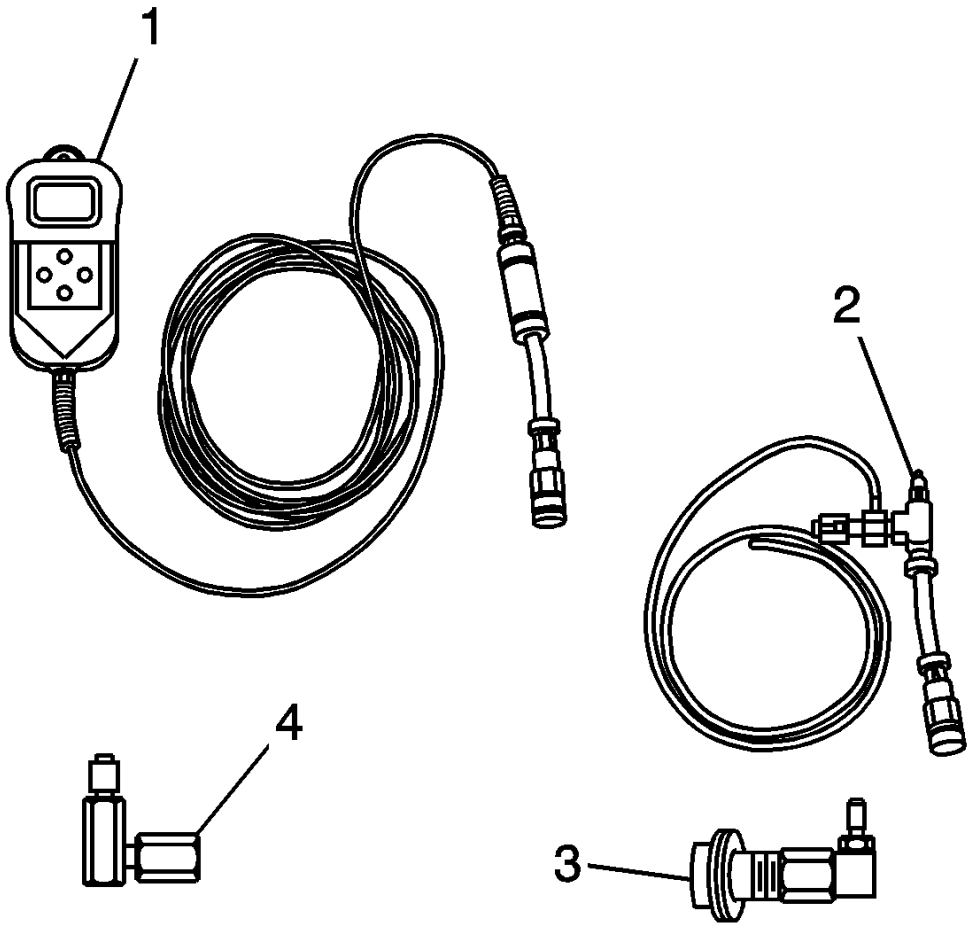


Fig. 12: View Of Digital Pressure Gauge, Special Tools & Components
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Gasoline/Gasoline Vapors Warning .**

WARNING: **Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will**

catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**.
2. Connect the CH-48027-1 (1) to the CH-48027-2 (2).
3. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.
4. Perform any tests and/or diagnostics as needed. For the proper usage of the **CH-48027** digital pressure gauge , refer to the manufacture's directions.

Removal Procedure

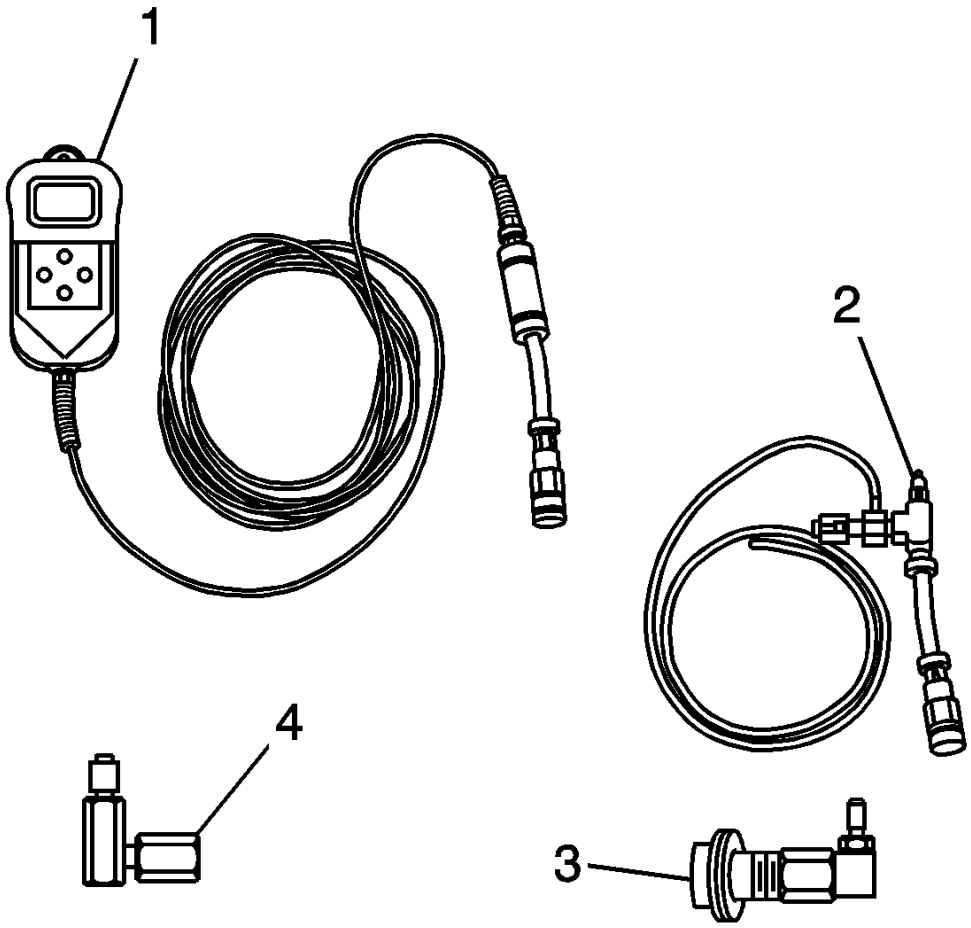


Fig. 13: View Of Digital Pressure Gauge, Special Tools & Components
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure, if required. Perform the following steps:

WARNING: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any

fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

1. Wrap a shop towel around the fuel rail service port.
2. Place the hose on the CH-48027-2 (2) into an approved gasoline container.
3. Open the valve on the CH-48027-2 (2) in order to bleed any fuel from the fuel rail.
4. Close the valve on the CH-48027-2 (2).
5. Remove the hose on the CH-48027-2 (2) from the approved gasoline container.
6. Remove the shop towel from around the fuel rail service port, and place in an approved gasoline container.

CAUTION: Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:

- **The fuel pipe connections**
- **The hose connections**
- **The areas surrounding the connections**

2. Disconnect the CH-48027-1 (1) from the CH-48027-2 (2).
3. Disconnect the CH-48027-2 (2) from the CH-48027-3 (4).
4. Disconnect the CH-48027-3 (4) from the fuel rail service port.
5. Install the fuel rail service port cap.
6. Install the engine cover, if required.
7. Tighten the fuel fill cap.

METAL COLLAR QUICK CONNECT FITTING SERVICE

Special Tools

J 37088-A Fuel Line Disconnect Tool Set

Removal Procedure

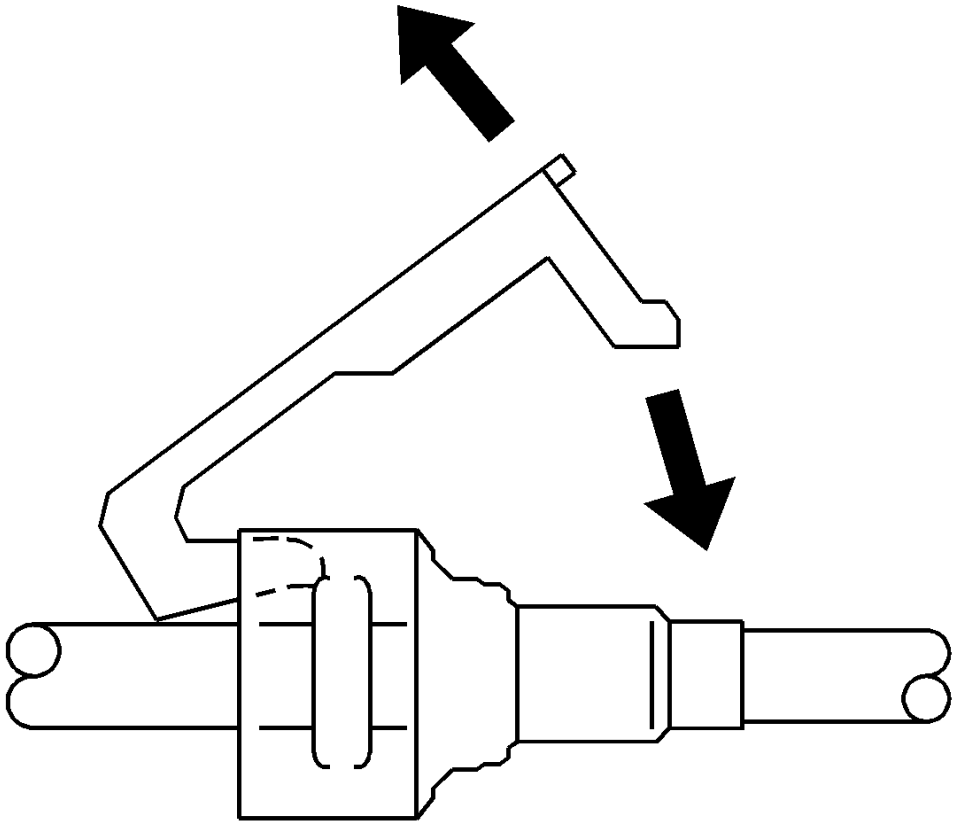


Fig. 14: Relieve Fuel System Pressure
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure. Refer to the **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**.
2. Remove the retainer from the fuel feed quick-connect fitting.

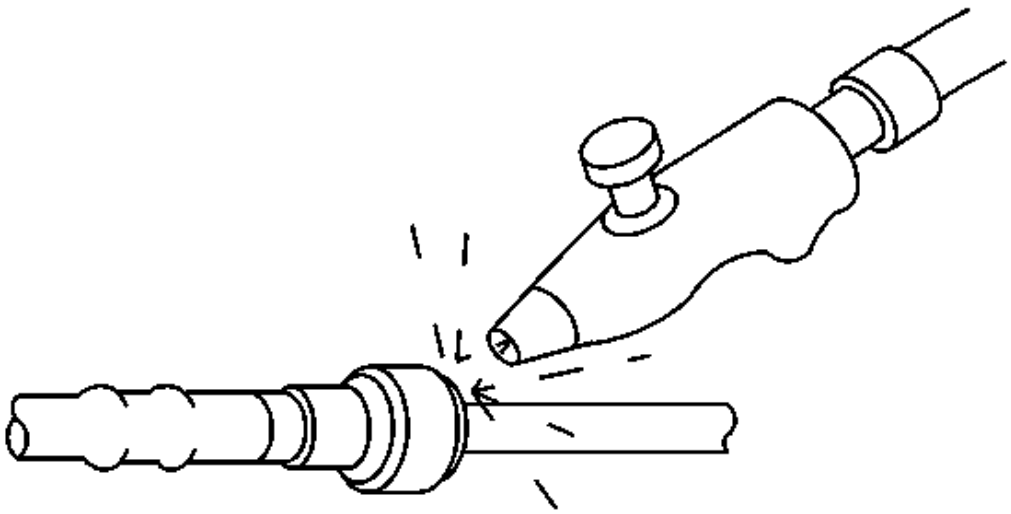


Fig. 15: Blowing Dirt Out Of Fitting (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Wear safety glasses when using compressed air, as flying dirt particles may cause eye injury.

3. Using compressed air, blow any dirt or debris from around the fitting.

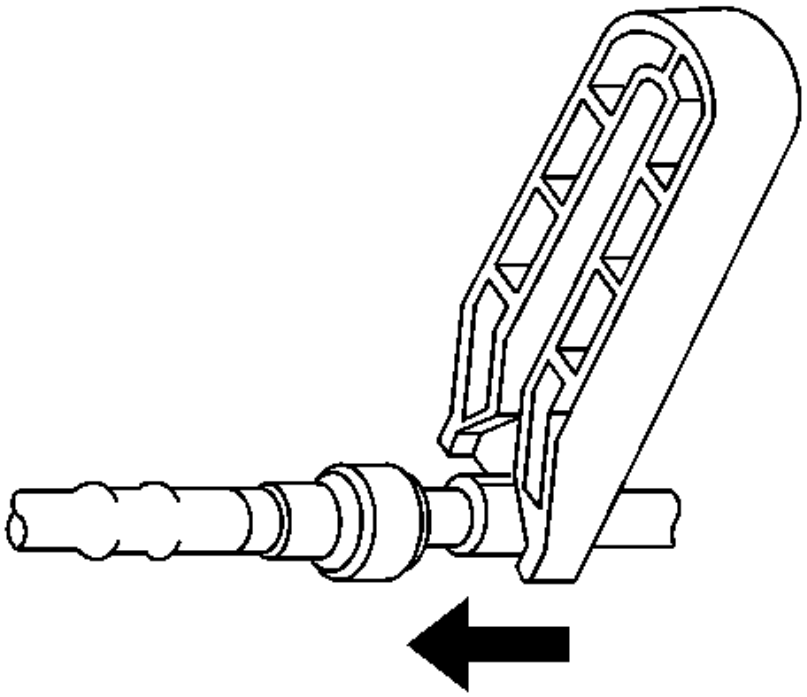


Fig. 16: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

4. Using the correct tool from the **J 37088-A** fuel line disconnect tool set , insert the tool into the female connector, then push inward in order to release the quick connect locking tabs.

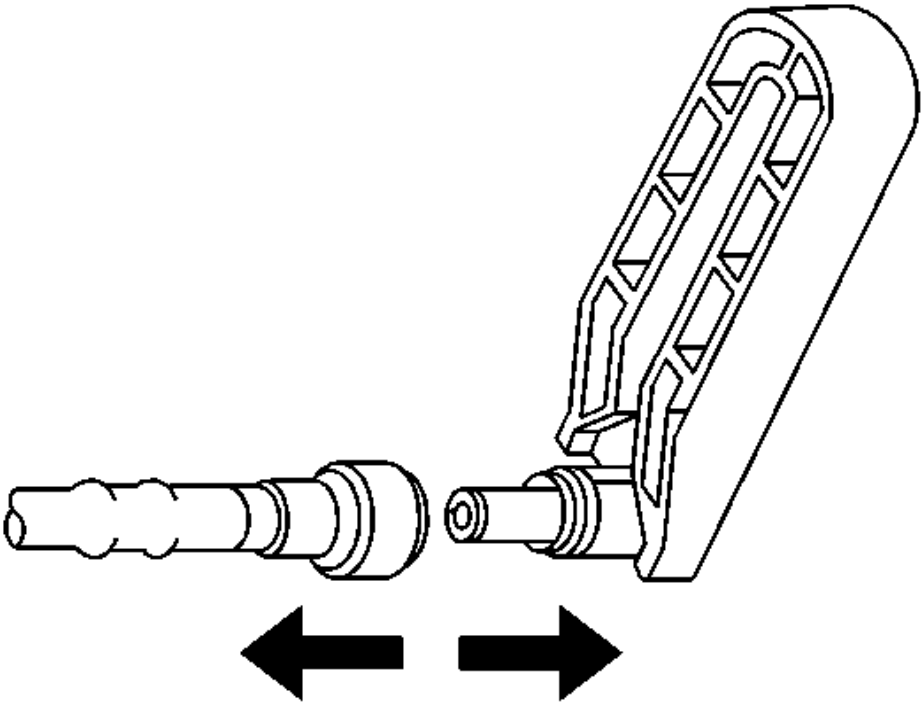


Fig. 17: View Of Quick Connect Locking Tabs (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

5. Pull the fuel line connection apart.

CAUTION: If necessary, remove rust or burrs from the fuel pipes with an emery cloth. Use a radial motion with the fuel pipe end in order to prevent damage to the O-ring sealing surface. Use a clean shop towel in order to wipe off the male tube ends. Inspect all the connections for dirt and burrs. Clean or replace the components and assemblies as required.

6. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components, as required.

Installation Procedure

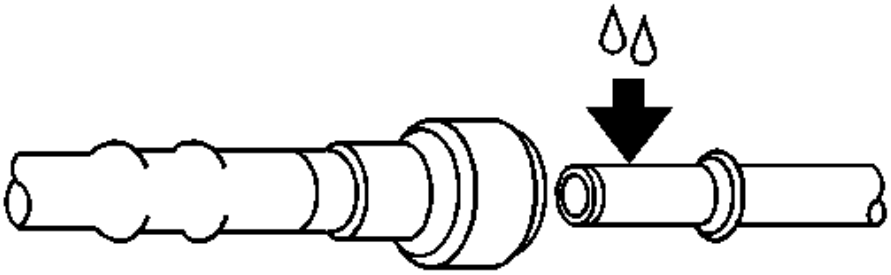


Fig. 18: Oiling Male Pipe Ends (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Fuel Pipe Fitting Warning .

1. Apply a few drops of clean engine oil to the male pipe end.

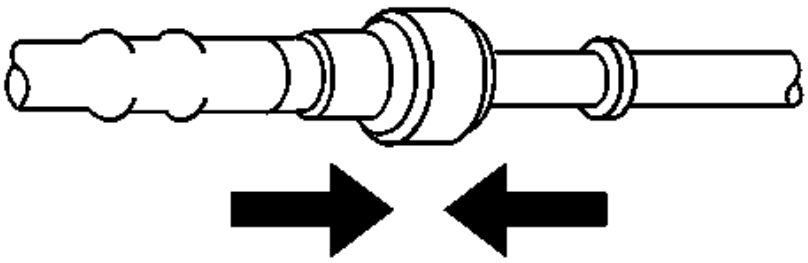


Fig. 19: View Of Connectors (Metal Collar)
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the fitting together in order to snap the retaining tabs into place.

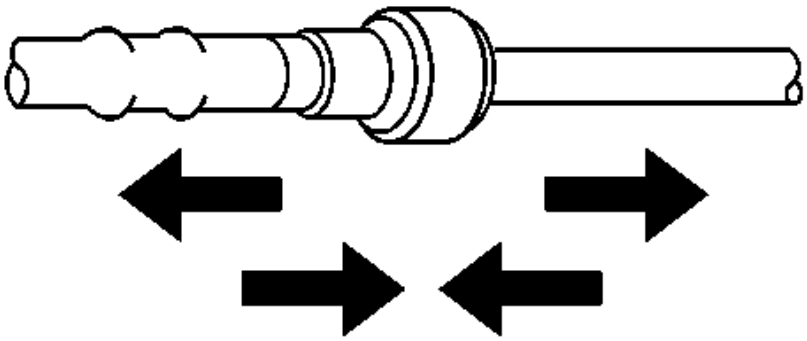


Fig. 20: Ensuring Connection (Metal Collar) Is Secure
Courtesy of GENERAL MOTORS COMPANY

3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.

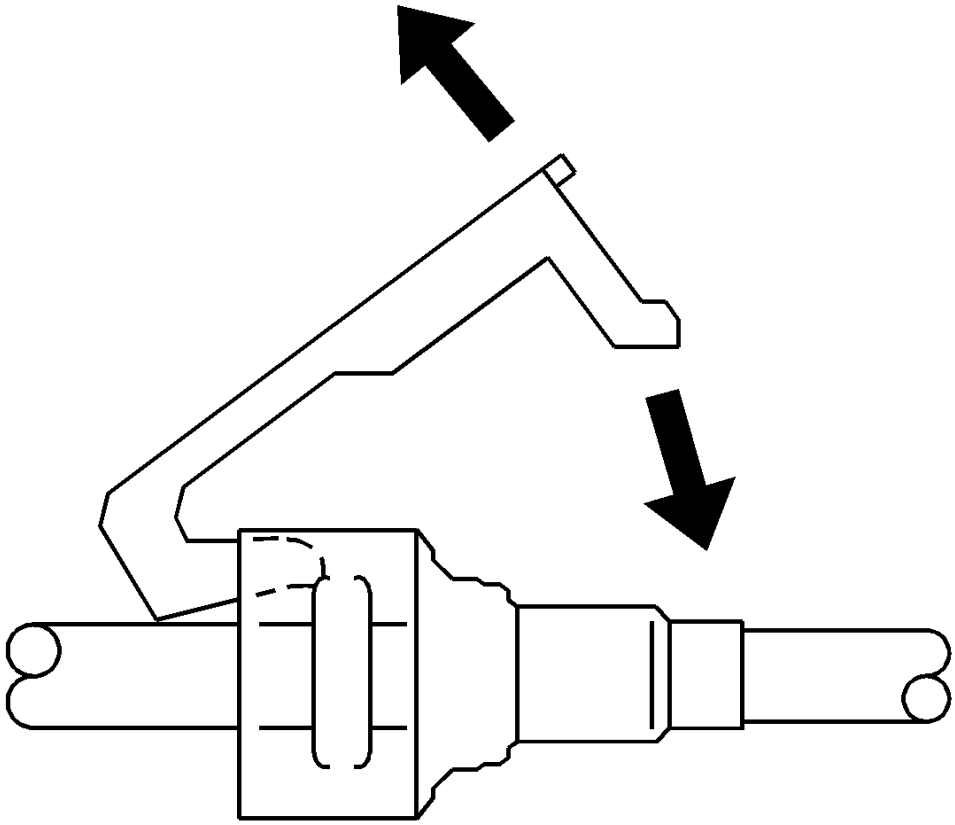


Fig. 21: Relieve Fuel System Pressure
Courtesy of GENERAL MOTORS COMPANY

4. Install the retainer to the fuel feed quick-connect fitting.

PLASTIC COLLAR QUICK CONNECT FITTING SERVICE

Removal Procedure

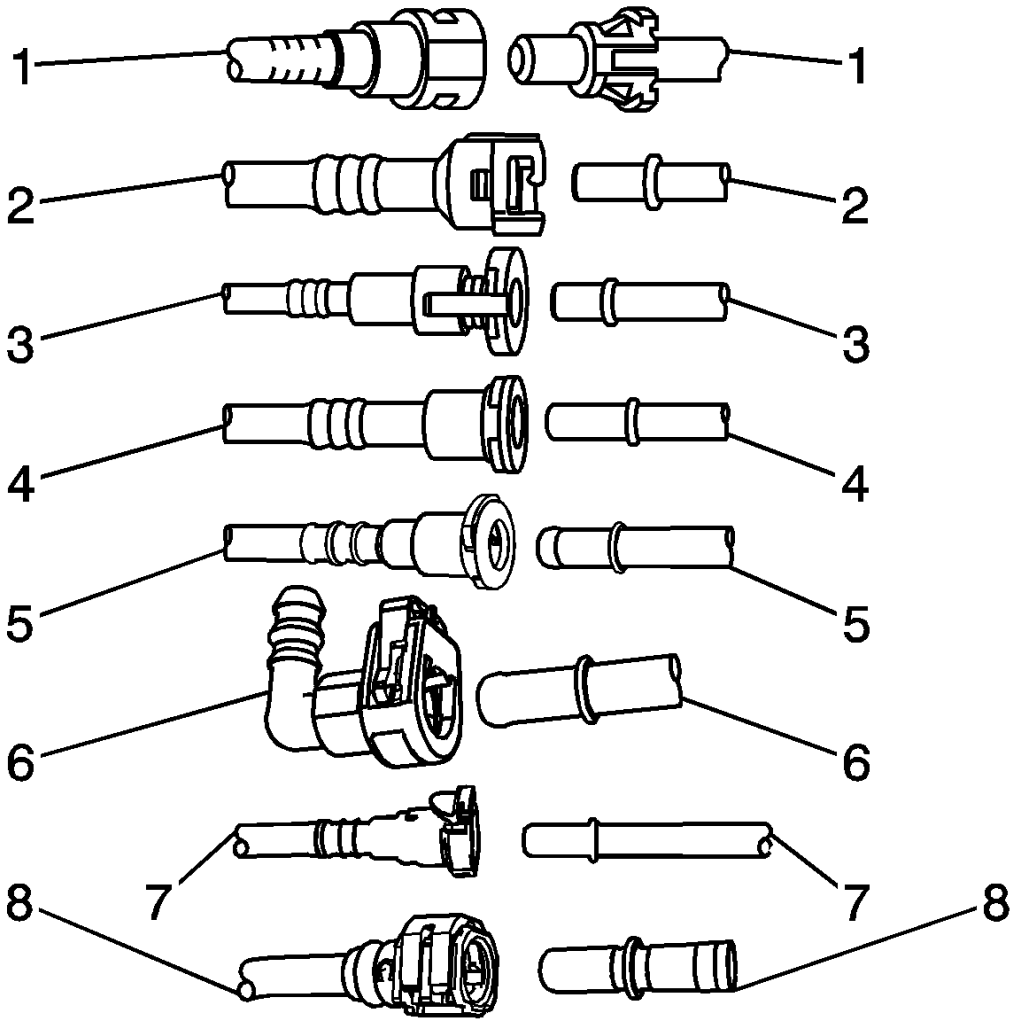


Fig. 22: Plastic Collar Quick Connect Fitting Service
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Gasoline/Gasoline Vapors Warning .**

NOTE: **There are several types of Plastic Collar Fuel and Evaporative Emission Quick Connect Fittings used on this vehicle.**

- **Bartholomew (1)**
- **Q Release (2)**
- **Squeeze to Release (3)**
- **Sliding Retainer (4)**
- **Global Connect (5)**
- **TI Loc (6)**
- **Safe Lock (7)**

The following instructions apply to all of these types of Plastic Collar Quick Connect Fittings except where indicated.

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to the **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**.

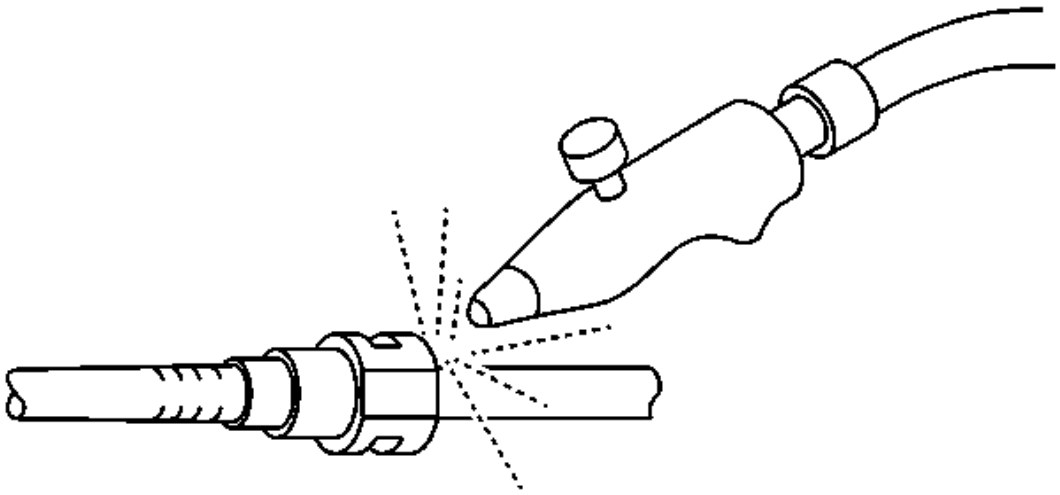


Fig. 23: Blowing Dirt Out Of Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses and Compressed Air Warning .

2. Using compressed air, blow any dirt out of the quick-connect fitting.

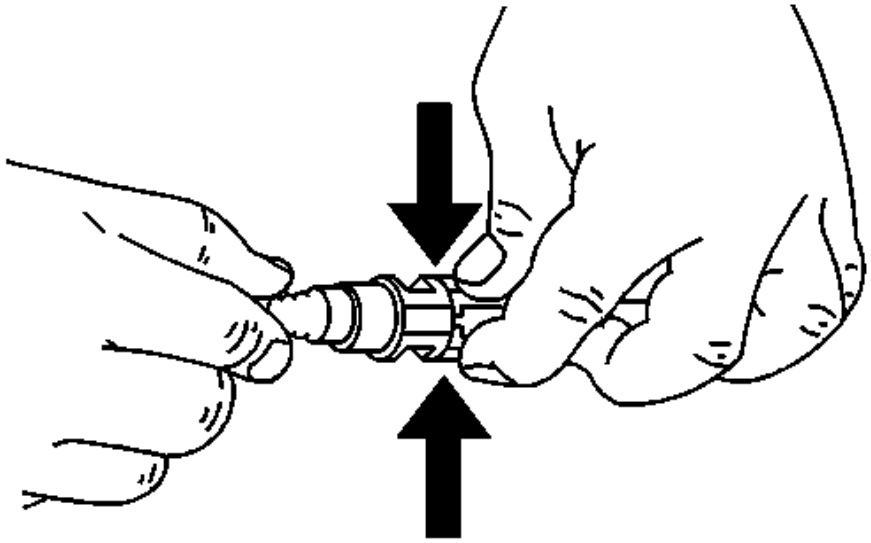


Fig. 24: View Of Quick Connect Fitting Release Tabs (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

3. This step applies to Bartholomew style connectors ONLY. Squeeze the plastic quick-connect fitting release tabs.

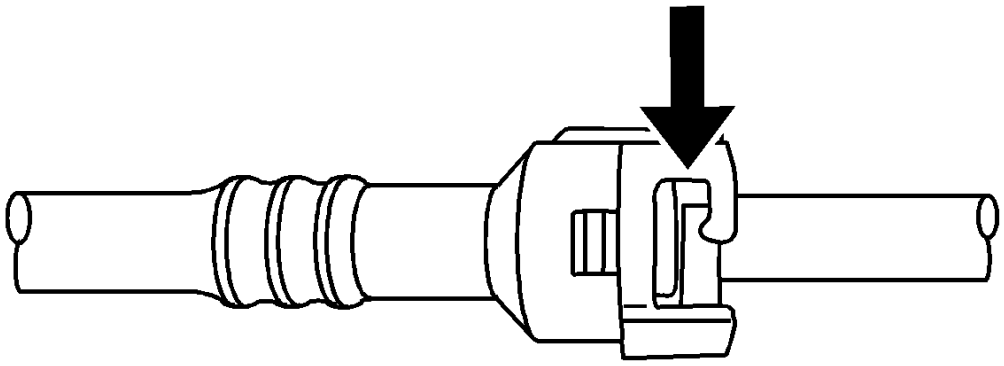


Fig. 25: Releasing Q Release Style Connectors (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

4. This step applies to Q Release style connectors ONLY. Release the fitting by Pushing the tab toward the other side of the slot in the fitting.

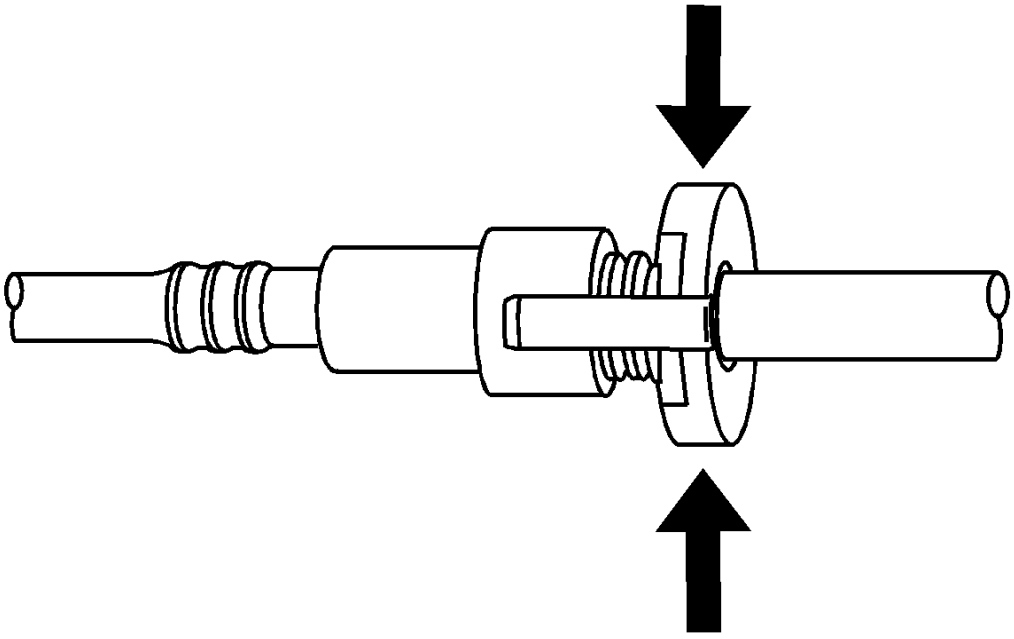


Fig. 26: Disengaging Quick Connect Fitting (Plastic Collar)
Courtesy of GENERAL MOTORS COMPANY

5. This step applies to Squeeze to Release style connectors ONLY. Squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick-connect fitting.

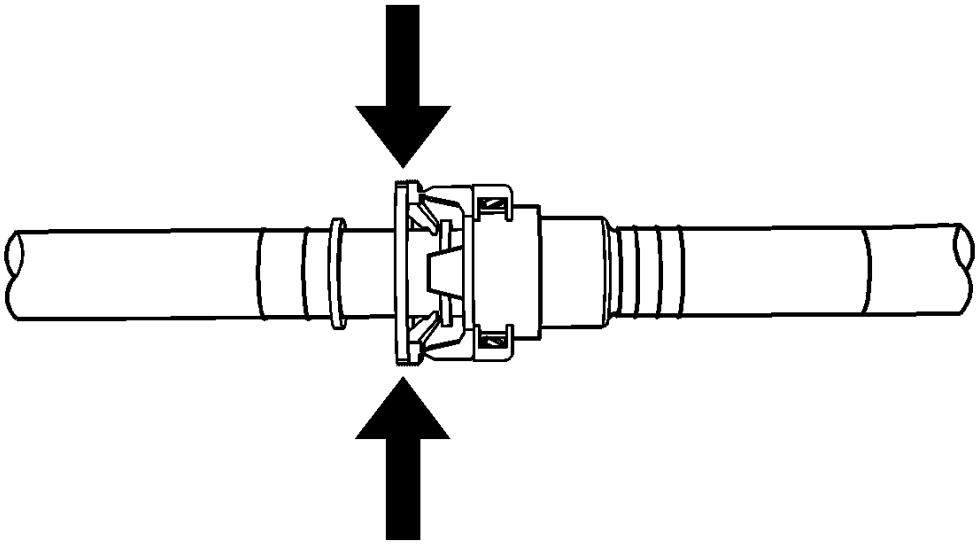


Fig. 27: Pushing In Male Side Of Connector
Courtesy of GENERAL MOTORS COMPANY

6. This step applies to Squeeze to Release style connectors ONLY. Push in the male side slightly in order to slide the retainer away from the retainers, squeeze where indicated by arrows on both sides of the plastic ring surrounding the quick-connect fitting.

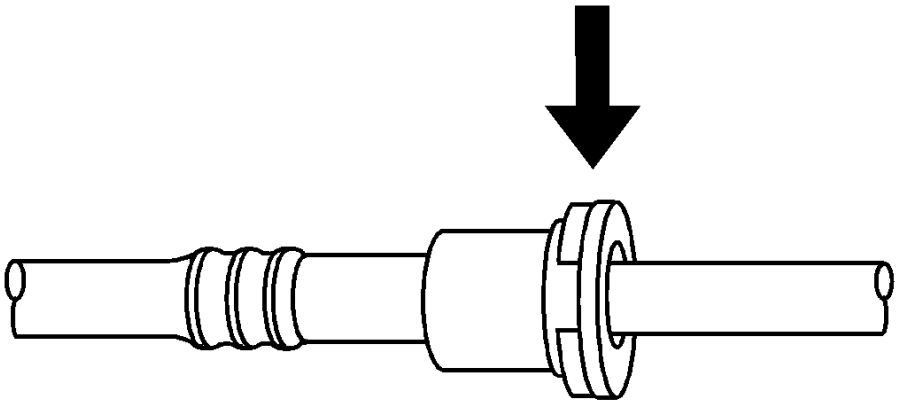


Fig. 28: View Of Sliding Retainer Style Connector
Courtesy of GENERAL MOTORS COMPANY

7. This step applies to Sliding Retainer style connectors ONLY. Release the fitting by pressing on one side of the release tab causing it to push in slightly. If the tab doesn't move try pressing the tab in from the opposite side. The tab will only move in one direction.

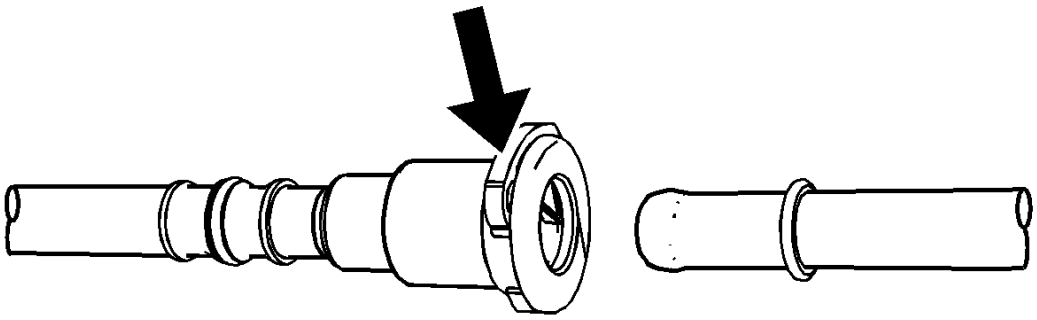


Fig. 29: Global Connector Style
Courtesy of GENERAL MOTORS COMPANY

8. This step applies to the Global Connector style only. Push the connector toward the tube in order to release the pressure. Press and hold down the release mechanism, and pull the connector straight out.

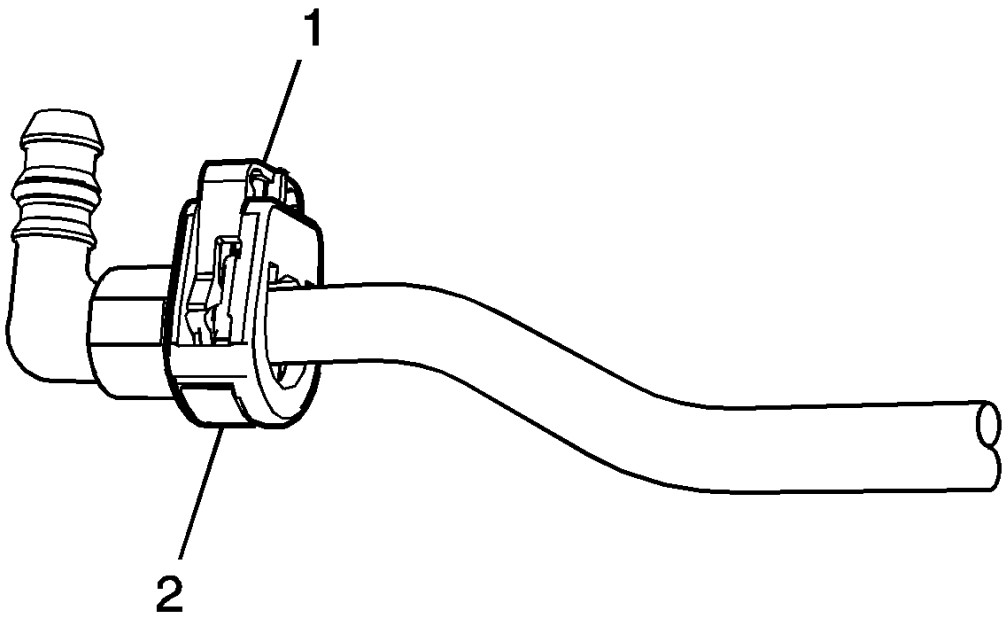


Fig. 30: TI Loc style
Courtesy of GENERAL MOTORS COMPANY

9. This step applies to the TI Loc style only. Push the connector toward the tube in order to release the pressure. Release the redundant latch (1) with two fingers or a flat bladed tool. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.

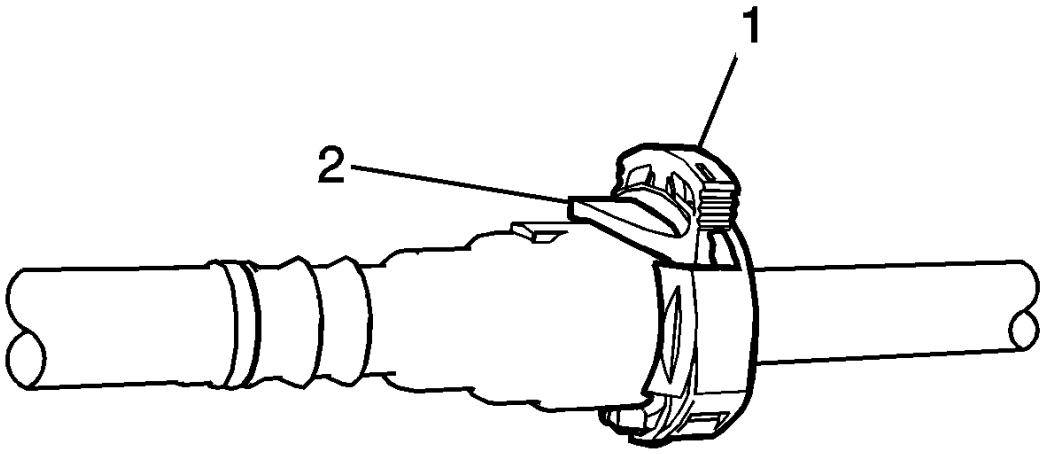


Fig. 31: Safe Lock Style
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Relieving Fuel Pressure Warning .

10. This step applies to the Safe Lock style only. Push the connector toward the tube in order to release the pressure. Release the second latch (1) with two fingers. Then press and hold down the bottom release mechanism (2) and pull the connector straight out.
11. Using a clean shop towel, wipe off the male pipe end.
12. Inspect both ends of the fitting for dirt and burrs.
13. Clean or replace components as necessary.

Installation Procedure

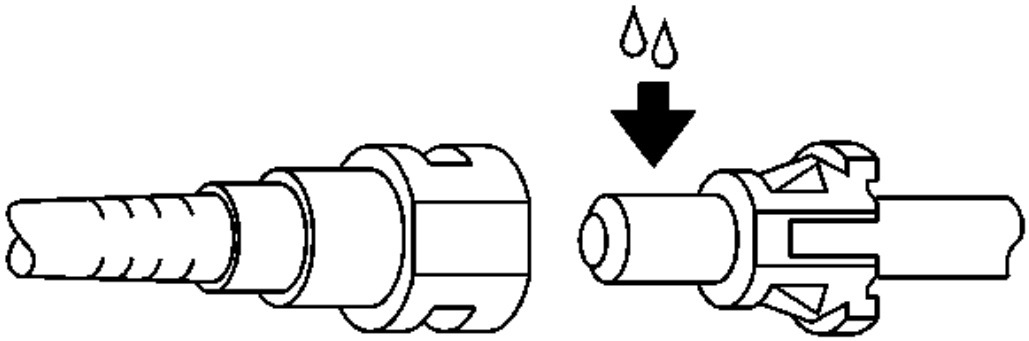


Fig. 32: Lubricating Male Pipe End
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Fuel Pipe Fitting Warning .

1. Apply a few drops of clean engine oil to the male pipe end.

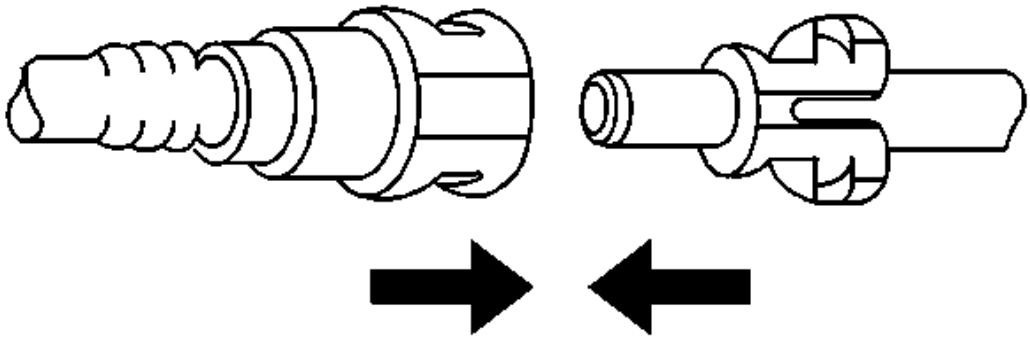


Fig. 33: Connecting Quick-Connect Fittings
Courtesy of GENERAL MOTORS COMPANY

2. Push both sides of the quick-connect fitting together in order to cause the retaining feature to snap into place.

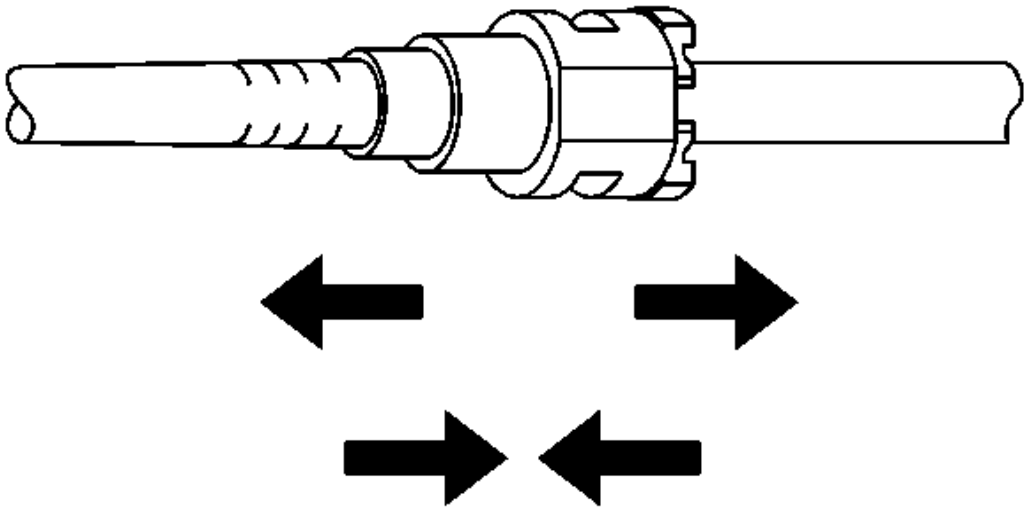


Fig. 34: View Of Quick-Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

3. Pull on both sides of the quick-connect fitting to make sure the connection is secure.

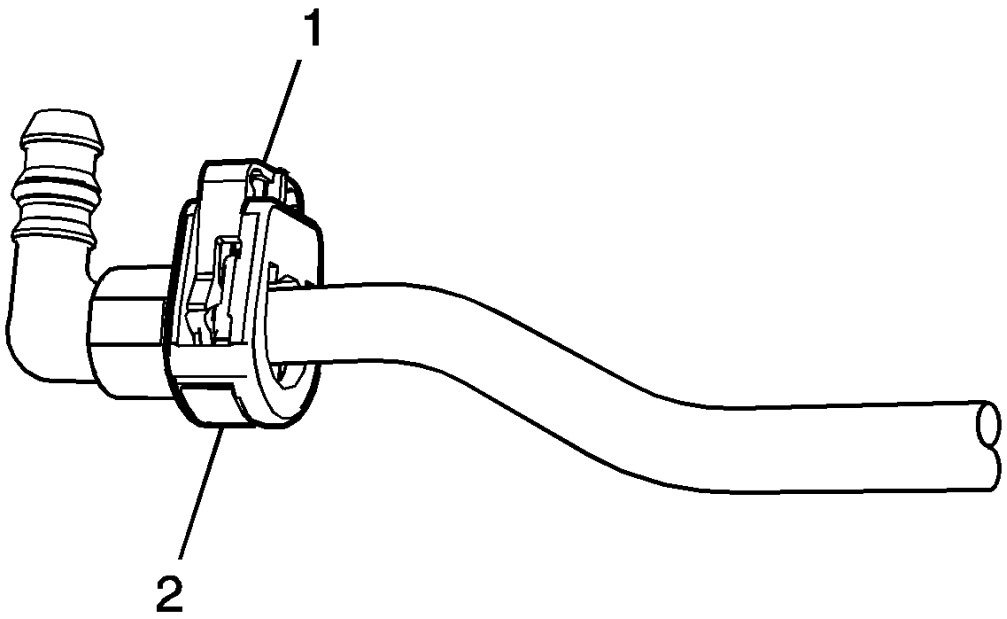


Fig. 35: TI Loc style
Courtesy of GENERAL MOTORS COMPANY

4. Insert the tube in the connector until the retainer snaps in place.
5. Push down on the redundant latch (1) until it is fully engaged and snapped into position.

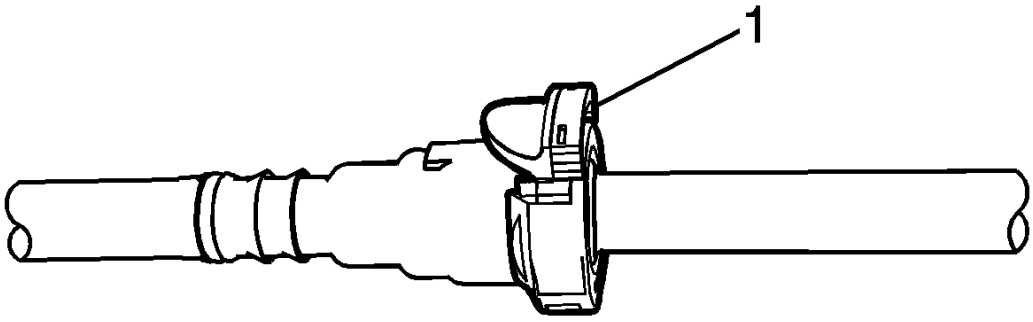


Fig. 36: Redundant Latch
Courtesy of GENERAL MOTORS COMPANY

6. Insert the tube in the connector until the retainer snaps in place.
7. Push down on the second latch (1) in order to secure the connection.
8. Inspect for leaks using the following procedure:
    1. Turn the ignition ON, with the engine OFF for 2 seconds.
    2. Turn the ignition OFF, for 10 seconds.
    3. Turn the ignition ON, with the engine OFF for 2 seconds.
    4. Turn the ignition OFF.
    5. Inspect for leaks.

FUEL TANK DRAINING (E-85)

Special Tools

- **J 36850** Transjel Lubricant
- **J 45004** Fuel Tank Drain Hose

WARNING: Never drain or store fuel in an open container. Always use an approved fuel storage container in order to reduce the chance of fire or explosion.

WARNING: Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

1. Raise and Support the Vehicle. Refer to **Lifting and Jacking the Vehicle**

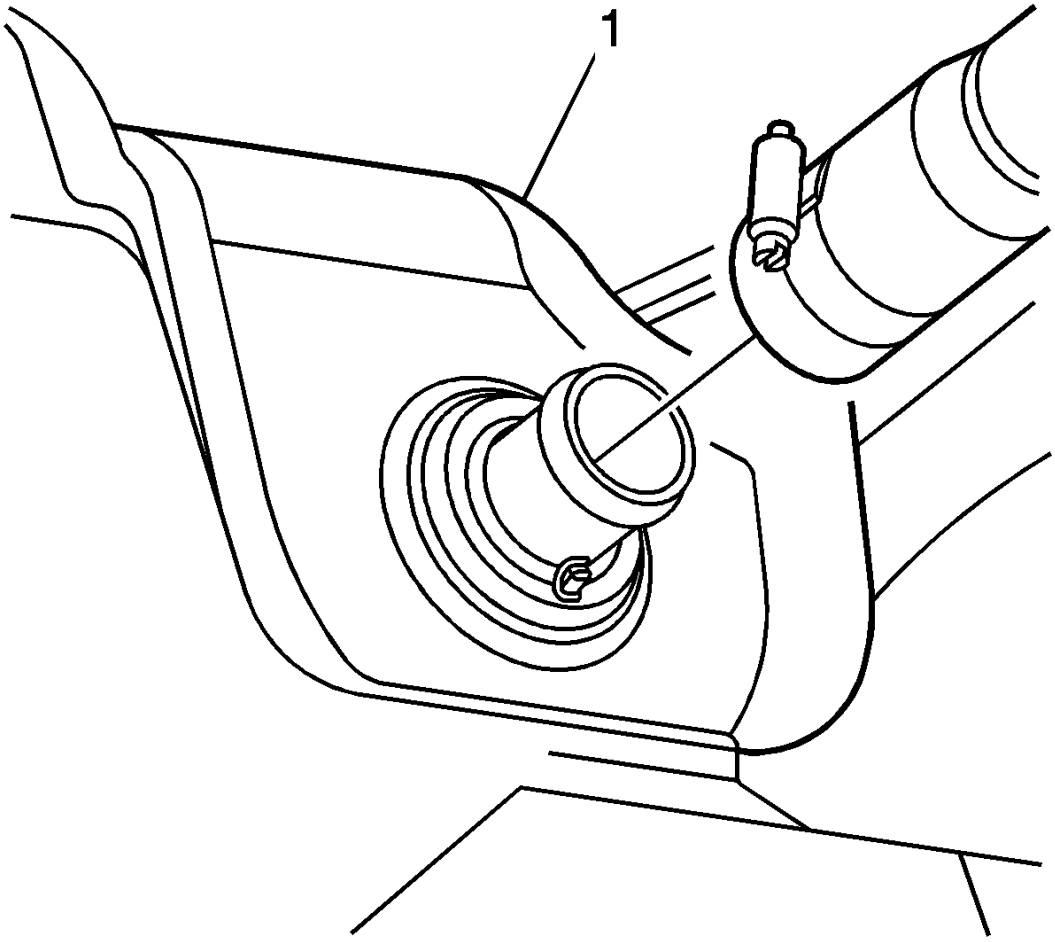


Fig. 37: Inserting Fuel Tank Drain Hose Into Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

NOTE: Lubricate the fuel drain hose with J 36850 Transjel Lubricant or equivalent to aid in hose insertion. Do not use an unapproved lubricant.

2. Loosen the lower drain hose clamp in order to separate the drain hose from the fuel tank (1).
3. Insert the **J 45004** Fuel Tank Drain Hose into the fuel tank (1) until the hose reaches the bottom of the fuel tank.
4. Use a hand or air operated pump device in order to drain as much fuel from the fuel tank as possible.

FUEL TANK PROTECTOR REPLACEMENT

Removal Procedure

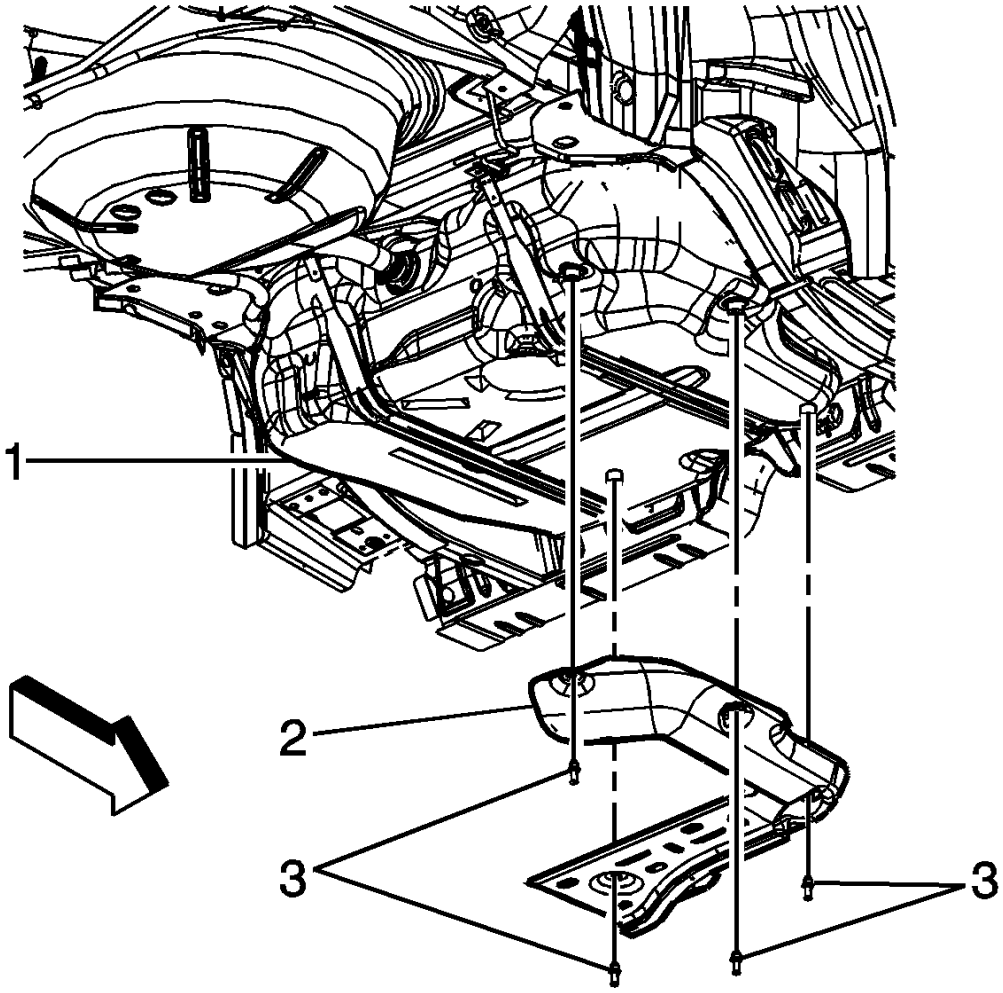


Fig. 38: View Of Fuel Tank Shield
Courtesy of GENERAL MOTORS COMPANY

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the fuel tank shield retainers (3).
3. Remove the fuel tank shield (2) from the fuel tank (1).

Installation Procedure

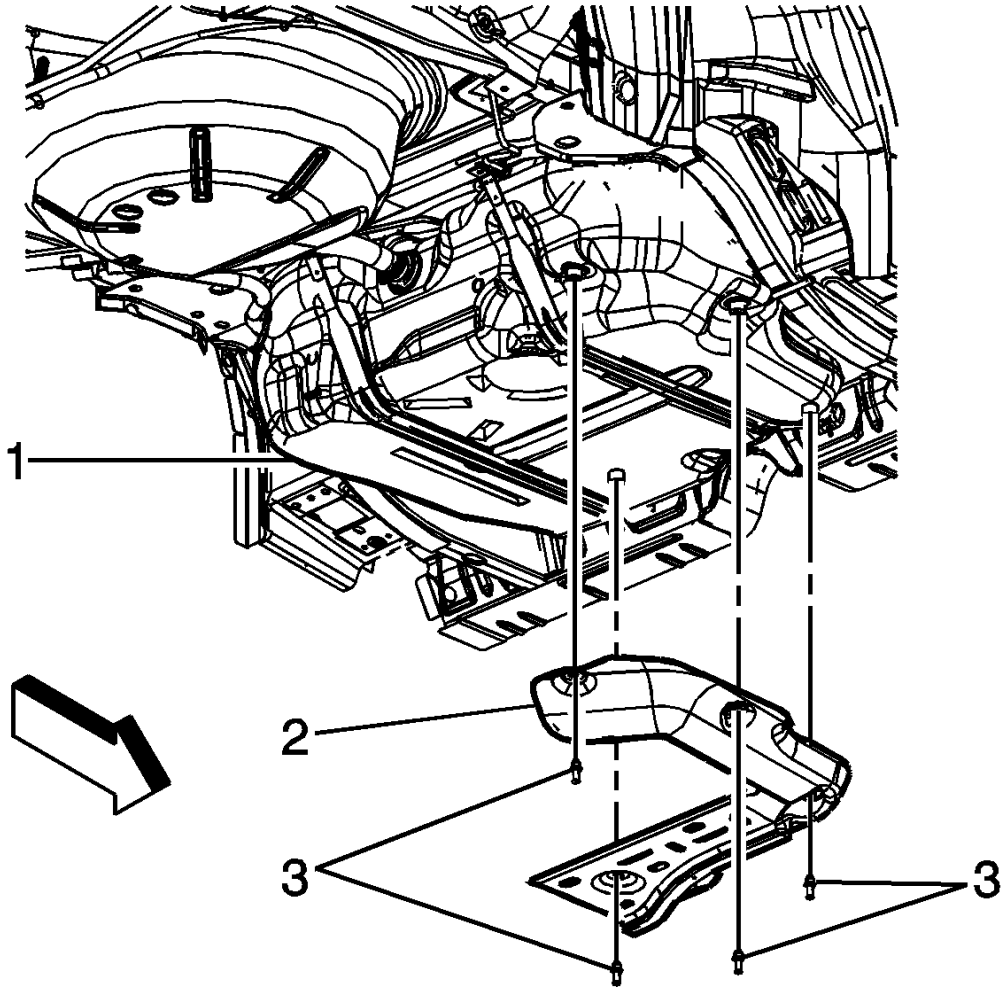


Fig. 39: View Of Fuel Tank Shield
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel tank shield (2) from the fuel tank (1).

CAUTION: Refer to Fastener Caution .

2. Install the fuel tank shield retainers (3).
3. Lower the vehicle.

FUEL TANK REPLACEMENT

Removal Procedure

NOTE: Clean the fuel and evaporative emission (EVAP) connections and surrounding areas prior to disconnecting the lines in order to avoid possible system contamination.

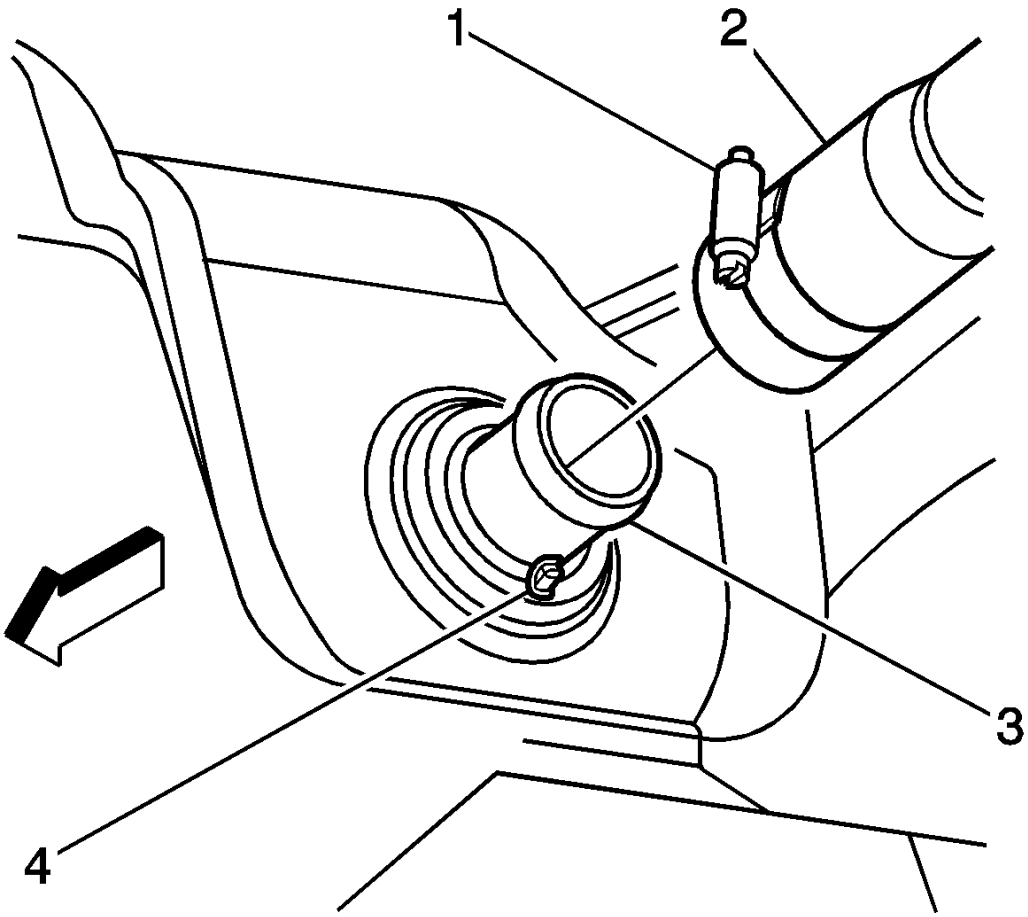


Fig. 40: Fuel Tank Clamp, Fuel Tank Hose and Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**.
2. Drain the fuel tank. Refer to **Fuel Tank Draining (E-85)**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Loosen the fuel fill hose clamp (1) at the fuel tank.
5. Remove the fuel tank fill hose (2) from the fuel tank (3).
6. Disconnect the EVAP vent pipe quick connect fitting from the fill pipe EVAP vent pipe quick connect fitting. **Plastic Collar Quick Connect Fitting Service**.

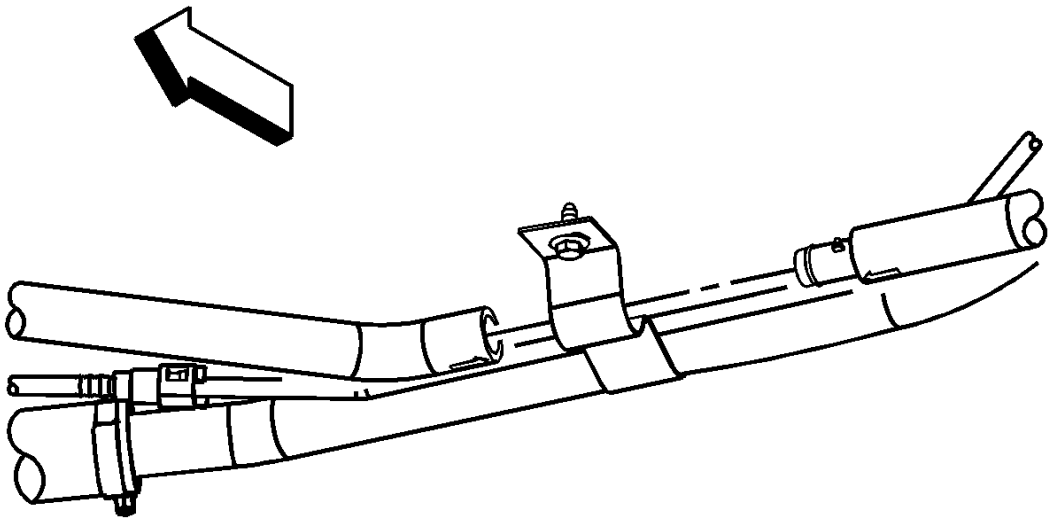


Fig. 41: EVAP Canister Vent Solenoid Valve And EVAP Emission Canister Hose
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the EVAP vent solenoid hose on the tank from the vent valve solenoid hose.

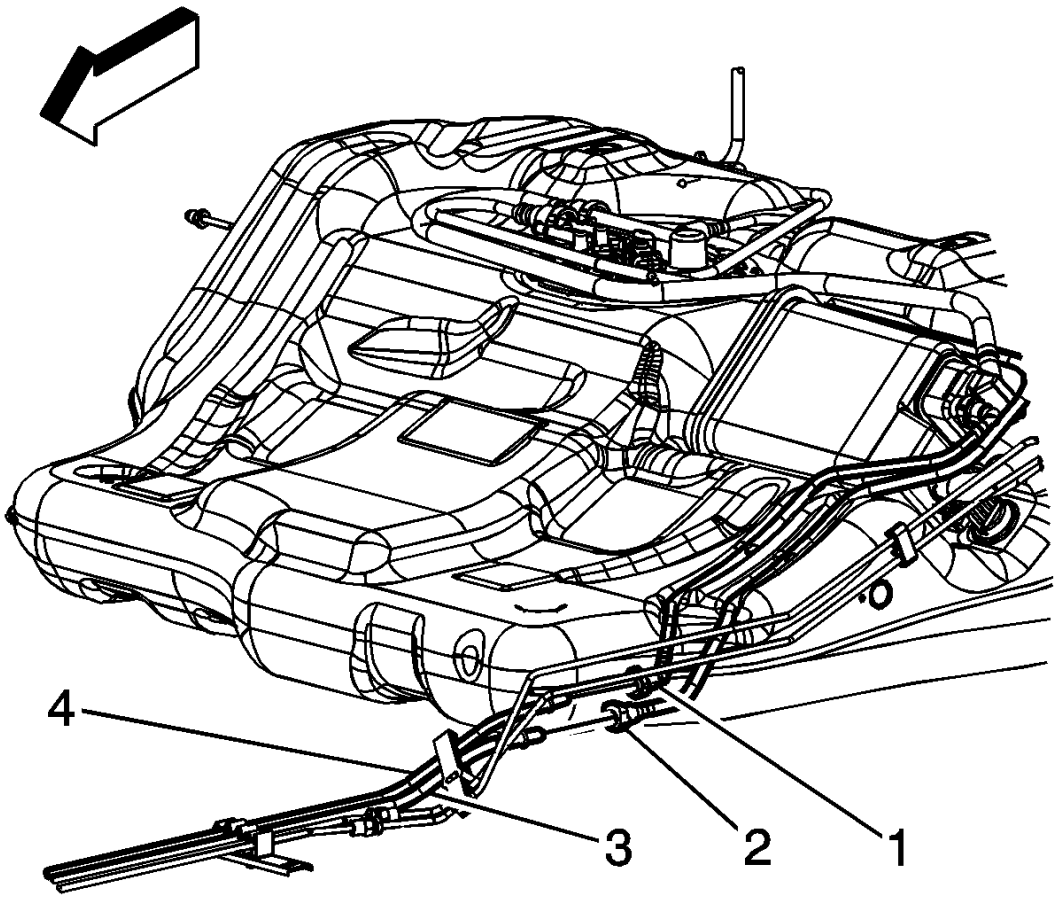


Fig. 42: View Of Fuel Feed, EVAP and Fuel Tank Lines
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the fuel feed (3), and the EVAP (4) lines from the fuel tank lines (1, 2). Refer to **Plastic Collar Quick Connect Fitting Service**.
9. Support the exhaust system.
10. Remove the rubber exhaust pipe hangers in order to allow the exhaust system to drop slightly.

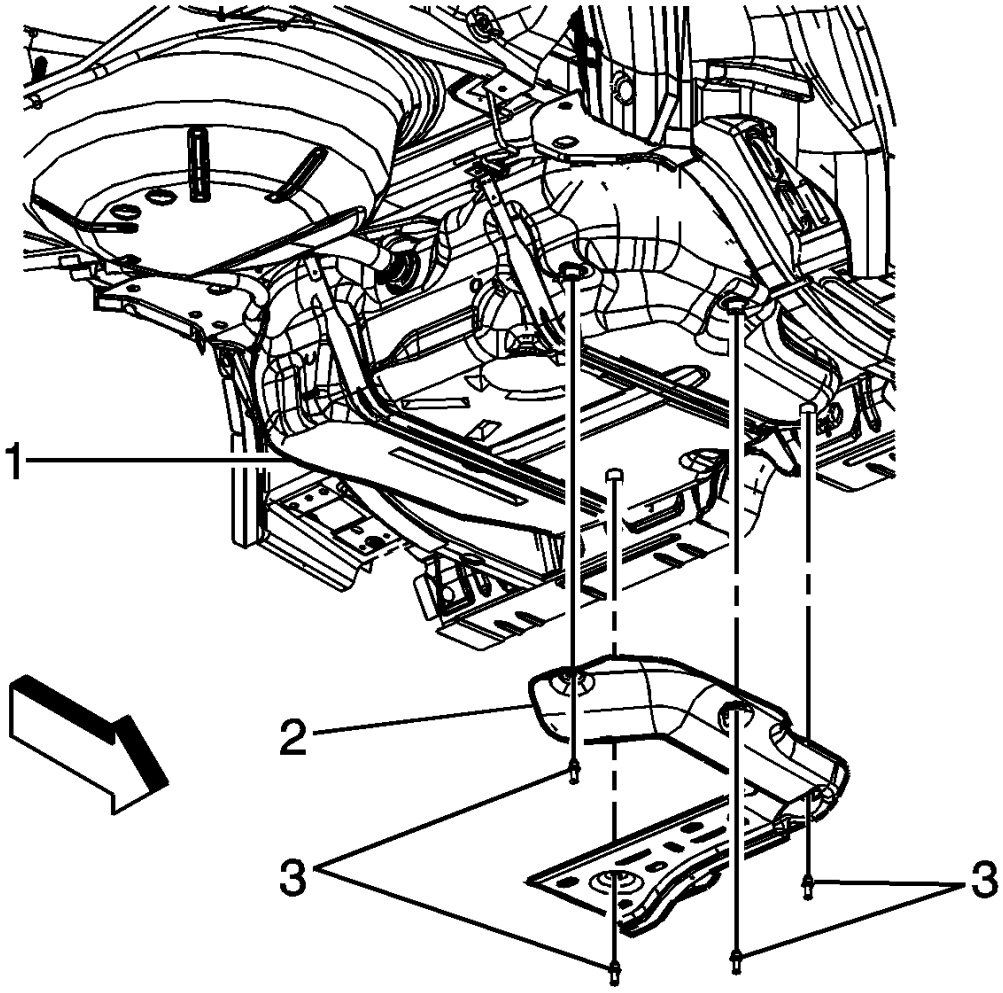


Fig. 43: View Of Fuel Tank Shield
Courtesy of GENERAL MOTORS COMPANY

11. Remove the fuel tank shield retainers (3).
12. Remove the fuel tank shield (2).

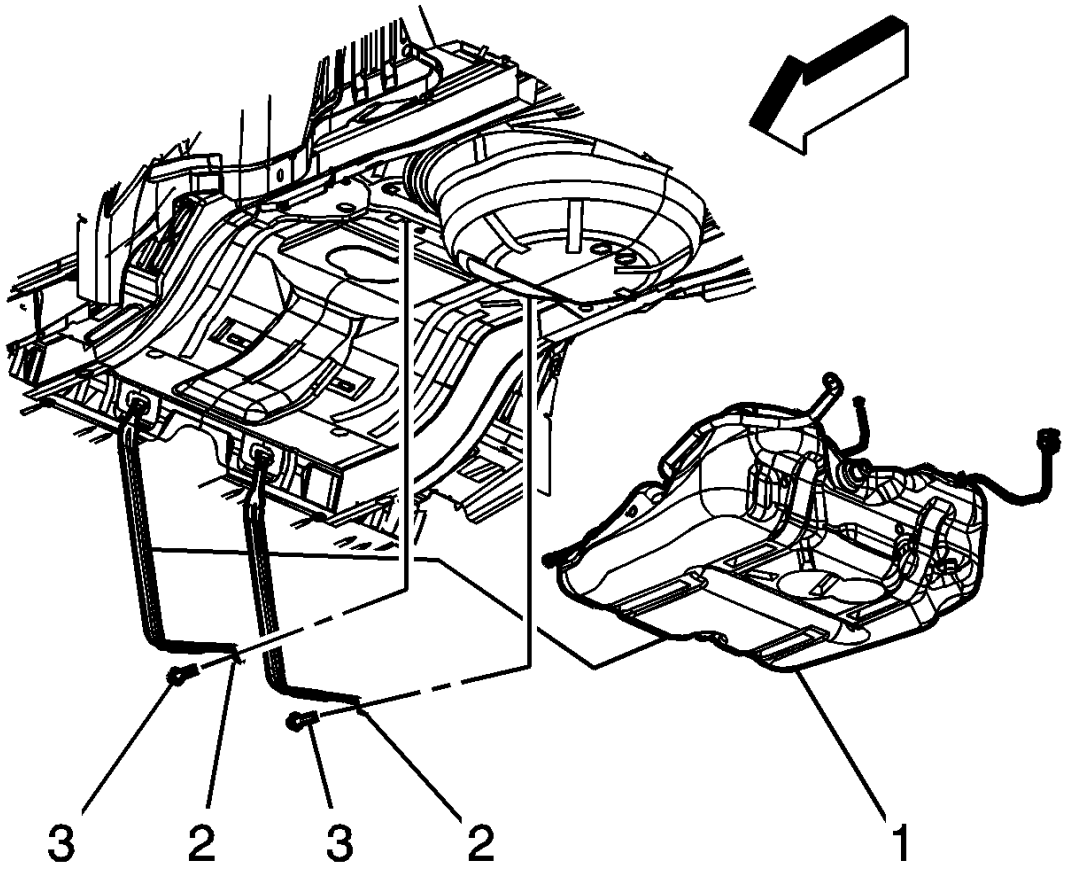


Fig. 44: View Of Fuel Tank & Straps
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not bend the fuel tank straps. Bending the fuel tank straps may damage the straps.

13. Support the fuel tank with a suitable adjustable jack.
14. Remove the fuel tank strap bolts (3).
15. Using the jack lower the fuel tank.

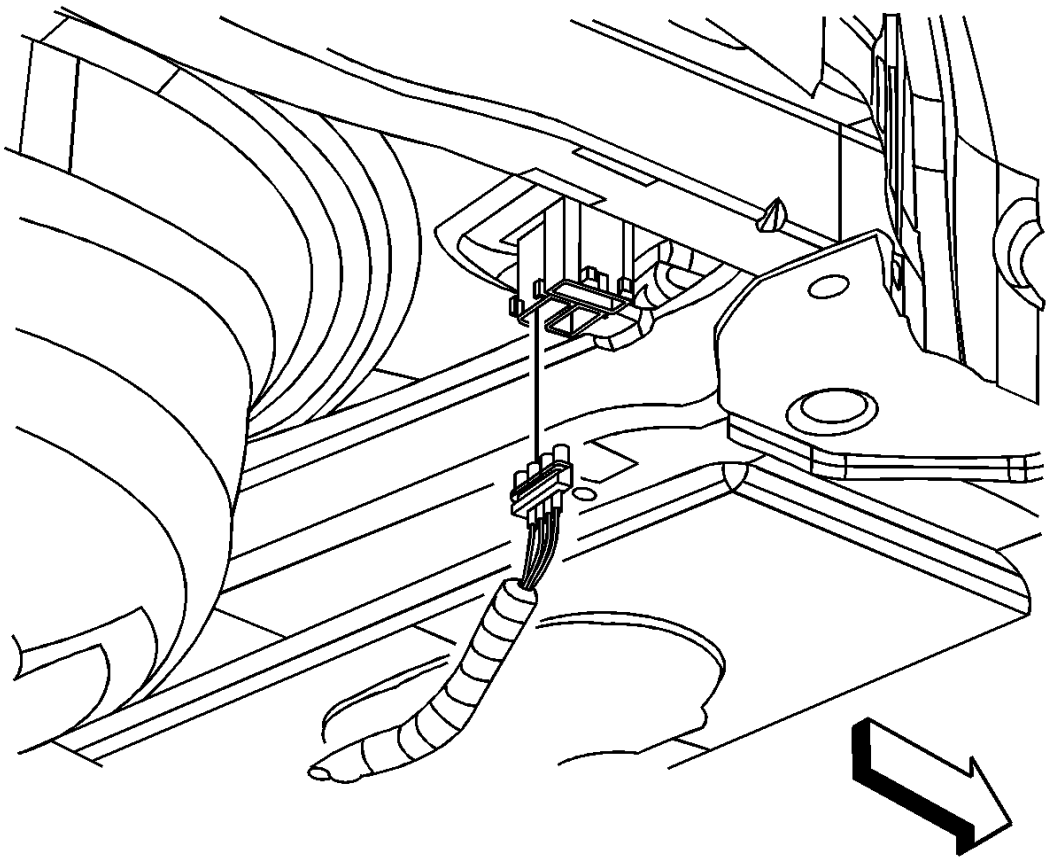


Fig. 45: View Of Fuel Sender Jumper Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

16. Disconnect the fuel sender jumper harness electrical connector.
17. Remove the fuel tank and place the tank in a suitable work area.

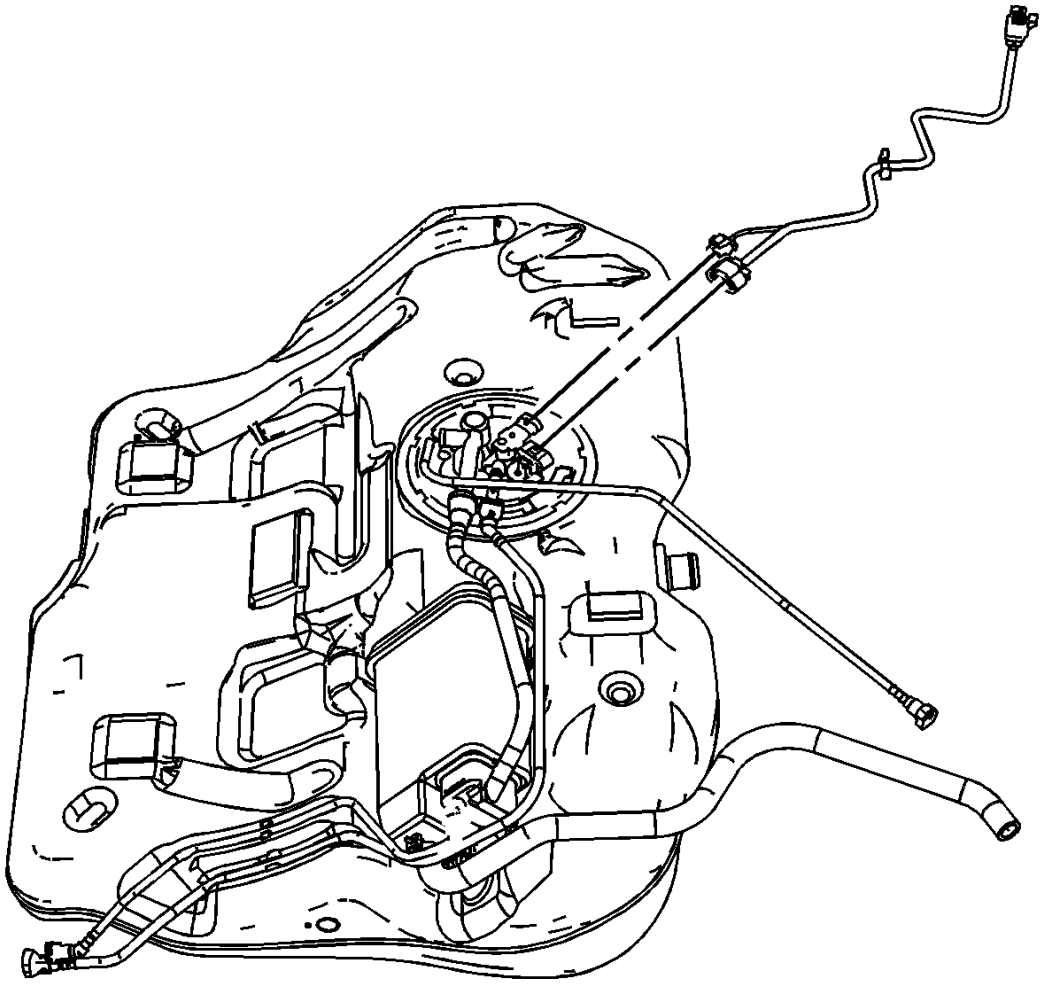


Fig. 46: View Of Top Of Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

18. Disconnect and remove the fuel pressure sensor and fuel sender jumper harness electrical connectors.

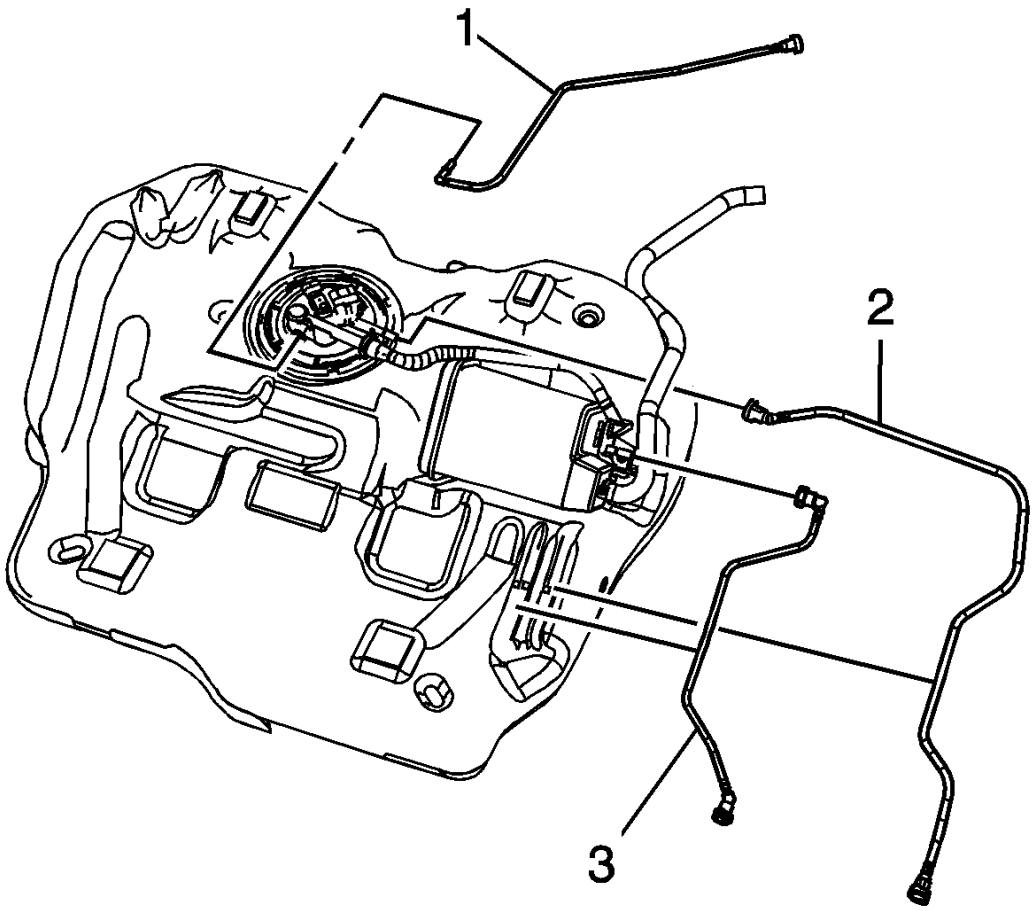


Fig. 47: View Of Fuel Tank Lines
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the routing of the lines for installation.**

19. Disconnect and remove the fuel feed line (2), and the EVAP lines (1, 3). Refer to **Plastic Collar Quick Connect Fitting Service**.
20. Remove the EVAP canister. Refer to **Evaporative Emission Canister Replacement**.
21. Remove the insulator pads from the fuel tank. Note the location of the insulator pads for installation. Replace with new insulator pads.

Installation Procedure

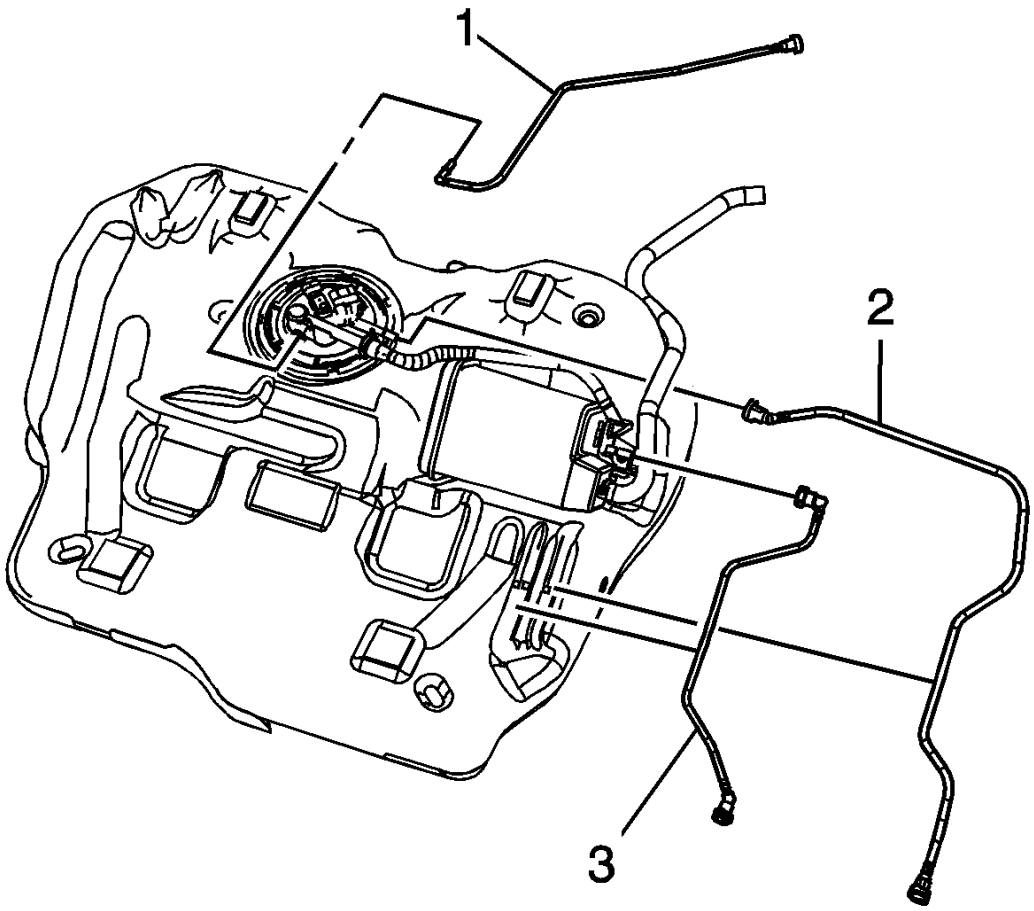


Fig. 48: View Of Fuel Tank Lines
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW insulator pads to the fuel tank.
2. Install the EVAP canister. Refer to **Evaporative Emission Canister Replacement**.

CAUTION:

- **Do not attempt to straighten kinked nylon pipes. Replace any kinked nylon pipes in order to prevent damage to the vehicle.**
- **Do not attempt to repair sections of nylon pipes. Replace damaged nylon pipes.**
- **Replace the vapor pipes with original equipment or parts that meet GM specifications.**
- **Replace the vapor hoses with original equipment or parts meeting GM specifications. Use only reinforced fuel-resistant hose identified with the word Fluoroelastomer or GM 6163M on the hose.**

3. Install and connect the fuel feed line (2), and the EVAP lines (1, 3). Refer to **Plastic Collar Quick Connect Fitting Service**.

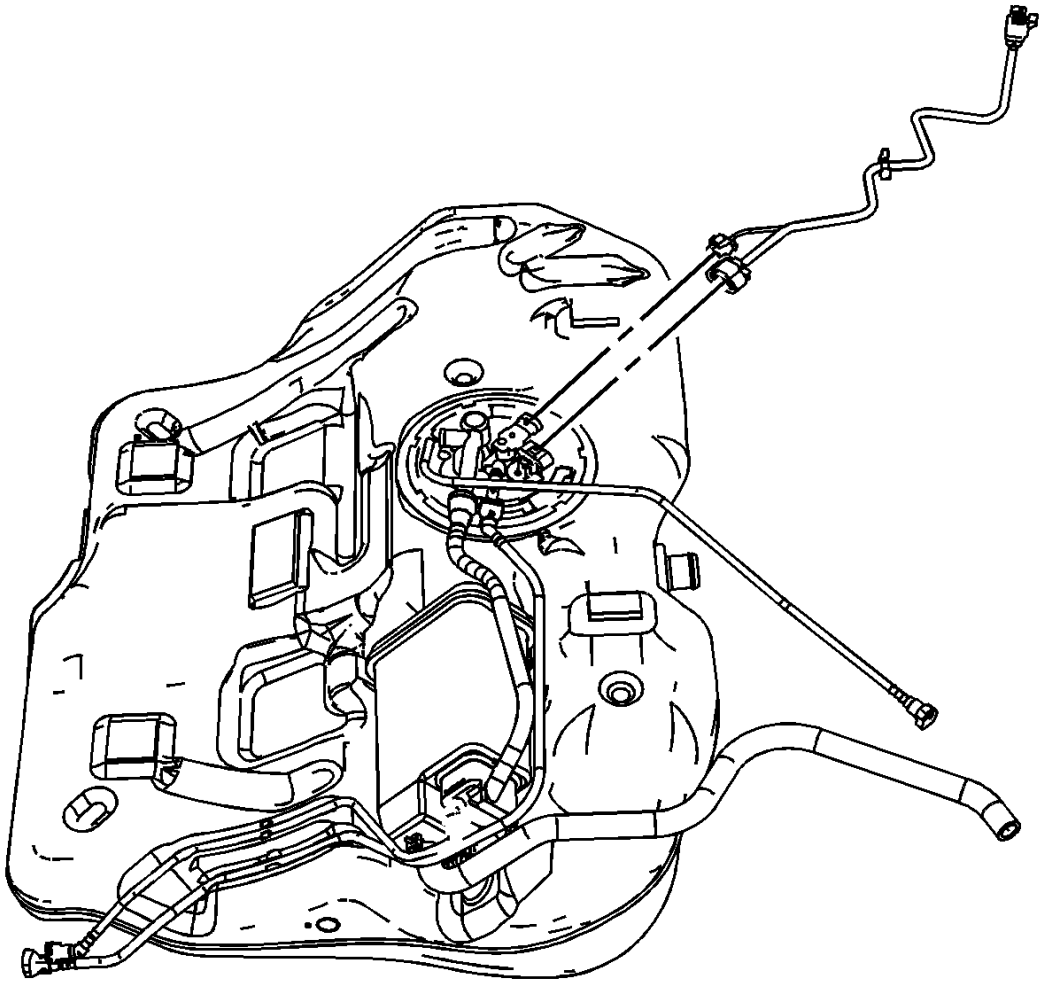


Fig. 49: View Of Top Of Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

4. Install and connect the fuel pressure sensor and fuel sender jumper harness electrical connectors.
5. Install the fuel tank onto a suitable jack.
6. Partially raise the fuel tank until the electrical connection can be made.

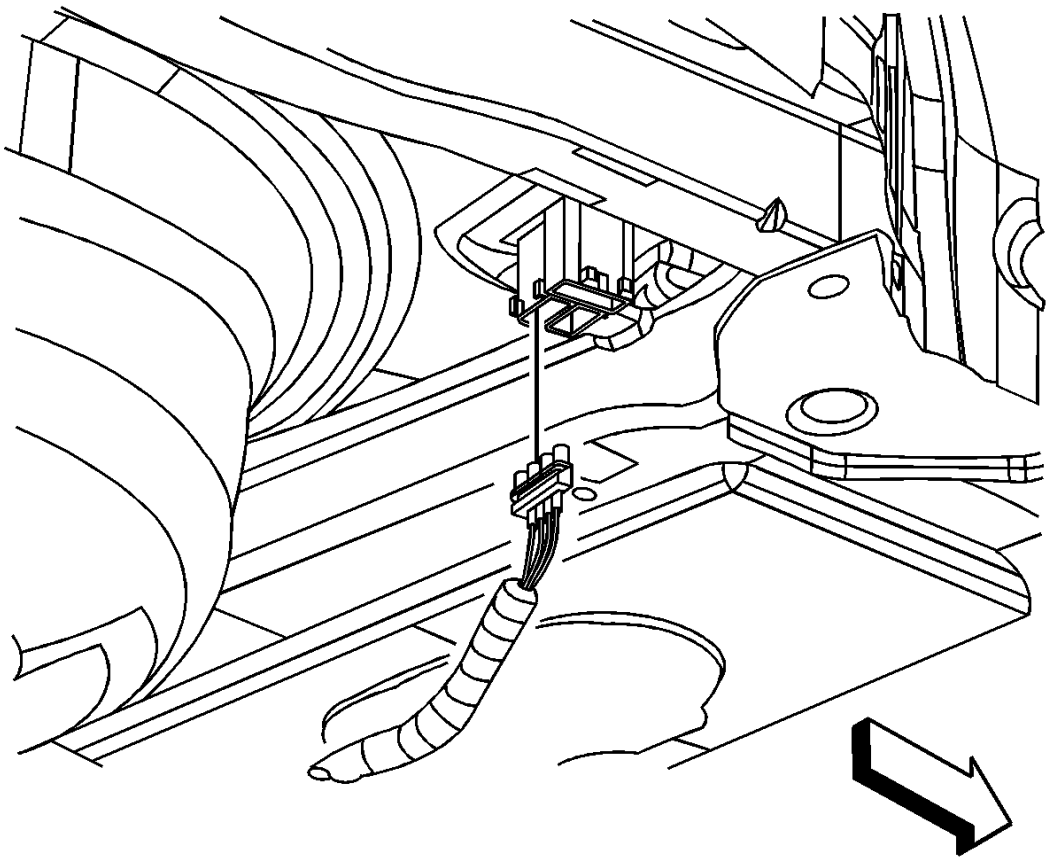


Fig. 50: View Of Fuel Sender Jumper Harness Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

7. Connect the fuel sender jumper harness electrical connector.

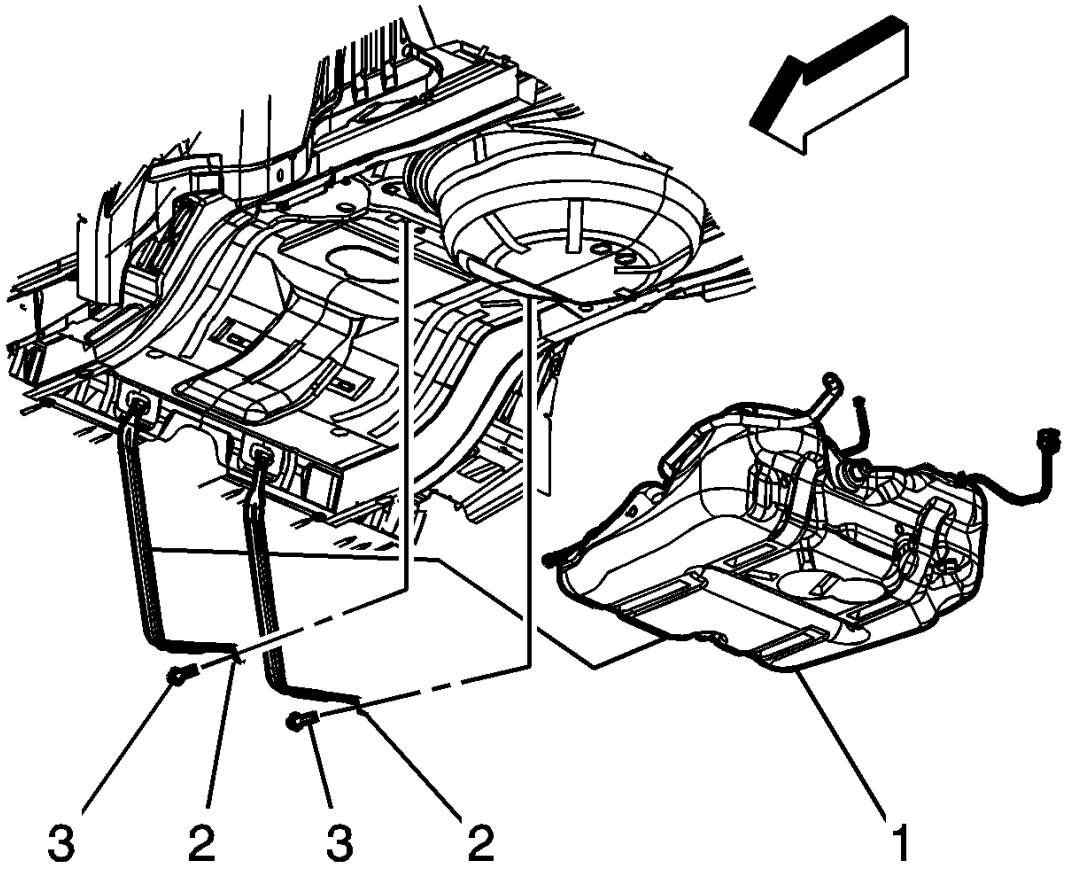


Fig. 51: View Of Fuel Tank & Straps
Courtesy of GENERAL MOTORS COMPANY

8. Completely raise the tank.

CAUTION: Refer to Fastener Caution .

9. Install the fuel tank strap bolts (3).

Tighten

Tighten the bolts to 48 N.m (35 lb ft).

10. Remove the jack from the fuel tank.

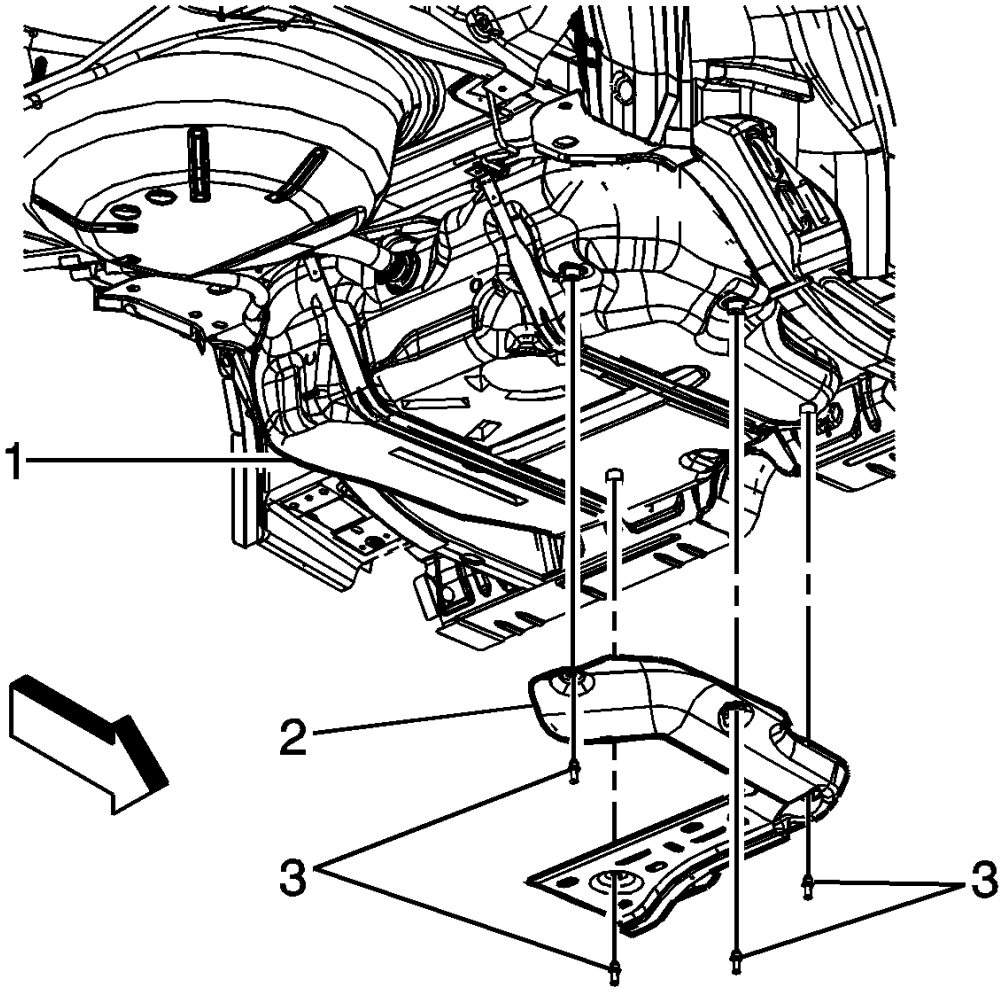


Fig. 52: View Of Fuel Tank Shield
Courtesy of GENERAL MOTORS COMPANY

11. Position the fuel tank shield (2) to the fuel tank.
12. Install the shield retainers (3).

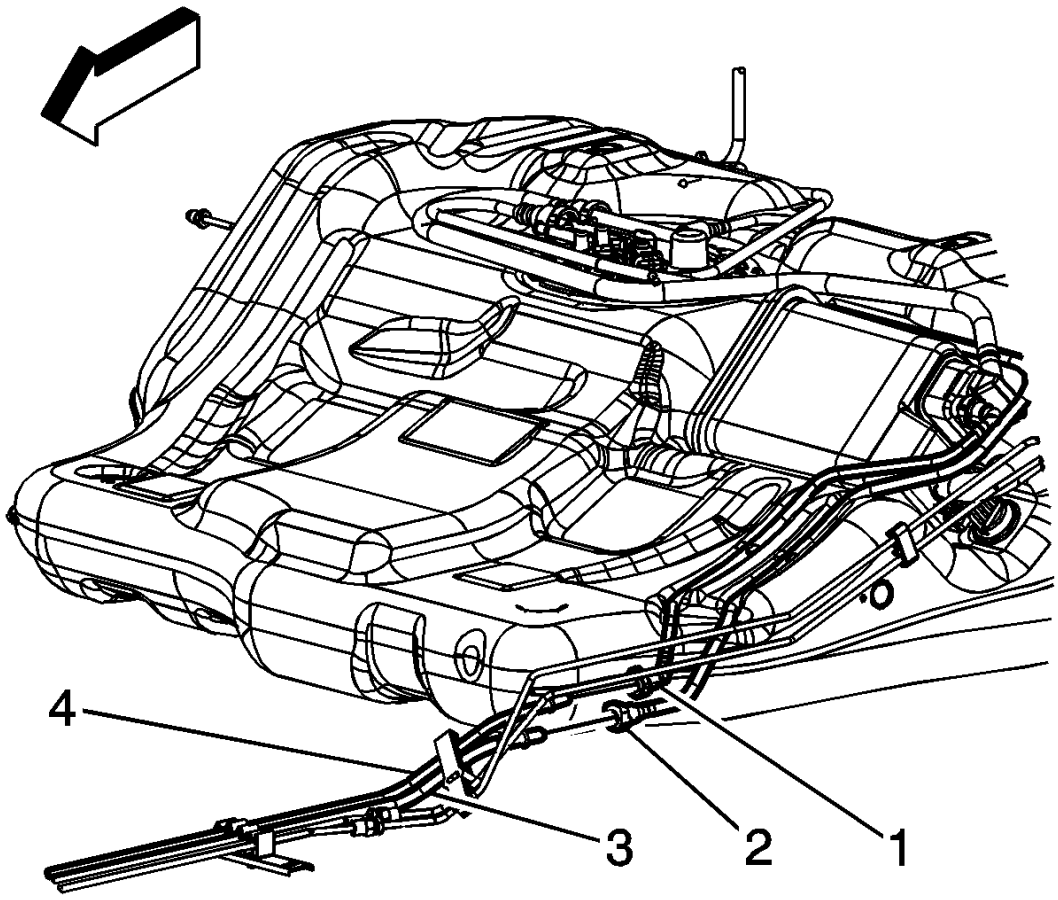


Fig. 53: View Of Fuel Feed, EVAP and Fuel Tank Lines
Courtesy of GENERAL MOTORS COMPANY

13. Install the rubber exhaust pipe hangers.
14. Remove the support from the exhaust system.
15. Connect the fuel feed (3) , and EVAP (4) lines to the fuel tank lines (1, 2). Refer to **Plastic Collar Quick Connect Fitting Service**.

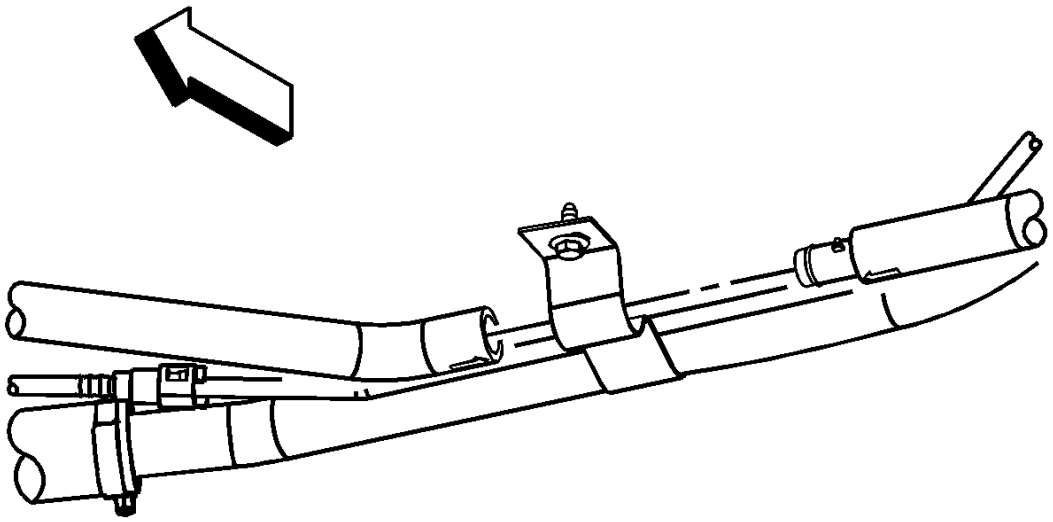


Fig. 54: EVAP Canister Vent Solenoid Valve And EVAP Emission Canister Hose
Courtesy of GENERAL MOTORS COMPANY

16. Connect the EVAP vent solenoid hose on the tank to the EVAP vent valve solenoid hose.

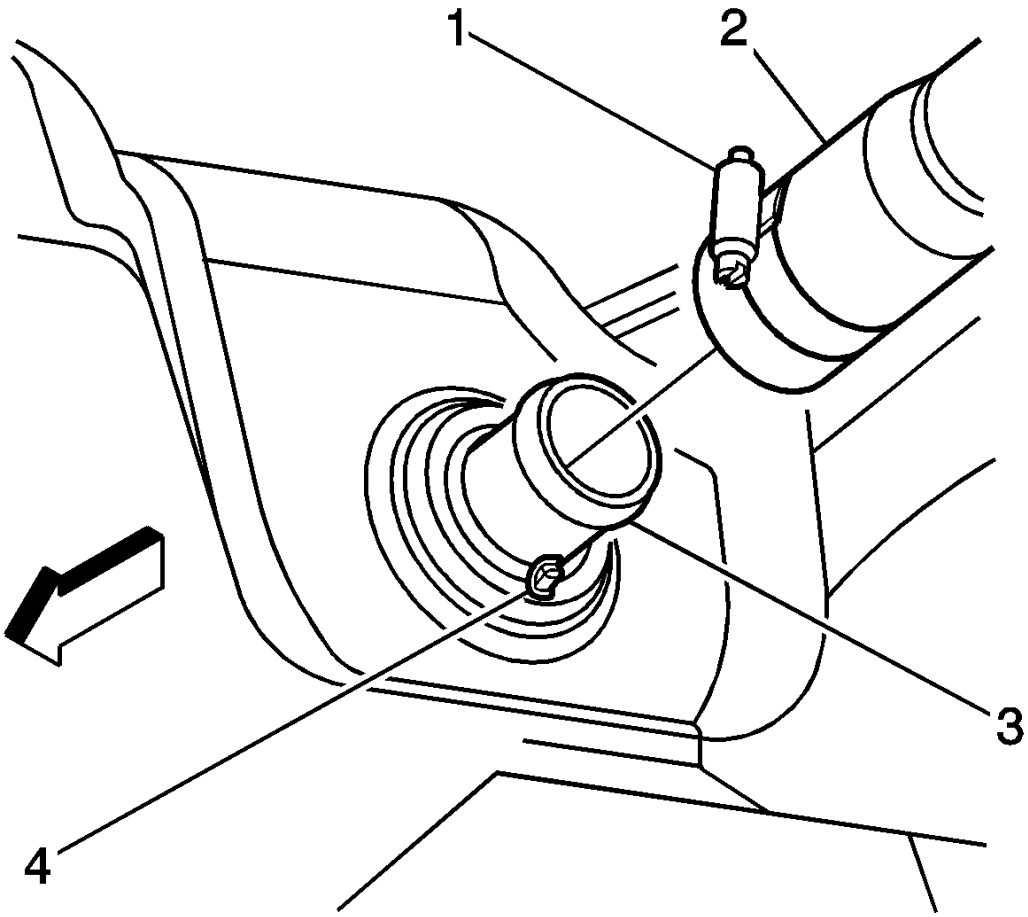


Fig. 55: Fuel Tank Clamp, Fuel Tank Hose and Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

17. Connect the EVAP vent pipe quick connect fitting to the fill pipe EVAP vent pipe quick connect fitting. **Plastic Collar Quick Connect Fitting Service**.
18. Install the fuel tank fill hose (2) onto the fuel tank (3). Install the hose over the orientation feature (4) on the tank until fully seated to the tank.
19. Tighten the fuel fill hose clamp (1) at the fuel tank.

    Tighten

    Tighten the clamp to 2.5 N.m (22 lb in).

20. Lower the vehicle.
21. Add fuel and install the fuel fill cap.
22. Inspect the fuel system for leaks by performing the following steps:
    1. Turn ON the ignition for 2 seconds.
    2. Turn OFF the ignition for 10 seconds.
    3. Turn ON the ignition.

4. Inspect for fuel leaks.

FUEL TANK FUEL PUMP MODULE REPLACEMENT

Special Tools

J 45722 Fuel Sender Lock Ring Wrench

Removal Procedure

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Disconnect the evaporative emission (EVAP) lines from the sender. Refer to **Plastic Collar Quick Connect Fitting Service**.
3. Disconnect the fuel line from the sender. Refer to **Plastic Collar Quick Connect Fitting Service**.
4. Reposition the fuel feed and EVAP lines in order to access the lock ring.

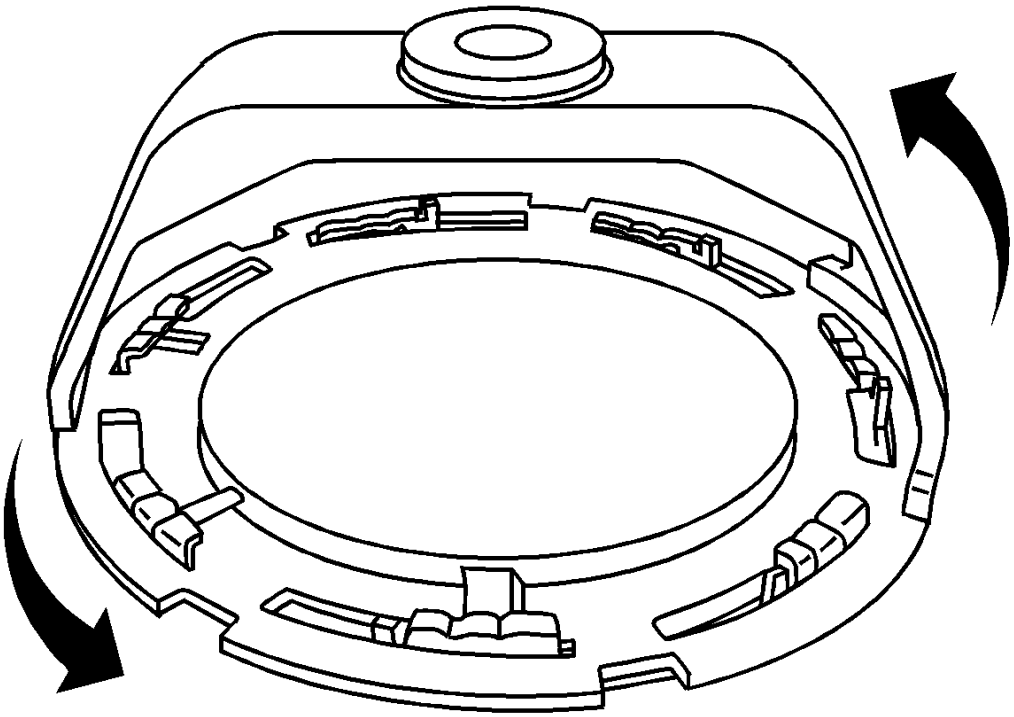


Fig. 56: Identifying Lock Ring
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Avoid damaging the lock ring. Use only J-45722 to prevent damage to the

lock ring.

CAUTION: Do Not handle the fuel sender assembly by the fuel pipes. The amount of leverage generated by handling the fuel pipes could damage the joints.

NOTE: Do NOT use impact tools. Significant force will be required to release the lock ring. The use of a hammer and screwdriver is not recommended. Secure the fuel tank in order to prevent fuel tank rotation.

5. Use the **J 45722** Fuel Sender Lock Ring Wrench and a long breaker-bar in order to unlock the fuel sender lock ring. Turn the fuel sender lock ring in a counterclockwise direction.

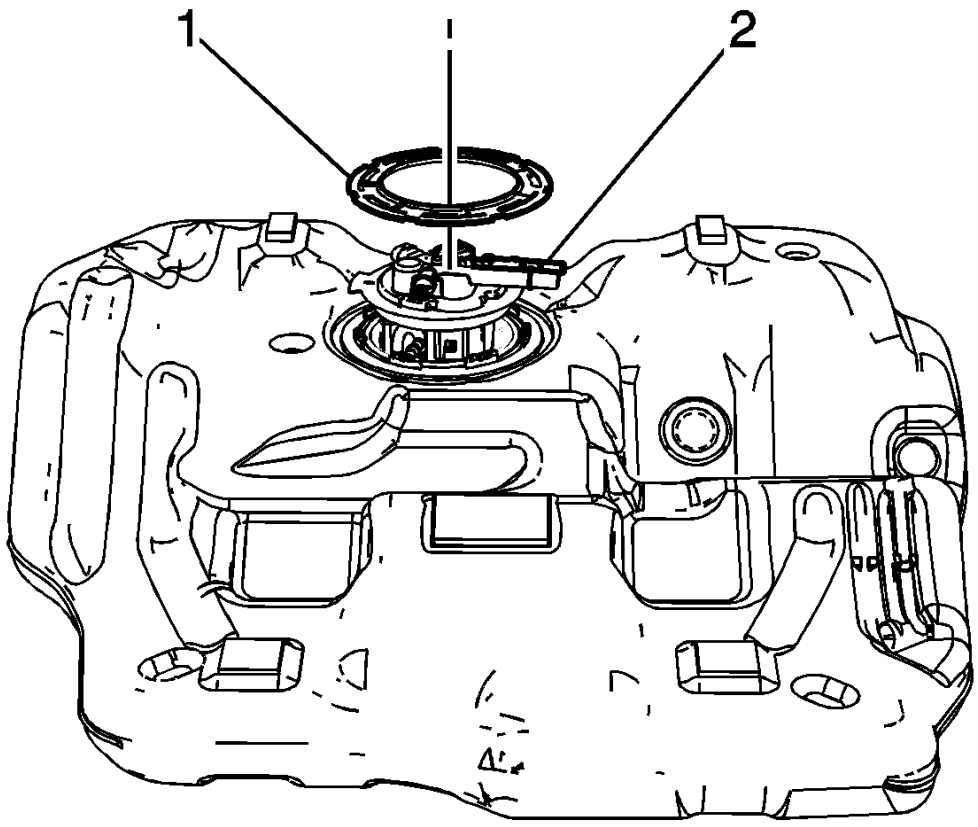


Fig. 57: Identifying Fuel Sender Assembly & Lock Ring
Courtesy of GENERAL MOTORS COMPANY

6. Remove the fuel sender (2) from the fuel tank.
7. Remove and discard the fuel sender O-ring seal.
8. Clean and inspect the fuel sender assembly O-ring seal sealing surfaces.

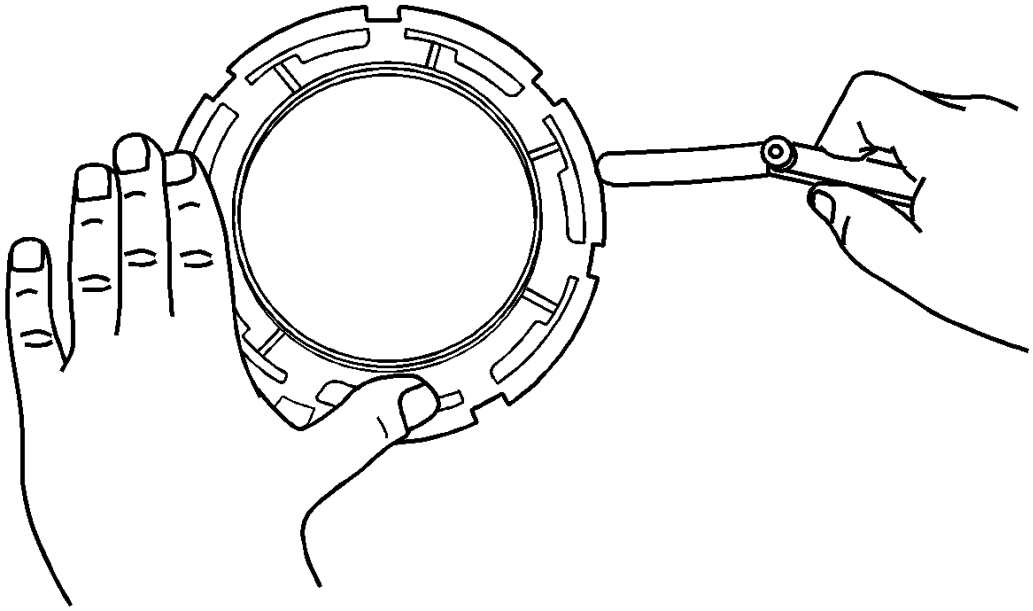


Fig. 58: Checking Lock Ring For Flatness
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Some lock ring were manufactured with DO NOT REUSE stamped into them. These lock rings may be reused if they are not damaged or warped.**

NOTE: **Inspect the lock ring for damage due to improper removal or installation procedures. If damage is found, install a NEW lock ring.**

NOTE: **Check the lock ring for flatness.**

9. Place the lock ring on a flat surface. Measure the clearance between to lock ring and the flat surface using a feeler gauge at 7 points.
10. If the warpage is less than 0.41 mm (0.016 in), the lock ring does not require replacement.
11. If the warpage is greater than 0.41 mm (0.016 in), the lock ring must be replaced.

Installation Procedure

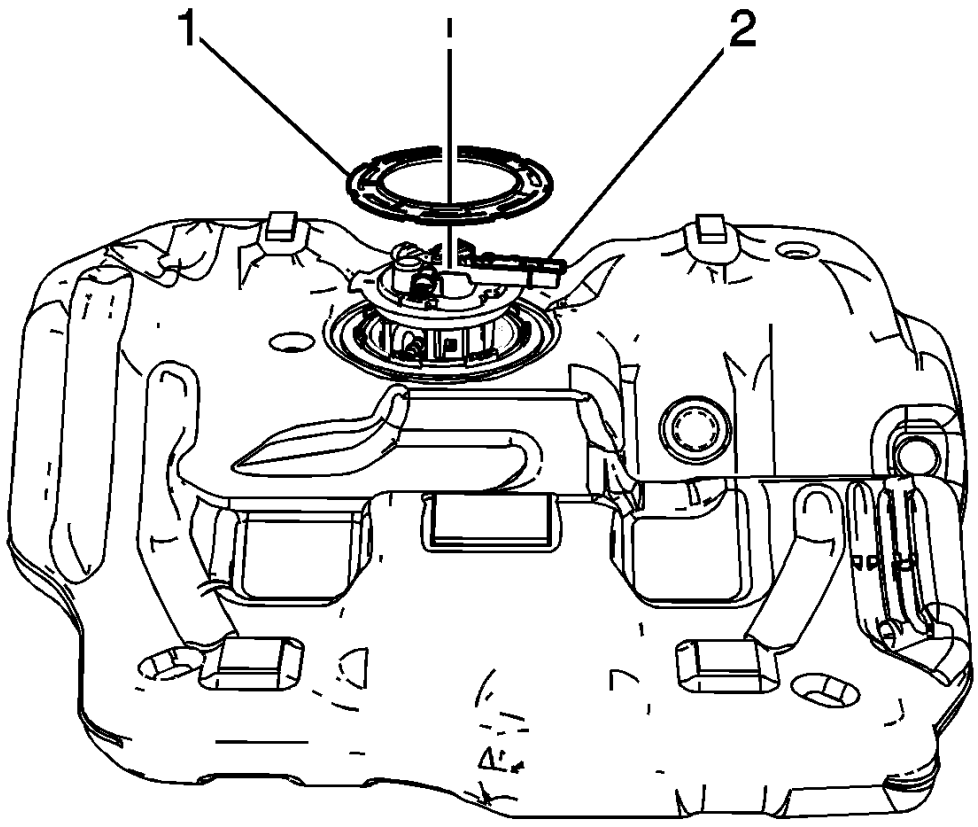


Fig. 59: Identifying Fuel Sender Assembly & Lock Ring
Courtesy of GENERAL MOTORS COMPANY

1. Position the NEW fuel sender O-ring seal onto the fuel tank.
2. Install the fuel sender (2) into the fuel tank. Ensure that the align tab is in the proper location.
3. Push down the fuel sender and position the lock ring (1) onto the fuel tank.

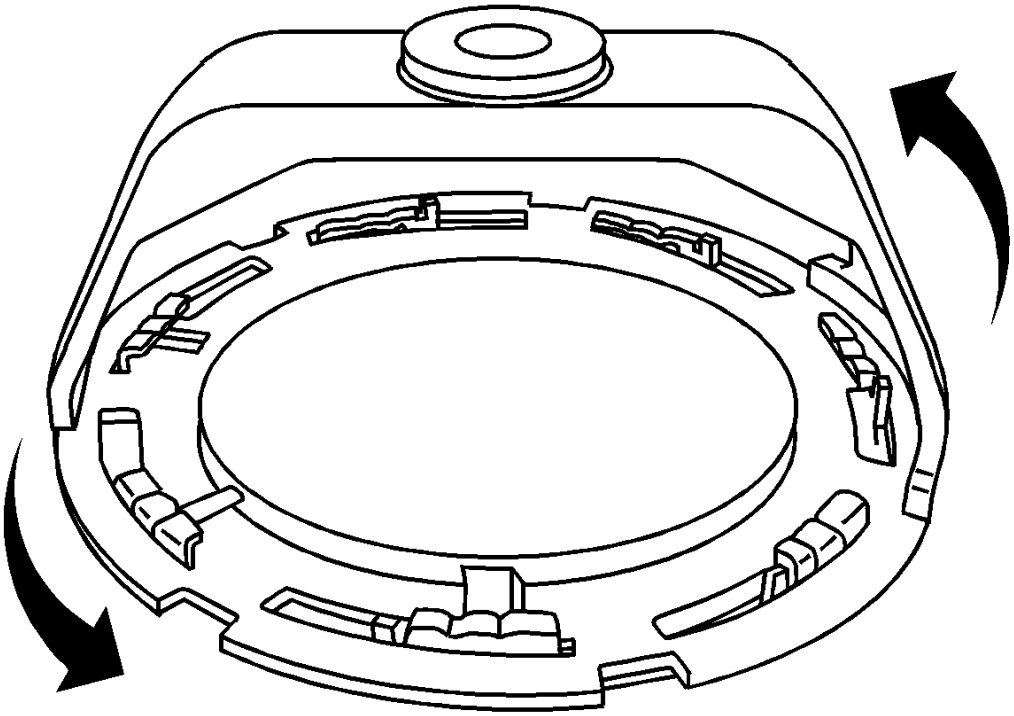


Fig. 60: Identifying Lock Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always replace the fuel sender seal when installing the fuel sender assembly. Replace the lock ring if necessary. Do not apply any type of lubrication in the seal groove.**

Ensure the lock ring is installed with the correct side facing upward. A correctly installed lock ring will only turn in a clockwise direction.

4. Use the **J 45722** Fuel Sender Lock Ring Wrench in order to install the fuel sender lock ring. Turn the fuel sender lock ring in a clockwise direction.
5. Connect the fuel line to the sender. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Connect the EVAP lines to the sender. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL PUMP FLOW CONTROL MODULE REPLACEMENT

Removal Procedure

1. Remove the rear compartment side trim panel right side. Refer to **Rear Compartment Side Trim Replacement - Right Side**

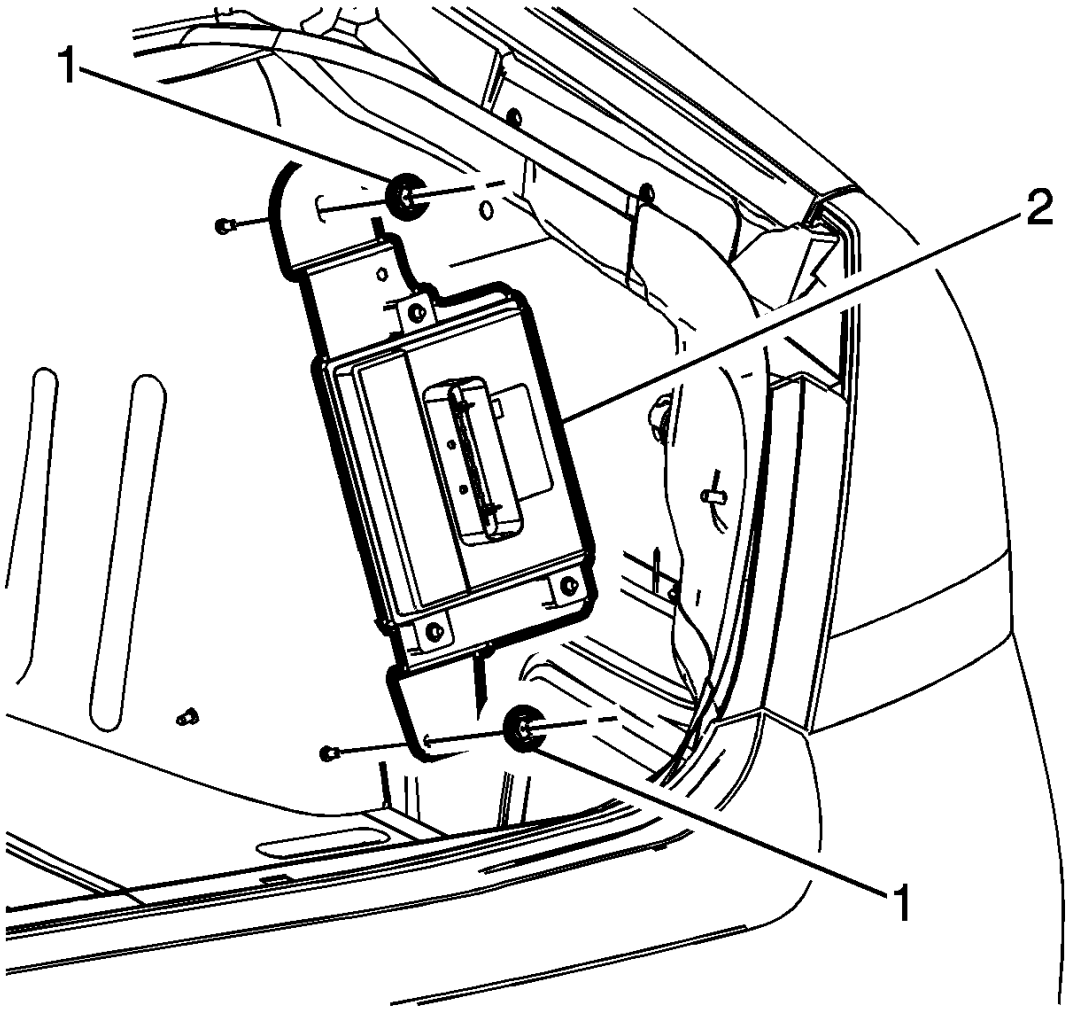


Fig. 61: Fuel Pump Flow Control Module Bracket And Nuts
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical connector.
3. Remove the fuel pump flow control module bracket nuts (1).
4. Remove the fuel pump flow control module and bracket (2).

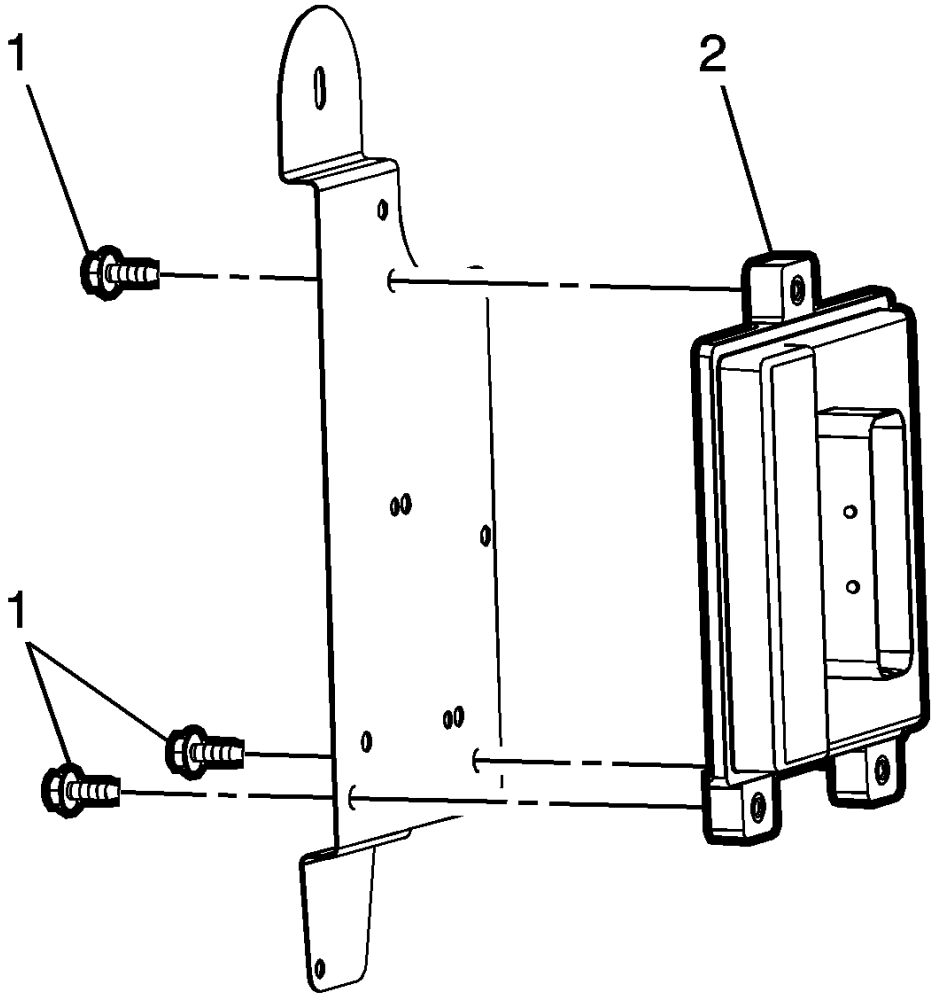


Fig. 62: Fuel Pump Flow Control Module And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the fuel pump flow control module bolts (1).
6. Remove the fuel pump flow control module (2).

Installation Procedure

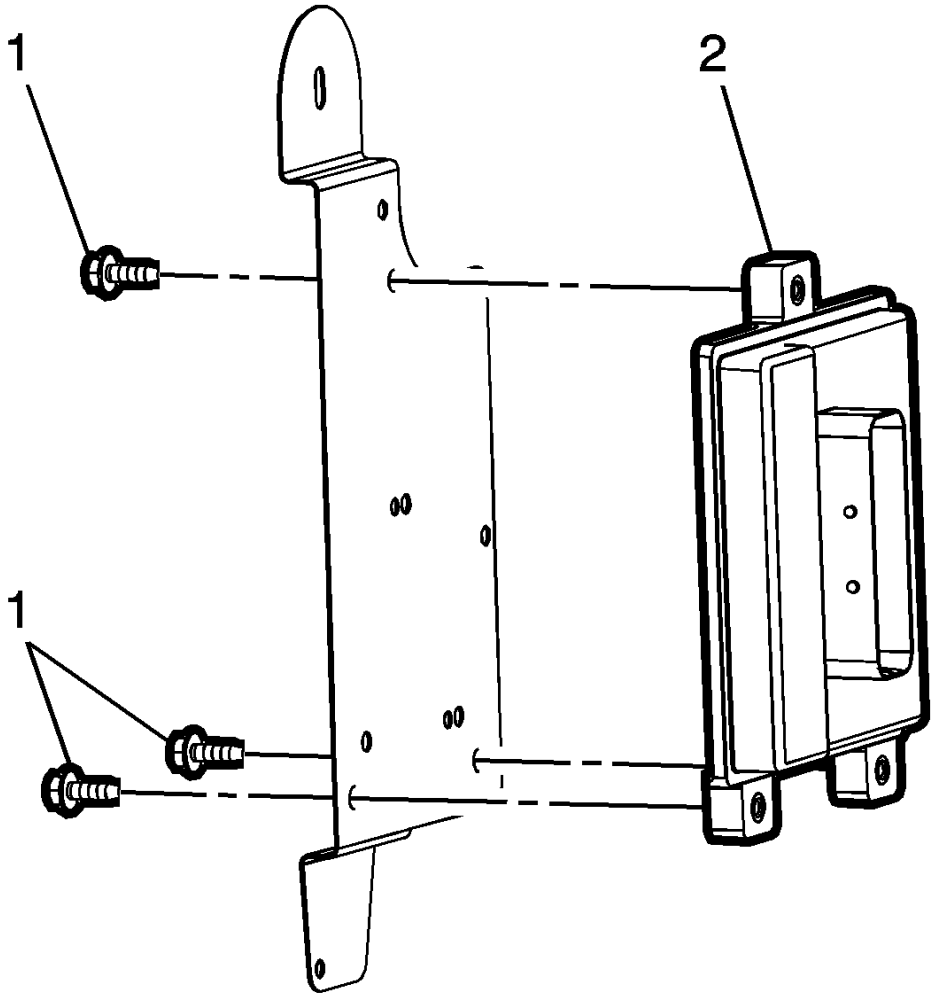


Fig. 63: Fuel Pump Flow Control Module And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel pump flow control module (2).

CAUTION: Refer to Fastener Caution .

2. Install the fuel pump flow control module bolts (1) and tighten to 6.5 N.m (58 lb in).

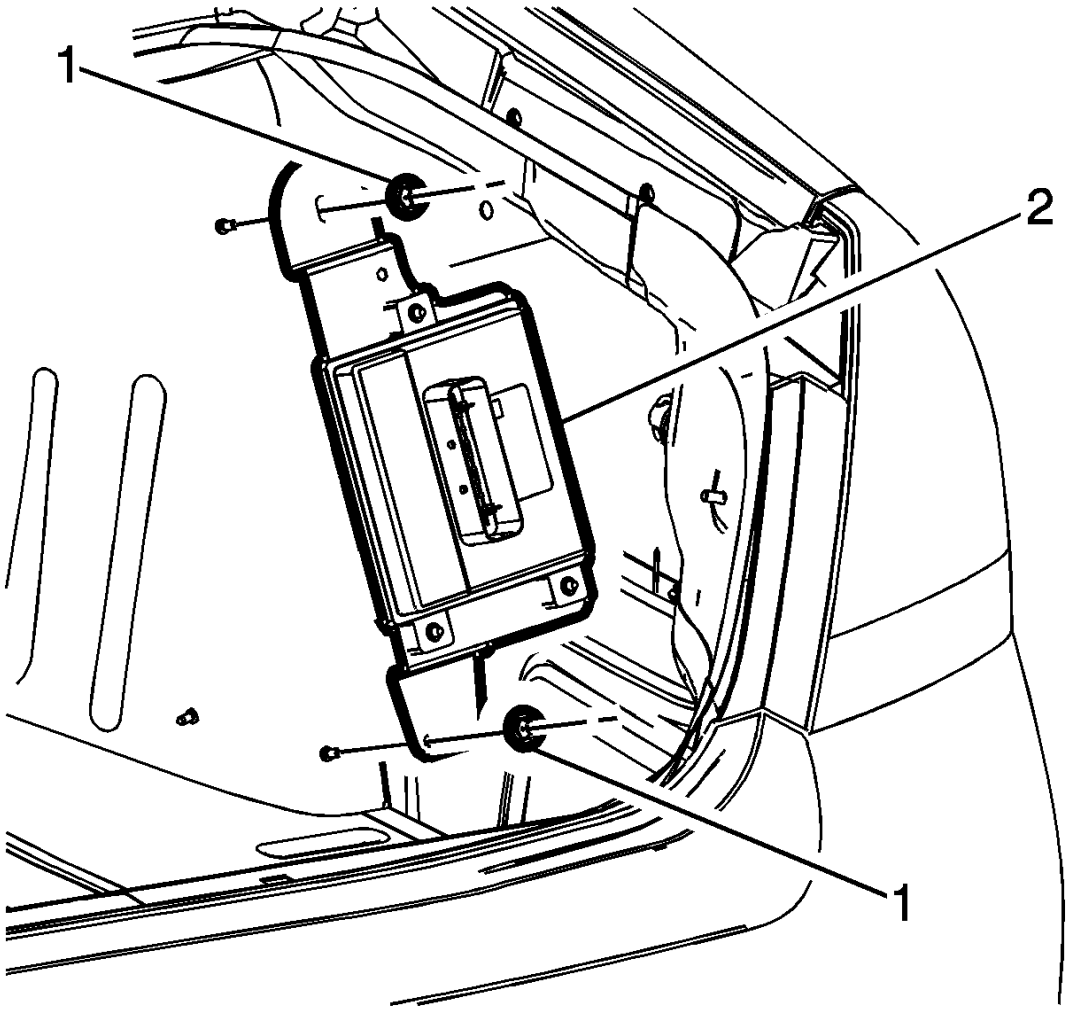


Fig. 64: Fuel Pump Flow Control Module Bracket And Nuts
Courtesy of GENERAL MOTORS COMPANY

3. Install the fuel pump flow control module and bracket (2).
4. Install the fuel pump flow control module bracket nuts (1) and tighten to 5 N.m (44 lb in).
5. Connect the electrical connector.
6. Install the rear compartment side trim panel right side. Refer to **Rear Compartment Side Trim Replacement - Right Side**
7. If replacing, reprogram the module. Refer to **Control Module References**

FUEL TANK PRESSURE SENSOR REPLACEMENT (E-85)

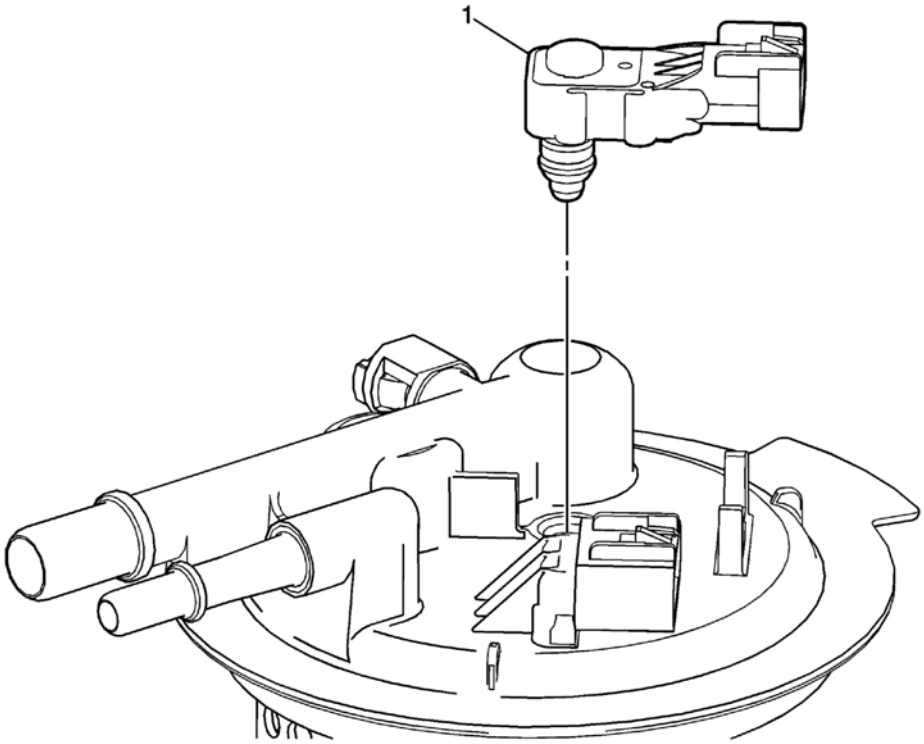


Fig. 65: Fuel Tank Pressure Sensor (E-85)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the fuel tank. Refer to **Fuel Tank Replacement**.	
1	Fuel Tank Pressure Sensor **Procedure** Disconnect the electrical connector.

FUEL TANK PRESSURE SENSOR REPLACEMENT (E-10)

Removal Procedure

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.

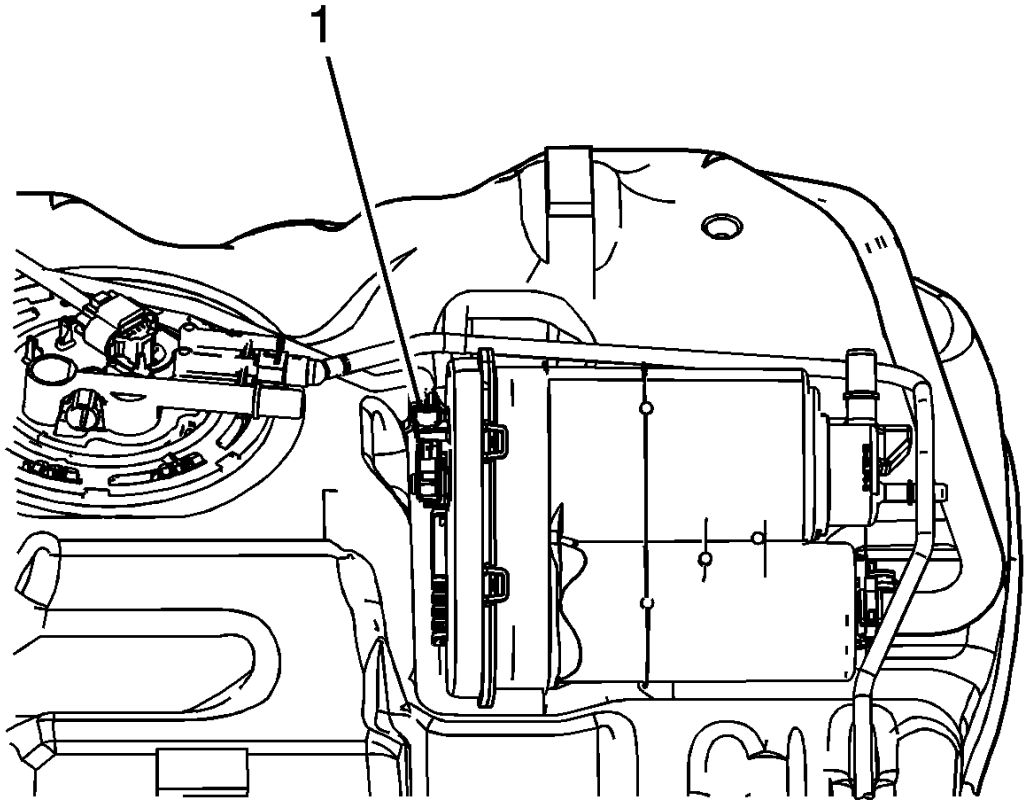


Fig. 66: Identifying Fuel Tank Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the fuel tank wiring harness electrical connector from the fuel pressure sensor (1).

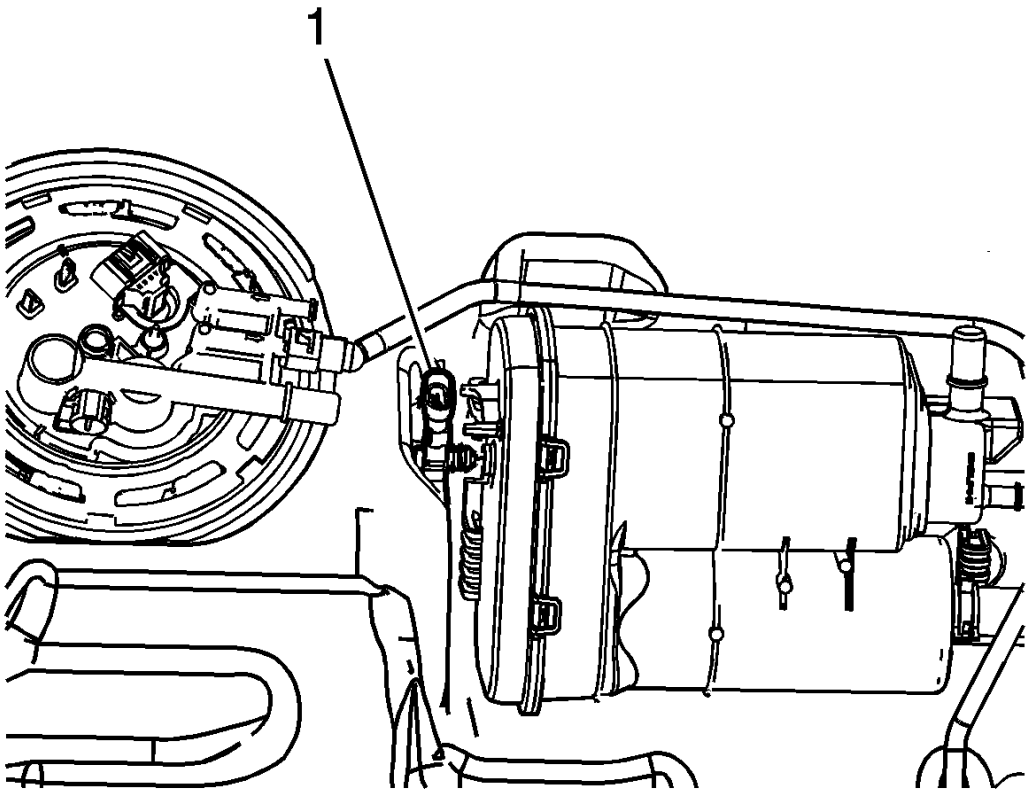


Fig. 67: Identifying Fuel Pressure Sensor & EVAP Canister
Courtesy of GENERAL MOTORS COMPANY

NOTE: **It is not necessary to remove the evaporative emission (EVAP) canister in order to remove the fuel pressure sensor.**

3. Using a small flat-bladed tool, gently pry the fuel pressure sensor (1) out of the EVAP canister in order to remove the sensor.

Installation Procedure

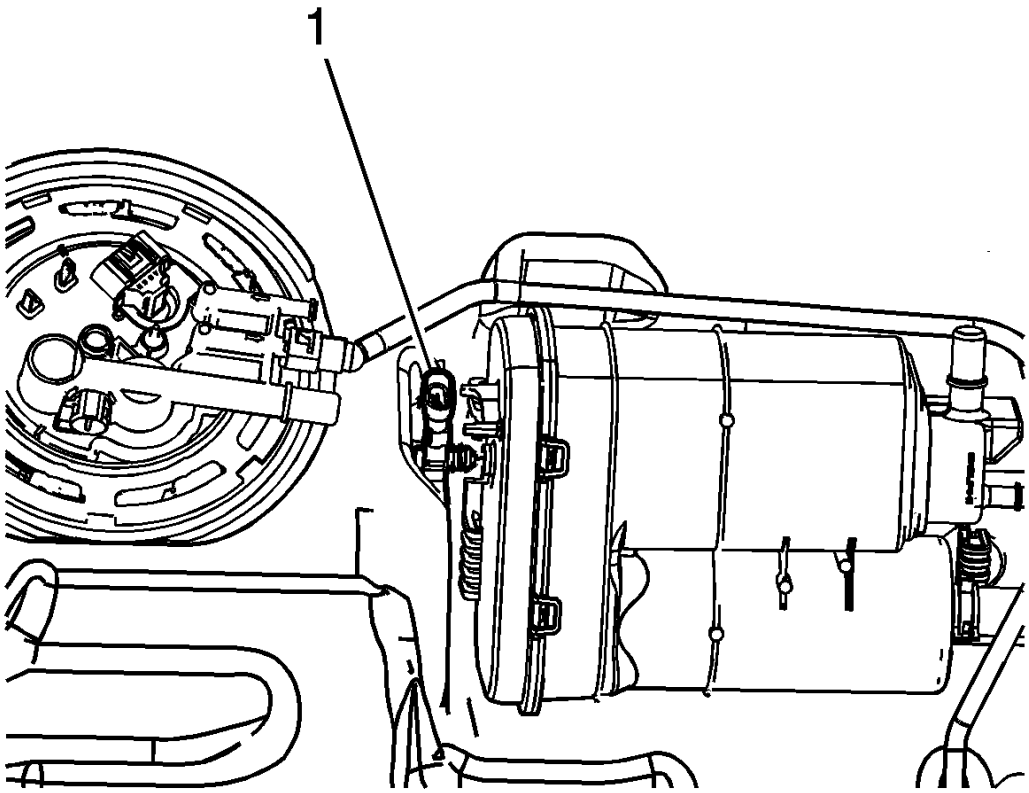


Fig. 68: Identifying Fuel Pressure Sensor & EVAP Canister
Courtesy of GENERAL MOTORS COMPANY

1. Lubricate the fuel pressure seal with a very small amount of clean engine oil.
2. Install the fuel pressure sensor (1) to the EVAP canister.

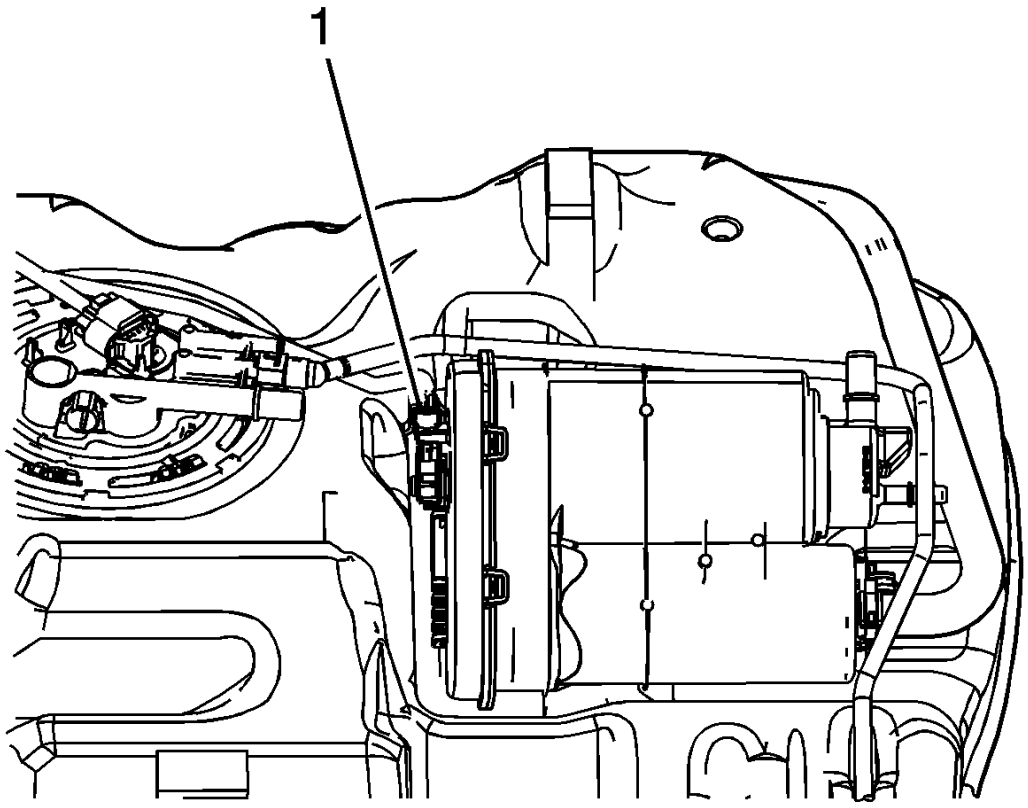


Fig. 69: Identifying Fuel Tank Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Connect the fuel tank wiring harness electrical connector to the fuel pressure sensor (1).
4. Install the fuel tank. Refer to **Fuel Tank Replacement**.

FUEL TANK FILLER PIPE REPLACEMENT

Removal Procedure

NOTE: **Clean the fuel and evaporative emission (EVAP) connections and surrounding areas prior to disconnecting the lines in order to avoid possible system contamination.**

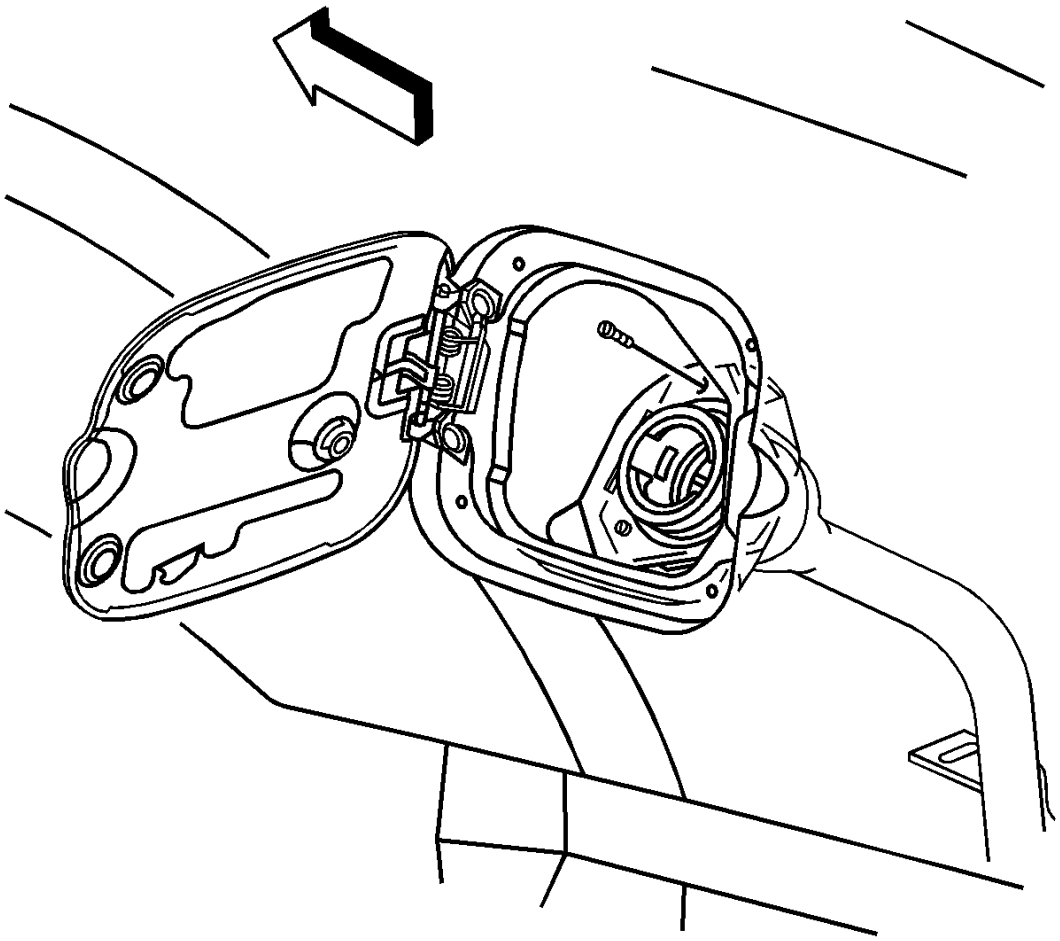


Fig. 70: Locating Fuel Fill Pipe Screws To Fuel Filler Pocket
Courtesy of GENERAL MOTORS COMPANY

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**.
2. Remove the fuel fill pipe screws from the fuel filler pocket.

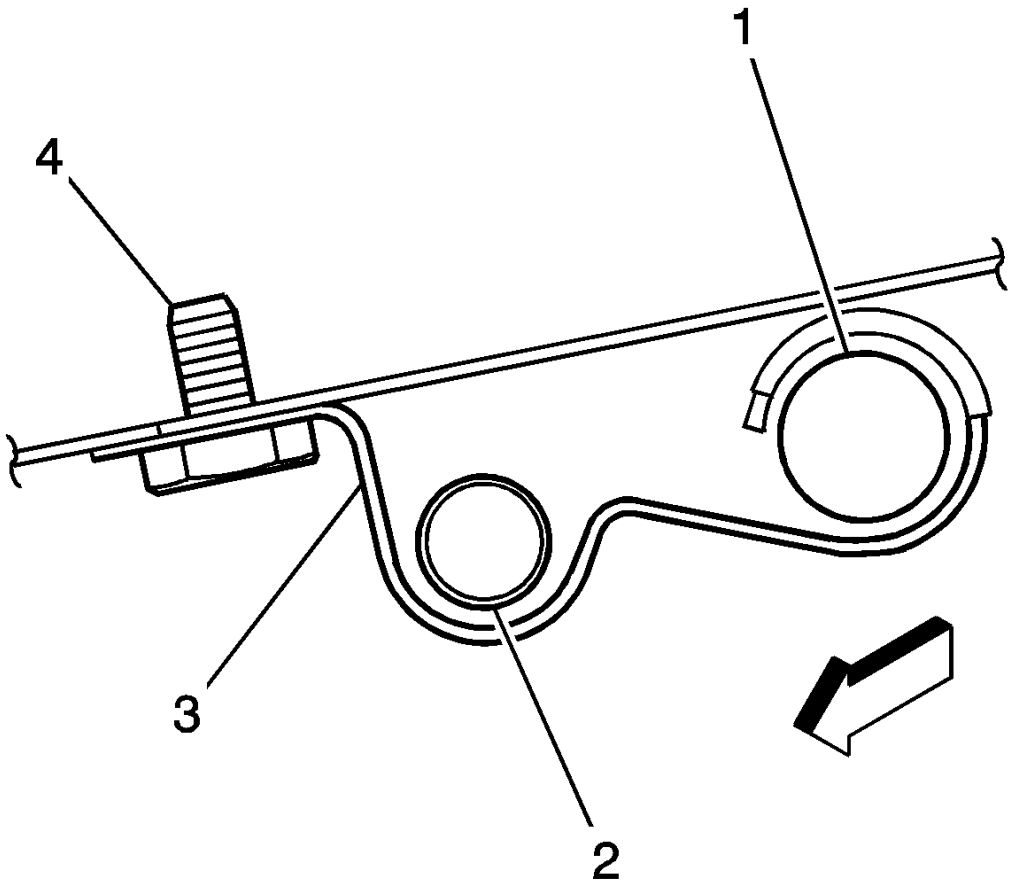


Fig. 71: Fill Pipe Bracket
Courtesy of GENERAL MOTORS COMPANY

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the fill pipe bracket bolt (4) from the underbody rail.
5. Remove the EVAP line (2) from the bracket (3).

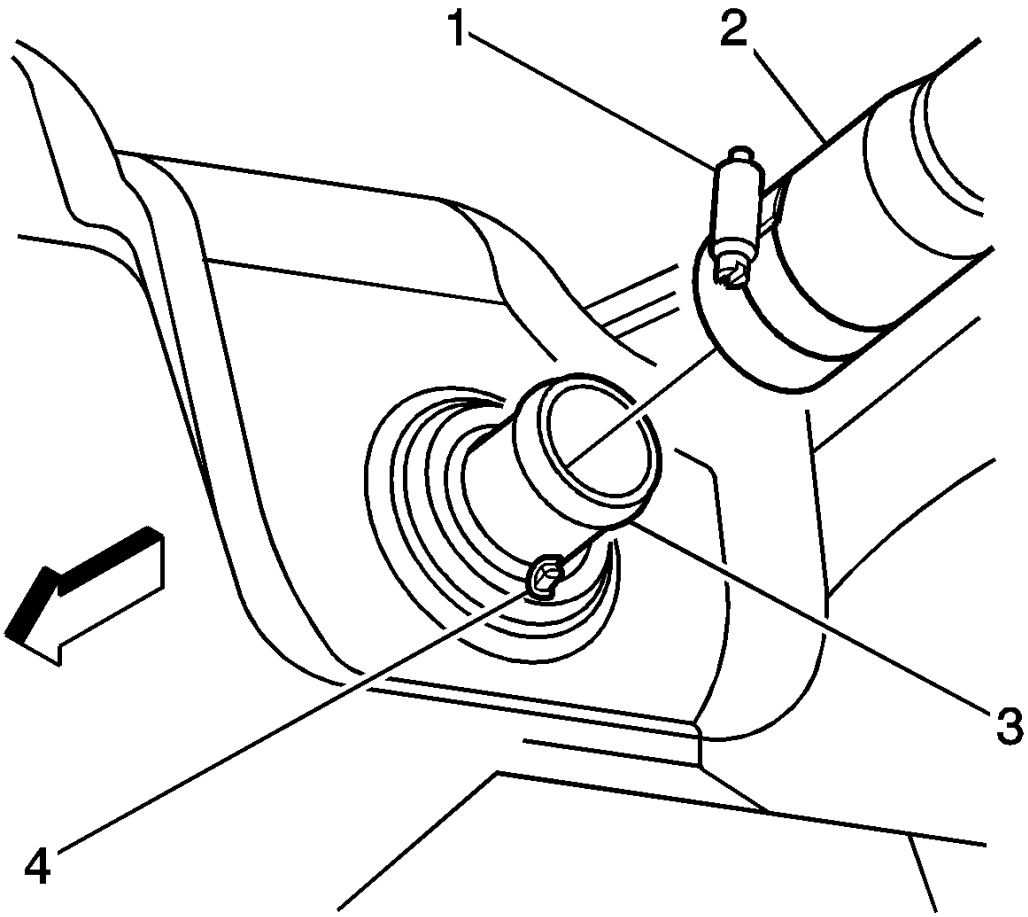


Fig. 72: Fuel Tank Clamp, Fuel Tank Hose and Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

6. Loosen the fuel fill pipe clamp (1) at the fuel tank.
7. Remove the fuel fill pipe hose (2) from the fuel tank (3).
8. Disconnect the vent pipe quick connect fitting from the fuel tank vent pipe quick connect fitting. Refer to **Plastic Collar Quick Connect Fitting Service**.

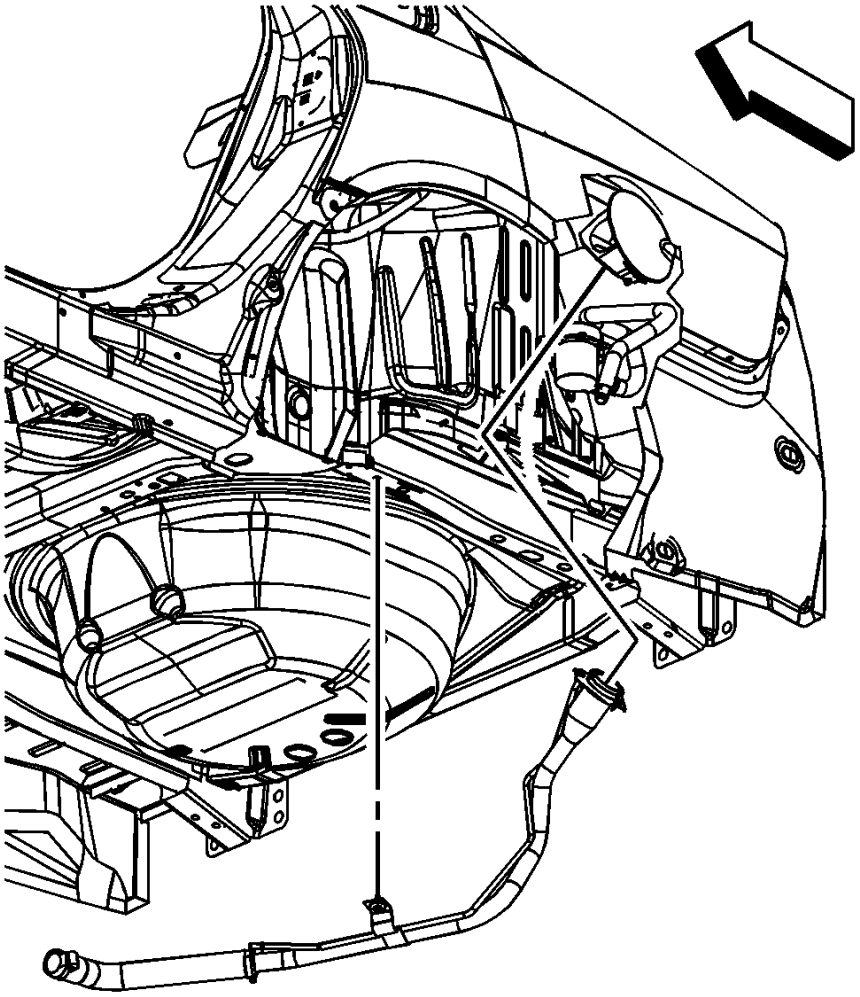


Fig. 73: Identifying Fuel Tank Fill Pipe
Courtesy of GENERAL MOTORS COMPANY

9. Remove the fuel tank fill pipe.

Installation Procedure

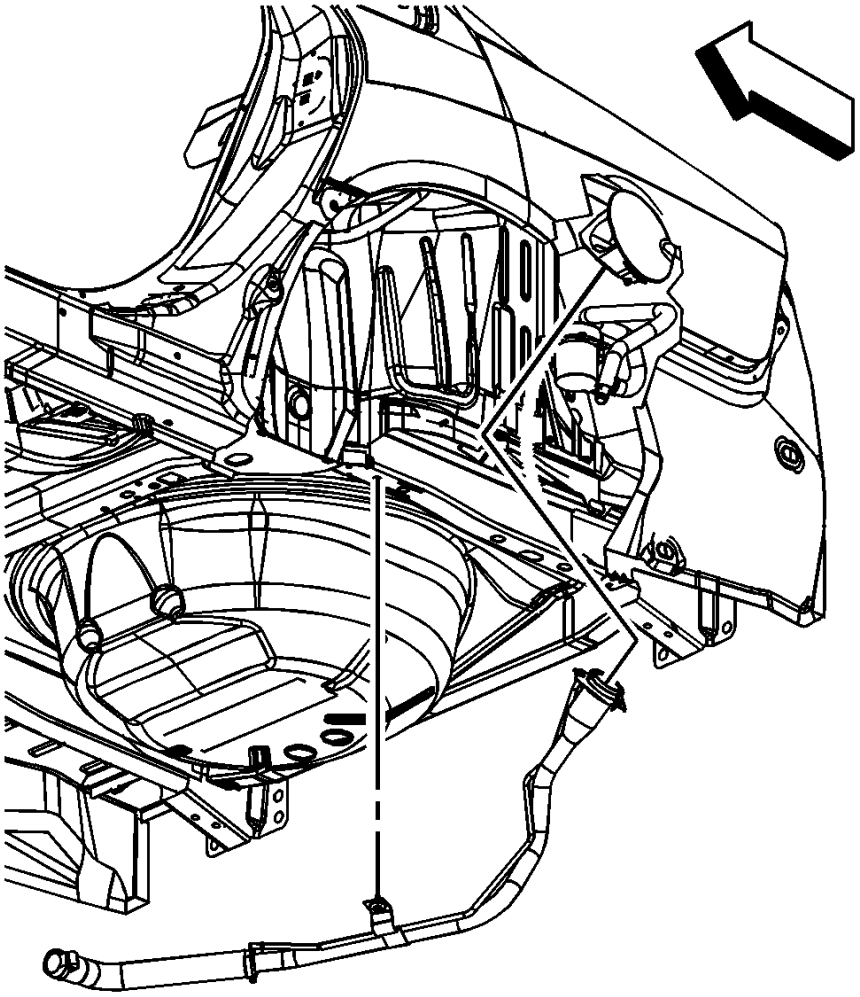


Fig. 74: Identifying Fuel Tank Fill Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel tank fill pipe.

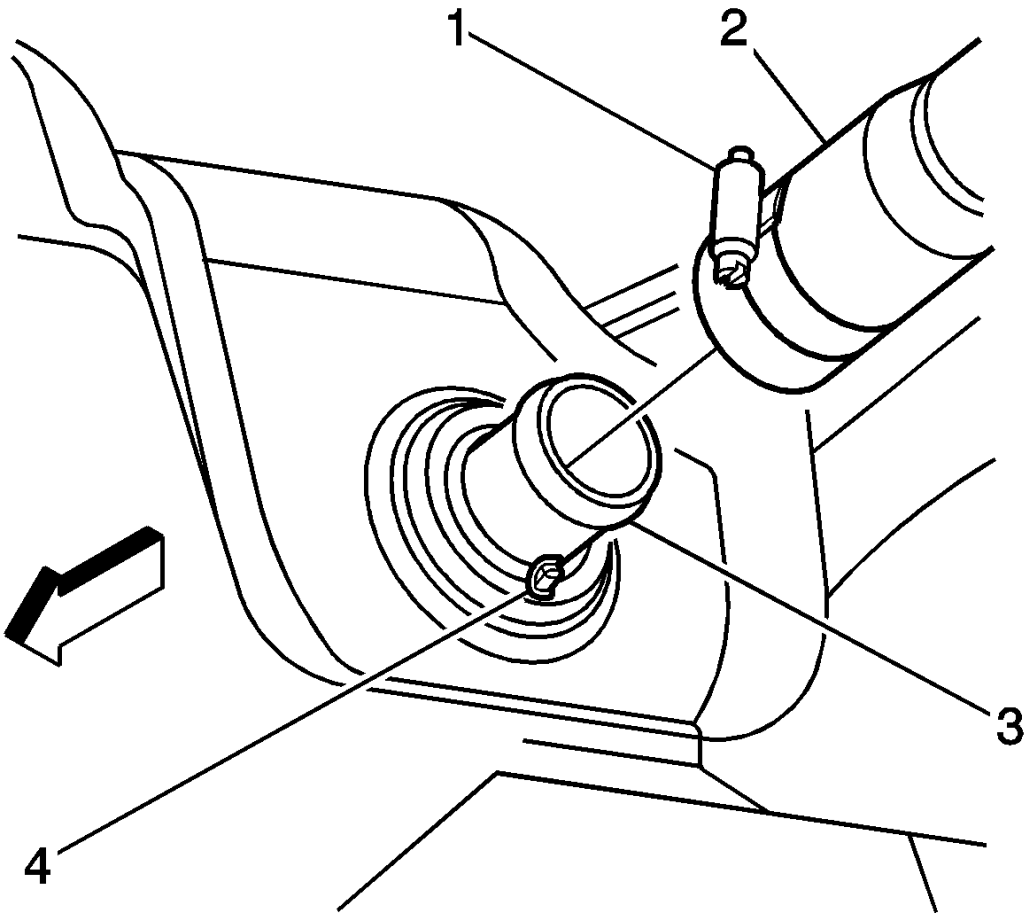


Fig. 75: Fuel Tank Clamp, Fuel Tank Hose and Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

2. Install the fuel tank fill pipe hose (2) onto the fuel tank (3)
3. Connect the vent pipe quick connect fitting to the fuel tank vent pipe quick connect fitting. Refer to **Plastic Collar Quick Connect Fitting Service**.

CAUTION: Refer to Fastener Caution .

4. Tighten the fuel fill pipe clamp (1) at the fuel tank and tighten to 2.5 N.m (22 lb in).

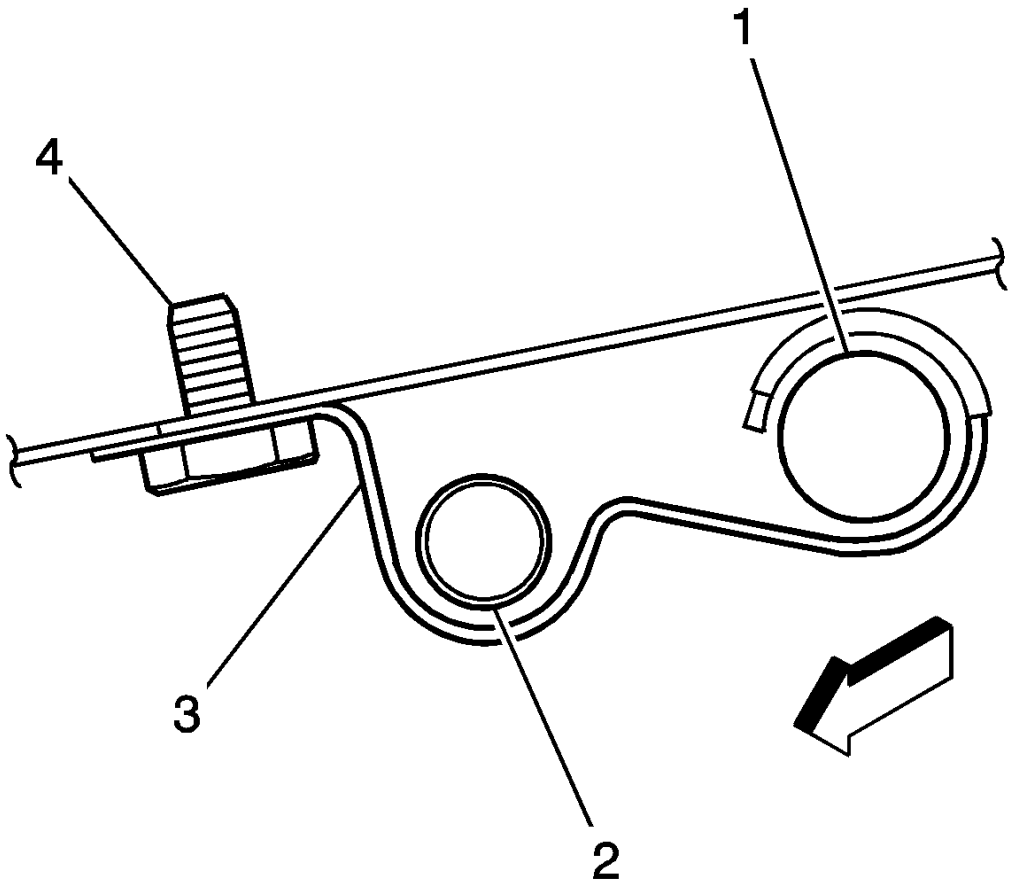


Fig. 76: Fill Pipe Bracket
Courtesy of GENERAL MOTORS COMPANY

5. Install the EVAP line (2) to the bracket (3).
6. Install the fill pipe bracket bolt (4) to the underbody rail and tighten to 13 N.m (115 lb in).
7. Lower the vehicle.

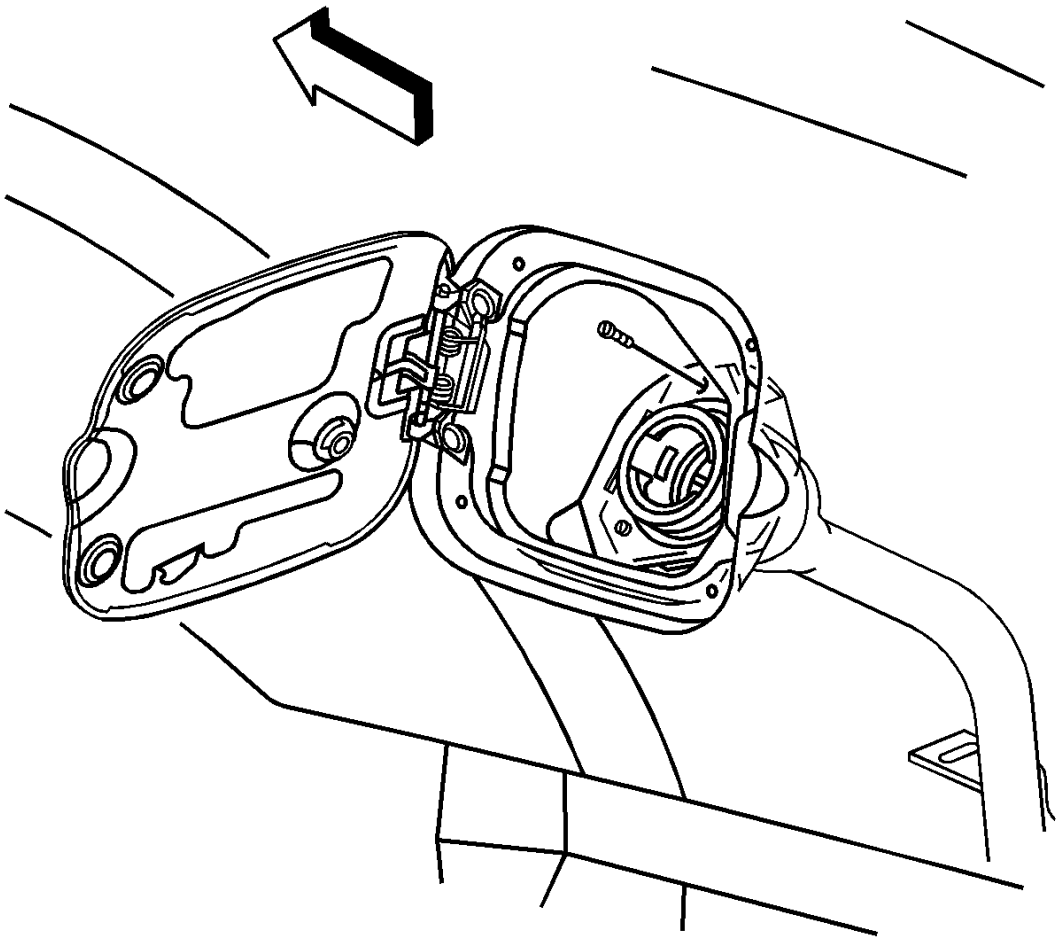


Fig. 77: Locating Fuel Fill Pipe Screws To Fuel Filler Pocket
Courtesy of GENERAL MOTORS COMPANY

8. Install the fuel fill pipe screws to the fuel filler pocket and tighten to 2.5 N.m (22 lb in).

FUEL LEVEL SENSOR REPLACEMENT

Removal Procedure

WARNING: Fuel Vapors can collect while servicing fuel system parts in enclosed areas such as a trunk. To reduce the risk of fire and increased exposure to vapors:

- **Use forced air ventilation such as a fan set outside of the trunk.**
- **Plug or cap any fuel system openings in order to reduce fuel vapor formation.**
- **Clean up any spilled fuel immediately.**
- **Avoid sparks and any source of ignition.**
- **Use signs to alert others in the work area that fuel system work is in process.**

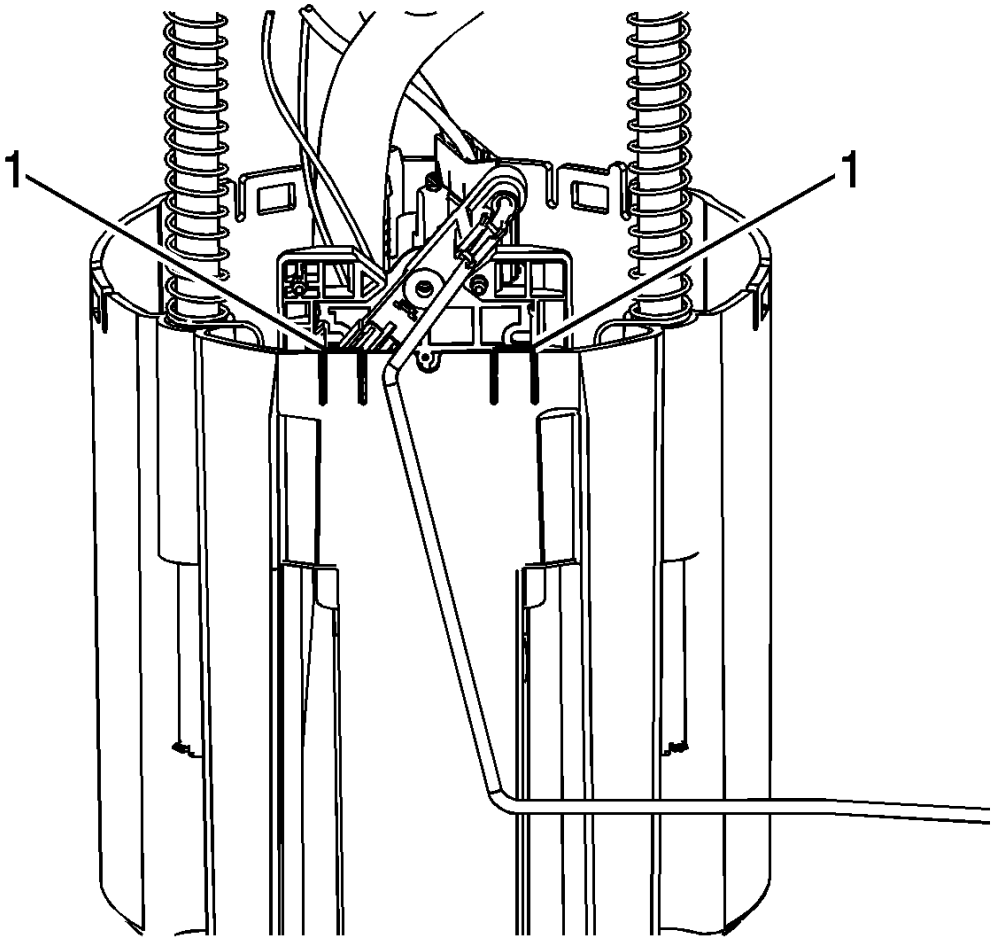


Fig. 78: Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.
2. Using two flat-bladed tools, carefully pull both locking tabs (1) outward while simultaneously lifting the level sensor.

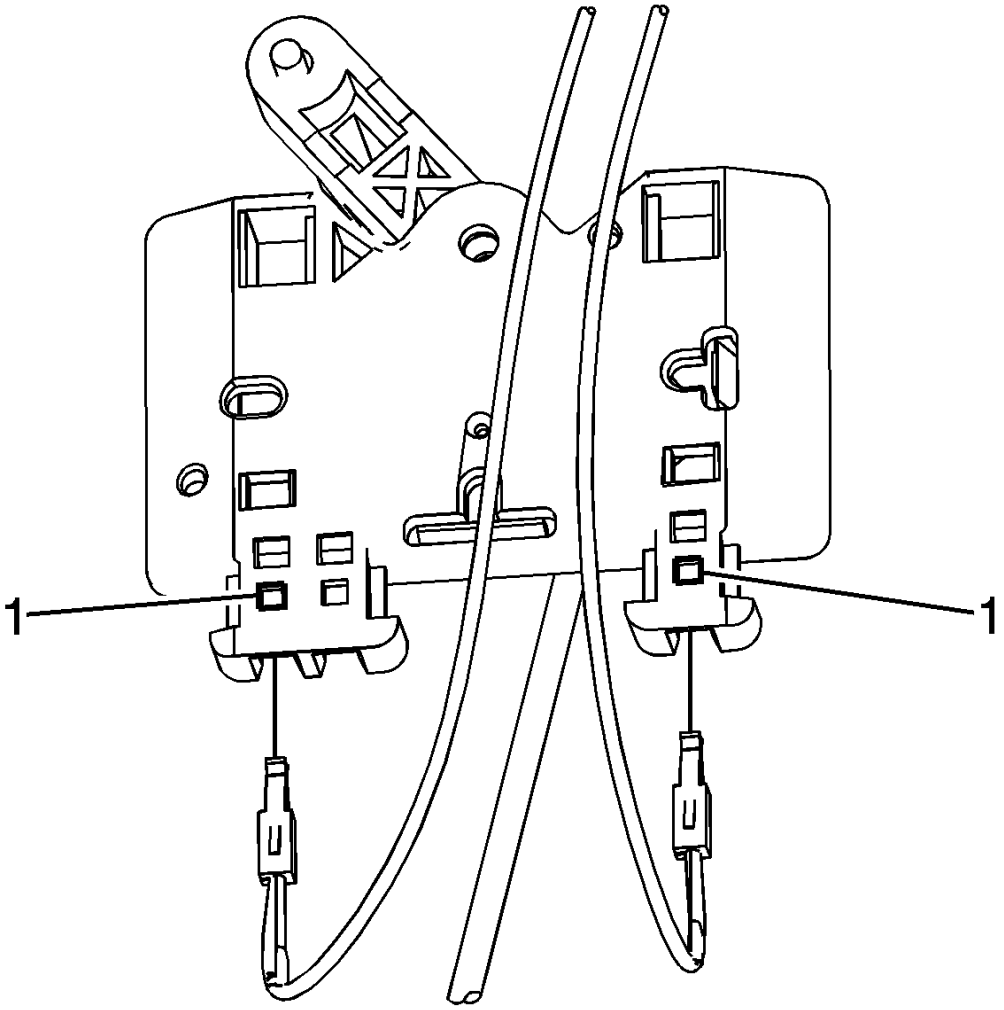


Fig. 79: Electrical Terminals
Courtesy of GENERAL MOTORS COMPANY

3. Using a small bladed tool, push in the electrical terminals (1) while simultaneously pulling out.

Installation Procedure

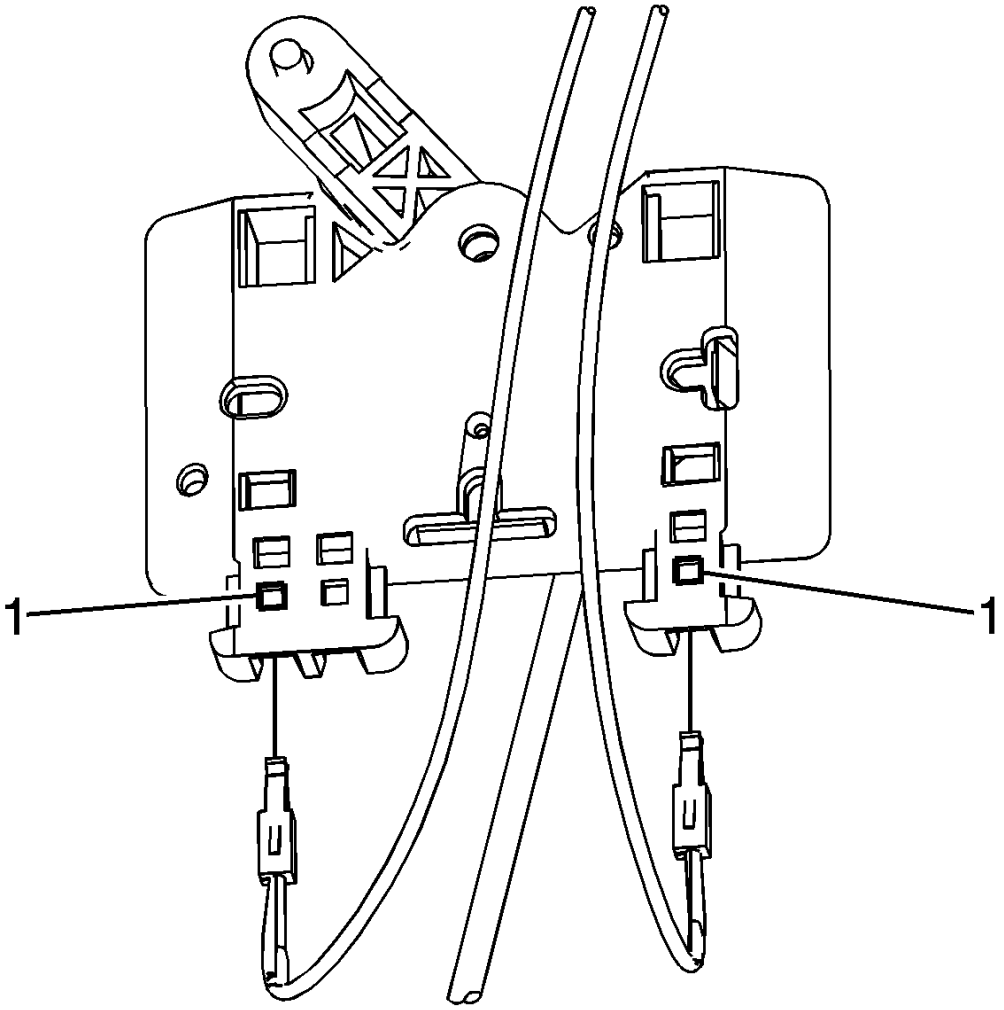


Fig. 80: Electrical Terminals
Courtesy of GENERAL MOTORS COMPANY

1. Push in the electrical terminals (1) and ensure the terminals are secure.

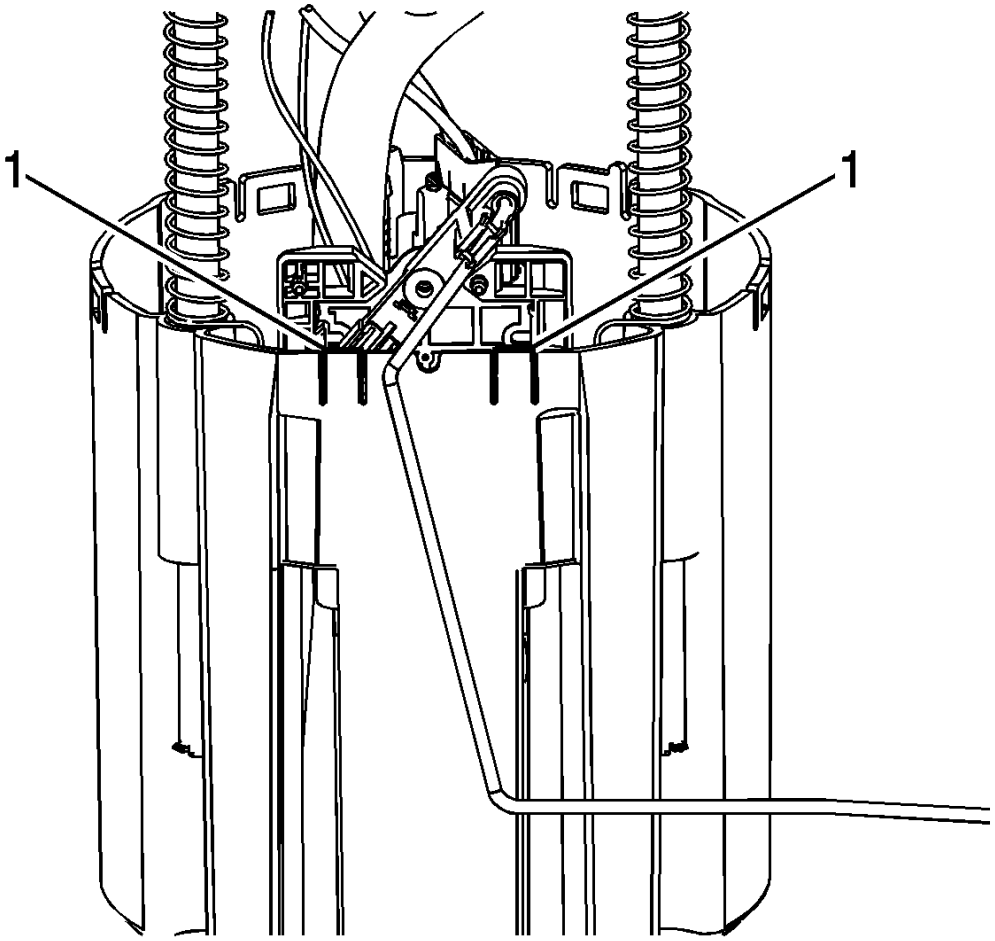


Fig. 81: Locking Tabs
Courtesy of GENERAL MOTORS COMPANY

2. Carefully insert the level sensor until the locking tabs (1) snap into the locking position.
3. Install the fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.

FUEL PUMP FUEL FEED HOSE REPLACEMENT

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**

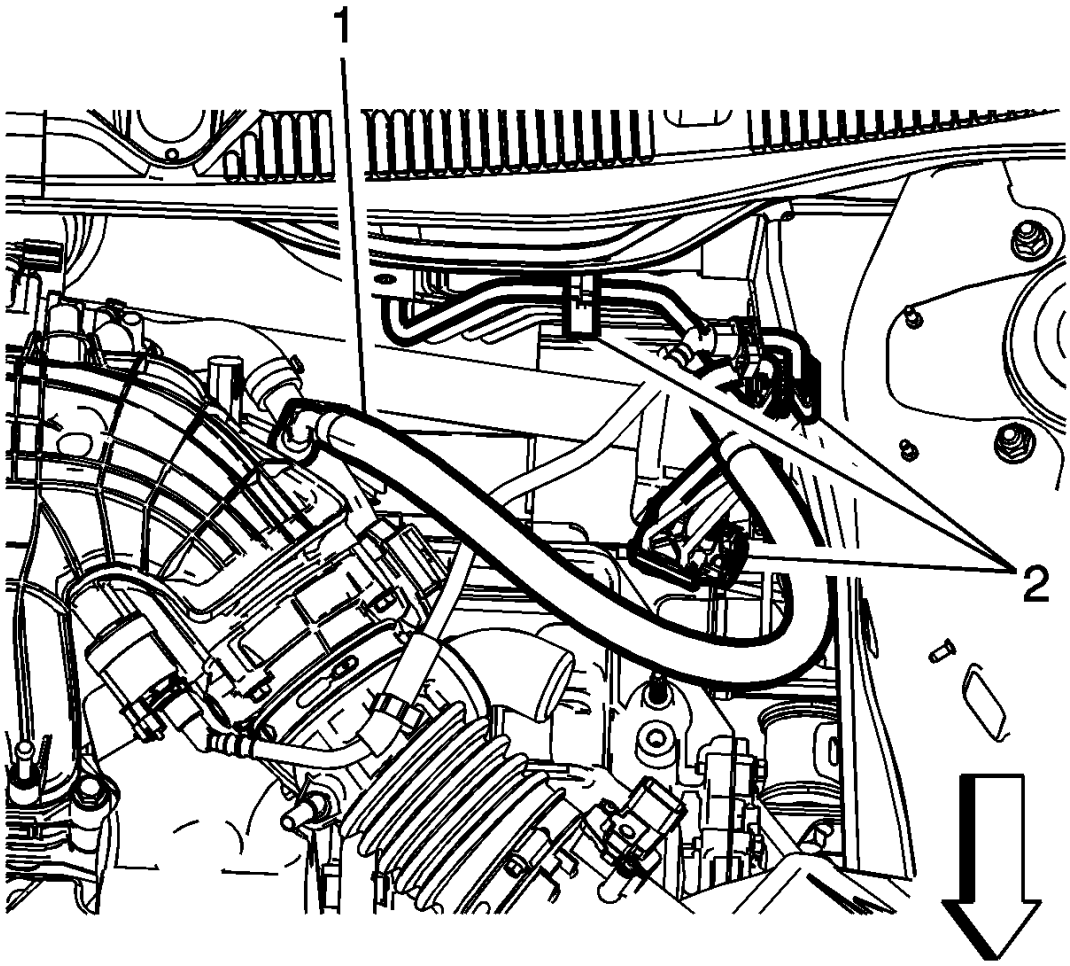


Fig. 82: Fuel Line And Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the fuel line (1) from the retainers (2). Refer to **Metal Collar Quick Connect Fitting Service**.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

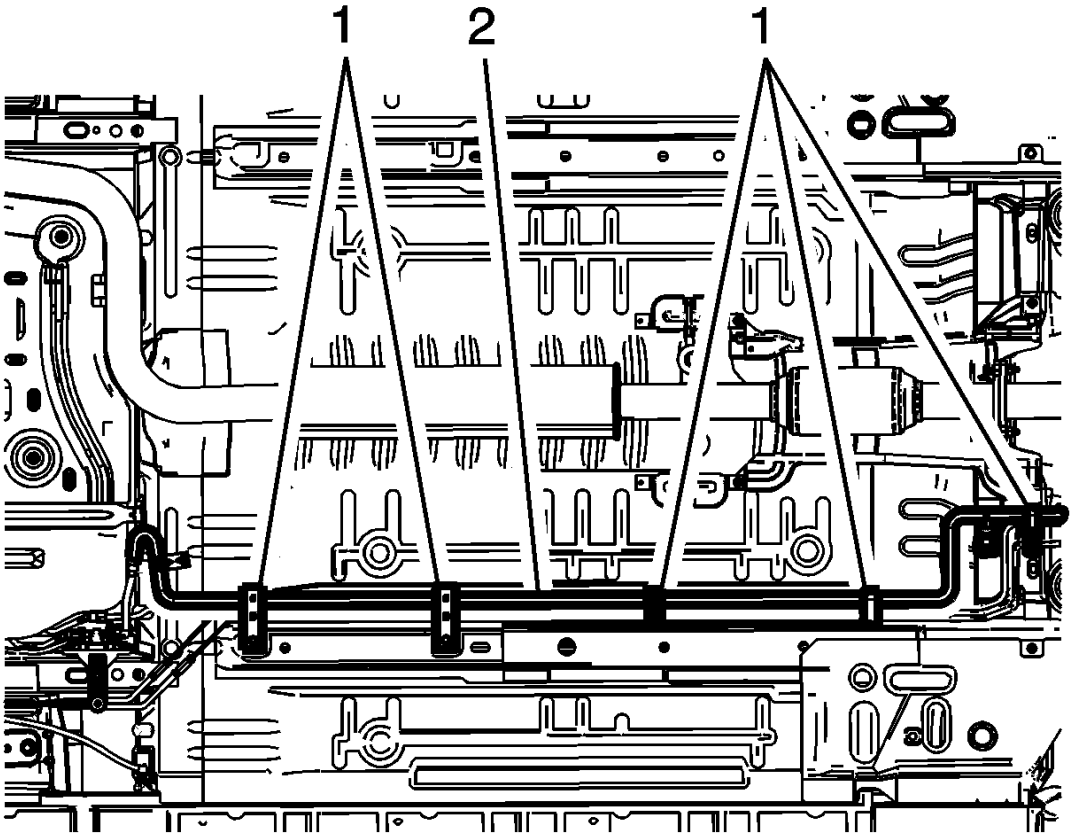


Fig. 83: Fuel Line And Retainers
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the fuel line (1) from the retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

Installation Procedure

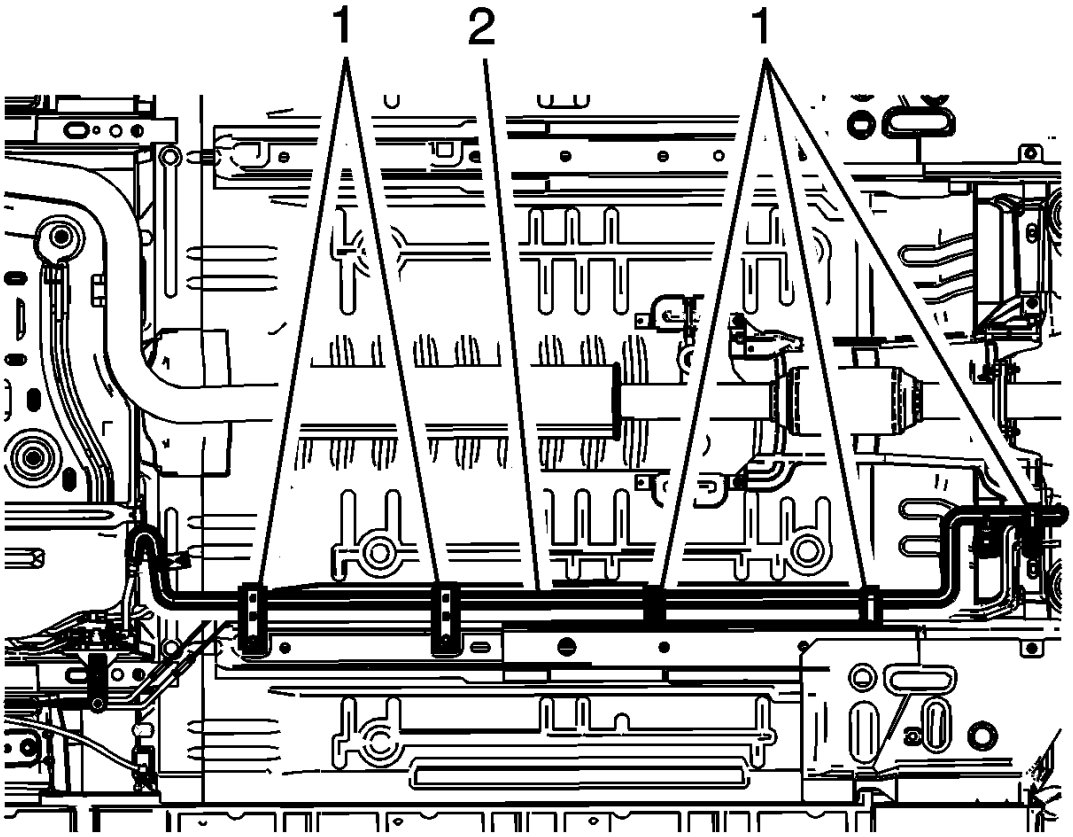


Fig. 84: Fuel Line And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Connect the fuel line (1) from the retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.
2. Lower the vehicle.

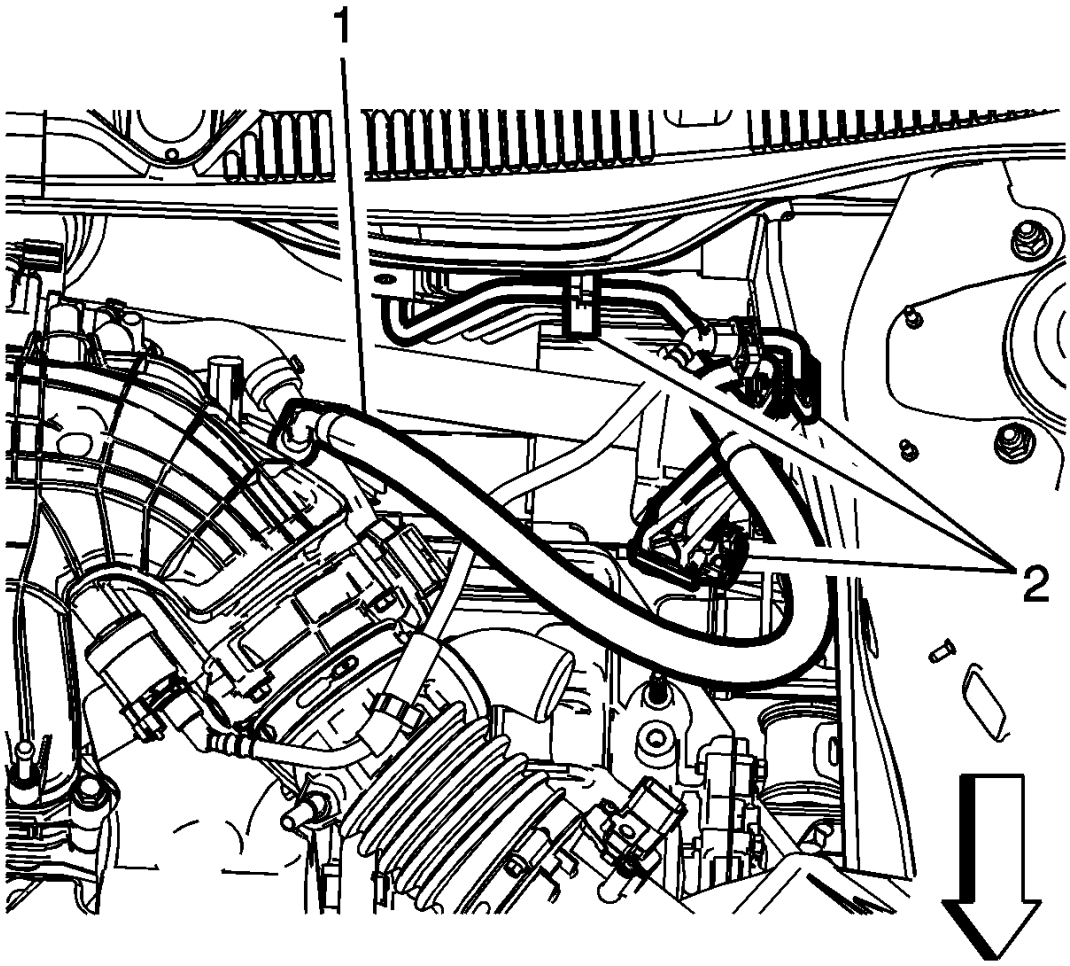


Fig. 85: Fuel Line And Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Connect the fuel line (1) from the retainers (2). Refer to **Metal Collar Quick Connect Fitting Service**.

FUEL FEED REAR PIPE REPLACEMENT

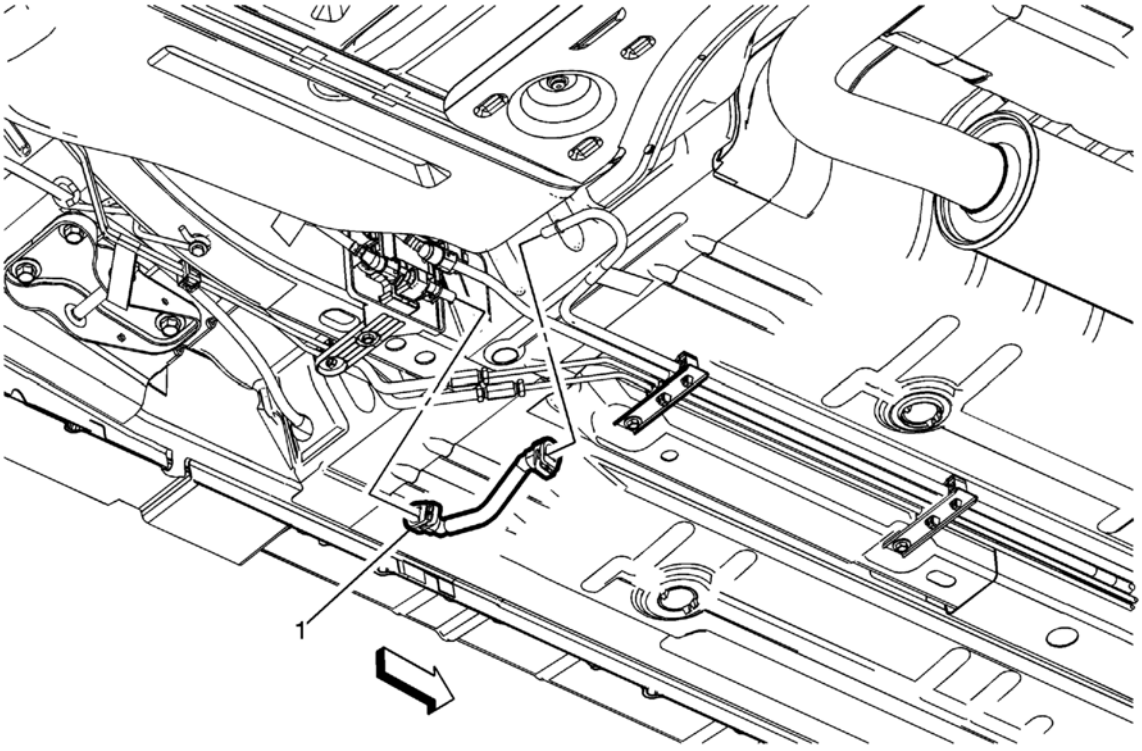


Fig. 86: Fuel Feed Rear Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Fuel Feed Rear Pipe. **Procedure** Disconnect the fuel feed rear pipe quick connect fittings. Refer to **Plastic Collar Quick Connect Fitting Service**

FLEXIBLE FUEL SENSOR REPLACEMENT

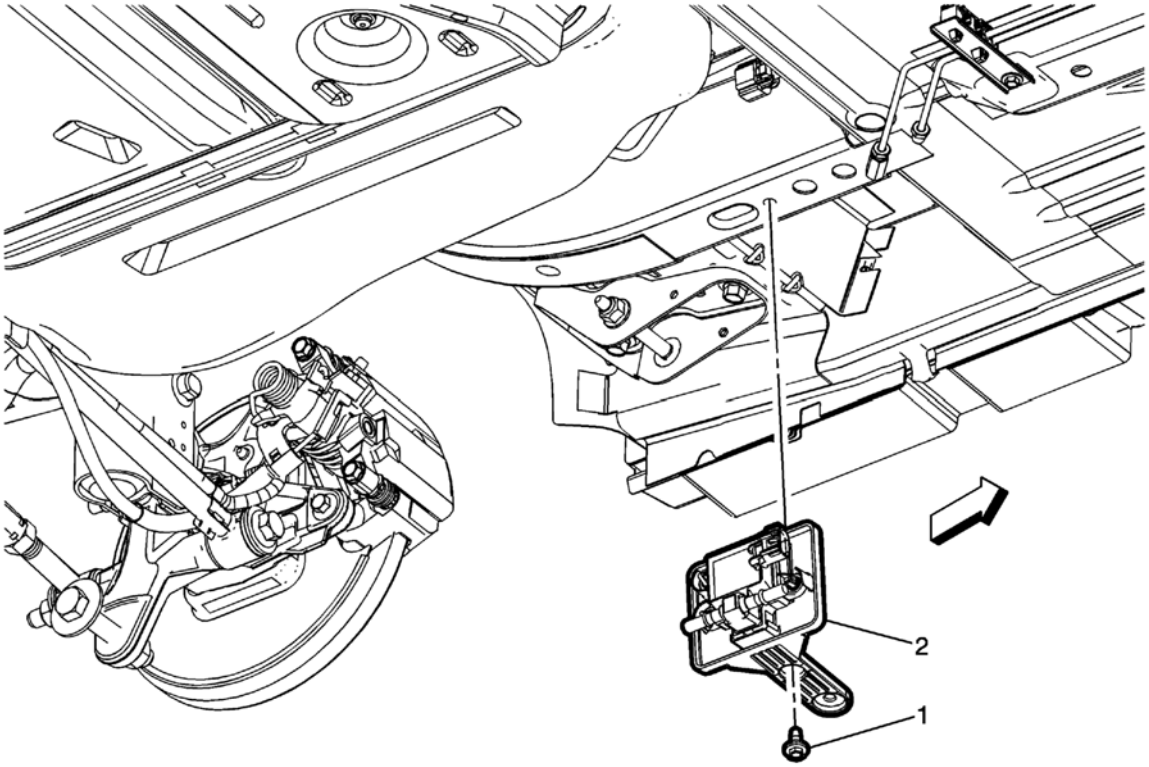


Fig. 87: Flexible Fuel Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)** 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**	
1	Flex Fuel Sensor Bolt. **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Flex Fuel Sensor. **Procedure** 1. Disconnect the fuel line connectors. Refer to **Plastic Collar Quick Connect Fitting Service**

Callout	Component Name
	2. Disconnect the electrical connector.

FUEL PRESSURE SENSOR REPLACEMENT - FUEL FEED PIPE

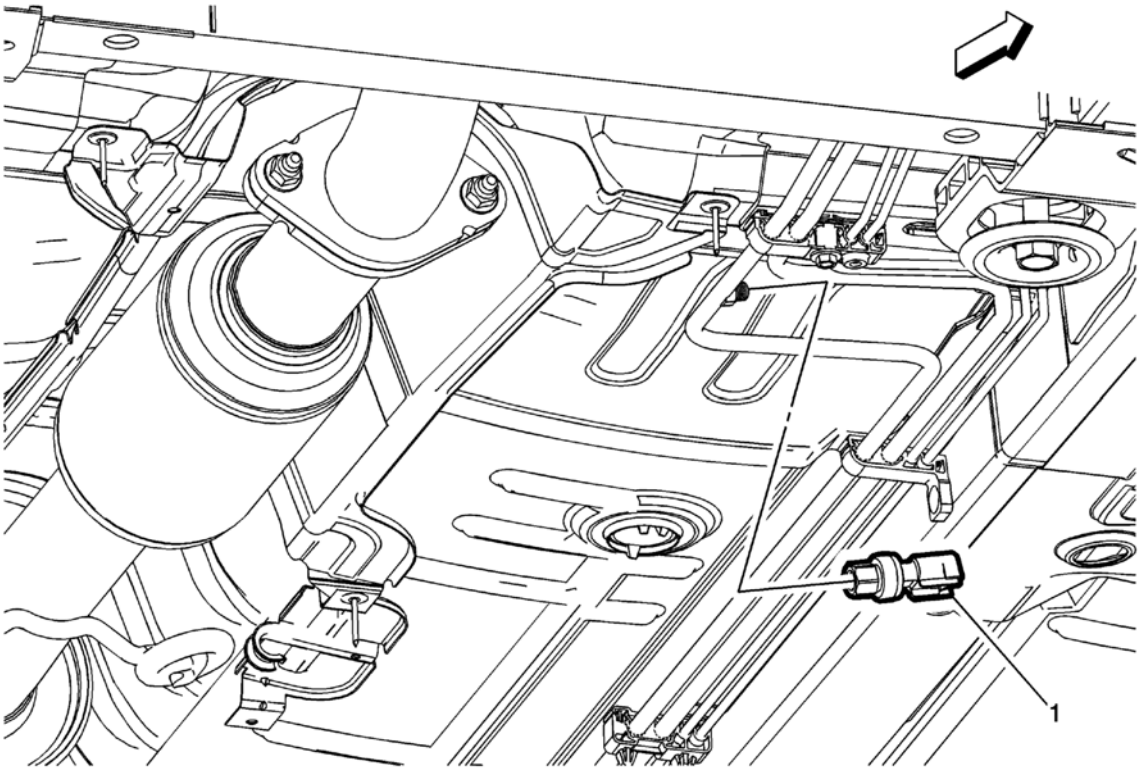


Fig. 88: Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Fuel Pressure Sensor **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Disconnect the electrical connector.

Callout	Component Name
	2. Use a NEW O-ring whenever the sensor is removed. **Tighten** 9Y (80 lb in)

FUEL FEED PIPE REPLACEMENT

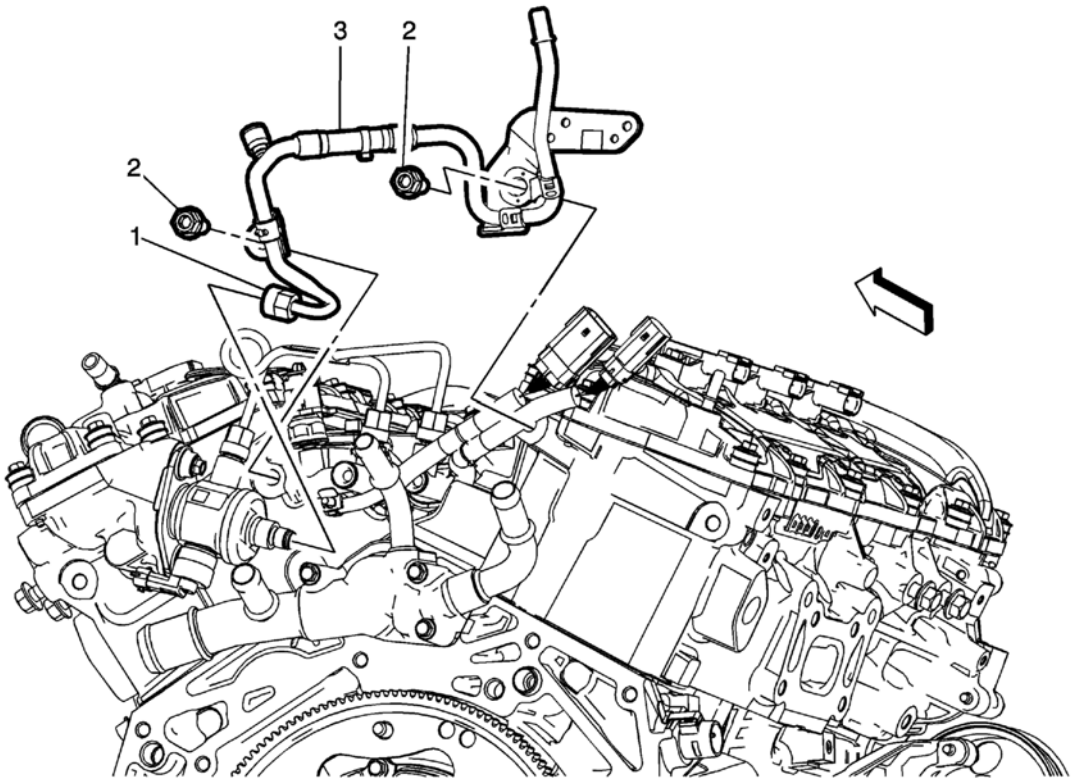


Fig. 89: Fuel Feed Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Predures 1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**. 2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** . 3. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**. 4. Disconnect the fuel feed line quick connect. Refer to **Metal Collar Quick Connect Fitting Service**.	
1	Fitting (Qty: 1) **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 28 N.m(20 lb ft)
2	Bolt (Qty: 2) **Tighten** 50 N.m(28 lb ft)
3	Fuel Feed Pipe **Procedure** 1. DISCARD the pipe when removed, and install a NEW pipe. 2. Ensure that the high pressure fuel pipe, and fuel pump fittings are clean and dry prior to assembly. 3. Pressure up the fuel system and check for leaks.

FUEL SYSTEM CLEANING

CAUTION: **Refer to Cover and Plug Openings Caution .**

NOTE: **When flushing the fuel tank, treat the fuel and water mixture as a hazardous material. Handle the material in accordance with all local, state and federal laws and regulations.**

NOTE: **Whenever the fuel tank is cleaned, inspect the fuel pump fuel strainer. If the fuel pump fuel strainer is contaminated, replace the fuel pump fuel strainer and inspect the fuel pump.**

NOTE: **Always maintain cleanliness when servicing fuel system components.**

1. Remove the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.
2. Inspect the fuel pump inlet for dirt and debris. If dirt and debris are found, replace the fuel pump.
3. Flush fuel tank with hot water.
4. Pour the water out of the fuel sender assembly opening in the fuel tank. Rock the fuel tank in order to ensure that the removal of the water from the fuel tank is complete.
5. Allow tank to dry completely before reassembly.
6. Install the fuel tank fuel pump module. Refer to **Fuel Tank Fuel Pump Module Replacement**.

FUEL PRESSURE SENSOR REPLACEMENT - FUEL INJECTION FUEL RAIL

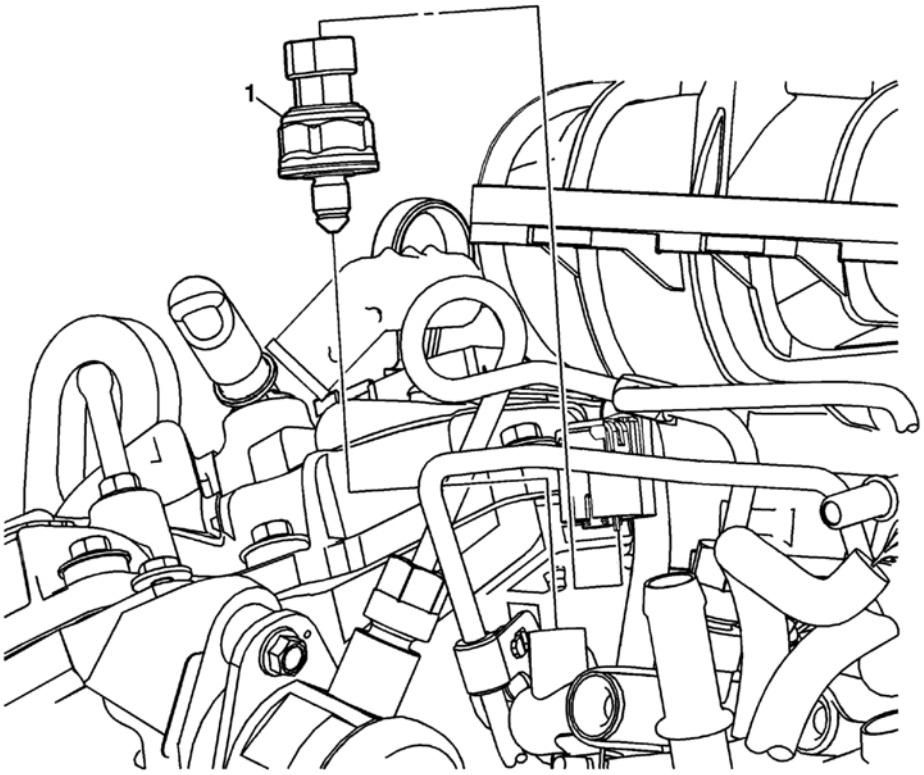


Fig. 90: Fuel Pressure Sensor - Fuel Injection Fuel Rail
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**. 2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.	
1	Fuel Injection Fuel Rail Fuel Pressure Sensor **CAUTION:** **Refer to Fastener Caution .** **Procedure** Disconnect the electrical connector. **Tighten** 33 N.m (25 lb ft)

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 1

Special Tools

EN-49248 Injector Rail Assembly Remover

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
5. Remove the fuel injection fuel rail noise shield from the fuel rails.

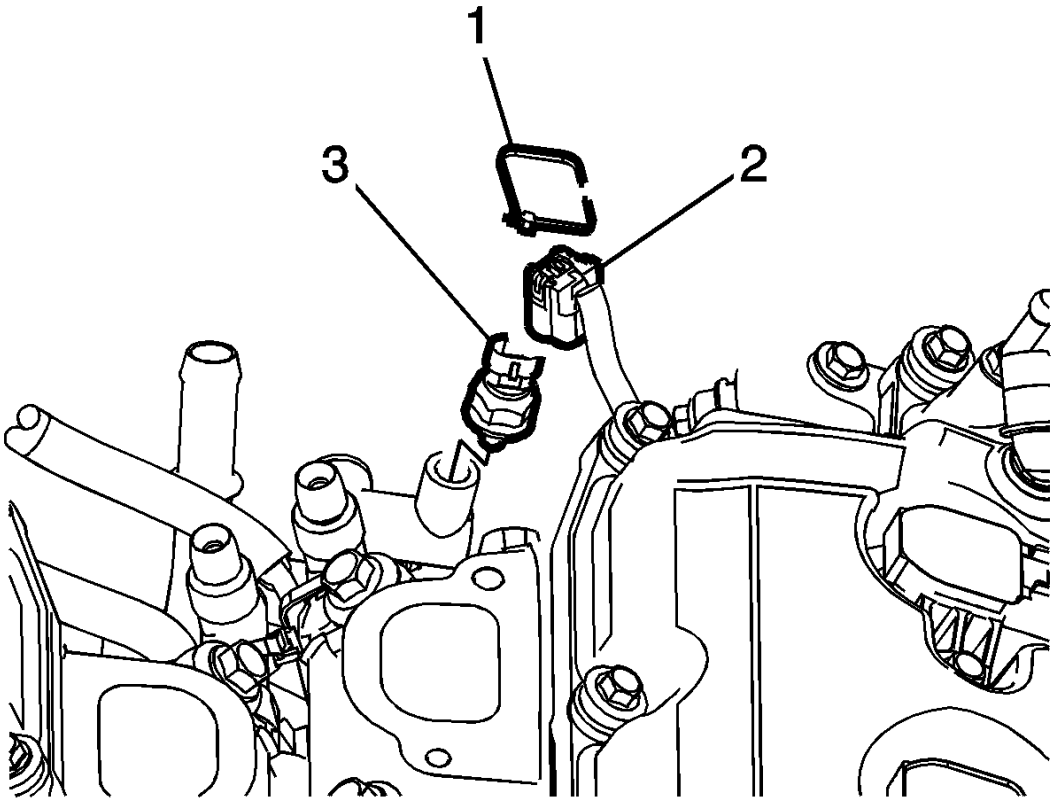


Fig. 91: Fuel Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Cut the plastic tie strap (1).
7. Disconnect the fuel pressure sensor electrical connector (2).
8. Remove the fuel pressure sensor (3).

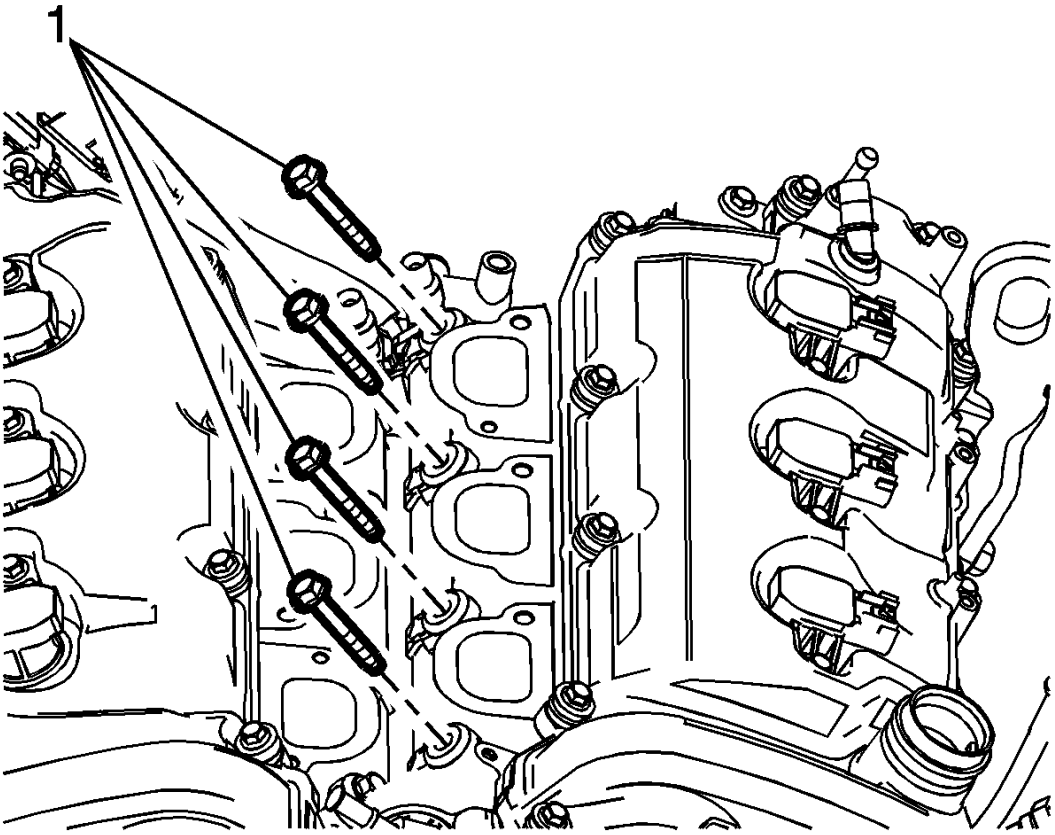


Fig. 92: Left Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Remove the bank 2 fuel rail fasteners (1).

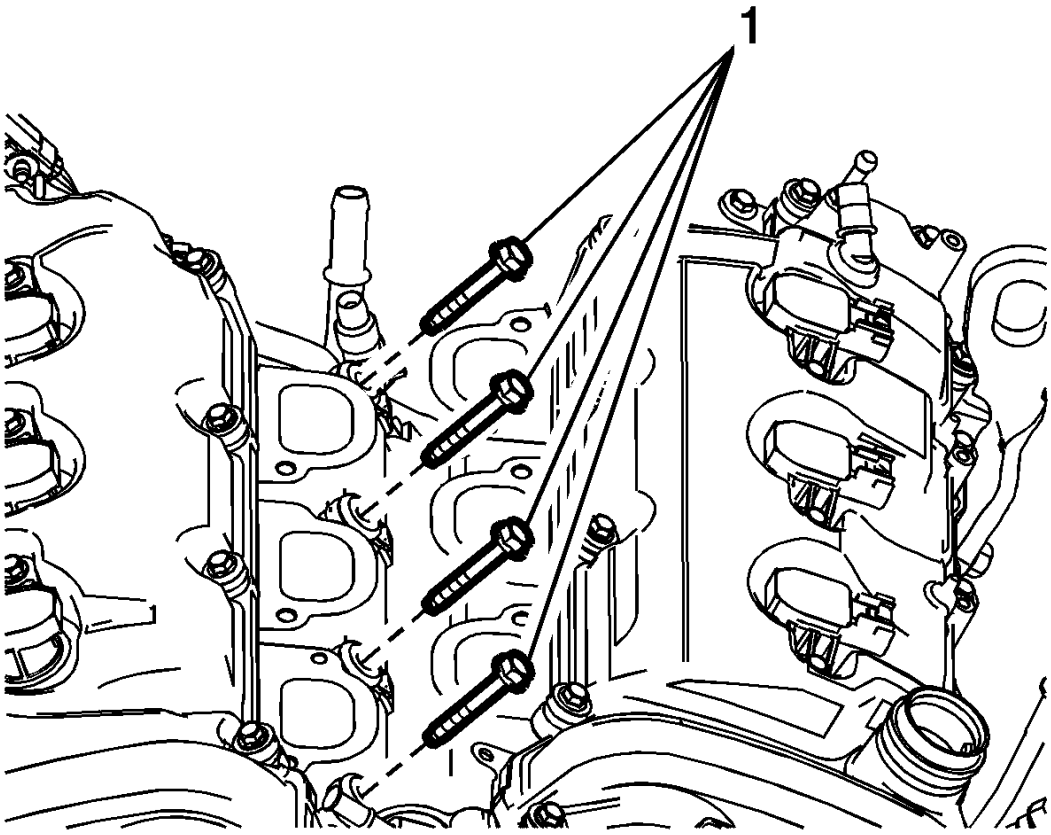


Fig. 93: Right Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Remove the bank 1 fuel rail fasteners (1) for clearance purposes.

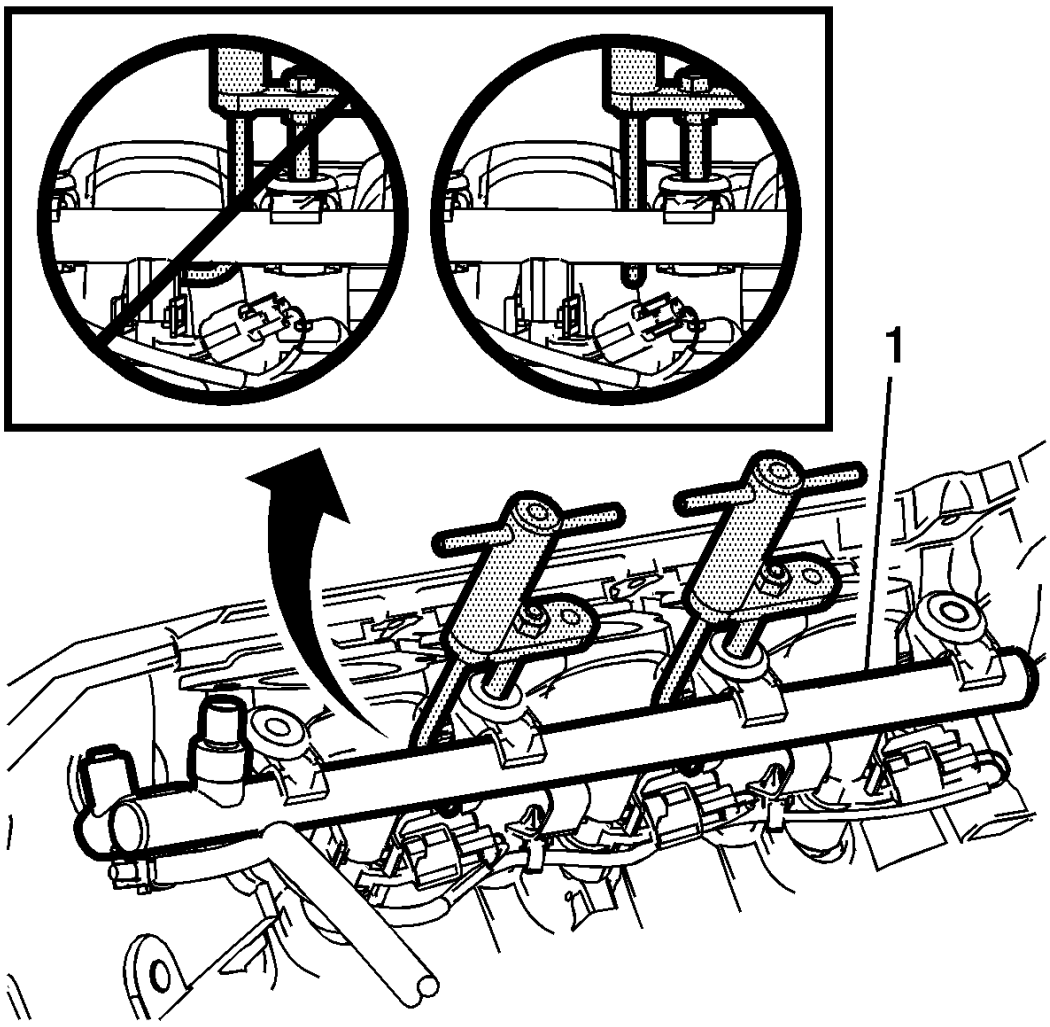


Fig. 94: Raising Fuel Rail With Special Tool
Courtesy of GENERAL MOTORS COMPANY

11. Using the **EN-49248-4** hook , raise the fuel rail (1) as an assembly.
12. Once the fuel rail is free, remove the **EN-49248** special tool.

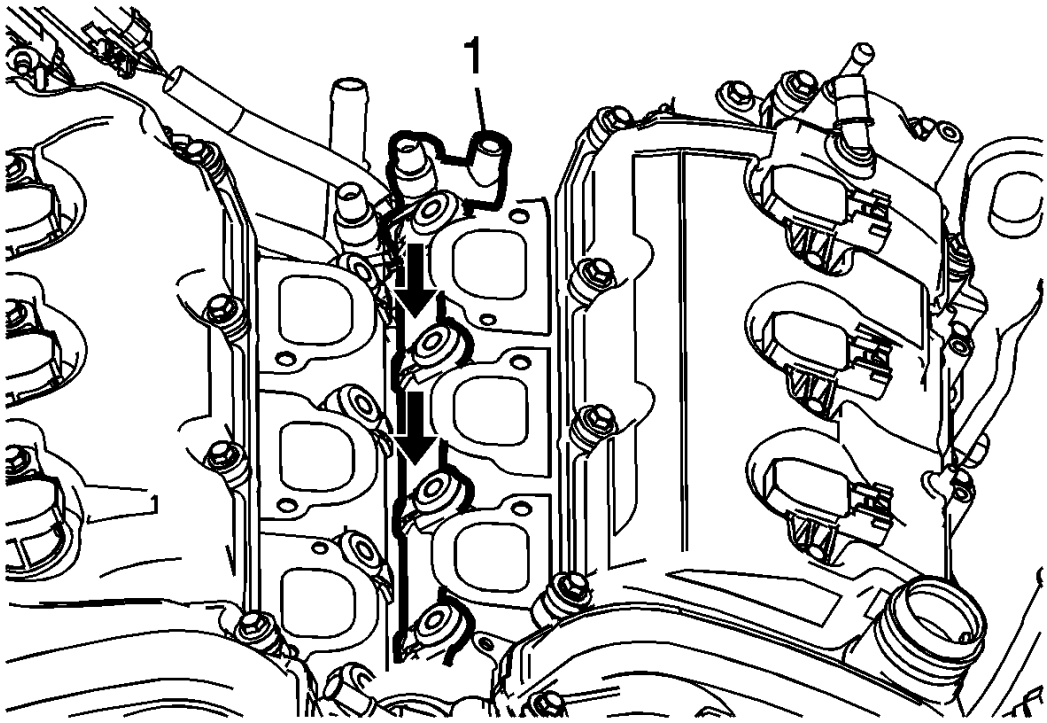


Fig. 95: Sliding Fuel Rail Toward Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

13. Slide the fuel rail (1) toward the front of the engine approximately 1 inch (25.4 mm), in order to clear the center injector bore.

NOTE: **The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.**

14. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1, LFW or LFX)** .

Installation Procedure

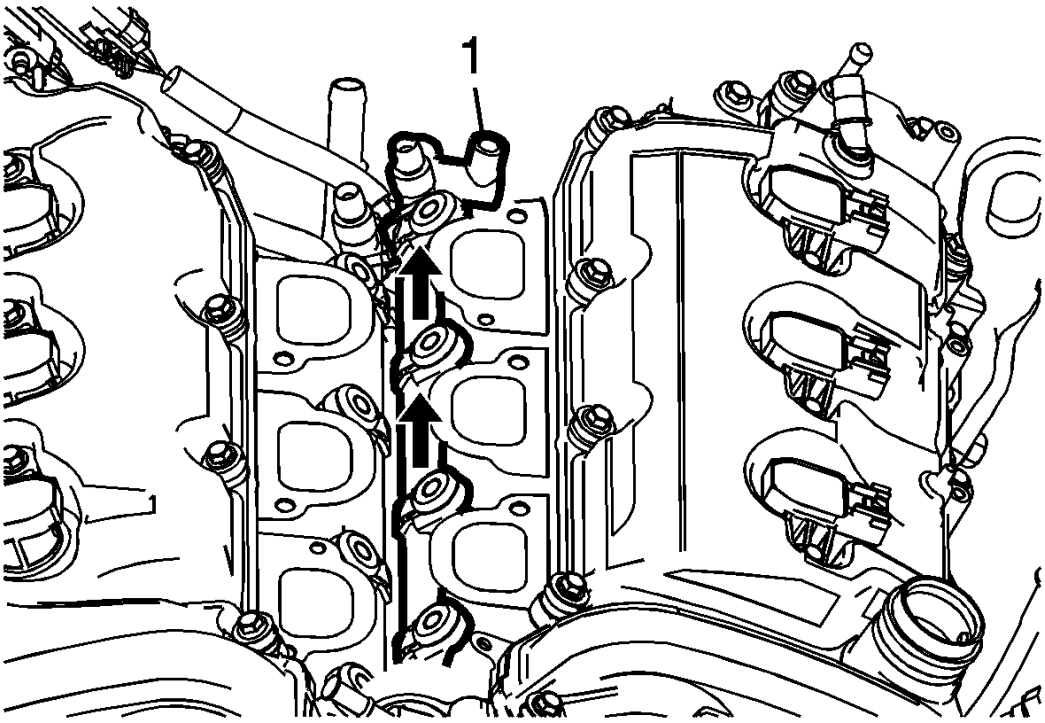


Fig. 96: Sliding Fuel Rail Toward Rear Of Engine
Courtesy of GENERAL MOTORS COMPANY

1. Slide the fuel rail (1) toward the rear of the engine approximately 1 inch (25.4 mm), in order to align the center injector bore.

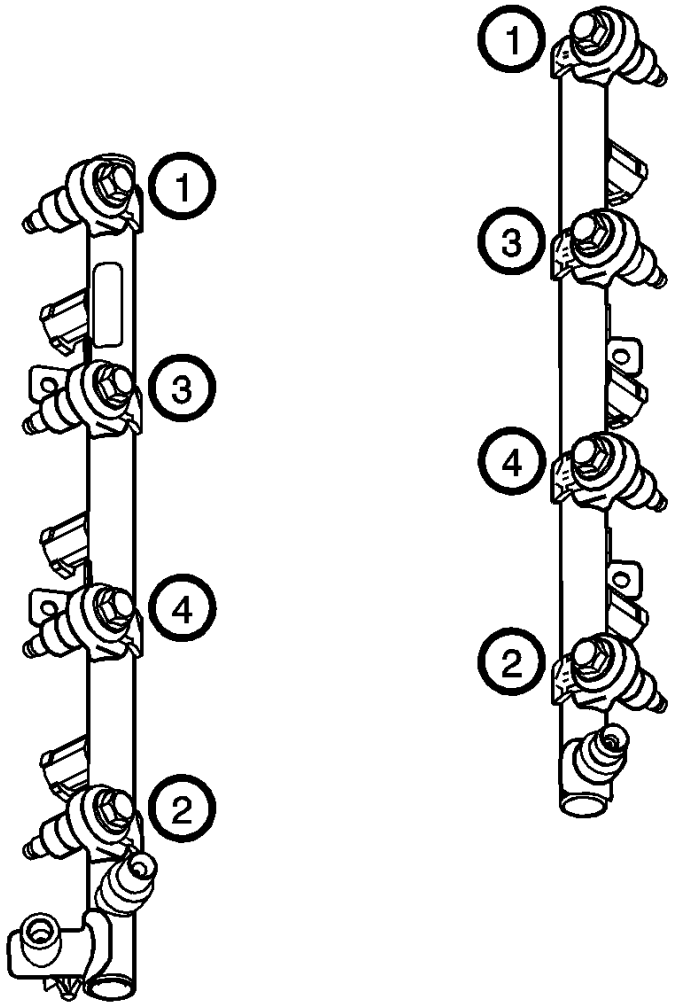


Fig. 97: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Hand tighten the two outer fuel rail fasteners to seat the injectors.
3. Start and hand tighten the remaining fuel rail fasteners.
4. Tighten the fuel rail fasteners in the sequence shown above:
    1. First pass 12 N.m (106 lb in).
    2. Final pass 23 N.m (17 lb ft).

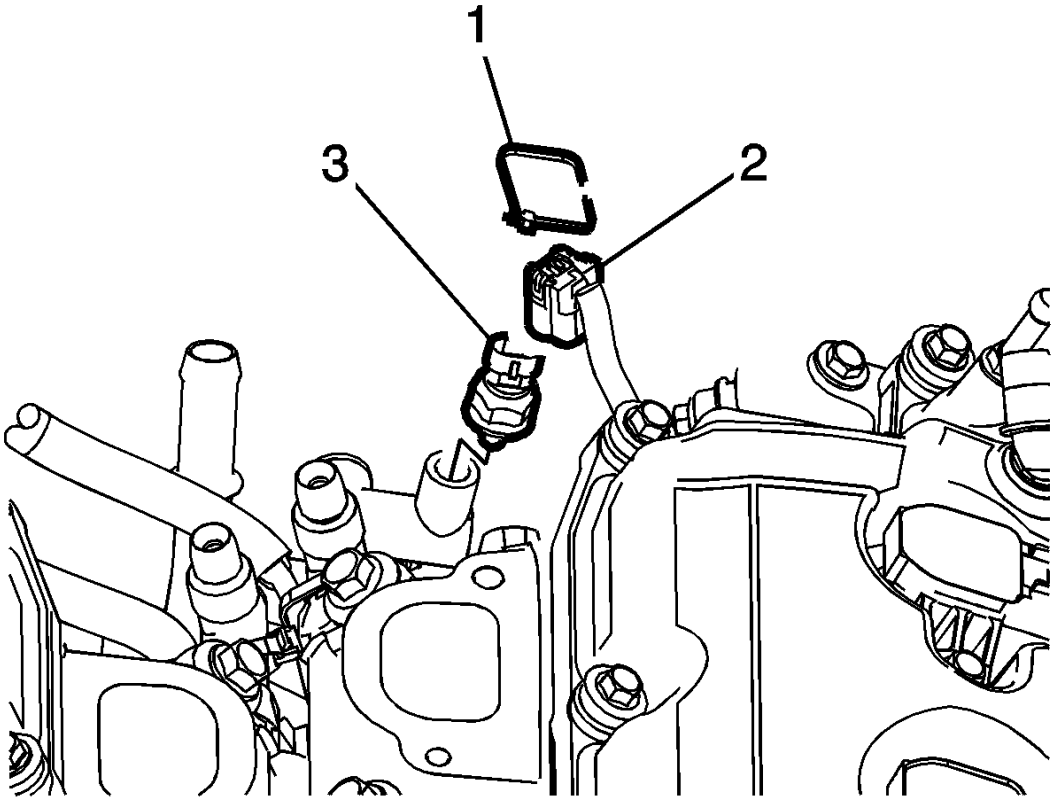


Fig. 98: Fuel Pressure Sensor And Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the fuel pressure sensor (3) to 33 N.m (25 lb ft).
6. Connect the fuel pressure sensor electrical connector (2) and secure it with a new plastic zip tie.
7. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
8. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
9. Install the fuel injection fuel rail noise shield to the fuel rails.
10. Install the intake manifold. Refer to **Intake Manifold Replacement** .
11. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
12. Install the low side fuel pressure service port cap.
13. Install the fuel tank cap.

FUEL INJECTION FUEL RAIL ASSEMBLY REPLACEMENT - BANK 2

Special Tools

EN-49248 Injector Rail Assembly Remover

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Removal Procedure

1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**.
2. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
3. Remove the intake manifold. Refer to **Intake Manifold Replacement** .
4. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
5. Remove the fuel injection fuel rail noise shield from the fuel rails.

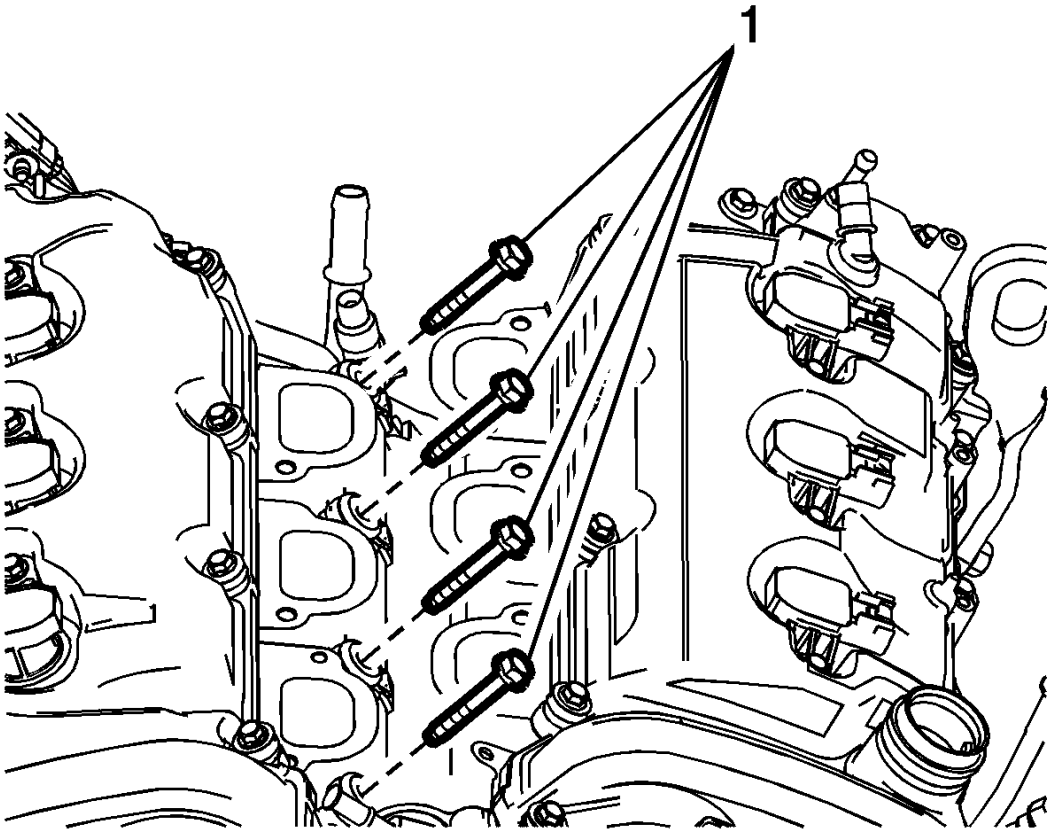


Fig. 99: Right Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the bank 1 fuel rail fasteners (1).

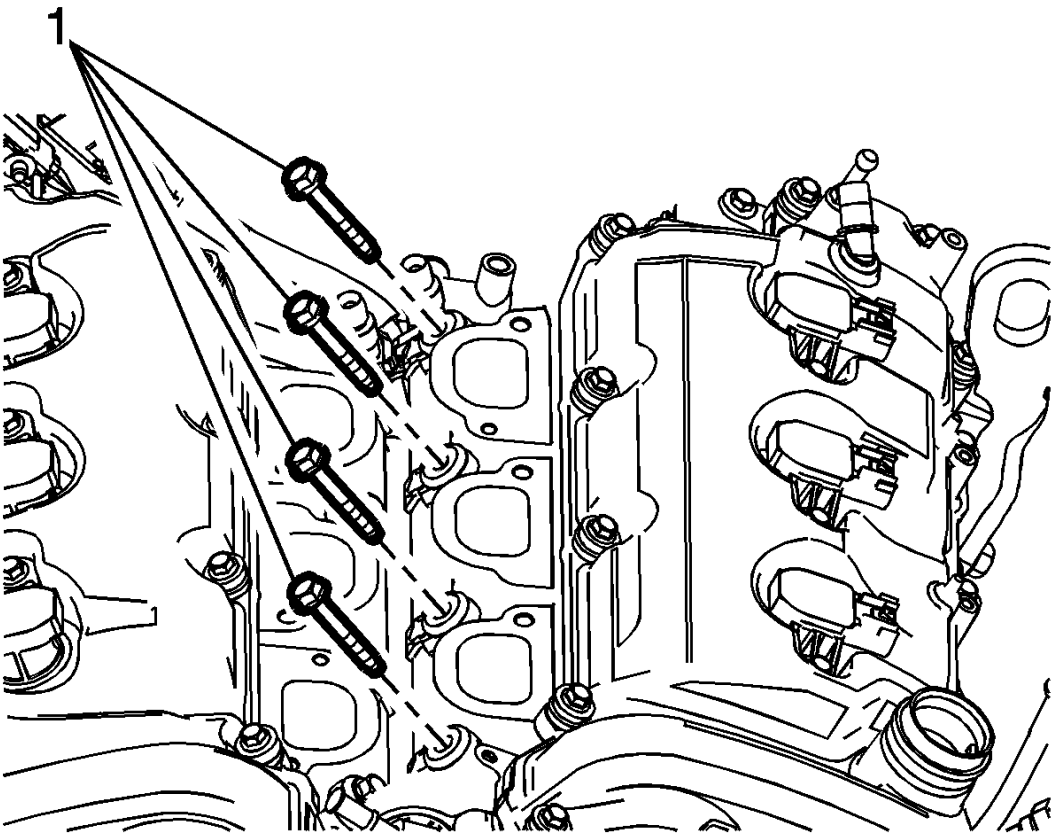


Fig. 100: Left Side Fuel Rail Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the bank 2 fuel rail fasteners (1) for clearance purposes.

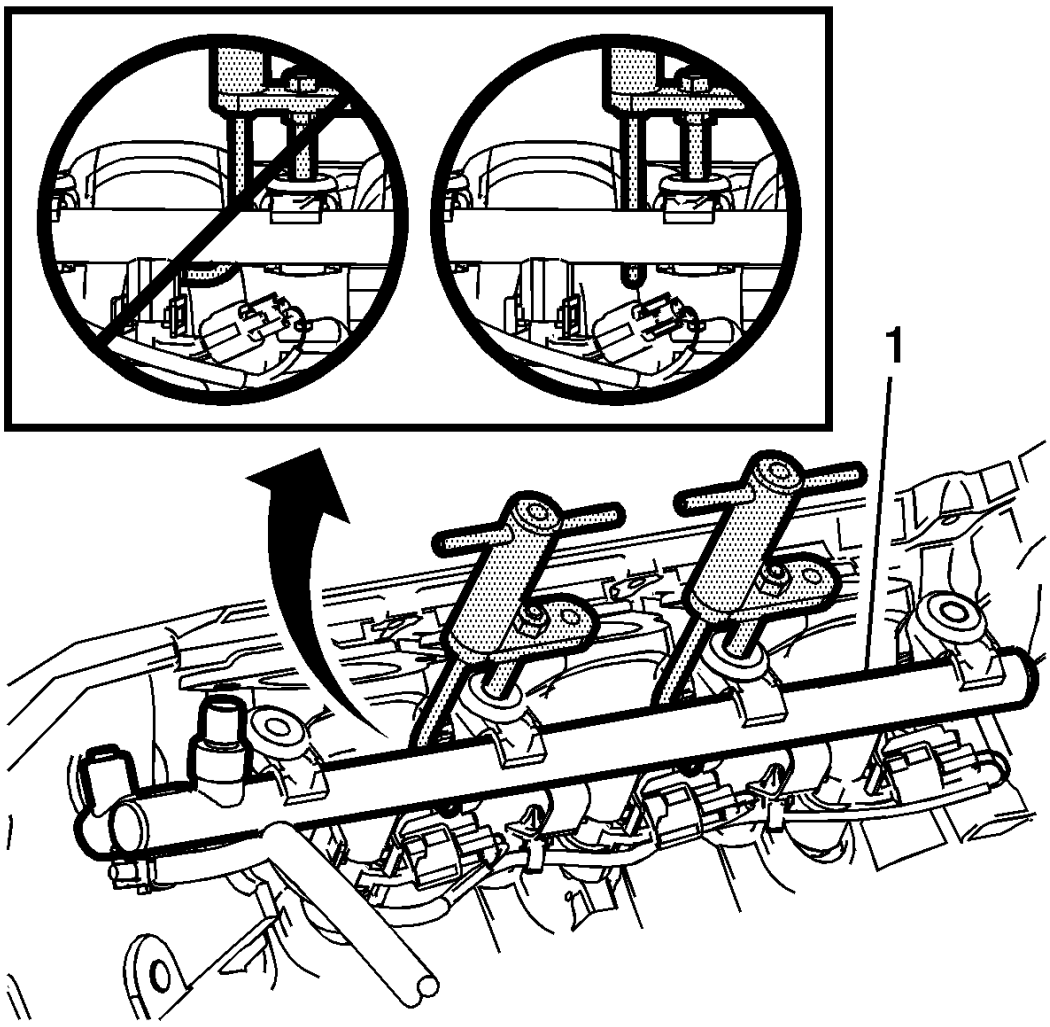


Fig. 101: Raising Fuel Rail With Special Tool
Courtesy of GENERAL MOTORS COMPANY

8. Using the **EN-49248-4** hook , raise the fuel rail (1) as an assembly.
9. Once the fuel rail is free, remove the **EN-49248** remover.

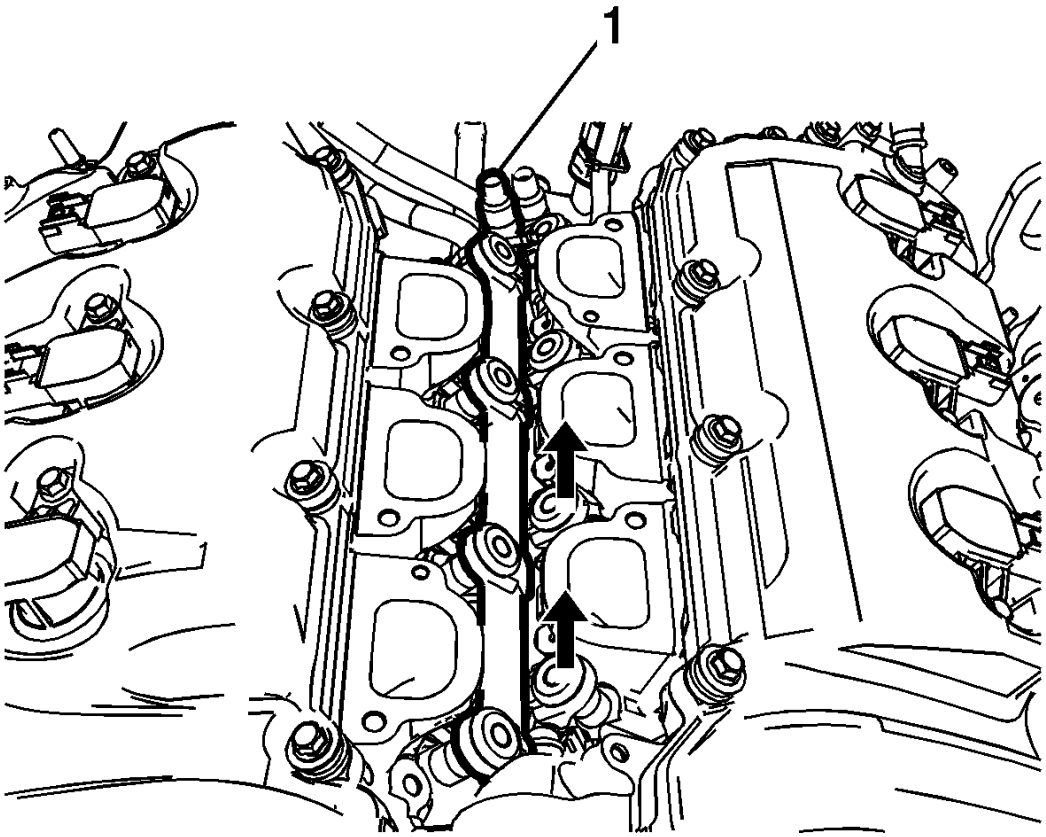


Fig. 102: Sliding Fuel Rail Toward Rear Of Engine
Courtesy of GENERAL MOTORS COMPANY

10. Slide the fuel rail (1) toward the rear of the engine approximately 1 inch (25.4mm), in order to clear the center injector bore.

NOTE: **The direct fuel injectors must be rebuilt whenever the injector has been released from the fuel rail or cylinder head.**

11. Once the fuel rail is removed, remove the fuel injectors and rebuild them. Refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1, LFW or LFX)** .

Installation Procedure

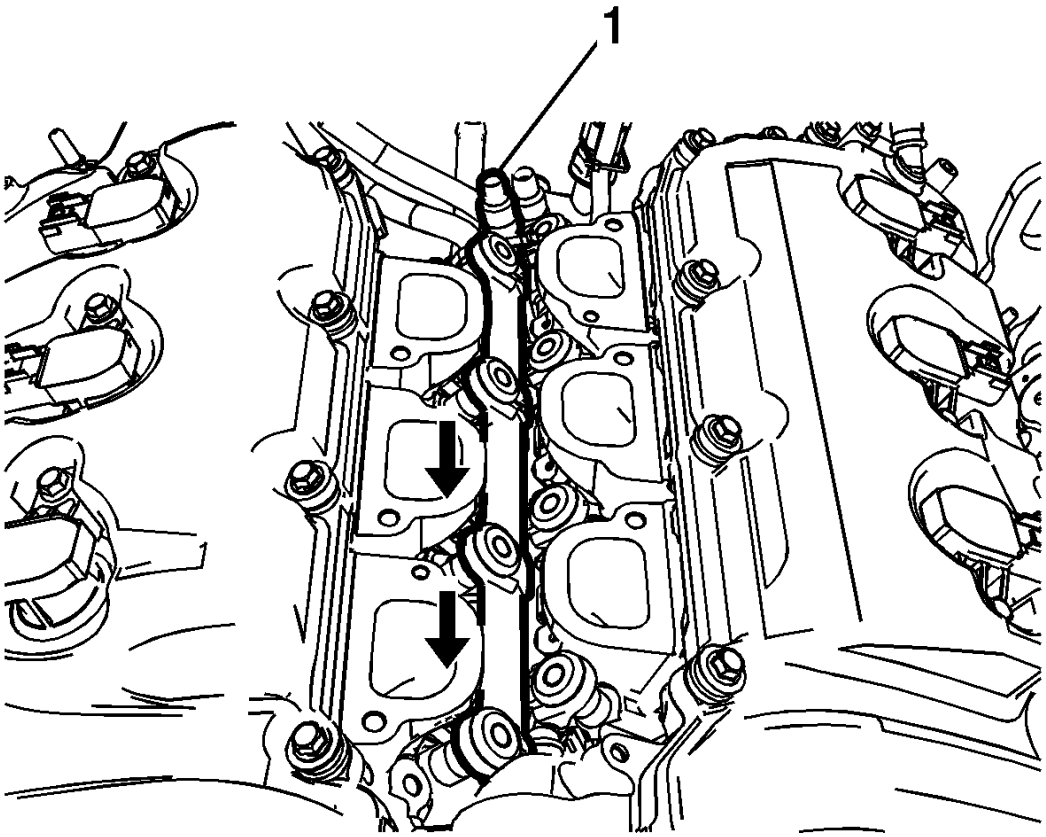


Fig. 103: Sliding Fuel Rail Toward Front Of Engine
Courtesy of GENERAL MOTORS COMPANY

1. Slide the fuel rail (1) toward the front of the engine approximately 1 inch (25.4mm), in order to align the center injector bore.

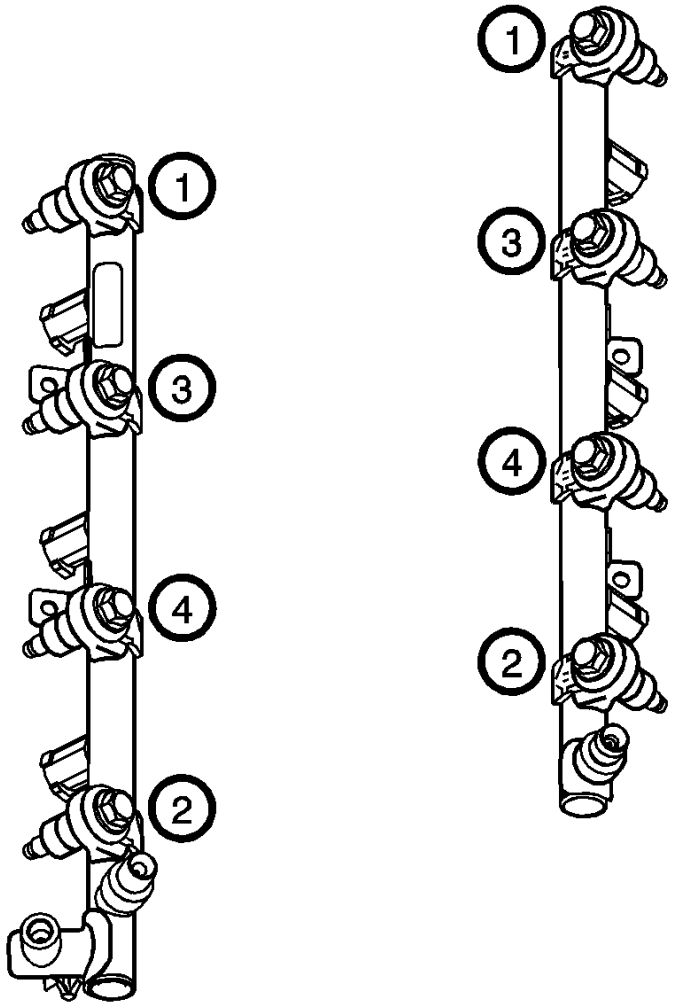


Fig. 104: Identifying Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Hand tighten the two outer fuel rail fasteners to seat the injectors.
3. Start and hand tighten the remaining fuel rail fasteners.
4. Tighten the fuel rail fasteners in the sequence shown above:
    1. Tighten the Bank 1 fuel rail bolts first pass to 12 N.m (106 lb in).
    2. Tighten the Bank 1 fuel rail bolts a final pass to 23 N.m (17 lb ft).
5. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
6. Inspect for fuel leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
7. Install the fuel injection fuel rail noise shield to the fuel rails.

8. Install the intake manifold. Refer to **Intake Manifold Replacement** .
9. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.
10. Install the low side fuel pressure service port cap.
11. Install the fuel tank cap.

FUEL FEED INTERMEDIATE PIPE REPLACEMENT

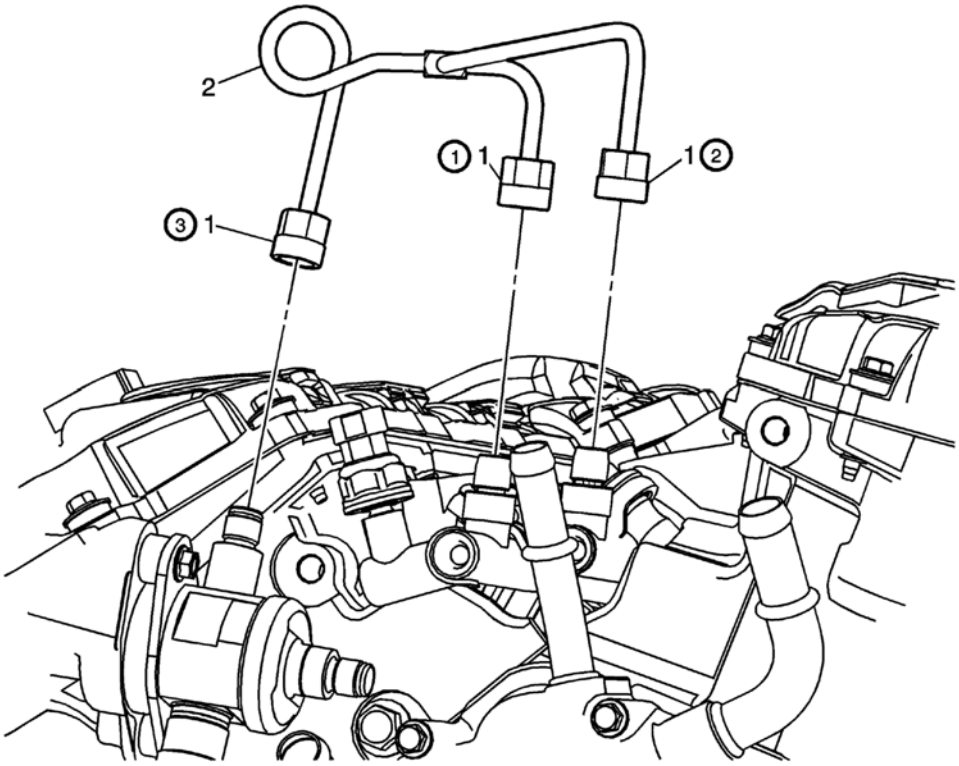


Fig. 105: View Of Fuel Feed Intermediate Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**. 2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** . 3. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement**.	
1	Fitting (Qty: 3) **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	NOTE: **Tighten the fittings in sequence as numbered:** **1, 2, 3** Tighten 20 (21 lb ft) Fuel Feed Intermediate Pipe **Procedure** 1. Discard the pipe when removed and install a NEW pipe. 2. Lubricate the pipes with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . 3. Pressure up the fuel system and check for leaks.
2	

FUEL PIPE SHIELD REPLACEMENT

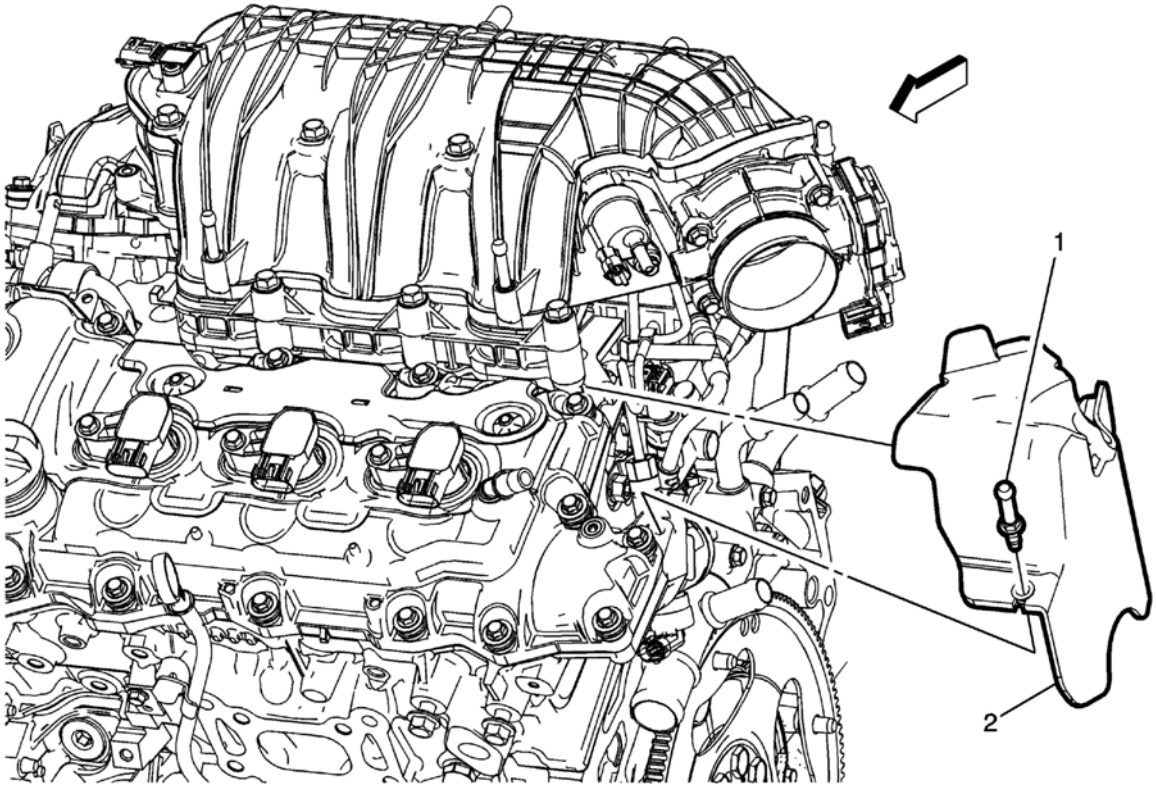


Fig. 106: Fuel Pipe Shield
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure **Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .**	
1	Bolt

Callout	Component Name
Preliminary Procedure **Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .**	
	CAUTION: **Refer to Fastener Caution .** Tighten 10 N.m (89 lb in)
2	Fuel Pipe Shield

FUEL PUMP REPLACEMENT

Special Tools

EN-48896 High Pressure Fuel Pump Installation Alignment Gauge

For equivalent regional tools, refer to **Special Tools (Diagnostic Tools)** **Special Tools (Repair Tools)** .

Removal Procedure

1. Relieve the low and high side fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**.
2. Remove the thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement** .

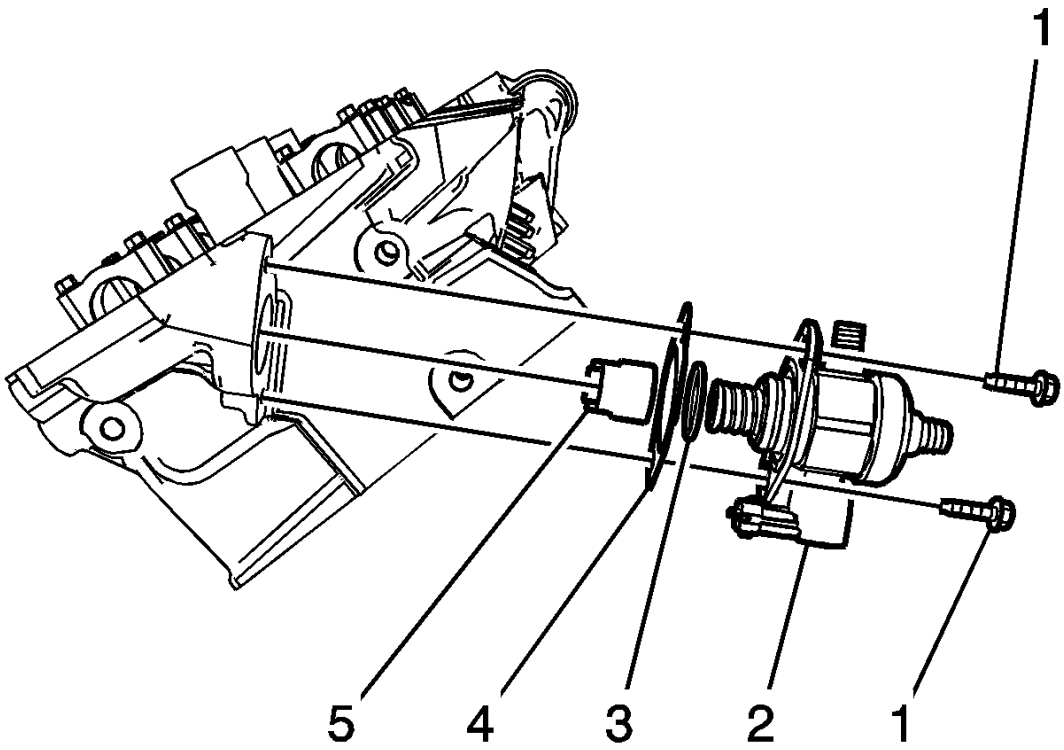


Fig. 107: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the engine wiring harness electrical connector from the high pressure fuel pump.
4. Remove the low pressure feed pipe. Discard the pipe. Refer to **Fuel Feed Pipe Replacement**.
5. Remove the high pressure pipe. Discard the pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.

CAUTION: Alternately loosen the fuel pump bolts one turn at a time until the pump is fully disengaged from fuel pump lifter follower. Trying to remove the pump bolts without even side-to-side loosening may result in pump plunger damage

6. Remove and discard the high pressure fuel pump bolts (1).
7. Remove the high pressure fuel pump (2).
8. Remove and DISCARD the high pressure fuel pump O-ring (3).
9. Remove and DISCARD the high pressure fuel pump gasket (4).
10. Remove the high pressure fuel pump roller lifter (5).

Installation Procedure

NOTE: **The camshaft must be in the base circle position before the high pressure fuel pump is installed.**

1. Use the **EN-48896** alignment gauge to ensure that the camshaft lobe is in the base circle position. At base circle the tool will be flush with the head.
2. Lubricate the high pressure fuel pump cylinder head bore and roller lifter with camshaft prelube. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

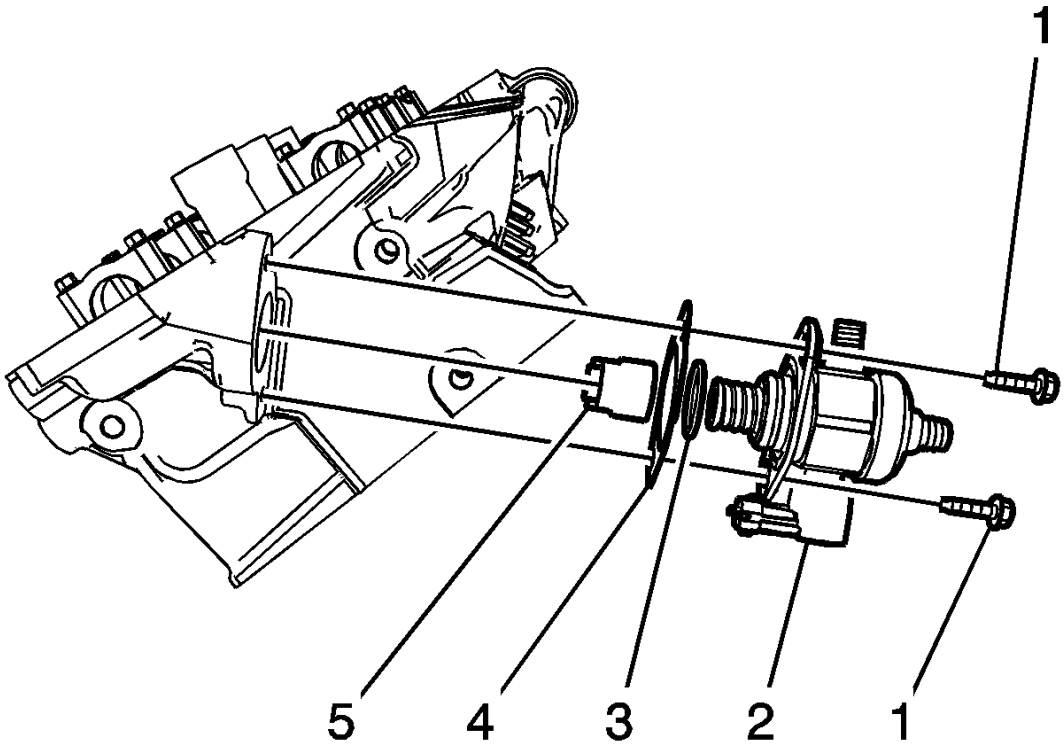


Fig. 108: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The high pressure fuel pump gasket has a retaining feature to hold the pump retaining bolts in place.**

3. Install the high pressure fuel pump roller lifter (5).

NOTE: **Lubricate the NEW O-ring seals with clean engine oil.**

4. Install a NEW high pressure fuel pump O-ring (3).
5. Position the NEW high pressure fuel pump gasket (4) and bolts (1) to the fuel pump.

CAUTION: **Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger damage.**

6. Install the high pressure fuel pump (2). Force will be required while hand tightening the bolts.

CAUTION: **Refer to Fastener Caution .**

7. Tighten the high pressure fuel pump retaining bolts to 15 (11 lb ft).
8. Ensure the high pressure fuel pump and fuel rail fittings are clean prior to assembly.
9. Install a NEW high pressure fuel pipe. Refer to **Fuel Feed Intermediate Pipe Replacement**.
10. Install a NEW fuel feed pipe to the high pressure fuel pump. Refer to **Fuel Feed Pipe Replacement**.
11. Connect the high pressure fuel pump wiring harness.
12. Install the thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement** .
13. Install the fuel tank cap.

NOTE: **If a fuel leak occurs at the fuel rail, the fuel rail will need to be replaced.**

14. Inspect for leaks using the following procedure:
    1. Turn ON the ignition, with the engine OFF for 2 seconds.
    2. Turn OFF the ignition, for 10 seconds.
    3. Turn ON the ignition, with the engine OFF.
    4. Inspect for fuel leaks.
15. Install the pressure relief cap to the fuel feed pipe.

FUEL INJECTOR REPLACEMENT

Removal Procedure

1. Relieve the high side fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**.

NOTE: **The fuel injectors have an alignment feature, note the position of the injectors alignment for installation.**

2. Remove the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1**, or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.
3. For removal of the fuel injectors, refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1, LFW or LFX)** .

Installation Procedure

1. Prepare the fuel injectors for assembly, refer to **Fuel Rail and Injectors Cleaning and Inspection (LF1, LFW or LFX)** .

NOTE: **The fuel injectors have an alignment feature and must be reinstalled as**

noted during removal.

2. Install the fuel injection fuel rail assembly. Refer to **Fuel Injection Fuel Rail Assembly Replacement - Bank 1**, or **Fuel Injection Fuel Rail Assembly Replacement - Bank 2**.
3. Pressurize the fuel system and check for leaks.

EVAPORATIVE EMISSION CANISTER PURGE SOLENOID VALVE REPLACEMENT

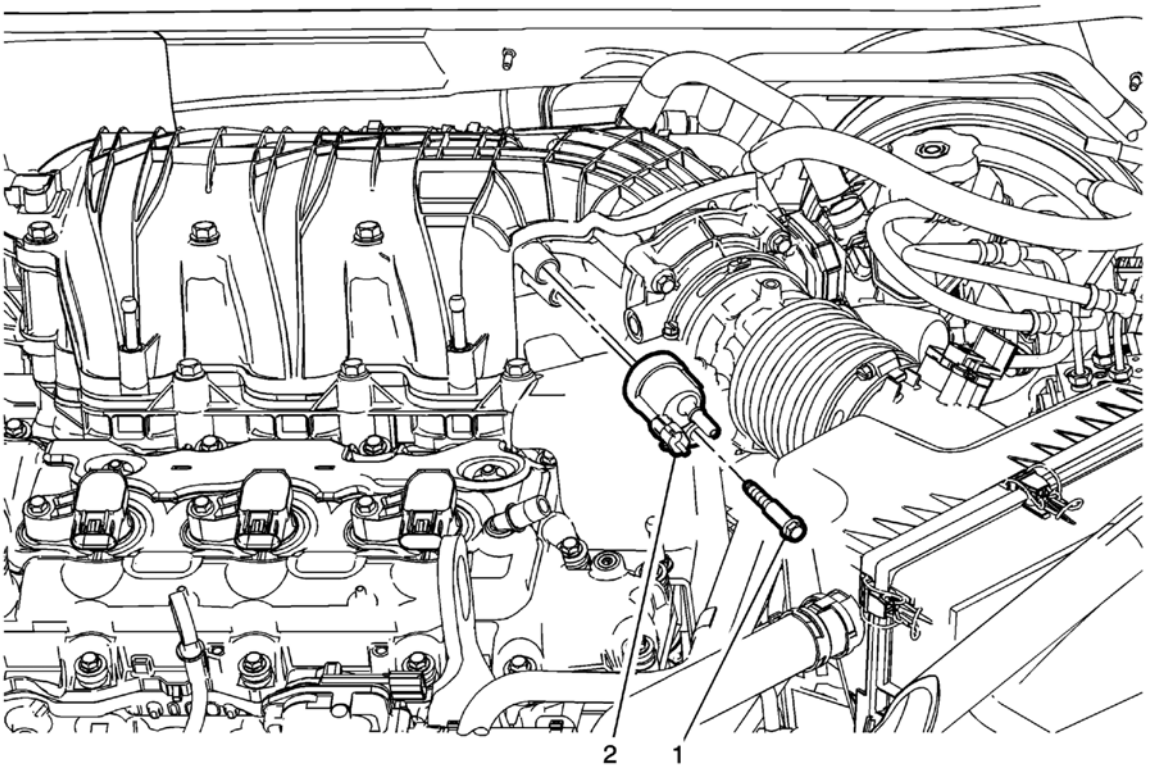


Fig. 109: Evaporative Emission Canister Purge Solenoid Valve
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** . 2. Disconnect the electrical connector. 3. Disconnect the chassis EVAP pipe from the EVAP canister purge solenoid. Refer to **Plastic Collar Quick Connect Fitting Service**	
1	Evaporative Emission Canister Purge Valve Bolt. **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	Tighten 16 N.m(12 lb ft)
2	Evaporative Emission Canister Purge Valve.

EVAPORATIVE EMISSION CANISTER VENT SOLENOID VALVE REPLACEMENT

Removal Procedure

NOTE: **Clean the evaporative emission (EVAP) connections and surrounding areas prior to disconnecting the line in order the avoid possible system contamination.**

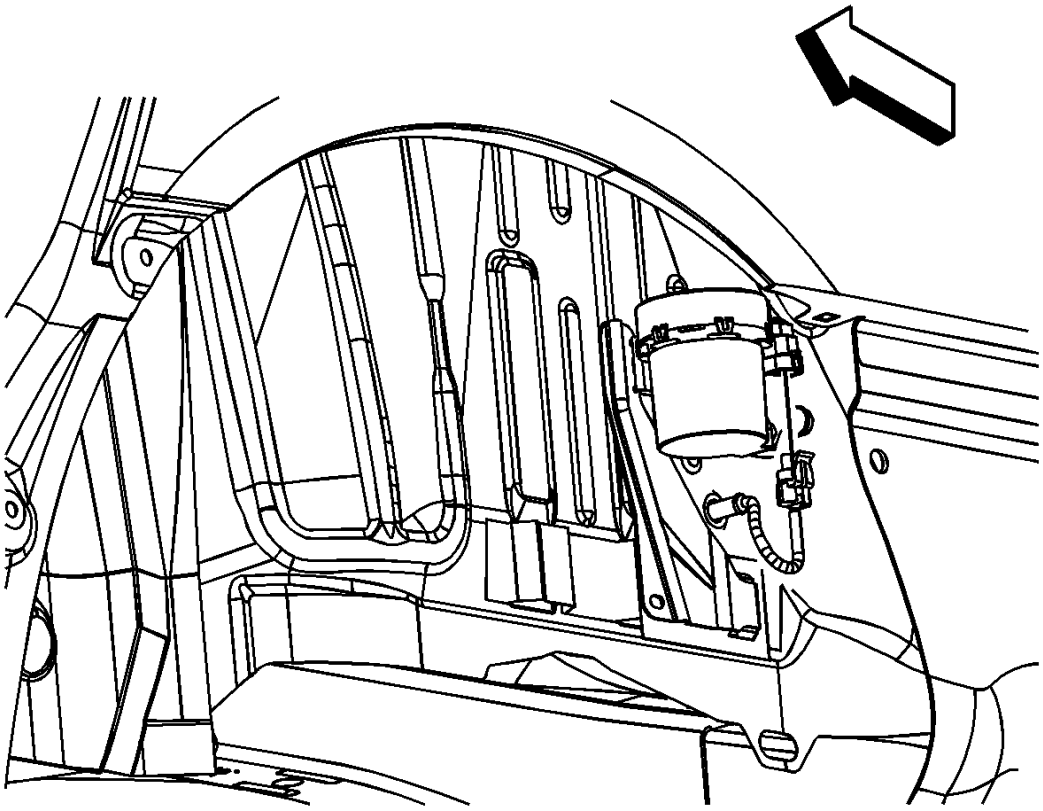


Fig. 110: EVAP Canister Vent Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Disconnect the EVAP canister vent solenoid valve electrical connector.

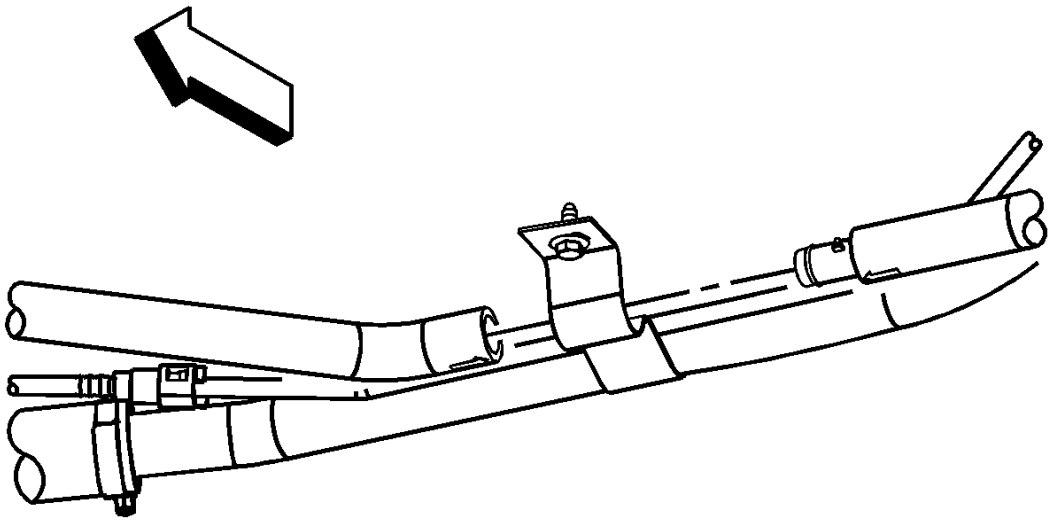


Fig. 111: EVAP Canister Vent Solenoid Valve And EVAP Emission Canister Hose
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the EVAP canister vent solenoid valve from the EVAP emission canister hose.

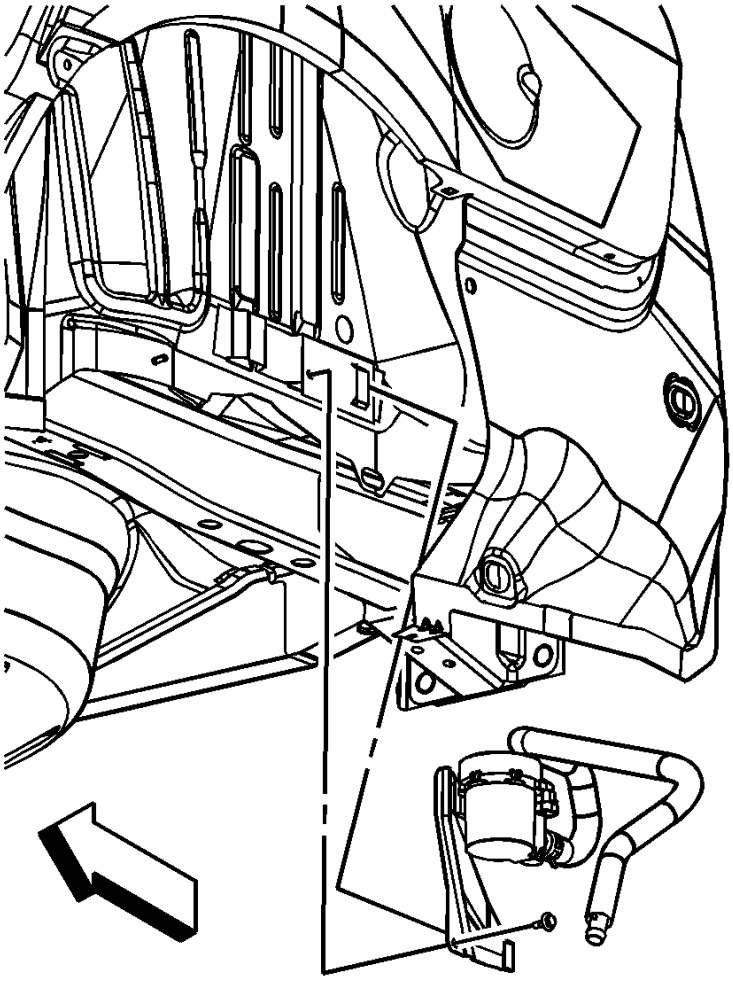


Fig. 112: Installing/Removing The EVAP Canister Vent Solenoid Valve Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the EVAP canister vent solenoid valve bracket bolt.
5. Remove the EVAP canister vent solenoid valve.

Installation Procedure

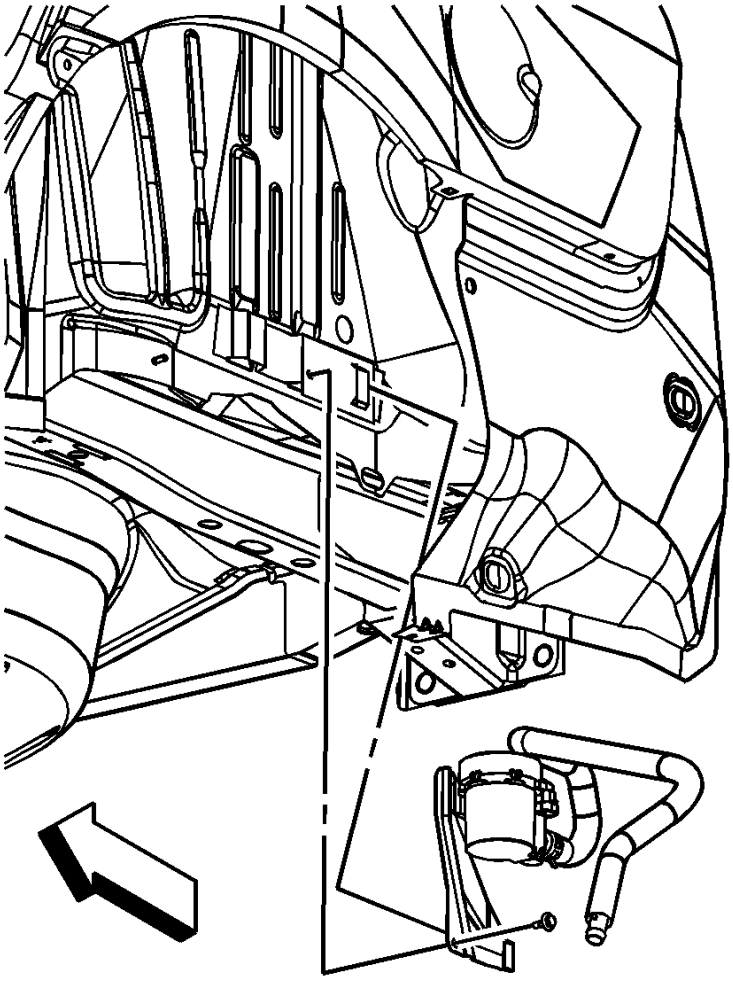


Fig. 113: Installing/Removing The EVAP Canister Vent Solenoid Valve Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the EVAP canister vent solenoid valve.

CAUTION: Refer to Fastener Caution .

2. Install the EVAP canister vent solenoid valve bracket bolt.

Tighten

Tighten the bolt to 10 N.m (89 lb in).

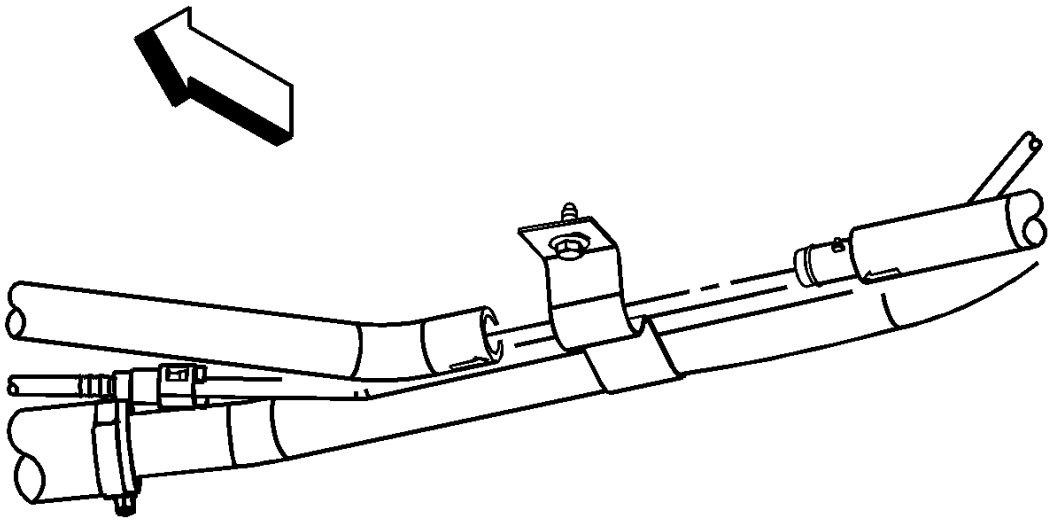


Fig. 114: EVAP Canister Vent Solenoid Valve And EVAP Emission Canister Hose
Courtesy of GENERAL MOTORS COMPANY

3. Connect the EVAP canister vent solenoid valve to the EVAP emission canister hose.

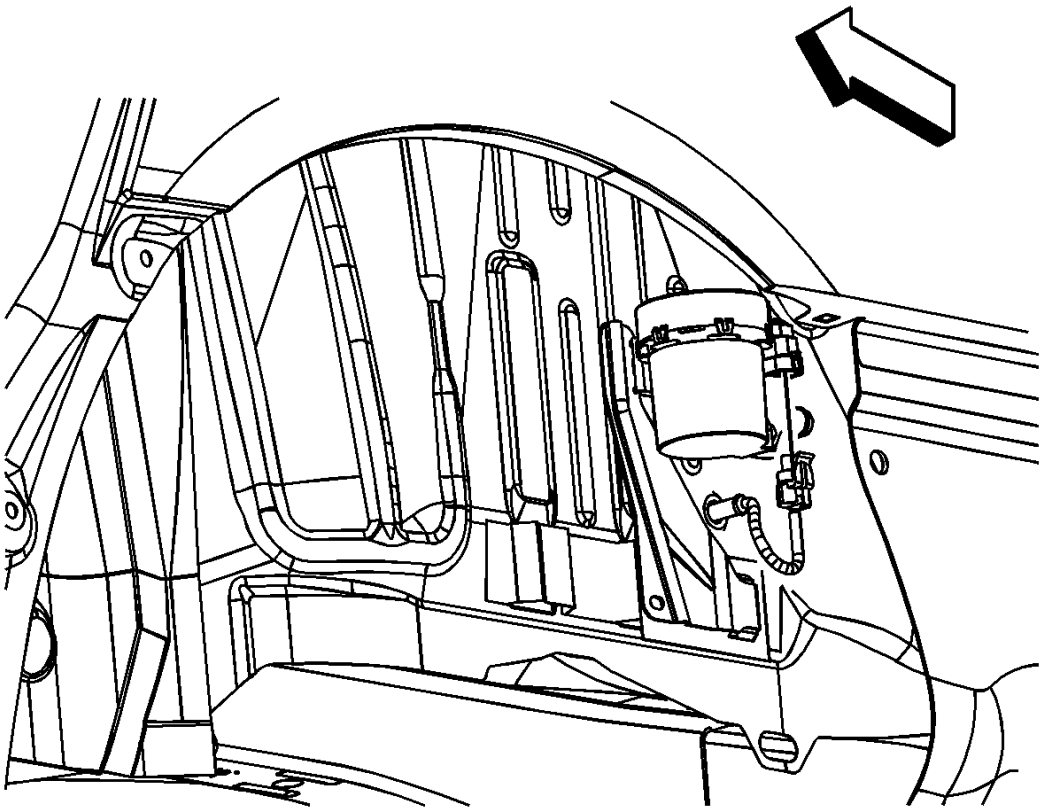


Fig. 115: EVAP Canister Vent Solenoid Valve Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

4. Connect the EVAP canister vent solenoid valve electrical connector.
5. Lower the vehicle.

EVAPORATIVE EMISSION CANISTER PURGE PIPE REPLACEMENT

Removal Procedure

1. Install the engine support fixture. Refer to **Engine Support Fixture** .
2. Relieve the fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)Fuel Pressure Relief (CH 48027)Fuel Pressure Relief (High Side)**

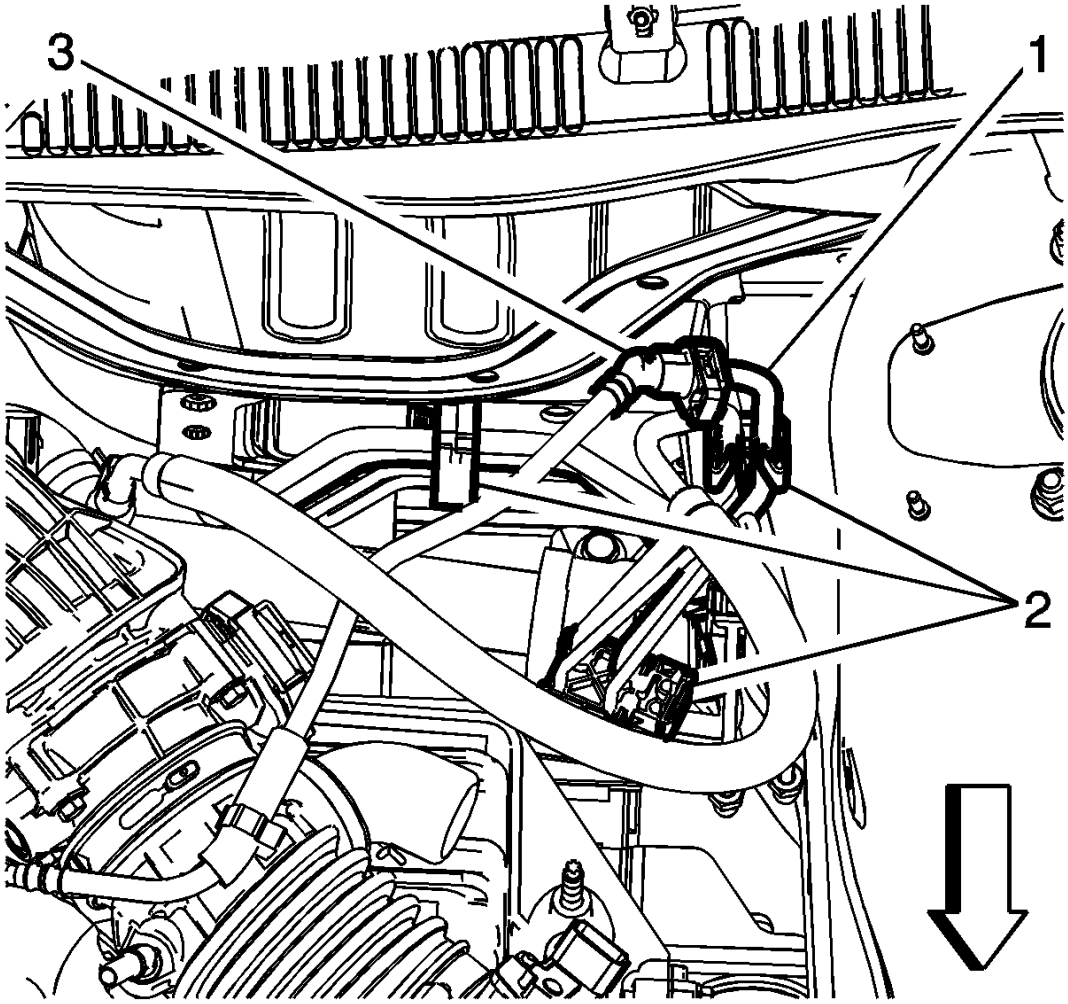


Fig. 116: Evaporative Emission Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the evaporative emission pipe from the evaporative emission canister vent front pipe (3). Refer to **Plastic Collar Quick Connect Fitting Service**
4. Disconnect the evaporative emission pipe (1) from the retainers (2).
5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
6. Lower the frame. Refer to **Frame Replacement**
7. Remove the fuel feed rear pipe. Refer to **Fuel Feed Rear Pipe Replacement**
8. Remove the evaporative emission pipe rear frame retaining bracket bolt.
9. Remove the evaporative emission pipe middle frame retaining bracket bolt.
10. Remove the evaporative emission pipe middle frame retaining press in pin.
11. Remove the evaporative emission pipe front retaining bracket bolt.

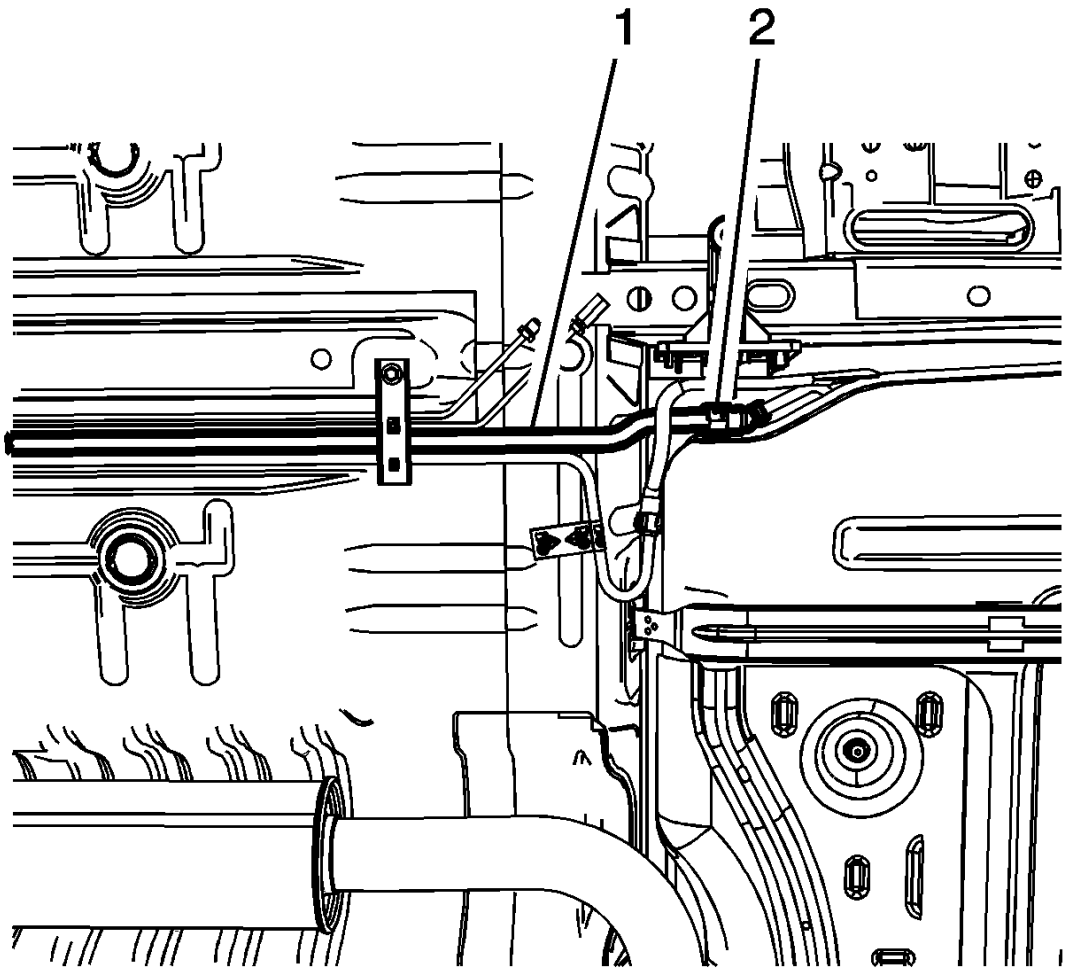


Fig. 117: Evaporative Emission Pipe And Evaporative Emission Purge Pipe
Courtesy of GENERAL MOTORS COMPANY

12. Remove the evaporative emission pipe (1) from the evaporative emission purge pipe (2) that goes to the EVAP canister.

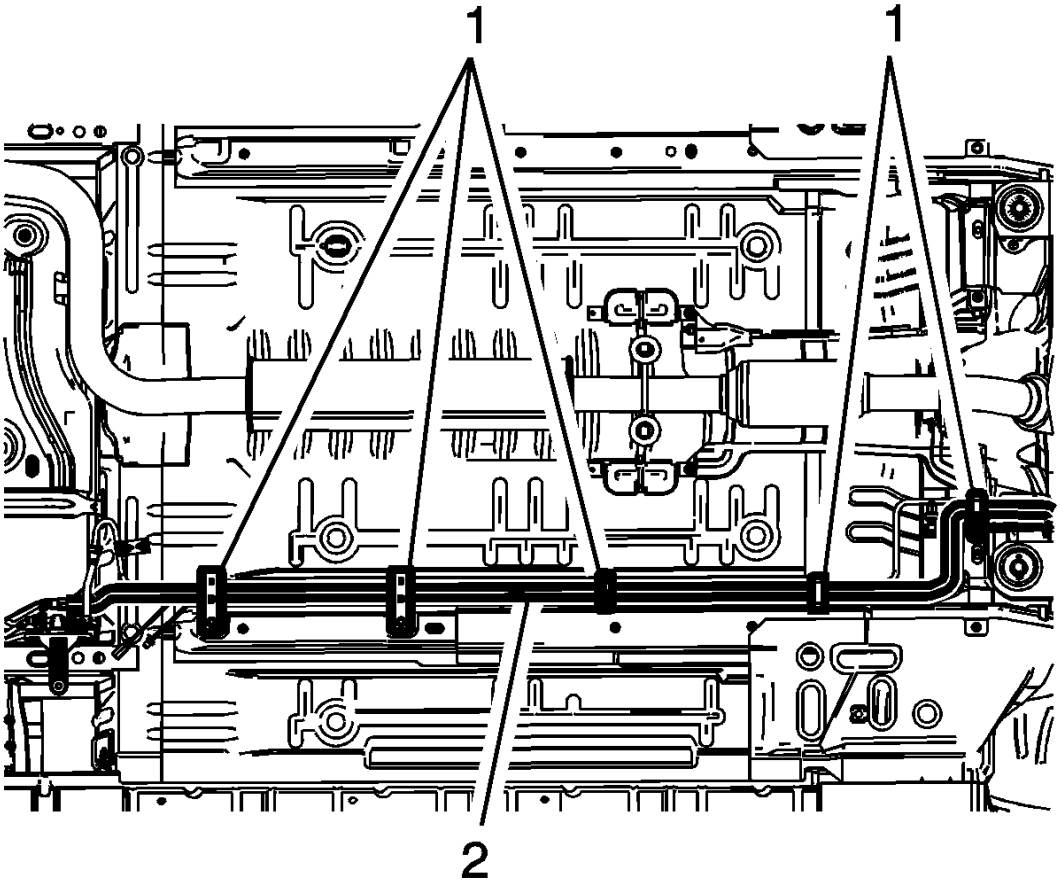


Fig. 118: Evaporative Emission Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the evaporative emission pipe (1) from the retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**
14. Remove the evaporative emission pipe from the vehicle.

Installation Procedure

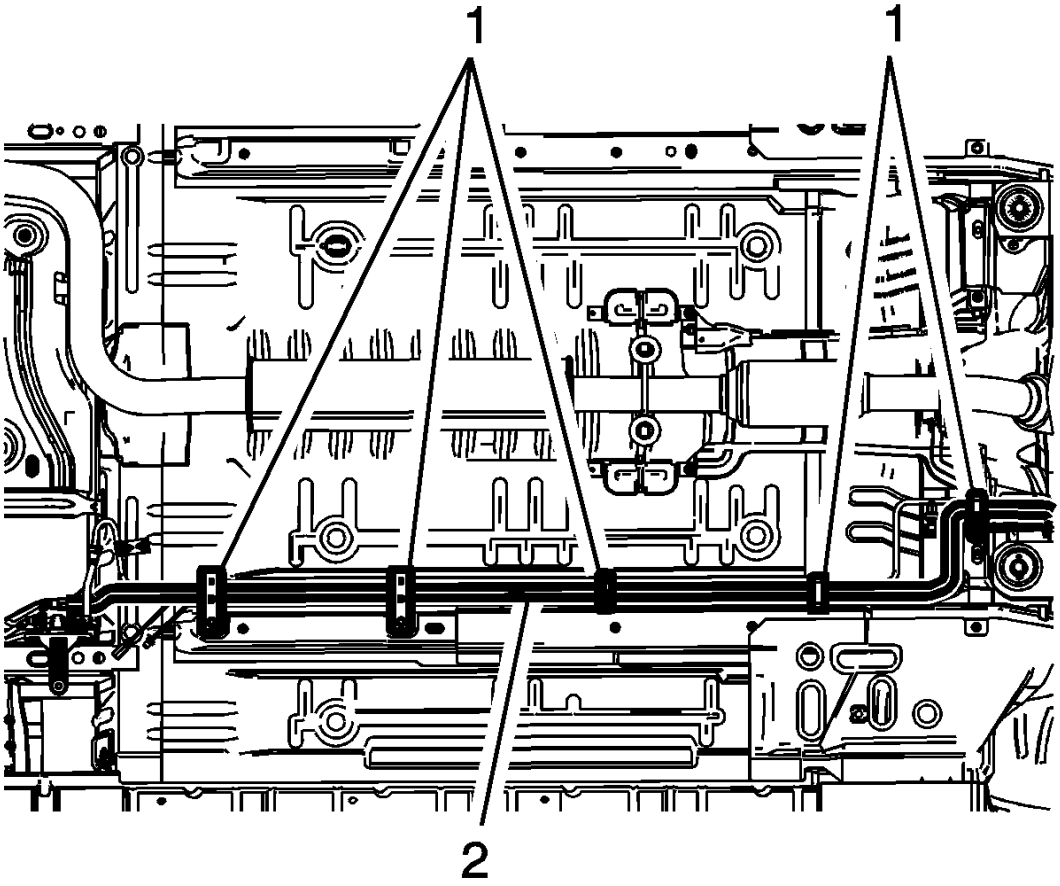


Fig. 119: Evaporative Emission Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

1. Install the evaporative emission pipe to the vehicle
2. Connect the evaporative emission pipe (1) from the retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

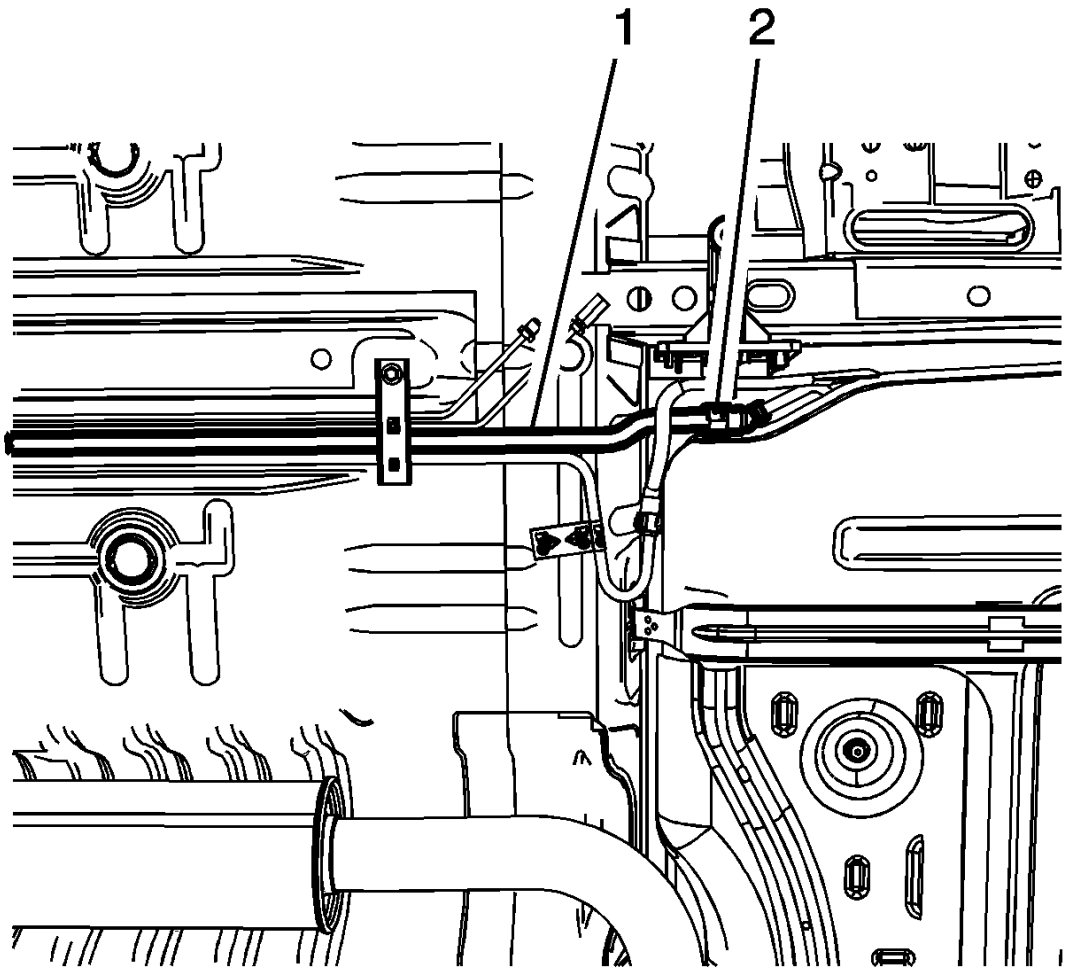


Fig. 120: Evaporative Emission Pipe And Evaporative Emission Purge Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Install the evaporative emission pipe (1) to the evaporative emission purge pipe (2) that goes to the EVAP canister.
4. Install the evaporative emission pipe front retaining bracket bolt.
5. Install the evaporative emission pipe middle frame retaining press in pin.
6. Install the evaporative emission pipe middle frame retaining bracket bolt.
7. Install the evaporative emission pipe rear frame retaining bracket bolt.
8. Install the fuel feed rear pipe. Refer to **Fuel Feed Rear Pipe Replacement**
9. Raise the frame. Refer to **Frame Replacement**
10. Lower the vehicle.

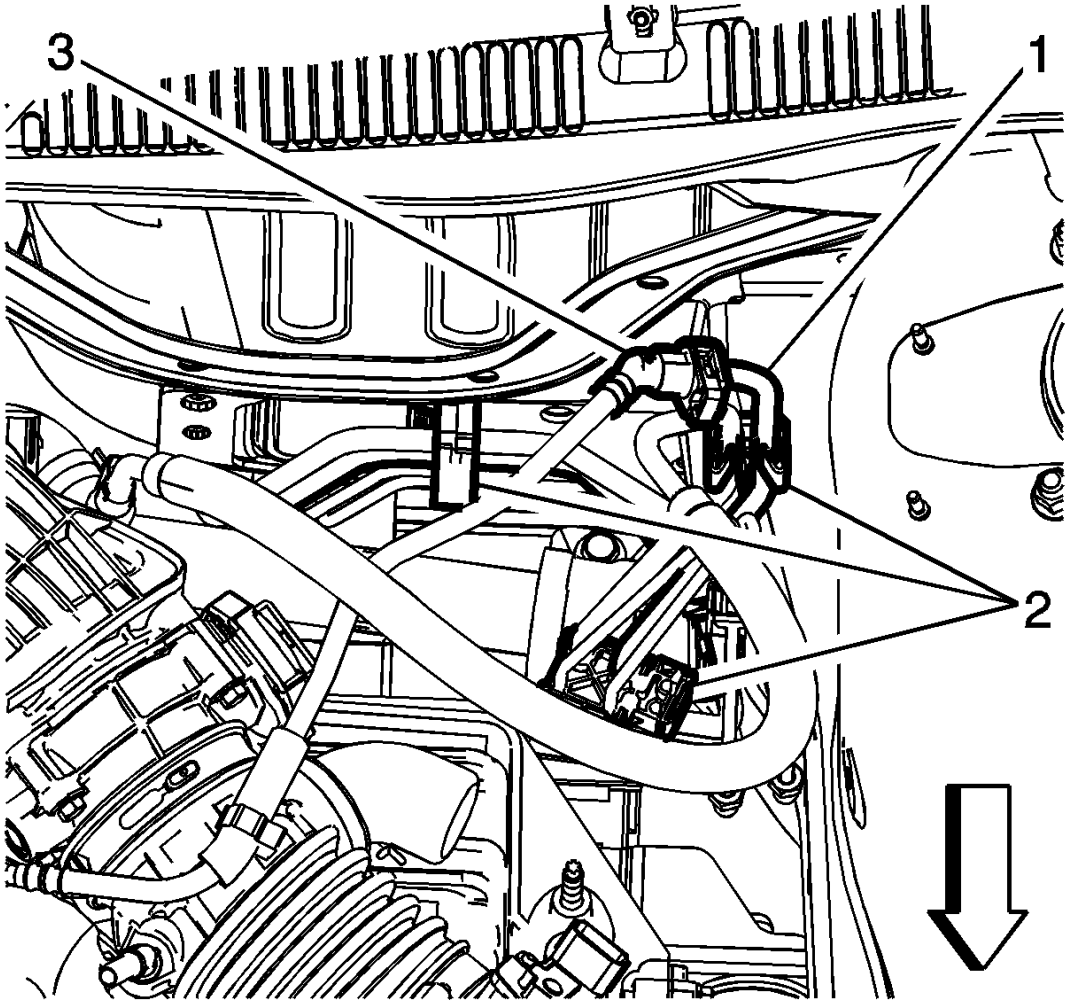


Fig. 121: Evaporative Emission Pipe And Retainers
Courtesy of GENERAL MOTORS COMPANY

11. Connect the evaporative emission pipe to the evaporative emission canister vent front pipe (3). Refer to **Plastic Collar Quick Connect Fitting Service**
12. Connect the evaporative emission pipe (1) from the retainers (2). Refer to **Plastic Collar Quick Connect Fitting Service**.

EVAPORATIVE EMISSION CANISTER VENT FRONT PIPE REPLACEMENT

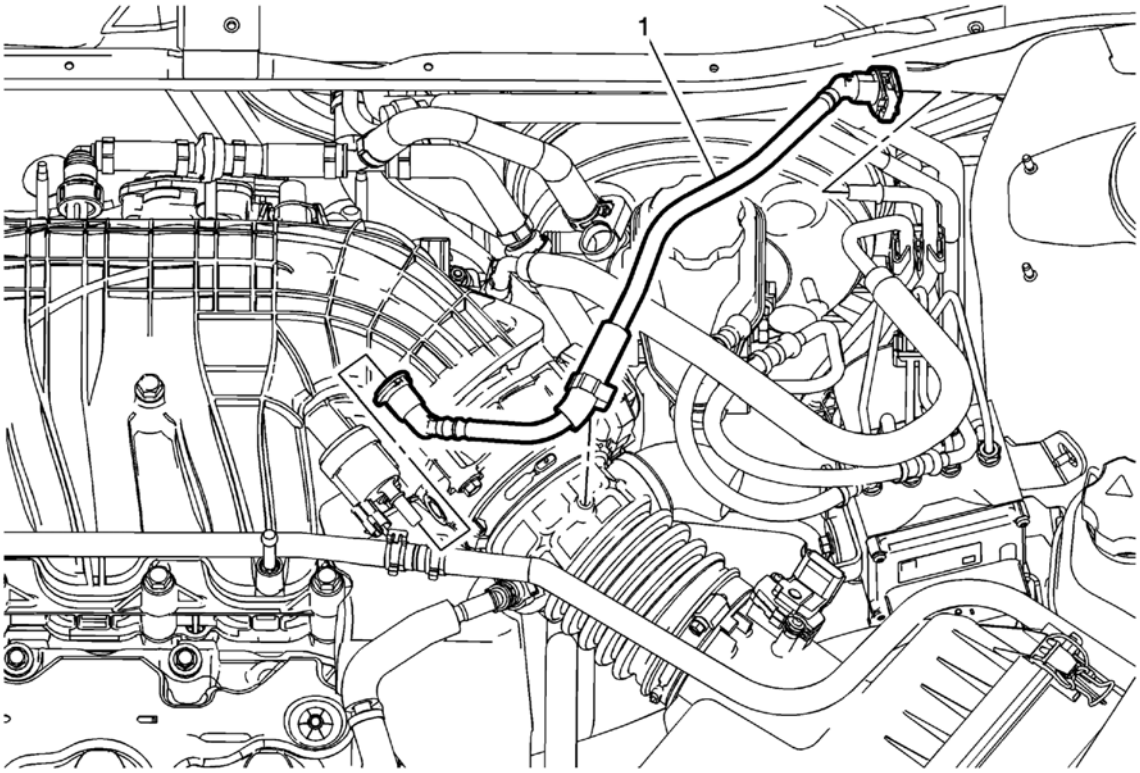


Fig. 122: Evaporative Emission Canister Vent Front Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .	
1	Evaporative Emission Canister Vent Front Pipe. **Procedure** Disconnect the EVAP pipe from the EVAP canister purge valve and the EVAP pipe. Refer to **Plastic Collar Quick Connect Fitting Service**

EVAPORATIVE EMISSION CANISTER REPLACEMENT

Removal Procedure

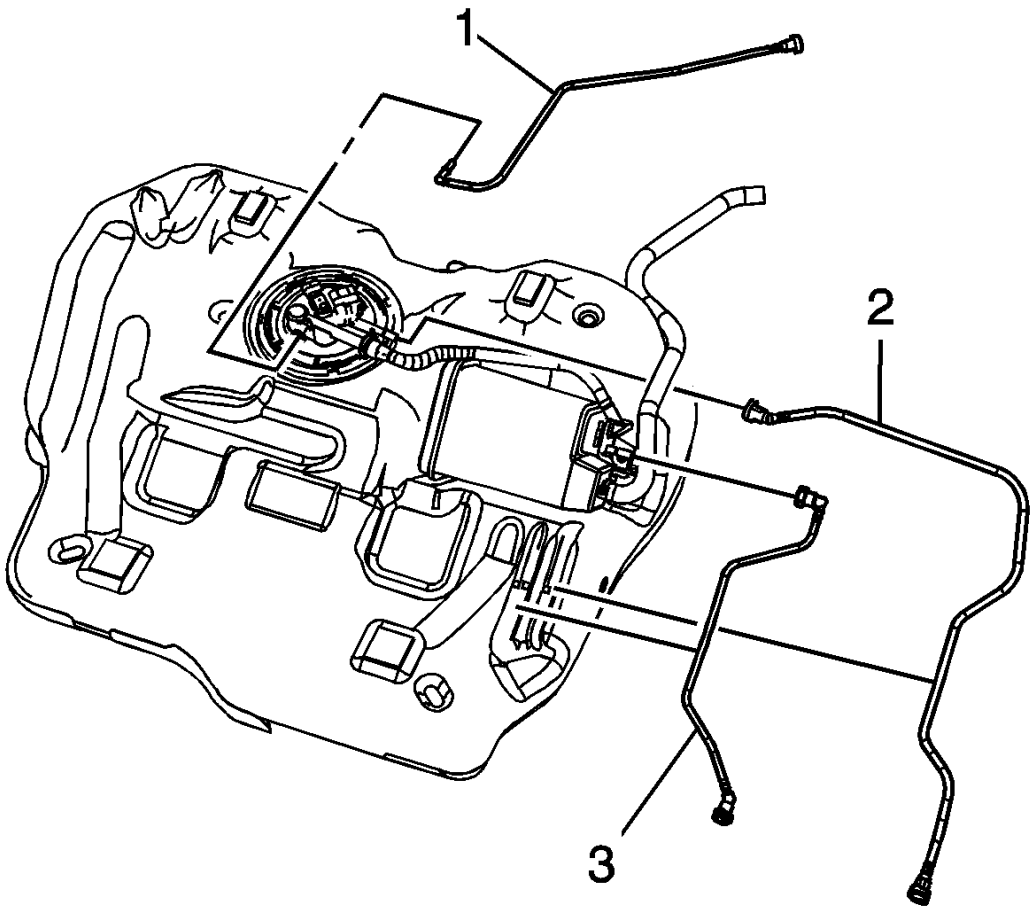


Fig. 123: View Of Fuel Tank Lines
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
2. Disconnect the evaporative emission (EVAP) line (3) from the canister. Refer to **Plastic Collar Quick Connect Fitting Service**.

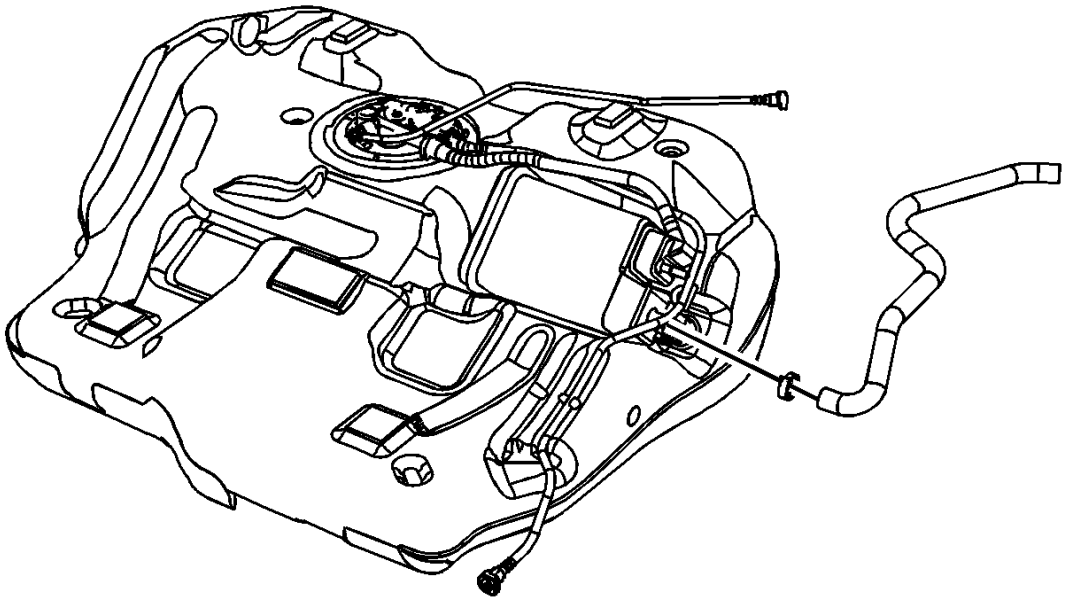


Fig. 124: EVAP Canister Hose
Courtesy of GENERAL MOTORS COMPANY

3. Reposition the EVAP canister hose clamp.
4. Remove the EVAP canister hose.

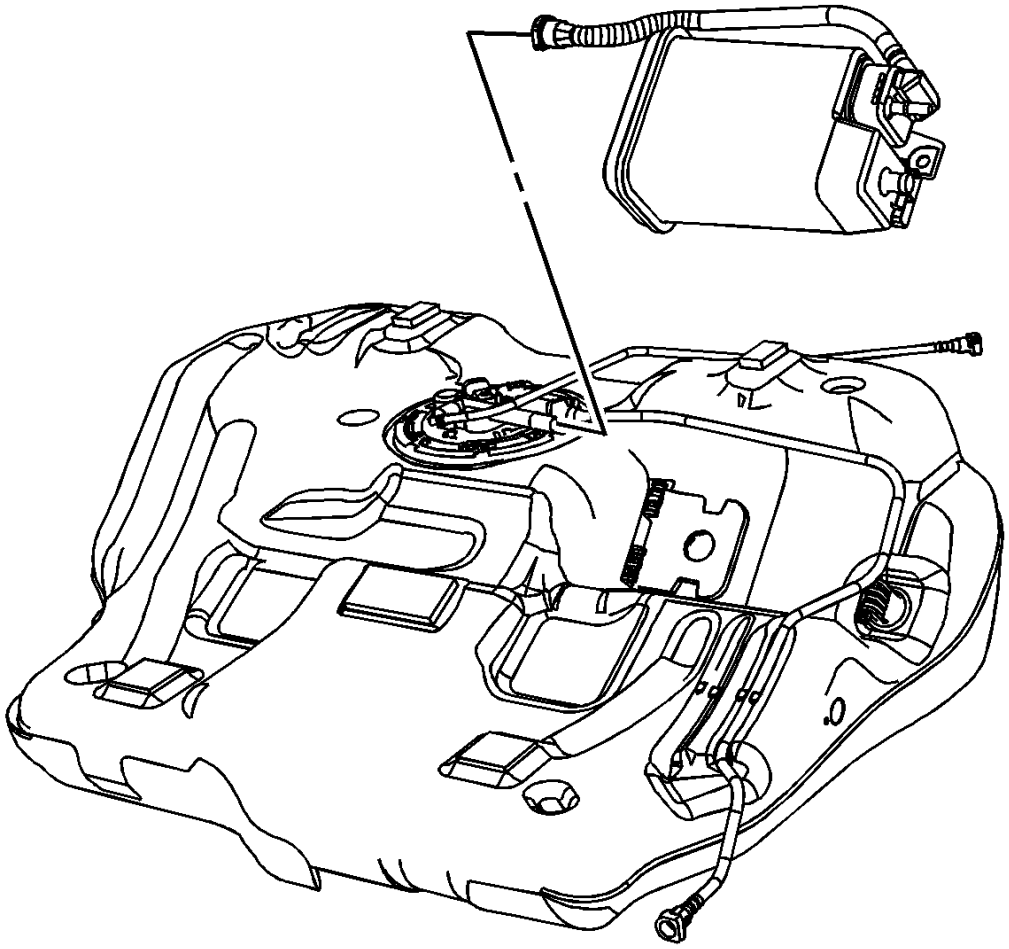


Fig. 125: EVAP Canister & Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the canister EVAP line from the fuel sender. Refer to **Plastic Collar Quick Connect Fitting Service**.
6. Squeeze the small retainer in front of the canister in order to disengage the canister.
7. Remove the EVAP canister.

Installation Procedure

CAUTION:

- **Do not attempt to straighten kinked nylon pipes. Replace any kinked nylon pipes in order to prevent damage to the vehicle.**
- **Do not attempt to repair sections of nylon pipes. Replace damaged nylon pipes.**
- **Replace the vapor pipes with original equipment or parts that meet GM specifications.**
- **Replace the vapor hoses with original equipment or parts meeting GM specifications. Use only reinforced fuel-resistant hose identified with the word Fluoroelastomer or GM 6163M on the hose.**

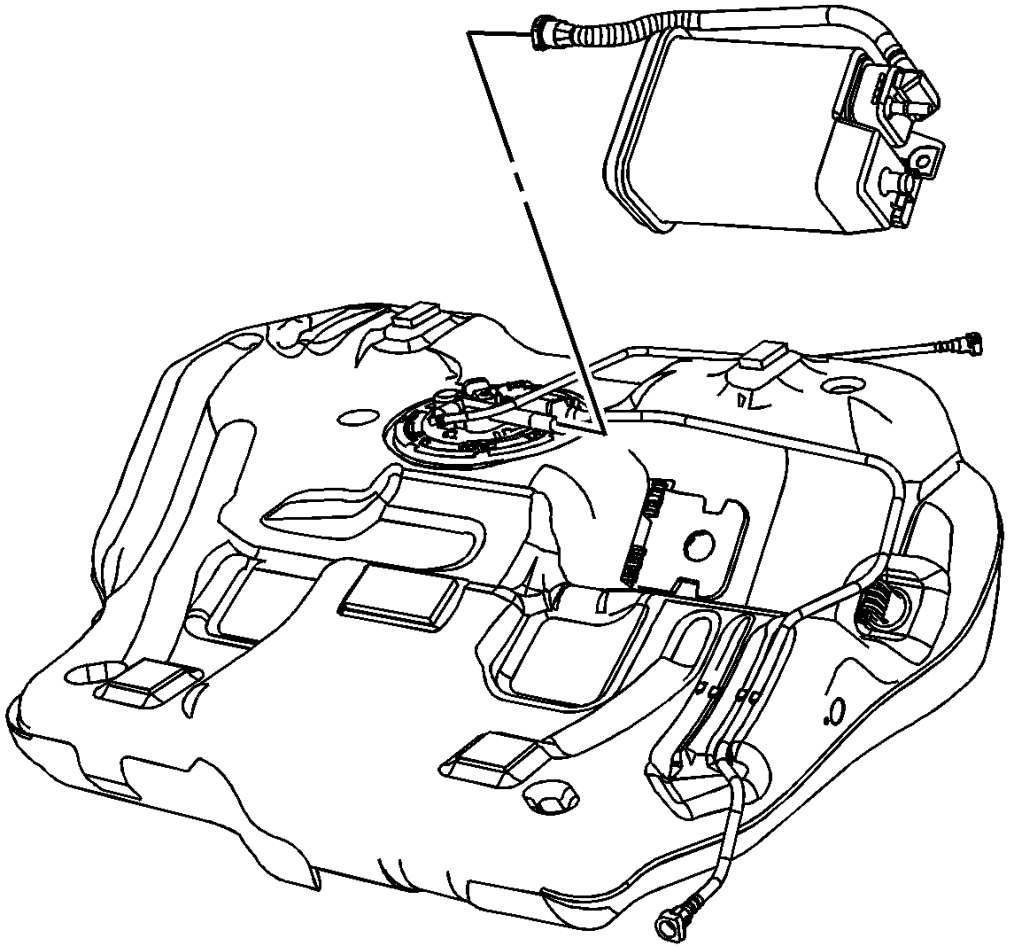


Fig. 126: EVAP Canister & Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

1. Install the EVAP canister.
2. Squeeze the small retainer in front of the canister in order to engage the canister.
3. Connect the canister EVAP line to the fuel sender. Refer to **Plastic Collar Quick Connect Fitting Service**.

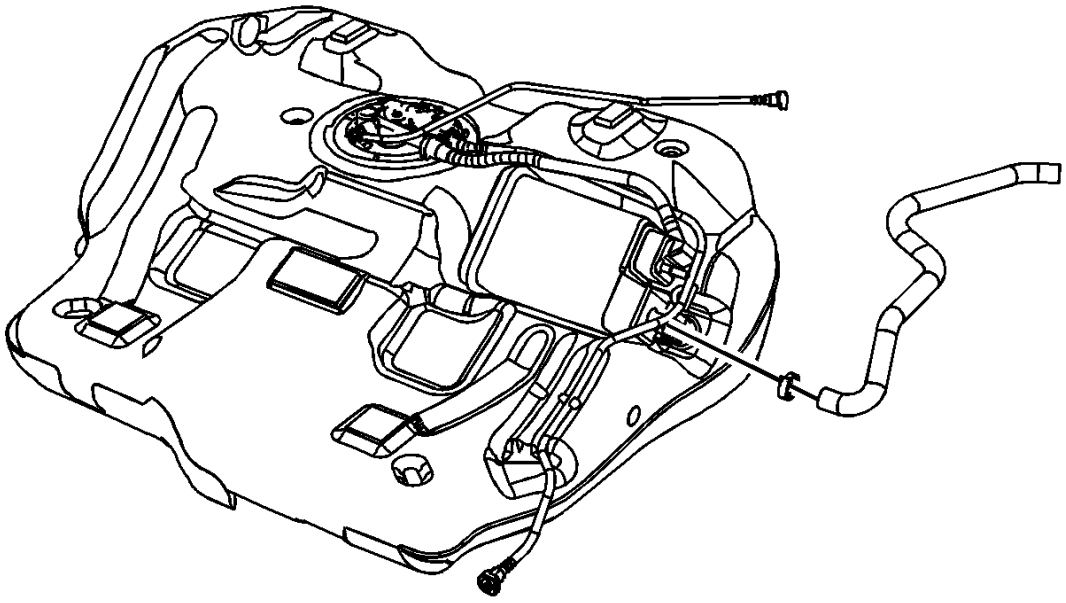


Fig. 127: EVAP Canister Hose
Courtesy of GENERAL MOTORS COMPANY

4. Install the EVAP canister hose.
5. Position the EVAP canister hose clamp.

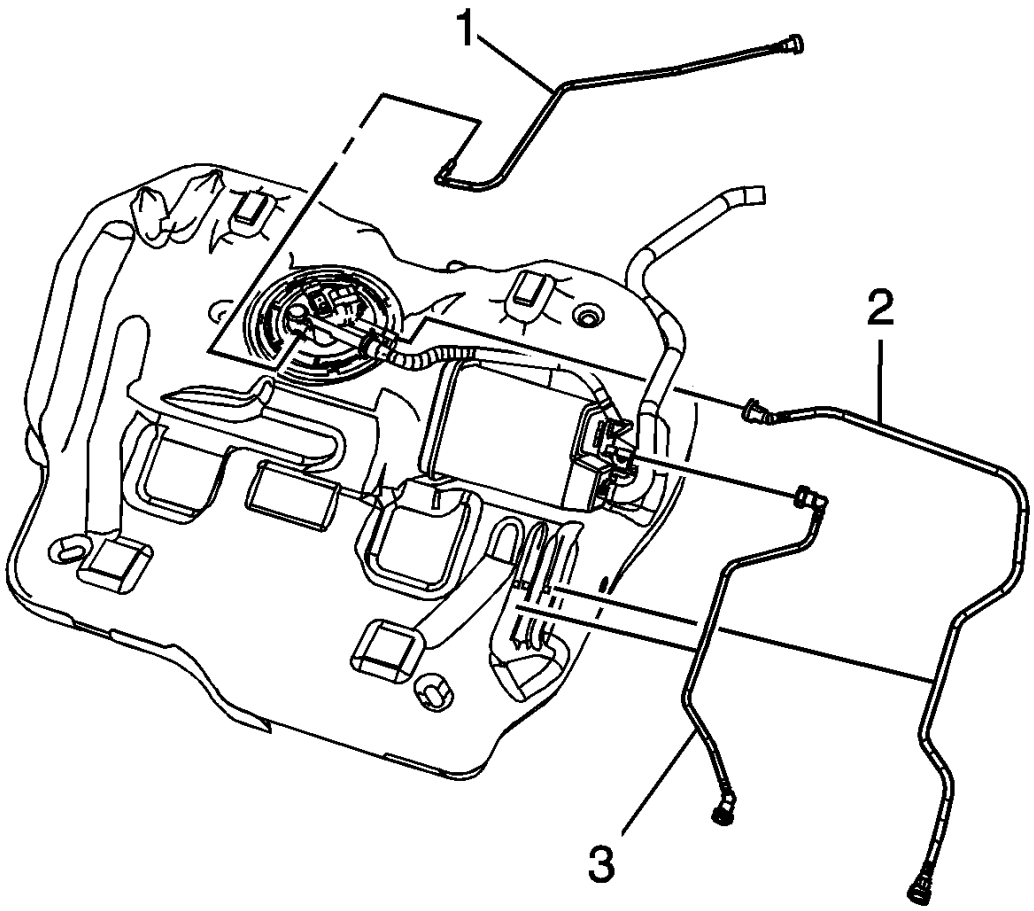


Fig. 128: View Of Fuel Tank Lines
Courtesy of GENERAL MOTORS COMPANY

6. Connect the EVAP line (3) to the canister. Refer to **Plastic Collar Quick Connect Fitting Service**.
7. Install the fuel tank. Refer to **Fuel Tank Replacement**.

EVAPORATIVE EMISSION SYSTEM CLEANING

Tools Required

J 41413-200 EVAP Pressure/Purge Diagnostic Station

Inspection Procedure

IMPORTANT: Do not perform this procedure unless instructed by an evaporative emission (EVAP) diagnostic.

1. Turn OFF the ignition.
2. Remove the EVAP canister purge solenoid. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**.
3. Lightly tap the EVAP canister purge valve on a clean hard surface.

4. Inspect for carbon particles exiting either of the vacuum ports.
    - If no carbon particles are found reinstall the EVAP canister purge solenoid and continue with the EVAP cleaning procedure. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**.
    - If carbon particles are found during the inspection procedure, replace the EVAP canister purge solenoid and continue with the EVAP cleaning procedure. Refer to **Evaporative Emission Canister Purge Solenoid Valve Replacement**.
    - If you were instructed to replace the EVAP canister purge solenoid, and no carbon particles are found, return to the EVAP diagnostic procedure. Do not perform the EVAP cleaning procedure.

EVAP Cleaning Procedure

1. Remove the EVAP canister. Refer to **Evaporative Emission Canister Replacement**.
2. Turn OFF the main valve on **J 41413-200** EVAP Pressure/Purge Diagnostic Station.
3. Disconnect the hose from the diagnostic station pressure regulator.
4. Using a section of vacuum hose, connect one end to the diagnostic station pressure regulator.
5. Connect the other end of the vacuum hose to the canister side of the purge pipe.
6. Turn ON the main nitrogen cylinder valve and continue to discharge nitrogen for 15 seconds.
7. If the nitrogen does not dislodge the carbon particles, replace the purge pipe.
8. Return the EVAP pressure/purge diagnostic station to the stations original condition.
9. Install a new EVAP canister. Refer to **Evaporative Emission Canister Replacement**.
10. Connect all previously disconnected EVAP pipe connectors.
11. Lower the vehicle.
12. Continue with the published service manual diagnostic DTC procedure.

IGNITION COIL REPLACEMENT - BANK 1

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement** .

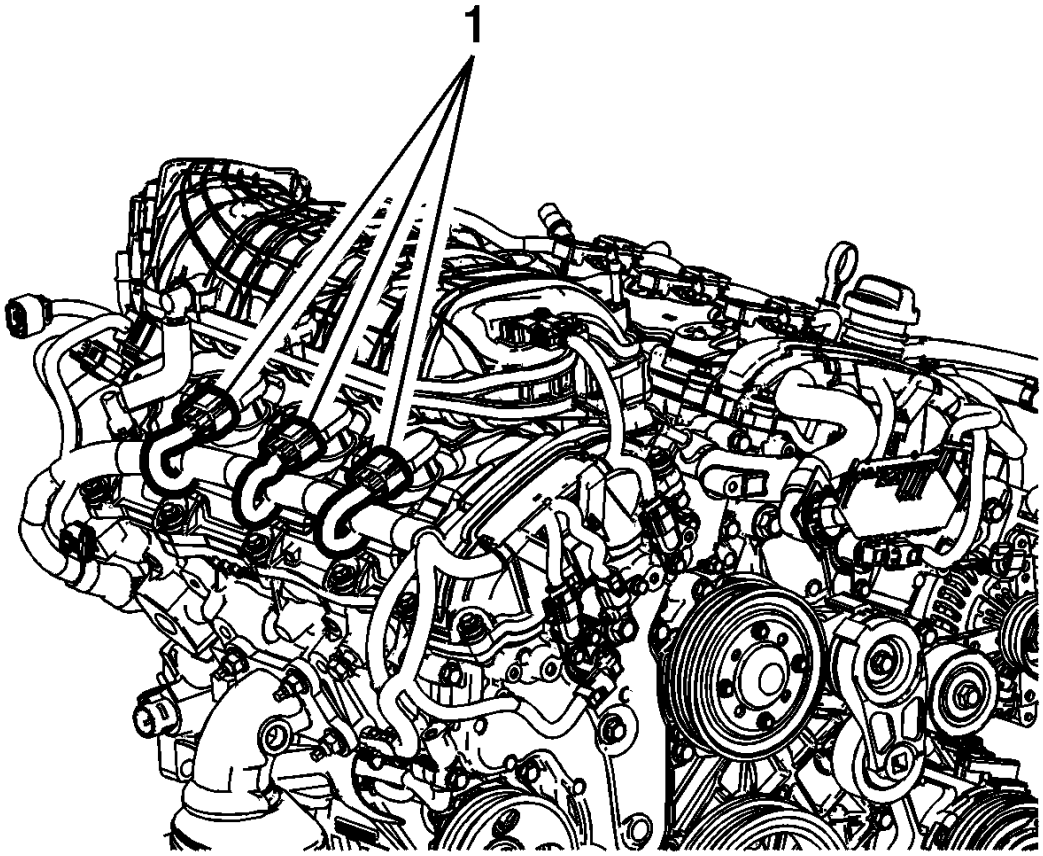


Fig. 129: Engine Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the engine wiring harness electrical connector(s) (1) from the ignition coil(s).

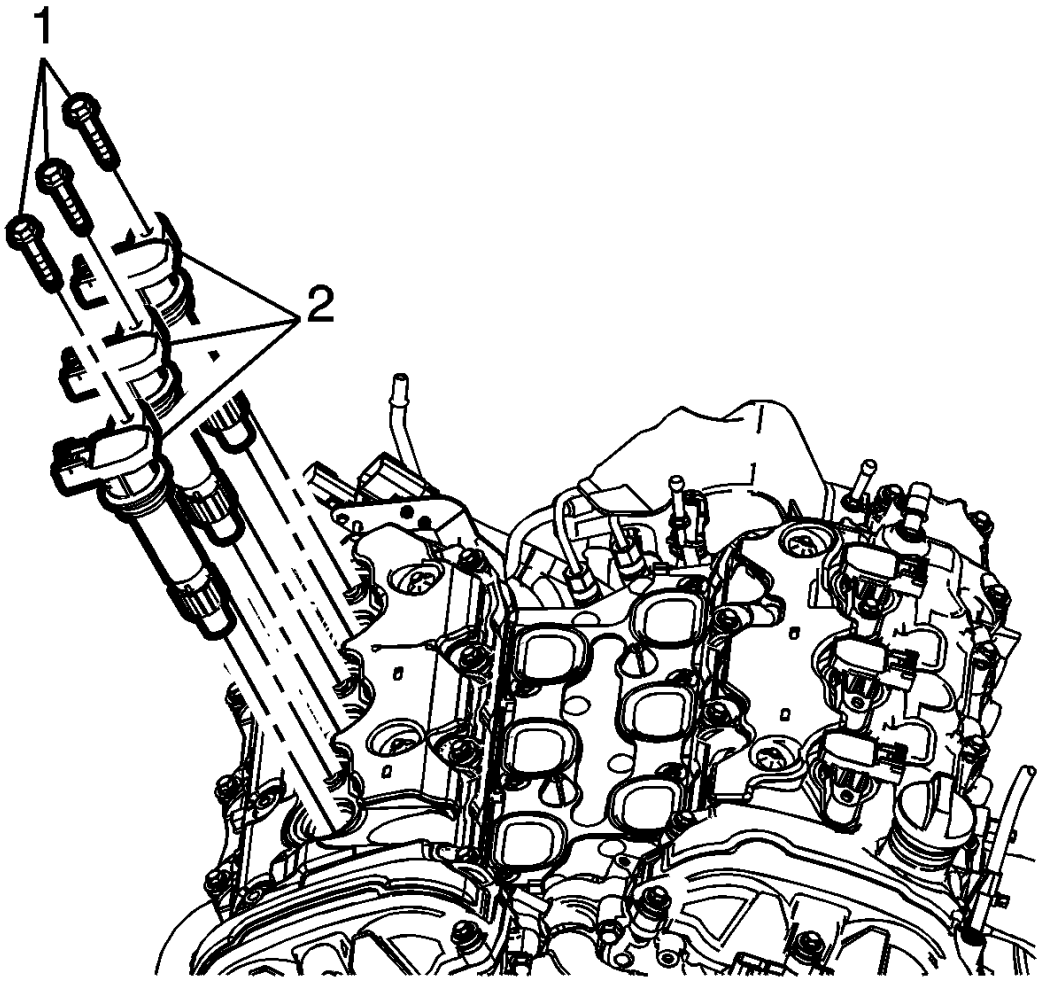


Fig. 130: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the ignition coil bolt(s) (1).
4. Remove the ignition coil(s) (2).

Installation Procedure

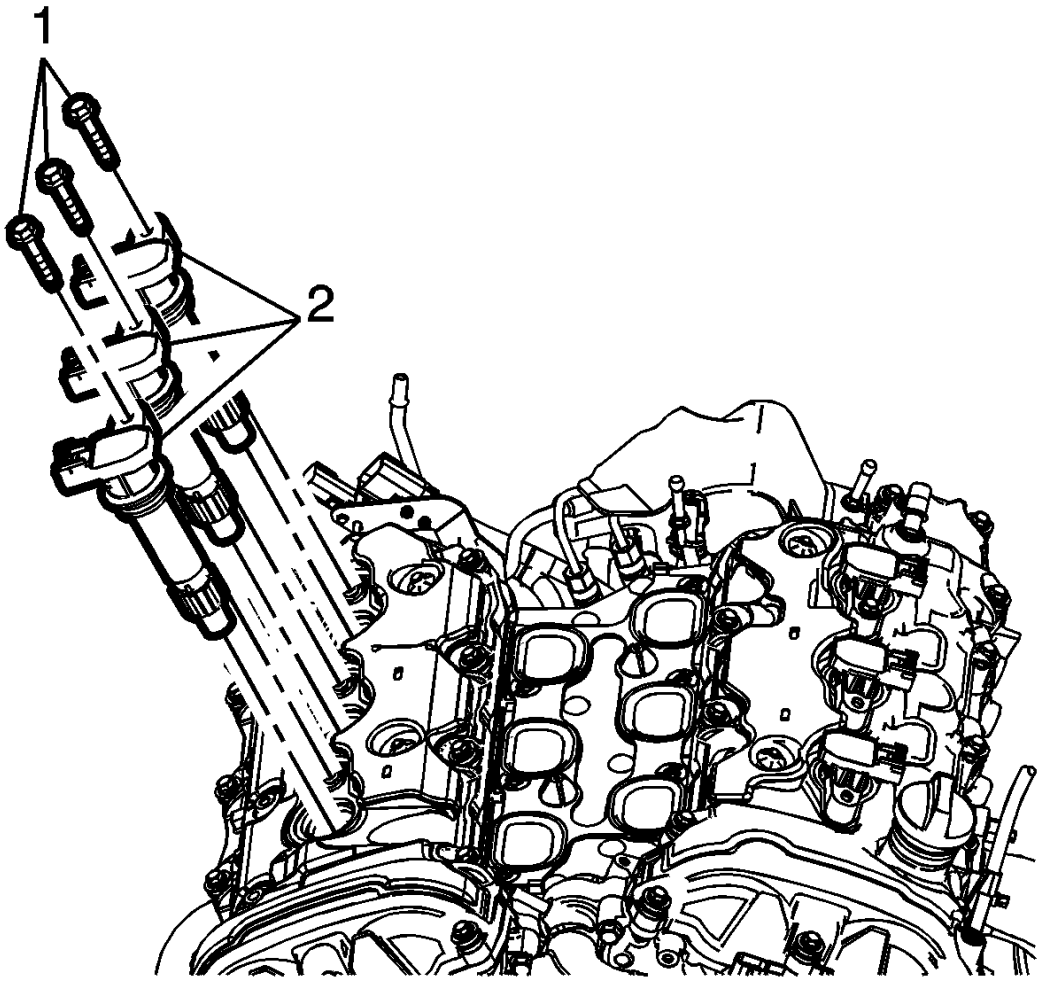


Fig. 131: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil(s) (2).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s) (1)and tighten to 10 N.m (89 lb in).

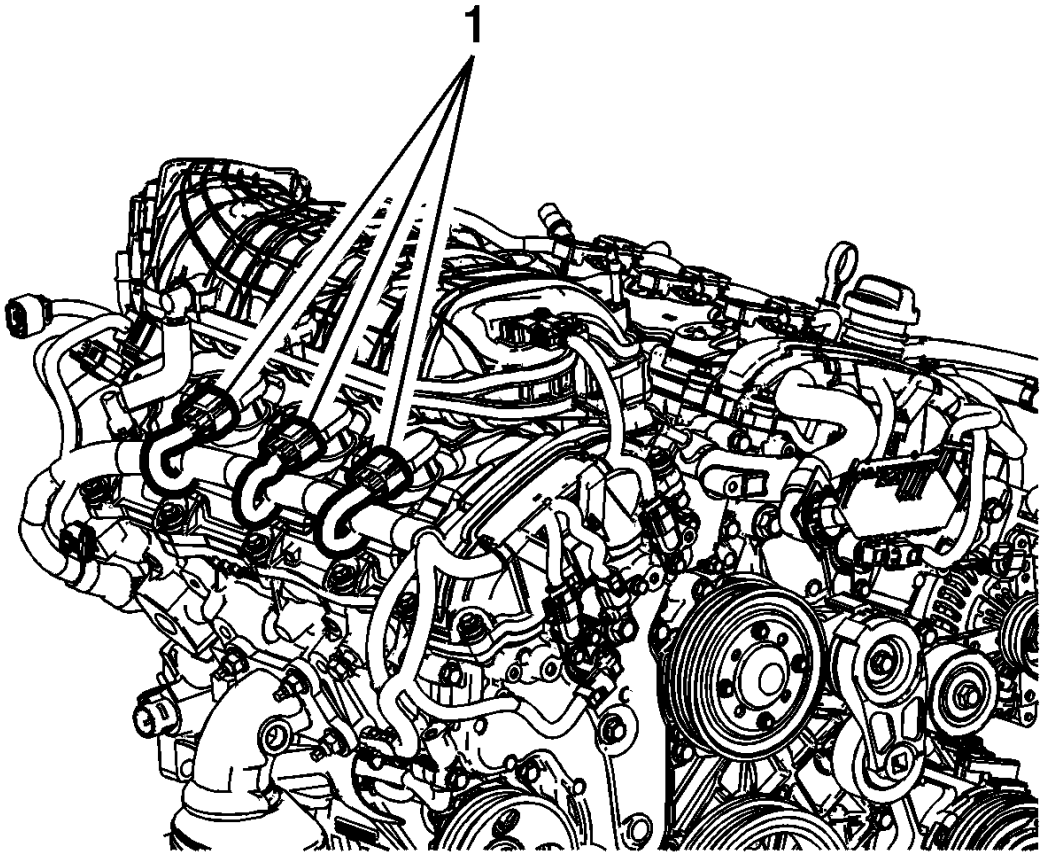


Fig. 132: Engine Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s).
4. Install the intake manifold. Refer to **Intake Manifold Replacement** .

IGNITION COIL REPLACEMENT - BANK 2

Removal Procedure

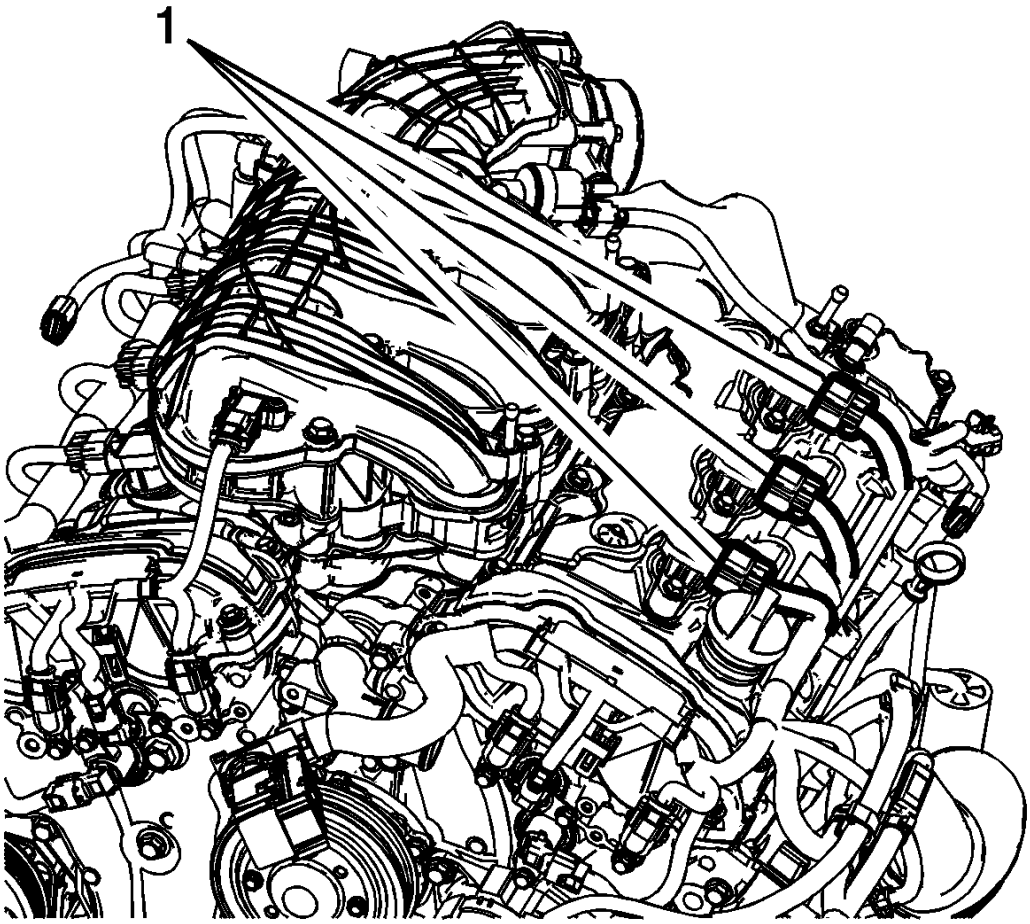


Fig. 133: Engine Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
2. Disconnect the engine wiring harness electrical connector(s) (1) from the ignition coil(s).

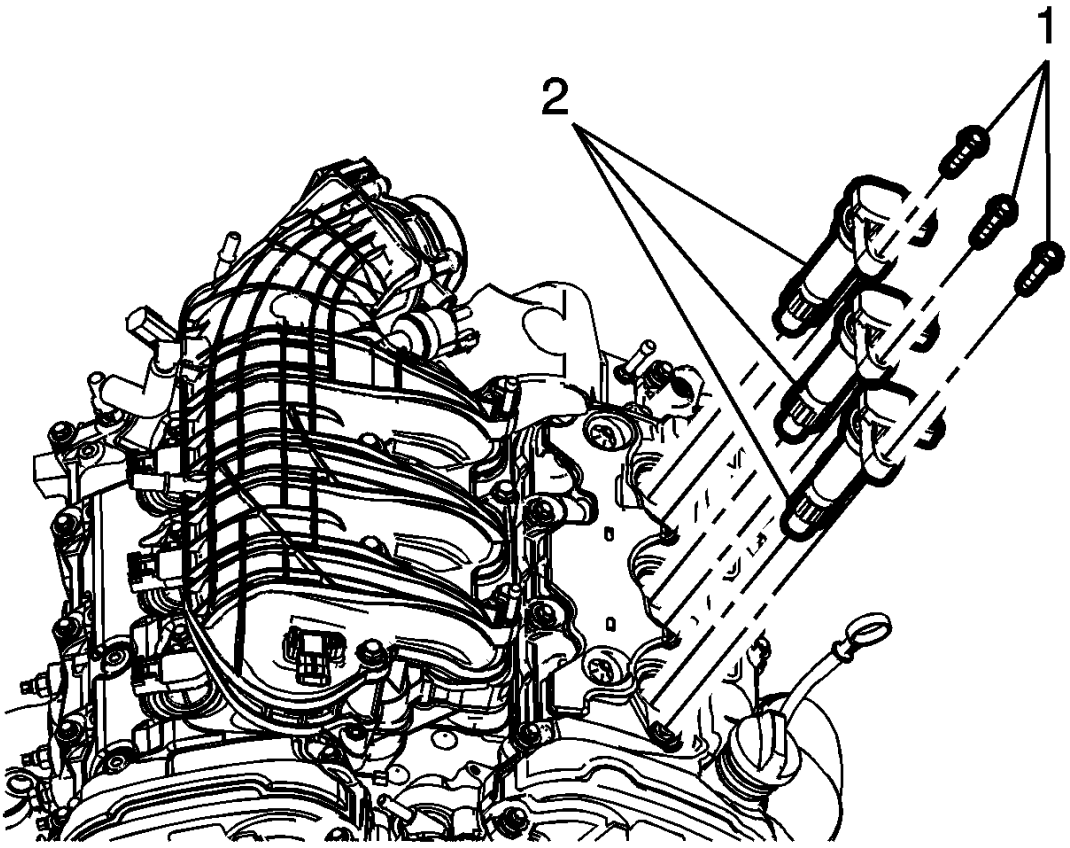


Fig. 134: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the ignition coil bolt(s) (1).
4. Remove the ignition coil(s) (2).

Installation Procedure

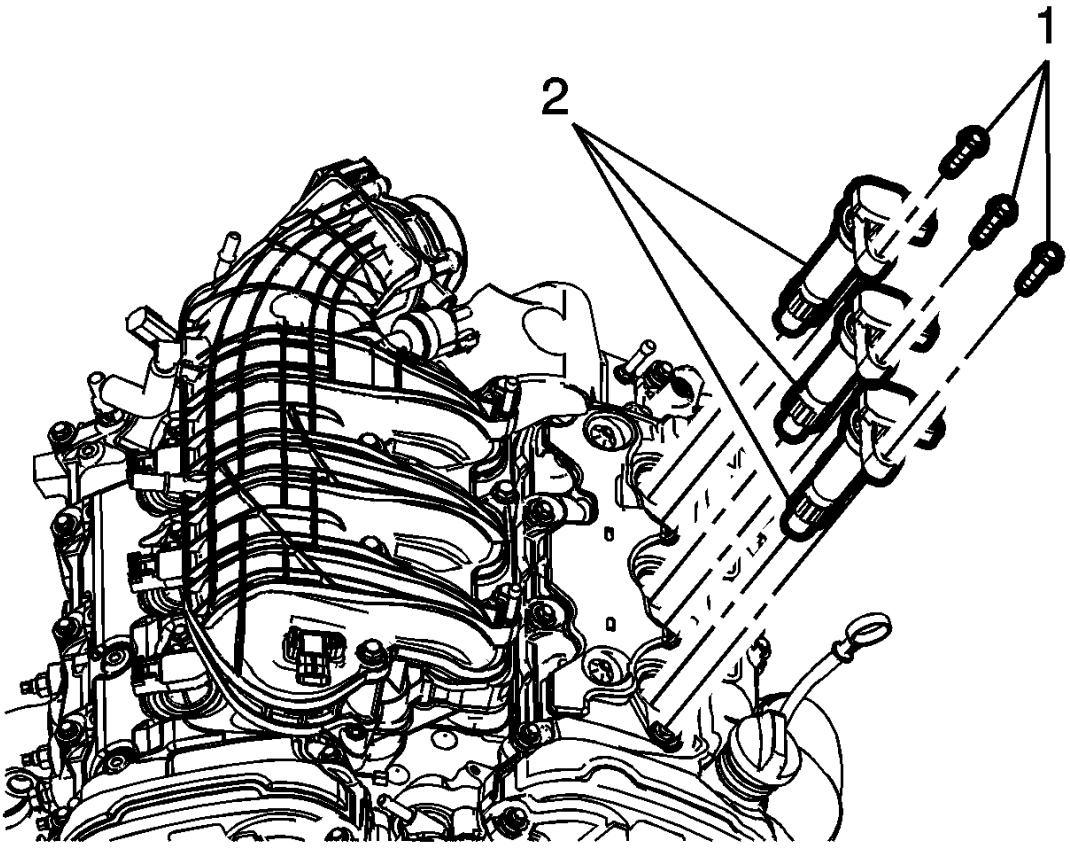


Fig. 135: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the ignition coil(s) (2).

CAUTION: Refer to Fastener Caution .

2. Install the ignition coil bolt(s) (1) and tighten to 10 N.m (89 lb in).

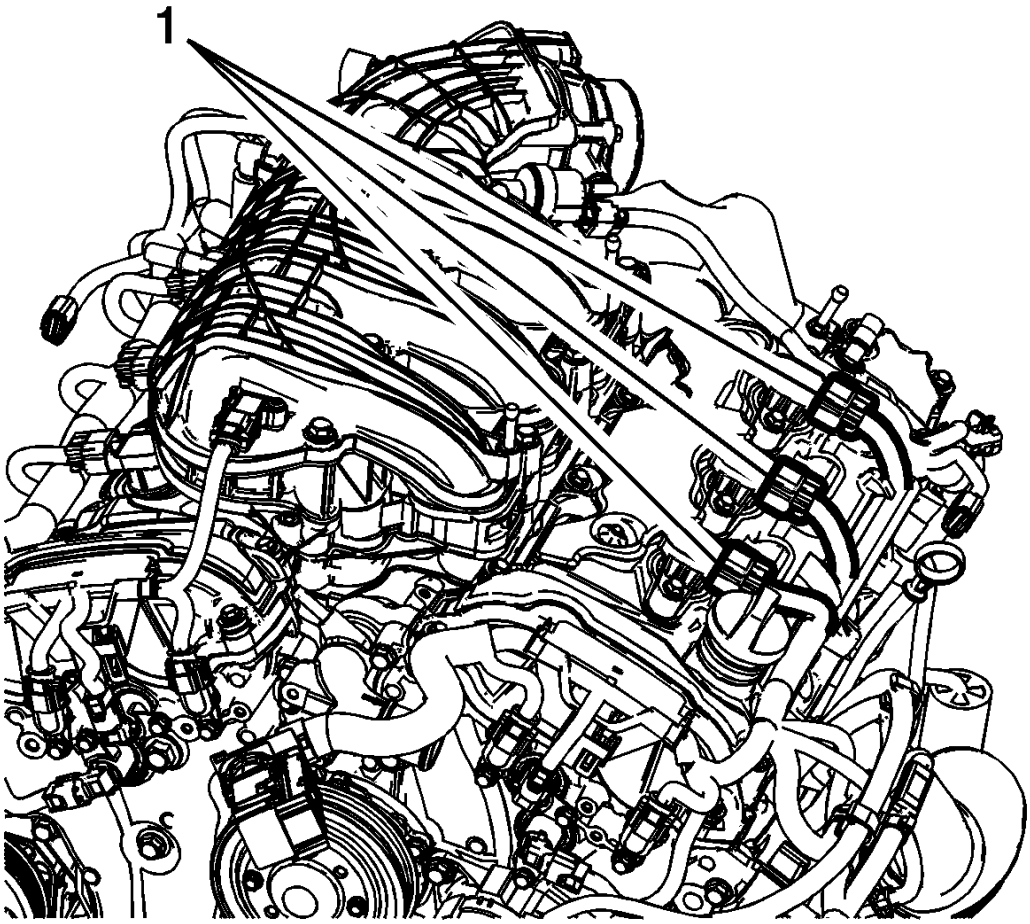


Fig. 136: Engine Wiring Harness Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine wiring harness electrical connector(s) (1) to the ignition coil(s).
4. Install theintake manifold cover. Refer to **Intake Manifold Cover Replacement** .

SPARK PLUG INSPECTION

Spark Plug Usage

Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions. Refer to the Electronic Parts Catalog.

Spark Plug Inspection

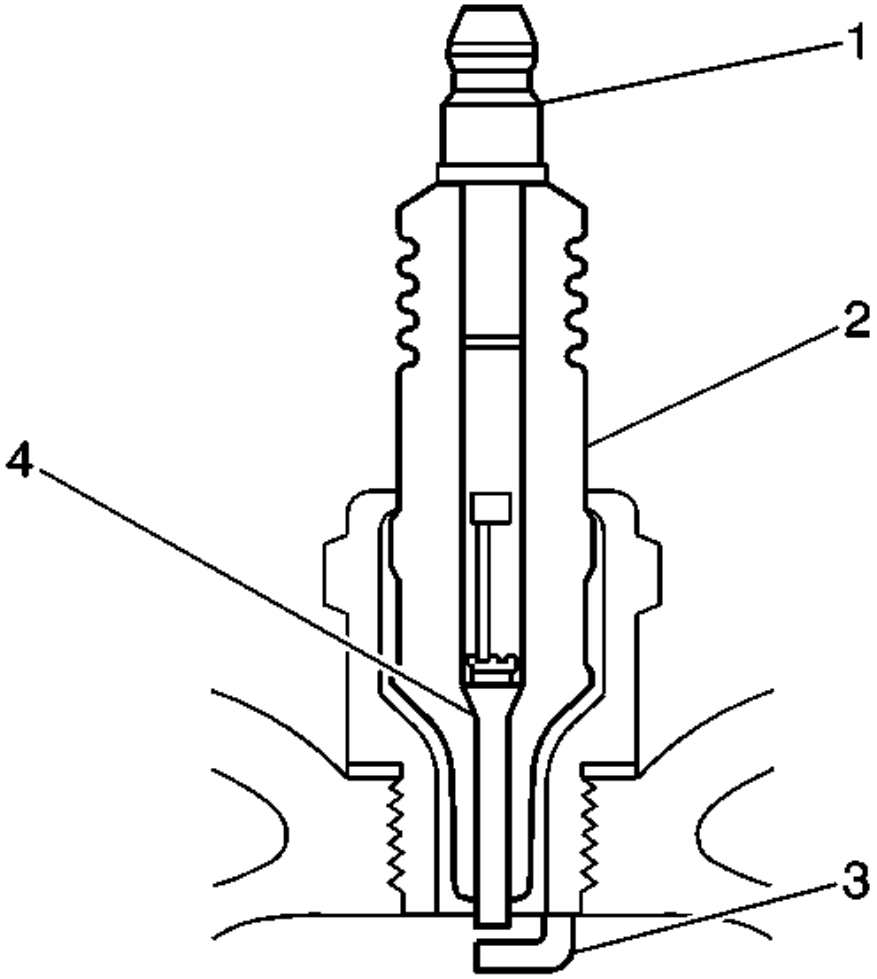


Fig. 137: Cross Sectional View Of Spark Plug
Courtesy of GENERAL MOTORS COMPANY

- Inspect the terminal post (1) for damage.
  - Inspect for a bent or broken terminal post (1).
  - Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.
- Inspect the insulator (2) for flashover or carbon tracking, soot. This condition is often mistakenly identified as a cracked insulator. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
  - Inspect the spark plug boot for damage.
  - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.
- Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).
- Inspect for evidence of improper arcing.
  - Measure the gap between the center electrode (4) and the side electrode (3) terminals. This must be

done carefully in order to avoid damaging the small diameter Iridium center electrode. Refer to **Ignition System Specifications** . An excessively wide electrode gap can prevent correct spark plug operation.

- Inspect for the correct spark plug torque. Refer to **Ignition System Specifications** . Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.
- Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
- Inspect for a broken or worn side electrode (3).
- Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.
  - A rattling sound indicates internal damage.
  - A loose center electrode (4) reduces the spark intensity.
- Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
- Inspect for worn or missing platinum pads on the electrodes (3, 4) If equipped.
- Inspect for excessive fouling.

- Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

Spark Plug Visual Inspection

- Normal operation-Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives. Reddish orange deposits can indicate MMT fuel additive which is still used in some markets around the world (will cause misfire and cannot be burned off). MMT fuel additive use should be avoided.
- Carbon Fouled-Dry, fluffy black carbon, or soot caused by the following conditions:
  - Rich fuel mixtures
    - Leaking fuel injectors
    - Excessive fuel pressure
    - Restricted air filter element
    - Incorrect combustion
  - Reduced ignition system voltage output
    - Weak coils
    - Worn ignition wires
    - Incorrect spark plug gap
  - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit Fouling-Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

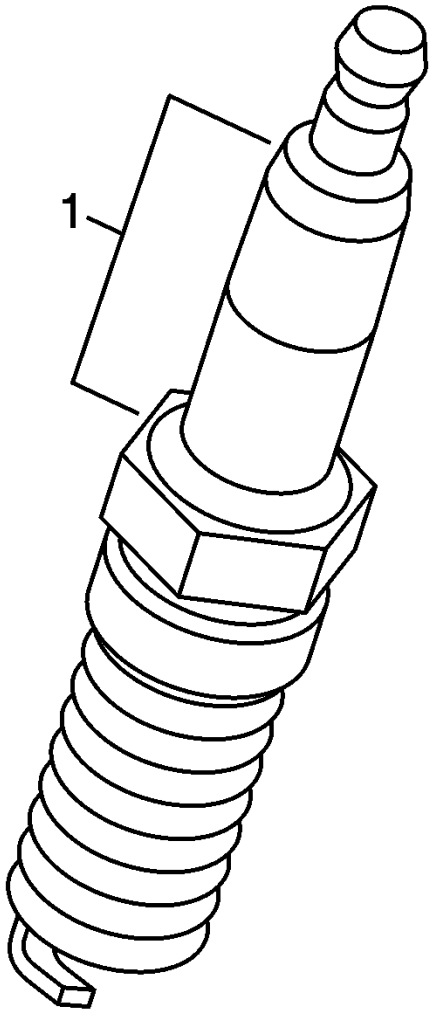


Fig. 138: Inspect For Carbon On Spark Plug Tower
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Carbon on spark plug tower means carbon will also be on inside of spark plug wire boot or coil boot and will cause both new spark plug and spark plug wire or coil boot to fail again.**

-
- If carbon tracking occurs on spark plug tower (1), replace spark plug and spark plug wire or coil boot.

SPARK PLUG REPLACEMENT

Removal Procedure

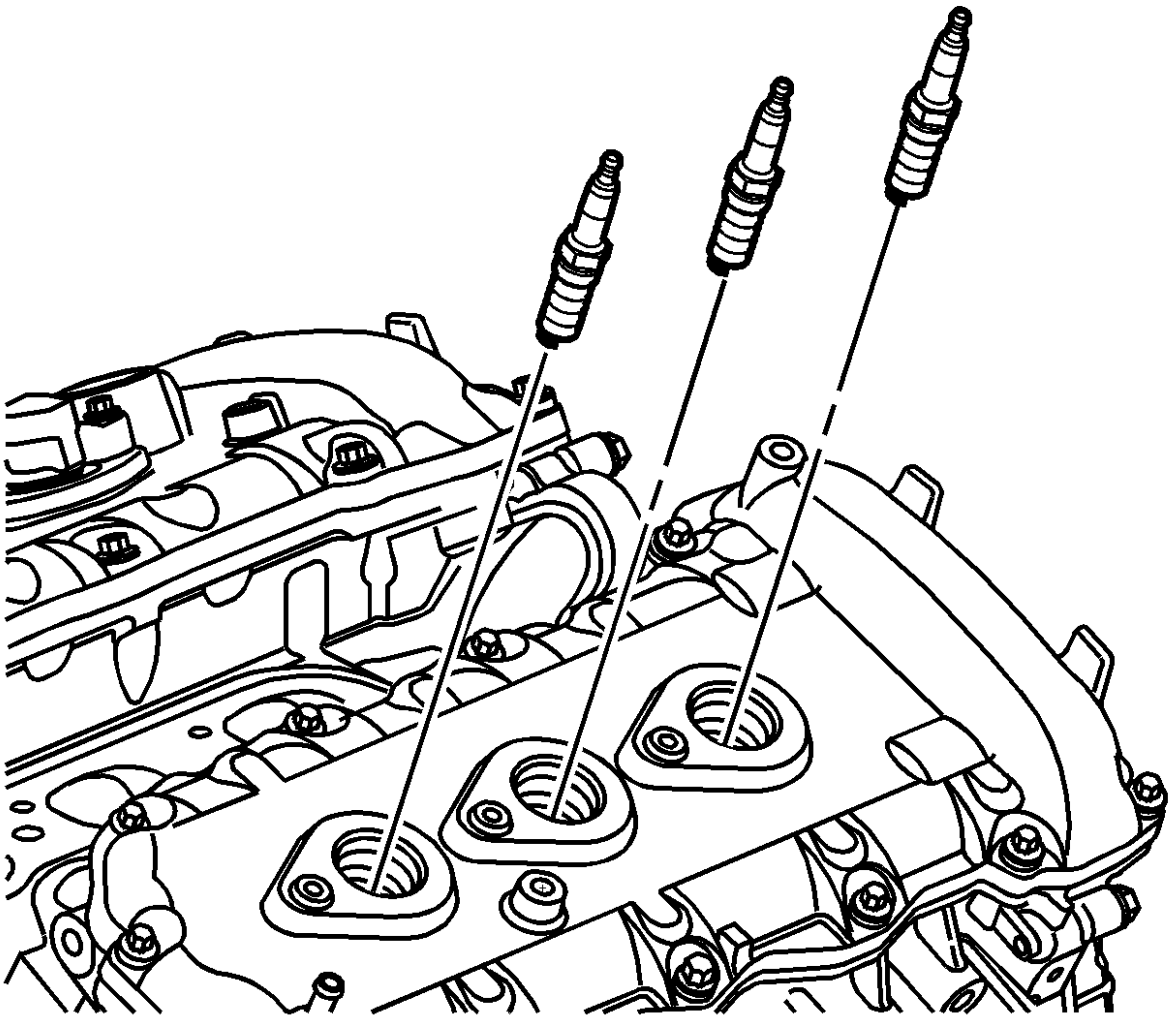


Fig. 139: View Of Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

1. Remove the ignition coil(s). Refer to **Ignition Coil Replacement - Bank 1**, and/or **Ignition Coil Replacement - Bank 2**.

WARNING: **Refer to Safety Glasses and Compressed Air Warning .**

CAUTION: **Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.**

2. Use compressed air in order to remove debris from the spark plug cavity.

CAUTION: **Allow the engine to cool before removing the spark plugs. Attempting to remove the spark plugs from a hot engine may cause the plug threads to**

seize, causing damage to cylinder head threads.

3. Remove the spark plug.

Installation Procedure

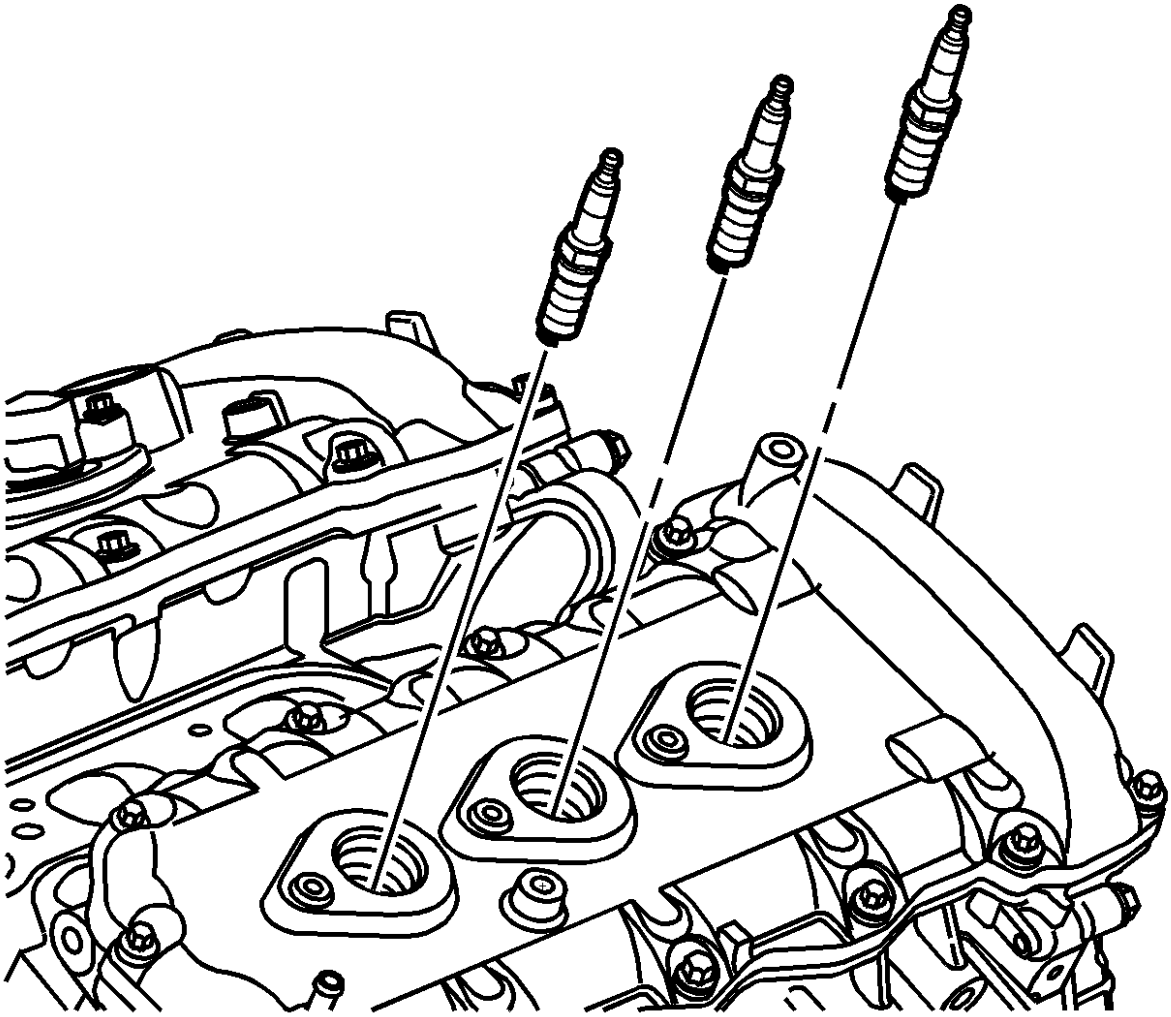


Fig. 140: View Of Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use only the spark plugs specified for use in the vehicle. Do not install spark plugs that are either hotter or colder than those specified for the vehicle. Installing spark plugs of another type can severely damage the engine.

CAUTION: Check the gap of all new and reconditioned spark plugs before installation. The pre-set gaps may have changed during handling. Use a round feeler gauge to ensure an accurate check. Installing the spark plugs with the wrong gap can cause poor engine performance and may even damage the engine.

1. Ensure that the spark plug gap is equivalent to the spark plug gap specification. Refer to **Ignition System Specifications** .

CAUTION: **Be sure that the spark plug threads smoothly into the cylinder head and the spark plug is fully seated. Use a thread chaser, if necessary, to clean threads in the cylinder head. Cross-threading or failing to fully seat the spark plug can cause overheating of the plug, exhaust blow-by, or thread damage.**

CAUTION: **Refer to Fastener Caution .**

2. Install the spark plug and tighten to 20 N.m (15 lb ft)..
3. Install the ignition coil(s). Refer to **Ignition Coil Replacement - Bank 1**, and/or **Ignition Coil Replacement - Bank 2**.

CRANKSHAFT POSITION SENSOR REPLACEMENT

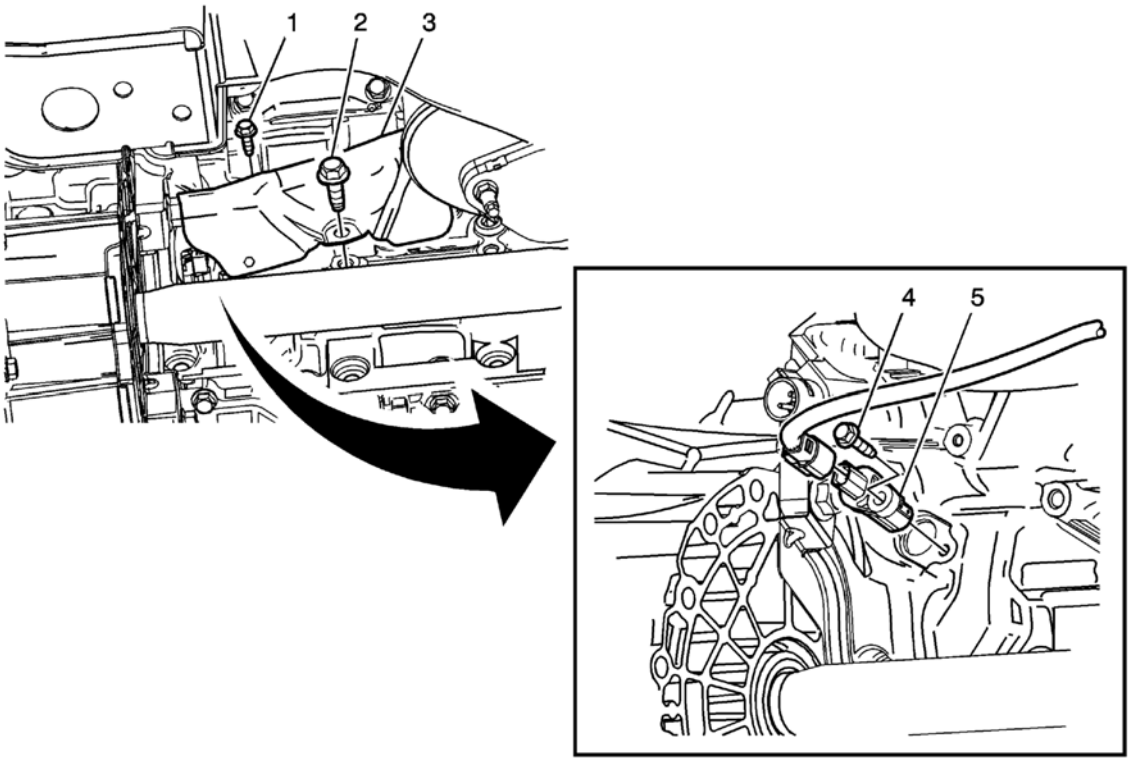


Fig. 141: Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. If equipped with AWD, remove the right side catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (Rear)** . 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	

Callout	Component Name
1	Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Bolt **Tighten** 58 N.m (42 lb ft)
3	Exhaust Manifold Lower Heat Shield
4	Bolt **Tighten** 10 N.m (89 lb in)
5	Crankshaft Position Sensor **Procedure** Disconnect the crankshaft position sensor harness connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

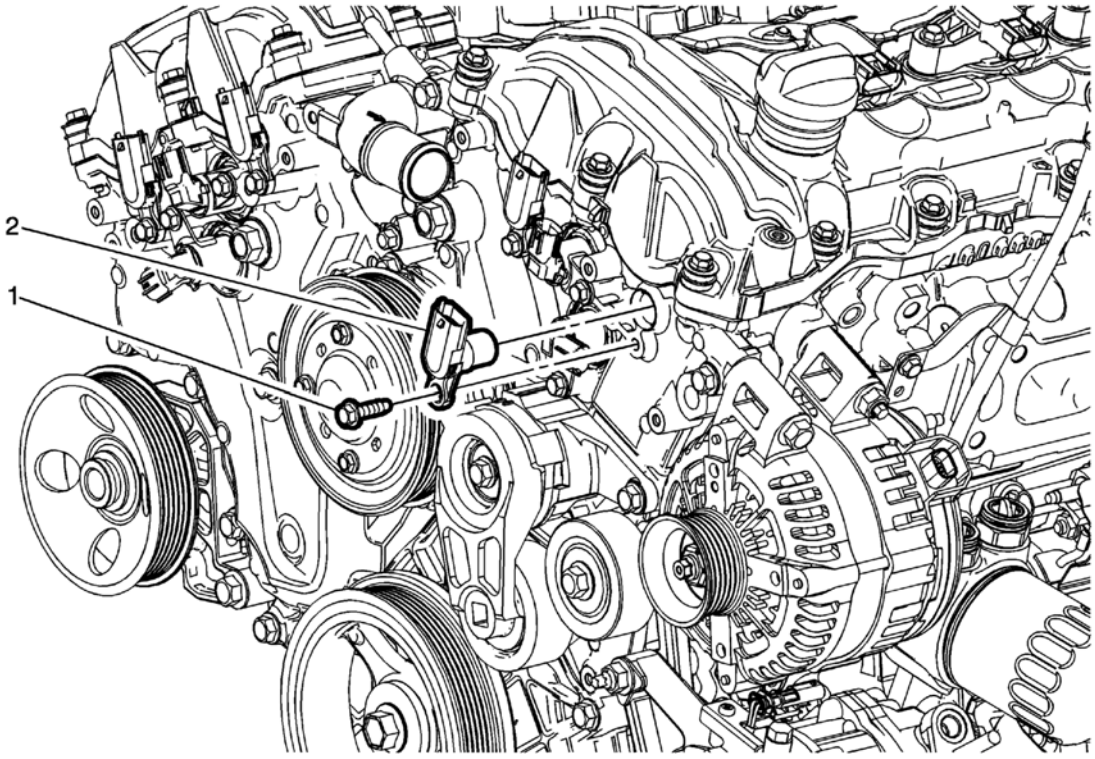


Fig. 142: Camshaft Position Sensor - Bank 2 (Left Side) Exhaust
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Position Sensor Fastener **CAUTION:** **Refer to** Fastener Caution **.** **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Sensor **Procedure** Disconnect the electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

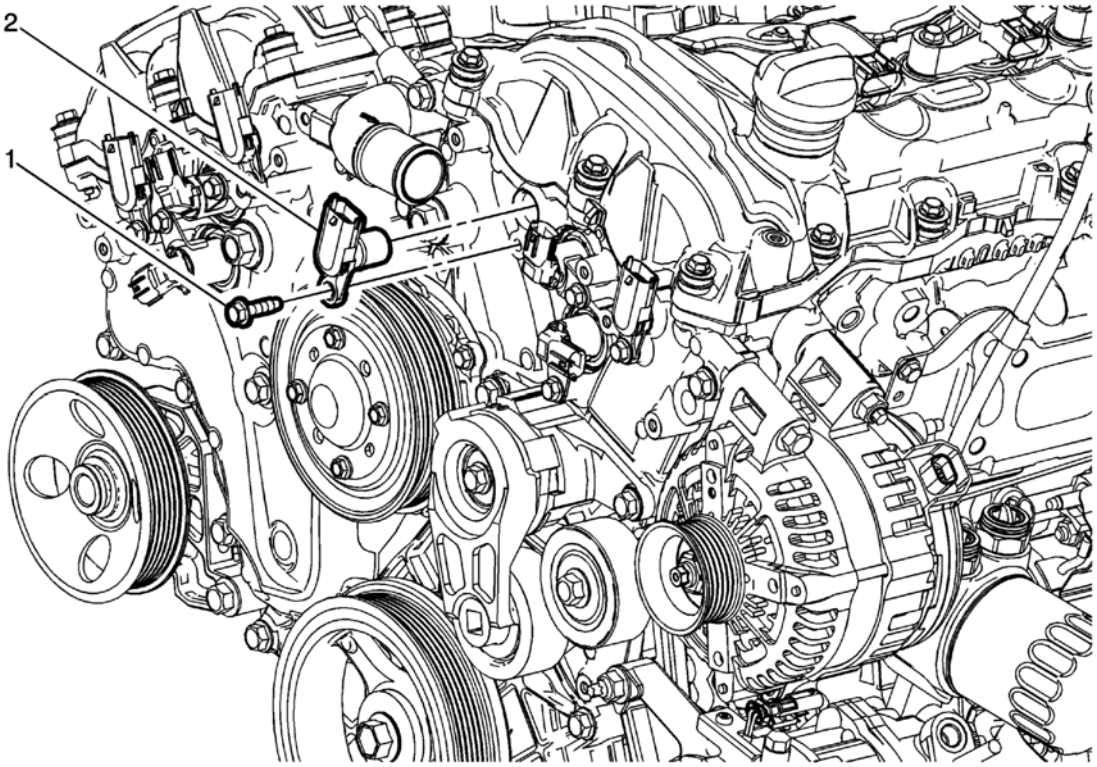


Fig. 143: Camshaft Position Sensor - Bank 2 (Left Side) Intake
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Position Sensor Fastener **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Sensor **Procedure** Disconnect the electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

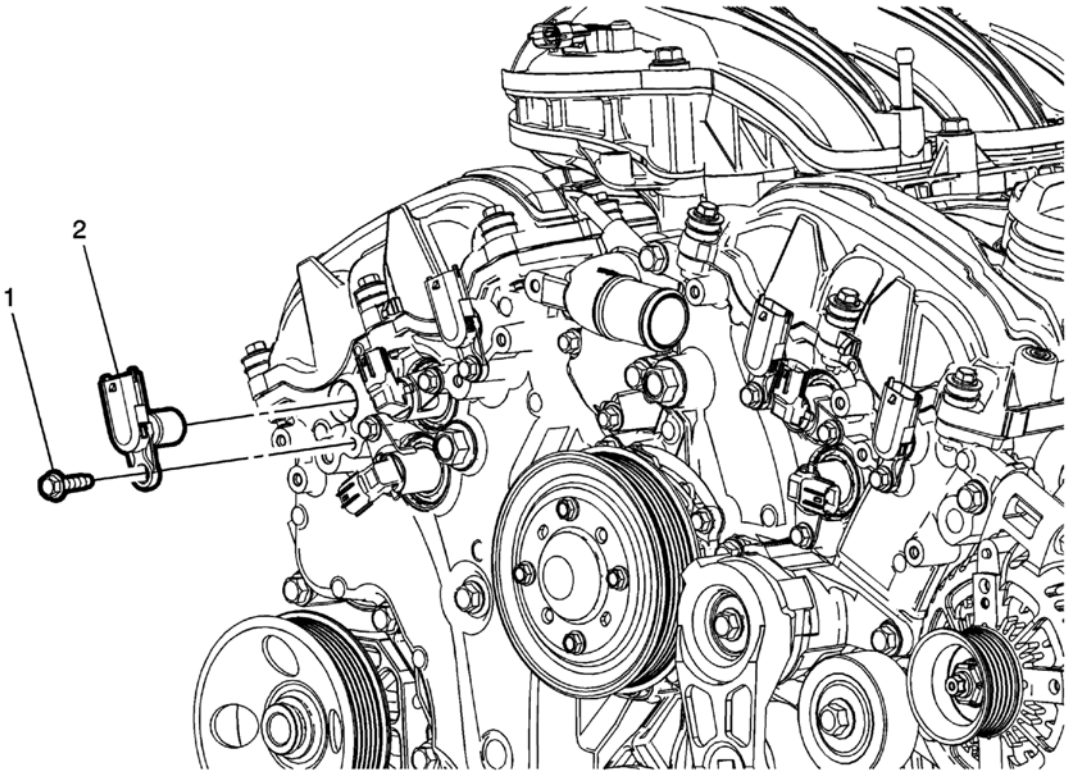


Fig. 144: Camshaft Position Sensor - Bank 1 (Right Side) Exhaust
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Position Sensor Fastener **CAUTION:** **Refer to** Fastener Caution .

Callout	Component Name
	Tighten 10 N.m (89 lb in)
2	Camshaft Position Sensor **Procedure** Disconnect the electrical connector.

CAMSHAFT POSITION SENSOR REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

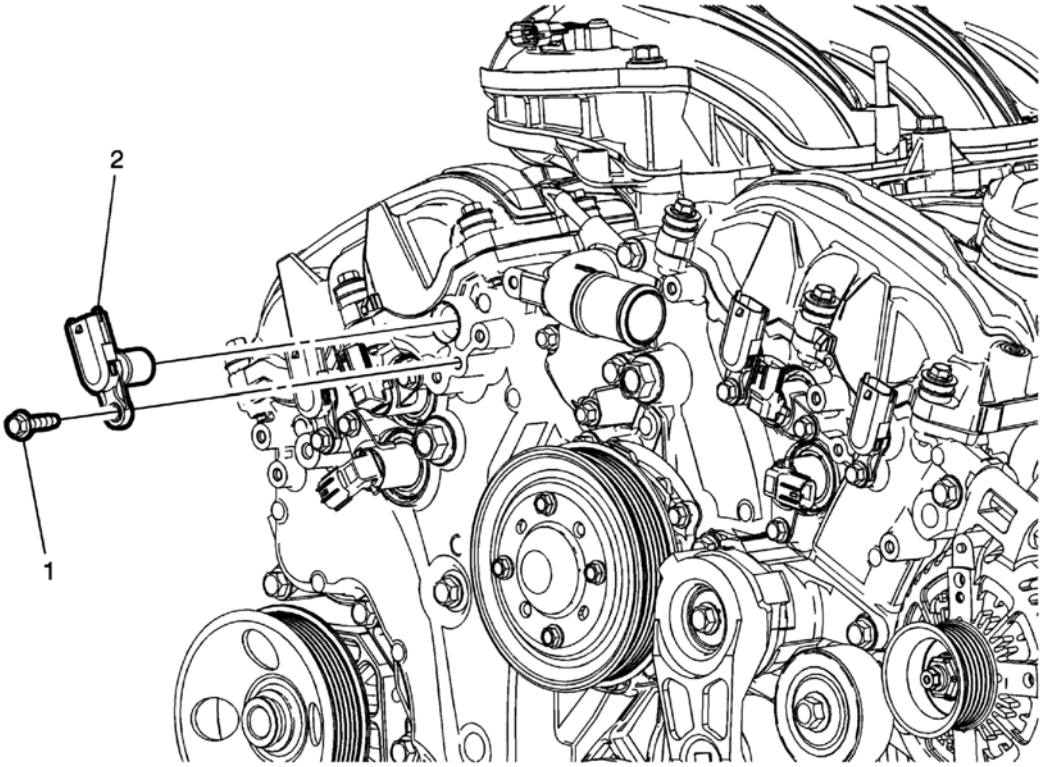


Fig. 145: Camshaft Position Sensor - Bank 1 (Right Side) Intake
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Position Sensor Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Sensor **Procedure** Disconnect the electrical connector.

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) INTAKE

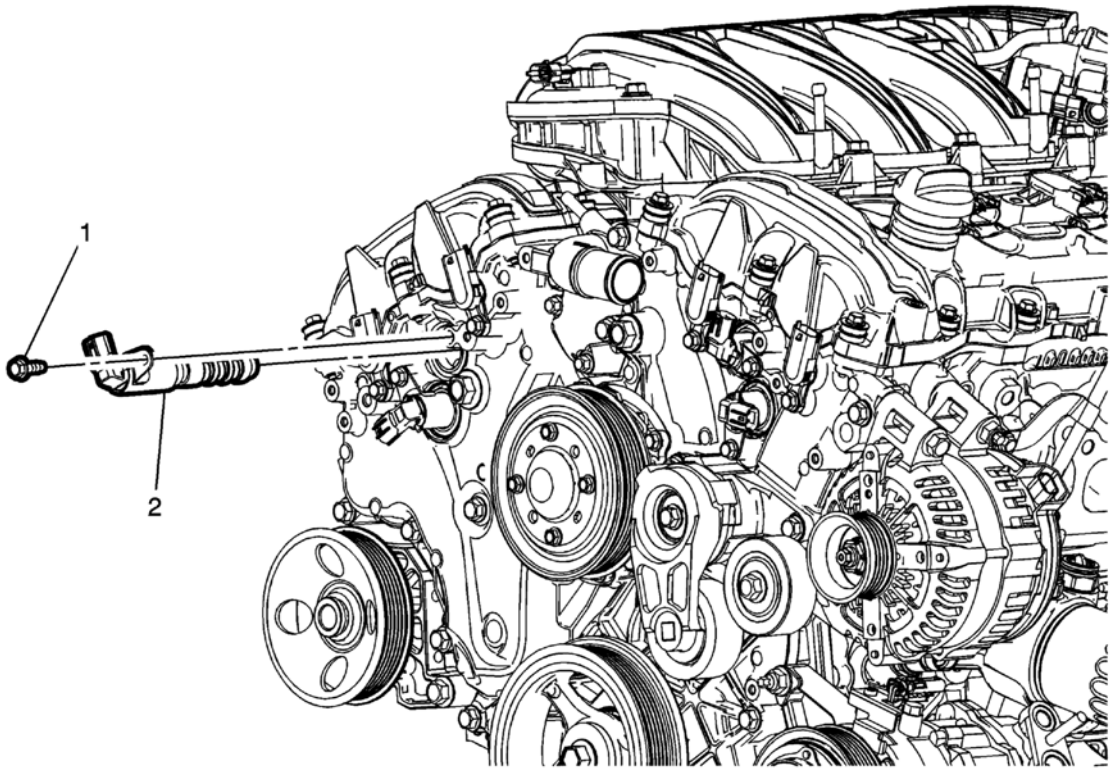


Fig. 146: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Intake
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Position Actuator Solenoid Valve Fastener **CAUTION:** **Refer to Fastener Caution .** **Procedure** Disconnect the electrical connector. **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 1 (RIGHT SIDE) EXHAUST

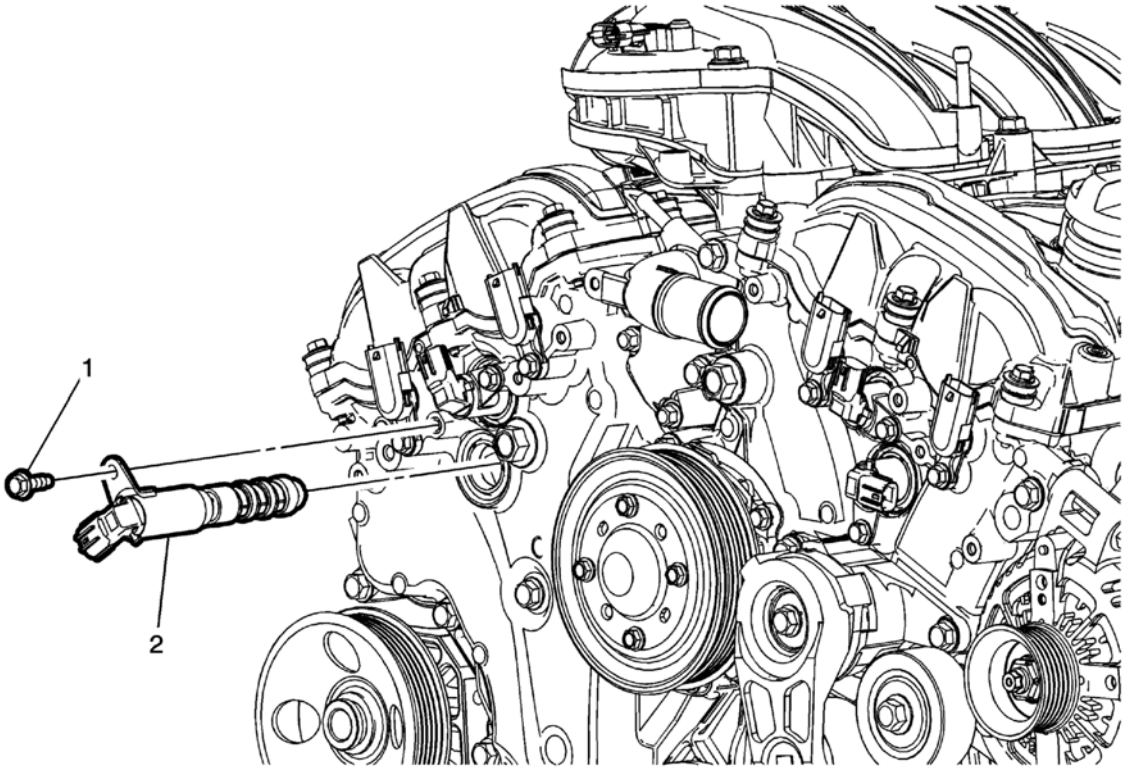


Fig. 147: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 1 (Right Side) Exhaust
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Position Actuator Solenoid Valve Fastener **CAUTION:** **Refer to Fastener Caution .** **Procedure** Disconnect the electrical connector. **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) INTAKE

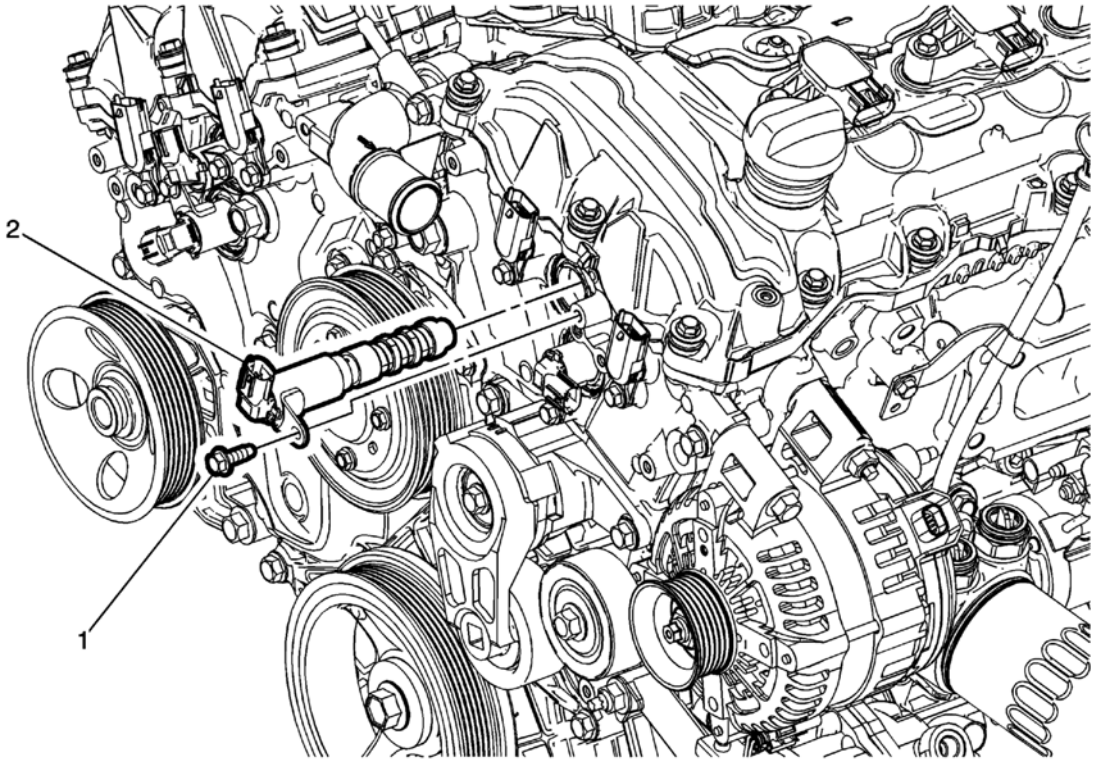


Fig. 148: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Intake
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Position Actuator Solenoid Valve Fastener **CAUTION:** **Refer to Fastener Caution .** **Procedure** Disconnect the electrical connector. **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve

CAMSHAFT POSITION ACTUATOR SOLENOID VALVE SOLENOID REPLACEMENT - BANK 2 (LEFT SIDE) EXHAUST

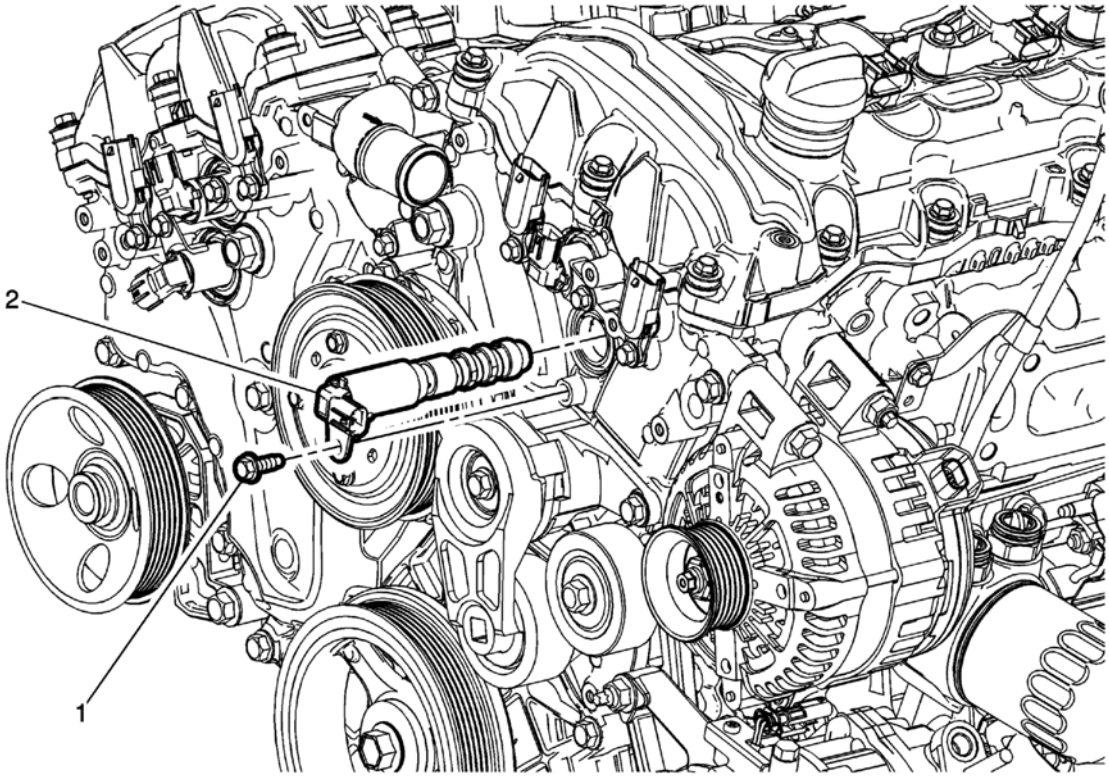


Fig. 149: Camshaft Position Actuator Solenoid Valve Solenoid - Bank 2 (Left Side) Exhaust
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Position Actuator Solenoid Valve Fastener **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Camshaft Position Actuator Solenoid Valve **Procedure** Disconnect the electrical connector.

KNOCK SENSOR REPLACEMENT - BANK 1

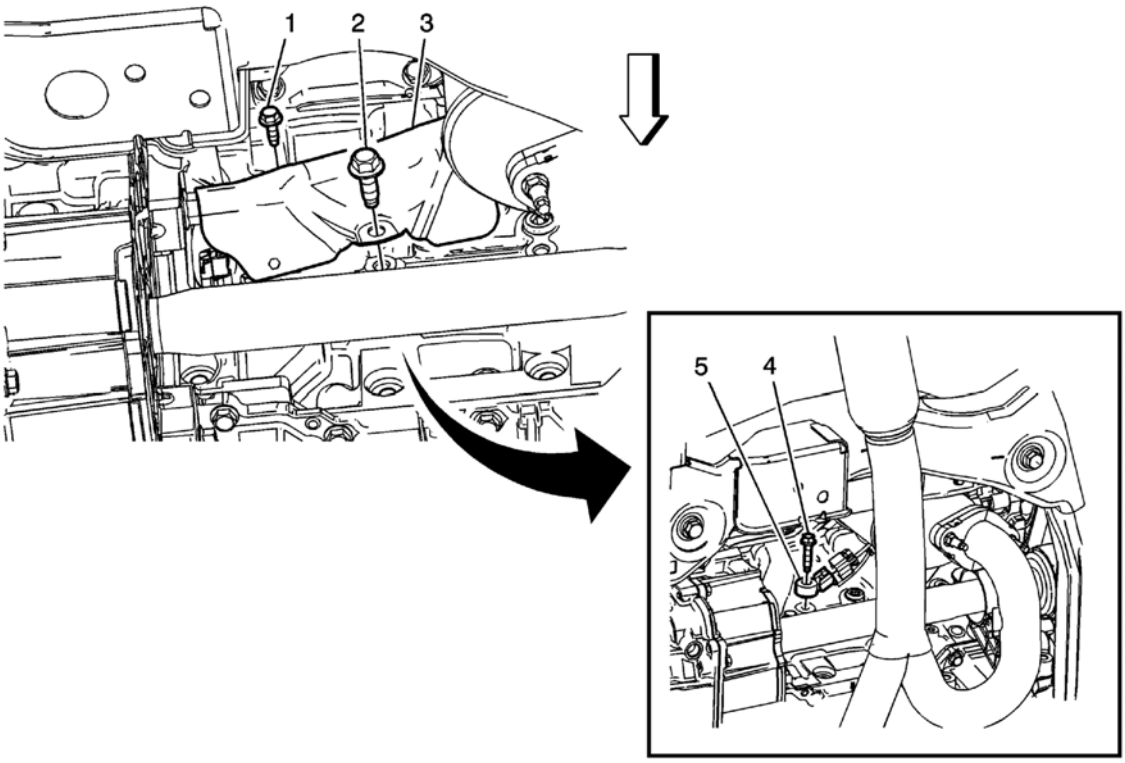


Fig. 150: Knock Sensor - Bank 1
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
2	Bolt **Tighten** 58 N.m (42 lb ft)
3	Exhaust Manifold Lower Heat Shield
4	Bolt **Tighten** 23 N.m (17 lb ft)
5	Knock Sensor **Procedure** Disconnect the electrical connector.

KNOCK SENSOR REPLACEMENT - BANK 2

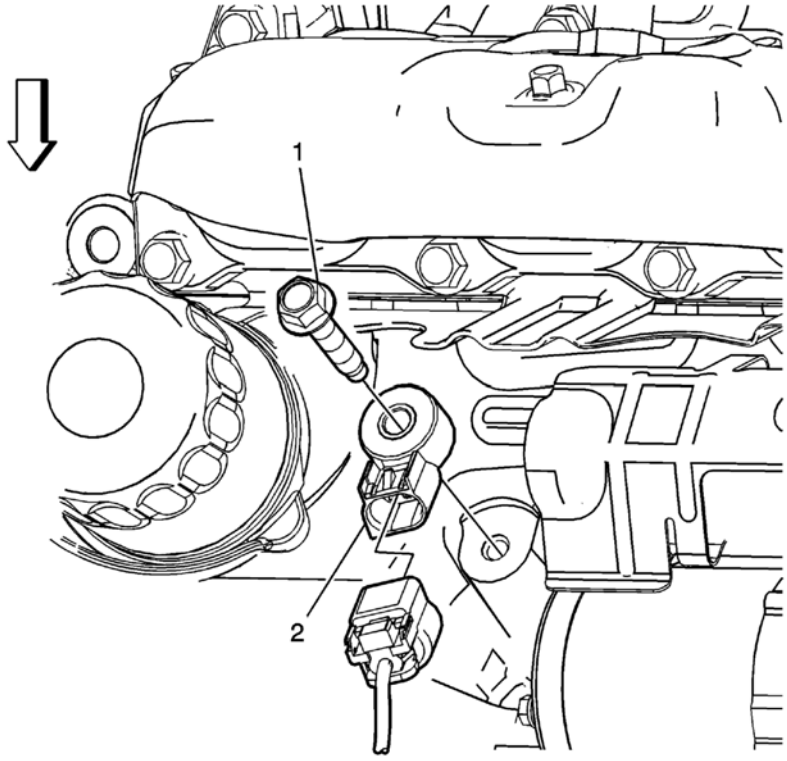


Fig. 151: Knock Sensor - Bank 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Knock Sensor Fastener **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 23 N.m (17 lb ft)
2	Knock Sensor **Procedure** Disconnect the electrical connector.

SECONDARY AIR INJECTION PIPE REPLACEMENT

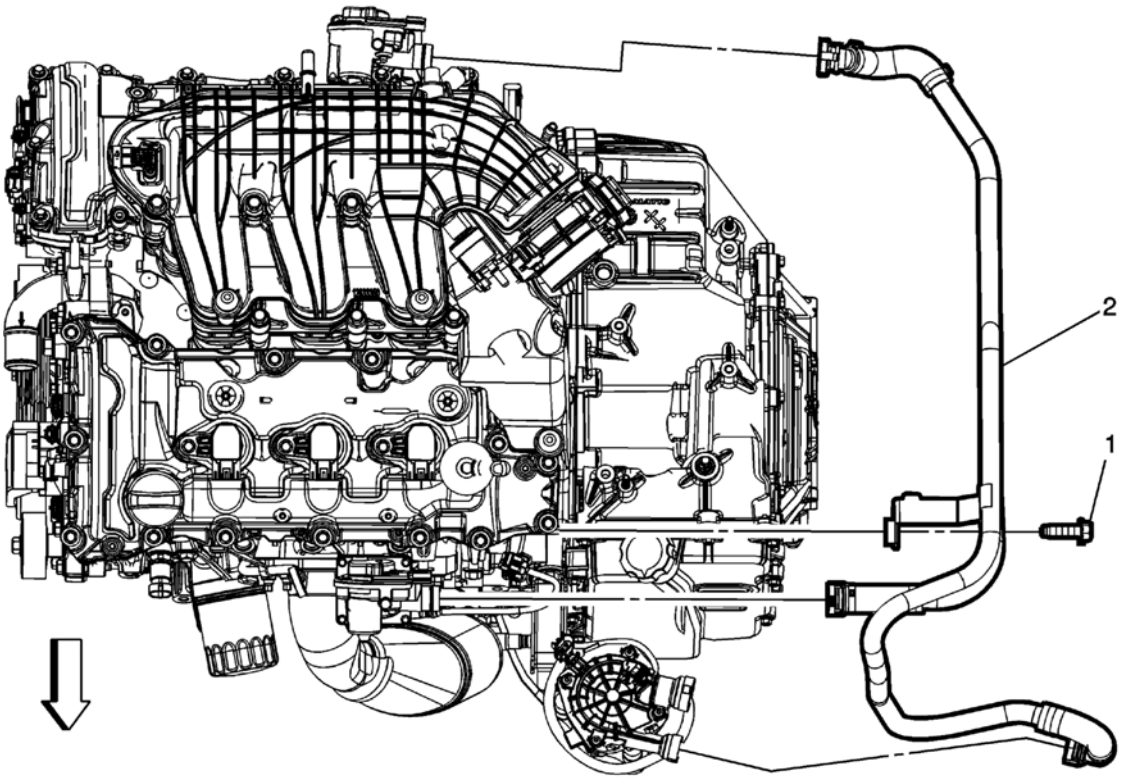


Fig. 152: Secondary Air Injection Pipe
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	Preliminary Procedures **1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .** **2. Remove the air cleaner outlet duct. Refer to Air Cleaner Outlet Duct Replacement.**
1	Secondary Air Injection Pipe Bolt. **CAUTION:** **Refer to Fastener Caution .** **Tighten** 58 N.m (43 lb ft)
2	Secondary Air Injection Pipe. **Procedure** Disconnect the quick connect fittings by squeezing both sides.

SECONDARY AIR INJECTION BYPASS VALVE REPLACEMENT - BANK 2

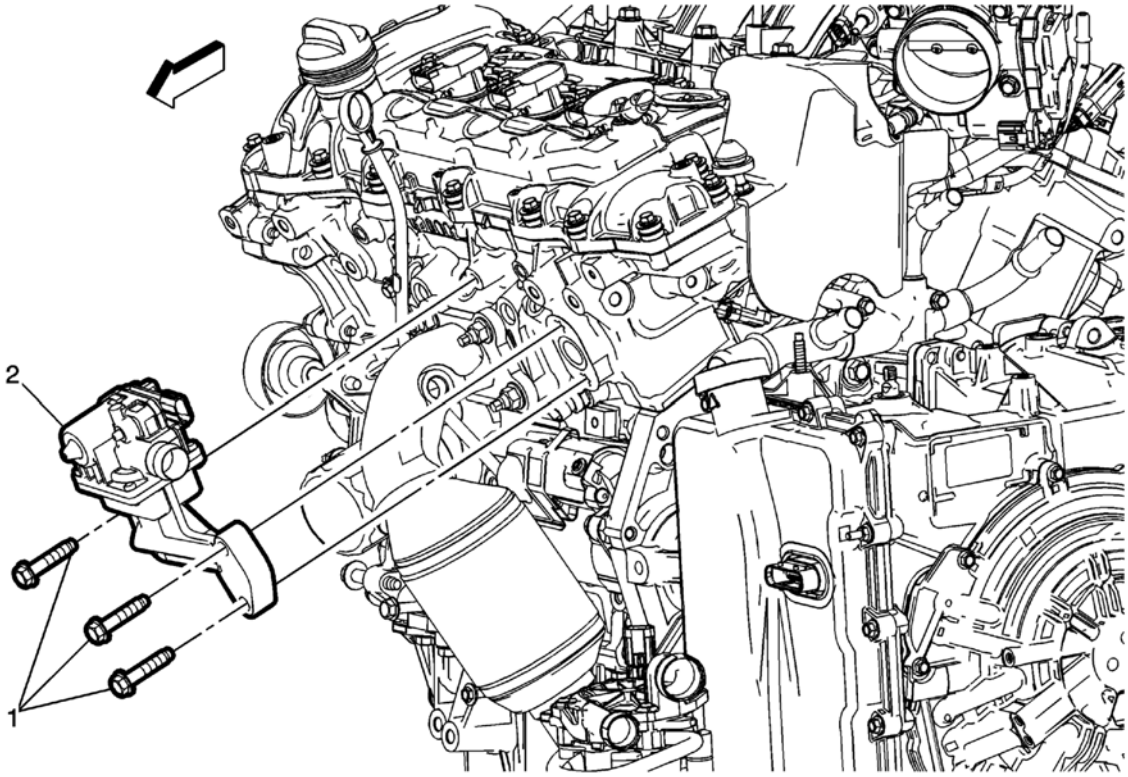


Fig. 153: Secondary Air Injection Bypass Valve - Bank 2
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	Preliminary Procedures **1. Remove the intake manifold cover. Refer to Intake Manifold Cover Replacement .** **2. Remove the secondary air injection pipe. Refer to Secondary Air Injection Pipe Replacement.**
1	Secondary Air Injection Bypass Valve Bolts (Qty: 3). **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
2	Secondary Air Injection Bypass Valve. **Procedure** Disconnect the secondary air injection valve electrical connector.

SECONDARY AIR INJECTION BYPASS VALVE REPLACEMENT - BANK 1

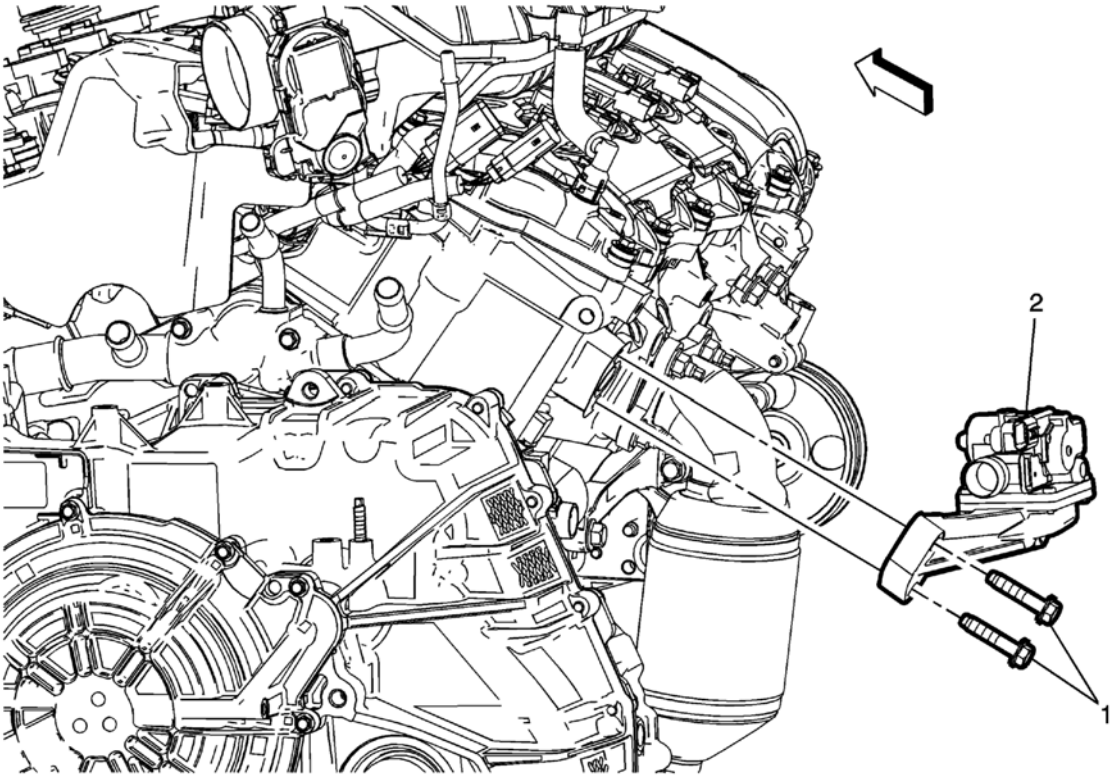


Fig. 154: Secondary Air Injection Bypass Valve - Bank 1
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	Preliminary Procedures **1. Remove the secondary air injection pipe. Refer to Secondary Air Injection Pipe Replacement.** **2. Raise and support the vehicle. Refer to Lifting and Jacking the Vehicle**
1	Secondary Air Injection Bypass Valve Bolts (Qty: 2). **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
2	Secondary Air Injection Bypass Valve. **Procedure** Disconnect the secondary air injection valve electrical connector.

SECONDARY AIR INJECTION PUMP REPLACEMENT

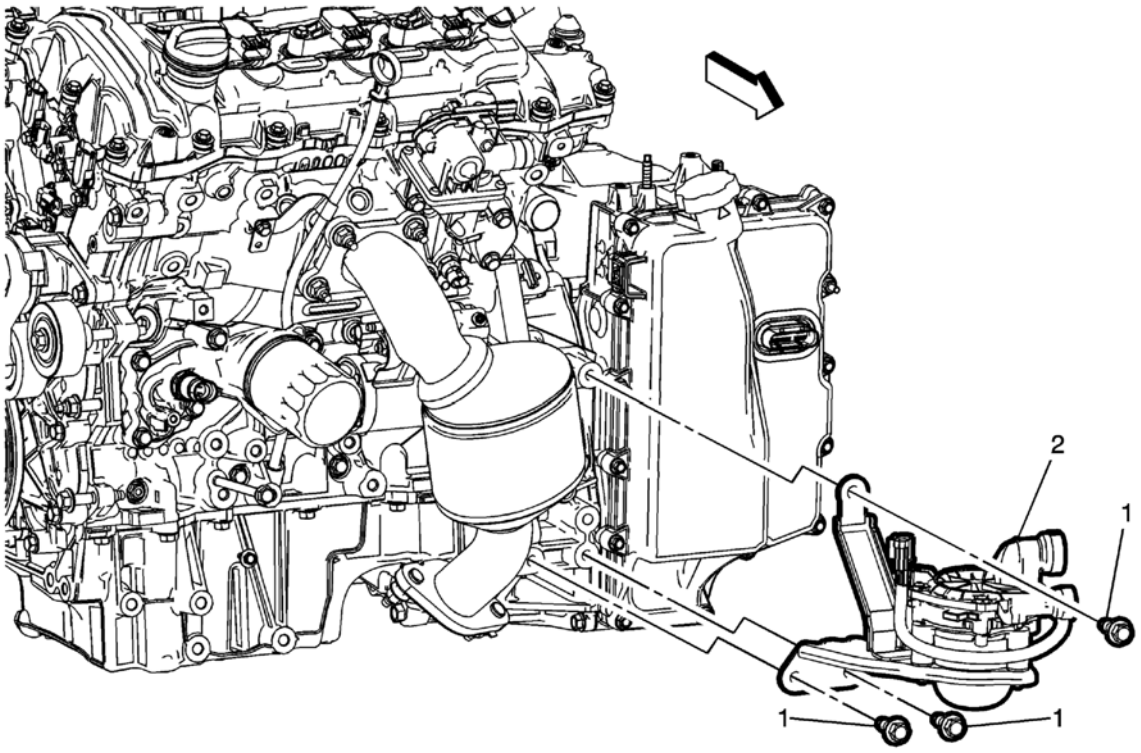


Fig. 155: Secondary Air Injection Pump
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
	Preliminary Procedures **1. Revove the radiator air lower baffel and deflector. Refer to Radiator Air Lower Baffle and Deflector Replacement** **2. Remove the secondary air injection pipe. Refer to Secondary Air Injection Pipe Replacement** **3. Remove the secondary air injection pump hose. Refer to Secondary Air Injection Pump Hose Replacement**
1	Secondary Air Injection Pump Bolts (Qty: 3). **CAUTION:** **Refer to Fastener Caution .** **Tighten** 58 N.m (43 lb ft)
2	Secondary Air Injection Pump. **Procedure** Disconnect the secondary air injection pump elactrical connector.

SECONDARY AIR INJECTION PUMP HOSE REPLACEMENT

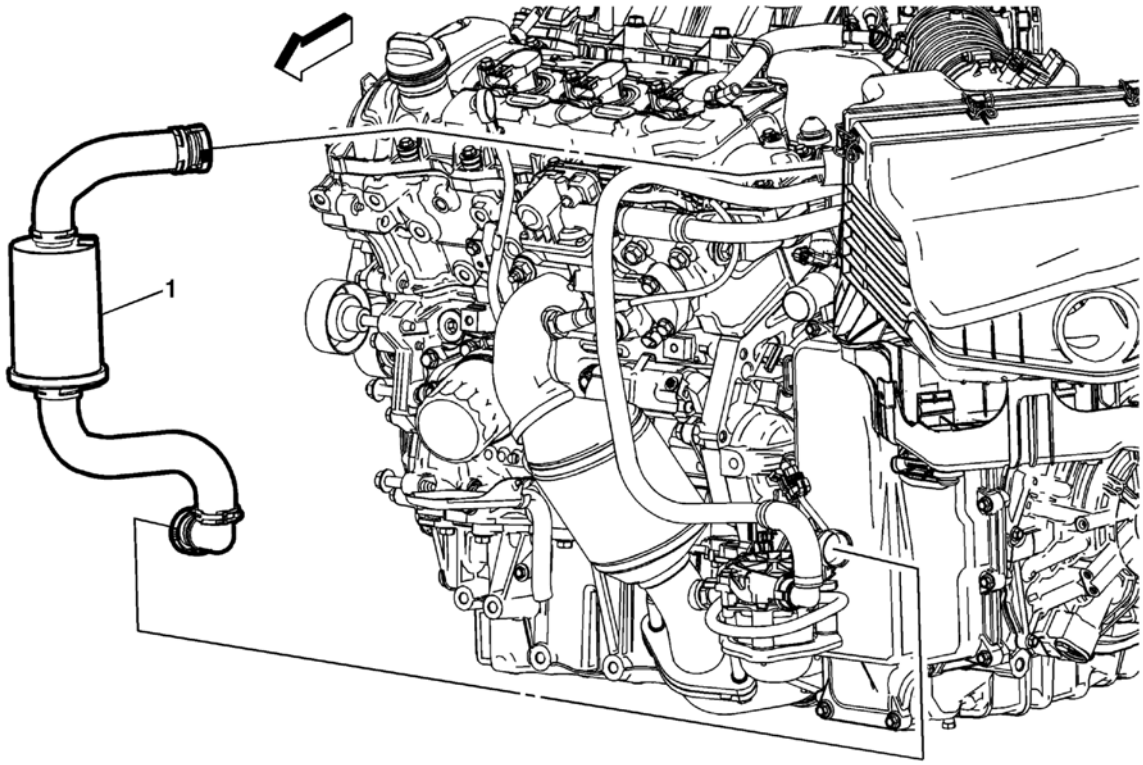


Fig. 156: Secondary Air Injection Pump Hose
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures **Revove the radiator air lower baffel and deflector. Refer to Radiator Air Lower Baffle and Deflector Replacement**	
1	Secondary Air Injection Pump Inlet Hose. **Procedure** Disconnect the quick connect fittings by squeezing both sides.

AIR CLEANER ELEMENT REPLACEMENT

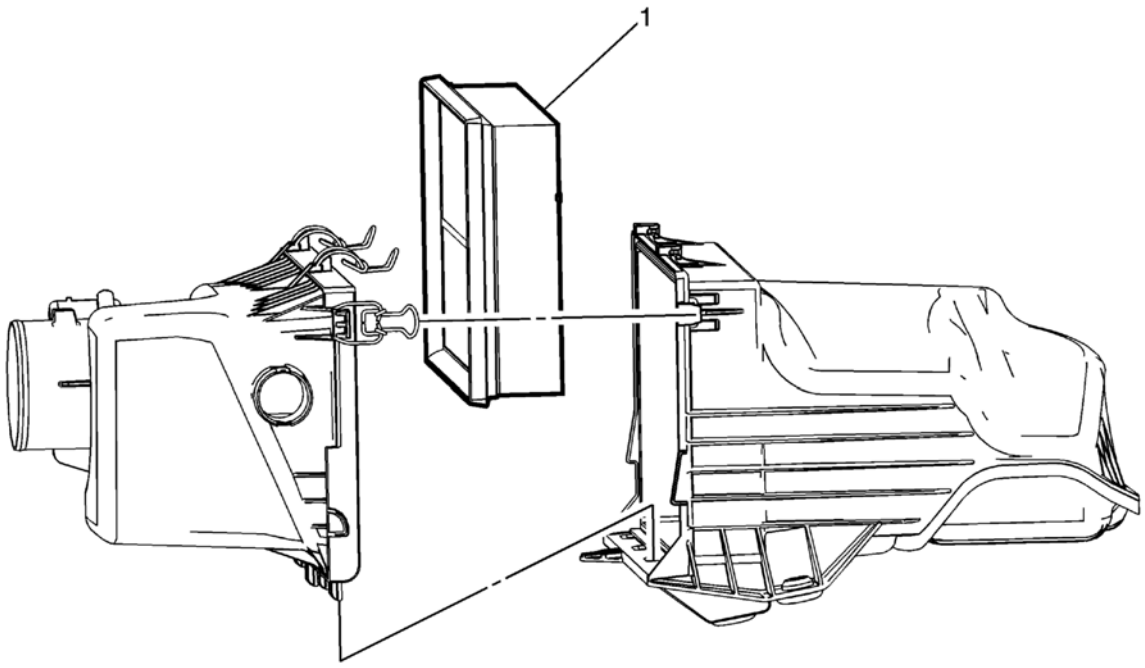


Fig. 157: Air Cleaner Element
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** 2. Remove the secondary air injection pump hose. Refer to **Secondary Air Injection Pump Hose Replacement** 3. Disconnect the MAF sensor electrical connector.	
1	Air Cleaner Element **Procedure** Release the spring clamps on top and side of the air cleaner housing.

AIR CLEANER ASSEMBLY REPLACEMENT

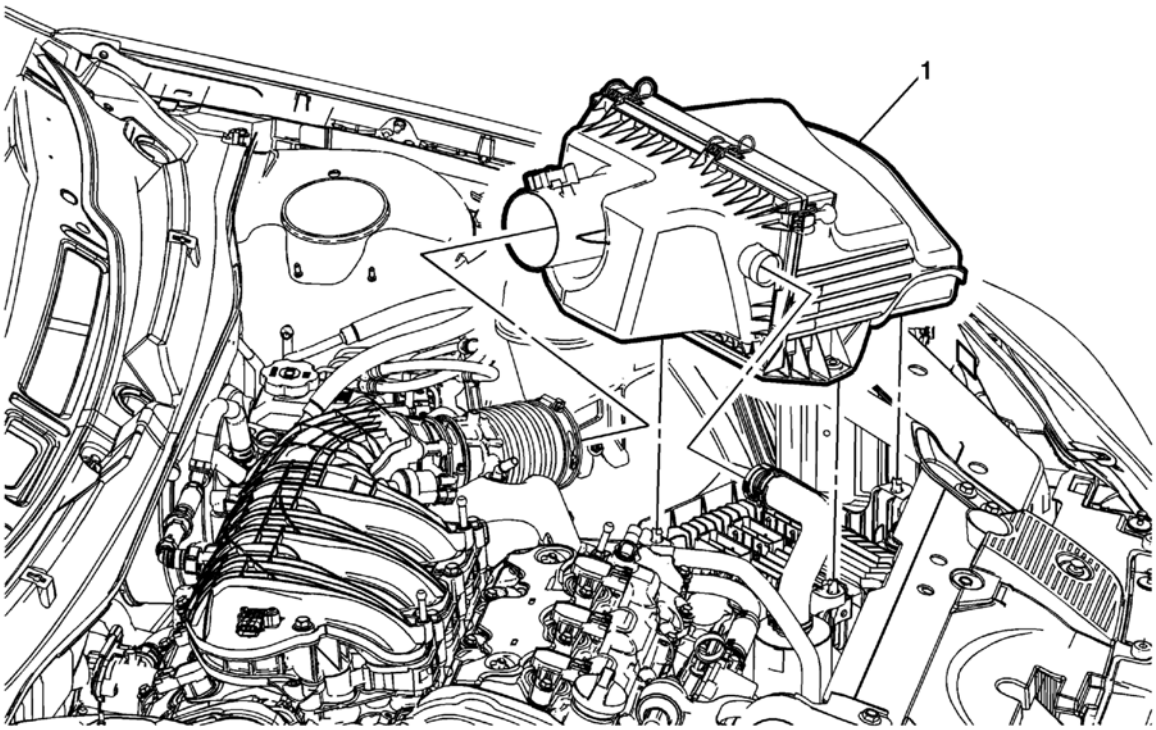


Fig. 158: Air Cleaner Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement** 2. Remove the secondary air injection pump hose. Refer to **Secondary Air Injection Pump Hose Replacement** 3. Disconnect the MAF sensor electrical connector.	
1	Air Cleaner Assembly.

AIR CLEANER OUTLET DUCT REPLACEMENT

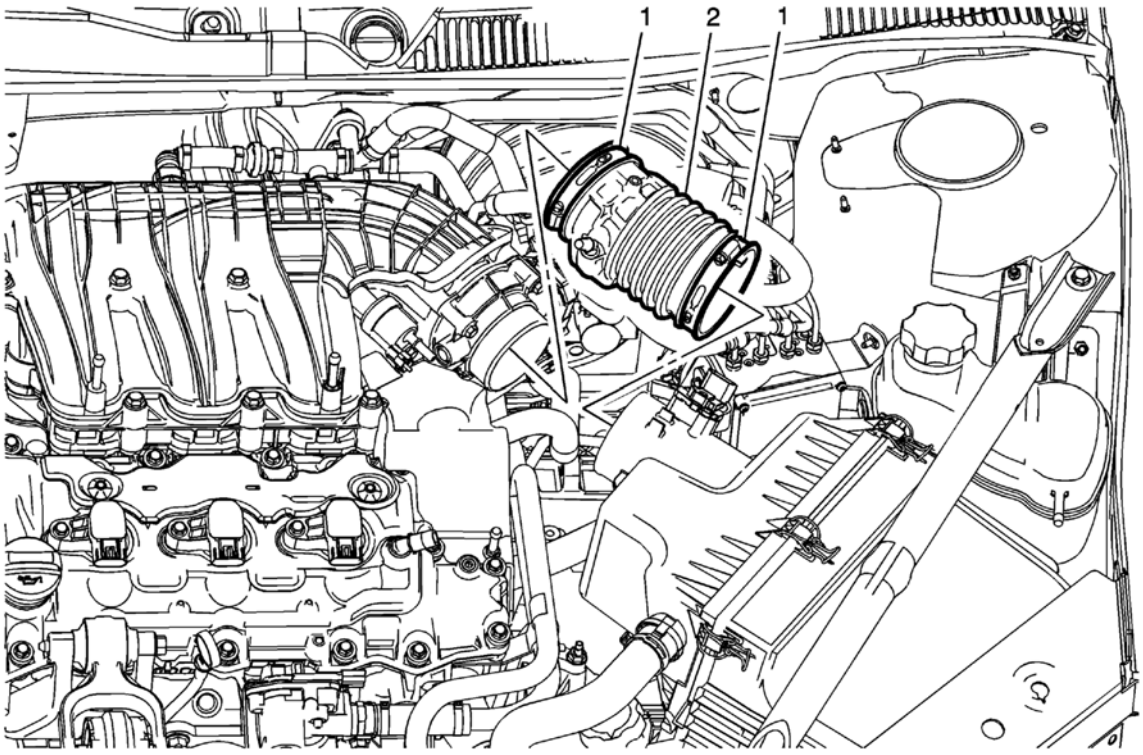


Fig. 159: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the positive crankcase ventilatioin tube front. Refer to **Positive Crankcase Ventilation Tube Replacement - Front**	
1	Air Cleaner Outlet Duct Clamps. (Qty: 2). **CAUTION:** **Refer to Fastener Caution .** **NOTE:** **Ensure the outlet duct is fully seated to the mating surfaces before clamping. Verify that the cuff is not rolled**

Callout	Component Name
	under. **Tighten** 3 N.m (27 lb in)
2	Air Cleaner Outlet Duct

AIR CLEANER BRACKET REPLACEMENT

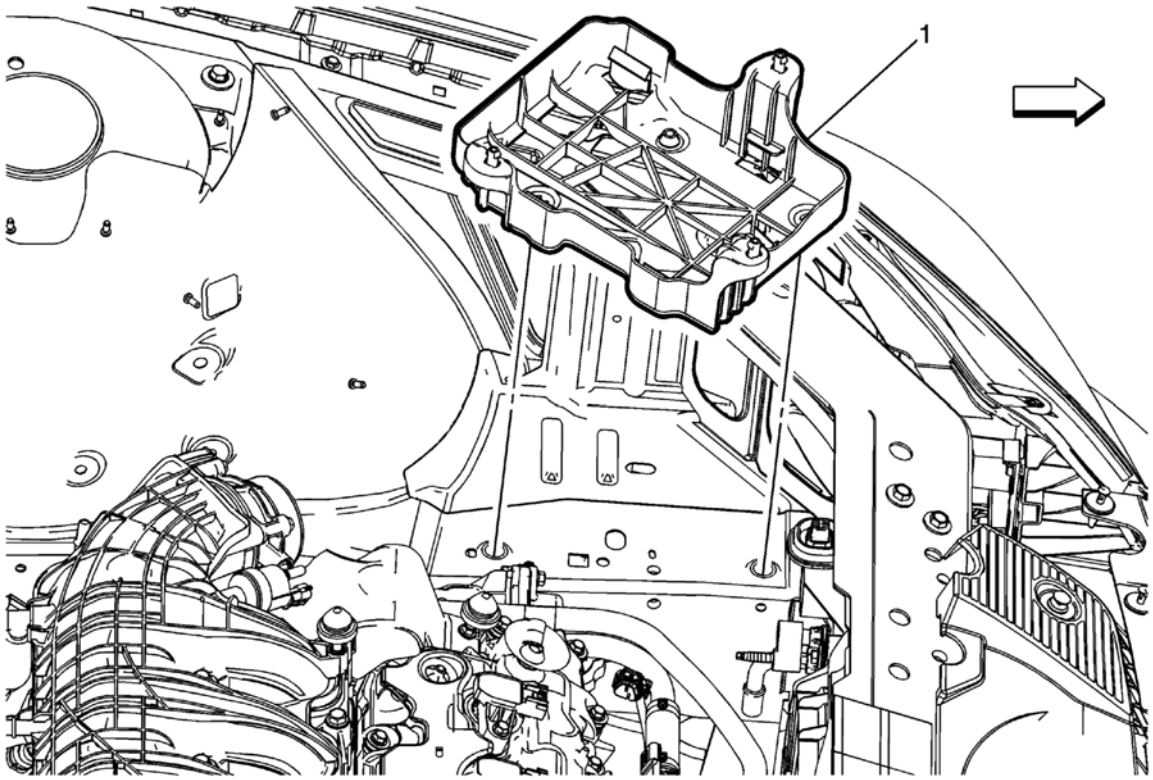


Fig. 160: Air Cleaner Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the engine control module. Refer to **Engine Control Module Replacement**	
1	Air Cleaner Bracket. **Procedure** Apply suitable upward pressure to the air cleaner bracket to release the retainers.

Article GUID: A00737163

SCHEMATIC WIRING DIAGRAMS

ENGINE CONTROLS WIRING SCHEMATICS

Module Power, Ground, Serial Data, Brake Pedal Position and MIL

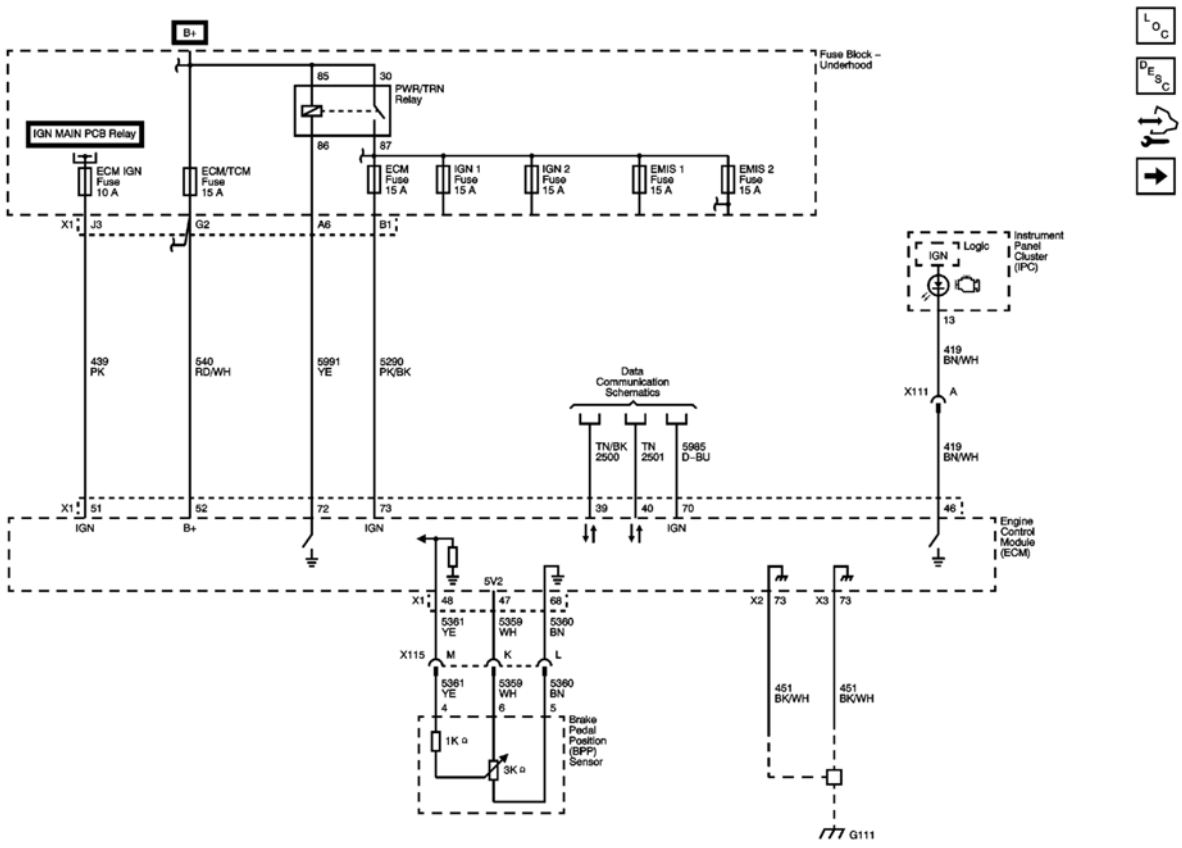


Fig. 1: Module Power, Ground, Serial Data, Brake Pedal Position and MIL Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

5V1, and Low Reference Bus (1 of 2)

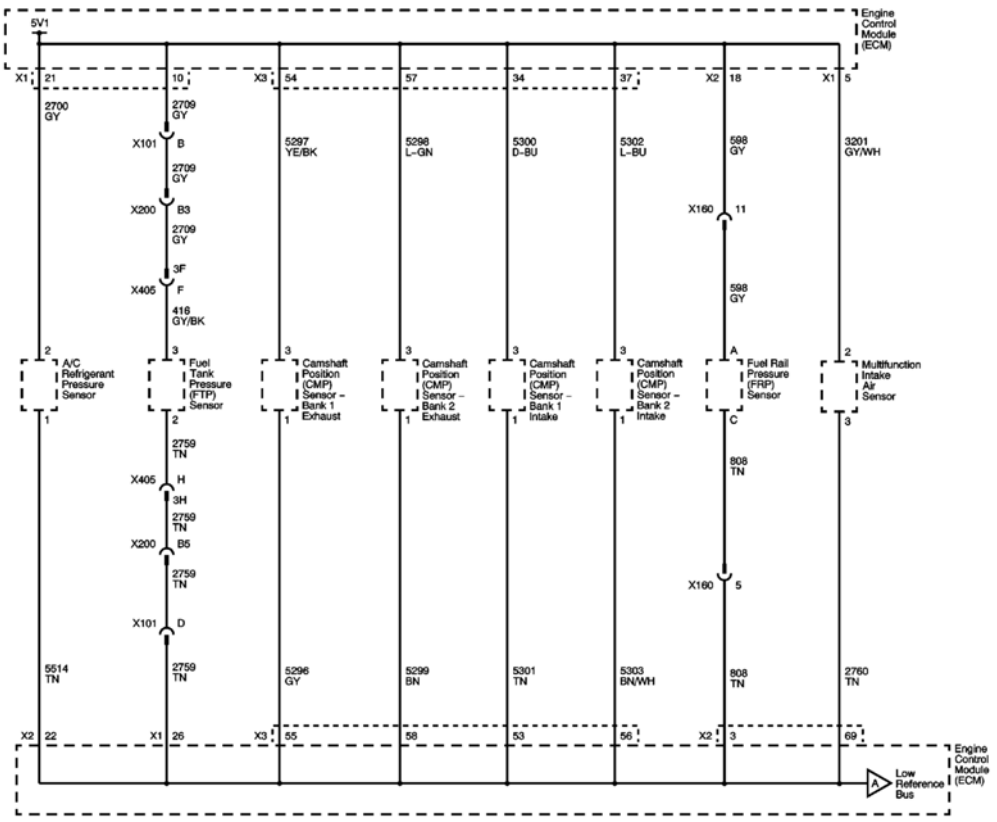


Fig. 2: 5V1 and Low Reference Bus Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

5V2, 5V3, and Low Reference Bus (2 of 2)

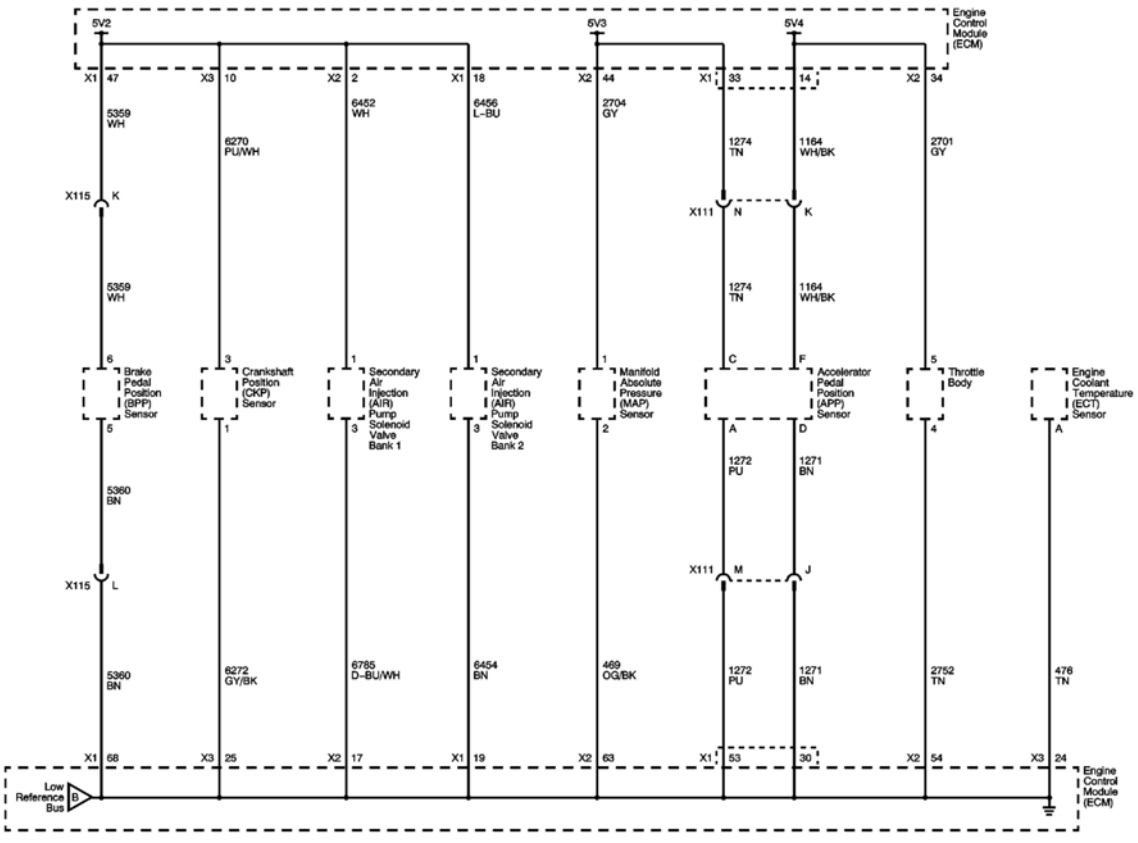


Fig. 3: 5V2, 5V3 and Low Reference Bus Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Pressure, Temperature, and Throttle Controls

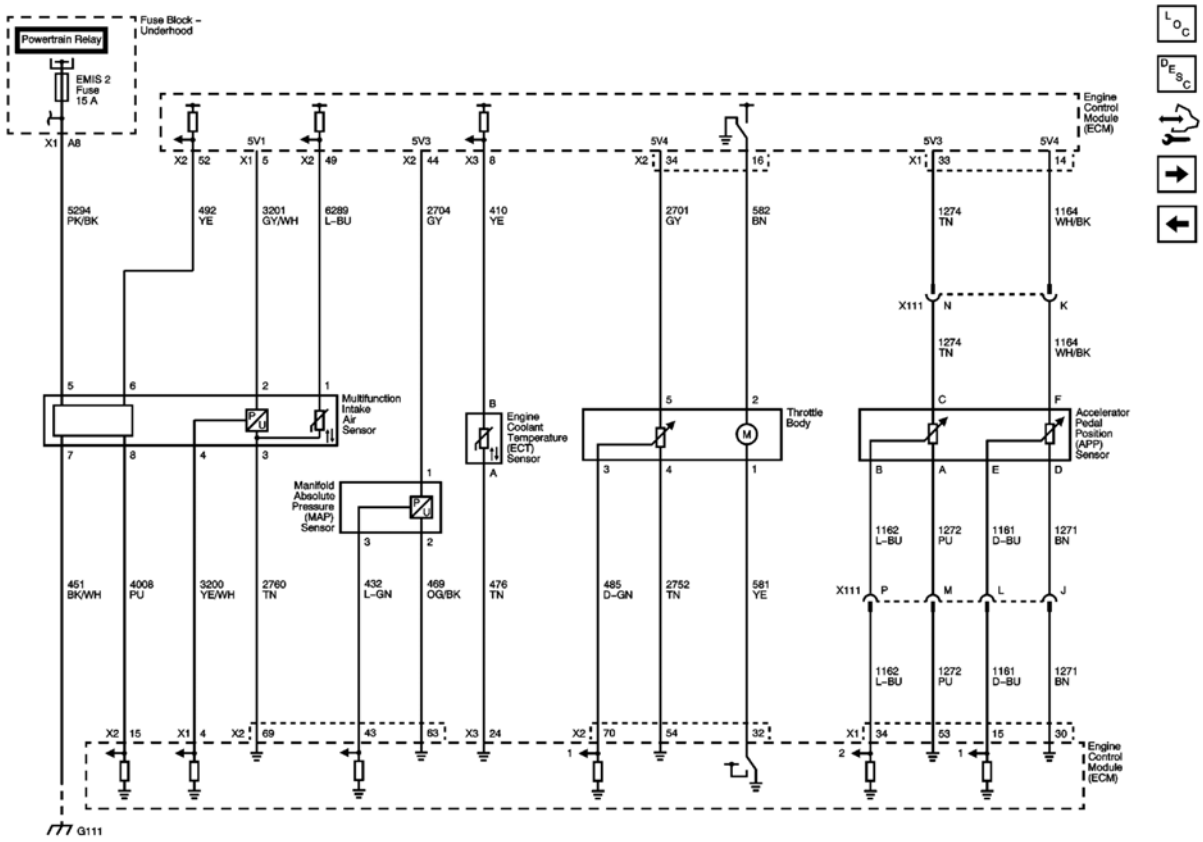


Fig. 4: Engine Data Sensors - Pressure, Temperature, and Throttle Controls Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Engine Data Sensors - Heated Oxygen Sensors

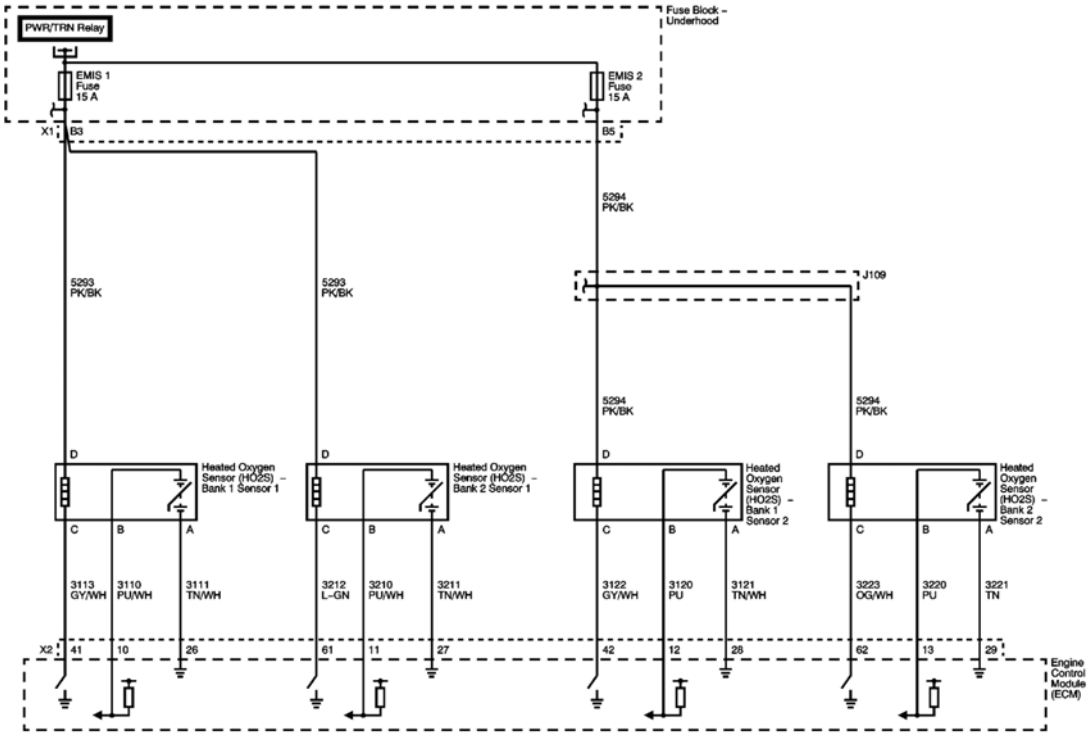


Fig. 5: Engine Data Sensors - Heated Oxygen Sensors Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Ignition System Coils 1, 3, and 5

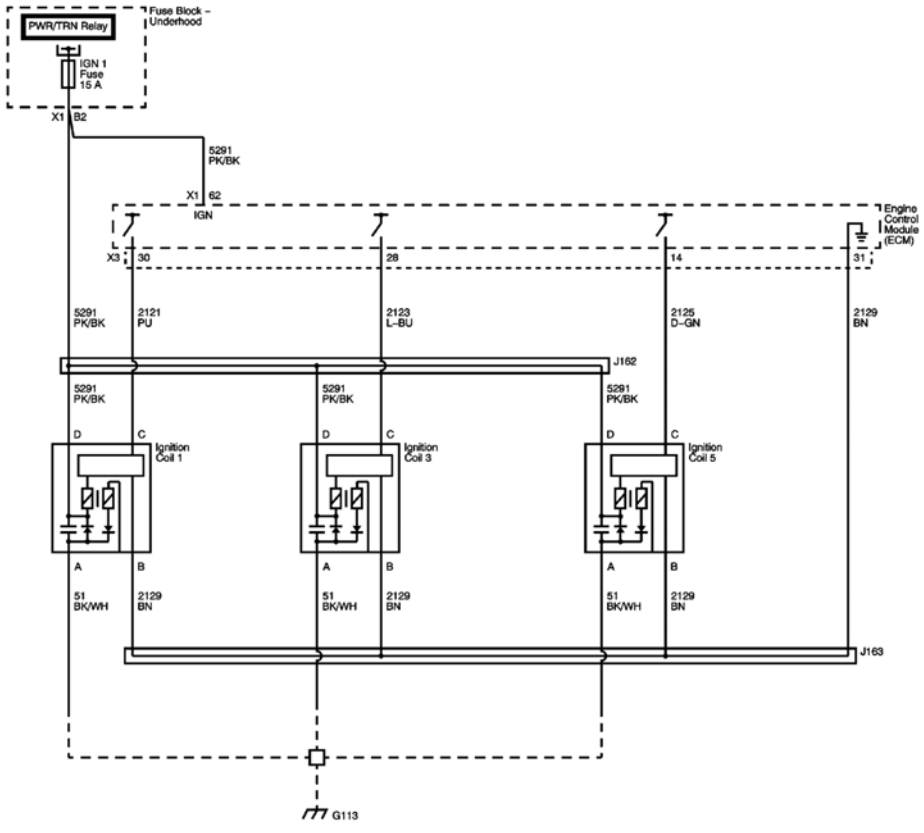


Fig. 6: Ignition Controls - Ignition System Coils 1, 3, and 5 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - Ignition System Coils 2, 4, and 6

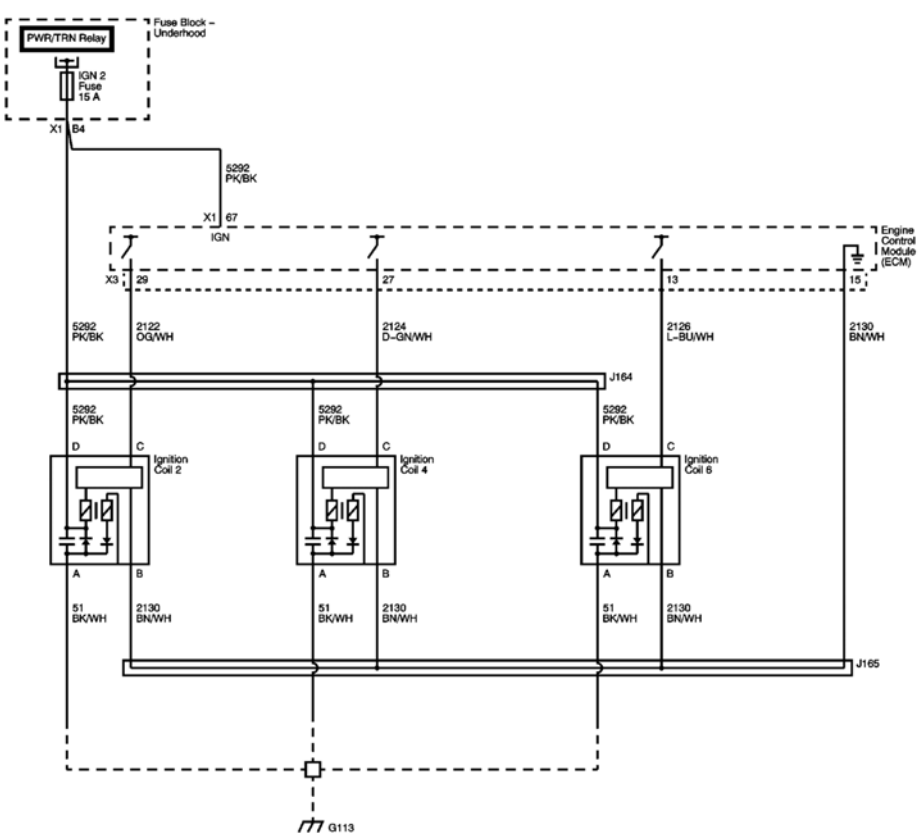


Fig. 7: Ignition Controls - Ignition System Coils 2, 4, and 6 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Ignition Controls - CKP, CMP, and Knock Sensors, CMP Actuators

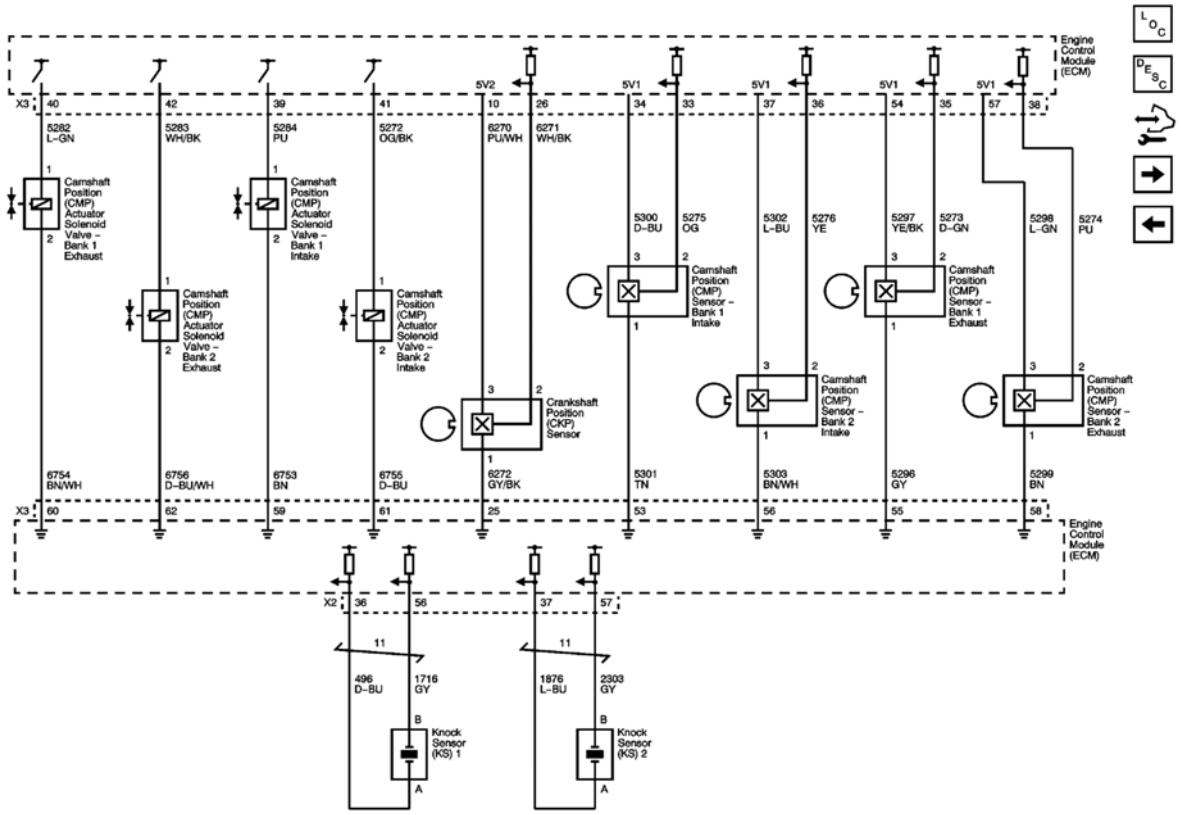


Fig. 8: Ignition Controls - CKP, CMP, and Knock Sensors, CMP Actuators Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Injectors, FRP Sensor, and High Pressure Fuel Pump

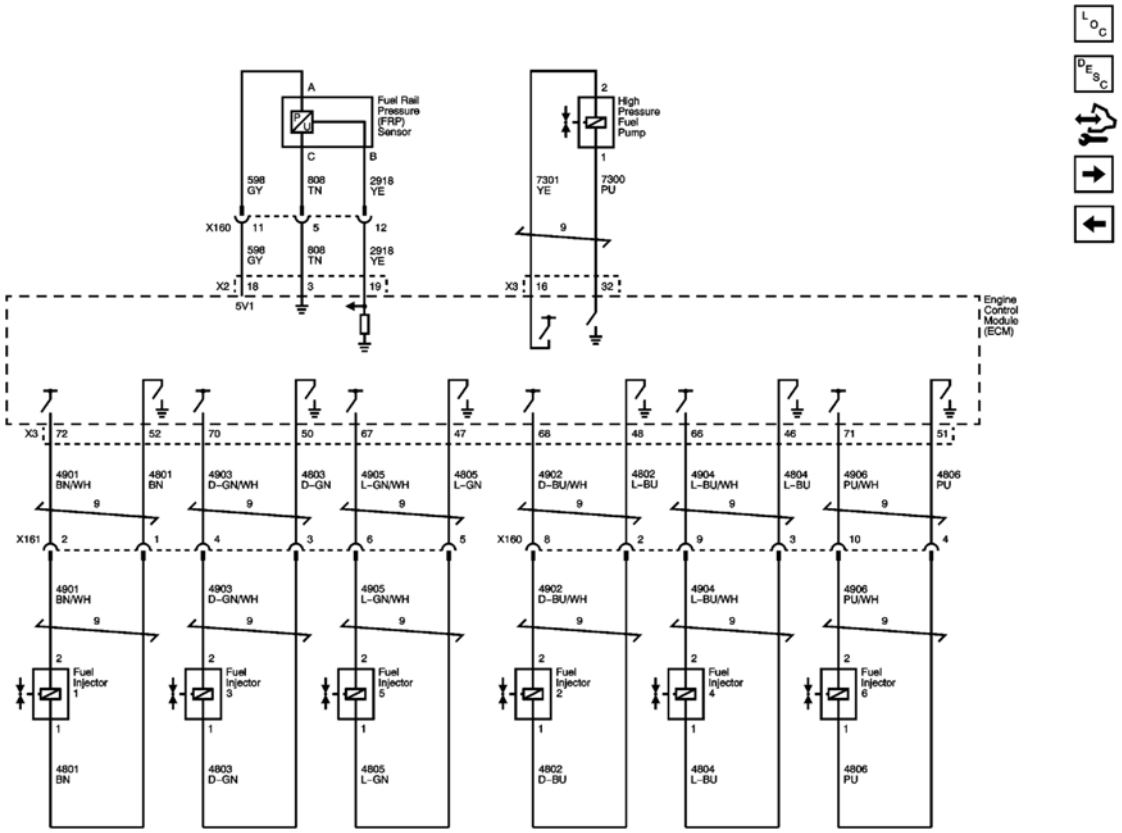


Fig. 9: Fuel Controls - Fuel Injectors, FRP Sensor, and High Pressure Fuel Pump Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls - Fuel Pump Flow Control

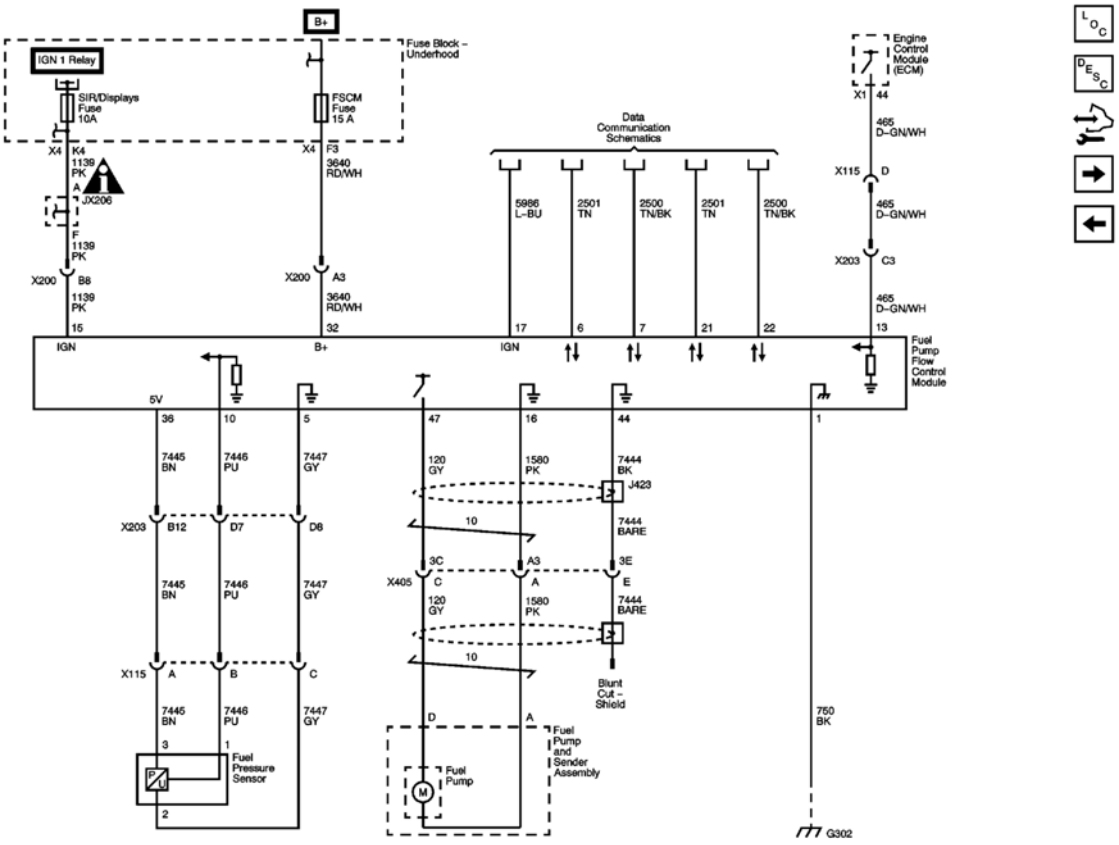


Fig. 10: Fuel Controls - Fuel Pump Flow Control Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Fuel Controls- EVAP Controls, Fuel Composition, and FTP Sensors

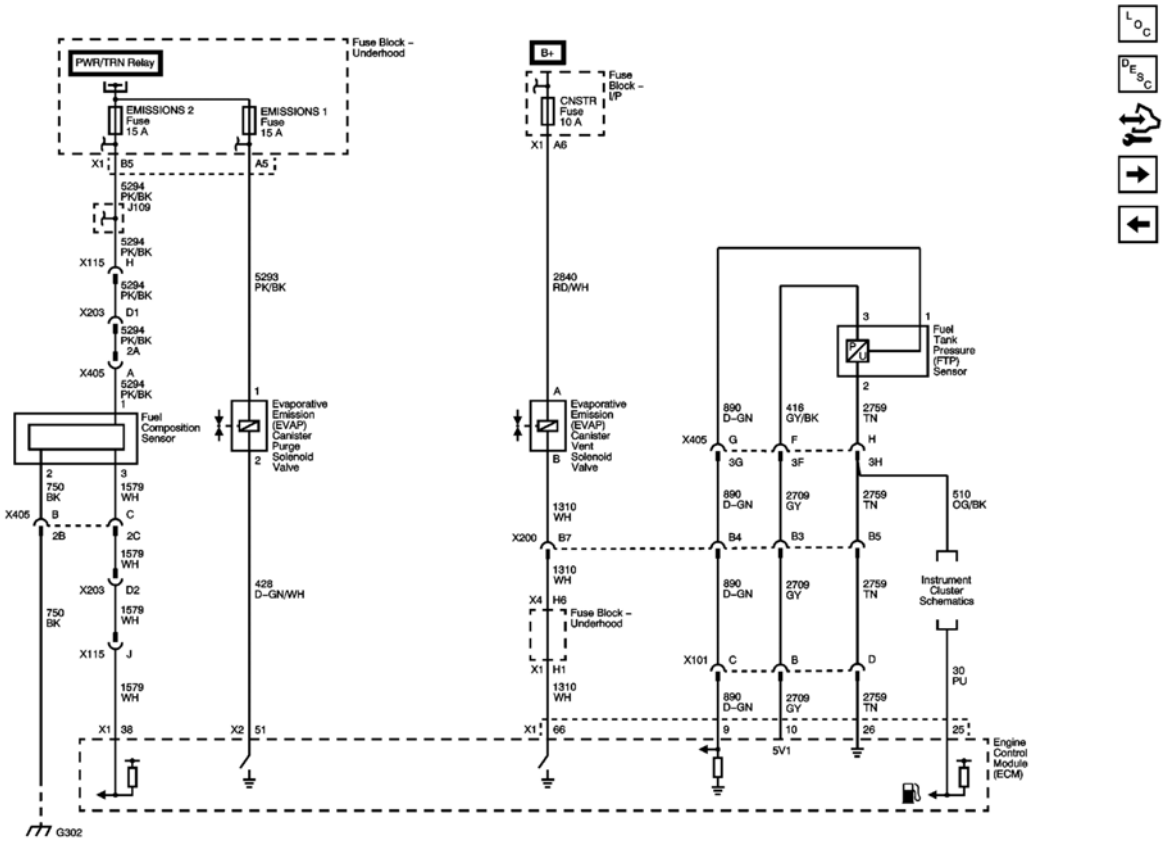


Fig. 11: Fuel Controls -- EVAP Controls, Fuel Composition, and FTP Sensors Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Secondar Air Injection- NU5 or NU6

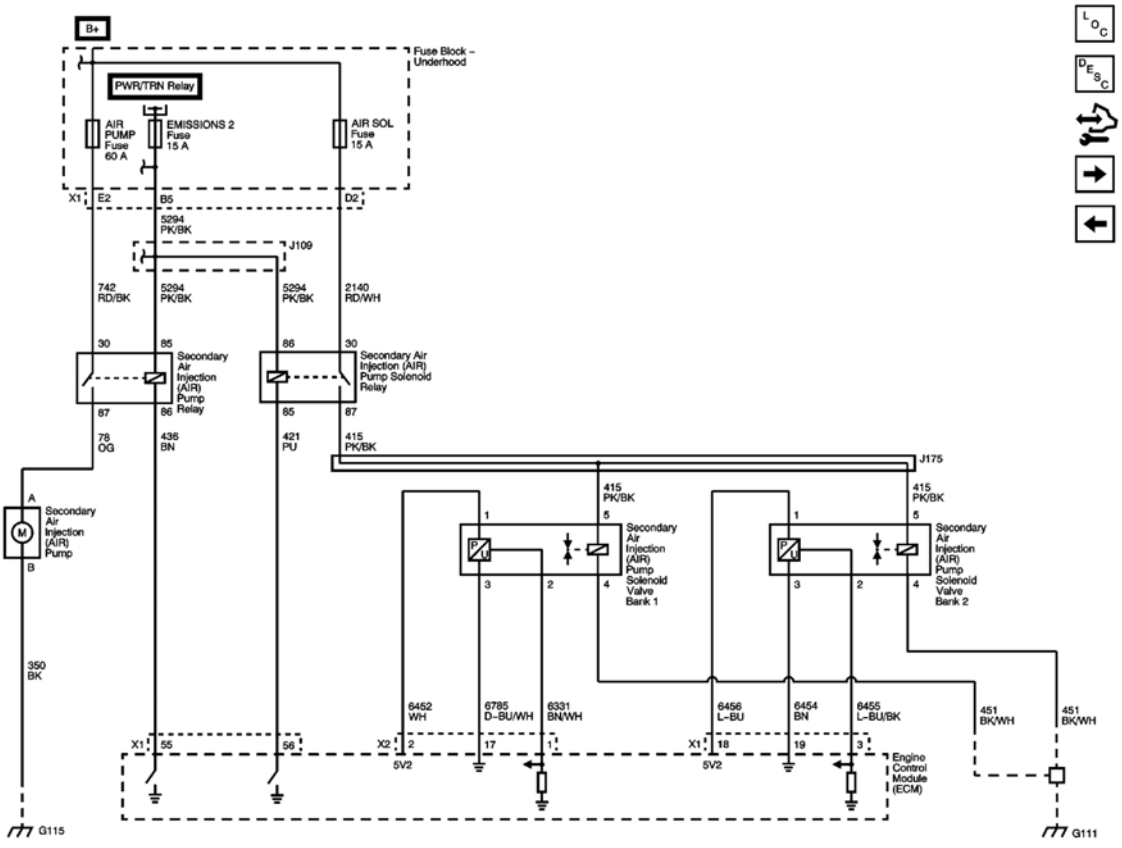


Fig. 12: Secondary Air Injection -- NU5 or NU6 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Monitored/Controlled Subsystem References

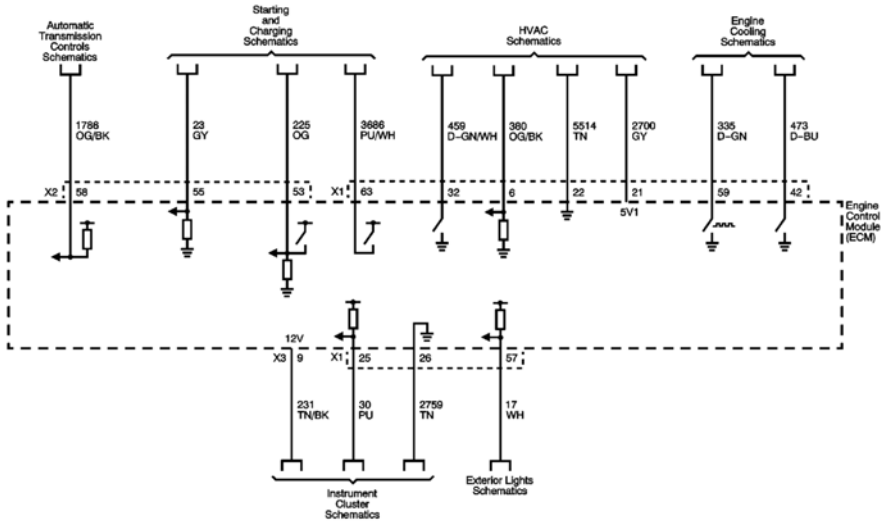


Fig. 13: Monitored/Controlled Subsystem References Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Article GUID: A00737193

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS (DIAGNOSTIC TOOLS)

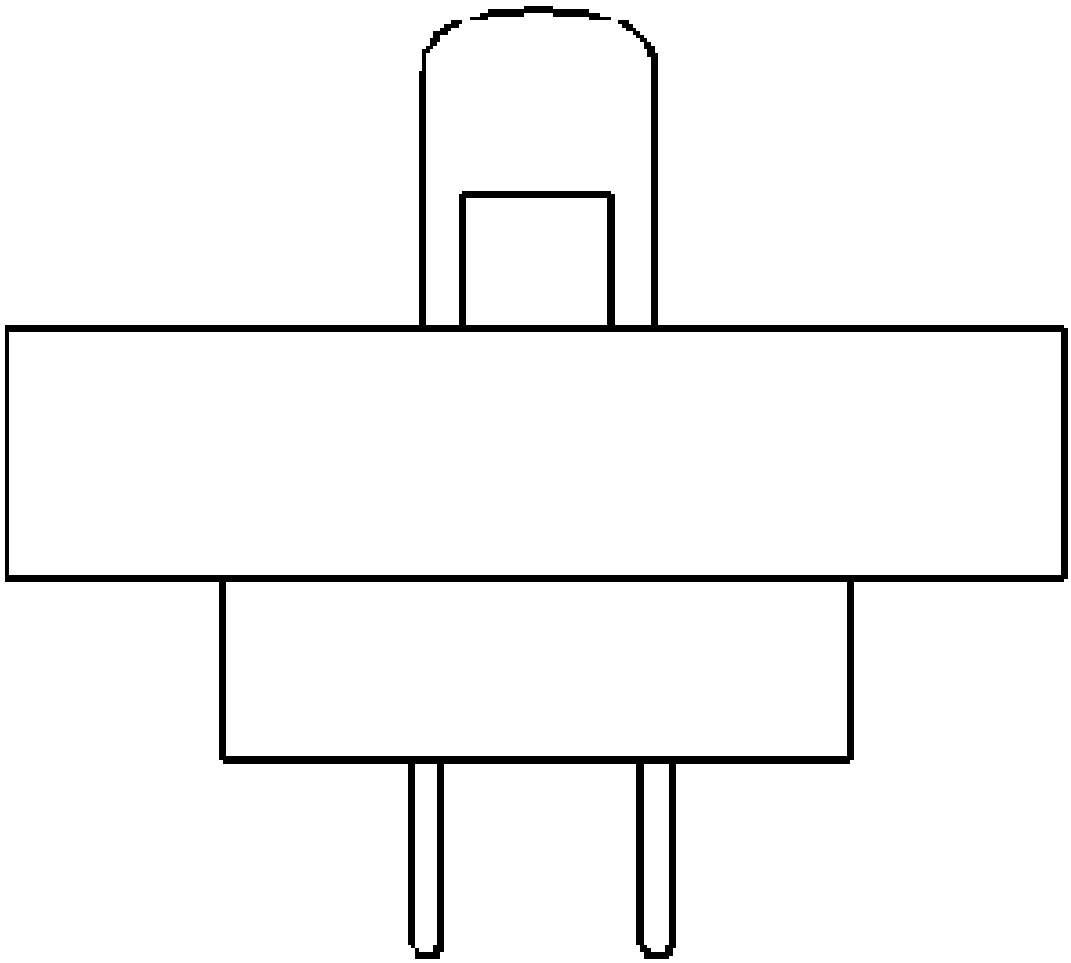
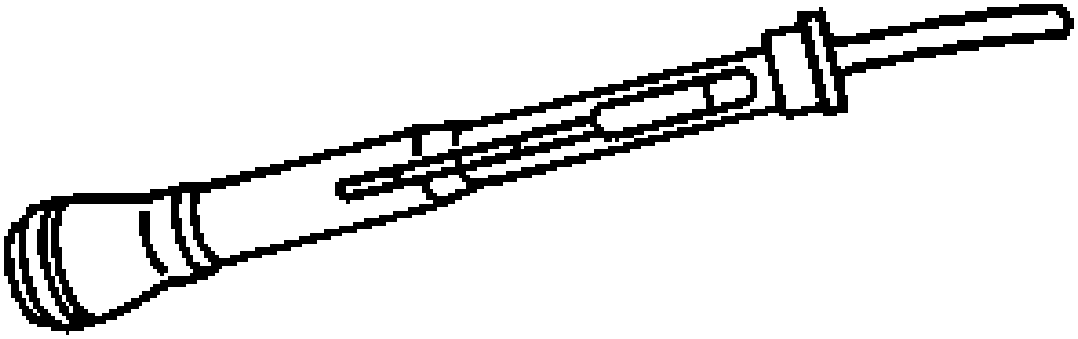
Illustration	Tool Number/Description
	CH-34730-2C J-34730-2C Injector Test Lamp

Illustration	Tool Number/Description
	CH-37287-1A Fuel Pressure Gauge Adapter 3/8"

Illustration	Tool Number/Description
	CH-38641-B J-38641-B Diesel Fuel Quality Tester

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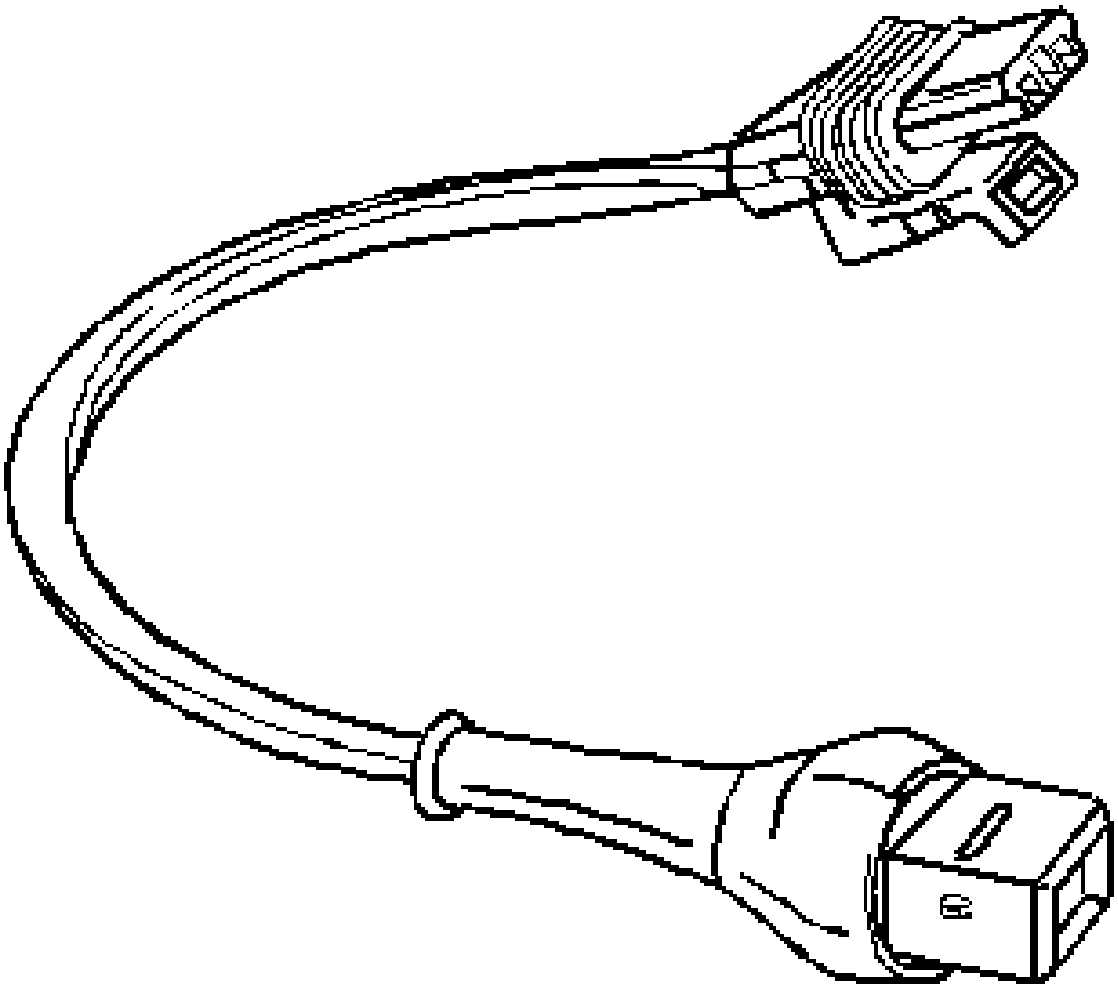	CH-39021-301 J-39021-301 Fuel Injector Harness Adapter

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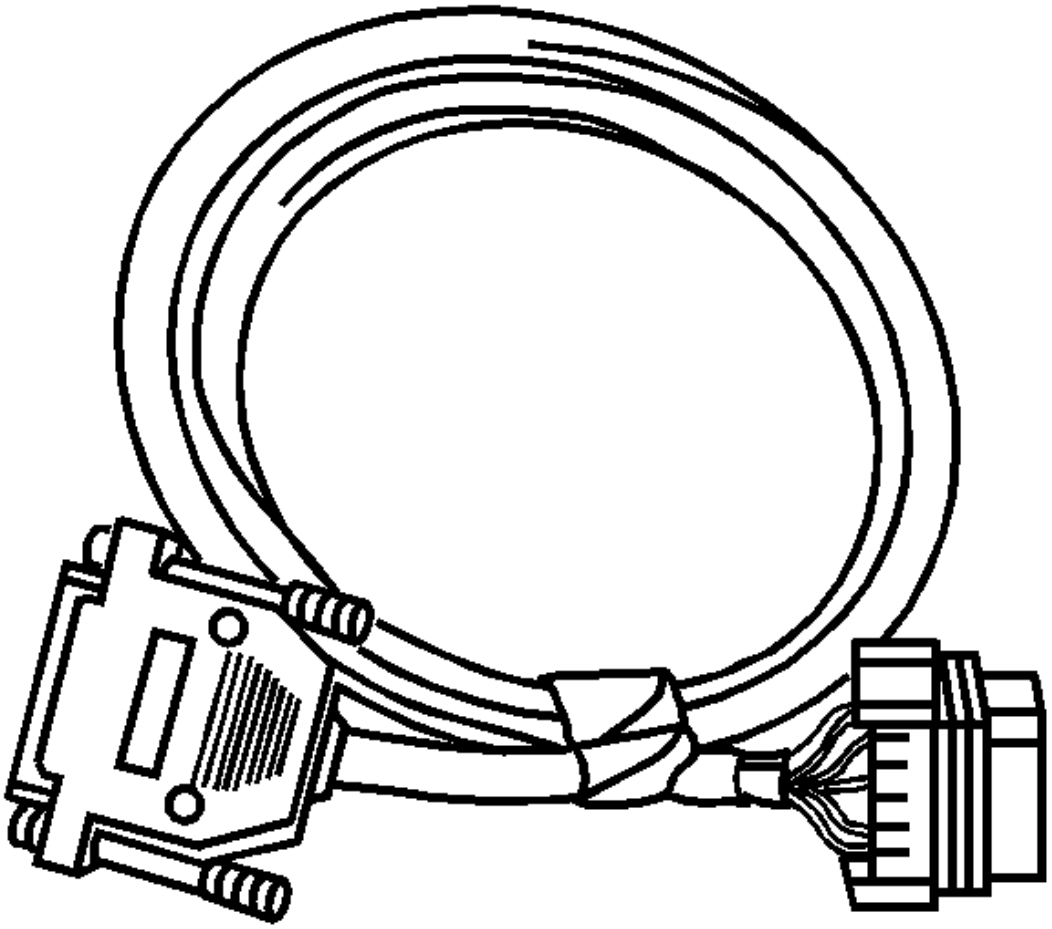	CH-39021-460 J-39021-460 Fuel Injector Test Adapter

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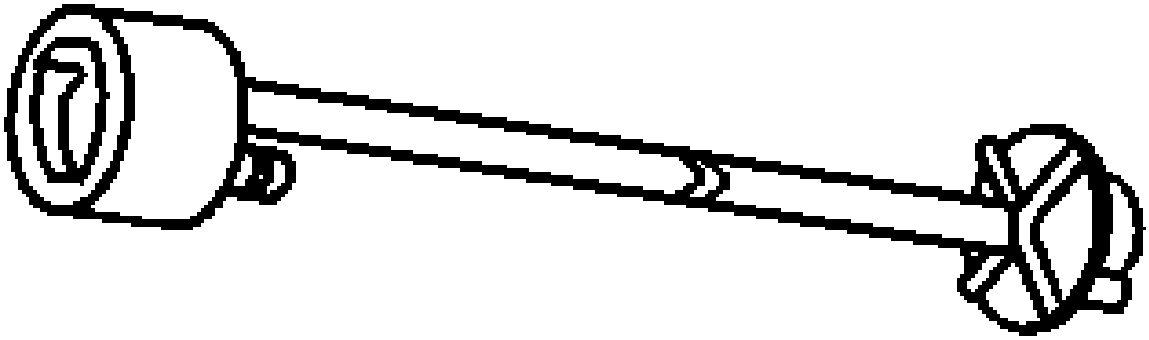	CH-41415-30 GE-41415-30 J-41415-30 Fuel Tank Cap Adapter

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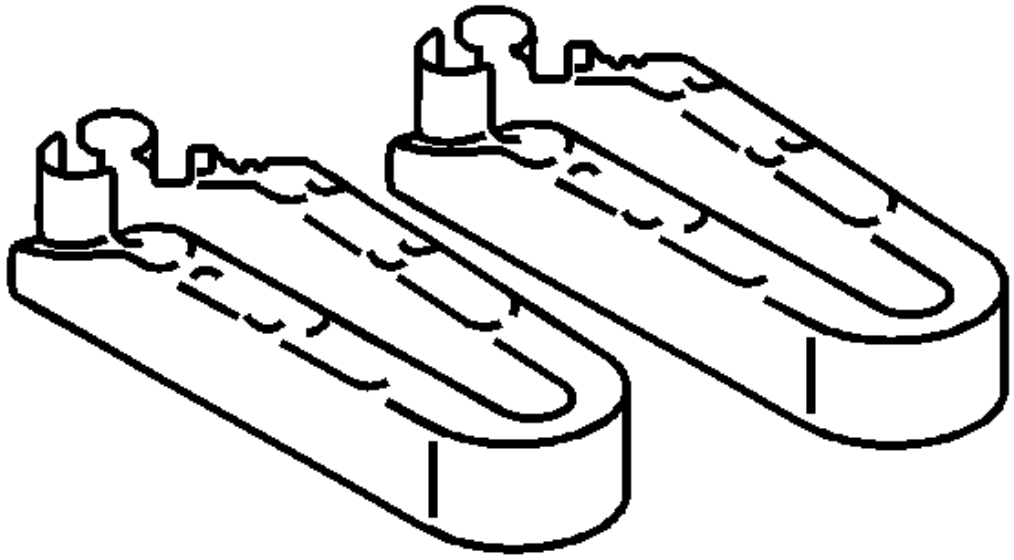	CH-41769 J-41769 Fuel Line Quick Disconnect Tool

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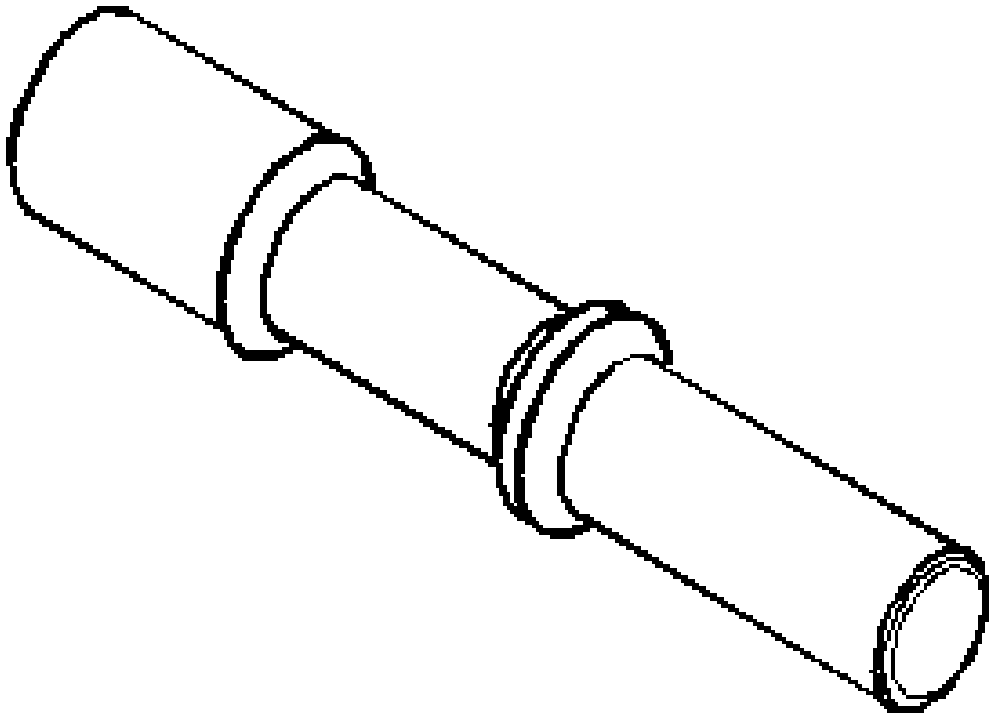	CH-42960-2 J-42960-2 Fuel Flapper Door Holder

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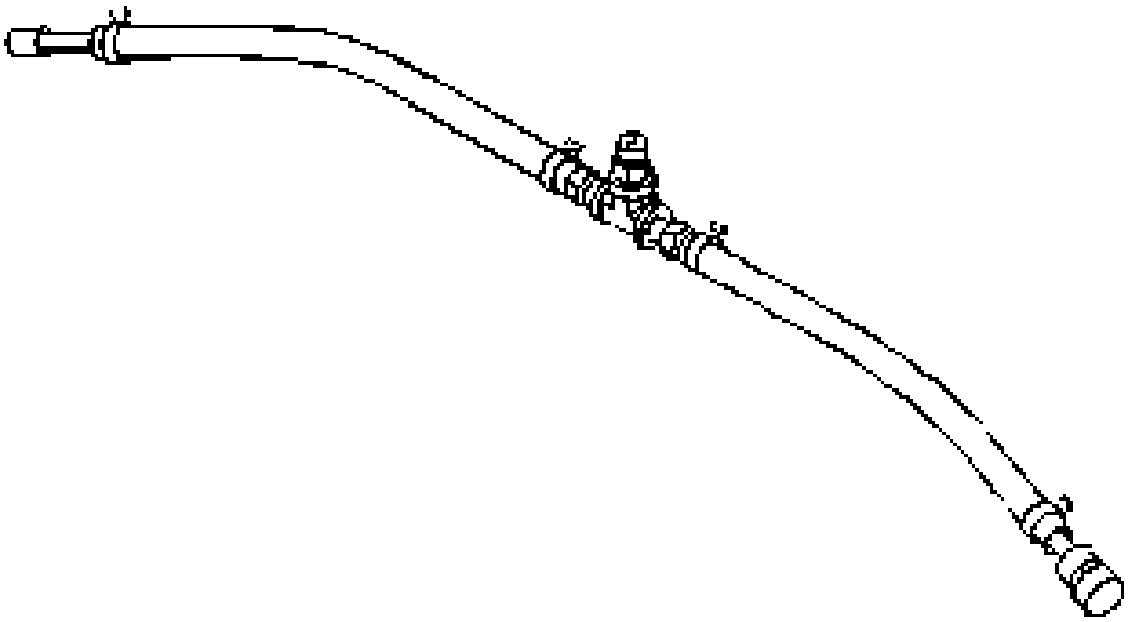
	CH-42982 J-42982 Fuel Pressure Gauge Adapter

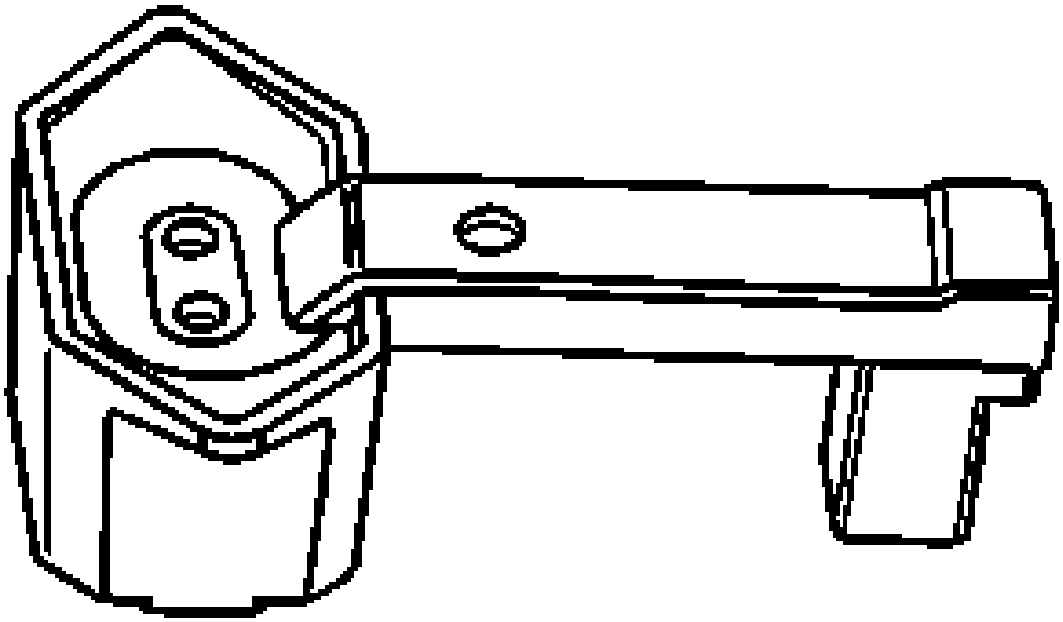
Illustration	Tool Number/Description
	CH-44175-A J-44175-A Fuel Composition Tester

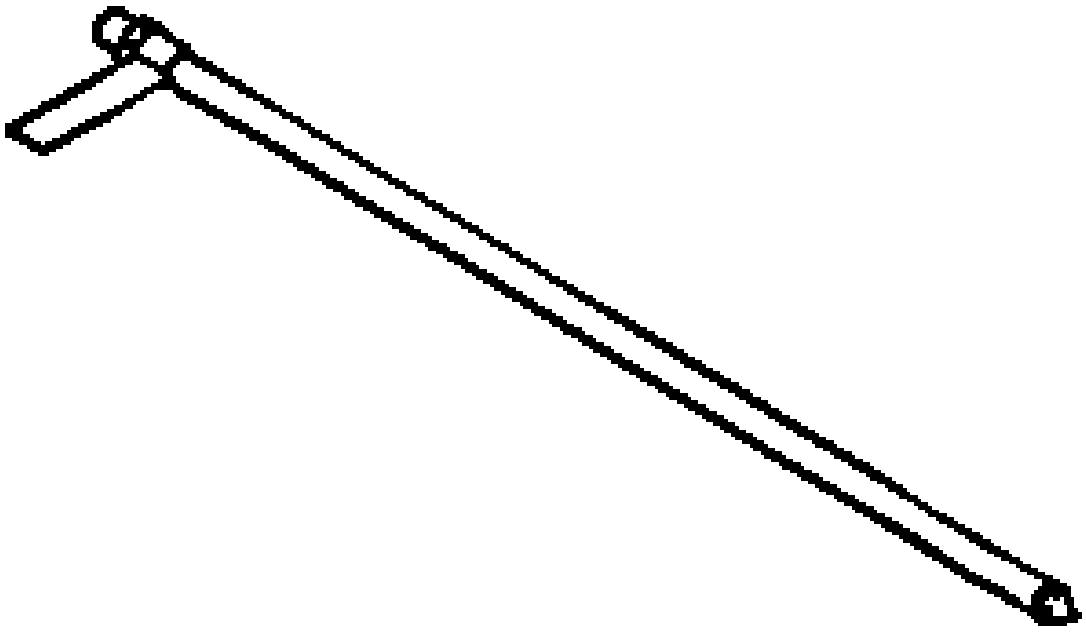
Illustration	Tool Number/Description
	CH-45004 J-45004 Fuel Tank Drain Hose

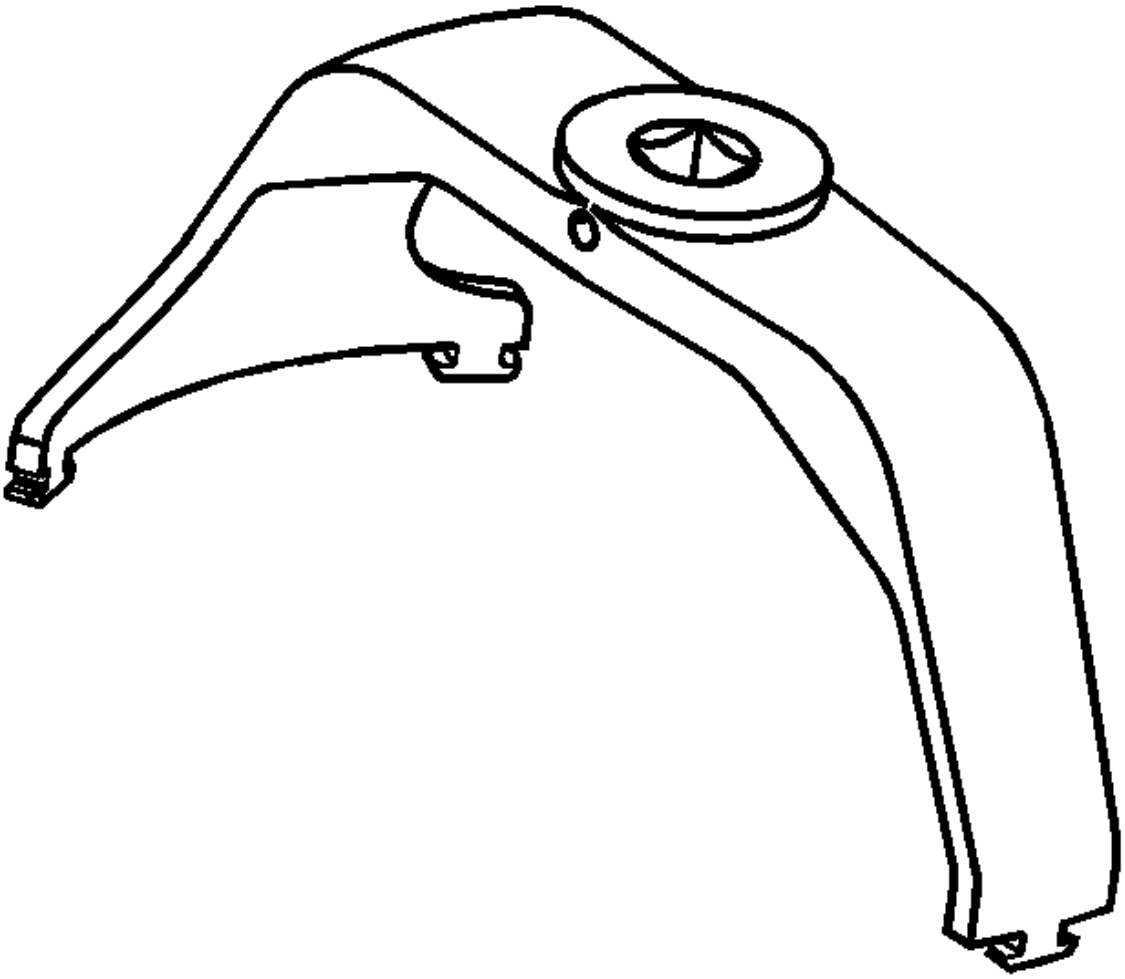
Illustration	Tool Number/Description
	CH-45722 J-45722 Fuel Sender Lock Ring Wrench

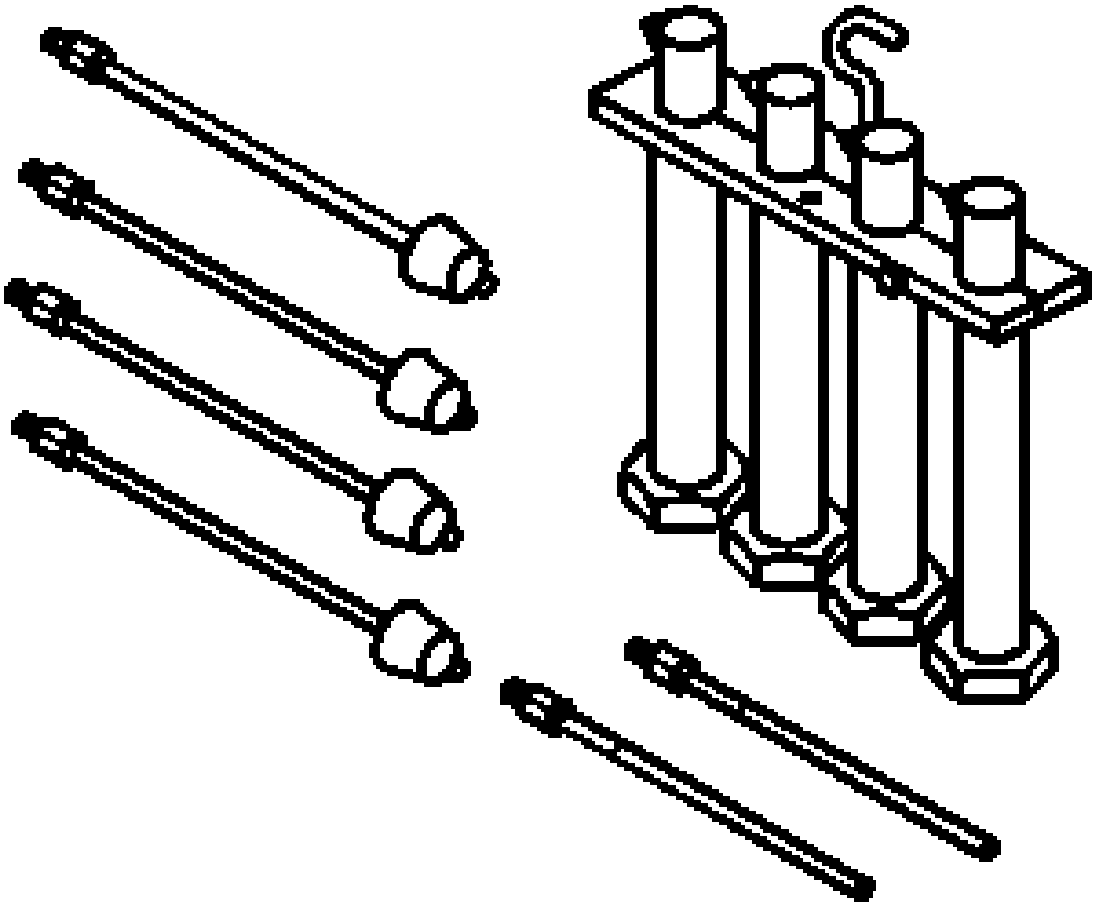
Illustration	Tool Number/Description
	CH-45873 J-45873 Fuel Return Volume Test Kit

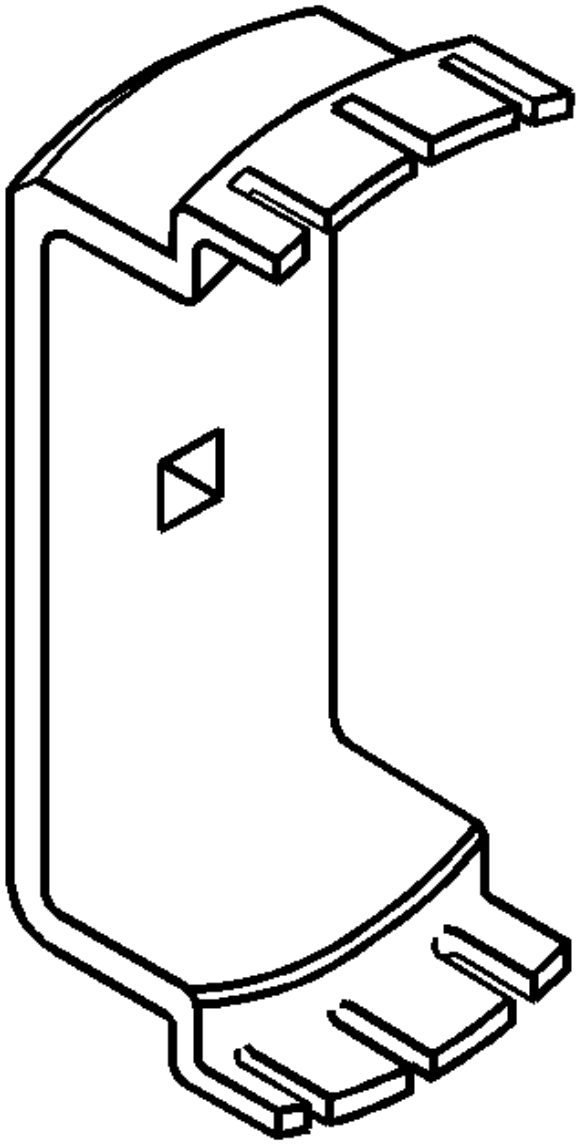
Illustration	Tool Number/Description
	CH-47717 Lock Ring Wrench

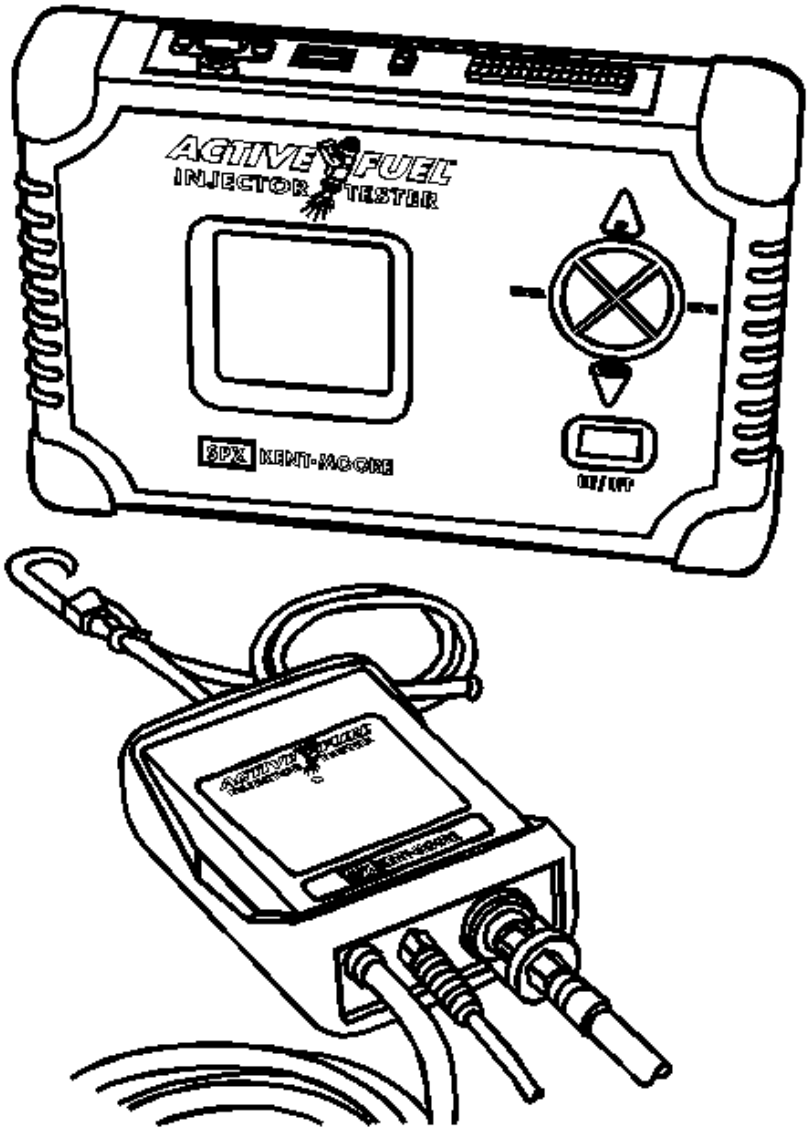
Illustration	Tool Number/Description
	CH-47976 Active Fuel Injector Tester (AFIT)

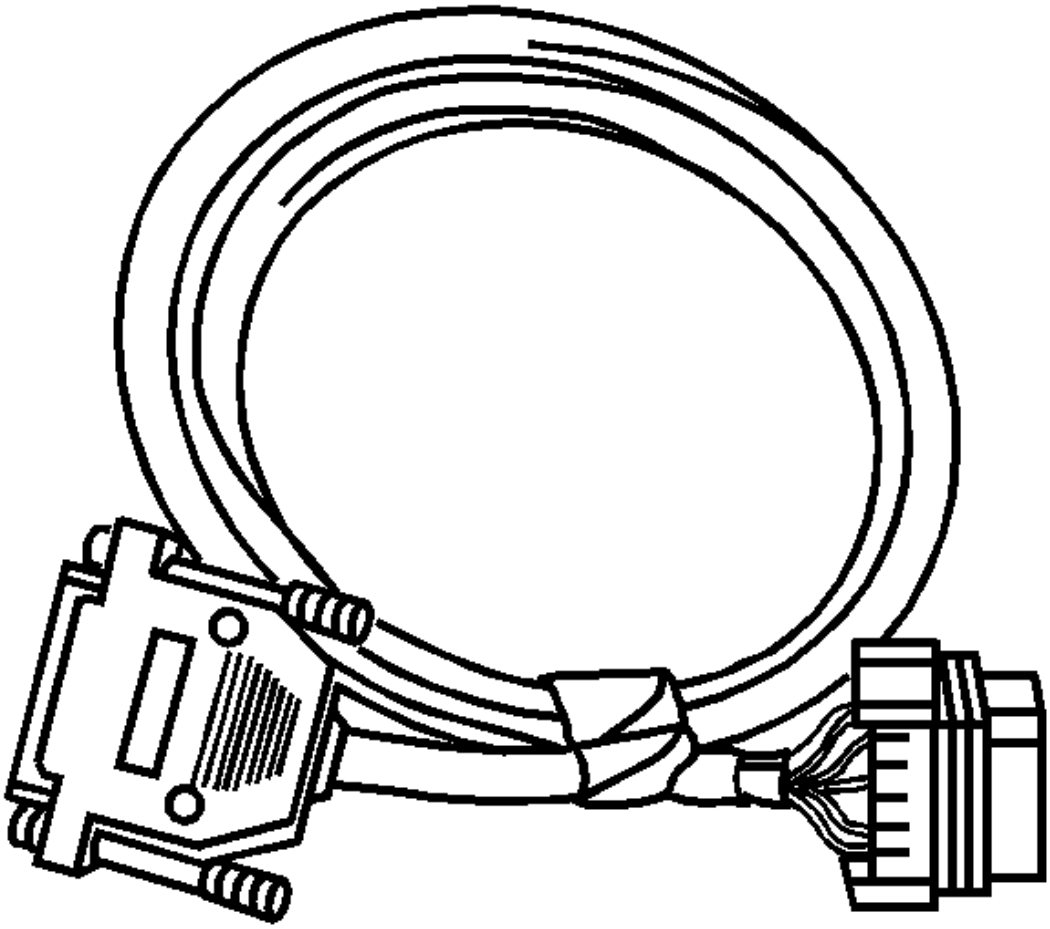
Illustration	Tool Number/Description
	CH-47976-75 Fuel Injector Harness Adapter

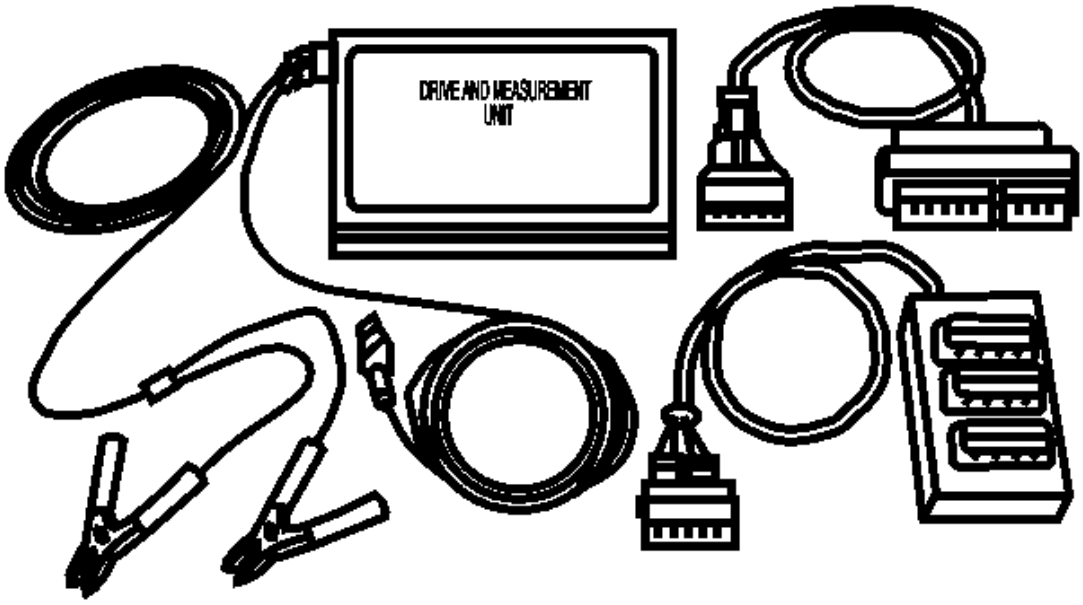
Illustration	Tool Number/Description
	CH-47976-500A Active Fuel Injection Tester (AFIT) SIDI Adapter Kit

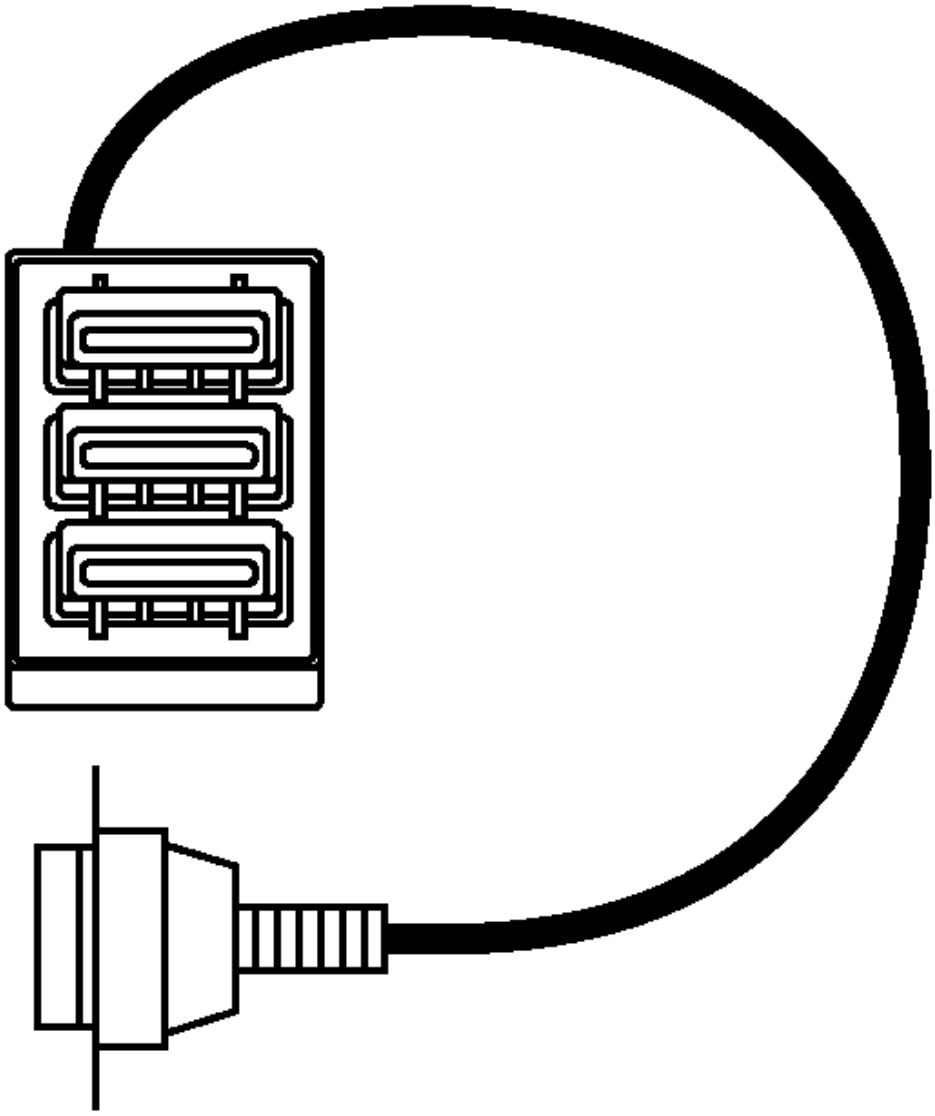
Illustration	Tool Number/Description
	CH-47976-502A AFIT SIDI E92 G2A Adapter Cable

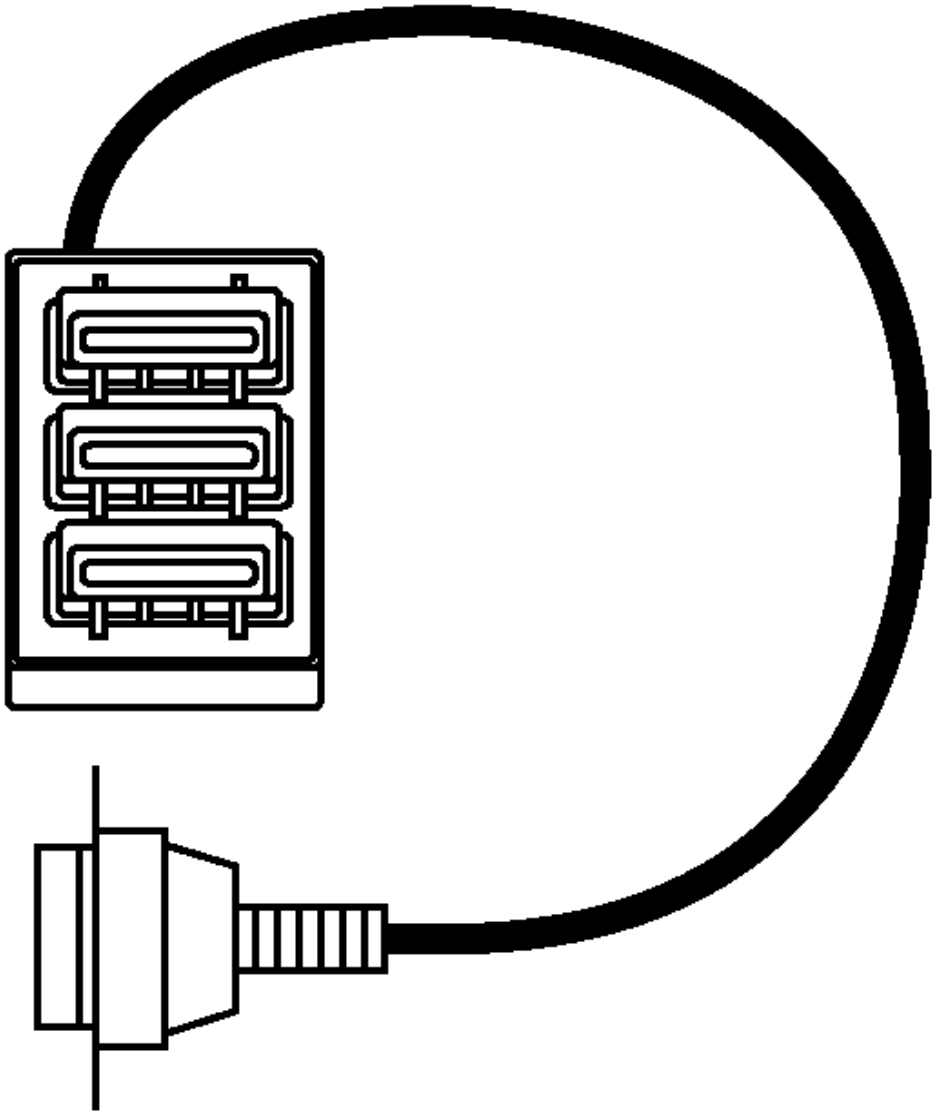
Illustration	Tool Number/Description
	CH-47976-503 AFIT SIDI E80 G3 Adapter Cable

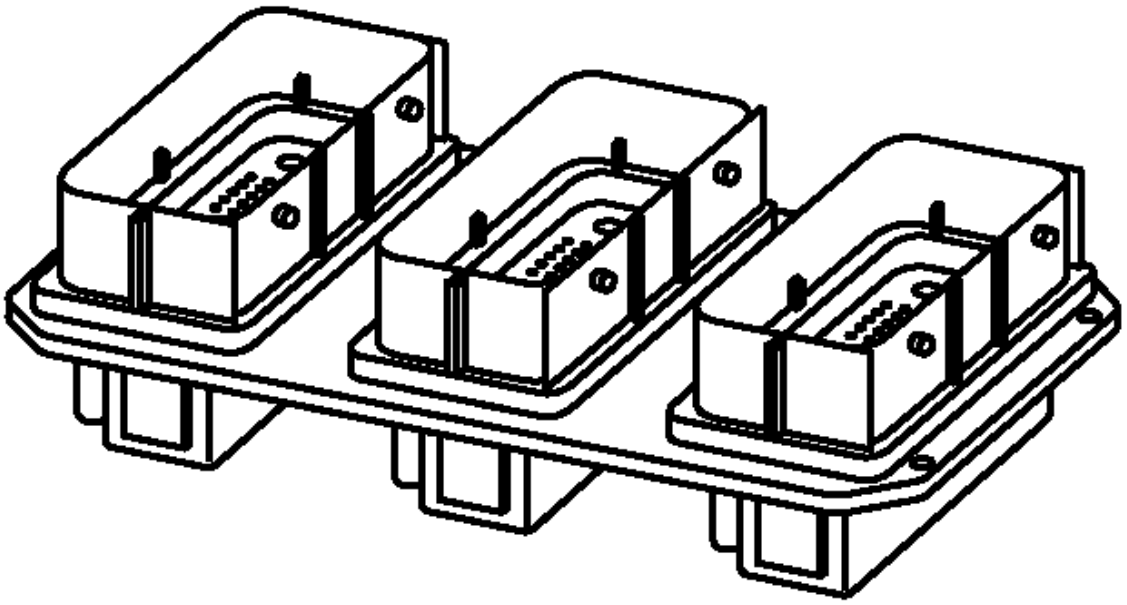
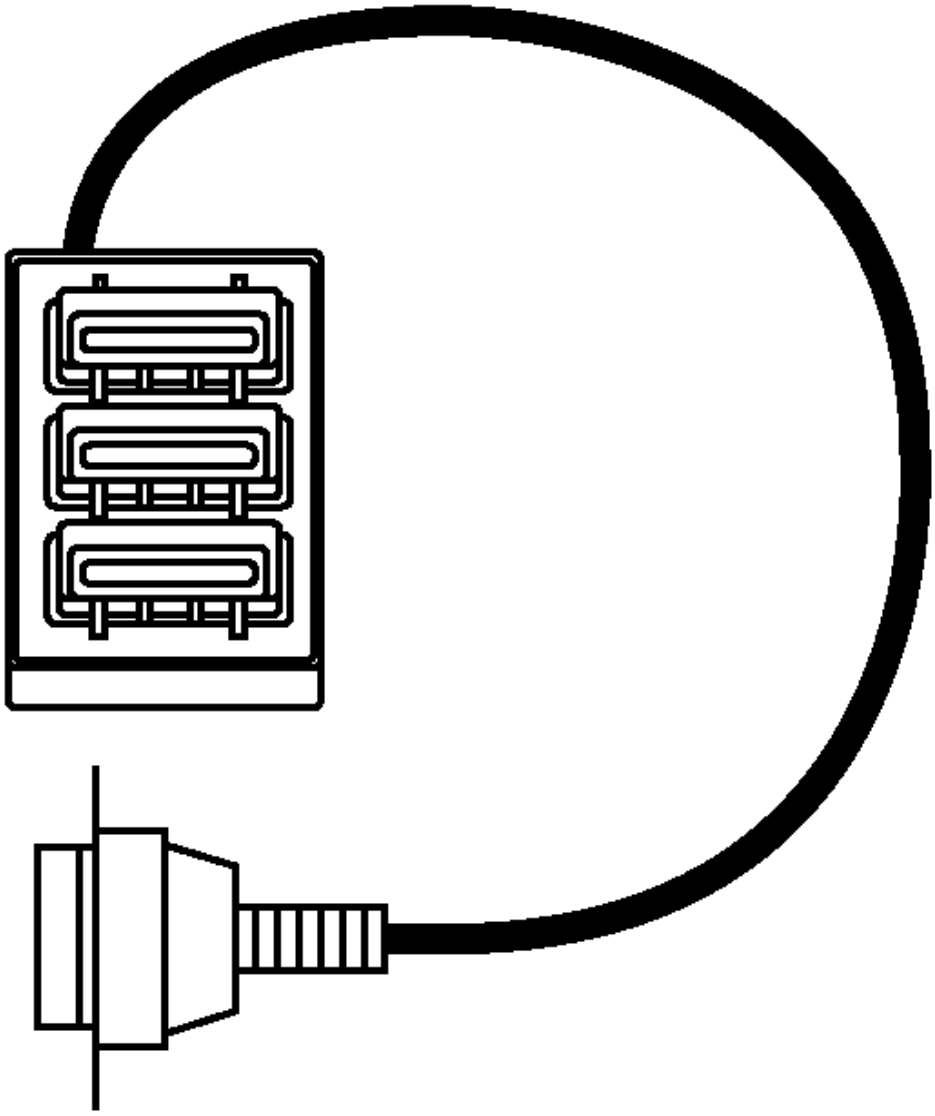
Illustration	Tool Number/Description
	CH-47976-504 E92/E39A G2B Start/Stop Adapter

Illustration	Tool Number/Description
	CH-47976-509 AFIT SIDI E81 G4 Adapter Cable

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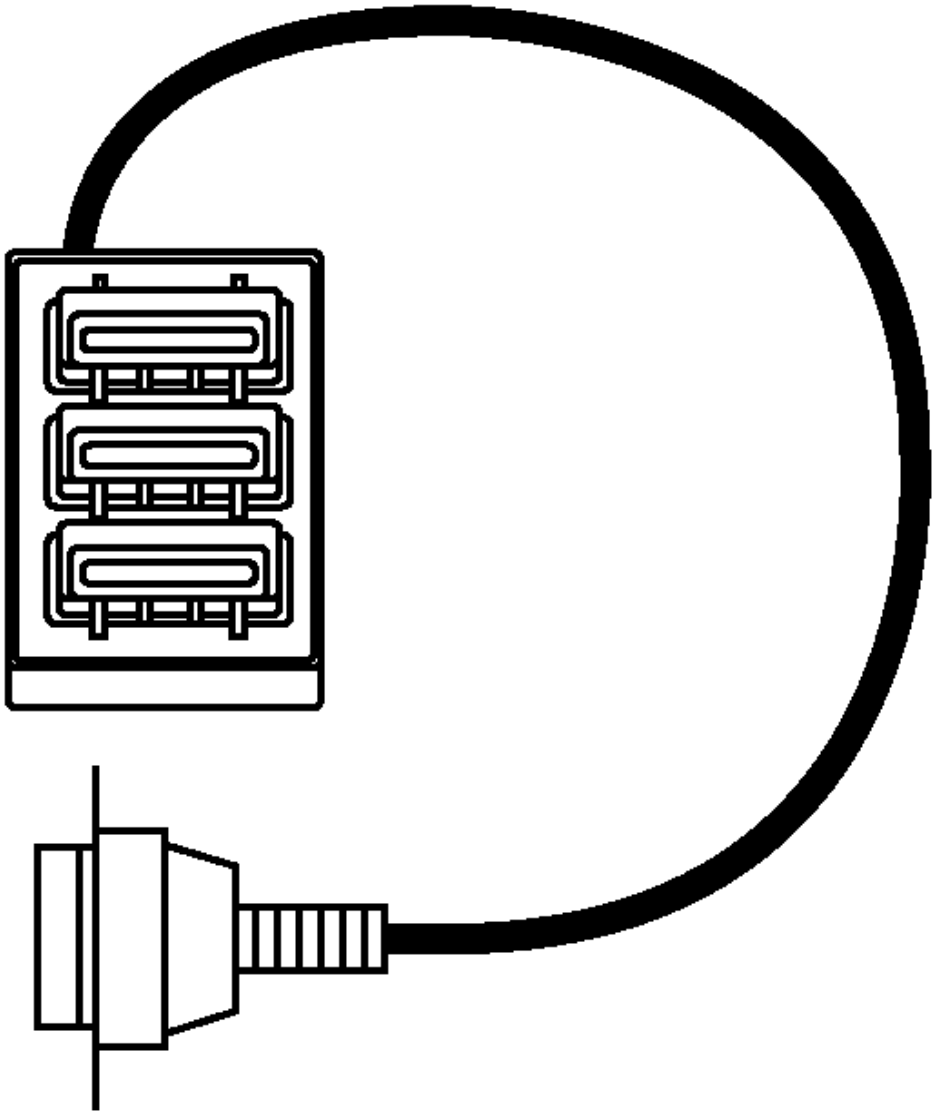	CH-47976-511 AFIT SIDI E82 G5 Adapter Cable

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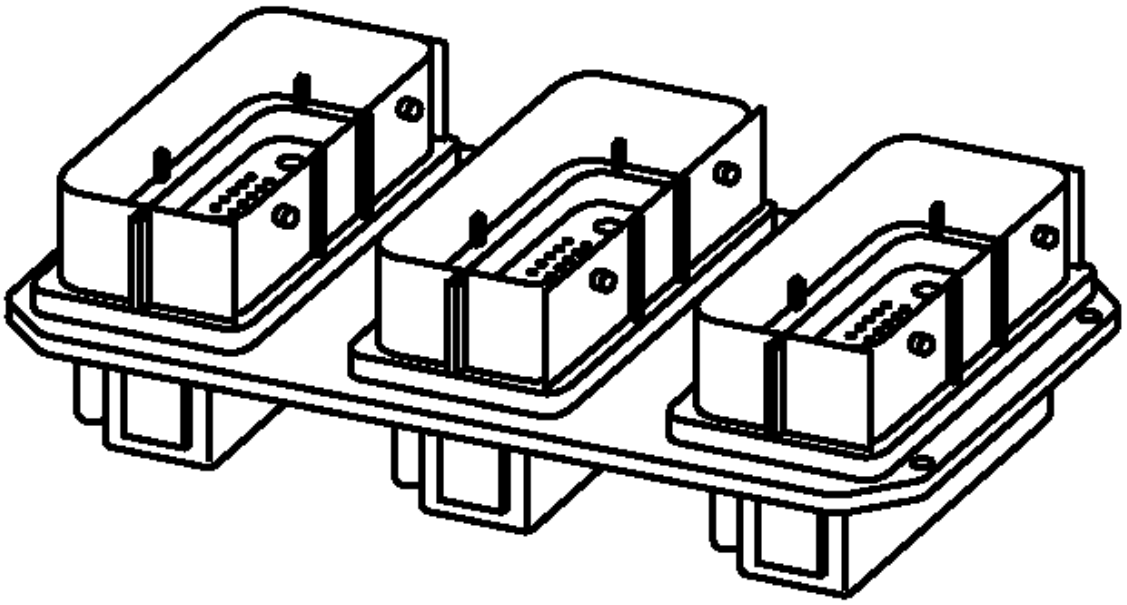	CH-47976-512 E80 G3B Stop/Start Adapter

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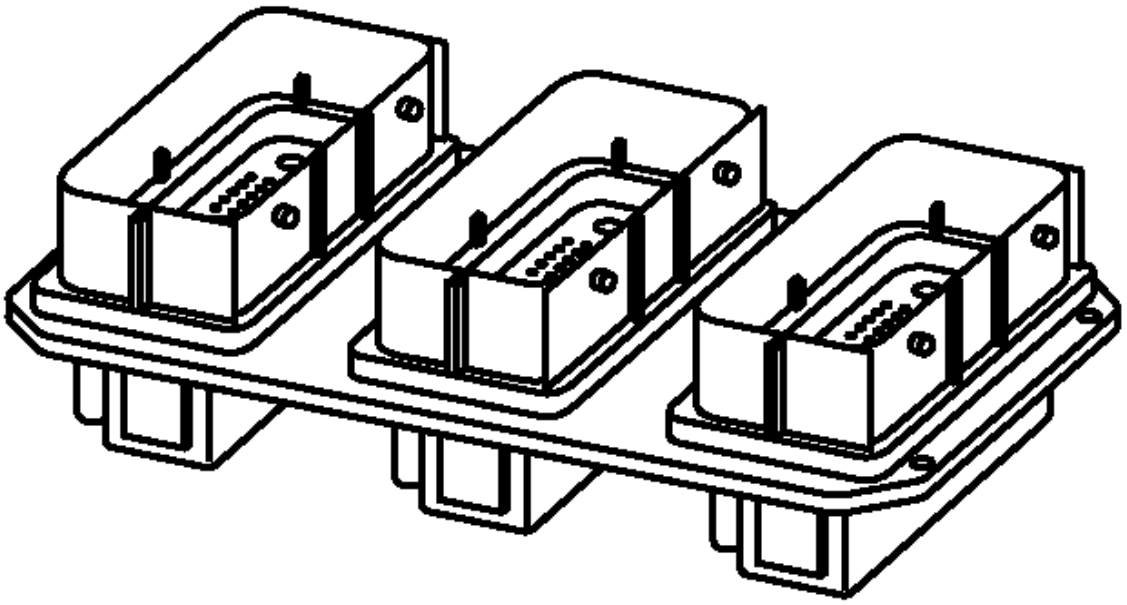
	CH-47976-513 E92 G2C Stop/Start and SENT Adapter

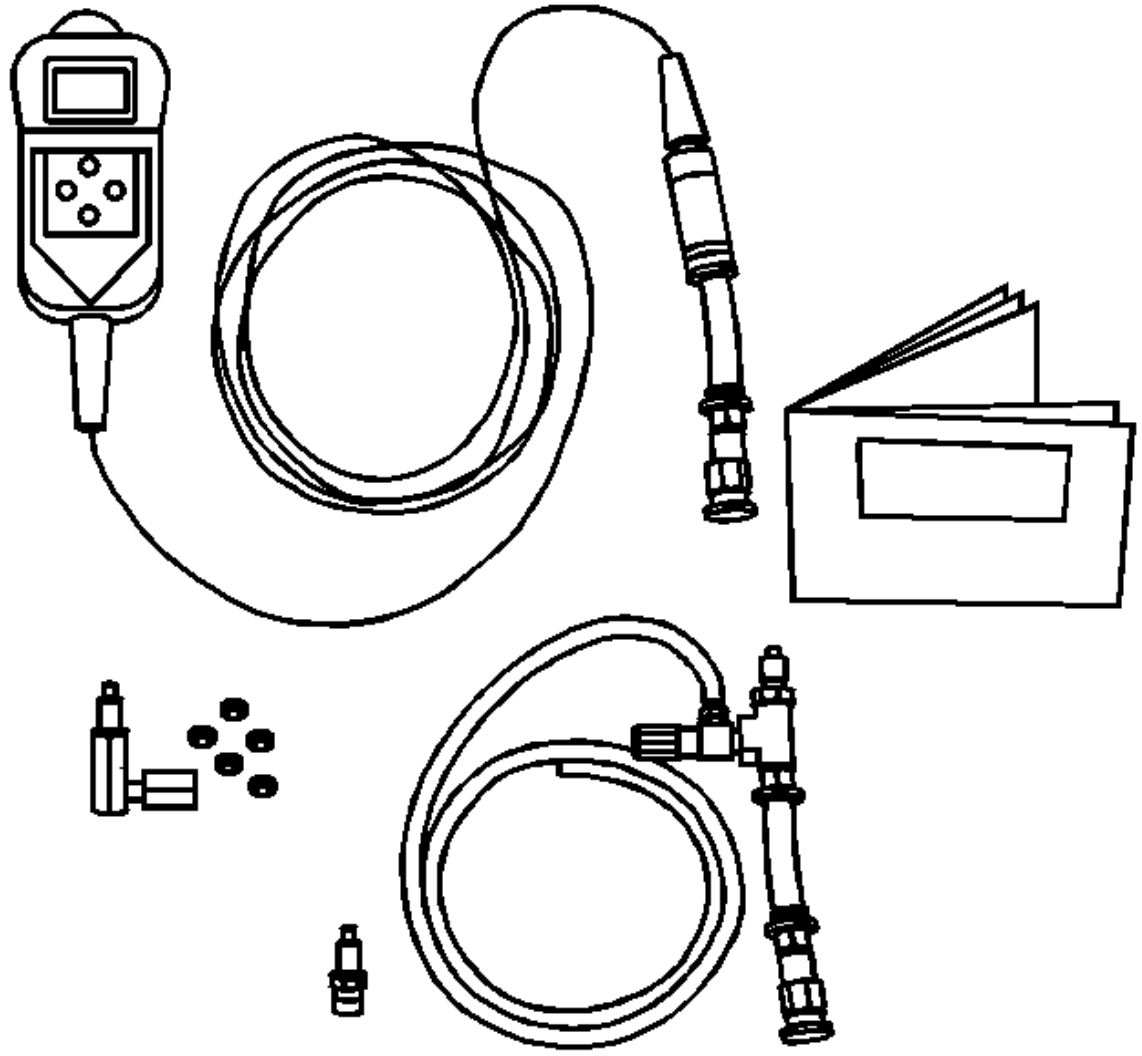
Illustration	Tool Number/Description
	CH-48027 Fuel Pressure Gauge

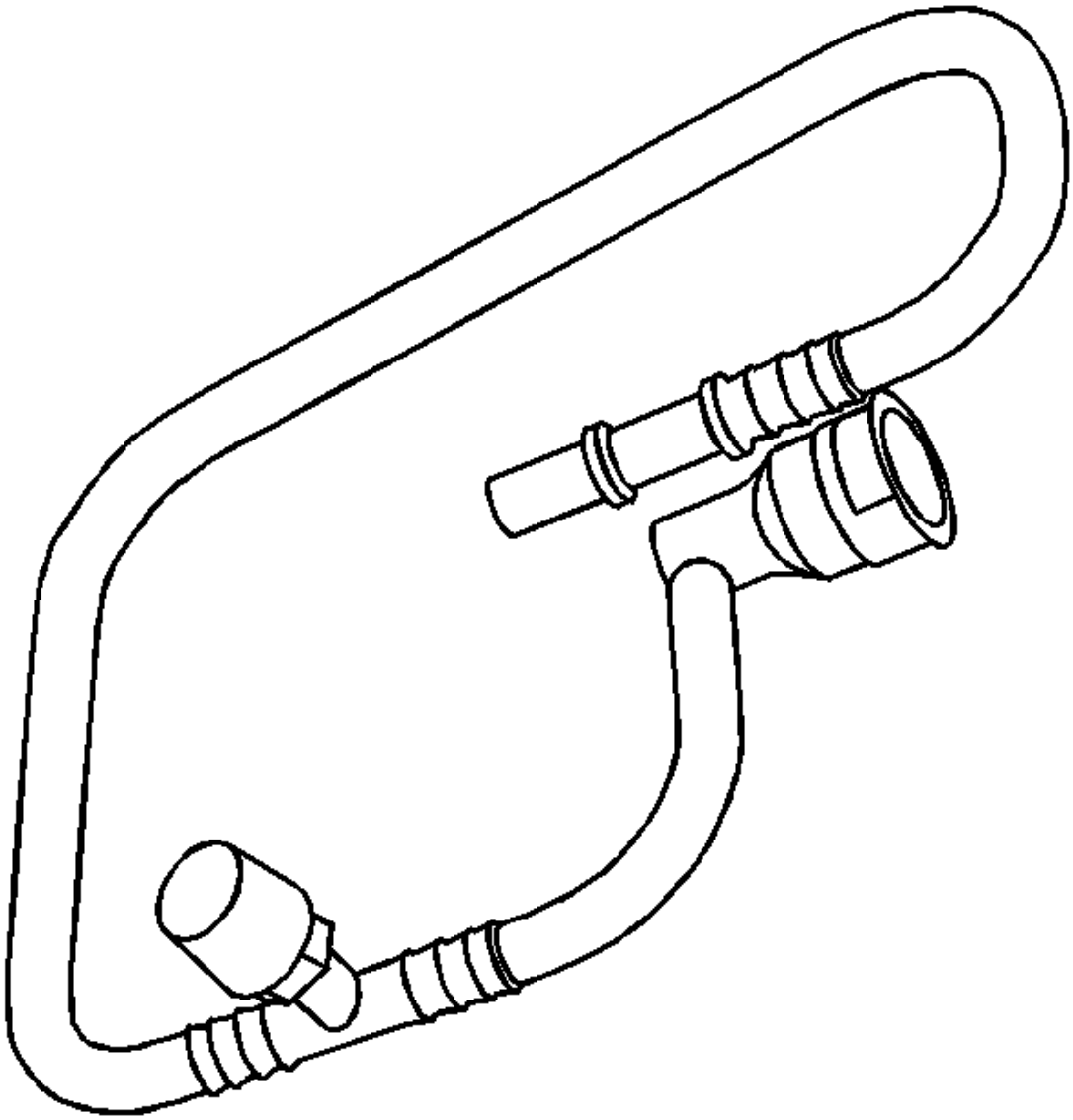
Illustration	Tool Number/Description
	CH-48096 EVAP Service Access Port Tool

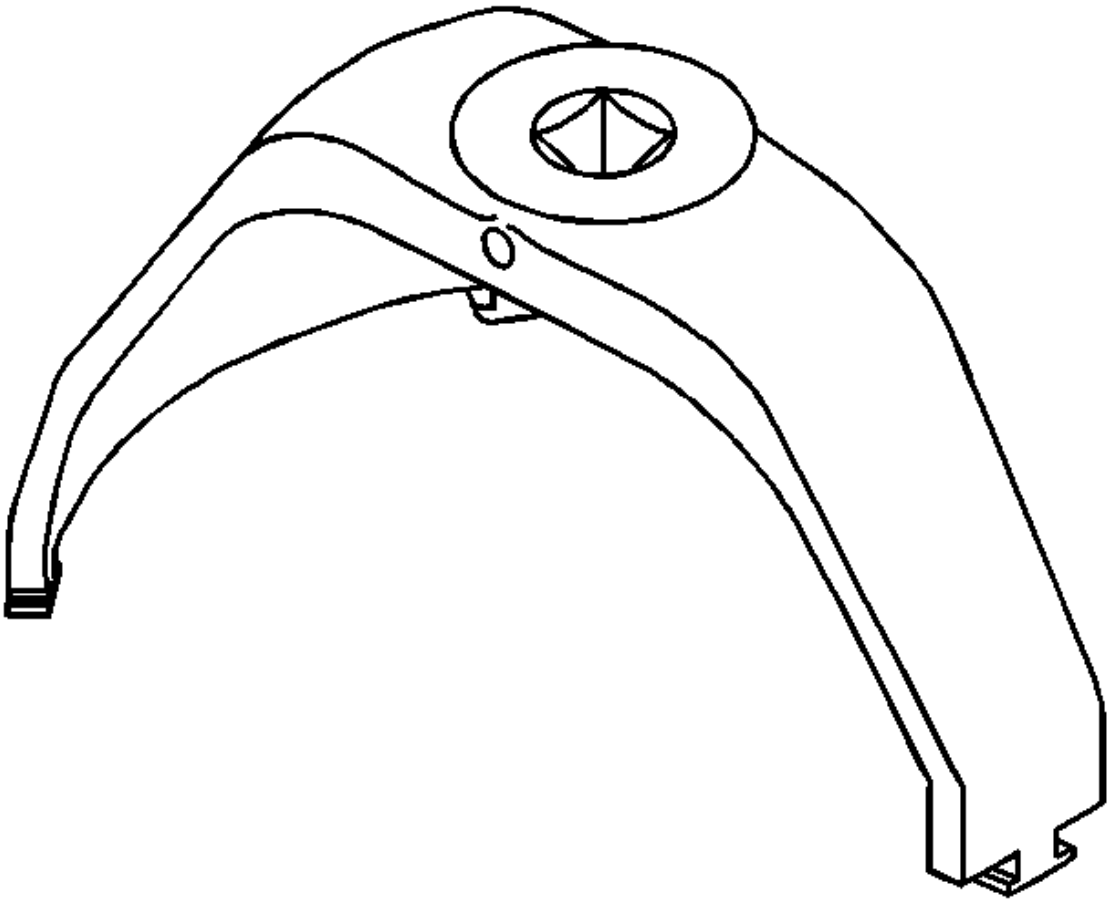
Illustration	Tool Number/Description
	CH-48482 Fuel Sender Lock Ring Wrench

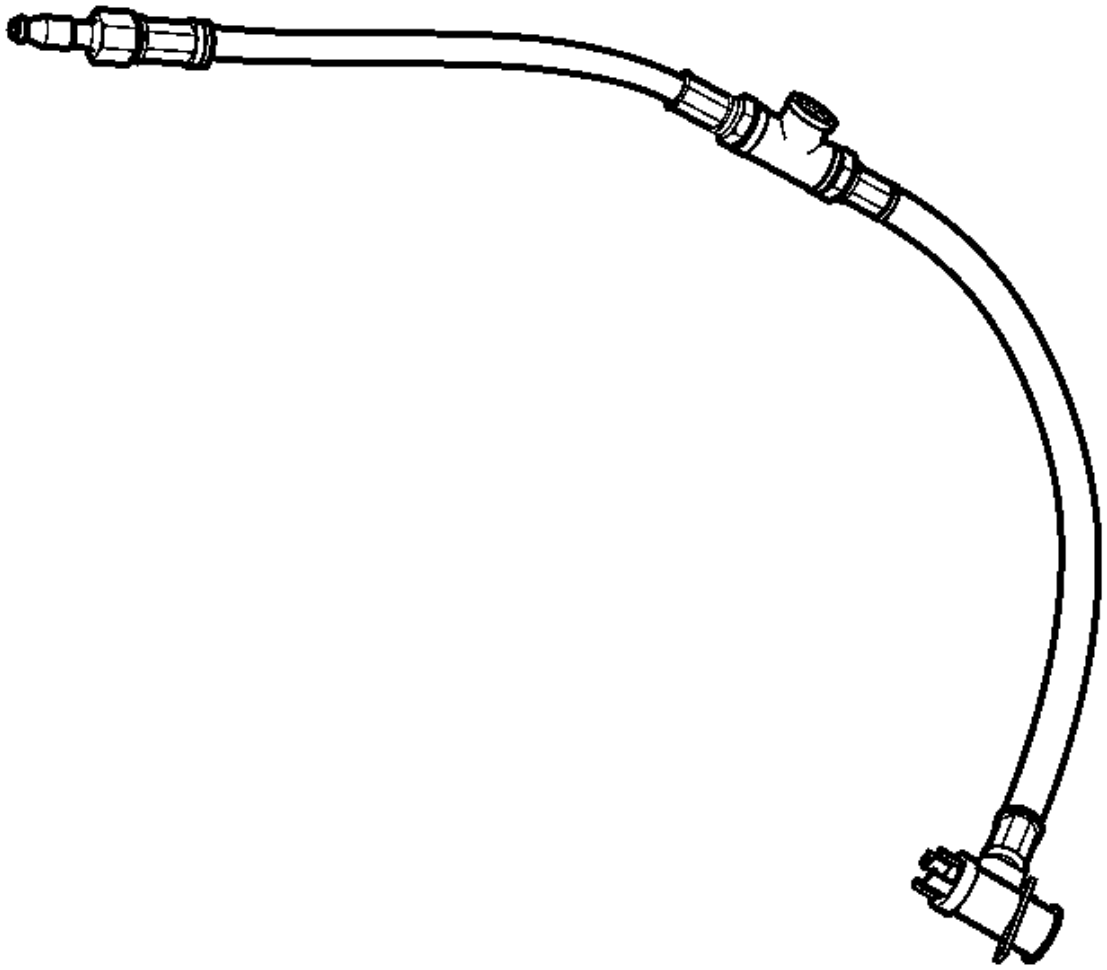
Illustration	Tool Number/Description
	CH-50375 Diesel Injector Return Line Pressure Adapter

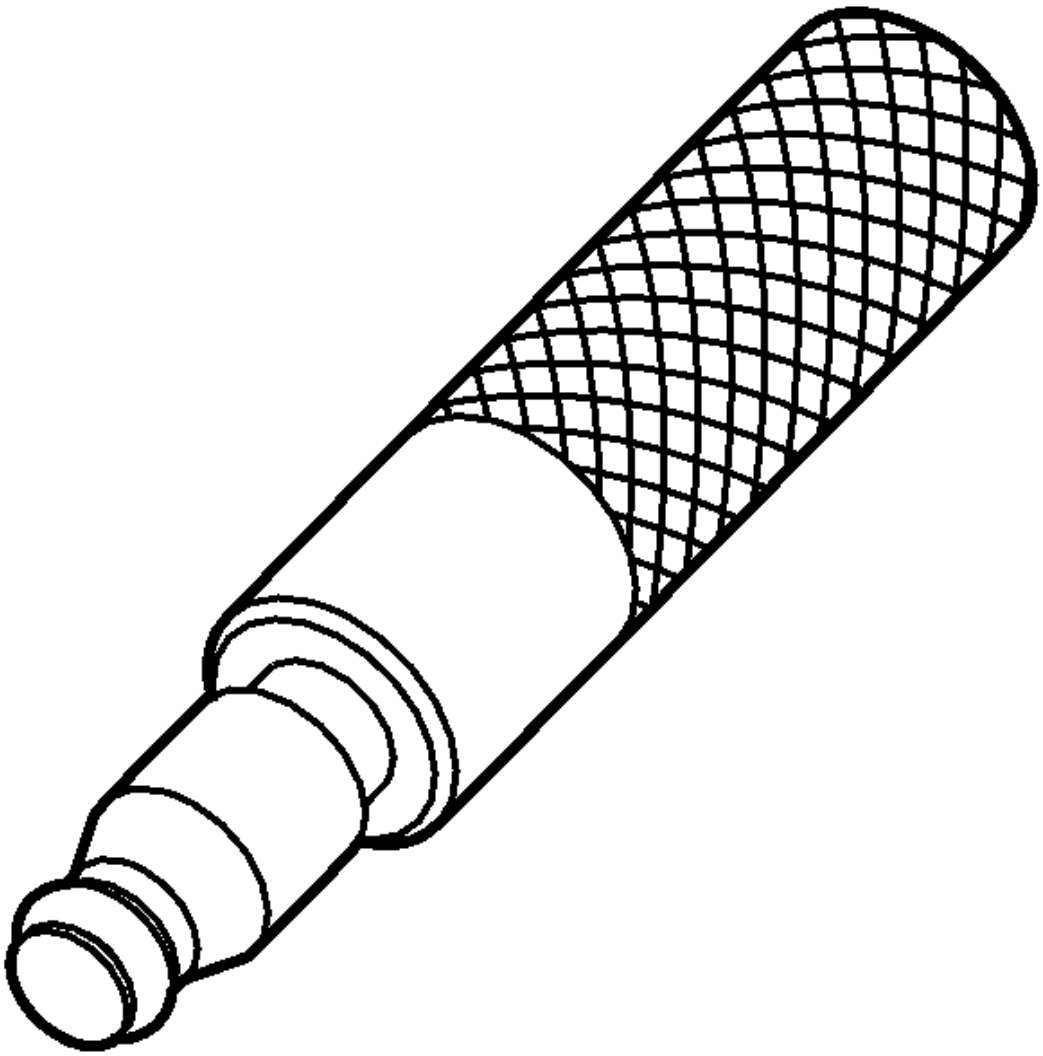
Illustration	Tool Number/Description
	CH-50377-A Injector Return Line Cap

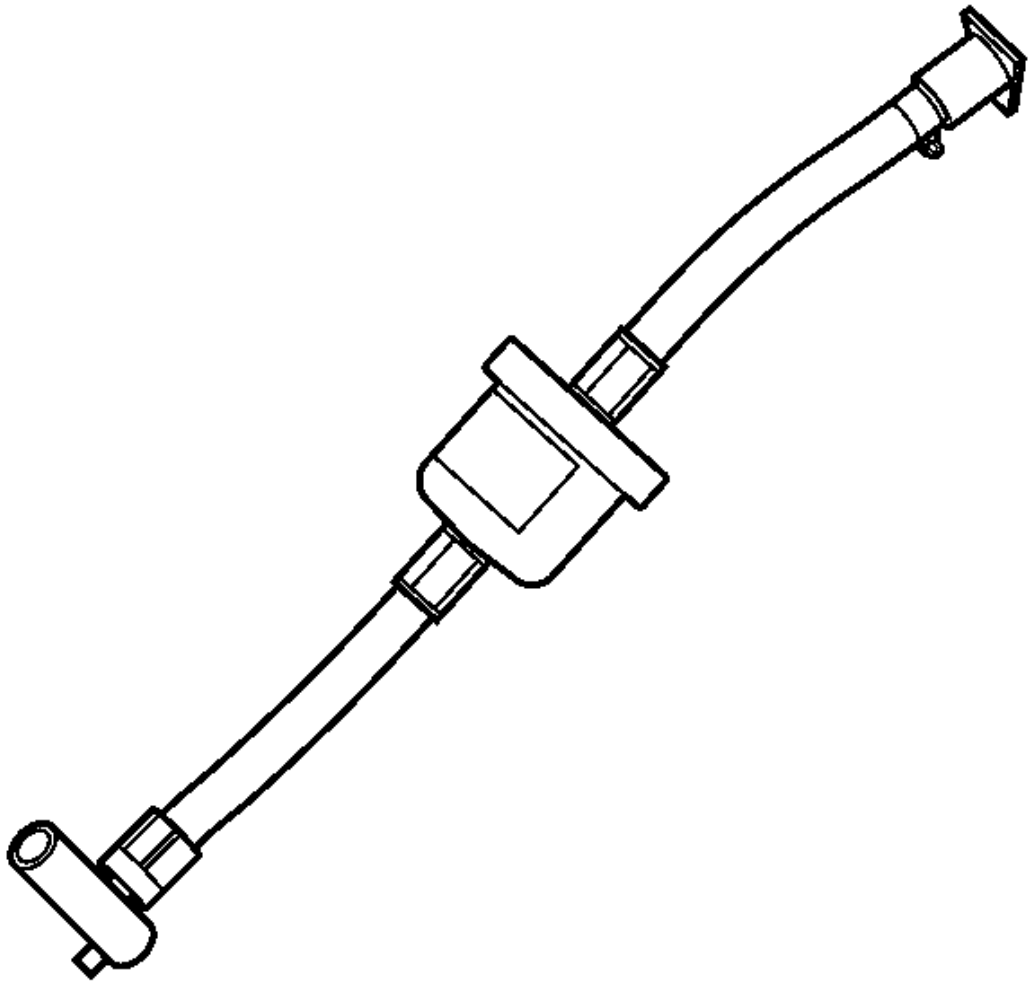
Illustration	Tool Number/Description
	CH-50378 Injector Return Leakage Test Adapter

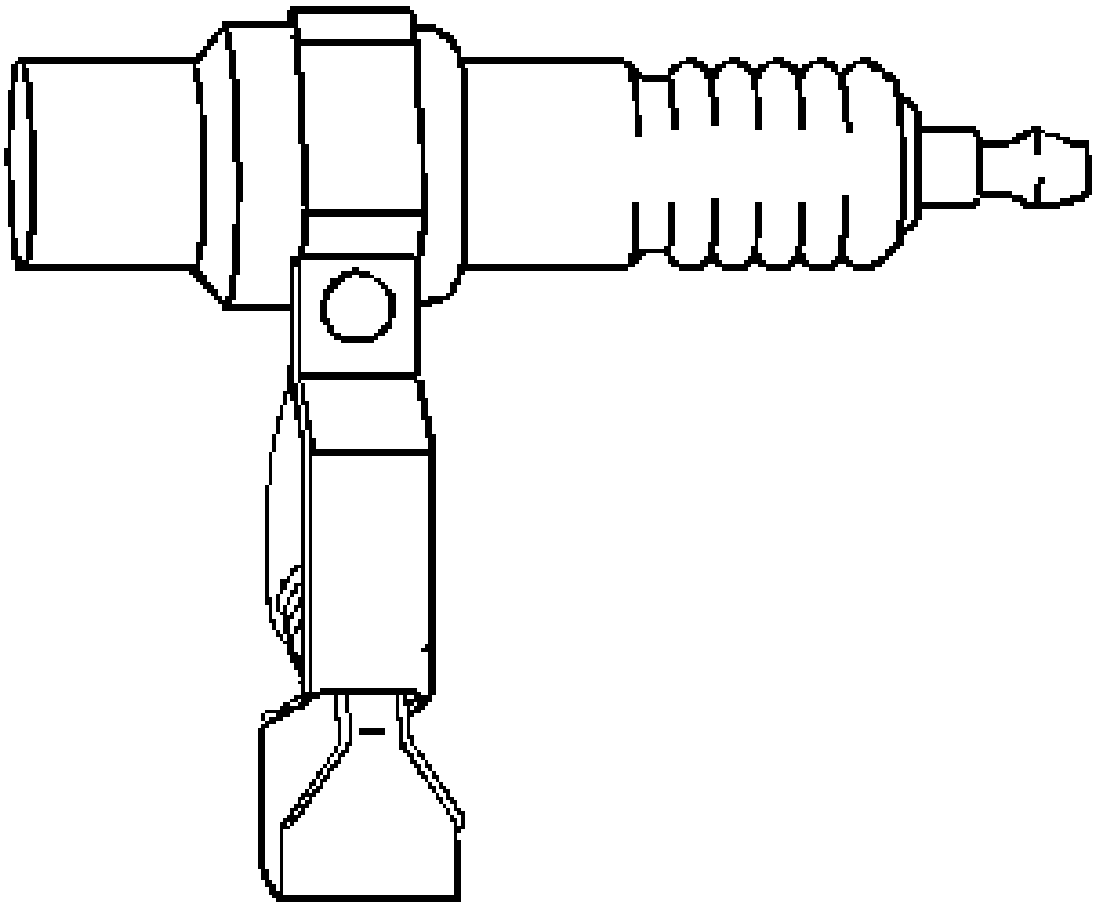
Illustration	Tool Number/Description
	EL-26792 J-26792 HEI Spark Tester

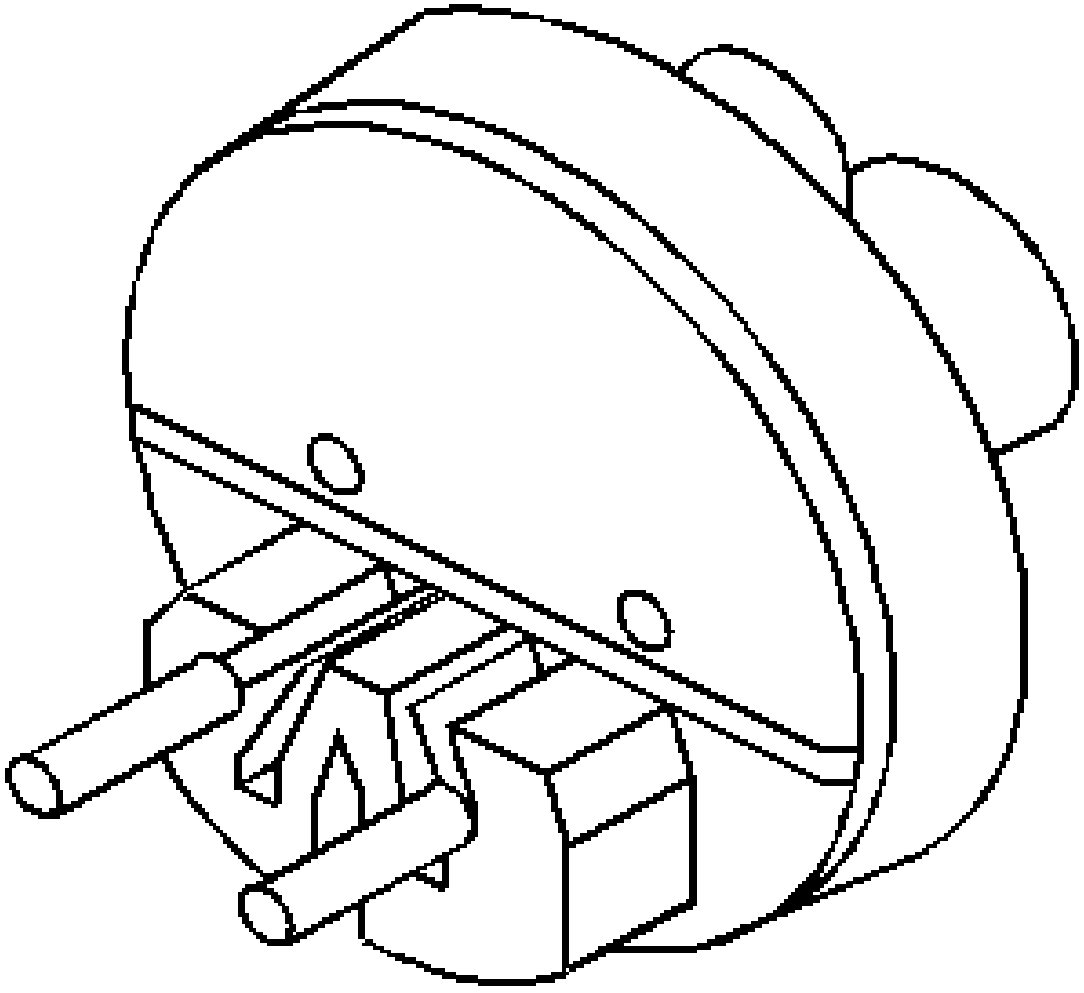
Illustration	Tool Number/Description
	EL-34730-405 J-34730-405 Injector Test Lamp

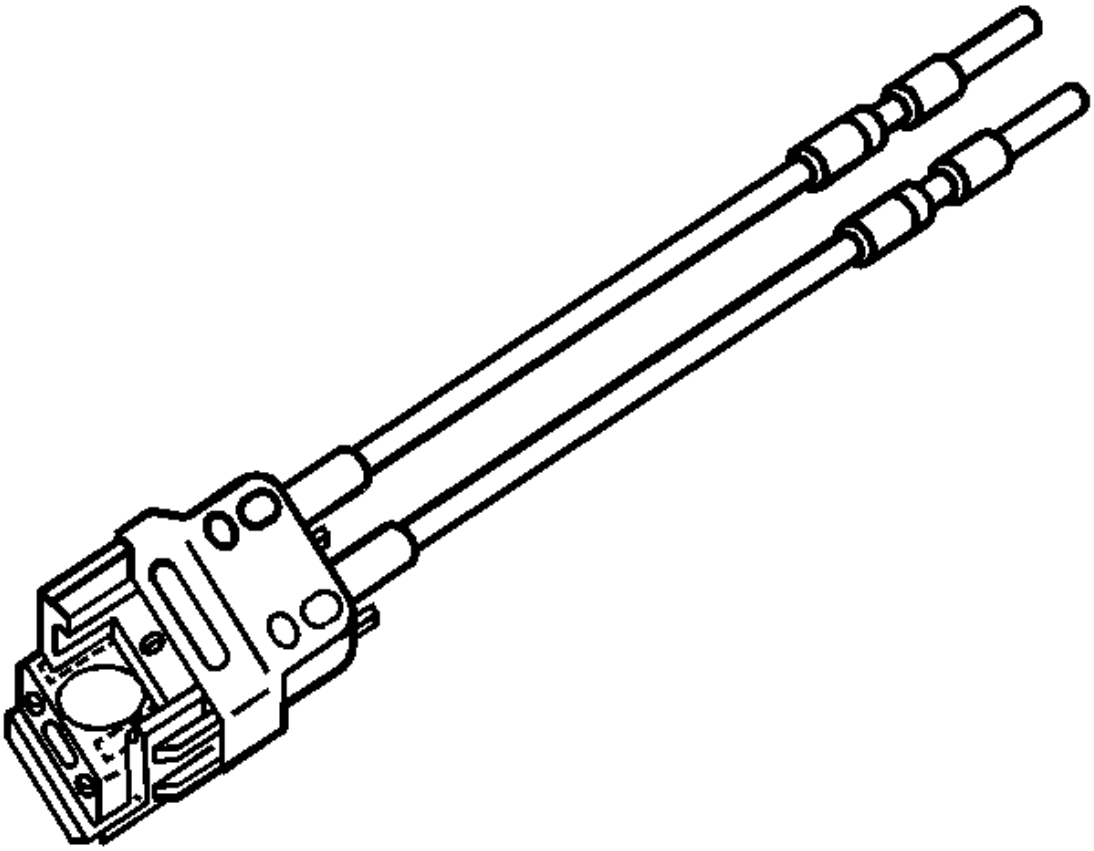
Illustration	Tool Number/Description
	EL-36169-HD Heavy Duty Fused Jumper

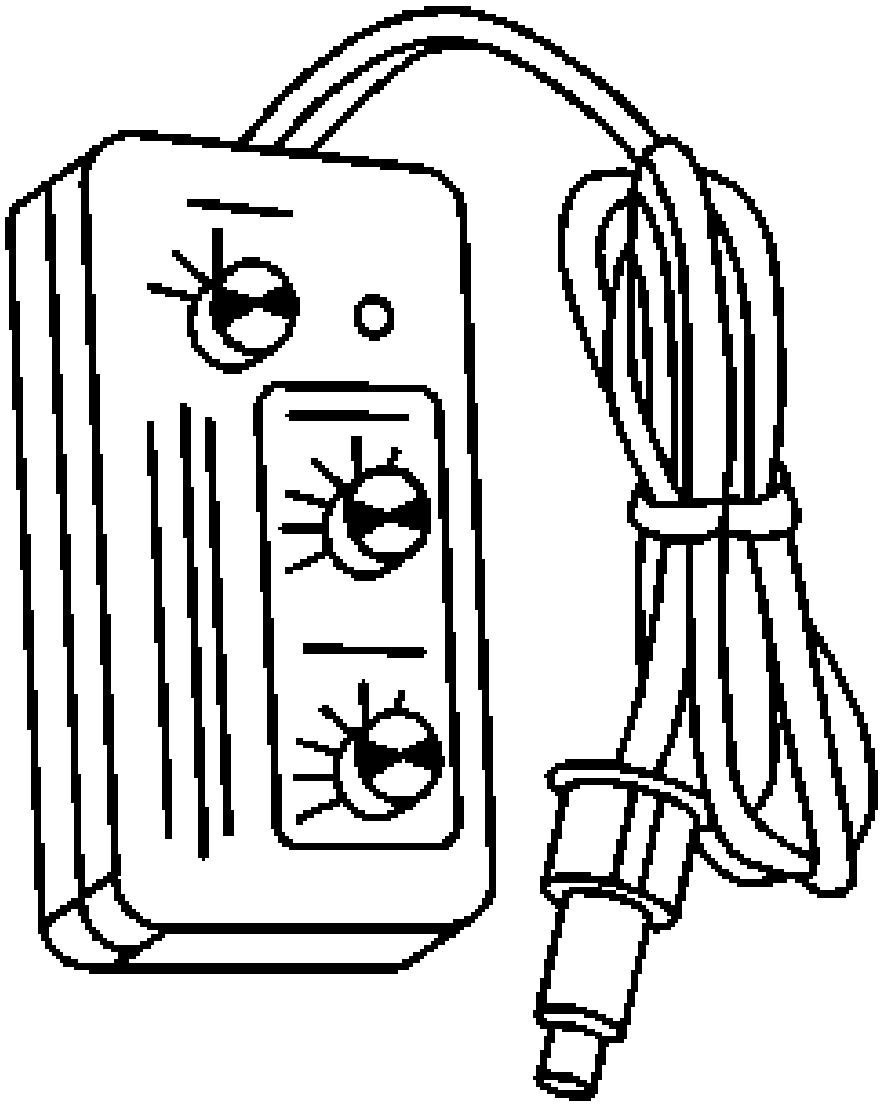
Illustration	Tool Number/Description
	EL-38522-A J-38522-A Variable Signal Generator

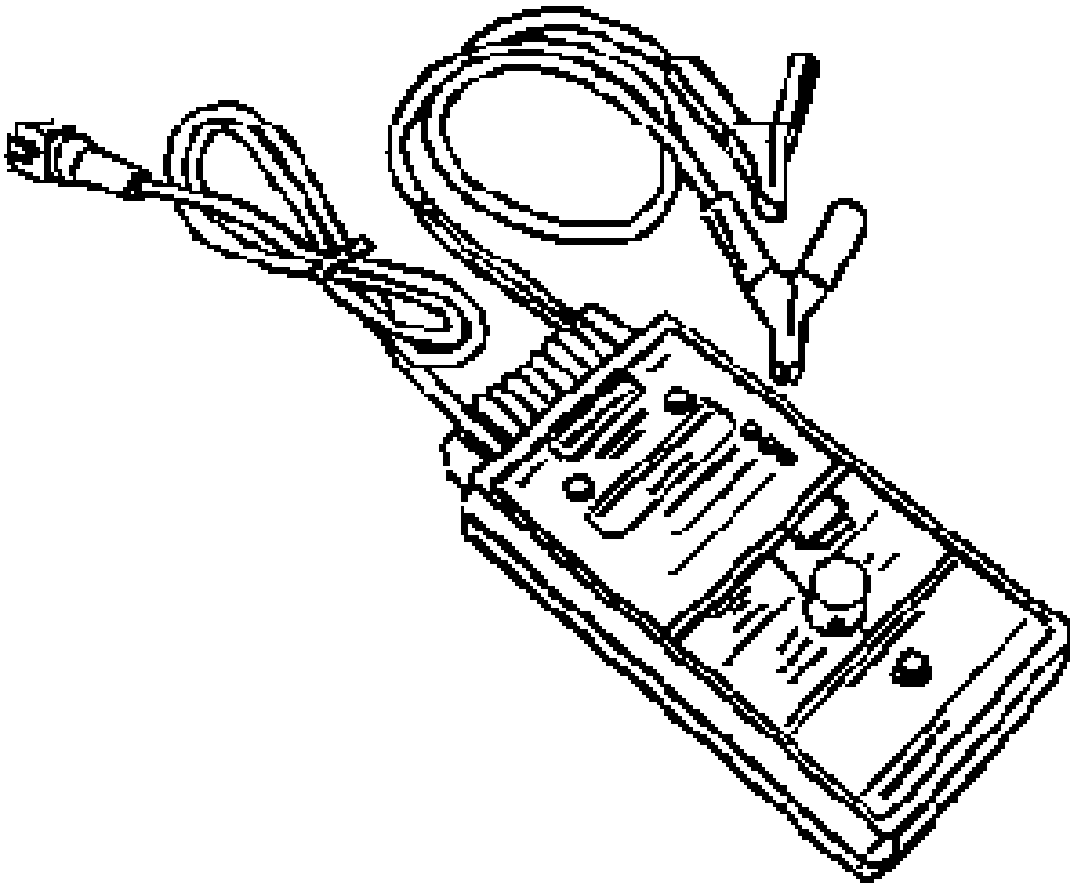
Illustration	Tool Number/Description
	EL-39021 J-39021 Fuel Injector Coil Balance Tester

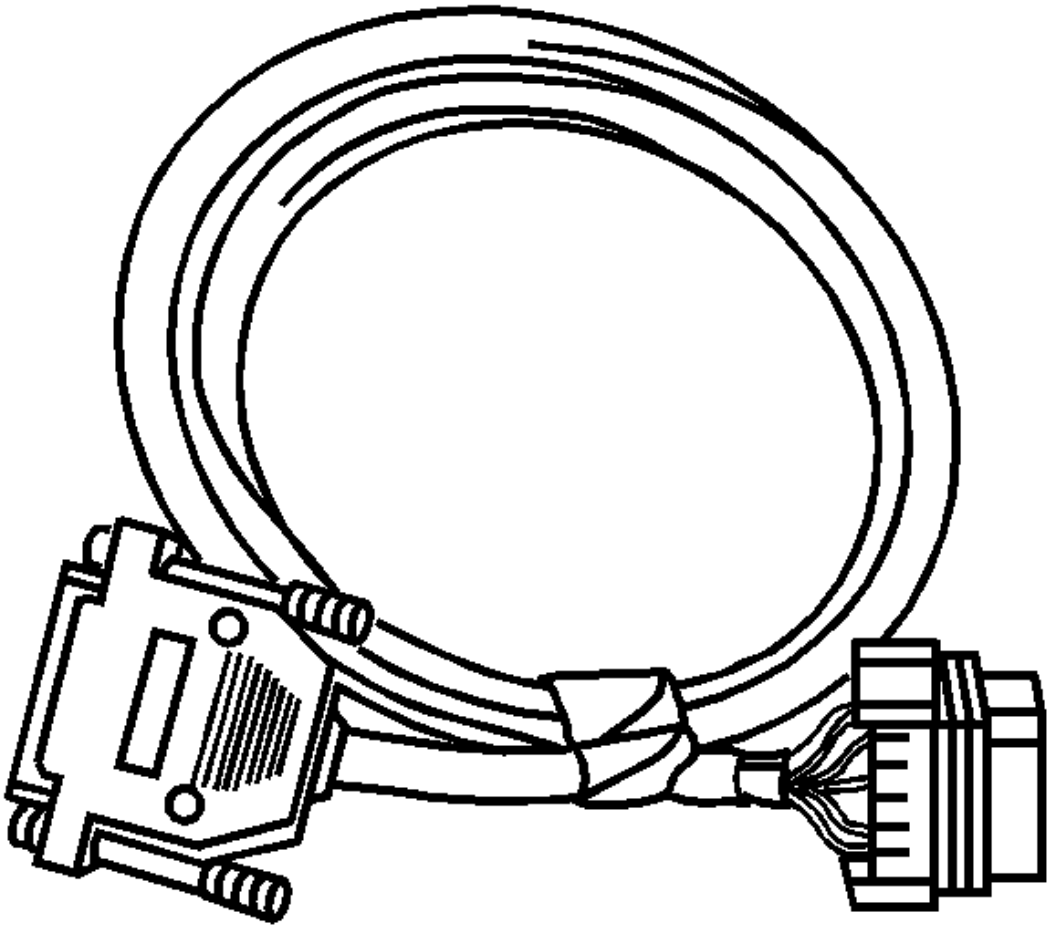
Illustration	Tool Number/Description
	EL-39021-460 J-39021-460 Fuel Injector Test Adapter

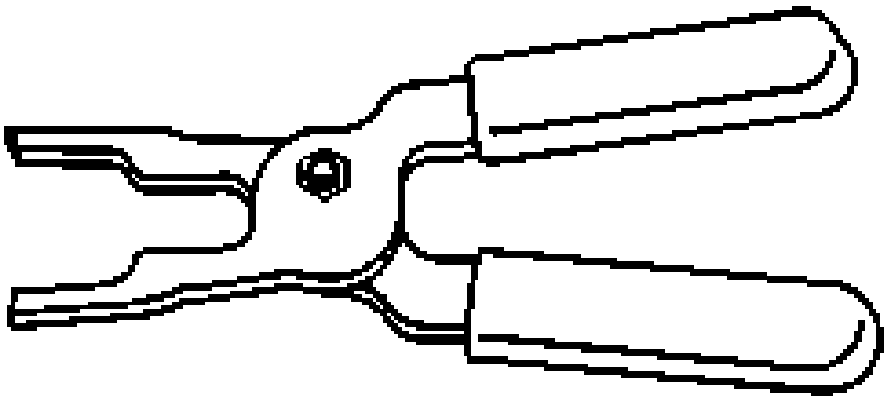
Illustration	Tool Number/Description
	EL-43244 J-43244 Relay Puller Pliers

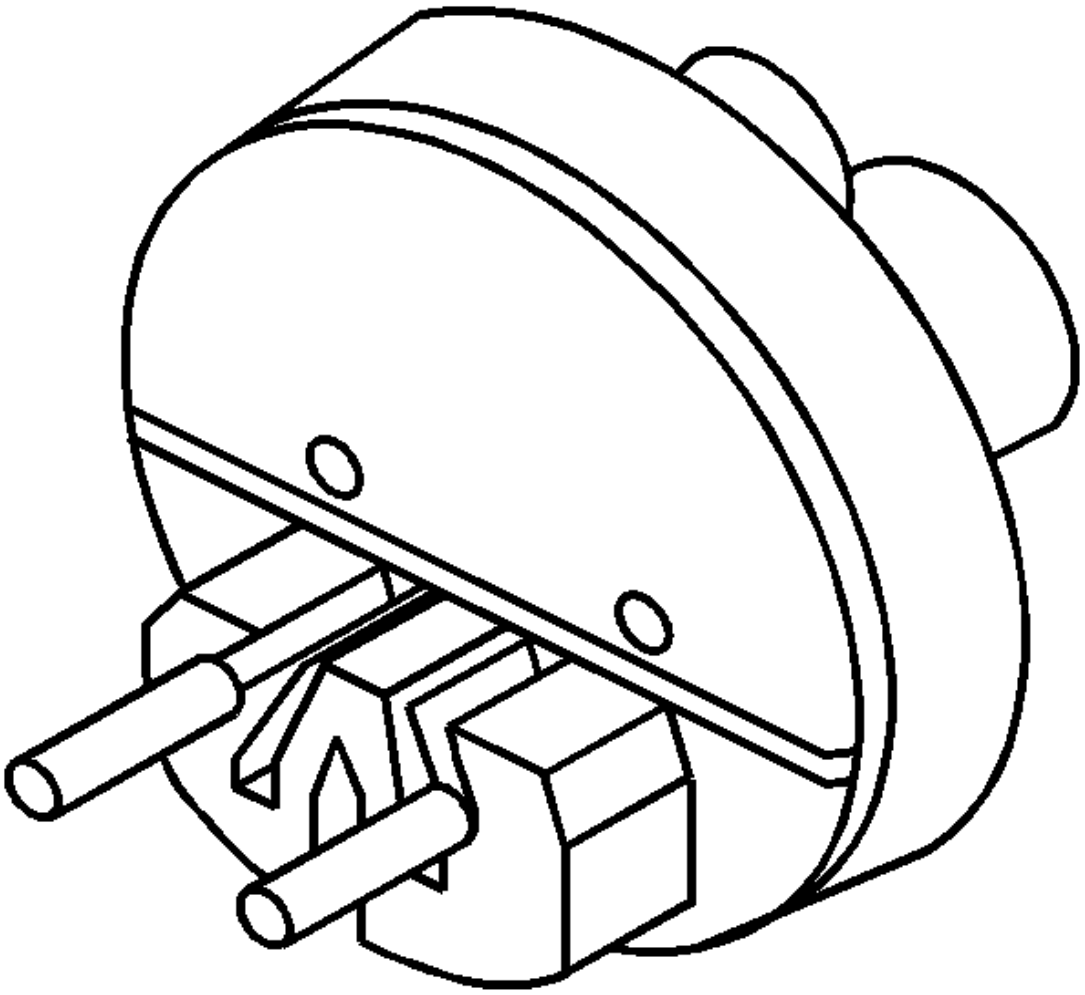
Illustration	Tool Number/Description
	EL-44603 J-44603 Injector Test Lamp

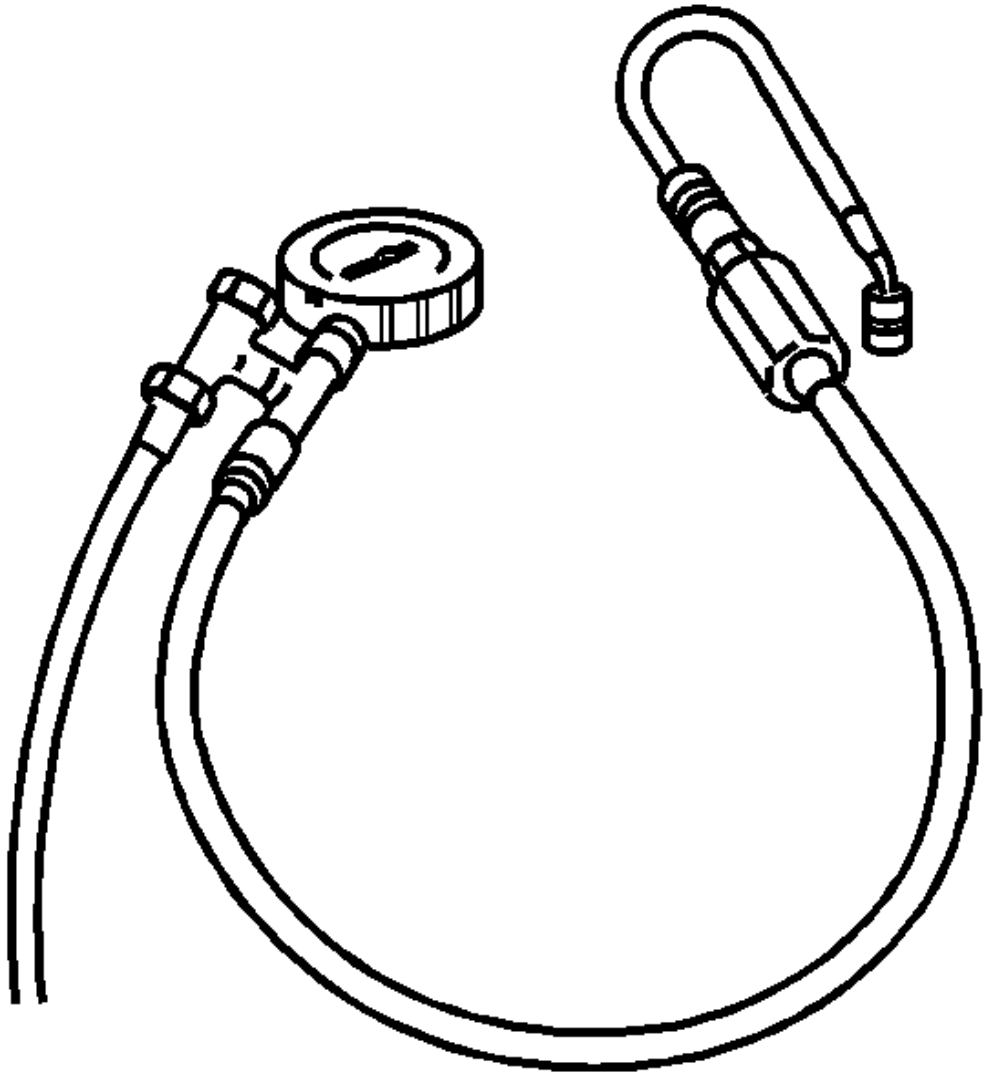
Illustration	Tool Number/Description
	EN-34730-91 J-34730-91 KM-J-34730-91 Pressure Tester

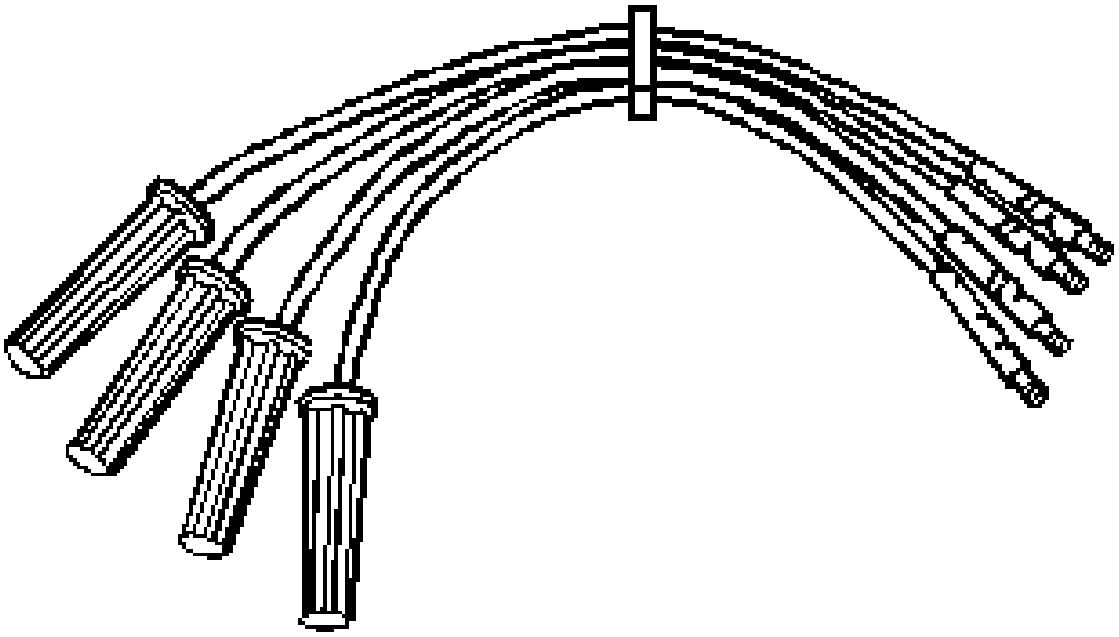
Illustration	Tool Number/Description
	EN-36012-A J-36012-A Ignition System Diagnosis Harness

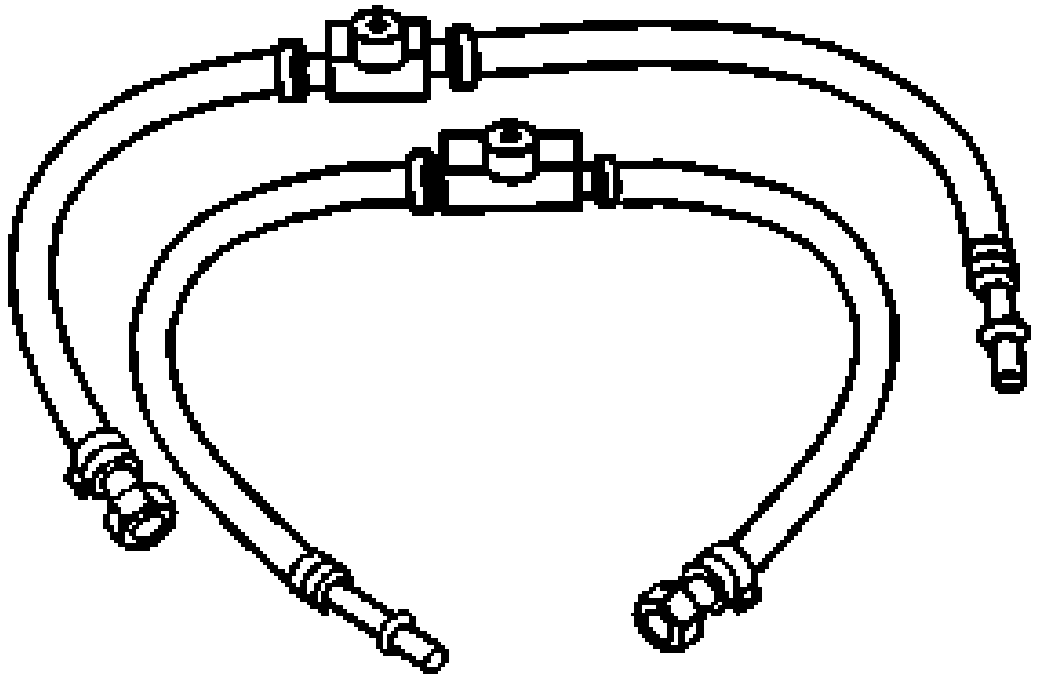
Illustration	Tool Number/Description
	EN-37287 J-37287 Fuel Line Shut-off Adapters

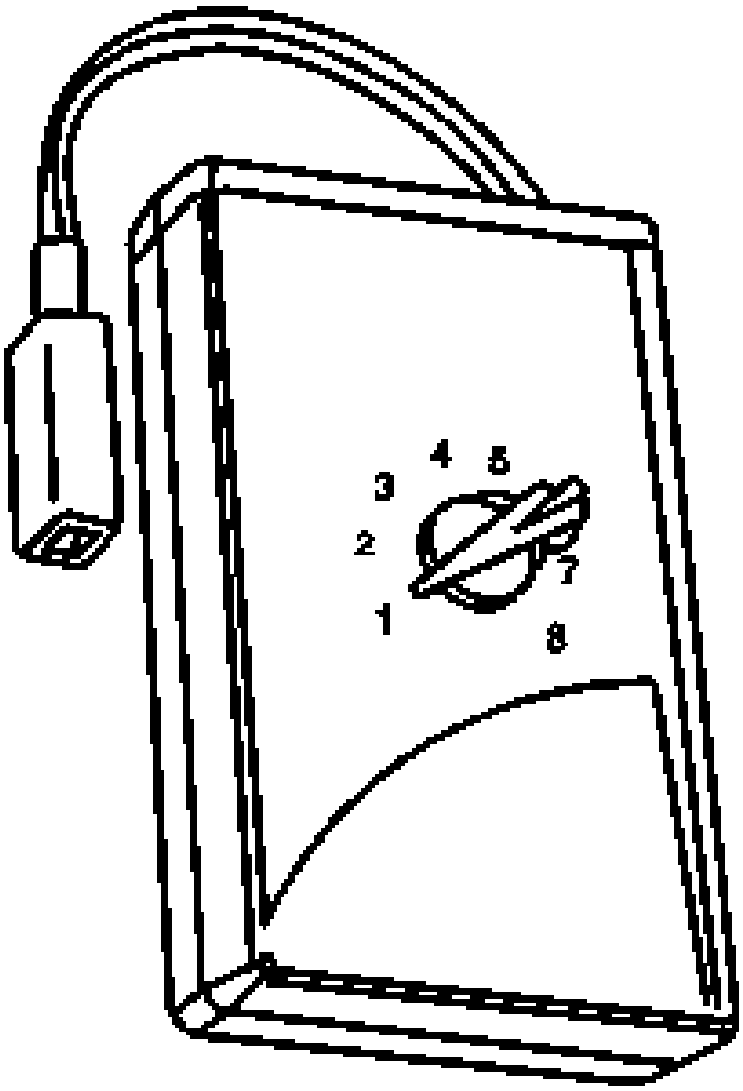
Illustration	Tool Number/Description
	EN-39021-210 J-39021-210 Injector Tester Adapter Box

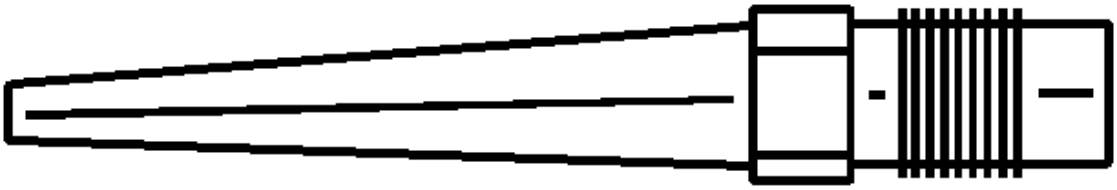
Illustration	Tool Number/Description
	EN-41413-311 J-41413-311 EVAP Plug

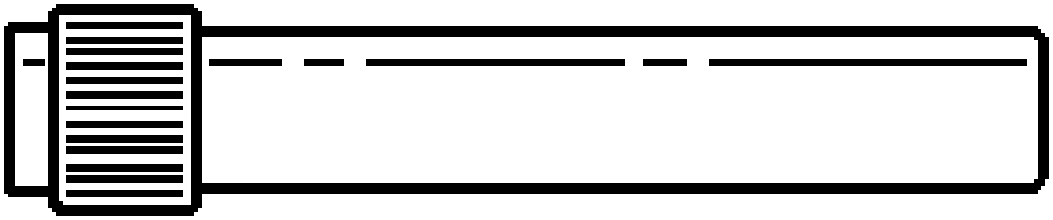
Illustration	Tool Number/Description
	EN-41413-VLV J-41413-VLV EVAP Service Port Vent Fitting

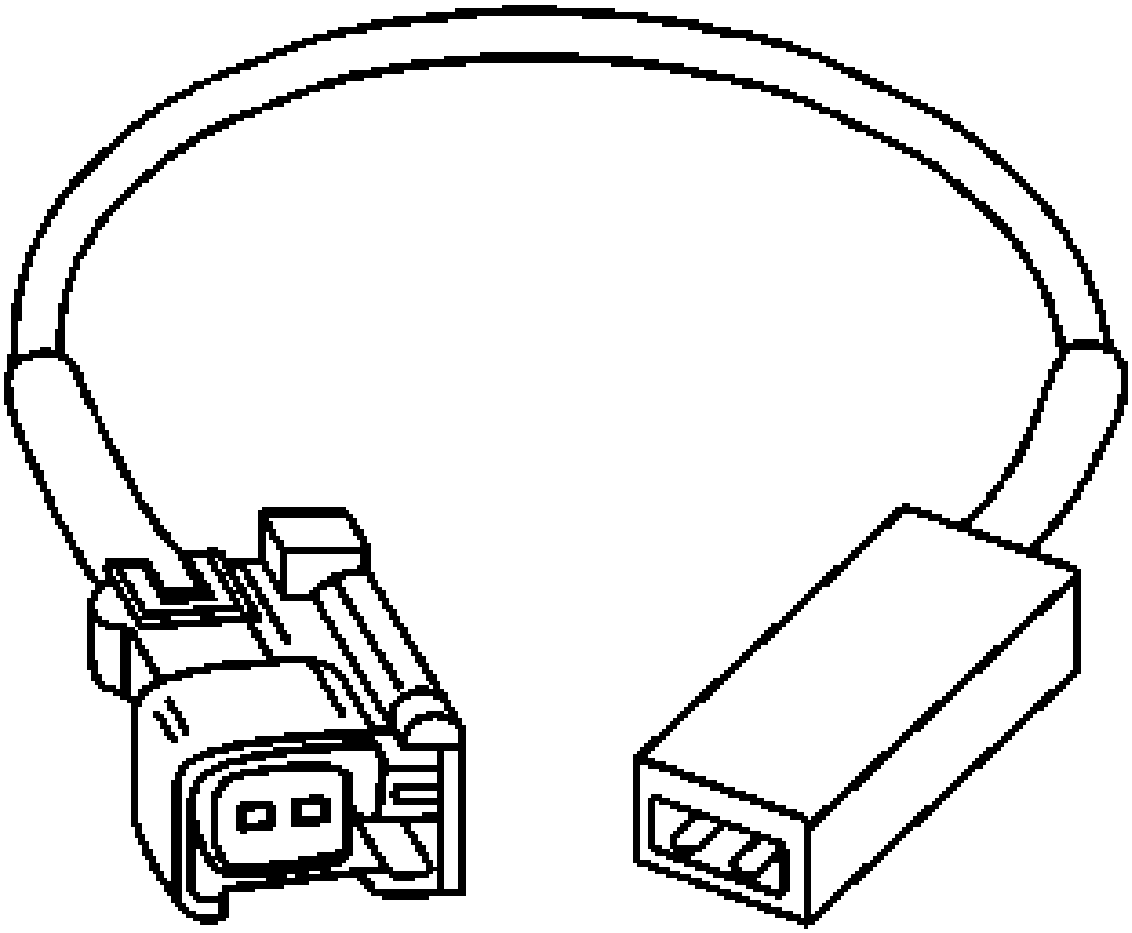
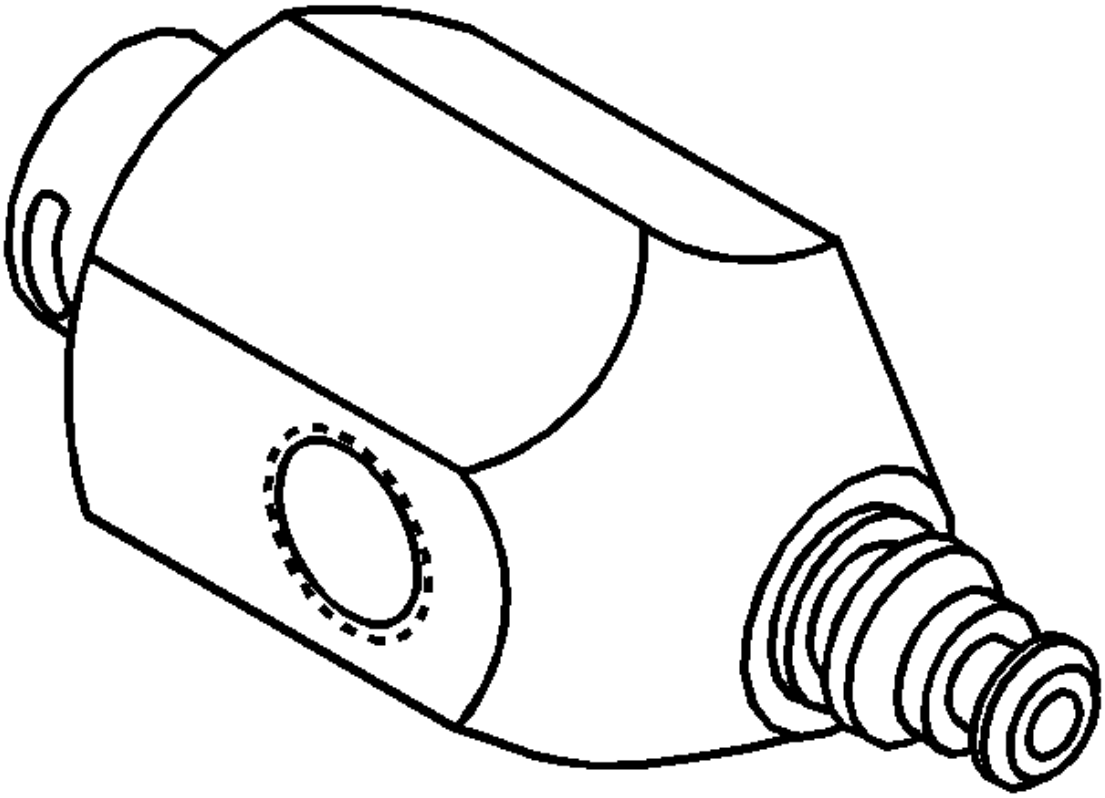
Illustration	Tool Number/Description
	EN-44602 J-44602 Injector Test Adapter

Illustration	Tool Number/Description
	EN-45873-30 J-45873-30 Injector Flow Test Adapter

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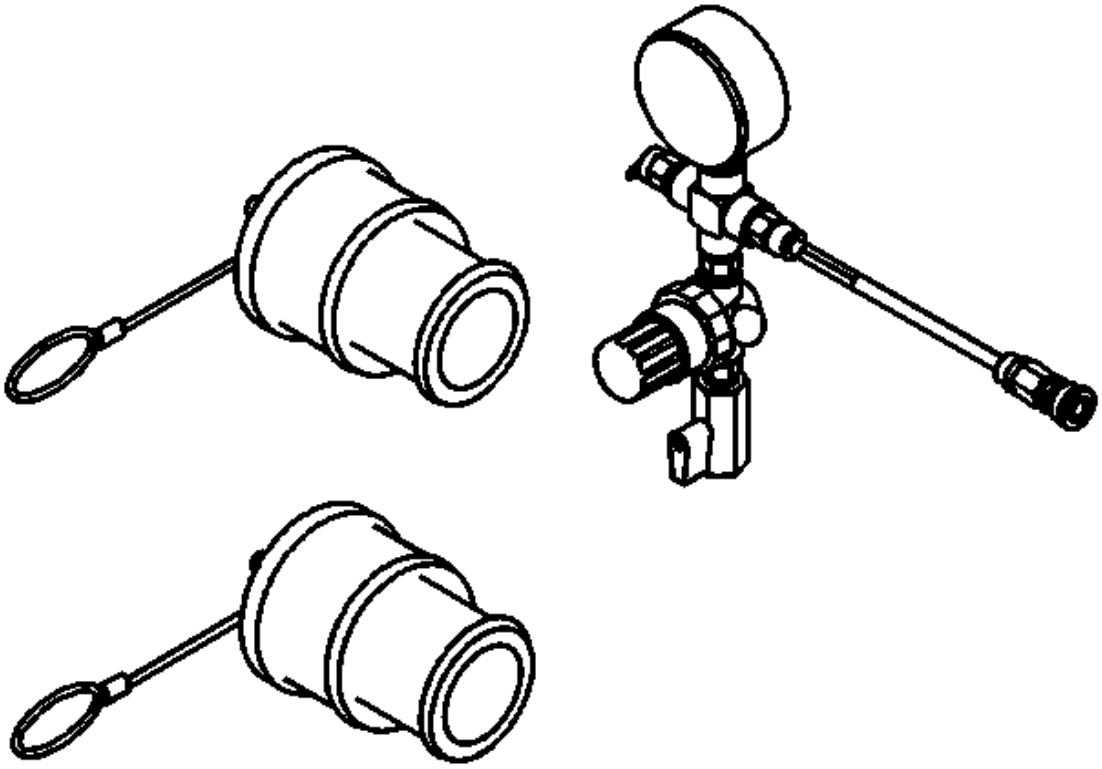
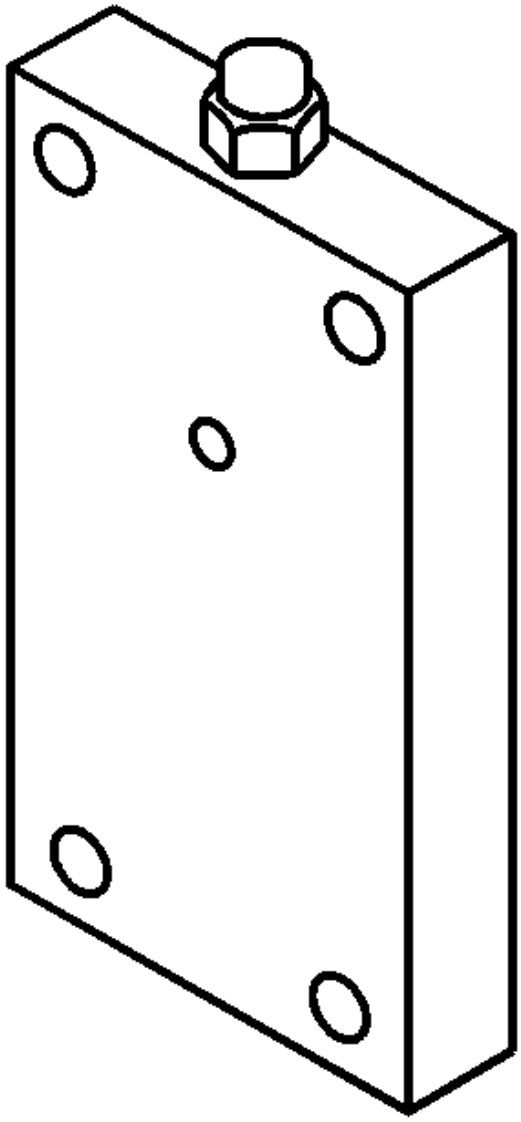
	EN-46091 J-46091 Charge Air Cooler Tester

Illustration	Tool Number/Description
	EN-46091-5 J-46091-5 Charge Air Cooler Tester Adapter

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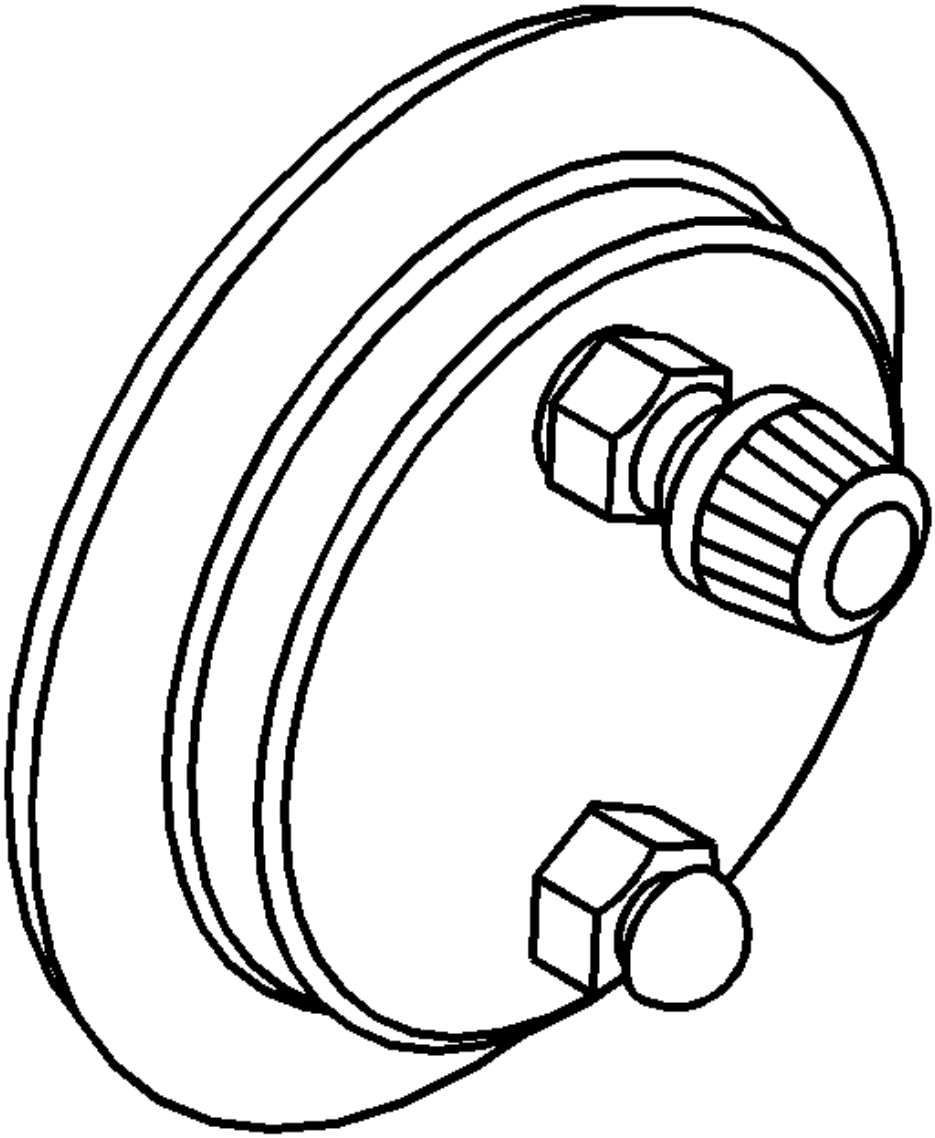
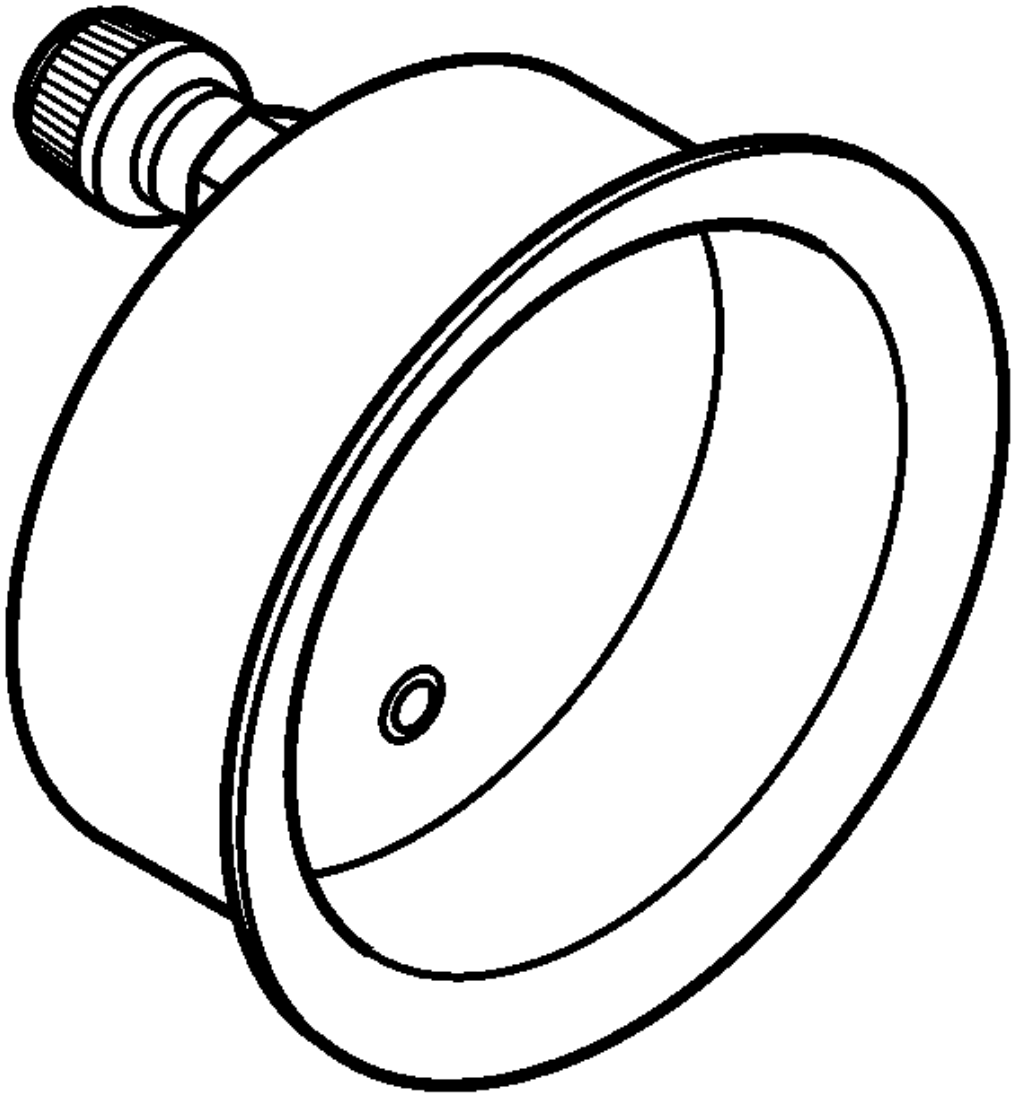
	EN-46091-15 J-46091-15 Engine Pressure Test Adapter

Illustration	Tool Number/Description
	EN-46091-15A J-46091-15A Diesel Engine Pressure Test Adapter

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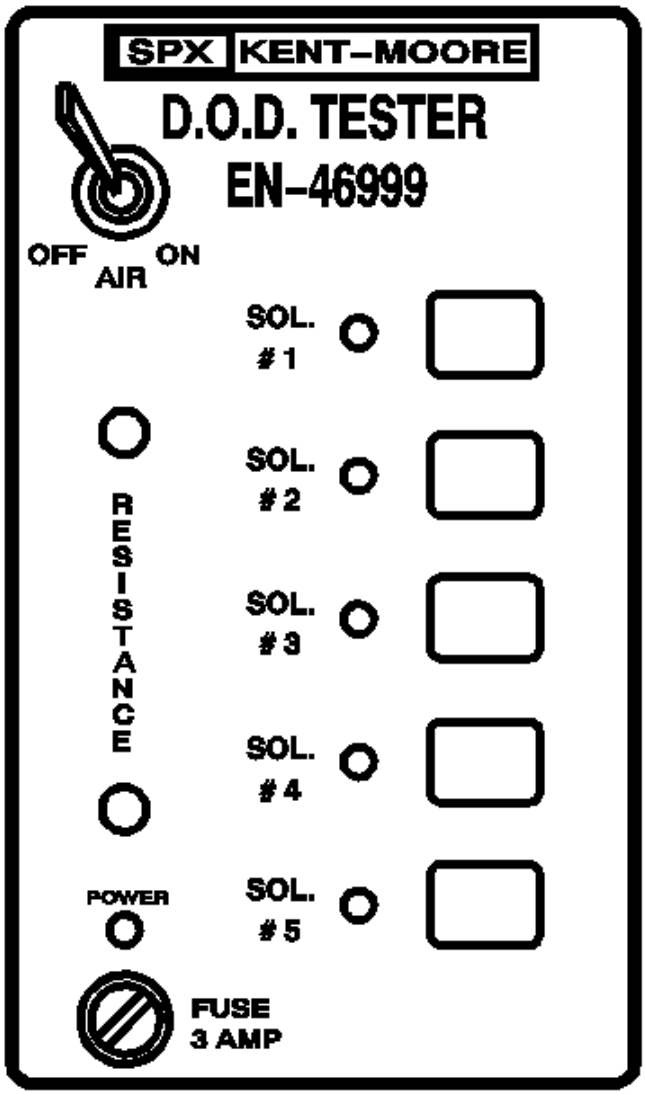
	EN-46999 Displacement On Demand Electric Tool

Illustration	Tool Number/Description
	EN-47603 Compression Gauge Adapter

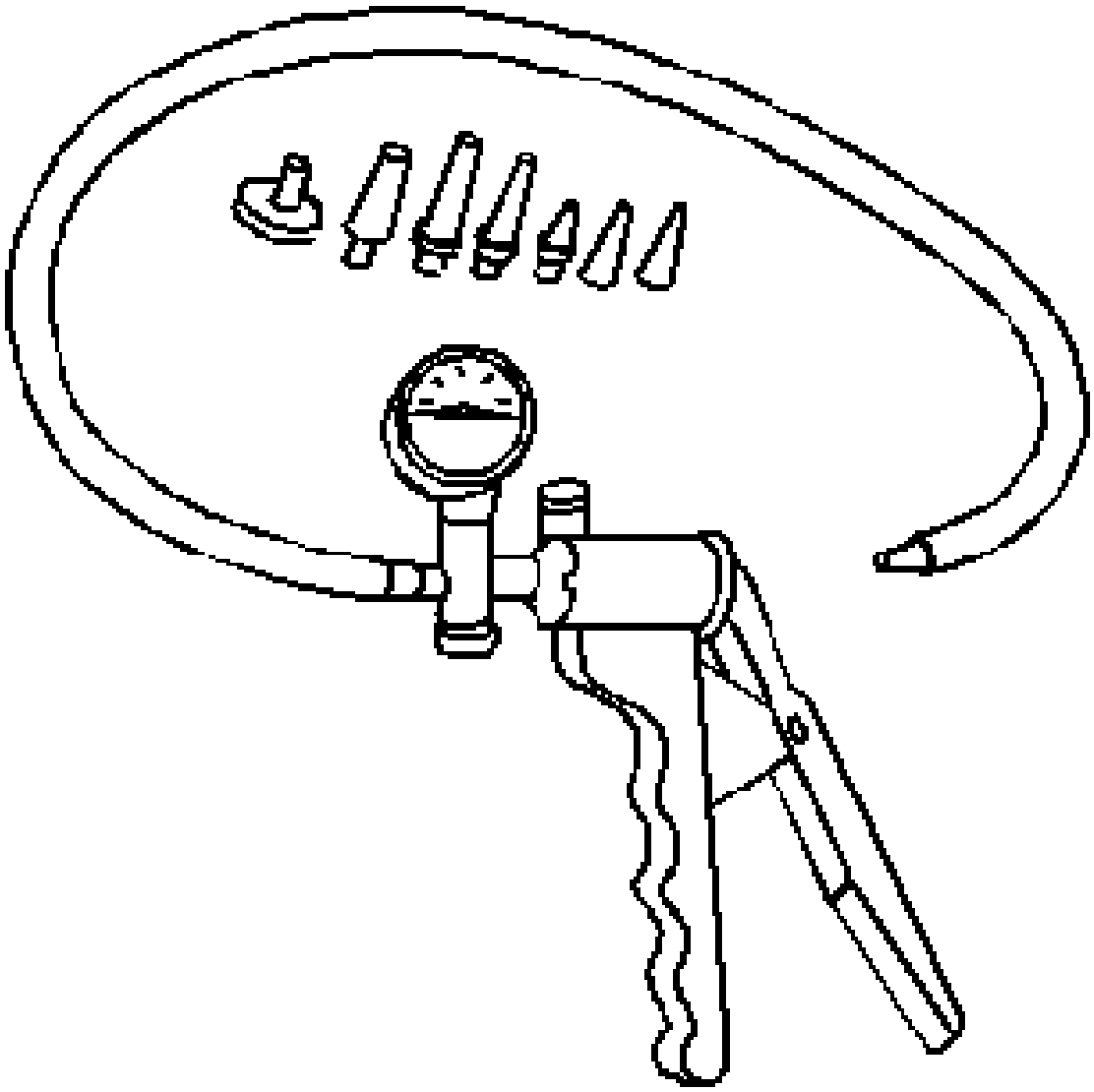
Illustration	Tool Number/Description
	GE-23738-A J-23738-A Vacuum Pump

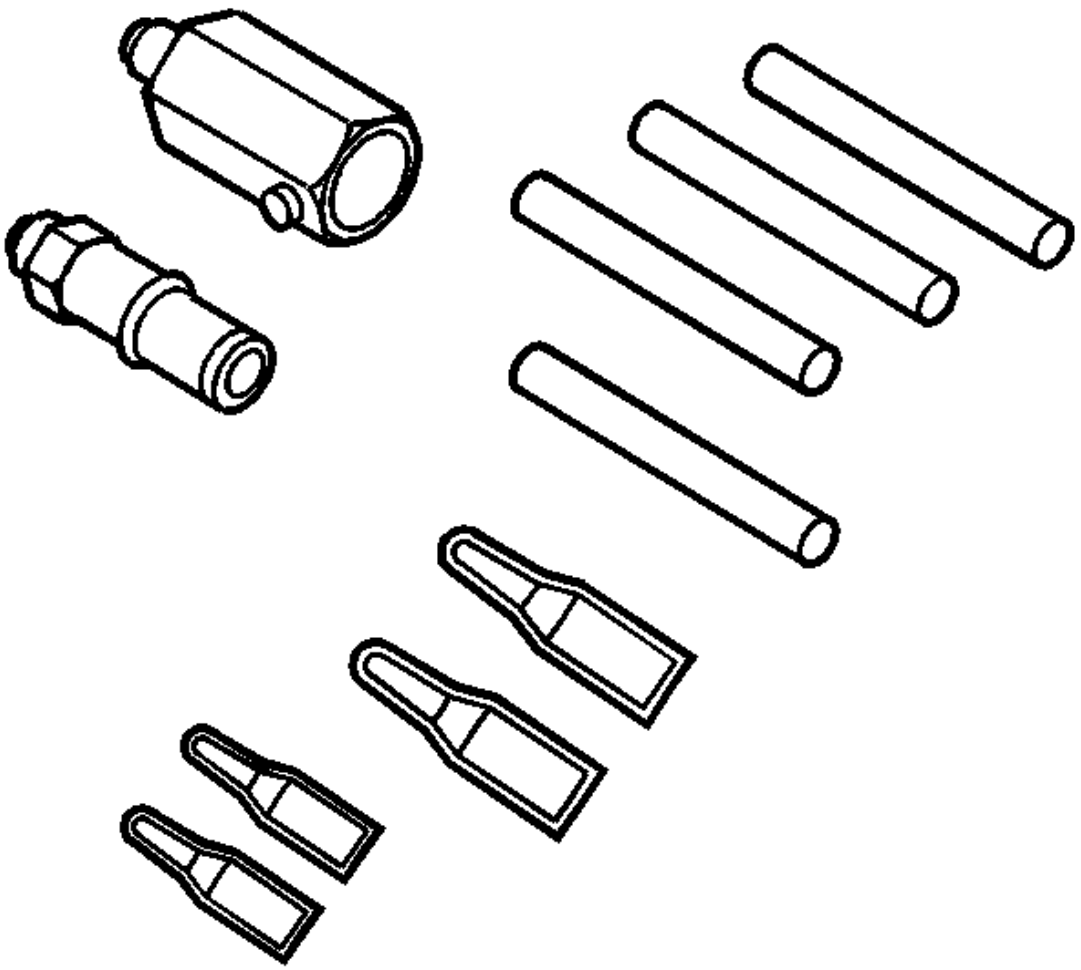
Illustration	Tool Number/Description
	GE-41413-300 EN-41413-300 J-41413-300 EVAP Cap and Plug Kit

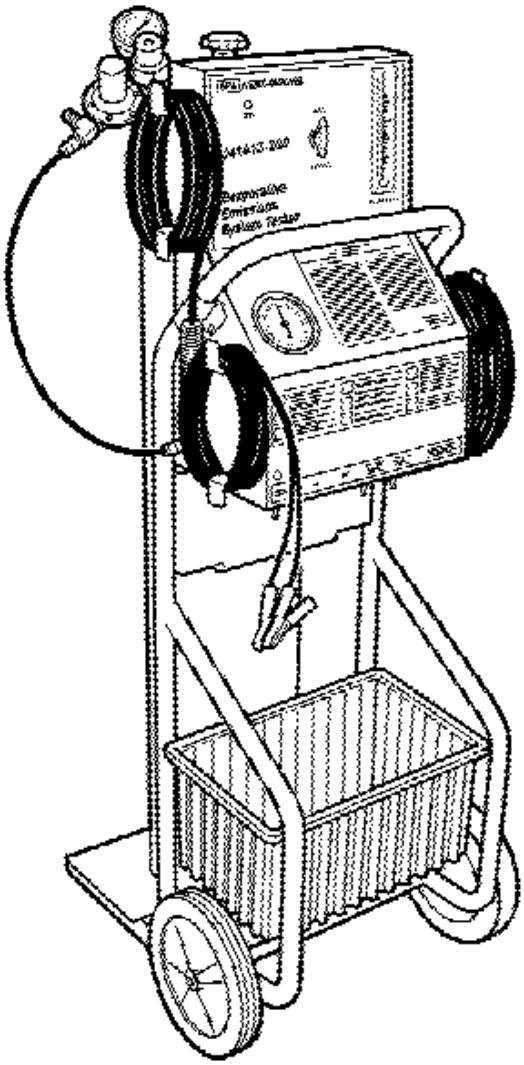
Illustration	Tool Number/Description
	GE-41413-A EN-41413-A J-41413-A Evaporative Emissions System Tester (EEST)

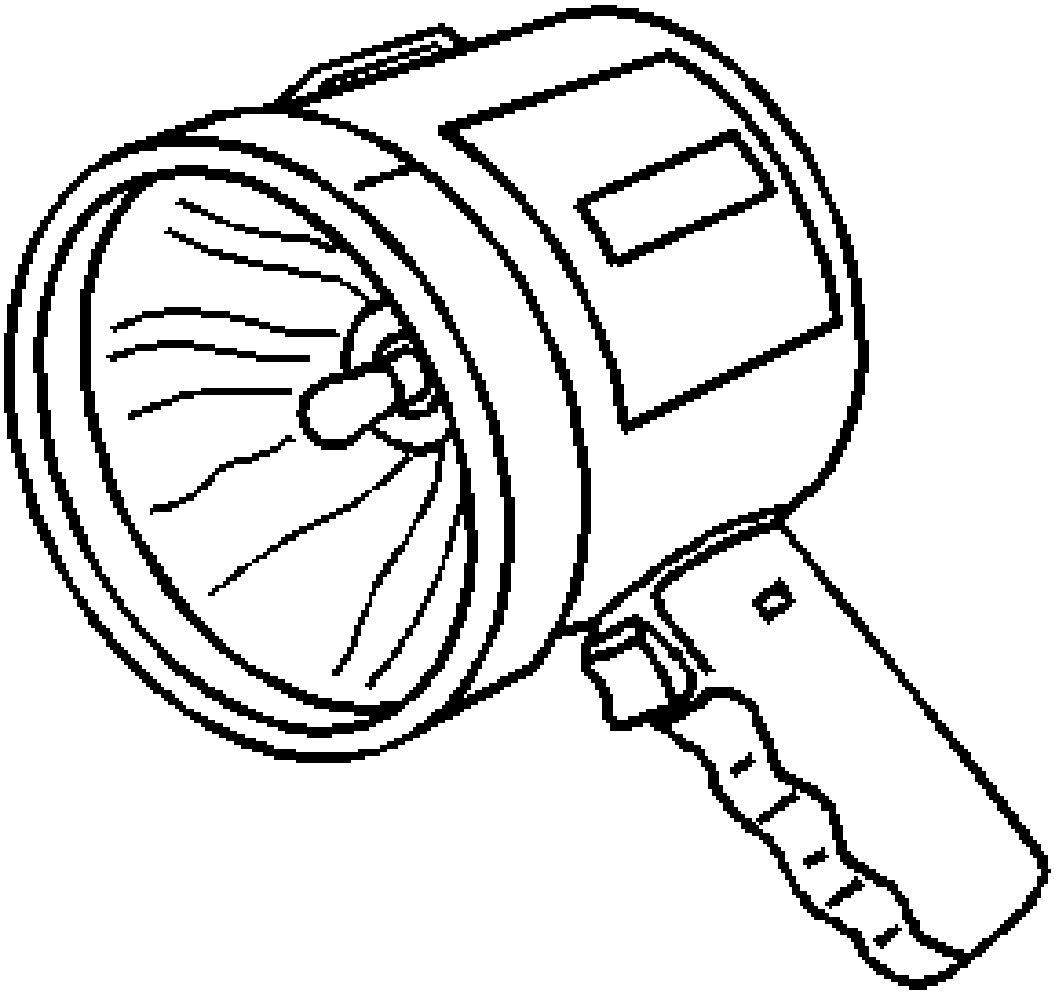
Illustration	Tool Number/Description
	GE-41413-SPT J-41413-SPT High Intensity White Light

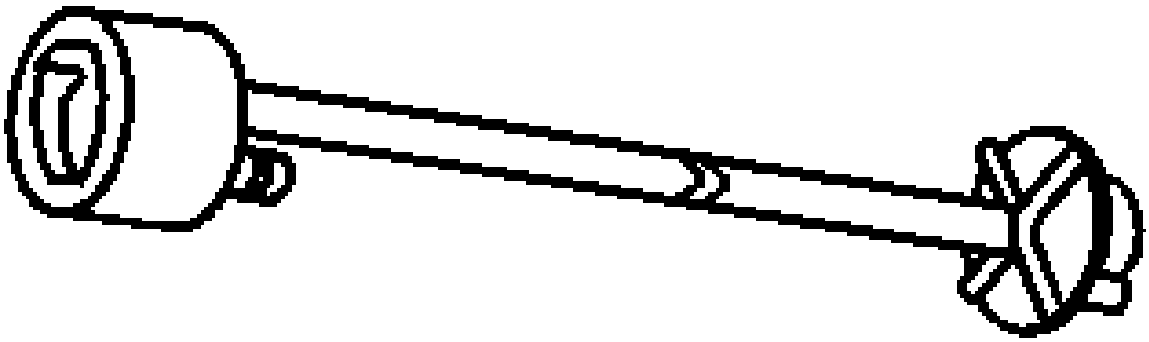
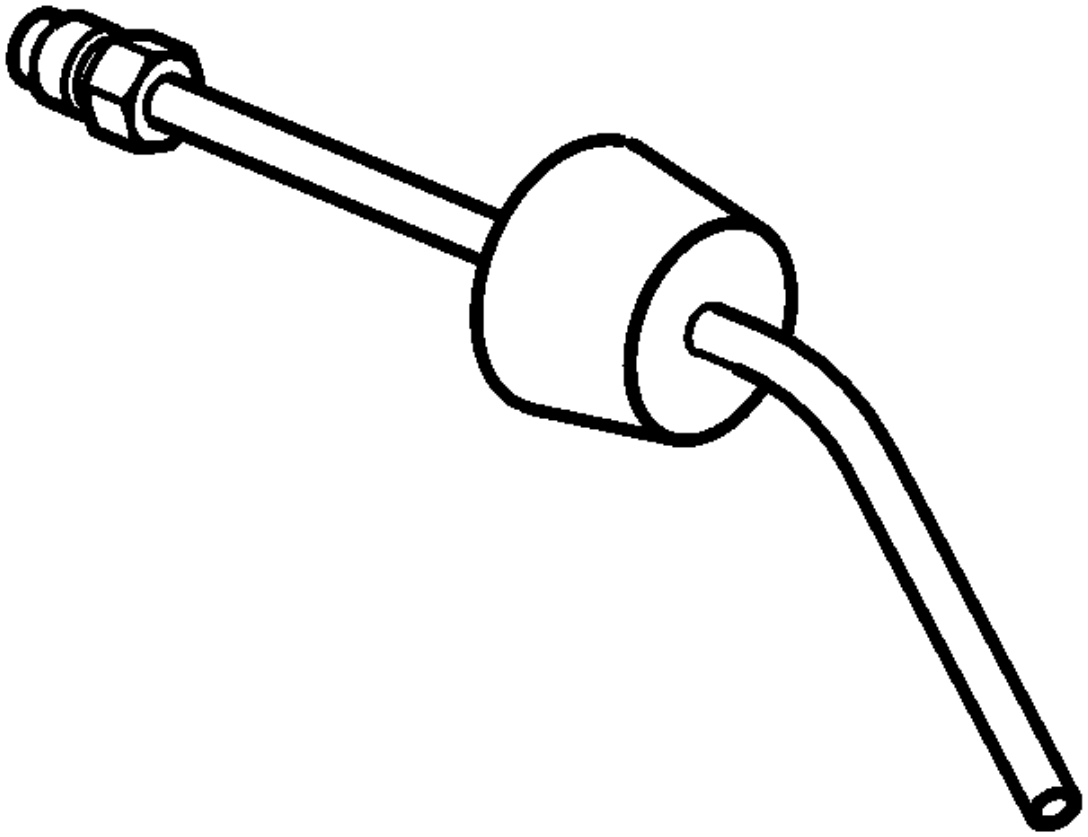
Illustration	Tool Number/Description
	GE-41415-50 J-41415-50 Fuel Tank Cap Adapter

Illustration	Tool Number/Description
	GE-41415-60 Engine Induction System Leak Test Adapter/Capless Fuel Fill Adapter

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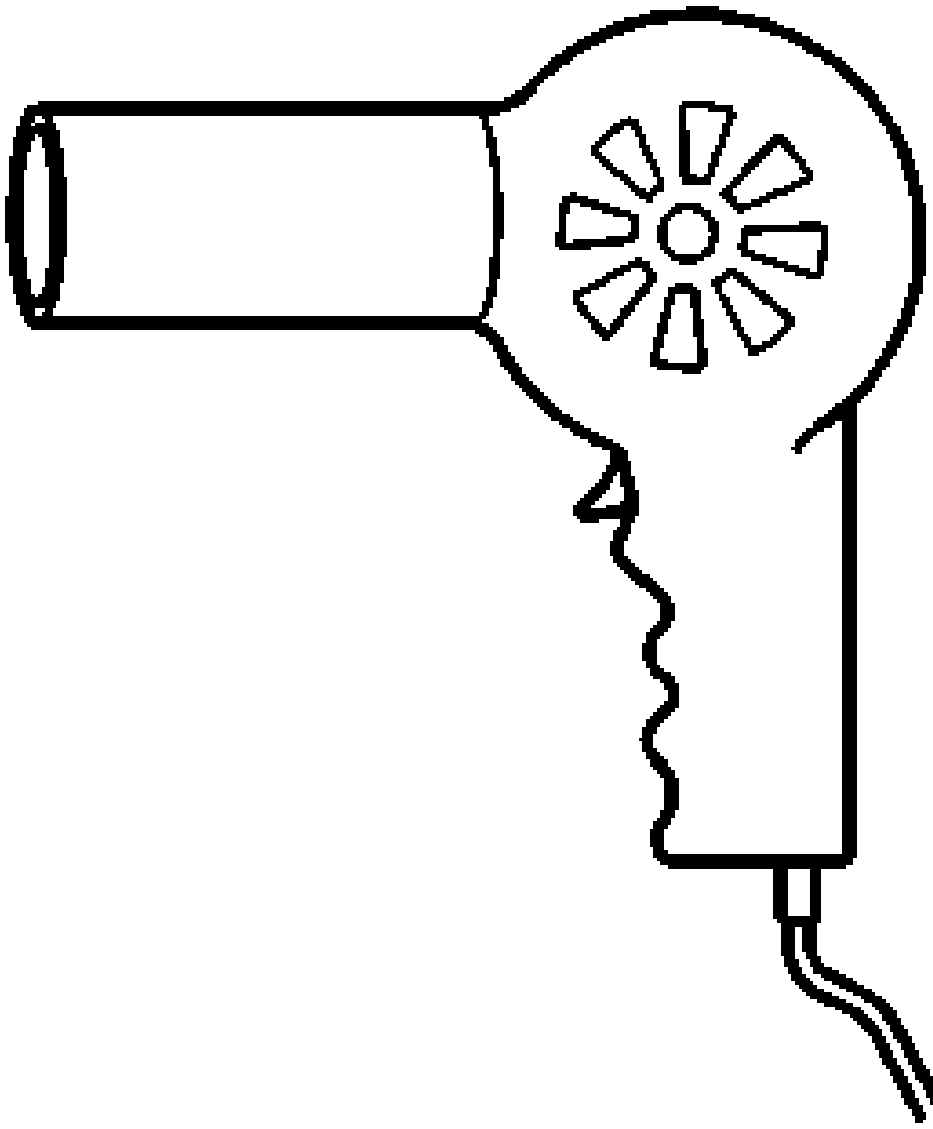
	J-25070 Heat Gun 260-399Â°C (500-750Â°F)

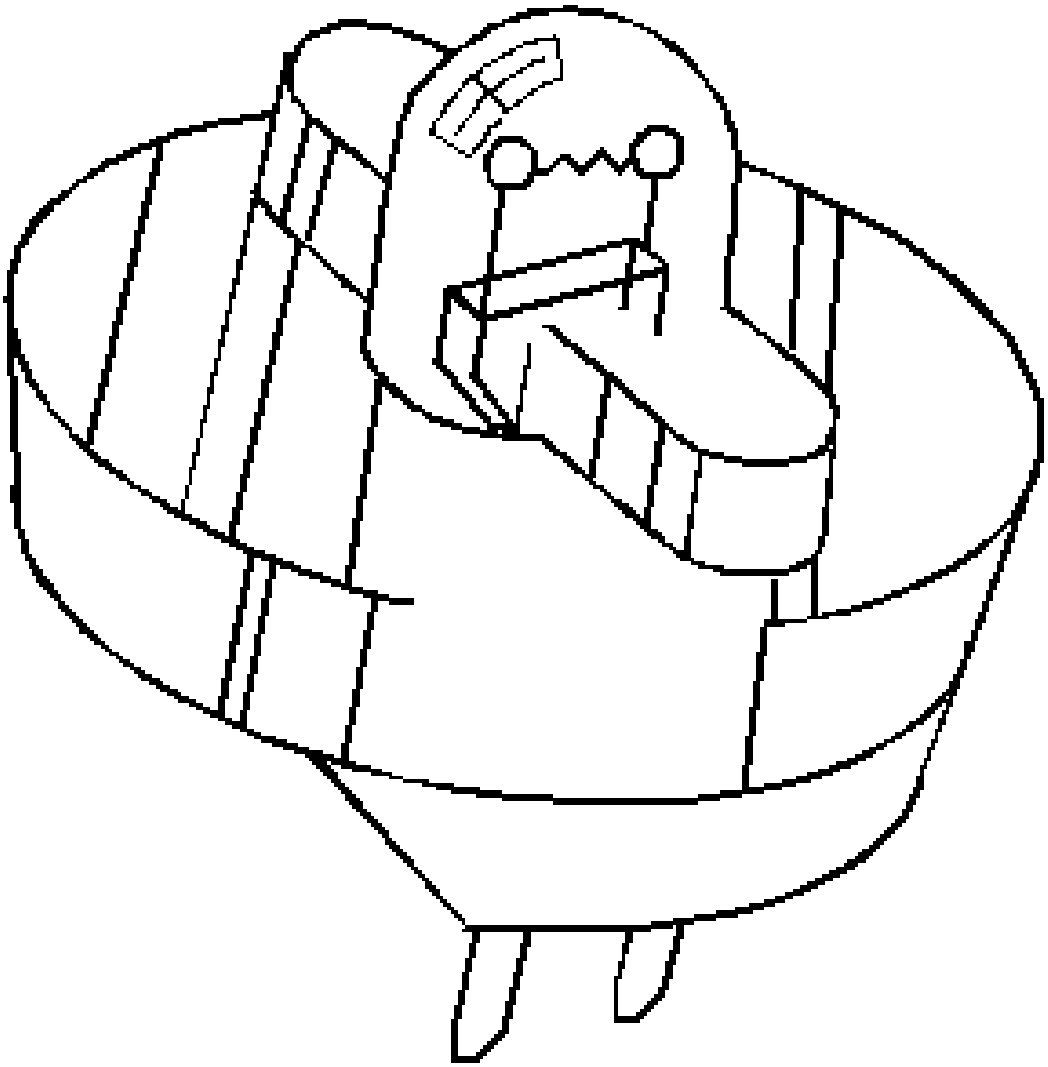
Illustration	Tool Number/Description
	J-34730-375 Injector Test Lamp

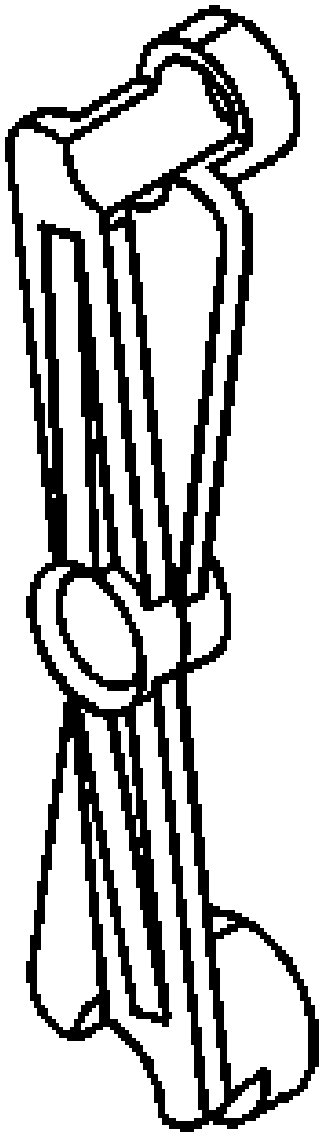
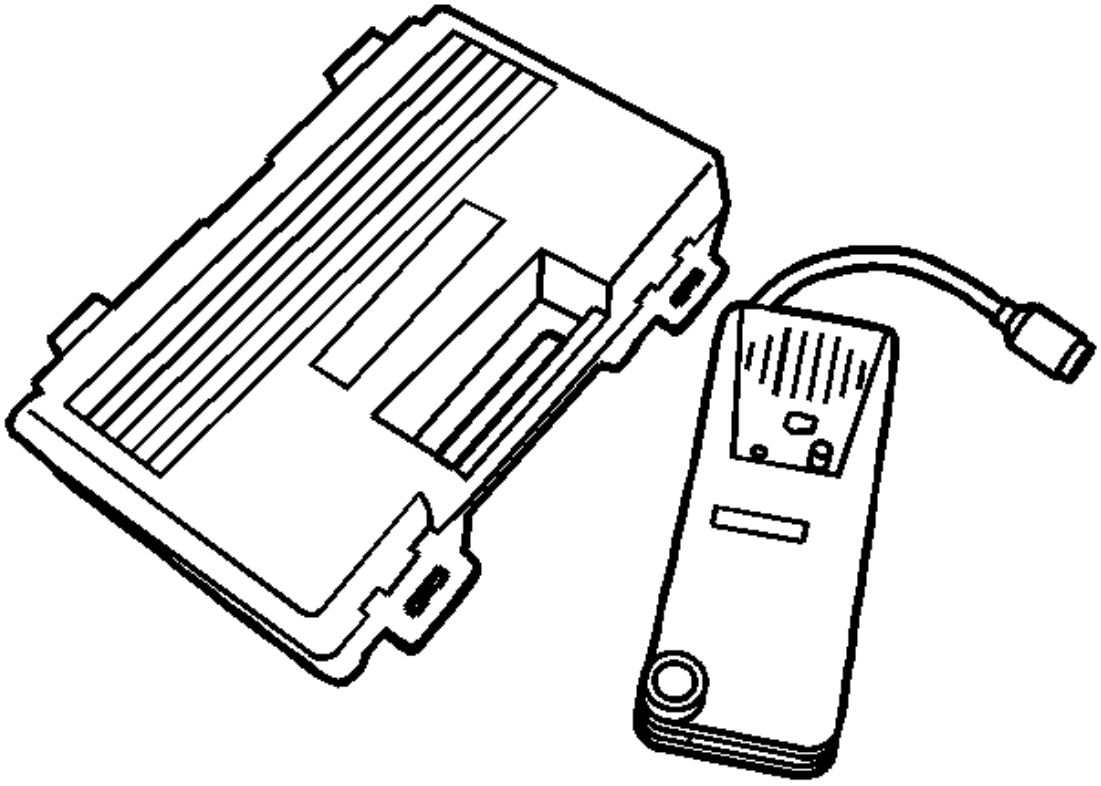
Illustration	Tool Number/Description
	J-44581 Fuel Line Disconnect Tool

Illustration	Tool Number/Description
	J-45878 Combustible Gas Detector

SPECIAL TOOLS (REPAIR TOOLS)

Illustration	Tool Number/Description

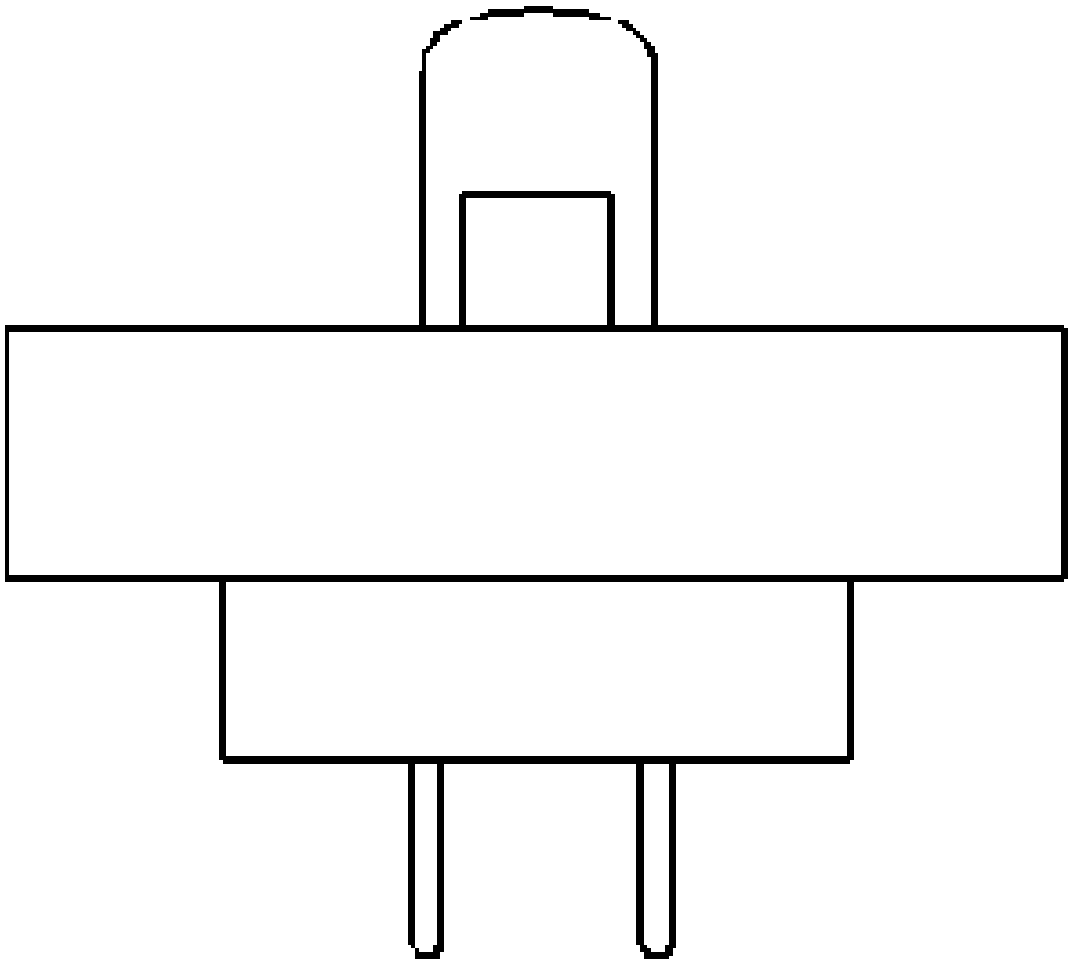
Illustration	Tool Number/Description
	CH-34730-2C J-34730-2C Injector Test Lamp

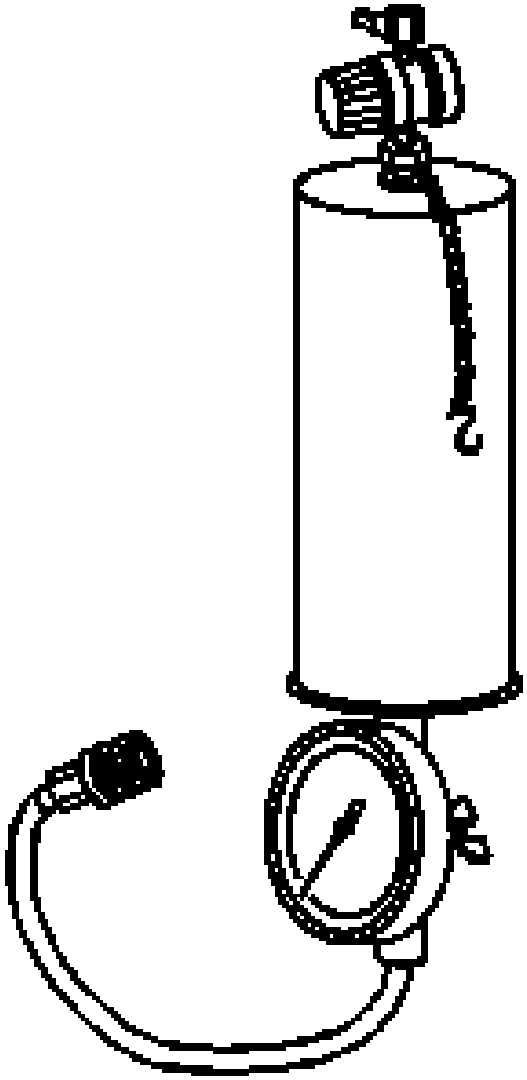
Illustration	Tool Number/Description
	CH-35800-A J-35800-A Fuel Injector Cleaner

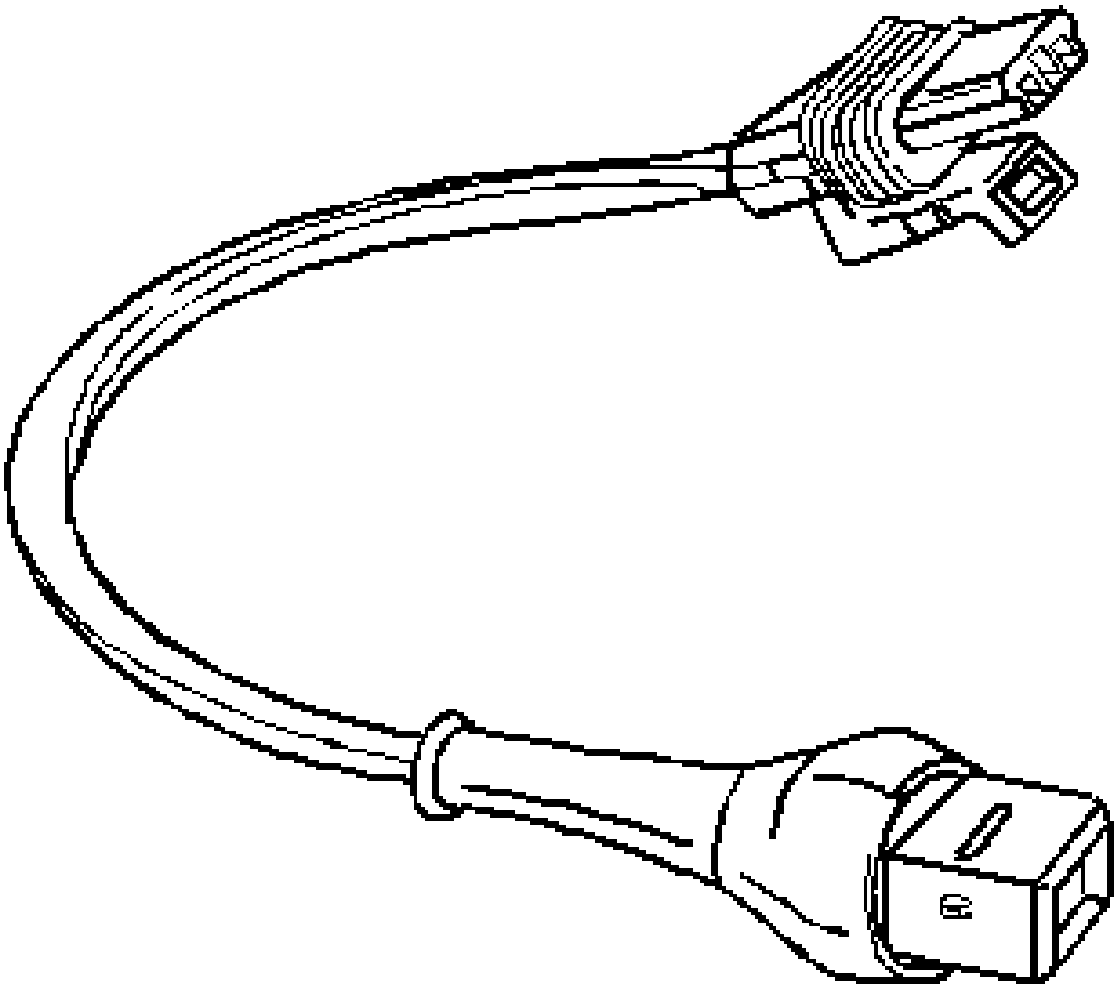
Illustration	Tool Number/Description
	CH-39021-380 J-39021-380 Fuel Injector Harness Adapter

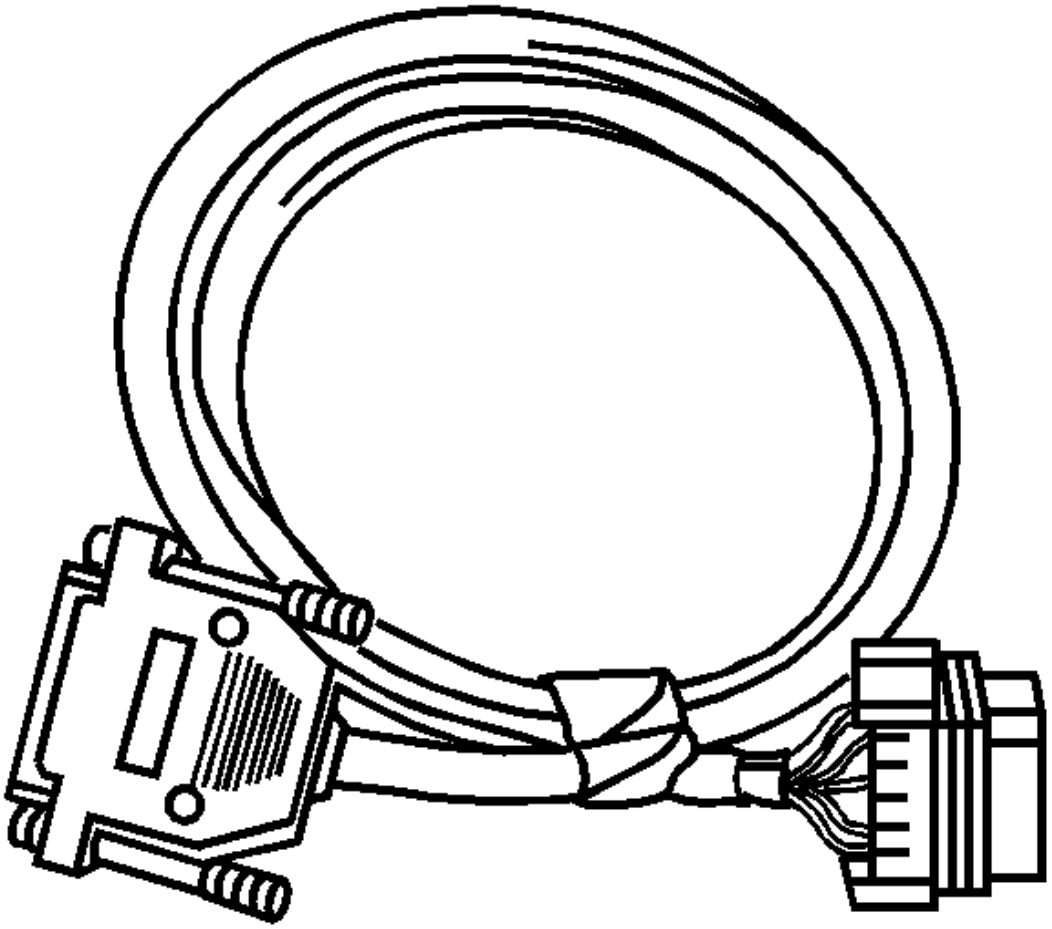
Illustration	Tool Number/Description
	CH-39021-450 J-39021-450 Fuel Injector Harness Adapter

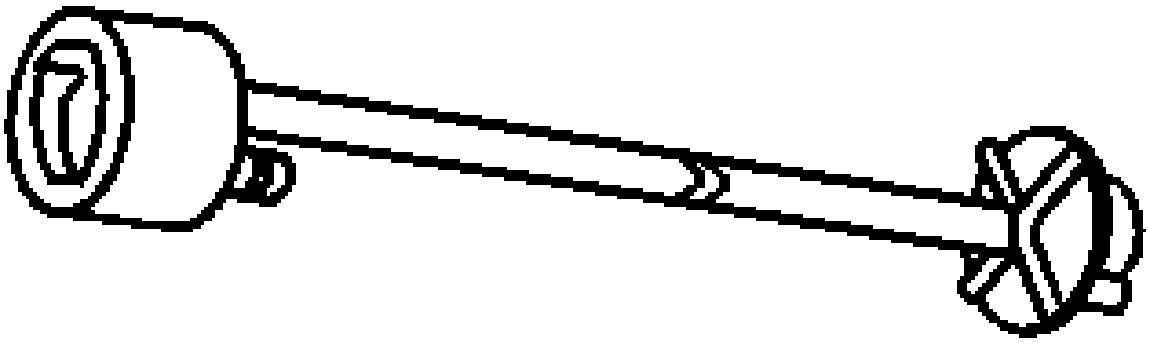
Illustration	Tool Number/Description
	CH-41415-30 J-41415-30 Fuel Tank Cap Adapter South America- Use Local Equivalent

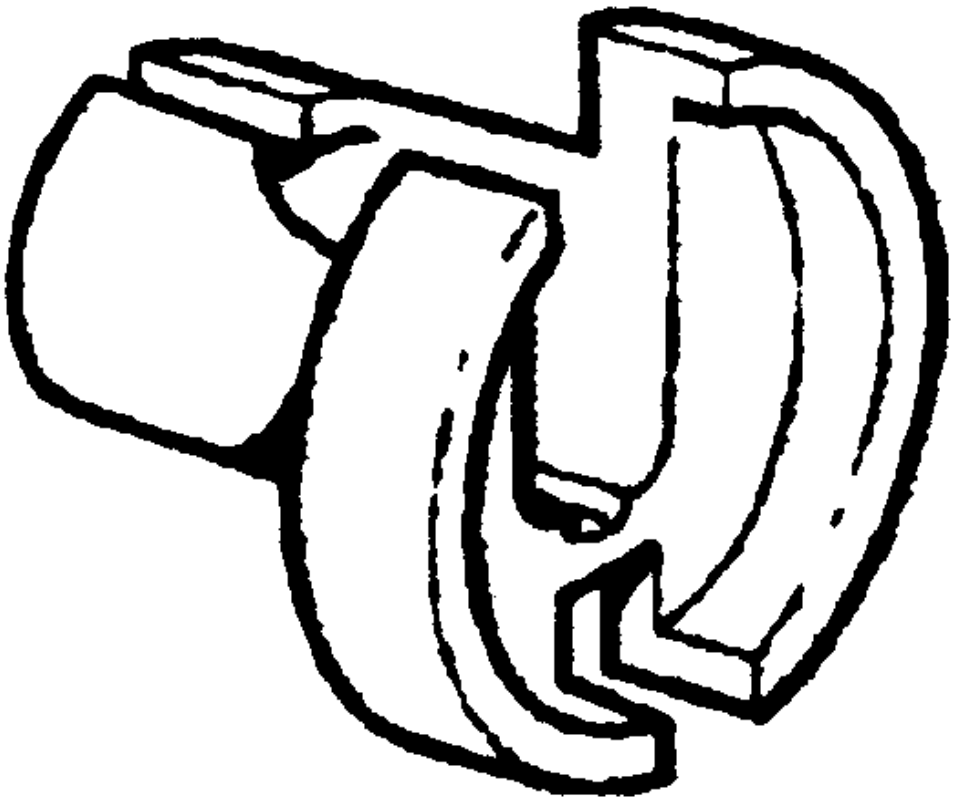
Illustration	Tool Number/Description
	CH-41769-1 Fuel Line Quick Connect Separator 3/8

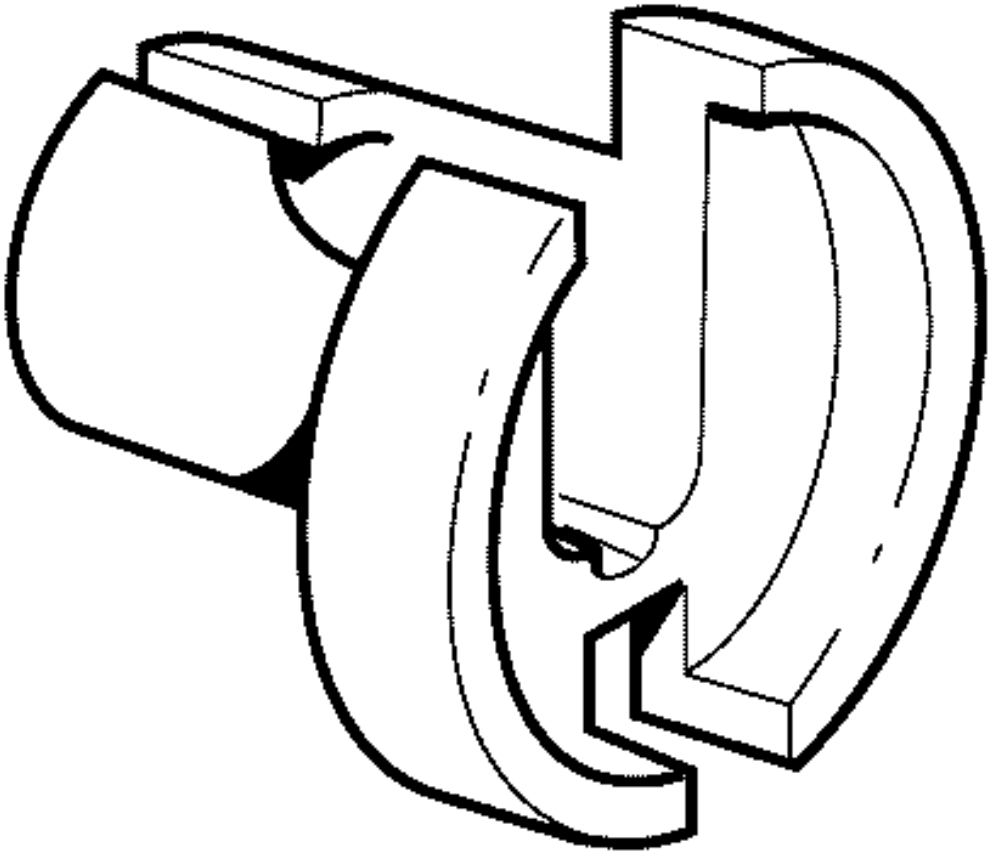
Illustration	Tool Number/Description
	CH-41769-2 Fuel Line Quick Connect Separator 5/16

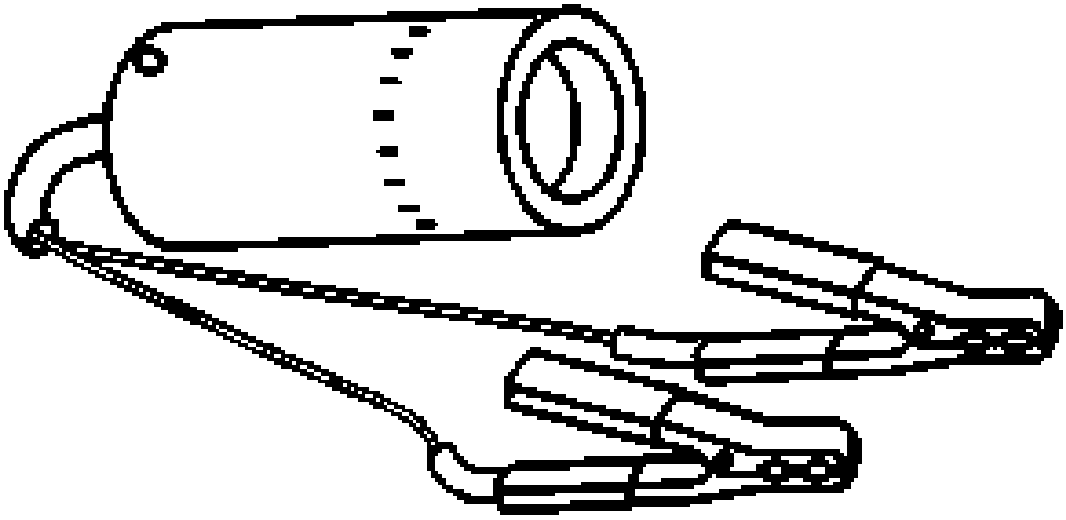
Illustration	Tool Number/Description
	CH-42220 J-42220 Universal 12 Volt Leak Detection Lamp

Illustration	Tool Number/Description
	CH-42242 J-42242 Fuel Pressure Gauge Adapter

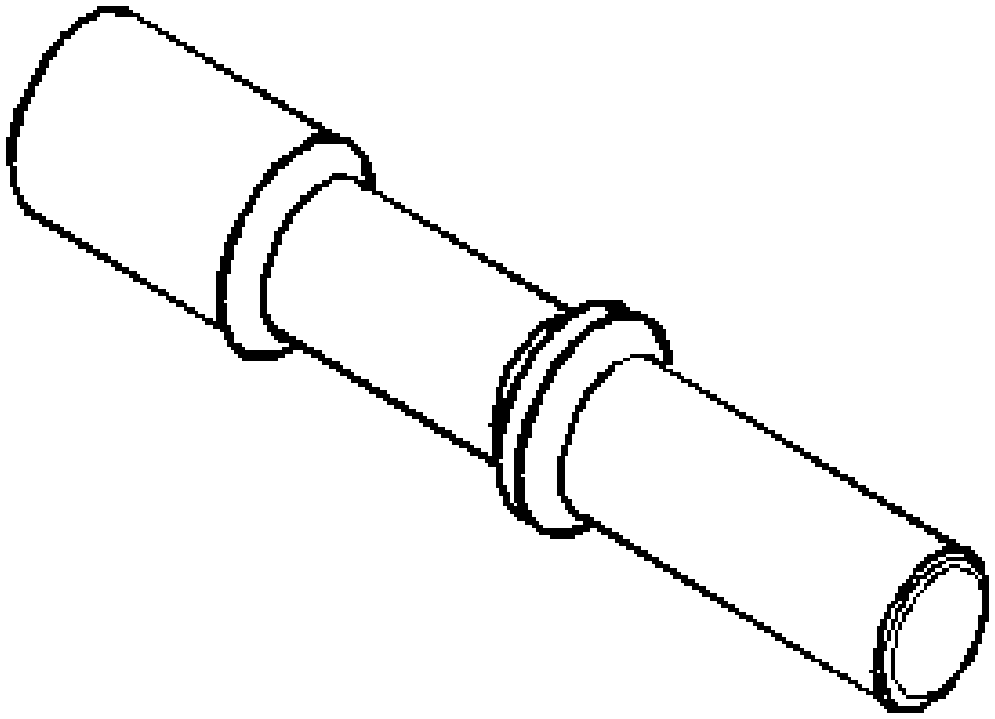
Illustration	Tool Number/Description
	CH-42960-2 J-42960-2 Fuel Flapper Door Holder

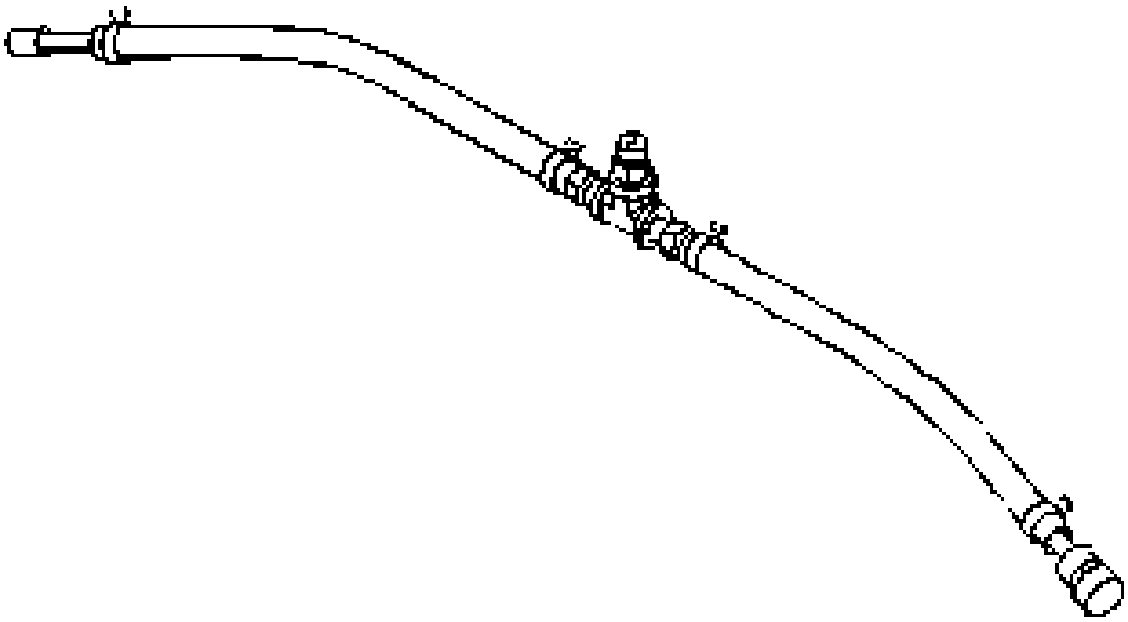
Illustration	Tool Number/Description
	CH-42982 J-42982 Fuel Pressure Gauge Adapter

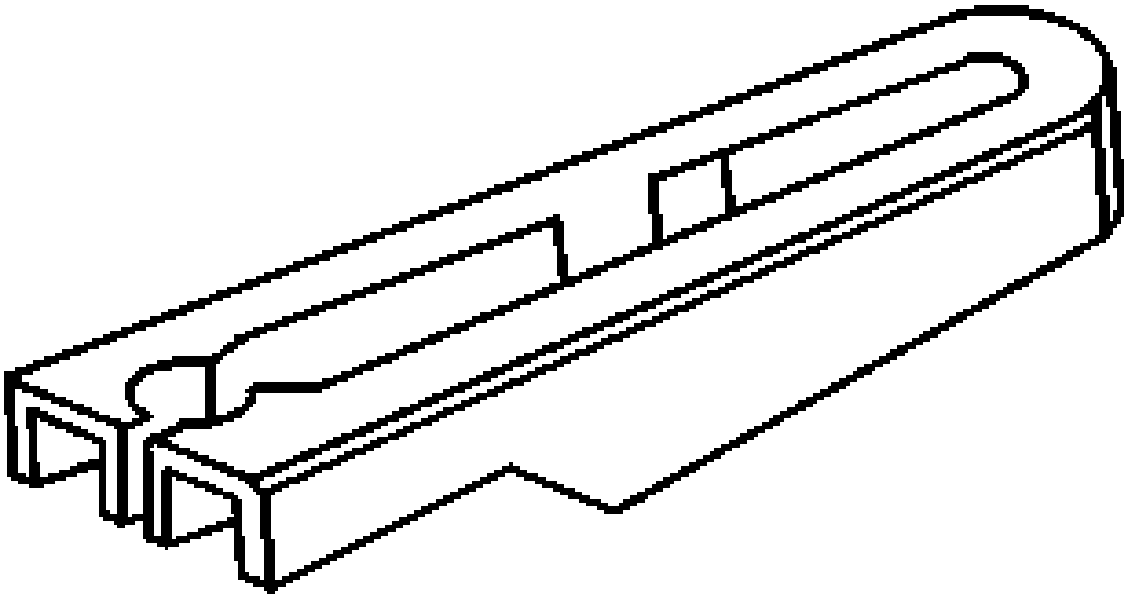
Illustration	Tool Number/Description
	CH-43178 J-43178 Fuel Line Disconnect Tool

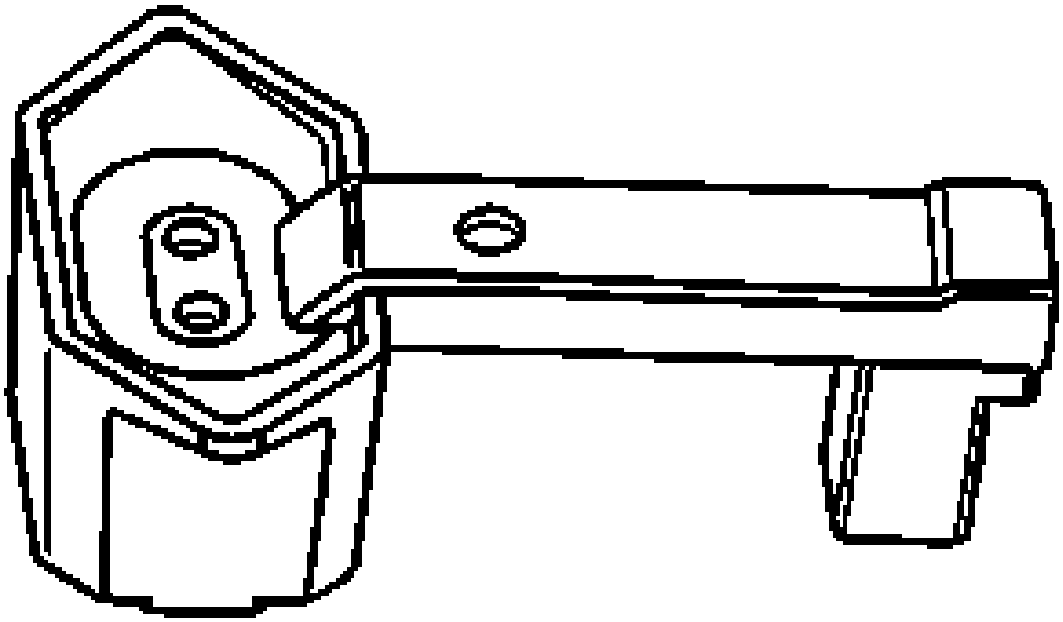
Illustration	Tool Number/Description
	CH-44175 J-44175 Fuel Composition Testers South America- Use Local Equivalent

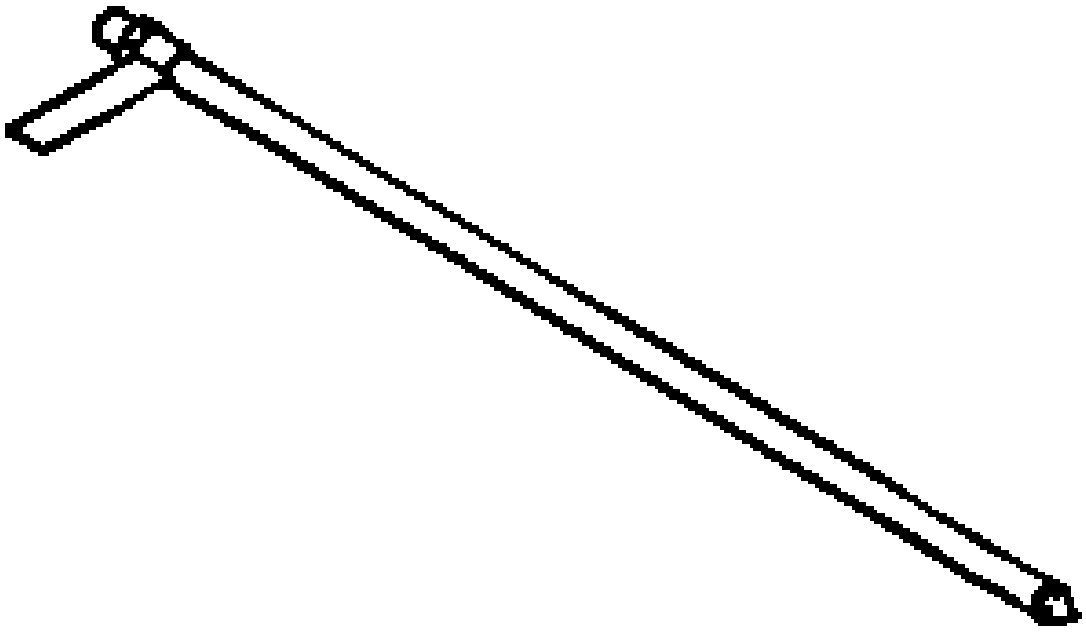
Illustration	Tool Number/Description
	CH-45004 J-45004 Fuel Tank Drain Hose South America- Use Local Equivalent

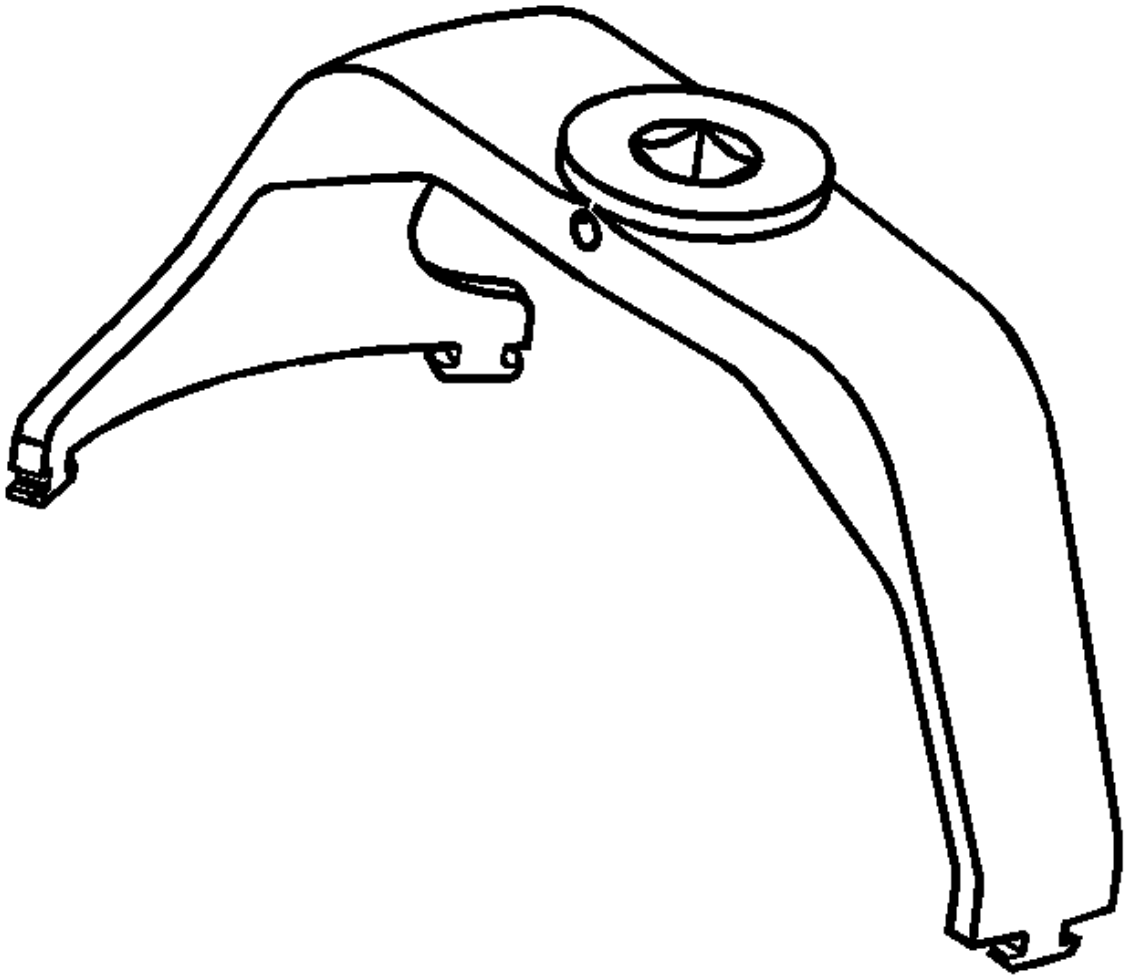
Illustration	Tool Number/Description
	CH-45722 J-45722 Fuel Sender Lock Ring Wrench

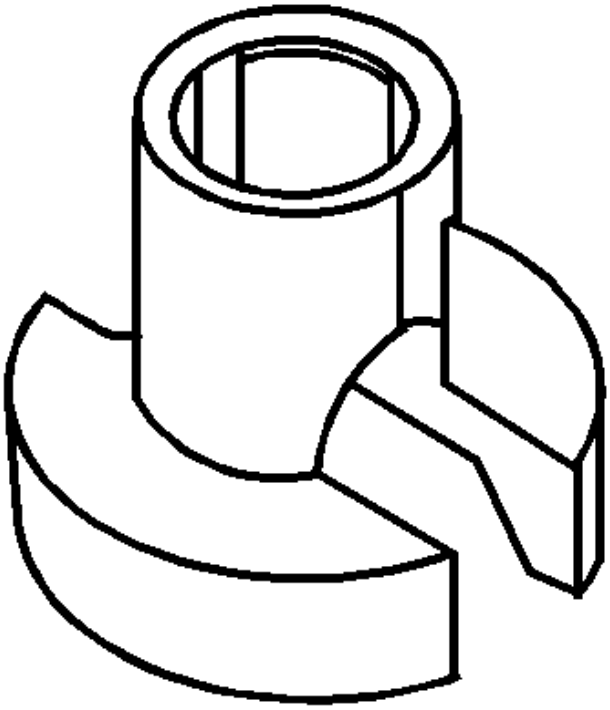
Illustration	Tool Number/Description
	CH-47831 Fuel Line Disconnect Tool

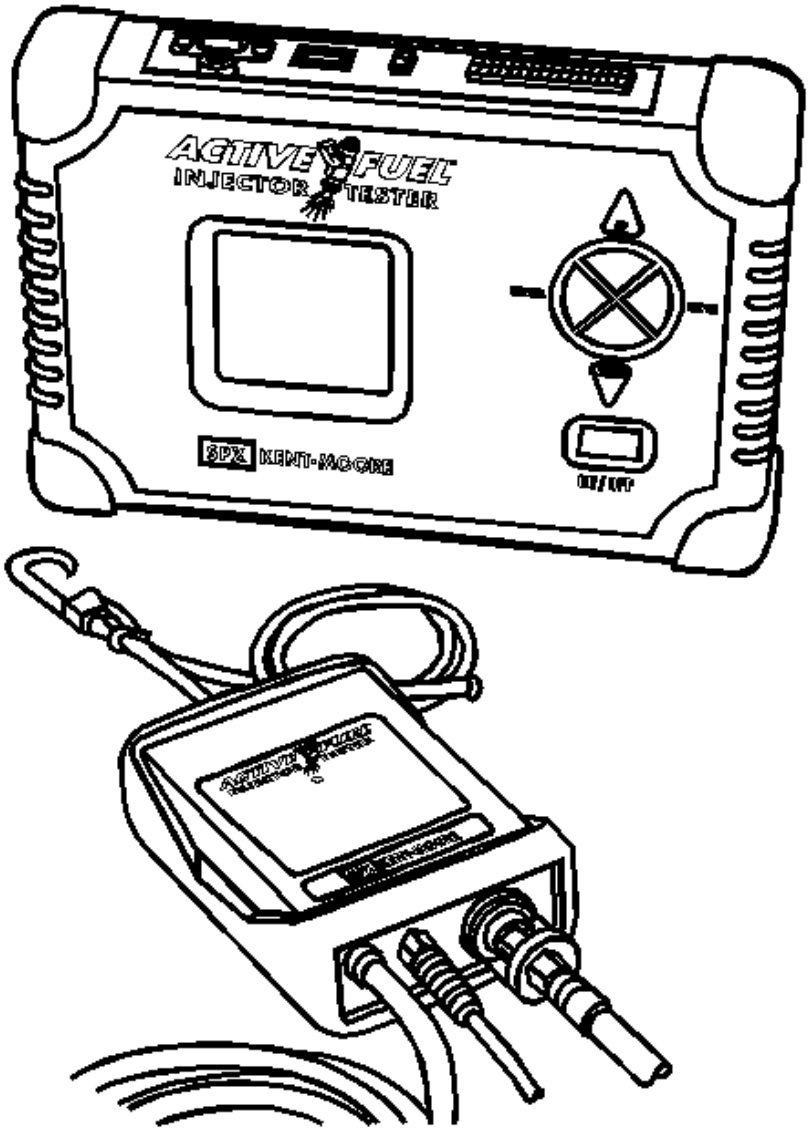
Illustration	Tool Number/Description
	CH-47976 Active Fuel Injector Tester (AFIT)

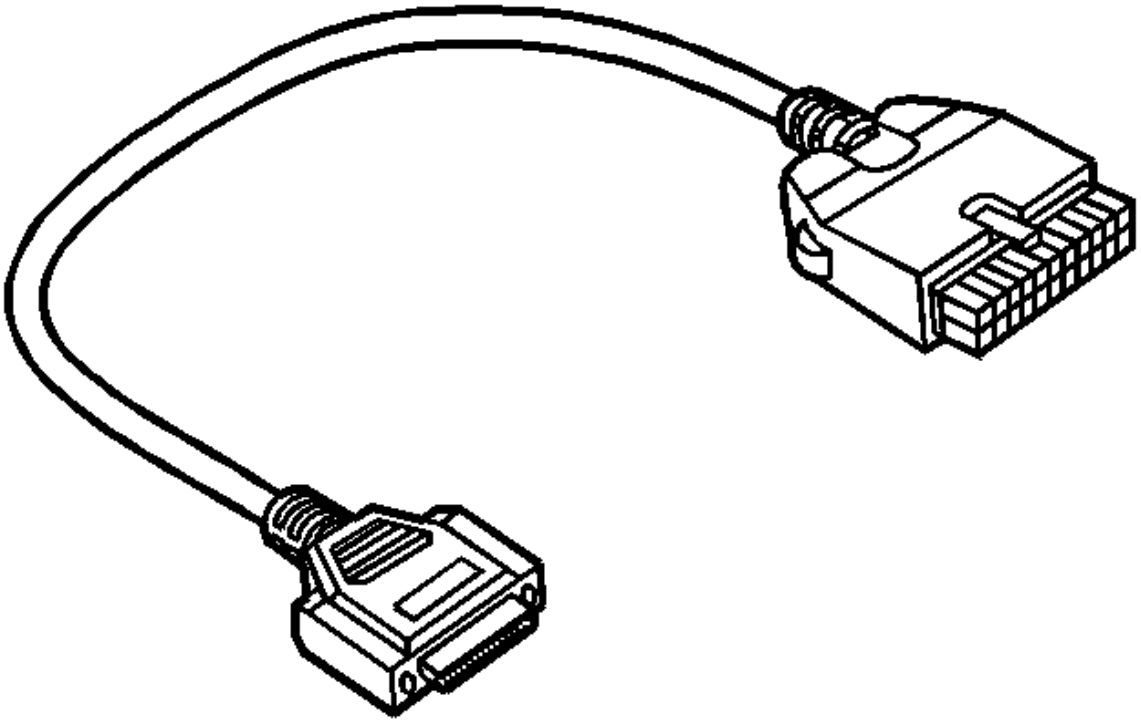
Illustration	Tool Number/Description
	CH-47976-60 AFIT Harness Adapter

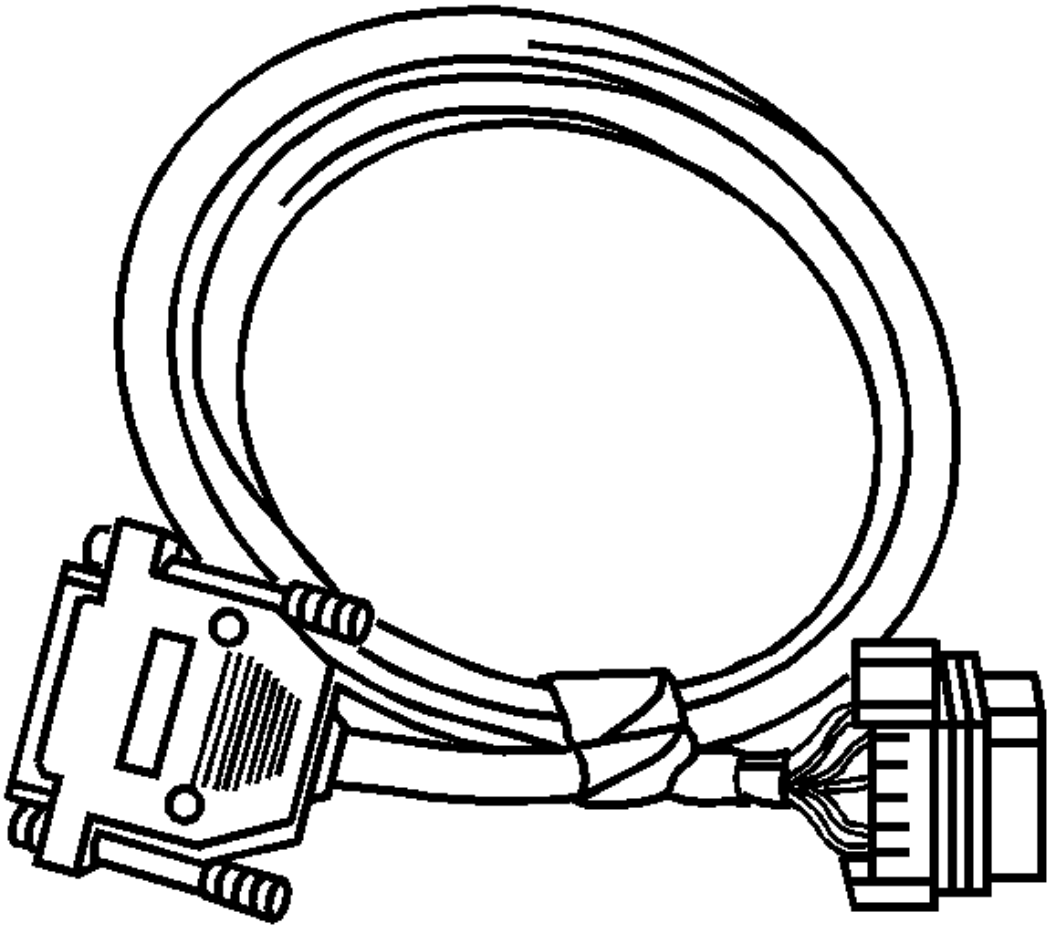
Illustration	Tool Number/Description
	CH-47976-75 Fuel Injector Harness Adapter

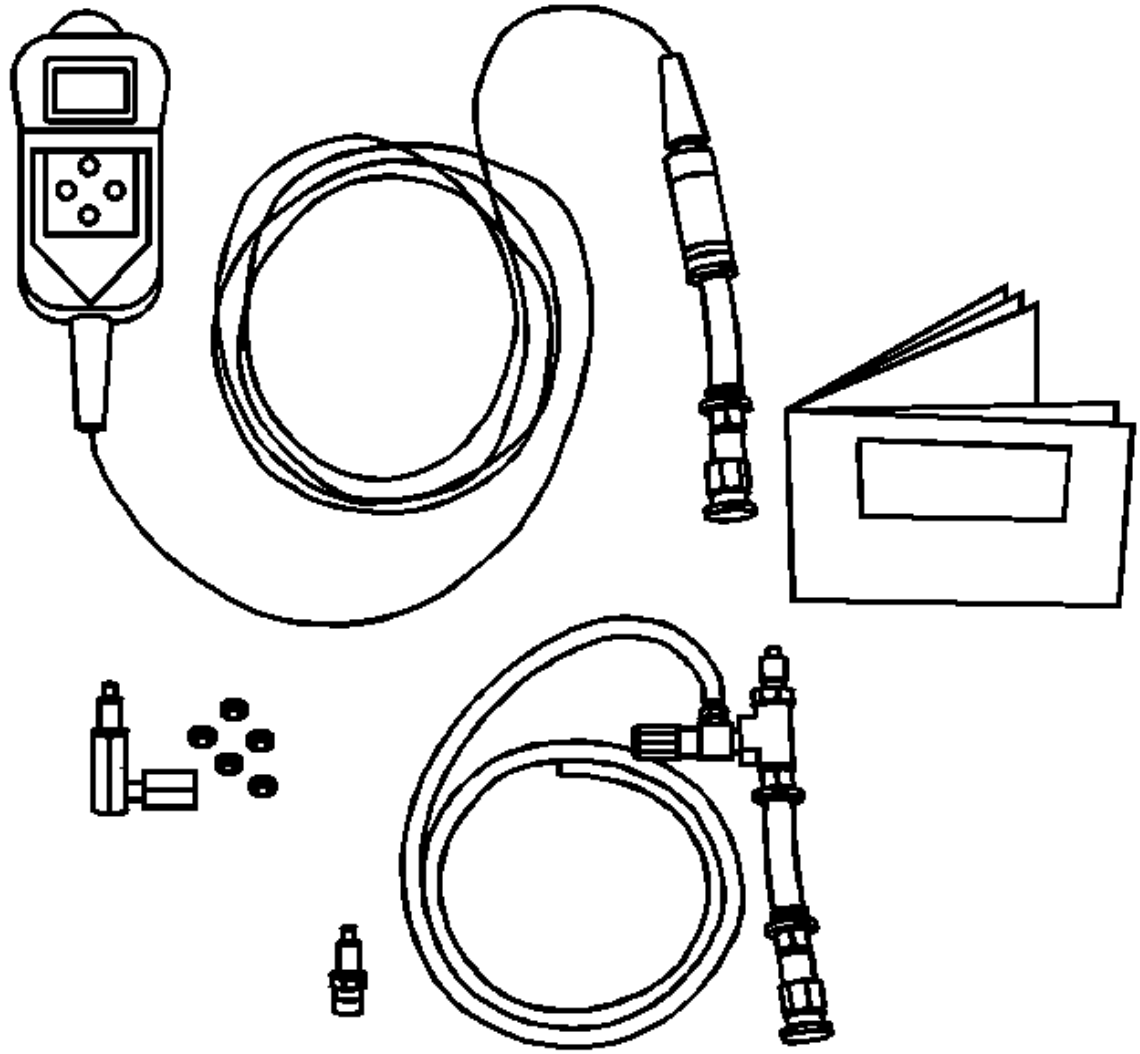
Illustration	Tool Number/Description
	CH-48027 Digital Pressure gauge South America- Use Local Equivalent

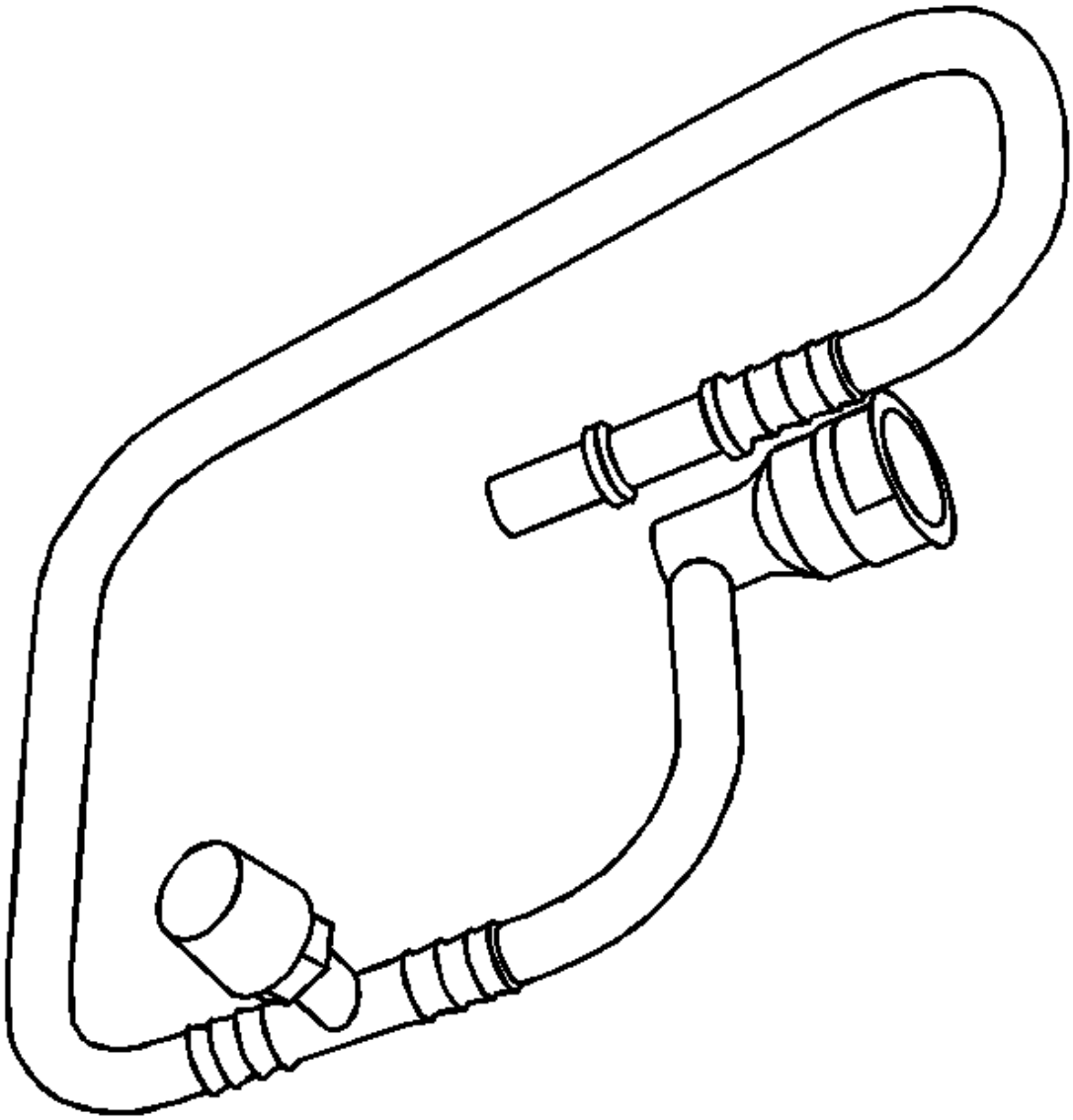
Illustration	Tool Number/Description
	CH-48096 EVAP Service Access Port Tool

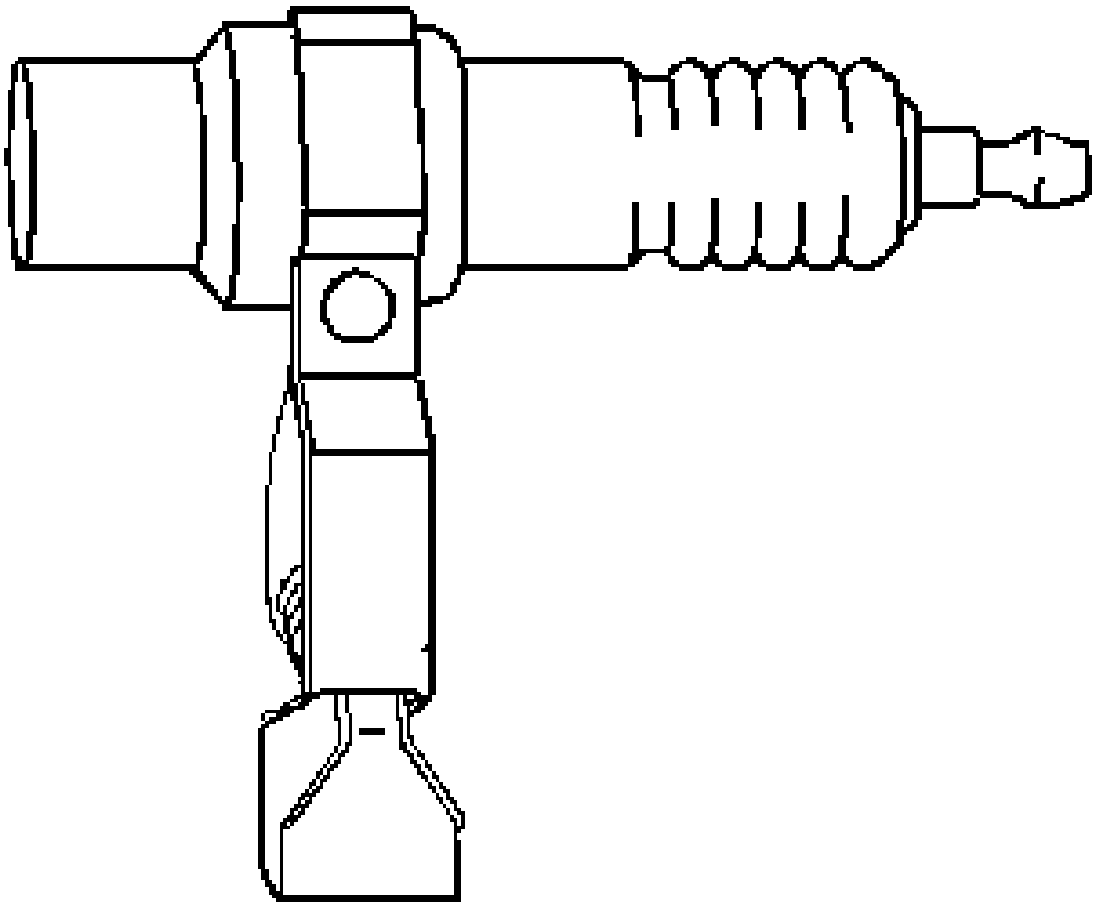
Illustration	Tool Number/Description
	EL-26792 J-26792 HEI Spark Tester South America- Use Local Equivalent

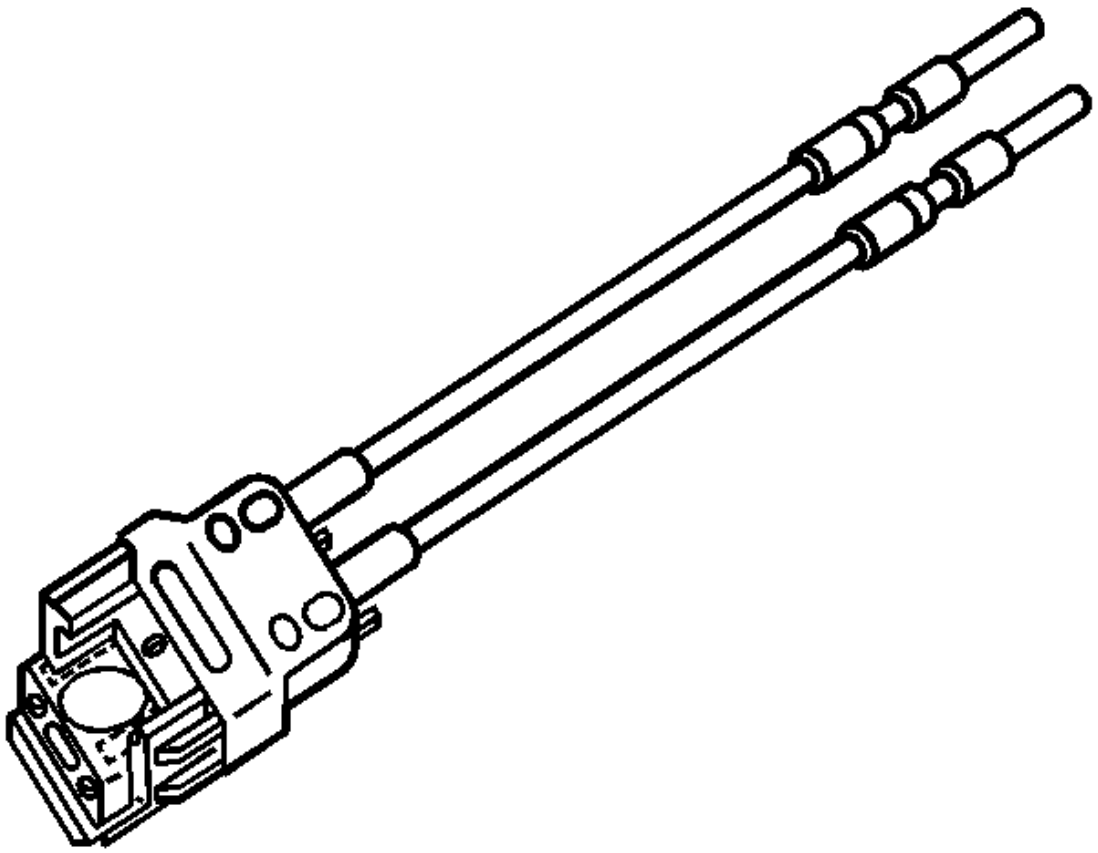
Illustration	Tool Number/Description
	EL 36169-HD J 36169-HD Heavy Duty Fused Jumper

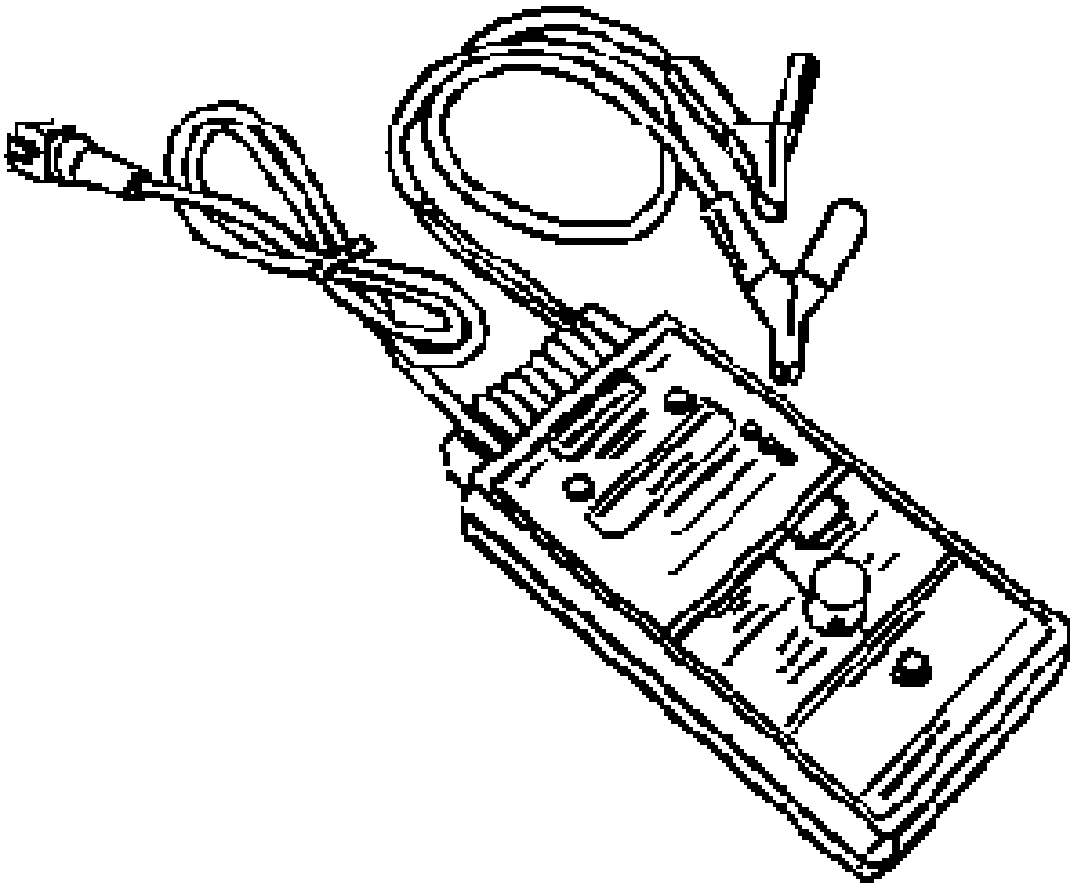
Illustration	Tool Number/Description
	EL-39021 J-39021 Fuel Injector Coil and Balancer Tester

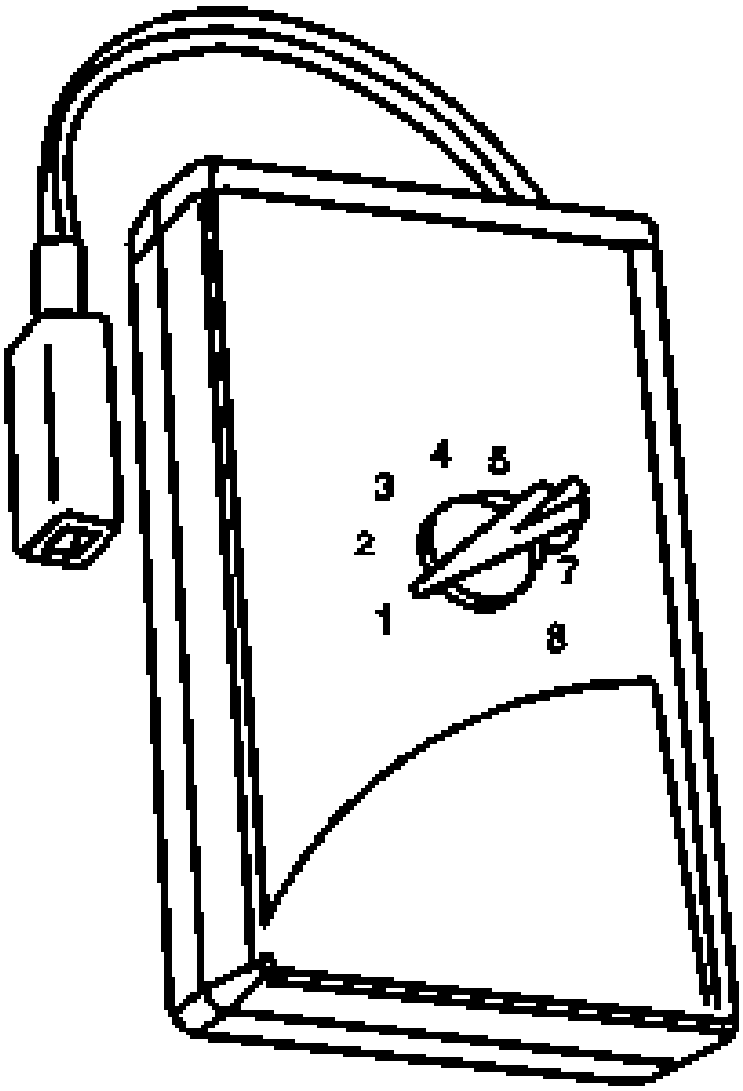
Illustration	Tool Number/Description
	EL-39021-210 J-39021-210 Injector Tester Adapter Box

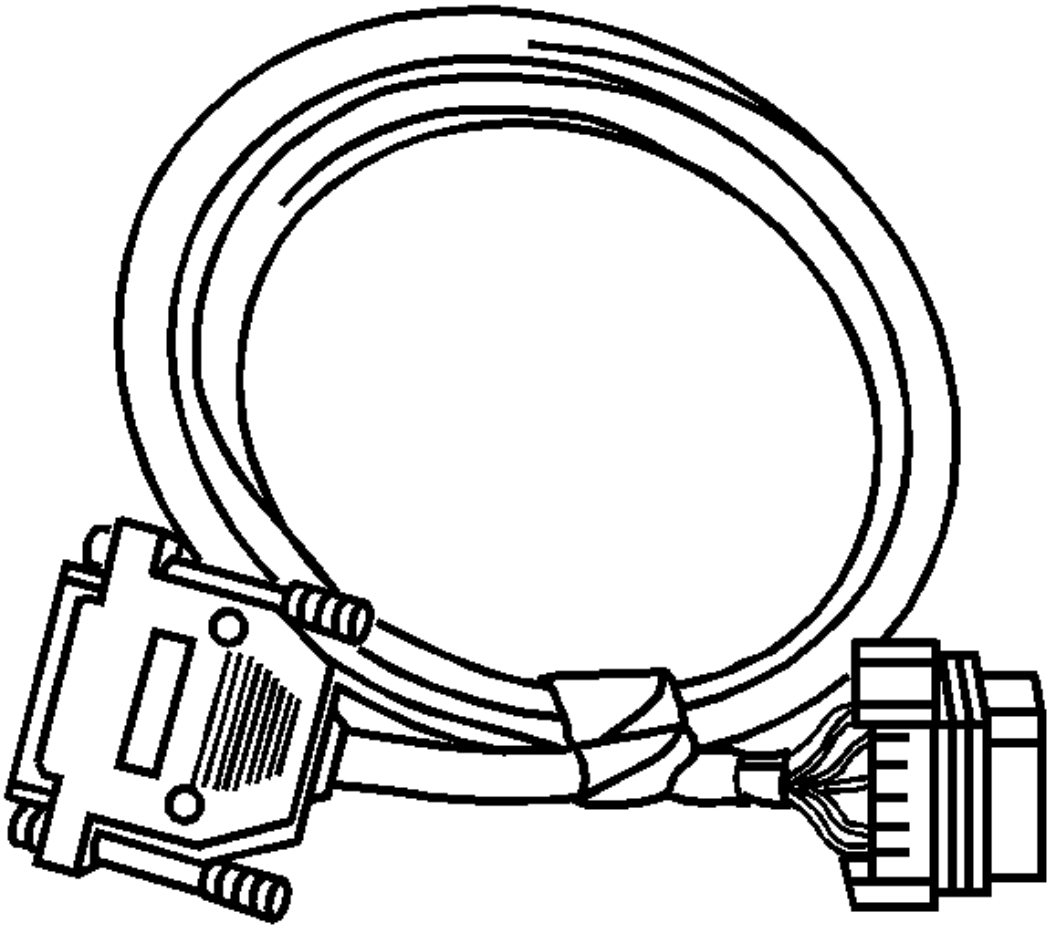
Illustration	Tool Number/Description
	EL-39021-460 J-39021-460 Fuel Injector Test Adapter

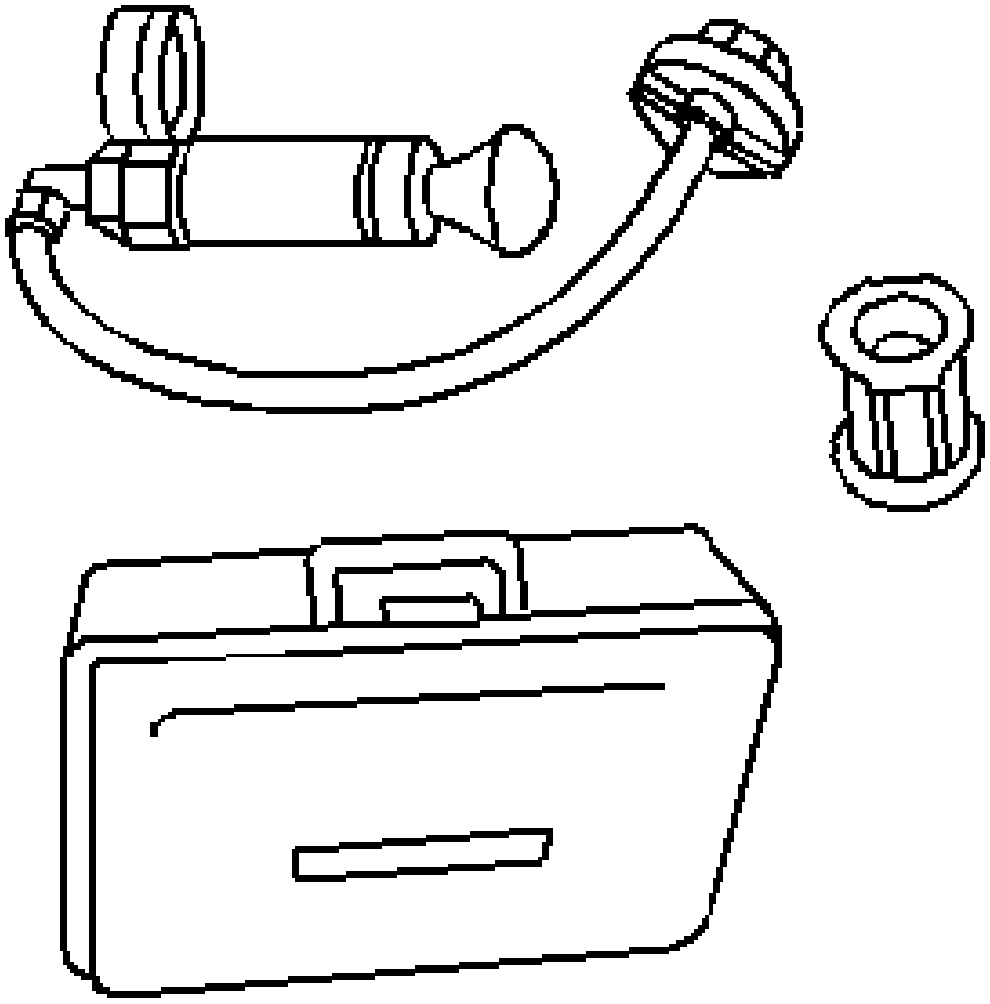
Illustration	Tool Number/Description
	EN-24460-A J-24460-A Cooling System Pressure Tester

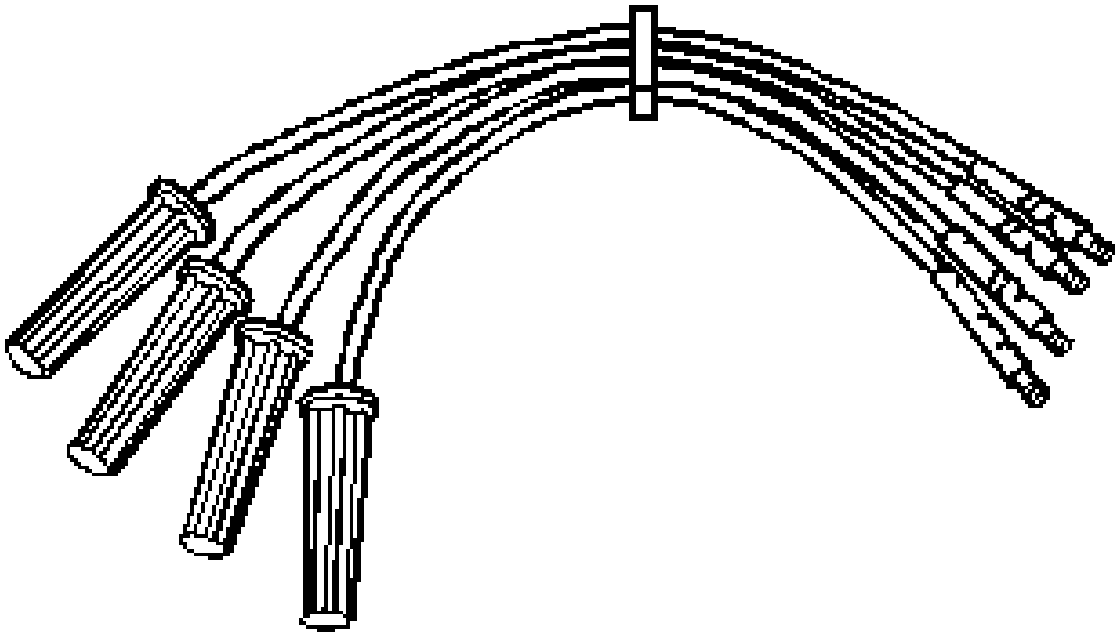
Illustration	Tool Number/Description
	EN-36012-A J-36012-A Ignition System Diagnosis Harness

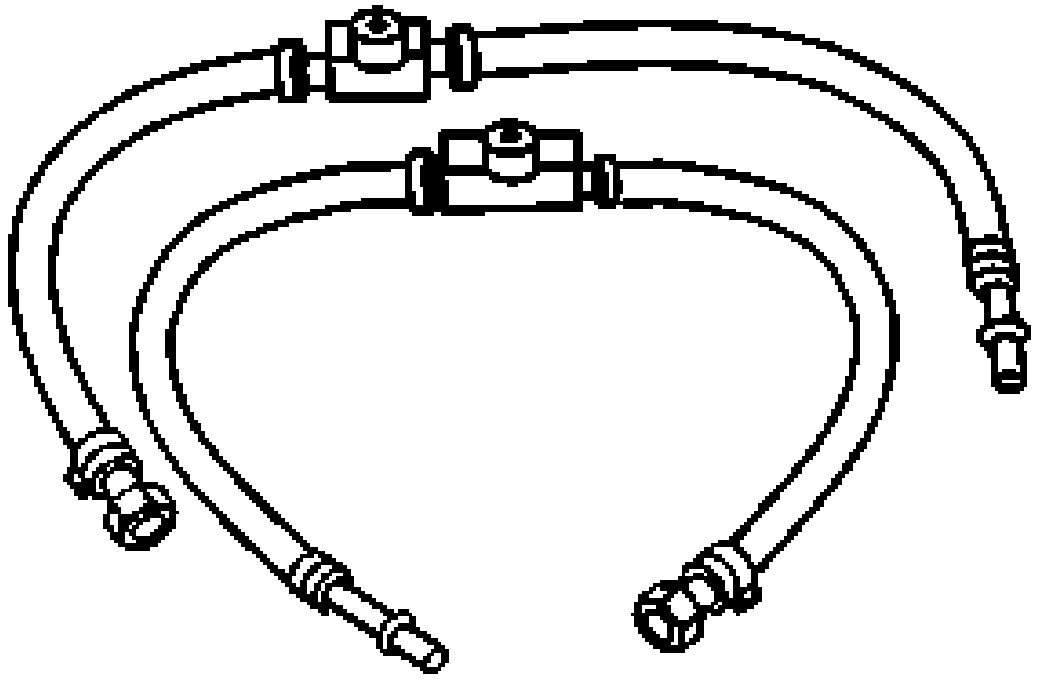
Illustration	Tool Number/Description
	EN-37287 J-37287 Fuel Line Shut-Off Adapters (Flex Fuel)

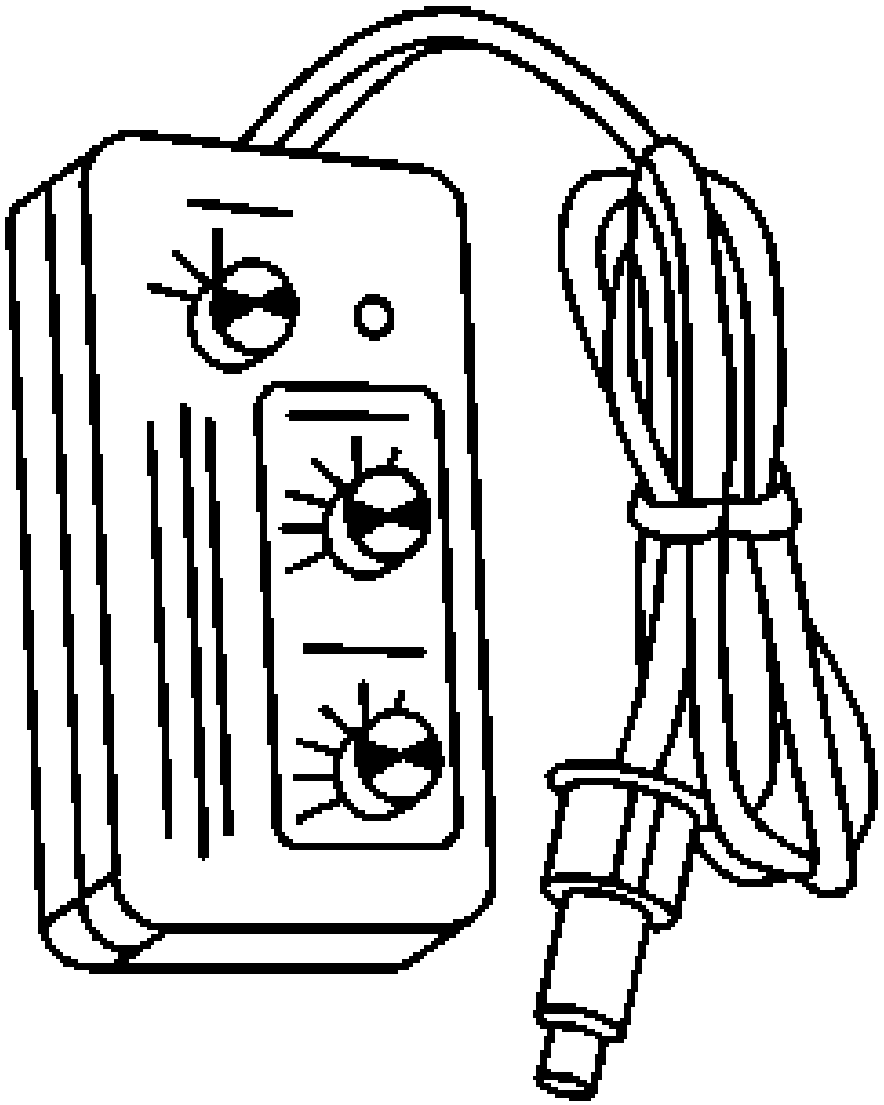
Illustration	Tool Number/Description
	EN-38522 J-38522 Variable Signal Generator

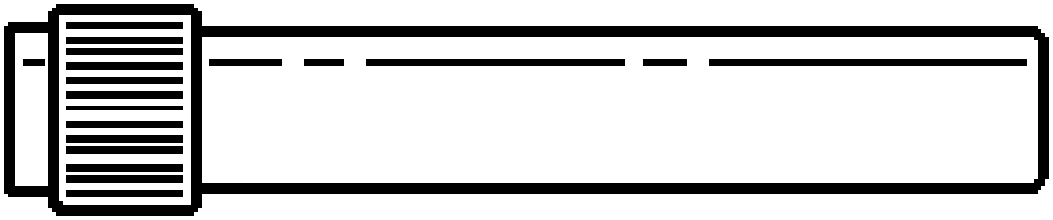
Illustration	Tool Number/Description
	EN-41413-VLV J-41413-VLV EVAP Service Port Vent Fitting South America- Use Local Equivalent

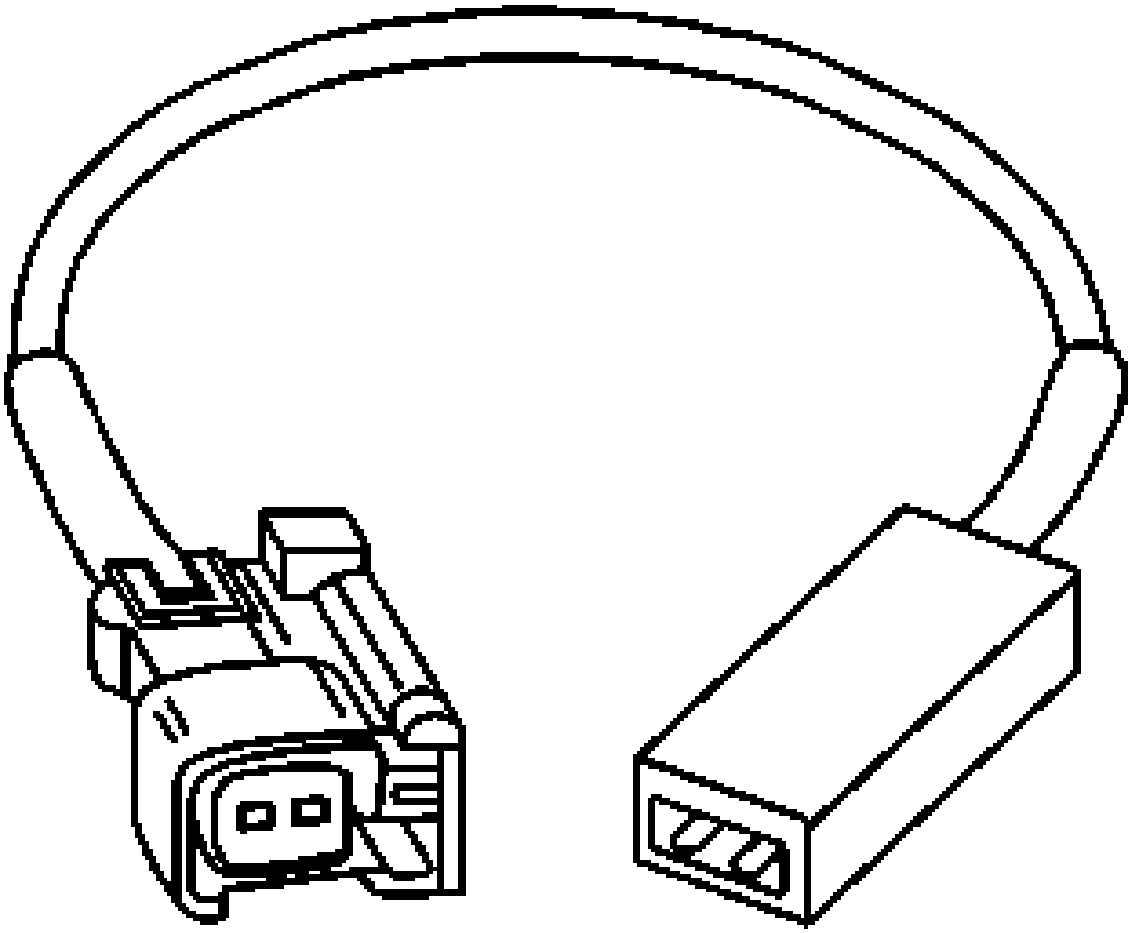
Illustration	Tool Number/Description
	EN-44602 J-44602 Injector Test Adapter

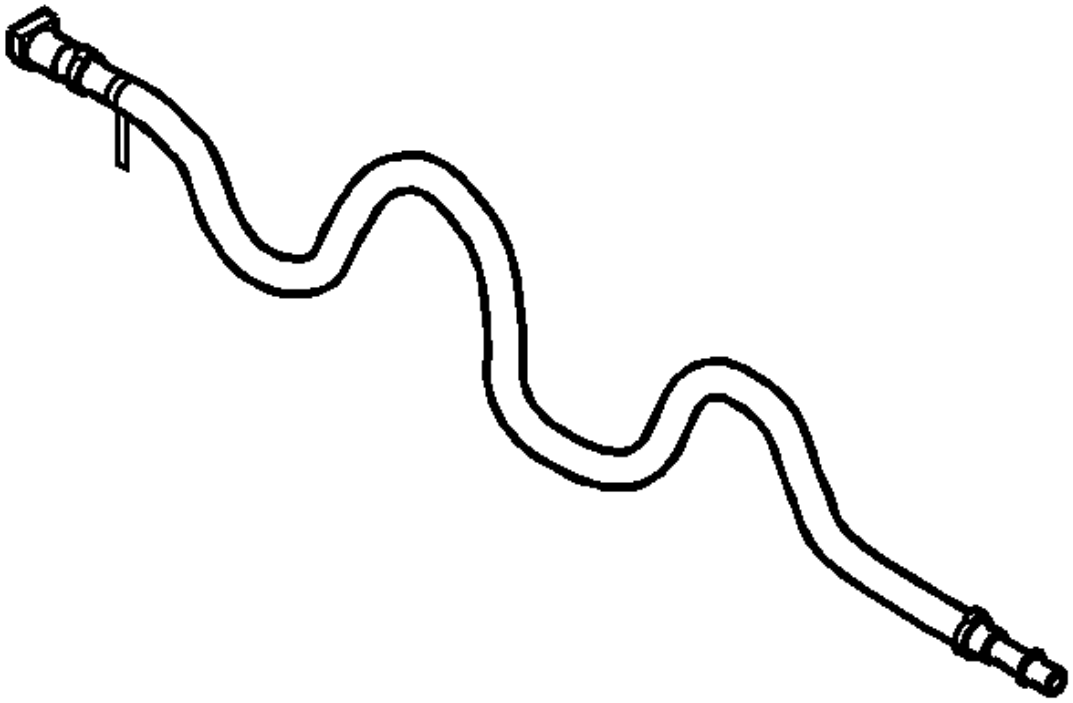
Illustration	Tool Number/Description
	EN-47969 Fuel Supply Diagnostic Hose

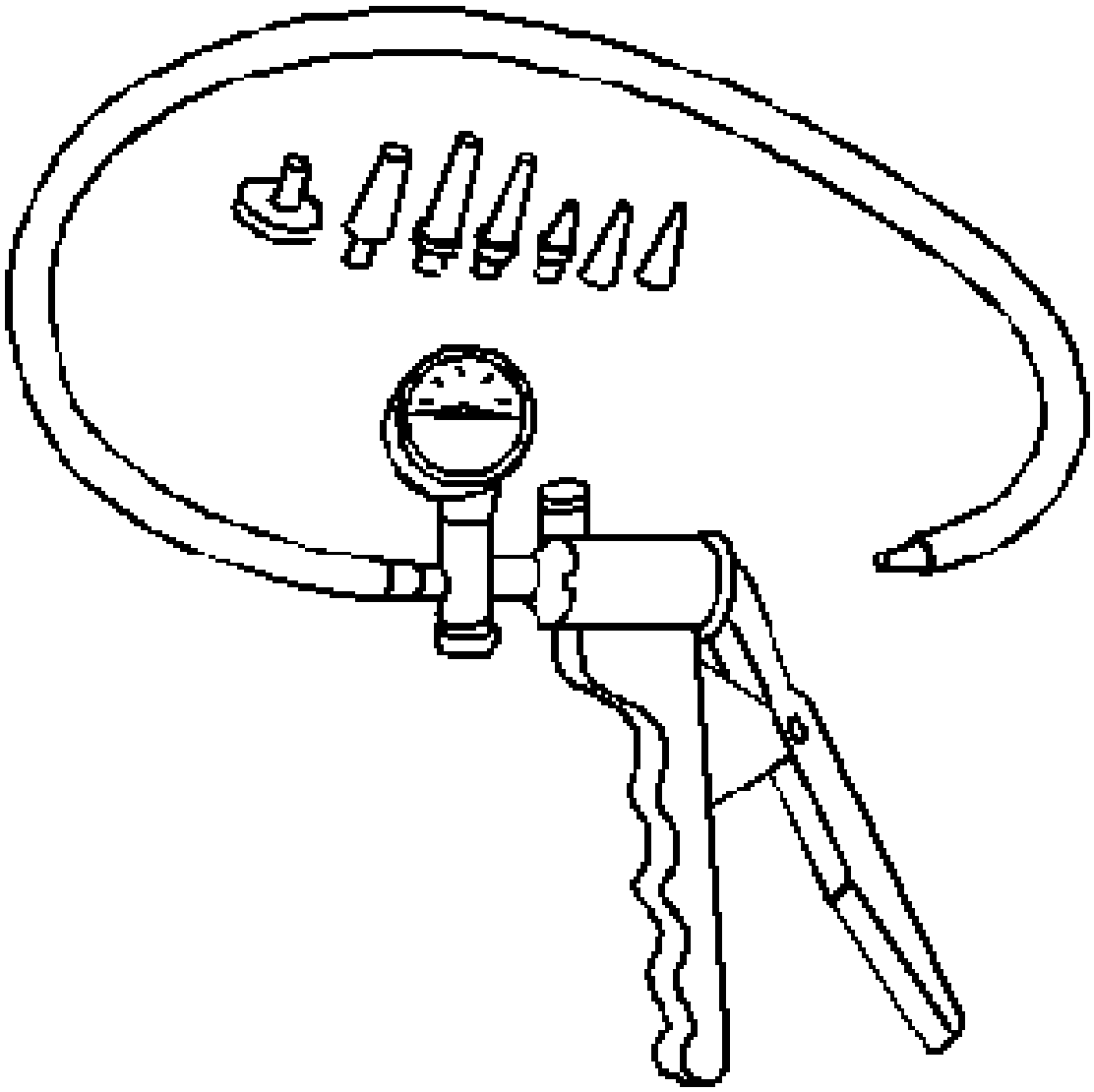
Illustration	Tool Number/Description
	GE-23738-A J-23738-A Vacuum Pump

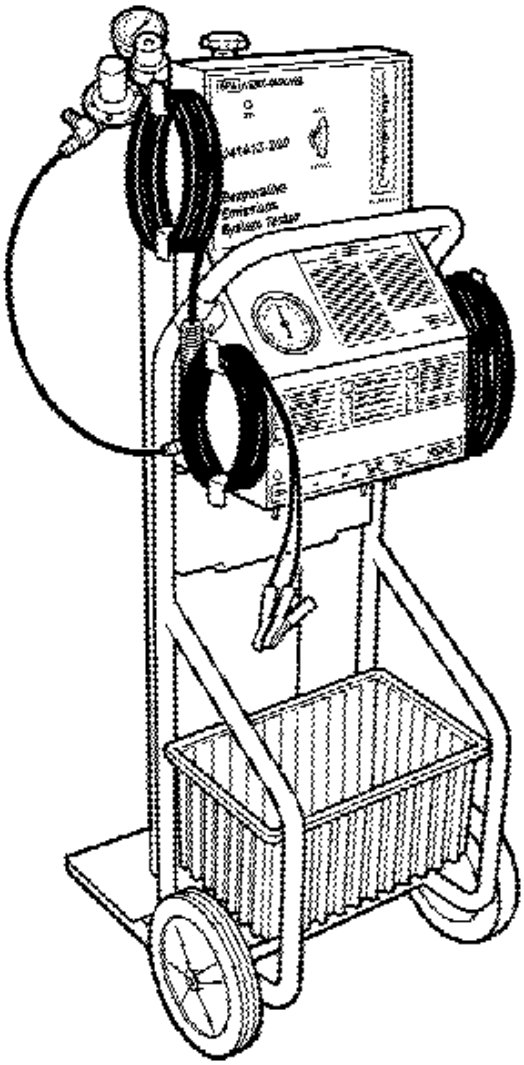
Illustration	Tool Number/Description
	GE-41413-A J-41413-A Evaporative Emissions System Tester (EEST) South America- Use Local Equivalent

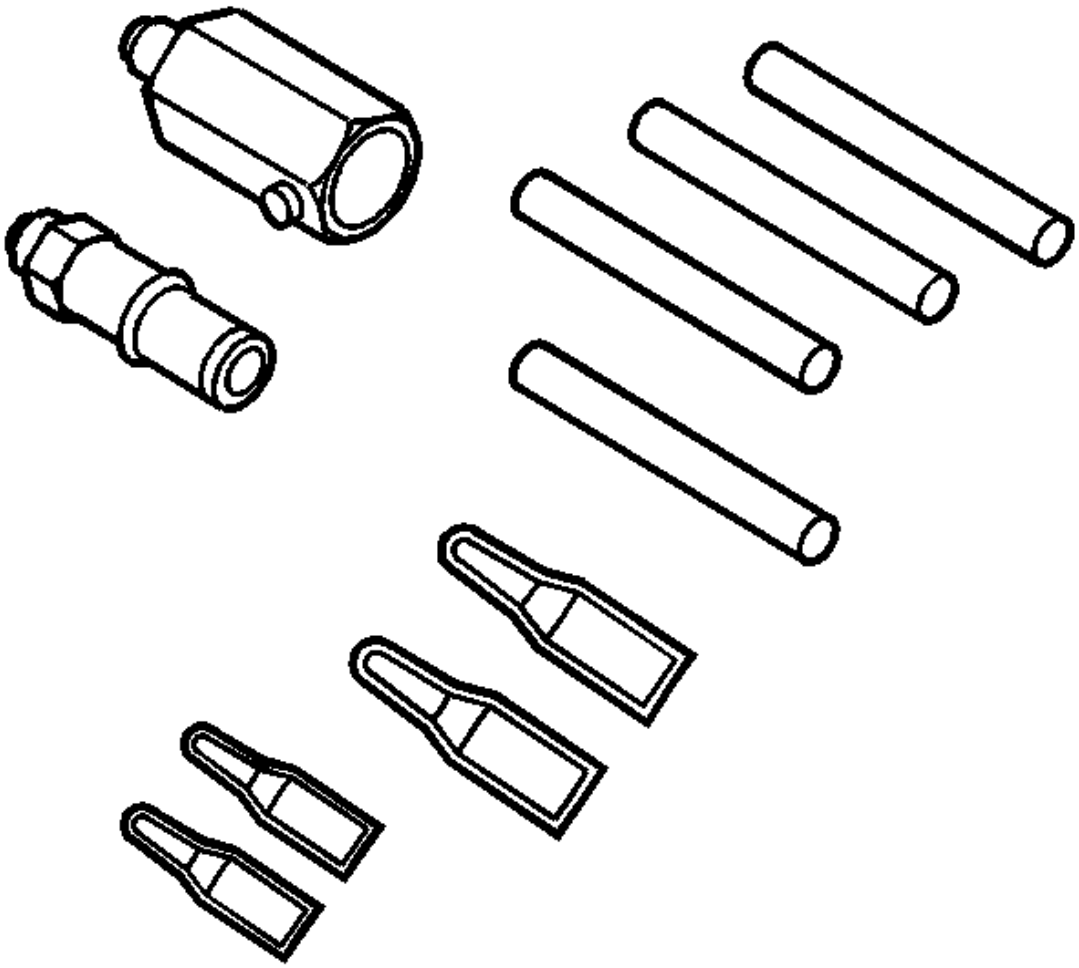
Illustration	Tool Number/Description
	GE-41413-300 J-41413-300 EVAP Cap and Plug Kit South America- Use Local Equivalent

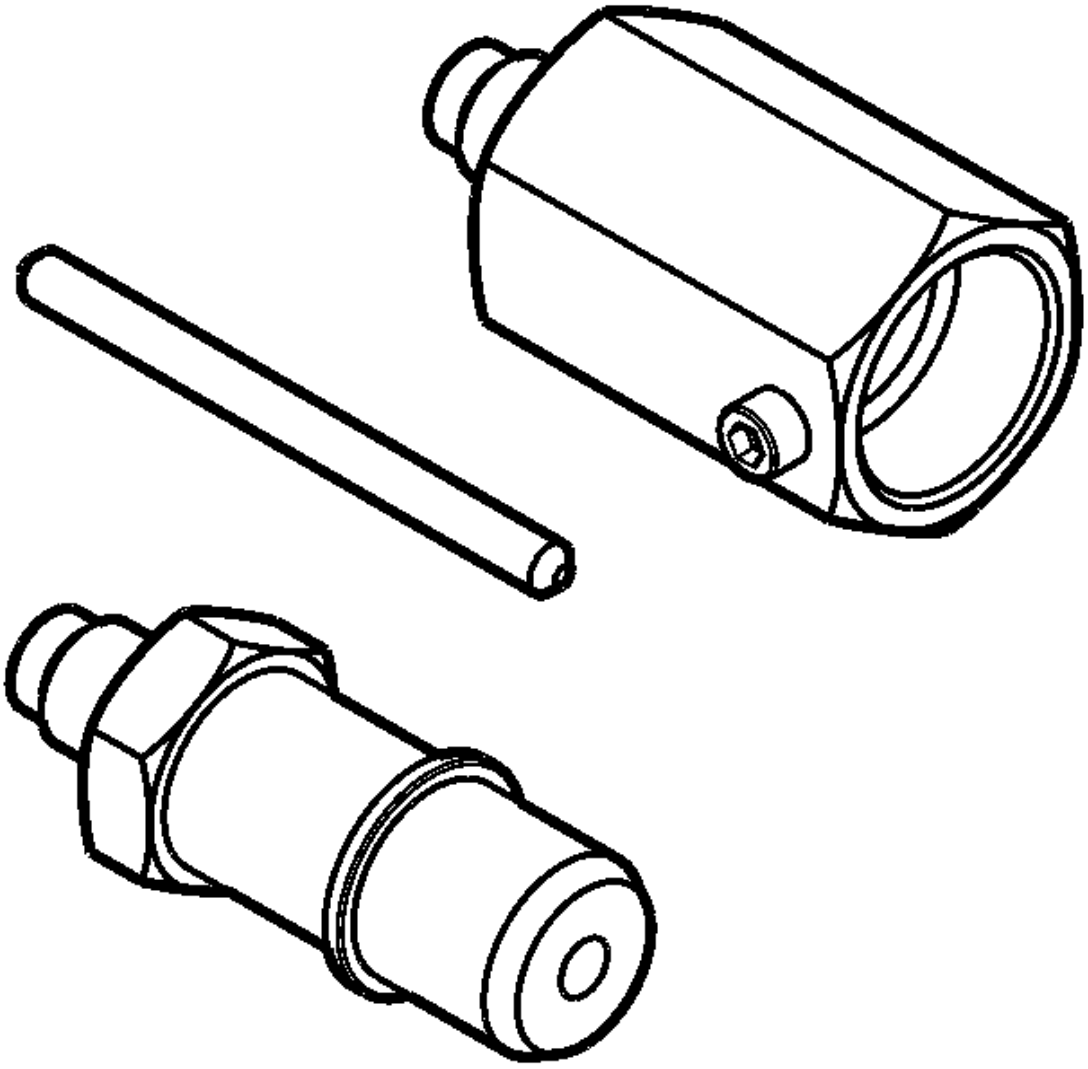
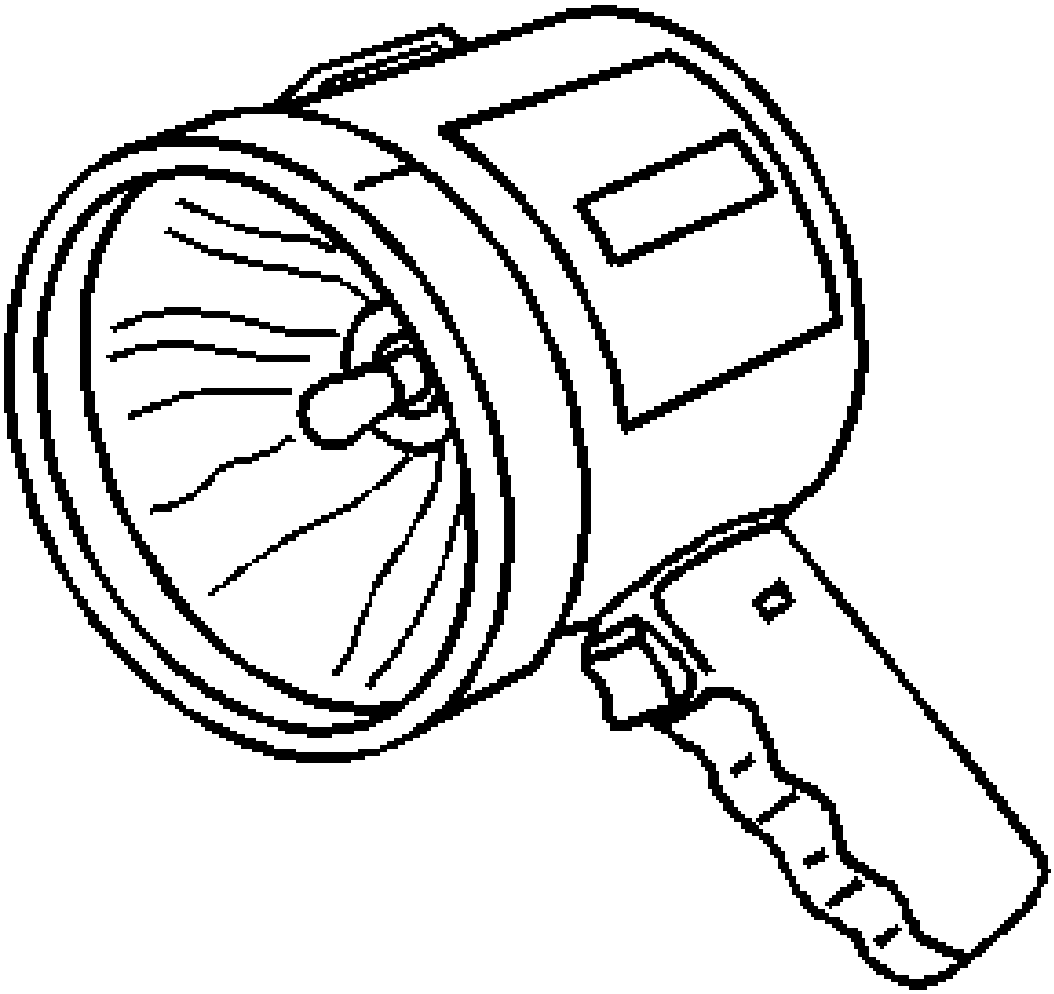
Illustration	Tool Number/Description
	GE-41413-320 J-41413-320 EVAP Cap and Plug Kit South America- Use Local Equivalent

Illustration	Tool Number/Description
	GE-41413-SPT J-41413-SPT High Intensity White Light South America- Use Local Equivalent

Article GUID: A00737246

SPECIFICATIONS

TEMPERATURE VERSUS RESISTANCE - ENGINE COOLANT TEMPERATURE SENSOR

Temperature	Resistance
150Â°C (302Â°F)	47 to 49 ohms
140Â°C (284Â°F)	58 to 62 ohms
130Â°C (266Â°F)	76 to 80 ohms
120Â°C (248Â°F)	98 to 104 ohms
110Â°C (230Â°F)	130 to 136 ohms
100Â°C (212Â°F)	174 to 182 ohms
90Â°C (194Â°F)	237 to 247 ohms
80Â°C (176Â°F)	327 to 341 ohms
70Â°C (158Â°F)	459 to 479 ohms
60Â°C (140Â°F)	656 to 686 ohms
50Â°C (122Â°F)	958 to 1002 ohms
45Â°C (113Â°F)	1167 to 1223 ohms
40Â°C (104Â°F)	1430 to 1500 ohms
35Â°C (95Â°F)	1763 to 1849 ohms
30Â°C (86Â°F)	2185 to 2295 ohms
25Â°C (77Â°F)	2725 to 2865 ohms
20Â°C (68Â°F)	3418 to 3604 ohms
15Â°C (59Â°F)	4318 to 4564 ohms
10Â°C (50Â°F)	5493 to 5823 ohms
5Â°C (41Â°F)	7041 to 7485 ohms
0Â°C (32Â°F)	9097 to 9701 ohms
-5Â°C (23Â°F)	11844 to 12678 ohms
-10Â°C (14Â°F)	15540 to 16700 ohms
-15Â°C (5Â°F)	20559 to 22183 ohms
-20Â°C (-4Â°F)	27439 to 29725 ohms
-30Â°C (-22Â°F)	50264 to 54924 ohms
-40Â°C (-40Â°F)	95953 to 105777 ohms

TEMPERATURE VERSUS RESISTANCE - INTAKE AIR TEMPERATURE SENSOR (HITACHI SENSOR)

Temperature CÂ°/FÂ°	Resistance Minimum Ohms	Resistance Maximum Ohms
Hitachi Intake Air Temperature (IAT) Sensor		

Temperature CÂ°/FÂ°	Resistance Minimum Ohms	Resistance Maximum Ohms
Hitachi Intake Air Temperature (IAT) Sensor		
-40/-40	37,527	49,882
-20/-4	13,110	16,329
-10/14	8,145	9,851
0/32	5,205	6,122
20/68	2,298	2,570
25/77	1,900	2,100
40/104	1,073	1,226
60/140	537	639
80/176	289	356
100/212	165	210
120/248	99	129
140/284	62	83
150/302	49	67

ALTITUDE VERSUS BAROMETRIC PRESSURE (WITH LFX)

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)	Barometric Pressure Measured in Pounds Per Square Inch (PSI)
Determine your altitude by contacting a local weather station or by using another reference source.			
4,267	14,000	56-64	8.1-9.3
3,962	13,000	58-66	8.4-9.6
3,658	12,000	61-69	8.8-10.0
3,353	11,000	64-72	9.3-10.4
3,048	10,000	66-74	9.6-10.7
2,743	9,000	69-77	10.0-11.2
2,438	8,000	71-79	10.3-11.5
2,134	7,000	74-82	10.7-11.9
1,829	6,000	77-85	11.2-12.3
1,524	5,000	80-88	11.6-12.8
1,219	4,000	83-91	12.0-13.2
914	3,000	87-95	12.6-13.8
610	2,000	90-98	13.1-14.2
305	1,000	94-102	13.6-14.8
0	0 Sea Level	96-104	13.9-15.1
-305	-1,000	101-105	14.6-15.2

IGNITION SYSTEM SPECIFICATIONS

Application	Specification

Application	Specification
Firing Order	1-2-3-4-5-6
Spark Plug Torque	Refer to **Fastener Specifications**
Spark Plug Gap	Refer to **Engine Mechanical Specifications**
Spark Plug Type	Refer to Electronic Parts Catalog

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Accelerator Pedal Position (APP) Sensor Bolt	9 N.m	80 lb in
Air Cleaner Outlet Duct Clamp	3 N.m	27 lb in
Camshaft Position (CMP) Sensor Bolt	10 N.m	89 lb in
Crankshaft Position (CKP) Sensor Stud	10 N.m	89 lb in
Engine Coolant Temperature (ECT) Sensor	20 N.m	15 lb ft
Evaporative Emission (EVAP) Canister Purge Solenoid Valve Bolt	16 N.m	12 lb ft
Evaporative Emission (EVAP) Canister Vent Solenoid Valve Bracket Bolt	10 N.m	89 lb in
Fuel/Brake Line Retainer Bolt	10 N.m	89 lb in
Fuel Fill Hose Clamp	2.5 N.m	22 lb in
Fuel Fill Pipe Bracket Bolt	13 N.m	115 lb in
Fuel Fill Pipe to Fill Pocket Bolt	2.5 N.m	22 lb in
Fuel Injector Harness Connector Bracket Bolt	8 N.m	71 lb in
Fuel Rail Bolt	10 N.m	89 lb in
Fuel Tank Strap Bolt	48 N.m	35 lb ft
Heated Oxygen Sensor (HO2S)	42 N.m	31 lb ft
Heater Inlet/Outlet Hose/Pipe Clip Nut	10 N.m	89 lb in
Ignition Coil Bolt/Stud/Nut	25 N.m	15 lb ft
Intake Manifold- Upper Bolt	25 N.m	18 lb ft
Knock Sensor (KS)	25 N.m	18 lb ft
Mass Air Flow(MAF)/Intake Air Temperature Sensor Bolt	2 N.m	18 lb in
Spark Plug	15 N.m	11 lb ft
Throttle Body Bolt/Stud	10 N.m	89 lb in

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
Fuel Tank Capacity - RPO FHO	65.5 liters	17.3 gallons
Fuel Tank Capacity - RPO FHS	66.3 liters	17.5 gallons

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number
All Purpose Parts Cleaner	Cleaner	Refer to Electronic Parts Catalog
Anti-Seize Compound	Lubricant	Refer to Electronic Parts Catalog
Coolant Temperature Sensor Threads	Sealant	Refer to Electronic Parts Catalog
Engine Oil	5W-30 Oil	Refer to Electronic Parts Catalog
Fuel Injection Fuel Rail Bolts	Threadlock	Refer to Electronic Parts Catalog
Intake Air Temperature Sensor Threads	Sealant	Refer to Electronic Parts Catalog

Article GUID: A00737150

DESCRIPTION AND OPERATION

CAMSHAFT ACTUATOR SYSTEM DESCRIPTION

Camshaft Actuator System Overview

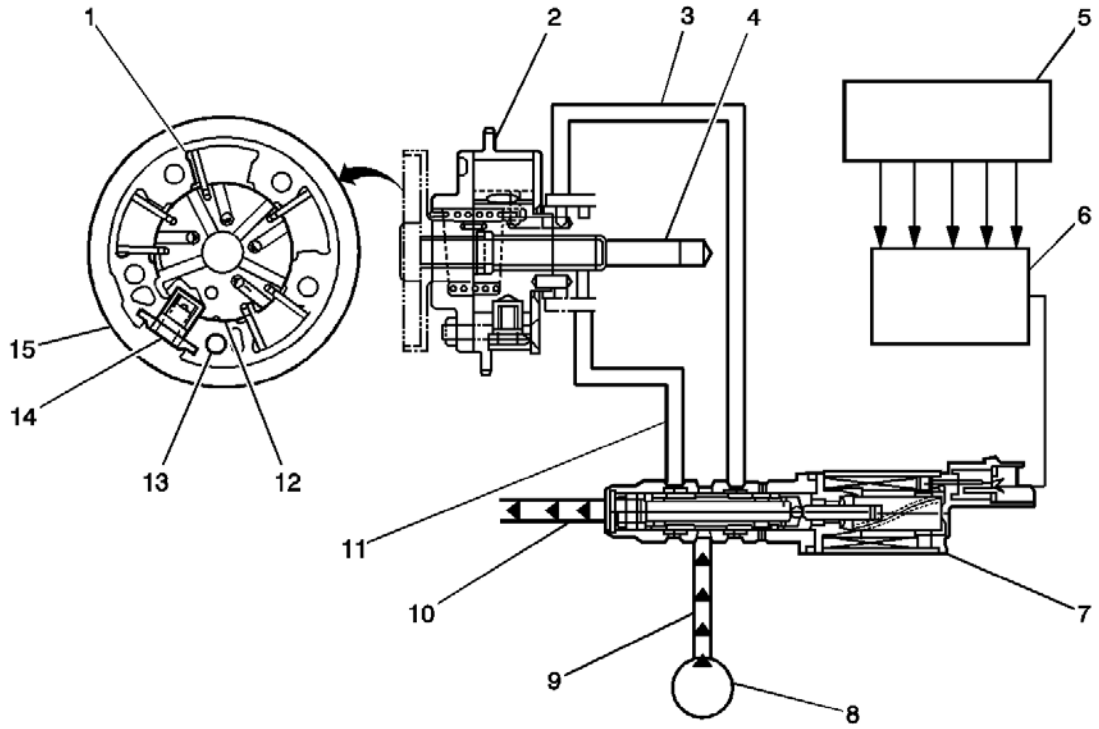


Fig. 1: Identifying Camshaft Actuator System Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Camshaft Actuator Vane
2	Timing Chain Sprocket
3	Engine Oil Pressure-For retarding the camshaft
4	Camshaft
5	Input Signals from Engine Sensors
6	Engine Control Module (ECM)
7	Camshaft Actuator Solenoid
8	Engine Oil Pump
9	Engine Oil Pressure Supply
10	Engine Oil Drain
11	Engine Oil Pressure-For advancing the camshaft
12	Camshaft Actuator Rotor

Callout	Component Name
13	Camshaft Position Sensor Reluctor
14	Camshaft Actuator Lock Pin
15	Camshaft Actuator Housing

The camshaft actuator system enables the engine control module (ECM) to change camshaft timing of all 4 camshafts while the engine is operating. The camshaft position (CMP) actuator assembly (15) varies the camshaft position in response to directional changes in oil pressure. The CMP actuator solenoid valve controls the oil pressure that is applied to advance or retard a camshaft. Modifying camshaft timing under changing engine demand provides better balance between the following performance concerns:

- Engine power output
- Fuel economy
- Tailpipe emissions

The CMP actuator solenoid valve (7) is controlled by the ECM. The crankshaft position (CKP) sensor and the CMP sensors are used to monitor changes in camshaft positions. The ECM uses the following information in order to calculate the desired camshaft positions:

- Engine coolant temperature
- Calculated engine oil temperature (EOT)
- Mass air flow (MAF)
- Throttle position (TP)
- Vehicle speed
- Volumetric efficiency

Operation

The CMP actuator assembly has an outer housing that is driven by an engine timing chain. Inside the assembly is a rotor with fixed vanes that is attached to the camshaft. Oil pressure that is applied to the fixed vanes will rotate a specific camshaft in relationship to the crankshaft. The movement of the intake camshafts will advance the intake valve timing. The movement of the exhaust camshafts will retard the exhaust valve timing. When oil pressure is applied to the return side of the vanes, the camshafts will return to 0 crankshaft degrees, or top dead center (TDC). The CMP actuator solenoid valve directs the oil flow that controls the camshaft movement. The ECM commands the CMP solenoid to move the solenoid plunger and spool valve until oil flows from the advance passage (11). Oil flowing thru the CMP actuator assembly from the CMP solenoid advance passage applies pressure to the advance side of the vanes in the CMP actuator assembly. When the camshaft position is retarded, the CMP actuator solenoid valve directs oil to flow into the CMP actuator assembly from the retard passage (3). The ECM can also command the CMP actuator solenoid valve to stop oil flow from both passages in order to hold the current camshaft position.

The ECM operates the CMP actuator solenoid valve by pulse width modulation (PWM) of the solenoid coil. The higher the PWM duty cycle, the larger the change in camshaft timing. The CMP actuator assembly also contains a lock pin (14) that prevents movement between the outer housing and the rotor vane assembly. The lock pin is released by oil pressure before any movement in the CMP actuator assembly takes place. The ECM is continuously comparing CMP sensor inputs with CKP sensor input in order to monitor camshaft position and detect any system malfunctions. If a condition exists in either the intake or exhaust camshaft actuator system,

the opposite bank, intake or exhaust, camshaft actuator will default to 0 crankshaft degrees.

CMP Actuator System Operation

Driving Condition	Change in Camshaft Position	Objective	Result
Idle	No Change	Minimize Valve Overlap	Stabilized Idle Speed
Light Engine Load	Retarded Valve Timing	Decrease Valve Overlap	Stabled Engine Output
Medium Engine Load	Advanced Valve Timing	Increase Valve Overlap	Better Fuel Economy with Lower Emissions
Low to Medium RPM with Heavy Load	Advanced Valve Timing	Advance Intake Valve Closing	Improved Low to Mid-range Torque
High RPM with Heavy Load	Retarded Valve Timing	Retard Intake Valve Closing	Improved Engine Output

ELECTRONIC IGNITION SYSTEM DESCRIPTION

The electronic ignition system produces and controls a high-energy secondary spark. This spark is used to ignite the compressed air/fuel mixture at precisely the correct time. This provides optimal performance, fuel economy, and control of exhaust emissions. This ignition system uses an individual coil for each cylinder. The ignition coils are mounted in the center of each camshaft cover with short integrated boots connecting the coils to the spark plugs. The driver modules within each ignition coil are commanded ON/OFF by the Engine Control Module (ECM). The ECM primarily uses engine speed, the mass air flow (MAF) sensor signal, and position information from the crankshaft position and the camshaft position sensors. This controls the sequence, dwell, and timing of the spark. The electronic ignition system consists of the following components:

Crankshaft Position Sensor

The crankshaft position sensor works in conjunction with a reluctor wheel on the crankshaft (front mounted crankshaft position sensor) or a reluctor wheel that is part of the flywheel (rear mounted crankshaft position sensor). The ECM monitors the voltage frequency on the crankshaft position sensor signal circuit. As each reluctor wheel tooth rotates past the sensor, the sensor creates a digital ON/OFF pulse. This digital signal is processed by the ECM. This creates a signature pattern that enables the ECM to determine the crankshaft position. The ECM uses the signal to determine which pair of cylinders is approaching top dead center based on the crankshaft position signal alone. The camshaft position sensor signals are used in order to determine which of these 2 cylinders is on a firing stroke, and which is on the exhaust stroke. The ECM uses this to properly synchronize the ignition system, the fuel injectors, and the knock control. This sensor is also used in order to detect misfire.

The ECM also has a dedicated replicated crankshaft position sensor signal output circuit that may be used as an input signal to other modules for monitoring engine RPM.

Camshaft Position Sensor

This engine uses a camshaft position sensor for each camshaft. The camshaft position sensor signals are a digital ON/OFF pulse and output 4 times per revolution of the camshaft. The camshaft position sensor does not directly affect the operation of the ignition system. The camshaft position sensor information is used by the ECM to determine the position of the camshaft relative to the crankshaft position. By monitoring the camshaft position and crankshaft position signals the ECM can accurately time the operation of the fuel injectors. The ECM supplies the camshaft position sensor with a 5 V reference circuit and a low reference circuit. The

camshaft position sensor signals are an input to the ECM. These signals are also used to detect camshaft alignment with the crankshaft.

The ECM also has a dedicated replicated camshaft position sensor signal output circuit that may be used as an input signal to other modules for monitoring engine RPM.

Knock Sensor

The knock sensor system enables the ECM to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation, also known as spark knock. The knock sensor system uses 1 or 2 flat response 2-wire sensors. The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level. The amplitude and frequency depend upon the level of knock that the knock sensor detects. The ECM receives the knock sensor signal through the high and low signal circuits.

The ECM learns a minimum noise level, or background noise, at idle from the knock sensor and uses calibrated values for the rest of the RPM range. The ECM uses the minimum noise level to calculate a noise channel. A normal knock sensor signal will ride within the noise channel. As engine speed and load change, the noise channel upper and lower parameters will change to accommodate the normal knock sensor signal, keeping the signal within the channel. In order to determine which cylinders are knocking, the ECM only uses knock sensor signal information when each cylinder is near top dead center (TDC) of the firing stroke. If knock is present, the signal will range outside of the noise channel.

If the ECM has determined that knock is present, it will retard the ignition timing to attempt to eliminate the knock. The ECM will always try to work back to a zero compensation level, or no spark retard. An abnormal knock sensor signal will stay outside of the noise channel or will not be present. Knock sensor diagnostics are calibrated to detect faults with the knock sensor circuitry inside the ECM, the knock sensor wiring, or the knock sensor voltage output. Some diagnostics are also calibrated to detect constant noise from an outside influence such as a loose/damaged component or excessive engine mechanical noise.

Ignition Coils

Each ignition coil contains a solid state driver module as its primary element. The engine ECM (ECM) signals the coil driver to initiate a firing event by applying ignition control circuit voltage for the appropriate amount of time otherwise known as dwell. When the voltage is removed the coil fires the spark plug.

Engine Control Module (ECM)

The ECM controls all ignition system functions and constantly corrects the spark timing. The ECM monitors information from various sensor inputs that may include the following components, if applicable:

- Throttle position sensor
- Engine coolant temperature (ECT) sensor
- Mass air flow (MAF) sensors
- Intake air temperature (IAT) sensors
- Vehicle speed sensor (VSS)
- Transmission gear position or range information sensors
- Engine knock sensors

- Ambient pressure sensors (BARO)

ENGINE CONTROL MODULE DESCRIPTION

The Engine Control Module (ECM) interacts with many emission related components and systems, and monitors emission related components and systems for deterioration. OBD II diagnostics monitor the system performance and a diagnostic trouble code (DTC) sets if the system performance degrades. The ECM is part of a network and communicates with various other vehicle control modules.

Malfunction indicator lamp (MIL) operation and DTC storage are dictated by the DTC type. A DTC is ranked as a Type A or Type B if the DTC is emissions related. Type C is a non-emissions related DTC.

The ECM is the control center of the engine controls system. Review the components and wiring diagrams in order to determine which systems are controlled by the ECM.

The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect engine performance and emissions. The ECM also performs diagnostic tests on various parts of the system and can turn on the MIL when it recognizes an operational problem that affects emissions. When the ECM detects a malfunction, the ECM stores a DTC. The condition area is identified by the particular DTC that is set. This aids the technician in making repairs.

ECM Function

The ECM can supply 5 V or 12 V to various sensors or switches. This is done through pull-up resistors to regulated power supplies within the ECM. In some cases, even an ordinary shop voltmeter will not give an accurate reading due to low input resistance. Therefore, a digital multimeter (DMM) with at least 10 megaohms input impedance is required in order to ensure accurate voltage readings.

The ECM controls the output circuits by controlling the ground or the power feed circuit through transistors or a device called an output driver module.

EEPROM

The electronically erasable programmable read only memory (EEPROM) is an integral part of the ECM. The EEPROM contains program and calibration information that the ECM needs in order to control engine operation.

Special equipment, as well as the correct program and calibration for the vehicle, are required in order to reprogram the ECM.

Data Link Connector (DLC)

The data link connector (DLC) provides serial data communication for ECM diagnosis. This connector allows the technician to use a scan tool in order to monitor various serial data parameters, and display DTC information. The DLC is located inside the driver's compartment, underneath the instrument panel.

Malfunction Indicator Lamp (MIL)

The malfunction indicator lamp (MIL) is inside the instrument panel cluster (IPC). The MIL is controlled by the ECM and illuminates when the ECM detects a condition that affects vehicle emissions.

ECM Service Precautions

The ECM, by design, can withstand normal current draws that are associated with vehicle operations. However, care must be used in order to avoid overloading any of these circuits. When testing for opens or shorts, do not ground or apply voltage to any of the ECM circuits unless the diagnostic procedure instructs you to do so. These circuits should only be tested with a DMM unless the diagnostic procedure instructs otherwise.

Emissions Diagnosis For State I/M Programs

This OBD II equipped vehicle is designed to diagnose any conditions that could lead to excessive levels of the following emissions:

- Hydrocarbons (HC)
- Carbon monoxide (CO)
- Oxides of nitrogen (NOx)
- Evaporative emission (EVAP) system losses

Should this vehicle's on-board diagnostic system (ECM) detect a condition that could result in excessive emissions, the ECM turns ON the MIL and stores a DTC that is associated with the condition.

Aftermarket (Add-On) Electrical And Vacuum Equipment

CAUTION: Do not attach add-on vacuum operated equipment to this vehicle. The use of add-on vacuum equipment may result in damage to vehicle components or systems.

CAUTION: Connect any add-on electrically operated equipment to the vehicle's electrical system at the 12 V battery (power and ground) in order to prevent damage to the vehicle.

Aftermarket, add-on, electrical and vacuum equipment is defined as any equipment installed on a vehicle after leaving the factory that connects to the vehicle's electrical or vacuum systems. No allowances have been made in the vehicle design for this type of equipment.

Add-on electrical equipment, even when installed to these strict guidelines, may still cause the powertrain system to malfunction. This may also include equipment not connected to the vehicle electrical system, such as portable telephones and radios. Therefore, the first step in diagnosing any powertrain condition is to eliminate all of the aftermarket electrical equipment from the vehicle. After this is done, if the problem still exists, the problem may be diagnosed in the normal manner.

Electrostatic Discharge (ESD) Damage

NOTE: In order to prevent possible electrostatic discharge damage to the ECM, DO NOT touch the connector pins on the ECM.

The electronic components that are used in the control systems are often designed to carry very low voltage. These electronic components are susceptible to damage caused by electrostatic discharge. Less than 100 V of static electricity can cause damage to some electronic components. By comparison, it takes as much as 4,000 V for a person to even feel a static discharge.

There are several ways for a person to become statically charged. The most common methods of charging are

by friction and by induction. An example of charging by friction is a person sliding across a car seat.

Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off leaving the person highly charged with the opposite polarity. Static charges can cause damage, therefore, it is important to use care when handling and testing electronic components.

Emissions Control Information Label

The underhood Vehicle Emissions Control Information Label contains important emission specifications. This identifies the year, the displacement of the engine in liters, and the class of the vehicle.

This label is located in the engine compartment of every General Motors vehicle. If the label has been removed, it can be ordered from GM service parts operations (GMSPO).

EVAPORATIVE EMISSION CONTROL SYSTEM DESCRIPTION

Typical Evaporative Emission (EVAP) System Hose Routing Diagram

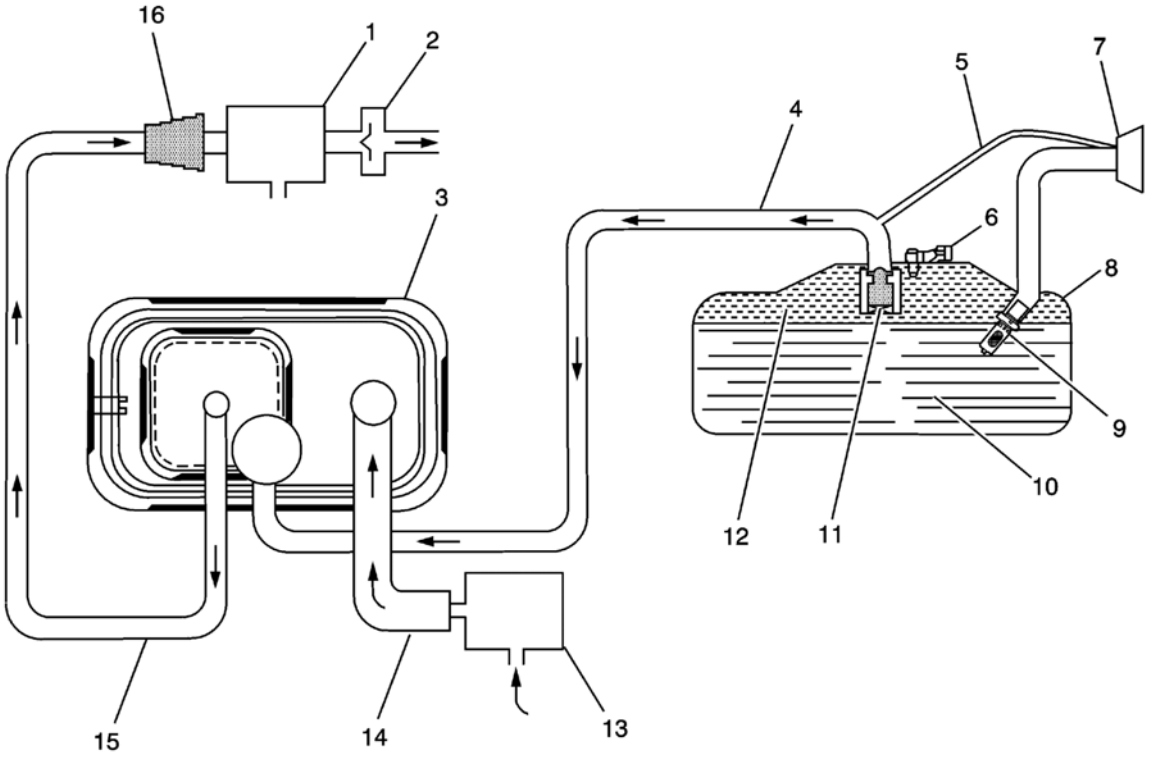


Fig. 2: View Of Typical Evaporative Emission (EVAP) System Hose Routing Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Evaporative Emissions (EVAP) Purge Solenoid Valve
2	Purge Tube Check Valve, Turbo-Charged Applications Only
3	EVAP Canister
4	EVAP Vapor Tube
5	Vapor Recirculation Tube (ORVR)
6	Fuel Tank Pressure Sensor
7	Fuel Filler Cap (Some Vehicles May Have A Capless Design)
8	Fuel Tank
9	Fuel Fill Pipe Inlet Check Valve
10	Liquid Fuel
11	Fill Limit Vent Valve (FLVV)
12	Fuel Vapor
13	EVAP Canister Vent Solenoid Valve
14	Vent hose
15	EVAP Purge Tube
16	EVAP Canister Purge Tube Connector

EVAP System Operation

The EVAP control system limits fuel vapors from escaping into the atmosphere. Fuel tank vapors are allowed to move from the fuel tank, due to pressure in the tank, through the EVAP vapor tube, into the EVAP canister. Carbon in the canister absorbs and stores the fuel vapors. Excess pressure is vented through the vent hose and EVAP vent solenoid valve to the atmosphere. The EVAP canister stores the fuel vapors until the engine is able to use them. At an appropriate time, the engine control module (ECM) will command the EVAP purge solenoid valve ON, allowing engine vacuum to be applied to the EVAP canister. With the normally open EVAP vent solenoid valve OFF, fresh air is drawn through the vent solenoid valve and the vent hose to the EVAP canister. Fresh air is drawn through the canister, pulling fuel vapors from the carbon. The air/fuel vapor mixture continues through the EVAP purge tube and EVAP purge solenoid valve into the intake manifold to be consumed during normal combustion. The ECM uses several tests to determine if the EVAP system is leaking or restricted.

Purge Solenoid Valve Leak Test

If the EVAP purge solenoid valve does not seal properly fuel vapors could enter the engine at an undesired time, causing driveability concerns. The ECM tests for this by commanding the EVAP purge solenoid valve OFF and the vent solenoid valve ON which seals the system. With the engine running, the ECM then monitors the fuel tank pressure sensor for an increase in vacuum. The ECM will set a DTC if a vacuum develops in the tank under these test conditions.

Large Leak Test

This diagnostic creates a vacuum condition in the EVAP system. When the enabling criteria has been met, the ECM commands the normally open EVAP vent solenoid valve closed and the EVAP purge solenoid valve open, creating a vacuum in the EVAP system. The ECM then monitors the fuel tank pressure sensor voltage to verify that the system is able to reach a predetermined level of vacuum within a set amount of time. Failure to achieve the expected level of vacuum indicates the presence of a large leak in the EVAP system or a restriction in the

purge path. The ECM will set a DTC if it detects a weaker than expected vacuum level under these test conditions.

Canister Vent Restriction Test

If the EVAP vent system is restricted, fuel vapors will not be properly purged from the EVAP canister. The ECM tests this by commanding the EVAP purge solenoid valve ON while commanding the EVAP vent solenoid valve OFF, and then monitoring the fuel tank pressure sensor for an increase in vacuum. If the vacuum increases more than the expected amount, in a set amount of time, a fault will be logged by the ECM.

Small Leak Test

The engine off natural vacuum diagnostic is the small-leak detection diagnostic for the EVAP system. The engine off natural vacuum diagnostic monitors the EVAP system pressure with the ignition OFF. Because of this, it may be normal for the ECM to remain active for up to 40 min after the ignition is turned OFF. This is important to remember when performing a parasitic draw test on vehicles equipped with engine off natural vacuum.

When the vehicle is driven, the temperature rises in the tank due to heat transfer from the exhaust system. After the vehicle is parked, the temperature in the tank continues to rise for a period of time, then starts to drop. The engine off natural vacuum diagnostic relies on this temperature change, and the corresponding pressure change in a sealed system, to determine if an EVAP system leak is present.

The engine off natural vacuum diagnostic is designed to detect leaks as small as 0.51 mm (0.020 in).

EVAP System Components

The EVAP system consists of the following components:

EVAP Purge Solenoid Valve

The EVAP purge solenoid valve controls the flow of vapors from the EVAP system to the intake manifold. The purge solenoid valve opens when commanded ON by the ECM. This normally closed valve is pulse width modulated (PWM) by the ECM to precisely control the flow of fuel vapor to the engine. The valve will also be opened during some portions of the EVAP testing when the engine is running, allowing engine vacuum to enter the EVAP system.

Purge Tube Check Valve

NOTE: **The presence of this one-way check valve prevents pressure testing the EVAP system for leaks at the EVAP canister purge tube connector.**

Turbocharged vehicles have a check valve in the purge tube between the EVAP purge solenoid valve and the intake manifold to prevent pressurization of the EVAP system under boost conditions. Some applications may have this check valve between the EVAP purge solenoid valve and the EVAP canister.

EVAP Canister

The canister is filled with carbon pellets used to absorb and store fuel vapors. Fuel vapor is stored in the canister until the ECM determines that the vapor can be consumed in the normal combustion process.

Vapor Recirculation Tube

A vapor path between the fuel fill pipe and the vapor tube to the carbon canister is necessary for Vehicle Onboard Diagnostics to fully diagnose the EVAP system. It also accommodates service diagnostic procedures by allowing the entire EVAP system to be diagnosed from either end of the system.

The On-Board Refueling Vapor Recovery System is an on-board vehicle system designed to recover fuel vapors during the vehicle refueling operation. The flow of liquid fuel down the fuel filler pipe provides a liquid seal which prevents vapor from leaving the fuel filler pipe. An EVAP pipe transports the fuel vapor to the EVAP canister for use by the engine.

Fuel Tank Pressure Sensor

The fuel tank pressure sensor measures the difference between the pressure or vacuum in the fuel tank and outside air pressure. Depending on the vehicle, the sensor can be located in the vapor space on top of the fuel tank, in the vapor tube between the canister and the tank, or on the EVAP canister. A high fuel tank pressure sensor voltage indicates a low fuel tank pressure or vacuum. A low fuel tank pressure sensor voltage indicates a high fuel tank pressure.

Fuel Fill Pipe Check Valve

The check valve on the fuel fill pipe is there to prevent spit-back during refueling.

EVAP Vent Solenoid Valve

The EVAP vent solenoid valve controls fresh airflow into the EVAP canister. The valve is normally open. The canister vent solenoid valve is closed only during EVAP system tests performed by the ECM like large leak and engine off natural vacuum test.

Fuel Fill Cap

The fuel fill cap is equipped with a seal and a vacuum relief valve and is tethered. A torque-limiting device prevents the cap from being over tightened. To install the cap, turn the cap clockwise until you hear clicks. This indicates that the cap is correctly torqued and fully seated. A built-in device indicates that the fuel filler cap is fully seated. A fuel filler cap that is not fully seated may cause a malfunction in the emission system.

Capless Fuel Fill

Some vehicles may have a capless fuel fill design behind a locking fuel door. There is no fuel fill cap to remove. One just fully inserts the fuel nozzle into the fill neck, making sure it latches before refueling. Flapper valves close to seal this interface once the fill nozzle is removed.

Fill Limit Vent Valve

This acts as a shut off valve during refueling. This will vary based on fuel tank design. The fuel limit vent valve has the following functions:

- The fuel limit vent valve is located on the inside top of the fuel tank
- This valve is not serviced separately
- Controls the fuel tank fill level by closing the primary vent from the fuel tank and forcing the fuel fill

nozzle to shut off.

- Prevents liquid fuel from exiting the fuel tank via the EVAP pipe to the canister.
- Provides fuel-spillage protection in the event of a vehicle rollover by closing the vapor path from the tank to the EVAP canister.

FUEL SYSTEM DESCRIPTION

Fuel System Overview

The fuel tank stores the fuel supply. The fuel pump module, located in the fuel tank, supplies fuel through the fuel feed pipe to the high pressure fuel pump. The high pressure fuel pump supplies fuel to a variable-pressure fuel rail. Fuel enters the combustion chamber through precision multi-hole fuel injectors. The in-tank fuel pump is controlled with a Chassis Control Module. The Engine Control Module (ECM) enables the Chassis Control Module and sends the desired fuel line pressure to the Chassis Control Module via GMLAN. The Chassis Control Module sends a pulse width modulated (PWM) voltage to the in-tank fuel pump allowing the fuel line pressure to be varied as commanded by the ECM. The high pressure fuel pump, fuel rail pressure, fuel injection timing, and injection duration are controlled by the ECM.

Fuel Tank

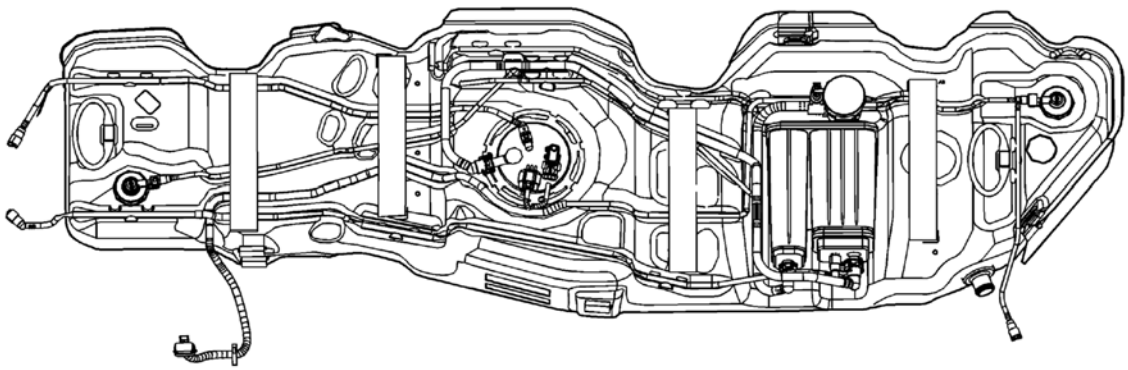


Fig. 3: Identifying Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

The fuel storage tank is made of high density polyethylene. The fuel storage tank is held in place by metal straps that are attached to the under body of the vehicle. The tank shape includes a sump in order to maintain a constant supply of fuel around the fuel pump strainer during low fuel conditions or during aggressive maneuvers.

On-Board Refueling Vapor Recovery (ORVR) System

The on-board refueling vapor recovery (ORVR) system is an on-board vehicle system to recover fuel vapors during the vehicle refueling operation. The flow of liquid fuel down to the fuel tank filler neck provides a liquid seal. The purpose of ORVR is to prevent refueling vapor from exiting the fuel tank filler neck. The ORVR components are listed below, with a brief description of their operation:

- The fuel tank-The fuel tank contains the modular fuel sender assembly.
- The fuel filler pipe-The fuel filler pipe carries fuel from the fuel nozzle to the fuel tank.
- The evaporative emission (EVAP) canister-The EVAP canister receives refueling vapor from the fuel system, stores the vapor, and releases the vapor to the engine upon demand.
- The vapor lines-The vapor lines transport fuel vapor from the tank assembly to the EVAP canister and engine.
- The check valve-The check valve limits fuel spit-back from the fuel tank during the refueling operation by allowing fuel flow only into the fuel tank. The check valve is located at the bottom of the fuel filler pipe.
- The modular fuel sender assembly-The modular fuel sender assembly pumps fuel to the engine from the fuel tank.
- The fuel tank pressure (FTP) sensor is located on top of the fuel sender assembly.
- The FLVV-The FLVV acts as a shut-off valve. The FLVV is located in the fuel sender assembly. This valve has the following functions:
    - Controlling the fuel tank fill level by closing the primary vent from the fuel tank
    - Preventing fuel from exiting the fuel tank via the vapor line to the canister
    - Providing fuel spillage protection in the event of a vehicle rollover by closing the vapor path from the tank to the engine
- The pressure vacuum relief valve-The pressure vacuum relief valve provides venting of excessive fuel tank pressure and vacuum. The valve is located in the fuel fill cap.
- The vapor recirculation line-The vapor recirculation line is used to transport vapor from the fuel tank to the top of the fill pipe during refueling to reduce vapor loading to the enhanced EVAP canister.

Fuel Tank Filler Pipe

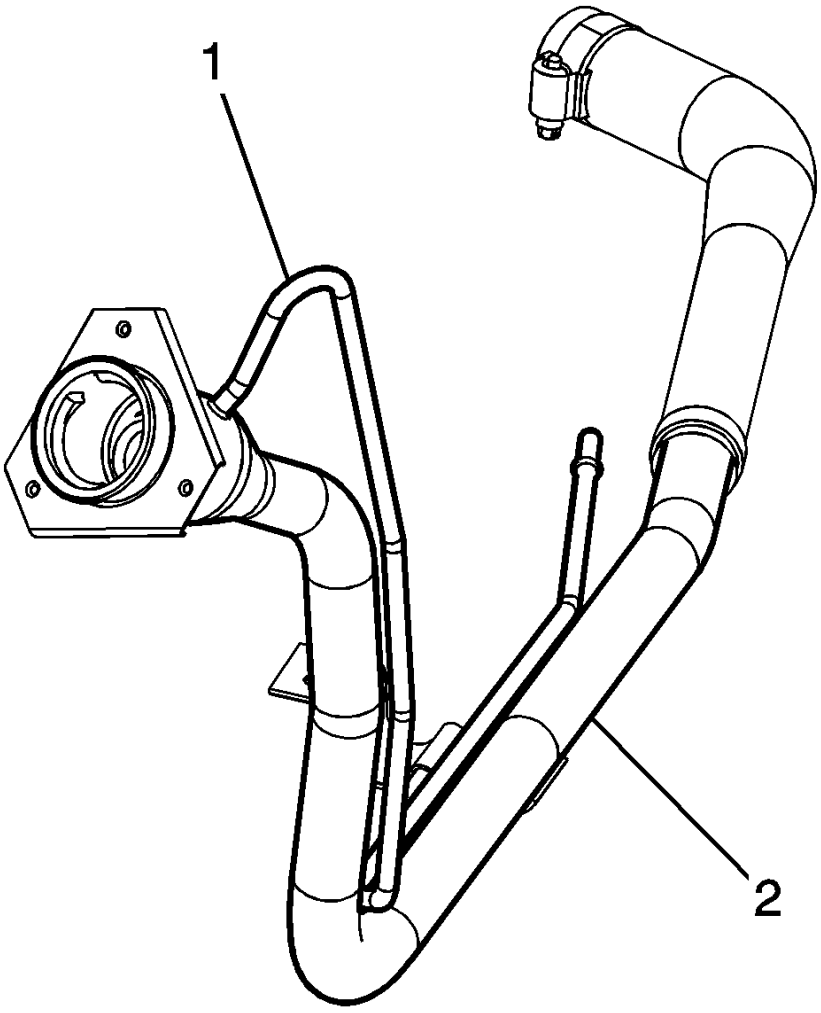


Fig. 4: Identifying Fuel Fill Pipe
Courtesy of GENERAL MOTORS COMPANY

In order to prevent refueling with leaded fuel, the fuel filler pipe has a built-in restrictor and a deflector. The opening in the restrictor will accept only the smaller unleaded gasoline fuel nozzle which must be fully inserted in order to bypass the deflector. The tank is vented during filling by an internal vent tube inside of the filler pipe.

Fuel Filler Cap

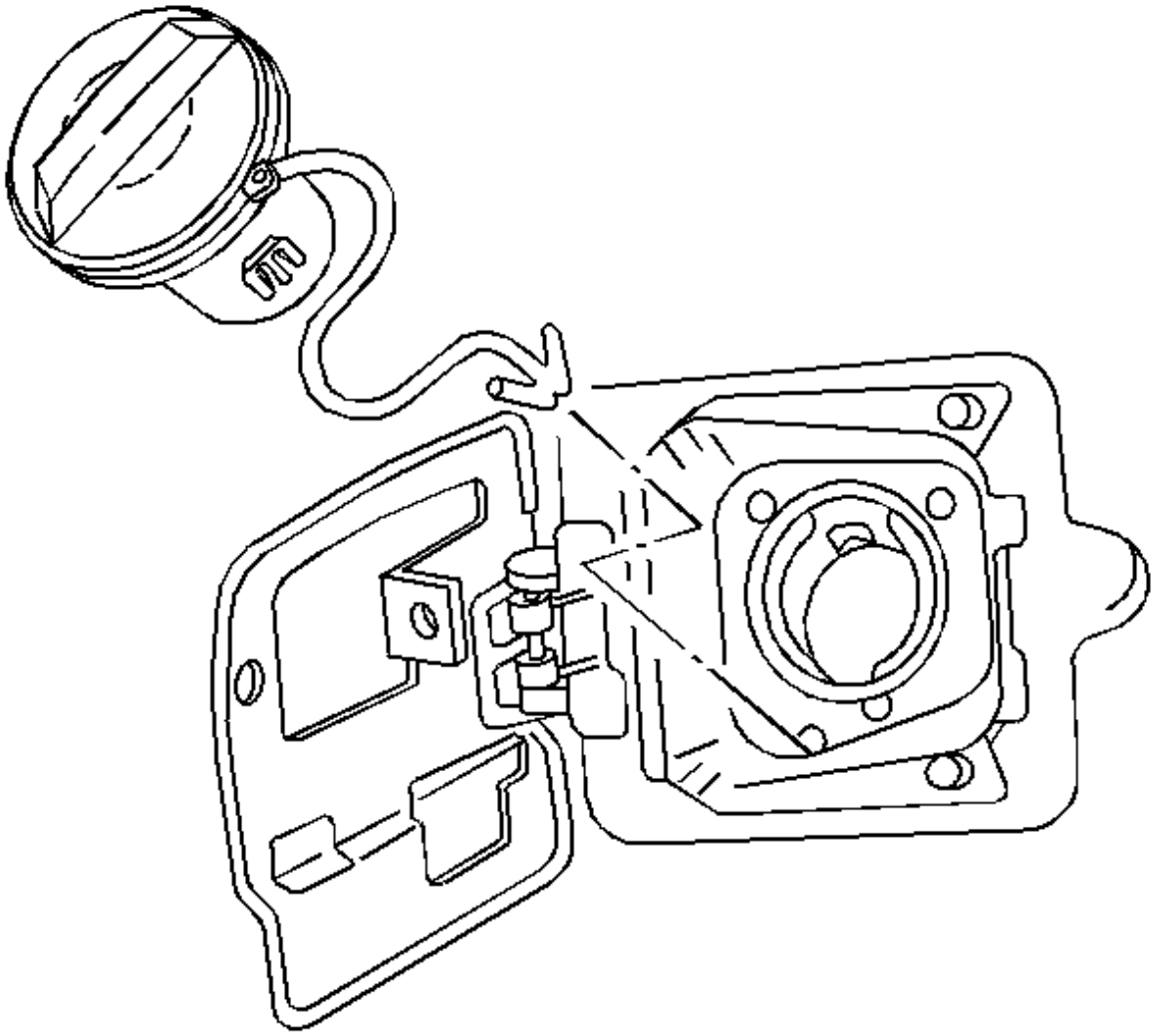


Fig. 5: View Of Fuel Filler Cap & Tether
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use a fuel tank filler pipe cap with the same features as the original when a replacement is necessary. Failure to use the correct fuel tank filler pipe cap can result in a serious malfunction of the fuel system.

The fuel tank filler pipe is equipped with a turn to vent, screw on type cap, which incorporates a ratchet action in order to prevent over-tightening.

The turn to vent feature allows for fuel tank pressure relief prior to removal. Instructions for proper use are imprinted on the cap cover. A vacuum safety relief valve is incorporated into this cap.

Fuel Sender Assembly

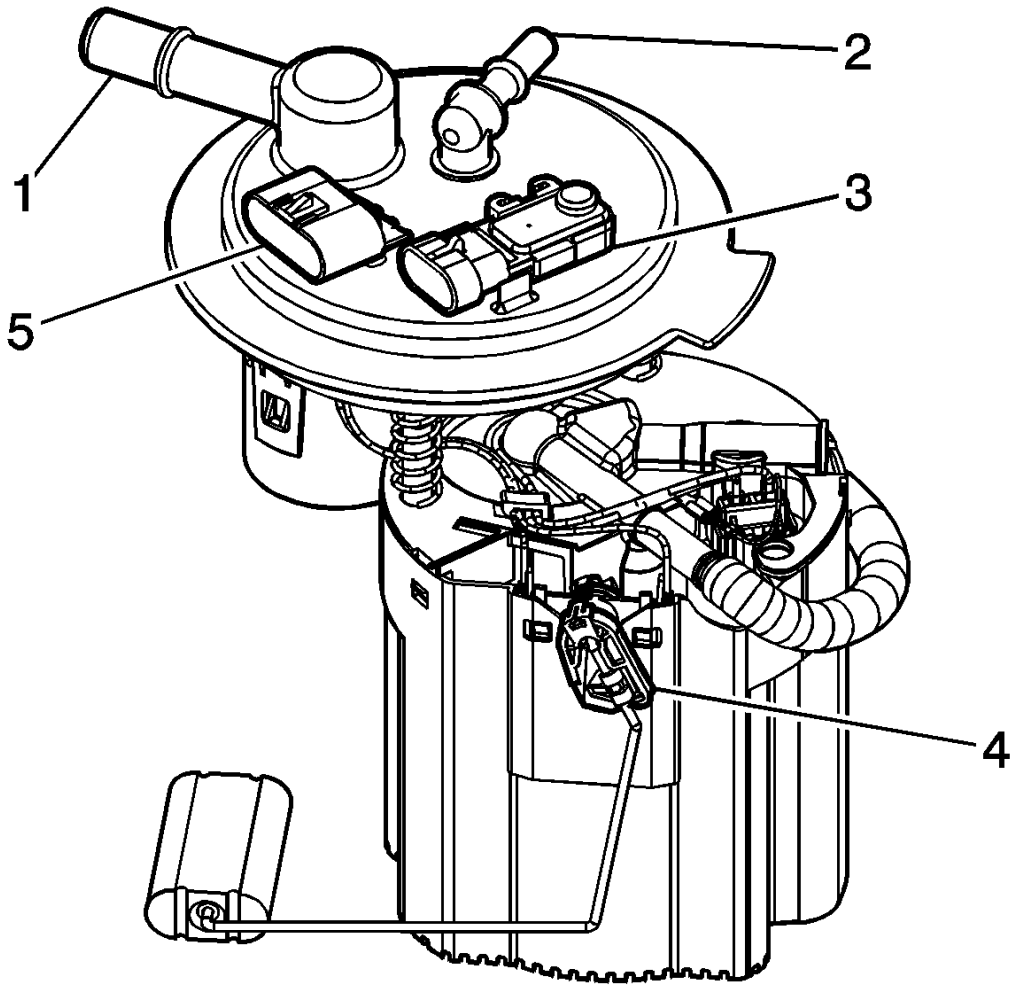


Fig. 6: View Of Fuel Sender Assembly
Courtesy of GENERAL MOTORS COMPANY

The fuel sender assembly consists of the following major components:

- The fill limit vent valve (1)
- The fuel feed pipe (2)
- The fuel tank pressure sensor (3)
- The fuel level sensor (4)
- The fuel pump electrical connector (5)

The modular fuel sender assembly mounts to the threaded opening of the plastic fuel tank with a seal and a retainer ring. The reservoir, containing the exterior inlet strainer, the electric fuel pump and the fuel filter, maintains contact with the tank bottom. This design provides:

- Optimum fuel level in the integral fuel reservoir during all fuel tank levels and during driving conditions
- An improved tank fuel level measuring accuracy
- An improved coarse straining and added pump inlet filtering
- More extensive internal fuel pump isolation for noiseless operation

Fuel Pump

The electric fuel pump is a turbine pump which is located inside of the modular fuel sender. The electric fuel pump operation is controlled by the Chassis Control Module.

Fuel Sender Strainer

The strainer acts as a coarse filter to perform the following functions:

- Filter contaminants
- Separate water from fuel
- Provide a wicking action that helps draw fuel into the fuel pump

Fuel stoppage at the strainer indicates that the fuel tank contains an abnormal amount of sediment or water. Therefore, the fuel tank will need to be removed and cleaned, and the filter strainer should be replaced.

Fuel Feed Hose/Pipe

The fuel feed pipe carries fuel from the fuel tank to the fuel rail assembly. The fuel pipes consist of 2 sections:

- The rear fuel pipe assembly connects from the top of the fuel tank module to the chassis fuel pipe. The rear fuel pipe is constructed of nylon.

  CAUTION: **Refer to Fuel and Evaporative Emission Hose/Pipe Connection Cleaning Caution .**

  NOTE: **Precautions must be taken to prevent any form of contamination, that may cause the check valve to stick open, when servicing the fuel system. Particles in the fuel system larger than 75 microns may cause a condition.**

- The chassis fuel hose/pipe is located under the vehicle and connects the rear fuel hose/pipe to the fuel inlet pipe at the high pressure fuel pump. The chassis fuel hose/pipe is constructed of steel and braided TeleflexÂ® hose.

  The flexible portion of the chassis fuel hose/pipe contains a check flow valve. The check valve does not hold pressure. It is designed to reduce the pressure pulsations going back to the in-tank fuel pump from the high pressure fuel pump. It is also designed to bleed off pressure from the high pressure fuel pump to the chassis fuel pipe during a hot soak.

Chassis Control Module

The Chassis Control Module is a serviceable GMLAN module. The Chassis Control Module receives the desired fuel pressure message from the Engine Control Module (ECM) and controls the fuel pump located within the fuel tank to achieve the desired fuel pressure. The Chassis Control Module sends a PWM signal to the fuel pump, and pump speed is changed by varying the duty cycle of this signal.

Liquid Fuel Pressure Sensor

The fuel pressure sensor is a serviceable 5-volt, 3-pin device. It is located on the fuel feed line forward of the fuel tank, and receives power and ground from the Chassis Control Module through a vehicle wiring harness. The sensor provides a fuel pressure signal to the Chassis Control Module, which is used to aid Closed Loop fuel

pressure control.

Fuel Filter

The fuel filter is contained in the fuel sender assembly inside the fuel tank. The paper filter element of the fuel filter traps particles in the fuel that may damage the fuel injection system. There is no service interval for fuel filter replacement.

EVAP Lines and Hoses

The EVAP line extends from the fuel tank vent valve to the EVAP canister and into the engine compartment. The EVAP line is made of nylon and connects to the EVAP canister with a quick connect fitting.

Pressure Relief Regulator Valve

The pressure relief regulator valve replaces the typical fuel pressure regulator used on a mechanical returnless fuel system. The pressure relief regulator valve is closed during normal vehicle operation. The pressure relief regulator valve is used to vent pressure during hot soaks and also functions as a fuel pressure regulator in the event of the fuel pump flow control module defaulting to 100 percent pulse width modulation (PWM) of the fuel pump. Due to variation in fuel system pressures, the opening pressure for the pressure relief regulator valve is set higher than the pressure that is used on a mechanical returnless fuel system pressure regulator.

High Pressure Fuel Pump

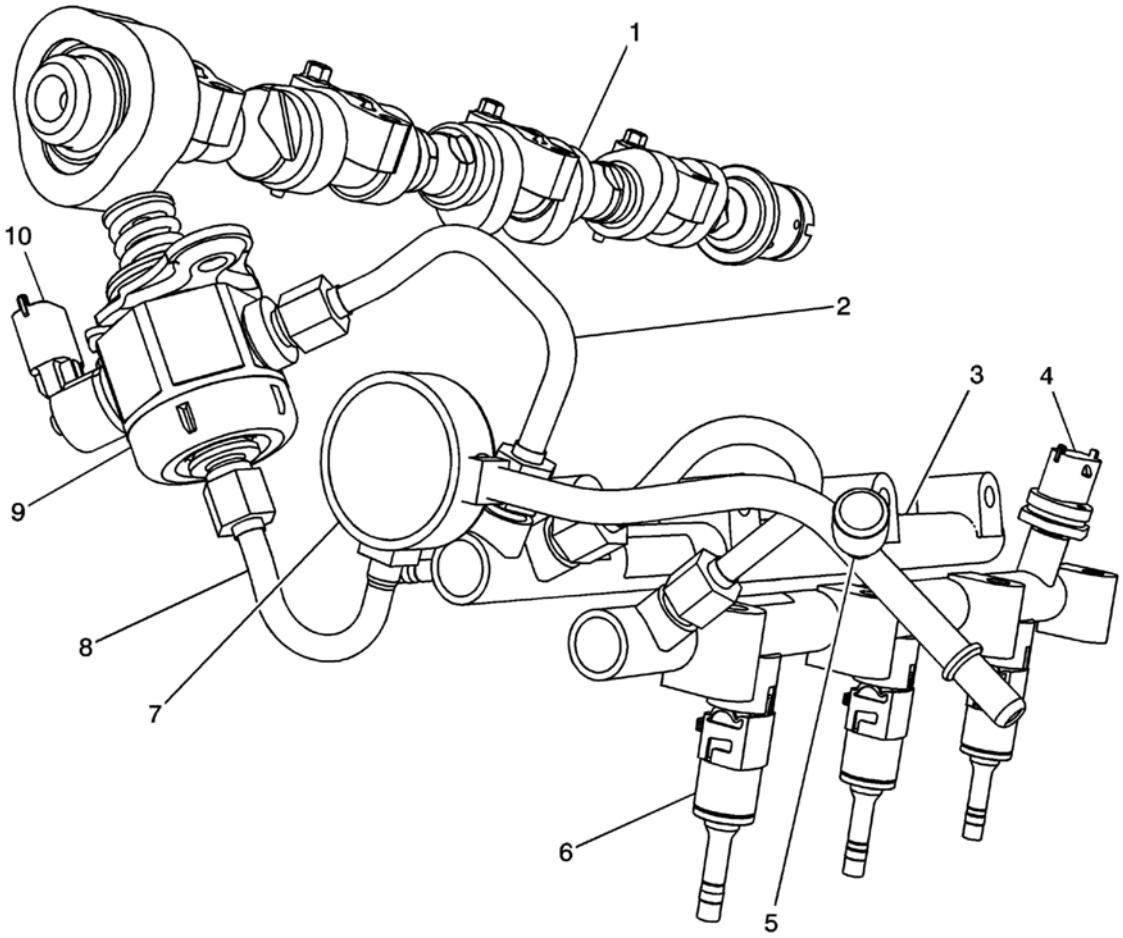


Fig. 7: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

The high pressure fuel pump (9) is a mechanical one cylinder design driven by an eccentric on the exhaust camshaft (1) of bank 2. High pressure fuel is regulated by the high pressure fuel pump actuator, which is a part of the high pressure fuel pump. The high pressure fuel pump actuator is a magnetic actuator which controls the inlet valve of the high pressure pump. The ECM provides battery voltage on the actuator high control circuit and ground on the actuator low control circuit. Both circuits are controlled by the ECM. When the ECM deactivates the high pressure fuel pump actuator, both circuits are disabled and the inlet valve is held open with spring pressure. When the ECM activates the high pressure fuel pump actuator, the low control circuit driver connects the low control circuit to ground and the high control circuit driver pulse-width modulates (PWM) the high control circuit. The ECM uses the camshaft and crankshaft position sensor inputs to synchronize the high pressure fuel pump actuator with the position of the eccentric on the camshaft. The ECM regulates fuel pressure by adjusting the portion of each pump stroke that provides fuel to the rail. The high pressure fuel pump also contains an integrated pressure relief valve.

Fuel Rail Fuel Pressure Sensor

The fuel rail pressure sensor (4) detects fuel pressure within the fuel rail. The engine control module (ECM) provides a 5 volt reference voltage on the 5 volt reference circuit and ground on the low reference circuit. The

ECM receives a varying signal voltage on the signal circuit. The ECM monitors the voltage on the FRP sensor circuits. When the fuel pressure is high, the signal voltage is high. When the fuel pressure is low, the signal voltage is low.

Fuel Rail Assembly

The fuel rail assembly (3) attaches to each cylinder head. The fuel rail distributes high pressure fuel to the fuel injectors. The fuel rail assembly consists of the following components:

- Six fuel injectors
- A fuel rail pressure (FRP) sensor

Fuel Injectors

The fuel injection system is a high pressure, direct injection, returnless on-demand design. The fuel injectors (6) are mounted in the cylinder head beneath the intake ports and spray fuel directly into the combustion chamber. Direct injection requires high fuel pressure due to the fuel injector's location in the combustion chamber. Fuel pressure must be higher than compression pressure requiring a high pressure fuel pump. The fuel injectors also require more electrical power due to the high fuel pressure. The ECM supplies a separate high voltage supply circuit and a high voltage control circuit for each fuel injector. The injector high voltage supply circuit and the high voltage control circuit are both controlled by the ECM. The ECM energizes each fuel injector by grounding the control circuit. The ECM controls each fuel injector with 65 volts. This is controlled by a boost capacitor in the ECM. During the 65 volt boost phase, the capacitor is discharged through an injector, allowing for initial injector opening. The injector is then held open with 12 volts.

The fuel injector assembly is an inside opening electrical magnetic injector. The injector has six precision machined holes that generate a cone shaped oval spray pattern. The fuel injector has a slim extended tip in order to allow a sufficient cooling jacket in the cylinder head.

The fuel injectors will cause various driveability conditions if the following conditions occur:

- If the injectors will not open
- If the injectors are stuck open
- If the injectors are leaking
- If the injectors have a low coil resistance

Engine Fueling

The engine is fueled by six individual injectors, one for each cylinder, that are controlled by the ECM. The ECM controls each injector by energizing the injector coil for a brief period once every other engine revolution. The length of this brief period, or pulse, is carefully calculated by the ECM to deliver the correct amount of fuel for proper driveability and emissions control. The period of time when the injector is energized is called the pulse width and is measured in milliseconds, thousandths of a second.

While the engine is running, the ECM is constantly monitoring the inputs and recalculating the appropriate pulse width for each injector. The pulse width calculation is based on the injector flow rate, mass of fuel the energized injector will pass per unit of time, the desired air/fuel ratio, and actual air mass in each cylinder and is adjusted for battery voltage, short term, and long term fuel trim. The calculated pulse is timed to occur as each cylinders intake valves are closing to attain largest duration and most vaporization.

Fueling during a crank is slightly different than fueling during an engine run. As the engine begins to turn, a prime pulse may be injected to speed starting. As soon as the ECM can determine where in the firing order the engine is, the ECM begins pulsing the injectors. The pulse width during the crank is based on the coolant temperature and the engine load.

The fueling system has several automatic adjustments in order to compensate for the differences in the fuel system hardware, the driving conditions, the fuel used, and the engine aging. The basis for the fuel control is the pulse width calculation that is described above. Included in this calculation are an adjustment for the battery voltage, the short term fuel trim, and the long term fuel trim. The battery voltage adjustment is necessary since the changes in the voltage across the injector affect the injector flow rate. The short term and the long term fuel trims are fine and coarse adjustments to the pulse width that are designed in order to maximize the driveability and emissions control. These fuel trims are based on the feedback from the oxygen sensors in the exhaust stream and are only used when the fuel control system is in a Closed Loop operation.

Under certain conditions, the fueling system will turn OFF the injectors for a period of time. This is referred to as fuel shut-off. Fuel shut-off is used in order to improve traction, save fuel, improve emissions, and protect the vehicle under certain extreme or abusive conditions.

In case of a major internal problem, the ECM may be able to use a back-up fuel strategy for limp in mode that will run the engine until service can be performed.

Sequential Fuel Injection (SFI)

The ECM controls the fuel injectors based on information that the ECM receives from several information sensors. Each injector is fired individually in the engine firing order, which is called sequential fuel injection. This allows precise fuel metering to each cylinder and improves the driveability under all of the driving conditions.

The ECM has several operating modes for fuel control, depending on the information that has been received from the sensors.

Starting Mode

When the ECM detects reference pulses from the CKP sensor, the ECM will enable the fuel pump. The fuel pump runs and builds up pressure in the fuel system. The ECM then monitors the MAF, IAT, engine coolant temperature (ECT), and the throttle position (TP) sensor signal in order to determine the required injector pulse width for starting.

Clear Flood Mode

If the engine is flooded with fuel during starting and will not start, the Clear Flood Mode can be manually selected. To select Clear Flood Mode, push the accelerator to wide open throttle (WOT). With this signal, the ECM will completely turn OFF the injectors and will maintain this stage as long as the ECM indicates a WOT condition with engine speed below 1,000 RPM.

Run Mode

The Run Mode has 2 conditions: Open Loop operation and Closed Loop operation. When the engine is first started and the engine speed is above 480 RPM, the system goes into Open Loop operation. In Open Loop operation, the ECM ignores the signals from the oxygen sensors and calculates the required injector pulse width based primarily on inputs from the MAF, IAT and ECT sensors.

In Closed Loop, the ECM adjusts the calculated injector pulse width for each bank of injectors based on the signals from each oxygen sensor.

Acceleration Mode

The ECM monitors the changes in the TP and the MAF sensor signals in order to determine when the vehicle is being accelerated. The ECM will then increase the injector pulse width in order to provide more fuel for improved performance.

Deceleration Mode

The ECM monitors changes in TP and MAF sensor signals to determine when the vehicle is being decelerated. The ECM will then decrease injector pulse width or even shut OFF injectors for short periods to reduce exhaust emissions, and for better (engine braking) deceleration.

Battery Voltage Correction Mode

The ECM can compensate in order to maintain acceptable vehicle driveability when the ECM sees a low battery voltage condition. The ECM compensates by performing the following functions:

- Increasing the injector pulse width in order to maintain the proper amount of fuel being delivered
- Increasing the idle speed to increase the generator output

Fuel Shut-Off Mode

The ECM has the ability to completely turn OFF all of the injectors or selectively turn OFF some of the injectors when certain conditions are met. These fuel shut-off modes allow the ECM to protect the engine from damage and also to improve the vehicles driveability.

The ECM will disable all of the six injectors under the following conditions:

- Ignition OFF-Prevents engine run-on
- Ignition ON but no CKP signal-Prevents flooding or backfiring
- A high engine speed-Above the red line
- A high vehicle speed-Above the rated tire speed
- Closed throttle coast down-Reduces the emissions and increases engine braking.

The ECM will selectively disable the injectors under the following conditions:

- The torque management enabled-Transmission shifts or abusive maneuvers.
- The traction control enabled-In conjunction with the front brakes applying

THROTTLE ACTUATOR CONTROL (TAC) SYSTEM DESCRIPTION

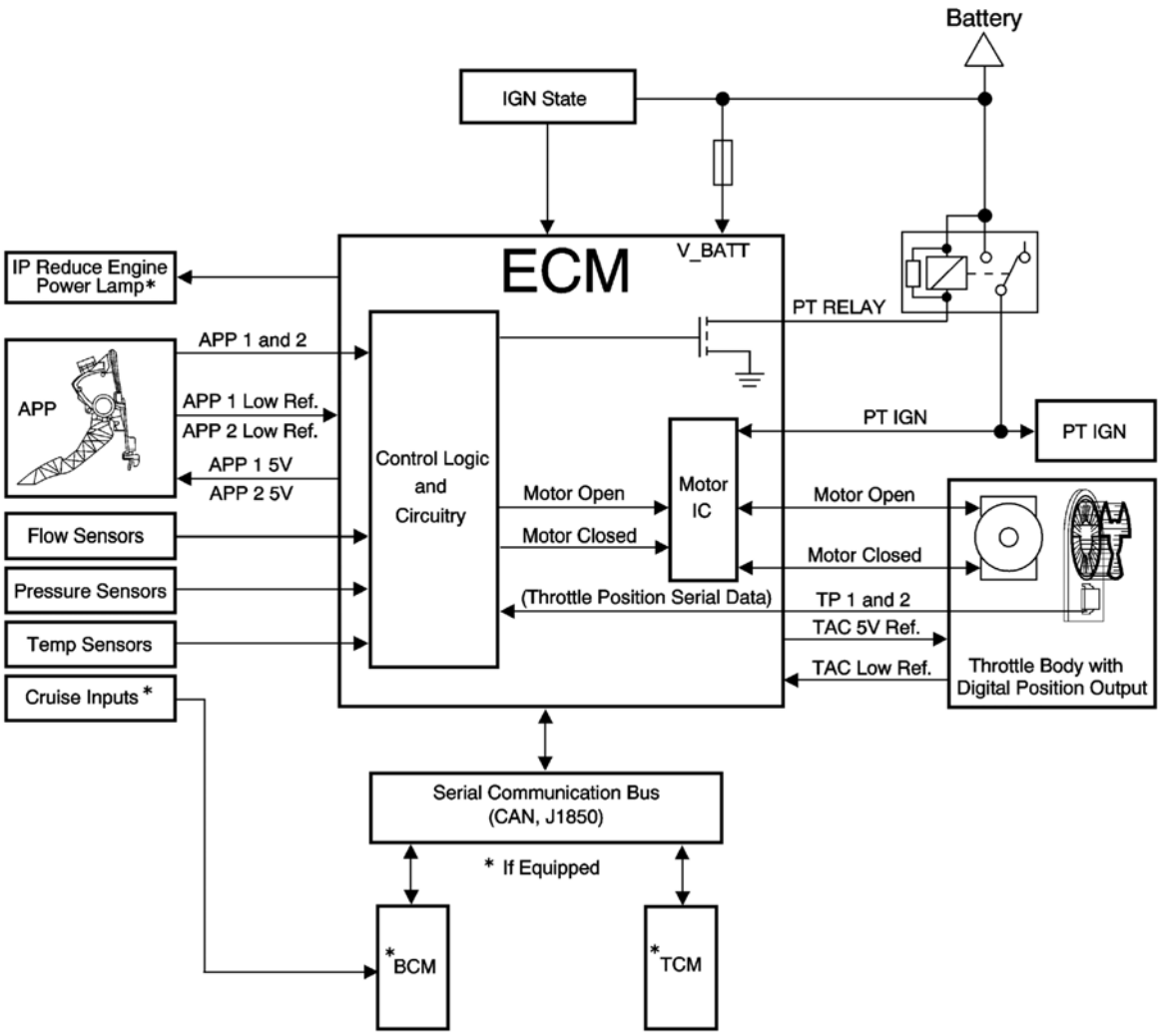


Fig. 8: Throttle Actuator Control (TAC) System Description
Courtesy of GENERAL MOTORS COMPANY

The engine control module (ECM) is the control center for the throttle actuator control (TAC) system. The ECM determines the driver's intent based on input from the accelerator pedal position sensors, then calculates the appropriate throttle response based on the throttle position sensors. The ECM achieves throttle positioning by providing a pulse width modulated voltage to the throttle actuator motor. The throttle blade is spring loaded in both directions, and the default position is slightly open.

Modes Of Operation

Normal Mode

During the operation of the TAC system, several modes, or functions, are considered normal. The following modes may be entered during normal operations:

- Minimum pedal value-At key-up, the ECM updates the learned minimum pedal value.
- Minimum throttle position values-At key-up, the ECM updates the learned minimum throttle position value. In order to learn the minimum throttle position value, the throttle blade is moved to the Closed position.
- Ice break mode-If the throttle blade is not able to reach a predetermined minimum throttle position, the

ice break mode is entered. During the ice break mode, the ECM commands the maximum pulse width several times to the throttle actuator motor in the closing direction.

- Battery saver mode-After a predetermined time without engine speed, the ECM commands the battery saver mode. During the battery saver mode, the TAC module removes the voltage from the motor control circuits, which removes the current draw used to maintain the idle position and allows the throttle to return to the spring loaded default position.

Reduced Engine Power Mode

When the ECM detects a condition with the TAC system, the ECM may enter a reduced engine power mode. Reduced engine power may cause one or more of the following conditions:

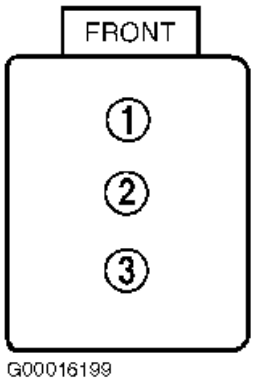
- Acceleration limiting-The ECM will continue to use the accelerator pedal for throttle control, however, the vehicle acceleration is limited.
- Limited throttle mode-The ECM will continue to use the accelerator pedal for throttle control, however, the maximum throttle opening is limited.
- Throttle default mode-The ECM will turn OFF the throttle actuator motor, and the throttle will return to the spring loaded default position.
- Forced idle mode-The ECM will perform the following actions:
  - Limit engine speed to the idle position
  - Ignore the accelerator pedal input.
- Engine shutdown mode-The ECM will disable fuel and de-energize the throttle actuator.

Article GUID: A00737245

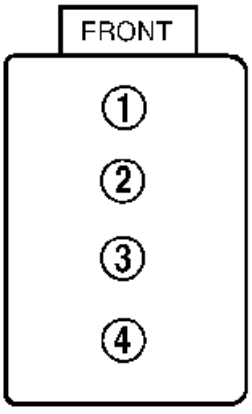
FIRING ORDER & CYLINDER IDENTIFICATION

NOTE: **This information is intended as a quick reference for firing order and cylinder identification only. The information provided covers many vehicles and may include some information that does not apply to the vehicle you have currently selected.**

3 CYLINDER ENGINE

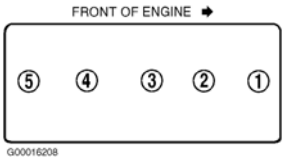
Engine Configuration	Firing Order	Cylinder Identification
In-Line 3	1-3-2	 G00016199

4 CYLINDER ENGINE

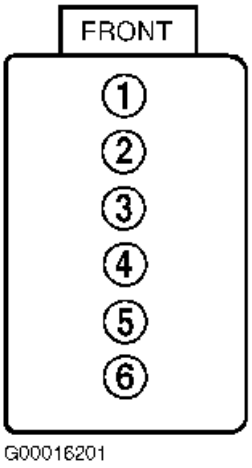
Engine Configuration	Firing Order	Cylinder Identification
In-Line 4	1-3-4-2	 G00016200

5 CYLINDER ENGINE

Engine Configuration	Firing Order	Cylinder Identification

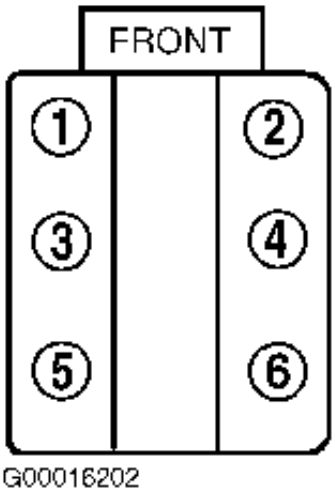
Engine Configuration	Firing Order	Cylinder Identification
In-Line 5	1-3-5-4-2	

IN-LINE 6 ENGINE

Engine Configuration	Firing Order	Cylinder Identification
In-Line 6	1-5-3-6-2-4	

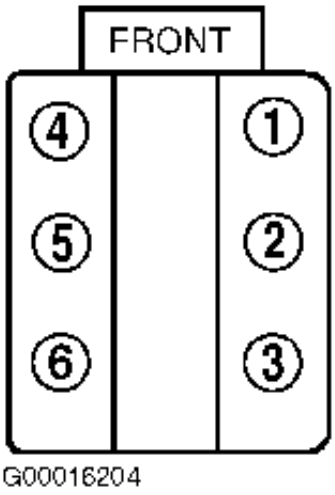
V6 ENGINE

2.5L V6 Engine - Tracker

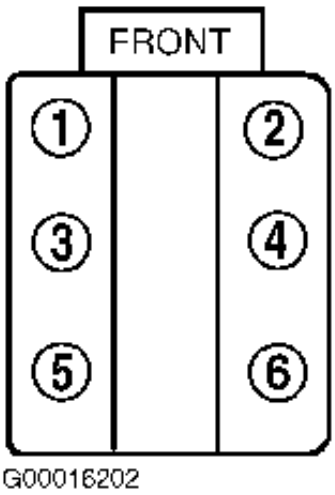
Engine Configuration	Firing Order	Cylinder Identification
2.5L Tracker	1-2-3-4-5-6	

3.5L VIN 4 V6 Engine

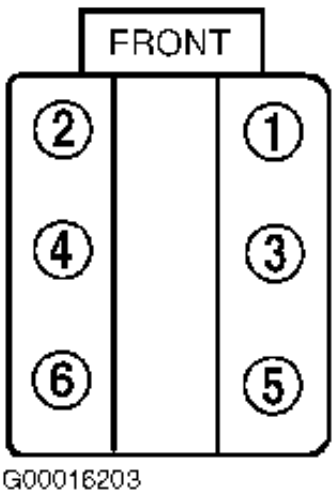
Engine Configuration	Firing Order	Cylinder Identification

3.5L VIN 4	1-4-2-5-3-6	 G00016204

3.8L & 4.3L V6 Engines

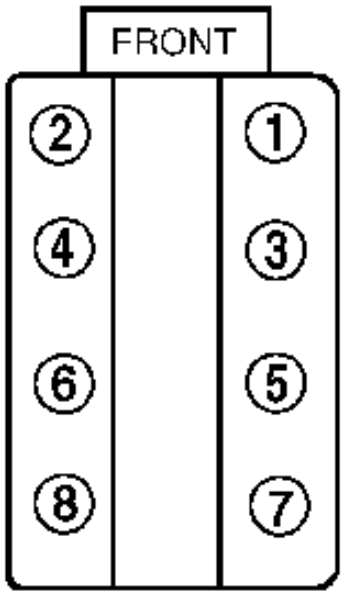
Engine Configuration	Firing Order	Cylinder Identification
3.8L & 4.3L	1-6-5-4-3-2	 G00016202

All Other V6 Engines Except 2.5L, 3.5L (VIN 4), 3.8L & 4.3L

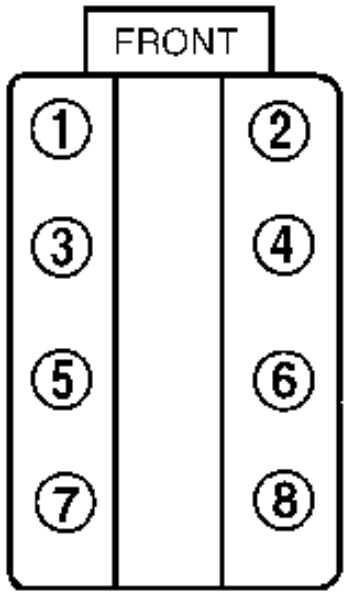
Engine Configuration	Firing Order	Cylinder Identification
All Others	1-2-3-4-5-6	 G00016203

8 CYLINDER ENGINE

4.0L, 4.4L & 4.6L V8 Engines

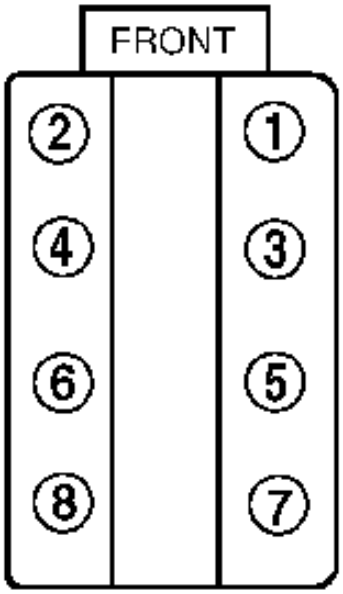
Engine Configuration	Firing Order	Cylinder Identification
4.0L, 4.4L, 4.6L	1-2-7-3-4-5-6-8	 G00016206

5.0L, 5.7L (VIN R & VIN K) & 7.4L V8 Engines

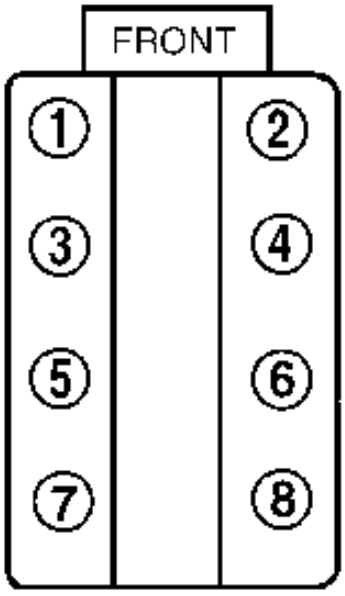
Engine Configuration	Firing Order	Cylinder Identification
5.0L, 5.7L (VIN R & K), 7.4L	1-8-4-3-6-5-7-2	 G00016205

6.6L Diesel V8 Engine

Engine Configuration	Firing Order	Cylinder Identification

Engine Configuration	Firing Order	Cylinder Identification
6.6L Diesel	1-2-7-8-4-5-6-3	 G00016206

All Other V8 Engines Except 4.0L, 4.4L, 4.6L, 5.0L, 5.7L (VIN R & K), 7.4L & 6.6L

Engine Configuration	Firing Order	Cylinder Identification
All Others	1-8-7-2-6-5-4-3	 G00016205

Article GUID: A00342330

GENERAL INFORMATION

State Emission Standards

ARIZONA

NOTE: **Because of frequent revisions in state emission standards, the emission standards listed in this article should only be used as a guide.**

ARIZONA EMISSION STANDARDS - PHOENIX & TUCSON AREA (DIESEL OPACITY LOADED CRUISE TEST)

Application	Altitude (Feet)	Opacity (% For 10 Seconds)
Light Duty Vehicles (8500 GVWR Or Less)		
All Years	Less Than 2000	20 Or Less
Â Â	2001-4000	30 Or Less
Â Â	Greater Than 4000	40 Or Less

ARIZONA EMISSION STANDARDS - PHOENIX & TUCSON AREA (DIESEL J1667 SNAP IDLE TEST)

Application	Altitude (Feet)	Opacity (% For 10 Seconds)
Heavy Duty Vehicles (8500 GVWR Or Greater)		
1990 & Earlier	All	55
1991 & Newer	All	40

COLORADO

COLORADO EMISSION STANDARDS - DIESEL OPACITY

Application	Opacity %
14,000 GVWR Or Less	
Non-Turbo	40
Turbo	35
14,000 GVWR Or More	
Non-Turbo	35
Turbo	20

CONNECTICUT

CONNECTICUT EMISSION STANDARDS - DIESEL OPACITY

Application	Opacity %
10,000 GVWR Or Less	
1979 & Newer	20
26,000 GVWR Or More	

Application	Opacity %
1974 & Earlier	70
1974-90	55
1991 & Newer	40

IDAHO

IDAHO EMISSION STANDARDS - DIESEL OPACITY

Application	Opacity %
All Weight Range	
1965-74	70
1975-91	55
1992 & Newer	40

KENTUCKY

KENTUCKY EMISSION STANDARDS - BOONE, CAMPBELL & KENTON COUNTIES (DIESEL OPACITY)

Application	Opacity
18,000 GVWR Or Less	
All Years	10% @ Idle

MASSACHUSETTS

MASSACHUSETTS EMISSION STANDARDS - DIESEL OPACITY

Application	Opacity %
Light Duty (8500 GVWR Or Less)	
1984 & Newer	20
Light Duty (8501-10,000 GVWR Or Less)	
1984 & Newer	40
Heavy Duty Buses (10,000 GVWR Or More)	
1984-93	40
1994 & Newer	30
Heavy Duty Trucks (10,000 Or Less GVWR)	
1984-90	55
1991 & Newer	40

NEW YORK

NEW YORK EMISSION STANDARDS - DIESEL OPACITY TEST

Application	Opacity %
Heavy Duty Vehicles (8500 GVWR Or More)	
1973 & Earlier	70
1974-90	55

Application	Opacity %
1991 & Newer	40

OHIO

OHIO EMISSION STANDARDS - DIESEL OPACITY TEST

Application	Opacity %
Light Duty Diesel	20

RHODE ISLAND

RHODE ISLAND EMISSION STANDARDS - DIESEL OPACITY TEST

Application	Opacity %
All Model Years (8500 GVWR Or Less)	20

UTAH

UTAH EMISSION STANDARDS - DAVIS COUNTY - DIESEL OPACITY TEST

Application	Opacity %
Light Duty Diesel - Turbo (16,000 GVWR Or Less)	30
Light Duty Diesel - Non-Turbo (16,000 GVWR Or Less)	35
Heavy Duty Diesel (16,000 GVWR Or More)	70

UTAH EMISSION STANDARDS - SALT LAKE COUNTY - DIESEL OPACITY TEST

Application	Opacity %
All Model Years - Turbo (16,000 GVWR Or Less)	30
All Model Years - Non-Turbo (16,000 GVWR Or Less)	35
All Model Years (16,000 GVWR Or More)	70

UTAH EMISSION STANDARDS - UTAH COUNTY - DIESEL OPACITY TEST

Application	Opacity %
All Model Years - Turbo (16,000 GVWR Or Less)	30
All Model Years - Non-Turbo (16,000 GVWR Or Less)	35
All Model Years (16,000 GVWR Or More)	70

WASHINGTON

WASHINGTON EMISSION STANDARDS - DIESEL OPACITY TEST

Application	Opacity %
Light Duty Diesel (8500 GVWR Or Less)	
All Model Years	20
Heavy Duty Diesel (8500 GVWR Or More)	
1991 & Earlier	55
1992 & Newer	40

GENERAL INFORMATION

State Emission Standards - Gasoline

ALASKA

NOTE: **Because of frequent revisions in state emission standards, the emission standards listed in this article should only be used as a guide.**

NOTE: **As of March 1, 2012, Alaska is not testing for tailpipe emissions.**

ALASKA EMISSION STANDARDS - ANCHORAGE & FAIRBANKS (2-SPEED IDLE TEST)

Application	Idle HC ppm (CO %)	2500 RPM HC ppm (CO %)
Passenger Cars (1)		
1968-71	1000 (5.0)	1000 (4.0)
1972-74	1000 (4.0)	1000 (3.0)
1975-80	1000 (2.0)	1000 (2.0)
1981-83	1000 (1.0)	1000 (1.0)
1984-93	750 (1.0)	750 (1.0)
1994-	200 (0.5)	200 (0.5)
Light & Medium Duty Trucks (1)		
1968-72	1000 (5.0)	1000 (4.0)
1973-78	1000 (4.0)	1000 (3.0)
1979-83	1000 (2.0)	1000 (2.0)
1984-93	750 (1.0)	750 (1.0)
1994-	220 (0.5)	220 (0.5)
Heavy Duty Vehicles (2)		
1968-73	1000 (5.0)	1000 (5.0)
1974-93	1000 (4.0)	1000 (4.0)
1994-	220 (1.0)	220 (1.0)

(1) 8500 GVWR or less.

(2) 8500 GVWR or more.

ARIZONA

NOTE: **Curb idle only test are for vehicles with full-time 4WD, non-defeatable traction control and motorcycles. Curb idle and loaded cruise tests are performed on 1967-80 light-duty gasoline powered vehicles and all heavy-duty gasoline powered vehicles.**

ARIZONA EMISSION STANDARDS - PHOENIX AREA (CURB IDLE & LOADED CRUISE TESTS)

Application (1)	Idle HC ppm (CO %)	(2) Loaded/Cruise HC

		ppm (CO %)
Light Duty Vehicles (6000 GVWR Or Less)		
1967-71 4-Cyl. Or Less	500 (5.50)	500 (4.20)
1967-71 More Than 4-Cyl.	450 (5.00)	450 (3.75)
1972-74 4-Cyl. Or Less	400 (5.50)	400 (4.20)
1972-74 More Than 4-Cyl.	400 (5.00)	400 (3.75)
1975-78 4-Cyl. Or Less	250 (2.20)	250 (1.65)
1975-78 More Than 4-Cyl.	250 (2.00)	250 (1.50)
Light Duty Vehicles (8500 GVWR Or Less)		
1979 4-Cyl. Or Less	220 (2.20)	220 (1.65)
1979 More Than 4-Cyl.	220 (2.20)	220 (1.50)
1980	220 (1.20)	220 (1.20)
1981 & Newer	220 (1.20)	.....
Light Duty Trucks (6000 GVWR Or Less)		
1967-80	(3)	(3)
Light Duty Trucks (6001-8500 GVWR)		
1967-74	(3)	(3)
1975-78	350 (4.00)	350 (3.00)
1979 4-Cyl. Or Less	220 (2.20)	220 (1.65)
1979 More Than 4-Cyl.	220 (2.00)	220 (1.50)
1980	220 (1.20)	220 (1.20)
1981 & Newer	220 (1.20)	.....
Heavy Duty Trucks (Greater Than 8500 GVWR)		
1967-74	(3)	(3)
1975-78	350 (4.00)	350 (3.00)
1979 & Newer	300 (4.00)	300 (3.00)
Motorcycles		
1967 & Newer	1800 (5.50)	.....

(1) 4-stroke engines only.

(2) Except AWD, non-defeatable traction control and motorcycles.

(3) Same as light duty vehicles.

ARIZONA EMISSION STANDARDS - PHOENIX AREA (IM147 TEST)

Application	HC gpm (CO gpm)	NOx gpm
Light Duty Vehicles		
1981-82	3.0 (25.0)	3.5
1983-85	2.4 (20.0)	3.5
1986-89	1.6 (15.0)	2.5
1990-93	1.0 (12.0)	2.5
1994 & Newer	0.8 (12.0)	2.0
Light Trucks (6000 GVWR Or Less)		

Application	HC gpm (CO gpm)	NOx gpm
1981-85	4.0 (40.0)	5.5
1986-89	3.0 (25.0)	4.5
1990-93	2.0 (20.0)	4.0
1994 & Newer	1.6 (20.0)	3.0
Light Duty Trucks (6000-8500 GVWR)		
1981-85	4.4 (48.0)	7.0
1986-87	4.0 (40.0)	5.5
1988-89	3.0 (25.0)	5.5
1990-93	3.0 (25.0)	5.0
1994 & Newer	2.4 (25.0)	4.0

NOTE: **Curb idle test only for 1967-80 light-duty gasoline vehicles, all vehicles with full-time 4WD and/or non-defeatable traction control and motorcycles. Curb idle and loaded cruise tests are performed on all 1981 and later vehicles except those with full-time 4WD and/or non-defeatable traction control.**

ARIZONA EMISSION STANDARDS - TUCSON AREA (CURB IDLE & LOADED CRUISE TESTS)

Application (1)	Idle HC ppm (CO %)	(2) Loaded/Cruise HC ppm (CO %)
Light Duty Vehicles (6000 GVWR Or Less)		
1967-71 4-Cyl. Or Less	500 (5.50)	.....
1967-71 More Than 4-Cyl.	450 (5.00)	.....
1972-74 4-Cyl. Or Less	400 (5.50)	.....
1972-74 More Than 4-Cyl.	400 (5.00)	.....
1975-78 4-Cyl. Or Less	250 (2.20)	.....
1975-78 More Than 4-Cyl.	250 (2.00)	.....
Light Duty Vehicles (8500 GVWR Or Less)		
1979 4-Cyl. Or Less	220 (2.20)	.....
1979 More Than 4-Cyl.	220 (2.20)	.....
1980	220 (1.20)	.....
1981 & Newer	220 (1.20)	220 (1.20)
Light Duty Trucks (6000 GVWR Or Less)		
1967-80	(3)	(3)
Light Duty Trucks (6001-8500 GVWR)		
1967-74	(3)	(3)
1975-78	350 (4.00)	.....
1979 4-Cyl. Or Less	220 (2.20)	.....
1979 More Than 4-Cyl.	220 (2.00)	.....
1980	220 (1.20)	.....
1981 & Newer	220 (1.20)	220 (1.20)
Heavy Duty Trucks (Greater Than 8500 GVWR)		
1967-74	(3)	(3)

Application (1)	Idle HC ppm (CO %)	(2) Loaded/Cruise HC ppm (CO %)
1975-78	350 (4.00)	.....
1979-80	300 (4.00)	.....
1981 & Newer	300 (4.00)	300 (3.00)
Motorcycles		
1967 & Newer	1800 (5.50)	.....

(1) 4-stroke engines only.

(2) Except AWD, non-defeatable traction control and motorcycles.

(3) Same as light duty vehicles.

CALIFORNIA

CALIFORNIA EMISSION STANDARDS ASM TESTS

Specific vehicle cutpoints are available on the California BAR web site at www.bar.ca.gov under the Industry tab, then Cutpoints Application.

ESC	MODEL YEAR GROUP	VEHICLE TYPE (by GVWR and LVW)					PASS/FAIL EMISSION STANDARD						GROSS POLLUTER STANDARD					
							ASM 5015			ASM 2525			ASM 5015			ASM 2525		
		PC	LDT1	LDT2	MDV		HC	CO	NO	HC	CO	NO	HC	CO	NO	HC	CO	NO
1	1974-	X	X	X		A	235.4	2.56	1301.5	185.4	2.36	1161.5	435.4	4.26	2659.3	385.4	4.06	2459.3
						B	436041.7	4453.19	1192593.0	436041.7	4453.19	1192593.0	436041.7	4453.19	1703703.7	436041.7	4453.19	1703703.7
2	1975-1980	X				A	123.0	0.91	1016.3	90.3	0.71	876.3	315.3	2.51	2051.9	265.3	2.31	1851.9
						B	273316.7	1362.96	1043519.0	273316.7	1362.96	1043519.0	273316.7	1362.96	1490740.7	273316.7	1362.96	1490740.7
3	1981-1983	X				A	63.2	0.64	850.0	42.1	0.44	680.0	253.1	2.14	1844.4	192.4	1.94	1644.4
						B	234259.3	1064.81	894444.5	212963.0	1064.81	894444.5	234259.3	1064.81	1277777.8	212963.0	1064.81	1277777.8
4	1984-1986	X				A	67.0	0.52	850.0	42.1	0.32	680.0	242.4	2.02	1744.4	192.4	1.82	1544.4
						B	212963.0	979.63	894444.5	212963.0	979.63	894444.5	212963.0	979.63	1277777.8	212963.0	979.63	1277777.8
5	1987-1992	X				A	57.0	0.48	608.0	31.7	0.32	547.0	231.7	1.98	1729.6	181.7	1.82	1529.6
						B	191666.7	851.85	596296.3	191666.7	979.63	596296.3	191666.7	851.85	851851.9	191666.7	979.63	851851.9
6	1993-1995	X				A	59.0	0.29	617.1	24.3	0.23	547.0	234.3	1.79	1759.3	184.3	1.73	1559.3
						B	89951.3	724.07	271314.8	89951.3	851.85	596296.3	128501.9	724.07	553703.7	128501.9	851.85	553703.7
7	1996-2000	X				A	16.8	0.29	260.0	0.5	0.23	547.0	234.3	1.79	1759.3	184.3	1.73	1559.3
						B	128501.9	724.07	596296.3	128501.9	851.85	596296.3	128501.9	724.07	553703.7	128501.9	851.85	553703.7
8	2001-2003	X				A	16.8	0.29	260.0	0.5	0.23	547.0	234.3	1.79	1759.3	184.3	1.73	1559.3
						B	128501.9	724.07	596296.3	128501.9	851.85	596296.3	128501.9	724.07	553703.7	128501.9	851.85	553703.7
9	2004+	X				A	16.8	0.29	260.0	0.5	0.23	547.0	234.3	1.79	1759.3	184.3	1.73	1559.3
						B	128501.9	724.07	596296.3	128501.9	851.85	596296.3	128501.9	724.07	553703.7	128501.9	851.85	553703.7
10	1975-1978		X			A	139.4	1.08	1320.9	105.0	0.88	1180.9	330.0	2.58	2487.0	280.0	2.38	2287.0
						B	225000.0	2025.00	745370.4	225000.0	2025.00	745370.4	225000.0	2025.00	1064814.8	225000.0	2025.00	1064814.8
11	1979-1983		X			A	139.4	0.88	1315.7	80.0	0.68	1175.7	320.0	2.38	2479.6	255.0	2.18	2279.6
						B	225000.0	2025.00	596296.3	150000.0	2025.00	596296.3	225000.0	2025.00	851851.9	150000.0	2025.00	851851.9
12	1984-1987		X			A	91.3	0.41	945.0	63.1	0.50	840.0	280.0	1.71	1850.0	230.0	1.80	1700.0
						B	150000.0	1725.00	525000.0	150000.0	2250.00	1050000.0	150000.0	1725.00	750000.0	150000.0	2250.00	1500000.0
13	1988-1992		X			A	83.0	0.27	875.0	63.1	0.43	735.0	270.0	1.57	1600.0	220.0	1.73	1400.0
						B	150000.0	1725.00	525000.0	150000.0	1875.00	525000.0	150000.0	1725.00	750000.0	150000.0	1875.00	750000.0
14	1993-1995		X			A	68.3	0.30	377.0	33.3	0.40	630.0	247.5	1.60	1350.0	197.5	1.70	1400.0
						B	78750.0	1350.00	525000.0	78750.0	1500.00	525000.0	112500.0	1350.00	750000.0	112500.0	1500.00	750000.0
15	1996-2000		X			A	22.1	0.30	377.0	5.8	0.40	630.0	247.5	1.60	1350.0	197.5	1.70	1400.0
						B	112500.0	1350.00	525000.0	112500.0	1500.00	525000.0	112500.0	1350.00	750000.0	112500.0	1500.00	750000.0
16	2001-2003		X			A	22.1	0.30	377.0	5.8	0.40	630.0	247.5	1.60	1350.0	197.5	1.70	1400.0
						B	112500.0	1350.00	525000.0	112500.0	1500.00	525000.0	112500.0	1350.00	750000.0	112500.0	1500.00	750000.0
17	2004+		X			A	22.1	0.30	377.0	5.8	0.40	630.0	247.5	1.60	1350.0	197.5	1.70	1400.0
						B	112500.0	1350.00	525000.0	112500.0	1500.00	525000.0	112500.0	1350.00	750000.0	112500.0	1500.00	750000.0
18	1975-1978			X		A	139.4	1.08	1320.9	105.0	0.88	1180.9	330.0	2.58	2487.0	280.0	2.38	2287.0
						B	225000.0	2025.00	745370.4	225000.0	2025.00	745370.4	225000.0	2025.00	1064814.8	225000.0	2025.00	1064814.8
19	1979-1983			X		A	139.4	0.88	1315.7	80.0	0.68	1175.7	320.0	2.38	2479.6	255.0	2.18	2279.6
						B	225000.0	2025.00	596296.3	150000.0	2025.00	596296.3	225000.0	2025.00	851851.9	150000.0	2025.00	851851.9
20	1984-1987			X		A	91.3	0.41	945.0	63.1	0.50	840.0	280.0	1.71	1850.0	230.0	1.80	1700.0
						B	150000.0	1725.00	525000.0	150000.0	2250.00	1050000.0	150000.0	1725.00	750000.0	150000.0	2250.00	1500000.0
21	1988-1992			X		A	83.0	0.27	875.0	63.1	0.43	735.0	270.0	1.57	1600.0	220.0	1.73	1400.0
						B	150000.0	1725.00	525000.0	150000.0	1875.00	525000.0	150000.0	1725.00	750000.0	150000.0	1875.00	750000.0
22	1993-1995			X		A	68.3	0.30	377.0	33.3	0.40	630.0	247.5	1.60	1350.0	197.5	1.70	1400.0
						B	78750.0	1350.00	525000.0	78750.0	1500.00	525000.0	112500.0	1350.00	750000.0	112500.0	1500.00	750000.0
23	1996-2000			X		A	22.1	0.30	377.0	5.8	0.40	630.0	247.5	1.60	1350.0	197.5	1.70	1400.0
						B	112500.0	1350.00	525000.0	112500.0	1500.00	525000.0	112500.0	1350.00	750000.0	112500.0	1500.00	750000.0
24	2001-2003			X		A	22.1	0.30	377.0	5.8	0.40	630.0	247.5	1.60	1350.0	197.5	1.70	1400.0
						B	112500.0	1350.00	525000.0	112500.0	1500.00	525000.0	112500.0	1350.00	750000.0	112500.0	1500.00	750000.0
25	2004+			X		A	22.1	0.30	377.0	5.8	0.40	630.0	247.5	1.60	1350.0	197.5	1.70	1400.0
						B	112500.0	1350.00	525000.0	112500.0	1500.00	525000.0	112500.0	1350.00	750000.0	112500.0	1500.00	750000.0
26	1978-				X	A	173.3	2.90	1703.3	123.3	2.70	1563.3	423.3	5.40	3233.3	373.3	5.20	3033.3
						B	583333.3	3500.00	1633333.3	583333.3	3500.00	1633333.3	583333.3	3500.00	2333333.3	583333.3	3500.00	2333333.3
27	1979-1983				X	A	139.4	0.88	1315.7	80.0	0.68	1175.7	320.0	2.38	2479.6	255.0	2.18	2279.6
						B	225000.0	2025.00	596296.3	150000.0	2025.00	596296.3	225000.0	2025.00	851851.9	150000.0	2025.00	851851.9
28	1984-1987				X	A	91.3	0.41	945.0	63.1	0.50	840.0	280.0	1.71	1850.0	230.0	1.80	1700.0
						B	150000.0	1725.00	525000.0	150000.0	2250.00	1050000.0	150000.0	1725.00	750000.0	150000.0	2250.00	1500000.0
29	1988-1992				X	A	83.0	0.27	875.0	63.1	0.43	735.0	270.0	1.57	1600.0	220.0	1.73	1400.0
						B	150000.0	1725.00	525000.0	150000.0	1875.00	525000.0	150000.0	1725.00	750000.0	150000.0	1875.00	750000.0
30	1993-1995				X	A	83.0	0.30	875.0	60.0	0.70	735.0	300.0	1.60	1750.0	250.0	2.00	1550.0
						B	150000.0	1350.00	525000.0	150000.0	1500.00	525000.0	150000.0	1350.00	750000.0	150000.0	1500.00	750000.0
31	1996-2000				X	A	71.2	0.30	875.0	60.0	0.70	735.0	300.0	1.60	1750.0	250.0	2.00	1550.0
						B	150000.0	1350.00	525000.0	150000.0	1500.00	525000.0	150000.0	1350.00	750000.0	150000.0	1500.00	750000.0
32	2001-2003				X	A	71.2	0.30	875.0	60.0	0.70	735.0	300.0	1.60	1750.0	250.0	2.00	1550.0
						B	150000.0	1350.00	525000.0	150000.0	1500.00	525000.0	150000.0	1350.00	750000.0	150000.0	1500.00	750000.0
33	2004+				X	A	71.2	0.30	875.0	60.0	0.70	735.0	300.0	1.60	1750.0	250.0	2.00	1550.0
						B	150000.0	1350.00	525000.0	150000.0	1500.00	525000.0	150000.0	1350.00	750000.0	150000.0	1500.00	750000.0

Fig. 1: California Emission Standards - Enhanced & Partially Enhanced Program Areas - Light & Medium Duty Vehicles (ASM Test)

ESC	MODEL YEAR GROUP	VEHICLE TYPE (by GVWR and LVW)						PASS/FAIL EMISSION STANDARD						GROSS POLLUTER STANDARD					
								ASM 5015			ASM 2525			ASM 5015			ASM 2525		
		PC	LDT1	LDT2	MDV	HDV		HC	CO	NO	HC	CO	NO	HC	CO	NO	HC	CO	NO
46	1978-					X	A	243.8	3.92	2615.8	199.8	3.92	2770.8	594.9	7.29	4970.0	605.4	7.57	5375.4
							B	583333.3	3500.00	1633333.3	583333.3	3500.00	1633333.3	583333.3	3500.00	1633333.3	583333.3	3500.00	1633333.3
47	1979 - 1983					X	A	205.5	2.16	2250.6	106.0	1.96	2400.6	454.2	6.62	4231.1	338.1	6.54	4657.2
							B	225000.0	2025.00	596296.3	150000.0	2025.00	596296.3	225000.0	2025.00	596296.3	150000.0	2025.00	596296.3
48	1984 - 1987					X	A	143.0	1.60	2162.5	78.0	1.80	1975.0	307.5	6.67	4238.5	250.0	6.48	3989.5
							B	150000.0	1725.00	525000.0	150000.0	2250.00	1050000.0	150000.0	1725.00	525000.0	150000.0	2250.00	1050000.0
49	1988 - 1992					X	A	105.0	1.01	2112.5	78.0	1.24	2062.5	300.0	5.87	3865.9	250.0	4.98	3929.9
							B	150000.0	1725.00	525000.0	150000.0	1875.00	525000.0	150000.0	1725.00	525000.0	150000.0	1875.00	525000.0
50	1993 - 1995					X	A	105.0	0.49	1912.5	75.0	1.22	1862.5	300.0	2.61	3825.0	250.0	3.49	3929.9
							B	150000.0	1350.00	525000.0	150000.0	1500.00	525000.0	150000.0	1350.00	525000.0	150000.0	1500.00	525000.0
51	1996 - 2000					X	A	105.0	0.49	1862.5	75.0	1.16	1462.5	300.0	2.61	3325.0	250.0	3.32	3085.9
							B	150000.0	1350.00	525000.0	150000.0	1500.00	525000.0	150000.0	1350.00	525000.0	150000.0	1500.00	525000.0
52	2001+					X	A	105.0	0.49	1862.5	75.0	1.16	1462.5	300.0	2.61	3325.0	250.0	3.32	3085.9
							B	150000.0	1350.00	525000.0	150000.0	1500.00	525000.0	150000.0	1350.00	525000.0	150000.0	1500.00	525000.0

Fig. 2: California Emission Standards - Enhanced & Partially Enhanced Program Areas - Heavy Duty Vehicles (ASM Test)

LEGEND

ESC - Emission Standard Category

GVWR - Manufacture's Gross Vehicle Weight Rating

LVW - Loaded Vehicle Weight

PC - Passenger Car

LDT1 - Light-Duty Truck up through 3750 LVW and GVWR no greater than 6000 lbs.

LDT2 - Light-Duty Truck greater than 3750 LVW and GVWR no greater than 6000 lbs.

MDV - Medium-Duty Vehicle, GVWR from 6001 to 8500 lbs.

HC - Hydrocarbon, ppm

CO - Carbon Monoxide, %

NO - Nitric Oxide, ppm

PASS/FAIL EMISSION STANDARDS = A+B / VTW

PASS/FAIL STANDARDS - Emission standards used to determine if a vehicle passes the emission inspection. A vehicle passes if the emission levels are equal to or less than the standards for HC, CO and NO for ASM 5015 and ASM 2525.

GROSS POLLUTER STANDARDS - Emission standards used to designate a vehicle as a gross polluter. A vehicle is designated as a gross polluter if the emission levels at the time of the initial inspection, before repairs are greater than the gross polluter standards for HC, CO or NO for ASM 5015 or ASM 2525.

NOTE: **If test data on emission pass/fail rates or gross polluter identification rates indicate adjustments are required, the emission standards may be increased or decreased by the bureau by 30% or by the following tolerances, or standards may be set for any specific vehicle and engine configuration which the bureau determines has excessive errors of commission of omission, whichever is necessary to comply with Section 44001.5 of the Health and Safety Code.**

COLORADO

COLORADO EMISSION STANDARDS - ENHANCED PROGRAM (IM240)

Application	HC gpm	CO gpm	NOx gpm
Passenger Cars			
1982	3.5	45	5.0
1983	3.5	30	4.5
1984	3.0	30	4.5
1985	2.5	20	4.5
1986	2.5	20	4.5
1987	2.5	20	4.0
1988 & 1989	2.0	20	4.0
1990	2.0	20	3.5
1991	1.5	20	3.5
1992	1.5	15	3.5
1993	1.5	15	3.5
1994	1.2	15	3.0
1995	1.2	15	2.5
1996	1.2	15	2.0
1997	1.2	15	2.0
1998 & Newer	1.2	15	1.5
Light Duty Vehicles			
1982	6.0	65	6.0
1983	6.0	65	6.0
1984	5.0	55	6.0
1985	4.5	45	6.0
1986	4.0	40	6.0
1987	3.5	30	5.5
1988 & 1989	3.0	25	5.0
1990	3.0	25	5.0
1991	2.5	25	4.5
1992	2.5	25	4.5
1993	2.5	25	4.5
1994	2.0	20	4.0
1995	2.0	20	4.0
1996	1.2	15	3.5
1997	1.2	15	3.0
1998	1.2	15	2.0
1999 & Newer	1.2	15	2.0

COLORADO EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	HC ppm	CO %
Passenger Cars & Light Duty Trucks		
1970 & Earlier	1000	3.5

Application	HC ppm	CO %
1971	1000	3.0
1972	1000	3.0
1973	1000	3.0
1974	1000	3.0
1975	600	2.0
1976	600	2.0
1977	400	1.5
1978	400	1.5
1979	400	1.5
1980	400	1.5
1981 & Newer	220	1.2
Heavy Duty Trucks (6000 GVWR Or Greater)		
1967 Or Earlier	1500	7.0
1968-69	1200	6.5
1969	1200	6.5
1970	1000	5.5
1971	1000	5.5
1972	1000	5.5
1973	1000	5.5
1974	1000	5.5
1975	1000	5.5
1976	1000	5.5
1977	1000	5.5
1978	1000	5.5
Heavy Duty Trucks (8501 GVWR Or Greater)		
1979	800	4.0
1980	800	3.5
1981	600	3.0
1982	600	3.0
1983	600	3.0
1984	600	3.0
1985	600	3.0
1986 & Newer	300	2.0

CONNECTICUT

CONNECTICUT EMISSION STANDARDS - IDLE TEST

Application	HC ppm (CO)
10,000 GVWR Or Less	
1979	250 (2.1)
1980	225 (2.0)

Application	HC ppm (CO)
1981-82	200 (1.2)
1983	175 (1.0)
1984-87	150 (1.0)
1988 & Newer	125 (1.0)

DELAWARE

DELAWARE EMISSION STANDARDS - KENT, NEW CASTLE & SUSSEX COUNTIES (IDLE TEST)

Application	HC ppm (CO %)
Light Duty Vehicles (6000 GVWR Or Less)	
1968-70	900 (9.0)
1971-74	600 (6.0)
1975-79	400 (4.0)
1980	220 (2.0)
1981 & Newer	220 (1.2)
Light Duty Trucks (6001-8500 GVWR)	
1970-72	900 (9.0)
1973-78	600 (6.0)
1979-83	400 (4.0)
1984 & Newer	220 (1.2)

DISTRICT OF COLUMBIA

DISTRICT OF COLUMBIA EMISSION STANDARDS - IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles & Trucks (26000 GVWR Or Less)	
1968-70	1250 (11.0)
1971-74	1200 (9.0)
1975-79	600 (6.5)
1980	300 (1.5)
1981 & Newer	220 (1.2)

GEORGIA

NOTE: **The Georgia program incorporates original U.S. EPA recommended start-up ASM2525 and ASM5015 standards for 1995 and older model year vehicles. Refer to appropriate model year range in appropriate table. See U. S. EPA ASM2525 & ASM5015 START-UP EMISSION STANDARDS.**

GEORGIA EMISSION STANDARDS - 2-SPEED IDLE TEST

Application (1)	HC ppm (CO %)
1979	500 (5.0)
1980	350 (3.5)

Application (1)	HC ppm (CO %)
1981-83	250 (1.5)
1984 & Newer	220 (1.2)
(1) 8500 GVWR or less.	

IDAHO

IDAHO EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles	
8500 GVWR Or Less	
1965-74	900 (5.0)
1975-79	700 (3.0)
1980	400 (1.5)
1981 & Newer	220 (1.2)
Heavy Duty Trucks	
8501 GVWR Or More	
1965-74	900 (6.0)
1975-80	700 (5.0)
1981 & Newer	500 (3.0)

ILLINOIS

ILLINOIS EMISSION STANDARDS - IM240 TEST

Application	HC gpm	CO gpm
Light Duty Vehicles (6000 GVWR Or Less)		
1981-82	2.00	60.0
1983-87	2.00	30.0
1988-95	0.80	15.0
1996 & Newer	0.60	10.0
Light Duty Trucks (6000 GVWR Or Less)		
1981-83	7.50	100.0
1984-87	3.20	80.0
1988-95	1.60	40.0
1996 & Newer (3750 LVW Or More) (1)	0.80	13.0
1996 & Newer (3750 LVW Or Less) (1)	0.60	10.0
Light Duty Trucks (6001-6500 GVWR)		
1981-83	7.50	100.0
1984-87	3.20	80.0
1988-95	1.60	40.0
1996 & Newer (5750 ALVW Or More)	0.80	15.0
1996 & Newer (5750 ALVW Or Less)	0.80	13.0

Application	HC gpm	CO gpm
(1) Loaded Vehicle Weight (LVW) is vehicle curb weight plus 300 lbs.		

ILLINOIS EMISSION STANDARDS - IDLE TEST

Application	HC ppm (CO %)
Passenger Vehicles (6000 GVWR Or Less)	
1968-71	900 (9.0)
1972-74	800 (8.0)
1975-77	700 (7.0)
1978-79	600 (6.0)
1980	300 (3.0)
1981 & Newer	220 (1.2)
Light Duty Vehicles (8000 GVWR Or Less)	
1968-71	900 (9.0)
1972-74	800 (8.0)
1975-78	700 (7.0)
1979-80	600 (6.0)
1981-83	300 (3.0)
1984 & Newer	220 (1.2)
Heavy Duty Vehicles (8001 GVWR Or More)	
1968-71	1500 (9.5)
1972-78	900 (9.0)
1979-84	700 (7.0)
1985 & Newer	300 (3.0)

INDIANA

INDIANA EMISSION STANDARDS - IM93 TEST

Application	HC gpm (CO gpm)	NOx (gpm)
Passenger Cars		
1981-82	2.0 (60)	3.0
1983-86	2.0 (30)	3.0
1987-90	1.4 (20)	3.0
1991-95	0.8 (15)	2.5
1996 & Newer	0.6 (10)	2.5
Light Duty Trucks (6000 GVWR Or Less)		
1981-83	5.0 (80)	7.0
1984-86	3.2 (70)	7.0
1987-90	2.2 (55)	3.5
1991-95	1.6 (40)	3.0
1996 & Newer	0.8 (20)	3.0
Light Duty Trucks (6001-8500 GVWR)		

Application	HC gpm (CO gpm)	NOx (gpm)
1981-83	5.0 (80)	7.0
1984-86	3.2 (70)	7.0
1987-90	2.2 (55)	5.0
1991-96	1.6 (40)	4.5
1997 & Newer	0.8 (20)	4.5
Heavy Duty Trucks (8501-9000 GVWR)		
1981-82	7.5 (100)	8.0
1983-84	6.0 (100)	8.0
1985-86	5.0 (75)	8.0
1987-90	3.0 (60)	8.0
1991-97	2.4 (40)	8.0
1998 & Newer	2.0 (30)	6.0

INDIANA EMISSION STANDARDS - IDLE TEST

Application	HC ppm (CO %)
Passenger Cars	
1976-79	350 (3.5)
1980	250 (2.0)
1981 & Newer	220 (1.2)
Light Duty Trucks (6000 GVWR Or Less)	
1976-78	500 (5.0)
1979-83	350 (3.5)
1984 & Newer	220 (1.2)
Medium Duty Trucks (6001-8500 GVWR)	
1976-78	500 (5.0)
1979-83	350 (3.5)
1984 & Newer	220 (1.2)

KENTUCKY

NOTE: **Currently, there is no emission testing in Kentucky.**

KENTUCKY EMISSION STANDARDS - BOONE, CAMPBELL & KENTON COUNTIES (IDLE TEST)

Application	HC ppm (CO)
Passenger Cars (Automobiles)	
1968	950 (8.5)
1969	900 (8.5)
1970	850 (8.1)
1972	800 (8.0)
1973	800 (7.8)
1974	800 (7.6)

Application	HC ppm (CO)
1975	700 (7.5)
1976	700 (6.5)
1977	650 (6.3)
1978	600 (5.5)
1979	600 (4.5)
1980	250 (2.5)
1981 & Newer	220 (1.2)
Light Duty Trucks (6000 GVWR Or Less)	
1968	1300 (8.0)
1969	1200 (8.0)
1970-71	1100 (8.0)
1972-73	1000 (7.8)
1974	950 (7.8)
1975	900 (7.0)
1976-77	700 (7.0)
1978	700 (6.3)
1979	450 (5.5)
1980	450 (4.0)
1981	350 (1.7)
1982 & Newer	220 (1.2)
Light Duty Trucks (6001-10,000 GVWR)	
1969	1500 (9.0)
1970	1100 (8.0)
1971	1000 (8.0)
1972-75	950 (7.5)
1976	900 (7.5)
1977	850 (7.5)
1978	700 (6.0)
1979	650 (5.5)
1980	550 (5.0)
1981	450 (4.0)
1982	400 (2.5)
1983	350 (2.0)
1984	220 (1.5)
1985 & Newer	220 (1.2)
Heavy Duty Trucks (10,001-18,000 GVWR)	
1968	1500 (9.0)
1969-70	1300 (8.5)
1971	1200 (8.5)
1972-76	1000 (7.0)
1977-80	900 (6.5)

Application	HC ppm (CO)
1982-83	400 (3.0)
1984 & Newer	250 (1.5)

MARYLAND

MARYLAND EMISSION STANDARDS - IM240 TEST

Application	HC gpm (CO gpm)	NOx gpm
Light Duty Vehicles (6000 GVWR Or Less)		
1984-87	1.80 (30.0)	2.8
1988-90	1.40 (30.0)	2.5
1991-93	1.00 (20.0)	2.2
1994-95	0.90 (20.0)	2.1
Light Duty Trucks (6000 GVWR Or Less)		
1984-87	2.80 (80.0)	5.8
1988-90	2.40 (80.0)	3.0
1991-93	2.00 (60.0)	2.7
1994-95	1.80 (60.0)	2.6
Light Duty Trucks (6001-8500 GVWR)		
1984-87	2.90 (80.0)	6.6
1988-90	2.40 (80.0)	4.2
1991-93	2.00 (60.0)	4.0
1994-95	1.80 (60.0)	3.7
Heavy Duty Trucks (8501-9999 GVWR)		
1984	5.80 (100.0)	7.7
1985-86	4.70 (80.0)	7.7
1987	3.00 (80.0)	7.7
1988-90	2.60 (80.0)	7.0
1991-97	2.50 (60.0)	5.5
1998 & Newer	2.20 (60.0)	4.0

MARYLAND EMISSION STANDARDS - IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (6000 GVWR Or Less)	
1977	500 (6.0)
1978	430 (5.5)
1979	400 (4.0)
1980	220 (1.7)
1981 & Newer	220 (1.2)
Light Duty Trucks (6001-9999 GVWR)	
1977	580 (7.0)
1978	550 (6.7)
1979	470 (5.0)

Application	HC ppm (CO %)
1980	350 (5.0)
1981	250 (3.0)
1982	220 (2.5)
1983	220 (1.5)
1984 & Newer	220 (1.2)
Heavy Duty Trucks (10,000-26,000 GVWR)	
1977-78	650 (7.0)
1979	650 (6.5)
1980-82	500 (6.0)
1983	500 (3.5)
1984-85	440 (3.0)
1986	280 (2.5)
1987 & Newer	220 (1.2)

MASSACHUSETTS

MASSACHUSETTS EMISSION STANDARDS - MA31 TEST

Application	HC gpm (CO gpm)	NOx gpm
Passenger Cars		
1984-90	2.0 (30)	3.0
1991-95	1.2 (20)	2.5
1996 & Newer	0.8 (13)	2.0
Light Duty Trucks (6000 GVWR Or Less)		
1984-87	3.2 (80)	7.0
1988-1990	3.2 (80)	3.5
1991-95	2.4 (60)	3.0
1996 & Newer (3750 LVW (1) Or Less)	0.8 (15)	2.0
1996 & Newer (3751 LVW (1) Or Greater)	1.0 (20)	2.5
Light Duty Trucks (6001-8500 GVWR)		
1984-87	3.2 (80)	7.0
1988-90	3.2 (80)	5.0
1991-95	2.4 (60)	4.5
1996 & Newer (5750 ALVW (2) Or Less)	1.0 (20)	2.5
1996 & Newer (5751 ALVW (2) Or Greater)	2.4 (60)	4.0
Heavy Duty Trucks (8501-10,000 Or Greater)		
1984-87	3.2 (80)	7.0
1988-90	3.2 (80)	5.0
1991-95	2.4 (60)	4.5
1996 & Newer	2.4 (60)	4.0

Application	HC gpm (CO gpm)	NOx gpm
(1) Loaded Vehicle Weight (LVW).		
(2) Adjusted Loaded Vehicle Weight (ALVW).		

MASSACHUSETTS EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	HC ppm (CO %)
All Vehicles	
1984-86	220 (0.80)
1987 & Newer	100 (0.60)

MISSOURI

MISSOURI EMISSION STANDARDS - JEFFERSON, ST. CHARLES & ST. LOUIS COUNTIES - IM240 TEST

Application	HC gpm (CO gpm)	NOx gpm
Light Duty Vehicles (6000 GVWR Or Less)		
1981-82	0.80 (30.0)	2.0
1983-95	0.80 (15.0)	2.0
1996 & Newer	0.60 (10.0)	1.5
Light Duty Trucks (6000 GVWR Or Less)		
1981-83	3.40 (70.0)	4.5
1984-87	1.60 (40.0)	4.5
1988-95	1.60 (40.0)	2.5
1996 & Newer (Less Than 3750 LVW)	0.80 (13.0)	1.8
1996 & Newer (3750 LVW Or Less)	0.60 (10.0)	1.5
Light Duty Trucks (6001-8500 GVWR)		
1981-83	3.4 (70.0)	4.5
1984-87	1.6 (40.0)	4.5
1988-95	1.60 (40.0)	3.5
1996 & Newer (5750 ALVW Or Less)	0.80 (13.0)	1.8
1996 & Newer (5750 ALVW Or More)	0.80 (15.0)	2.0

MISSOURI EMISSION STANDARDS - FRANKLIN, JEFFERSON, ST. CHARLES & ST. LOUIS COUNTIES - IDLE TEST

Application (1)	HC ppm (CO %)
1971-74	700 (7.0)
1975-79	600 (6.0)
1980	300 (3.0)
1981 & Newer	220 (1.2)
(1) 8500 GVWR or less.	

MISSOURI EMISSION STANDARDS - FRANKLIN, JEFFERSON, ST. CHARLES & ST. LOUIS COUNTIES - REMOTE SENSING CLEAN SCREEN TEST

Application (1)	HC ppm (CO %)	NOx ppm
All Vehicles (8500 GVWR Or Less)		
1971 & Newer	200 (0.5)	2000
(1) 8500 GVWR or less.		

NEVADA

NEVADA EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (8500 GVWR Or Less)	
1968-69	800 (4.0)
1970-74	700 (3.5)
1975-78	500 (2.5)
1979-80	500 (2.0)
1981 & Newer	220 (1.2)
Heavy Duty Vehicles (8501 GVWR Or More)	
1968-69	1400 (7.0)
1970-78	1400 (6.0)
1979	1000 (5.0)
1980	1000 (4.0)
1981 & Newer	1000 (3.5)

NEW JERSEY

NOTE: **The New Jersey program incorporates original U.S. EPA recommended start-up ASM5015 standards for 1981 and newer model year vehicles. Refer to appropriate model year range in appropriate table. See U. S. EPA ASM2525 & ASM5015 START-UP EMISSION STANDARDS.**

NEW JERSEY EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	Idle HC ppm (CO %)	2500 RPM HC ppm (CO %)
Light Duty Vehicles (8500 GVWR Or Less)		
1967 & Earlier	1400 (8.5)	.....
1968-70	700 (7.0)	.....
1971-74	500 (5.0)	.....
1975-80	300 (3.0)	.....
1981 & Newer	220 (1.2)	100 (0.5)
Heavy Duty Vehicles (8501 GVWR Or Greater)		
1967 & Earlier	1400 (8.5)	.....
1968-70	1200 (8.5)	.....
1971-74	700 (6.0)	.....
1975-78	500 (4.0)	.....
1979 & Earlier	300 (3.0)	.....

NEW MEXICO

NEW MEXICO EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	Idle HC ppm (CO %)	2500 RPM HC ppm (CO %)
Light Duty Vehicles (6000 GVWR Or Less)		
1975-78	500 (5.0)	500 (5.0)
1979-80	400 (4.0)	400 (4.0)
1981-85	220 (1.2)	220 (1.2)
1986-90	200 (1.2)	200 (1.2)
1991-95	180 (1.2)	180 (1.2)
Light Duty Trucks (6001-8000 GVWR)		
1975-78	600 (6.0)	600 (6.0)
1979-80	600 (4.5)	600 (4.5)
1981-82	400 (2.7)	400 (3.0)
1983-88	300 (1.2)	300 (3.0)
1989-95	220 (1.2)	220 (1.2)
Medium Duty Trucks (8001-10,000 GVWR)		
1975 & Newer	650 (6.5)	650 (6.5)

NEW YORK

NEW YORK EMISSION STANDARDS - IM240 TEST

Application	HC gpm Composite	HC gpm Phase 2	CO gpm Composite	CO gpm Phase 2	NOx gpm Both
Light Duty Vehicles					
1981-82	0.80	0.50	30.0	24.0	2.0
1983-95	0.80	0.50	15.0	12.0	2.0
1996 & Newer	0.60	0.40	10.0	8.0	1.5
Light Duty Trucks (6000 GVWR Or Less)					
1981-83	3.40	2.00	70.0	56.0	4.5
1984-87	1.60	1.00	40.0	32.0	4.5
1988-95	1.60	1.00	40.0	32.0	2.5
1996 & Newer (3750 LVW Or Less)	0.60	0.40	10.0	8.0	1.5
1996 & Newer (3751 LVW Or More)	0.80	0.50	13.0	10.0	1.8
Light Duty Trucks (6501-8500 GVWR)					
1981-83	3.40	2.00	70.0	56.0	4.5
1984-87	1.60	1.00	40.0	32.0	4.5
1988-95	1.60	1.00	40.0	32.0	3.5
1996 & Newer (5750 ALVW Or Less)	0.80	0.50	13.0	10.0	1.8

Application	HC gpm Composite	HC gpm Phase 2	CO gpm Composite	CO gpm Phase 2	NOx gpm Both
1996 & Newer (5751 ALVW Or More)	0.80	0.50	15.0	12.0	2.0

NEW YORK EMISSION STANDARDS - IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (8500 GVWR Or Less)	
1978	300 (3.0)
1979-80	300 (2.5)
1981 & Newer	220 (1.2)
Heavy Duty Vehicles (8501 GVWR Or More)	
1978	600 (4.5)
1979 & Newer	300 (3.0)

NORTH CAROLINA

NORTH CAROLINA EMISSION STANDARDS - IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (8500 GVWR Or Less)	
1977	450 (4.5)
1978-79	350 (3.5)
1980	250 (2.0)
1981 & Newer	250 (1.2)
Heavy Duty Trucks (8501 GVWR Or More)	
1977-78	500 (5.0)
1979 & Newer	400 (4.0)

OHIO

NOTE: **The Ohio program incorporates original U.S. EPA recommended start-up ASM2525 standards for all model year vehicles. Refer to appropriate model year range in appropriate table. See U. S. EPA ASM2525 & ASM5015 START-UP EMISSION STANDARDS.**

OHIO EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	HC ppm (CO %)
1978	350 (4.0)
1979	275 (3.0)
1980	230 (2.0)
1981 & Newer	220 (1.2)

OREGON

OREGON EMISSION STANDARDS - METROPOLITAN PORTLAND ENHANCED AREA - BAR31

Application	HC gpm (CO gpm)	NOx gpm
Light Duty Passenger Cars		
1981-82	2.0 (64)	3.70
1983-89	2.0 (32)	3.70
1990-95	1.2 (30)	3.00
1996 & Newer	OBD-II Test	OBD-II Test
Light Duty Trucks (6000 GVWR Or Less)		
1981-83	8.5 (149)	8.32
1984-87	4.0 (85)	8.32
1988-89	4.0 (85)	4.62
1990-95	2.4 (80)	3.75
1996 & Newer	OBD-II Test	OBD-II Test
Light Duty Trucks (6001-8500 GVWR)		
1981-83	8.5 (149)	8.32
1984-87	4.0 (85)	8.32
1988-89	4.0 (85)	6.47
1990-95	2.4 (80)	5.25
1996 & Newer	OBD-II Test	OBD-II Test

OREGON EMISSION STANDARDS - METROPOLITAN PORTLAND & ROGUE VALLEY AREA BASIC TEST - 2-SPEED IDLE TEST

Application	Idle HC ppm (CO %)	2500 RPM HC ppm (CO %)
Light Duty Passenger Cars (6000 GVWR Or Less)		
1975-80 (No Catalyst)	300 (2.5)	-
1975-80 (Catalyst)	220 (1.0)	-
1981 & Newer (All)	220 (1.0)	220 (1.0)
1975 & Newer (2-Stroke)	n/a (7.0)	-
Light Duty Trucks (6001-8500 GVWR)		
1975-78 (All)	350 (2.5)	-
1979-80 (No Catalyst)	300 (2.5)	-
1979-80 (Catalyst)	220 (1.0)	-
1981 & Newer (All)	220 (1.0)	220 (1.0)
1996 & Newer (3750 LVW Or Less)	0.9 (20)	2.25
Heavy Duty Trucks (8501 GVWR Or More)		
1975-78 (Carbureted)	500 (4.0)	n/a (3.0)
1975-78 (Fuel Injection)	500 (4.0)	-
1979-84 (Carbureted)	350 (3.0)	n/a (3.0)
1979-84 (Fuel Injection)	350 (3.0)	-
1985 & Newer (No Catalyst)	350 (3.0)	n/a (3.0)
1985 & Newer (W/Catalyst)	220 (1.0)	220 (1.0)

OREGON EMISSION STANDARDS - METROPOLITAN PORTLAND & ROGUE VALLEY AREA BASIC TEST - EXHAUST OPACITY TEST

Application	Opacity % @ Idle	Opacity % @ High Idle
1975 & Newer		
2-Cycle Engines	20	.....
Gasoline Engines	0	0

PENNSYLVANIA

NOTE: **The Pennsylvania (in Philadelphia area) program incorporates original U.S. EPA recommended start-up ASM5015 standards for 1981 and newer model year vehicles. Refer to appropriate model year range in appropriate table. See U. S. EPA ASM2525 & ASM5015 START-UP EMISSION STANDARDS.**

PENNSYLVANIA EMISSION STANDARDS - PITTSBURGH & OLDER PHILADELPHIA VEHICLES - IDLE TEST

Application	HC ppm (CO %)
6000 GVWR Or Less	
1975-79	400 (4.0)
1980	300 (3.0)
1981-92	220 (1.2)
1993 & Newer	130 (1.0)
6001-9000 GVWR	
1975-78	650 (6.0)
1979	400 (4.0)
1980	300 (3.0)
1981-92	220 (1.2)
1993 & Newer	180 (1.0)

RHODE ISLAND

RHODE ISLAND EMISSION STANDARDS - RI2000 TEST

Application	HC gpm (CO gpm)	NOx gpm
Light Duty Vehicles		
1974 & Earlier	15.92 (132.44)	14.92
1975-76	6.74 (96.21)	9.92
1977-79	6.74 (96.21)	6.59
1980	2.25 (45.48)	6.59
1981-82	2.25 (45.48)	3.25
1983-95	2.25 (23.74)	3.25
1996 & Newer	1.84 (16.50)	2.42
Light Duty Trucks (6000 GVWR Or Less)		
1975 & Earlier	16.94 (175.92)	14.92
1975-78	8.78 (117.95)	9.92

Application	HC gpm (CO gpm)	NOx gpm
1979-83	7.55 (103.45)	7.42
1984-87	3.88 (59.97)	7.42
1988-90	3.88 (59.97)	4.09
1991-95	3.88 (59.97)	4.09
1996 & Newer (3750 LVW Or Less)	1.84 (16.50)	2.42
1996 & Newer (3751 LVW Or More)	2.25 (20.84)	2.92
Light Duty Trucks (6001-8500 GVWR)		
1974 & Earlier	16.94 (175.92)	14.92
1975-78	8.78 (117.95)	9.92
1979-83	7.55 (103.45)	7.42
1984-87	3.88 (59.97)	7.42
1989-90	3.88 (59.97)	5.75
1991-95	3.88 (59.97)	5.75
1996 & Newer (5750 LVW Or Less)	2.25 (20.84)	2.92
1996 & Newer (5751 LVW or More)	5.51 (23.74)	3.25

RHODE ISLAND EMISSION STANDARDS - 2-SPEED IDLE TEST

Application Idle (1)	HC ppm (CO %)
1967 & Earlier	800 (7.0)
1968-74	700 (6.0)
1975-78	300 (3.0)
1979-80	300 (2.5)
1981 & Newer	220 (1.2)
(1) 8500 GVWR or less.	

TENNESSEE

TENNESSEE EMISSION STANDARDS - MEMPHIS - IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (9000 GVWR Or Less)	
1971 & Older	900 (8.9)
1972-74	700 (8.2)
1975-79	600 (7.5)
1980	400 (4.7)
1981 & Newer	220 (1.2)
Heavy Duty Trucks (9001-25,999 GVWR)	
1971 & Older	1000 (8.9)
1972-74	1000 (8.2)
1975-79	1000 (8.0)
1980	800 (6.0)
1981 & Newer	400 (4.0)

TENNESSEE EMISSION STANDARDS - DAVIDSON & NASHVILLE COUNTIES - IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (6000 GVWR Or Less)	
1975-77	500 (5.0)
1978-79	400 (4.0)
1980	300 (3.0)
1981 & Newer	220 (1.2)
Medium Duty Trucks (6001-8500 GVWR)	
1975-77	750 (6.5)
1978-79	600 (6.0)
1980	400 (4.5)
1981 & Newer	400 (4.0)

TENNESSEE EMISSION STANDARDS - FOUR COUNTY AREA SURROUNDING NASHVILLE - IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (6000 GVWR Or Less)	
1975-77	500 (5.0)
1978-79	400 (4.0)
1980	300 (3.0)
1981 & Newer	220 (1.2)
Medium Duty Trucks (6001-8500 GVWR)	
1975-77	750 (6.5)
1978-79	600 (6.0)
1980	400 (4.5)
1981 & Newer	400 (4.0)

TEXAS

NOTE: **The Texas program incorporates original U.S. EPA recommended start-up ASM2525 and ASM5015 standards for 1995 and newer model year vehicles. Refer to appropriate model year range in appropriate table. See U. S. EPA ASM2525 & ASM5015 START-UP EMISSION STANDARDS.**

TEXAS EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (8500 GVWR Or Less)	
1979	600 (6.0)
1980	400 (4.0)
1981 & Newer	220 (1.2)
Heavy Duty Vehicles (8501 GVWR Or More)	
1979-81	700 (7.0)
1982-84	500 (5.0)

Application	HC ppm (CO %)
1985 & Newer	300 (3.0)

UTAH

UTAH EMISSION STANDARDS - DAVIS COUNTY - DC98 TEST

Application	HC gpm (CO gpm)	NOx gpm
Light Duty Vehicles (6000 GVWR Or Less)		
1989-90	2.00 (30)	3.0
1991-95	1.2 (20)	2.5
Light Duty Trucks (6000 GVWR Or Less)		
1989-90	3.2 (80)	3.5
1991-95	2.4 (60)	3.0
Light Duty Trucks (6001-8500 GVWR)		
1989-90	3.2 (80)	5.0
1991-95	2.4 (60)	4.5

UTAH EMISSION STANDARDS - DAVIS COUNTY - 2-SPEED IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (6000 GVWR Or Less)	
1968-69	800 (6.0)
1970-74	700 (5.0)
1975-76	600 (4.0)
1977-79	500 (3.0)
1980	300 (2.0)
1981-95	220 (1.2)
Light Duty Vehicles (6001-8500 GVWR)	
1968-69	1500 (7.0)
1970-78	1200 (5.0)
1979	500 (3.0)
1980	300 (2.0)
1981-95	220 (1.2)
Heavy Duty Vehicles (8501 GVWR Or More)	
1968-69	1500 (7.0)
1970-78	1200 (5.0)
1979-80	1000 (4.0)
1981 & Newer	800 (3.5)

NOTE: **The Salt Lake County program incorporates California style ASM2525 and ASM5015 standards for 1968 and newer model year vehicles; however, actual cutpoints are unique to this program and current information is not available at this time.**

UTAH EMISSION STANDARDS - SALT LAKE COUNTY - 2-SPEED IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (6000 GVWR Or Less)	
1968-69	800 (6.0)
1970-74	700 (5.0)
1975-76	600 (4.0)
1977-79	500 (3.0)
1980	300 (2.0)
1981 & Newer	220 (1.2)
Light Duty Trucks (6000 GVWR Or Less)	
1968-99	800 (6.0)
1970-74	700 (5.0)
1975-76	600 (4.0)
1977-79	500 (3.0)
1980	300 (2.0)
1981 & Newer	220 (1.2)
Light Duty Trucks (6001-8500 GVWR)	
1968-69	1500 (7.0)
1970-78	1200 (5.0)
1979	500 (3.0)
1980	300 (2.0)
1981 & Newer	220 (1.2)
Heavy Duty Trucks (8500 GVWR Or More)	
1968-69	1500 (7.0)
1970-78	1200 (5.0)
1979-80	1000 (4.0)
1981 & Newer	800 (3.5)

UTAH EMISSION STANDARDS - UTAH & WEBER COUNTIES - 2-SPEED IDLE TEST

Application	HC ppm (CO %)
Light Duty Vehicles (6000 GVWR Or Less)	
1968-69	800 (6.0)
1970-74	700 (5.0)
1975-76	600 (4.0)
1977-79	500 (3.0)
1980	300 (2.0)
1981-95	220 (1.2)
Light Duty Trucks (6000 GVWR Or Less)	
1968-99	800 (6.0)
1970-74	700 (5.0)
1975-76	600 (4.0)
1977-79	500 (3.0)
1980	300 (2.0)

Application	HC ppm (CO %)
1981 & Newer	220 (1.2)
Light Duty Trucks (6001-8500 GVWR)	
1968-69	1500 (7.0)
1970-78	1200 (5.0)
1979	500 (3.0)
1980	300 (2.0)
1981 & Newer	220 (1.2)
Heavy Duty Trucks (8500 GVWR Or More)	
1968-69	1500 (7.0)
1970-78	1200 (5.0)
1979-80	1000 (4.0)
1981 & Newer	800 (3.5)

VIRGINIA

NOTE: **The Virginia program incorporates original U.S. EPA recommended start-up ASM2525 and ASM5015 standards for 1981 and newer model year vehicles. Refer to appropriate model year range in appropriate table. See U. S. EPA ASM2525 & ASM5015 START-UP EMISSION STANDARDS.**

VIRGINIA EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	HC ppm (CO %)
8500 GVWR Or Less	
1975-90	400 (4.0)
1980	220 (2.0)
1981-89	220 (1.2)
1990-95	125 (1.0)
1996 & Newer	100 (0.75)
8501-10,000 GVWR	
1975-79	400 (4.0)
1980	220 (2.0)
1981-90	220 (1.2)
1991-96	150 (1.0)
1997 & Newer	125 (0.75)

WASHINGTON

WASHINGTON EMISSION STANDARDS - ASM2525 TEST

Application	HC ppm (CO %)
1980 & Earlier (Light-Duty Vehicles)	
1750 GVWR	400 (4.2)
1875 GVWR	380 (4.0)

Application	HC ppm (CO %)
2000 GVWR	350 (3.8)
2125 GVWR	340 (3.6)
2250 GVWR	320 (3.4)
2375 GVWR	300 (3.2)
2500 GVWR	290 (3.0)
2625 GVWR	270 (2.9)
2750 GVWR	260 (2.8)
2875 GVWR	250 (2.7)
3000 GVWR	240 (2.6)
3125 GVWR	230 (2.5)
3250 GVWR	220 (2.4)
3375 GVWR	220 (2.3)
3500 GVWR	210 (2.2)
3625 GVWR	200 (2.1)
3750 Or Greater GVWR (Passenger Cars Only)	200 (2.1)
3750 Or Greater GVWR (Light Duty Trucks)	300 (2.5)
1981 & Newer (Light-Duty Vehicles)	
1750 GVWR	250 (1.8)
1875 GVWR	240 (1.7)
2000 GVWR	220 (1.6)
2125 GVWR	210 (1.5)
2250 GVWR	200 (1.5)
2375 GVWR	190 (1.4)
2500 GVWR	180 (1.3)
2625 GVWR	180 (1.3)
2750 GVWR	171 (1.2)
2875 GVWR	160 (1.2)
3000 GVWR	160 (1.1)
3125 GVWR	150 (1.1)
3250 GVWR	150 (1.0)
3375 GVWR	150 (1.0)
3500 GVWR	150 (1.0)
3625 GVWR	150 (1.0)
3750 Or Greater GVWR (Passenger Cars Only)	150 (1.0)
3750 Or Greater GVWR (Light Duty Trucks)	300 (2.5)

WASHINGTON EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	Idle/2500 RPM HC ppm (CO %)
Light Duty Vehicles (8500 GVWR Or Less)	
1980 & Earlier	600 (3.0)
1981 & Newer	220 (1.2)

Application	Idle/2500 RPM HC ppm (CO %)
Heavy Duty Trucks (8500 GVWR Or More)	
1981 & Newer	400 (3.0)

WISCONSIN

WISCONSIN EMISSION STANDARDS - IM240 TEST

Application	HC gpm (CO gpm)	NOx gpm
Light Duty Vehicles (6000 GVWR Or Less)		
1968-72	7.0 (120)	7.0
1973-74	7.0 (120)	6.0
1975-76	3.0 (65)	6.0
1977-79	3.0 (65)	4.0
1980	2.0 (60)	4.0
1981-82	2.0 (60)	3.0
1983-86	2.0 (30)	3.0
1987-93	0.8 (15)	2.0
1991-95	0.8 (15)	2.0
1996 & Newer	0.6 (10)	1.5
Light Duty Trucks (6000 GVWR Or Less)		
1968-72	7.0 (120)	7.0
1973-74	7.0 (120)	6.0
1975-78	4.0 (80)	6.0
1979-83	3.4 (70)	4.5
1984-86	3.2 (70)	4.5
1987	1.6 (40)	4.5
1988-95	1.6 (40)	2.5
1996 & Newer (3750 LVW Or Less)	0.6 (10)	1.5
1996 & Newer (3751 LVW Or More)	0.8 (13)	1.8
Light Duty Trucks (6001-8500 GVWR)		
1968-72	7.0 (120)	7.0
1973-74	7.0 (120)	6.0
1975-78	4.0 (80)	6.0
1979-83	3.4 (70)	4.5
1984-86	3.2 (70)	4.5
1988-96	1.6 (40)	3.5
1997 & Newer (5750 ALVW Or Less)	0.8 (13)	1.8
1997 & Newer (5751 ALVW Or More)	0.8 (15)	2.0
Heavy Duty Trucks (8501-10,000 GVWR)		
1968-69	20.0 (200)	15.0
1970-73	10.0 (175)	10.0
1974-78	10.0 (150)	10.0

Application	HC gpm (CO gpm)	NOx gpm
1979-84	7.5 (100)	8.0
1985-86	5.0 (80)	8.0
1987-90	2.0 (40)	6.0
1991-97	2.0 (40)	5.0
1998 & Newer	2.0 (30)	4.0
Heavy Duty Trucks (10,001 GVWR or More)		
1968-69	24.0 (250)	30.0
1970-73	13.0 (175)	20.0
1974-78	13.0 (150)	20.0
1979-84	11.5 (150)	16.0
1985-86	10.0 (150)	16.0
1987-90	3.5 (70)	11.0
1991-97	3.5 (70)	9.0
1998 & Newer	3.5 (60)	7.0

WISCONSIN EMISSION STANDARDS - 2-SPEED IDLE TEST

Application	HC ppm (CO %)
Passenger Cars	
1968-71	800 (8.0)
1972-74	550 (7.0)
1975-77	450 (5.5)
1978	350 (4.0)
1979	275 (3.0)
1980	230 (2.0)
1981 & Newer	220 (1.2)
Light Duty Trucks (6000 GVWR Or Less)	
1968-71	800 (8.0)
1972-74	700 (7.0)
1975-77	500 (6.0)
1978	450 (5.0)
1979	300 (3.0)
1980	275 (2.5)
1981-84	250 (2.0)
1985 & Newer	220 (1.2)
Light Duty Trucks (6001-8500 GVWR)	
1968-69	1450 (9.0)
1970-71	800 (8.0)
1972-74	700 (7.0)
1975-77	550 (6.5)
1978	450 (5.5)
1979	300 (3.0)

Application	HC ppm (CO %)
1980	275 (2.5)
1981-84	250 (2.0)
1985 & Newer	220 (1.2)
Heavy Duty Trucks (8501 GVWR Or More)	
1968-71	1500 (9.5)
1972-78	900 (9.0)
1979-84	700 (7.0)
1985 & Newer	300 (3.0)

U. S. EPA ASM2525 & ASM5015 START-UP EMISSION STANDARDS

U.S. EPA ASM EMISSION STANDARDS - 1968-72 LIGHT DUTY VEHICLES

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	1118 (8.02)	4990	1098 (9.90)	4990
1875	1052 (7.56)	4990	1034 (9.90)	4990
2000	992 (7.14)	4990	975 (9.90)	4990
2125	938 (6.75)	4990	921 (9.66)	4990
2250	887 (6.40)	4990	872 (9.14)	4990
2375	841 (6.07)	4990	827 (8.67)	4990
2500	800 (5.78)	4990	786 (8.25)	4990
2625	761 (5.51)	4990	748 (7.85)	4990
2750	726 (5.26)	4990	714 (7.50)	4772
2875	695 (5.03)	4892	683 (7.17)	4556
3000	666 (4.83)	4680	654 (6.87)	4359
3125	639 (4.64)	4488	628 (6.60)	4180
3250	615 (4.47)	4311	604 (6.35)	4016
3375	593 (4.31)	4150	583 (6.13)	3866
3500	573 (4.17)	4002	563 (5.92)	3728
3625	554 (4.04)	3867	544 (5.73)	3602
3750	537 (3.91)	3741	527 (5.55)	3485
3875	521 (3.80)	3625	512 (5.39)	3377
4000	506 (3.70)	3517	497 (5.24)	3276
4125	492 (3.60)	3416	484 (5.09)	3182
4250	479 (3.51)	3321	471 (4.96)	3094
4375	467 (3.42)	3230	459 (4.83)	3010
4500	455 (3.34)	3145	447 (4.71)	2930
4625	444 (3.26)	3063	436 (4.60)	2854
4750	433 (3.18)	2983	425 (4.49)	2780
4875	423 (3.11)	2907	415 (4.38)	2709

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
5000	412 (3.03)	2833	405 (4.28)	2540
5125	402 (2.97)	2760	395 (4.18)	2573
5250	393 (2.90)	2690	386 (4.08)	2507
5375	383 (2.83)	2621	376 (3.98)	2443
5500	374 (2.77)	2554	367 (3.89)	2381
5625	365 (2.70)	2489	359 (3.80)	2321
5750	357 (2.64)	2426	350 (3.71)	2262
5875	348 (2.59)	2366	342 (3.62)	2206
6000	341 (2.53)	2308	334 (3.54)	2152
6125	333 (2.48)	2254	327 (3.47)	2102
6250	326 (2.43)	2204	320 (3.40)	2056
6375	320 (2.39)	2159	314 (3.34)	2014
6500	315 (2.35)	2119	309 (3.28)	1977
6625	310 (2.32)	2087	304 (3.23)	1947
6750	307 (2.29)	2062	301 (3.20)	1924
6875	305 (2.28)	2046	299 (3.17)	1909
7000	304 (2.27)	2040	298 (3.17)	1904
7125 Or More	304 (2.27)	2045	298 (3.17)	1904

U.S. EPA ASM EMISSION STANDARDS - 1973-74 LIGHT DUTY VEHICLES

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	1118 (8.02)	4990	1098 (9.90)	4980
1875	1052 (7.56)	4990	1034 (9.90)	4906
2000	992 (7.14)	4919	975 (9.90)	4838
2125	938 (6.75)	4853	921 (9.66)	4776
2250	887 (6.40)	4792	872 (9.14)	4720
2375	841 (6.07)	4736	827 (8.67)	4668
2500	800 (5.78)	4685	786 (8.25)	4620
2625	761 (5.51)	4639	748 (7.85)	4577
2750	726 (5.26)	4596	714 (7.50)	4374
2875	695 (5.03)	4484	683 (7.17)	4176
3000	666 (4.83)	4290	654 (6.87)	3996
3125	639 (4.64)	4114	628 (6.60)	3832
3250	615 (4.47)	3952	604 (6.35)	3681
3375	593 (4.31)	3804	583 (6.13)	3544
3500	573 (4.17)	3669	563 (5.92)	3418
3625	554 (4.04)	3544	544 (5.73)	3302

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
3750	537 (3.91)	3429	527 (5.55)	3195
3875	521 (3.80)	3323	512 (5.39)	3096
4000	506 (3.70)	3224	497 (5.24)	3003
4125	492 (3.60)	3131	484 (5.09)	2917
4250	479 (3.51)	3044	471 (4.96)	2836
4375	467 (3.42)	2961	459 (4.83)	2759
4500	455 (3.34)	2883	447 (4.71)	2686
4625	444 (3.26)	2807	436 (4.60)	2616
4750	433 (3.18)	2735	425 (4.49)	2549
4875	423 (3.11)	2665	415 (4.38)	2483
5000	412 (3.03)	2597	405 (4.28)	2420
5125	402 (2.97)	2530	395 (4.18)	2359
5250	393 (2.90)	2466	386 (4.08)	2298
5375	383 (2.83)	2403	376 (3.98)	2240
5500	374 (2.77)	2341	367 (3.89)	2183
5625	365 (2.70)	2282	359 (3.80)	2127
5750	357 (2.64)	2224	350 (3.71)	2074
5875	348 (2.59)	2168	342 (3.62)	2022
6000	341 (2.53)	2116	334 (3.54)	1973
6125	333 (2.48)	2066	327 (3.47)	1927
6250	326 (2.43)	2020	320 (3.40)	1884
6375	320 (2.39)	1979	314 (3.34)	1846
6500	315 (2.35)	1943	309 (3.28)	1813
6625	310 (2.32)	1913	304 (3.23)	1785
6750	307 (2.29)	1890	301 (3.20)	1764
6875	305 (2.28)	1875	299 (3.17)	1750
7000	304 (2.27)	1870	298 (3.17)	1745
7125 Or More	304 (2.27)	1874	298 (3.17)	1745

U.S. EPA ASM EMISSION STANDARDS - 1975-76 LIGHT DUTY VEHICLES

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	774 (3.92)	4990	761 (5.45)	4980
1875	729 (3.70)	4990	717 (5.14)	4906
2000	688 (3.49)	4919	676 (4.85)	4838
2125	650 (3.31)	4853	638 (4.58)	4776
2250	615 (3.13)	4792	604 (4.34)	4720
2375	583 (2.98)	4736	573 (4.12)	4668

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
2500	554 (2.83)	4685	544 (3.91)	4620
2625	528 (2.70)	4639	518 (3.73)	4577
2750	503 (2.58)	4596	495 (3.56)	4374
2875	481 (2.47)	4484	473 (3.41)	4176
3000	461 (2.37)	4290	453 (3.27)	3996
3125	443 (2.28)	4114	435 (3.14)	3832
3250	426 (2.20)	3952	419 (3.02)	3681
3375	411 (2.12)	3804	404 (2.91)	3544
3500	397 (2.05)	3669	390 (2.82)	3418
3625	384 (1.99)	3544	377 (2.73)	3302
3750	372 (1.93)	3429	365 (2.64)	3195
3875	361 (1.87)	3323	355 (2.57)	3096
4000	351 (1.82)	3224	345 (2.49)	3003
4125	341 (1.77)	3131	335 (2.43)	2917
4250	332 (1.73)	3044	326 (2.36)	2836
4375	323 (1.68)	2961	318 (2.31)	2759
4500	315 (1.64)	2883	310 (2.25)	2686
4625	308 (1.61)	2807	302 (2.19)	2616
4750	300 (1.57)	2735	295 (2.14)	2549
4875	293 (1.53)	2665	288 (2.09)	2483
5000	286 (1.50)	2597	281 (2.04)	2420
5125	279 (1.46)	2530	274 (2.00)	2359
5250	272 (1.43)	2466	267 (1.95)	2298
5375	266 (1.40)	2403	261 (1.90)	2240
5500	259 (1.37)	2341	255 (1.86)	2183
5625	253 (1.34)	2282	248 (1.82)	2127
5750	247 (1.31)	2224	243 (1.78)	2074
5875	241 (1.28)	2168	237 (1.74)	2022
6000	236 (1.25)	2116	232 (1.70)	1973
6125	231 (1.23)	2066	227 (1.66)	1927
6250	226 (1.20)	2020	222 (1.63)	1884
6375	222 (1.18)	1979	218 (1.60)	1846
6500	218 (1.16)	1943	214 (1.57)	1813
6625	215 (1.15)	1913	211 (1.55)	1785
6750	213 (1.14)	1890	209 (1.54)	1764
6875	211 (1.13)	1875	207 (1.52)	1750
7000	211 (1.12)	1870	207 (1.52)	1745
7125 Or More	211 (1.12)	1874	206 (1.52)	1745

U.S. EPA ASM EMISSION STANDARDS - 1977-79 LIGHT DUTY VEHICLES

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	774 (3.92)	4990	761 (5.45)	4950
1875	729 (3.70)	4990	717 (5.14)	4655
2000	688 (3.49)	4707	676 (4.85)	4384
2125	650 (3.31)	4441	638 (4.58)	4136
2250	615 (3.13)	4197	604 (4.34)	3909
2375	583 (2.98)	3974	573 (4.12)	3701
2500	554 (2.83)	3771	544 (3.91)	3512
2625	528 (2.70)	3585	518 (3.73)	3339
2750	503 (2.58)	3416	495 (3.56)	3181
2875	481 (2.47)	3261	473 (3.41)	3037
3000	461 (2.37)	3120	453 (3.27)	2906
3125	443 (2.28)	2992	435 (3.14)	2787
3250	426 (2.20)	2874	419 (3.02)	2677
3375	411 (2.12)	2767	404 (2.91)	2577
3500	397 (2.05)	2668	390 (2.82)	2486
3625	384 (1.99)	2578	377 (2.73)	2401
3750	372 (1.93)	2494	365 (2.64)	2323
3875	361 (1.87)	2417	355 (2.57)	2251
4000	351 (1.82)	2345	345 (2.49)	2184
4125	341 (1.77)	2277	335 (2.43)	2122
4250	332 (1.73)	2214	326 (2.36)	2063
4375	323 (1.68)	2154	318 (2.31)	2007
4500	315 (1.64)	2096	310 (2.25)	1953
4625	308 (1.61)	2042	302 (2.19)	1903
4750	300 (1.57)	1989	295 (2.14)	1854
4875	293 (1.53)	1938	288 (2.09)	1806
5000	286 (1.50)	1889	281 (2.04)	1760
5125	279 (1.46)	1840	274 (2.00)	1715
5250	272 (1.43)	1793	267 (1.95)	1672
5375	266 (1.40)	1747	261 (1.90)	1629
5500	259 (1.37)	1703	255 (1.86)	1587
5625	253 (1.34)	1659	248 (1.82)	1547
5750	247 (1.31)	1617	243 (1.78)	1508
5875	241 (1.28)	1577	237 (1.74)	1471
6000	236 (1.25)	1539	232 (1.70)	1435
6125	231 (1.23)	1503	227 (1.66)	1401
6250	226 (1.20)	1469	222 (1.63)	1371
6375	222 (1.18)	1439	218 (1.60)	1343

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
6500	218 (1.16)	1413	214 (1.57)	1318
6625	215 (1.15)	1391	211 (1.55)	1298
6750	213 (1.14)	1374	209 (1.54)	1283
6875	211 (1.13)	1364	207 (1.52)	1273
7000 Or More	211 (1.12)	1360	207 (1.52)	1269

U.S. EPA ASM EMISSION STANDARDS - 1980 LIGHT DUTY VEHICLES

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	291 (2.78)	4990	282 (3.64)	4950
1875	275 (2.63)	4990	266 (3.43)	4655
2000	260 (2.48)	4707	252 (3.24)	4384
2125	246 (2.35)	4441	239 (3.06)	4136
2250	234 (2.23)	4197	227 (2.90)	3909
2375	223 (2.12)	3974	216 (2.76)	3701
2500	212 (2.02)	3771	206 (2.62)	3512
2625	203 (1.92)	3585	197 (2.50)	3339
2750	194 (1.84)	3416	189 (2.39)	3181
2875	187 (1.76)	3261	181 (2.29)	3037
3000	180 (1.69)	3120	174 (2.19)	2906
3125	173 (1.63)	2992	168 (2.11)	2787
3250	167 (1.57)	2874	162 (2.03)	2677
3375	162 (1.52)	2767	157 (1.96)	2577
3500	157 (1.47)	2668	152 (1.89)	2486
3625	152 (1.42)	2578	148 (1.84)	2401
3750	148 (1.38)	2492	144 (1.78)	2323
3875	144 (1.34)	2417	140 (1.73)	2251
4000	140 (1.31)	2345	137 (1.68)	2184
4125	137 (1.27)	2277	133 (1.64)	2122
4250	134 (1.24)	2214	130 (1.60)	2063
4375	131 (1.21)	2154	127 (1.56)	2007
4500	128 (1.18)	2096	124 (1.52)	1953
4625	125 (1.15)	2042	122 (1.48)	1903
4750	122 (1.13)	1989	119 (1.45)	1854
4875	120 (1.10)	1938	117 (1.42)	1806
5000	117 (1.08)	1889	114 (1.38)	1760
5125	115 (1.05)	1840	112 (1.35)	1715
5250	112 (1.03)	1793	110 (1.32)	1672

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
5375	110 (1.01)	1747	107 (1.29)	1629
5500	108 (0.99)	1703	105 (1.26)	1587
5625	106 (0.97)	1659	103 (1.24)	1547
5750	104 (0.94)	1617	101 (1.21)	1508
5875	102 (0.92)	1577	99 (1.18)	1471
6000	100 (0.91)	1539	97 (1.16)	1435
6125	98 (0.89)	1503	95 (1.13)	1401
6250	96 (0.87)	1469	94 (1.11)	1371
6375	95 (0.86)	1439	92 (1.09)	1343
6500	93 (0.84)	1413	91 (1.08)	1318
6625	92 (0.83)	1391	90 (1.06)	1298
6750	91 (0.82)	1374	89 (1.05)	1283
6875	91 (0.82)	1364	89 (1.04)	1273
7000	91 (0.82)	1360	88 (1.04)	1269
7125 Or More	90 (0.81)	1360	88 (1.04)	1269

U.S. EPA ASM EMISSION STANDARDS - 1981-82 LIGHT DUTY VEHICLES

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	291 (2.78)	2272	282 (3.64)	2114
1875	275 (2.63)	2181	266 (3.43)	1991
2000	260 (2.48)	2058	252 (3.24)	1877
2125	246 (2.35)	1944	239 (3.06)	1774
2250	234 (2.23)	1839	227 (2.90)	1678
2375	223 (2.12)	1744	216 (2.76)	1592
2500	212 (2.02)	1657	206 (2.62)	1512
2625	203 (1.92)	1577	197 (2.50)	1440
2750	194 (1.84)	1504	189 (2.39)	1374
2875	187 (1.76)	1438	181 (2.29)	1313
3000	180 (1.69)	1378	174 (2.19)	1258
3125	173 (1.63)	1323	168 (2.11)	1208
3250	167 (1.57)	1273	162 (2.03)	1163
3375	162 (1.52)	1227	157 (1.96)	1121
3500	157 (1.47)	1184	152 (1.89)	1082
3625	152 (1.42)	1146	148 (1.84)	1047
3750	148 (1.38)	1110	144 (1.78)	1014
3875	144 (1.34)	1077	140 (1.73)	984
4000	140 (1.31)	1046	137 (1.68)	956

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
4125	137 (1.27)	1017	133 (1.64)	930
4250	134 (1.24)	990	130 (1.60)	905
4375	131 (1.21)	964	127 (1.56)	882
4500	128 (1.18)	939	124 (1.52)	859
4625	125 (1.15)	916	122 (1.48)	838
4750	122 (1.13)	893	119 (1.45)	818
4875	120 (1.10)	872	117 (1.42)	798
5000	117 (1.08)	850	114 (1.38)	778
5125	115 (1.05)	830	112 (1.35)	760
5250	112 (1.03)	810	110 (1.32)	741
5375	110 (1.01)	790	107 (1.29)	723
5500	108 (0.99)	771	105 (1.26)	706
5625	106 (0.97)	752	103 (1.24)	689
5750	104 (0.94)	734	101 (1.21)	673
5875	102 (0.92)	717	99 (1.18)	657
6000	100 (0.91)	701	97 (1.16)	642
6125	98 (0.89)	685	95 (1.13)	628
6250	96 (0.87)	671	94 (1.11)	615
6375	95 (0.86)	658	92 (1.09)	604
6500	93 (0.84)	647	91 (1.08)	593
6625	92 (0.83)	638	90 (1.06)	585
6750	91 (0.82)	631	89 (1.05)	578
6875	91 (0.82)	626	89 (1.04)	574
7000	91 (0.82)	624	88 (1.04)	573
7125 Or More	90 (0.81)	625	88 (1.04)	573

U.S. EPA ASM EMISSION STANDARDS - 1983-90 LIGHT DUTY VEHICLES

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	291 (1.64)	2272	282 (1.83)	2114
1875	275 (1.55)	2181	266 (1.72)	1991
2000	260 (1.47)	2058	252 (1.63)	1877
2125	246 (1.39)	1944	239 (1.54)	1774
2250	234 (1.31)	1839	227 (1.47)	1678
2375	223 (1.26)	1744	216 (1.39)	1592
2500	212 (1.20)	1657	206 (1.33)	1512
2625	203 (1.15)	1577	197 (1.27)	1440
2750	194 (1.10)	1504	189 (1.21)	1374

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
2875	187 (1.05)	1438	181 (1.16)	1313
3000	180 (1.01)	1378	174 (1.12)	1258
3125	173 (0.98)	1323	168 (1.08)	1208
3250	167 (0.94)	1273	162 (1.04)	1163
3375	162 (0.91)	1227	157 (1.00)	1121
3500	157 (0.88)	1184	152 (0.97)	1082
3625	152 (0.86)	1146	148 (0.94)	1047
3750	148 (0.83)	1110	144 (0.92)	1014
3875	144 (0.81)	1077	140 (0.89)	984
4000	140 (0.79)	1046	137 (0.87)	956
4125	137 (0.77)	1017	133 (0.85)	930
4250	134 (0.75)	990	130 (.83)	905
4375	131 (0.74)	964	127 (0.81)	882
4500	128 (0.72)	939	124 (0.79)	859
4625	125 (0.70)	916	122 (0.77)	838
4750	122 (0.69)	893	119 (0.76)	818
4875	120 (0.67)	872	117 (0.74)	798
5000	117 (0.66)	850	114 (0.73)	778
5125	115 (0.65)	830	112 (0.71)	760
5250	112 (0.63)	810	110 (0.70)	741
5375	110 (0.62)	790	107 (0.68)	723
5500	108 (0.61)	771	105 (0.67)	706
5625	106 (0.59)	752	103 (0.65)	689
5750	104 (0.58)	734	101 (0.64)	673
5875	102 (0.57)	717	99 (0.63)	657
6000	100 (0.56)	701	97 (0.62)	642
6125	98 (0.55)	685	95 (0.61)	628
6250	96 (0.54)	671	94 (0.60)	615
6375	95 (0.53)	658	92 (0.59)	604
6500	93 (0.52)	647	91 (0.58)	593
6625	92 (0.52)	638	90 (0.57)	585
6750	91 (0.51)	631	89 (0.57)	578
6875	91 (0.51)	626	89 (0.56)	574
7000	91 (0.51)	624	88 (0.56)	573
7125	90 (0.51)	625	88 (0.56)	573
7250 Or More	90 (0.50)	625	88 (0.56)	573

U.S. EPA ASM EMISSION STANDARDS - 1991-95 LIGHT DUTY VEHICLES

Test Weight	ASM5015	ASM2525

	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	224 (1.26)	1819	216 (1.22)	1642
1875	212 (1.19)	1713	205 (1.16)	1547
2000	201 (1.13)	1616	194 (1.09)	1460
2125	191 (1.07)	1527	184 (1.04)	1380
2250	182 (1.02)	1446	175 (0.99)	1307
2375	173 (0.97)	1372	167 (0.94)	1240
2500	166 (0.93)	1304	160 (0.90)	1179
2625	159 (0.89)	1242	153 (0.86)	1123
2750	152 (0.85)	1186	147 (0.82)	1072
2875	146 (0.82)	1134	141 (0.79)	1026
3000	141 (0.79)	1088	136 (0.76)	984
3125	136 (0.76)	1045	132 (0.73)	945
3250	132 (0.73)	1006	127 (0.71)	910
3375	128 (0.71)	970	123 (0.69)	878
3500	124 (0.69)	937	120 (0.67)	848
3625	120 (0.67)	907	117 (0.65)	821
3750	117 (0.65)	879	114 (0.63)	796
3875	114 (0.63)	853	111 (0.61)	773
4000	112 (0.62)	829	108 (0.60)	751
4125	109 (0.60)	807	106 (0.58)	731
4250	107 (0.59)	786	103 (0.57)	712
4375	104 (0.58)	766	101 (0.56)	694
4500	102 (0.57)	747	99 (0.55)	677
4625	100 (0.55)	728	97 (0.54)	661
4750	98 (0.54)	711	95 (0.53)	645
4875	96 (0.53)	694	93 (0.52)	630
5000	94 (0.52)	677	92 (0.51)	615
5125	93 (0.51)	661	90 (0.50)	600
5250	91 (0.50)	646	88 (0.49)	586
5375	89 (0.49)	631	86 (0.48)	573
5500	87 (0.48)	616	85 (0.47)	559
5625	86 (0.47)	601	83 (0.46)	546
5750	84 (0.46)	587	82 (0.45)	534
5875	83 (0.45)	574	80 (0.44)	522
6000	81 (0.44)	561	79 (0.44)	510
6125	80 (0.44)	549	78 (0.43)	499
6250	79 (0.43)	538	76 (0.42)	489
6375	77 (0.42)	528	75 (0.42)	480
6500	76 (0.42)	519	74 (0.41)	473
6625	76 (0.41)	512	74 (0.41)	466

6750	75 (0.41)	507	73 (0.41)	461
6875	75 (0.40)	503	73 (0.40)	458
7000 Or More	74 (0.40)	502	72 (0.40)	457

U.S. EPA ASM EMISSION STANDARDS - 1994 & NEWER + TIER 1 LIGHT DUTY VEHICLES

Test Weight	**ASM5015**		**ASM2525**	
	HC ppm (CO %)	**NOx ppm**	**HC ppm (CO %)**	**NOx ppm**
1750	142 (0.80)	1212	136 (0.77)	1095
1875	134 (0.75)	1142	129 (0.73)	1031
2000	127 (0.71)	1077	123 (0.69)	973
2125	121 (0.68)	1018	116 (0.66)	920
2250	115 (0.64)	964	111 (0.62)	871
2375	109 (0.61)	915	106 (0.59)	827
2500	105 (0.59)	869	101 (0.57)	786
2625	100 (0.56)	828	97 (0.54)	749
2750	96 (0.54)	791	93 (0.52)	715
2875	92 (0.52)	756	89 (0.50)	684
3000	89 (0.50)	725	86 (0.48)	656
3125	86 (0.48)	696	83 (0.46)	630
3250	83 (0.46)	670	80 (0.45)	607
3375	81 (0.45)	647	78 (0.43)	585
3500	78 (0.44)	625	76 (0.42)	566
3625	76 (0.42)	605	74 (0.41)	547
3750	74 (0.41)	586	72 (0.40)	531
3875	72 (0.40)	569	70 (0.39)	515
4000	71 (0.39)	553	68 (0.38)	501
4125	69 (0.38)	538	67 (0.37)	487
4250	67 (0.37)	524	65 (0.36)	475
4375	66 (0.36)	510	64 (0.35)	463
4500	65 (0.36)	498	63 (0.35)	440
4625	63 (0.35)	486	61 (0.34)	440
4750	62 (0.34)	474	60 (0.33)	430
4875	61 (0.34)	463	59 (0.33)	420
5000	60 (0.33)	452	58 (0.32)	410
5125	58 (0.32)	441	57 (0.31)	400
5250	57 (0.32)	431	56 (0.31)	391
5375	56 (0.31)	420	55 (0.30)	382
5500	55 (0.30)	410	54 (0.30)	373
5625	54 (0.30)	401	53 (0.29)	364
5750	53 (0.29)	391	52 (0.29)	356
5875	52 (0.29)	383	51 (0.28)	348

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
6000	51 (0.28)	374	50 (0.28)	340
6125	50 (0.28)	366	49 (0.27)	333
6250	50 (0.27)	359	48 (0.27)	326
6375	49 (0.27)	352	48 (0.26)	320
6500	48 (0.26)	346	47 (0.26)	315
6625	48 (0.26)	341	46 (0.26)	311
6750	47 (0.26)	338	46 (0.26)	307
6875	47 (0.26)	335	46 (0.25)	305
7000 Or More	47 (0.25)	335	46 (0.25)	305

U.S. EPA ASM EMISSION STANDARDS - 1968-72 LIGHT DUTY TRUCKS (6000 GVWR OR LESS)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	1118 (8.02)	4990	1098 (9.90)	4990
1875	1052 (7.56)	4990	1034 (9.90)	4990
2000	992 (7.14)	4990	975 (9.90)	4990
2125	938 (6.75)	4990	921 (9.66)	4990
2250	887 (6.40)	4990	872 (9.14)	4990
2375	841 (6.07)	4990	827 (8.67)	4990
2500	800 (5.78)	4990	786 (8.25)	4990
2625	761 (5.51)	4990	748 (7.85)	4990
2750	726 (5.26)	4990	714 (7.50)	4772
2875	695 (5.03)	4892	683 (7.17)	4556
3000	666 (4.83)	4680	654 (6.87)	4359
3125	639 (4.64)	4488	628 (6.60)	4180
3250	615 (4.47)	4311	604 (6.35)	4016
3375	593 (4.31)	4150	583 (6.13)	3866
3500	573 (4.17)	4002	563 (5.92)	3728
3625	554 (4.04)	3867	544 (5.73)	3602
3750	537 (3.91)	3741	527 (5.55)	3485
3875	521 (3.80)	3625	512 (5.39)	3377
4000	506 (3.70)	3517	497 (5.24)	3276
4125	492 (3.60)	3416	484 (5.09)	3182
4250	479 (3.51)	3321	471 (4.96)	3094
4375	467 (3.42)	3230	459 (4.83)	3010
4500	455 (3.34)	3145	447 (4.71)	2930
4625	444 (3.26)	3063	436 (4.60)	2854
4750	433 (3.18)	2983	425 (4.49)	2780

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
4875	423 (3.11)	2907	415 (4.38)	2709
5000	412 (3.03)	2833	405 (4.28)	2540
5125	402 (2.97)	2760	395 (4.18)	2573
5250	393 (2.90)	2690	386 (4.08)	2507
5375	383 (2.83)	2621	376 (3.98)	2443
5500	374 (2.77)	2554	367 (3.89)	2381
5625	365 (2.70)	2489	359 (3.80)	2321
5750	357 (2.64)	2426	350 (3.71)	2262
5875	348 (2.59)	2366	342 (3.62)	2206
6000	341 (2.53)	2308	334 (3.54)	2152
6125	333 (2.48)	2254	327 (3.47)	2102
6250	326 (2.43)	2204	320 (3.40)	2056
6375	320 (2.39)	2159	314 (3.34)	2014
6500	315 (2.35)	2119	309 (3.28)	1977
6625	310 (2.32)	2087	304 (3.23)	1947
6750	307 (2.29)	2062	301 (3.20)	1924
6875	305 (2.28)	2046	299 (3.17)	1909
7000	304 (2.27)	2040	298 (3.17)	1904
7125 Or More	304 (2.27)	2045	298 (3.17)	1904

U.S. EPA ASM EMISSION STANDARDS - 1973-74 LIGHT DUTY TRUCKS (6000 GVWR OR LESS)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	1118 (8.02)	4990	1098 (9.90)	4980
1875	1052 (7.56)	4990	1034 (9.90)	4906
2000	992 (7.14)	4919	975 (9.90)	4838
2125	938 (6.75)	4853	921 (9.66)	4776
2250	887 (6.40)	4792	872 (9.14)	4720
2375	841 (6.07)	4736	827 (8.67)	4668
2500	800 (5.78)	4685	786 (8.25)	4620
2625	761 (5.51)	4639	748 (7.85)	4577
2750	726 (5.26)	4596	714 (7.50)	4374
2875	695 (5.03)	4484	683 (7.17)	4176
3000	666 (4.83)	4290	654 (6.87)	3996
3125	639 (4.64)	4114	628 (6.60)	3832
3250	615 (4.47)	3952	604 (6.35)	3681
3375	593 (4.31)	3804	583 (6.13)	3544
3500	573 (4.17)	3669	563 (5.92)	3418

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
3625	554 (4.04)	3544	544 (5.73)	3302
3750	537 (3.91)	3429	527 (5.55)	3195
3875	521 (3.80)	3323	512 (5.39)	3096
4000	506 (3.70)	3224	497 (5.24)	3003
4125	492 (3.60)	3131	484 (5.09)	2917
4250	479 (3.51)	3044	471 (4.96)	2836
4375	467 (3.42)	2961	459 (4.83)	2759
4500	455 (3.34)	2883	447 (4.71)	2686
4625	444 (3.26)	2807	436 (4.60)	2616
4750	433 (3.18)	2735	425 (4.49)	2549
4875	423 (3.11)	2665	415 (4.38)	2483
5000	412 (3.03)	2597	405 (4.28)	2420
5125	402 (2.97)	2530	395 (4.18)	2359
5250	393 (2.90)	2466	386 (4.08)	2298
5375	383 (2.83)	2403	376 (3.98)	2240
5500	374 (2.77)	2341	367 (3.89)	2183
5625	365 (2.70)	2282	359 (3.80)	2127
5750	357 (2.64)	2224	350 (3.71)	2074
5875	348 (2.59)	2168	342 (3.62)	2022
6000	341 (2.53)	2116	334 (3.54)	1973
6125	333 (2.48)	2066	327 (3.47)	1927
6250	326 (2.43)	2020	320 (3.40)	1884
6375	320 (2.39)	1979	314 (3.34)	1846
6500	315 (2.35)	1943	309 (3.28)	1813
6625	310 (2.32)	1913	304 (3.23)	1785
6750	307 (2.29)	1890	301 (3.20)	1764
6875	305 (2.28)	1875	299 (3.17)	1750
7000	304 (2.27)	1870	298 (3.17)	1745
7125 Or More	304 (2.27)	1874	298 (3.17)	1745

U.S. EPA ASM EMISSION STANDARDS - 1975-78 LIGHT DUTY TRUCKS (6000 GVWR OR LESS)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	843 (5.07)	4990	828 (7.26)	4980
1875	794 (4.78)	4990	780 (6.84)	4906
2000	749 (4.51)	4919	736 (6.45)	4838
2125	707 (4.26)	4853	695 (6.10)	4776
2250	669 (4.04)	4792	658 (5.78)	4720

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
2375	635 (3.83)	4736	624 (5.48)	4668
2500	603 (3.65)	4685	593 (5.21)	4620
2625	574 (3.48)	4639	564 (4.96)	4577
2750	548 (3.32)	4596	539 (4.73)	4374
2875	524 (3.18)	4484	515 (4.53)	4176
3000	502 (3.05)	4290	493 (4.34)	3996
3125	482 (2.93)	4114	474 (4.17)	3832
3250	464 (2.82)	3952	456 (4.01)	3681
3375	447 (2.72)	3804	440 (3.87)	3544
3500	432 (2.63)	3669	424 (3.74)	3418
3625	418 (2.55)	3544	411 (3.62)	3302
3750	405 (2.47)	3429	398 (3.51)	3195
3875	393 (2.40)	3323	386 (3.40)	3096
4000	382 (2.33)	3224	375 (3.31)	3003
4125	371 (2.27)	3131	365 (3.22)	2917
4250	361 (2.21)	3044	355 (3.13)	2836
4375	352 (2.16)	2961	346 (3.05)	2759
4500	343 (2.11)	2883	337 (2.98)	2686
4625	335 (2.06)	2807	329 (2.90)	2616
4750	327 (2.01)	2735	321 (2.83)	2549
4875	319 (1.96)	2665	313 (2.77)	2483
5000	311 (1.92)	2597	305 (2.70)	2420
5125	304 (1.87)	2530	298 (2.64)	2359
5250	296 (1.83)	2466	291 (2.58)	2298
5375	289 (1.79)	2403	284 (2.51)	2240
5500	282 (1.75)	2341	277 (2.46)	2183
5625	276 (1.71)	2282	271 (2.40)	2127
5750	269 (1.67)	2224	264 (2.34)	2074
5875	263 (1.63)	2168	258 (2.29)	2022
6000	257 (1.60)	2116	252 (2.24)	1973
6125	251 (1.57)	2066	247 (2.19)	1927
6250	246 (1.54)	2020	242 (2.15)	1884
6375	242 (1.51)	1979	237 (2.11)	1846
6500	238 (1.48)	1943	233 (2.07)	1813
6625	234 (1.46)	1913	230 (2.04)	1785
6750	232 (1.45)	1890	227 (2.02)	1764
6875	230 (1.44)	1875	225 (2.00)	1750
7000	229 (1.43)	1870	225 (2.00)	1745
7125 Or More	229 (1.43)	1874	225 (2.00)	1745

U.S. EPA ASM EMISSION STANDARDS - 1979-83 LIGHT DUTY TRUCKS (6000 GVWR OR LESS)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	774 (4.31)	4990	761 (6.06)	4960
1875	729 (4.06)	4990	717 (5.70)	4738
2000	688 (3.83)	4778	676 (5.38)	4535
2125	650 (3.63)	4578	638 (5.09)	4349
2250	615 (3.44)	4395	604 (4.82)	4179
2375	583 (3.26)	4228	573 (4.57)	4024
2500	554 (3.10)	4076	544 (4.35)	3881
2625	528 (2.96)	3936	518 (4.14)	3752
2750	503 (2.83)	3809	495 (3.95)	3579
2875	481 (2.71)	3669	473 (3.78)	3417
3000	461 (2.60)	3510	453 (3.62)	3270
3125	443 (2.50)	3366	435 (3.48)	3135
3250	426 (2.40)	3234	419 (3.35)	3012
3375	411 (2.32)	3113	404 (3.23)	2899
3500	397 (2.24)	3002	390 (3.12)	2796
3625	384 (2.17)	2900	377 (3.02)	2701
3750	372 (2.11)	2806	365 (2.93)	2614
3875	361 (2.05)	2719	355 (2.58)	2533
4000	351 (1.99)	2638	345 (2.77)	2457
4125	341 (1.94)	2562	335 (2.69)	2387
4250	332 (1.89)	2490	326 (2.62)	2320
4375	323 (1.84)	2423	318 (2.55)	2258
4500	315 (1.80)	2359	310 (2.49)	2198
4625	308 (1.76)	2297	302 (2.43)	2140
4750	300 (1.72)	2238	295 (2.37)	2085
4875	293 (1.68)	2180	288 (2.32)	2032
5000	286 (1.64)	2125	281 (2.26)	1980
5125	279 (1.60)	2070	274 (2.21)	1930
5250	272 (1.56)	2017	267 (2.16)	1881
5375	26 (1.53)	1966	261 (2.11)	1833
5500	259 (1.49)	1916	255 (2.06)	1786
5625	253 (1.46)	1867	248 (2.01)	1740
5750	247 (1.43)	1820	243 (1.96)	1697
5875	241 (1.40)	1774	237 (1.92)	1654
6000	236 (1.37)	1731	232 (1.88)	1614
6125	231 (1.34)	1690	227 (1.84)	1577
6250	226 (1.31)	1653	222 (1.80)	1542
6375	222 (1.29)	1619	218 (1.77)	1510

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
6500	218 (1.27)	1590	214 (1.74)	1483
6625	215 (1.25)	1565	211 (1.72)	1460
6750	213 (1.24)	1546	209 (1.70)	1443
6875	211 (1.23)	1534	207 (1.68)	1432
7000	211 (1.23)	1530	207 (1.68)	1428
7125 Or More	211 (1.22)	1531	206 (1.68)	1428

U.S. EPA ASM EMISSION STANDARDS - 1984-87 LIGHT DUTY TRUCKS (6000 GVWR OR LESS)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	390 (3.54)	4990	381 (4.85)	4960
1875	368 (3.34)	4990	359 (4.57)	4738
2000	348 (3.16)	4778	339 (4.31)	4535
2125	329 (2.99)	4578	321 (4.08)	4349
2250	312 (2.83)	4395	305 (3.86)	4179
2375	297 (2.69)	4228	290 (3.66)	4024
2500	283 (2.56)	4076	276 (3.48)	3881
2625	270 (2.44)	3936	263 (3.32)	3752
2750	258 (2.33)	3809	252 (3.17)	3579
2875	247 (2.23)	3669	241 (3.03)	3417
3000	237 (2.14)	3510	232 (2.91)	3270
3125	228 (2.06)	3366	223 (2.79)	3135
3250	220 (1.99)	3234	215 (2.69)	3012
3375	213 (1.92)	3113	208 (2.60)	2899
3500	206 (1.86)	3002	201 (2.51)	2796
3625	200 (1.80)	2900	195 (2.43)	2701
3750	194 (1.74)	2806	189 (2.36)	2614
3875	188 (1.69)	2719	184 (2.29)	2533
4000	183 (1.65)	2638	179 (2.22)	2457
4125	179 (1.61)	2562	175 (2.16)	2387
4250	174 (1.56)	2490	170 (2.11)	2320
4375	170 (1.53)	2423	166 (2.06)	2258
4500	166 (1.49)	2359	162 (2.01)	2198
4625	162 (1.46)	2297	159 (1.96)	2140
4750	159 (1.42)	2238	155 (1.91)	2085
4875	155 (1.39)	2180	152 (1.87)	2032
5000	152 (1.36)	2125	148 (1.82)	1980
5125	148 (1.33)	2070	145 (1.78)	1930

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
5250	145 (1.30)	2017	142 (1.74)	1881
5375	142 (1.27)	1966	139 (1.70)	1833
5500	139 (1.24)	1916	136 (1.66)	1786
5625	136 (1.12)	1867	133 (1.62)	1740
5750	133 (1.19)	1820	130 (1.59)	1697
5875	130 (1.16)	1774	127 (1.55)	1654
6000	127 (1.14)	1731	124 (1.52)	1614
6125	125 (1.11)	1690	122 (1.49)	1577
6250	123 (1.09)	1653	120 (1.46)	1542
6375	120 (1.07)	1619	118 (1.43)	1510
6500	119 (1.06)	1590	116 (1.41)	1483
6625	117 (1.04)	1565	114 (1.39)	1460
6750	116 (1.03)	1546	113 (1.37)	1443
6875	115 (1.02)	1534	113 (1.36)	1432
7000	115 (1.02)	1530	112 (1.36)	1428
7125 Or More	115 (1.02)	1531	112 (1.36)	1428

U.S. EPA ASM EMISSION STANDARDS - 1988-90 LIGHT DUTY TRUCKS (6000 GVWR OR LESS)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	390 (3.54)	2725	381 (4.85)	2587
1875	368 (3.34)	2649	359 (4.57)	2435
2000	348 (3.16)	2499	339 (4.31)	2295
2125	329 (2.99)	2360	321 (4.08)	2167
2250	312 (2.83)	2232	305 (3.86)	2050
2375	297 (2.69)	2115	290 (3.66)	1943
2500	283 (2.56)	2009	276 (3.48)	1845
2625	270 (2.44)	1912	263 (3.32)	1756
2750	258 (2.33)	1823	252 (3.17)	1675
2875	247 (2.23)	1742	241 (3.03)	1601
3000	237 (2.14)	1668	232 (2.91)	1533
3125	228 (2.06)	1601	223 (2.79)	1471
3250	220 (1.99)	1539	215 (2.69)	1415
3375	213 (1.92)	1483	208 (2.60)	1363
3500	206 (1.86)	1432	201 (2.51)	1316
3625	200 (1.80)	1384	195 (2.43)	1273
3750	194 (1.74)	1340	189 (2.36)	1233
3875	188 (1.69)	1300	184 (2.29)	1195

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
4000	183 (1.65)	1262	179 (2.22)	1161
4125	179 (1.61)	1227	175 (2.16)	1126
4250	174 (1.56)	1194	170 (2.11)	1098
4375	170 (1.53)	1162	166 (2.06)	1069
4500	166 (1.49)	1132	162 (2.01)	1042
4625	162 (1.46)	1104	159 (1.96)	1015
4750	159 (1.42)	1076	155 (1.91)	990
4875	155 (1.39)	1049	152 (1.87)	966
5000	152 (1.36)	1023	148 (1.82)	942
5125	148 (1.33)	998	145 (1.78)	919
5250	145 (1.30)	974	142 (1.74)	896
5375	142 (1.27)	950	139 (1.70)	874
5500	139 (1.24)	926	136 (1.66)	853
5625	136 (1.12)	904	133 (1.62)	832
5750	133 (1.19)	882	130 (1.59)	812
5875	130 (1.16)	860	127 (1.55)	793
6000	127 (1.14)	840	124 (1.52)	774
6125	125 (1.11)	822	122 (1.49)	757
6250	123 (1.09)	804	120 (1.46)	741
6375	120 (1.07)	788	118 (1.43)	727
6500	119 (1.06)	775	116 (1.41)	714
6625	117 (1.04)	763	114 (1.39)	704
6750	116 (1.03)	755	113 (1.37)	696
6875	115 (1.02)	749	113 (1.36)	691
7000 Or More	115 (1.02)	747	112 (1.36)	689

U.S. EPA ASM EMISSION STANDARDS - 1991-95 LIGHT DUTY TRUCKS (6000 GVWR OR LESS)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	324 (2.78)	2272	315 (3.64)	2114
1875	306 (2.63)	2181	297 (3.43)	1991
2000	289 (2.48)	2058	281 (3.24)	1877
2125	274 (2.35)	1944	267 (3.06)	1774
2250	260 (2.23)	1839	253 (2.90)	1678
2375	247 (2.12)	1744	241 (2.76)	1592
2500	236 (2.02)	1657	230 (2.62)	1512
2625	225 (1.92)	1577	219 (2.50)	1440
2750	216 (1.84)	1504	210 (2.39)	1374

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
2875	207 (1.76)	1438	210 (2.29)	1313
3000	199 (1.69)	1378	194 (2.19)	1258
3125	191 (1.63)	1323	186 (2.11)	1208
3250	185 (1.57)	1273	180 (2.03)	1163
3375	179 (1.52)	1227	174 (1.96)	1121
3500	173 (1.47)	1184	169 (1.89)	1082
3625	168 (1.42)	1146	164 (1.84)	1047
3750	163 (1.38)	1110	159 (1.78)	1014
3875	159 (1.34)	1077	155 (1.73)	984
4000	155 (1.31)	1046	151 (1.68)	956
4125	151 (1.27)	1017	147 (1.64)	930
4250	147 (1.24)	990	143 (1.60)	905
4375	144 (1.21)	964	140 (1.56)	882
4500	141 (1.18)	939	137 (1.52)	859
4625	137 (1.15)	916	134 (1.48)	838
4750	134 (1.13)	893	131 (1.45)	818
4875	132 (1.10)	872	128 (1.42)	798
5000	129 (1.08)	850	126 (1.38)	778
5125	126 (1.05)	830	123 (1.35)	760
5250	123 (1.03)	810	120 (1.32)	741
5375	121 (1.01)	790	118 (1.29)	723
5500	118 (0.99)	771	115 (1.26)	706
5625	116 (0.97)	752	113 (1.24)	689
5750	113 (0.94)	734	111 (1.21)	673
5875	111 (0.92)	717	108 (1.18)	657
6000	109 (0.91)	701	106 (1.16)	642
6125	107 (0.89)	685	104 (1.13)	628
6250	105 (.087)	671	102 (1.11)	615
6375	103 (0.86)	658	101 (1.09)	604
6500	102 (0.84)	647	99 (1.08)	593
6625	101 (0.83)	638	98 (1.06)	585
6750	100 (0.82)	631	97 (1.05)	578
6875	99 (0.82)	626	97 (1.04)	574
7000	99 (0.82)	624	96 (1.04)	573
7125 Or More	98 (0.81)	625	96 (1.04)	573

U.S. EPA ASM EMISSION STANDARDS - 1994 + TIER 1 LIGHT DUTY TRUCKS (3750 LVW OR LESS)

Test Weight	ASM5015	ASM2525

	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	142 (0.80)	1212	136 (0.77)	1095
1875	134 (0.75)	1142	129 (0.73)	1031
2000	127 (0.71)	1077	123 (0.69)	973
2125	121 (0.68)	1018	116 (0.66)	920
2250	115 (0.64)	964	111 (0.62)	871
2375	109 (0.61)	915	106 (0.59)	827
2500	105 (0.59)	869	101 (0.57)	786
2625	100 (0.56)	828	97 (0.54)	749
2750	96 (0.54)	791	93 (0.52)	715
2875	92 (0.52)	756	89 (0.50)	684
3000	89 (0.50)	725	86 (0.48)	656
3125	86 (0.48)	696	83 (0.46)	630
3250	83 (0.46)	670	80 (0.45)	607
3375	81 (0.45)	647	78 (0.43)	585
3500	78 (0.44)	625	76 (0.42)	566
3625	76 (0.42)	605	74 (0.41)	547
3750	74 (0.41)	586	72 (0.40)	531
3875	72 (0.40)	569	70 (0.39)	515
4000	71 (0.39)	553	68 (0.38)	501
4125	69 (0.38)	538	67 (0.37)	487
4250	67 (0.37)	524	65 (0.36)	475
4375	66 (0.36)	510	64 (0.35)	463
4500	65 (0.36)	498	63 (0.35)	440
4625	63 (0.35)	486	61 (0.34)	440
4750	62 (0.34)	474	60 (0.33)	430
4875	61 (0.34)	463	59 (0.33)	420
5000	60 (0.33)	452	58 (0.32)	410
5125	58 (0.32)	441	57 (0.31)	400
5250	57 (0.32)	431	56 (0.31)	391
5375	56 (0.31)	420	55 (0.30)	382
5500	55 (0.30)	410	54 (0.30)	373
5625	54 (0.30)	401	53 (0.29)	364
5750	53 (0.29)	391	52 (0.29)	356
5875	52 (0.29)	383	51 (0.28)	348
6000	51 (0.28)	374	50 (0.28)	340
6125	50 (0.28)	366	49 (0.27)	333
6250	50 (0.27)	359	48 (0.27)	326
6375	49 (0.27)	352	48 (0.26)	320
6500	48 (0.26)	346	47 (0.26)	315
6625	48 (0.26)	341	46 (0.26)	311

6750	47 (0.26)	338	46 (0.26)	307
6875	47 (0.26)	335	46 (0.25)	305
7000 Or More	47 (0.25)	335	46 (0.25)	305

U.S. EPA ASM EMISSION STANDARDS - 1994 + TIER 1 LIGHT DUTY TRUCKS (3751 LVW OR MORE)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	224 (1.26)	1819	216 (1.22)	1642
1875	212 (1.19)	1713	205 (1.16)	1547
2000	201 (1.13)	1616	194 (1.09)	1460
2125	191 (1.07)	1527	184 (1.04)	1380
2250	182 (1.02)	1446	175 (0.99)	1307
2375	173 (0.97)	1372	167 (0.94)	1240
2500	166 (0.93)	1304	160 (0.90)	1179
2625	159 (0.89)	1242	153 (0.86)	1123
2750	152 (0.85)	1186	147 (0.82)	1072
2875	146 (0.82)	1134	141 (0.79)	1026
3000	141 (0.79)	1088	136 (0.76)	984
3125	136 (0.76)	1045	132 (0.73)	945
3250	132 (0.73)	1006	127 (0.71)	910
3375	128 (0.71)	970	123 (0.69)	878
3500	124 (0.69)	937	120 (0.67)	848
3625	120 (0.67)	907	117 (0.65)	821
3750	117 (0.65)	879	114 (0.63)	796
3875	114 (0.63)	853	111 (0.61)	773
4000	112 (0.62)	829	108 (0.60)	751
4125	109 (0.60)	807	106 (0.58)	731
4250	107 (0.59)	786	103 (0.57)	712
4375	104 (0.58)	766	101 (0.56)	694
4500	102 (0.57)	747	99 (0.55)	677
4625	100 (0.55)	728	97 (0.54)	661
4750	98 (0.54)	711	95 (0.53)	645
4875	96 (0.53)	694	93 (0.52)	630
5000	94 (0.52)	677	92 (0.51)	615
5125	93 (0.51)	661	90 (0.50)	600
5250	91 (0.50)	646	88 (0.49)	586
5375	89 (0.49)	631	86 (0.48)	573
5500	87 (0.48)	616	85 (0.47)	559
5625	86 (0.47)	601	83 (0.46)	546
5750	84 (0.46)	587	82 (0.45)	534

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
5875	83 (0.45)	574	80 (0.44)	522
6000	81 (0.44)	561	79 (0.44)	510
6125	80 (0.44)	549	78 (0.43)	499
6250	79 (0.43)	538	76 (0.42)	489
6375	77 (0.42)	528	75 (0.42)	480
6500	76 (0.42)	519	74 (0.41)	473
6625	76 (0.41)	512	74 (0.41)	466
6750	75 (0.41)	507	73 (0.41)	461
6875	75 (0.40)	503	73 (0.40)	458
7000 Or More	74 (0.40)	502	72 (0.40)	457

U.S. EPA ASM EMISSION STANDARDS - 1968-72 LIGHT DUTY TRUCKS (6001 GVWR OR MORE)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	1118 (8.02)	4990	1098 (9.90)	4990
1875	1052 (7.56)	4990	1034 (9.90)	4990
2000	992 (7.14)	4990	975 (9.90)	4990
2125	938 (6.75)	4990	921 (9.66)	4990
2250	887 (6.40)	4990	872 (9.14)	4990
2375	841 (6.07)	4990	827 (8.67)	4990
2500	800 (5.78)	4990	786 (8.25)	4990
2625	761 (5.51)	4990	748 (7.85)	4990
2750	726 (5.26)	4990	714 (7.50)	4772
2875	695 (5.03)	4892	683 (7.17)	4556
3000	666 (4.83)	4680	654 (6.87)	4359
3125	639 (4.64)	4488	628 (6.60)	4180
3250	615 (4.47)	4311	604 (6.35)	4016
3375	593 (4.31)	4150	583 (6.13)	3866
3500	573 (4.17)	4002	563 (5.92)	3728
3625	554 (4.04)	3867	544 (5.73)	3602
3750	537 (3.91)	3741	527 (5.55)	3485
3875	521 (3.80)	3625	512 (5.39)	3377
4000	506 (3.70)	3517	497 (5.24)	3276
4125	492 (3.60)	3416	484 (5.09)	3182
4250	479 (3.51)	3321	471 (4.96)	3094
4375	467 (3.42)	3230	459 (4.83)	3010
4500	455 (3.34)	3145	447 (4.71)	2930
4625	444 (3.26)	3063	436 (4.60)	2854

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
4750	433 (3.18)	2983	425 (4.49)	2780
4875	423 (3.11)	2907	415 (4.38)	2709
5000	412 (3.03)	2833	405 (4.28)	2640
5125	402 (2.97)	2760	395 (4.18)	2573
5250	393 (2.90)	2690	386 (4.08)	2507
5375	383 (2.83)	2621	376 (3.98)	2443
5500	374 (2.77)	2554	367 (3.89)	2381
5625	365 (2.70)	2489	359 (3.80)	2321
5750	357 (2.64)	2426	350 (3.71)	2262
5875	348 (2.59)	2366	342 (3.62)	2206
6000	341 (2.53)	2308	334 (3.54)	2152
6125	333 (2.48)	2254	327 (3.47)	2102
6250	326 (2.43)	2204	320 (3.40)	2056
6375	320 (2.39)	2159	314 (3.34)	2014
6500	315 (2.35)	2119	309 (3.28)	1977
6625	310 (2.32)	2087	304 (3.23)	1947
6750	307 (2.29)	2062	301 (3.20)	1924
6875	305 (2.28)	2046	299 (3.17)	1909
7000	304 (2.27)	2040	298 (3.17)	1904
7125 Or More	304 (2.27)	2045	298 (3.17)	1904

U.S. EPA ASM EMISSION STANDARDS - 1973-74 LIGHT DUTY TRUCKS (6001 GVWR OR MORE)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	1118 (8.02)	4990	1098 (9.90)	4980
1875	1052 (7.56)	4990	1034 (9.90)	4906
2000	992 (7.14)	4919	975 (9.90)	4838
2125	938 (6.75)	4853	921 (9.66)	4776
2250	887 (6.40)	4792	872 (9.14)	4720
2375	841 (6.07)	4736	827 (8.67)	4668
2500	800 (5.78)	4685	786 (8.25)	4620
2625	761 (5.51)	4639	748 (7.85)	4577
2750	726 (5.26)	4596	714 (7.50)	4374
2875	695 (5.03)	4484	683 (7.17)	4176
3000	666 (4.83)	4290	654 (6.87)	3996
3125	639 (4.64)	4114	628 (6.60)	3832
3250	615 (4.47)	3952	604 (6.35)	3681
3375	593 (4.31)	3804	583 (6.13)	3544

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
3500	573 (4.17)	3669	563 (5.92)	3418
3625	554 (4.04)	3544	544 (5.73)	3302
3750	537 (3.91)	3429	527 (5.55)	3195
3875	521 (3.80)	3323	512 (5.39)	3096
4000	506 (3.70)	3224	497 (5.24)	3003
4125	492 (3.60)	3131	484 (5.09)	2917
4250	479 (3.51)	3044	471 (4.96)	2836
4375	467 (3.42)	2961	459 (4.83)	2759
4500	455 (3.34)	2883	447 (4.71)	2686
4625	444 (3.26)	2807	436 (4.60)	2616
4750	433 (3.18)	2735	425 (4.49)	2549
4875	423 (3.11)	2665	415 (4.38)	2483
5000	412 (3.03)	2597	405 (4.28)	2420
5125	402 (2.97)	2530	395 (4.18)	2359
5250	393 (2.90)	2466	386 (4.08)	2298
5375	383 (2.83)	2403	376 (3.98)	2240
5500	374 (2.77)	2341	367 (3.89)	2183
5625	365 (2.70)	2282	359 (3.80)	2127
5750	357 (2.64)	2224	350 (3.71)	2074
5875	348 (2.59)	2168	342 (3.62)	2022
6000	341 (2.53)	2116	334 (3.54)	1973
6125	333 (2.48)	2066	327 (3.47)	1927
6250	326 (2.43)	2020	320 (3.40)	1884
6375	320 (2.39)	1979	314 (3.34)	1846
6500	315 (2.35)	1943	309 (3.28)	1813
6625	310 (2.32)	1913	304 (3.23)	1785
6750	307 (2.29)	1890	301 (3.20)	1764
6875	305 (2.28)	1875	299 (3.17)	1750
7000	304 (2.27)	1870	298 (3.17)	1745
7125 Or More	304 (2.27)	1874	298 (3.17)	1745

U.S. EPA ASM EMISSION STANDARDS - 1975-78 LIGHT DUTY TRUCKS (6001 GVWR OR MORE)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	843 (5.07)	4990	828 (7.26)	4980
1875	794 (4.78)	4990	780 (6.84)	4906
2000	749 (4.51)	4919	736 (6.45)	4838
2125	707 (4.26)	4853	695 (6.10)	4776

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
2250	669 (4.04)	4792	658 (5.78)	4720
2375	635 (3.83)	4736	624 (5.48)	4668
2500	603 (3.65)	4685	593 (5.21)	4620
2625	574 (3.48)	4639	564 (4.96)	4577
2750	548 (3.32)	4596	539 (4.73)	4374
2875	524 (3.18)	4484	515 (4.53)	4176
3000	502 (3.05)	4290	493 (4.34)	3996
3125	482 (2.93)	4114	474 (4.17)	3832
3250	464 (2.82)	3952	456 (4.01)	3681
3375	447 (2.72)	3804	440 (3.87)	3544
3500	432 (2.63)	3669	424 (3.74)	3418
3625	418 (2.55)	3544	411 (3.62)	3302
3750	405 (2.47)	3429	398 (3.51)	3195
3875	393 (2.40)	3323	386 (3.40)	3096
4000	382 (2.33)	3224	375 (3.31)	3003
4125	371 (2.27)	3131	365 (3.22)	2917
4250	361 (2.21)	3044	355 (3.13)	2836
4375	352 (2.16)	2961	346 (3.05)	2759
4500	343 (2.11)	2883	337 (2.98)	2686
4625	335 (2.06)	2807	329 (2.90)	2616
4750	327 (2.01)	2735	321 (2.83)	2549
4875	319 (1.96)	2665	313 (2.77)	2483
5000	311 (1.92)	2597	305 (2.70)	2420
5125	304 (1.87)	2530	298 (2.64)	2359
5250	296 (1.83)	2466	291 (2.58)	2298
5375	289 (1.79)	2403	284 (2.51)	2240
5500	282 (1.75)	2341	277 (2.46)	2183
5625	276 (1.71)	2282	271 (2.40)	2127
5750	269 (1.67)	2224	264 (2.34)	2074
5875	263 (1.63)	2168	258 (2.29)	2022
6000	257 (1.60)	2116	252 (2.24)	1973
6125	251 (1.57)	2066	247 (2.19)	1927
6250	246 (1.54)	2020	242 (2.15)	1884
6375	242 (1.51)	1979	237 (2.11)	1846
6500	238 (1.48)	1943	233 (2.07)	1813
6625	234 (1.46)	1913	230 (2.04)	1785
6750	232 (1.45)	1890	227 (2.02)	1764
6875	230 (1.44)	1875	225 (2.00)	1750
7000	229 (1.43)	1870	225 (2.00)	1745

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
7125 Or More	229 (1.43)	1874	225 (2.00)	1745

U.S. EPA ASM EMISSION STANDARDS - 1979-83 LIGHT DUTY TRUCKS (6001 GVWR OR MORE)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	774 (4.31)	4990	761 (6.06)	4960
1875	729 (4.06)	4990	717 (5.70)	4738
2000	688 (3.83)	4778	676 (5.38)	4535
2125	650 (3.63)	4578	638 (5.09)	4349
2250	615 (3.44)	4395	604 (4.82)	4179
2375	583 (3.26)	4228	573 (4.57)	4024
2500	554 (3.10)	4076	544 (4.35)	3881
2625	528 (2.96)	3936	518 (4.14)	3752
2750	503 (2.83)	3809	495 (3.95)	3579
2875	481 (2.71)	3669	473 (3.78)	3417
3000	461 (2.60)	3510	453 (3.62)	3270
3125	443 (2.50)	3366	435 (3.48)	3135
3250	426 (2.40)	3234	419 (3.35)	3012
3375	411 (2.32)	3113	404 (3.23)	2899
3500	397 (2.24)	3002	390 (3.12)	2796
3625	384 (2.17)	2900	377 (3.02)	2701
3750	372 (2.11)	2806	365 (2.93)	2614
3875	361 (2.05)	2719	355 (2.58)	2533
4000	351 (1.99)	2638	345 (2.77)	2457
4125	341 (1.94)	2562	335 (2.69)	2387
4250	332 (1.89)	2490	326 (2.62)	2320
4375	323 (1.84)	2423	318 (2.55)	2258
4500	315 (1.80)	2359	310 (2.49)	2198
4625	308 (1.76)	2297	302 (2.43)	2140
4750	300 (1.72)	2238	295 (2.37)	2085
4875	293 (1.68)	2180	288 (2.32)	2032
5000	286 (1.64)	2125	281 (2.26)	1980
5125	279 (1.60)	2070	274 (2.21)	1930
5250	272 (1.56)	2017	267 (2.16)	1881
5375	26 (1.53)	1966	261 (2.11)	1833
5500	259 (1.49)	1916	255 (2.06)	1786
5625	253 (1.46)	1867	248 (2.01)	1740
5750	247 (1.43)	1820	243 (1.96)	1697

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
5875	241 (1.40)	1774	237 (1.92)	1654
6000	236 (1.37)	1731	232 (1.88)	1614
6125	231 (1.34)	1690	227 (1.84)	1577
6250	226 (1.31)	1653	222 (1.80)	1542
6375	222 (1.29)	1619	218 (1.77)	1510
6500	218 (1.27)	1590	214 (1.74)	1483
6625	215 (1.25)	1565	211 (1.72)	1460
6750	213 (1.24)	1546	209 (1.70)	1443
6875	211 (1.23)	1534	207 (1.68)	1432
7000	211 (1.23)	1530	207 (1.68)	1428
7125 Or More	211 (1.22)	1531	206 (1.68)	1428

U.S. EPA ASM EMISSION STANDARDS - 1984-87 LIGHT DUTY TRUCKS (6001 GVWR OR MORE)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	390 (3.54)	4990	381 (4.85)	4960
1875	368 (3.34)	4990	359 (4.57)	4738
2000	348 (3.16)	4778	339 (4.31)	4535
2125	329 (2.99)	4578	321 (4.08)	4349
2250	312 (2.83)	4395	305 (3.86)	4179
2375	297 (2.69)	4228	290 (3.66)	4024
2500	283 (2.56)	4076	276 (3.48)	3881
2625	270 (2.44)	3936	263 (3.32)	3752
2750	258 (2.33)	3809	252 (3.17)	3579
2875	247 (2.23)	3669	241 (3.03)	3417
3000	237 (2.14)	3510	232 (2.91)	3270
3125	228 (2.06)	3366	223 (2.79)	3135
3250	220 (1.99)	3234	215 (2.69)	3012
3375	213 (1.92)	3113	208 (2.60)	2899
3500	206 (1.86)	3002	201 (2.51)	2796
3625	200 (1.80)	2900	195 (2.43)	2701
3750	194 (1.74)	2806	189 (2.36)	2614
3875	188 (1.69)	2719	184 (2.29)	2533
4000	183 (1.65)	2638	179 (2.22)	2457
4125	179 (1.61)	2562	175 (2.16)	2387
4250	174 (1.56)	2490	170 (2.11)	2320
4375	170 (1.53)	2423	166 (2.06)	2258
4500	166 (1.49)	2359	162 (2.01)	2198

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
4625	162 (1.46)	2297	159 (1.96)	2140
4750	159 (1.42)	2238	155 (1.91)	2085
4875	155 (1.39)	2180	152 (1.87)	2032
5000	152 (1.36)	2125	148 (1.82)	1980
5125	148 (1.33)	2070	145 (1.78)	1930
5250	145 (1.30)	2017	142 (1.74)	1881
5375	142 (1.27)	1966	139 (1.70)	1833
5500	139 (1.24)	1916	136 (1.66)	1786
5625	136 (1.12)	1867	133 (1.62)	1740
5750	133 (1.19)	1820	130 (1.59)	1697
5875	130 (1.16)	1774	127 (1.55)	1654
6000	127 (1.14)	1731	124 (1.52)	1614
6125	125 (1.11)	1690	122 (1.49)	1577
6250	123 (1.09)	1653	120 (1.46)	1542
6375	120 (1.07)	1619	118 (1.43)	1510
6500	119 (1.06)	1590	116 (1.41)	1483
6625	117 (1.04)	1565	114 (1.39)	1460
6750	116 (1.03)	1546	113 (1.37)	1443
6875	115 (1.02)	1534	113 (1.36)	1432
7000	115 (1.02)	1530	112 (1.36)	1428
7125 Or More	115 (1.02)	1531	112 (1.36)	1428

U.S. EPA ASM EMISSION STANDARDS - 1988-90 LIGHT DUTY TRUCKS (6001 GVWR OR MORE)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	390 (3.54)	4084	381 (4.85)	4005
1875	368 (3.34)	4054	359 (4.57)	3767
2000	348 (3.16)	3824	339 (4.31)	3548
2125	329 (2.99)	3609	321 (4.08)	3348
2250	312 (2.83)	3411	305 (3.86)	3165
2375	297 (2.69)	3231	290 (3.66)	2998
2500	283 (2.56)	3066	276 (3.48)	2845
2625	270 (2.44)	2916	263 (3.32)	2706
2750	258 (2.33)	2779	252 (3.17)	2579
2875	247 (2.23)	2654	241 (3.03)	2463
3000	237 (2.14)	2539	232 (2.91)	2357
3125	228 (2.06)	2435	223 (2.79)	2260
3250	220 (1.99)	2340	215 (2.69)	2172

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
3375	213 (1.92)	2253	208 (2.60)	2092
3500	206 (1.86)	2174	201 (2.51)	2018
3625	200 (1.80)	2100	195 (2.43)	1950
3750	194 (1.74)	2033	189 (2.36)	1887
3875	188 (1.69)	1970	184 (2.29)	1829
4000	183 (1.65)	1912	179 (2.22)	1775
4125	179 (1.61)	1857	175 (2.16)	1724
4250	174 (1.56)	1806	170 (2.11)	1677
4375	170 (1.53)	1757	166 (2.06)	1632
4500	166 (1.49)	1711	162 (2.01)	1589
4625	162 (1.46)	1666	159 (1.96)	1548
4750	159 (1.42)	1624	155 (1.91)	1508
4875	155 (1.39)	1583	152 (1.87)	1470
5000	152 (1.36)	1542	148 (1.82)	1433
5125	148 (1.33)	1503	145 (1.78)	1397
5250	145 (1.30)	1465	142 (1.74)	1362
5375	142 (1.27)	1428	139 (1.70)	1327
5500	139 (1.24)	1392	136 (1.66)	1294
5625	136 (1.12)	1357	133 (1.62)	1261
5750	133 (1.19)	1323	130 (1.59)	1230
5875	130 (1.16)	1290	127 (1.55)	1199
6000	127 (1.14)	1259	124 (1.52)	1171
6125	125 (1.11)	1230	122 (1.49)	1144
6250	123 (1.09)	1203	120 (1.46)	1119
6375	120 (1.07)	1179	118 (1.43)	1096
6500	119 (1.06)	1158	116 (1.41)	1077
6625	117 (1.04)	1140	114 (1.39)	1060
6750	116 (1.03)	1127	113 (1.37)	1048
6875	115 (1.02)	1118	113 (1.36)	1040
7000 Or More	115 (1.02)	1115	112 (1.36)	1037

U.S. EPA ASM EMISSION STANDARDS - 1991-95 LIGHT DUTY TRUCKS (6001 GVWR OR MORE)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	324 (2.78)	3631	315 (3.64)	3532
1875	306 (2.63)	3586	297 (3.43)	3323
2000	289 (2.48)	3383	281 (3.24)	3131
2125	274 (2.35)	3192	267 (3.06)	2955

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
2250	260 (2.23)	3018	253 (2.90)	2794
2375	247 (2.12)	2859	241 (2.76)	2646
2500	236 (2.02)	2714	230 (2.62)	2512
2625	225 (1.92)	2581	219 (2.50)	2389
2750	216 (1.84)	2460	210 (2.39)	2277
2875	207 (1.76)	2350	210 (2.29)	2175
3000	199 (1.69)	2249	194 (2.19)	2082
3125	191 (1.63)	2157	186 (2.11)	1997
3250	185 (1.57)	2073	180 (2.03)	1920
3375	179 (1.52)	1997	174 (1.96)	1849
3500	173 (1.47)	1926	169 (1.89)	1784
3625	168 (1.42)	1862	164 (1.84)	1724
3750	163 (1.38)	1802	159 (1.78)	1669
3875	159 (1.34)	1747	155 (1.73)	1618
4000	155 (1.31)	1695	151 (1.68)	1570
4125	151 (1.27)	1647	147 (1.64)	1526
4250	147 (1.24)	1602	143 (1.60)	1484
4375	144 (1.21)	1559	140 (1.56)	1444
4500	141 (1.18)	1518	137 (1.52)	1406
4625	137 (1.15)	1479	134 (1.48)	1370
4750	134 (1.13)	1441	131 (1.45)	1336
4875	132 (1.10)	1405	128 (1.42)	1302
5000	129 (1.08)	1369	126 (1.38)	1269
5125	126 (1.05)	1335	123 (1.35)	1237
5250	123 (1.03)	1031	120 (1.32)	1206
5375	121 (1.01)	1269	118 (1.29)	1176
5500	118 (0.99)	1237	115 (1.26)	1147
5625	116 (0.97)	1206	113 (1.24)	1118
5750	113 (0.94)	1176	111 (1.21)	1090
5875	111 (0.92)	1147	108 (1.18)	1064
6000	109 (0.91)	1120	106 (1.16)	1039
6125	107 (0.89)	1094	104 (1.13)	1015
6250	105 (.087)	1070	102 (1.11)	993
6375	103 (0.86)	1049	101 (1.09)	973
6500	102 (0.84)	1030	99 (1.08)	956
6625	101 (0.83)	1014	98 (1.06)	941
6750	100 (0.82)	1003	97 (1.05)	931
6875	99 (0.82)	995	97 (1.04)	924
7000	99 (0.82)	992	96 (1.04)	921

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
7125 Or More	98 (0.81)	992	96 (1.04)	921

U.S. EPA ASM EMISSION STANDARDS - 1994 + TIER 1 LIGHT DUTY TRUCKS (5750 LVW OR LESS)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	224 (1.26)	1819	216 (1.22)	1642
1875	212 (1.19)	1713	205 (1.16)	1547
2000	201 (1.13)	1616	194 (1.09)	1460
2125	191 (1.07)	1527	184 (1.04)	1380
2250	182 (1.02)	1446	175 (0.99)	1307
2375	173 (0.97)	1372	167 (0.94)	1240
2500	166 (0.93)	1304	160 (0.90)	1179
2625	159 (0.89)	1242	153 (0.86)	1123
2750	152 (0.85)	1186	147 (0.82)	1072
2875	146 (0.82)	1134	141 (0.79)	1026
3000	141 (0.79)	1088	136 (0.76)	984
3125	136 (0.76)	1045	132 (0.73)	945
3250	132 (0.73)	1006	127 (0.71)	910
3375	128 (0.71)	970	123 (0.69)	878
3500	124 (0.69)	937	120 (0.67)	848
3625	120 (0.67)	907	117 (0.65)	821
3750	117 (0.65)	879	114 (0.63)	796
3875	114 (0.63)	853	111 (0.61)	773
4000	112 (0.62)	829	108 (0.60)	751
4125	109 (0.60)	807	106 (0.58)	731
4250	107 (0.59)	786	103 (0.57)	712
4375	104 (0.58)	766	101 (0.56)	694
4500	102 (0.57)	747	99 (0.55)	677
4625	100 (0.55)	728	97 (0.54)	661
4750	98 (0.54)	711	95 (0.53)	645
4875	96 (0.53)	694	93 (0.52)	630
5000	94 (0.52)	677	92 (0.51)	615
5125	93 (0.51)	661	90 (0.50)	600
5250	91 (0.50)	646	88 (0.49)	586
5375	89 (0.49)	631	86 (0.48)	573
5500	87 (0.48)	616	85 (0.47)	559
5625	86 (0.47)	601	83 (0.46)	546

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
5750	84 (0.46)	587	82 (0.45)	534
5875	83 (0.45)	574	80 (0.44)	522
6000	81 (0.44)	561	79 (0.44)	510
6125	80 (0.44)	549	78 (0.43)	499
6250	79 (0.43)	538	76 (0.42)	489
6375	77 (0.42)	528	75 (0.42)	480
6500	76 (0.42)	519	74 (0.41)	473
6625	76 (0.41)	512	74 (0.41)	466
6750	75 (0.41)	507	73 (0.41)	461
6875	75 (0.40)	503	73 (0.40)	458
7000 Or More	74 (0.40)	502	72 (0.40)	457

U.S. EPA ASM EMISSION STANDARDS - 1994 + TIER 1 LIGHT DUTY TRUCKS (5751 LVW OR MORE)

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1750	324 (2.78)	3178	315 (3.64)	3060
1875	306 (2.63)	3117	297 (3.43)	2879
2000	289 (2.48)	2941	281 (3.24)	2713
2125	274 (2.35)	2776	267 (3.06)	2561
2250	260 (2.23)	2625	253 (2.90)	2422
2375	247 (2.12)	2487	241 (2.76)	2295
2500	236 (2.02)	2361	230 (2.62)	2179
2625	225 (1.92)	2246	219 (2.50)	2073
2750	216 (1.84)	2142	210 (2.39)	1976
2875	207 (1.76)	2046	210 (2.29)	1888
3000	199 (1.69)	1959	194 (2.19)	1808
3125	191 (1.63)	1879	186 (2.11)	1734
3250	185 (1.57)	1806	180 (2.03)	1667
3375	179 (1.52)	1740	174 (1.96)	1606
3500	173 (1.47)	1679	169 (1.89)	1550
3625	168 (1.42)	1623	164 (1.84)	1498
3750	163 (1.38)	1571	159 (1.78)	1451
3875	159 (1.34)	1523	155 (1.73)	1407
4000	155 (1.31)	1479	151 (1.68)	1365
4125	151 (1.27)	1437	147 (1.64)	1327
4250	147 (1.24)	1398	143 (1.60)	1291
4375	144 (1.21)	1360	140 (1.56)	1257

Test Weight	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
4500	141 (1.18)	1325	137 (1.52)	1224
4625	137 (1.15)	1291	134 (1.48)	1193
4750	134 (1.13)	1259	131 (1.45)	1163
4875	132 (1.10)	1227	128 (1.42)	1134
5000	129 (1.08)	1196	126 (1.38)	1106
5125	126 (1.05)	1167	123 (1.35)	1078
5250	123 (1.03)	1138	120 (1.32)	1051
5375	121 (1.01)	1109	118 (1.29)	1025
5500	118 (0.99)	1082	115 (1.26)	1000
5625	116 (0.97)	1055	113 (1.24)	975
5750	113 (0.94)	1029	111 (1.21)	951
5875	111 (0.92)	1004	108 (1.18)	928
6000	109 (0.91)	980	106 (1.16)	906
6125	107 (0.89)	958	104 (1.13)	886
6250	105 (.087)	937	102 (1.11)	867
6375	103 (0.86)	919	101 (1.09)	850
6500	102 (0.84)	902	99 (1.08)	835
6625	101 (0.83)	889	98 (1.06)	823
6750	100 (0.82)	879	97 (1.05)	813
6875	99 (0.82)	872	97 (1.04)	807
7000	99 (0.82)	870	96 (1.04)	805
7125 Or More	98 (0.81)	870	96 (1.04)	805

U. S. EPA REVISED FINAL ASM EMISSION STANDARDS (ASM5015 & ASM2525)

NOTE: **EPA has not published a revised final standards for High Altitude, Light Duty Trucks 2 (6000-8500 GVWR), or vehicles older than 1980 model year. EPA guidance as of February 2003 states that a program may choose to use combinations of the Original and the Revised Final Standards.**

U.S. EPA REVISED FINAL ASM EMISSION STANDARDS

Application	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
Passenger Cars				
1980	275 (1.3)	8500	500 (2.3)	4750
1981-82	275 (1.3)	3600	500 (2.3)	3500

Application	ASM5015		ASM2525	
	HC ppm (CO %)	NOx ppm	HC ppm (CO %)	NOx ppm
1983-89	275 (1.1)	3600	500 (1.6)	3500
1990 & Newer	275 (1.1)	3600	300 (1.6)	3500
Light Duty Trucks (Less Than 6000 GVWR)				
1980-83	1140 (9.7)	14,145	340 (23.28)	32,200
1984-87	537 (5.4)	14,145	160 (12.96)	32,200
1988-95	537 (5.4)	7380	160 (12.96)	16,800
1996 & Newer	275 (1.1)	6150	82 (4.40)	14,000

U.S. EPA IM240 EMISSION STANDARDS

START-UP STANDARDS

Start-up standards should be used during the first 2 years of program operation. Tier 1 standards are recommended for all 1996 and newer vehicles and may be used for 1994 and newer vehicles certified to Tier 1 standards as well.

U.S. EPA IM240 HYDROCARBONS EMISSION START-UP STANDARDS

Application	Hydrocarbons (Grams/Mile)	
	Composite	Phase 2
Light Duty Vehicles		
1996 & Newer	0.80	0.50
1991-95	1.20	0.75
1983-90	2.00	1.25
1980-82	2.00	1.25
1975-79	7.50	5.00
1968-74	10.0	6.00
High Altitude Light Duty Vehicles		
1983-84	2.00	1.25
1982	2.00	1.25
Light Duty Trucks (0-6000 Lbs. GVWR)		
1996 & Newer (Less Than 3750 LVW)	0.80	0.50
1996 & Newer (More Than 3750 LVW)	1.00	0.63
1991-95	2.40	1.50
1984-90	3.20	2.00
1979-83	7.50	5.00

Application	Hydrocarbons (Grams/Mile)	
Composite		Phase 2
1975-78	8.00	5.00
1968-74	10.0	6.00
High Altitude Light Duty Trucks (0-6000 Lbs. GVWR)		
1991 & Newer	3.00	2.00
1984-90	4.00	2.50
1982-83	8.00	5.00
Light Duty Trucks (6001-8500 Lbs. GVWR)		
1996 & Newer (Less Than 5750 ALVW)	1.00	0.63
1996 & Newer (More Than 5750 ALVW)	2.40	1.50
1991-95	2.40	1.50
1984-90	3.20	2.00
1979-83	7.50	5.00
1975-78	8.00	5.00
1968-74	10.0	6.00
High Altitude Light Duty Trucks (6001-8500 Lbs. GVWR)		
1991 & Newer	3.00	2.00
1984-90	4.00	2.50
1982-83	8.00	5.00
Heavy Duty Trucks (Greater Than 8500 Lbs. GVWR)		
1998 & Newer	2.00	1.30
1987-97	3.00	1.90
1985-86	5.00	3.10
1979-84	6.00	3.80
1970-78	10.0	6.30
1969 & Earlier	20.0	12.50

U.S. EPA IM240 CARBON MONOXIDE EMISSION START-UP STANDARDS

Application	Carbon Monoxide (Grams/Mile)	
Composite		Phase 2
Light Duty Vehicles		
1996 & Newer	15.0	12.0
1991-95	20.0	16.0
1983-90	30.0	24.0
1980-82	60.0	48.0
1975-79	90.0	72.0
1968-74	150.0	120.0
High Altitude Light Duty Vehicles		
1983-84	60.0	48.0
1982	75.0	60.0
Light Duty Trucks (0-6000 Lbs. GVWR)		

Application	Carbon Monoxide (Grams/Mile)	
Composite		Phase 2
1996 & Newer (Less Than 3750 LVW)	15.0	12.0
1996 & Newer (More Than 3750 LVW)	20.0	16.0
1991-95	60.0	48.0
1984-90	80.0	64.0
1979-83	100.0	80.0
1975-78	120.0	96.0
1968-74	150.0	120.0
High Altitude Light Duty Trucks (0-6000 Lbs. GVWR)		
1991 & Newer	70.0	56.0
1984-90	90.0	72.0
1982-83	130.0	104.0
Light Duty Trucks (6001-8500 Lbs. GVWR)		
1996 & Newer (Less Than 5750 ALVW)	20.0	16.0
1996 & Newer (More Than 5750 ALVW)	60.0	48.0
1991-95	60.0	48.0
1984-90	80.0	64.0
1979-83	100.0	80.0
1975-78	120.0	96.0
1968-74	150.0	120.0
High Altitude Light Duty Trucks (6001-8500 Lbs. GVWR)		
1991 & Newer	70.0	56.0
1984-90	90.0	72.0
1982-83	130.0	104.0
Heavy Duty Trucks (Greater Than 8500 Lbs. GVWR)		
1998 & Newer	30.0	24.0
1987-97	60.0	48.0
1985-86	75.0	60.0
1979-84	100.0	80.0
1974-78	150.00	120.0
1970-73	175.00	140.00
1969 & Earlier	200.0	160.0

U.S. EPA IM240 OXIDES OF NITROGEN EMISSION START-UP STANDARDS

Application	Oxides Of Nitrogen (Grams/Mile)	
Composite		Phase 2
Light Duty Vehicles		
1996 & Newer	2.0	2.0
1991-95	2.5	2.5
1981-90	3.0	3.0
1977-80	6.0	6.0

Application	Oxides Of Nitrogen (Grams/Mile)	
Composite		Phase 2
1973-76	9.0	9.0
1968-72	10.0	10.0
High Altitude Light Duty Vehicles		
1982-84	3.0	3.0
Light Duty Trucks (0-6000 Lbs. GVWR)		
1996 & Newer (Less Than 3750 LVW)	2.0	2.0
1996 & Newer (More Than 3750 LVW)	2.5	2.5
1991-95	3.0	3.0
1988-90	3.5	3.5
1979-87	7.0	7.0
1973-78	9.0	9.0
1968-72	10.0	10.0
High Altitude Light Duty Trucks (0-6000 Lbs. GVWR)		
1991 & Newer	3.0	3.0
1988-90	3.5	3.5
1982-87	7.0	7.0
Light Duty Trucks (6001-8500 Lbs. GVWR)		
1996 & Newer (Less Than 5750 ALVW)	2.5	2.5
1996 & Newer (More Than 5750 ALVW)	4.0	4.0
1991-95	4.5	4.5
1988-90	5.0	5.0
1979-87	7.0	7.0
1973-78	9.0	9.0
1968-72	10.0	10.0
High Altitude Light Duty Trucks (6001-8500 Lbs. GVWR)		
1991 & Newer	4.5	4.5
1988-90	5.0	5.0
1982-87	7.0	7.0
Heavy Duty Trucks (Greater Than 8500 Lbs. GVWR)		
1998 & Newer	4.0	4.0
1991-97	6.0	6.0
1979-90	8.0	8.0
1970-78	10.0	10.0
1969 & Earlier	15.0	15.0

FINAL STANDARDS

Final standards are recommended for vehicles tested in calendar years 1997 and later. Tier 1 standards are recommended for all 1996 and newer vehicles and may be used for 1994 and newer vehicles.

U.S. EPA IM240 HYDROCARBONS EMISSION FINAL STANDARDS

Application	Hydrocarbons (Grams/Mile)	
	Composite	Phase 2
Light Duty Vehicles		
1996 & Newer	0.60	0.40
1980-95	0.80	0.50
1975-79	3.00	2.00
1968-74	7.00	4.50
High Altitude Light Duty Vehicles		
1982-84	1.20	0.75
Light Duty Trucks (0-6000 Lbs. GVWR)		
1996 & Newer (Less Than 3750 LVW)	0.60	0.40
1996 & Newer (More Than 3750 LVW)	0.80	0.50
1984-95	1.60	1.00
1979-83	3.40	2.00
1975-78	4.00	2.50
1968-74	7.00	4.50
High Altitude Light Duty Trucks (0-6000 Lbs. GVWR)		
1988 & Newer	2.00	1.25
1984-87	2.00	1.25
1982-83	4.00	2.50
Light Duty Trucks (6001-8500 Lbs. GVWR)		
1996 & Newer (Less Than 5750 ALVW)	0.80	0.50
1996 & Newer (More Than 5750 ALVW)	0.80	0.50
1984-95	1.60	1.00
1979-83	3.40	2.00
1975-78	4.00	2.50
1968-74	7.00	4.50
High Altitude Light Duty Trucks (6001-8500 Lbs. GVWR)		
1988 & Newer	2.00	1.25
1984-87	2.00	1.25
1982-83	4.00	2.50
Heavy Duty Trucks (Greater Than 8500 Lbs. GVWR)		
1998 & Newer	2.00	1.30
1987-97	2.00	1.30
1985-86	3.00	1.90
1979-84	5.00	3.10
1970-78	10.0	6.30
1969 & Earlier	20.0	12.50

U.S. EPA IM240 CARBON MONOXIDE EMISSION FINAL STANDARDS

Application	Carbon Monoxide (Grams/Mile)	
	Composite	Phase 2

Application	Carbon Monoxide (Grams/Mile)	
	Composite	Phase 2
Light Duty Vehicles		
1996 & Newer	10.0	8.0
1983-95	15.0	12.0
1980-82	30.0	24.0
1975-79	65.0	52.0
1968-74	120.0	96.0
High Altitude Light Duty Vehicles		
1983-84	30.0	24.0
1982	45.0	36.0
Light Duty Trucks (0-6000 Lbs. GVWR)		
1996 & Newer (Less Than 3750 LVW)	10.0	8.0
1996 & Newer (More Than 3750 LVW)	13.0	10.0
1984-95	40.0	32.0
1979-83	70.0	56.0
1975-78	80.0	64.0
1968-74	120.0	96.0
High Altitude Light Duty Trucks (0-6000 Lbs. GVWR)		
1988 & Newer	60.0	48.0
1984-87	60.0	48.0
1982-83	90.0	72.0
Light Duty Trucks (6001-8500 Lbs. GVWR)		
1996 & Newer (Less Than 5750 ALVW)	13.0	10.0
1996 & Newer (More Than 5750 ALVW)	15.0	12.0
1984-95	40.0	32.0
1979-83	70.0	56.0
1975-78	80.0	64.0
1968-74	120.0	96.0
High Altitude Light Duty Trucks (6001-8500 Lbs. GVWR)		
1984 & Newer	60.0	48.0
1982-83	90.0	72.0
Heavy Duty Trucks (Greater Than 8500 Lbs. GVWR)		
1998 & Newer	30.0	24.0
1987-97	40.0	32.0
1985-86	50.0	40.0
1979-84	75.0	60.0
1974-78	150.0	120.0
1970-73	175.0	140.0
1969 & Earlier	200.0	160.0

U.S. EPA IM240 OXIDES OF NITROGEN EMISSION FINAL STANDARDS

Application	Oxides Of Nitrogen (Grams/Mile)	
	Composite	Phase 2
Light Duty Vehicles		
1996 & Newer	1.5	1.5
1981-95	2.0	2.0
1977-80	4.0	4.0
1973-76	6.0	6.0
1968-72	7.0	7.0
High Altitude Light Duty Vehicles		
1982-84	2.0	2.0
Light Duty Trucks (0-6000 Lbs. GVWR)		
1996 & Newer (Less Than 3750 LVW)	1.5	1.5
1996 & Newer (More Than 3750 LVW)	1.8	1.8
1988-95	2.5	2.5
1979-87	4.5	4.5
1973-78	6.0	6.0
1968-72	7.0	7.0
High Altitude Light Duty Trucks (0-6000 Lbs. GVWR)		
1988 & Newer	2.5	2.5
1982-87	4.5	4.5
Light Duty Trucks (6001-8500 Lbs. GVWR)		
1996 & Newer (Less Than 5750 ALVW)	1.8	1.8
1996 & Newer (More Than 5750 ALVW)	2.0	2.0
1988-95	3.5	3.5
1979-87	4.5	4.5
1973-78	6.0	6.0
1968-72	7.0	7.0
High Altitude Light Duty Trucks (6001-8500 Lbs. GVWR)		
1988 & Newer	3.5	3.5
1982-87	4.5	4.5
Heavy Duty Trucks (Greater Than 8500 Lbs. GVWR)		
1998 & Newer	4.0	4.0
1991-97	5.0	5.0
1979-90	6.0	6.0
1970-78	10.0	10.0
1969 & Earlier	15.0	15.0

Article GUID: A00157750

Engine

Engine Cooling - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Condenser Hold Down Bracket	6 N.m	53 lb in
Condenser Tubes Bracket Bolt	10 N.m	89 lb in
Cooling Fan Motor Nut	6 N.m	53 lb in
Cooling Fan Shroud Bolt	10 N.m	89 lb in
Fan Shroud Bolt	6 N.m	53 lb in
Lower Radiator Air Deflector Screw	10 N.m	89 lb in
Radiator Bracket Upper Support Bolt	10 N.m	89 lb in
Radiator Upper Mount Bracket Bolt	8 N.m	71 lb in
Radiator Upper Support Bracket Bolt	6 N.m	53 lb in
Thermostat Housing Bolt / Stud	10 N.m	89 lb in
Water Outlet Fastener	10 N.m	89 lb in
Water Pump Bolt		
• First Pass	10 N.m	89 lb in (1)
• Second Pass	10 N.m	89 lb in
• Final Pass	45 Degrees	
Water Pump Pulley Bolt	10 N.m	89 lb in
1. Use NEW fastener.		

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
Cooling System		
3.6L	9.6 L	10.1 qt
Police Package	16.0 L	10.6 qt

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
DEX-COOLÂ®	Coolant	12346290	10953464

SCHEMATIC WIRING DIAGRAMS

ENGINE HEATING/COOLING WIRING SCHEMATICS

Cooling Fans

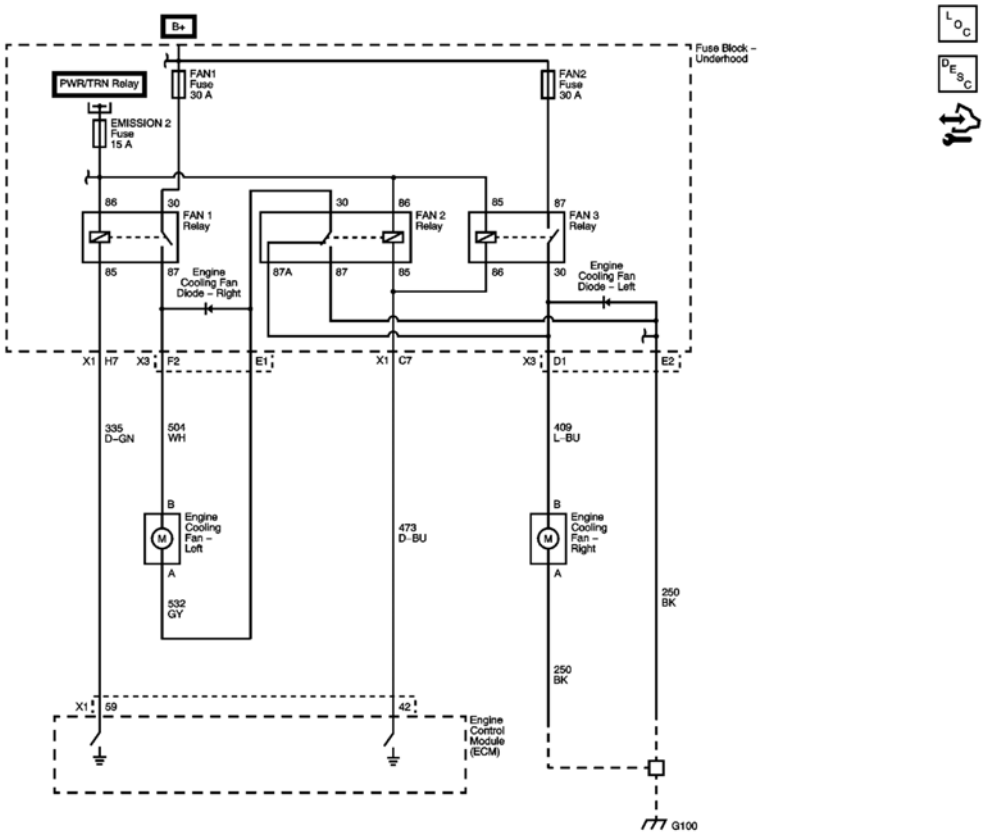


Fig. 1: Except WRH Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0480, P0481, P0691, P0692, P0693, OR P0694: COOLING FAN RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0480

Cooling Fan Relay 1 Control Circuit

DTC P0481

Cooling Fan Relays 2 and 3 Control Circuit

DTC P0691

Cooling Fan Relay 1 Control Circuit Low Voltage

DTC P0692

Cooling Fan Relay 1 Control Circuit High Voltage

DTC P0693

Cooling Fan Relays 2 and 3 Control Circuit Low Voltage

DTC P0694

Cooling Fan Relays 2 and 3 Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Coil Ignition	P0480	P0480, P0481	-	-
Relay Switch B+	1	1	-	-
Low Speed Cooling Fan Relay Control	P0691	P0480, P0691	P0692	-
High Speed Cooling Fan Relay Control	P0693	P0481 or 1	P0694	-
Cooling Fan Speed Control Relay Control	P0693	P0481 or 1	P0694	-
Relay Controlled Output	1	1	2	-

1. Fan(s) inoperative without a DTC
2. Fan(s) always ON without a DTC

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Conditions for Running the DTC

- The ignition voltage is greater than 11 volts.
- The ECM driver transitions from ON to OFF or from OFF to ON.
- DTCs P0480, P0481, P0691, P0692, P0693, and P0694 run continuously when the conditions above are met.

Conditions for Setting the DTC

The commanded state of the ECM driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the DTC Sets

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Conditions for Clearing the MIL/DTC

DTCs P0480, P0481, P0691, P0692, P0693, and P0694 are Type B DTCs.

Diagnostic Aids

- The ECM has the capability of providing command to the fan relays even when a scan tool output control is being used. Always refer to the fan control command parameters on the scan tool to know which fans are being commanded ON by the ECM.
- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates both fans at a low speed
  - Cooling Fan Relays 2 and 3 operates one fan at a high speed
  - Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Electrical Center Identification Views**

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify an audible click is heard or felt from cooling fan relays 1, 2, and 3 when commanding the cooling fans ON and OFF with a scan tool.
   - **If a click is not heard or felt at one or more of the relays**

     Refer to Circuit/System Testing

   - **If a click is heard or felt at each of the relays**
3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing

   - **If the DTC does not set**
5. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect all of the cooling fan relays. Ignition ON.

   NOTE: **The following tests must be performed on all three fan relay circuits.**

2. Verify that a test lamp illuminates between ground and a relay coil ignition circuit terminal listed below:
   - KR20C Cooling Fan Low Speed Relay terminal 85/2
   - KR20D Cooling Fan High Speed Relay terminal 86/1
   - KR20E Cooling Fan Speed Control Relay terminal 86/1
   - **If the test lamp does not illuminate**

   1. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Remove the test lamp.
   2. Test for less than 2 Ω in the ignition circuit of the appropriate cooling fan relay, end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

   - **If the test lamp does not illuminate and the circuit fuse is open**

   1. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down. Remove the test lamp.
   2. Test for infinite resistance between the appropriate cooling fan relay ignition circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance test or replace the appropriate cooling fan relay.

   - **If the test lamp illuminates**

NOTE: **The following tests must be performed on all three fan relay circuits.**

3. Connect a DMM, set on the diode setting, between ground and a relay control circuit terminal listed below:
    - KR20C cooling fan low speed relay terminal 86/1
    - KR20D cooling fan high speed relay terminal 85/2
    - KR20E cooling fan speed control relay terminal 85/2
4. Verify the DMM reading is greater than 2.5 V or displays O.L with the cooling fan relays commanded OFF with a scan tool.
    - **If 2.5 V or less**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the appropriate relay coil control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K20 Engine Control Module.
    - **If greater than 2.5 V or displays O.L.**
5. Verify the DMM reading is less than 1 V when commanding the cooling fan relays ON with a scan tool.
    - **If greater than 1 V or displays OL.**
    1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the appropriate cooling fan relay control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V.
    3. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
    4. Test for less than 2 Ω in the appropriate cooling fan relay control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K20 Engine Control Module.
    - **If less than 1 V**
6. Test or replace the appropriate cooling fan relay.

Component Testing

1. Ignition OFF.
2. Disconnect a cooling fan relay.
3. Test for 70-110 Ω between terminals 85/2 and 86/1.
    - **If less than 70 Ω or greater than 110 Ω**

      Replace the cooling fan relay.

    - **If between 70-110 Ω**
4. Test for infinite resistance between the following terminals:
    - 30 and 86

- 30 and 87
- 30 and 85
- 85 and 87

  OR

- 3 and 2
- 3 and 5
- 3 and 1
- 1 and 5
- **If less than infinite resistance**

  Replace the cooling fan relay.

- **If infinite resistance**

NOTE: **This test only applies to the speed control relay.**

5. Test for less than 2 Ω between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.
   - **If 2 Ω or greater**

     Replace the KR20E Cooling Fan Speed Control Relay.

   - **If less than 2 Ω**
6. Install a 10 A fused jumper wire between relay terminal 85 or 2 and 12 V.
7. Install a jumper wire between relay terminal 86 or 1 and ground.
8. Test for less than 2 Ω between terminals 3/30 and 5/87.
   - **If 2 Ω or greater**

     Replace the cooling fan relay.

   - **If less than 2 Ω**
9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming

DTC P1258: ENGINE COOLANT OVERTEMPERATURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P1258

Engine Coolant Overtemperature - Protection Mode Active

Circuit/System Description

The engine control module (ECM) uses the engine coolant temperature sensor to monitor the engine for an over-temperature condition. This condition occurs when the coolant temperature is above a calibrated value. The ECM will alternately disable 2 groups of cylinders by turning OFF the fuel injectors. By switching between the 2 groups of cylinders, the ECM is able to reduce the temperature of the coolant.

Conditions for Running the DTC

- The engine is operating for greater than 30 seconds.
- DTC P1258 runs continuously once the conditions above have been met.

Conditions for Setting the DTC

The ECM detects that engine coolant temperature is warmer than 131Â°C (268Â°F) for greater than 2 seconds.

Action Taken When the DTC Sets

- DTC P1258 is a Type A DTC.
- The engine will operate in the Overheated Engine Protection Operating Mode.
- The IP will illuminate the coolant temperature indicator lamp and the driver information center (DIC), if equipped, may display a message.
- If the protection mode is active and an ECT sensor DTC sets, the protection mode will remain active at the start of the next drive cycle until the ECT sensor DTC runs and passes.

Conditions for Clearing the MIL/DTC

DTC P1258 is a Type A DTC.

Reference Information

Schematic Reference

Engine Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Cooling Fan Description and Operation**
- **Instrument Cluster Description and Operation**

- **Indicator/Warning Message Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

K20 Engine Control Module: Scan Tool Information for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.
   - **If a DTC is set**

     Refer to **DTC P0480, P0481, P0691, P0692, P0693, or P0694**.

   - **If no DTCs is set**

   NOTE: A short delay occurs before the ECM changes the cooling fan speed.

3. Verify the cooling fan operates at each available speed as commanded with a scan tool.
   - **Cooling fan does not operate**

     Refer to **Cooling Fan Inoperative**.

   - **Cooling fan operates**
4. Verify that the engine does not overheat.
   - **Engine overheats**

     Refer to **Engine Overheating**.

   - **Engine does not overheat**
5. Operate the vehicle within the Conditions for Running the DTC.
   - **If the DTC sets**

     Refer to **Symptoms - Engine Cooling**.

   - **If the DTC does not set**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

SYMPTOMS - ENGINE COOLING

Important Preliminary Inspections Before Starting

Before using the Symptom diagnosis, perform the following:

- Perform **Diagnostic System Check - Vehicle** and verify all of the following items:
  - Engine control module (ECM) and malfunction indicator lamp (MIL) are operating correctly.
  - There are no diagnostic trouble codes (DTCs) stored.
  - Scan tool data is within a normal operating range.
- Verify the customer concern.
- Perform the Visual/Physical Inspection in this section. The visual/physical inspection is extremely important, and can lead to correcting a condition without additional testing. It may also help reveal the cause of an intermittent condition.
- Locate the correct symptom. Perform the tests and inspections associated with the symptom.

Review the entire cooling system operation in order to familiarize yourself with the system functions. Refer to **Cooling Fan Description and Operation**, and **Cooling System Description and Operation**.

Visual/Physical Inspection

CAUTION: Use the connector test adapter kit EL-35616-F for any test that requires probing the following items:

- **The control module harness connectors**
- **The electrical center fuse/relay cavities**
- **The component terminals**
- **The component harness connector**

Using this kit will prevent damage caused by the improper probing of connector terminals.

Several of the symptom procedures call for a careful visual and physical inspection. This can lead to correcting a condition without further tests and can save time. This inspection should include the following:

- Ensure that the control module grounds are clean, tight, and correctly located.
- Inspect cooling system hoses and pipes for splits, kinks, and improper connections. Inspect thoroughly for any type of leak or restriction.
- Inspect for a dirty or restricted radiator or HVAC condenser.
- Inspect for aftermarket devices which could affect the operation of the cooling system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect the coolant recovery reservoir for proper coolant level.

Identifying Intermittent Conditions

Many intermittent conditions occur with harness or connector movement due to engine torque, rough pavement, vibration or physical movement of a component. Refer to the following for a list to help isolate an intermittent condition:

- Water intrusion in connectors, terminals, or components
- Poor connector mating
- Terminal contact
- High circuit or component resistance-High resistance can include any resistance, regardless of the amount, which can interrupt the operation of the component.
- Harness' that are routed too tight, or chaffed circuits
- High or low ambient temperatures
- High or low engine coolant temperatures
- High underhood temperatures
- Heat build up in components or circuits due to circuit resistance, poor terminal contact, or high electrical load
- High or low system voltage
- High vehicle load conditions
- Rough road surface
- Electro-magnetic interference (EMI)/circuit interference from relays, solenoids or other electrical surge
- Incorrect installation of non-factory, aftermarket, or after factory add on accessories

If an intermittent fault is detected, refer to **Testing for Intermittent Conditions and Poor Connections** for specific strategies in diagnosing intermittent conditions.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Cooling Fan Always On**
- **Cooling Fan Inoperative**
- **Engine Overheating**
- **Loss of Coolant**
- **Thermostat Diagnosis**
- **Engine Fails To Reach Normal Operating Temperature**

COOLING FAN ALWAYS ON

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates both fans at a low speed
  - Cooling Fan Relays 2 and 3 operates one fan at a high speed
  - Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed
- Certain resistance conditions with IAT or ECT sensors may cause unwarranted cooling fan activation. If the ECM is commanding the cooling fans ON for no apparent reason and without any component or system DTCs set, the IAT or ECT sensor may be skewed. If this condition is suspected, refer to the temperature versus resistance tables in the appropriate Engine Controls subsection.

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Electrical Center Identification Views**

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.

- **If a DTC is set**

  Refer to **DTC P0480, P0481, P0691, P0692, P0693, or P0694**.

- **If no DTC is set**

3. Verify the scan tool parameters listed below display OFF:
   - Cooling Fan Relay 1 Command
   - Cooling Fan Relays 2 and 3 Command
   - **If a scan tool parameter displays ON**

     Refer to Diagnostic Aids and **Symptoms - Engine Cooling** for further diagnosis.

   - **If both scan tool parameters display OFF**
4. Verify that the fans are not activated.
   - **If a fan is operating**

     Refer to Circuit/System Testing.

   - **If both fans are OFF**
5. All OK

Circuit/System Testing

Both Cooling Fans Always ON

1. Ignition OFF, disconnect KR20C Cooling Fan Low Speed Relay, ignition ON.
2. Verify that both cooling fans are OFF.
   - **If the cooling fans are ON**
   1. Ignition OFF, disconnect the harness connector at the G10R Cooling Fan Motor-Right, ignition ON.
   2. Test for less than 1 V between KR20C Cooling Fan Low Speed Relay terminal 87/5 and ground.
      - If 1 V or greater, repair the short to voltage in the relay controlled output circuit.
   - **If the cooling fans are OFF**
3. Test or replace the KR20C Cooling Fan Low Speed Relay.

One Cooling Fan Always ON

1. Ignition OFF, disconnect the KR20D Cooling Fan High Speed Relay, ignition ON.
2. Verify the cooling fan is OFF.
   - **If the cooling fan is ON**
   1. Ignition OFF, disconnect the harness connector at the G10L Cooling Fan Motor-Left, ignition ON.
   2. Test for less than 1 V between KR20D Cooling Fan High Speed Relay terminal 30/3 and ground.
      - If 1 V or greater, repair the short to voltage in the relay controlled output circuit.
   - **If the cooling fan is OFF**
3. Test or replace the KR20D Cooling Fan High Speed Relay.

Component Testing

1. Ignition OFF.
2. Disconnect a KR20 Cooling Fan Relay.
3. Test for 70-110 Ω between terminals 85/2 and 86/1.
    - **If less than 70 Ω or greater than 110 Ω**

      Replace the KR20 cooling fan relay.

    - **If between 70-110 Ω**
4. Test for infinite resistance between the following terminals:
    - 30/3 and 86/1
    - 30/3 and 87/5
    - 30/3 and 85/2
    - 85/2 and 87/5
    - **If less than infinite resistance**

      Replace the KR20 Cooling Fan Relay.

    - **If infinite resistance**

    NOTE: **This test only applies to the speed control relay.**

5. Test for less than 2 Ω between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.
    - **If 2 Ω or greater**

      Replace the KR20E Cooling Fan Speed Control Relay.

    - **If less than 2 Ω**
6. Install a 10 A fused jumper wire between relay terminal 85 or 2 and 12 V.
7. Install a jumper wire between relay terminal 86 or 1 and ground.
8. Test for less than 2 Ω between terminals 30/3 and 87/5.
    - **If 2 Ω or greater**

      Replace the KR20 Cooling Fan Relay.

    - **If less than 2 Ω**
9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Relay Replacement (Attached to Wire Harness) **Relay Replacement (Within an Electrical Center)**

COOLING FAN INOPERATIVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The engine cooling fan system consists of a cooling fan assembly containing two electric cooling fans. The engine control module (ECM) uses two fan control circuits and a series of three relays to command the fans ON in either high speed or low speed, depending on cooling requirements. The ECM activates the applicable relay by grounding the control circuit with a solid state device called a driver. Each driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage. In low speed, both fans are turned ON at a reduced speed. High speed has both fans turned ON at full speed.

Diagnostic Aids

- The scan tool cooling fan output control operates as follows:
  - Cooling Fan Relay 1 operates both fans at a low speed
  - Cooling Fan Relays 2 and 3 operates one fan at a high speed
  - Cooling Fan Relays 1, 2 and 3 operates both fans at a high speed

Reference Information

Schematic Reference

Engine Heating/Cooling Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Electrical Center Identification Views**

Description and Operation

Cooling Fan Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P0480, P0481, P0691, P0692, P0693, or P0694 is not set.
   - **If a DTC is set**

     Refer to **DTC P0480, P0481, P0691, P0692, P0693, or P0694**.

   - **If no DTCs is set**
3. Verify that both cooling fans turn ON and OFF and operate at low and high speed, when commanding the appropriate cooling fan relays ON and OFF with a scan tool.
   - **If a cooling fan does not operate**

     Refer to Circuit/System Testing

   - **If both cooling fans operate**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect all of the KR20 Cooling Fan Relays.
2. Ignition ON, verify a test lamp illuminates between ground and the B+ circuit terminals listed below:
   - KR20C Cooling Fan Low Speed Relay B+ circuit terminal 85/2
   - KR20C Cooling Fan Low Speed Relay B+ circuit terminal 30/3
   - KR20D Cooling Fan High Speed Relay B+ circuit terminal 87/5
   - KR20D Cooling Fan High Speed Relay B+ circuit terminal 86/1
   - KR20E Cooling Fan Speed Control Relay B+ circuit terminal 86/1
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Disconnect the appropriate cooling fan fuse or power source.
   2. Test for less than 2 Ω between the fuse and the appropriate relay B+ circuit terminal, end to end.
      - If 2 Ω or greater, repair the open/high resistance in the B+ circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Connect a DMM to the appropriate relay B+ circuit terminal.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the B+ circuit.
      - If infinite resistance
   3. Disconnect the harness connector at the appropriate G10 Cooling Fan Motor.
   4. Test for infinite resistance between the appropriate relay controlled output circuit terminal and ground.
      - KR20C Cooling Fan Low Speed Relay output circuit terminal 87/5
      - KR20D Cooling Fan High Speed Relay output circuit terminal 30/3
      - KR20E Cooling Fan Speed Control Relay circuit terminal 30/3

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test or replace the appropriate G10 Cooling Fan Motor.

- **If the test lamp illuminates**

NOTE: **The following tests must be performed on both fan relay circuits.**

3. Connect a DMM, set on the diode setting, between ground and a relay control circuit terminal listed below:
   - KR20D Cooling Fan High Speed Relay terminal 85/2
   - KR20E Cooling Fan Speed Control Relay terminal 85/2
4. Verify the DMM reading is less than 1 V when commanding the cooling fan relays ON with a scan tool.
   - **If greater than 1 V or displays OL.**
   1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the appropriate cooling fan relay control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V.
   3. Ignition OFF, and all vehicle systems OFF. It may take up to 2 minutes for all vehicle systems to power down.
   4. Test for less than 2 Ω between the KR20E Cooling Fan Speed Control Relay terminal 85/2 and KR20D Cooling Fan High Speed Relay terminal 85/2.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If less than 1 V**
5. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the G10L Cooling Fan Motor-Left. It may take up to 2 minutes for all vehicle systems to power down.
6. Test for less than 5 Ω between the circuits listed below and ground:
   - G10L Cooling Fan Motor-Left terminal A
   - KR20E Cooling Fan Speed Control Relay terminal 87/5
   - **If 5 Ω or greater**
   1. Ignition OFF and all vehicle systems OFF, it may take up to 2 minutes for all vehicle systems to power down.
   2. Test for less than 2 Ω in the appropriate ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 5 Ω**
7. Connect the harness connector at the G10L Cooling Fan Motor-Left.
8. Connect a 50 A fused jumper between the KR20D Cooling Fan High Speed Relay terminals 30/3 and 87/5.
9. Ignition ON, verify the G10L Cooling Fan Motor-Left is activated at high speed.

- **If the cooling fan does not activate or jumper fuse opens**

1. Disconnect the harness connector at the G10L Cooling Fan Motor-Left.
2. Test for less than 2 Ω in the circuit between KR20D Cooling Fan High Speed Relay terminal 30/3 and the G10L Cooling Fan Motor-Left terminal B.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the G10L Cooling Fan Motor-Left.

- **If the cooling fan activates**

10. Ignition OFF, connect a fused jumper between the KR20E Cooling Fan Speed Control Relay switch circuit terminal 30/3 and the ground circuit terminal 87/5.
11. Connect a 40 A fused jumper between the KR20C Cooling Fan Low Speed Relay terminals 30/3 and 87/5.
12. Ignition ON, verify the G10R Cooling Fan Motor-Right is activated at high speed.

- **If the cooling fan does not activate**

1. Disconnect the harness connector at the G10R Cooling Fan Motor-Right.
2. Test for less than 2 Ω in the circuit between KR20C Cooling Fan Low Speed Relay terminal 87/5 and the G10R Cooling Fan Motor-Right terminal B.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω
3. Test for less than 2 Ω in the circuit between KR20E Cooling Fan Speed Control Relay terminal 30/3 and the G10R Cooling Fan Motor-Right terminal A.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the G10R Cooling Fan Motor-Right.

- **If the cooling fan activates**

13. Ignition OFF, Install the KR20E Cooling Fan Speed Control Relay.
14. Ignition ON, verify both fan motors activate at low speed.

- **If both cooling fans do not activate at low speed**

1. Disconnect both cooling fan motor harness connectors and the KR20E Cooling Fan Speed Control Relay.
2. Test for less than 2 Ω in circuit between KR20E Cooling Fan Speed Control Relay terminal 87A/4 and the G10L Cooling Fan Motor-Left terminal B.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω
3. Test for infinite resistance between KR20E Cooling Fan Speed Control Relay terminal listed below and ground.
    - KR20E Cooling Fan Speed Control Relay terminal 30/3
    - KR20E Cooling Fan Speed Control Relay terminal 87A/4
    - If less than infinite, repair the short to ground in the circuit.
    - If infinite, replace the KR20E cooling fan speed control relay.

- **If both cooling fans activate**

15. Ignition OFF, test or replace the cooling fan relay listed below as appropriate:

- KR20C Cooling Fan Low Speed Relay
- KR20D Cooling Fan High Speed Relay

Component Testing

1. Ignition OFF.
2. Disconnect a KR20 Cooling Fan Relay.
3. Test for 70-110 Ω between terminals 85/2 and 86/1.
   - **If less than 70 Ω or greater than 110 Ω**

     Replace the KR20 cooling fan relay.

   - **If between 70-110 Ω**
4. Test for infinite resistance between the following terminals:
   - 30/3 and 86/1
   - 30/3 and 87/5
   - 30/3 and 85/2
   - 85/2 and 87/5
   - **If less than infinite resistance**

     Replace the KR20 Cooling Fan Relay.

   - **If infinite resistance**

   NOTE: **This test only applies to the speed control relay.**

5. Test for less than 2 Ω between KR20E Cooling Fan Speed Control Relay terminals 30/3 and 87A/4.
   - **If 2 Ω or greater**

     Replace the KR20E Cooling Fan Speed Control Relay.

   - **If less than 2 Ω**
6. Install a 20 A fused jumper wire between relay terminal 85/2 and 12 V.
7. Install a jumper wire between relay terminal 86/1 and ground.
8. Test for less than 2 Ω between terminals 3/30 and 87/5.
   - **If 2 Ω or greater**

     Replace the KR20 Cooling Fan Relay.

   - **If less than 2 Ω**
9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

- **Engine Coolant Fan Shroud Replacement**

ENGINE OVERHEATING

Step	Action	Yes	No
DEFINITION: The engine temperature lamp comes on and stays on, or temperature gauge shows hot, or coolant overflows from the surge tank onto the ground while the engine is running.			
1	Check for a loss of coolant. Refer to **Loss of Coolant**. Is there a loss of coolant?	Go to **Step 2**	Go to **Step 3**
2	Fill the system to the specified level. Refer to **Cooling System Draining and Filling**. Does the engine still overheat?	Go to **Step 3**	System OK
3	Check for kinked or pinched surge tank hoses, especially at the radiator. Are any surge tank hoses kinked or pinched?	Go to **Step 4**	Go to **Step 5**
4	1. Relieve any kinks by rerouting the hoses. 2. Replace the hoses, if necessary. Does the engine still overheat?	Go to **Step 5**	System OK
5	Check for loose, missing, or damaged radiator air seals or deflectors. Are there any loose, missing, or damaged radiator air seals or deflectors?	Go to **Step 6**	Go to **Step 7**
6	Repair or replace any loose, missing, or damaged radiator air seals or deflectors. Does the engine still overheat?	Go to **Step 7**	System OK
7	Check the coolant concentration. Does the coolant concentration test correctly?	Go to **Step 9**	Go to **Step 8**
8	Replace the coolant, if necessary. Refer to **Cooling System Draining and Filling**. Does the engine still overheat?	Go to **Step 9**	System OK
9	IMPORTANT: Use the correct pressure cap. Check the system for loss of pressure.Is there a loss of pressure?	Go to **Step 10**	Go to **Step 11**
10	Repair any leaks, as necessary. Does the engine still overheat?	Go to **Step 11**	System OK
11	Check for a faulty engine coolant temperature (ECT) sensor. Is the ECT sensor faulty?	Go to **Step 12**	Go to **Step 13**
12	Replace the ECT sensor. Refer to **Engine Coolant Temperature Sensor Replacement** for the 3.6L engine. Does the engine still overheat?	Go to **Step 13**	System OK

Step	Action	Yes	No
13	Check the radiator for any air flow obstructions or bent fins. Is there any airflow obstruction or bent fins?	Go to **Step 14**	Go to **Step 15**
14	1. Remove or relocate add-on parts that block air flow to the radiator. 2. Clean any debris from the radiator core. Does the engine still overheat?	Go to **Step 15**	System OK
15	Check for any blocked cooling system passages. Are there any blocked cooling system passages?	Go to **Step 16**	Go to **Step 17**
16	1. Remove any obstruction. 2. Flush the cooling system as required. Refer to **Flushing**. 3. Refill the coolant. Refer to **Cooling System Draining and Filling**. Does the engine still overheat?	Go to **Step 17**	System OK
17	Check for an inoperative cooling fan. Is the cooling fan inoperative?	Go to **Step 18**	Go to **Step 19**
18	Replace the cooling fan. Refer to **Engine Coolant Fan Motor Replacement**. Does the engine still overheat?	Go to **Step 19**	System OK
19	Check for a thermostat that is stuck closed. Is the thermostat stuck closed?	Go to **Step 20**	Go to **Step 21**
20	Replace the thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement**. Does the engine still overheat?	Go to **Step 21**	System OK
21	Check for a faulty water pump. The impeller blades may be eroded or broken. Is the water pump faulty?	Go to **Step 22**	-
22	Replace the water pump. Refer to **Water Pump Replacement**. Does the engine still overheat?	-	System OK

LOSS OF COOLANT

Step	Action	Yes	No
DEFINITION: The cooling system is loosing coolant either internally or externally.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to **Step 2**	Go to **Symptoms - Engine Cooling**
2	Repair any present DTCs. Refer to **Diagnostic Starting Point - Vehicle** . Is the action complete?	Go to **Step 3**	-

Step	Action	Yes	No
3	Inspect the coolant level. Is the coolant at the proper level?	Go to **Step 5**	Go to **Step 4**
4	Fill the cooling system to the proper level. Refer to **Cooling System Draining and Filling**. Is the action complete?	Go to **Step 5**	-
5	If the engine is suspected to have a coolant leak into a cylinder, the coolant can hydraulically lock the engine. Does the engine crankshaft rotate?	Go to **Step 6**	Go to **Step 28**
6	Engine overheating can cause a loss of coolant. Is the engine overheating?	Go to **Step 27**	Go to **Step 7**
7	Extended operation with a low coolant level can cause engine internal component failure. Is the engine knocking?	Go to **Step 31**	Go to **Step 8**
8	1. Idle the engine at normal operating temperature. 2. Inspect for heavy white smoke coming out of the exhaust pipe. Is a heavy white smoke present from the exhaust pipe?	Go to **Step 9**	Go to **Step 10**
9	• Coolant in the exhaust system creates a distinctive, burning coolant odor in the exhaust. • Condensation in the exhaust system can cause an odorless white smoke during engine warm up. Does the white smoke have a burning coolant type odor?	Go to **Step 30**	Go to **Step 10**
10	**WARNING:** **Refer to Moving Parts and Hot Surfaces Warning .** With the engine idling, inspect the coolant recovery system.Does the coolant recovery system discharge coolant while the engine is idling?	Go to **Step 15**	Go to **Step 11**
11	Visually inspect the hoses, pipes and hose clamps at the following locations: • Coolant bypass • Coolant reservoir • Heater core • Radiator	Go to **Step 22**	Go to **Step 12**

Step	Action	Yes	No
	Are any of the hoses, clamps or pipes leaking?		
12	Visually inspect the following components: • Block heater • Coolant pressure cap • Core plugs • Cylinder head gaskets • Engine block • Intake manifold • Radiator • Thermostat housing • Water pump Are any of the listed components leaking?	Go to **Step 22**	Go to **Step 13**
13	1. Pressure test the cooling system. Refer to **Cooling System Leak Testing**. 2. With the cooling system pressurized, visually inspect the components listed in steps 11 and 12. Are any leaks present?	Go to **Step 22**	Go to **Step 14**
14	Pressure test the coolant pressure cap. Refer to **Pressure Cap Testing**. Does the coolant pressure cap hold pressure?	Go to **Step 16**	Go to **Step 23**
15	Pressure test the coolant pressure cap. Refer to **Pressure Cap Testing**. Does the coolant pressure cap hold pressure?	Go to **Step 32**	Go to **Step 23**
16	Inspect for the following conditions: • A coolant smell inside of the vehicle • Coolant in the HVAC module drain tube • Coolant on the vehicles floor covering near the HVAC module Is coolant present?	Go to **Step 24**	Go to **Step 17**
17	1. Add 30 ml (1 oz) of GM P/N 89022219 (Canadian P/N 89022220) Canada Extended Life Coolant Leak Detection Dye to the cooling system for each 15 liters (4 gal) of coolant. Refer to **Approximate Fluid Capacities** . 2. Start the vehicle and allow the engine to reach normal operating temperature.	Go to **Step 22**	Go to **Step 18**

Step	Action	Yes	No
	3. Shut the engine off. 4. Use **J 42220** Universal 12V Leak Detection Lamp to visually inspect the components listed in steps 11 and 12. Are any leaks present?		
18	Use the **J 42220** Universal 12V Leak Detection Lamp to inspect for the following conditions: • Coolant dye in the HVAC module drain tube • Coolant dye on the vehicle floor covering near the HVAC module Is the coolant dye present?	Go to **Step 24**	Go to **Step 19**
19	Inspect the underside of the engine oil fill cap for a gray/white milky substance. Is there a milky substance on under the oil fill cap?	Go to **Step 20**	Go to **Step 21**
20	Inspect the engine oil fluid level indicator for a gray/white milky substance. Is there a milky substance on the engine fluid level indicator?	Go to **Step 30**	Go to **Step 21**
21	Inspect the automatic transmission oil fluid level indicator for a gray/white milky substance. Is there a milky substance on the automatic transmission fluid level indicator?	Go to **Step 25**	Go to **Step 33**
22	Repair or replace the leaking component. Refer to the appropriate repair. Is the repair complete?	Go to **Step 33**	-
23	Replace the coolant pressure cap. Is the repair complete?	Go to **Step 33**	-
24	Replace the heater core. Refer to **Heater Core Replacement** . Is the repair complete?	Go to **Step 33**	-
25	1. Remove the transmission oil cooler lines from the radiator. 2. Pressure test the cooling system. Refer to **Cooling System Leak Testing**. 3. Inspect the transmission oil cooler for coolant. Is coolant present?	Go to **Step 26**	Go to **Step 27**
26	1. Replace the radiator. Refer to **Radiator Replacement**. 2. Service the automatic transmission. Refer to	Go to **Step 33**	-

Step	Action	Yes	No
	Engine Coolant/Water in Transmission . Is the repair complete?		
27	Install the cooler lines to the radiator. Is the repair complete?	Go to **Step 33**	-
28	Repair the engine no crank condition. Refer to the following: **Engine Will Not Crank - Crankshaft Will Not Rotate** Is the repair complete?	Go to **Step 33**	-
29	Repair the engine overheating condition. Refer to **Engine Overheating**. Is the repair complete?	Go to **Step 33**	-
30	Repair the engine internal coolant leak. Refer to the following: • **Coolant in Combustion Chamber** • **Coolant in Engine Oil** Is the repair complete?	Go to **Step 33**	-
31	Repair the engine knock. Refer to the following: **Lower Engine Noise, Regardless of Engine Speed** Is the repair complete?	Go to **Step 33**	-
32	Repair the combustion pressure in the cooling system problem. Refer to the following: **Cylinder Leakage Test** Is the repair complete?	Go to **Step 33**	-
33	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to **Step 2**

THERMOSTAT DIAGNOSIS

Thermostat Test Procedure Using Glycol

Inspect the operation of the thermostat by hanging the thermostat on a hook in a 33 percent glycol solution.

In order to inspect if the thermostat valve is opening properly, perform the following test:

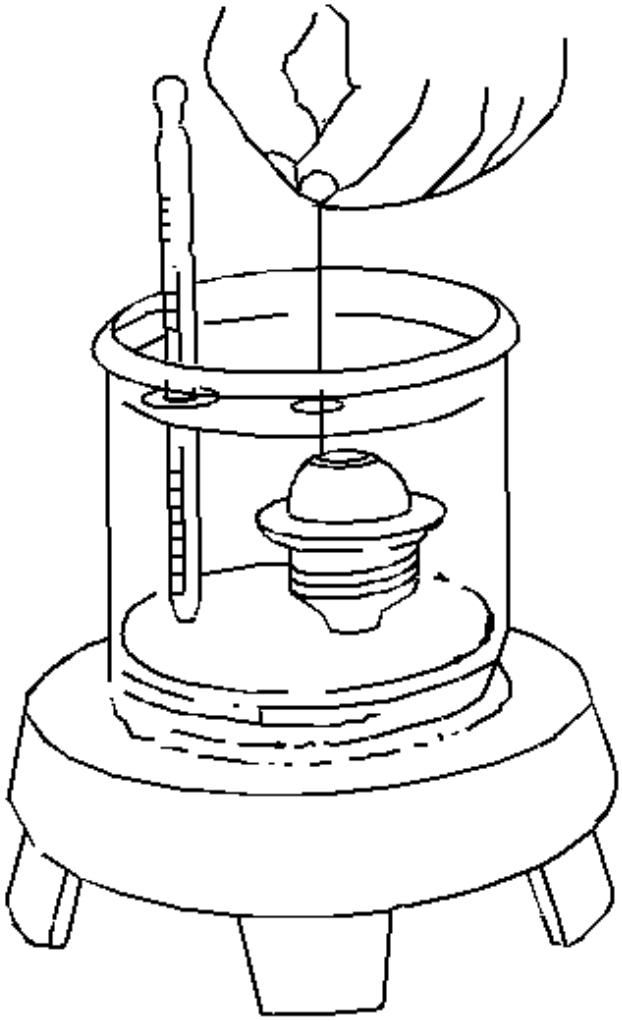


Fig. 2: View Of Thermostat Test Procedure Using Glycol
Courtesy of GENERAL MOTORS COMPANY

1. Completely submerge the thermostat in a glycol solution. The solution should be 11Â°C (22Â°F) above the temperature indicated on the thermostat valve.
2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should open.

In order to inspect if the thermostat valve is closing properly, perform the following test:

1. Completely submerge the thermostat in a glycol solution. The solution should be 6Â°C (10Â°F) below the temperature indicated on the thermostat valve.
2. Thoroughly agitate the solution. Under these conditions, the thermostat valve should close completely.

ENGINE FAILS TO REACH NORMAL OPERATING TEMPERATURE

Step	Action	Value(s)	Yes	No
1	Check the coolant level in the radiator surge	-	Go to **Step 3**	Go to **Step 2**

Step	Action	Value(s)	Yes	No
	tank. Refer to **Cooling System Draining and Filling**. Is the coolant at the proper level?			
2	Add coolant to the radiator surge tank as necessary. Does the engine still fail to reach normal operating temperatures?	-	Go to **Step 3**	System OK
3	Check for a blockage in the coolant passages. Are there any blockages in the coolant passages?	-	Go to **Step 4**	Go to **Step 5**
4	Flush the cooling system or flow check the radiator. Refer to **Flushing**. Does the engine still fail to reach normal operating temperatures?	-	Go to **Step 5**	System OK
5	Check to see if the incorrect thermostat was installed or if it is stuck or sticks in the open position. Was the incorrect thermostat installed, or is it stuck or does it stick in the open position?	-	Go to **Step 6**	-
6	Replace the thermostat housing. Refer to **Engine Coolant Thermostat Housing Replacement**. Does the engine still fail to reach normal operating temperature?	-	-	System OK

PRESSURE CAP TESTING

Special Tools

- **J 24460-01** Cooling System Pressure Tester
- **J 42401** Radiator Cap/Surge Tank Test Adapter

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

1. Remove the pressure cap.
2. Wash the pressure cap sealing surface with water.

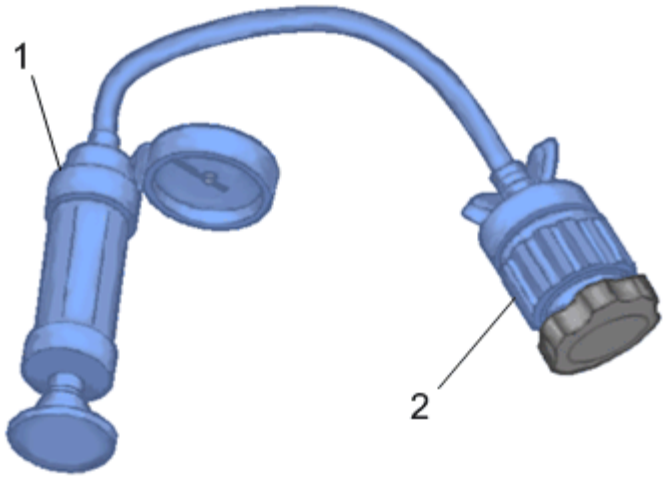


Fig. 3: Identifying Pressure Cap Tester
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Lubricate J-42401 and pressure cap o-rings with coolant and press cap to seat o-ring on J-42401 before turning to engage threads.**

3. Use the **J 24460-01** Cooling System Pressure Tester (1) with **J 42401** Radiator Cap/Surge Tank Test Adapter (2) in order to test the pressure cap.
4. Test the pressure cap for the following conditions:
   - Pressure release when the **J 24460-01** Cooling System Pressure Tester exceeds the pressure rating of the pressure cap.
   - Maintain the rated pressure for at least 10 seconds.

     Note the rate of pressure loss.
5. Replace the pressure cap under the following conditions:
   - The pressure cap does not release pressure which exceeds the rated pressure of the cap.
   - The pressure cap does not hold the rated pressure.

COOLANT LEAK TESTING

Special Tools

- **J 24460-01** Cooling System Pressure Tester
- **J 42401** Radiator Cap/Surge Tank Test Adapter

WARNING: **Under pressure, the temperature of the solution in the radiator can be considerably higher, without boiling. Removing the radiator cap while the**

engine is hot (pressure is high), will cause the solution to boil instantaneously, with explosive force. The solution will spew out over the engine, fenders, and the person removing the cap. Serious bodily injury may result. Flammable antifreeze, such as alcohol, is not recommended for use at any time. Flammable antifreeze could cause a serious fire.

WARNING: In order to help avoid being burned, do not remove the radiator cap while the engine and the radiator are hot. Scalding fluid and steam can be blown out under pressure if the cap is removed too soon.

1. Remove the pressure cap.
2. Test the operation of the pressure cap. Refer to **Pressure Cap Testing**.
3. Wash the pressure cap mating surface with water.

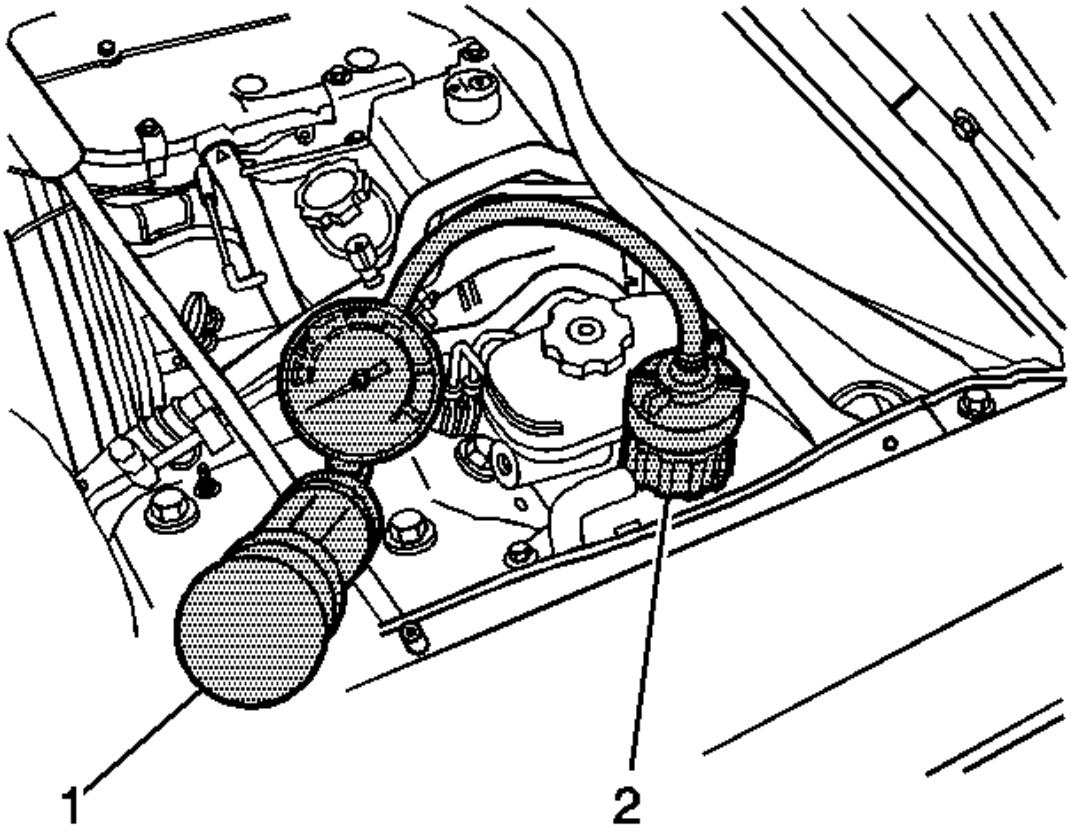


Fig. 4: Applying Pressure To Cooling System
Courtesy of GENERAL MOTORS COMPANY

4. Use the **J 24460-01** Cooling System Pressure Tester (1) with **J 42401** Radiator Cap/Surge Tank Test Adapter (2) in order to apply pressure to the cooling system.

Do not exceed the pressure cap rating.

5. The cooling system should hold the rated pressure for at least 2 minutes.

   Observe the gauge for any pressure loss.

6. Repair any leaks as required.

REPAIR INSTRUCTIONS

COOLING SYSTEM DRAINING AND FILLING

Special Tools

J 26568 Coolant and Battery Tester

Draining Procedure

WARNING: To avoid being burned, do not remove the radiator cap or surge tank cap while the engine is hot. The cooling system will release scalding fluid and steam under pressure if radiator cap or surge tank cap is removed while the engine and radiator are still hot.

NOTE: Draining the cooling system with the pressure cap installed will syphon the coolant from the overflow tank.

1. Remove the coolant pressure cap.
2. Remove the right front fender liner to gain access to the drain plug. Refer to **Front Fender Liner Replacement** .
3. Place a drain pan under the drain cock.
4. Open the radiator drain cock.
5. Drain the cooling system.
6. If a complete engine block drain is required, remove the coolant drain plugs from the engine block.
7. Inspect the coolant.
8. Follow the appropriate procedure based on the condition of the coolant.
   - Normal in appearance-Follow the filling procedure.
   - Discolored-Follow the flush procedure. Refer to **Flushing**.

Filling Procedure

CAUTION: The procedure below must be followed. Improper coolant level could result in a low or high coolant level condition, causing engine damage.

CAUTION: Use the correct fastener in the correct location. Replacement fasteners must be the correct part number for that application. Fasteners requiring replacement or fasteners requiring the use of thread locking compound or sealant are identified in the service procedure. Do not use paints,

lubricants, or corrosion inhibitors on fasteners or fastener joint surfaces unless specified. These coatings affect fastener torque and joint clamping force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems.

1. Close the radiator drain cock.
2. Install the right front fender liner. Refer to **Front Fender Liner Replacement** .
3. If a complete engine block drain was required, install the coolant drain plugs to the engine block. .

NOTE: **Use a 50/50 mixture of DEX-COOL antifreeze and clean, drinkable water.**

4. Slowly fill the cooling system with a 50/50 coolant mixture until the coolant level is visible and stable. Refer to **Approximate Fluid Capacities** .
5. Install the pressure cap loosely (threaded on about one turn).
6. Start the engine and raise the engine speed to 2500 RPM and hold it there for 40 seconds, then shut engine off.
7. Remove the pressure cap and fill the coolant system until the level is visible and stable.
8. Install the pressure cap loosely (threaded on about one turn).
9. Start the engine and raise the engine speed to 2500 RPM and hold it there for 30 seconds, then shut engine off.
10. Remove the pressure cap and fill the coolant system until the level is visible and stable.
11. Install the pressure cap loosely (threaded on about one turn).
12. Start the engine and raise the engine speed to 2500 RPM and hold it there for 20 seconds, then shut engine off.
13. Remove the pressure cap and fill the coolant system until the level is visible and stable.
14. Install the pressure cap, fully threaded on.
15. Fill the coolant recovery bottle to the indicator line, then add 400 milliliters (13.5 ounces) more.
16. Start the engine and run it above 2500 RPM until it is hot enough to open the thermostat, this will allow the trapped air to be purged from the engine.
17. Complete a series of three, 4-second-duration idles with 4-second-duration 3000 RPM cycles.
18. Turn the engine off and allow it to cool down to room temperature.
19. Fill the coolant recovery bottle to the indicator line.
20. Inspect the concentration of the engine coolant using the **J 26568** tester.
21. Rinse away any excess coolant from the engine and the engine compartment.

FLUSHING

NOTE:

- **When the cooling system becomes contaminated, the cooling system should be flushed thoroughly to remove the contaminants before the engine is seriously damaged.**
- **This procedure is effective in removing contaminants caused by the use of improper coolants, coolant at the end of its life, or some liquid chemical**

flushing agents. This procedure is NOT effective for removing debris contamination caused by component failure, or the use of 'stop leak' additives. When the system is contaminated by this type of debris, use the system flow diagrams to identify components that may need replacement to restore proper system flow.

- **Do not use chemical flush agents.**
- **Store used coolant in the proper manner, such as in a used engine coolant holding tank. Do not pour used coolant down a drain. Ethylene glycol antifreeze is a very toxic chemical. Do not dispose of coolant into the sewer system or ground water. This is illegal and ecologically unsound.**
- **Various methods and equipment can be used to flush the cooling system. If special equipment is used, such as a back flusher, follow the manufacturer's instruction. Always remove the thermostat before flushing the cooling system.**

1. Drain the cooling system. **Cooling System Draining and Filling**.
2. Remove the radiator surge tank. **Radiator Surge Tank Replacement**.
3. Clean and flush the coolant recovery reservoir with clean, drinkable water.
4. Install the radiator surge tank. **Radiator Surge Tank Replacement**.
5. Follow the drain and fill procedure using only clean, drinkable water. **Cooling System Draining and Filling**.
6. Run the engine for 20 minutes.
7. Stop the engine.
8. Drain the cooling system. **Cooling System Draining and Filling**.
9. Repeat the procedure if necessary, until the fluid is nearly colorless.
10. Fill the cooling system. **Cooling System Draining and Filling**.

RADIATOR CLEANING

WARNING: **NEVER spray water on a hot heat exchanger. The resulting steam could cause personal injury.**

CAUTION: **The heat exchanger fins are necessary for good heat transfer. Do not brush the fins. This may cause damage to the fins, reducing heat transfer.**

NOTE: **Remove bugs, leaves, dirt and other debris by blowing compressed air through the engine side of the radiator.**

- Some conditions may require the use of warm water and a mild detergent.
- Clean the A/C condenser fins.
- Clean between the A/C condenser and radiator.
- Clean the radiator cooling fins.
- Straighten any damaged cooling fins.

RADIATOR SURGE TANK REPLACEMENT

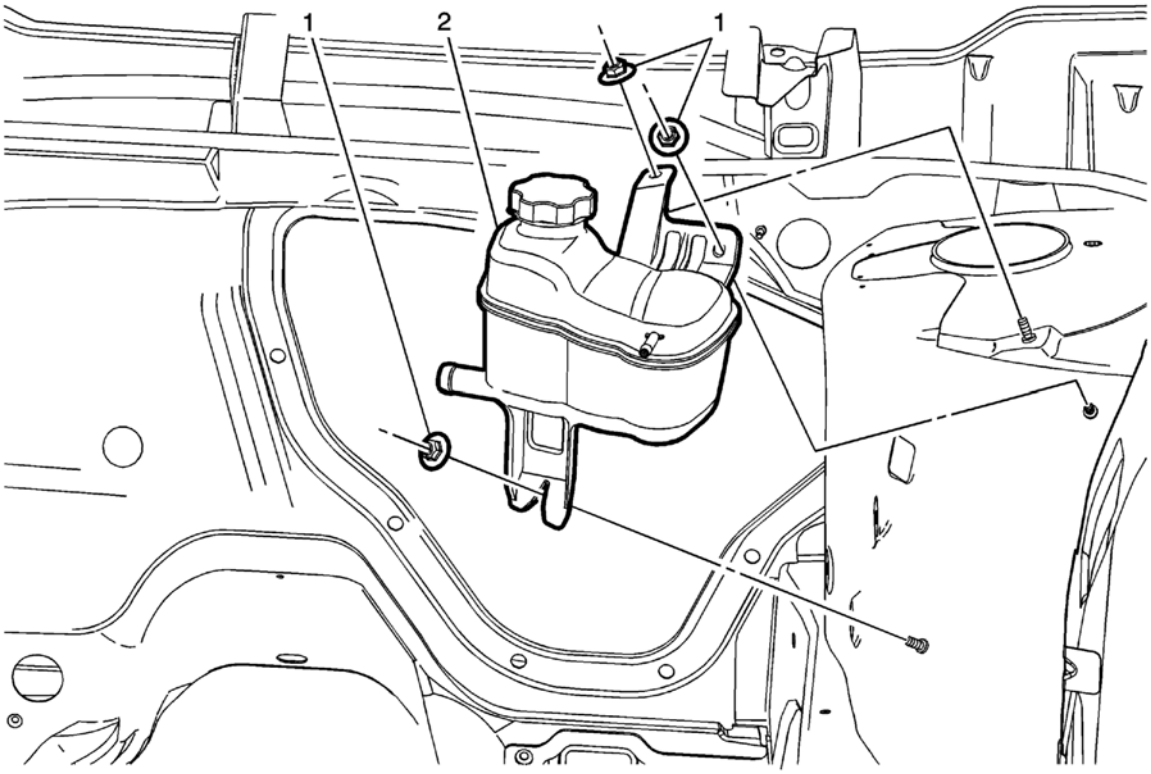


Fig. 5: Radiator Surge Tank & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 3. Remove the radiator surge tank hose. Refer to **Radiator Surge Tank Inlet Hose Replacement**. 4. Remove the radiator surge tank hose. Refer to **Radiator Surge Tank Outlet Hose Replacement**.	
1	Radiator Surge Tank Fastener (Qty: 3) **CAUTION:** **Refer to Fastener Caution .**
2	Radiator Surge Tank

RADIATOR SURGE TANK INLET HOSE REPLACEMENT

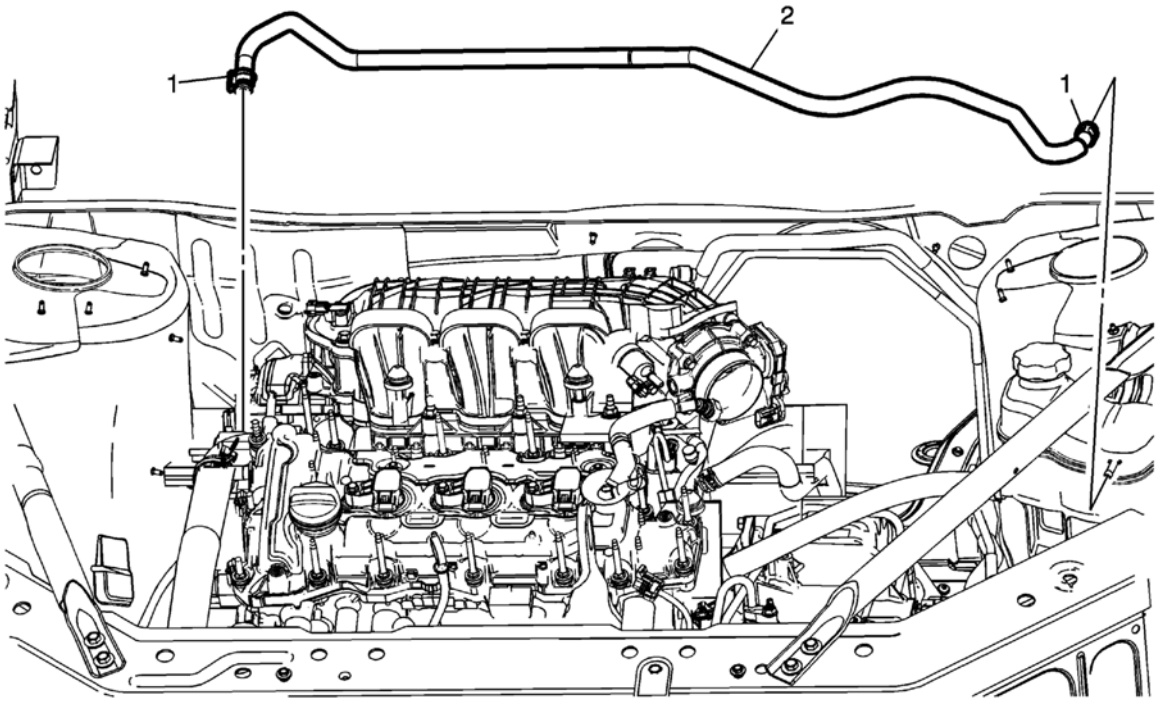


Fig. 6: Radiator Surge Tank Inlet Hose & Clamps
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** . 2. Loosen the power steering reservoir mounting hardware. Reposition the power steering reservoir without draining fluid. Refer to **Power Steering Fluid Reservoir Replacement** .	
1	Hose Clamp (Qty: 2)
2	Radiator Surge Inlet Hose

RADIATOR SURGE TANK OUTLET HOSE REPLACEMENT

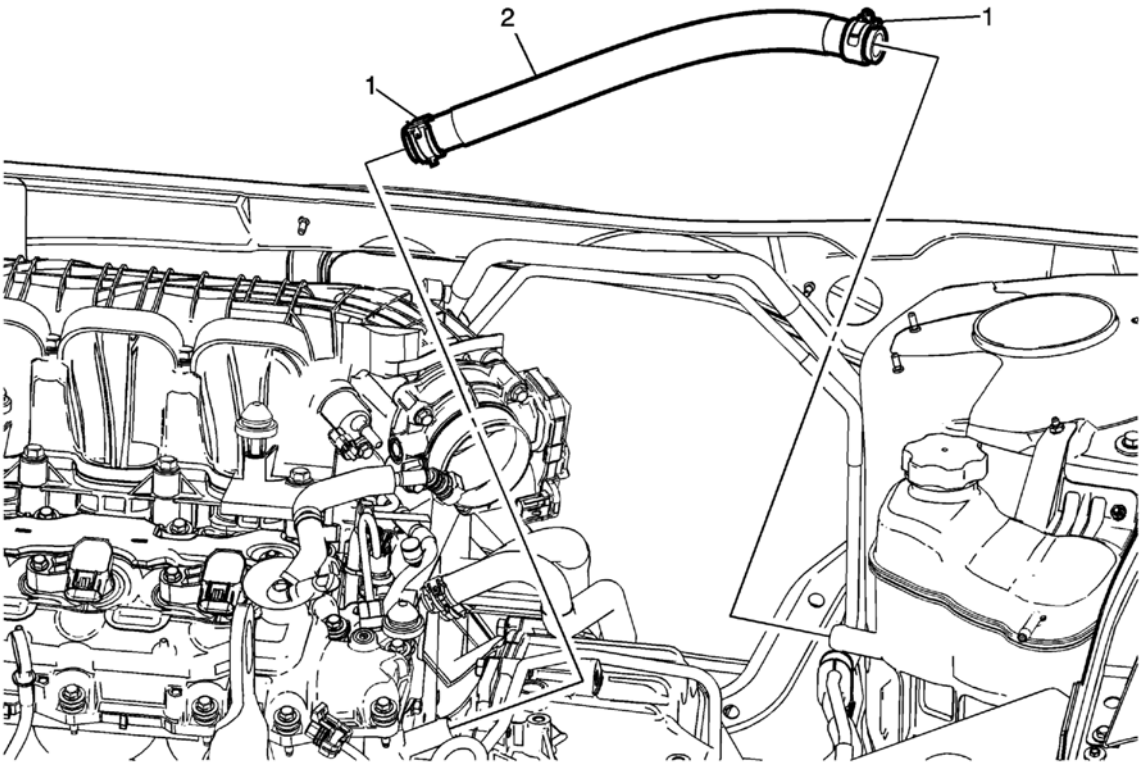


Fig. 7: Radiator Surge Tank Outlet Hose & Clamps
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Drain the cooling system. Refer to **Cooling System Draining and Filling**	
1	Radiator Surge Tank Outlet Hose Clamps(Qty: 2)
2	Radiator Surge Tank Outlet Hose

RADIATOR INLET HOSE REPLACEMENT

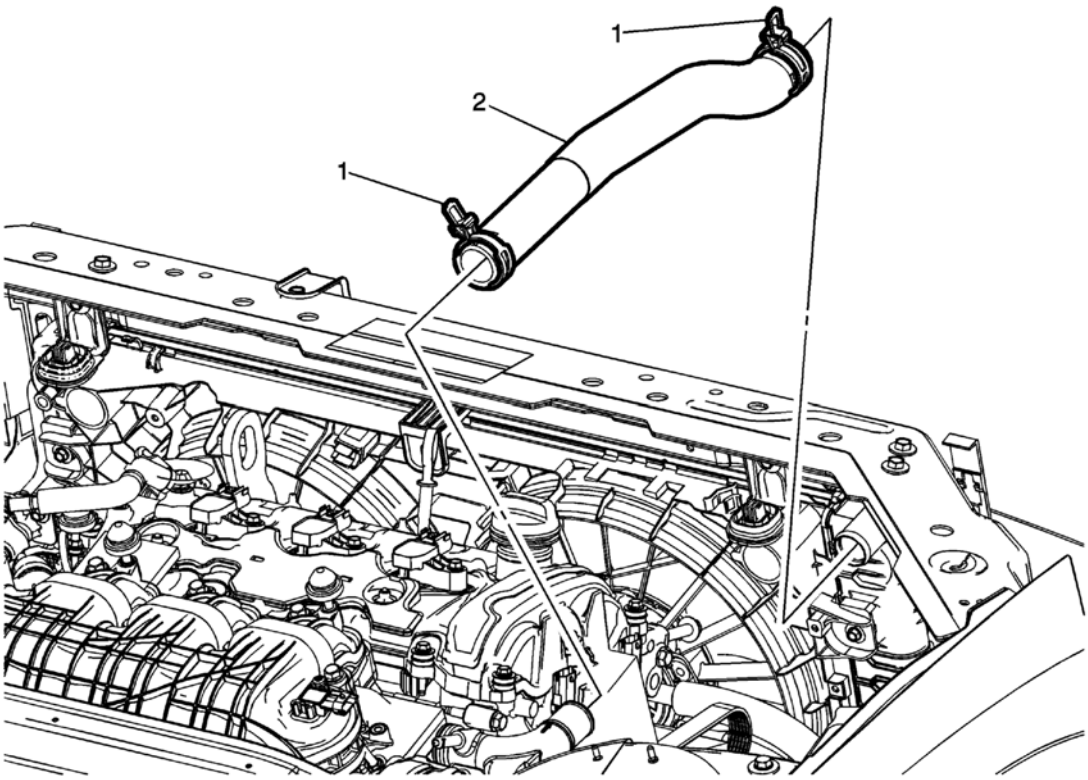


Fig. 8: Radiator Inlet Hose & Clamps
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Radiator Hoses Clamps(Qty: 2)
2	Radiator Intlet Hose

RADIATOR OUTLET HOSE REPLACEMENT

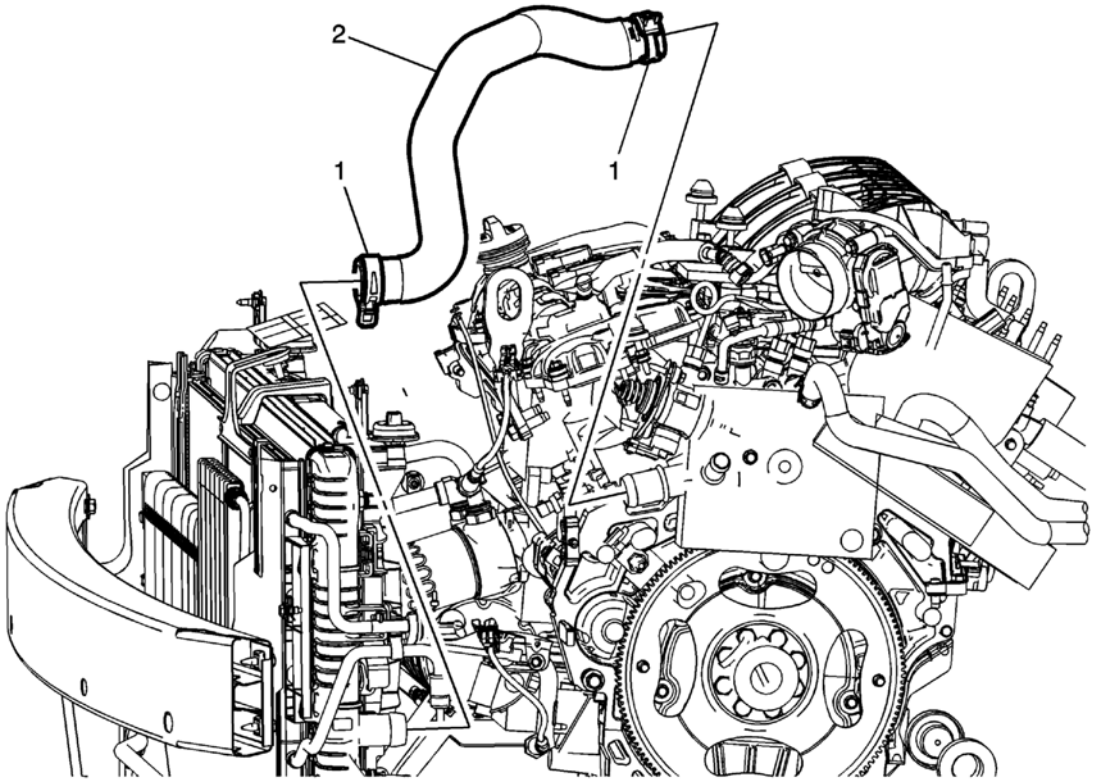


Fig. 9: Radiator Outlet Hose & Clamps
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling**. 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Radiator Hoses Clamps(Qty: 2)
2	Radiator Outlet Hose

ENGINE OIL COOLER PIPE/HOSE QUICK CONNECT FITTING REPLACEMENT

Removal Procedure

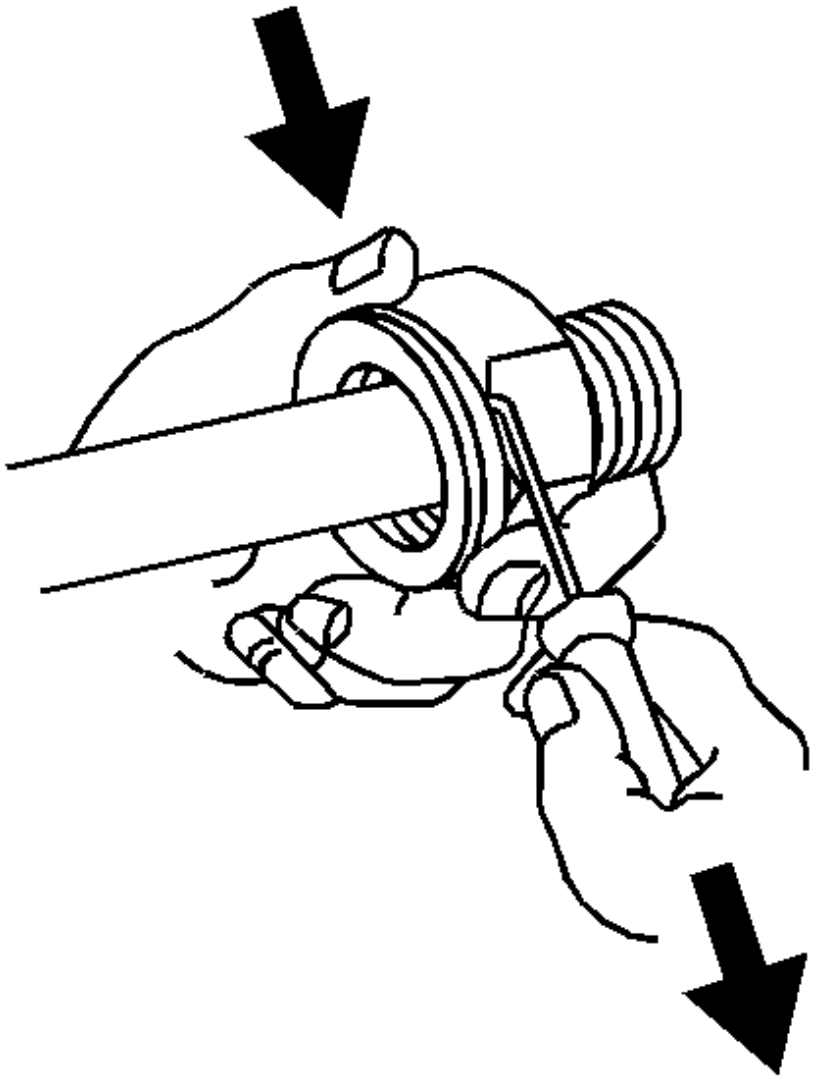


Fig. 10: Rotating Retaining Ring Using Screwdriver
Courtesy of GENERAL MOTORS COMPANY

1. Using a bent-tip screwdriver or equivalent, pull on one of the open ends of the retaining ring in order to rotate the retaining ring.
2. Rotate the retaining ring around the quick connector until the retaining ring is out of position and can be completely removed.
3. Remove the engine oil cooler line from the quick connector fitting.

   Pull the lines straight out from the connector.

4. Clean all of the components in a suitable solvent, and dry them with compressed air.
5. Inspect the fittings, the connectors, the cooler lines, and the cooler for damage, distortion, or restriction. Replace parts as necessary.

Installation Procedure

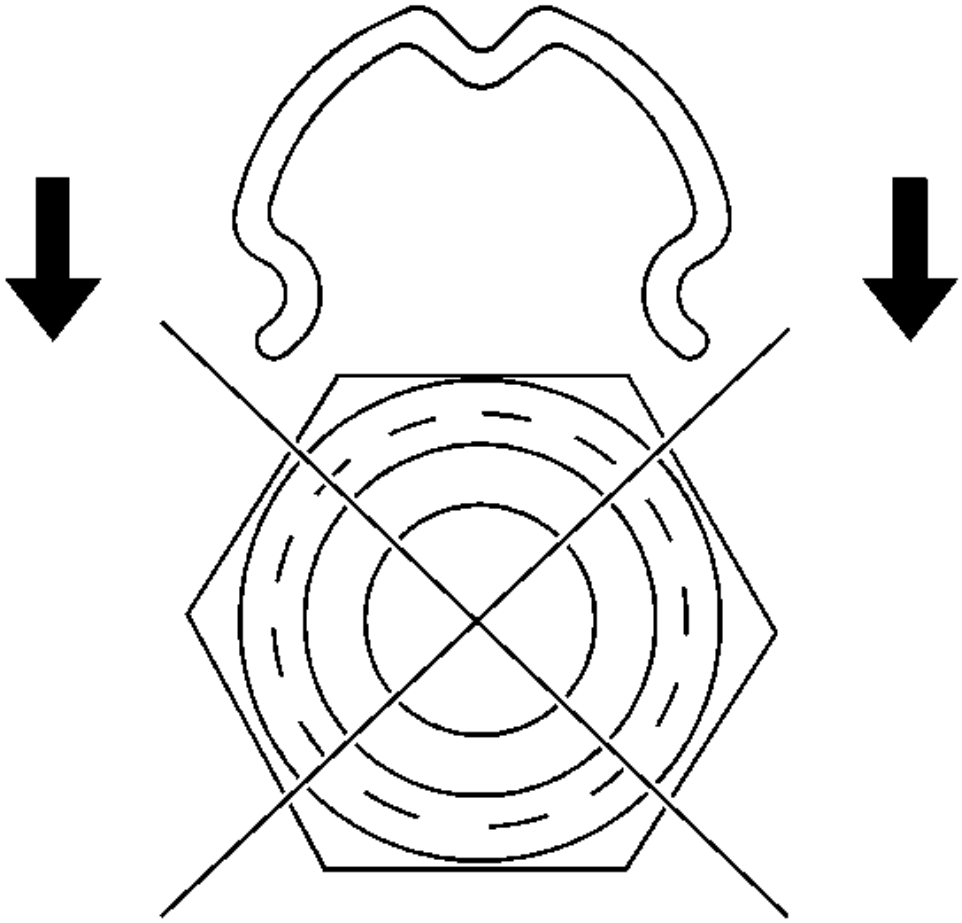


Fig. 11: View Of Retaining Ring & Quick Connector
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not install the new retaining ring onto the fitting by pushing the retaining ring down over the fitting.**

1. Install the retaining ring into each quick connector fitting.

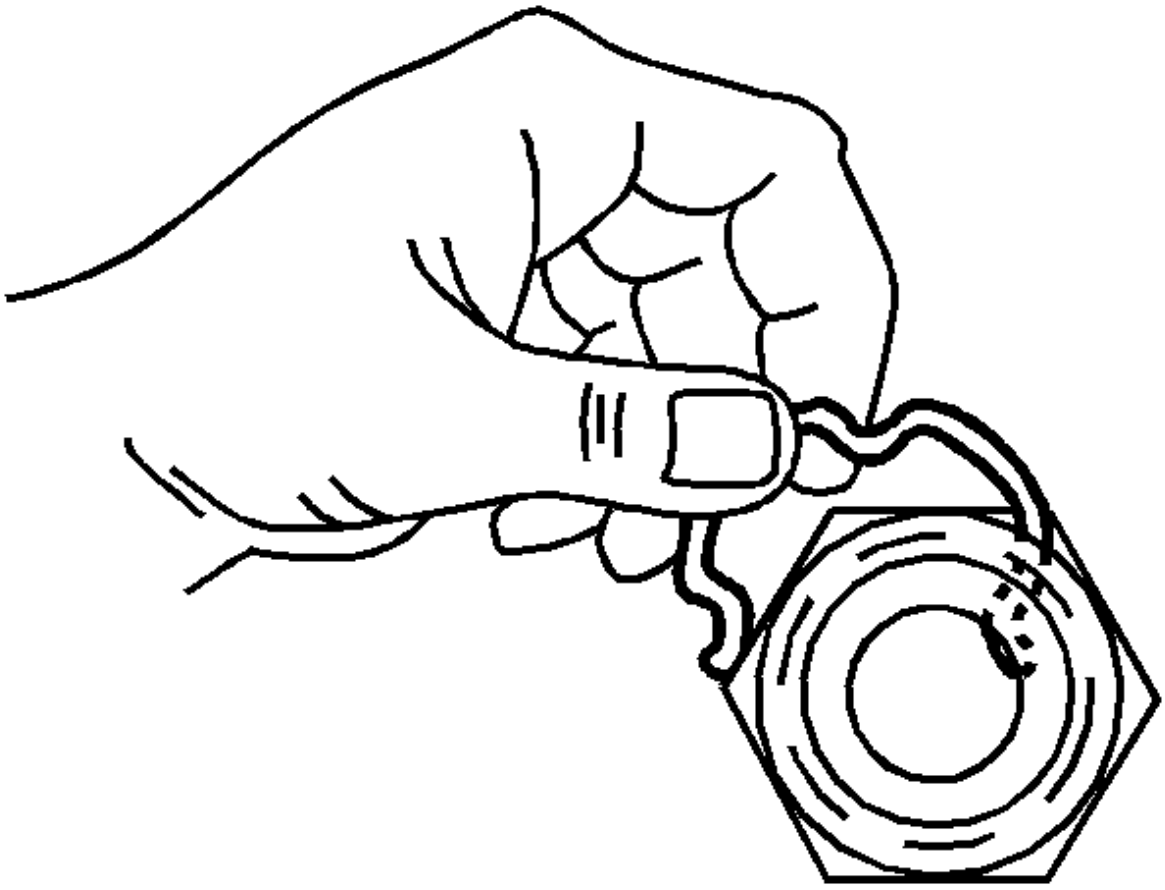


Fig. 12: Hooking Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

2. Hook one of the open ends of the retaining ring in one of the slots in the quick connector.

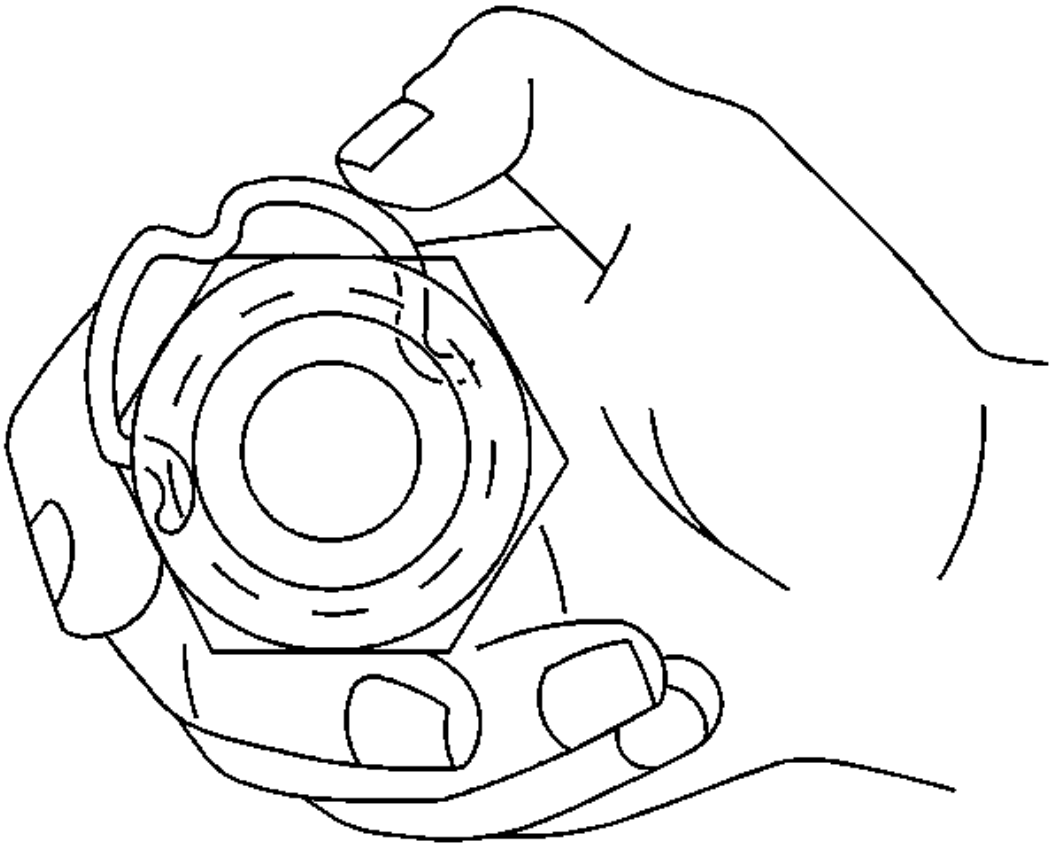


Fig. 13: View Of Retaining Ring & Connector
Courtesy of GENERAL MOTORS COMPANY

3. Rotate the retaining ring around the connector until the retaining ring is positioned with all 3 ears through the 3 slots.

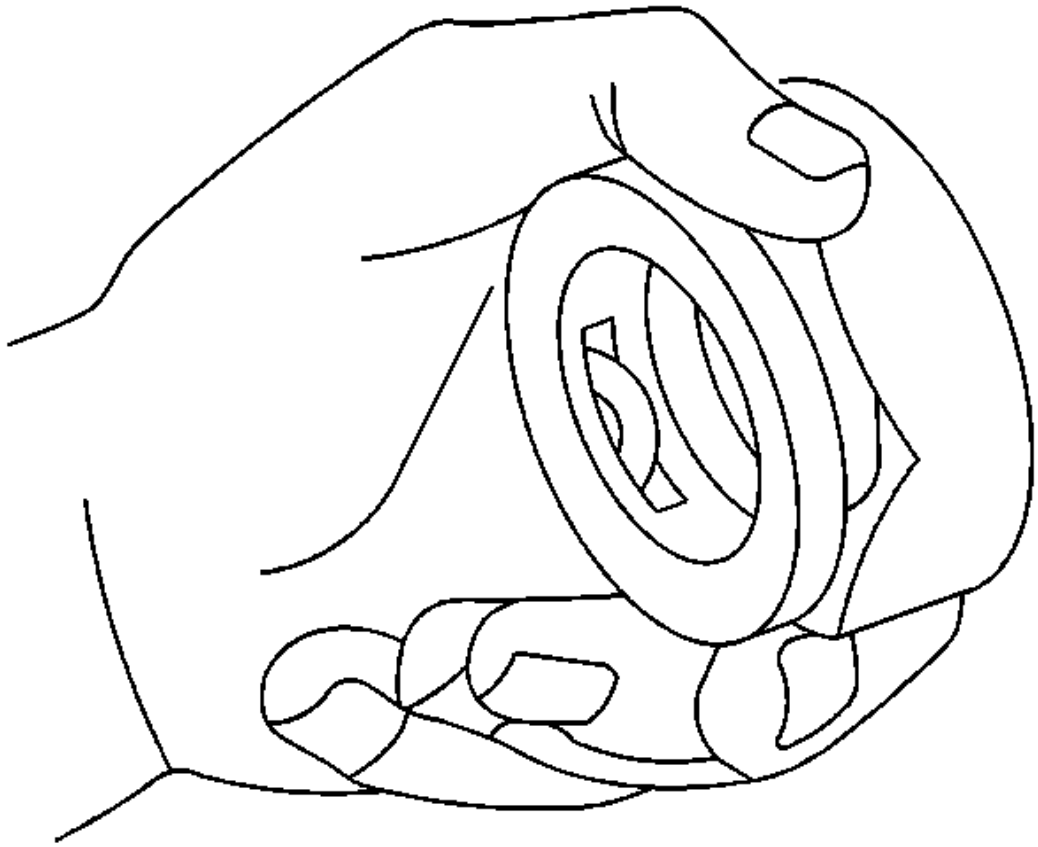


Fig. 14: View Of Retaining Ring Ears From Inside Of Connector
Courtesy of GENERAL MOTORS COMPANY

4. Ensure the 3 retaining ring ears can be seen from the inside of the connector and the retaining ring can move freely in the slots.
5. Install the engine oil cooler line into the quick connector fitting.

   Pull back on the engine oil cooler lines to ensure a proper connection.

6. Inspect and fill the engine oil to the proper level.

ENGINE OIL COOLER HOSE/PIPE REPLACEMENT

Removal Procedure

1. Remove the right engine splash shield. Refer to **Engine Splash Shield Replacement (Right)** **Engine Splash Shield Replacement (Left)** .
2. Remove the lower air baffle. Refer to **Radiator Air Lower Baffle and Deflector Replacement**.
3. Remove the support clip from the engine oil cooler lines.

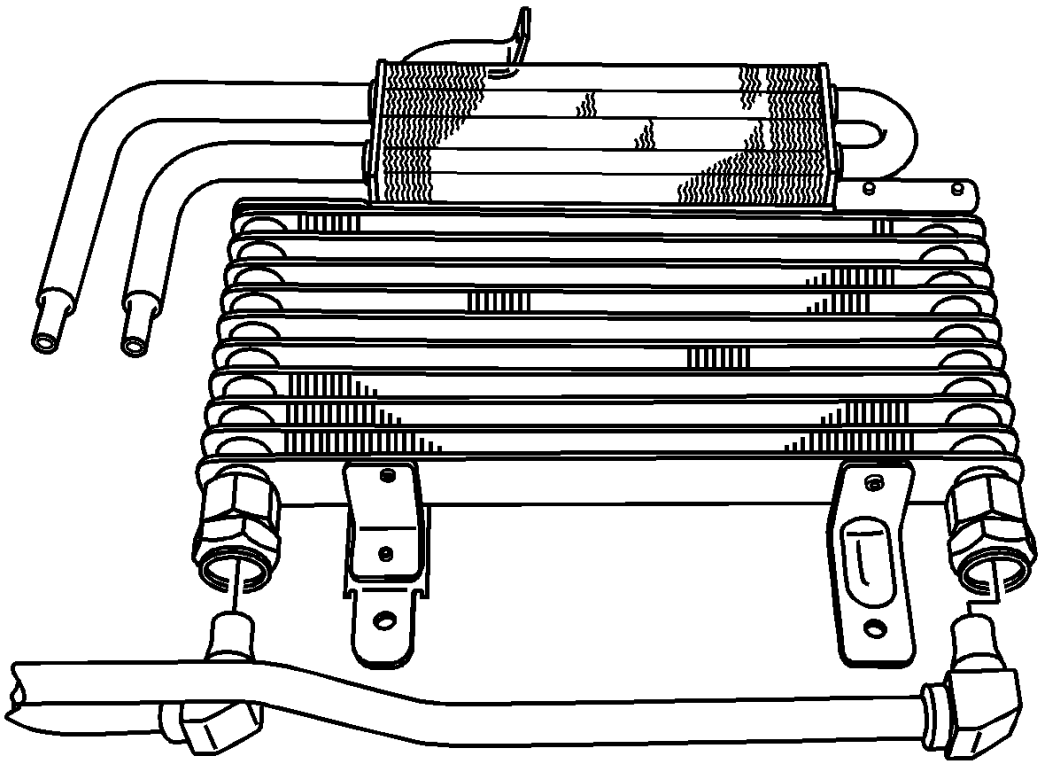


Fig. 15: Engine Oil Cooler Lines
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine oil cooler lines from the engine oil cooler. Refer to **Engine Oil Cooler Pipe/Hose Quick Connect Fitting Replacement**.
5. Remove the engine oil cooler lines from the engine oil filter adapter. Refer to **Engine Oil Cooler Pipe/Hose Quick Connect Fitting Replacement**.
6. Remove the engine oil cooler lines from the vehicle.

Installation Procedure

1. Install the engine oil cooler lines to the vehicle.

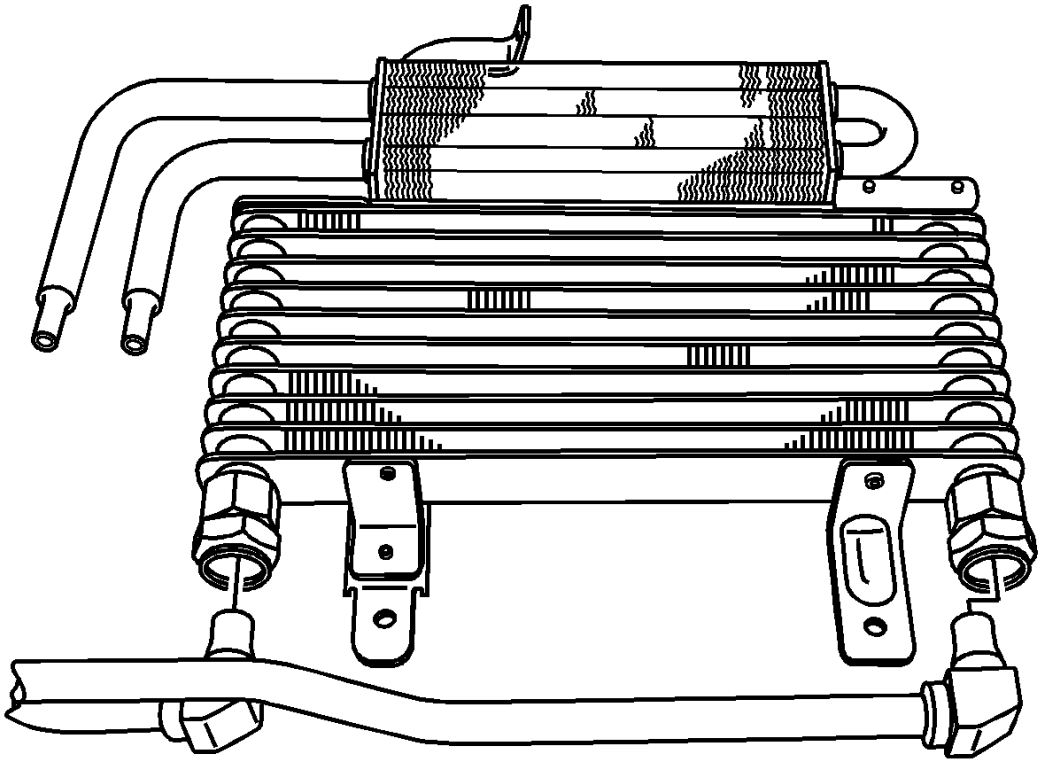


Fig. 16: Engine Oil Cooler Lines
Courtesy of GENERAL MOTORS COMPANY

2. Install the engine oil cooler lines to the engine oil cooler. Refer to **Engine Oil Cooler Pipe/Hose Quick Connect Fitting Replacement**.
3. Install the engine oil cooler lines to the engine oil filter adapter. Refer to **Engine Oil Cooler Pipe/Hose Quick Connect Fitting Replacement**.
4. Install the engine oil cooler line support clip to the engine oil cooler lines.
5. Install the right engine splash shield. Refer to **Engine Splash Shield Replacement (Right)** **Engine Splash Shield Replacement (Left)** .
6. Install the lower air baffle. Refer to **Radiator Air Lower Baffle and Deflector Replacement**.
7. Add the proper amount of engine oil.

AUXILIARY ENGINE OIL COOLER REPLACEMENT

Removal Procedure

1. Remove the upper air baffle. Refer to **Radiator Air Upper Baffle and Deflector Replacement**.
2. Remove the right engine splash shield. Refer to **Engine Splash Shield Replacement (Right)** **Engine**

Splash Shield Replacement (Left) .

3. Remove the lower air baffle. Refer to Radiator Air Lower Baffle and Deflector Replacement.
4. Remove the support clip from the engine oil cooler lines.
5. Reposition the hose clamps on the power steering cooler lines.
6. Remove the power steering oil cooler lines from the power steering cooler.
7. Remove the engine oil cooler lines from the engine oil cooler. Refer to Engine Oil Cooler Pipe/Hose Quick Connect Fitting Replacement.

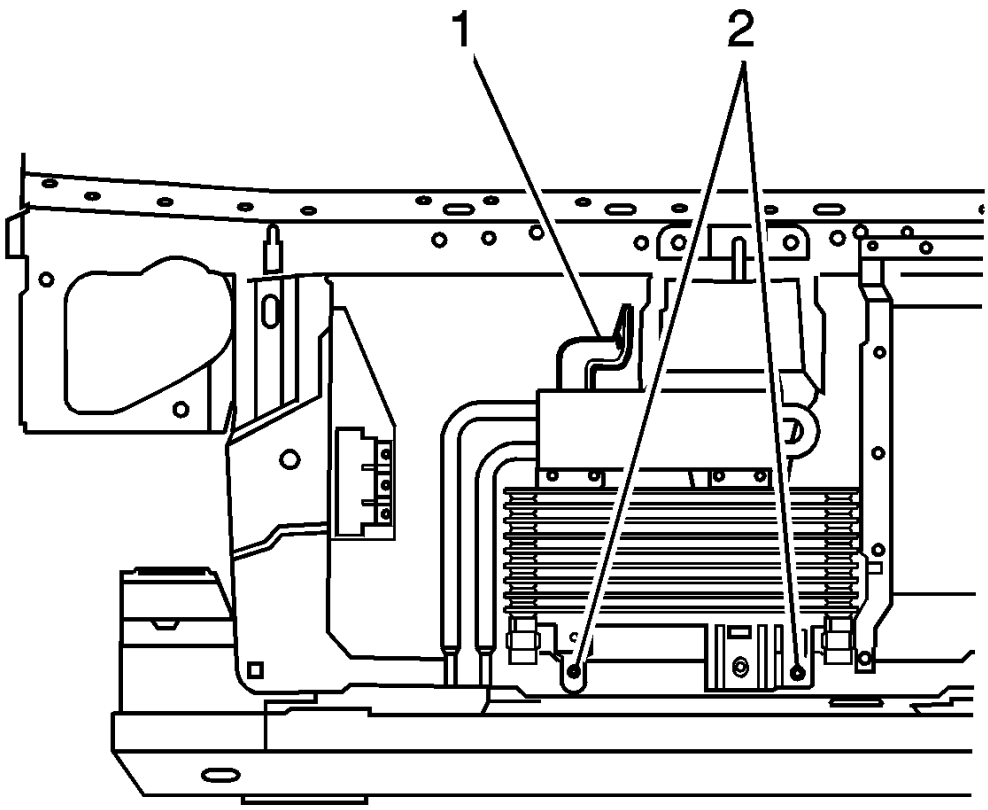


Fig. 17: Locating Engine Oil Cooler/Power Steering Cooler Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the upper bolt (1) from the engine oil cooler/power steering cooler.
9. Remove the lower bolts (2) from the engine oil cooler/power steering cooler.
10. Remove the engine oil cooler/power steering cooler from the vehicle.

Installation Procedure

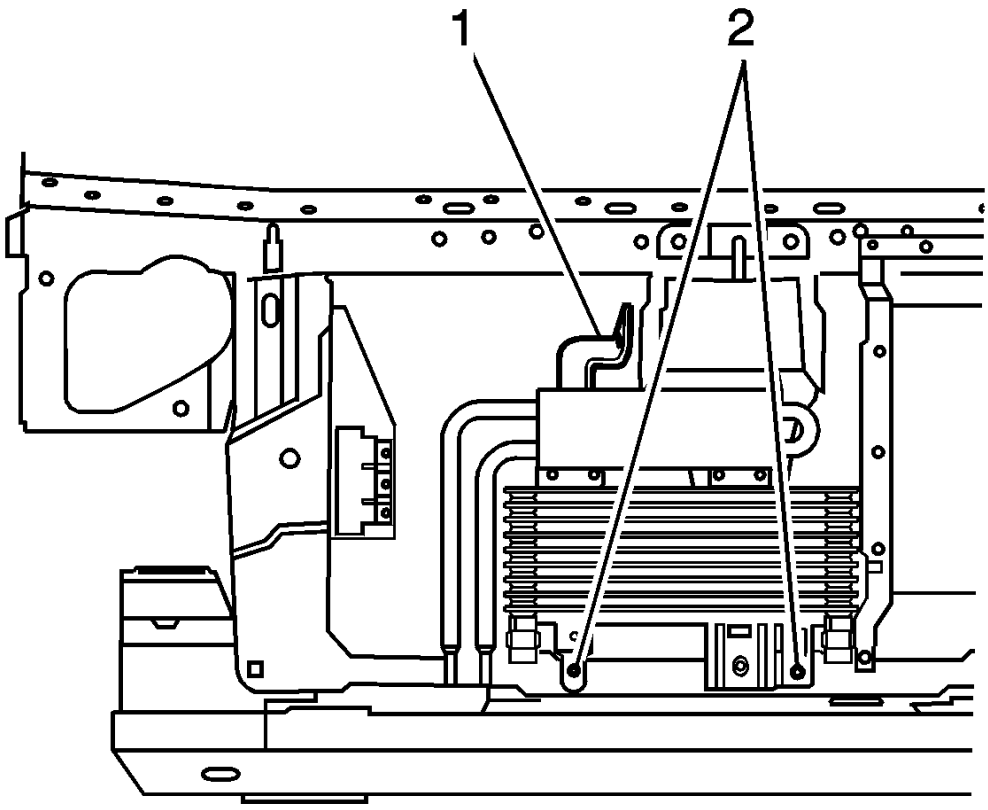


Fig. 18: Locating Engine Oil Cooler/Power Steering Cooler Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine oil cooler/power steering cooler to the vehicle.

CAUTION: Refer to Fastener Caution .

2. Install the upper bolt (1) to the engine oil cooler/power steering cooler bracket and tighten to 2 N.m (18 lb in).
3. Install the lower bolts (2) to the engine oil cooler/power steering cooler bracket and tighten to 2 N.m (18 lb in).
4. Install the engine oil cooler lines to the engine oil cooler. Refer to **Engine Oil Cooler Pipe/Hose Quick Connect Fitting Replacement**.
5. Install the power steering oil cooler lines to the power steering cooler.
6. Reposition the hose clamps on the power steering cooler lines.
7. Install the support clip to the engine oil cooler lines.
8. Install the right engine splash shield. Refer to **Engine Splash Shield Replacement (Right)** **Engine Splash Shield Replacement (Left)** .

9. Install the lower air baffle. Refer to **Radiator Air Lower Baffle and Deflector Replacement**.
10. Install the upper air baffle. Refer to **Radiator Air Upper Baffle and Deflector Replacement**.
11. Add the proper amount of engine oil and power steering fluid.
12. Bleed the power steering system. Refer to **Power Steering System Bleeding** .

ENGINE COOLANT FAN MOTOR REPLACEMENT

Special Tools

GE-47827 Socket

Removal Procedure

WARNING: An electric fan under the hood can start up even when the engine is not running and can injure you. Keep hands, clothing and tools away from any underhood electric fan.

WARNING: To help avoid personal injury or damage to the vehicle, a bent, cracked, or damaged fan blade or housing should always be replaced.

WARNING: Unless directed otherwise, the ignition must be OFF with the key removed, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStarÂ® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÂ® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÂ®module). Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÂ® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Remove the fan shroud assembly from the vehicle. Refer to **Engine Coolant Fan Shroud Replacement**.

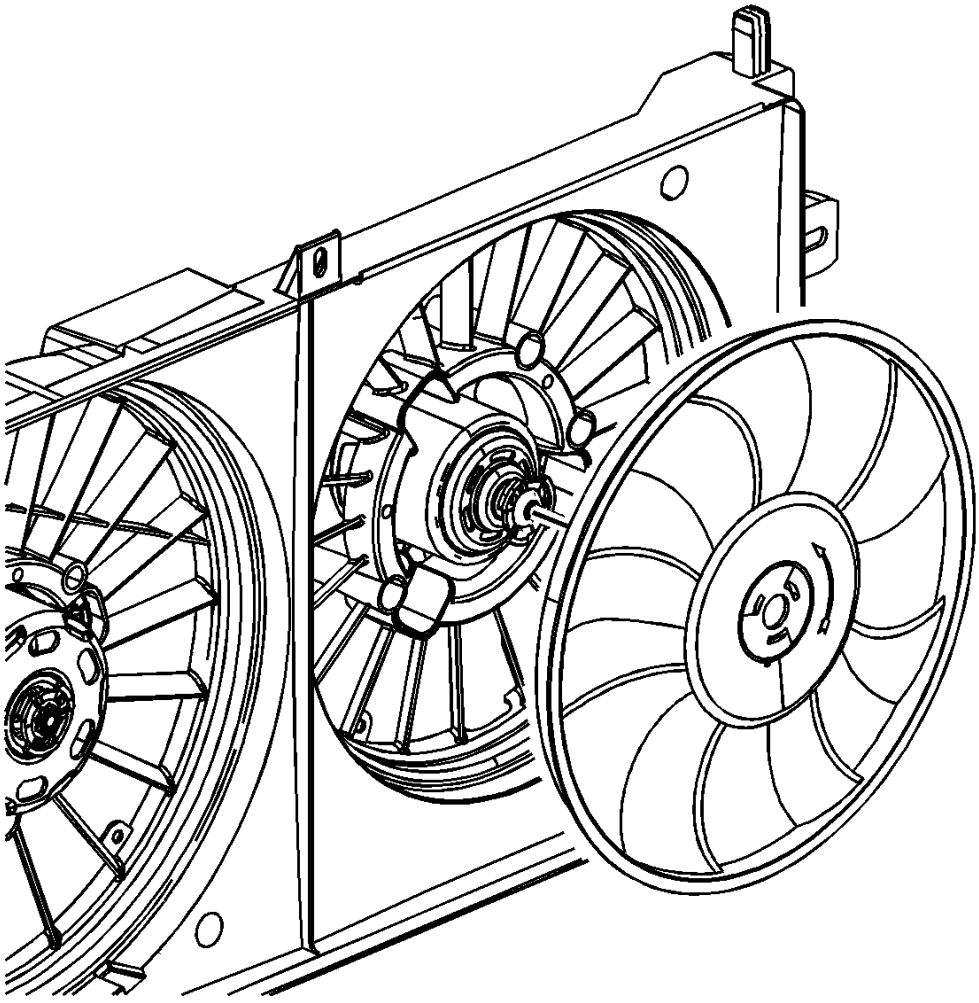


Fig. 19: Identifying Fan Shroud Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Hold the fan blade to prevent rotation.**

2. Using **GE-47827** Socket turn the fan motor drive plate in the opposite direction of the arrow on the fan blade until the motor drive plate disengages from the fan blade.
3. Remove and discard the fan blade.

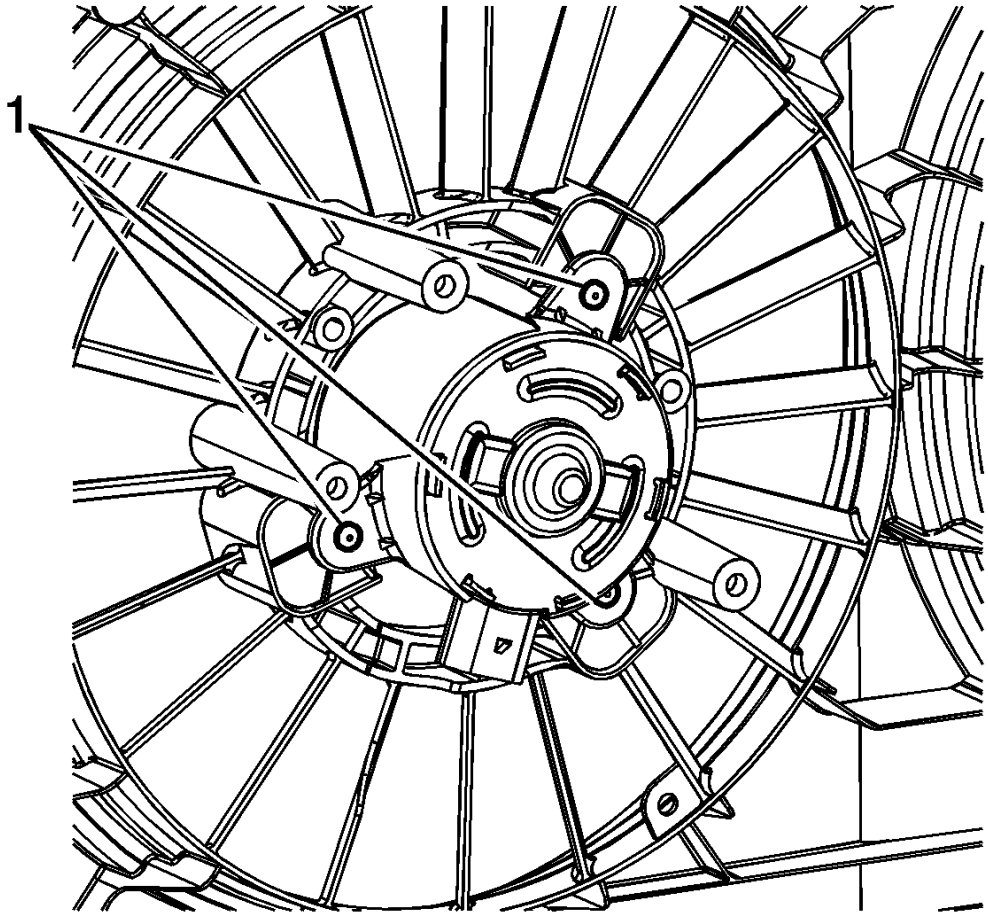


Fig. 20: Identifying Fan Blade
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Failure to tape off all of the entry points to the cooling fan motor(s) will allow debris to enter and damage the motor(s).

NOTE: When reusing the fan motor tape off the front and rear entry points of the fan motor before drilling the rivets.

4. Center punch each of the rivets (1) from the rear of the motor.
5. Drill the head of the rivets (1) from the fan motor using a 6.35 mm (0.25 in) drill bit.

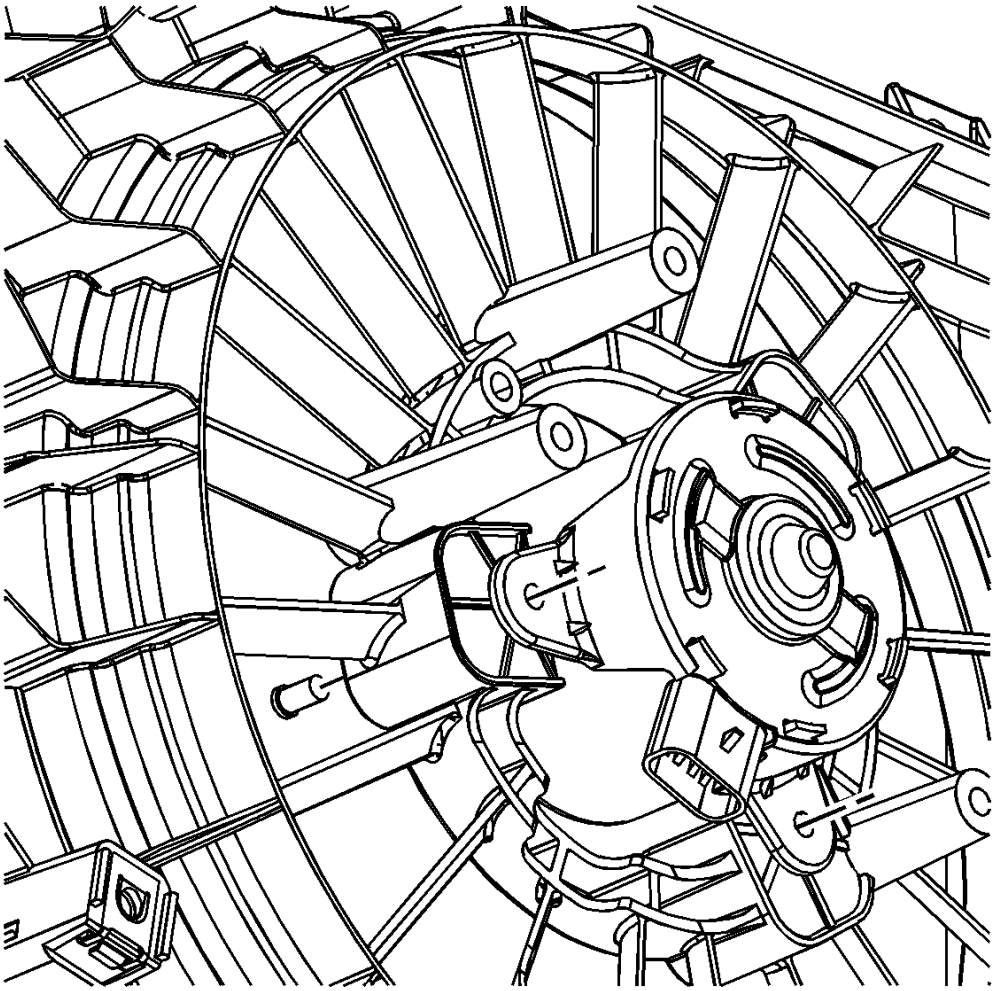


Fig. 21: Identifying Fan Rivets
Courtesy of GENERAL MOTORS COMPANY

6. Tap the rivets out of the fan shroud.

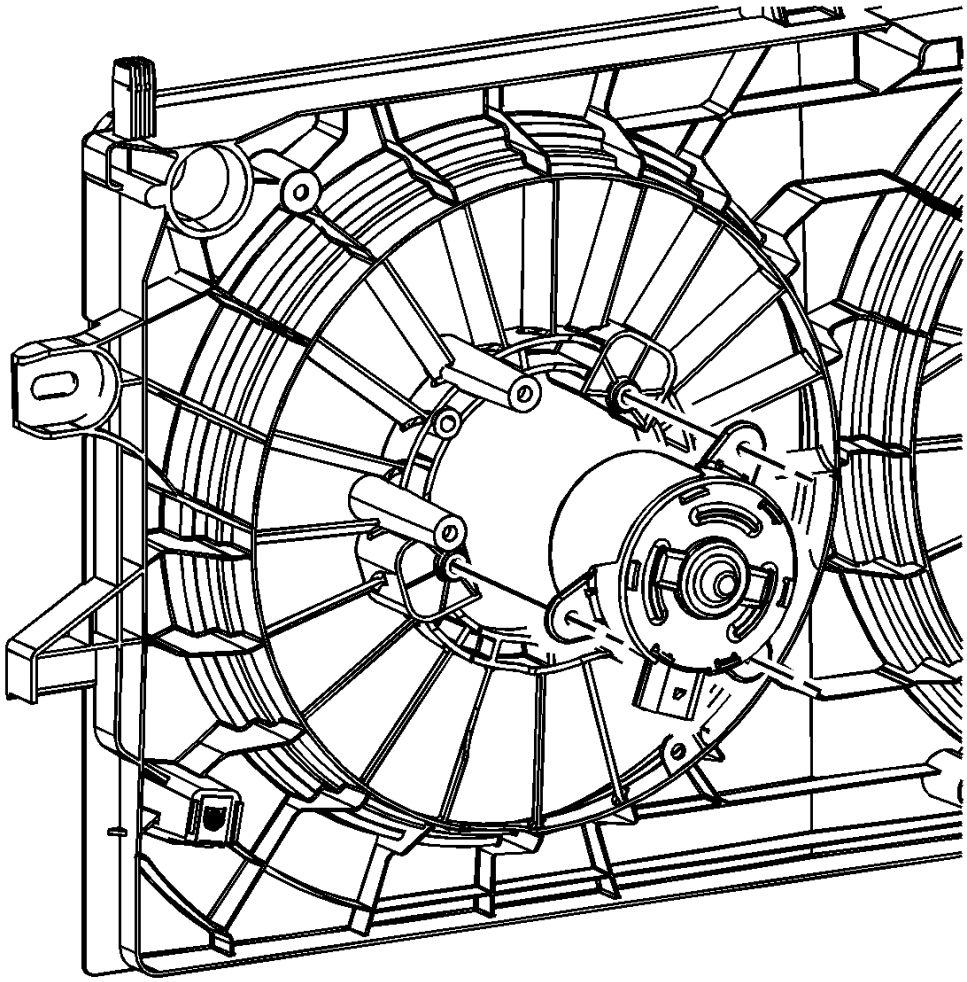


Fig. 22: View Of Fan Motor & Fan Shroud
Courtesy of GENERAL MOTORS COMPANY

7. Remove the fan motor from the fan shroud.

NOTE: **Blow off any excess debris from the fan motor.**

8. Remove the tape covering the entry points from the fan motor.

Installation Procedure

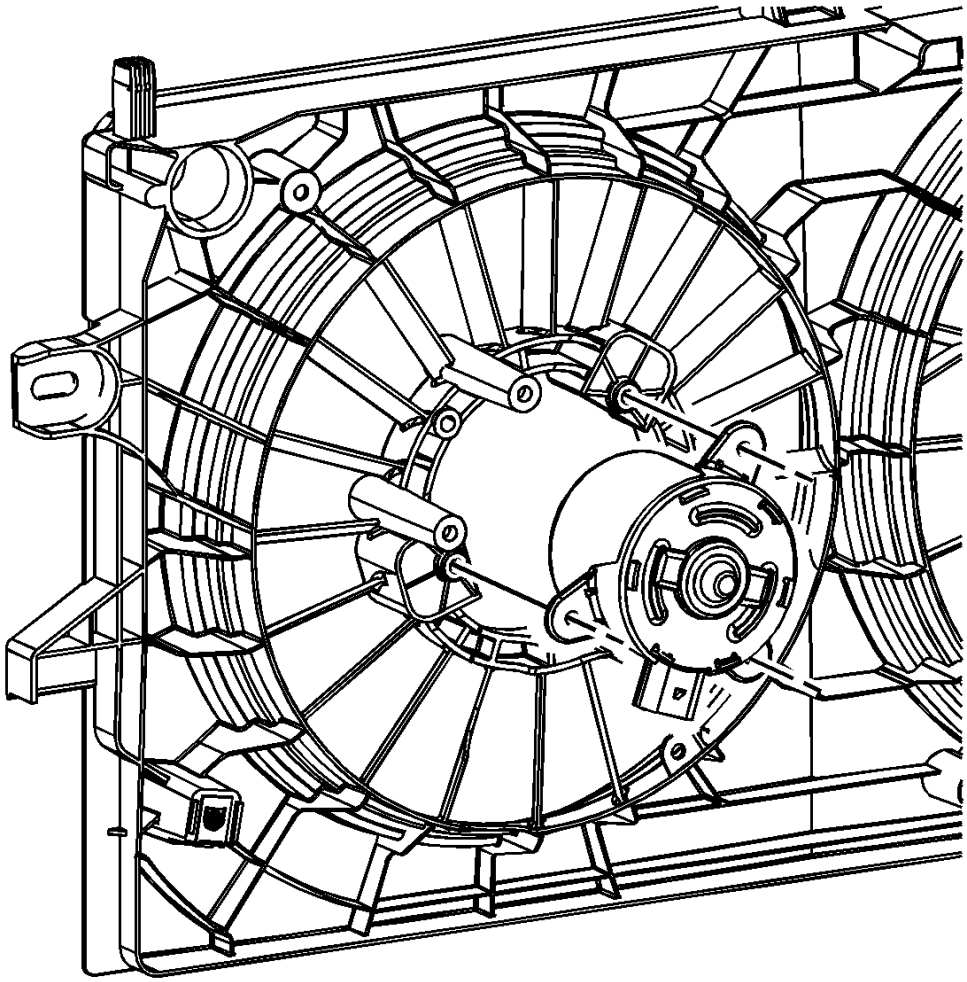


Fig. 23: View Of Fan Motor & Fan Shroud
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine cooling fan motor to the fan shroud.

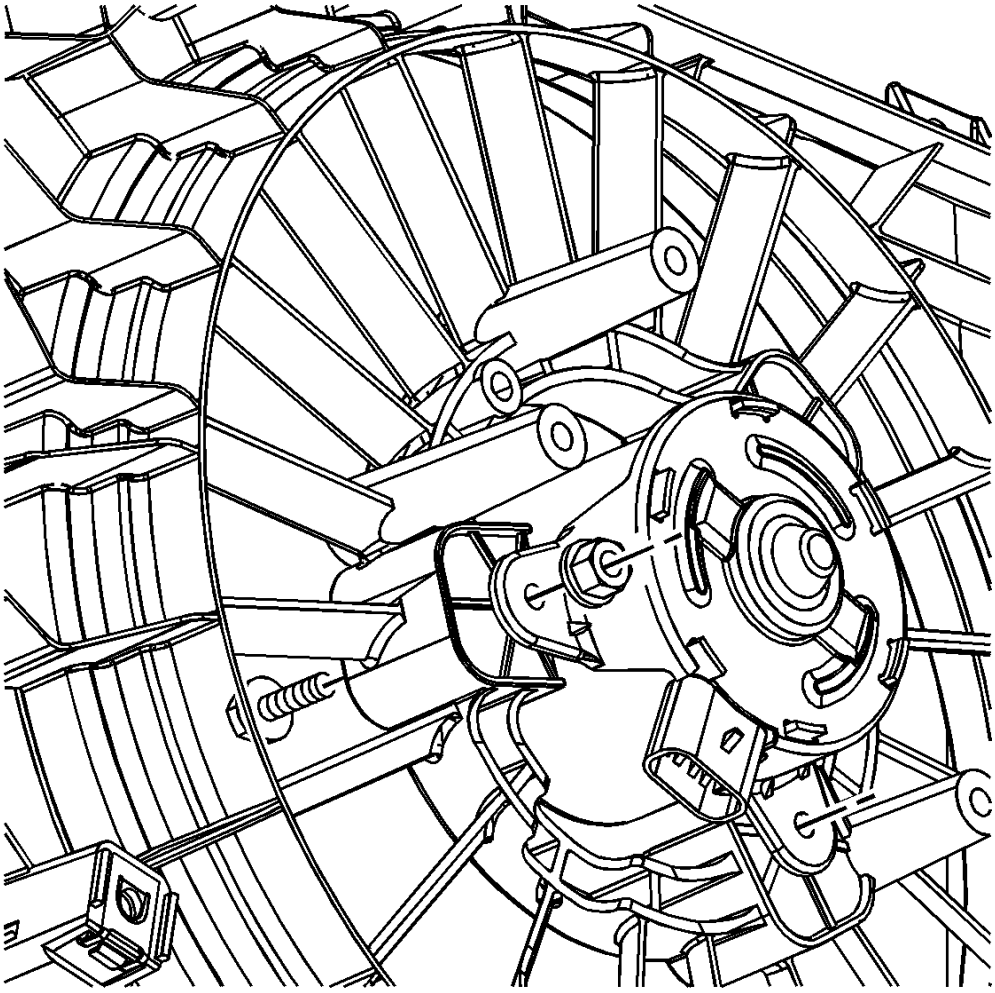


Fig. 24: Locating Cooling Fan Motor Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Position the fan motor to the fan shroud and insert the bolts from the front side.**

2. Install the cooling fan motor bolts.

CAUTION: **Refer to Fastener Caution .**

3. Install the cooling fan motor nuts and tighten to 6 N.m (53 lb in).

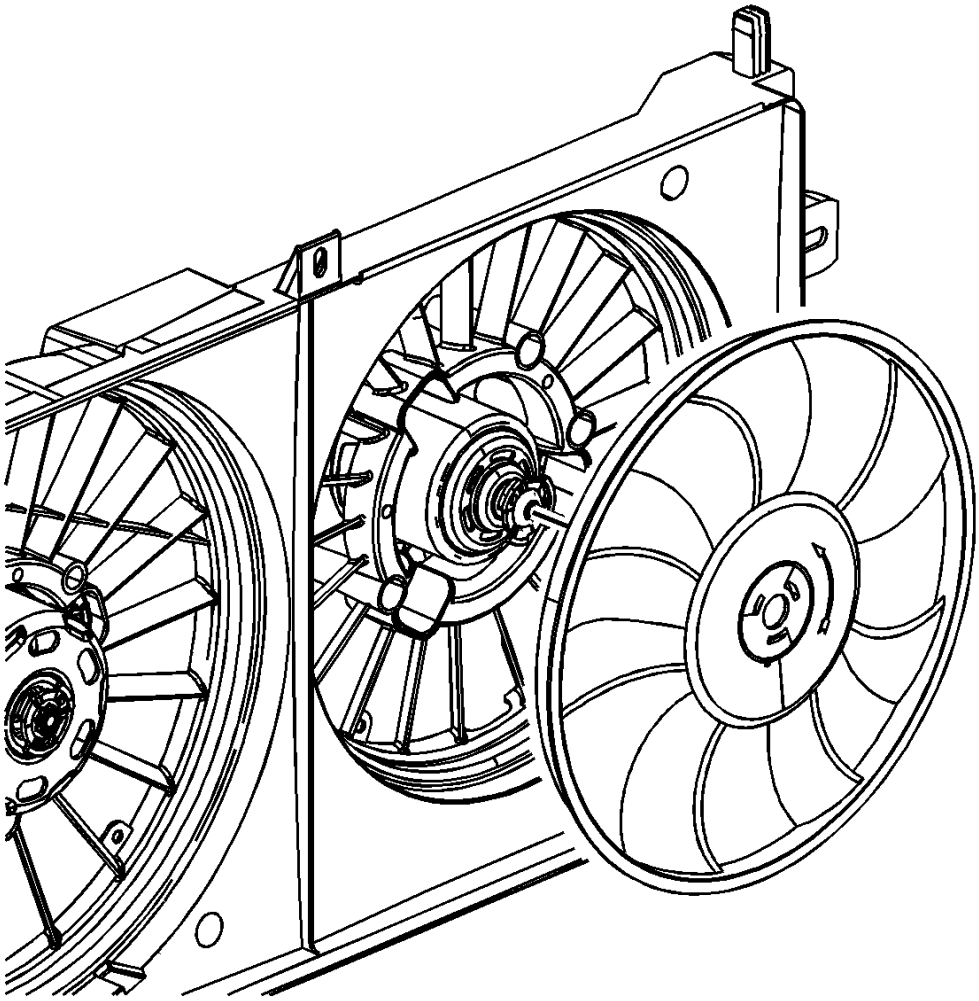


Fig. 25: Identifying Fan Shroud Assembly
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Failure to heat the fan hub in hot tap water before installation will result in cooling fan failure due to cracking. Allowing the heated fan to cool for more than one minute prior to installation will also result in failure due to cracking.**

NOTE: **Using hot tap water at a minimum of 49Â°C (120Â°F), hold the new fan blade hub under the running water for a minimum of 60 seconds to heat the fan blade to the temperature of the water.**

Immediately after heating, position the fan blade on the fan motor drive plate.

4. Install the new engine cooling fan blade.

NOTE: **Hold the fan blade to prevent rotation.**

5. Using the **GE-47827** Socket turn the fan motor drive plate in the same direction of the arrow on the fan

blade until the fan motor drive plate engages to the fan blade. Full engagement is attained when the motor drive plate fully occupies the three slots in the face of the fan blade.

6. Rotate the cooling fan blade to ensure proper rotation.
7. Install the fan shroud assembly to the vehicle. Refer to **Engine Coolant Fan Shroud Replacement**.

ENGINE COOLANT THERMOSTAT HOUSING REPLACEMENT

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
3. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
4. Remove the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** .

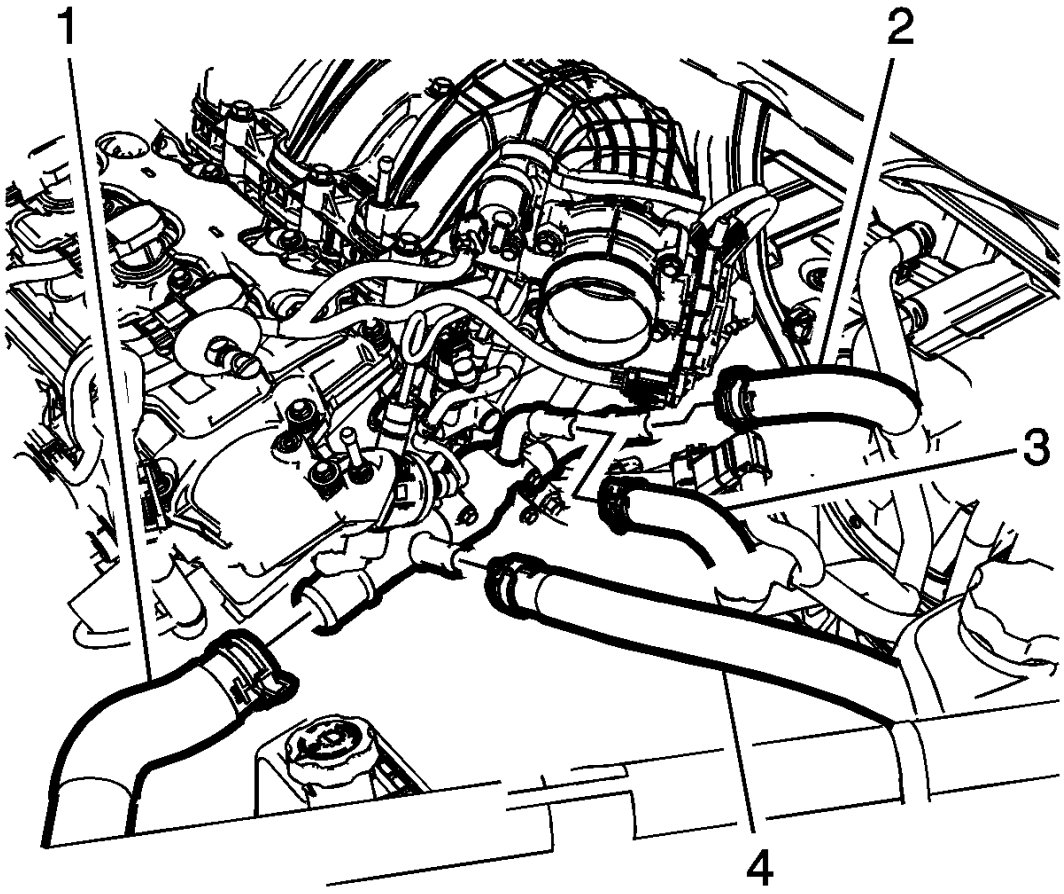


Fig. 26: Radiator Outlet Hose, Heater Inlet Hose, Heater Outlet And Surger Tank Hose
Courtesy of GENERAL MOTORS COMPANY

5. Remove the following hoses:
   - Radiator Outlet Hose (1).

- Heater Inlet Hose (2).
- Heater Outlet (3).
- Surger Tank Hose (4).

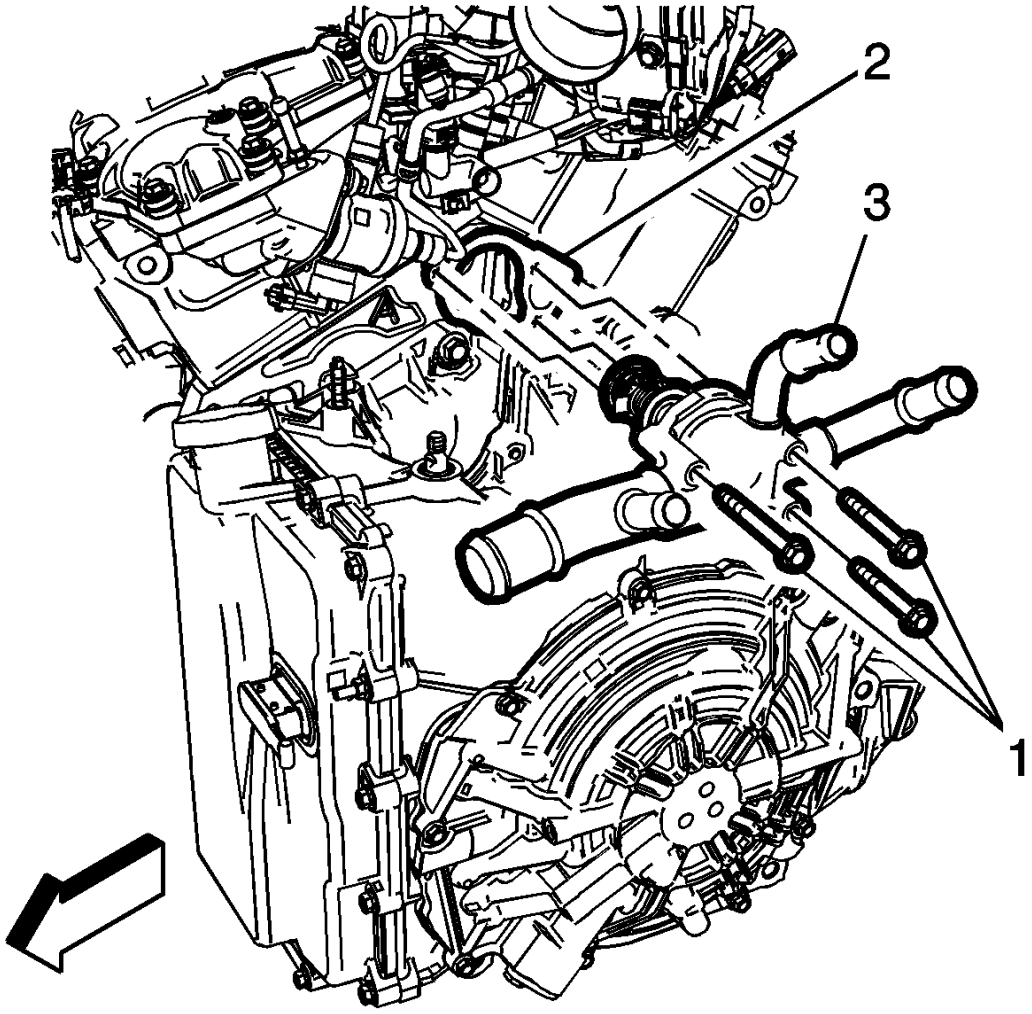


Fig. 27: Thermostat Housing Assembly, Fasteners And Seal
Courtesy of GENERAL MOTORS COMPANY

6. Remove the thermostat housing fasteners (1) and the thermostat housing assembly (3).
7. Discard the engine coolant thermostat housing seal (2).

Installation Procedure

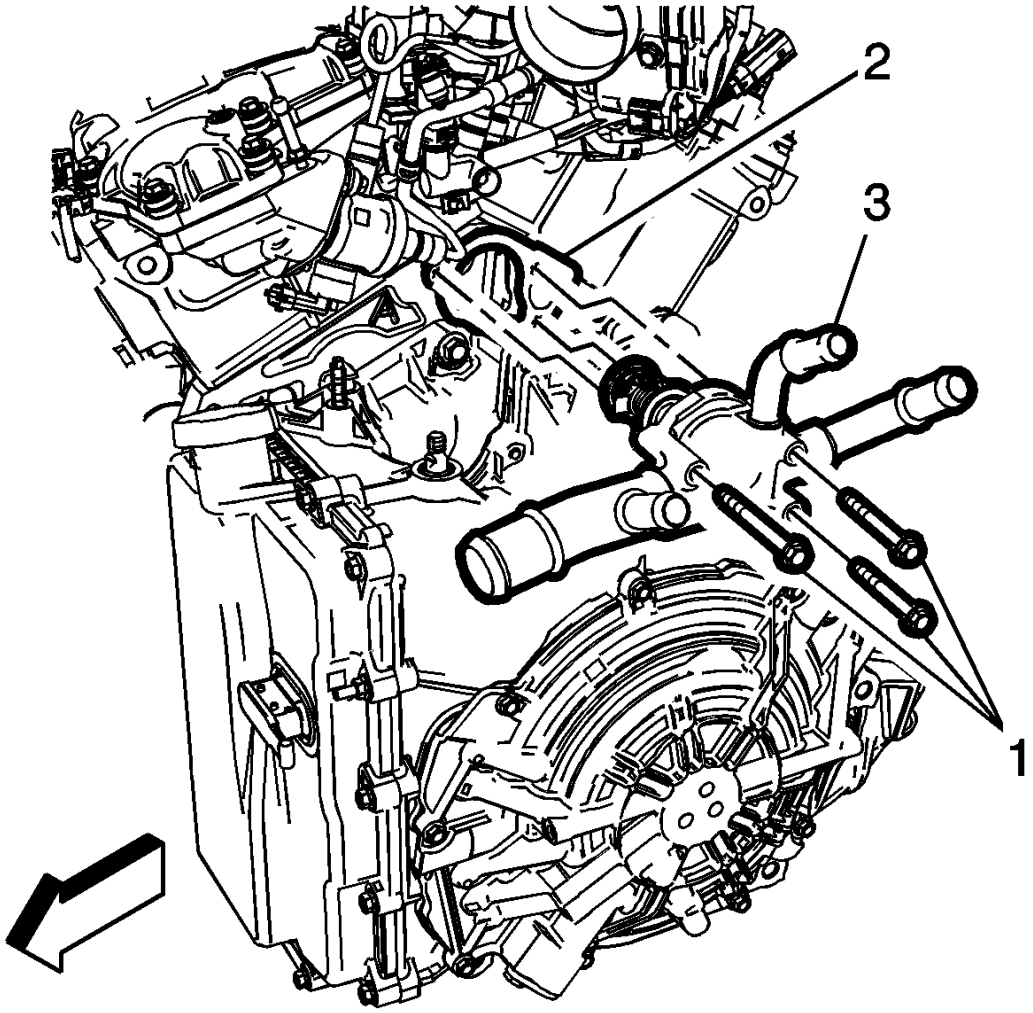


Fig. 28: Thermostat Housing Assembly, Fasteners And Seal
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the engine cooling thermostat housing (3) with a NEW seal (2). Tighten the fasteners (1) to

   Tighten

   Tighten the bolts to 10 N.m (89 lb in).

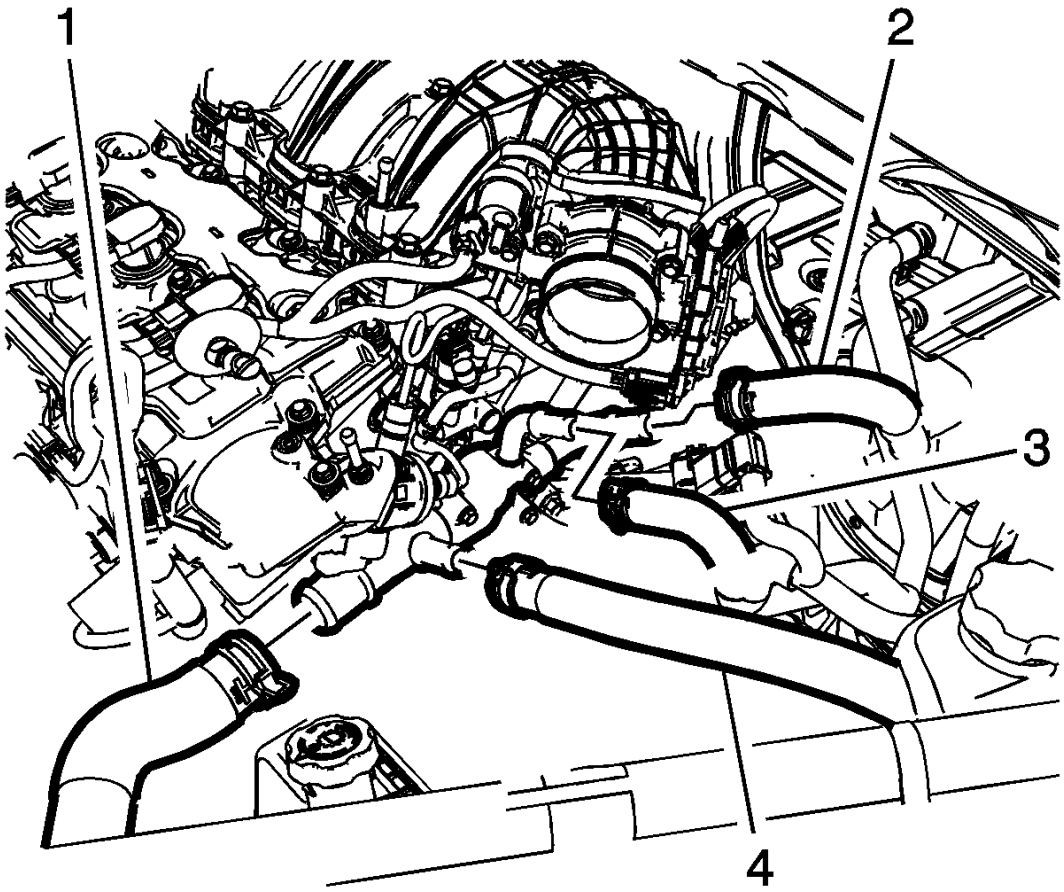


Fig. 29: Radiator Outlet Hose, Heater Inlet Hose, Heater Outlet And Surger Tank Hose
Courtesy of GENERAL MOTORS COMPANY

2. Install the following hoses:
    - Radiator Outlet Hose (1).
    - Heater Inlet Hose (2).
    - Heater Outlet (3).
    - Surger Tank Hose (4).
3. Install the fuel pipe shield. Refer to **Fuel Pipe Shield Replacement** .
4. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
5. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
6. Fill the cooling system. Refer to **Cooling System Draining and Filling**.

WATER OUTLET REPLACEMENT

Special Tools

EN 38185 Hose Clamp Pliers

For equivalent regional tools refer to **Special Tools**.

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling**.
2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .

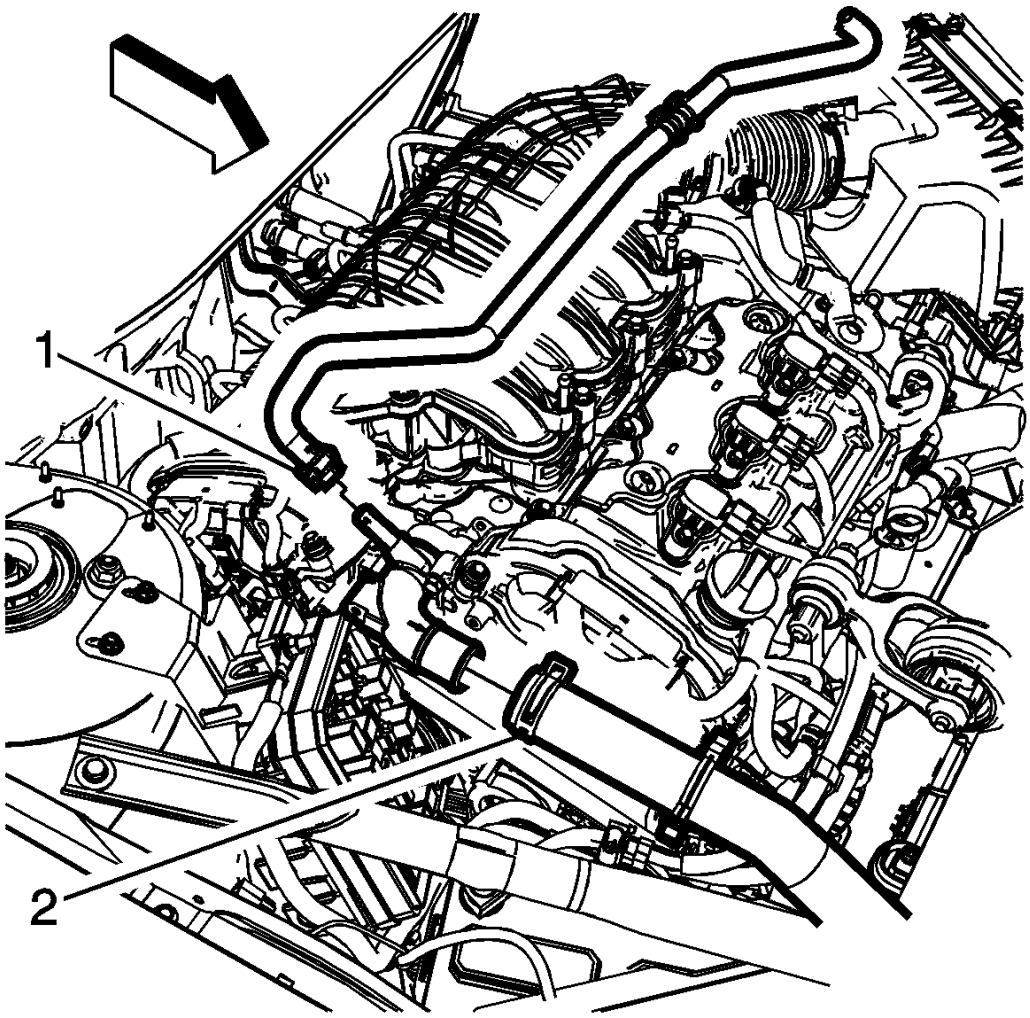


Fig. 30: Radiator Inlet Hose And Air Bleed Pipe
Courtesy of GENERAL MOTORS COMPANY

3. Remove the air bleed pipe (1) and the radiator inlet hose (2) from the water outlet pipe.

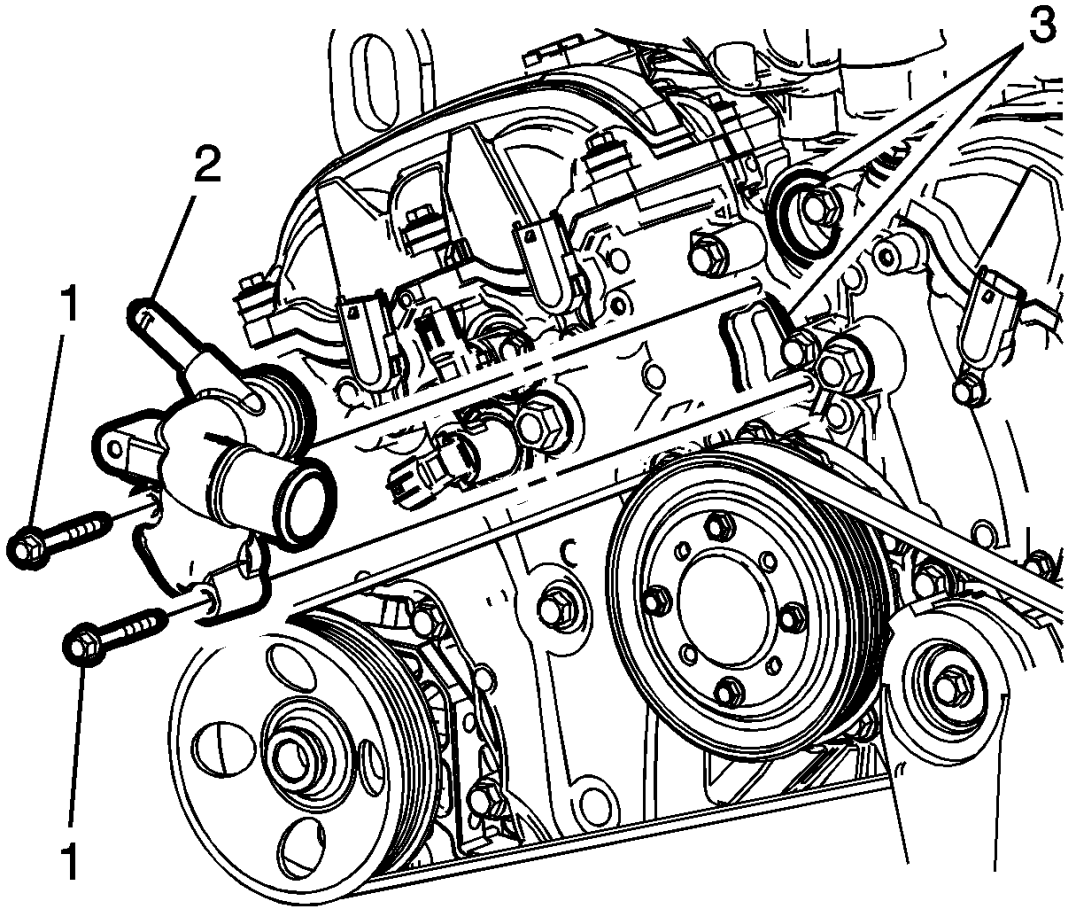


Fig. 31: Water Outlet, Fasteners And Seals
Courtesy of GENERAL MOTORS COMPANY

4. Remove the water outlet fasteners (1)and remove the water outlet (2).
5. Discard the water outlet seals (3).
6. Carefully clean the water outlet sealing surfaces.

Installation Procedure

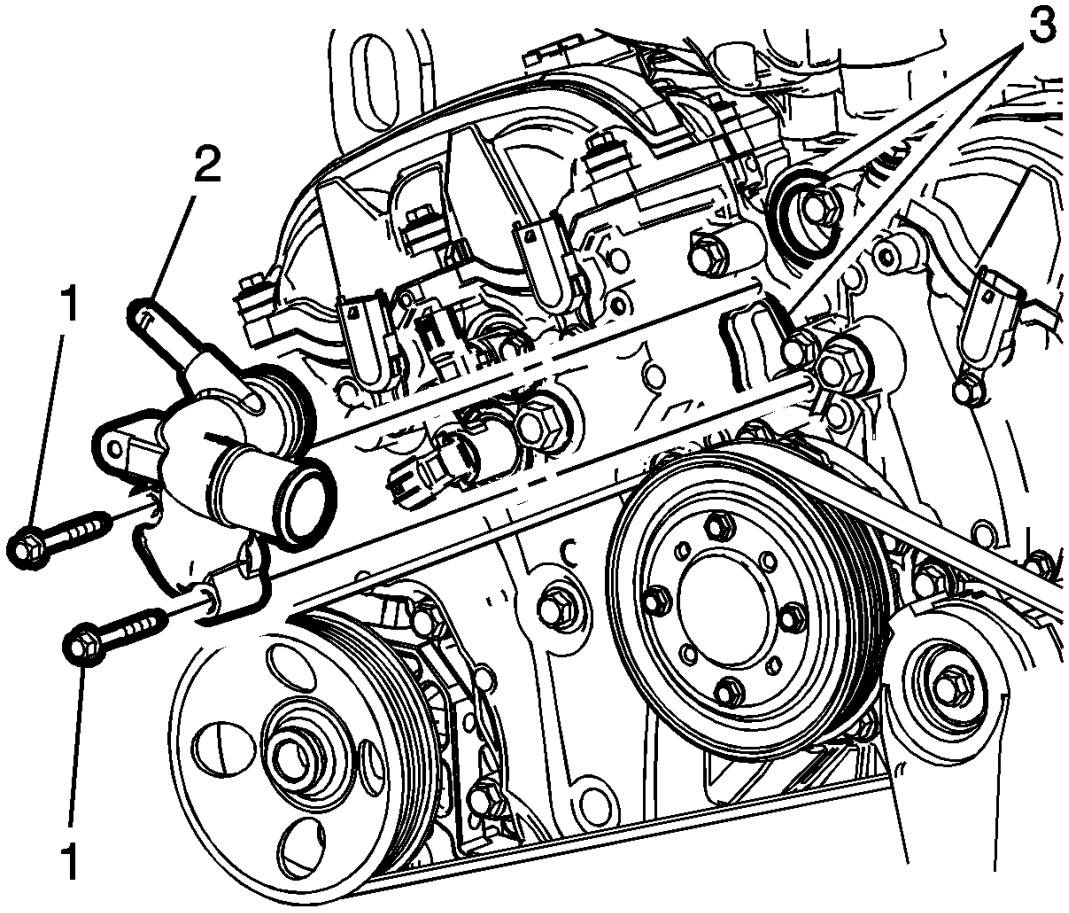


Fig. 32: Water Outlet, Fasteners And Seals
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the water outlet (2) with NEW seals (3) and tighten the water outlet fasteners (1) to 10 N.m (89 lb in).

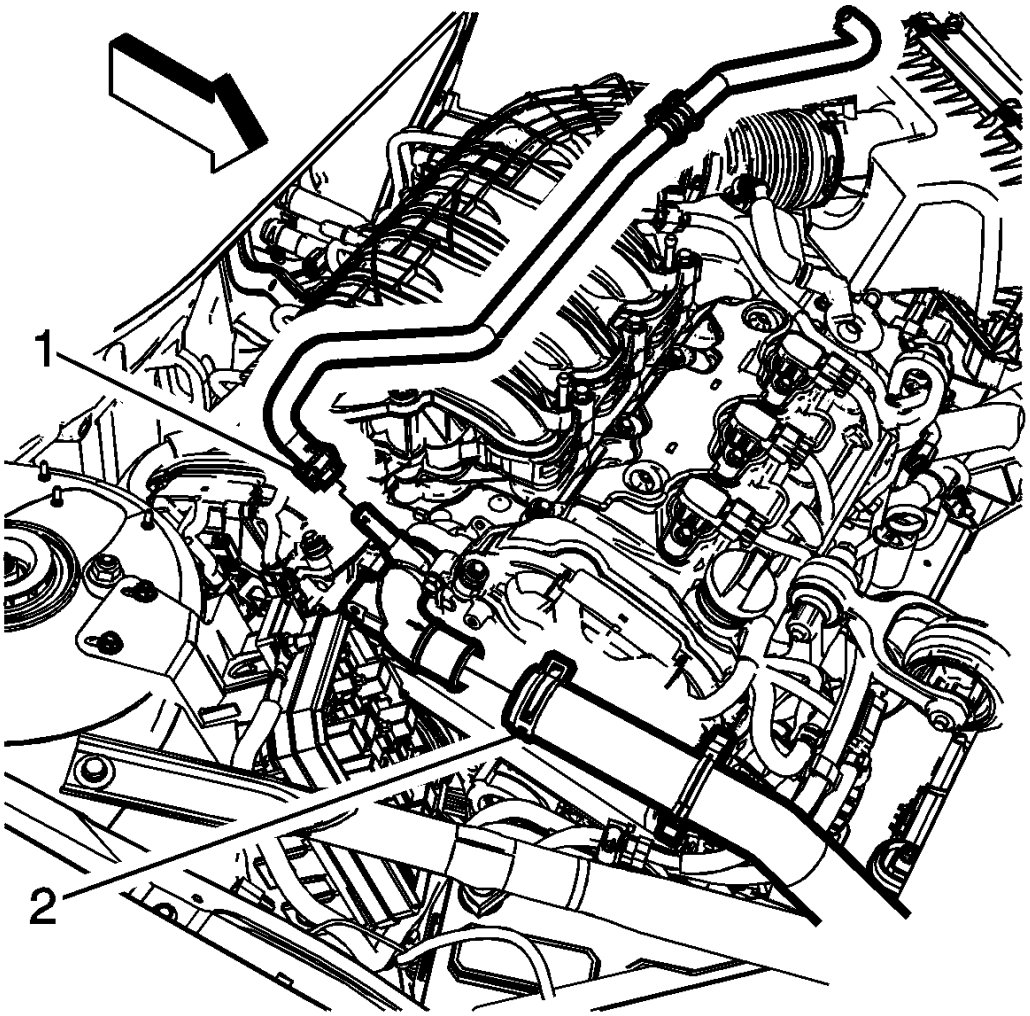


Fig. 33: Radiator Inlet Hose And Air Bleed Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Install the radiator inlet hose (2) and the engine coolant air bleed pipe (1).
3. Install the intake manifold cover. Refer to **Intake Manifold Cover Replacement** .
4. Fill the cooling system. Refer to **Cooling System Draining and Filling**.
5. Start the engine and check for coolant leaks.

WATER PUMP REPLACEMENT

Special Tools

EN 46104 Water Pump Pulley Holder

For equivalent regional tools refer to **Special Tools**

Removal Procedure

1. Drain the cooling system. Refer to **Cooling System Draining and Filling**.
2. Remove the drive belt. Refer to **Drive Belt Replacement** .

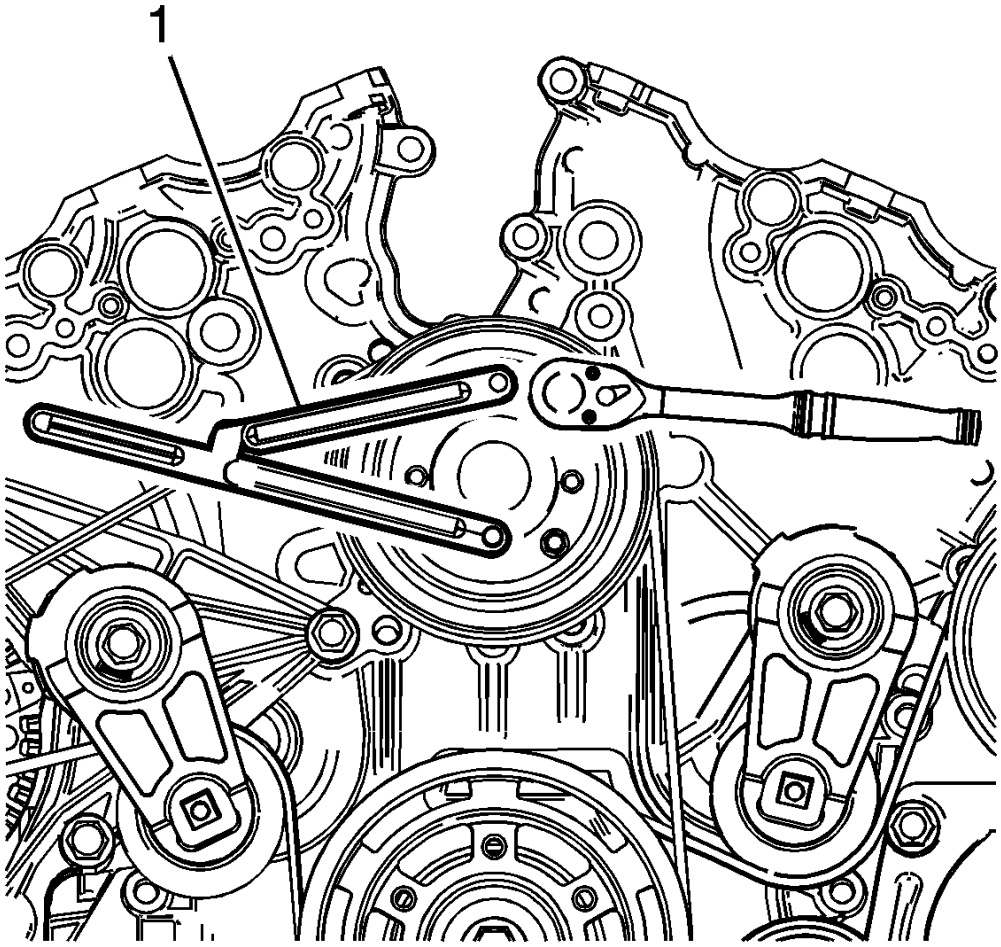


Fig. 34: Securing Water Pump Pulley With Holder
Courtesy of GENERAL MOTORS COMPANY

3. Use the **EN 46104** water pump pulley holder (1) to retain the pulley.

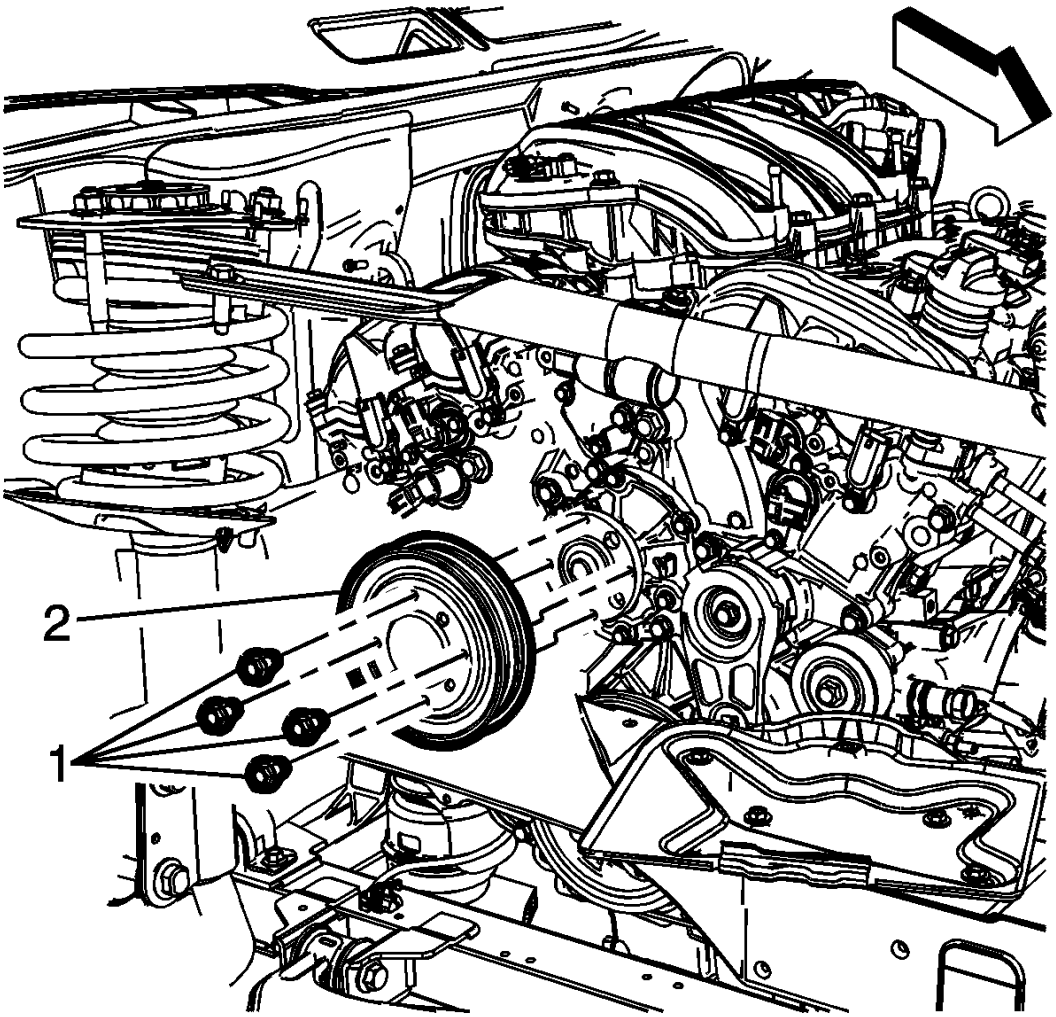


Fig. 35: Water Pump Pulley And Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the water pump pulley fasteners (1).
5. Remove the water pump pulley (2).

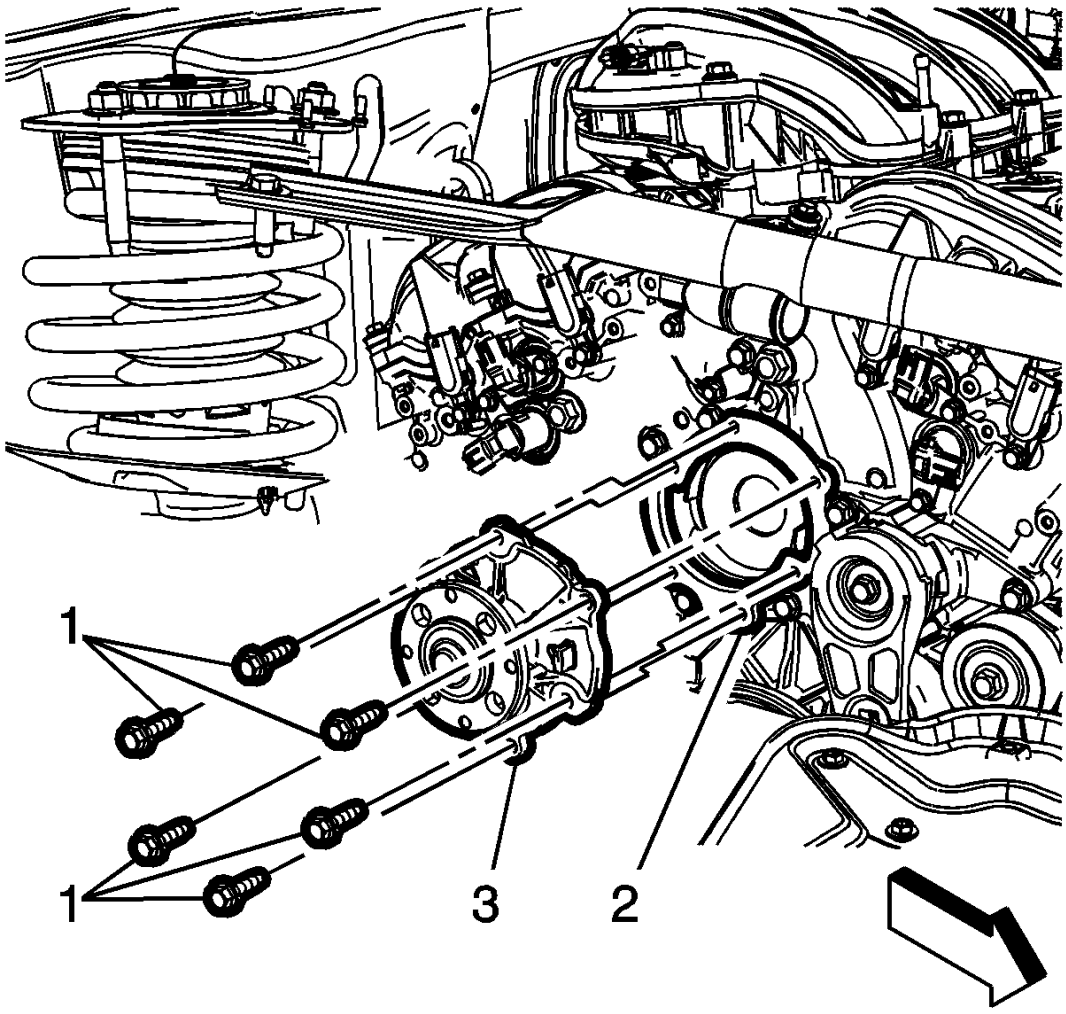


Fig. 36: Water Pump, Seal And Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the water pump fasteners (1) and remove the water pump (3). DISCARD the water pump fasteners.
7. Discard the water pump seal (2).
8. Carefully clean the water pump sealing surfaces.

Installation Procedure

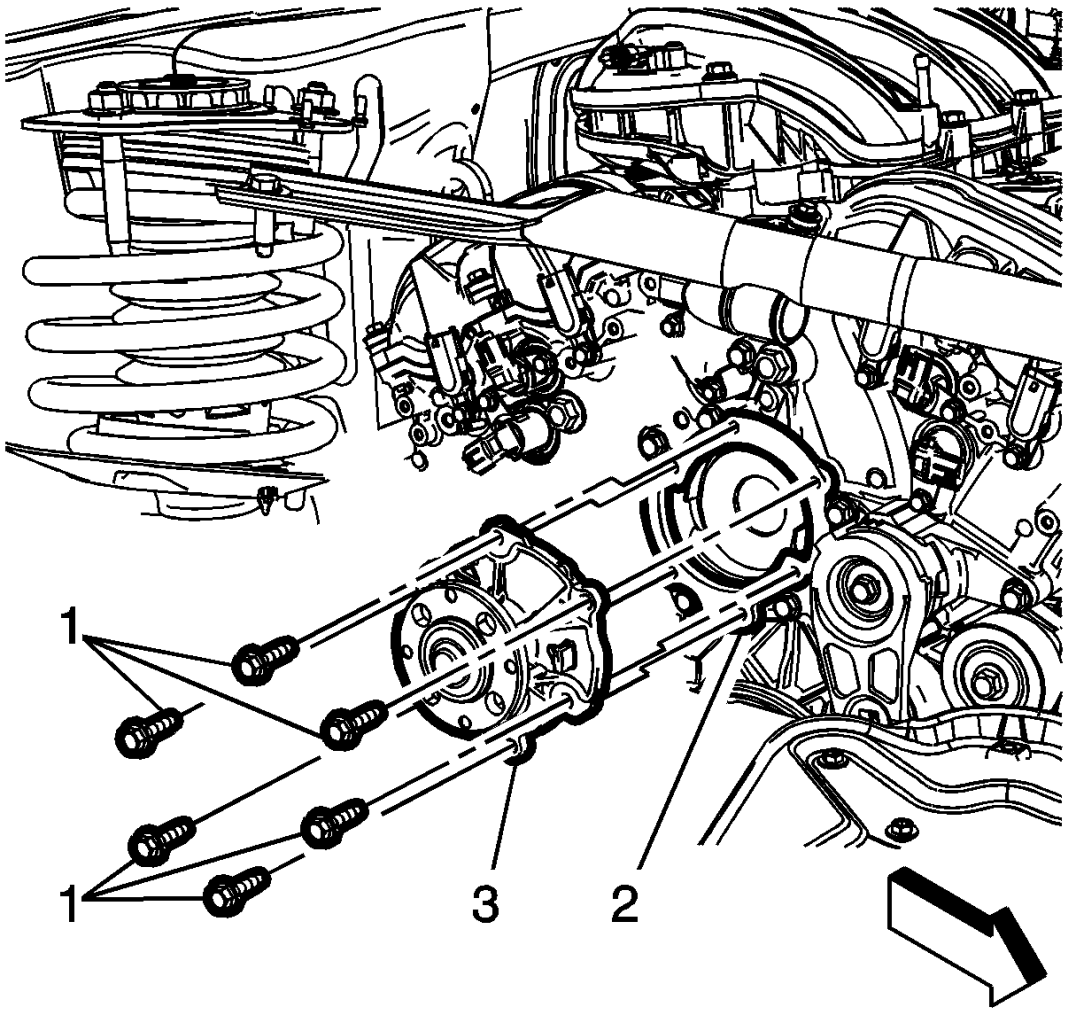


Fig. 37: Water Pump, Seal And Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Install the water pump (3) with a NEW seal (2) and hand tighten the NEW water pump fasteners (1).

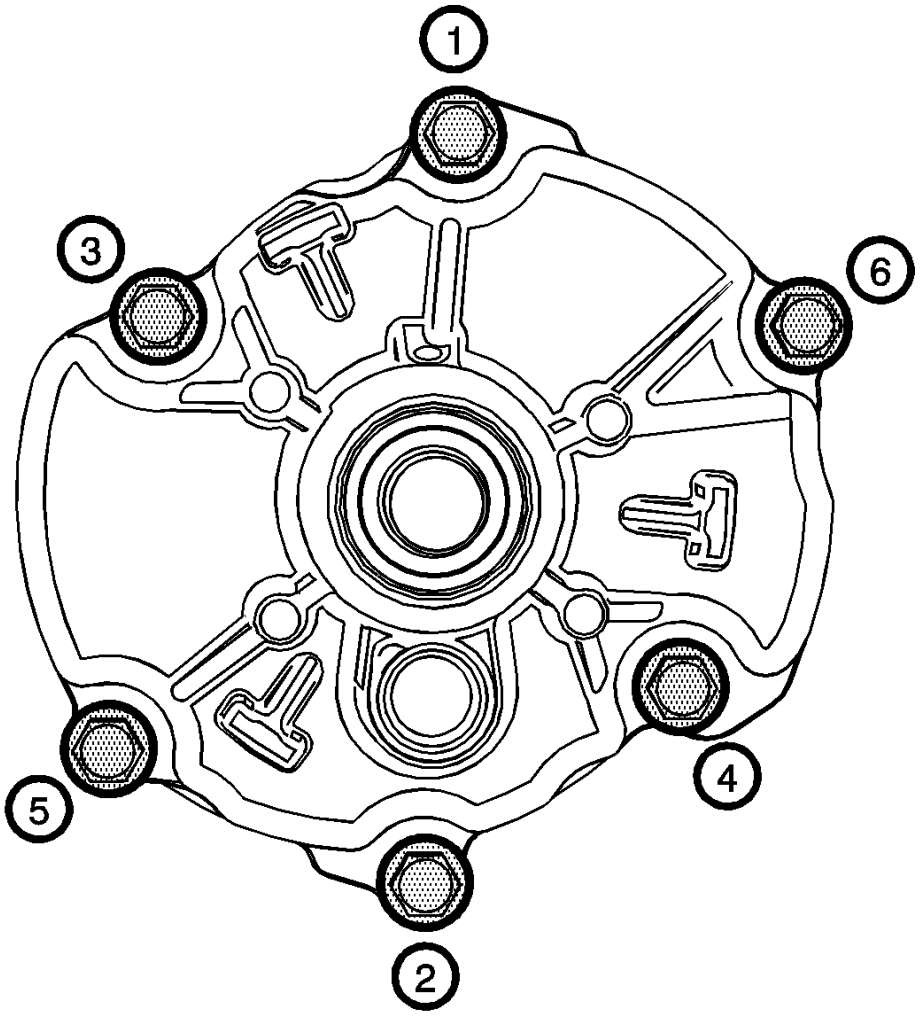


Fig. 38: Water Pump Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

CAUTION: Refer to Fastener Caution .

2. Tighten the water pump bolts in the sequence.
    1. On the initial pass, tighten the bolts in sequence to 10 N.m (89 lb in).
    2. On the second pass, tighten the bolts in sequence to 10 N.m (89 lb in).
    3. On the final pass, tighten the bolts in sequence shown an additional 45 degrees.

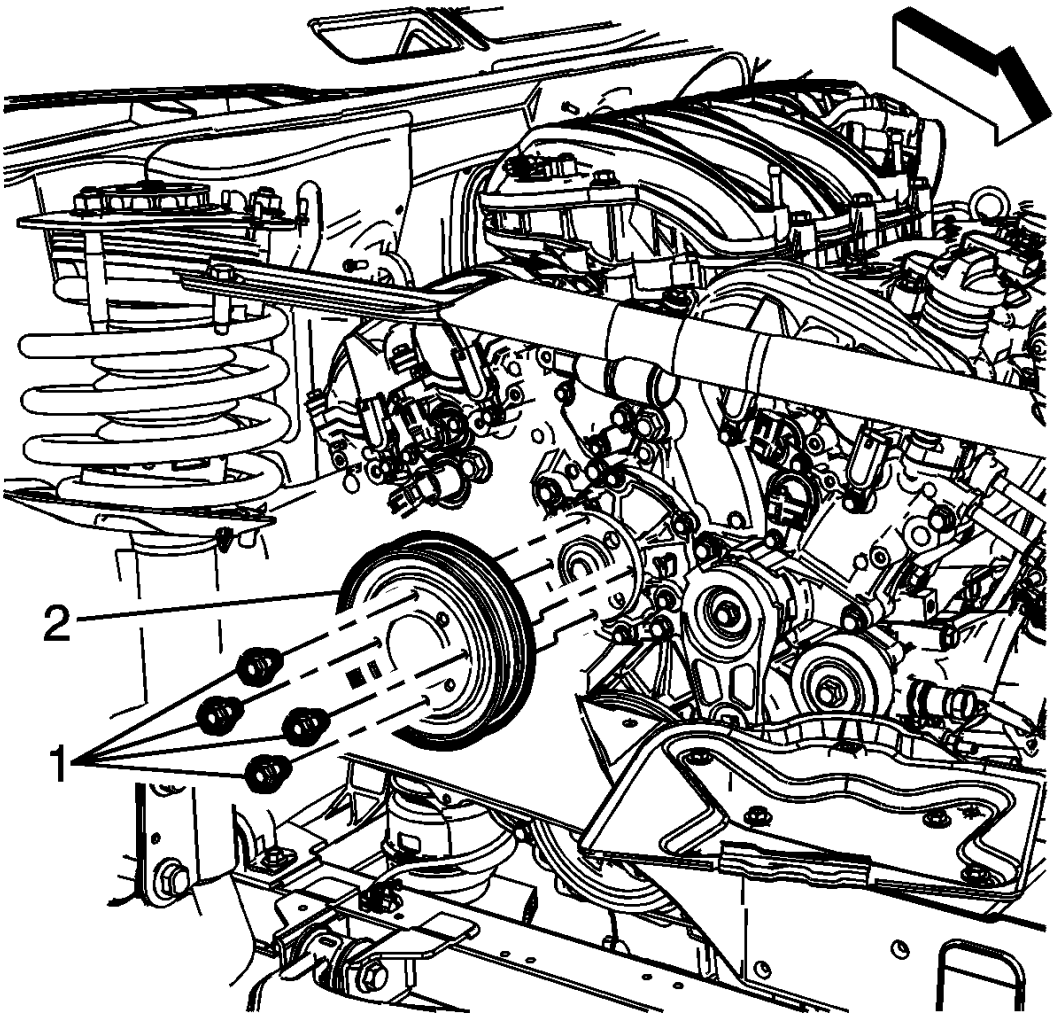


Fig. 39: Water Pump Pulley And Fasteners
Courtesy of GENERAL MOTORS COMPANY

3. Use the **EN 46104** water pump pulley holder to hold the pulley .
4. Install the water pump pulley (2) and tighten the water pump pulley fasteners (1) to 10 N.m (89 lb in).
5. Install the drive belt. Refer to **Drive Belt Replacement** .
6. Fill the cooling system. Refer to **Cooling System Draining and Filling**.
7. Start the engine and check for coolant leaks.

RADIATOR DRAIN COCK REPLACEMENT

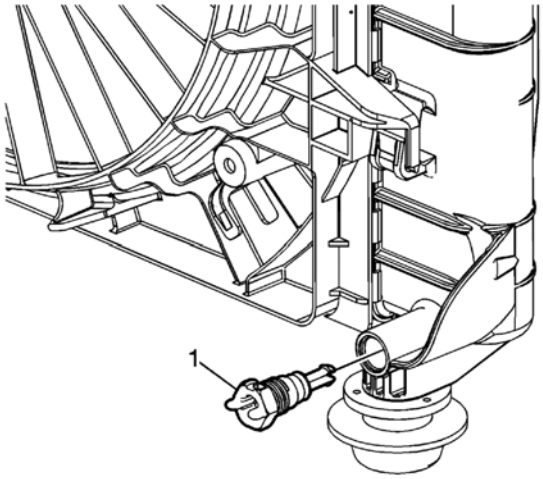


Fig. 40: Identifying Radiator Drain Cock
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Drain the cooling system. Refer to **Cooling System Draining and Filling**.	
1	Drain Cock **Procedure** 1. Remove the radiator drain cock from the radiator side tank with a firm tug. 2. Install a new drain cock seal.

ENGINE COOLANT FAN SHROUD REPLACEMENT

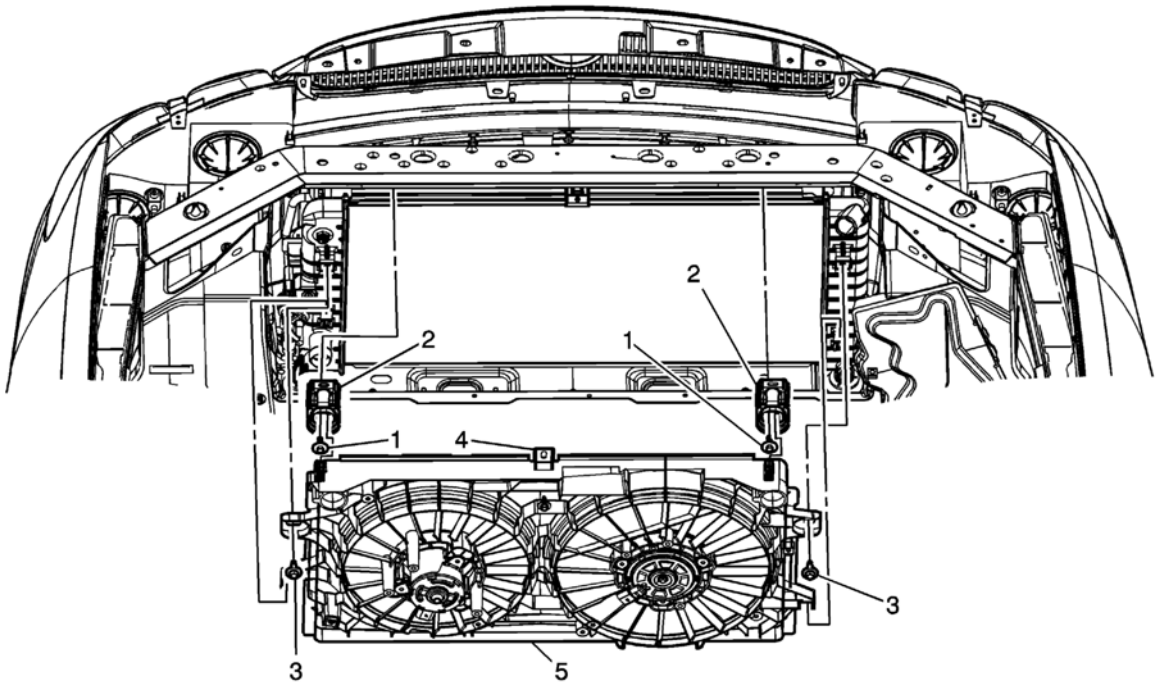


Fig. 41: Identifying Fan Shroud & Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Keep hands, tools, and clothing away from the electric engine coolant fans in order to help prevent personal injury. These fans are electric and can turn on whether or not the engine is running. The fans can start automatically with the**	

Callout	Component Name
ignition in the ON position. **WARNING:** An electric fan under the hood can start up even when the engine is not running and can injure you. Keep hands, clothing and tools away from any underhood electric fan. **WARNING:** To help avoid personal injury or damage to the vehicle, a bent, cracked, or damaged fan blade or housing should always be replaced. **WARNING:** Unless directed otherwise, the ignition must be OFF with the key removed, and all electrical loads must be OFF before servicing	

Callout	Component Name
any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components. **For Vehicles equipped with OnStarÂ® (UE1) with Back Up Battery:** **The Back Up Battery is a redundant power supply to allow limited OnStarÂ® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÂ®module). Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply**	

Callout	Component Name
opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÂ® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced. **Preliminary Procedures** 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** . 2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** . 3. Disconnect the upper transaxle oil cooler pipe from the radiator. Refer to **Fluid Cooler Inlet Hose Replacement** . 4. Remove engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side** . 5. Disconnect the electrical connections from the fan shroud.	
1	Radiator Bracket Upper Support Bolt

Callout	Component Name
	CAUTION: **Refer to** **Fastener** **Caution .** Tighten 10 N.m (89 lb in)
2	Radiator Upper Support Bracket
3	Fan Shroud Bolt **Tighten** 6 N.m (53 lb in)
4	Condenser Hold Down Bracket **Procedure** Remove the bolt that connects the fan shroud to the condenser hold down bracket. **Tighten** 6 N.m (53 lb in)
5	Fan Shroud **Procedure** Transfer all necessary parts.

RADIATOR REPLACEMENT

Special Tools

J 38185 Hose Clamp Pliers

For equivalent region tools, refer to **Special Tools**.

Removal Procedure

WARNING: Unless directed otherwise, the ignition must be OFF with the key removed, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStarÂ® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÂ® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÂ®module). Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÂ® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until

it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**
3. Drain the cooling system. Refer to **Cooling System Draining and Filling**.
4. Use **J 38185** pliers to reposition the upper radiator hose clamp from the radiator.
5. Remove the upper radiator hose from the radiator.
6. Remove the engine front strut. Refer to **Engine Mount Strut Replacement - Right Side** .
7. Remove the condenser tubes bracket bolt from the fan shroud.

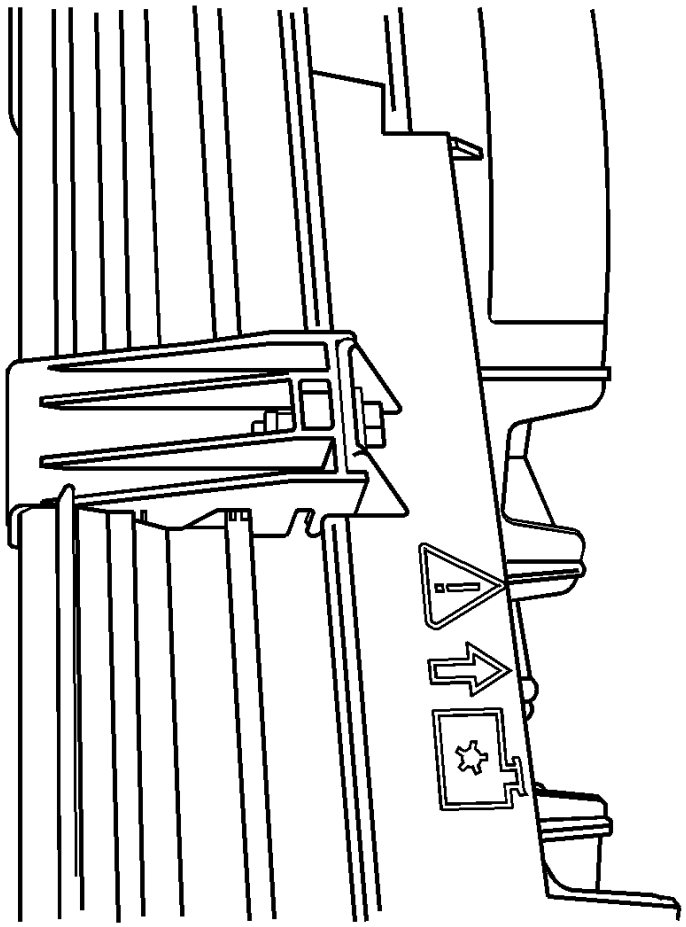


Fig. 42: Identifying Fan Shroud To Condenser Hold Down Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the bolt that connects the fan shroud to the condenser hold down bracket.
9. Remove the condenser hold down bracket from the radiator and condenser.

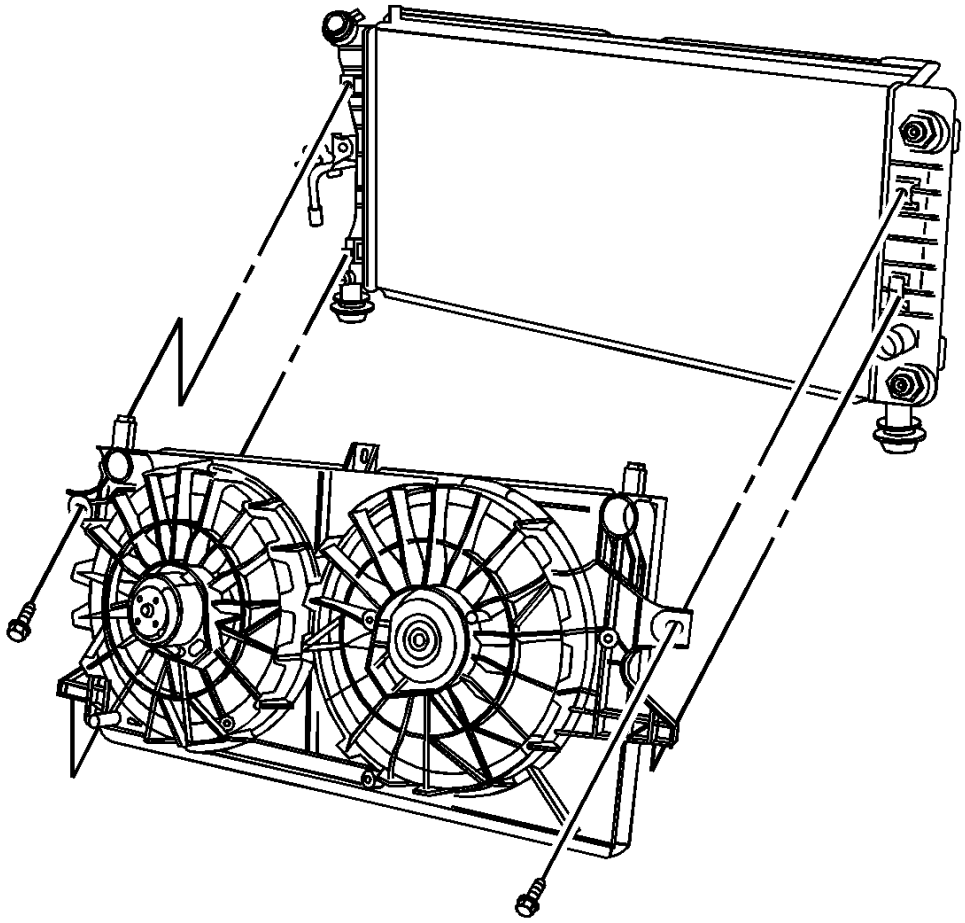


Fig. 43: View Of Cooling Fan Shroud Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove the cooling fan shroud bolts.

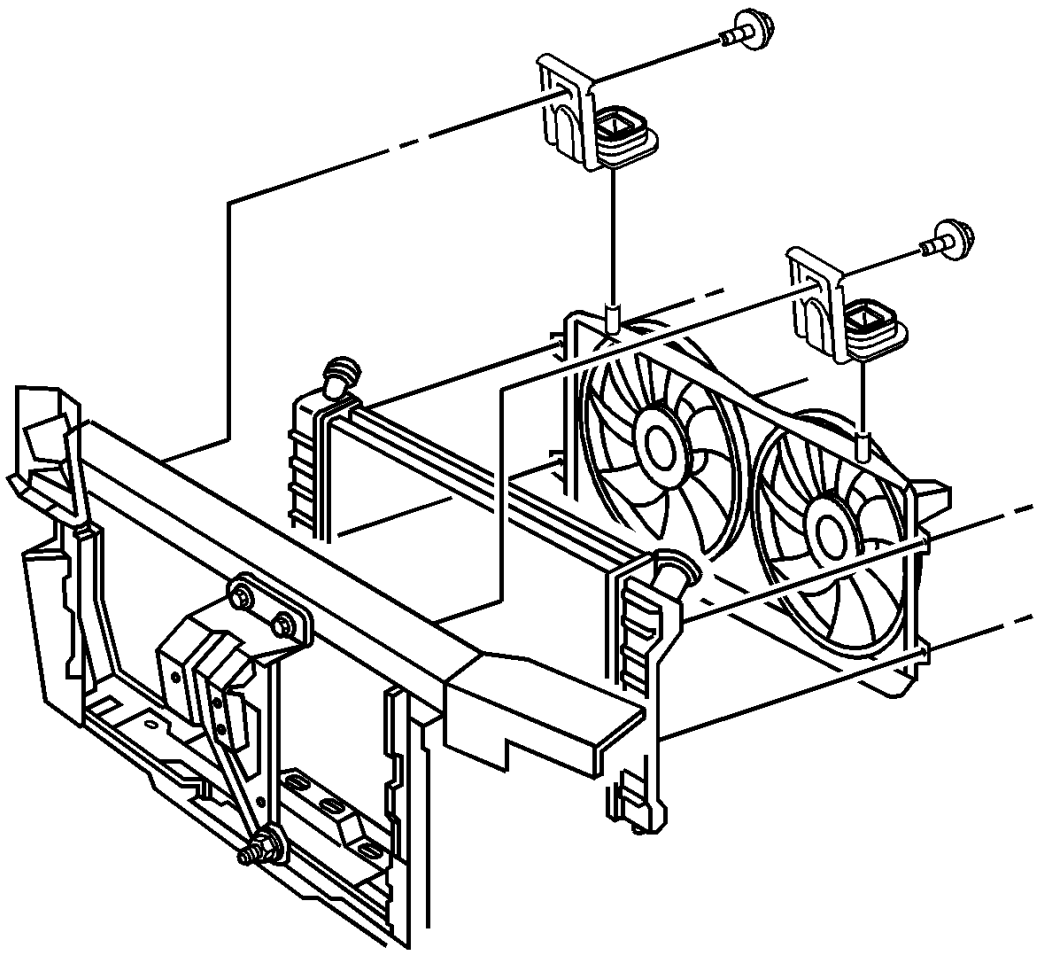


Fig. 44: View Of Fan Shroud To Radiator Upper Support Brackets
Courtesy of GENERAL MOTORS COMPANY

11. Remove the radiator upper support brackets and bolts that connect to the fan shroud.
12. Disconnect the engine cooling fan motors electrical connectors.
13. Remove the cooling fan motors electrical harness from the fan shroud clips.
14. Remove the cooling fan shroud.
15. Use **J 38185** pliers to reposition the lower radiator hose clamp from the radiator.
16. Remove the lower radiator hose from the radiator.
17. Disconnect the transaxle oil cooler pipes from the radiator. Refer to **Fluid Cooler Inlet Hose Replacement** , and **Fluid Cooler Outlet Hose Replacement** .
18. Tilt the top of the radiator rearward.

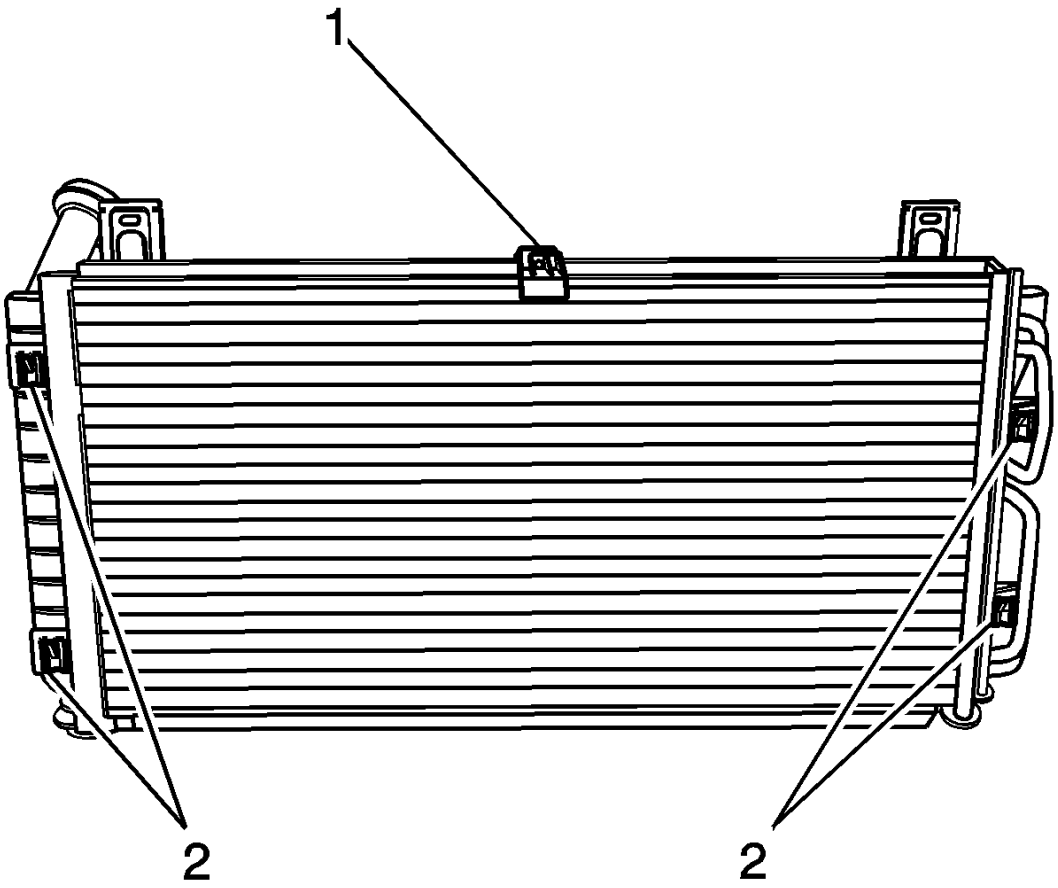


Fig. 45: Condenser Hold Down Bracket & Mount Tabs
Courtesy of GENERAL MOTORS COMPANY

19. Lift the condenser from the mounting tabs on the radiator (2). Position the condenser aside.
20. Remove the radiator.

Installation Procedure

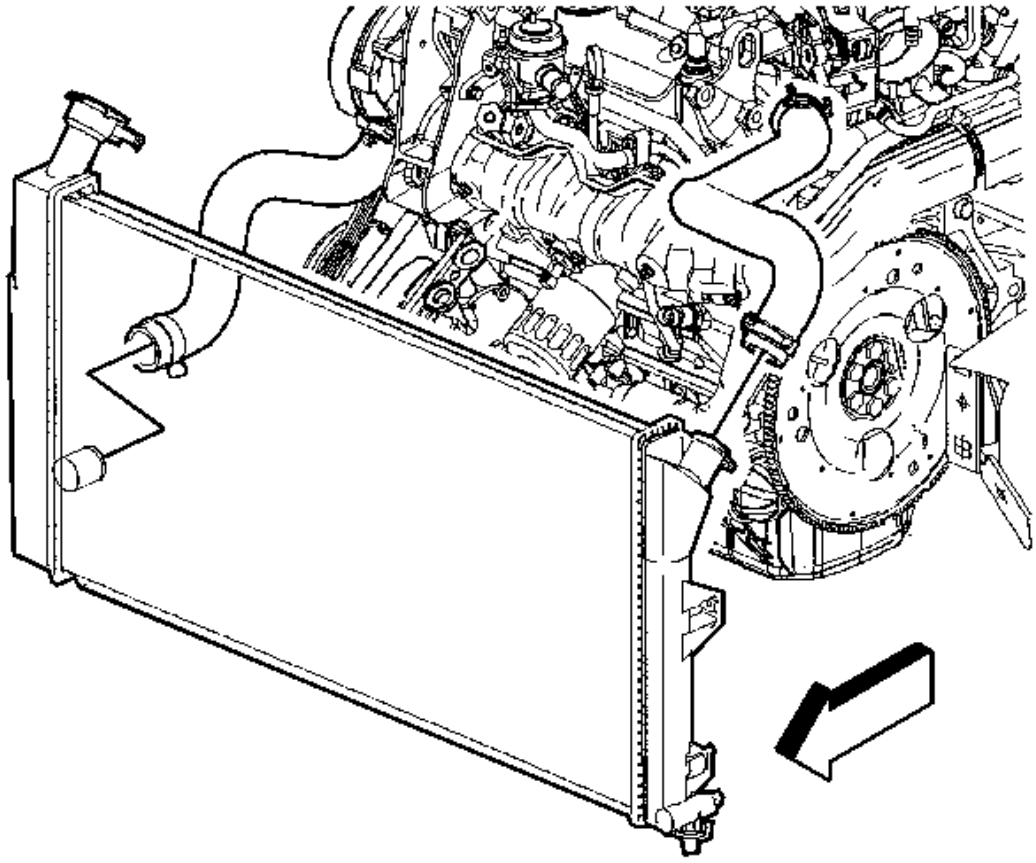


Fig. 46: View Of Radiator Hoses To/From Radiator
Courtesy of GENERAL MOTORS COMPANY

1. Install the radiator to the lower mounts.

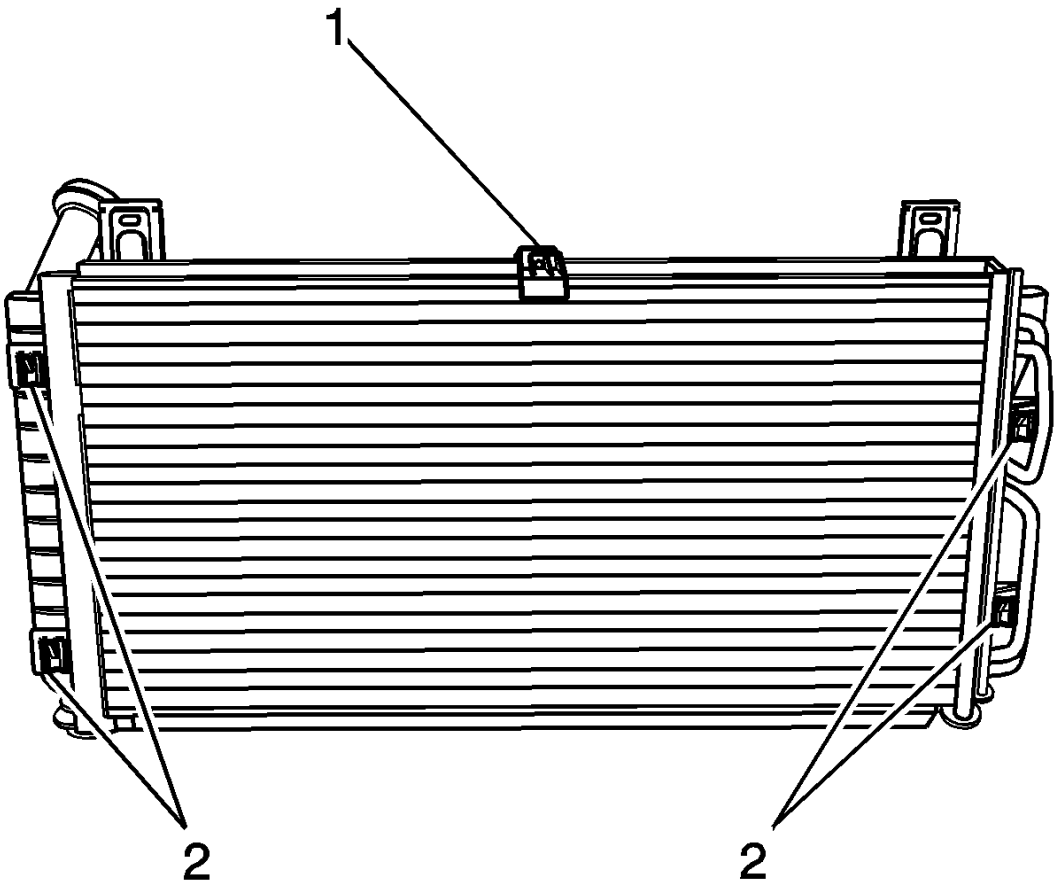


Fig. 47: Condenser Hold Down Bracket & Mount Tabs
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Verify that the condenser is fully seated in the radiator mounting tabs.**

2. Install the condenser to the mounting tabs on the radiator (2).
3. Install the condenser hold down bracket (1) to the radiator and condenser.
4. Install the lower radiator hose to the radiator.
5. Use **J 38185** pliers to install the lower radiator hose clamp to the radiator.

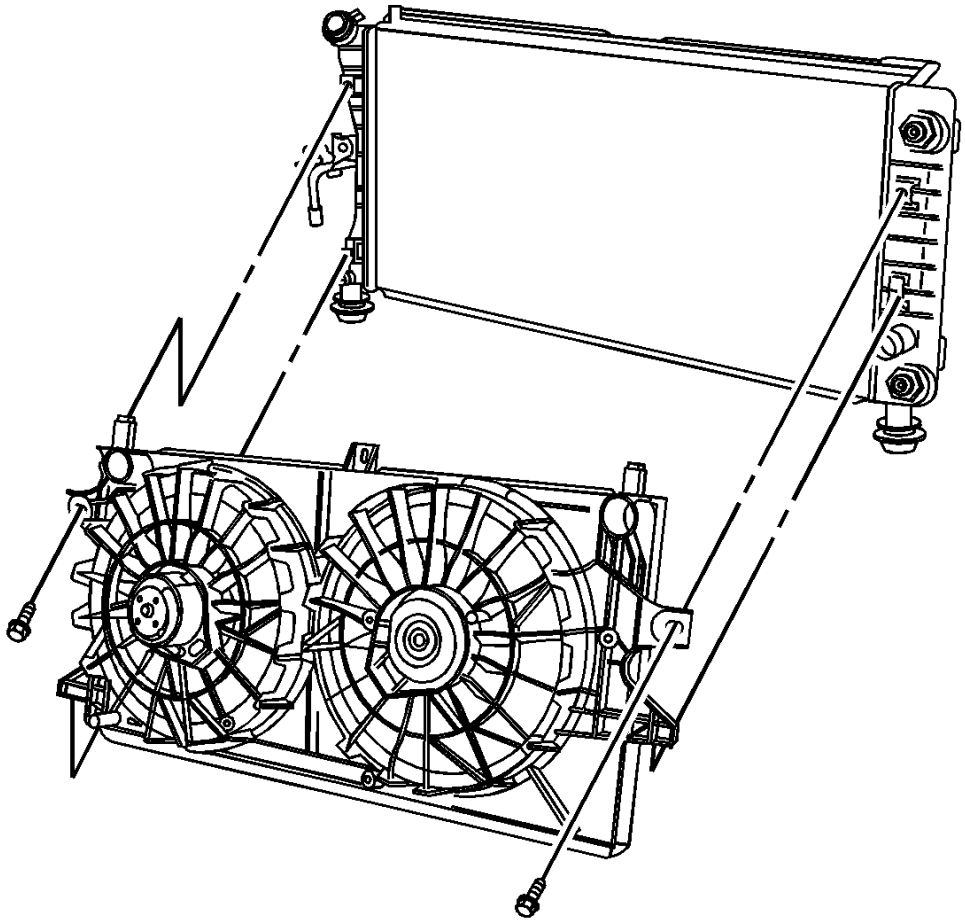


Fig. 48: View Of Cooling Fan Shroud Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the right and left edge of the fan shroud engages the radiator slots.**

6. Install the cooling fan shroud.

CAUTION: **Refer to Fastener Caution .**

7. Install the condenser tubes bracket bolt to the fan shroud and tighten to 10 N.m (89 lb in).
8. Install the cooling fan motors electrical harness to the fan shroud clips.
9. Connect the engine cooling fan motors electrical connectors.
10. Install the cooling fan shroud bolts and tighten to 10 N.m (89 lb in).
11. Connect the transaxle oil cooler pipes to the radiator. Refer to **Fluid Cooler Inlet Hose Replacement** , and **Fluid Cooler Outlet Hose Replacement** .

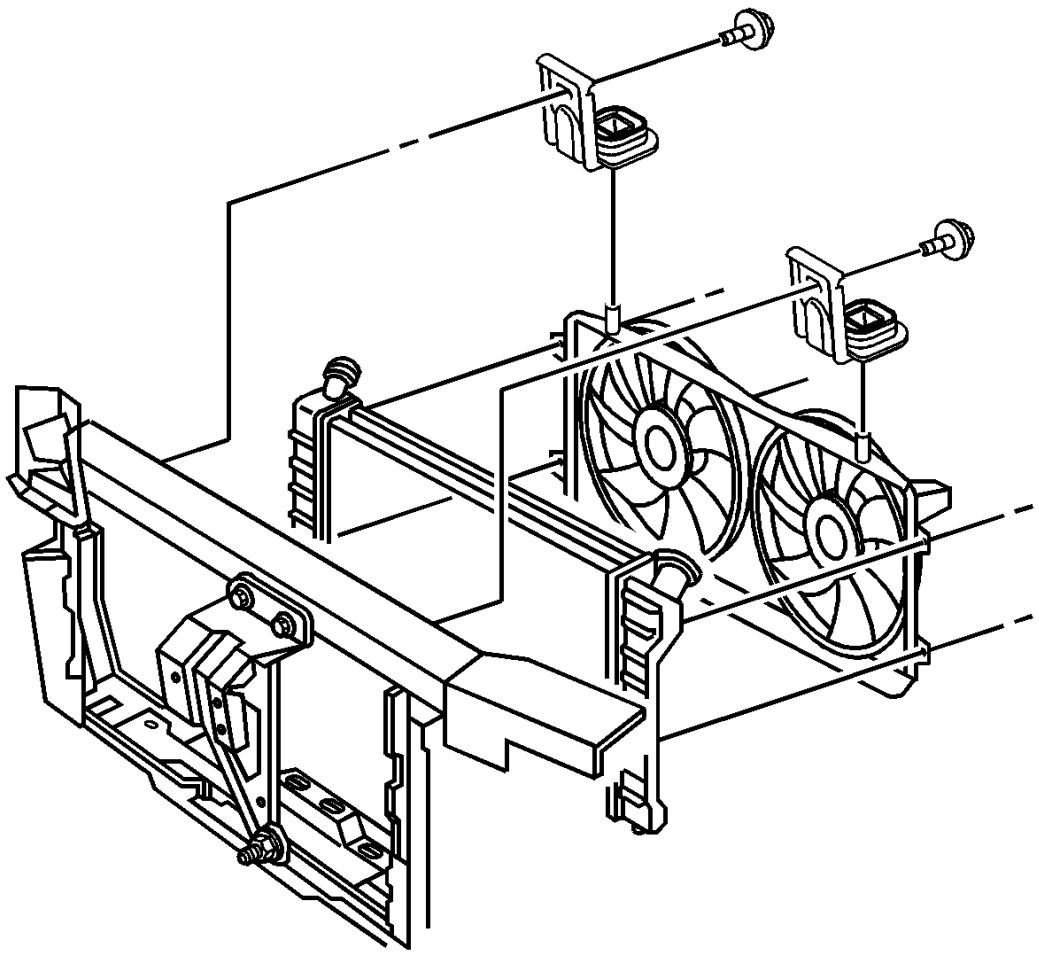


Fig. 49: View Of Fan Shroud To Radiator Upper Support Brackets
Courtesy of GENERAL MOTORS COMPANY

12. Install the radiator upper support brackets and bolts that connect to the fan shroud and tighten to 6 N.m (53 lb in).

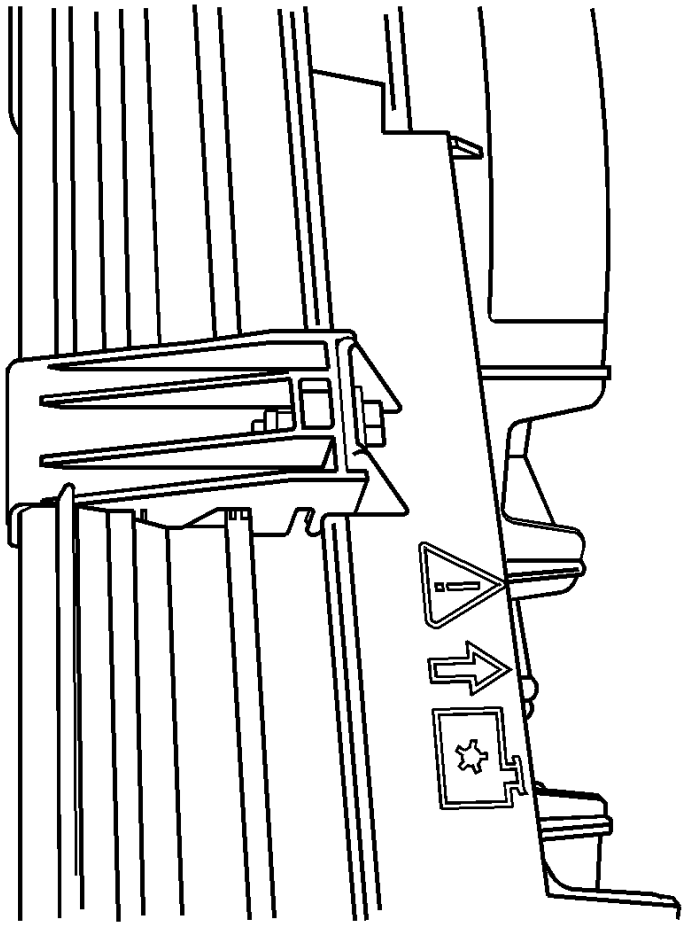


Fig. 50: Identifying Fan Shroud To Condenser Hold Down Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

13. Install the bolt that connects the fan shroud to the condenser hold down bracket and tighten to 6 N.m (53 lb in).
14. Install the upper radiator hose to the radiator.
15. Install the engine front strut. Refer to **Engine Mount Strut Replacement - Right Side** .
16. Use **J 38185** pliers to install the upper radiator hose clamp to the radiator.
17. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
18. Install the coolant reservoir hose to the fan shroud.
19. Install the radiator vent hose to the right upper radiator tank and fill neck.
20. Fill the cooling system. Refer to **Cooling System Draining and Filling**.
21. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .

CAUTION: Do NOT overfill the transaxle. The overfilling of the transaxle causes foaming, loss of fluid, shift complaints, and possible damage to the transaxle.

22. Adjust the transaxle fluid level.

RADIATOR AIR LOWER BAFFLE AND DEFLECTOR REPLACEMENT

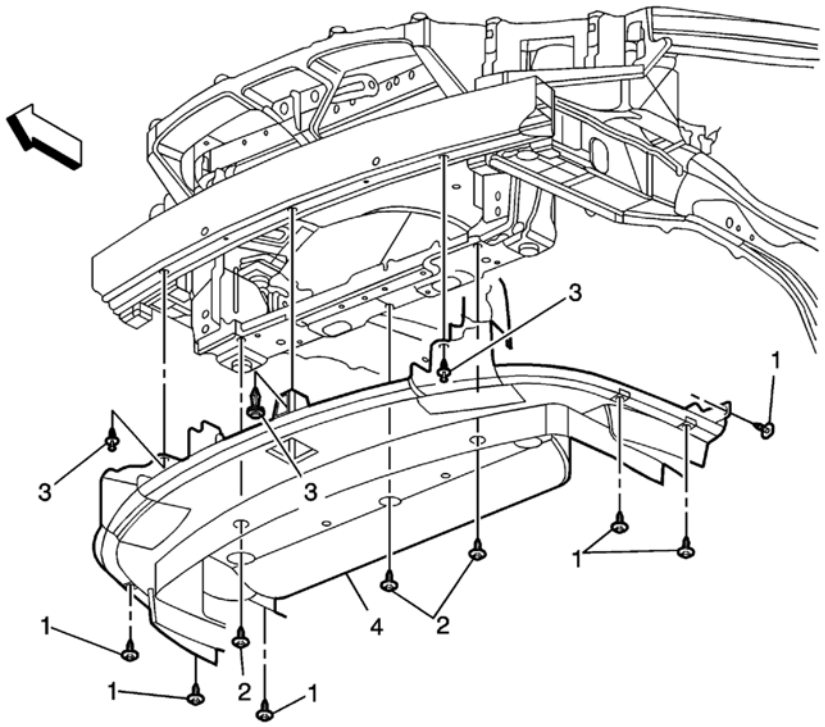


Fig. 51: Lower Radiator Air Baffle and Deflector
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Lower Radiator Air Deflector Screw (Qty: 6) **CAUTION:** **Refer to** **Fastener** **Caution** . **Tighten** 10 N.m (89 lb in)
2	Lower Radiator Air Deflector Screw (Qty: 3) **Tighten** 10 N.m (89 lb in)
3	Push Retainer (Qty: 3)
4	Radiator Front End Panel Deflector

RADIATOR AIR UPPER BAFFLE AND DEFLECTOR REPLACEMENT

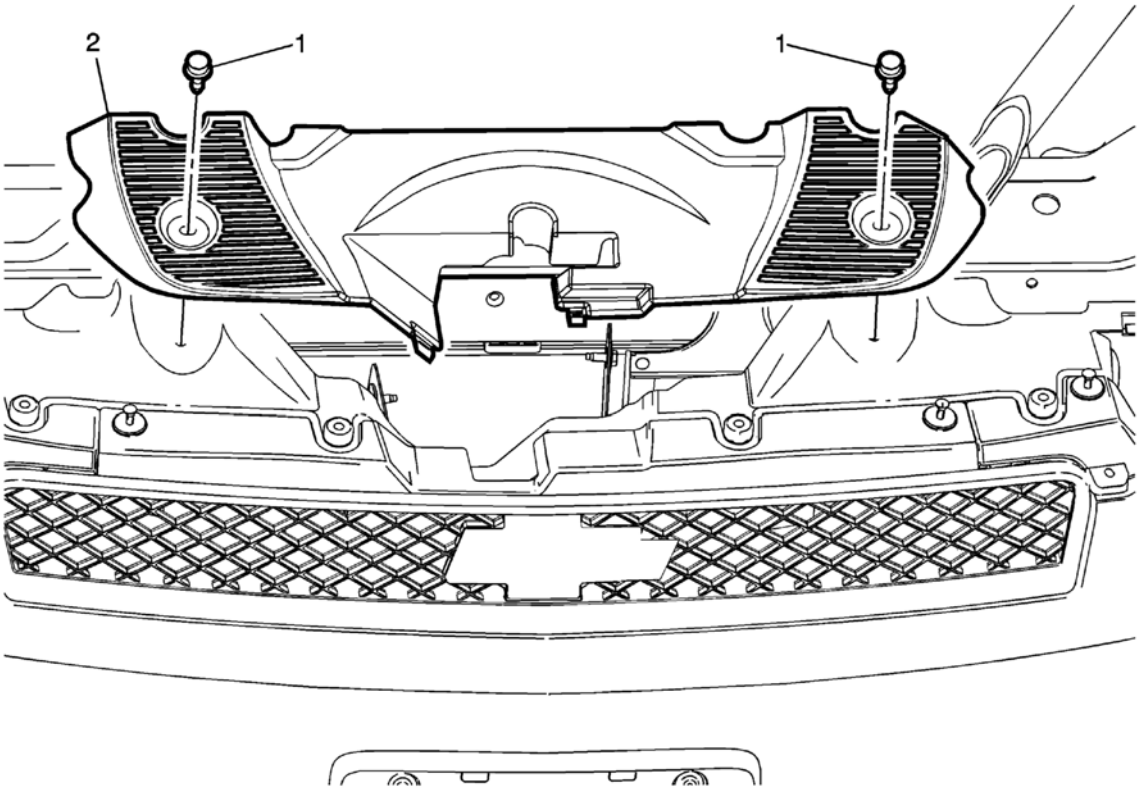


Fig. 52: Radiator Air Upper Baffle And Deflector
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Upper Radiator Air Deflector Push Pins(Qty: 2)
2	Upper Radiator Air Baffle

COOLANT HEATER REPLACEMENT (LFX)

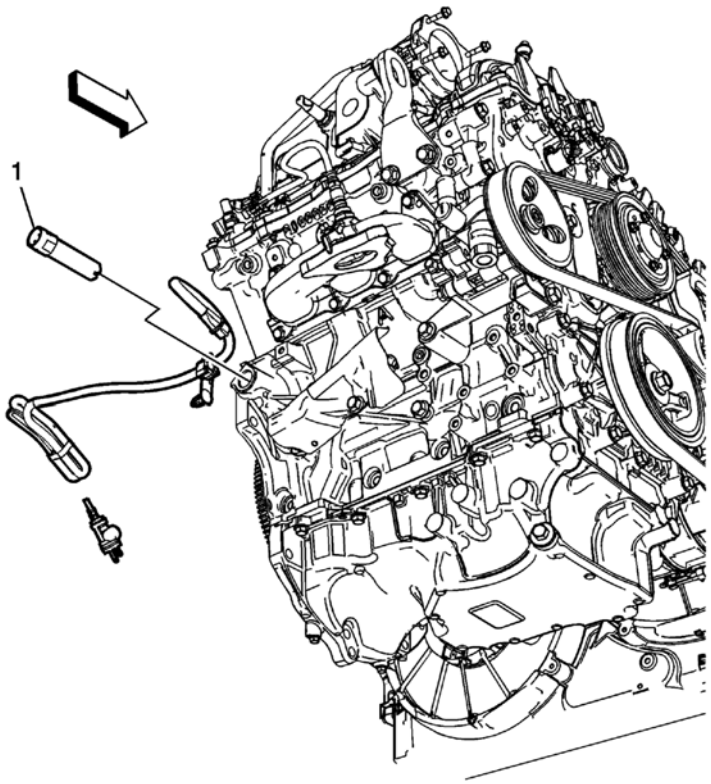


Fig. 53: Engine Coolant Heater
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Coolant Heater **TIP:** Be careful not to score inner surface of the engine block when removing coolant heater.

COOLANT HEATER CORD REPLACEMENT (LFX)

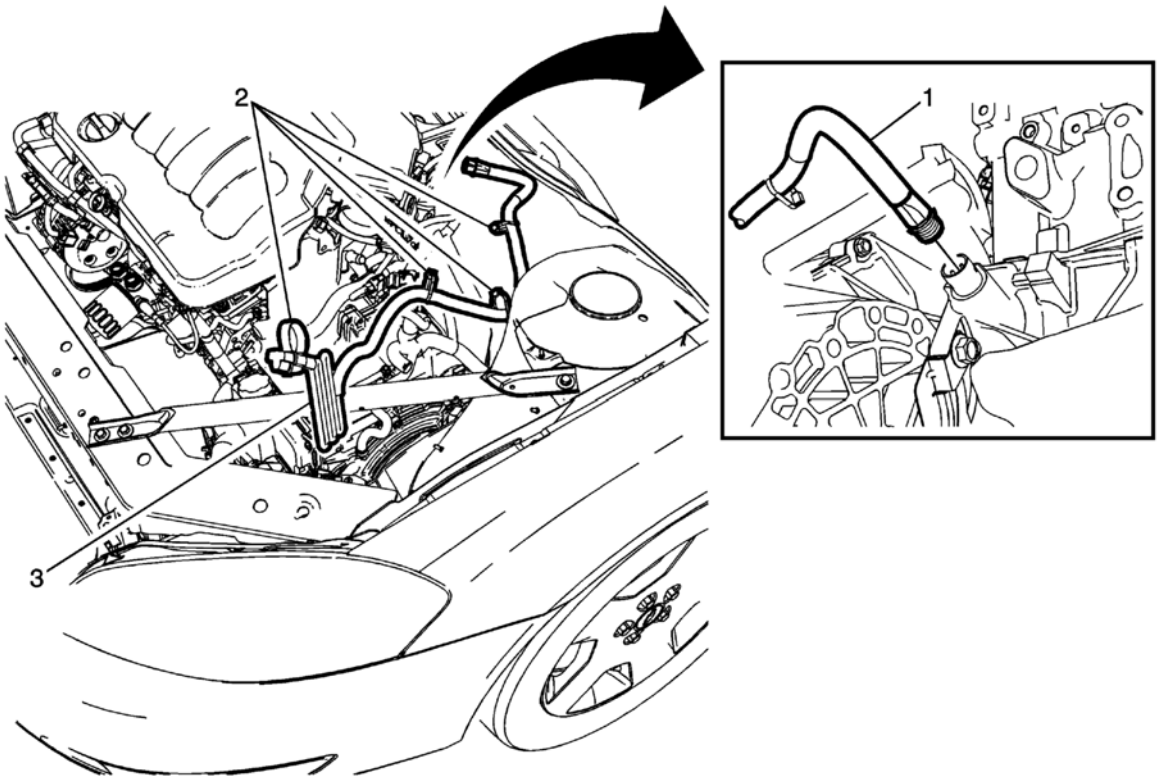


Fig. 54: Coolant Heater Cord, Retainers & Connector (LFX)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .	
1	Coolant Heater Connector
2	Coolant Heater Cord Retainers
3	Coolant Heater Cord

DESCRIPTION AND OPERATION

COOLING FAN DESCRIPTION AND OPERATION

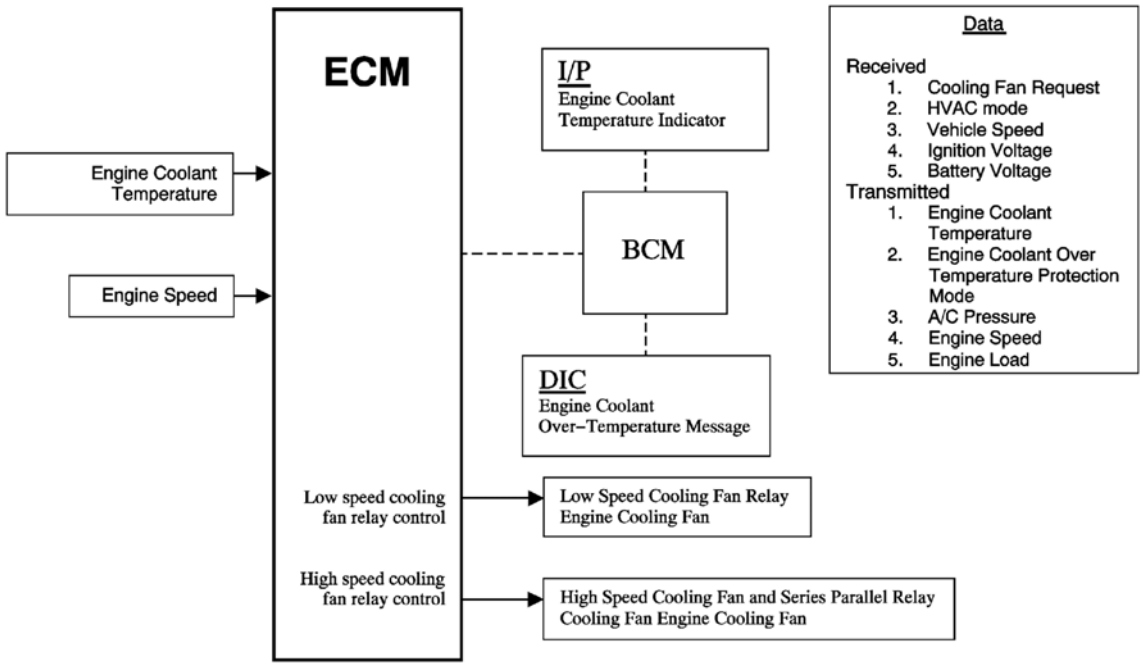


Fig. 55: Cooling Fan Description and Operation
Courtesy of GENERAL MOTORS COMPANY

The engine cooling fan system consists of 2 electrical cooling fans and 3 fan relays. The relays are arranged in a series/parallel (S/P) configuration that allows the engine control module (ECM) to operate both fans together at low or high speeds. The cooling fans receive positive voltage from the cooling fan relays which receive battery positive voltage from the underhood fuse block.

During low speed operation, the ECM supplies the ground path for the low speed fan 1 relay through the fan 1 relay control circuit. This energizes the fan 1 relay coil, closes the relay contacts, and supplies battery positive voltage from the Fan 1 fuse through the cooling fan motor supply voltage circuit to the left engine cooling fan. The ground path for the left cooling fan is through the S/P fan 2 relay and the right engine cooling fan. The result is a series circuit with both fans running at low speed.

During high speed operation the ECM continues to supply battery positive voltage for the right cooling fan by grounding the coil of the fan 1 relay. The ECM also grounds the high speed fan 3 relay and the S/P fan 2 relay through the fan 3 relay control circuit. This energizes the S/P fan 2 relay coil, closes the relay contacts, and provides a direct ground path for the left engine cooling fan. At the same time the fan 3 relay coil is energized closing the relay contacts and providing battery positive voltage from the Fan 2 fuse on the cooling fan motor supply voltage circuit to the right cooling fan. During high speed fan operation, both engine cooling fans have their own ground path. The result is a parallel circuit with both fans running at high speed.

COOLING SYSTEM DESCRIPTION AND OPERATION

Engine Coolant Indicators

TEMP

- The instrument panel cluster (IPC) illuminates the TEMP indicator when the powertrain control module (PCM) determines that the coolant temperature is more than 128Â°C (262Â°F). The IPC receives a discrete input from the PCM requesting illumination.
- The IPC performs the display test at the start of each ignition cycle. The IPC illuminates the TEMP indicator.

Coolant Level Control

The engine cooling system contains an engine coolant level switch to alert the driver in the event of a low coolant level. When the engine coolant level in the coolant recovery reservoir falls below a certain level, the coolant level switch opens. When the body control module (BCM) detects an open or a high voltage level on the coolant level indicator control circuit, for at least 10 seconds, it will send a GM LAN message to the driver information center (DIC) requesting display of the low coolant level message. There is approximately a 10 second delay before the BCM sends the GM LAN message to prevent the message from being displayed, due to coolant sloshing in the surge tank.

Coolant Heater

The optional engine coolant heater (RPO K05) operates using AC external power and is designed to warm the coolant in the engine block area for improved starting in very cold weather -29Â°C (-20Â°F). The coolant heater helps reduce fuel consumption when a cold engine is warming up. The unit is equipped with a detachable AC power cord. A weather shield on the cord is provided to protect the plug when not in use.

Cooling System

The cooling systems function is to maintain an efficient engine operating temperature during all engine speeds and operating conditions. The cooling system is designed to remove approximately one-third of the heat produced by the burning of the air-fuel mixture. When the engine is cold, the coolant does not flow to the radiator until the thermostat opens. This allows the engine to warm quickly.

Cooling Cycle

Coolant is drawn from the radiator outlet to the thermostat. The flow of coolant will be stopped at the thermostat until the engine is warmed; while the thermostat is closed the water pump circulates coolant through the engine block and heater core. Coolant is returned to the water pump through the engine bypass and the heater core outlet hose. This provides the passenger compartment with heat and defrost.

After the thermostat opens, the coolant is pumped through the water pump outlet and into the engine block and heater core. In the engine block, the coolant circulates through the water jackets surrounding the cylinders where it absorbs heat.

The coolant is then forced through the cylinder head gasket openings and into the cylinder heads. In the cylinder heads, the coolant flows through the water jackets surrounding the combustion chambers and valve seats, where it absorbs additional heat.

From the cylinder heads, the coolant is then forced into the radiator where it is cooled and the coolant cycle is completed.

Operation of the cooling system requires proper functioning of all cooling system components. The cooling system consists of the following components:

Coolant

The engine coolant is a solution made up of a 50/50 mixture of DEX-COOLÂ® and suitable drinking water. The coolant solution carries excess heat away from the engine to the radiator, where the heat is dissipated to the atmosphere.

Radiator

The radiator is a heat exchanger consisting of a core and 2 tanks. The aluminum core is a tube and fin crossflow design that extends from the inlet tank to the outlet tank. Fins are placed around the outside of the tubes to improve heat transfer to the atmosphere.

The inlet and outlet tanks are a molded, high temperature, nylon reinforced plastic material. A high temperature rubber gasket seals the tank flange edge to the aluminum core. The tanks are clamped to the core with clinch tabs. The tabs are part of the aluminum header at each end of the core.

The radiator also has a drain cock located in the bottom of the end tank. The drain cock unit includes the drain cock and drain cock seal.

Heat is removed from the coolant as the coolant passes through the radiator. The fins on the core transfer heat from the coolant passing through the tubes. Air passing between the fins absorbs the heat and cools the coolant.

Pressure Cap

The pressure cap seals and pressurizes the cooling system. The cap contains a blow off, or pressure valve and a vacuum, or an atmospheric valve:

- The pressure valve is held against the seat by a spring that protects the radiator by relieving pressure that exceeds 15 psi.
- The vacuum valve is held against the seat by a spring that permits opening of the valve to relieve vacuum created when the cooling system cools. The vacuum, if not relieved, might cause the radiator to collapse.

The pressure cap allows the cooling system pressure to build up when the temperature increases. As the pressure builds, the boiling point of the coolant increases. Therefore, the engine coolant can be safely run at a temperature much higher than the boiling point of the coolant at atmospheric pressure. The hotter the coolant becomes, the faster the heat transfers from the radiator into the cooler air.

The pressure in the cooling system can get too high. When the pressure exceeds the strength of the spring, the pressure valve rises, venting the excess pressure.

As the engine cools, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum causes the vacuum valve to open. This equalizes the pressure in the cooling system with the atmospheric pressure, preventing the radiator from collapsing.

Coolant Recovery System

The coolant recovery system consists of a plastic coolant recovery reservoir and overflow tube. The recovery reservoir is also called a recovery tank or expansion tank. This tank is partially filled with coolant and is connected to the radiator fill neck with the overflow tube. Coolant can flow back and forth between the radiator and the reservoir.

In effect, a cooling system with a coolant recovery reservoir is a closed system. When the pressure within the cooling system gets too high, the pressure valve in the pressure cap will open. This allows the coolant, which has expanded due to heat, to flow through the overflow tube and into the recovery reservoir. As the engine cools down, the temperature of the coolant drops and a vacuum is created in the cooling system. This vacuum opens the vacuum valve in the pressure cap, allowing some of the coolant in the reservoir to be siphoned back into the radiator. Under normal operating conditions, no coolant is lost. Although the coolant level in the recovery reservoir goes up and down, the radiator and cooling system are kept full. An advantage to using a coolant recovery reservoir is the elimination of almost all air bubbles from the cooling system. Coolant without bubbles absorbs heat much better than coolant with bubbles.

Air Baffles and Seals

The cooling system uses deflectors, air baffles and air seals to increase cooling system capability. Deflectors are installed under the vehicle to redirect airflow beneath the vehicle and through the radiator to increase engine cooling. Air baffles are also used to direct airflow through the radiator and increase cooling capability. Air seals prevent air from bypassing the radiator and A/C condenser, and prevent recirculation of hot air for better hot weather cooling and A/C condenser performance.

Water Pump

The water pump is a centrifugal vane impeller type pump. The pump consists of a housing with coolant inlet and outlet passages and an impeller. The impeller is a flat plate mounted on the pump shaft with a series of flat or curved blades or vanes. When the impeller rotates, the coolant between the vanes is thrown outward by centrifugal force. The impeller shaft is supported by one or more sealed bearings, which never need to be lubricated. With a sealed bearing, grease cannot leak out, and dirt and water cannot get in.

The water pump circulates coolant throughout the cooling system. The pump is driven by the crankshaft from the drive belt.

Thermostat

The thermostat is a coolant flow control component, whose purpose is to regulate the operating temperature of the engine. The thermostat utilizes a temperature sensitive wax-pellet element, which connects to a valve through a piston. Heating causing the element to expand and exert pressure against a rubber diaphragm. This pressure forces the valve to open. Cooling causes the element to contract. This contraction allows a spring to push the valve closed.

When the coolant temperature is below 91Â°C (195Â°F), the thermostat valve remains closed. This prevents circulation of the coolant to the radiator and allows the engine to warm up quickly. After the coolant temperature reaches 91Â°C (195Â°F), the thermostat valve will open. The coolant is then allowed to circulate through the thermostat to the radiator where the engine heat is dissipated to the atmosphere. The thermostat also provides a restriction in the cooling system, even after opening. This restriction creates a pressure difference which prevents cavitation at the water pump and forces coolant to circulate through the engine block.

Engine Oil Cooler

The engine oil cooler is a heat exchanger which is located external to the radiator. The oil temperature is cooled by the air passing through the oil cooler fins. The oil pump pumps the oil through the feed line to the oil cooler. The oil flows through the cooler where the air absorbs heat from the oil. The oil is then pumped through the cooler return line to the oil filter and returns to the main oil passage.

Transmission Oil Cooler - Internal

The transmission oil cooler is a heat exchanger that is located inside one of the radiator end tanks. The transmission fluid temperature is regulated by the temperature of the engine coolant in the radiator. The oil pump pumps the fluid through the transmission oil cooler feed line to the oil cooler. The fluid flows through the cooler where the engine coolant absorbs heat from the fluid. The fluid is then pumped through the oil cooler return line back to the transmission.

Transmission Oil Cooler - External

The transmission oil cooler is a heat exchanger that is located external to the radiator. Air passing through the oil cooler fins cools the transmission fluid temperature. Within the transmission system, the oil pump pumps the fluid through the feed line to the oil cooler. The fluid then flows through the cooler where air absorbs heat from the fluid. The fluid is then pumped through the oil cooler return line back to the transmission.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

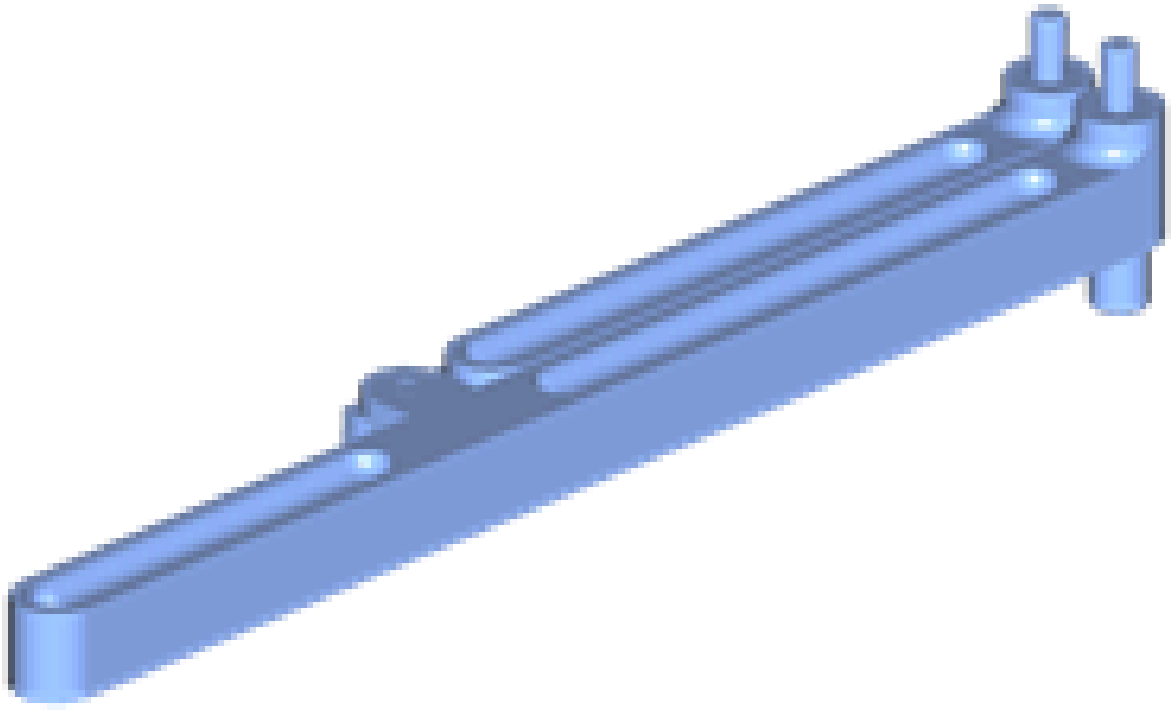
Illustration	Tool Number/ Description
	EN 46104 Water Pump Pulley Holder

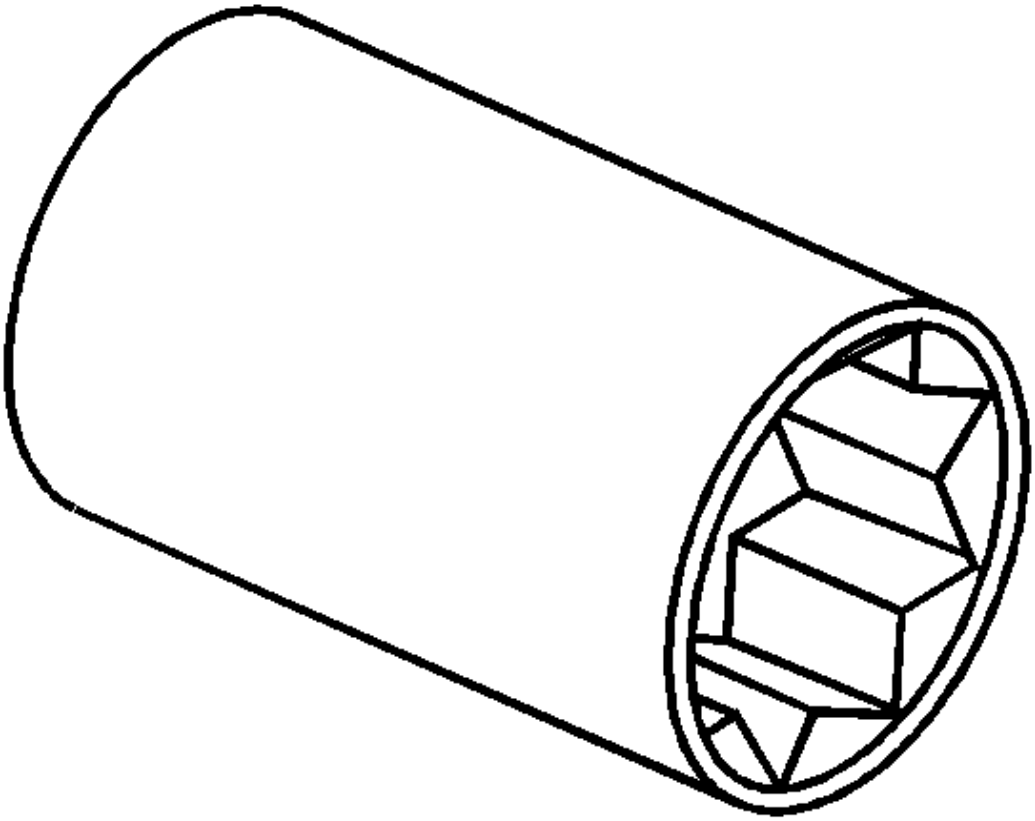
Illustration	Tool Number/ Description
	GE 47827 Socket

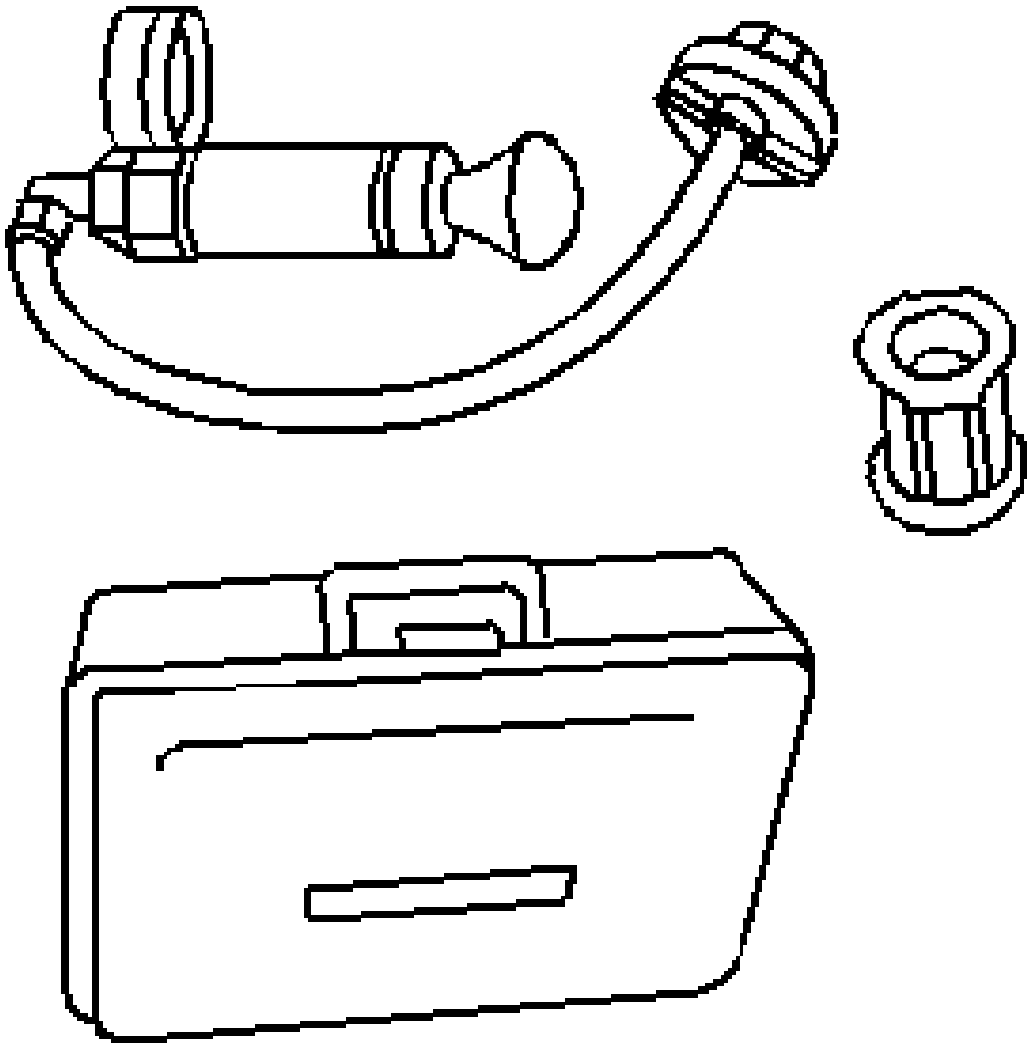
Illustration	Tool Number/ Description
	J 24460-01 Cooling System Pressure Tester

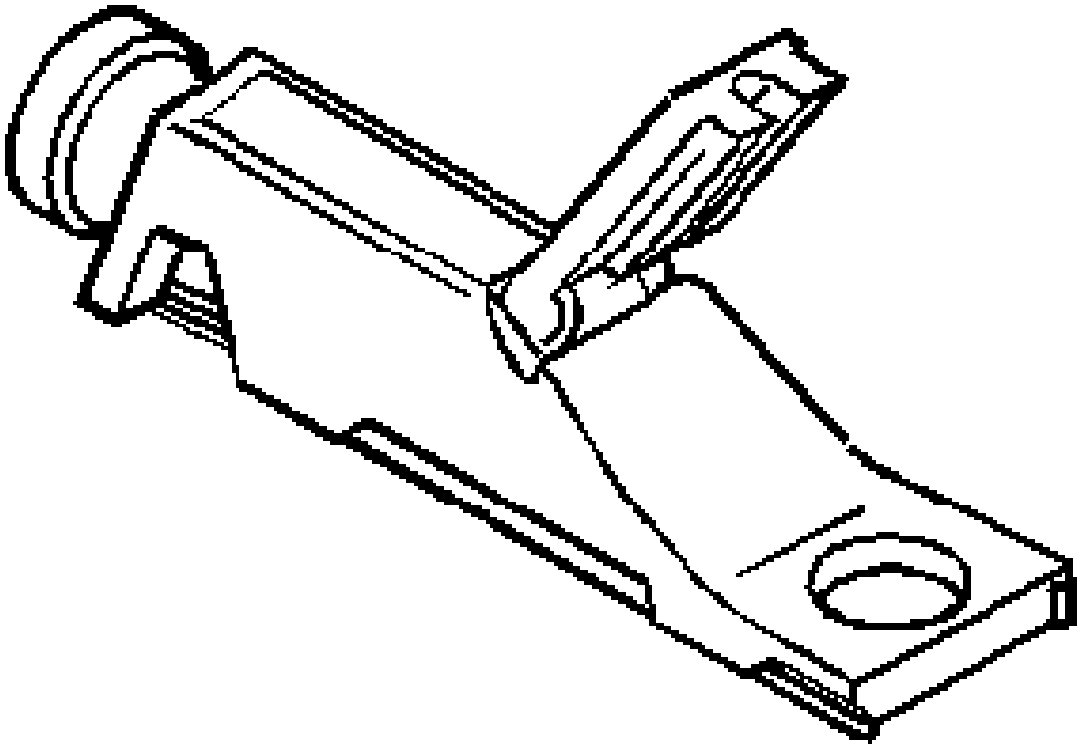
Illustration	Tool Number/ Description
	J 26568 Coolant and Battery Fluid Tester

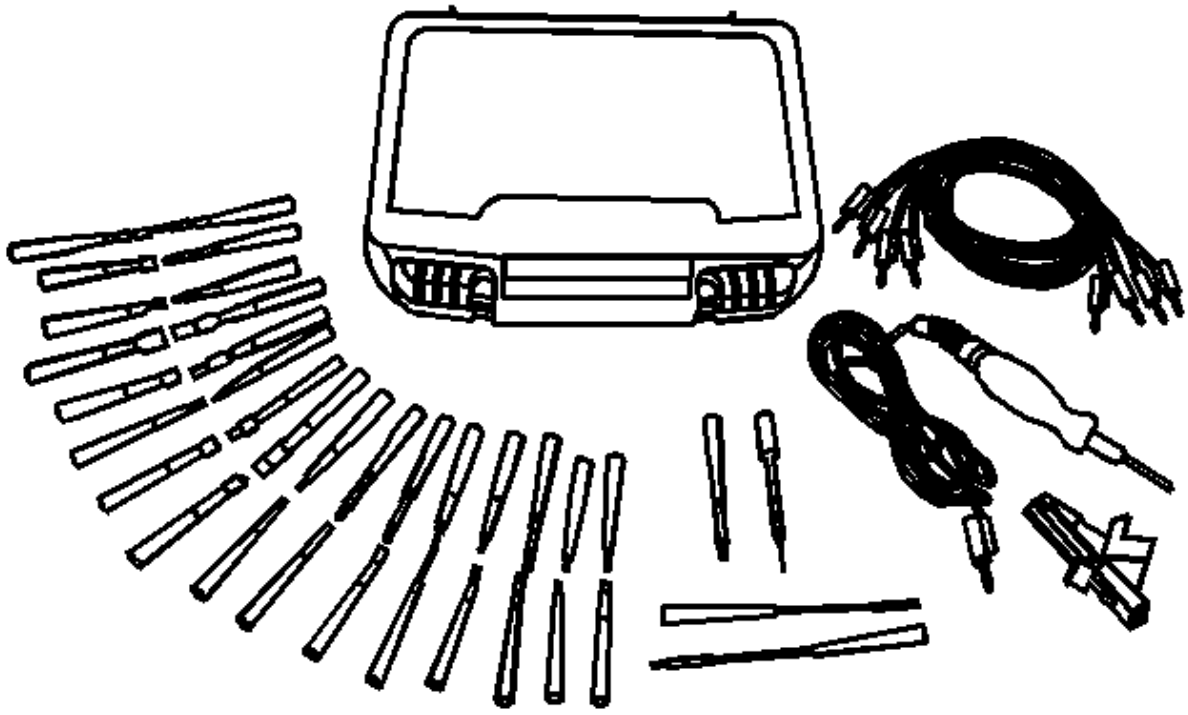
Illustration	Tool Number/ Description
	J 35616 Connector Test Adapter Kit

Illustration	Tool Number/ Description
	J 38185 Hose Clamp Pliers

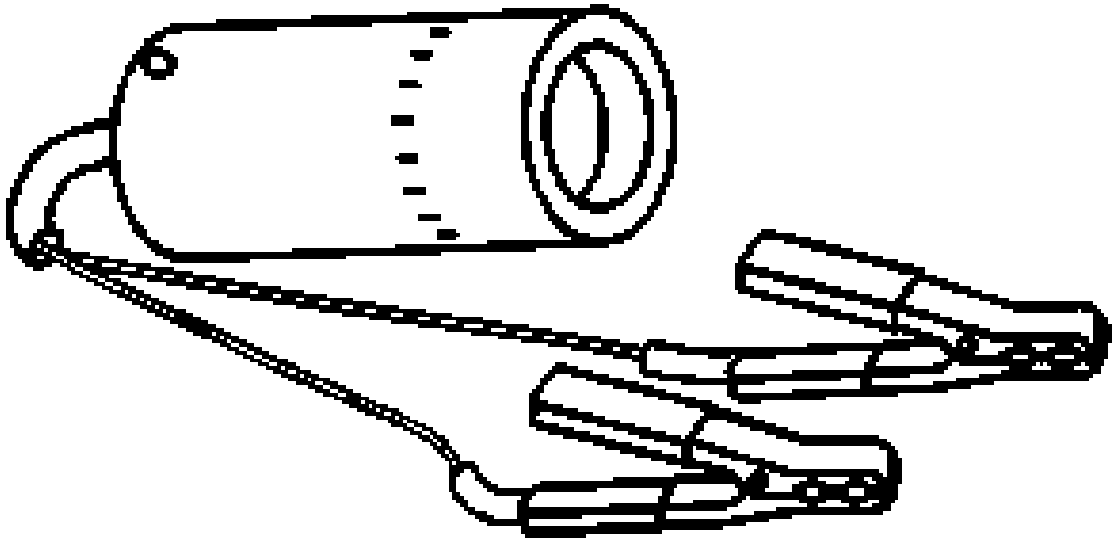
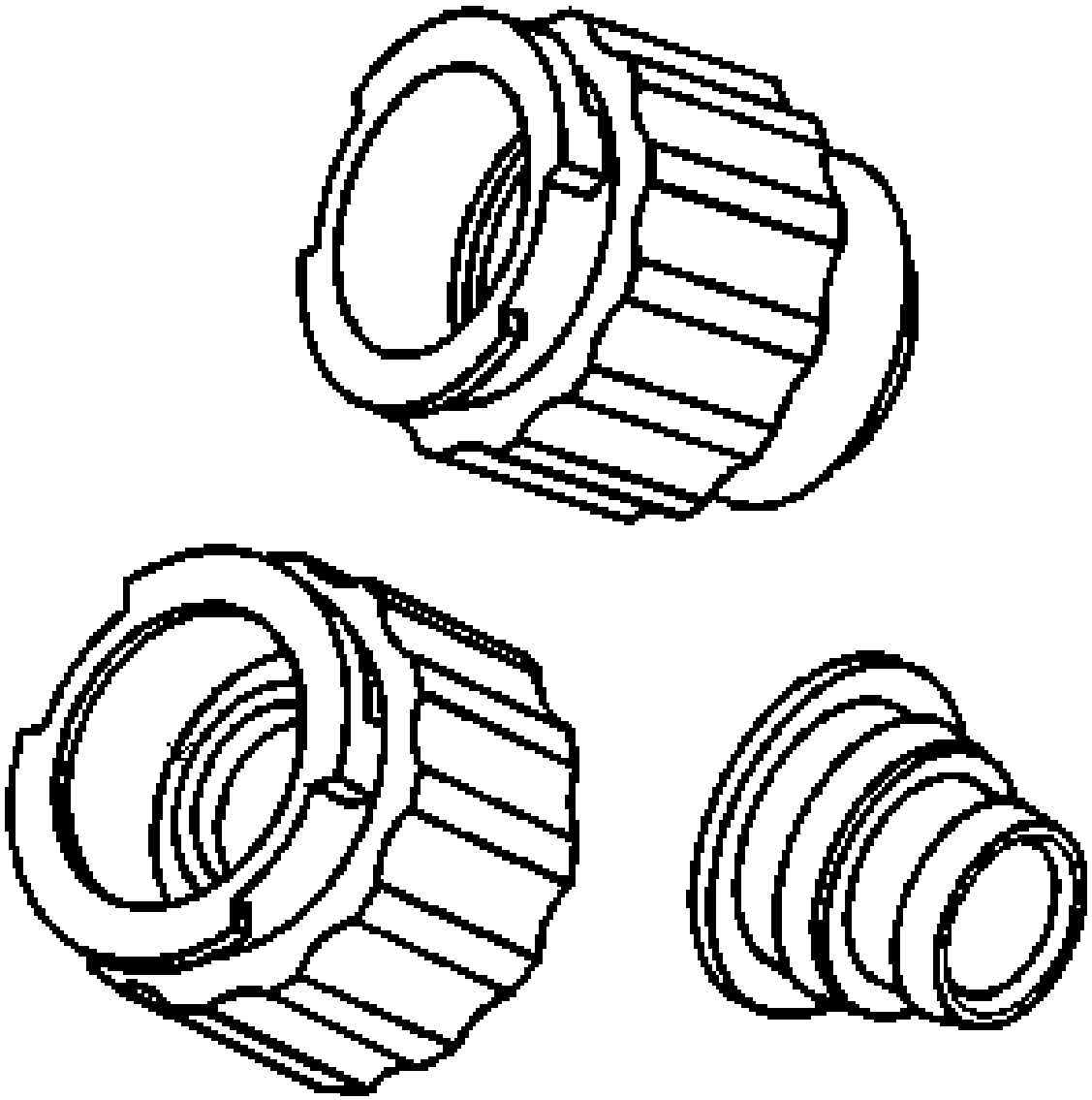
Illustration	Tool Number/ Description
	J 42220 Universal 12V Leak Detection Lamp

Illustration	Tool Number/ Description
	J 42401 Radiator Cap/Surge Tank Test Adapter

Article GUID: A00737179

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Catalytic Converter to Cylinder Head - First Pass	20 N.m	15 lb ft
Catalytic Converter to Cylinder Head - Second Pass	46 N.m	34 lb ft
Catalytic Converter-to- Exhaust Front Flexible Pipe Fastener	43 N.m	32 lb ft
Exhaust Front Flexible Pipe-to-Front Catalytic Converter	43 N.m	32 lb ft
Exhaust Front Flexible Pipe-to-Rear Catalytic Converter	43 N.m	32 lb ft
Exhaust Muffler-to-Exhaust Front Pipe	43 N.m	32 lb ft
Catalytic Converter Clamp (Service)	50 N.m	37 lb ft

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - ENGINE EXHAUST

- Review the exhaust system description in order to familiarize yourself with the exhaust system components and the intended function of the components.
- All diagnostics on a vehicle should follow a logical process. Strategy Based Diagnostics is a uniform approach for repairing all systems. The diagnostic flow is the place to start when repairs are necessary and may always be used in order to resolve a system problem. For a detailed explanation, refer to **Strategy Based Diagnosis** .

Visual/Physical Inspection

- Inspect for aftermarket or non-OEM devices such as, but not limited to; tailpipe extensions, headers, and exhaust cutouts. Any aftermarket exhaust system devices could affect the operation and proper performance of the exhaust system.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, engine temperature, engine load, and frequency of concern.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause any symptom.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating as designed.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Loss of power

  Refer to **Restricted Exhaust**

- Poor acceleration

  Refer to **Restricted Exhaust**

- Poor fuel economy

  Refer to **Restricted Exhaust**

- Excessive smoke diesel

  Refer to **Restricted Exhaust**

- Exhaust hissing noise

  Refer to **Exhaust Leakage**

- Exhaust popping noise

  Refer to **Exhaust Leakage**

- Exhaust rattle noise

  Refer to **Exhaust Noise**

- Loud exhaust noise

  Refer to **Exhaust Noise**

- Exhaust buzz, groan, hum noise

  Refer to **Exhaust Noise**

RESTRICTED EXHAUST

Special Tools

J-35314-A Exhaust Back Pressure Gauge

For equivalent regional tools, refer to **Special Tools**

Diagnostic Aids

WARNING: Refer to Hot Exhaust System Warning .

For dual exhaust systems a quick check of exhaust flow will help determine which side of the exhaust system is restricted. The side that has less exhaust flow is the side that will be suspect, and diagnosis should begin there.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4

The exhaust system has very low back pressure under normal conditions. If the exhaust system is restricted, a significant increase in the exhaust pressure is noticed on the **J-35314-A** gauge.

Removing the HO2S sensor may set a DTC. When finishing this diagnostic table, be sure to clear all codes.

5

This step will isolate the catalytic converter from the remainder of the exhaust system.

8

Confirming that the condition has been fixed is essential. If the symptom still exists and the vehicle has a dual exhaust system, proceed to step 2 and repeat diagnostic procedure on the opposite exhaust pipe.

Step	Action	Value(s)	Yes	No
1	Did you verify the customers complaint?	-	Go to **Step 2**	-
2	Did you review the exhaust symptoms diagnostic information and perform the necessary inspections?	-	Go to **Step 3**	Go to **Symptoms - Engine Exhaust**
3	Is the system equipped with dual exhaust?	-	Go to Diagnostic Aids	Go to **Step 4**
4	1. Remove the heated oxygen sensor (HO2S) that is in front of the catalytic converter. Refer to the appropriate procedure. Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 1** , or **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1** . 2. Install the **J-35314-A** Exhaust Back Pressure Gauge in place of the HO2S sensor. 3. Start the engine. 4. Increase and monitor the engine speed at 2,500 RPM. 5. Observe the exhaust system back pressure reading on the gauge. Does the reading exceed the specified value?	9 kPa (1.25 psi)	Go to **Step 5**	Go to **Step 8**
5	1. Turn the engine OFF and place the ignition in the lock position. 2. Remove the **J-35314-A** gauge. 3. Reinstall the HO2S sensor. Refer to	9 kPa (1.25 psi)	Go to **Step 6**	Go to **Step 7**

Step	Action	Value(s)	Yes	No
	Heated Oxygen Sensor Replacement - Bank 1 Sensor 1 , or **Heated Oxygen Sensor Replacement - Bank 2 Sensor 1** . 4. Remove the post-catalyst HO2S sensor. Refer to the appropriate procedure. Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2** , or **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2** . 5. Install the **J-35314-A** gauge in place of the post HO2S sensor. 6. Start the engine. 7. Increase and monitor the engine speed at 2,500 RPM. 8. Observe the exhaust system back pressure reading on the gauge. Does the reading exceed the specified value?			
6	Inspect the exhaust system for the following conditions: • Secondary catalytic converter restricted • Damage in the exhaust pipe • Debris in the exhaust pipe • Muffler or resonator internal failure • Two-layer exhaust pipe separation Did you find and correct the condition?	-	Go to **Step 8**	-
7	Replace the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (Front)**, or **Catalytic Converter Replacement - Right Side (Rear)**. Did you find and correct the condition?	-	Go to **Step 8**	-

Step	Action	Value(s)	Yes	No
8	1. Remove the **J-35314-A** gauge. 2. Reinstall the applicable HO2S sensor. Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2** , or **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2** . 3. Clear any codes. 4. Road test the vehicle in order to verify the repair. Did you correct the condition?	-	System OK	Go to **Step 2**

EXHAUST LEAKAGE

Condition	Action
WARNING: **Refer to Hot Exhaust System Warning .** DEFINITION: An exhaust leak may show stains at the area of the leak. The leak may be felt by holding a hand close to the suspected areas or using a smoke pencil. The leak may make a popping or hissing noise.Refer to **Symptoms - Engine Exhaust** prior to beginning this table.	
Misaligned or improperly installed exhaust system components	• Align and tighten the exhaust system components to the specifications. Refer to **Fastener Specifications**. • Ensure the exhaust hangers are in the proper locations and not loose.
Exhaust leaks at the following connections: • Exhaust manifold to pipe • Flanges • Pipe clamps	Tighten the components to the specifications. Refer to **Fastener Specifications**.
Seals or gaskets leaking; • Exhaust manifold to cylinder head • Exhaust pipes to exhaust manifold • Catalytic converter connection	Replace the leaking seal or gasket. Refer to the affected components procedure for service.

Condition	Action
Irregularities at the mating surfaces on the flange connections	Repair as required or replace the affected component. Refer to the affected components procedure for service.
Catalytic Converter cracked or broken	Replace the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (Front)**, or **Catalytic Converter Replacement - Right Side (Rear)**.
Exhaust system component connection welds leaking	Replace the leaking component. Refer to the affected component's procedure for service.
Muffler or resonator, if equipped, damaged or leaking at the seams	Replace the affected muffler or resonator, if equipped. Refer to **Exhaust Muffler Replacement**.

EXHAUST NOISE

Condition	Action
WARNING: **Refer to Hot Exhaust System Warning .** DEFINITION: An audible or physical noise due to a faulty component or damaged components causing a loose or misaligned exhaust system resulting in a rattle or vibration noise, i.e. buzz, groan, hum.Refer to **Symptoms - Engine Exhaust** prior to beginning this table.	
Popping or hissing noise	Exhaust leak-Refer to **Exhaust Leakage**.
Loud exhaust	1. Compare to a known good vehicle. 2. Inspect for a damaged or failed muffler or resonator, if equipped. 3. Replace the faulty muffler or resonator (if equipped). Refer to **Exhaust Muffler Replacement**.
External rattle or vibration noise	1. Inspect for a bent or loose hanger, loose heat shield, or loose clamp. 2. Inspect for a exhaust pipe causing interference. 3. Repair or replace the affected component. Refer to the affected component's service procedure.
Internal rattle	1. Test the components by tapping with a rubber mallet to confirm a rattle. 2. Replace the faulty catalytic converter, resonator, if equipped, or muffler. Refer to **Exhaust Muffler Replacement**.

REPAIR INSTRUCTIONS

EXHAUST FRONT PIPE REPLACEMENT

Removal Procedure

WARNING: Refer to Hot Exhaust System Warning .

WARNING: Refer to Safety Glasses Warning .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the right wheel drive shaft. Refer to **Wheel Drive Shaft Replacement (Left Side)** **Wheel Drive Shaft Replacement (Right Side)** .
3. Remove the pinch bolt on the steering gear intermediate shaft. Refer to **Intermediate Steering Shaft Replacement** .
4. Remove the cradle frame rear bolts and lower enough to allow clearance to remove the front pipe.

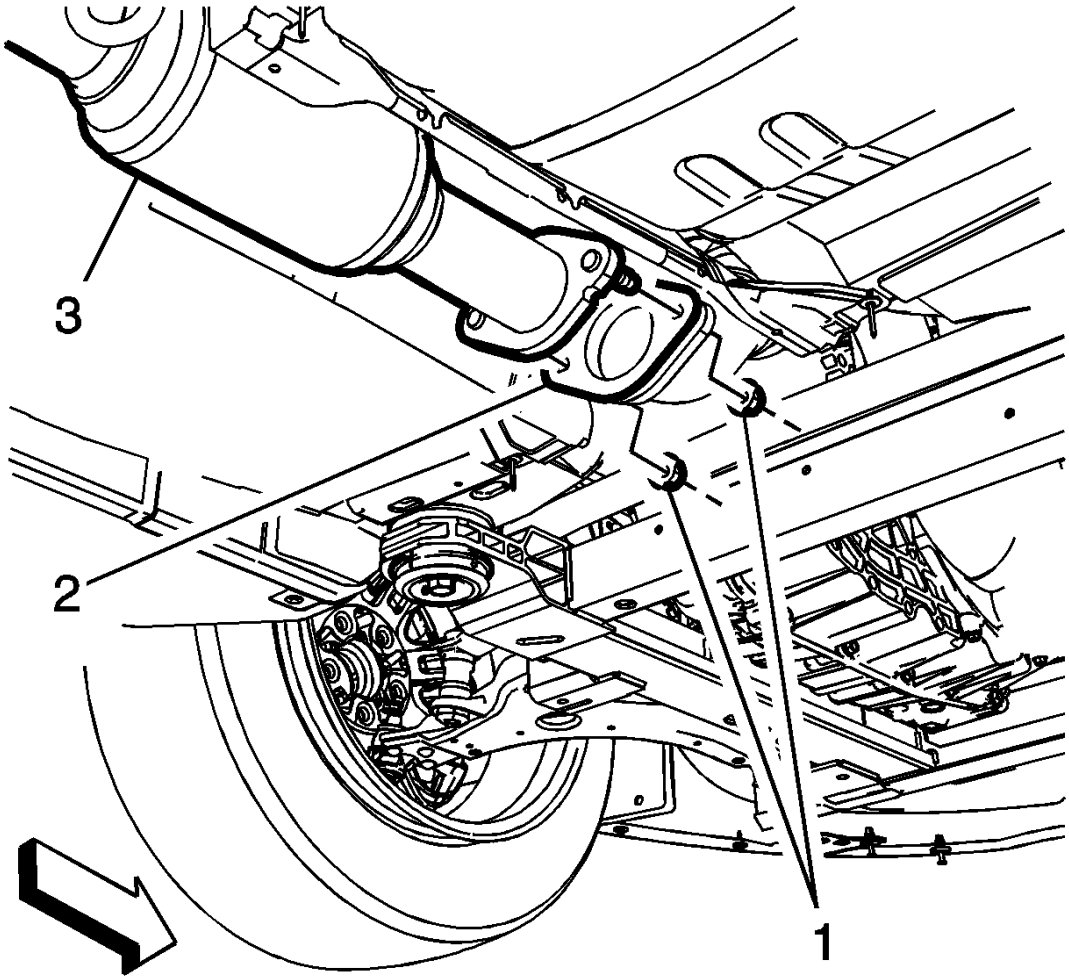


Fig. 1: Exhaust Gasket, Rear Muffler Pipe And Fasteners
Courtesy of GENERAL MOTORS COMPANY

5. Remove the front pipe exhaust fasteners (1) from the rear muffler pipe (3) and discard the exhaust gasket (2).
6. Support the rear muffler pipe (3) with mechanics wire .

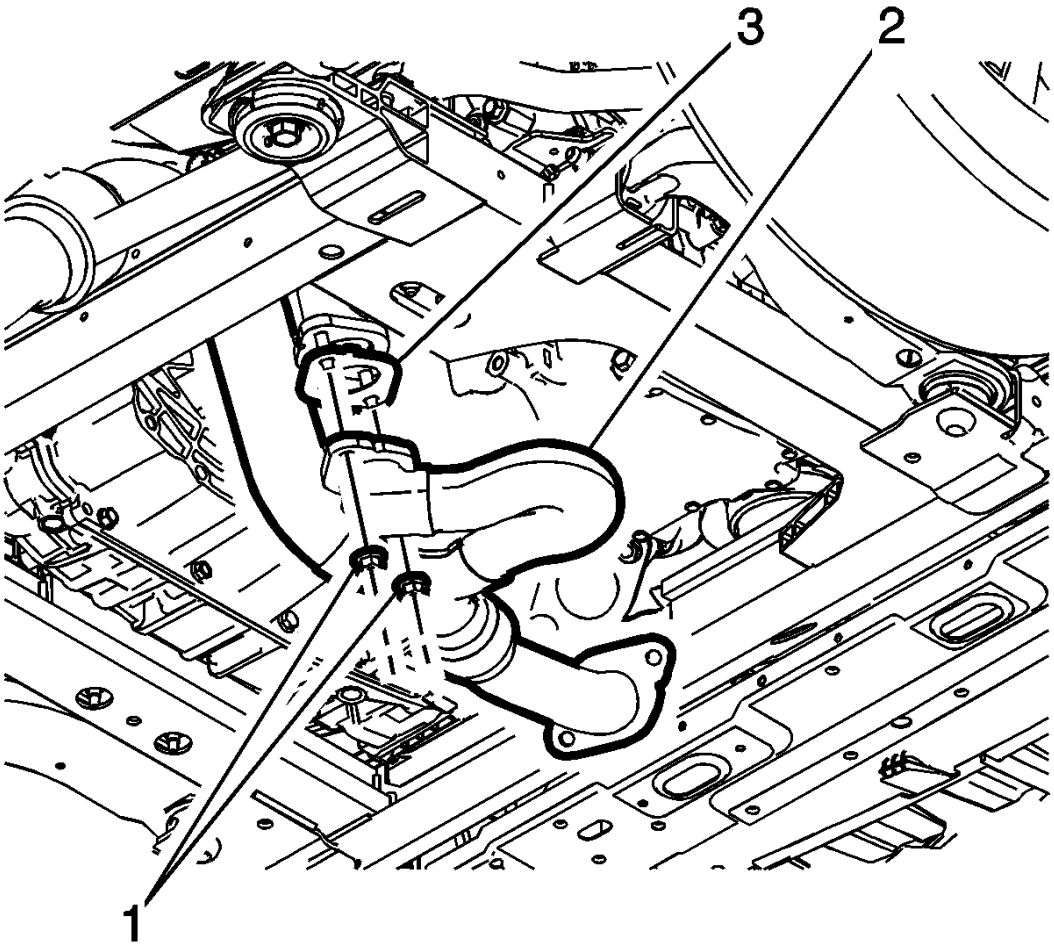


Fig. 2: Rear Catalytic Converter, Gasket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the fasteners (1) from the rear catalytic converter and discard the gasket (2).

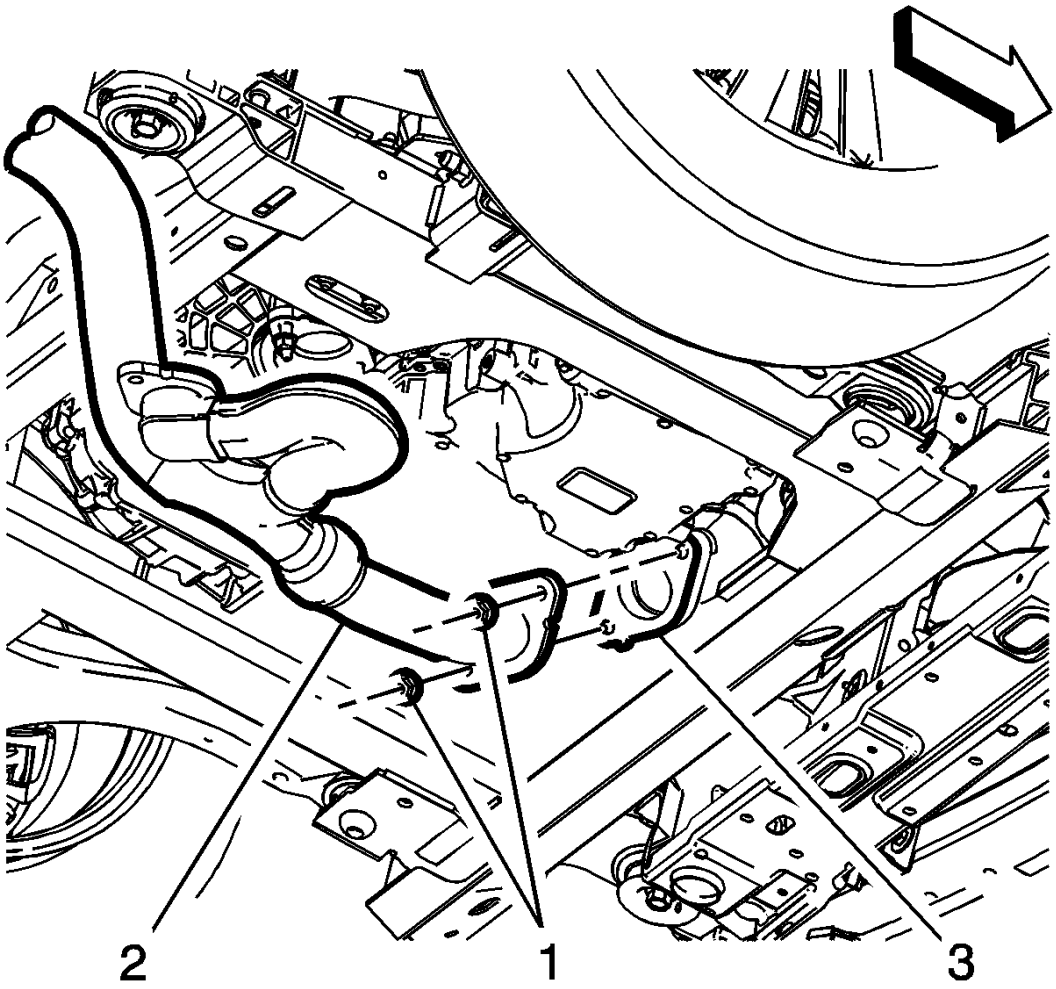


Fig. 3: Front Exhaust Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Remove the fasteners (1) from the front catalytic converter and discard the gasket (3).

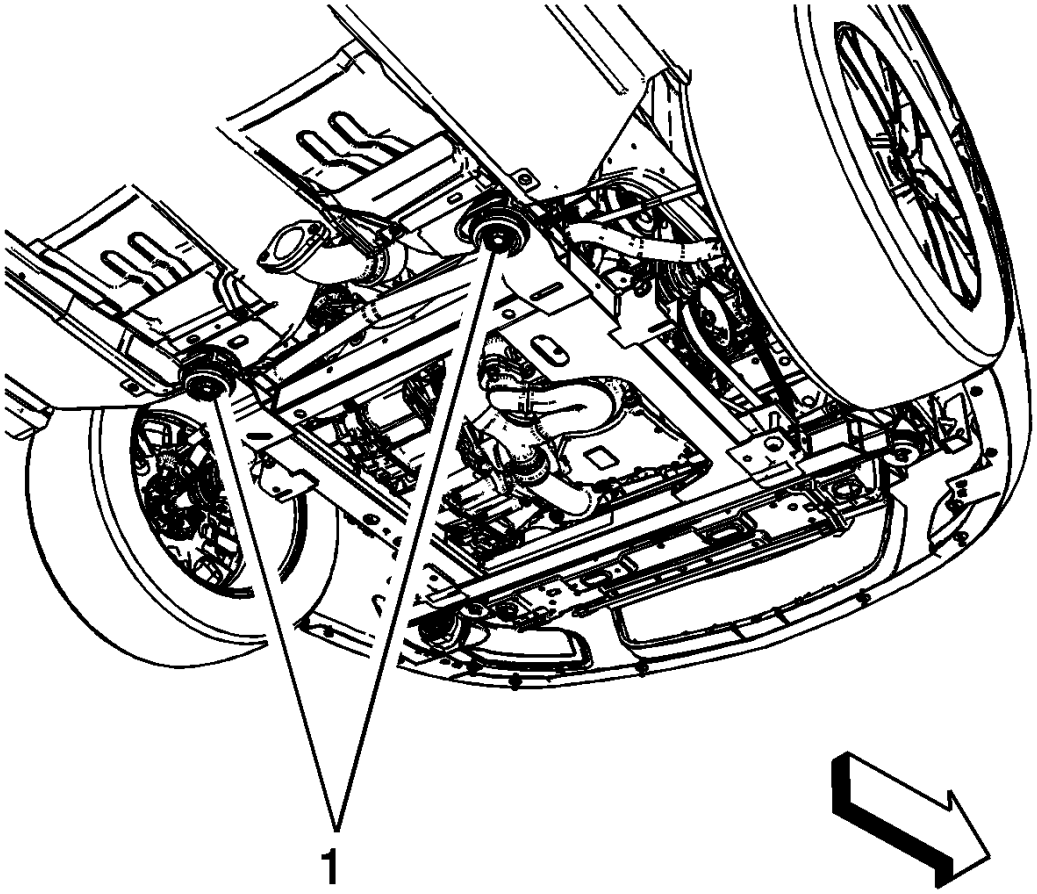


Fig. 4: Rear Engine Cradle Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Support the rear engine cradle with a suitable jack.
10. Loosen the rear cradle frame fasteners (1).
11. Lower the support jack and the rear engine cradle to allow clearance to remove the exhaust front pipe.
12. Slide out the exhaust front pipe and lower to the floor.

Installation Procedure

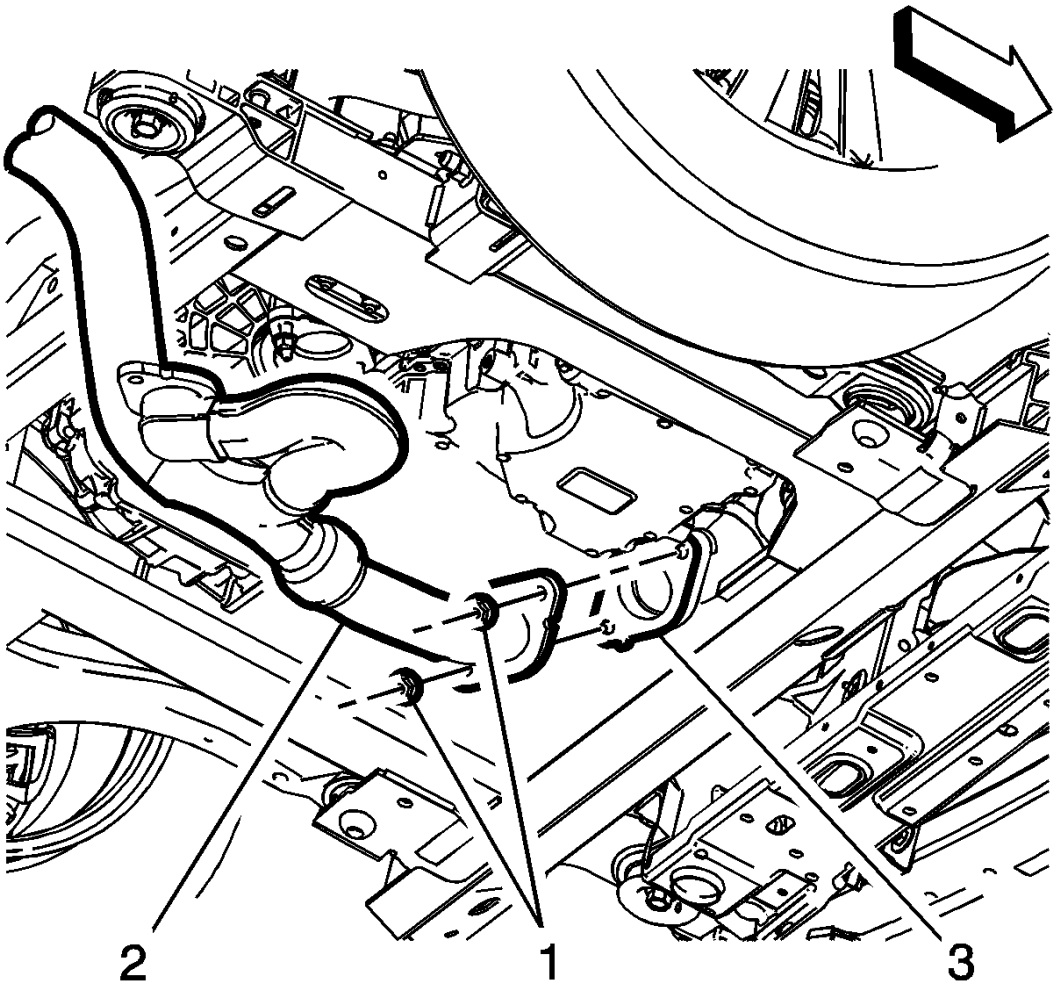


Fig. 5: Front Exhaust Pipe
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the exhaust front pipe (2) to the front catalytic converter with a NEW gasket (3) and tighten the fasteners (1) to 43 N.m (32 lb ft).

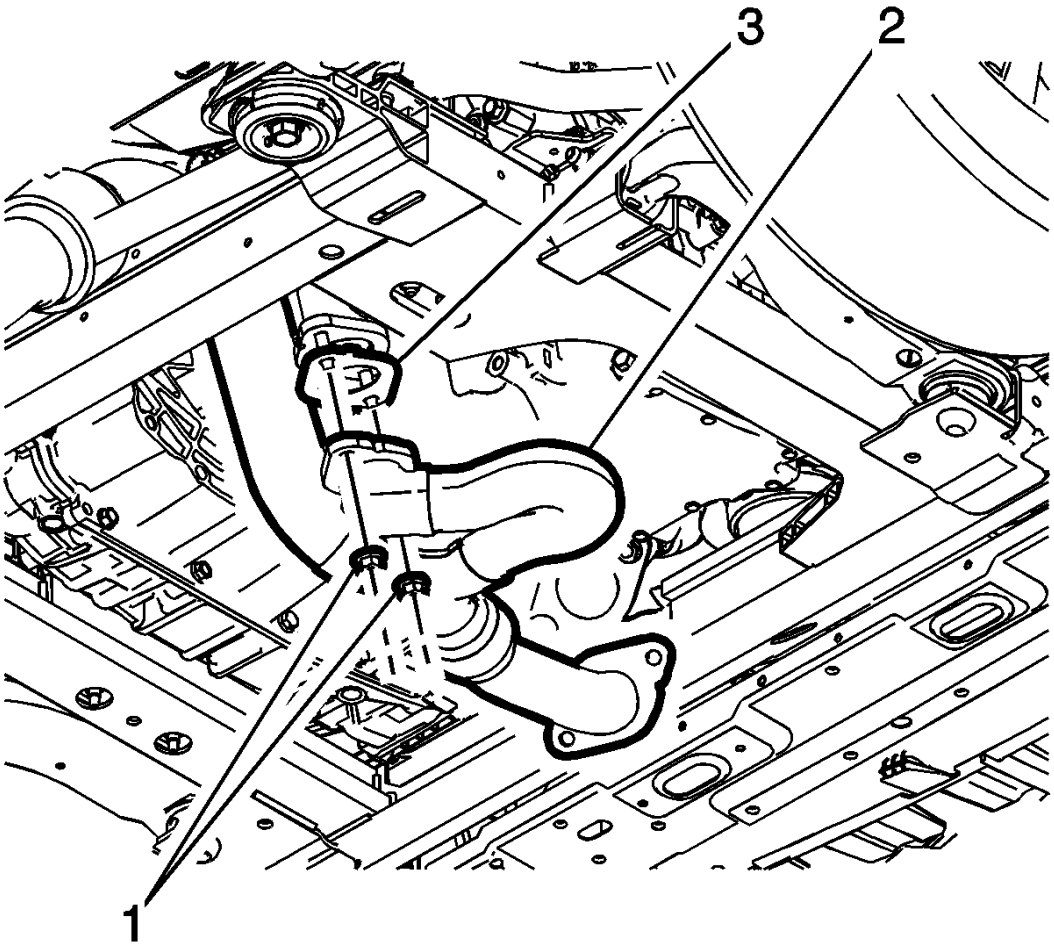


Fig. 6: Rear Catalytic Converter, Gasket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Install the exhaust front pipe (2) to the rear catalytic converter with a NEW gasket (3) and tighten the fasteners (1) to 43 N.m (32 lb ft).

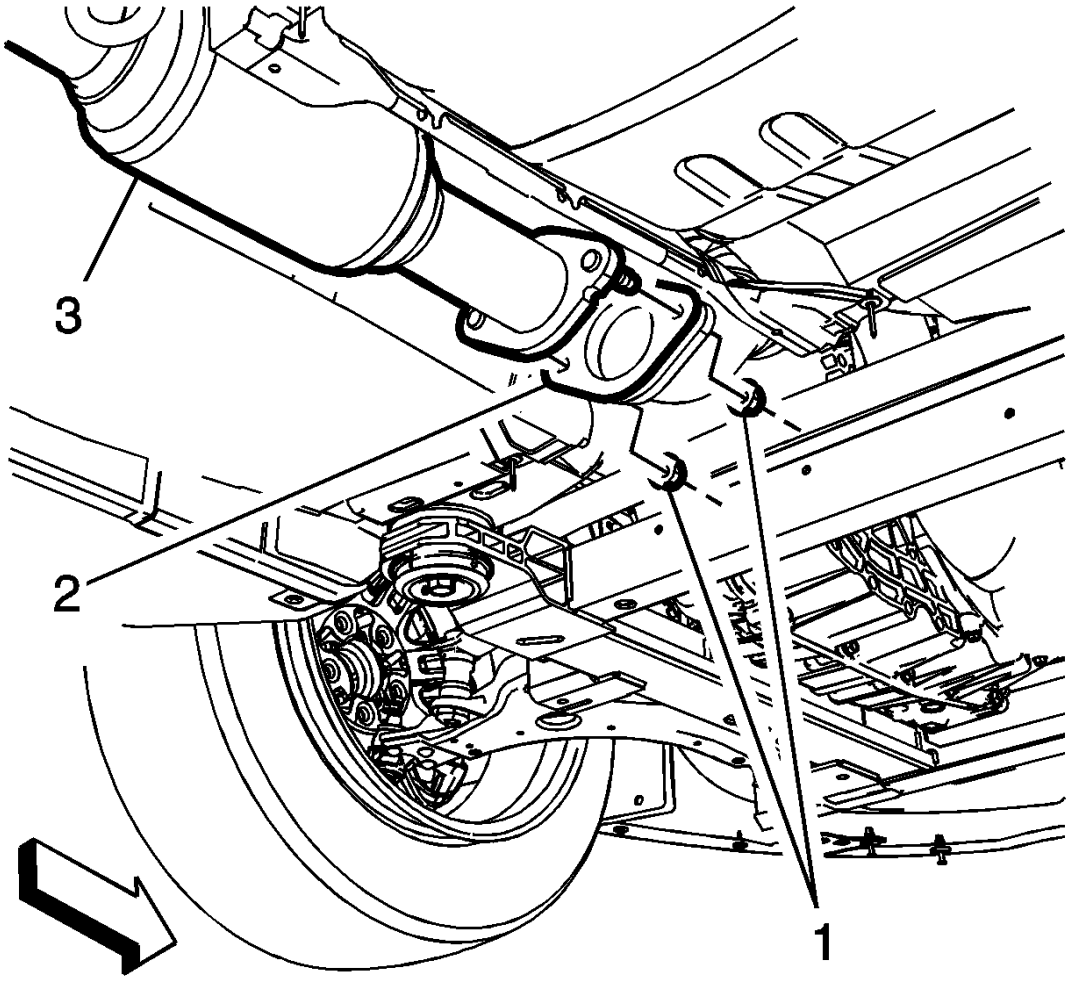


Fig. 7: Exhaust Gasket, Rear Muffler Pipe And Fasteners
Courtesy of GENERAL MOTORS COMPANY

3. Install the exhaust front pipe to the rear muffler (3) with a NEW gasket (2). Tighten the fasteners (1) to 43 N.m (32 lb ft).

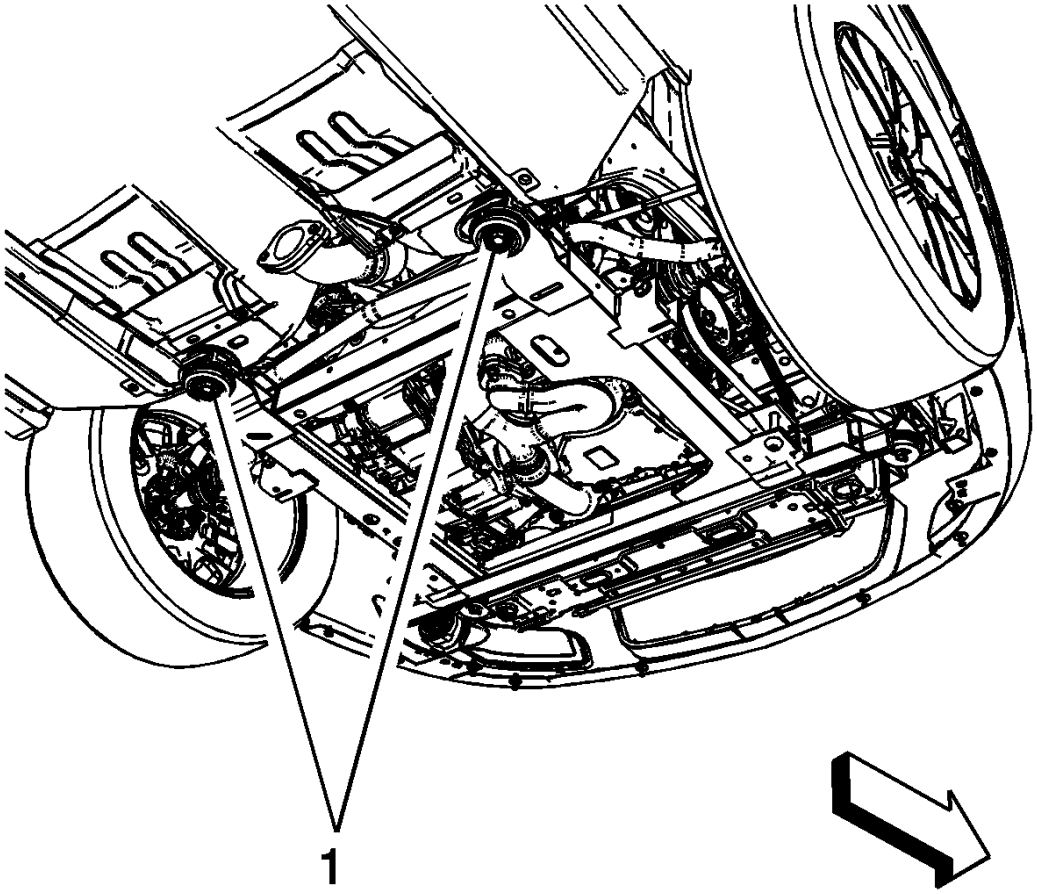


Fig. 8: Rear Engine Cradle Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the rear engine cradle fasteners (1) to 160 N.m (118 lb ft).
5. Remove the engine cradle support fixture.
6. Install the pinch bolt on the steering gear intermediate shaft. Refer to **Intermediate Steering Shaft Replacement** .
7. Install the right wheel drive shaft. Refer to **Wheel Drive Shaft Replacement (Left Side)** **Wheel Drive Shaft Replacement (Right Side)** .
8. Lower the vehicle.
9. Inspect the exhaust system for leaks.

CATALYTIC CONVERTER REPLACEMENT - LEFT SIDE (FRONT)

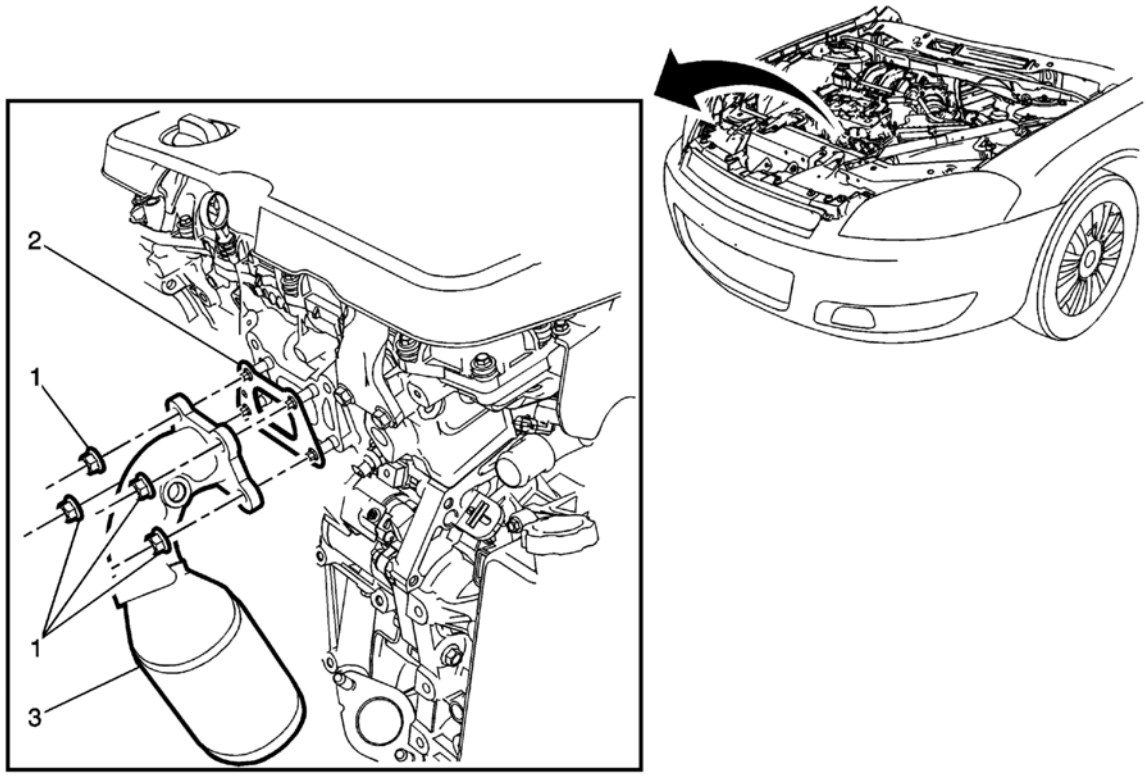


Fig. 9: Catalytic Converter, Gasket & Nuts - Left Side (Front)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Hot Exhaust System Warning .** **Preliminary Procedure** 1. Lift and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Disconnect the exhaust front pipe from the front catalytic converter without removing the entire front pipe. Refer to **Exhaust Front Pipe Replacement**. 3. Remove the heated oxygen sensor-bank 2 sensor 2. Refer to **Heated Oxygen Sensor Replacement - Bank 2 Sensor 2** .	
1	Catalytic Converter Nuts (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **CAUTION:**

Callout	Component Name
	To prevent damage to the exhaust manifold flange or stud, make sure the flange is fully seated before tightening. **Procedure** 1. Replace the exhaust front pipe nuts and the gasket with new ones. 2. Clean and inspect the studs on the engine cylinder head, replace as necessary. 3. Verify that the studs are fully seated. Stud collar should touch the surface of the engine cylinder head. 4. Tighten nuts in a criss-cross pattern. **Tighten** • First Pass: 20 N.m (15 lb ft) • Final Pass: 46 N.m (34 lb ft)
2	Gasket **NOTE:** • **If replacing catalytic converter,transfer oxygen sensor.** • **Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or On-Board Diagnostics (OBD) II system performance.**
3	Catalytic Converter

CATALYTIC CONVERTER REPLACEMENT - RIGHT SIDE (REAR)

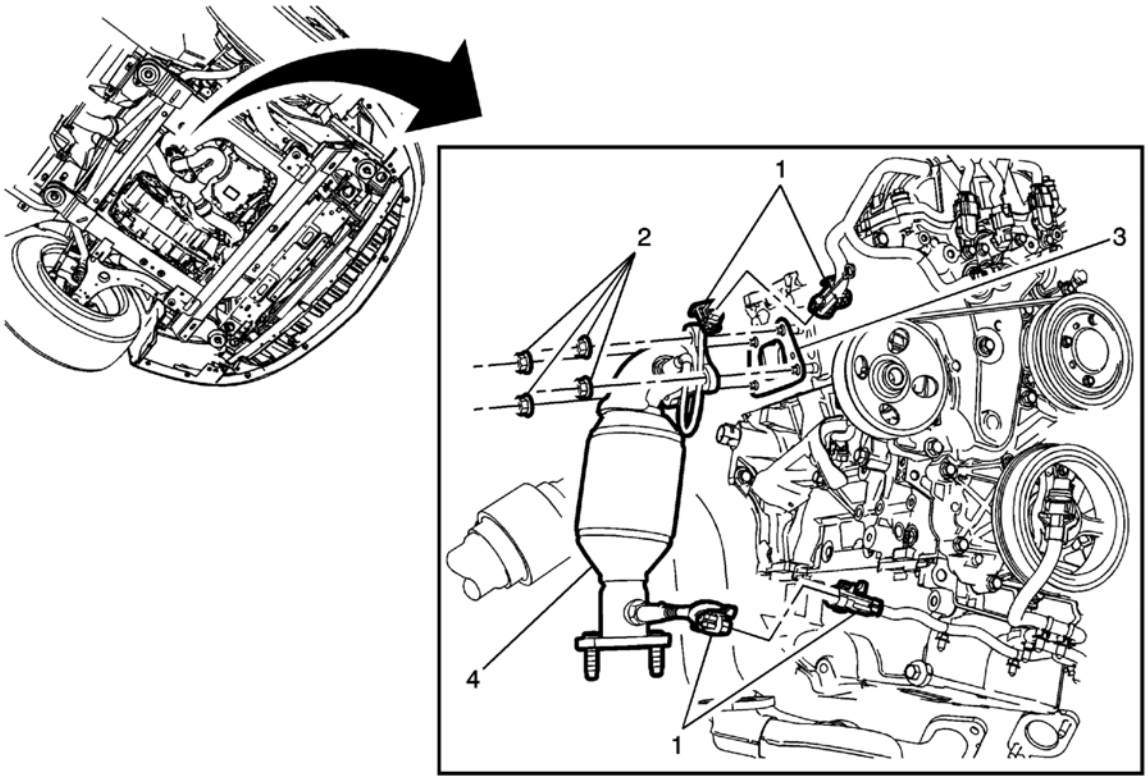


Fig. 10: Catalytic Converter, Gasket & Nuts - Right Side (Rear)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to Hot Exhaust System Warning .** **Preliminary Procedure** 1. Lift and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the exhaust front pipe to the front catalytic converter. Refer to **Exhaust Front Pipe Replacement**. 3. Remove the heated oxygen sensor bank 1 - sensor 2. Refer to **Heated Oxygen Sensor Replacement - Bank 1 Sensor 2** .	
1	Heated Oxygen Sensor Connectors
2	Catalytic Converter Nuts (Qty: 4) **CAUTION:** **Refer to Fastener**

Callout	Component Name
	Caution . **CAUTION:** **To prevent damage to the exhaust manifold flange or stud, make sure the flange is fully seated before tightening.** **Procedure** 1. Replace the exhaust front pipe nuts and the gasket with new ones. 2. Clean and inspect the studs on the engine cylinder head, replace as necessary. 3. Verify that the studs are fully seated. Stud collar should touch the surface of the engine cylinder head. 4. Tighten nuts in a criss-cross pattern. **Tighten** • First Pass: 20 N.m (15 lb ft) • Final Pass: 46 N.m (34 lb ft)
3	Gasket **NOTE:** • **If replacing catalytic converter,transfer oxygen sensors.** • **Improperly installed and/or leaking exhaust manifold gaskets may affect vehicle emissions and/or On-Board Diagnostics (OBD) II system**

Callout	Component Name
	performance.
4	Catalytic Converter

THREE-WAY CATALYTIC CONVERTER REPLACEMENT

Removal Procedure

WARNING: Refer to Hot Exhaust System Warning .

WARNING: Refer to Safety Glasses Warning .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

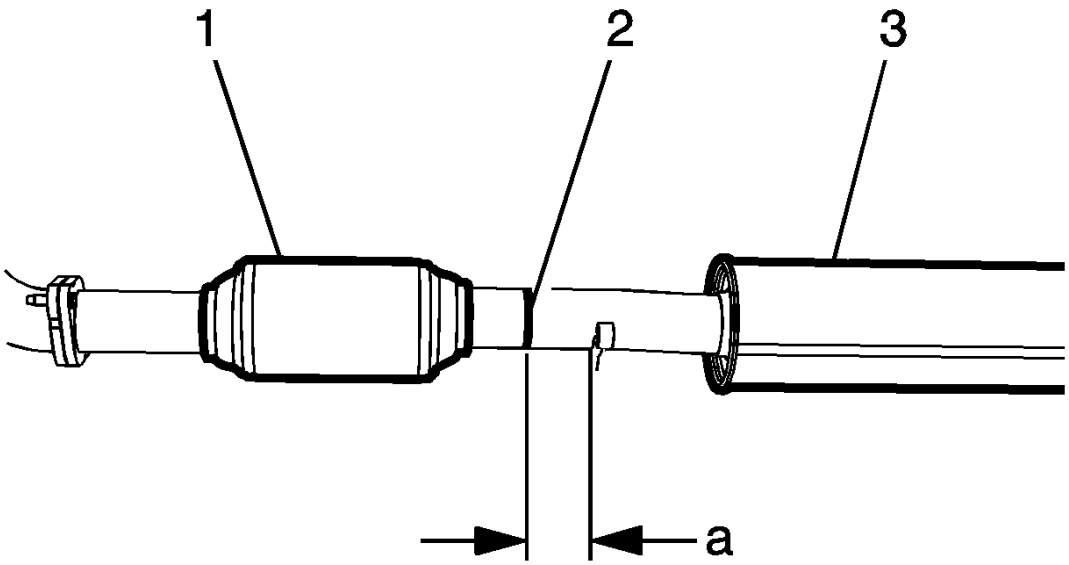


Fig. 11: Exhaust Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Cut the exhaust pipe (2) 64mm (2.5 inches) from the front exhaust muffler front hanger rods (a).

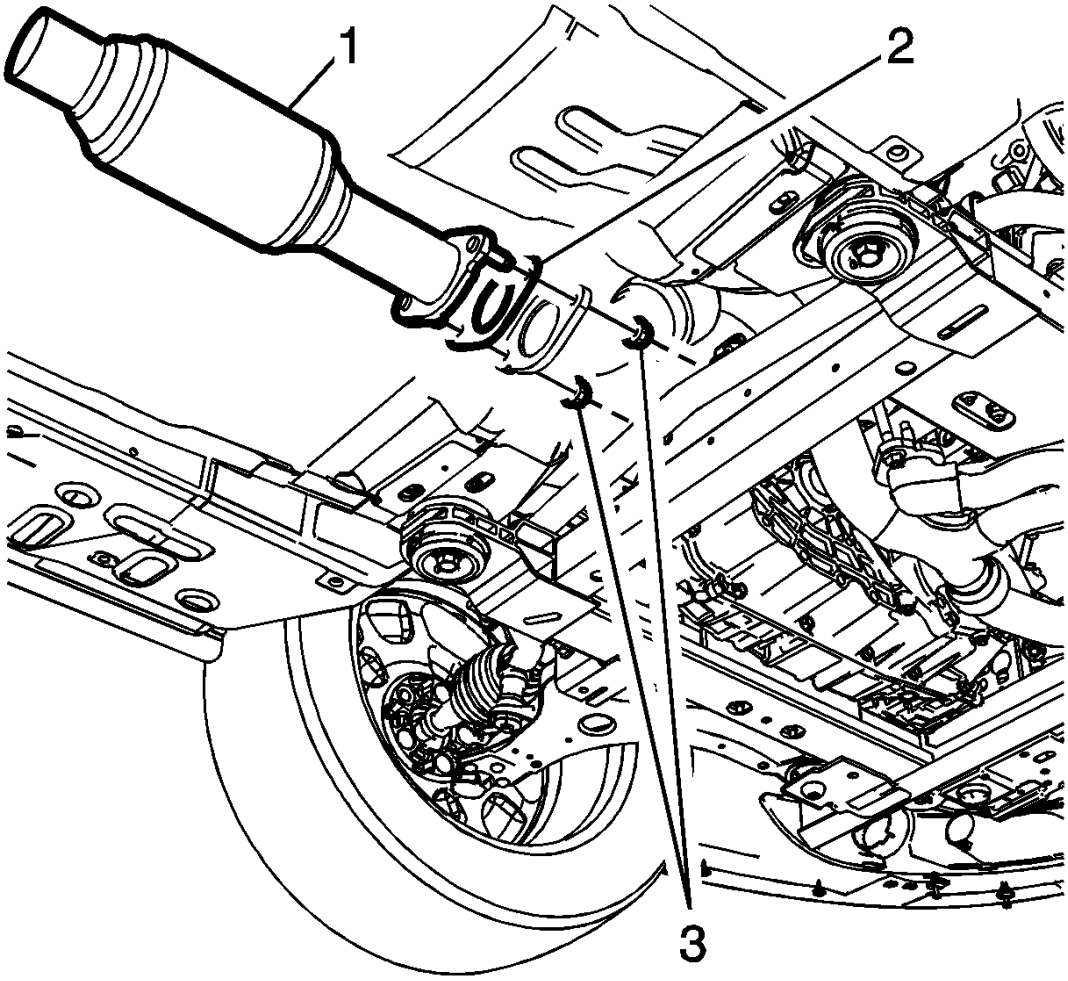


Fig. 12: Catalytic Converter, Exhaust Gasket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

3. Remove the exhaust front pipe fasteners (3) from the catalytic converter (1) and discard the exhaust gasket (2).
4. Remove the catalytic converter (1).

Installation Procedure

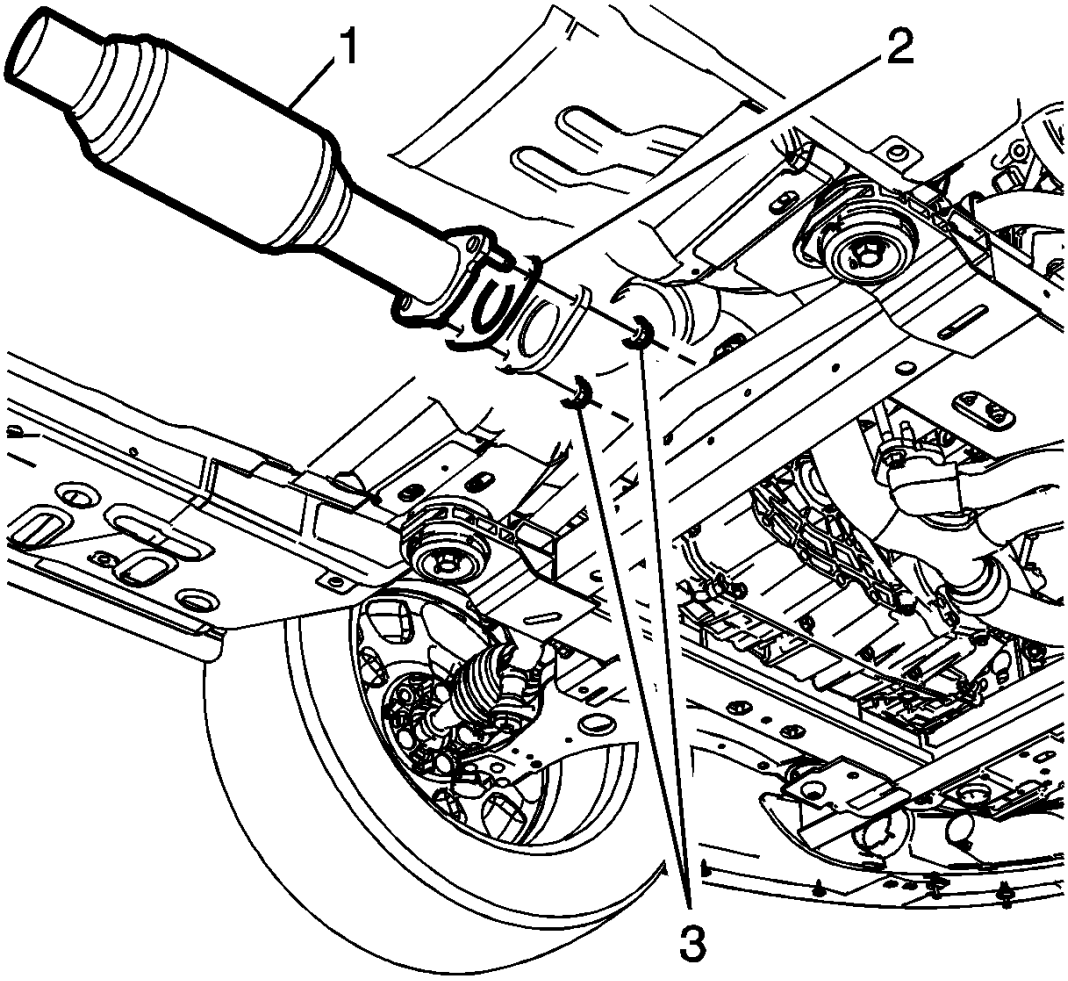


Fig. 13: Catalytic Converter, Exhaust Gasket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the NEW catalytic converter (1) with a NEW gasket (2) and tighten the exhaust front pipe fasteners (3) to 43 N.m (32 lb ft).

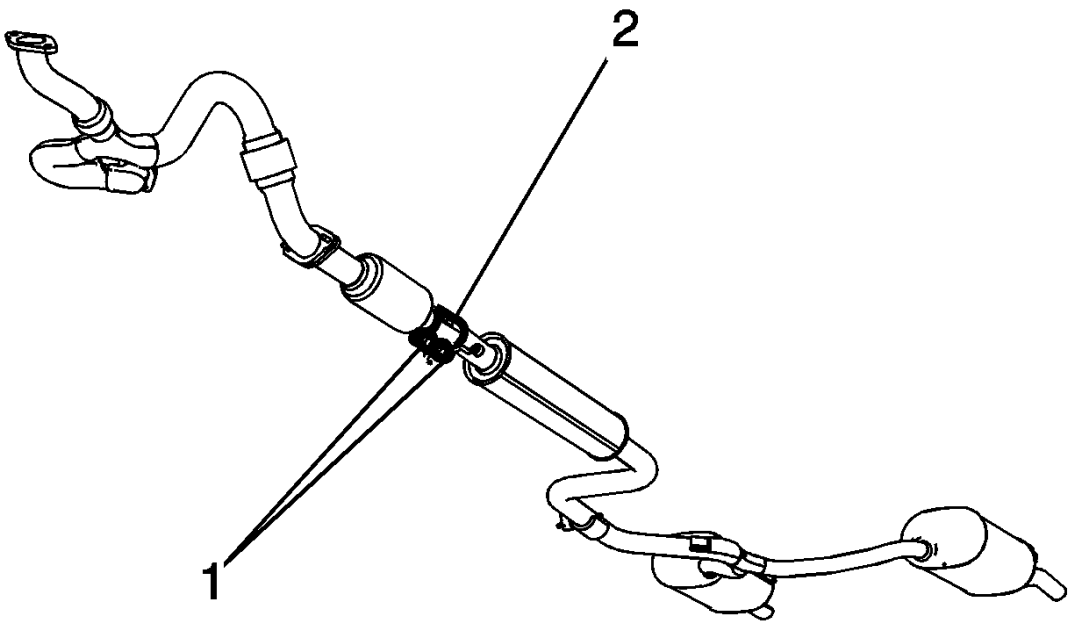


Fig. 14: Exhaust Service Clamp And Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Install the exhaust service clamp (2) onto the exhaust muffler and the NEW catalytic converter. Tighten the exhaust clamp fasteners (1) to 50 N.m (37 lb ft).
3. Inspect the exhaust system for leaks.

EXHAUST MUFFLER REPLACEMENT

Removal Procedure

WARNING: Refer to Hot Exhaust System Warning .

WARNING: Refer to Safety Glasses Warning .

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

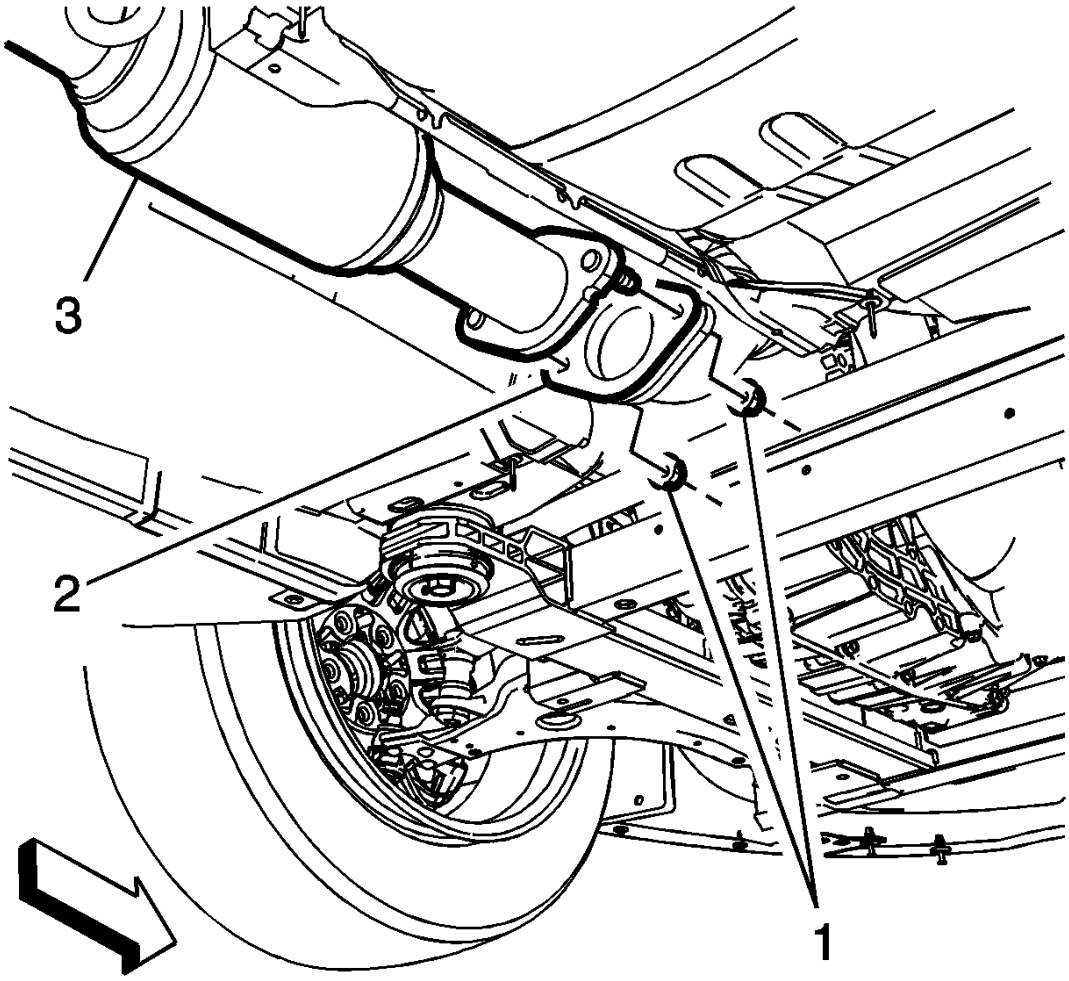


Fig. 15: Exhaust Gasket, Rear Muffler Pipe And Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Remove the exhaust front pipe fasteners (1) and remove the exhaust muffler (3).
3. Discard the exhaust gasket (2).

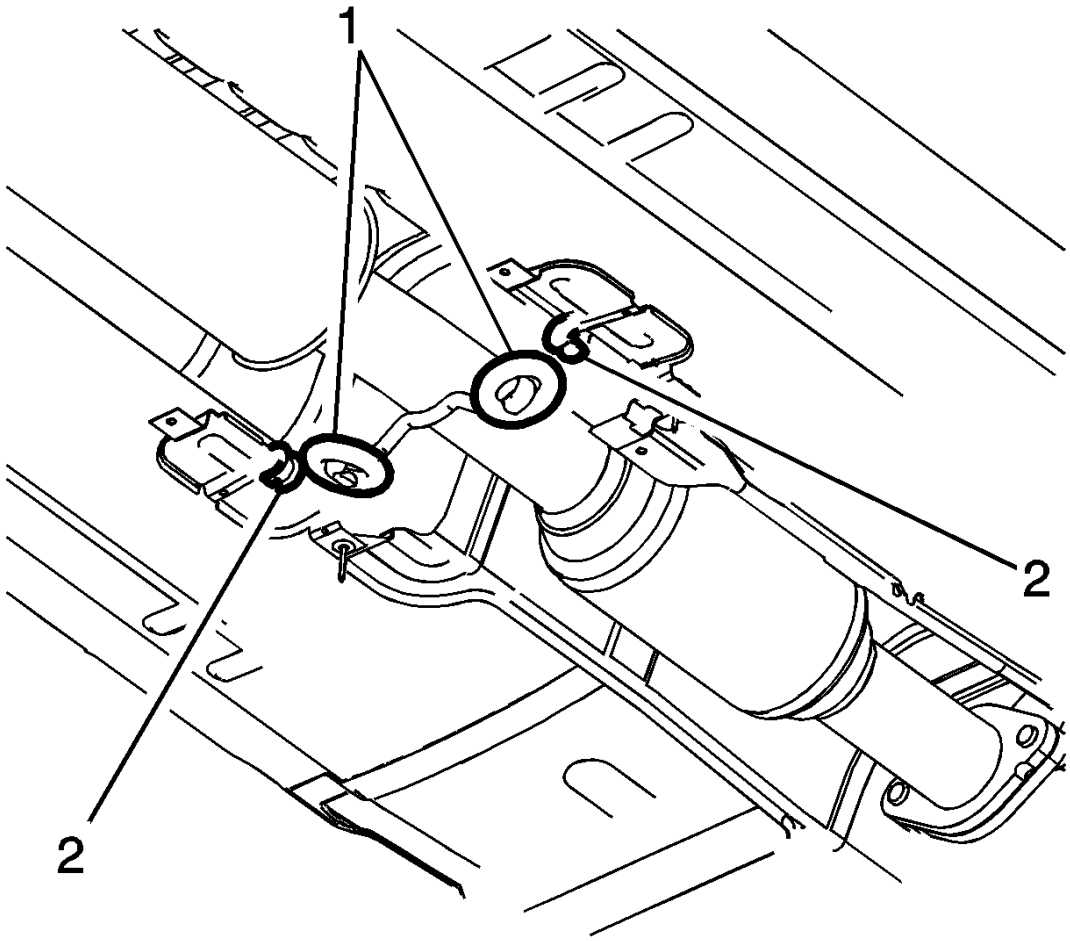


Fig. 16: Exhaust Muffler Hangers And Brackets
Courtesy of GENERAL MOTORS COMPANY

4. Remove the front exhaust muffler hangers (1) from the hanger brackets (2).
5. Support the front exhaust muffler with a suitable hanger.

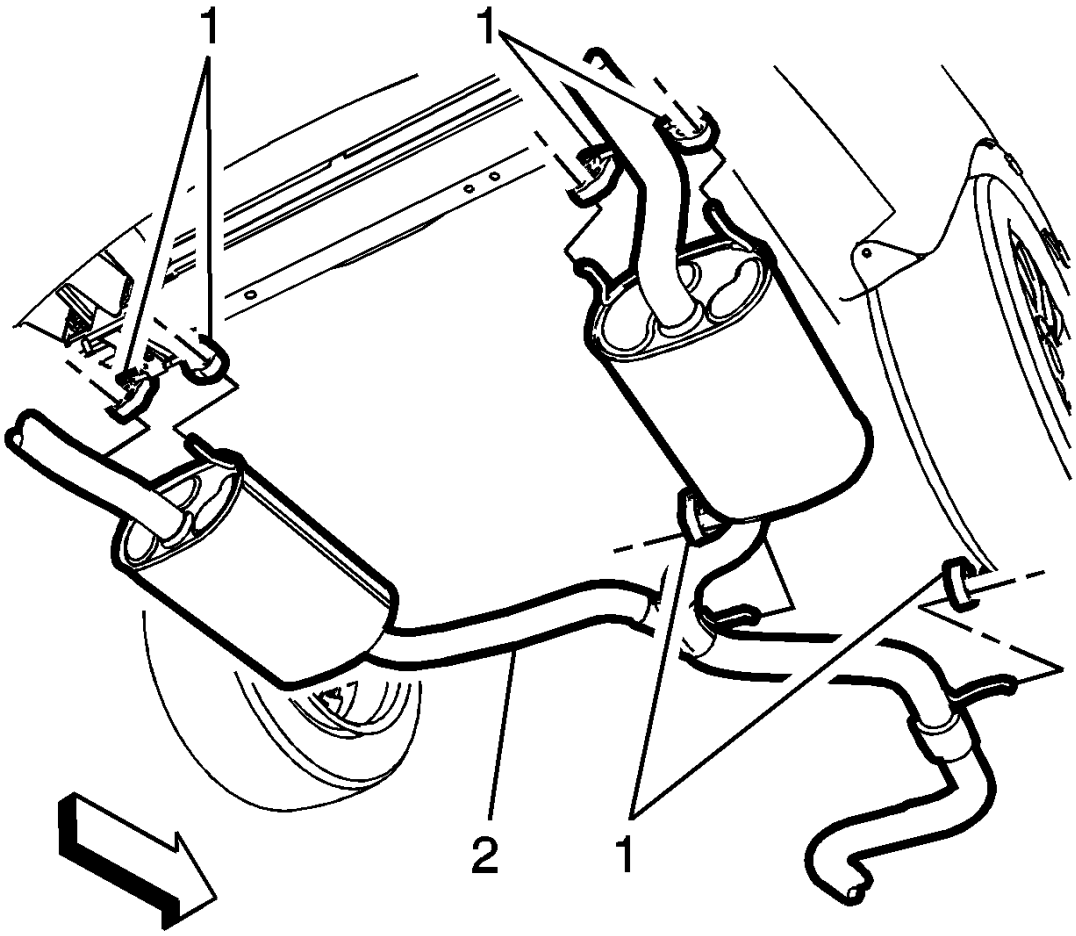


Fig. 17: Exhaust Isolators And Exhaust Muffler
Courtesy of GENERAL MOTORS COMPANY

6. Remove the exhaust muffler (2) from the exhaust isolators (1).

NOTE: **Clean and lubricate the exhaust muffler hanger rods for ease of installation.**

7. With the aid of a second technician, lower the exhaust muffler to the floor.

Installation Procedure

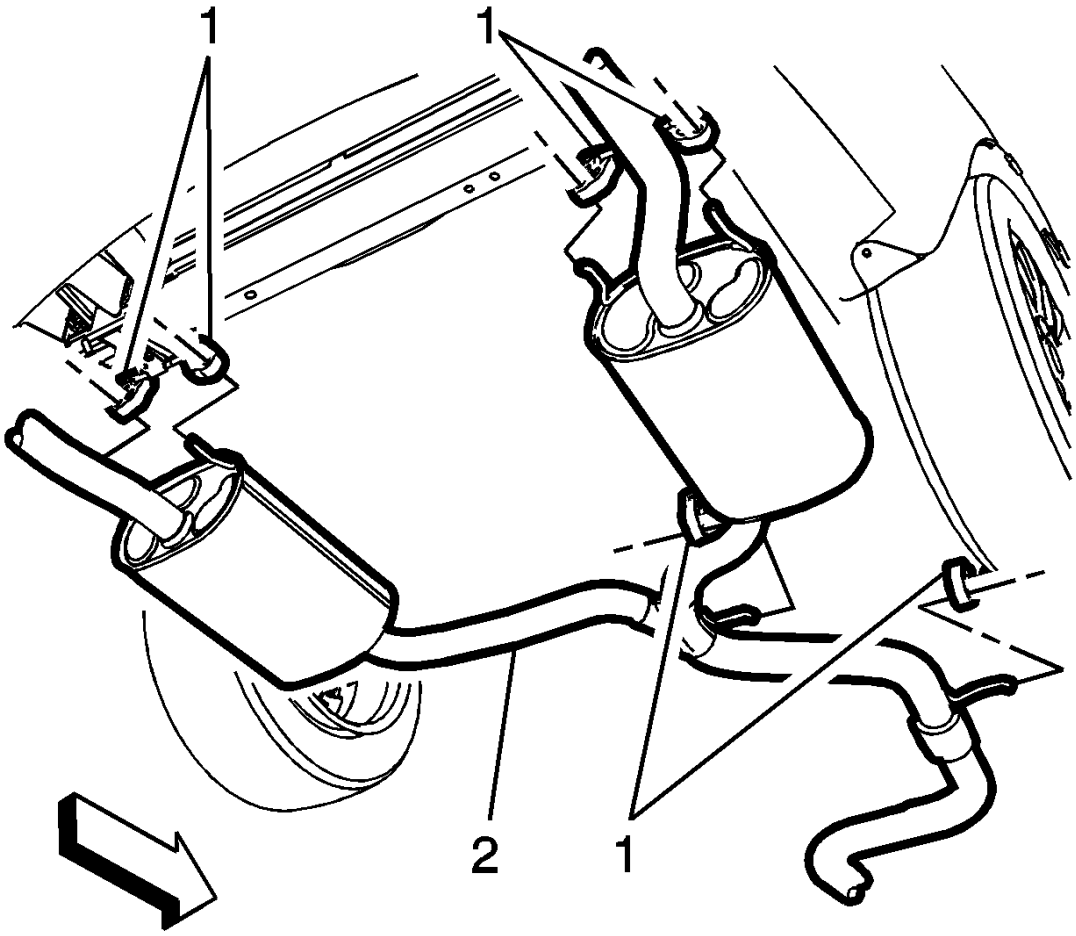


Fig. 18: Exhaust Isolators And Exhaust Muffler
Courtesy of GENERAL MOTORS COMPANY

1. Install the exhaust muffler (2) into the exhaust muffler isolators (1).

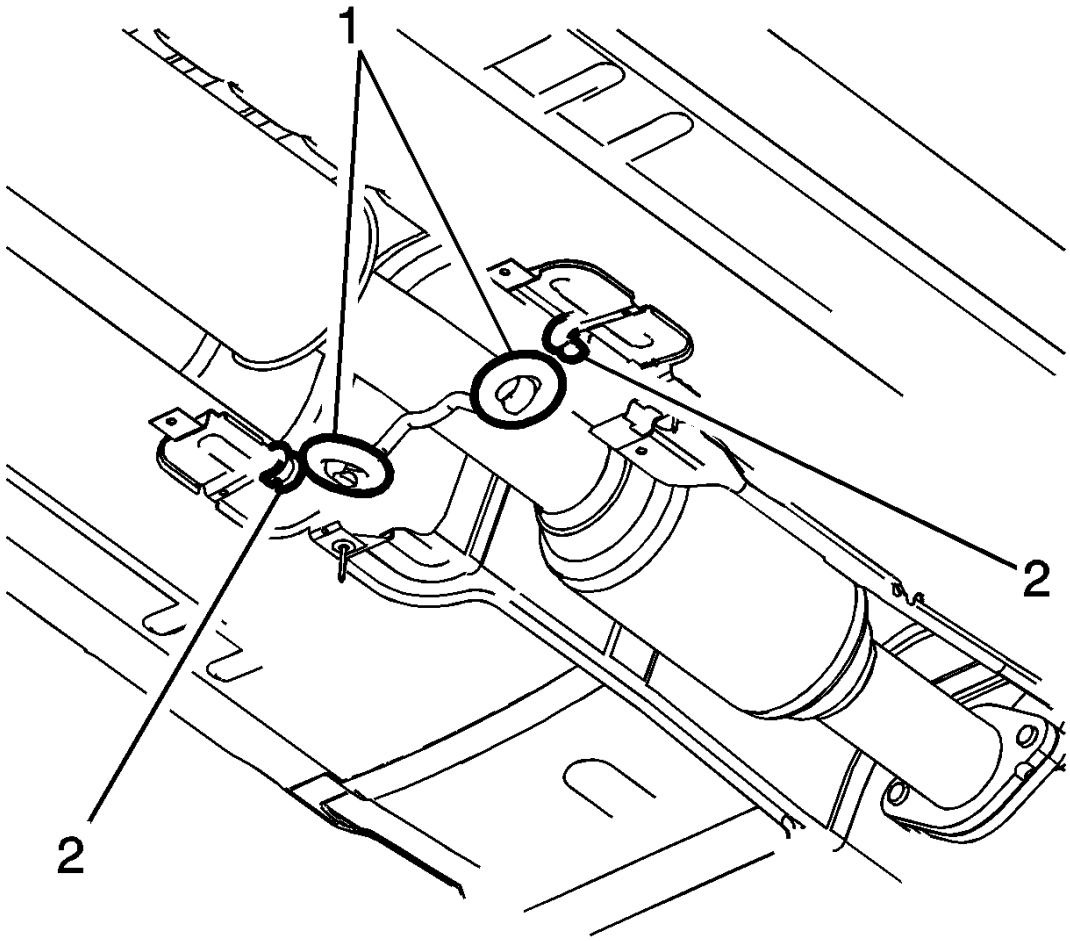


Fig. 19: Exhaust Muffler Hangers And Brackets
Courtesy of GENERAL MOTORS COMPANY

2. Install the exhaust hangers (1) into the exhaust bracket hangers (2).

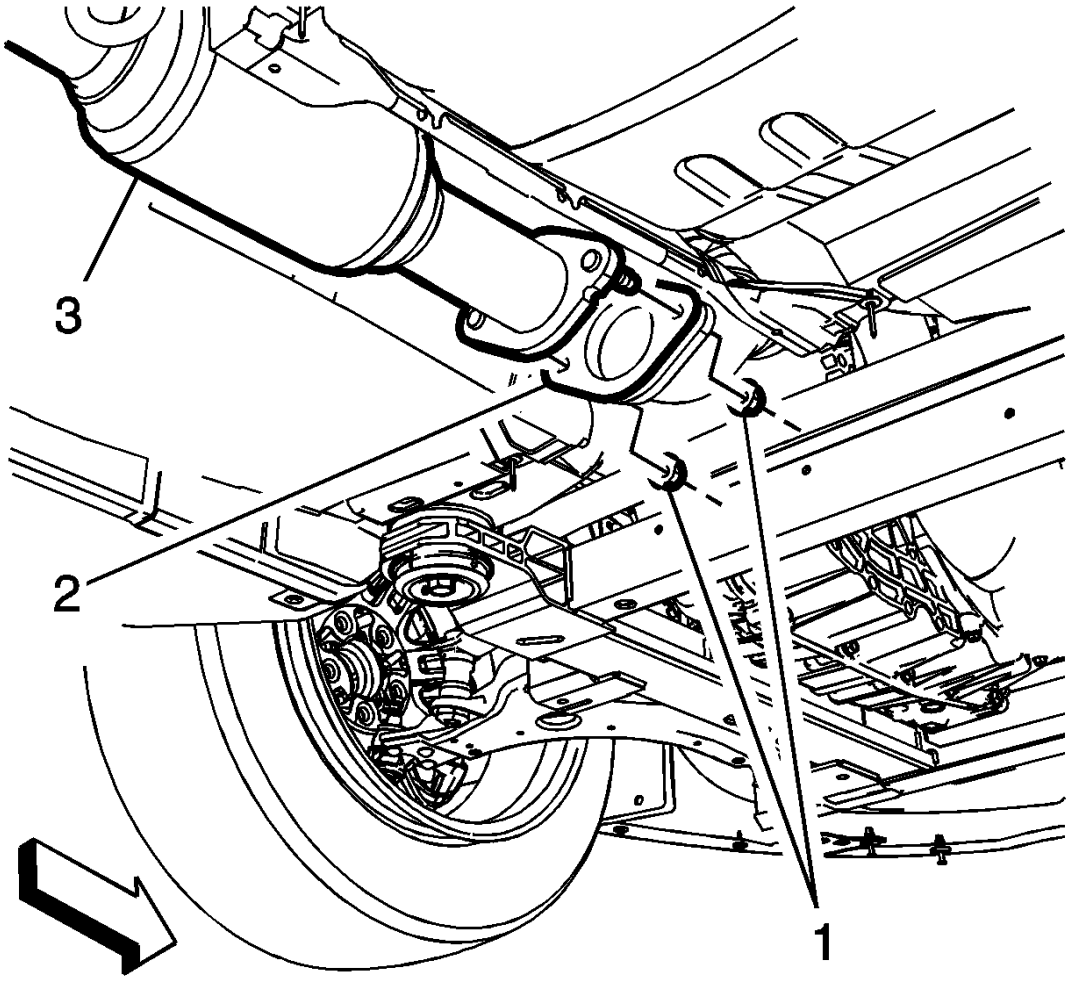


Fig. 20: Exhaust Gasket, Rear Muffler Pipe And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the exhaust muffler (3) into the exhaust front pipe with a NEW gasket (2). Tighten the fasteners (1) to 43 N.m (32 lb ft).
4. Inspect the exhaust system for leaks.

CATALYTIC CONVERTER HEAT SHIELD REPLACEMENT

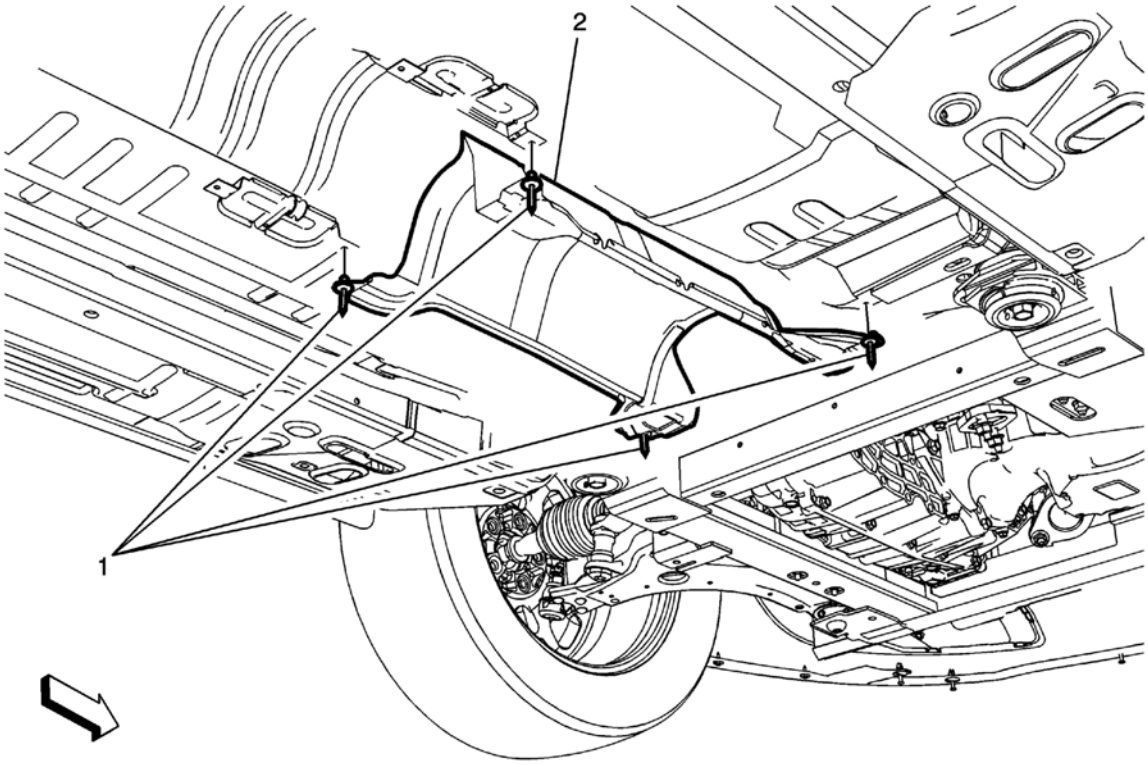


Fig. 21: Catalytic Converter Heat Shield & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Lift and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the exhaust muffler. Refer to **Exhaust Muffler Replacement**.	
1	Catalytic Converter Heat Shield Fastener (Qty 4) **WARNING:** **Refer to Hot Exhaust System Warning .**
2	Catalytic Converter Heat Shield **Procedure** 1. Drill out the rivets securing the catalytic converter heat shield . 2. Replace the catalytic converter heat shield and secure with #4 rivets.

DESCRIPTION AND OPERATION

EXHAUST SYSTEM DESCRIPTION

NOTE: **Use of Non-OEM parts may cause driveability concerns.**

The exhaust system carries exhaust gases, treated by the catalytic converter, through a resonator, if applicable and into the exhaust muffler where exhaust noise is lessened.

In order to secure the exhaust pipe to the exhaust manifold, a flange and seal-joint coupling is utilized.

Exhaust hangers and rubber insulators help to support the weight of the exhaust pipe along with insulating any exhaust system vibration, rattle, or noise.

Exhaust hangers also space the exhaust system away from the underbody of the vehicle and allows the exhaust system to expand as the exhaust system warms up.

Exhaust heat shields are used to protect the body and other components from damage due to the heat from the exhaust system.

The exhaust system may be comprised of the following components:

- Exhaust manifold
- Exhaust pipes
- Catalytic converters
- Exhaust muffler
- Exhaust resonator, if equipped
- Exhaust hangers
- Exhaust heat shields

Catalytic Converter

Through developments in various emissions reduction system, significant reductions in emissions have been achieved. The developments have been primarily concerned with refinements in engine calibration and the optimization of exhaust system catalytic converter configurations.

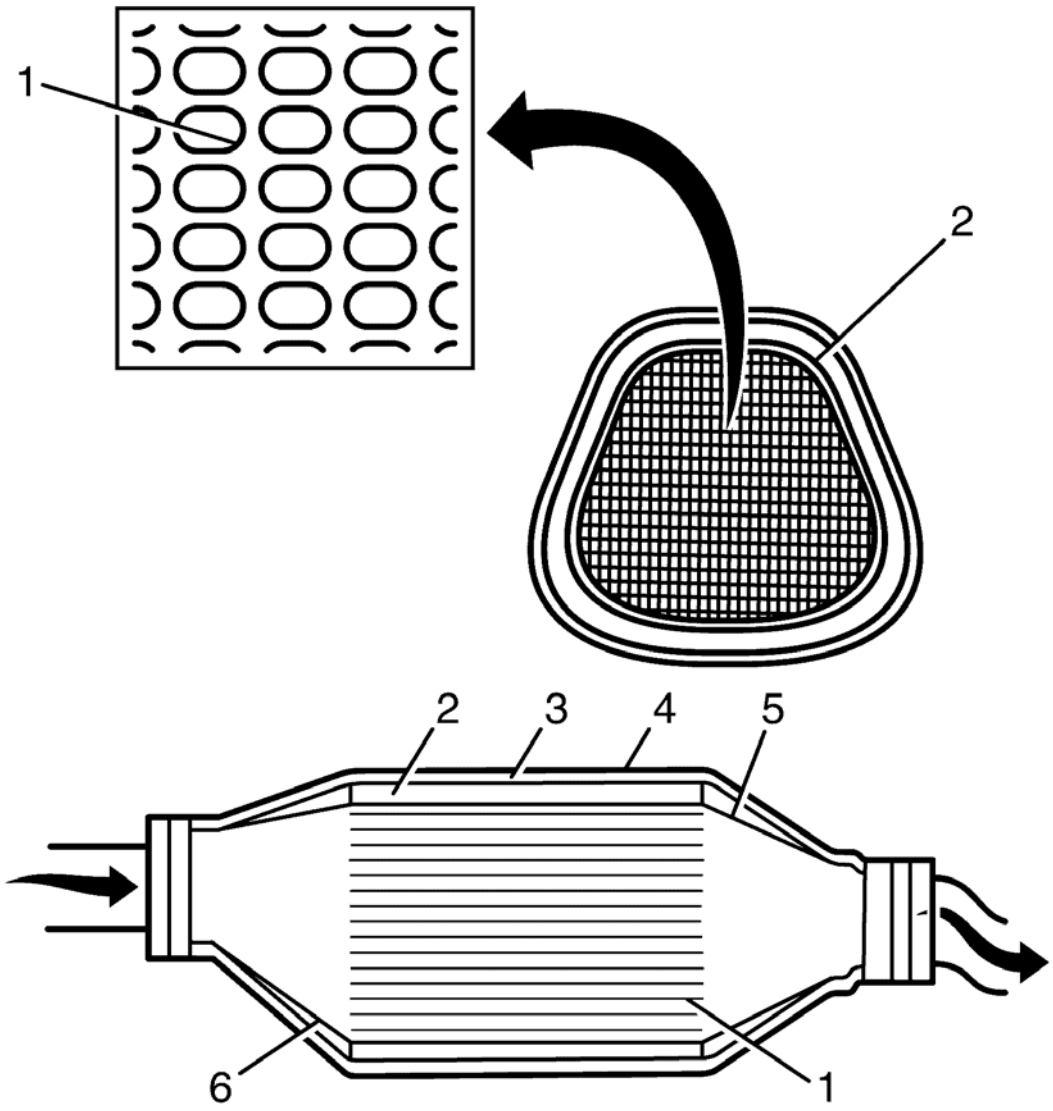


Fig. 22: View Of Ceramic Monolith
Courtesy of GENERAL MOTORS COMPANY

The catalytic converter is similar to a muffler in appearance however, within the outer stainless steel shell (4), there is a ceramic monolith (1) which is honeycombed in the direction of the exhaust, as shown. The ceramic monolith is surrounded by a mat (2), which has the primary function of holding the monolith firmly in place to prevent any contact with the inner shell (3). A mesh (5 and 6) at each end of the converter prevents exhaust gases from fouling and eroding the mat.

Surfaces of the ceramic monolith that are exposed to exhaust gases are coated with a catalytic material. This material contains rhodium and platinum, which act to facilitate the chemical reactions necessary to oxidize carbon monoxide and hydrocarbons into harmless carbon dioxide.

The catalytic converter is a substance that accelerates a chemical reaction without itself being changed. Engine exhaust gases contain carbon monoxide (CO), hydrocarbons (HC) and oxides of nitrogen (NOx). When the exhaust gases flow through the monolith, reactions with the catalytic converter occur. CO and HC are converted by oxidation with oxygen (O2) in the exhaust gases to produce carbon dioxide (CO2) and water vapour (H2O). NOx is converted by reduction with CO to produce nitrogen (N2). The catalytic converter is called a three-way type because it simultaneously converts three components of exhaust gas (CO, HC and NOx) to harmless natural

gases.

Service Notes

- Vehicles fitted with a catalytic converter should not be operated with leaded petrol. Lead will contaminate the catalytic converter.
- Do not drop the catalytic converter as it will damage the ceramic monolith.
- Do not allow water, oil or fuel to enter the converter as the ceramic monolith will be contaminated.
- Do not drive the vehicle with the engine misfiring or with any of the spark plug leads disconnected.

NOTE: **Catalytic converter can be damaged or rendered infective, if:**

- **Operated outside the limits of the closed loop mixture control system.**
- **The engine burns excessive amount of oil.**
- **The exhaust temperature at the converter is too high (exceeds 840Â°C).**

Resonator

Some exhaust systems are equipped with a resonator. The resonator, located either before or after the muffler, allows the use of mufflers with less back pressure. Resonators are used when vehicle characteristics require specific exhaust tuning.

Muffler

The exhaust muffler reduces the noise levels of the engine exhaust by the use of tuning tubes. The tuning tubes create channels inside the exhaust muffler that lower the sound levels created by the combustion of the engine.

The center mufflers on vehicles fitted with the LFW engine option contains a variable exhaust valve. The purpose of the valve is to reduce exhaust noise for minimal impact on performance and back pressure. The valve consists of a spring loaded flap which is closed at lower gas flow (lower engine speed/load) forcing the exhaust gasses through a more restrictive path therefore providing improved noise performance. As gas flow increases with higher engine load/speed, the valve opens providing a less restrictive path for the exhaust gases and therefore providing good wide open throttle performance.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

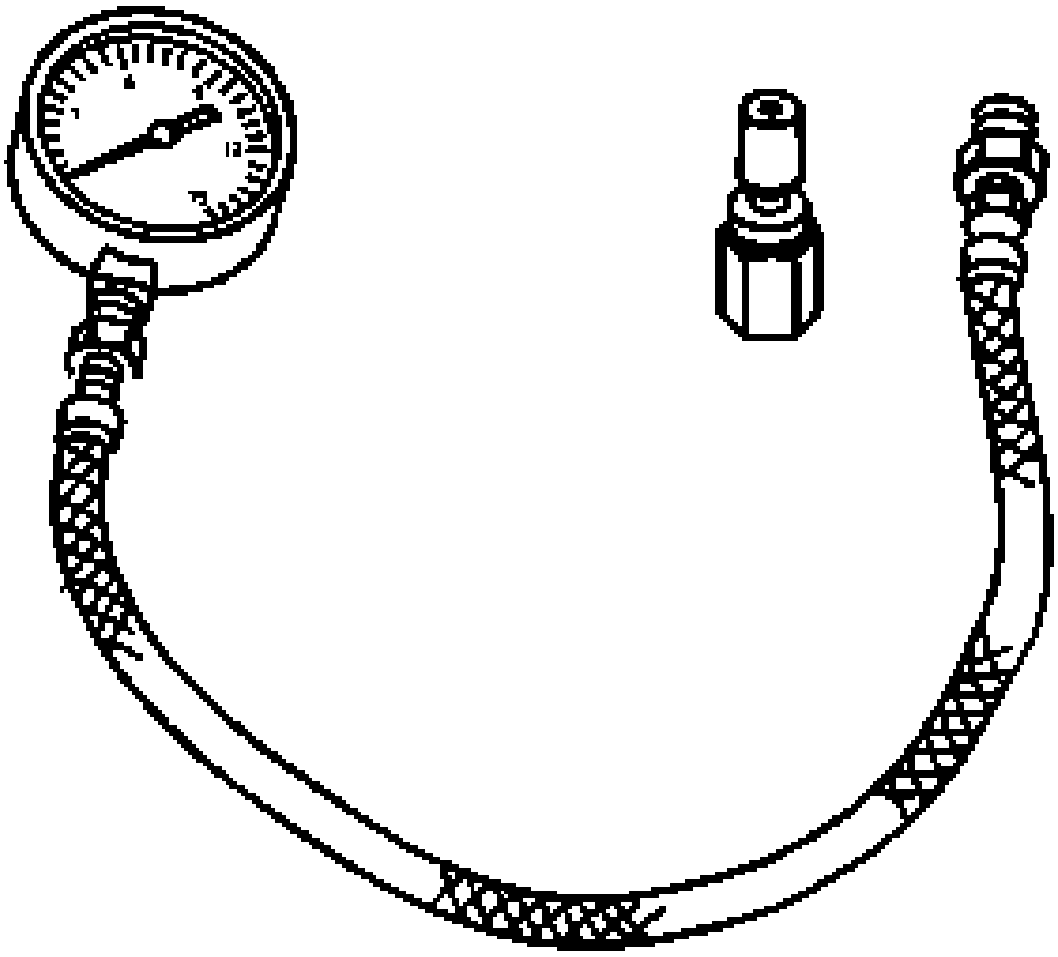
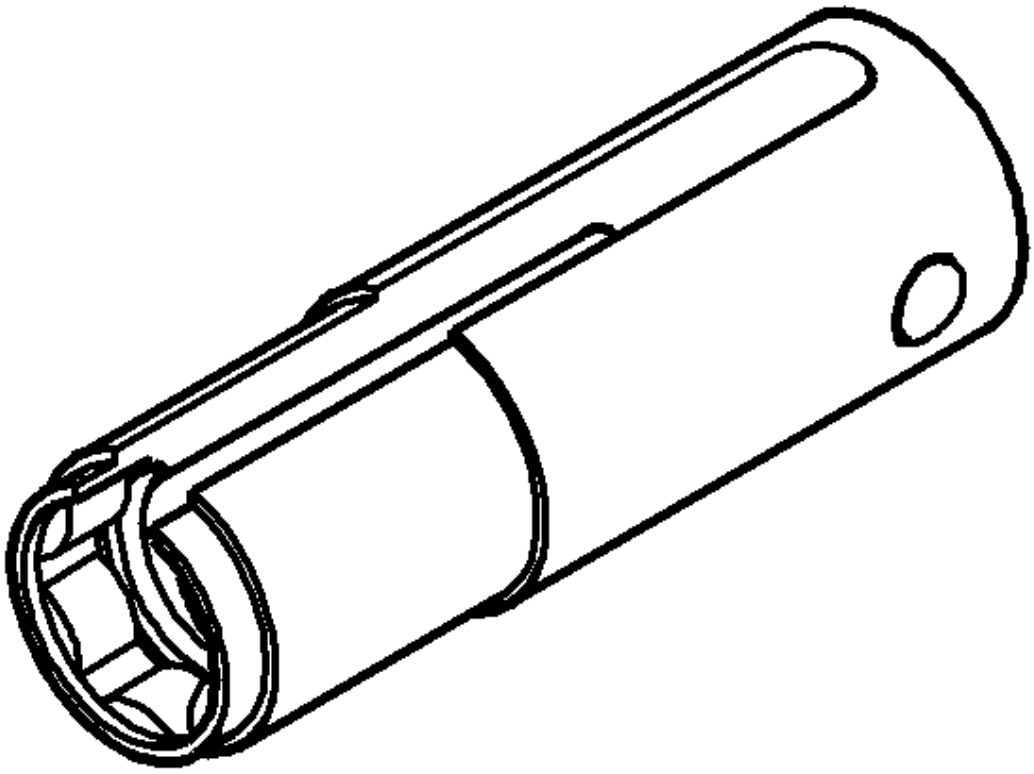
Illustration	Tool Number/ Description
	J 35314-A Exhaust Back Pressure Gauge

Illustration	Tool Number/ Description
	CH 39194-C Oxygen Sensor Remover/Installer

Article GUID: A00737207

COMPONENT LOCATOR

DISASSEMBLED VIEWS

Engine Covers and Component Assemblies (1 of 2)

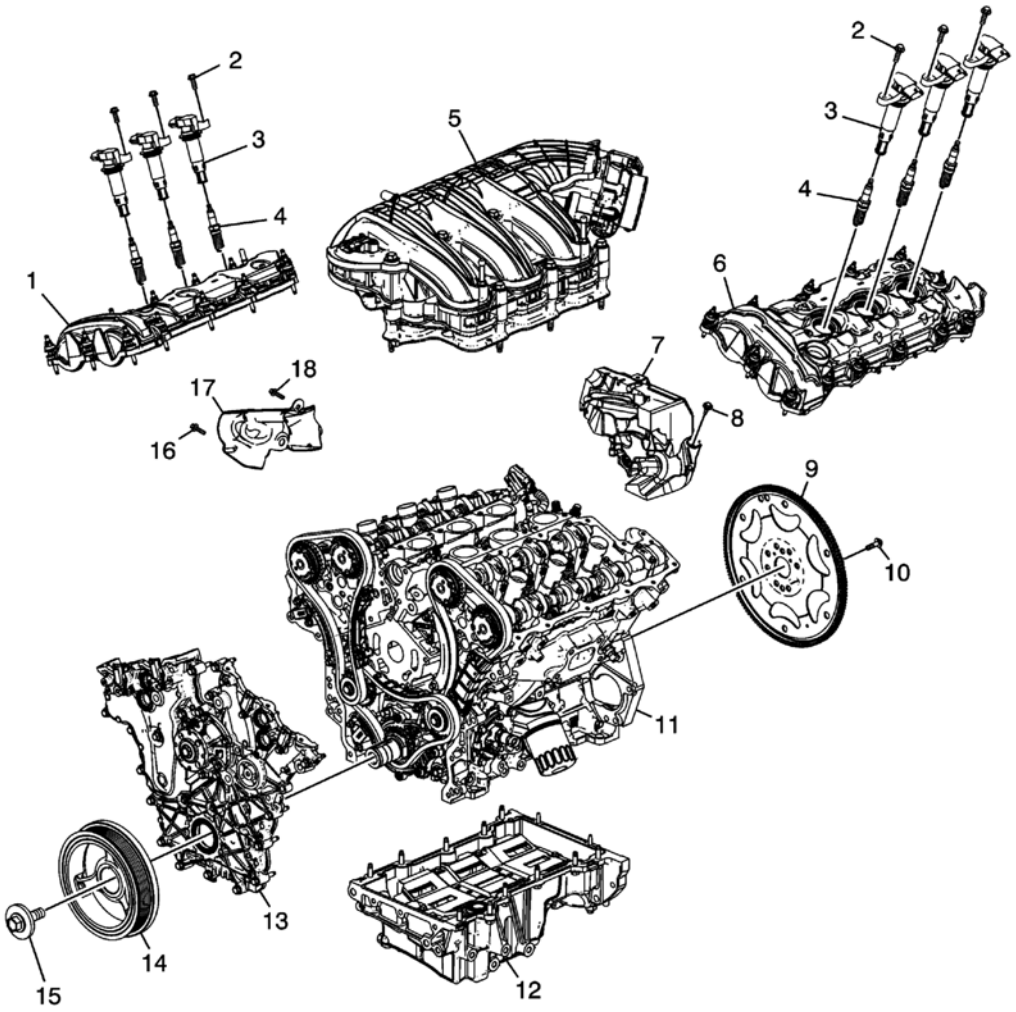


Fig. 1: Engine Covers and Component Assemblies (1 of 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Right Camshaft Cover Assembly
2	Ignition Coil Bolt
3	Ignition Coil
4	Spark Plug
5	Intake Manifold Assembly

Callout	Component Name
6	Left Camshaft Cover Assembly
7	Engine Rear Noise Shield
8	Engine Rear Noise Shield Bolt
9	Engine Flywheel
10	Engine Flywheel Bolt
11	Engine Assembly
12	Oil Pan Assembly
13	Engine Front Cover Assembly
14	Crankshaft Balancer
15	Crankshaft Balancer Bolt
16	Crankshaft Position Sensor Heat Shield Bolt - Large
17	Crankshaft Position Sensor Heat Shield
18	Crankshaft Position Sensor Heat Shield Bolt - Small

Engine Covers and Component Assemblies (2 of 2)

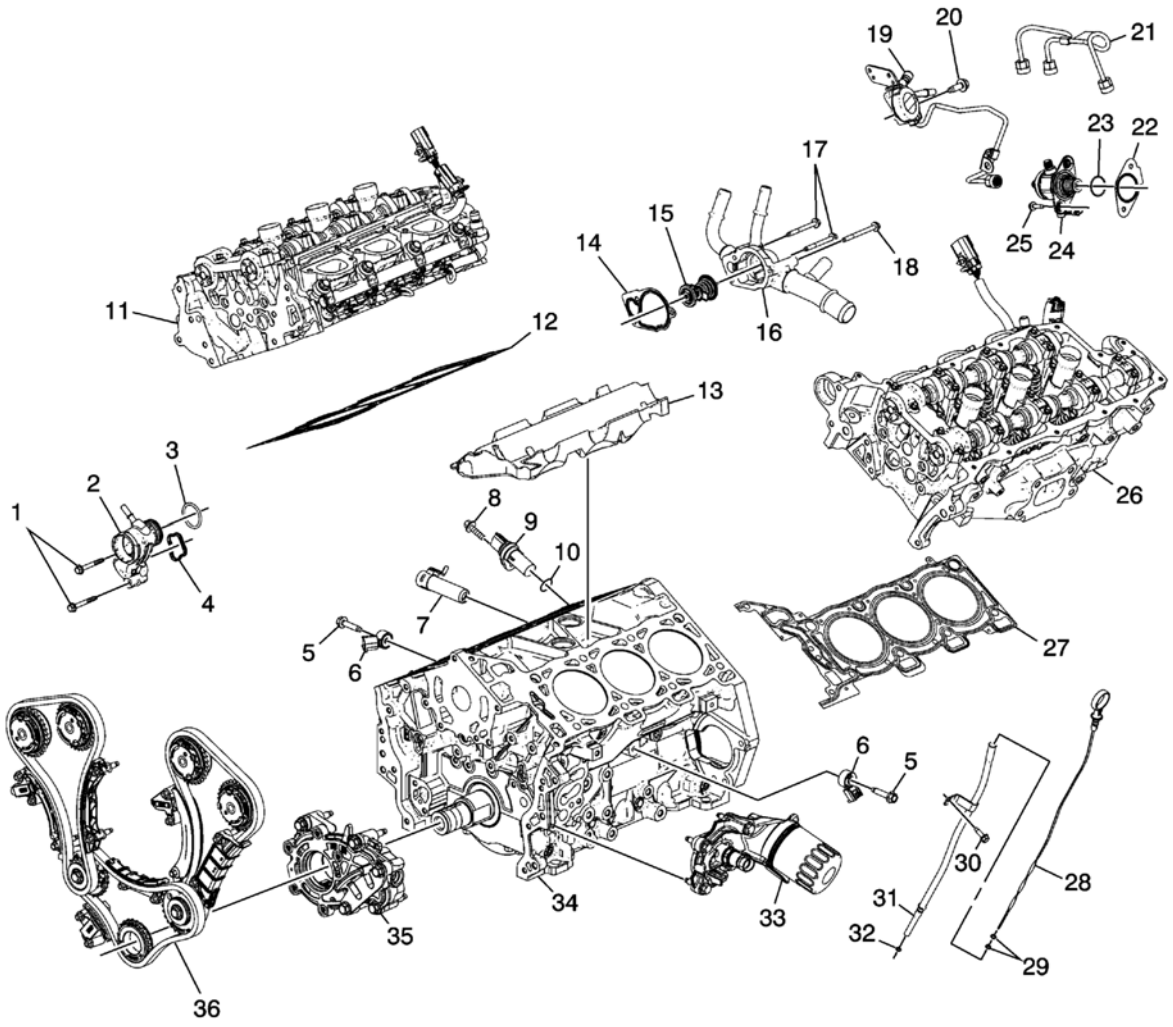


Fig. 2: Engine Covers and Component Assemblies (2 of 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Water Outlet Bolt
2	Water Outlet
3	Water Outlet O-ring
4	Water Outlet Seal
5	Knock Sensor Bolt
6	Knock Sensor
7	Engine Coolant Heater Assembly
8	Crankshaft Position Sensor Bolt
9	Crankshaft Position Sensor
10	Crankshaft Position Sensor O-ring
11	Right Cylinder Head Assembly
12	Right Cylinder Head Gasket
13	Lower Fuel Rail Noise Shield
14	Engine Cooling Thermostat Gasket
15	Engine Cooling Thermostat
16	Engine Cooling Thermostat Housing
17	Engine Cooling Thermostat Bolt - Short
18	Engine Cooling Thermostat Housing Bolt - Long
19	Fuel Feed Pipe Assembly
20	Fuel Feed Pipe Assembly Bolt
21	Fuel Feed Intermediate Pipe Assembly
22	Fuel Pump Gasket
23	Fuel Pump O-ring Seal
24	Fuel Pump
25	Fuel Pump Bolt
26	Left Cylinder Head Assembly
27	Left Cylinder Head Gasket
28	Oil Level Indicator
29	Oil Level Indicator Handle O-ring
30	Oil Level Indicator Tube Bolt
31	Oil Level Indicator Tube
32	Oil Level Indicator Tube O-ring
33	Oil Filter Adapter Assembly
34	Engine Short Block Assembly
35	Oil Pump Assembly
36	Timing Drive Assembly

Camshaft Cover Assembly

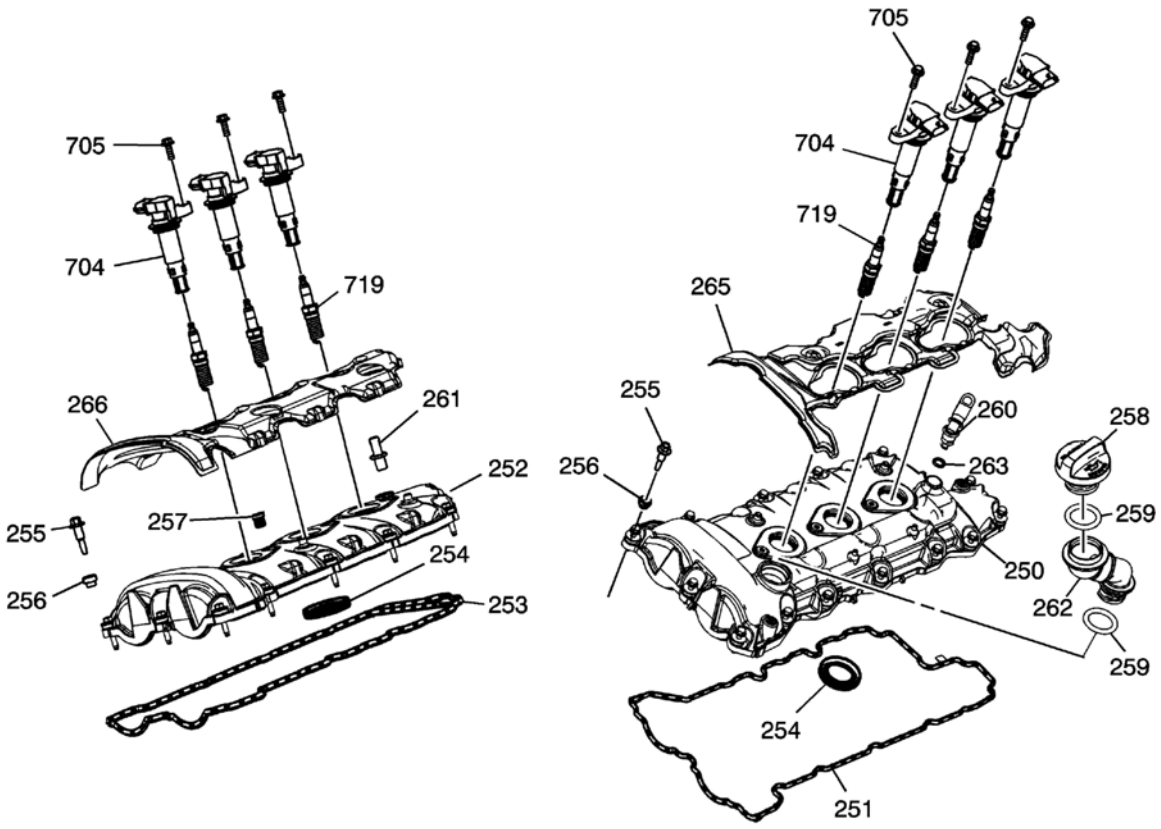


Fig. 3: Camshaft Cover Assembly

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
250	Left Camshaft Cover
251	Left Camshaft Cover Gasket
252	Right Camshaft Cover
253	Right Camshaft Cover Gasket
254	Camshaft Cover Spark Plug Port Seal
255	Camshaft Cover Bolt
256	Camshaft Cover Bolt Insulator
257	Ignition Coil Bolt Thread Insert
258	Oil Fill Cap
259	Oil Fill O-ring
260	Left Camshaft Cover PCV Fitting
261	Right Camshaft Cover PCV Fitting Orifice
262	Oil Fill Tube
263	Left Camshaft Cover PCV Fitting O-ring

Callout	Component Name
265	Left Camshaft Housing Cover Insulator
266	Right Camshaft Housing Cover Insulator
704	Ignition Coil
705	Ignition Coil Bolt
719	Spark Plug

Camshaft Timing Components

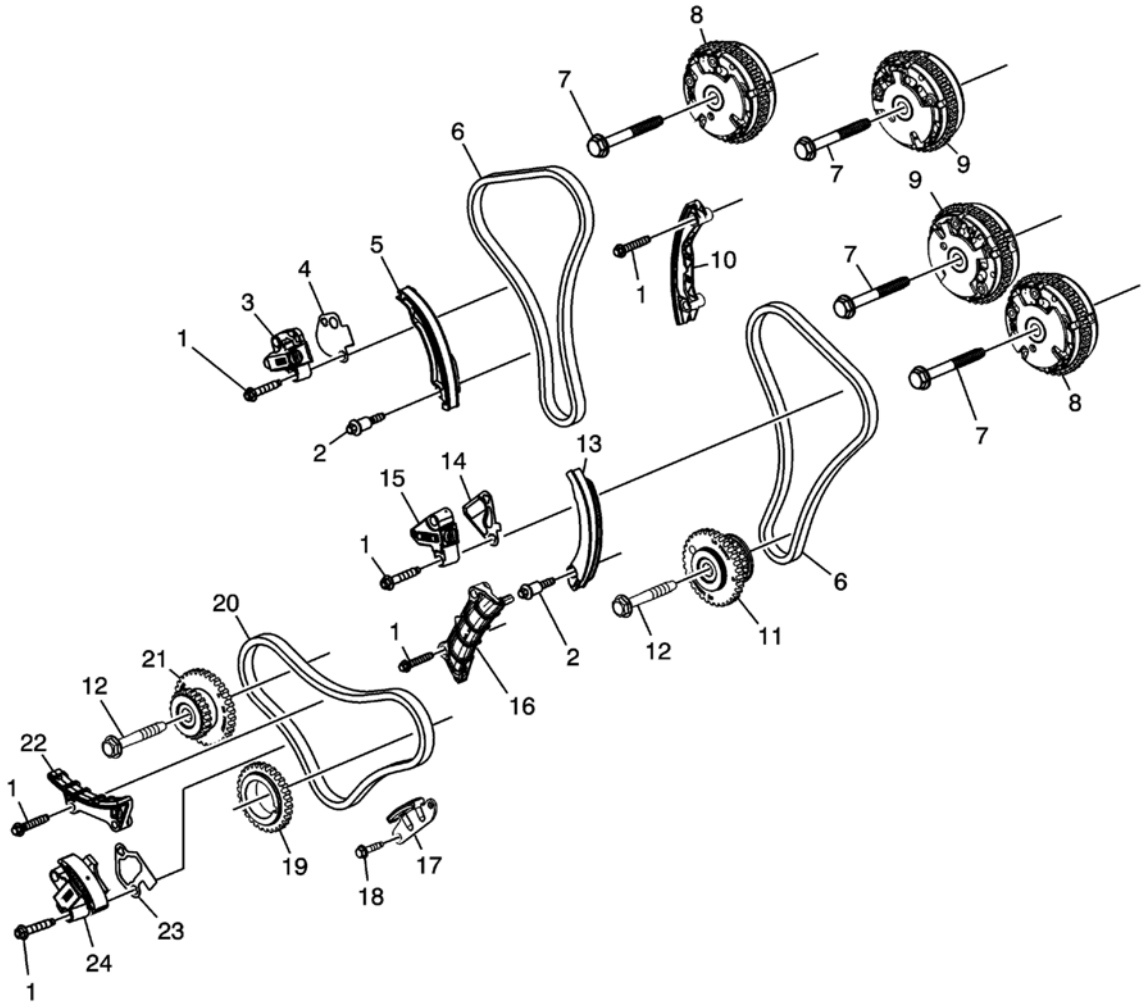


Fig. 4: Camshaft Timing Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Right Secondary Timing Chain Tensioner Bolt
2	Right Secondary Timing Chain Guide Bolt
3	Right Secondary Timing Chain Tensioner
4	Right Timing Chain Housing Gasket
5	Right Secondary Timing Chain Guide
6	Secondary Camshaft Intermediate Drive Chain

Callout	Component Name
7	Camshaft Position Actuator Bolt
8	Exhaust Camshaft Position Actuator
9	Intake Camshaft Position Actuator
10	Right Pivot Arm Timing Chain Guide
11	Left Camshaft Timing Chain Idler Sprocket
12	Camshaft Intermediate Drive Shaft Sprocket Bolt
13	Left Pivot Arm Timing Chain Guide
14	Left Timing Chain Housing Gasket
15	Left Secondary Timing Chain Tensioner
16	Left Secondary Timing Chain Guide
17	Lower Primary Timing Chain Guide
18	Lower Primary Timing Chain Guide Bolt
19	Crankshaft Sprocket
20	Primary Timing Chain
21	Right Camshaft Timing Chain Idler Sprocket
22	Upper Primary Timing Chain Guide
23	Timing Chain Housing Gasket
24	Camshaft Intermediate Drive Chain Tensioner

Intake Manifold

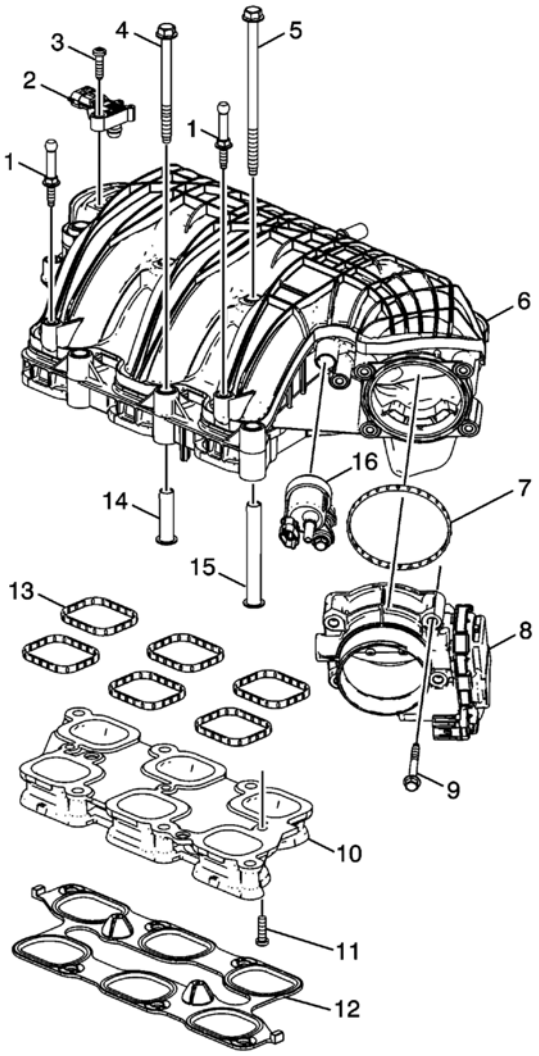


Fig. 5: Intake Manifold
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Intake Manifold Cover Ball Studs
2	MAP Sensor
3	MAP Sensor Bolt
4	Upper Intake Manifold Bolt-Short
5	Upper Intake Manifold Bolt-Long
6	Upper Intake Manifold
7	Throttle Body Gasket
8	Throttle Body
9	Throttle Body Bolt
10	Lower Intake Manifold
11	Lower Intake Manifold Bolt
12	Intake Manifold Gasket
13	Lower Intake Manifold Gaskets
14	Compression Limiters-Small

Callout	Component Name
15	Compression Limiters-Large
16	EVAP Solenoid

Fuel Rail

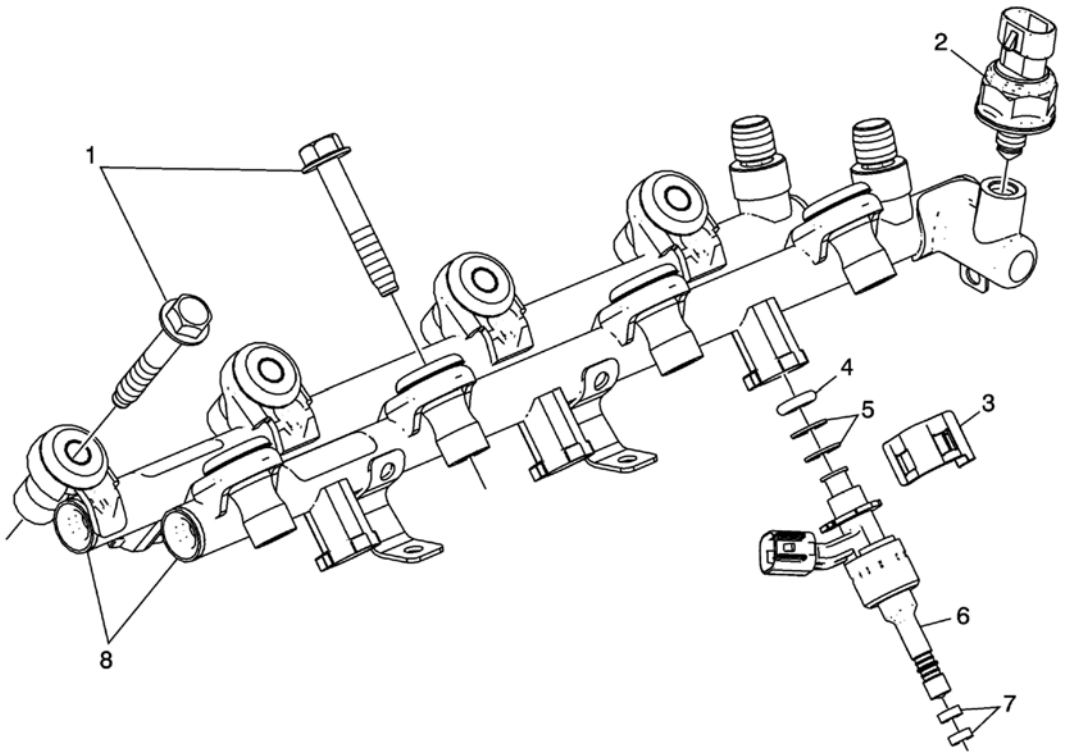


Fig. 6: Identifying Fuel Rail Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Fuel Rail Bolt
2	Fuel Pressure Sensor
3	Fuel Injector Retainer
4	Fuel Injector O-ring Seal
5	Fuel Injector Spacer
6	Fuel Injector
7	Fuel Injector Teflon Seal
8	Fuel Rail

Cylinder Head Assemblies

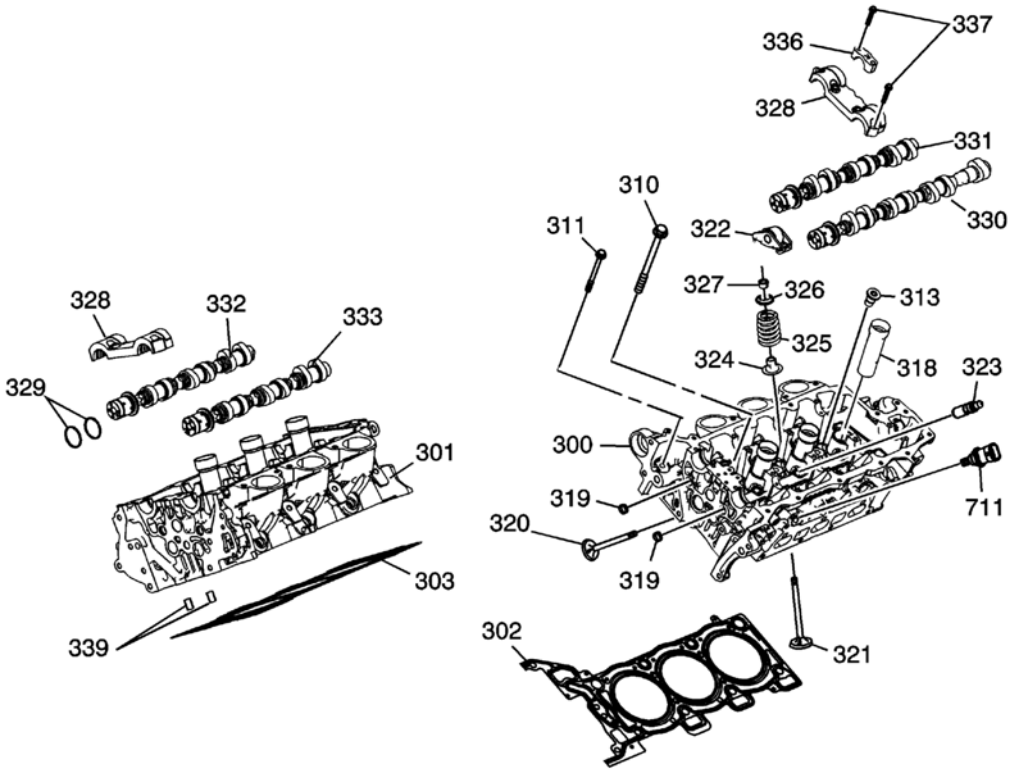


Fig. 7: Cylinder Head Assemblies
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
300	Left Cylinder Head
301	Right Cylinder Head
302	Left Cylinder Head Gasket
303	Right Cylinder Head Gasket
310	Cylinder Head Bolt
311	Cylinder Head Front Bolt
313	Cylinder Head Water Jacket Hole Threaded Plug
318	Spark Plug Wire Sleeve
319	Cylinder Head Oil Gallery Expansion Plug - 14 mm
320	Exhaust Valve
321	Intake Valve
322	Valve Rocker Arm
323	Hydraulic Valve Lash Adjuster
324	Valve Stem Oil Seal
325	Valve Spring
326	Valve Spring Cap
327	Valve Stem Key
328	Cylinder Head Camshaft Front Thrust Bearing Cap
328	Cylinder Head Camshaft Front Thrust Bearing Cap
329	Camshaft Oil Seal Ring

Callout	Component Name
330	Left Exhaust Camshaft
331	Left Intake Camshaft
332	Right Intake Camshaft
333	Right Exhaust Camshaft
336	Cylinder Head Camshaft Cap - Intermediate
337	Cylinder Head Camshaft Cap Bolt
339	Cylinder Head Oil Gallery Check Valve
711	Engine Coolant Temperature Sensor

Engine Front Cover

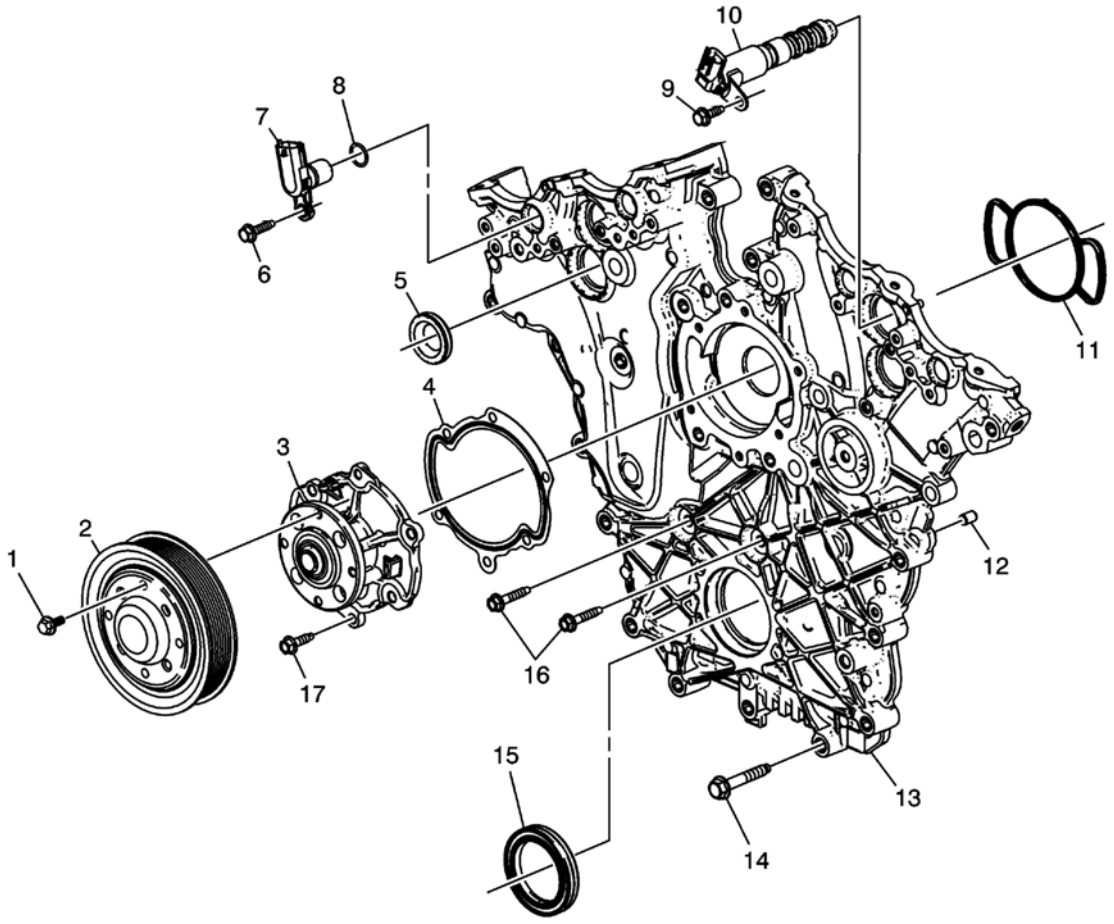


Fig. 8: View Of Engine Front Cover Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Water Pump Pulley Bolt
2	Water Pump Pulley
3	Water Pump Assembly

Callout	Component Name
4	Water Pump Pulley Gasket
5	Camshaft Position Actuator Solenoid Valve Seal
6	Camshaft Position Sensor Bolt
7	Camshaft Position Sensor
8	Camshaft Position Sensor O-ring Seal
9	Camshaft Position Actuator Solenoid Valve Bolt
10	Camshaft Position Actuator Solenoid Valve
11	Engine Front Cover Gasket
12	Engine Front Cover Locating Pin
13	Engine Front Cover
14	Engine Front Cover Bolt
15	Engine Front Cover Seal
16	Engine Front Cover Bolt
17	Water Pump Bolt

Oil Pump

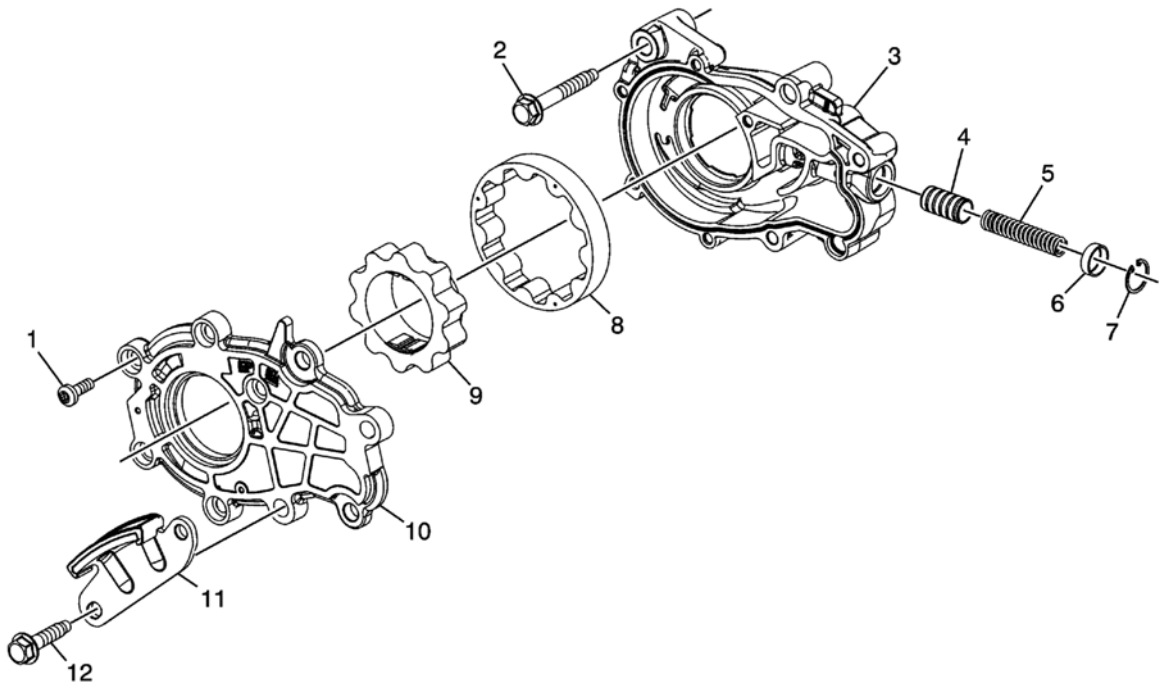


Fig. 9: Oil Pump Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pump Cover Bolt
2	Oil Pump Bolt
3	Oil Pump Housing

Callout	Component Name
4	Oil Pressure Relief Valve
5	Oil Pressure Relief Valve Spring
6	Oil Pressure Relief Valve Bore Plug
7	Oil Pressure Relief Valve Bore Plug Retainer Clip
8	Oil Pump Driven Gear
9	Oil Pump Drive Gear
10	Oil Pump Cover
11	Lower Primary Timing Chain Guide
12	Lower Primary Timing Chain Guide Bolt

Engine Block Assembly

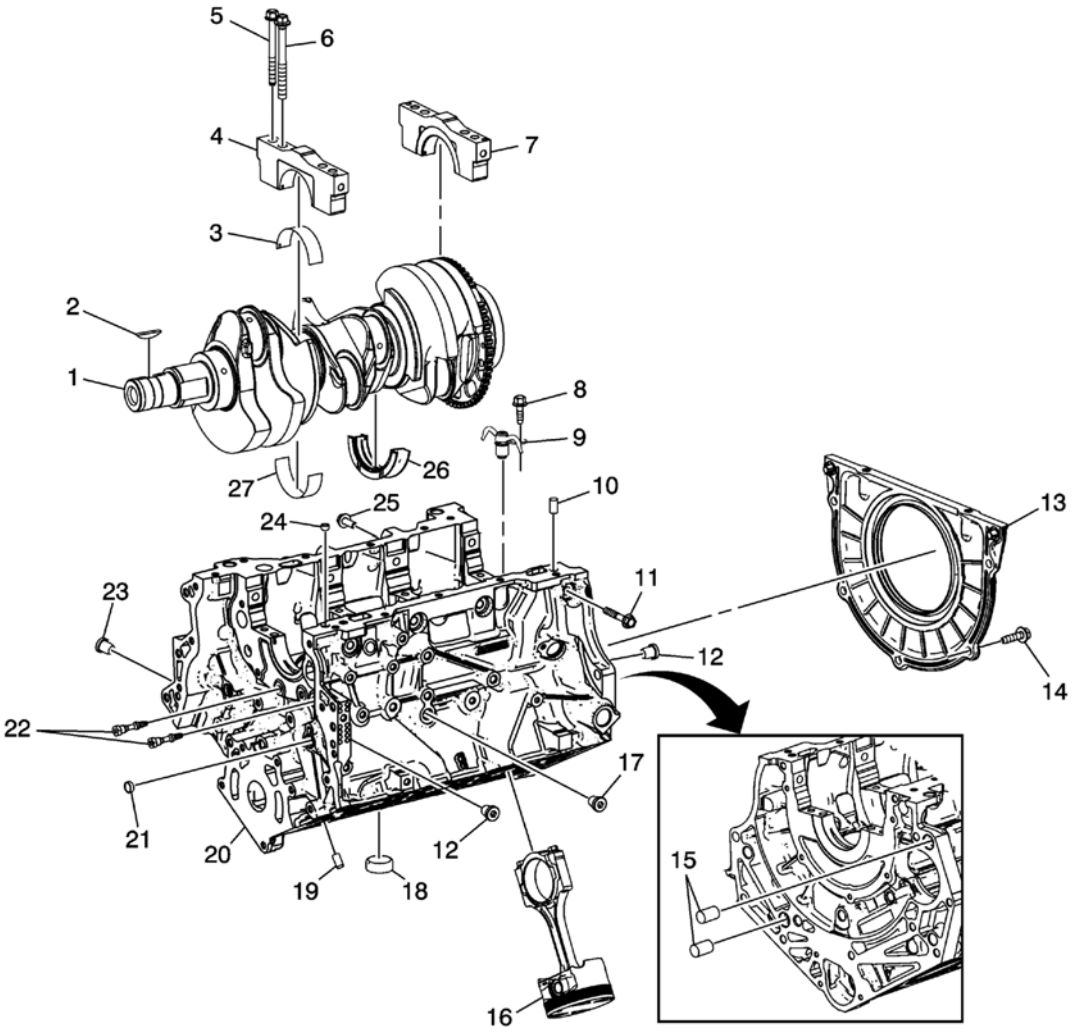


Fig. 10: Identifying Engine Block Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Crankshaft
2	Crankshaft Key

Callout	Component Name
3	Crankshaft Lower Bearing
4	Crankshaft Bearing Cap
5	Crankshaft Bearing Cap Outboard Bolt
6	Crankshaft Bearing Cap Inboard Bolt
7	Crankshaft Bearing Thrust Cap
8	Piston Oil Nozzle Bolt
9	Piston Oil Nozzle
10	Oil Pan Locating Pin
11	Crankshaft Bearing Cap Side Bolt - Long
12	Engine Block Oil Gallery Threaded Plug - 14 mm
13	Crankshaft Rear Oil Seal Housing Assembly
14	Crankshaft Rear Oil Seal Housing Assembly Bolt
15	Transaxle Locating Pin
16	Piston and Connecting Rod Assembly
17	Engine Block Coolant Drain Threaded Plug - 14 mm
18	Engine Block Core Coolant Expansion Plug - 34.3 mm
19	Cylinder Head Locating Pin
20	Engine Block
21	Engine Block Oil Gallery Expansion Plug- 14 mm
22	Engine Front Cover Stud
23	Engine Block Oil Gallery Threaded Plug - 20 mm
24	Engine Block Oil Gallery Expansion Plug - 10 mm
25	Crankshaft Bearing Cap Side Bolt - Short
26	Crankshaft Upper Thrust Bearing #3
27	Crankshaft Upper Bearing

Piston, Rings, Bearing and Connecting Rod

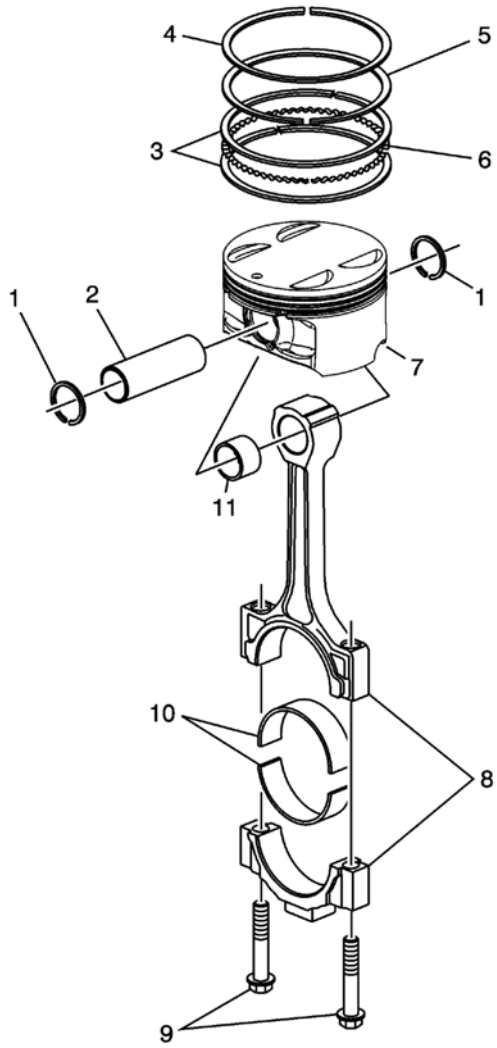


Fig. 11: Piston, Rings, Bearing and Connecting Rod
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Piston Pin Retainer
2	Piston Pin
3	Piston Oil Control Rail Ring
4	Piston Upper Compression Ring
5	Piston Lower Compression Ring
6	Piston Oil Control Ring Spacer
7	Piston
8	Connecting Rod
9	Connecting Rod Bolt
10	Connecting Rod Bearing
11	Connecting Rod Bushing

Oil Pan Assembly

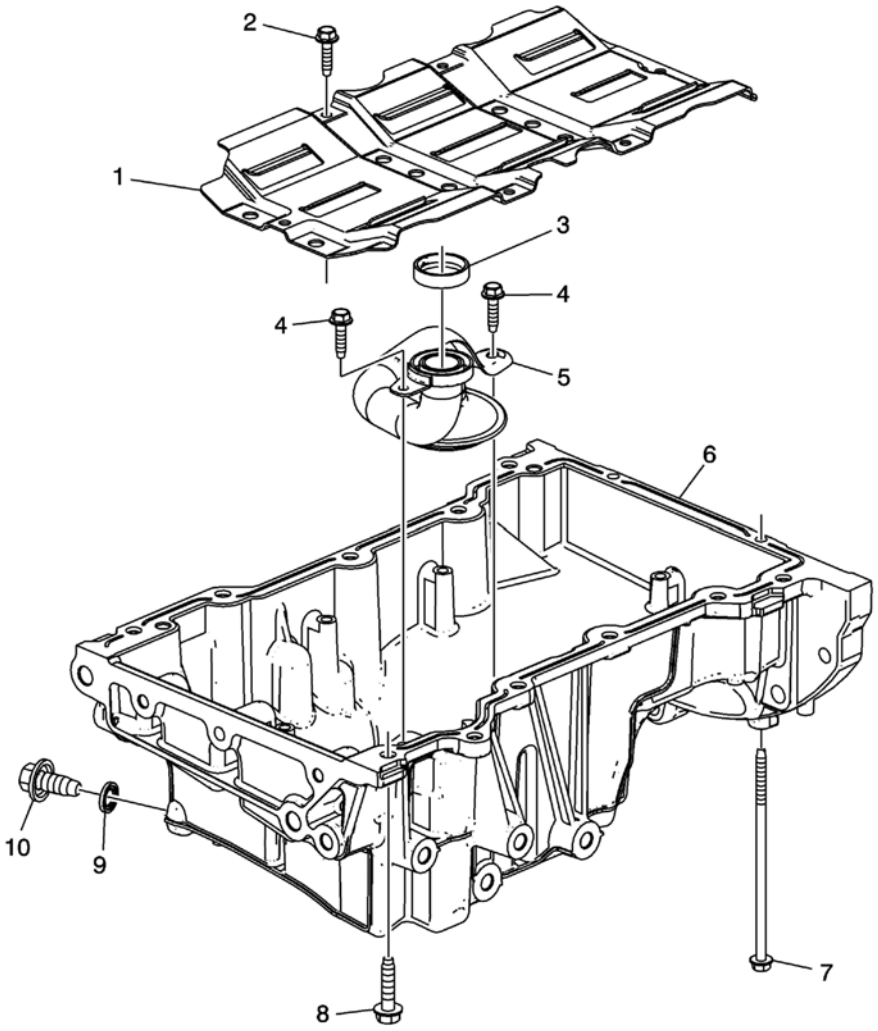


Fig. 12: Oil Pan Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Pan Baffle Scraper
2	Oil Pan Baffle Scraper Bolt
3	Oil Pump Suction Pipe Seal
4	Oil Pump Suction Pipe Bolt
5	Oil Pump Suction Pipe
6	Oil Pan
7	Oil Pan Bolt - Long
8	Oil Pan Bolt
9	Oil Pan Drain Plug Seal
10	Oil Pan Drain Plug

Oil Filter Adapter

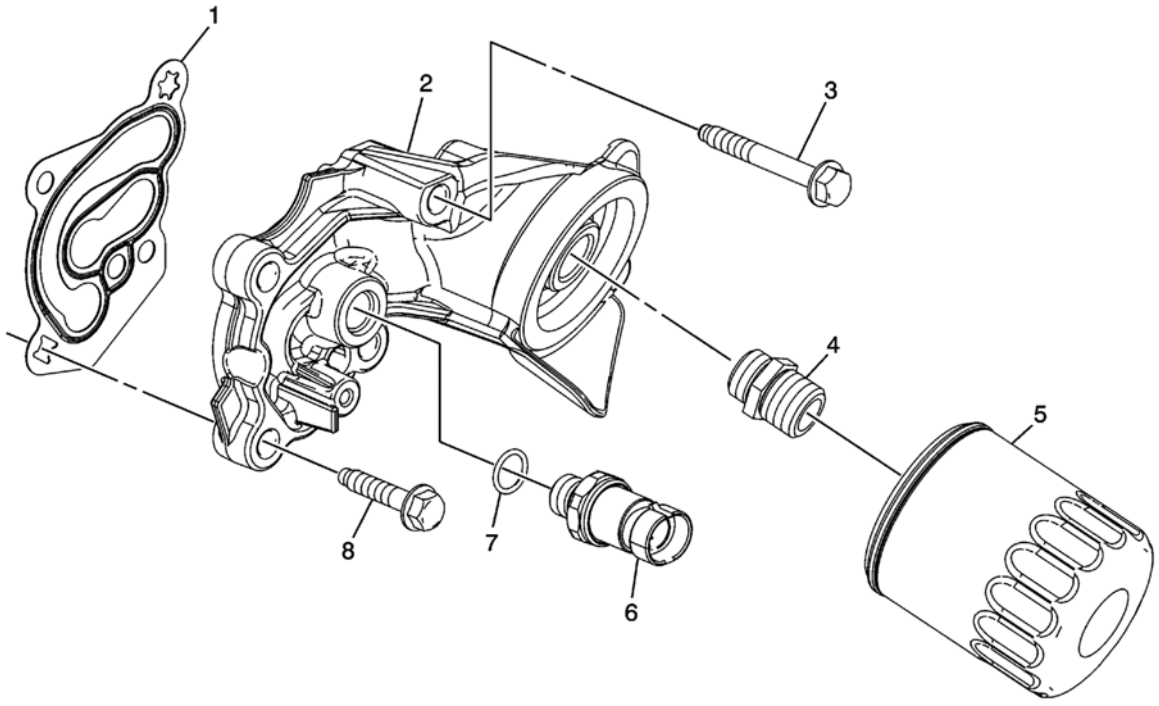


Fig. 13: Oil Filter Adapter
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Filter Adapter Gasket
2	Oil Filter Adapter
3	Oil Filter Adapter Bolt - Long
4	Oil Filter Fitting
5	Oil Filter
6	Engine Oil Pressure Sensor
7	Engine Oil Pressure Sensor Seal
8	Oil Filter Adapter Bolt

ENGINE IDENTIFICATION

Vehicle Identification Number

The Vehicle Identification Number (VIN) Derivative is located in two places on the engine and is a nine digit number stamped or laser etched onto the block at the vehicle assembly plant. If reading the identification number the following information can be obtained:

- The first digit identifies the vehicle division.
- The second digit is the model year.
- The third digit identifies the assembly plant.
- The fourth through ninth digits are the last six digits of the Vehicle Identification Number (VIN).

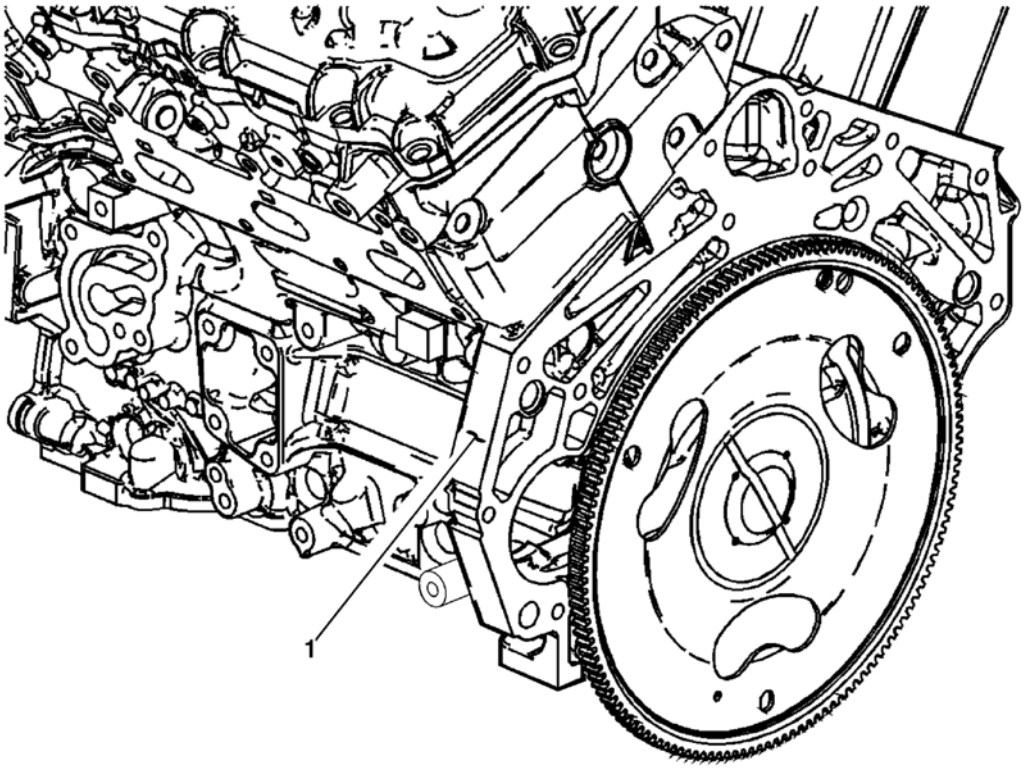


Fig. 14: Locating Engine VIN - Left Rear Side
Courtesy of GENERAL MOTORS COMPANY

The engine block is marked with the VIN on a pad area on the left rear side (1).

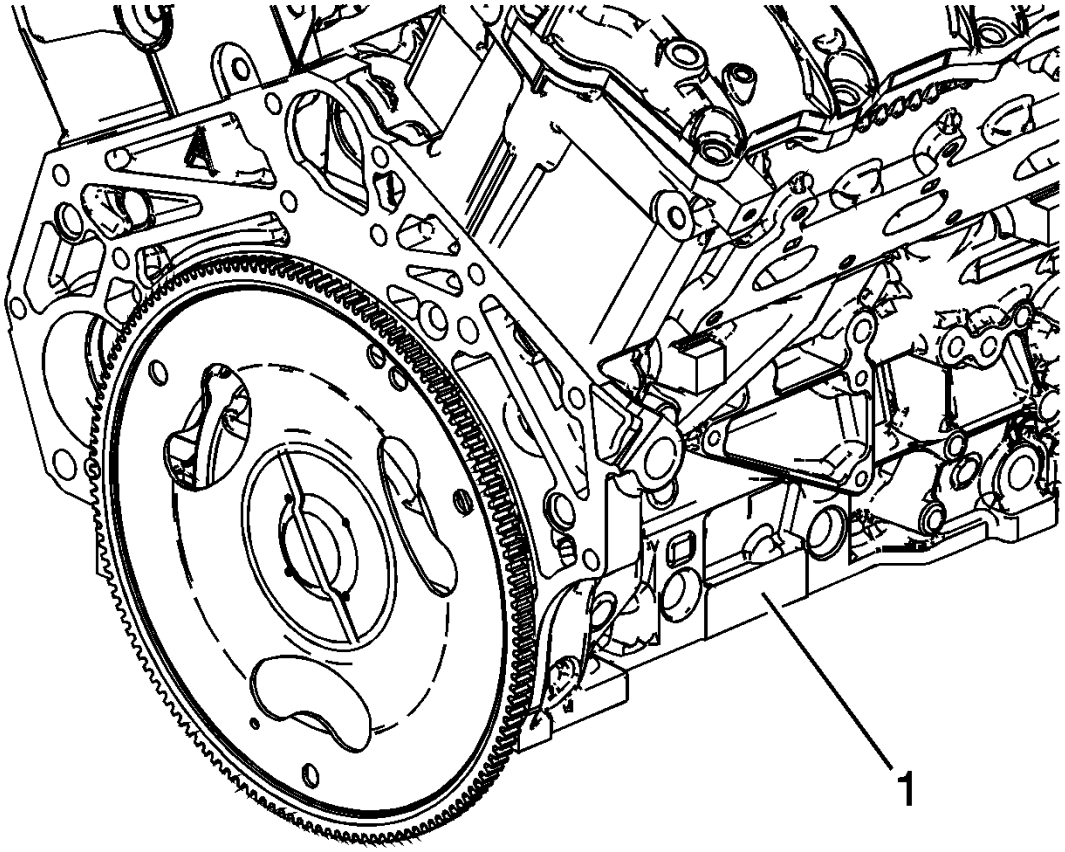


Fig. 15: Locating Vehicle Identification Number (VIN) - Center Lower Right Side
Courtesy of GENERAL MOTORS COMPANY

The engine block is marked with the VIN on a pad area on the center lower right side (1).

Engine Traceability Label

The engine traceability label is located in two places on the engine and consists of the broadcast code, bar code and sequence number. This label is used in engine and vehicle assembly plants and is not intended to be permanent. If it is missing refer back to the engine block VIN pad for the permanent ID.

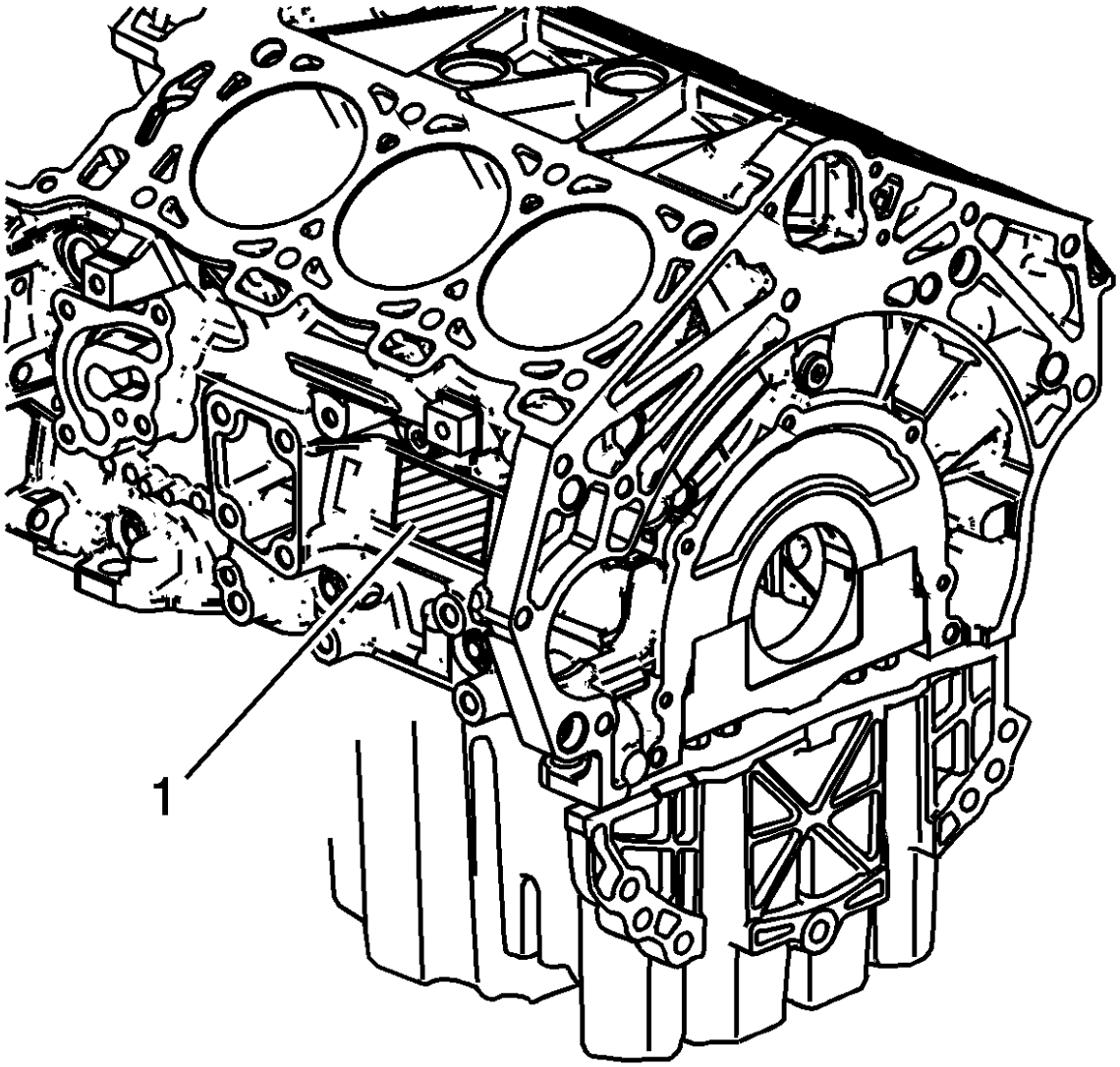


Fig. 16: Locating Left Rear Engine Traceability Label
Courtesy of GENERAL MOTORS COMPANY

One engine traceability label (1) is located on the left rear side of the engine block. This label is used in engine and vehicle assembly plants and is not intended to be permanent. If it is missing refer back to the engine block VIN pad for the permanent ID.

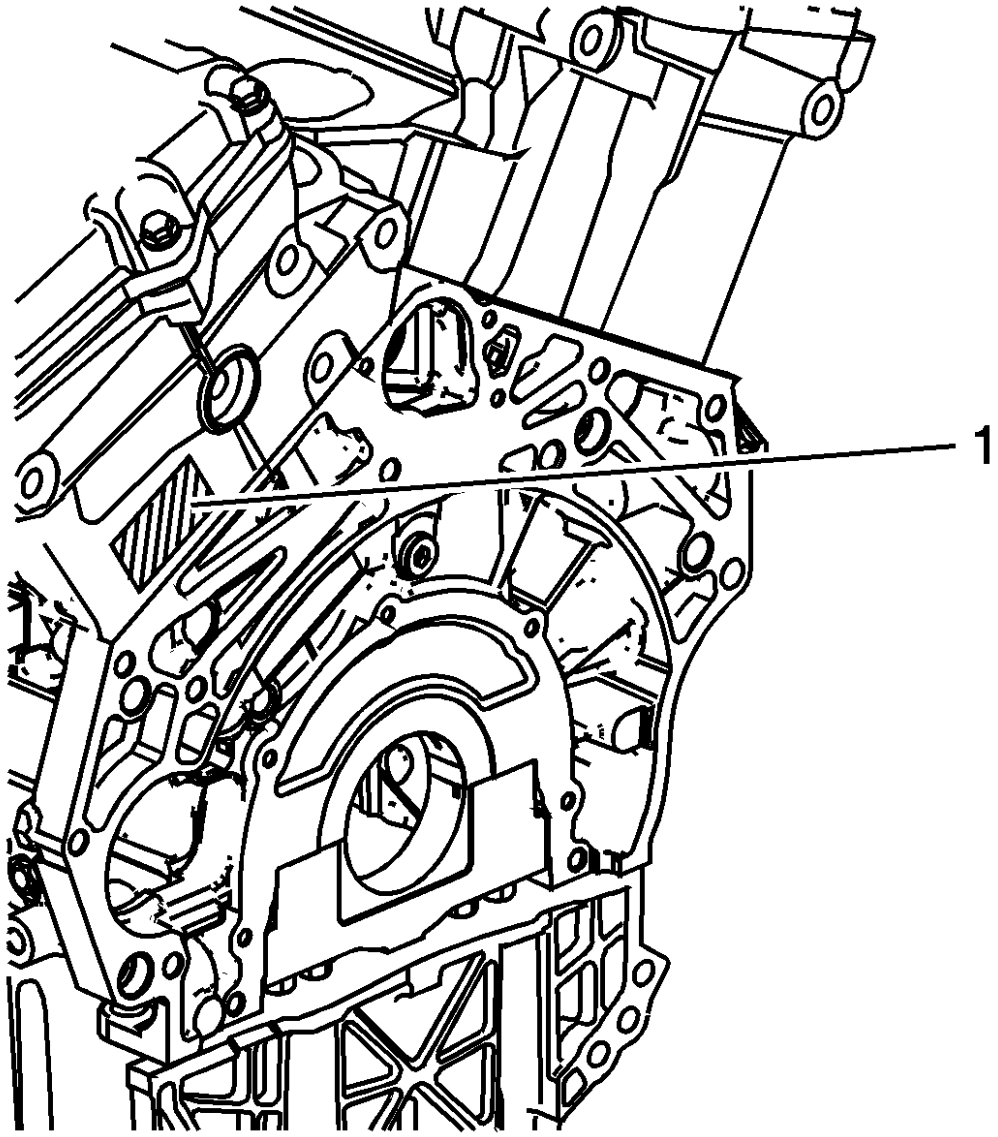


Fig. 17: View Of Engine Traceability Label On Left Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

Another engine traceability label (1) is located on the rear of the left cylinder head. This label is used in engine and vehicle assembly plants and is not intended to be permanent. If it is missing refer back to the engine block VIN pad for the permanent ID.

Engine Verification Label

The engine verification label is located in two places on the engine and consists of the broadcast code and bar code. This label is used in engine and vehicle assembly plants and is not intended to be permanent. If it is missing refer back to the engine block VIN pad for the permanent ID.

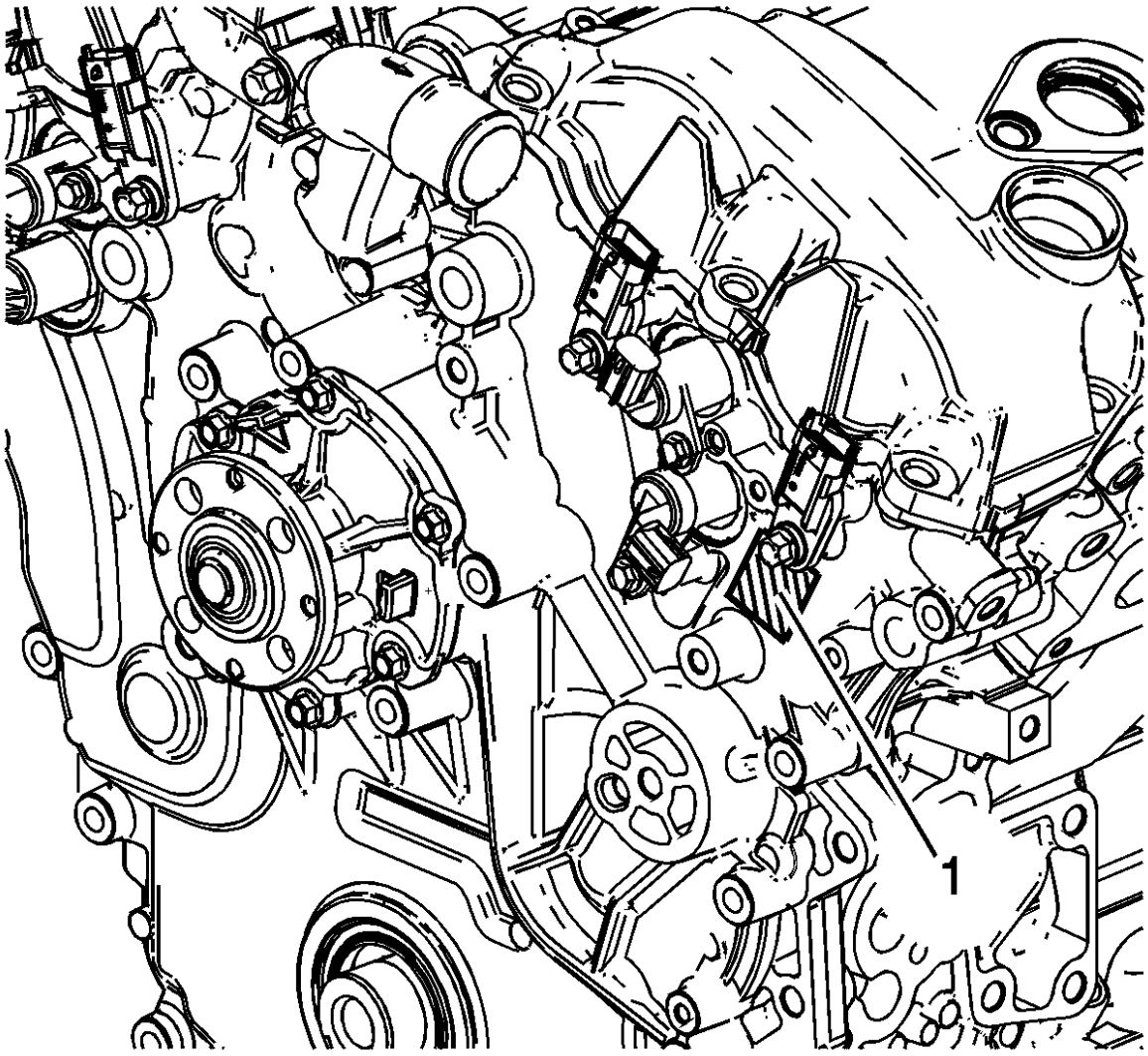


Fig. 18: Locating Left Engine Verification Label
Courtesy of GENERAL MOTORS COMPANY

One engine verification label (1) is located on the left side of the engine front cover below the exhaust camshaft position sensor. This label is used in engine and vehicle assembly plants and is not intended to be permanent. If it is missing refer back to the engine block VIN pad for the permanent ID.

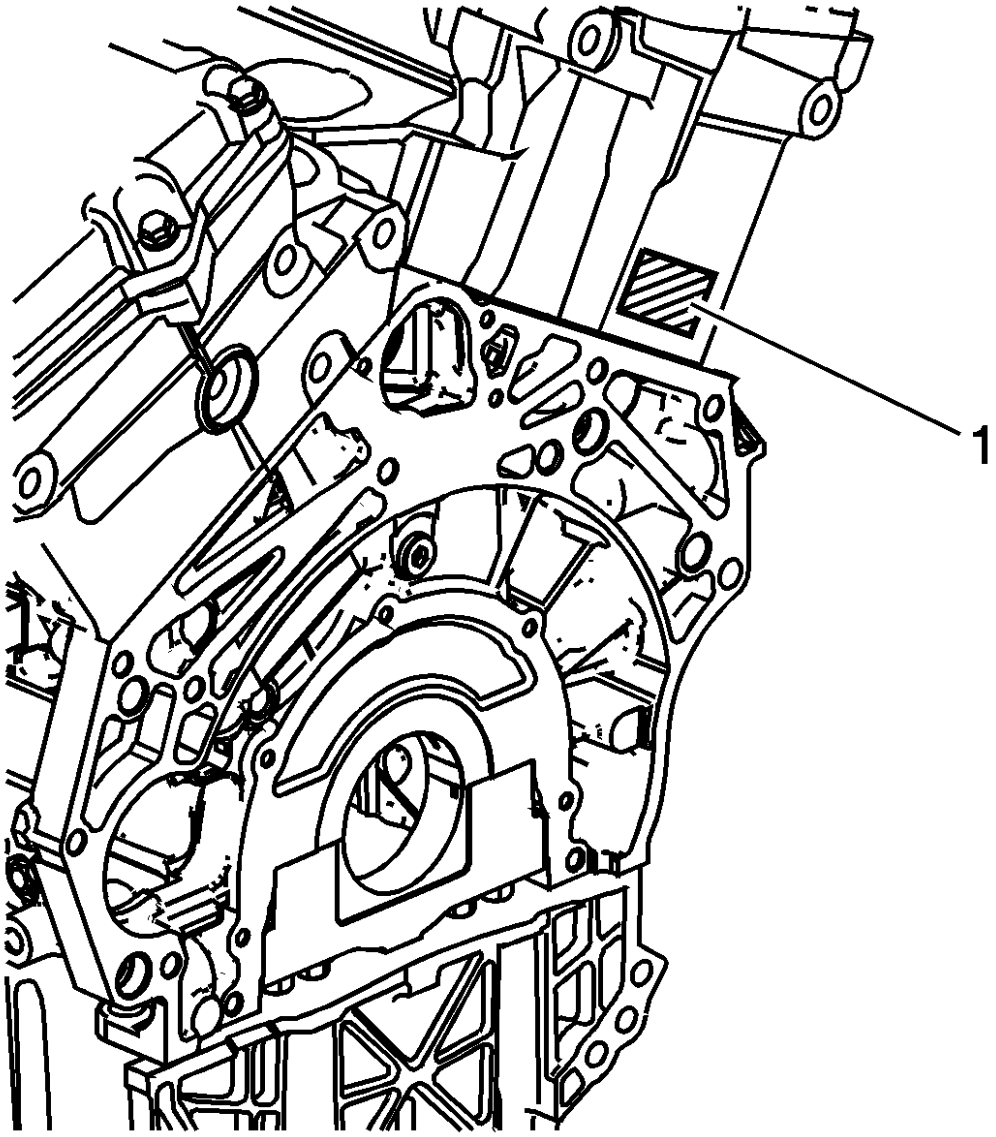


Fig. 19: Identifying Engine Verification Label On Rear Of Right Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

Another engine verification label (1) is located on the rear of the right cylinder head. This label is used in engine and vehicle assembly plants and is not intended to be permanent. If it is missing refer back to the engine block VIN pad for the permanent ID.

Article GUID: A00737149

DESCRIPTION AND OPERATION

CRANKCASE VENTILATION SYSTEM DESCRIPTION

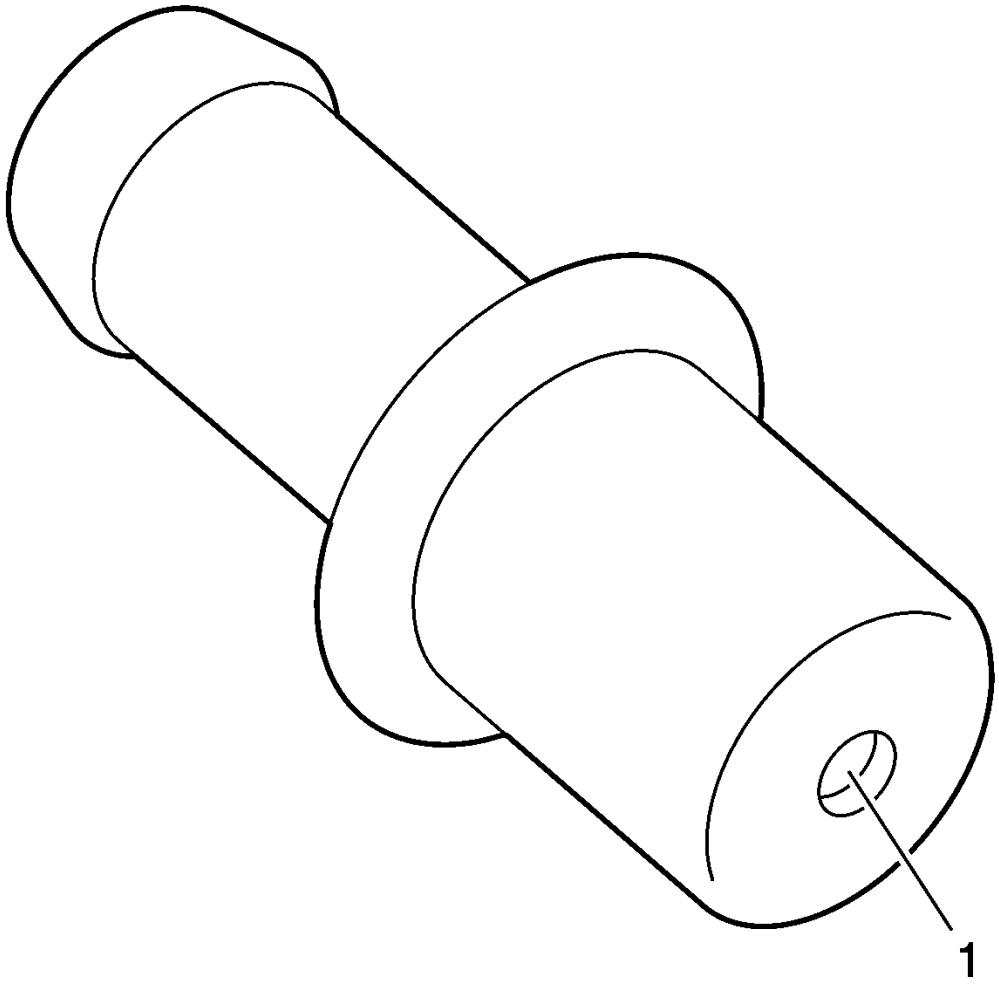


Fig. 1: PCV Orificed Tube
Courtesy of GENERAL MOTORS COMPANY

A crankcase ventilation system is used to consume crankcase vapors created during the combustion process instead of venting them to the atmosphere.

Fresh air is supplied through a filter to the crankcase, the crankcase mixes the fresh air with the blow-by gases and then passed through a positive crankcase ventilation (PCV) orificed tube into the intake manifold.

The PCV orificed tube restricts the flow rate of the blow-by gases using an orifice (1) located at the end of the tube. If abnormal operating conditions arise, the system is designed to allow excessive amounts of blow-by gases to back flow through the crankcase vent tube into the throttle body in order to be consumed by normal

combustion.

DRIVE BELT SYSTEM DESCRIPTION

The drive belt system consists of the following components:

- The drive belt
- The drive belt tensioner
- The drive belt idler pulley
- The crankshaft balancer pulley
- The accessory drive component mounting brackets
- The accessory drive components
  - The power steering pump, if belt driven
  - The generator
  - The A/C compressor, if equipped
  - The engine cooling fan, if belt driven
  - The water pump, if belt driven
  - The vacuum pump, if equipped
  - The air compressor, if equipped

The drive belt system may use 1 belt or 2 belts. The drive belt is thin so that it can bend backwards and has several ribs to match the grooves in the pulleys. The drive belts are made of different types of rubbers, chloroprene or EPDM, and have different layers or plys containing either fiber cloth or cords for reinforcement.

Both sides of the drive belt may be used to drive the different accessory drive components. When the back side of the drive belt is used to drive a pulley, the pulley is smooth.

The drive belt is pulled by the crankshaft balancer pulley across the accessory drive component pulleys. The spring loaded drive belt tensioner keeps constant tension on the drive belt to prevent the drive belt from slipping. The drive belt tensioner arm will move when loads are applied to the drive belt by the accessory drive components and the crankshaft.

The drive belt system may have an idler pulley, which is used to add wrap to the adjacent pulleys. Some systems use an idler pulley in place of an accessory drive component when the vehicle is not equipped with the accessory.

ENGINE COMPONENT DESCRIPTION (LFX)

The High Feature V6 (VIN Code Identifier "3" for both cars and trucks) RPO LFX is a 3.6 Liter VVT (Variable Valve Timing) engine with direct injection. The LFX has E85-compatible valves and seats with special materials and coatings that require slightly different service procedures from gasoline valves. The direct injection system places the high pressure injectors in the cylinder heads. This engine incorporates 2 intake and 2 exhaust valves per cylinder, and uses a dual overhead cam design with individual intake and exhaust camshafts. A camshaft position actuator is mounted on each camshaft. The cylinders are arranged in 2 banks of 3 with a 60 degree included angle. The right bank of cylinders are number 1-3-5 and the left bank of cylinders are 2-4-6, viewed from the flywheel end of the engine. The engine firing order is 1-2-3-4-5-6.

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Crankcase

The cylinder block is constructed of aluminum alloy by precision sand-casting with cast in place iron cylinder liners. Each main bearing cap incorporates 6 bolts bolting the cap into the engine block. Along with 2 outer and 2 inner bolts, 2 side bolts are used in the deep skirt block. To prevent aeration, oil return from the valvetrain and cylinder heads is channeled away from the rotating and reciprocating components through oil drain back passages incorporated into the cylinder heads and engine block. Pressure-actuated piston oil cooling jets are mounted between opposing cylinders. A knock sensor is located on the each side of the exterior of the engine block. The crankshaft position sensor is located on the right side of the exterior of the engine block.

Crankshaft

The crankshaft is a hardened, forged steel design with 4 main bearings. Crankshaft thrust is controlled by the upper portion of number 3 main bearing. The crankshaft position reluctor wheel is pressed onto the rear of the crankshaft in front of the rear main journal. A micro encapsulated adhesive is used on the reluctor wheel to aid retention. The crankshaft is internally balanced, and has an integral oil pump drive machined into the nose in front of the front main journal.

Connecting Rods and Pistons

The connecting rods are steel and have full floating piston pins. The piston pins are a slip fit in the bronze bushed connecting rod. Round wire retainers are used to retain the piston pin into the piston. The cast aluminum pistons incorporate a polymer-coated skirt to reduce friction. The piston uses two low tension compression rings and one multi-piece oil control ring. The top of the piston contains a shaped portion for the direct injection system to aid in fuel-air charge mixture and even combustion.

Camshaft Drive System

The camshaft drive system consists of one primary timing drive chain driven by the crankshaft sprocket. The primary timing drive chain drives two intermediate drive shaft sprockets. Each oil-pressure-fed intermediate drive shaft sprocket drives separate secondary timing drive chains. Each secondary timing drive chain drives the respective cylinder head's intake and exhaust camshaft position actuators.

The primary timing drive chain uses two stationary timing drive chain guides and a hydraulically-actuated tensioner with built-in shoe. The tensioner minimizes timing drive chain noise and provides accurate valve action by keeping slack out of the timing drive chains and continuously adjusting for timing drive chain wear. The tensioner incorporates a plunger that adjusts out with wear allowing only a minimal amount of backlash. The tensioner is equipped with an oiling jet to spray oil onto the timing components during engine operation. The secondary timing drive chains use a stationary timing drive chain guide and movable timing drive chain shoe. The secondary timing drive chain shoe is under tension from a hydraulically-actuated tensioner. All tensioners are sealed to the head or block using a rubber coated steel gasket. The gasket traps an adequate oil reserve to ensure quiet start-up.

Camshaft Position Actuator System

The engine incorporates a camshaft position actuator for each intake and exhaust camshaft. Camshaft phasing changes valve timing as engine operating conditions vary. Dual camshaft phasing allows the further optimization of performance, fuel economy and emissions without compromising overall engine response and driveability. Variable valve timing also contributes to a reduction in exhaust emissions. It optimizes exhaust and inlet valve overlap and eliminates the need for an exhaust gas recirculation (EGR) system.

The camshaft position actuator is a hydraulic vane-type actuator that changes the camshaft lobe timing relative to the camshaft drive sprocket. Engine oil is directed by a camshaft position actuator oil control valve to the appropriate passages in the camshaft position actuator. Oil acting on the vane in the camshaft position actuator rotates the camshaft relative to the sprocket. At idle, both camshafts are at the default or "home" position. At this position, the exhaust camshaft is fully advanced and the intake is fully retarded to minimize valve overlap for smooth idle. An internal lock pin locks the inner rotor to the outer camshaft position actuator housing at idle and maintains this position during start-up conditions. Under other engine operating conditions, the camshaft position actuator is controlled by the engine control module (ECM) to deliver optimal intake and exhaust valve timing for performance, driveability and fuel economy. The camshaft position actuator incorporates an integral trigger wheel, which is sensed by the camshaft position sensor mounted in the front cover, to accurately determine the position of each camshaft. The exhaust camshaft position actuator has a different internal configuration than the intake camshaft position actuator since the exhaust camshaft position actuator phases in the opposite direction relative to the inlet camshaft position actuator.

The camshaft position actuator oil control valve (OCV) directs oil from the oil feed in the head to the appropriate camshaft position actuator oil passages. There is one OCV for each camshaft position actuator. The OCV is sealed and mounted to the front cover. The ported end of the OCV is inserted into the cylinder head with a sliding fit. A filter screen protects each OCV oil port from any contamination in the oil supply.

The camshaft front journal has several drilled oil holes to allow camshaft position actuator control oil to transfer from the cylinder head to the camshaft position actuator. The center camshaft bolt hole is counterbored to allow oil to flow around the camshaft bolt and to the camshaft position actuator. Oil in this oil passage is used to move the camshaft position actuator to the default or home position.

Radially outward from the center of the journal is a set of 4 drilled camshaft position actuator oil holes. Oil in this group of oil holes is used to move the camshaft from the default position to a specific set position as determined by the ECM. Seal rings are used at the front and rear of the front camshaft journal to prevent oil leakage from the camshaft position actuator hydraulic system. The seal is made from a plastic compound that resists wear and has a diagonal end gap to enhance sealing. The camshaft position actuator is mounted to the front end of the camshaft and the timing notch in the nose of the camshaft aligns with the dowel pin in the camshaft position actuator to ensure proper cam timing and camshaft position actuator oil hole alignment.

Cylinder Heads

The cylinder heads are cast aluminum with powdered metal valve seat inserts and valve guides. The cylinder heads also feature integrated exhaust manifolds; the exhaust manifolds are incorporated into the head casting. Two intake valves and two exhaust valves are actuated by roller finger followers pivoting on a stationary hydraulic lash adjuster (SHLA). In the E85 fuel compatible LFX engine, the valves and seats are constructed with specialized materials and coatings to perform properly in the E85 fuel environment. The intake valves in the LFX engine are slightly larger than those in the LFW engine to allow the additional air necessary for a 3.6L displacement engine.

Separate exhaust and intake camshafts are supported by bearings machined into the cylinder head. The front camshaft bearing cap is used as a thrust control surface for each camshaft. Each spark plug is shielded by a tube that is pressed into the cylinder head. Each spark plug ignition coil is also mounted through the spark plug tube. The engine coolant temperature (ECT) sensor is threaded into the cylinder head. With direct injection, the high pressure injectors are located in machined bores below the intake ports. A stainless steel, high pressure fuel rail is attached to the intake side of the head.

Induction System

The intake manifold assembly is used to deliver a dry-air charge to the combustion chamber. Fuel is introduced directly to the cylinder during the intake stroke. As the piston approaches top-dead center, the air-fuel mixture is ignited by the spark plug. An electronically controlled throttle (ETC), through the ECM, coordinates the input from the driver with various control components.

Right and Left Bank Designation

Right hand (RH) and left hand (LH) designation through the engine mechanical section are viewed from the rear, non-front-cover side, of the engine or from inside the vehicle. These banks are also referred to as Bank 1 (RH) and Bank 2 (LH).

LUBRICATION DESCRIPTION

A structural diecast aluminum oil pan incorporates an oil suction tube and a windage tray. The oil suction tube is bolted into the oil pan and seals to the bottom of the block with O-ring gasket. The windage tray is bolted to the upper portion of the oil pan and reduces friction losses at high speed.

A crankshaft driven gerotor oil pump with internal pressure-relief valve is mounted to the front of the engine block and pulls oil from the oil suction tube through the lower passage in the engine block. The oil pump then directs the flow of pressurized oil back through the upper passage in the block to the left side of the engine block where the oil filter adapter is mounted.

An oil filter adapter is mounted with a gasket to the left side of the engine block.

RWD Applications : The oil filter adapter incorporates a top-access, cartridge style oil filter. The filter is accessed through a screw on cap with an O-ring gasket. The oil filter adapter cap has a built-in oil bypass valve. The oil filter adapter housing incorporates a drain back control valve and a threaded oil pressure sending unit. Oil flows through the lower passage in the oil filter adapter up to and through the oil filter cartridge. Filtered oil travels back through the upper passage of the oil filter adapter and back into the engine block.

FWD Applications : An oil filter adapter is mounted with a gasket to the left side of the engine block. The oil filter adapter incorporates a bottom-access, spin-on oil filter. The oil filter adapter housing incorporates a threaded oil pressure sending unit. Oil flows through the lower passage in the oil filter adapter to and through the oil filter. Filtered oil travels back through the upper passage of the oil filter adapter and back into the engine block.

Oil is directed up and across the engine block front through several drilled passages. These front passages feed oil to each cylinder head, oil to the passage for the main bearings and piston oil jets, oil to the right and left secondary idler sprockets, and oil to the primary timing drive chain tensioner.

Each cylinder head passage directs oil into the cylinder head where it is directed to oiling circuits for the stationary hydraulic lifter assemblies (SHLAs) and the camshaft bearing journals. Oil is also directed through 2 passages each with a spring-loaded check-ball valve to the 2 chambers where the camshaft position actuator oil control solenoid valves are mounted. Each chamber contains a camshaft position actuator oil control solenoid valve with built-in oil filter screen. One camshaft position actuator oil control solenoid valve is used to control the exhaust camshaft position actuator and 1 camshaft position actuator oil control solenoid valve is used to control the intake camshaft position actuator. The engine control module (ECM) electrically controls each camshaft position actuator oil control solenoid valve. When energized by the ECM the camshaft position

actuator oil control solenoid valve directs oil to pass up through the cylinder head front camshaft bearing cap. Oil passes through the camshaft bearing cap passage into oil holes drilled into the side of the front camshaft journal and onto the front of the camshaft mounting surface. Oil passes through to matching passages in the camshaft position actuator. Oil is directed by the camshaft position actuator oil control solenoid valve to the appropriate passage in the system to pressurize oil on the vanes on the inside of the of the camshaft position actuator. Oil acting on the vanes rotates the camshaft mounted to the inner camshaft position actuator rotor relative to the sprocket mounted to the outer camshaft position actuator housing. An internal lock pin locks the inner rotor to the outer camshaft position actuator housing at idle and maintains the camshaft position actuator in the home or default position during start-up conditions. Oil pressure directed by the camshaft position actuator oil control solenoid valve unlocks the pin and allows the camshaft position actuator to function. An additional passage in the cylinder head also directs oil to the secondary timing drive chain tensioner mounted to each cylinder head.

The oil passage that supplies oil to the main bearings also supplies oil to pressure-actuated piston-cooling oil jets. Each oil jet is mounted between opposing cylinder bores and directs oil to the 2 bores to provide extra cooling and control piston temperatures.

Oil is directed from the front passages to the front of the block where the right and left secondary idler sprockets and the primary timing drive chain tensioner are mounted. Each camshaft timing drive chain tensioner relies on a gasket in order to maintain an oil reserve after the engine is turned OFF. All camshaft timing drive chain tensioners incorporate a small oil jet to supply an oil spray onto the camshaft timing drive chain components.

Oil returns to the oil pan sump either through the camshaft timing drive chain area or through the cast oil drain back passages on the outboard walls of the cylinder heads and engine block.

CLEANLINESS AND CARE

An automobile engine is a combination of many of the following surfaces:

- Machined
- Honed
- Polished
- Lapped

The tolerances of these surfaces are measured in the ten-thousandths of an inch. When you service any internal engine part, cleanliness and care are important. Apply a liberal coating of engine oil to the friction areas during assembly in order to protect and lubricate the surfaces on initial operation. Throughout this section, practice proper cleaning and protection procedures to the machined surfaces and to the friction areas.

CAUTION: Engine damage may result if an abrasive paper, pad, or motorized wire brush is used to clean any engine gasket surfaces.

Whenever you remove the valve train components, keep the components in order. Follow this procedure in order to install the components in the same locations and with the same mating surfaces as when removed.

WARNING: Refer to Battery Disconnect Warning .

Disconnect the negative battery cables before you perform any major work on the engine.

SEPARATING PARTS

In addition to the room temperature vulcanizing (RTV) sealant's sealing capabilities, the RTV sealants may form an adhesive bond between the components. This may make the components difficult to remove or to separate. Pry points have been provided in the components that utilize RTV as the sealing system. Pry points are positioned so they can be used without damaging other vital engine components.

REPLACING ENGINE GASKETS

Special Tools

EN-28410 Gasket Remover

For equivalent regional tools, refer to **Special Tools** .

Gasket Reuse and Applying Sealant

- Do not reuse any gasket unless specified.
- Gaskets that can be reused will be identified in the service procedure.
- Do not apply sealant to any gasket or sealing surface unless specified in the service procedure.

Separating Components

- Use incorporated pry points to separate components using an RTV sealing system.
- Do not try to separate RTV sealed components by prying against other engine components.
- Pry points are positioned so no other vital engine components are damaged when they are used.

Cleaning Gasket Surfaces

- Use care to avoid gouging or scraping the sealing surfaces.
- Use a plastic or wood scraper in order to remove all the sealant from the components.

  Do not use any other method or technique to remove the sealant or the gasket material from a part.

- Do not use abrasive pads, sand paper, or power tools to clean the gasket surfaces.
  - These methods of cleaning can cause damage to the component sealing surfaces.
  - Abrasive pads also produce a fine grit that the oil filter cannot remove from the engine oil.

    This fine grit is an abrasive and can cause internal engine damage.

Assembling Components

- Assemble components using only the sealant, or equivalent, that is specified in the service procedure.
- Sealing surfaces must be clean and free of debris or oil.
- Specific components such as crankshaft oil seals or valve stem oil seals may require lubrication during assembly.
- Components requiring lubrication will be identified in the service procedure.
- Apply only the amount of sealant specified in the service procedure to a component.
- Do not allow the sealant to enter into any blind threaded holes, as the sealant may prevent the fastener

from clamping properly or cause component damage when tightened.

NOTE: **Do not overtighten the fasteners.**

- Tighten the fasteners to the proper specifications.

USE OF ROOM TEMPERATURE VULCANIZING (RTV) AND ANAEROBIC SEALANT

Cleaning Mating Part Surfaces for RTV Joints

RTV sealant depends greatly on adhesion to the mating parts in order to form and maintain a robust sealed joint. As with any adhesion system, proper surface preparation of the bonded parts is extremely important to ensure good adhesion over the life of the product.

CAUTION: **When cleaning the sealing surfaces of engine components, DO NOT use bristle discs, abrasive pads, wire wheels or surface conditioning discs. These types of devices should not be used because they produce a very fine grit that is abrasive and known to cause internal engine damage. The bristle discs and pads are embedded with abrasive material and wear down as they clean, continually exposing fresh abrasive to the surface of the component.**

Abrasive pads, wire wheels and bristle discs can remove enough metal to affect the engine front cover, cylinder head, engine block, oil pan rail, and intake manifold runner surface flatness, which can then result in engine coolant leaks, engine oil leaks and air leaks. It takes about 15 seconds to remove 0.203 mm (0.008 in) of metal with an abrasive pad.

Abrasive pads, wire wheels and bristle discs used with high speed grinders produce airborne debris that can travel throughout the shop contaminating other work being performed outside of the immediate work area.

When cleaning engine gasket sealing surfaces and/or cleaning parts from an engine that are to be reused, surface conditioning discs, typically constructed of woven fiber or molded bristles that contain abrasives, such as a high amount of aluminum oxide, should NOT be used. The use of such surface conditioning discs dislodges aluminum oxide from the disk and metal component particles, which can lead to premature engine bearing failure. The presence of aluminum oxide in engine oil has been shown to cause premature engine bearing failure. In some cases, this failure occurs in as little as 1,600 km (1,000 mi) or less after the repair has been made.

Surface conditioning discs may grind the component material and embed it into the disc. This can result when more aggressive grinding of the gasket surface takes place.

General Motors strongly recommends using a plastic razor blade, plastic gasket scraper, a wood scraper or a non-metallic scraper to remove all sealer/gasket material on the surface of engine components that are to be reused. Do not use any other method or technique to remove the sealant or the gasket material from a part.

- Do not gouge or scratch any engine sealing surface during the cleaning process.
- It is not necessary to remove every speck of the old sealer.

To remove the old RTV sealant from the sealing surface, spray GM Low VOC Cleaner or an equivalent, on the mating surfaces and allow it to soak to loosen the old gasket material. Use care to avoid getting GM Low VOC Cleaner in any area other than the mating surface to be cleaned.

Use a plastic razor blade, that mounts in a scraper device or a hand held plastic razor blade, to remove old RTV sealant from a sealing surface. Use a new blade for each corresponding engine component surface. Hold the blade as parallel to the flat surface as possible.

To properly clean the sealing surfaces prior to reassembly, spray GM Low VOC Cleaner on a folded lint free shop cloth. Wipe the mating surfaces on the engine and front cover and rotate the shop cloth until there are no more visible signs of contamination on the cloth.

After the final cleaning of the parts, allow up to 5 minutes for the components to dry before applying new RTV sealant.

NOTE: **After the final cleaning with GM Low VOC Cleaner and before reassembly, DO NOT touch the cleaned surfaces with your hand. Oils from your skin WILL CONTAMINATE the surface and prevent proper bonding of the new RTV sealant.**

Typical Applications

This procedure is intended for use in the following operations:

- Building of engines in a manual low volume build process where the use of assembly lubricants and other typical conditions exist which may contaminate the component sealing surfaces in an RTV joint.
- Cleaning of surfaces contaminated with oil or other substance during the assembly operation as a special case event.

In the typical situation, both the part being assembled, and the assembly to which it is to be sealed will be cleaned. An example is an oil pan assembled to a block/front cover/rear cover assembly using an RTV seal applied to the pan or the block. Both the pan and the block assembly should be cleaned prior to RTV application.

Any loose gaskets that are part of the RTV joint should not be cleaned unless it is known that they have been contaminated during the build process. Examples of loose gaskets are intake side and end seals which contact RTV used to seal a T-joint.

Assemblies supplied to GM with gaskets in place should not be cleaned unless they are known to be contaminated during the build process. Examples are rocker/cam covers with press in place gaskets using RTV at corners or T-joints.

Materials Needed

Use clean dry lint free cloths to wipe surface with approved solvent based cleaner. Examples are:

- GM Good Wrench Service Low VOC Brake Parts Cleaner
- AC Delco Non-Chlorinated Brake Parts Cleaner
- Loctite ODC -Free Cleaner & Degreaser

Procedure:

1. Identify the surfaces to which the RTV will come into contact in the assembled joint.
2. Using an approved solvent based cleaner, thoroughly soak an appropriate portion of a clean, dry cloth.

Immediately wipe the surfaces with the cloth to remove any residue of oil, soap, etc.

3. Repeat step 2 using a clean portion of the cloth as many times as required until the cleanliness of the cloth after wiping the surface becomes constant in appearance. There is typically some discoloration of the cloth after wiping however a clean surface should produce the same level of discoloration with successive wiping with a clean cloth and solvent.
4. If crevices exist in the joint such that wiping the surface would not be sufficient to clean the crevice, the approved solvent based cleaner should be directly sprayed on the joint to ensure wetting of the surfaces and removal of the contaminant. DO NOT spray rubber components directly. Care must be used to avoid getting solvent in areas other than necessary to clean the joint. Then continue with step 3.
5. Allow the surfaces to dry for a minimum of 1 minute or longer if necessary for the solvent to evaporate from the surface.
6. Do not touch the cleaned surface with anything prior to RTV application.
7. The surface is now prepared for RTV application.

Sealant Types

NOTE: **The correct sealant and amount of sealant must be used in the proper location to prevent oil leaks, coolant leaks, or the loosening of the fasteners. DO NOT interchange the sealants. Use only the sealant, or equivalent, as specified in the service procedure.**

The following two major types of sealant are commonly used in engines:

- Room Temperature Vulcanizing (RTV)
- Anaerobic sealant, which include the following:
  - Gasket Eliminator
  - Pipe Sealant
  - Threadlock

Room Temperature Vulcanizing (RTV) Sealer

This type of sealant is used where two components, such as the intake manifold and the engine block, are assembled together.

Use the following information when using RTV sealant:

- Do not use RTV sealant in areas where extreme temperatures are expected. These areas include:
  - The exhaust manifold
  - The head gasket
  - Any other surfaces where a different type of sealant is specified in the service procedure
- Do not use RTV sealant unless the ambient air temperature is at least 18Â°C (65Â°F) degrees or higher.
- Always follow all the safety recommendations and the directions that are on the RTV sealant container.
- Use a plastic or wood scraper in order to remove all the RTV sealant from the components.

CAUTION: **Do not allow the RTV sealant to enter any blind threaded hole. RTV sealant**

that is allowed to enter a blind threaded hole can cause hydraulic lock of the fastener when the fastener is tightened. Hydraulic lock of a fastener can lead to damage to the fastener and/or the components. Hydraulic lock of a fastener can also prevent the proper clamping loads to be obtained when the fastener is tightened. Improper clamping loads can prevent proper sealing of the components allowing leakage to occur. Preventing proper fastener tightening can allow the components to loosen or separate leading to extensive engine damage.

NOTE: **The bead size is critical and is easier to maintain consistency and application with a RTV dispensing tool. This also helps to eliminate waste.**

- The surfaces to be sealed must be clean and dry.
- Use a RTV sealant bead size as specified in the service procedure.
- Apply the RTV sealant bead to the inside of any bolt holes areas.

NOTE: **Do not wait for the RTV sealant to skin over.**

- Assemble the components while the RTV sealant is still wet to the touch, within 10 minutes.

NOTE: **Do not overtighten the fasteners.**

- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Anaerobic Type Gasket Eliminator Sealant

Anaerobic type gasket eliminator sealant cures in the absence of air. This type of sealant is used where two rigid parts, such as castings, are assembled together. When two rigid parts are disassembled and no sealant or gasket is readily noticeable, then the two parts were probably assembled using an anaerobic type gasket eliminator sealant.

Use the following information when using gasket eliminator sealant:

- Always follow all the safety recommendations and directions that are on the gasket eliminator sealant container.
- Apply a continuous bead of gasket eliminator sealant to one flange.
- The surfaces to be sealed must be clean and dry.

CAUTION: **Do not allow the sealant to enter a blind hole. The sealant may prevent the fastener from achieving proper clamp load, cause component damage when the fastener is tightened, or lead to component failure.**

- Do not allow the gasket eliminator sealed joint to cure more than 5 minutes before torquing to specification. This will result in an incorrect clamp load of assembled components.
- Do not overtighten the fasteners.
    - Apply the gasket eliminator sealant evenly to get a uniform thickness of the gasket eliminator sealant on the sealing surface.

- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.
- After properly tightening the fasteners, remove the excess gasket eliminator sealant from the outside of the joint.

Anaerobic Type Threadlock Sealant

Anaerobic type threadlock sealant cures in the absence of air. This type of sealant is used for threadlocking and sealing of bolts, fittings, nuts, and studs. This type of sealant cures only when confined between two close fitting metal surfaces.

Use the following information when using threadlock sealant:

- Always follow all safety recommendations and directions that are on the threadlock sealant container.
- The threaded surfaces to be sealed must be clean and dry.
- Apply the threadlock sealant as specified on the threadlock sealant container.

NOTE:

- **Do not allow the threadlock sealant to cure more than 5 minutes before torquing to specification. This will result in an incorrect clamp load of assembled components.**
- **Do not overtighten the fasteners.**

- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

Anaerobic Type Pipe Sealant

Anaerobic type pipe sealant cures in the absence of air and remains pliable when cured. This type of sealant is used where two parts are assembled together and require a leak proof joint.

Use the following information when using pipe sealant:

- Do not use pipe sealant in areas where extreme temperatures are expected. These areas include:
  - The exhaust manifold
  - The head gasket
  - Surfaces where a different sealant is specified
- Always follow all the safety recommendations and the directions that are on the pipe sealant container.
- The surfaces to be sealed must be clean and dry.
- Use a pipe sealant bead of the size or quantity as specified in the service procedure.

CAUTION: **Do not allow the sealant to enter a blind hole. The sealant may prevent the fastener from achieving proper clamp load, cause component damage when the fastener is tightened, or lead to component failure.**

- Apply the pipe sealant bead to the inside of any bolt hole areas.
- Apply a continuous bead of pipe sealant to one sealing surface.

NOTE: **Do not overtighten the fasteners.**

- Tighten the fasteners in sequence, if specified, and to the proper torque specifications.

TOOLS AND EQUIPMENT

- Special tools are listed and illustrated throughout this section, with a complete listing at the end of the section. These tools, or their equivalents, are designed to quickly and safely accomplish the operations for which they are intended. The use of these special tools also minimize possible damage to engine components. Some precision measuring tools are required for inspection of certain critical components. Torque wrenches and a torque angle meter are necessary for the proper tightening of various fasteners.
- To properly service the engine assembly, the following items should be readily available:
  - Approved eye protection and safety gloves
  - A clean, well-lit, work area
  - A suitable component cleaning tank
  - A compressed air supply
  - Trays or storage containers to keep components and fasteners organized
  - An adequate set of hand tools
  - Approved engine repair stand
  - An approved engine lifting device that adequately supports the weight of the components

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DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - ENGINE MECHANICAL

Strategy Based Diagnostics

1. Perform a **Diagnostic System Check - Vehicle** before using the symptom tables, if applicable.
2. Review the system operations in order to familiarize yourself with the system functions. Refer to **Disassembled Views** , **Engine Component Description (LFX)** , **Drive Belt System Description** , and **Lubrication Description** .

All diagnosis on a vehicle should follow a logical process. Strategy based diagnostics is a uniform approach for repairing all systems. The diagnostic flow may always be used in order to resolve a system problem. The diagnostic flow is the place to start when repairs are necessary. For a detailed explanation, refer to **Strategy Based Diagnosis** .

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the engine. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Check for the correct oil level, proper oil viscosity, and correct filter application.
- Verify the exact operating conditions under which the concern exists. Note factors such as engine RPM, ambient temperature, engine temperature, amount of engine warm-up time, and other specifics.
- Compare the engine sounds, if applicable, to a known good engine and make sure you are not trying to correct a normal condition.

Intermittent

Test the vehicle under the same conditions that the customer reported in order to verify the system is operating properly.

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Base Engine Misfire without Internal Engine Noises**
- **Base Engine Misfire with Abnormal Internal Lower Engine Noises**
- **Base Engine Misfire with Abnormal Valve Train Noise**
- **Base Engine Misfire with Coolant Consumption**
- **Base Engine Misfire with Excessive Oil Consumption**
- **Engine Noise on Start-Up, but Only Lasting a Few Seconds**

- **Upper Engine Noise, Regardless of Engine Speed**
- **Lower Engine Noise, Regardless of Engine Speed**
- **Engine Noise Under Load**
- **Engine Will Not Crank - Crankshaft Will Not Rotate**
- **Engine Compression Test**
- **Oil Consumption Diagnosis**
- **Oil Pressure Diagnosis and Testing**
- **Oil Leak Diagnosis**

BASE ENGINE MISFIRE WITHOUT INTERNAL ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps, or missing areas, in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations and lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to **Drive Belt Replacement** .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout and may lead to a misfire DTC. A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the flywheel and/or balancer as required. Refer to **Automatic Transmission Flex Plate Replacement** , or **Crankshaft Balancer Replacement** .
Restricted exhaust system A severe restriction in the exhaust flow can cause significant loss of engine performance and may set a DTC. Possible causes of restrictions include collapsed or dented pipes or plugged mufflers and/or catalytic converters.	Repair or replace as required.
Improperly installed or damaged vacuum hoses	Repair or replace as required.
Improper sealing between the intake manifold and cylinder heads, intake manifold and plenum duct, plenum duct and water crossover, water crossover and throttle body and/or pressure relief valve and intake manifold.	Replace the intake manifold, plenum duct, gaskets, cylinder heads, throttle body and/or pressure relief valve as required.
Improperly installed or damaged MAP sensor and/or seal The sealing grommet of the MAP sensor should not be torn or damaged.	Repair or replace the MAP sensor as required.
Improperly installed or damaged EVAP purge solenoid and/or O-ring seal	Repair or replace the EVAP purge solenoid as required.

Cause	Correction
Worn or loose followers, valve rocker arms The follower, valve rocker arm, roller bearing should be intact and in the proper position.	Replace the followers, valve rocker arms, as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain or chains	Replace the timing chain or chains and sprockets as required.
Worn camshaft lobes	Replace the camshaft or camshafts and SHLAs (valve lifters).
Excessive oil pressure A lubrication system with excessive oil pressure may lead to excessive valve lifter pump-up and loss of compression.	• Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. • Repair or replace the oil pump as required.
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to **Diagnostic Starting Point - Vehicle** . Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. Refer to **Spark Plug Inspection** for the 3.6L engine. • Inspect the cylinder heads, engine block, and/or head gaskets. • Repair or replace as required.
Worn Piston Rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** for the 3.6L engine. • Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. • Perform cylinder leak down and compression testing to identify the cause. • Repair or replace as required.
A damaged crankshaft reluctor wheel A damaged crankshaft reluctor wheel can result in different symptoms depending on the severity and location of the damage. • Systems with SEVERE reluctor ring damage may exhibit periodic loss of crankshaft position, stop delivering a signal, and then re-sync the crankshaft position. • Systems with SLIGHT reluctor ring damage may exhibit no loss of crankshaft position and no misfire may occur. However, a P0300 DTC may be set.	Replace the crankshaft as required.

BASE ENGINE MISFIRE WITH ABNORMAL INTERNAL LOWER ENGINE NOISES

Cause	Correction
Abnormalities, severe cracking, bumps or missing areas, in the accessory drive belt Abnormalities in the accessory drive system and/or components may cause engine RPM variations, noises similar to a faulty lower engine and also lead to a misfire condition. A misfire code may be present without an actual misfire condition.	Replace the drive belt. Refer to **Drive Belt Replacement** .
Worn, damaged, or mis-aligned accessory drive components or excessive pulley runout A misfire code may be present without an actual misfire condition.	Inspect the components, repair or replace as required.
Loose or improperly installed engine flywheel or crankshaft balancer A misfire code may be present without an actual misfire condition.	Repair or replace the engine flywheel and/or crankshaft balancer as required. Refer to **Automatic Transmission Flex Plate Replacement** , or **Crankshaft Balancer Replacement** .
Worn or broken piston rings Oil consumption may or may not cause the engine to misfire.	• Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . • Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. • Perform cylinder leak down and compression testing to determine the cause. • Repair or replace as required.
Worn crankshaft thrust bearings Severely worn thrust surfaces on the crankshaft and/or thrust bearing may permit fore and aft movement of the crankshaft and create a DTC without an actual misfire condition.	Replace the crankshaft and bearings as required.

BASE ENGINE MISFIRE WITH ABNORMAL VALVE TRAIN NOISE

Cause	Correction
Worn or loose followers, valve rocker arms The follower, valve rocker arm, roller bearing should be intact and in the proper position.	Replace the followers, valve rocker arms, as required.
Stuck valves Carbon buildup on the valve stem can cause the valve not to close properly.	Repair or replace as required.
Excessively worn or mis-aligned timing chain or chains	Replace the timing chain or chains and sprockets as required.
Worn camshaft lobes	Replace the camshaft or camshafts and SHLAs (valve lifters).

Cause	Correction
Sticking SHLAs (lifters)	Replace the SHLAs as required.

BASE ENGINE MISFIRE WITH COOLANT CONSUMPTION

Cause	Correction
Faulty cylinder head gaskets and/or cracking or other damage to the cylinder heads and engine block cooling system passages. Refer to **Diagnostic Starting Point - Vehicle** . Coolant consumption may or may not cause the engine to overheat.	• Inspect for spark plugs saturated by coolant. Refer to **Spark Plug Inspection** for the 3.6L engine. • Perform a cylinder leak down test. • Inspect the cylinder heads and engine block for damage to the coolant passages and/or a faulty head gasket. • Repair or replace as required.

BASE ENGINE MISFIRE WITH EXCESSIVE OIL CONSUMPTION

Cause	Correction
Worn valves, valve guides and/or valve stem oil seals	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Repair or replace as required.
Worn piston rings Oil consumption may or may not cause the engine to misfire.	1. Inspect the spark plugs for oil deposits. Refer to **Spark Plug Inspection** . 2. Inspect the cylinders for a loss of compression. Refer to **Engine Compression Test**. 3. Perform cylinder leak down and compression testing to determine the cause. 4. Repair or replace as required.

ENGINE NOISE ON START-UP, BUT ONLY LASTING A FEW SECONDS

Cause	Correction
Incorrect oil filter without anti-drainback feature	Install the correct oil filter.
Incorrect oil viscosity	Drain the engine oil and replace with the correct viscosity oil.
High stationary hydraulic lash adjuster (SHLA), valve lifter, leak down rate	Replace the SHLAs, valve lifters, as required.
Worn crankshaft thrust bearing	• Inspect the thrust bearing and crankshaft. • Repair or replace as required.

Cause	Correction
Damaged or faulty oil filter by-pass valve	• Inspect the oil filter by-pass valve for proper operation. • Repair or replace as required.
Malfunctioning camshaft position actuators - improper oil viscosity or contamination.	Isolate the noise to a specific camshaft position actuator. Disconnect the electrical connector on the camshaft position actuator solenoid valves and start the vehicle. If noise is gone, repeat procedure to limit to an individual actuator. Refer to **Camshaft Position Actuator Replacement - Bank 1** , or **Camshaft Position Actuator Replacement - Bank 2** .

UPPER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace as required.
Loose and/or worn follower, valve rocker arm	1. Inspect the follower, valve rocker arm. 2. Repair or replace as required.
Improper lubrication to the followers, valve rocker arms	Inspect the following components, and repair or replace as required: • The follower, valve rocker arm • The SHLA, valve lifter • The oil filter bypass valve • The oil pump and pump screen • The cylinder head oil galleries • The engine block oil galleries
Broken valve spring	Replace the valve spring.
Worn or dirty stationary hydraulic lash adjusters (SHLAs), valve lifters	Replace the SHLAs, valve lifters.
Stretched or broken timing chain or chains and/or damaged sprocket teeth	Replace the timing chain or chains and sprockets.
Worn timing chain tensioner or tensioners	Replace the timing chain tensioner or tensioners as required.
Worn timing chain shoe or shoes	Replace the timing chain shoe or shoes as required.
Worn timing chain guide or guides	Replace the timing chain guide or guides as required.

Cause	Correction
Worn engine camshaft lobes	1. Inspect the engine camshaft lobes. 2. Replace the camshaft or camshafts and SHLAs, valve lifters, as required.
Worn valve guides or valve stems	Inspect the following components, and repair as required: • The valves • The valve guides
• Stuck valves • Carbon on the valve stem or valve seat may cause the valve to stay open	Inspect the following components, and repair as required: • The valves • The valve guides

LOWER ENGINE NOISE, REGARDLESS OF ENGINE SPEED

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace damaged components as required.
• Worn accessory drive components • Abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components.	1. Inspect the accessory drive system. 2. Repair or replace as required.
Loose or damaged crankshaft balancer	1. Inspect the crankshaft balancer. 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition controls system. Refer to **Symptoms - Engine Controls** .
Loose torque converter bolts	1. Inspect the torque converter bolts and engine flywheel. 2. Repair or replace as required.
Loose or damaged engine flywheel	Repair or replace the engine flywheel.
• Damaged oil pan, contacting the oil pump screen • An oil pan that has been damaged may	1. Inspect the oil pan. 2. Inspect the oil pump screen. 3. Repair or replace as required.

Cause	Correction
improperly position the oil pump screen, preventing proper oil flow to the oil pump.	
Oil pump screen loose, damaged or restricted	1. Inspect the oil pump screen. 2. Repair or replace as required.
Excessive piston-to-cylinder bore clearance	1. Inspect the piston and cylinder bore. 2. Repair as required.
Excessive piston pin-to-bore clearance	1. Inspect the piston, piston pin, and the connecting rod. 2. Repair or replace as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft • The crankshaft journals
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals
• Incorrect piston, piston pin and connecting rod installation • Pistons must be installed with the mark or dimple on the top of the piston facing the front of the engine. Piston pins must be centered in the connecting rod pin bore.	1. Verify the pistons, piston pins and connecting rods are installed correctly. 2. Repair as required.

ENGINE NOISE UNDER LOAD

Cause	Correction
Low oil pressure	1. Perform an oil pressure test. Refer to **Oil Pressure Diagnosis and Testing**. 2. Repair or replace as required.
Detonation or spark knock	Verify the correct operation of the ignition controls. Refer to **Symptoms - Engine Controls** .

Cause	Correction
Loose torque converter bolts	1. Inspect the torque converter bolts and engine flywheel. 2. Repair as required.
Cracked engine flywheel	1. Inspect the engine flywheel and bolts. 2. Repair as required.
Excessive connecting rod bearing clearance	Inspect the following components, and repair as required: • The connecting rod bearings • The connecting rods • The crankshaft
Excessive crankshaft bearing clearance	Inspect the following components, and repair as required: • The crankshaft bearings • The crankshaft journals • The cylinder block crankshaft bearing bore

ENGINE WILL NOT CRANK - CRANKSHAFT WILL NOT ROTATE

Cause	Correction
Seized accessory drive system component	1. Remove the accessory drive belt or belts. 2. Rotate the crankshaft by hand at the crankshaft balancer or the engine flywheel location. 3. Repair or replace as required.
Hydraulically locked cylinder • Coolant/antifreeze in cylinder • Oil in cylinder • Fuel in cylinder	1. Remove the spark plugs and check for fluid. 2. Inspect for broken head gasket or gaskets. 3. Inspect for cracked engine block or cylinder head. 4. Inspect for a sticking fuel injector. 5. Repair or replace as required.
Seized automatic transmission torque converter	1. Remove the torque converter bolts. 2. Rotate the crankshaft by hand at the crankshaft balancer or the engine flywheel location.

Cause	Correction
	3. Repair or replace as required.
Material in cylinder • Broken valve • Piston material • Foreign material	1. Inspect the cylinder for damaged components and/or foreign materials. 2. Repair or replace as required.
Seized crankshaft or connecting rod bearings	1. Inspect the crankshaft and the connecting rod bearings. 2. Repair as required.
Bent or broken connecting rod	1. Inspect the connecting rods. 2. Repair as required.
Broken crankshaft	1. Inspect the crankshaft. 2. Repair as required.
Seized or broken camshaft	1. Inspect the camshaft or camshafts. 2. Inspect the cylinder head camshaft journals for damage. 3. Repair as required.
Seized or broken balance shaft	1. Inspect the balance shaft. 2. Inspect the block for damaged balance shaft bearings. 3. Repair as required.
Seized or broken camshaft timing components	1. Inspect the following sprockets: • The crankshaft sprocket • The exhaust sprockets • The intake sprockets 2. Inspect the following chains: • The primary camshaft drive chain • The secondary camshaft drive chains 3. Inspect the following guides: • The lower primary camshaft drive chain guide • The upper primary camshaft drive chain guides 4. Inspect the secondary camshaft drive chain

Cause	Correction
	shoe. 5. Inspect the following tensioners: • The primary camshaft drive chain tensioner • The secondary camshaft drive chain tensioners 6. Repair as required.
Seized or broken valve train components	1. Inspect the followers, rocker arms. 2. Inspect the lifters. 3. Inspect the valves. 4. Inspect the valve springs. 5. Repair as required.

COOLANT IN COMBUSTION CHAMBER

Cause	Correction
DEFINITION: Excessive white smoke and/or coolant type odor coming from the exhaust pipe may indicate coolant in the combustion chamber. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage. **NOTE:** **While not always conclusive, use of hydrocarbon block test kits may reveal hydrocarbons indicating combustion chamber gases in the cooling system. It is important to follow the kit instructions. This is not a substitute for the service information.**	

Cause	Correction
Combustion leak tests are available from a wide variety of aftermarket suppliers. 1. A slower than normal cranking speed may indicate coolant entering the combustion chamber. Refer to **Engine Will Not Crank - Crankshaft Will Not Rotate**. 2. Remove the spark plugs and inspect for spark plugs saturated by coolant or coolant in the cylinder bore. 3. Inspect by performing a **Cylinder Leakage Test**. During this test, excessive air bubbles within the coolant may indicate a faulty gasket or damaged component. 4. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine block, with low compression, may indicate a failed cylinder head gasket. Refer to **Engine Compression Test**.	
Cracked intake manifold or failed gasket	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to **Cylinder Head Cleaning and Inspection** , and **Cylinder Head Replacement - Left Side (LF1, LFW or LFX)** , or **Cylinder Head Replacement - Right Side (LF1, LFW or LFX)** .
Warped cylinder head	Machine the cylinder head to the proper flatness, if applicable and replace the cylinder head gasket. Refer to **Cylinder Head Cleaning and Inspection** .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head or engine block porosity	Replace the components as required.

COOLANT IN ENGINE OIL

Cause	Correction
DEFINITION: Foamy or discolored oil or an engine oil "overfill" condition may indicate coolant entering the engine crankcase. Low coolant levels, an inoperative cooling fan, or a faulty thermostat may lead to an "overtemperature" condition which may cause engine component damage. Contaminated engine oil and oil filter should be changed. 1. Inspect the oil for excessive foaming or an overfill condition. Oil diluted by coolant may not properly lubricate the crankshaft bearings and may lead to component damage. Refer to **Lower Engine Noise, Regardless of Engine Speed**. 2. Inspect by performing a **Cylinder Leakage Test**. During this test, excessive air bubbles within the cooling system may indicate a faulty gasket or damaged component. 3. Inspect by performing a cylinder compression test. Two cylinders "side-by-side" on the engine	

Cause	Correction
block with low compression may indicate a failed cylinder head gasket. Refer to **Engine Compression Test**.	
Faulty external engine oil cooler	Replace the components as required.
Faulty cylinder head gasket	Replace the head gasket and components as required. Refer to **Cylinder Head Cleaning and Inspection** , and **Cylinder Head Replacement - Left Side (LF1, LFW or LFX)** , or **Cylinder Head Replacement - Right Side (LF1, LFW or LFX)** .
Warped cylinder head	Machine the cylinder head to proper flatness, if applicable, and replace the cylinder head gasket. Refer to **Cylinder Head Cleaning and Inspection** .
Cracked cylinder head	Replace the cylinder head and gasket.
Cracked cylinder liner or engine block	Replace the components as required.
Cylinder head, block, or manifold porosity	Replace the components as required.

ENGINE COMPRESSION TEST

Special Tools

EN-39313 Spark Plug Port Adapter

For equivalent regional tools, refer to **Special Tools** .

A compression pressure test of the engine cylinders determines the condition of the piston rings, the valves and the head gaskets.

1. Run the engine until it reaches normal operating temperature. The battery must be at or near full charge. You may wish to connect a battery charger for the duration of the test to maintain an adequate battery level.
2. Turn the engine OFF.
3. Remove the intake manifold cover.
4. Remove the ignition coils and spark plugs from all cylinders. Refer to **Ignition Coil Replacement - Bank 1** , and **Ignition Coil Replacement - Bank 2** .
5. Connect the GDS2 to the vehicle and select "Compression Test". Enabling the Compression Test will disable the fuel pump, fuel injectors, and spark. The throttle body is opened to a Wide Open Throttle (WOT) position. The GDS2 will also automatically control the cranking procedure for many applications. If cranking control is not available use a remote start switch in place of the Starter Relay to control cranking.
6. Measure the engine compression, using the following procedure:
    1. Thread the **EN-39313** adapter into the spark plug hole.
    2. Thread the compression gauge into the **EN-39313** adapter.
    3. Enable cranking via the GDS2 or remote start switch. Record the reading after the cranking cycle completes.

4. When the compression measurement is normal, the compression builds up quickly and evenly to the specified compression on each cylinder.
5. Repeat the compression test for each cylinder.

7. Compare the compression readings from all of the cylinders.
   - The lowest reading should not be less than 70 percent of the highest reading.
   - No cylinder reading should be less than 690 kPa (100 psi).
8. The following are indicators of potential problems:
   - When low compression is caused by the piston rings, compression is low on the first stroke and tends to build up on the following strokes, but does not reach normal. Compression improves considerably with the addition of oil to the cylinder. Use approximately 3 squirts of oil from a plunger-type oiler into the cylinder and replace the gauge and measure again.
   - When low compression is caused by the valves, the measurement is low on the first stroke and does not build up even with the addition of oil.
   - Leaking head gaskets will provide the same results as worn valves but engine coolant may be identified in the crankcase. In addition, a leaking head gasket will give low readings on paired cylinders.
9. Disconnect GDS2 diagnostic tool or remote start switch.
10. Install the spark plugs. Refer to **Spark Plug Replacement** .
11. Install the ignition coils and spark plugs from all cylinders. Refer to **Ignition Coil Replacement - Bank 1** , and **Ignition Coil Replacement - Bank 2** .
12. Install the intake manifold cover.

CYLINDER LEAKAGE TEST

Special Tools

- **EN-35667-A** Cylinder Head Leakdown Tester
- **EN-39313** Spark Plug Port Adapter

For equivalent regional tools, refer to **Special Tools** .

NOTE: **A leakage test may be performed in order to measure cylinder/combustion chamber leakage. High cylinder leakage may indicate one or more of the following:**

- **Worn or burnt valves**
- **Broken valve springs**
- **Stuck valve lifters**
- **Incorrect valve lash/adjustment**
- **Damaged piston**
- **Worn piston rings**
- **Worn or scored cylinder bore**
- **Damaged cylinder head gasket**
- **Cracked or damaged cylinder head**

- **Cracked or damaged engine block**

WARNING: **Refer to Battery Disconnect Warning .**

1. Disconnect the battery ground negative cable.
2. Remove the spark plugs. Refer to **Spark Plug Replacement** .

CAUTION: **Only turn the engine in a CLOCKWISE direction as viewed from the crankshaft balancer. Counterclockwise rotation may result in the timing chain jumping a tooth, causing poor running, DTCs, or severe engine damage.**

3. Rotate the crankshaft to place the piston in the cylinder being tested at top dead center (TDC) of the compression stroke.
4. Thread the **EN-39313** adapter into the spark plug hole.
5. Install the **EN-35667-A** tester or equivalent.

NOTE: **It may be necessary to hold the crankshaft balancer bolt to prevent the engine from rotating.**

6. Apply shop air pressure to the **EN-35667-A** tester and adjust according to the manufacturers instructions.
7. Record the cylinder leakage value. Cylinder leakage that exceeds 25 percent is considered excessive and may require component service. In excessive leakage situations, inspect for the following conditions:
   - Air leakage sounds at the throttle body or air inlet hose that may indicate a worn or burnt intake valve or a broken valve spring
   - Air leakage sounds at the exhaust system tailpipe that may indicate a worn or burnt exhaust valve or a broken valve spring
   - Air leakage sounds from the crankcase, oil level indicator tube, or oil fill tube that may indicate worn piston rings, a damaged piston, a worn or scored cylinder bore, a damaged engine block or a damaged cylinder head
   - Air bubbles in the cooling system may indicate a damaged cylinder head or a damaged cylinder head gasket.
8. Perform the leakage test on the remaining cylinders and record the values.

OIL CONSUMPTION DIAGNOSIS

Checks	Causes
DEFINITION: Excessive oil consumption (not due to leaks) is the use of 0.946 L (1 qt) or more of engine oil within 3 200 km (2,000 mi). The causes of excessive oil consumption may include the following conditions:	
Preliminary	• External oil leaks - Refer to **Oil Leak Diagnosis**. • Incorrect oil level or improper reading of the oil level indicator With the vehicle on a level surface, run the engine for a few

Checks	Causes
	minutes, allow adequate drain down time (2-3 minutes) and check for the correct engine oil level. • Improper oil viscosity Refer to the vehicle owners manual and use the recommended SAE grade and viscosity for the prevailing temperatures. • Continuous high speed driving and/or severe usage • Crankcase ventilation system restrictions or malfunctioning components • Worn valve guides and/or valve stems • Worn, missing or improperly installed valve stem oil seals • Piston rings broken, worn, not seated properly Allow adequate time for the rings to seat. Replace worn piston rings as necessary. • Piston and rings improperly installed or miss-fitted to the cylinder bore

OIL PRESSURE DIAGNOSIS AND TESTING

Special Tools

- **EN-47971** Oil Pressure Gauge Adapter
- **CH-48027** Pressure Gauge

For equivalent regional tools, refer to **Special Tools** .

1. With the vehicle on a level surface, run the vehicle for a few minutes, allow adequate drain down time, 2-3 minutes, and measure the oil level.
2. If required, add the recommended grade engine oil and fill the crankcase until the oil level measures full on the oil level indicator.
3. Run the engine briefly, 10-15 seconds, and verify low or no oil pressure on the vehicle gauge or light.
4. Listen for a noisy valve train or a knocking noise.
5. Inspect for the following conditions:
    - Oil diluted by water or glycol antifreeze
    - Foamy oil

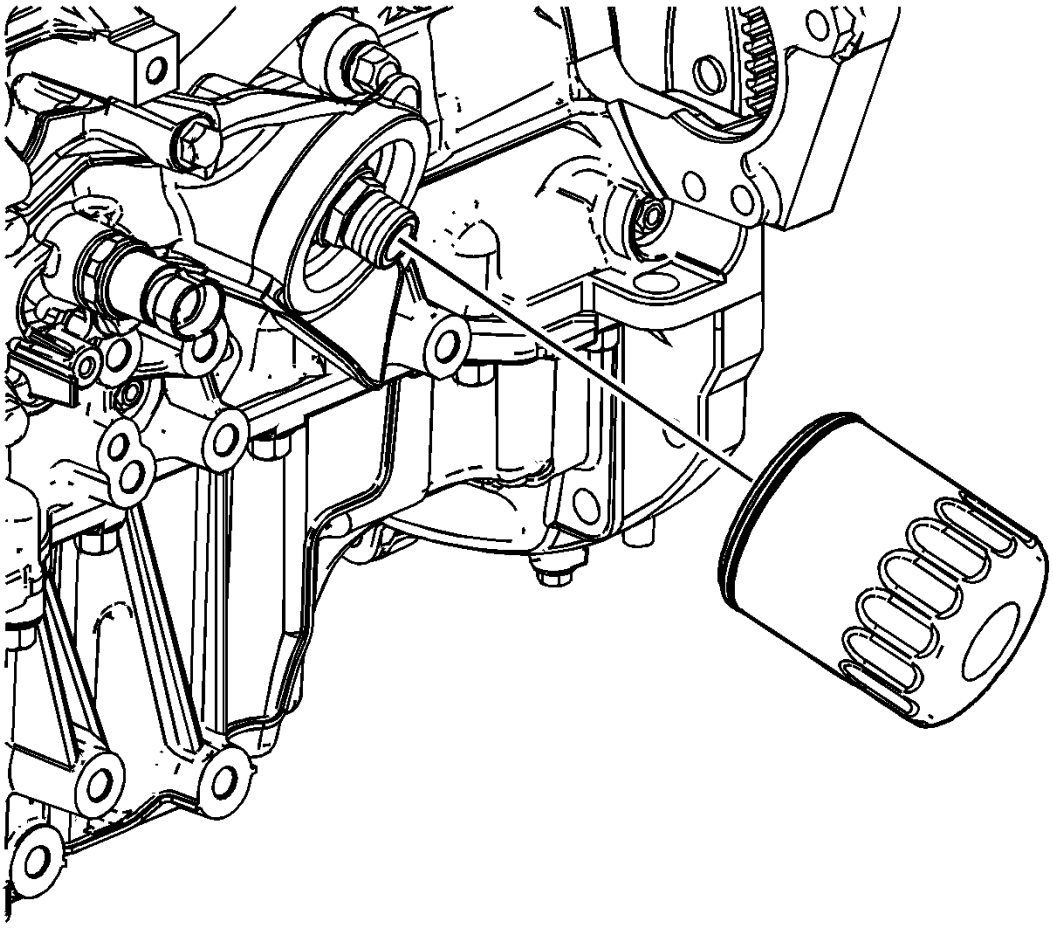

Fig. 1: Identifying Oil Filter
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil filter.

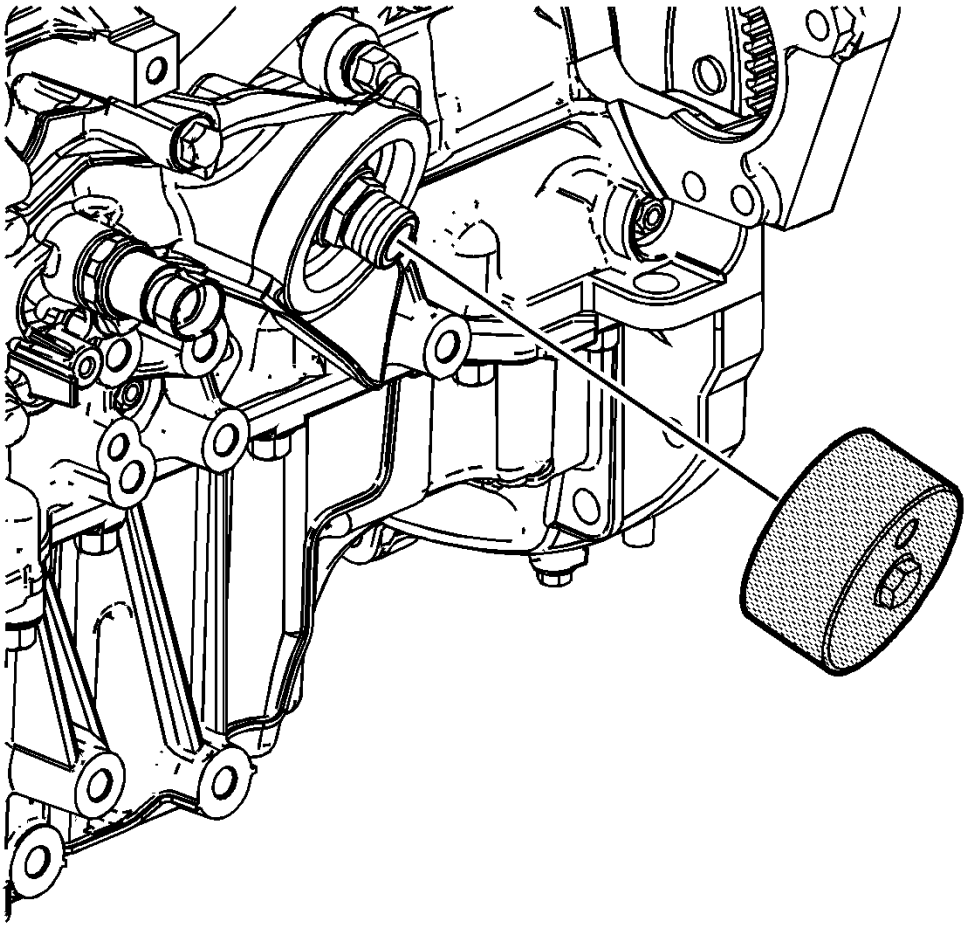

Fig. 2: Oil Pressure Gauge Adapter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Special new tool EN 47971 must be used. Due to the special size and thread pitch of the oil filter adapter fitting ensure the proper tool is used or component damage will result.

7. Install the **EN-47971** adapter onto the oil filter adapter.

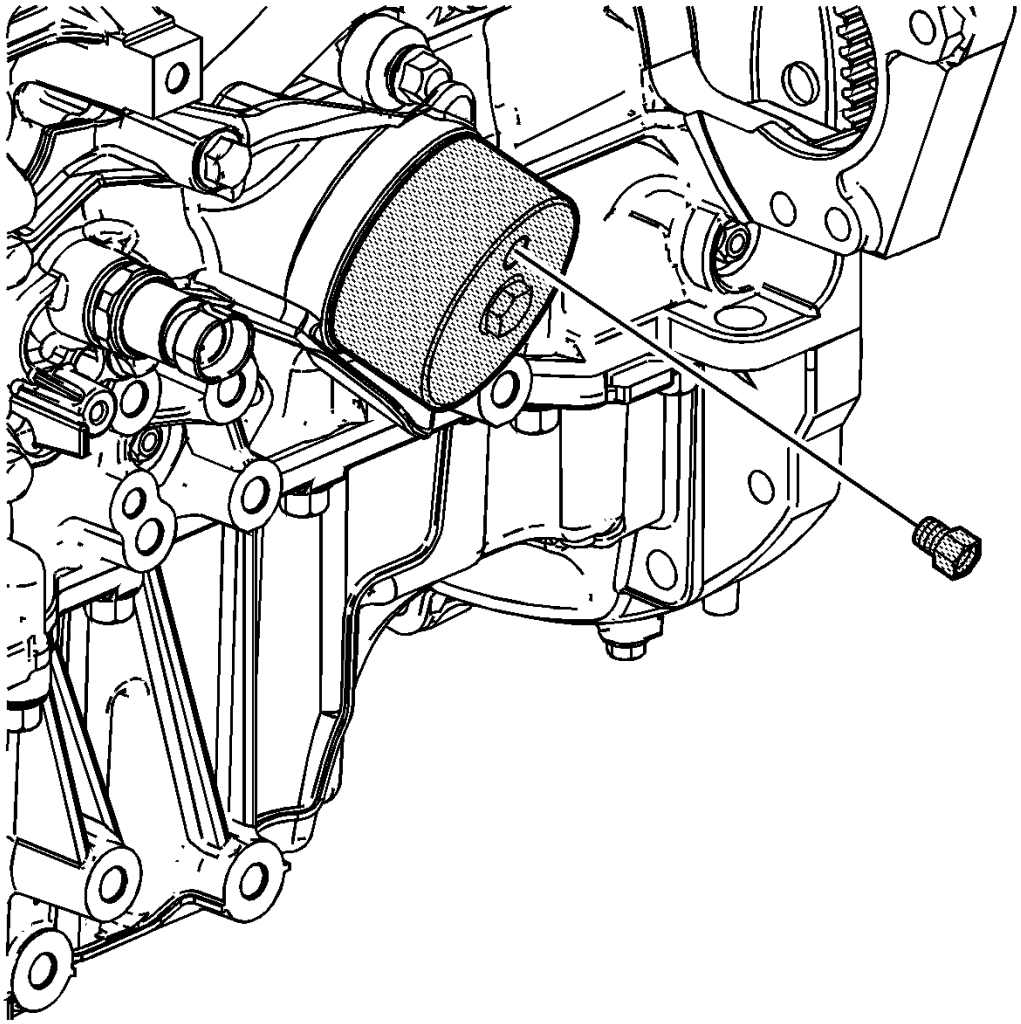

Fig. 3: Oil Pressure gauge Adaptor
Courtesy of GENERAL MOTORS COMPANY

8. Install the 1/8 NPT fitting from the **CH-48027** gauge into the port on the **EN-47971** adapter.

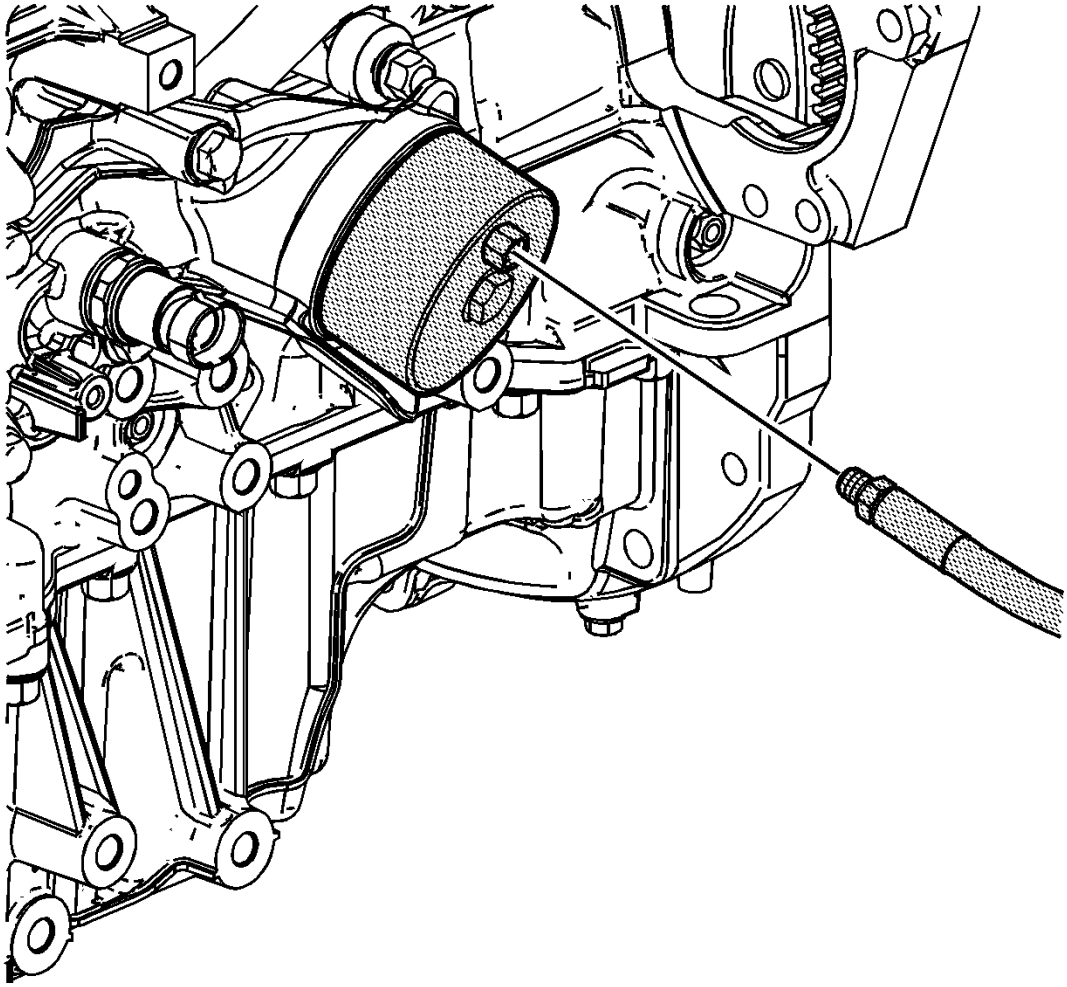

Fig. 4: Oil Pressure Gauge Adapter And Flexible Hose
Courtesy of GENERAL MOTORS COMPANY

9. Install the **CH-48027** gauge flexible hose to the **EN-47971** adapter.
10. Run the engine and measure the engine oil pressure.
11. Compare the readings to **Engine Mechanical Specifications** .
12. If the engine oil pressure is below specifications, inspect the engine for 1 or more of the following conditions:
    - Oil pump worn or dirty. Refer to **Oil Pump Replacement** , **Oil Pump Disassemble** , and **Oil Pump Cleaning and Inspection** .
    - Oil pump-to-engine block bolts loose. Refer to **Oil Pump Replacement** .
    - Oil pump screen loose, plugged, or damaged. Refer to **Oil Pump Suction Pipe and Screen Assembly Replacement** , and **Oil Pump Suction Pipe and Screen Cleaning and Inspection** .
    - Oil pump screen O-ring seal missing or damaged. Refer to **Oil Pump Suction Pipe and Screen Assembly Replacement** , and **Oil Pump Suction Pipe and Screen Cleaning and Inspection** .
    - Oil pump pressure relief valve malfunction. Refer to **Oil Pump Replacement** .
    - Engine bearing clearance excessive. Refer to **Crankshaft and Bearing Cleaning and Inspection** , **Crankshaft and Bearing Installation** , and **Piston, Connecting Rod, and Bearing Installation** .

- Cracked, porous, or restricted oil galleries.
- Oil gallery plugs missing or incorrectly installed. Refer to **Engine Block Assemble** , and **Cylinder Head Assemble (LF1, LFW or LFX)** .
- Valve lifters broken. Repair, as necessary. Refer to **Valve Lifter Replacement - Left Side** , and/or **Valve Lifter Replacement - Right Side** , and **Valve Lifter Cleaning and Inspection** .

CAUTION: This engine uses a special high performance oil filter. Use of any other filter may lead to filter failure and/or severe engine damage.

13. If the oil pressure reading on the **CH-48027** gauge , or equivalent, is within specifications, inspect for the following conditions:
    - Plugged or incorrect oil filter and/or malfunctioning oil bypass valve. Refer to **Engine Oil and Oil Filter Replacement** .
    - Malfunctioning oil pressure gauge or sensor. Repair, as necessary. Refer to **Engine Oil Pressure Sensor and/or Switch Replacement (LFX)** .

OIL LEAK DIAGNOSIS

Checks	Action
CAUTION: It is important to correctly identify the source of an oil leak. A power steering fluid leak or spillage can travel across the valley area of the engine and run out the weep hole, which is located at the back of the block. Failure to correctly identify the source of an oil leak can lead to the incorrect or	

Checks	Action
unnecessary replacement of components. You can repair most fluid leaks by first visually locating the leak, repairing or replacing the component, or by resealing the gasket surface. Once the leak is identified, determine the cause of the leak. Repair the cause of the leak as well as the leak itself.	
Locating and identifying the leak	To determine if the leaking fluid is engine oil, transmission fluid, power steering fluid, brake fluid, or some other fluid, use the visual inspection method.
Visual Inspection Method	1. Bring the vehicle to normal operating temperature. 2. Park the vehicle over a large sheet of paper, or other clean surface. 3. Wait several minutes, then check for drippings. 4. Identify the type of fluid, and the approximate location of the leak. 5. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 6. Check for leaks at sealing surfaces, fittings, or from cracked or damaged components. 7. If you cannot locate the leak, do the following: 1. Completely clean the entire engine and surrounding components. 2. Operate the vehicle for several miles at normal operation temperature and at varying speeds. 3. Park the vehicle over a large sheet of paper, or other clean surface. 4. Wait several minutes, then check for drippings. 5. Identify the type of fluid, and the approximate location of the leak. 6. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 7. See possible causes for leaks. 8. If you still cannot locate the leak, use the powder method or the black light and dye method.
Powder Method	1. Completely clean the entire engine and surrounding components. 2. Apply an aerosol-type powder (baby powder, foot powder, etc.) to the suspected area. 3. Operate the vehicle for several miles at normal operation temperature and at varying speeds.

Checks	Action
	4. Identify the type of fluid, and the approximate location of the leak, from the discolorations in the powder surface. 5. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 6. See possible causes for leaks.
Black Light and Dye Method	1. A dye and light kit is available for finding leaks. Use the **GE 28428-E** High-Intensity Black Light Kit or equivalent. Refer to the manufacturer's instructions when using the tool. 2. Visually inspect the suspected area. Use a small mirror to assist in looking at hard to see areas. 3. See possible causes for leaks.
Possible Causes for Leaks	Check for the following conditions: • Higher than recommended fluid levels • Higher than recommended fluid pressures • Plugged or malfunctioning fluid filters or pressure bypass valves • Plugged or malfunctioning engine ventilation system • Improperly tightened or damaged fasteners • Cracked or porous components • Improper sealants or gaskets where required • Improper sealant or gasket installation • Damaged or worn gaskets or seals • Damaged or worn sealing surfaces

CRANKCASE VENTILATION SYSTEM INSPECTION/DIAGNOSIS

Crankcase Ventilation (CV) System Inspection

- Test for vacuum at the vacuum hose where it connects to the crankcase ventilation housing. There should be manifold vacuum present at the hose. If there is no vacuum, inspect for a plugged hose, leaking hose or a plugged vent adapter.
- Plug the end of the vacuum hose while the engine is running. Inspect the hose for any areas that collapse when the end of the hose is blocked. Replace the hose if it collapses when blocked.
- If oil has accumulated in the intake air duct, inspect for the following conditions:
  - Plugged vacuum orifice in the crankcase ventilation housing
  - Plugged or restricted crankcase ventilation housing
  - Excessive crankcase pressure or blow-by, refer to **Oil Consumption Diagnosis**.
- Additional items to inspect:
  - Plugged or leaking fresh air vent hose assembly or vent adapter

- Plugged or restricted passages in the throttle body
- Missing or damaged O-ring seals on the vent adapter
- Inspect the cam covers, the oil pan gasket, and other sealing areas for leaks

Results of Incorrect Operation

A plugged crankcase ventilation housing or hose may contribute to the following conditions:

- A rough idle
- Stalling or a slow idle speed
- Oil leaks
- Oil accumulation in the intake air duct
- Sludge in the engine

A leaking housing or hose may contribute to the following conditions:

- A rough idle
- Stalling
- Unstable idle speed

DRIVE BELT CHIRPING, SQUEAL, AND WHINE DIAGNOSIS

Diagnostic Aids

- A chirping or squeal noise may be intermittent due to moisture on the drive belts or the pulleys. It may be necessary to spray a small amount of water on the drive belts in order to duplicate the customers concern. If spraying water on the drive belt duplicates the symptom, cleaning the belt pulleys may be the probable solution.
- If the noise is intermittent, verify the accessory drive components by varying their loads making sure they are operated to their maximum capacity. An overcharged A/C system, power steering system with a pinched hose or wrong fluid, or a generator failing are suggested items to inspect.
- A chirping, squeal or whine noise may be caused by a loose or improper installation of a body or suspension component. Other items of the vehicle may also cause the noise.
- The drive belts will not cause a whine noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

The noise may not be engine related. This step is to verify that the engine is making the noise. If the engine is not making the noise do not proceed further with this table.

3

The noise may be an internal engine noise. Removing the drive belts one at a time and operating the engine for a brief period will verify the noise is related to the drive belt. When removing the drive belt the

water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

4

Inspect all drive belt pulleys for pilling. Pilling is the small balls or pills or it can be strings in the drive belt grooves from the accumulation of rubber dust.

6

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

10

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut, spacer, or washer was installed.

12

Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

14

This test is to verify that the drive belt tensioner operates properly. If the drive belt tensioner is not operating properly, proper belt tension may not be achieved to keep the drive belt from slipping which could cause a squeal noise.

15

This test is to verify that the drive belt is not too long, which would prevent the drive belt tensioner from working properly. Also if an incorrect length drive belt was installed, it may not be routed properly and may be turning an accessory drive component in the wrong direction.

16

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure for that pulley.

17

This test is to verify that the pulleys are the correct diameter or width. Using a known good vehicle compare the pulley sizes.

19

Replacing the drive belt when it is not damaged or there is not excessive pilling will only be a temporary repair.

Step	Action	Yes	No
CAUTION: **Refer to Belt Dressing Caution .** DEFINITION: The following items are indications of chirping: • A high pitched noise that is heard once per revolution of the drive belt or a pulley. • Chirping may occur on cold damp start-ups and will subside once the vehicle reaches normal operating temp. DEFINITION: The following items are indications of drive belt squeal: • A loud screeching noise that is caused by a slipping drive belt. This is unusual for a drive belt with multiple ribs. • The noise occurs when a heavy load is applied to the drive belt, such as an air conditioning compressor engagement snapping the throttle, or slipping on a seized pulley or a faulty accessory drive component. DEFINITION: The following items are indications of drive belt whine: • A high pitched continuous noise. • The noise may be caused by an accessory drive component failed bearing.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**
2	Verify that there is a chirping, squeal or whine noise. Does the engine make the chirping squeal or whine noise?	Go to **Step 3**	Go to Diagnostic Aids
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the chirping, squeal or whine noise still exist?	Go to **Symptoms - Engine Mechanical**	Go to **Step 4**

Step	Action	Yes	No
4	If diagnosing a chirping noise, inspect for severe pilling exceeding 1/3 of the belt groove depth. If diagnosing a squeal or whine noise, proceed to step 13. Do the belt grooves have pilling?	Go to **Step 5**	Go to **Step 6**
5	Clean the drive belt pulleys with a suitable wire brush. Did you complete the repair?	Go to **Step 20**	Go to **Step 6**
6	Inspect for misalignment of the pulleys. Are any of the pulleys misaligned?	Go to **Step 7**	Go to **Step 8**
7	Replace or repair any misaligned pulleys. Did you complete the repair?	Go to **Step 20**	Go to **Step 8**
8	Inspect for bent or cracked brackets. Did you find any bent or cracked brackets?	Go to **Step 9**	Go to **Step 10**
9	Replace any bent or cracked brackets. Did you complete the repair?	Go to **Step 20**	Go to **Step 10**
10	Inspect for improper, loose or missing fasteners. Did you find the condition?	Go to **Step 11**	Go to **Step 12**
11	**CAUTION:** **Refer to Fastener Caution .** 1. Tighten any loose fasteners. Refer to **Fastener Specifications** . 2. Replace any improper or missing fasteners. Did you complete the repair?	Go to **Step 20**	Go to **Step 12**
12	Inspect for a bent pulley. Did you find the condition?	Go to **Step 18**	Go to **Step 19**
13	Inspect for an accessory drive component seized bearing or a faulty accessory drive component. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 14**
14	If diagnosing a whine noise and the condition still exist, proceed to Diagnostic Aids. Test the drive belt tensioner for proper operation. Refer to **Drive Belt Tensioner Diagnosis**. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 15**
15	Inspect for the correct drive belt length. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 16**
16	Inspect for misalignment of a pulley. Did you find and correct the condition?	Go to **Step 20**	Go to **Step 17**

Step	Action	Yes	No
17	Inspect for the correct pulley size. Did you find and correct the condition?	Go to **Step 20**	Go to Diagnostic Aids
18	Replace the bent pulley. Did you complete the repair?	Go to **Step 20**	Go to **Step 19**
19	Replace the drive belt. Refer to **Drive Belt Replacement** . Did you complete the repair?	Go to **Step 20**	Go to Diagnostic Aids
20	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

DRIVE BELT RUMBLING AND VIBRATION DIAGNOSIS

Diagnostic Aids

The accessory drive components can have an affect on engine vibration. Vibration from the engine operating may cause a body component or another part of the vehicle to make rumbling noise. Vibration can be caused by, but not limited to the A/C system over charged, the power steering system restricted or the incorrect fluid, or an extra load on the generator. To help identify an intermittent or an improper condition, vary the loads on the accessory drive components.

The drive belt may have a rumbling condition that can not be seen or felt. Sometimes replacing the drive belt may be the only repair for the symptom.

If replacing the drive belt, completing the diagnostic table, and the noise is only heard when the drive belts are installed, there might be an accessory drive component with a failure. Varying the load on the different accessory drive components may aid in identifying which component is causing the rumbling noise.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

This test is to verify that the symptom is present during diagnosing. Other vehicle components may cause a similar symptom.

3

This test is to verify that one of the drive belts is causing the rumbling noise or vibration. Rumbling noise may be confused with an internal engine noise due to the similarity in the description. Remove only one drive belt at a time if the vehicle has multiple drive belts. When removing the drive belts the water pump may not be operating and the engine may overheat. Also DTCs may set when the engine is operating with the drive belts removed.

4

Inspecting the drive belts is to ensure that they are not causing the noise. Small cracks across the ribs of the drive belt will not cause the noise. Belt separation is identified by the plys of the belt separating and may be seen at the edge of the belt our felt as a lump in the belt.

5

Small amounts of pilling is normal condition and acceptable. When the pilling is severe the drive belt does not have a smooth surface for proper operation.

9

Inspecting of the fasteners can eliminate the possibility that the wrong bolt, nut, spacer, or washer was installed.

11

This step should only be performed if the water pump is driven by the drive belt. Inspect the water pump shaft for being bent. Also inspect the water pump bearings for smooth operation and excessive play. Compare the water pump with a known good water pump.

12

Accessory drive component brackets that are bent, cracked, or loose may put extra strain on that accessory component causing it to vibrate.

Step	Action	Yes	No
CAUTION: **Refer to Belt Dressing Caution .** DEFINITION: The following items are indications of drive belt rumbling: • A low pitch tapping, knocking, or thumping noise heard at or just above idle. • Heard once per revolution of the drive belt or a pulley. • Rumbling may be caused from: ◦ Pilling, the accumulation of rubber dust that forms small balls (pills) or strings in the drive belt pulley groove ◦ The separation of the drive belt ◦ A damaged drive belt DEFINITION: The following items are indications of drive belt vibration: • The vibration is engine-speed related. • The vibration may be sensitive to accessory load.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**
2	Verify that there is a rumbling noise or that the vibration is engine related. Does the engine make the rumbling noise or vibration?	Go to **Step 3**	Go to Diagnostic Aids

Step	Action	Yes	No
3	1. Remove the drive belt. If the engine has multiple drive belts, remove the belts one at a time and perform the test below each time a belt is removed. 2. Operate the engine for no longer than 30-40 seconds. 3. Repeat this test if necessary by removing the remaining belt(s). Does the rumbling or vibration still exist?	Go to **Symptoms - Engine Mechanical** or Go to **Vibration Analysis - Engine**	Go to **Step 4**
4	Inspect the drive belts for wear, damage, separation, sections of missing ribs, and debris build-up. Did you find any of these conditions?	Go to **Step 7**	Go to **Step 5**
5	Inspect for severe pilling of more than 1/3 of the drive belt pulley grooves. Did you find severe pilling?	Go to **Step 6**	Go to **Step 7**
6	1. Clean the drive belt pulleys using a suitable wire brush. 2. Reinstall the drive belts. Refer to **Drive Belt Replacement** . Did you correct the condition?	Go to **Step 8**	Go to **Step 7**
7	Install a new drive belt. Refer to **Drive Belt Replacement** . Did you complete the replacement?	Go to **Step 8**	Go to **Step 9**
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 9**
9	Inspect for improper, loose or missing fasteners. Did you find any of these conditions?	Go to **Step 10**	Go to **Step 11**
10	1. Tighten any loose fasteners. Refer to **Fastener Specifications** . 2. Replace improper or missing fasteners. Did you complete the repair?	Go to **Step 13**	Go to **Step 11**
11	Inspect for a bent water pump shaft. Refer to **Water Pump Replacement** . Did you find and correct the condition?	Go to **Step 13**	Go to **Step 12**
12	Inspect for bent or cracked brackets. Did you find and correct the condition?	Go to **Step 13**	Go to Diagnostic Aids
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

DRIVE BELT FALLS OFF AND EXCESSIVE WEAR DIAGNOSIS

Diagnostic Aids

If the drive belt repeatedly falls off the drive belt pulleys, this is because of pulley misalignment.

An extra load that is quickly applied on released by an accessory drive component may cause the drive belt to fall off the pulleys. Verify the accessory drive components operate properly.

If the drive belt is the incorrect length, the drive belt tensioner may not keep the proper tension on the drive belt.

Excessive wear on a drive belt is usually caused by an incorrect installation or the wrong drive belt for the application.

Minor misalignment of the drive belt pulleys will not cause excessive wear, but will probably cause the drive belt to make a noise or to fall off.

Excessive misalignment of the drive belt pulleys will cause excessive wear but may also make the drive belt fall off.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

This inspection is to verify the condition of the drive belt. Damage may of occurred to the drive belt when the drive belt fell off. The drive belt may of been damaged, which caused the drive belt to fall off. Inspect the belt for cuts, tears, sections of ribs missing, or damaged belt plys.

4

Misalignment of the pulleys may be caused from improper mounting of the accessory drive component, incorrect installation of the accessory drive component pulley, or the pulley bent inward or outward from a previous repair. Test for a misaligned pulley using a straight edge in the pulley grooves across two or three pulleys. If a misaligned pulley is found refer to that accessory drive component for the proper installation procedure of that pulley.

5

Inspecting the pulleys for being bent should include inspecting for a dent or other damage to the pulleys that would prevent the drive belt from not seating properly in all of the pulley grooves or on the smooth surface of a pulley when the back side of the belt is used to drive the pulley.

6

Accessory drive component brackets that are bent or cracked will let the drive belt fall off.

7

Inspecting of the fasteners can eliminate the possibility that a wrong bolt, nut , spacer, or washer was installed. Missing. loose, or the wrong fasteners may cause pulley misalignment from the bracket moving

under load. Over tightening of the fasteners may cause misalignment of the accessory component bracket.

13

The inspection is to verify the drive belt is correctly installed on all of the drive belt pulleys. Wear on the drive belt may be caused by mis-positioning the drive belt by one groove on a pulley.

14

The installation of a drive belt that is two wide or two narrow will cause wear on the drive belt. The drive belt ribs should match all of the grooves on all of the pulleys.

15

This inspection is to verify the drive belt is not contacting any parts of the engine or body while the engine is operating. There should be sufficient clearance when the drive belt accessory drive components load varies. The drive belt should not come in contact with an engine or a body component when snapping the throttle.

Step	Action	Yes	No
CAUTION: **Refer to Belt Dressing Caution .** DEFINITION: The drive belt falls off the pulleys or may not ride correctly on the pulleys.DEFINITION: Wear at the outside ribs of the drive belt due to an incorrectly installed drive belt.			
1	Did you review the Drive Belt Symptom operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Engine Mechanical**
2	If diagnosing excessive wear, proceed to step 13. If diagnosing a drive belt that falls off, inspect for a damaged drive belt. Did you find the condition?	Go to **Step 3**	Go to **Step 4**
3	Install a new drive belt. Refer to **Drive Belt Replacement** . Does the drive belt continue to fall off?	Go to **Step 4**	System OK
4	Inspect for misalignment of the pulleys. Did you find and repair the condition?	Go to **Step 12**	Go to **Step 5**
5	Inspect for a bent or dented pulley. Did you find and repair the condition?	Go to **Step 12**	Go to **Step 6**
6	Inspect for a bent or a cracked bracket. Did you find and repair the condition?	Go to **Step 12**	Go to **Step 7**
7	Inspect for improper, loose or missing fasteners. Did you find loose or missing fasteners?	Go to **Step 8**	Go to **Step 9**
8	**CAUTION:**	Go to **Step 9**	System OK

Step	Action	Yes	No
	Refer to Fastener Caution . 1. Tighten any loose fasteners. Refer to **Fastener Specifications** . 2. Replace improper or missing fasteners. Does the drive belt continue to fall off?		
9	Test the drive belt tensioner for operating correctly. Refer to **Drive Belt Tensioner Diagnosis**. Does the drive belt tensioner operate correctly?	Go to **Step 11**	Go to **Step 10**
10	Replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement** . Does the drive belt continue to fall off?	Go to **Step 11**	System OK
11	Inspect for failed drive belt idler and drive belt tensioner pulley bearings. Did you find and repair the condition?	Go to **Step 12**	Go to Diagnostic Aids
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 2**
13	Inspect the drive belt for the proper installation. Refer to **Drive Belt Replacement** . Did you find this condition?	Go to **Step 16**	Go to **Step 14**
14	Inspect for the proper drive belt. Did you find this condition?	Go to **Step 16**	Go to **Step 15**
15	Inspect for the drive belt rubbing against a bracket, hose, or wiring harness. Did you find and repair the condition?	Go to **Step 17**	Go to Diagnostic Aids
16	Replace the drive belt. Refer to **Drive Belt Replacement** . Did you complete the replacement?	Go to **Step 17**	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

DRIVE BELT TENSIONER DIAGNOSIS

Step	Action	Yes	No
1	Remove the drive belt and inspect the drive belt tensioner pulley. Is the drive belt tensioner pulley loose or misaligned?	Go to **Step 4**	Go to **Step 2**
2	Rotate the drive belt tensioner. Does the tensioner rotate without any unusual resistance or binding?	Go to **Step 3**	Go to **Step 4**

.

Step	Action	Yes	No
3	1. Use a torque wrench in order to measure the torque required to move the tensioner off of the stop. 2. Use a torque wrench on a known good tensioner in order to measure the torque required to move the tensioner off of the stop. Is the first torque reading within 10 percent of the second torque reading?	System OK	Go to **Step 4**
4	Replace the drive belt tensioner. Is the repair complete?	System OK	-

Article GUID: A00737164

REPAIR INSTRUCTIONS - OFF VEHICLE

DRIVE BELT TENSIONER REMOVAL

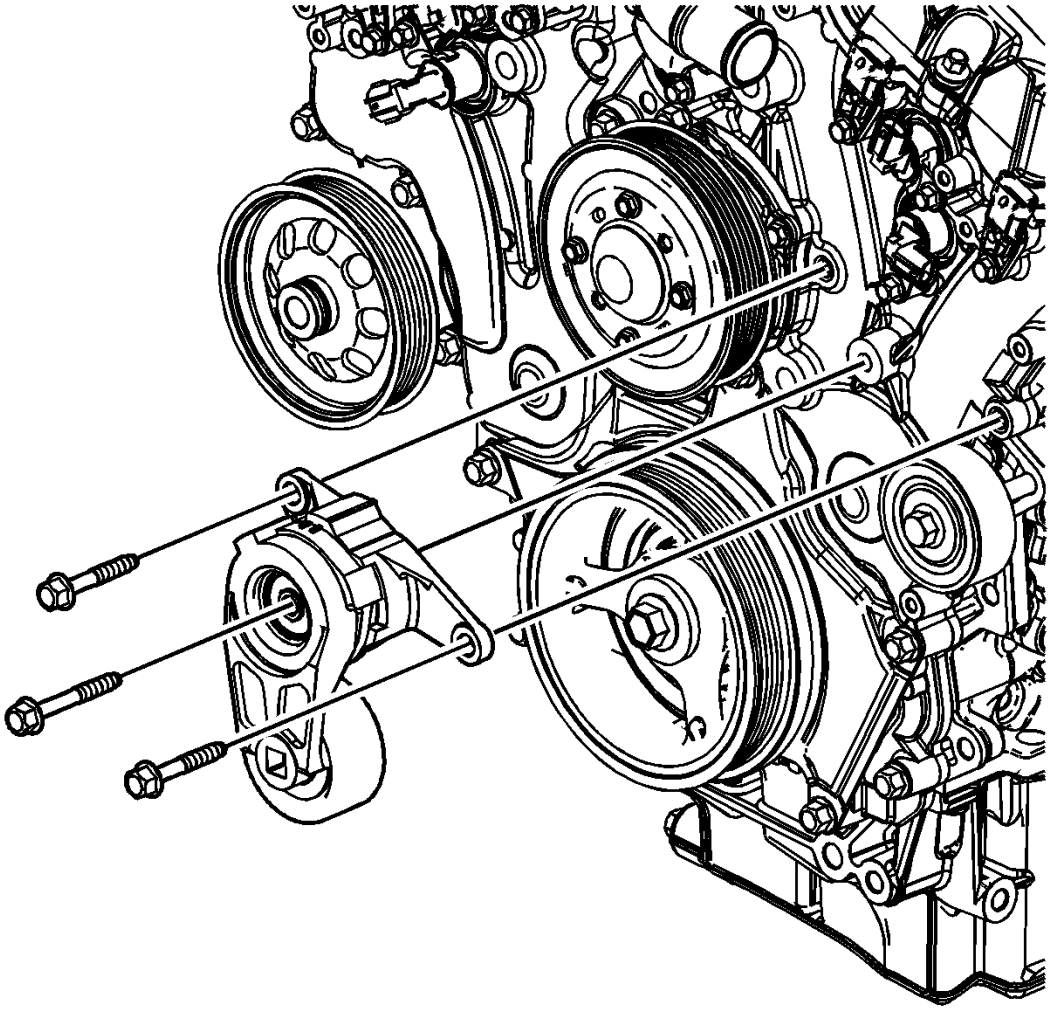

Fig. 1: Locating Drive Belt Tensioner Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the drive belt tensioner bracket bolts.
2. Remove the drive belt tensioner assembly.

OIL LEVEL INDICATOR AND TUBE REMOVAL (LFX)

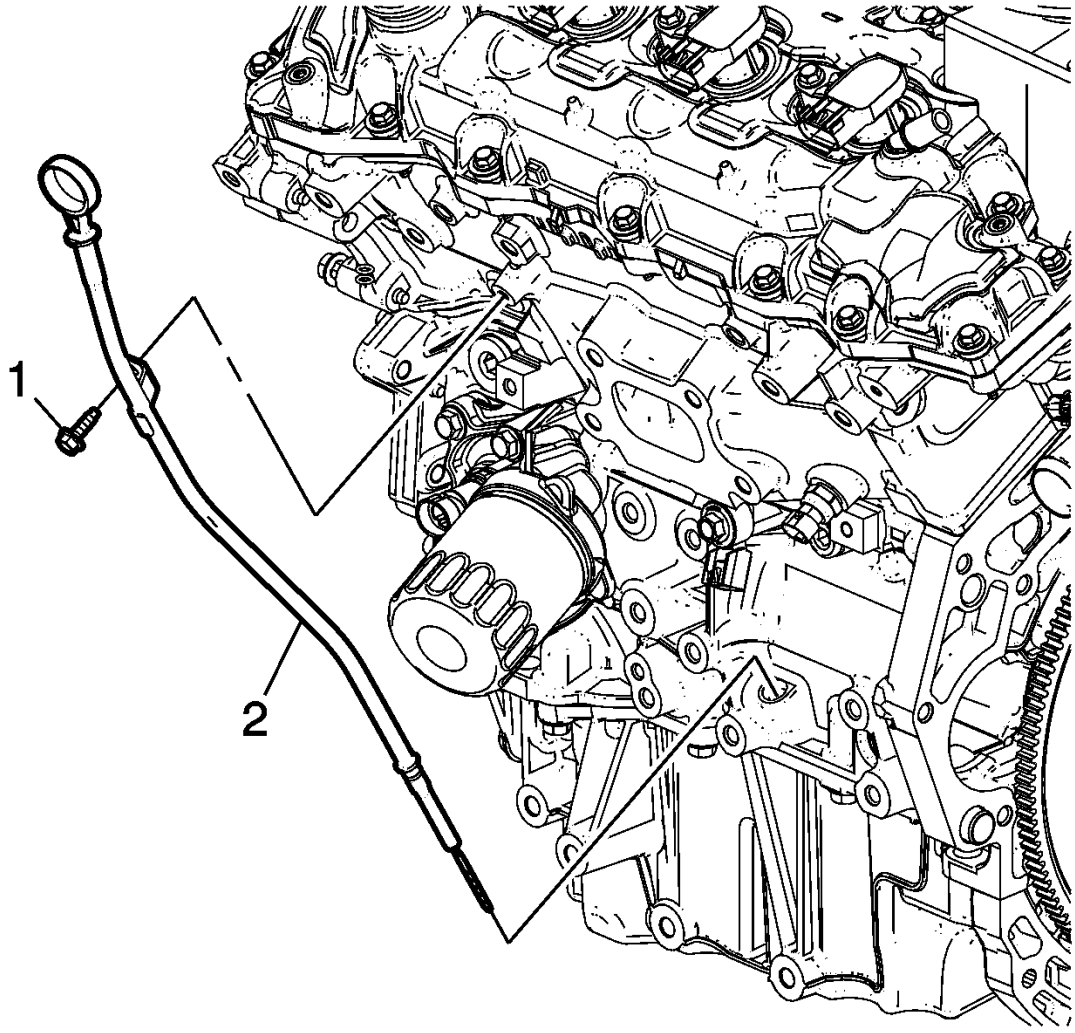

Fig. 2: Oil Level Indicator Tube Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil level indicator tube bracket bolt (1).
2. Remove the oil level indicator and tube (2) by sliding the tube out from the lower crankcase hole.

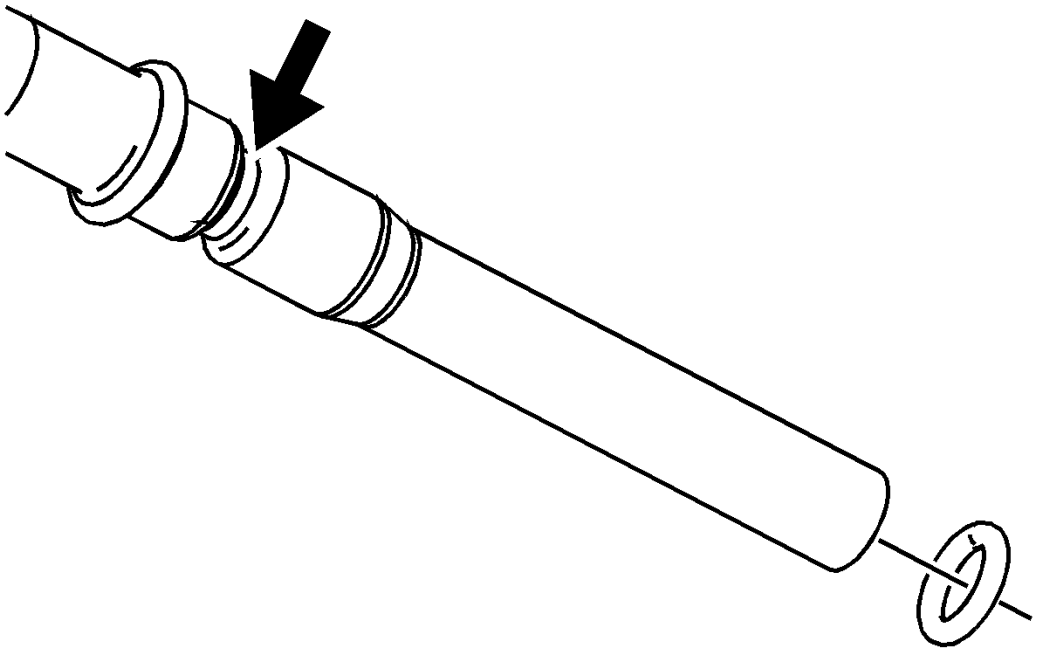

Fig. 3: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the O-ring from the oil level indicator tube if damaged.

OIL FILTER ADAPTER REMOVAL

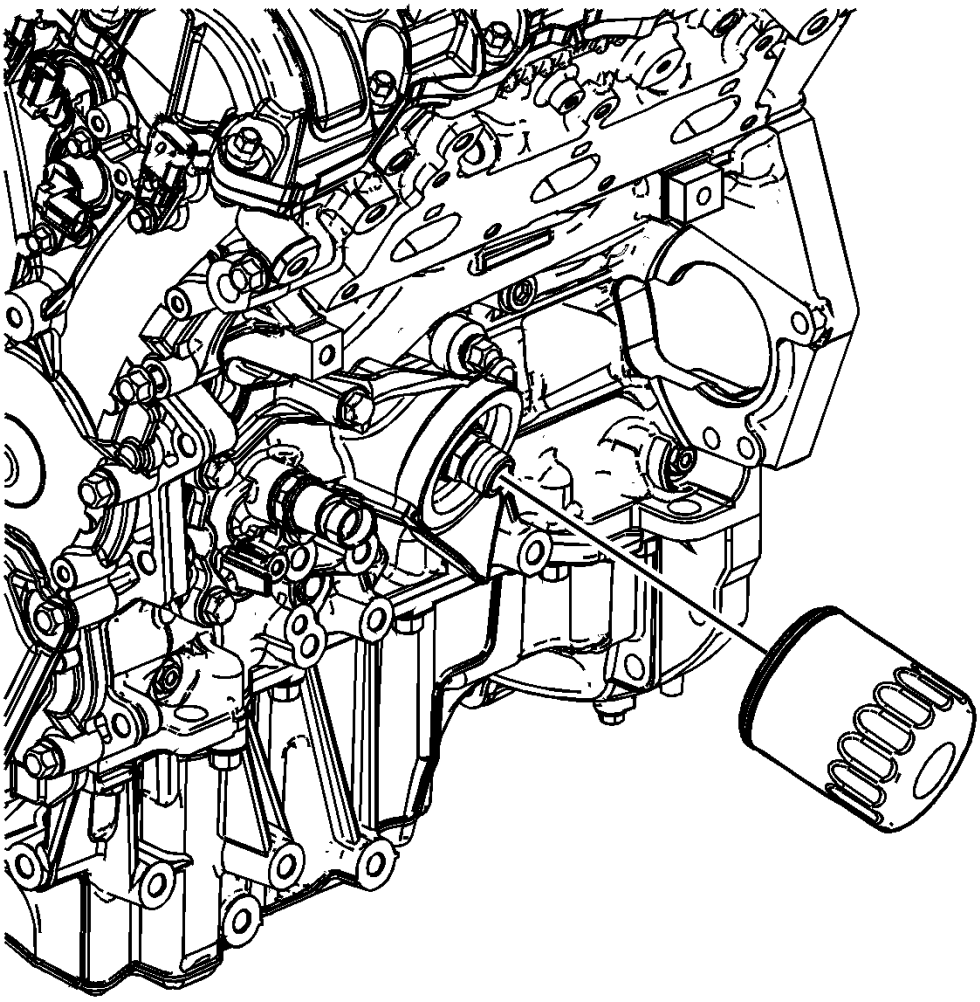

Fig. 4: Identifying Oil Filter
Courtesy of GENERAL MOTORS COMPANY

1. Remove and properly dispose of the oil filter.

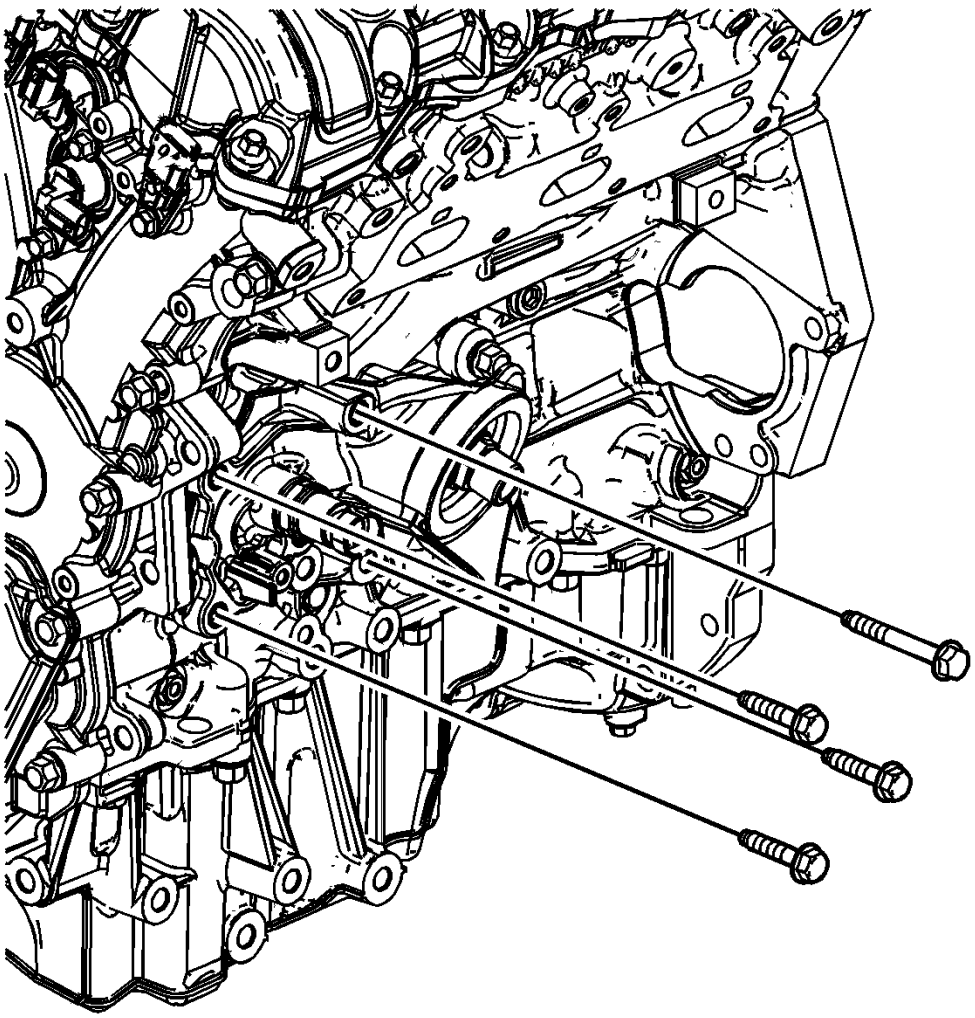

Fig. 5: View Of Oil Filter Adapter Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil filter adapter bolts from the engine block.

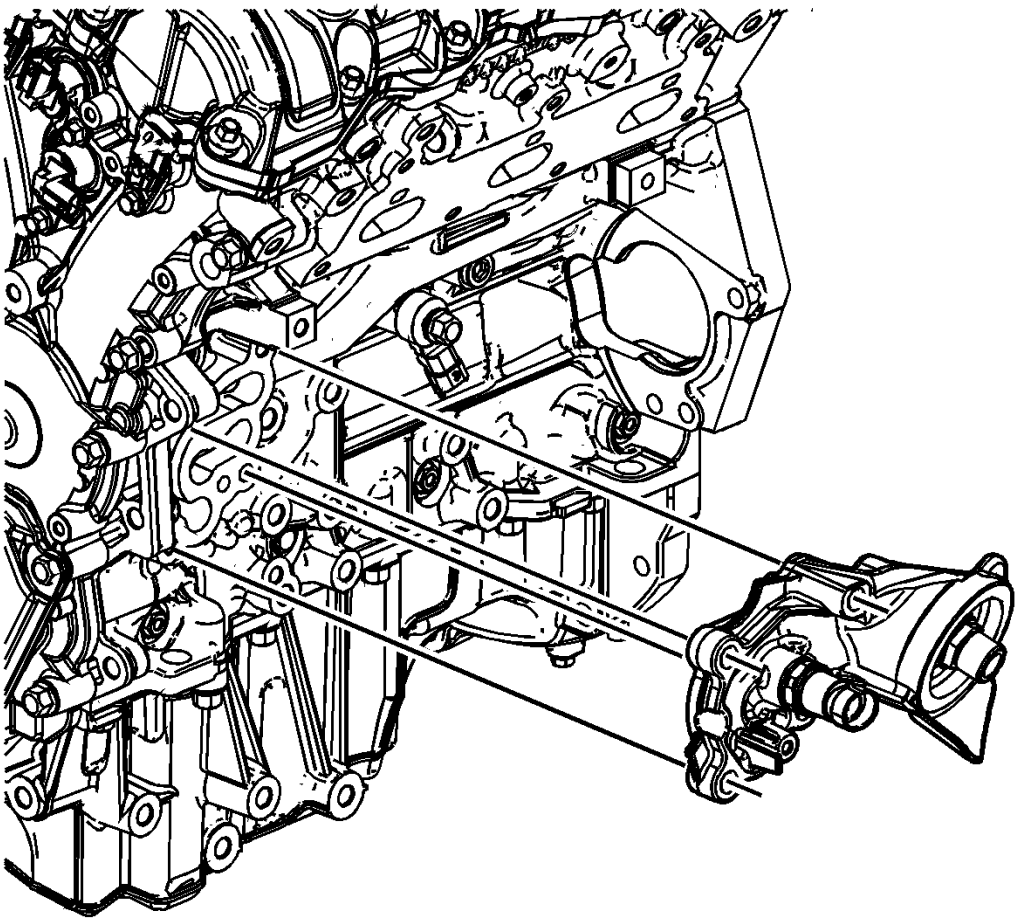

Fig. 6: Removing/Installing Oil Filter Adapter
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil filter adapter.

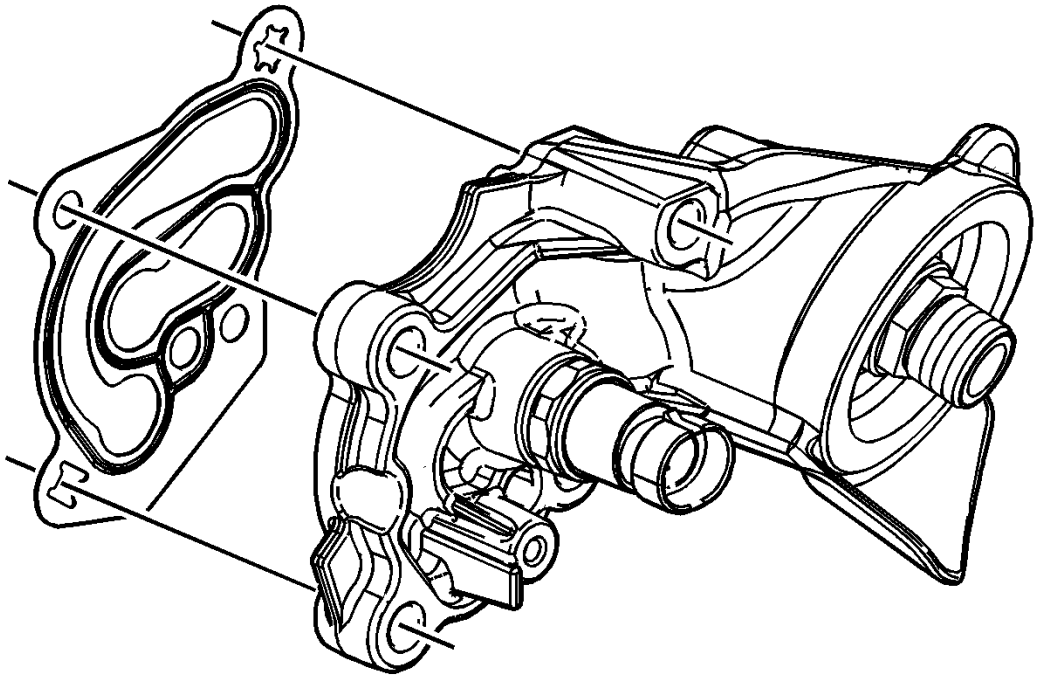

Fig. 7: Identifying Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the oil filter adapter gasket.

INTAKE MANIFOLD REMOVAL

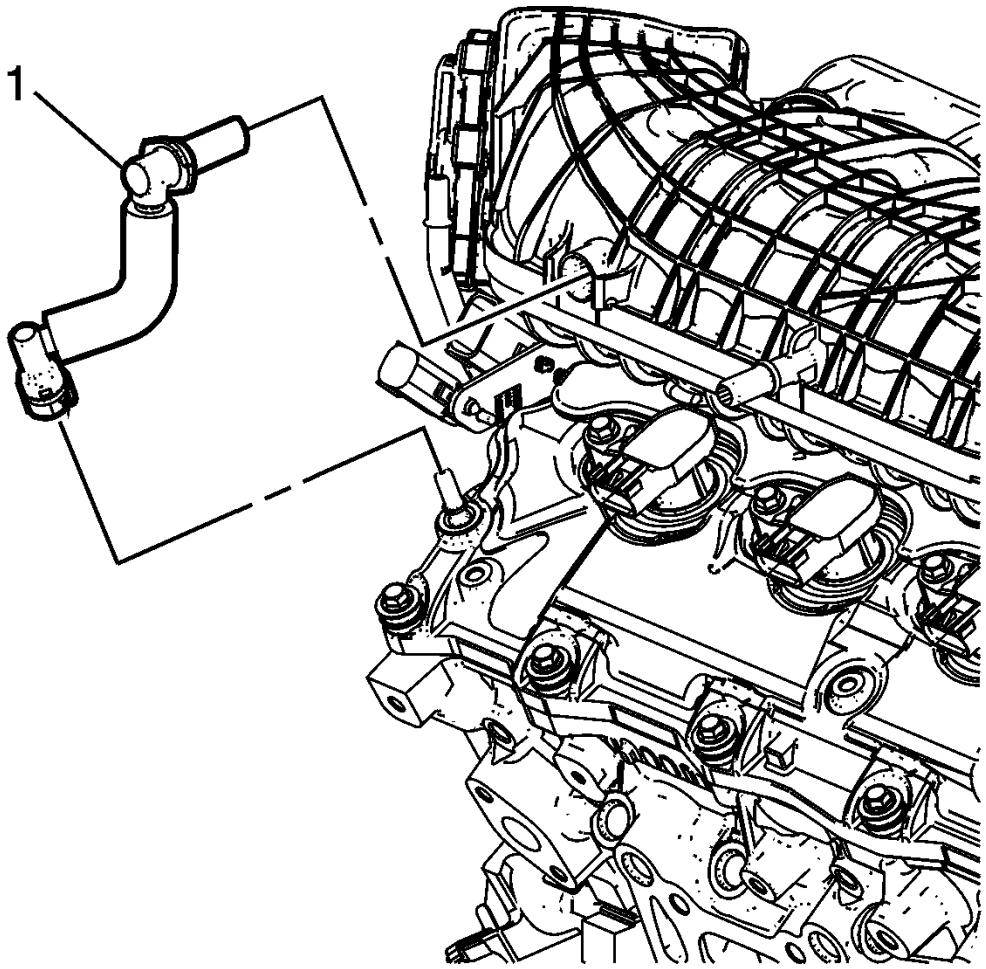

Fig. 8: Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect and remove the positive crankcase ventilation (PCV) tube (1) from the intake manifold and right camshaft cover.

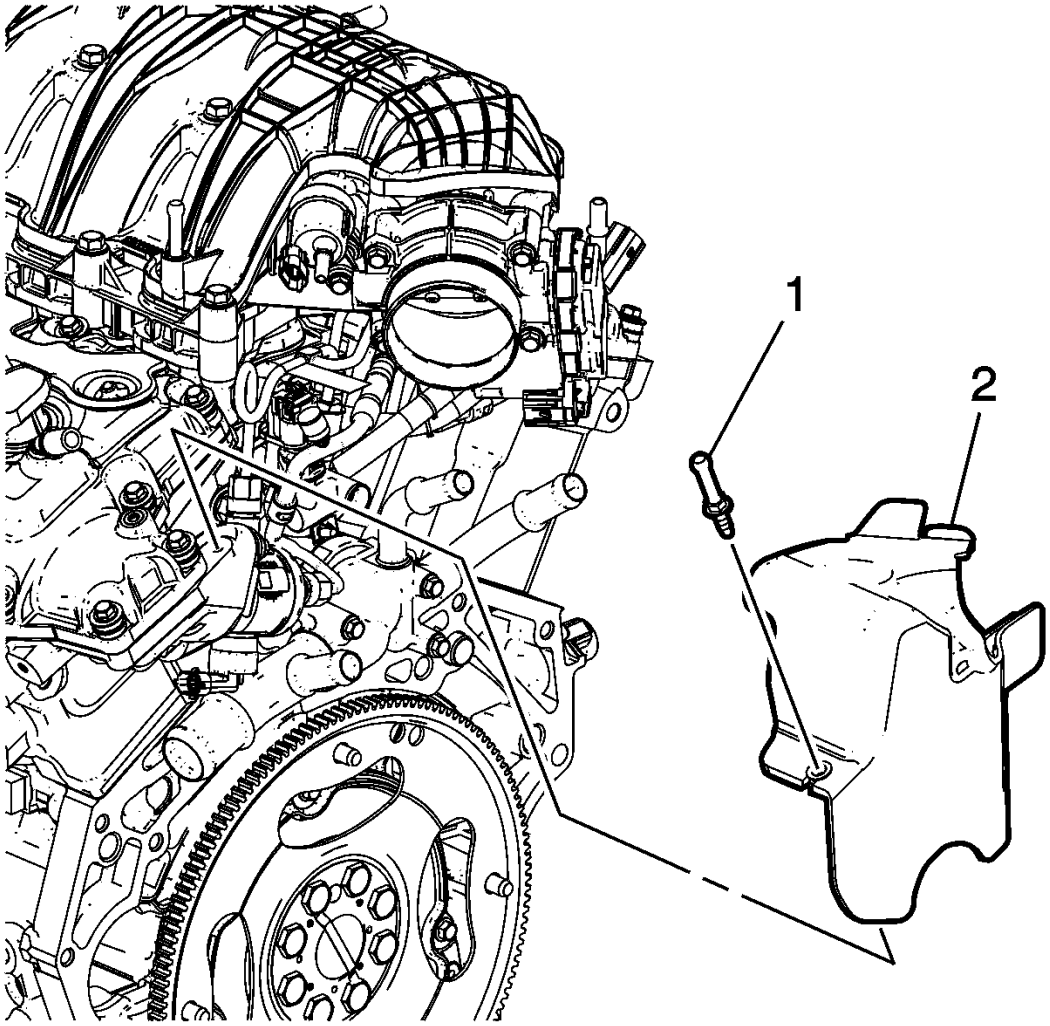

Fig. 9: Fuel Pump Cover And Stud
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine rear noise shield stud (1).
3. Remove the engine rear noise shield (2).

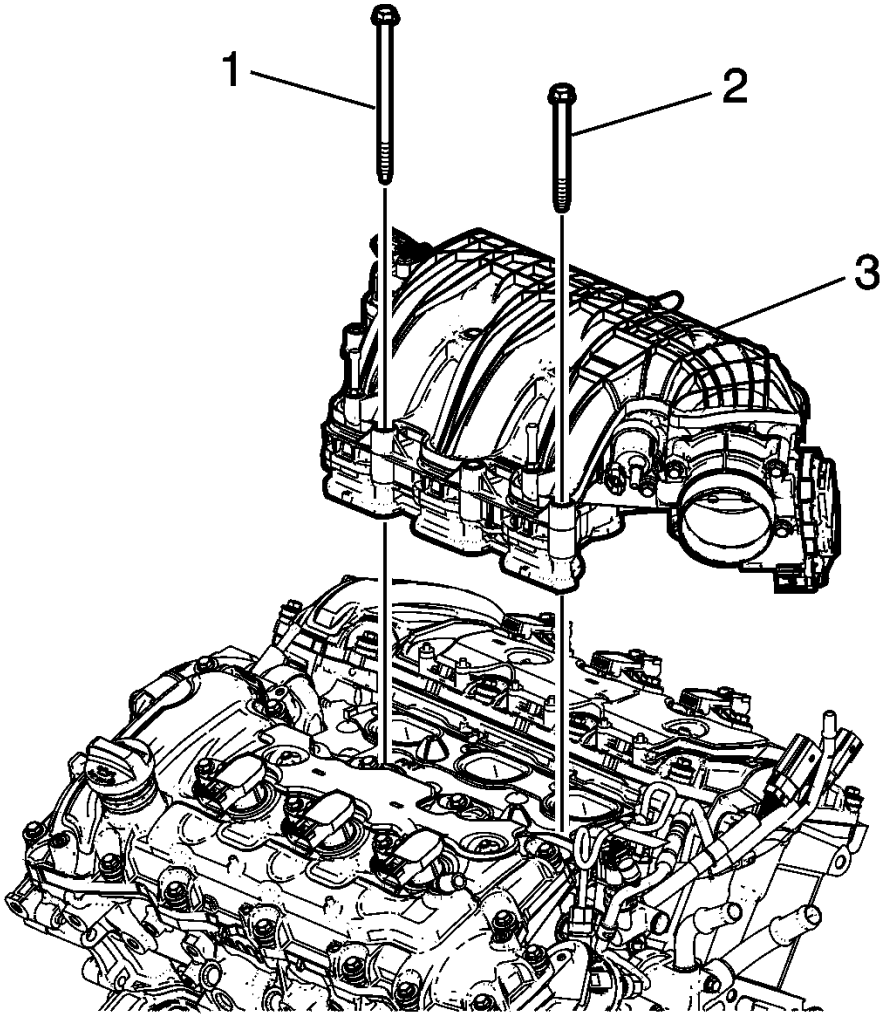

Fig. 10: Intake Manifold Assembly And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the intake manifold bolts (1, 2).
5. Remove the intake manifold assembly (3).

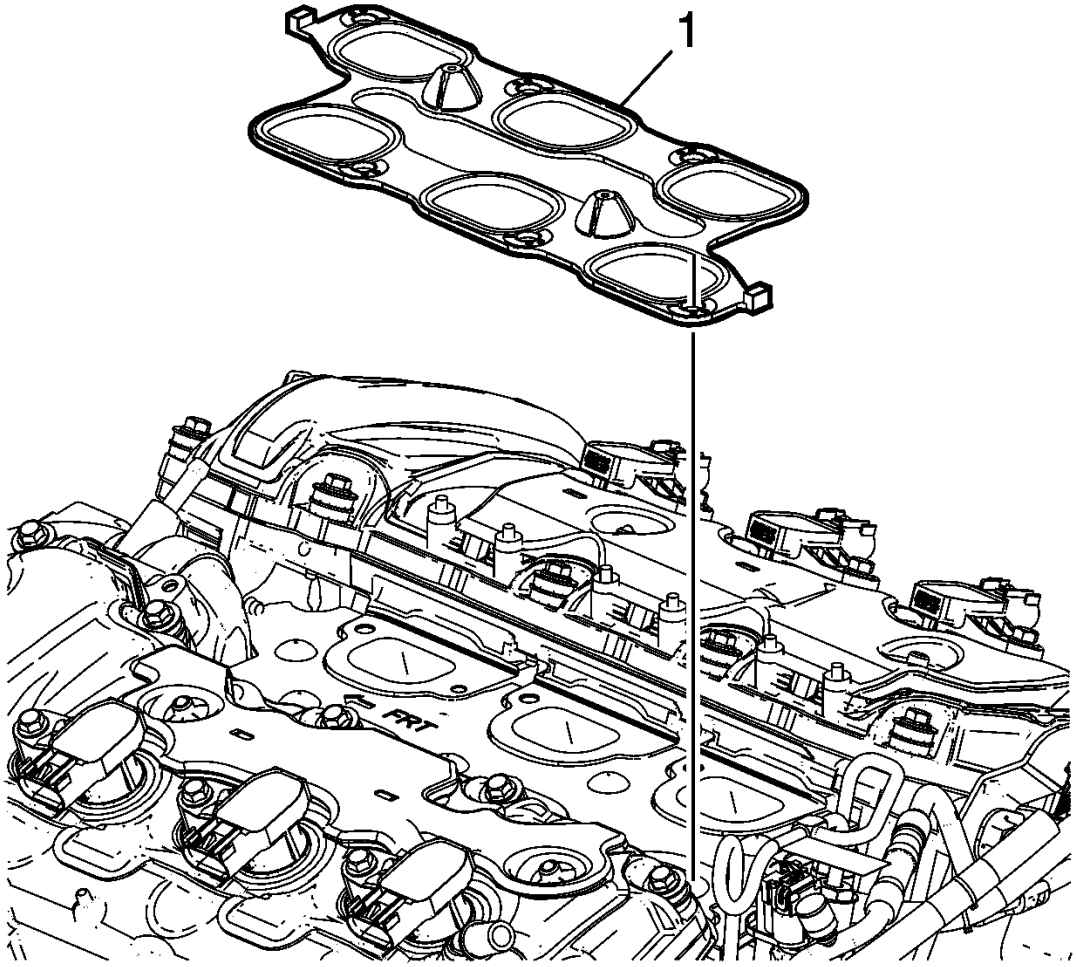

Fig. 11: Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard the intake manifold gasket (1).

WATER OUTLET REMOVAL

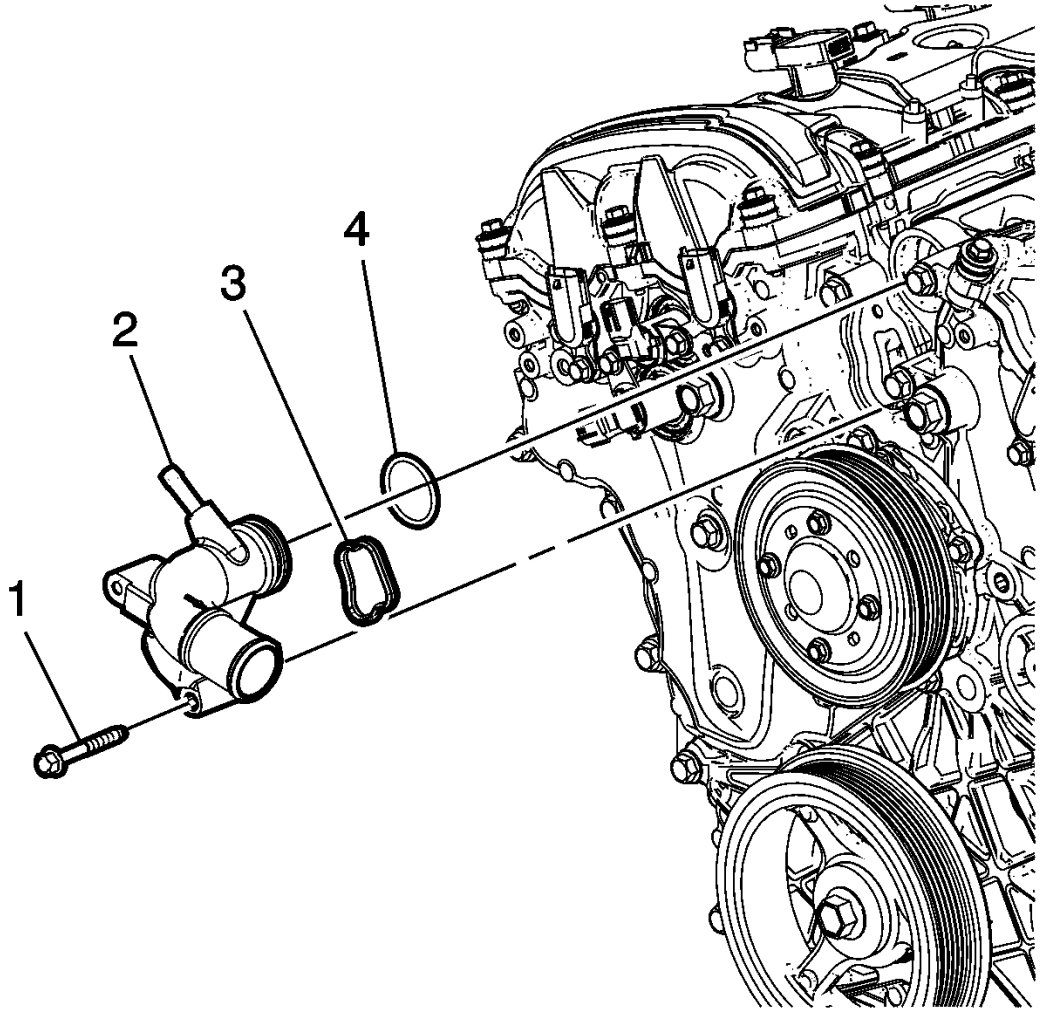

Fig. 12: Water Outlet, Seals And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the water outlet bolts (1).
2. Remove the water outlet (2).
3. Remove the water outlet seals (3, 4).

ENGINE COOLANT THERMOSTAT HOUSING REMOVAL

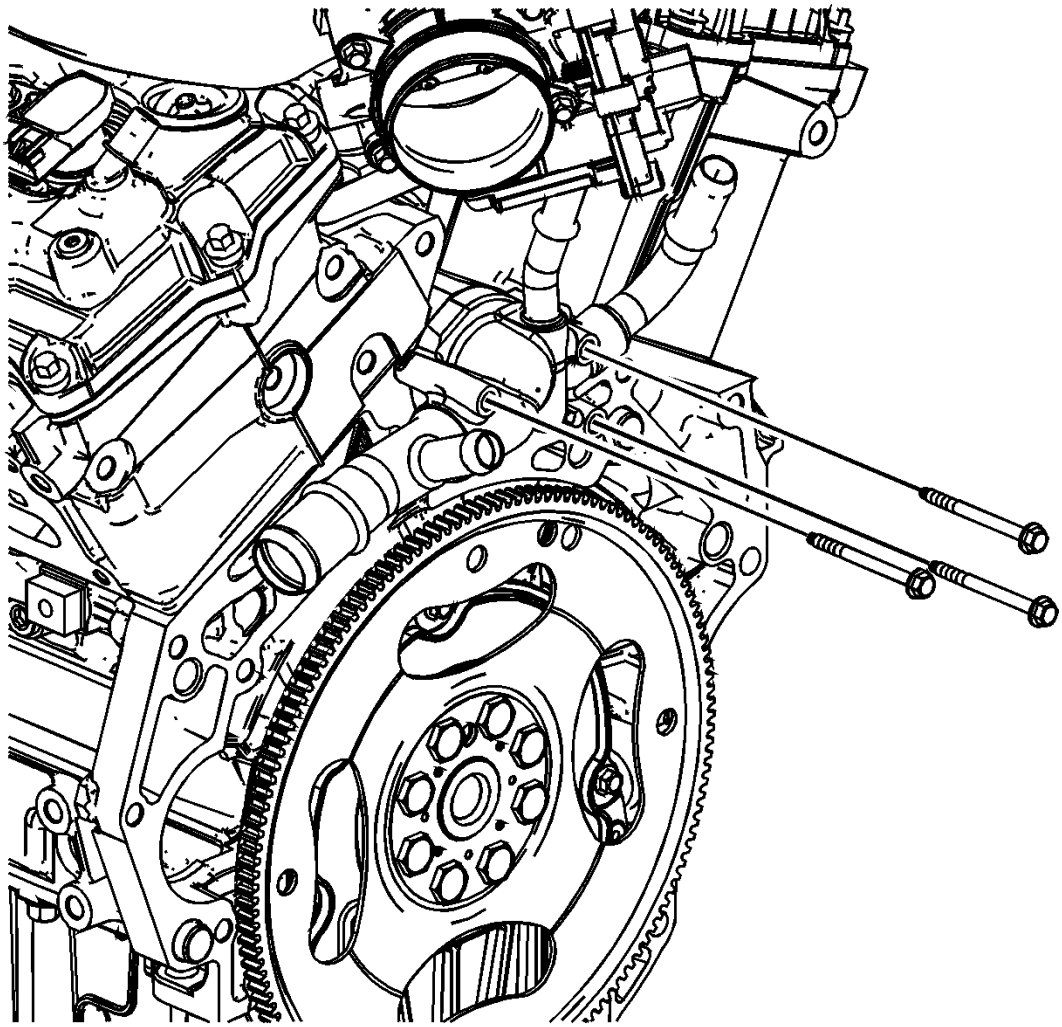

Fig. 13: Identifying Thermostat Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the thermostat housing bolts.

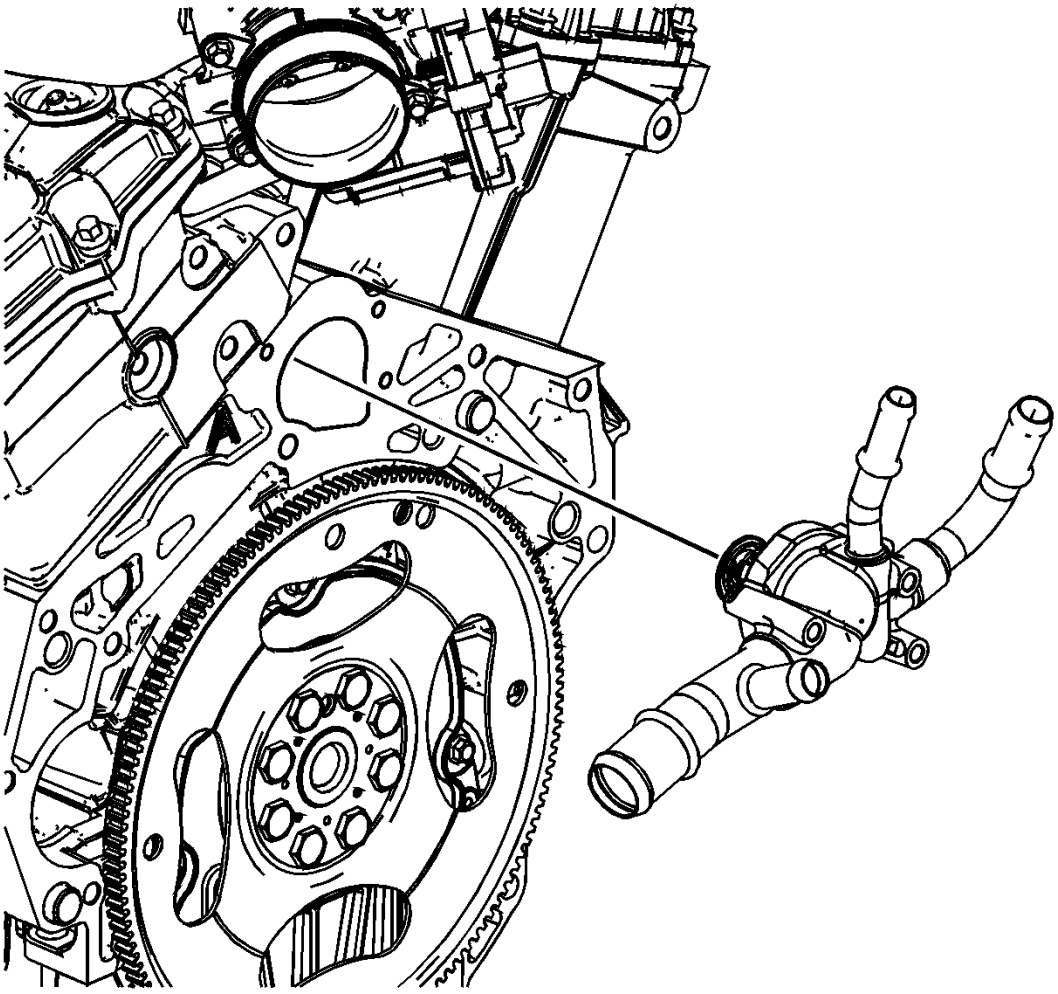

Fig. 14: Identifying Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

2. Remove the thermostat housing.

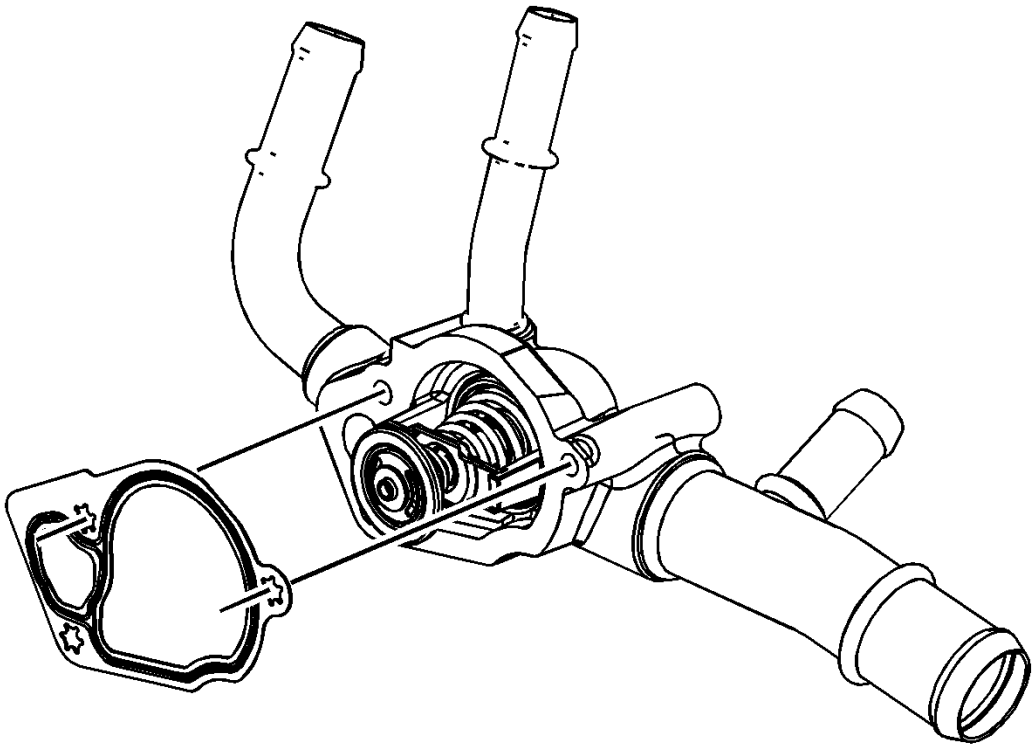

Fig. 15: Identifying Thermostat Housing Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the thermostat housing gasket.

CRANKSHAFT BALANCER REMOVAL

Special Tools

- **EN 38416-2** Crankshaft Button
- **EN 41816** Crankshaft Balancer Remover
- **EN 46106** Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

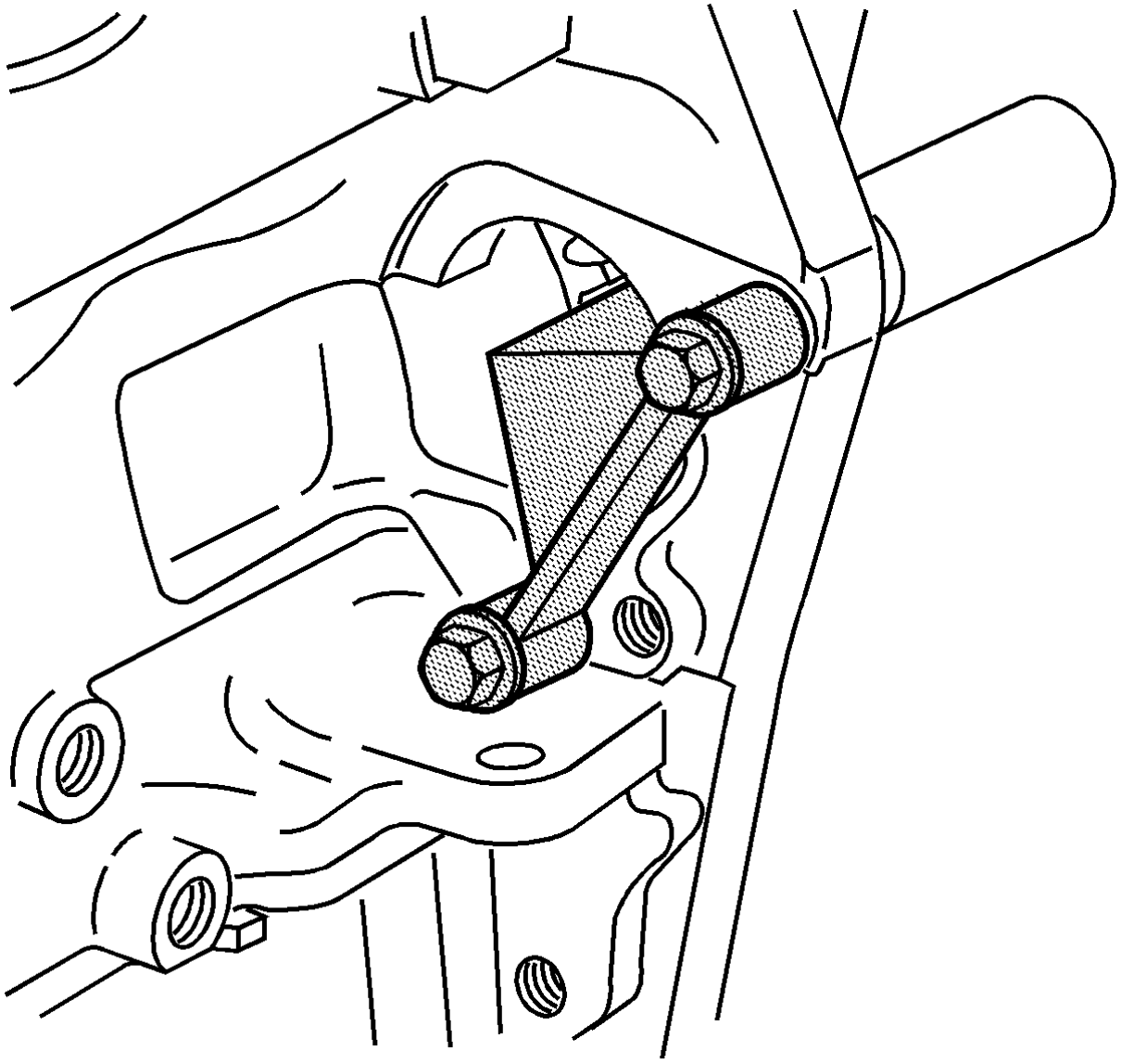

Fig. 16: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN 46106** tool through the starter mounting hole.

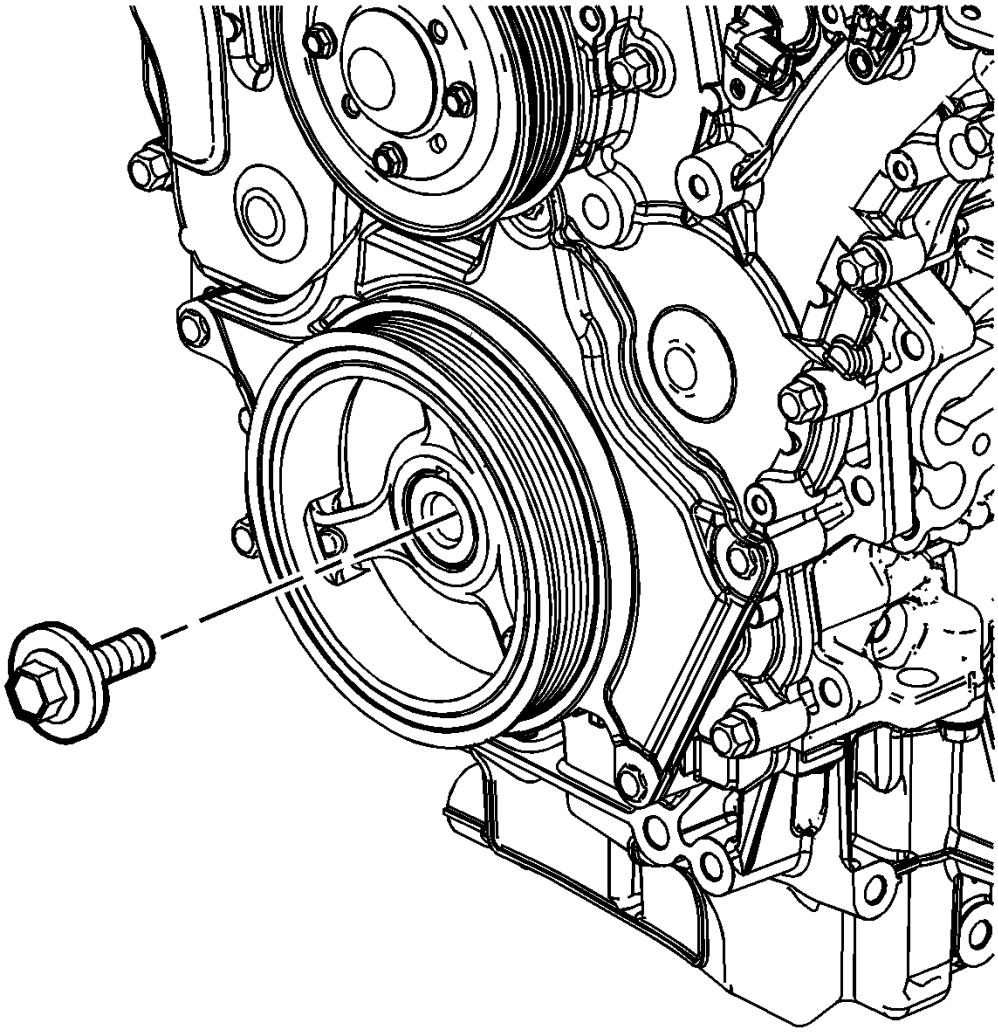

Fig. 17: View Of Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove and discard the crankshaft balancer bolt.

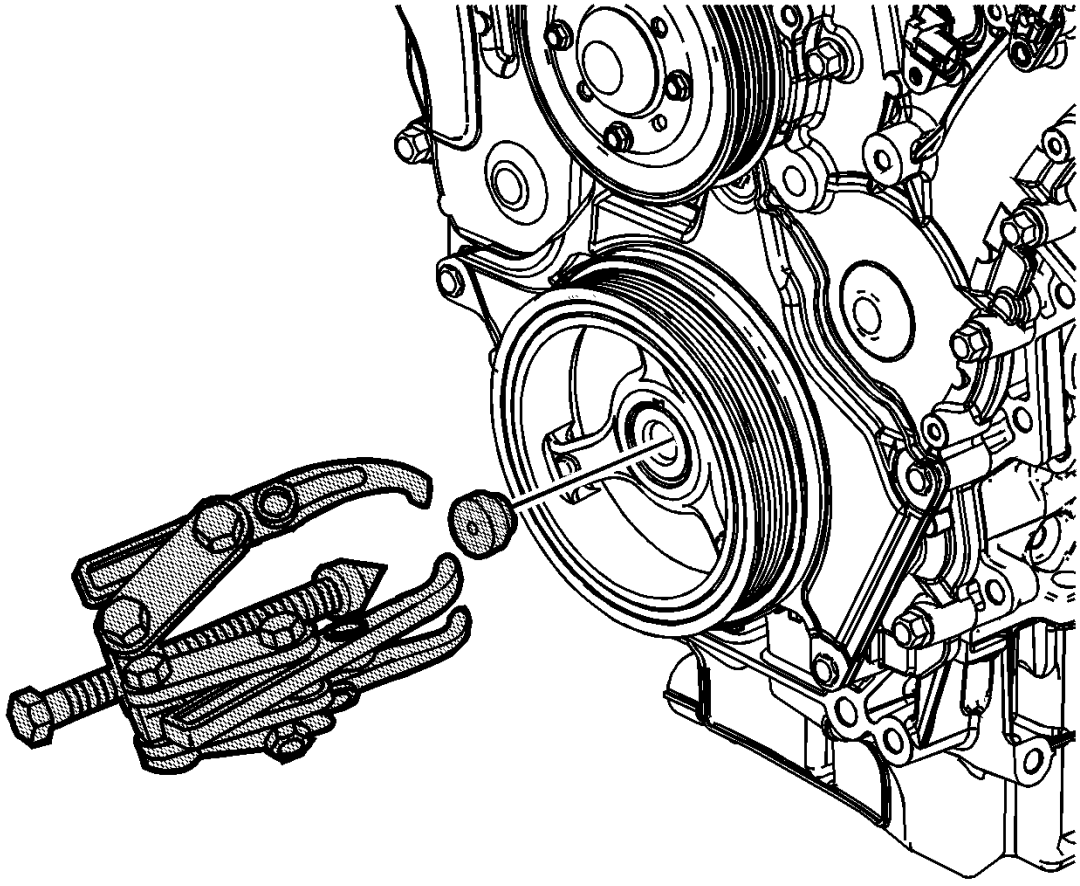

Fig. 18: Identifying Crankshaft Balancer Remover
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN 38416-2** button in the nose of the crankshaft.
4. Install the **EN 41816** remover in order to remove the crankshaft balancer.
5. Tighten the center bolt of the **EN 41816** remover in order to pull the crankshaft balancer off of the crankshaft.
6. Remove the **EN 41816** remover from the crankshaft balancer.

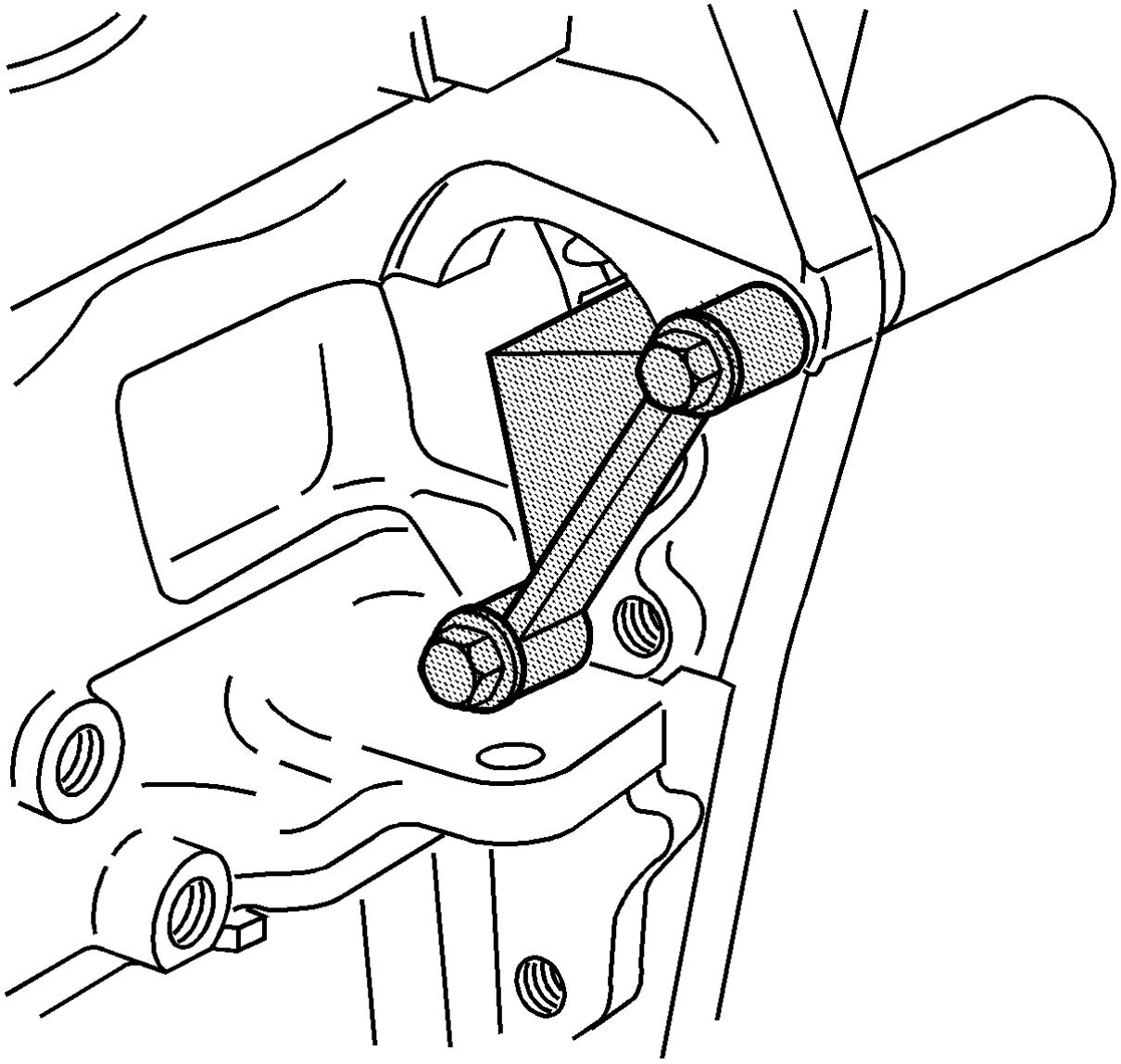

Fig. 19: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

7. Remove the **EN 46106** tool.

ENGINE FLYWHEEL REMOVAL

Special Tools

EN 46106 Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

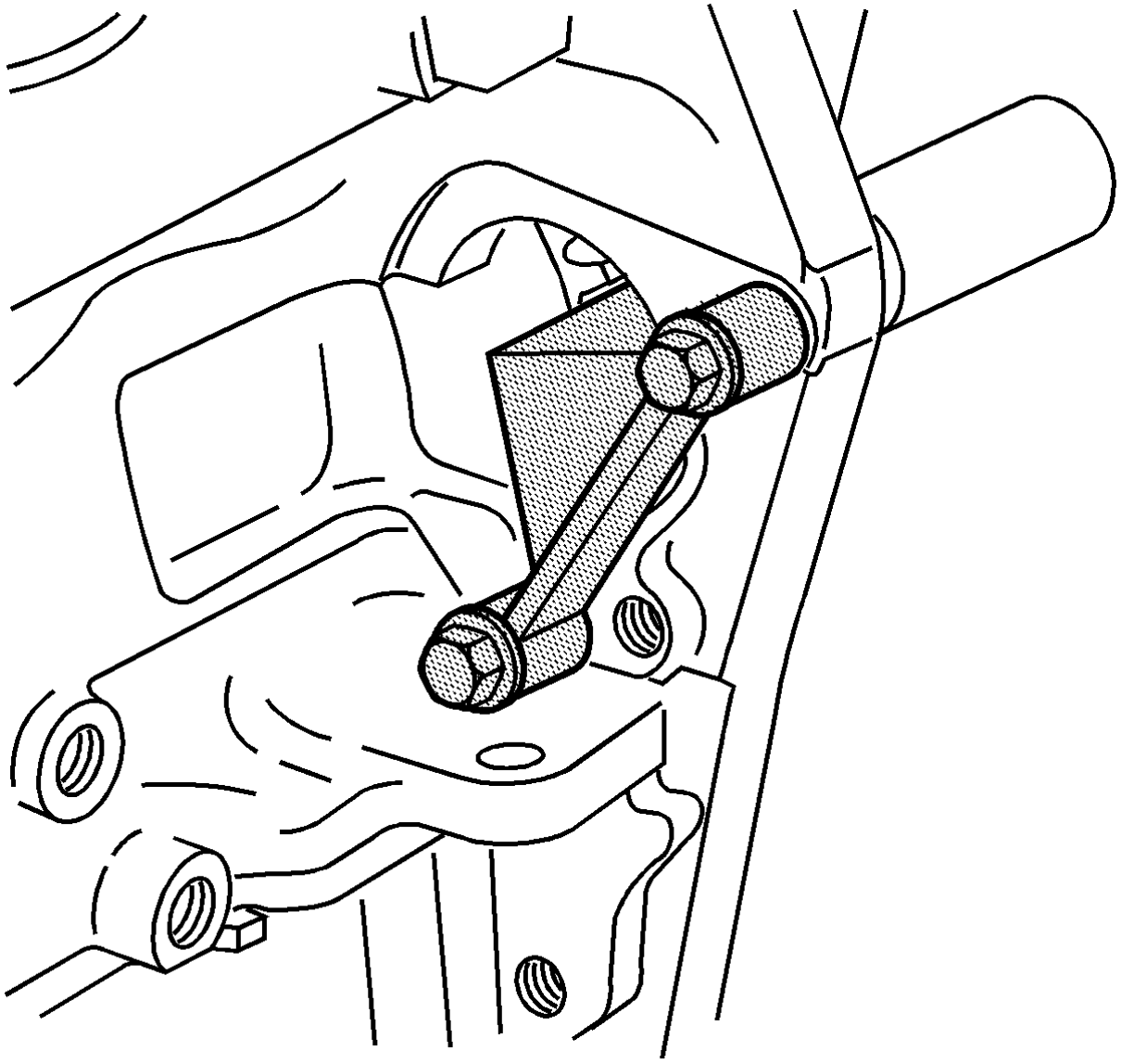

Fig. 20: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN 46106** tool through the starter mounting hole.

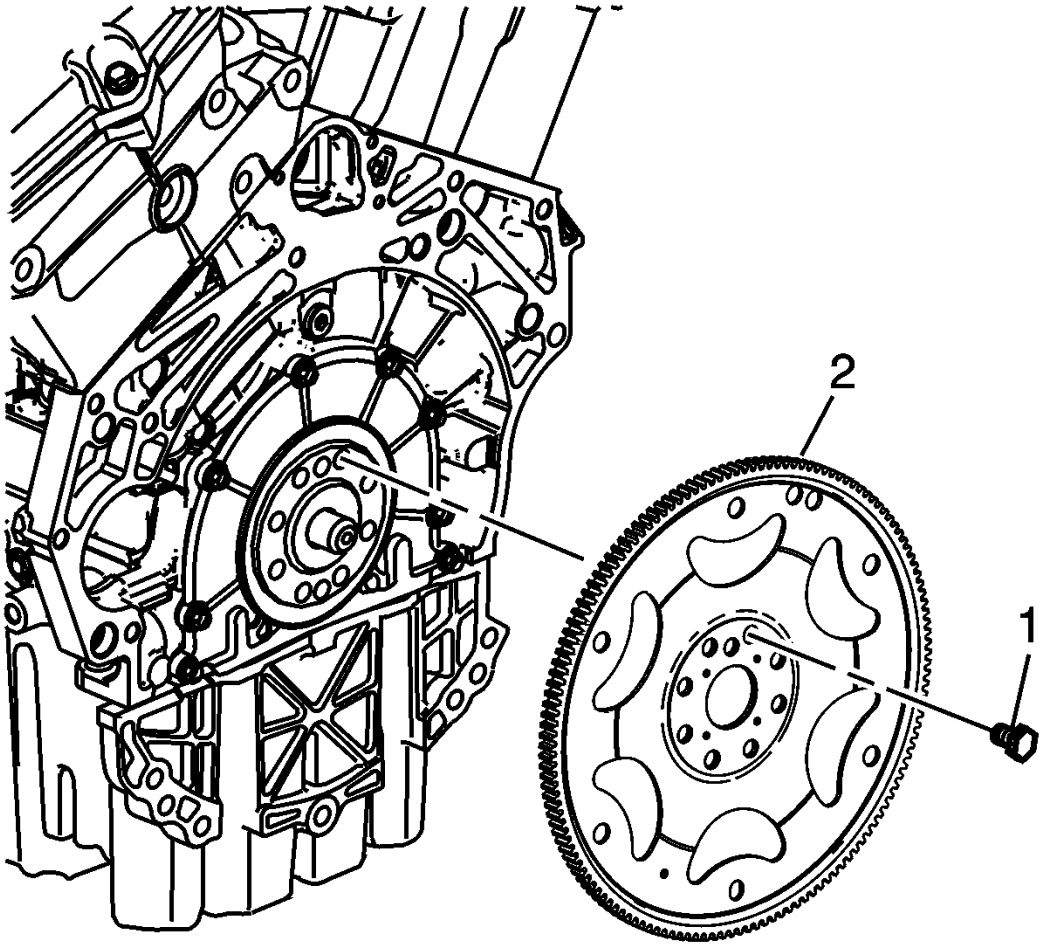

Fig. 21: View Of Engine Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the flex plate bolts (1) and discard.
3. Remove the flex plate (2) from the crankshaft.

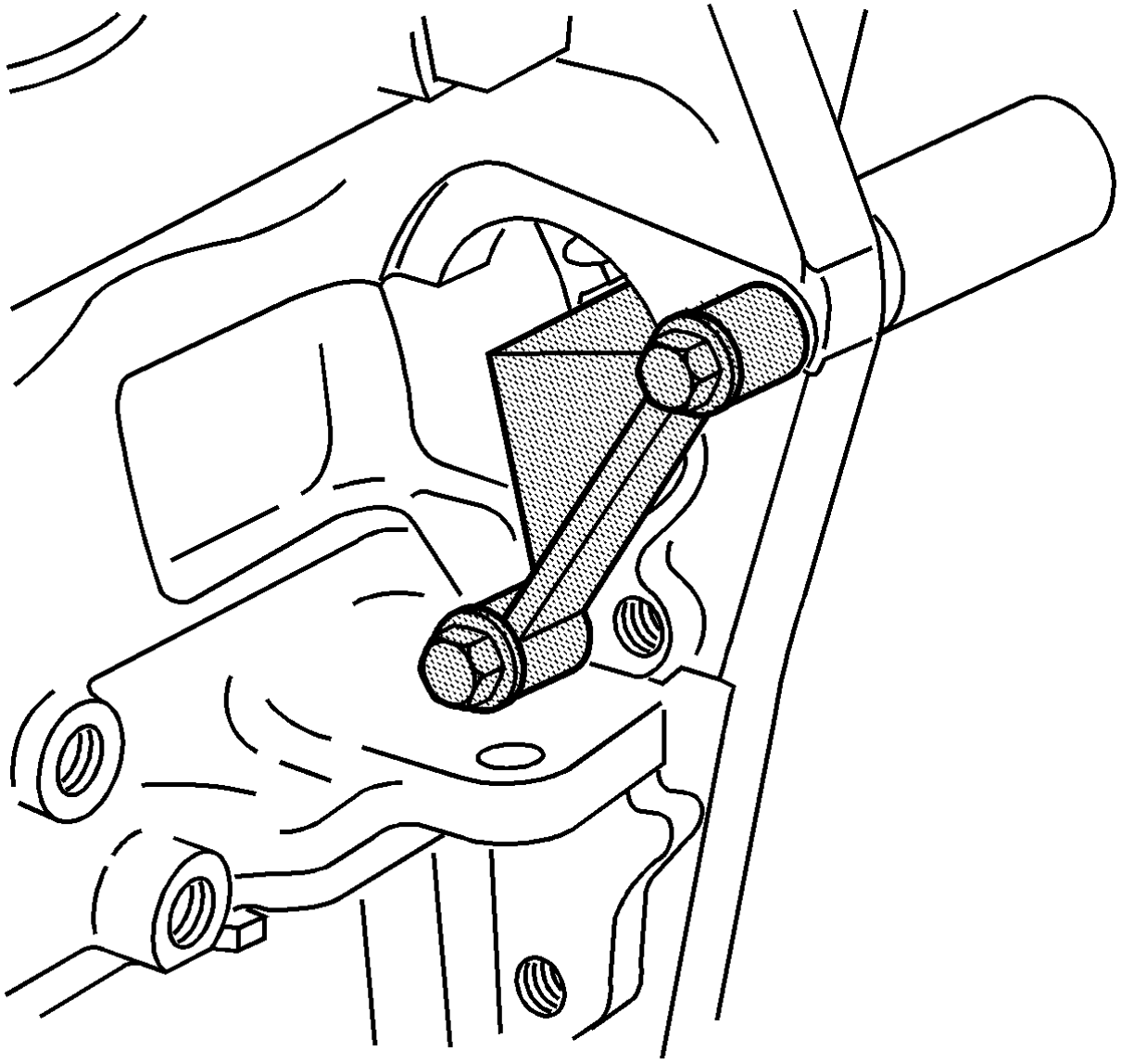

Fig. 22: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

4. Remove the **EN 46106** tool.

AUTOMATIC TRANSMISSION FLEX PLATE REMOVAL

Special Tools

EN 46106 Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

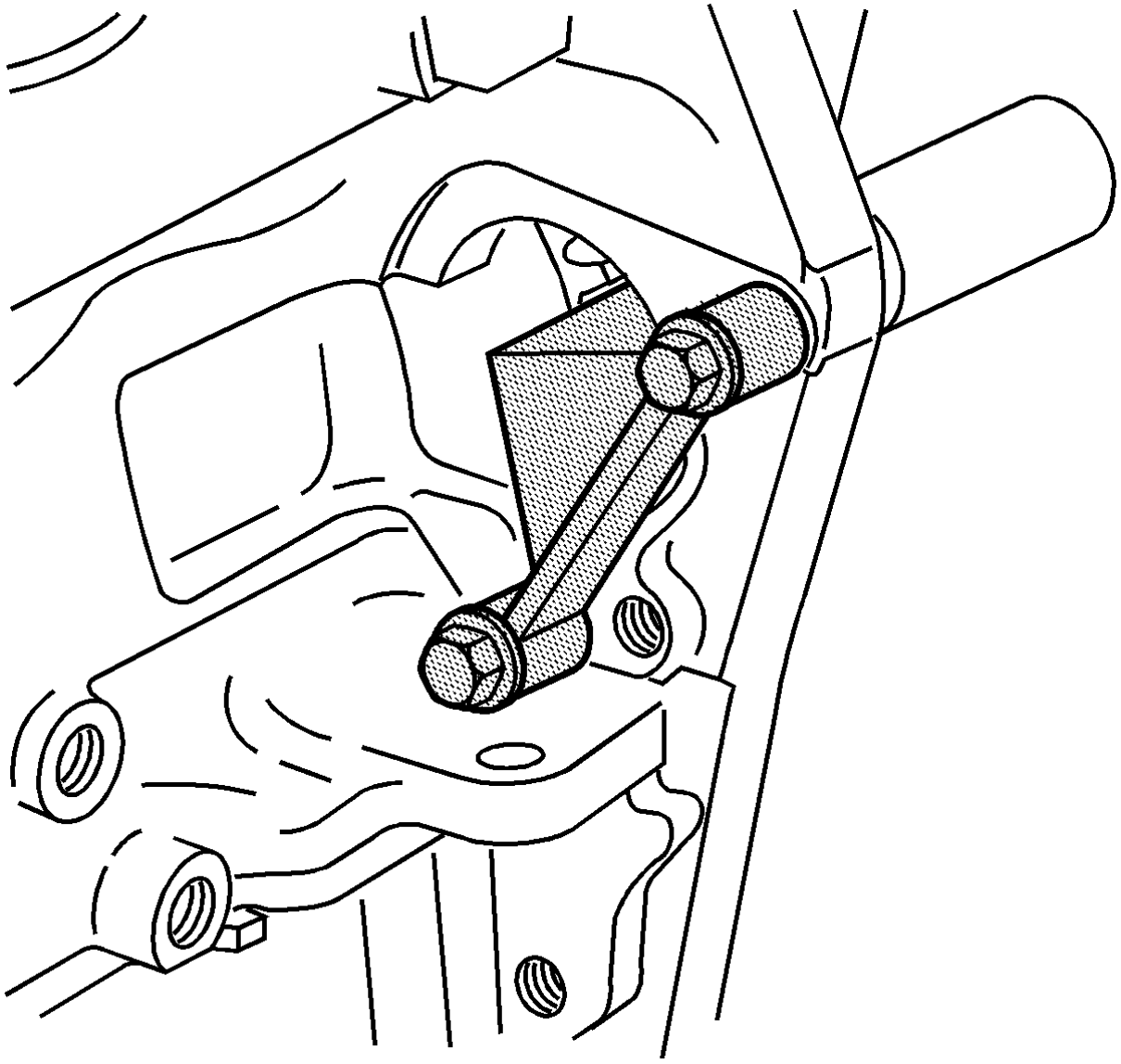

Fig. 23: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN 46106** tool through the starter mounting hole.

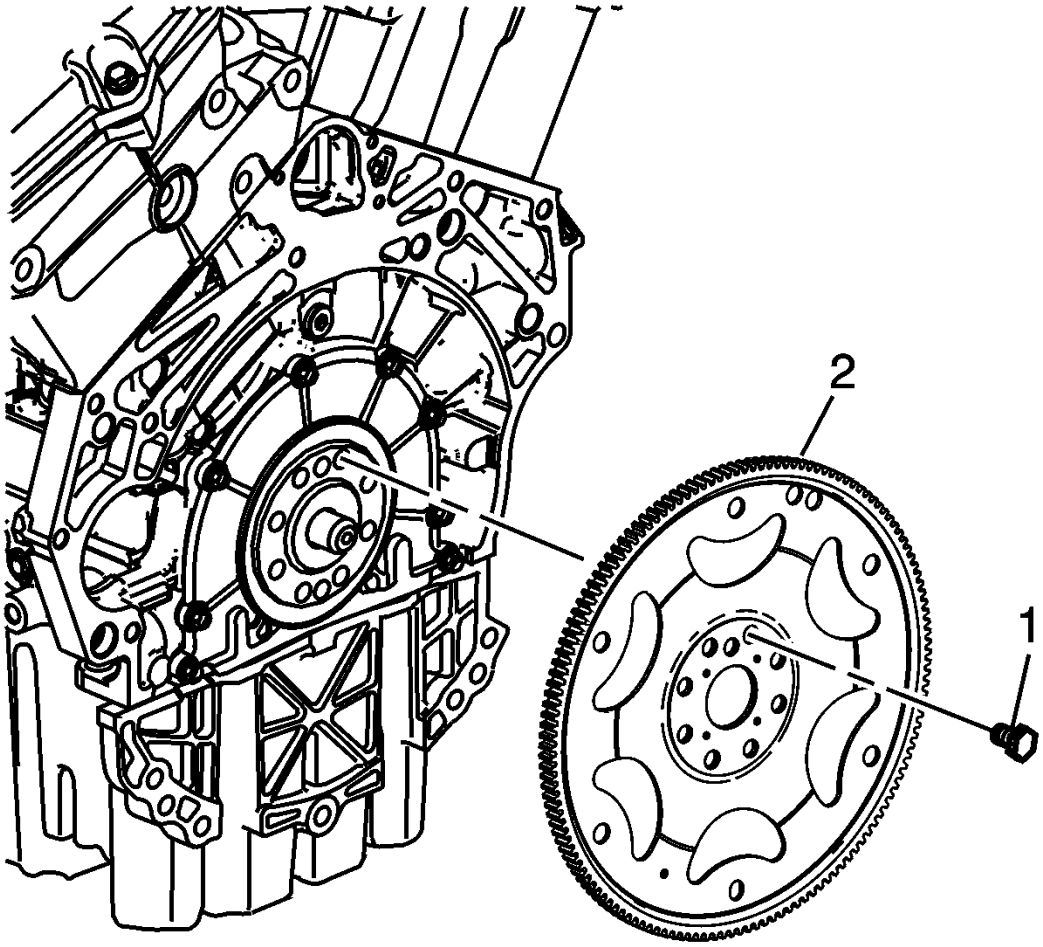

Fig. 24: View Of Engine Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the flex plate bolts (1) and discard.
3. Remove the flex plate (2) from the crankshaft.

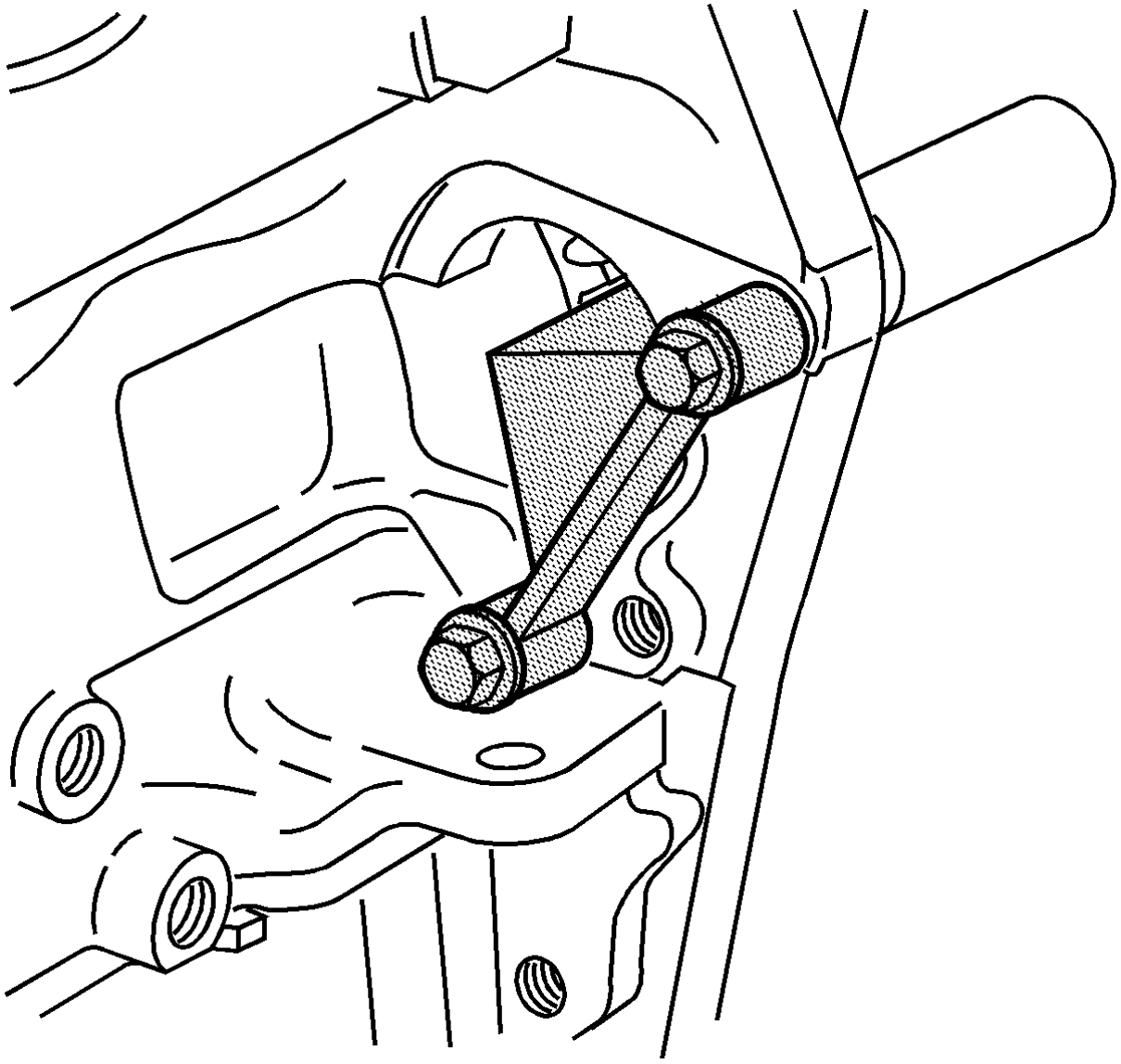

Fig. 25: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

4. Remove the **EN 46106** tool.

CAMSHAFT COVER REMOVAL - LEFT SIDE

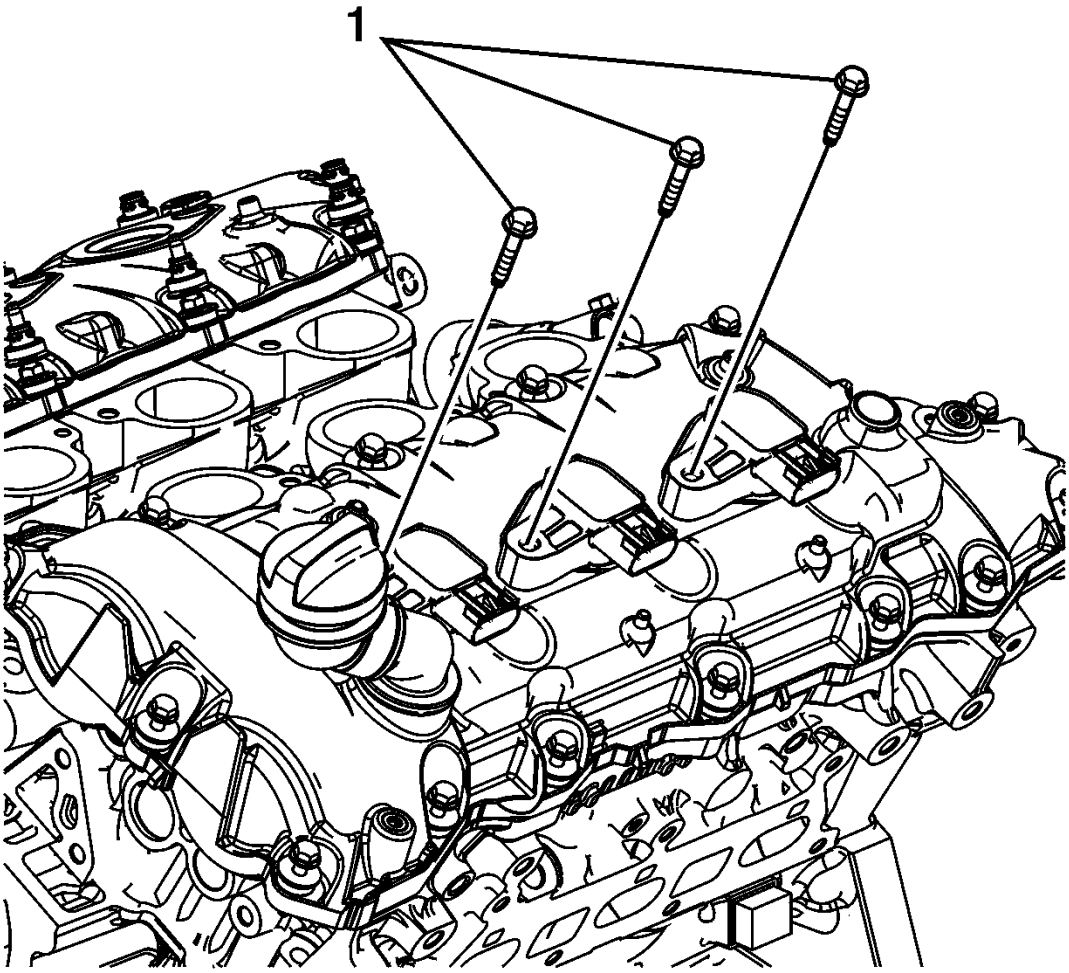

Fig. 26: View of Ignition Coil Bolts and Cylinder Heads
Courtesy of GENERAL MOTORS COMPANY

1. Remove the ignition coil bolts (1).

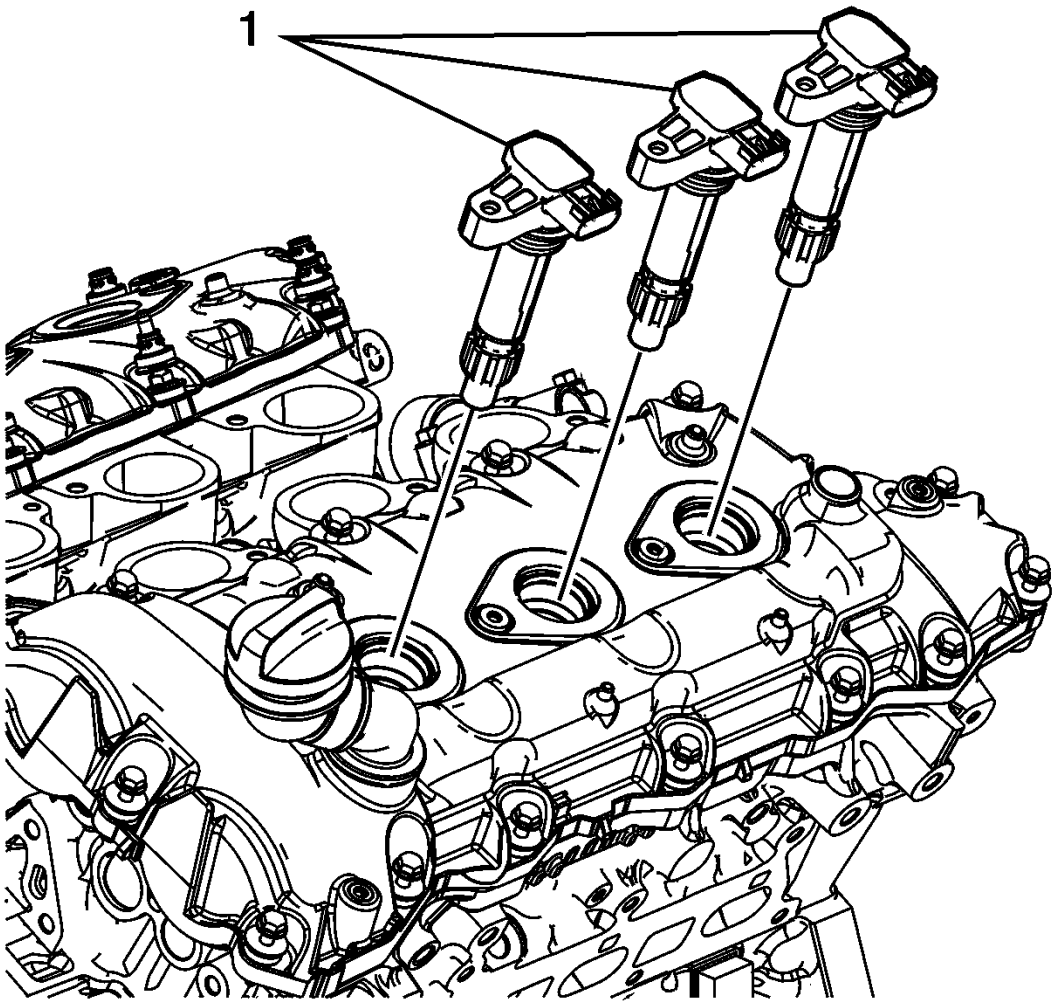

Fig. 27: View of Ignition Coils and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

2. Remove the ignition coils (1).

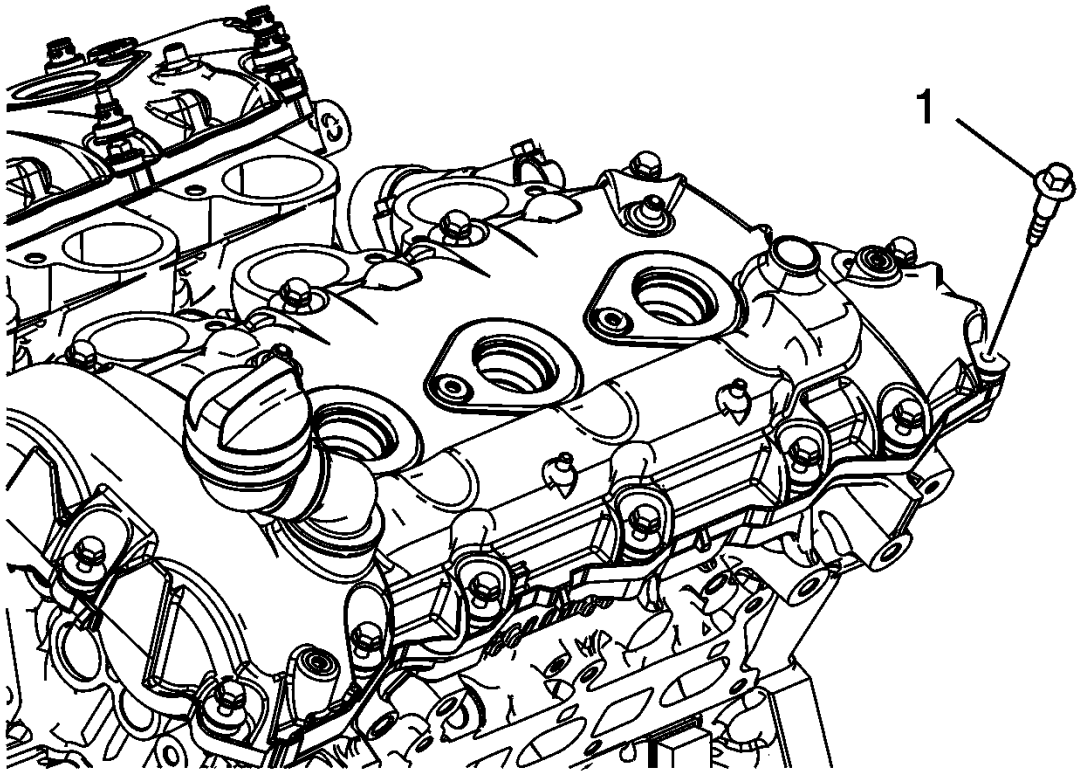

Fig. 28: View of Camshaft Cover and Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the left camshaft cover bolts (1).
4. Remove and discard the camshaft cover grommets and camshaft cover bolts if they are serviced with the grommet.

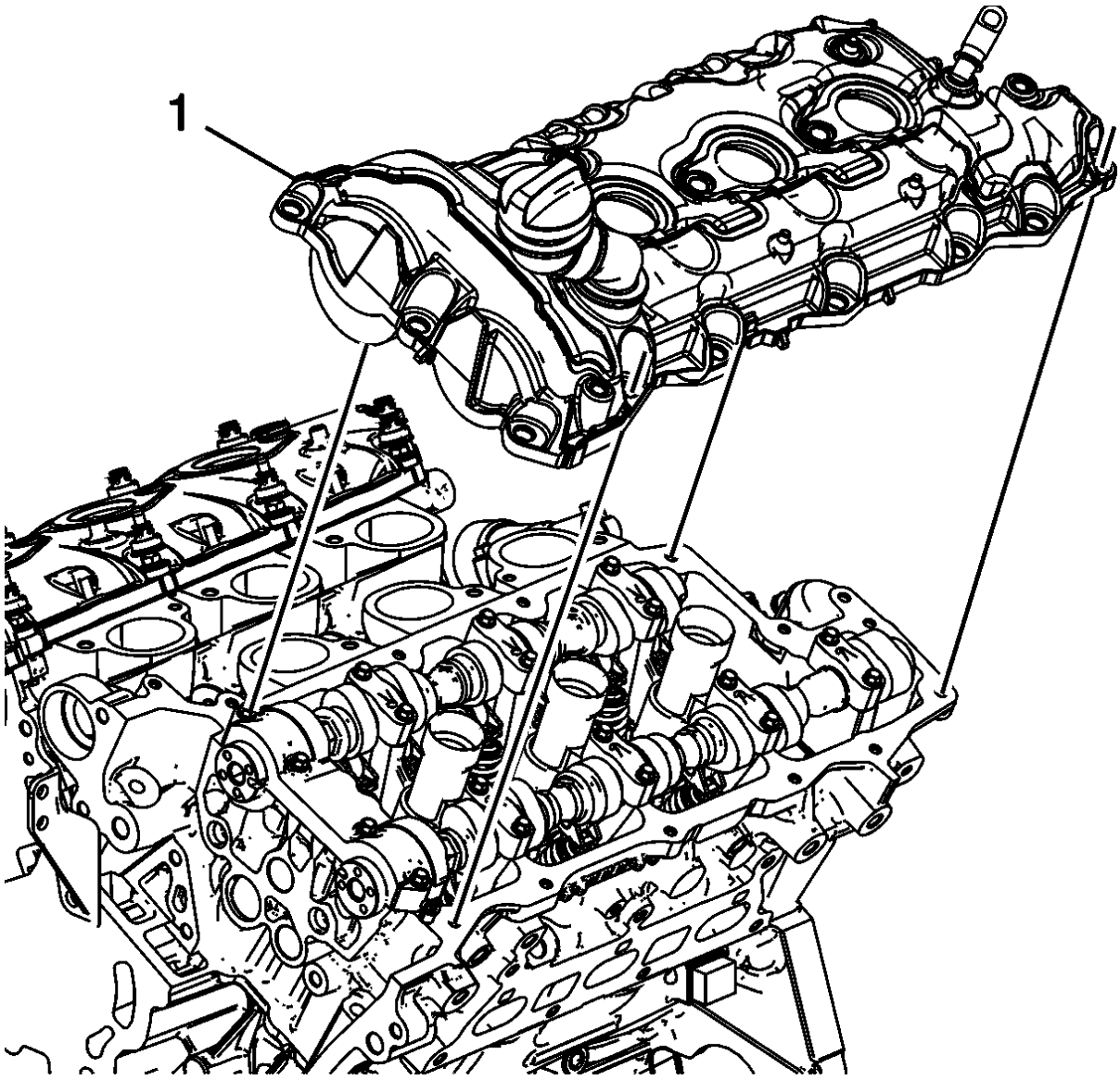

Fig. 29: View Of Left Camshaft Cover & Left Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

5. Remove the left camshaft cover (1) from the left cylinder head.

CAMSHAFT COVER REMOVAL - RIGHT SIDE

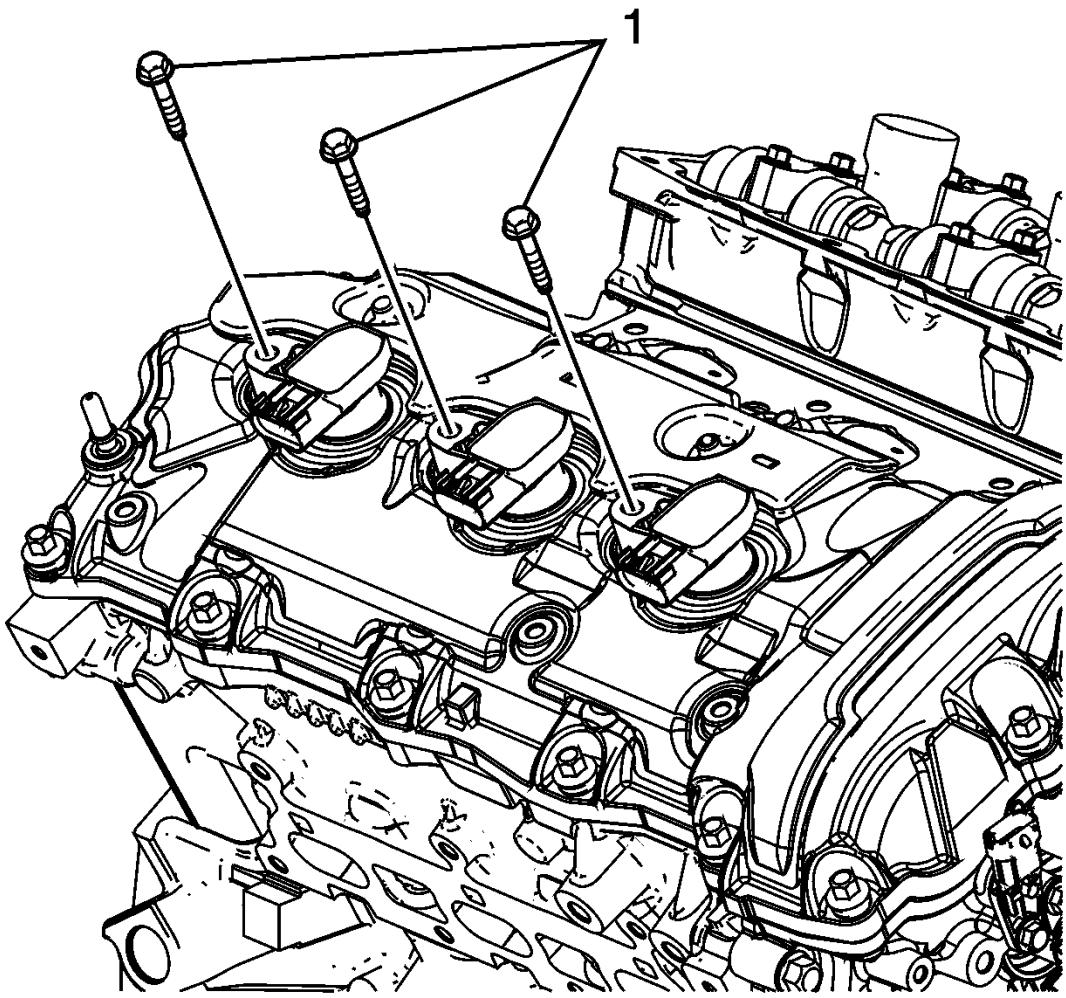

Fig. 30: Identifying Ignition Coil Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the ignition coil bolts (1).

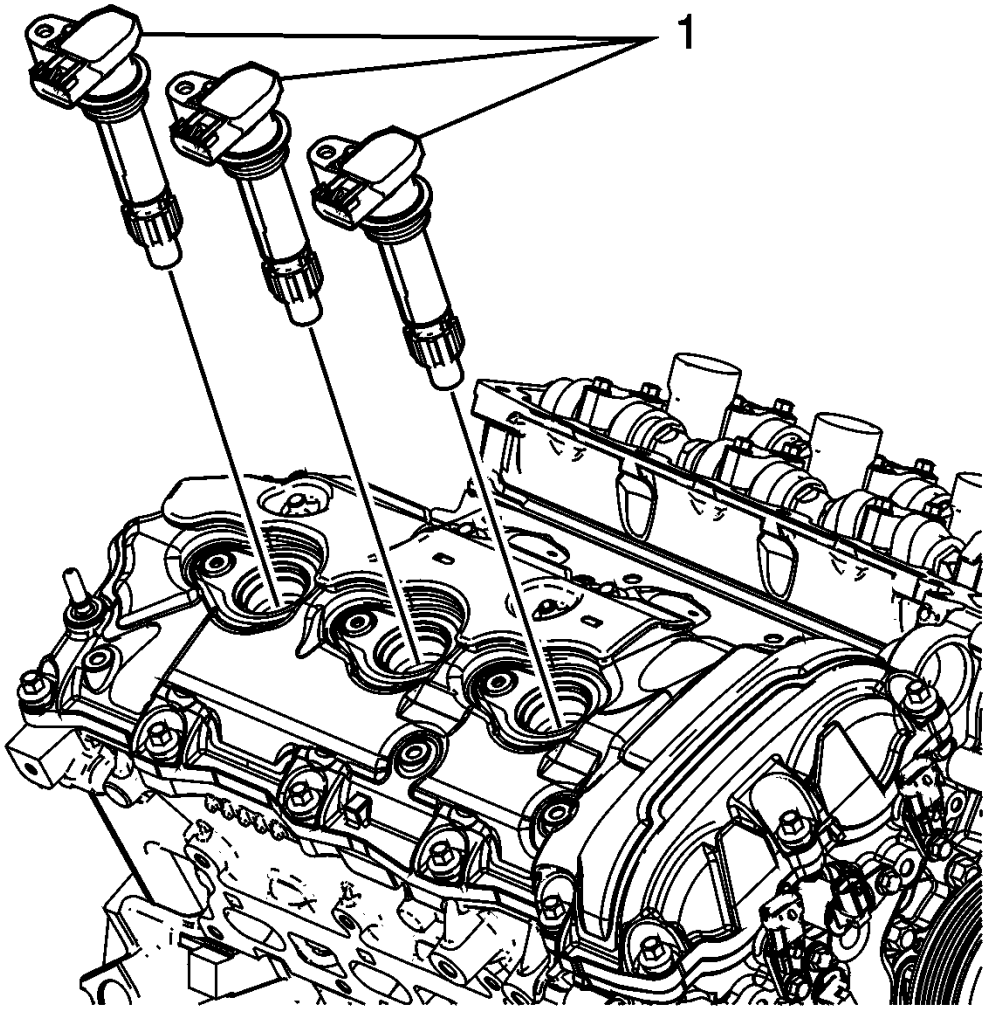

Fig. 31: View Of Ignition Coils
Courtesy of GENERAL MOTORS COMPANY

2. Remove the ignition coils (1).

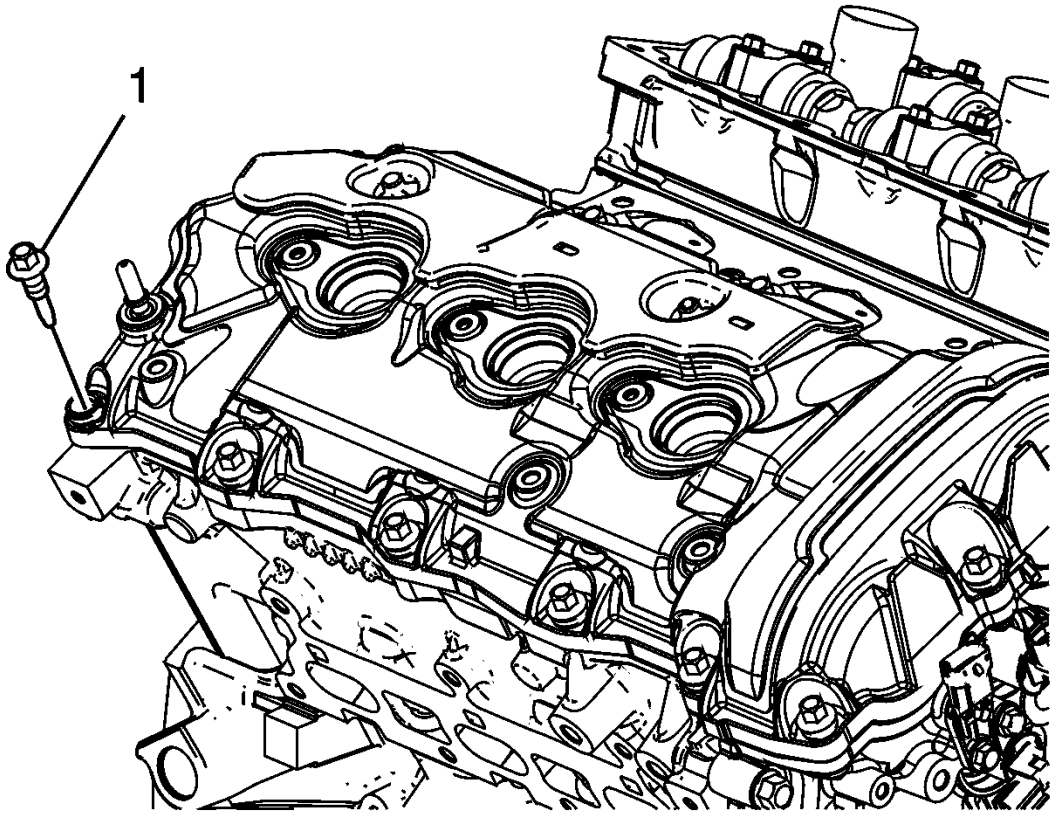

Fig. 32: View Of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the right camshaft cover bolts (1).
4. Remove and discard the camshaft cover grommets and camshaft cover bolts if they are serviced with the grommet.

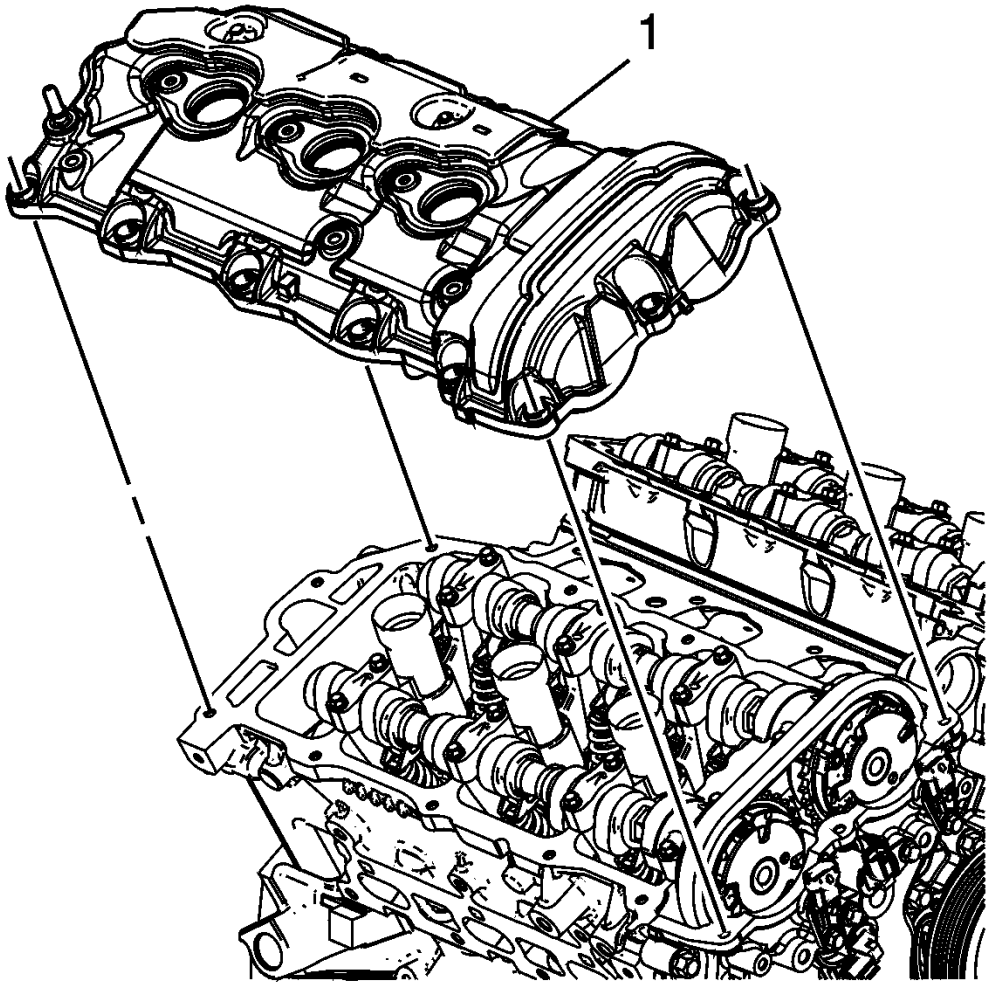

Fig. 33: View Of Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right camshaft cover (1) from the right cylinder head.

WATER PUMP REMOVAL

Special Tools

EN-46104 Water Pump Pulley Holding Tool

For equivalent regional tools, refer to **Special Tools** .

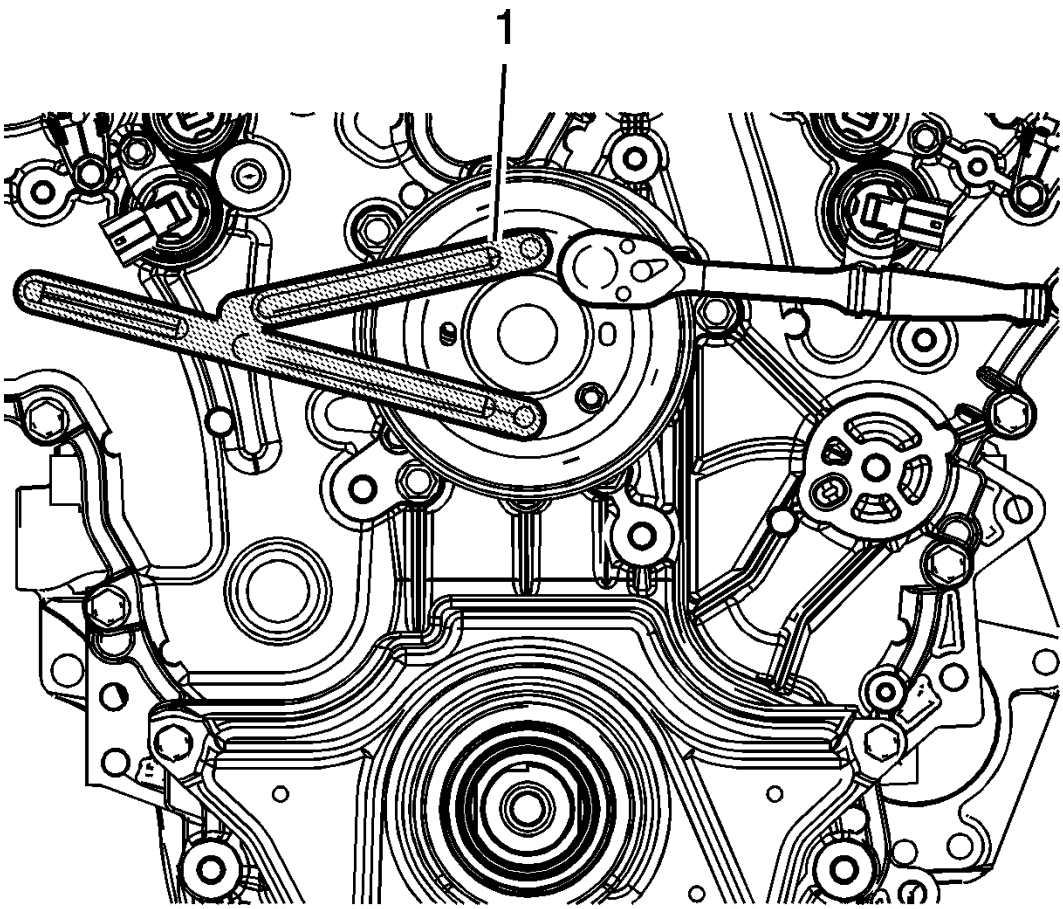

Fig. 34: Water Pump Holding Tool
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-46104** holding tool (1) onto the water pump pulley.

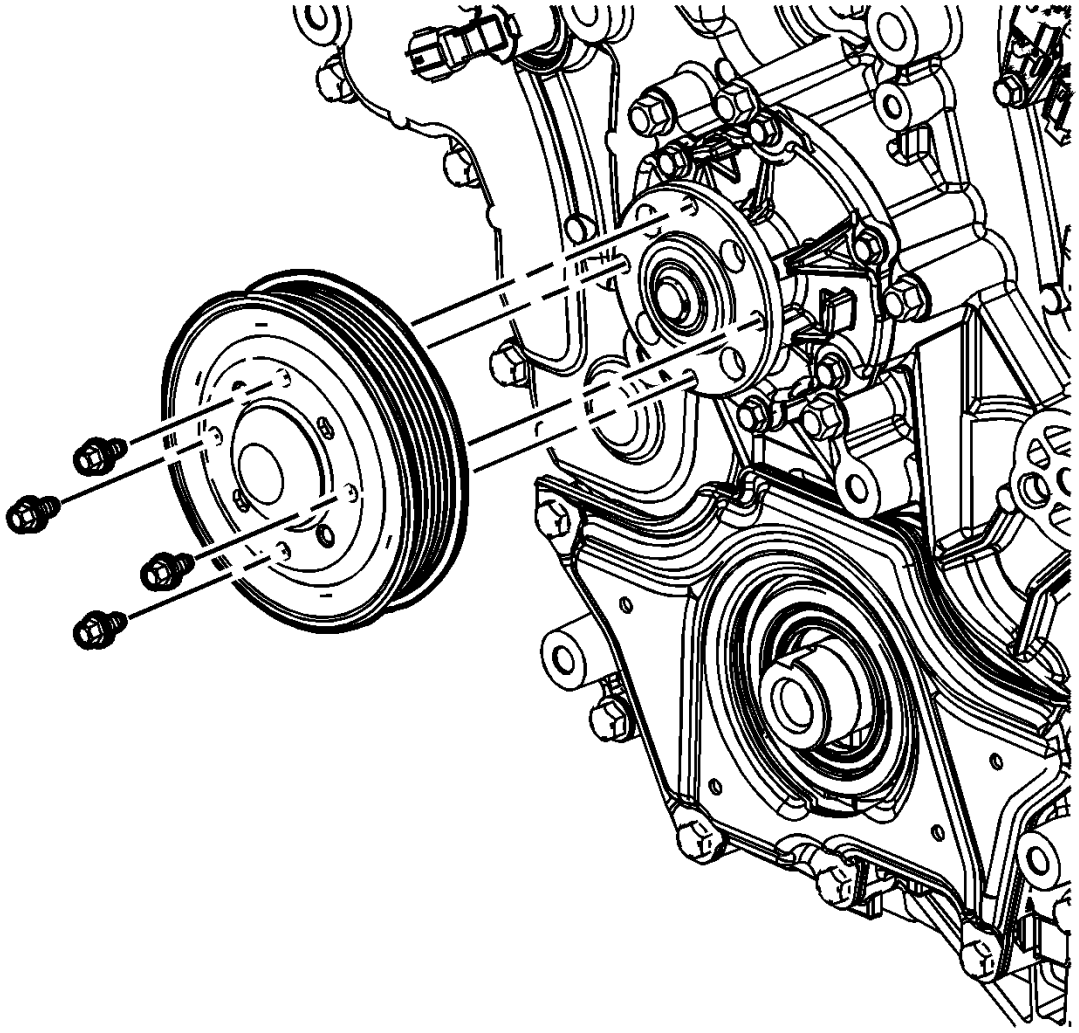

Fig. 35: View Of Water Pump Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the water pump pulley bolts.
3. Remove the water pump pulley.

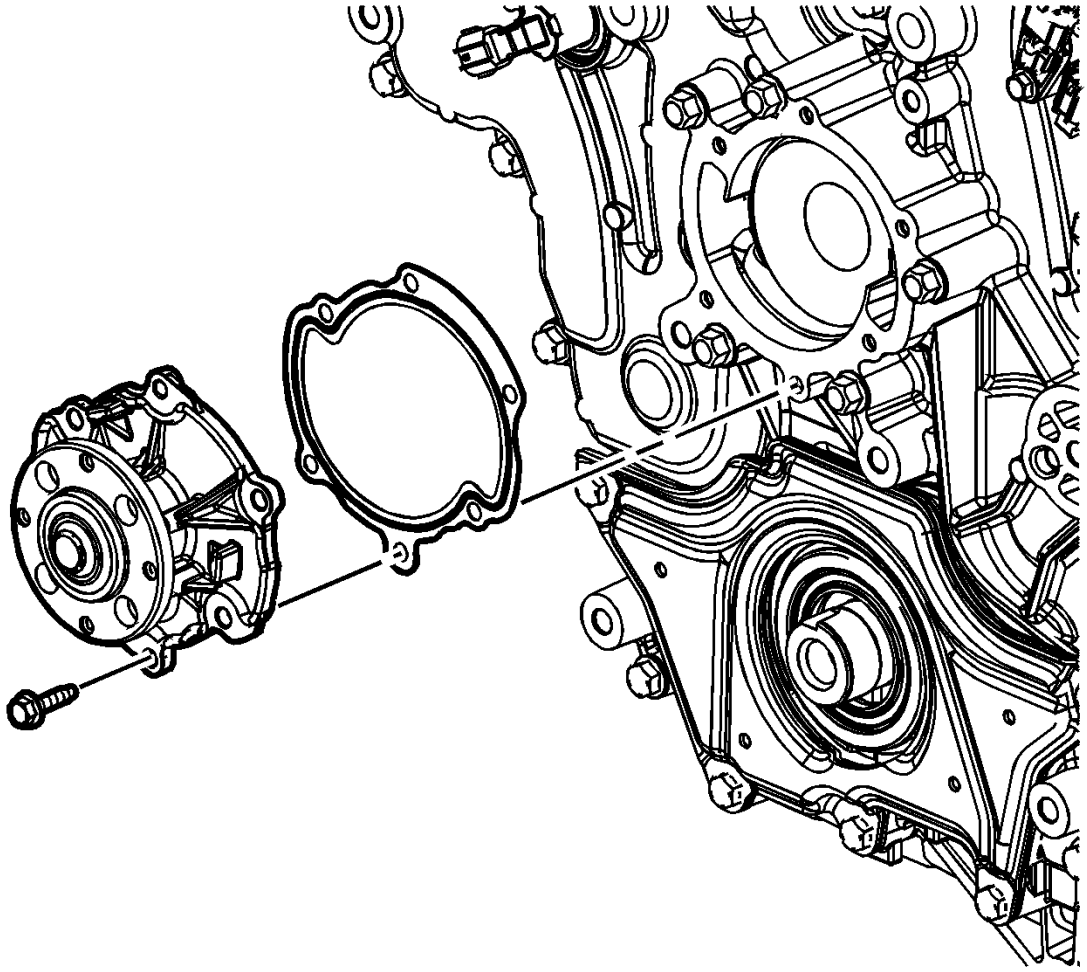

Fig. 36: View Of Water Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the water pump bolts and DISCARD the bolts.
5. Remove the water pump from the front cover.
6. Remove and DISCARD the water pump gasket.

ENGINE FRONT COVER REMOVAL

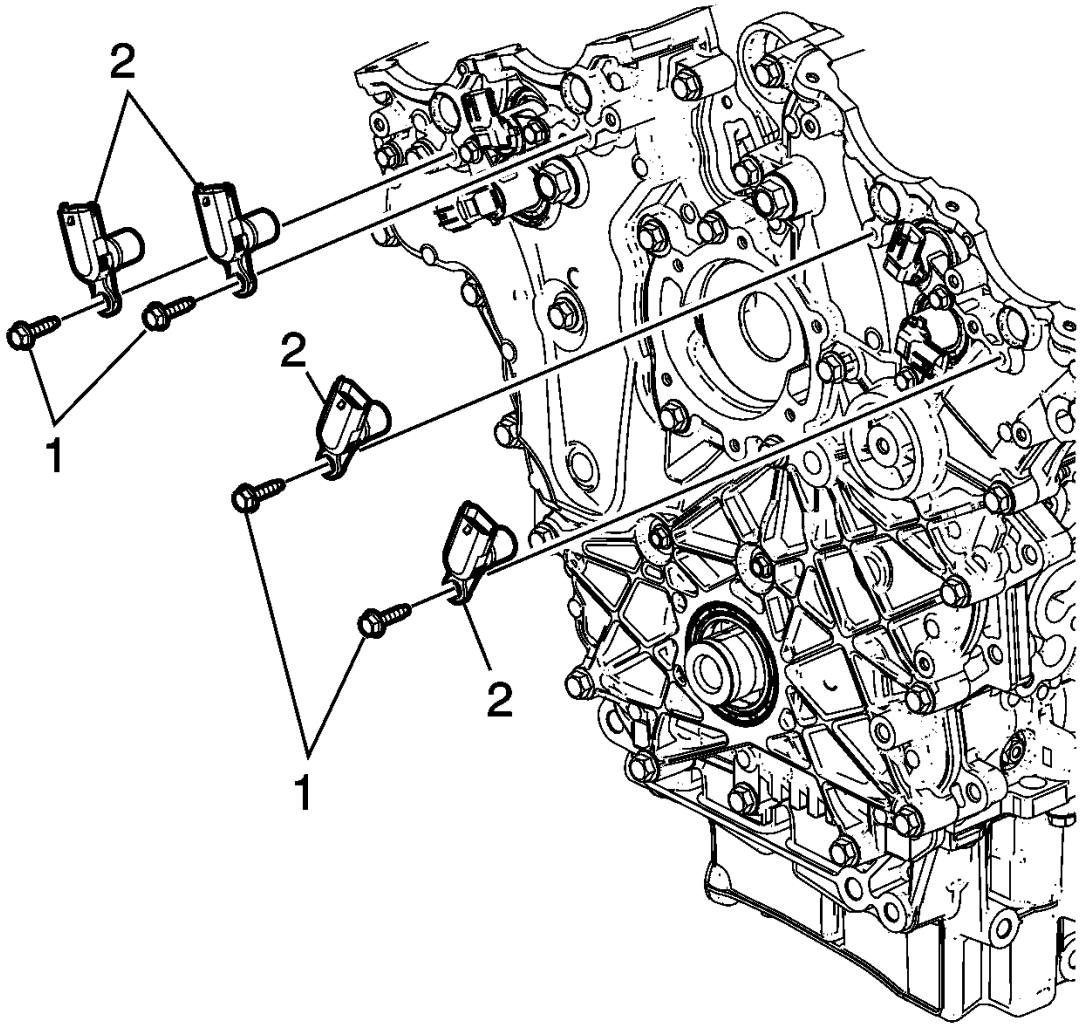

Fig. 37: Camshaft Position Sensors & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the camshaft position sensor bolts (1).
2. Remove the camshaft position sensors (2).

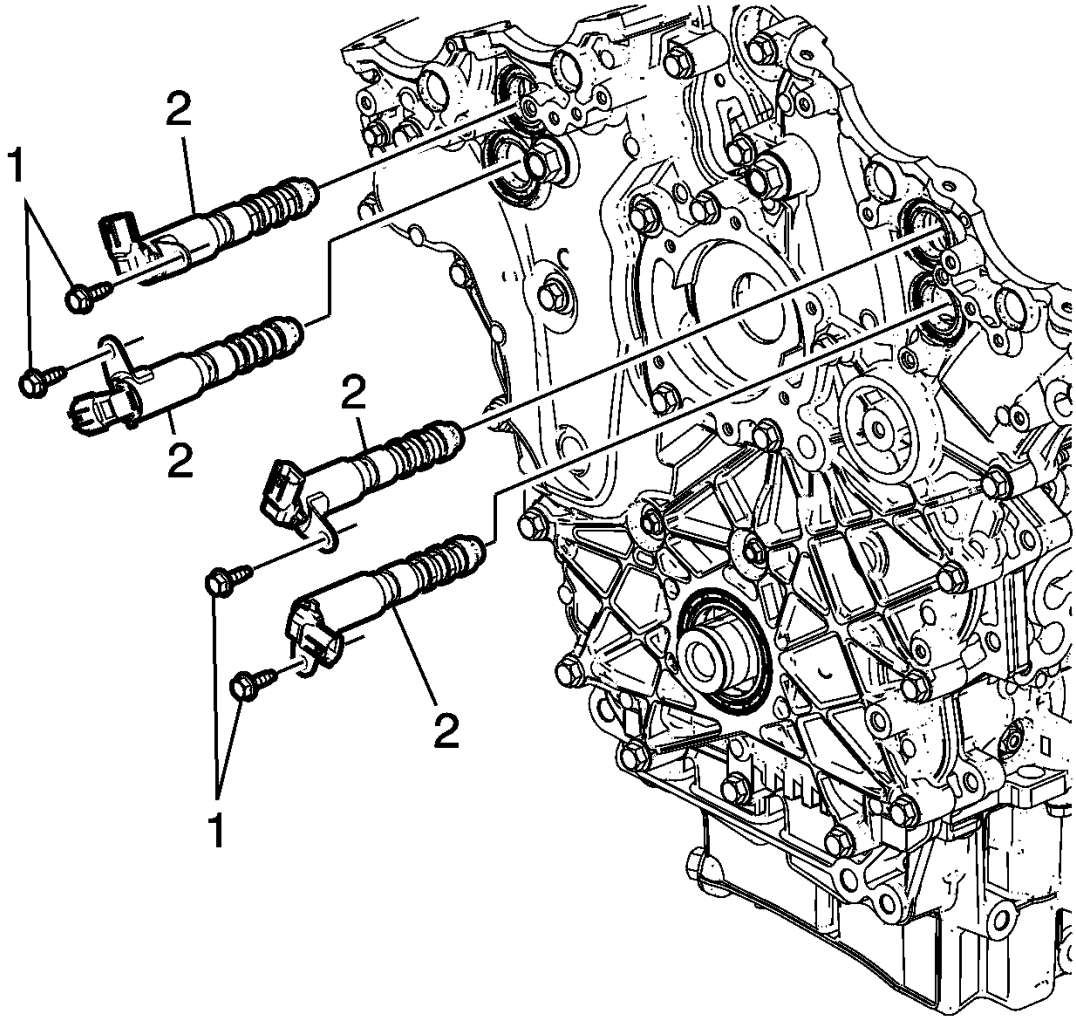

Fig. 38: Camshaft Position Actuator Valve And Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft position actuator valve bolts (1).

CAUTION: The camshaft position actuator valves must be removed from the front cover prior to front cover removal or damage to the valves may occur.

4. Remove the camshaft position actuator valves (2) from the front cover.

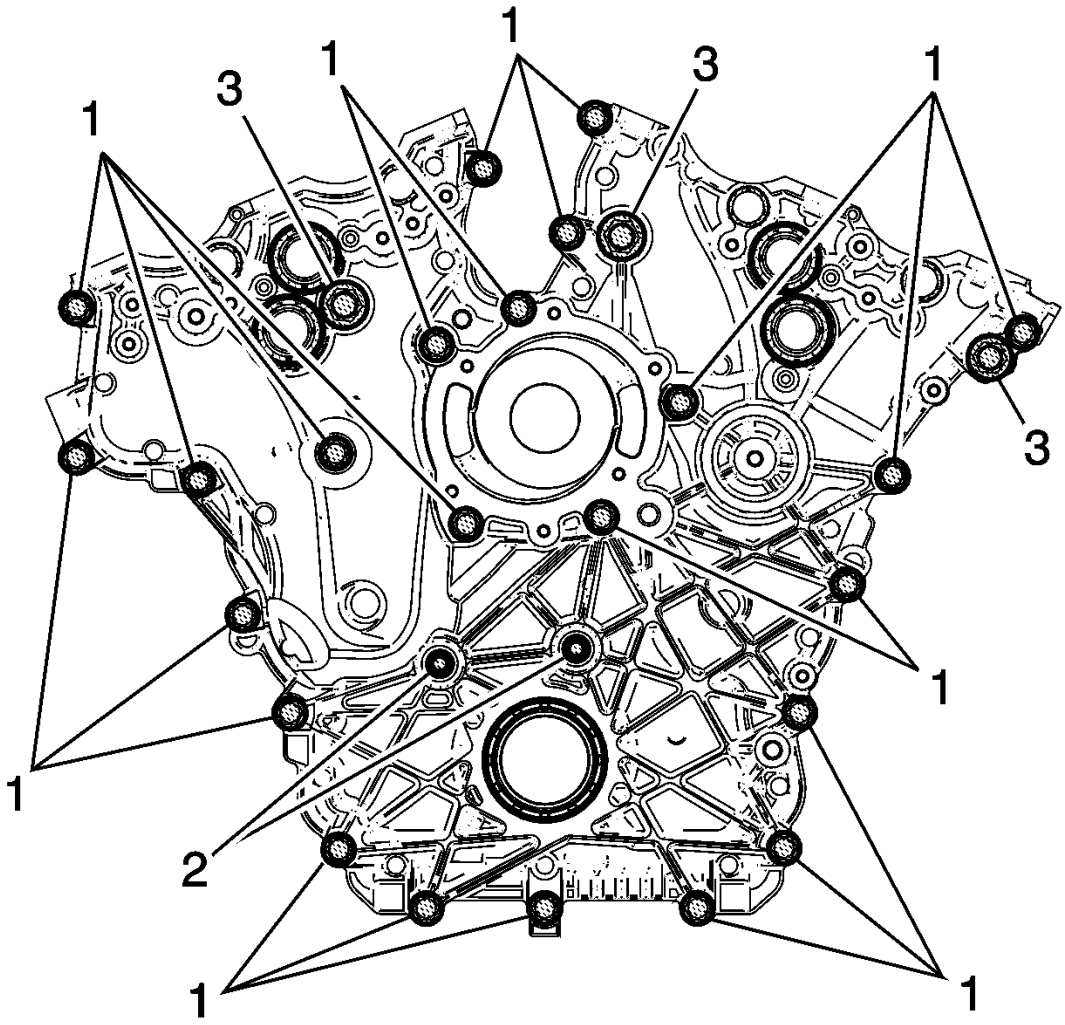

Fig. 39: Identifying Engine Front Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Engine front cover bolts in the number (3) location are model dependent and may have already been removed.**

NOTE: **There are a total of 23 M8 bolts (1) and 2 M6 bolts (2) that must be removed, and 3 optional M12 bolts (3) that may need to be removed before the front cover will separate from the engine block.**

5. Remove the engine front cover bolts (1-3).

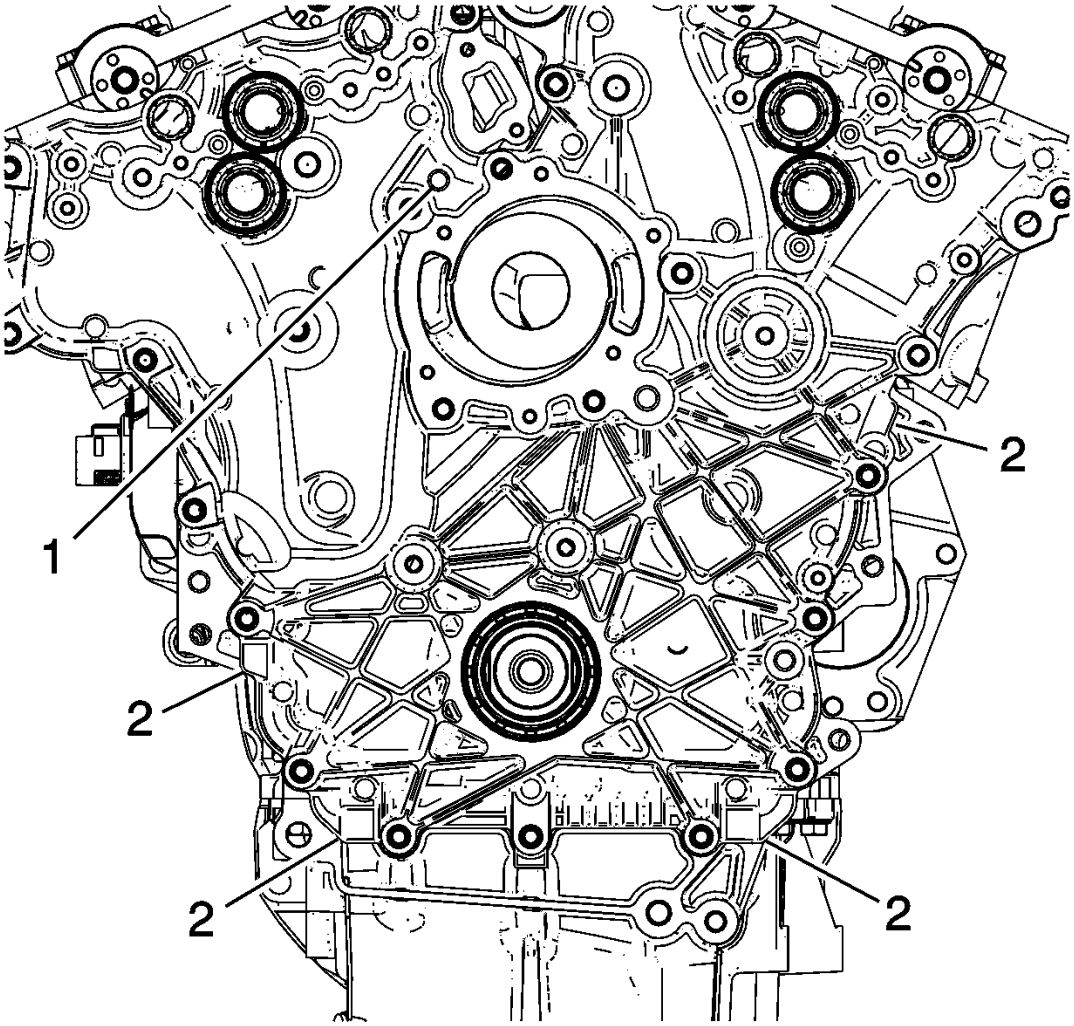

Fig. 40: Locating Jackscrew Hole
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Do not use the jackscrew hole without first removing all engine front cover bolts. Failure to remove all engine front cover bolts before using the jackscrew hole could result in damage to components.**

CAUTION: **Do not pry between the engine front cover and the camshaft position sensors or the camshaft position actuators in order to separate the RTV. Use the pry points and a bolt in the jackscrew hole in order to remove the engine front cover. Damage to the camshaft position sensors or the camshaft position actuators may occur if the camshaft position sensors or the camshaft position actuators are used to pry against in order to remove the engine front cover.**

6. Loosely install a 10 x 1.5 mm bolt in the jackscrew hole (1).
7. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
8. Using the pry points (2) located at the edge of the front cover and the jackscrew, separate the room temperature vulcanizing (RTV) sealant.

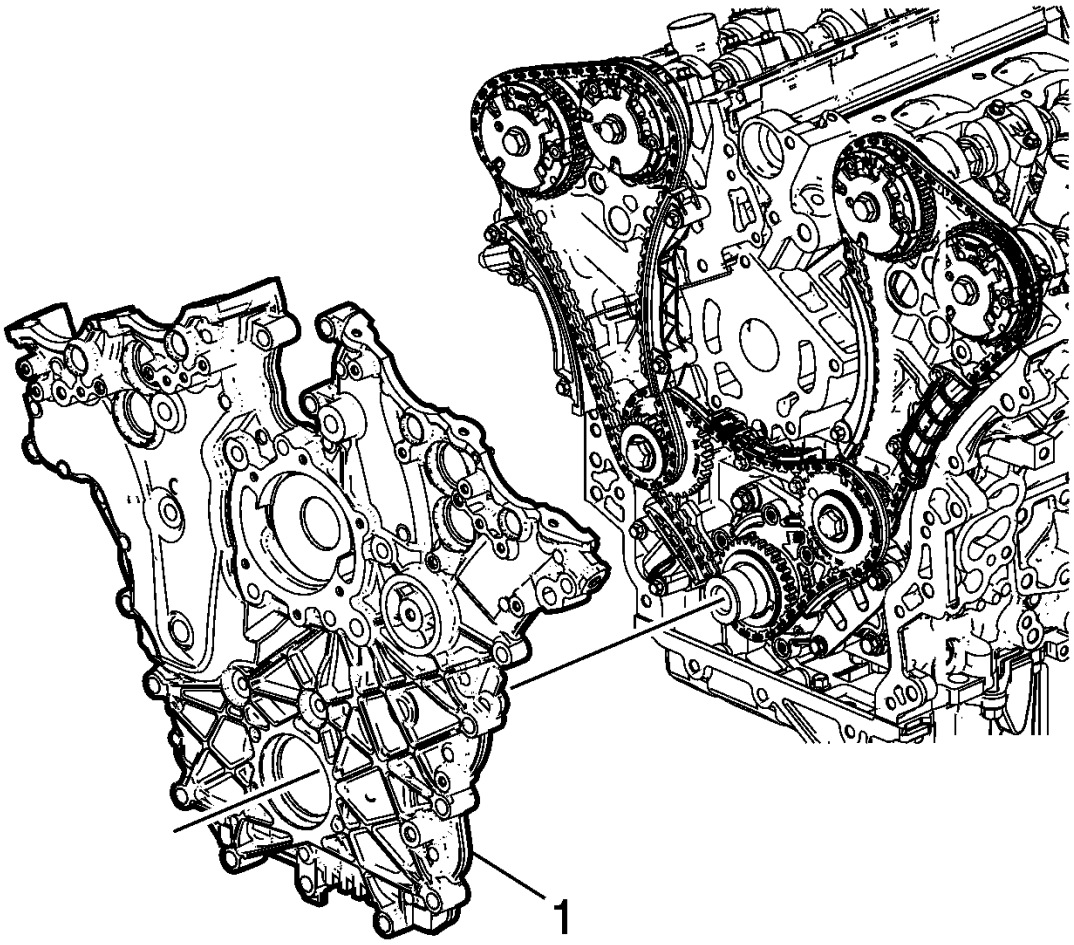

Fig. 41: View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

9. Remove the engine front cover (1).

CAMSHAFT TIMING CHAIN COMPONENTS REMOVAL

Secondary Camshaft Drive Chain Components Removal - Right Side

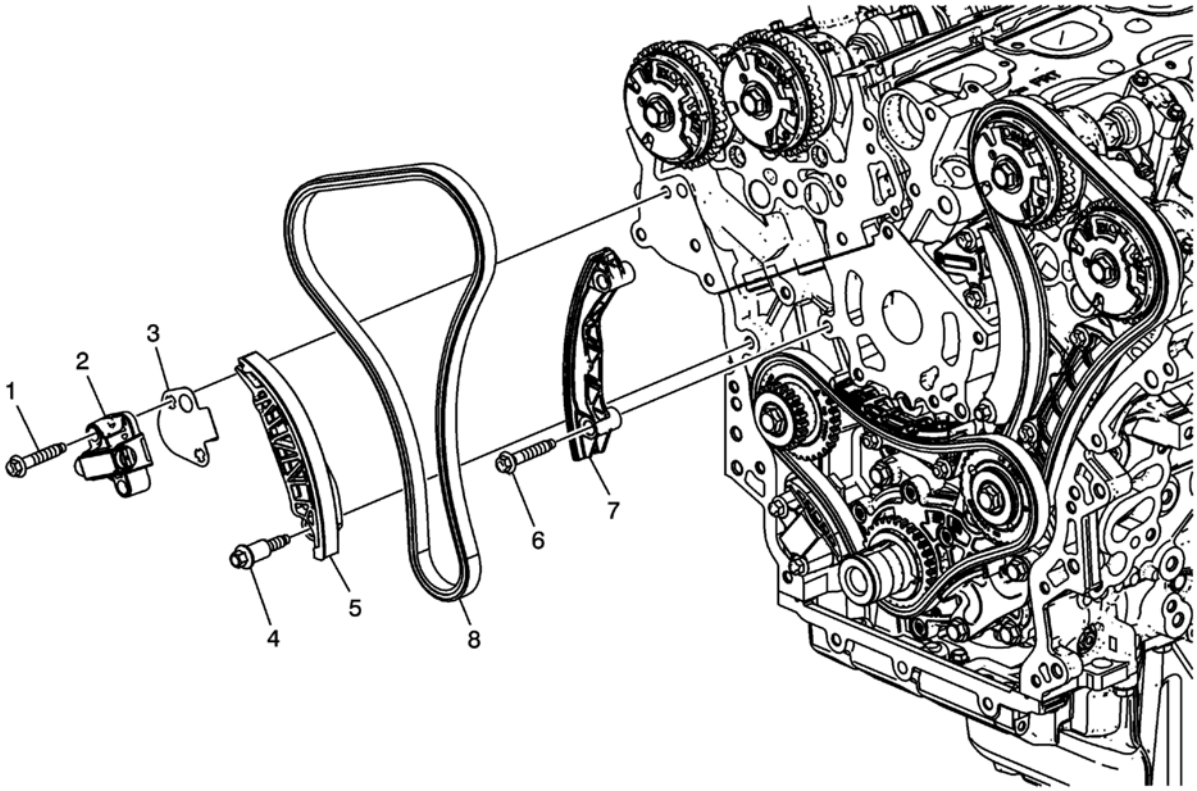

Fig. 42: Secondary Camshaft Drive Chain Components - Right Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Components Removal - Right Side

Callout	Component Name
1	Right Secondary Timing Chain Tensioner Bolt
2	Right Secondary Timing Chain Tensioner
3	Right Timing Chain Housing Gasket **NOTE:** **Discard the gasket.**
4	Right Secondary Timing Chain Guide Bolt
5	Right Secondary Timing Chain Guide
6	Right Pivot Arm Timing Chain Guide Bolt
7	Right Pivot Arm Timing Chain Guide
8	Secondary Camshaft Intermediate Drive Chain

Primary Camshaft Drive Chain Components Removal

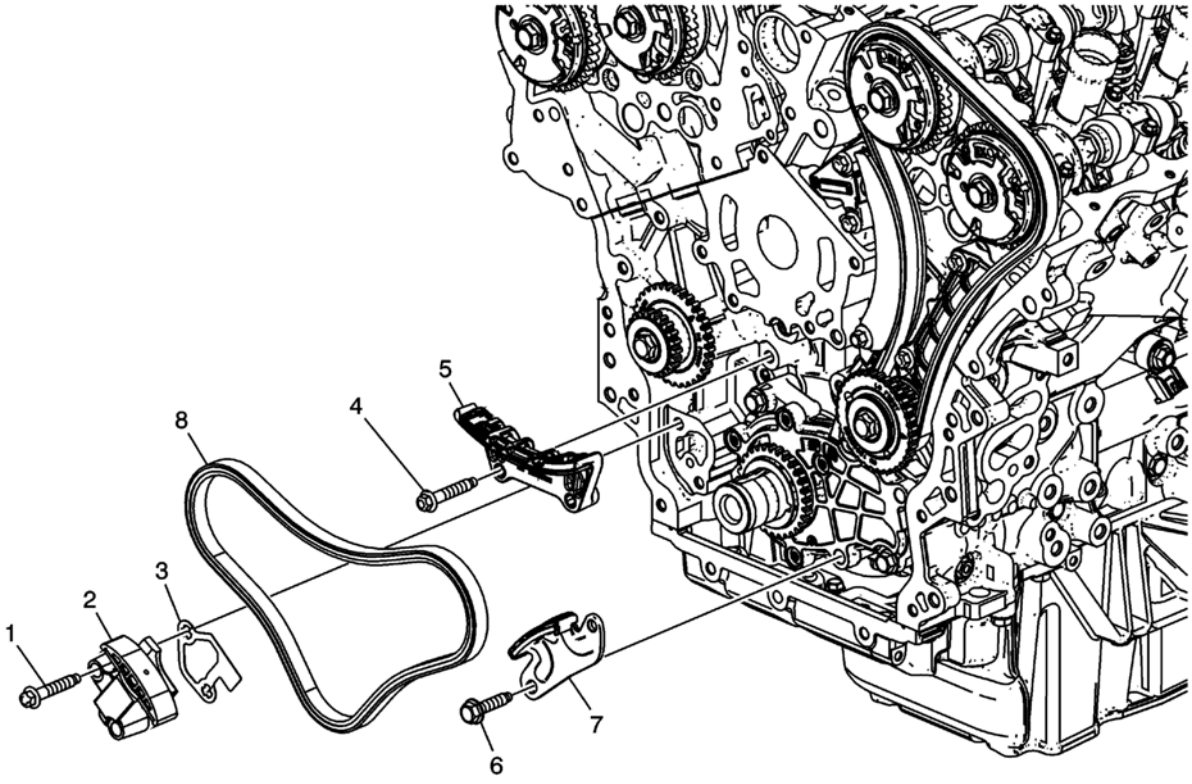

Fig. 43: Primary Camshaft Drive Chain Components
Courtesy of GENERAL MOTORS COMPANY

Primary Camshaft Drive Chain Components Removal

Callout	Component Name
1	Camshaft Intermediate Drive Chain Tensioner Bolt
2	Camshaft Intermediate Drive Chain Tensioner
3	Timing Chain Housing Gasket **NOTE:** **Discard the gasket.**
4	Upper Primary Timing Chain Guide Bolt
5	Upper Primary Timing Chain Guide
6	Lower Primary Timing Chain Guide Bolt
7	Lower Primary Timing Chain Guide
8	Primary Camshaft Drive Intermediate Chain

Secondary Camshaft Drive Chain Components Removal - Left Side

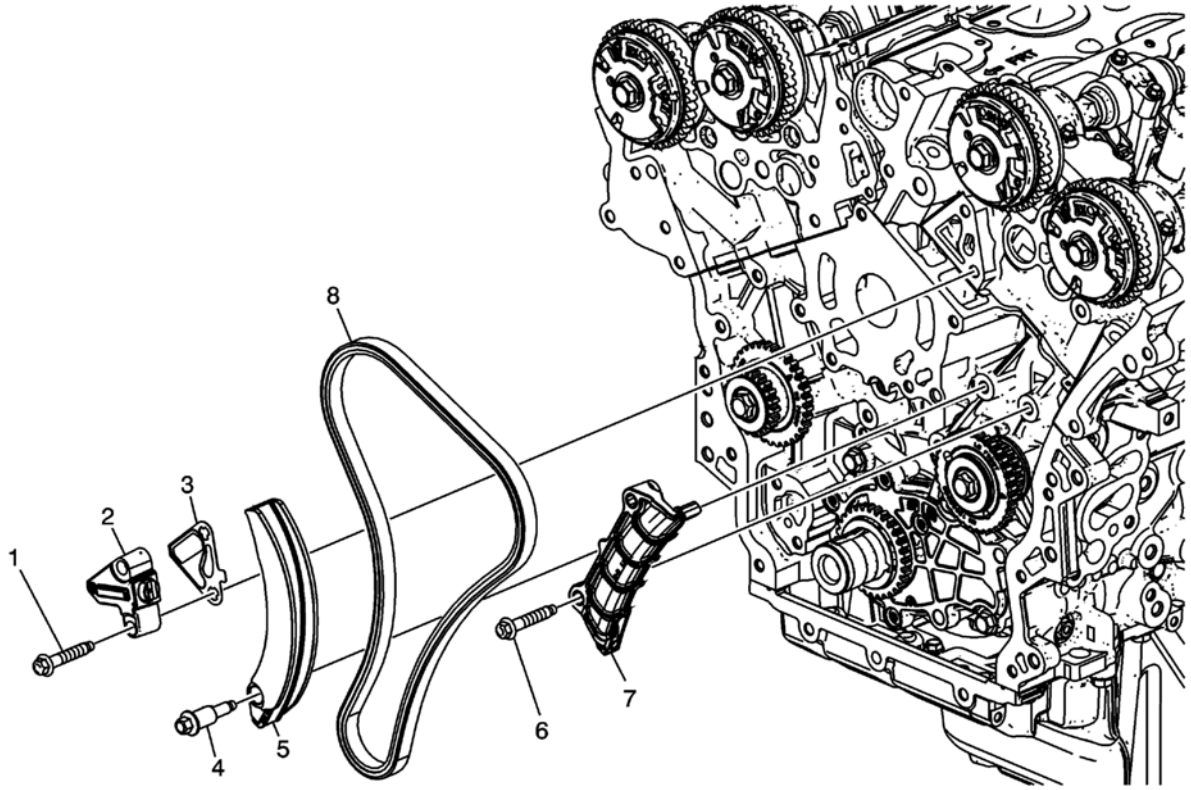

Fig. 44: Secondary Camshaft Drive Chain Components - Left Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Components Removal - Left Side

Callout	Component Name
1	Left Secondary Timing Chain Tensioner Bolt
2	Left Secondary Timing Chain Tensioner
3	Left Timing Chain Housing Gasket **NOTE:** **Discard the gasket.**
4	Left Pivot Arm Timing Chain Guide Bolt
5	Left Pivot Arm Timing Chain Guide
6	Left Secondary Timing Chain Guide Bolt
7	Left Secondary Timing Chain Guide
8	Secondary Camshaft Intermediate Drive Chain

TIMING CHAIN IDLER SPROCKET REMOVAL - RIGHT SIDE

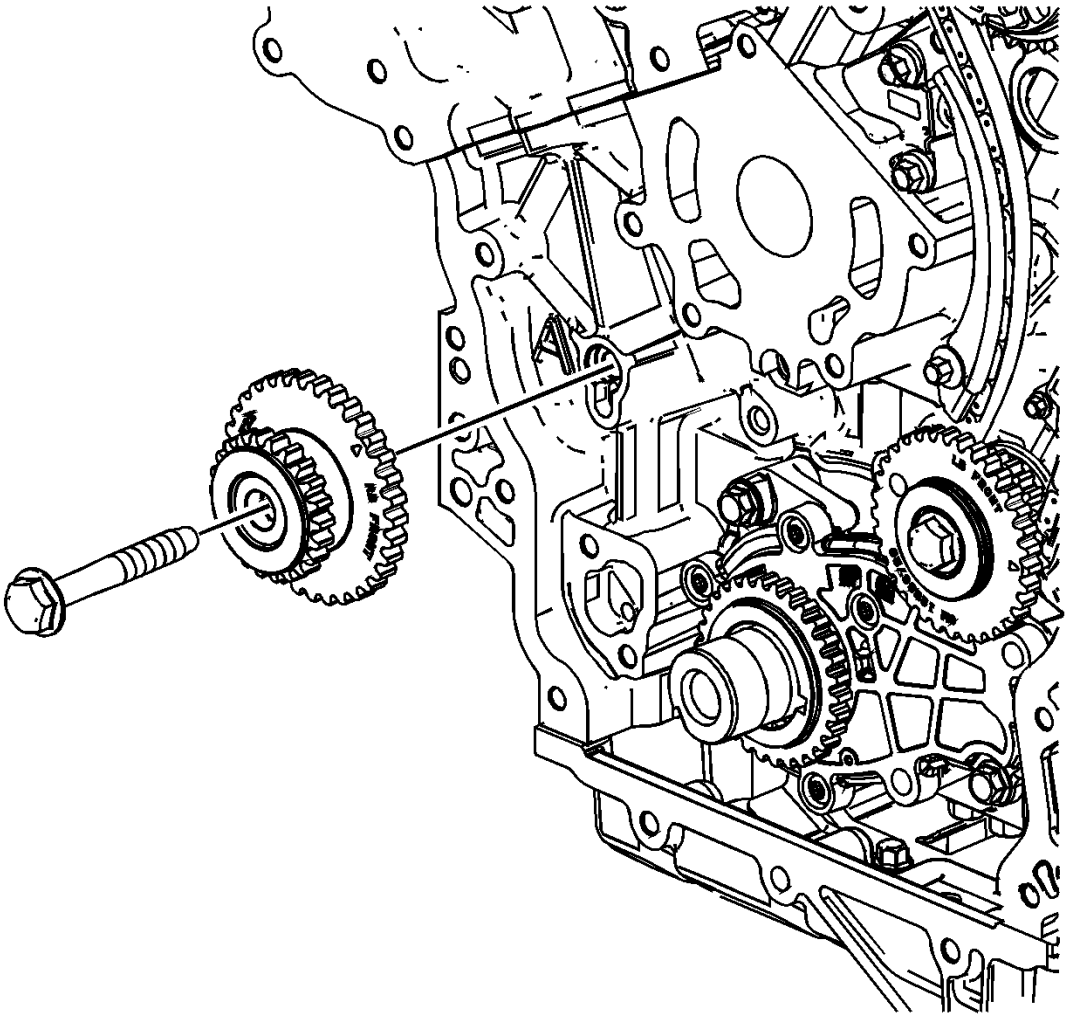

Fig. 45: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right camshaft intermediate drive chain idler bolt.
2. Remove the right camshaft intermediate drive chain idler.

TIMING CHAIN IDLER SPROCKET REMOVAL - LEFT SIDE

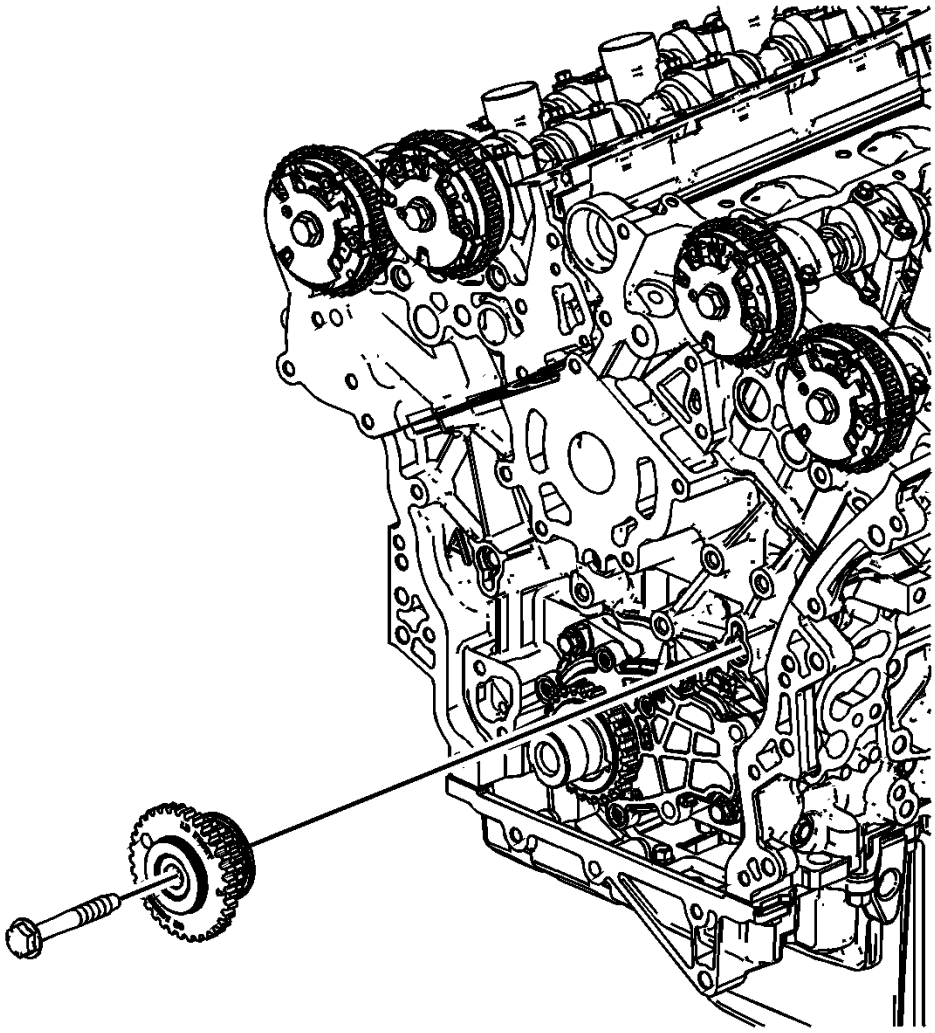

Fig. 46: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left camshaft intermediate drive chain idler bolt.
2. Remove the left camshaft intermediate drive chain idler.

CRANKSHAFT SPROCKET REMOVAL

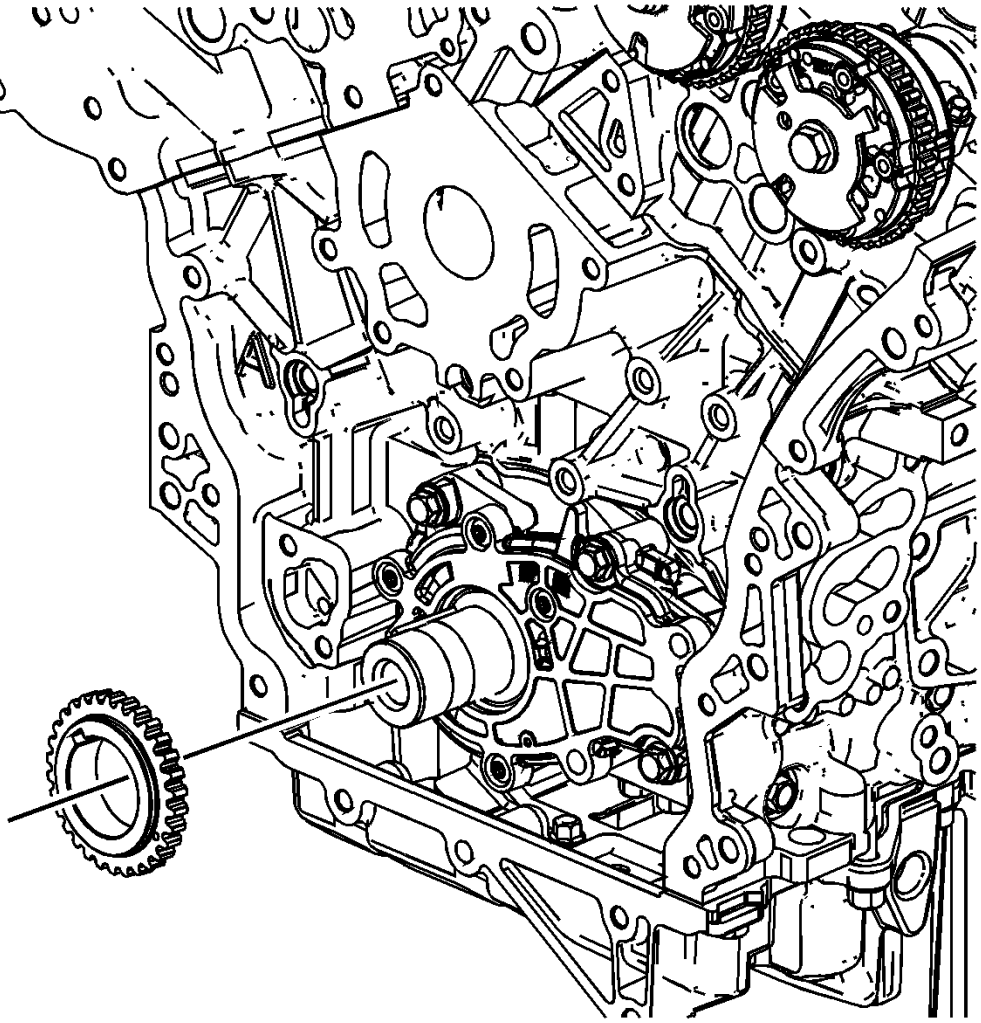

Fig. 47: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

Remove the crankshaft sprocket from the nose of the crankshaft.

CAMSHAFT POSITION ACTUATOR REMOVAL - LEFT SIDE EXHAUST

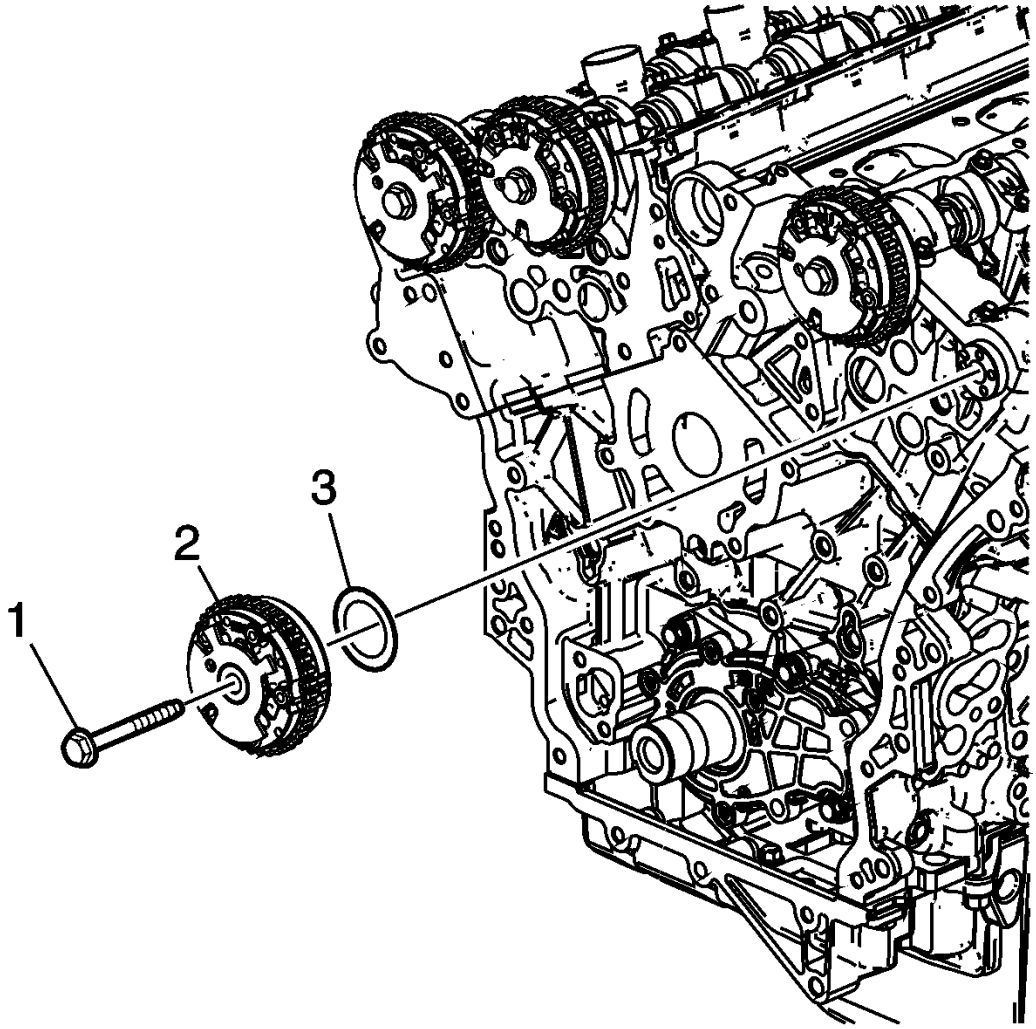

Fig. 48: Locating Exhaust Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
2. Remove the left exhaust camshaft position actuator bolt (1).
3. Remove the left exhaust camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

CAMSHAFT POSITION ACTUATOR REMOVAL - LEFT SIDE INTAKE

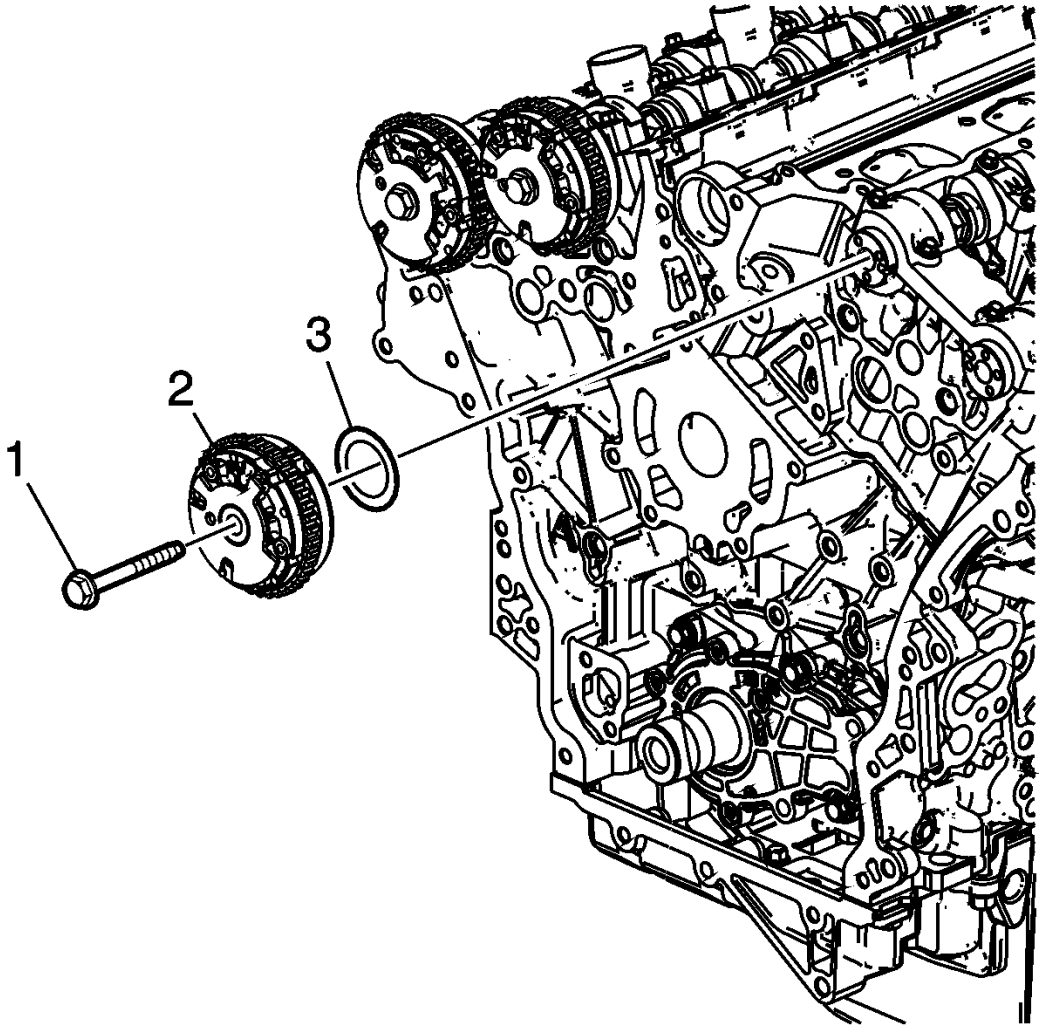

Fig. 49: View Of Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
2. Remove the left intake camshaft position actuator bolt (1).
3. Remove the left intake camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

CAMSHAFT POSITION ACTUATOR REMOVAL - RIGHT SIDE EXHAUST

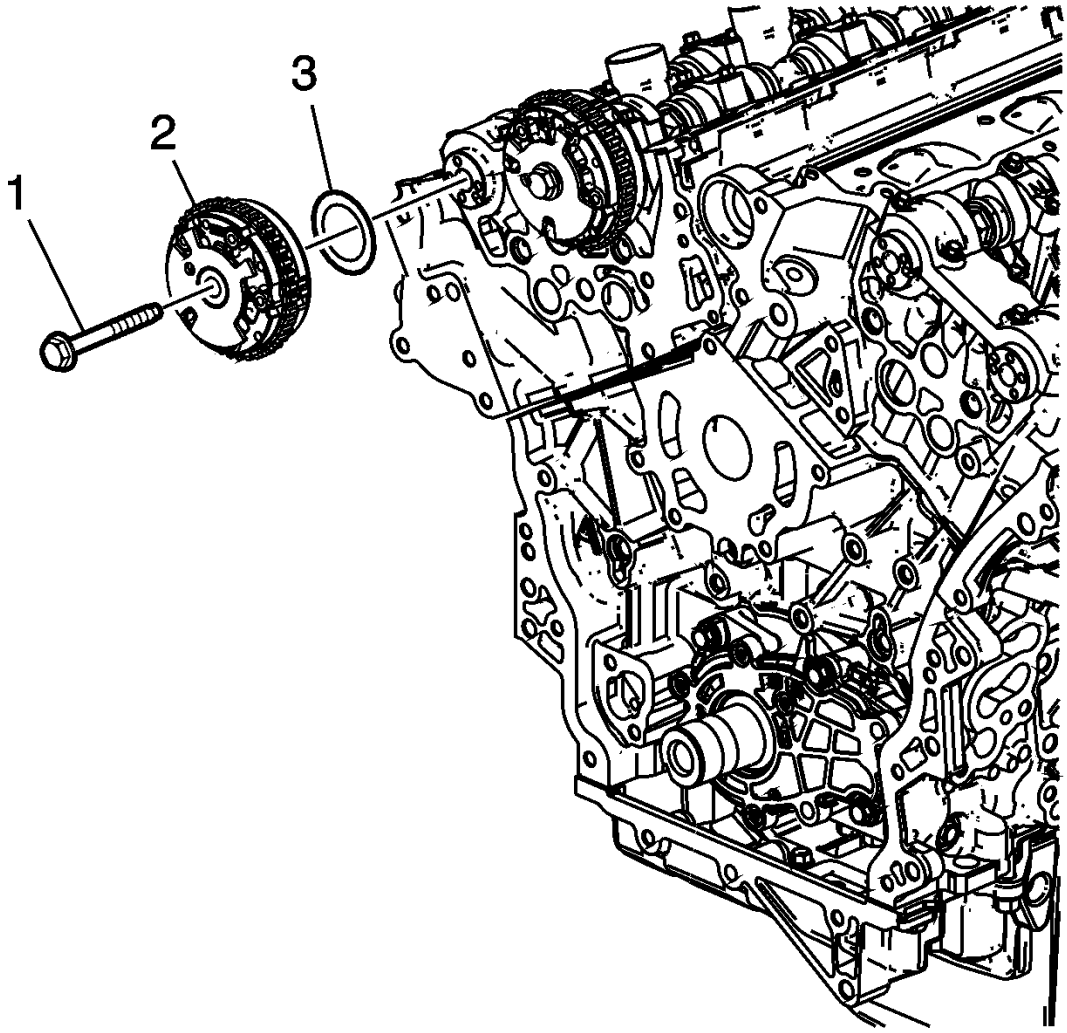

Fig. 50: Identifying Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
2. Remove the right exhaust camshaft position actuator bolt (1).
3. Remove the right exhaust camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

CAMSHAFT POSITION ACTUATOR REMOVAL - RIGHT SIDE INTAKE

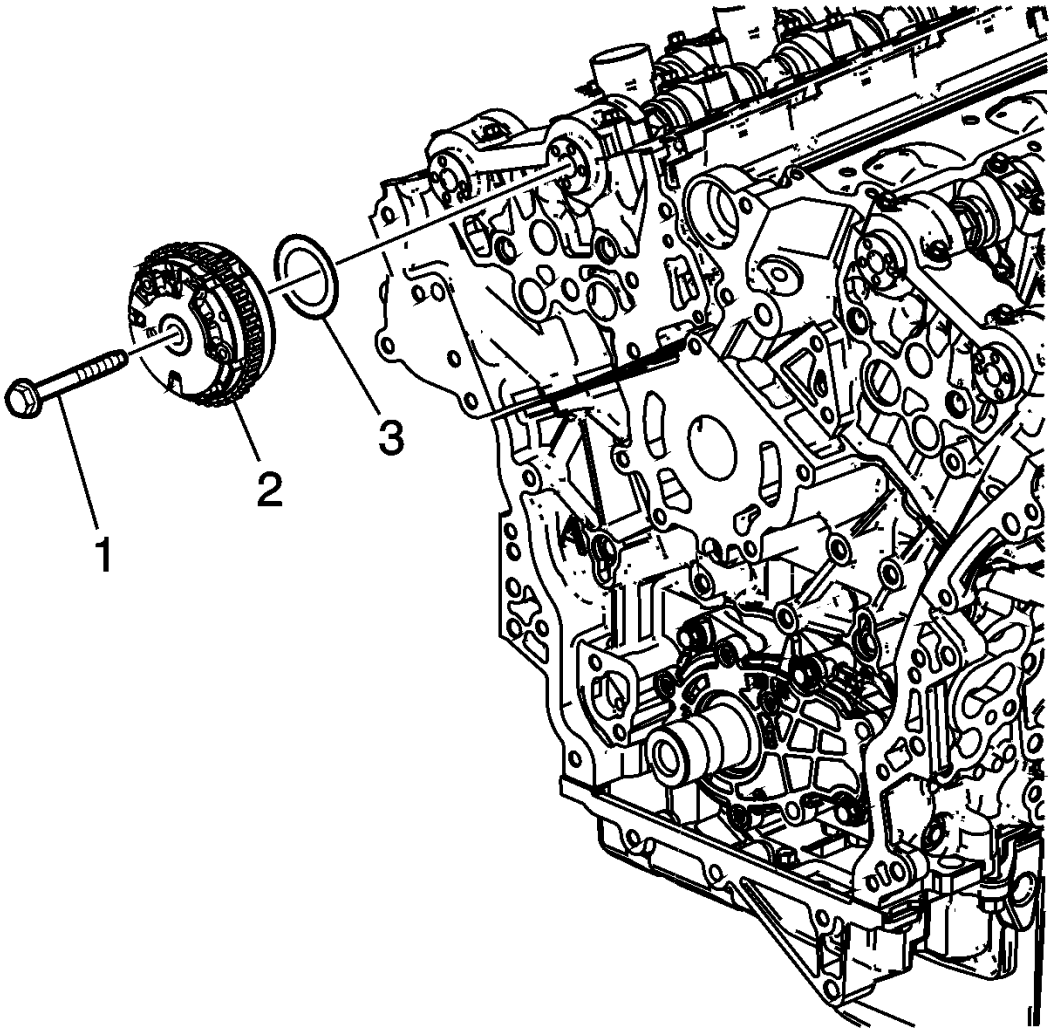

Fig. 51: Identifying Intake Camshaft Position Actuator & Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

1. Use an open wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
2. Remove the right intake camshaft position actuator bolt (1).
3. Remove the right intake camshaft position actuator (2).
4. Remove the camshaft thrust washer if applicable (3).

FUEL PUMP REMOVAL (LFX)

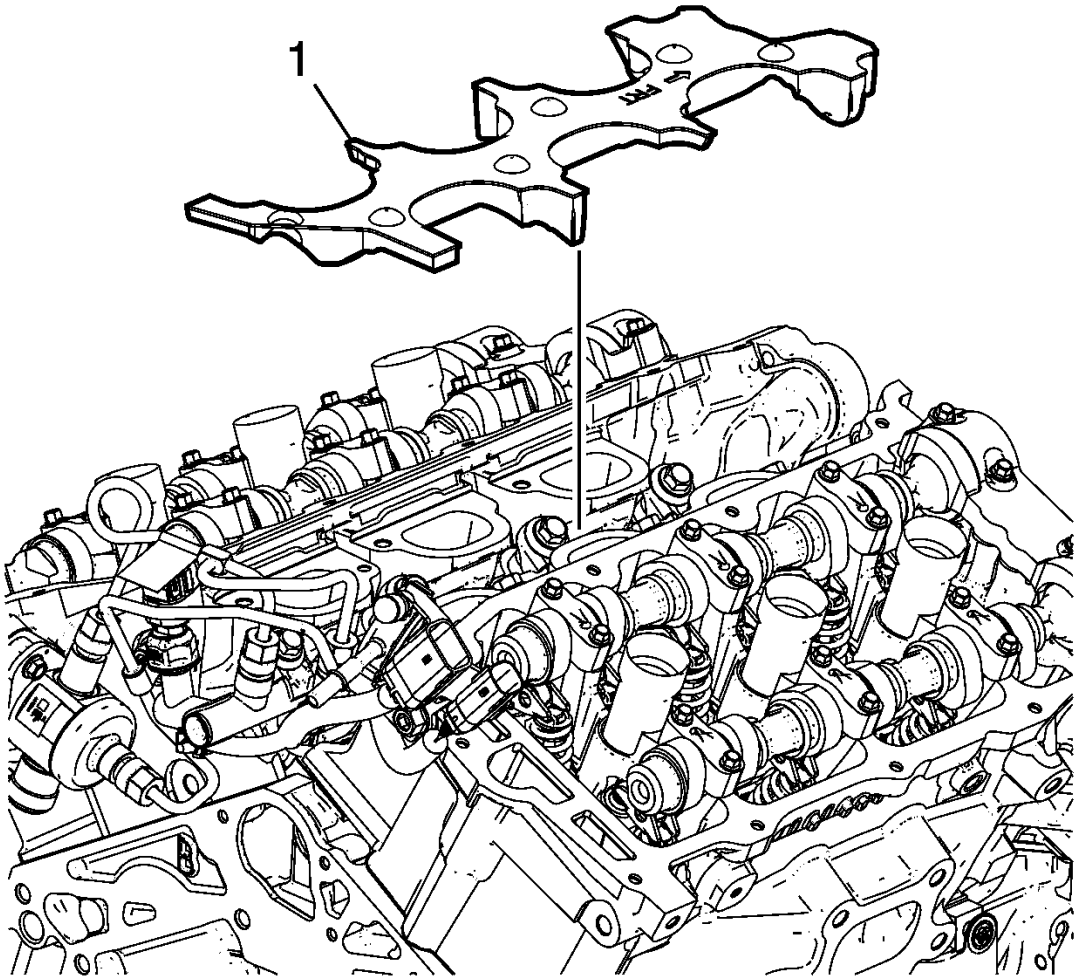

Fig. 52: Identifying Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel rail noise shield (1).

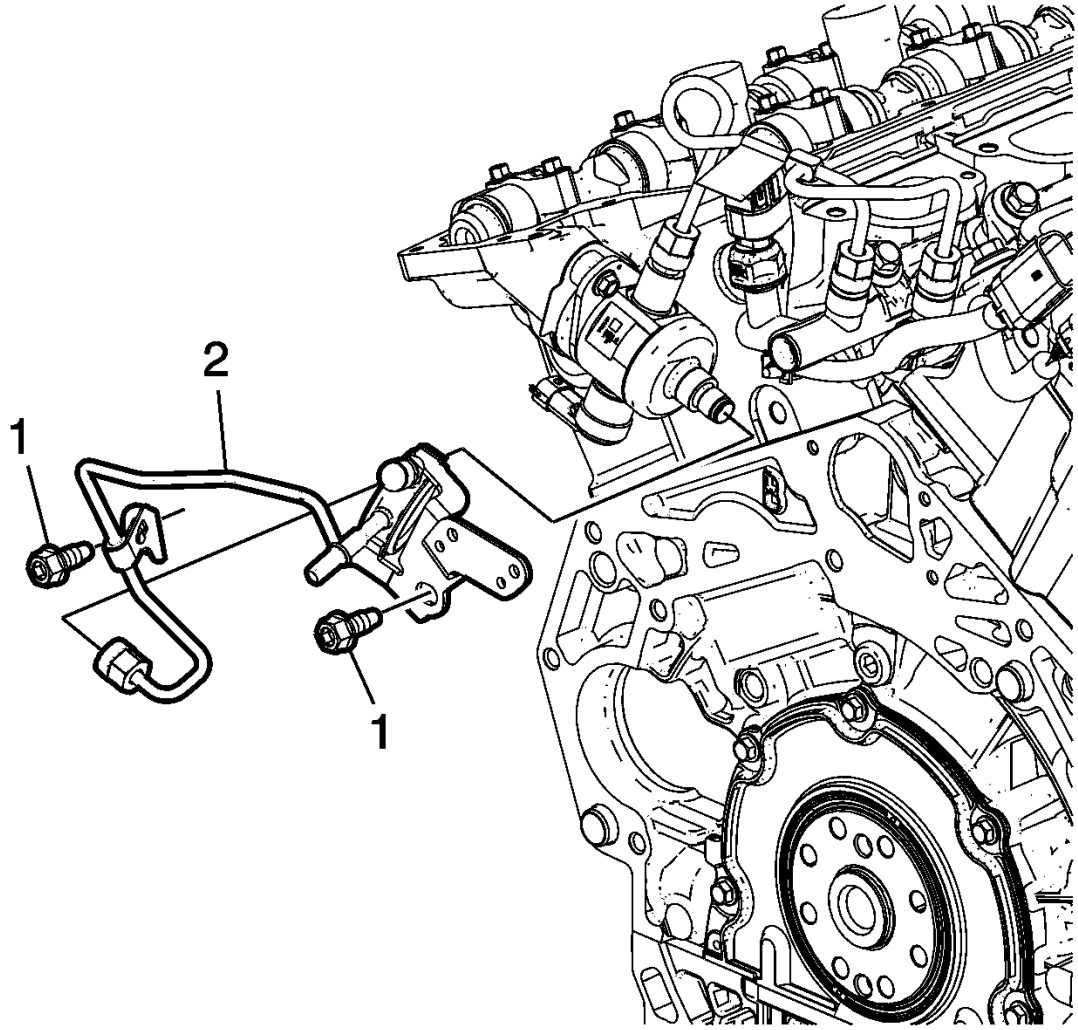

Fig. 53: Identifying Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel rail wiring connectors from the fuel feed pipe bracket.
3. Remove the fuel feed pipe bolts (1).
4. Remove and discard the fuel feed pipe (2).

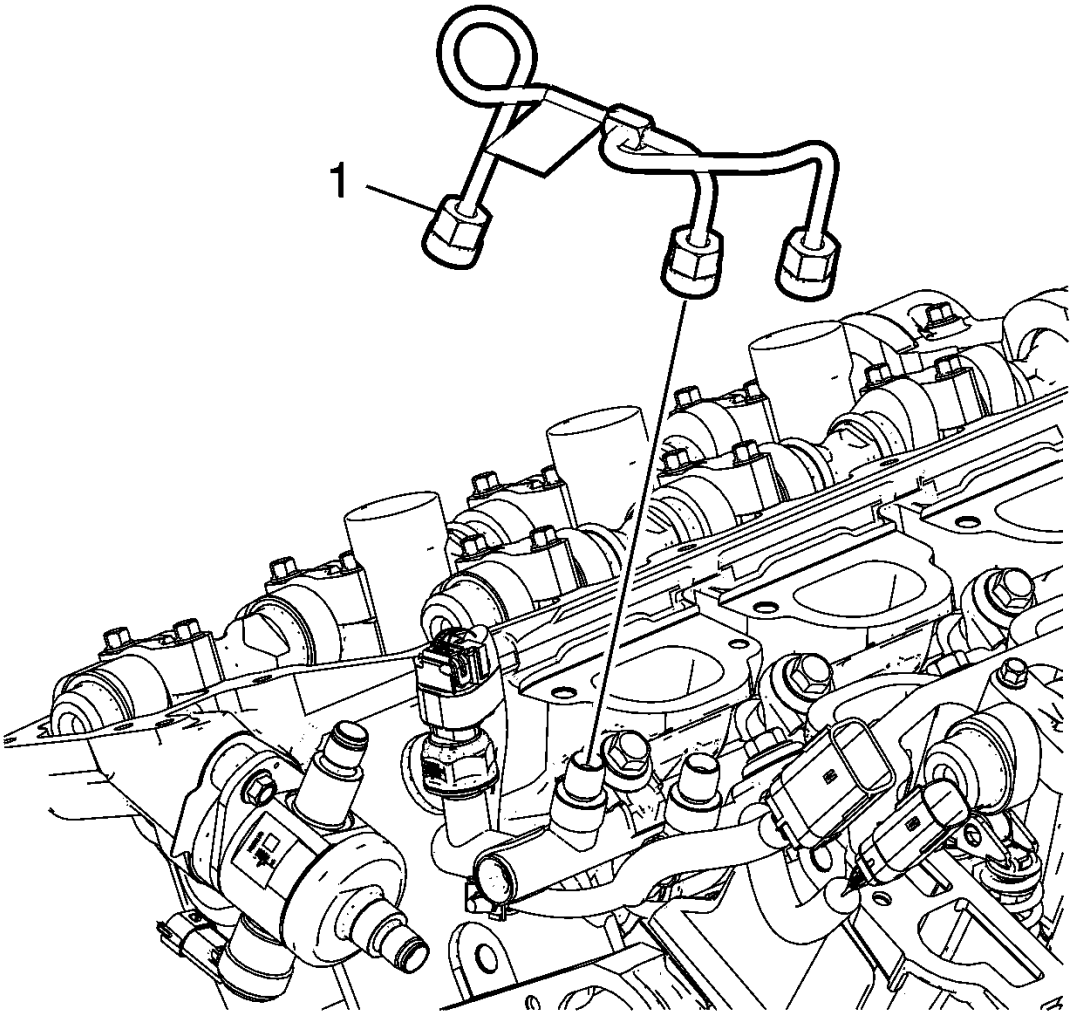

Fig. 54: Identifying High Pressure LH To RH Fuel Rail Crossover Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Remove and discard the high pressure LH to RH fuel rail crossover pipe (1).

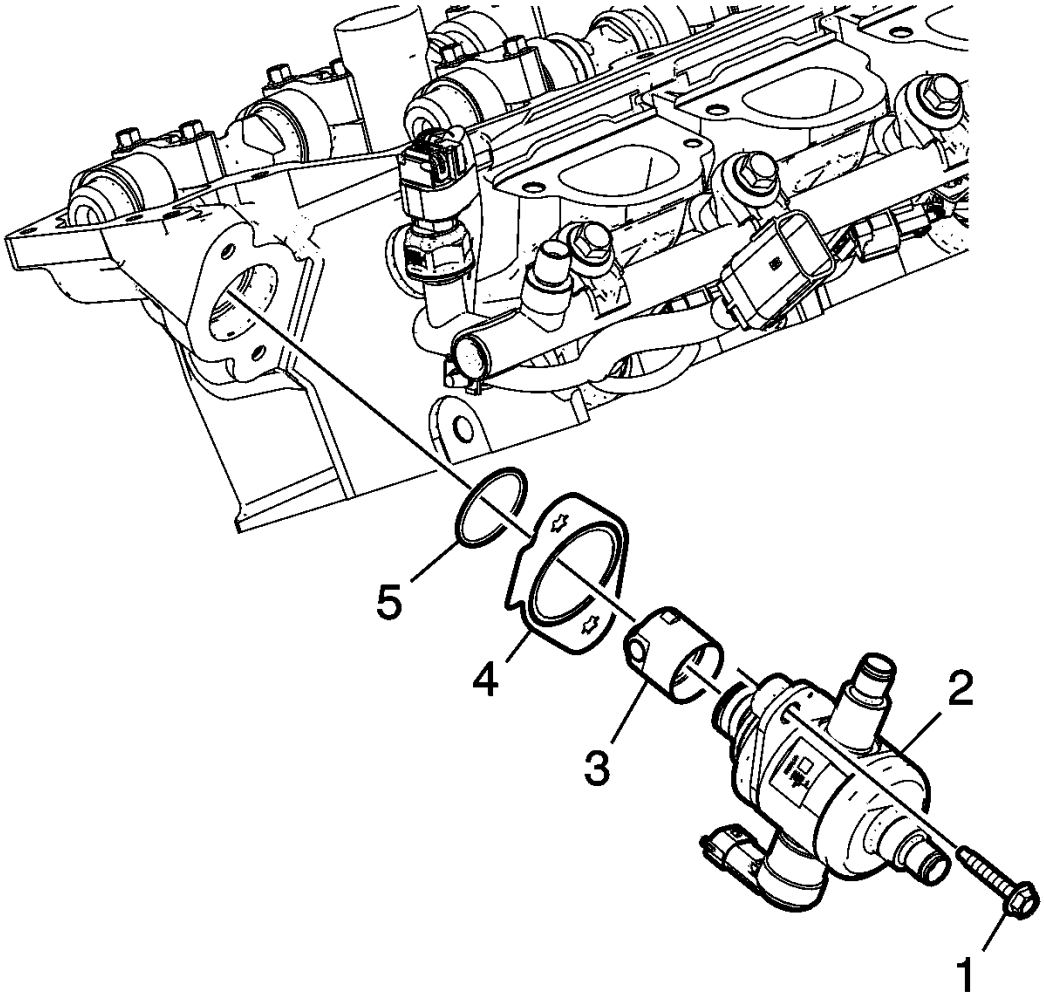

Fig. 55: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

6. Remove and discard high pressure fuel pump bolts (1).
7. Remove the high pressure fuel pump (2).
8. Remove the valve lifter follower (3).
9. Remove and discard the high pressure fuel pump gasket (4).
10. Remove and discard the high pressure fuel pump O-ring (5).

CAMSHAFT REMOVAL - LEFT SIDE

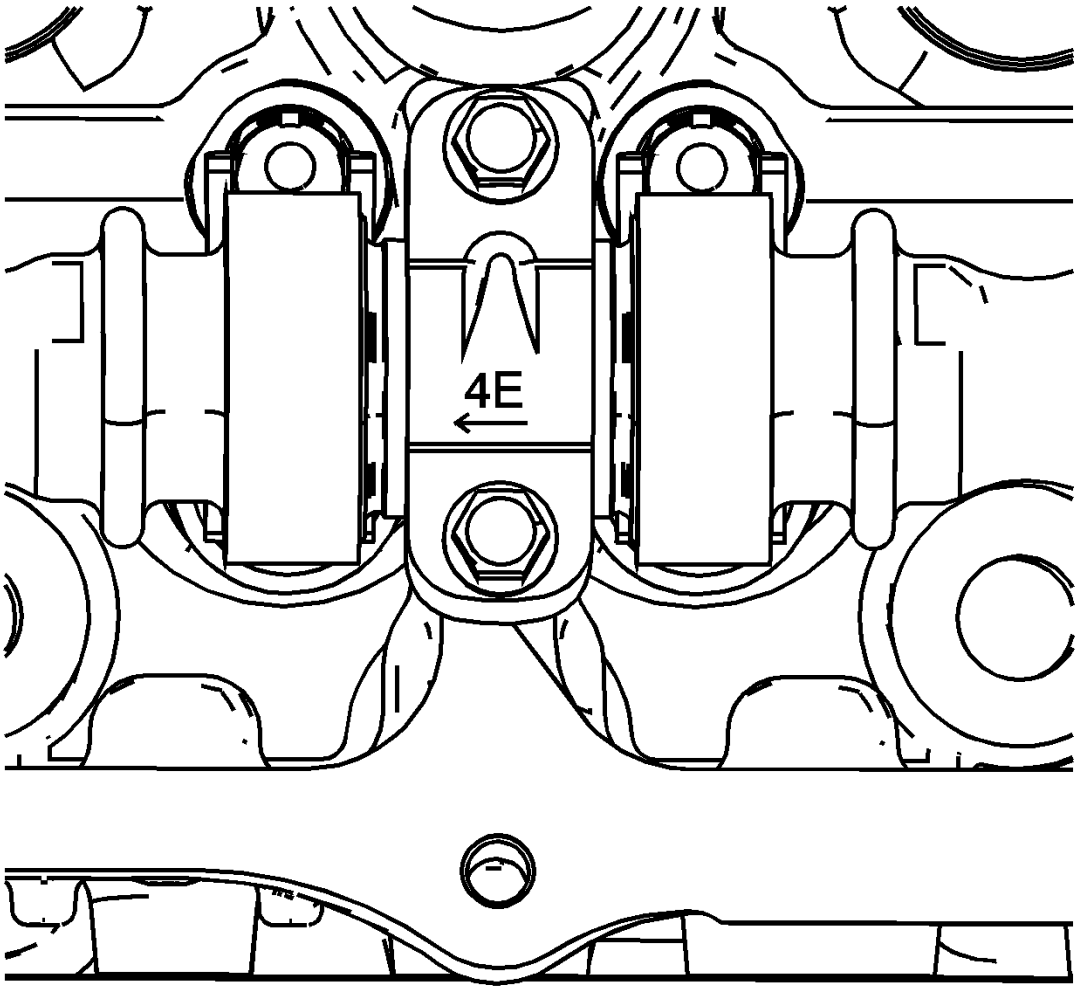

Fig. 56: Identifying Markings On Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number indicates the journal position from the front of the engine.

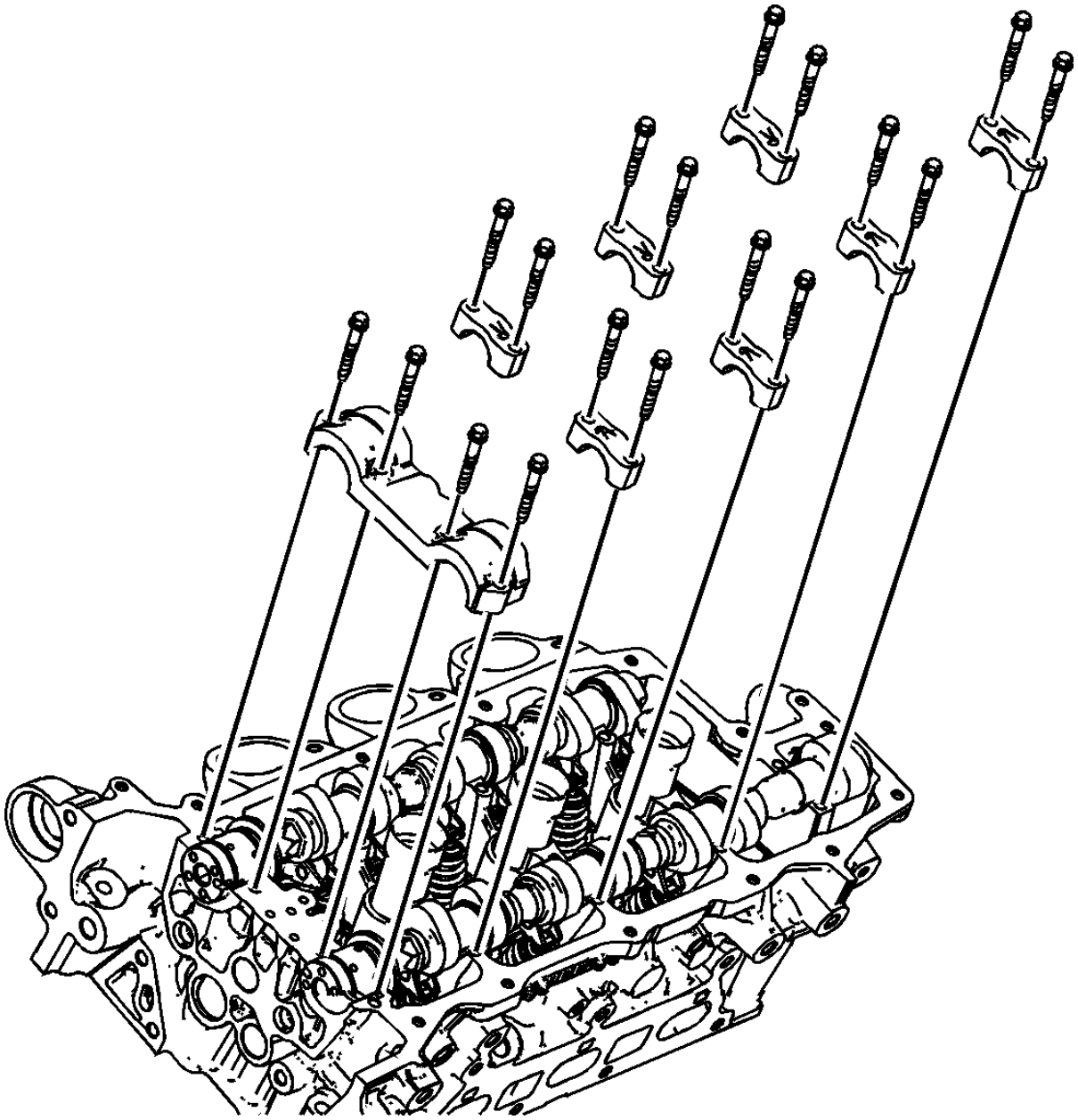

Fig. 57: Camshaft Bearing Thrust Caps
Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft bearing cap bolts.
3. Remove the camshaft bearing caps.

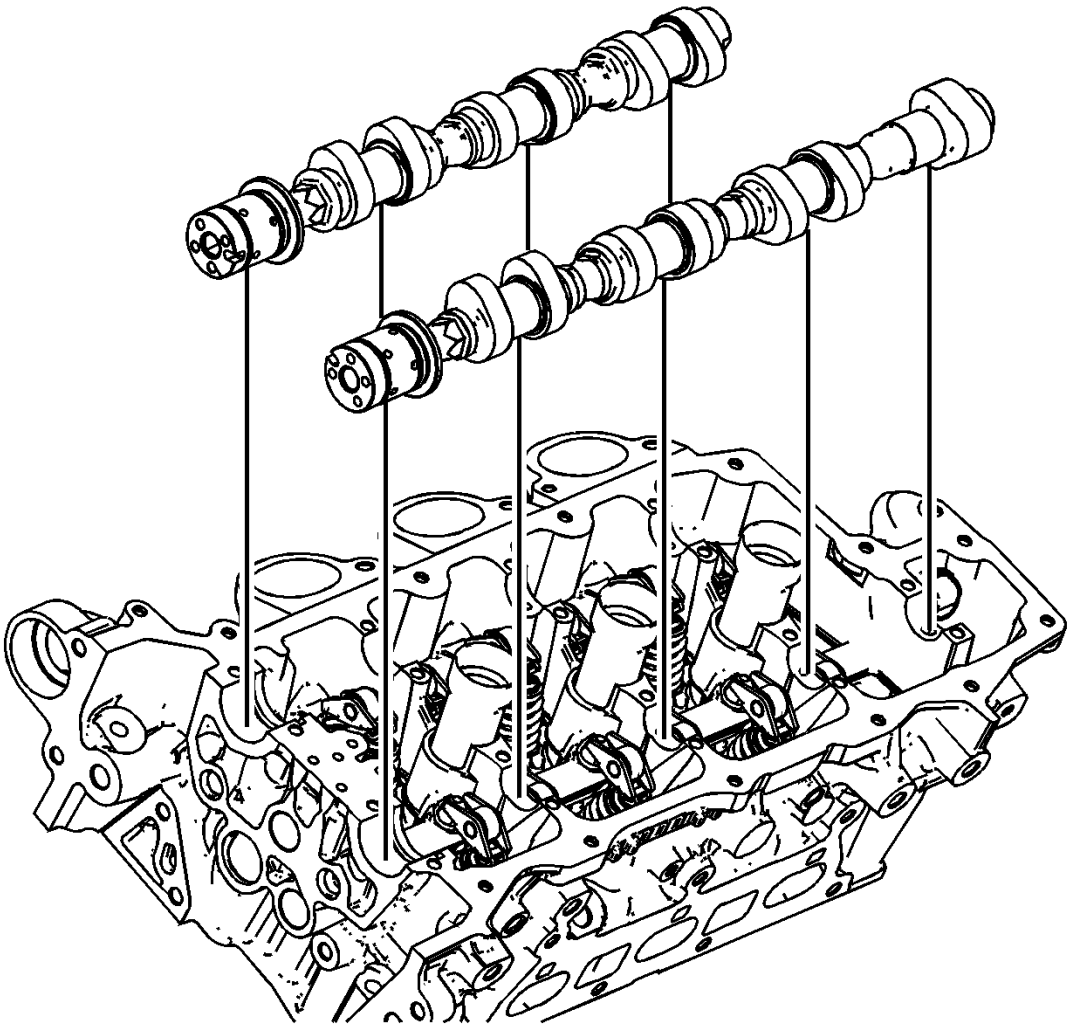

Fig. 58: View of Camshafts and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mark the camshafts upon removal to ensure installation is in the correct position.**

4. Remove the camshafts.

FUEL RAIL REMOVAL

Refer to **Cylinder Head Disassemble (LF1, LFW or LFX)**.

VALVE ROCKER ARM REMOVAL - LEFT SIDE

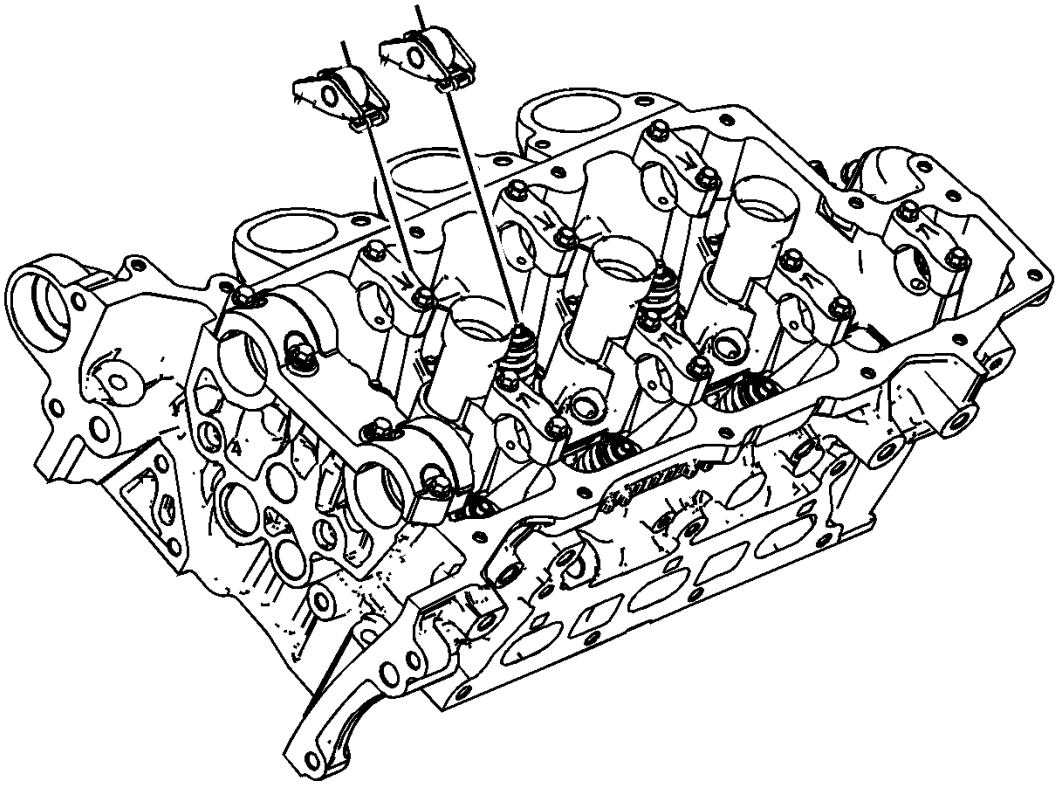

Fig. 59: View of Rocker Arm Assembly
Courtesy of GENERAL MOTORS COMPANY

Remove the valve rocker arms from the cylinder head. If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

VALVE LIFTER REMOVAL - LEFT SIDE

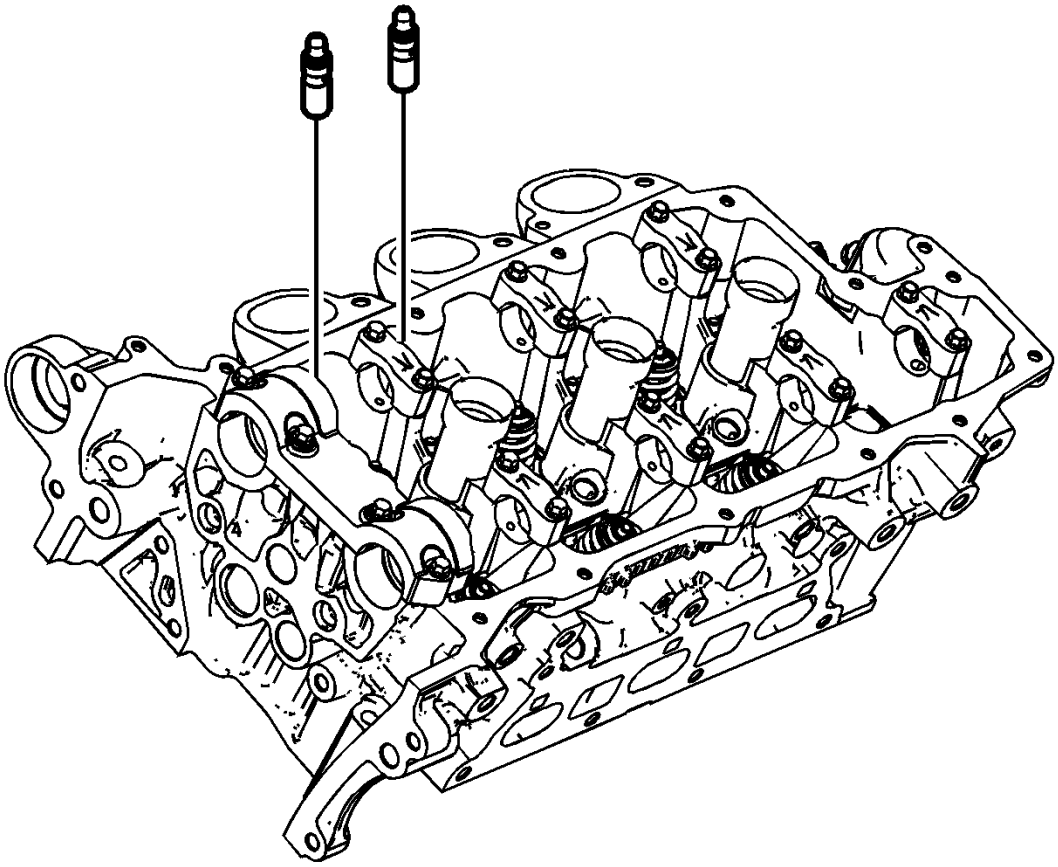

Fig. 60: Valve Lifter Removal - Left Side
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.**
- **Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.**

Remove the valve lifters (SHLAs) from the cylinder head. If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

CYLINDER HEAD REMOVAL - LEFT SIDE (LFX)

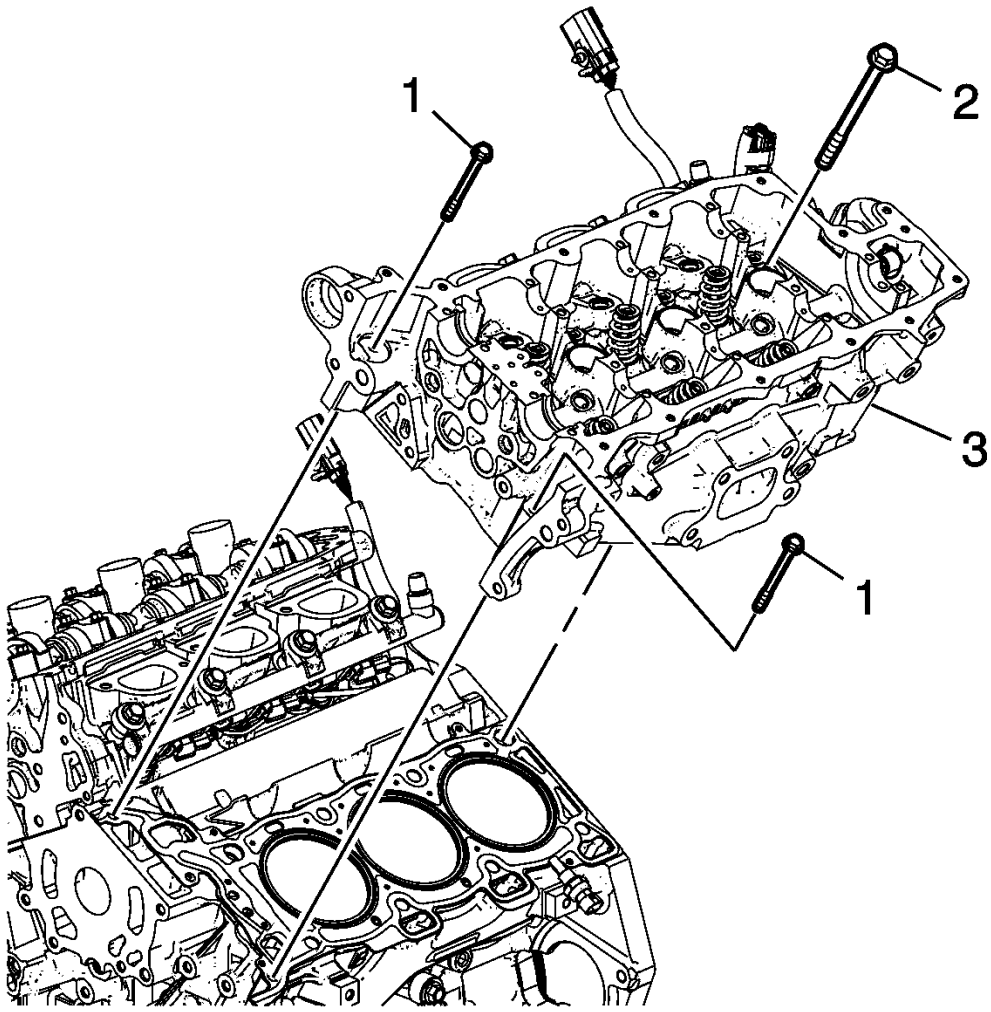

Fig. 61: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the two front M8 left cylinder head bolts (1) and discard.
2. Remove the left cylinder head bolts (2) and discard.
3. Remove the left cylinder head (3).

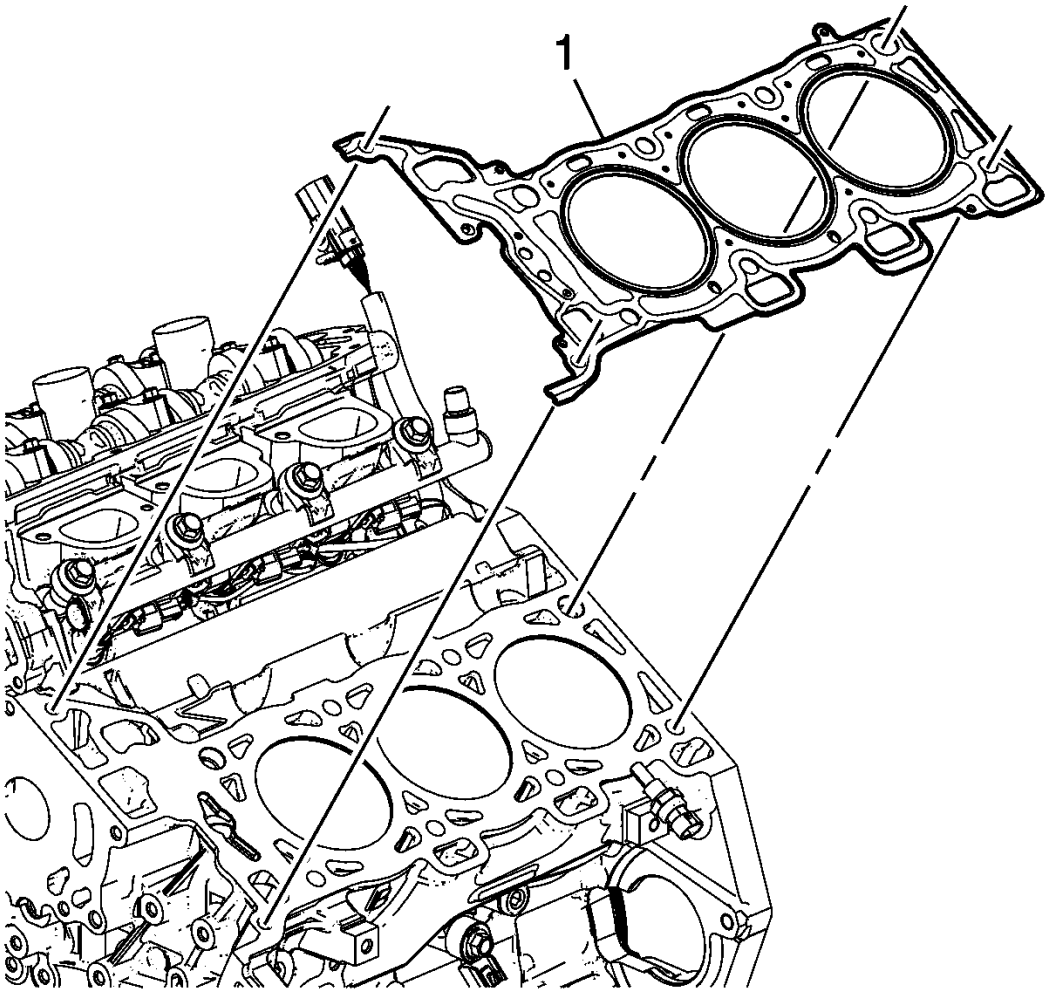

Fig. 62: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the left cylinder head gasket (1).

CAMSHAFT REMOVAL - RIGHT SIDE

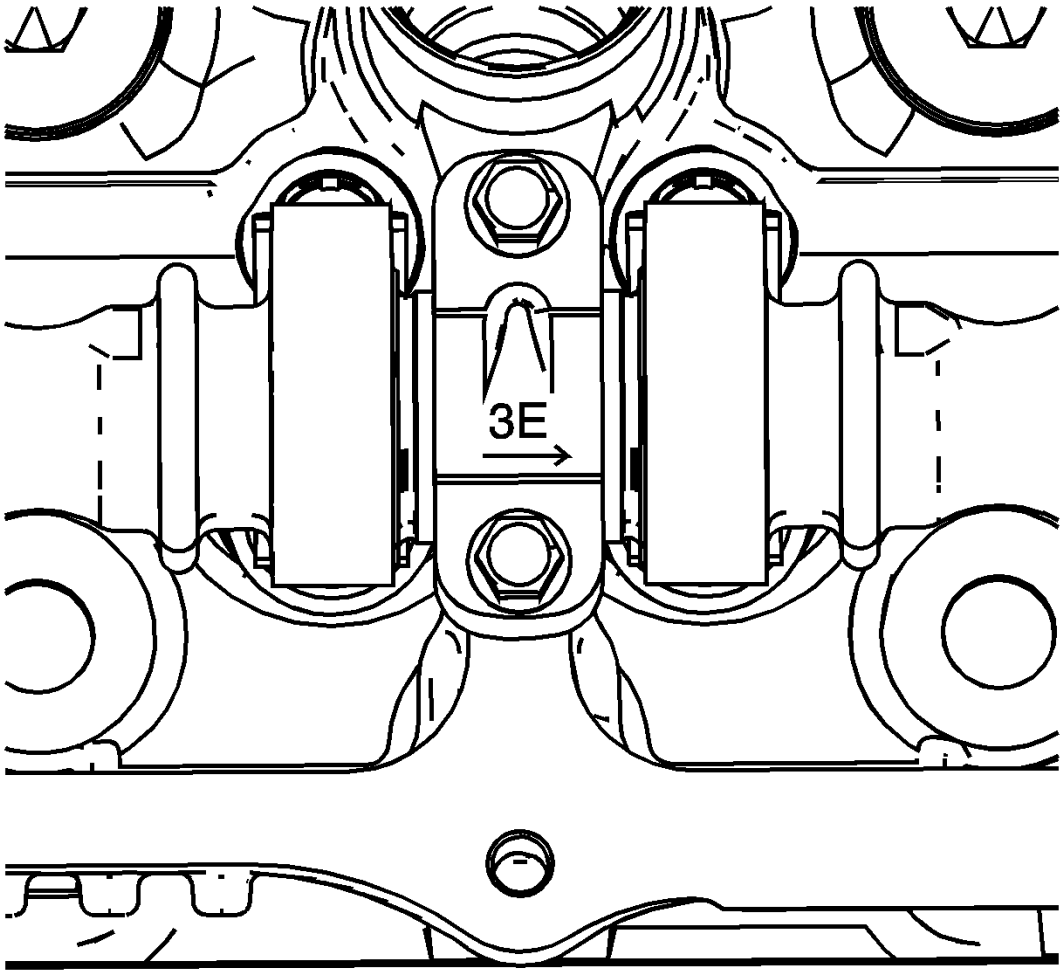

Fig. 63: Identifying Markings On Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

1. Observe the markings on the bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number indicates the journal position from the front of the engine.

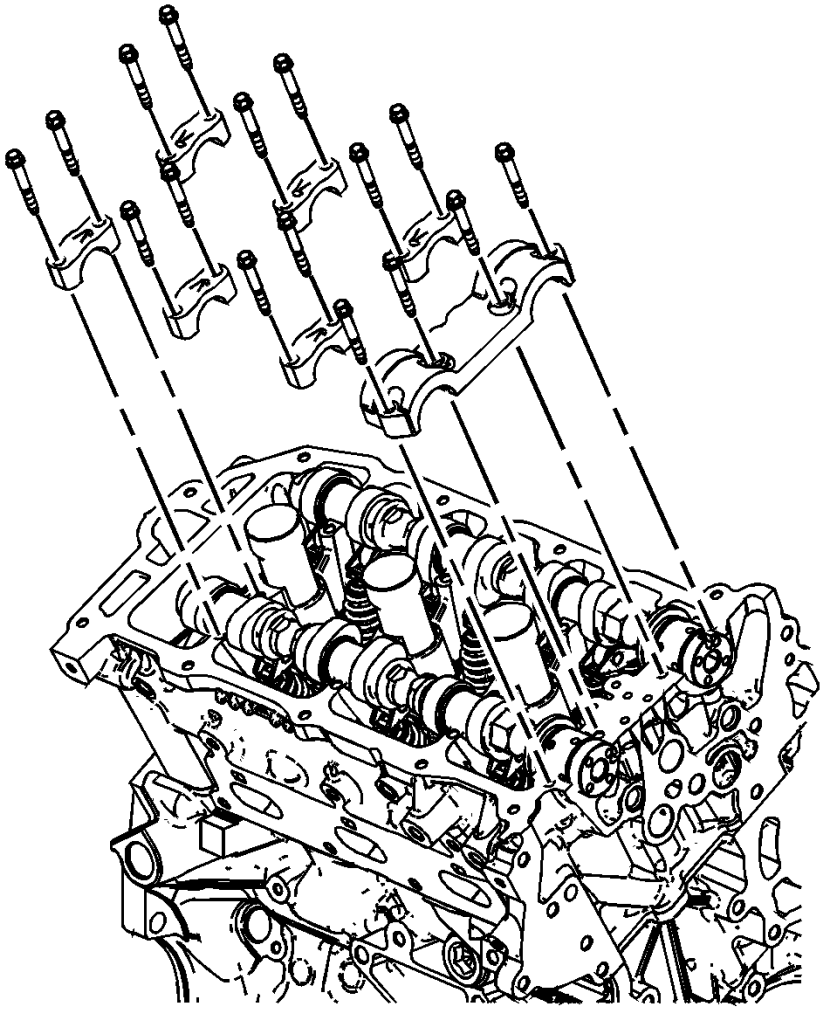

Fig. 64: View Of Camshaft Bearing Caps & Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft bearing cap bolts.
3. Remove the camshaft bearing caps.

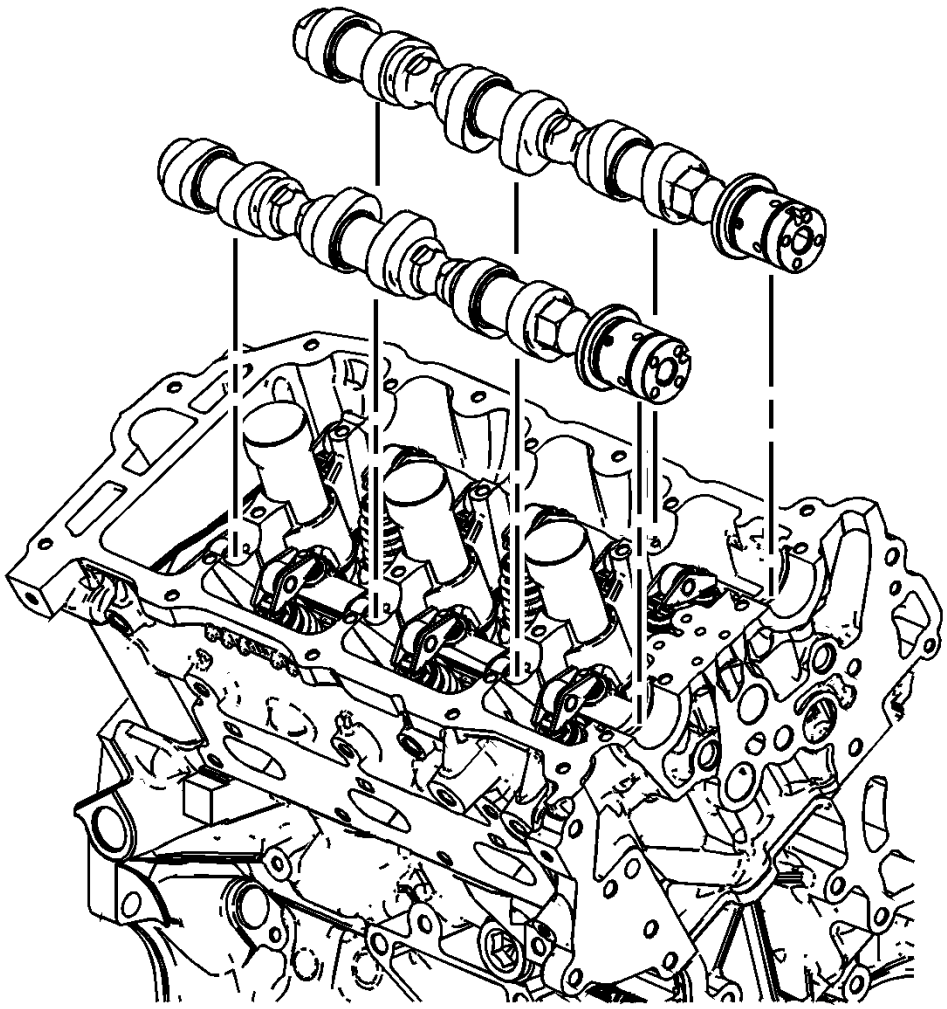

Fig. 65: Locating Camshafts
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Mark the camshafts upon removal to ensure installation is in the correct position.

4. Remove the camshafts.

VALVE ROCKER ARM REMOVAL - RIGHT SIDE

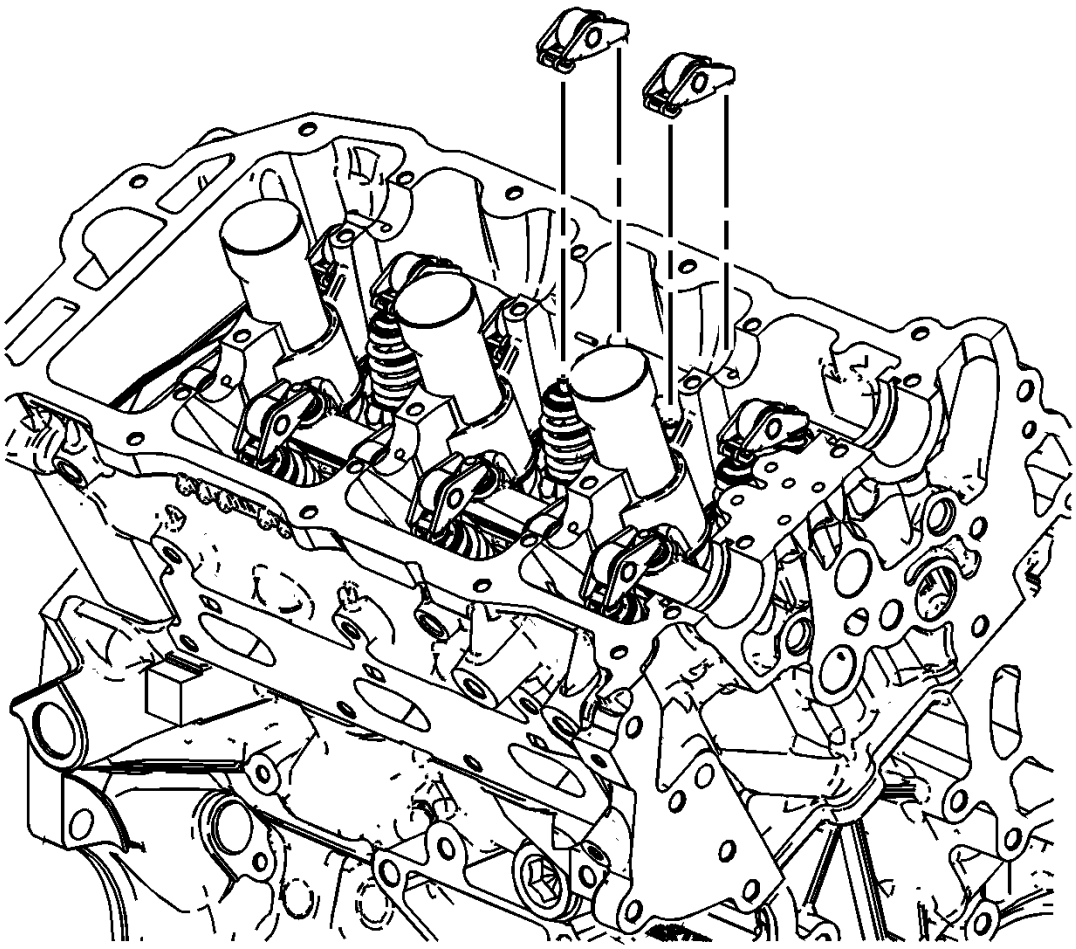

Fig. 66: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

Remove the valve rocker arms from the cylinder head. If the rocker arms are to be reused, keep in order so they can be reinstalled in the same position.

VALVE LIFTER REMOVAL - RIGHT SIDE

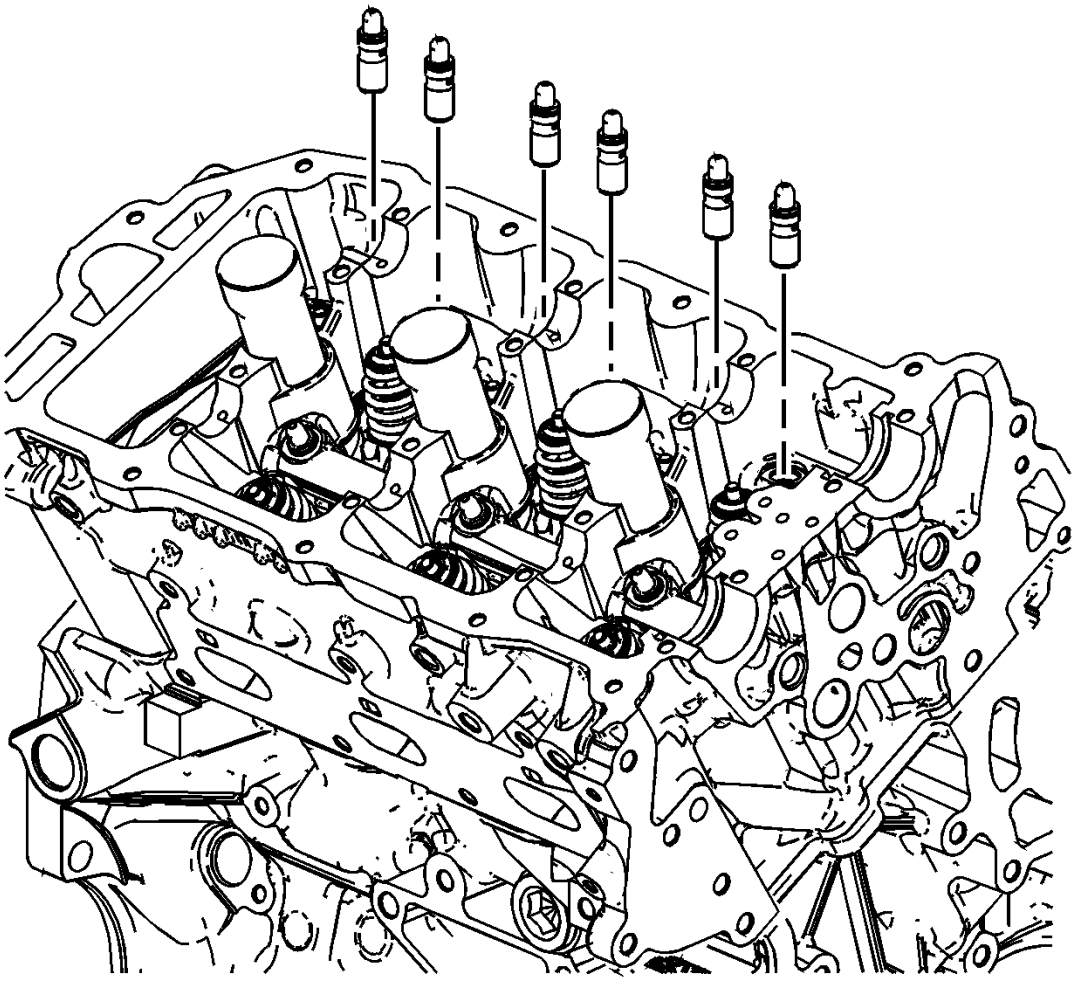

Fig. 67: Identifying Stationary Hydraulic Lash Adjuster (SHLA)
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT:

- Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.
- Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.

Remove the valve lifters (SHLAs) from the cylinder head. If the lifters are to be reused, keep in order so they can be reinstalled in the same position.

CYLINDER HEAD REMOVAL - RIGHT SIDE (LFX)

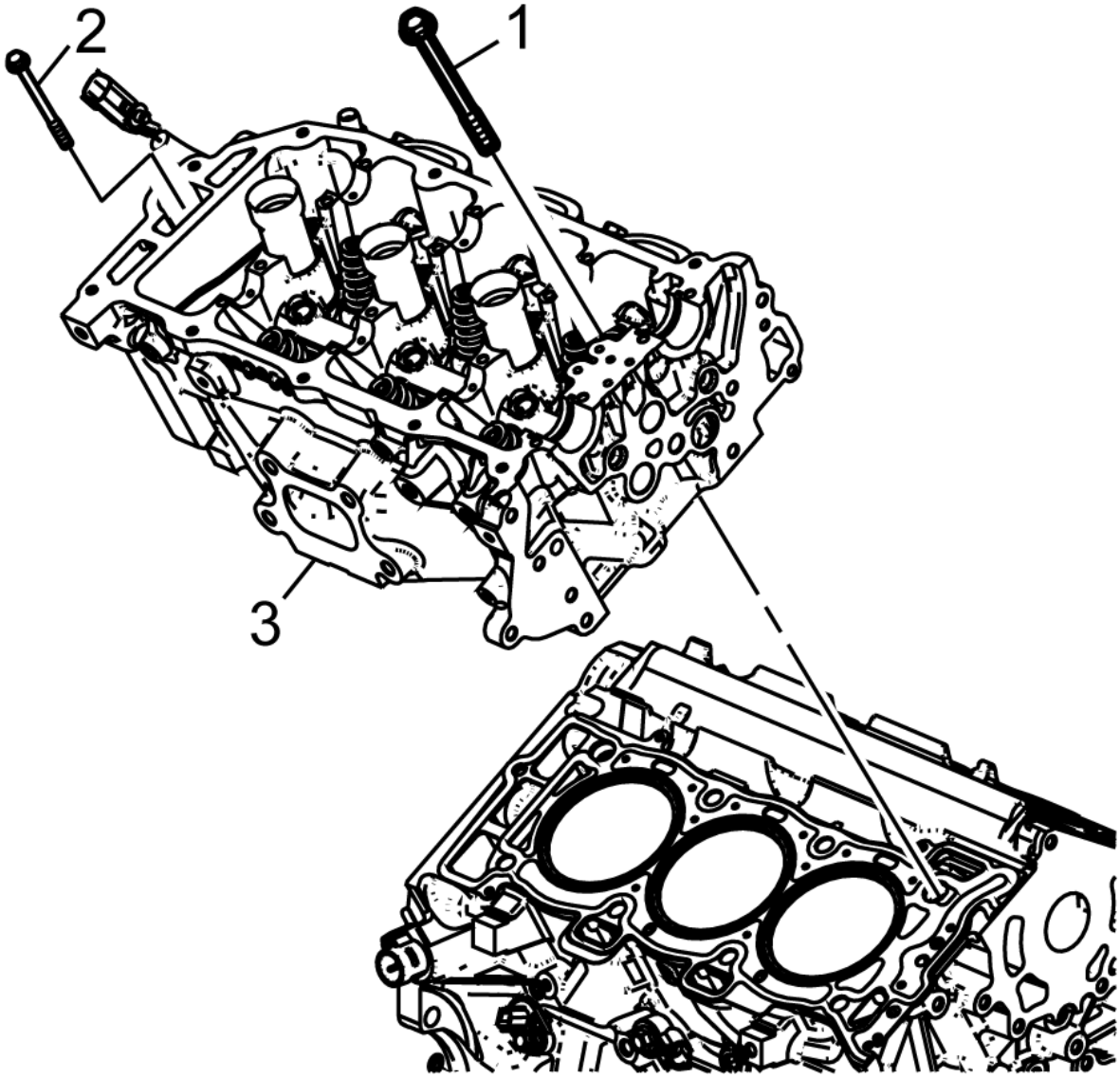

Fig. 68: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the right cylinder head bolts (1) and discard.
2. Remove the right cylinder head (2).

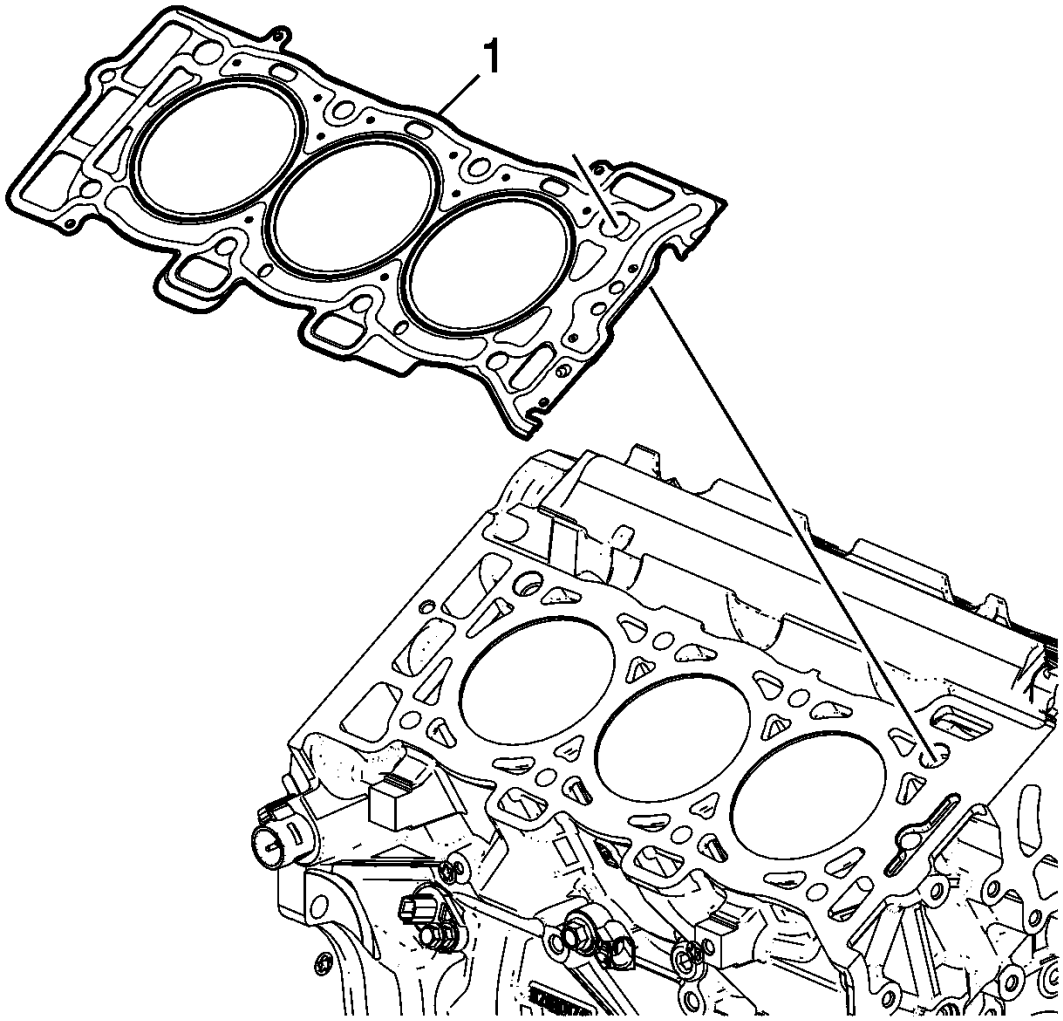

Fig. 69: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the right cylinder head gasket (1).

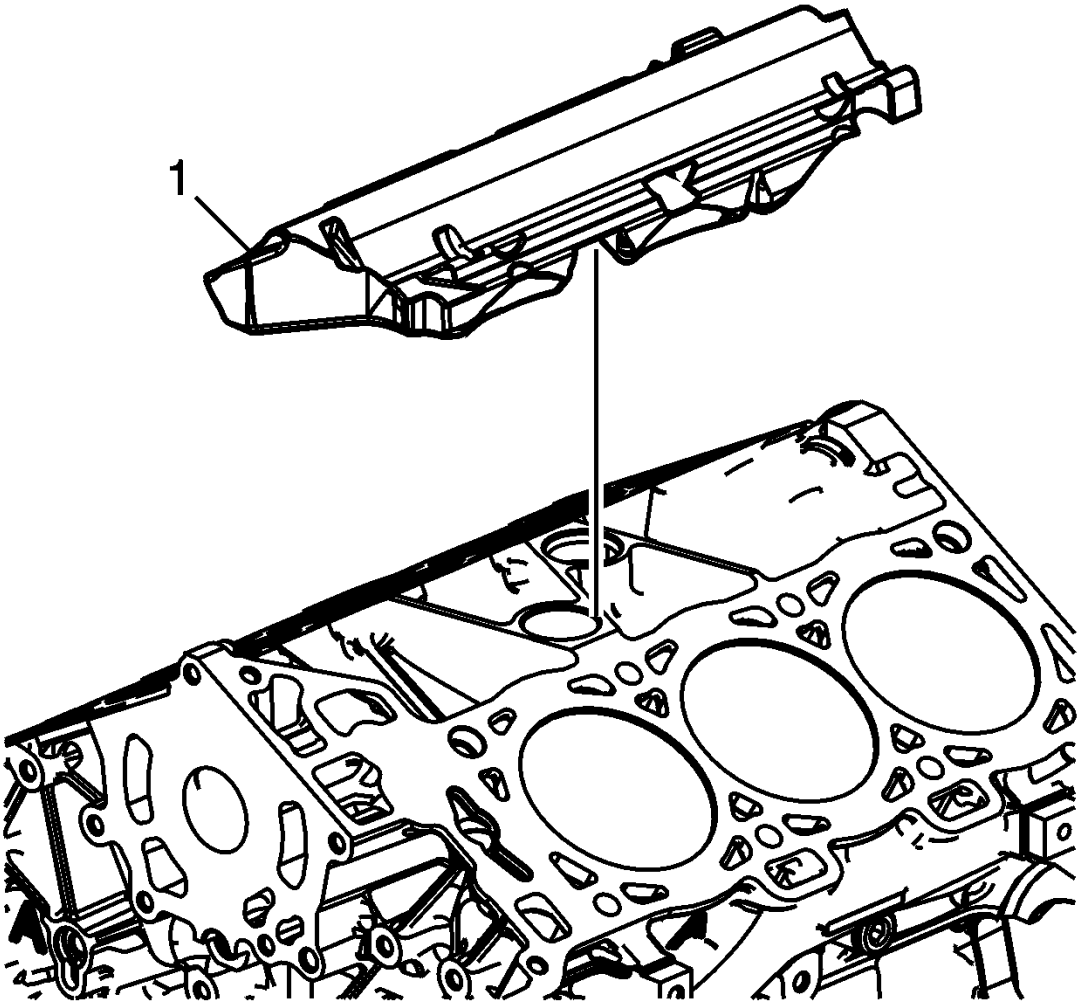

Fig. 70: Fuel Injection Fuel Rail Noise Shield-Lower
Courtesy of GENERAL MOTORS COMPANY

4. Remove the fuel injection fuel rail noise shield-lower (1).

OIL PAN REMOVAL

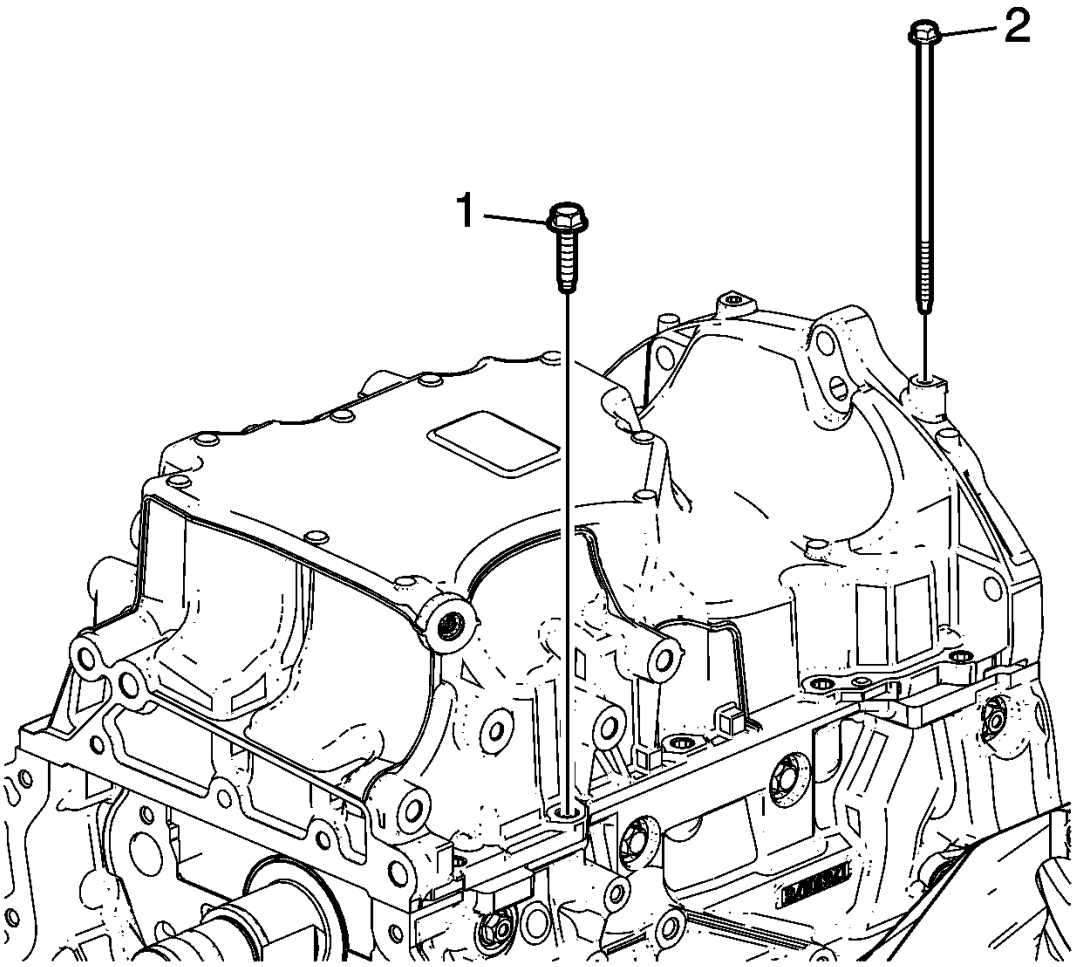

Fig. 71: Engine Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pan bolts (1) and (2).
2. Using the pry points located at the edge of the oil pan separate the RTV sealant.

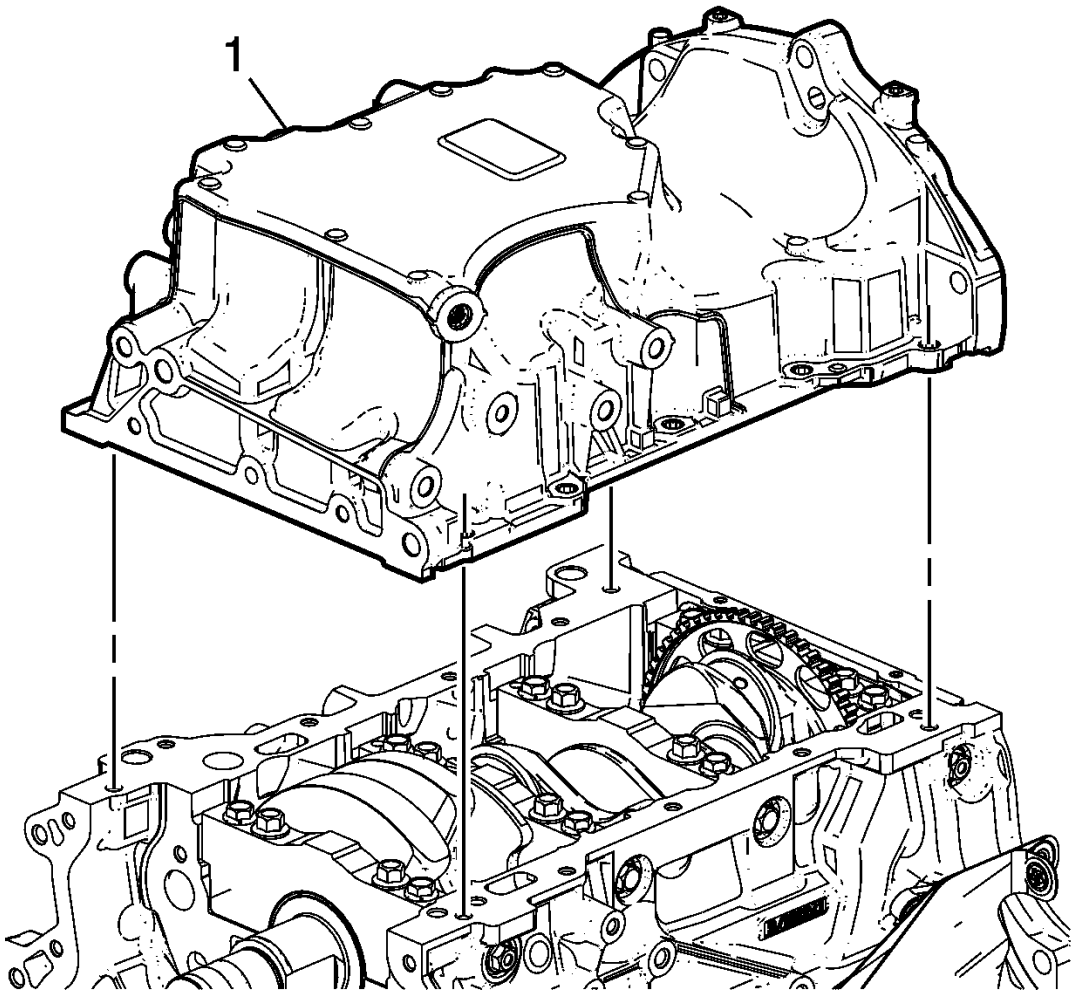

Fig. 72: View Of Engine Oil Pan
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil pan (1) from the block.

OIL PUMP REMOVAL

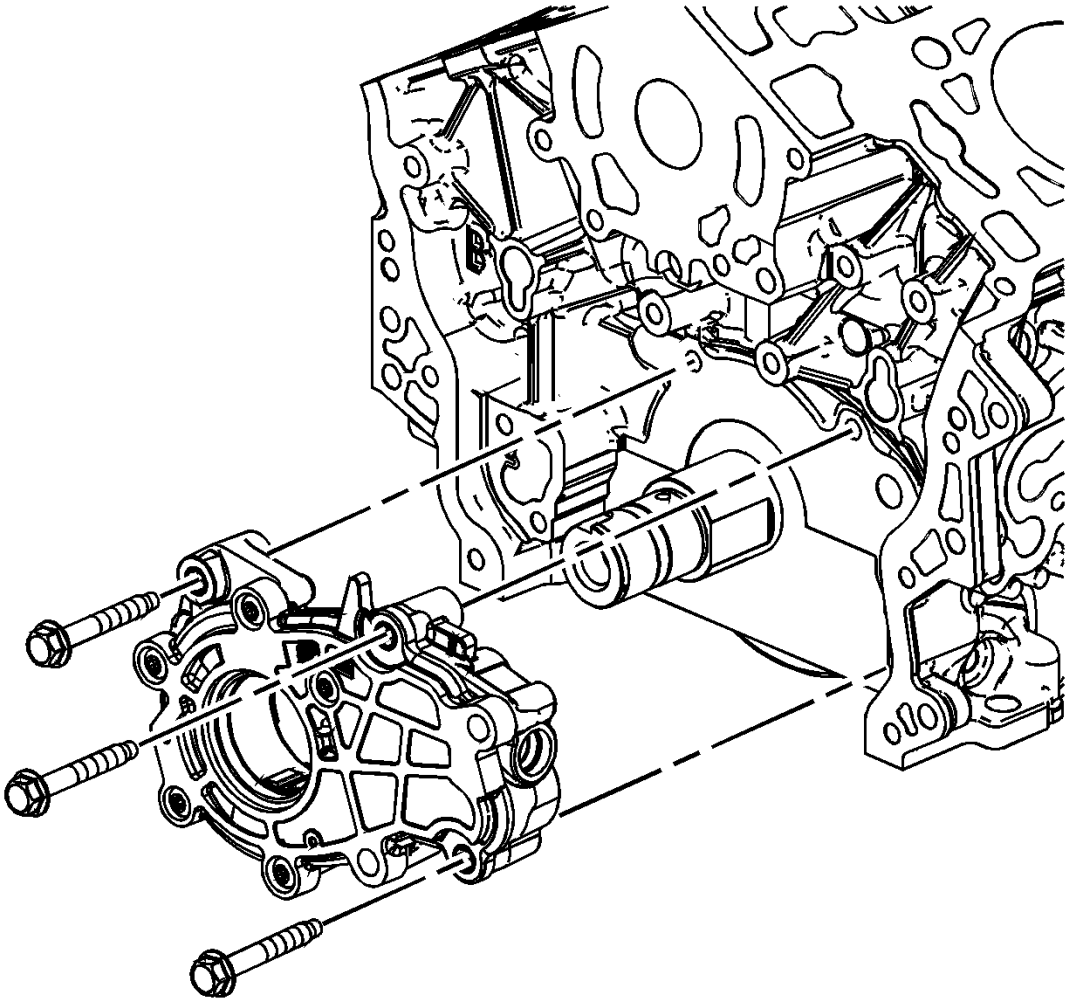

Fig. 73: Identifying Oil Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pump bolts.
2. Remove the oil pump.

CRANKSHAFT REAR OIL SEAL AND HOUSING REMOVAL

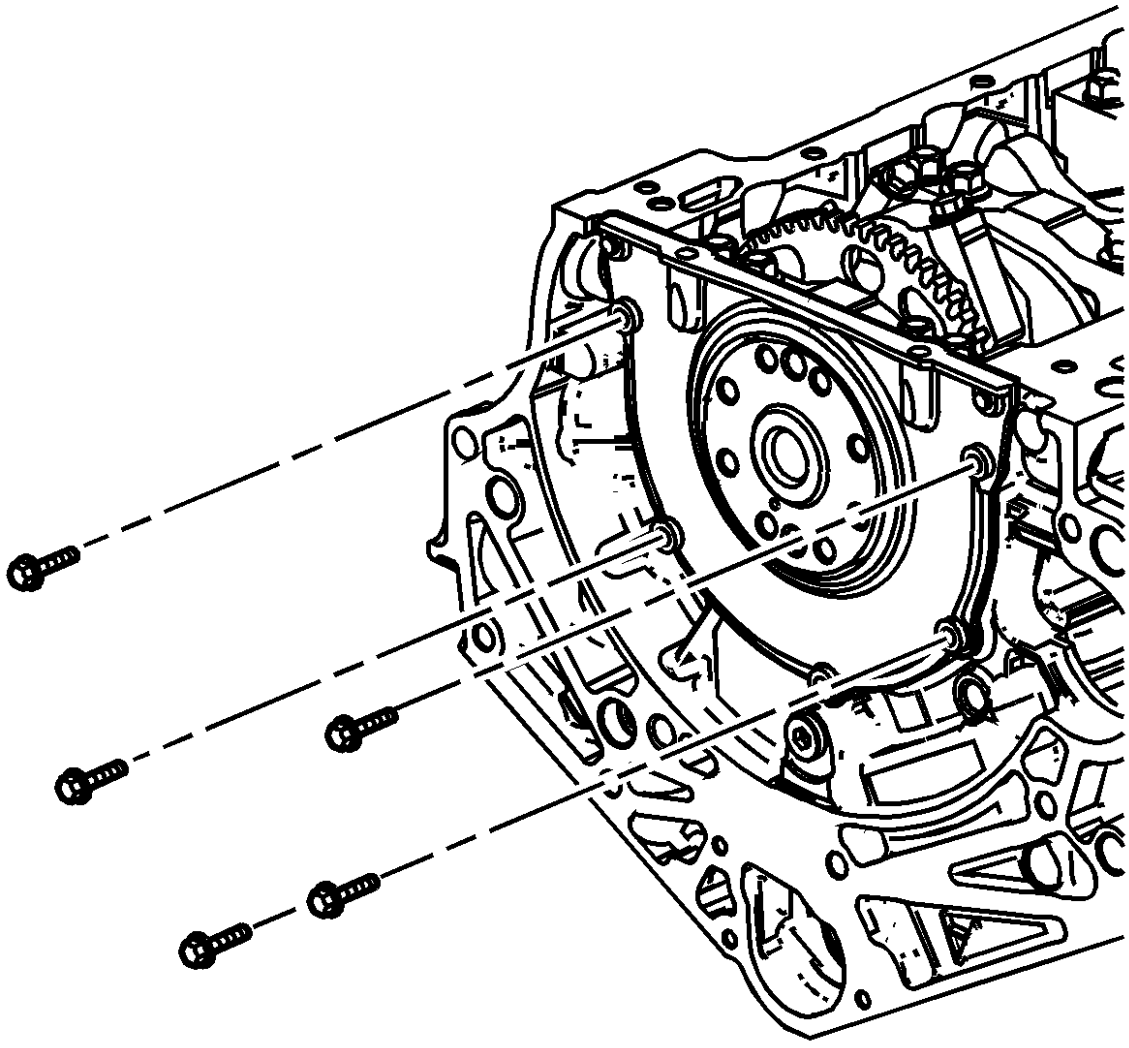

Fig. 74: Locating Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft rear oil seal housing bolts.

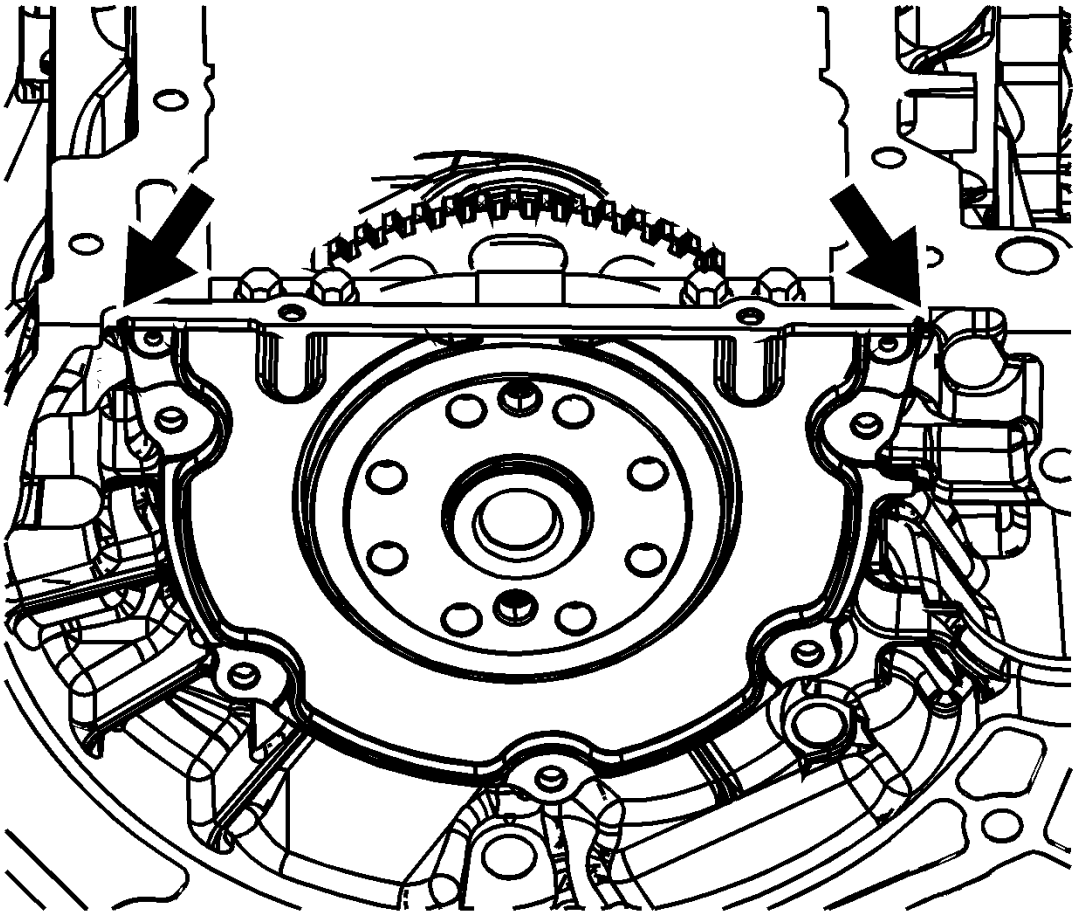

Fig. 75: Identifying Pry Points On Edge Of The Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
3. Use the pry points located at the edge of the crankshaft rear oil seal housing to separate the RTV sealant.

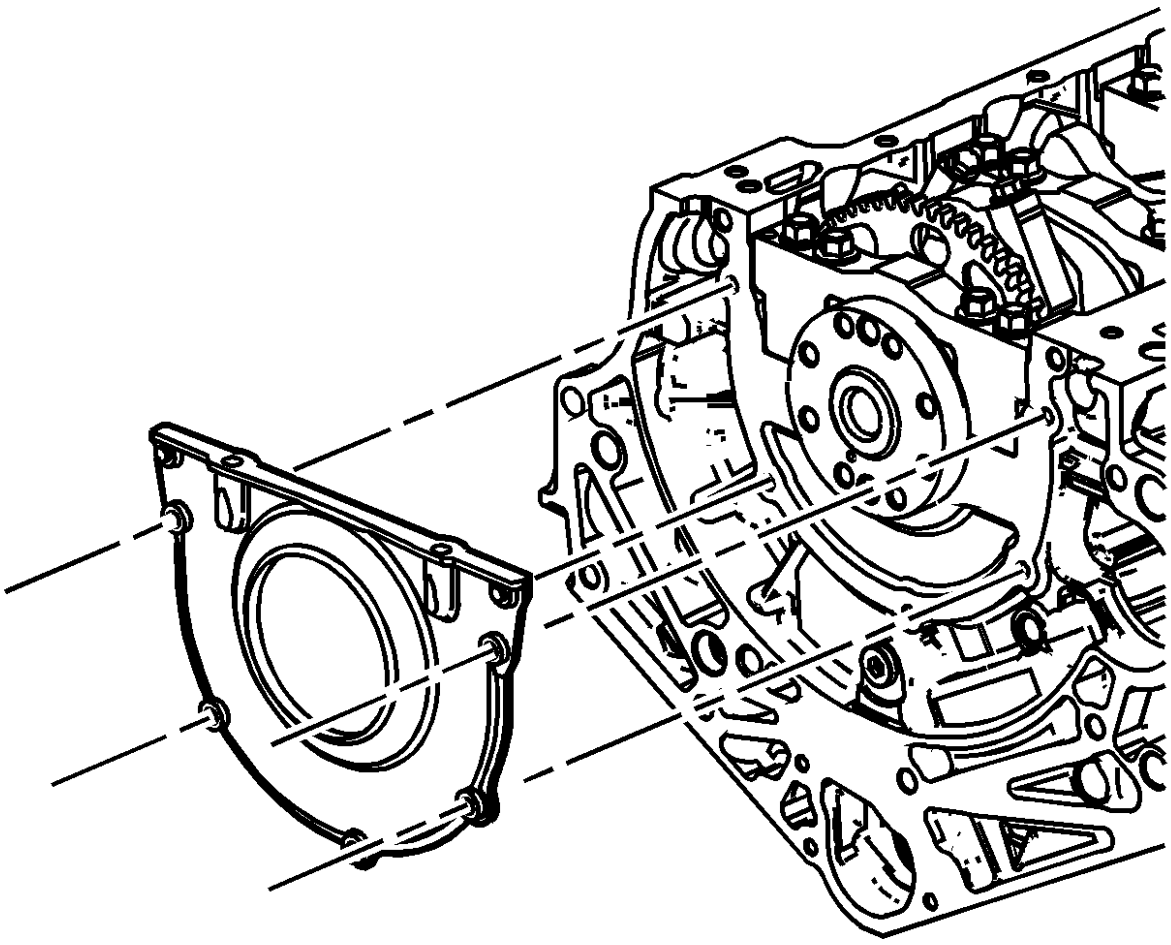

Fig. 76: View Of Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

4. Remove and discard the crankshaft rear oil seal housing.

PISTON, CONNECTING ROD, AND BEARING REMOVAL

Special Tools

EN 46121 Connecting Rod Guide Pin Set

For equivalent regional tools, refer to **Special Tools** .

NOTE:

- **An arrow/dot showing proper piston orientation is located on the top of the piston.**
- **If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for reassembly.**

.

1. Before removing the connecting rods, check the connecting rod side clearance using the following procedure:
    1. Tap the connecting rod to one end of the crankshaft journal with a dead-blow or wooden hammer.
    2. Using feeler gauges, measure the clearance between the crankshaft counterweight and the connecting rod.
    3. The connecting rod side clearance should not exceed specifications. Refer to **Engine Mechanical Specifications** .
    4. If the end play exceeds the specified limits, measure the width of the crankpin end of the connecting rod. Refer to **Piston, Connecting Rod, and Bearing Cleaning and Inspection**.
    5. If the connecting rod width is significantly smaller than specified and severe wear is present on the side of the connecting rod, replace the connecting rod.
    6. If the connecting rod width is within specification and excessive scoring is present on the crankshaft journals, replace the crankshaft.
2. Using a marker, number each piston face. Draw an arrow along the centerline of the piston pointing toward the front of the engine.

    CAUTION: Do not use a stamp, punch or any other method that may distort or stress the connecting rod or connecting rod cap. Extensive engine damage may result from a connecting rod that is distorted or stressed.

3. Mark the cylinder number on the connecting rod and the connecting rod cap with a scribe, paint stick or permanent marker.

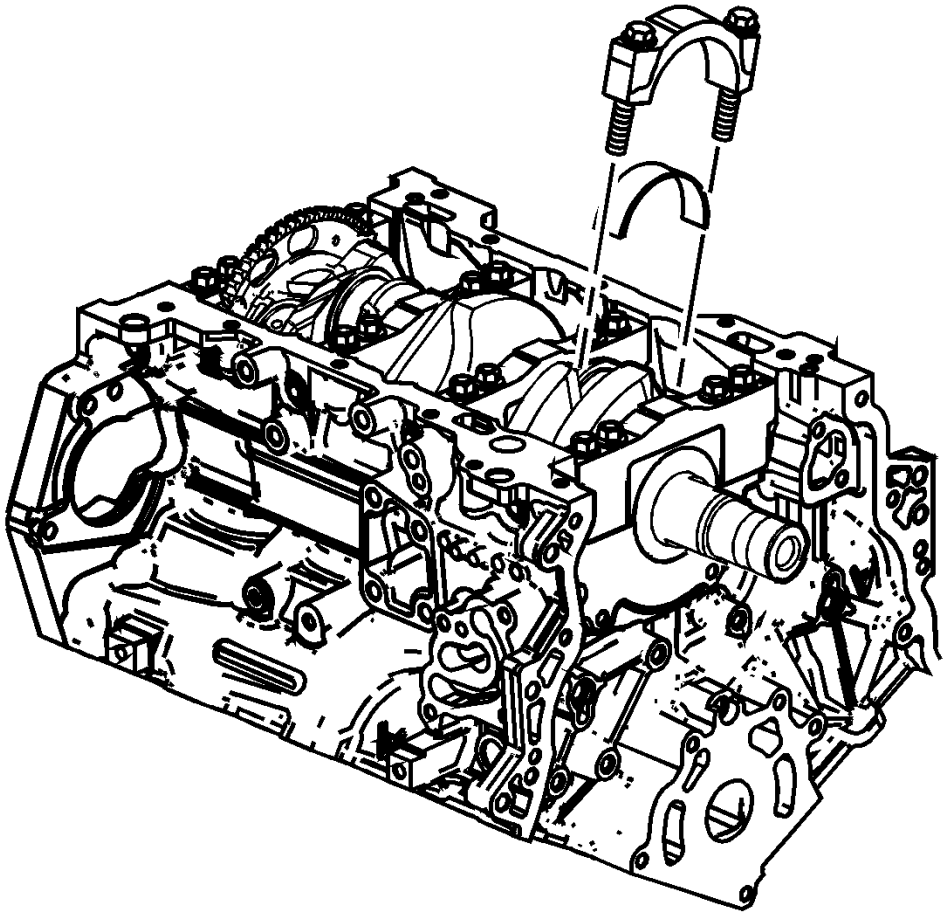

Fig. 77: View Of Connecting Rod Bearing & Cap
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Powdered metal connecting rods have rod bolts which yield when torqued. If the rod bolts are loosened or removed the rod bolts must be replaced. Rod bolts that are not replaced will not torque to the correct clamp load and can lead to serious engine damage.

4. Remove the connecting rod bolts.

NOTE: The connecting rod caps must remain with the original connecting rod.

5. Remove the connecting rod cap.

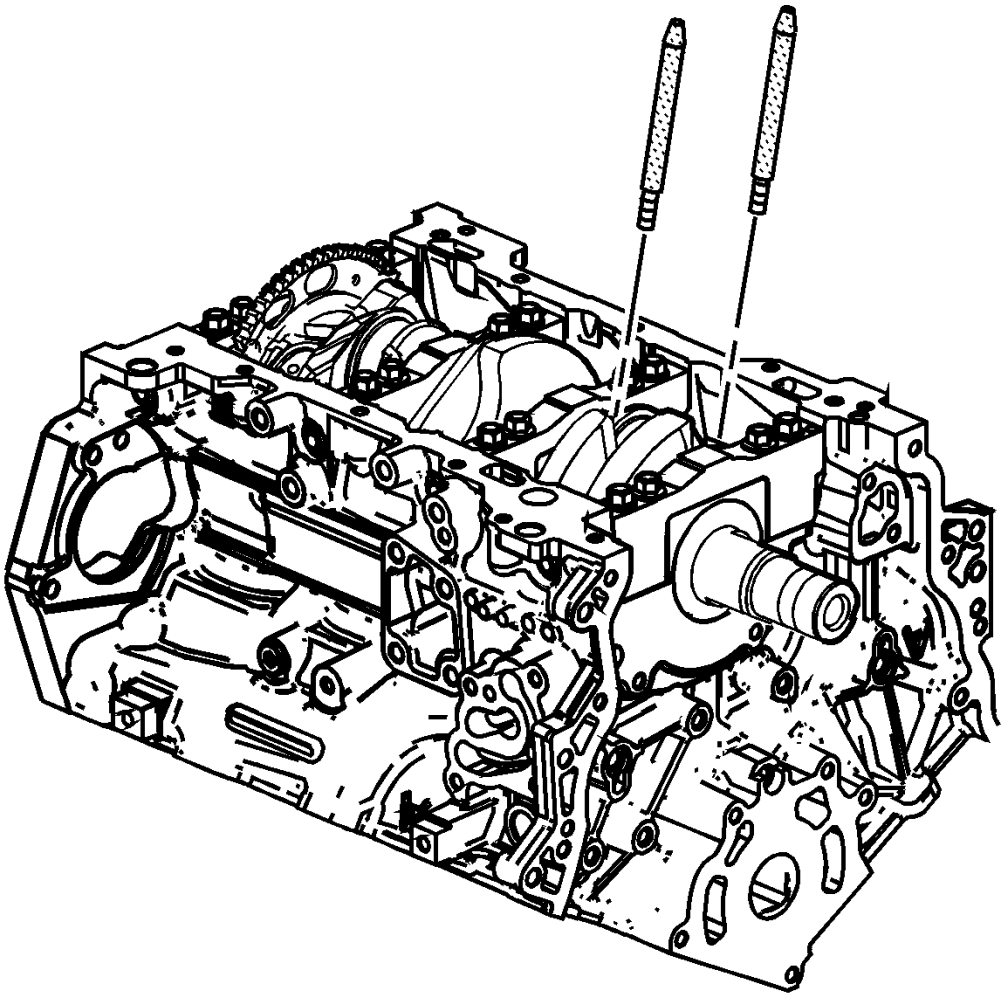

Fig. 78: Crankshaft Protector Pins Installed in Connecting Rod Bolt Holes
Courtesy of GENERAL MOTORS COMPANY

6. Install the **EN 46121** set into the connecting rod bolt holes.

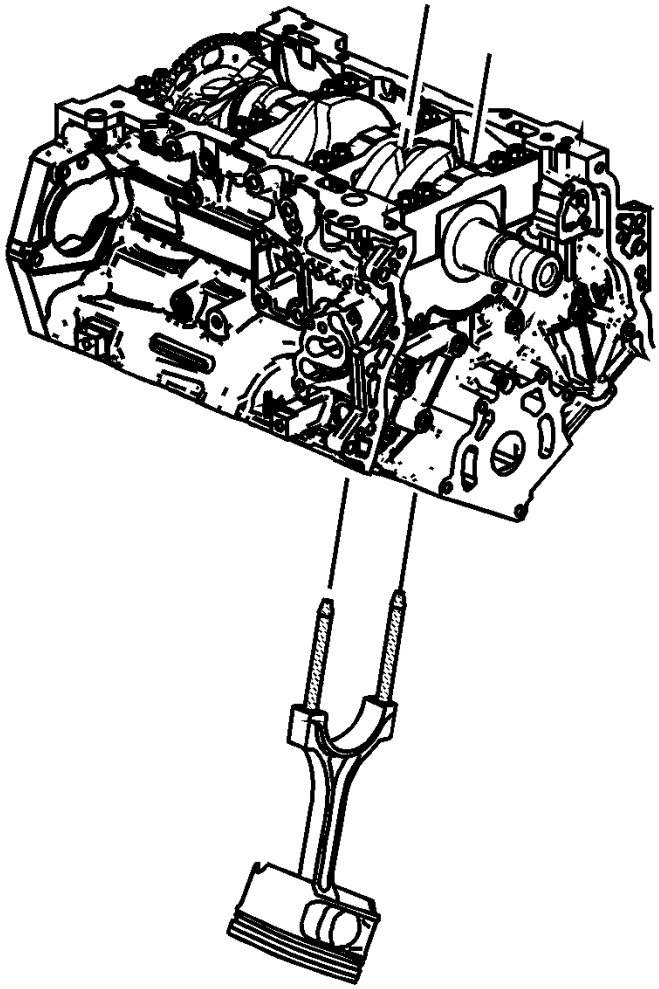

Fig. 79: View Of Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Using the **EN 46121** set , push the connecting rod and piston assembly through the top of the cylinder. DO NOT scratch the crankshaft journal or cylinder wall and DO NOT damage the oil jets when removing the connecting rod and piston assembly.

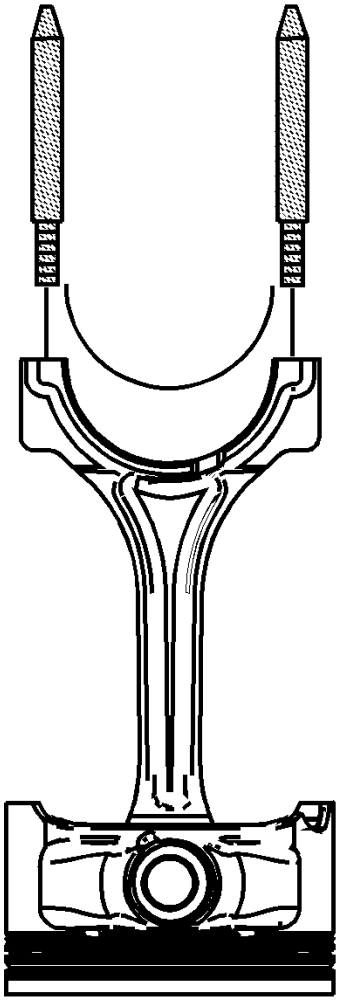

Fig. 80: View Of Piston/Connecting Rod Installation Tool
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **EN 46121** set from the connecting rod bolt holes.
9. Remove the upper connecting rod bearing from the connecting rod.

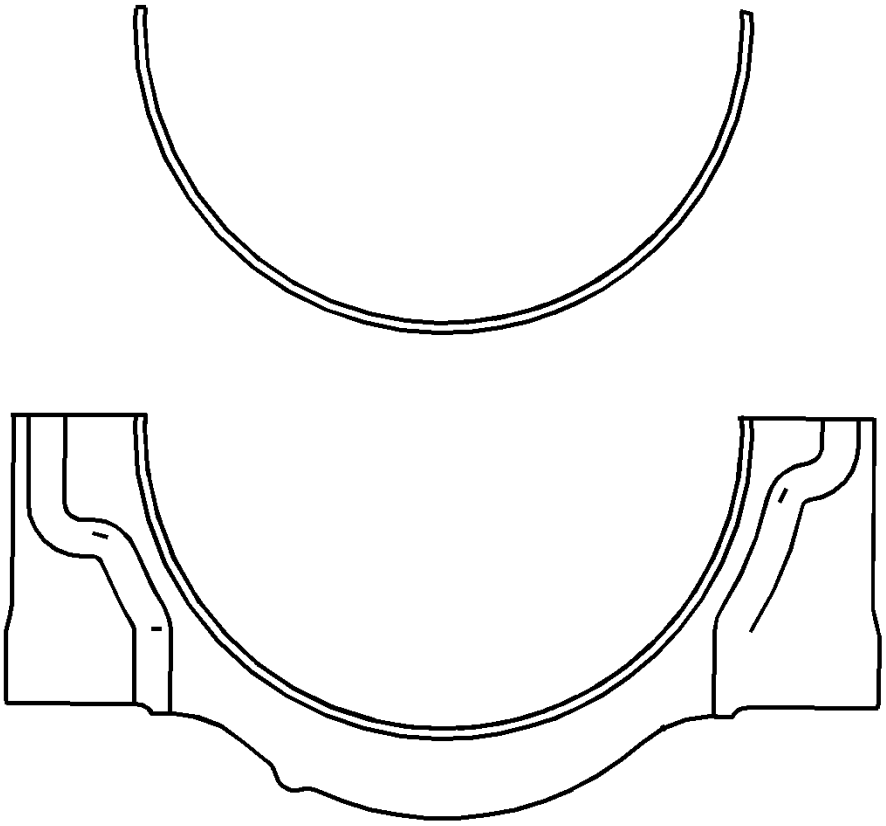

Fig. 81: View Of Lower Connecting Rod Cap & Bearing
Courtesy of GENERAL MOTORS COMPANY

10. Remove the lower connecting rod bearing from the connecting rod cap.

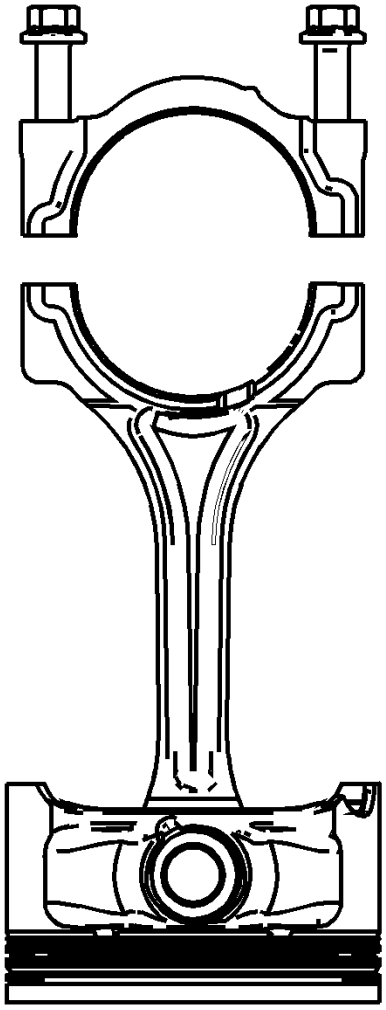

Fig. 82: View Of Connecting Rod Cap, Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS COMPANY

11. Reattach the connecting rod cap to the connecting rod to prevent damage to their mating surfaces. The cap and rod are a matched set and must be kept together.

CRANKSHAFT AND BEARING REMOVAL

Special Tools

- **GE 6125-1B** Slide Hammer Adapter
- **EN 49102** Crankshaft Bearing Cap Remover

For equivalent regional tools, refer to **Special Tools** .

Crankshaft End Play Measurement

1. Place a dial indicator at the crankshaft nose.
2. Gently force the crankshaft to the extreme front and rear positions with a pry tool while monitoring the movement of the dial indicator.

3. The crankshaft end play should not exceed specifications. Refer to **Engine Mechanical Specifications** .
4. If the specifications are exceeded inspect the thrust bearing thrust OD and the crankshaft thrust wall for wear and/or excessive runout. Refer to **Engine Mechanical Specifications** .
5. Replace the thrust bearing or crankshaft as necessary.

Crankshaft Removal

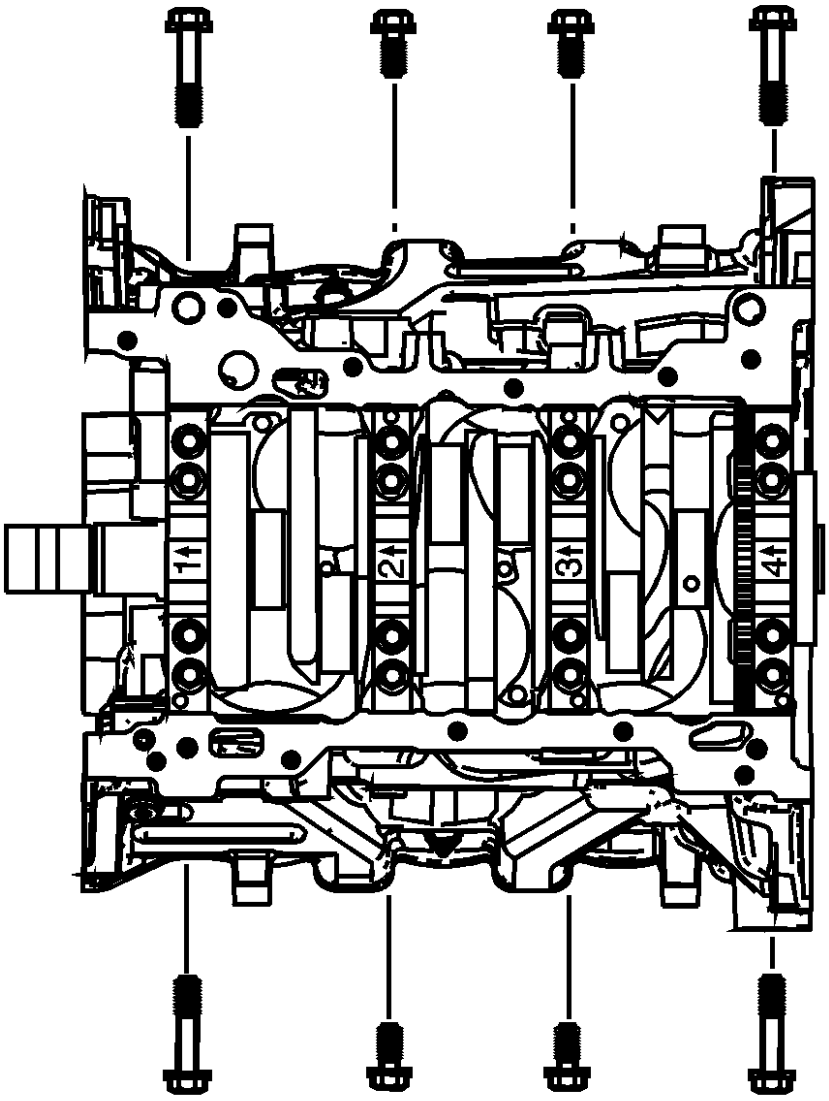

Fig. 83: Identifying Crankshaft Main Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft bearing cap side bolts.
2. Remove the crankshaft bearing cap outer bolts.
3. Remove the crankshaft bearing cap inner bolts.

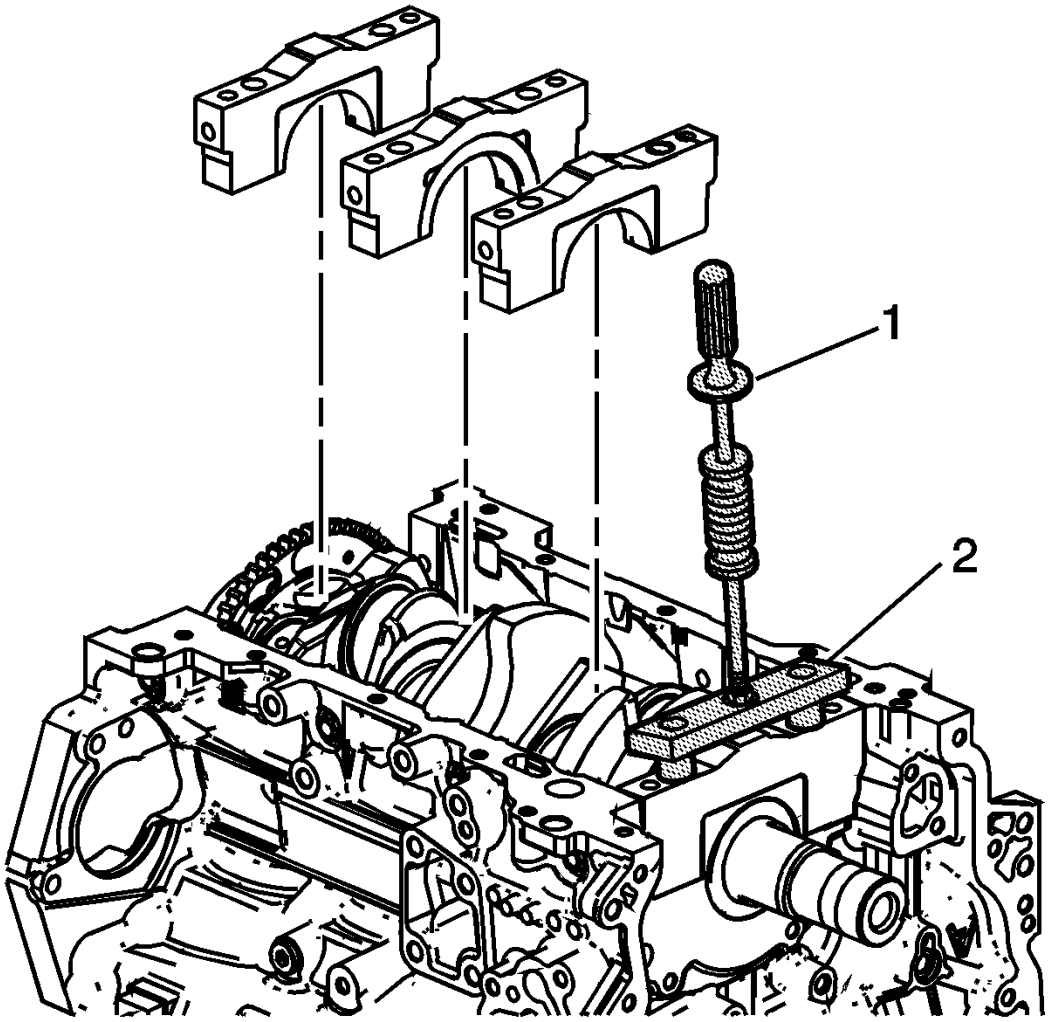

Fig. 84: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft bearing caps using the **GE 6125-1B** adapter (1) and **EN 49102** remover (2) .

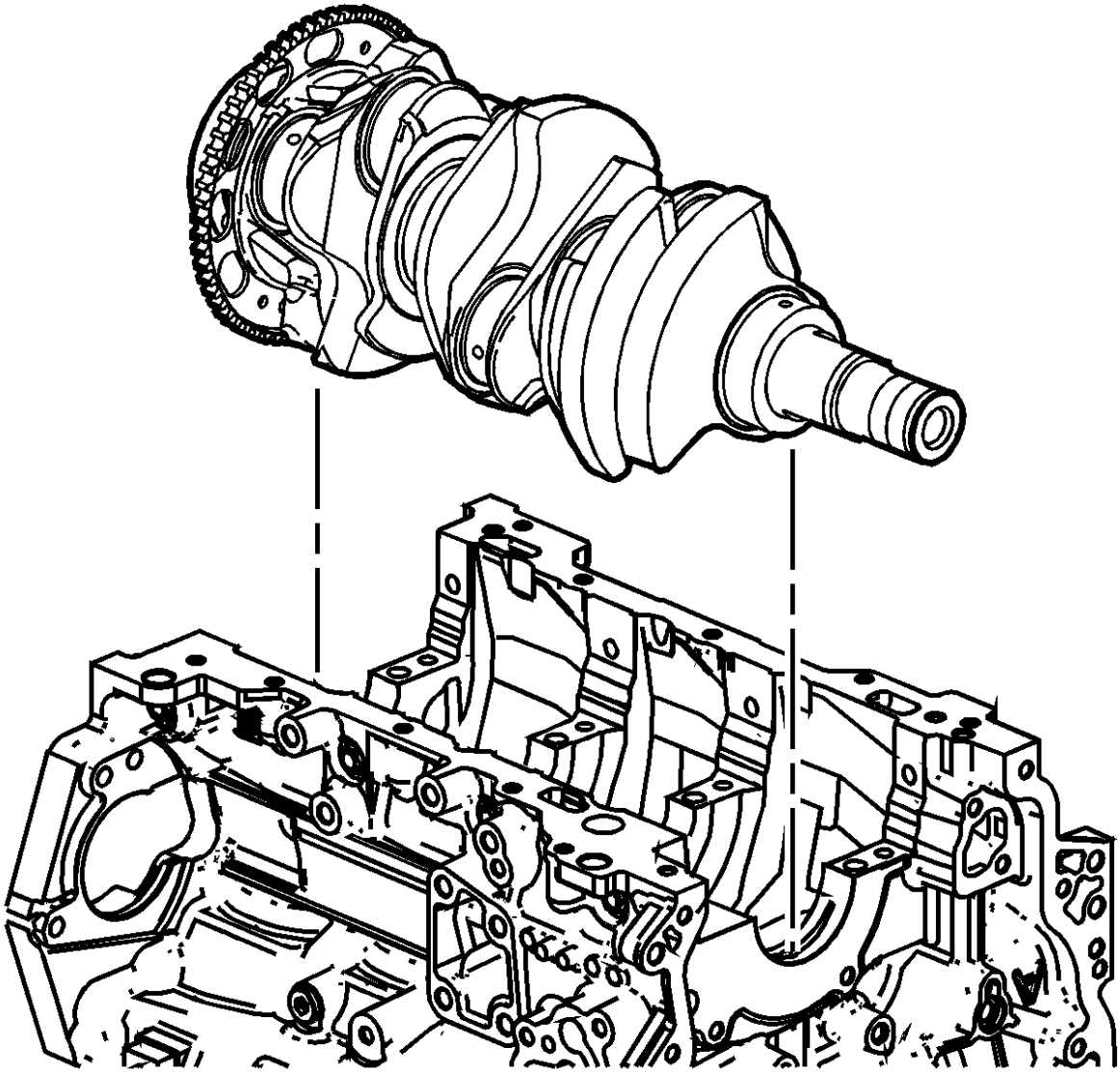

Fig. 85: View Of Crankshaft
Courtesy of GENERAL MOTORS COMPANY

5. Using two hands, lift the crankshaft straight up from the engine block.
6. Place the crankshaft in a secure place.

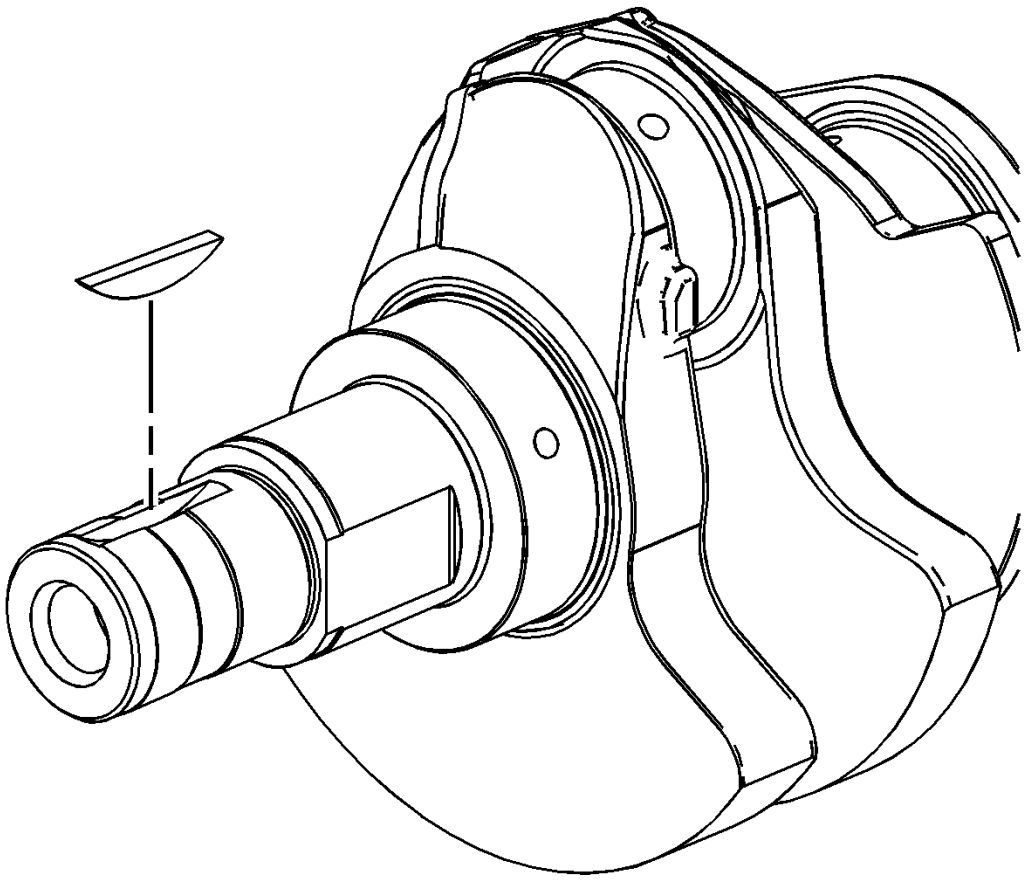

Fig. 86: Locating Crankshaft Sprocket Drive Pin
Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft key from the nose of the crankshaft, if damaged.

Crankshaft Bearing Removal

1. Prepare a piece of cardboard or equivalent, numbered 1-4 for bearing identification. Main bearing journals are numbered from the front of the engine.

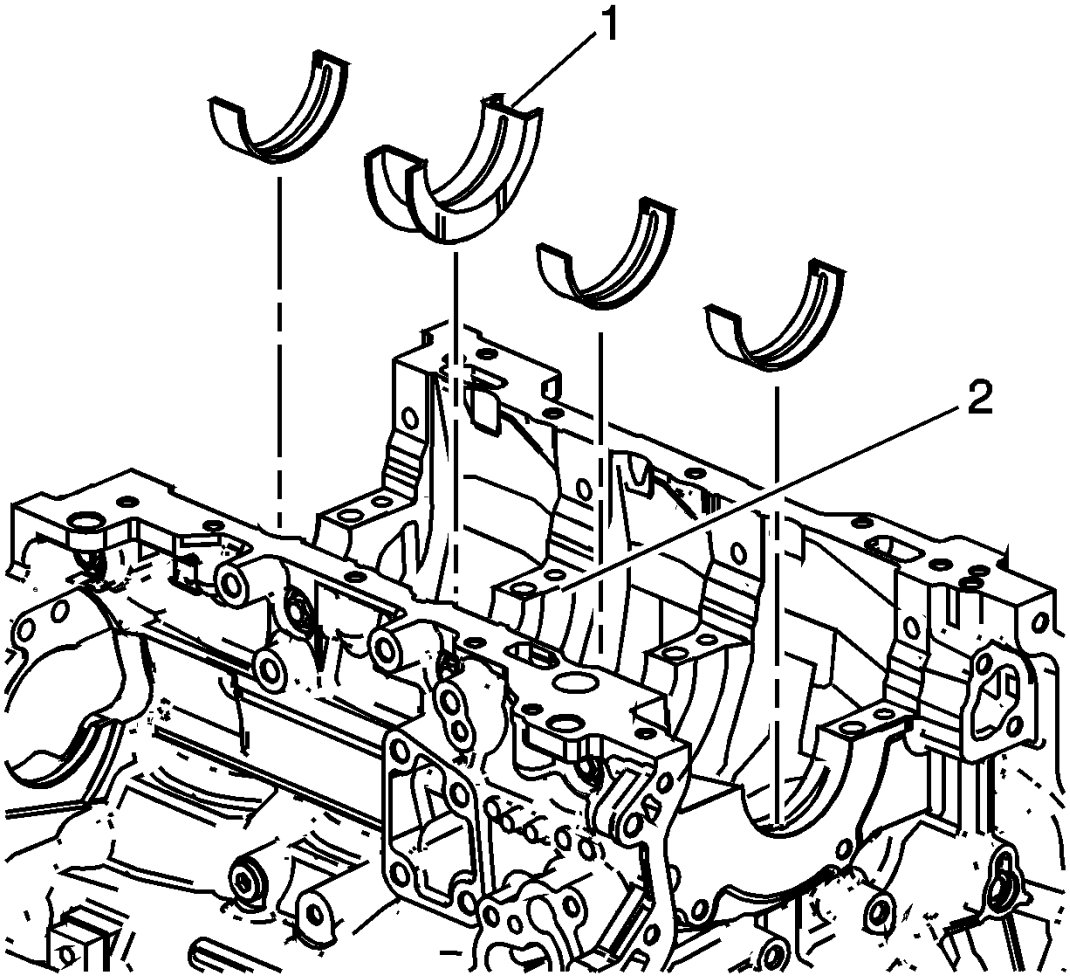

Fig. 87: Locating Thrust Bearing In Number 3 Journal
Courtesy of GENERAL MOTORS COMPANY

2. Remove the crankshaft upper bearing halves from the cylinder block. Note the position of the thrust bearing (1) at the number 3 journal (2).
3. Place the crankshaft upper bearing halves on the cardboard in the correct positions. Note that the number 3 bearing is the thrust bearing.

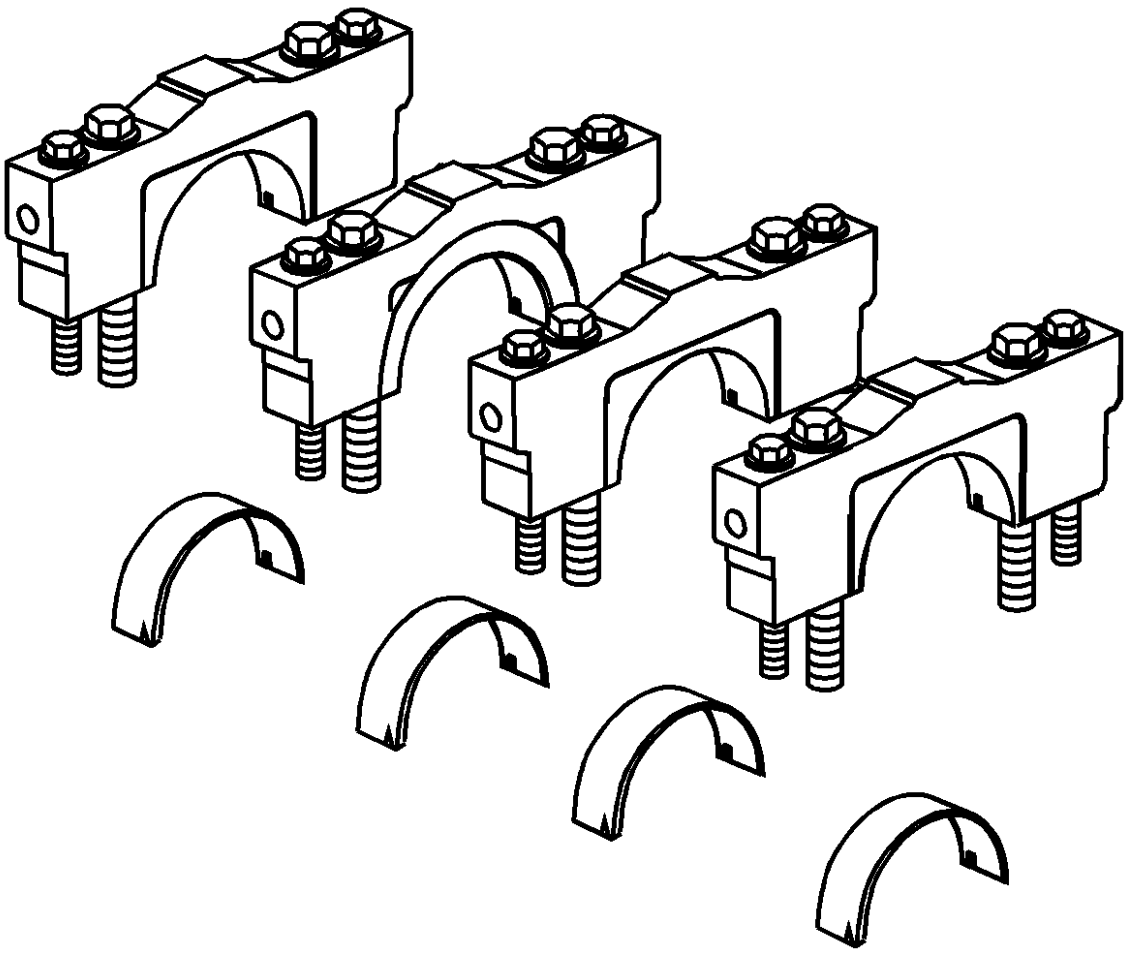

Fig. 88: View Of Crankshaft Bearing Caps & Lower Bearing Halves
Courtesy of GENERAL MOTORS COMPANY

4. Remove the crankshaft lower bearing halves from the crankshaft bearing caps.
5. Place the crankshaft lower bearing halves in the correct positions on the cardboard.

ENGINE BLOCK DISASSEMBLE

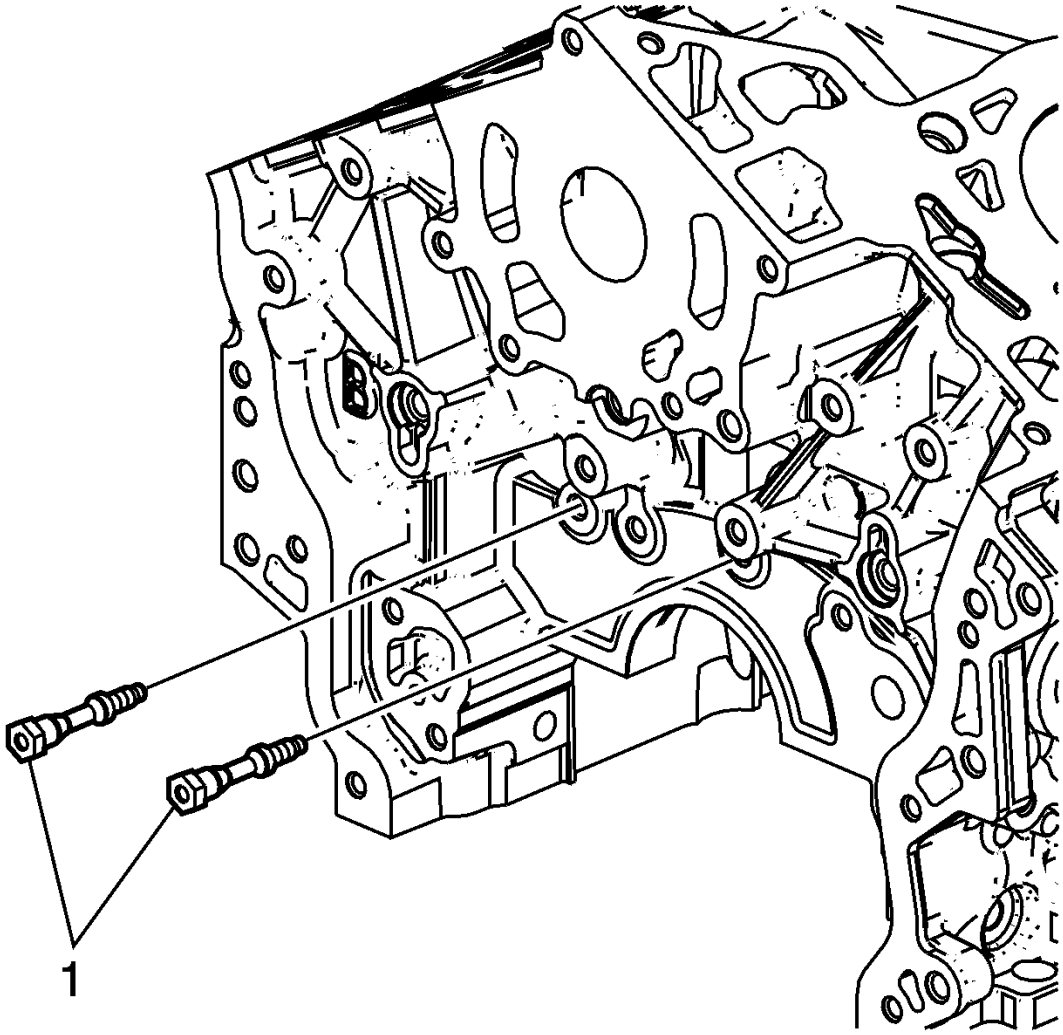

Fig. 89: Identifying Engine Front Cover Studs
Courtesy of GENERAL MOTORS COMPANY

1. Remove the engine front cover studs (1).

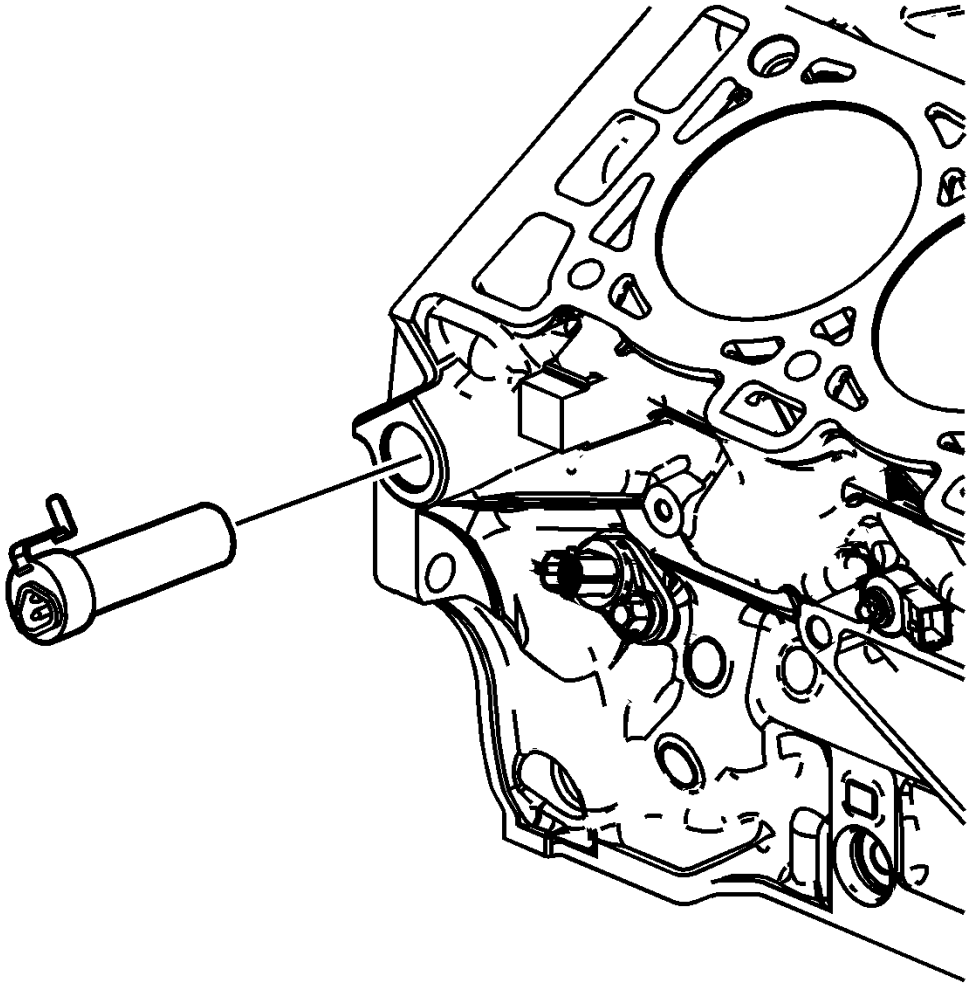

Fig. 90: View Of Block Heater Cartridge
Courtesy of GENERAL MOTORS COMPANY

2. Remove the block heater cartridge, if equipped.

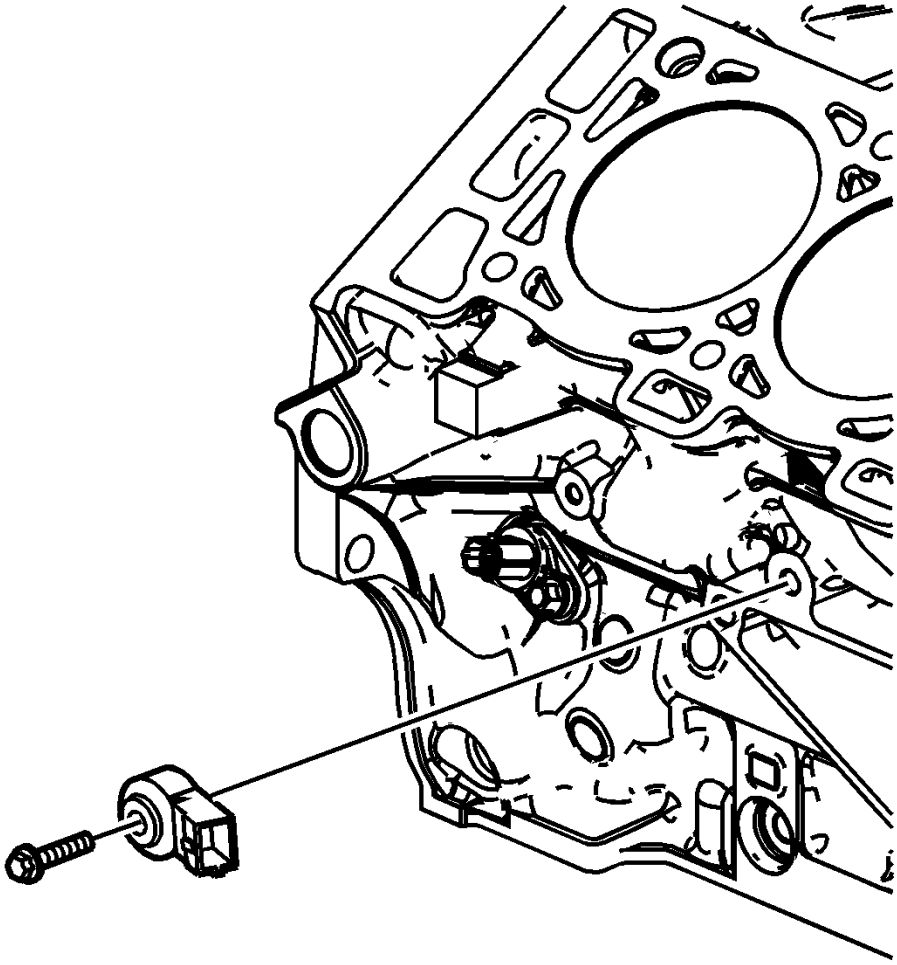

Fig. 91: View Of Right Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Remove the right knock sensor bolt.
4. Remove the right knock sensor.

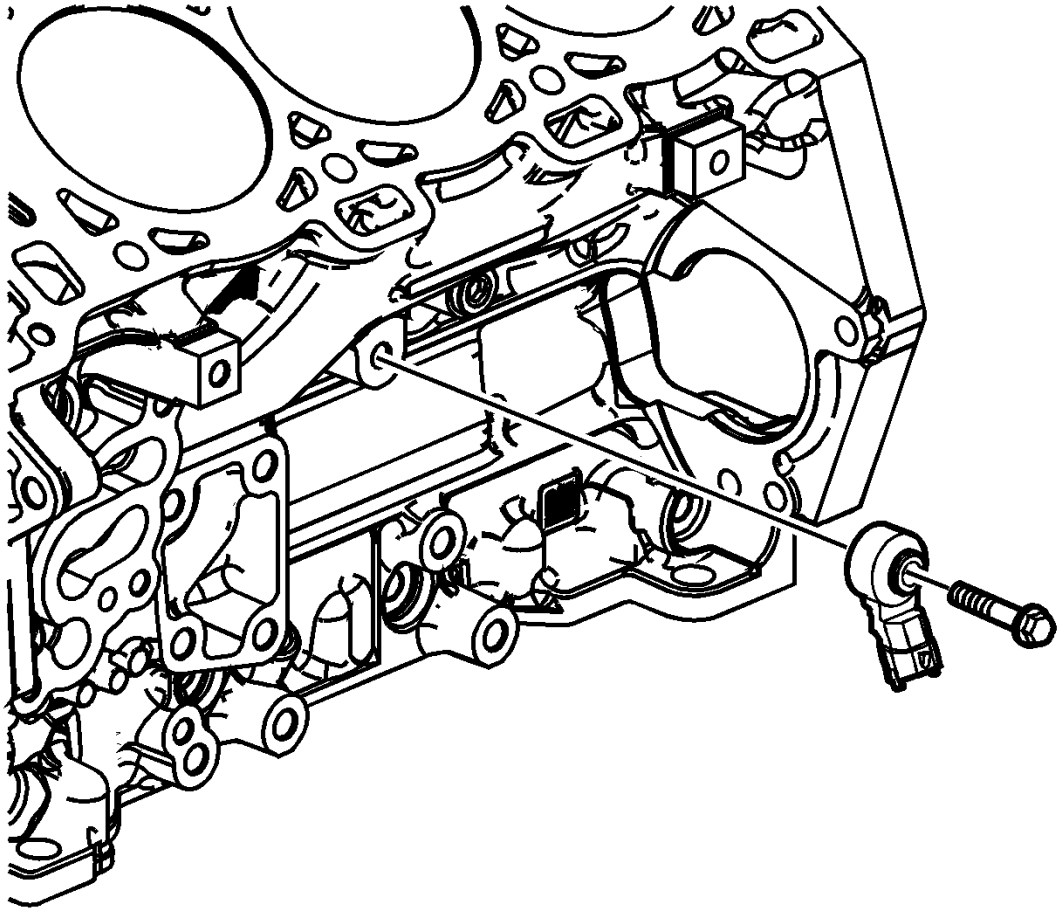

Fig. 92: Identifying Left Knock Sensor & Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the left knock sensor bolt.
6. Remove the left knock sensor.

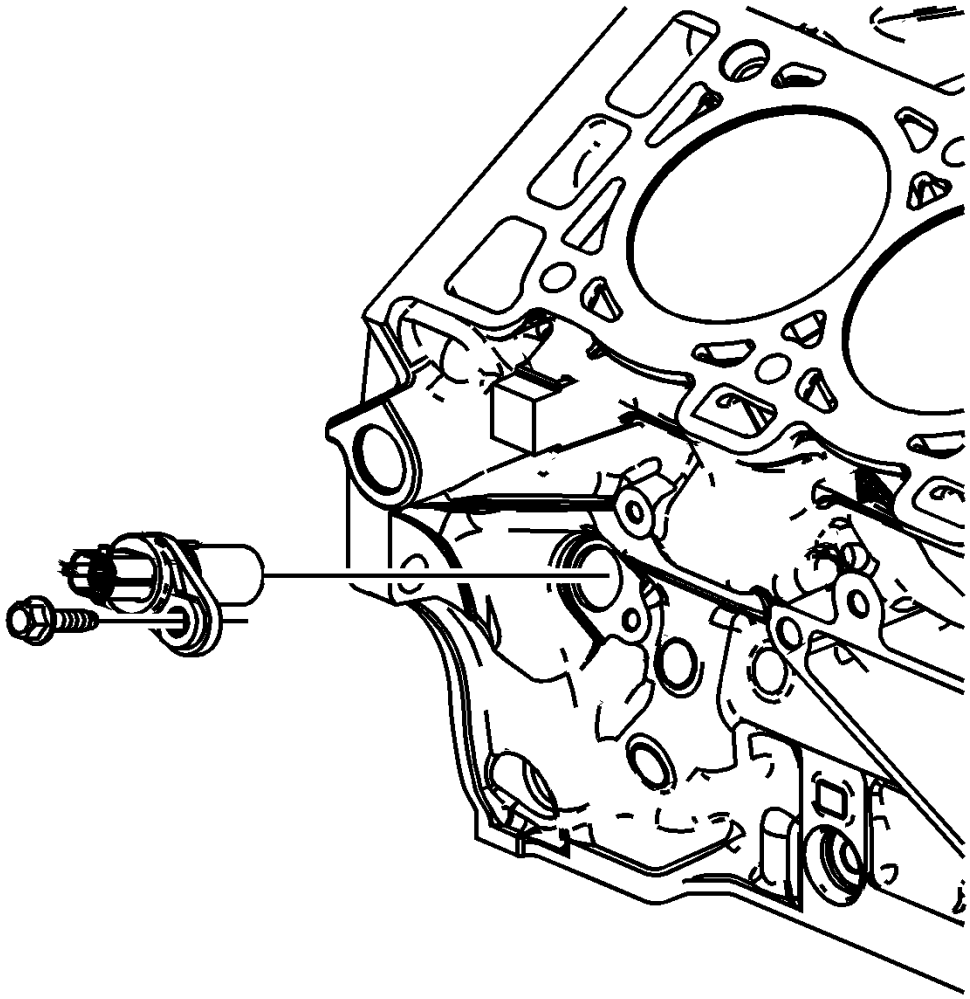

Fig. 93: View Of Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

7. Remove the crankshaft position sensor bolt.
8. Remove the crankshaft position sensor.

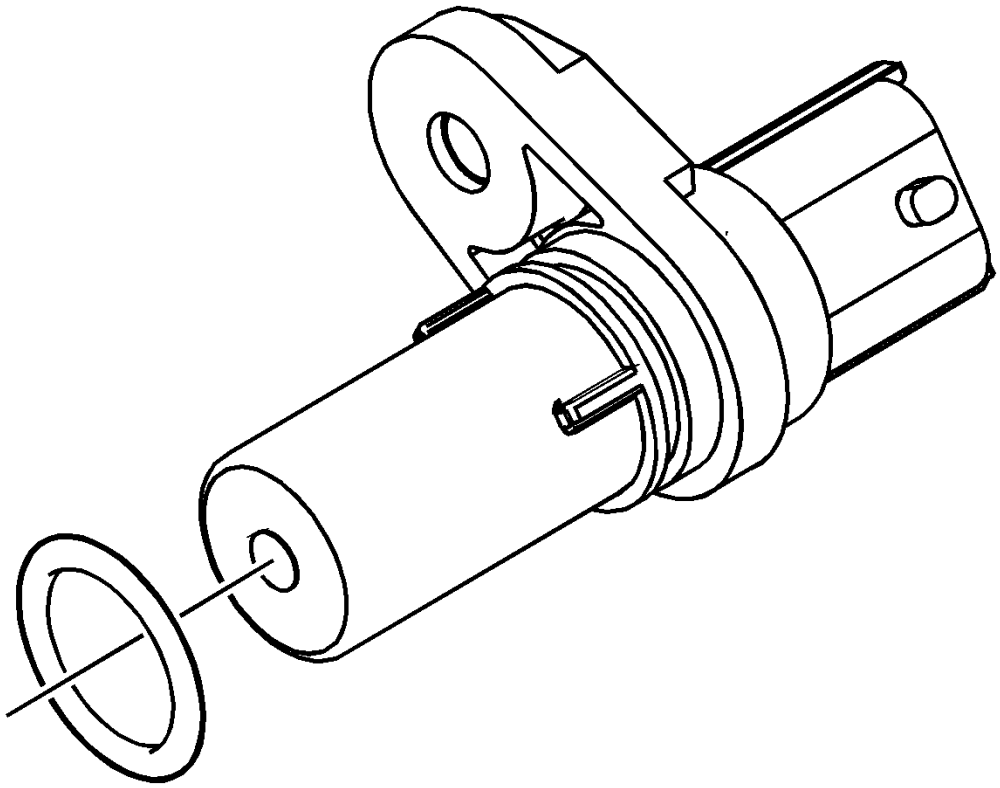

Fig. 94: View Of Crankshaft Position Sensor O-Ring
Courtesy of GENERAL MOTORS COMPANY

9. Remove the crankshaft position sensor O-ring, if damaged.

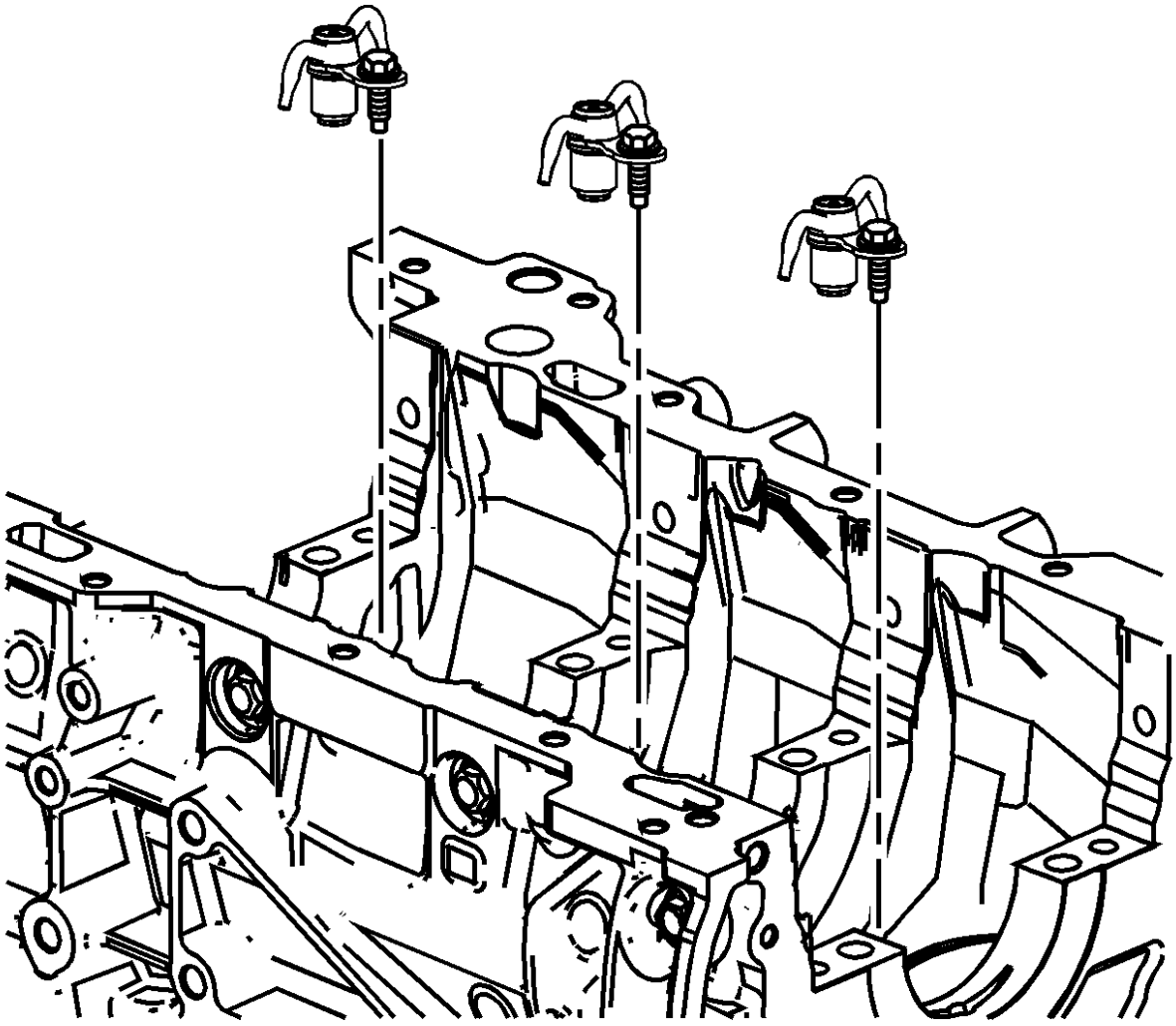

Fig. 95: Identifying Oil Jets & Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove oil jet bolts.
11. Remove oil jets.

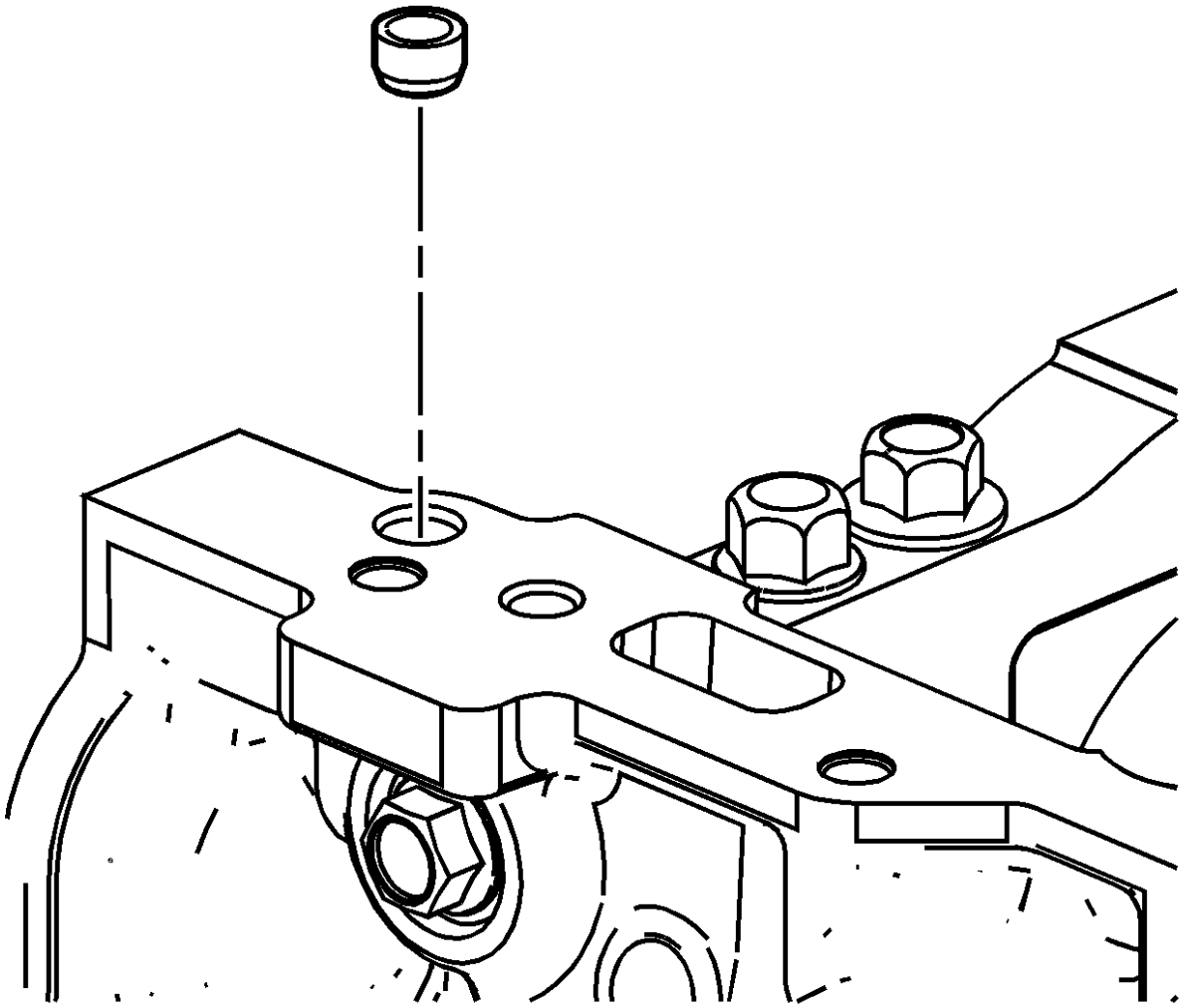

Fig. 96: Locating Right Front Oil Pan Rail Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS COMPANY

12. Remove the right front oil pan rail oil gallery expansion plug.

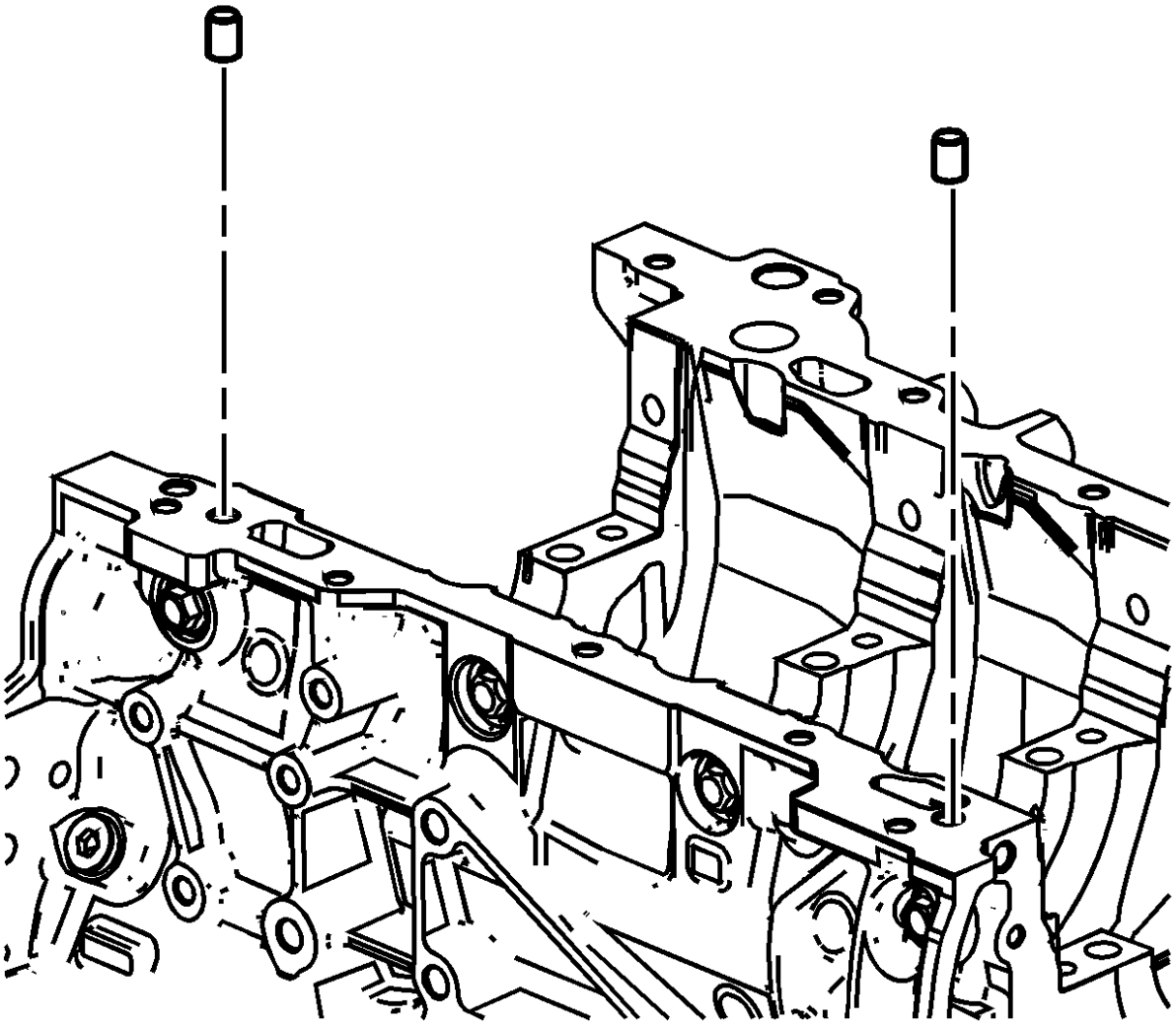

Fig. 97: Identifying Cylinder Block-To-Oil Pan Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

13. Remove the cylinder block-to-oil pan alignment dowels.

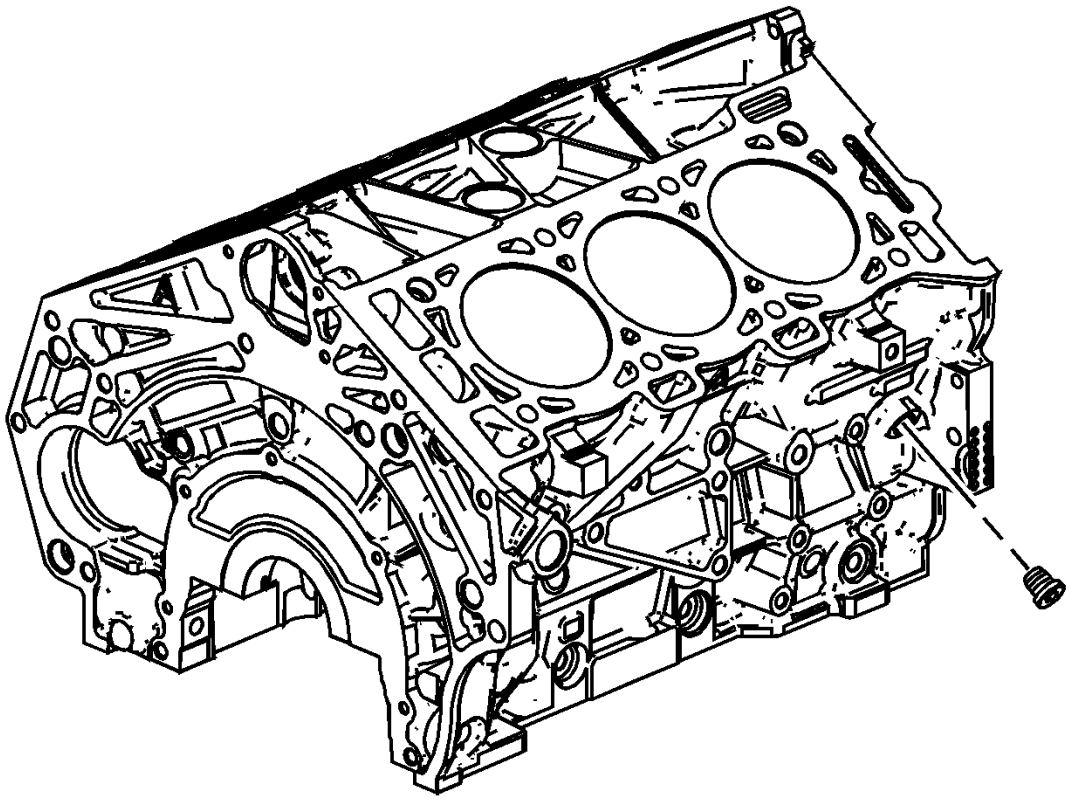

Fig. 98: Identifying M14 Right Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

14. Remove the M14 right side oil gallery threaded plug.

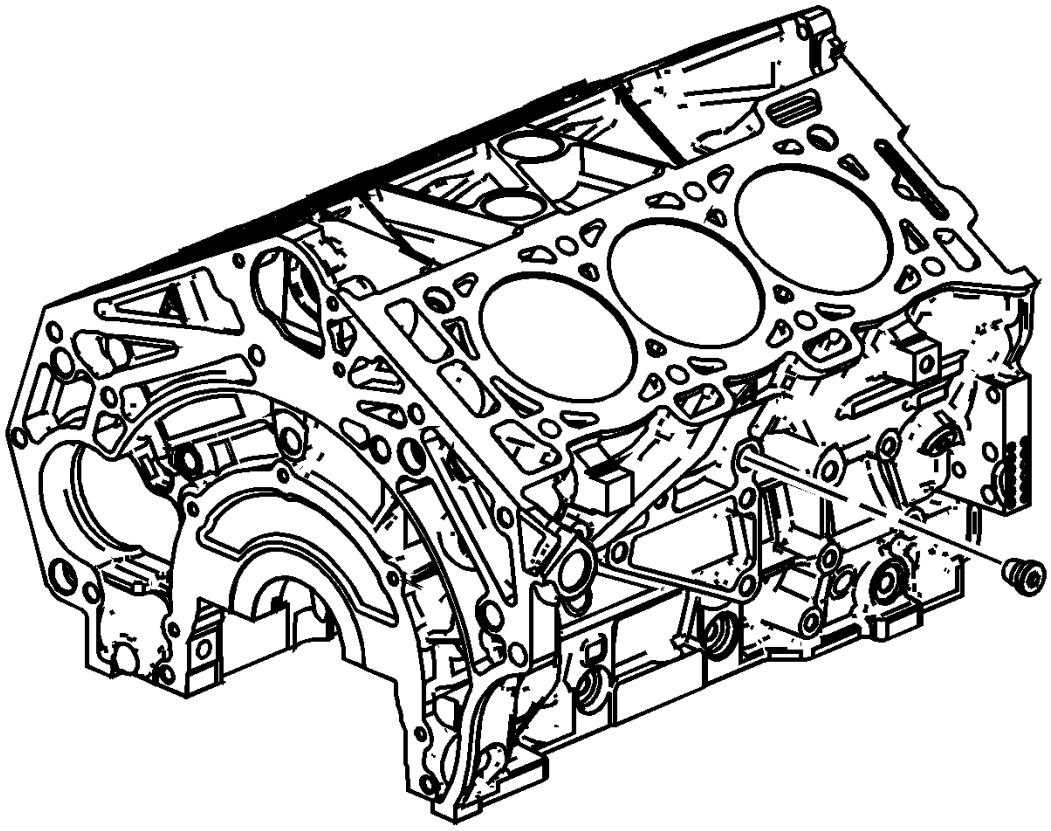

Fig. 99: Identifying M14 Right Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

15. Remove the M14 right side coolant drain threaded plug.

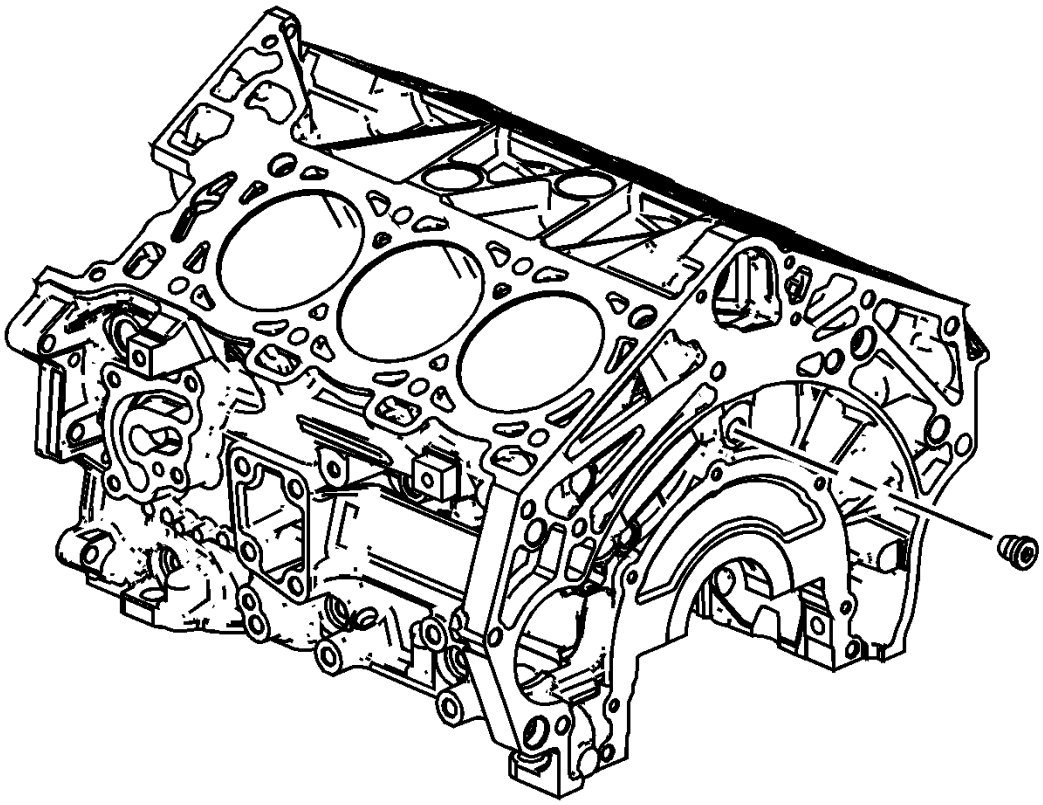

Fig. 100: Identifying M14 Rear Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

16. Remove the M14 rear oil gallery threaded plug.

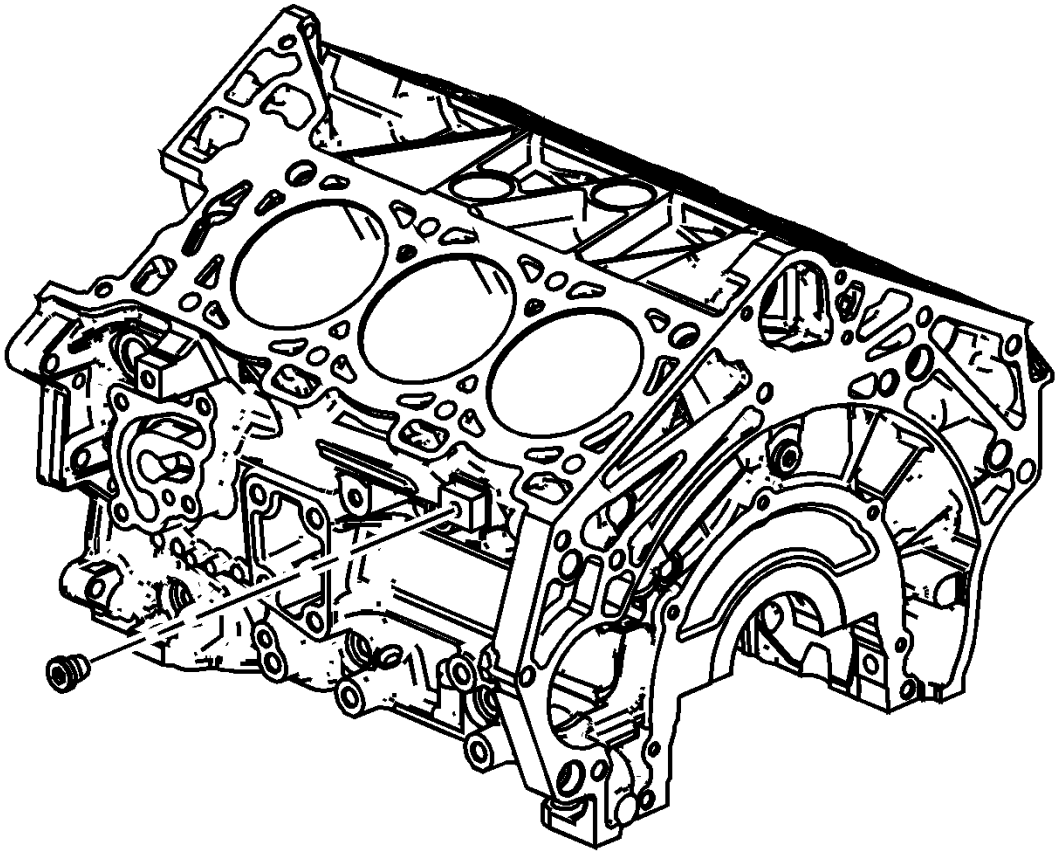

Fig. 101: View Of M14 Left Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

17. Remove the M14 left side coolant drain threaded plug.

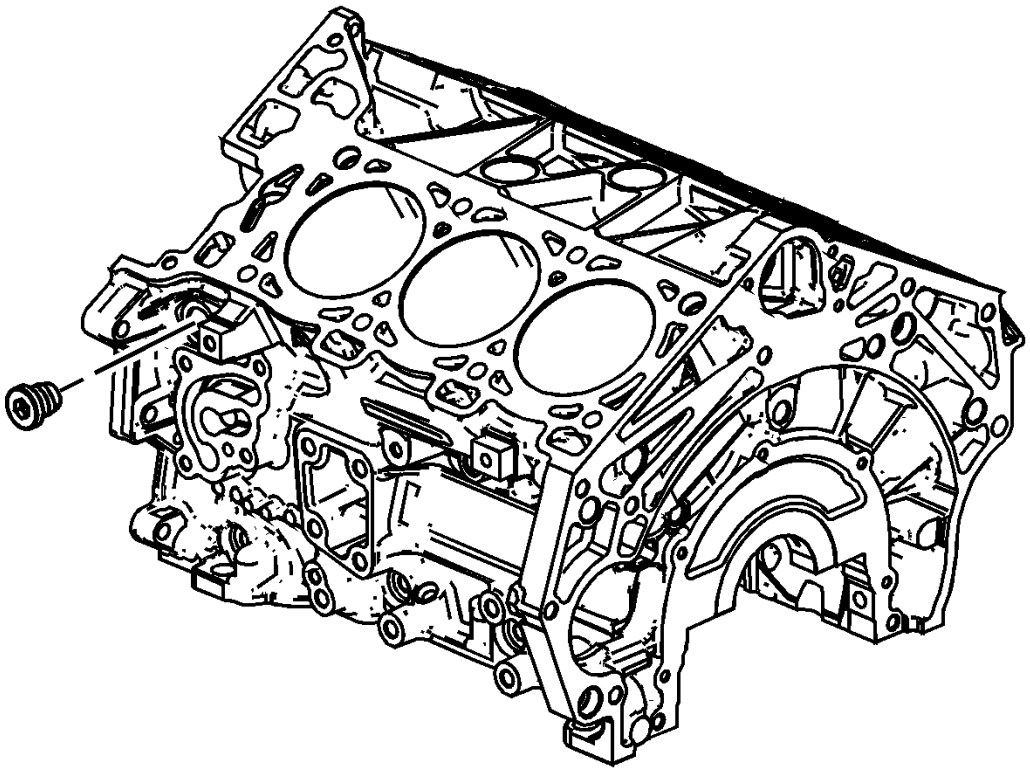

Fig. 102: M20 Left Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

18. Remove the M20 left side oil gallery threaded plug.

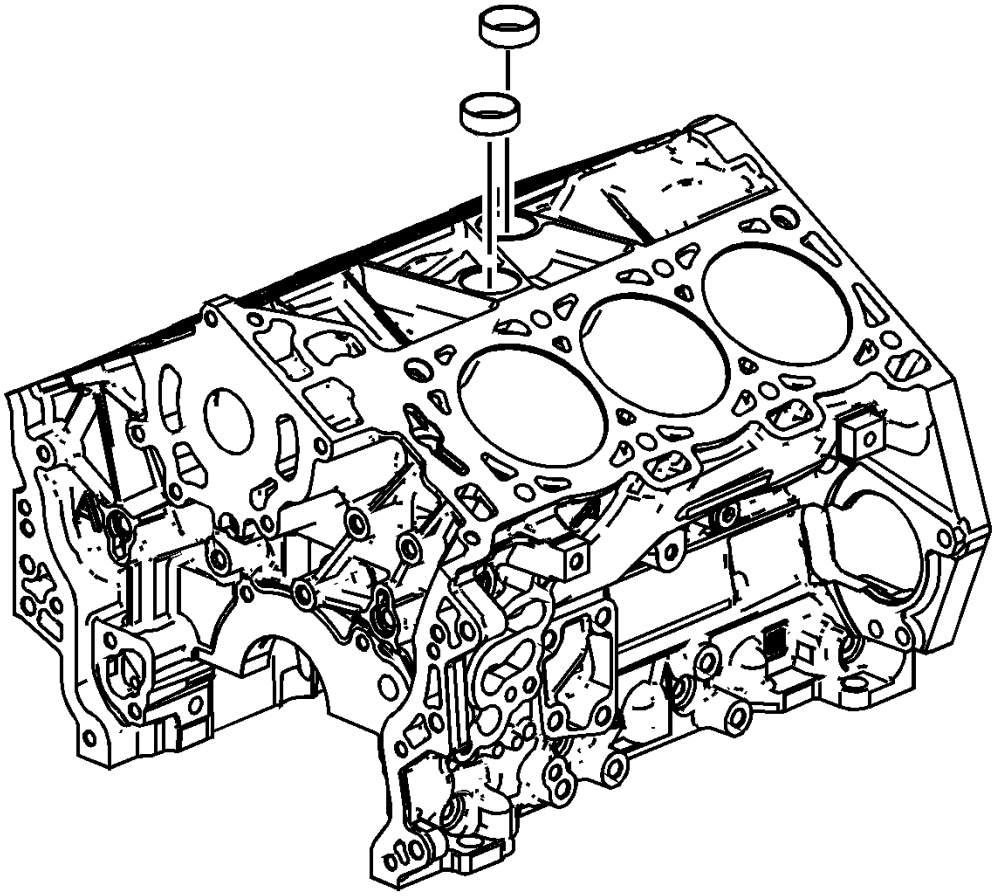

Fig. 103: Identifying Coolant Expansion Plugs
Courtesy of GENERAL MOTORS COMPANY

19. Remove the coolant expansion plugs.

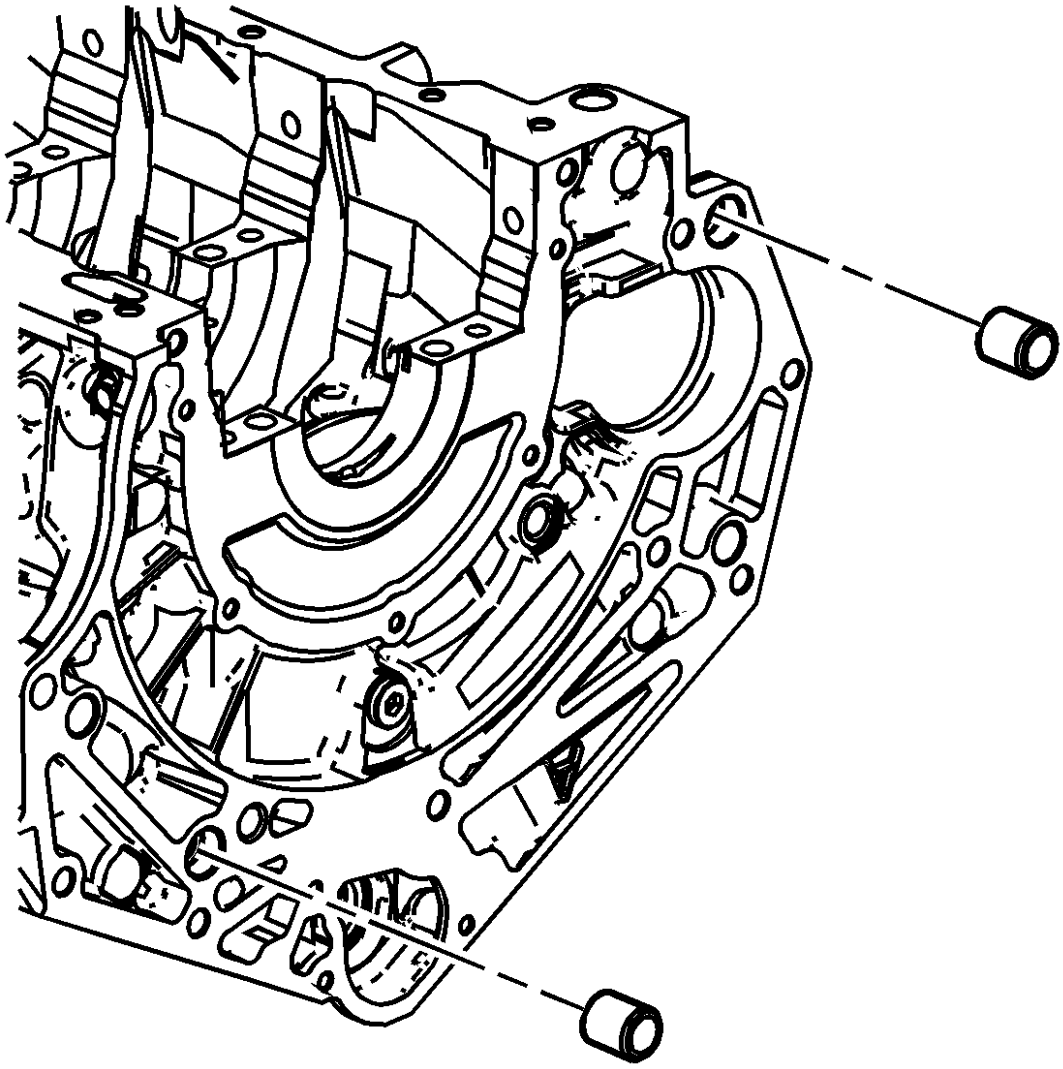

Fig. 104: Identifying Cylinder Block-To-Transmission Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

20. Remove the cylinder block-to-transmission alignment dowels.

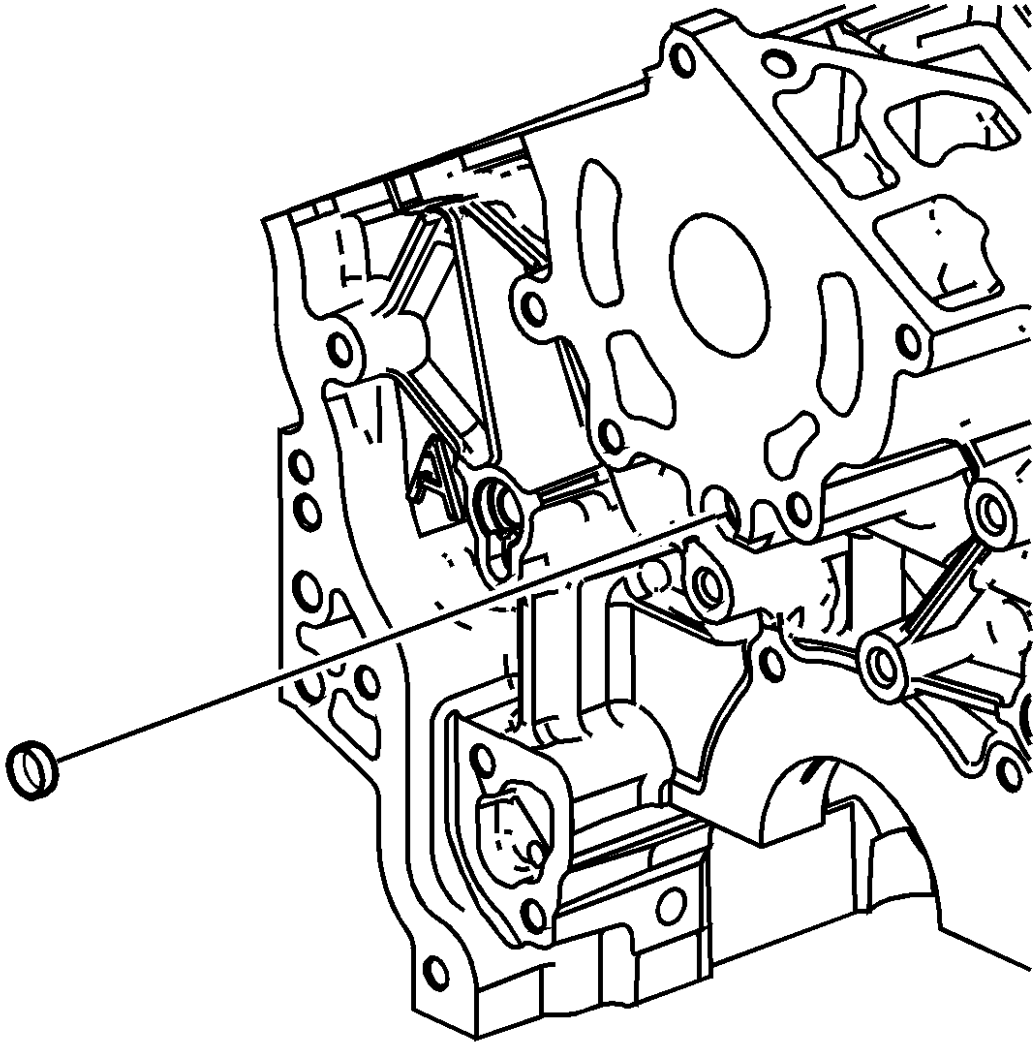

Fig. 105: View Of Front Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS COMPANY

21. Remove the front oil gallery expansion plug.

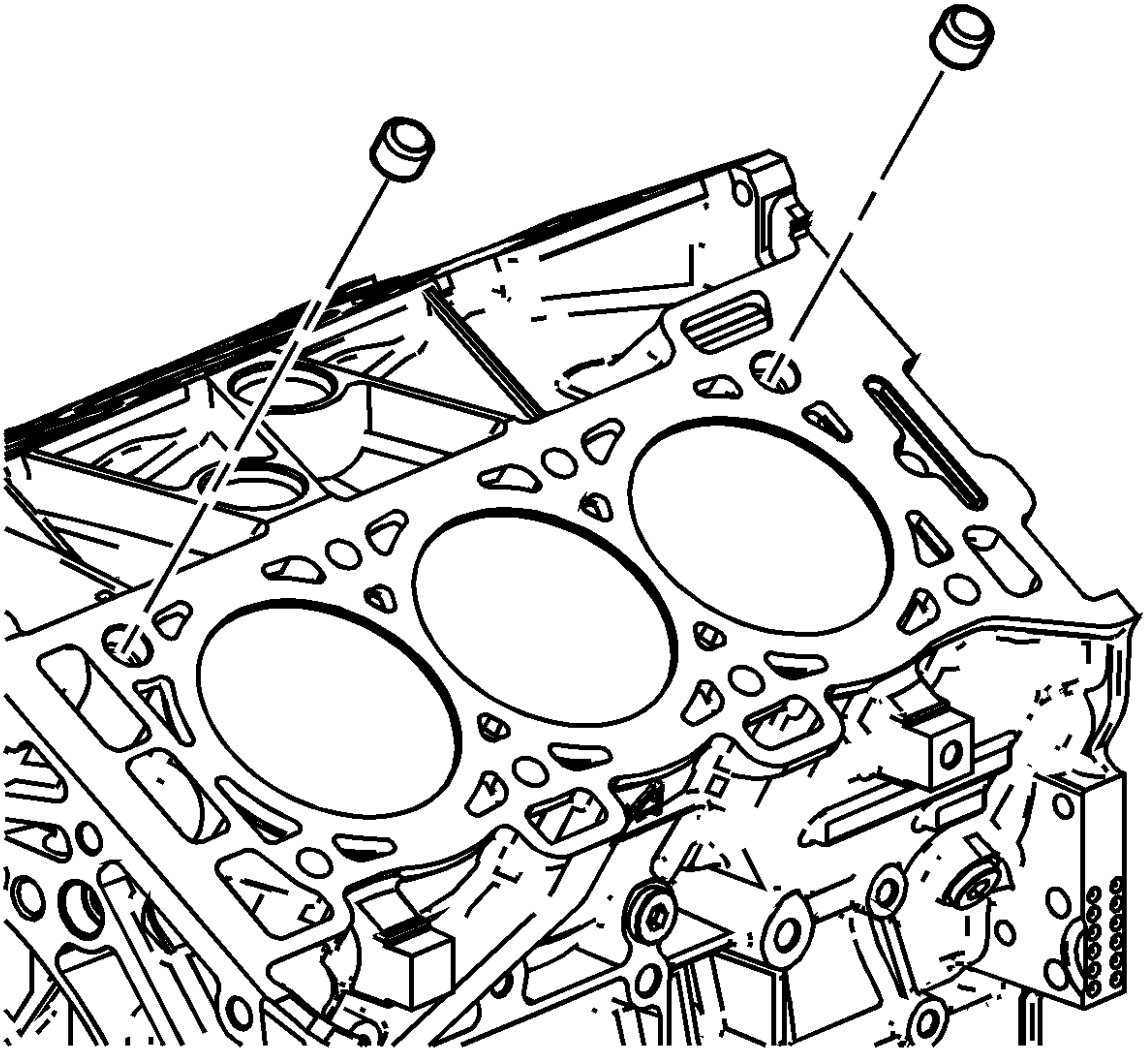

Fig. 106: Cylinder Block-To-Cylinder Head Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

22. Remove the cylinder block-to-cylinder head alignment dowels.

ENGINE BLOCK CLEANING AND INSPECTION

Special Tools

- **EN-8087** Cylinder Bore Gauge
- **EN-28410** Gasket Remover

For equivalent regional tools, refer to **Special Tools** .

Cleaning Procedure

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
2. Remove any old thread sealant, gasket material or sealant using **EN-28410** Gasket Remover.

3. Clean all the following areas with solvent:
    - Sealing surfaces
    - Cooling passages
    - Oil passages
    - Bearing journals
4. Clean all threaded and through holes with solvent.

WARNING: Refer to Safety Glasses Warning .

5. Dry the engine block with compressed air.

Visual Inspection

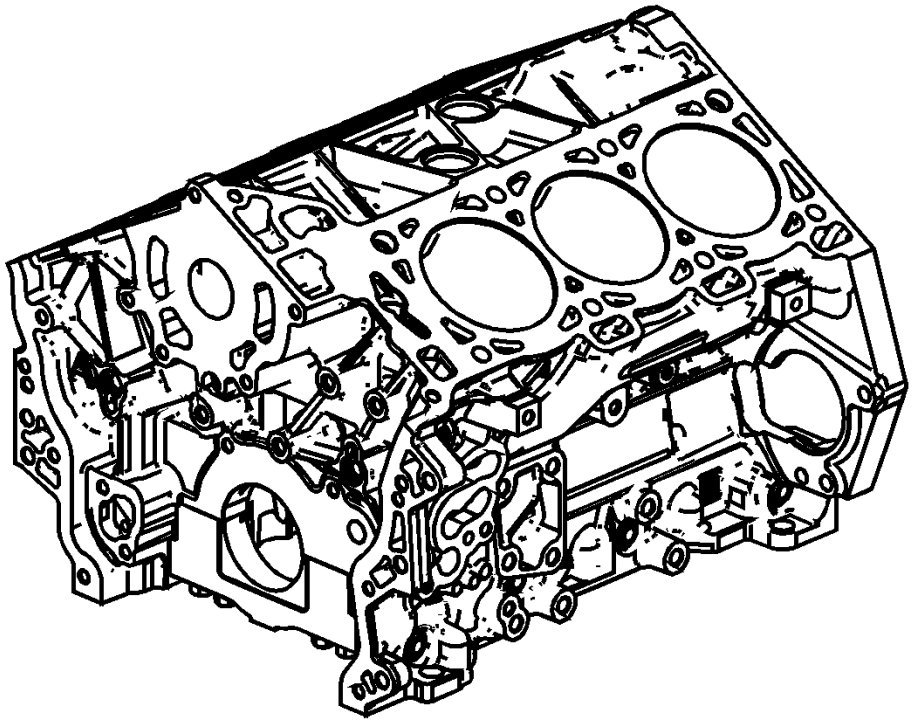

Fig. 107: View Of Engine Block
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the crankshaft bearings journals for damage or spun bearings. The crankshaft bearing journals are not repairable, if the crankshaft bearing journals are damaged the cylinder block assembly must be replaced.

2. Inspect the primary camshaft drive chain tensioner mounting surface on the engine block for burrs or any defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.
3. Inspect all sealing and mating surfaces for damage, repair or replace the cylinder block assembly if necessary.
4. Inspect all threaded and through holes for damage or excessive debris.
5. Inspect all bolts for damage, if damaged replace with NEW bolts only.
6. Check the cylinder condition. Some light vertical marks may be visible on the cylinder wall. In these areas, check that the honing marks are still visible in this marked area. If they are, the cylinder surface has not been compromised and the engine block can be used.
7. Inspect the cylinder walls for cracks or damage. The cylinder sleeves are not serviced separately, if the cylinders are damaged the cylinder block assembly must be replaced.
8. Inspect the engine block for cracks. Do not repair any cracks. If cracks are found, the cylinder block assembly must be replaced.
9. Repair any damaged threaded holes. Refer to **Thread Repair Specifications** , and **Thread Repair**.

Measuring Cylinder Bore Diameter

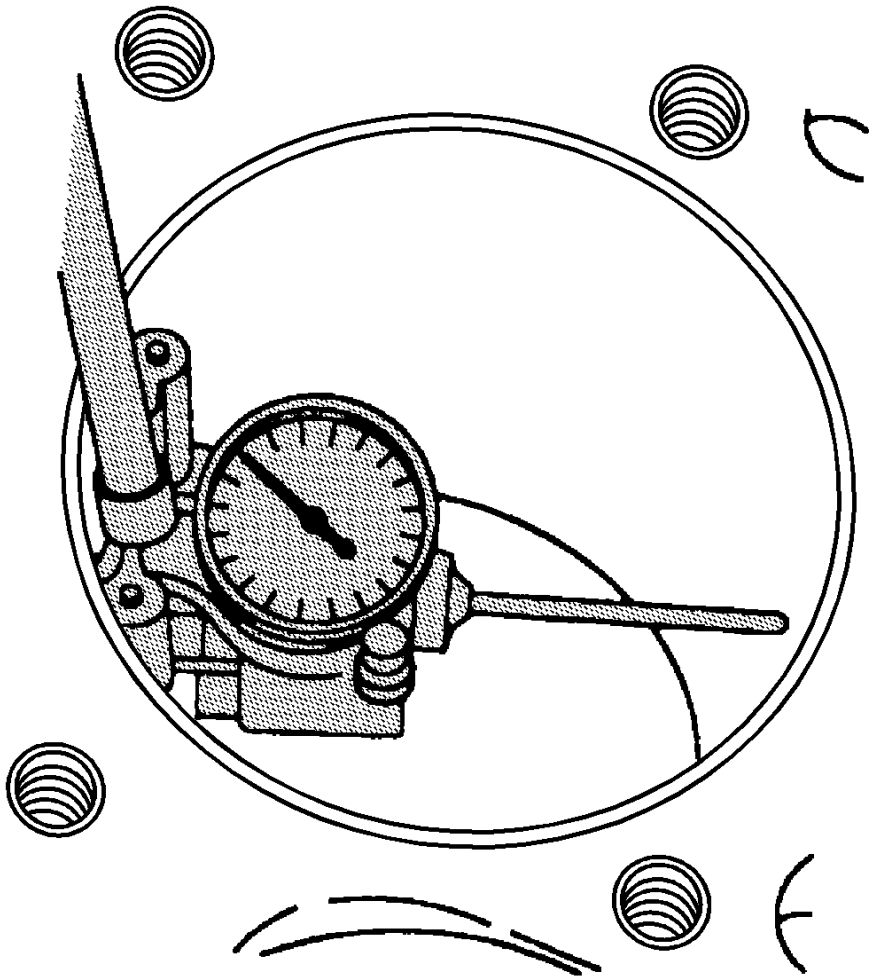

Fig. 108: Measuring Cylinder Bore

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Courtesy of GENERAL MOTORS COMPANY

Measure the cylinder bore diameter 37 mm (1.457 in) from the deck face using the **EN-8087** gauge.

Compare your results with the **Engine Mechanical Specifications** . If the cylinder diameter exceeds the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Measuring Cylinder Bore Taper

1. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 10 mm (0.397 in) below the deck surface and record your measurement.
2. Measure the cylinder bore along the thrust surfaces, perpendicular to the crankshaft centerline, at 100 mm (3.976 in) below the deck surface and record your measurement.
3. Calculate the difference between the 2 measurements. The result will be the cylinder taper.
4. Compare your results with the **Engine Mechanical Specifications** . If the cylinders exceed the specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Measuring Cylinder Bore Out-of-Round

1. Measure both the thrust and non-thrust cylinder diameter at 10 mm (0.397 in) below the deck. Record your measurements.
2. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the upper end of the cylinder.
3. Measure both the thrust and non-thrust cylinder diameter at 100 mm (3.976 in) below the deck surface. Record your measurements.
4. Calculate the difference between the 2 measurements. The result will indicate out-of-round at the lower end of the cylinder.
5. Compare your results with the **Engine Mechanical Specifications** . If the cylinders exceed these specifications, the cylinder block may be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Deck Flatness Inspection

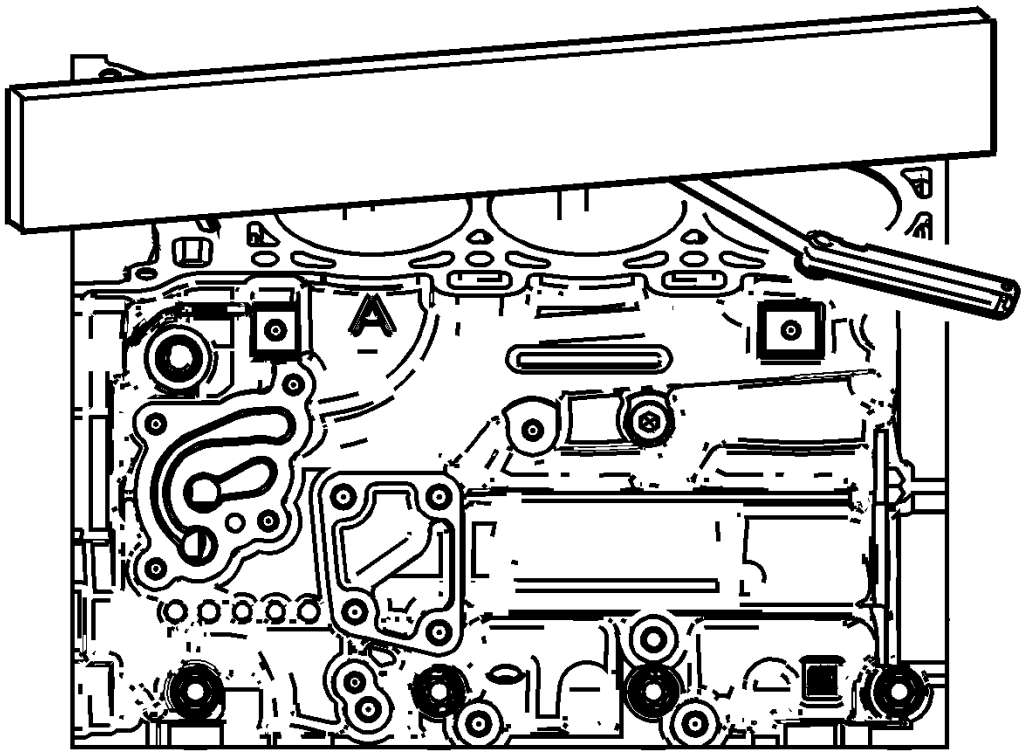

Fig. 109: Measuring Deck Flatness
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the engine block decks are clean and free of gasket material.
2. Inspect the surface for any imperfections or scratches that could inhibit proper cylinder head gasket sealing.
3. Place a straight-edge diagonally across the cylinder block deck face surface.
4. Measure the clearance between the straight-edge and the cylinder block deck face using a feeler gauge at 4 points along the straight-edge.
5. If the warpage is less than 0.05 mm (0.002 in), the cylinder block deck surface does not require resurfacing.
6. If the warpage is between 0.05-0.20 mm (0.002-0.008 in) or any imperfections or scratches that could inhibit proper cylinder head gasket sealing are present, the cylinder block deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).
8. If the cylinder block deck surface requires more than 0.25 mm (0.010 in) material removal the block must be replaced.

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CRANKSHAFT AND BEARING CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the following components in solvent:
    - Crankshaft bearings
    - Connecting rod bearings
    - Crankshaft journals
    - Crankpin journals
    - Crankshaft oil passages
    - Crankshaft threaded holes

    WARNING: Refer to Safety Glasses Warning .

2. Dry the following components with compressed air:
    - Crankshaft bearings
    - Connecting rod bearings
    - Crankshaft journals
    - Crankpin journals
    - Crankshaft oil passages
    - Crankshaft threaded holes

Visual Inspection

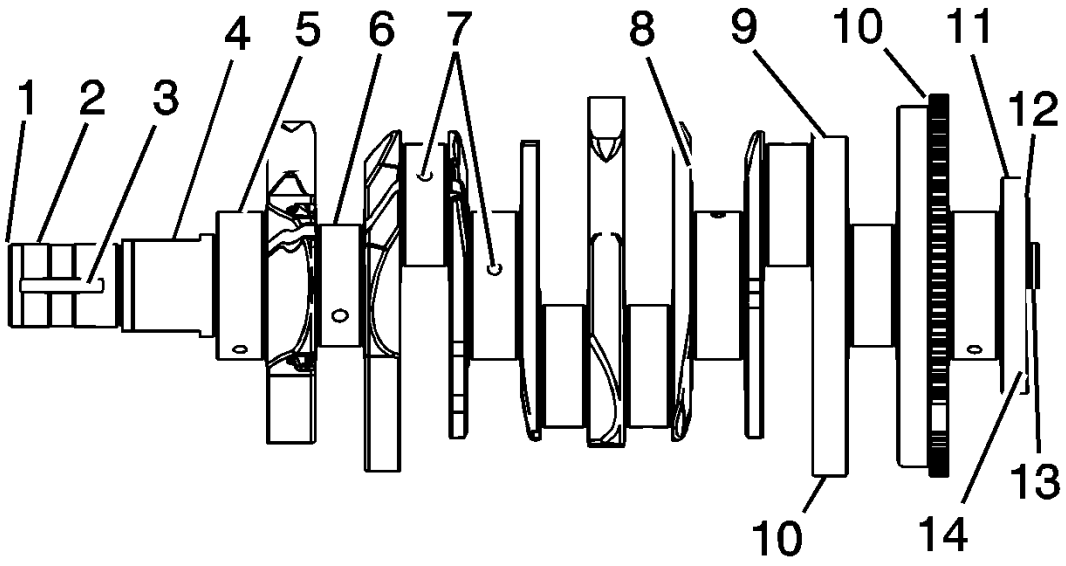

Fig. 110: Identifying Crankshaft Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Perform the following visual inspections:
    - Inspect the crankshaft balancer bolt hole (1) for thread damage.
    - Inspect the crankshaft balancer mounting area (2) for damage.
    - Inspect the crankshaft keyway (3) for damage.
    - Inspect the oil pump drive flats (4) for damage.
    - Inspect the crankshaft main journals (5) for damage.
    - Inspect the crankshaft connecting rod journals (6) for damage.
    - Inspect the crankshaft oil passages (7) for obstructions.
    - Inspect the crankshaft main bearing thrust wall surfaces (8) for damage.
    - Inspect the crankshaft counterweights (9) for damage.
    - Inspect the crankshaft reluctor ring teeth (10) for damage.
    - Inspect the crankshaft rear main oil seal surface (11) for damage.
    - Inspect the crankshaft engine flywheel mounting surface (12) for damage.
    - Inspect the crankshaft pilot hole (13) for damage.

- Inspect the crankshaft engine flywheel bolt holes (14) for thread damage.

2. Repair or replace the crankshaft as necessary.

Crankshaft Bearing Inspection

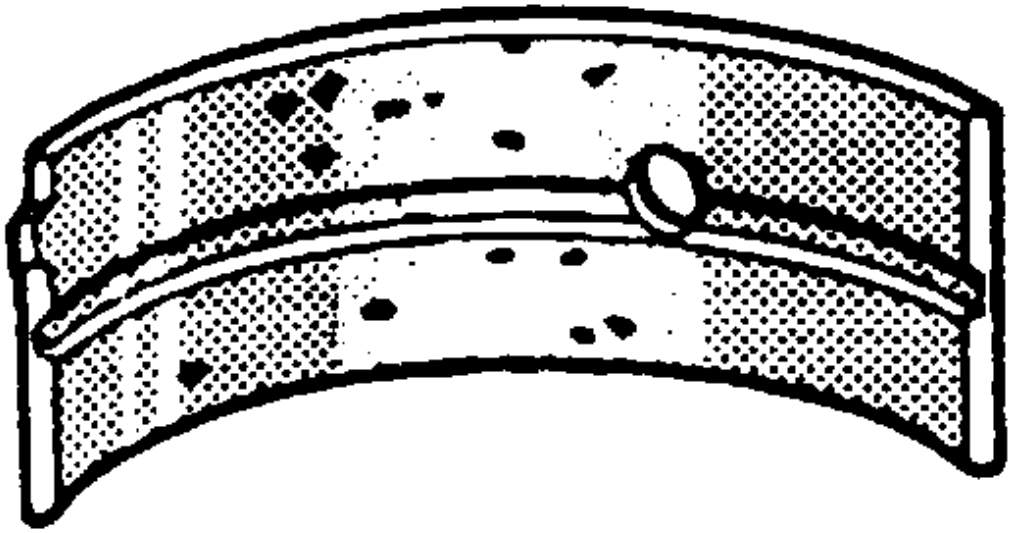

Fig. 111: Identifying Crankshaft Bearing Craters Or Pockets
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **All connecting rod and main journal bearings that have been used in a running engine must be replaced. Never re-use the crankshaft or connecting rod bearings.**
- **The following bearing wear conditions should be used to diagnose engine operating conditions or root cause of a condition.**

1. Inspect for fatigue indicated by craters or pockets. Flattened sections on the bearing halves also indicate fatigue.

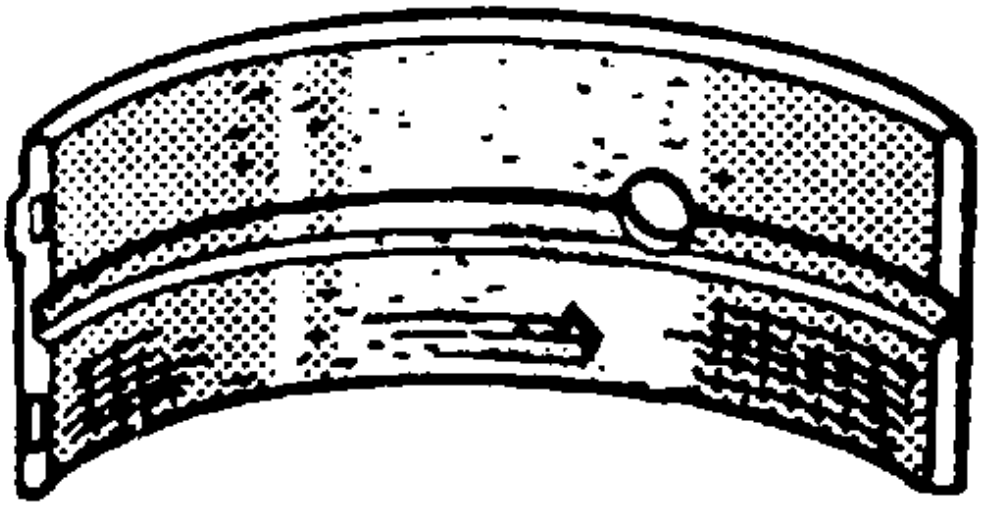

Fig. 112: Identifying Connecting Rod Bearing Scoring Or Discoloration
Courtesy of GENERAL MOTORS COMPANY

2. Inspect for excessive scoring or discoloration on both front and back of the bearing halves.
3. Inspect the main bearings for dirt embedded into the bearing material.

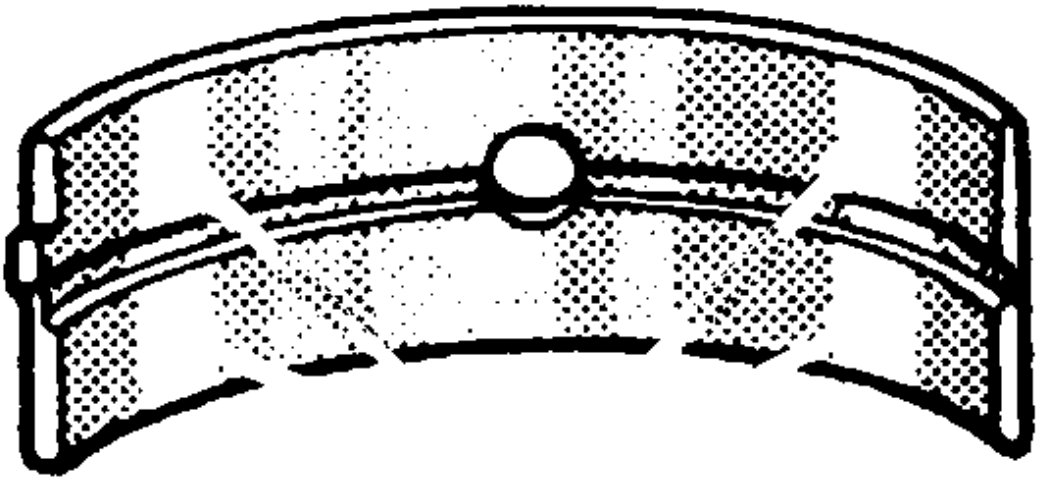

Fig. 113: View Of Crankshaft Bearing Improper Seating
Courtesy of GENERAL MOTORS COMPANY

4. Inspect for improper seating indicated by bright, polished sections.

Crankshaft Measurement

Special Tools

GE 7872 Magnetic Base Dial Indicator

For equivalent regional tools, refer to **Special Tools**

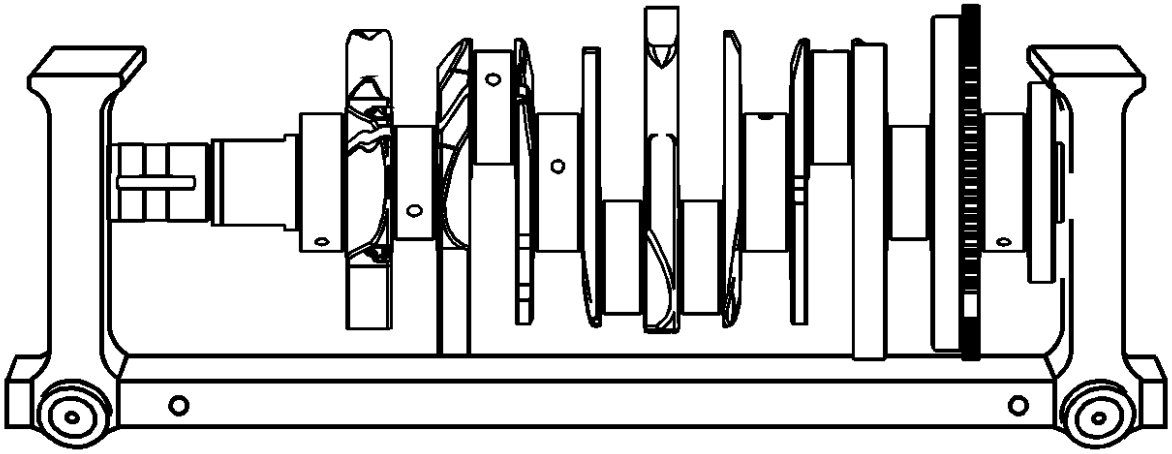

Fig. 114: View Of Crankshaft & Support
Courtesy of GENERAL MOTORS COMPANY

1. Using a suitable fixture, support the crankshaft.

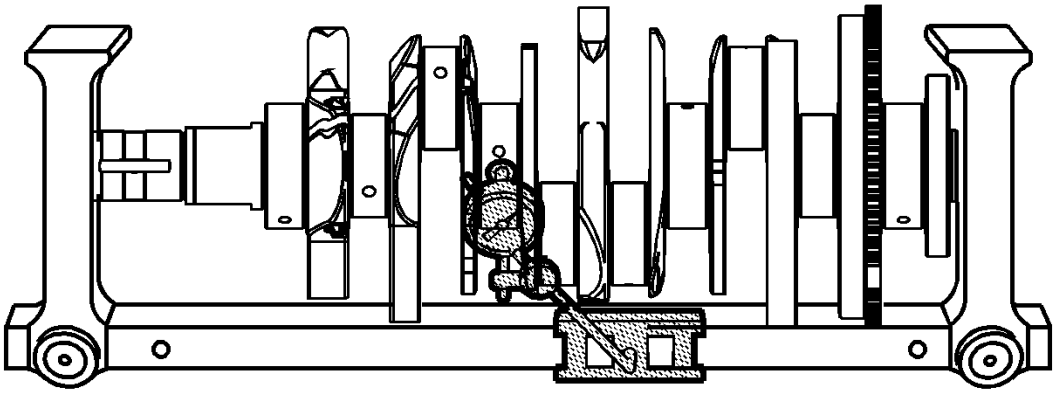

Fig. 115: Measuring Crankshaft Runout
Courtesy of GENERAL MOTORS COMPANY

2. Install the **GE 7872** indicator.
3. Measure the crankshaft runout using the **GE 7872** indicator. Refer to **Engine Mechanical Specifications** .

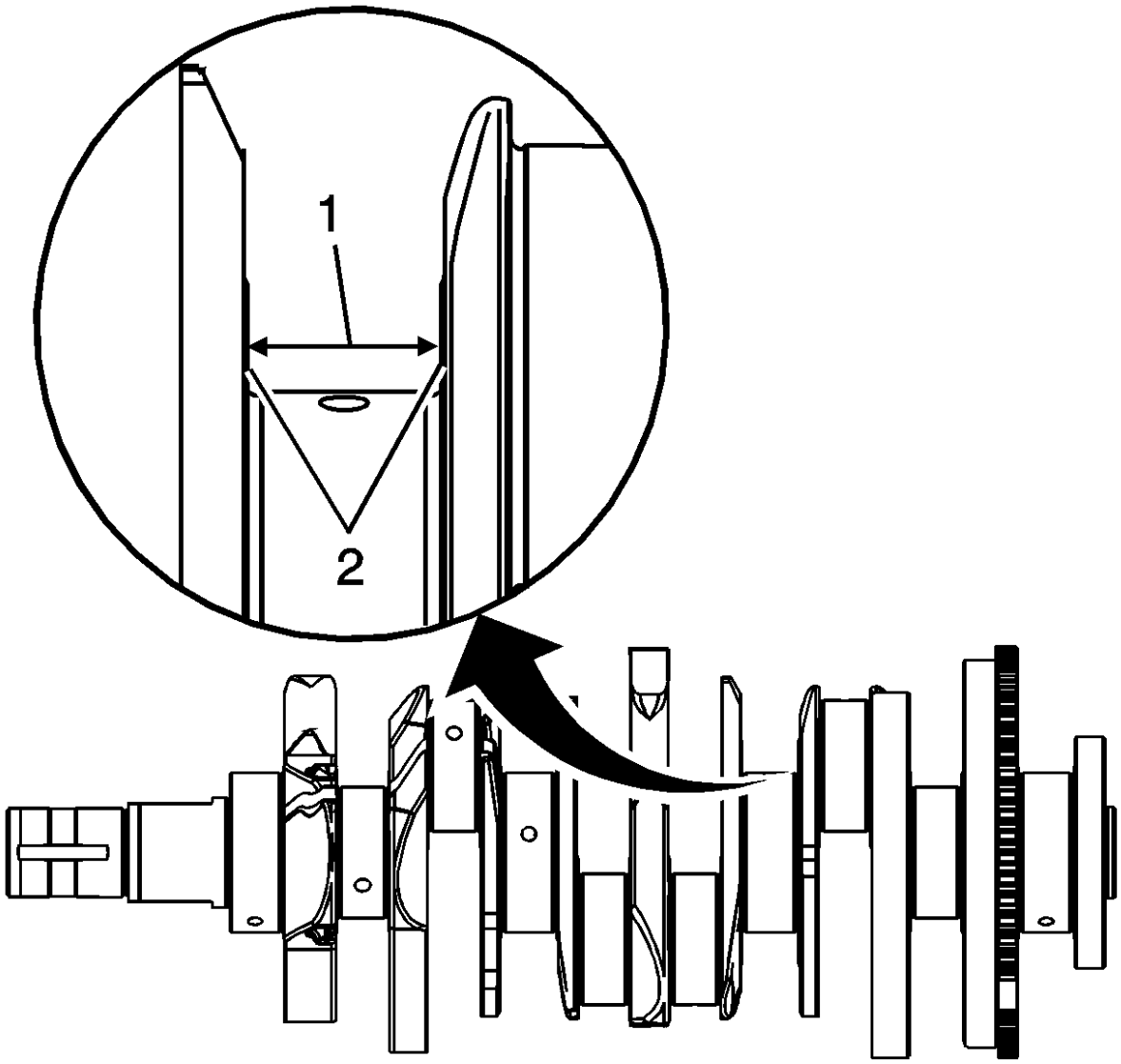

Fig. 116: Identifying Crankshaft Thrust Wall Width & Surface
Courtesy of GENERAL MOTORS COMPANY

4. Measure the crankshaft thrust wall width (1) for wear using an inside micrometer. Refer to **Engine Mechanical Specifications** .
5. Measure the crankshaft thrust wall surface (2) for runout using the **GE 7872** indicator. Refer to **Engine Mechanical Specifications** .
6. If the crankshaft journals are damaged or worn beyond specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized main bearings available for service.

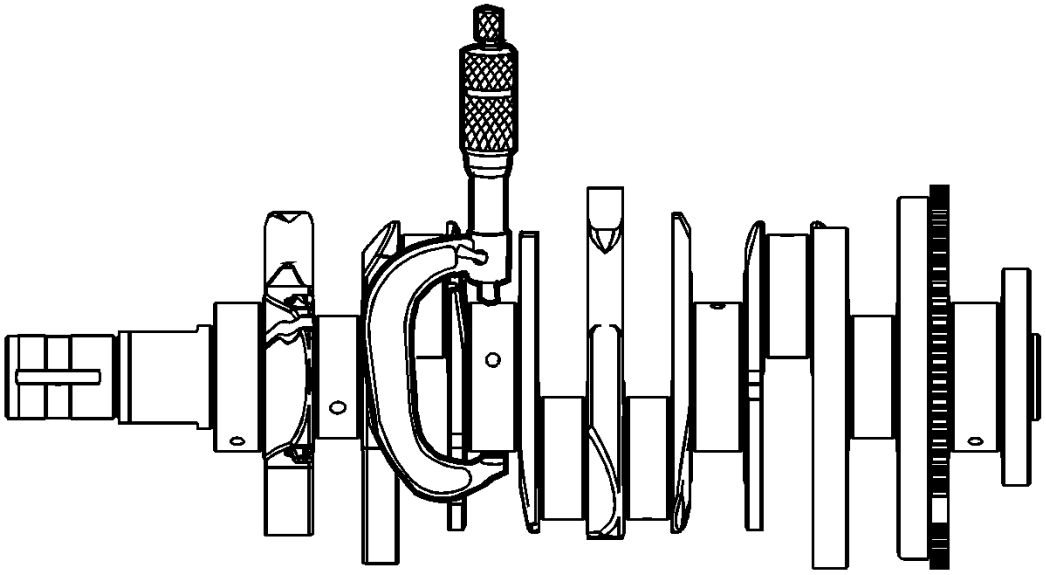

Fig. 117: Using Outside Micrometer To Inspect Crankshaft Main Journals
Courtesy of GENERAL MOTORS COMPANY

7. Inspect the crankshaft main journals for undersize, using an outside micrometer.

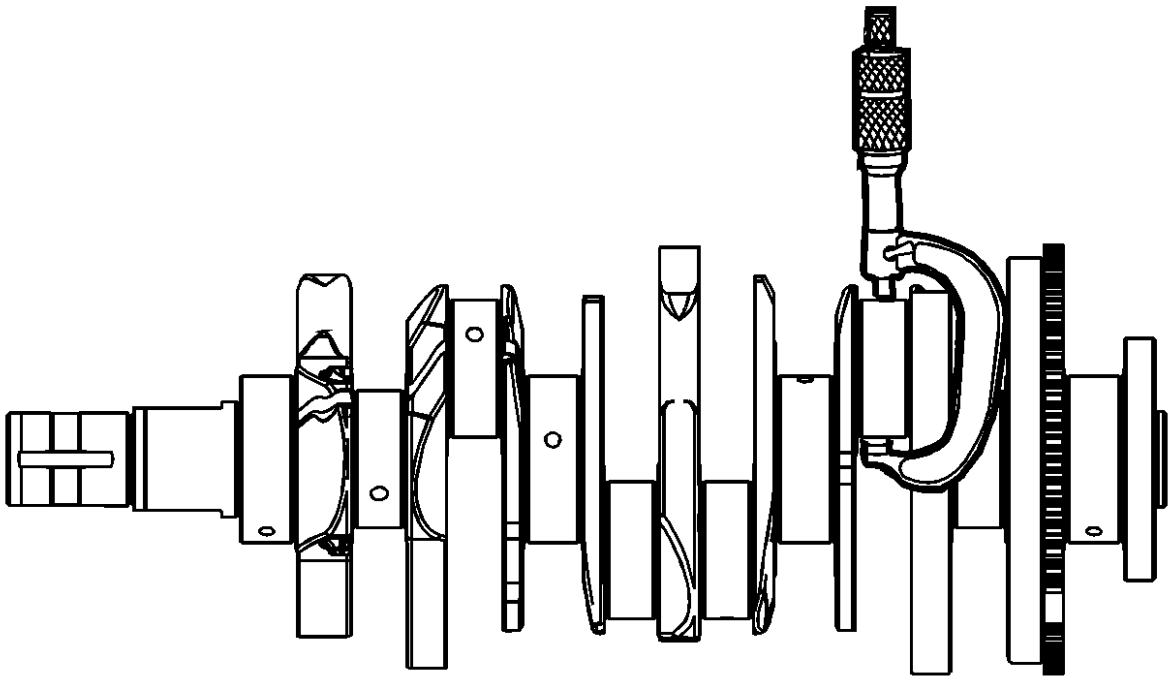

Fig. 118: View Of Micrometer & Crankshaft Journals
Courtesy of GENERAL MOTORS COMPANY

8. Inspect the crankpins for undersize using an outside micrometer.
9. Compare your measurements with those listed in the **Engine Mechanical Specifications** . If the crankpin journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized connecting rod bearings available for service.

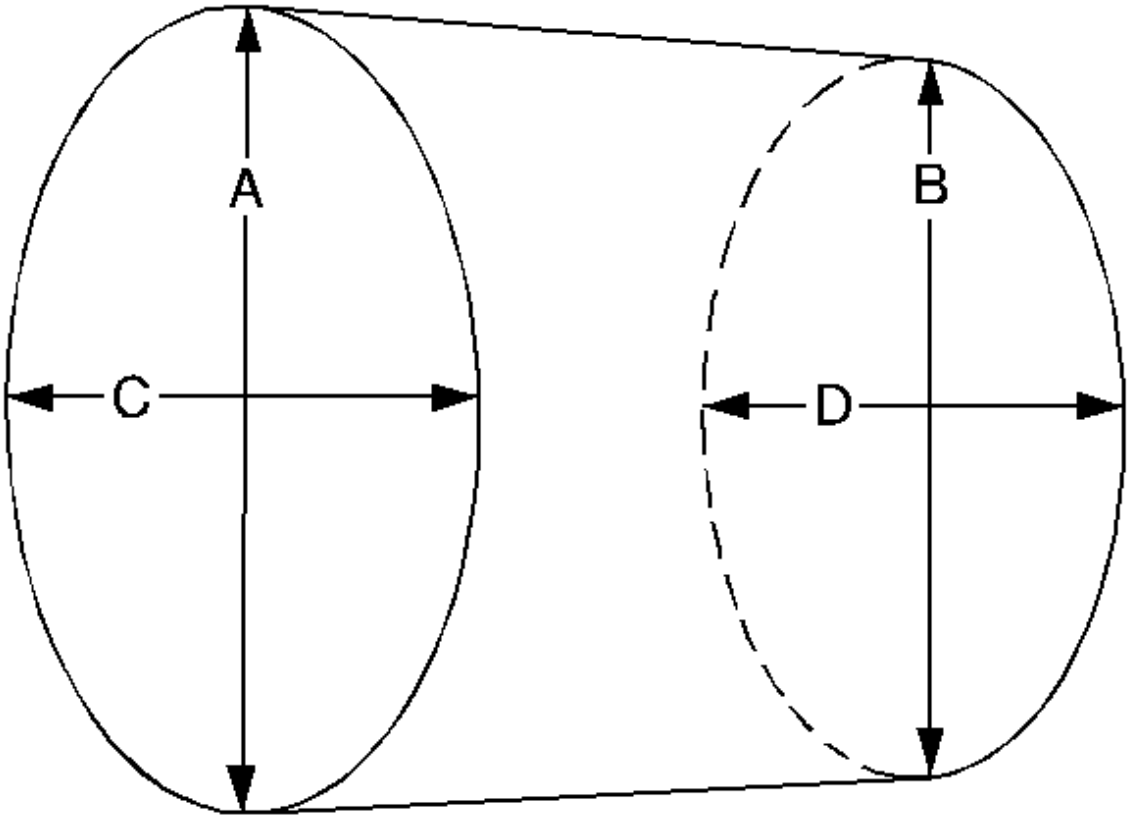

Fig. 119: Identifying Out-Of-Round Measurements
Courtesy of GENERAL MOTORS COMPANY

10. Measure the main bearing and crankpin journals for out-of-round using the following procedure:
    1. Using an outside micrometer, measure the journal at the extreme front and rear locations on the journal. Call these points A and B.
    2. Measure the journal in 2 new locations exactly 90 degrees from the first points. Call these points C and D.
    3. Subtract A from C and B from D. The differences will indicate journal out-of-round.
    4. The out-of-round should not exceed 0.004 mm (0.00016 in) maximum.
    5. If the journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized crankshaft and connecting rod bearings available for service.
11. Measure the main bearing and crankpin journals for taper using the following procedure:
    1. Using an outside micrometer, measure the journal at the extreme front (A) and rear (B) of the journal parallel to the crankshaft centerline.

2. Subtract the smallest from the largest measurement. The result will be the journal taper.
3. If the main bearing journal taper exceeds 0.004 mm (0.00016 in), replace the crankshaft.
4. If the journals are worn beyond the specifications, the crankshaft may be ground 0.25 mm (0.010 in). There is only 1 size of oversized crankshaft and connecting rod bearings available for service.

AUTOMATIC TRANSMISSION FLEX PLATE CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the flex plate in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the flex plate with compressed air.

Inspection Procedure

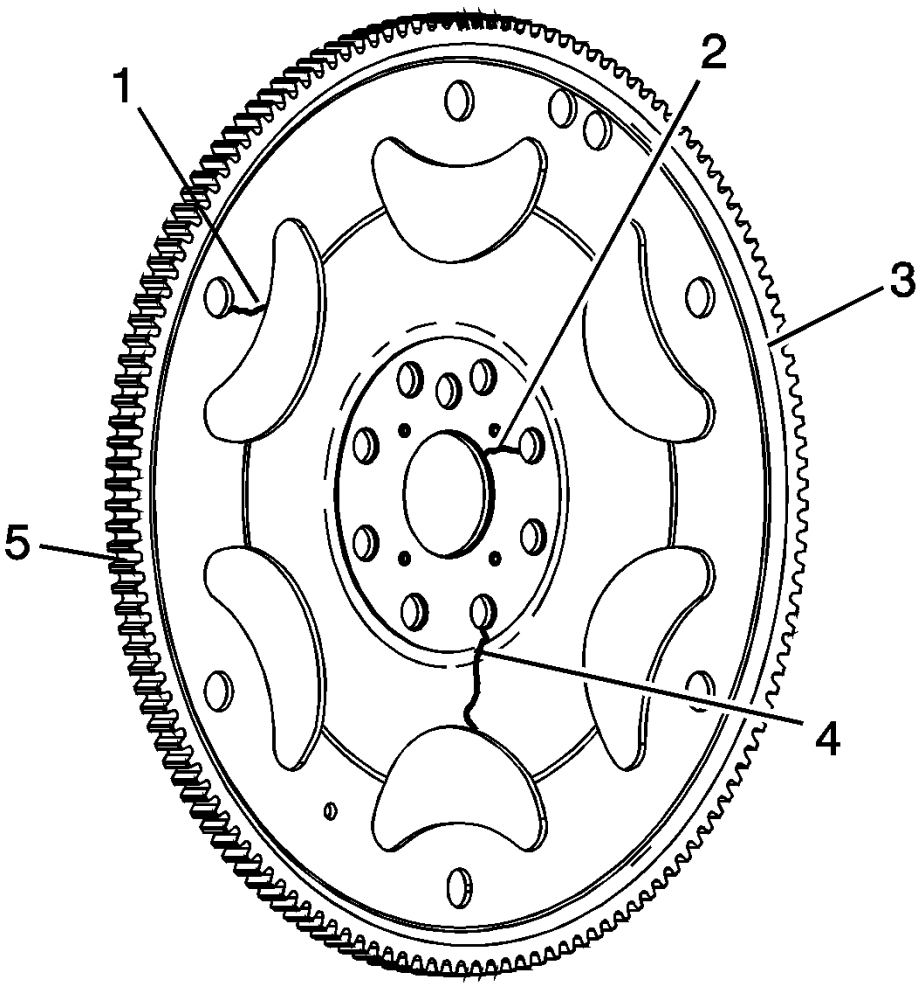

Fig. 120: Identifying Engine Flywheel Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the flex plate for the following conditions:

- Stress cracks around the flex plate-to-torque converter mounting bolt hole locations (1) and/or flex plate-to-crankshaft (2, 4)

NOTE: **Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a NEW flex plate.**

- Cracks at welded areas that retain the ring gear onto the flex plate (3)
- Damaged or missing ring gear teeth (5)

2. Replace the flex plate as necessary.

CRANKSHAFT BALANCER CLEANING AND INSPECTION

Cleaning Procedure

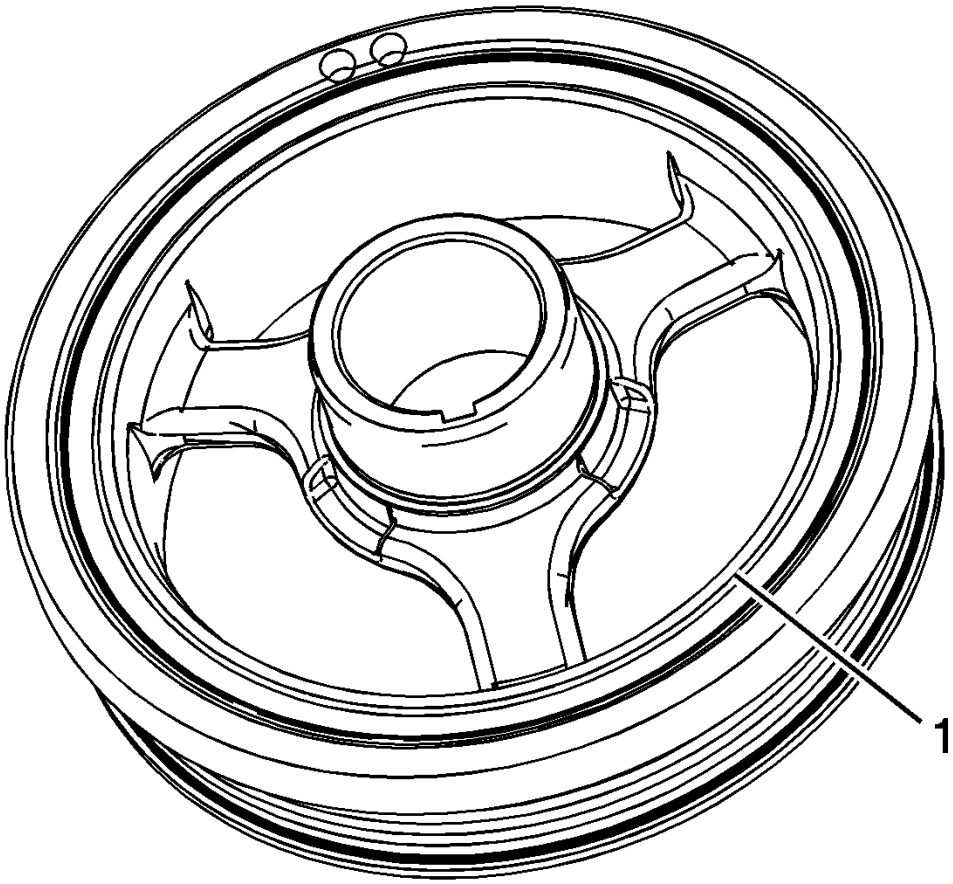

Fig. 121: View Of Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

1. Clean the crankshaft balancer in solvent that is compatible with the rubber (1).

WARNING: **Refer to Safety Glasses Warning .**

2. Dry the crankshaft balancer with compressed air.

Inspection Procedure

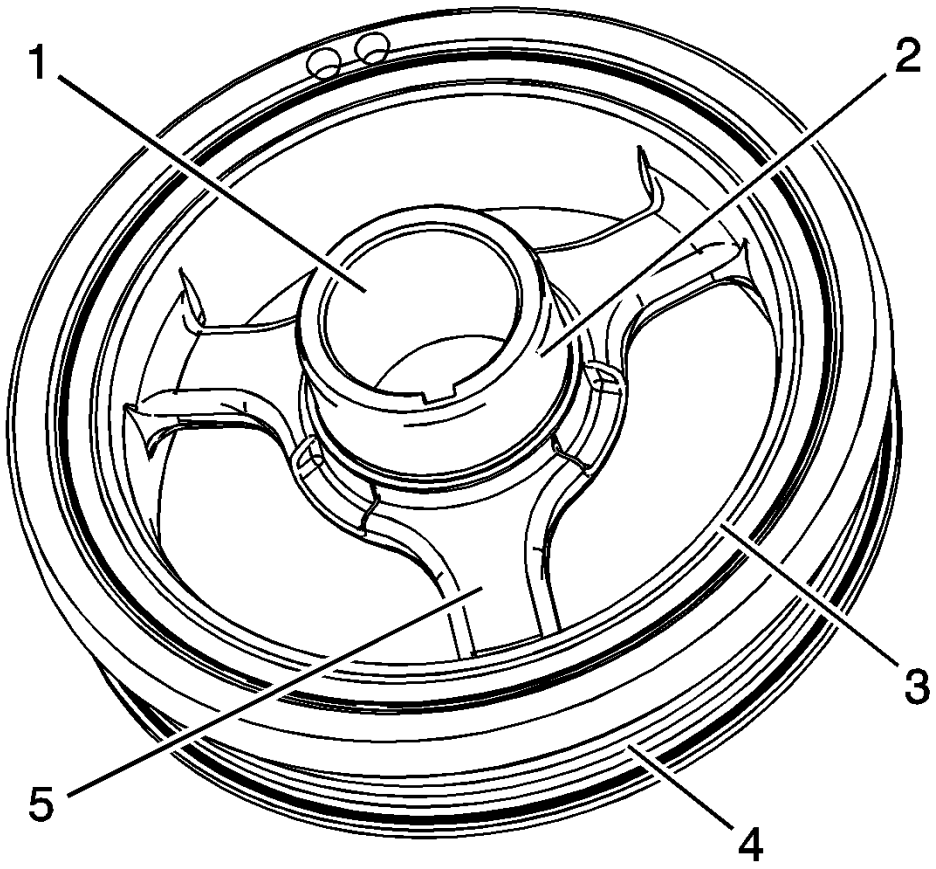

Fig. 122: Identifying Crankshaft Balancer Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the crankshaft balancer for the following:
   - Worn or damaged hub-to-crankshaft surface (1)
   - Worn, grooved or damaged hub seal surface (2)

     A crankshaft balancer hub seal surface with excessive scoring, grooves, rust or other damage must be replaced.

   - Worn, chunking or deteriorated rubber between the hub and pulley (3)
   - Damaged drive belt ribs (4)
   - Damaged webs (5)
2. Repair or replace the crankshaft balancer as necessary.

ENGINE FLYWHEEL CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the flex plate in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the flex plate with compressed air.

Inspection Procedure

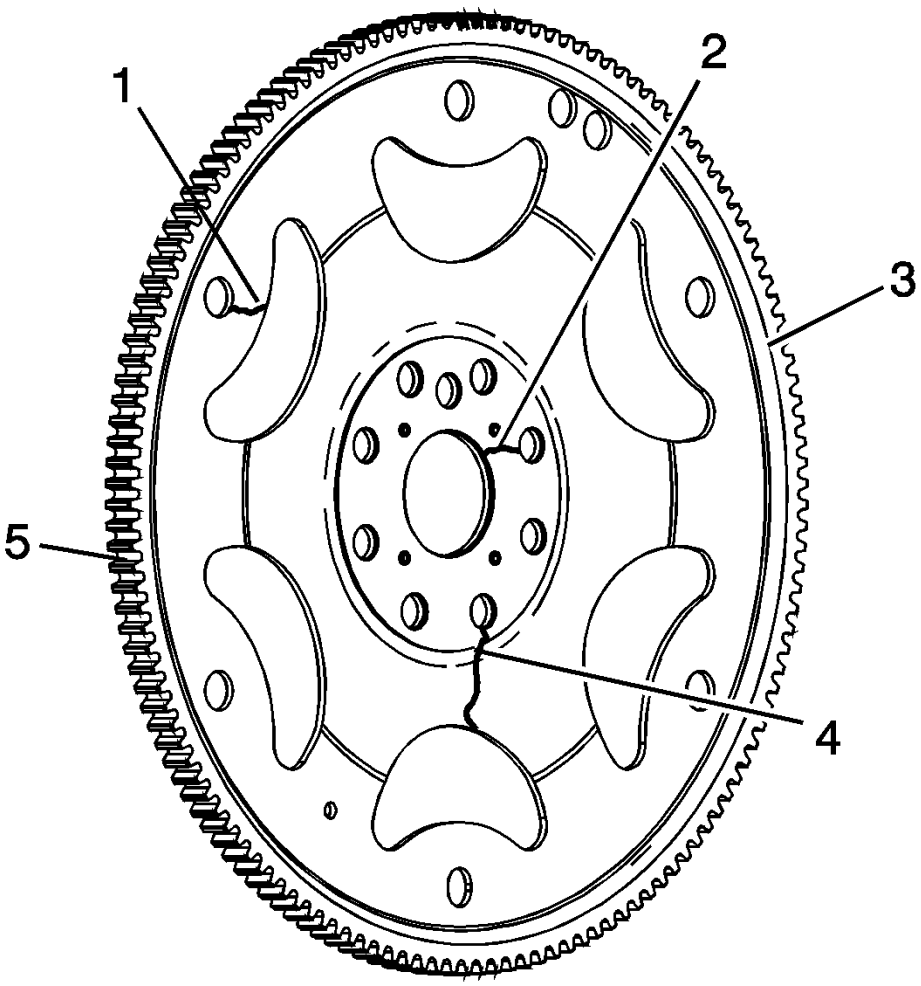

Fig. 123: Identifying Engine Flywheel Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the flex plate for the following conditions:
   - Stress cracks around the flex plate-to-torque converter mounting bolt hole locations (1) and/or flex plate-to-crankshaft (2, 4)

NOTE: Do not attempt to repair the welded areas that retain the ring gear to the flex plate. Install a NEW flex plate.

   - Cracks at welded areas that retain the ring gear onto the flex plate (3)

- Damaged or missing ring gear teeth (5)

2. Replace the flex plate as necessary.

PISTON AND CONNECTING ROD DISASSEMBLE

Special Tools

EN-46745 Piston Pin Clip Remover/Installer

For equivalent regional tools, refer to **Special Tools** .

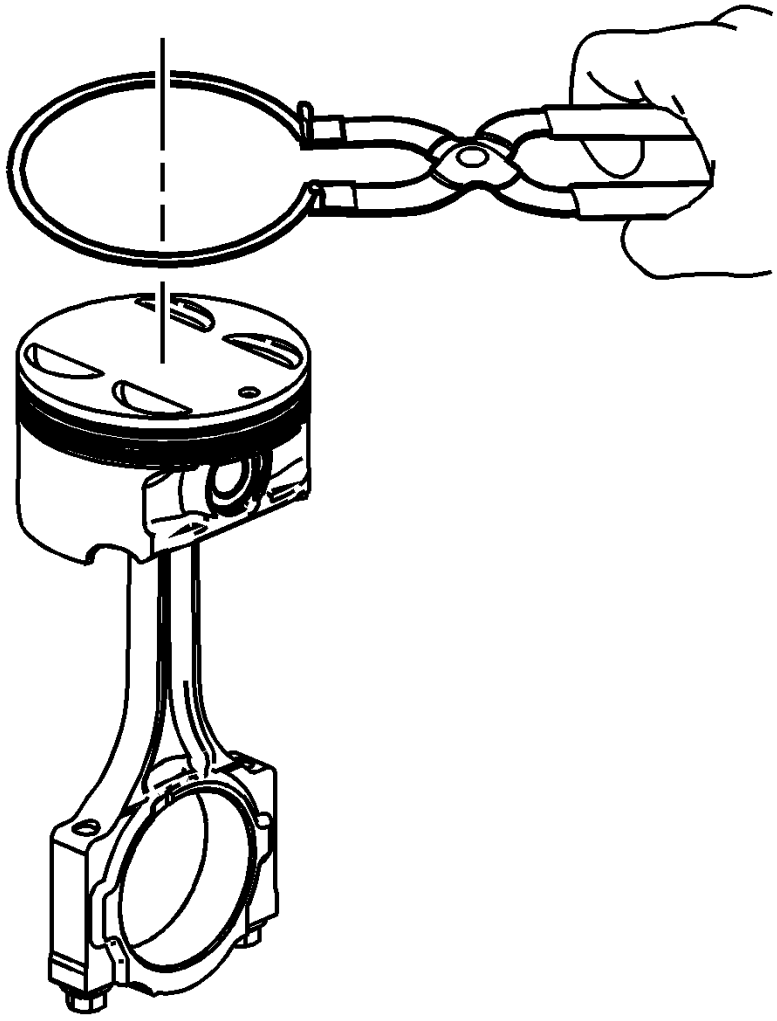

Fig. 124: View Of Piston Ring Expander
Courtesy of GENERAL MOTORS COMPANY

CAUTION: You must use a piston ring expander to remove and install the piston rings. Only expand the rings far enough to fit over the piston lands. If the rings are overexpanded, the top ring will shatter and the others will distort.

1. Remove the piston rings using a piston ring expander. Place each ring in a clean shop towel for storage.

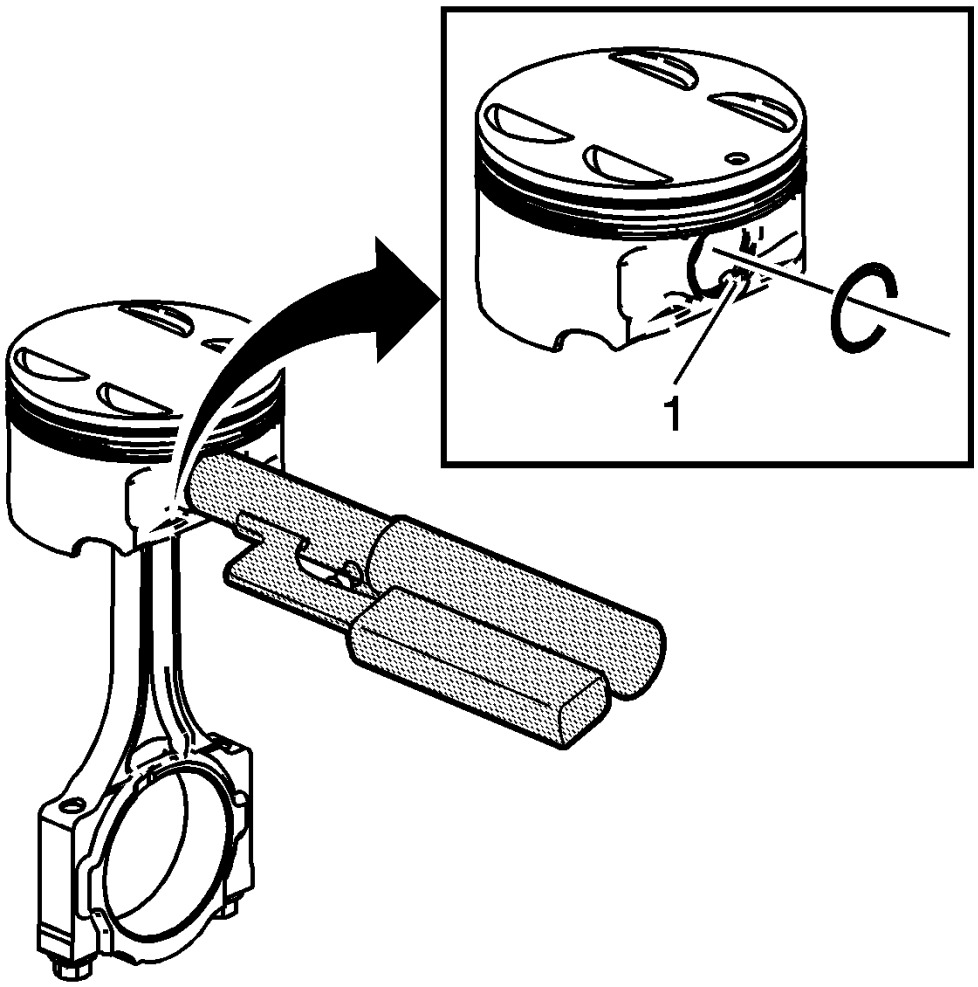

Fig. 125: Identifying Piston Pin Retainers Removal Access Notch
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The connecting rod is non-directional and may be assembled/reassembled to the piston in either direction.**
- **DO NOT reuse the piston pin retainers.**

2. Using the **EN-46745** remover/installer , remove the piston pin retainers by using the removal access notch (1) in the side of the piston. Discard the piston pin retainers.

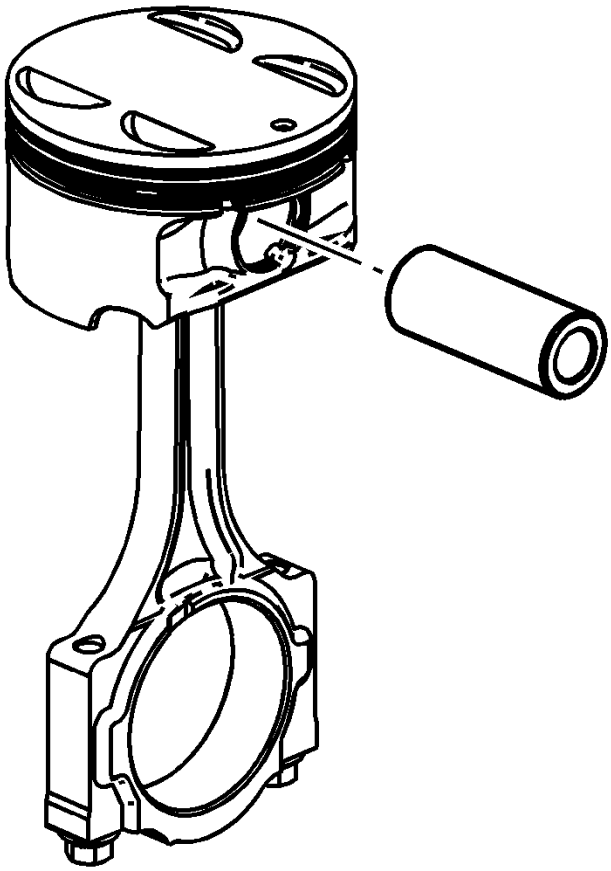

Fig. 126: View Of Piston Pin
Courtesy of GENERAL MOTORS COMPANY

3. Slide the piston pin out of the piston. The piston will disconnect from the connecting rod.

PISTON, CONNECTING ROD, AND BEARING CLEANING AND INSPECTION

Cleaning Procedure

NOTE: **DO NOT wire brush any part of the piston.**

1. Clean the piston skirts and the pins with a cleaning solvent.
2. Clean the piston ring grooves with a groove cleaner. Ensure that the oil ring holes and slots are clean.

WARNING: **Refer to Safety Glasses Warning .**

3. Dry the piston with compressed air.

Piston Inspection Procedure

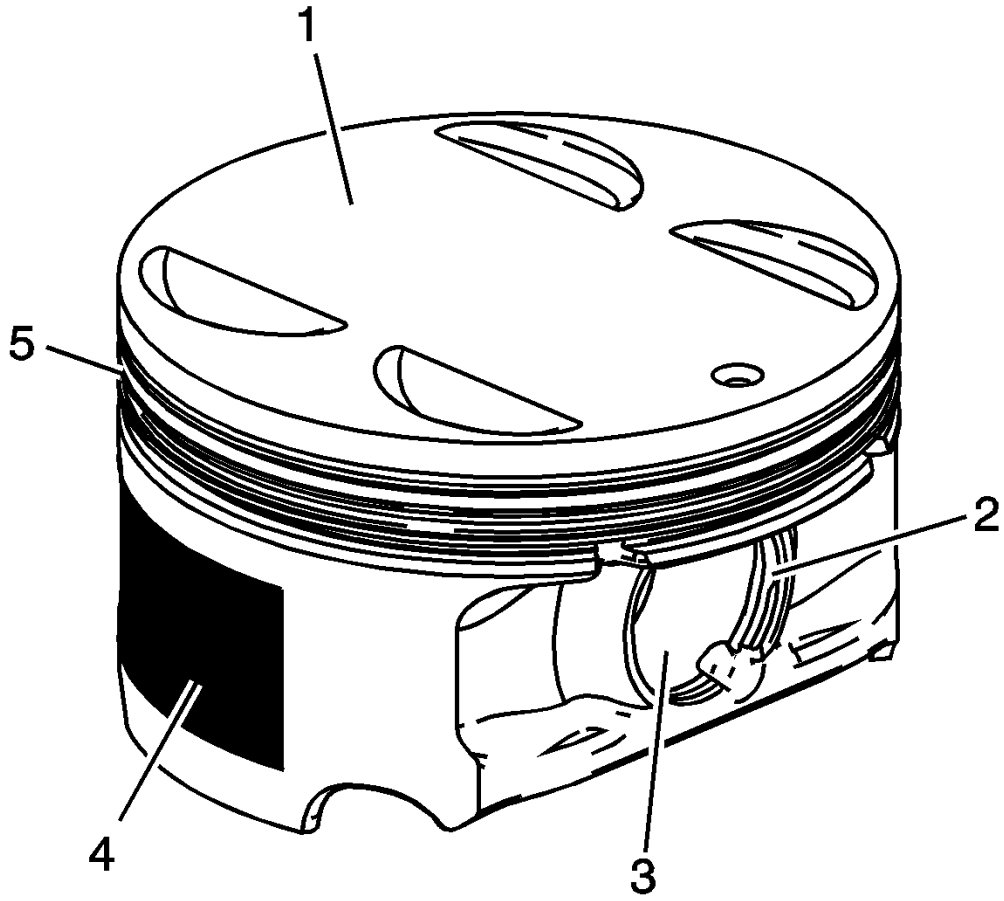

Fig. 127: Piston Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the pistons for the following conditions:
    - Cracked ring lands, skirts or pin bosses
    - Ring grooves for nicks, burrs that may cause binding (5)
    - Warped or worn ring lands (5)
    - Piston pin retainer grooves for burrs (2)
    - Eroded areas at the top of the piston (1)
    - Scuffed or damaged skirt coating (4)
    - Worn piston pin bores or worn piston pins (3)
2. Replace pistons that show any signs of damage or excessive wear.

Piston Measurement Procedure

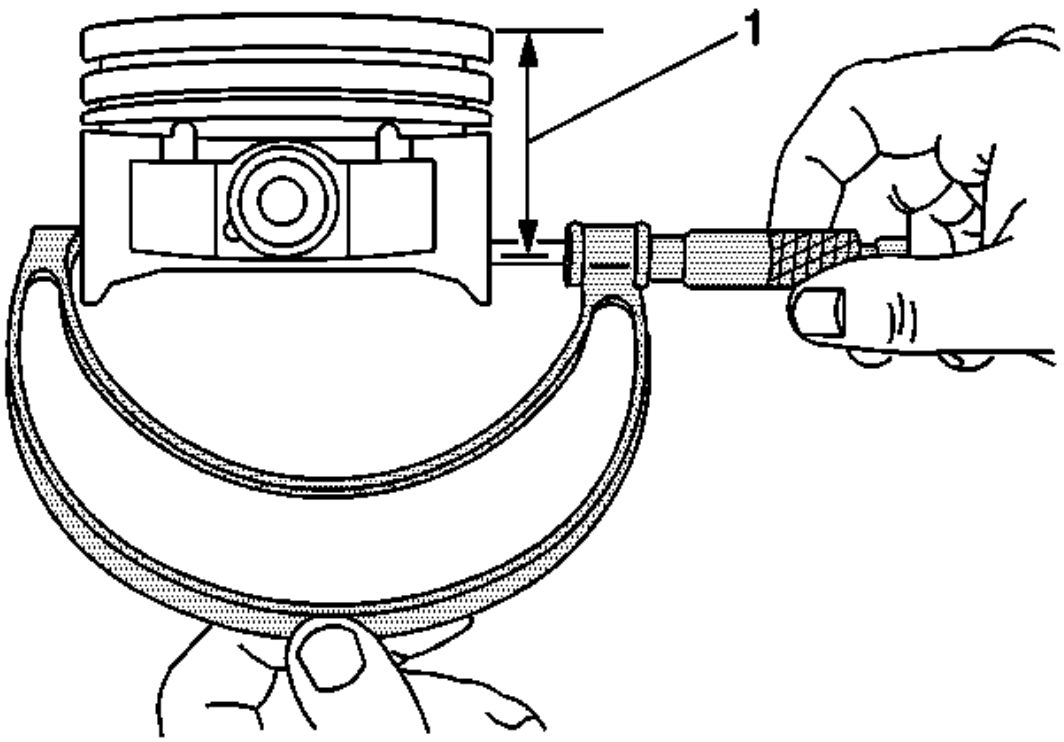

Fig. 128: Measuring Piston Width
Courtesy of GENERAL MOTORS COMPANY

1. Measure piston width using the following procedure:
    1. Using an outside micrometer, measure the width of the piston at 30 mm (1.181 in) below the crown, top (1), at the thrust surfaces of the piston, perpendicular to the piston pin centerline.
    2. Compare the measurement of the piston to its original cylinder by subtracting the piston width from the cylinder diameter.
    3. Check your measurements with the **Engine Mechanical Specifications** .
    4. If the clearance obtained through measurement is greater than the provided specifications and the cylinder bores are within specification, replace the piston.

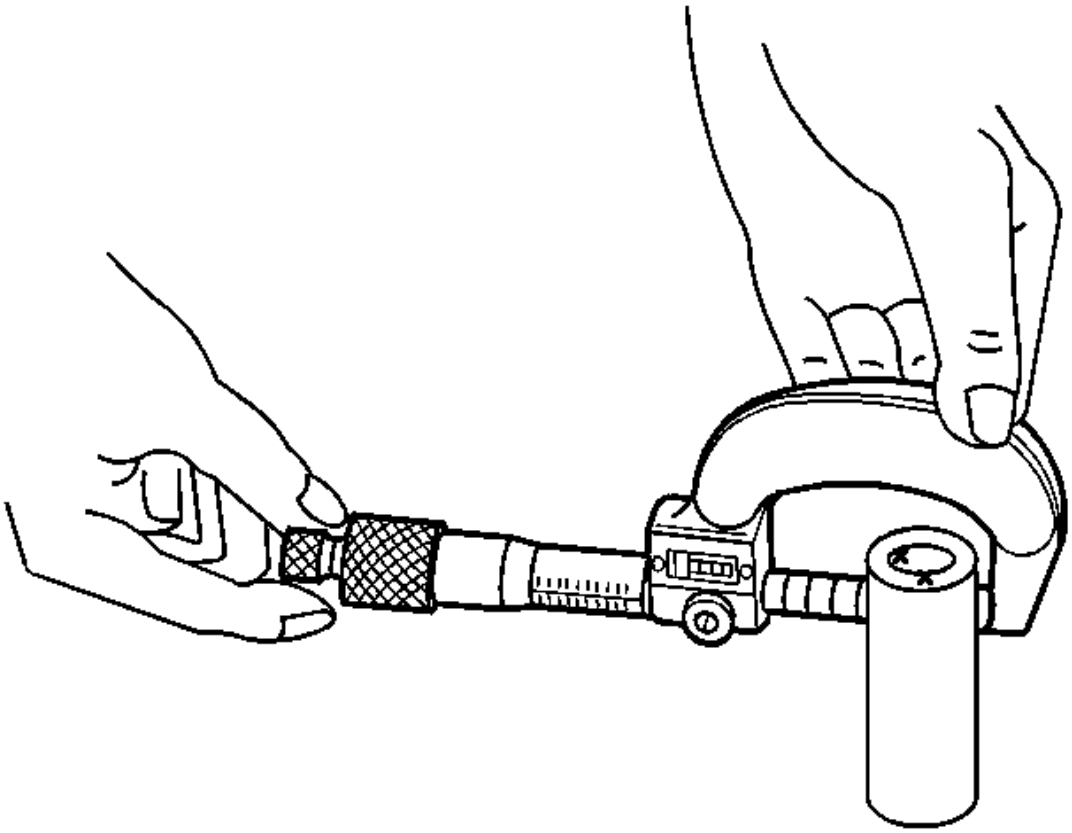

Fig. 129: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS COMPANY

2. Measure the piston pin bore to piston pin clearances using the following procedure:
    1. Piston pin bores and pins must be free of varnish or scuffing.
    2. Use an outside micrometer to measure the piston pin in the piston contact areas.

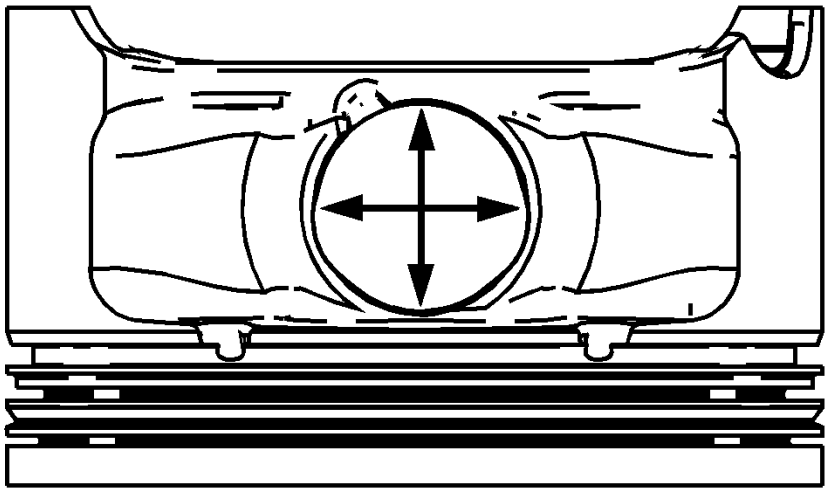

Fig. 130: Checking Piston Pin Bore Dimensions
Courtesy of GENERAL MOTORS COMPANY

3. Using an inside micrometer, measure the piston pin bore. Compare your result with the piston pin diameter and piston pin to piston pin bore clearance listed in the **Engine Mechanical Specifications** .
4. If the clearance is excessive, determine which piece is out of specification and replace as necessary.
5. You must replace the piston if any of its dimensions are out of specification.
6. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Piston Ring Measurement Procedure

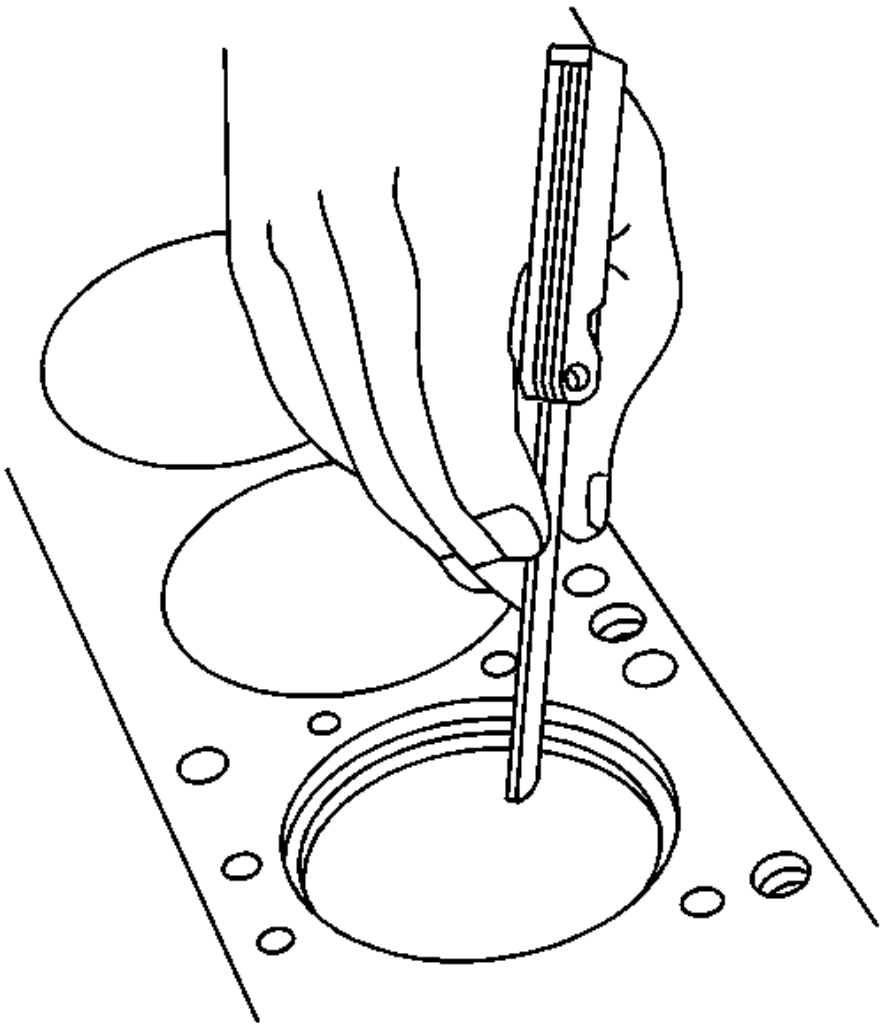

Fig. 131: Measuring Piston Ring End Gap
Courtesy of GENERAL MOTORS COMPANY

1. Measure the piston ring end gap using the following procedure:
    1. Place the piston ring in the area of the bore where the piston ring will travel approximately 25 mm (1 in) down from the deck surface. Ensure that the ring is square with the cylinder bore by positioning the ring with the piston head.
    2. Measure the end gap of the piston ring with feeler gauges. Refer to **Engine Mechanical Specifications** .
    3. If the clearance exceeds the provided specifications, the piston rings must be replaced.
    4. Repeat the procedure for all the piston rings.

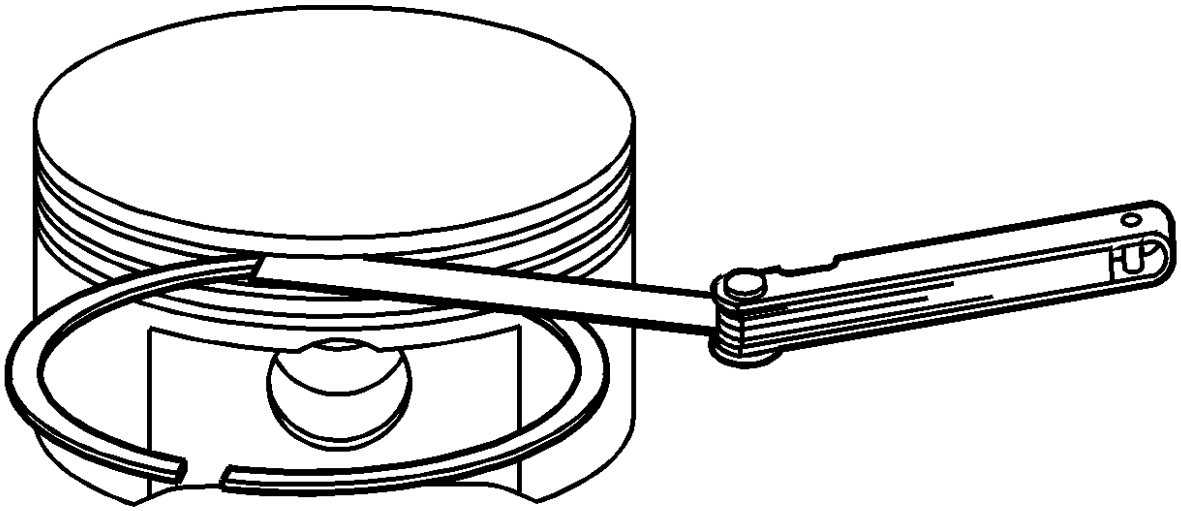

Fig. 132: Measuring Piston Ring Side Clearance
Courtesy of GENERAL MOTORS COMPANY

2. Measure the piston ring side clearance using the following procedure:
    1. Roll the piston ring entirely around the piston ring groove. If any binding is caused by the ring groove, dress the groove with a fine file. If any binding is caused by a distorted piston ring, replace the ring.
    2. With the piston ring on the piston, use feeler gauges to check clearance at multiple locations.
    3. Compare the measurements with piston ring side clearance listed in the **Engine Mechanical Specifications** .
    4. If the clearance is greater than specifications, replace the piston rings.

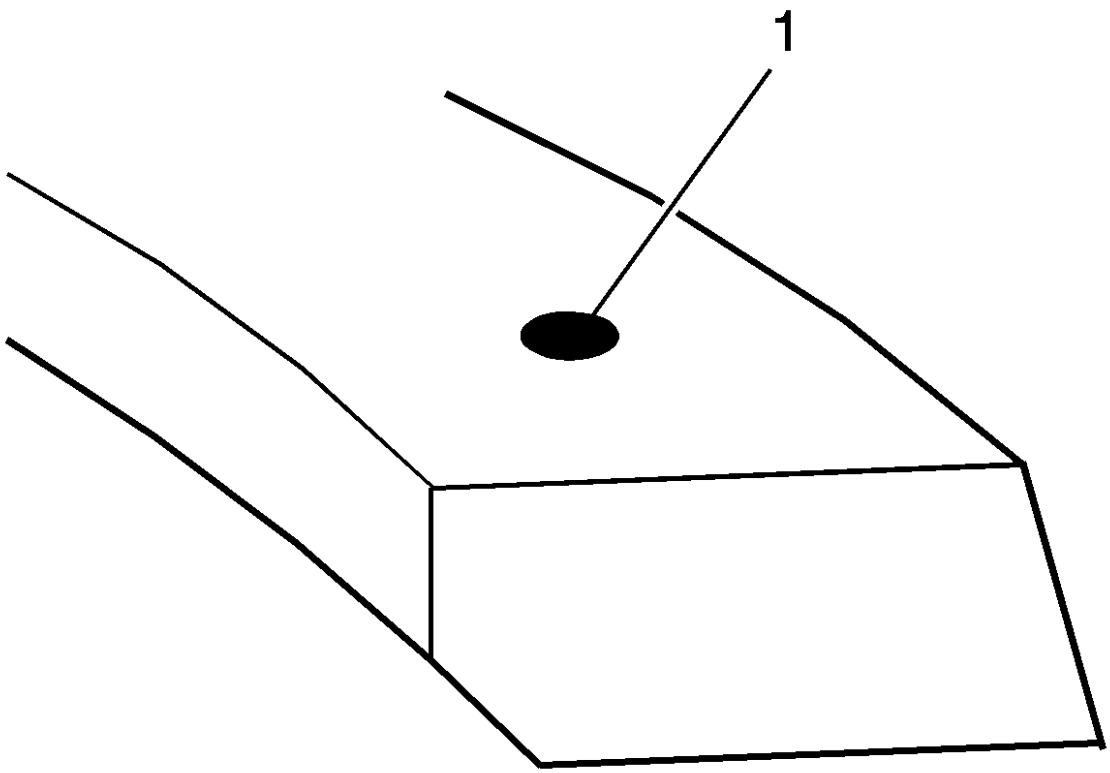

Fig. 133: View Of Lower Compression Piston Ring Mark
Courtesy of GENERAL MOTORS COMPANY

3. There is a locating dimple (1) on the compression rings near the end for identification. Install the compression rings with the dimple facing up.
4. If the new ring does not reduce the clearance to the proper specification, install a new piston.
5. If the new piston does not meet clearance specifications, the cylinder block may need to be oversized to 0.25 mm (0.010 in). There is only one size of oversized pistons and rings available for service.

Connecting Rod Cleaning Procedure

1. Clean the connecting rods in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the connecting rod using compressed air.
3. Remove the connecting rod cap and clean the threads.
4. Remove the connecting rod bearing and discard. Never reuse a connecting rod bearing used in a running

engine.

Connecting Rod Visual Inspection Procedure

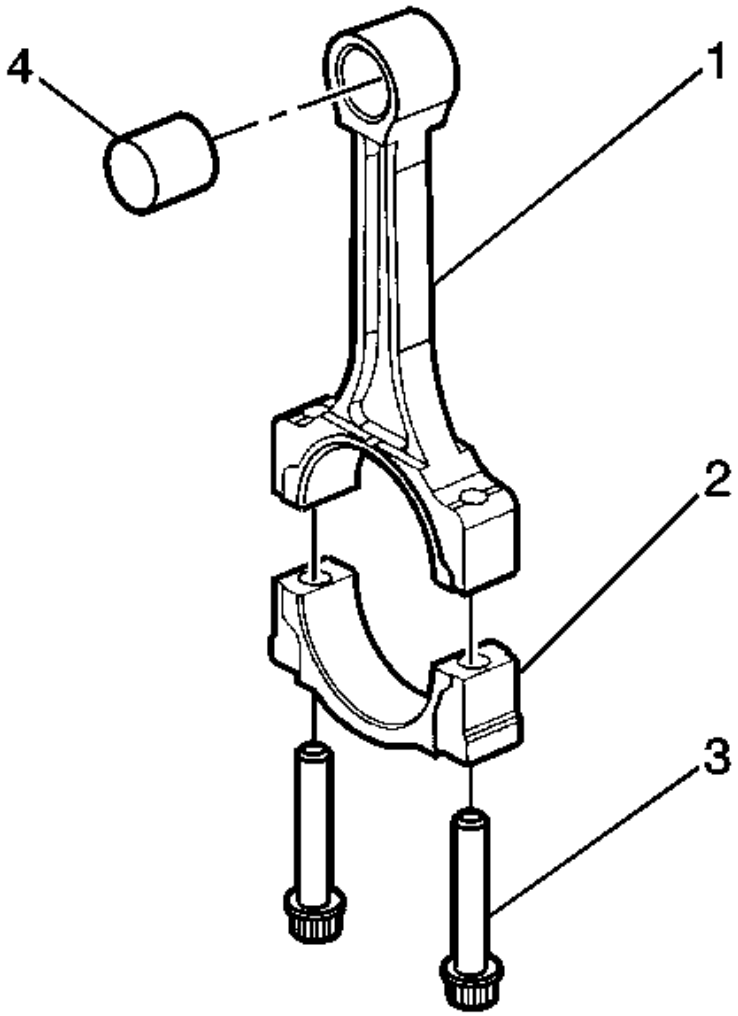

Fig. 134: Inspecting Connecting Rod Components
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the piston pin bushing (4) for scoring or damage.
2. Inspect the connecting rod beam (1) for twisting or bending.
3. Inspect the rod cap (2) for any nicks or damage caused by possible interference.
4. Inspect for scratches or abrasion on the rod bearing seating surface.

NOTE: **DO NOT scrape the rod or rod cap.**

5. If the connecting rod bores contain minor scratches or abrasions, clean the bores in a circular direction with a light emery paper.

Connecting Rod Measurement Procedure

Piston Pin End

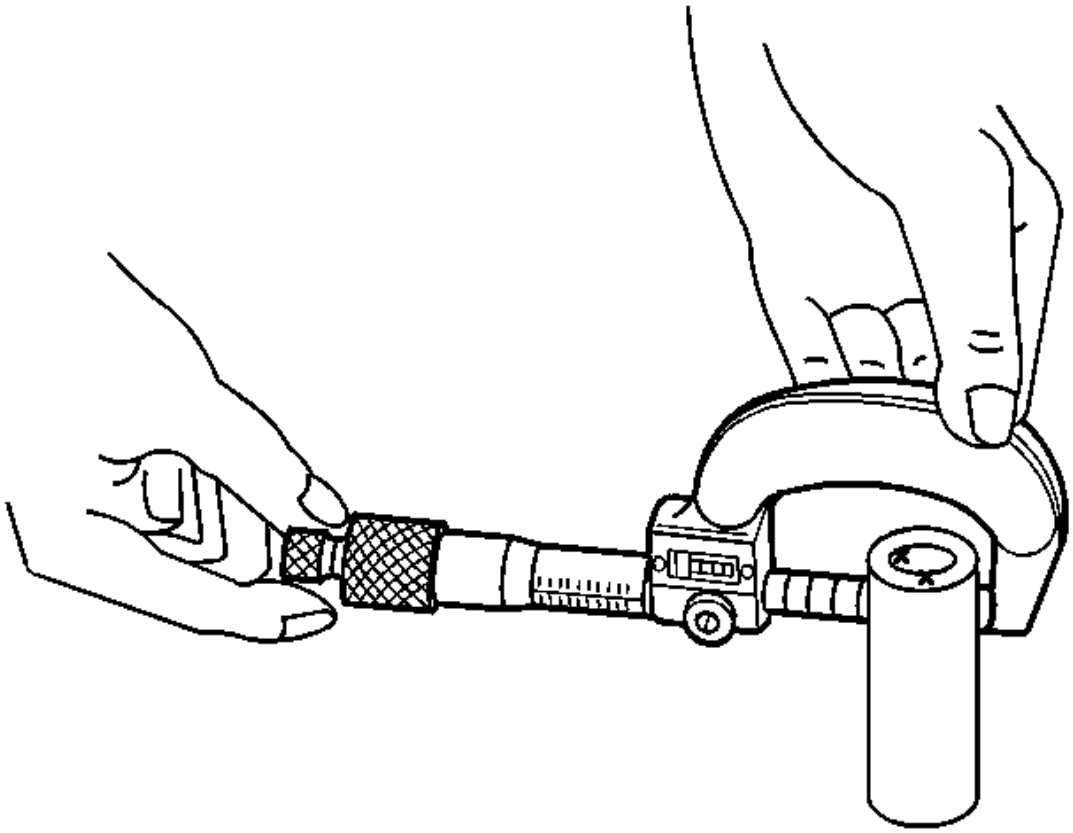

Fig. 135: Measuring Piston Pin Diameter
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Measurements of all components should be taken with the components at normal room temperature.**

1. Using an outside micrometer, take 2 measurements of the piston pin in the area of the connecting rod contact.

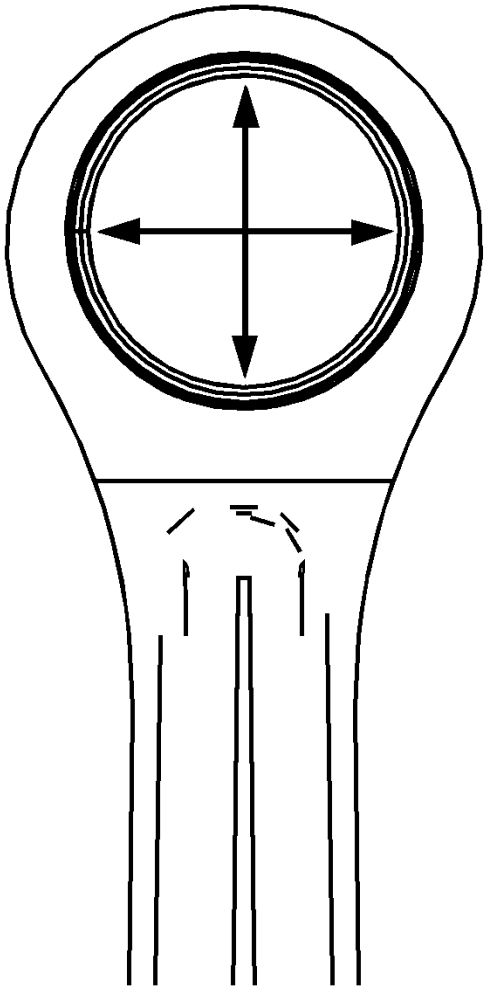

Fig. 136: Checking Connecting Rod Piston Pin Bore Dimensions
Courtesy of GENERAL MOTORS COMPANY

2. Using an inside micrometer, measure the connecting rod piston pin bore.
3. Subtract the piston pin diameter from the piston pin bore.
4. Compare the clearance measurements with the **Engine Mechanical Specifications** .
5. If the clearance is excessive, replace the piston pin. If a new pin does not resolve the clearance problem, replace the connecting rod.

Connecting Rod Crankshaft Bearing End

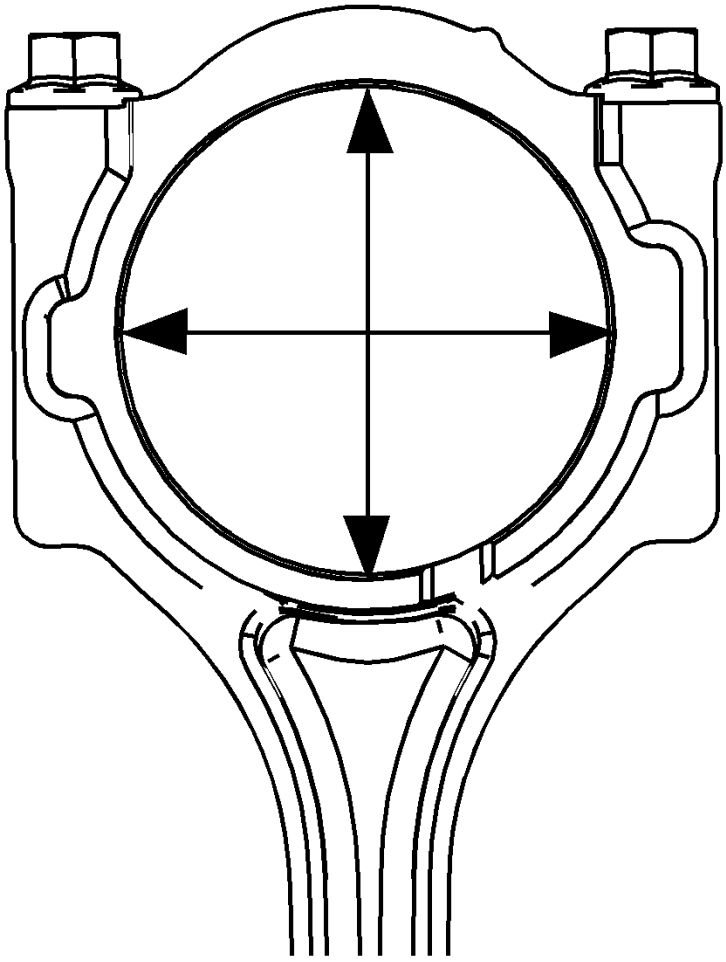

Fig. 137: Measuring Connecting Rod Crankshaft Bearing Bore
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Measurements of all components should be taken with the components at normal room temperature.**

1. Using an inside micrometer, measure the connecting rod crankshaft bearing bore.
2. Compare the bore measurements with the **Engine Mechanical Specifications** .
3. Replace the connecting rod if the bore is out of specifications. DO NOT recondition the connecting rod.

PISTON AND CONNECTING ROD ASSEMBLE

Special Tools

- **EN-46121** Connecting Rod Guide Pin Set
- **EN-46745** Piston Pin Clip Remover/Installer

For equivalent regional tools, refer to **Special Tools**

Piston and Piston Pin Installation Procedure

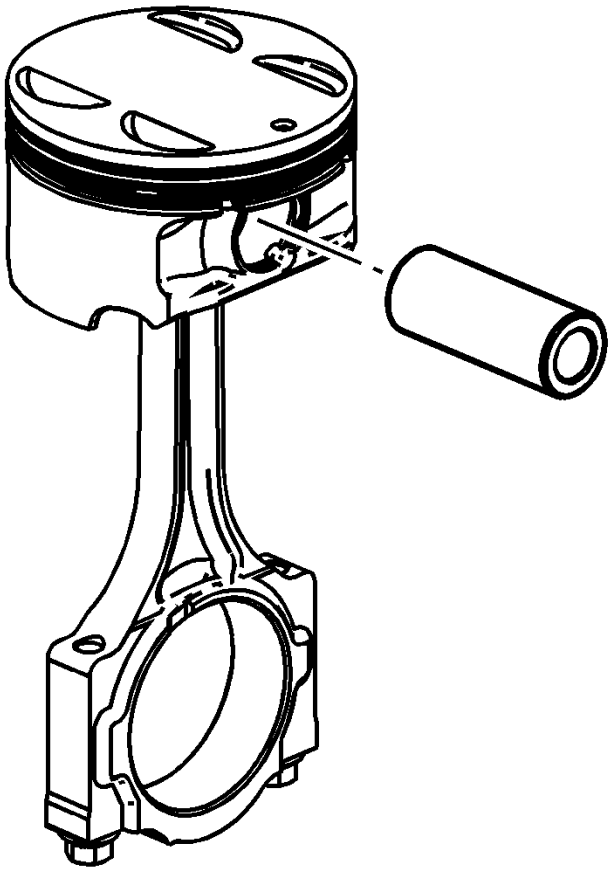

Fig. 138: View Of Piston Pin
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The piston is directional and must be installed in the engine block in the proper direction. The dot on the top of the piston must face the front of the engine.**
- **The piston is model dependent and may not appear exactly as shown.**

1. Lubricate the piston pin bores in the piston and the connecting rod with GM prelube lubricant. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.
2. Assemble the piston and piston pin to the connecting rod. Properly orient the piston when reusing a marked connecting rod.
3. Align the piston pin bore with the connecting rod pin bore.
4. Slide the piston pin into the piston and the connecting rod.

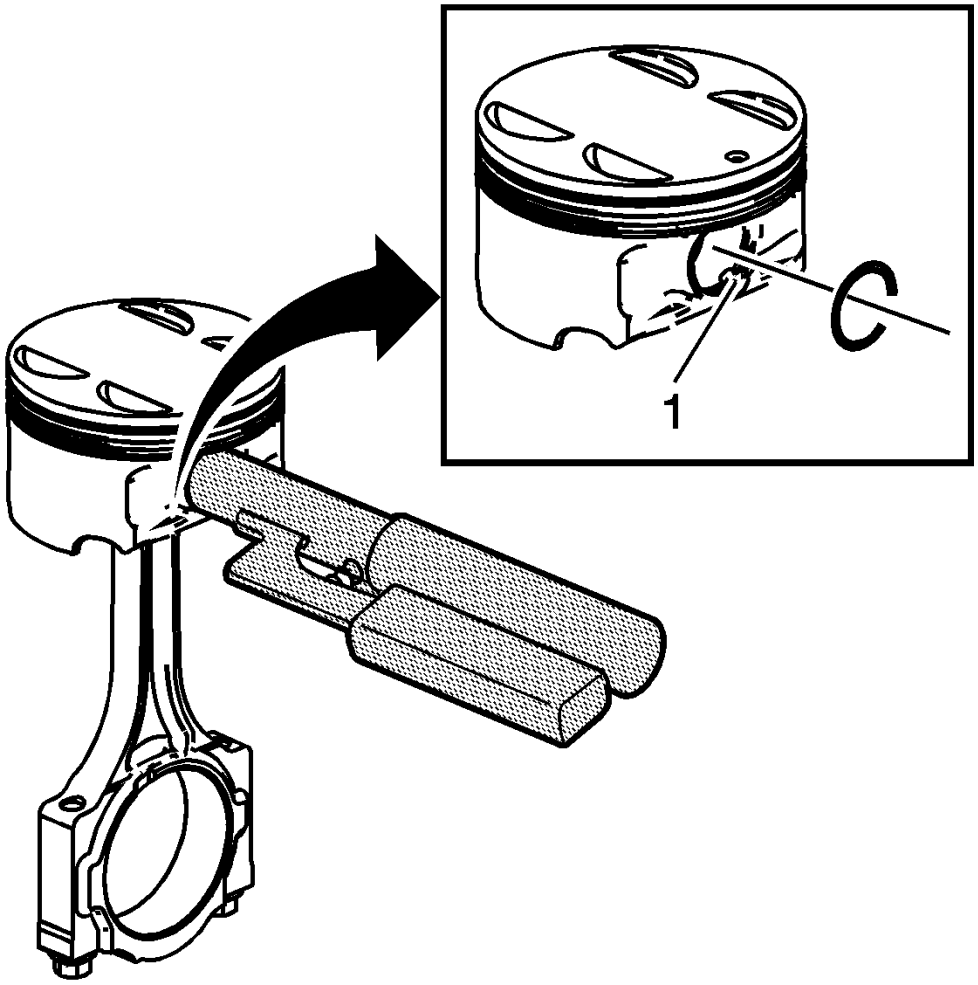

Fig. 139: Identifying Piston Pin Retainers Removal Access Notch
Courtesy of GENERAL MOTORS COMPANY

NOTE: **New piston pin retainers must be used. Never reuse the piston pin retainers.**

5. Install NEW piston pin retainers using the **EN-46745** remover/installer. Align the **EN-46745** remover/installer to the notch (1) in the piston.
6. Ensure that the piston pin retainers are fully seated in their grooves.
7. Repeat these procedures for the remaining pistons.

Piston Ring Installation Procedure

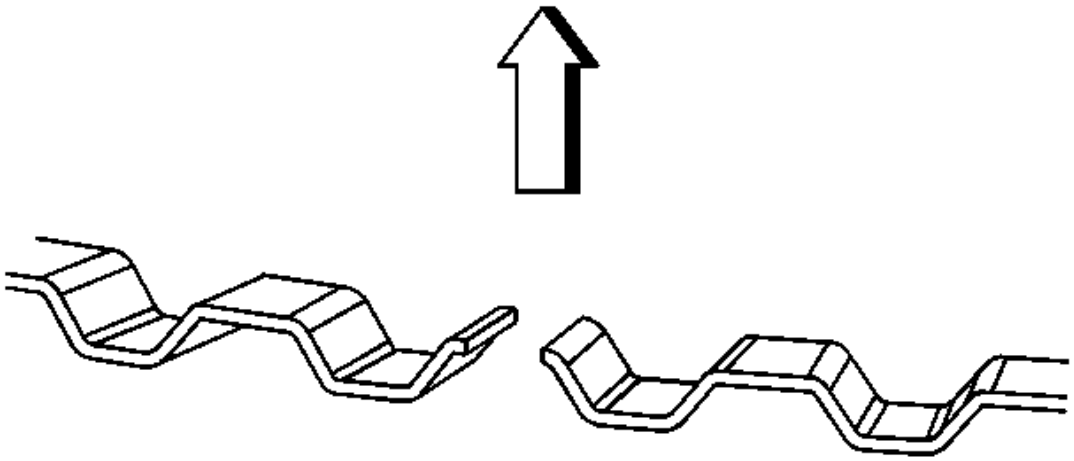

Fig. 140: Aligning Oil Control Ring Expander
Courtesy of GENERAL MOTORS COMPANY

1. Properly orient the oil control ring expander as shown before installation. The ends of the expander must be facing toward the top of the piston.

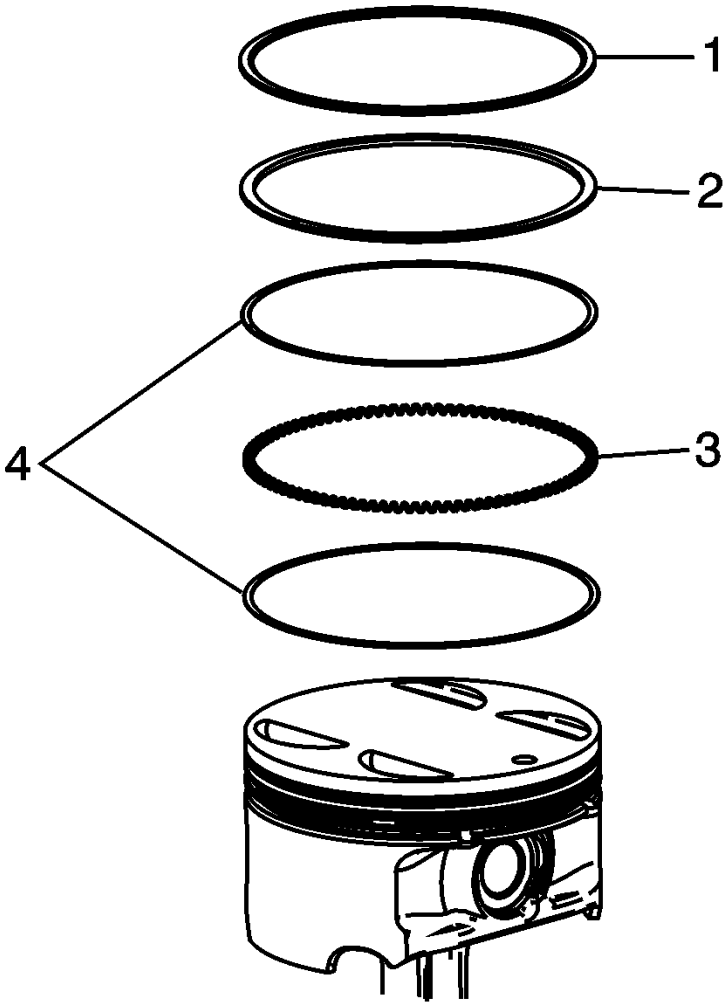

Fig. 141: Identifying Piston Rings
Courtesy of GENERAL MOTORS COMPANY

2. Using a piston ring expander, install the oil control ring assembly using the following procedure:
    1. Install the expander ring (3).
    2. Install the 2 oil scraper rings (4). Expand the rings only enough to clear the piston diameter. Overexpanding the piston rings will distort or crack the rings.

NOTE: **The lower compression piston ring (2) is thicker and will not fit in the upper compression rings (1) position.**

NOTE: **For the LY7, the upper compression ring is symmetrical and may be installed either side up. For all other RPO's, the mark on the piston ring should face the top of the piston.**

3. Install the lower compression piston ring (2) onto the piston with the mark facing the top of the piston.
4. Install the upper compression piston ring (1) onto the piston with the mark facing the top of the piston, if required.

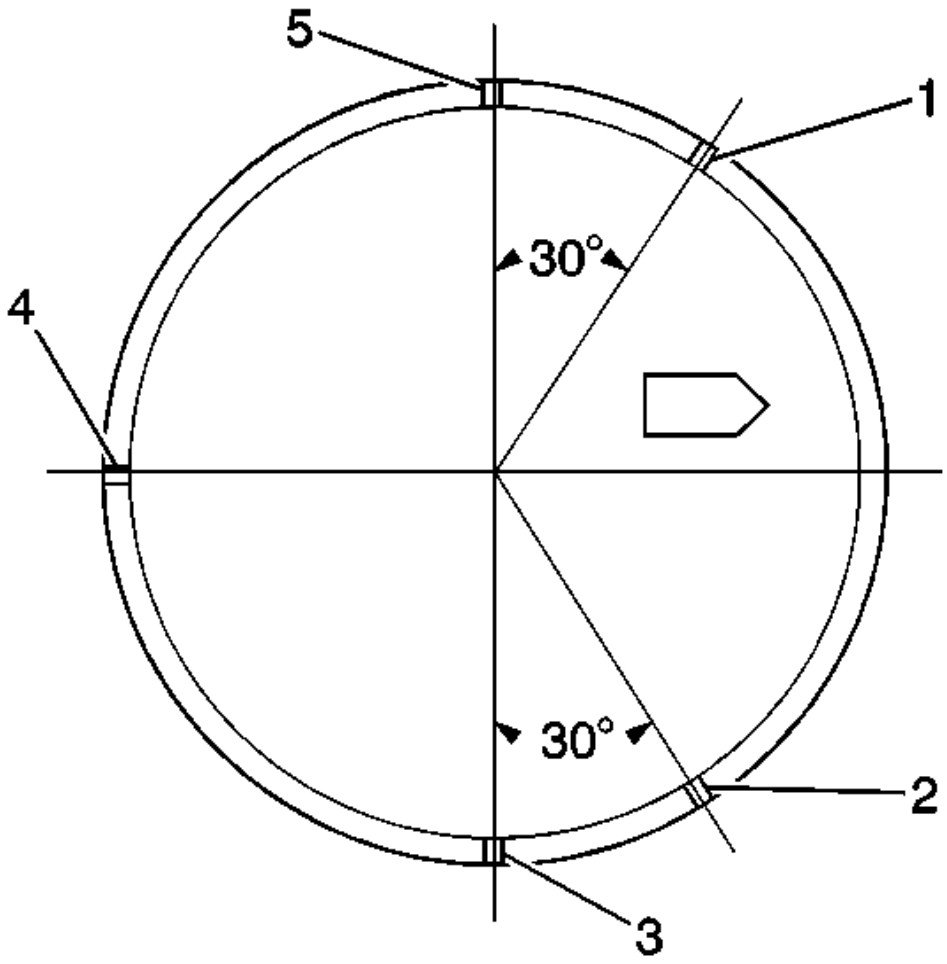

Fig. 142: Illustrating Ring Gap Positions
Courtesy of GENERAL MOTORS COMPANY

5. Once the rings are installed, set the ring gaps for the oil control, second and top ring as follows. Use the piston location arrow for reference.
    1. Lower oil control ring - position 1
    2. Upper oil control ring - position 2
    3. Top Ring - position 3
    4. Oil control ring expander - position 4
    5. Second ring - position 5

Connecting Rod Bearing Installation Procedure

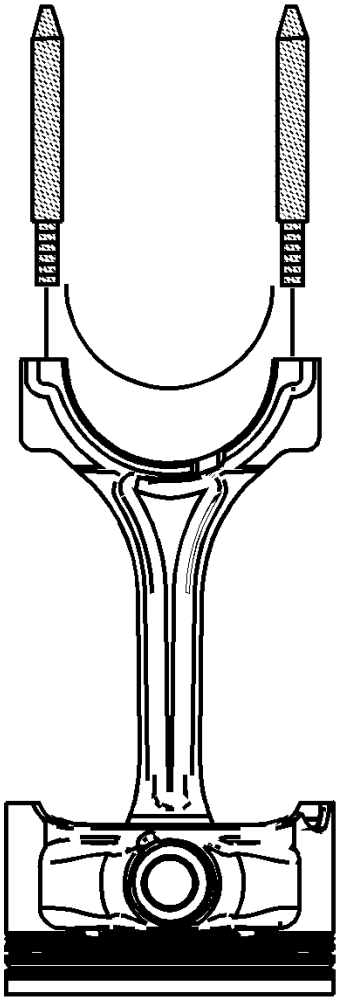

Fig. 143: View Of Piston/Connecting Rod Installation Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for reassembly.**

1. Clean the connecting rod and the connecting rod cap bearing bore with a lint-free cloth.
2. Clean all the oil from behind the connecting rod bearing halves.
3. Install NEW upper connecting rod bearings into position. Roll the bearing into position so that the lock tang engages the alignment slot. The bearing must fit flush in the connecting rod.
4. Install the **EN-46121** set into the connecting rod bolt holes.

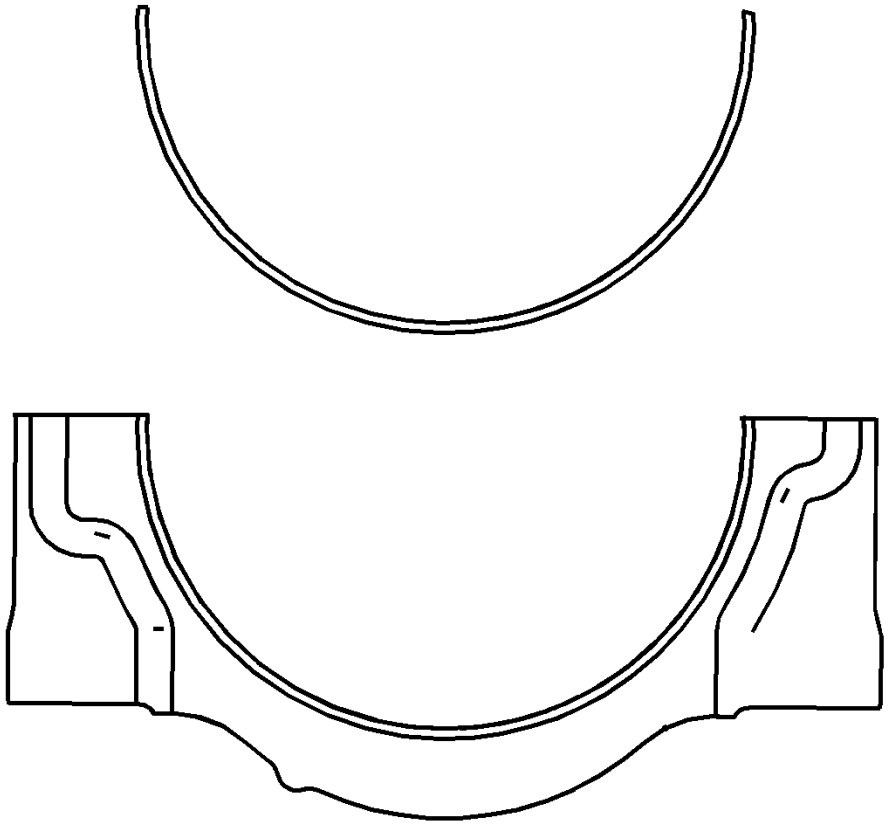

Fig. 144: View Of Lower Connecting Rod Cap & Bearing
Courtesy of GENERAL MOTORS COMPANY

5. Install NEW lower connecting rod bearings into position in the connecting rod cap. Roll the bearing into position so that the lock tang engages the alignment slot. The bearings must fit flush with the connecting rod cap.

CYLINDER HEAD DISASSEMBLE (LFX)

Special Tools

- **EN-8062** Valve Spring Compressor - Head Off
- **EN-46116** Valve Stem Seal Remover/Installer
- **EN-46117** Valve Stem Key Remover/Installer
- **EN-46119** Off-Vehicle Valve Spring Compressor Adapter
- **EN-46122** Camshaft Position Actuator Check-Ball Valve Remover/Installer
- **EN-49248** Injector Rail Assembly Remover

For equivalent regional tools, refer to **Special Tools** .

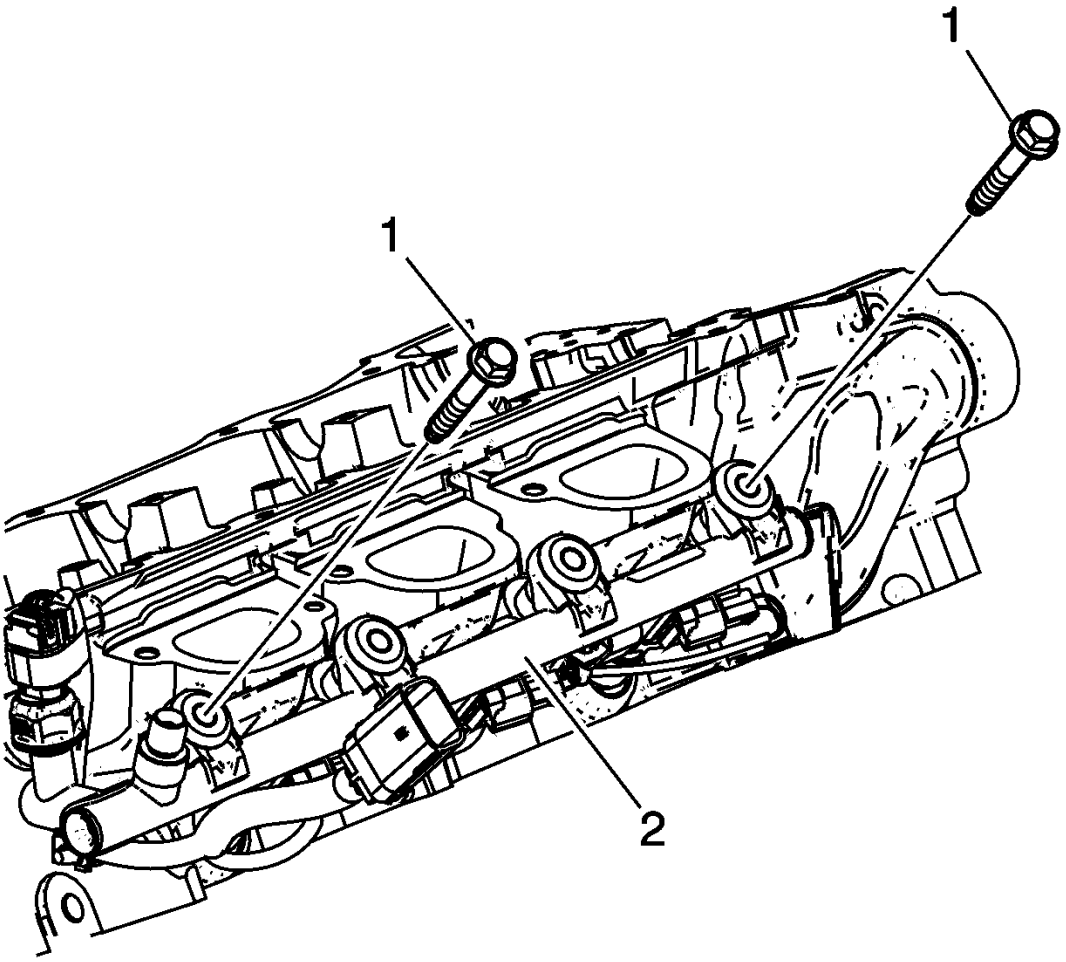

Fig. 145: Identifying Fuel Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the fuel rail bolts (1).

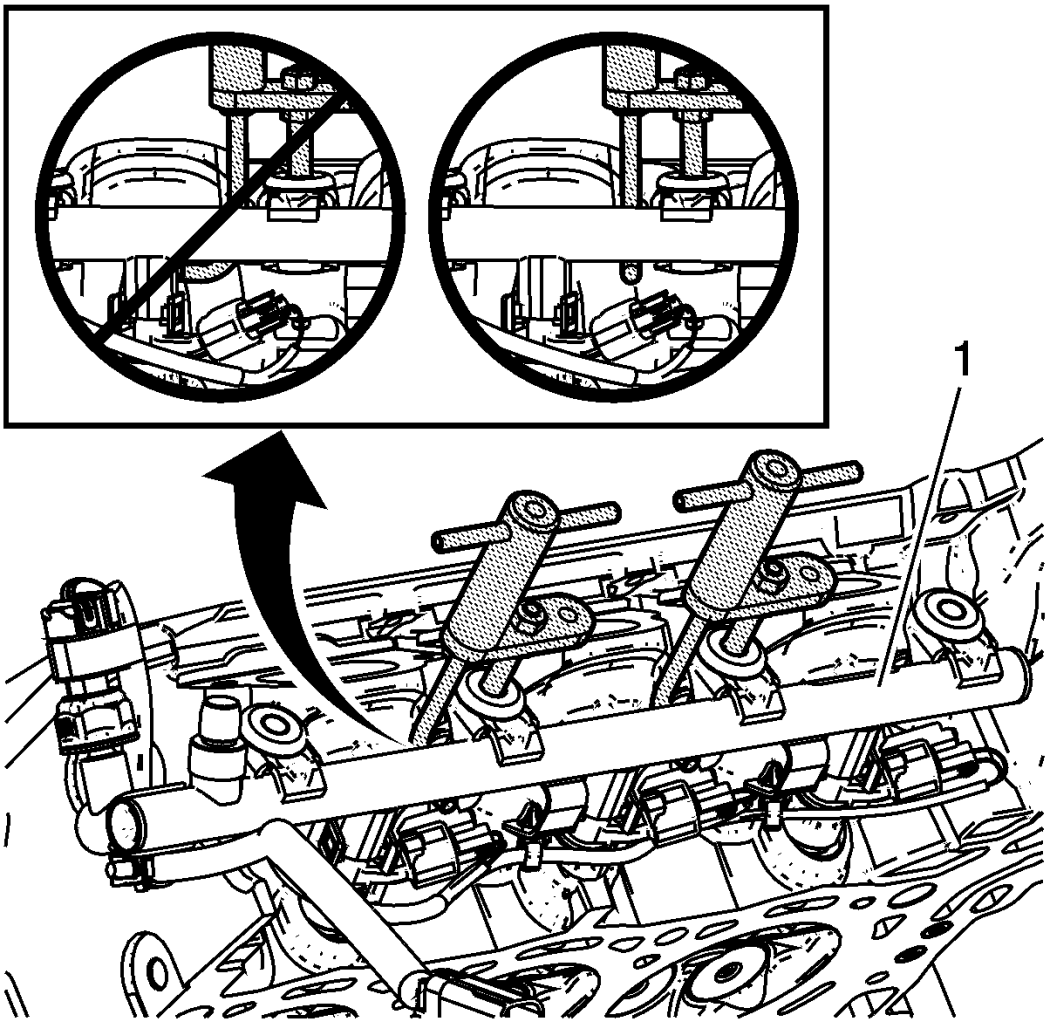

Fig. 146: Injector Rail Assembly & Remover
Courtesy of GENERAL MOTORS COMPANY

CAUTION:

- **Remove the fuel rail assembly carefully in order to prevent damage to the injector electrical connector terminals and the injector spray tips. Support the fuel rail after the fuel rail is removed in order to avoid damaging the fuel rail components.**
- **Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering open pipes and passages.**

2. Remove the fuel rail and injectors (1) as an assembly using the **EN-49248** remover.

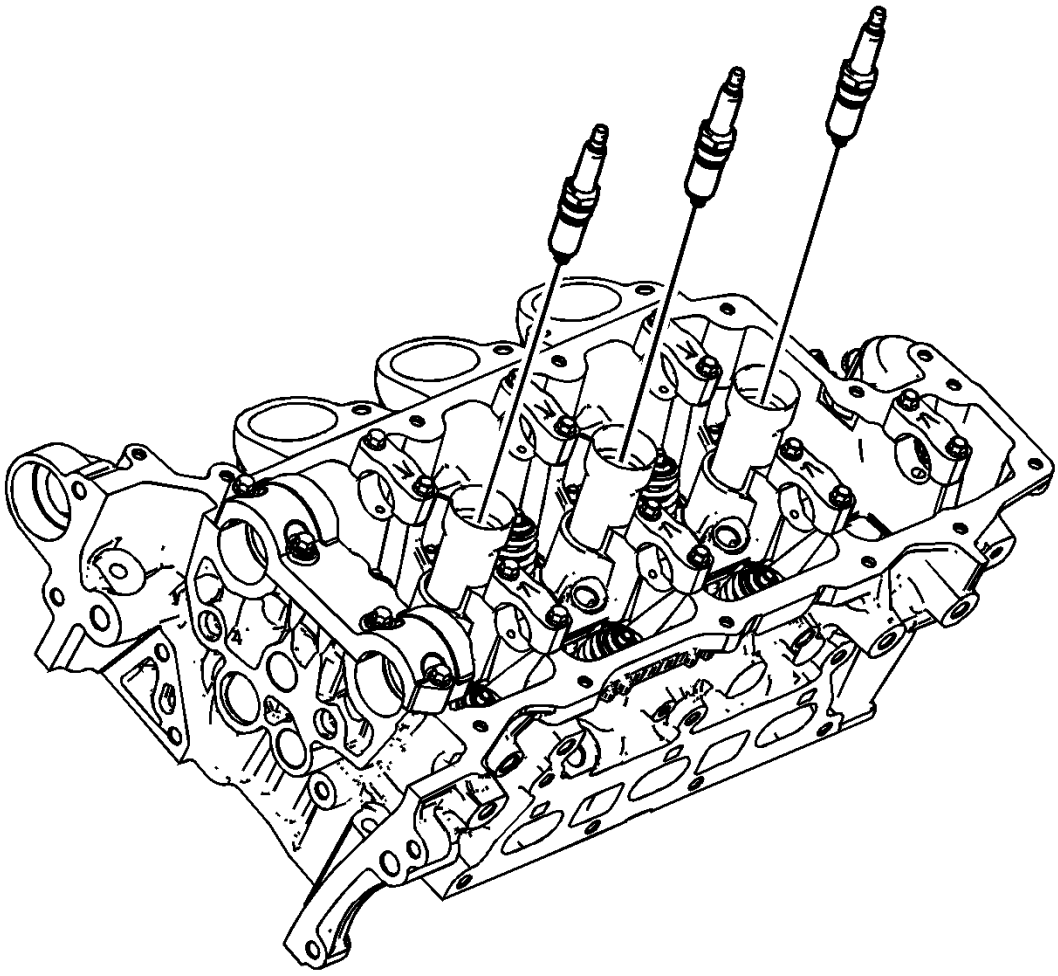

Fig. 147: View Of Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

3. Remove the spark plugs.

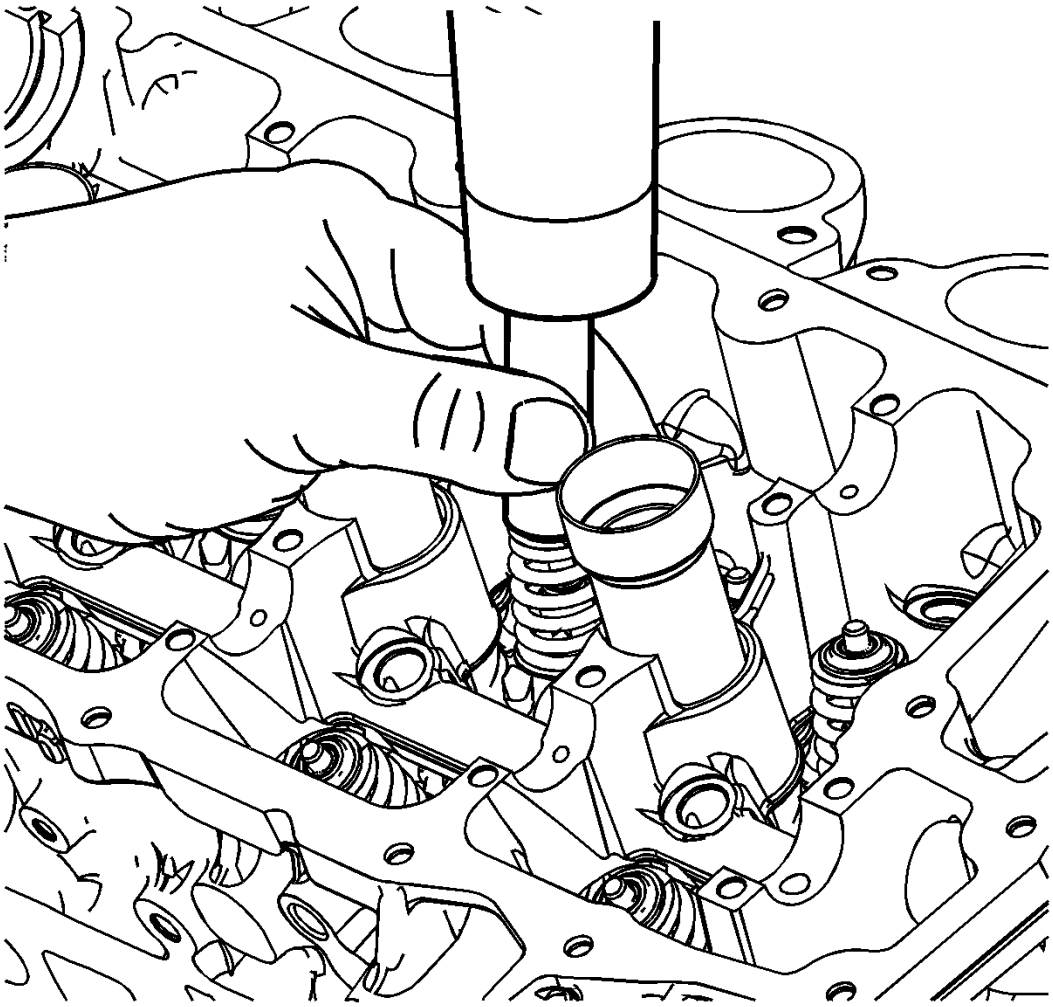

Fig. 148: Loosening Valve Keepers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure valve heads will not contact anything during the following step in order to avoid bending or damage.**

4. Using an appropriately sized deep socket and a plastic hammer, lightly tap on the valve spring retainer to loosen the valve keepers.

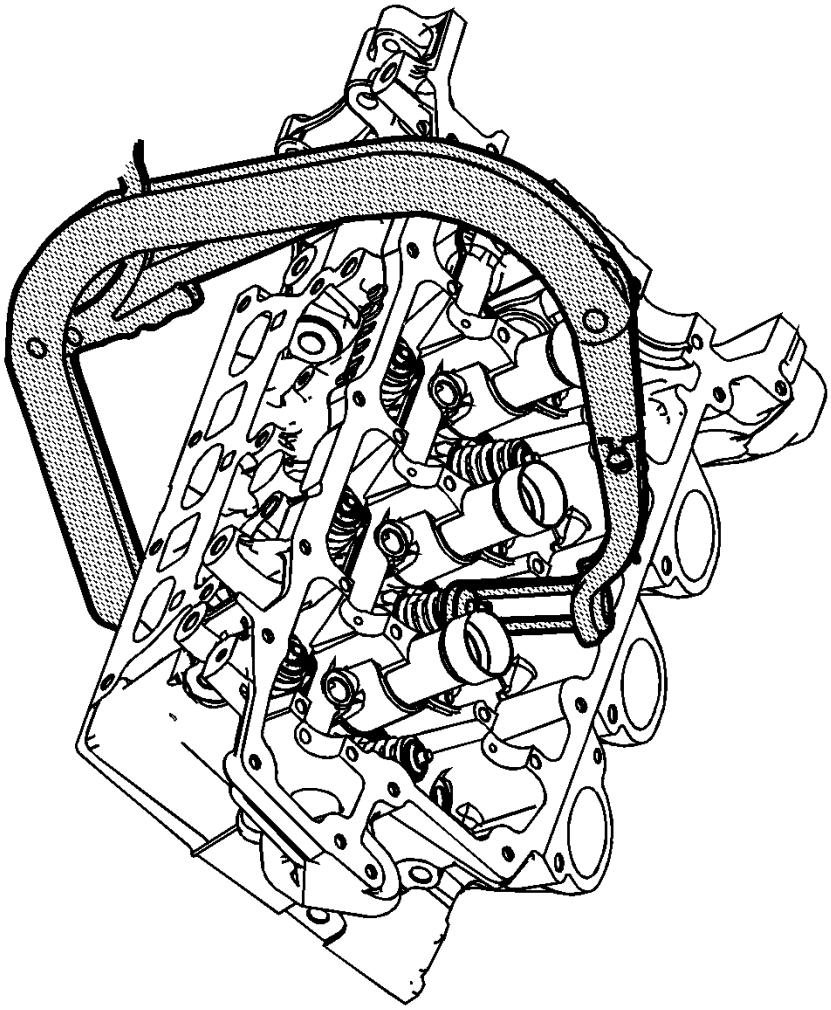

Fig. 149: Compressing Valve Spring
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

5. Compress the valve spring using the **EN-8062** compressor and the **EN-46119** adapter.

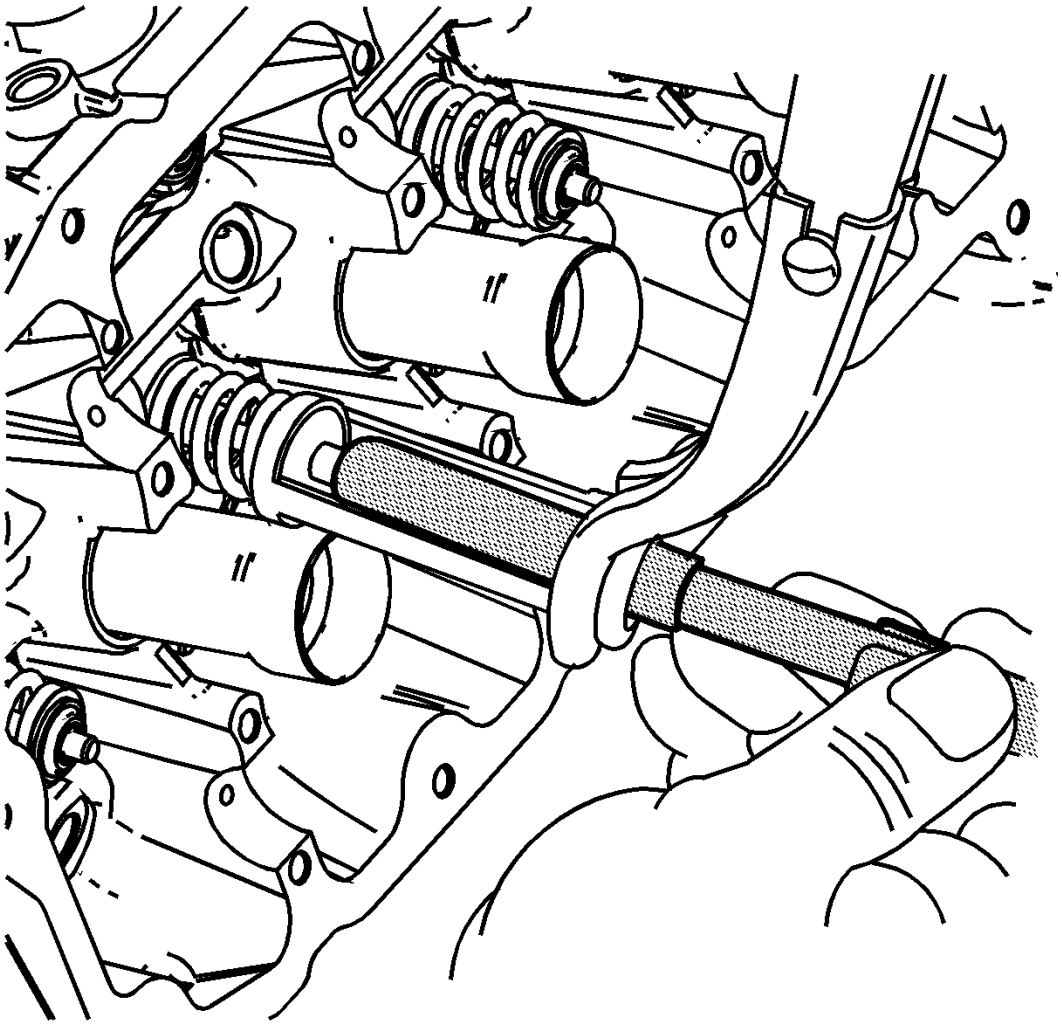

Fig. 150: Valve Keepers
Courtesy of GENERAL MOTORS COMPANY

6. Use the magnet of the **EN-46117** remover/installer in order to remove the valve keepers.
7. Remove the valve spring compressor and the adapter.

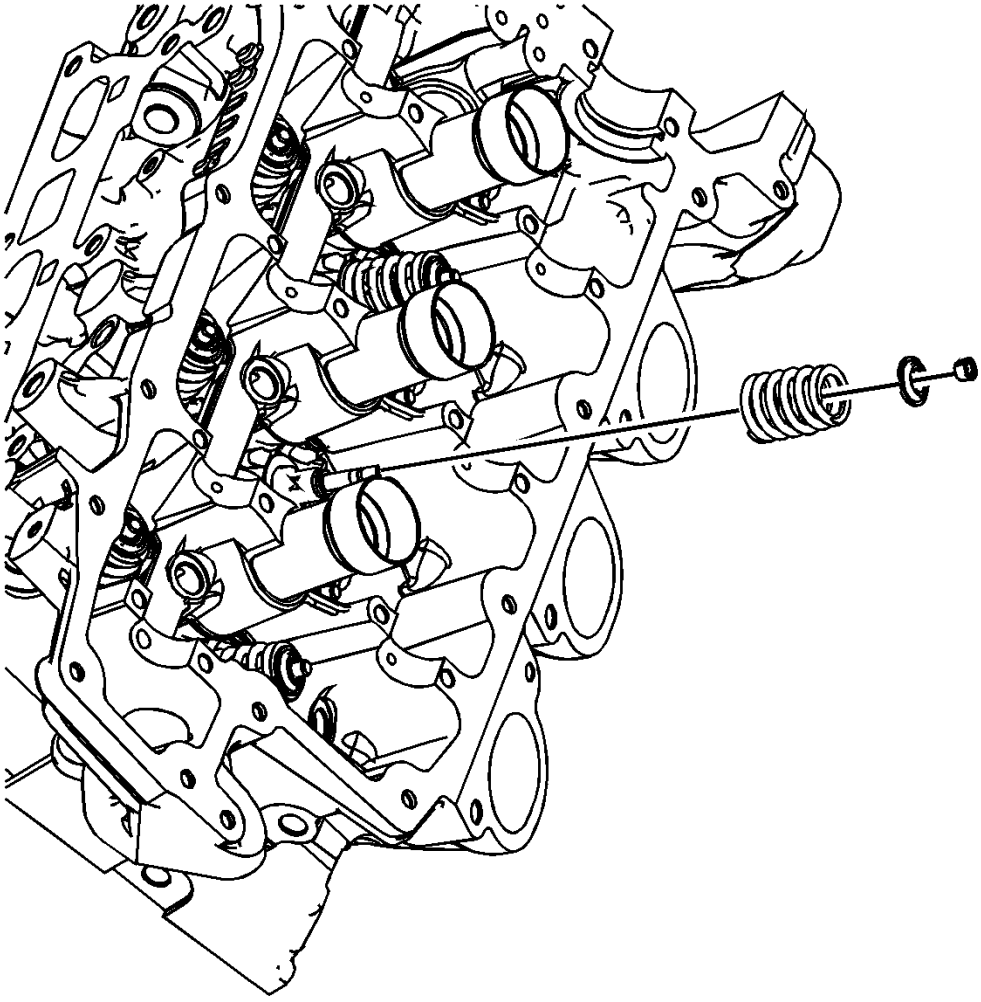

Fig. 151: View Of Valve Spring & Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Remove the valve spring retainer.
9. Remove the valve spring.

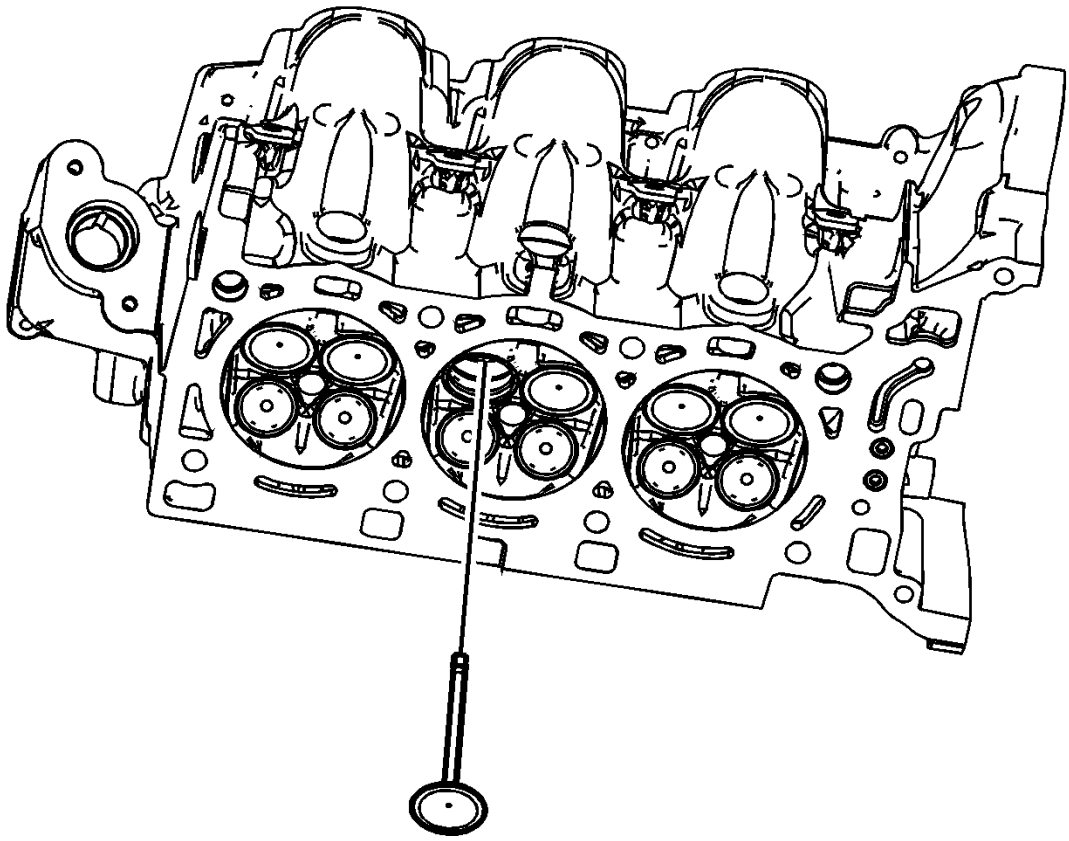

Fig. 152: View of Oil Seal and Valve Guide
Courtesy of GENERAL MOTORS COMPANY

10. Remove the valve.

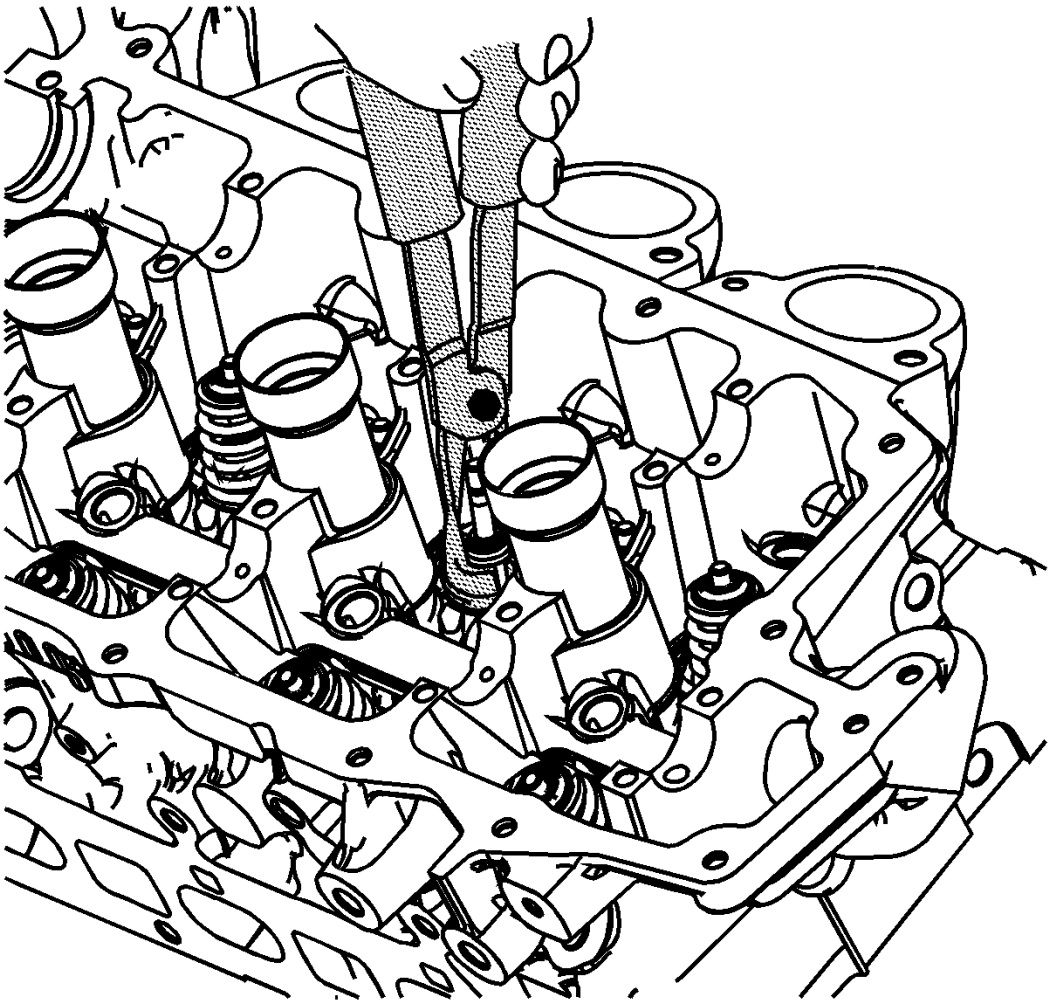

Fig. 153: Valve Stem Oil Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: **NEVER reuse a valve stem oil seal.**

11. Remove the valve stem oil seal using the **EN-46116** remover/installer and discard.
12. Repeat these procedures for the remaining valves.

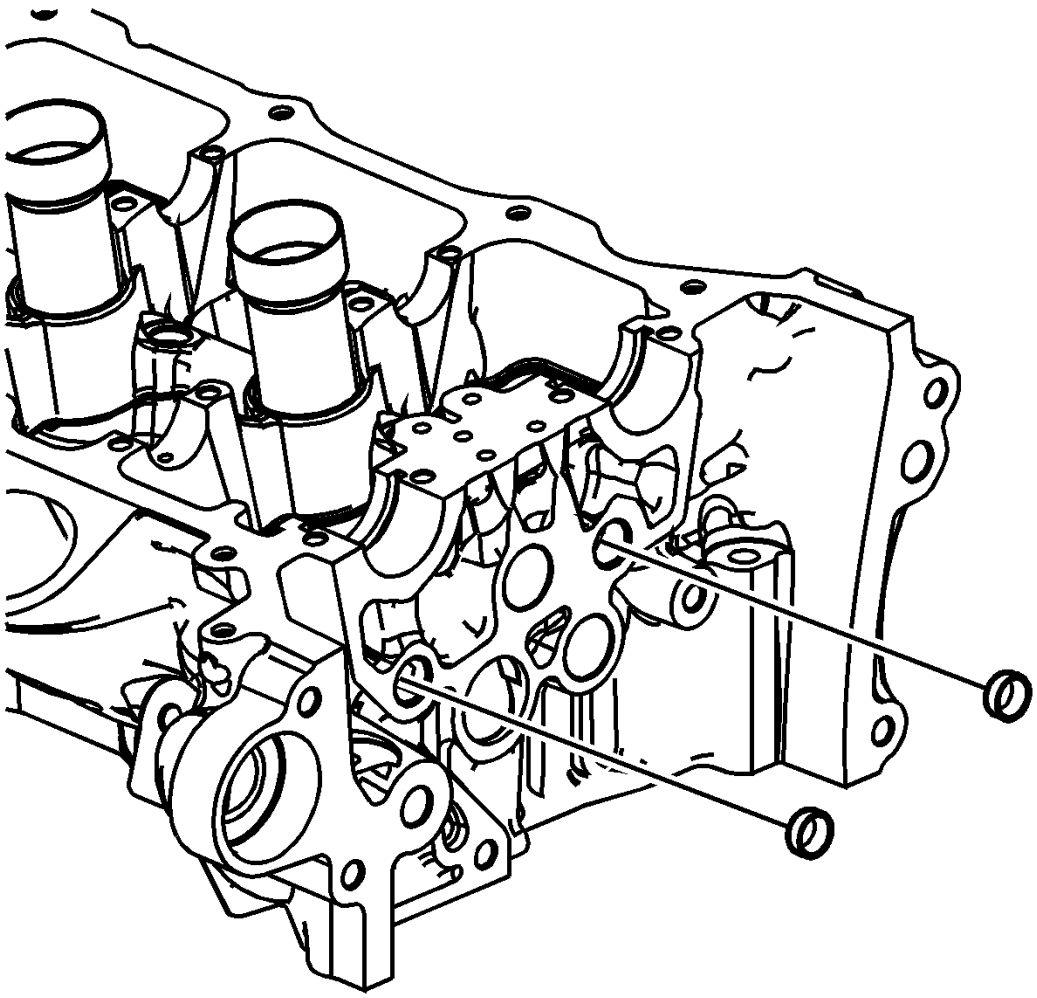

Fig. 154: View Of Cylinder Head Oil Gallery Expansion Plugs
Courtesy of GENERAL MOTORS COMPANY

13. Remove the cylinder head oil gallery expansion plugs.

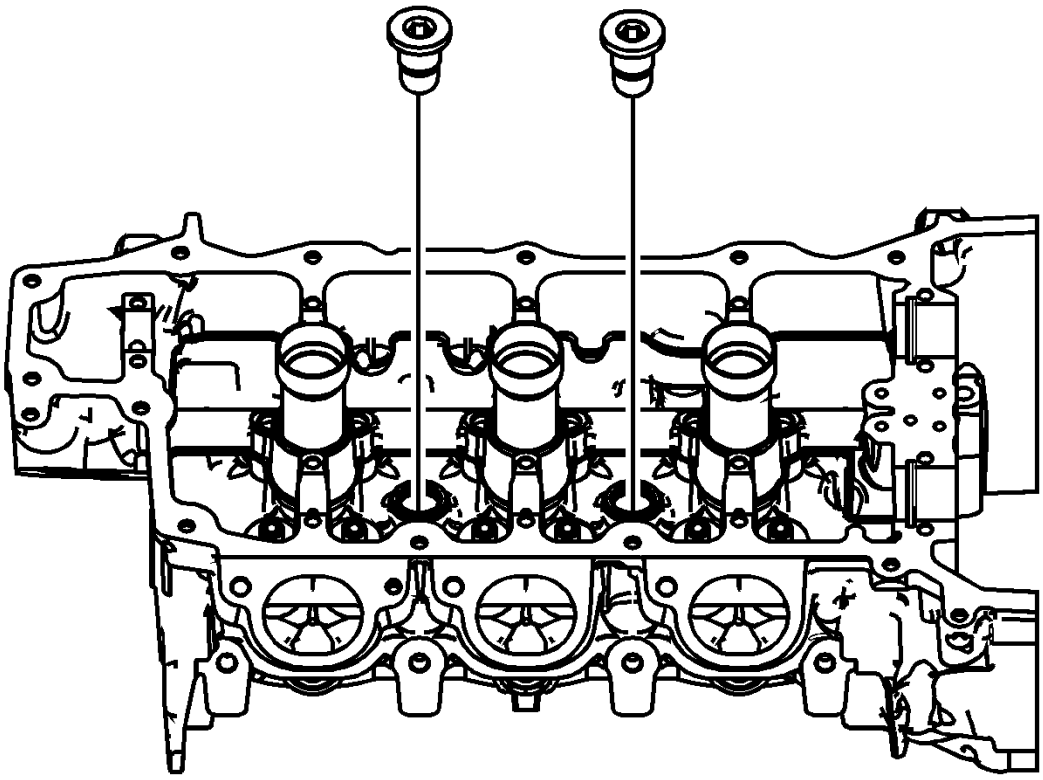

Fig. 155: View Of Cylinder Head Coolant Threaded Plugs
Courtesy of GENERAL MOTORS COMPANY

14. Remove the cylinder head coolant threaded plugs.

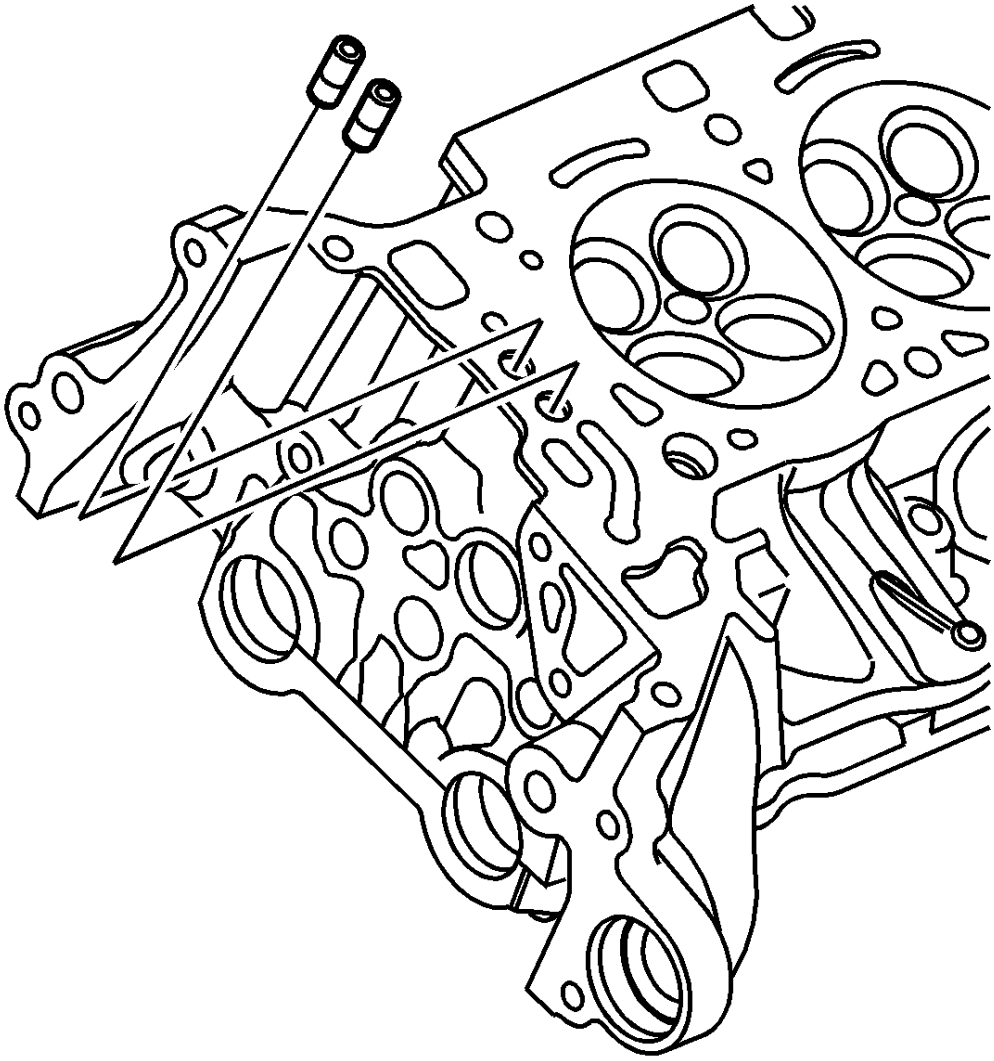

Fig. 156: View Of Camshaft Position Actuator Oil Feed Check Valve
Courtesy of GENERAL MOTORS COMPANY

15. Inspect the camshaft position actuator oil feed check valves. Damaged, restricted or clogged check valves must be replaced. If check valves are OK, disregard remaining steps which detail replacing the check valves.

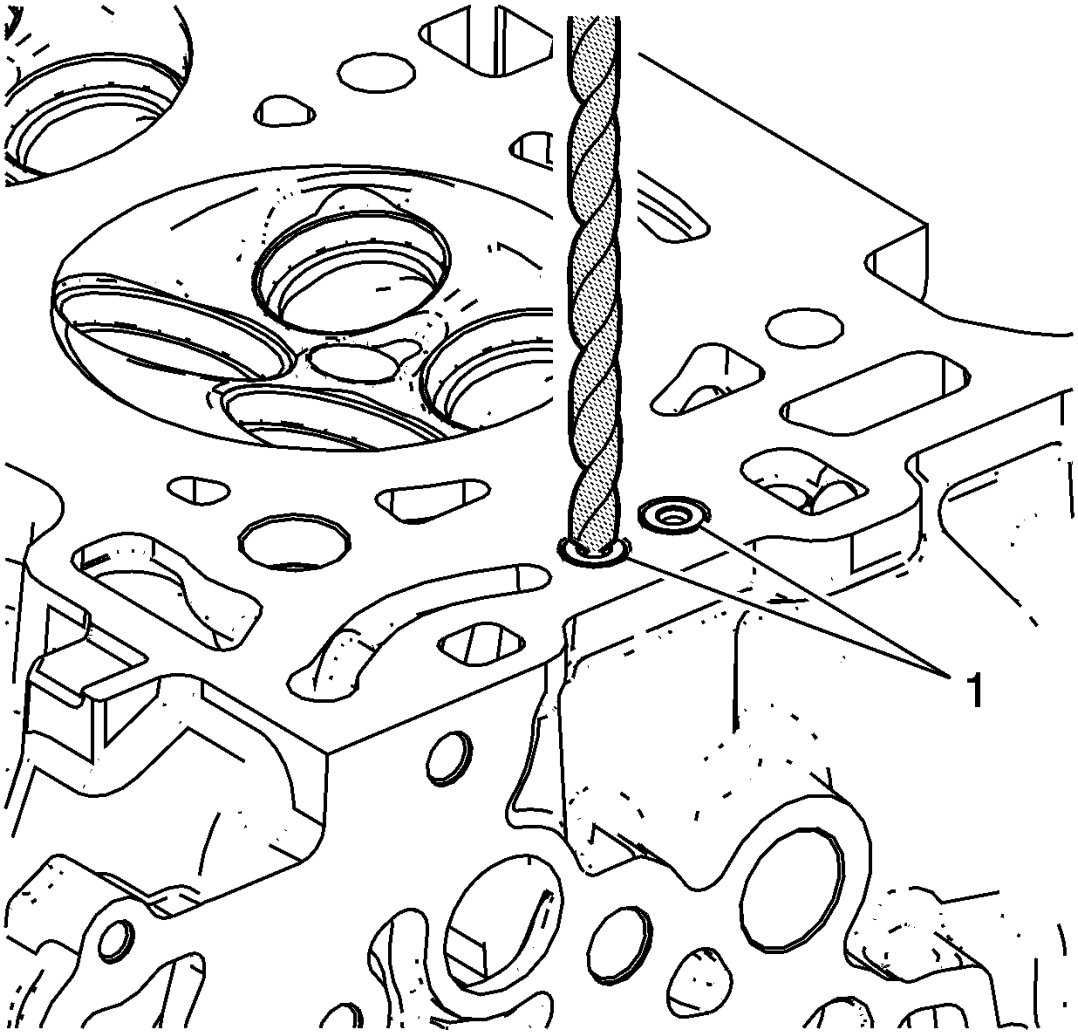

Fig. 157: Drill Out Top Portion Of Check Valve To Expose Internal Check Ball
Courtesy of GENERAL MOTORS COMPANY

16. Place cylinder head on firm surface with check valves (1) facing up. Protect all cylinder head components and machined surfaces.
17. Using drill bit EN-46122-3, drill out top portion of check valve to expose internal check ball.

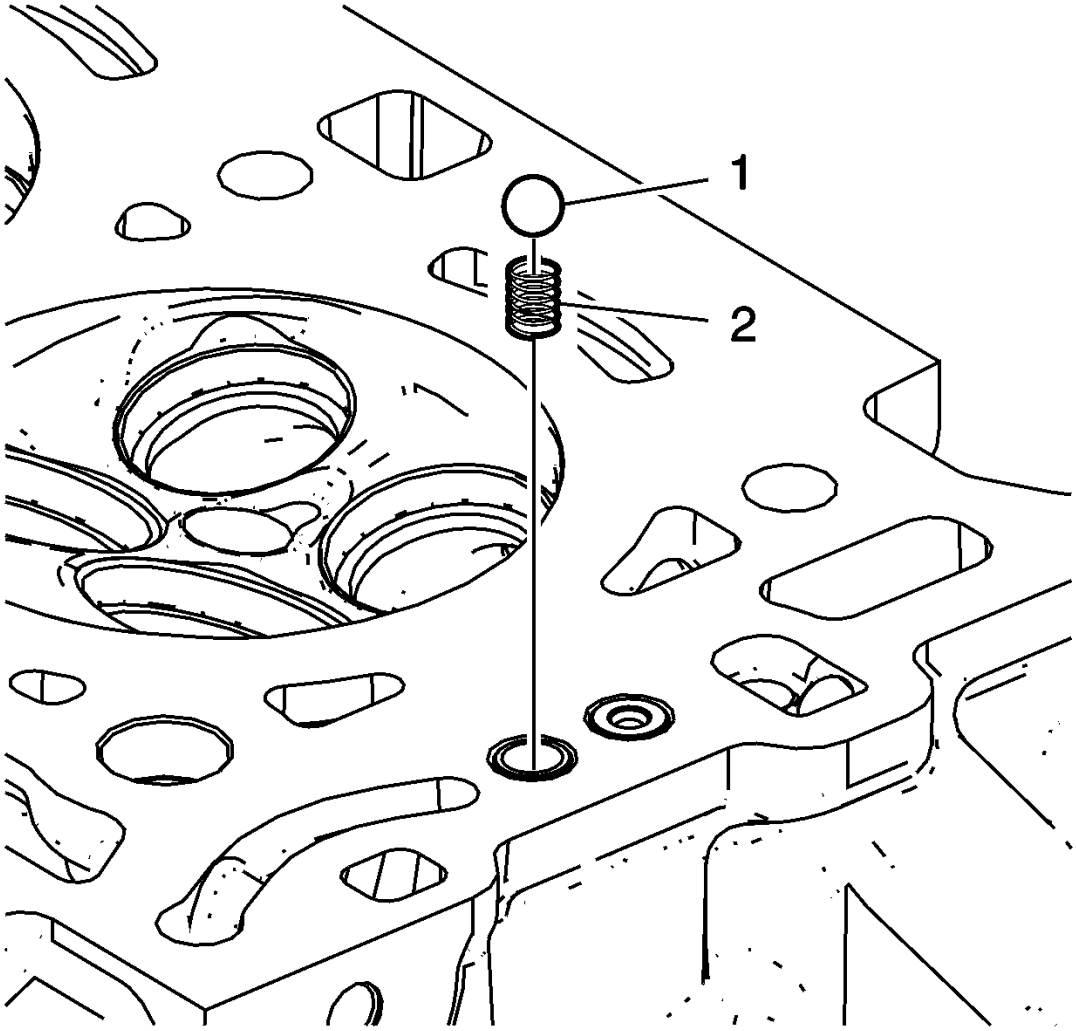

Fig. 158: Identifying Check Ball & Check Ball Spring
Courtesy of GENERAL MOTORS COMPANY

18. Remove check ball (1) and check ball spring (2) from inside of check valve.

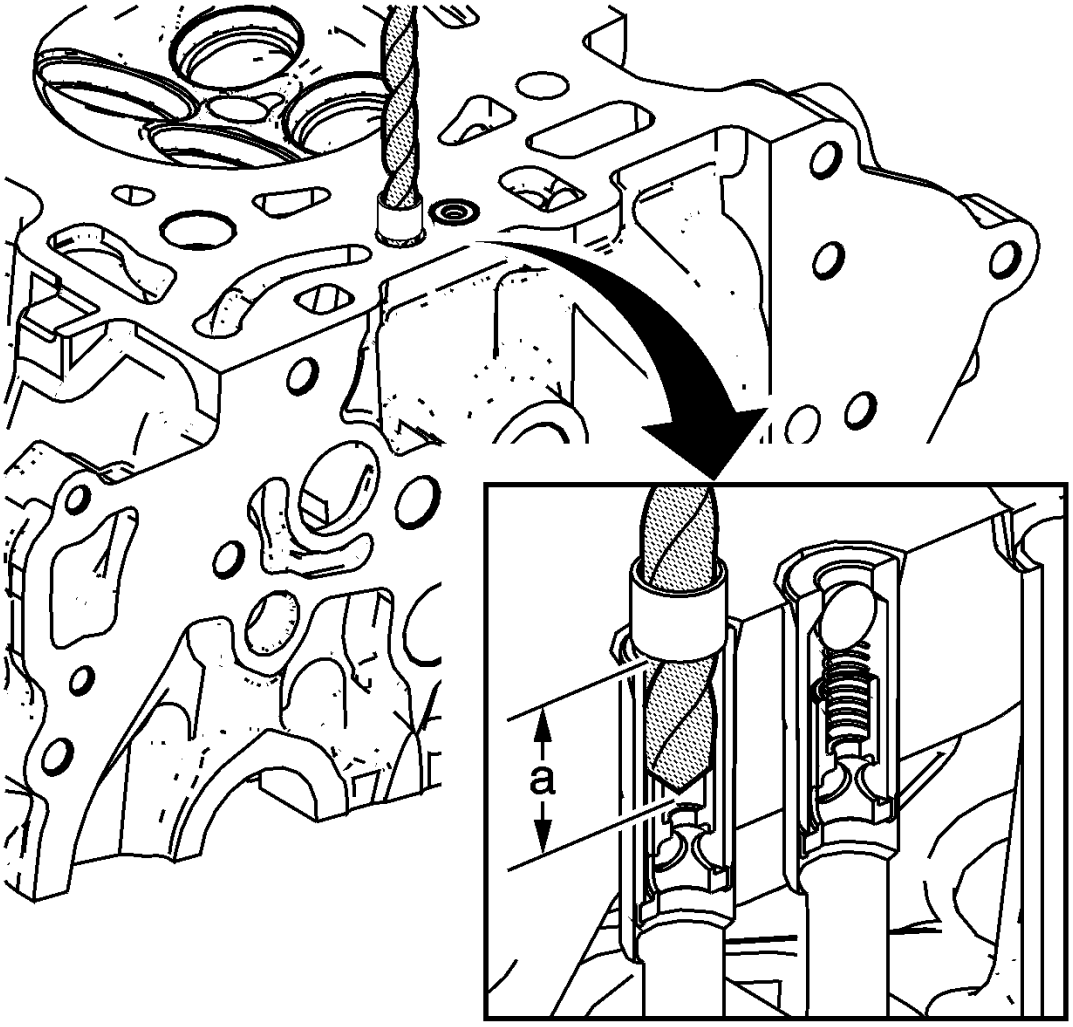

Fig. 159: Drill Remainder Of Check Valve Sleeve To A Depth Of Approximately 19 mm (0.75 In)
Courtesy of GENERAL MOTORS COMPANY

19. Continue drilling remainder of check valve sleeve to a depth of approximately 19 mm (0.75 in) (a) by placing tape on drill bit as a depth gauge. It is not necessary or desirable to drill completely through the bottom of the check valve.

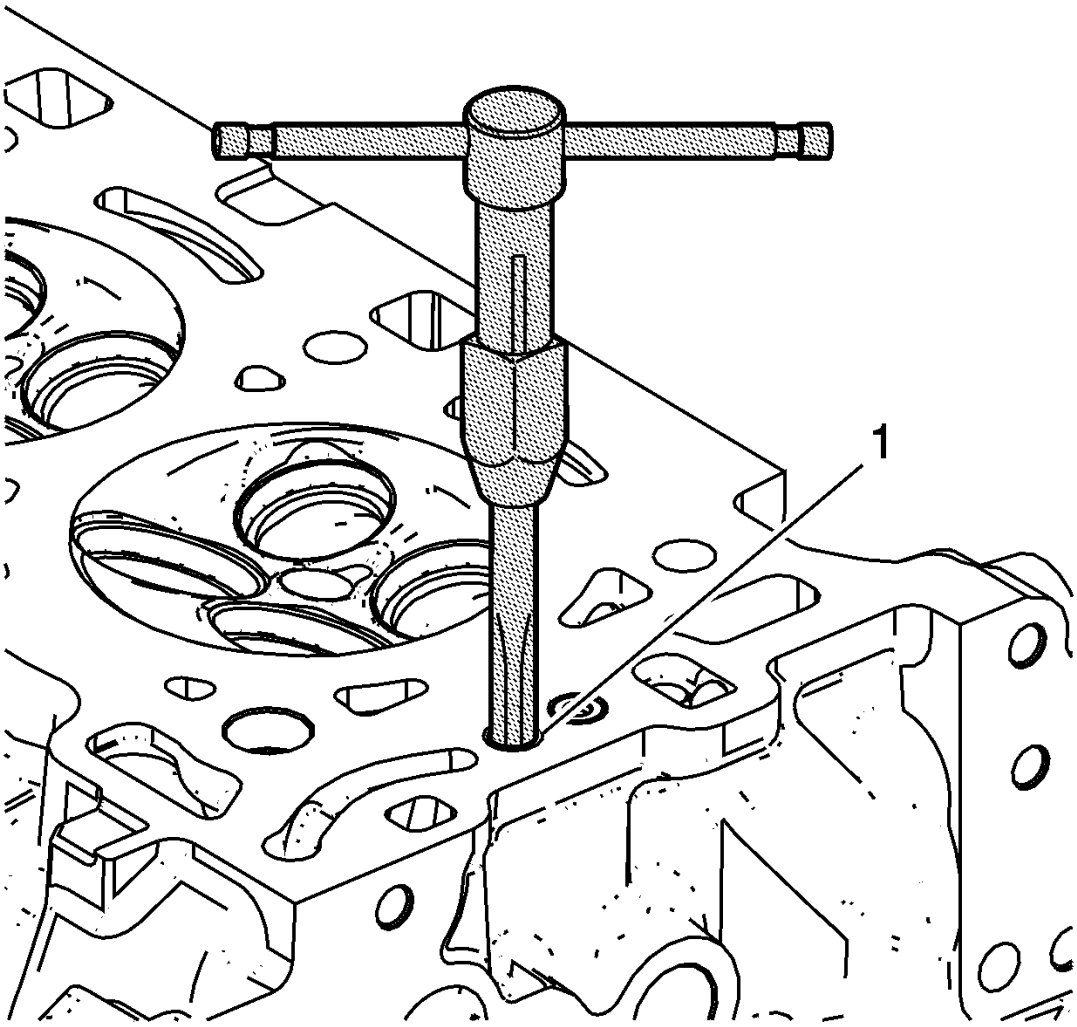

Fig. 160: Tapping Drilled Out Portion Of Check Valve
Courtesy of GENERAL MOTORS COMPANY

20. Lubricate tap **EN-46122-4** with lubricant included in **EN-46122** remover/installer. Tap drilled out portion of check valve (1) remaining in cylinder head. Tap to full depth possible until tap bottoms out in head.

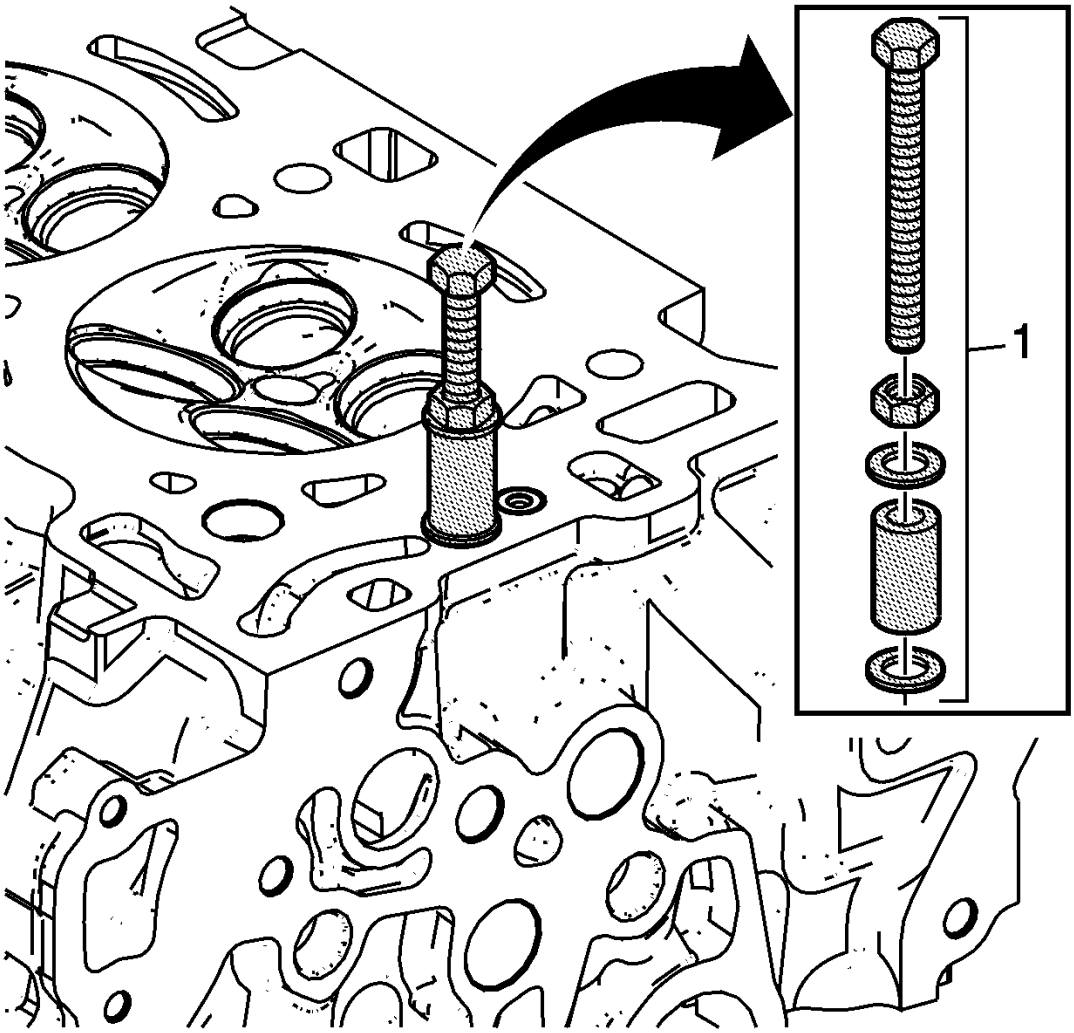

Fig. 161: Assembling Bolt, Nut, Washers & Collar EN-46122-2
Courtesy of GENERAL MOTORS COMPANY

21. Assemble bolt, nut, washers, and collar **EN-46122-2** (1) as shown. Position collar with slightly-larger inside diameter DOWN toward the cylinder head.
22. Screw bolt by hand fully down into threaded check valve sleeve, then lightly tighten nut against washer.

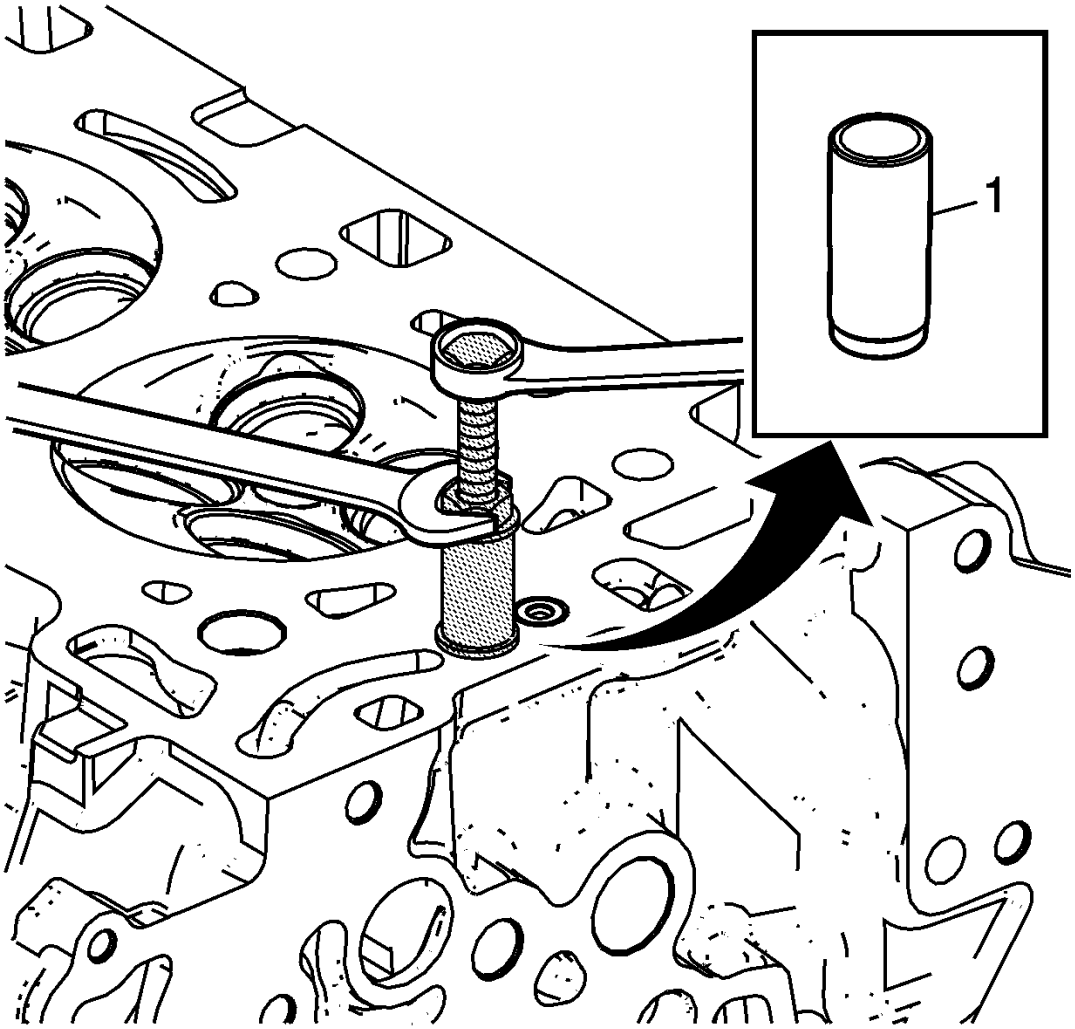

Fig. 162: Hold Bolt With One Wrench, And Use Another To Tighten The Nut Until The Check Valve Sleeve Is Removed From Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

23. Hold bolt with one wrench, and use another to tighten the nut until the check valve sleeve (1) is removed from the cylinder head.
24. Clean check valve bore and related passages thoroughly to remove any drilling chips or other debris.

CYLINDER HEAD CLEANING AND INSPECTION

Special Tools

- **GE-8001** Dial Indicator Set
- **GE-8358** Carbon Removal Brush
- **EN-28410** Gasket Remover
- **EN-42096** Valve Guide Reamer
- **EN-47909** Injector Bore and Sleeve Cleaning Kit

For equivalent regional tools, refer to **Special Tools** .

Cleaning Procedure

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
2. Remove any old thread sealant, gasket material or sealant using **EN-28410** remover.
3. Clean all cylinder head surfaces with non-corrosive solvent.

WARNING: Refer to Safety Glasses Warning .

4. Blow out all the oil galleries using compressed air.
5. Remove any carbon deposits from the combustion chambers using the **GE-8358** brush.
6. Clean any debris or build-up from the lifter pockets.

Visual Inspection

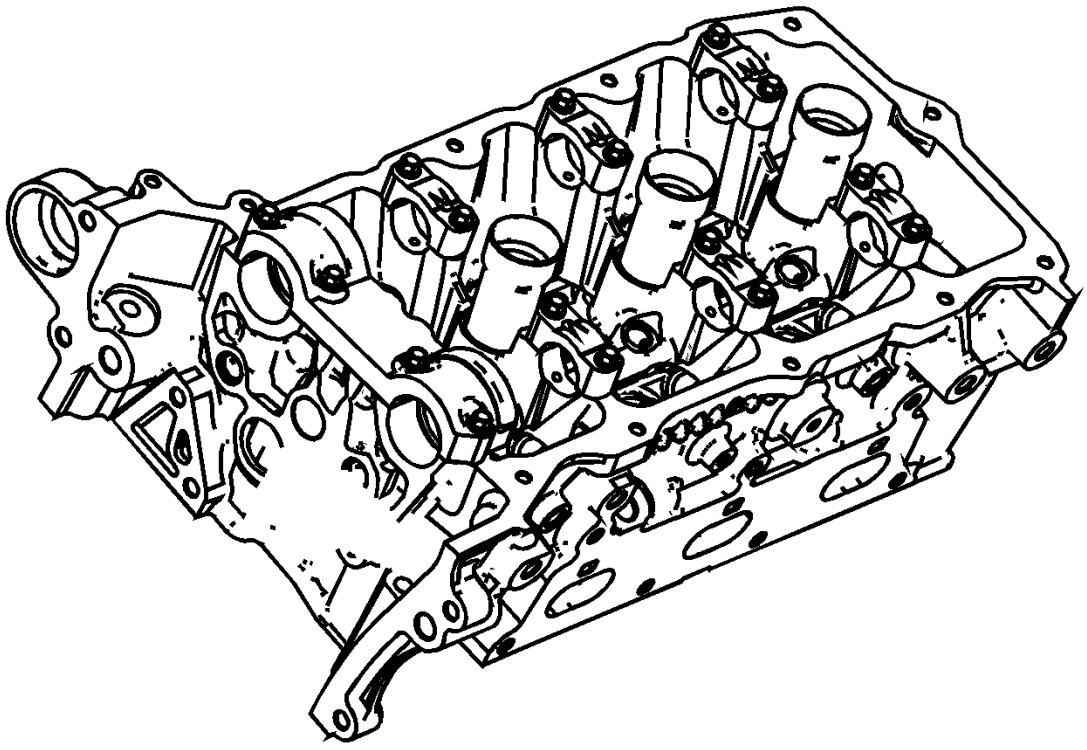

Fig. 163: View Of Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the cylinder head camshaft bearing surfaces for the following conditions:
   - Excessive scoring or pitting

.

- Discoloration from overheating
- Deformation from excessive wear
- If the camshaft bearing journals appear to be scored or damaged, you must replace the cylinder head. DO NOT machine the camshaft bearing journals.

2. If any of the above conditions exist on the camshaft bearing surfaces, replace the cylinder head.
3. Inspect the cylinder head for the following:
    - Cracks, damage or pitting in the combustion chambers
    - Debris in the oil galleries - Continue to clean the galleries until all debris is removed.
    - Coolant leaks or damage to the deck face sealing surface - If coolant leaks are present, measure the surface warpage as described under Cylinder Head Measurement - Deck Flatness Inspection.
    - Burrs or any defects that would degrade the sealing of the NEW secondary camshaft drive chain tensioner gasket
    - Damage to any gasket surfaces
    - Damage to any threaded bolt holes
    - Burnt or eroded areas in the combustion chamber
    - Cracks in the exhaust ports and combustion chambers
    - External cracks in the water passages
    - Restrictions in the intake or exhaust passages
    - Restrictions in the cooling system passages
    - Rusted, damaged or leaking core plugs
4. If the cylinder head is cracked or damaged, it must be replaced. No welding or patching of the cylinder head is recommended.

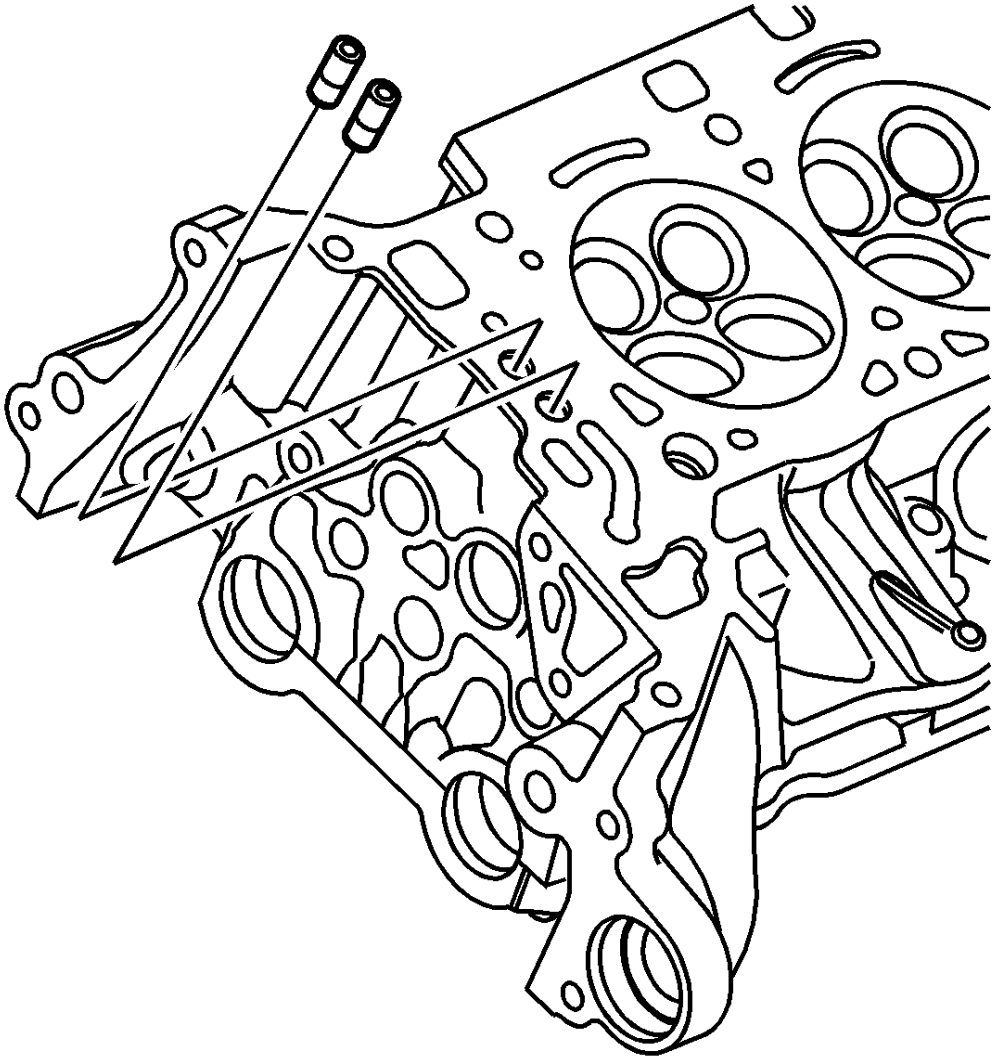

Fig. 164: View Of Camshaft Position Actuator Oil Feed Check Valve
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the camshaft position actuator oil feed check valves. Damaged, restricted or clogged check valves must be replaced. Refer to **Cylinder Head Disassemble (LF1, LFW or LFX)**.

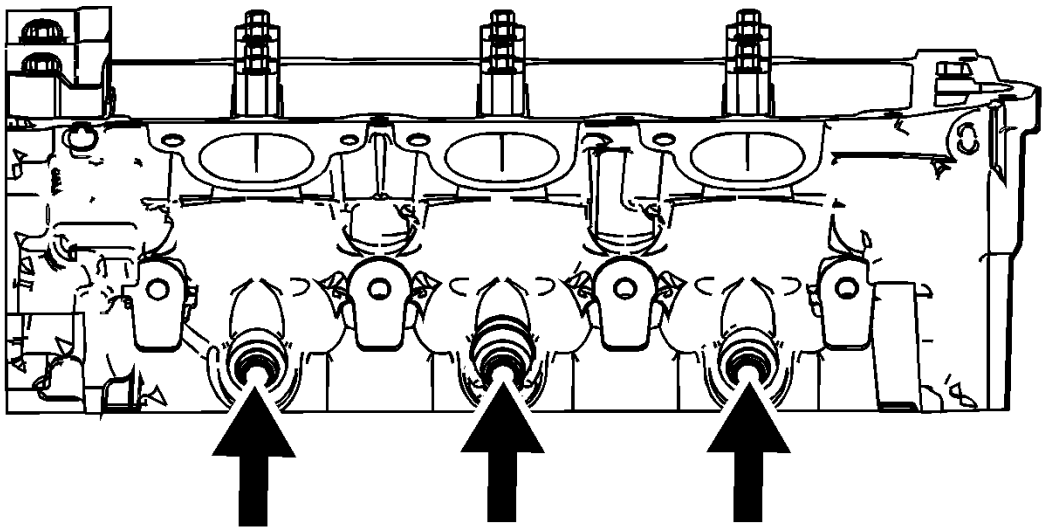

Fig. 165: View of Fuel Rail injector Bores
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the fuel rail injector bores and clean with **EN-47909** kit , if required.

Cylinder Head Measurement

Camshaft Journal Clearance

1. Install the camshaft bearing cap in the cylinder head without the camshaft.

CAUTION: Refer to Fastener Caution .

2. Install the camshaft cap bolts and tighten to 10 N.m (89 lb in).
3. Measure the camshaft bearings using an inside micrometer.
4. Subtract the camshaft journal diameter from the camshaft bearing diameter. This will provide the running clearance. If the running clearance exceeds specifications and the camshaft journals are within specification, replace the cylinder head.

Camshaft Journal Alignment

1. Ensure the camshafts are serviceable.
2. Inspect the cylinder head camshaft bearing surfaces for any imperfections or scratches that could inhibit proper camshaft clearances. Repair minor imperfections or scratches.
3. Install the camshafts in the cylinder head.
4. Install the camshaft bearing caps.
5. Install the camshaft cap bolts and tighten to 10 N.m (89 lb in).
6. Ensure the camshafts spin freely in the cylinder head. If the camshaft does not run freely, replace the cylinder head.

Deck Flatness Inspection

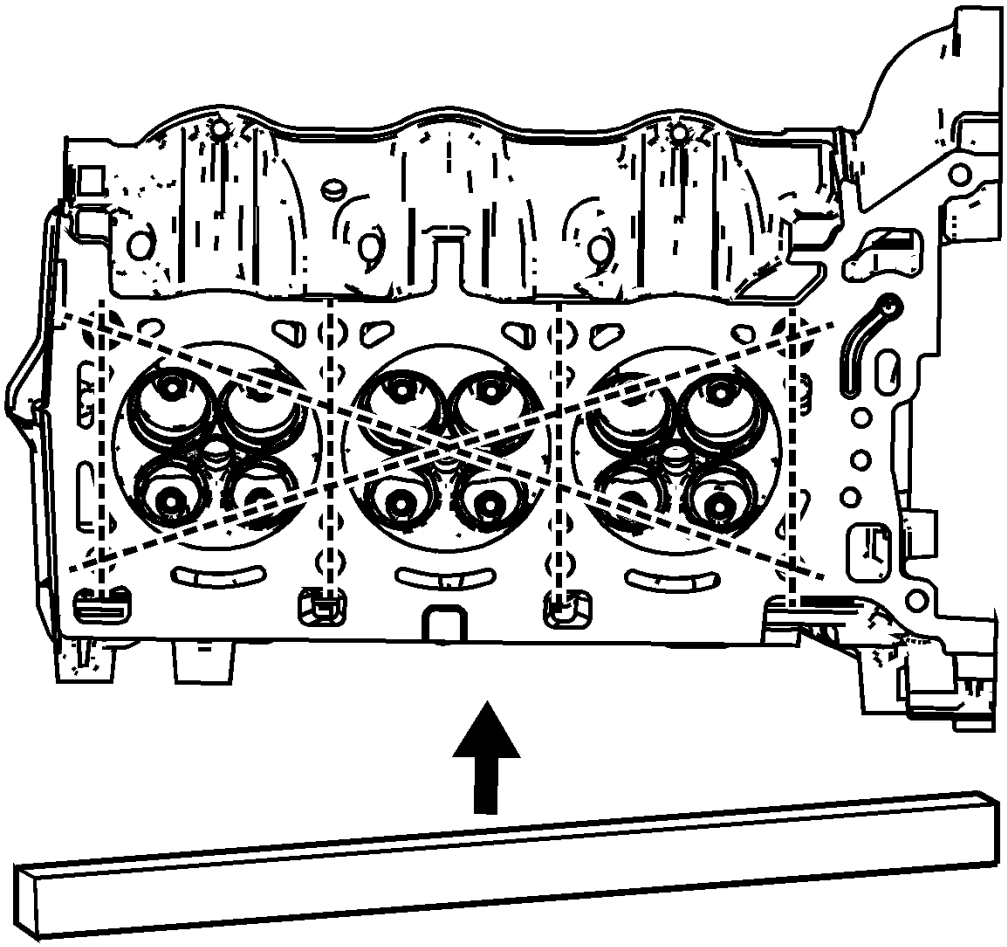

Fig. 166: Measuring Deck Flatness
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the cylinder head decks are clean and free of gasket material.
2. Inspect the surface for any imperfections or scratches that could inhibit proper cylinder head gasket sealing.
3. Place a straight-edge diagonally across the cylinder head deck face surface.

4. Measure the clearance between the straight-edge and the cylinder head deck face using a feeler gauge at 4 points along the straight-edge.
5. If the warpage is less than 0.05 mm (0.002 in), the cylinder head deck surface does not require resurfacing.
6. If the warpage is between 0.05-0.20 mm (0.002-0.008 in) or any imperfections or scratches that could inhibit proper cylinder head gasket sealing are present, the cylinder head deck surface requires resurfacing.
7. If resurfacing is required the maximum amount that can be removed is 0.25 mm (0.010 in).
8. If the cylinder head deck surface requires more than 0.25 mm (0.010 in) material removal the head must be replaced.

Valve Guide Measurement

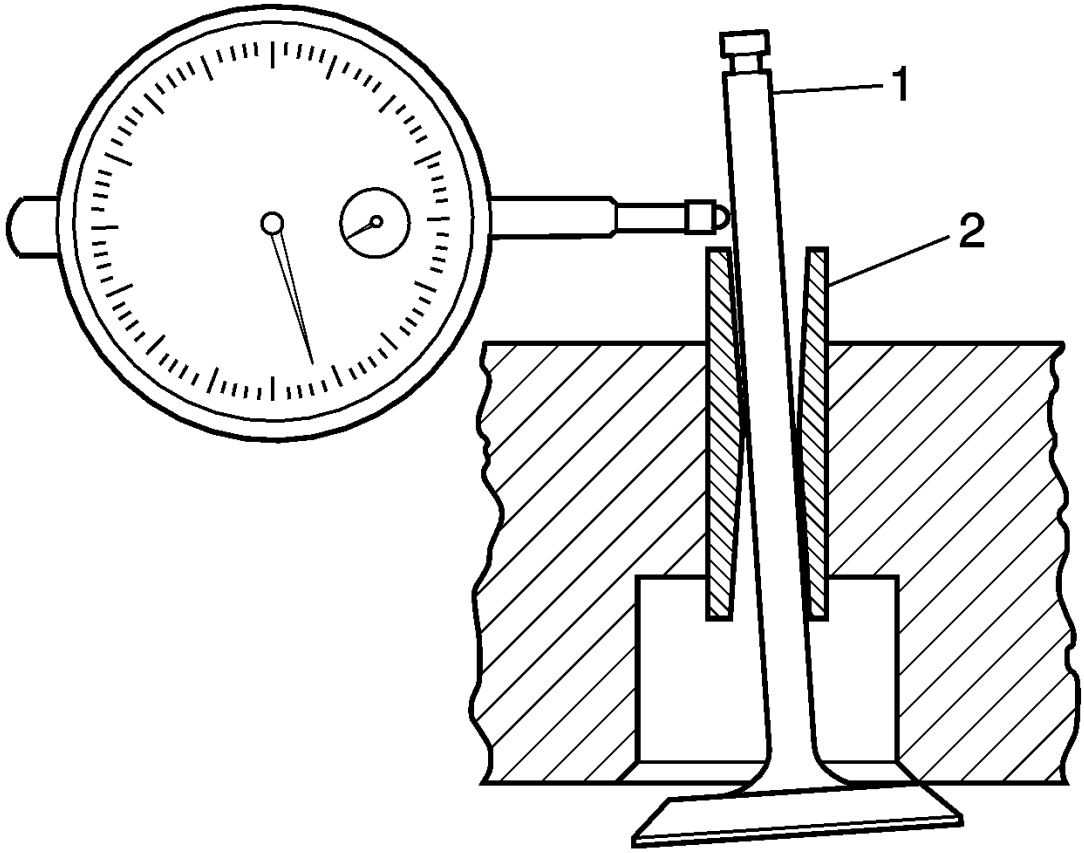

Fig. 167: Inspecting For Excessive Valve Stem To Guide Clearance
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve stem (1)-to-guide (2) clearance. Excessive valve stem-to-guide clearance may cause an excessive oil consumption and may also cause a valve to break. Insufficient clearance will result in noisy and sticky functioning of the valve and will disturb the engine assembly smoothness.

2. Clamp the **GE-8001** set to the cylinder head at the camshaft cover rail.
3. Locate the dial indicator so that the movement of the valve stem from side to side, crossways to the cylinder head, will cause a direct movement of the indicator stem. The dial indicator stem must contact the side of the valve stem just above the valve guide.
4. Drop the valve head about 0.064 mm (0.0025 in) off the valve seat.
5. Use light pressure when moving the valve stem from side to side in order to obtain a clearance reading. Refer to **Engine Mechanical Specifications** for proper clearance.
    - If the clearance for the valve is greater than specifications and a new standard diameter valve stem will not bring the clearance within specifications, the valve guide may be oversized by 0.075 mm (0.003 in) using the **EN-42096** reamer. There is 1 size of oversized valve stem available for service.
    - Valve guide wear at the bottom 10 mm (0.390 in) of the valve guide is not significant to normal operation.
    - If oversizing the guide does not bring the clearance within specifications, replace the cylinder head.

VALVE SPRING INSPECTION AND MEASUREMENT

Special Tools

EN 22738-B Valve Spring Tester

For equivalent regional tools, refer to **Special Tools** .

Inspection Procedure

1. Clean the valve springs in solvent.

    WARNING: Refer to Safety Glasses Warning .

2. Dry the valve springs with compressed air.
3. Inspect the valve springs for broken coils or coil ends.

Measurement Procedure

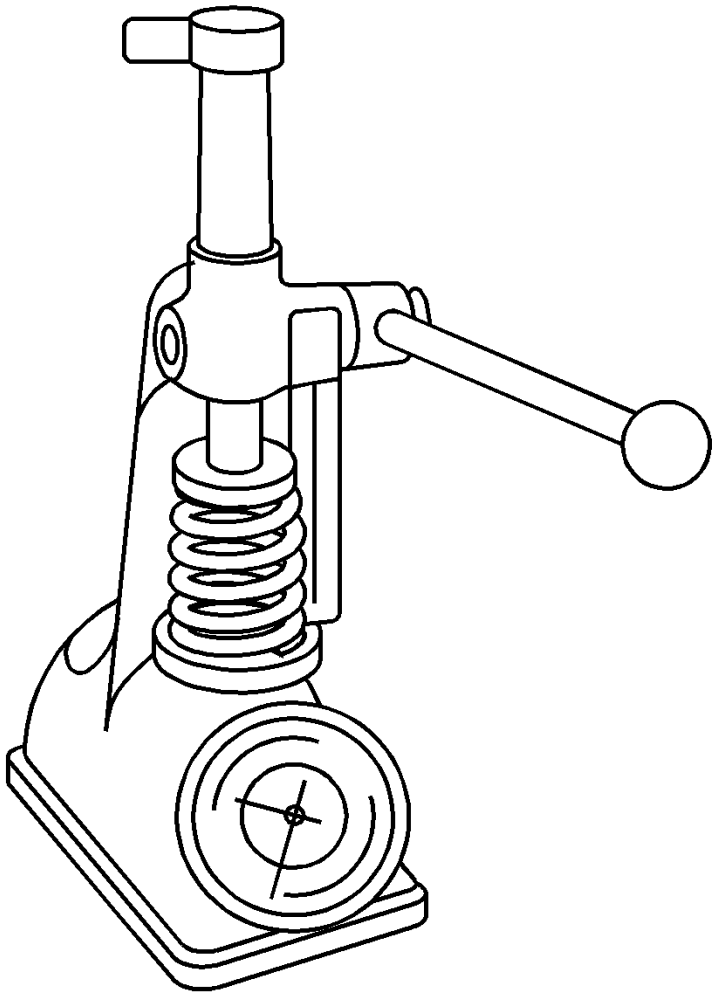

Fig. 168: Measuring Valve Spring Tension
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve spring tension using the **EN 22738-B** tester. Refer to **Engine Mechanical Specifications** .
2. If low valve spring load is found, replace the valve springs. DO NOT use shims to increase spring load. The use of shims can cause the valve spring to bottom out before the camshaft lobe is at peak lift.

VALVE AND SEAT GRINDING

Valve Cleaning Procedure

1. Use soft bristle wire brush to clean any carbon build-up from the valve head. DO NOT use a wire brush on any part of the valve stem. The valve stem is chrome plated to provide enhanced wear characteristics. Wire brushing the stem could remove the chrome plating.
2. Thoroughly clean the valve with solvent and wipe dry.

Valve Visual Inspection Procedure

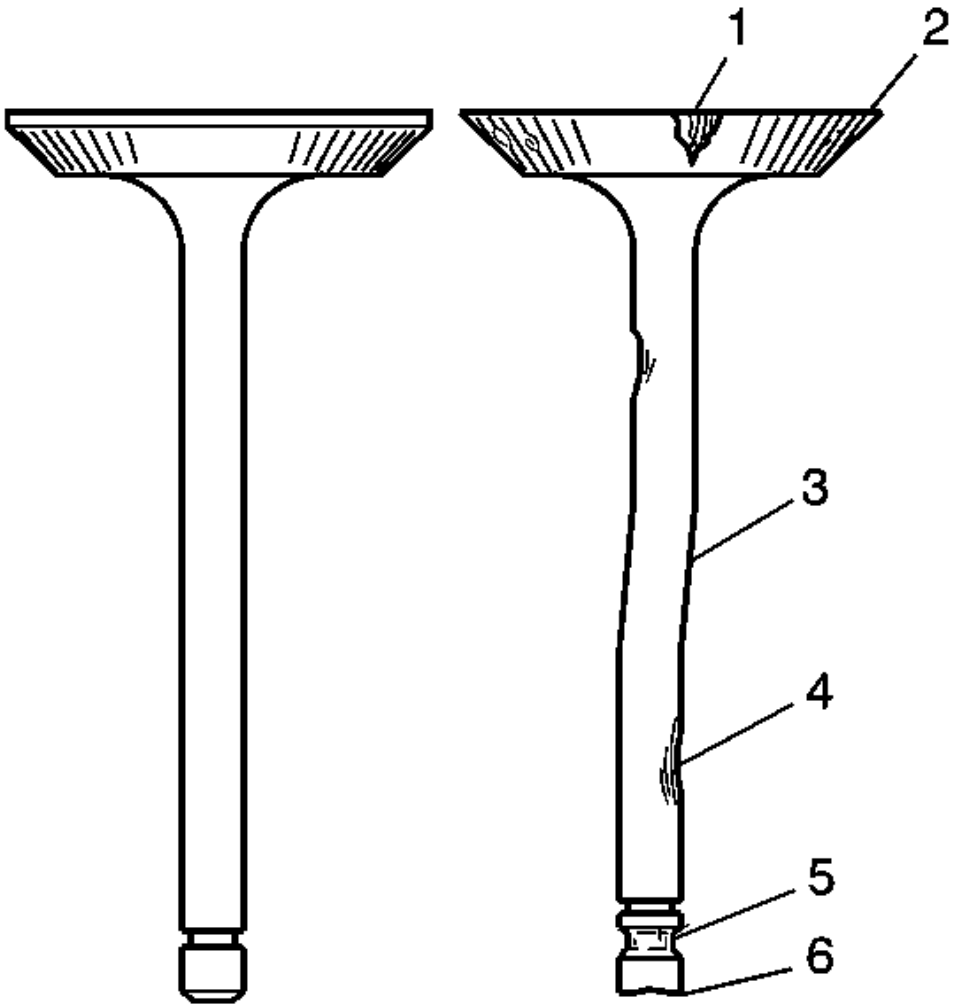

Fig. 169: Identifying Inspection Points For Valves Damage
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the valve for damage from the head to tip for the following conditions:
    - Pitting in the valve seat area (1)
    - Lack of valve margin (2)
    - Bending in the valve stem (3)
    - Pitting or excessive wear in the stem (4)
    - Worn valve key grooves (5)
    - Worn valve tip (6)
2. Replace the valve if any of these conditions exist.

Valve Measurement Overview

NOTE: **The following measurement and reconditioning procedures must be followed to ensure proper engine performance.**

1. Proper valve service is critical to engine performance. Therefore, all detailed measurement procedures must be followed to identify components that are out of specification.
2. If the measurement procedures reveal that the valve seat must be reconditioned, it is critical to perform the measurement procedures after reconditioning. Valves for E85-compatible engines CANNOT be reconditioned. Any grinding, lapping, wire-brushing or other similar procedure will damage or destroy the coating that gives the valve the E-85 compatible features. If an E85-compatible valve is out of specification in any area, replace it.

Valve Seat Width Measurement Procedure

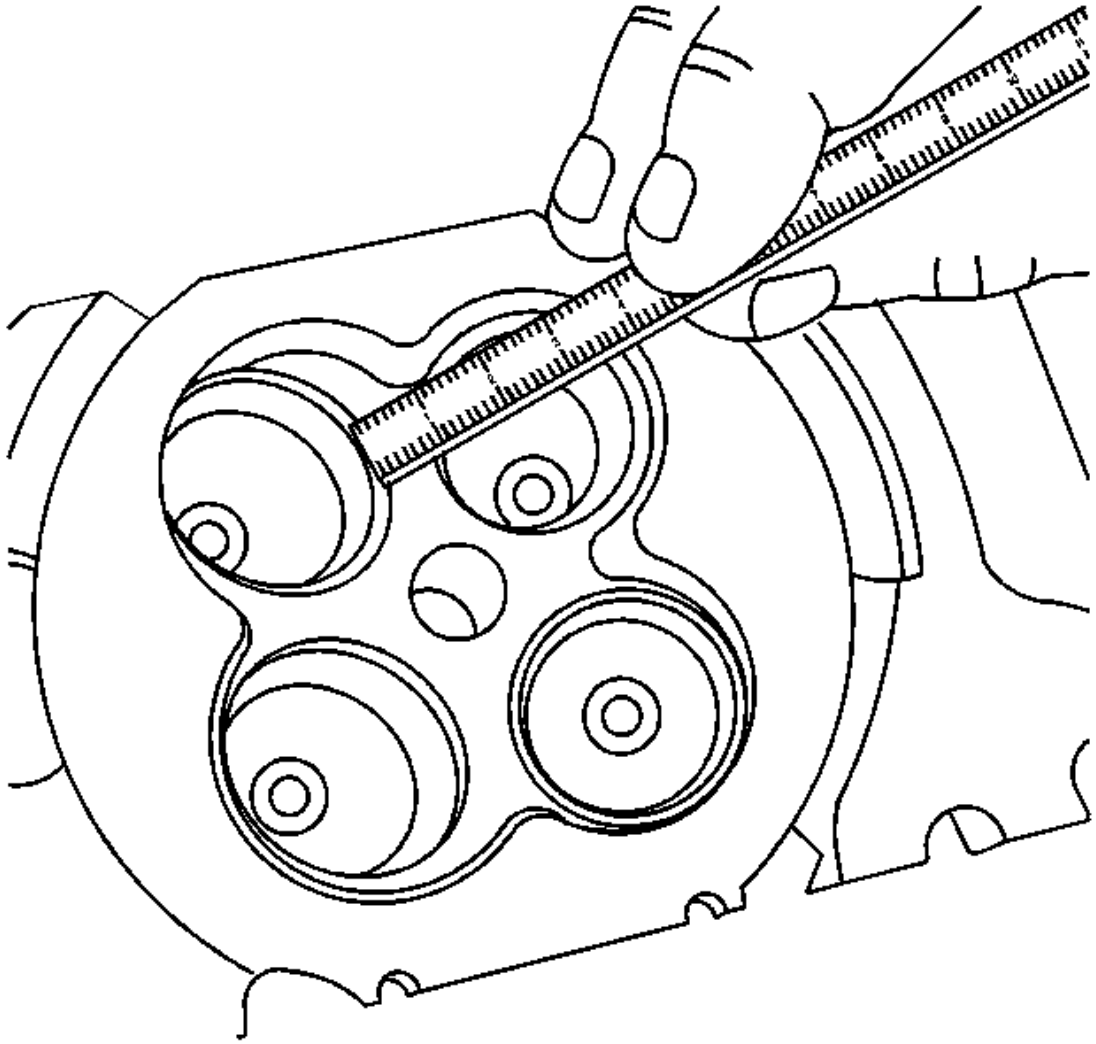

Fig. 170: Checking Valve Seat Width
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve seat width in the cylinder head using a proper scale.

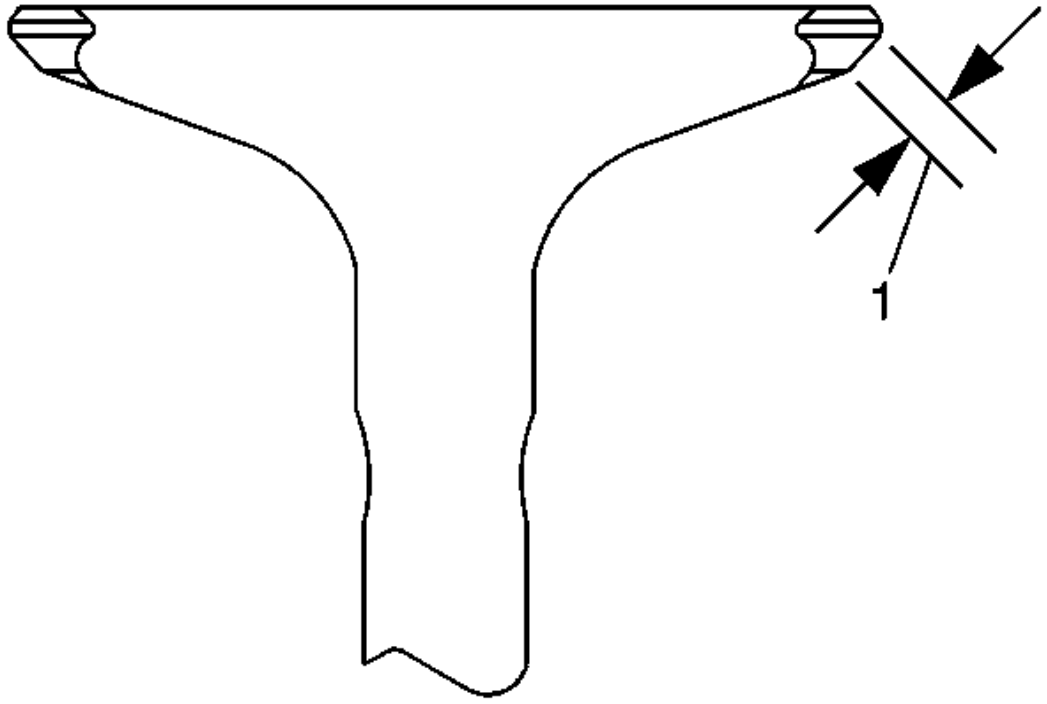

Fig. 171: Measuring Seat Width On Valve Face
Courtesy of GENERAL MOTORS COMPANY

2. Measure the seat width on the valve face (1) using a proper scale.

NOTE: **The seat contact area must be at least 0.5 mm (0.020 in) from the outer diameter (margin) of the valve. If the contact area is too close to the margins, the valve must be replaced.**

3. Compare your measurements with the specifications listed in **Engine Mechanical Specifications** .
4. If the seat widths are acceptable, check the valve seat roundness using the Valve Seat Roundness Measurement Procedure.
5. If the seat width is not acceptable, you must replace the valve. Proper valve seat width is critical to providing the correct amount of valve heat dissipation.

Valve Seat Roundness Measurement Procedure

1. Measure the valve seat roundness using a dial indicator attached to a tapered pilot installed in the guide. The pilot should have a slight bind when installed in the guide.

CAUTION: The correct size pilot must be used. Do not use adjustable diameter pilots. Adjustable pilots may damage the valve guides.

2. Compare your measurements with the specifications listed in **Engine Mechanical Specifications** .
3. If the valve seat exceeds the roundness specification, you must replace the valve.
4. If new valves are being used, the valve seat roundness must be within 0.05 mm (0.002 in).

Valve Margin Measurement Procedure

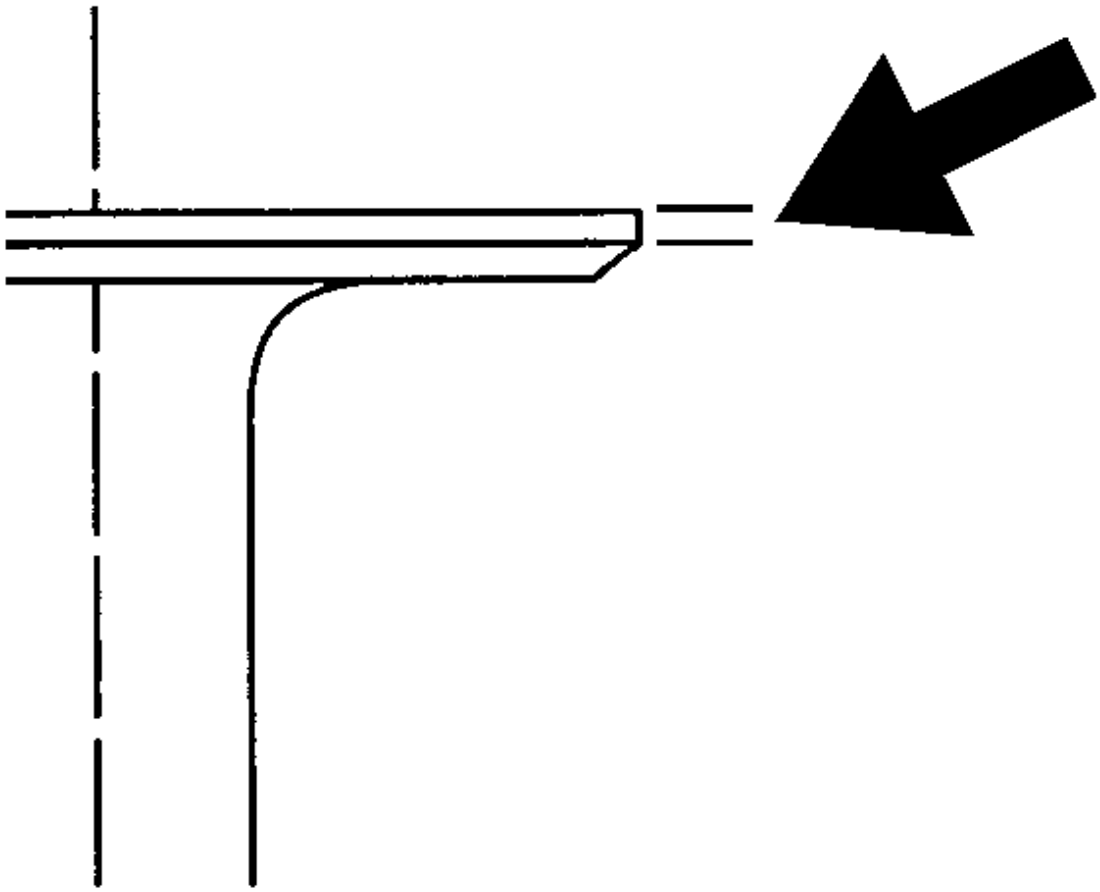

Fig. 172: View Of Valve Margin Measurement
Courtesy of GENERAL MOTORS COMPANY

1. Measure the valve margin using an appropriate scale.
2. Reference the specifications in this section for minimum valve margin and compare them to your measurements.
3. If the valve margins are beyond specification, replace the valves.

4. If the valve margins are within specification, test the valve for seat concentricity using the Valve-to-Seat Concentricity Measurement Procedure.

Valve-to-Seat Concentricity Measurement Procedure

NOTE:

- **Checking the valve-to-seat concentricity determines whether the valve and seat are sealing properly.**
- **You must measure the valve face and the valve seat to ensure proper valve sealing.**

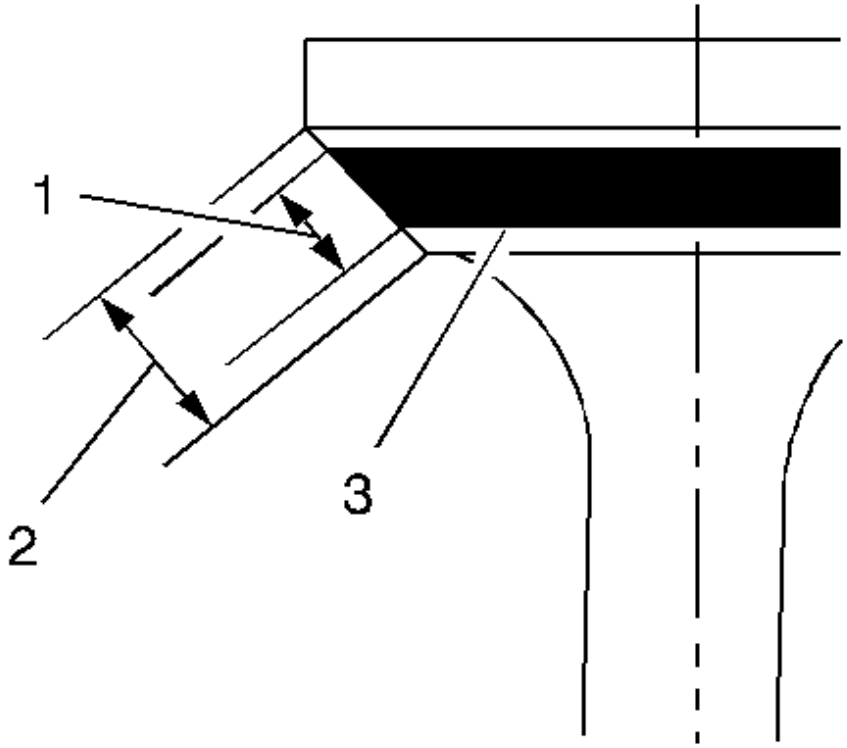

Fig. 173: View Of Valve Contact Face Measurements
Courtesy of GENERAL MOTORS COMPANY

1. Coat the valve face lightly with blue dye (3).
2. Install the valve in the cylinder head.
3. Turn the valve against the seat with enough pressure to wear off the dye.

4. Remove the valve from the cylinder head.
5. Inspect the valve face.
    - If the valve face is concentric, providing a proper seal-with the valve stem, a continuous mark will be made around the entire face (1).

      NOTE: **The wear mark MUST be at least 0.5 mm (0.020 in) from the outer diameter, the margin, of the valve. If the wear mark is too close to the margin, the seat must be reconditioned to move the contact area away from the margin.**

    - If the face is not concentric with the stem, the mark will NOT be continuous around the valve face. The valve should be replaced and the seat must be reconditioned using the Valve and Seat Reconditioning Procedure.

Valve and Seat Reconditioning Procedure

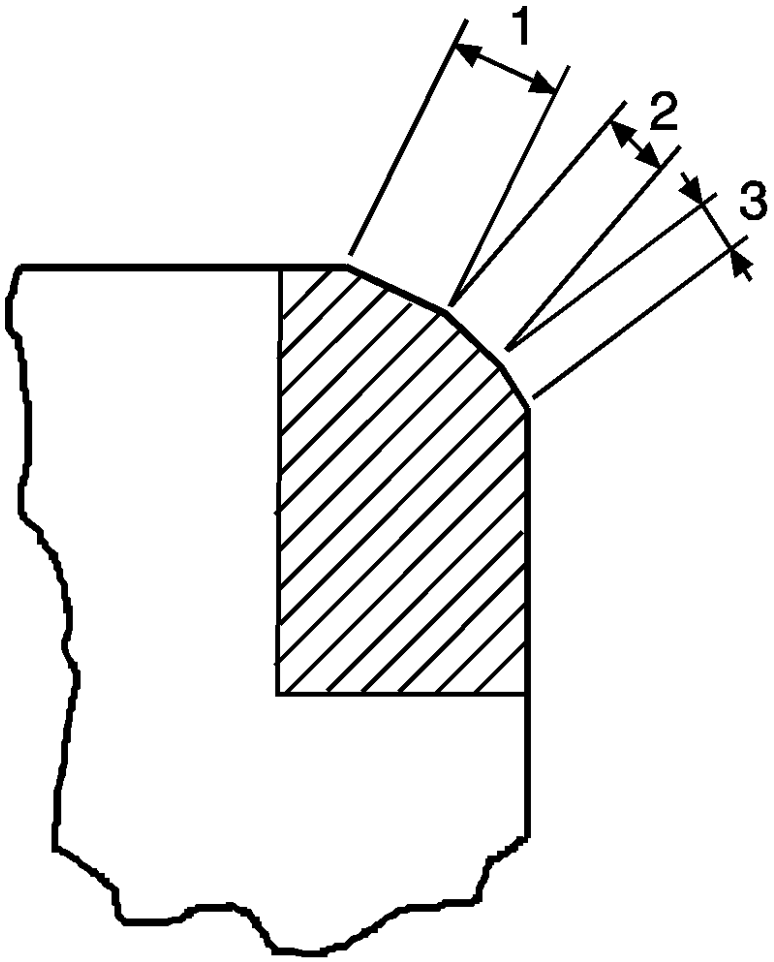

Fig. 174: View Of Valve Seat Proper Angles
Courtesy of GENERAL MOTORS COMPANY

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NOTE:

- **If the valve seat width, roundness or concentricity is beyond specifications, you must grind the seats in order to ensure proper heat dissipation and prevent the buildup of carbon on the seats.**
- **A NEW valve must be used with any reconditioned seat.**

1. Grind the valve seats (2) to the proper angle specification listed in **Engine Mechanical Specifications** .
2. Using the proper angle specification listed in **Engine Mechanical Specifications** , grind, relieve, the valve seats (1) to correctly position the valve seating surface (2) to the valve.
3. Using the proper angle specification listed in **Engine Mechanical Specifications** , grind, undercut, the valve seats (3) to narrow the valve seat widths to the specifications listed in **Engine Mechanical Specifications** .
4. When grinding the seats, grind off as little material as possible. Cutting valve seat results in lowering the valve spring pressure.
5. Install the valve in the cylinder head. Do not lap the valves under any condition, whether the valves are new or used.
6. After obtaining the proper valve seat width in the cylinder head, you must re-measure the valve stem height using the Valve Stem Height Measurement Procedure.
7. If the valve stem height is acceptable, test the seats for concentricity using the Valve-to-Seat Concentricity Measurement Procedure.

Valve Stem Height Measurement Procedure

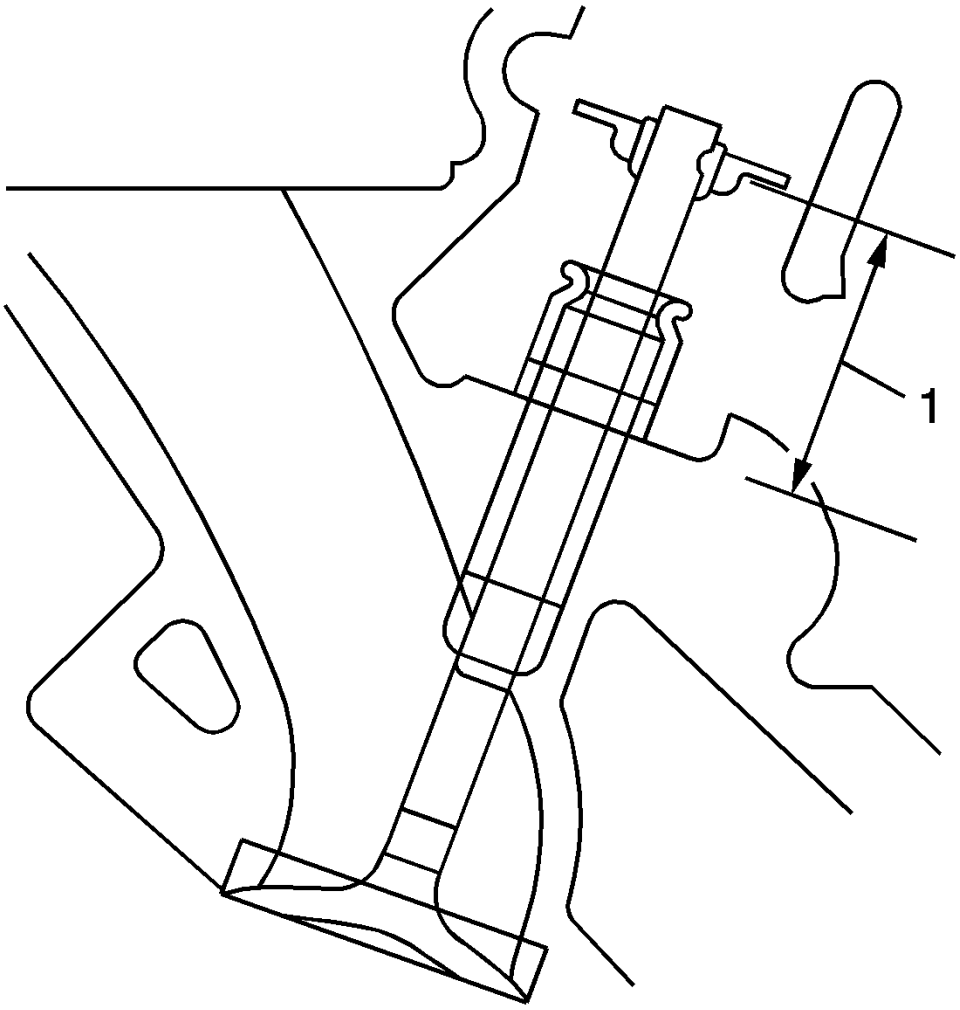

Fig. 175: Measuring Valve Stem Height
Courtesy of GENERAL MOTORS COMPANY

NOTE: **To determine the valve stem height measurement, measure from the valve spring seat to the valve spring retainer.**

1. Install the valve into the valve guide.
2. Ensure the valve is seated to the cylinder head valve seat.
3. Install the valve stem oil seal.
4. Install the valve spring retainer and valve stem locks.
5. Measure the distance (1) between the cylinder head to the bottom of the valve spring retainer. Refer to **Engine Mechanical Specifications** .
6. If the maximum height specification is exceeded, a new valve should be installed and the valve stem height re-measured.

CAUTION: **DO NOT grind the valve stem tip. The tip of the valve is hardened and grinding the tip will eliminate the hardened surface causing premature wear and possible engine damage.**

CAUTION: **DO NOT use shims in order to adjust valve stem height. The use of shims will cause the valve spring to bottom out before the camshaft lobe is at peak lift and engine damage could result.**

7. If the valve stem height still exceeds the maximum height specification, the cylinder head must be replaced.

FUEL RAIL AND INJECTORS CLEANING AND INSPECTION (LF1, LFW OR LFX)

Special Tools

- **EN-47909** Injector Bore and Sleeve Cleaning Kit
- **EN-49245** Injector Seal Installer Kit
- **EN-49247** Injector Retaining Clip Installer

For equivalent regional tools, refer to **Special Tools** .

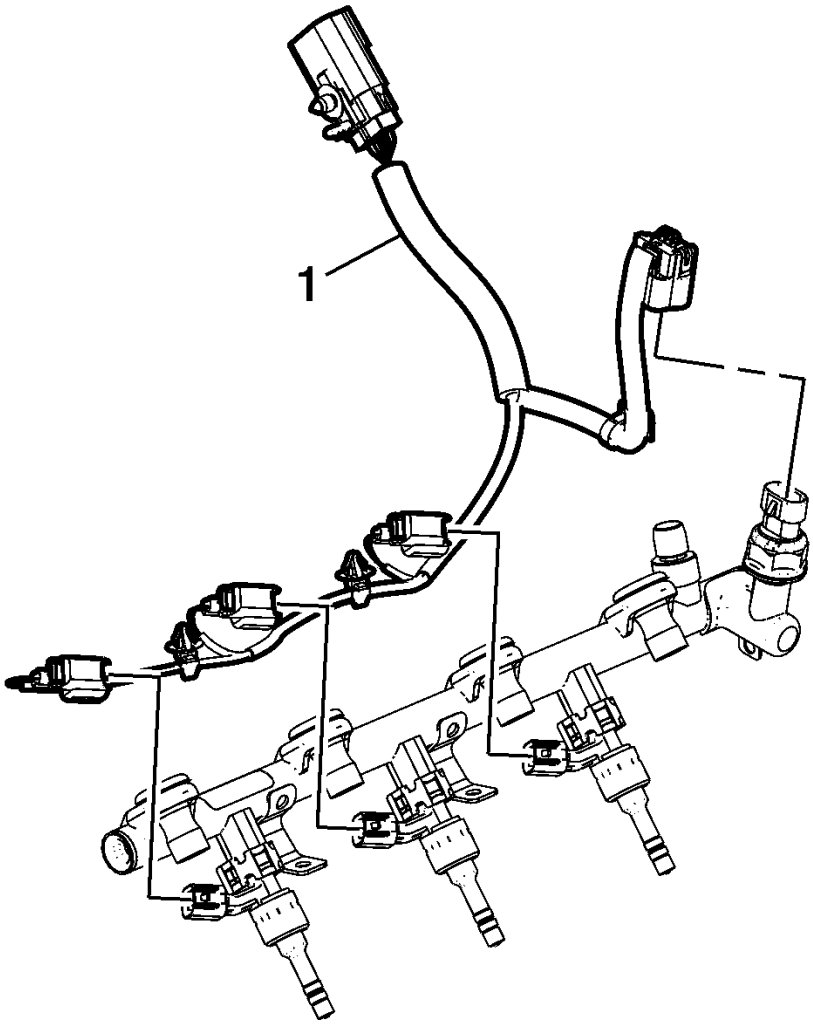

Fig. 176: View Of Fuel Rail Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

1. Detach and remove the fuel rail wiring harness (1) from the fuel injector rail.

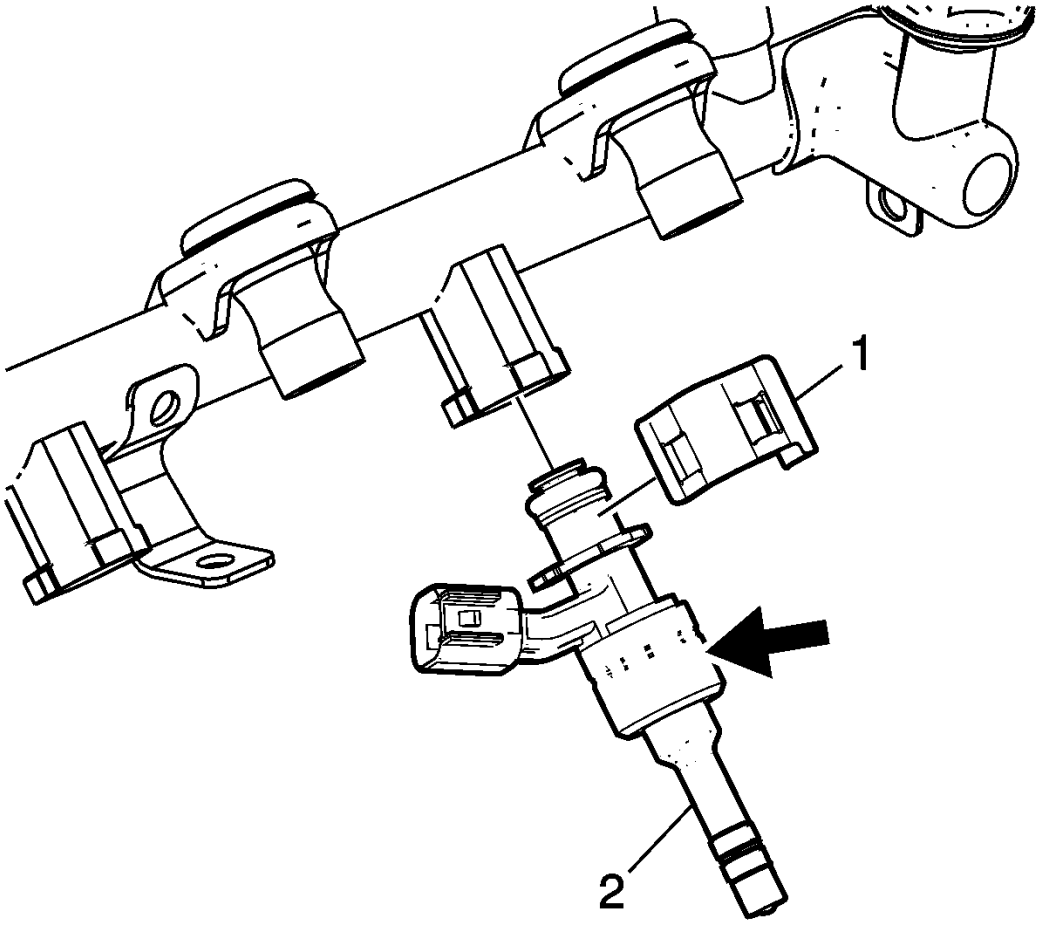

Fig. 177: View Of Fuel Injector & Retainer
Courtesy of GENERAL MOTORS COMPANY

2. Using a suitable tool remove the fuel injector to rail retainer (1) from the fuel injector rail by spreading both sides of the fuel injector to rail retainer at the same time.
3. Discard the fuel injector to rail retainer (1).
4. Carefully twist the fuel injector to remove the fuel injector (2) from the fuel injector rail.

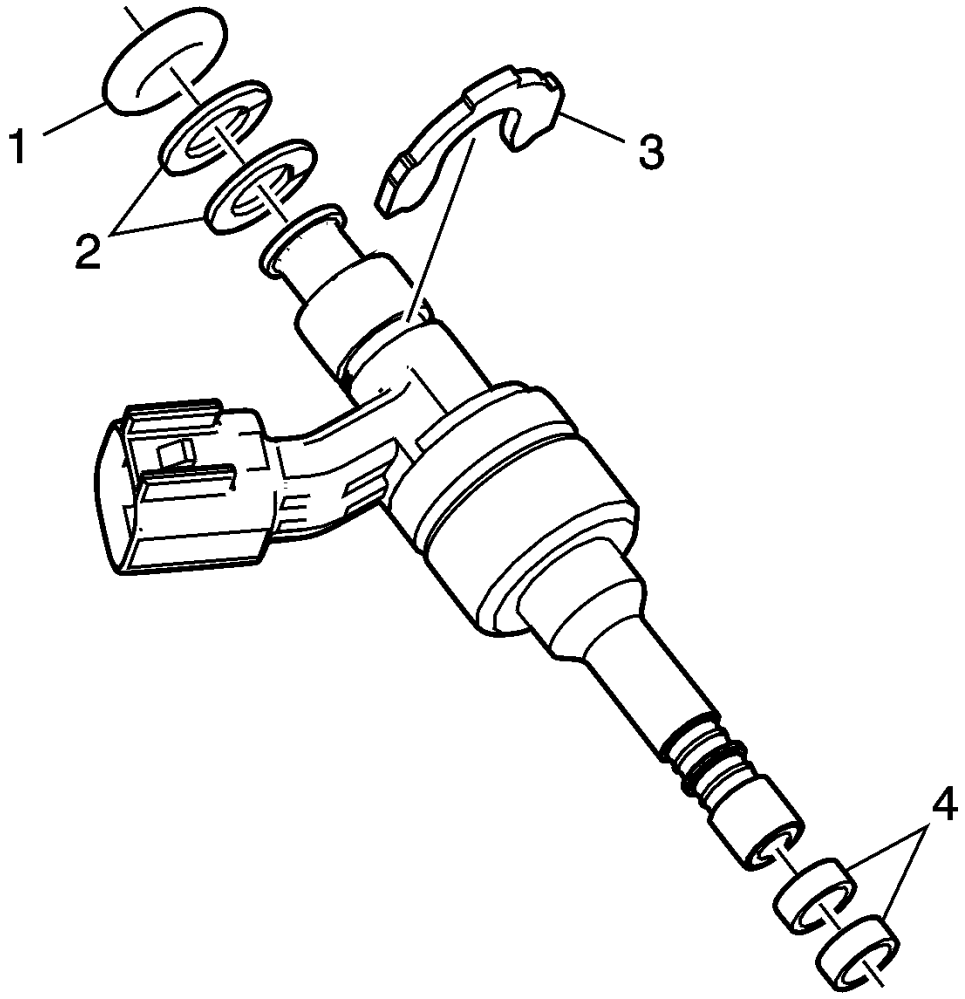

Fig. 178: View Of Fuel Injector Components
Courtesy of GENERAL MOTORS COMPANY

5. Using a suitable tool remove the fuel injector bushing (3).
6. Discard fuel injector bushing.
7. Remove and discard the following components:
    - Fuel injector O-ring (1).
    - Plastic spacers (2).
    - Fuel injector seals (4).

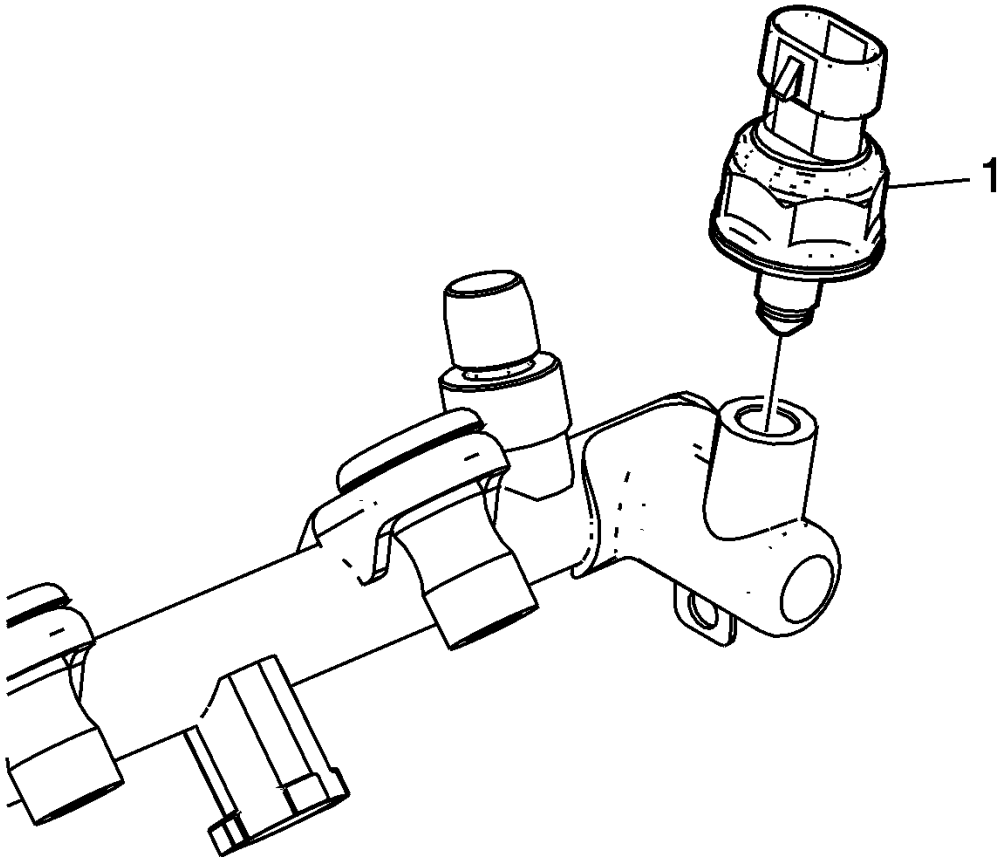

Fig. 179: Identifying Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not apply force to the plastic housing of the fuel pressure sensor. Failure to comply will destroy the sensor.**

8. Remove the fuel pressure sensor (1) from the fuel injector rail.

NOTE: **Do not soak or submerge the fuel rail or injectors in solvent.**

9. Clean the exterior of the fuel injector rail and fuel injectors with solvent using the injector bore and sleeve cleaning kit **EN-47909** injector bore and sleeve cleaning kit.

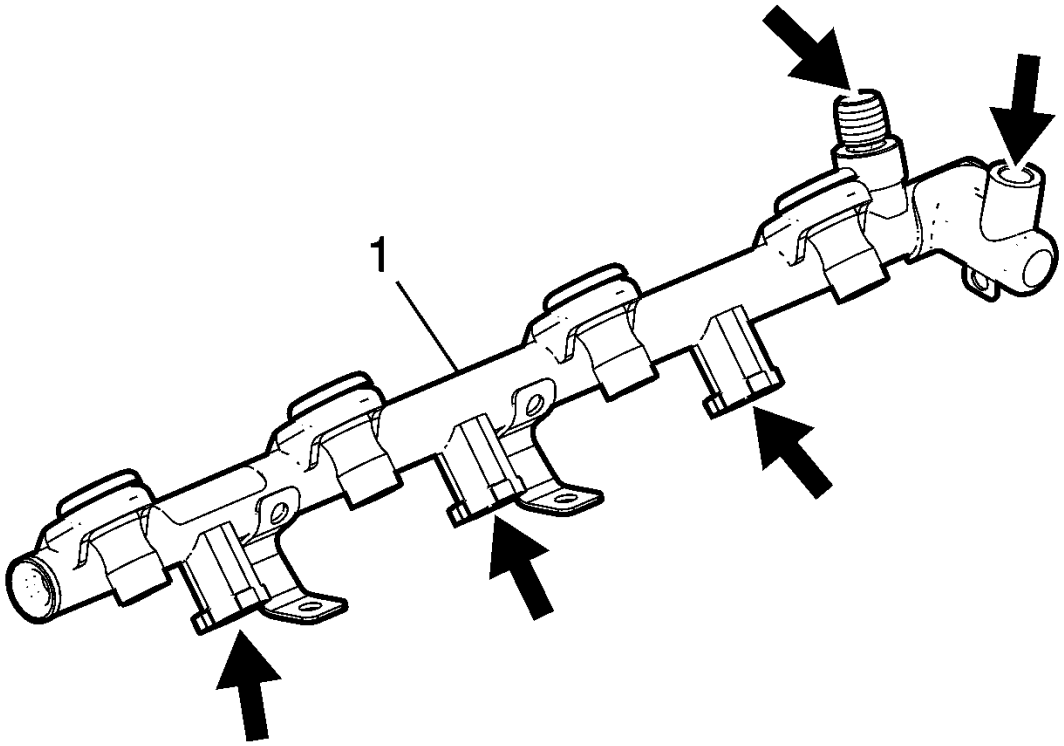

Fig. 180: Identifying Fuel Rail Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

10. Inspect the fuel injector rail (1) for the following conditions:
    - Damage, debris or restrictions to the fuel rail
    - Damage, debris or restrictions to the fuel ports in the fuel rail
    - Damage to the mounting area for the fuel rail
    - Damage to the fuel rail mounting bolts or mounting bolt grommets/isolators
    - Damage to the threads on the fuel rail feed fitting
    - Damage to the threads in the fuel pressure sensor bore
    - Damage to the fuel pressure sensor connector, threads, or sealing face
11. If any of the above conditions are found, replace the fuel injector rails. Do not attempt to repair the fuel injector rails.

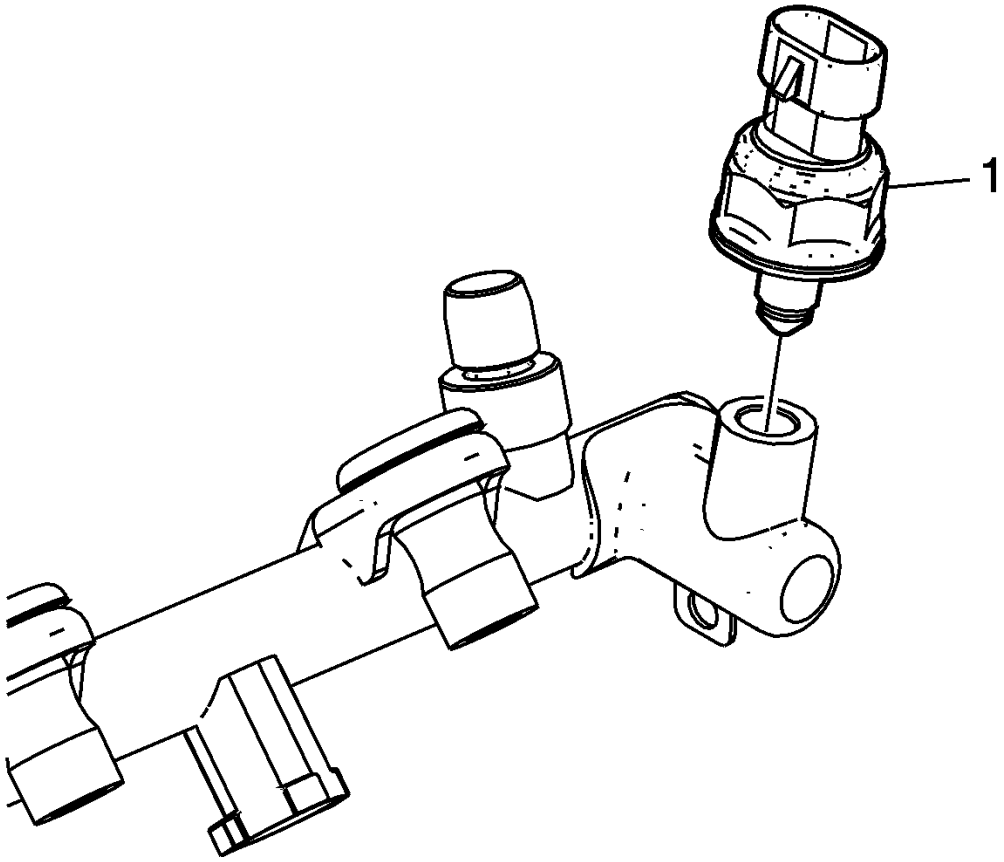

Fig. 181: Identifying Fuel Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not apply force to the plastic housing of the fuel pressure sensor. Failure to comply will destroy the sensor.**

12. Install the fuel pressure sensor (1) to the fuel injector rail.

NOTE: **Ensure that the fuel rail threads have been cleaned of any excess fuel or the fuel pressure sensor will NOT seal properly.**

1. Lubricate the threads and the sealing area in the fuel rail with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.
2. Lubricate the threads and the sealing area on the fuel pressure sensor with silicon free engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.
3. Install the fuel pressure sensor to the fuel injector rail and hand tighten.
4. Remove the fuel pressure sensor from the fuel injector rail and re-lubricate.

CAUTION: **Refer to Fastener Caution .**

5. Install the fuel pressure sensor to the fuel injector rail and tighten to 33 (25 lb ft).

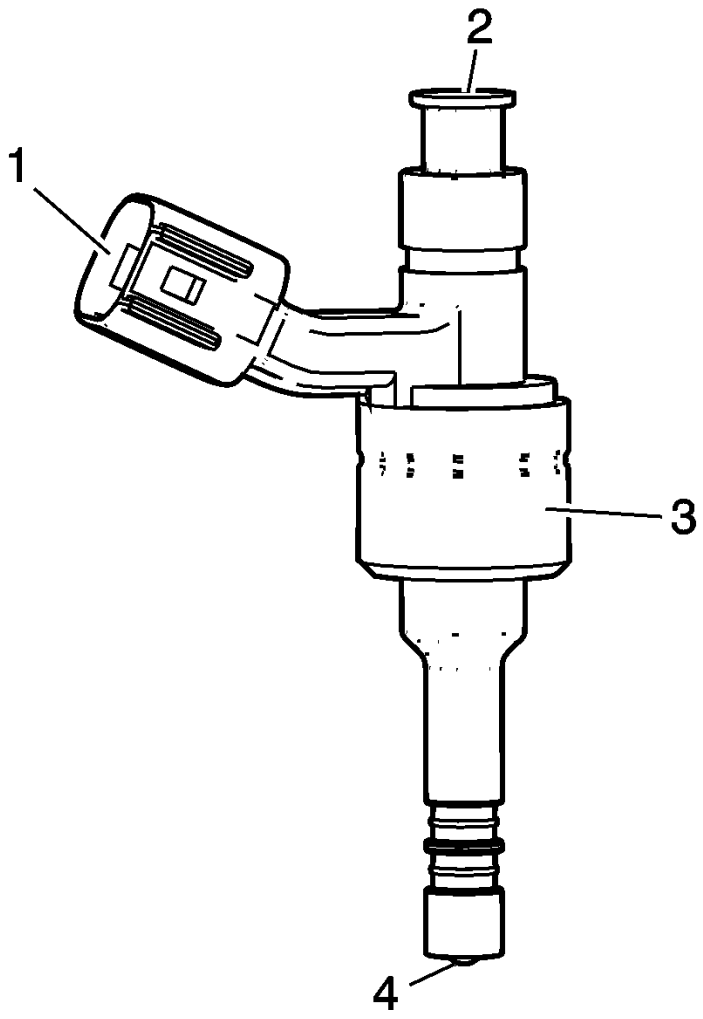

Fig. 182: Identifying Fuel Injector Components
Courtesy of GENERAL MOTORS COMPANY

13. Inspect the fuel injectors for the following conditions:
    - Damage to the fuel injector connector (1)
    - Damage to the fuel inlet cone (2)
    - Damage to the fuel injector body (3)
    - Damage to the fuel injector tip (4)
14. Replace the fuel injector if any of the above conditions are found. Do not attempt to repair the fuel injectors.

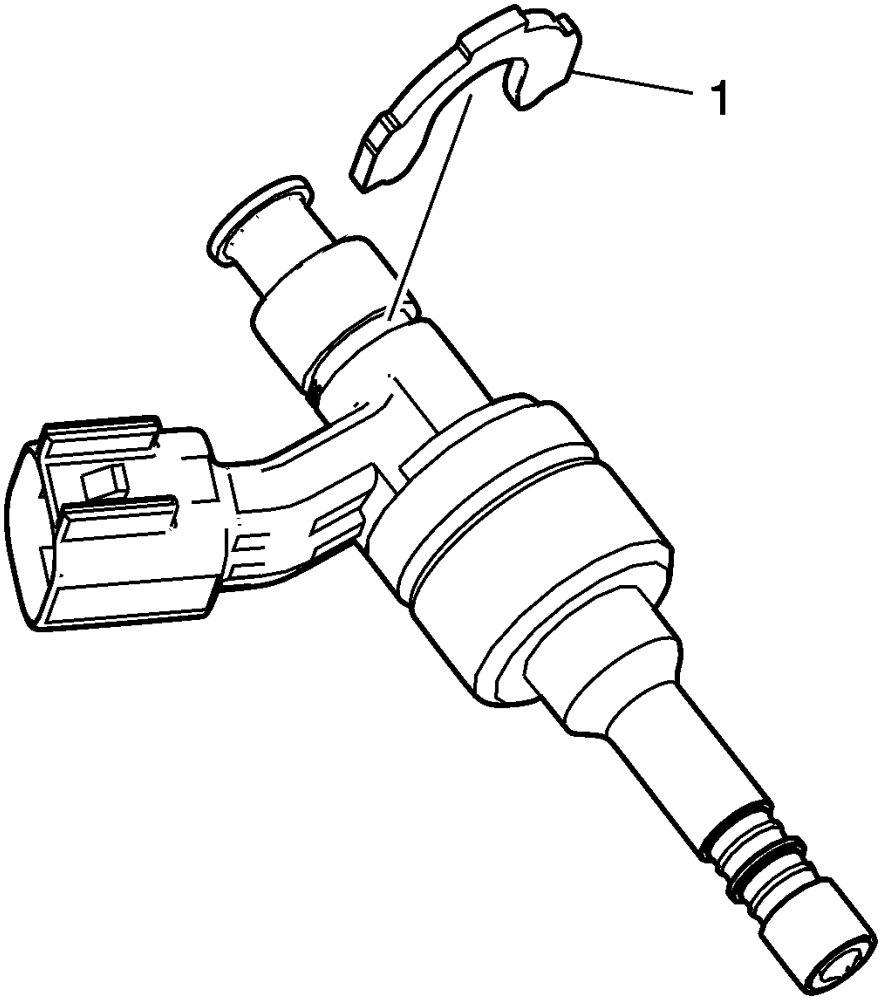

Fig. 183: Fuel Injector Bushing
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The fuel injector bushing (1) is to be installed BEFORE O-ring or backup rings are installed.**
- **Listen for an audible click to confirm correct installation of the fuel injector bushing**

15. Install NEW fuel injector bushing (1) onto injector body. Bushing should seat with a distinct "snap" sound and feel. Ensure bushing is fully seated.

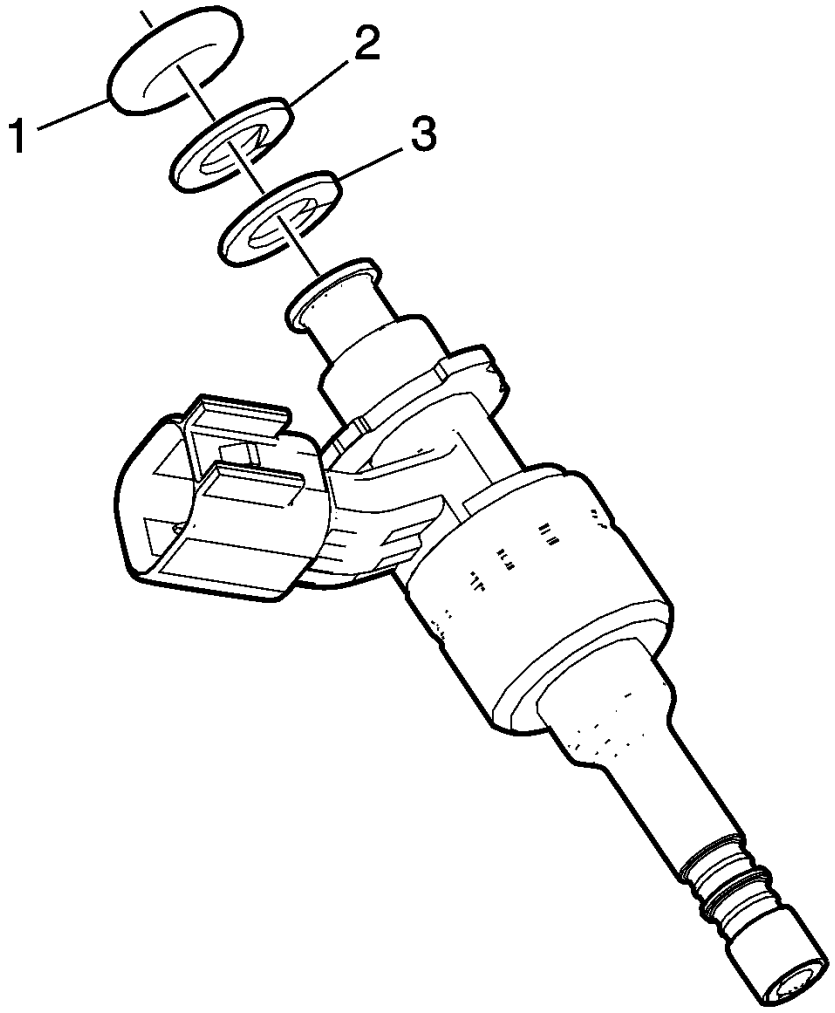

Fig. 184: View Of Injector O-Ring & Spacers
Courtesy of GENERAL MOTORS COMPANY

16. Install the NEW white plastic spacer (3) on the fuel injector first.
17. Install the brown plastic spacer (2) second.
18. Lubricate the NEW O-ring (1) with one drop of clean engine oil.

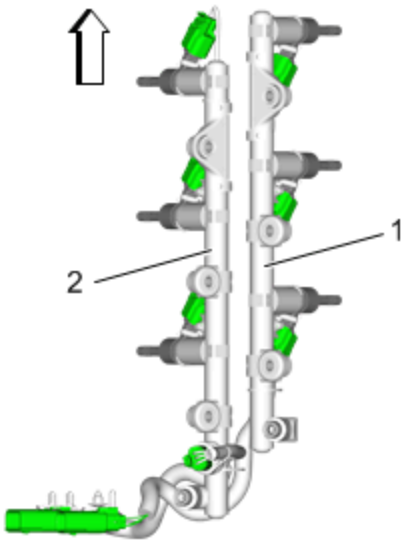

Fig. 185: Fuel Injector Wiring Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Ensure the fuel injectors are installed in the correct orientation. Improper orientation of the fuel injectors may result in engine misfire and possible engine damage.

19. The right side (bank 1) fuel injector wiring harness connectors (1) should point to the rear of the engine. The left side (bank 2) fuel injector wiring harness connectors (2) should point to the front of the engine.

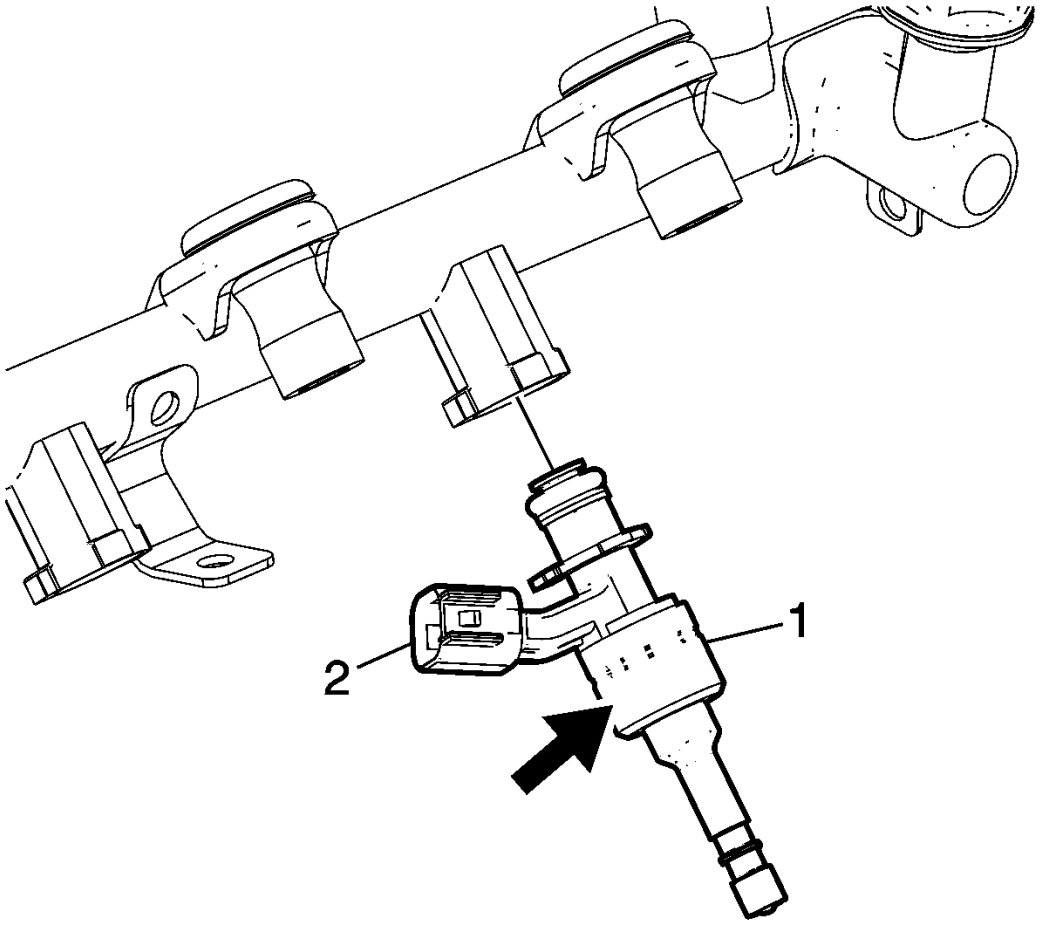

Fig. 186: View Of Injector Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do NOT install the Teflon injector tip/bore seals until AFTER the injectors are installed on the fuel rail.**
- **Make sure that the fuel injector connectors are placed in the correct position.**

20. Holding the largest diameter/body of the injector only, indicated by arrow in graphic, insert the injector assembly (1) into the fuel rail. Ensure correct orientation of the electrical connector (2).
21. Clamp the fuel rail in a bench vise USING SOFT JAWS to aid in holding the rail during the installation of the retainer.

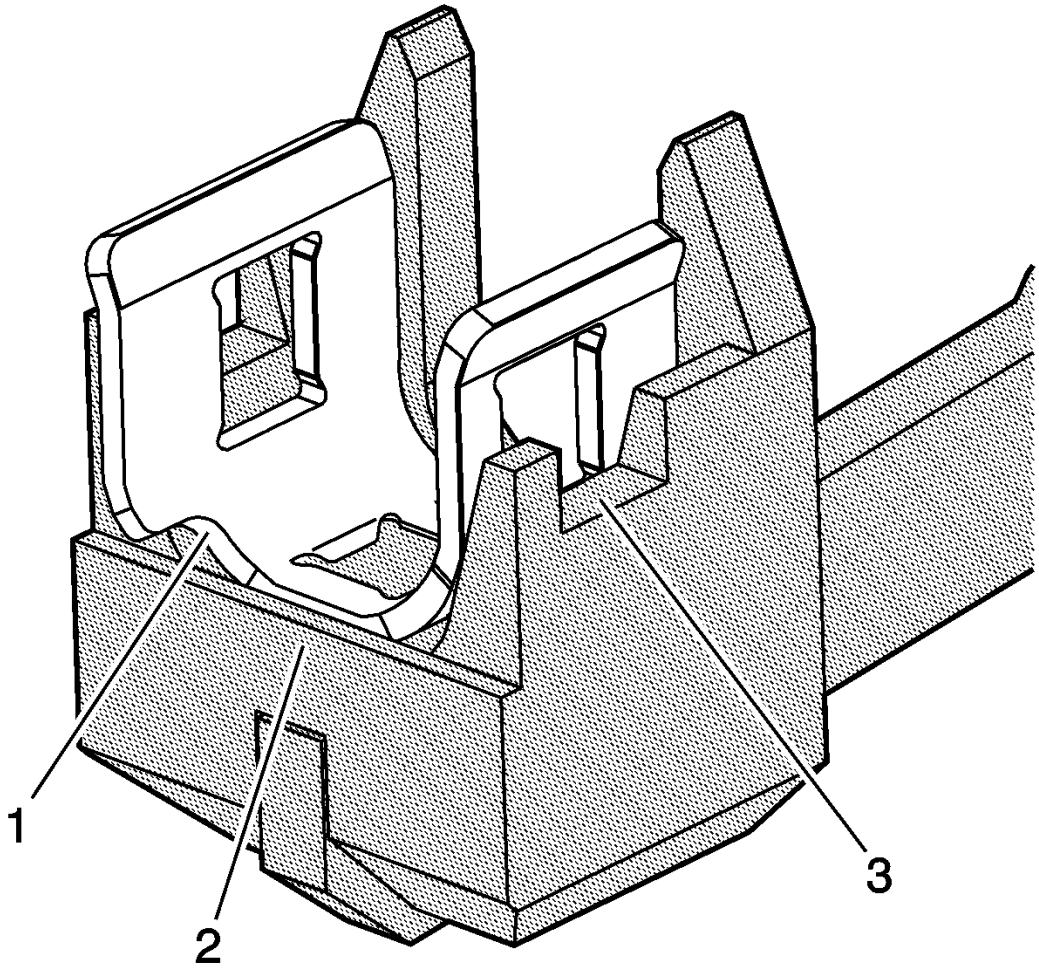

Fig. 187: Retainer Installer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure the retainer is set properly into EN-49247 installer.**

- **The notch (1) should always face forward**
- **The fuel injector to fuel rail retainer should be behind the plate (2)**
- **The tool windows (3) allow for visual alignment**

22. Support the fuel injector fuel rail in a vise.
23. Install the fuel injector to fuel rail retainer to the **EN-49247** injector retaining clip installer.

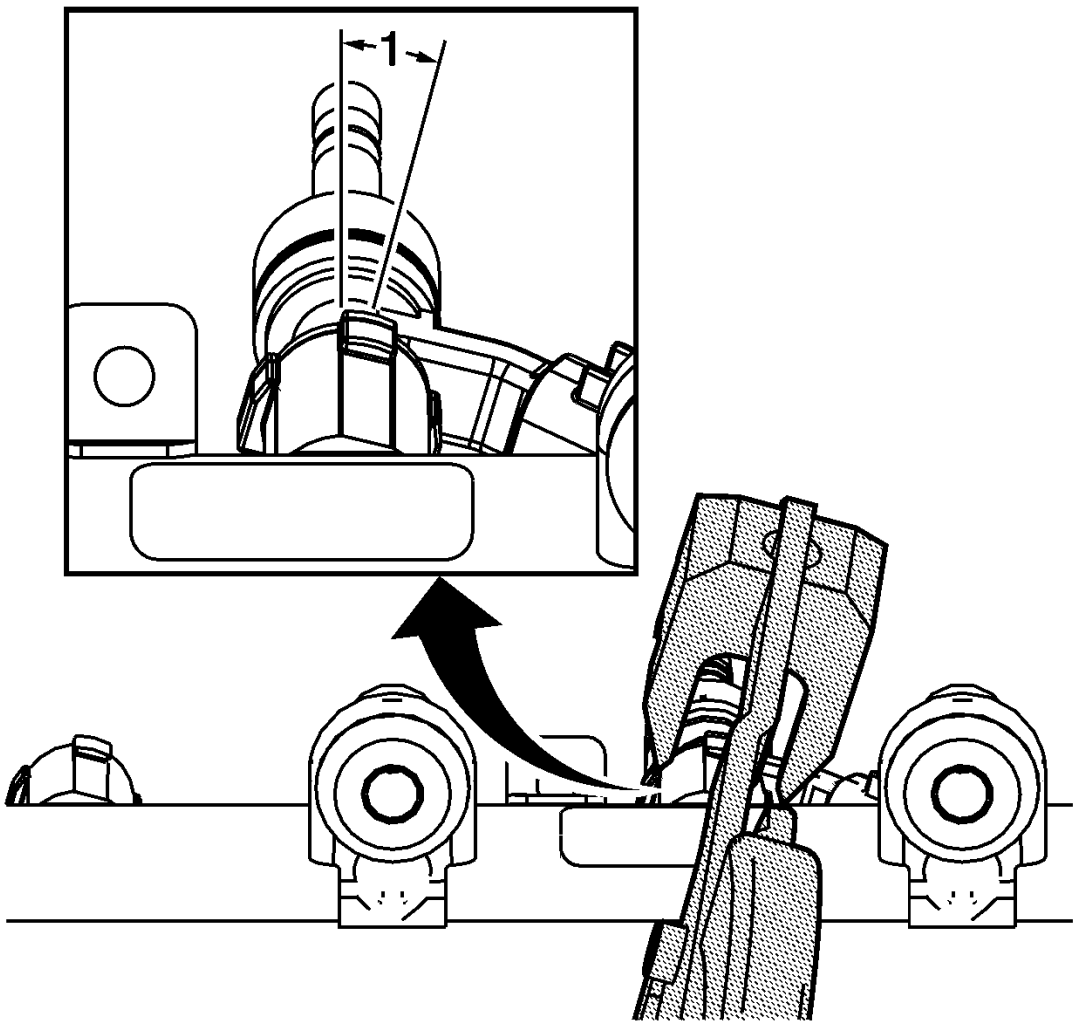

Fig. 188: Identifying 15-Degree Angle Of Rotation
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Observe the following steps before installing the fuel injector to fuel rail retainer.**

24. There is a 15-degree angle of rotation (1) with the fuel injector rail flanges relative to the fuel injector rail. Hold the **EN-49247** injector retaining clip installer at a similar angle to aid the correct installation of the fuel injector to fuel rail retainer.

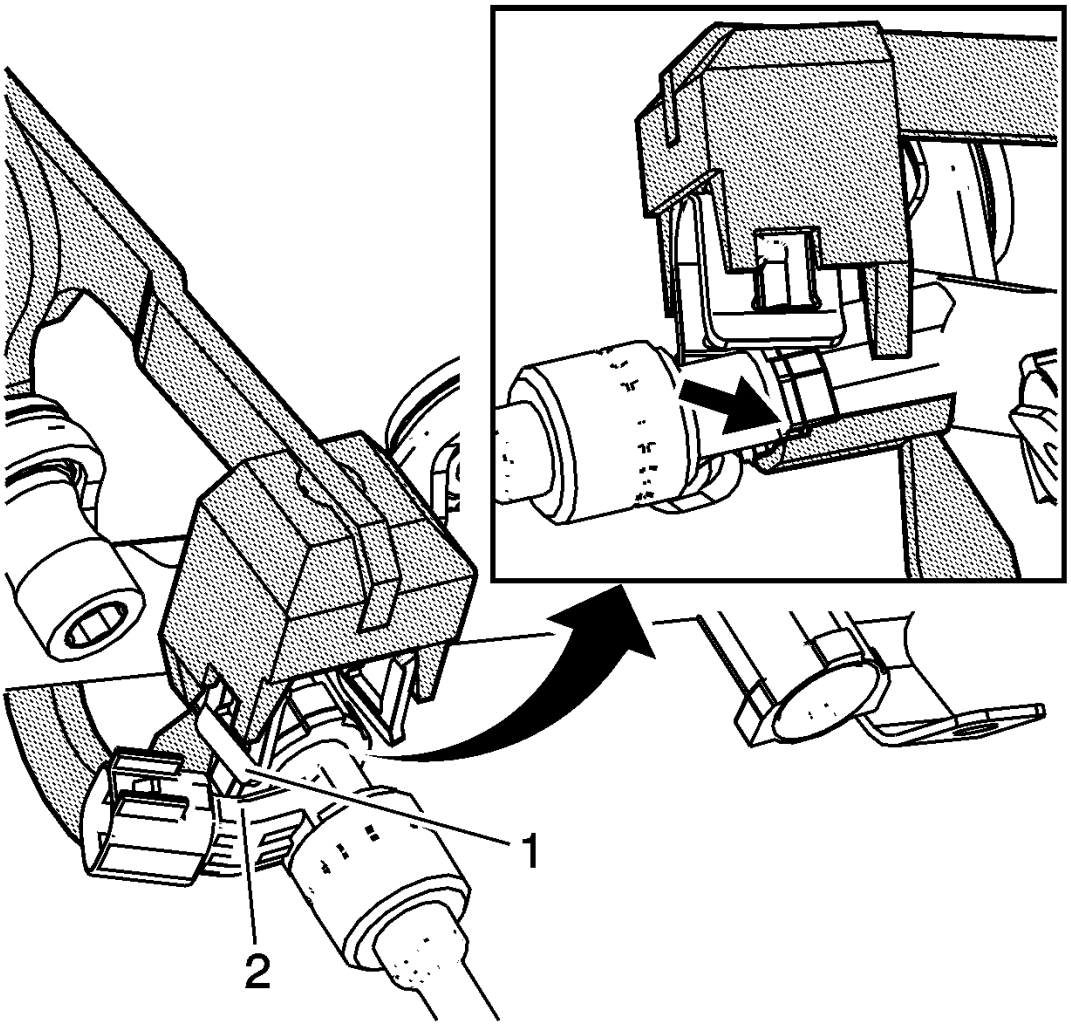

Fig. 189: Positioning Retainer Installer
Courtesy of GENERAL MOTORS COMPANY

25. When mounting the **EN-49247** injector retaining clip installer to the fuel injector rail, the fuel injector to fuel rail retainer should nearly be touching the electrical connector (2).
26. The base of the **EN-49247** injector retaining clip installer should be positioned as shown before squeezing the tool to complete the installation.

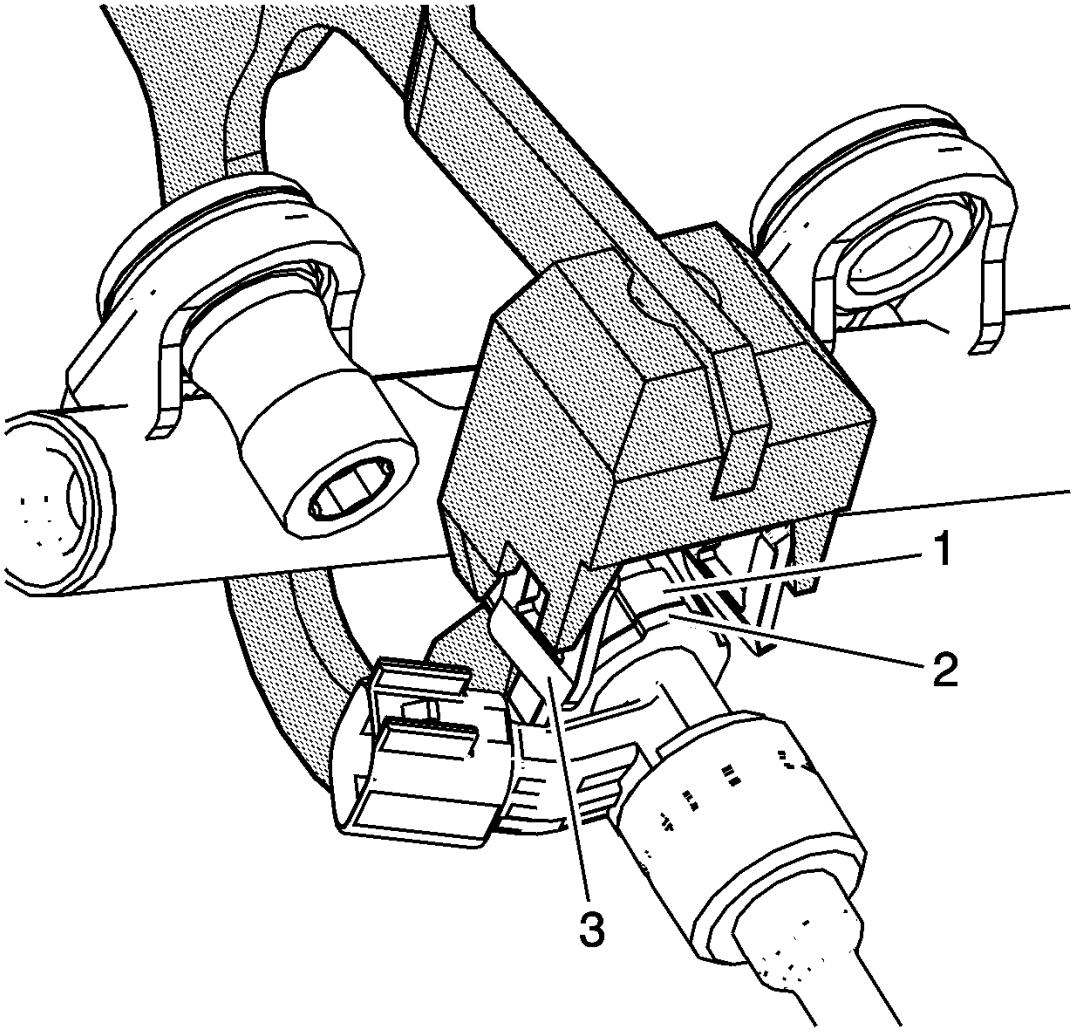

Fig. 190: Installing Fuel Injector Retainer
Courtesy of GENERAL MOTORS COMPANY

27. Hold the injector bushing (2) and fuel injector rail flanges (1) in alignment.
28. Hold the injector assembly firmly against the fuel injector rail to prevent a gap forming between the fuel injector and the fuel injector rail.
29. Install the fuel injector to fuel rail retainer (3).

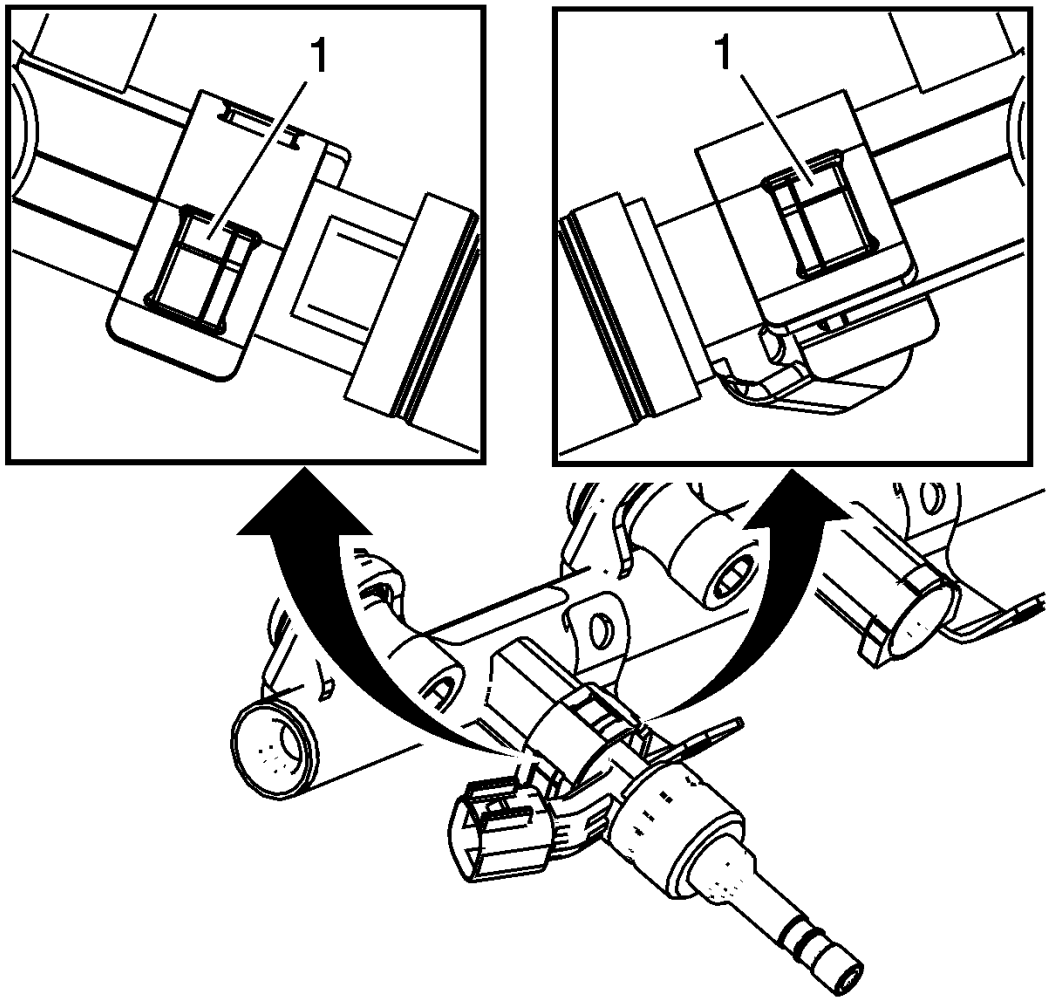

Fig. 191: Identifying Fuel Rail Flanges
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Ensure the fuel injector retainer is properly installed. Failure to completely install the retainers may degrade fuel injection system performance or cause system malfunction.

30. Ensure all 3 fuel injector bushing tabs and fuel rail flanges (1) are properly and completely captured by the fuel injector retainer.
31. Repeat the above steps for the remaining fuel injectors until all the fuel injectors are installed and retained in the fuel injector rail.

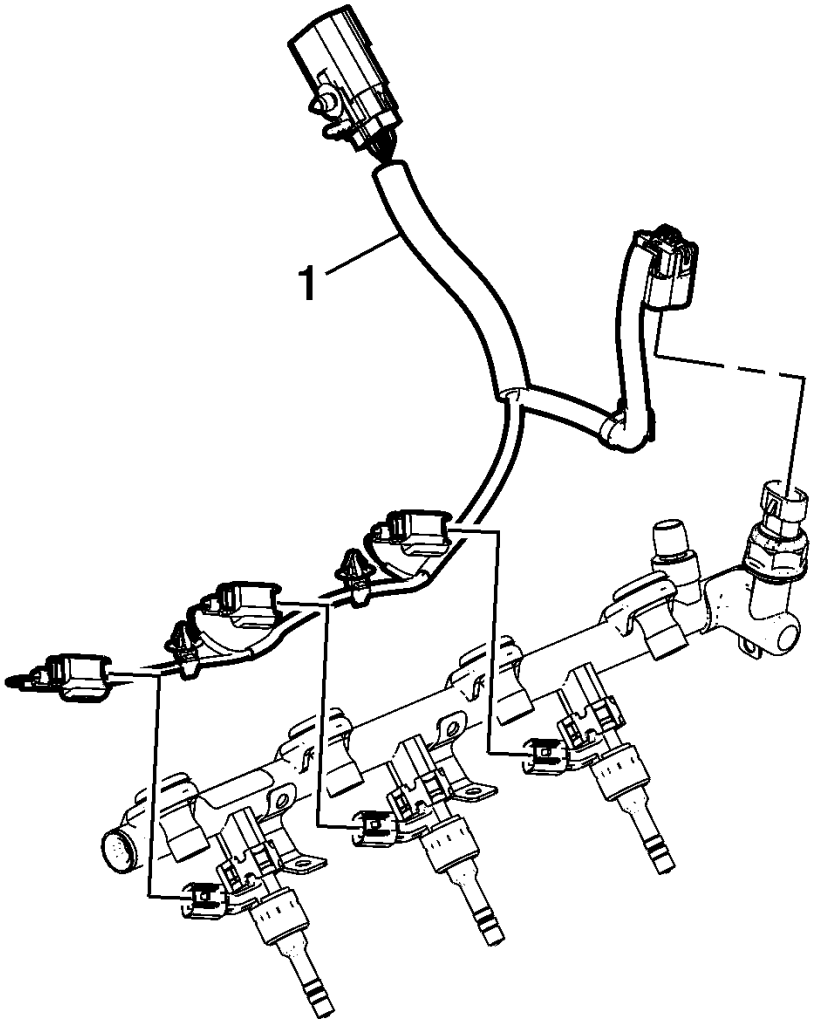

Fig. 192: View Of Fuel Rail Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

32. Install the fuel injector rail wiring harness (1) to the fuel injector rail.

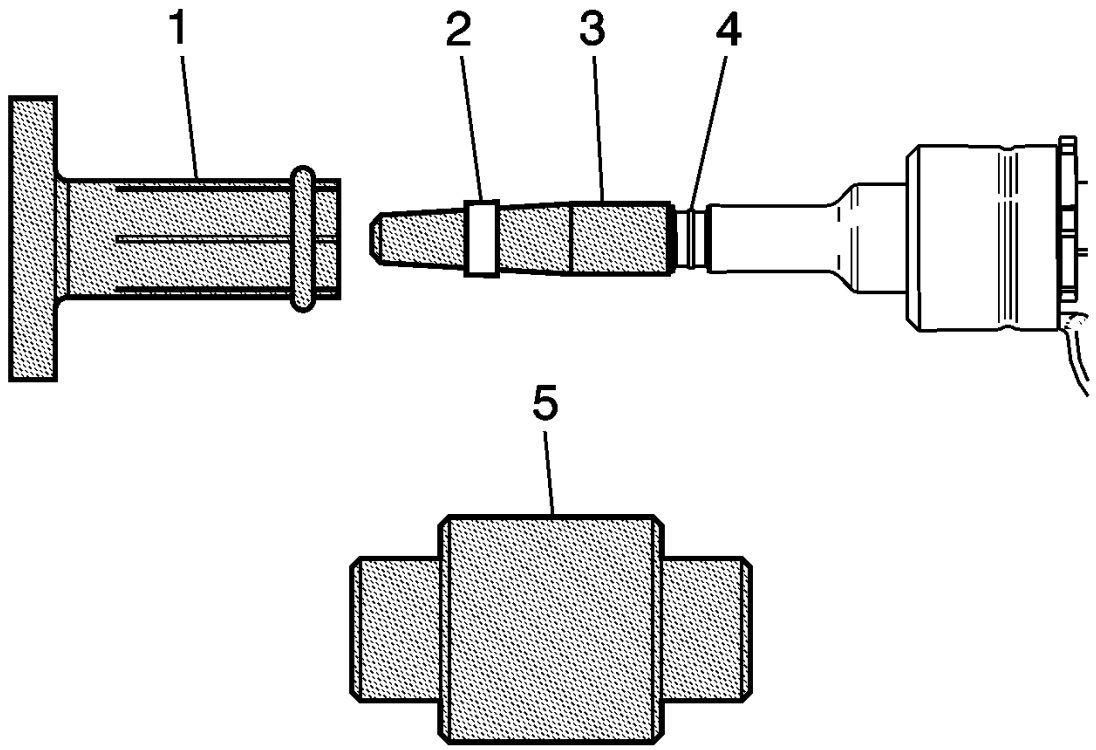

Fig. 193: Identifying Fuel Injector Tip & Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use any type of lubricant when installing the NEW seals (2) on the fuel injector tip.**

33. Install the long protector (3) of the **EN-49245-1** fuel injector seal install/sizer to the fuel injector spray tip covering the first recessed area closest to the tip.
34. Place a NEW seal (2) onto long protector (3) of the **EN-49245-1** fuel injector seal install/sizer.
35. Using the pusher (1) of the **EN-49245-3** fuel injector seal install/sizer , push the seal (2) into the second recessed area (4) of the fuel injector.

NOTE: **The sizer (5) of the EN-49245-4 fuel injector seal install/sizer is two sided, and either direction will size the seal correctly.**

36. Compress the seal (2) with your fingers.
37. Resize the seal (2) using the sizer (5) of the **EN-49245-4** fuel injector seal install/sizer.

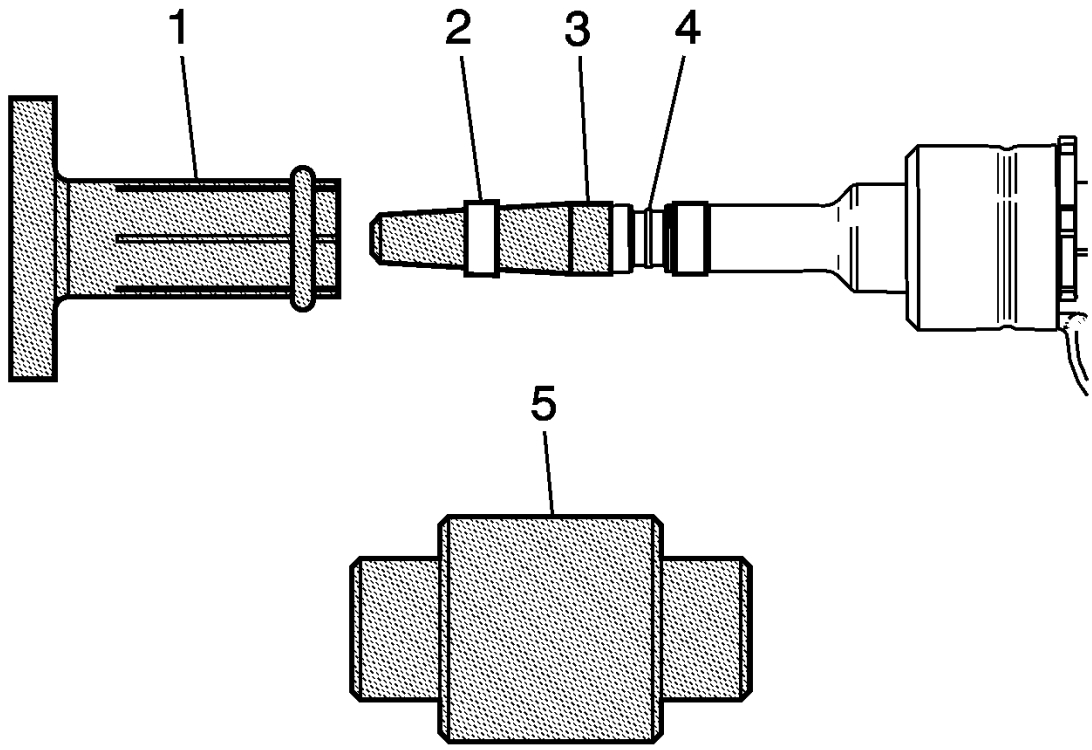

Fig. 194: Identifying Fuel Injector Tip & Seals
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not use any type of lubricant when installing the NEW seals (2) on the fuel injector tip.**

38. Install the short protector (3) of the **EN-49245-2** fuel injector seal install/sizer to the fuel injector tip.
39. Place a NEW seal (2) onto the short protector (3) of **EN-49245-2** fuel injector seal install/sizer.
40. Using the pusher (1) of the **EN-49245-3** fuel injector seal install/sizer , push the seal (2) into the first recessed area (4) of the fuel injector.

NOTE: **The sizer (5) of the EN-49245-4 fuel injector seal install/sizer is two sided, and either direction will size the seal correctly.**

41. Compress the seal (2) with your fingers.
42. Resize the seal (2) using the sizer (5) of the **EN-49245-4** fuel injector seal install/sizer.

CYLINDER HEAD ASSEMBLE (LF1, LFW OR LFX)

Special Tools

- **EN 8062** Valve Spring Compressor - Head Off
- **EN 46116** Valve Stem Seal Remover/Installer
- **EN 46117** Valve Stem Key Remover/Installer
- **EN 46119** Off-Vehicle Valve Spring Compressor Adapter
- **EN 46122** Camshaft Position Actuator Check-Ball Valve Remover/Installer

For equivalent regional tools, refer to **Special Tools** .

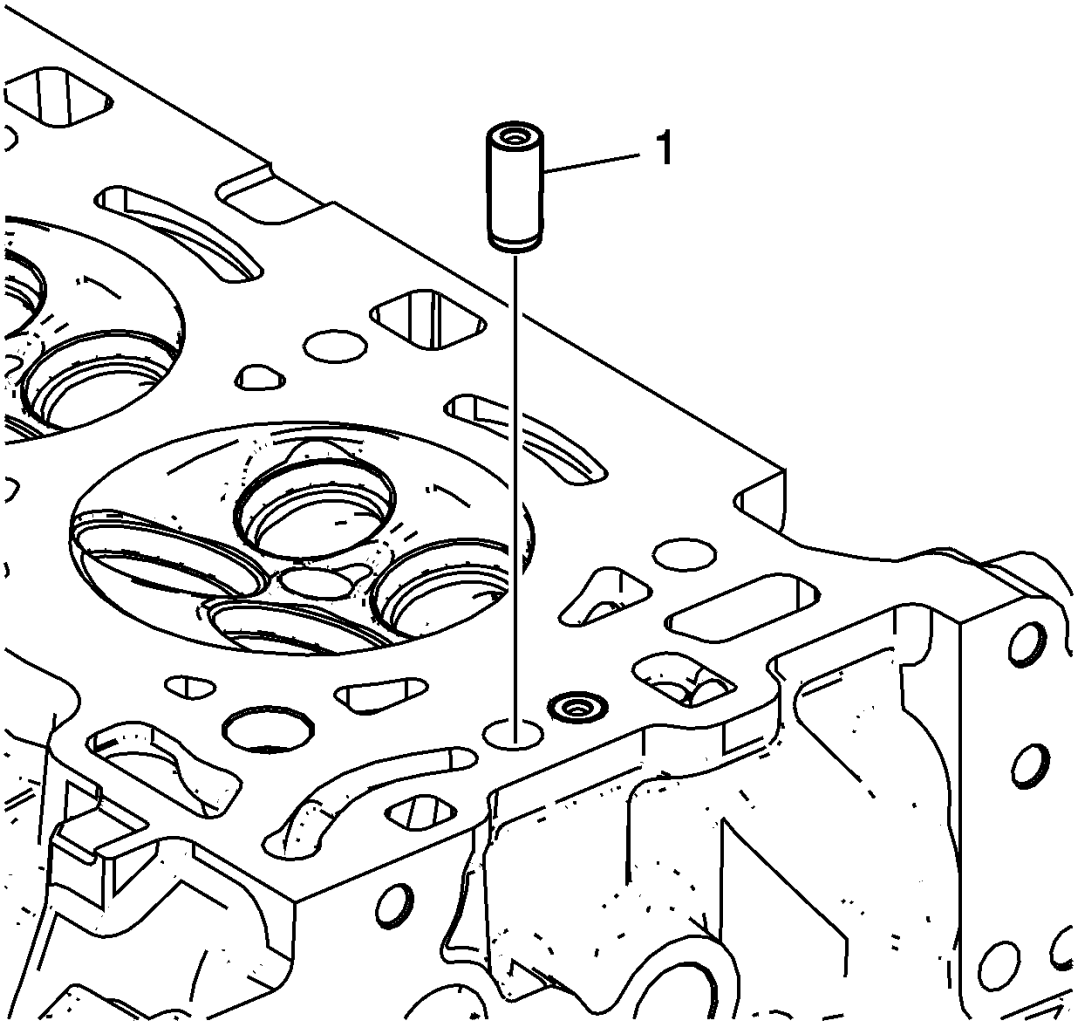

Fig. 195: Lubricate Outside Of New Check Valve
Courtesy of GENERAL MOTORS COMPANY

1. Use lubricant included with **EN 46122** remover/installer to lubricate outside of new check valve (1).
2. With the check ball end of the check valve facing UP, away from the head, insert the NEW check valve into the check valve bore in the cylinder head.

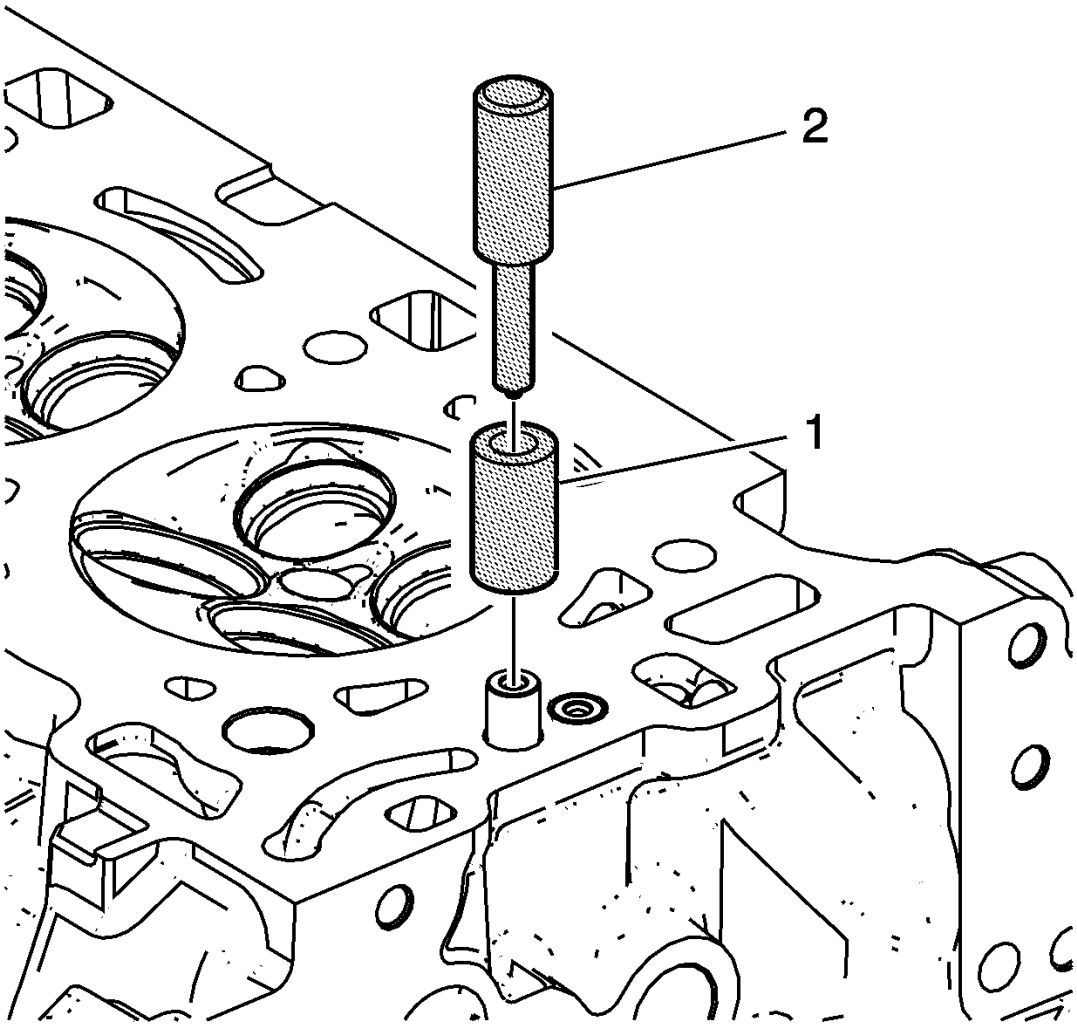

Fig. 196: Tapping Check Valve Into Place
Courtesy of GENERAL MOTORS COMPANY

3. Place collar EN 46122-2 (1) over the new check valve with the slightly-larger inside diameter of the collar DOWN toward the cylinder head.
4. Using the driver EN 46122-1 (2), lightly tap the new check valve into place until the driver stops against the top of the collar.

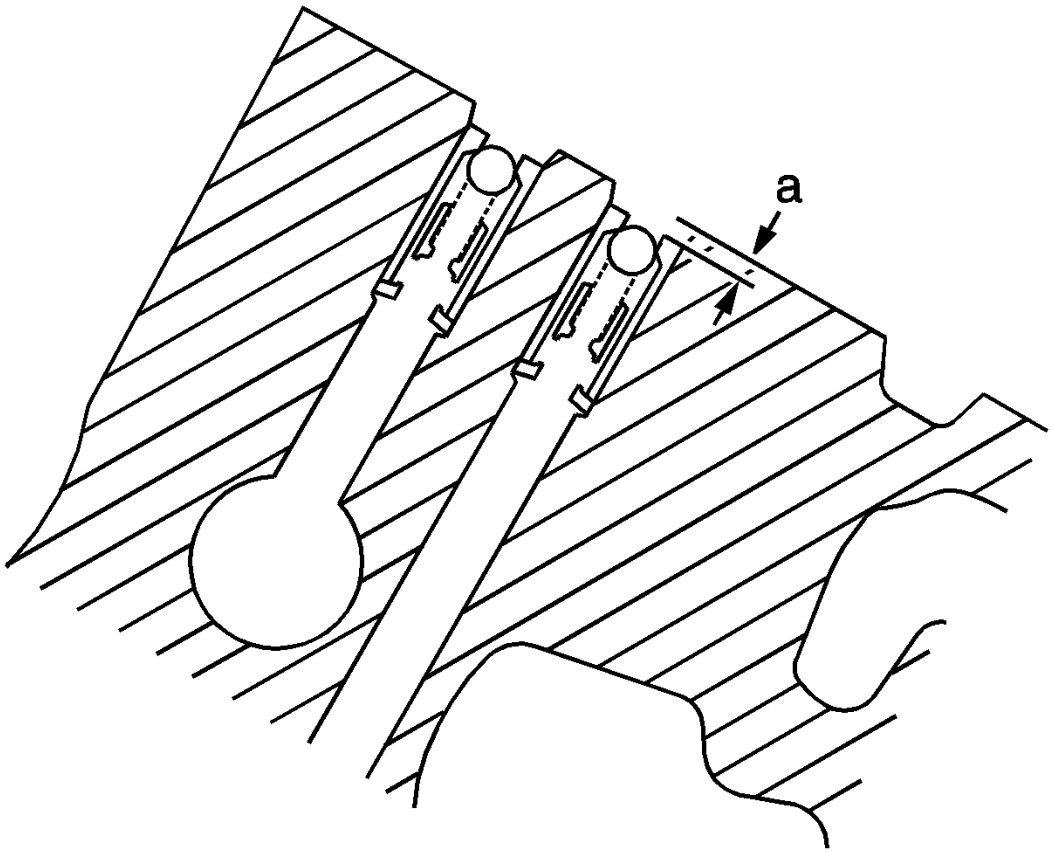

Fig. 197: Inspecting Camshaft Position Actuator Oil Feed Check Valve
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the camshaft position actuator oil feed check valves in order to ensure they are properly installed in the cylinder head. The camshaft position actuator oil feed check valve should be flush to 2 mm (0.0787 in) below the cylinder head deck surface (a).

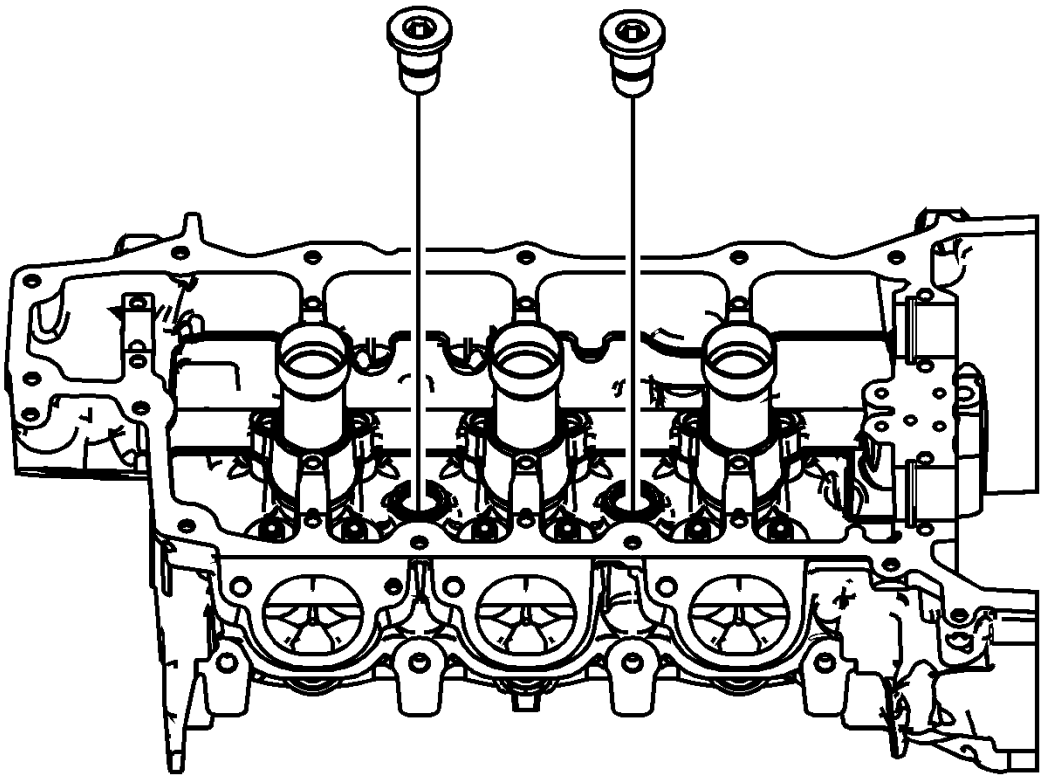

Fig. 198: View Of Cylinder Head Coolant Threaded Plugs
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Install the cylinder head coolant threaded plugs and tighten to 75 N.m (55 lb ft).

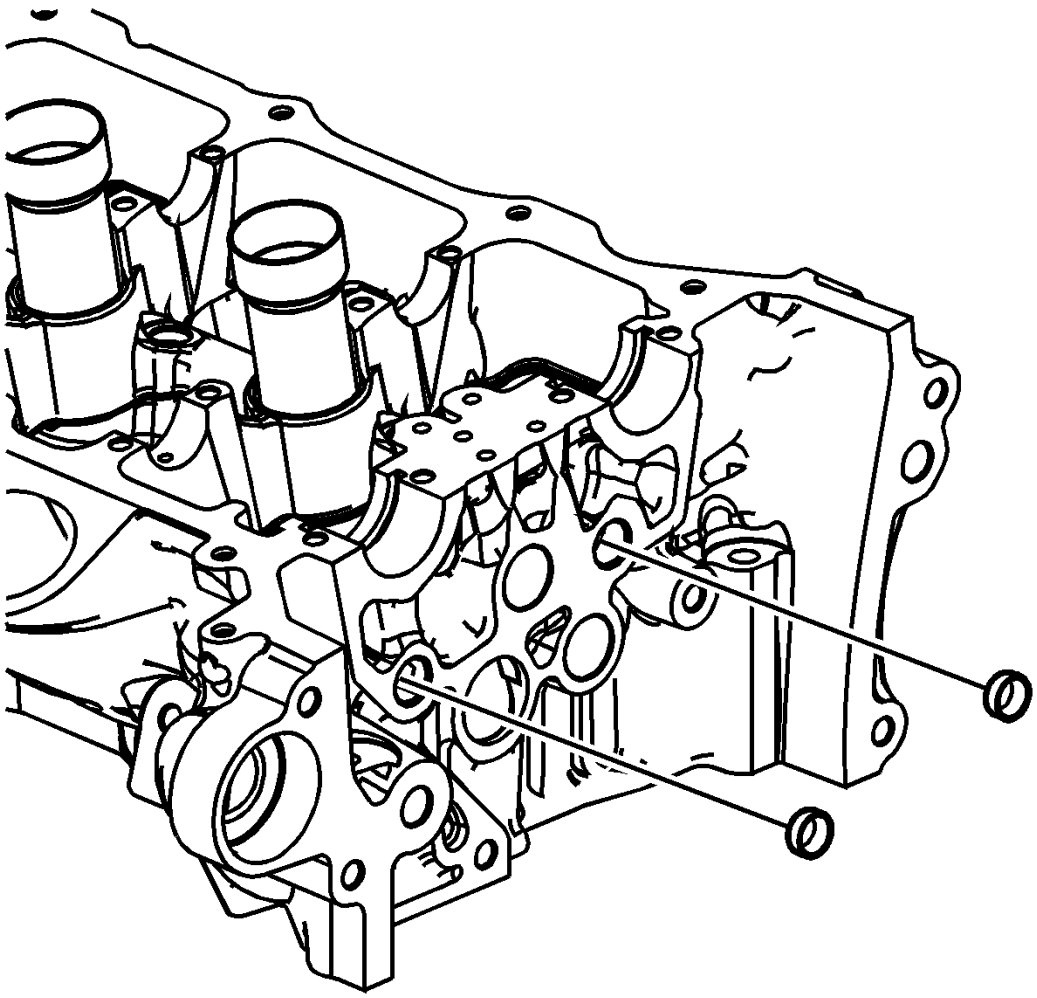

Fig. 199: View Of Cylinder Head Oil Gallery Expansion Plugs
Courtesy of GENERAL MOTORS COMPANY

7. Install the NEW cylinder head oil gallery expansion plugs.

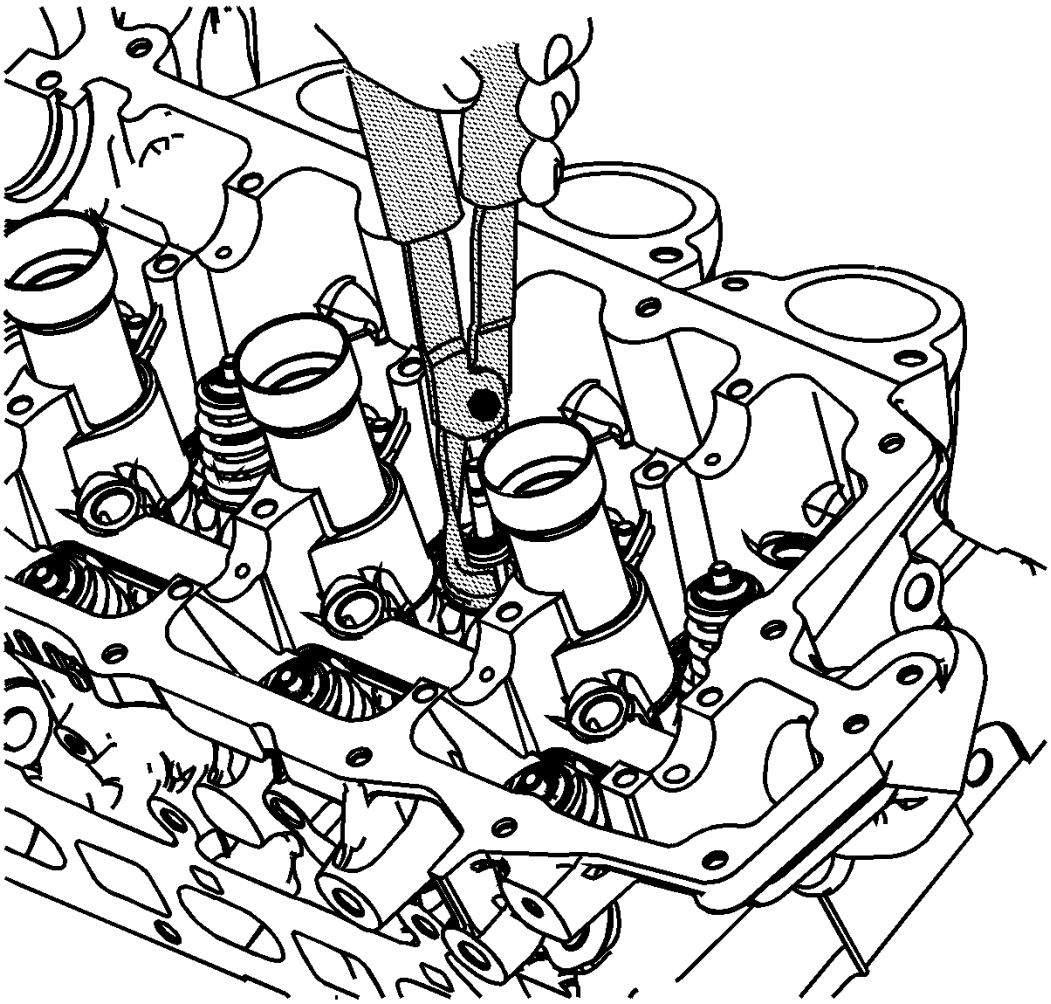

Fig. 200: Removing/Installing Valve Stem Oil Seals
Courtesy of GENERAL MOTORS COMPANY

8. Place the valve stem oil seals onto the guides.

NOTE: **NEVER reuse a valve stem oil seal. Always use new seals when assembling the cylinder head.**

9. Mount a new valve stem oil seal using the **EN 46116** remover/installer.

NOTE: **Force should only be applied to the valve spring contact area of the new valve stem oil seal during installation.**

10. Push and twist the valve stem oil seal into position on the valve guide until the seal positively locks on the guide using the **EN 46116** remover/installer.
11. Lubricate the valve stem and valve guide ID with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

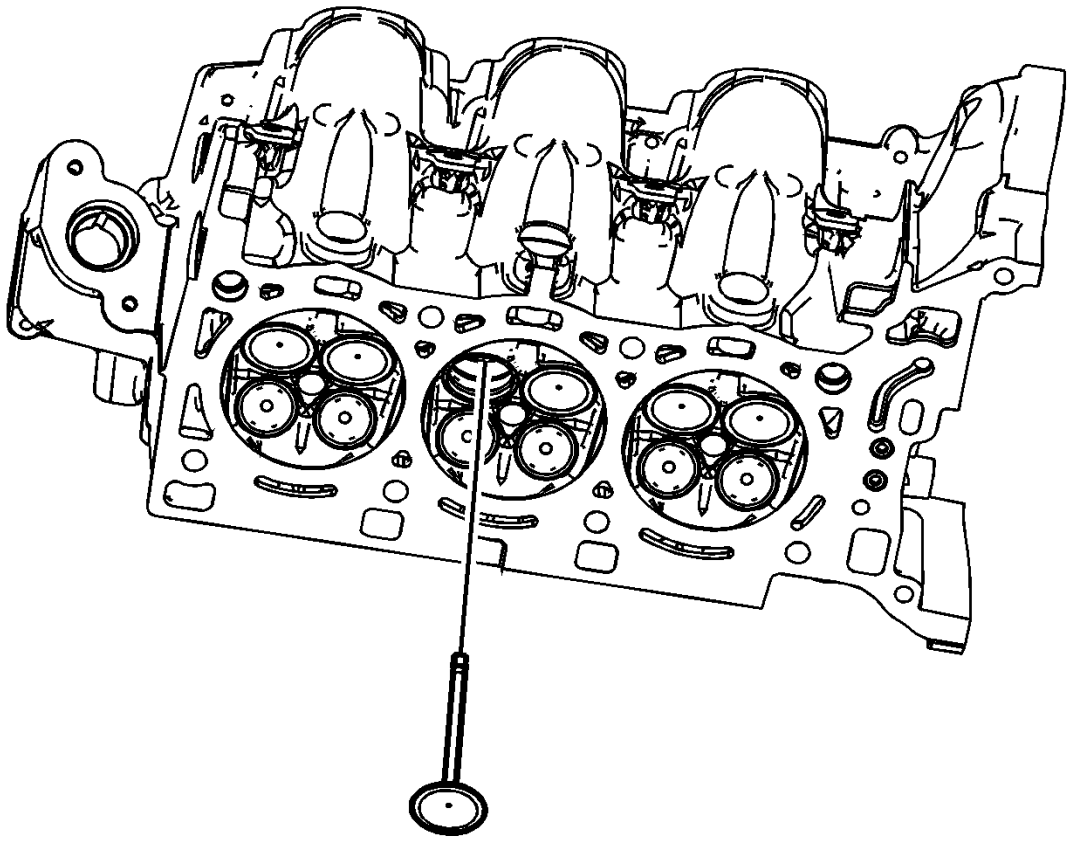

Fig. 201: View of Oil Seal and Valve Guide
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The valve stem oil seal must not come loose from the valve guide when the valve is installed.**

12. Insert the valve into the valve guide until it bottoms on the valve seat.

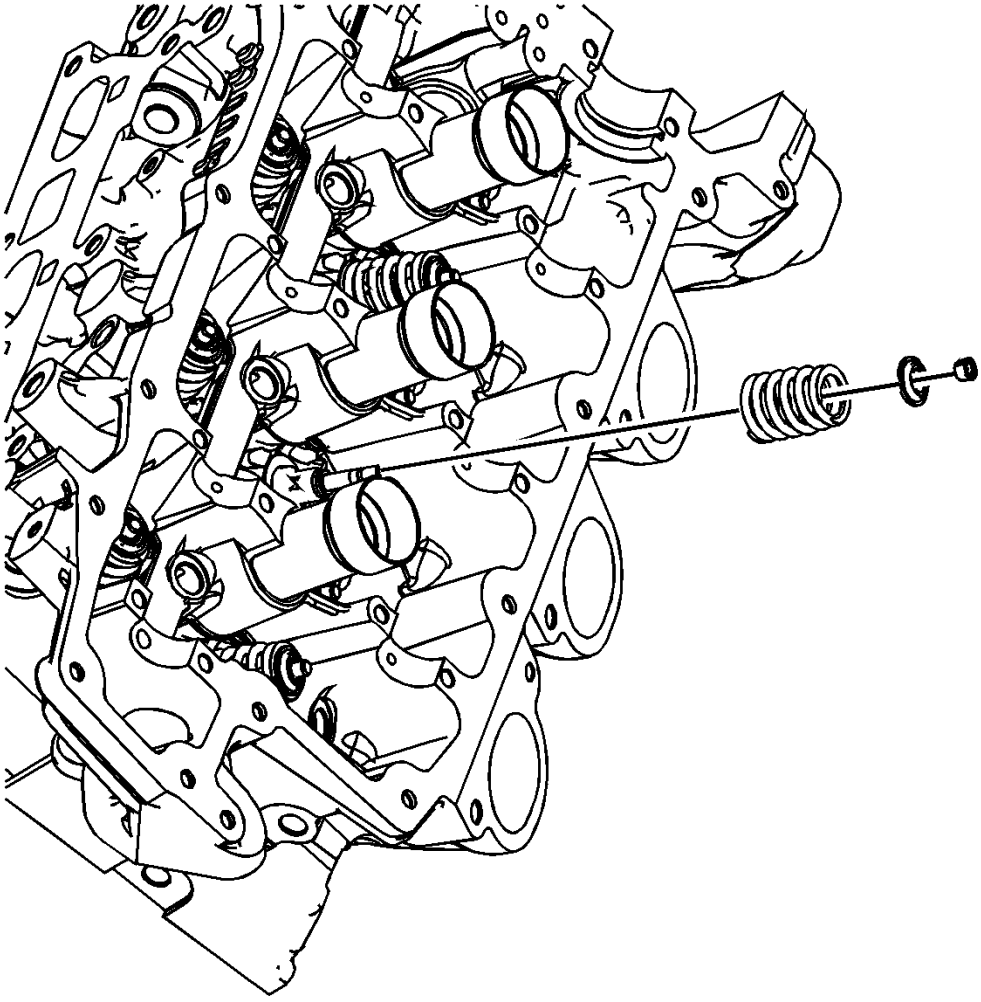

Fig. 202: View Of Valve Spring & Retainer
Courtesy of GENERAL MOTORS COMPANY

13. Position the valve spring on the spring seat.
14. Place the valve spring retainer onto the valve spring.

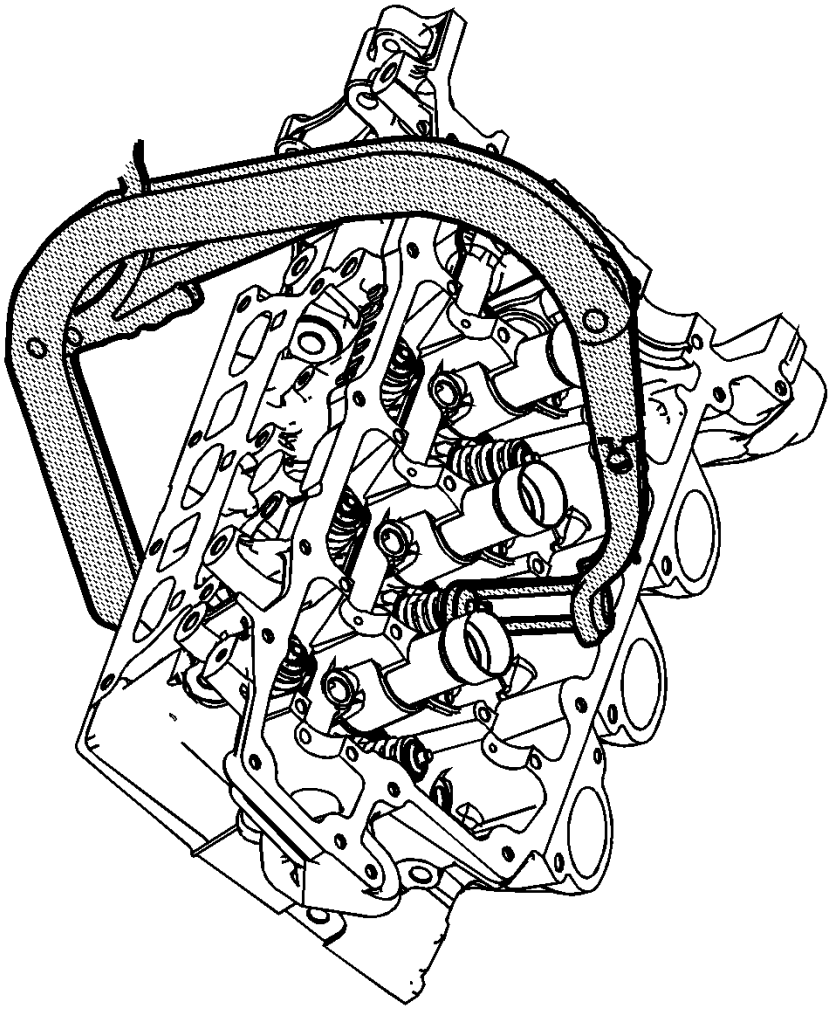

Fig. 203: Compressing Valve Spring
Courtesy of GENERAL MOTORS COMPANY

WARNING: Compressed valve springs have high tension against the valve spring compressor. Valve springs that are not properly compressed by or released from the valve spring compressor can be ejected from the valve spring compressor with intense force. Use care when compressing or releasing the valve spring with the valve spring compressor and when removing or installing the valve stem keys. Failing to use care may cause personal injury.

CAUTION: Do not compress the valve springs to less than 24.0 mm (0.943 in). Contact between the valve spring retainer and the valve stem oil seal can cause potential valve stem oil seal damage.

15. Compress the valve spring using the **EN 8062** compressor and the **EN 46119** adapter.

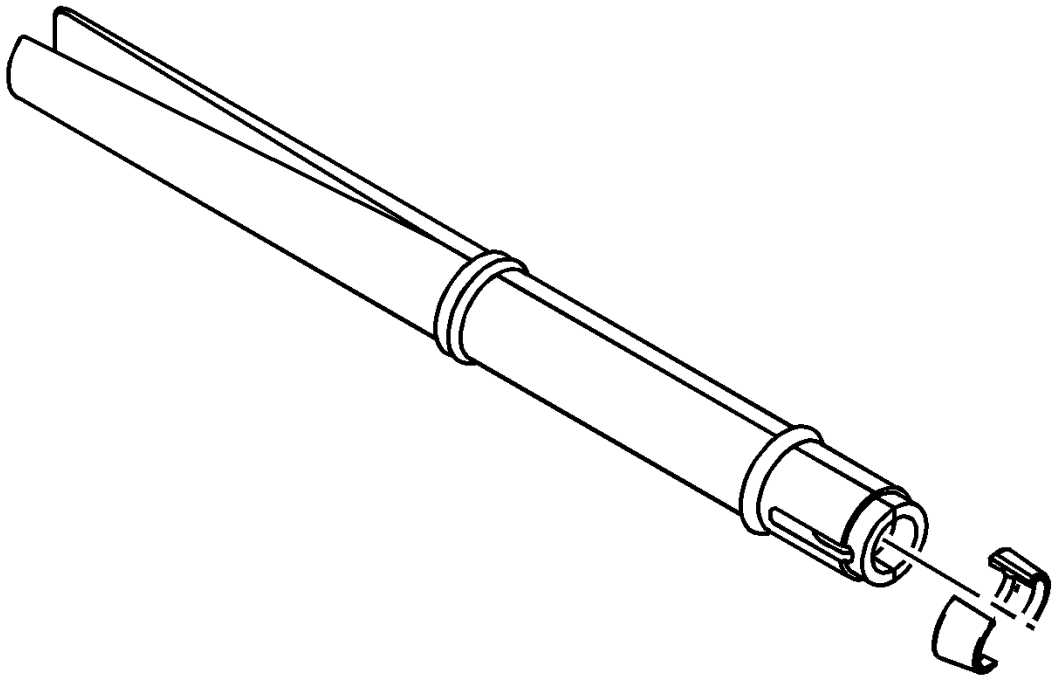

Fig. 204: View Of Valve Keepers
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure proper directional placement of valve keepers in the EN 46117 remover/installer. The valve keepers must be installed with the tapered end towards the valve stem seal.**

16. With the spring compressed, install the valve keepers into the **EN 46117** remover/installer.

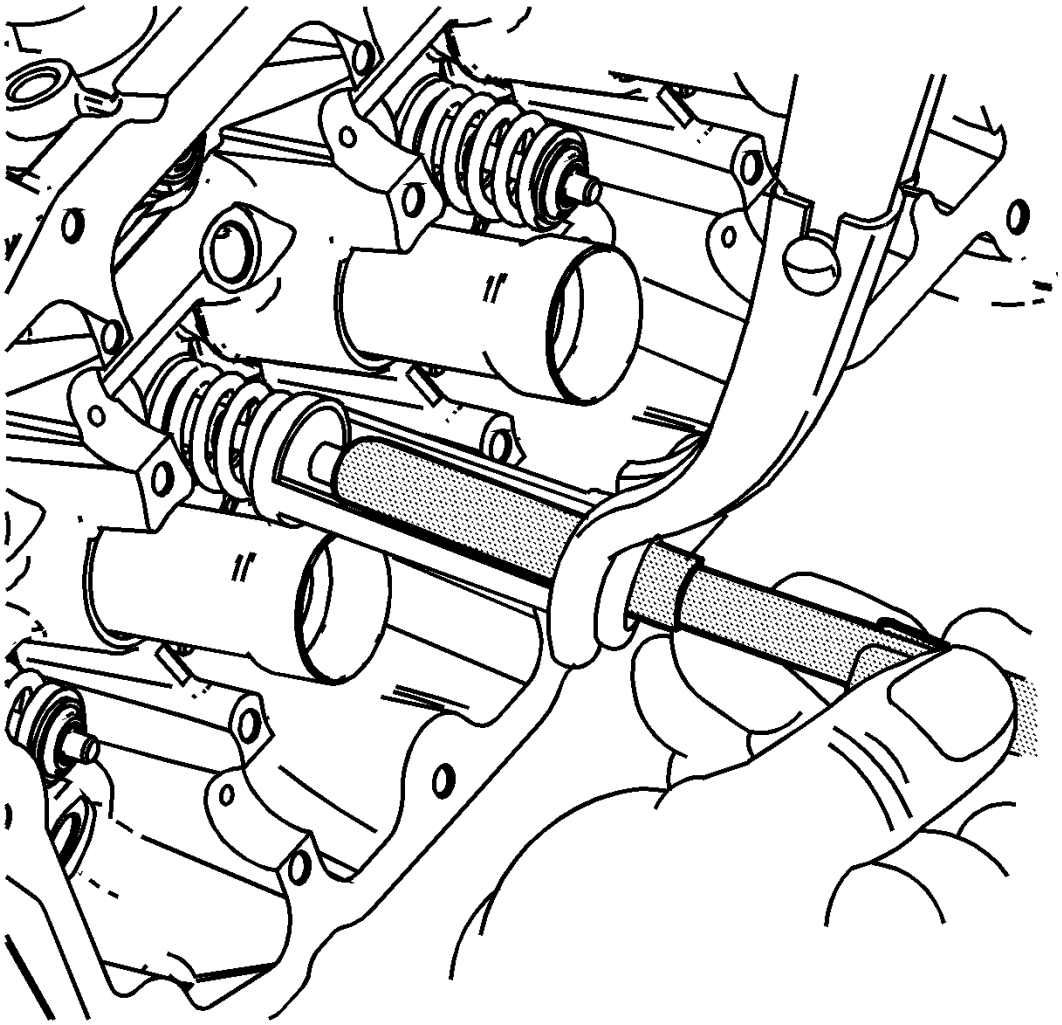

Fig. 205: Identifying Valve Spring Compressor & Adapter
Courtesy of GENERAL MOTORS COMPANY

17. Place the keepers into position by pushing the tool downward. While holding the tool lightly together in the area between the O-rings, using the thumb and forefinger, release tension on the **EN-46119** adapter and the **EN 8062** compressor. This will slowly push the **EN-46117** remover/installer off the valve stem, leaving the keepers in place.
18. Verify that the valve keepers are installed by placing a rag over the valve tip and tapping with a dead-blow hammer.

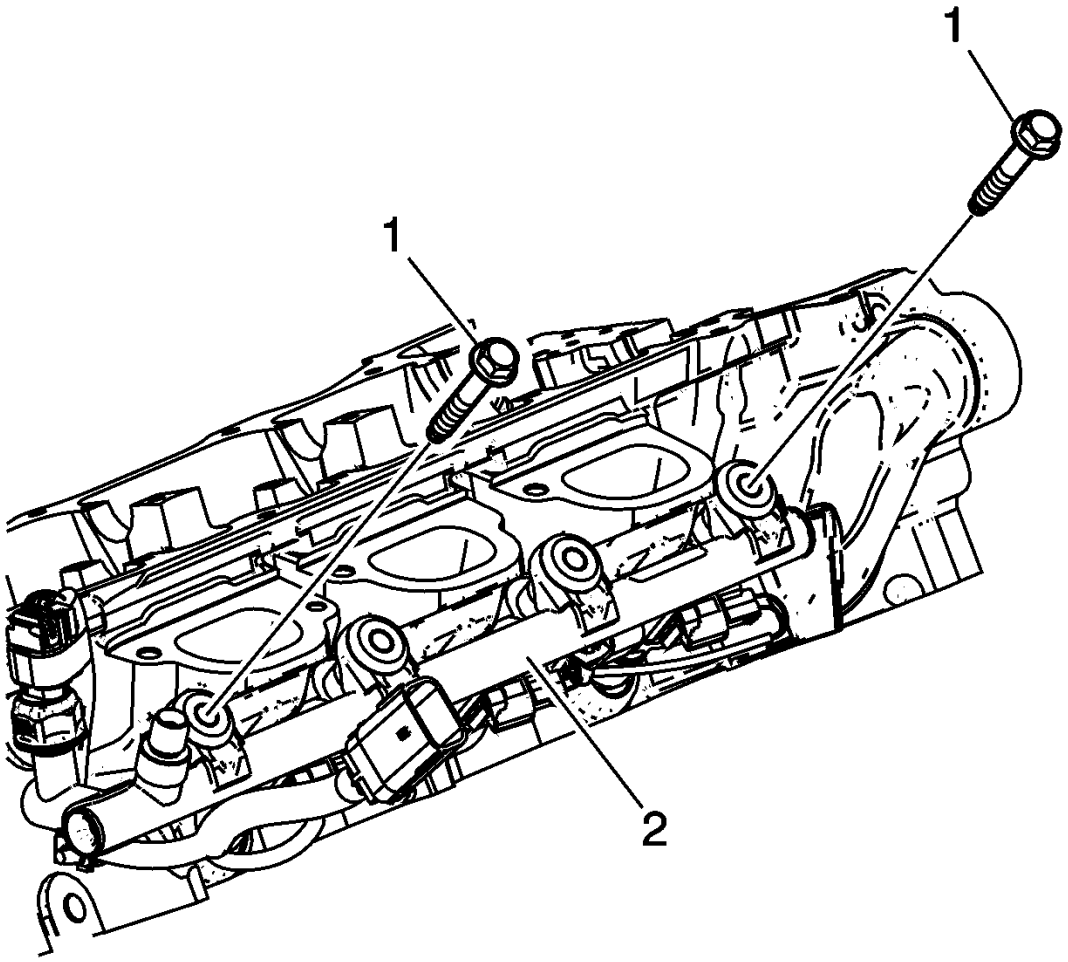

Fig. 206: Identifying Fuel Rail Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the fuel rail was removed from the cylinder head, the fuel injector tip seals must be replaced. Refer to Fuel Rail and Injectors Cleaning and Inspection (LF1, LFW or LFX).**

19. Install the fuel rail with injectors (2) into the cylinder head evenly.
20. Install and hand tighten the two outer fuel rail bolts (1) to seat the injectors in the injector bores.
21. Install and hand tighten the two inner fuel rail bolts.

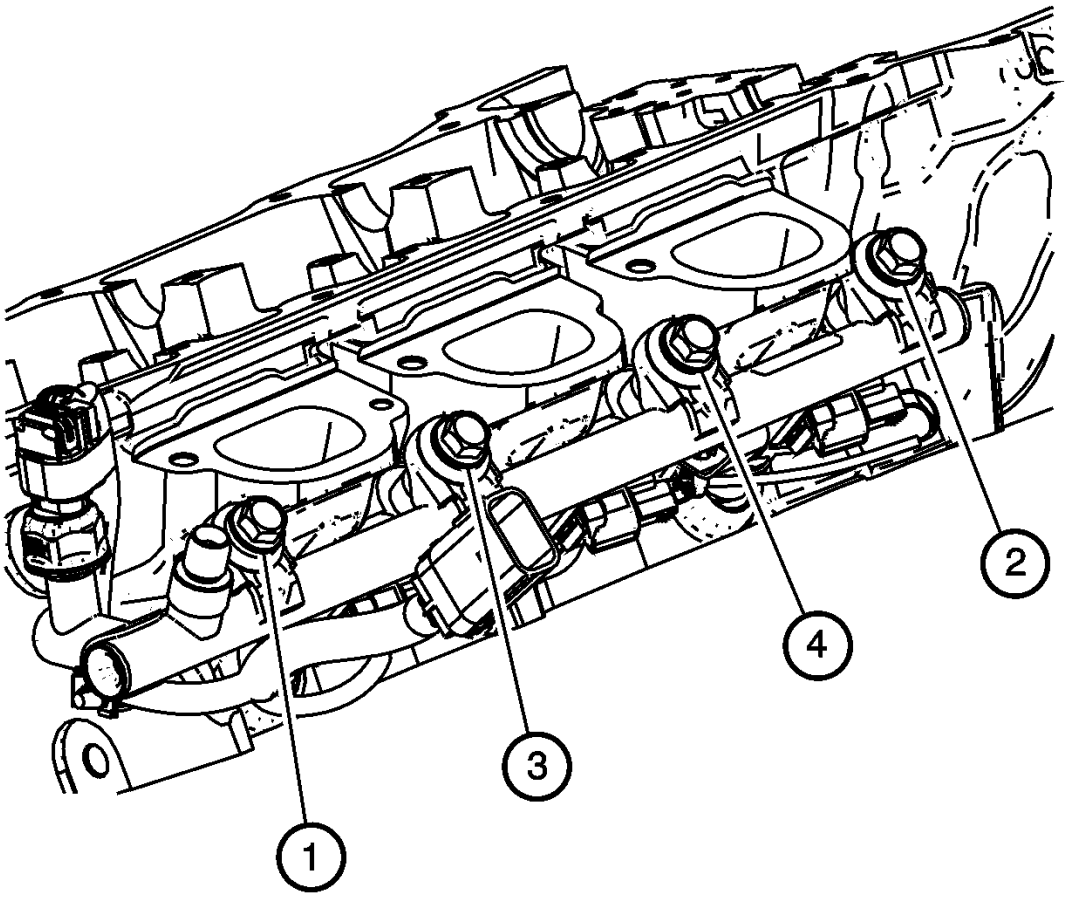

Fig. 207: Fuel Rail Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

22. Tighten the fuel rail bolts in the sequence shown to 25 N.m (18 lb ft).

CAMSHAFT CLEANING AND INSPECTION

Special Tools

GE 7872 Magnetic Base Dial Indicator

For equivalent regional tools, refer to **Special Tools** .

Cleaning Procedure

1. Clean the camshaft in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the camshaft with compressed air.

Visual Inspection

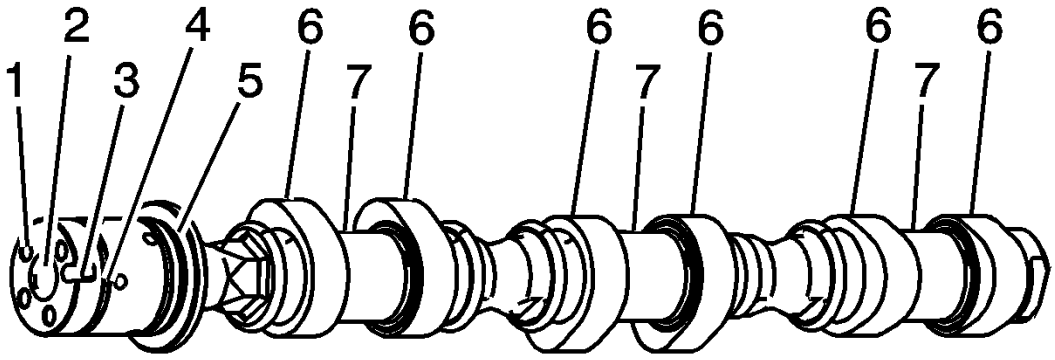

Fig. 208: Identifying Camshaft Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft oil feed holes (1) to the camshaft position actuator for dirt, debris or blockage.
2. Inspect the threaded hole (2) for damage.
3. Inspect the camshaft position actuator locating notch (3) for damage or wear.
4. Inspect the camshaft sealing grooves (4) for damage.
5. Inspect the camshaft thrust surface (5) for damage.
6. Inspect the camshaft lobes (6) and journals (7) for the following conditions:
    - Excessive scoring or pitting
    - Discoloration from overheating
    - Deformation from excessive wear, especially the camshaft lobes
7. If any of the above conditions exist on the camshaft, replace the camshaft.

Camshaft Measurement

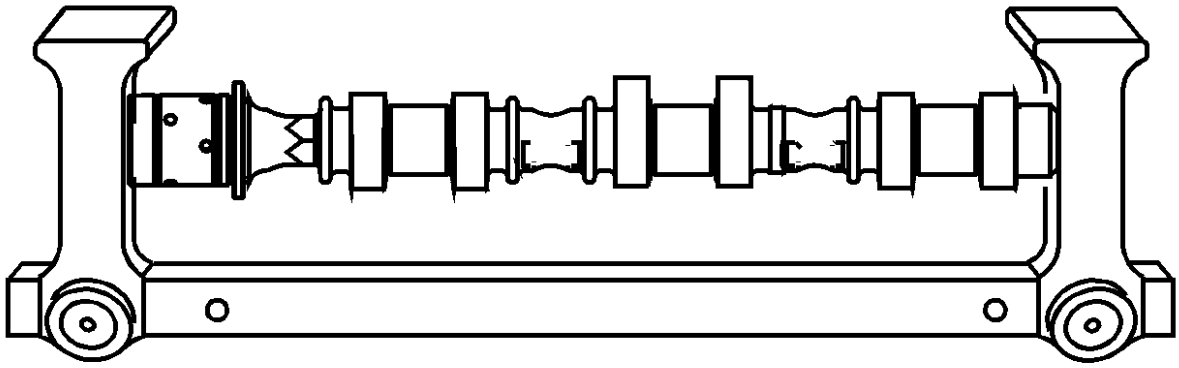

Fig. 209: Supporting Camshaft In Fixture
Courtesy of GENERAL MOTORS COMPANY

1. With the camshaft in a suitable fixture, measure the camshaft for wear.

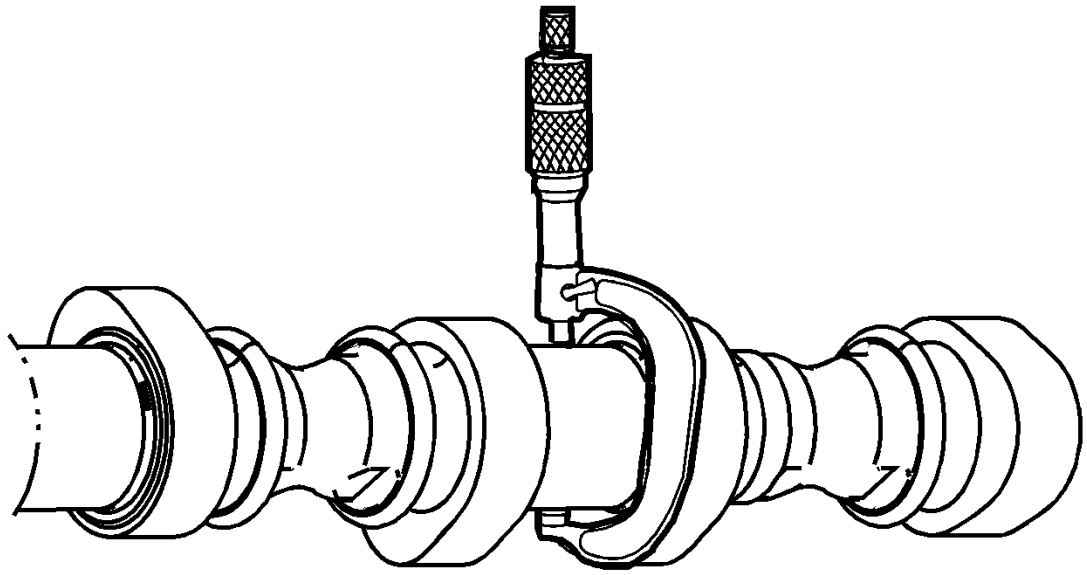

Fig. 210: Measuring Camshaft Journals
Courtesy of GENERAL MOTORS COMPANY

2. Measure the camshaft journals for diameter and out-of-round using an outside micrometer. Refer to **Engine Mechanical Specifications** .
    - If the diameter is smaller than specifications, replace the camshaft.
    - If the out-of-round exceeds specifications, replace the camshaft.

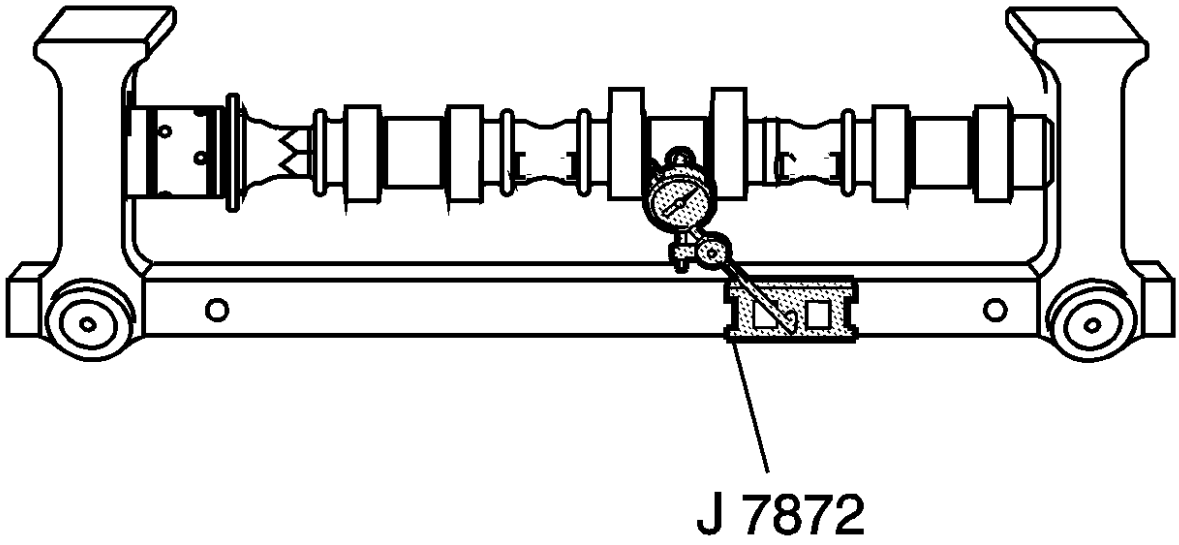

Fig. 211: Checking Camshaft Runout
Courtesy of GENERAL MOTORS COMPANY

3. Measure the camshaft runout using the **GE 7872** indicator. Refer to **Engine Mechanical Specifications** .

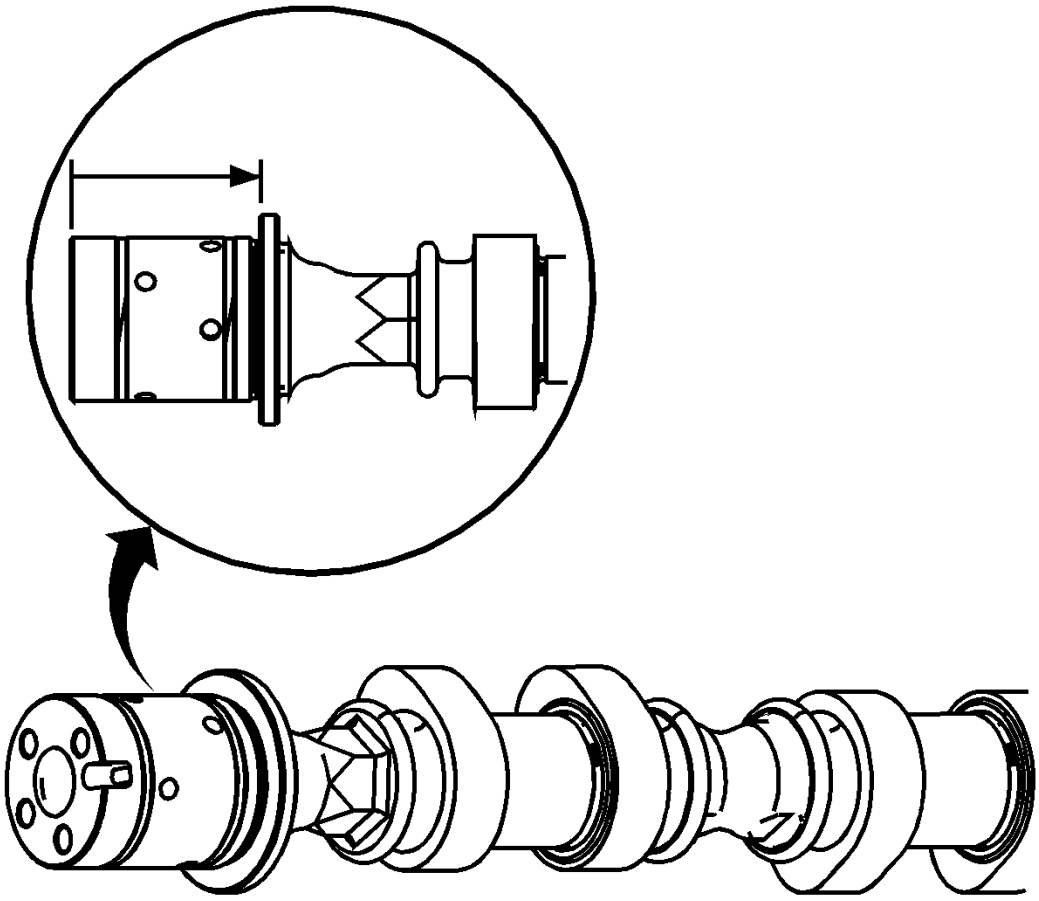

Fig. 212: Measuring Camshaft Thrust Width
Courtesy of GENERAL MOTORS COMPANY

4. Measure the camshaft thrust width for wear using a depth micrometer. Refer to **Engine Mechanical Specifications** .

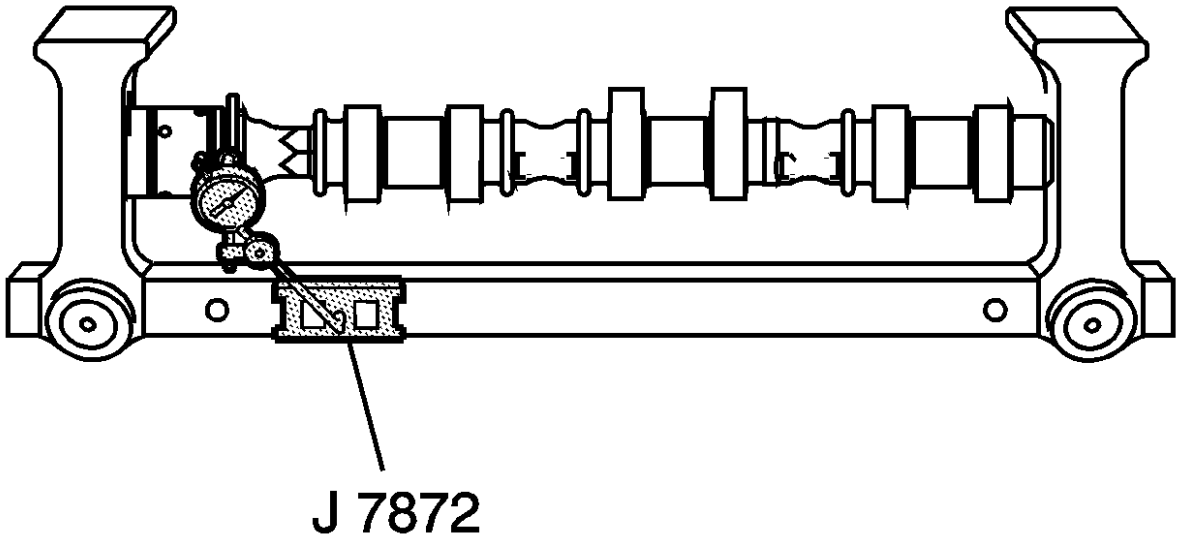

Fig. 213: Measuring Camshaft
Courtesy of GENERAL MOTORS COMPANY

5. Measure the camshaft thrust wall surface for runout using **GE 7872** indicator. Refer to **Engine Mechanical Specifications** .
6. If the camshaft is damaged or worn beyond specifications, replace the camshaft. No machining of the camshaft is allowed.

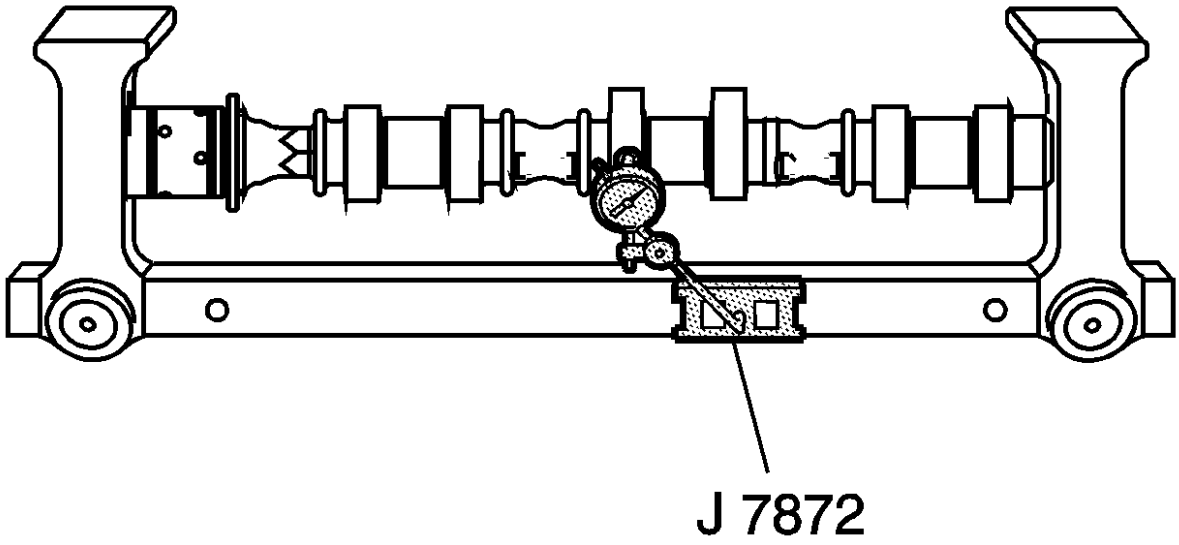

Fig. 214: Measuring Camshaft Lobes For Wear
Courtesy of GENERAL MOTORS COMPANY

7. Measure the camshaft lobes for wear using the **GE 7872** indicator.

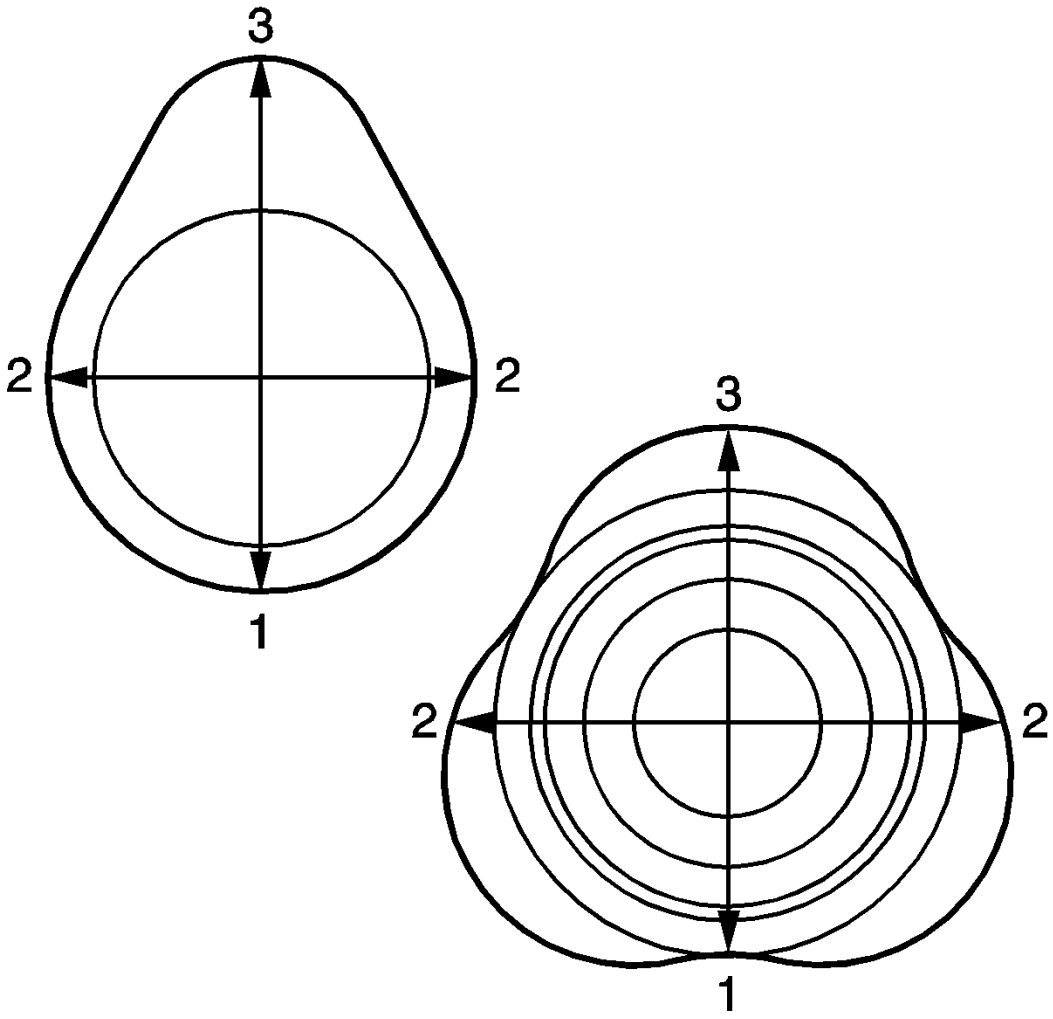

Fig. 215: View of Lobe Diagram
Courtesy of GENERAL MOTORS COMPANY

8. Place the **GE 7872** indicator with the indicator tip on the base circle (1) of the camshaft lobe.
    1. Place the **GE 7872** indicator at zero.
    2. Rotate the camshaft until the indicator tip is at the highest point (3) on the lobe. This reading is the lift of the camshaft lobe. Refer to **Engine Mechanical Specifications** .
    3. If the indicated measurement is significantly lower than these specifications, replace the camshaft or engine performance will be reduced.

VALVE LIFTER CLEANING AND INSPECTION

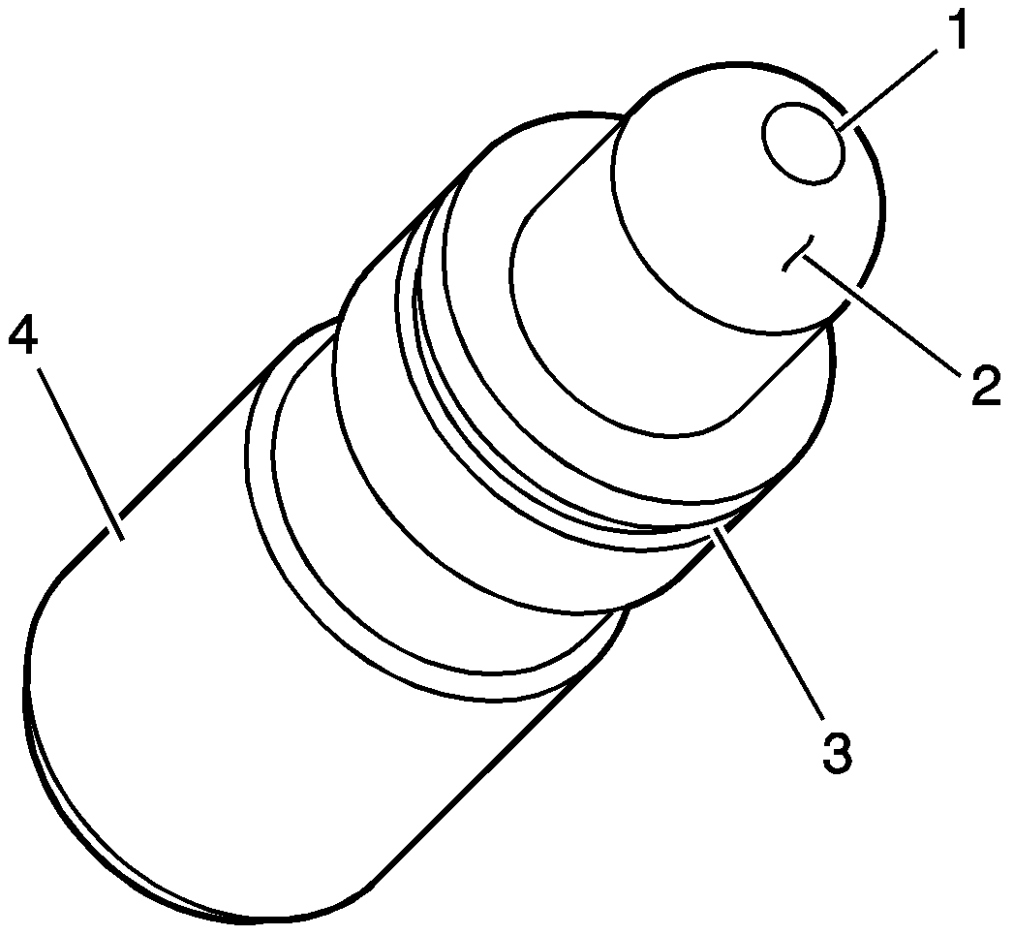

Fig. 216: Identifying Valve Lifter Inspection Points
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Valve Lifter Priming Caution .**

1. Inspect the stationary hydraulic lash adjuster (SHLA) in the following areas:
    - A plugged oil passage (1)
    - A scored or worn camshaft follower pivot area (2)
    - A damaged or broken retainer (3), some applications
    - A severely scuffed or worn SHLA body (4)
2. Replace the SHLA or SHLAs as necessary.

VALVE ROCKER ARM CLEANING AND INSPECTION

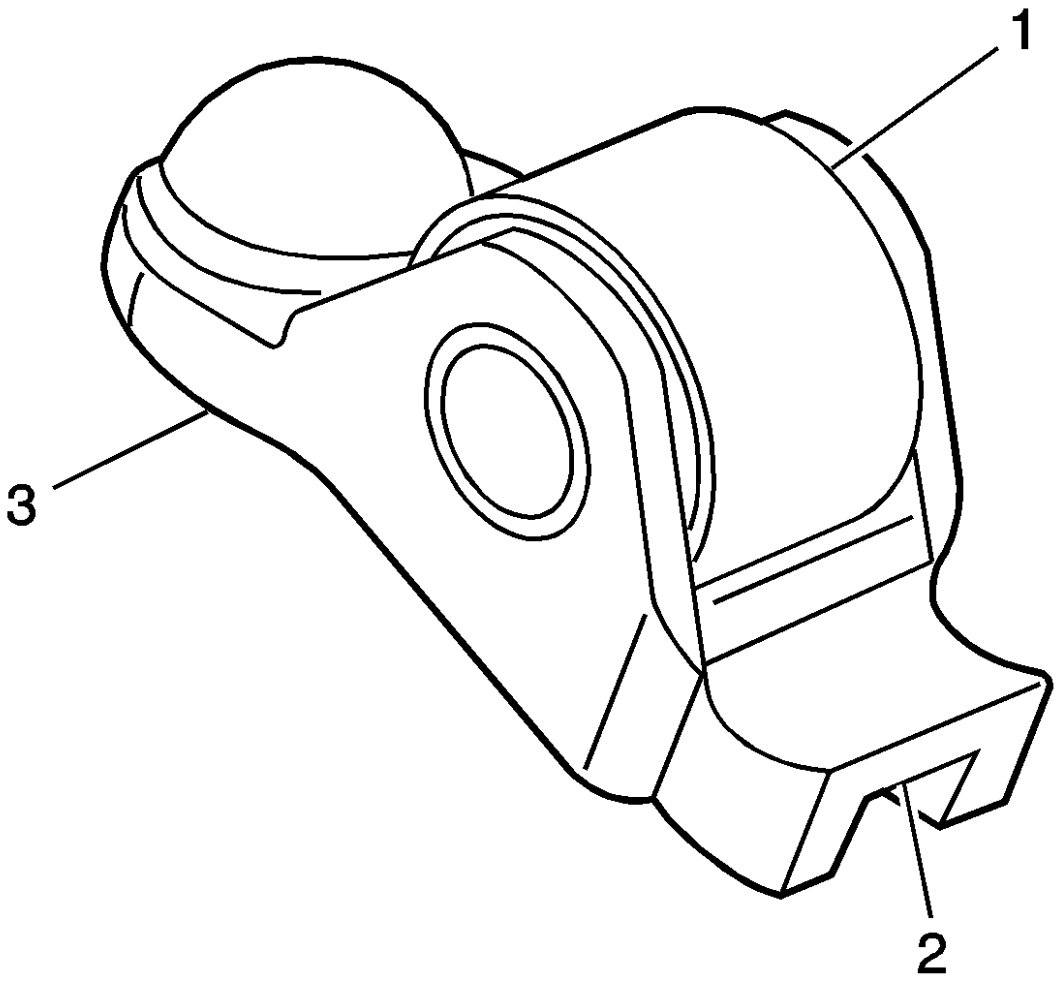

Fig. 217: Inspecting Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft follower roller (1) for the following:
    - Flat spots
    - Excessive scoring and pitting
    - Ensure the roller spins freely
2. Inspect the camshaft follower valve tip area (2).
3. Inspect the camshaft follower stationary hydraulic lash adjuster (SHLA) pivot area (3).
4. Replace the camshaft follower or followers as necessary.

CAMSHAFT TIMING DRIVE COMPONENTS CLEANING AND INSPECTION

Cleaning Procedure

1. Clean all the following components with solvent:
    - Crankshaft sprocket

- Primary timing drive chain
- Primary timing drive chain shoe
- Primary timing drive chain guides
- Primary timing drive chain tensioner
- Secondary timing drive chains
- Secondary timing drive chain shoes
- Secondary timing drive chain guides
- Secondary timing drive chain tensioners
- Timing component fastening bolts

2. Clean each camshaft position actuator's exterior with solvent.

WARNING: Refer to Safety Glasses Warning .

3. Dry the timing components with compressed air.

Visual Inspection

Camshaft Thrust Washers (If Equipped)

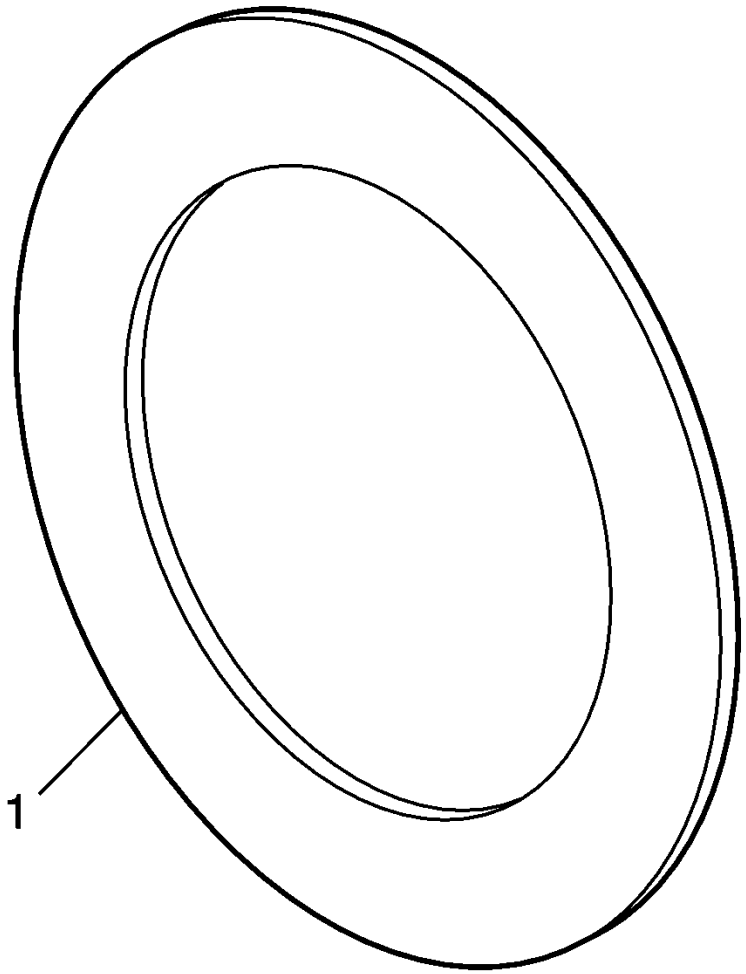

Fig. 218: Identifying Camshaft Thrust Washer
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft thrust washers for deep scoring or uneven wear (1).
2. Replace as necessary.

Camshaft Position Actuators

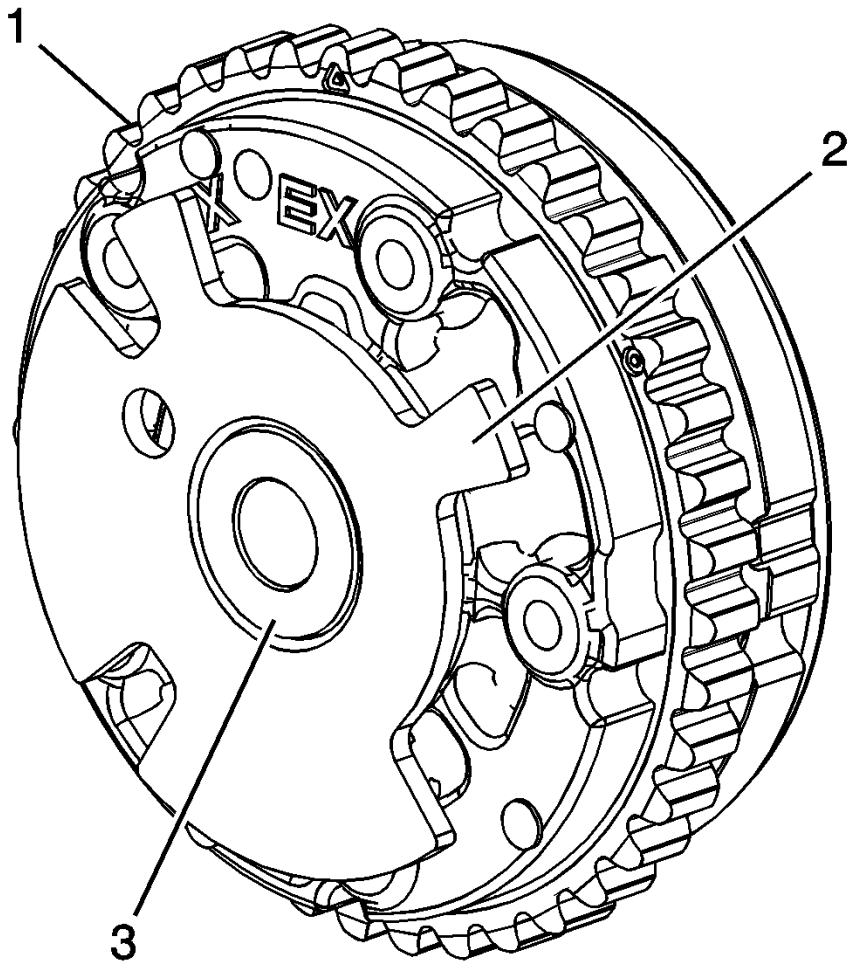

Fig. 219: View Of Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Actual camshaft position actuators may vary in appearance from the ones shown.**

1. Inspect the front of the exhaust camshaft position actuators for the following:
   - Sprocket damage (1)
   - Reluctor/sensor wheel damage (2)
   - Camshaft position actuator bolt seating/sealing inner hub flange damage (3)

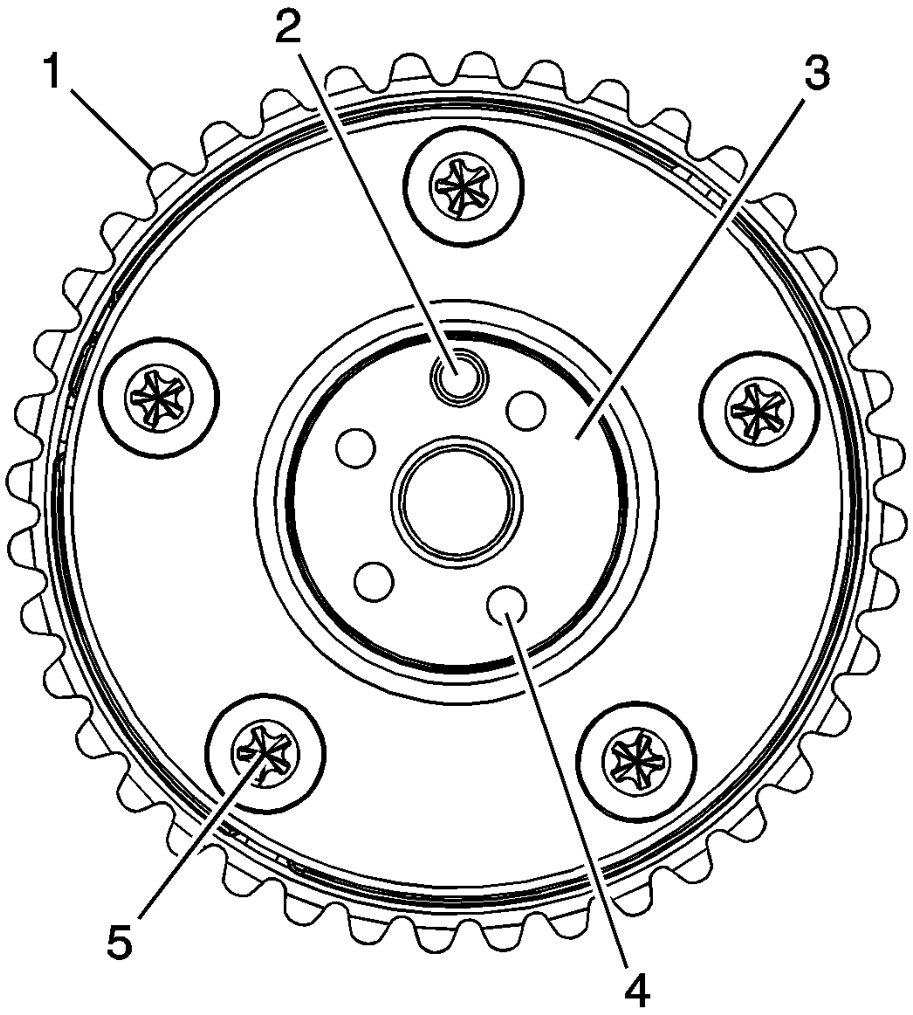

Fig. 220: View Of Exhaust Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the back of the exhaust camshaft position actuators for the following:
    - Sprocket damage (1)
    - Camshaft locating pin damage (2)
    - Camshaft seating/sealing inner hub flange damage (3)
    - Blockage to the oil passages (4)
    - Loose or missing housing bolts (5)

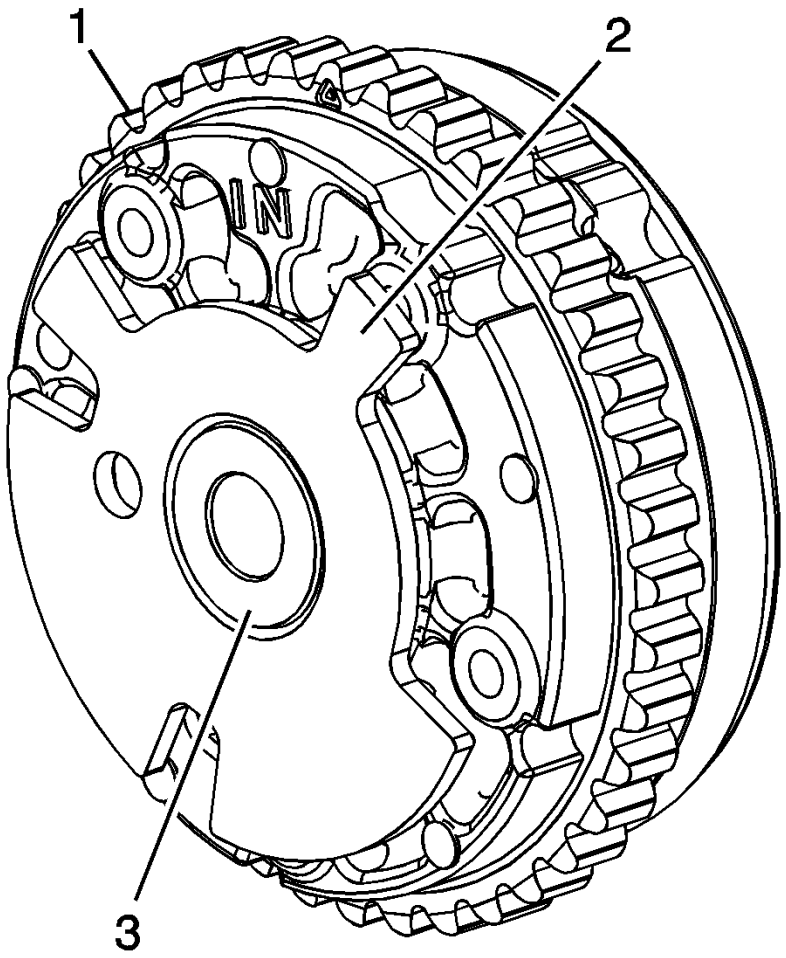

Fig. 221: View Of Left Intake Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the front of the left intake camshaft position actuators for the following:
    - Sprocket damage (1)
    - Reluctor/sensor wheel damage (2)
    - Camshaft position actuator oil control valve bolt seating/sealing inner hub flange damage (3)

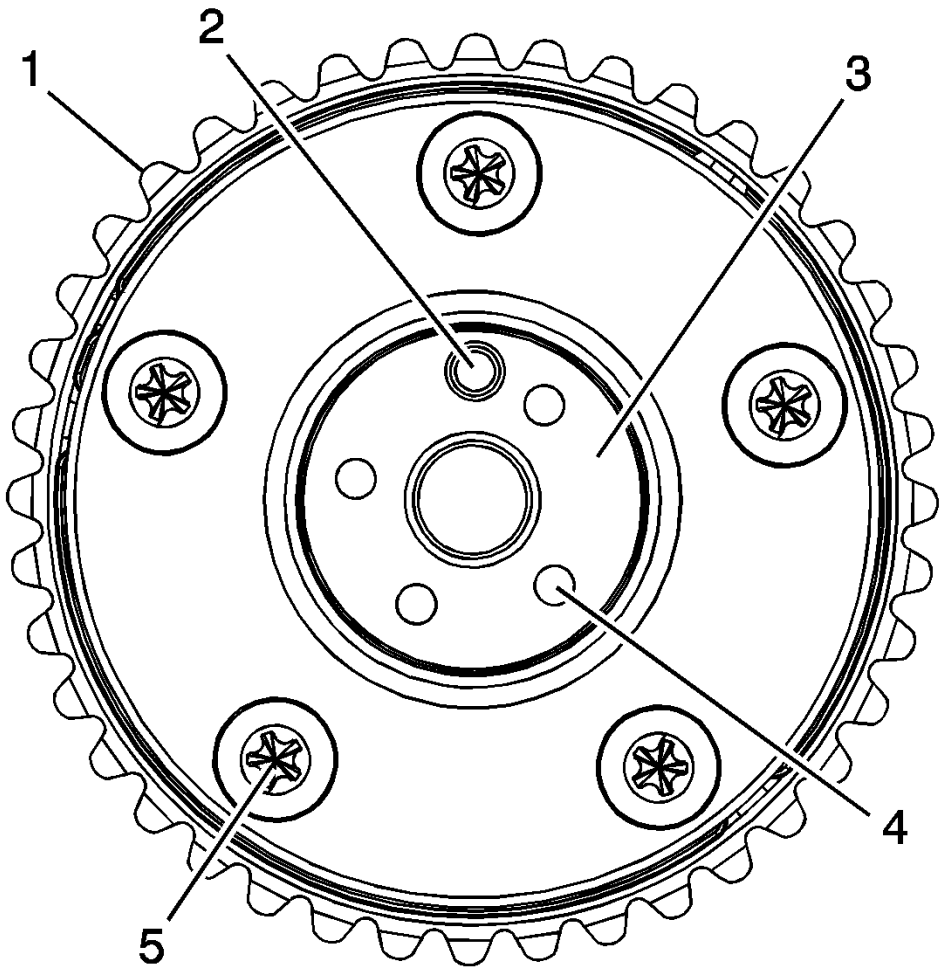

Fig. 222: View Of Left Intake Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the back of the left intake camshaft position actuators for the following:
    - Sprocket damage (1)
    - Camshaft locating pin damage (2)
    - Camshaft seating/sealing inner hub flange damage (3)
    - Blockage to the oil passages (4)
    - Loose or missing housing bolts (5)

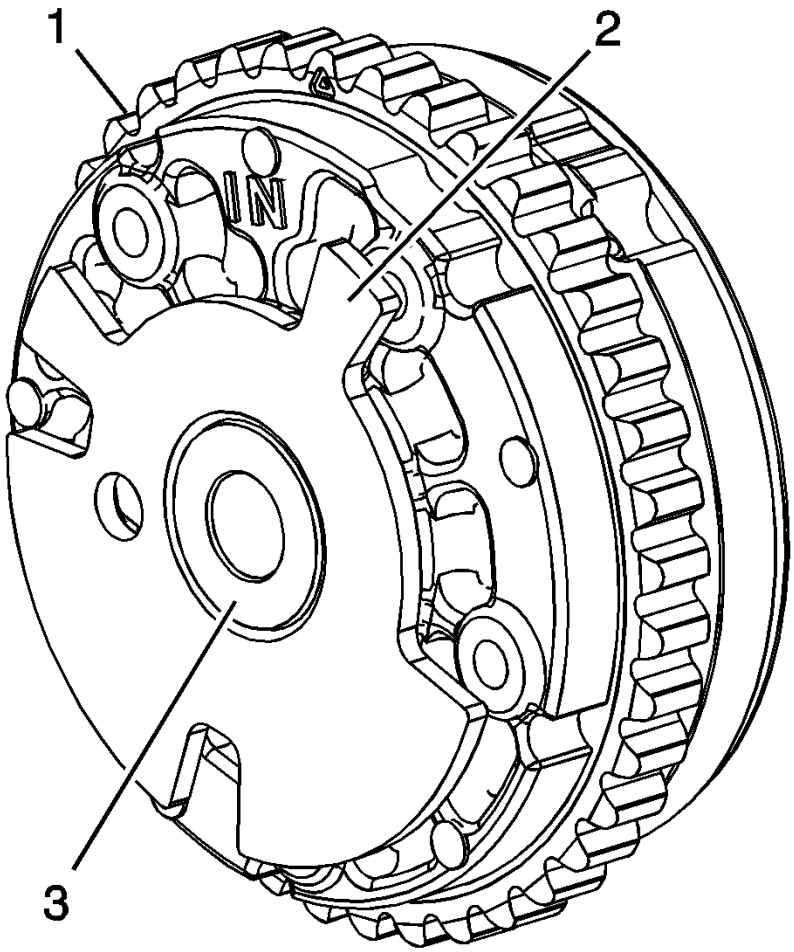

Fig. 223: View Of Right Intake Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the front of the right intake camshaft position actuators for the following:
    - Sprocket damage (1)
    - Reluctor/sensor wheel damage (2)
    - Camshaft position actuator oil control valve bolt seating/sealing inner hub flange damage (3)

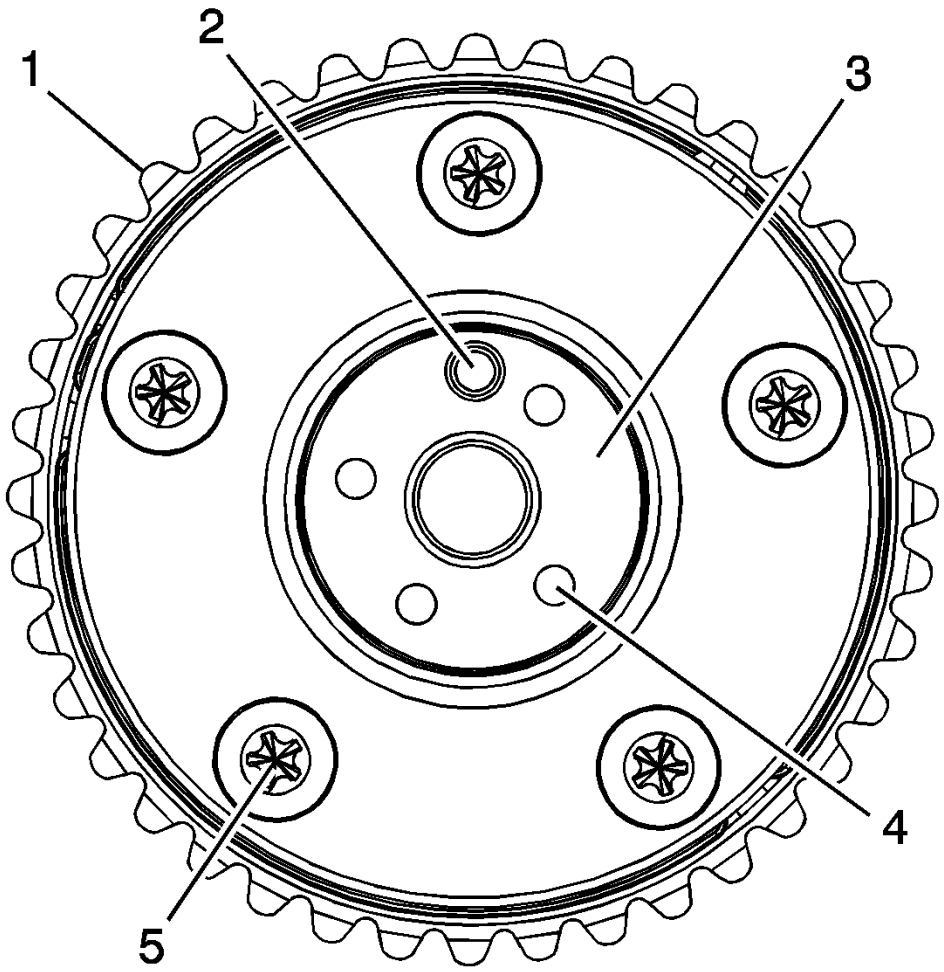

Fig. 224: View Of Left Intake Camshaft Position Actuators Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the back of the right intake camshaft position actuators for the following:
    - Sprocket damage (1)
    - Camshaft locating pin damage (2)
    - Camshaft seating/sealing inner hub flange damage (3)
    - Blockage to the oil passages (4)
    - Loose or missing housing bolts (5)
7. Replace a damaged camshaft position actuator.

Camshaft Position Actuator Oil Control Valves

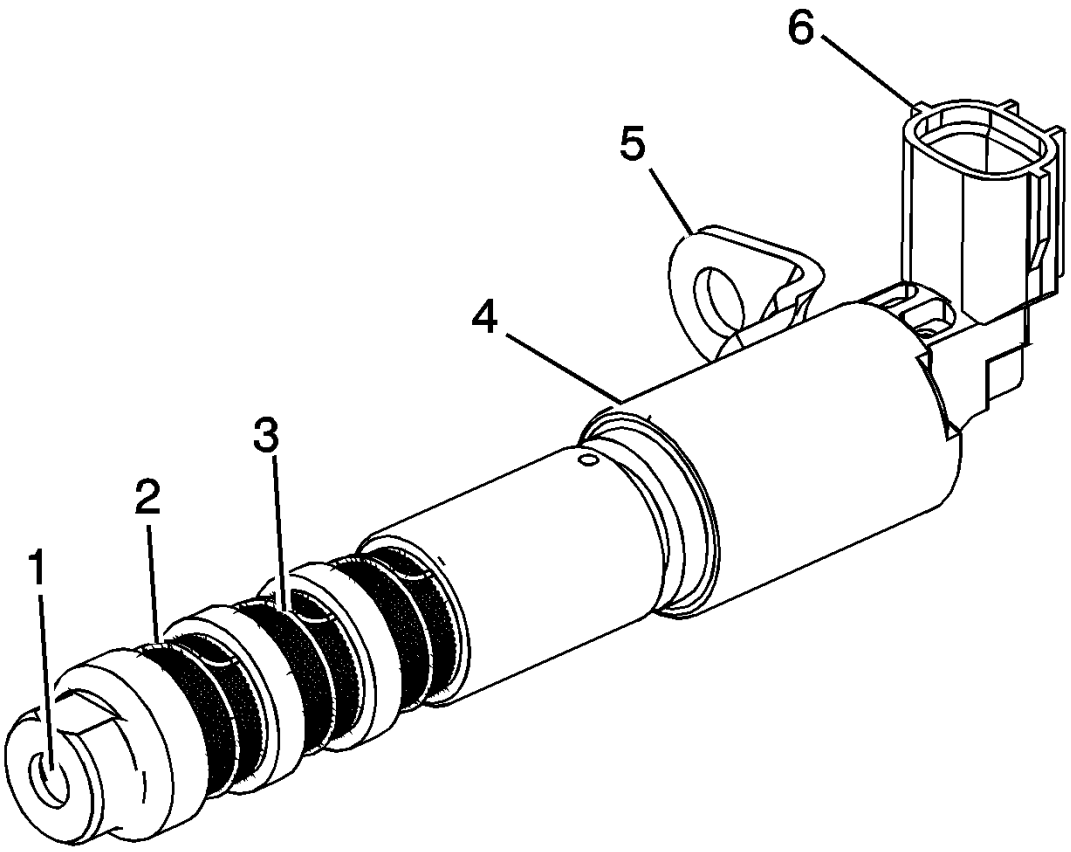

Fig. 225: Identifying Camshaft Position Actuator Oil Control Valves Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the camshaft position actuator oil control valves for the following:
    - Blockage to the oil passage (1)
    - Missing or damaged oil screen clip (2)
    - Blockage or damage to the oil screen (3)
    - Damage to the sealing surface for the camshaft position actuator oil control valve solenoid oil seal (4)
    - Damage to the bracket (5)
    - Damage to the wiring harness connection and/or terminals (6)
2. Replace a damaged camshaft position actuator oil control valve.

Left Intermediate Sprocket with Primary and Secondary Inverted Tooth (IT) Chain

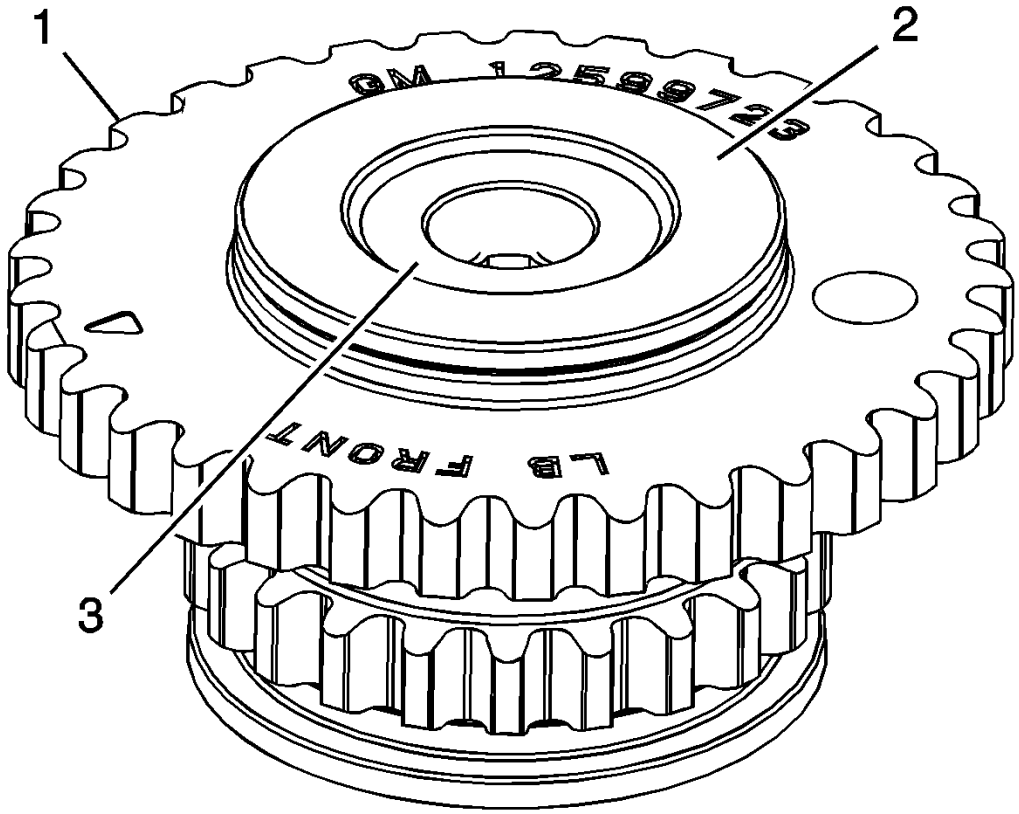

Fig. 226: View Of Left Intermediate Sprocket Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the front of the left intermediate sprocket for the following:
    - Damage to the primary camshaft drive chain sprocket (1)
    - Damage to the hub bearing (2)-Ensure the hub bearing spins freely. If the hub bearing wobbles, is noisy, or feels rough when rotated, replace the intermediate sprocket.
    - Damage to the bolt flange seating/sealing surface (3)

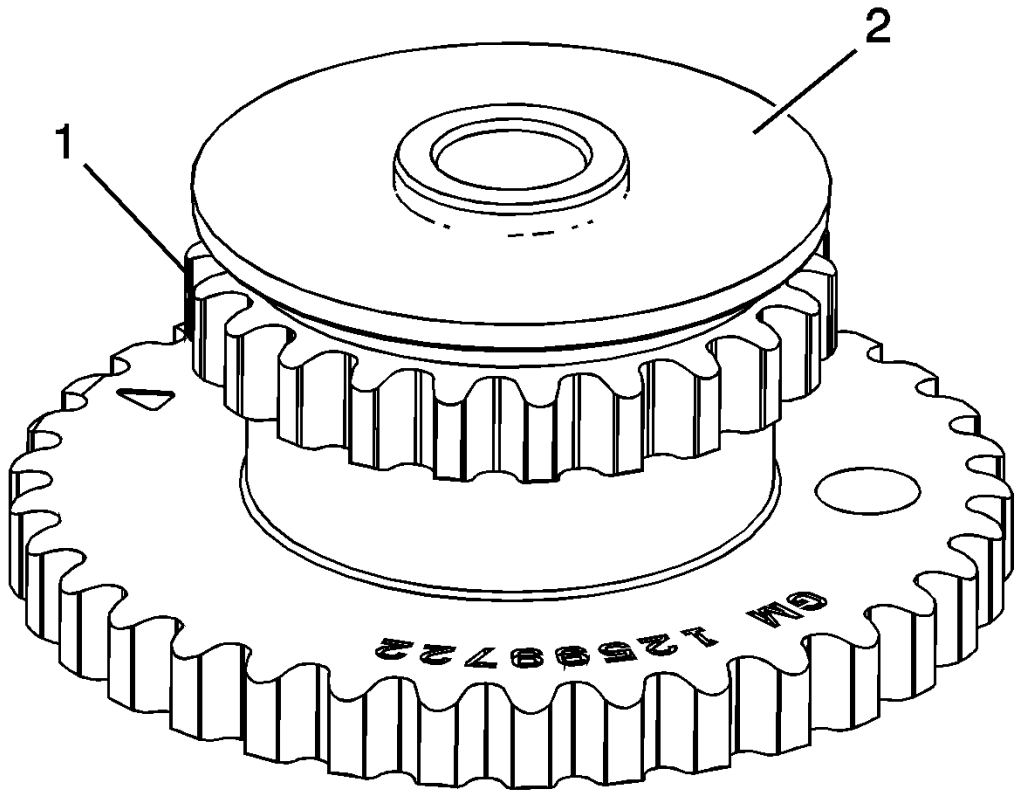

Fig. 227: View Of Left Intermediate Sprocket Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the back of the left intermediate sprocket for the following:
    - Damage to the left secondary camshaft drive chain sprocket (1)
    - Damage to the bearing hub-to-engine block sealing surface (2)
3. Replace a damaged left intermediate sprocket.

Right Intermediate Sprocket with Primary and Secondary Inverted Tooth (IT) Chain

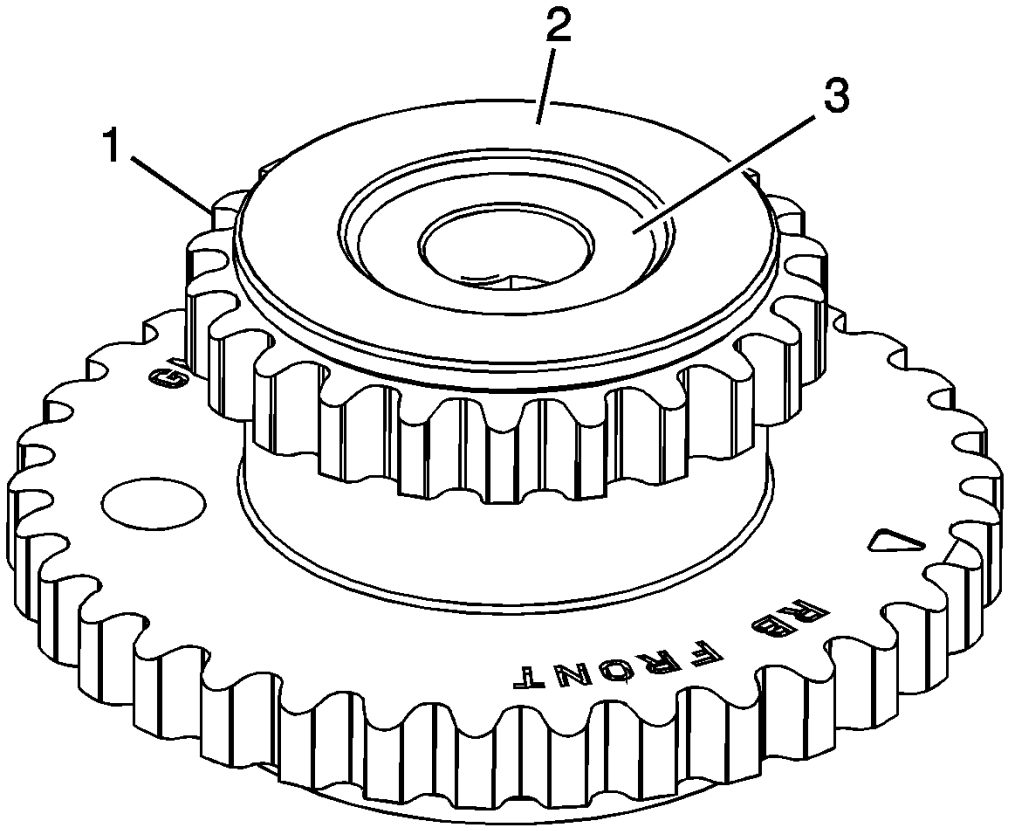

Fig. 228: View Of Right Intermediate Sprocket Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the front of the right intermediate sprocket for the following:
    - Damage to the right secondary camshaft drive chain sprocket (1)
    - Damage to the hub bearing (2)-Ensure the hub bearing spins freely. If the hub bearing wobbles, is noisy, or feels rough when rotated, replace the intermediate sprocket.
    - Damage to the bolt flange seating/sealing surface (3)

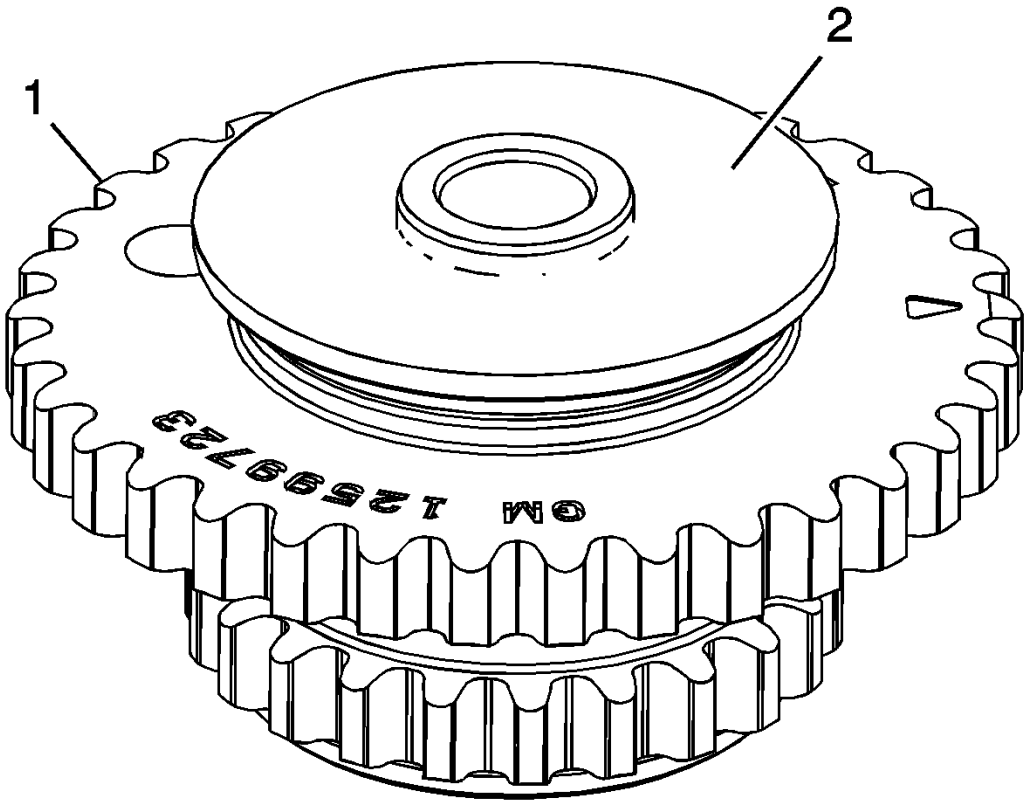

Fig. 229: View Of Right Intermediate Sprocket Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the back of the right intermediate sprocket for the following:
    - Damage to the primary camshaft drive chain sprocket (1)
    - Damage to the bearing hub-to-engine block sealing surface (2)
3. Replace a damaged right intermediate sprocket.

Crankshaft Sprocket with Primary Inverted Tooth (IT) Chain

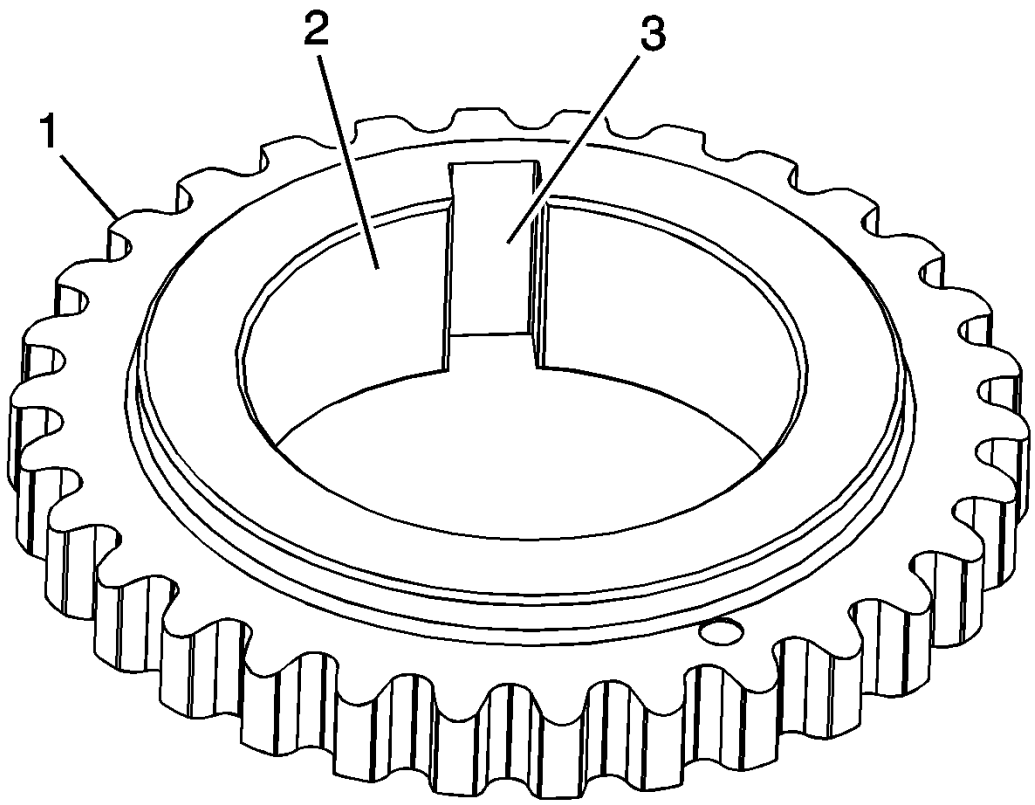

Fig. 230: View Of Crankshaft Sprocket Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the crankshaft sprocket for the following:
    - Sprocket damage (1)
    - Bore damage (2)
    - Keyway damage (3)
2. Replace a damaged crankshaft sprocket.

Secondary Timing Chains with Inverted Tooth (IT) Chain

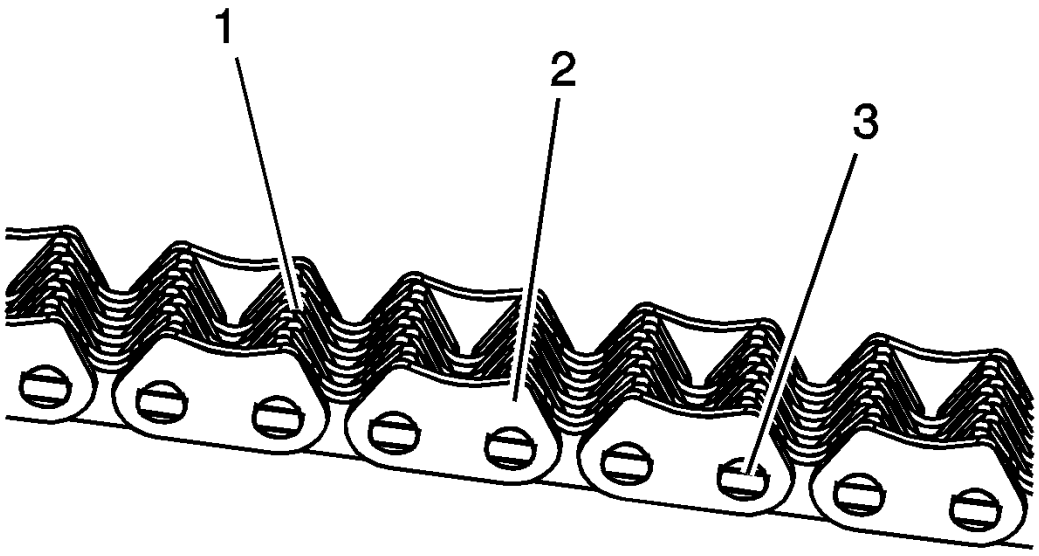

Fig. 231: Identifying Primary & Secondary Timing Chain Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the secondary timing chain for the following:
    - Binding or worn links (1)
    - Loose links (2)
    - Loose pins (3)
2. Replace a damaged secondary timing chain.

Primary Timing Chain with Inverted Tooth (IT) Chain

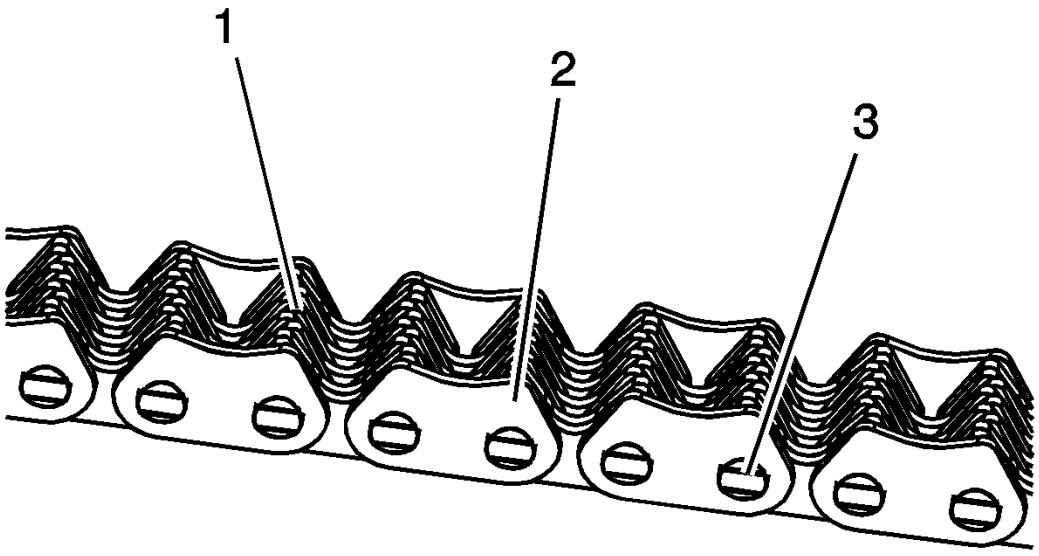

Fig. 232: Identifying Primary & Secondary Timing Chain Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the primary timing chain for the following:
    - Binding or worn links (1)
    - Loose links (2)
    - Loose pins (3)
2. Replace a damaged primary timing chain.

Primary Timing Chain Upper Guide

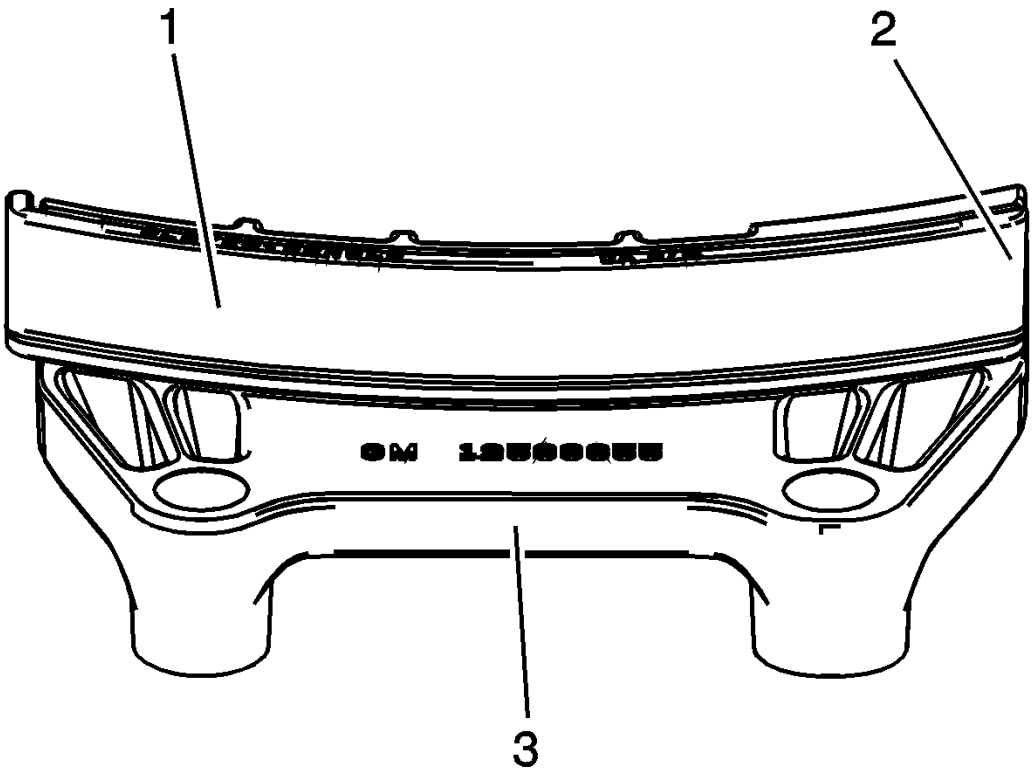

Fig. 233: View Of Primary Timing Chain Upper Guide Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the primary timing chain upper guide for the following:
    - Worn guide surface (1)
    - Cracked or broken guide surface (2)
    - Cracked or damaged guide base (3)
2. Replace a damaged primary timing chain upper guide.

Primary Timing Chain Lower Guide

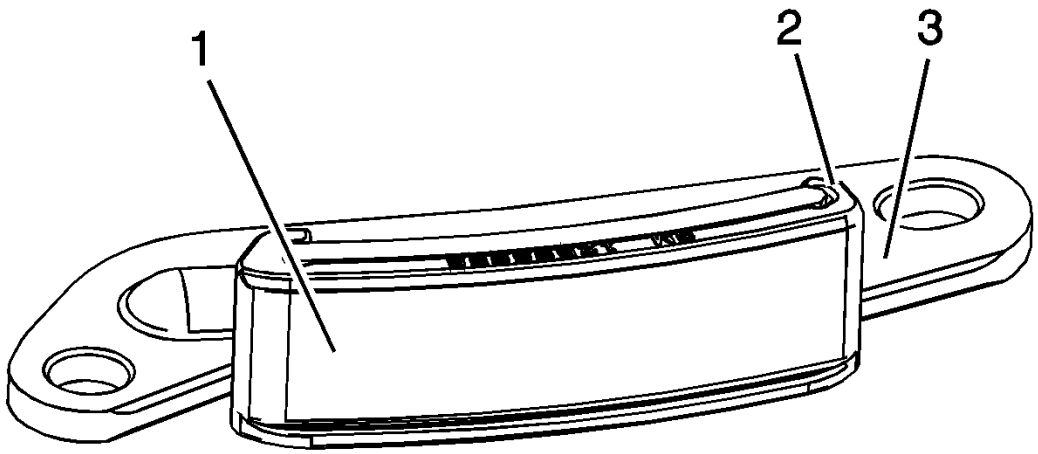

Fig. 234: View Of Primary Camshaft Drive Chain Lower Guide Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the primary timing chain lower guide for the following:
    - Worn guide surface (1)
    - Cracked or broken guide surface (2)
    - Cracked or damaged guide base (3)
2. Replace a damaged primary timing chain lower guide.

Left Secondary Timing Chain Guide

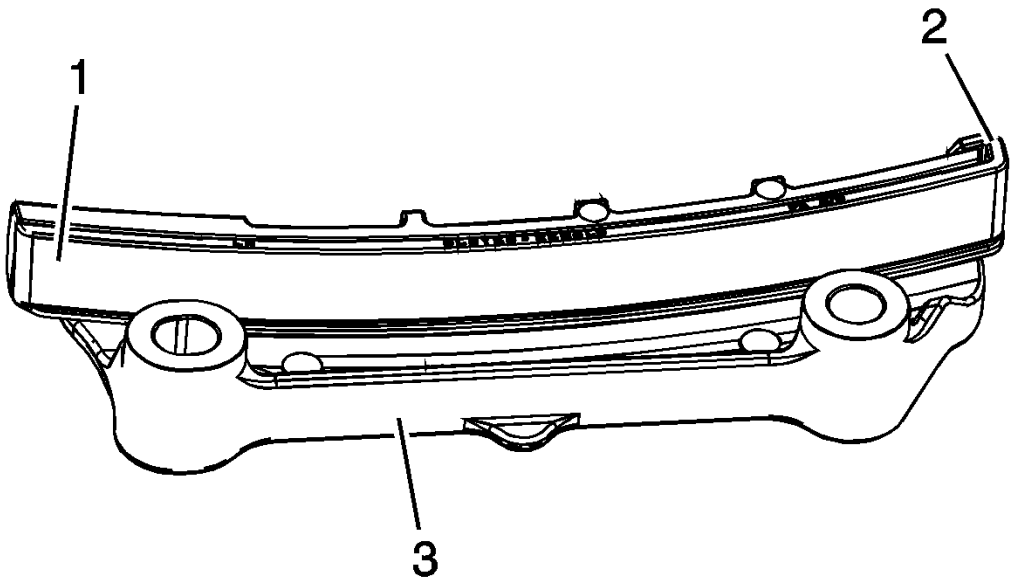

Fig. 235: View Of Left Secondary Timing Chain Guide Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the left secondary timing chain guides for the following:
    - Worn guide surface (1)
    - Cracked or broken guide surface (2)
    - Cracked or damaged guide base (3)
2. Replace a damaged left secondary timing chain guide.

Right Secondary Timing Chain Guide

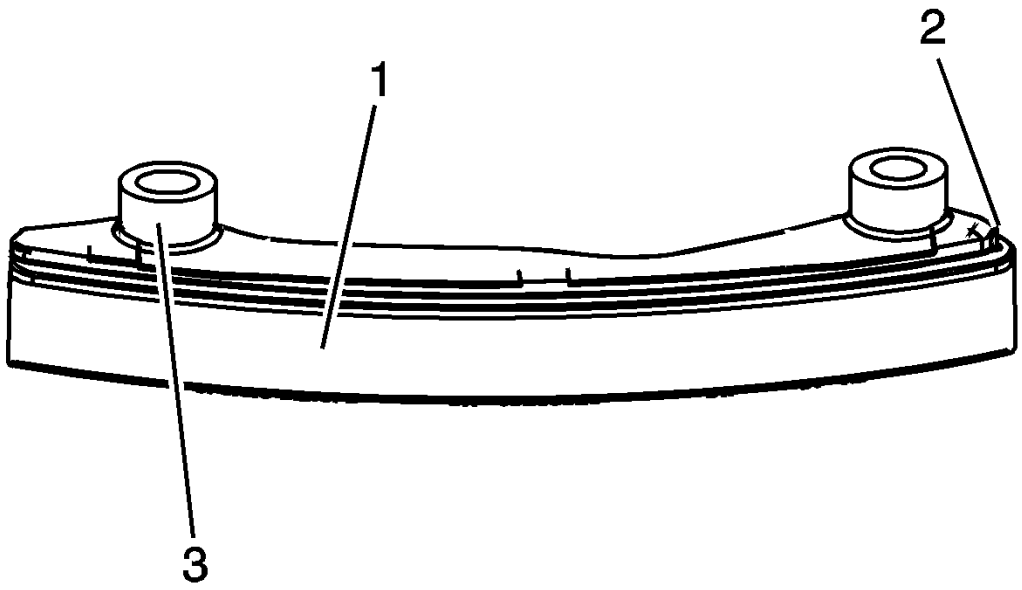

Fig. 236: Identifying Right Secondary Timing Chain Guide Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the right secondary timing chain guides for the following:
    - Worn guide surface (1)
    - Cracked or broken guide surface (2)
    - Cracked or damaged guide base (3)
2. Replace a damaged right secondary timing chain guide.

Left Secondary Timing Chain Shoe

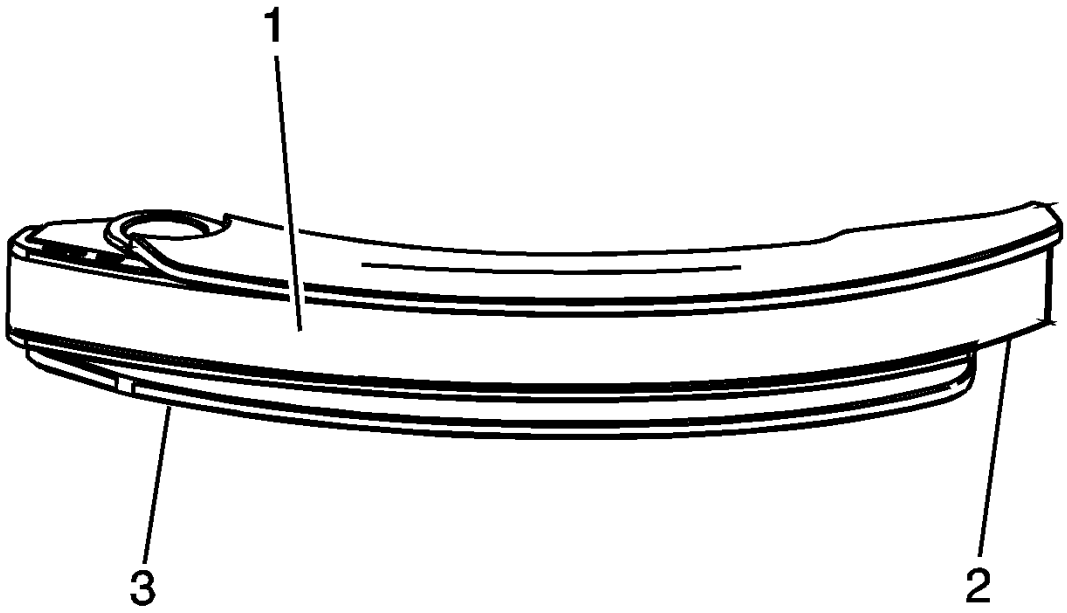

Fig. 237: View Of Left Secondary Timing Chain Shoe Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the front of the left secondary timing chain shoe for the following:
    - Worn shoe surface (1)
    - Cracked or broken shoe surface (2)
    - Cracked or damaged shoe (3)

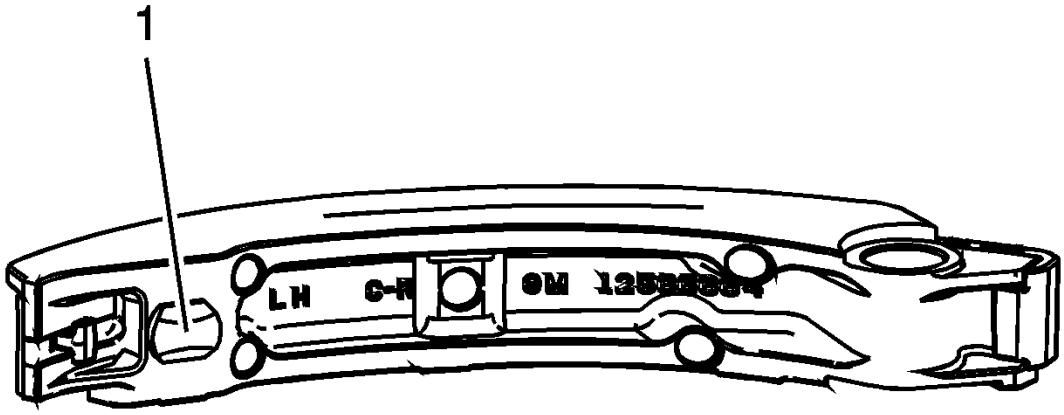

Fig. 238: View of Left Secondary Timing Chain Tensioner Contact Pad
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the back of the left secondary timing chain shoe for a damaged, worn, or missing left secondary timing chain tensioner contact pad (1).
3. Replace a damaged left secondary timing chain shoe.

Right Secondary Timing Chain Shoe

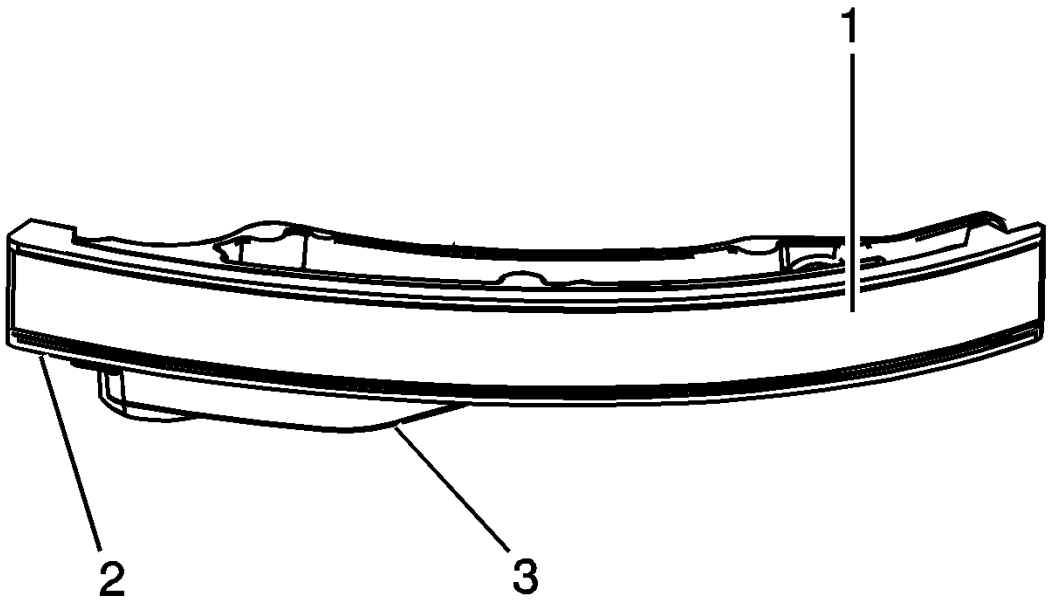

Fig. 239: Identifying Right Secondary Timing Chain Shoe
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the front of the right secondary timing chain shoe for the following:
    - Worn shoe surface (1)
    - Cracked or broken shoe surface (2)
    - Cracked or damaged shoe (3)

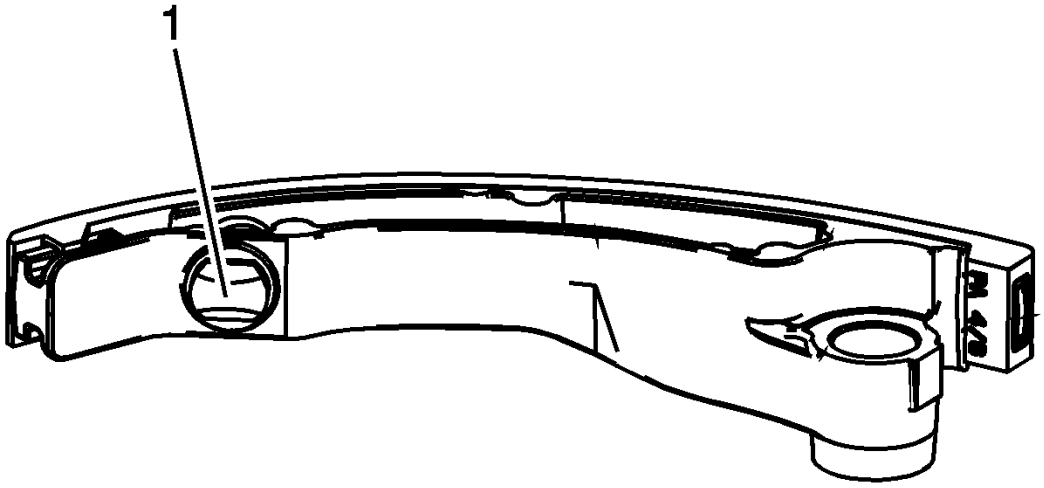

Fig. 240: Inspecting Right Secondary Timing Chain Tensioner Contact Pad
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the back of the right secondary timing chain shoe for a damaged, worn, or missing right secondary timing chain tensioner contact pad (1).
3. Replace a damaged right secondary timing chain shoe.

Primary Timing Chain Tensioner

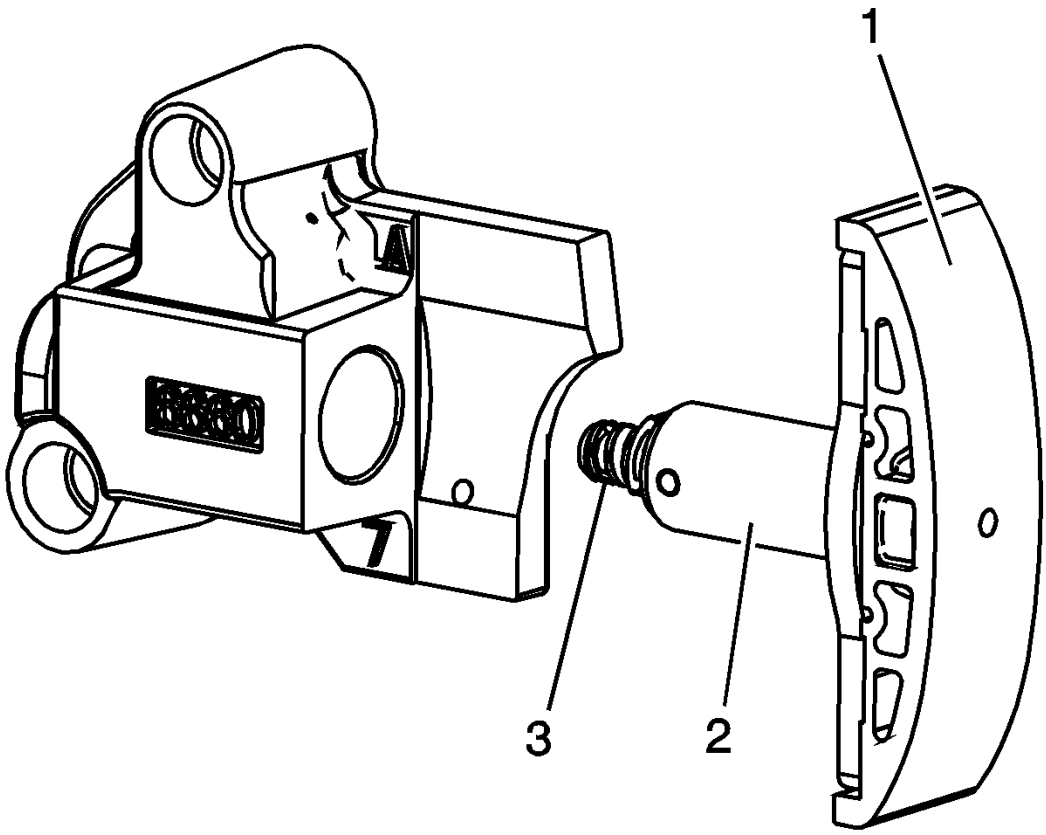

Fig. 241: View Of Primary Timing Chain Tensioner Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the primary timing chain tensioner for worn primary timing chain tensioner shoe surface (1).
2. Inspect the primary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to **Camshaft Timing Chain Components Installation**.
3. Replace a damaged primary timing chain tensioner.

Left Secondary Timing Chain Tensioner

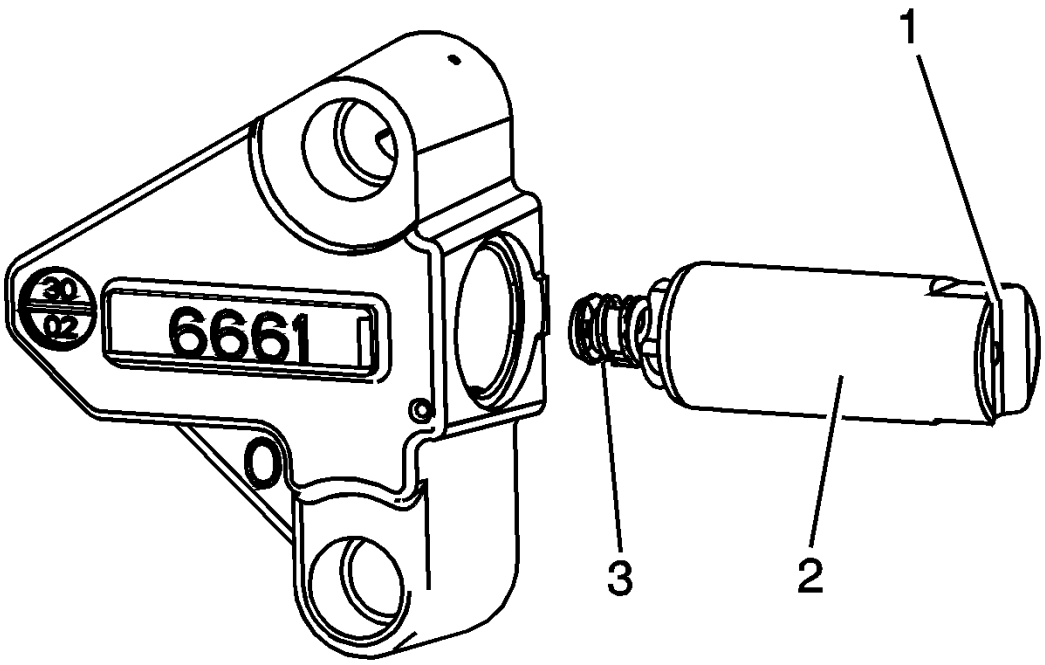

Fig. 242: View Of Left Secondary Timing Chain Tensioner Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the left secondary timing chain tensioner for damaged plunger-to-shoe contact surface (1).
2. Inspect the left secondary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to **Camshaft Timing Chain Components Installation**.
3. Replace a damaged left secondary timing chain tensioner.

Right Secondary Timing Chain Tensioner

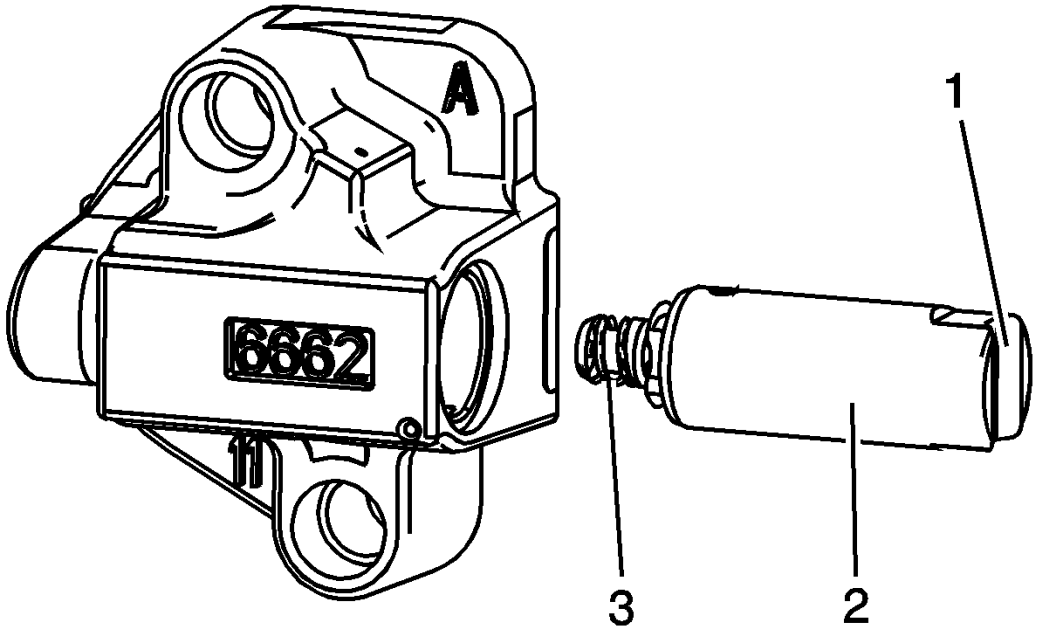

Fig. 243: View Of Right Secondary Timing Chain Tensioner Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the right secondary timing chain tensioner for damaged plunger-to-shoe contact surface (1).
2. Inspect the right secondary timing chain tensioner for locked or binding timing chain tensioner. Reset the plunger (3) and ensure the plunger moves freely (2) in and out of the body of the tensioner. Refer to **Camshaft Timing Chain Components Installation**.
3. Replace a damaged right secondary timing chain tensioner.

OIL PUMP DISASSEMBLE

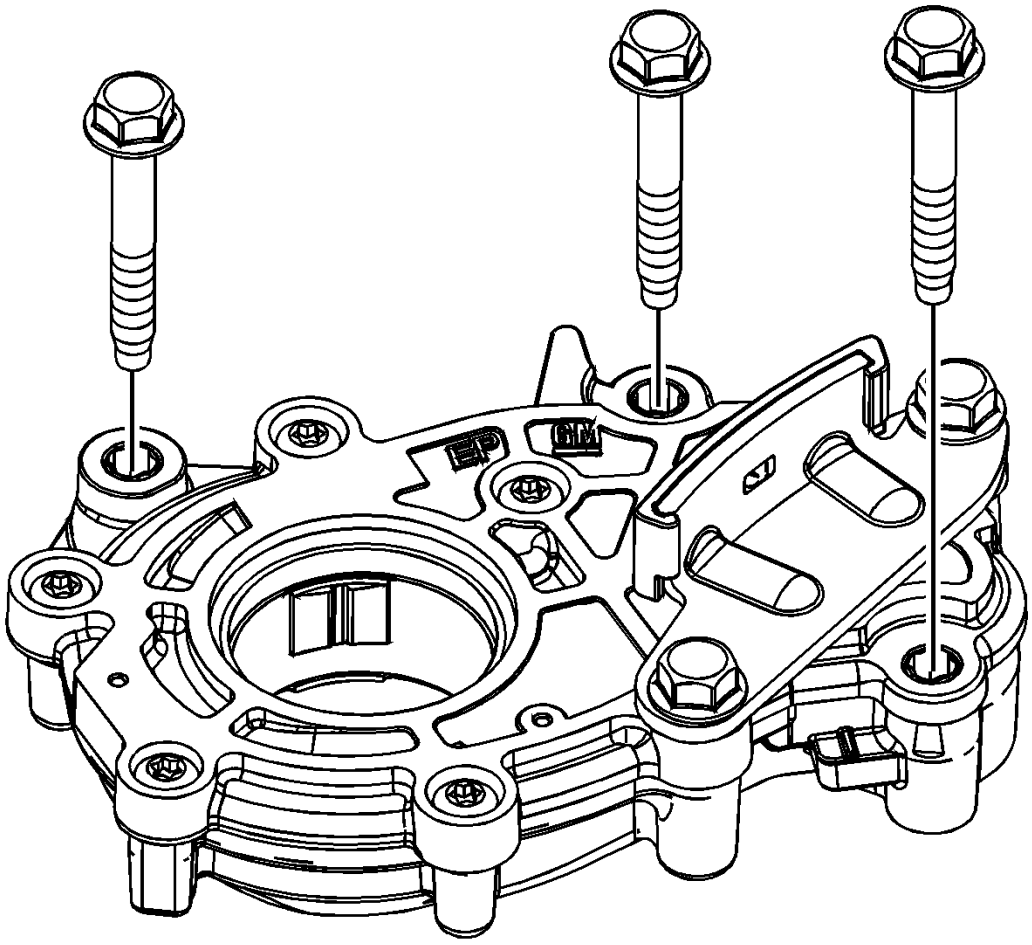

Fig. 244: Identifying Oil Pump Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.

1. Remove the oil pump mounting bolts.

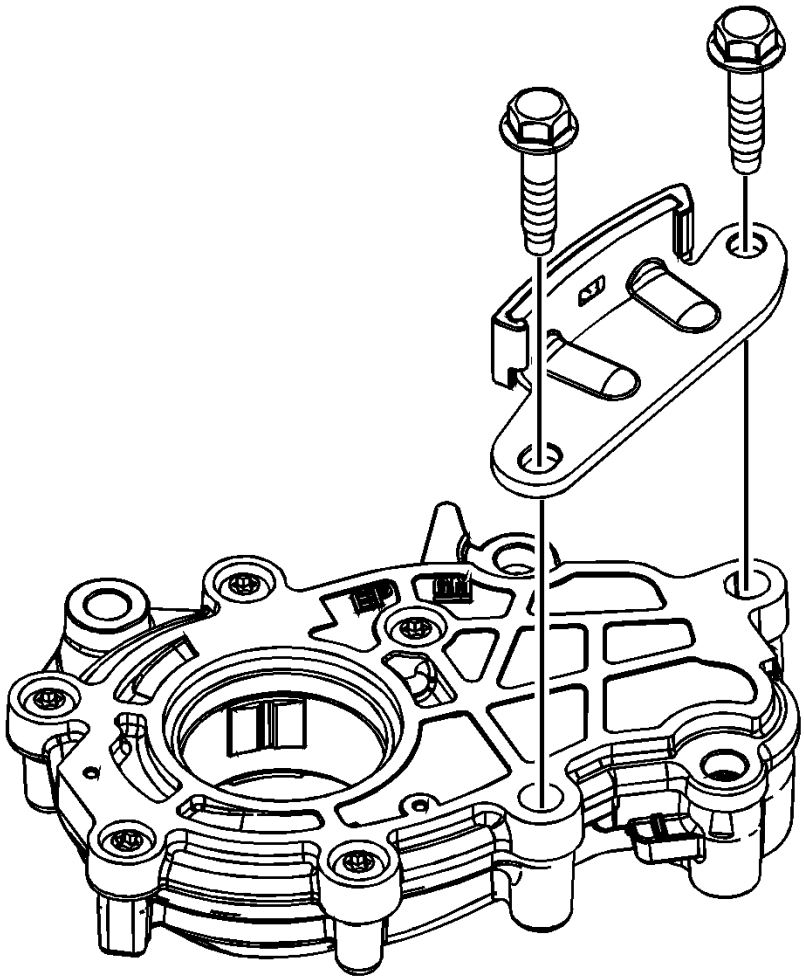

Fig. 245: View Of Oil Pump Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the primary camshaft drive chain lower guide bolts.
3. Remove the primary camshaft drive chain lower guide.

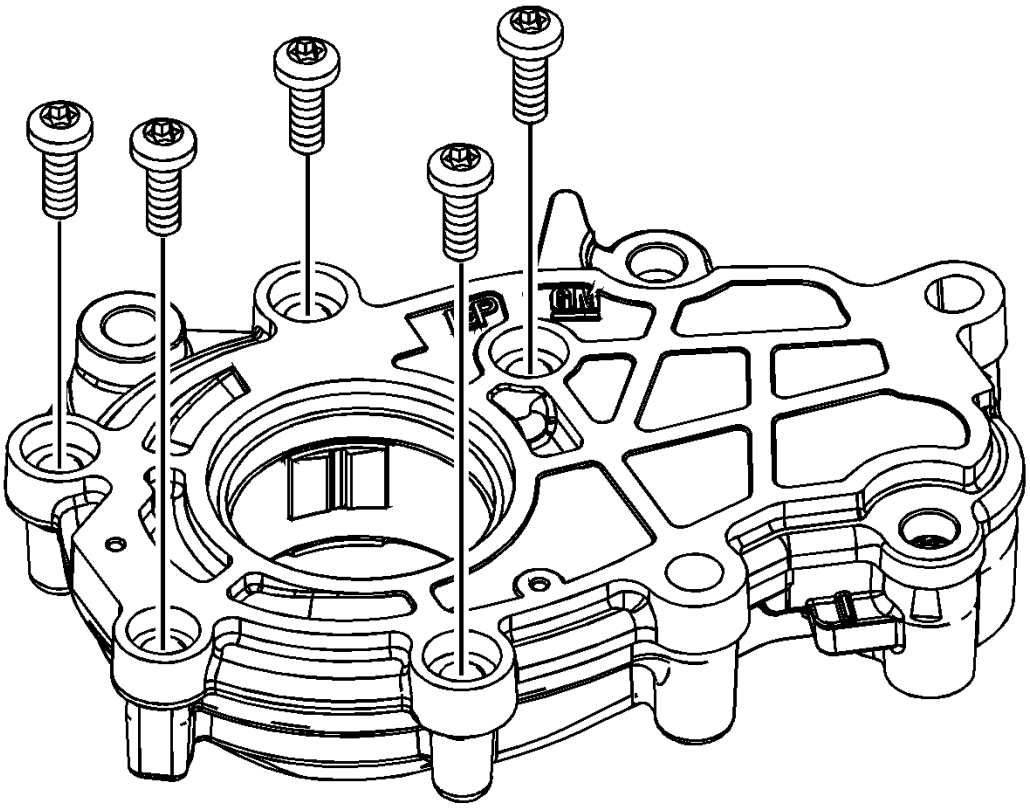

Fig. 246: View Of Oil Pump Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the bolts holding the oil pump cover to the oil pump housing.

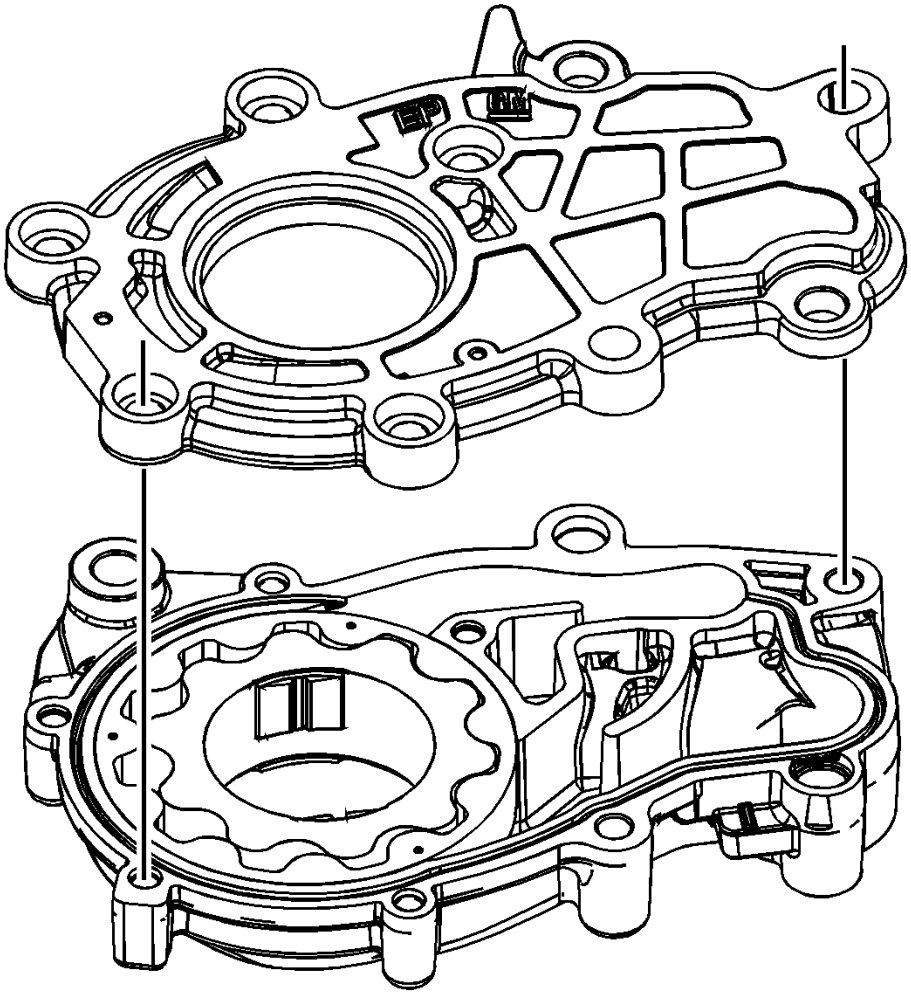

Fig. 247: View Of Oil Pump Housing & Cover
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil pump cover from the oil pump housing.

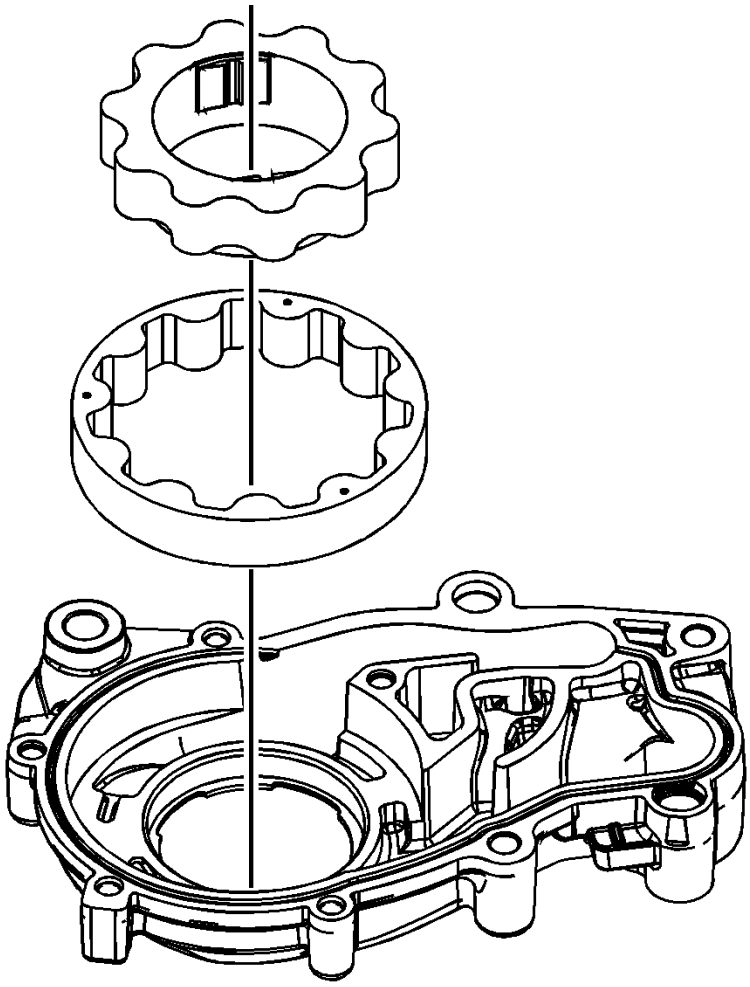

Fig. 248: Inner & Outer Rotors In Oil Pump Cover
Courtesy of GENERAL MOTORS COMPANY

6. Remove the inner oil pump drive gear.
7. Remove the outer oil pump driven gear.

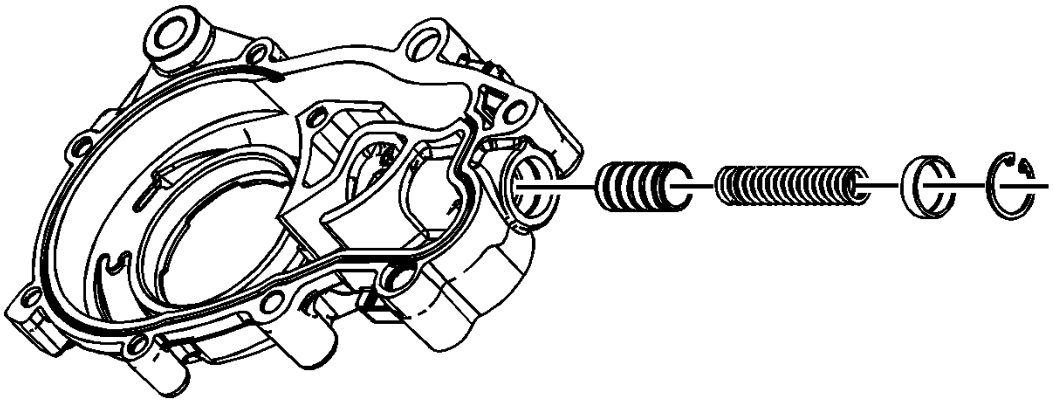

Fig. 249: Identifying Oil Pressure Relief Valve Components
Courtesy of GENERAL MOTORS COMPANY

8. Remove the clip, holding the cap, for the oil relief valve components.
9. Remove the cap, spring, and plunger from the oil pump housing.

OIL PUMP CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the oil pump components with non-corrosive solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the oil pump components with compressed air.

Inspection Procedure

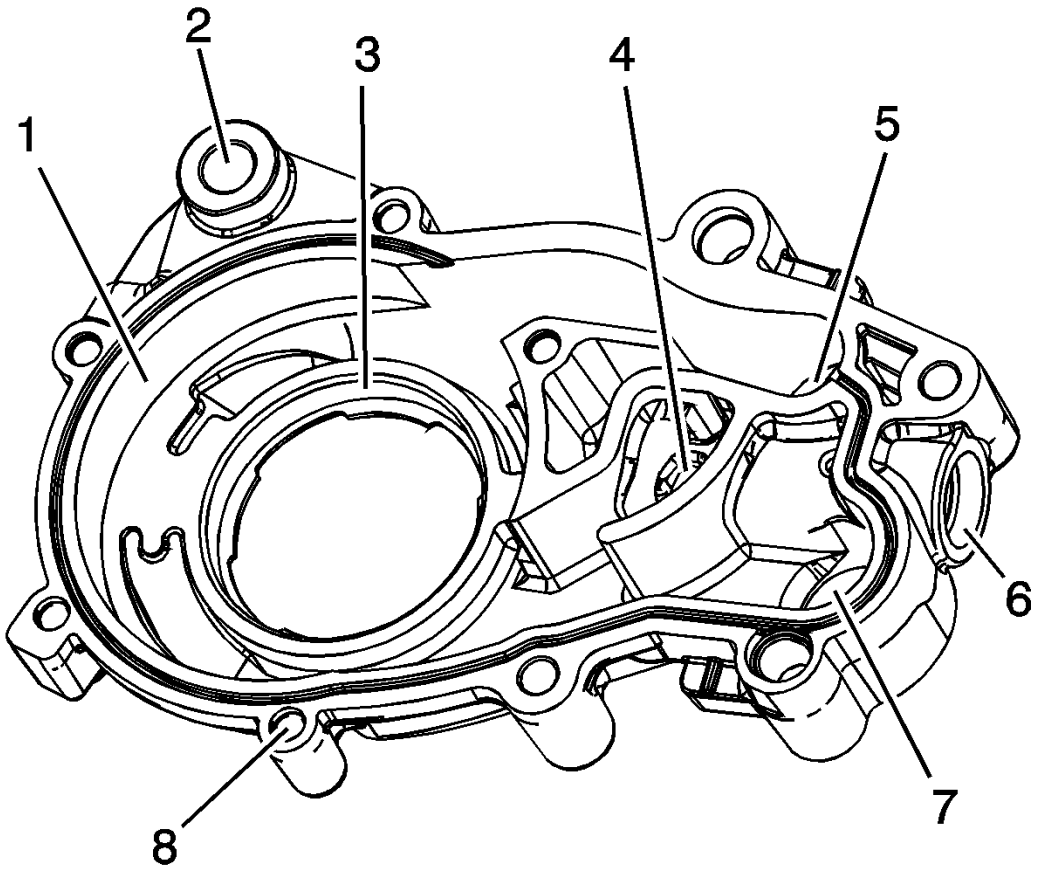

Fig. 250: Identifying Oil Pump Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

NOTE: **There are no serviceable components within the oil pump. Disassemble the pump only to diagnose an oiling concern. A disassembled oil pump must not be reused. A disassembled oil pump must be replaced.**

1. Inspect the oil pump housing for the following:
    - Damage, scoring, or debris on the housing surface for the driven gear (1)
    - Damage to the oil pump mounting bosses (2)
    - Damage, scoring, or debris on the housing surface for the drive gear (3)
    - Damage, scoring, or debris in the oil pump relief valve port (4)
    - Damage, scoring, or debris in the oil pump intake port (5)
    - Damage, scoring, or debris in the oil pump relief valve bore (6)
    - Damage, scoring, or debris in the oil pump output port (7)
    - Damage to the threads in the oil pump housing for the oil pump cover bolts (8)

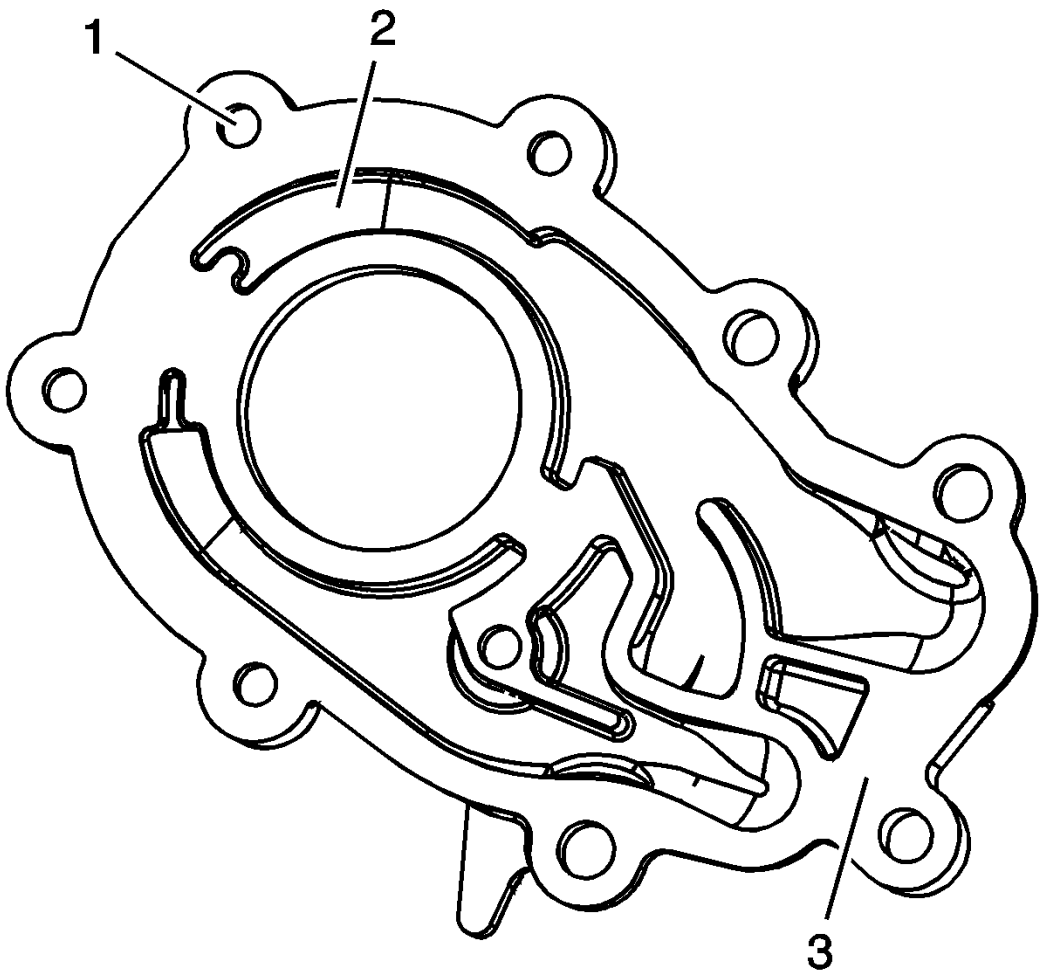

Fig. 251: View Of Oil Pump Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the oil pump cover for the following conditions:
    - Damage to the oil pump cover mounting bosses (1)
    - Damage, scoring, or debris in the oil pump cover oil passages (2)
    - Damage to the sealing surface between the oil pump cover and the oil pump housing (3)

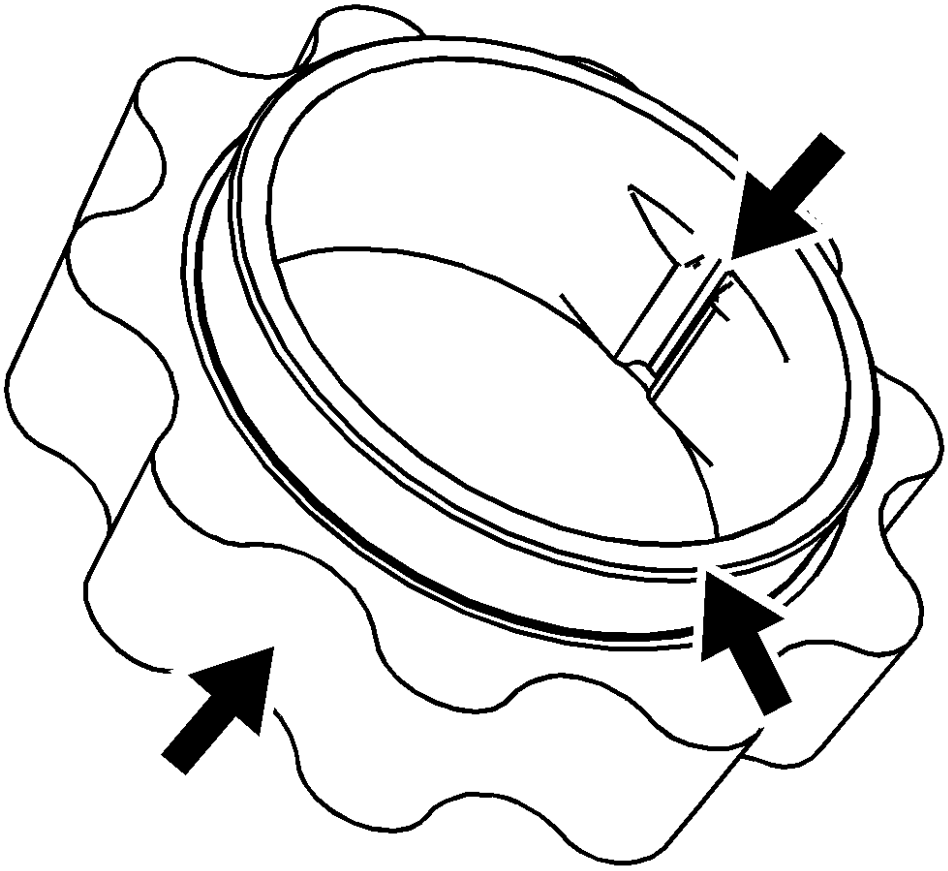

Fig. 252: View Of Inner Drive Gear Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the inner drive gear for damage. If inner diameter damage is found, ensure the crankshaft is also inspected.

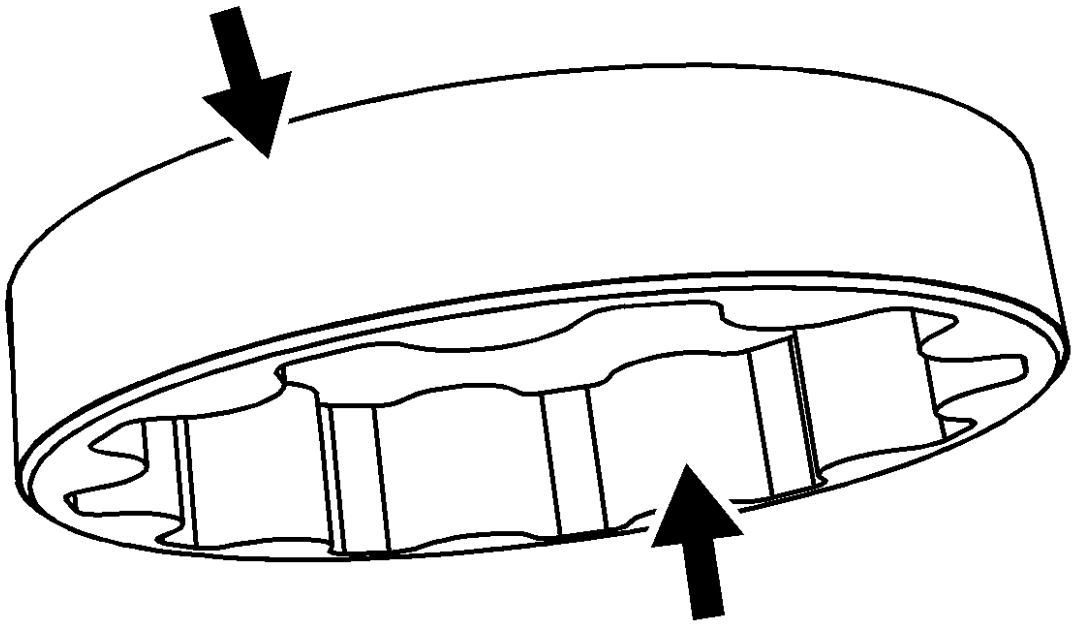

Fig. 253: Identifying Inspection Areas Inner/Outer Driven Gear
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the outer driven gear for damage.

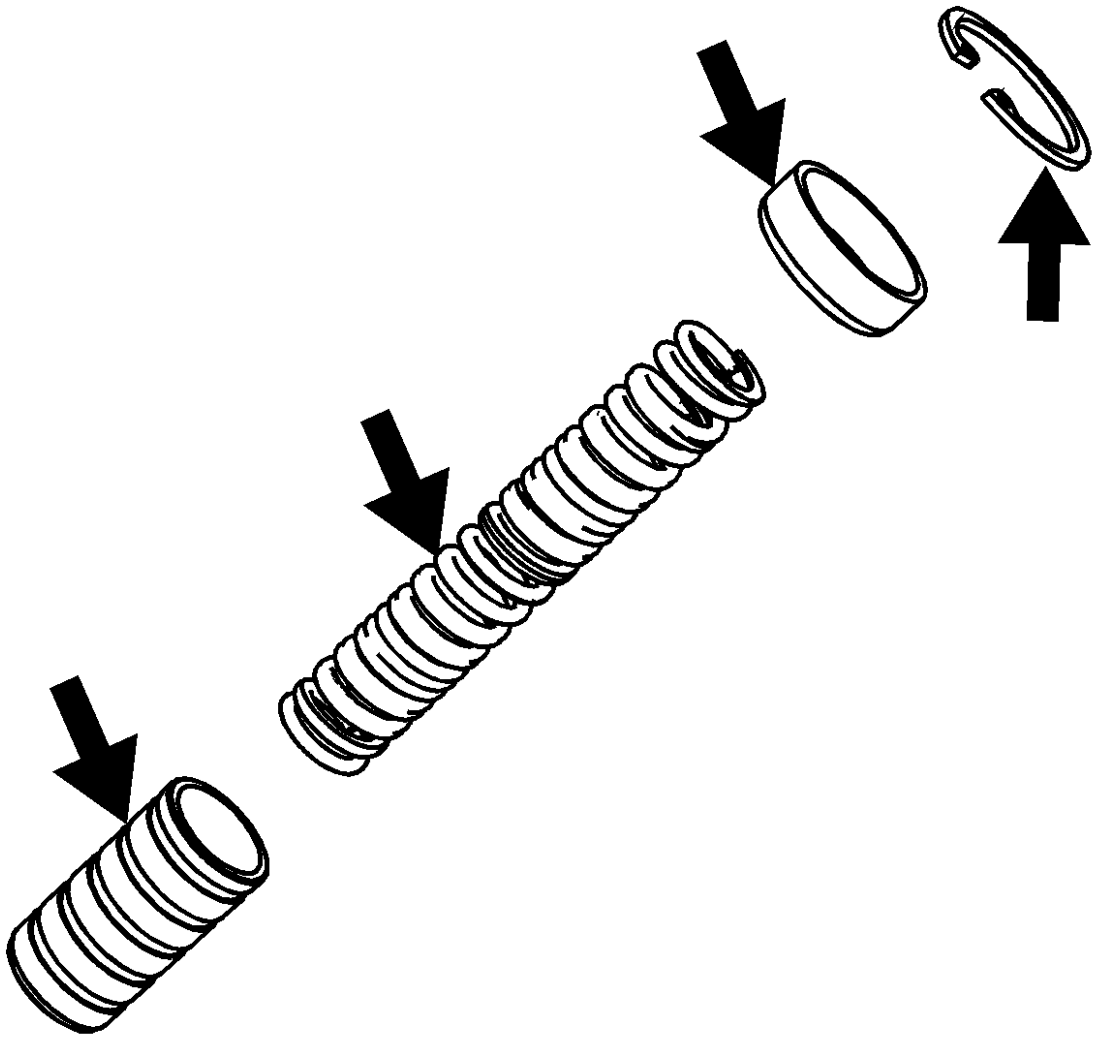

Fig. 254: Inspecting Oil Pump Relief Valve Components
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the oil pump relief valve components for debris or damage.

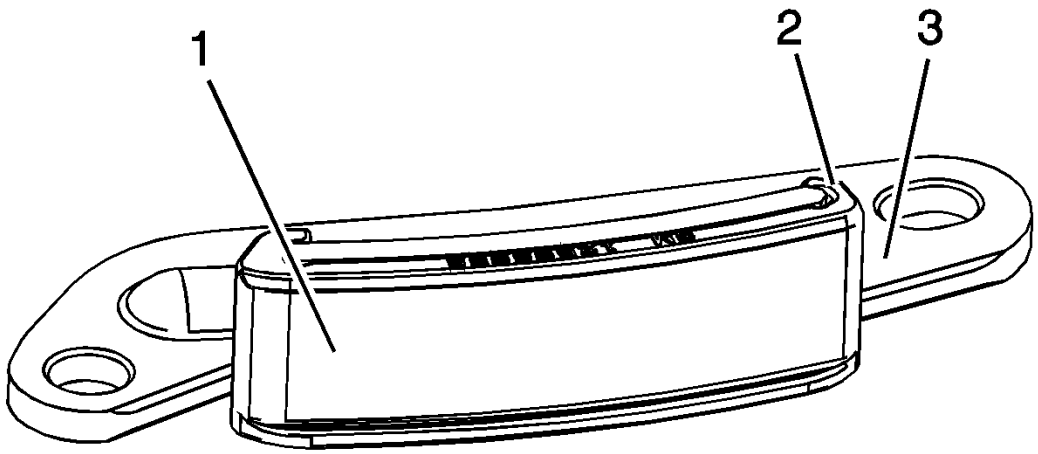

Fig. 255: View Of Primary Camshaft Drive Chain Lower Guide Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the primary camshaft drive chain lower guide for damage (1-3).
7. If debris or damage is present within the oil pump, further inspection of all of the engine components is necessary.

OIL FILTER ADAPTER DISASSEMBLE

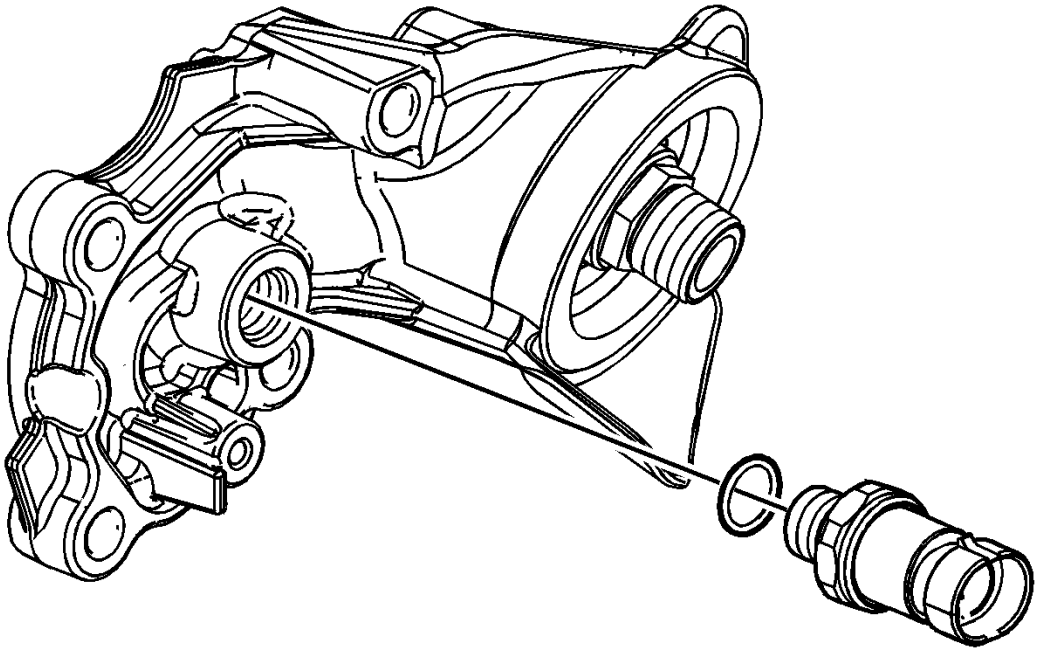

Fig. 256: Identifying Oil Pressure Sender
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pressure sender.

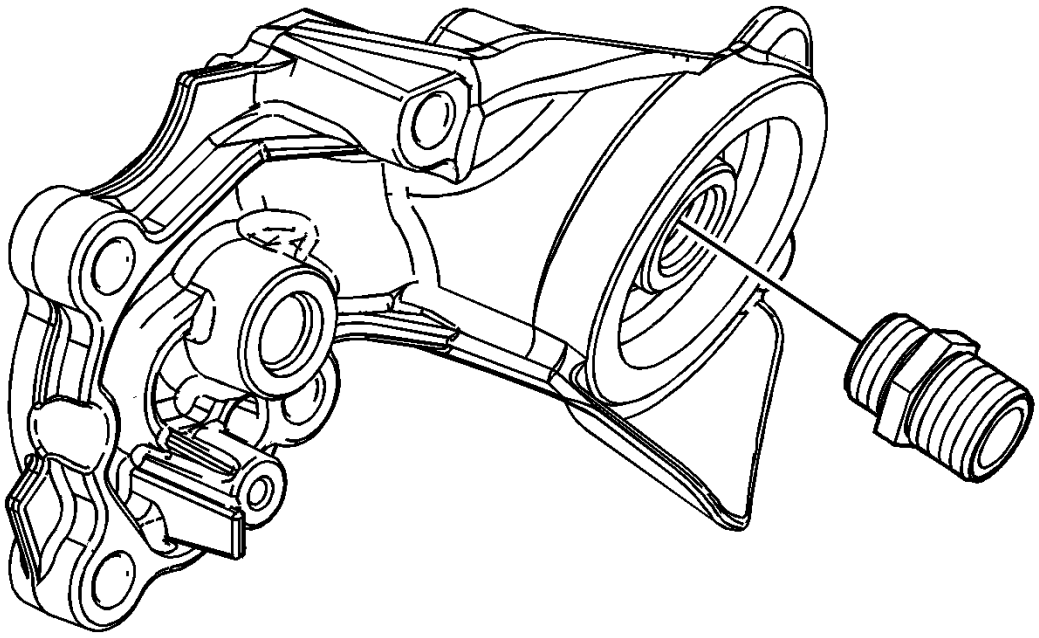

Fig. 257: Identifying Oil Filter Fitting
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil filter fitting.

OIL FILTER ADAPTER CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the oil filter adapter components with non-corrosive solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the oil filter adapter components with compressed air.

Inspection Procedure

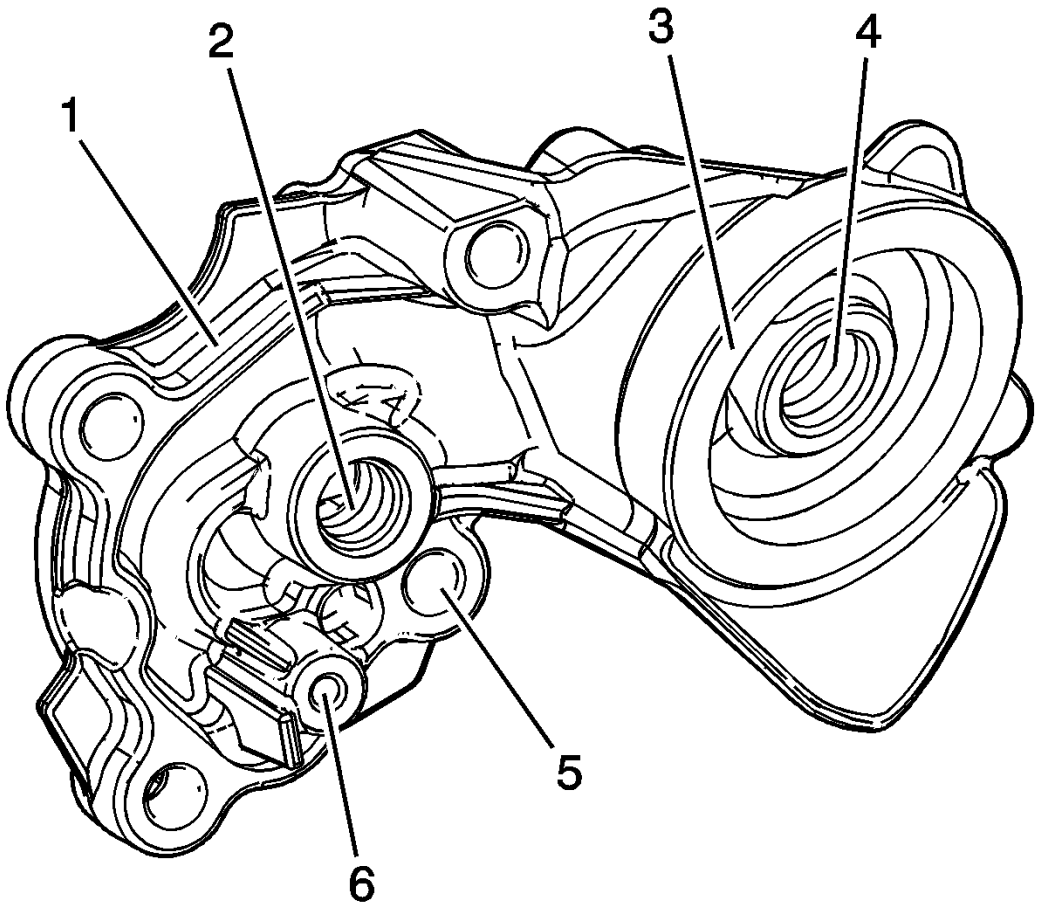

Fig. 258: Identifying Oil Filter Adapter Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The internal parts of the oil filter adapter housing are not serviced separately. If wear or damage is noted, replace the entire oil filter adapter assembly.**

1. Inspect the oil filter adapter housing for cracks, casting imperfections or damage (1).
2. Inspect the threads for the oil pressure sender (2) or the bracket (6) for damage.
3. Inspect the oil filter sealing surface (3) for damage.
4. Inspect the threads for the oil filter fitting (4) for damage.
5. Inspect the mounting holes (5) for damage.

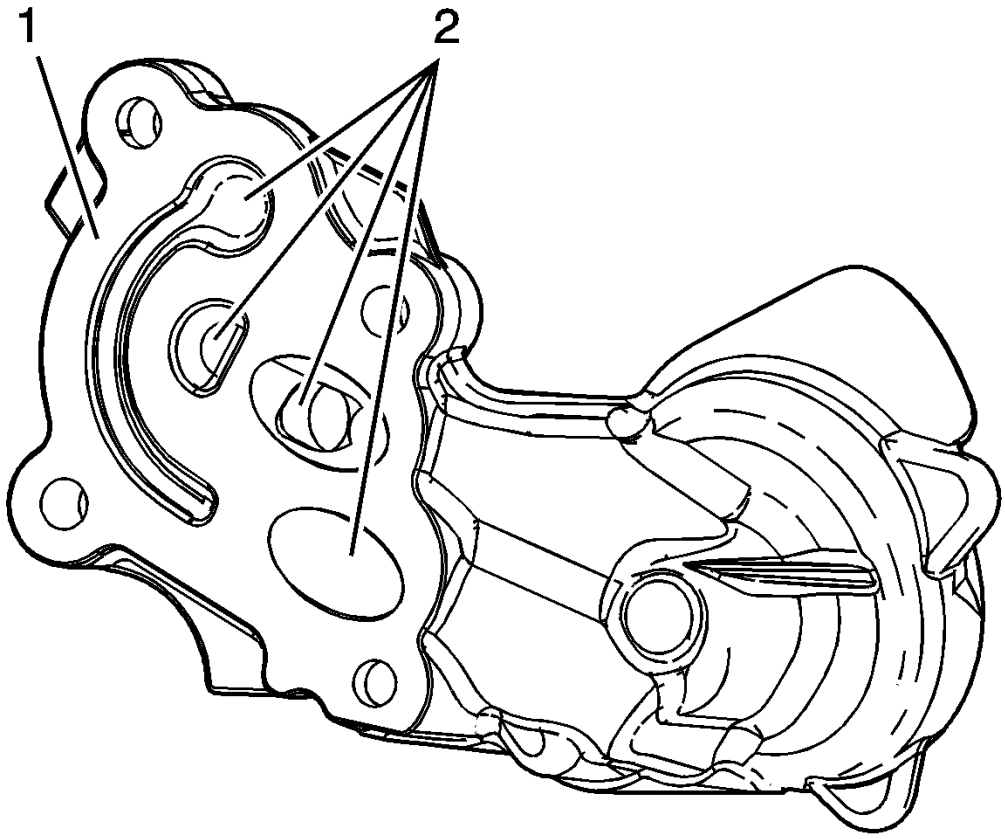

Fig. 259: Identifying Inspection Areas Of Oil Filter Adapter Housing Surfaces
Courtesy of GENERAL MOTORS COMPANY

6. Inspect the oil filter adapter housing gasket sealing surface (1) for damage.
7. Inspect the oil filter adapter housing passages (2) for damage or blockage.
8. Repair or replace the oil filter adapter housing as necessary.

OIL FILTER ADAPTER ASSEMBLE

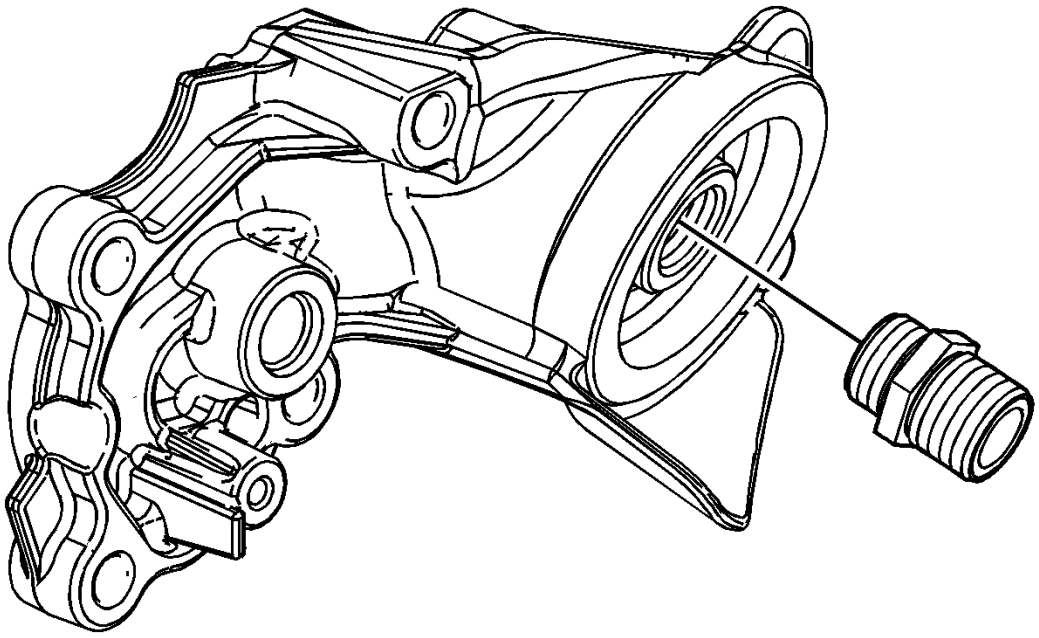

Fig. 260: Identifying Oil Filter Fitting
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the oil filter fitting and tighten to 50 N.m (37 lb ft).

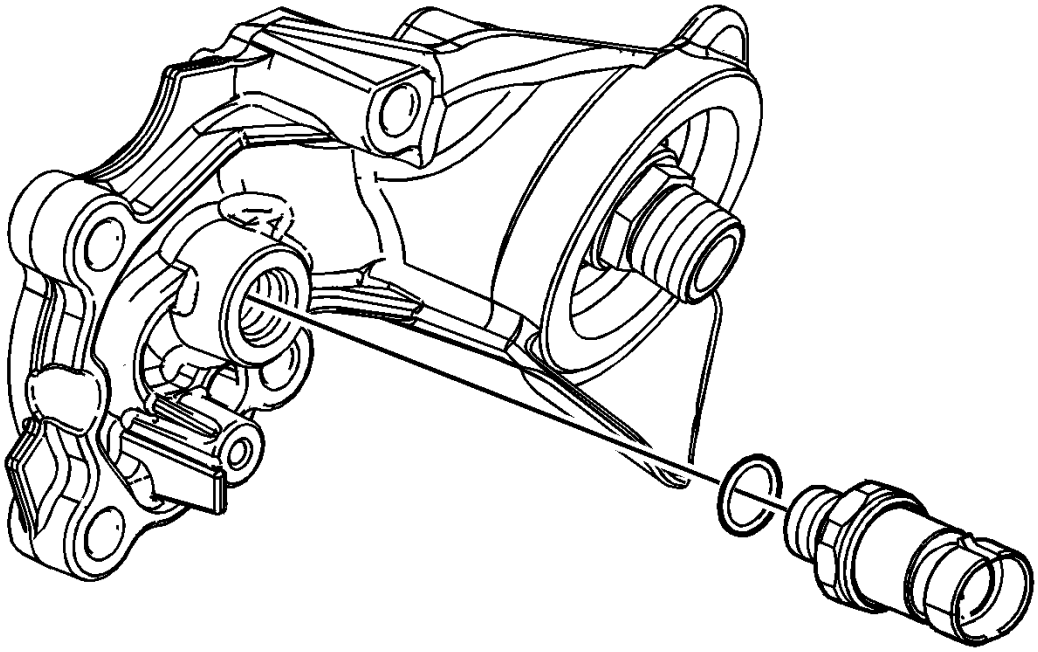

Fig. 261: Identifying Oil Pressure Sender
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil pressure sender and tighten to 20 N.m (15 lb ft).

OIL PAN DISASSEMBLE

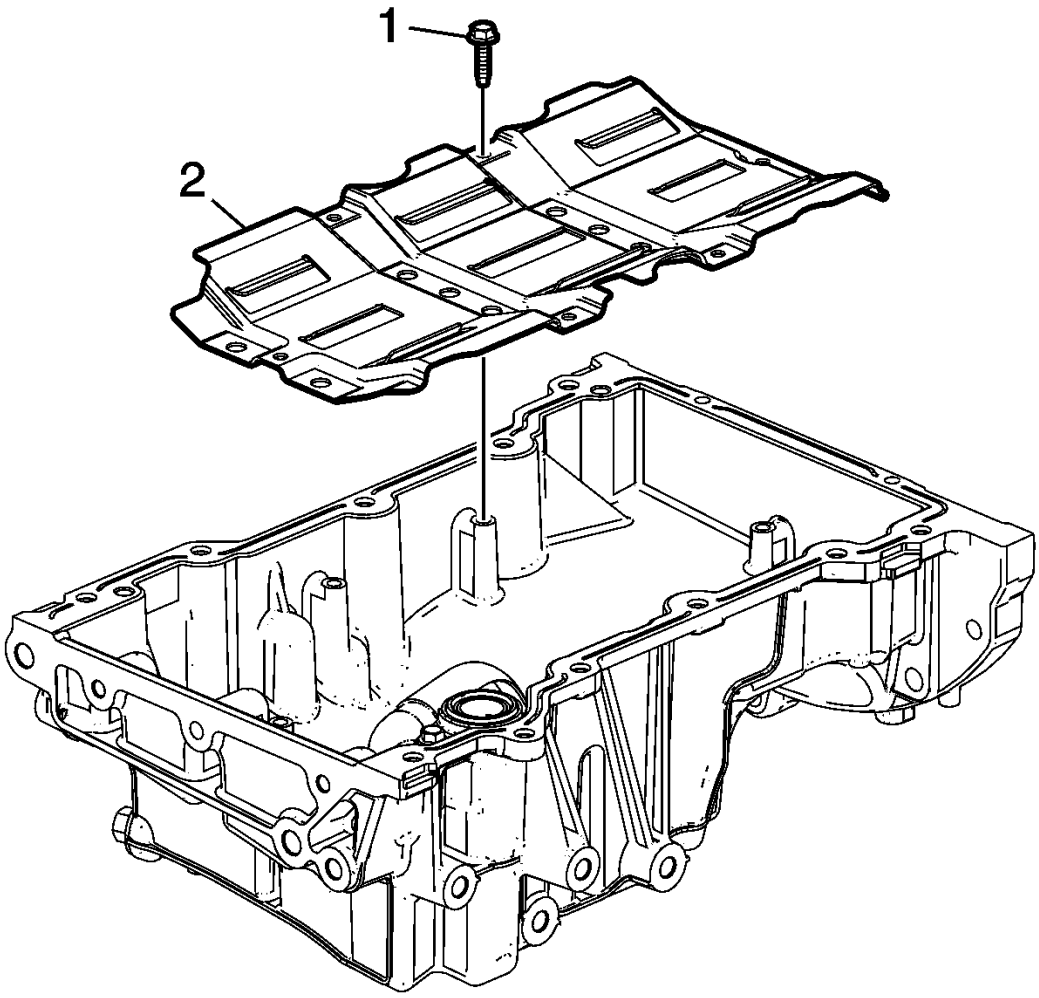

Fig. 262: View Of Oil Pan Scraper & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the oil pan scraper bolts (1).
2. Remove the oil pan scraper (2).

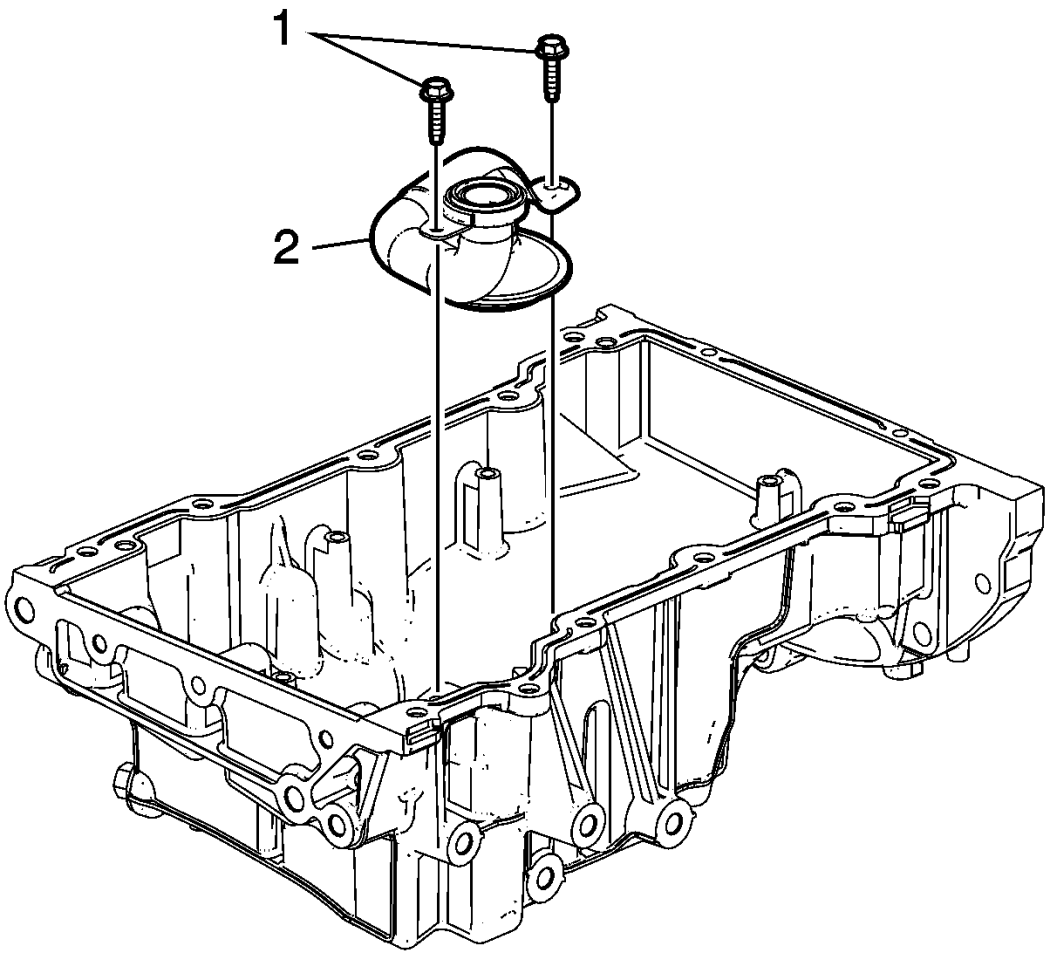

Fig. 263: View Of Oil Suction Pipe & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil suction pipe bolts (1).
4. Remove the oil suction pipe (2).

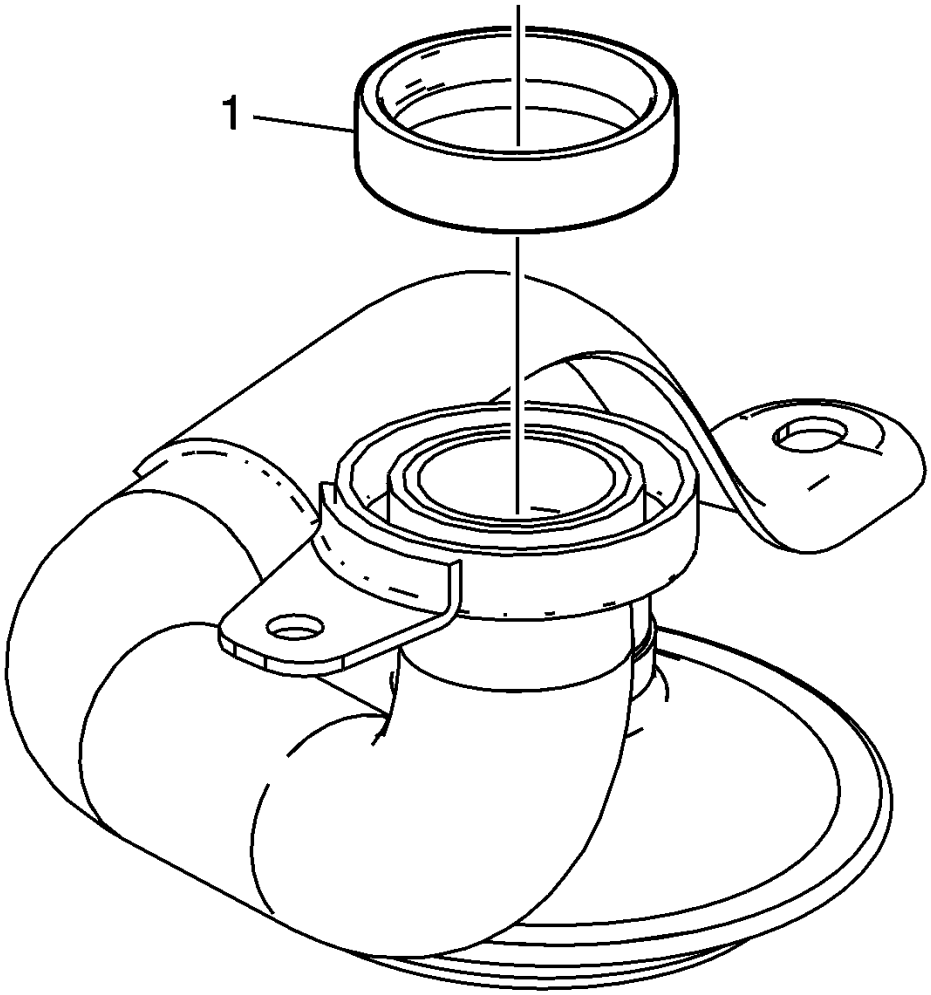

Fig. 264: View Of Oil Suction Pipe O-Ring
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil suction pipe O-ring (1).

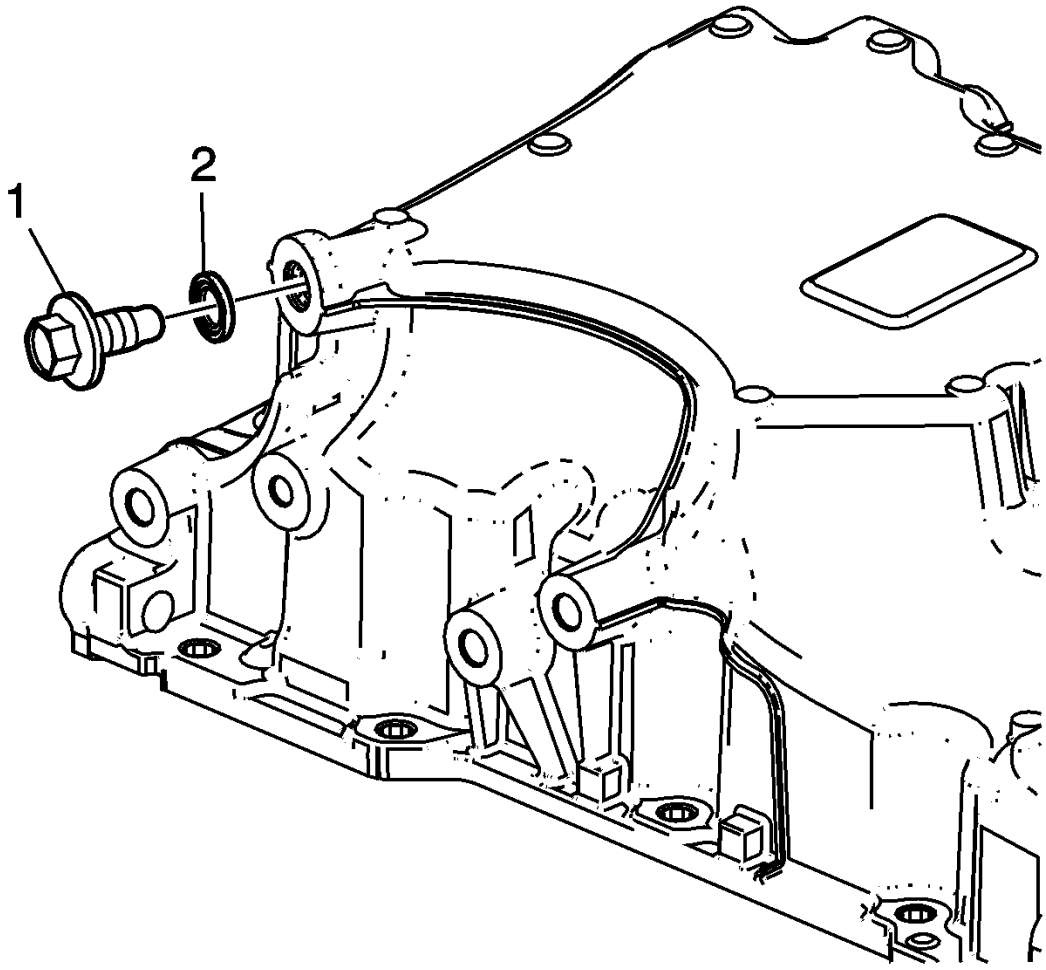

Fig. 265: View Of Oil Pan Drain Plug & Seal
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil pan drain plug (1) and seal (2).

OIL PAN CLEANING AND INSPECTION

Special Tools

EN-28410 Gasket Remover

For equivalent regional tools, refer to **Special Tools**

Cleaning Procedure

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
2. Remove any old thread sealant, gasket material or sealant using **EN-28410** remover.
3. Clean the oil pan and oil pan components in solvent.
4. Clean out debris from the bolt holes.

WARNING: Refer to Safety Glasses Warning .

5. Dry the oil pan and oil pan components with compressed air.

Inspection Procedure

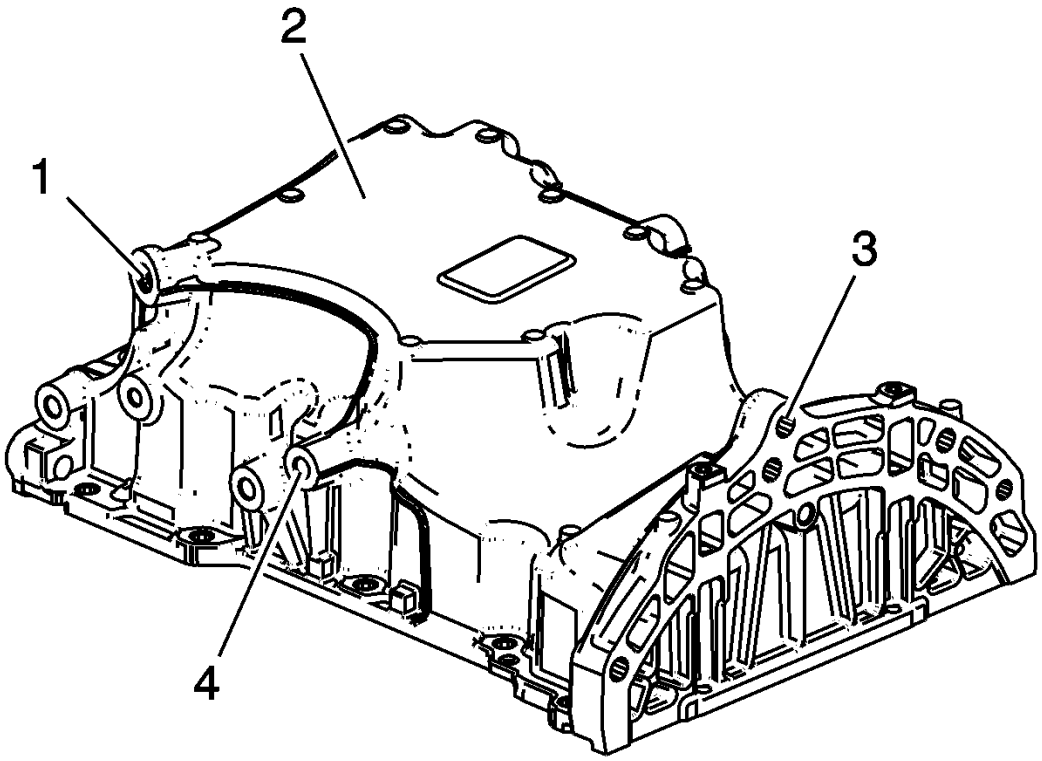

Fig. 266: Identifying Exterior Of Oil Pan
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the exterior of the oil pan for the following conditions:
   - Dents or damage to the exterior (2)
   - Damage to the drain plug or drain plug hole (1)
   - Damage to the transaxle brace mounting bosses (4)
   - Damage to the transaxle mounting bosses (3)

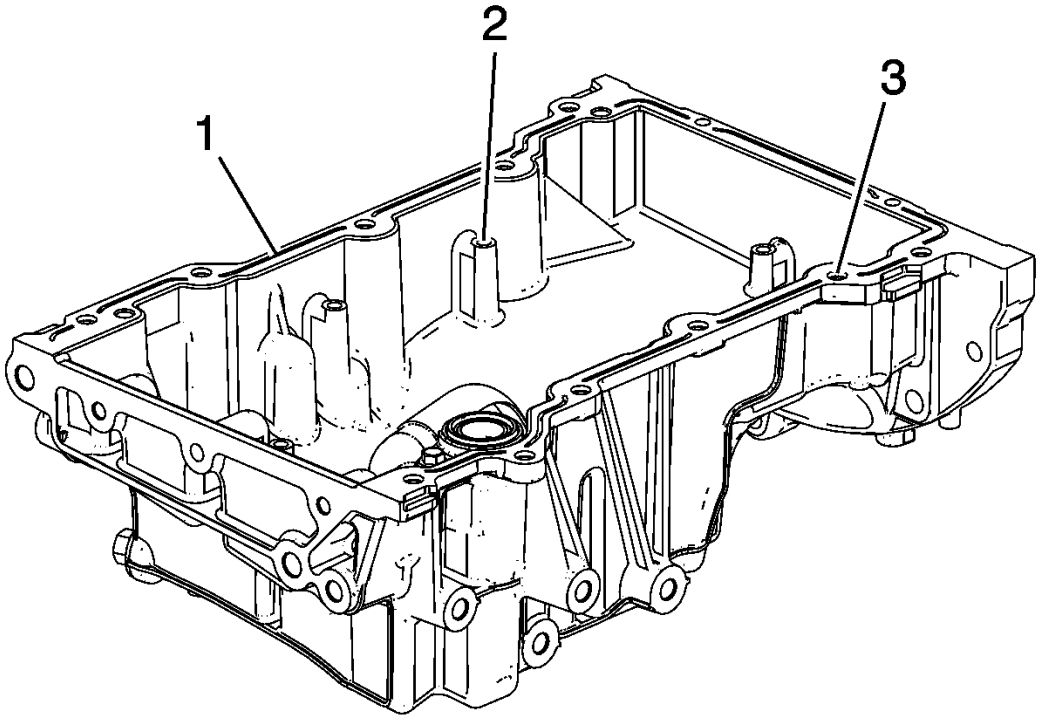

Fig. 267: View Of Interior Of Oil Pan
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the interior of the oil pan for the following conditions:
    - Gouges or damage to the oil pan sealing surfaces (1)
    - Damage to the oil pan scraper mounting holes (2)
    - Damage to the bolt holes (3)
3. Repair or replace the oil pan and/or oil pan components as necessary.

OIL PUMP SUCTION PIPE AND SCREEN CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the oil pump pipe and screen with solvent.

    WARNING: Refer to Safety Glasses Warning .

2. Dry the oil pump pipe and screen with compressed air.

Inspection Procedure

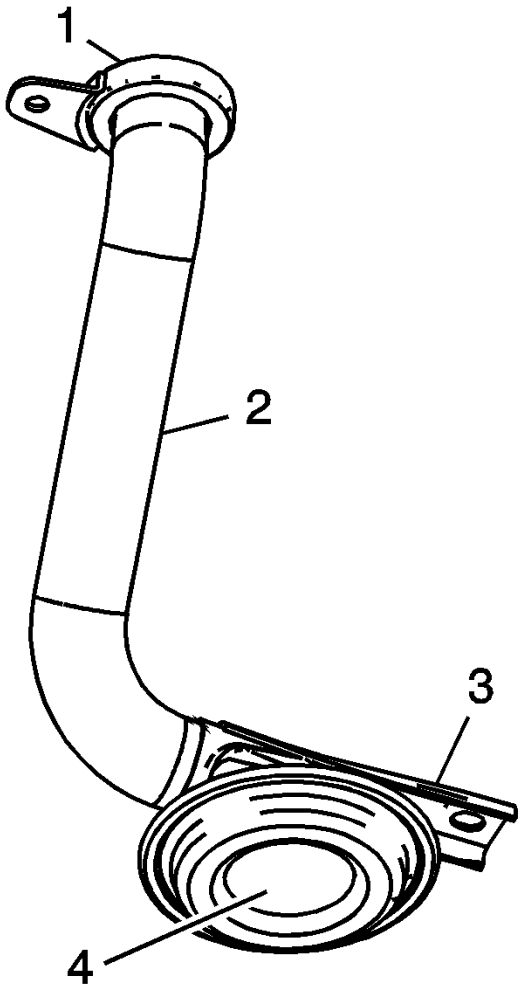

Fig. 268: Inspecting Oil Pump Pipe
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the mounting surface (1) for possible leakage paths.
2. Inspect the oil pump pipe tube (2) for cracks, imperfections and/or damage.
3. Inspect the oil pump pipe support bracket (3) for cracks or damage.
4. Inspect the oil pump screen (4) for blockage, foreign material, tears, cracks and/or damage.

OIL PAN ASSEMBLE

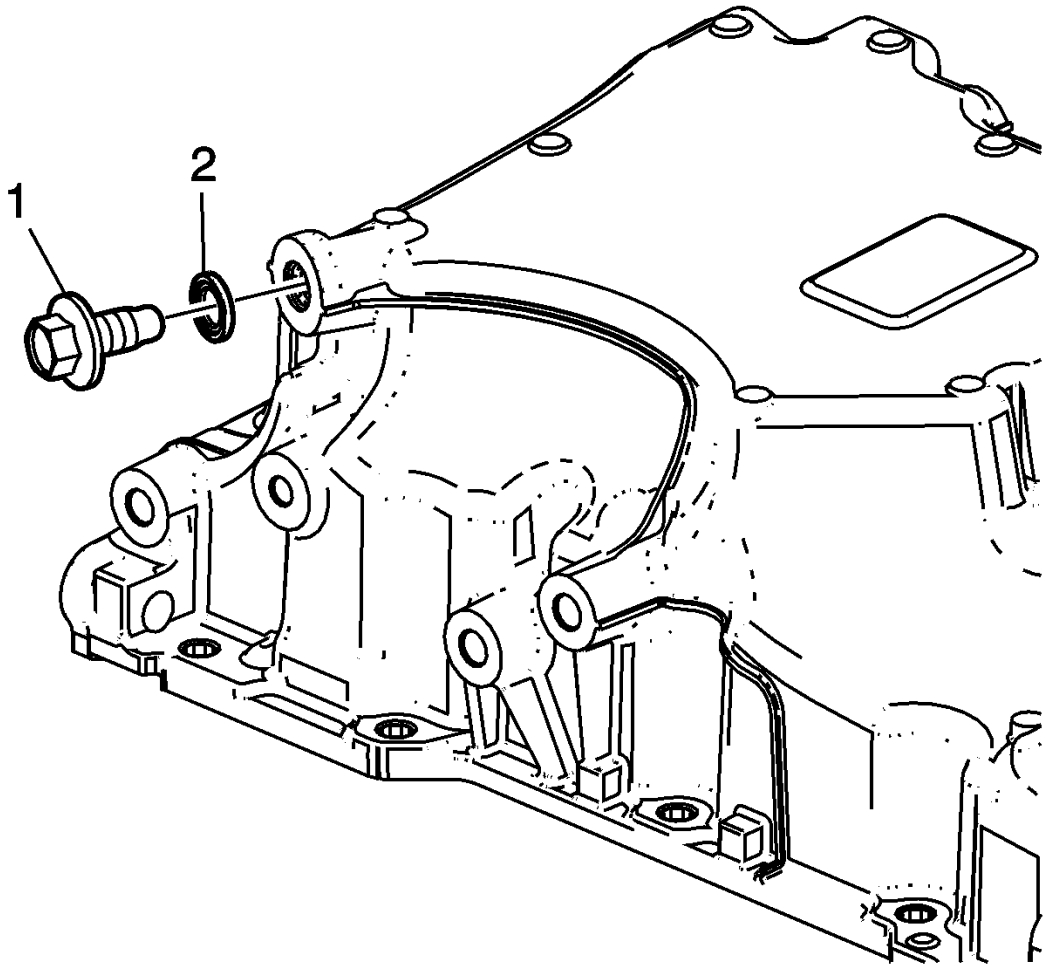

Fig. 269: View Of Oil Pan Drain Plug & Seal
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the oil pan drain plug (1) and NEW O-ring seal (2) and tighten to 25 N.m (18 lb ft).

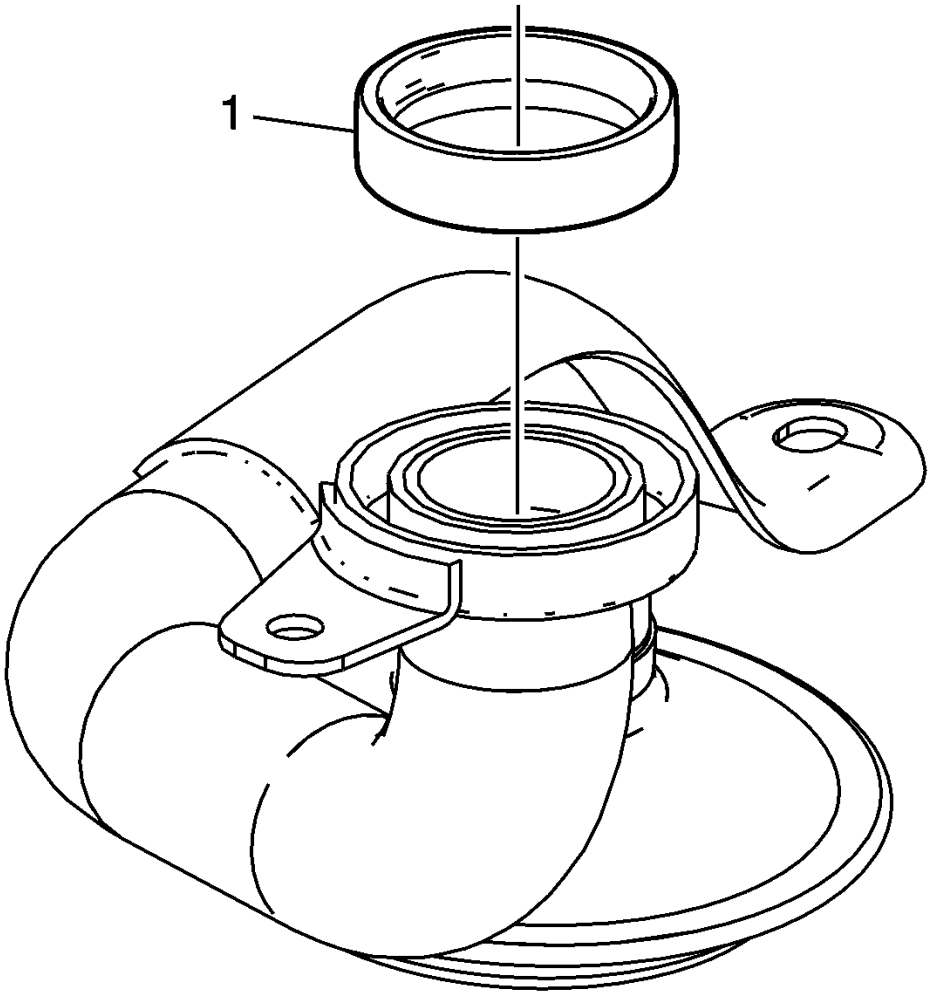

Fig. 270: View Of Oil Suction Pipe O-Ring
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW oil suction pipe O-ring (1).

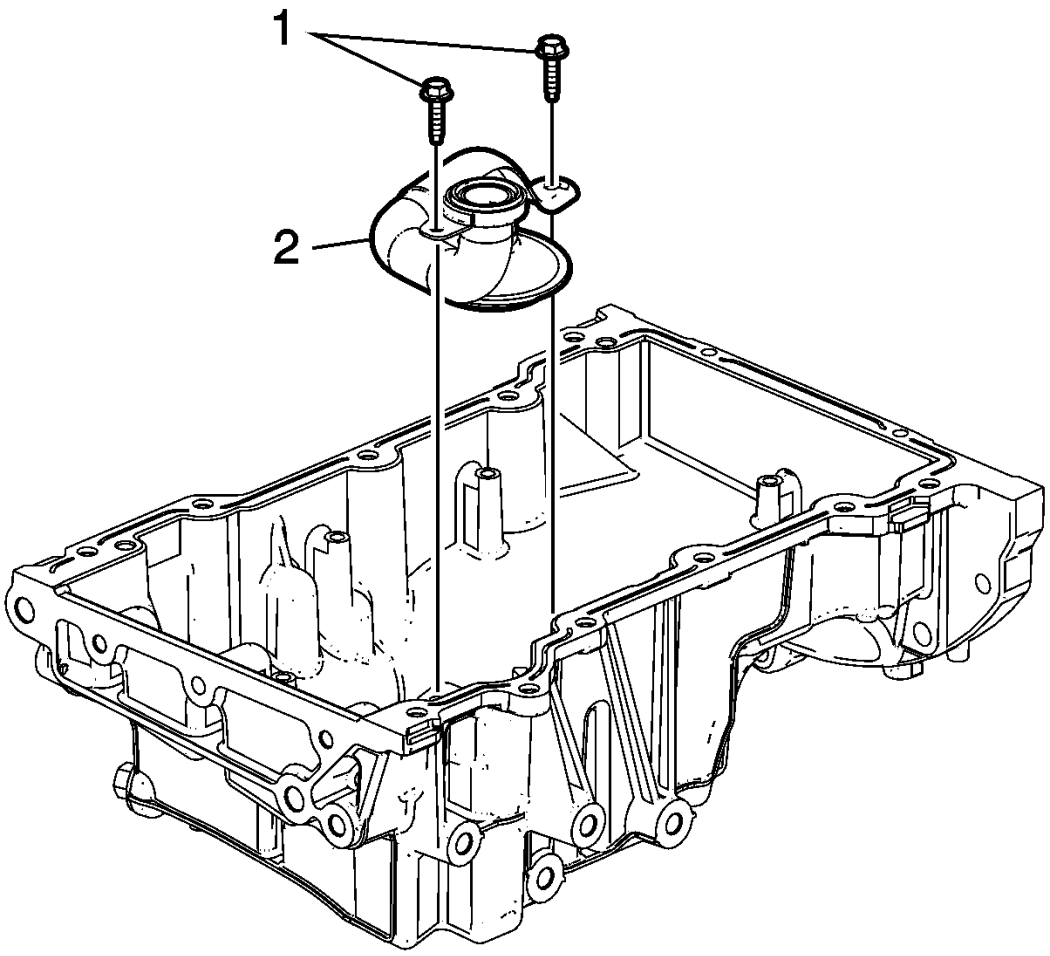

Fig. 271: View Of Oil Suction Pipe & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the oil suction pipe (2).
4. Install the oil suction pipe bolts (1) and tighten to 10 N.m (89 lb in).

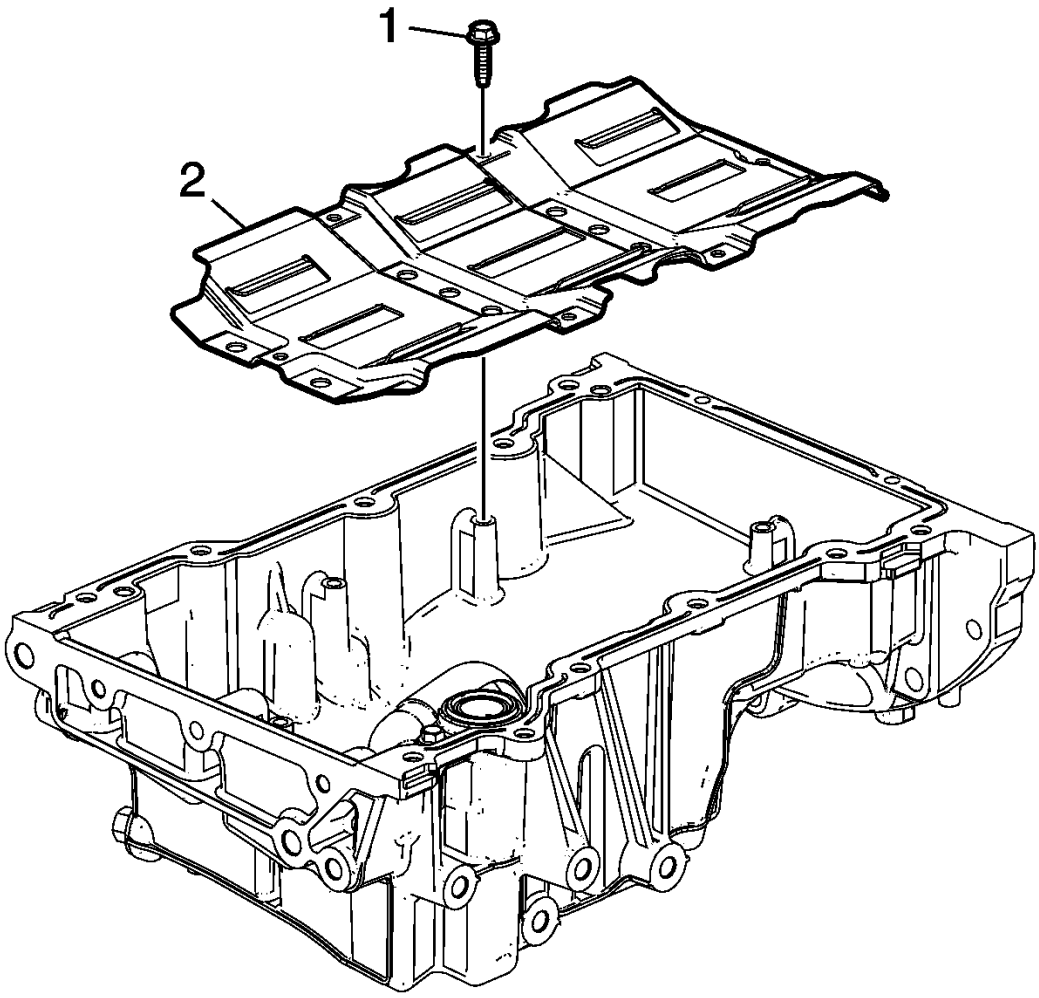

Fig. 272: View Of Oil Pan Scraper & Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the oil pan scraper (2).
6. Install the oil pan scraper bolts (1) and tighten to 10 N.m (89 lb in).

ENGINE FRONT COVER DISASSEMBLE

Special Tools

EN 45000 Seal Remover

For equivalent regional tools, refer to **Special Tools**

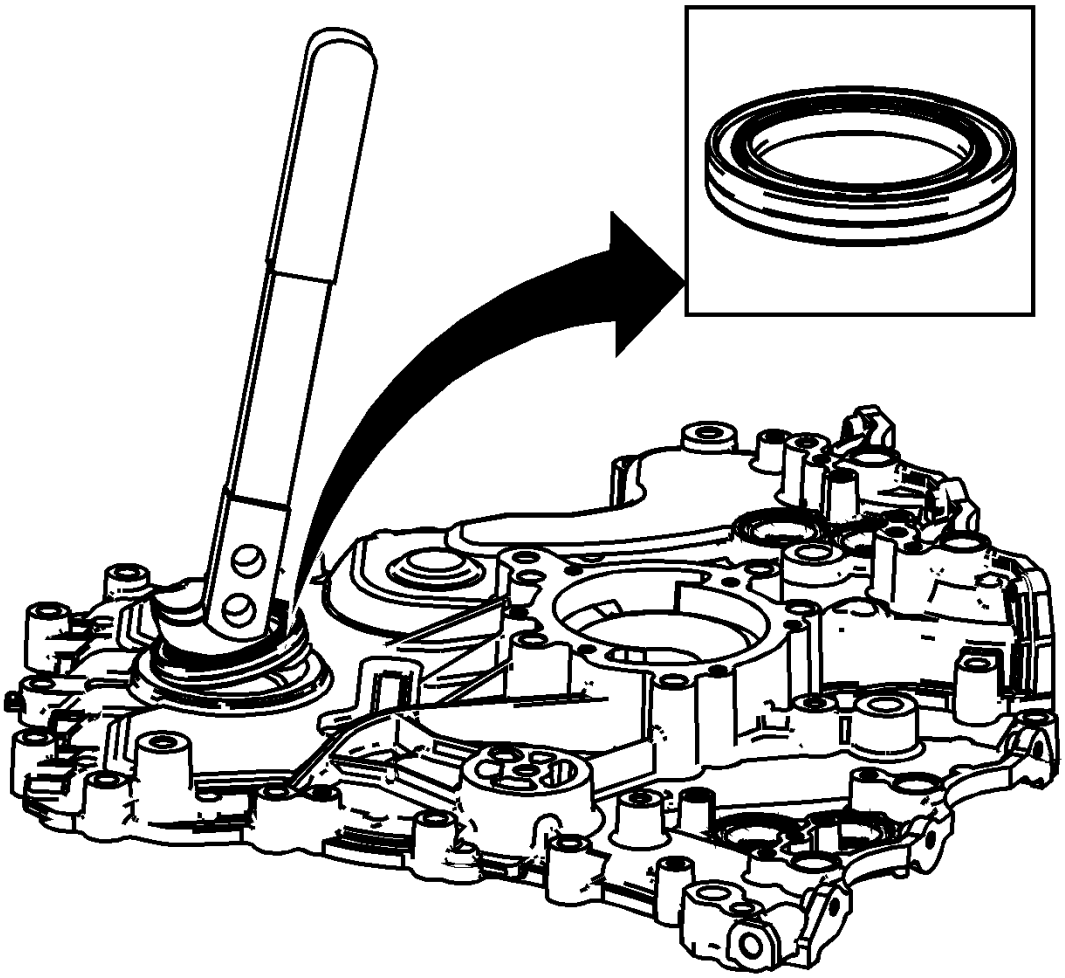

Fig. 273: Identifying Crankshaft Front Oil Seal & Removal Tool
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft front oil seal from the engine front cover using the **EN 45000** remover.

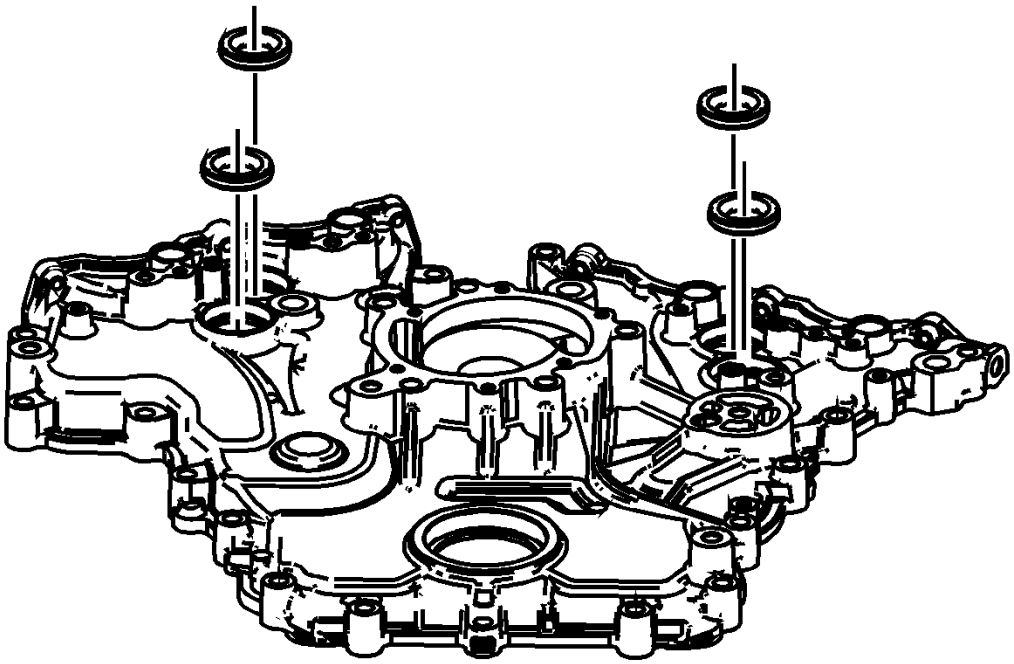

Fig. 274: View Of Camshaft Position Actuator Valve Oil Seals
Courtesy of GENERAL MOTORS COMPANY

2. Remove the camshaft position actuator valve oil seals from the engine front cover.

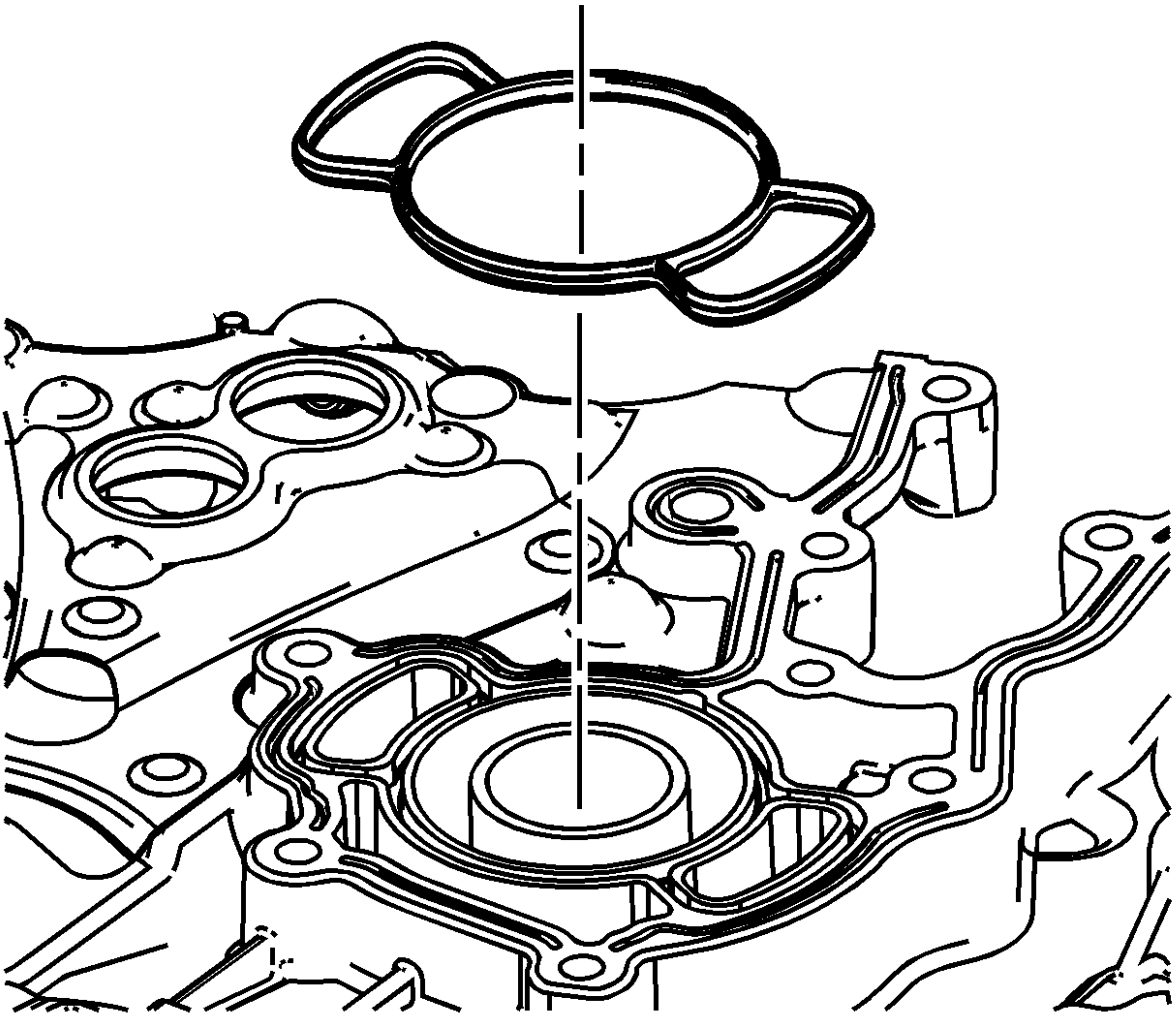

Fig. 275: Identifying Water Pump Seal
Courtesy of GENERAL MOTORS COMPANY

3. Remove the water pump seal from the engine front cover.
4. Discard the water pump seal.

ENGINE FRONT COVER CLEANING AND INSPECTION

Special Tools

EN-28410 Gasket Remover

For equivalent regional tools, refer to **Special Tools** .

Cleaning Procedure

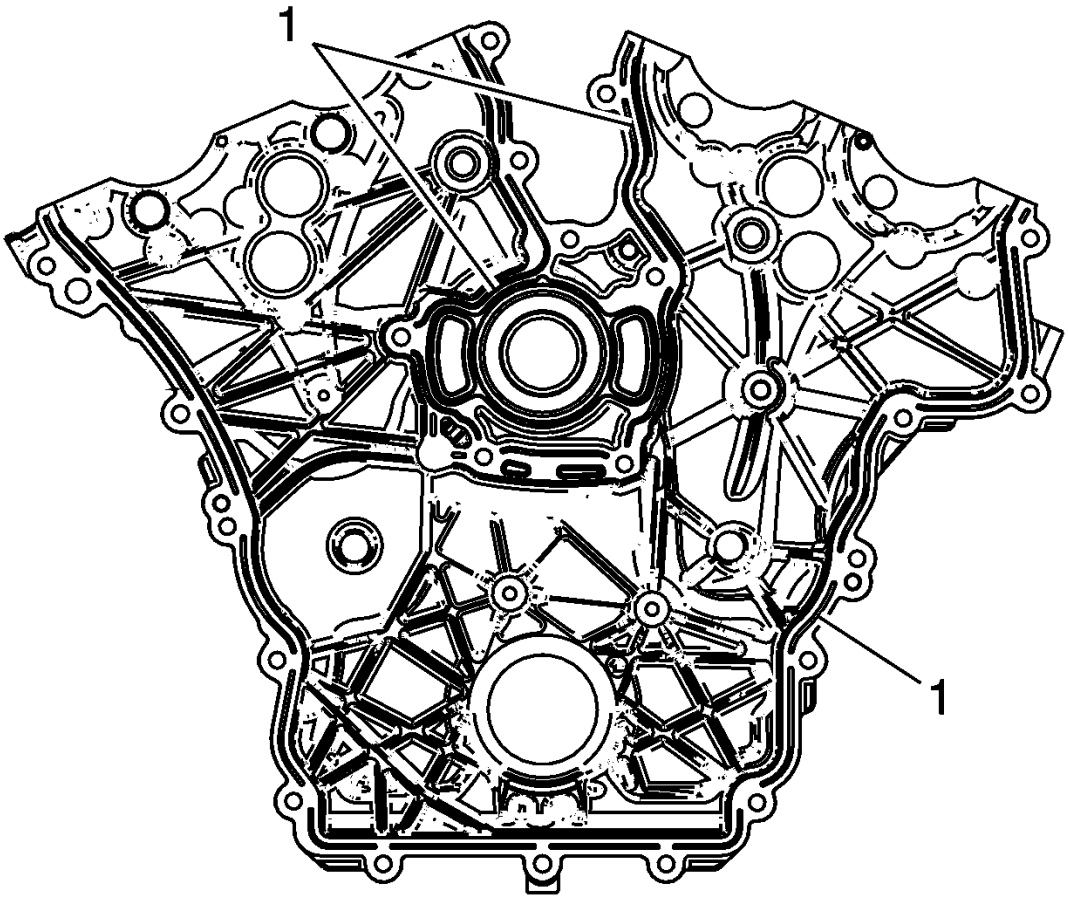

Fig. 276: Sealant On Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**

   Remove any RTV sealant (1) from the engine front cover using **EN-28410** remover.

2. Clean out debris from the bolt holes.
3. Clean the engine front cover in solvent.

   WARNING: Refer to Safety Glasses Warning .

4. Dry the engine front cover with compressed air.

Inspection Procedure

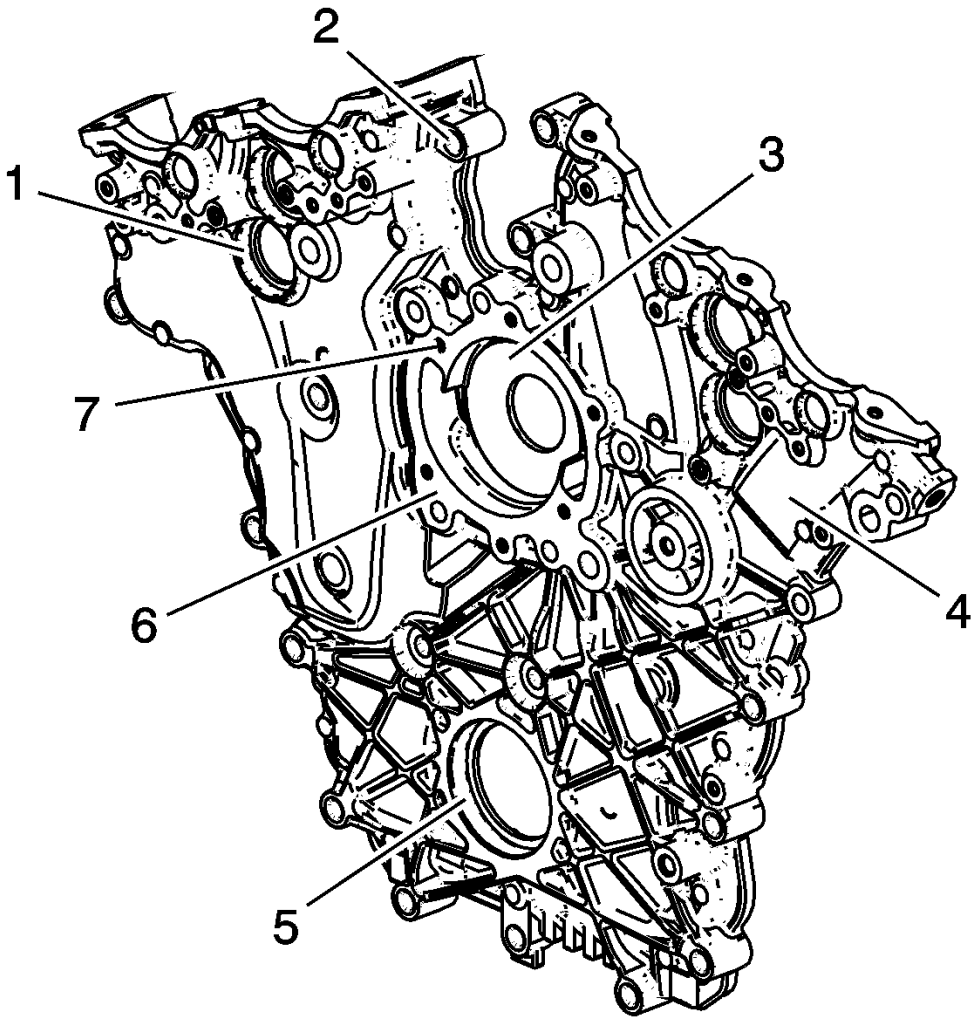

Fig. 277: View Of Exterior Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the exterior of the engine front cover for the following conditions:
    - Damage to the water pump bolt hole threads (7)
    - Gouges or damage to the water pump sealing surfaces (6)
    - Damage to the crankshaft front oil seal bore (5)
    - Damage to the camshaft position actuator valve oil seal bores (1)
    - Damage to the engine front cover bolt holes (2)
    - Damage and/or corrosion to the engine coolant passage (3)
    - Dents or damage to the exterior (4)

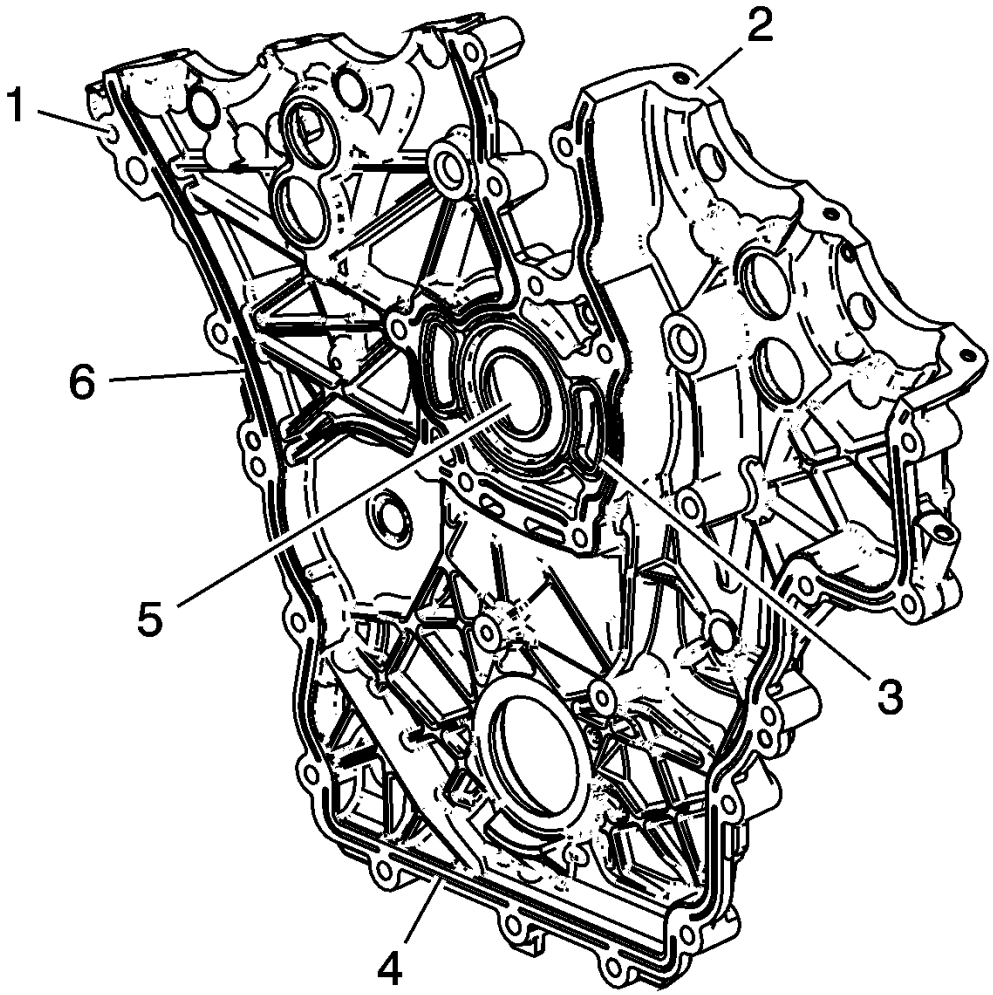

Fig. 278: View Of Interior Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the interior of the engine front cover for the following conditions:
    - Gouges or damage to the engine front cover sealing surfaces to the engine block (6), oil pan (4), and/or camshaft covers (2)
    - Damage and/or corrosion to the engine coolant passage (5)
    - Damage to the crankshaft front oil seal bore
    - Gouges or damage to the O-ring sealing areas
    - Gouges or damage to the water pump seal area (3)
    - Damage to the engine front cover bolt holes (1)
3. Repair or replace the engine front cover as necessary.

ENGINE FRONT COVER ASSEMBLE

Special Tools

- **EN 29184** Oil Seal Installer

- **EN 46103** Camshaft Actuator Valve Seal Installer

For equivalent regional tools, refer to **Special Tools** .

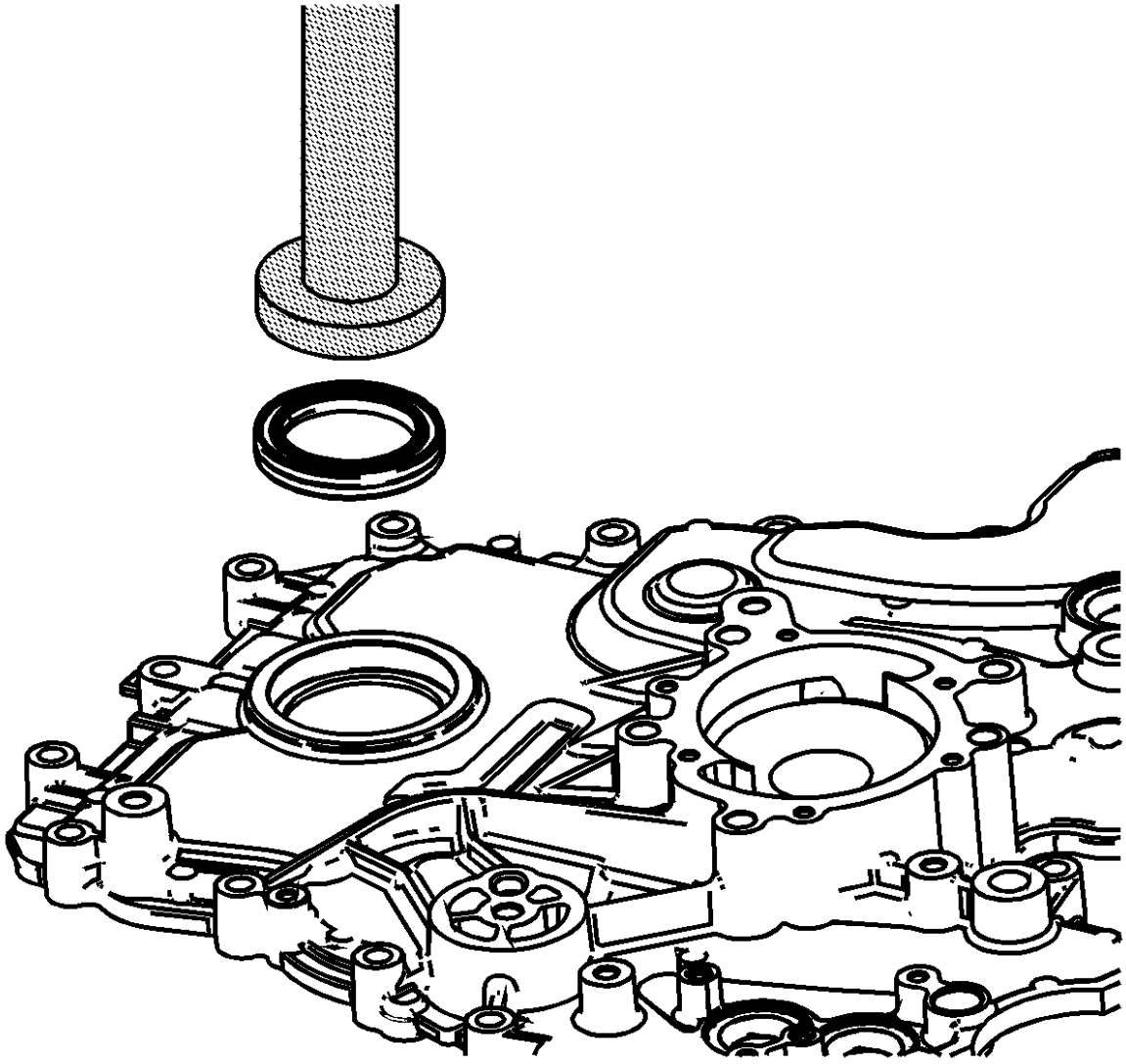

Fig. 279: View of Crankshaft Front Oil Seal Assembly
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.

1. Install the NEW crankshaft front oil seal into the engine front cover using the **EN 29184** installer.

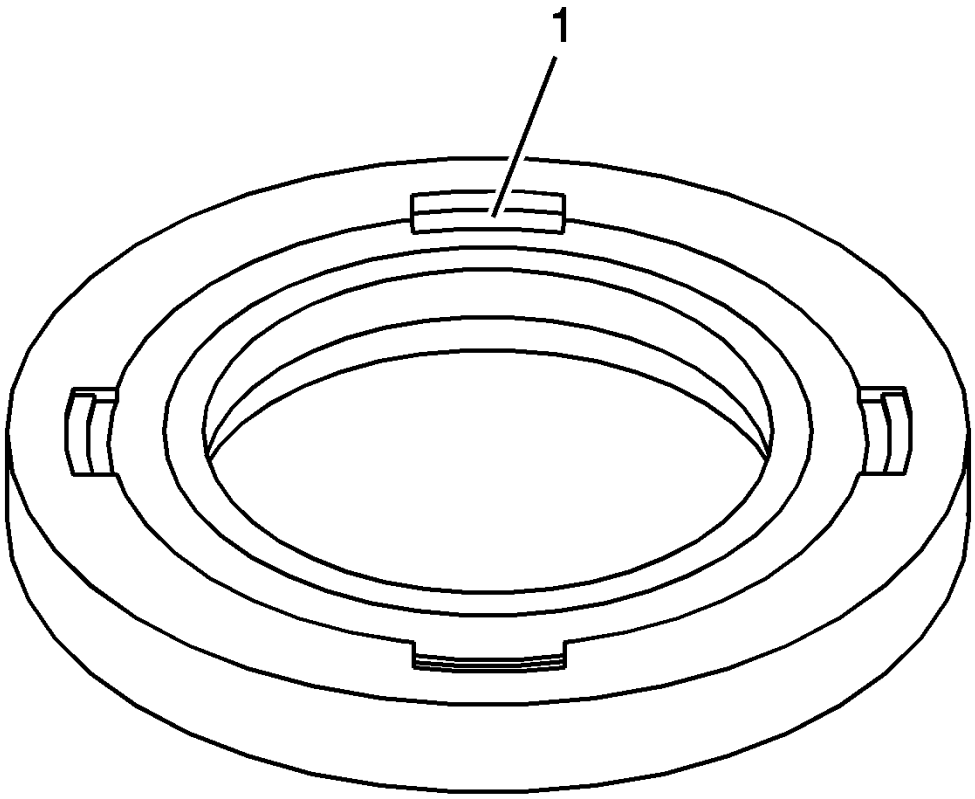

Fig. 280: View of Crankshaft Front Oil Seal Notches
Courtesy of GENERAL MOTORS COMPANY

2. Place the seal into position with the notches (1) in the seal down. The notches (1) will face inboard when properly installed.

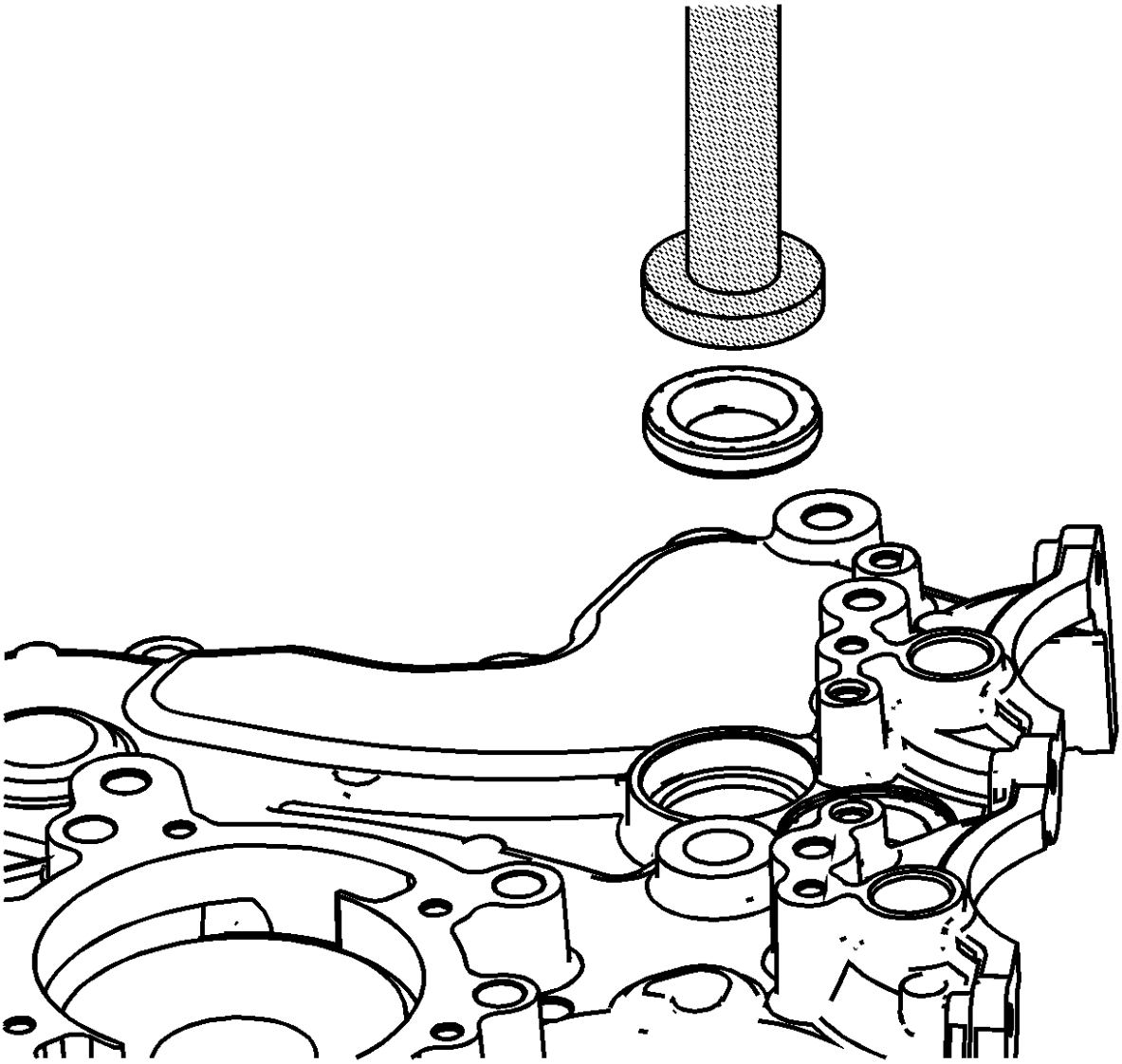

Fig. 281: Installing Camshaft Position Actuator Valve Oil Seals
Courtesy of GENERAL MOTORS COMPANY

3. Install the NEW camshaft position actuator valve oil seals into the engine front cover using the **EN 46103** installer.

CAMSHAFT COVER DISASSEMBLE

Left Camshaft Cover

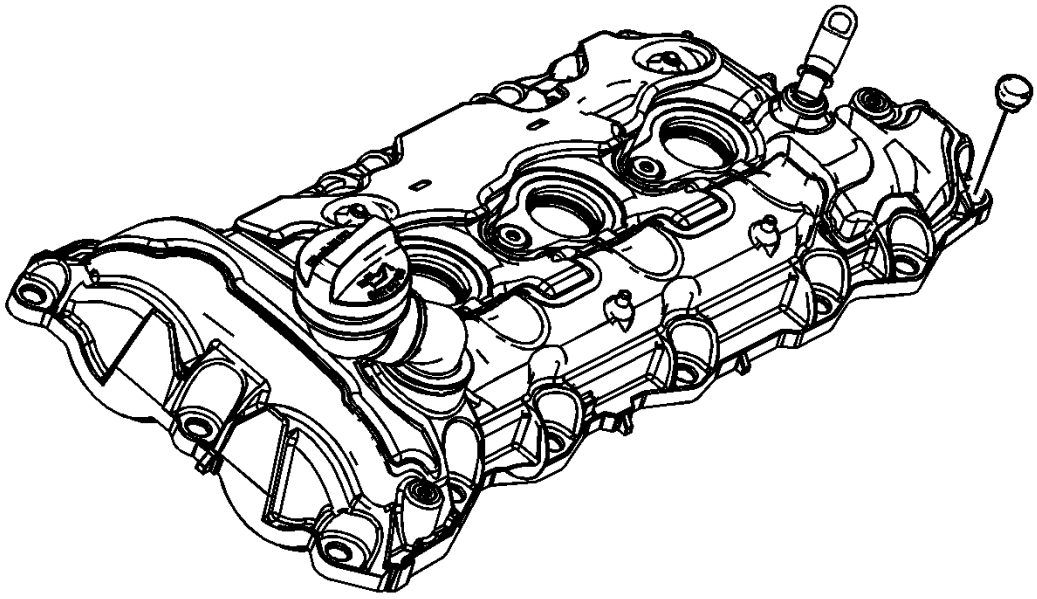

Fig. 282: View of Left Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

1. Remove and discard the left camshaft cover bolt grommets.

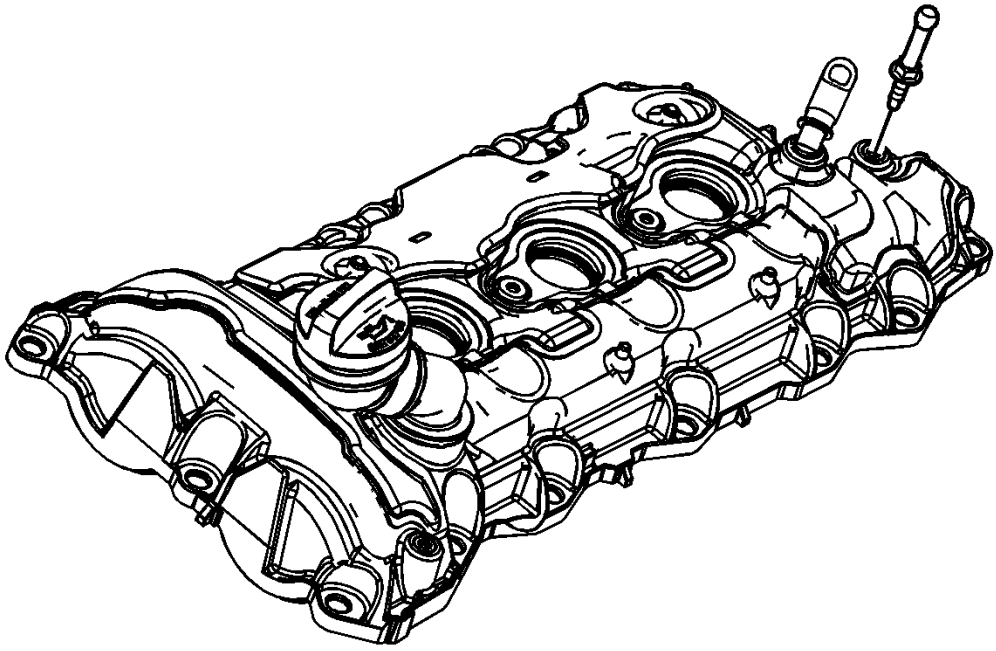

Fig. 283: View of Fuel Injector Sight Shield Cover Ballstud
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fuel injector sight shield ballstud.

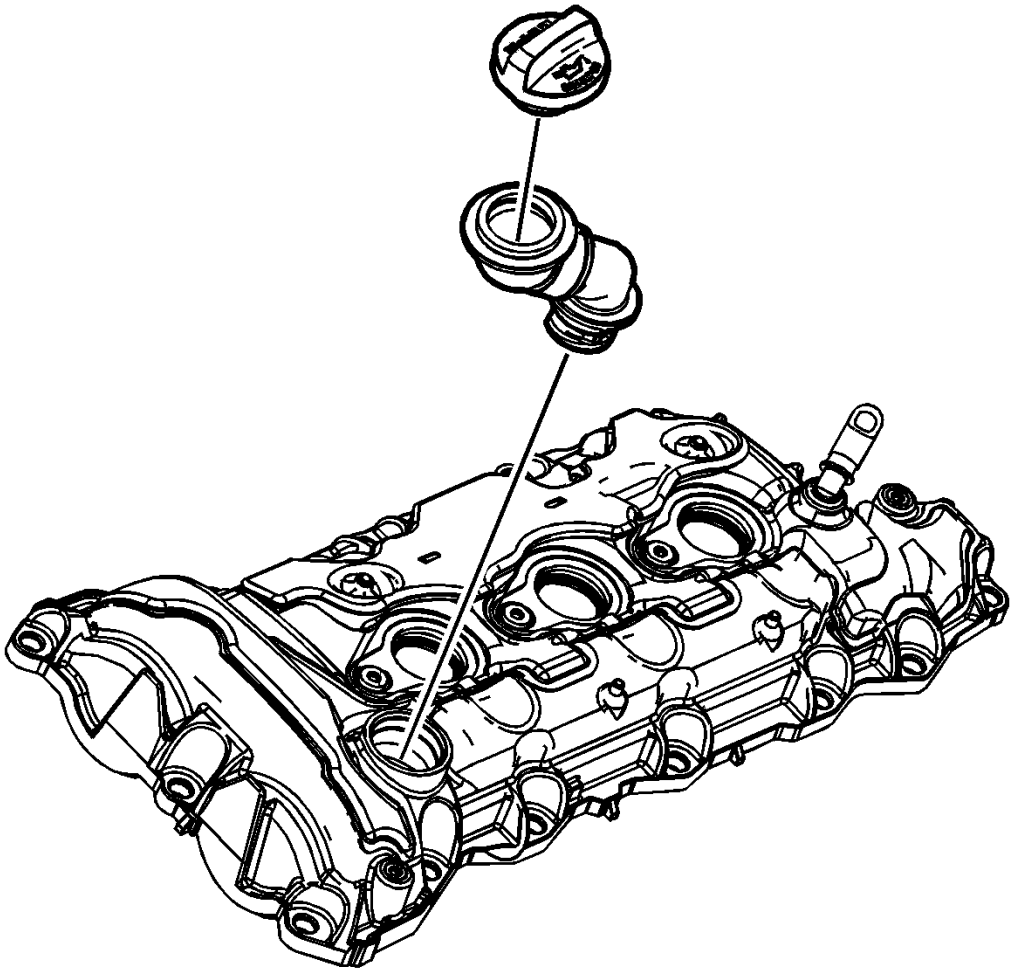

Fig. 284: View of Oil Filter Cap Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil fill cap.

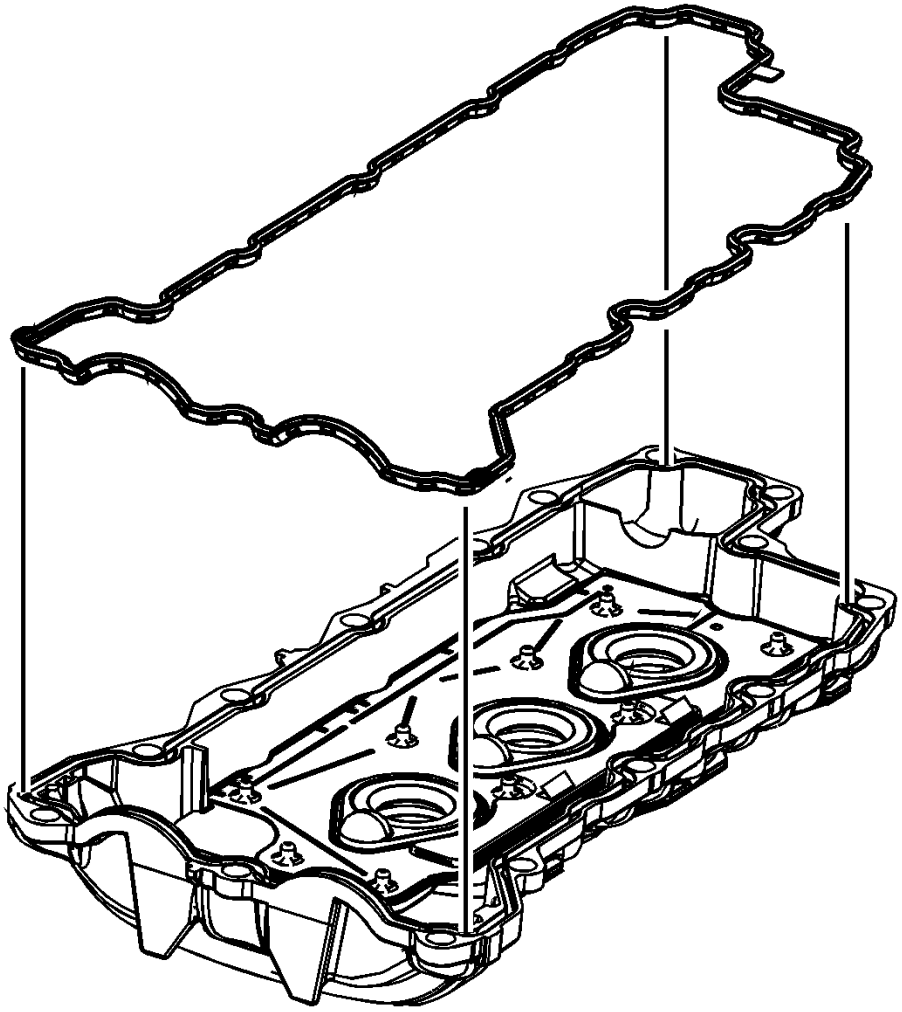

Fig. 285: View of Left Camshaft Cover Gasket Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not reuse the camshaft cover gasket and spark plug shield tube seals.**

4. Remove and discard the left camshaft cover gasket.

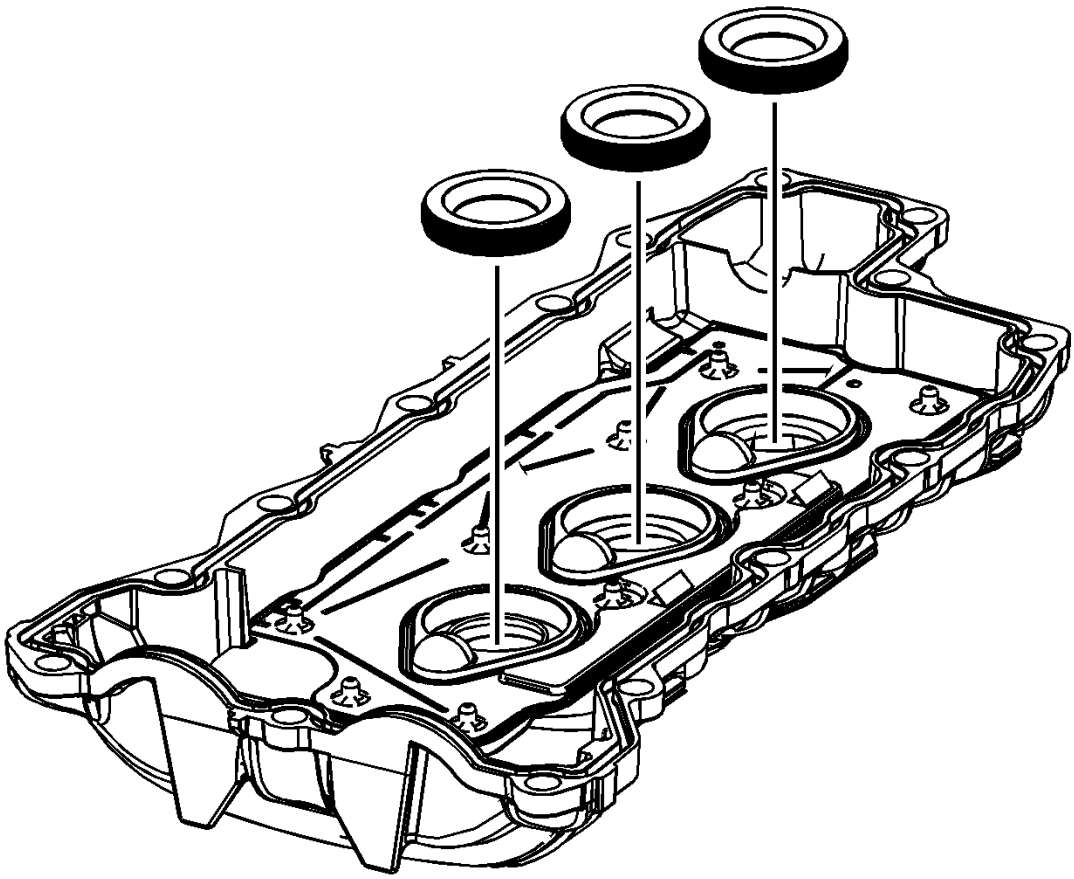

Fig. 286: View Of Right Spark Plug Shield Tube Seals
Courtesy of GENERAL MOTORS COMPANY

5. Remove and discard the left spark plug shield tube seals.

Right Camshaft Cover

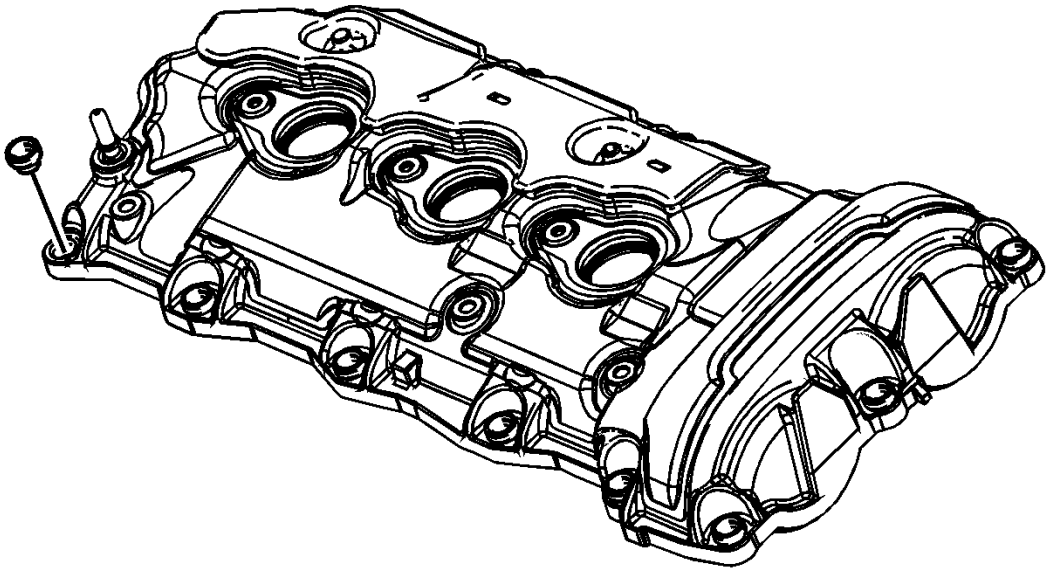

Fig. 287: View Of Right Camshaft Cover Bolt Grommet
Courtesy of GENERAL MOTORS COMPANY

1. Remove and discard the right camshaft cover bolt grommets.

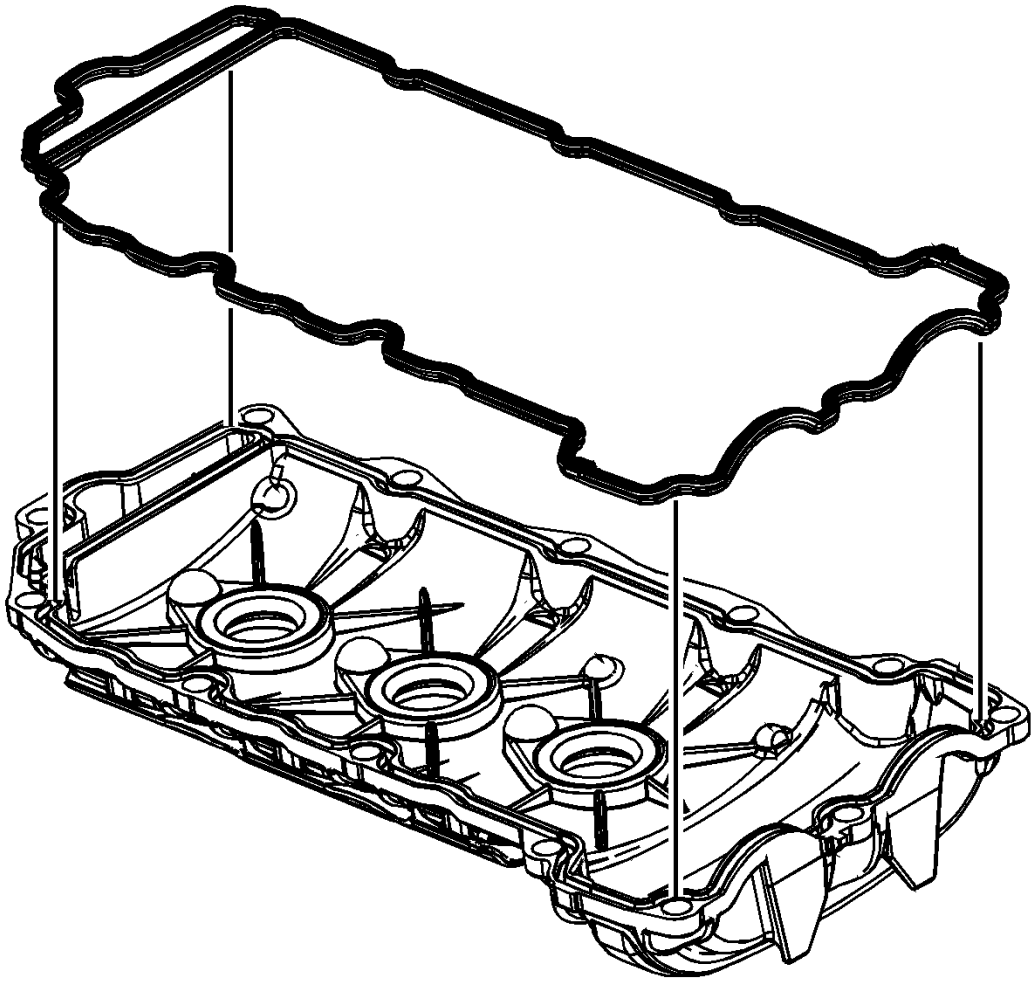

Fig. 288: View Of Right Camshaft Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not reuse the camshaft cover gasket and spark plug shield tube seals.**

2. Remove and discard the right camshaft cover gasket.

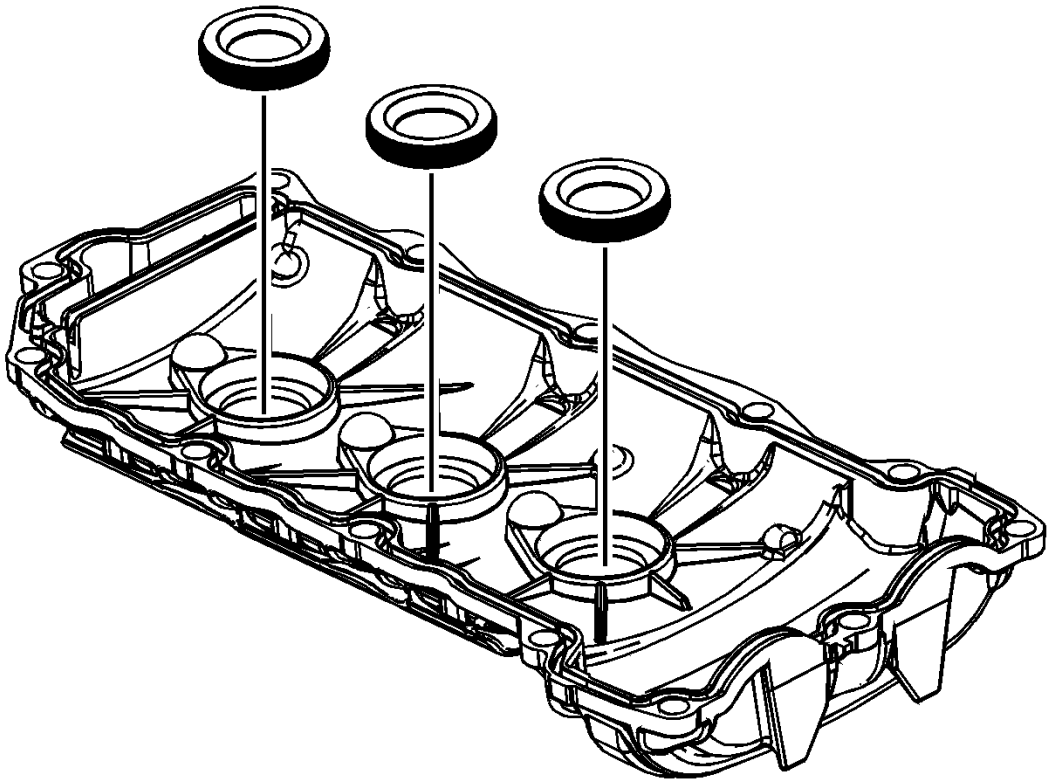

Fig. 289: View Of Right Spark Plug Shield Tube Seals
Courtesy of GENERAL MOTORS COMPANY

3. Remove and discard the right spark plug shield tube seals.

CAMSHAFT COVER CLEANING AND INSPECTION

Cleaning Procedure

1. Clean the camshaft covers in solvent.

WARNING: Refer to Safety Glasses Warning .

2. Dry the camshaft covers with compressed air.

Inspection Procedure

1. Inspect each camshaft cover for the dents or damage to the exterior. A dented or damaged camshaft cover may:
   - Leak engine oil
   - Affect crankcase ventilation

- Interfere with the camshafts
- Interfere with the ignition coil sealing
- Allow water or condensation to enter the engine

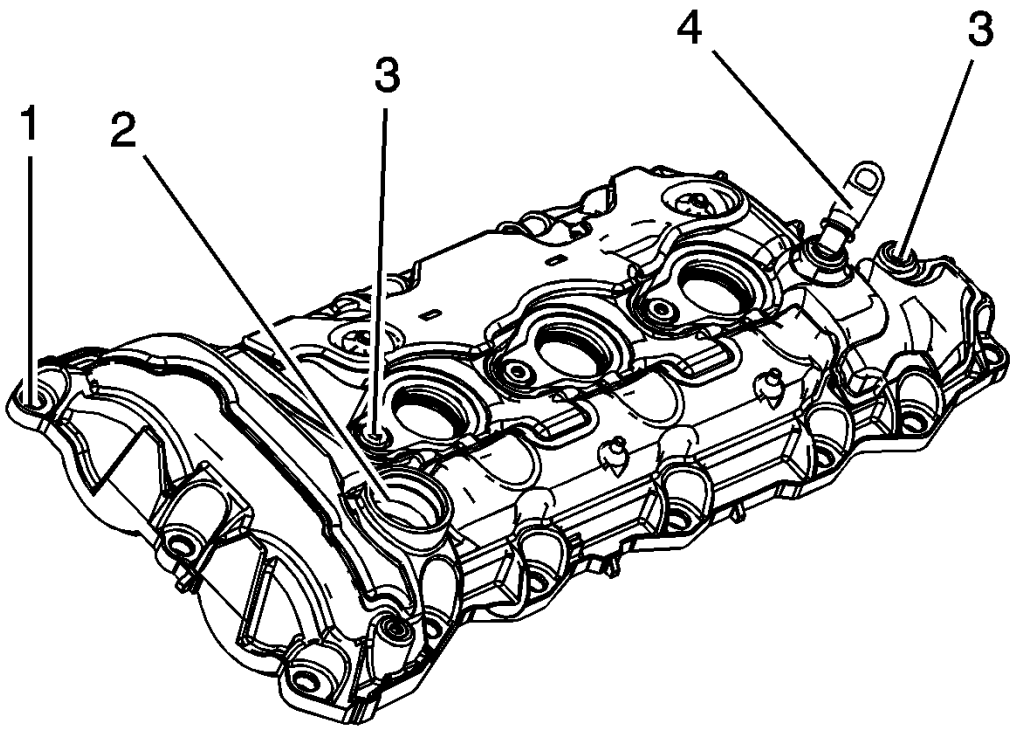

Fig. 290: Identifying Inspection Points Of Left Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the exterior of the left camshaft cover for the following conditions:
   - Damage to the camshaft cover bolt holes (1)
   - Damage to the oil fill hole (2)
   - Damage to the mounting holes (3) for the ignition coil assembly and fuel injector sight shield ballstud.
   - Damage to the positive crankcase ventilation (PCV) hose connector (4)-A damaged PCV hose connector is replaceable.

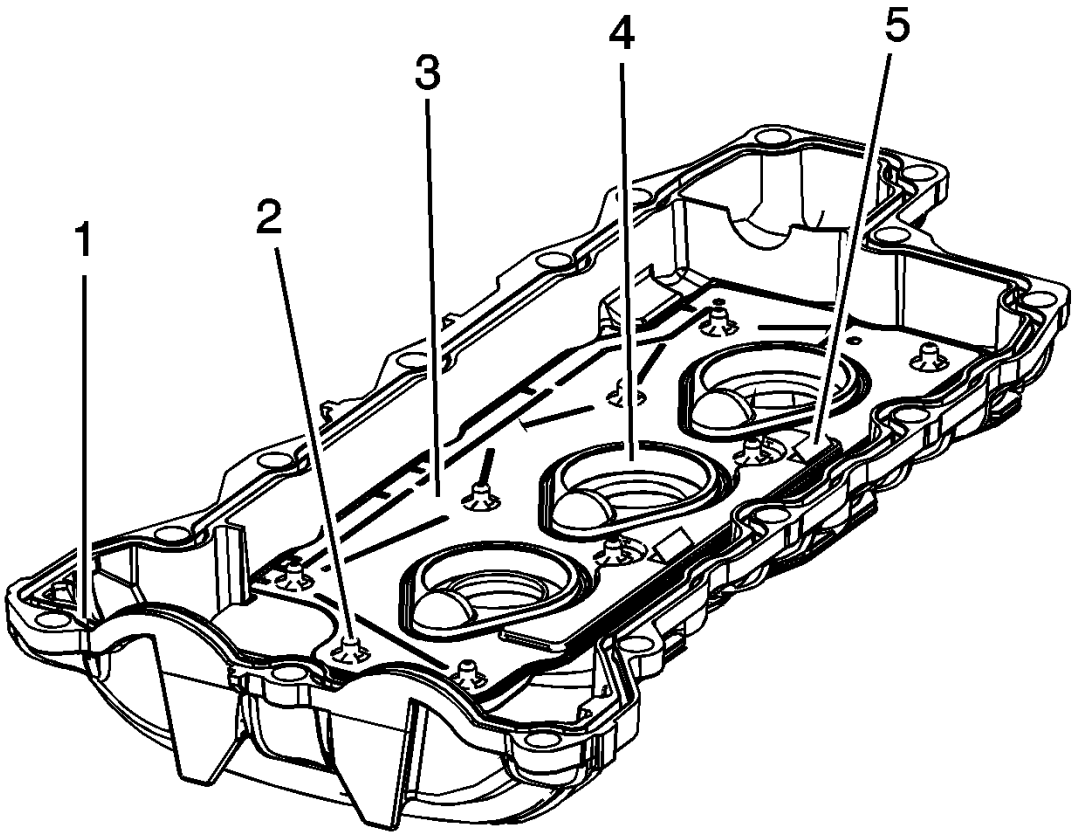

Fig. 291: Identifying Inspection Points Of Left Camshaft Cover Interior
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the interior of the left camshaft cover for the following conditions:
    - Gouges or damage to the camshaft cover sealing groove (1)
    - Damaged, loose or missing baffle fasteners (2)
    - Damaged, loose or missing baffle (3)
    - Gouges or damage to the spark plug shield seal bore (4)
    - Restrictions to the ventilation system (5)

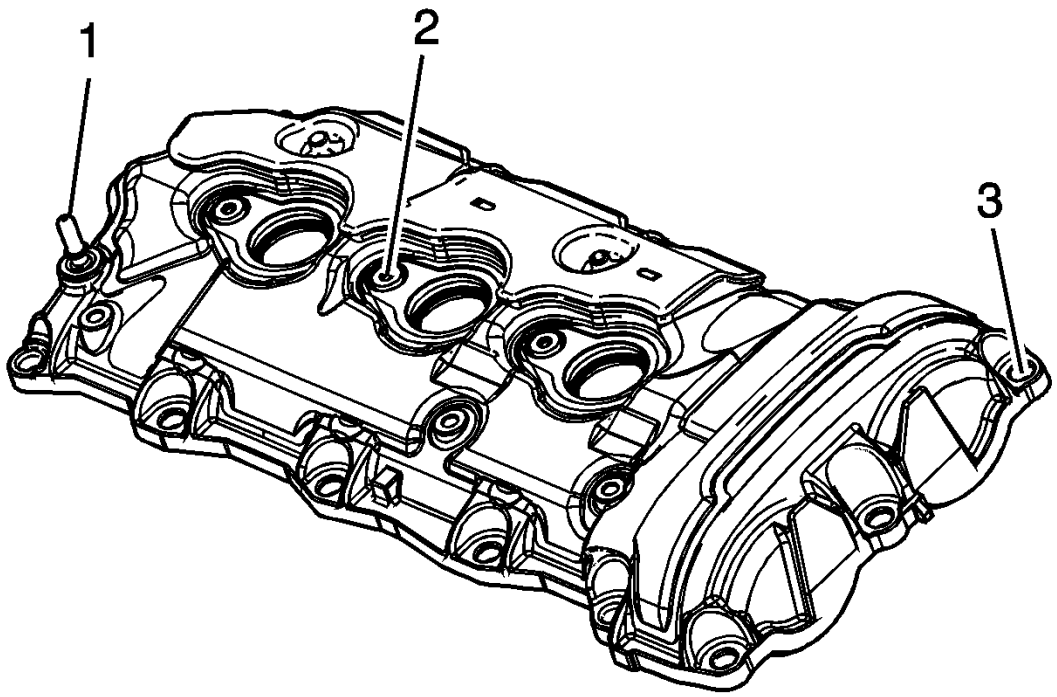

Fig. 292: View Of Right Camshaft Cover Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the exterior of the right camshaft cover for the following conditions:
    - Damage to the PCV orifice (1)-A damaged PCV orifice can be replaced. Refer to PCV Orifice Replacement.
    - Damage to the mounting holes (2) for the ignition coil assembly
    - Damage to the camshaft cover bolt holes (3)

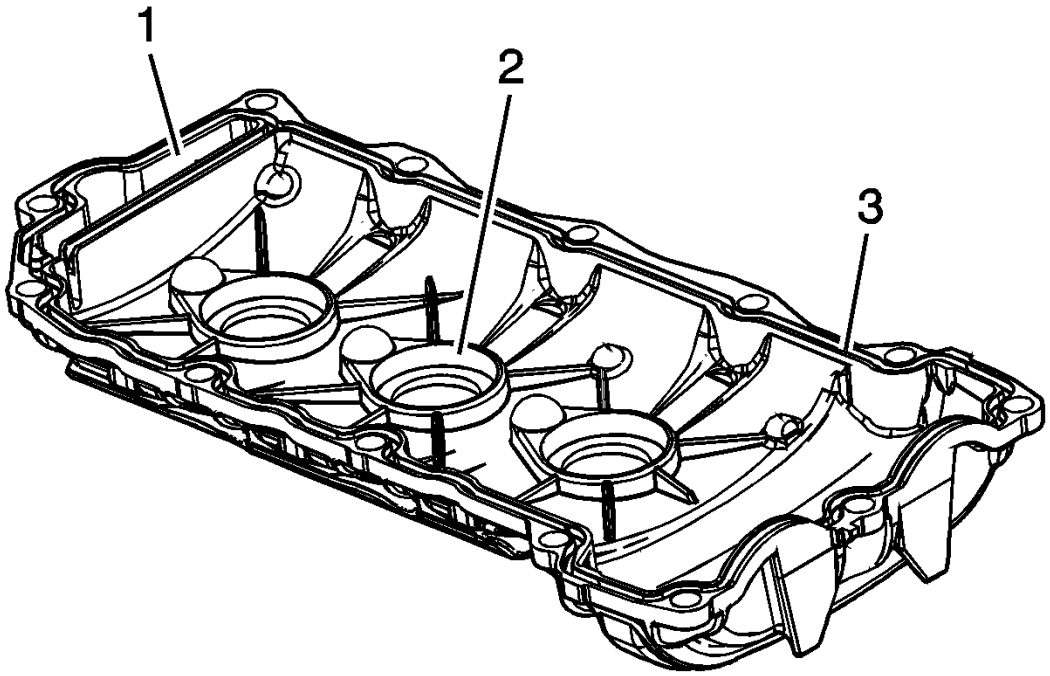

Fig. 293: View Of Right Camshaft Cover Inspection Locations
Courtesy of GENERAL MOTORS COMPANY

5. Inspect the interior of the right camshaft cover for the following conditions:
    - Restrictions to the ventilation system (1)
    - Gouges or damage to the spark plug shield seal bore (2)
    - Gouges or damage to the camshaft cover sealing groove (3)
6. Repair or replace the camshaft cover or covers as necessary.

PCV Orifice Replacement

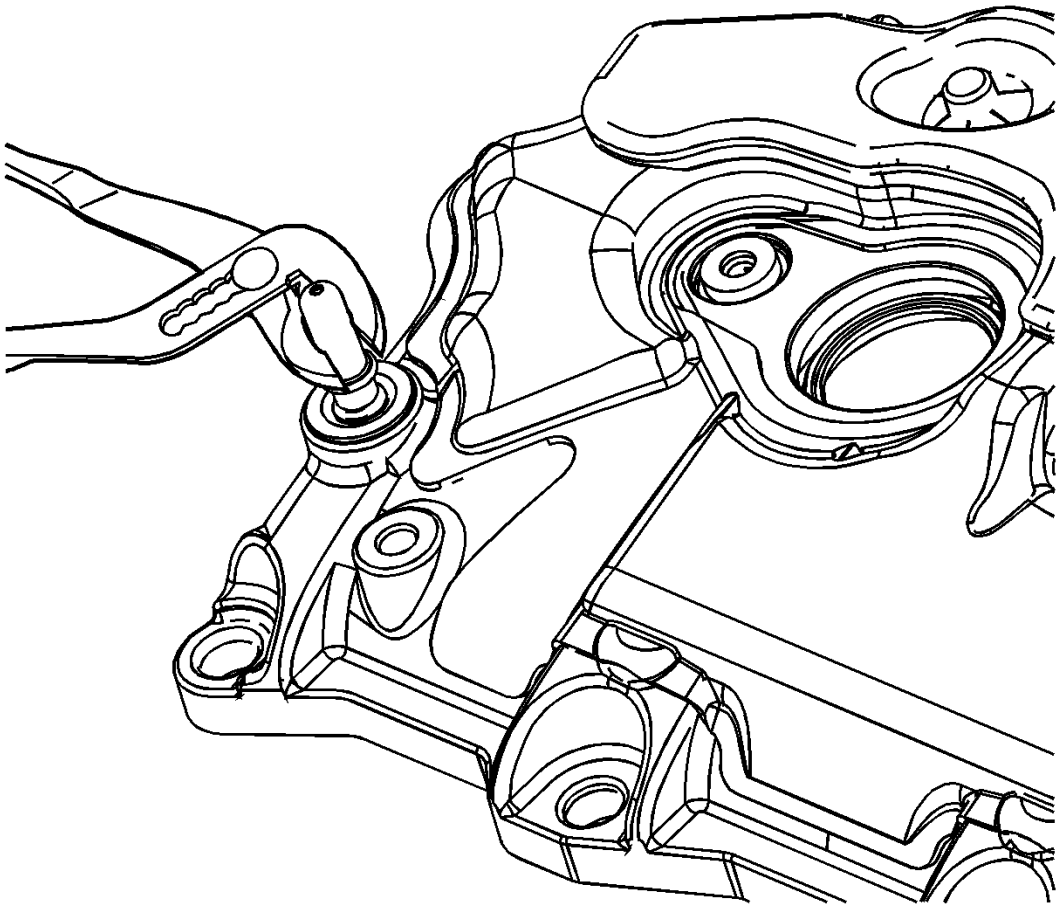

Fig. 294: View Of PCV Orifice
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the PCV orifice is damaged or plugged and cannot be cleaned out, the PCV orifice can be replaced.**

1. Remove the old PCV orifice by gripping the neck of the orifice with pliers and twisting and pulling out of the right camshaft cover.

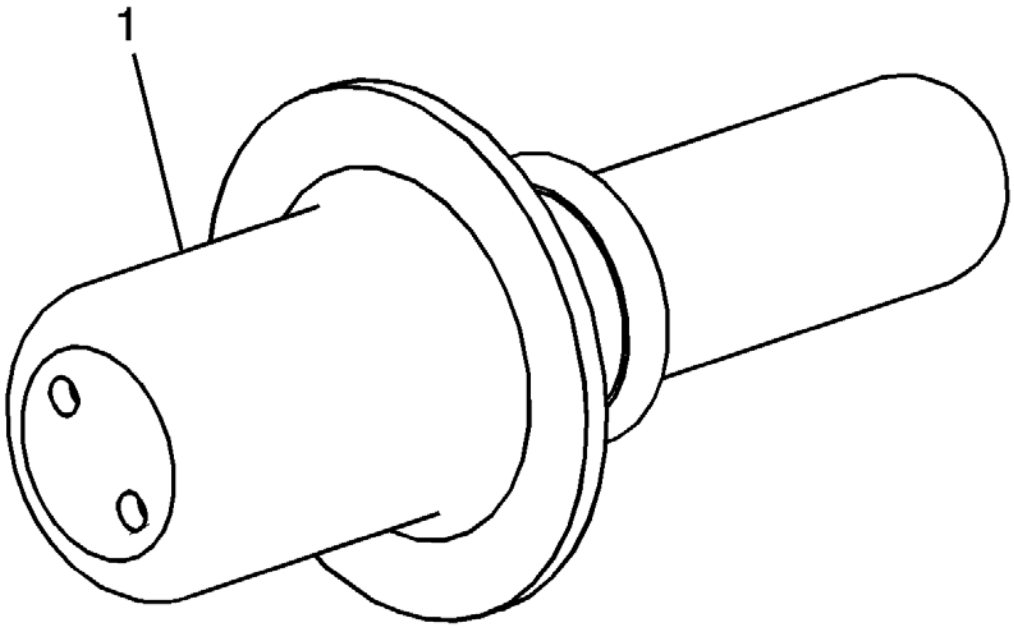

Fig. 295: Identifying Sealant Area On PCV Orifice
Courtesy of GENERAL MOTORS COMPANY

2. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
3. Apply sealant to the NEW PCV orifice (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

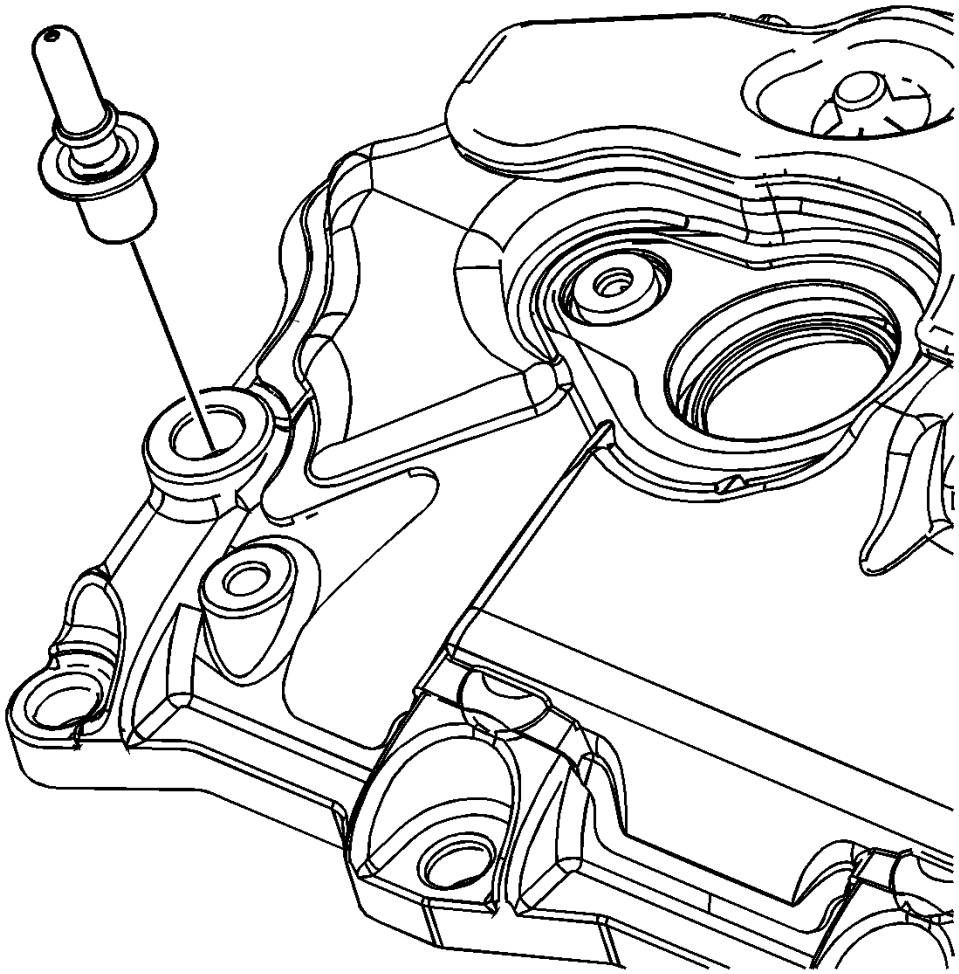

Fig. 296: View Of PCV Orifice & Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

4. Install the NEW PCV orifice into the right camshaft cover. After insertion, twist the PCV orifice in order to eliminate any vertical leak paths in the sealant.

PCV Fitting Replacement

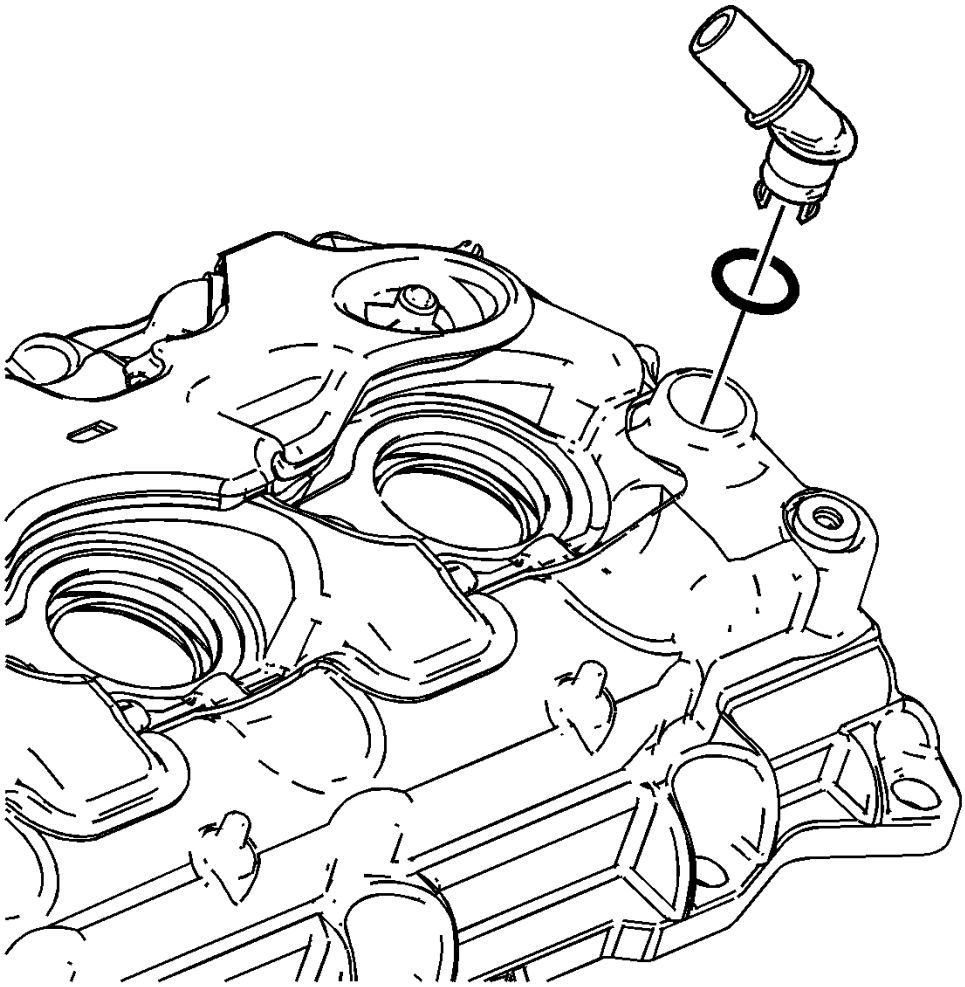

Fig. 297: View Of PCV Fitting & O-Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the PCV fitting is damaged or plugged and cannot be cleaned out, the PCV fitting can be replaced.**

1. Remove the old PCV fitting.
2. Install the new PCV fitting with a NEW O-ring.

CAMSHAFT COVER ASSEMBLE

Special Tools

- **DT 5590** Bearing and Seal Driver
- **J-25254-A** Oil Seal Installer

For equivalent regional tools, refer to **Special Tools** .

Left Camshaft Cover

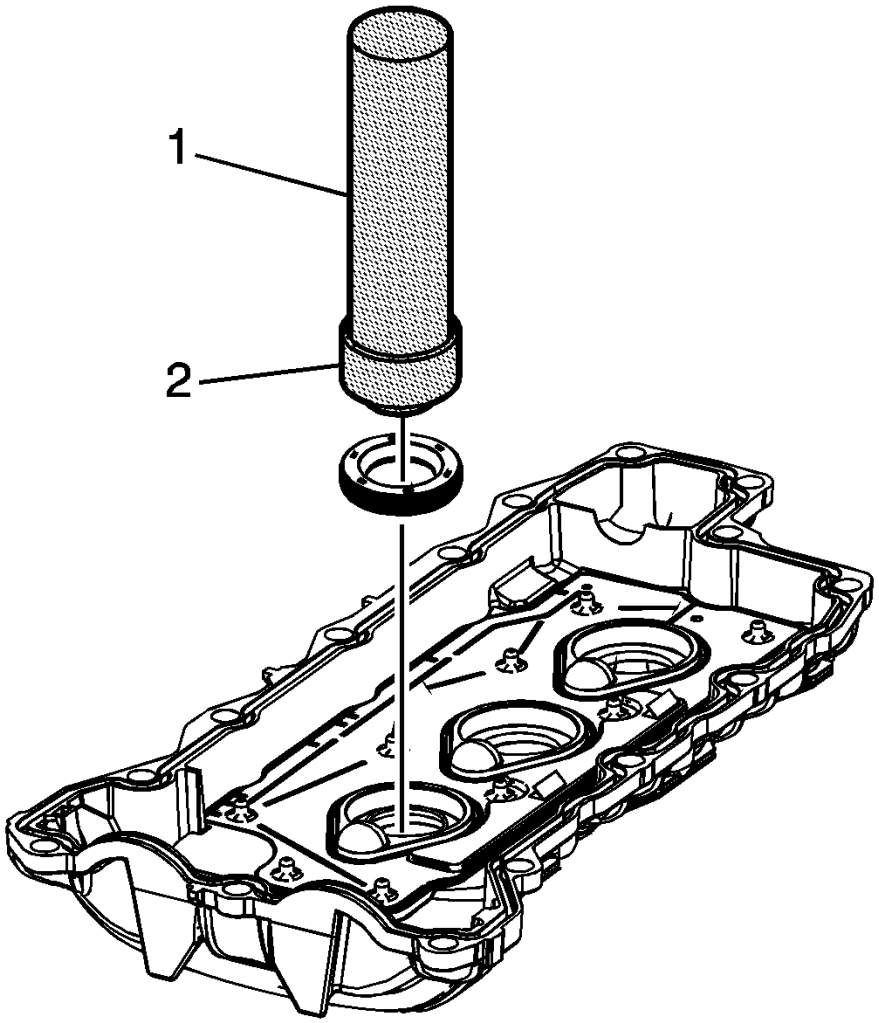

Fig. 298: Left Spark Plug Shield Tube Seals And Special Tools
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW left spark plug shield tube seals using the **DT 5590** driver (1) and **J-25254-A** installer (2)
.

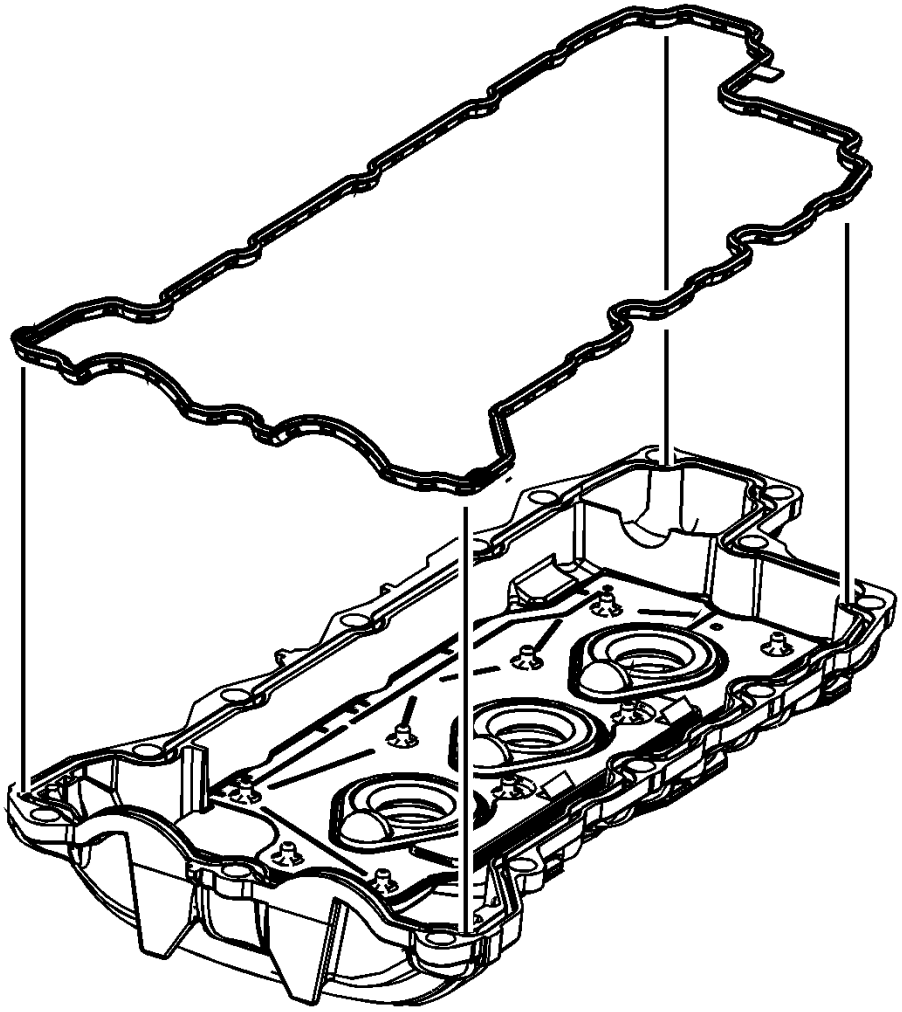

Fig. 299: View of Left Camshaft Cover Gasket Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW left camshaft cover gasket.

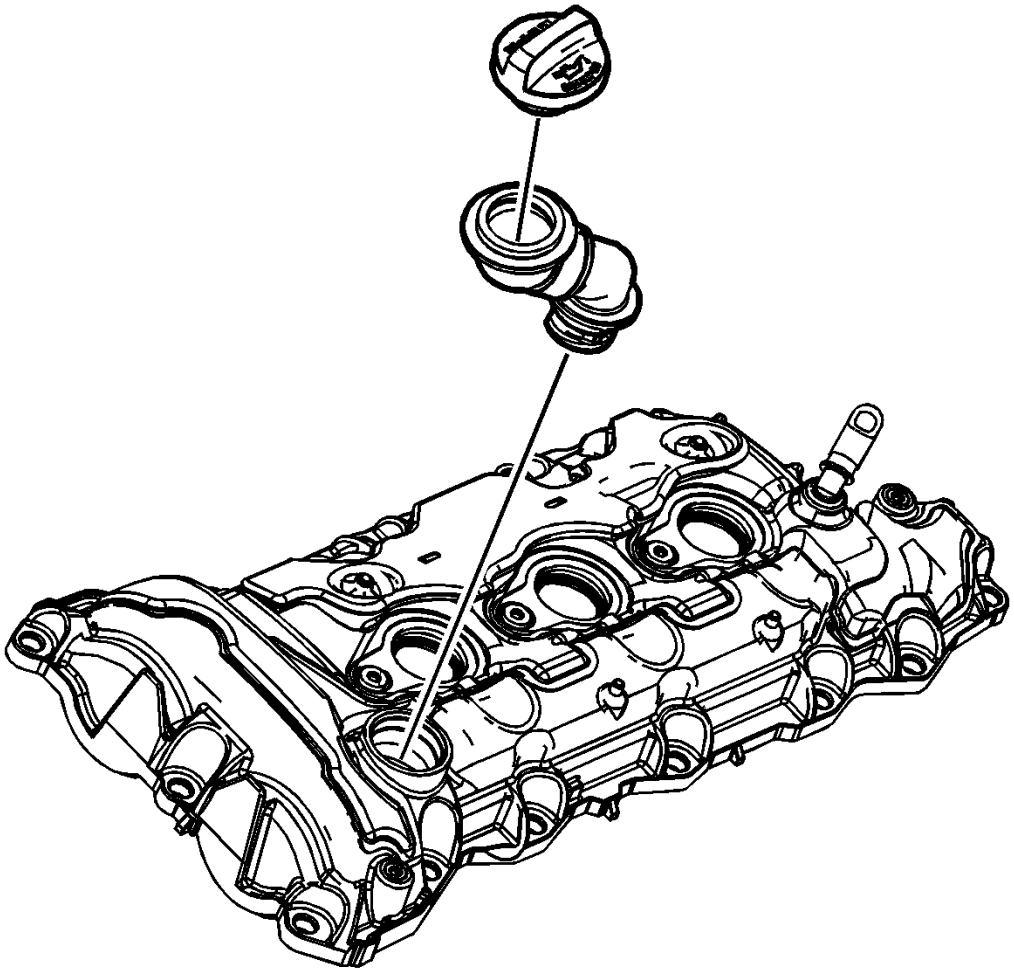

Fig. 300: View of Oil Filter Cap Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Install the oil fill cap.

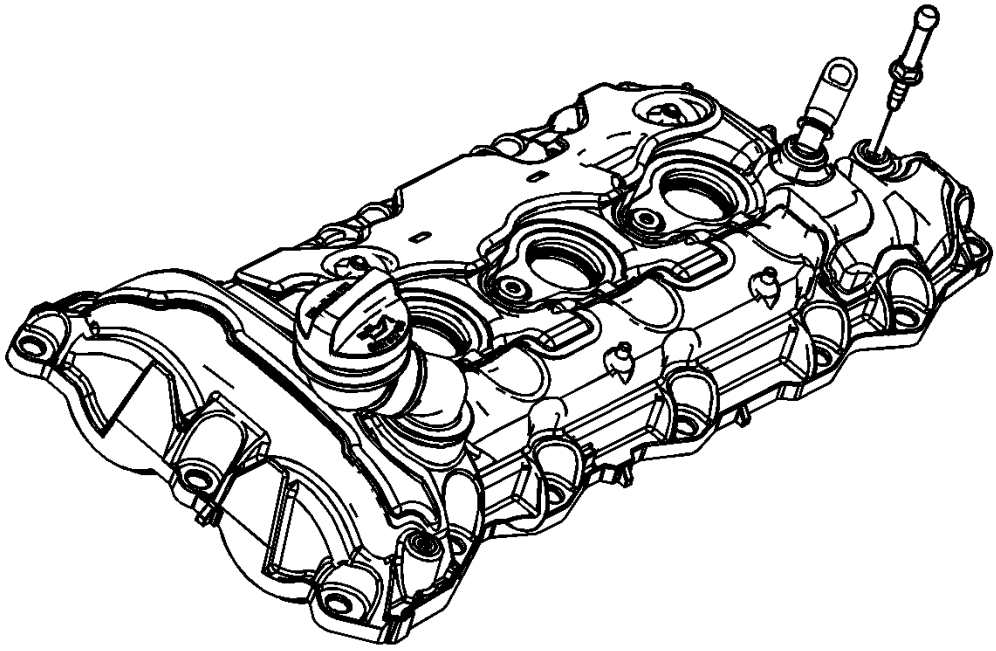

Fig. 301: View of Fuel Injector Sight Shield Cover Ballstud
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the fuel injector sight shield cover ballstud and tighten to 10 N.m (89 lb in).

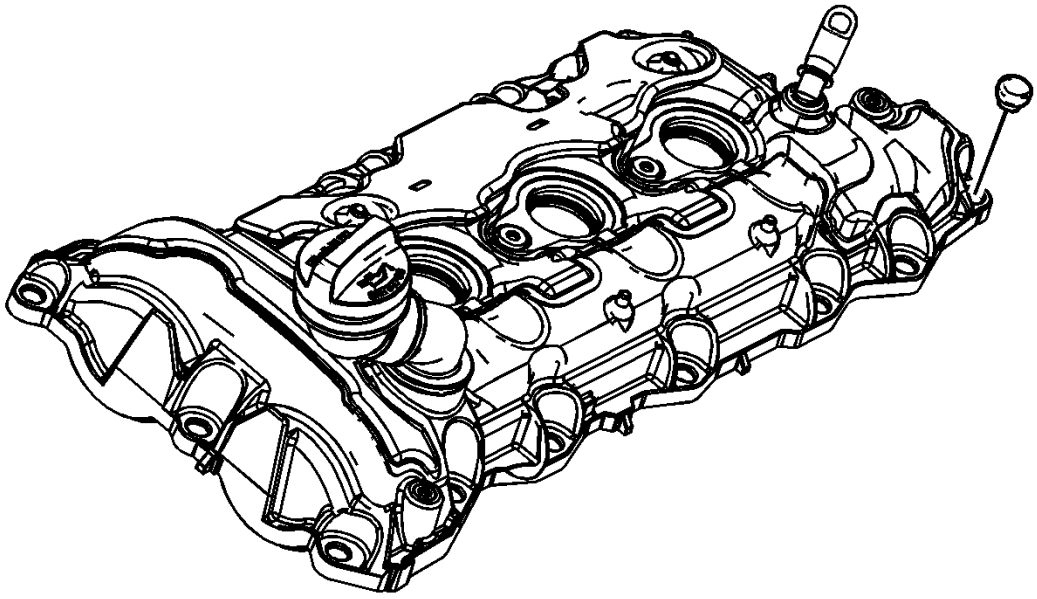

Fig. 302: View of Left Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The camshaft cover bolt grommet must be installed into the camshaft cover bolt hole before installing the camshaft cover bolt.**

5. Install the NEW left camshaft cover bolt grommets.

Right Camshaft Cover

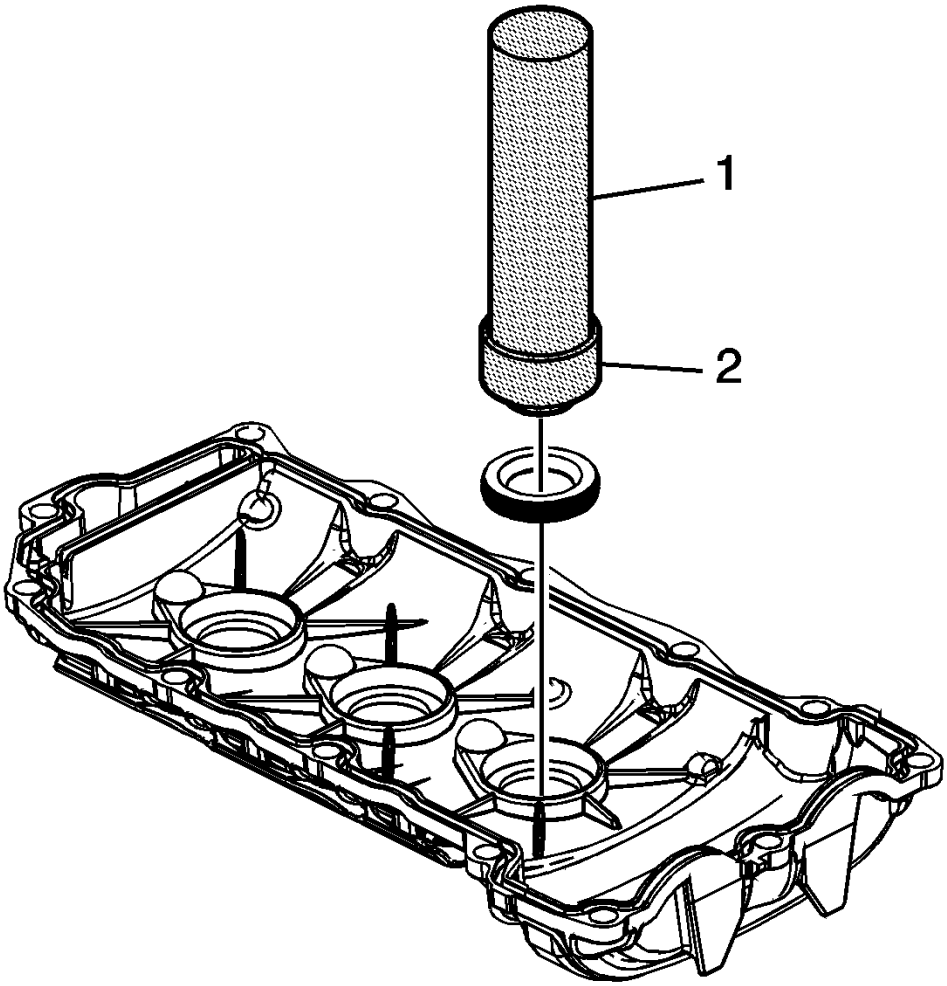

Fig. 303: Installing Spark Plug Shield Tube Coil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW right spark plug shield tube coil seals using the **DT 5590** driver (1) and **J-25254-A** installer (2) .

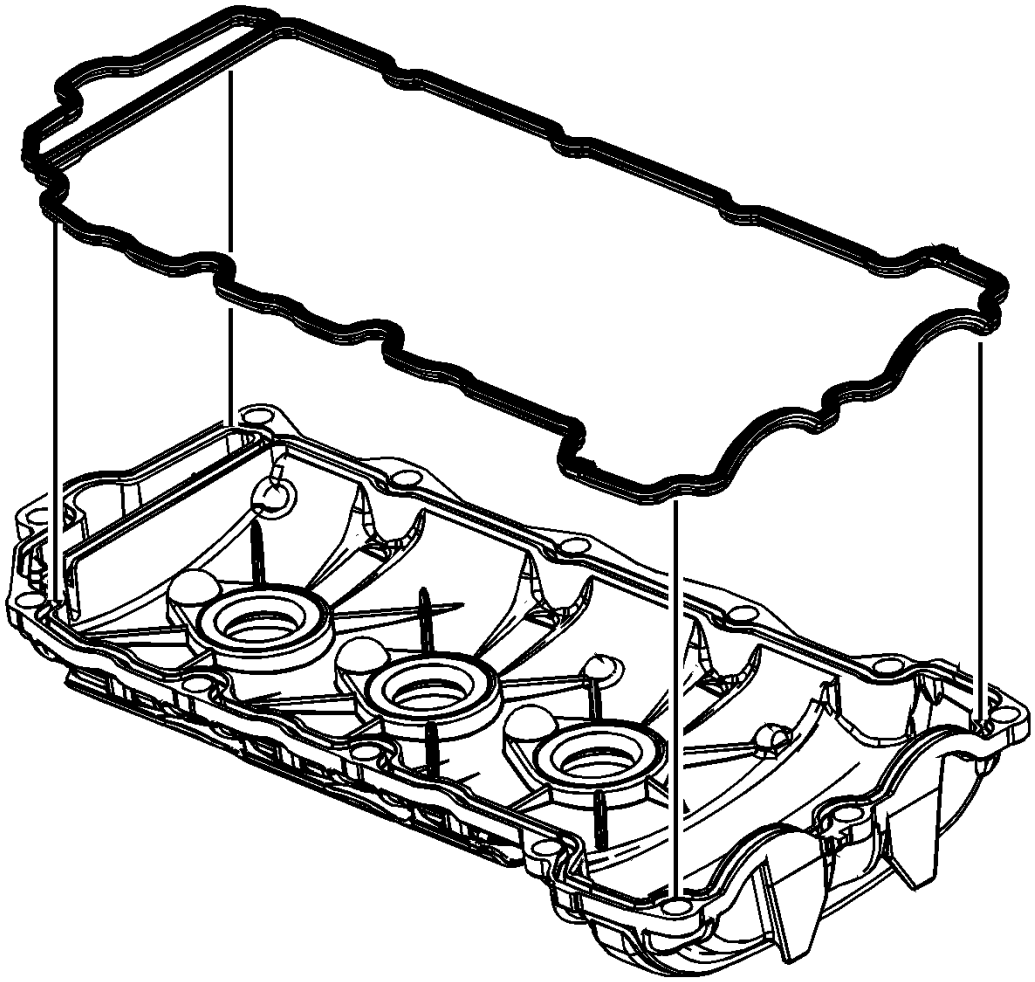

Fig. 304: View Of Right Camshaft Cover Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW right camshaft cover gasket.

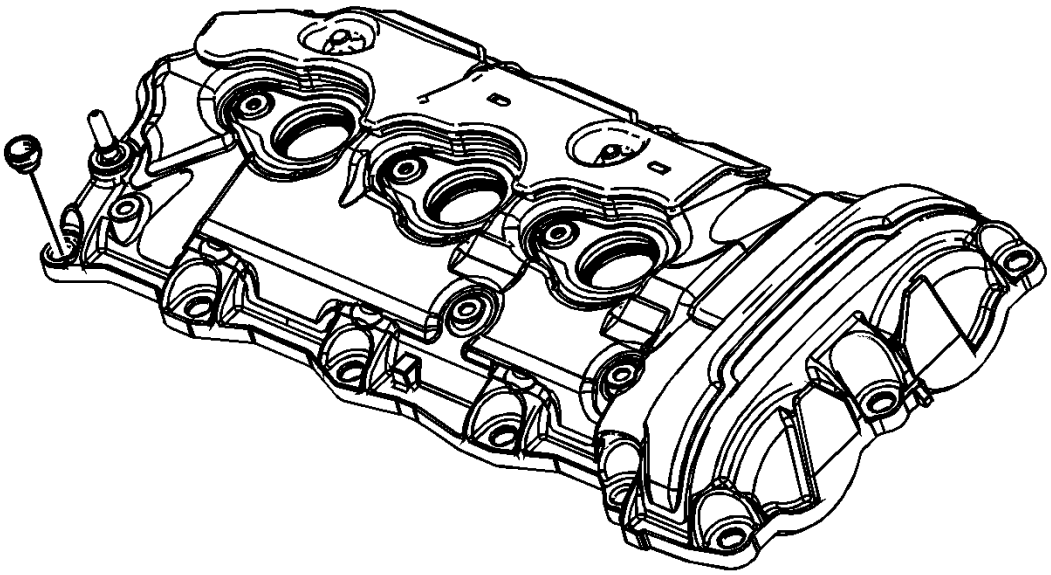

Fig. 305: View Of Right Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The camshaft cover bolt grommet must be installed into the camshaft cover bolt hole before installing the camshaft cover bolt.**

3. Install the NEW right camshaft cover bolt grommets.

INTAKE MANIFOLD DISASSEMBLE

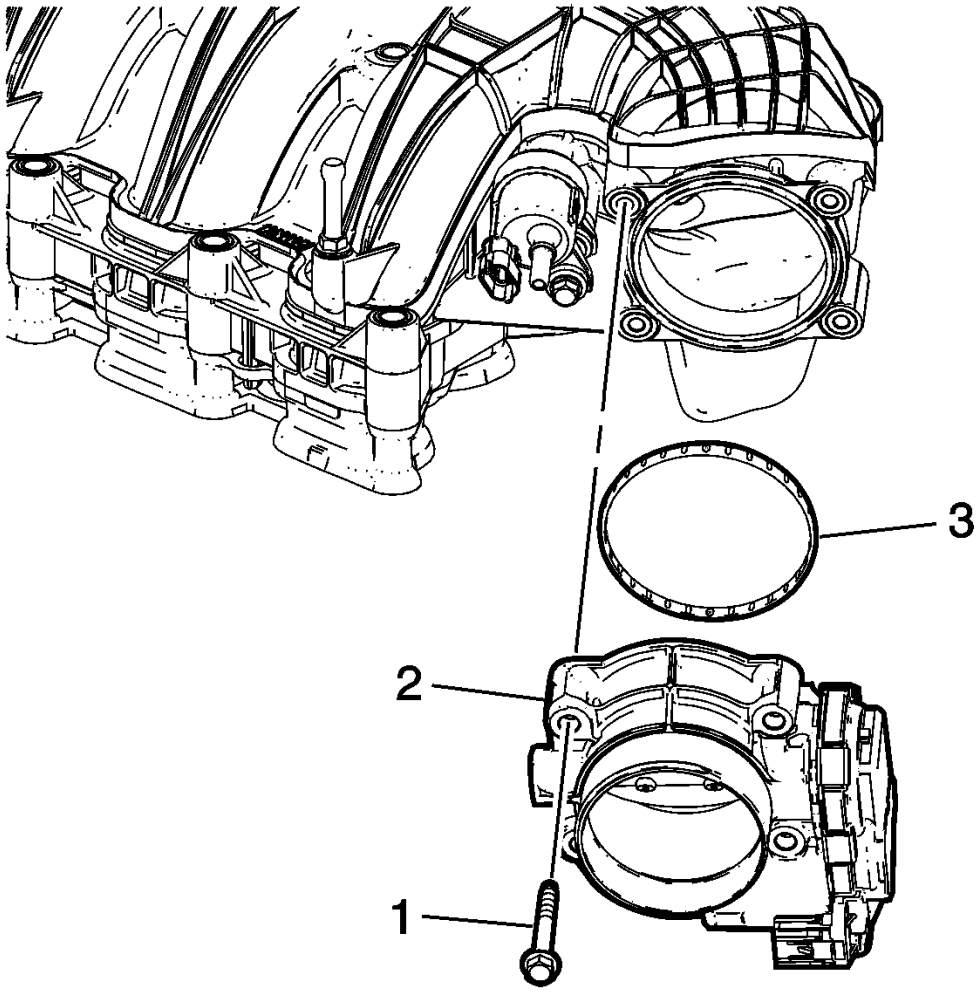

Fig. 306: Throttle Body, Bolts And Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the throttle body bolts (1).
2. Remove the throttle body (2).
3. Remove and discard the throttle body seal (3).

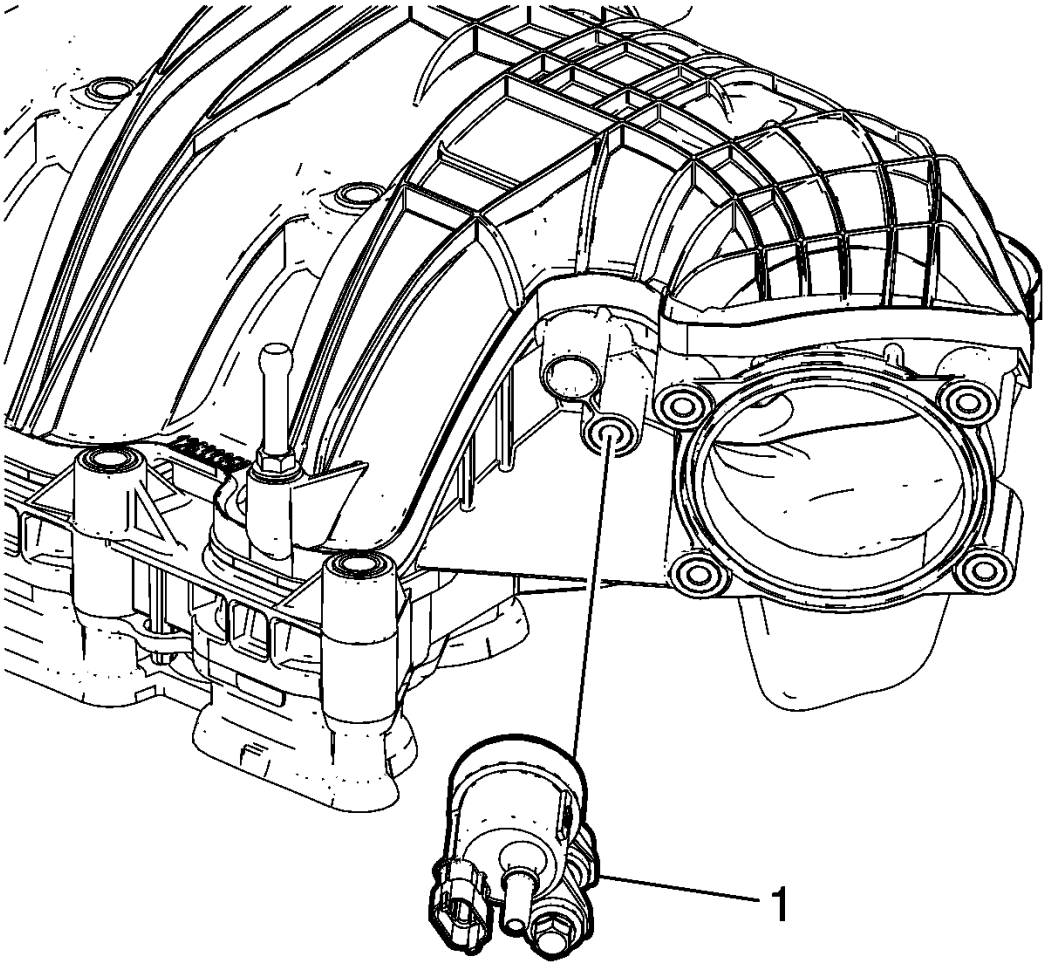

Fig. 307: EVAP Solenoid
Courtesy of GENERAL MOTORS COMPANY

4. Loosen the evaporative (EVAP) solenoid bolt.
5. Remove the EVAP solenoid (1).

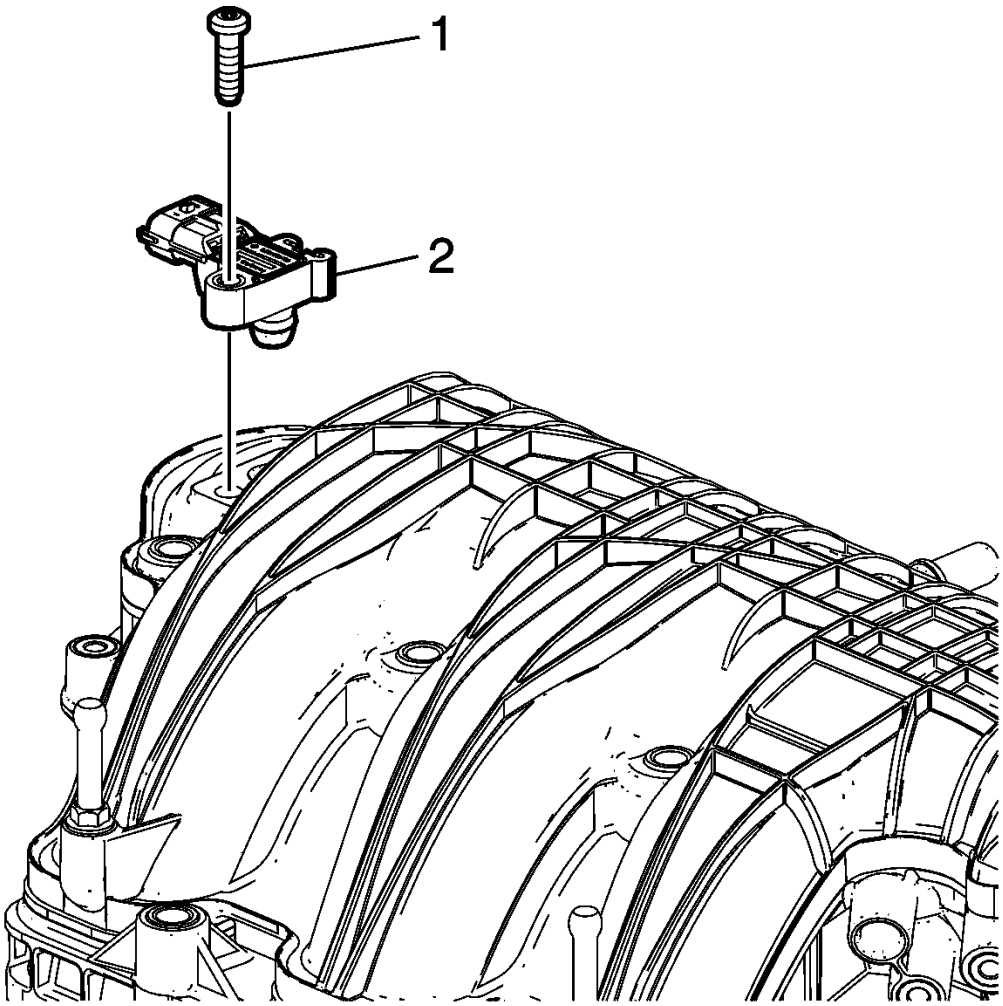

Fig. 308: Manifold Absolute Pressure Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the manifold absolute pressure (MAP) sensor bolt (1).
7. Remove the MAP sensor (2).

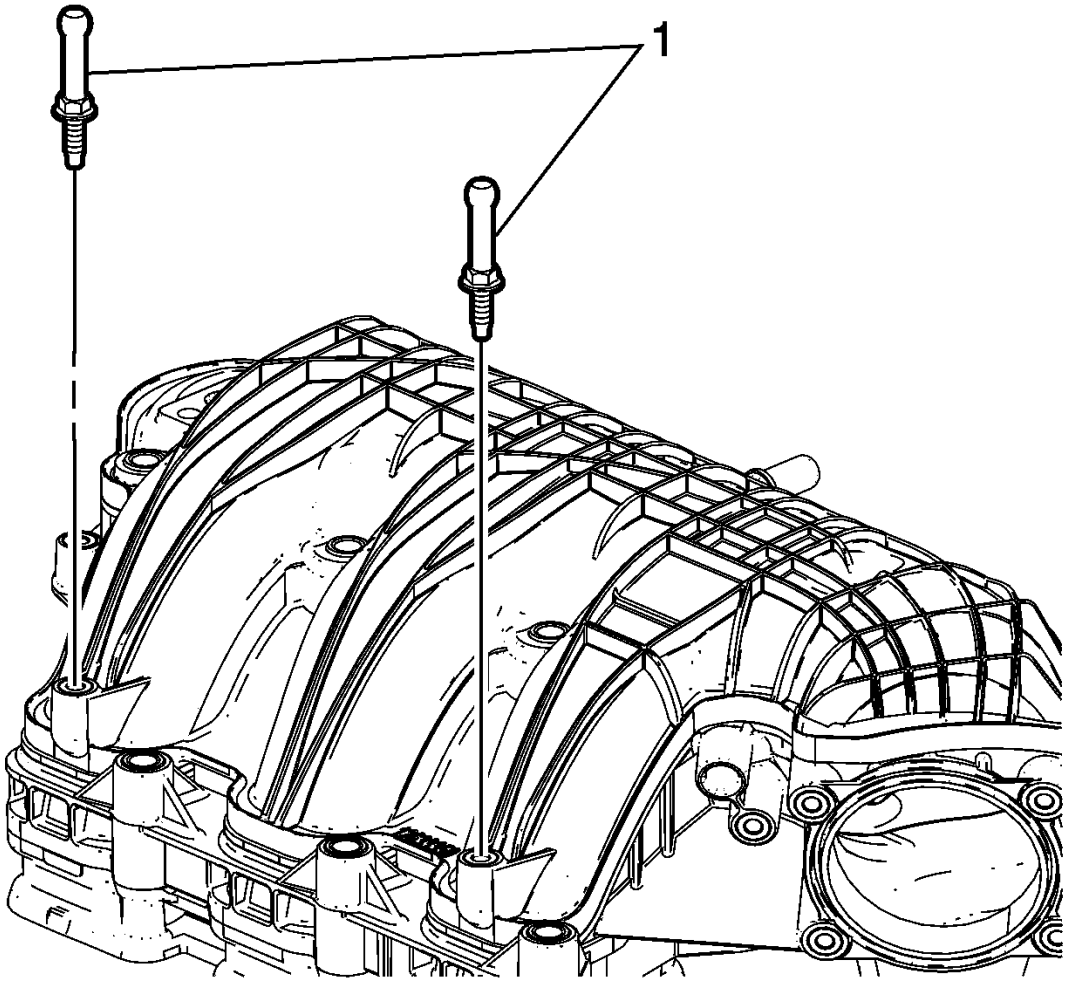

Fig. 309: Intake Manifold Cover Ball Studs
Courtesy of GENERAL MOTORS COMPANY

8. Remove the intake manifold cover ball studs (1).

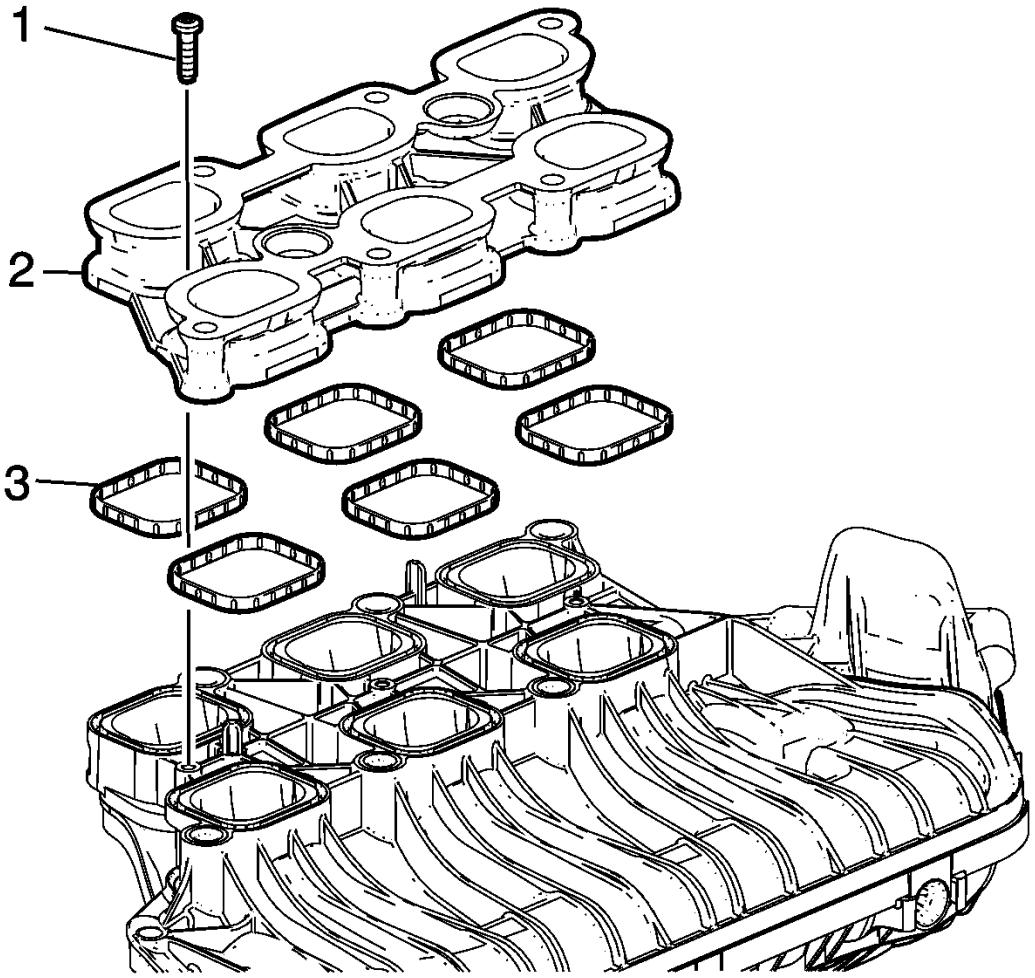

Fig. 310: Lower Intake Manifold, Gaskets And Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the lower intake manifold bolts 1) and lower intake manifold (2).
10. Remove and discard the lower intake manifold gaskets (3).

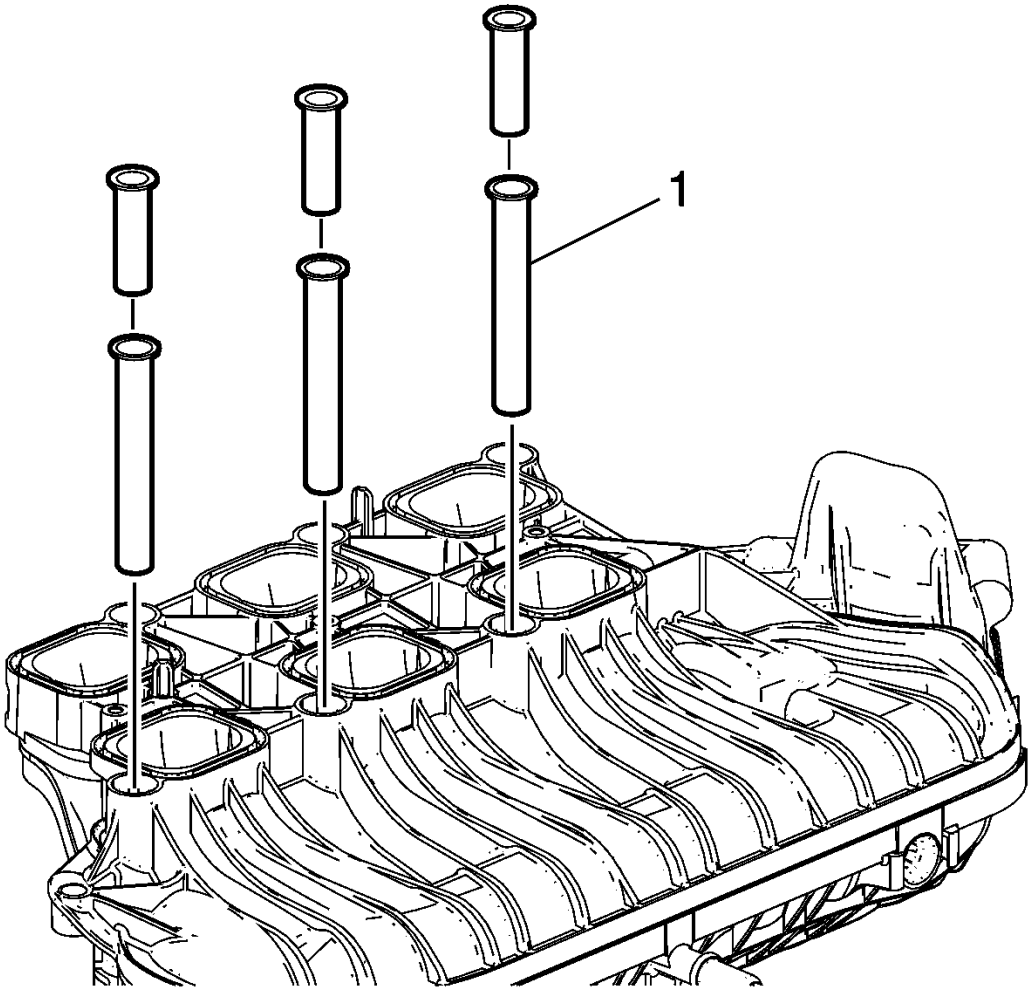

Fig. 311: Plastic Compression Limiters
Courtesy of GENERAL MOTORS COMPANY

11. Remove and discard the plastic compression limiters (1).

INTAKE MANIFOLD CLEANING AND INSPECTION

Intake Manifold Cleaning Procedure

1. Remove any remaining gasket and/or gasket material from the following:
   - Throttle body
   - Intake manifold
2. Clean the following intake manifold areas in solvent.
   - Intake manifold gasket sealing areas
   - Intake manifold passages
   - Brake booster hose passage
   - Evaporative emission (EVAP) solenoid passage
   - Positive crankcase ventilation (PCV) vacuum hose passages

WARNING: Refer to Safety Glasses Warning .

3. Dry the intake manifold and throttle body with compressed air.

Inspection Procedure

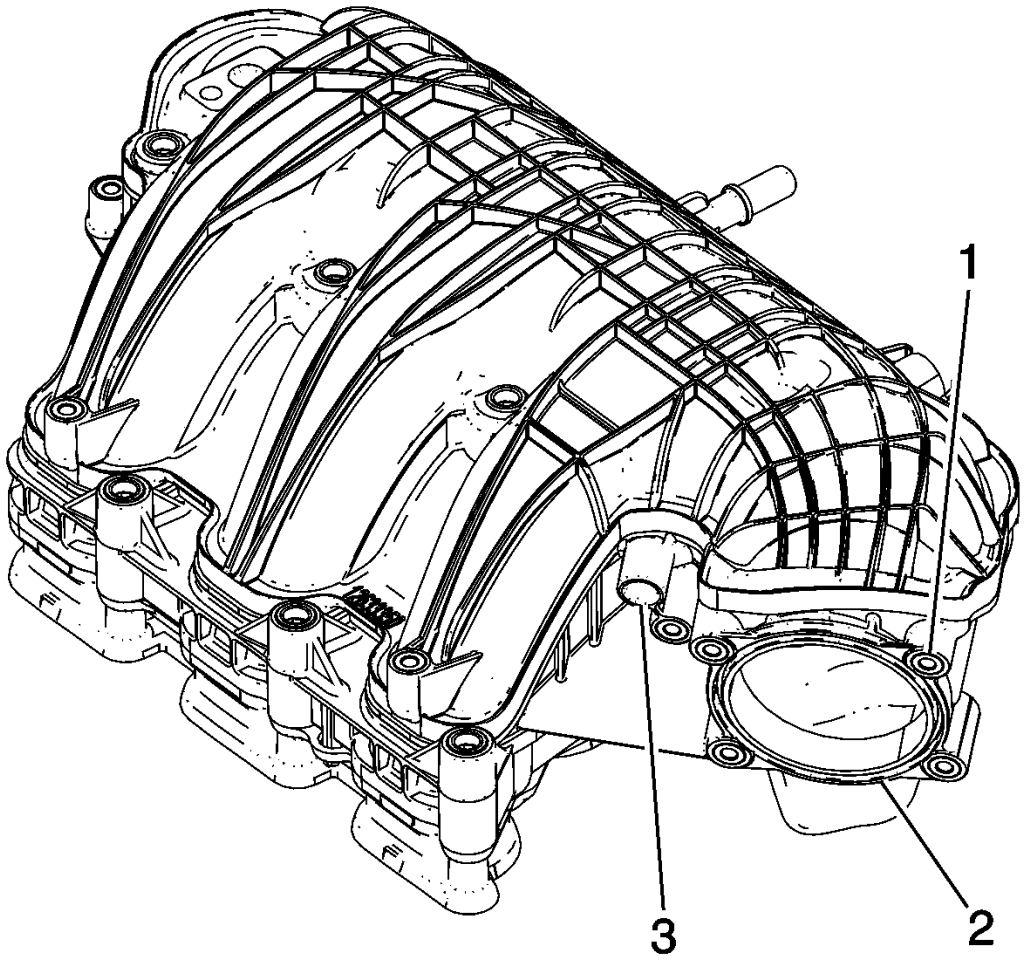

Fig. 312: Throttle Body, Bolt Holes And EVAP Purge Solenoid Port
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the intake manifold for the following conditions:
   - Damage to the throttle body bolt holes (1)
   - Damage, debris or restrictions to the EVAP purge solenoid port (3)
   - Damage to the gasket sealing surface for the throttle body (2)

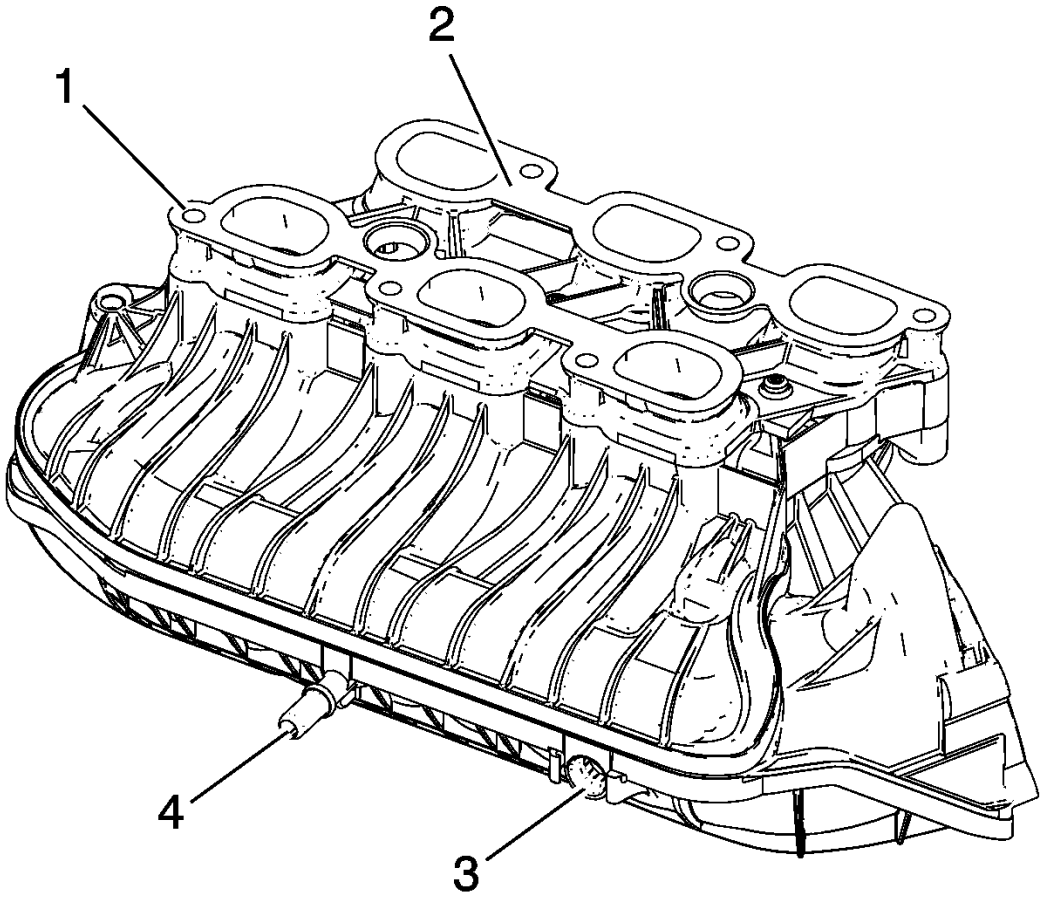

Fig. 313: Intake Manifold Inspection Points
Courtesy of GENERAL MOTORS COMPANY

2. Inspect the intake manifold for the following conditions:
    - Damage, debris or restrictions to the brake vacuum booster hose port (4)
    - Damage to the intake manifold bolt bosses (1)
    - Gouges or damage to the intake manifold sealing surfaces (2)
    - Damage, debris or restrictions to the PCV system hose ports (3)

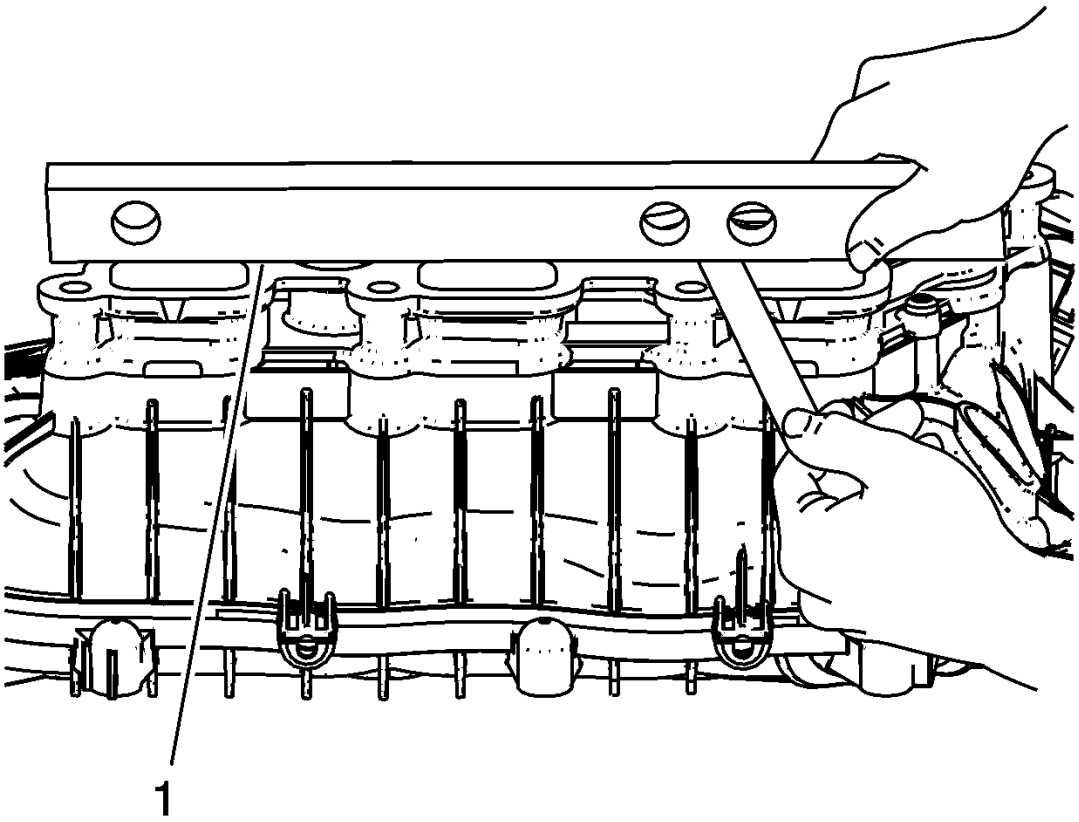

Fig. 314: Inspecting Intake Manifold Sealing Surface
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the intake manifold sealing surface (1) for warpage.
    1. Locate a straight edge across the intake manifold sealing surface.
    2. Insert a feeler gauge between the intake manifold and the straight edge. An intake manifold with warpage in excess of 0.50 mm (0.020 in) must be replaced.
4. Repair or replace the intake manifold as necessary.

INTAKE MANIFOLD ASSEMBLE

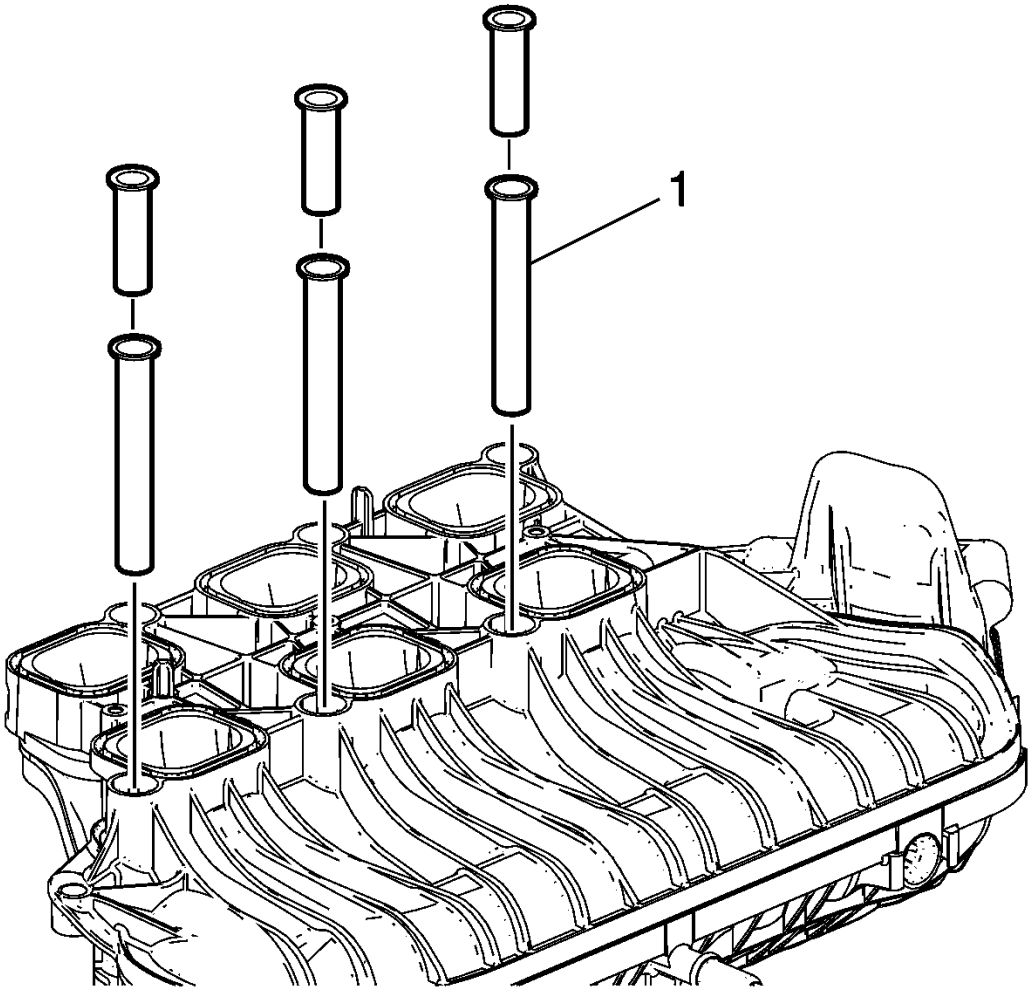

Fig. 315: Plastic Compression Limiters
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW plastic compression limiters (1).

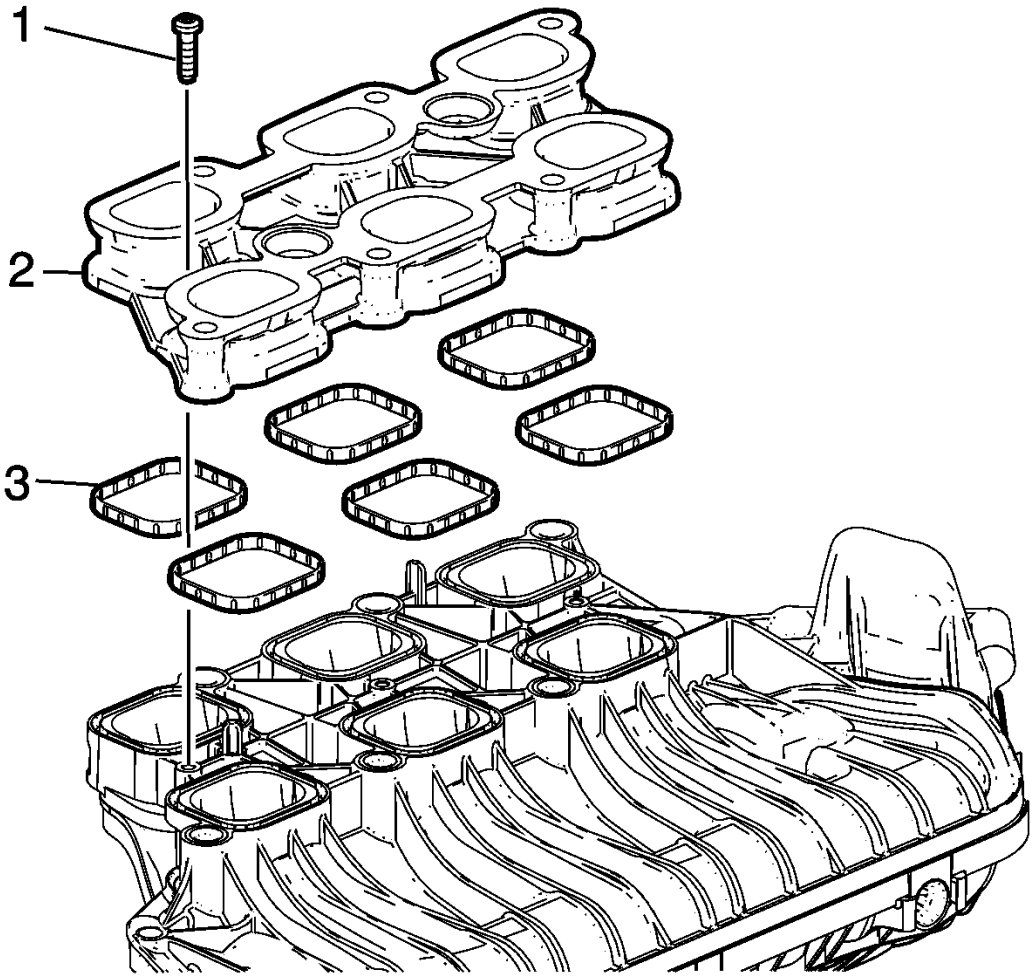

Fig. 316: Lower Intake Manifold, Gaskets And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW lower intake manifold gaskets (3).
3. Install the lower intake manifold (2) and bolts (1).

CAUTION: Refer to Fastener Caution .

4. Tighten the lower intake manifold bolts (1) to 7 N.m (62 lb in).

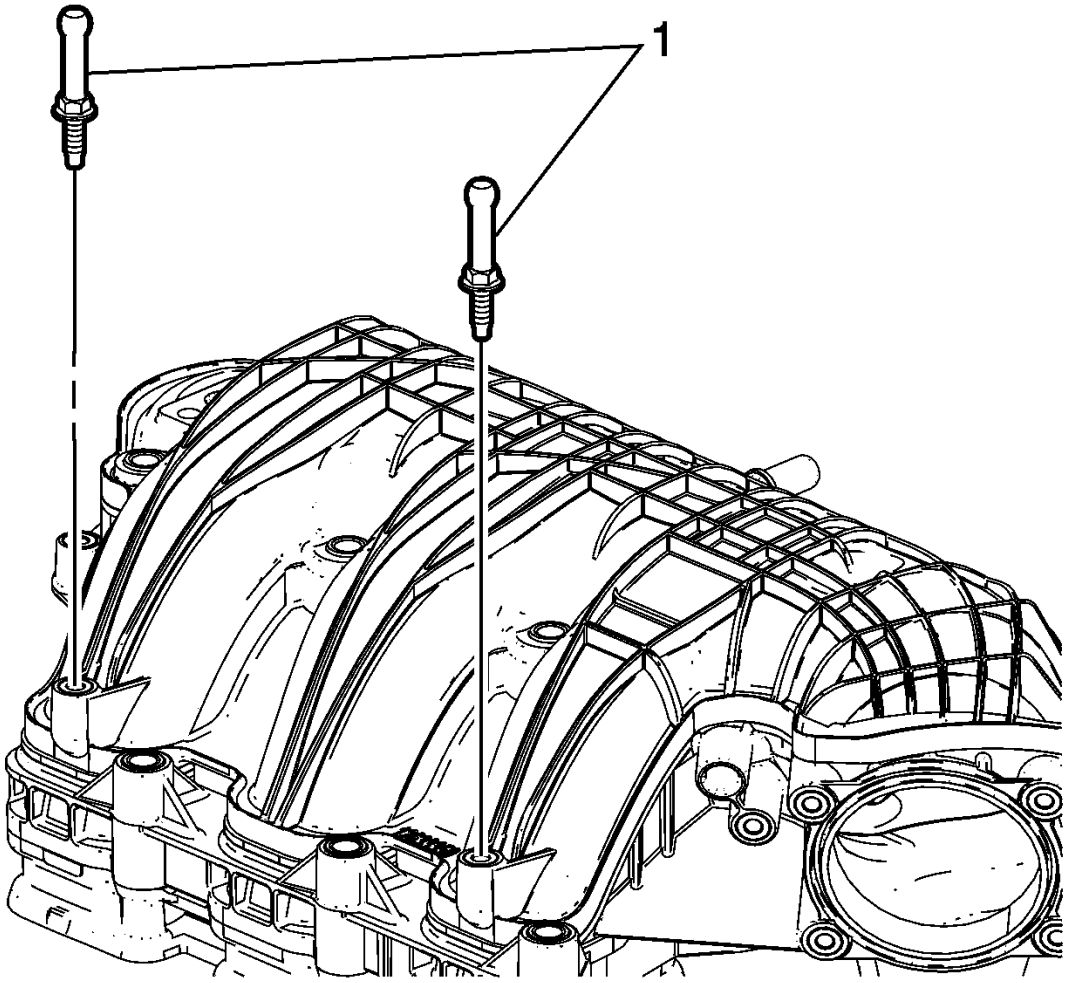

Fig. 317: Intake Manifold Cover Ball Studs
Courtesy of GENERAL MOTORS COMPANY

5. Install the intake manifold cover ball studs (1) and tighten to 9 N.m (80 lb in).

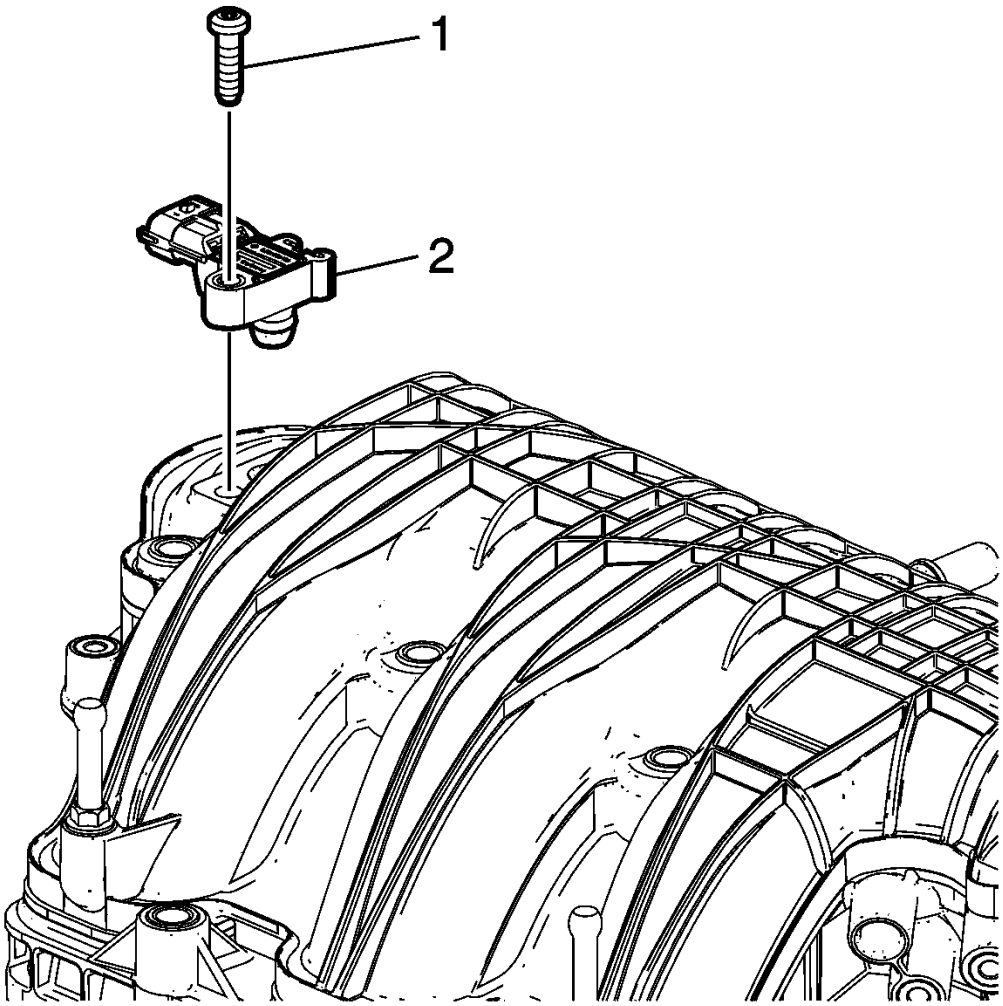

Fig. 318: Manifold Absolute Pressure Sensor And Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Install the MAP sensor (2).
7. Install the MAP sensor bolt (1) and tighten to 4 N.m (35 lb in).

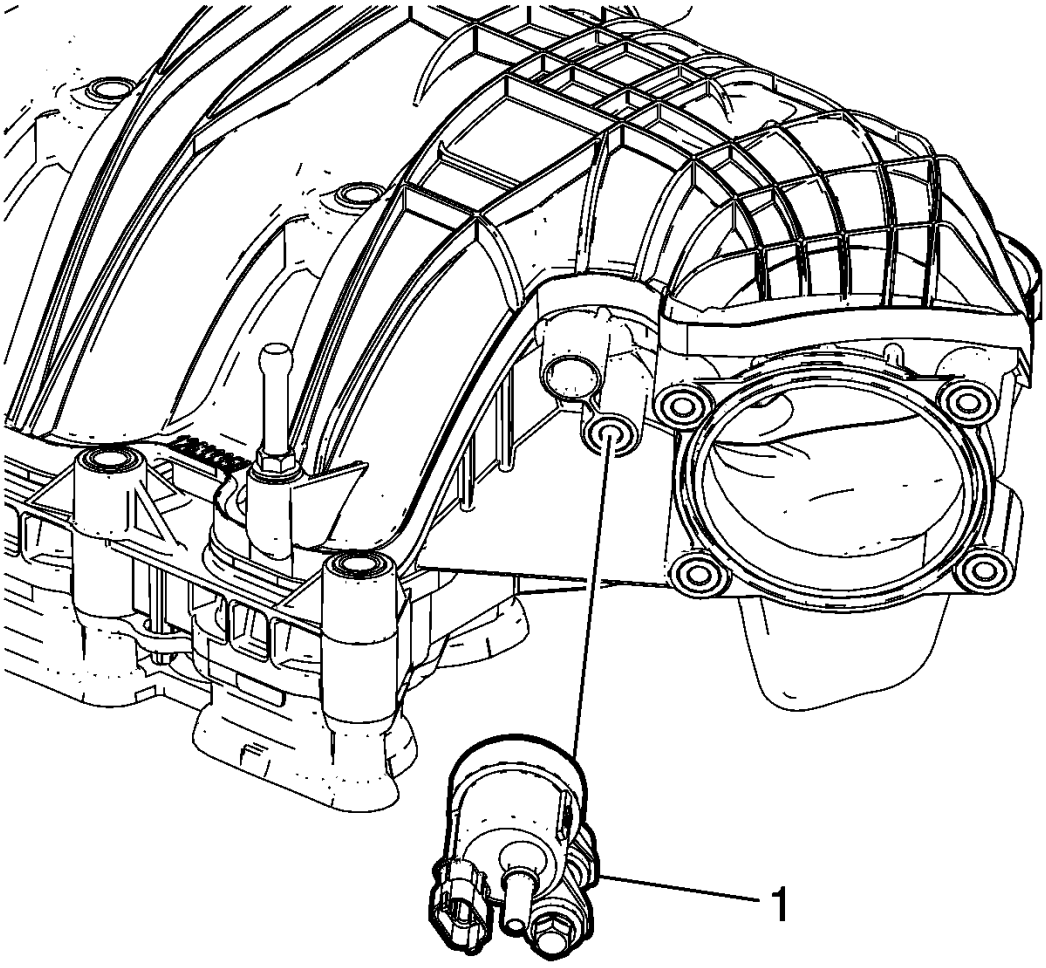

Fig. 319: EVAP Solenoid
Courtesy of GENERAL MOTORS COMPANY

8. Install the EVAP solenoid (1).
9. Tighten the EVAP solenoid bolt to 10 N.m (89 lb in).

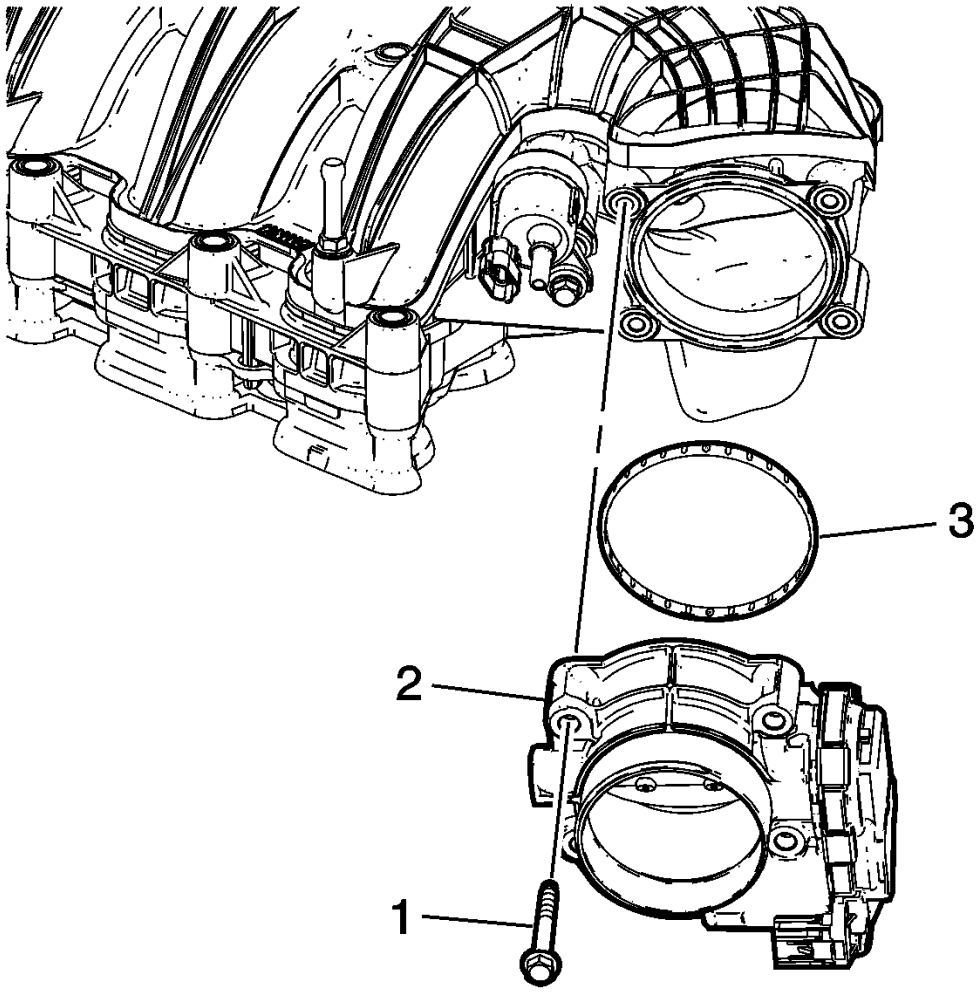

Fig. 320: Throttle Body, Bolts And Seal
Courtesy of GENERAL MOTORS COMPANY

10. Install the NEW throttle body seal (3).
11. Install the throttle body (2).
12. Install the throttle body bolts (1) and tighten to 10 N.m (89 lb in).

WATER PUMP CLEANING AND INSPECTION

Cleaning Procedure

CAUTION: Do not immerse the water pump in solvent. The solvent may enter the water pump's permanently lubricated bearings and cause premature bearing failure.

1. Remove the old gasket material from the water pump sealing surfaces.
2. Clean all excess dirt and debris from the water pump housing.

Inspection Procedure

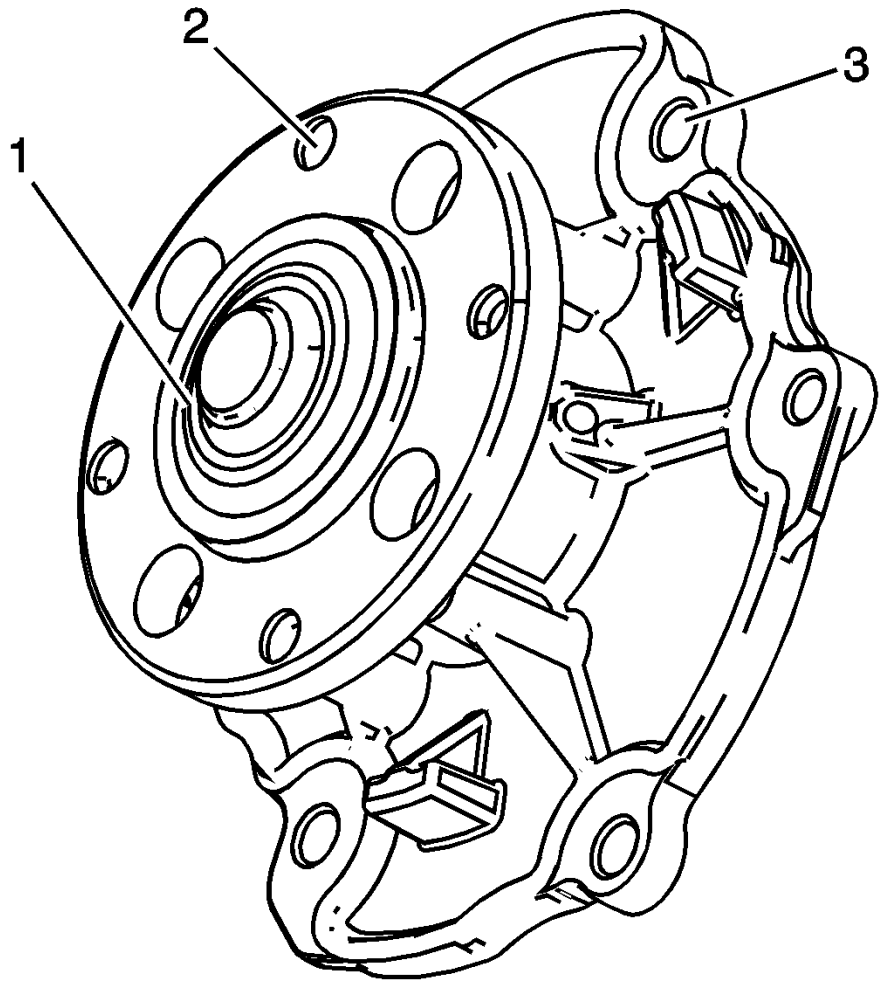

Fig. 321: Inspecting Water Pump & Hub
Courtesy of GENERAL MOTORS COMPANY

1. Rotate the water pump hub (1). The water pump hub and impeller should turn straight and smoothly. If the hub wobbles, is noisy, or feels rough when rotated, replace the water pump.
2. Inspect the exterior of the water pump for the following:
    - Damage to the water pump hub bolt threads (2) for the water pump pulley
    - Damage to the water pump bolt holes (3)

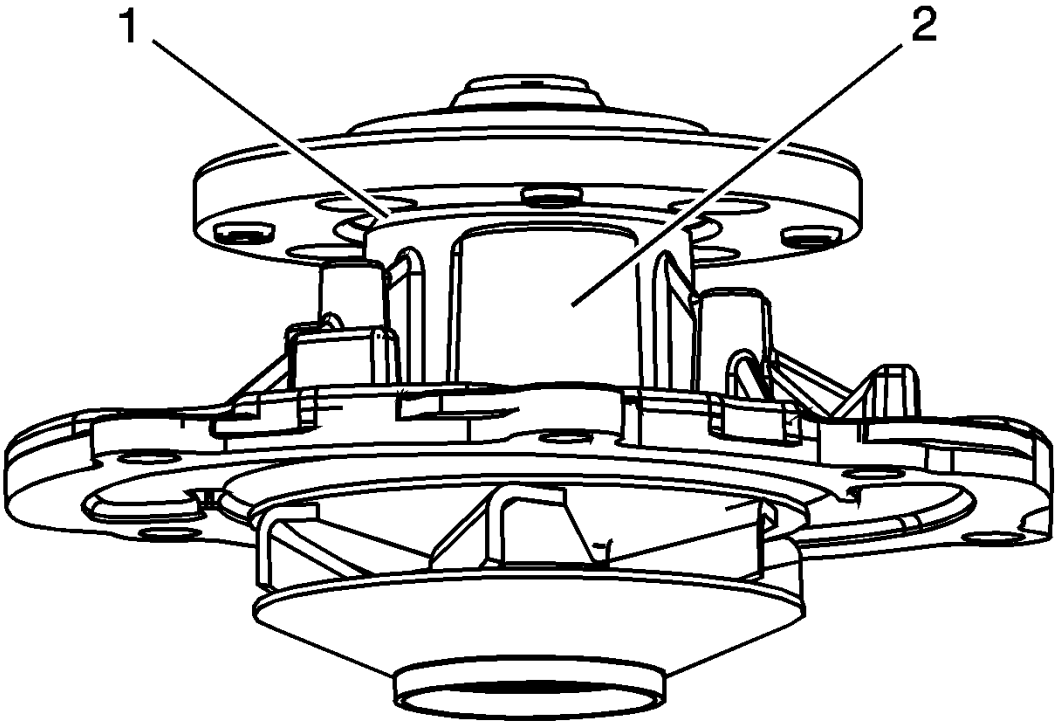

Fig. 322: Checking Water Pump Shaft & Weep Hole For Leakage
Courtesy of GENERAL MOTORS COMPANY

3. Examine the water pump shaft (1) and the weep hole reservoir (2) in the water pump body for signs of leakage. If coolant leakage is evident, replace the water pump.

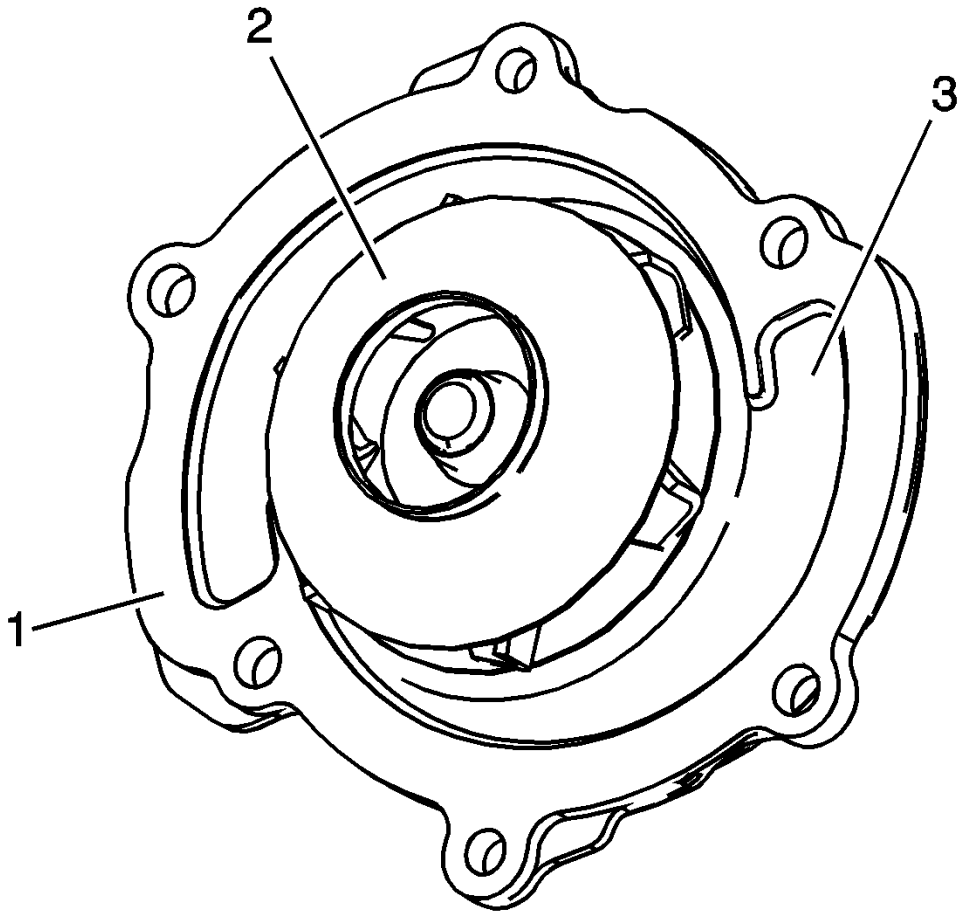

Fig. 323: Inspecting Interior Of Water Pump For Damage
Courtesy of GENERAL MOTORS COMPANY

4. Inspect the interior of the water pump for the following:
    - Damage to the water pump gasket sealing surface (1)
    - Damage, corrosion or restrictions to the water pump impeller (2)
    - Damage, corrosion or restrictions to the coolant passages (3)
5. Repair or replace the water pump as necessary.

THREAD REPAIR

Special Tools

- **EN 42385-700** High Feature Thread Repair Kit
- **EN 42385-2000** Thread Insert Kit
- **EN 43965** Thread Repair Extension Kit

For equivalent regional tools, refer to **Special Tools** .

The thread repair process involves a solid, thin walled, self-locking, carbon steel, bushing type insert. During the insert installation process, the installation driver tool cold-rolls the bottom internal threads and expands the bottom external threads of the insert into the base material. This action mechanically locks the insert into place.

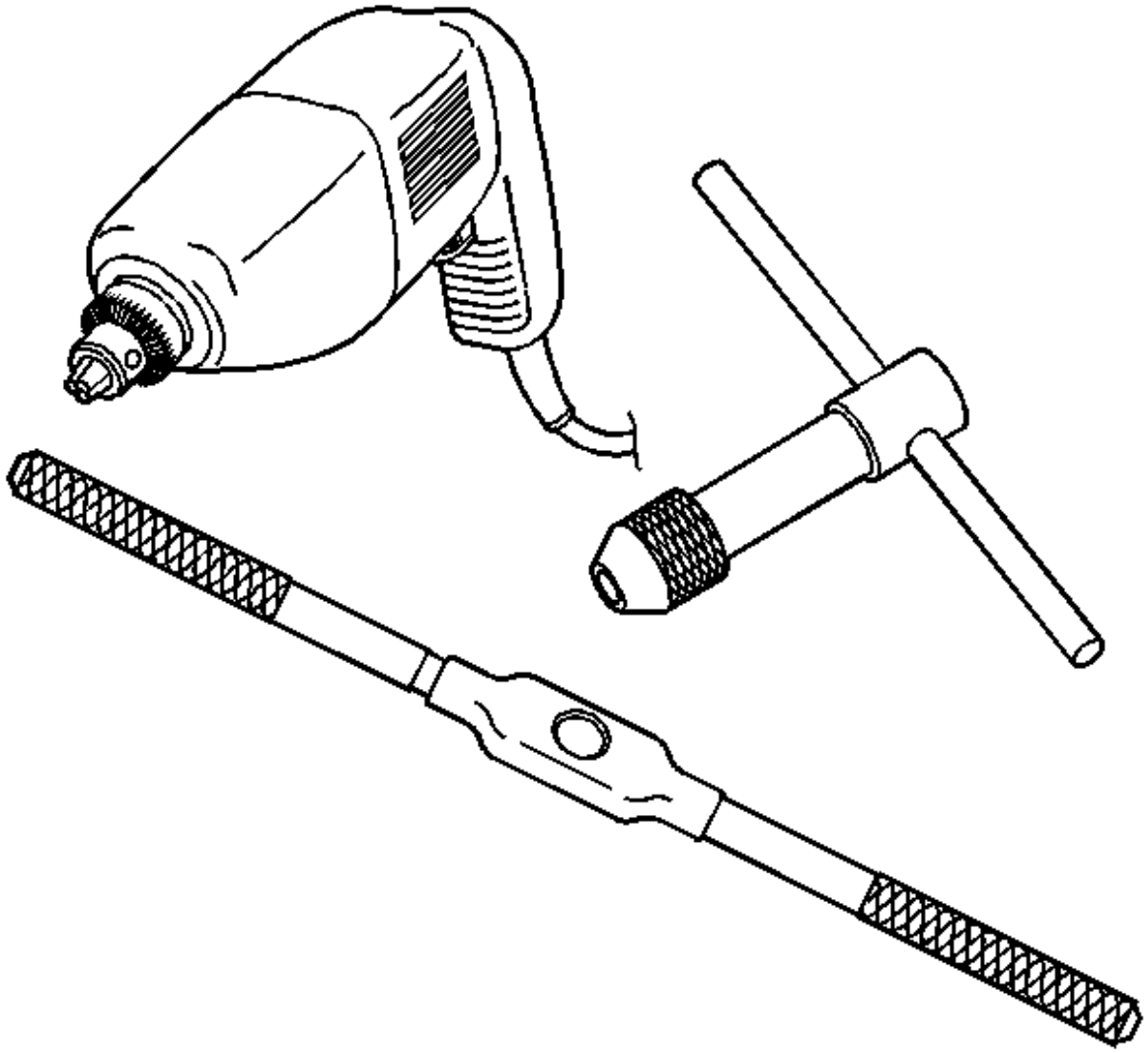

Fig. 324: View Of J 42385-400 Tool Kit
Courtesy of GENERAL MOTORS COMPANY

The drill bit and counter bore tool from the tool kit **EN 42385-700** kit and **EN 42385-2000** insert kit is designed for use with either a suitable tap wrench or drill motor. Limited access and larger hole repair may process better using a tap wrench. An extension from kit **EN 43965** extension kit may also be necessary to drive the thread repair tooling dependent on access to the hole being repaired. Use only a tap wrench when tapping the hole and during installation of the insert.

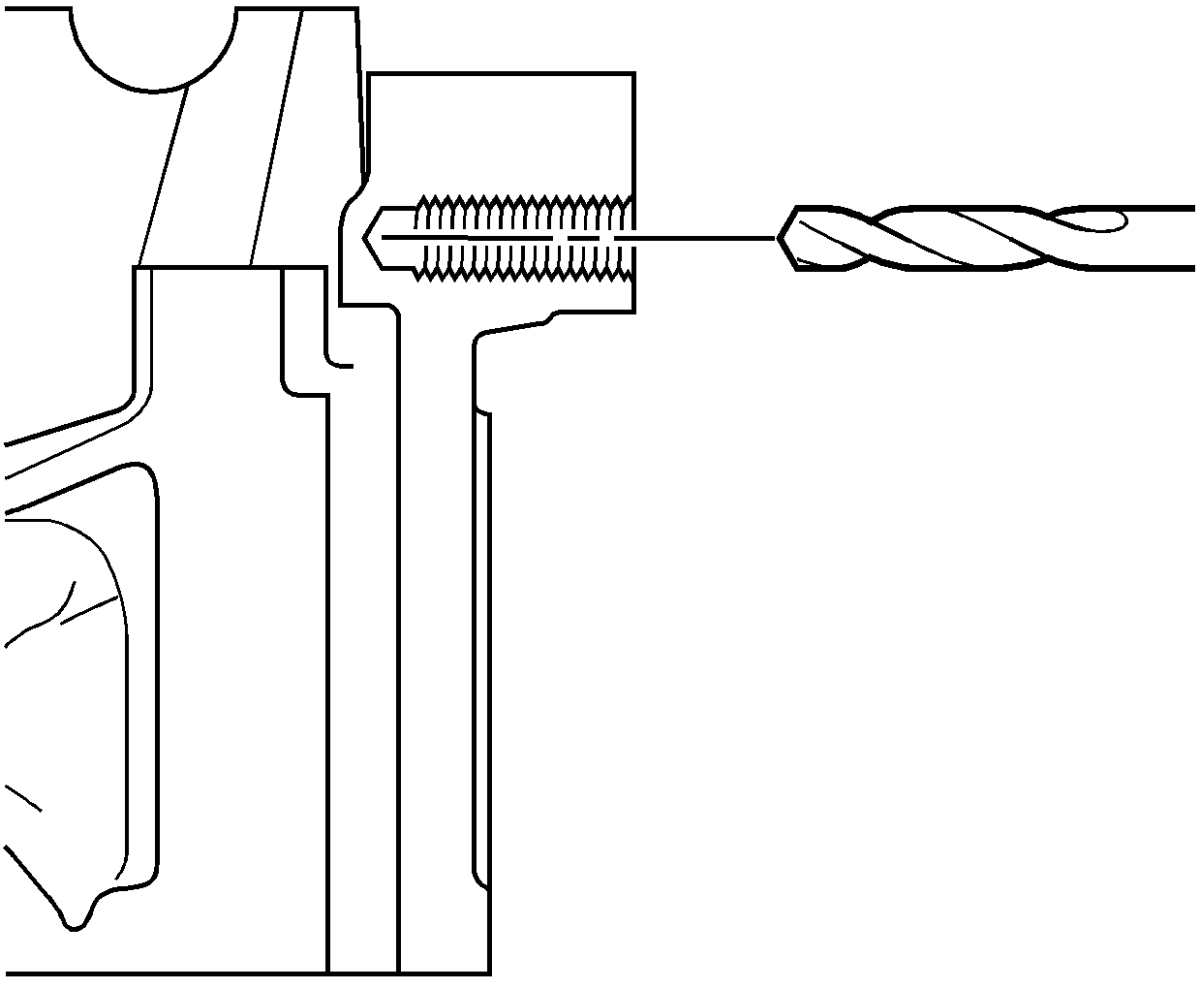

Fig. 325: Drilled Hole Centerline
Courtesy of GENERAL MOTORS COMPANY

It is critical that the drilling, counterboring and tapping of the hole to be repaired follows the same centerline as the original hole.

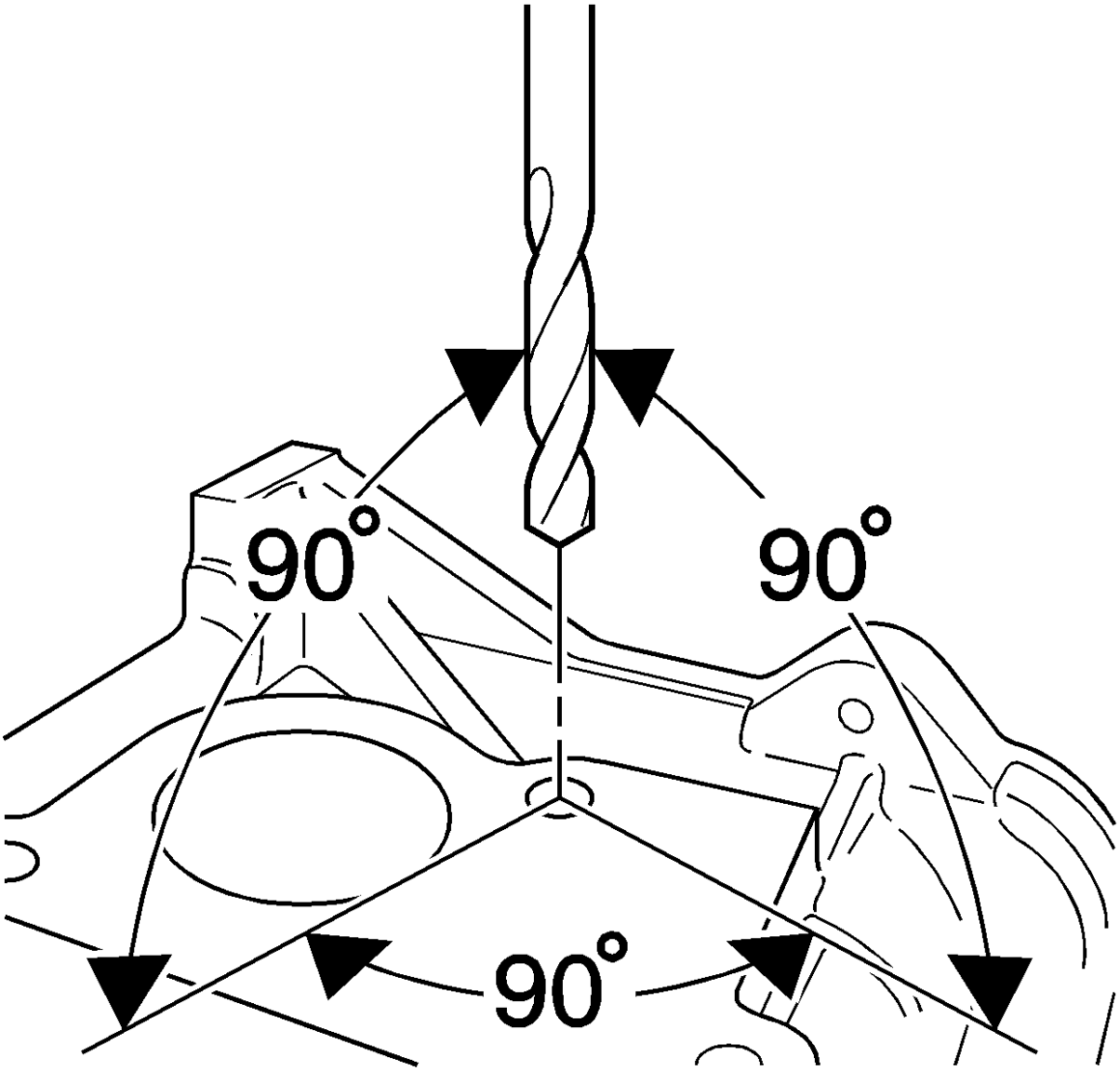

Fig. 326: Identifying Proper Drilling Angle
Courtesy of GENERAL MOTORS COMPANY

During the drilling and tapping of the hole being repaired ensure the tooling is consistently machining perpendicular to the surface of the base material.

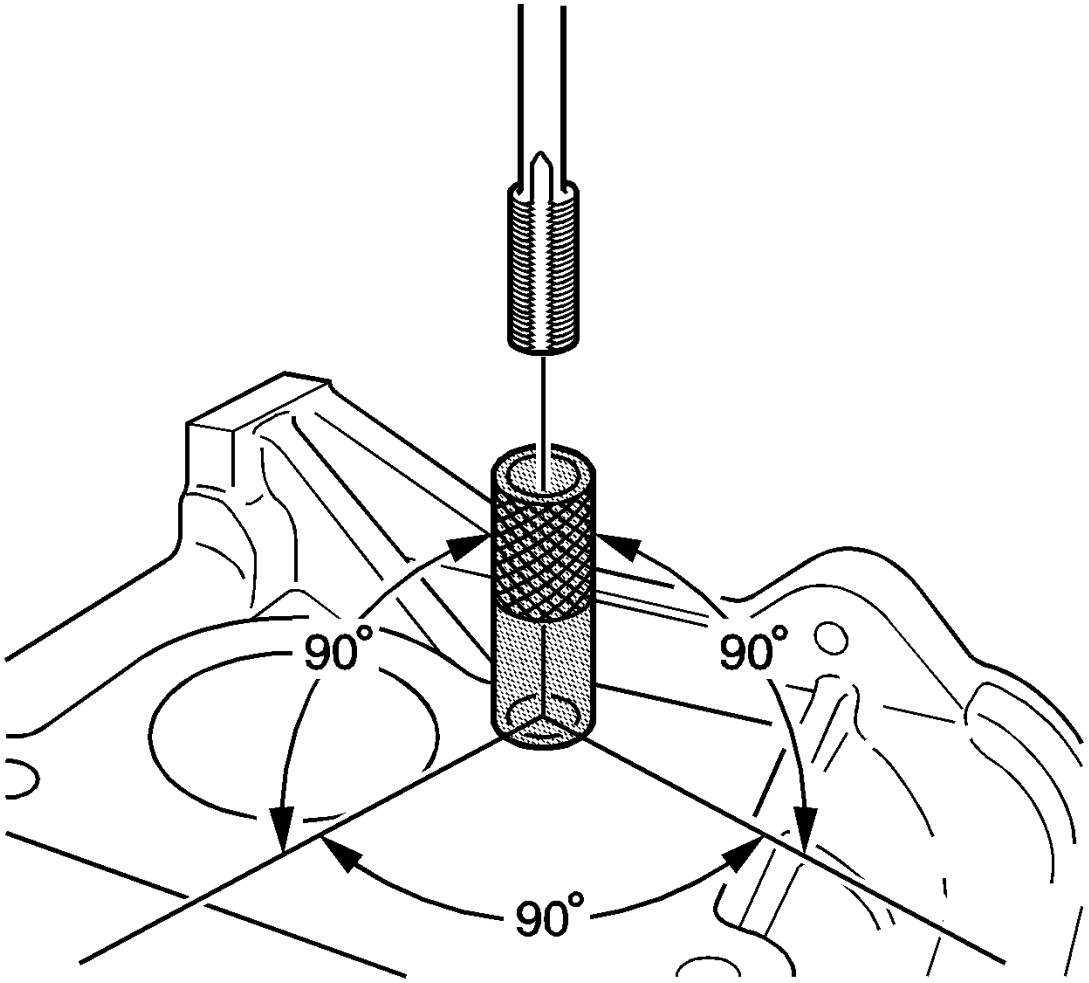

Fig. 327: View Of Tapping Guide
Courtesy of GENERAL MOTORS COMPANY

If the threaded hole being repaired has a base surface perpendicular to the hole centerline, tapping guides are available to aid in tapping the hole.

Tap Size	Tap Guide	Tap Size	Tap Guide	Tap Size	Tap Guide
-	EN 42385-	-	EN 42385-	-	EN 42385-
6 x 1.0	729	10 x 1.5	731	14 x 1.5	736
8 x 1.25	730	12 x 1.5	732	20 x 1.5	737

Standard Thread Repair - Flush Hole

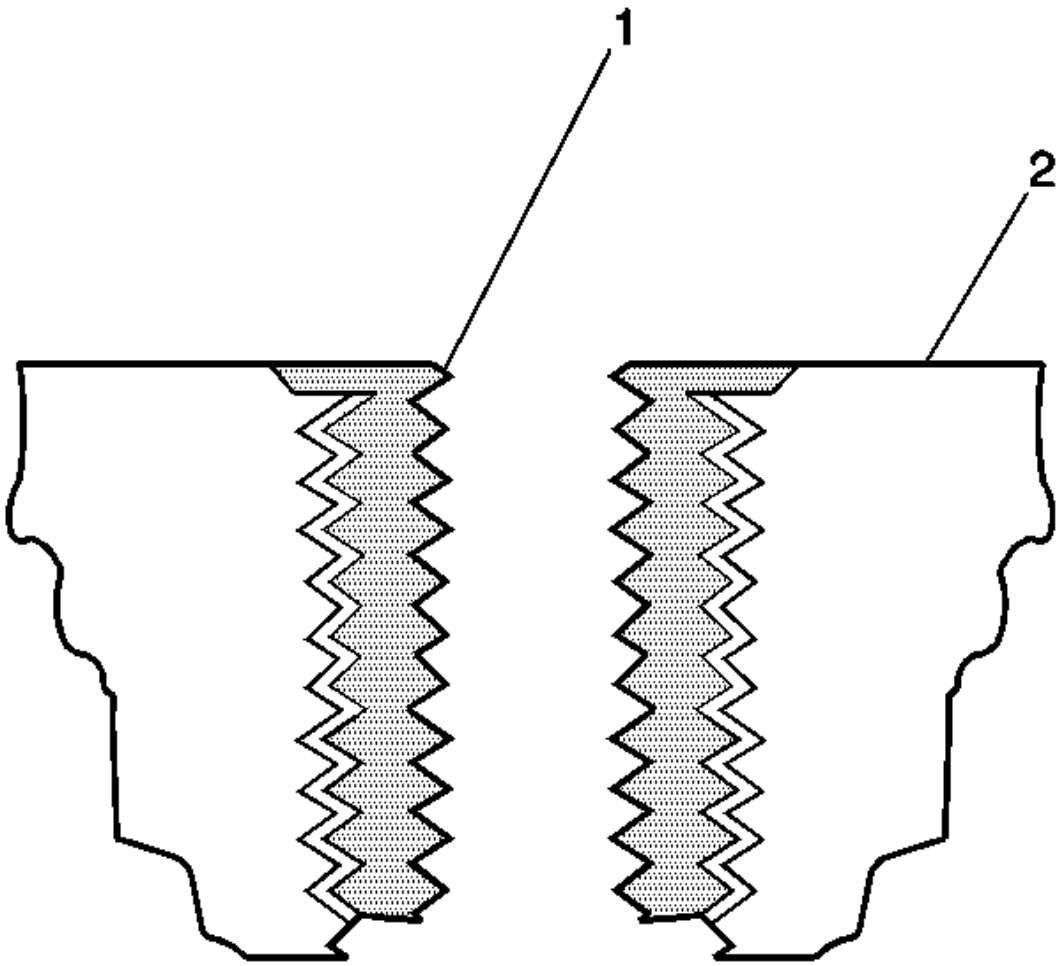

Fig. 328: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Safety Glasses Warning .**

NOTE: **The use of a cutting type fluid is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.**

When installed to the proper depth, the flange (1) of the insert will be seated against the counterbore of the drilled/tapped hole and just below the surface (2) of the base material.

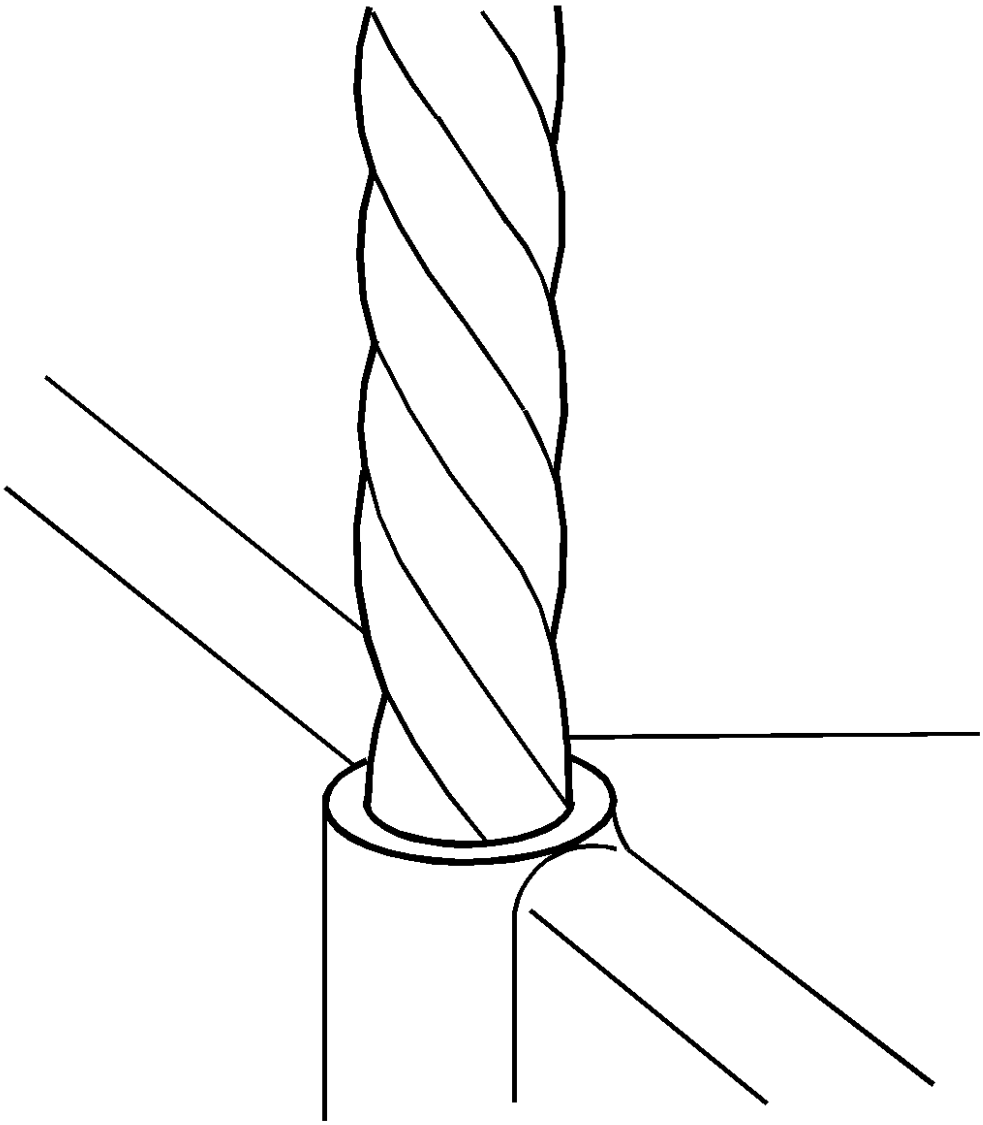

Fig. 329: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Do NOT drill any further than the original hole depth.**

1. Drill out the threads of the damaged hole.

Specifications

- M6 inserts require a minimum drill depth of 15 mm (0.59 in).
- M8 inserts require a minimum drill depth of 20 mm (0.79 in).
- M10 inserts require a minimum drill depth of 23.5 mm (0.93 in).

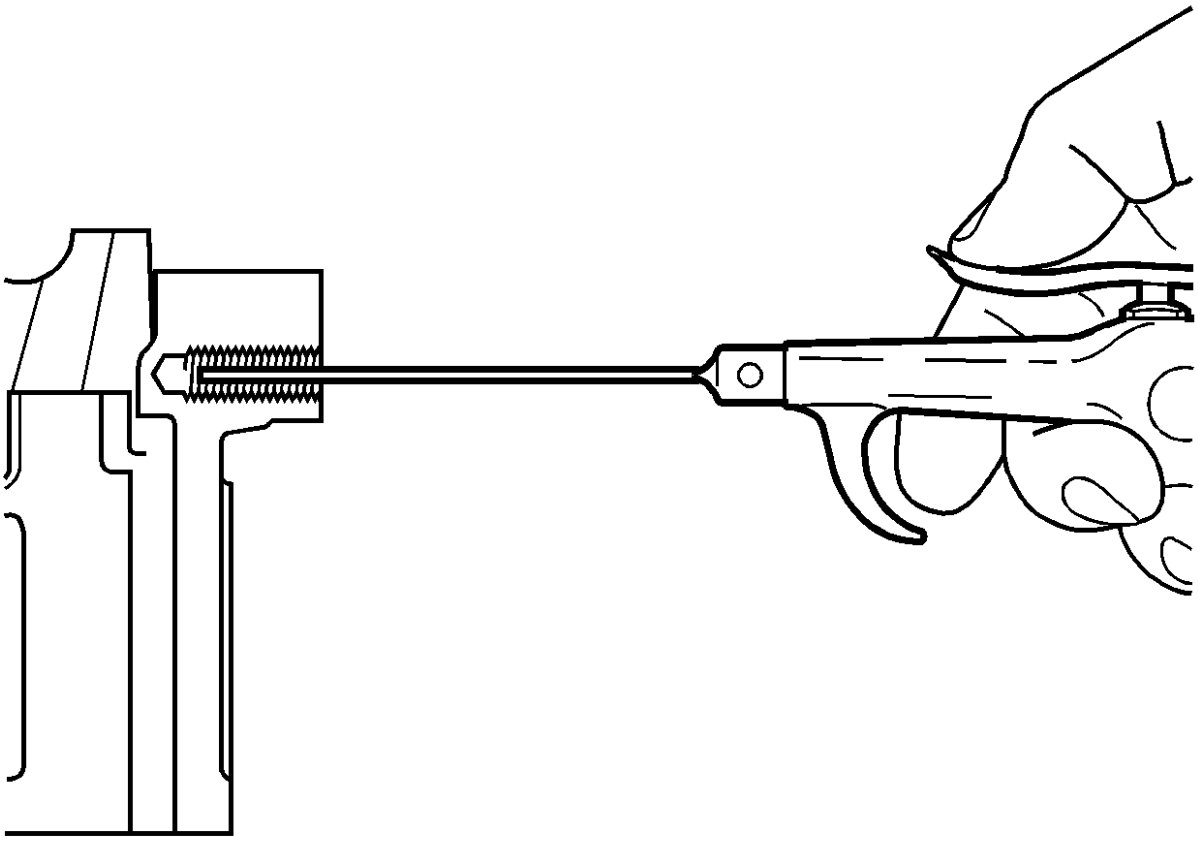

Fig. 330: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the drilled hole prior to tapping.**

2. Using compressed air, clean out any chips.

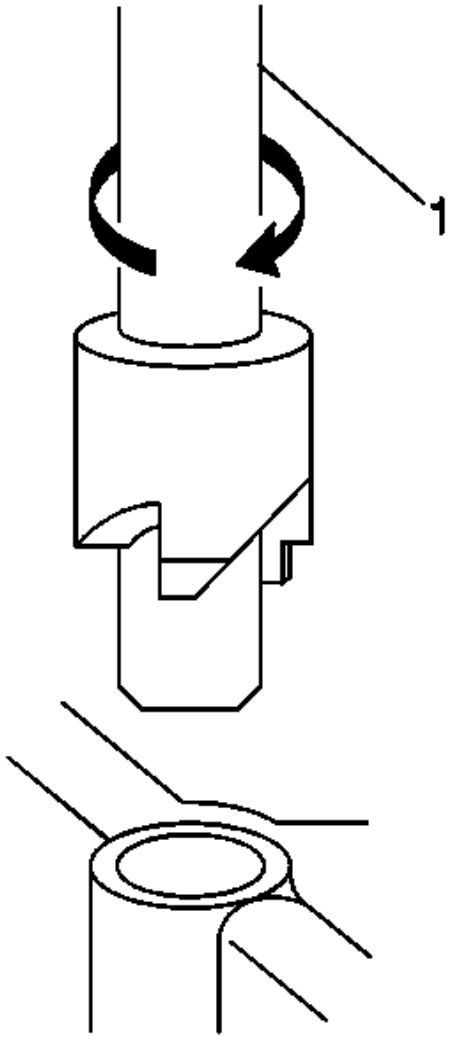

Fig. 331: Identifying Tool Used To Counterbore The Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE: **A properly counterbored hole will show a slight burnishing on the surface of the base material for 360 degrees around the drilled hole.**

3. Counterbore the drilled hole to the full depth permitted by the tool (1).

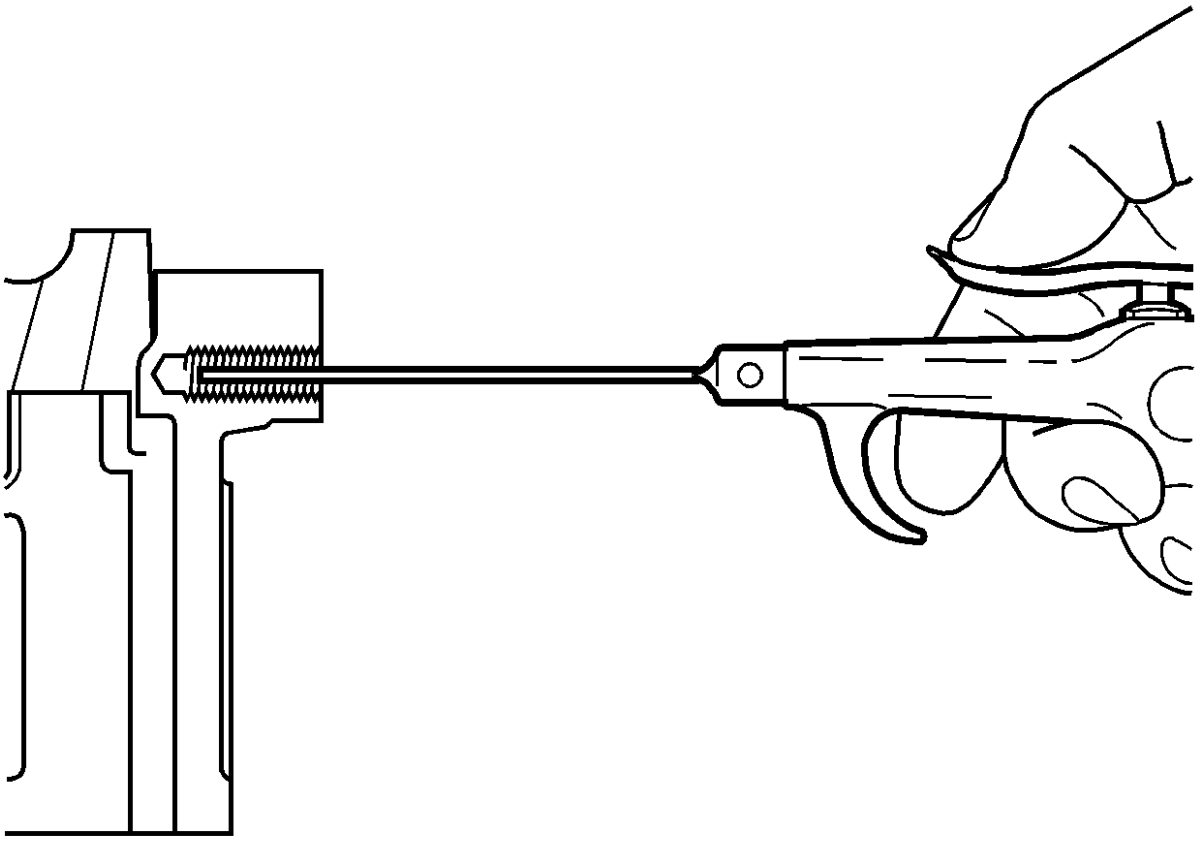

Fig. 332: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the drilled hole prior to tapping.**

4. Using compressed air, clean out any chips.

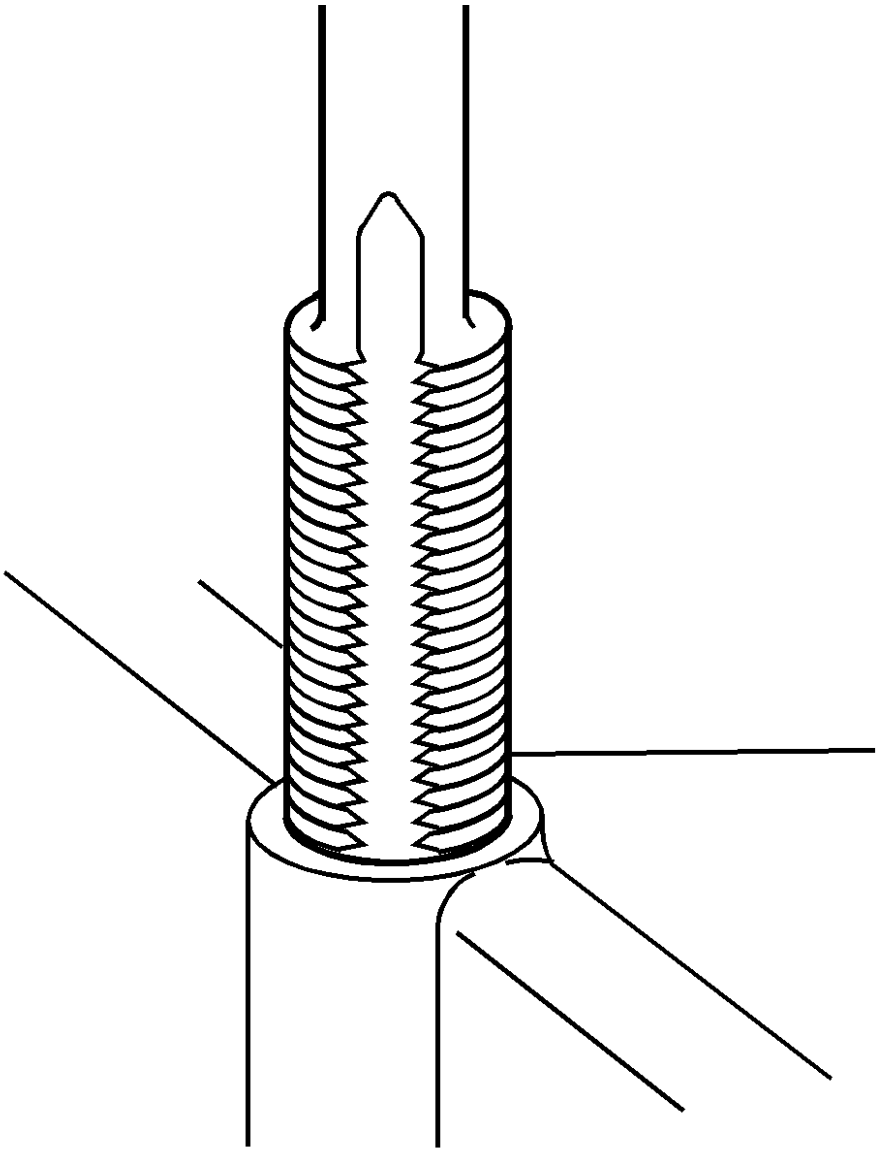

Fig. 333: Tapping Threads Of Drilled Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**
- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

5. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

Specifications

- M6 inserts require a minimum tap depth of 15 mm (0.59 in).
- M8 inserts require a minimum tap depth of 20 mm (0.79 in).
- M10 inserts require a minimum tap depth of 23.5 mm (0.93 in).

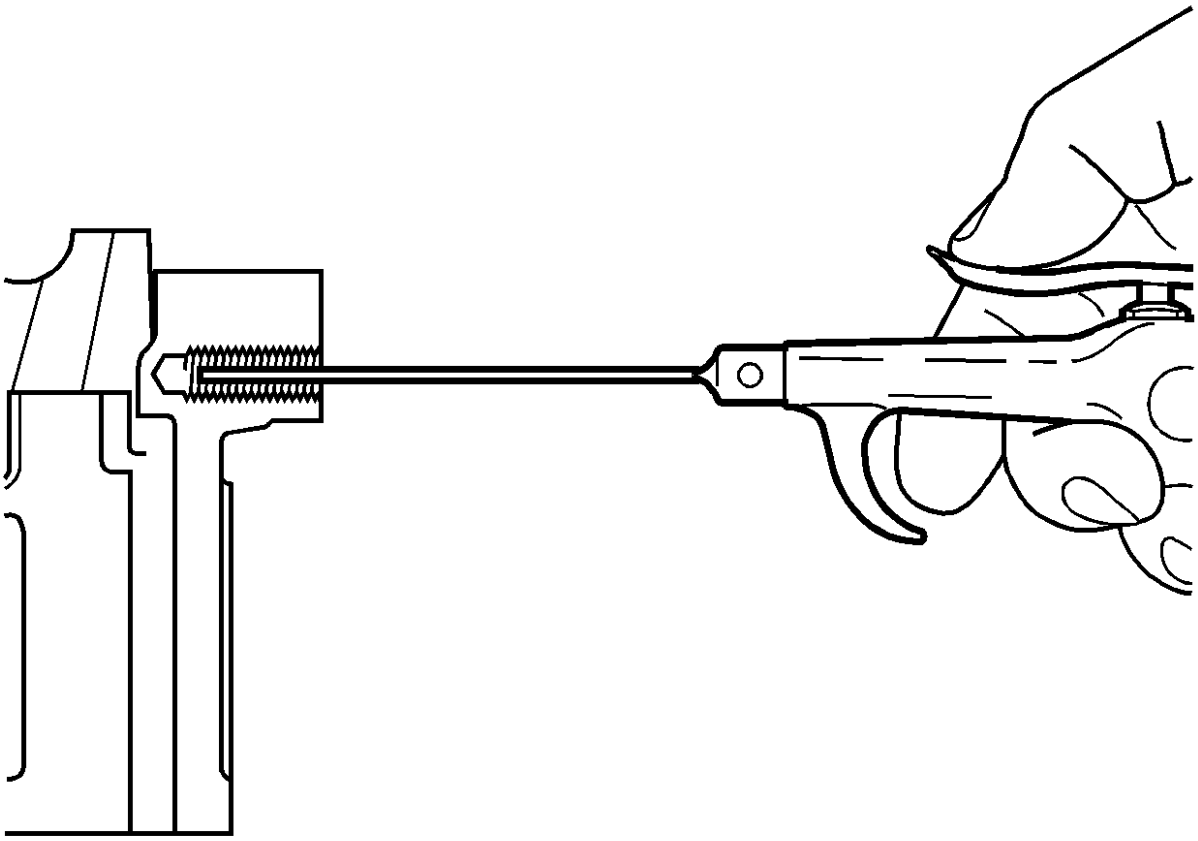

Fig. 334: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

6. Using compressed air, clean out any chips.

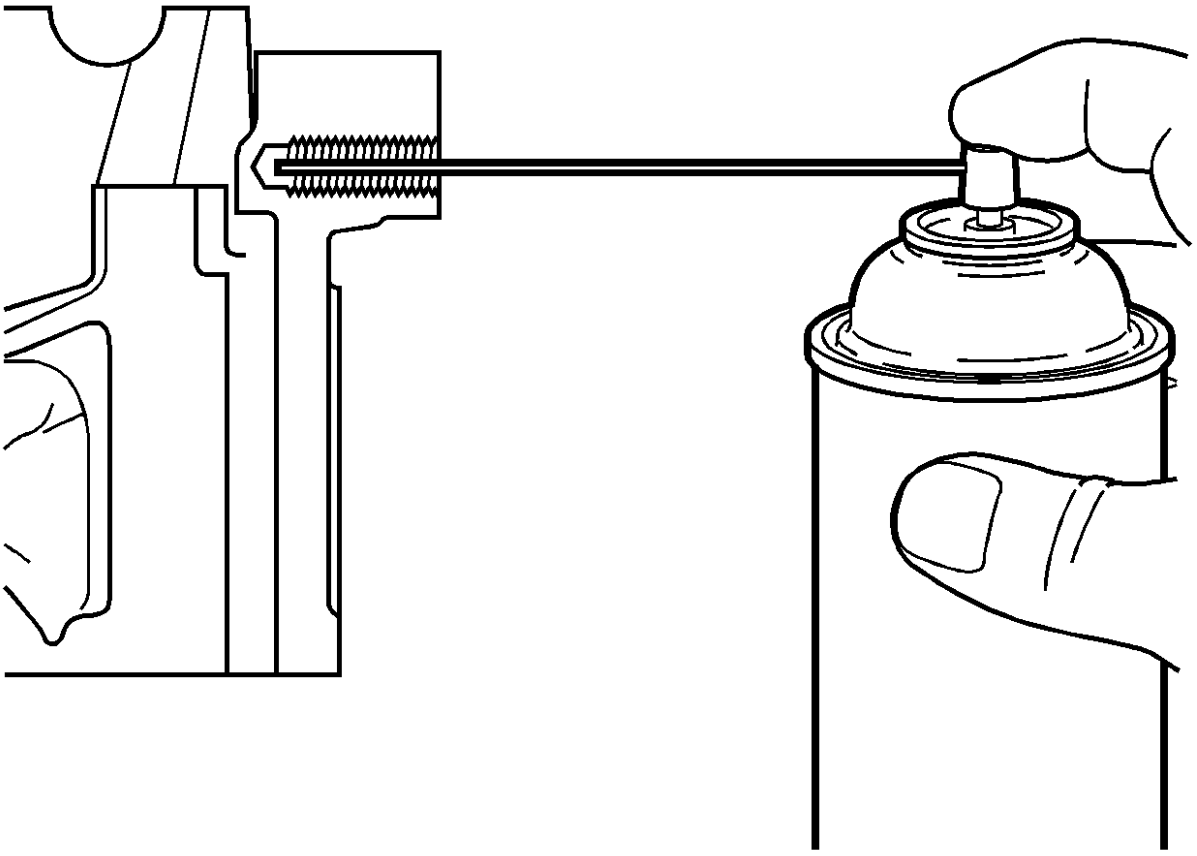

Fig. 335: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

7. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

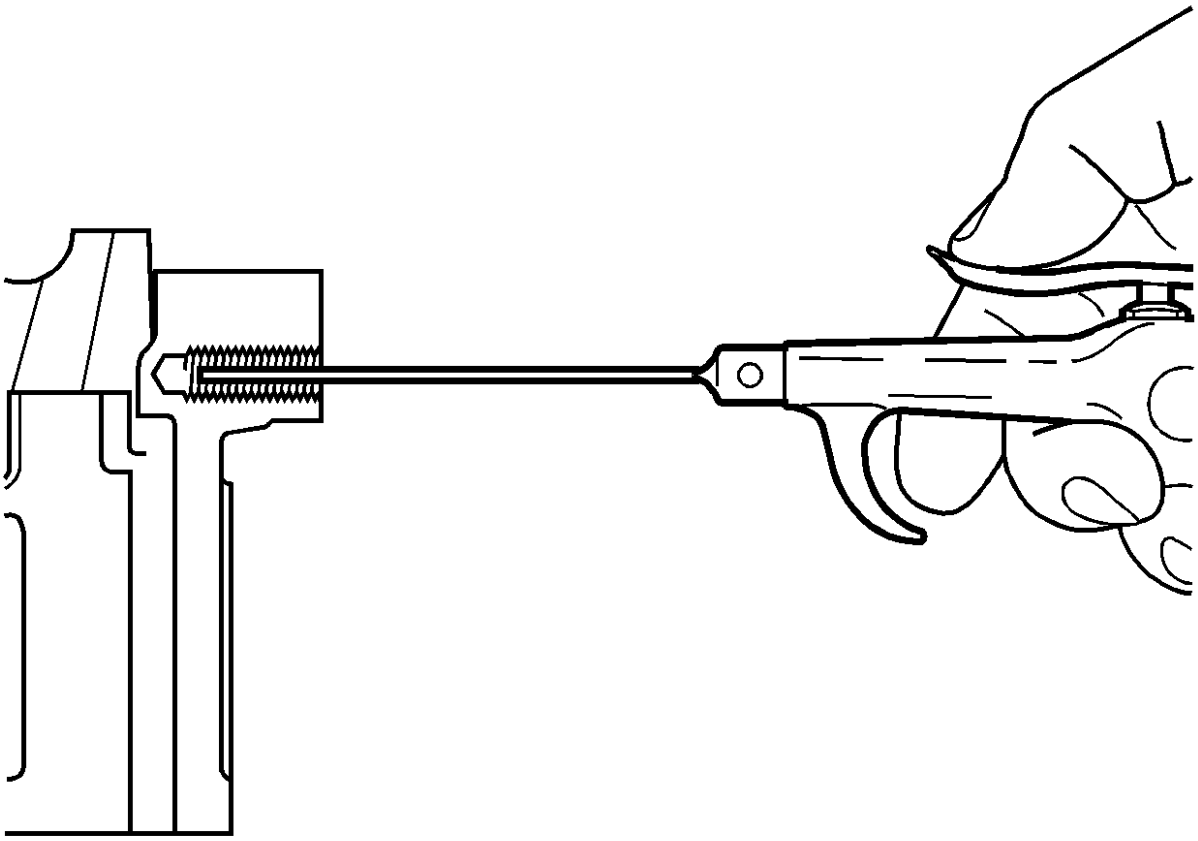

Fig. 336: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

8. Using compressed air, clean out any chips.

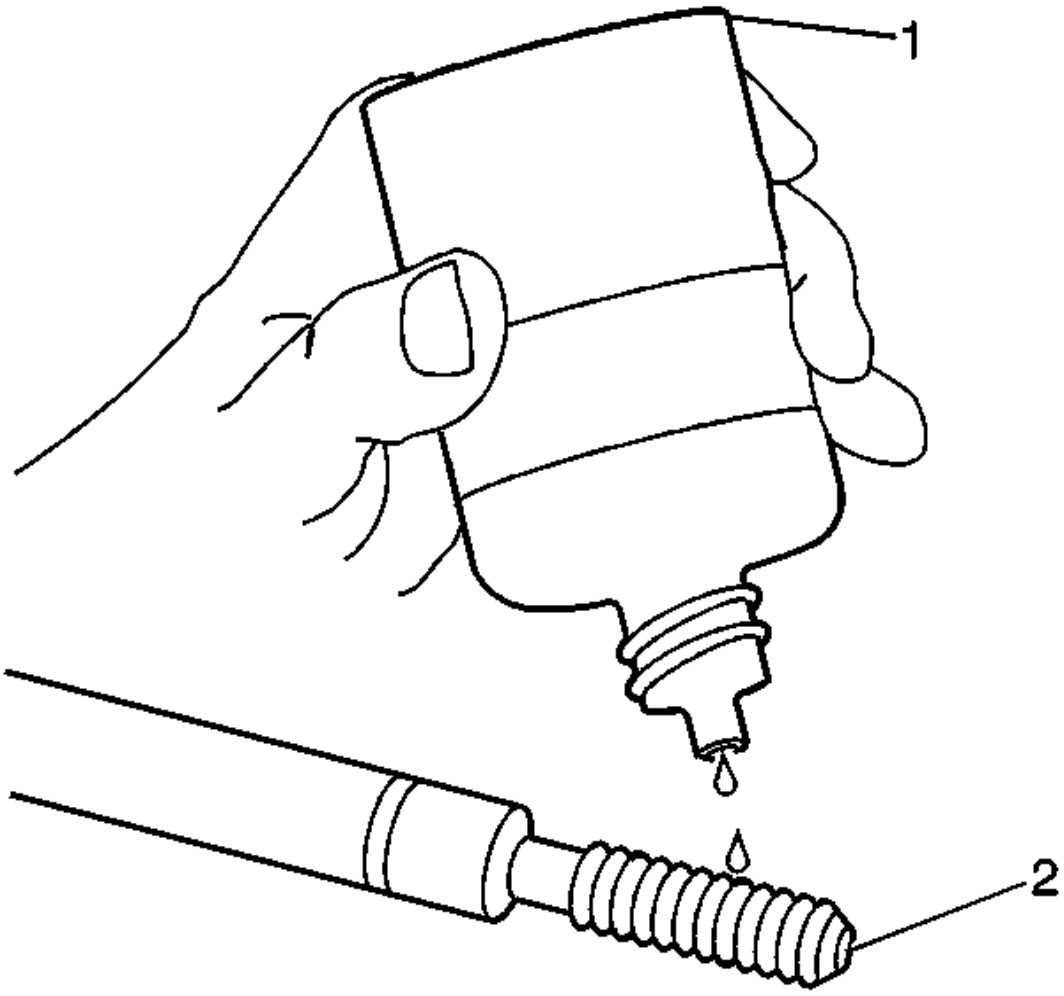

Fig. 337: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

9. Lubricate the threads of the driver installation tool (2) with the EN 42385-110 (1).

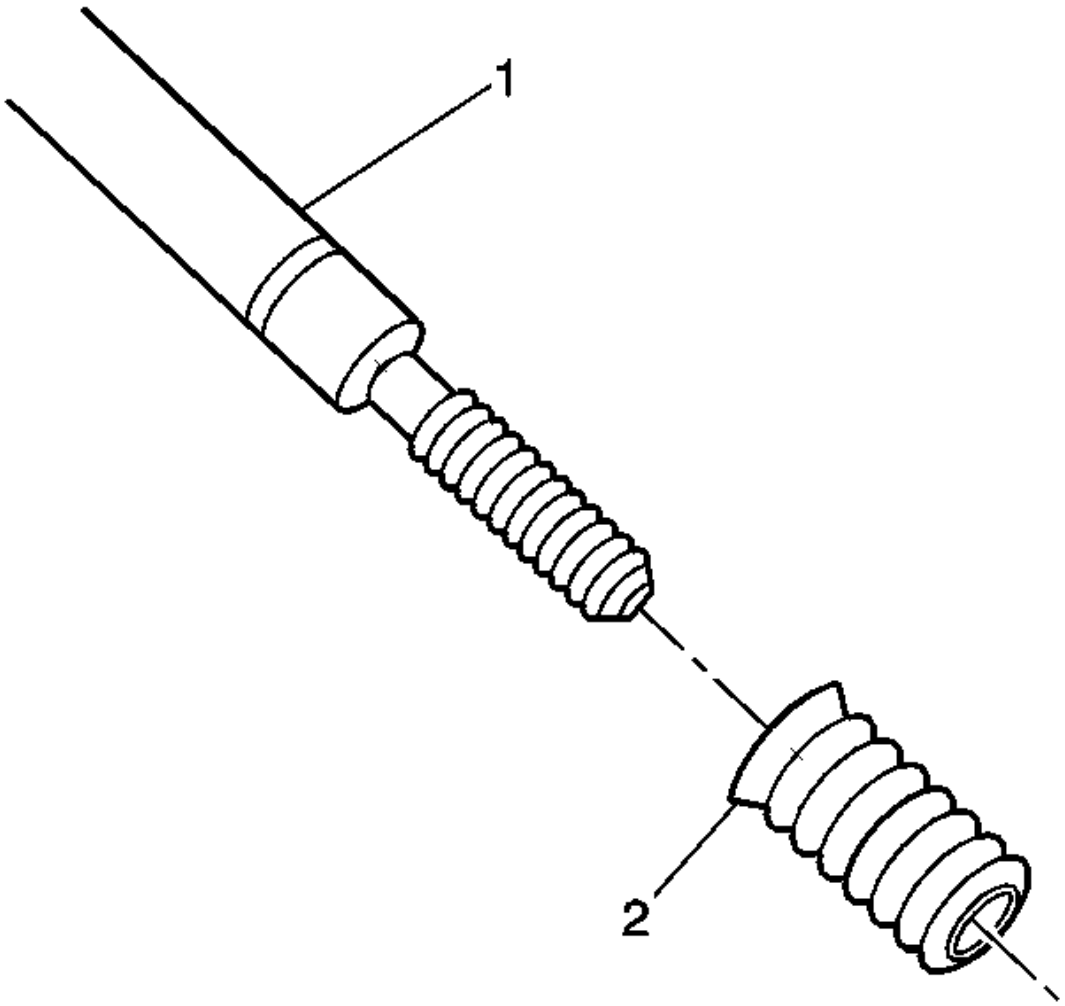

Fig. 338: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

10. Install the insert (2) onto the driver installation tool (1).

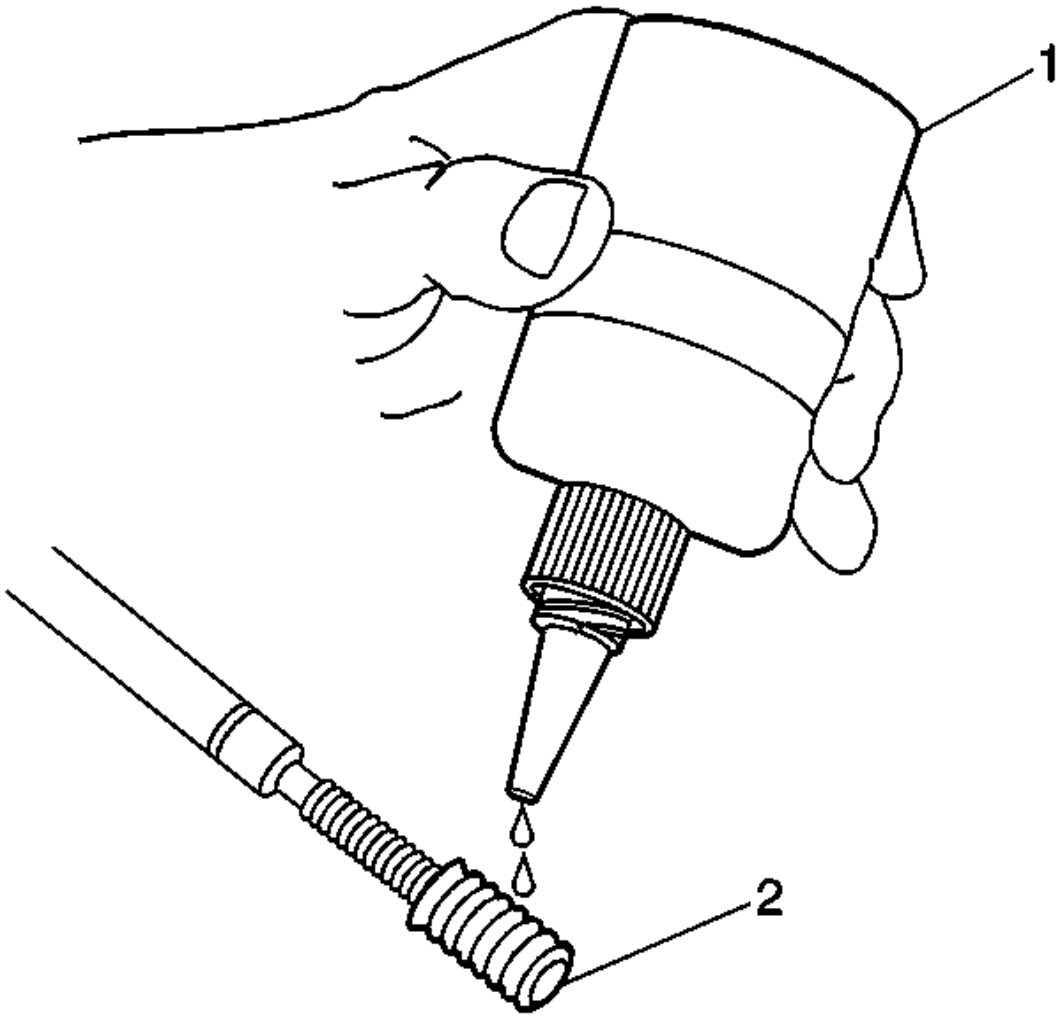

Fig. 339: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

11. Apply threadlock sealant, EN 42385-109, LOCTITE 277Â® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

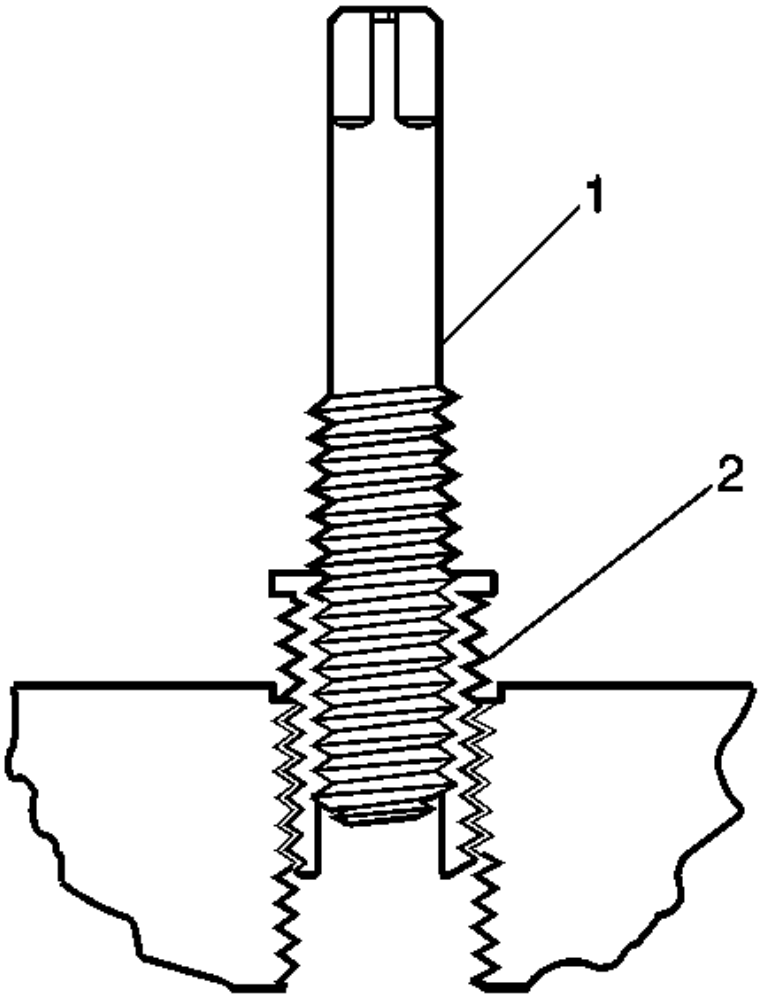

Fig. 340: View Of Insert In Tapped Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

12. Install the insert (2) into the tapped hole by hand only.

NOTE: **If the insert will not thread down until the flange contacts the counterbored surface, remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.**

13. Install the insert until the flange (2) of the insert contacts the counterbored surface.

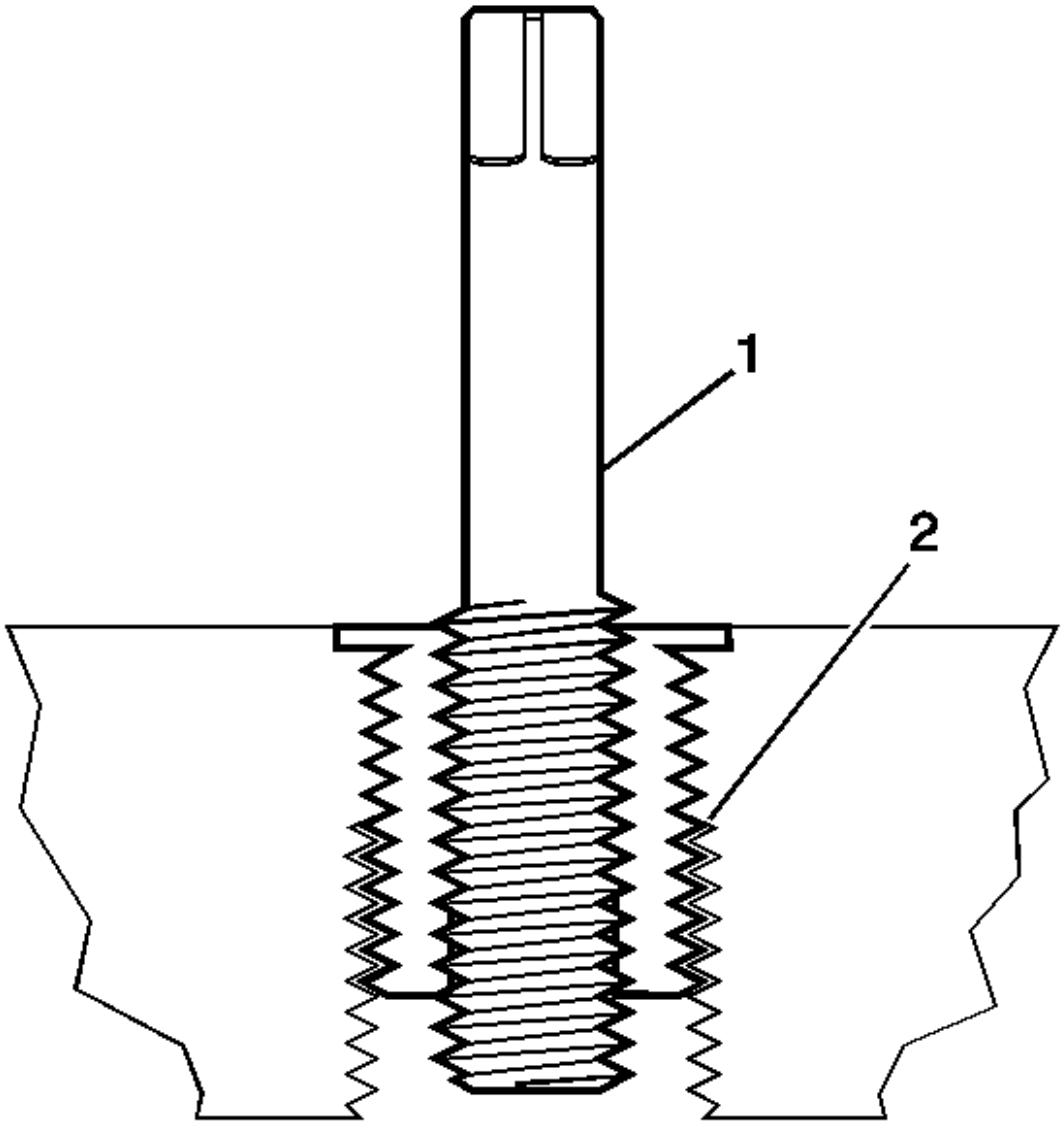

Fig. 341: View Insert & Tool - Standard Thread
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.**

14. Continue to rotate the driver installation tool (1) through the insert (2).

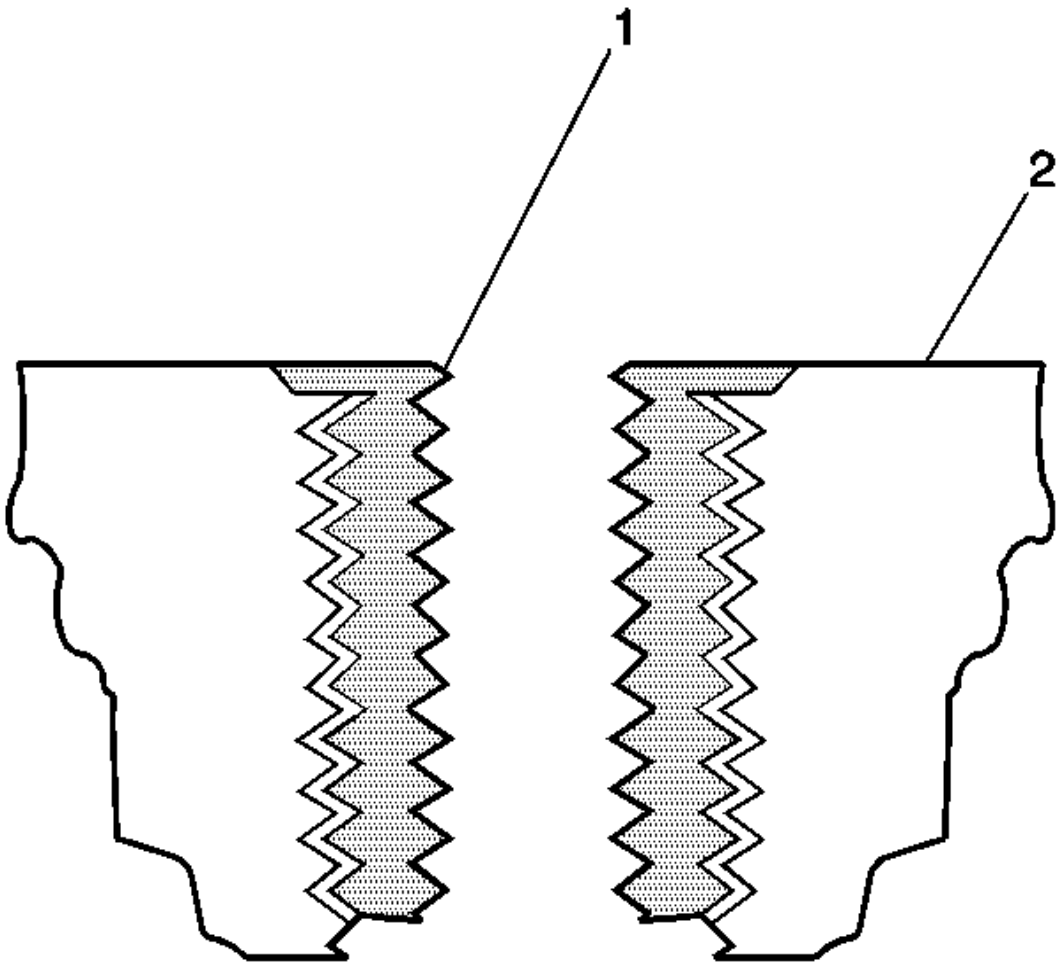

Fig. 342: View Of Bushing Type Insert & Base Material
Courtesy of GENERAL MOTORS COMPANY

15. Inspect the insert for proper installation into the tapped hole. A properly installed insert (1) will be either flush or slightly below flush with the surface of the base material (2).

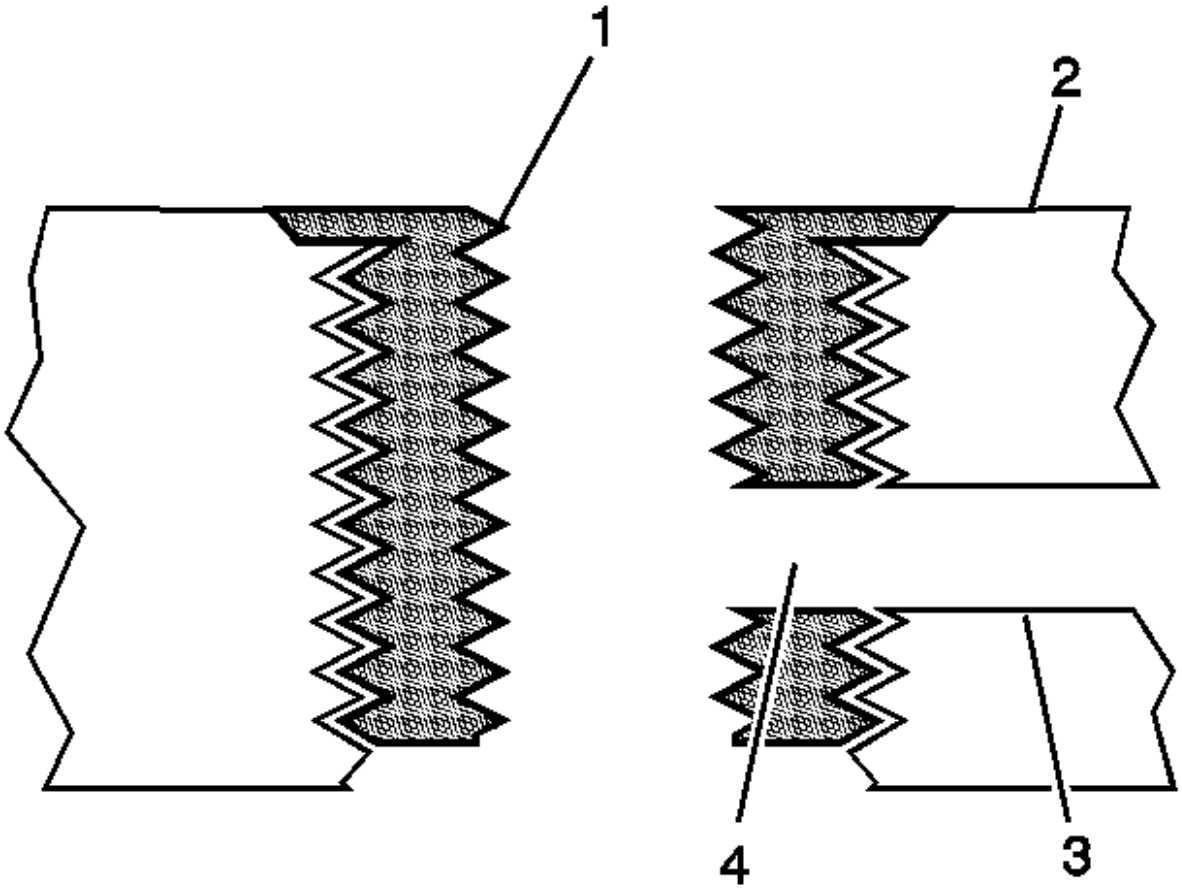

Fig. 343: View Of Restricted Engine Coolant Passages - Standard Thread Repair
Courtesy of GENERAL MOTORS COMPANY

16. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

Recessed Thread Repair

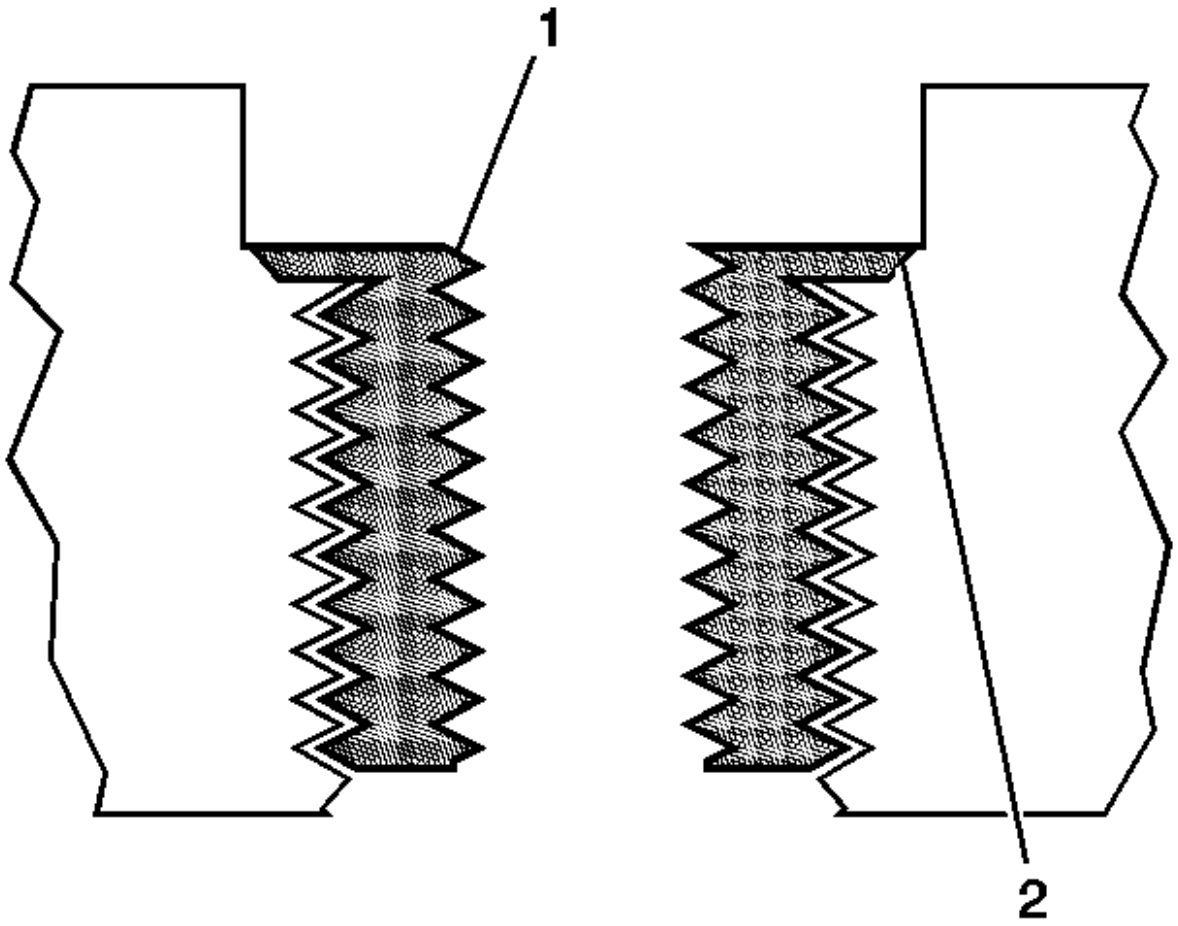

Fig. 344: Inspecting Insert For Proper Installation - Recessed Thread
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Safety Glasses Warning .**

NOTE:

- **The use of a cutting type fluid, WD 40Â® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.**
- **Do NOT remove the original stop collar from a counterbore drill.**

When installed to the proper depth, the flange of the insert (1) will be seated against the counterbore (2) of the drilled/tapped hole.

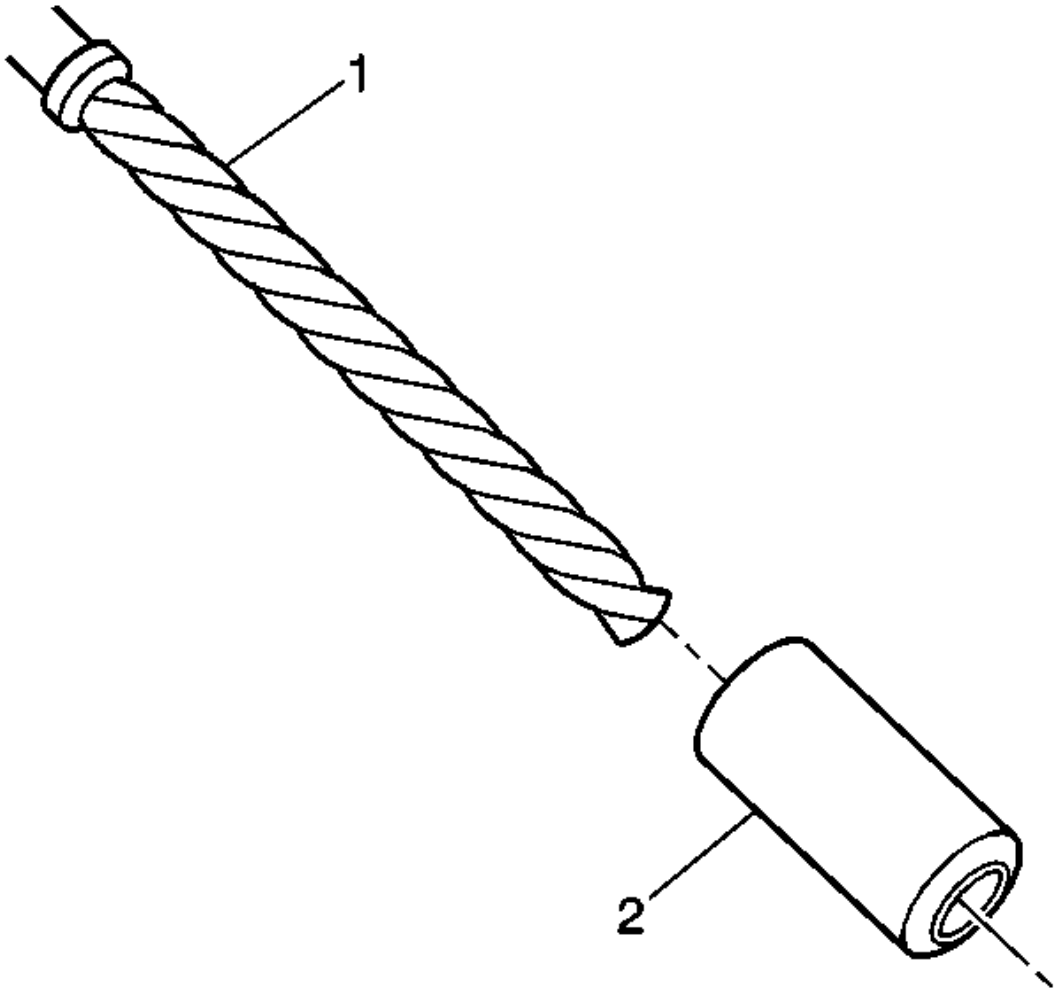

Fig. 345: View Of Stop Collar & Counterbore Drill
Courtesy of GENERAL MOTORS COMPANY

1. Install a stop collar (2) on the counterbore drill (1), if required.

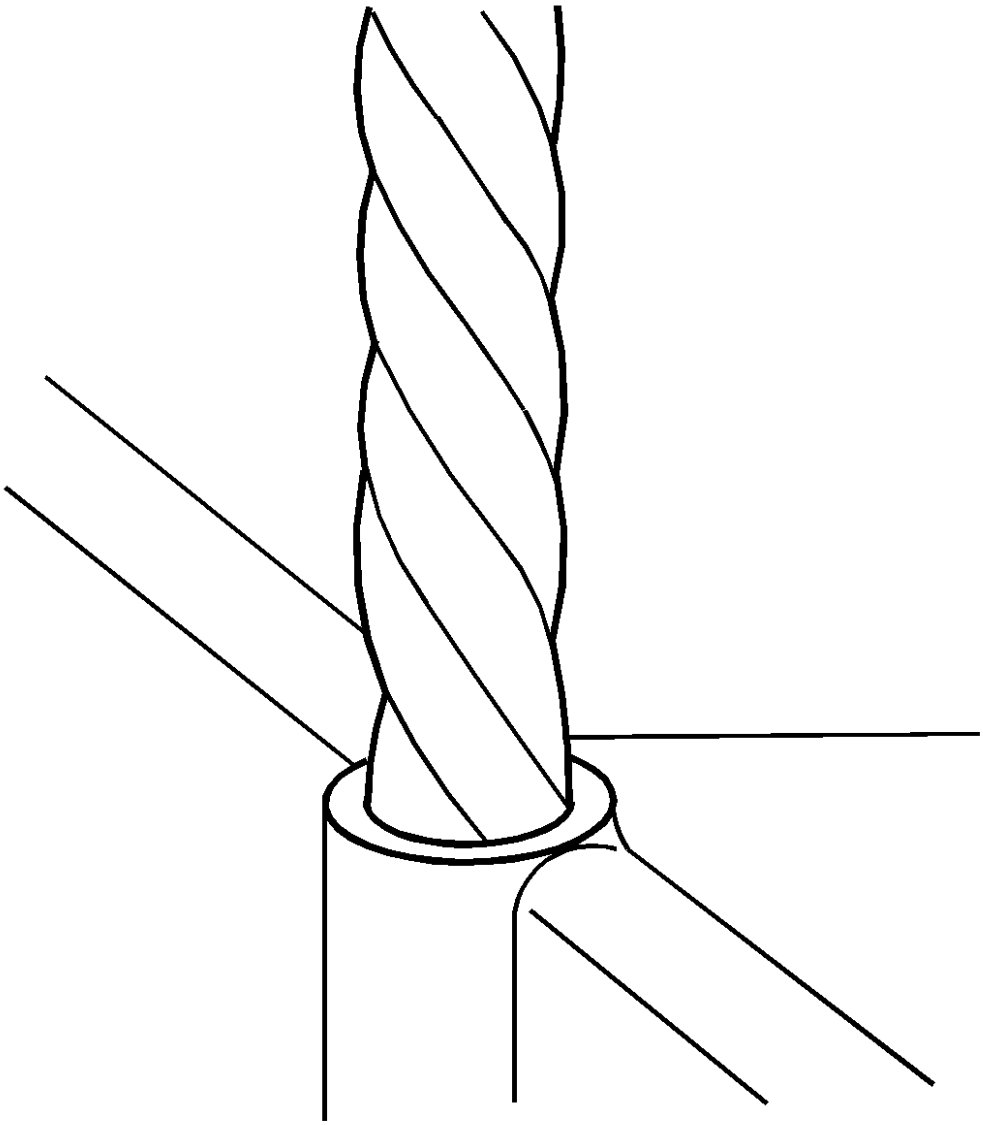

Fig. 346: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Drill the hole until the stop collar contacts the surface of the base material.**

2. Drill out the threads of the damaged hole.

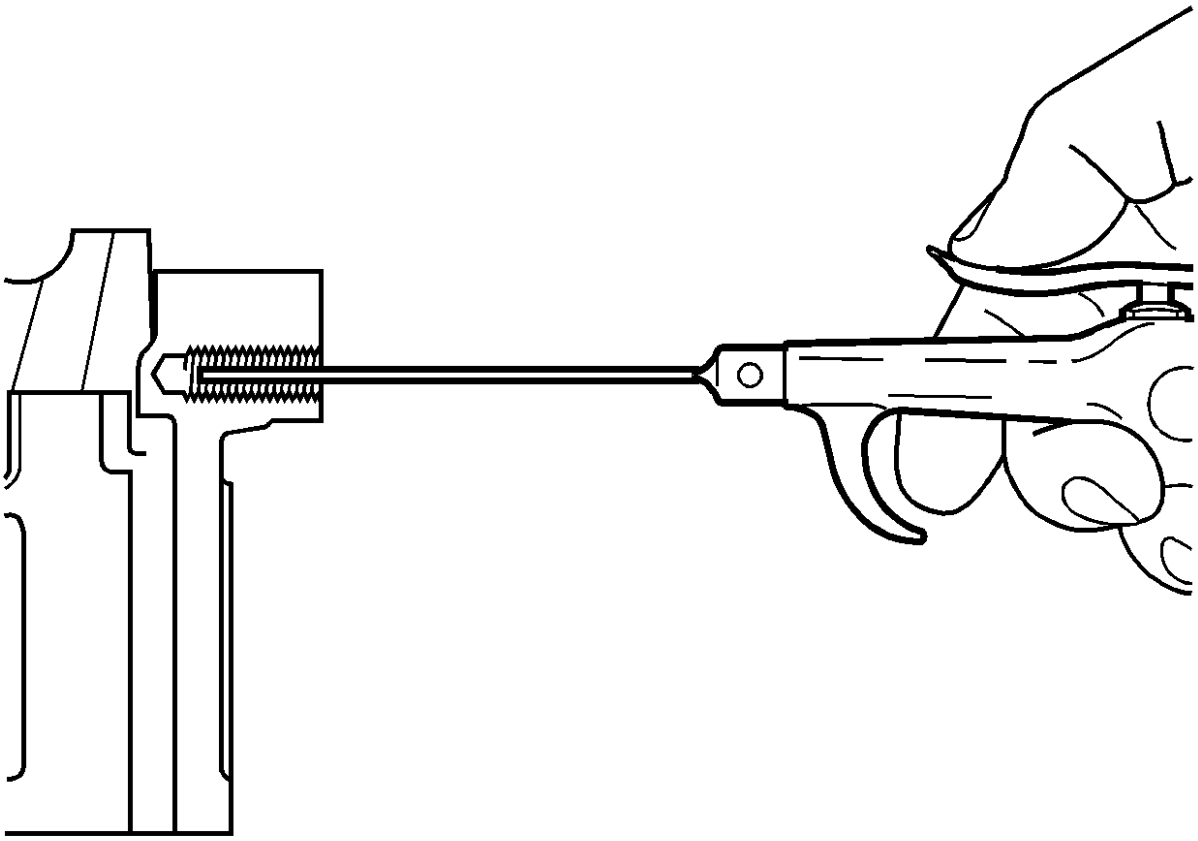

Fig. 347: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the drilled hole prior to tapping.**

3. Using compressed air, clean out any chips.

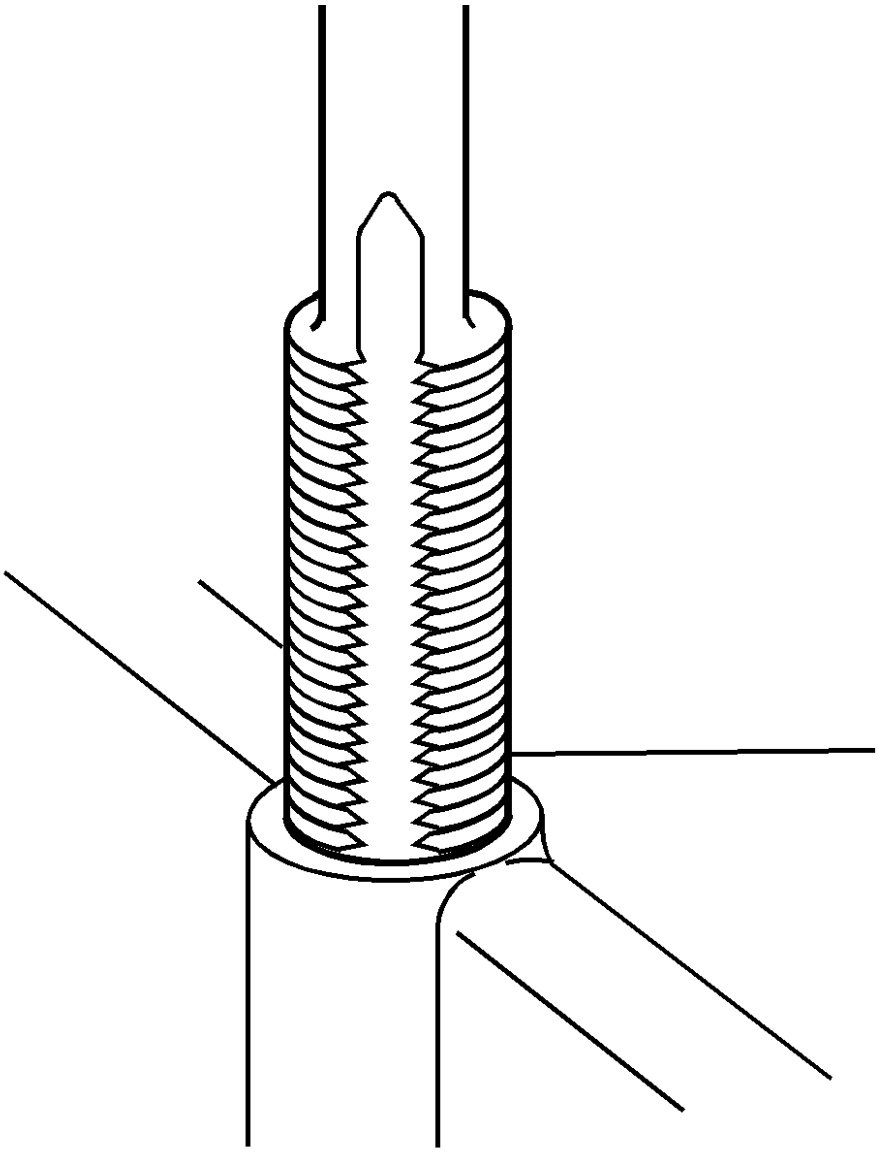

Fig. 348: Tapping Threads Of Drilled Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**
- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

4. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

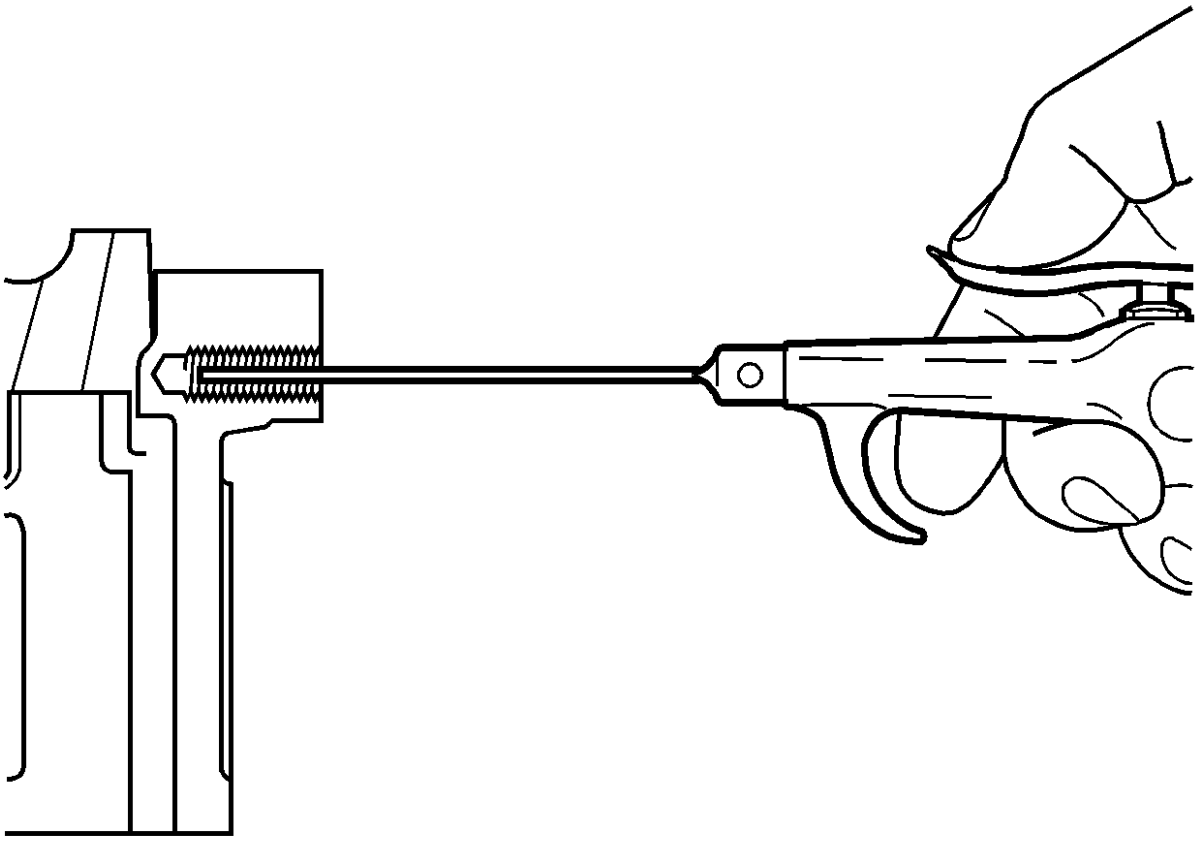

Fig. 349: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

5. Using compressed air, clean out any chips.

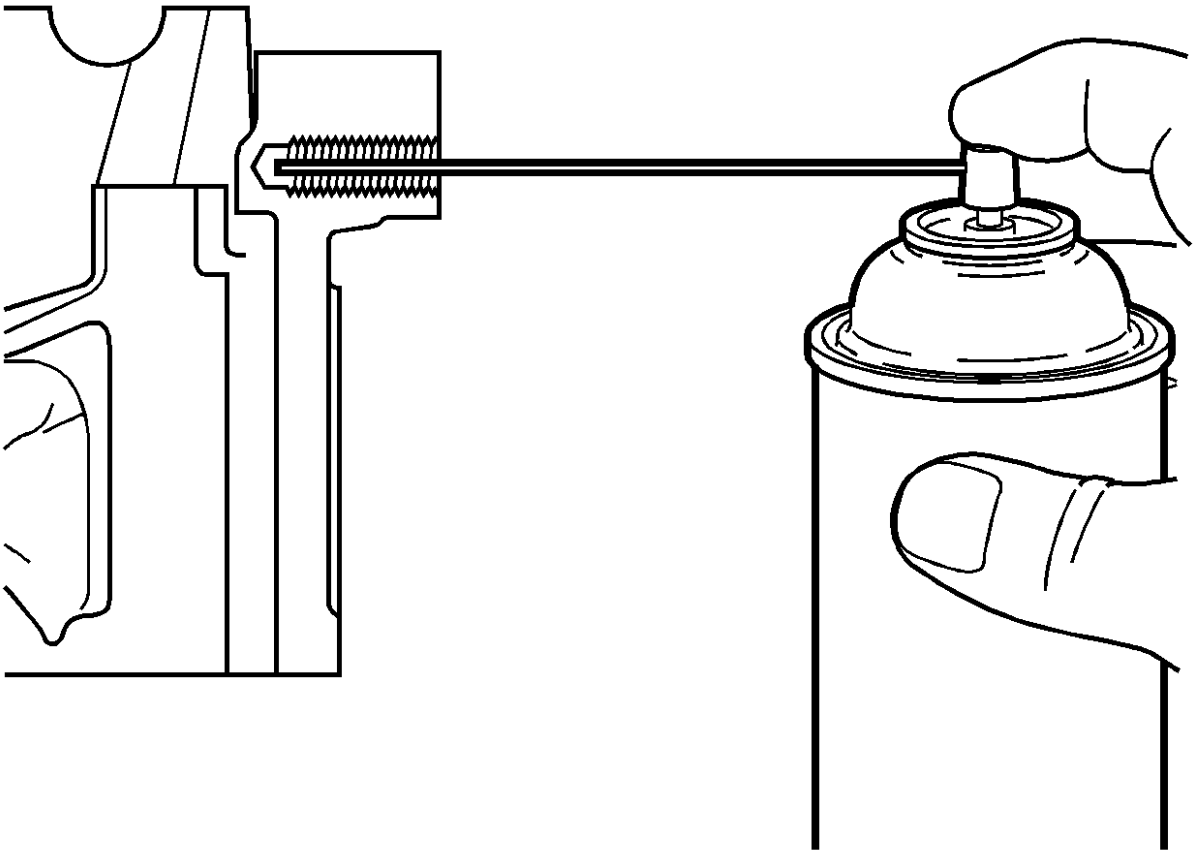

Fig. 350: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

6. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

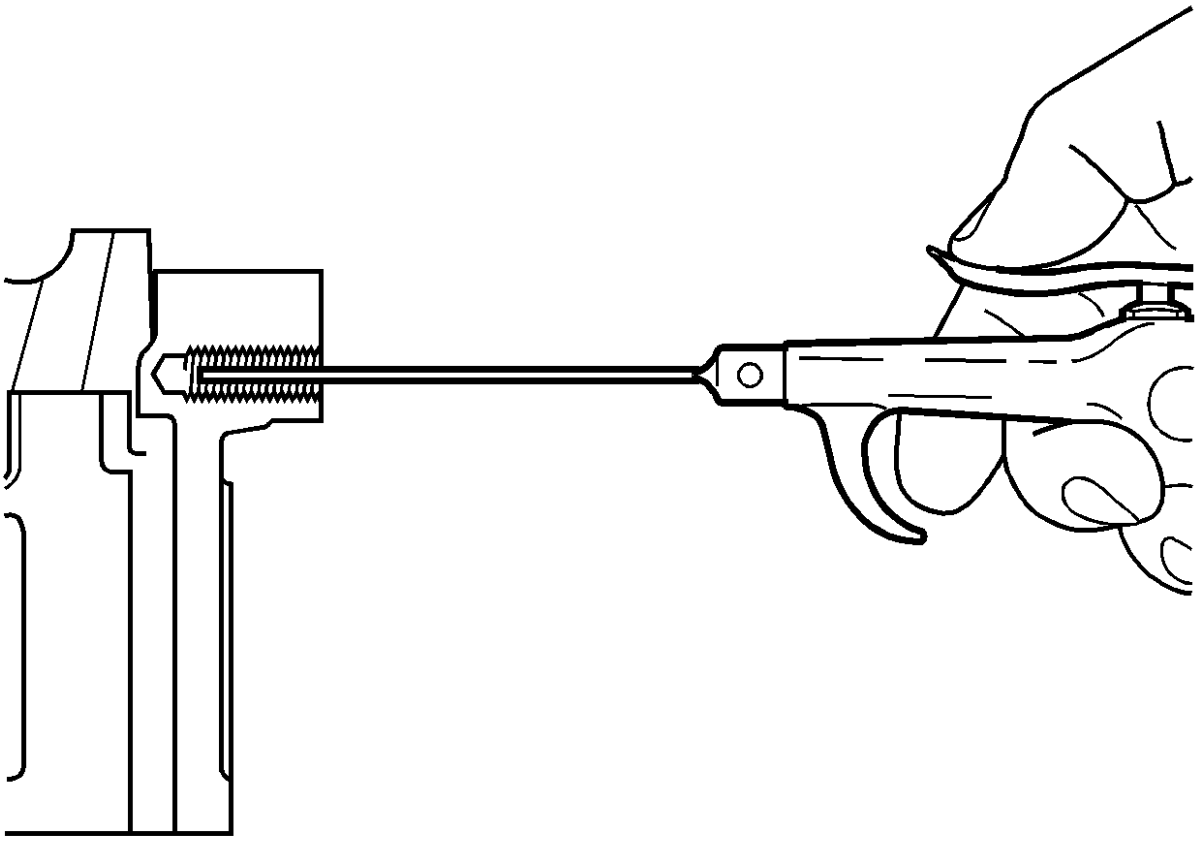

Fig. 351: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

7. Using compressed air, clean out any chips.

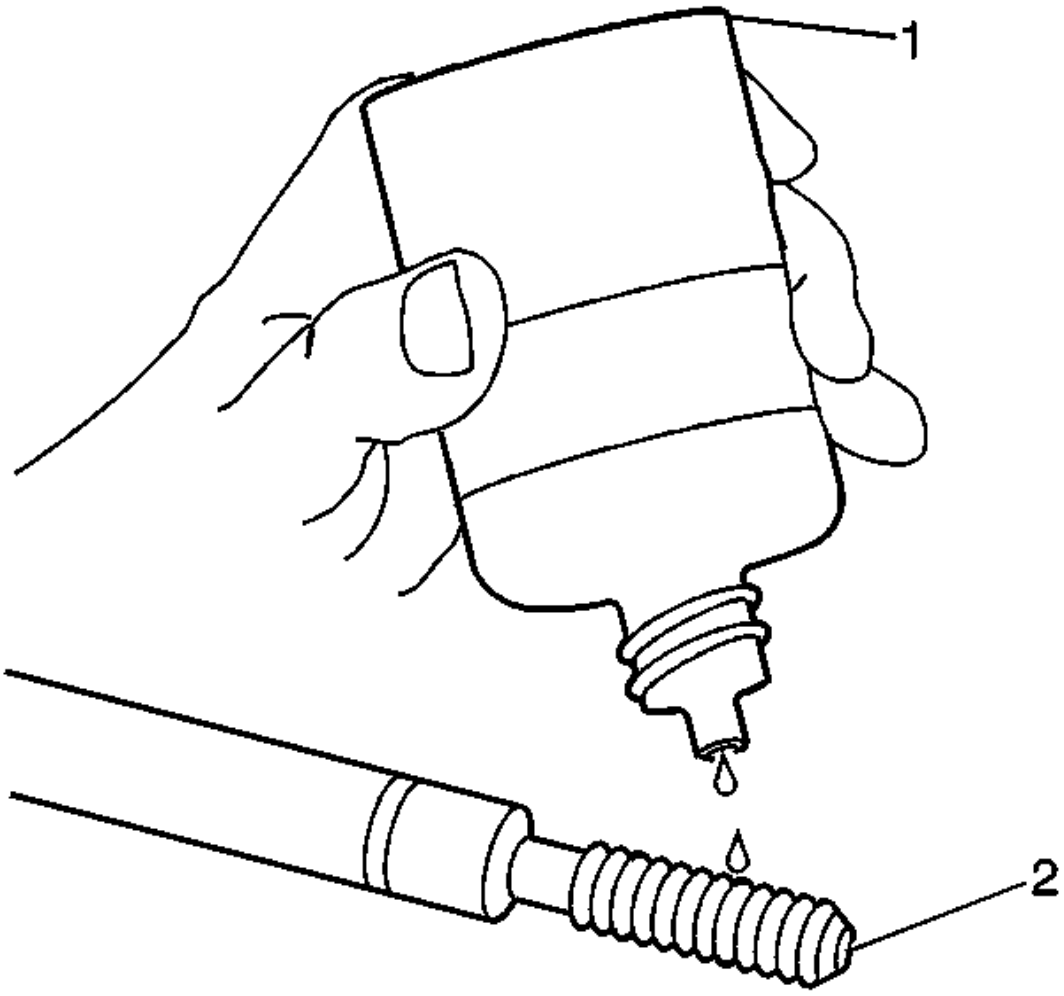

Fig. 352: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

8. Lubricate the threads of the driver installation tool (2) with the EN 42385-110 (1).

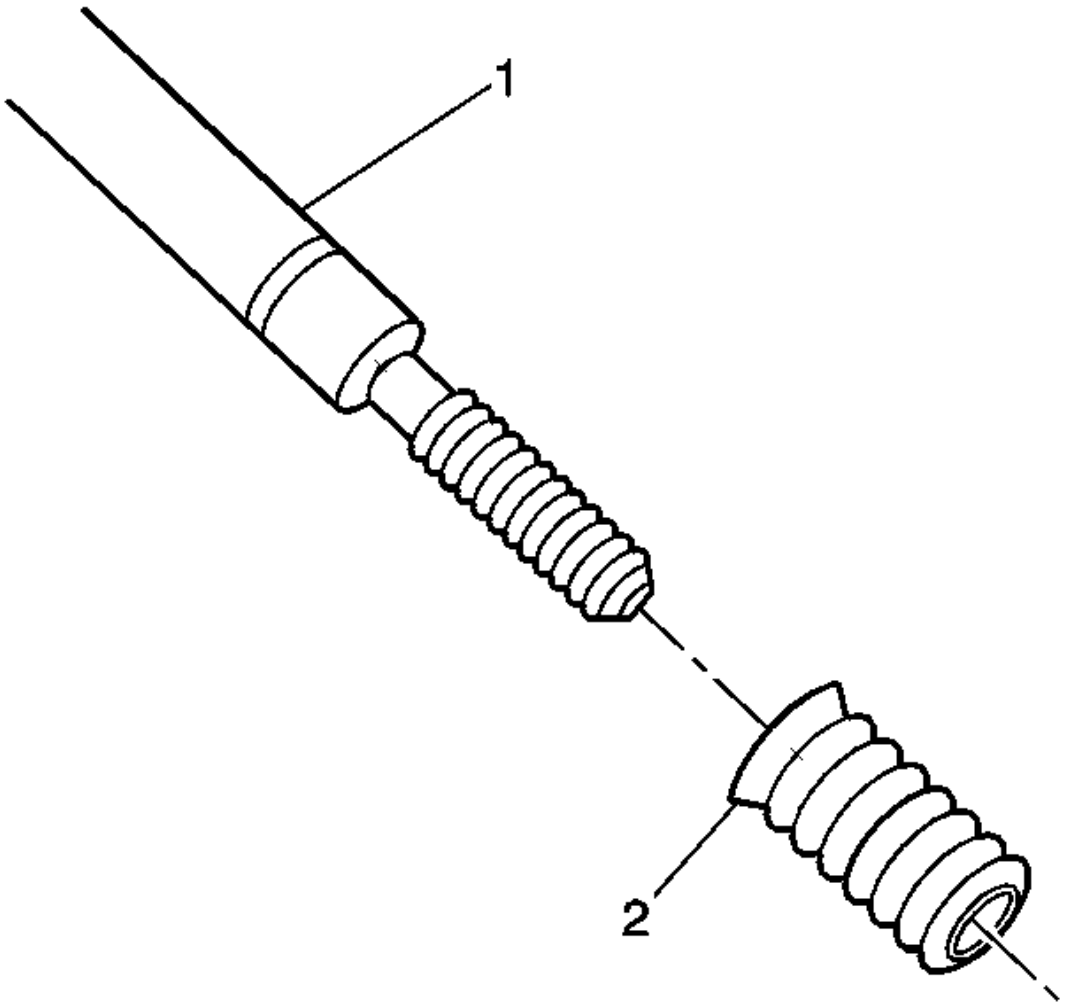

Fig. 353: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

9. Install the insert (2) onto the driver installation tool (1).

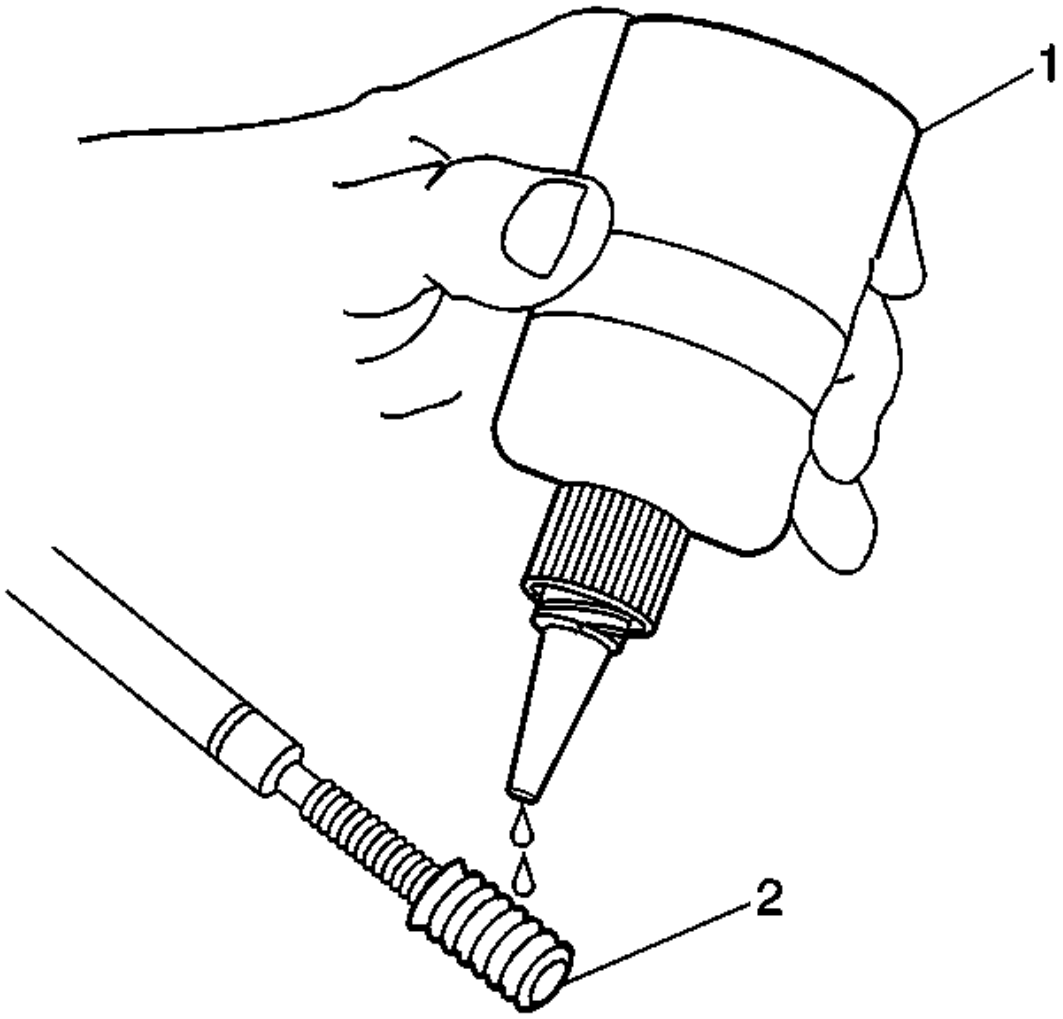

Fig. 354: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

10. Apply threadlock sealant, EN 42385-109, LOCTITE 277Â® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

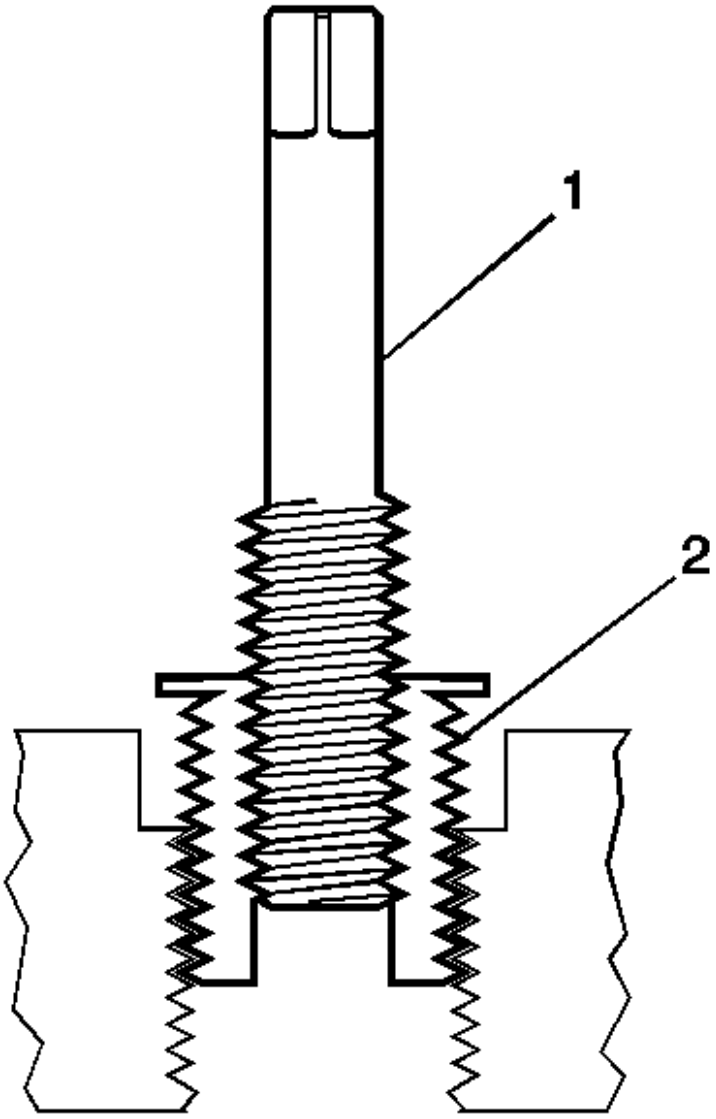

Fig. 355: Installing Insert - Recessed Thread
Courtesy of GENERAL MOTORS COMPANY

11. Install the insert (2) into the tapped hole by hand only.

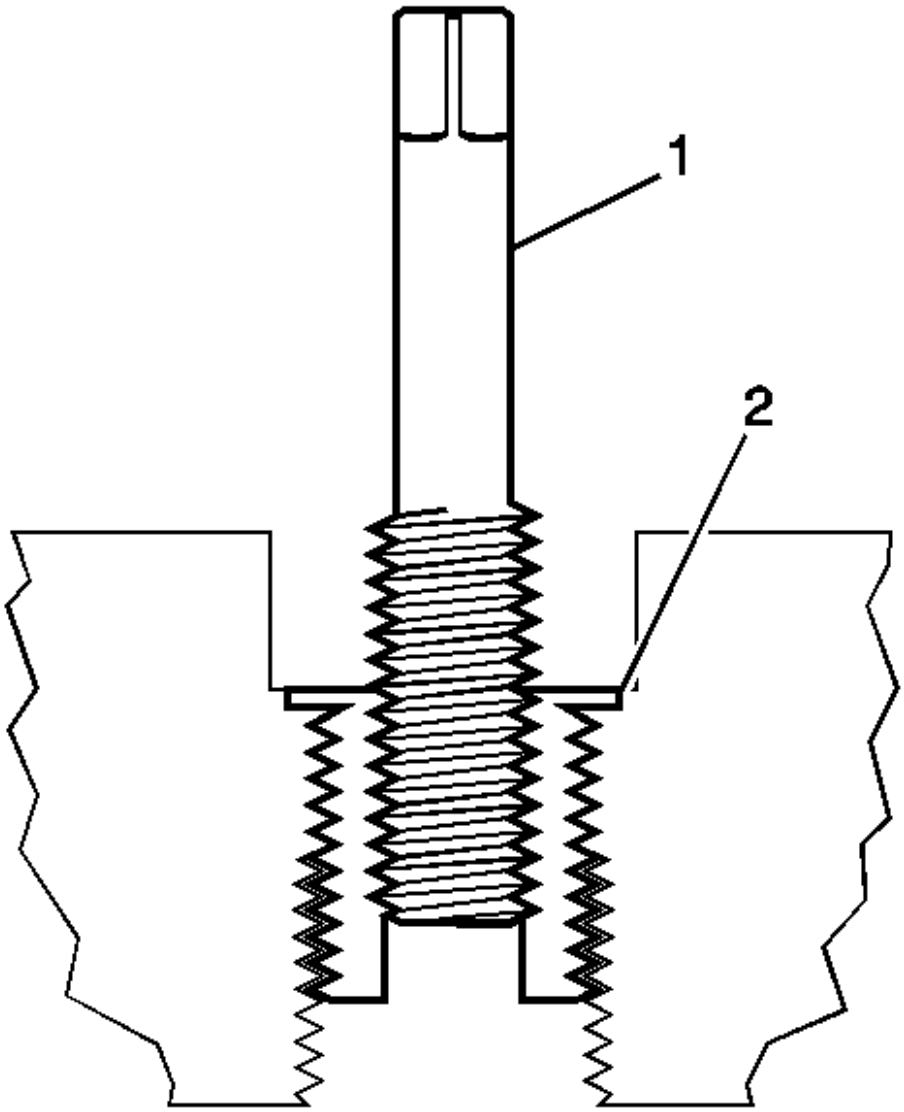

Fig. 356: View Of Installed Insert - Recessed Thread
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.**

12. Install the insert until the flange (2) of the insert contacts the counterbored surface.

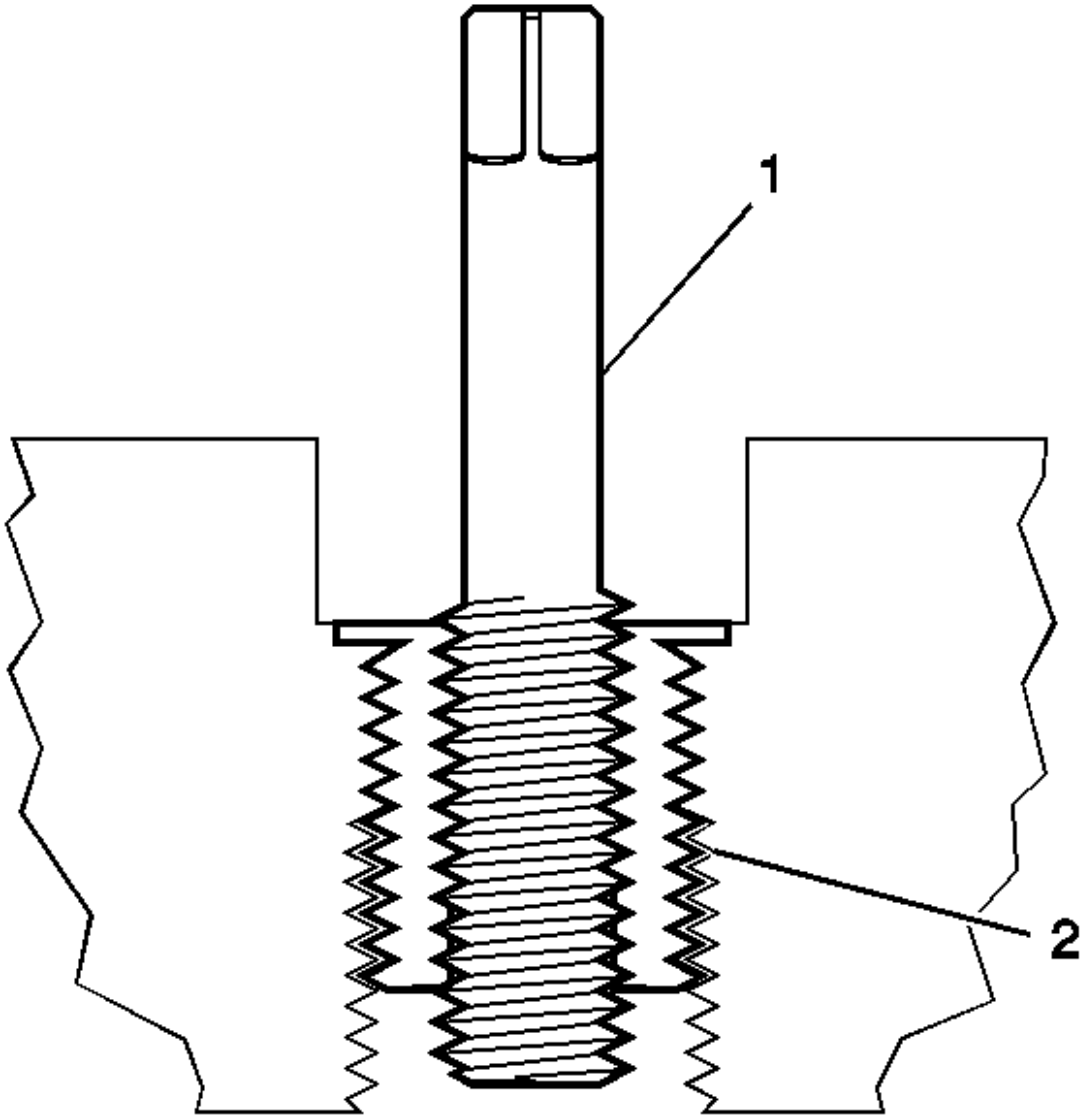

Fig. 357: Installed Insert - Recessed Thread Repair
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.**

13. Continue to rotate the driver installation tool (1) through the insert (2).

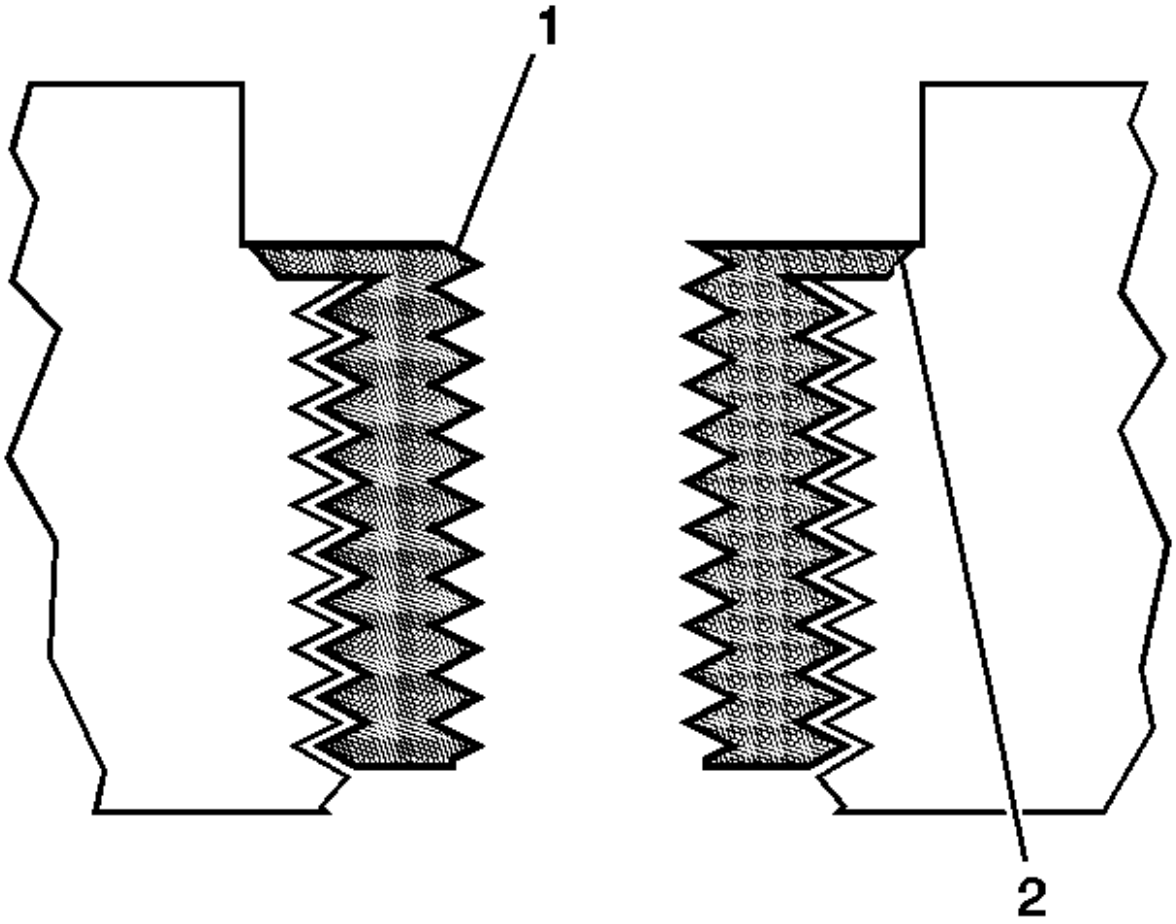

Fig. 358: Inspecting Insert For Proper Installation - Recessed Thread
Courtesy of GENERAL MOTORS COMPANY

14. Inspect the insert (1) for proper installation (2) into the tapped hole.

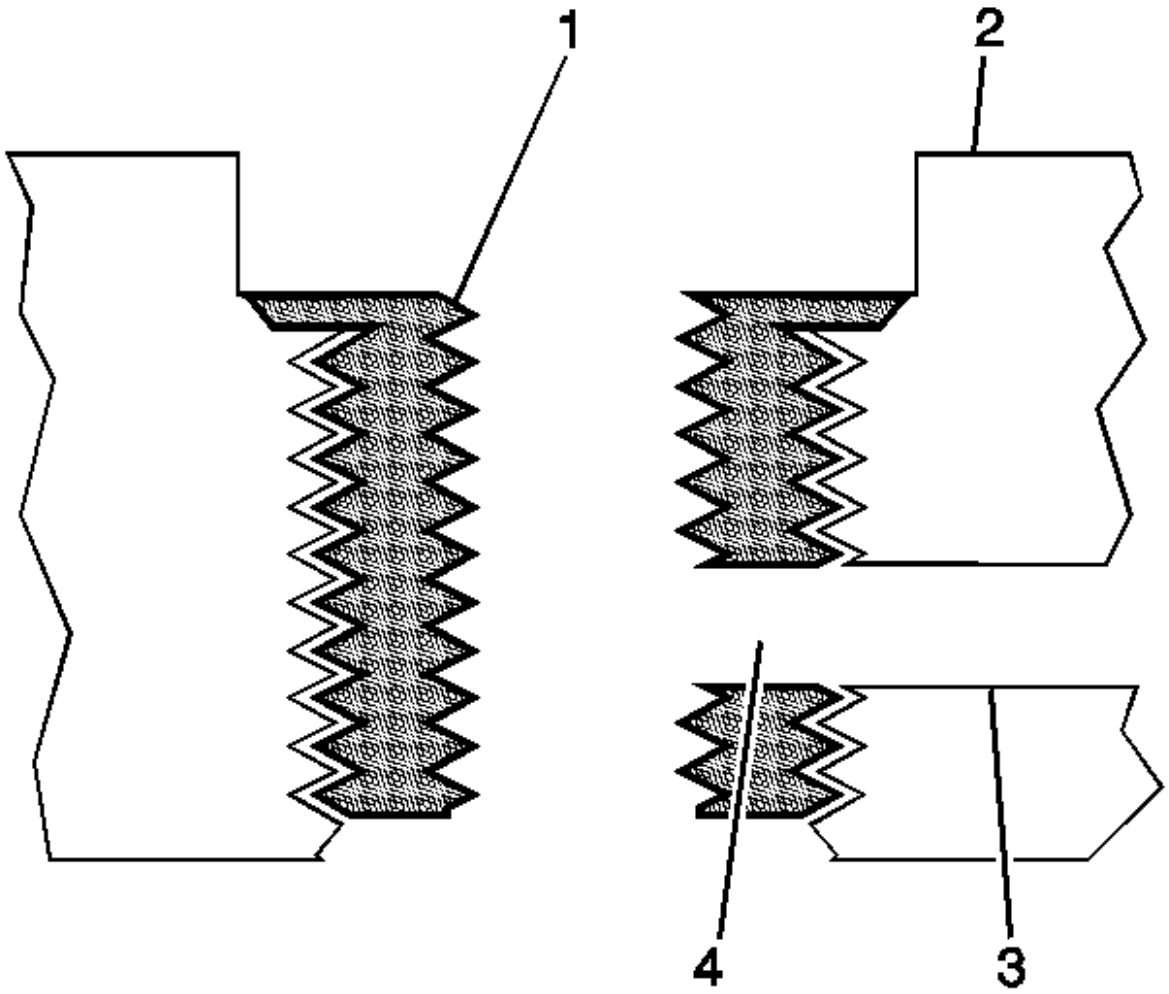

Fig. 359: View Of Restricted Engine Coolant Passage - Recessed Thread Repair
Courtesy of GENERAL MOTORS COMPANY

15. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

Tapered Pipe Thread Repair

The thread repair insert for tapered pipe threads is coated with a clear silver zinc coating.

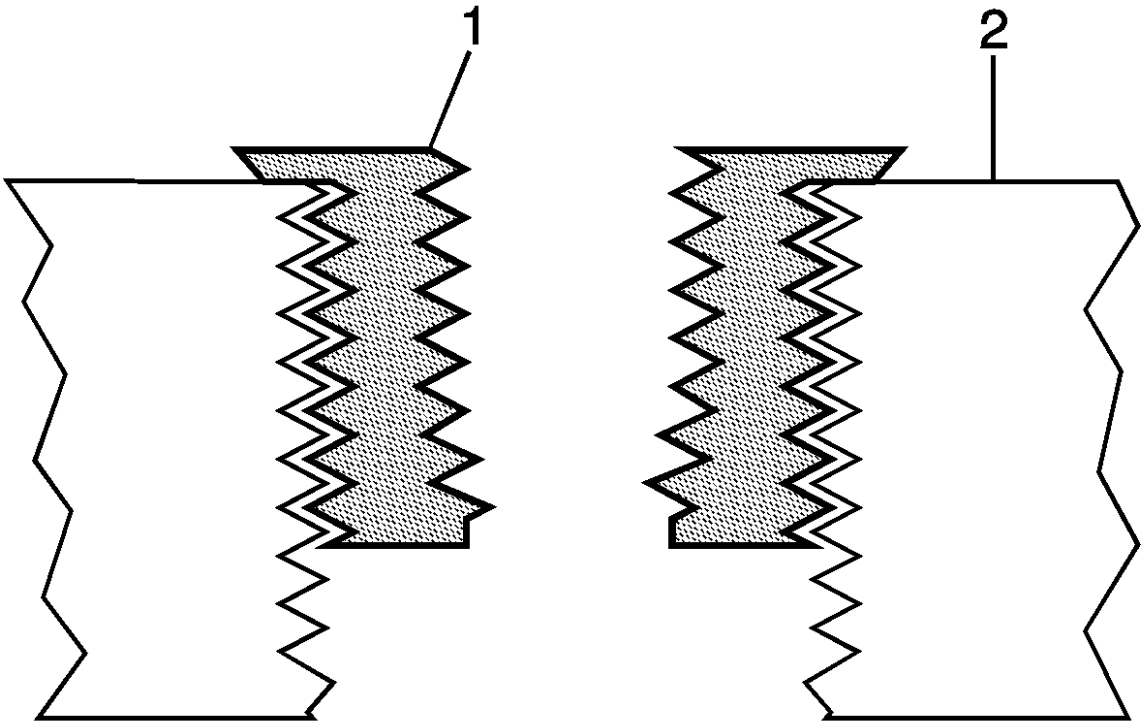

Fig. 360: Inspecting Insert For Proper Installation - Tapered Thread
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Safety Glasses Warning .**

NOTE: **The use of a cutting type fluid, WD 40Â® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.**

When installed to the proper depth, the flange (1) of the insert will be seated against surface (2) of the base material of the drilled/tapped hole.

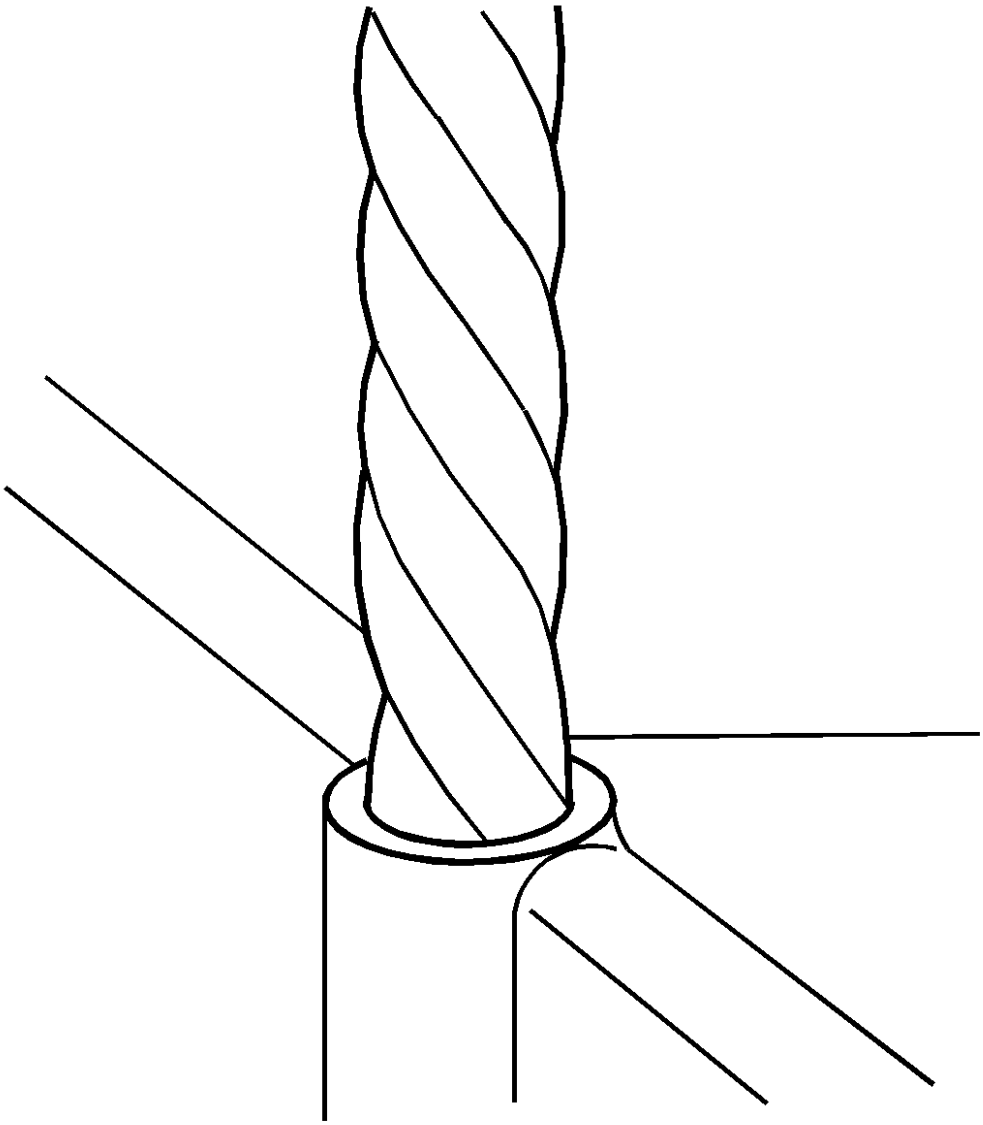

Fig. 361: Drilling Out Threads Of Damaged Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Drill the hole until the stop collar contacts the surface of the base material.**

1. Drill out the threads of the damaged hole.

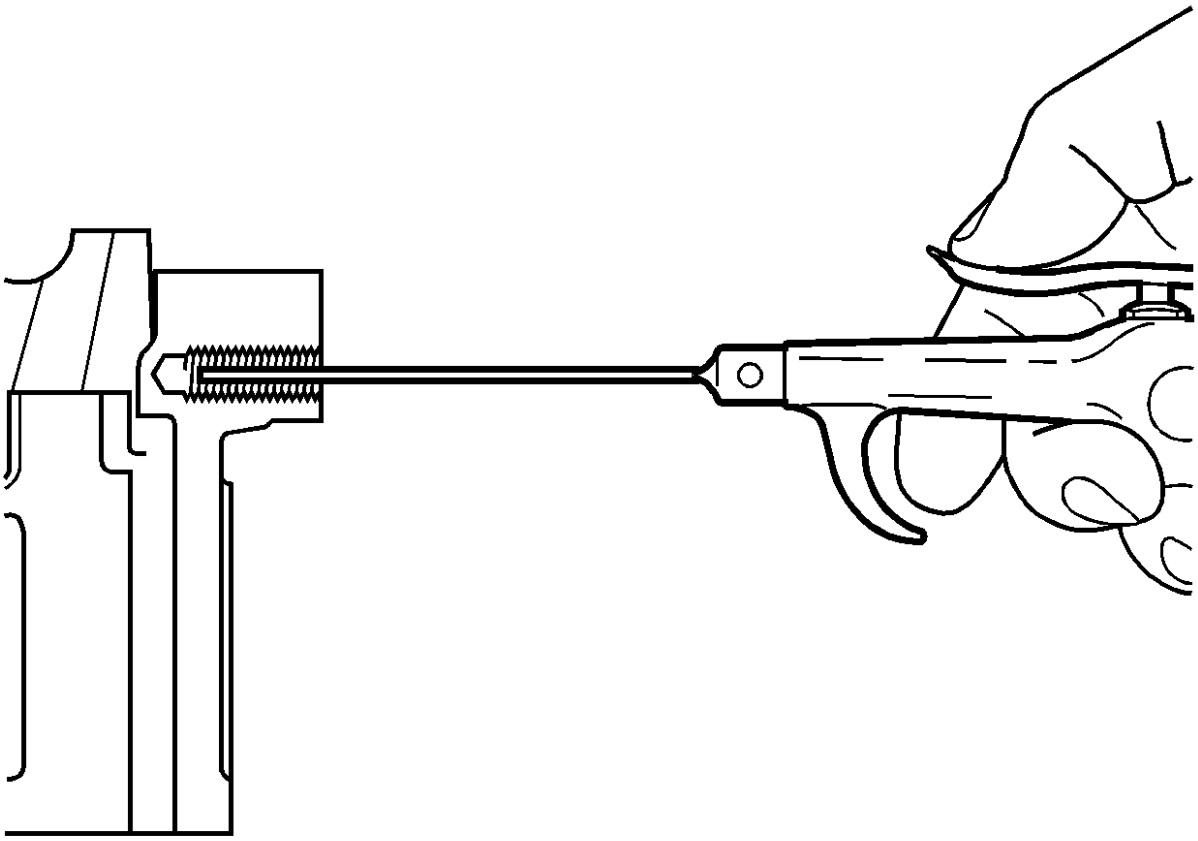

Fig. 362: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the drilled hole prior to tapping.**

2. Using compressed air, clean out any chips.

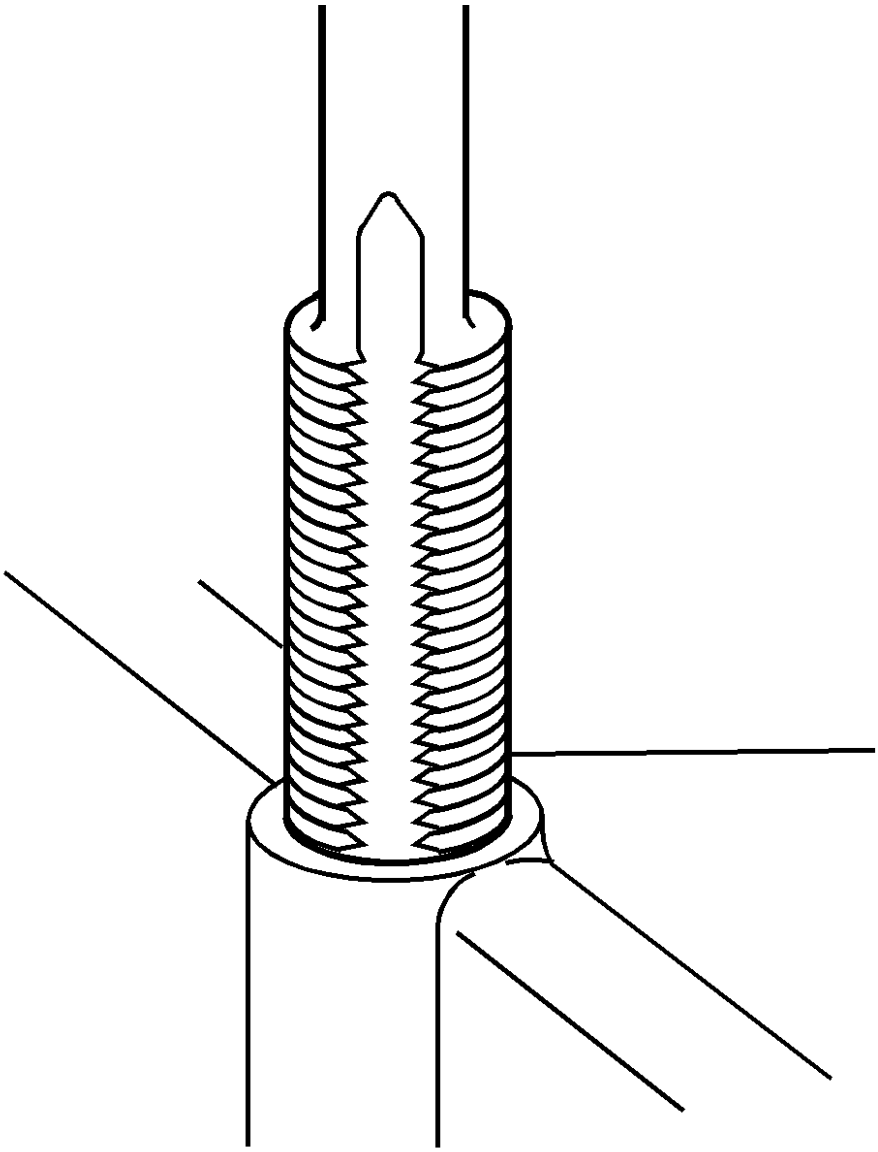

Fig. 363: Tapping Threads Of Drilled Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**
- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

3. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

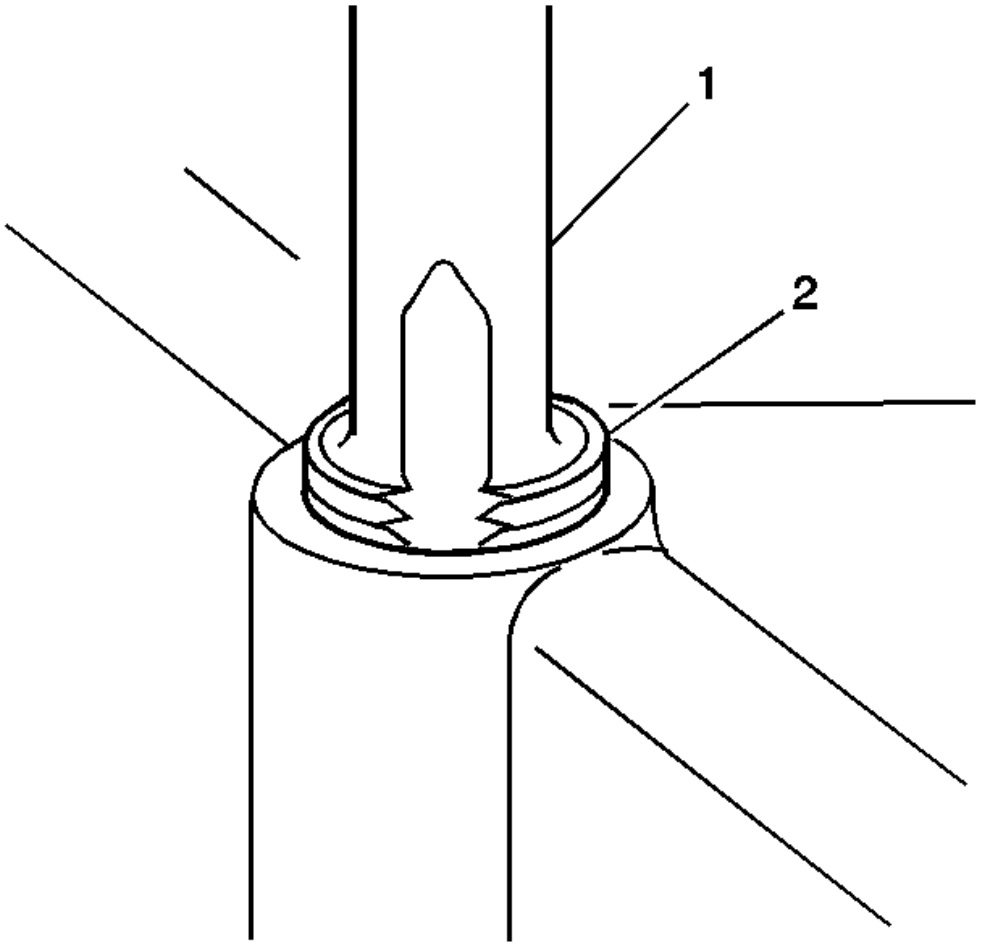

Fig. 364: View Of Proper Tapping Distance - Tapered Thread
Courtesy of GENERAL MOTORS COMPANY

4. Tap the drilled hole until the threads at the top of the tap (2) are down to the surface of the base material.

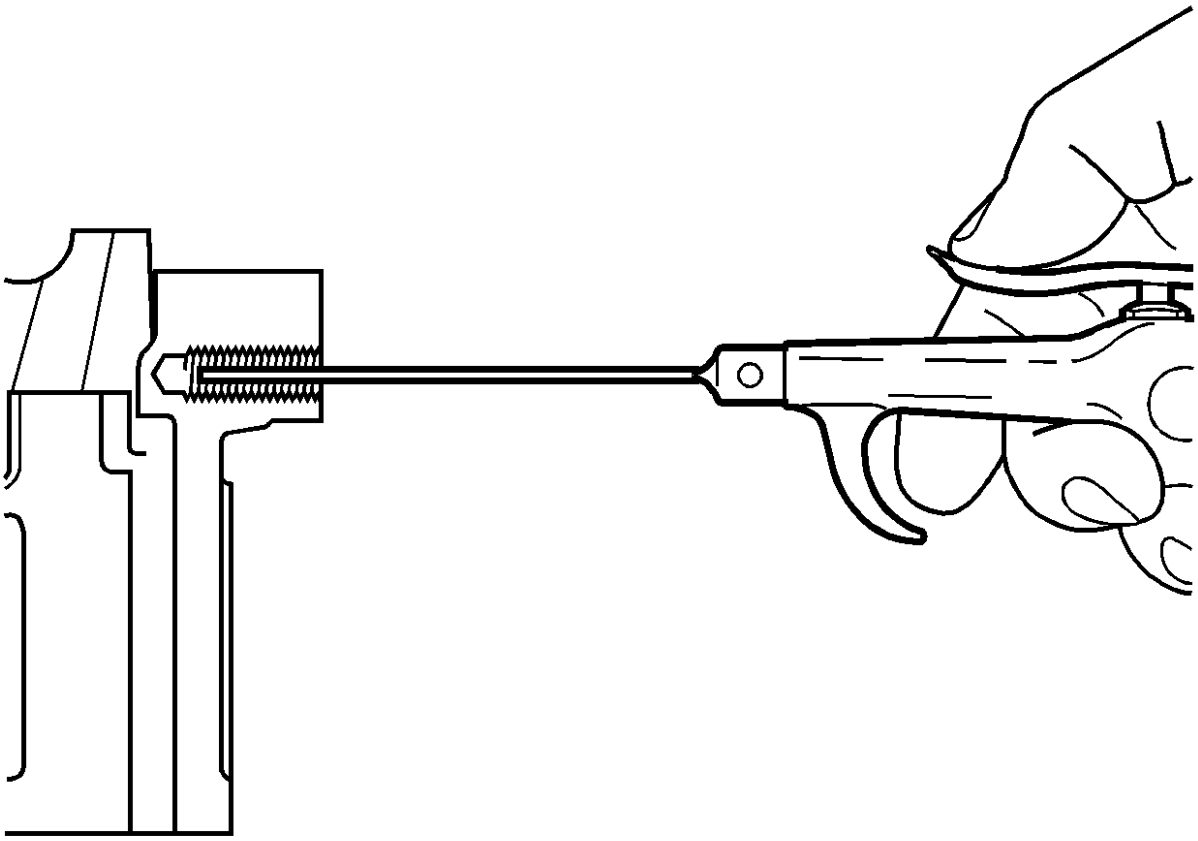

Fig. 365: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

5. Using compressed air, clean out any chips.

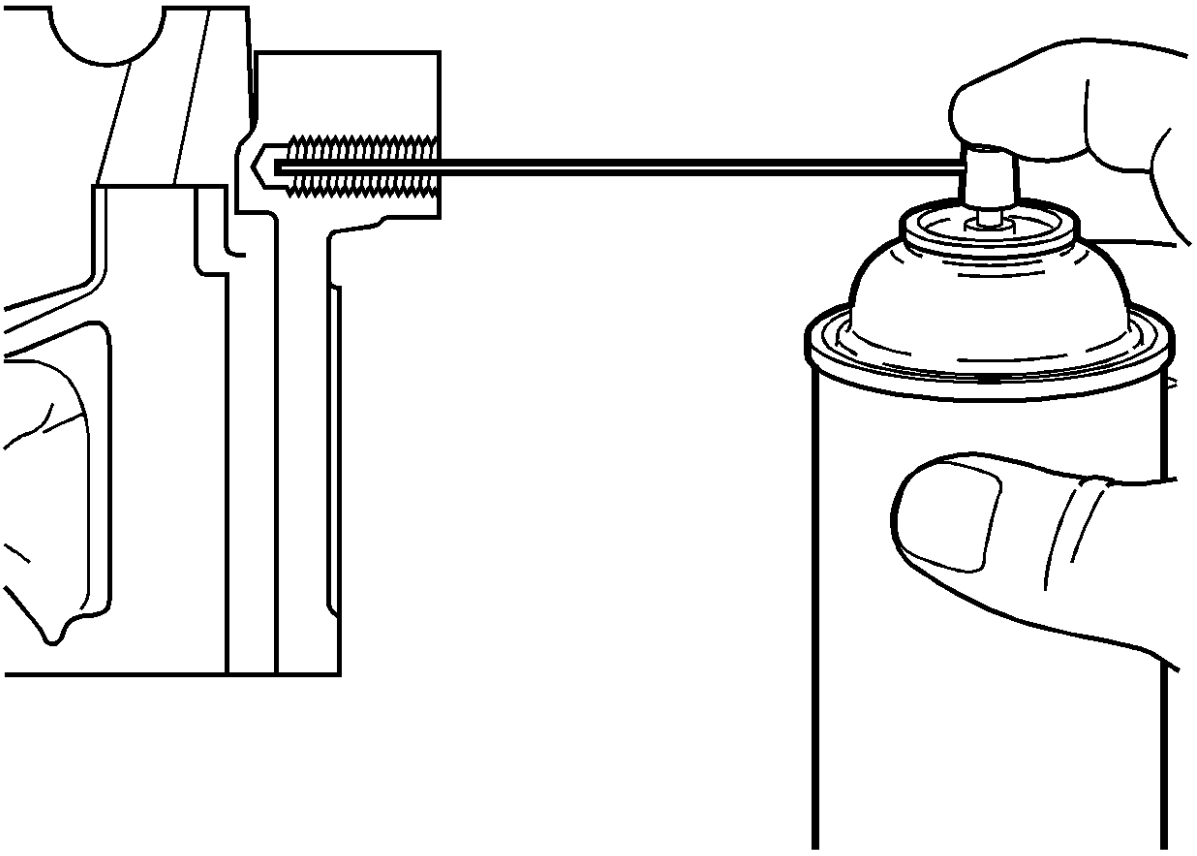

Fig. 366: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

6. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

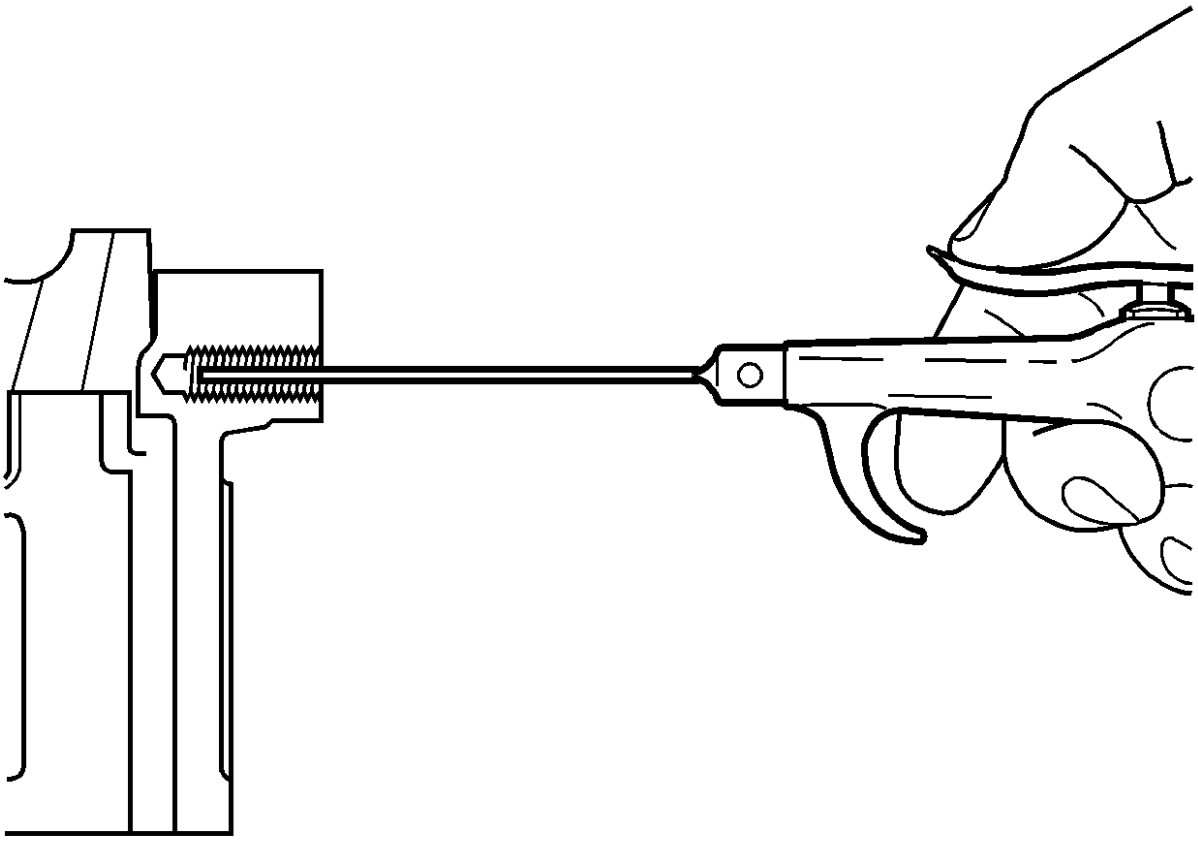

Fig. 367: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

7. Using compressed air, clean out any chips.

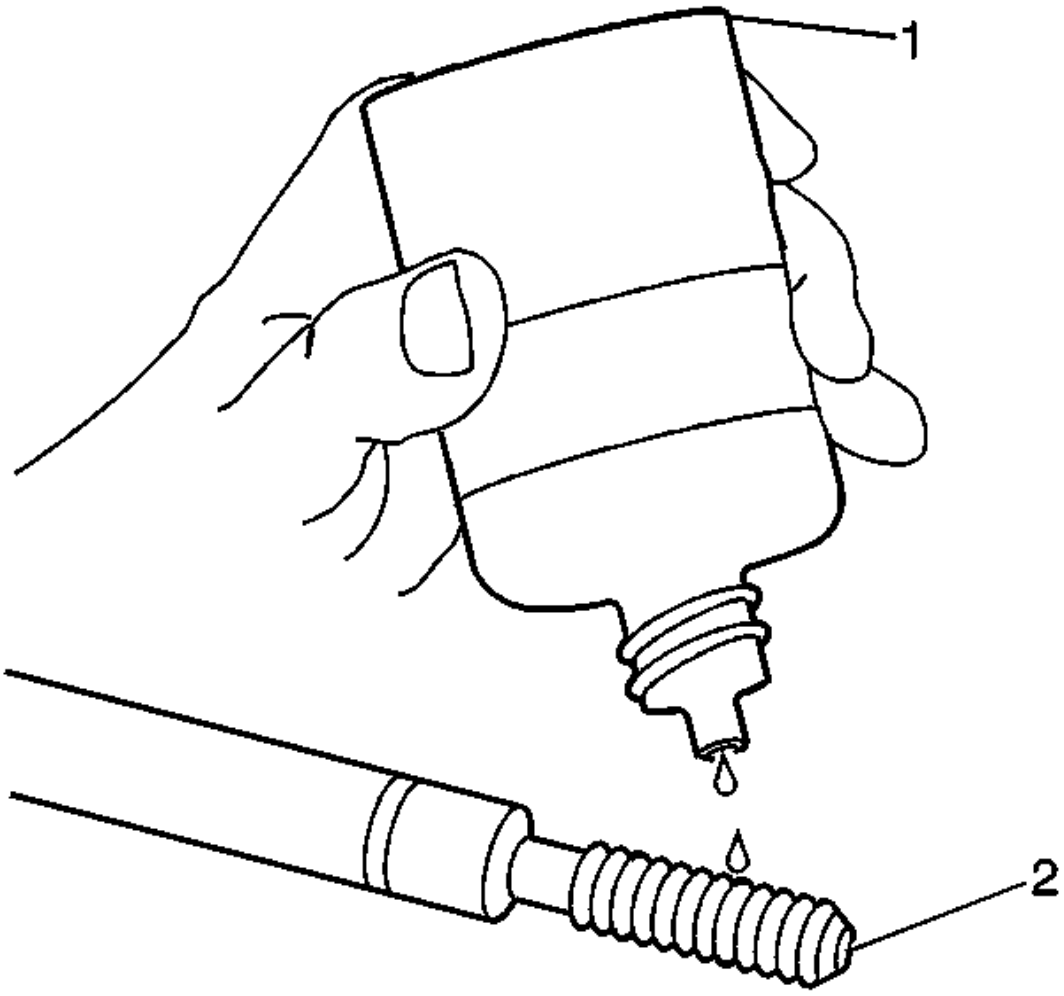

Fig. 368: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

8. Lubricate the threads of the driver installation tool (2) with the EN 42385-110 (1).

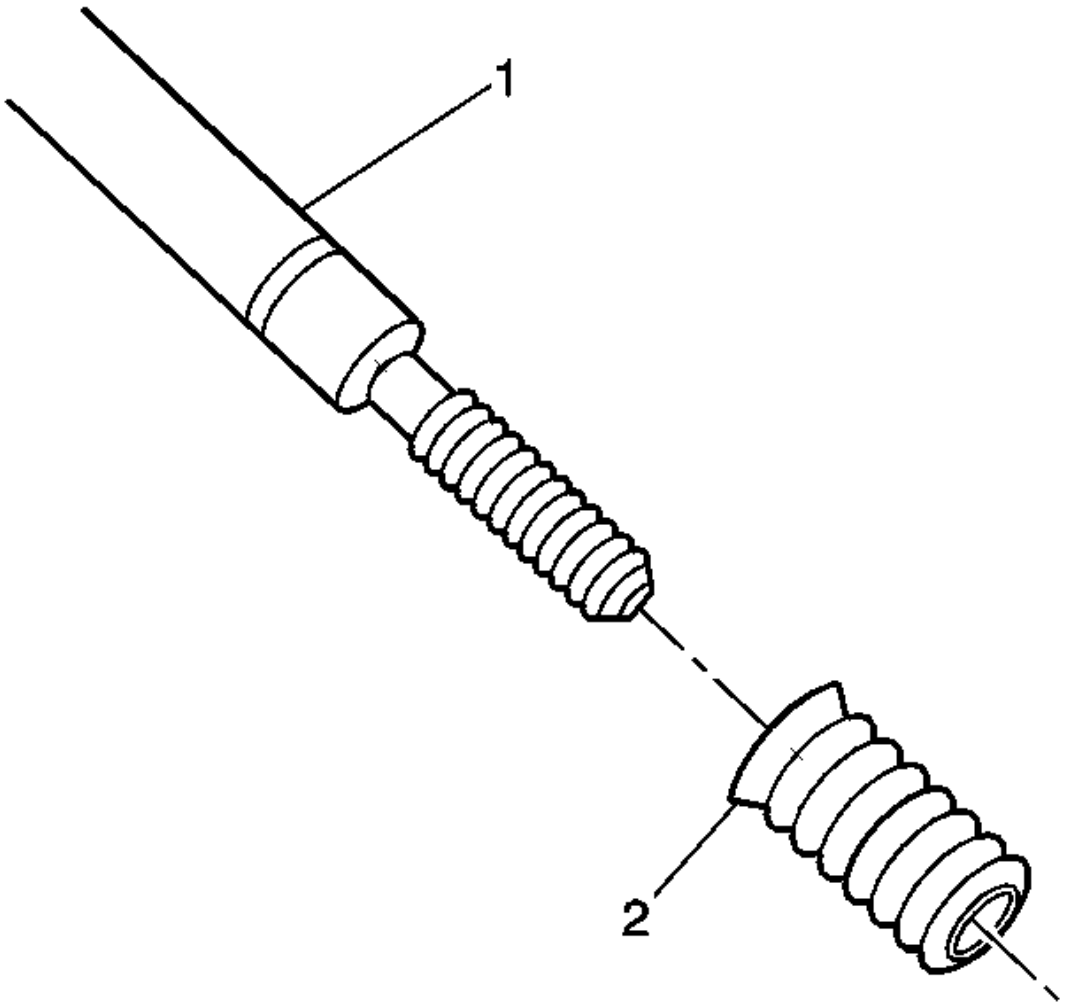

Fig. 369: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

9. Install the insert (2) onto the driver installation tool (1).

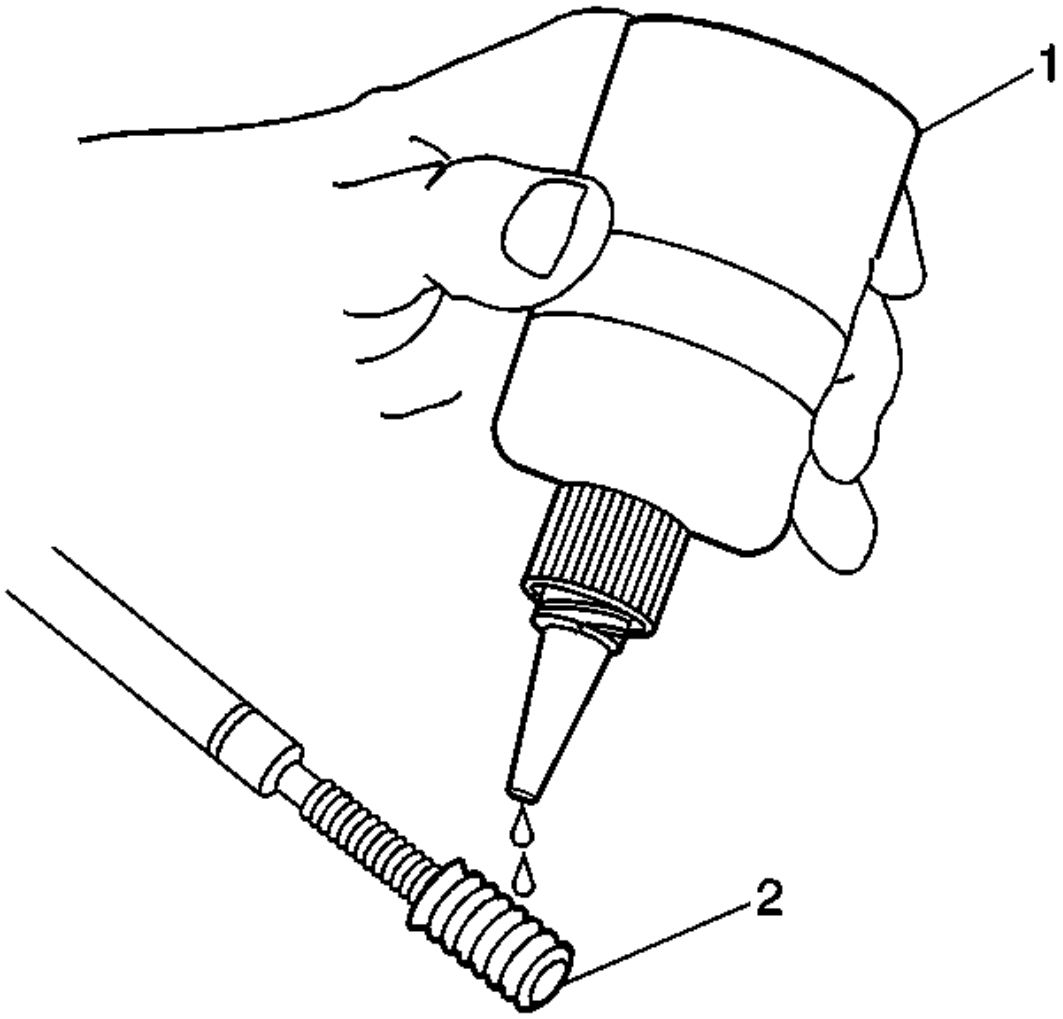

Fig. 370: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

10. Apply threadlock sealant, EN 42385-109, LOCTITE 277Â® or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

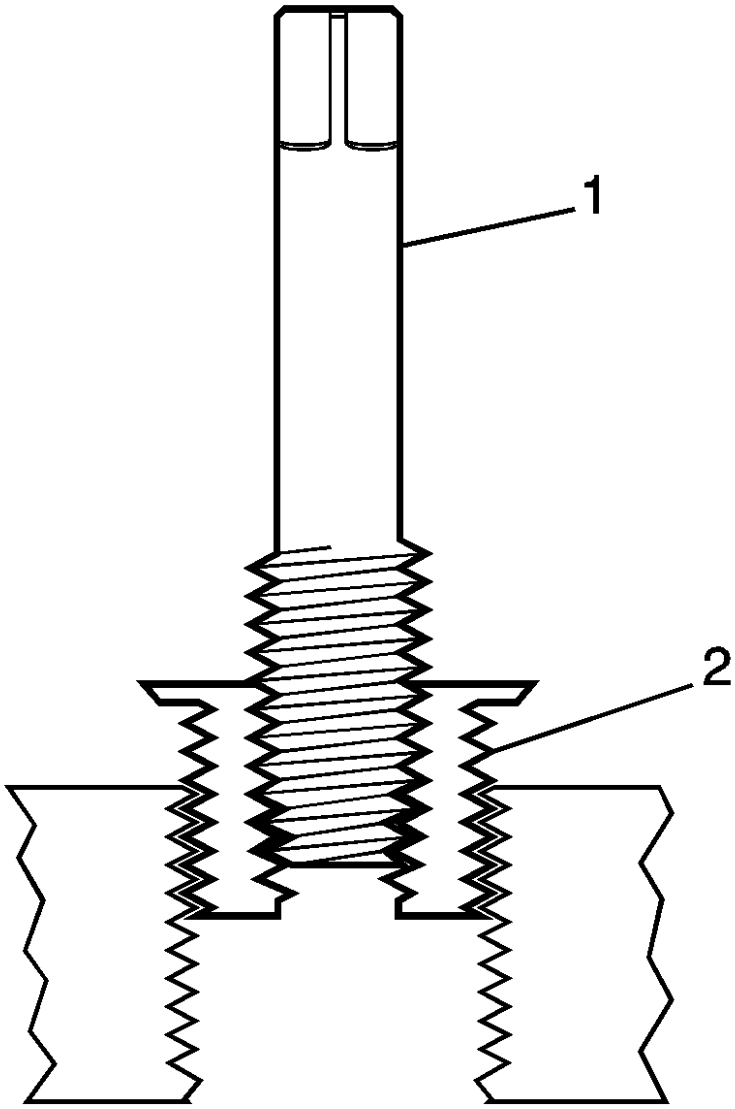

Fig. 371: View Of Insert - Tapered Thread
Courtesy of GENERAL MOTORS COMPANY

11. Install the insert (2) into the tapped hole by hand only.

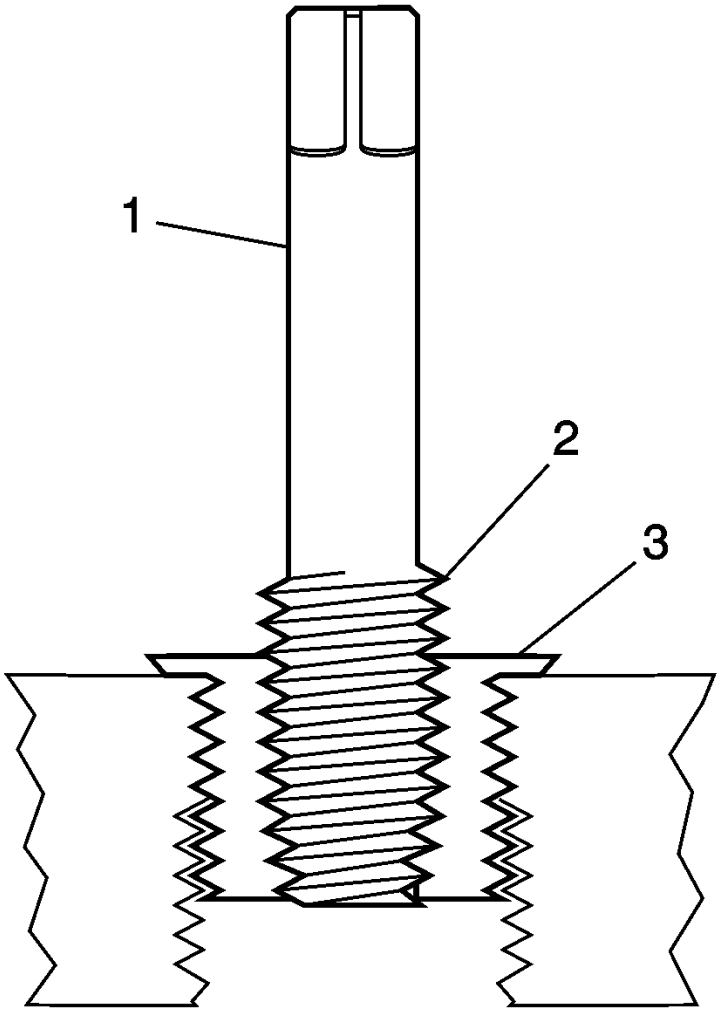

Fig. 372: View Of Insert - Tapered Pipe Thread Repair
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the insert will not thread down until the flange contacts the surface of the base material remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.**

12. Install the insert until the flange of the insert (3) contacts the surface of the base material.

NOTE: **The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.**

13. Continue to rotate the driver installation tool (1) until the top of the threaded section (2) is level with the top of the insert (3).

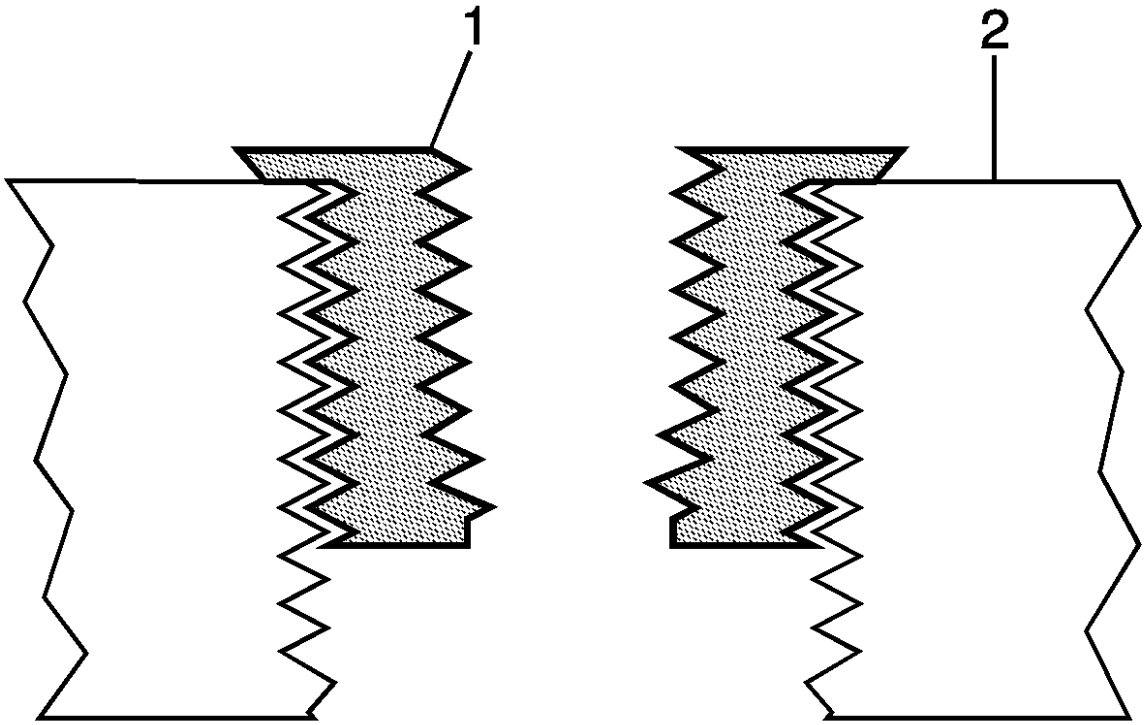

Fig. 373: Inspecting Insert For Proper Installation - Tapered Thread
Courtesy of GENERAL MOTORS COMPANY

14. Inspect the insert (1) for proper installation (2) into the tapped hole.

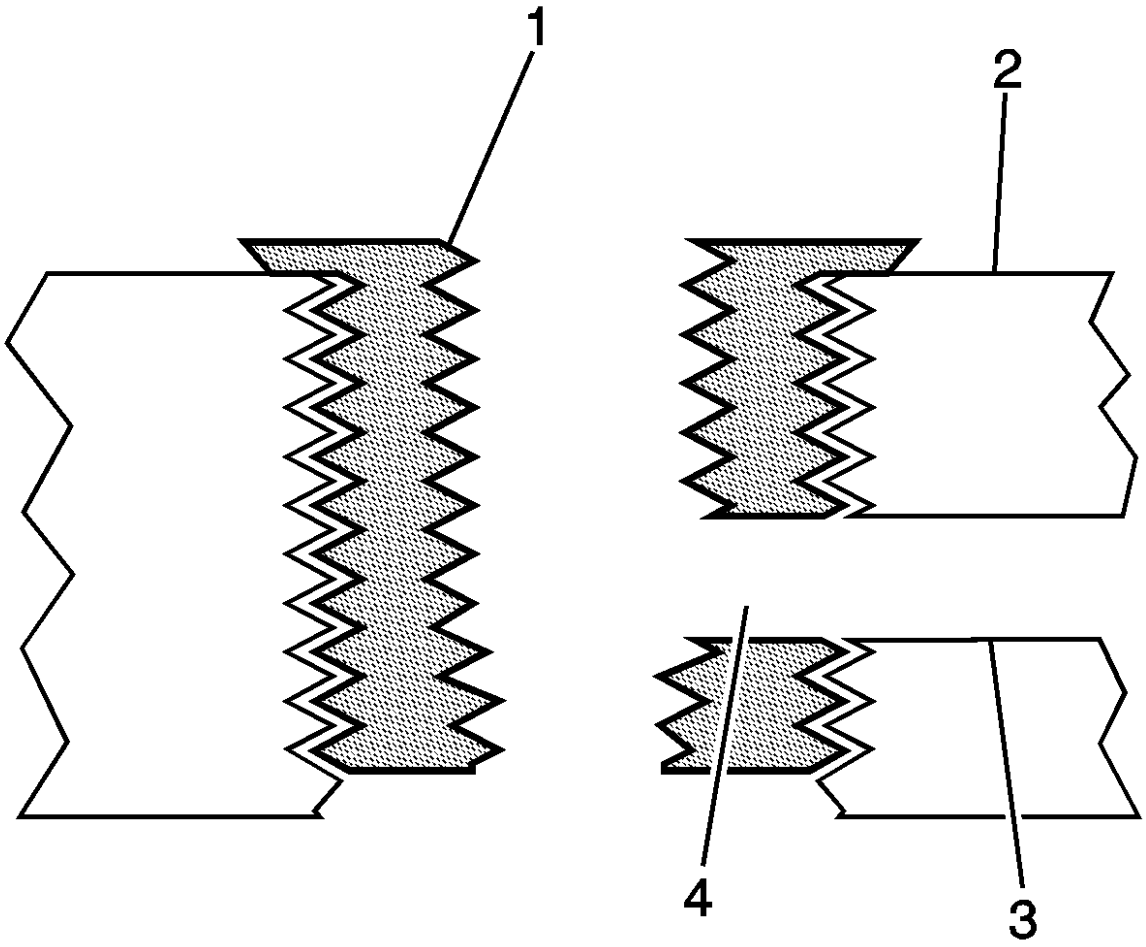

Fig. 374: View Of Restricted Engine Coolant Passages - Tapered Pipe Thread Repair
Courtesy of GENERAL MOTORS COMPANY

15. Any installed insert that restricts or blocks an oil or engine coolant passage (3) will need to have the oil or engine coolant passage drilled out (4) to the original size of the oil or engine coolant passage. After drilling the restriction or blockage, clean out any chips and thread the installation driver tool through the insert again to remove any burrs caused by the drilling of the oil or engine coolant passage.

Cylinder Head Bolt Hole Thread Repair

Special Tools

- **EN 42385-700** High Feature Thread Repair Kit
- **EN 42385-2000** Thread Insert Kit

For equivalent regional tools, refer to **Special Tools** .

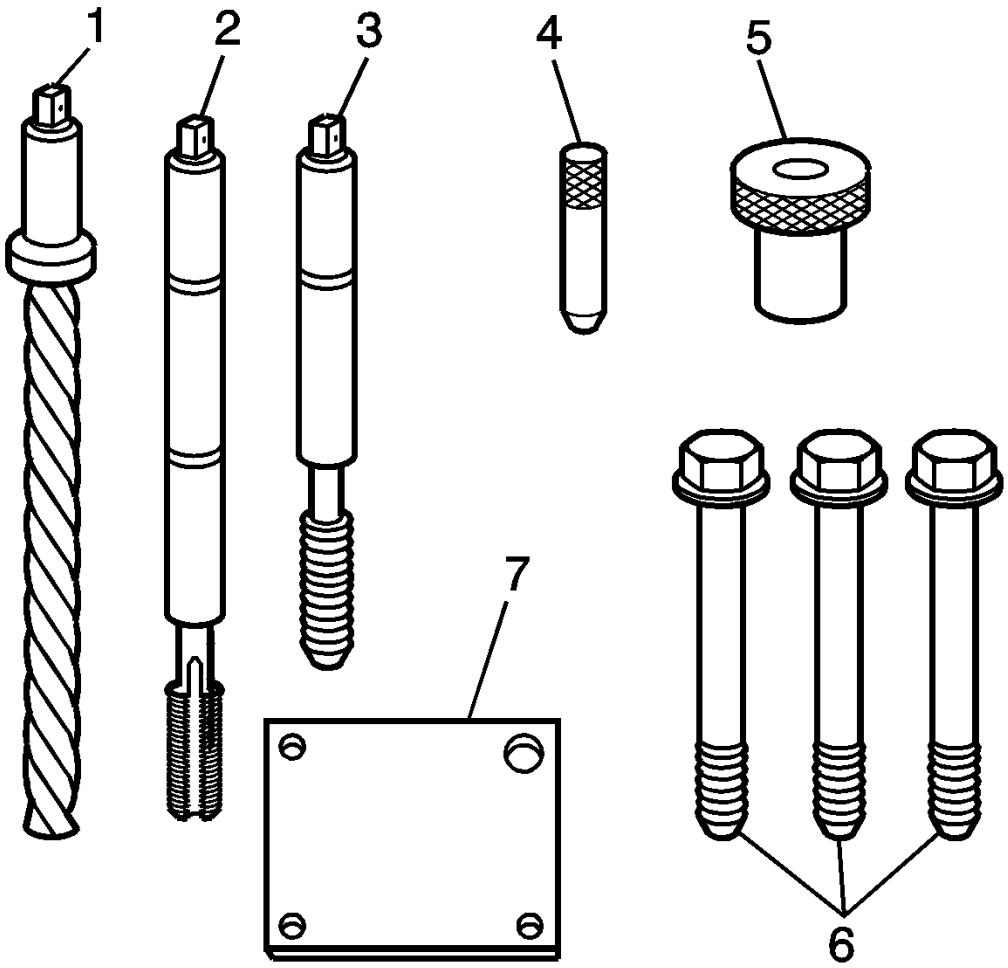

Fig. 375: Identifying Cylinder Head Bolt Hole Thread Repair Kit Components
Courtesy of GENERAL MOTORS COMPANY

The cylinder head bolt hole thread repair tooling are in the kits **EN 42385-2000** insert kit and **EN 42385-700** kit. The cylinder head bolt hole thread repair components consist of the following:

- EN 42385-723 Drill (1)
- EN 42385-724 Tap (2)
- EN 42385-725 Installation driver (3)
- EN 42385-303 Alignment pin (4)
- EN 42385-302 Bushing (5)
- EN 42385-733 Bolts (6)
- EN 42385-401 Fixture plate (7)

WARNING: Refer to Safety Glasses Warning .

NOTE:

- **Remove the fixture plate prior to installing the insert with the installer tool.**
- **The use of a cutting type fluid, WD 40Â®; or equivalent is recommended**

when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.

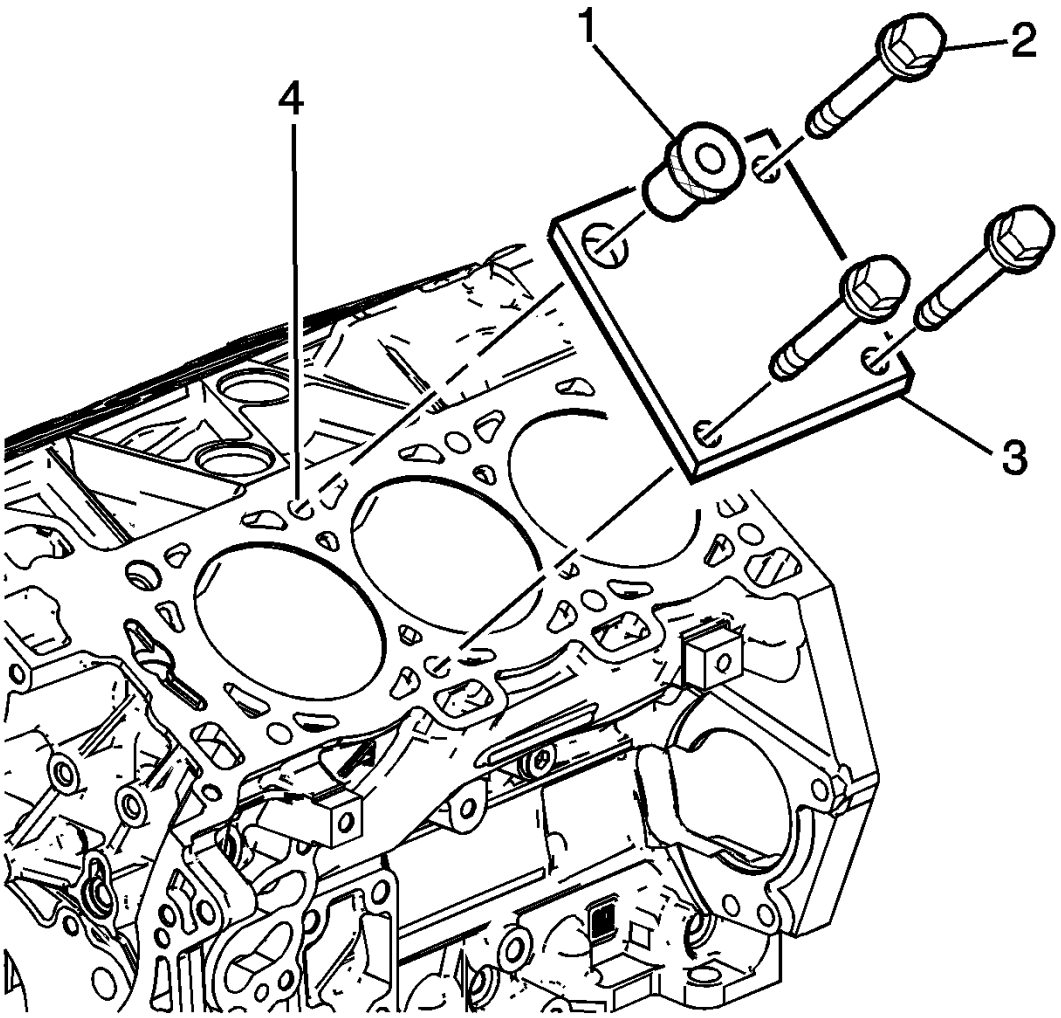

Fig. 376: View Of Fixture Plate & Components - Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

1. Position the fixture plate (3) with the bushing (1) installed over the cylinder head bolt hole to be repaired (4).
2. Loosely install the fixture plate bolts (2) into the remaining cylinder head bolt holes.

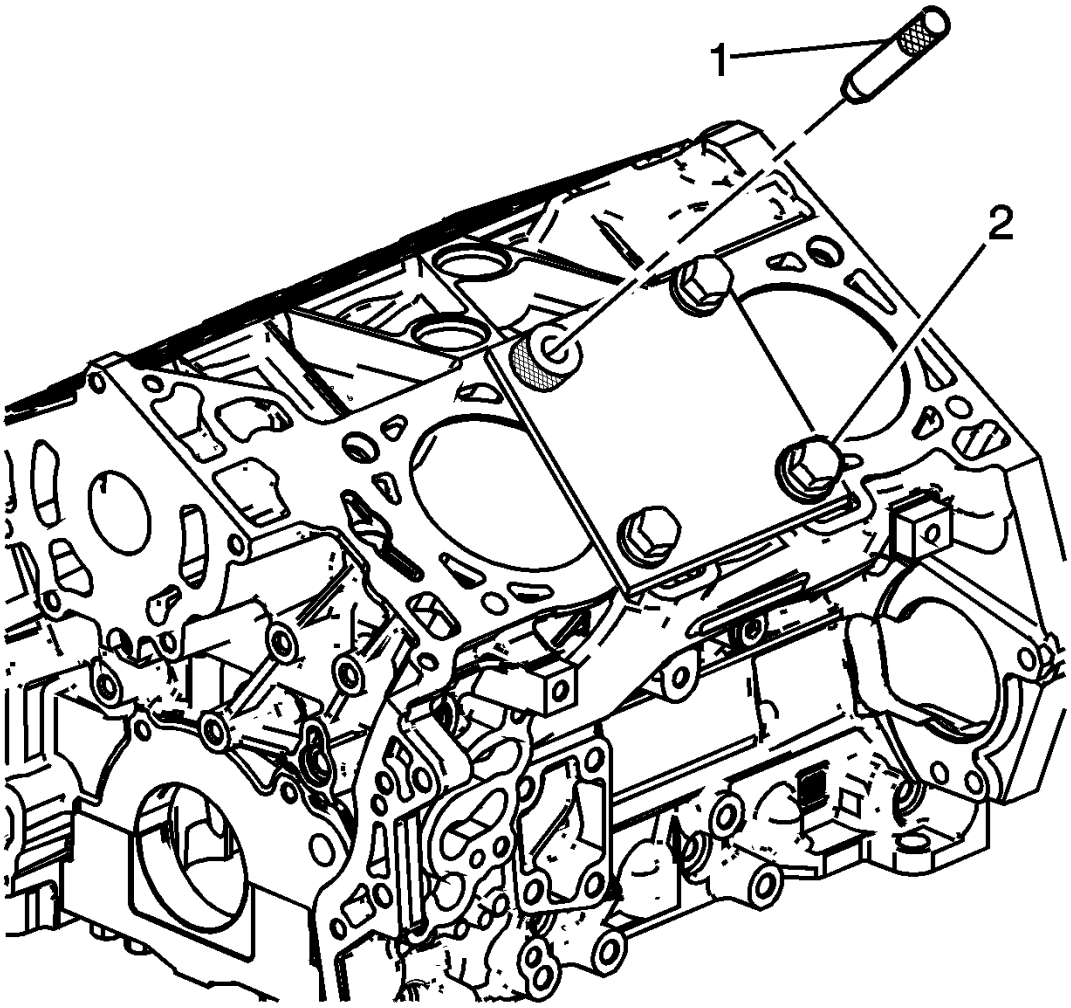

Fig. 377: Locating Alignment Pin
Courtesy of GENERAL MOTORS COMPANY

3. Position the alignment pin (1) through the bushing and into the cylinder head bolt hole.
4. With the alignment pin in the desired cylinder head bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the cylinder head bolt hole.

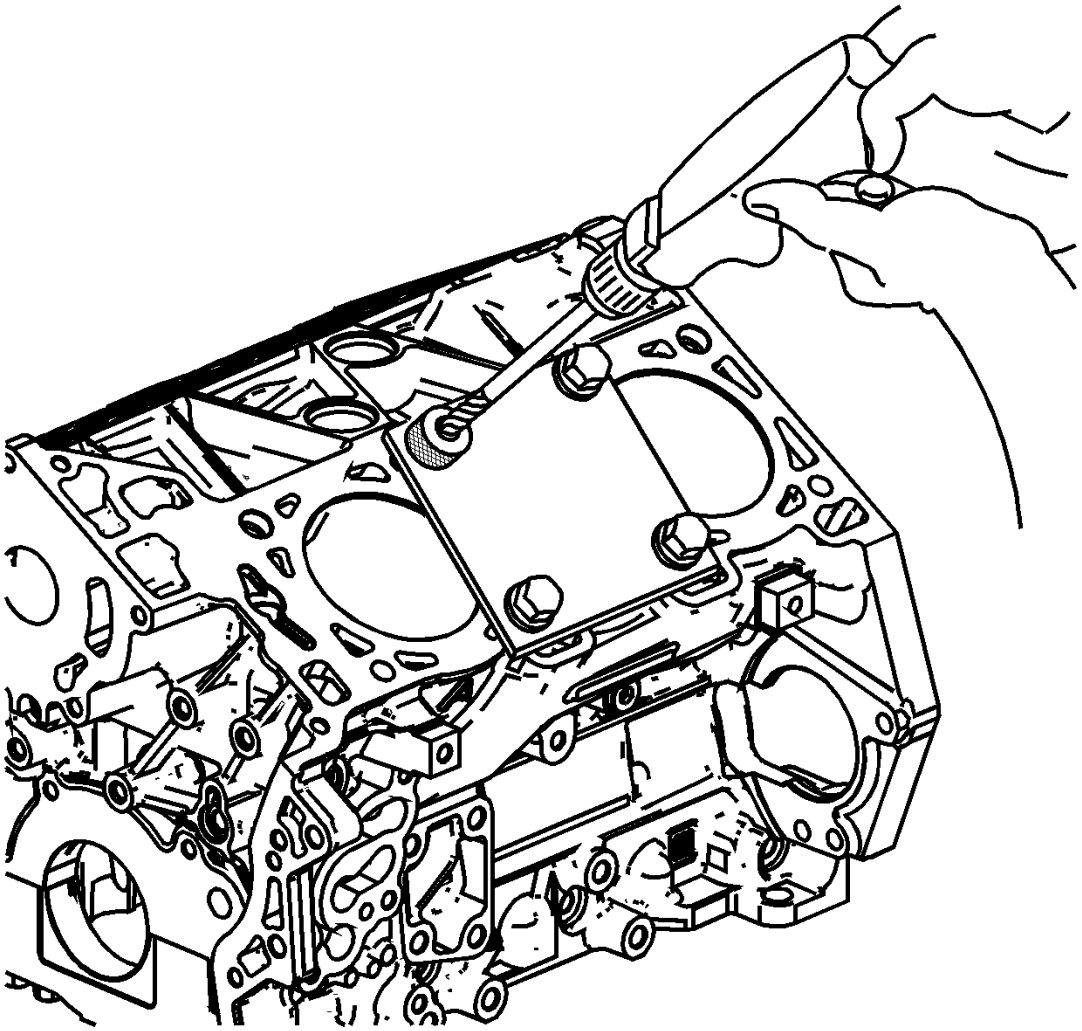

Fig. 378: Drilling Out Threads Of Damaged Hole - Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Drill the hole until the stop collar contacts the top of the drill bushing.**

6. Drill out the threads of the damaged hole.

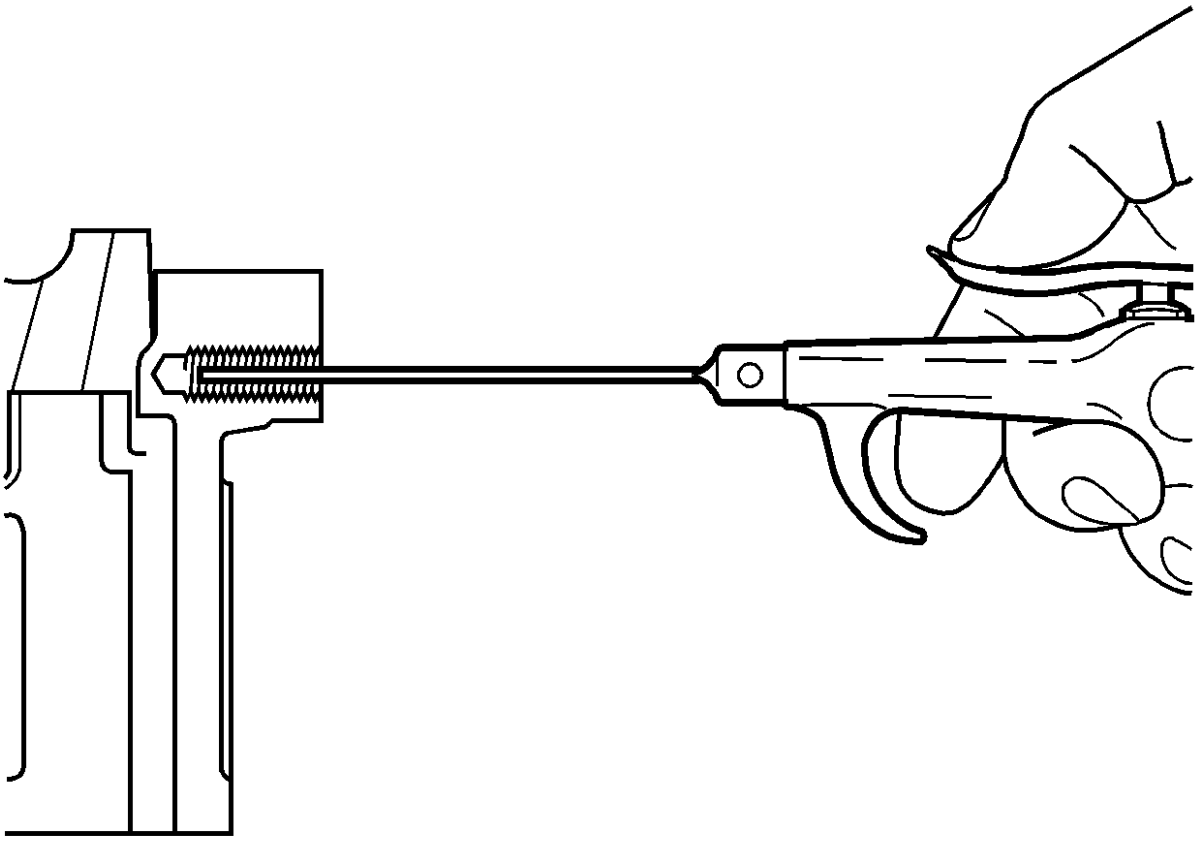

Fig. 379: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the drilled hole prior to tapping.**

7. Using compressed air, clean out any chips.

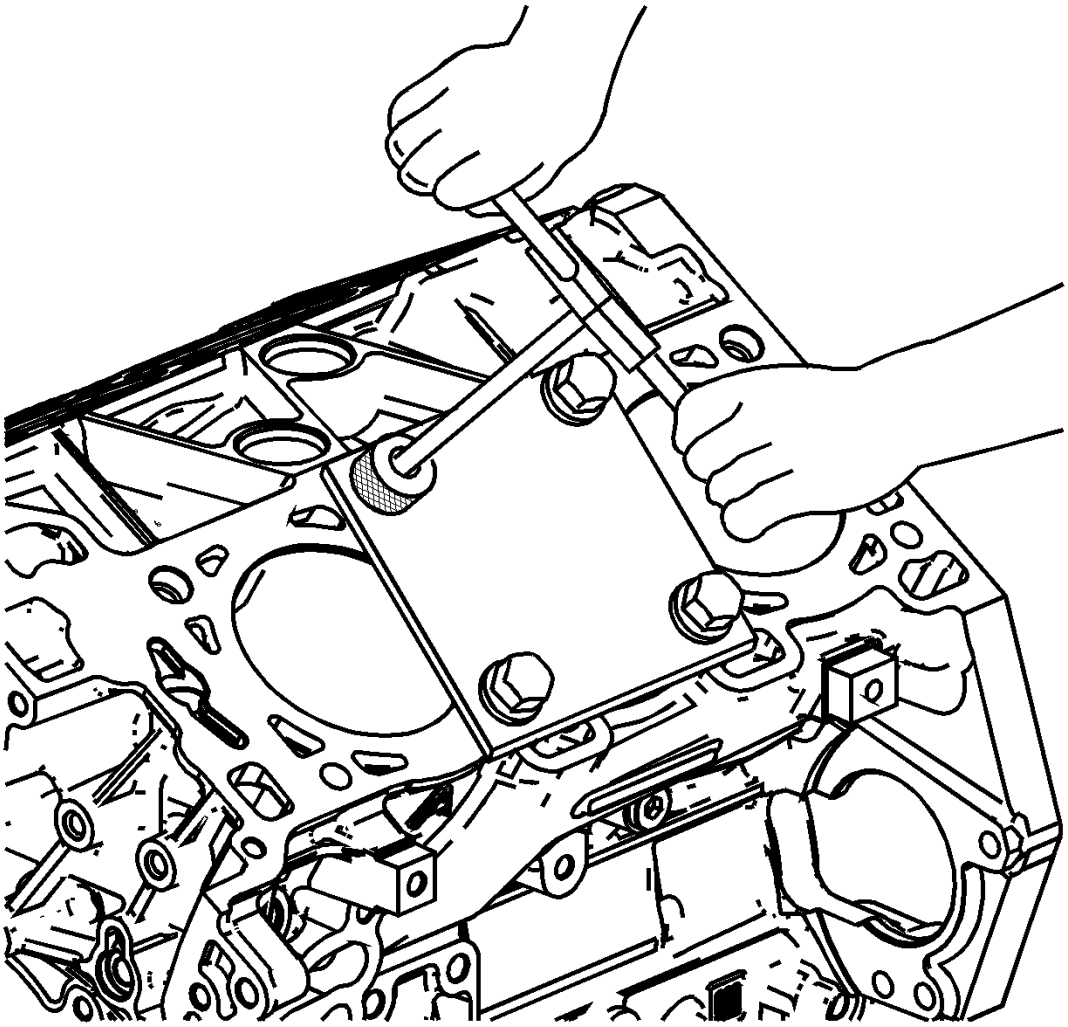

Fig. 380: Tapping Threads Of Drilled Hole Using Tapping Wrench - Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**
- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

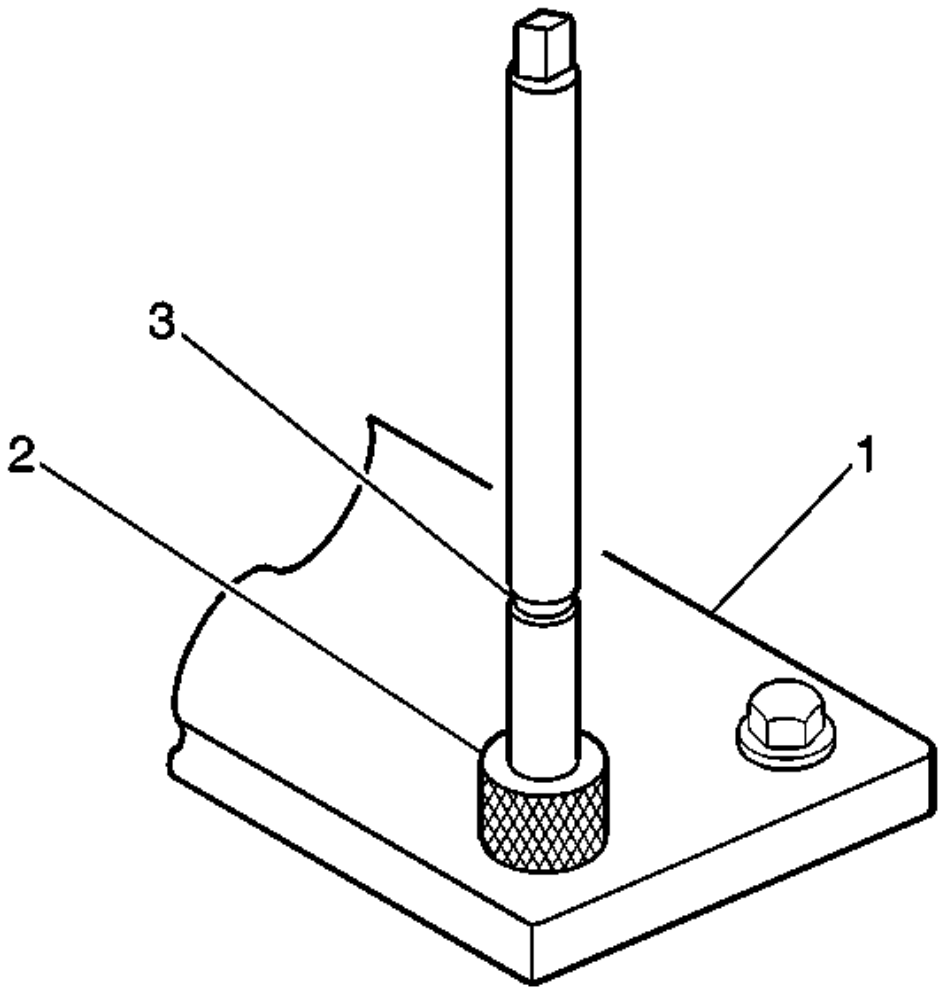

Fig. 381: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the cylinder head bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

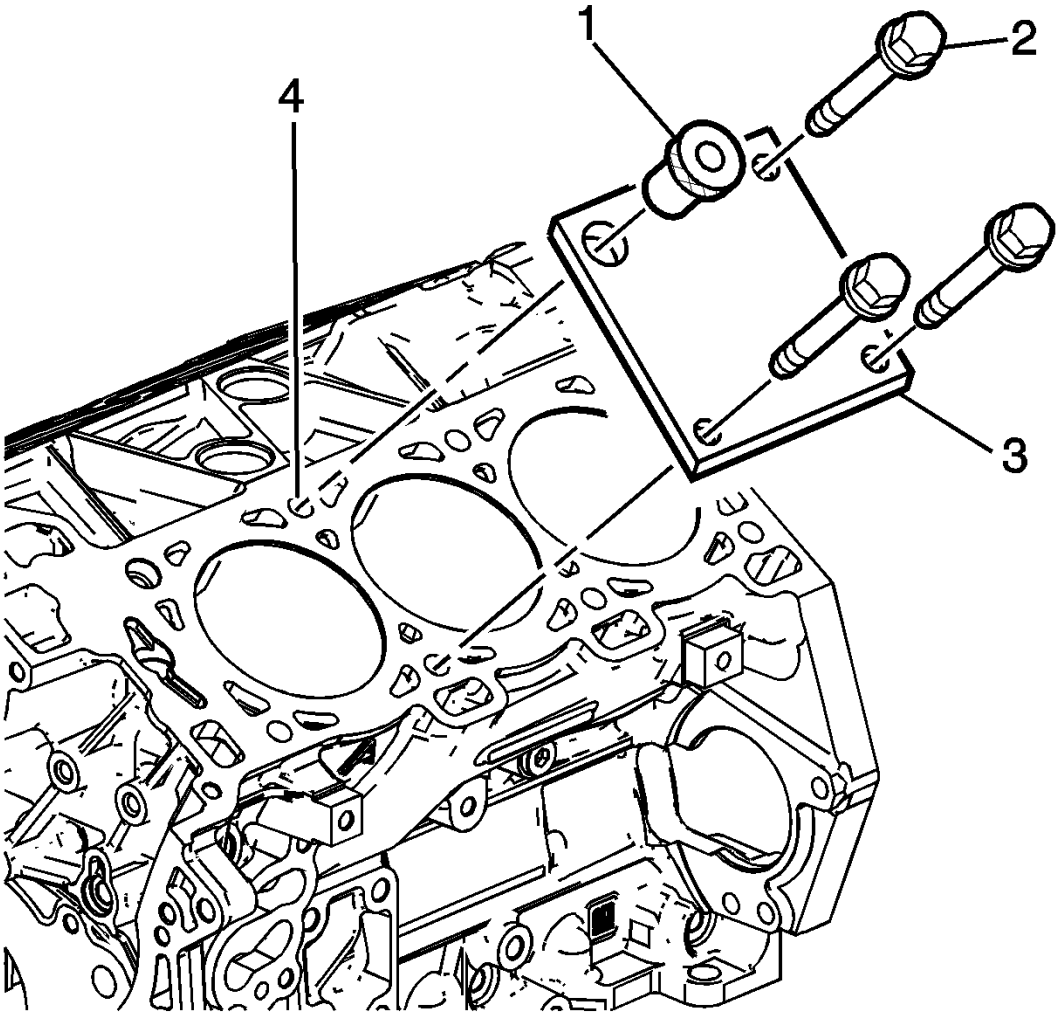

Fig. 382: View Of Fixture Plate & Components - Cylinder Head Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Remove the fixture plate prior to installing the insert with the installer tool.**

10. Remove the fixture plate bolts (2).
11. Remove the fixture plate (3) and bushing (1).

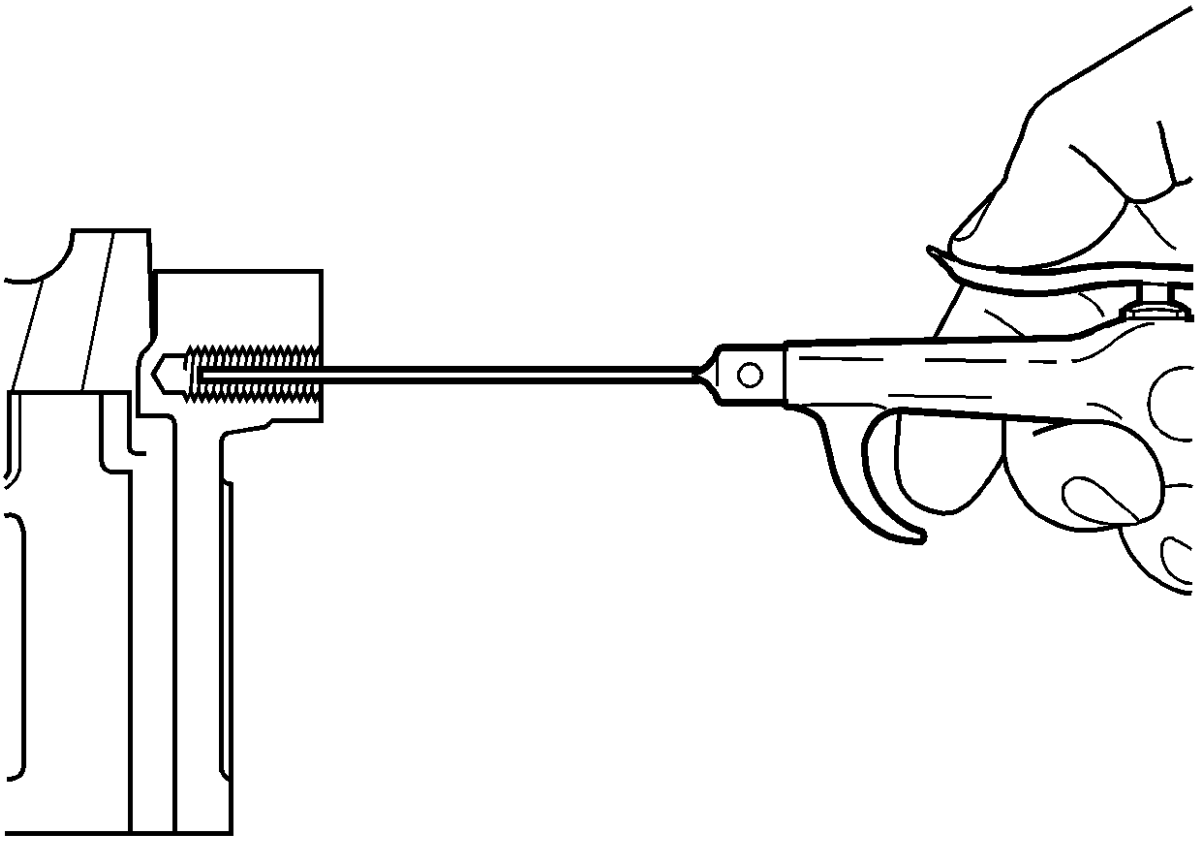

Fig. 383: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

12. Using compressed air, clean out any chips.

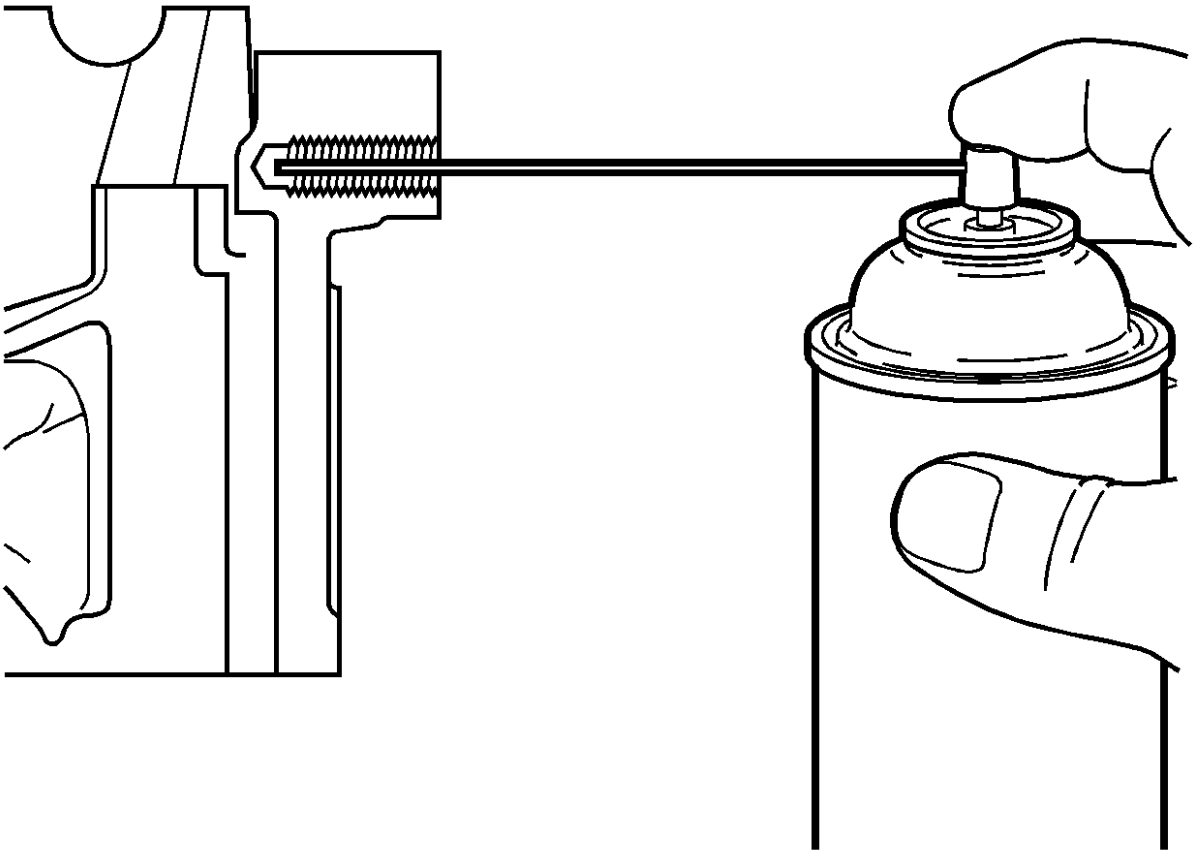

Fig. 384: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

13. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

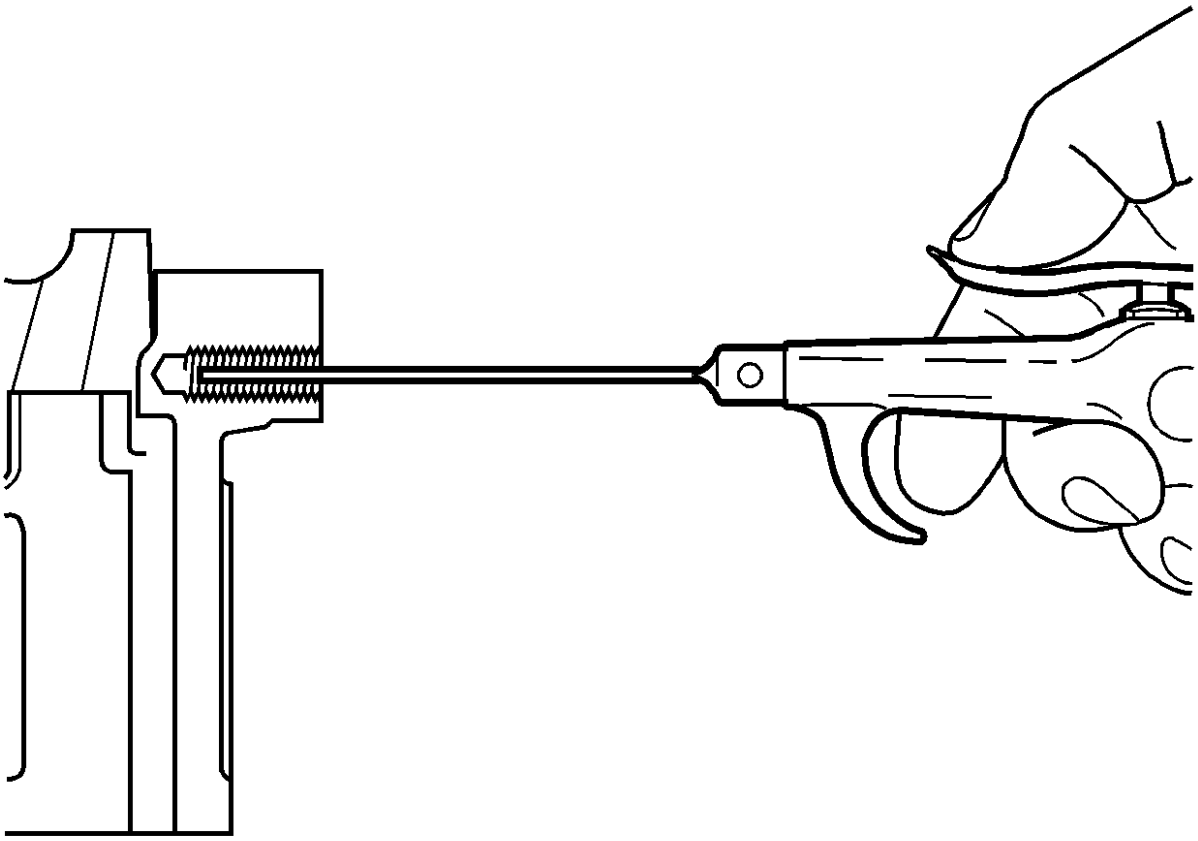

Fig. 385: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

14. Using compressed air, clean out any chips.

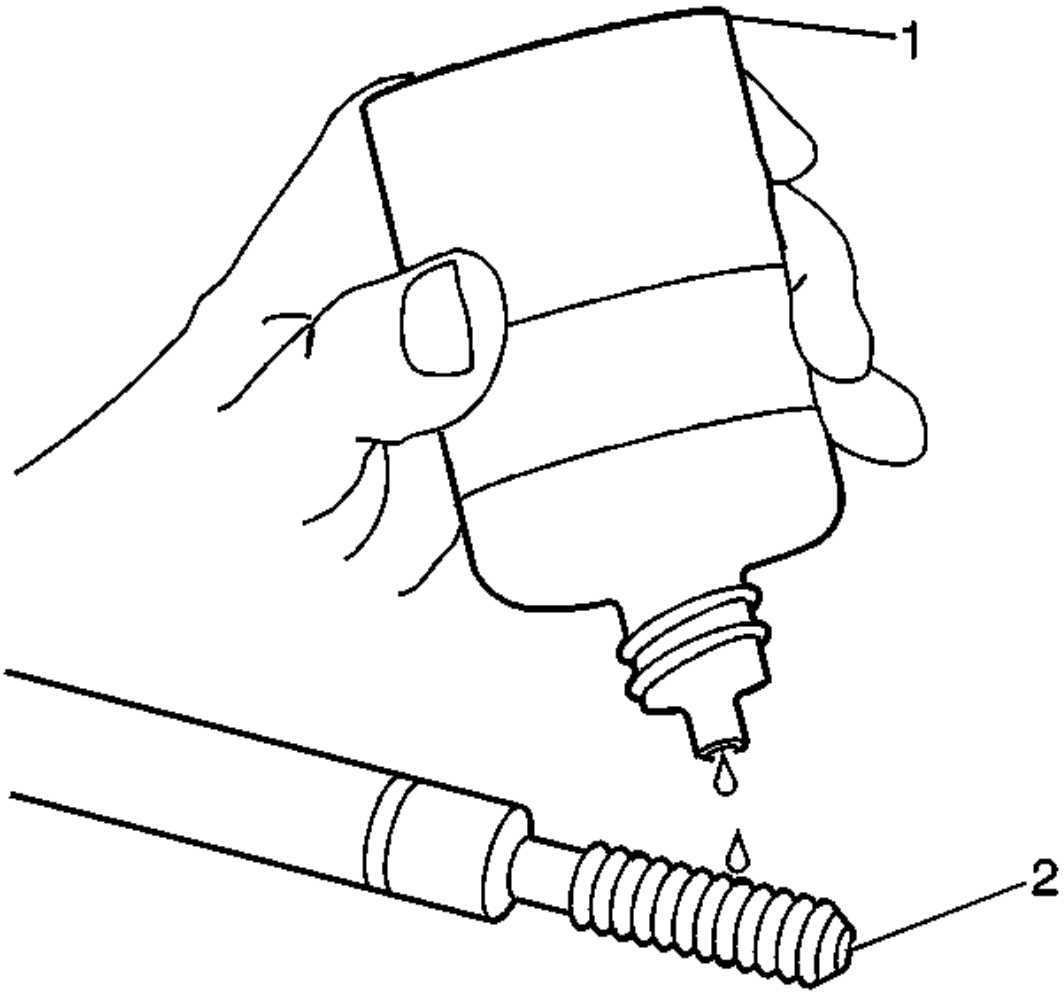

Fig. 386: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

15. Lubricate the threads of the driver installation tool (2) with the EN 42385-110 (1).

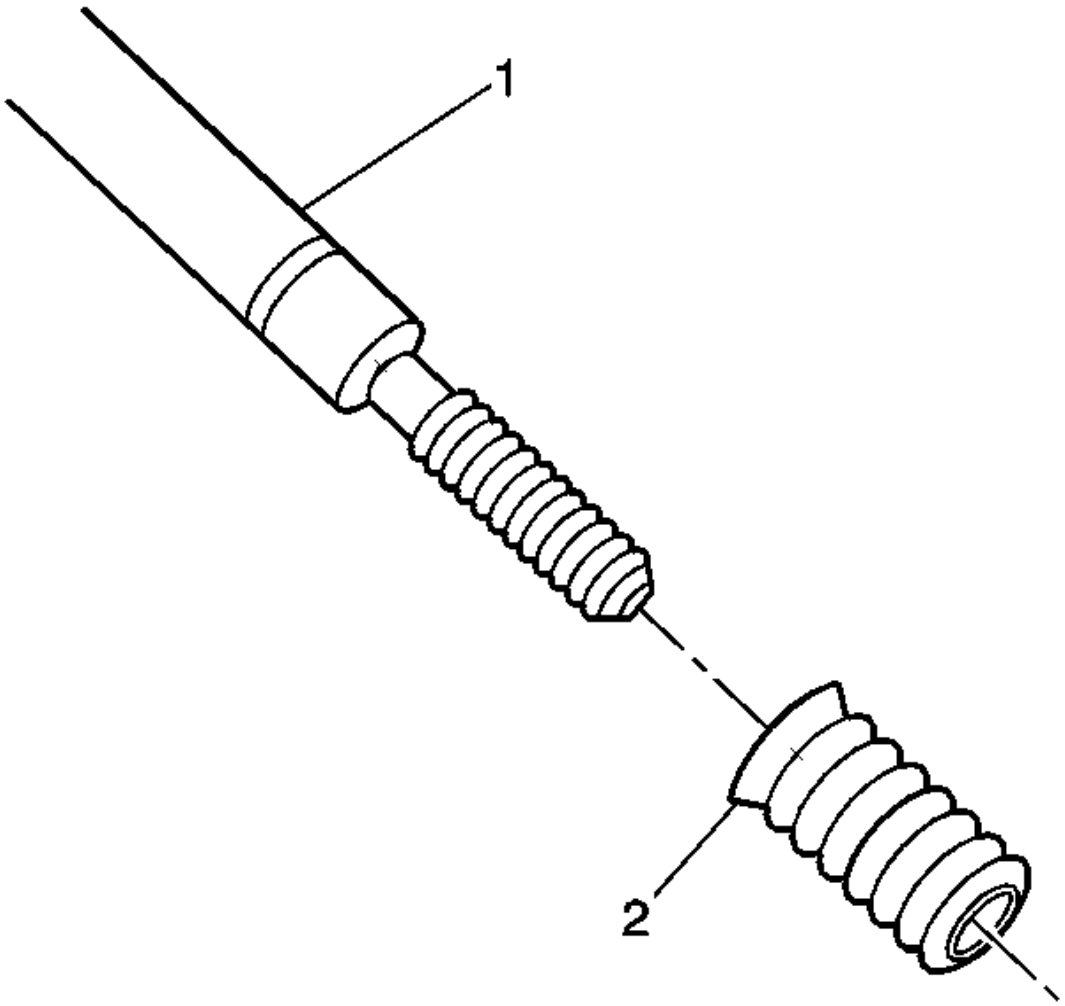

Fig. 387: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

16. Install the insert (2) onto the driver installation tool (1).

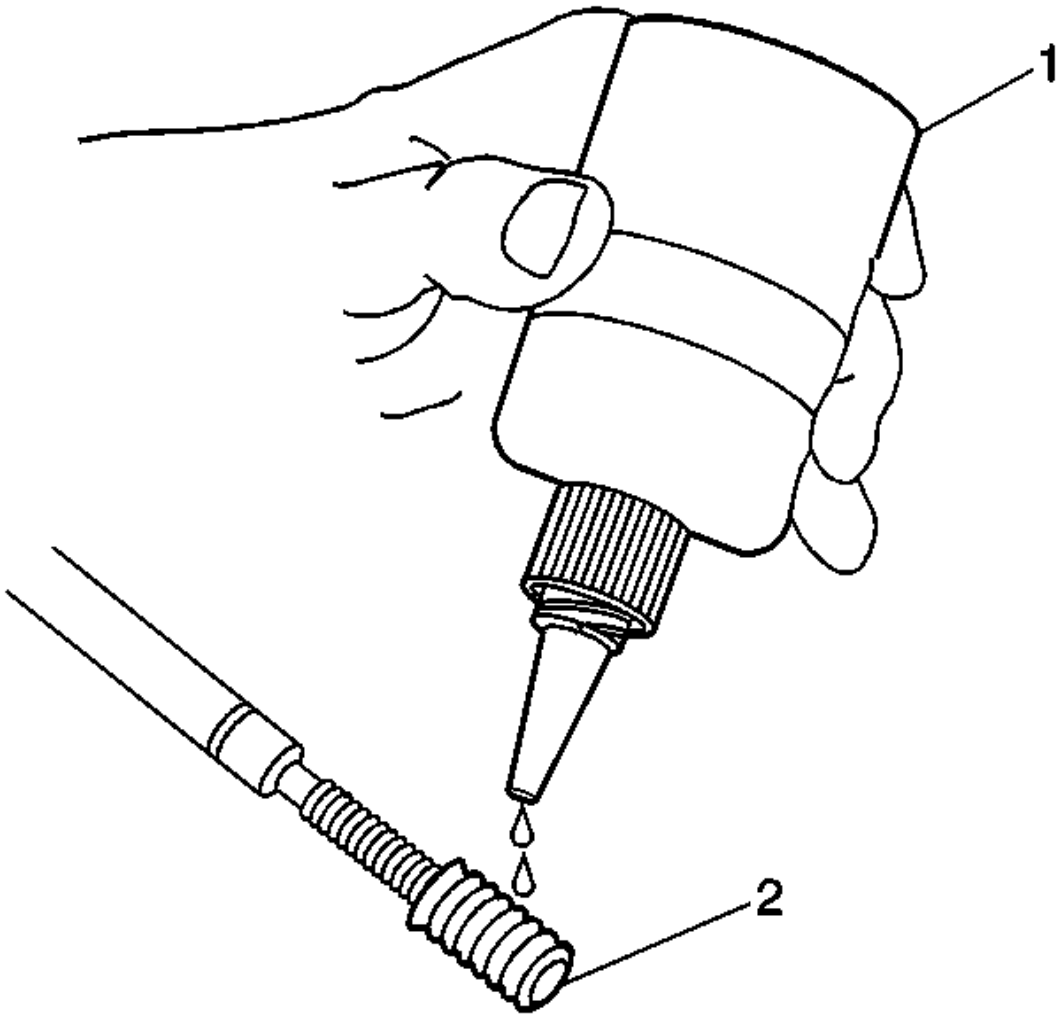

Fig. 388: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

17. Apply threadlock sealant, EN 42385-109, LOCTITE 277Â®; or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

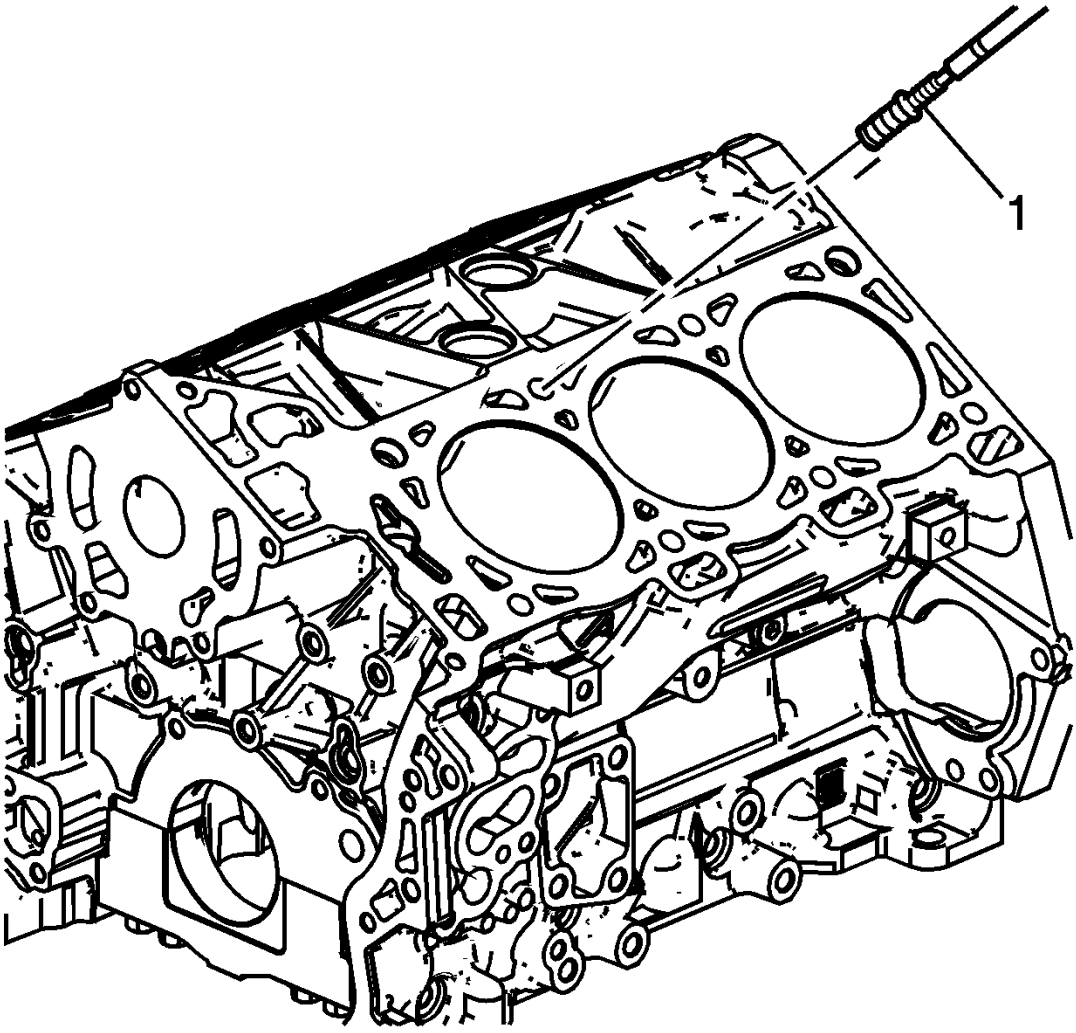

Fig. 389: Installing Installation Driver By Hand
Courtesy of GENERAL MOTORS COMPANY

18. Install the insert and installation driver (1) into the tapped hole by hand only.
19. Start the insert into the threaded hole.

NOTE: **If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.**

20. Install the insert until the flange of the insert contacts the counterbored surface.

NOTE: **The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.**

21. Continue to rotate the driver installation tool through the insert.

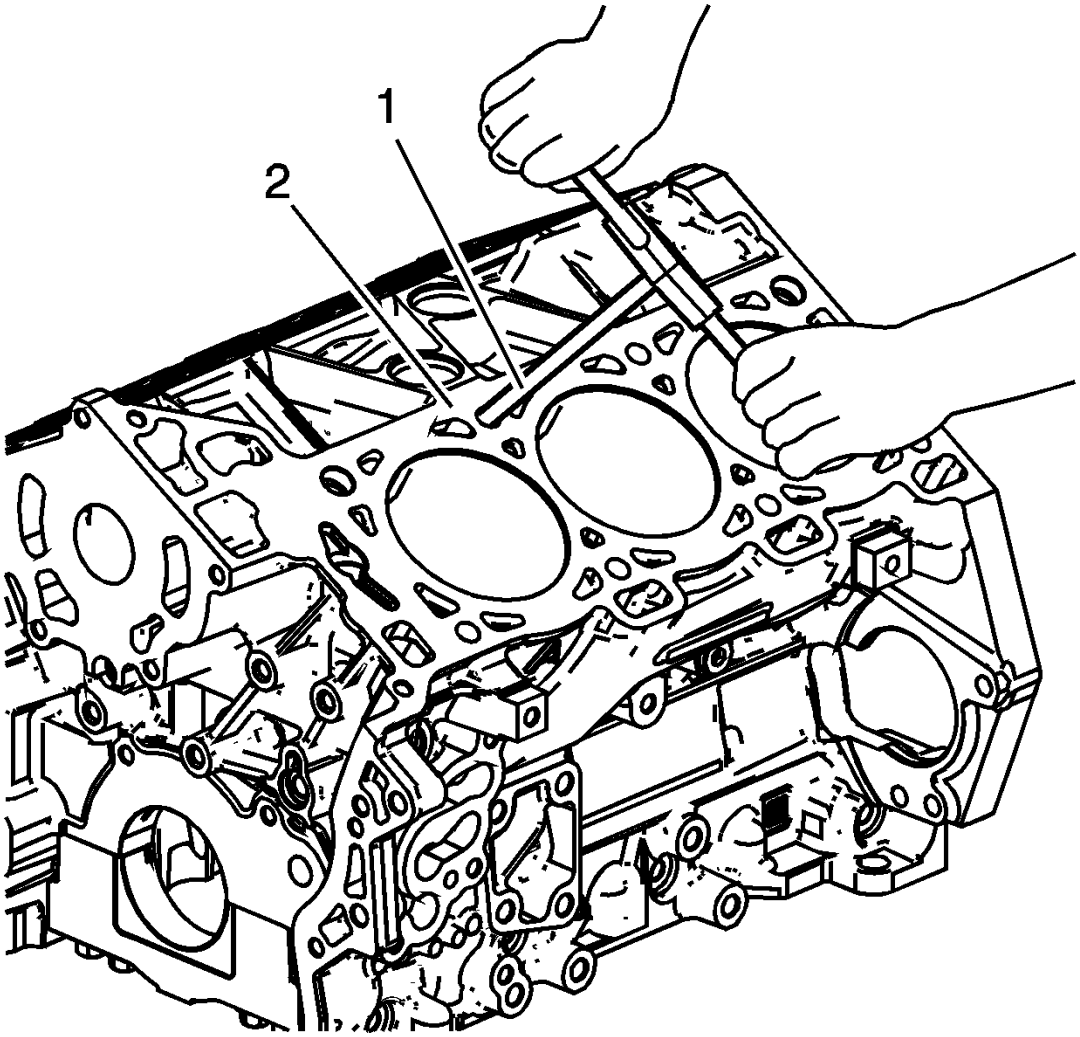

Fig. 390: View Of Driver Installation Tool & Surface Of Engine Block Deck
Courtesy of GENERAL MOTORS COMPANY

22. In order to completely form the new threads in the insert, rotate the driver installation tool through the insert until the mark (1) on the driver installation tool aligns with the surface of the engine block deck (2).
23. Inspect the insert for proper installation into the tapped hole.

Crankshaft Main Bolt Hole Thread Repair

Special Tools

- **EN 42385-700** High Feature Thread Repair Kit
- **EN 42385-2000** Thread Insert Kit

For equivalent regional tools, refer to **Special Tools** .

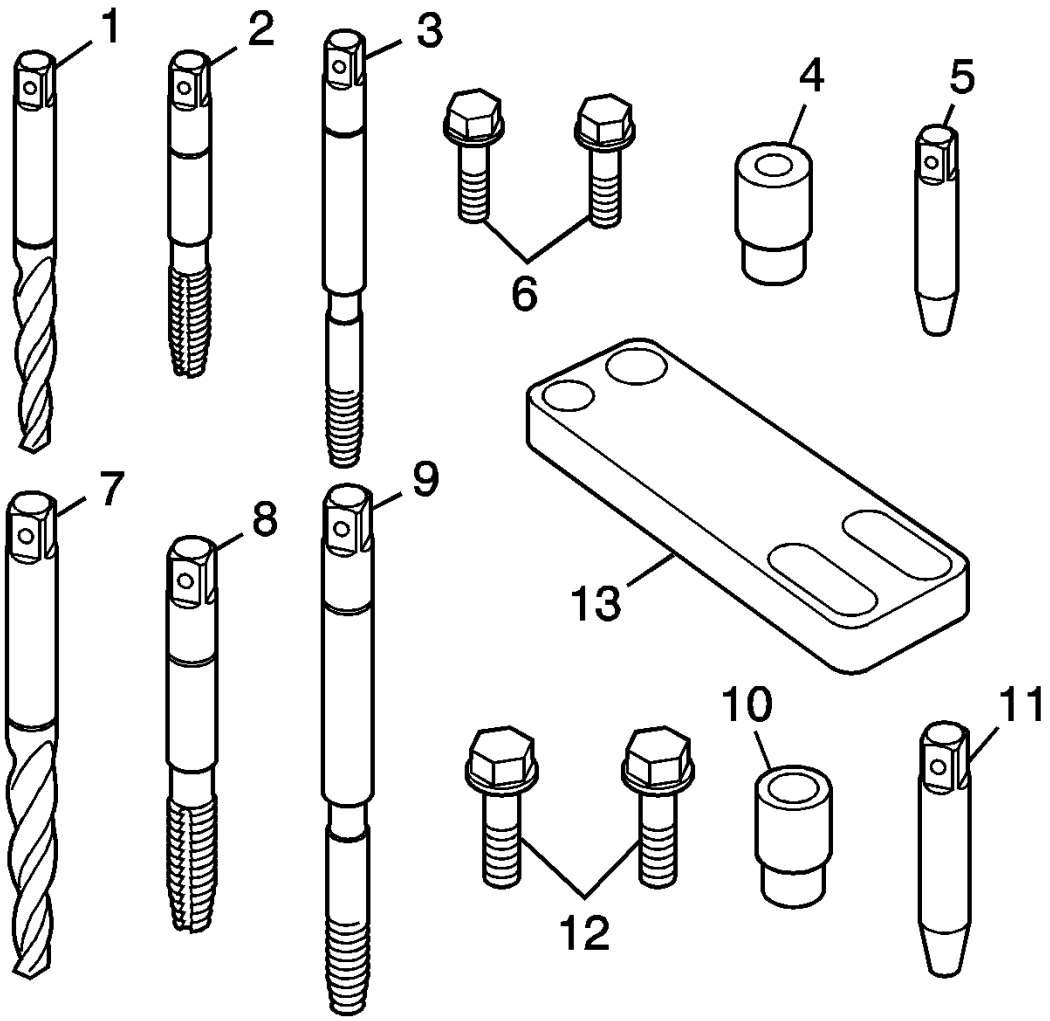

Fig. 391: High Feature Thread Repair Kit
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **In order to repair some crankshaft main bolt holes it will be necessary to mount the fixture plate upside down.**
- **Do NOT remove the fixture plate prior to installing the insert with the installation driver. The fixture plate remains in position throughout the thread repair process.**

The crankshaft main bearing bolt hole thread repair tooling are in the kits **EN 42385-2000** insert kit and **EN 42385-700** kit. The crankshaft main bearing bolt hole thread repair components consist of the following:

- EN 42385-702 Drill (1) for outboard holes
- EN 42385-703 Tap (2) for outboard holes
- EN 42385-704 Installation driver (3) for outboard holes
- EN 42385-726 Bushing (4) for outboard holes
- EN 42385-727 Alignment pin (5) for outboard holes
- EN 42385-728 Bolts (6) for outboard holes

- EN 42385-720 Drill (7) for inboard holes
- EN 42385-721 Tap (8) for inboard holes
- EN 42385-722 Installation driver (9) for inboard holes
- EN 42385-713 Bushing (10)
- EN 42385-308 Alignment pin (11)
- EN 42385-734 Bolts (12)
- EN 42385-712 Fixture plate (13)

Outboard Bolt Holes

WARNING: **Refer to Safety Glasses Warning .**

NOTE:

- **Ensure the fixture plate is installed during the machining and installation processes of the insert.**
- **The use of a cutting type fluid, WD 40Â® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.**

When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.

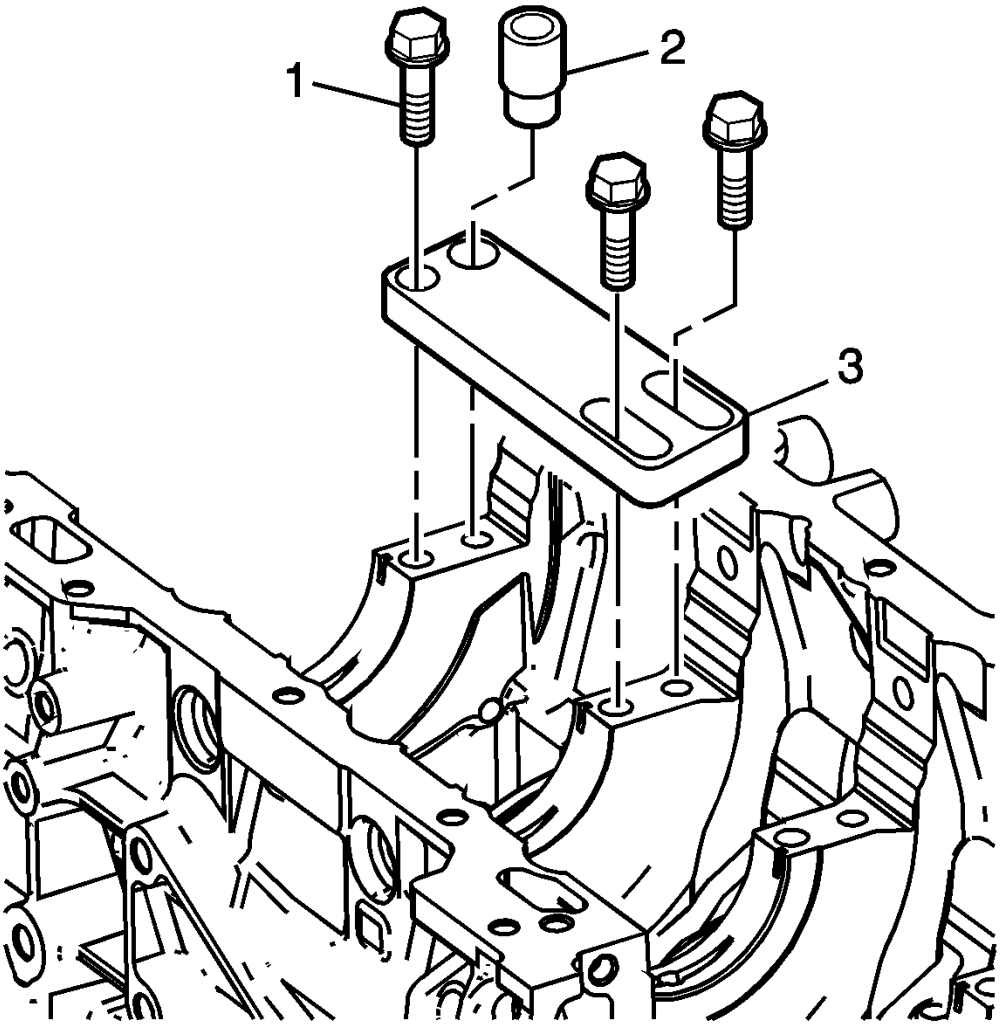

Fig. 392: Identifying Fixture Plate Over Crankshaft Main Cap Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

1. Position the fixture plate (3) with the bushing (2) installed over the crankshaft main cap bolt hole to be repaired.
2. Loosely install the fixture plate bolts (1) into the remaining crankshaft main cap bolt holes.

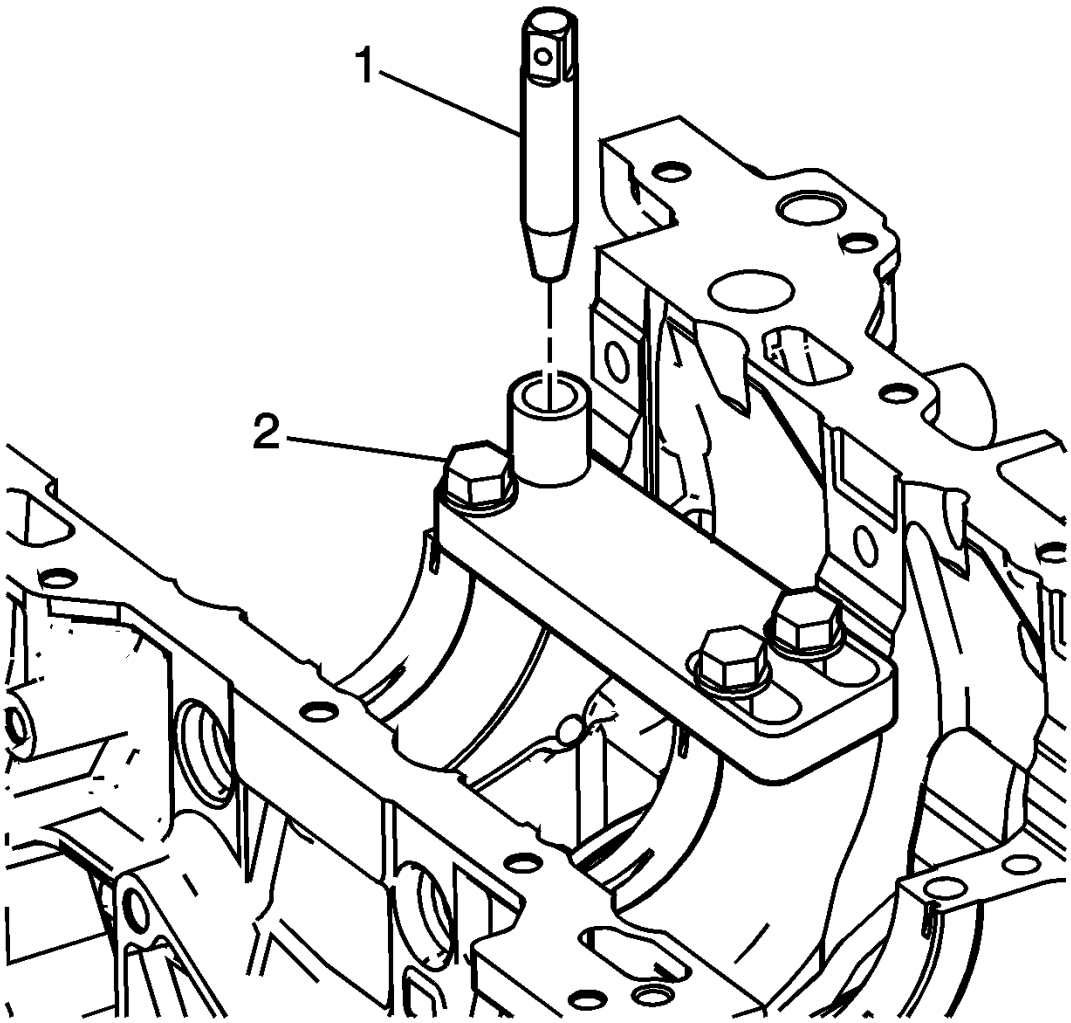

Fig. 393: Identifying Alignment Pin & Bushing
Courtesy of GENERAL MOTORS COMPANY

3. Position the alignment pin (1) through the bushing and into the crankshaft main cap bolt hole.
4. With the alignment pin in the desired crankshaft main cap bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the crankshaft main cap bolt hole.

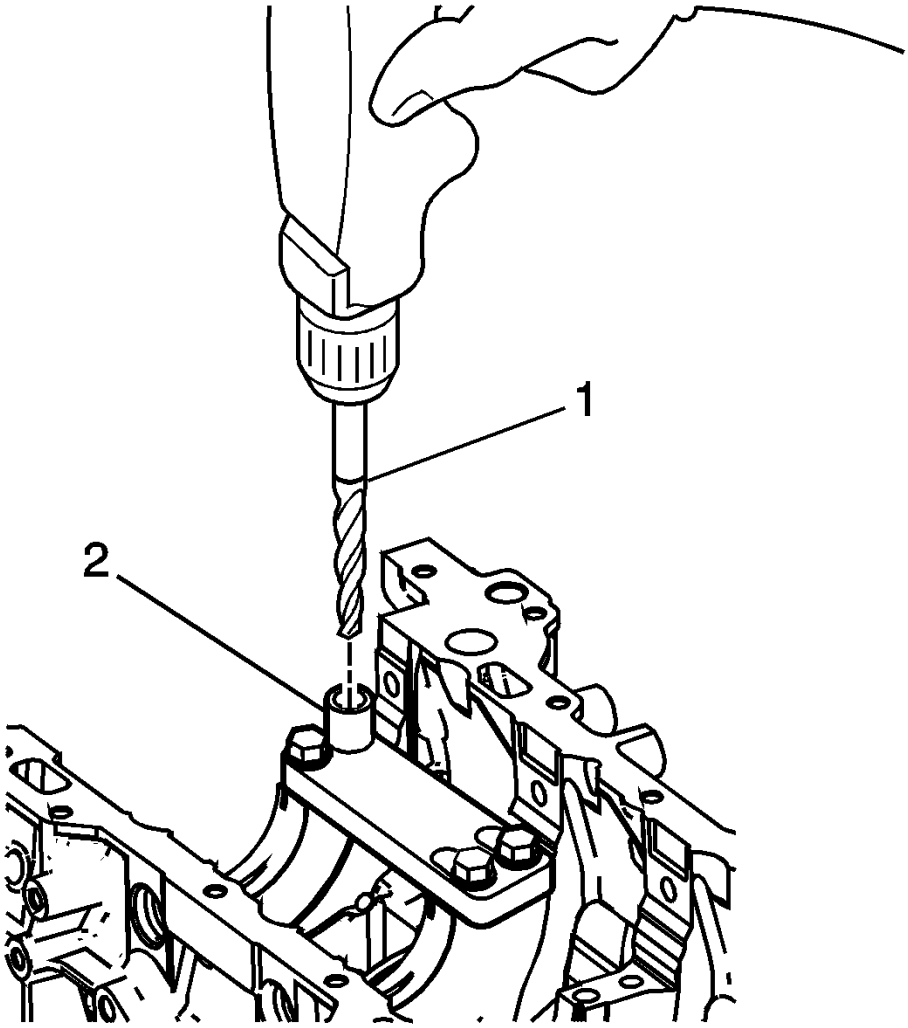

Fig. 394: Aligning Drill & Drill Bushing
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Drill the crankshaft main bolt hole until the mark (1) on the drill aligns with the top of the drill bushing (2).**

6. Drill out the threads of the damaged hole.

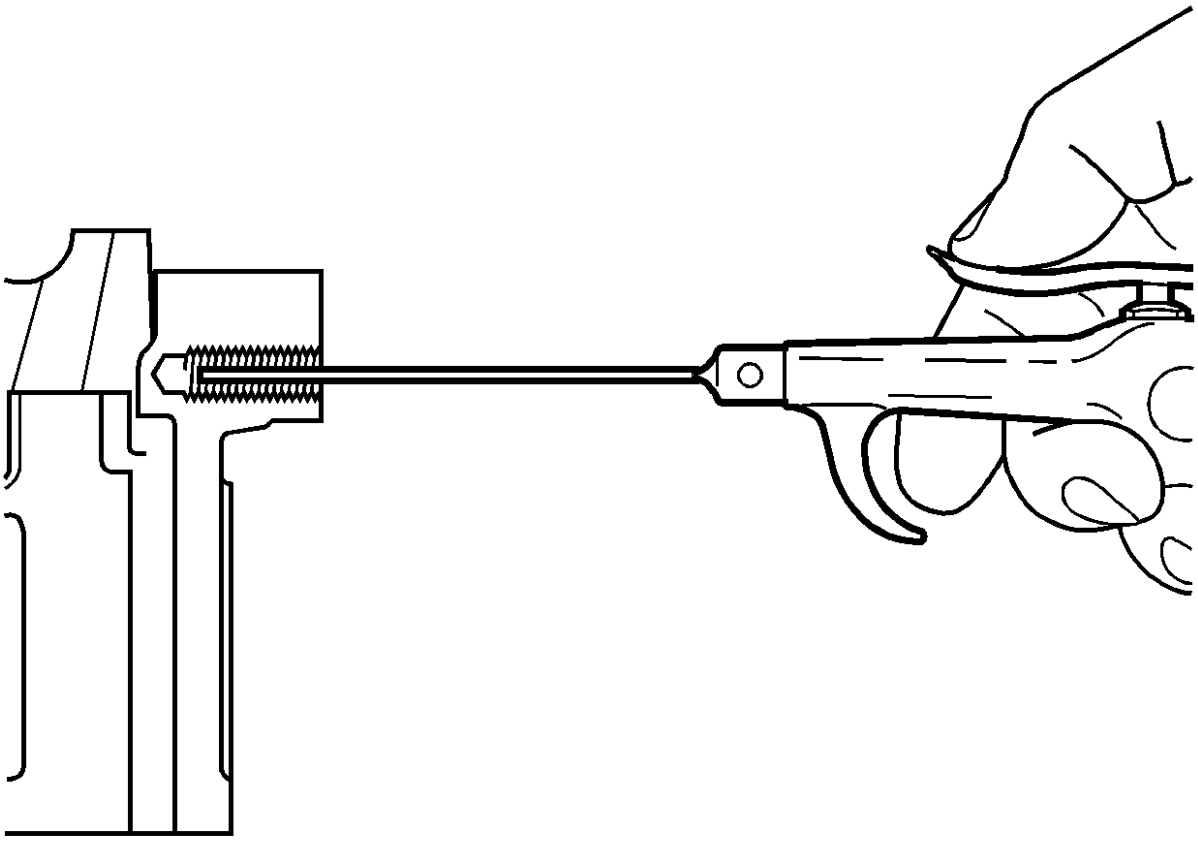

Fig. 395: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the drilled hole prior to tapping.**

7. Using compressed air, clean out any chips.

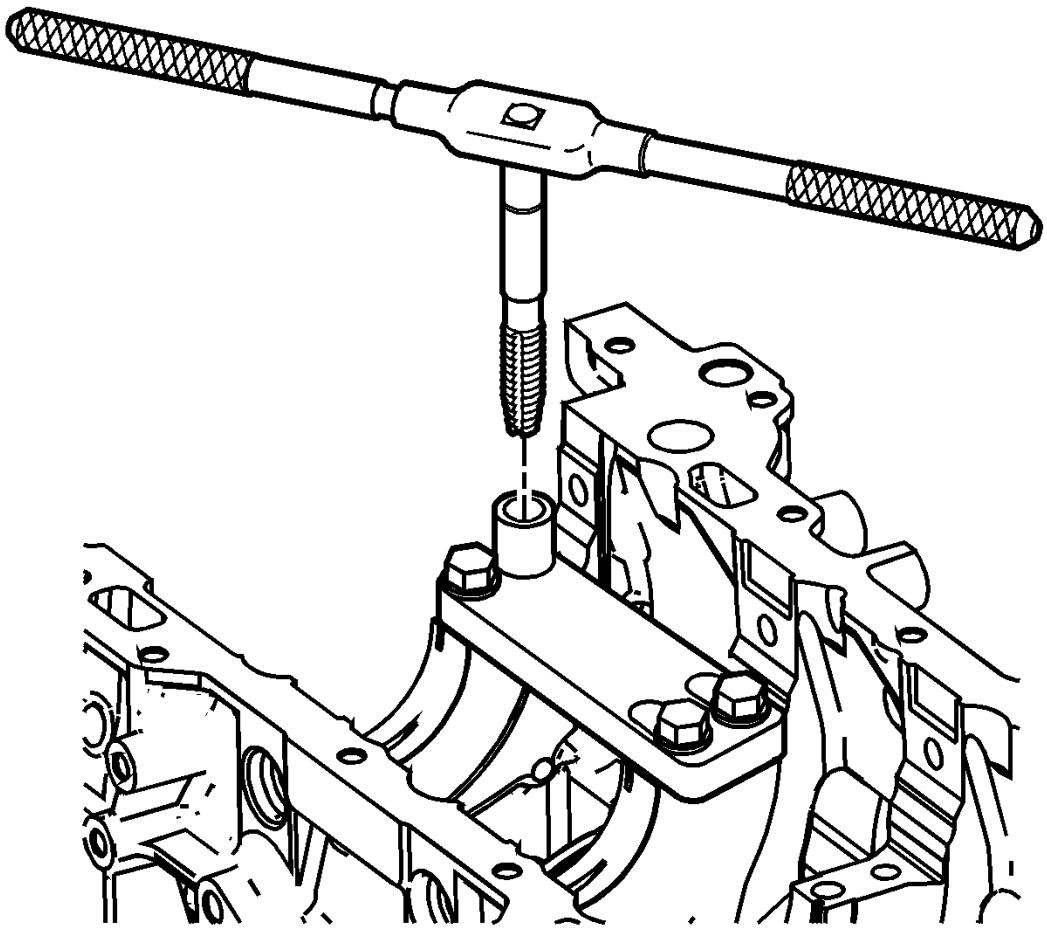

Fig. 396: View Of Tapping Wrench
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not remove the fixture plate, ensure the fixture plate is installed during the machining and installation processes of the insert.**
- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**
- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

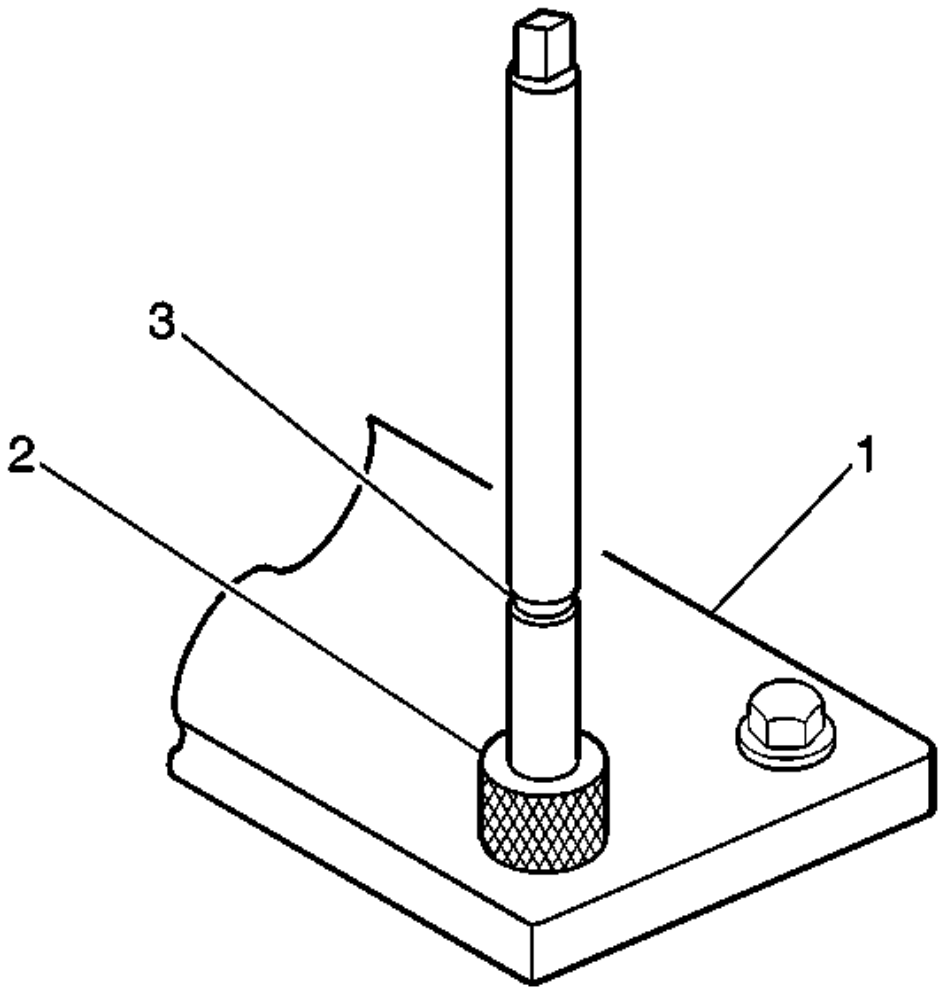

Fig. 397: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the crankshaft main cap bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

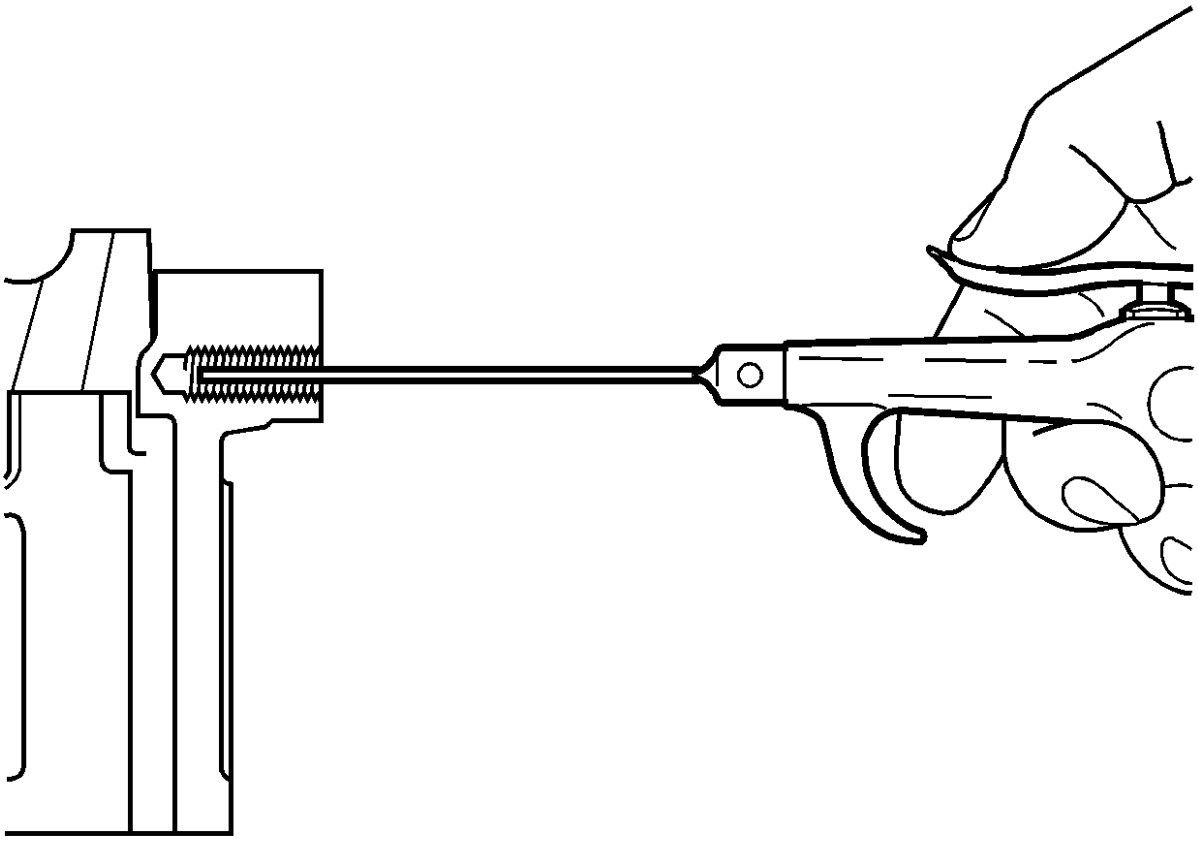

Fig. 398: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

10. Using compressed air, clean out any chips.

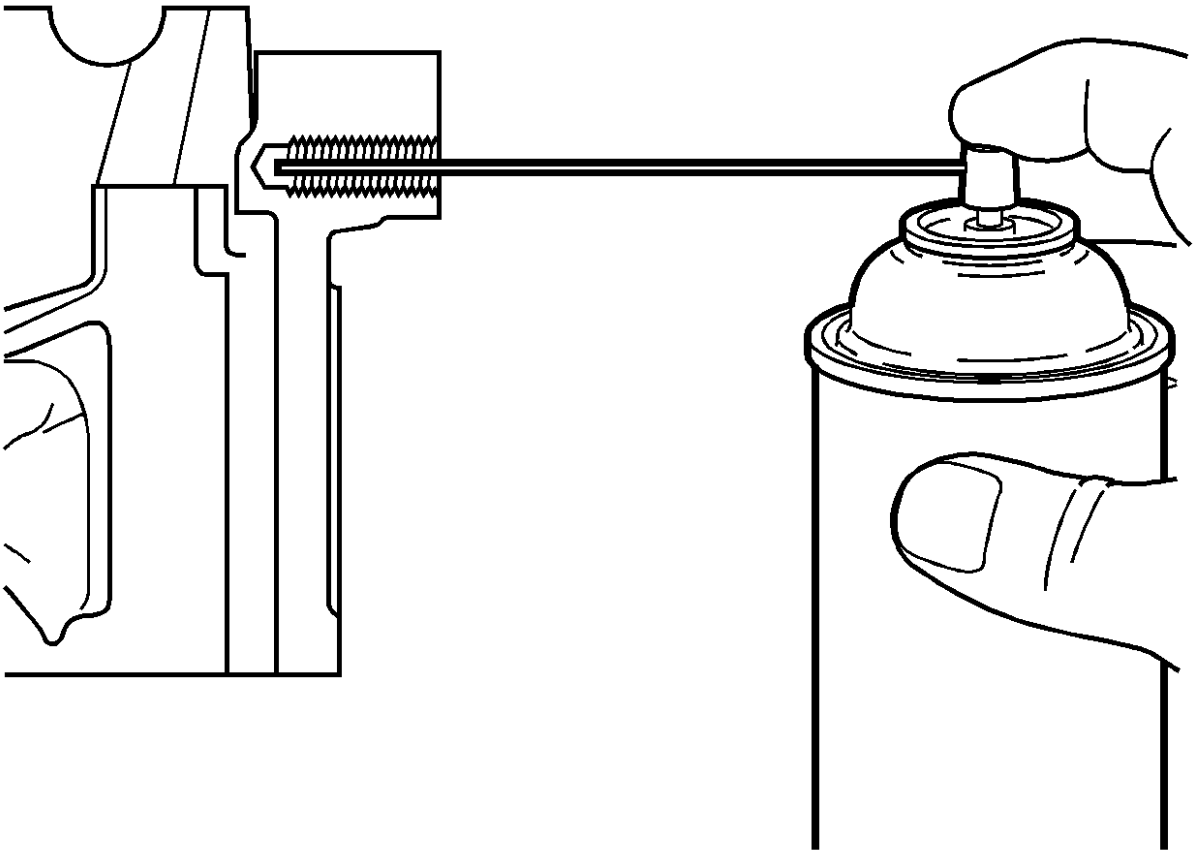

Fig. 399: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

11. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

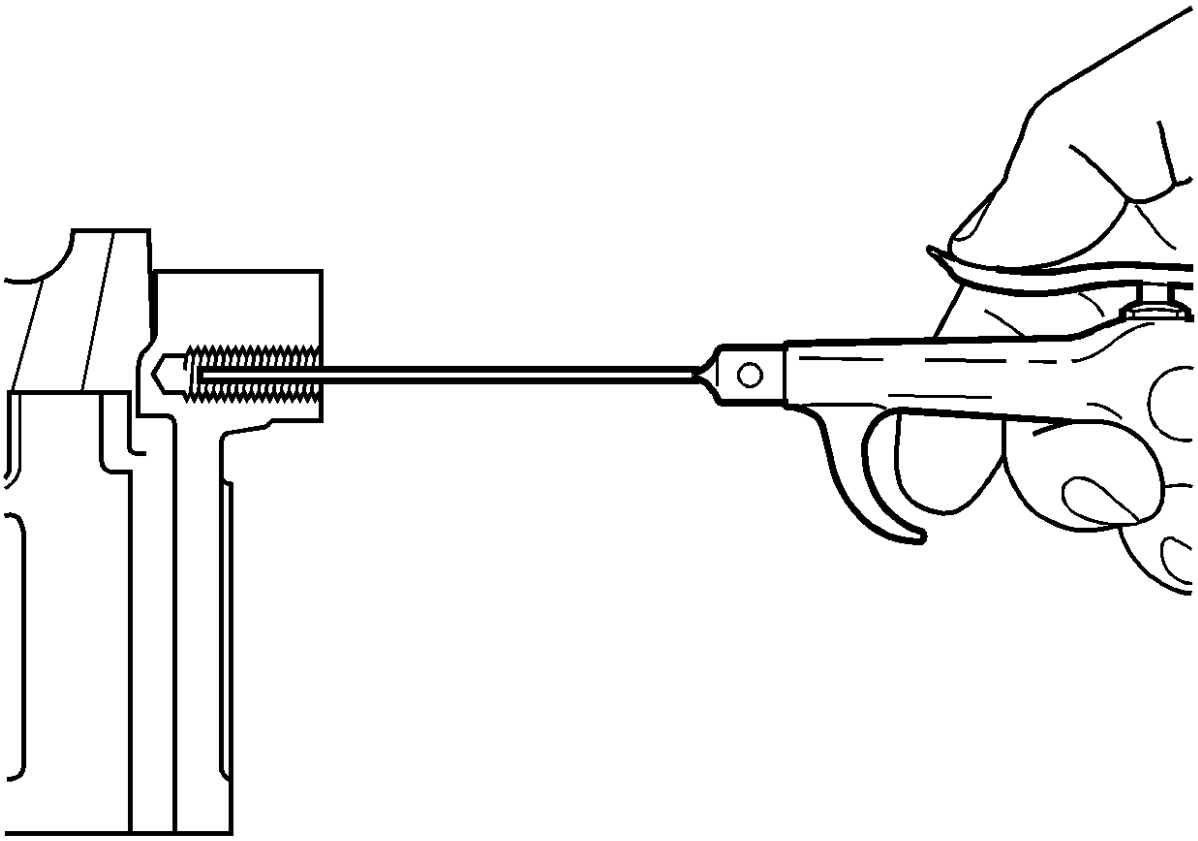

Fig. 400: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

12. Using compressed air, clean out any chips.

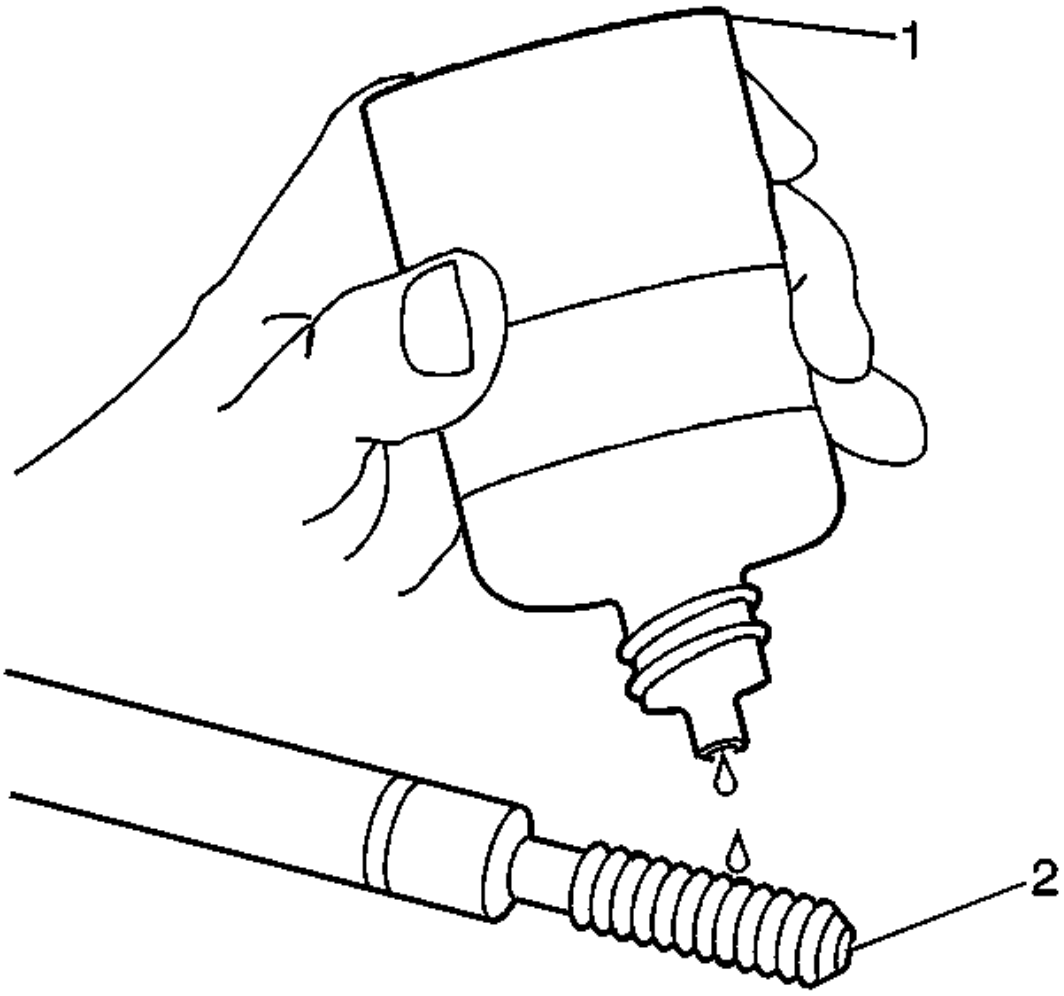

Fig. 401: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not remove the fixture plate, ensure the fixture plate is installed during the installation process of the insert.**
- **Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

13. Lubricate the threads of the driver installation tool (2) with the EN 42385-110 (1).

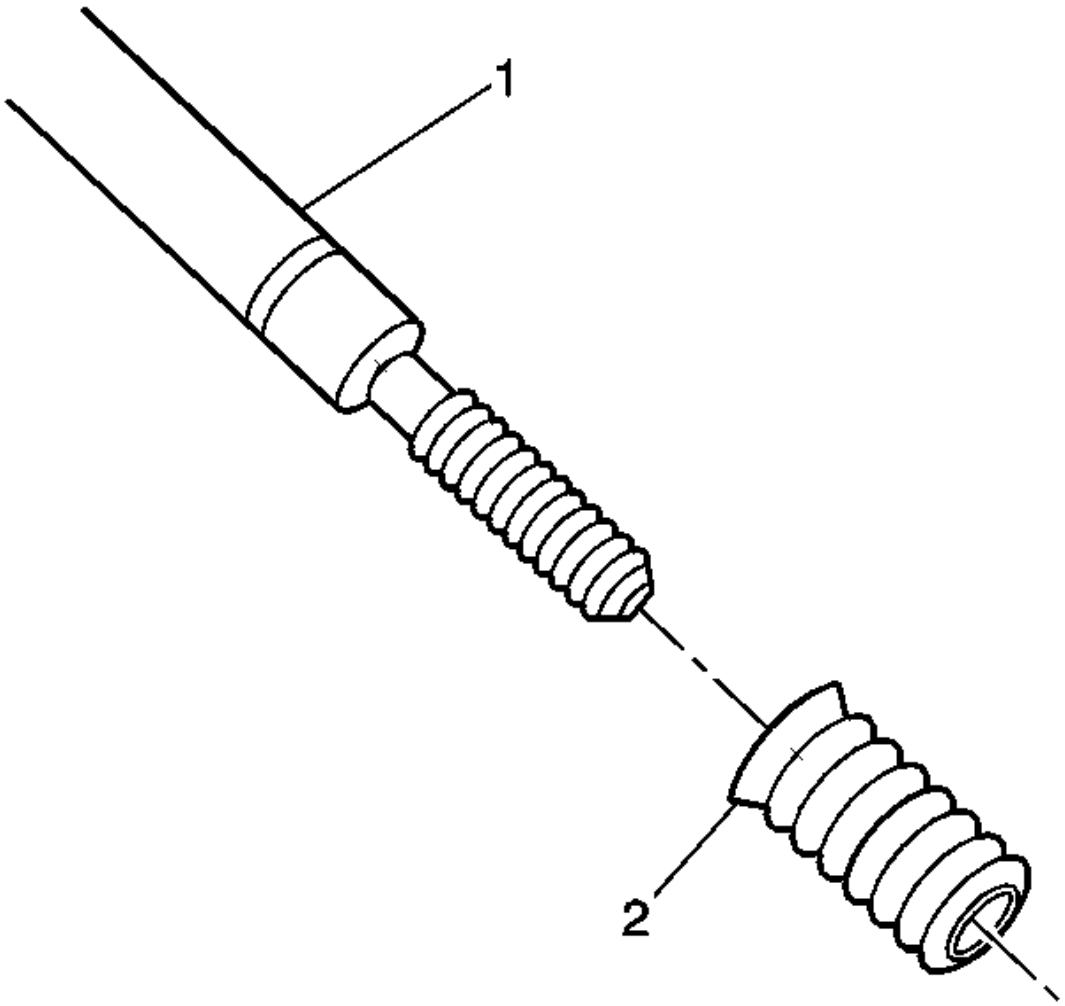

Fig. 402: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

14. Install the insert (2) onto the driver installation tool (1).

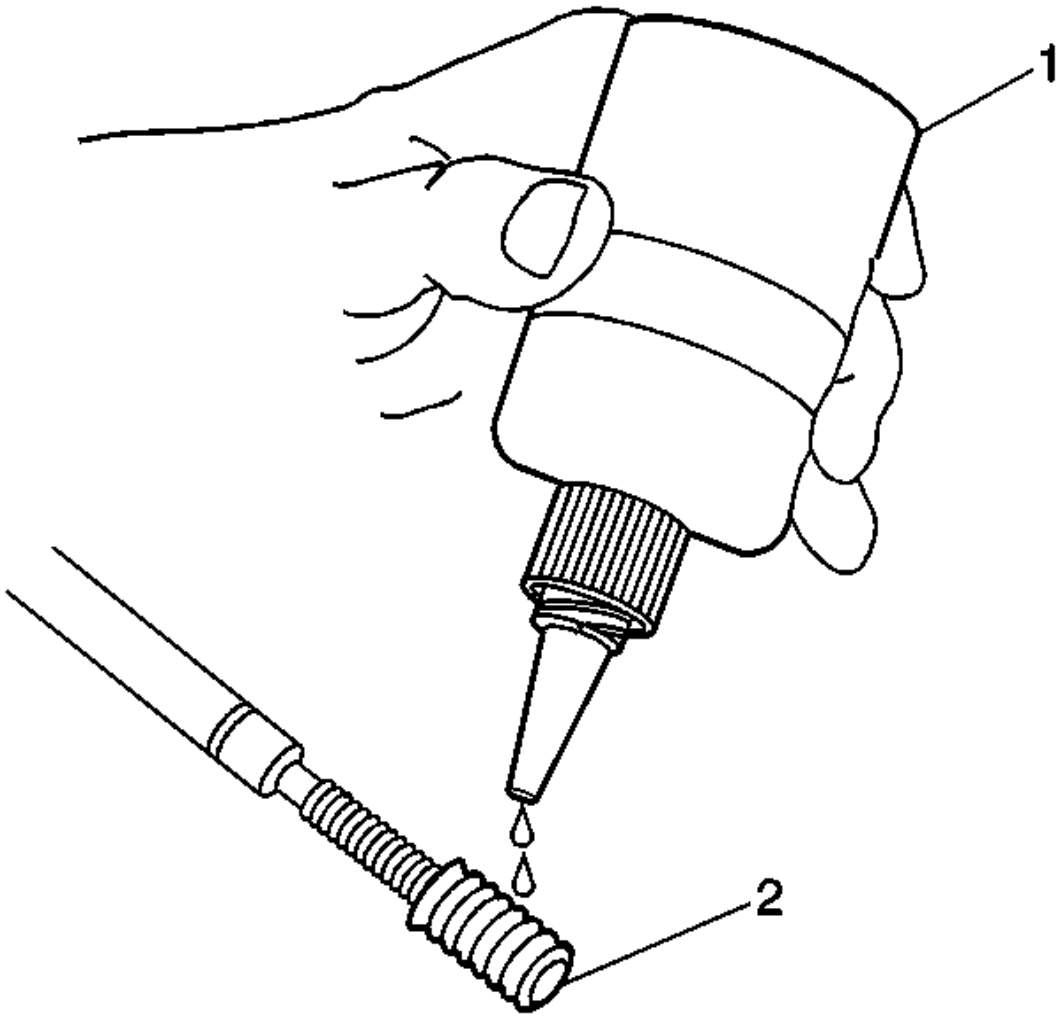

Fig. 403: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

15. Apply threadlock sealant, EN 42385-109, LOCTITE 277Â®, or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

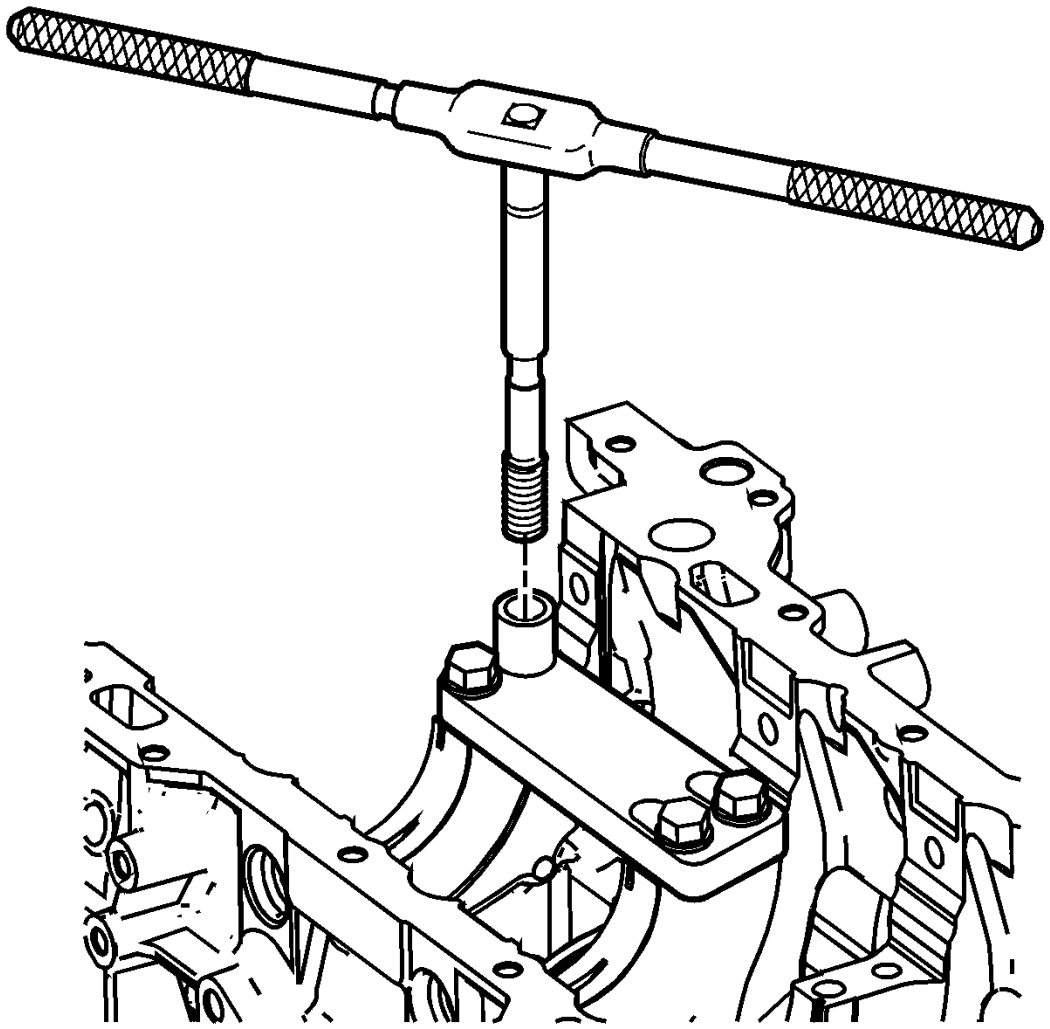

Fig. 404: Identifying Tapping Wrench
Courtesy of GENERAL MOTORS COMPANY

16. Install the insert and installation driver into the tapped hole by hand only.
17. Start the insert into the threaded hole.

NOTE: **If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.**

18. Install the insert until the flange of the insert contacts the counterbored surface.

NOTE: **The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.**

19. Continue to rotate the driver installation tool through the insert.

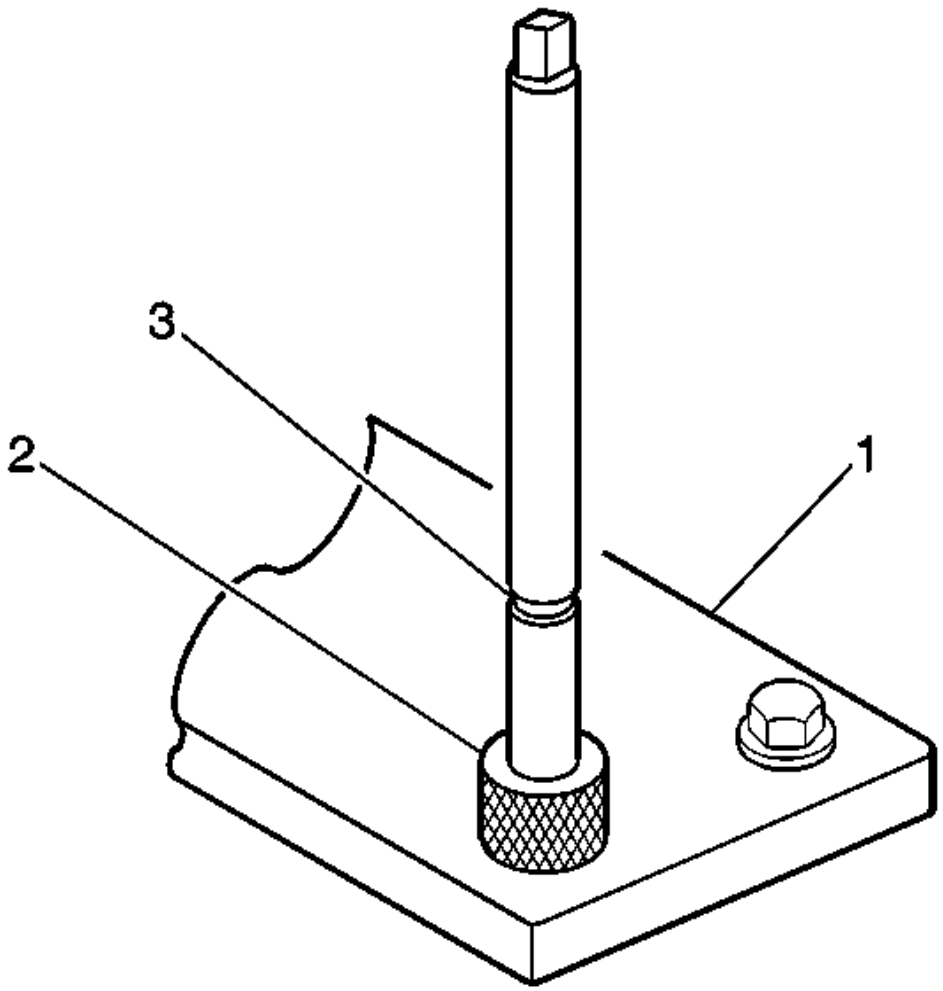

Fig. 405: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

20. Rotate the driver installation tool until the mark (3) on the driver installation tool aligns with the top of the drill bushing (2).
21. Inspect the insert for proper installation into the tapped hole.

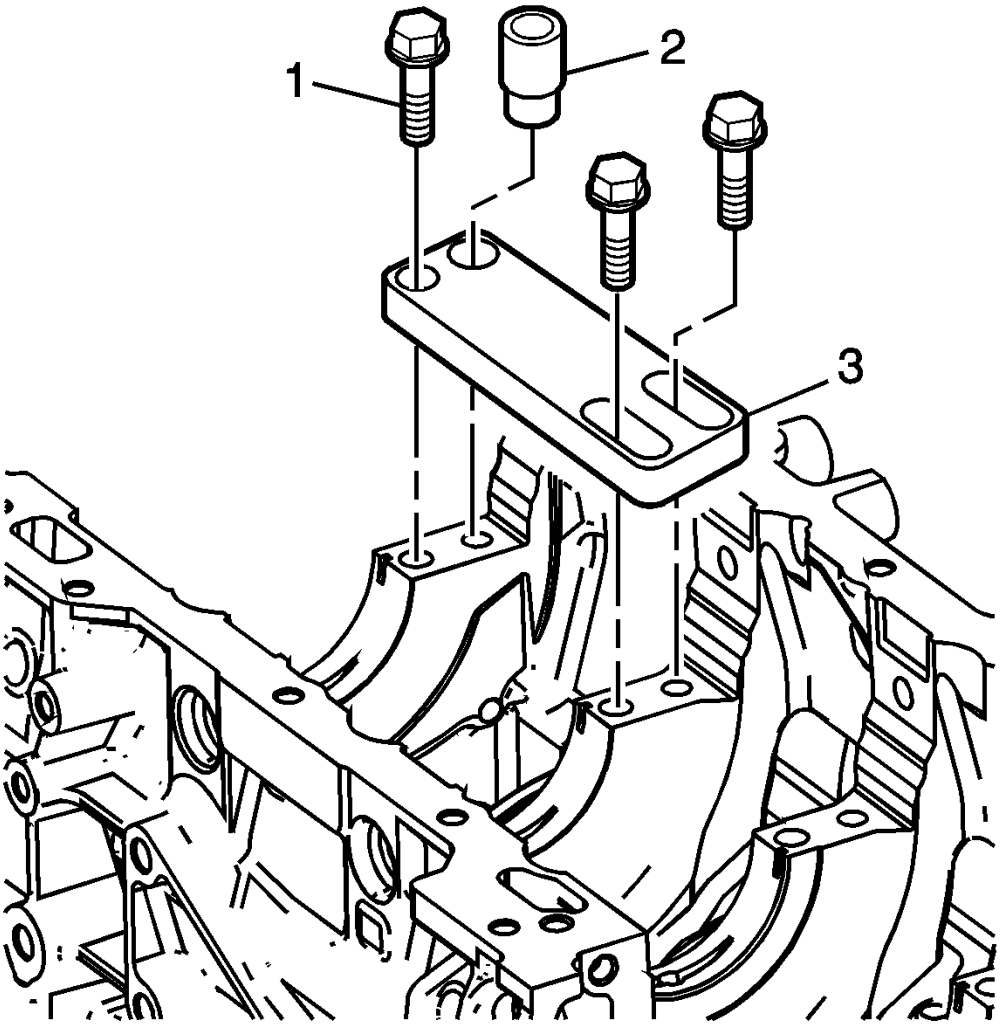

Fig. 406: Identifying Fixture Plate Over Crankshaft Main Cap Bolt Hole
Courtesy of GENERAL MOTORS COMPANY

22. Remove the fixture plate bolts (1).
23. Remove the fixture plate (3) and bushing (2).

Inboard Bolt Holes

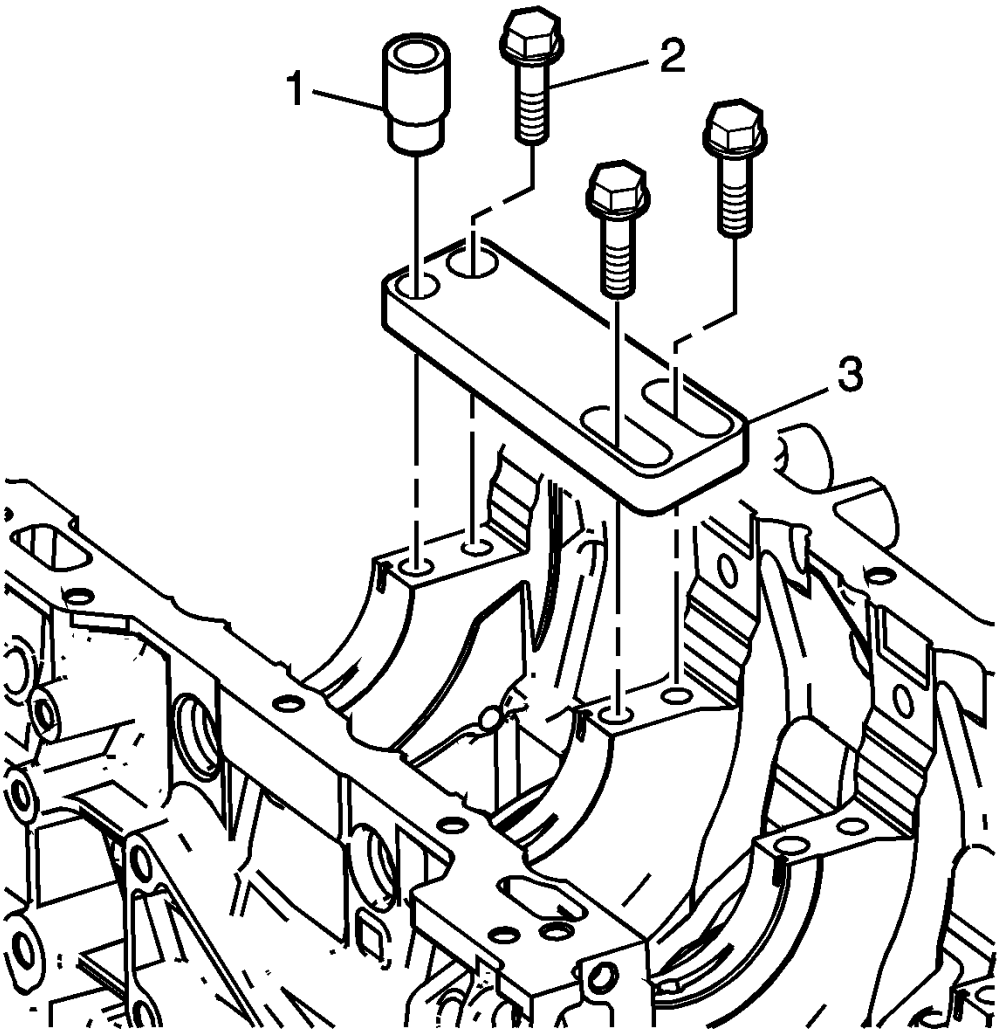

Fig. 407: View Of Fixture Plate & Components - Inboard Bolt Holes
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Safety Glasses Warning .

NOTE:

- **Ensure the fixture plate is installed during the machining and installation processes of the insert.**
- **The use of a cutting type fluid, WD 40Â® or equivalent is recommended when performing the drilling, counterboring and tapping procedures. Refer to Adhesives, Fluids, Lubricants, and Sealers for recommended cutting fluid.**

  When installed to the proper depth, the flange of the insert will be seated against the counterbore of the drilled/tapped hole.

1. Position the fixture plate (3) with the bushing (1) installed over the crankshaft main cap bolt hole to be repaired.
2. Loosely install the fixture plate bolts (2) into the remaining crankshaft main cap bolt holes.

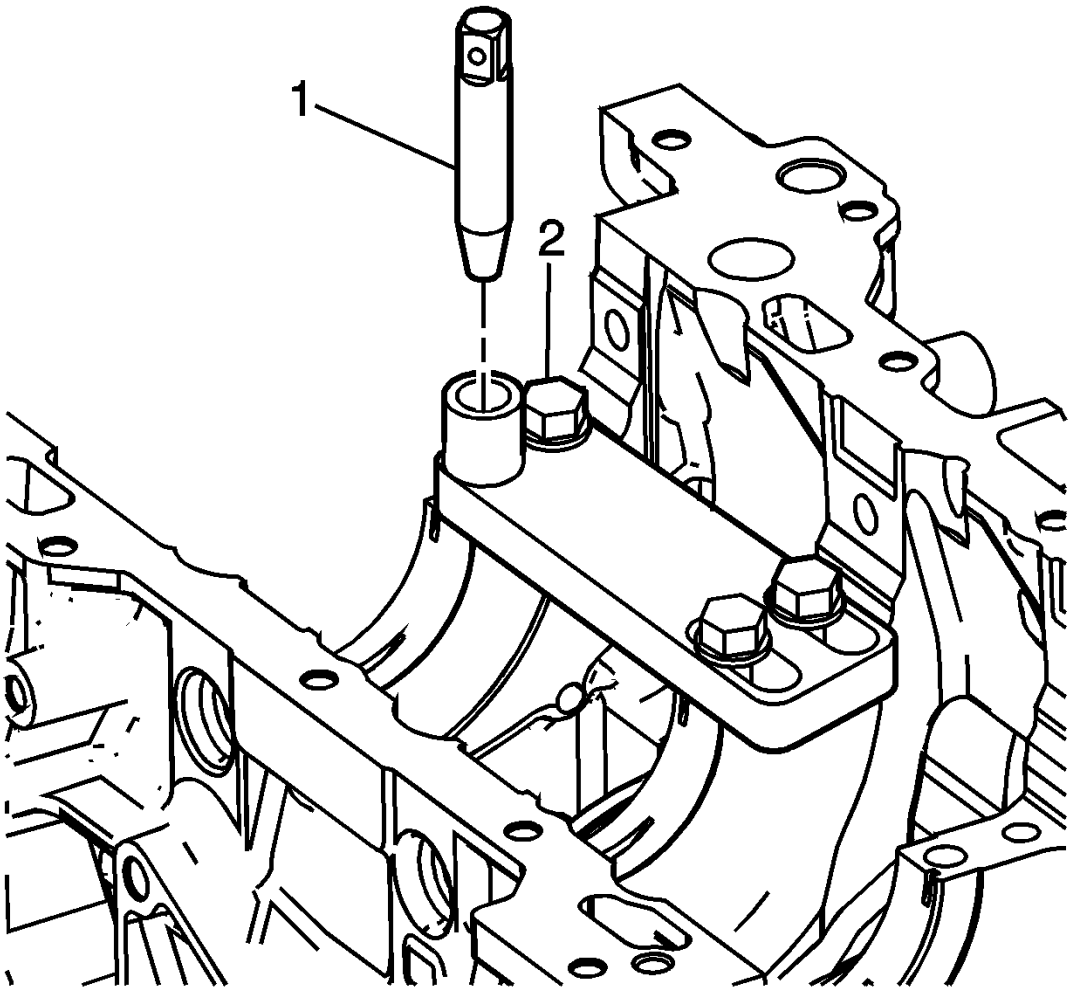

Fig. 408: Locating Alignment Pin
Courtesy of GENERAL MOTORS COMPANY

3. Position the alignment pin (1) through the bushing and into the crankshaft main cap bolt hole.
4. With the alignment pin in the desired crankshaft main cap bolt hole, tighten the fixture retaining bolts (2).
5. Remove the alignment pin (1) from the crankshaft main cap bolt hole.

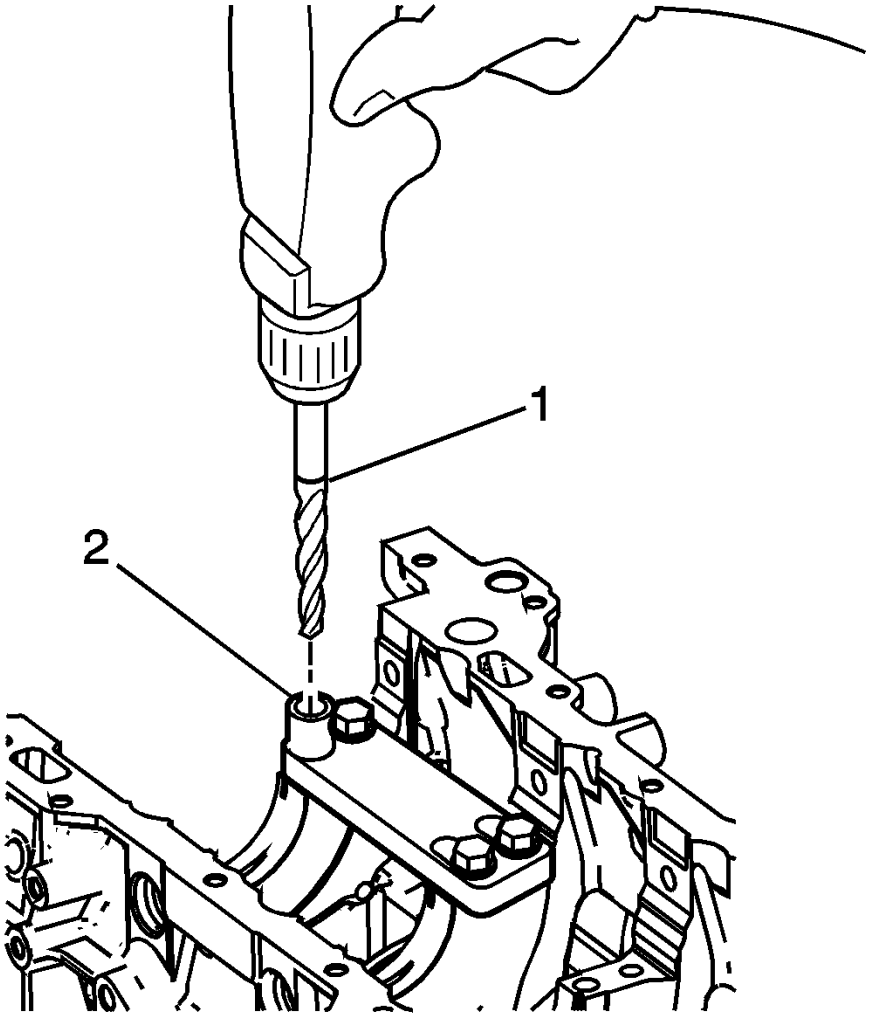

Fig. 409: Drilling Out Threads Of Damaged Hole - Inboard Bolt Holes
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **During the drilling process, it is necessary to repeatedly remove the drill and clean chips from the hole and the flutes of the drill.**
- **Drill the crankshaft main bolt hole until the mark (1) on the drill aligns with the top of the drill bushing (2).**

6. Drill out the threads of the damaged hole.

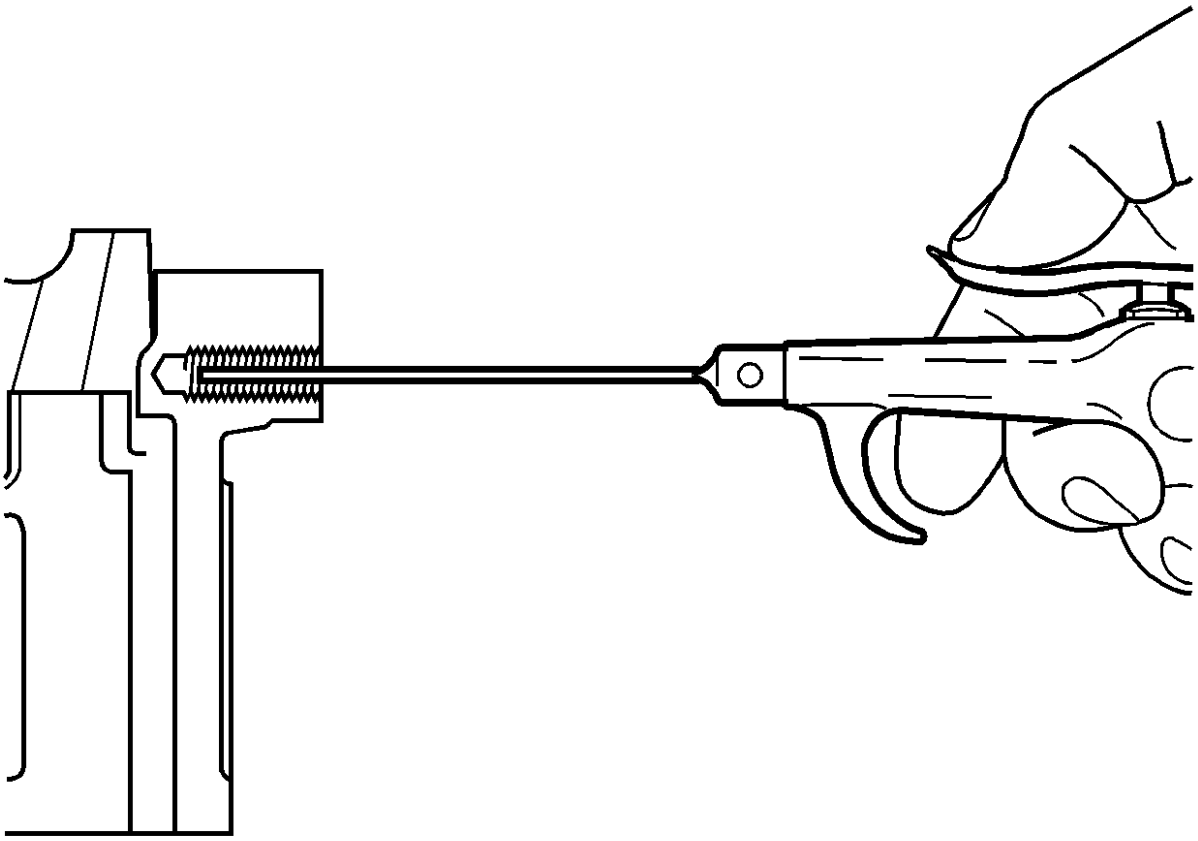

Fig. 410: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the drilled hole prior to tapping.**

7. Using compressed air, clean out any chips.

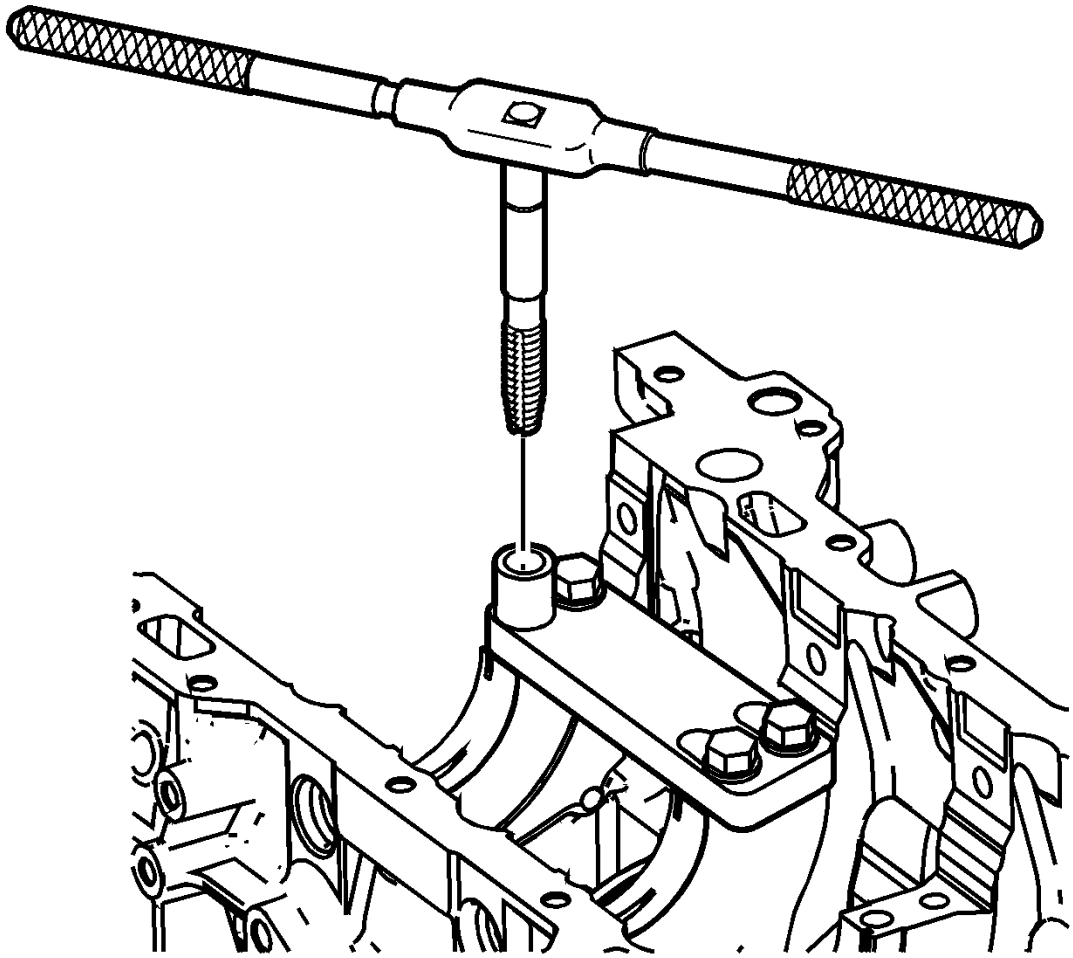

Fig. 411: Positioning Tapping Wrench
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not remove the fixture plate, ensure the fixture plate is installed during the machining and installation processes of the insert.**
- **During the tapping process, it is necessary to repeatedly remove the tap and clean chips from the hole and the flutes of the tap.**
- **Ensure the tap has created full threads at least to the depth equal to the insert length.**

8. Using a suitable tapping wrench, tap the threads of the drilled hole by hand only.

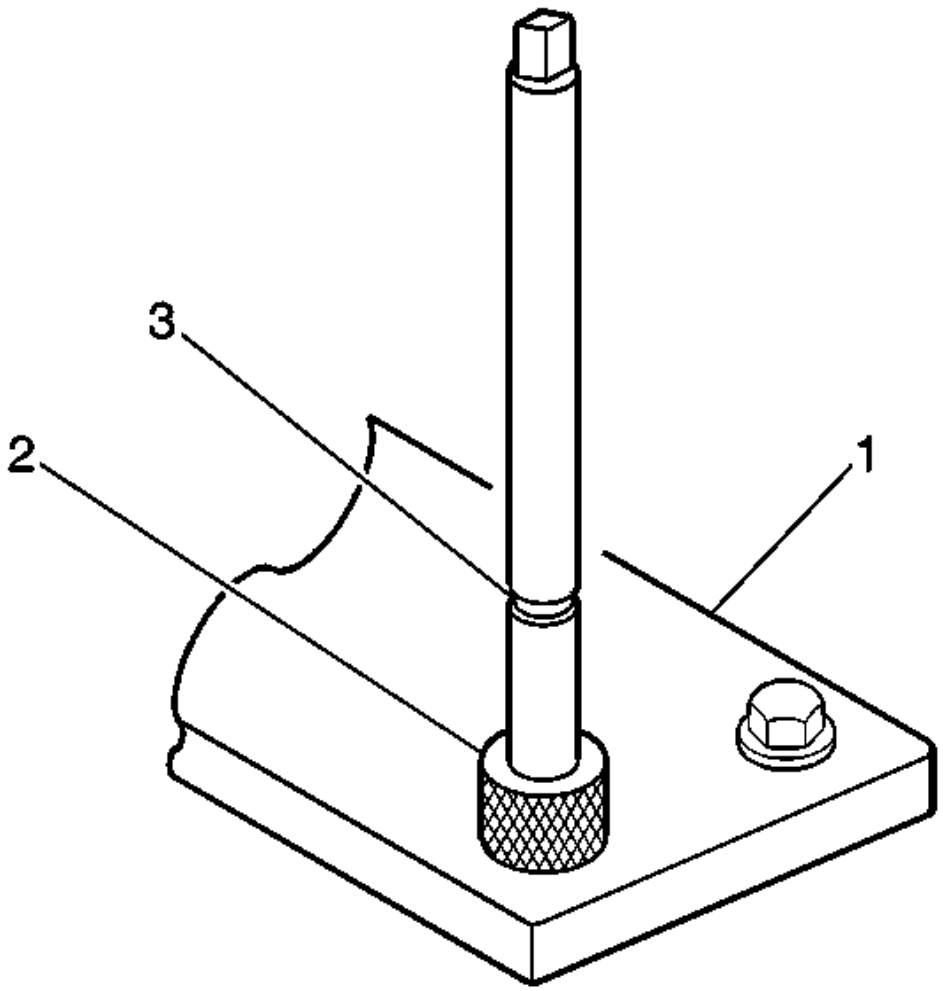

Fig. 412: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

9. In order to tap the new threads for the insert to the proper depth, rotate the tap into the crankshaft main cap bolt hole until the mark (3) on the tap aligns with the top of the drill bushing (2).

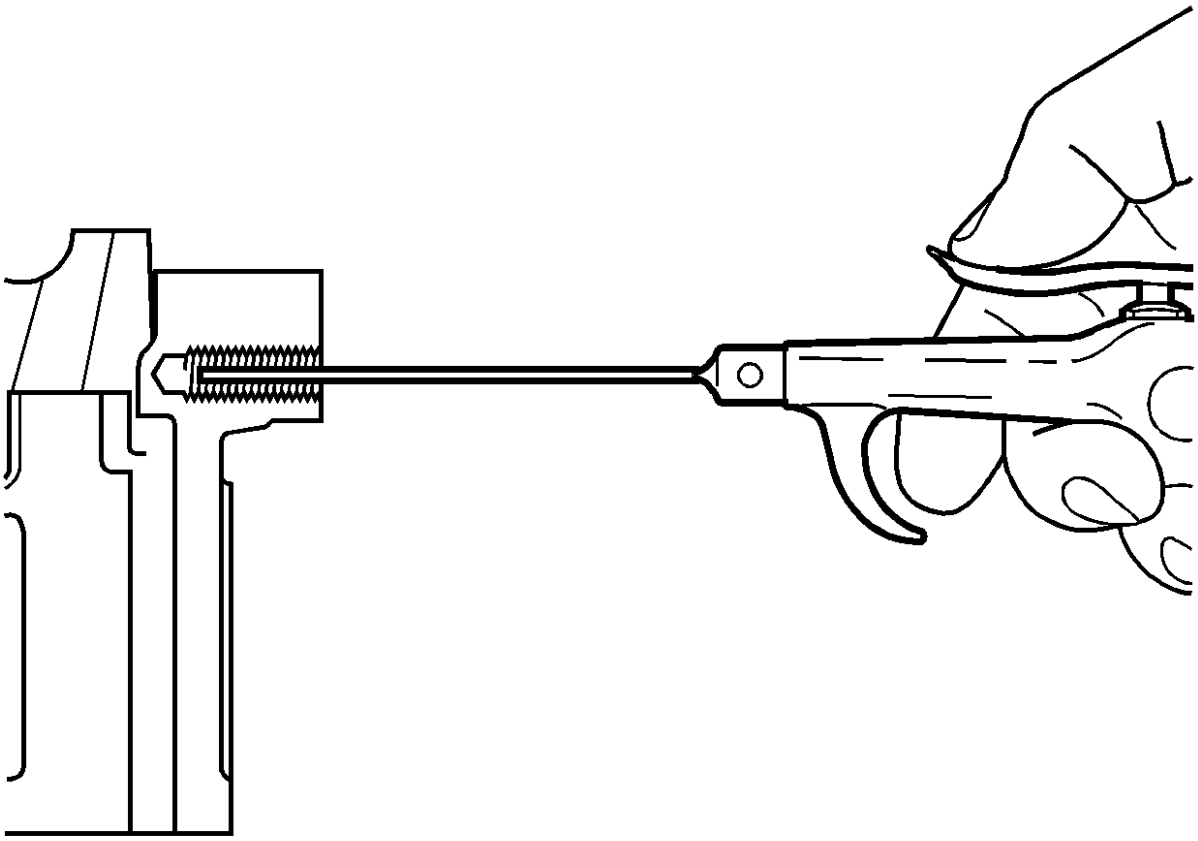

Fig. 413: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

10. Using compressed air, clean out any chips.

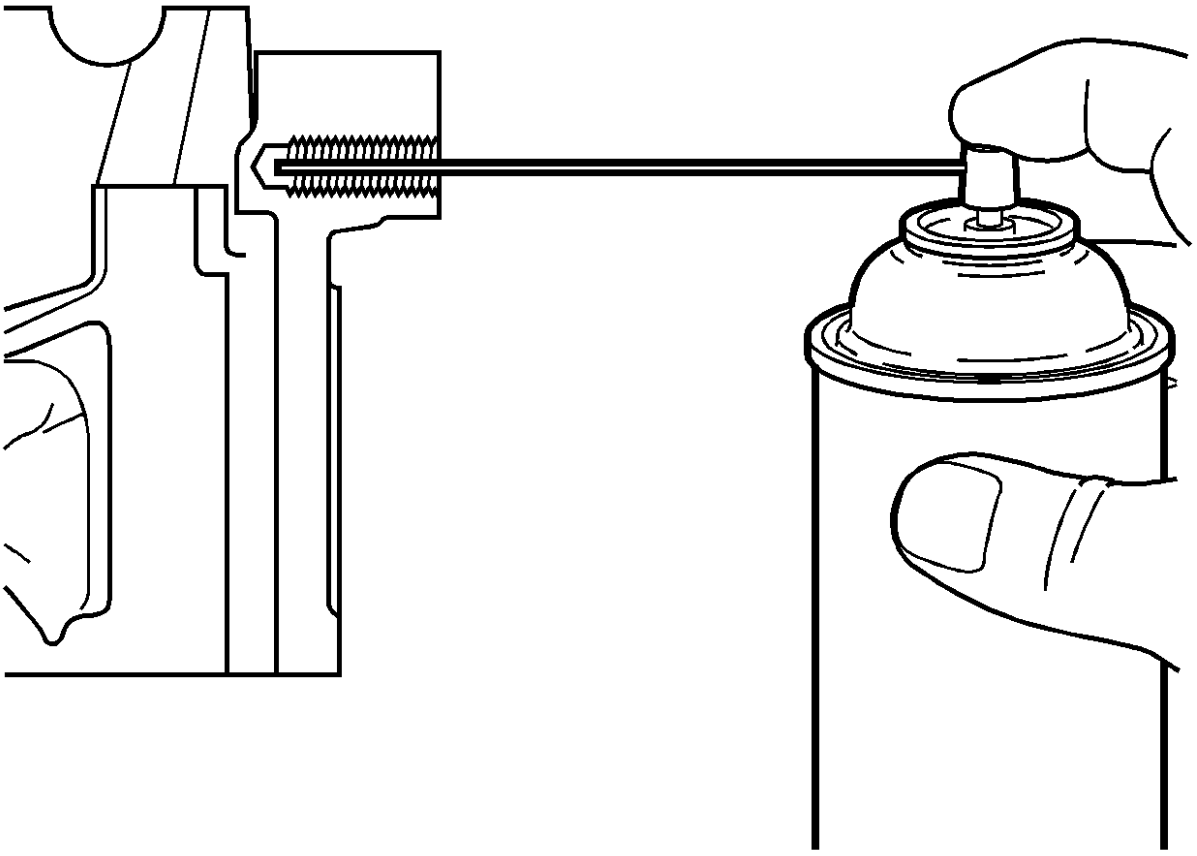

Fig. 414: Spraying Cleaner Into Tapped Hole
Courtesy of GENERAL MOTORS COMPANY

11. Spray cleaner into the tapped hole. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended cleaner.

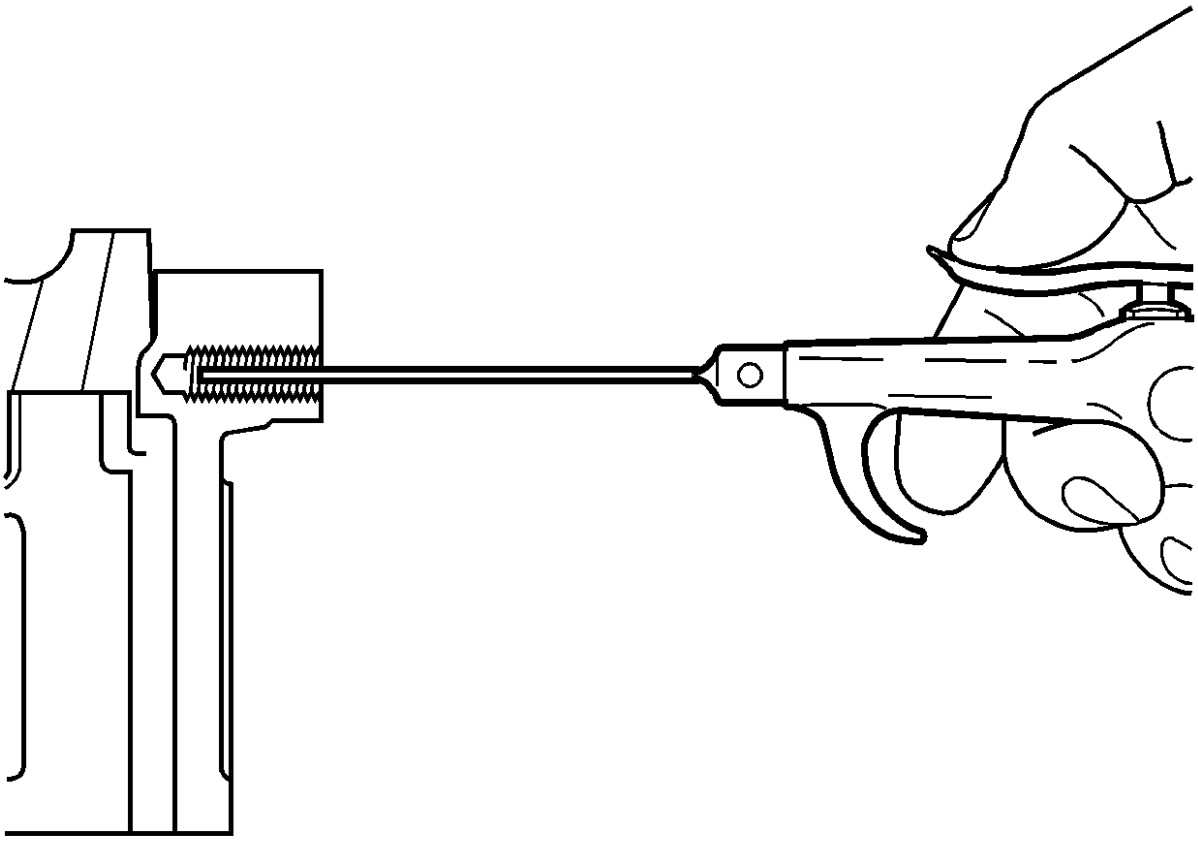

Fig. 415: Cleaning Out Metal Chips
Courtesy of GENERAL MOTORS COMPANY

NOTE: **All chips must be removed from the tapped hole prior to insert installation.**

12. Using compressed air, clean out any chips.

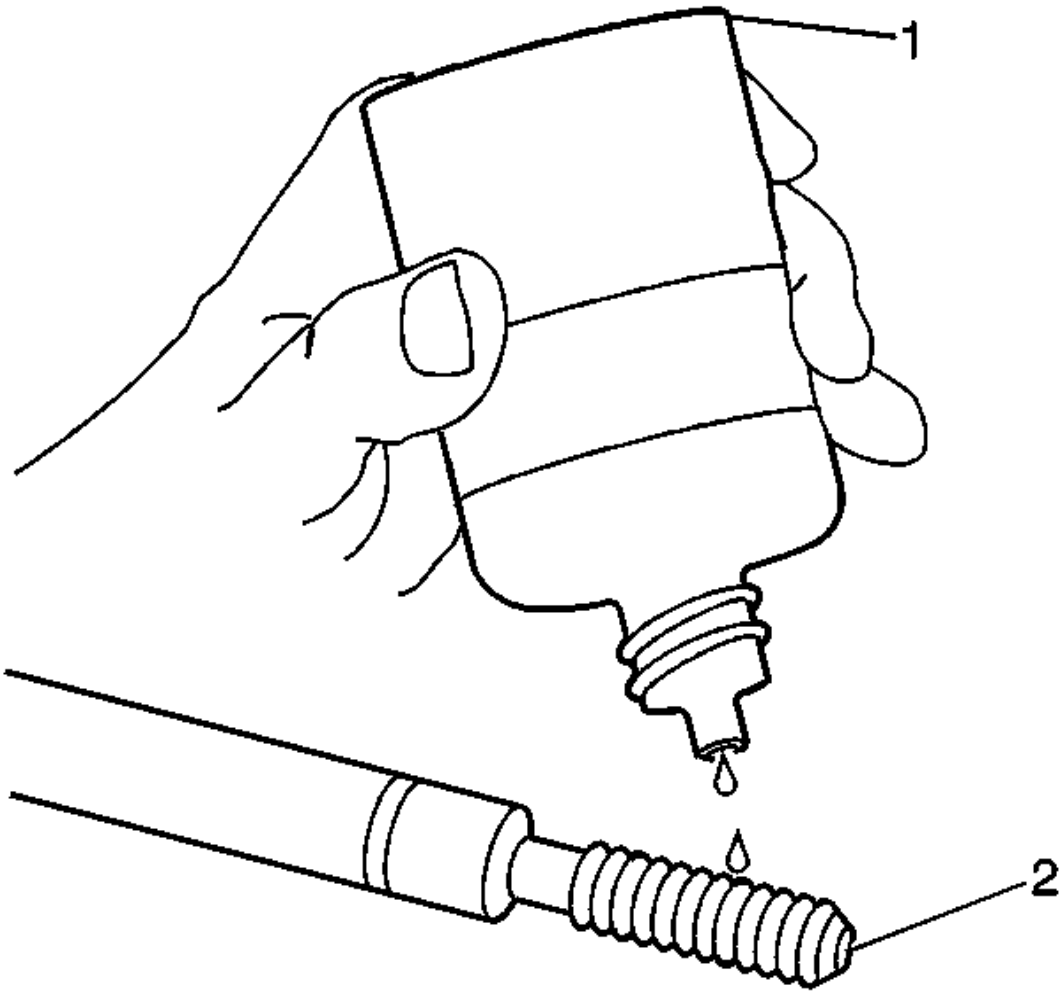

Fig. 416: Lubricating Installer Tool Using Driver Oil
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not remove the fixture plate, ensure the fixture plate is installed during the installation process of the insert.**
- **Do not allow oil or other foreign material to contact the outside diameter (OD) of the insert.**

13. Lubricate the threads of the driver installation tool (2) with the EN 42385-110 (1).

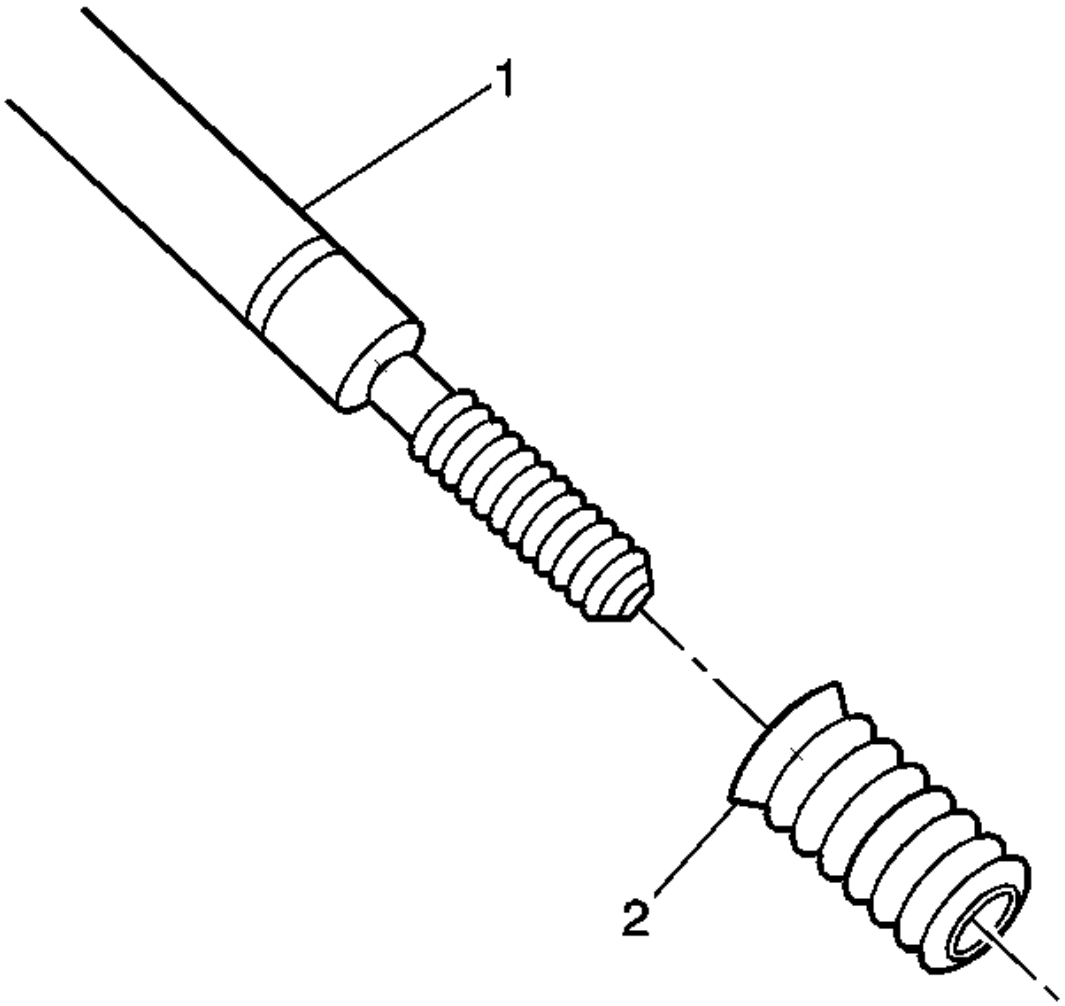

Fig. 417: View of Bushing Type Insert
Courtesy of GENERAL MOTORS COMPANY

14. Install the insert (2) onto the driver installation tool (1).

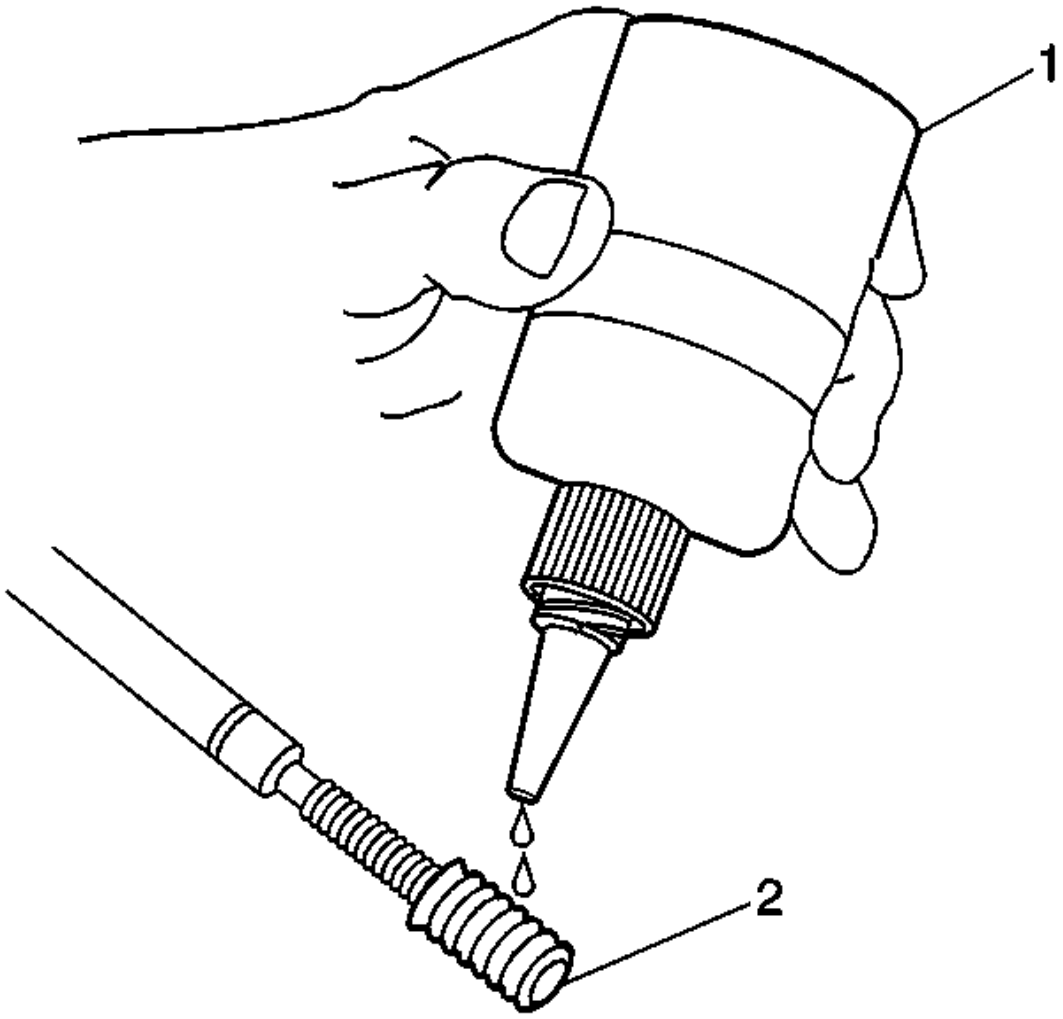

Fig. 418: Applying Threadlock To Insert
Courtesy of GENERAL MOTORS COMPANY

15. Apply threadlock sealant, EN 42385-109, LOCTITE 277Â®, or equivalent (1) to the insert OD threads (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

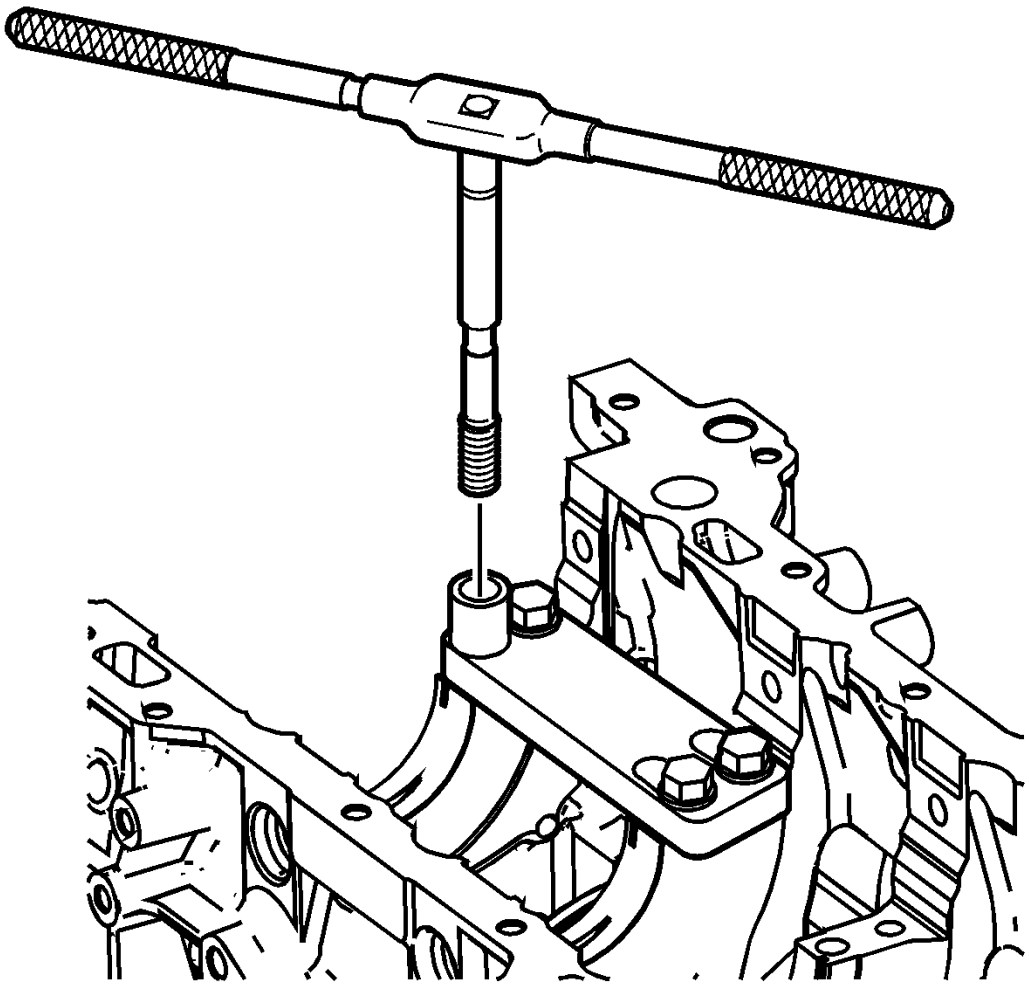

Fig. 419: View Of Insert & Installation Driver
Courtesy of GENERAL MOTORS COMPANY

16. Install the insert and installation driver into the tapped hole by hand only.
17. Start the insert into the threaded hole.

NOTE: **If the insert will not thread down until the flange contacts the counterbored surface remove the insert immediately with a screw extracting tool and inspect the tapped hole for any remaining chips and/or improper tapping.**

18. Install the insert until the flange of the insert contacts the counterbored surface.

NOTE: **The driver installation tool will tighten up before screwing completely through the insert. This is acceptable. The threads at the bottom of the insert are being formed and the insert is mechanically locking the insert into the base material threads.**

19. Continue to rotate the driver installation tool through the insert.

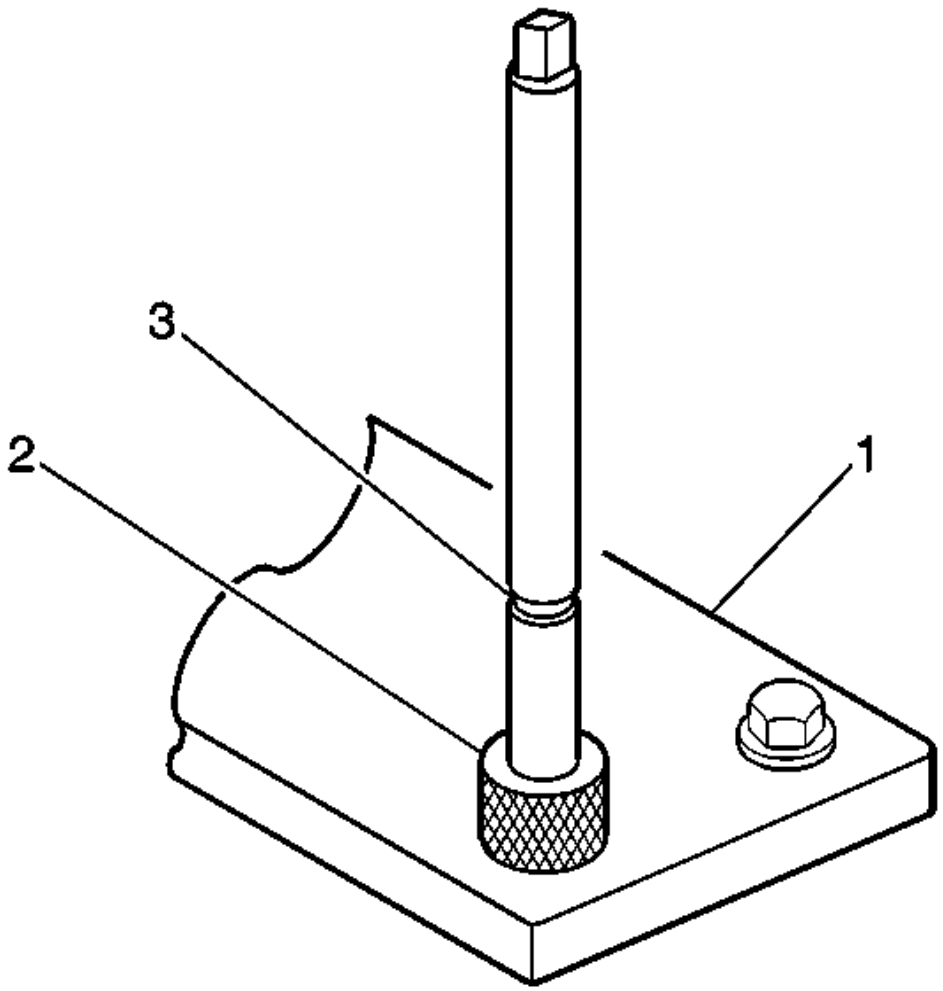

Fig. 420: View Of Fixture Plate, Drill Bushing & Tool Marking
Courtesy of GENERAL MOTORS COMPANY

20. Rotate the driver installation tool until the mark (3) on the driver installation tool aligns with the top of the drill bushing (2).
21. Inspect the insert for proper installation into the tapped hole.

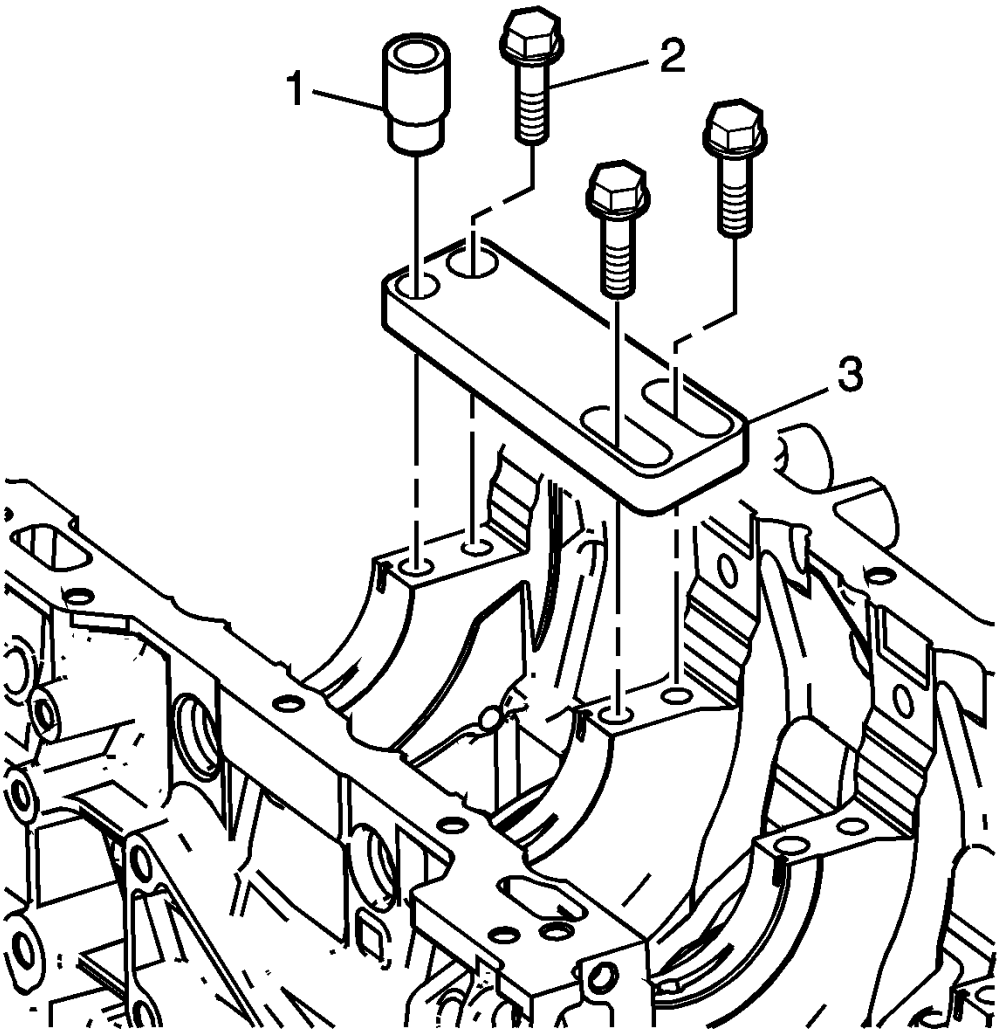

Fig. 421: View Of Fixture Plate & Components - Inboard Bolt Holes
Courtesy of GENERAL MOTORS COMPANY

22. Remove the fixture plate bolts (2).
23. Remove the fixture plate (3) and bushing (1).

SERVICE PRIOR TO ASSEMBLY

- Dirt will cause premature wear of the rebuilt engine. Clean all the components.
- Use the proper tools to measure the components when checking for excessive wear. Components not within the manufacturer's specification must be repaired or replaced.
- When the components are reinstalled into an engine, return the components to their original location, position, and direction.
- During assembly, lubricate all the moving parts with clean engine oil (unless otherwise specified). This will provide initial lubrication when the engine is first started.

ENGINE BLOCK ASSEMBLE

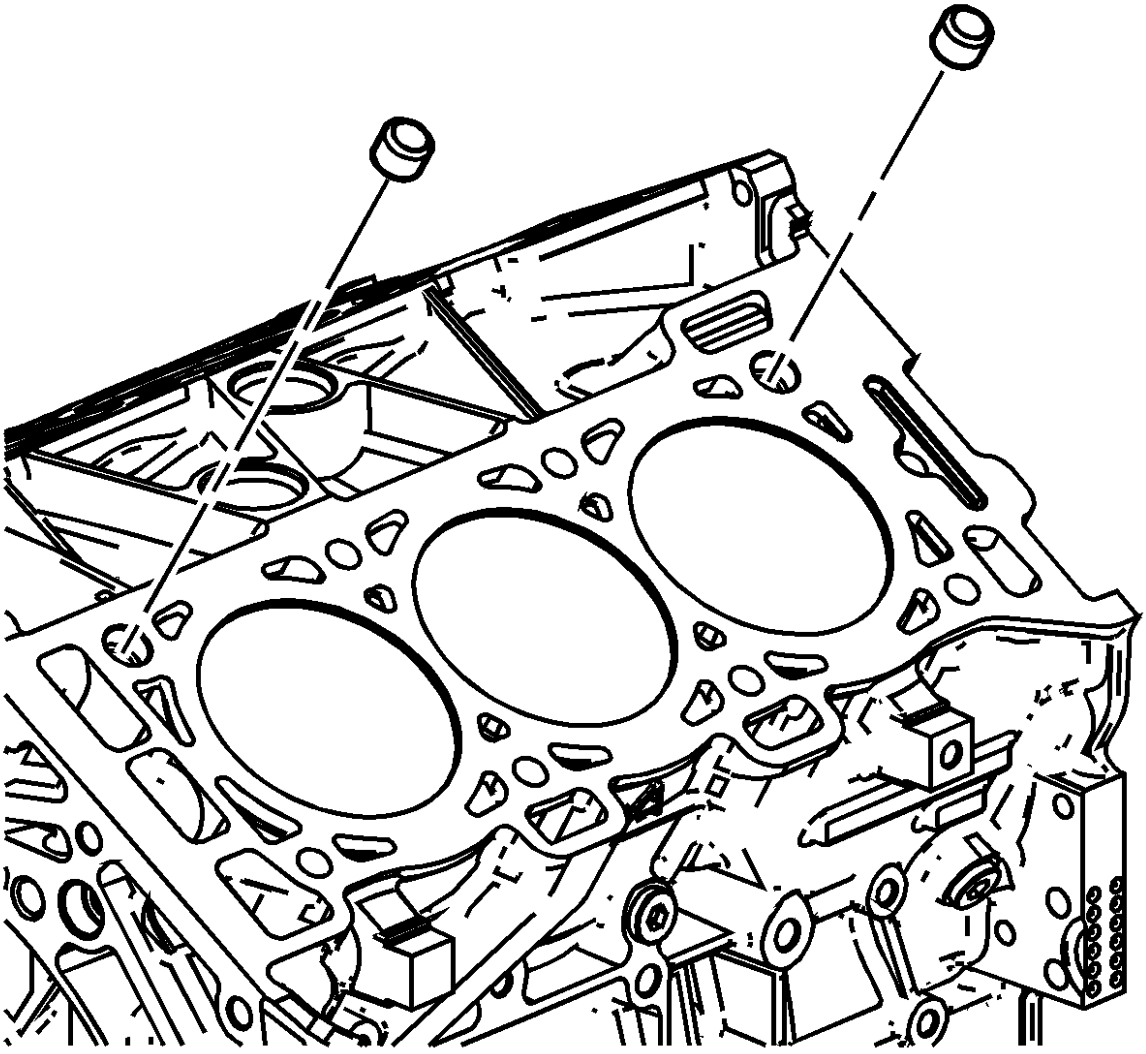

Fig. 422: Cylinder Block-To-Cylinder Head Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

1. Install the cylinder block-to-cylinder head alignment dowels.

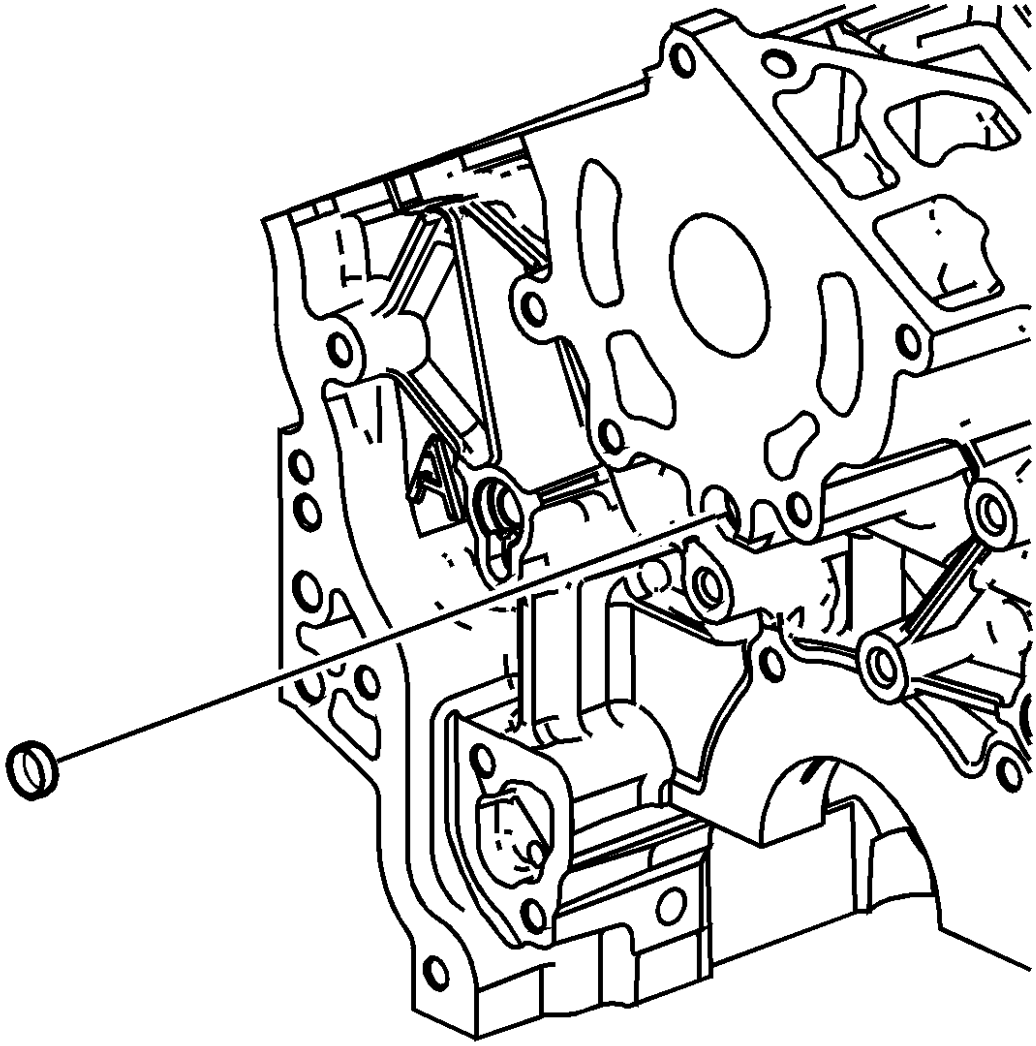

Fig. 423: View Of Front Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW front oil gallery expansion plug.
3. Ensure the NEW front oil gallery expansion plug is installed to the proper depth.

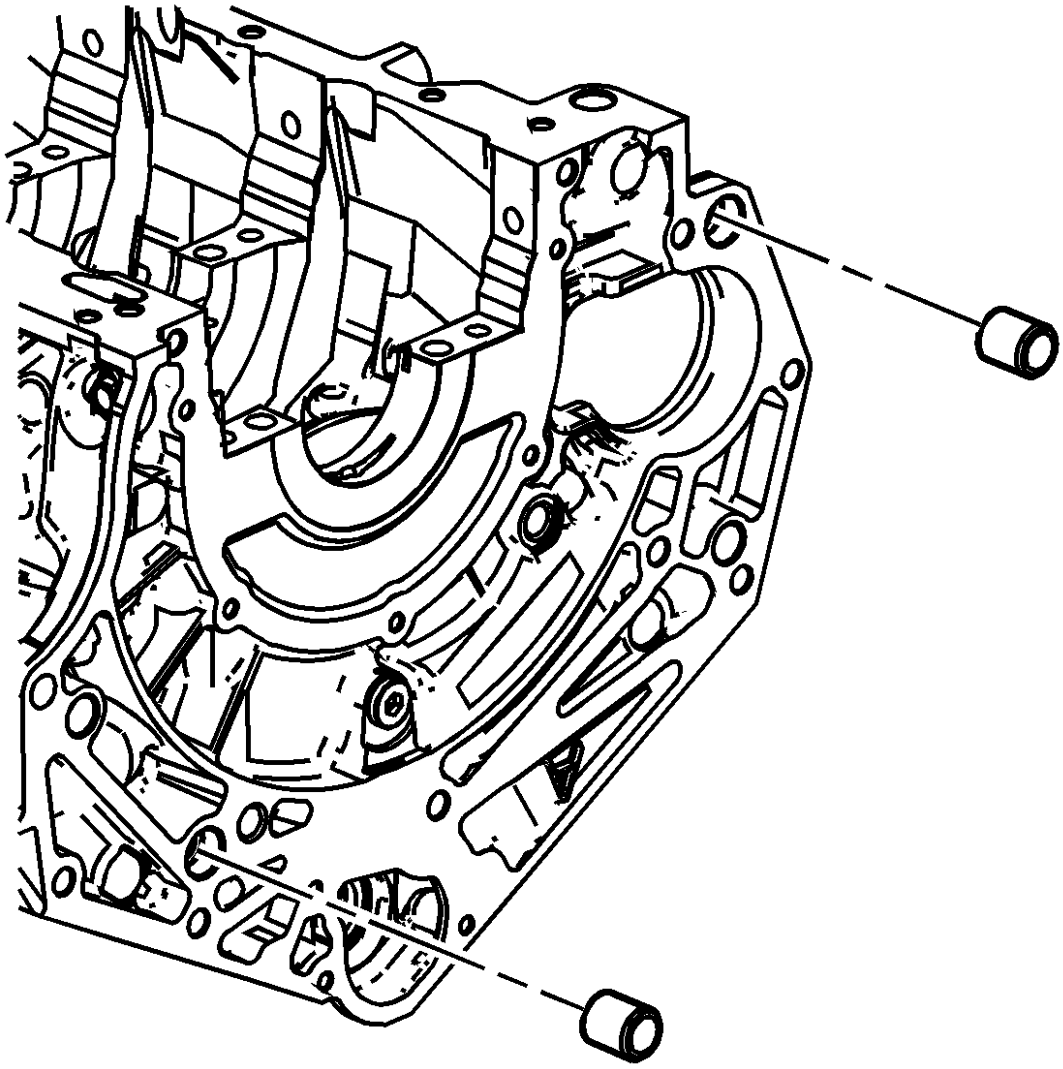

Fig. 424: Identifying Cylinder Block-To-Transmission Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

4. Install the cylinder block-to-transmission alignment dowels.

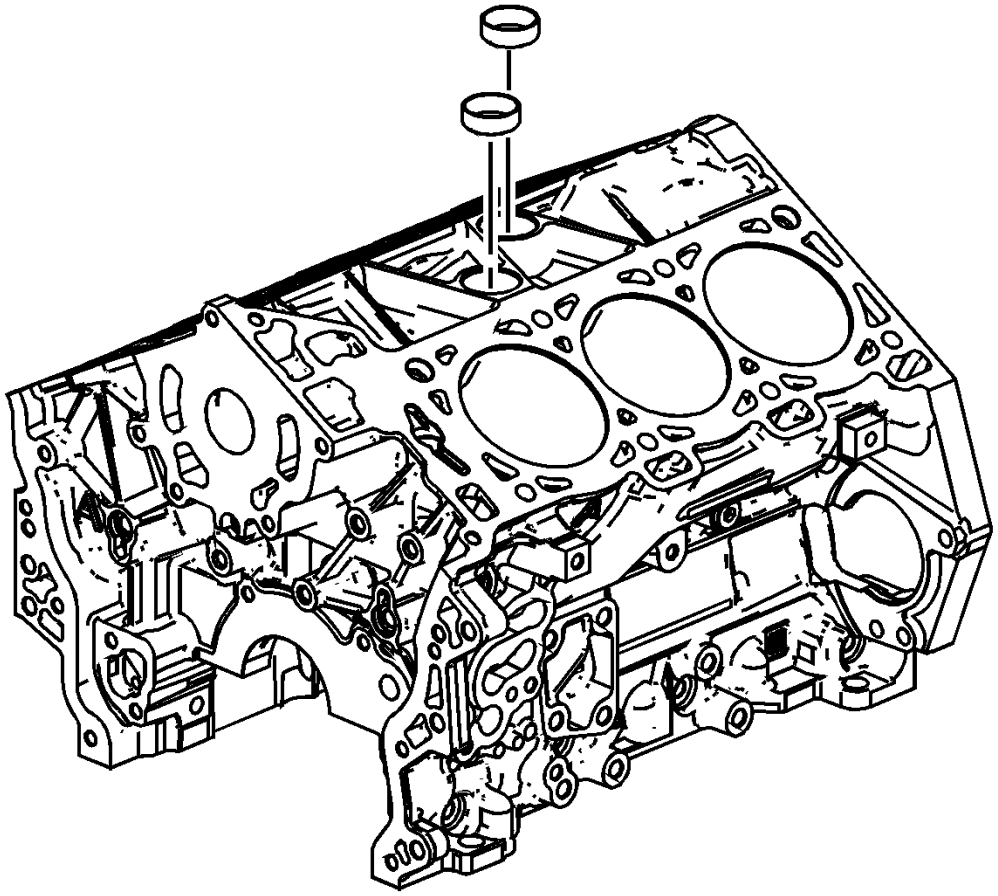

Fig. 425: Identifying Coolant Expansion Plugs
Courtesy of GENERAL MOTORS COMPANY

5. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**

   Apply the RTV sealant on the NEW coolant expansion plugs. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

6. Install the NEW coolant expansion plugs.
7. Ensure the NEW coolant expansion plugs are installed to the proper depth.

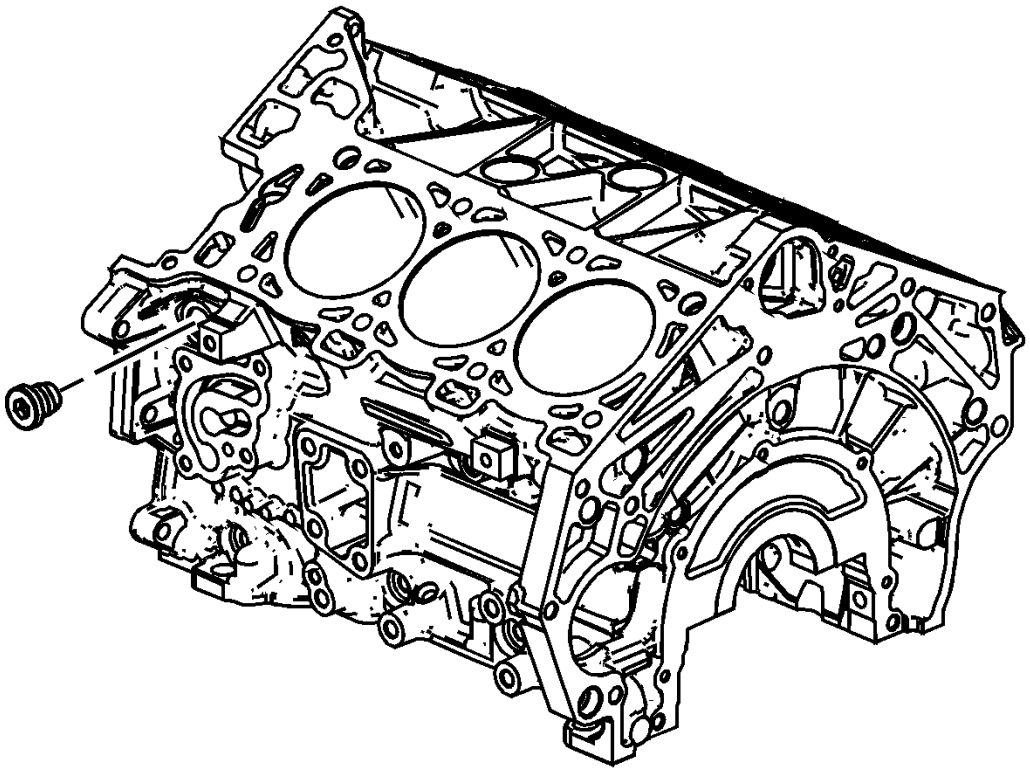

Fig. 426: Removing/Installing M20 Left Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

8. Apply thread sealant on the threads of the M20 left side oil gallery threaded plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

CAUTION: Refer to Fastener Caution .

9. Install the M20 left side oil gallery threaded plug and tighten to 75 N.m (55 lb ft).

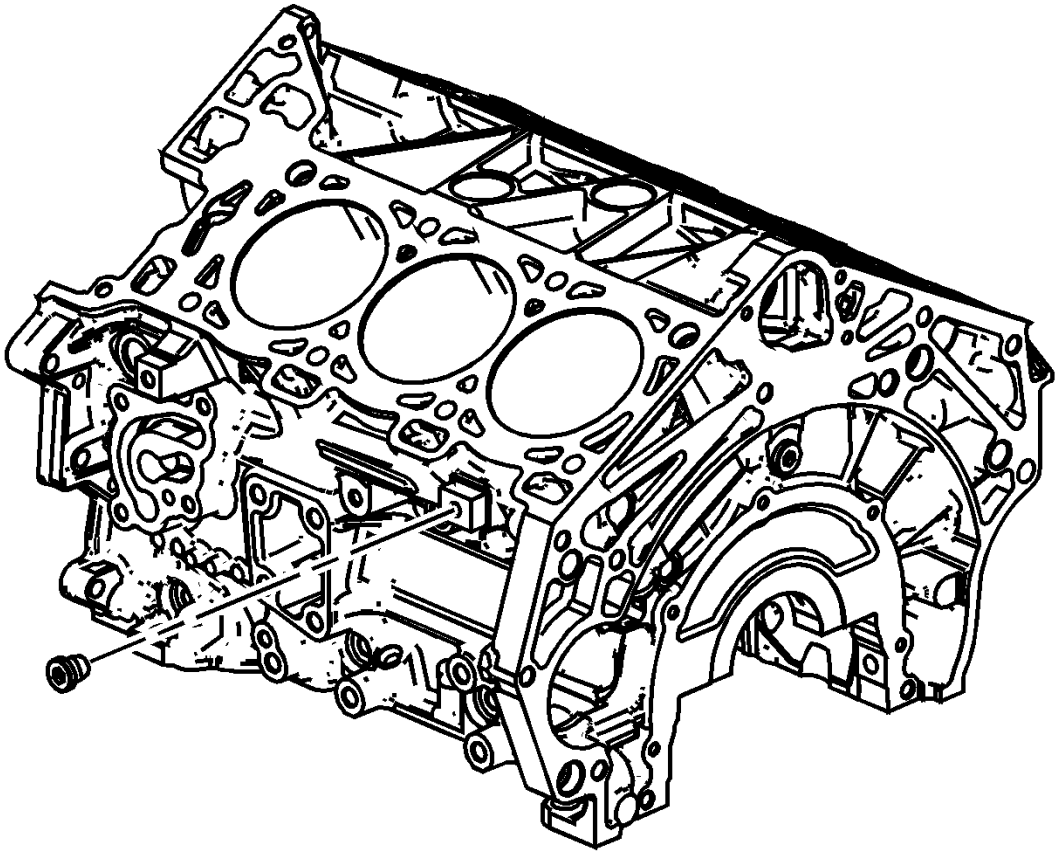

Fig. 427: View Of M14 Left Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

10. Apply thread sealant on the threads of the M14 left side coolant drain threaded plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.
11. Install the M14 left side coolant drain threaded plug and tighten to 50 N.m (37 lb ft).

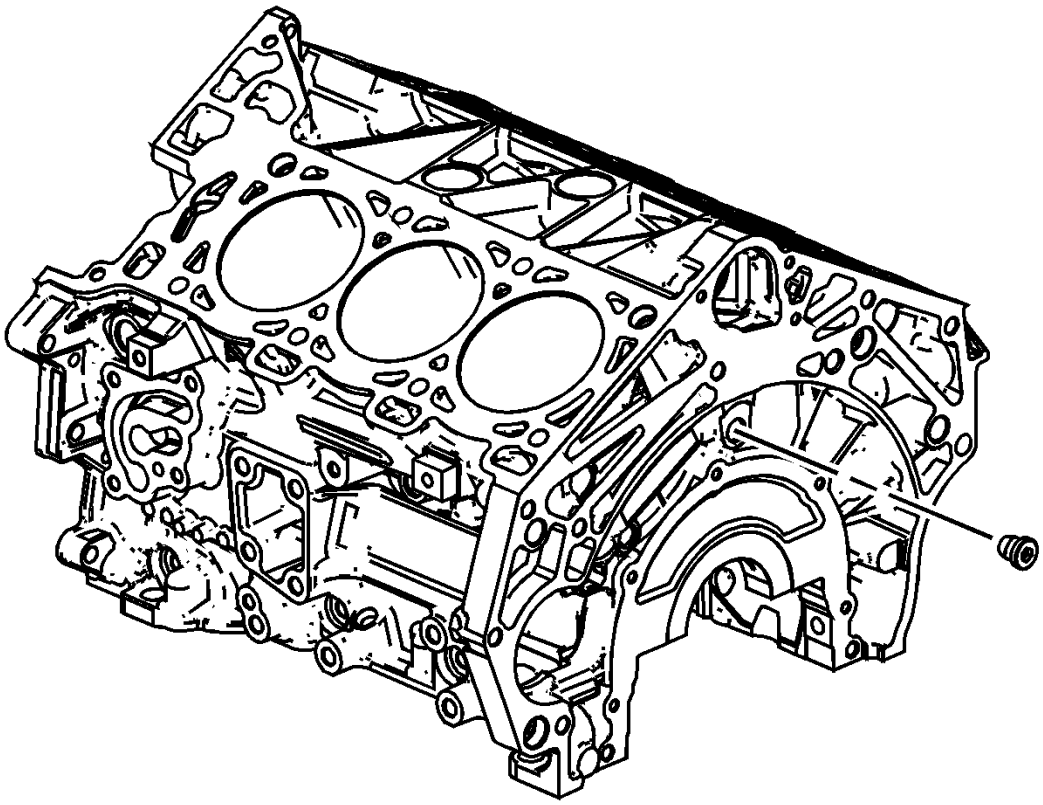

Fig. 428: Identifying M14 Rear Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

12. Apply thread sealant on the threads of the M14 rear oil gallery threaded plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.
13. Install the M14 rear oil gallery threaded plug and tighten to 50 N.m (37 lb ft).

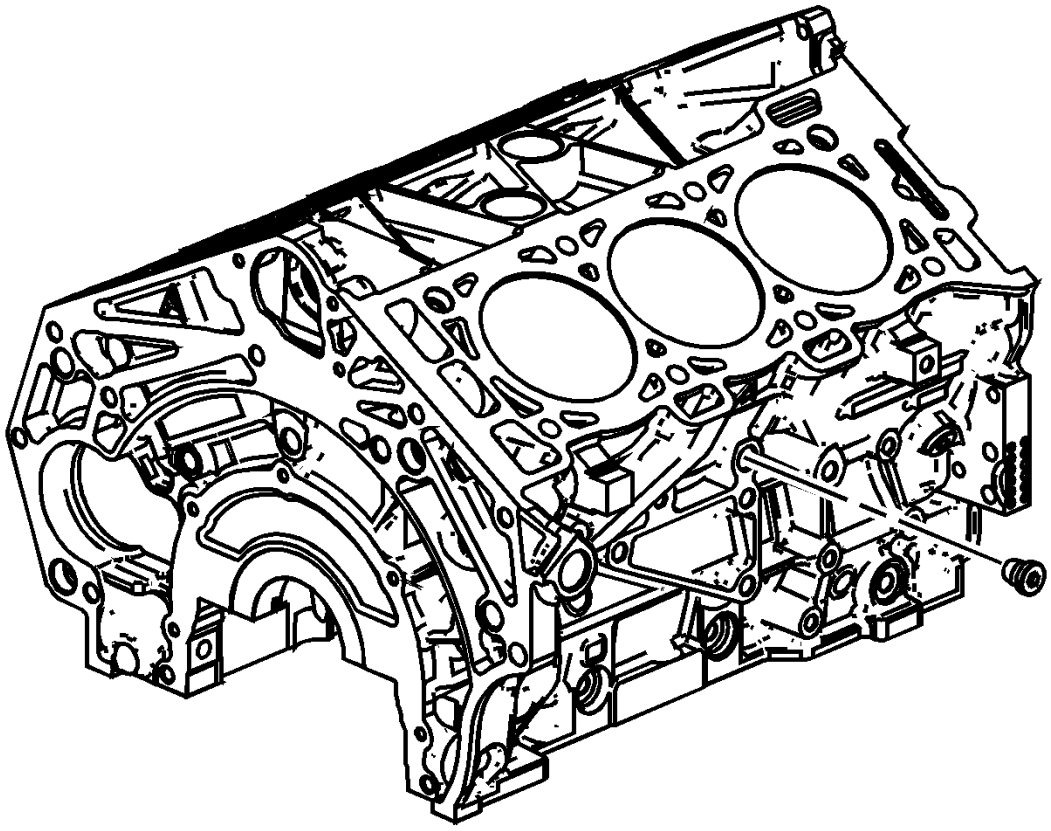

Fig. 429: Identifying M14 Right Side Coolant Drain Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

14. Apply thread sealant on the threads of the M14 right side coolant drain threaded plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.
15. Install the M14 right side coolant drain threaded plug and tighten to 50 N.m (37 lb ft).

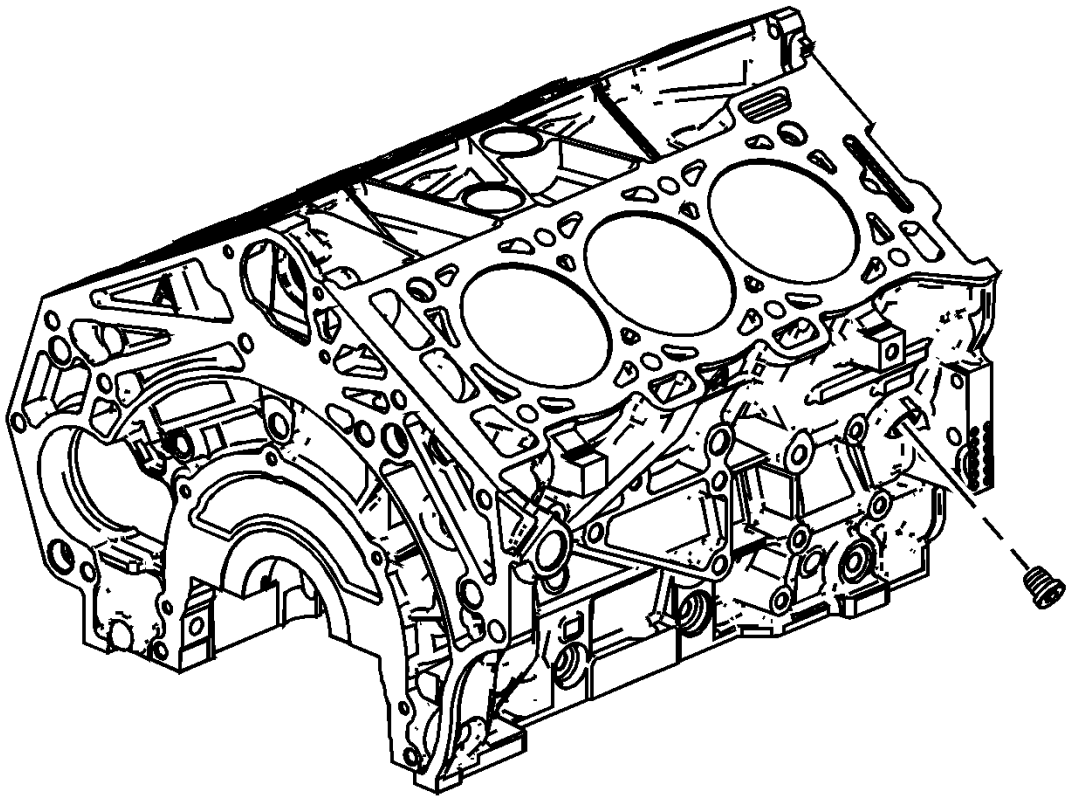

Fig. 430: Identifying M14 Right Side Oil Gallery Threaded Plug
Courtesy of GENERAL MOTORS COMPANY

16. Apply thread sealant on the threads of the M14 right side oil gallery threaded plug. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.
17. Install the M14 right side oil gallery threaded plug and tighten to 50 N.m (37 lb ft).

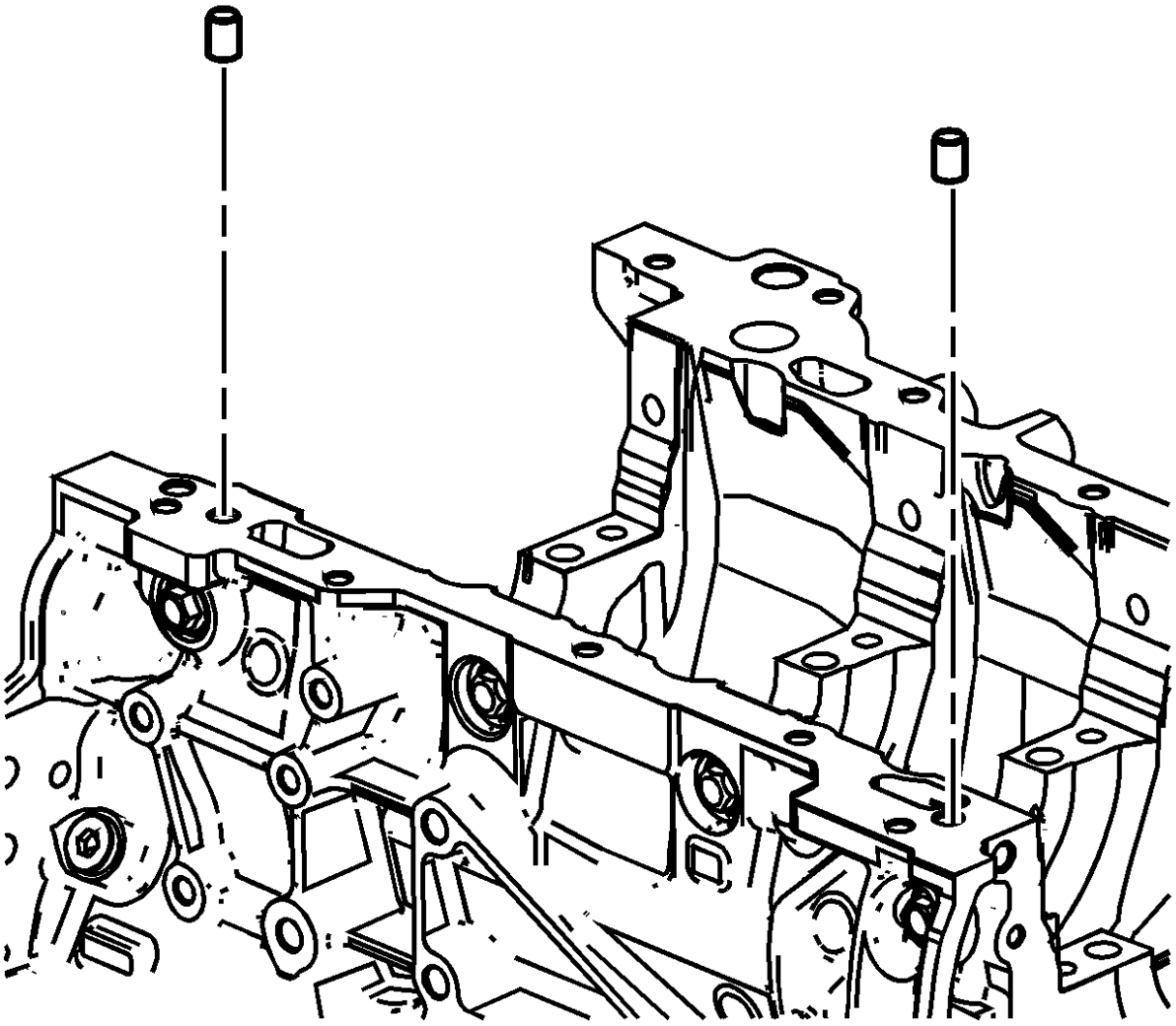

Fig. 431: Identifying Cylinder Block-To-Oil Pan Alignment Dowels
Courtesy of GENERAL MOTORS COMPANY

18. Install the cylinder block-to-oil pan alignment dowels.

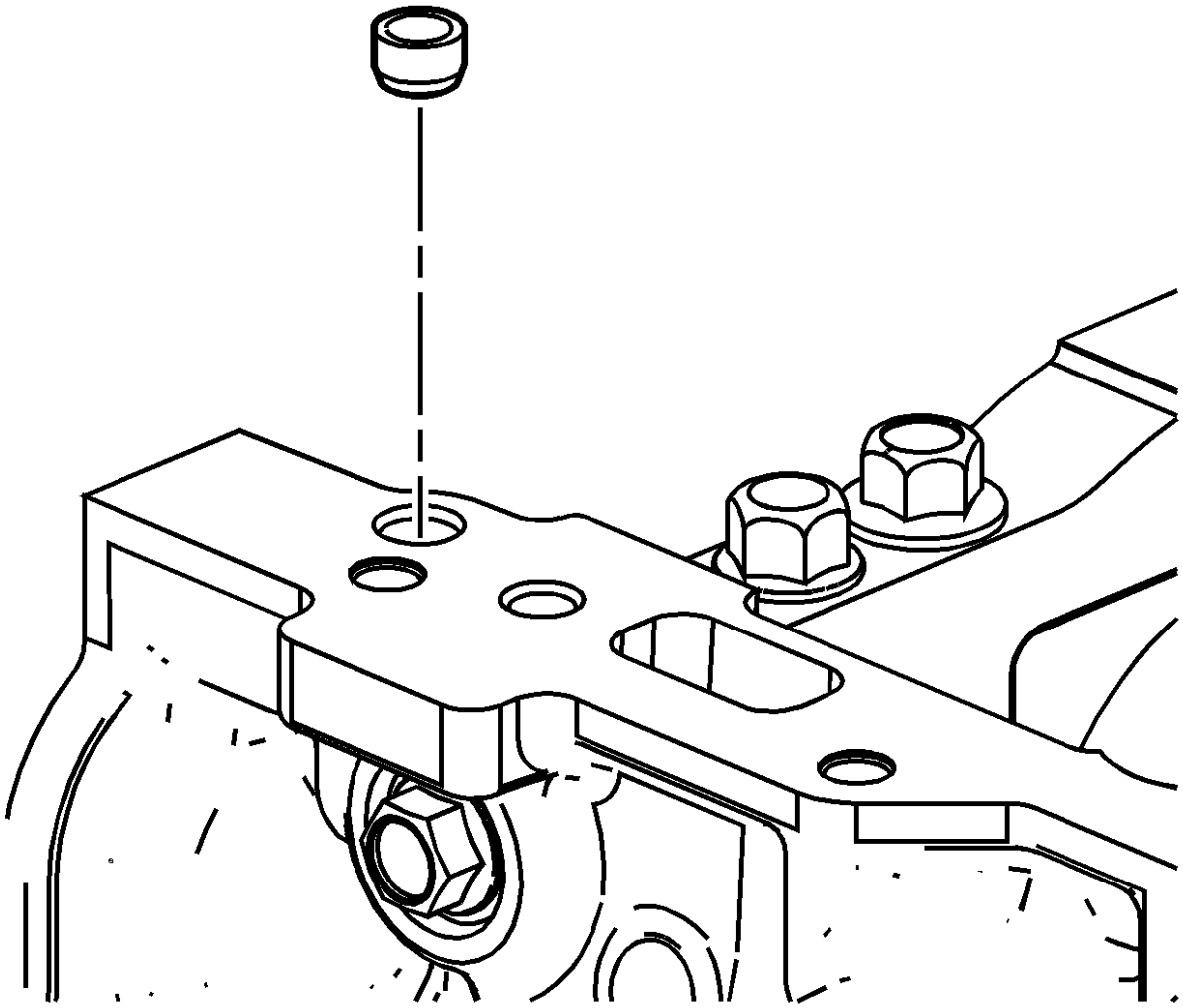

Fig. 432: Locating Right Front Oil Pan Rail Oil Gallery Expansion Plug
Courtesy of GENERAL MOTORS COMPANY

19. Install the NEW right front oil pan rail oil gallery expansion plug.
20. Ensure the NEW right front oil pan rail oil gallery expansion plug is installed to the proper depth.

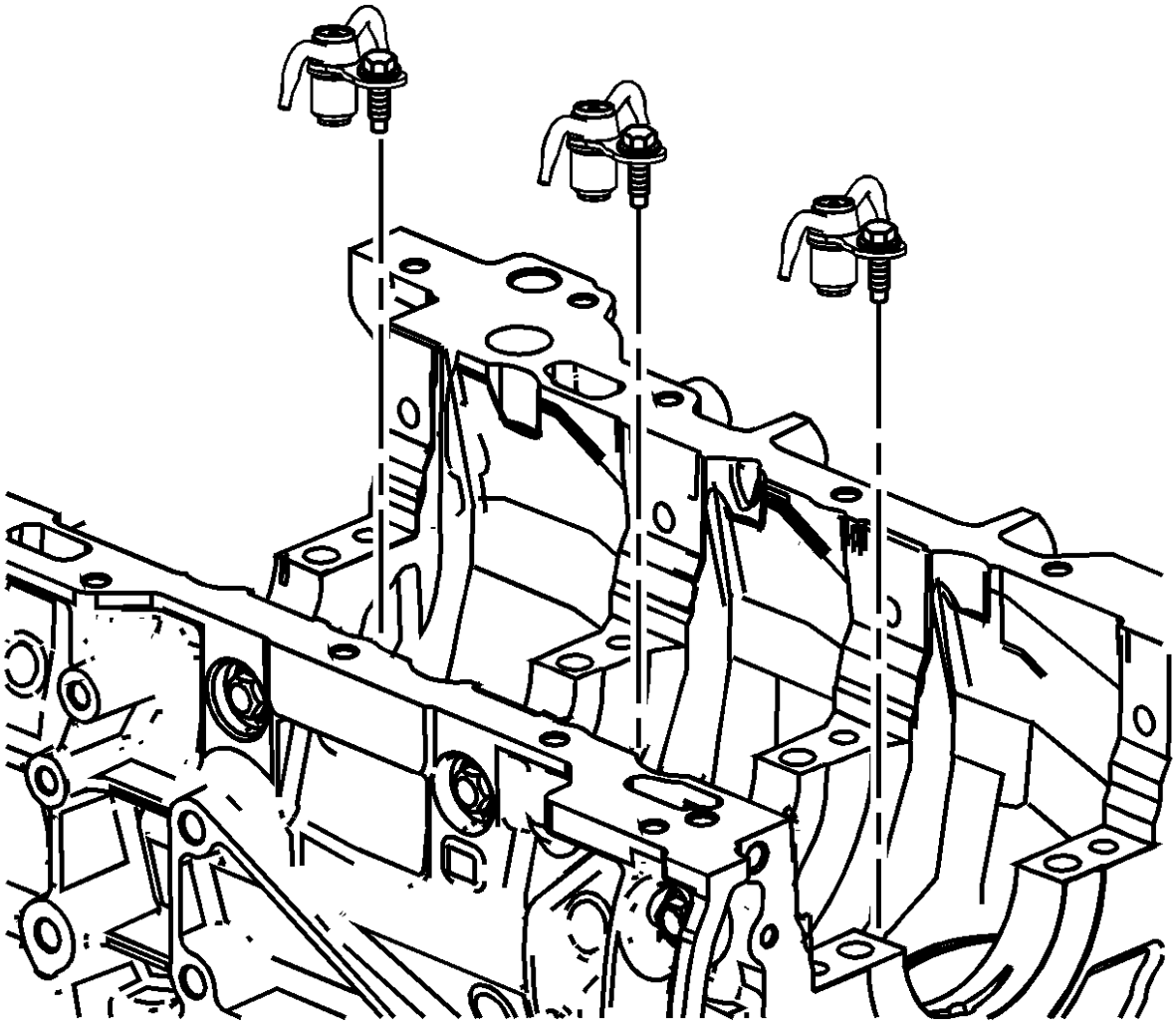

Fig. 433: Identifying Oil Jets & Bolts
Courtesy of GENERAL MOTORS COMPANY

21. Install the oil jets.
22. Install the oil jet bolts and tighten to 10 N.m (89 lb in).

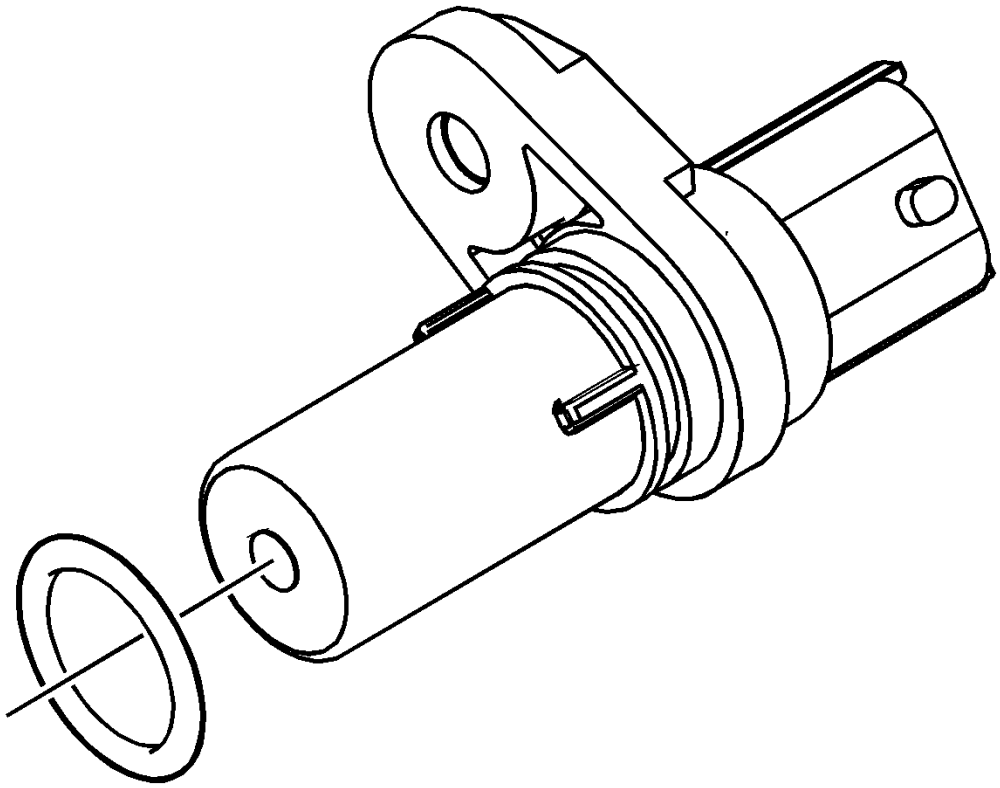

Fig. 434: View Of Crankshaft Position Sensor O-Ring
Courtesy of GENERAL MOTORS COMPANY

23. Install the NEW crankshaft position sensor O-ring, if damaged.

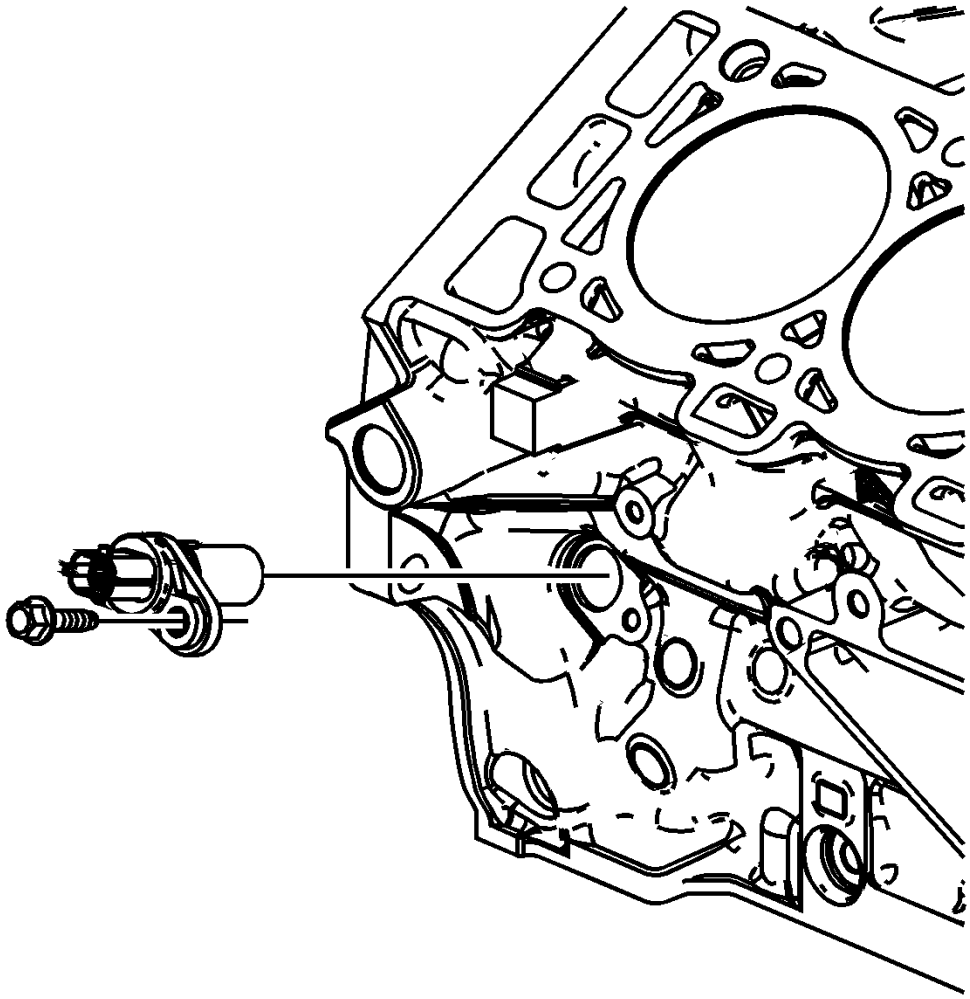

Fig. 435: View Of Crankshaft Position Sensor
Courtesy of GENERAL MOTORS COMPANY

24. Install the crankshaft position sensor.
25. Install the crankshaft position sensor bolt and tighten to 10 N.m (89 lb in).

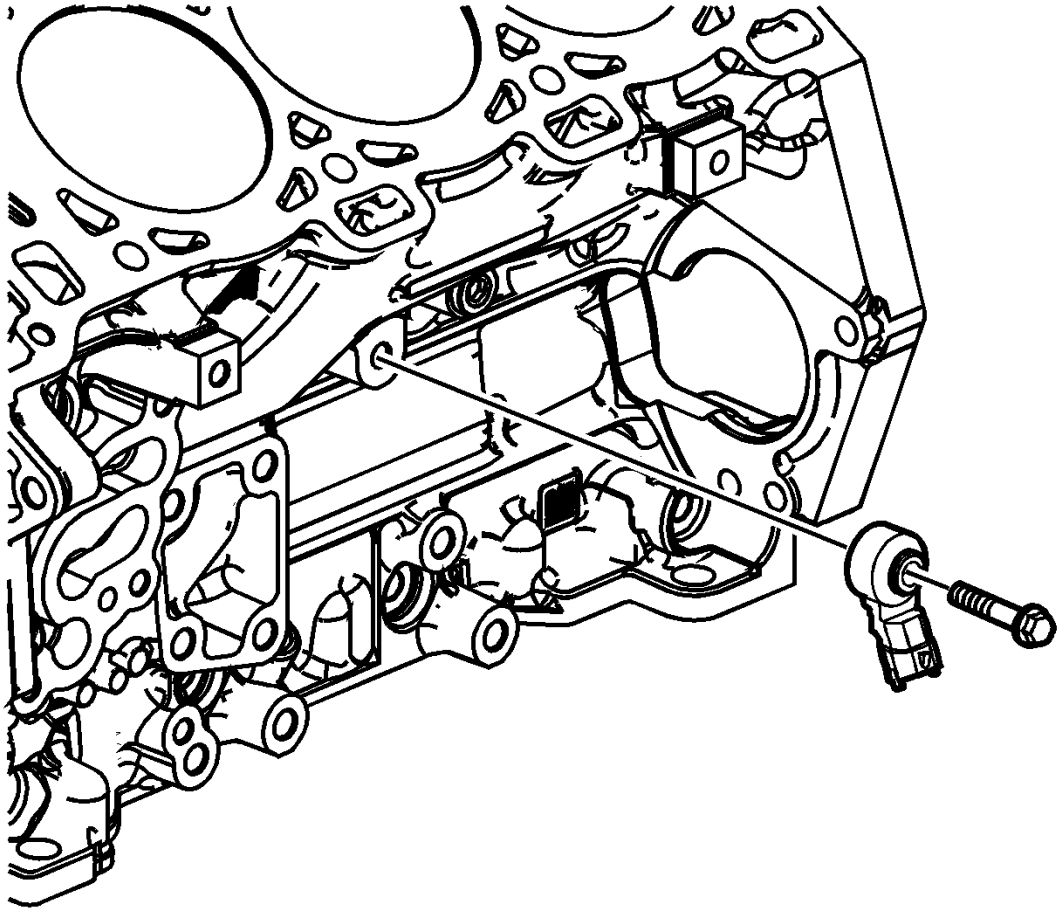

Fig. 436: Identifying Left Knock Sensor & Bolt
Courtesy of GENERAL MOTORS COMPANY

26. Install the left knock sensor to the cylinder block, as shown.
27. Install the left knock sensor bolt and tighten to 25 N.m (18 lb ft).
28. Ensure proper sensor orientation.

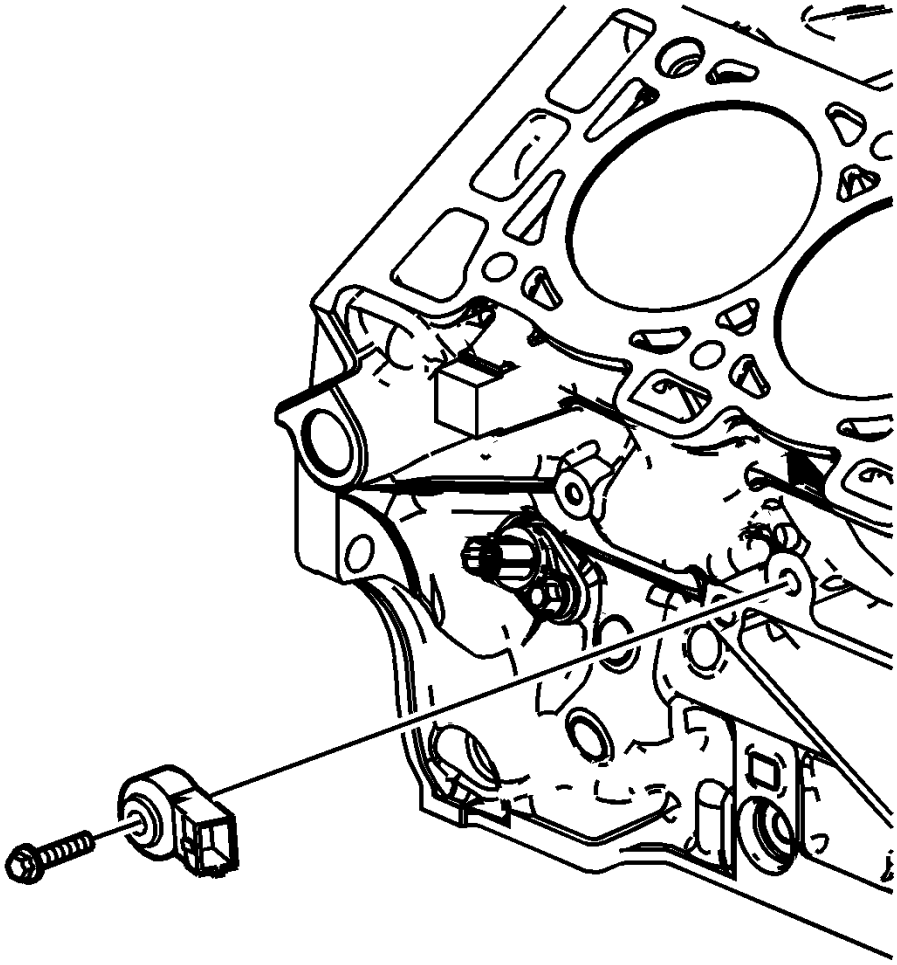

Fig. 437: View Of Right Knock Sensor
Courtesy of GENERAL MOTORS COMPANY

29. Install the right knock sensor to the cylinder block, as shown.
30. Install the right knock sensor bolt and tighten to 25 N.m (18 lb ft).
31. Ensure proper sensor orientation.

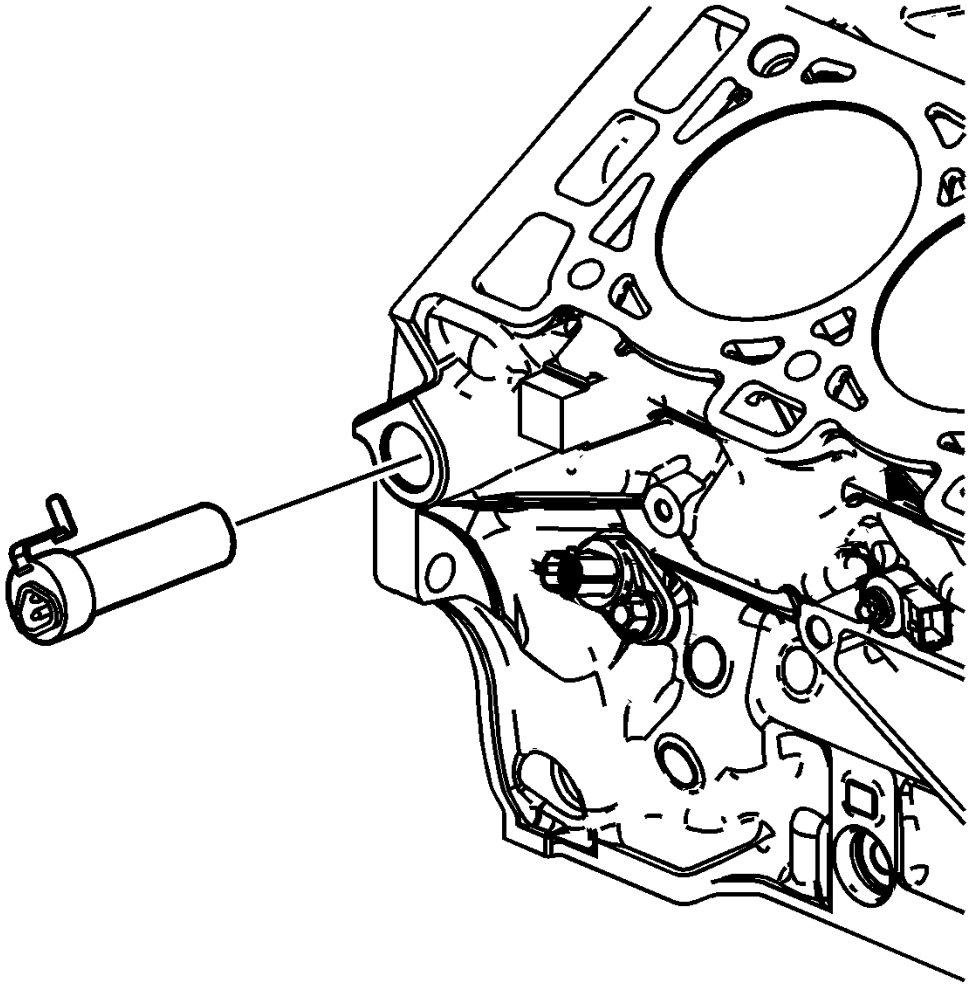

Fig. 438: View Of Block Heater Cartridge
Courtesy of GENERAL MOTORS COMPANY

32. Install the block heater cartridge, if equipped.

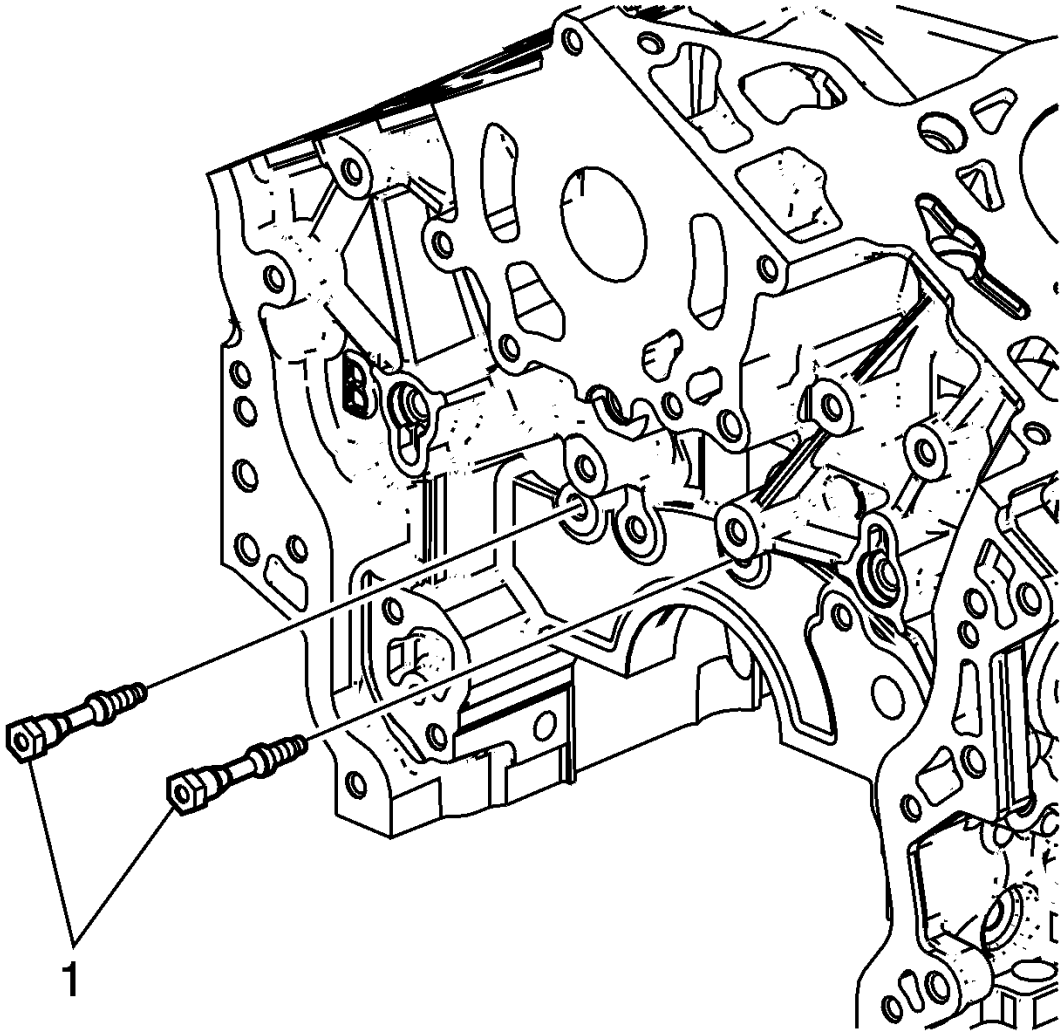

Fig. 439: Identifying Engine Front Cover Studs
Courtesy of GENERAL MOTORS COMPANY

33. Install the engine front cover studs (1) and tighten to 15 N.m (11 lb ft).

CRANKSHAFT AND BEARING INSTALLATION

Special Tools

- **GE 6125-1B** Slide Hammer Adapter
- **EN 45059** Angle Meter
- **EN 49102** Crankshaft Bearing Cap Remover

For equivalent regional tools, refer to **Special Tools** .

Crankshaft Bearing Installation Procedure

NOTE: **If the crankshaft bearings have been used in a running engine, you must replace them with NEW crankshaft bearings for reassembly.**

1. Clean the crankcase crank bore with a lint-free cloth.

2. Clean all the oil from the backside of new bearing halves.

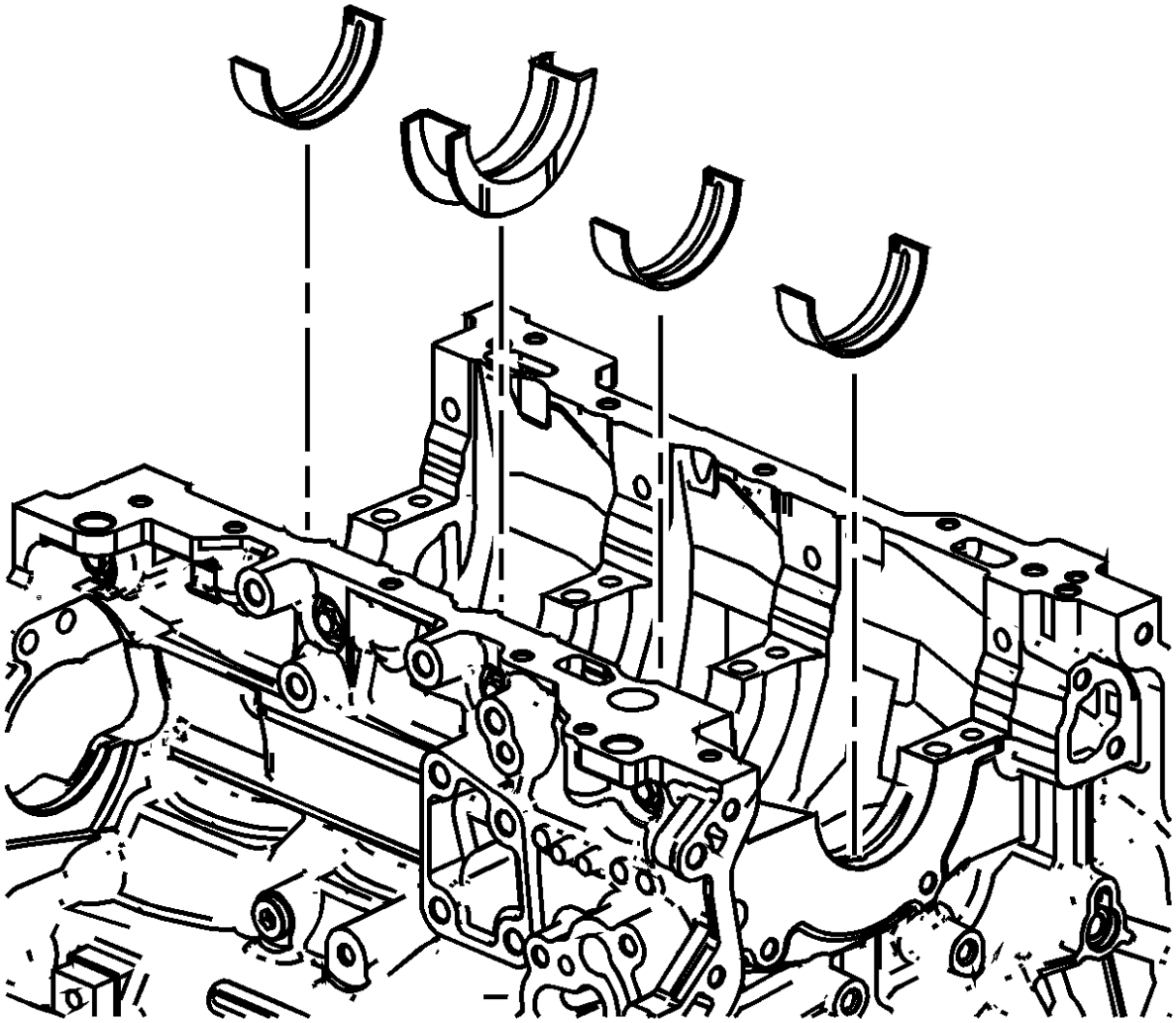

Fig. 440: View Of Upper Crankshaft Bearings
Courtesy of GENERAL MOTORS COMPANY

3. Install the NEW upper crankshaft bearings into position. The thrust bearing belongs in the number 3 journal. Ensure that the upper bearing insert contains the oil transfer hole and groove. Roll the bearing into position so that the lock tang engages the crank slot. The bearing must fit flush with the upper crankcase.

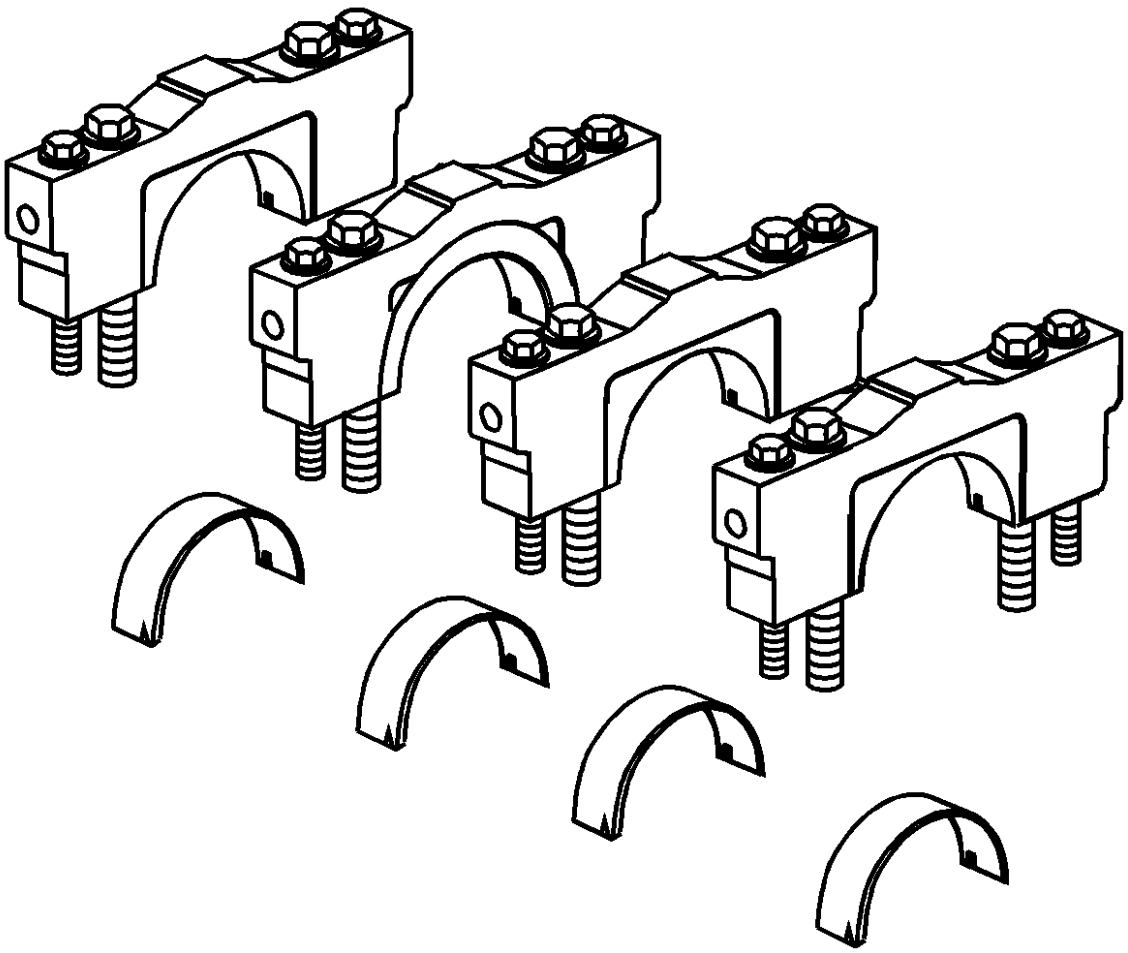

Fig. 441: View Of Crankshaft Bearing Caps & Lower Bearing Halves
Courtesy of GENERAL MOTORS COMPANY

4. Install the NEW lower crankshaft bearings into position in the main bearing caps. The lower crankshaft bearings are identified by NO grooves or holes. The bearings must fit flush with the crankshaft bearing caps.

Crankshaft Installation Procedure

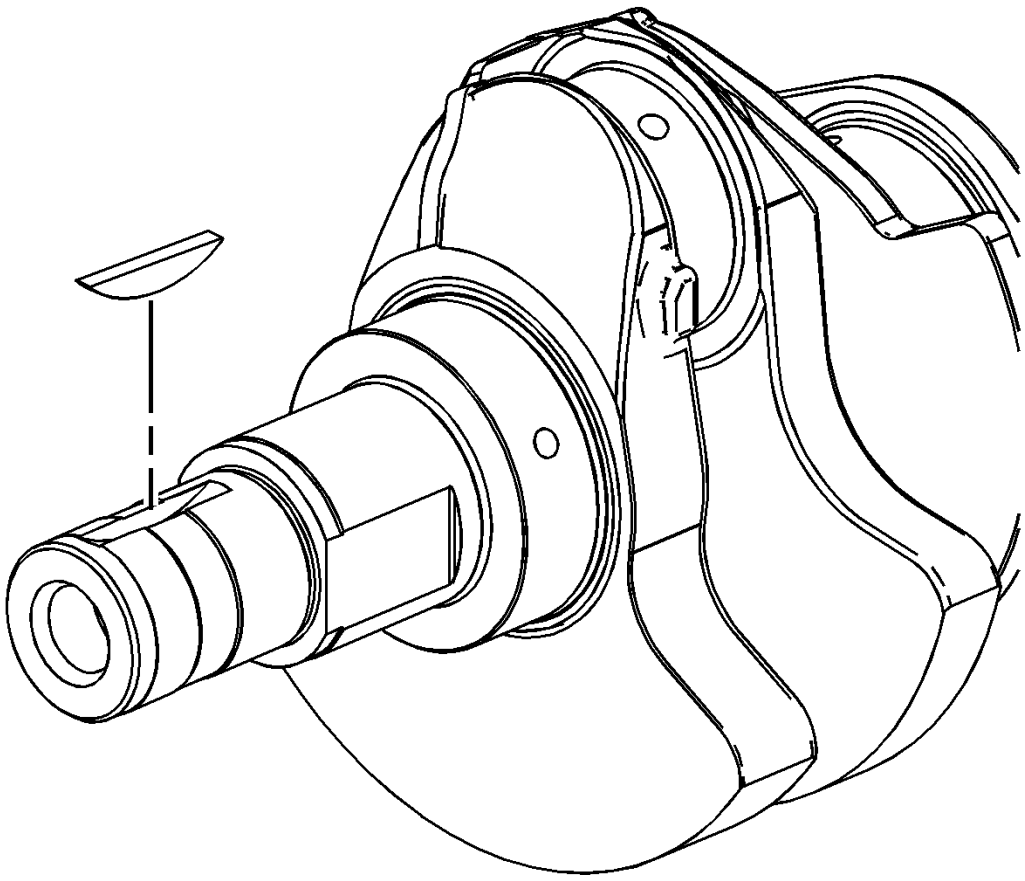

Fig. 442: Locating Crankshaft Sprocket Drive Pin
Courtesy of GENERAL MOTORS COMPANY

1. If removed, install the crankshaft key. Lightly tap the key in place with a small soft face, bronze/plastic, hammer until it bottoms in the keyway.

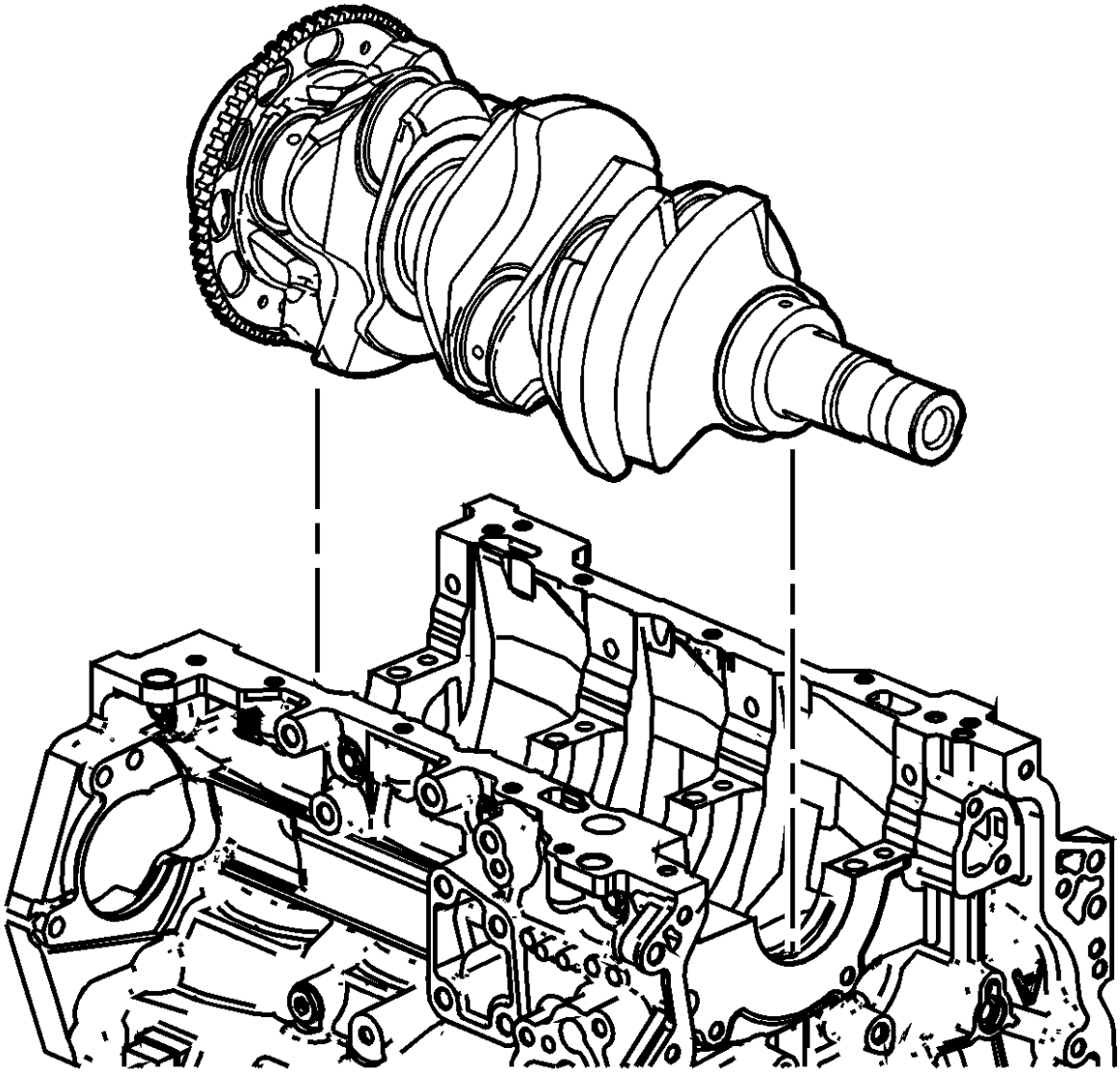

Fig. 443: View Of Crankshaft
Courtesy of GENERAL MOTORS COMPANY

2. Gently lower the crankshaft into position in the cylinder block.

Crankshaft Bearing Clearance Measurement Procedure

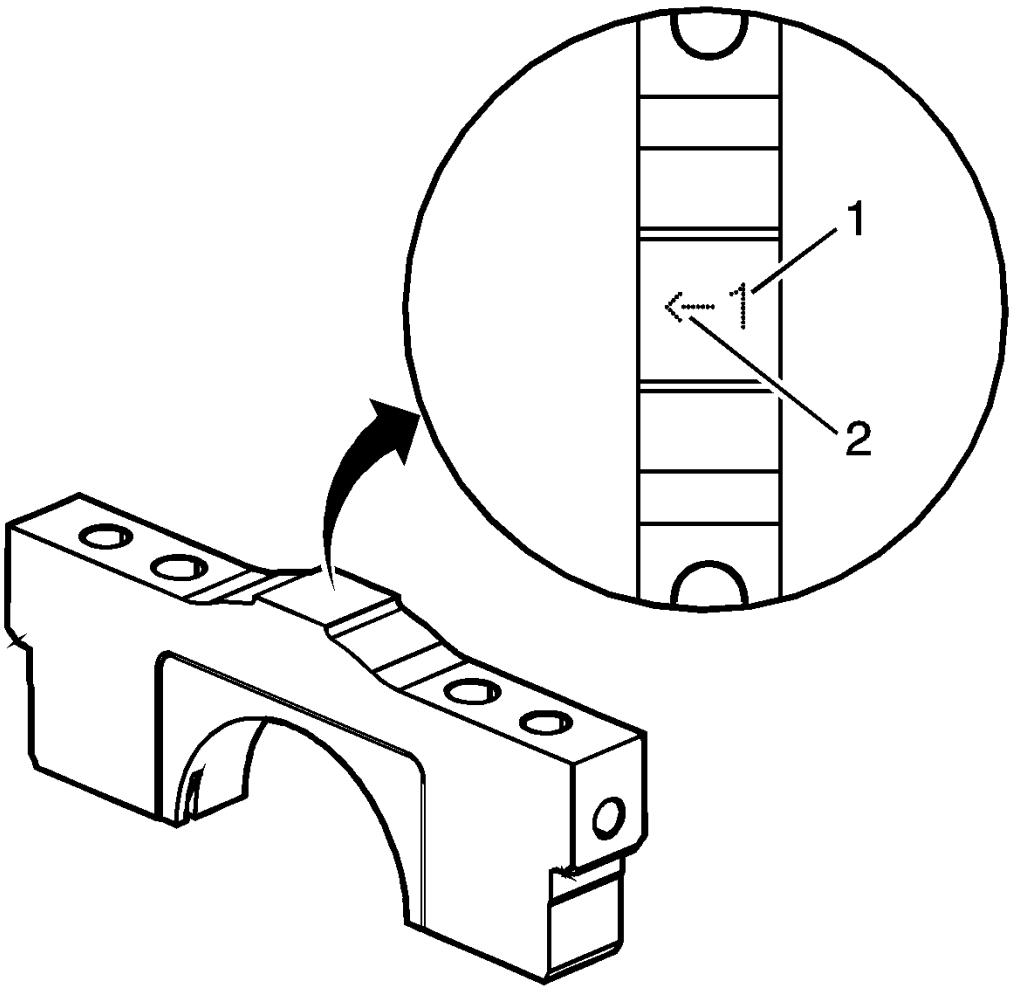

Fig. 444: Identifying Front Main Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

1. Place a length of fresh, room temperature plastic gaging material all the way across all the crankshaft bearing journals.
2. Identify the proper order of the main bearing caps. The main bearing caps are numbered 1 (1) through 4, with the front main bearing cap marked with the number 1. The arrow (2) is to be oriented to the front of the engine.

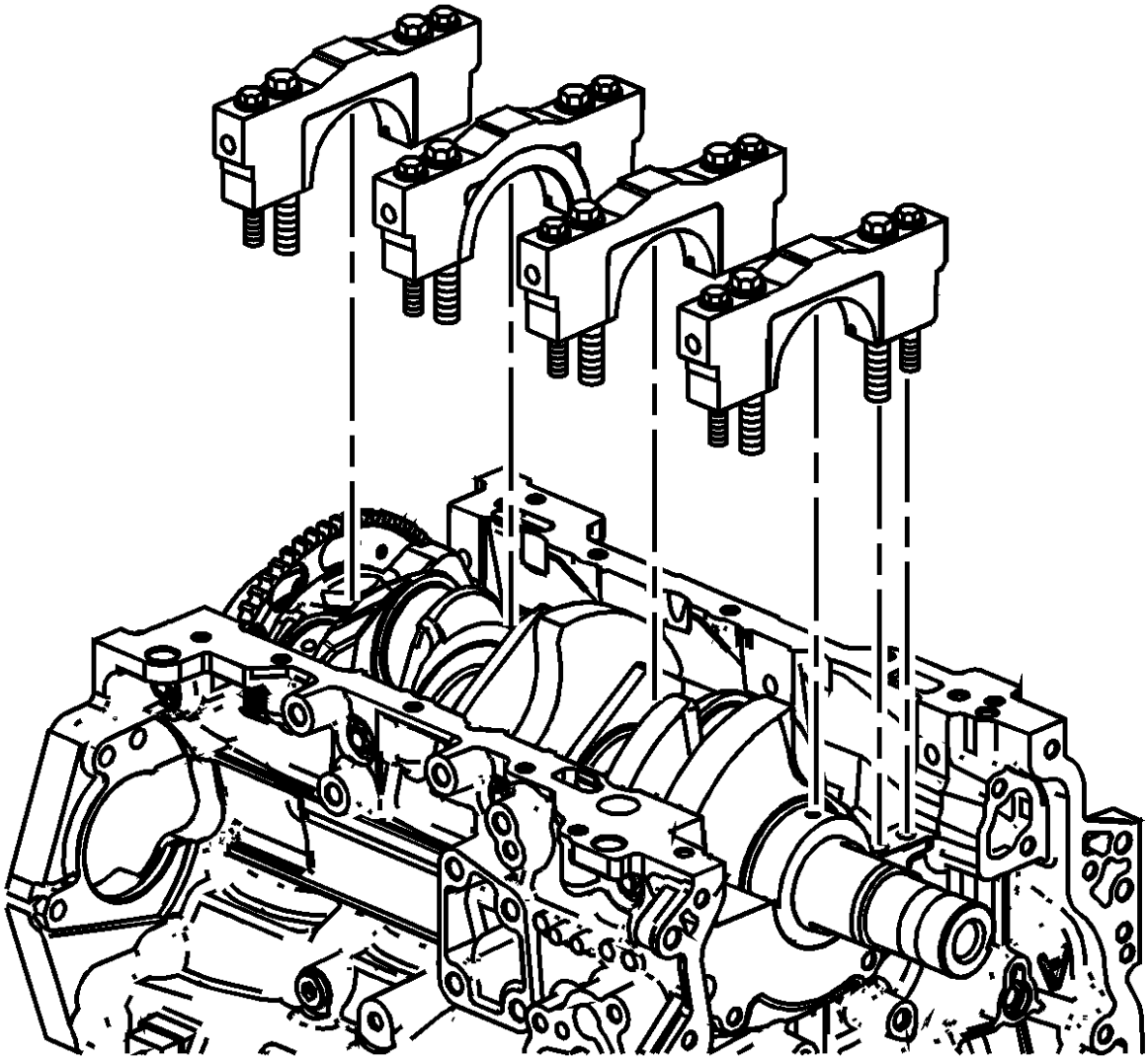

Fig. 445: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

3. Install the crankshaft main bearing caps.
4. Loosely install the original inner main cap bolts.
5. Loosely install the original outer main cap bolts.

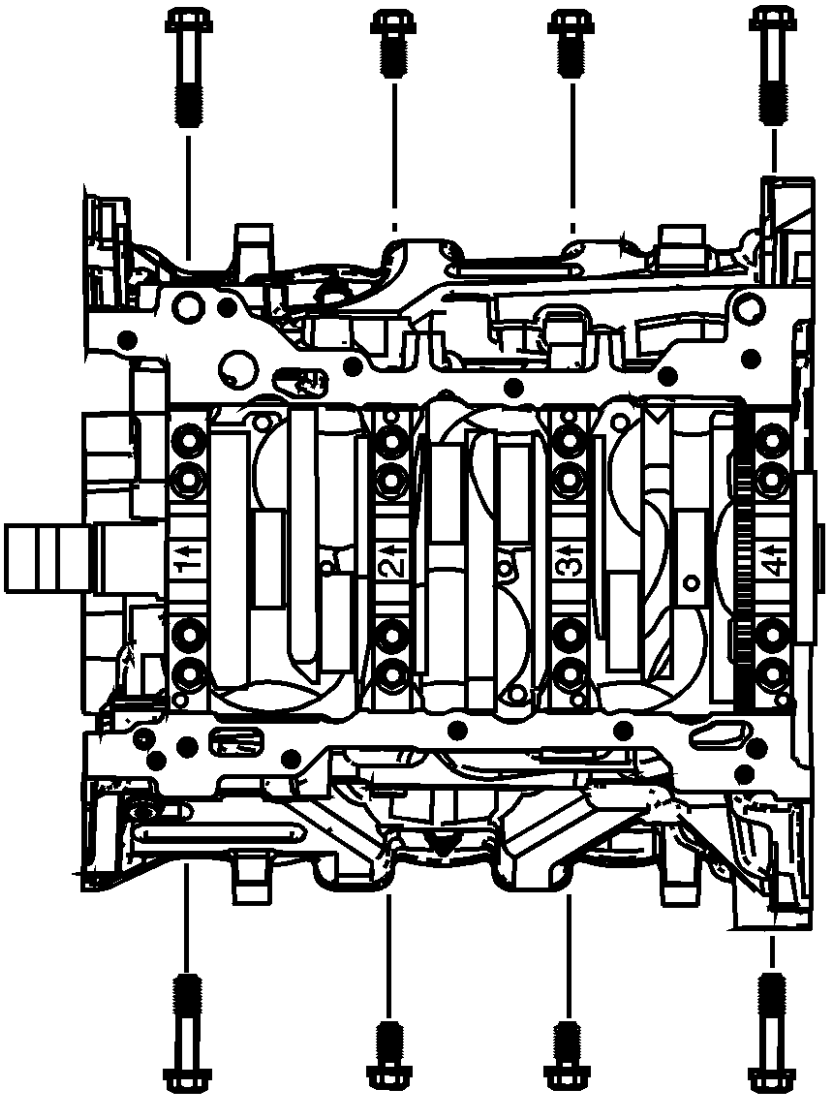

Fig. 446: Identifying Crankshaft Main Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Loosely install the original short/inner side main cap bolts.
7. Loosely install the original long/outer side main cap bolts.

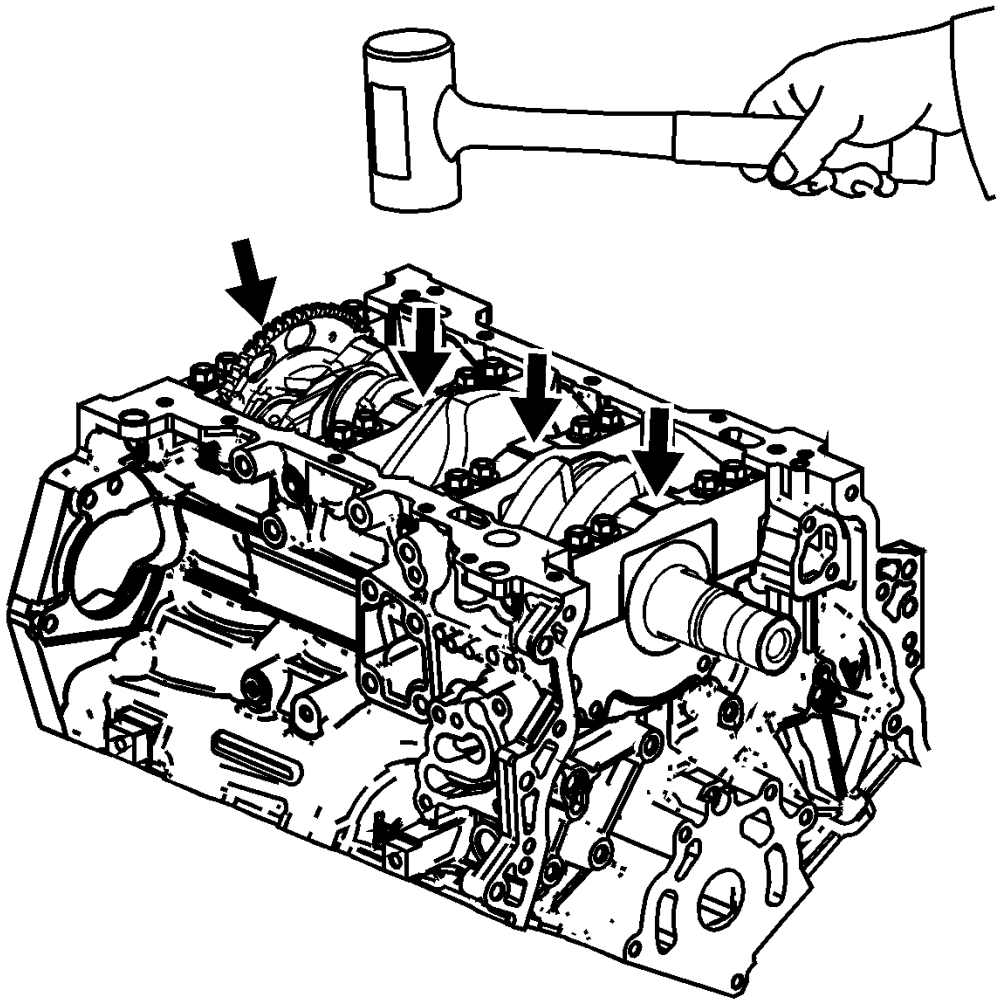

Fig. 447: Setting Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

8. Tap the crankshaft main bearing caps with a soft-faced hammer.

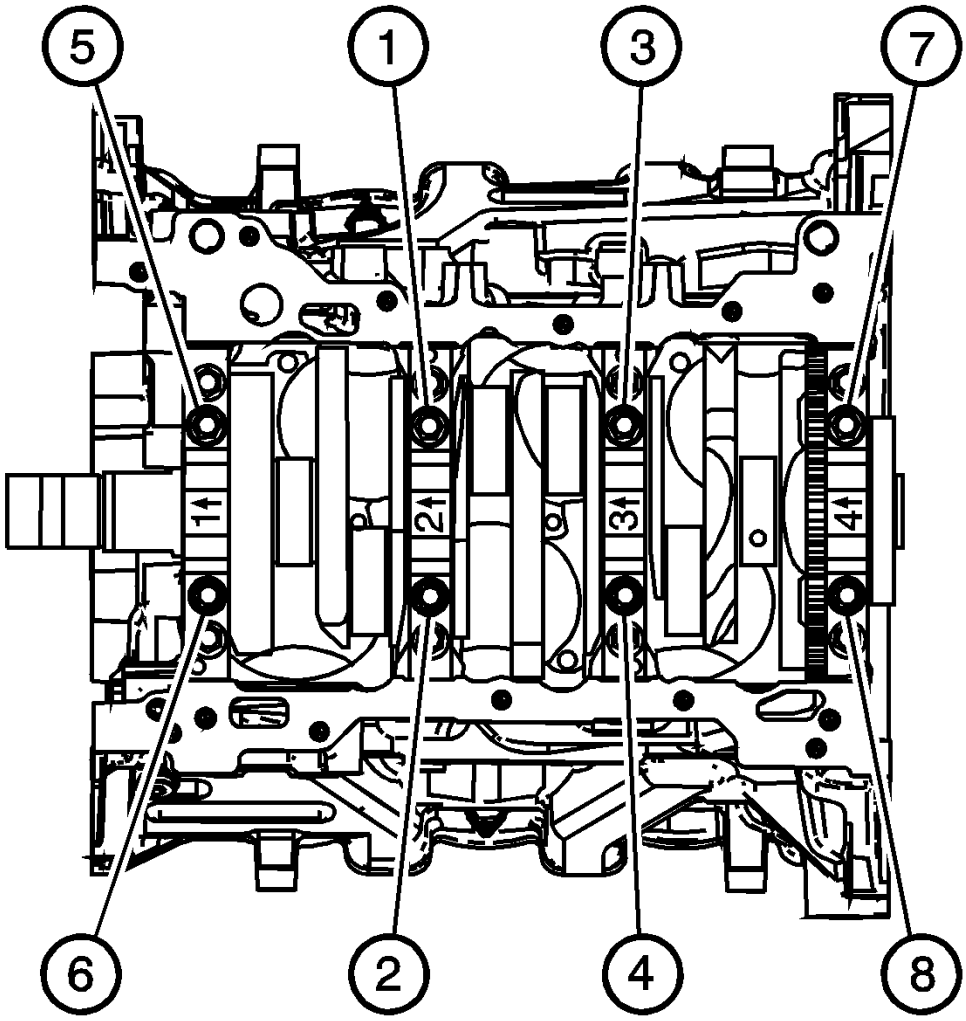

Fig. 448: Identifying Crankshaft Main Bearing Inboard Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

9. Tighten the main caps bolts using the **EN 45059** meter in the following sequence:

CAUTION: Refer to Fastener Caution .

10. Tighten the inboard bolts (1-8) first, in two passes.
    1. Tighten the inboard bolts to 20 N.m (15 lb ft) on the first pass.
    2. Tighten the inboard bolts (1-8) an additional 80 degrees on the 2nd pass.

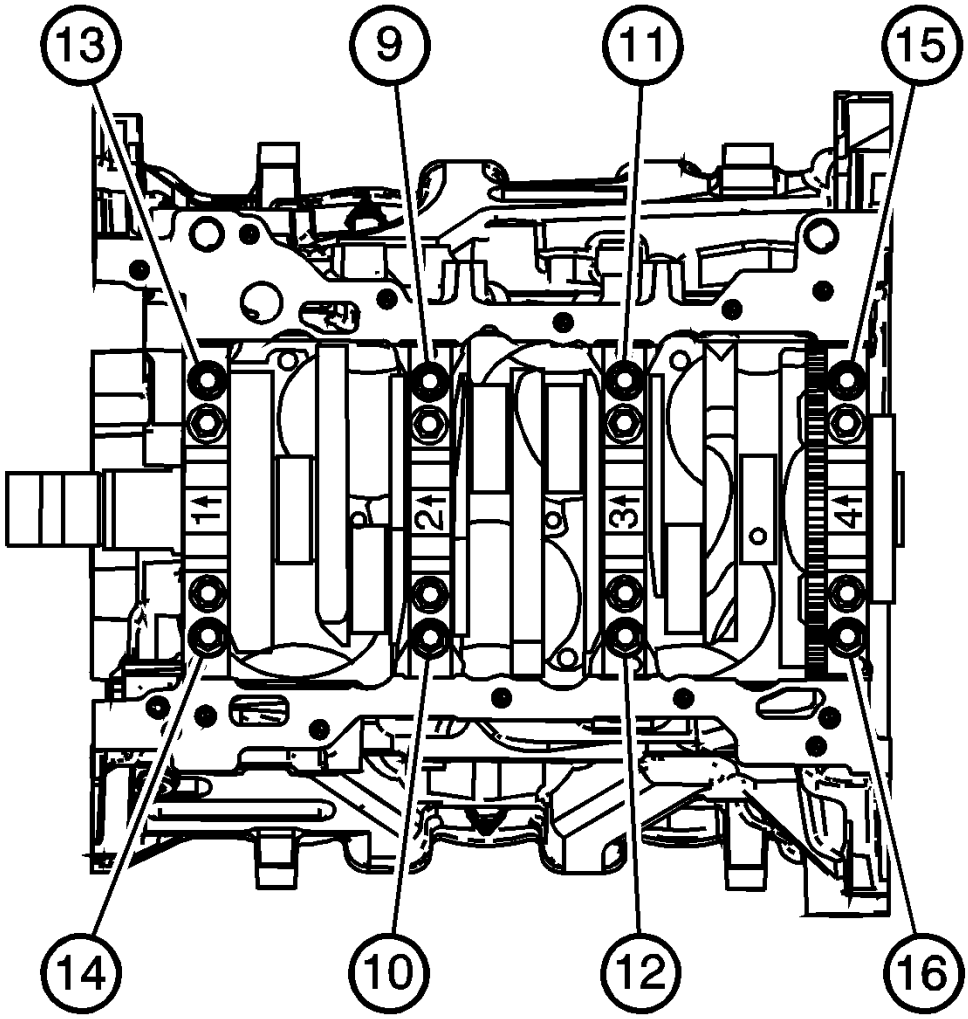

Fig. 449: Identifying Outboard Crankshaft Main Bearing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

11. Tighten the outboard bolts (9-16) second, in two passes.
    1. Tighten the outboard bolts to 15 N.m (11 lb ft) on the first pass.
    2. Tighten the outboard bolts (9-16) an additional 110 degrees on the 2nd pass.

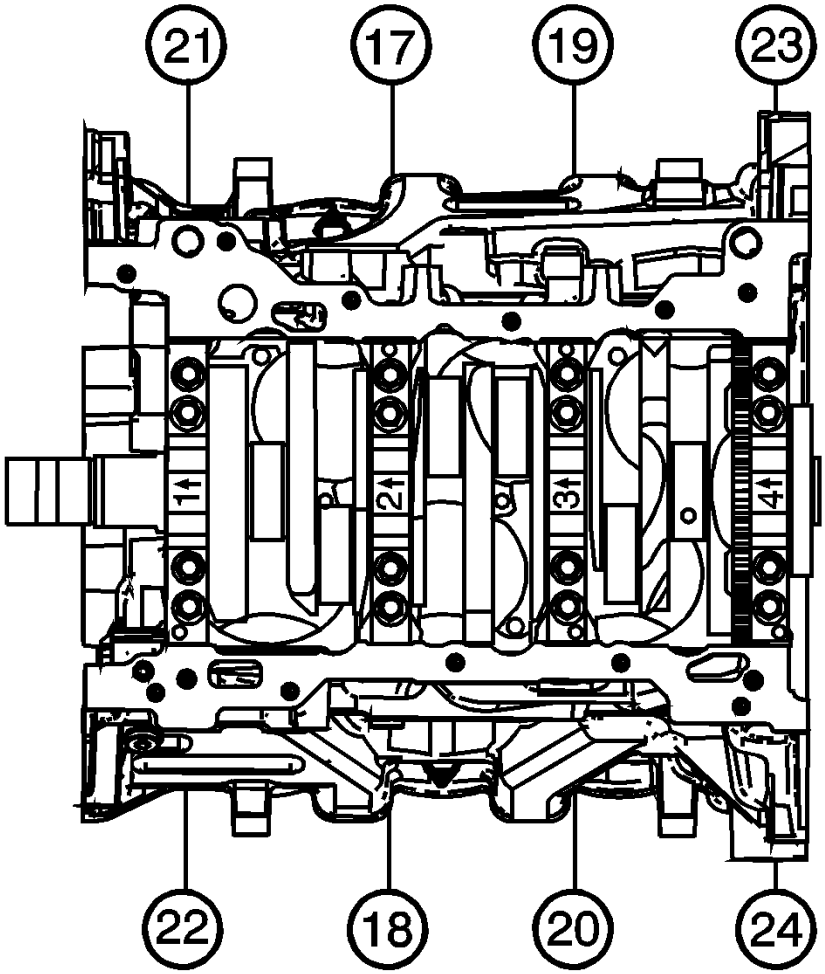

Fig. 450: Identifying Short/Inner Crankshaft Main Bearing (Bolt Tightening Sequence)
Courtesy of GENERAL MOTORS COMPANY

12. Tighten the short/inner bolts (17-20) third, in two passes.
    1. Tighten the short/inner bolts to 30 N.m (22 lb ft) on the first pass.
    2. Tighten the short/inner bolts (17-20) an additional 60 degrees on the 2nd pass.
13. Tighten the long/outer bolts (21-24) fourth, in two passes.
    1. Tighten the long/outer bolts to 30 N.m (22 lb ft) on the first pass.
    2. Tighten the long/outer bolts (21-24) an additional 60 degrees on the 2nd pass.

NOTE: **Do not rotate the crankshaft.**

14. After reaching final torque, allow the assembly to sit for 2 minutes.

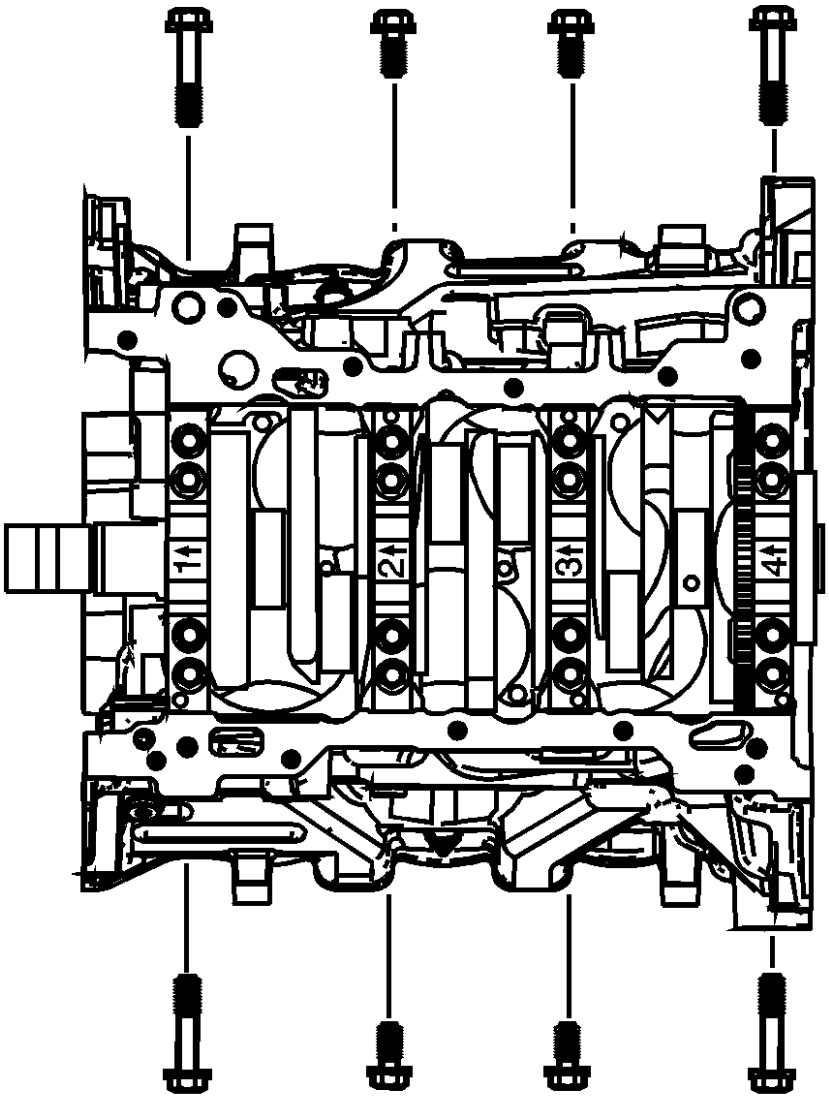

Fig. 451: Identifying Crankshaft Main Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS COMPANY

15. Remove the crankshaft bearing cap side bolts.

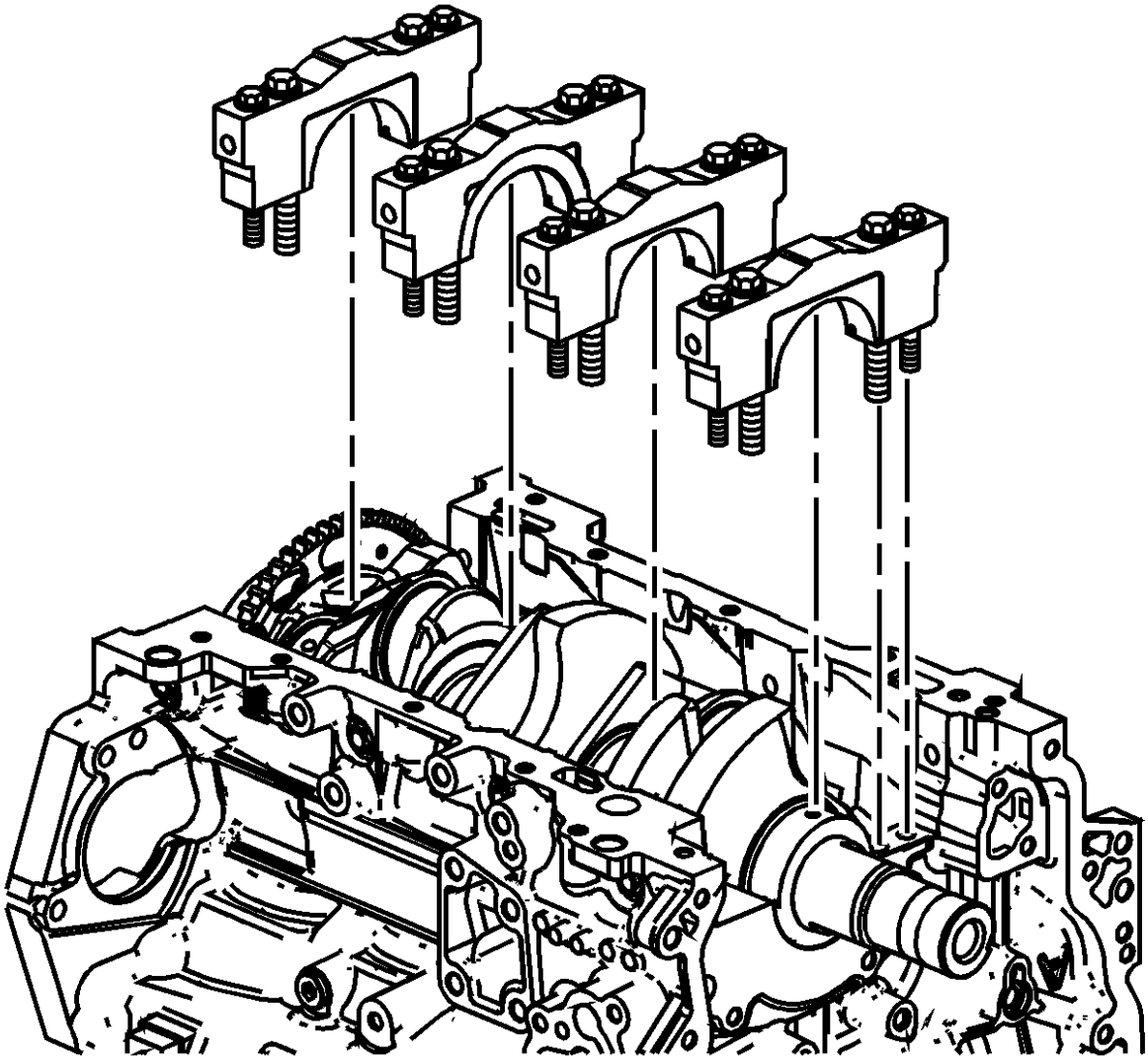

Fig. 452: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

16. Remove the crankshaft bearing cap outer bolts.
17. Remove the crankshaft bearing cap inner bolts.
18. Remove the crankshaft bearing caps using the **GE 6125-1B** adapter and **EN 49102** remover.

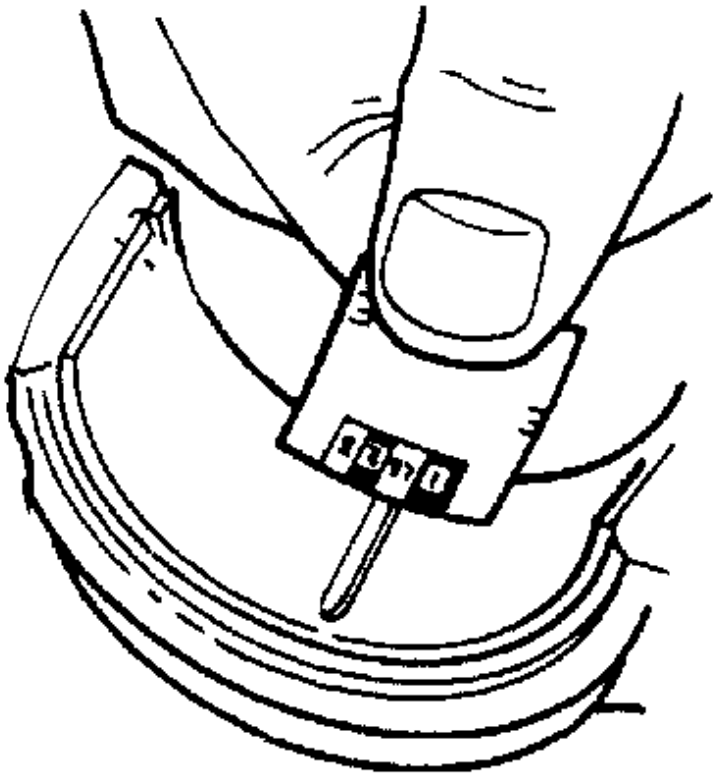

Fig. 453: Measuring Plastigage
Courtesy of GENERAL MOTORS COMPANY

19. Determine the crankshaft bearing clearance by comparing the width of the flattened plastic gaging material at its widest point with the graduation on the gaging material container.

NOTE: **The crankshaft bearings CAN be reused after checking the clearance if the bearings have never been used in a running engine.**

20. Compare your measurements with the **Engine Mechanical Specifications** . If the new bearings do not provide the proper crankshaft to bearing clearance, inspect the following:
    1. Re-measure the crankshaft journals for the correct specified size and ensure the proper new bearings are being installed. If the crankshaft journals are incorrectly sized, replace or regrind the crankshaft. Crankshaft machining is permitted and undersized bearings are available.
    2. Re-measure the engine block crankshaft bearing bore diameter to ensure proper size. The engine block crankshaft bearing bore is not machinable and the block must be replaced if out of specification.

21. Clean the plastic gaging material from the crankshaft bearing journals with a soft, lint-free cloth.

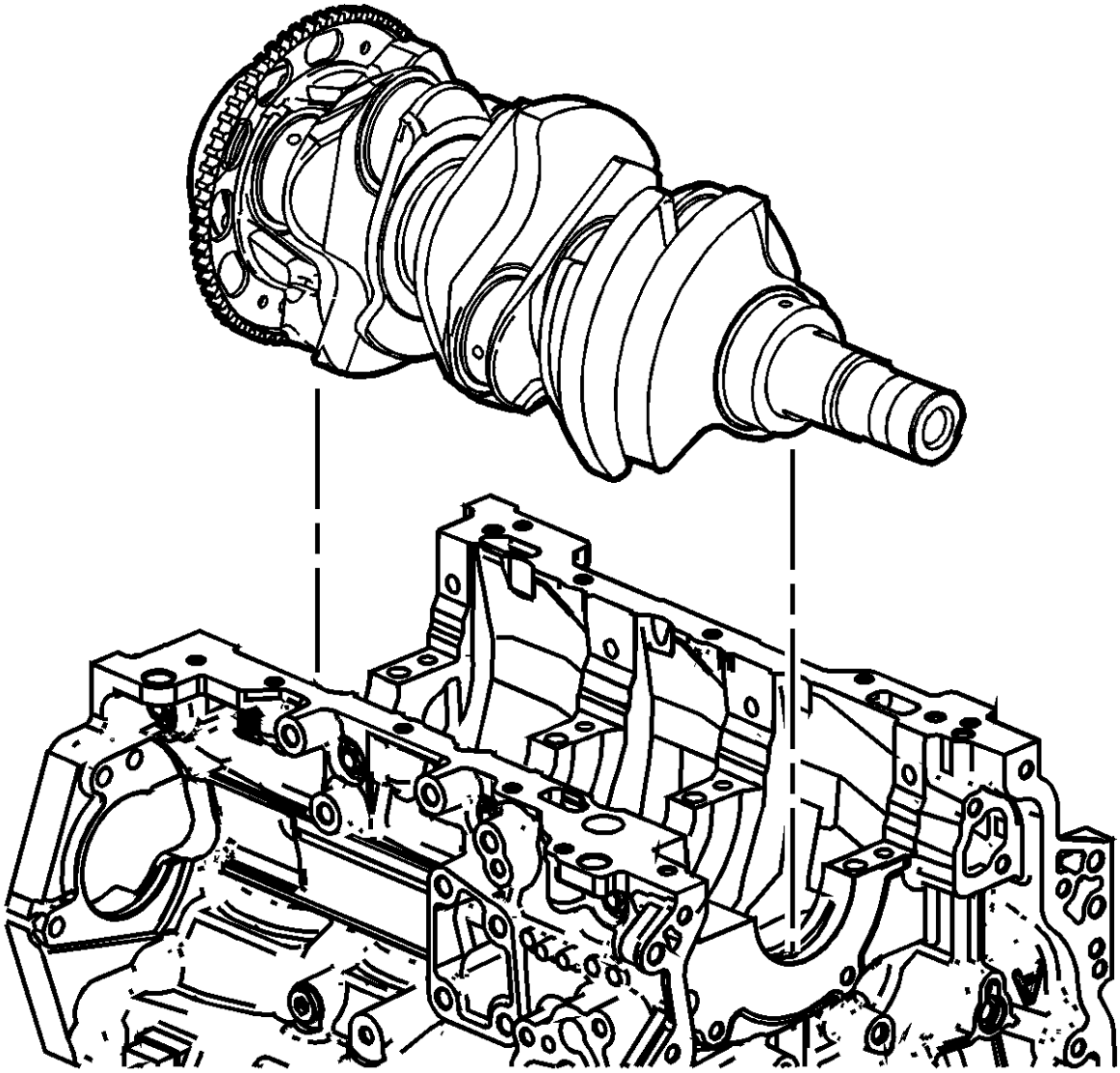

Fig. 454: View Of Crankshaft
Courtesy of GENERAL MOTORS COMPANY

22. Lift the crankshaft out of the cylinder block.

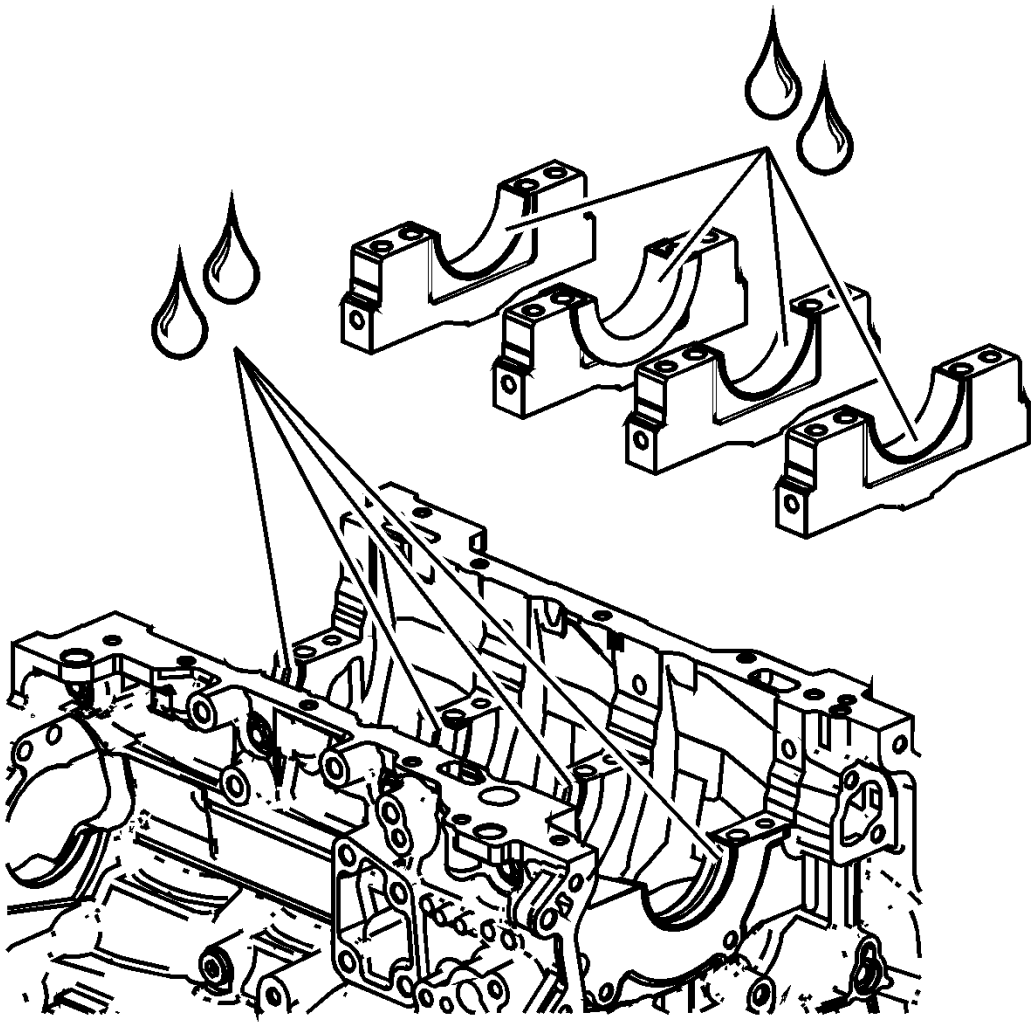

Fig. 455: Prelubing Upper & Lower Bearing Surfaces
Courtesy of GENERAL MOTORS COMPANY

23. Apply a liberal amount of crankshaft prelube or clean engine oil to the upper and lower bearing surfaces. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

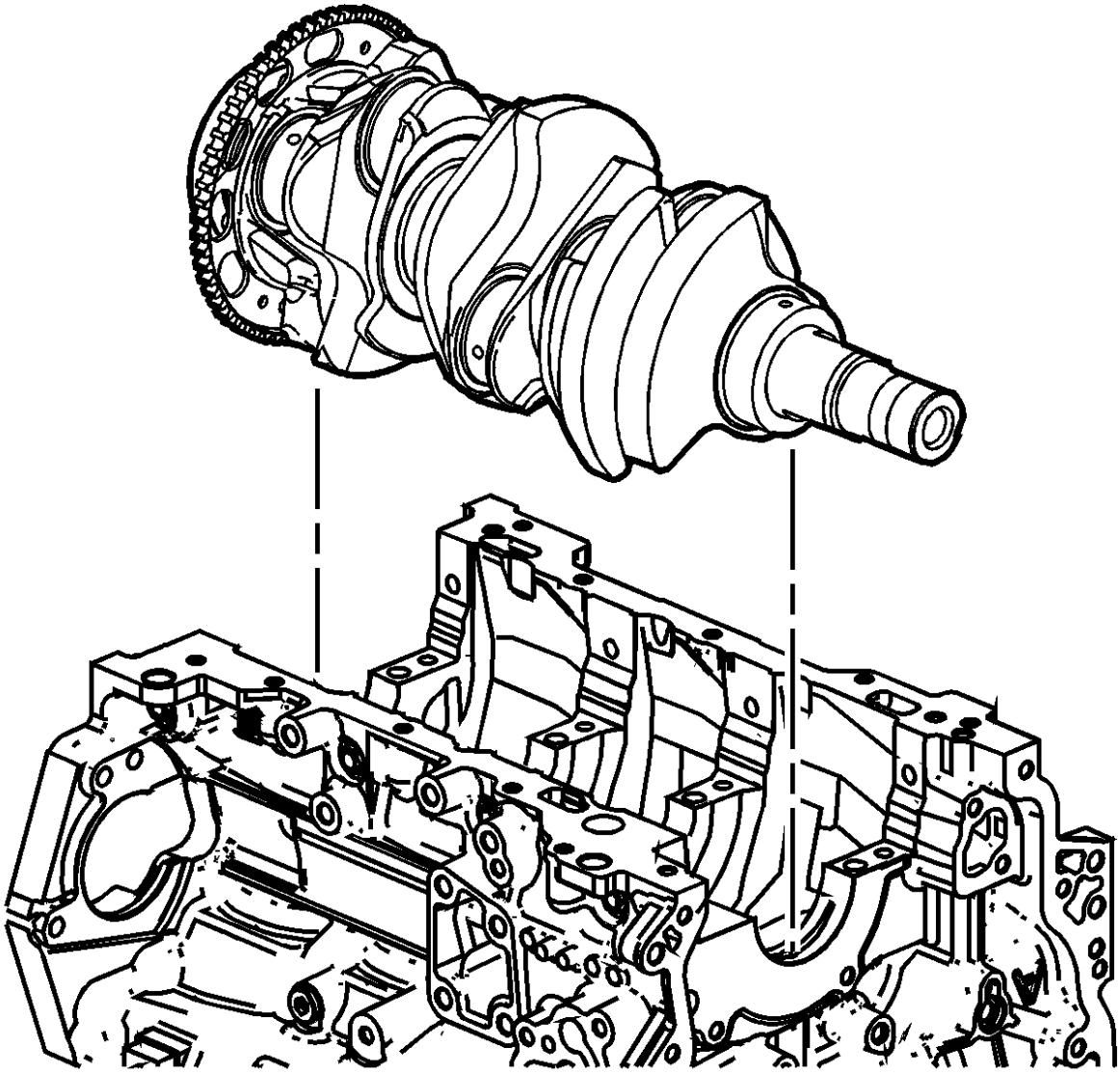

Fig. 456: View Of Crankshaft
Courtesy of GENERAL MOTORS COMPANY

24. Gently lower the crankshaft into position in the cylinder block.

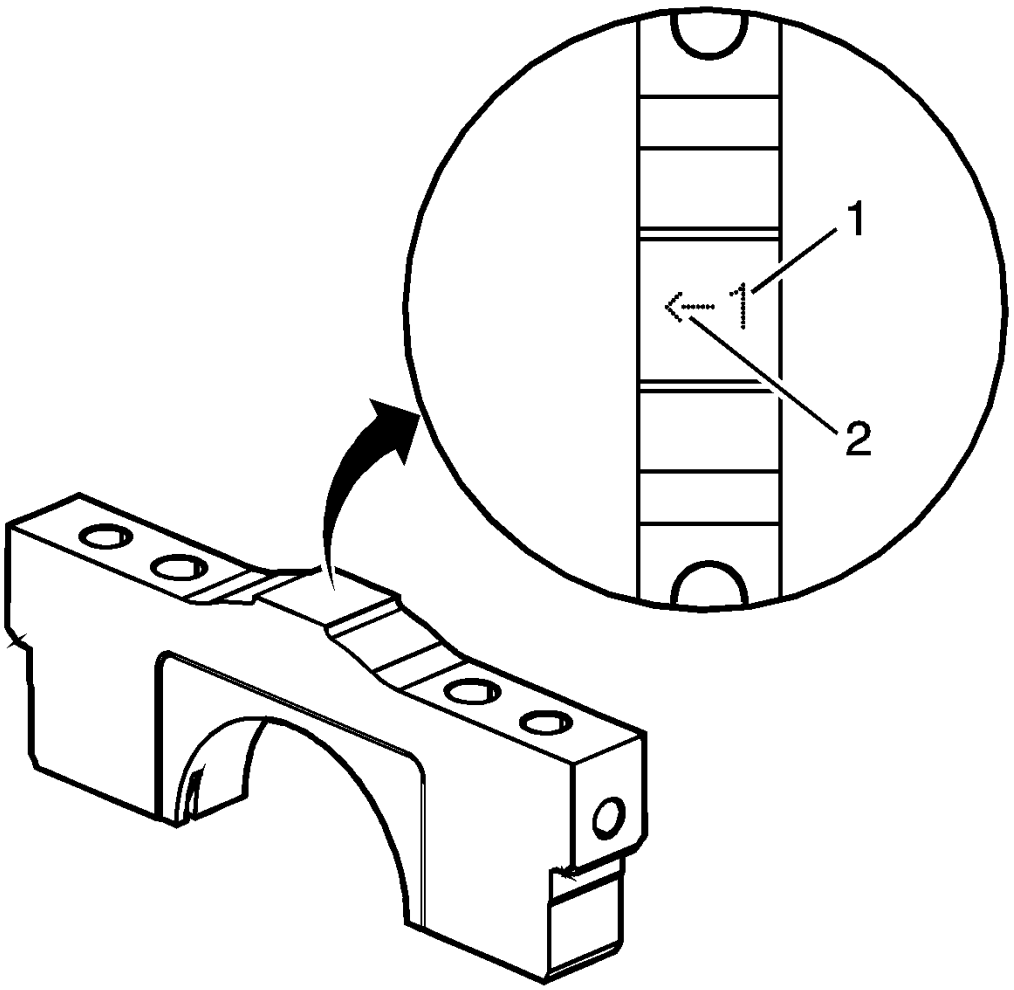

Fig. 457: Identifying Front Main Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

25. Identify the proper order of the main bearing caps. The main bearing caps are numbered 1 (1) through 4, with the front main bearing cap marked with the number 1. The arrow (2) is to be oriented to the front of the engine.

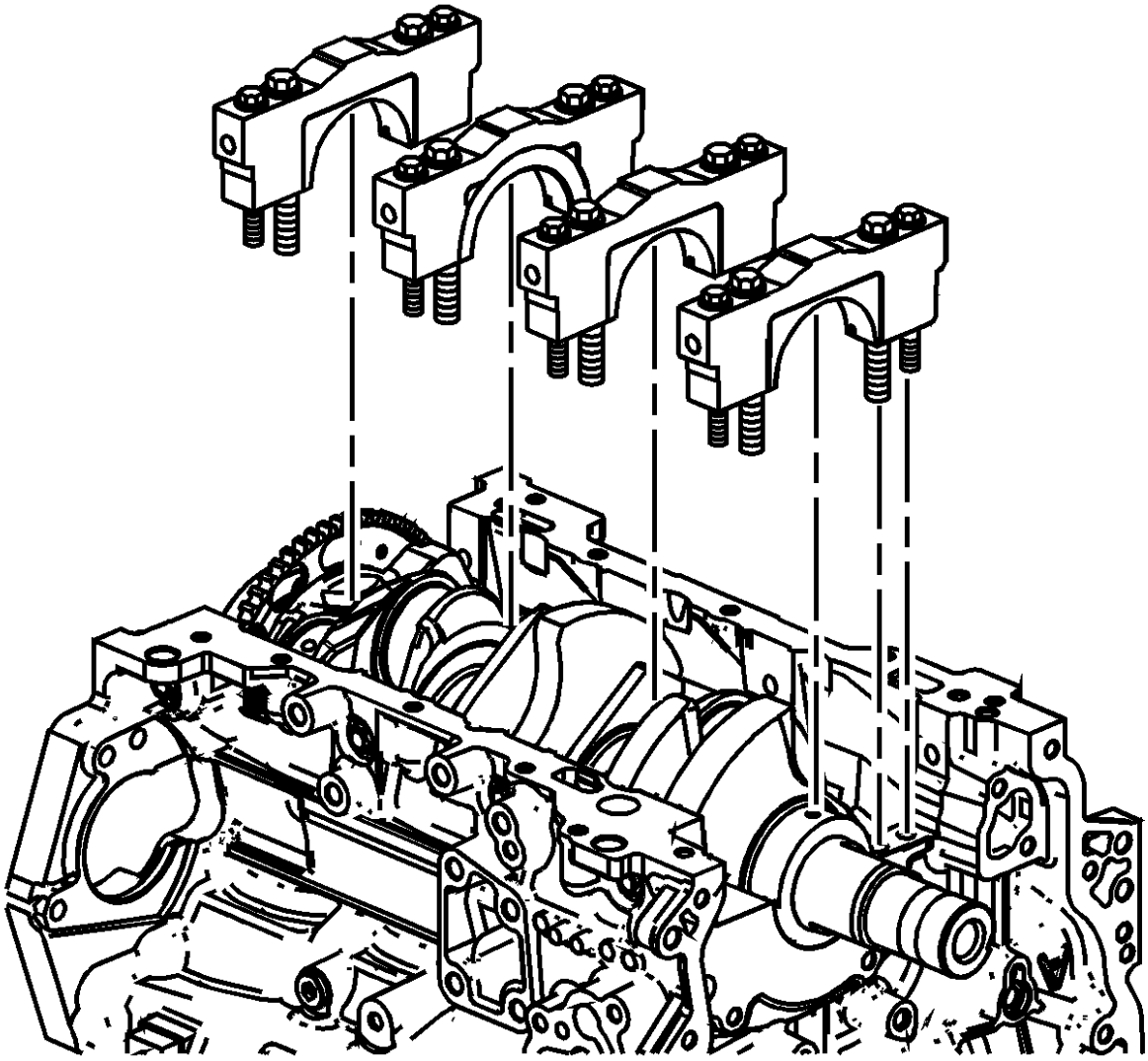

Fig. 458: View Of Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

26. Install the crankshaft main bearing caps.

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

27. Loosely install the NEW inner main cap bolts.
28. Loosely install the NEW outer main cap bolts.

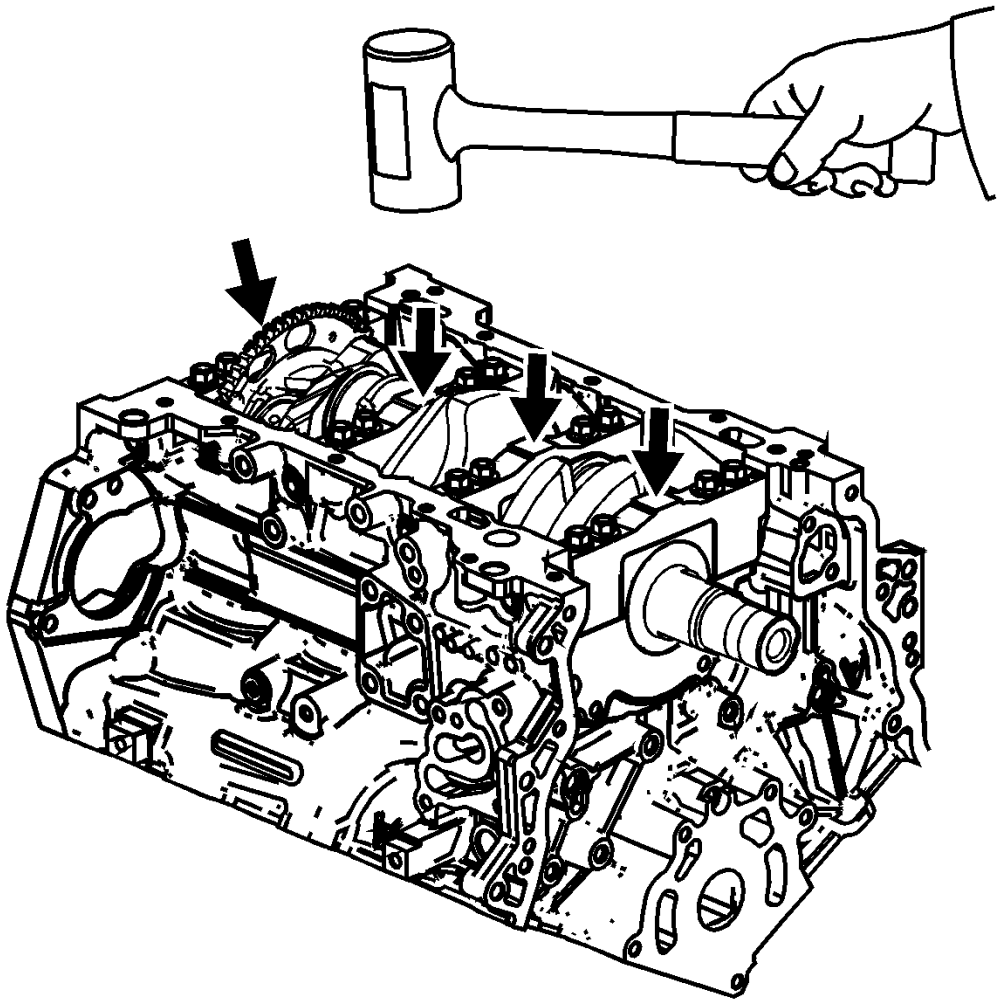

Fig. 459: Setting Crankshaft Main Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

29. Tap the crankshaft main bearing caps with a soft-faced hammer.

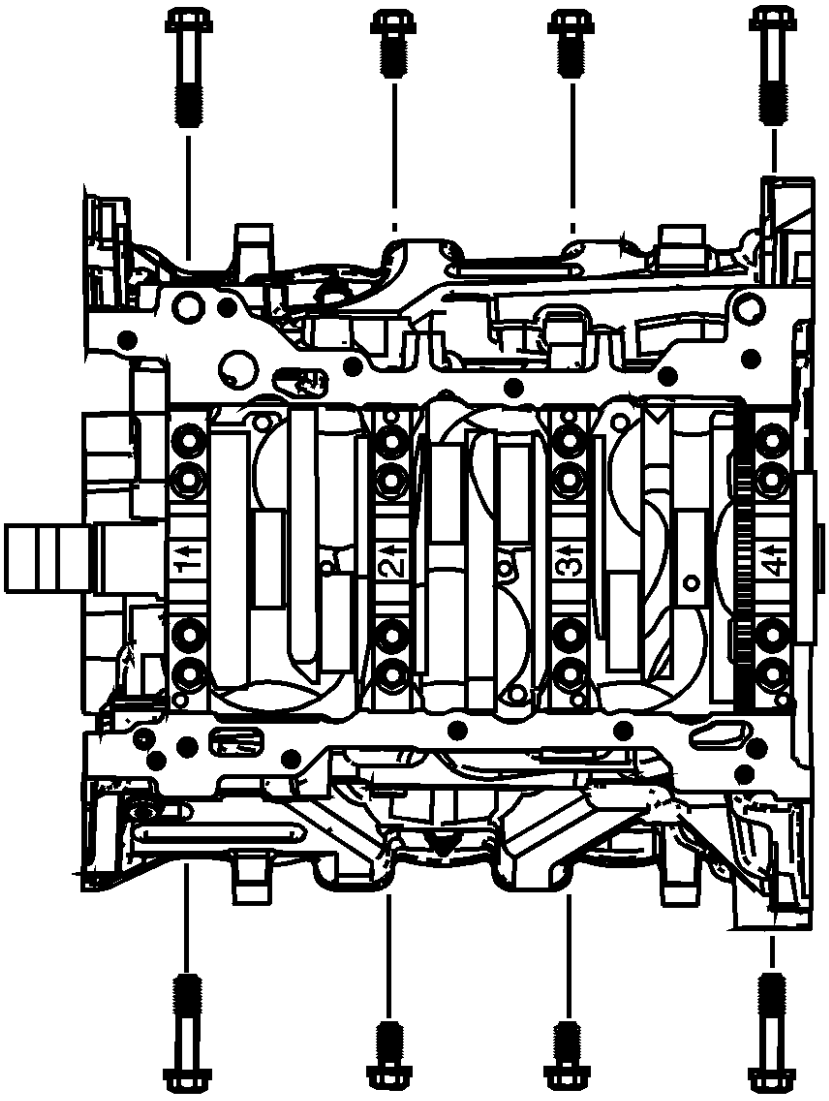

Fig. 460: Identifying Crankshaft Main Bearing Cap Side Bolts
Courtesy of GENERAL MOTORS COMPANY

30. Loosely install the NEW short/inner side main cap bolts.
31. Loosely install the NEW long/outer side main cap bolts.

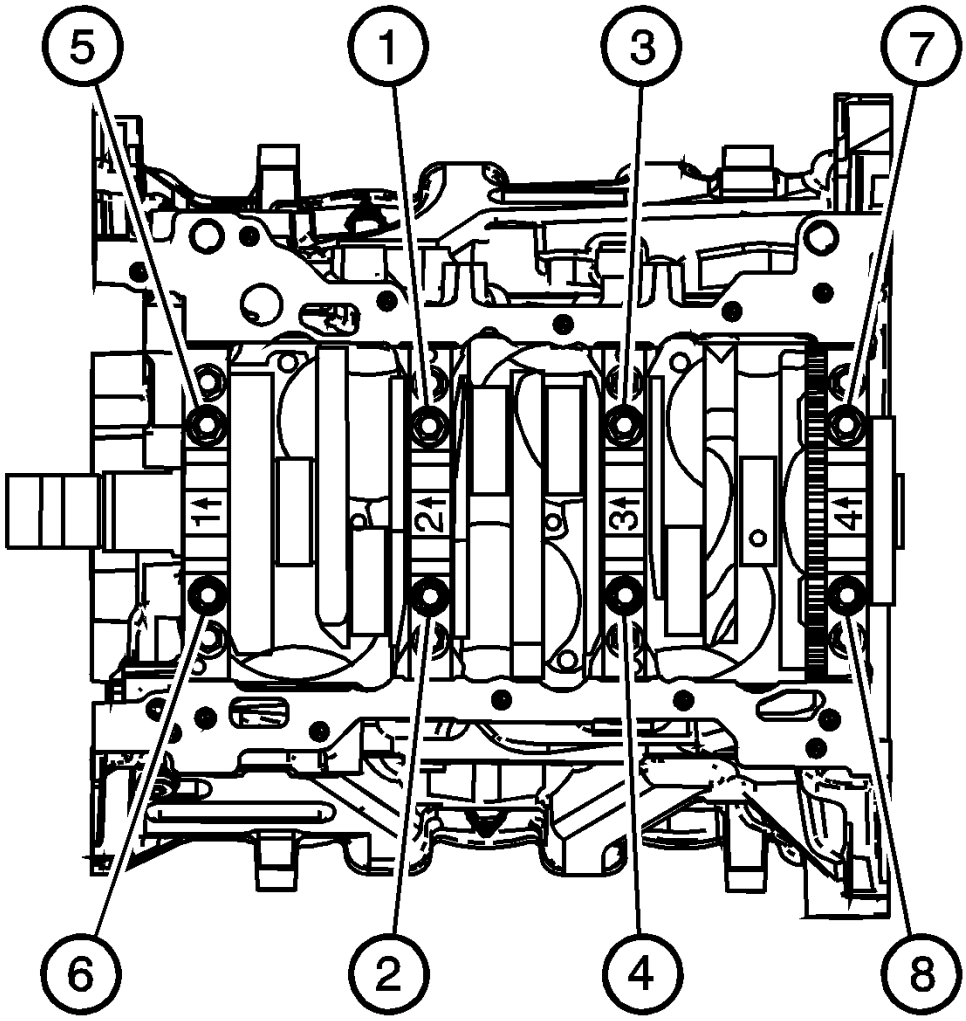

Fig. 461: Identifying Crankshaft Main Bearing Inboard Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

32. Tighten the main cap bolts using the **EN 45059** meter in the following sequence:
33. Tighten the inboard bolts (1-8) first, in two passes.
    1. Tighten the inboard bolts to 20 N.m (15 lb ft) on the first pass.
    2. Tighten the inboard bolts (1-8) an additional 80 degrees on the 2nd pass.

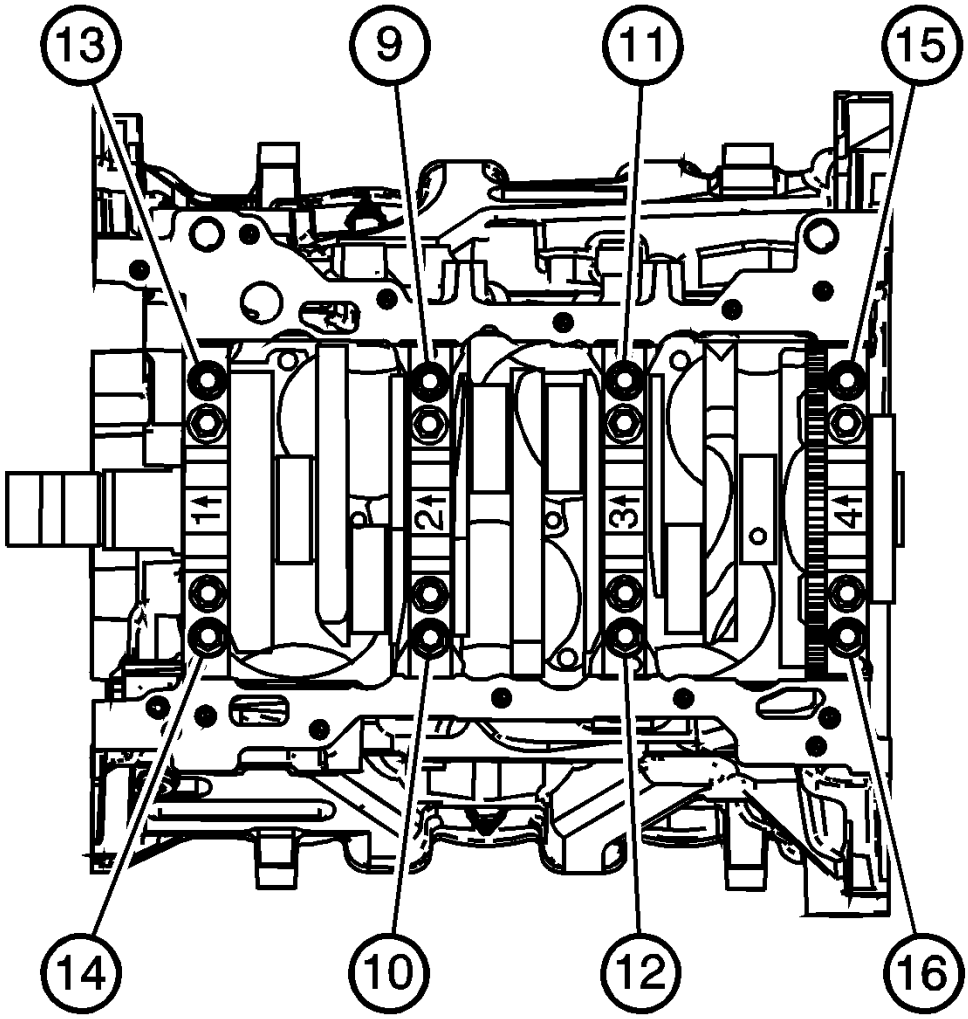

Fig. 462: Identifying Outboard Crankshaft Main Bearing Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

34. Tighten the outboard bolts (9-16) second, in two passes.
    1. Tighten the outboard bolts to 15 N.m (11 lb ft) on the first pass.
    2. Tighten the outboard bolts (9-16) an additional 110 degrees on the 2nd pass.

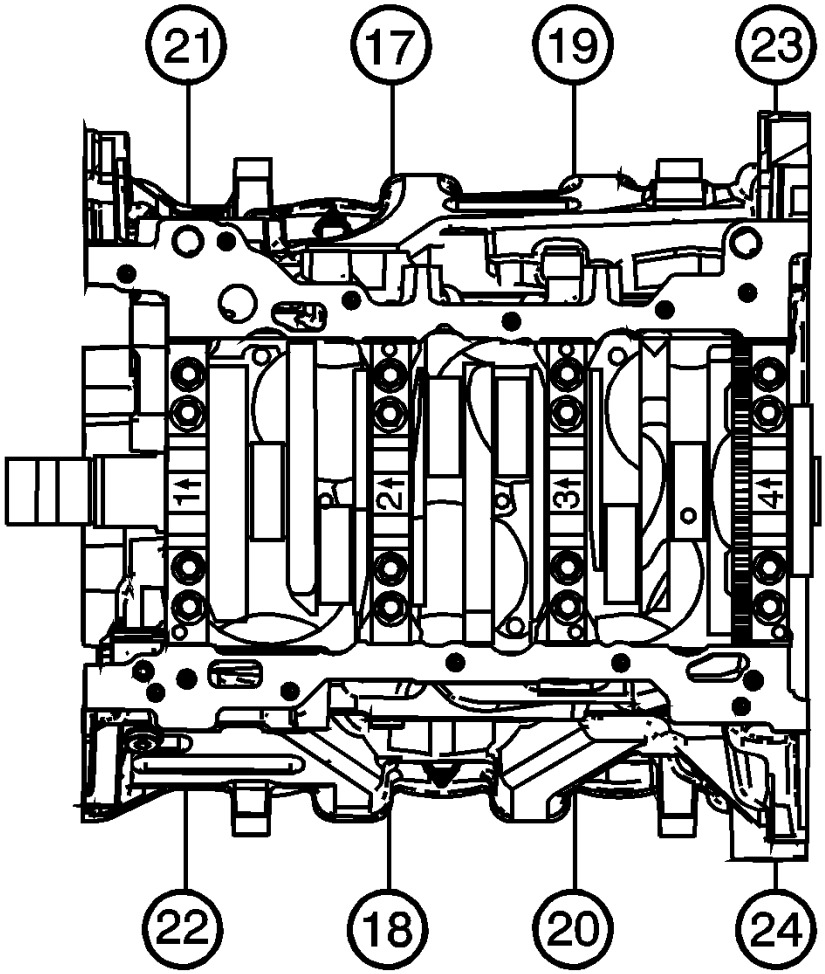

Fig. 463: Identifying Short/Inner Crankshaft Main Bearing (Bolt Tightening Sequence)
Courtesy of GENERAL MOTORS COMPANY

35. Tighten the short/inner bolts (17-20) third, in two passes.
    1. Tighten the short/inner bolts to 30 N.m (22 lb ft) on the first pass.
    2. Tighten the short/inner bolts (17-20) an additional 60 degrees on the 2nd pass.
36. Tighten the long/outer bolts (21-24) fourth, in two passes.
    1. Tighten the long/outer bolts to 30 N.m (22 lb ft) on the first pass.
    2. Tighten the long/outer bolts (21-24) an additional 60 degrees on the 2nd pass.
37. Ensure that the crankshaft turns without binding or noise.

PISTON, CONNECTING ROD, AND BEARING INSTALLATION

Special Tools

- **EN-43690-A** Rod Bearing Clearance Checking Tool
- **EN-45059** Angle Meter
- **EN-46121** Connecting Rod Guide Pin Set

- **EN-48589** Crankshaft Rotation Socket

For equivalent regional tools, refer to **Special Tools** .

Piston and Connecting Rod Assembly Procedure

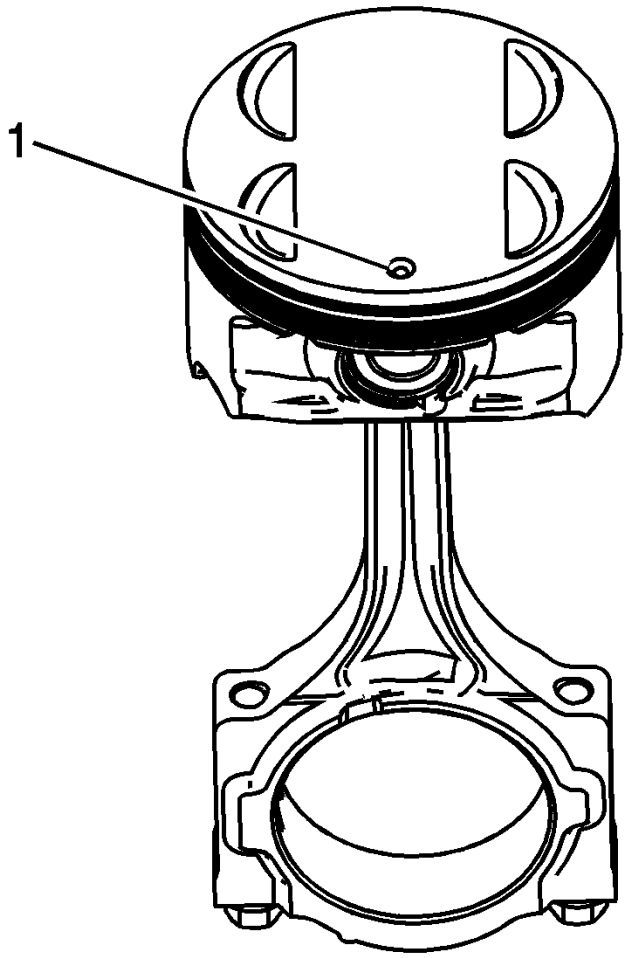

Fig. 464: Identifying Proper Piston Orientation With Dot On Piston
Courtesy of GENERAL MOTORS COMPANY

1. Liberally lubricate the cylinder walls, piston rings and piston skirts with engine oil.

NOTE:

- **The piston is directional and must be installed in the engine block in the proper direction. The dot on the top of the piston must face the front of the engine.**
- **Ensure the Bowl of the piston faces the intake.**

2. Select the correctly numbered piston/connecting rod assembly for the cylinder. A dot (1) showing proper piston orientation is located on the top of the piston.

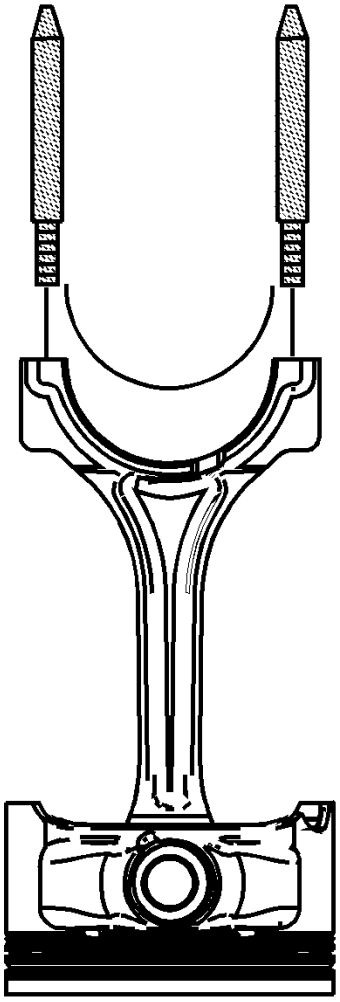

Fig. 465: View Of Piston/Connecting Rod Installation Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the connecting rod bearings have been used in a running engine, you must replace them with NEW connecting rod bearings for reassembly.**

3. Install the connecting rod bearing into the connecting rod.
4. Install the **EN 46121** pin set into the connecting rod bolt holes.
5. Compress the piston rings using the a ring compressor sleeve or equivalent.

NOTE: **When installing a piston into a cylinder, use a ring compressor sleeve or equivalent for best results. The following features should be looked for when selecting a ring compressor sleeve.**

1. **Hard anodized and Teflon coated for low friction and prolonged wear resistance.**
2. **Smooth radius that tapers down to the specific bore size.**
3. **Sleeve should compress the piston rings smoothly and evenly.**
4. **Using a ring compressor sleeve greatly reduces the difficulty with**

installing thin high-performance oil rings.

If a ring compressor sleeve is unavailable, a universal ring compressor will work but is more difficult to use.

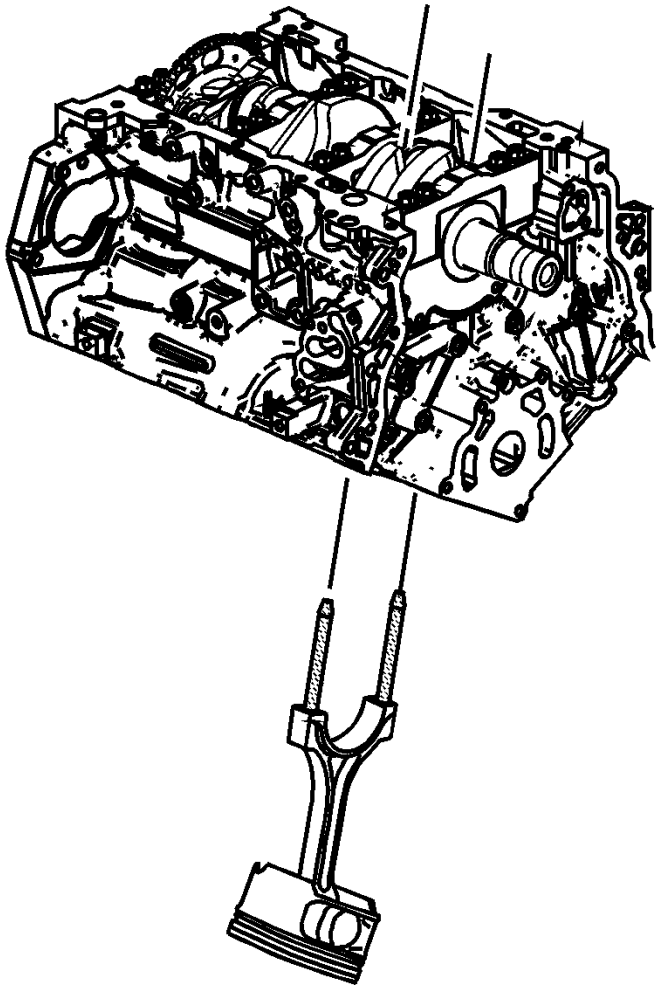

Fig. 466: View Of Connecting Rod & Piston Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Extreme care must be used when installing the piston and connecting rod in order to be sure the rod does not scrape or nick the cylinder bore, the oil jets, or the crankshaft surfaces.**

6. Using both hands, slowly guide the piston and connecting rod assembly into the cylinder from the top and bottom of the cylinder. DO NOT allow the connecting rod to contact the cylinder wall.
7. Tap the piston into its bore with a hammer handle. Guide the connecting rod to the connecting rod journal using the **EN-46121** set while gently tapping the piston into place. Hold the ring compressor sleeve or equivalent against the engine block until all the rings have entered the cylinder bore.

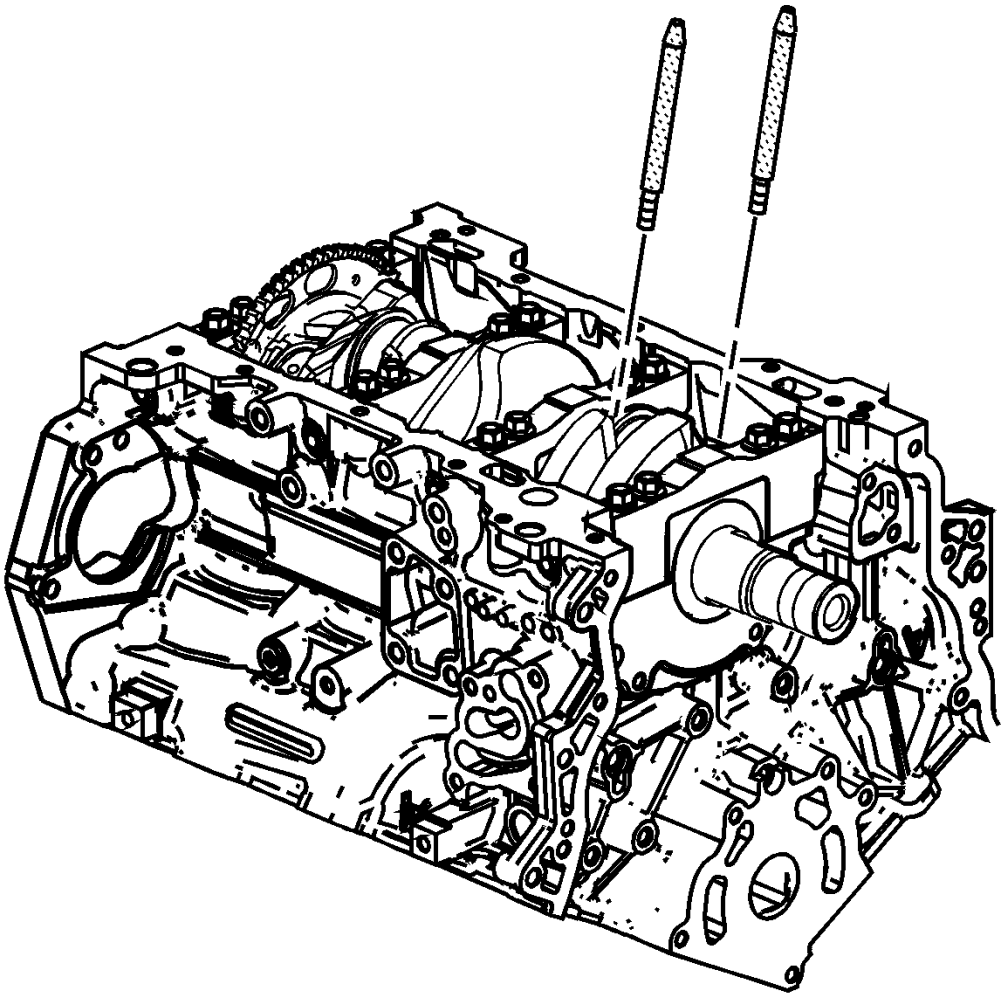

Fig. 467: Crankshaft Protector Pins Installed in Connecting Rod Bolt Holes
Courtesy of GENERAL MOTORS COMPANY

8. Remove the **EN 46121** pin set from the connecting rod bolt holes.

Connecting Rod Bearing Clearance Measurement Procedure - Using Plastic Gaging

NOTE: **Connecting rod bearings that have been run in an engine should NEVER be reused.**

Before final assembly it is important to check the clearance of the new connecting rod bearings.

1. Place a length of fresh, room temperature plastic gaging material all the way across the connecting rod bearing journal.
2. Install the connecting rod bearing into the connecting rod cap.

NOTE: **The connecting rod is non-directional therefore the connecting rod bearing lock tangs can face inboard or outboard.**

3. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are

aligned on the same side of the rod.

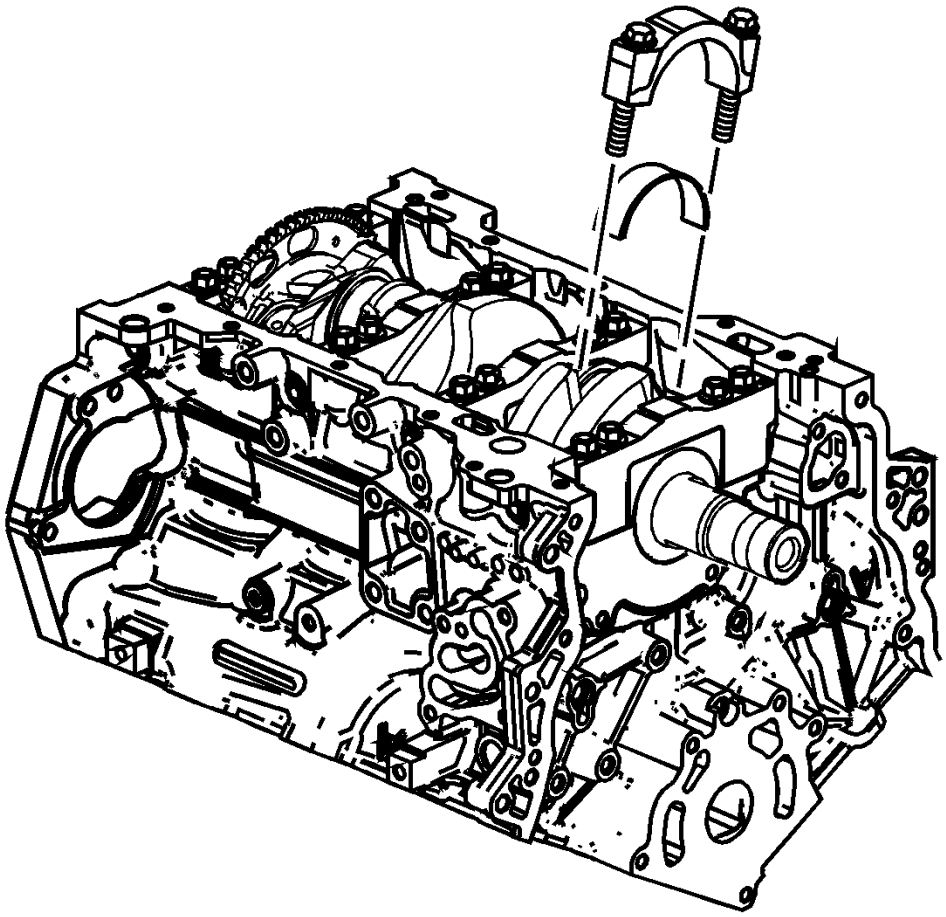

Fig. 468: View Of Connecting Rod Bearing & Cap
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

CAUTION: **Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine damage.**

NOTE: **Reuse the old connecting rod bolts ONLY for measuring the connecting rod bearing clearance.**

4. Install the connecting rod bolts into the connecting rod cap.
5. Tighten the connecting rod bolts.
    1. First Pass

Tighten the connecting rod bolts to 25 N.m (18 lb ft).

2. Final Pass

   Tighten the connecting rod bolts an additional 110 degrees using the **EN 45059** meter.

6. Allow the assembly to sit for at least 2 minutes.
7. Remove the connecting rod cap bolts.
8. Remove the connecting rod cap.

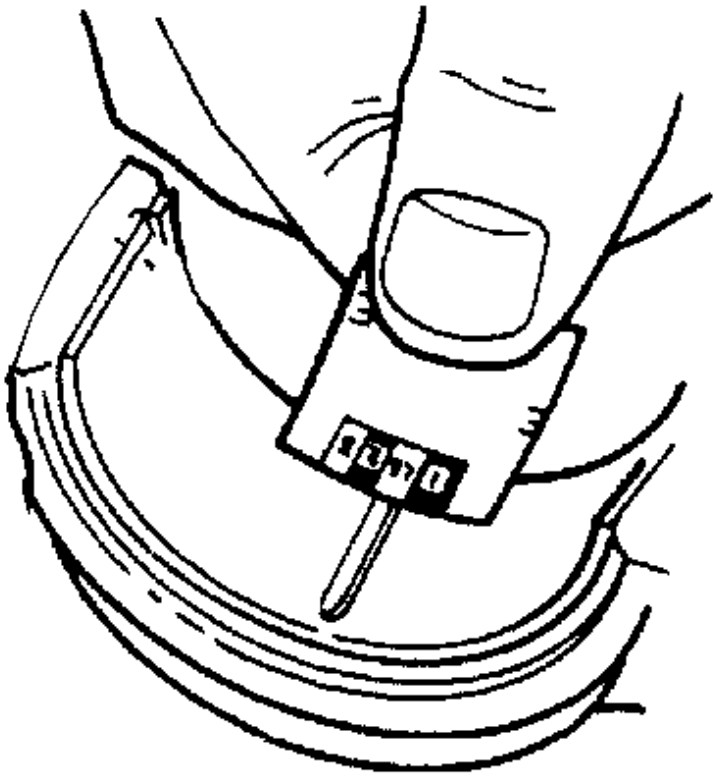

Fig. 469: Measuring Plastigage
Courtesy of GENERAL MOTORS COMPANY

9. Determine the connecting rod bearing clearance by comparing the width of the flattened plastic gaging material at its widest point with the graduation on the gaging material container.
10. Compare your measurements with the engine mechanical specifications. If the new bearings do not provide the proper crankshaft to connecting rod bearing clearance, inspect the following:

1. Re-measure the crankshaft connecting rod journals for the correct specified size and ensure the proper new bearings are being installed. If the crankshaft connecting rod journals are incorrectly sized, replace or regrind the crankshaft. Crankshaft machining is permitted and undersized bearings are available.
2. Re-measure the connecting rod bearing bore diameter to ensure proper size. The connecting rod is not machinable and the connecting rod must be replaced if out of specification.

11. Clean the plastic gaging material from the connecting rod bearing journals using a soft lint-free cloth.

Connecting Rod Bearing Clearance Measurement Procedure - Using EN-43690-A

The **EN-43690-A** checking tool has been developed as a more accurate method to measure connecting rod bearing clearances. The instructions below provide an overview of tool set-up and usage. For more detailed information, refer to the tool instruction sheets as supplied by the tool manufacturer.

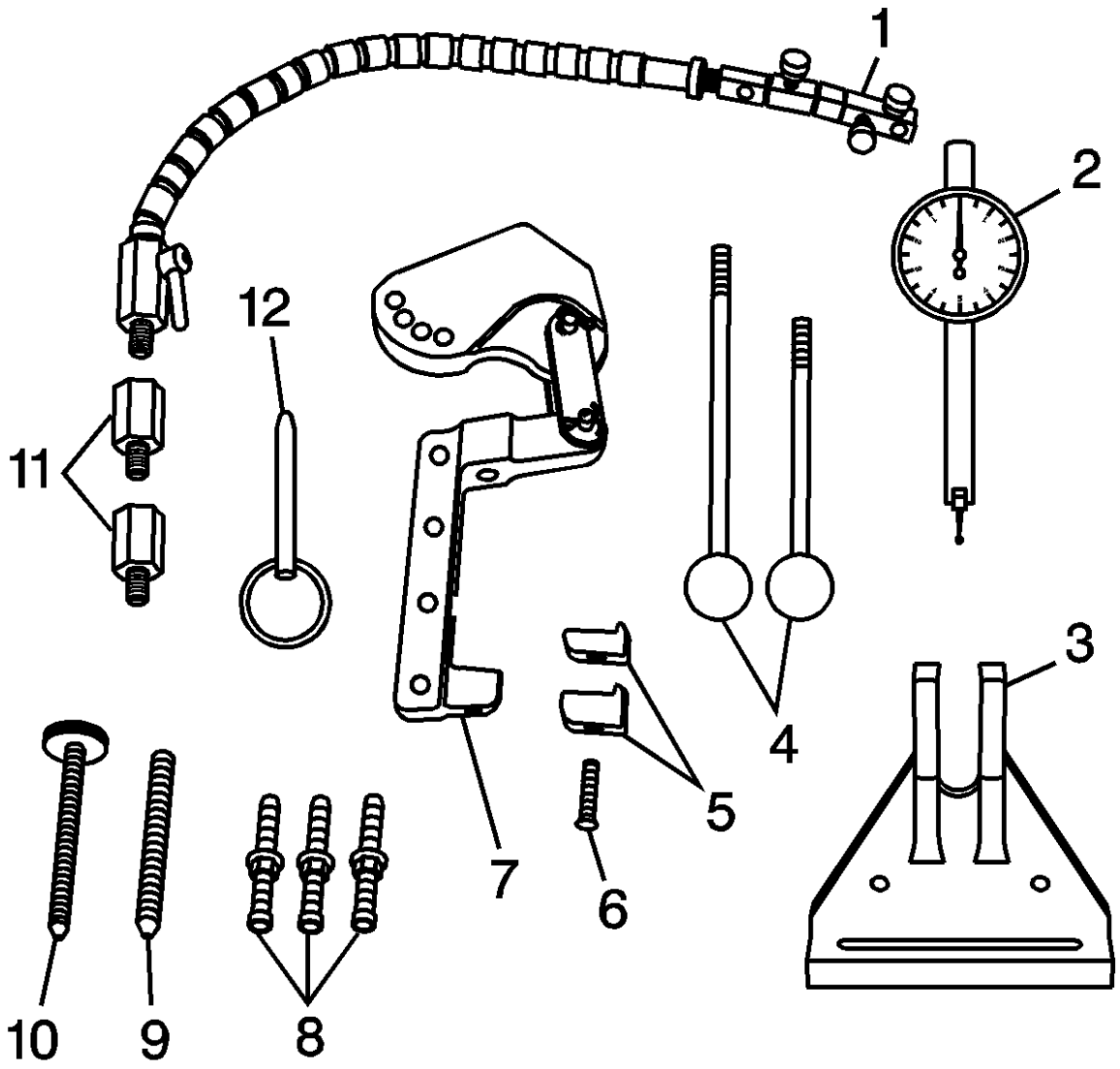

Fig. 470: Identifying Rod Bearing Clearance Checking Tool
Courtesy of GENERAL MOTORS COMPANY

EN 43690-A checking tool

- EN 43690-20 Swivel Base (1)
- EN 43690-19 Dial Indicator (2)
- EN 43690-2 Base (3)
- EN 43690-5, -6 Handle (4)
- EN 43690-10, -11 Foot (5)
- 280307 Screw (6)
- EN 43690-1 Pivot Arm Assembly (7)
- EN 43690-3, -7, -8 Screws (8)
- 280319 Screw (9)
- 280311 Screw (10)
- EN 43690-17, -18 Adapter (11)
- 280310 Pin (12)

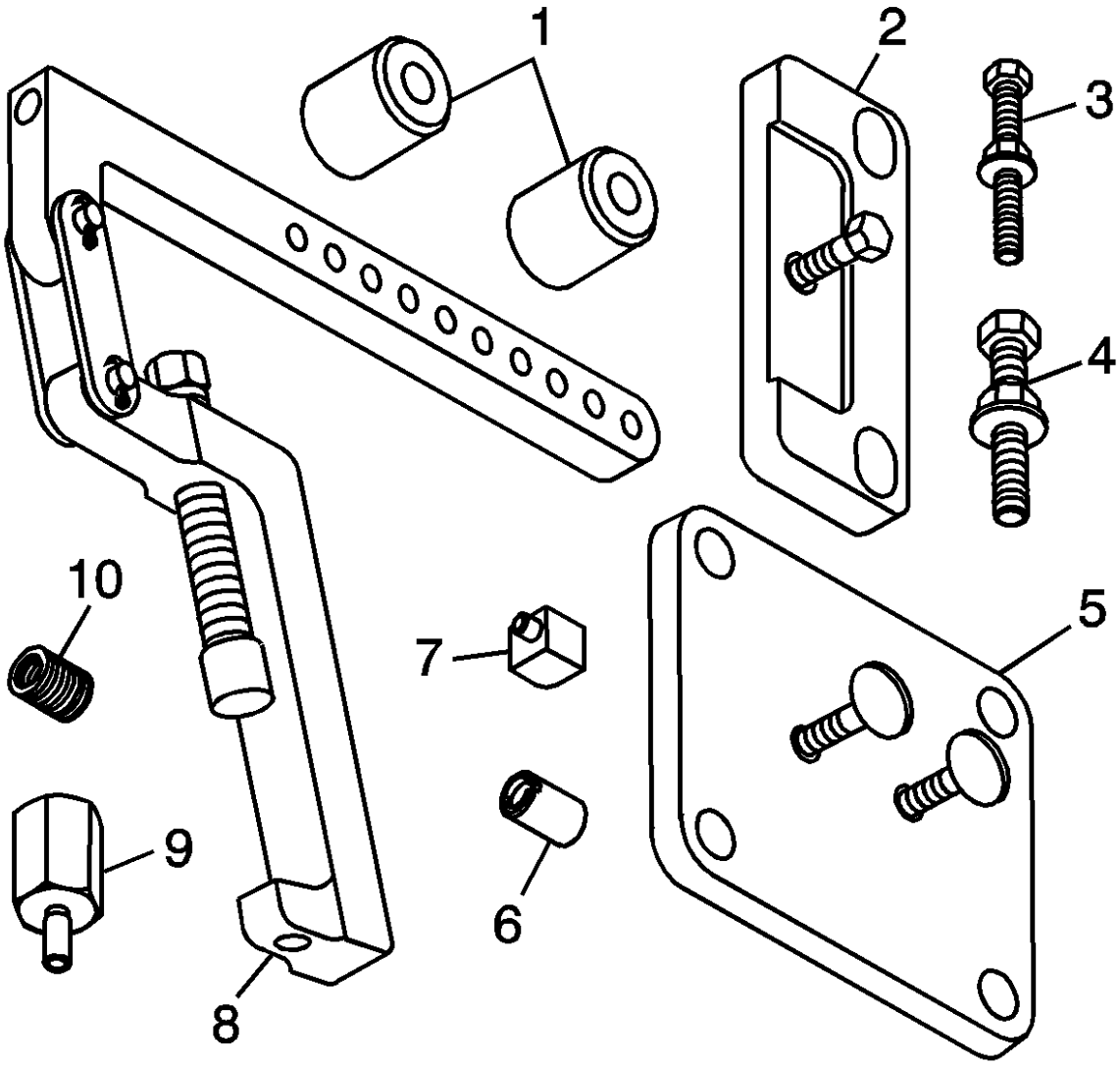

Fig. 471: Identifying Rod Bearing Clearance Tool - Adapter Kit

Courtesy of GENERAL MOTORS COMPANY

EN 43690-A adapter kit

- EN 43690-104 Spacer (1)
- EN 43690-105 Retainer Plate (2)
- 505478 Bolt (3)
- 511341 Bolt (4)
- EN 43690-106 Retainer Plate (5)
- EN 43690-107 Cap (6)
- EN 43690-102 Foot (7)
- EN 43690-101 Pivot Arm Assembly (8)
- EN 43690-103 Adapter (9)
- 505439 Adapter (10)

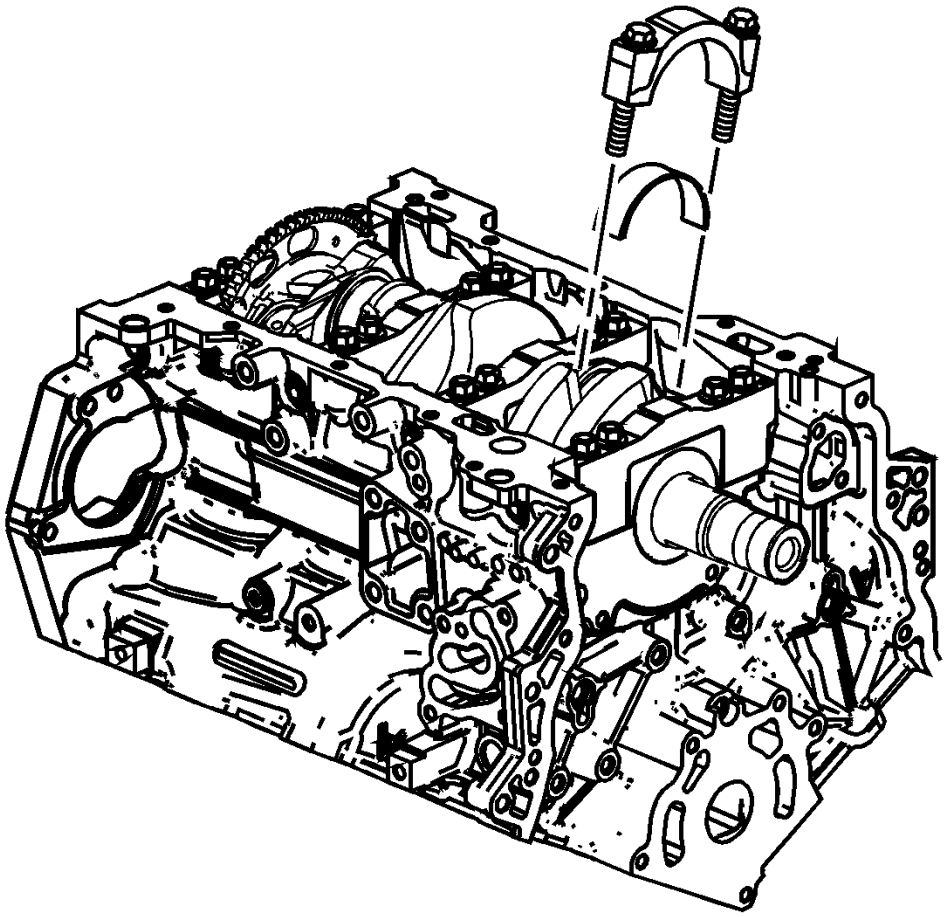

Fig. 472: View Of Connecting Rod Bearing & Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Connecting rod bearings that have been run in an engine should NEVER be reused.**

Before final assembly it is important to check the clearance of the new connecting rod bearings.

1. Install the connecting rod bearing into the connecting rod cap.

NOTE: **The connecting rod is non-directional therefore the connecting rod bearing lock tangs can face inboard or outboard.**

2. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.

CAUTION: **Refer to Fastener Caution .**

CAUTION: **Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine damage.**

NOTE: **Reuse the old connecting rod bolts ONLY for measuring the connecting rod bearing clearance.**

3. Install the connecting rod bolts into the connecting rod cap.
4. Tighten the connecting rod bolts.
    1. First Pass

       Tighten the connecting rod bolts to 25 N.m (18 lb ft).

    2. Final Pass

       Tighten the connecting rod bolts an additional 110 degrees using the **EN 45059** meter.
5. Rotate the crankshaft until the crankshaft journal and the connecting rod to be measured is in the 12 o'clock position.

NOTE: **The crankshaft must be secure with no movement or rotation in order to obtain an accurate reading.**

6. Remove the crankshaft main bolts required to install the retainer plate EN 43690-105.

NOTE: **Do not allow the EN 43690-105 retainer plate screw to contact the reluctor ring.**

7. Install the EN 43690-105 and crankshaft main bolts.
8. Loosen the connecting rod bolts until the torque reading is zero.

9. Re-tighten the connecting rod bolts.
    1. First Pass

       Tighten the connecting rod bolts to 25 N.m (18 lb ft).

    2. Final Pass

       Tighten the connecting rod bolts an additional 110 degrees using the **EN 45059** meter.

10. During and after installation, ensure each piston is positioned properly in the correct cylinder. The locating arrow on the top of each piston must be pointing toward the front of the engine.
11. Repeat these procedures for the remaining piston/connecting rod assemblies using the **EN-48589** socket in order to rotate the crankshaft.

Connecting Rod Final Assembly Procedure

1. Guide the connecting rod away from the crankshaft connecting rod journal in order to lubricate the crankshaft connecting rod bearing journal.
2. Apply a liberal amount of crankshaft prelube or clean engine oil to the crankshaft connecting rod bearing journal. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.
3. Guide the connecting rod to the crankshaft connecting rod journal.
4. Install the connecting rod end cap on its original connecting rod and ensure the bearing lock tangs are aligned on the same side of the rod.

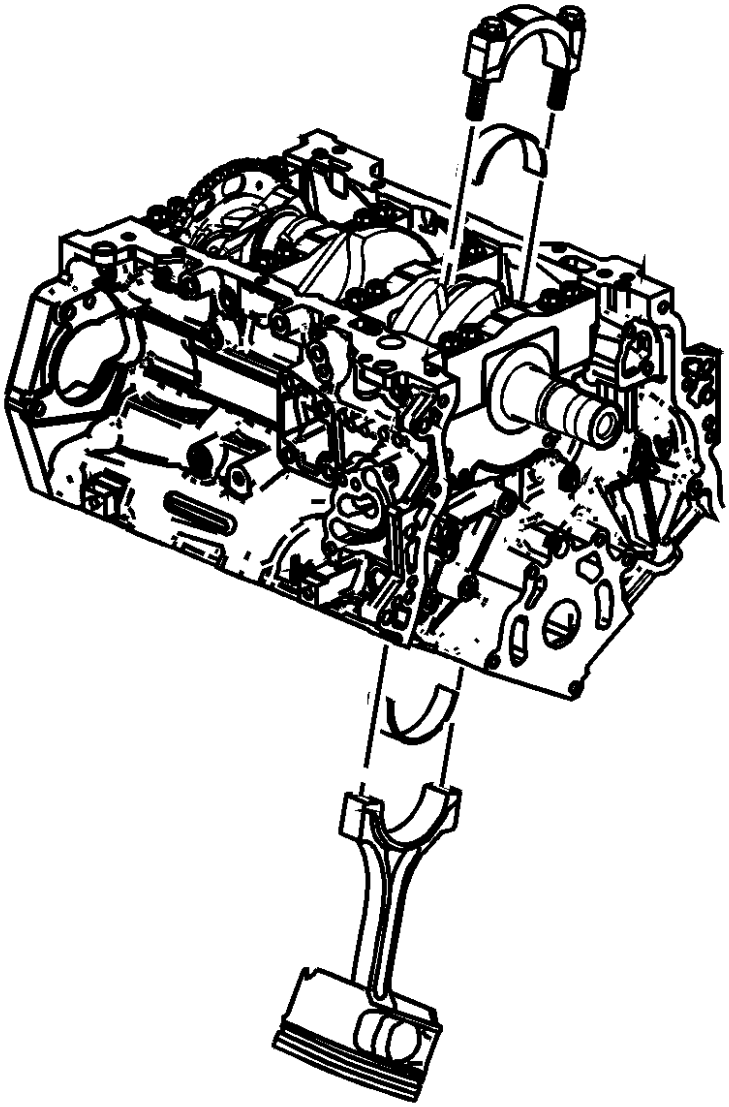

Fig. 473: Identifying Piston & Connecting Rod Assembly
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not lubricate the NEW connecting rod bolts. The NEW bolts have a pre-applied graphite lubricant. Applying lubricant to the connecting rod bolts will effect the clamp load when the connecting rod bolts are torqued. Improper clamp load can lead to component failure and extensive engine damage.

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

5. Install the NEW connecting rod bolts into the connecting rod cap.
6. Tighten the connecting rod bolts.
    1. First Pass

Tighten the connecting rod bolts to 25 N.m (18 lb ft).

2. Final Pass

   Tighten the connecting rod bolts an additional 110 degrees using the **EN 45059** meter.

7. During and after installation, ensure each piston is positioned properly in the correct cylinder. The locating arrow on the top of each piston must be pointing toward the front of the engine.
8. Repeat these procedures for the remaining piston/connecting rod assemblies using the **EN 45059** meter in order to rotate the crankshaft.

CRANKSHAFT REAR OIL SEAL AND HOUSING INSTALLATION

Special Tools

- **EN-42183** Handle
- **EN-46109** Guide Pin Set
- **EN-47839** Crankshaft Rear Oil Seal Installation Tool

For equivalent regional tools, refer to **Special Tools** .

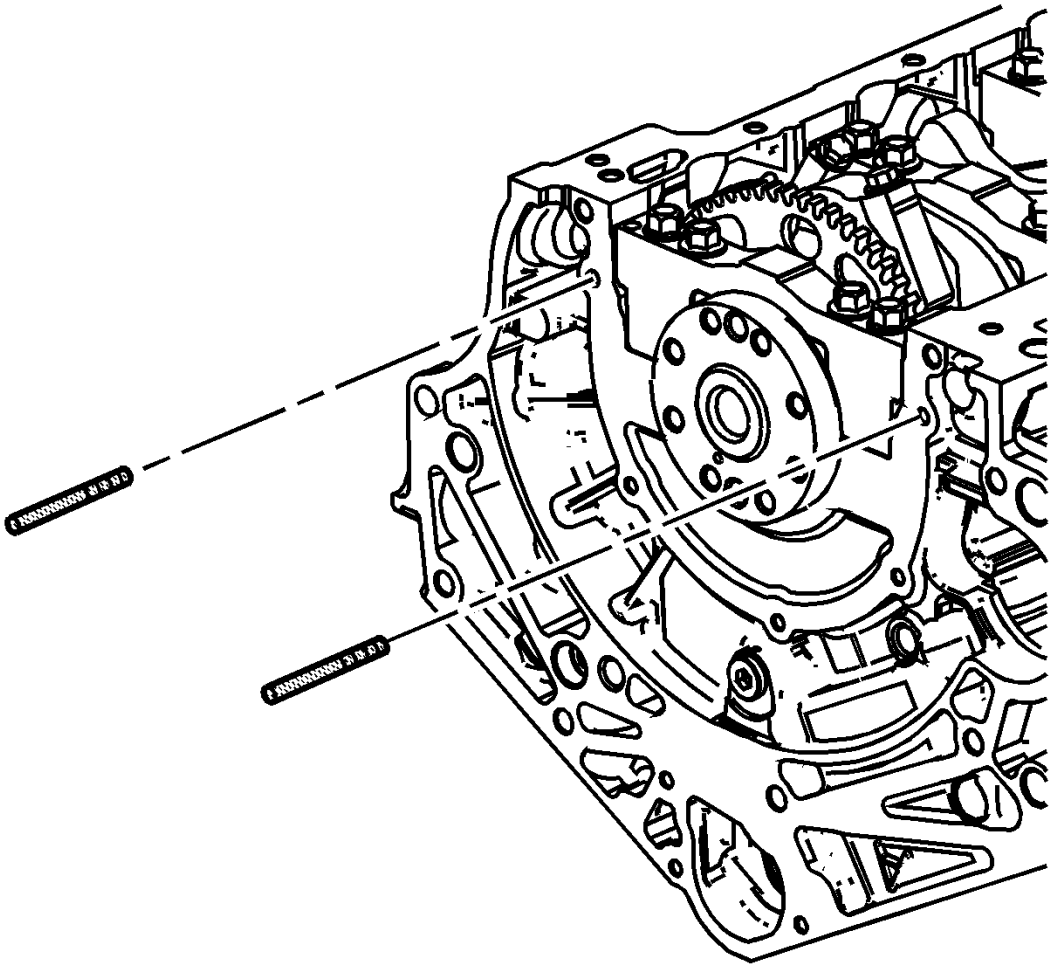

Fig. 474: Guide Pin Set
Courtesy of GENERAL MOTORS COMPANY

1. Install the 6 mm (0.236 in) guides from the **EN-46109** pin set into the 2 crankshaft rear oil seal housing corner bolt holes of the engine block.

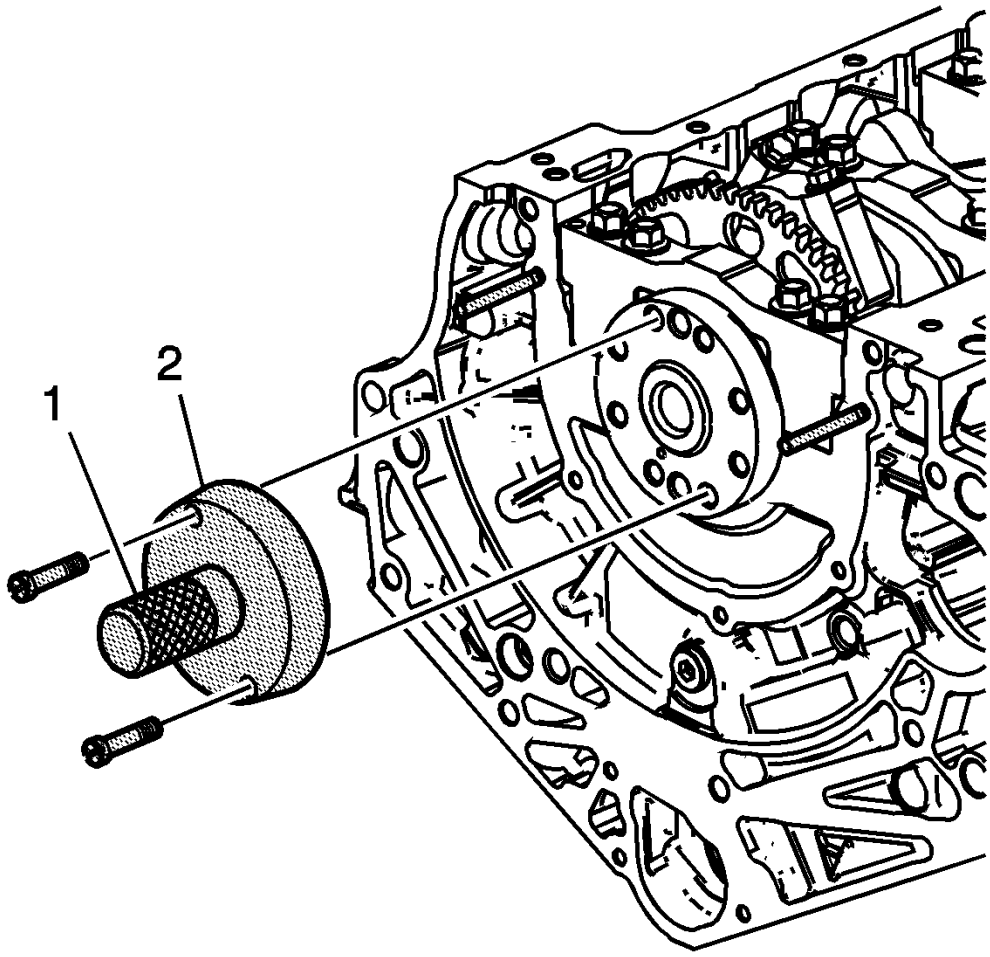

Fig. 475: Crankshaft Rear Seal Installer
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-47839** tool with the **EN-42183** handle (1, 2) onto the rear of the crankshaft flange.

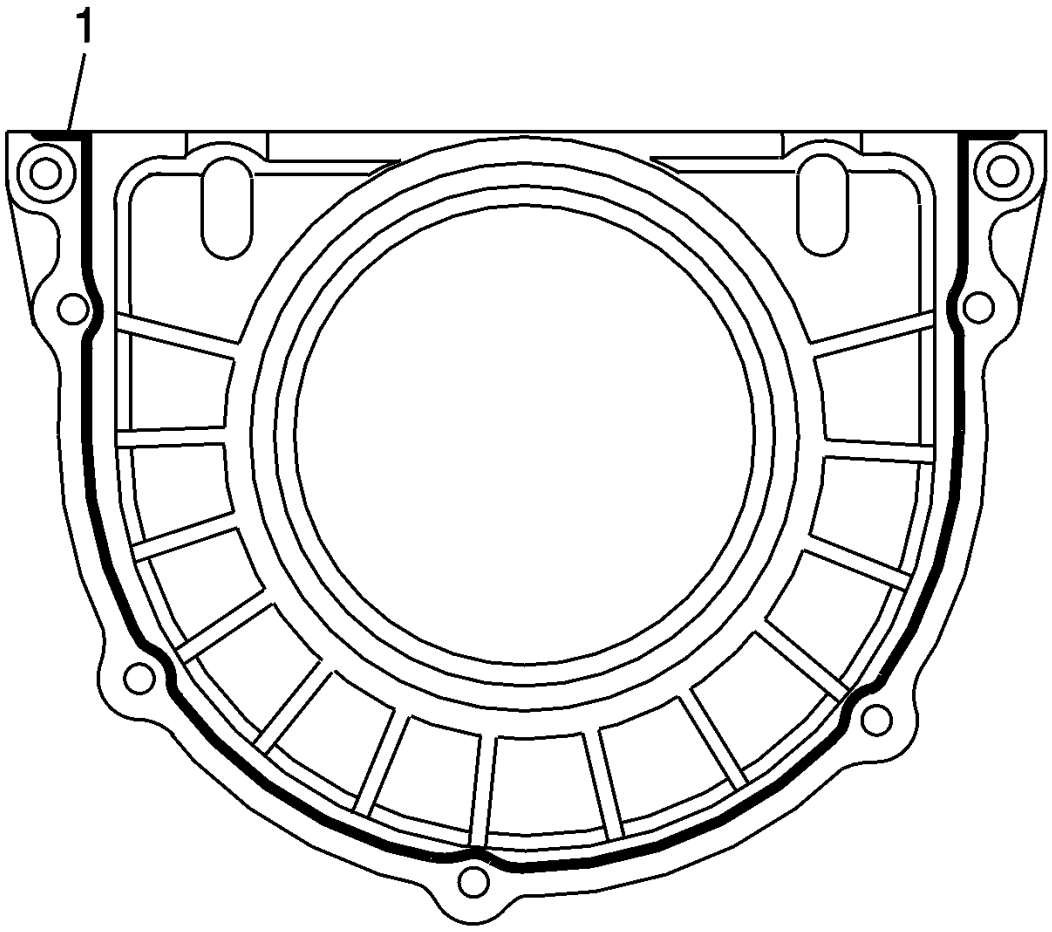

Fig. 476: Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

3. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
4. Place a 3 mm (0.118 in) bead of RTV sealant to the NEW crankshaft rear oil seal housing as shown (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

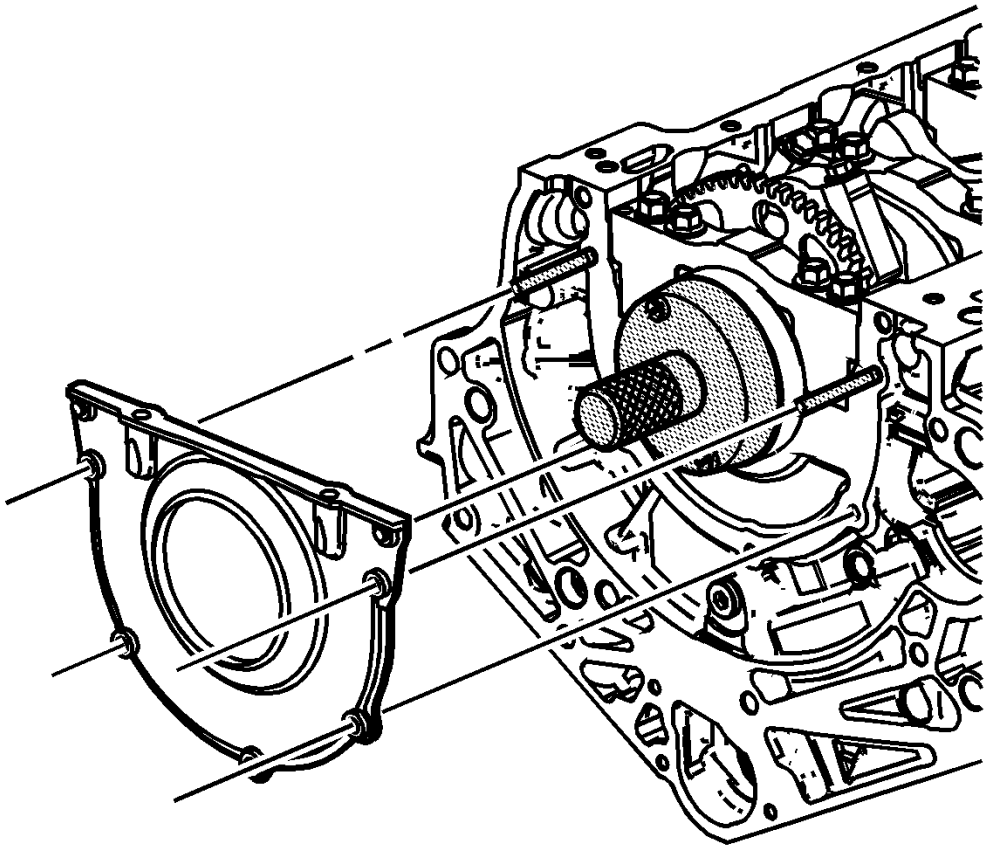

Fig. 477: Identifying Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

NOTE: **DO NOT allow any engine oil on the area where the crankshaft rear oil seal housing is to be installed.**

5. Install the crankshaft rear oil seal housing to the engine block.

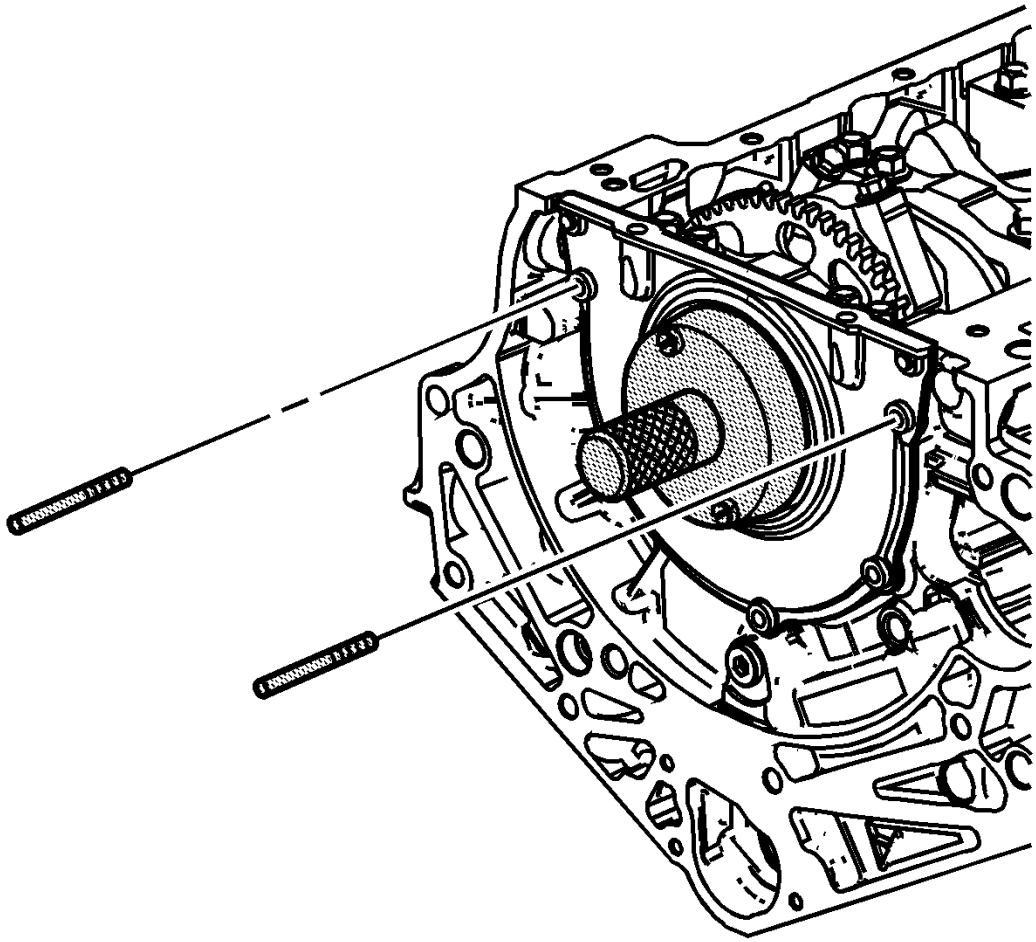

Fig. 478: Guide Pin Set
Courtesy of GENERAL MOTORS COMPANY

6. Remove the **EN-46109** pin set 6 mm (0.236 in) guides from the engine block.

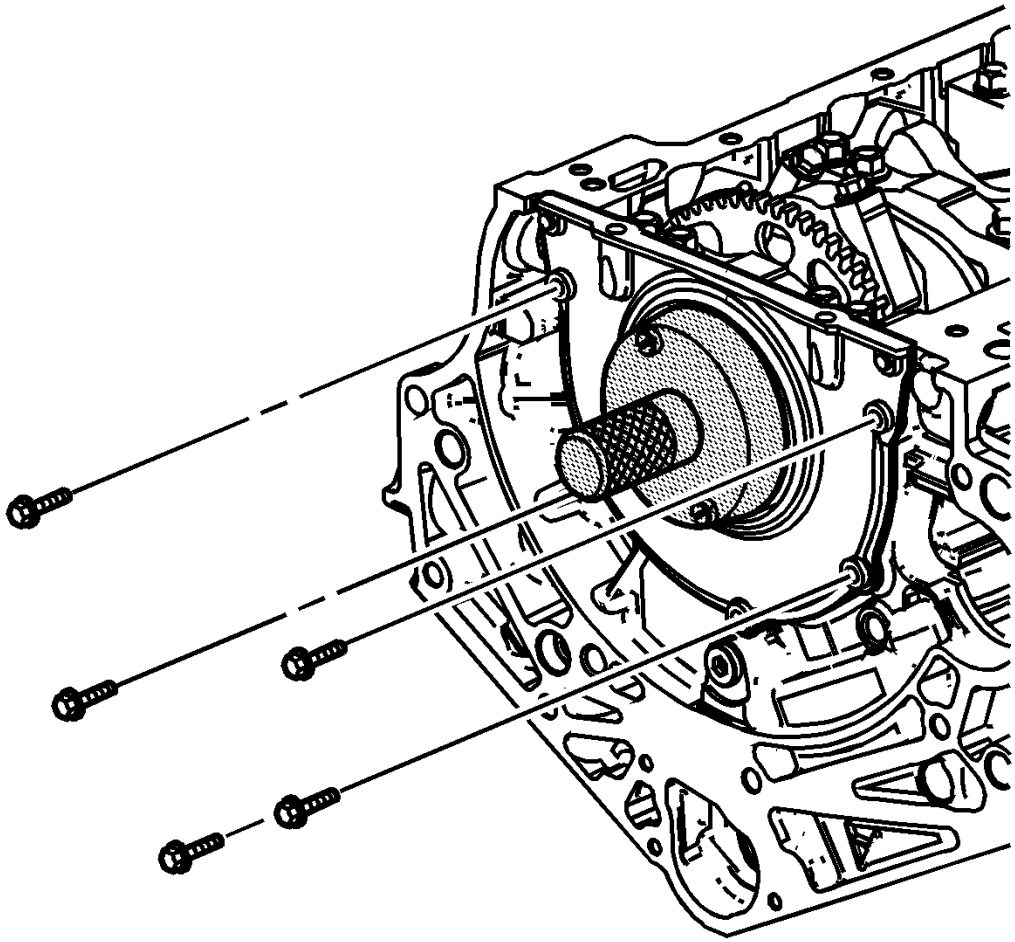

Fig. 479: Locating Crankshaft Rear Oil Seal Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the crankshaft rear oil seal housing bolts.

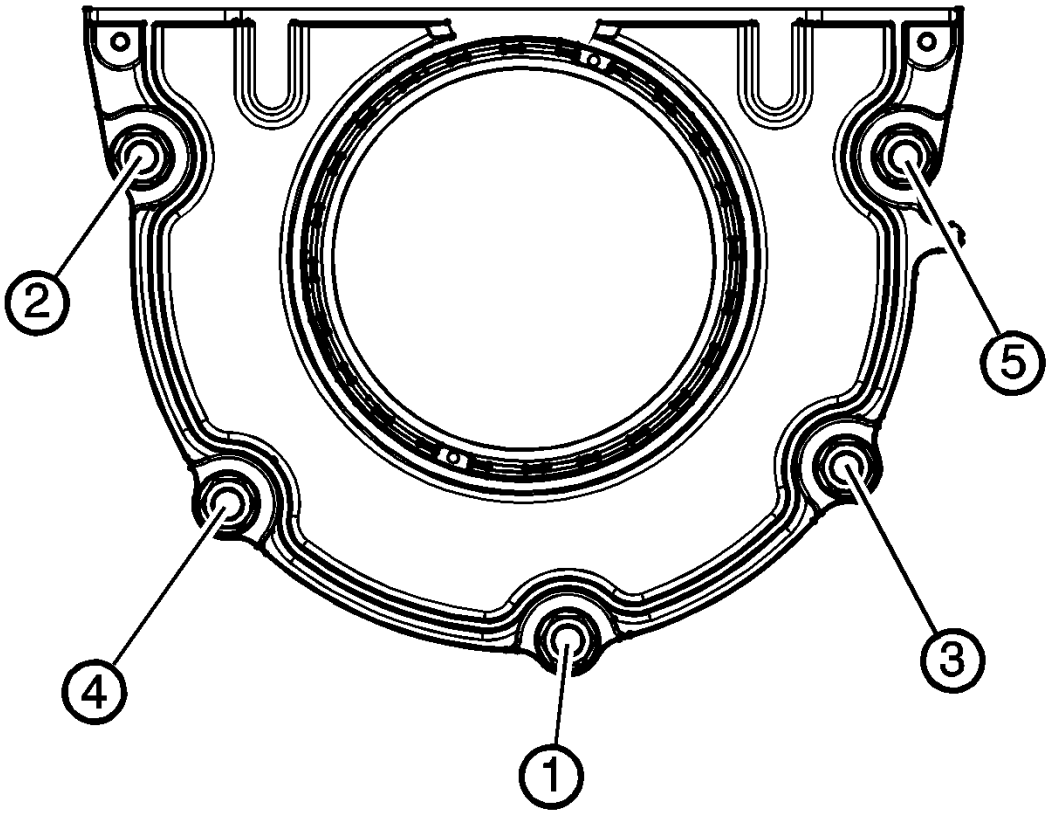

Fig. 480: Identifying Crankshaft Rear Oil Seal Housing Bolts Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

8. Tighten the crankshaft rear oil seal housing bolts in sequence and tighten to 10 N.m (89 lb in).

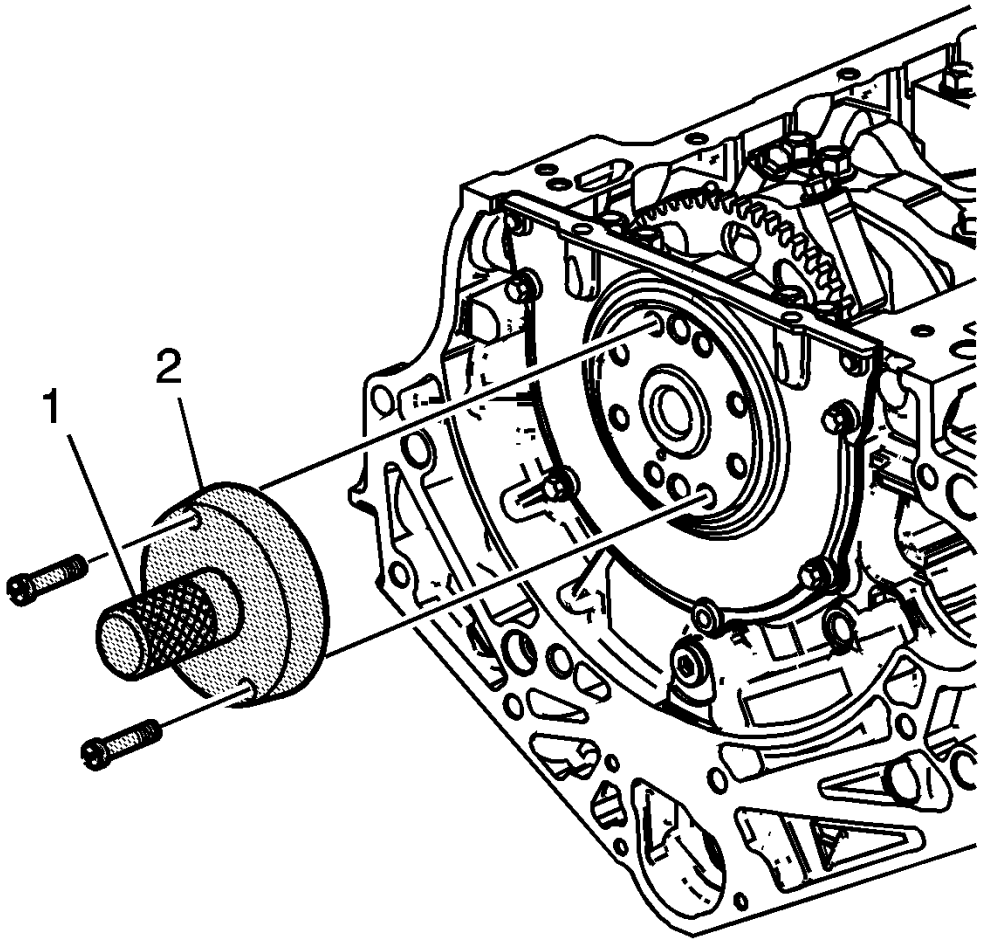

Fig. 481: Crankshaft Rear Oil Seal Installation Tool
Courtesy of GENERAL MOTORS COMPANY

9. Remove the **EN-47839** tool and **EN-42183** handle (1, 2) from the crankshaft flange.

OIL PUMP INSTALLATION

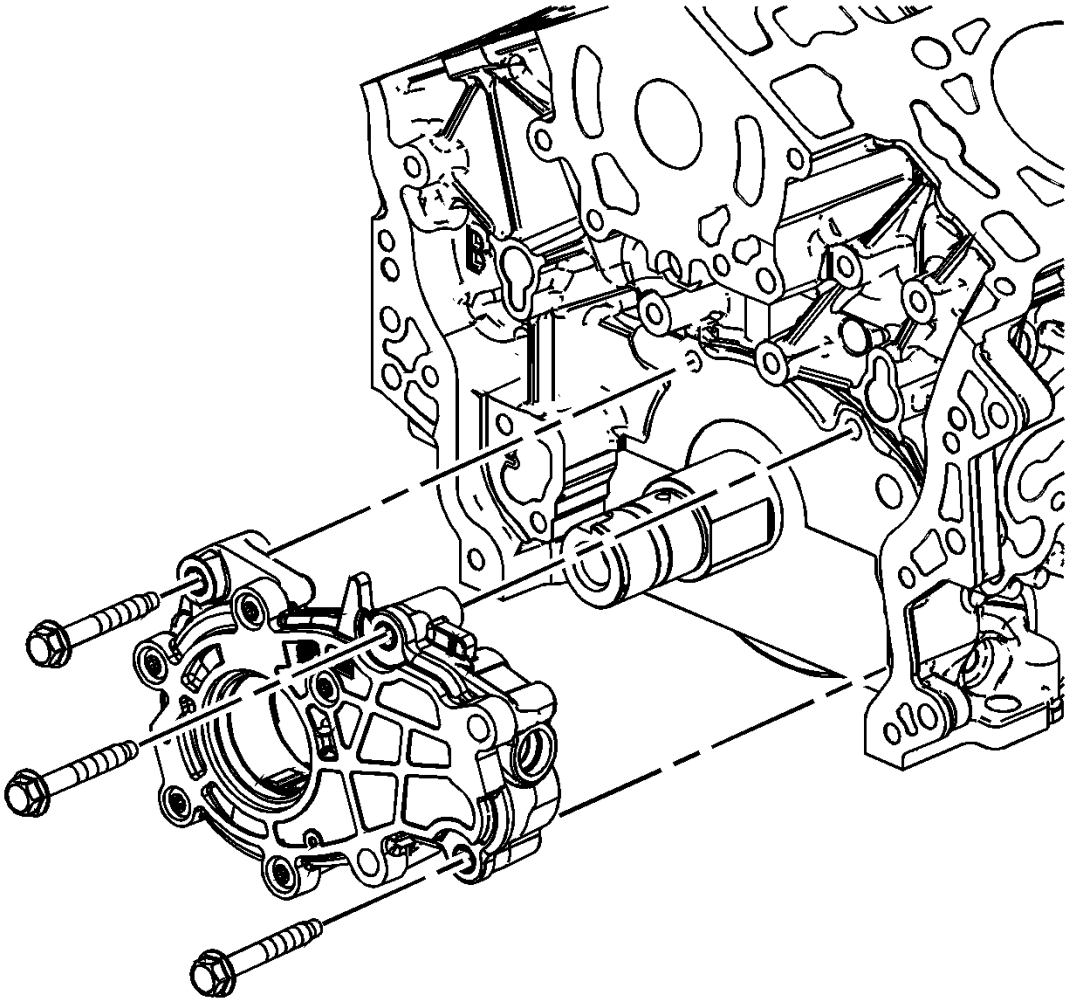

Fig. 482: Identifying Oil Pump & Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Align the oil pump drive gear with the crankshaft flats and install the oil pump to the engine block.
2. Align the pump body with the mounting holes in the cylinder block.

CAUTION: Refer to Fastener Caution .

3. Install the oil pump bolts and tighten to 25 N.m (18 lb ft).

OIL PAN INSTALLATION

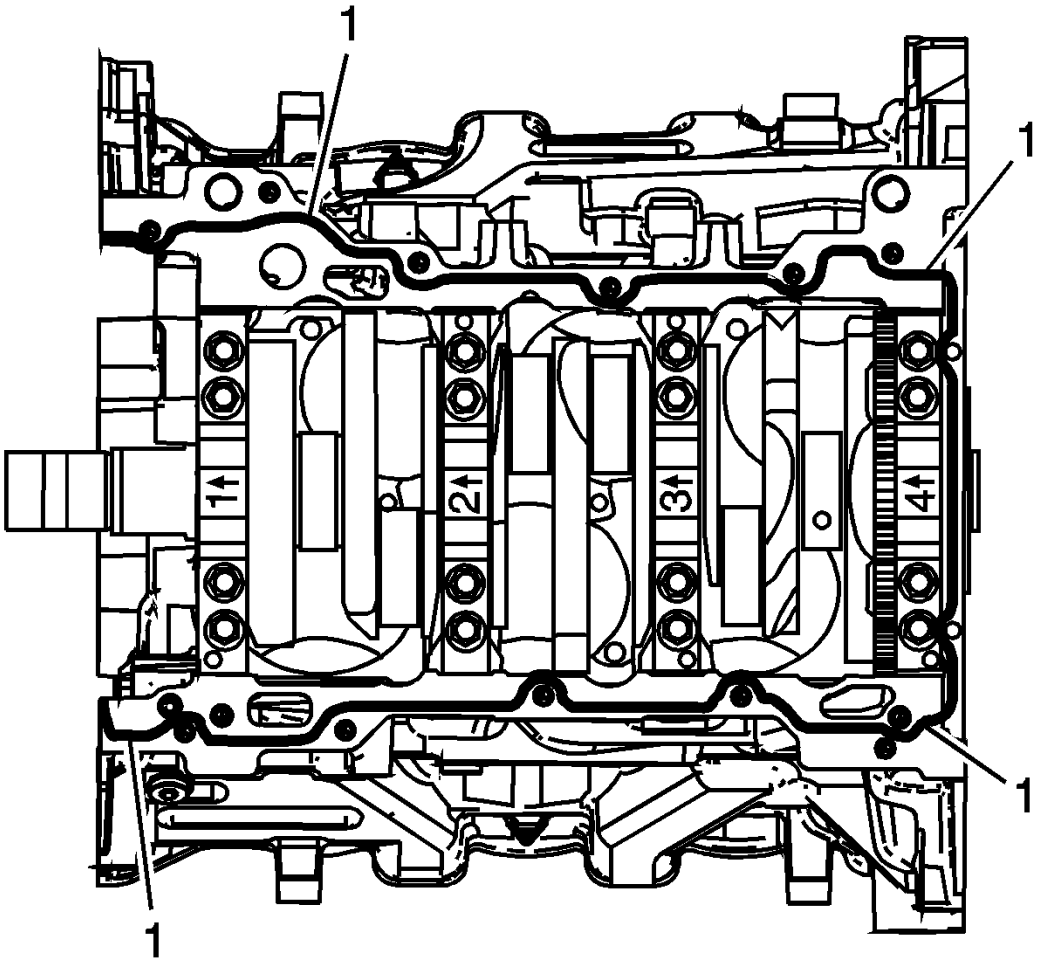

Fig. 483: Identifying Sealant Application Locations On Block Pan Rail & Crankshaft Rear Oil Seal Housing
Courtesy of GENERAL MOTORS COMPANY

1. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
2. Place a 3 mm (0.118 in) bead of RTV sealant, on the block pan rail and the crankshaft rear oil seal housing (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

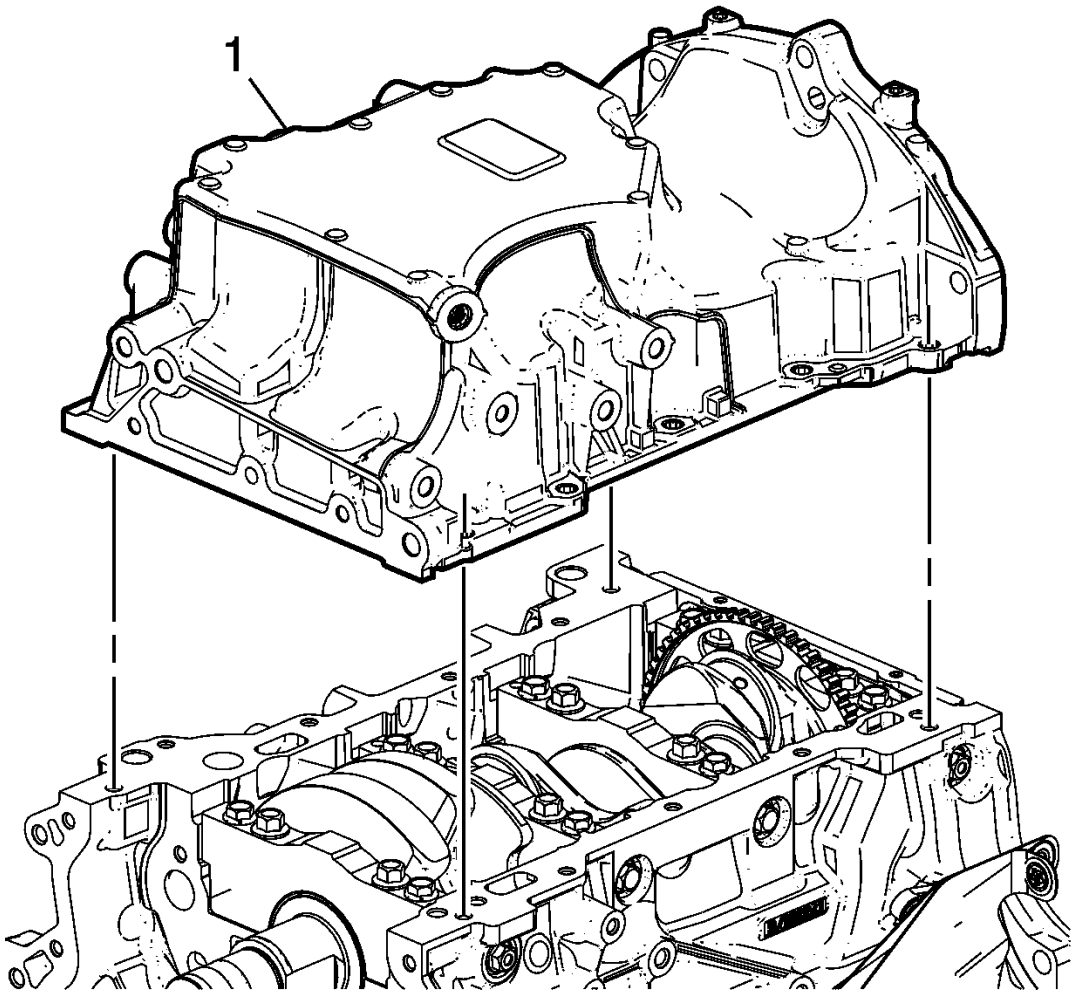

Fig. 484: View Of Engine Oil Pan
Courtesy of GENERAL MOTORS COMPANY

3. Position the oil pan (1) onto the block.

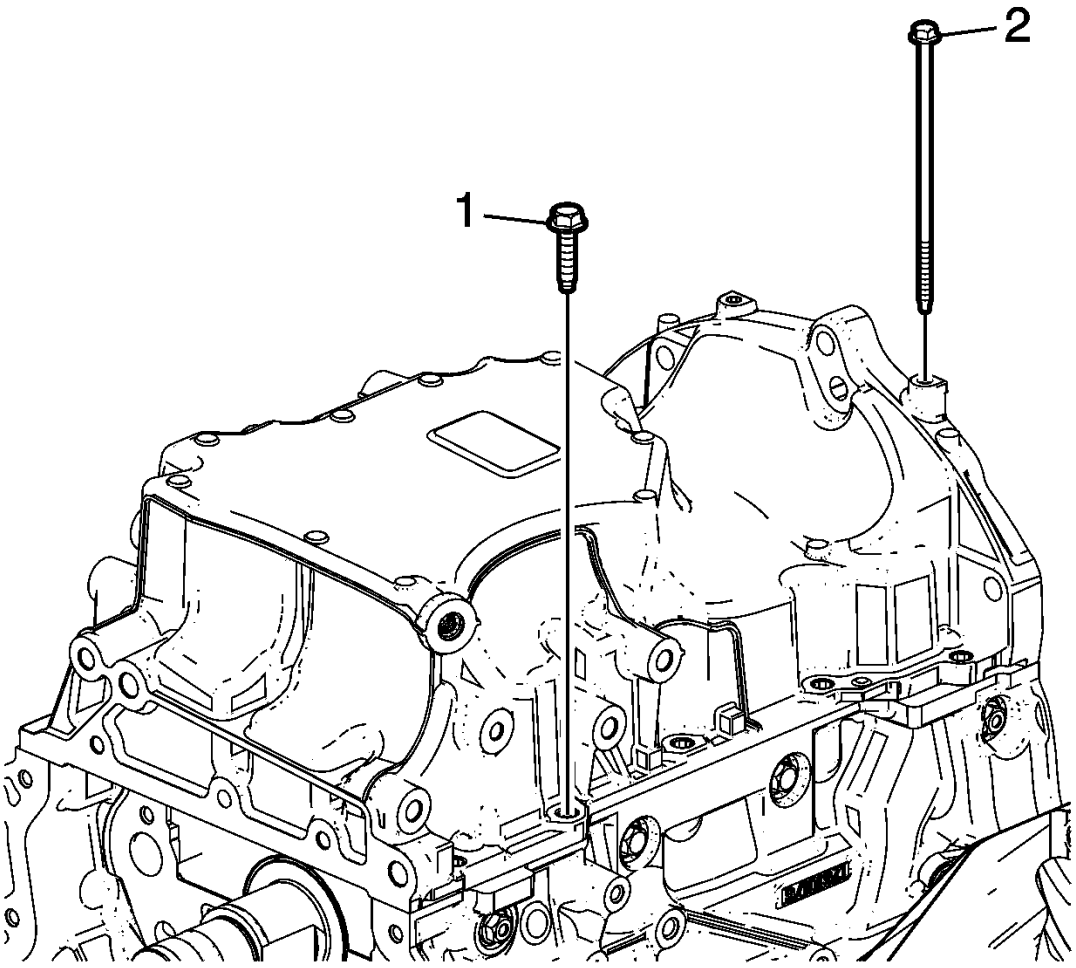

Fig. 485: Engine Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Loosely install the oil pan bolts (1) and (2).

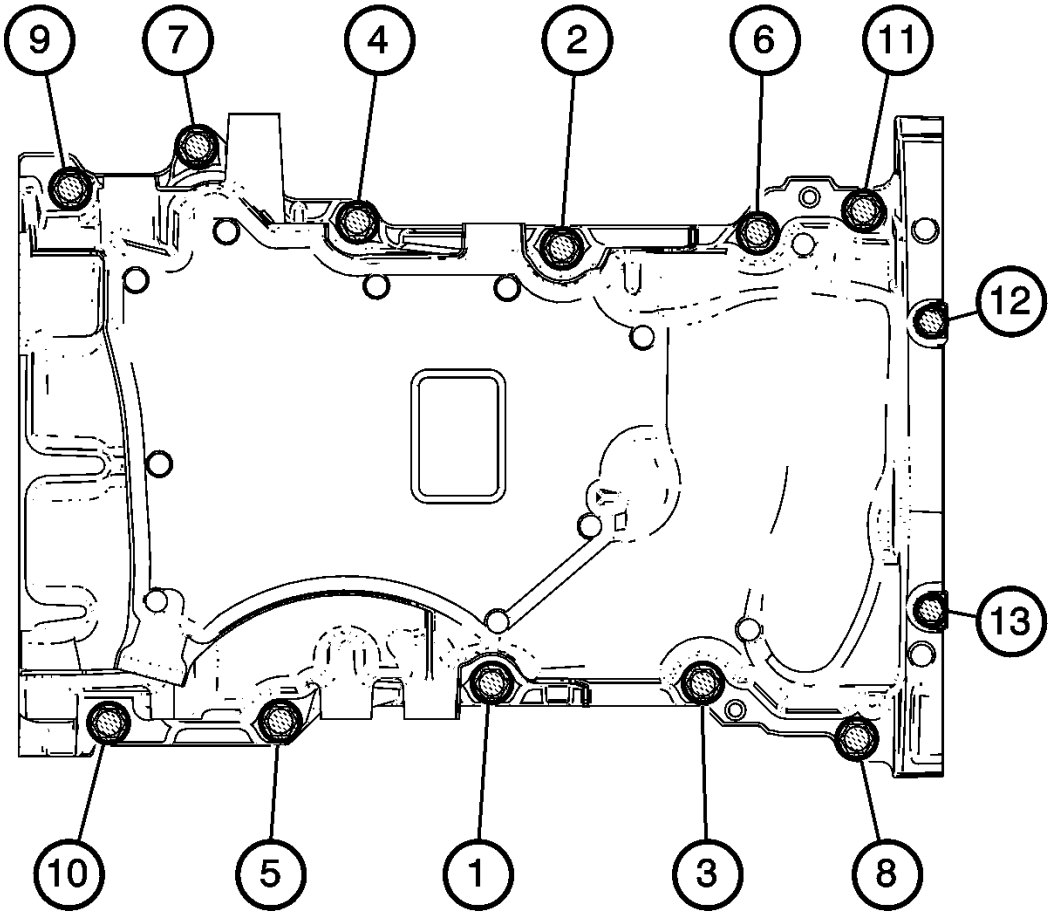

Fig. 486: Engine Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Tighten the oil pan bolts in sequence shown.
    1. Tighten the 8 mm bolts (1-11) to 25 N.m (18 lb ft).
    2. Tighten the 6 mm bolts (12, 13) to 10 N.m (89 lb in).

CYLINDER HEAD INSTALLATION - RIGHT SIDE (LFX)

Special Tools

EN-45059 Angle Meter

For equivalent regional tools, refer to **Special Tools** .

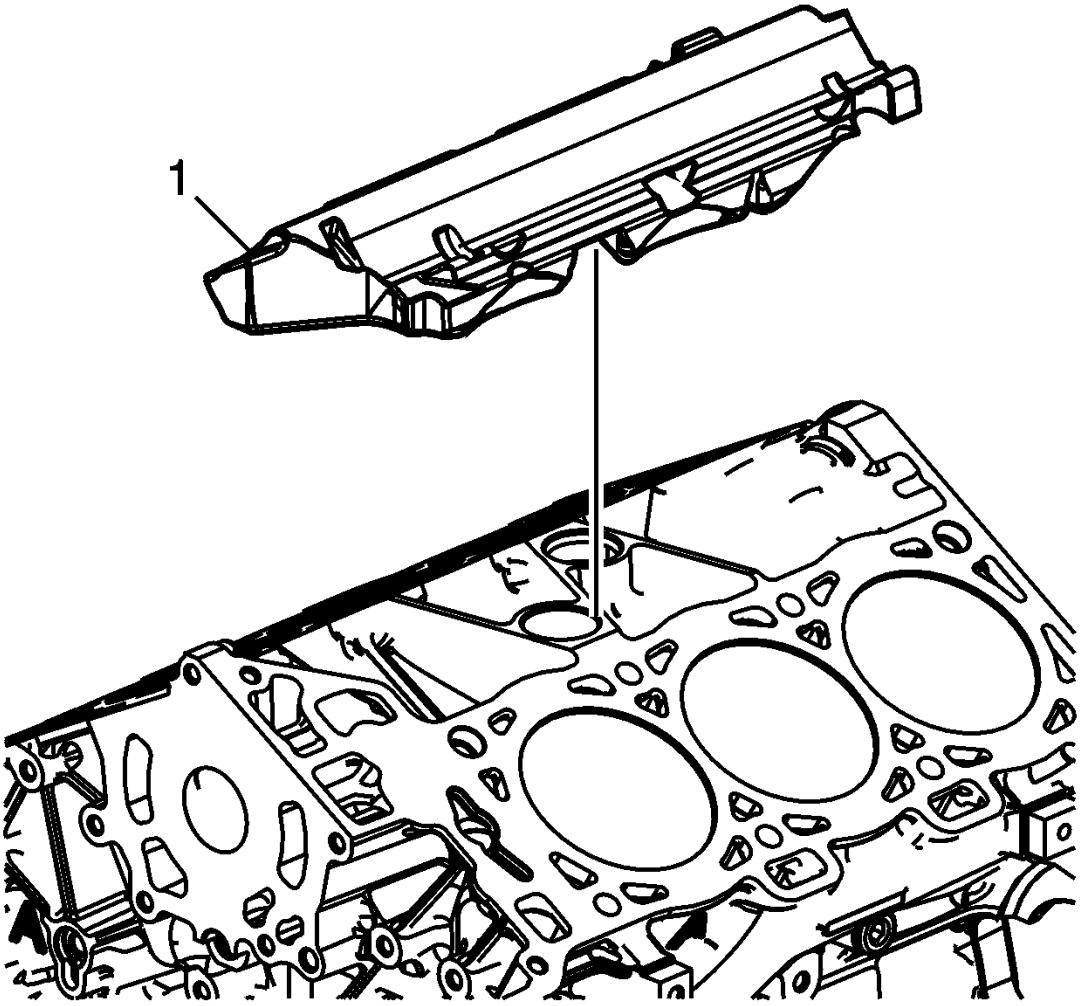

Fig. 487: Fuel Injection Fuel Rail Noise Shield-Lower
Courtesy of GENERAL MOTORS COMPANY

1. Install the fuel injection fuel rail noise shield-lower (1).

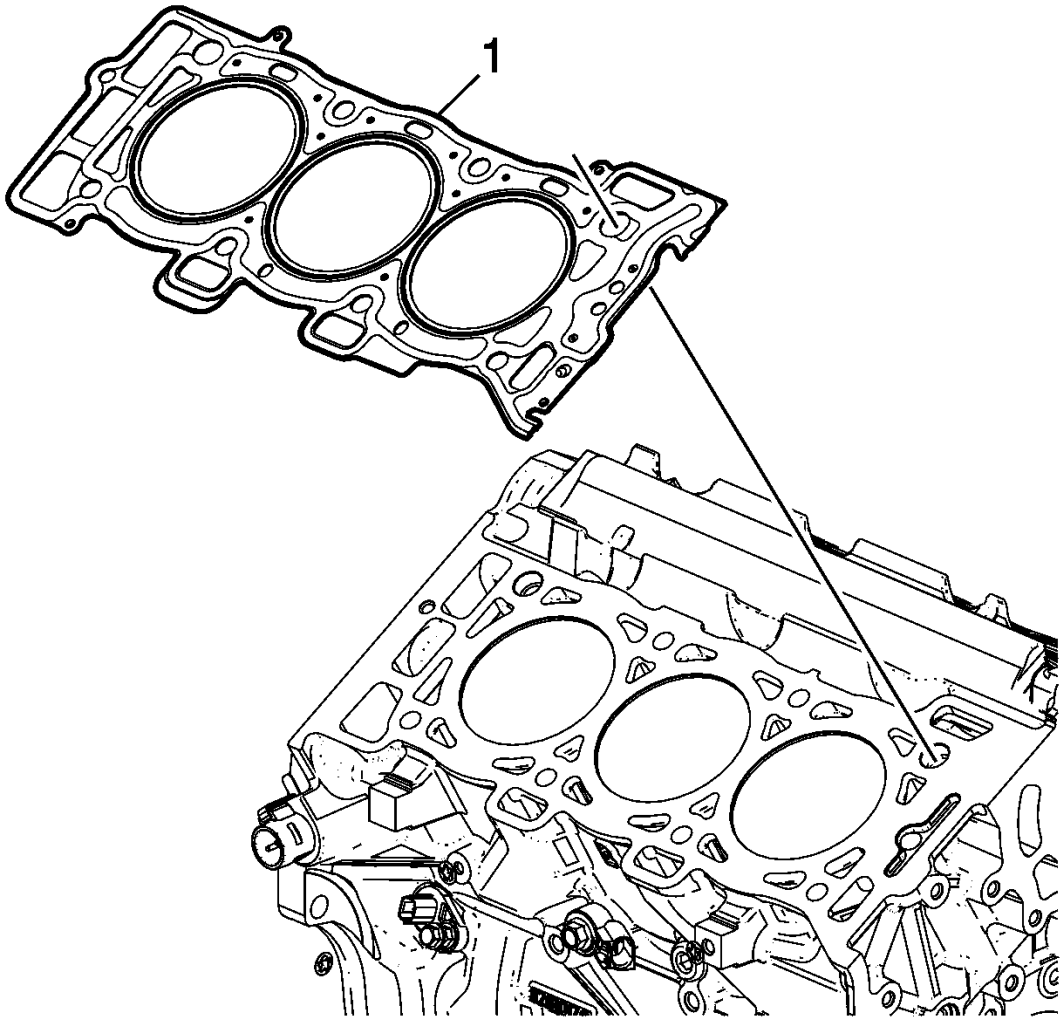

Fig. 488: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

2. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
3. Install a NEW right cylinder head gasket (1) using the deck face locating pins for retention.

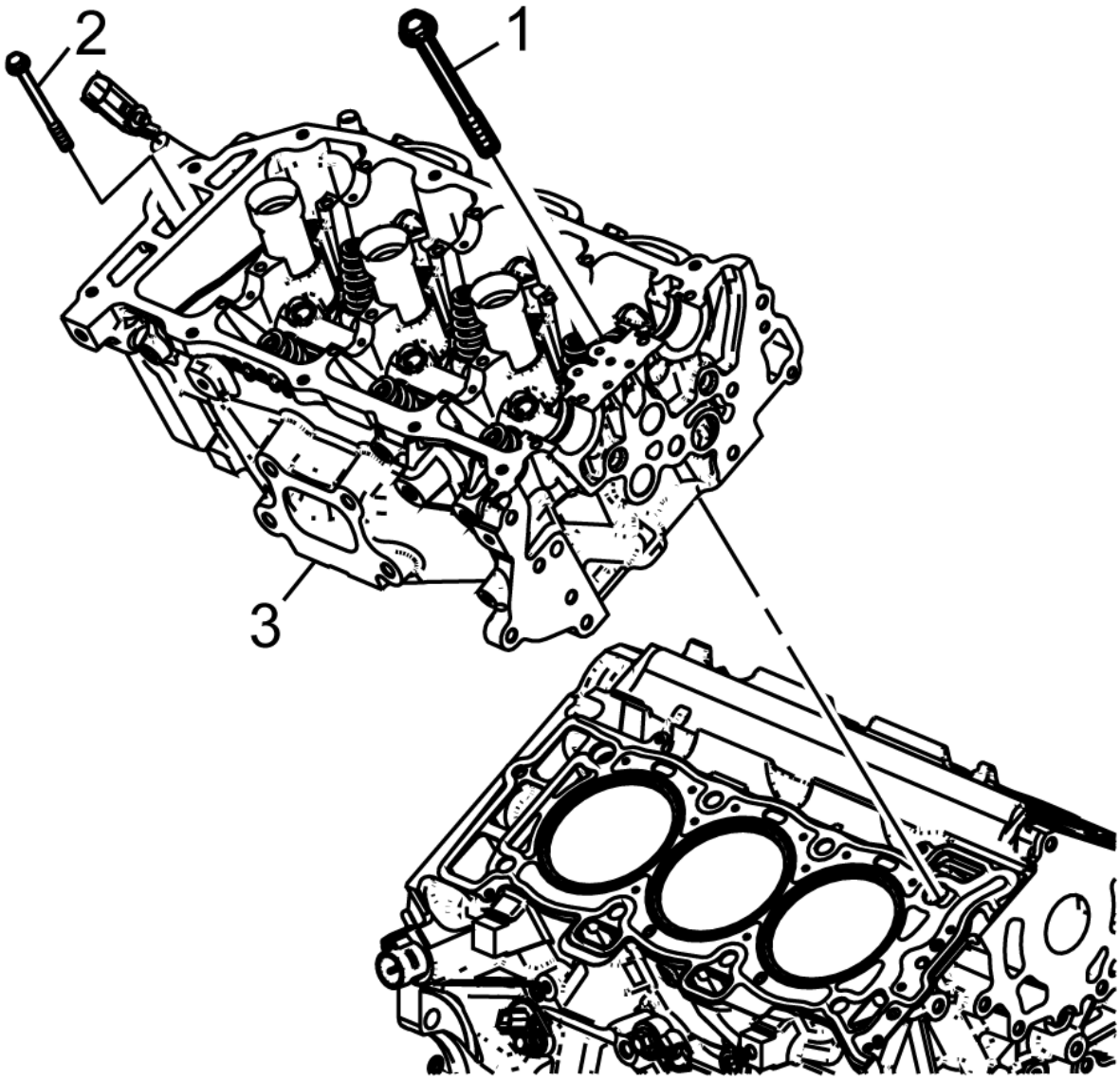

Fig. 489: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Align the right cylinder head (2) with the deck face locating pins.
5. Place the right cylinder head in position on the deck face.

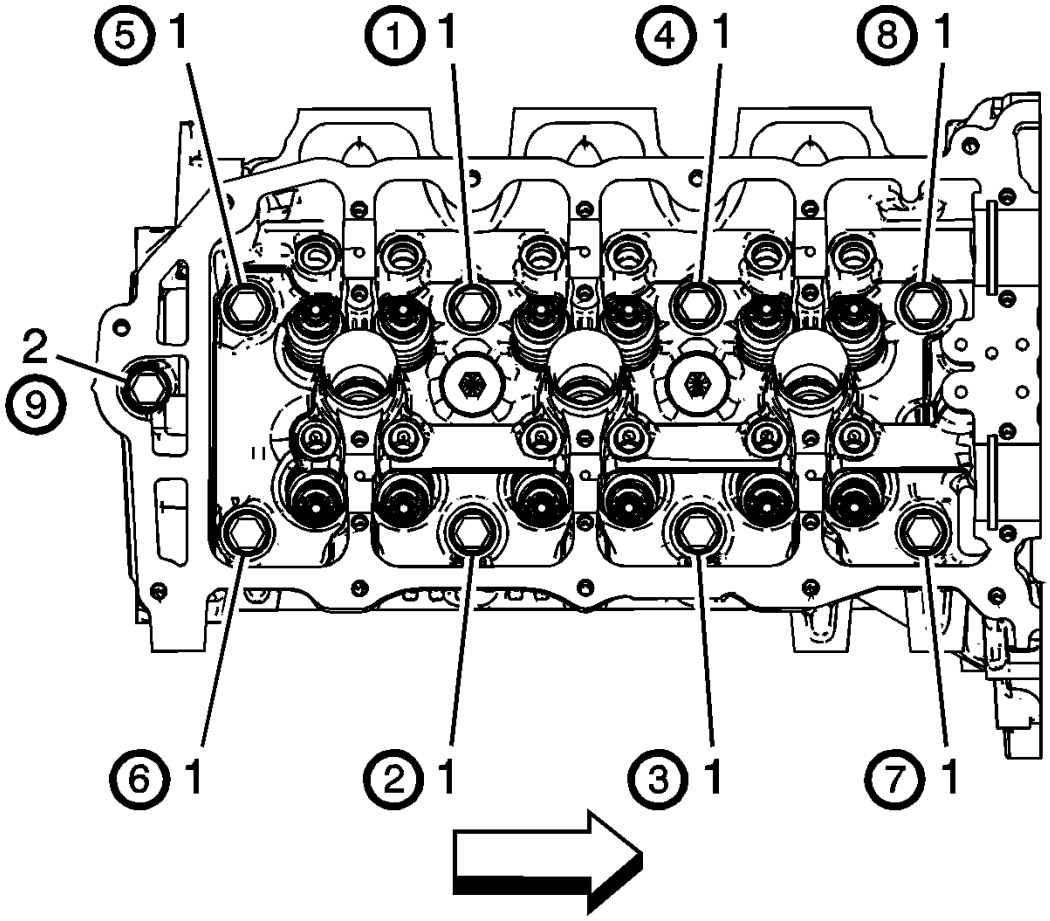

Fig. 490: Identifying M11 Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

NOTE: **DO NOT allow oil on the cylinder head bolt bosses.**

6. Install the NEW M11 cylinder head bolts (1).
    1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
    2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **EN 45059** meter.
7. Install the NEW M8 cylinder head bolt (2).
    1. Tighten the M8 cylinder head bolt a first pass to 15 N.m (11 lb ft).
    2. Tighten the M8 cylinder head bolt a second pass an additional 75 degrees using the **EN 45059**

meter.

VALVE LIFTER INSTALLATION - RIGHT SIDE

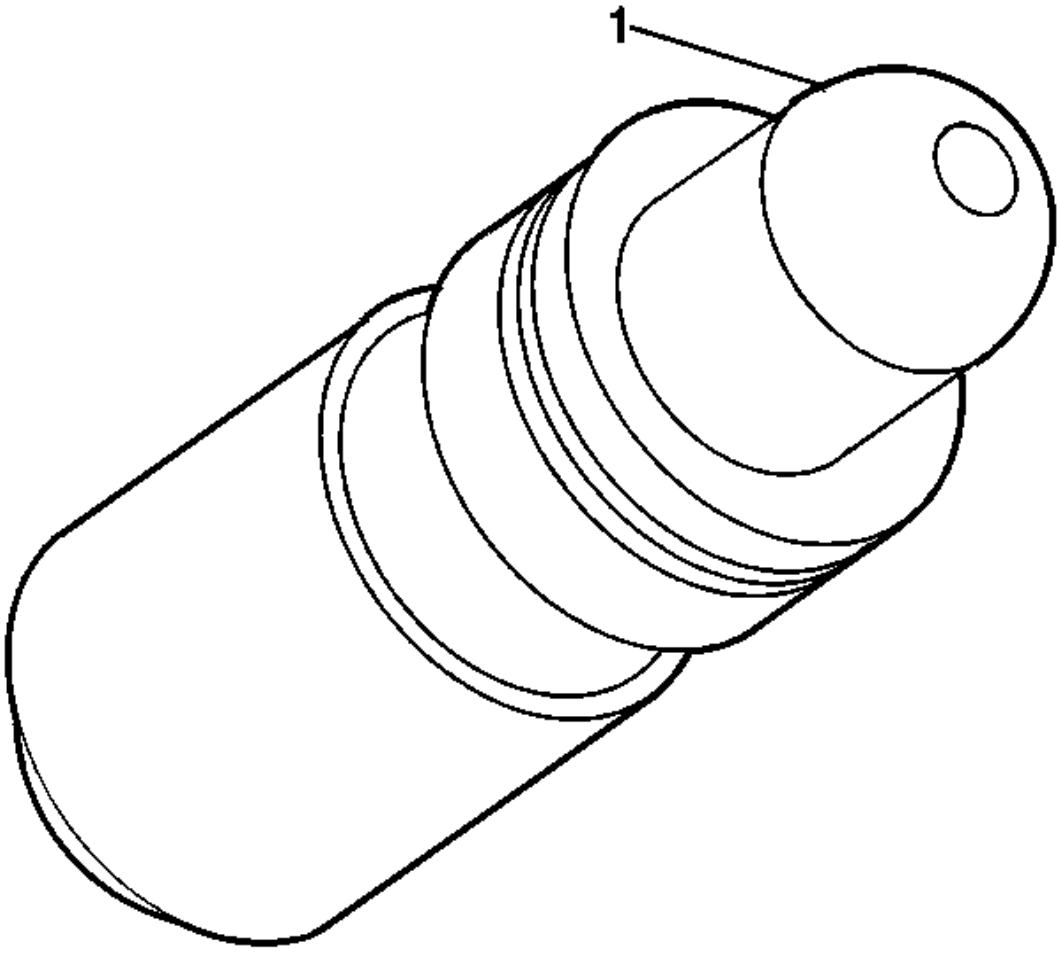

Fig. 491: View Of Valve Lifter
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.**

NOTE: **Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.**

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended engine oil. Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.
2. Lubricate the SHLA bores in the cylinder head with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended engine oil.

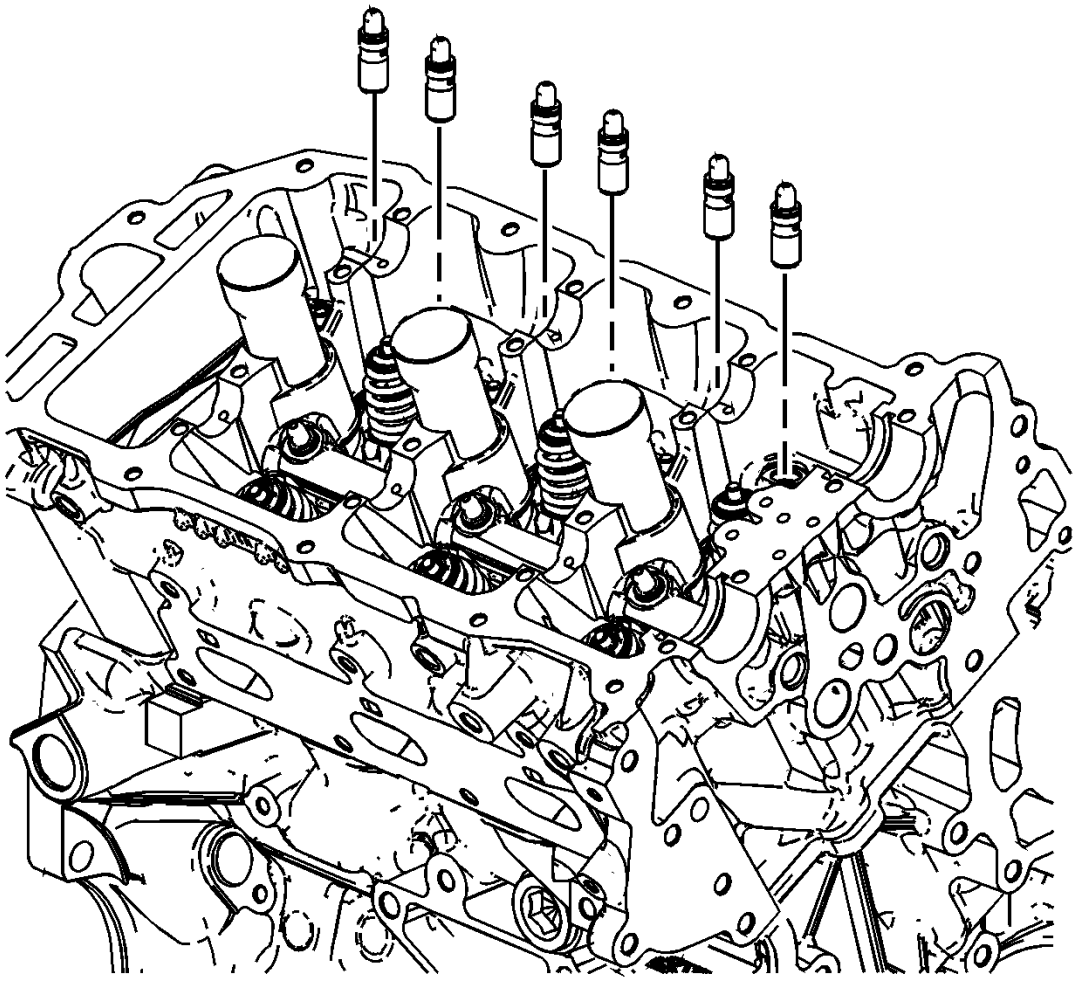

Fig. 492: Identifying Stationary Hydraulic Lash Adjuster (SHLA)
Courtesy of GENERAL MOTORS COMPANY

3. Install the SHLAs in the cylinder head.
4. Apply a liberal amount of lubricant to the SHLA pivot spheres. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

VALVE ROCKER ARM INSTALLATION - RIGHT SIDE

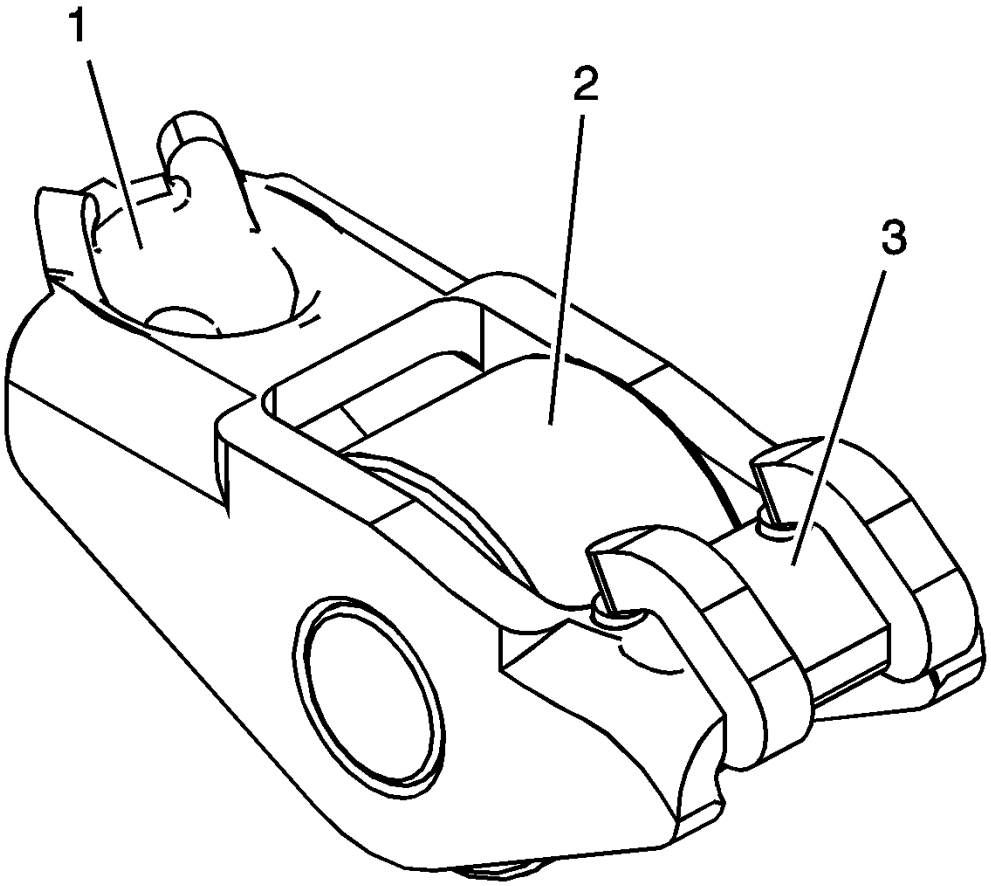

Fig. 493: Identifying Valve Rocker Arm Lubrication Areas
Courtesy of GENERAL MOTORS COMPANY

1. Apply a liberal amount of lubricant to the pivot pocket (1), roller (2) and valve slot (3) areas of the camshaft followers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

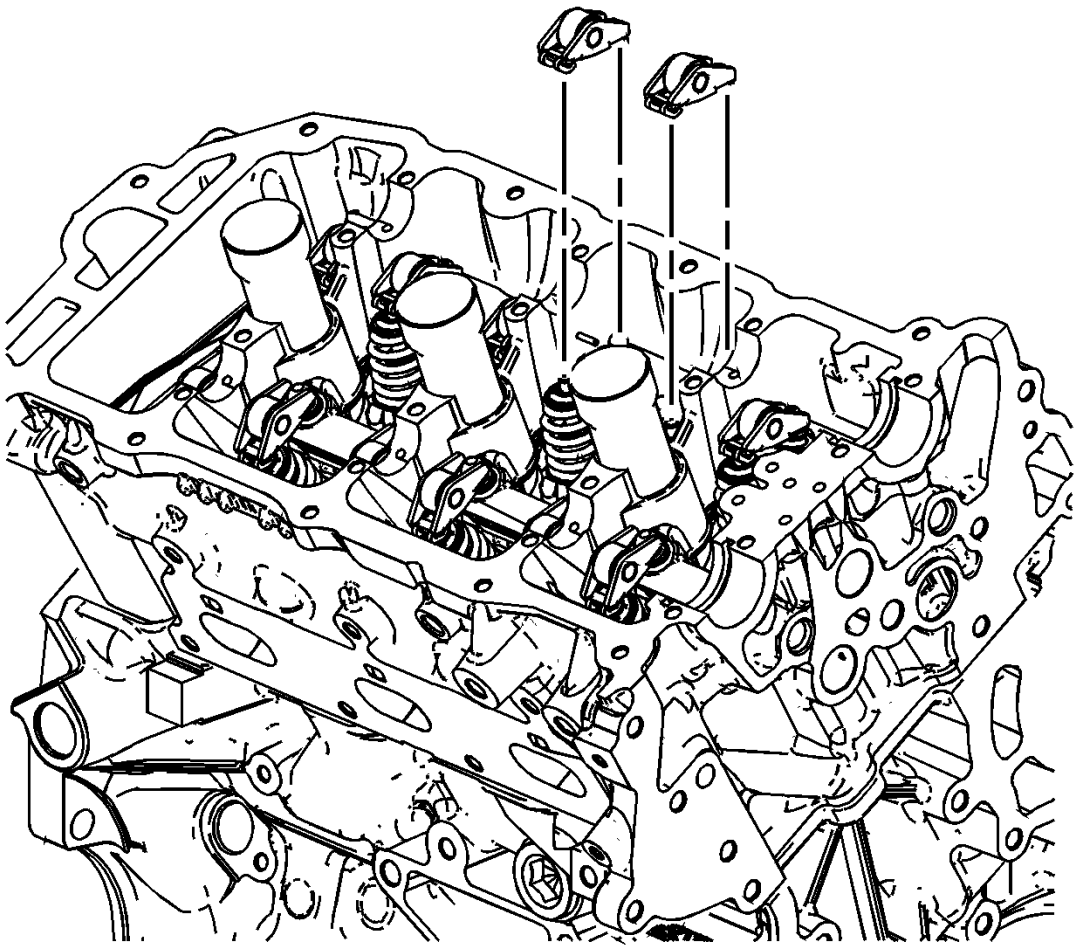

Fig. 494: Identifying Valve Rocker Arms
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.**

2. Place the camshaft followers in position on the valve tip and stationary hydraulic lash adjuster (SHLA).
3. The rounded head end of the follower goes on the SHLA while the flat end goes on the valve tip.
4. Clean the camshaft journals and carriers with a clean, lint-free cloth.

CAMSHAFT INSTALLATION - RIGHT SIDE

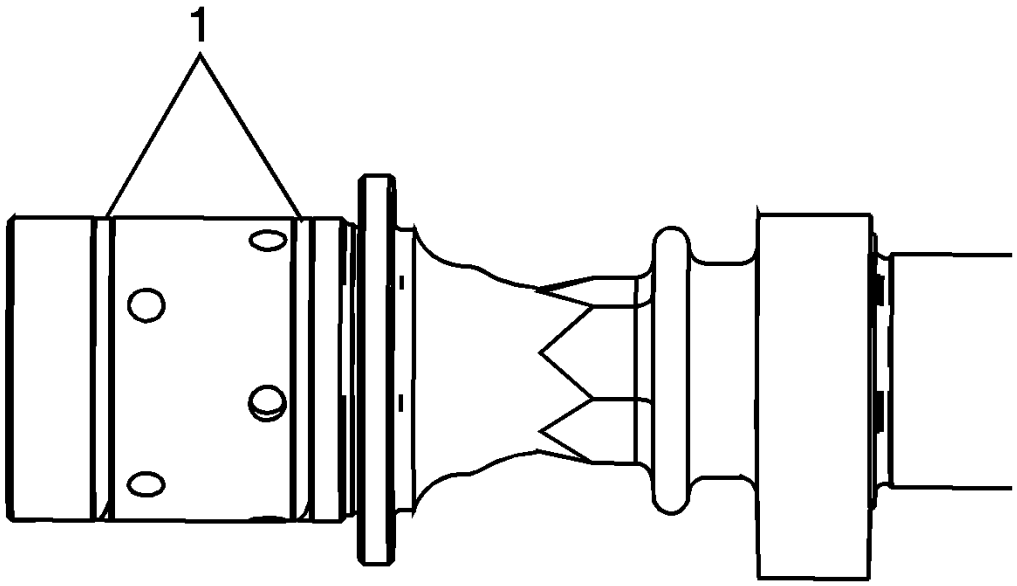

Fig. 495: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

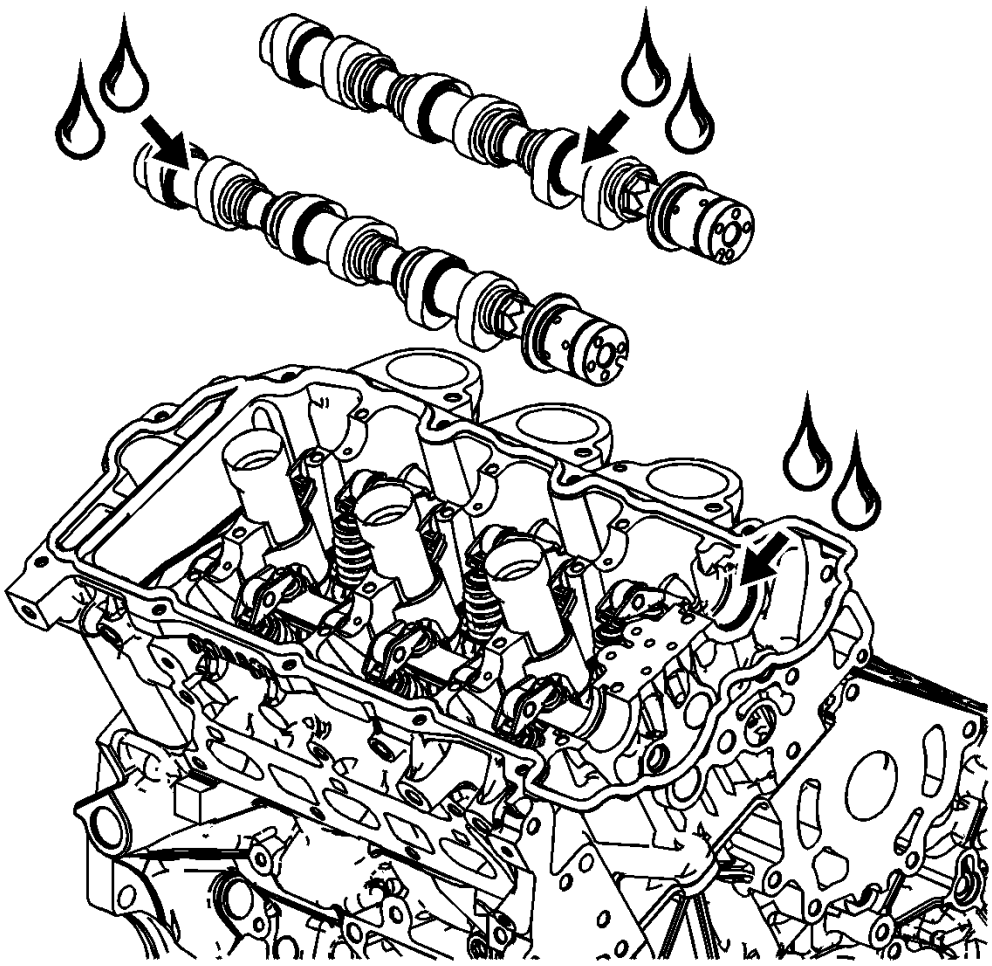

Fig. 496: Applying Liberal Amount Of Lubricant Or Equivalent To Camshaft Journals & Right Cylinder Head Camshaft Carriers
Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant to the camshaft journals and the right cylinder head camshaft carriers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

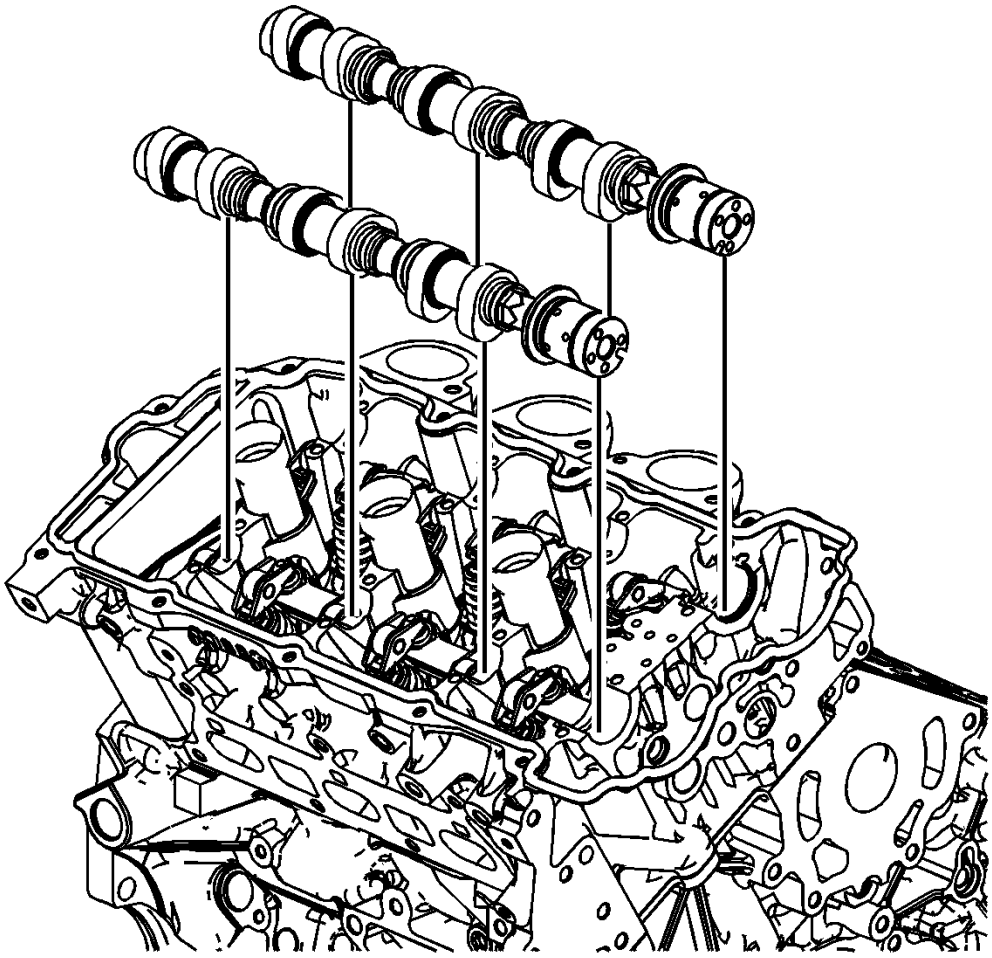

Fig. 497: Positioning Right Intake & Right Exhaust Camshafts In Right Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The right intake camshaft has a laser inscription marking on the rear of the shaft to identify it as right bank intake (RI).**

3. Place the right intake and right exhaust camshafts in position in the right cylinder head.

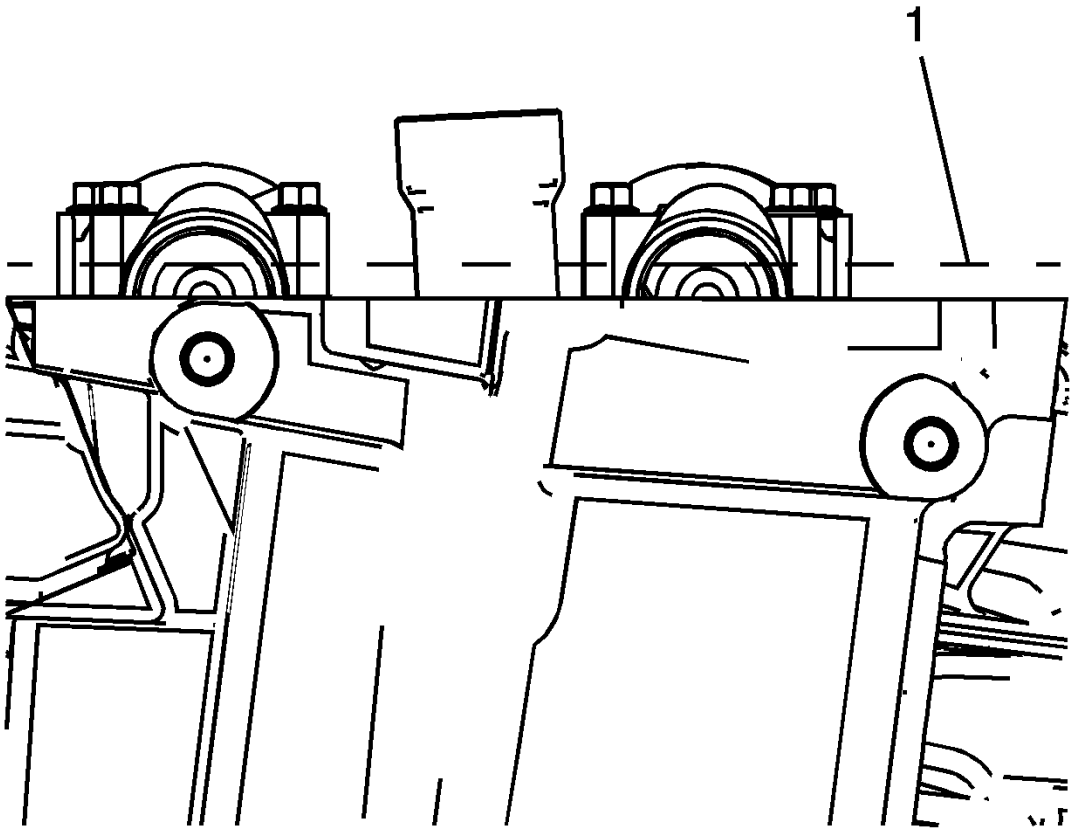

Fig. 498: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.

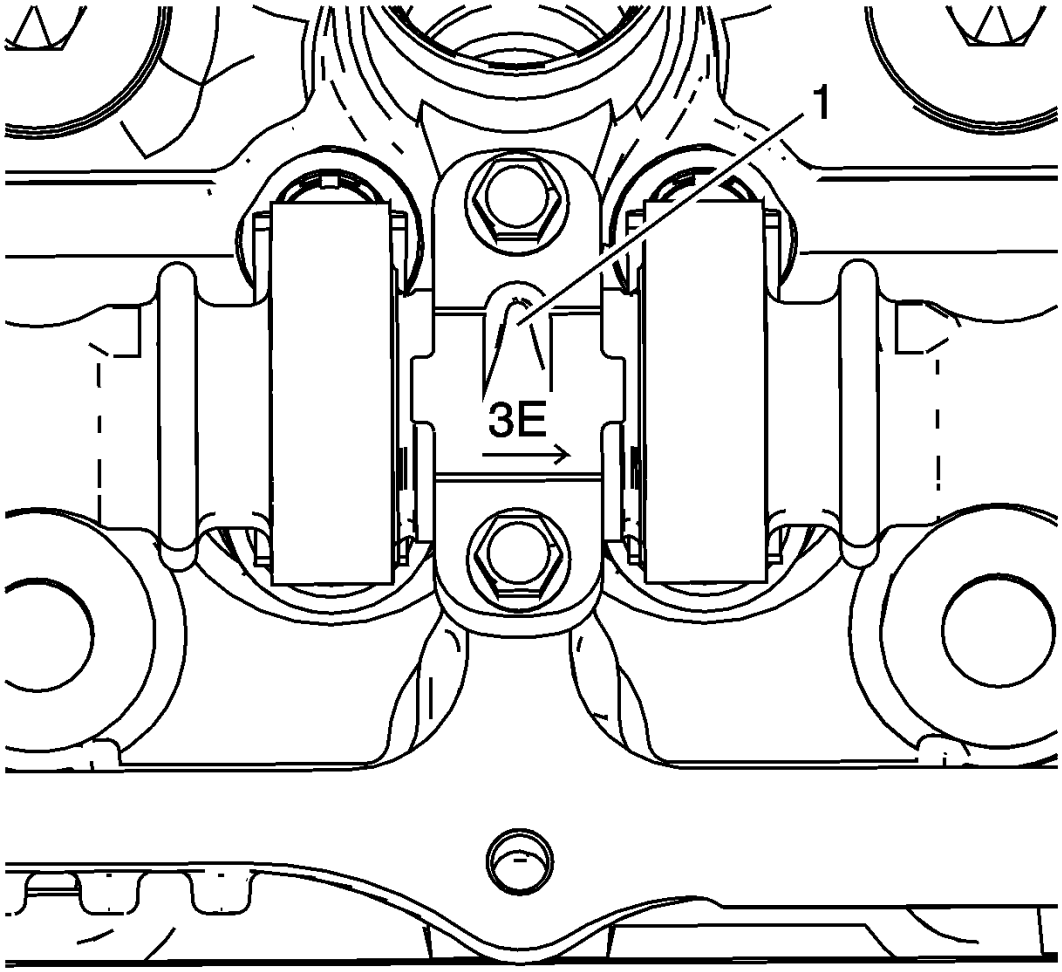

Fig. 499: Right Cylinder Head Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature (1) must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number 1, 3, 5 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

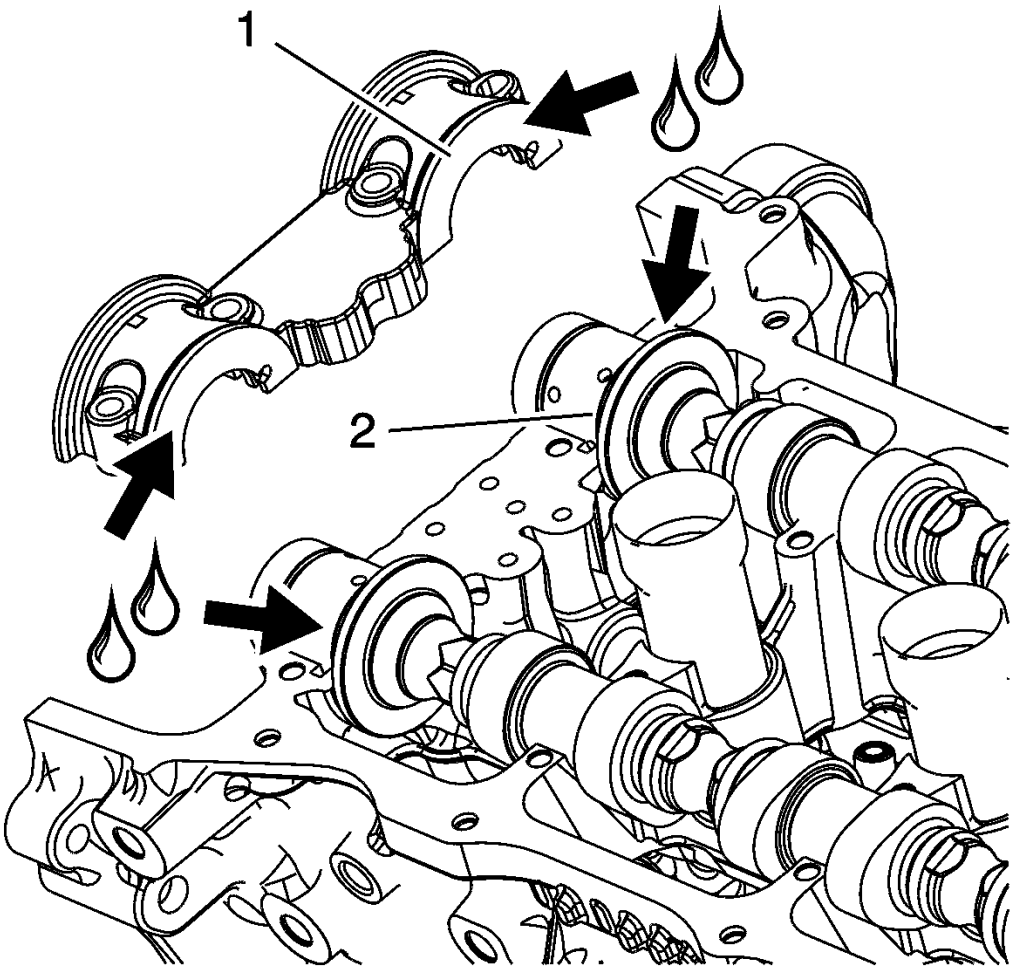

Fig. 500: Camshaft Bearing Cap And Camshaft Thrust Surface
Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

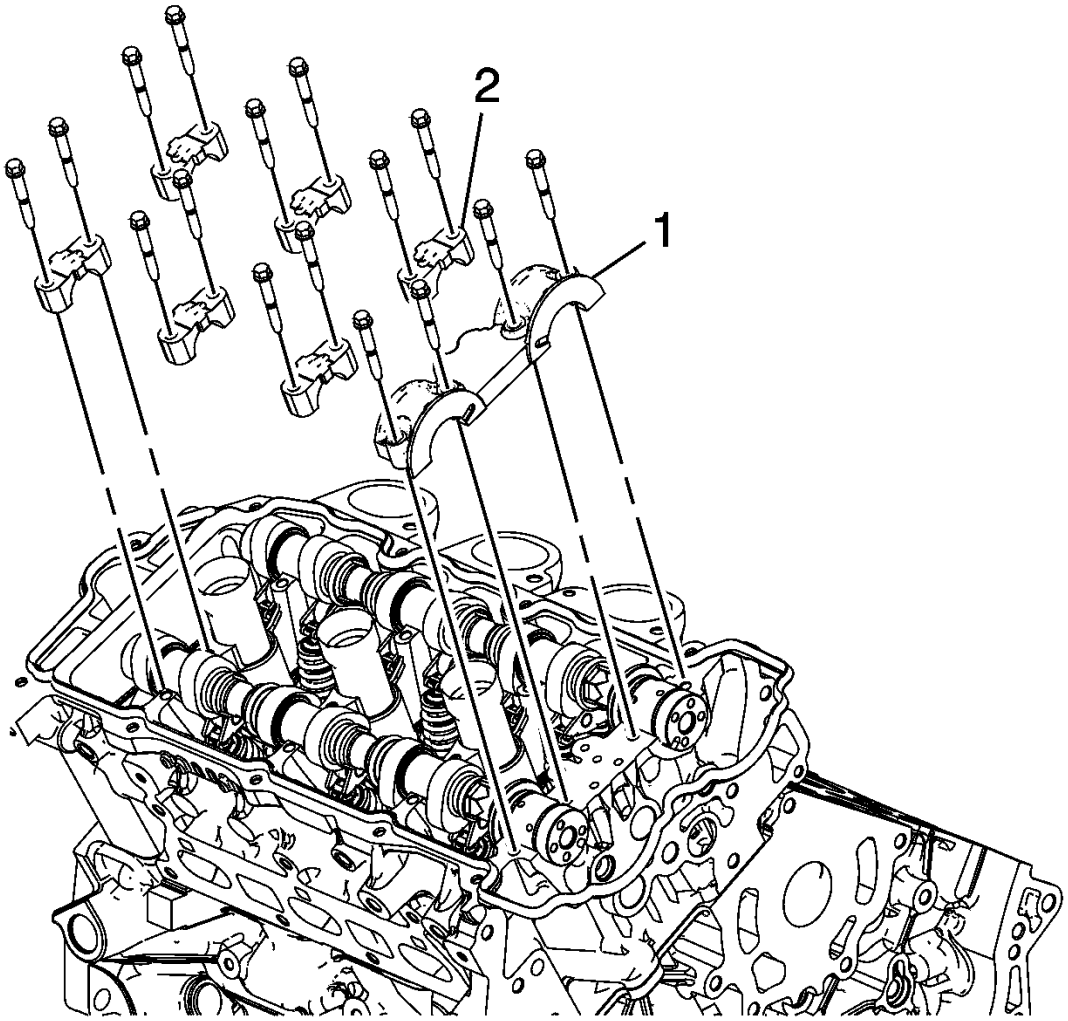

Fig. 501: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust caps (1) in the first journal of the right cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

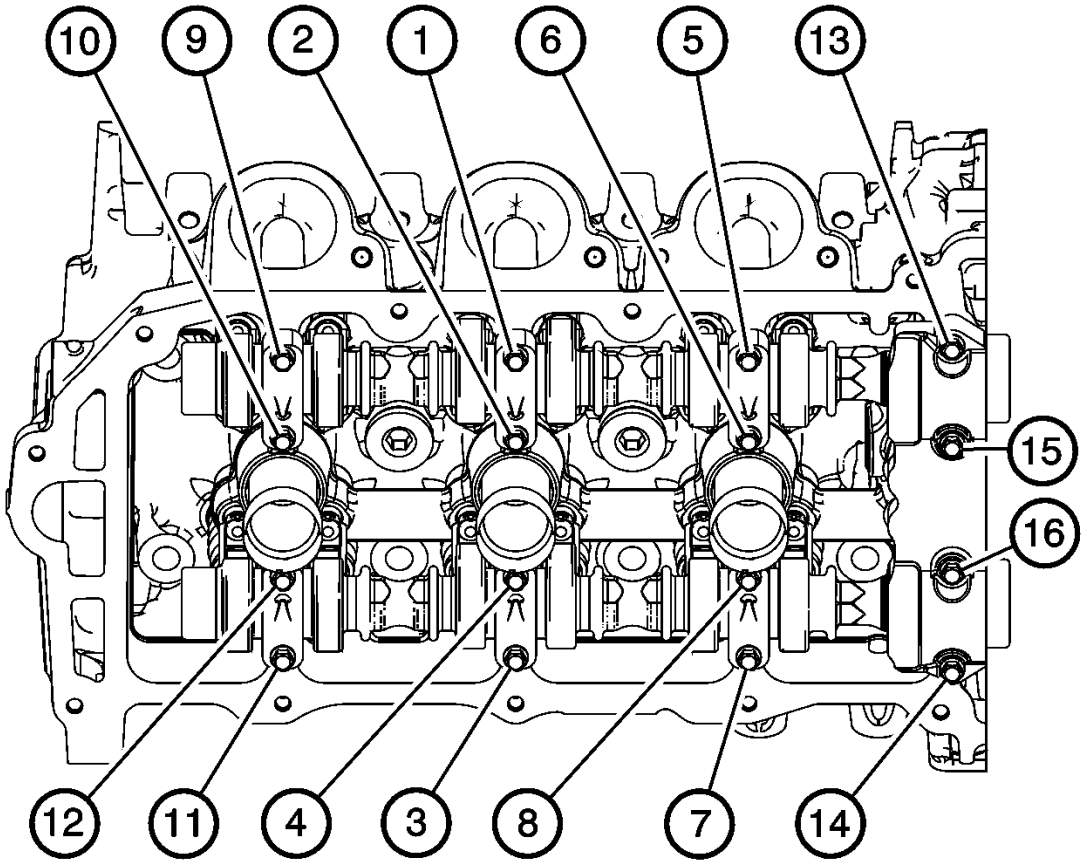

Fig. 502: Camshaft Bearing Cap Bolts Tighten Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).
13. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4) and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

FUEL RAIL INSTALLATION

Refer to **Cylinder Head Assemble (LF1, LFW or LFX)**.

CYLINDER HEAD INSTALLATION - LEFT SIDE (LFX)

Special Tools

EN 45059 Angle Meter

For equivalent regional tools, refer to **Special Tools** .

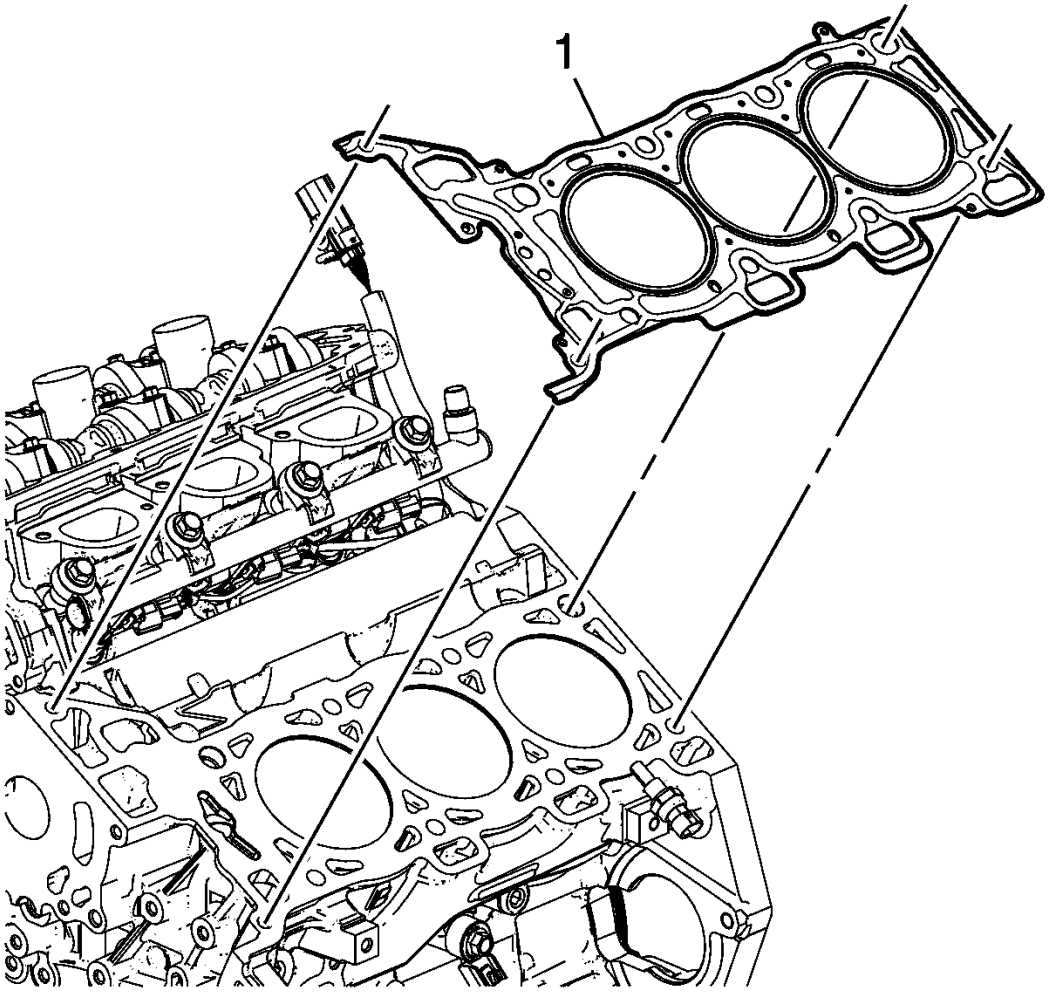

Fig. 503: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
2. Install a NEW left cylinder head gasket (1) using the deck face locating pins for retention.

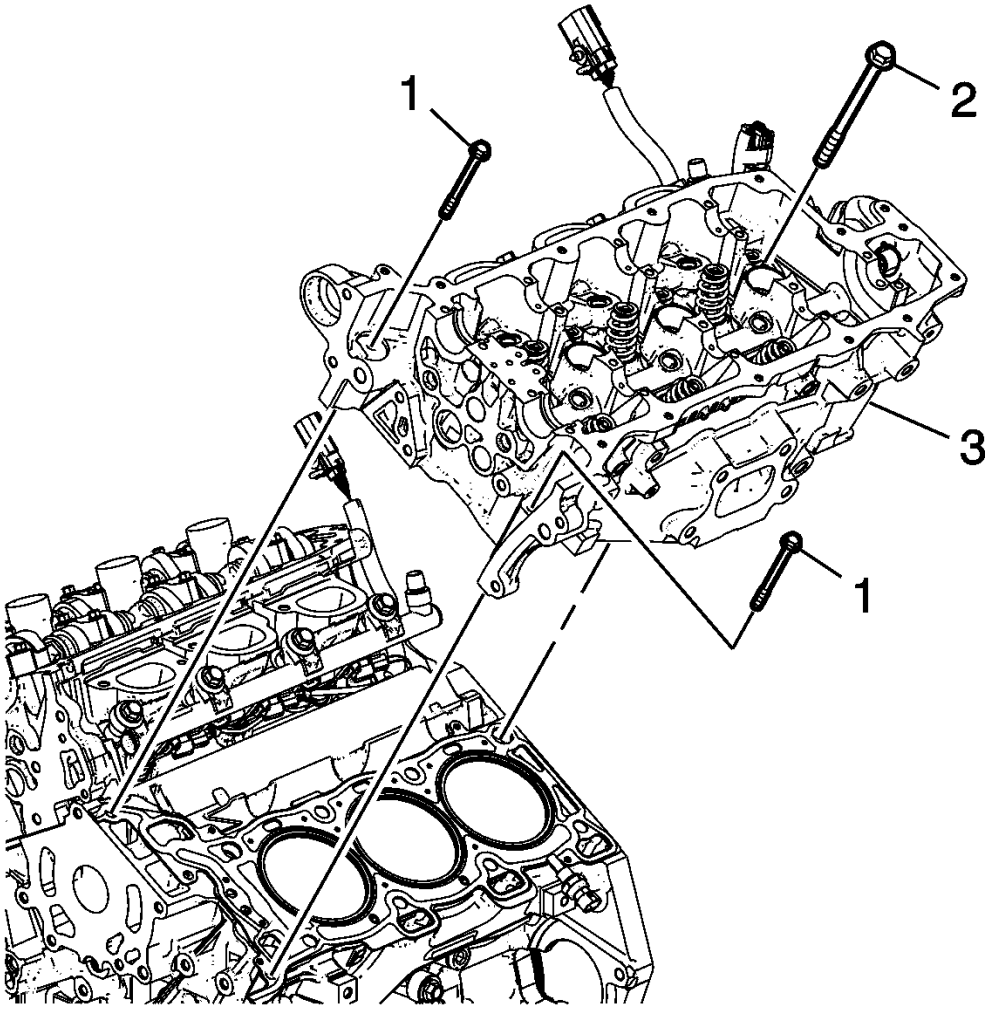

Fig. 504: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Align the left cylinder head (3) with the deck face locating pins.
4. Place the left cylinder head in position on the deck face.

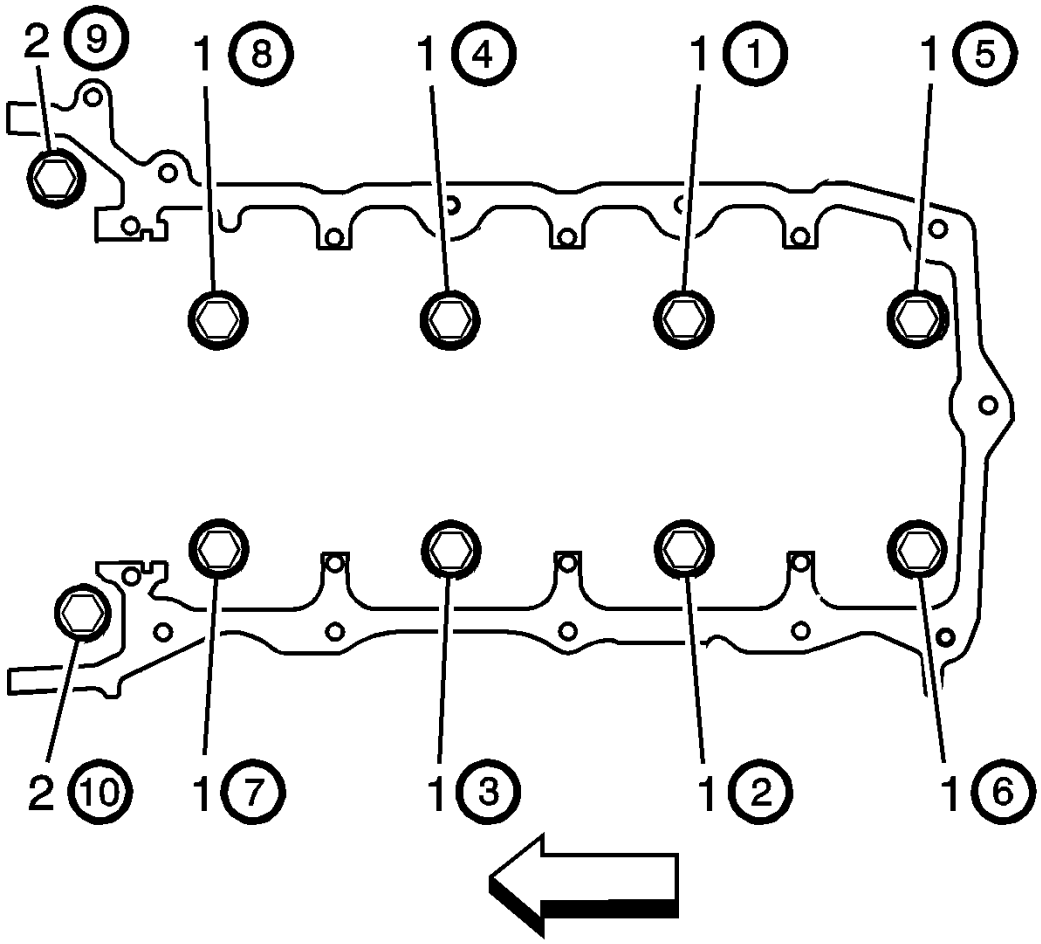

Fig. 505: Identifying M11 Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

NOTE: **DO NOT allow oil on the cylinder head bolt bosses.**

5. Install the NEW M11 cylinder head bolts (1).
    1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 (22 lb ft).
    2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **EN 45059** meter.
6. Install the 2 NEW front M8 left cylinder head bolts (2).
    1. Tighten the M8 cylinder head bolts a first pass to 15 (11 lb ft).
    2. Tighten the M8 cylinder head bolts a second pass in sequence an additional 75 degrees using the

EN 45059 meter.

VALVE LIFTER INSTALLATION - LEFT SIDE

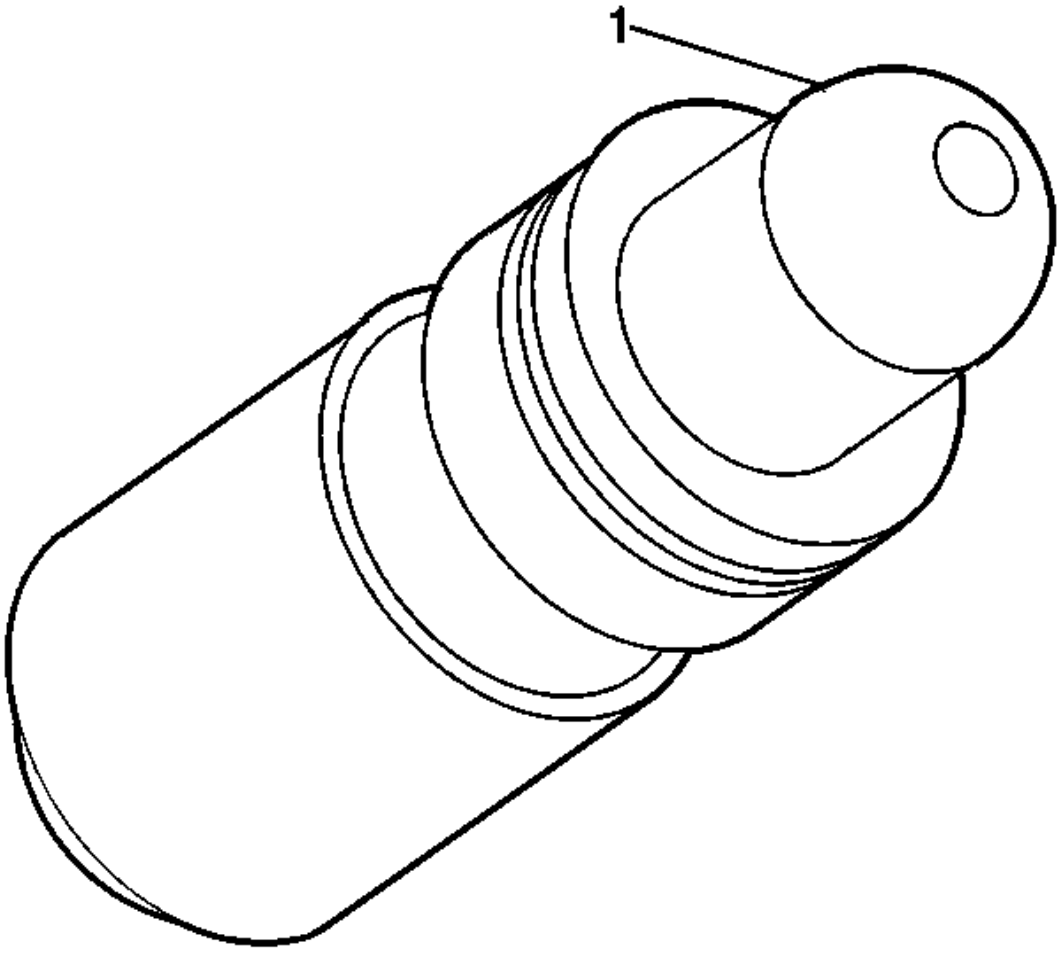

Fig. 506: View Of Valve Lifter
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not stroke/cycle the stationary hydraulic lash adjuster plunger without oil in the lower pressure chamber.**

NOTE: **Do not allow the stationary hydraulic lash adjuster to tip over, plunger down, after the oil fill.**

1. Fill the stationary hydraulic lash adjuster (SHLA) with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant. Take precautions to prevent scratching the pivot sphere area (1) of the SHLA.
2. Lubricate the SHLA bores in the cylinder head with clean engine oil. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

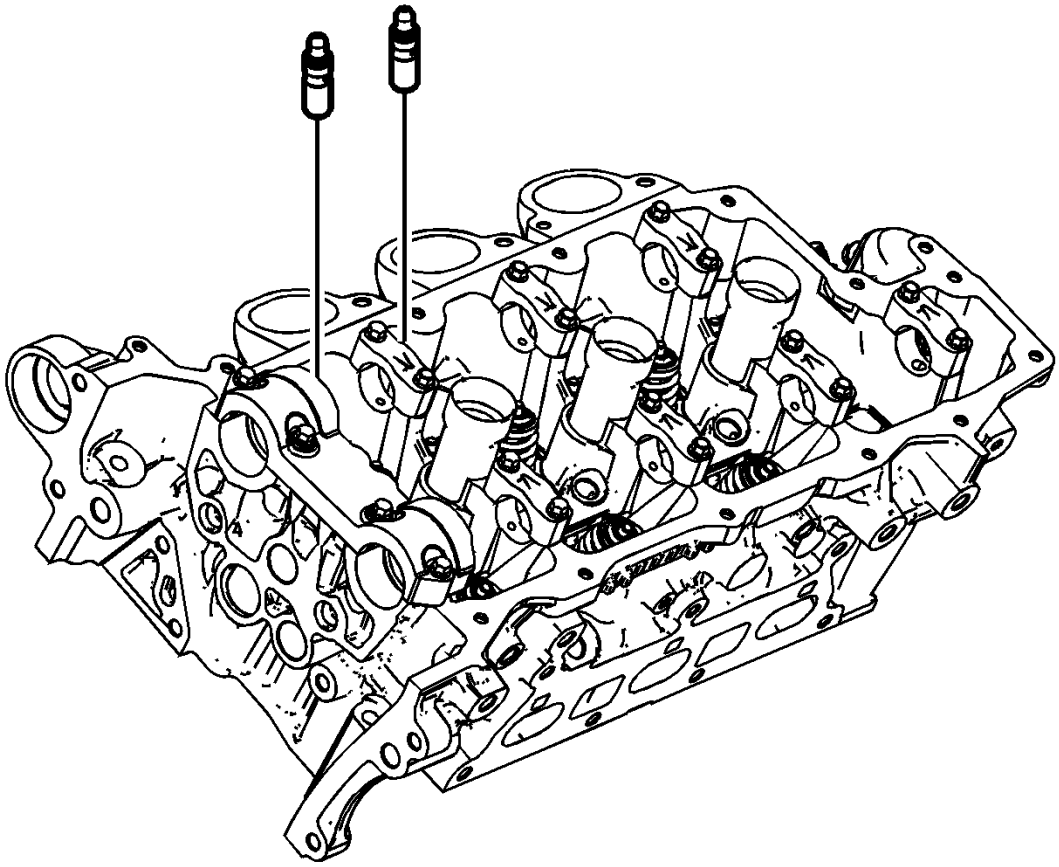

Fig. 507: Valve Lifter Removal - Left Side
Courtesy of GENERAL MOTORS COMPANY

3. Install the SHLAs in the cylinder head.
4. Apply a liberal amount of lubricant to the SHLA pivot spheres. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

VALVE ROCKER ARM INSTALLATION - LEFT SIDE

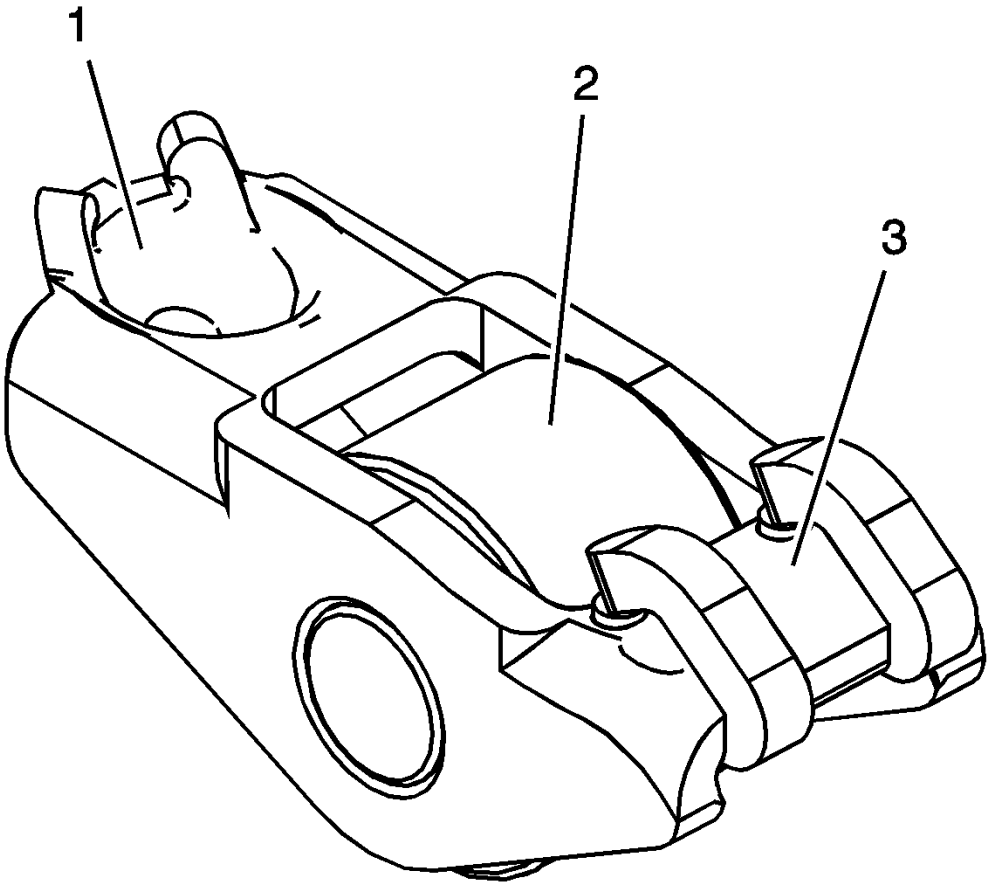

Fig. 508: Identifying Valve Rocker Arm Lubrication Areas
Courtesy of GENERAL MOTORS COMPANY

1. Apply a liberal amount of lubricant to the pivot pocket (1), roller (2) and valve slot (3) areas of the camshaft followers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

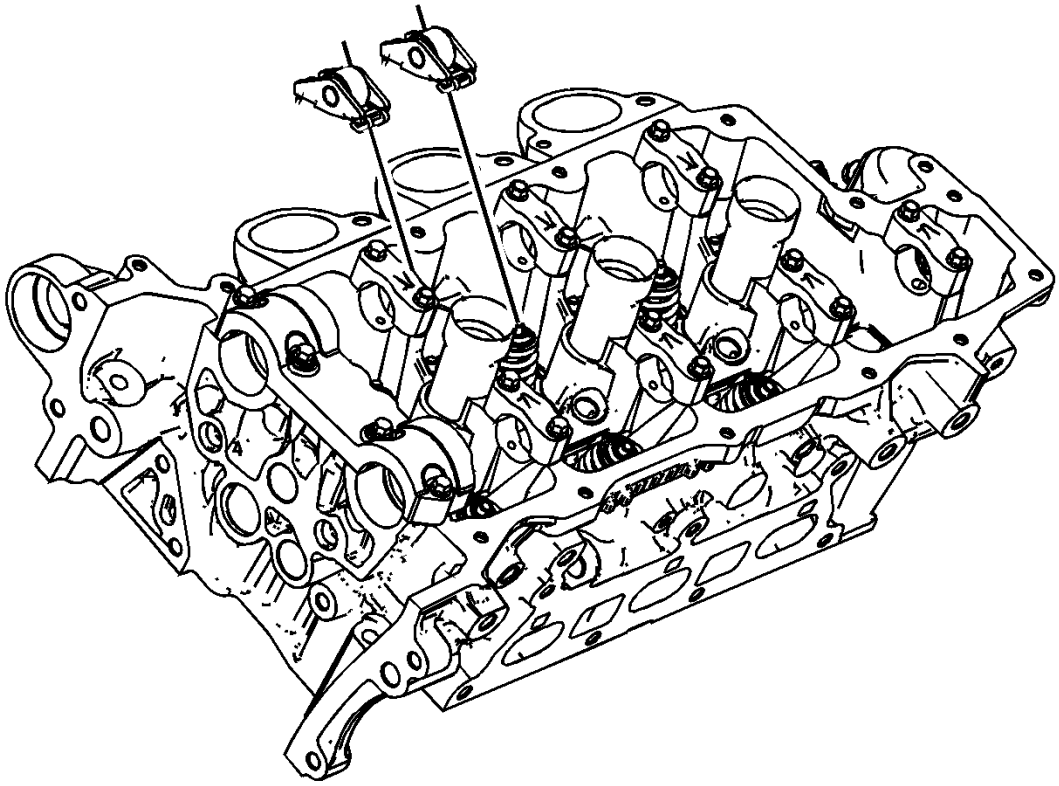

Fig. 509: View of Rocker Arm Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The follower must be positioned squarely on the valve tip so that the full width of the roller will completely contact the camshaft lobe. If the followers are being reused you must put them back in their original location.**

2. Place the camshaft followers in position on the valve tip and stationary hydraulic lash adjuster (SHLA).
3. The rounded head end of the follower goes on the SHLA while the flat end goes on the valve tip.
4. Clean the camshaft journals and carriers with a clean, lint-free cloth.

CAMSHAFT INSTALLATION - LEFT SIDE

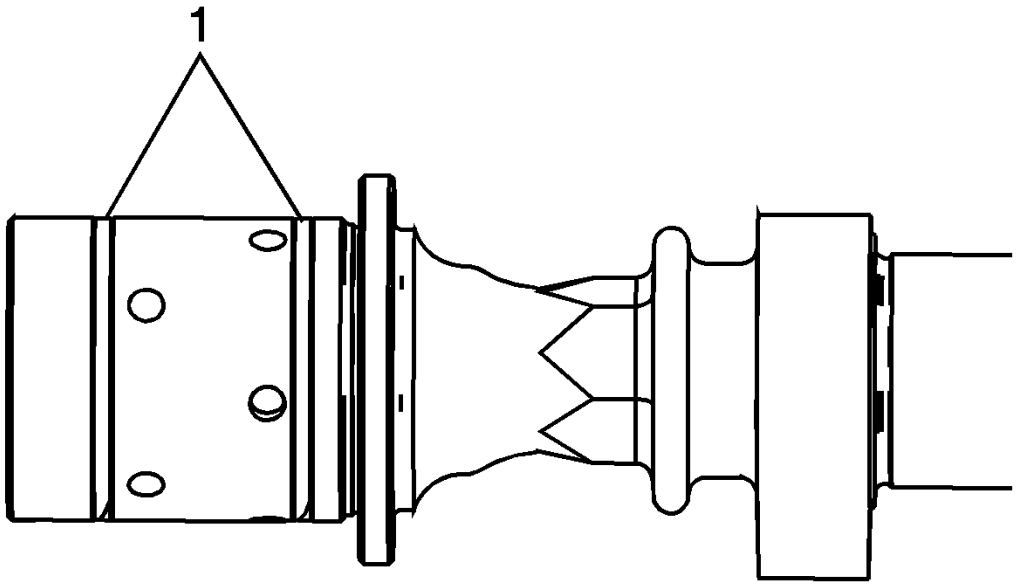

Fig. 510: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

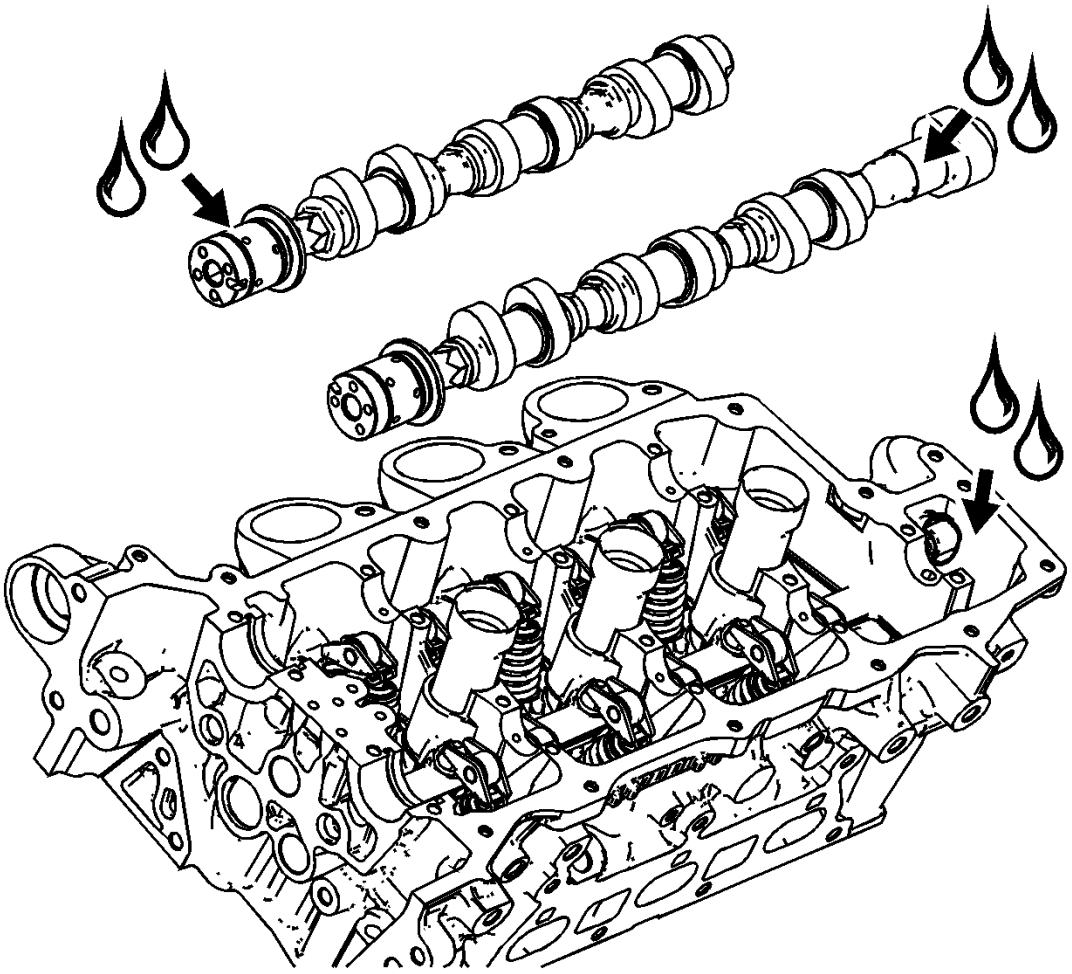

Fig. 511: Lubricating Camshaft Journals
Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant to the camshaft journals and the left cylinder head camshaft carriers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

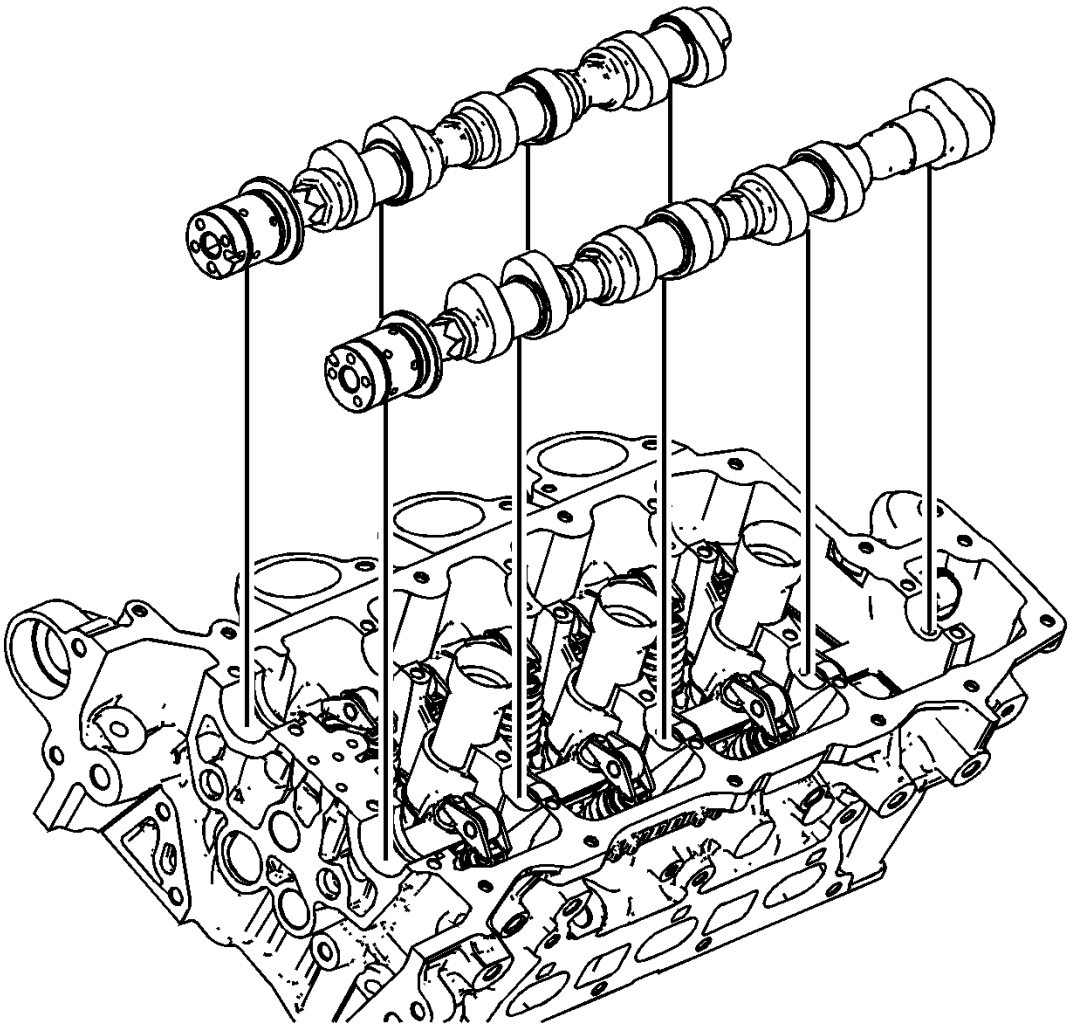

Fig. 512: View of Camshafts and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The left intake camshaft has a laser inscription marking on the rear of the shaft to identify it as left bank intake (LI).**

3. Place the left intake and left exhaust camshafts in position in the left cylinder head.

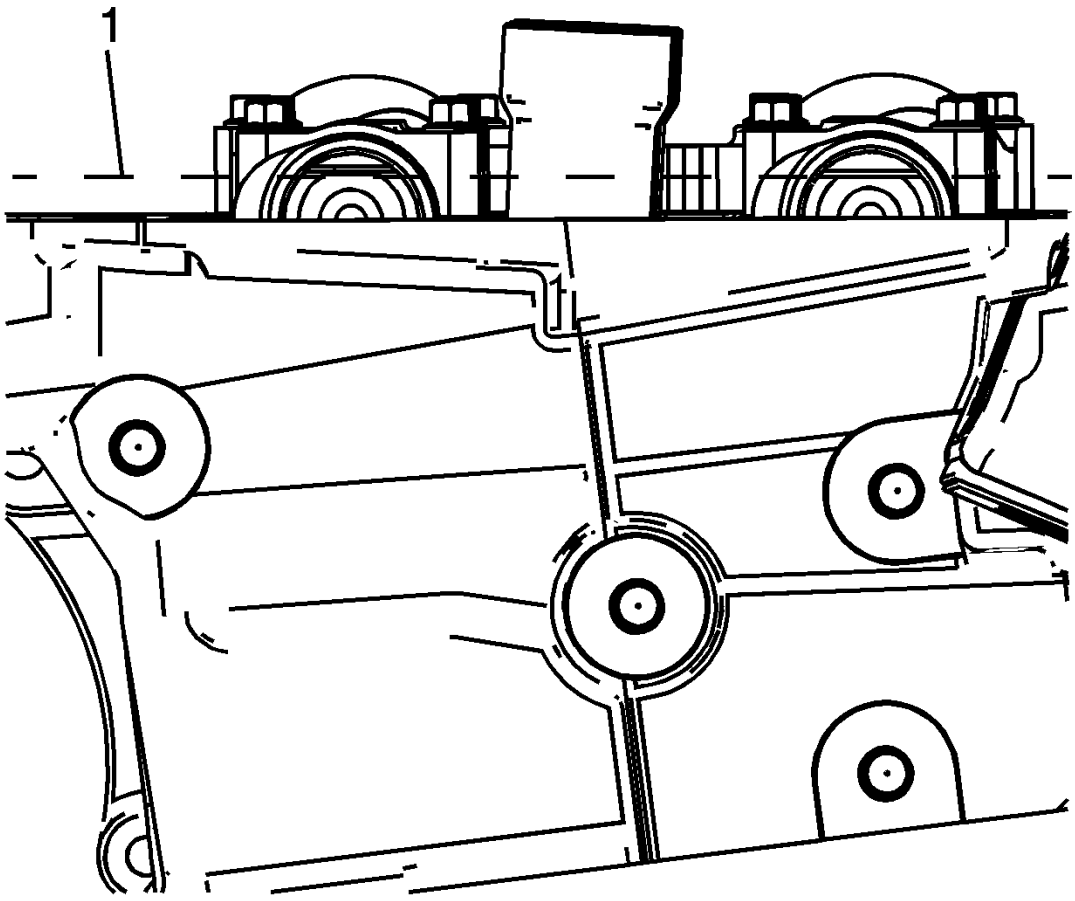

Fig. 513: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the left cylinder head camshaft cover rail.

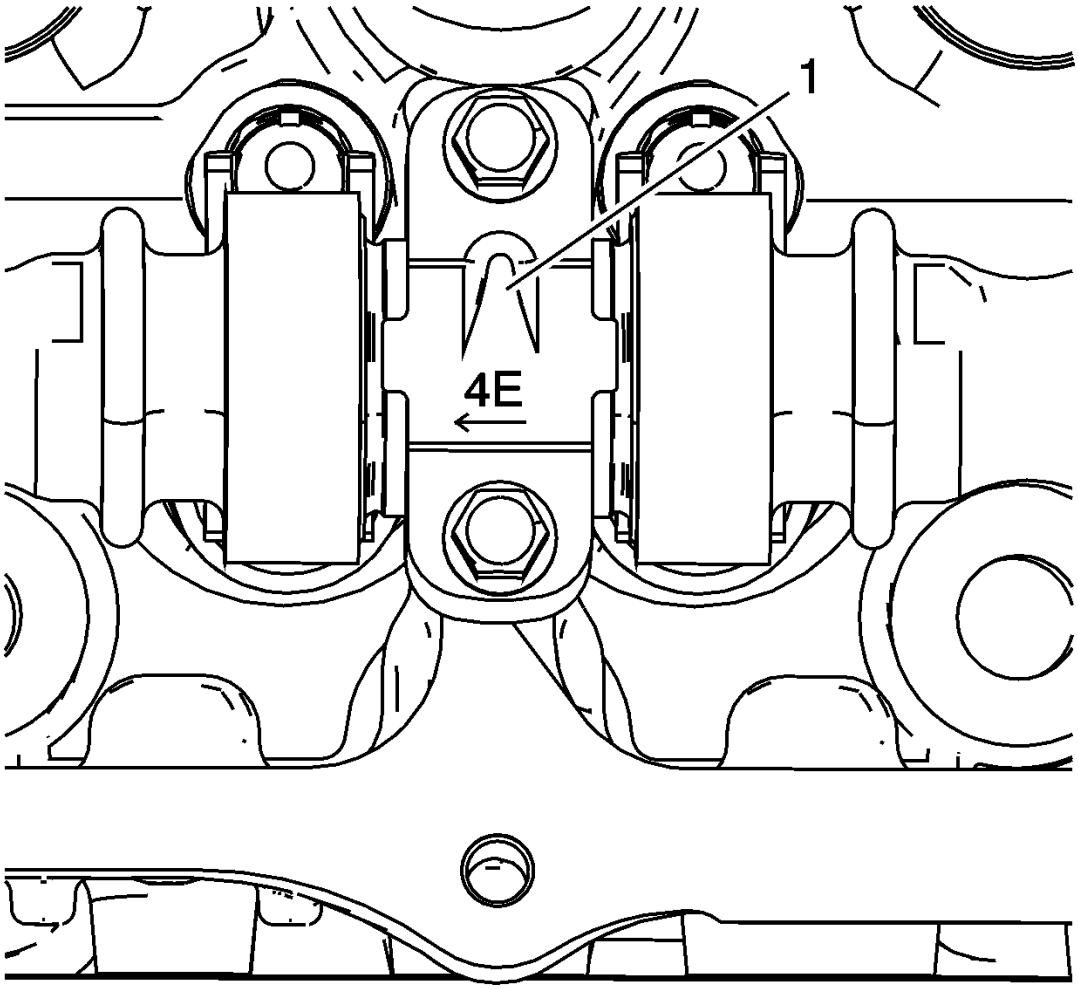

Fig. 514: Left Cylinder Head Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature (1) must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number 2, 4, 6 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

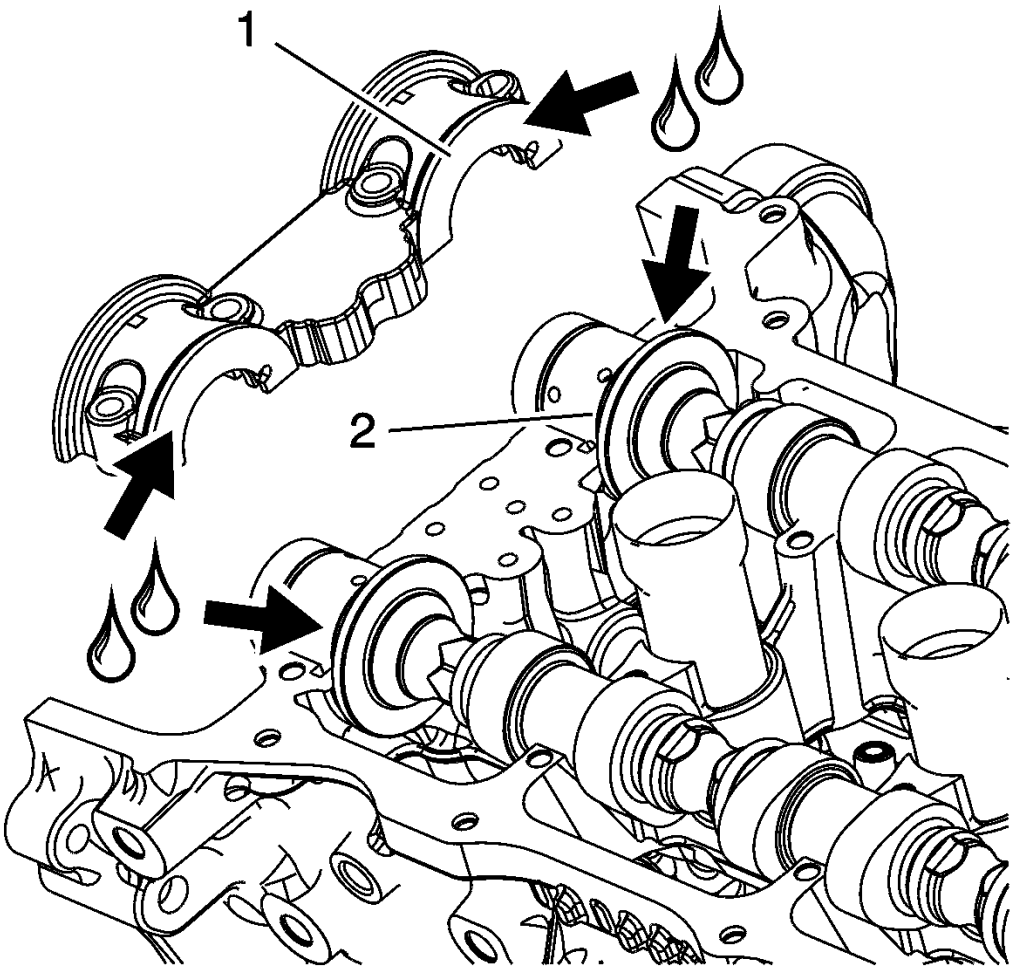

Fig. 515: Camshaft Bearing Cap And Camshaft Thrust Surface
Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

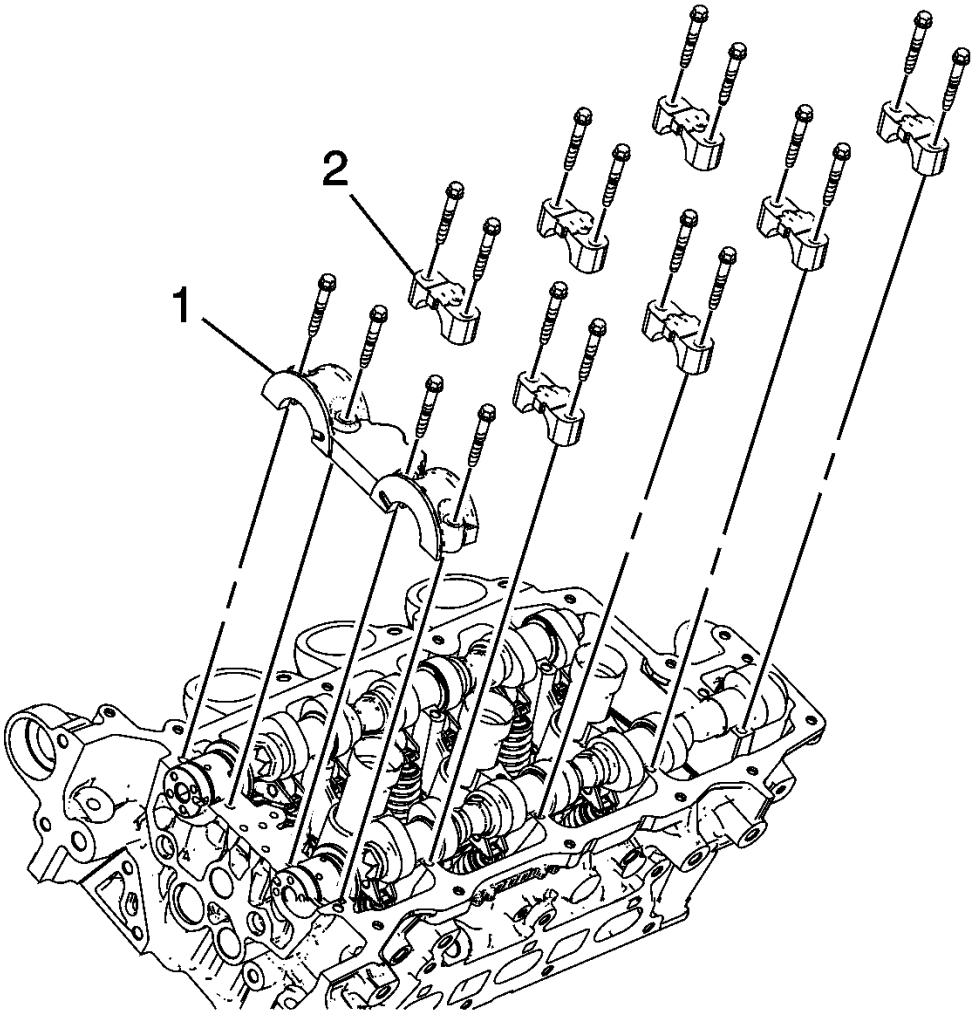

Fig. 516: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust cap (1) in the first journal of the left cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

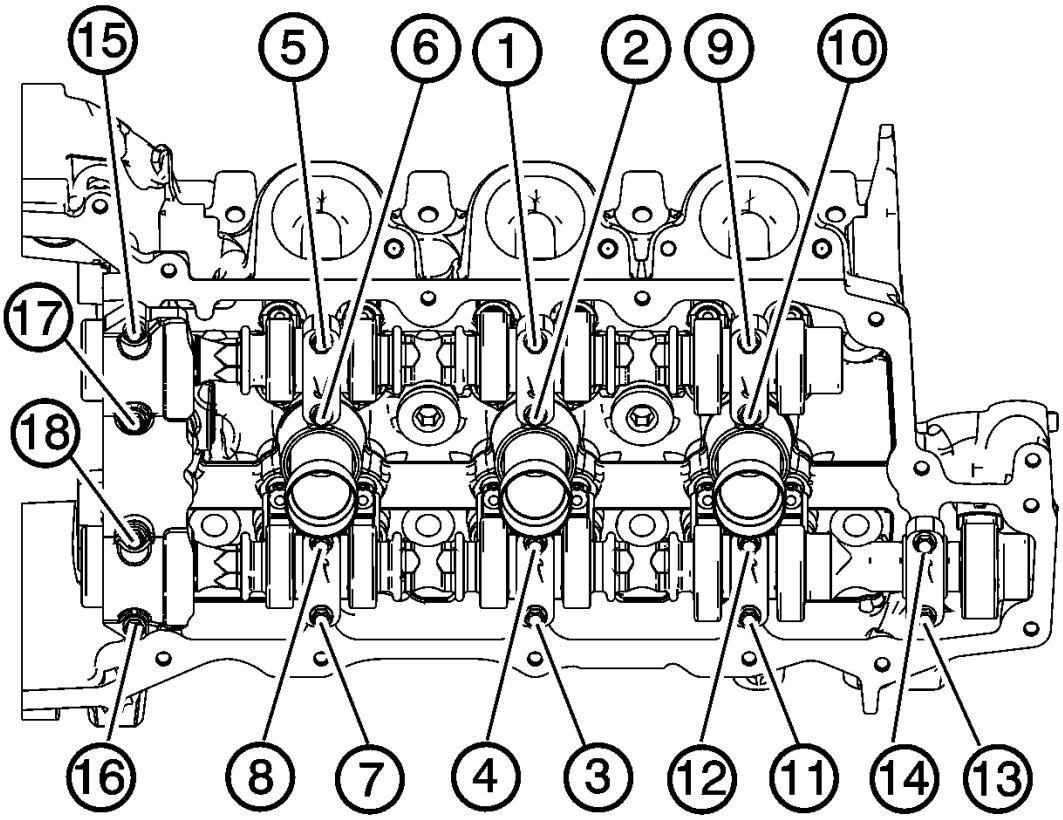

Fig. 517: Identifying Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
13. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).

FUEL PUMP INSTALLATION (LFX)

Special Tools

EN 48896 HP Fuel Pump Installation Alignment Gauge

For equivalent regional tools, refer to **Special Tools** .

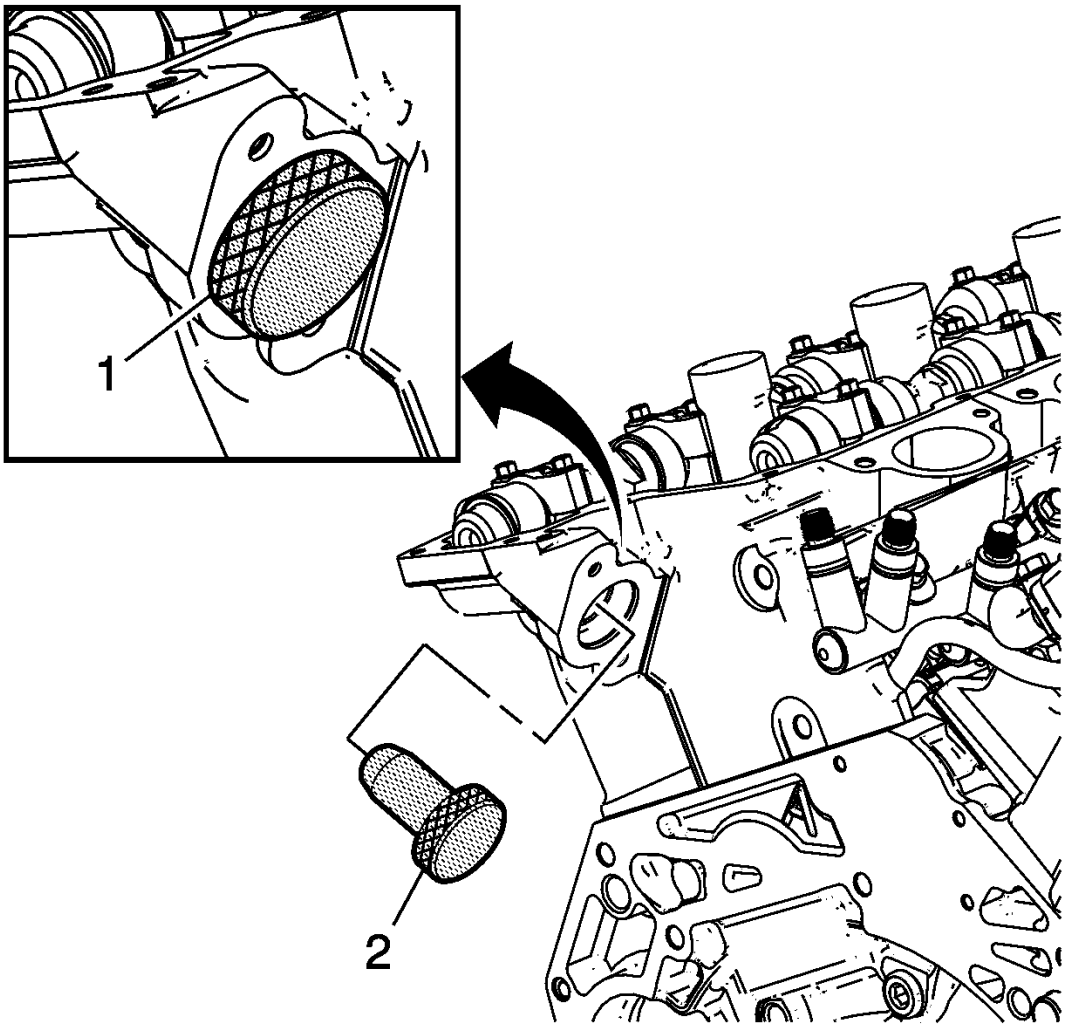

Fig. 518: View Of Alignment Gauge
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The camshaft must be in the base circle position before the high pressure fuel pump is installed.**

1. Use the **EN 48896** alignment gauge (2) to ensure that the camshaft lobe is in the base circle position. At base circle position, the tool will be flush with the head (1).

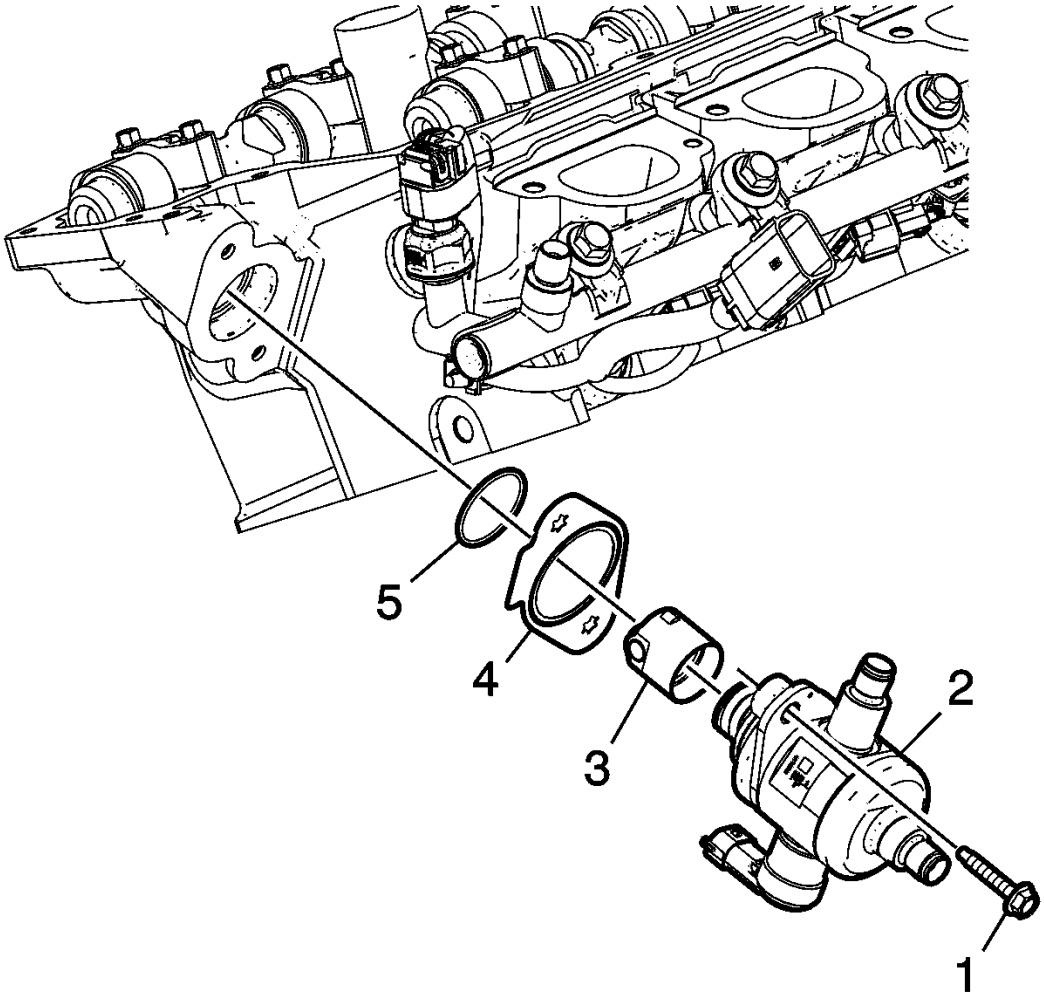

Fig. 519: Identifying High Pressure Fuel Pump Components
Courtesy of GENERAL MOTORS COMPANY

2. Lubricate the high pressure fuel pump cylinder head bore with clean engine oil.

NOTE: **Ensure that the high pressure fuel pump roller lifter is oriented properly, the camshaft is at base circle and the number 1 piston is at top dead center (TDC) on the exhaust stroke.**

3. Lubricate the high pressure fuel pump roller lifter with clean engine oil and install into the cylinder head bore.
4. Install a NEW high pressure fuel pressure fuel pump gasket (4).

NOTE: **If a high pressure pump is replaced on an engine which originally had a pump WITH a gasket, it must be rebuilt WITH a pump kit that includes the gasket; if a high pressure pump is replaced on an engine which originally had a pump WITHOUT a gasket, it must be rebuilt WITHOUT a gasket.**

5. Lubricate NEW high pressure fuel pump O-ring (5) with one drop of clean engine oil and install.

NOTE: **Ensure the plastic bolt retainers are installed in the high pressure fuel pump mounting holes before installing.**

6. Install the valve lifter follower (3).
7. Install the high pressure fuel pump (2).

CAUTION: **Refer to Fastener Caution .**

CAUTION: **Alternately hand-tighten the fuel pump bolts one turn at a time until the pump is fully seated. Trying to draw down the pump without even side-to-side tightening may result in pump plunger damage.**

CAUTION: **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.**

8. Start and hand-tighten the high pressure fuel pump bolts (1) evenly .
    1. Tighten the fuel pump bolts (1) a first pass in sequence to 15 N.m (11 lb ft) .
    2. Tighten the fuel pump bolts (1) a second pass in an additional 60 degrees .

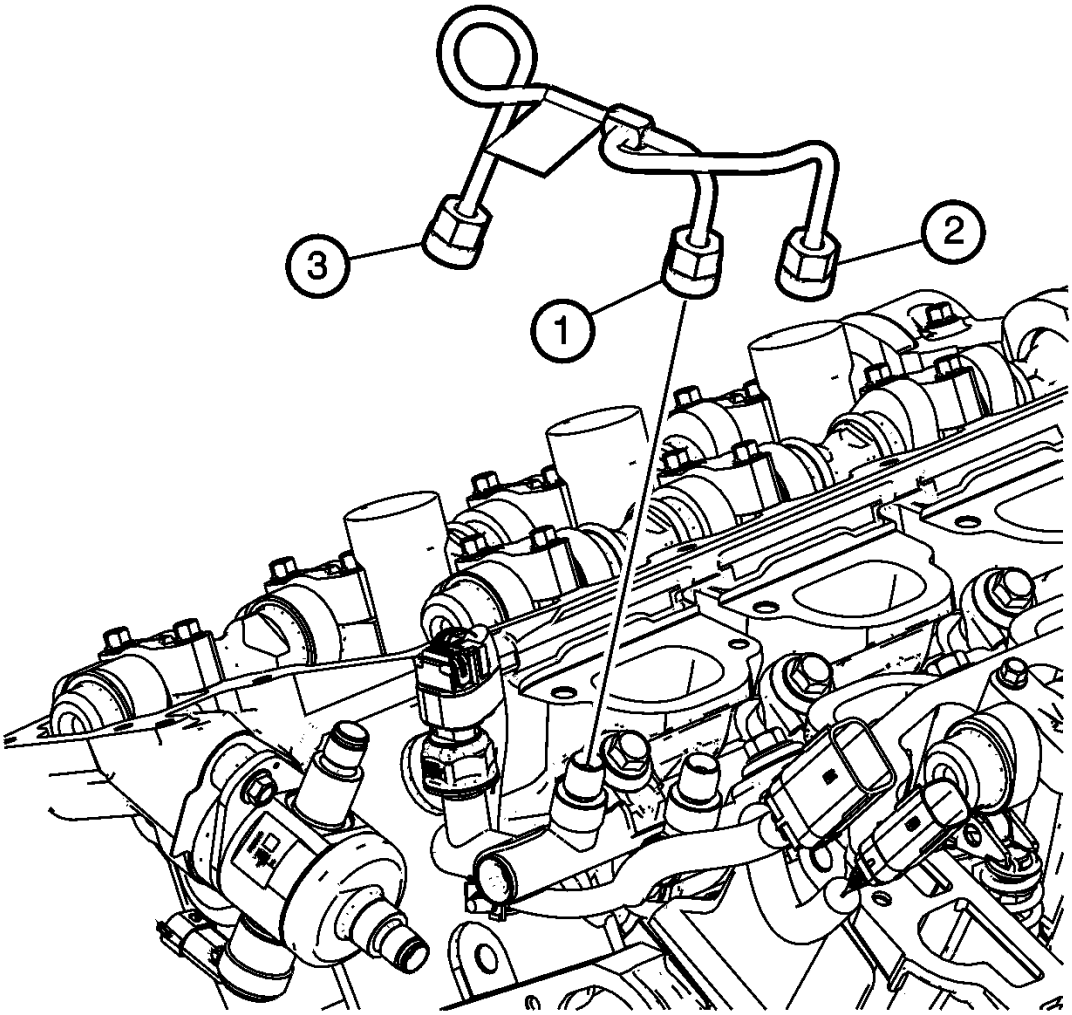

Fig. 520: Identifying Fuel Rail Crossover Pipe Components
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **DO NOT reuse the high pressure fuel rail crossover pipe.**
- **The tightening order and torque are critical to proper fuel system fit and function. Be sure to follow installation and tightening steps exactly.**

9. Install the NEW high pressure LH to RH fuel rail crossover pipe by starting all three fuel crossover pipe fitting nuts (1), (2) and (3) to finger-tight only.
10. Tighten the fuel rail crossover pipe fittings to 28 (21 lb ft) in the following order: (1) left fuel rail, (2) right fuel rail, then (3) fuel pump.

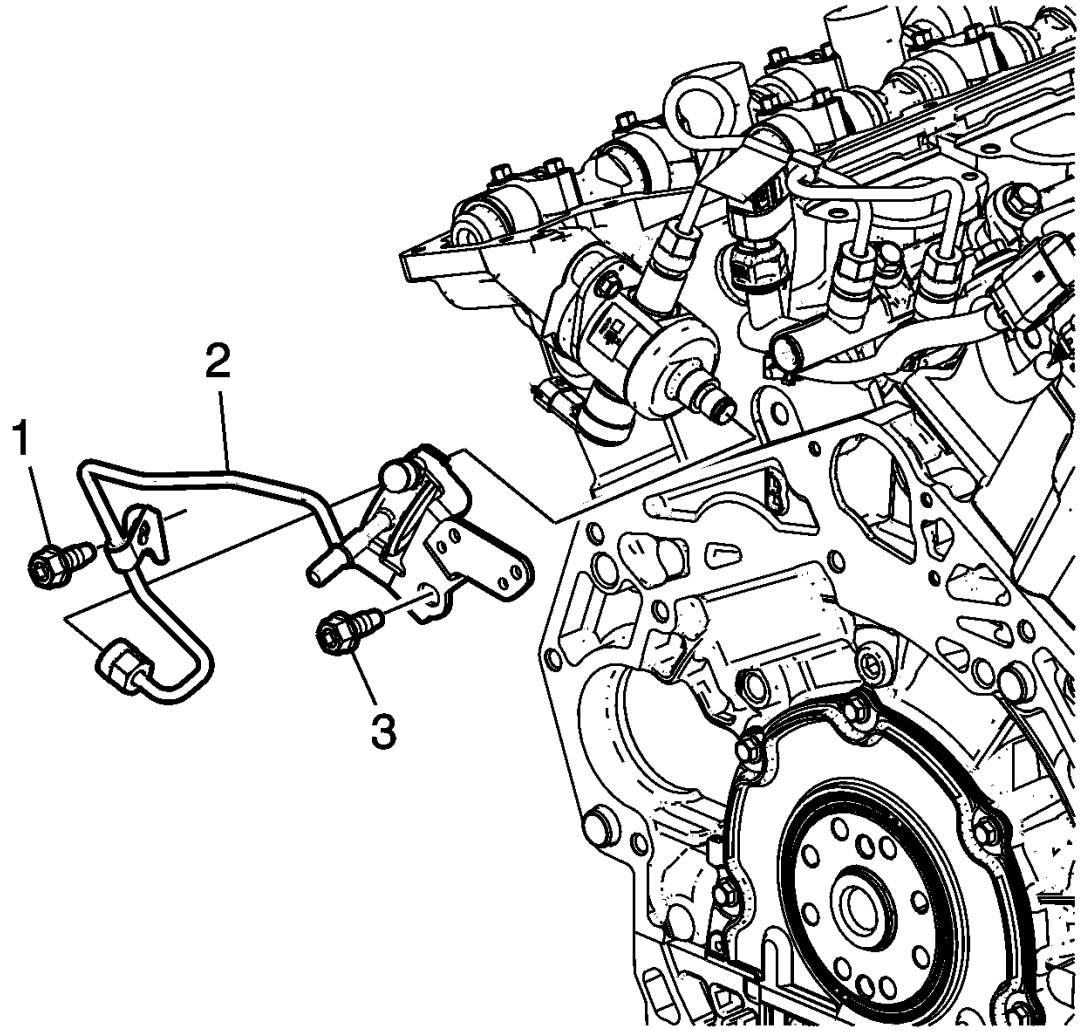

Fig. 521: View Of Fuel Feed Pipe Components
Courtesy of GENERAL MOTORS COMPANY

11. Install the NEW fuel feed pipe (2) by installing the fuel line nut to the fuel pump finger-tight.
12. Install the fuel feed pipe bolts finger tight (1 and 3).
13. Tighten the fuel feed pipe bolts (1 and 3) to 50 N.m (37 lb ft).
14. Tighten the fuel feed pipe fitting nut to 28 N.m (21 lb ft).
15. Install the fuel rail wiring connectors to the fuel feed pipe bracket.

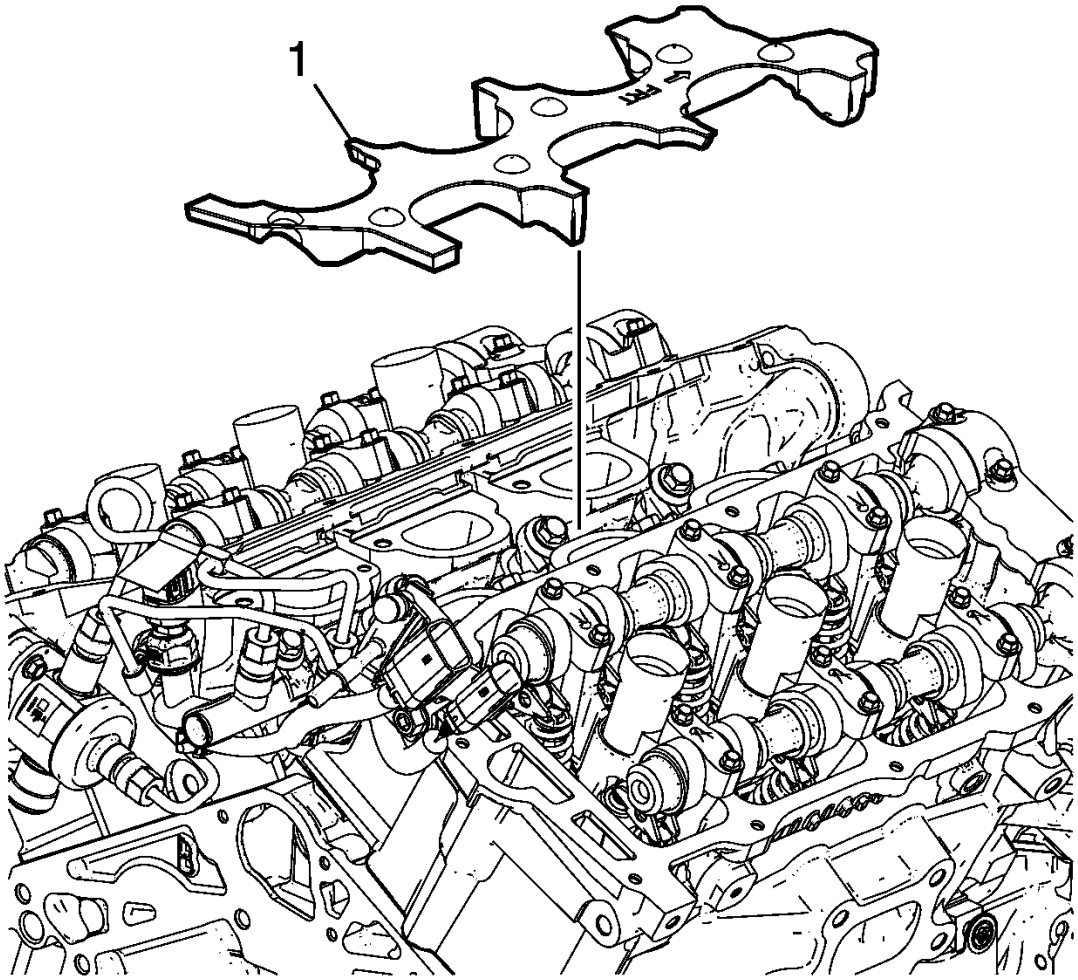

Fig. 522: Identifying Fuel Rail Noise Shield
Courtesy of GENERAL MOTORS COMPANY

16. Install the fuel rail noise shield (1).

CAMSHAFT POSITION ACTUATOR INSTALLATION - RIGHT SIDE INTAKE

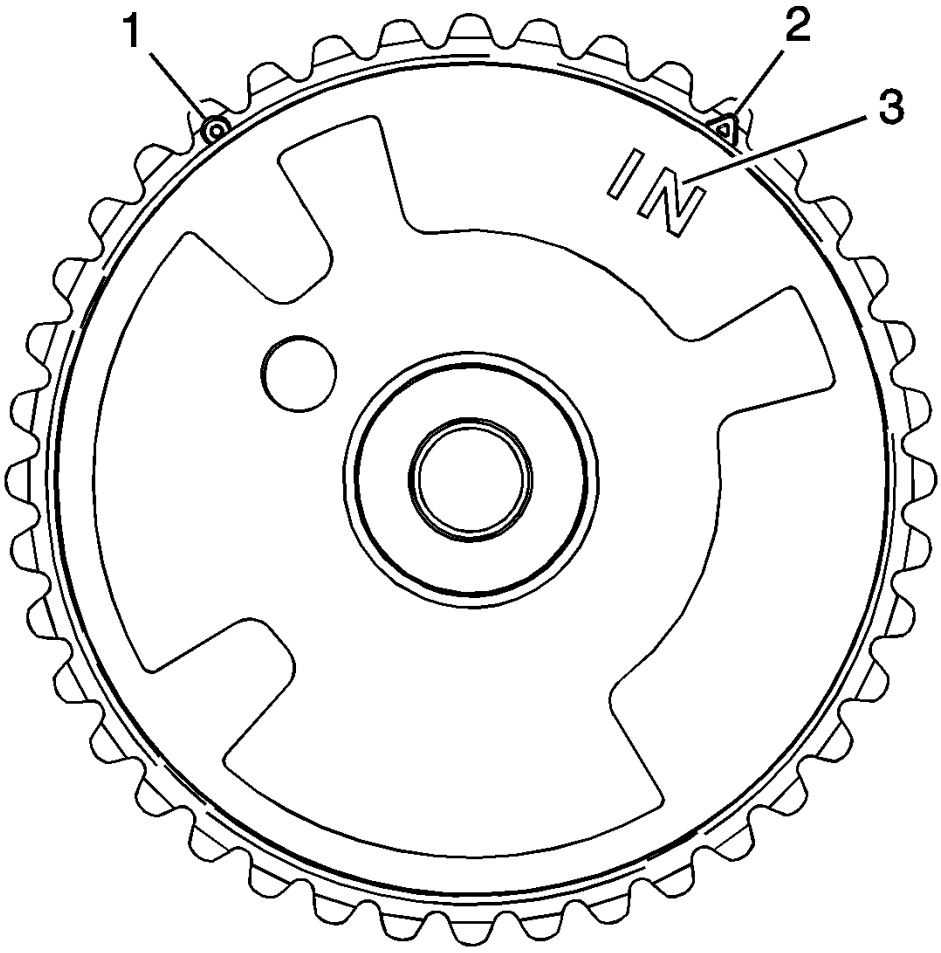

Fig. 523: View Of Camshaft Position Actuator Markings
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "IN" marking (3). The marking is for an intake camshaft position actuator.

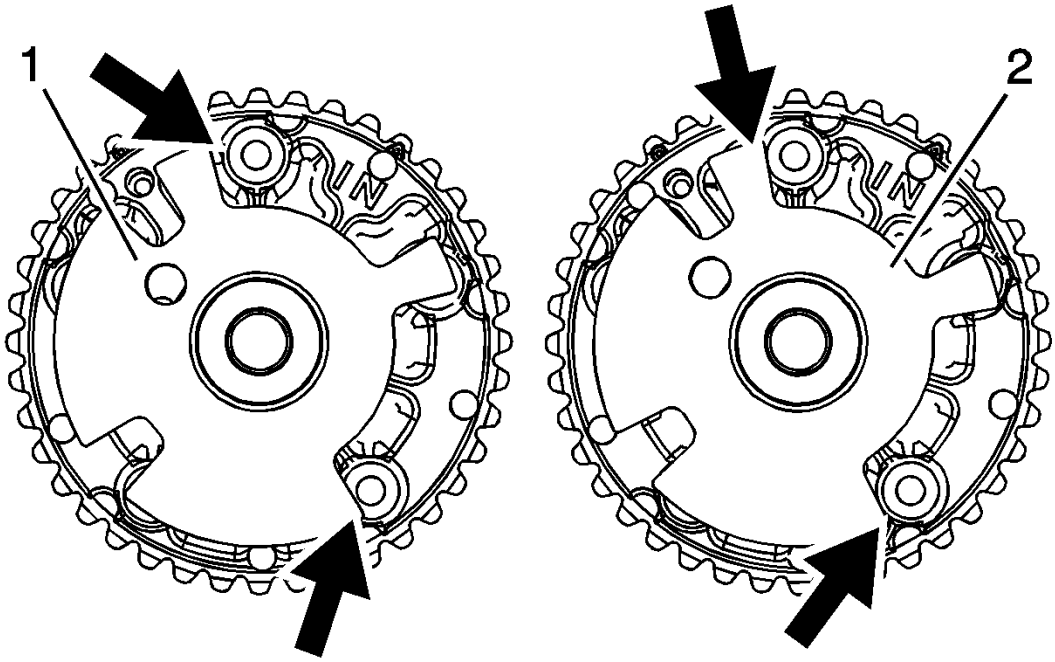

Fig. 524: View Of Right Intake Camshaft Position Actuator & Left Intake Camshaft Position Actuator

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Ensure the proper camshaft position actuator is installed in the correct position. Failure to install the proper camshaft position actuator can effect engine performance and set an engine code.

2. Ensure the proper camshaft position actuator is being installed. The reluctor wheel on the right intake camshaft position actuator (1) is indexed in a different position compared to the left intake camshaft position actuator (2).

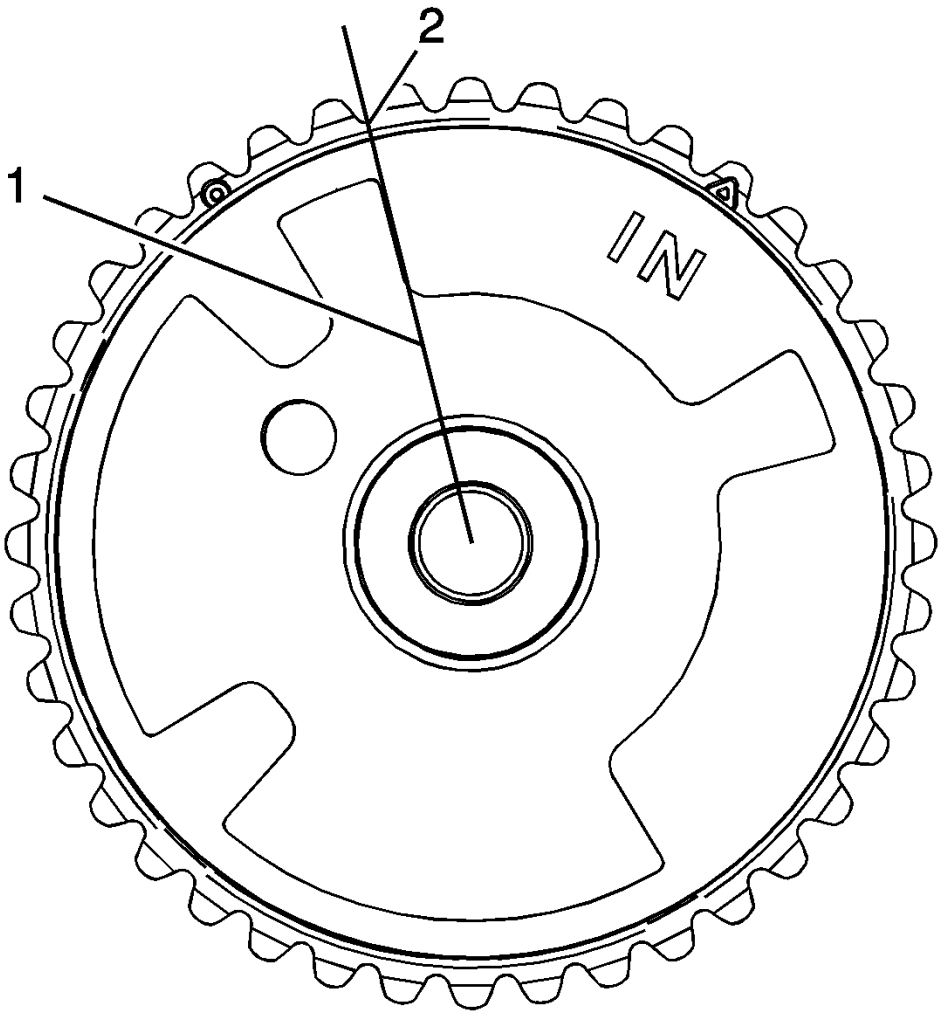

Fig. 525: View Of Reluctor Wheel & Valley
Courtesy of GENERAL MOTORS COMPANY

3. On the right intake camshaft actuator the edge of the reluctor wheel (1) lines up with the valley (2) of the sprocket tooth.

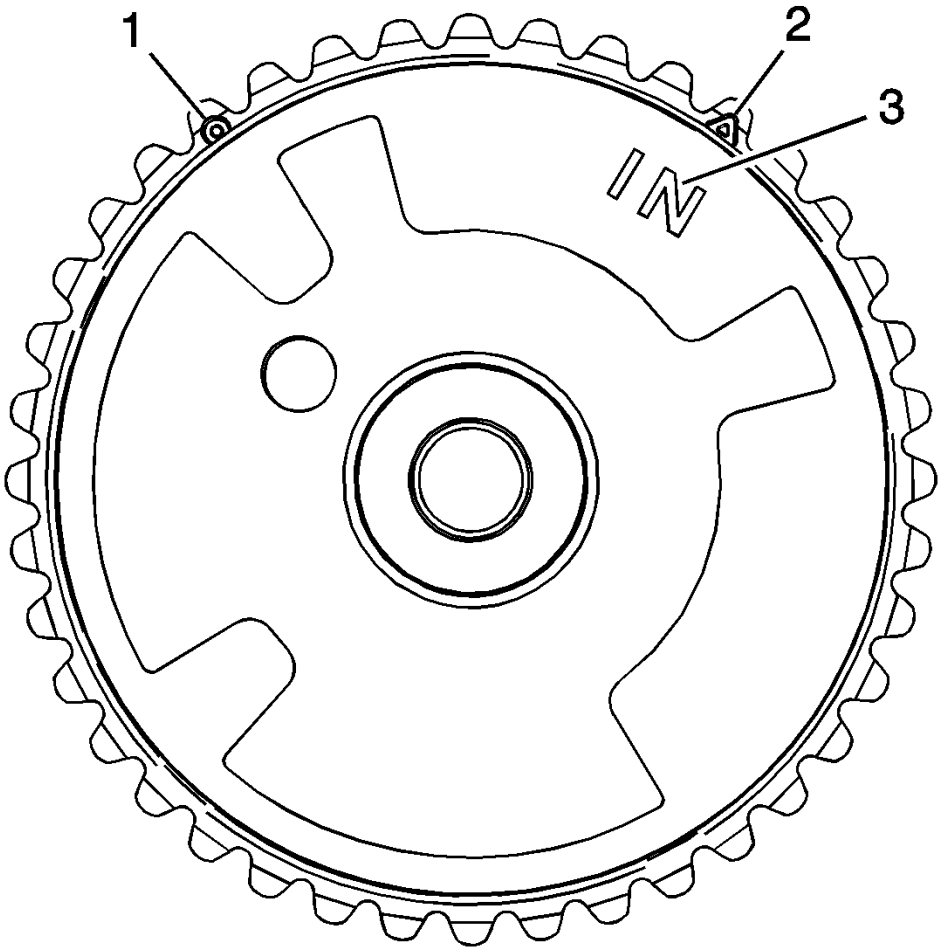

Fig. 526: View Of Camshaft Position Actuator Markings
Courtesy of GENERAL MOTORS COMPANY

4. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the triangle marking (2). The triangle marking is for alignment to the highlighted timing chain link on the right side of the engine.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

5. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.

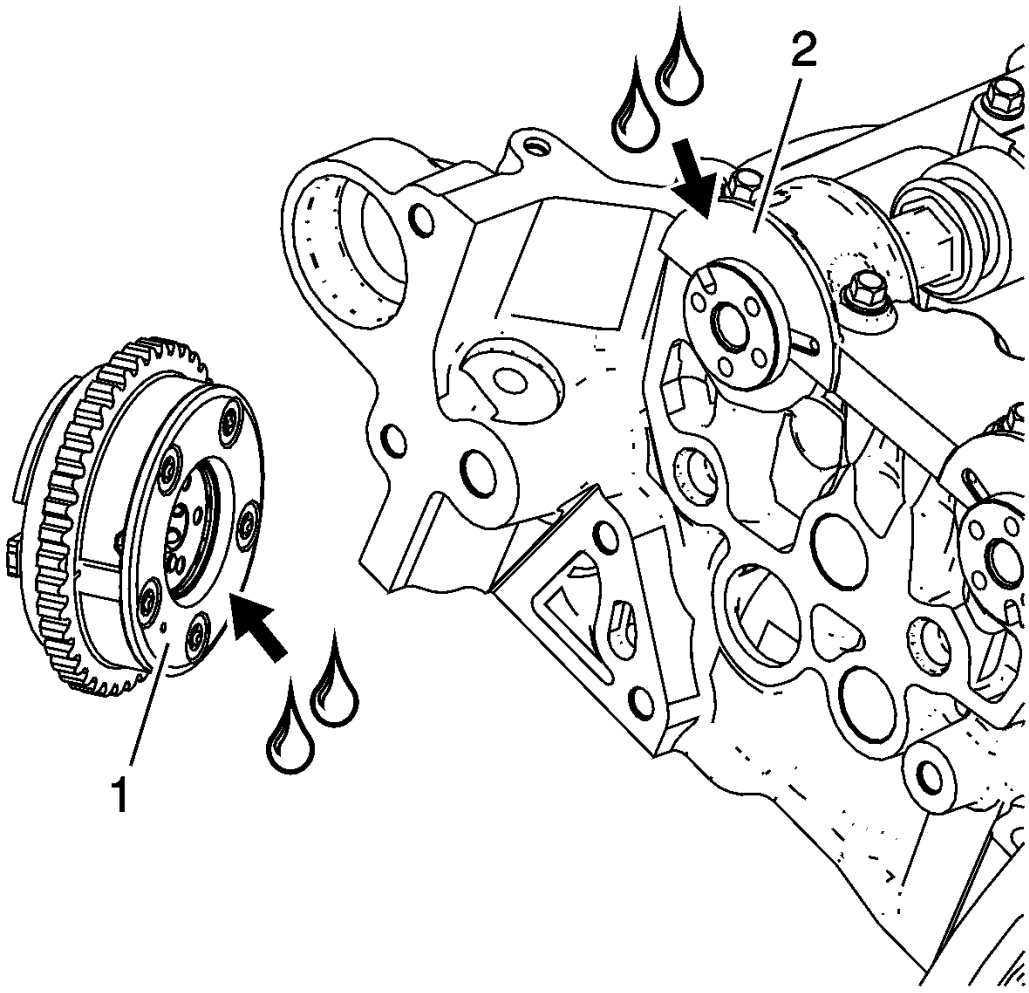

Fig. 527: Applying Lubricant To Back Of Camshaft Position Actuator And Front Of Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

6. Apply a liberal amount of lubricant to the back of the camshaft position actuator (1) and front of the camshaft bearing cap (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

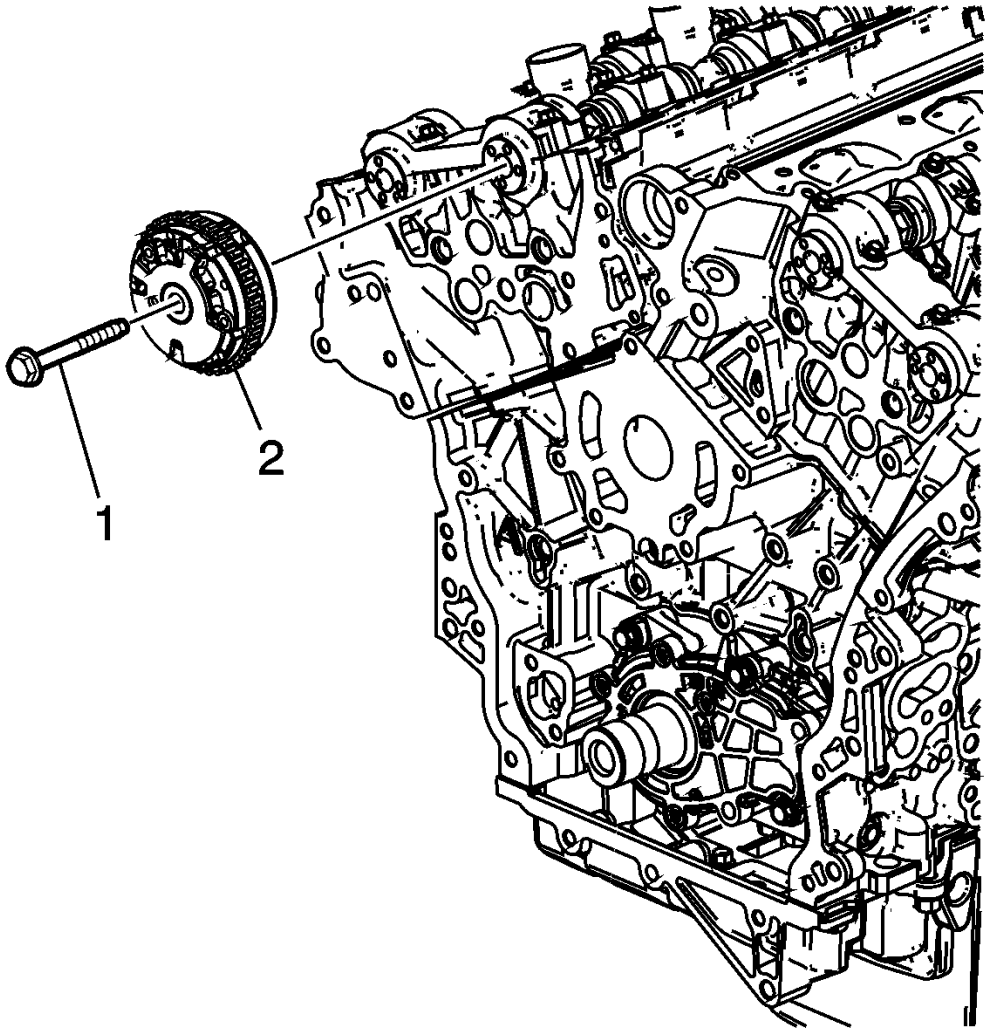

Fig. 528: Right Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

7. Install the right intake camshaft position actuator (2).

CAUTION: Refer to Fastener Caution .

8. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CAMSHAFT POSITION ACTUATOR INSTALLATION - RIGHT SIDE EXHAUST

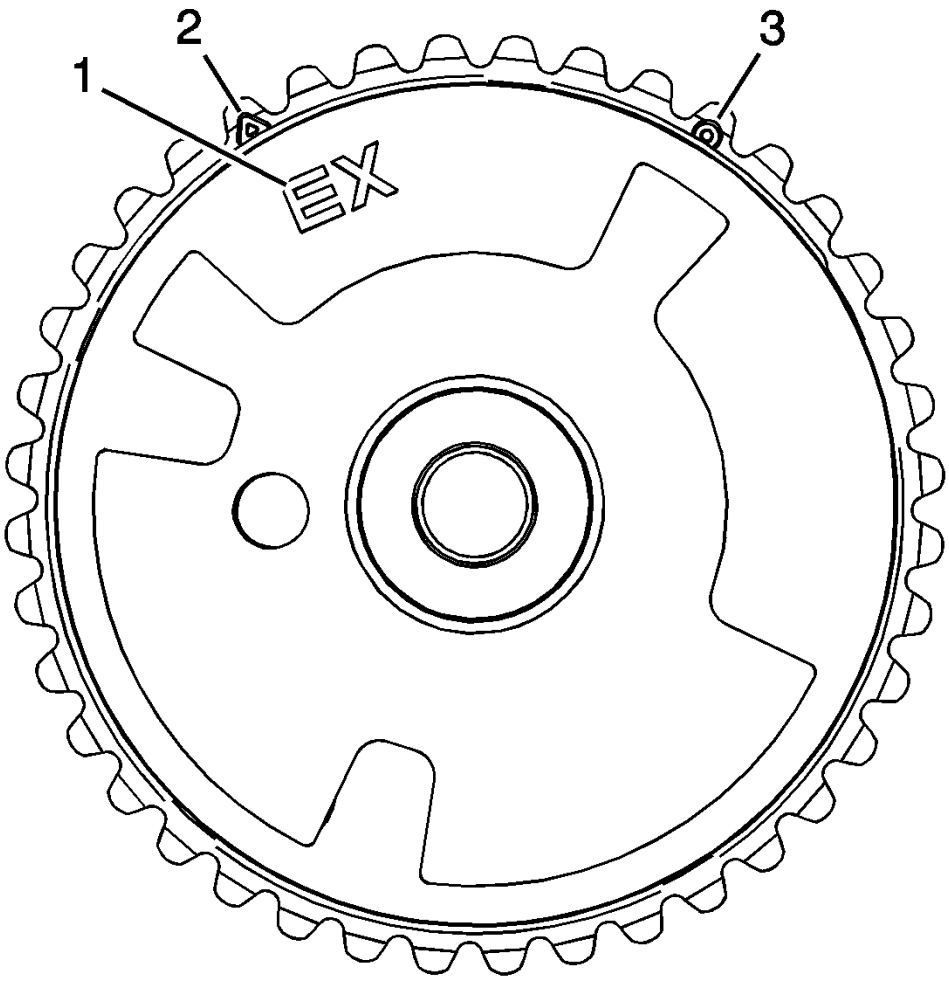

Fig. 529: View Of EX Marking, Triangle & Circle Marking
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "EX" marking (1). The marking is for an exhaust camshaft position actuator.
2. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the triangle marking (2). The marking is for alignment to the highlighted timing chain link on the right side of the engine.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

3. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.

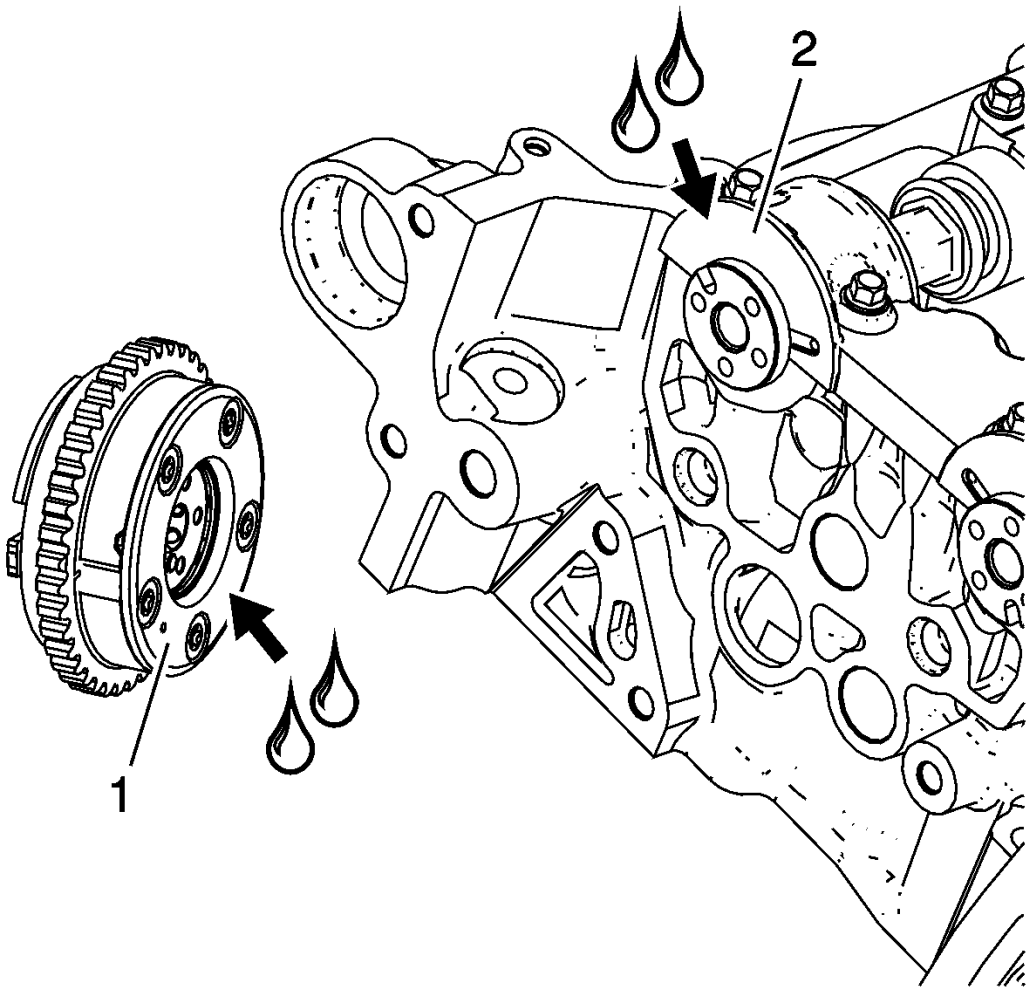

Fig. 530: Applying Lubricant To Back Of Camshaft Position Actuator And Front Of Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

4. Apply a liberal amount of lubricant to the back of the camshaft position actuator (1) and front of the camshaft bearing cap (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

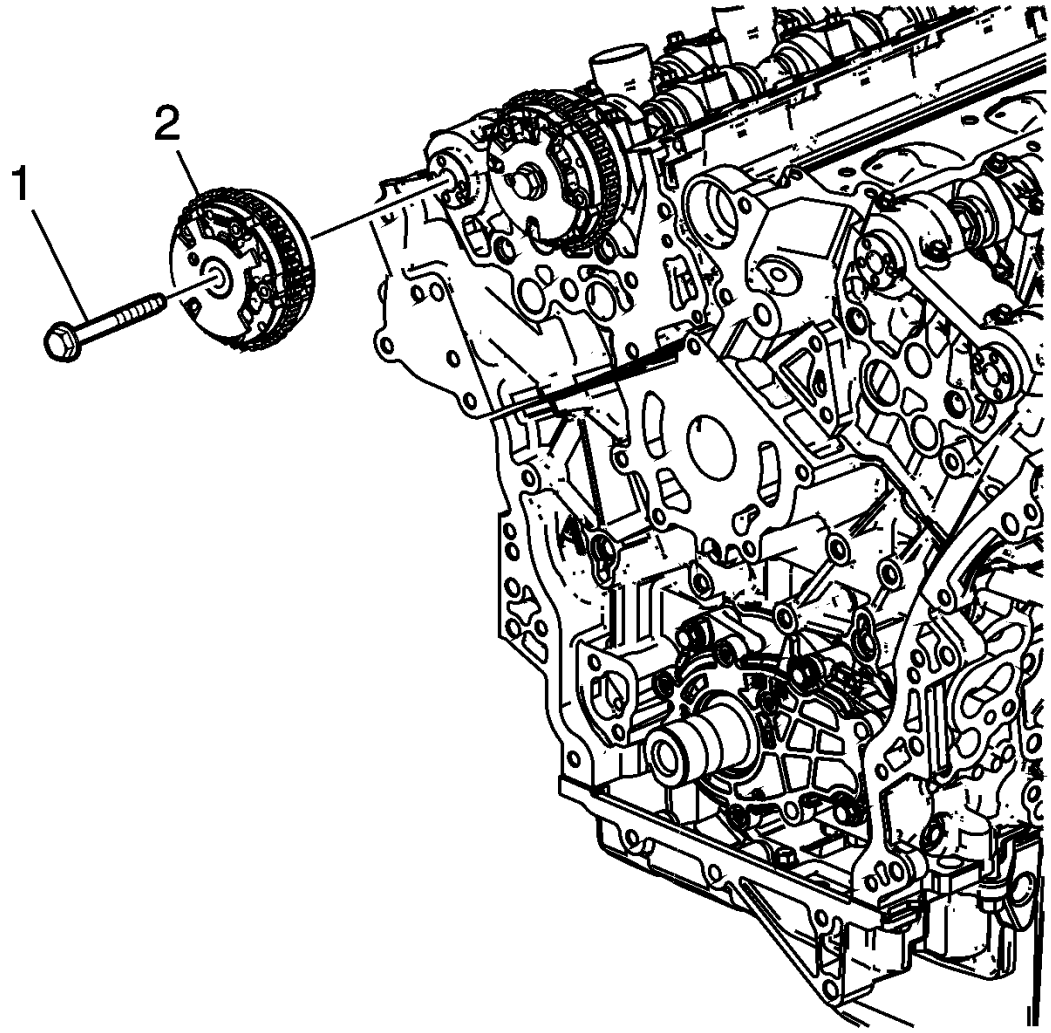

Fig. 531: Right Exhaust Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

5. Install the right exhaust camshaft position actuator (2).

CAUTION: Refer to Fastener Caution .

6. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CAMSHAFT POSITION ACTUATOR INSTALLATION - LEFT SIDE INTAKE

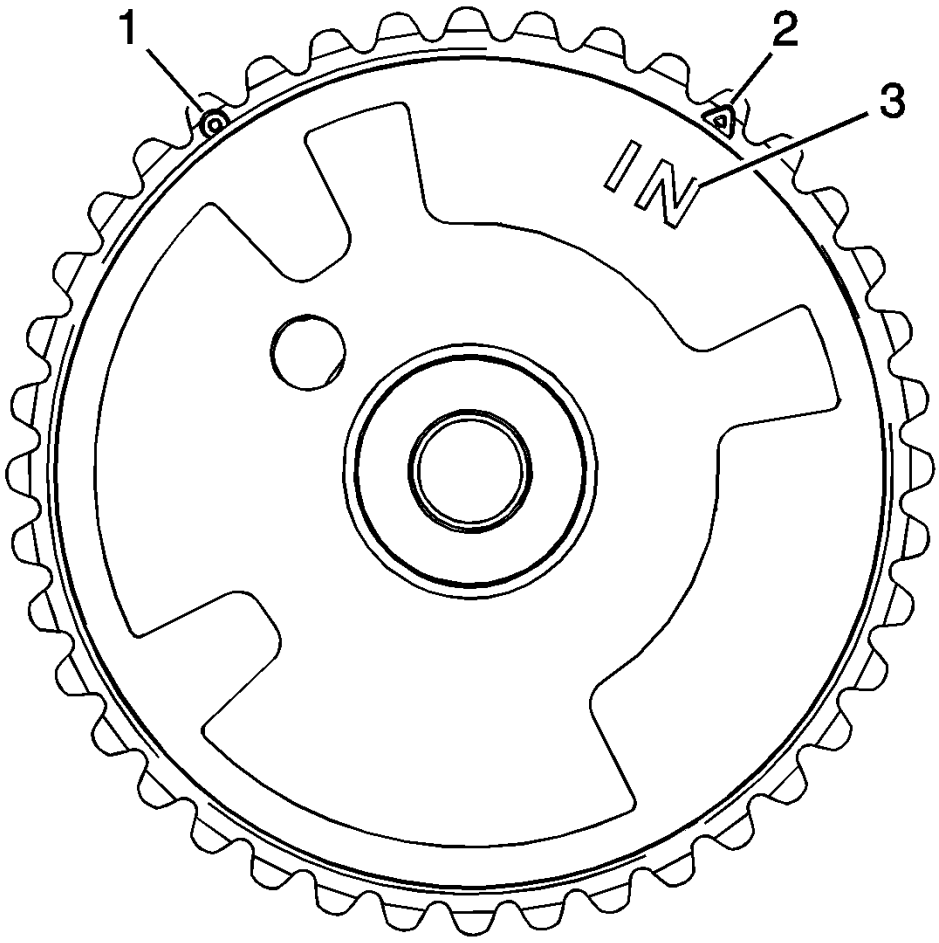

Fig. 532: Identifying Camshaft Position Actuator Marks
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "IN" marking (3). The marking is for an intake camshaft position actuator.

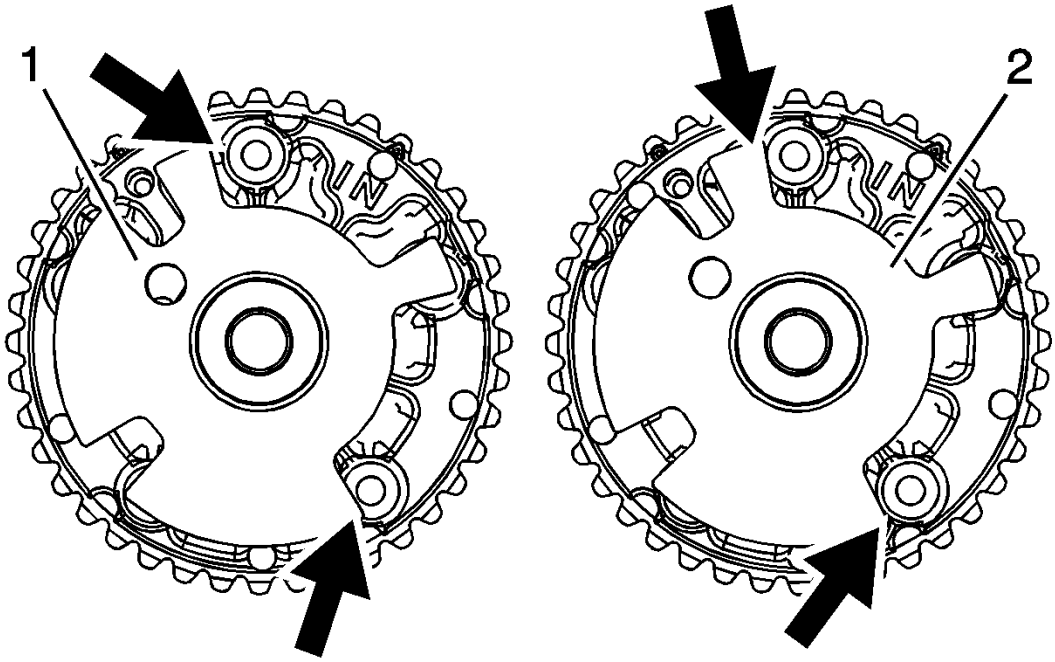

Fig. 533: View Of Right Intake Camshaft Position Actuator & Left Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Ensure the proper camshaft position actuator is installed in the correct position. Failure to install the proper camshaft position actuator can effect engine performance and set an engine code.

2. Ensure the proper camshaft position actuator is being installed. The reluctor wheel on the right intake camshaft position actuator (1) is indexed in a different position compared to the left intake camshaft position actuator (2).

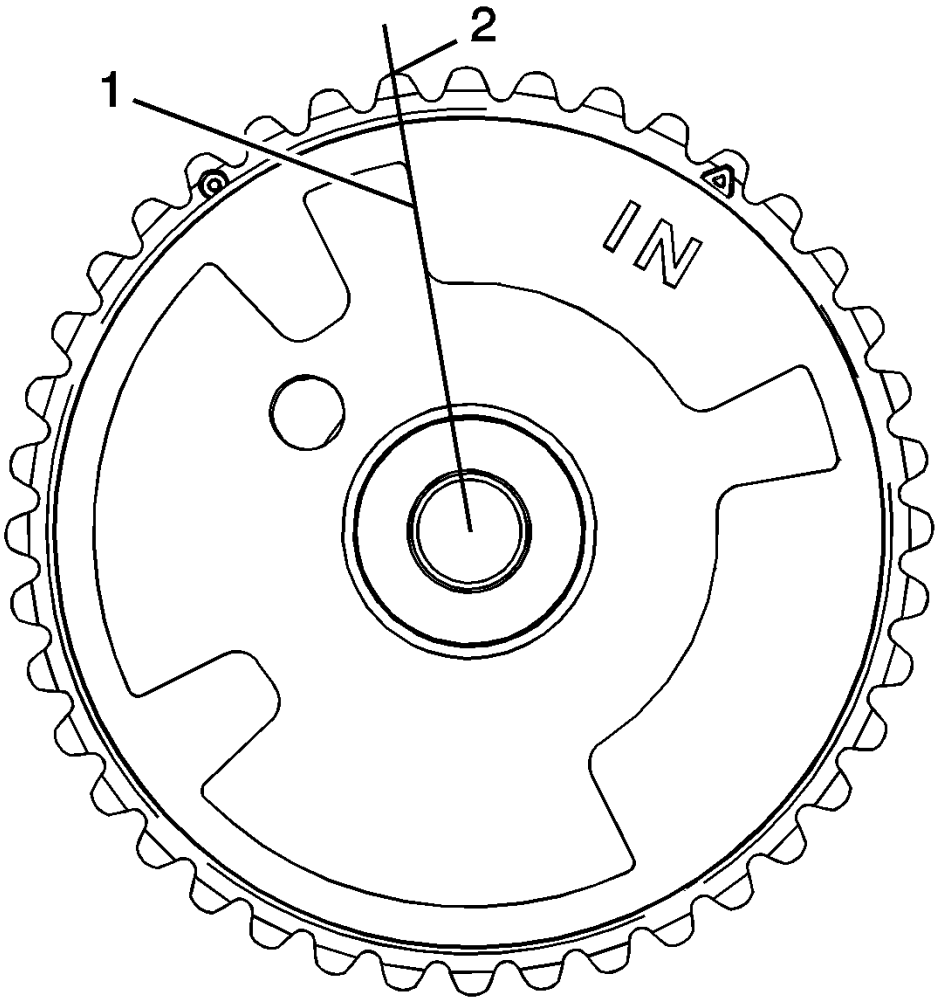

Fig. 534: View Of Reluctor Wheel Lines Up With Peak
Courtesy of GENERAL MOTORS COMPANY

3. On the left intake camshaft actuator the edge of the reluctor wheel (1) lines up with the peak (2) of the sprocket tooth.

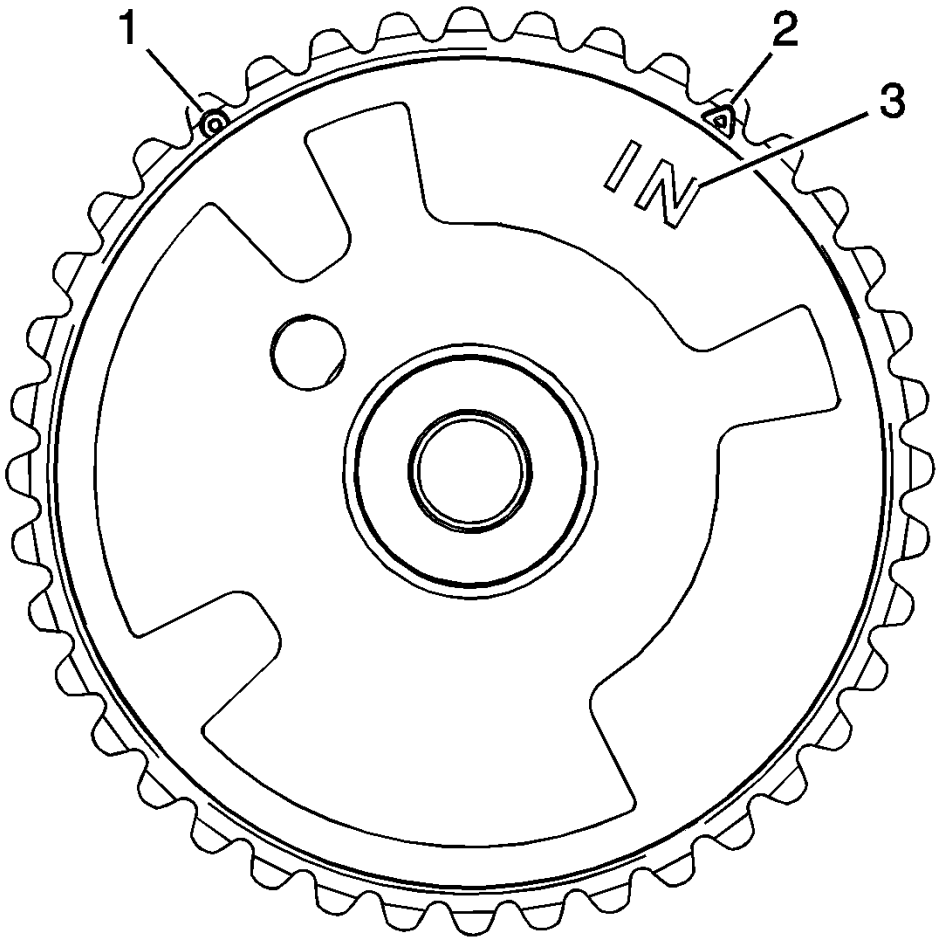

Fig. 535: Identifying Camshaft Position Actuator Marks
Courtesy of GENERAL MOTORS COMPANY

4. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the circle marking (1). The circle marking is for alignment to the highlighted timing chain link on the left side of the engine.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

5. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.

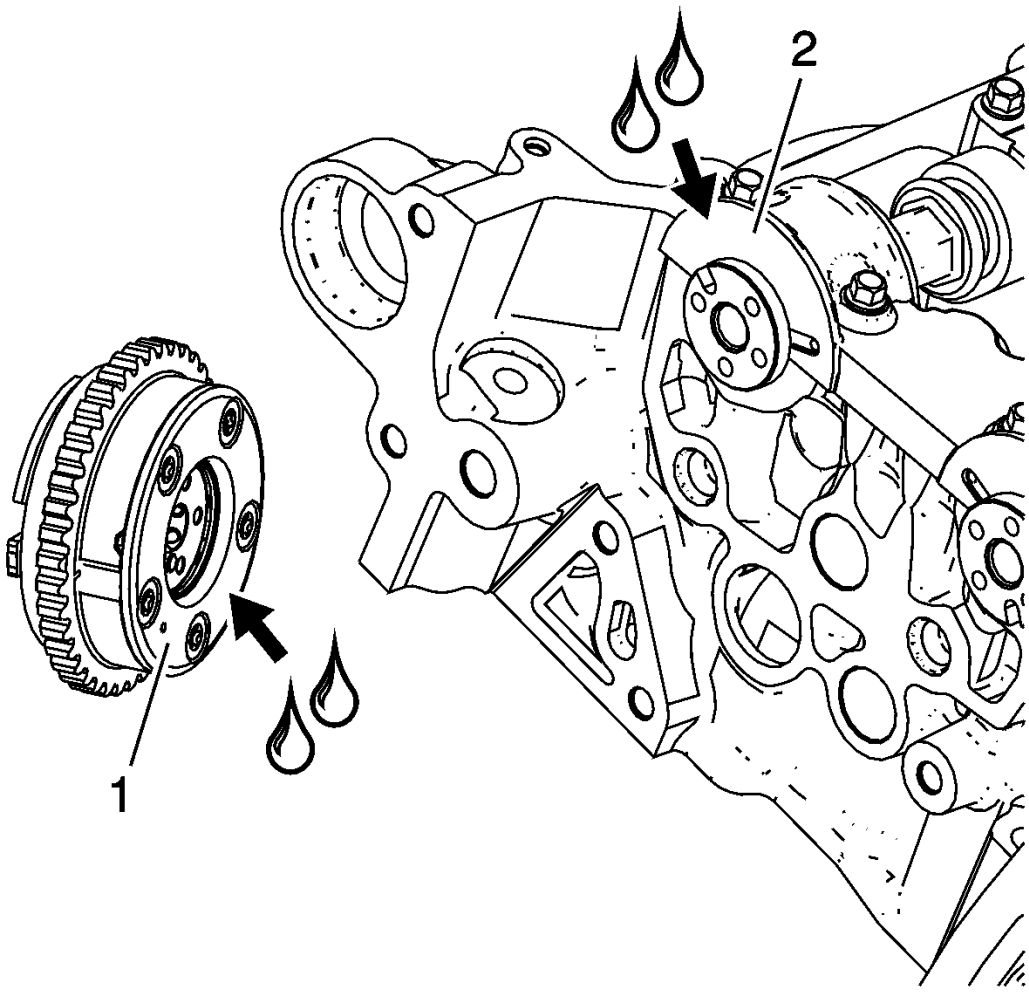

Fig. 536: Applying Lubricant To Back Of Camshaft Position Actuator And Front Of Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

6. Apply a liberal amount of lubricant to the back of the camshaft position actuator (1) and front of the camshaft bearing cap (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

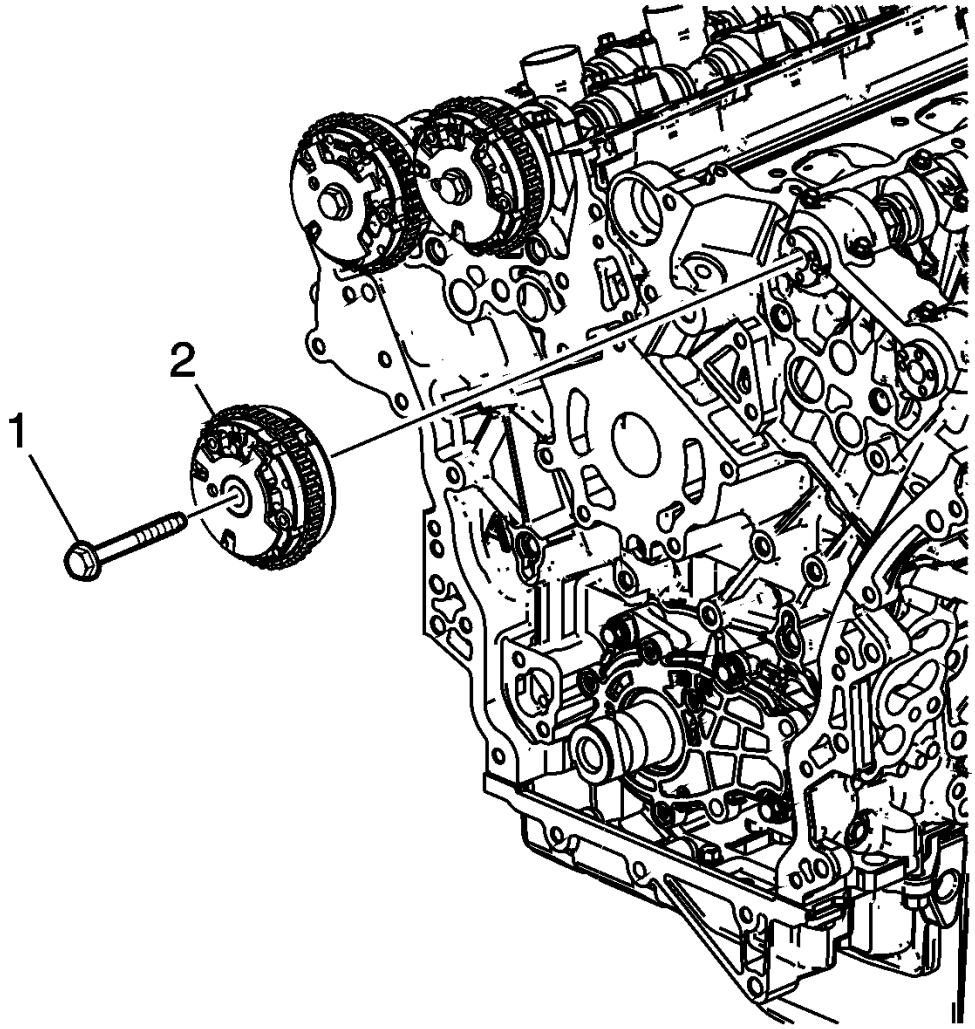

Fig. 537: Left Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

7. Install the left intake camshaft position actuator (2).

CAUTION: Refer to Fastener Caution .

8. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CAMSHAFT POSITION ACTUATOR INSTALLATION - LEFT SIDE EXHAUST

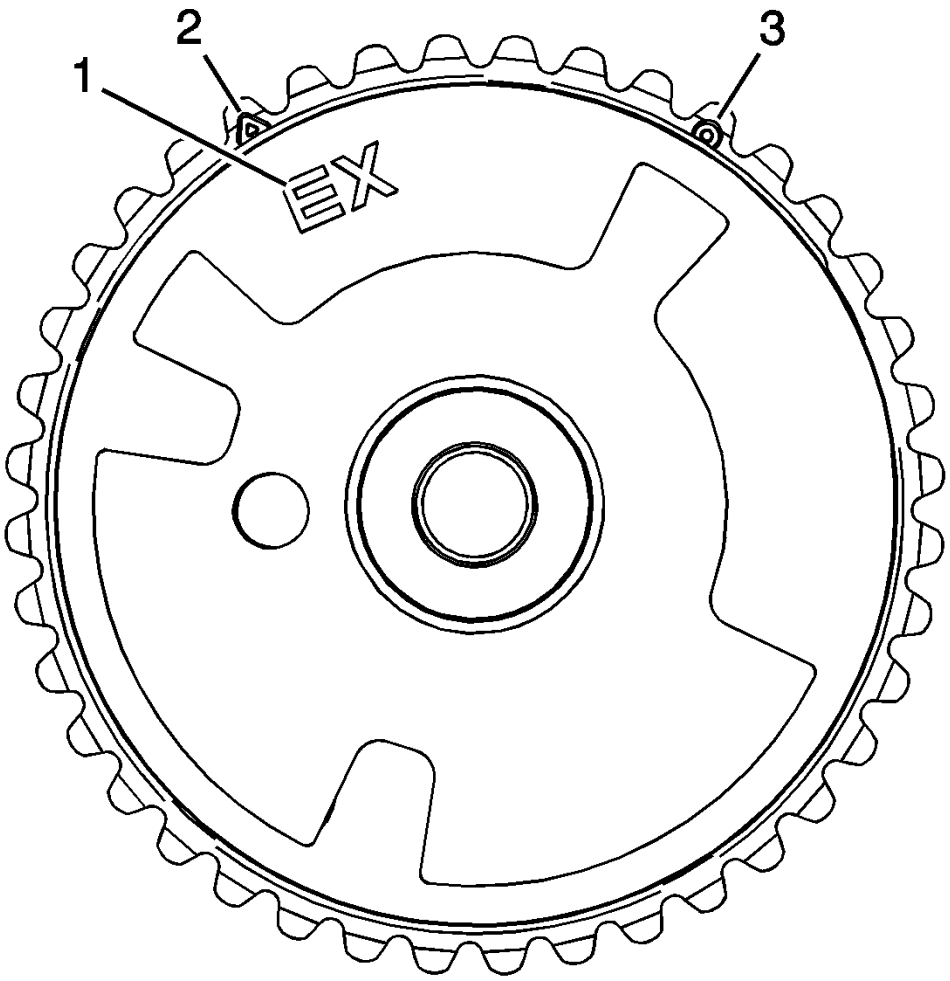

Fig. 538: View Of EX Marking, Triangle & Circle Marking
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the proper camshaft position actuator is installed. Observe the body of the camshaft position actuator for the "EX" marking (1). The marking is for an exhaust camshaft position actuator.
2. Ensure the proper timing mark is used. Observe the outer ring of the camshaft position actuator for the circle marking (3). The marking is for alignment to the highlighted timing chain link on the left side of the engine.

CAUTION: Refer to Torque Reaction Against Timing Drive Chain Caution .

3. Use an open wrench on the hex cast into the camshaft in order to prevent camshaft rotation when tightening the camshaft position actuator bolt.

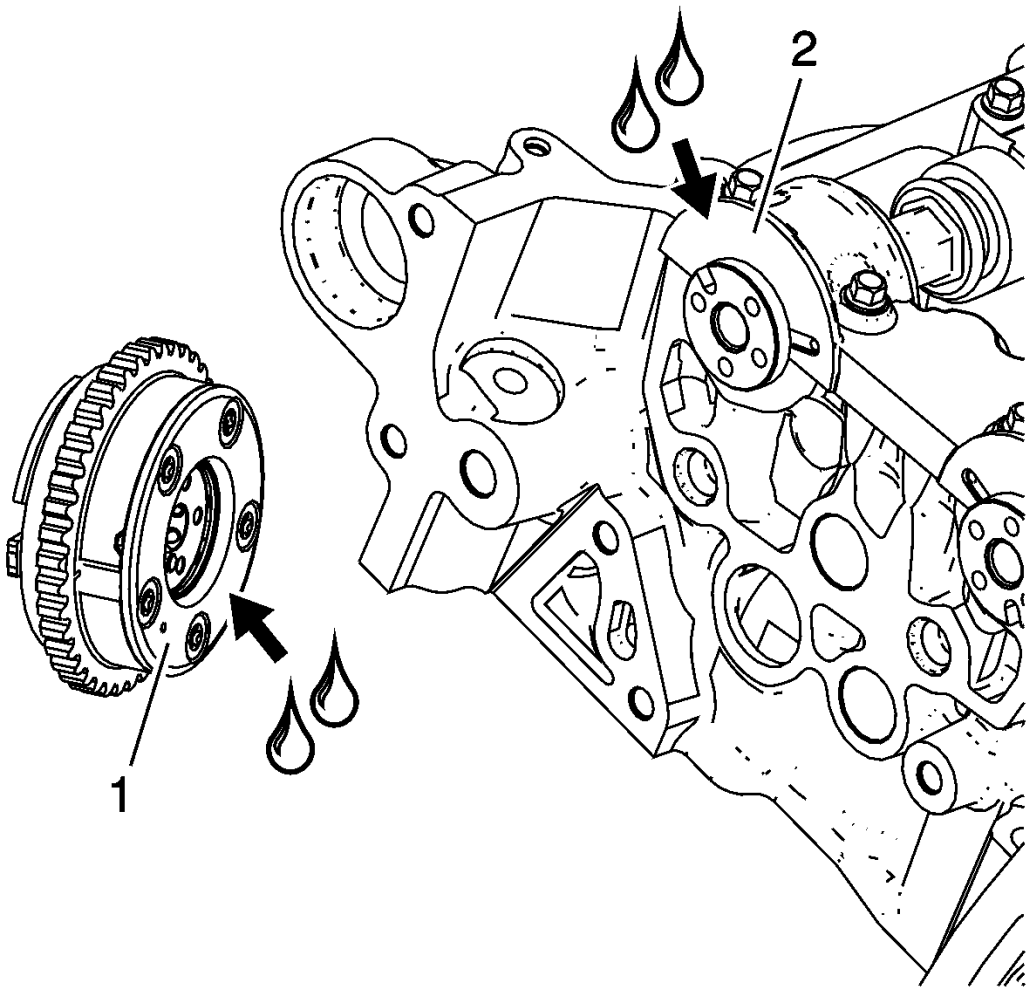

Fig. 539: Applying Lubricant To Back Of Camshaft Position Actuator And Front Of Camshaft Bearing Cap
Courtesy of GENERAL MOTORS COMPANY

4. Apply a liberal amount of lubricant to the back of the camshaft position actuator (1) and front of the camshaft bearing cap (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

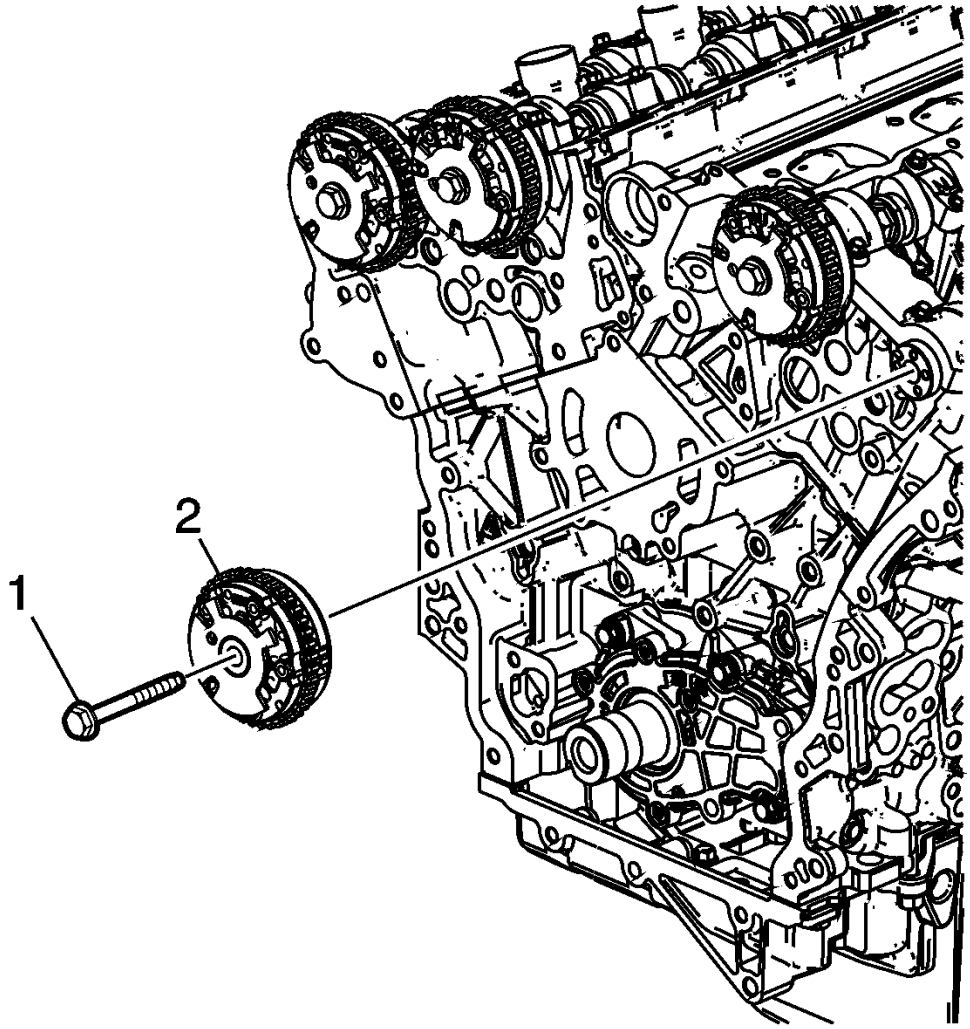

Fig. 540: Left Exhaust Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

5. Install the left exhaust camshaft position actuator (2).

CAUTION: Refer to Fastener Caution .

6. Install the camshaft position actuator bolt (1) and tighten to 58 N.m (43 lb ft).

CRANKSHAFT SPROCKET INSTALLATION

Special Tools

EN-48589 Crankshaft Rotation Socket

For equivalent regional tools, refer to **Special Tools** .

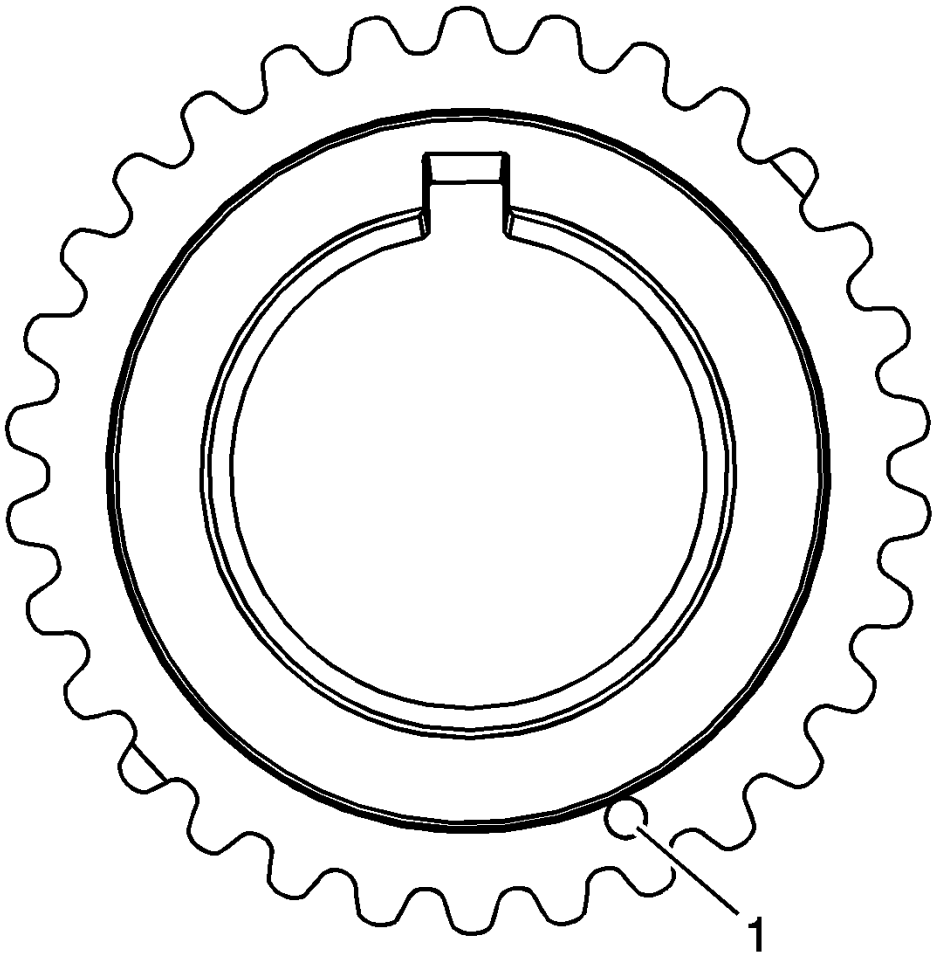

Fig. 541: Identifying Crankshaft Sprocket Timing Mark
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the crankshaft sprocket is installed with the timing mark (1) visible.

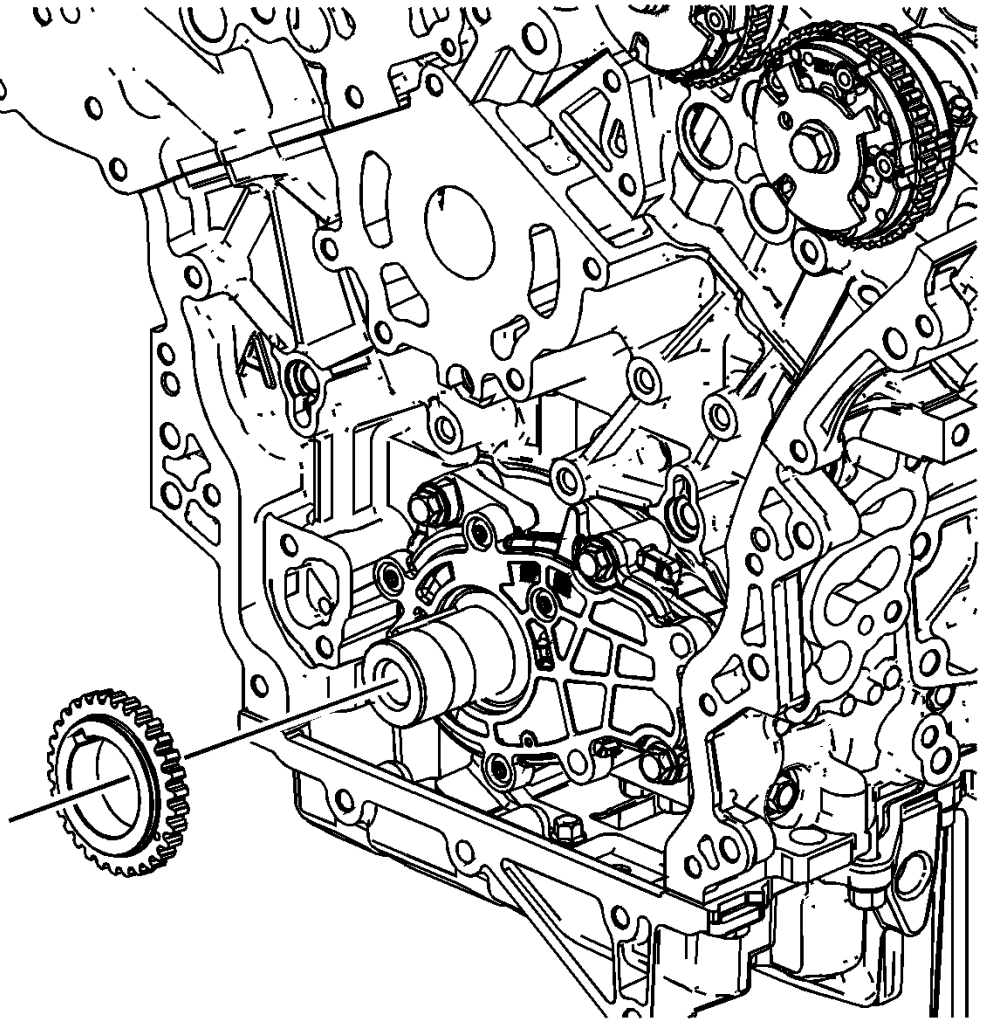

Fig. 542: View Of Crankshaft Sprocket
Courtesy of GENERAL MOTORS COMPANY

2. Install the crankshaft sprocket onto the nose of the crankshaft.
3. Align the notch in the crankshaft sprocket with the pin in the crankshaft.
4. Slide the crankshaft sprocket on the crankshaft nose until the crankshaft sprocket contacts the step in the crankshaft.

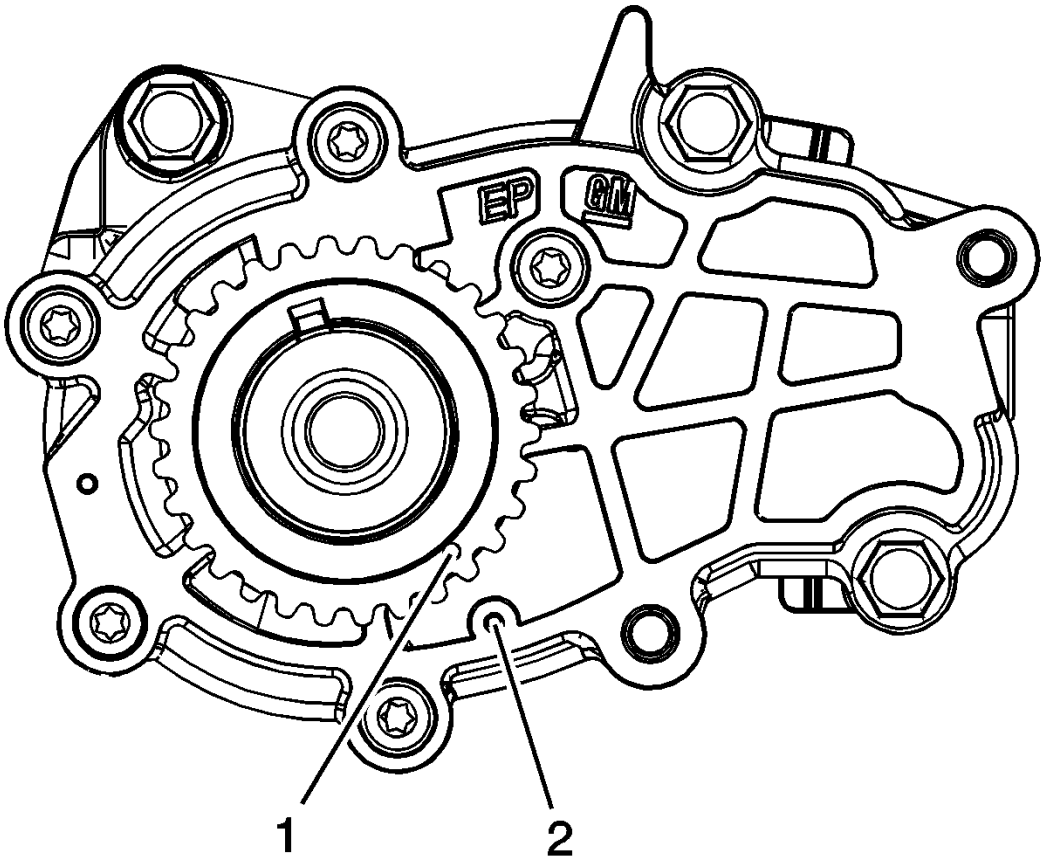

Fig. 543: View Of Stage One Timing Mark On Oil Pump Cover & Sprocket Timing Mark
Courtesy of GENERAL MOTORS COMPANY

5. Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (1) aligned to the stage one timing mark on the oil pump cover (2) using the **EN-48589** socket. Refer to **Timing Chain Alignment Diagram** .

TIMING CHAIN IDLER SPROCKET INSTALLATION - LEFT SIDE

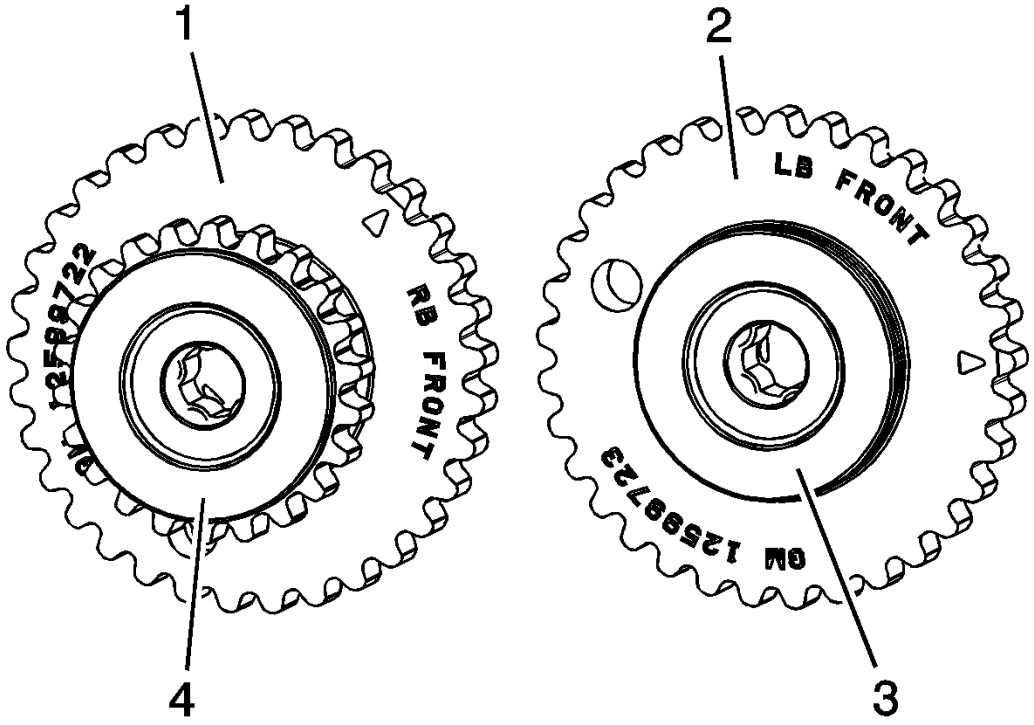

Fig. 544: Identifying Camshaft Intermediate Drive Chain Idlers
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the left camshaft intermediate drive chain idler (2) is being installed. The recessed hub (3) and the larger sprocket of the left camshaft intermediate drive chain idler is installed outward. The raised hub and the smaller sprocket of the left camshaft intermediate drive chain idler is installed towards the block.

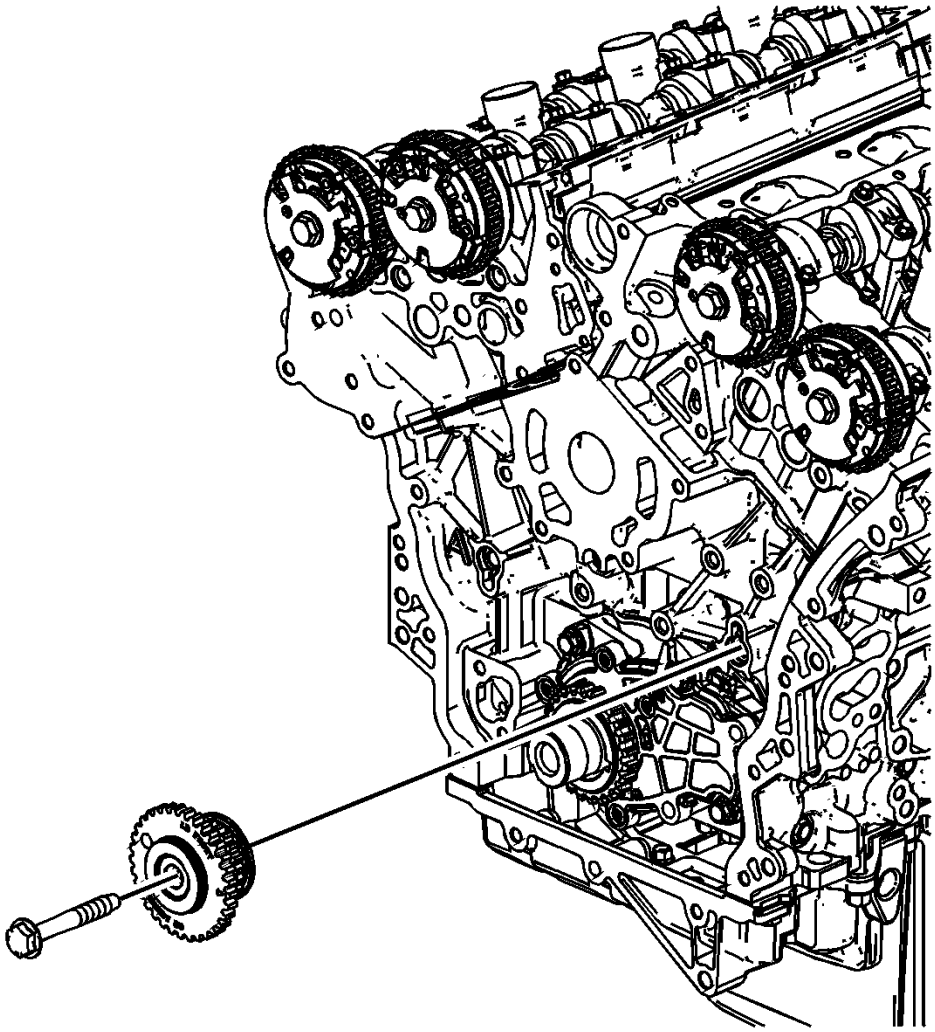

Fig. 545: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Place the left camshaft intermediate drive chain idler to the cylinder block.

CAUTION: Refer to Fastener Caution .

3. Install the camshaft intermediate drive chain idler bolt and tighten to 58 N.m (43 lb ft).

CAMSHAFT TIMING CHAIN COMPONENTS INSTALLATION

Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 1

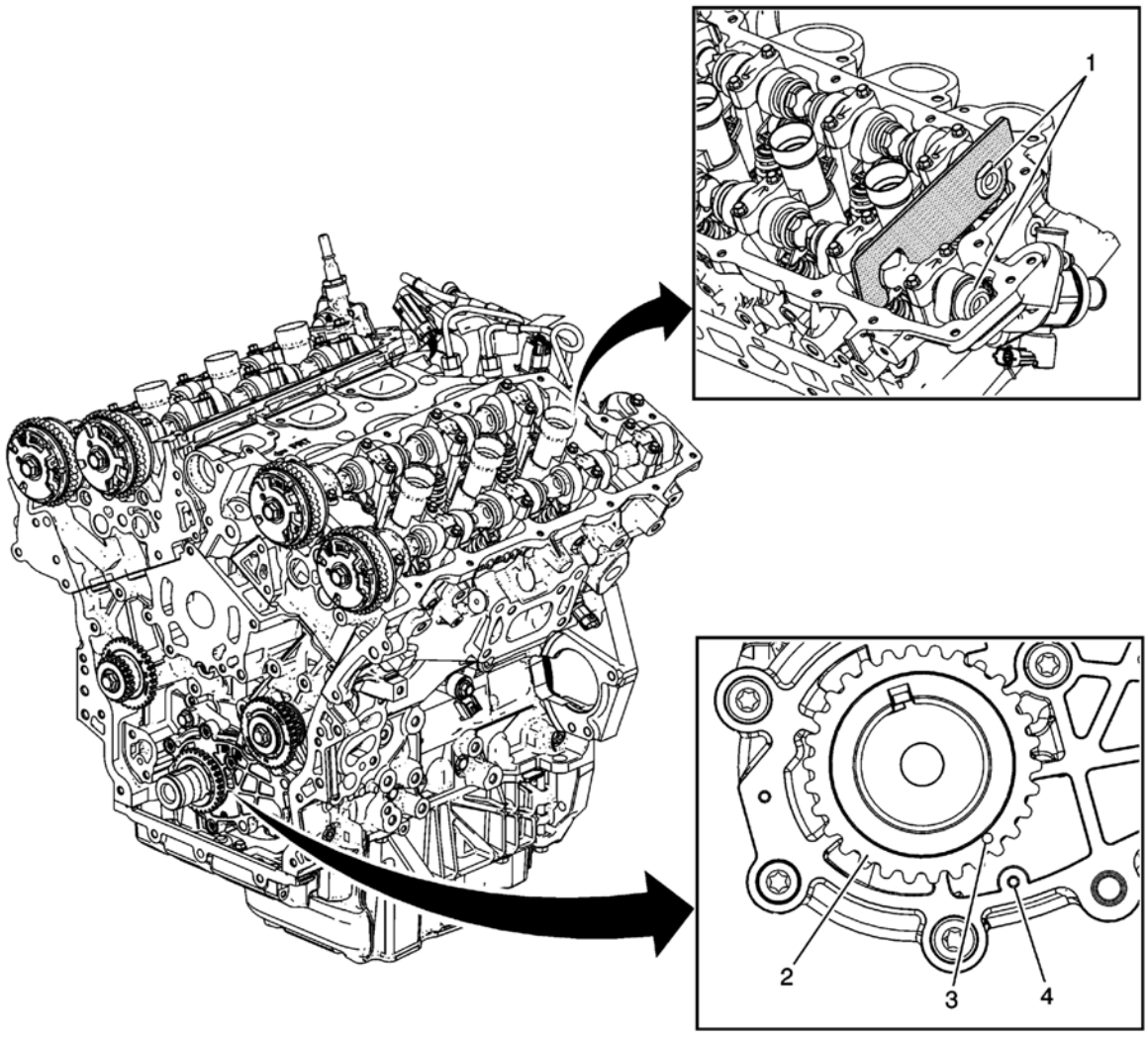

Fig. 546: Secondary Camshaft Intermediate Drive Chain Components - Left Side - Step 1
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 1

Callout	Component Name
NOTE: **If you are performing this procedure for the first time, it is recommended that you view video 56510.12V from the common training website before beginning (U.S. Dealers Only). To search for the video number, click on the catalog icon on the home page. Canadian dealers should view Tech Assist video 16038.01W on the LMS website and a related video on GM Global Connect (Library-**	

Callout	Component Name
Service>Technician Review>TAC Talk Video Help). See https://www.centerlearning.com /HomePage/Portal.asp for more information.	
1	Left Intake and Exhaust Camshaft **Procedure** **NOTE:** • **There should be no need to rotate the camshaft more than 10 degrees. Using the hex cast into the camshaft rotate the camshaft in order to install the EN-48383 retaining tools .** • **All camshafts must be locked in place before installation of any camshaft drive chains.** 1. Install the **EN-48383-1** retaining tool onto the rear of the left camshafts. 2. Ensure the **EN-48383-1** retaining tool is fully seated onto the camshafts.

Callout	Component Name
	Special Tools **EN-48383** Camshaft Retaining Tools For equivalent regional tools, refer to **Special Tools** .
2	Crankshaft Sprocket **NOTE:** **Ensure the crankshaft is in the stage one timing position with the crankshaft sprocket timing mark (3) aligned to the stage one timing mark on the oil pump cover (4) using the EN-48589 socket. Refer to Timing Chain Alignment Diagram .** **Special Tools** **EN-48589** Crankshaft Rotation Socket For equivalent regional tools, refer to **Special Tools** .
3	Crankshaft Sprocket Timing Mark
4	Stage One Timing Mark On The Oil Pump Cover

Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 2

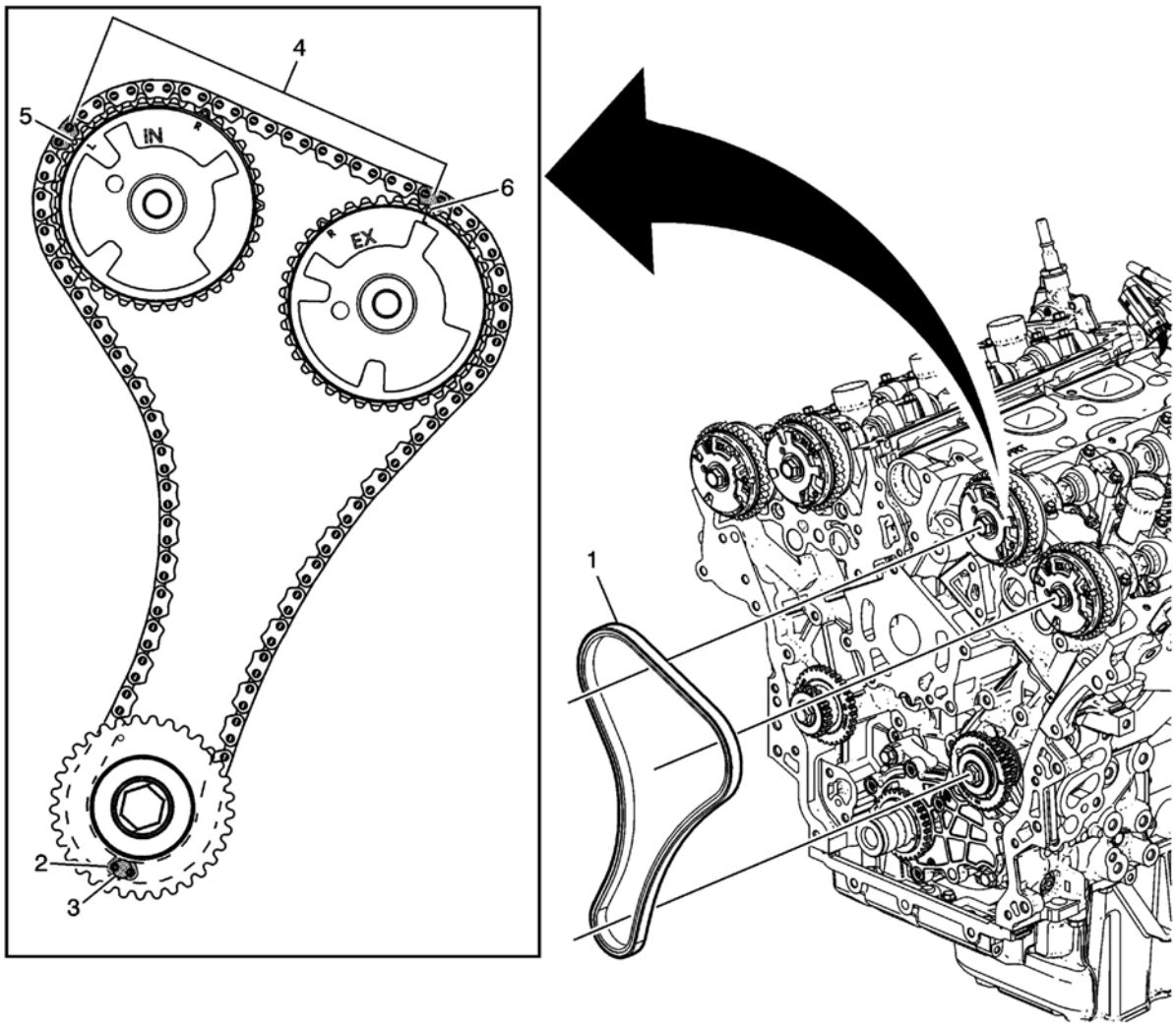

Fig. 547: Secondary Camshaft Intermediate Drive Chain Components - Left Side - Step 2
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Intermediate Drive Chain Installation - Left Side - Step 2

Callout	Component Name
NOTE: **Ensure that the left (L) camshaft position actuator sprocket alignment circle marks are used during this step.**	
1	Secondary Camshaft Intermediate Drive Chain **Procedure**

Callout	Component Name
	NOTE: **Once the lower timing link is aligned, it may be helpful to hold the drive chain in position using a small flat blade screwdriver through the idler sprocket alignment access hole.** 1. Place the left secondary camshaft drive chain around the inner sprocket of the left camshaft intermediate drive chain idler with the camshaft drive chain timing link (2) aligned to the alignment access hole (3) in the left camshaft intermediate drive chain idler outer sprocket. 2. Wrap the secondary camshaft drive chain around both left (L) actuator drive sprockets. 3. Align the left (L) intake camshaft position actuator sprocket alignment circle mark (5) with the camshaft drive chain timing link. 4. Align the left (L) exhaust camshaft position actuator sprocket alignment circle mark (6) with the camshaft drive chain timing link. 5. Once aligned, ensure there are 10 chain links (4) between timing marks for the left (L) camshaft position actuator sprockets.
2	Timing Camshaft Drive Chain
3	Alignment Access Hole
4	10 Chain Links Between Timing Marks for the Left (L) Camshaft Position Actuator Sprockets
5	Left (L) Intake Camshaft Position Actuator Sprocket Alignment Circle Mark
6	Left (L) Exhaust Camshaft Position Actuator Sprocket Alignment Circle Mark

Secondary Camshaft Drive Chain Guide and Shoe Installation - Left

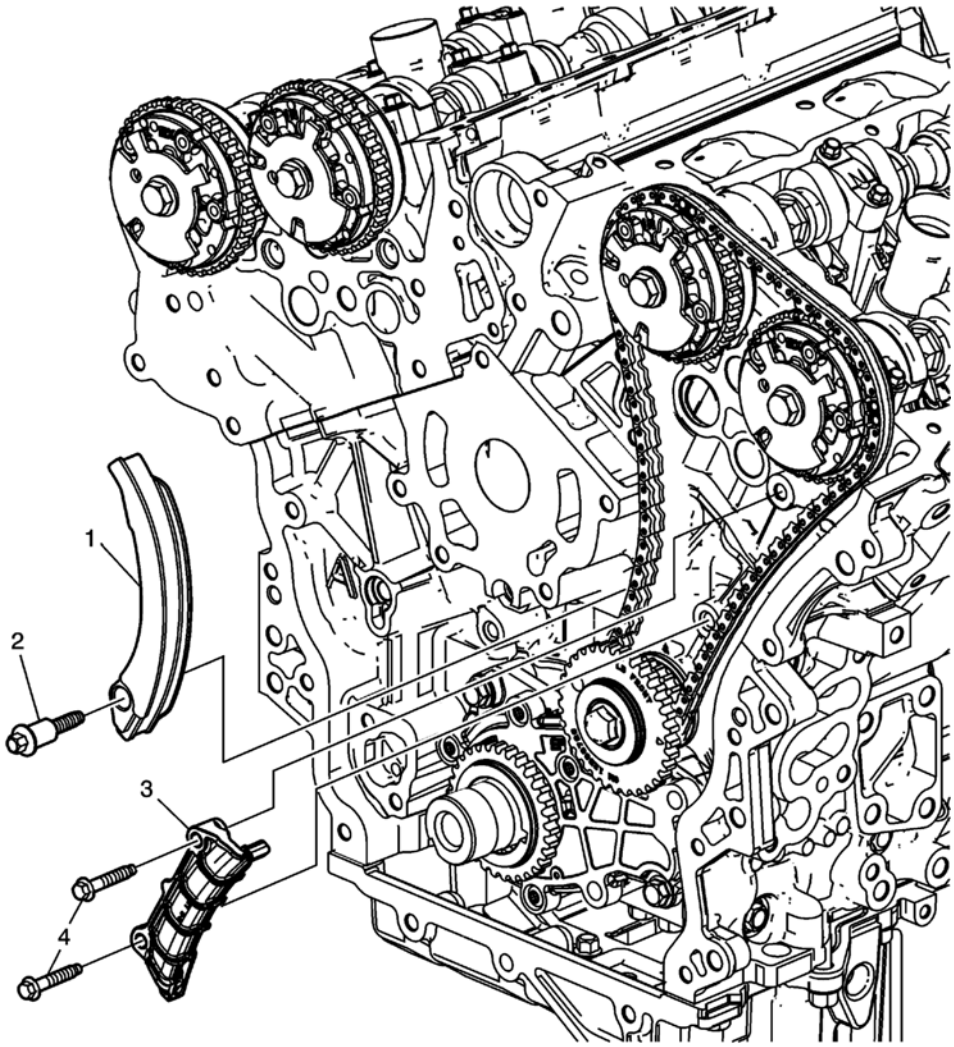

Fig. 548: Secondary Camshaft Drive Chain Guide And Shoe - Left
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Guide and Shoe Installation - Left

Callout	Component Name
1	Left Pivot Arm Timing Chain Guide
2	Left Pivot Arm Timing Chain Guide Bolt **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 25 (18 lb ft)
3	Left Secondary Timing Chain Guide
4	Left Secondary Timing Chain Guide Bolt **Tighten** 25 (18 lb ft)

Secondary Camshaft Drive Chain Tensioner Installation - Left Side

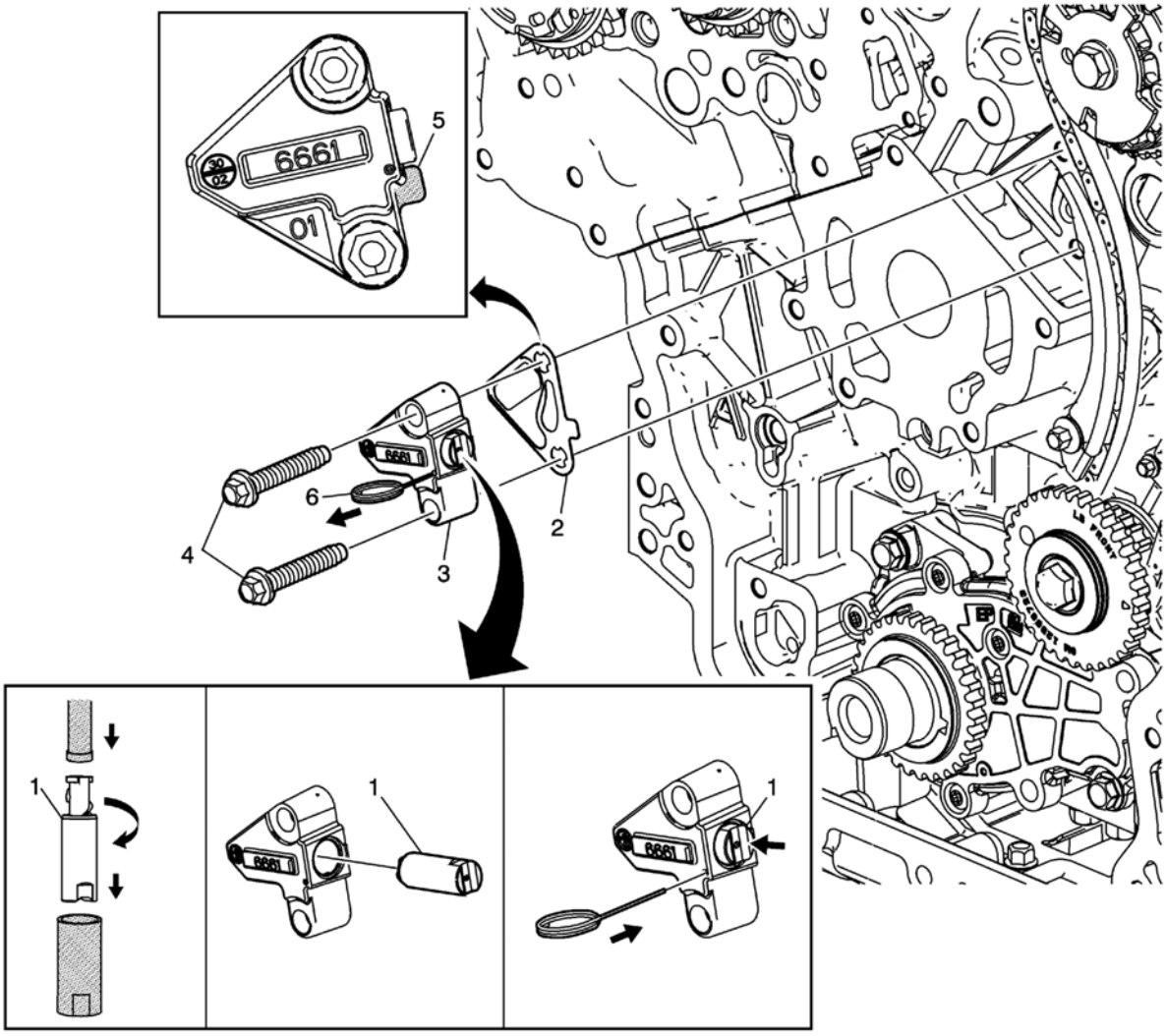

Fig. 549: Secondary Camshaft Drive Chain Tensioner And Components - Left Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Tensioner Installation - Left Side

Callout	Component Name
1	Left Secondary Timing Chain Tensioner Plunger. **Procedure** 1. Reset the left secondary camshaft drive chain tensioner plunger using **EN-45027** tensioner tool. 2. Install left secondary camshaft drive chain tensioner plunger into body. 3. Compress the plunger into the body and lock the left secondary camshaft drive chain tensioner by inserting the **EN-46112** tensioner retraction pins into the access hole in the side of the left secondary camshaft drive chain tensioner body. 4. Slowly release pressure on the left secondary camshaft drive chain tensioner. The left secondary camshaft drive chain tensioner should remain compressed.

Callout	Component Name
	Special Tools • **EN-45027** Tensioner Tool • **EN-46112** Tensioner Retraction Pins For equivalent regional tools, refer to **Special Tools** .
2	Left Timing Chain Housing Gasket **NOTE:** **Ensure the left secondary camshaft drive chain tensioner mounting surface on the left cylinder head does not have any burrs or defects that would degrade the sealing of the NEW left secondary camshaft drive chain tensioner gasket.**
3	Left Secondary Timing Chain Tensioner
4	Left Secondary Timing Chain Tensioner Bolt **Procedure** 1. Place the chain tensioner into position and loosely install the bolts to the block. 2. Verify the proper placement of the drive chain tensioner gasket tab (5). 3. Tighten the drive chain tensioner bolts in two passes. 4. Verify the timing marks are in the correct position before releasing the drive chain tensioner. 5. Release the drive chain tensioner by pulling out the **EN-46112** tensioner retraction pins pin (6) and unlocking the tensioner plunger. 6. Verify the left secondary camshaft drive chain timing mark alignments by referring to

Callout	Component Name
	Timing Chain Alignment Diagram - Stage One. **Tighten** • First Pass 5 (44 lb in) • Second Pass 25 (18 lb ft)
5	Left Timing Chain Housing Gasket Tab
6	**EN-46112** Pin

Primary Camshaft Intermediate Drive Chain Installation

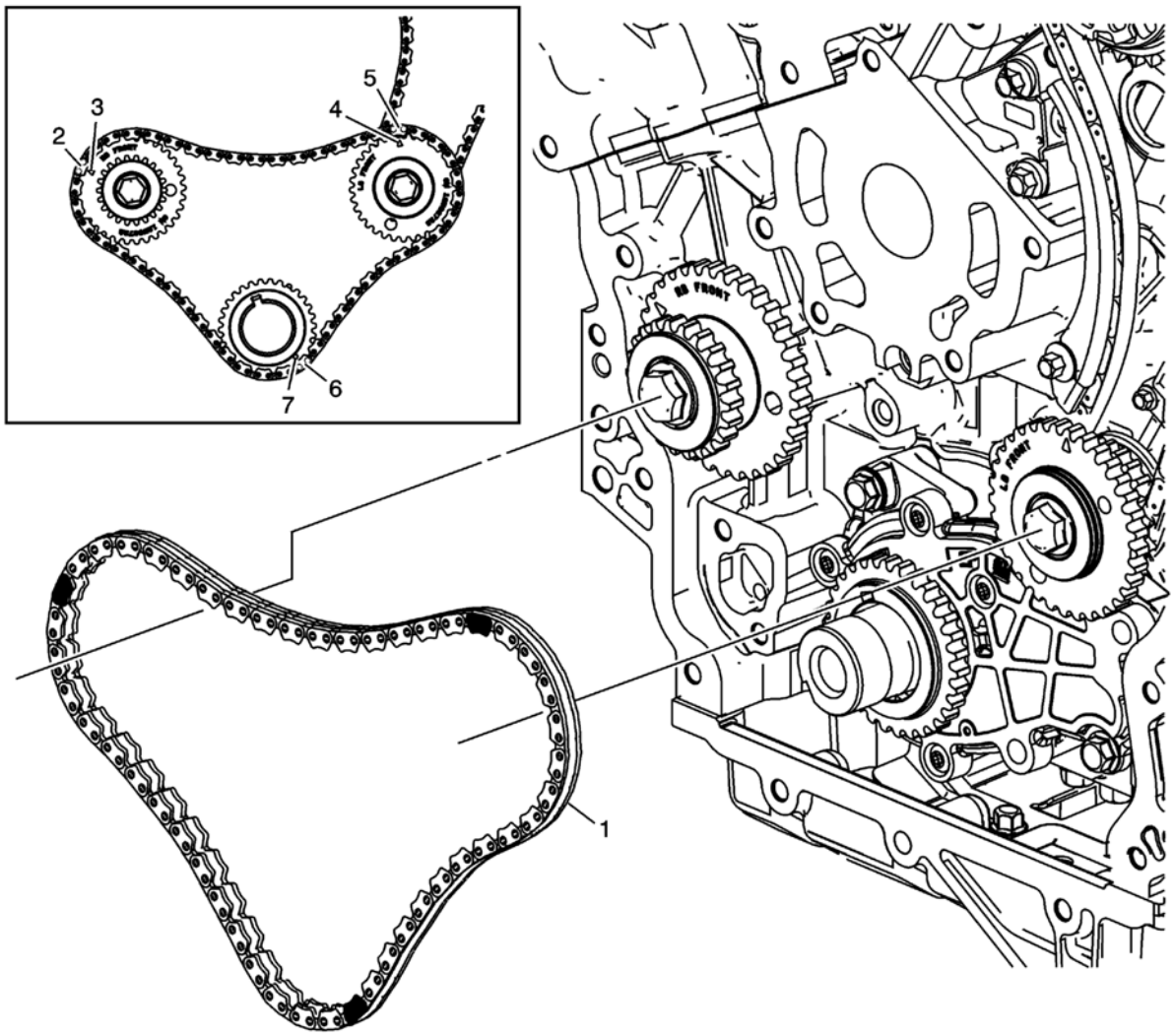

Fig. 550: Primary Camshaft Intermediate Drive Chain Components
Courtesy of GENERAL MOTORS COMPANY

Primary Camshaft Intermediate Drive Chain Installation

Callout	Component Name
1	Primary Camshaft Drive Intermediate Chain

Callout	Component Name
	Procedure 1. Wrap the primary camshaft drive chain around the large sprockets of each camshaft intermediate drive chain idler and the crankshaft sprocket. 2. The left camshaft intermediate drive chain idler timing mark (2) will align with camshaft drive chain timing link (3). 3. The right camshaft intermediate drive chain idler timing mark (4) will align with camshaft drive chain timing link (5). 4. The crankshaft sprocket timing mark (7) will align with camshaft drive chain timing link (6).
2	Left Camshaft Intermediate Drive Chain Idler Timing Mark
3	Camshaft Drive Chain Timing Link
4	Right Camshaft Intermediate Drive Chain Idler Timing Mark
5	Camshaft Drive Chain Timing Link
6	Camshaft Drive Chain Timing Link
7	Crankshaft Sprocket Timing Mark

Primary Timing Chain Guide Installation - Lower and Upper

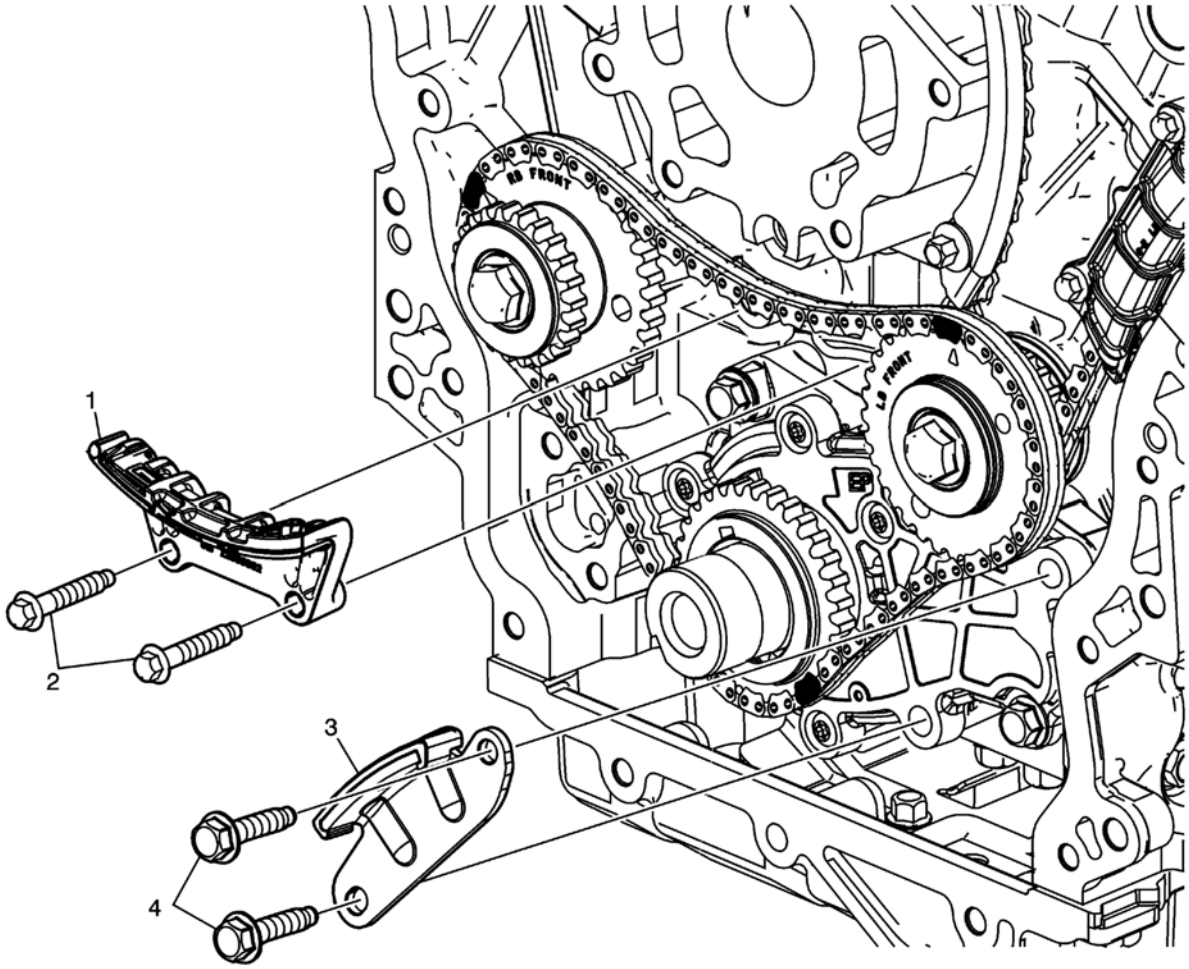

Fig. 551: Primary Timing Chain Guide & Bolts - Lower and Upper
Courtesy of GENERAL MOTORS COMPANY

Primary Timing Chain Guide Installation - Lower and Upper

Callout	Component Name
1	Upper Primary Timing Chain Guide
2	Upper Primary Timing Chain Guide Bolt **Tighten** 25 N.m (18 lb ft)
3	Lower Primary Timing Chain Guide
4	Lower Primary Timing Chain Guide Bolt **Tighten** 25 N.m (18 lb ft)

Primary Camshaft Intermediate Drive Chain Tensioner Installation

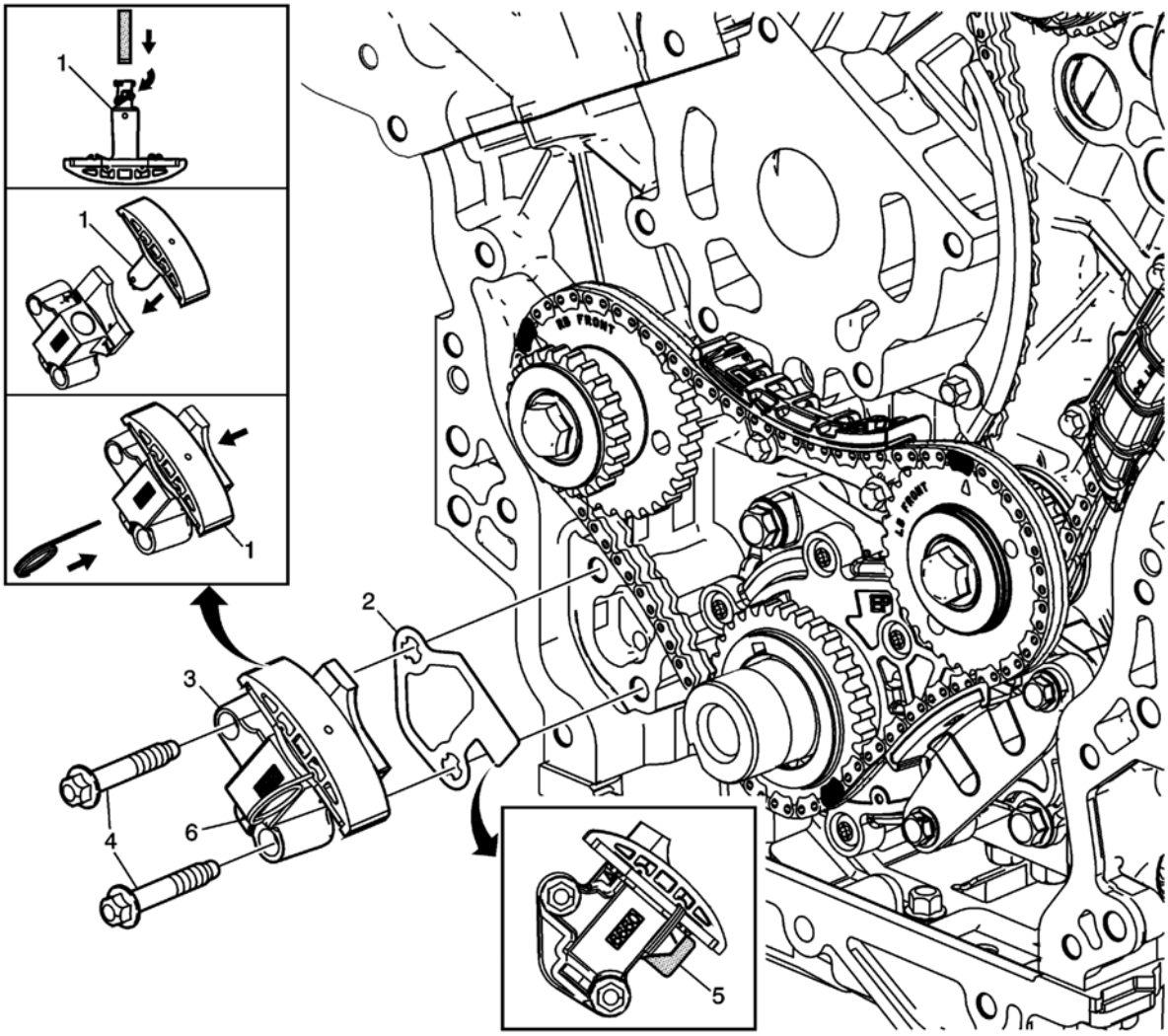

Fig. 552: Primary Camshaft Intermediate Drive Chain Tensioner & Components
Courtesy of GENERAL MOTORS COMPANY

Primary Camshaft Intermediate Drive Chain Tensioner Installation

Callout	Component Name
1	Camshaft Intermediate Drive Chain Tensioner Plunger. **Procedure** 1. Reset the primary camshaft drive chain tensioner plunger using **EN-45027** tensioner tool. 2. Install primary camshaft drive chain tensioner plunger into body. 3. Compress the plunger into the body and lock the primary camshaft drive chain tensioner by inserting the **EN-46112** tensioner retraction pins into the access hole in the side of the primary camshaft drive chain tensioner body. 4. Slowly release pressure on the primary camshaft drive chain tensioner. The primary camshaft drive chain tensioner should remain compressed. **Special Tools**

Callout	Component Name
	• **EN-45027** Tensioner Tool • **EN-46112** Tensioner Retraction Pins For equivalent regional tools, refer to **Special Tools** .
2	Timing Chain Housing Gasket **NOTE:** **Ensure the primary camshaft drive chain tensioner mounting surface on the engine block does not have any burrs or defects that would degrade the sealing of the NEW primary camshaft drive chain tensioner gasket.**
3	Camshaft Intermediate Drive Chain Tensioner
4	Camshaft Intermediate Drive Chain Tensioner Bolt **Procedure** 1. Place the drive chain tensioner into position and loosely install the bolts to the block. 2. Verify the proper placement of the drive chain tensioner gasket tab (5). 3. Tighten the drive chain tensioner bolts in two passes. 4. Verify the timing marks are in the correct position before releasing the drive chain tensioner. 5. Release the drive chain tensioner by pulling out the **EN-46112** pin (6) and unlocking the tensioner plunger. 6. Verify the primary and left secondary camshaft drive chain timing mark alignments by referring to **Timing Chain Alignment Diagram** - Stage One.

Callout	Component Name
	Tighten • First Pass 5 (44 lb in) • Second Pass 25 (18 lb ft)
5	Timing Chain Housing Gasket Tab
6	**EN-46112** Pin

Stage 1 Alignment Position to the Stage 2 Alignment Position

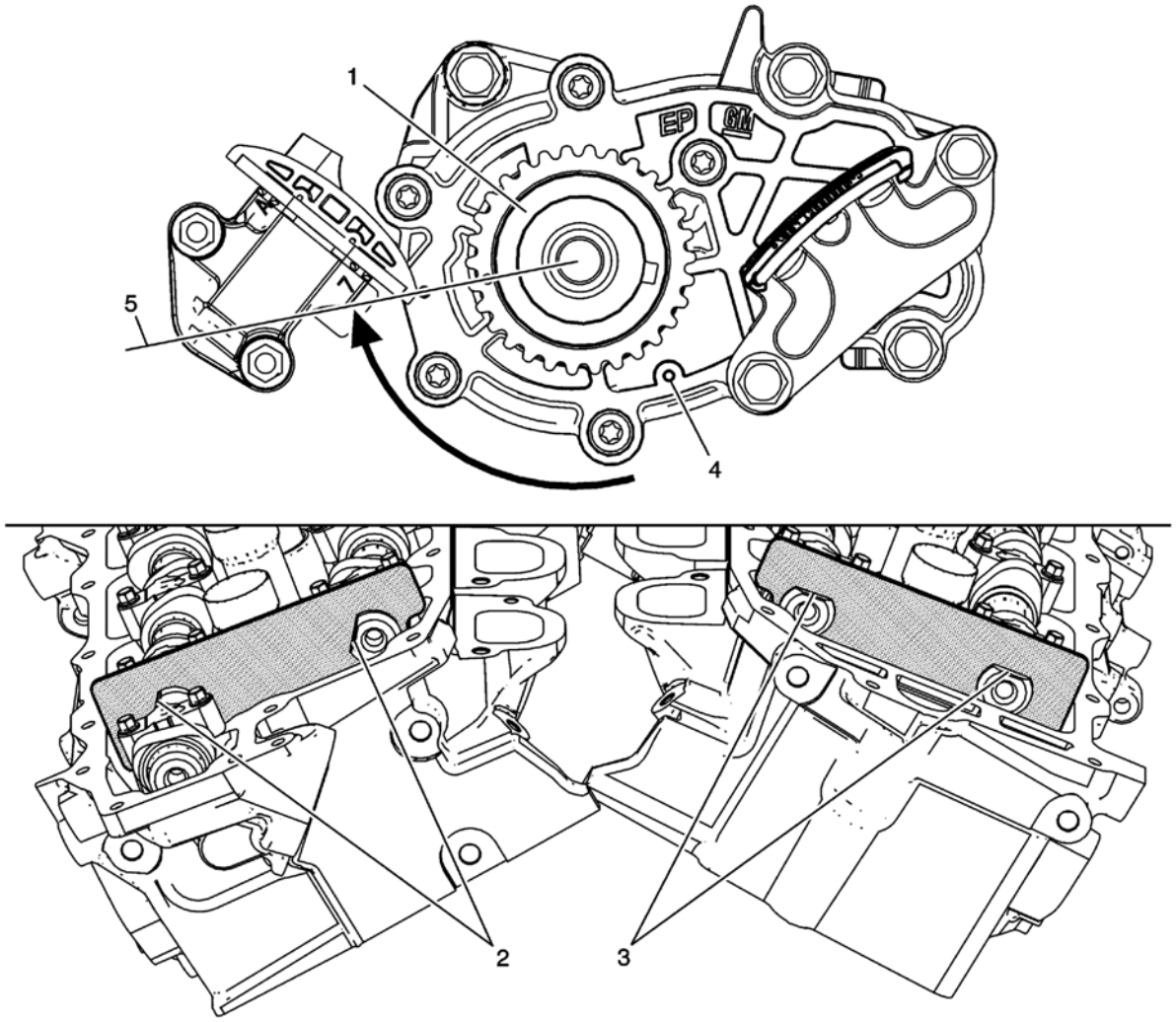

Fig. 553: Crankshaft Sprocket, Camshafts & Alignment Positions
Courtesy of GENERAL MOTORS COMPANY

Stage 1 Alignment Position to the Stage 2 Alignment Position

Callout	Component Name
Preliminary Procedure Remove the EN 48383-1 from the rear of the left camshafts.	

.

Callout	Component Name
1	Crankshaft Sprocket **Procedure** Using the **EN-48589** crankshaft rotation socket , rotate the crankshaft and crankshaft sprocket from the stage one alignment position (4) to the stage two alignment position (5), 115 crankshaft degrees, in order to install the right secondary camshaft drive chain components. **Special Tools** **EN-48589** Crankshaft Rotation Socket For equivalent regional tools, refer to **Special Tools** .

Callout	Component Name
2	Left Intake and Exhaust Camshaft **Procedure** **NOTE:** • **There should be no need to rotate the camshaft more than 10 degrees. Using the hex cast into the camshaft rotate the camshaft in order to install the EN-48383-2 retainer .** • **All camshafts must be locked in place before installation of any camshaft drive chains.** 1. Install the **EN-48383-2** retainer onto the rear of the left camshafts. 2. Ensure the **EN-48383-2** retainer is fully seated onto the camshafts. **Special Tools** **EN-48383** Crankshaft Rotation Tools For equivalent regional tools, refer to **Special Tools** .
3	Right Intake and Exhaust Camshaft **Procedure**

Callout	Component Name
	NOTE: • **There should be no need to rotate the camshaft more than 10 degrees. If using the hex cast into the camshaft rotate the** 1. Install the **EN-48383-3** retainer onto the rear of the right camshafts. 2. Ensure the **EN-48383-3** retainer is fully seated onto the camshafts. **Special Tools** **EN-48383** Crankshaft Rotation Tools For equivalent regional tools, refer to **Special Tools** .
4	Stage One Alignment Position
5	Stage Two Alignment Position

Secondary Camshaft Intermediate Drive Chain Installation - Right Side

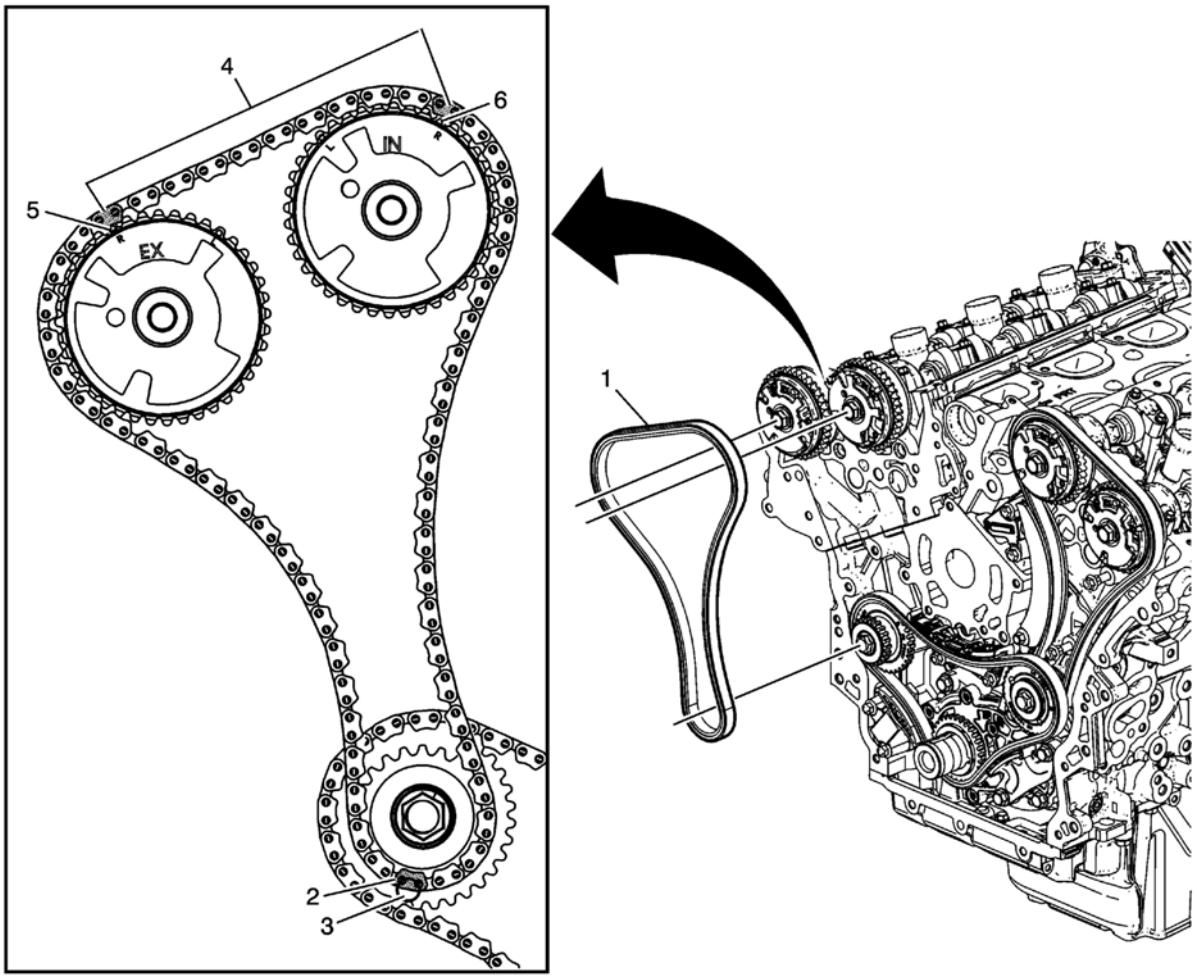

Fig. 554: Secondary Camshaft Intermediate Drive Chain - Right Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Intermediate Drive Chain Installation - Right Side

Callout	Component Name

Callout	Component Name
NOTE:	
Ensure that the right (R) camshaft position actuator sprocket alignment triangle marks are used during this step.	Secondary Camshaft Intermediate Drive Chain **NOTE:** **Ensure that the crankshaft is in the stage 2 timing drive assembly position.** **Procedure** 1. Place the secondary camshaft intermediate drive chain around the right camshaft intermediate drive chain idler outer sprocket, aligning the camshaft drive chain timing link (2) with the alignment access hole (3) in the right camshaft intermediate drive chain idler inner sprocket. 2. Wrap the secondary camshaft intermediate drive chain around both right (R) actuator drive sprockets. 3. Align the right (R) intake camshaft position actuator sprocket alignment triangle mark (5) with the camshaft drive chain timing link. 4. Align the right (R) exhaust camshaft position actuator sprocket alignment triangle mark (6) with the camshaft drive chain timing link. 5. Once aligned, ensure there are 10 chain links (4) between timing marks for the right (R) camshaft position actuator sprockets. 6. There will be 22 links between the right camshaft intermediate drive chain idler timing camshaft drive chain link and each right camshaft position actuator sprocket timing camshaft drive chain link.
1	
2	Camshaft Drive Chain Timing Link
3	Alignment Access Hole
4	10 Chain Links Between Timing Marks for the Right (R) Camshaft Position Actuator Sprockets
5	Right (R) Intake Camshaft Position Actuator Sprocket Alignment Triangle Mark
6	Right (R) Exhaust Camshaft Position Actuator Sprocket Alignment Triangle Mark

Secondary Camshaft Drive Chain Guide and Shoe Installation - Right Side

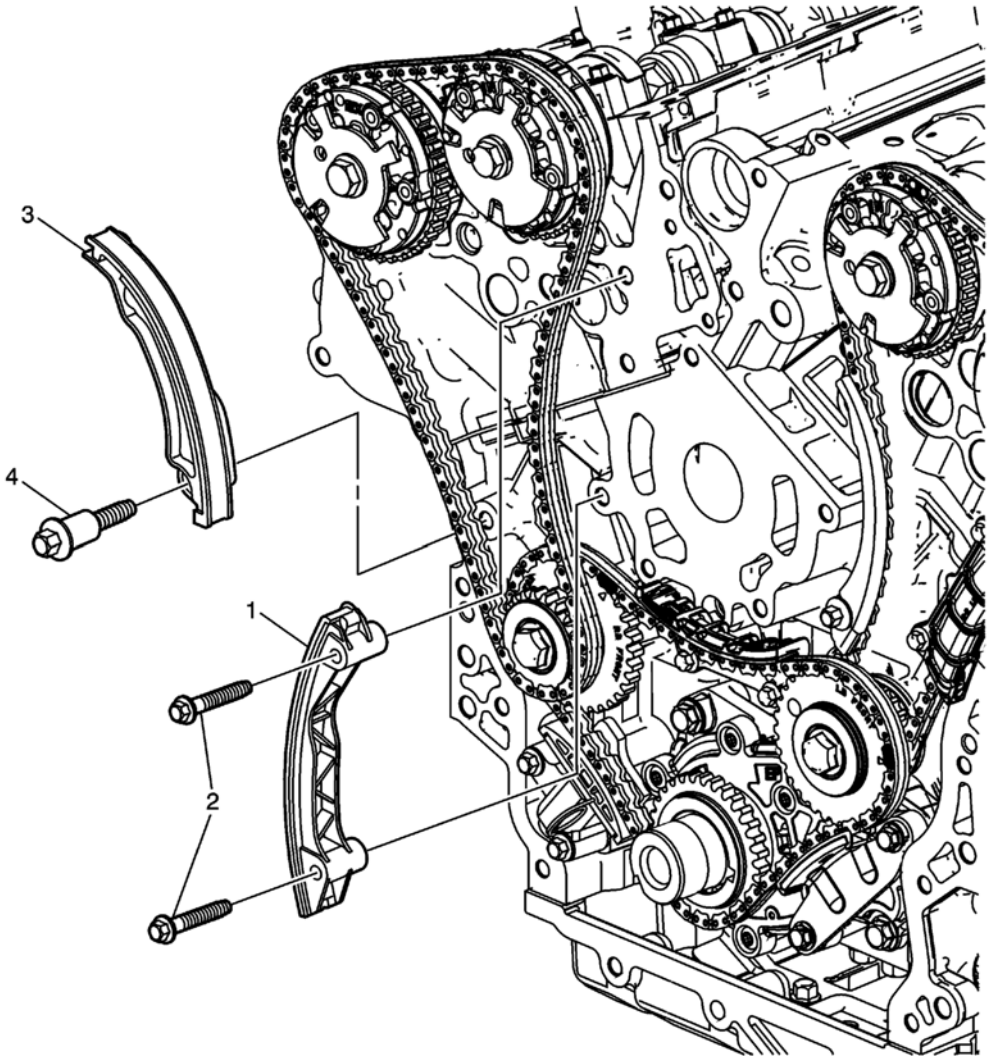

Fig. 555: Secondary Camshaft Drive Chain Guide And Shoe - Right Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Guide and Shoe Installation - Right Side

Callout	Component Name
1	Right Pivot Arm Timing Chain Guide
2	Right Pivot Arm Timing Chain Guide Bolt **Tighten** 25 N.m (18 lb ft)
3	Right Secondary Timing Chain Guide
4	Right Secondary Timing Chain Guide Bolt **Tighten** 25 N.m (18 lb ft)

Secondary Camshaft Drive Chain Tensioner Installation - Right Side

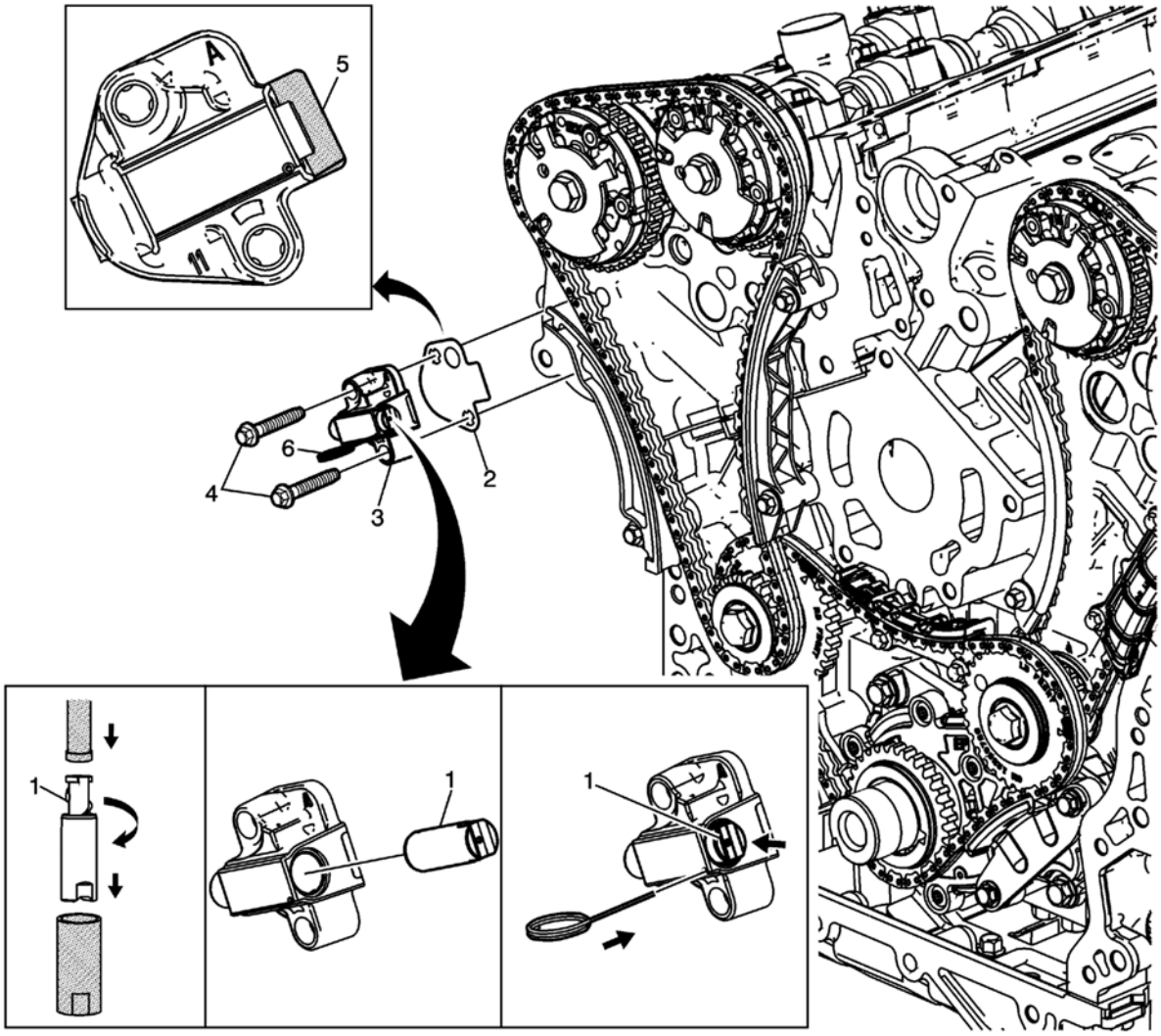

Fig. 556: Secondary Camshaft Drive Chain Tensioner - Right Side
Courtesy of GENERAL MOTORS COMPANY

Secondary Camshaft Drive Chain Tensioner Installation - Right Side

Callout	Component Name
1	Right Secondary Timing Chain Tensioner Plunger **Procedure** 1. Reset the right secondary camshaft drive chain tensioner plunger using **EN-45027** tensioner tool. 2. Install right secondary camshaft drive chain tensioner plunger into body. 3. Compress the plunger into the body and lock the right secondary camshaft drive chain tensioner by inserting the **EN-46112** tensioner retraction pins into the access hole in the side of the right secondary camshaft drive chain tensioner body. 4. Slowly release pressure on the right secondary camshaft drive chain tensioner. The right secondary camshaft drive chain tensioner should remain compressed. **Special Tools**

Callout	Component Name
	• **EN-45027** Tensioner Tool • **EN-46112** Tensioner Retraction Pins For equivalent regional tools, refer to **Special Tools** .
2	Right Timing Chain Housing Gasket **NOTE:** **Ensure the right secondary camshaft drive chain tensioner mounting surface on the right cylinder head does not have any burrs or defects that would degrade the sealing of the NEW right secondary camshaft drive chain tensioner gasket.**
3	Right Secondary Timing Chain Tensioner
4	Right Secondary Timing Chain Tensioner Bolt **Procedure** 1. Place the right secondary drive chain tensioner into position and loosely install the bolts to the block. 2. Verify the proper placement of the right secondary drive chain tensioner gasket tab (5). 3. Tighten the drive chain tensioner bolts in two passes. 4. Verify the timing marks are in the correct position before releasing the drive chain tensioner. 5. Release the right secondary drive chain tensioner by pulling out the **EN-46112** pin (6) and unlocking the tensioner plunger.

Callout	Component Name
	6. Verify all primary and secondary camshaft drive chain timing mark alignments by referring to **Timing Chain Alignment Diagram** - Stage One. **Tighten** • First Pass 5 N.m (44 lb in) • Second Pass 25 N.m (18 lb ft)
5	Right Timing Chain Housing Gasket Tab
6	**EN-46112** Pin

TIMING CHAIN IDLER SPROCKET INSTALLATION - RIGHT SIDE

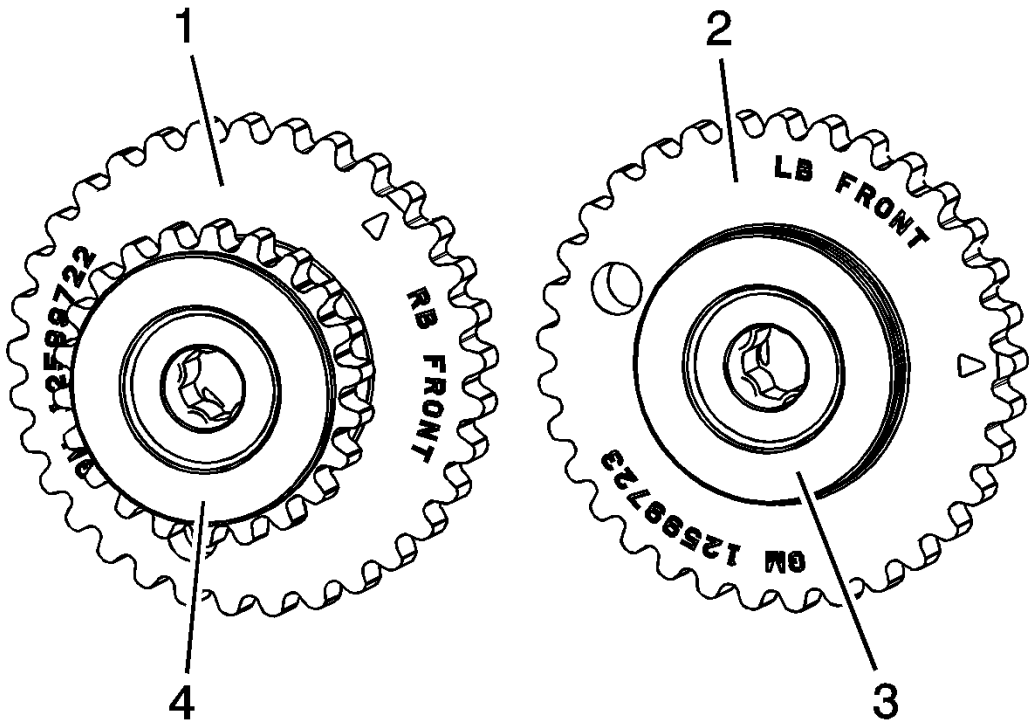

Fig. 557: Identifying Camshaft Intermediate Drive Chain Idlers
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the right camshaft intermediate drive chain idler (1) is being installed. The recessed hub (4) and the smaller sprocket of the right camshaft intermediate drive chain idler is installed outward. The

raised hub and the larger sprocket of the right camshaft intermediate drive chain idler is installed towards the block.

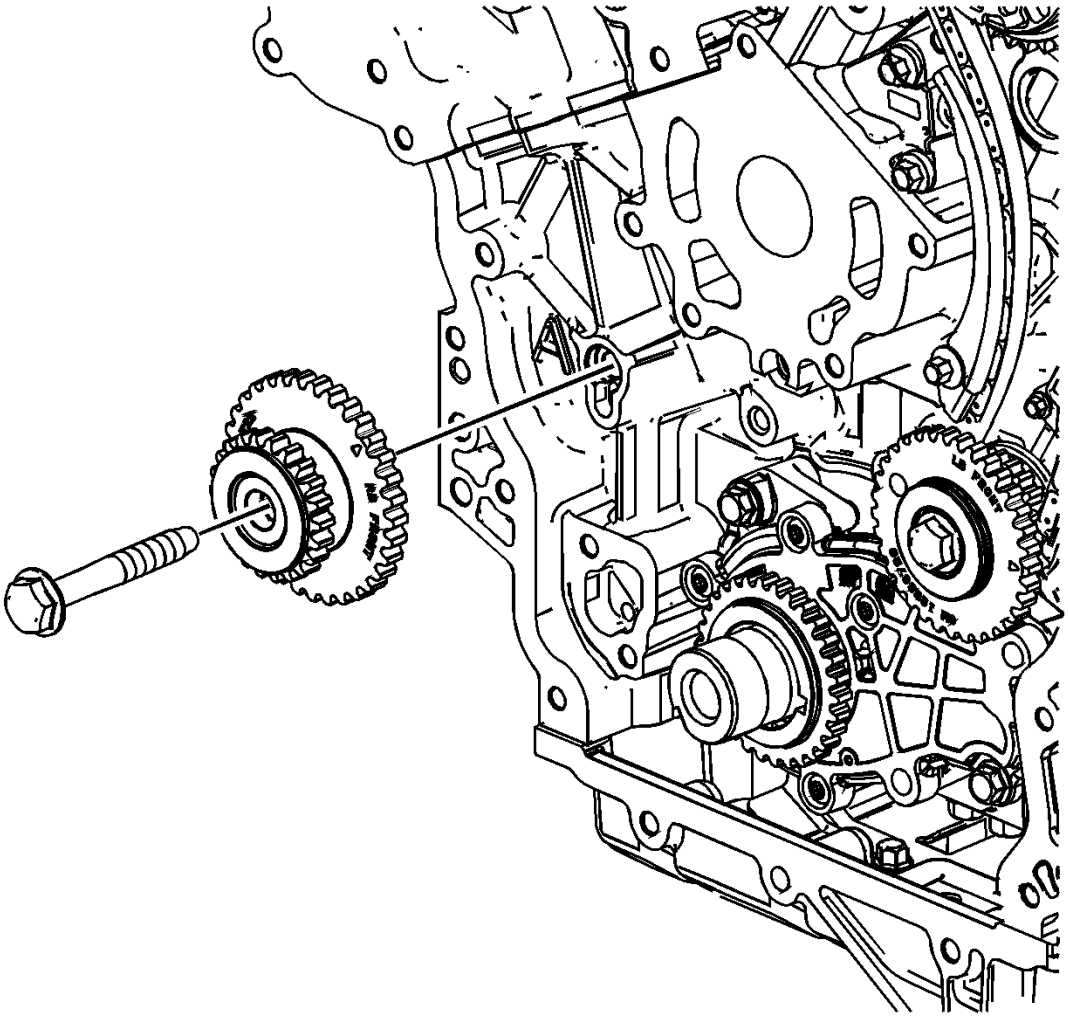

Fig. 558: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the right camshaft intermediate drive chain idler.

CAUTION: Refer to Fastener Caution .

3. Install the camshaft intermediate drive chain idler bolt and tighten to 58 N.m (43 lb ft).

ENGINE FRONT COVER INSTALLATION

Special Tools

EN-46109 Guide Pins

For equivalent regional tools, refer to **Special Tools** .

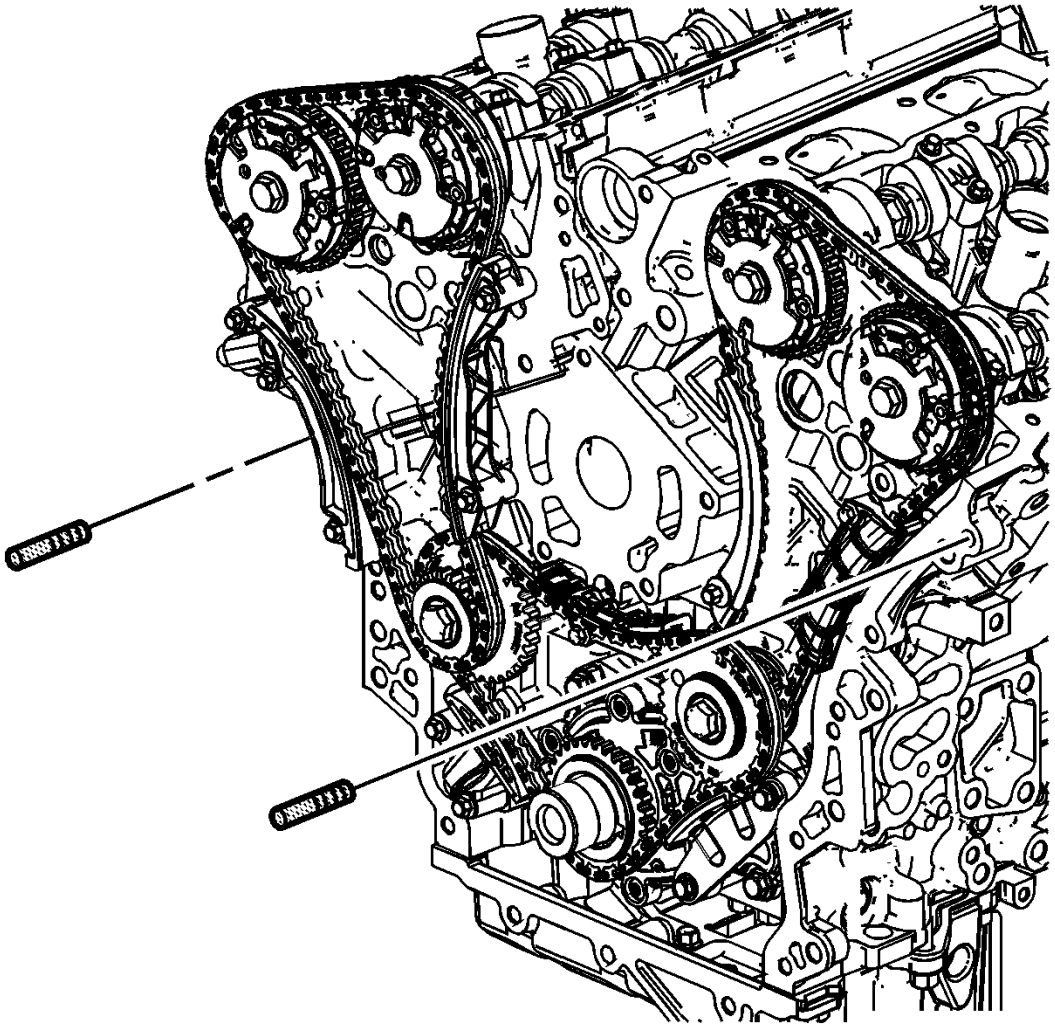

Fig. 559: Identifying Cylinder Block Guide Studs
Courtesy of GENERAL MOTORS COMPANY

1. Install the 8 mm (0.315 in) guide from the **EN-46109** pins into the cylinder block positions as shown.

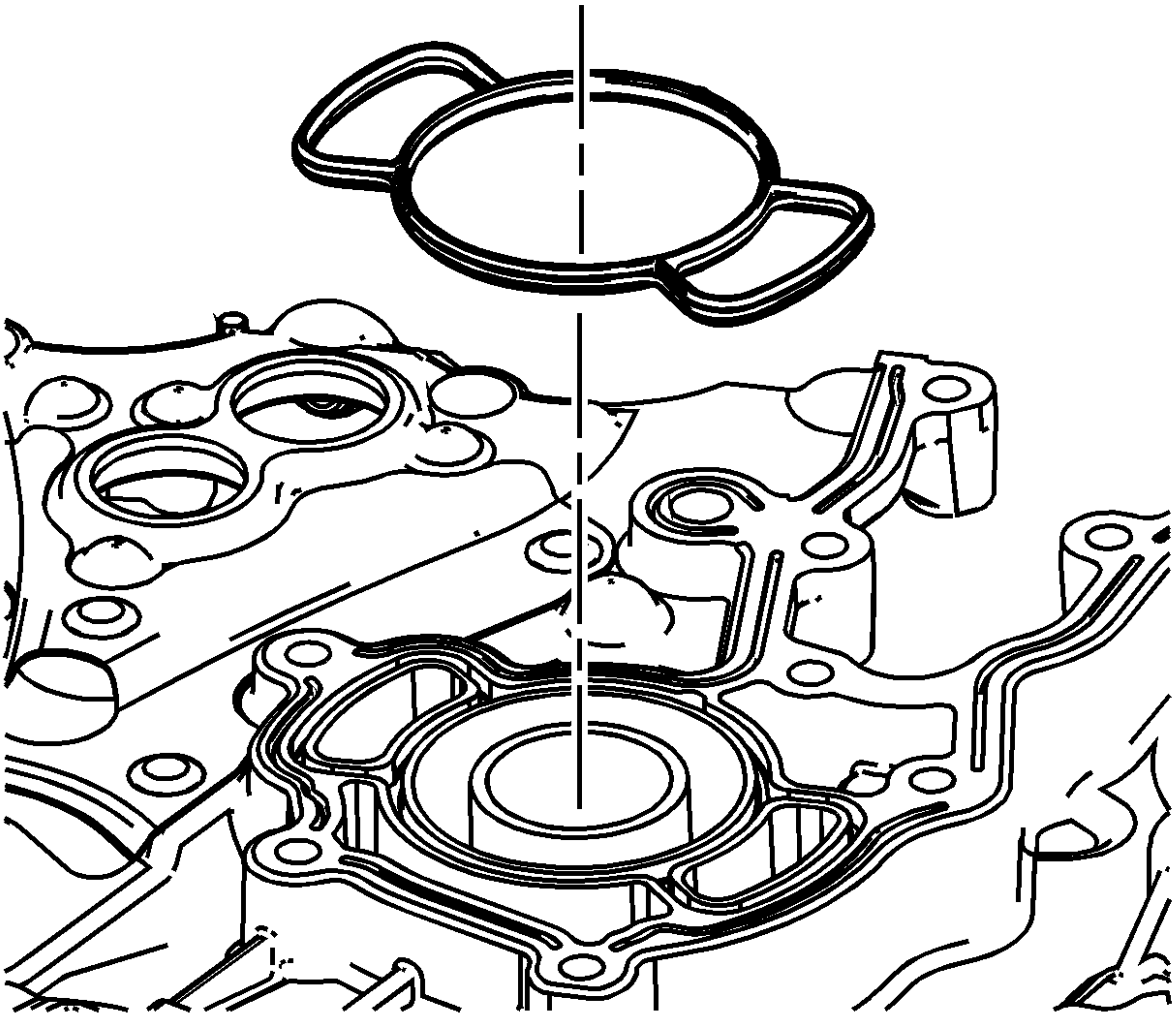

Fig. 560: Identifying Water Pump Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW engine front cover to cylinder block seal.

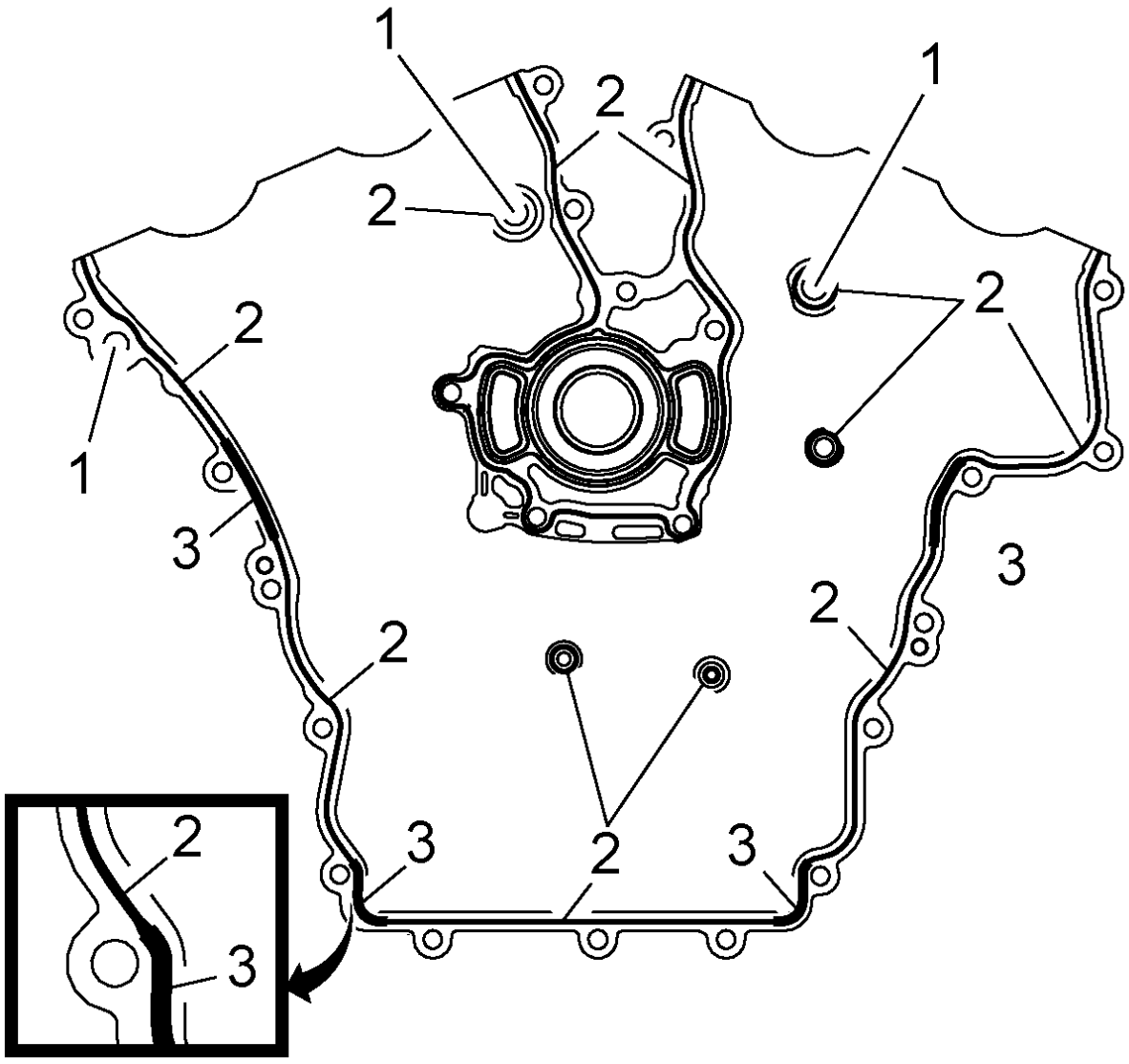

Fig. 561: Applying Sealant
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **No RTV sealant should be visible in the M12 bolt holes (1) upon final assembly of front cover to engine.**
- **Keep the RTV bead path on the outward edge of the t-joints to ensure proper sealant coverage.**

3. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
4. Apply a 3 mm (0.118 in) bead of RTV sealant on the engine front cover as shown (2).
5. Apply a 5 mm (0.197 in) bead of RTV sealant on the engine front cover as shown (3). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended sealant.

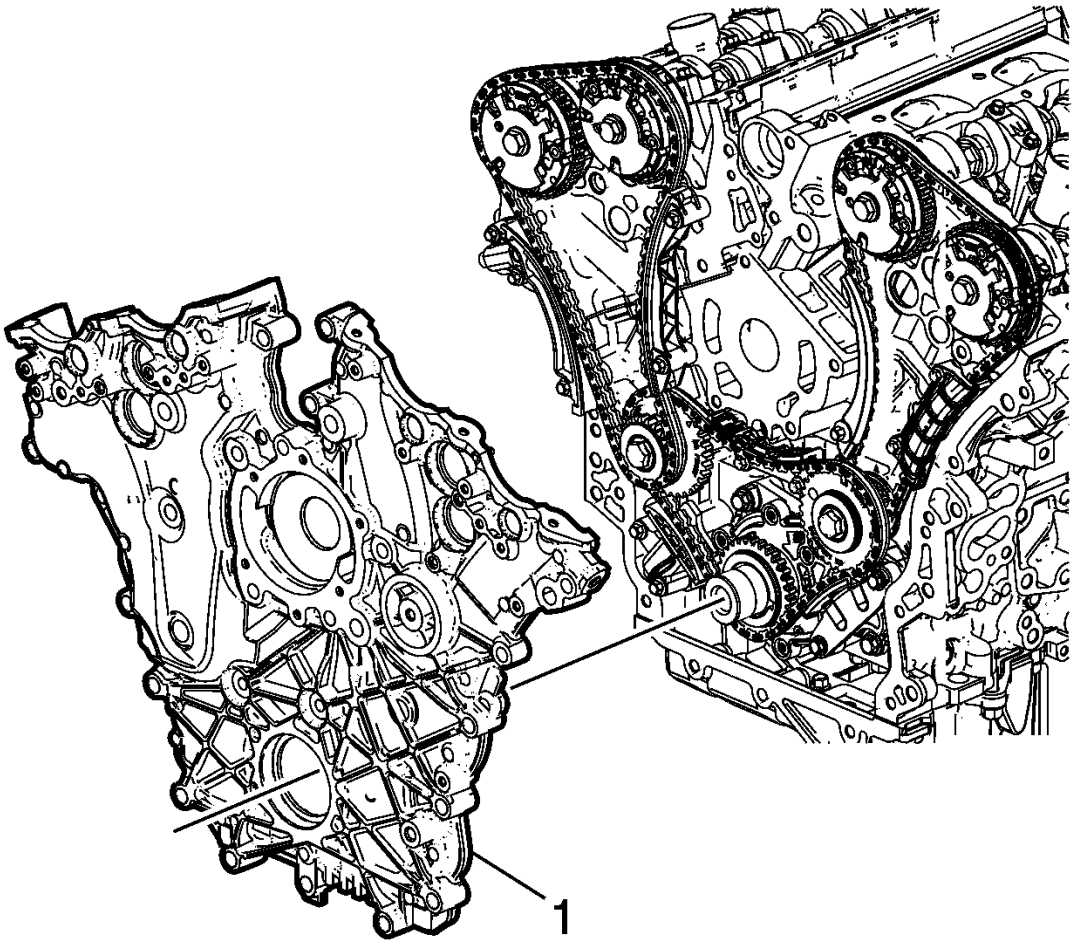

Fig. 562: View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

6. Place the engine front cover (1) onto the **EN-46109** pins and slide into position.
7. Remove the **EN-46109** pins from the cylinder block.
8. Hand start all the engine front cover bolts.

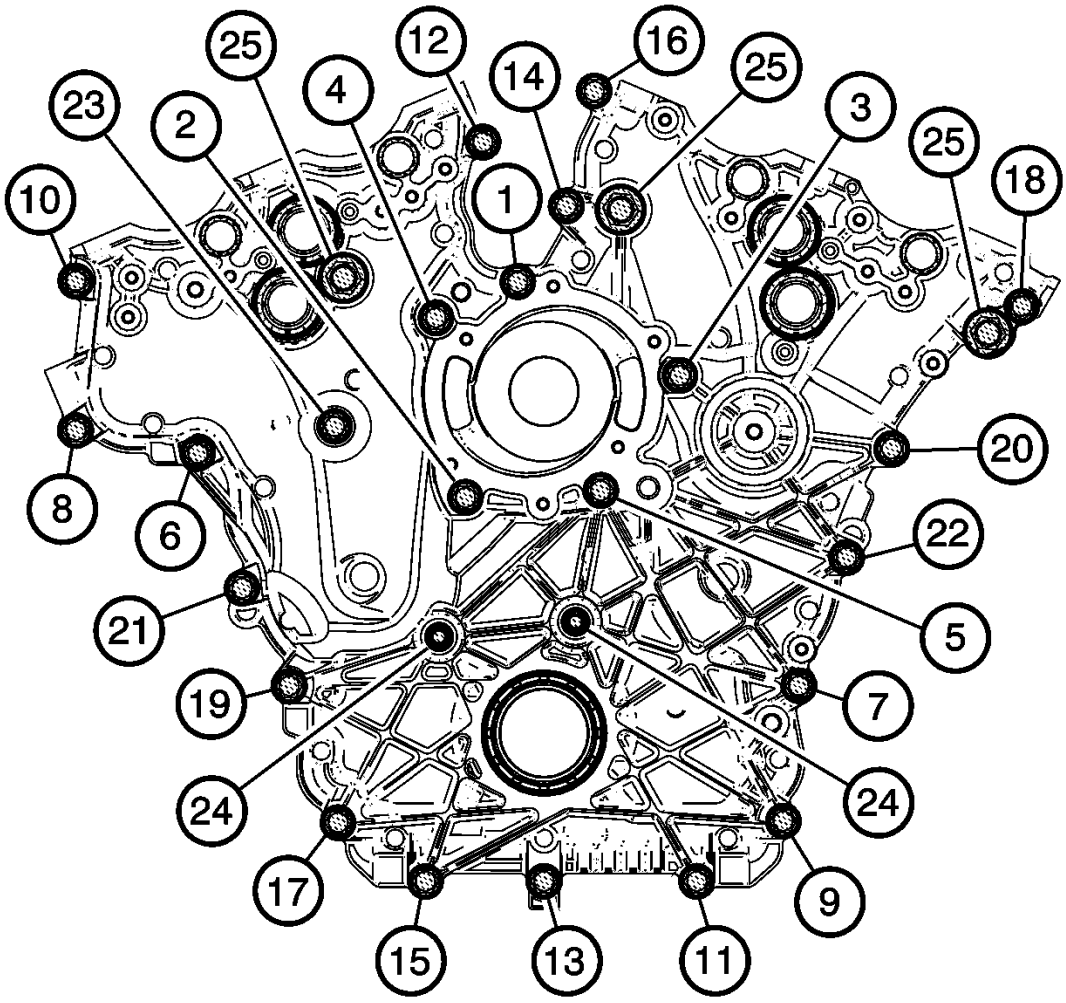

Fig. 563: Identifying Engine Front Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **Engine front cover bolts in the number (25) location are model dependent and may not apply.**

9. Tighten the engine front cover bolts (1-23) in the sequence shown to 20 N.m (15 lb ft).
    1. Tighten the engine front cover bolts (1-23) a second pass in sequence to 20 N.m (15 lb ft).
    2. Tighten the engine front cover bolts (1-23) a third pass in sequence an additional 60 degrees.
    3. Tighten the engine front cover bolts (24) to 15 N.m (11 lb ft).
    4. Tighten the engine front cover bolts (25) to 65 N.m (48 lb ft).

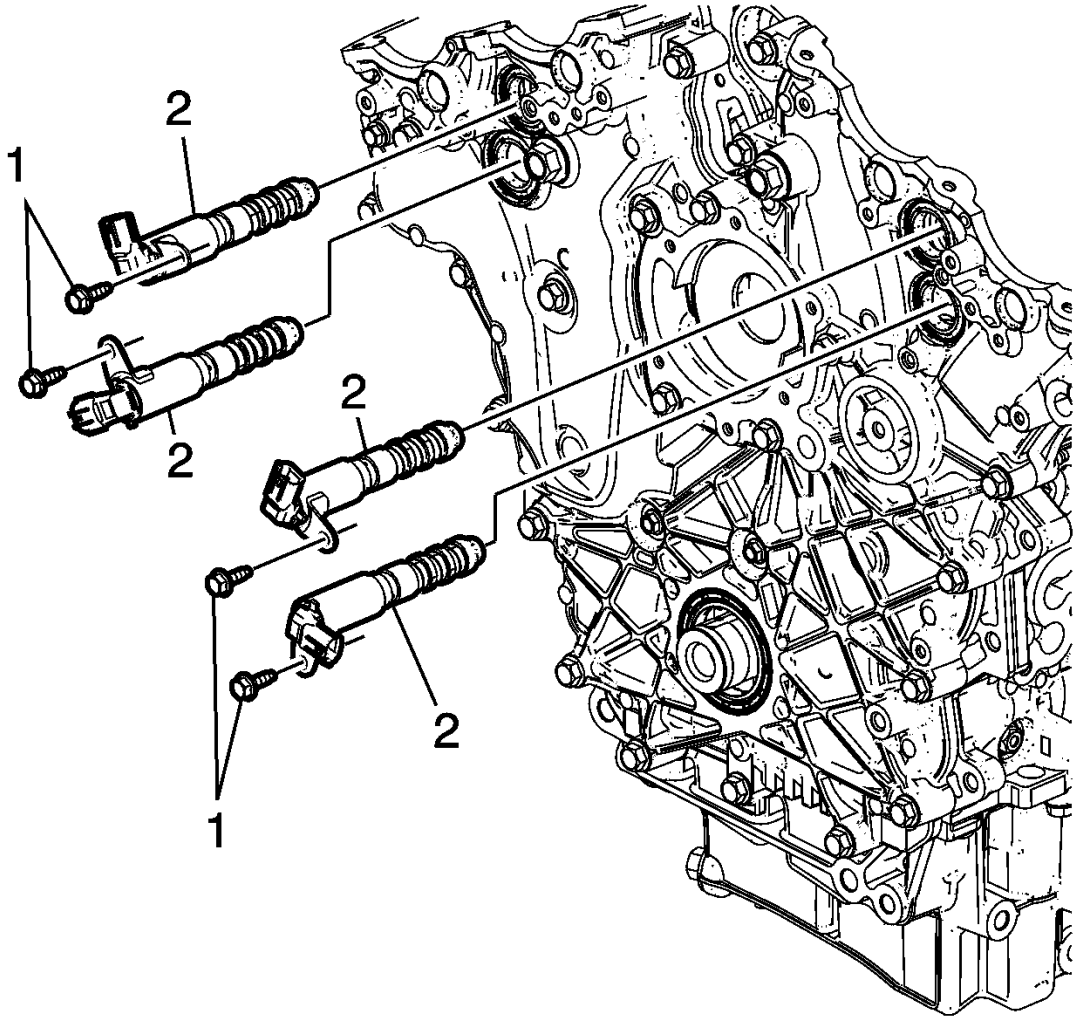

Fig. 564: Camshaft Position Actuator Valve And Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Place the camshaft position actuator valves (2) in position on the front cover.
11. Install the camshaft position actuator valve bolts (1) and tighten to 10 N.m (89 lb in).

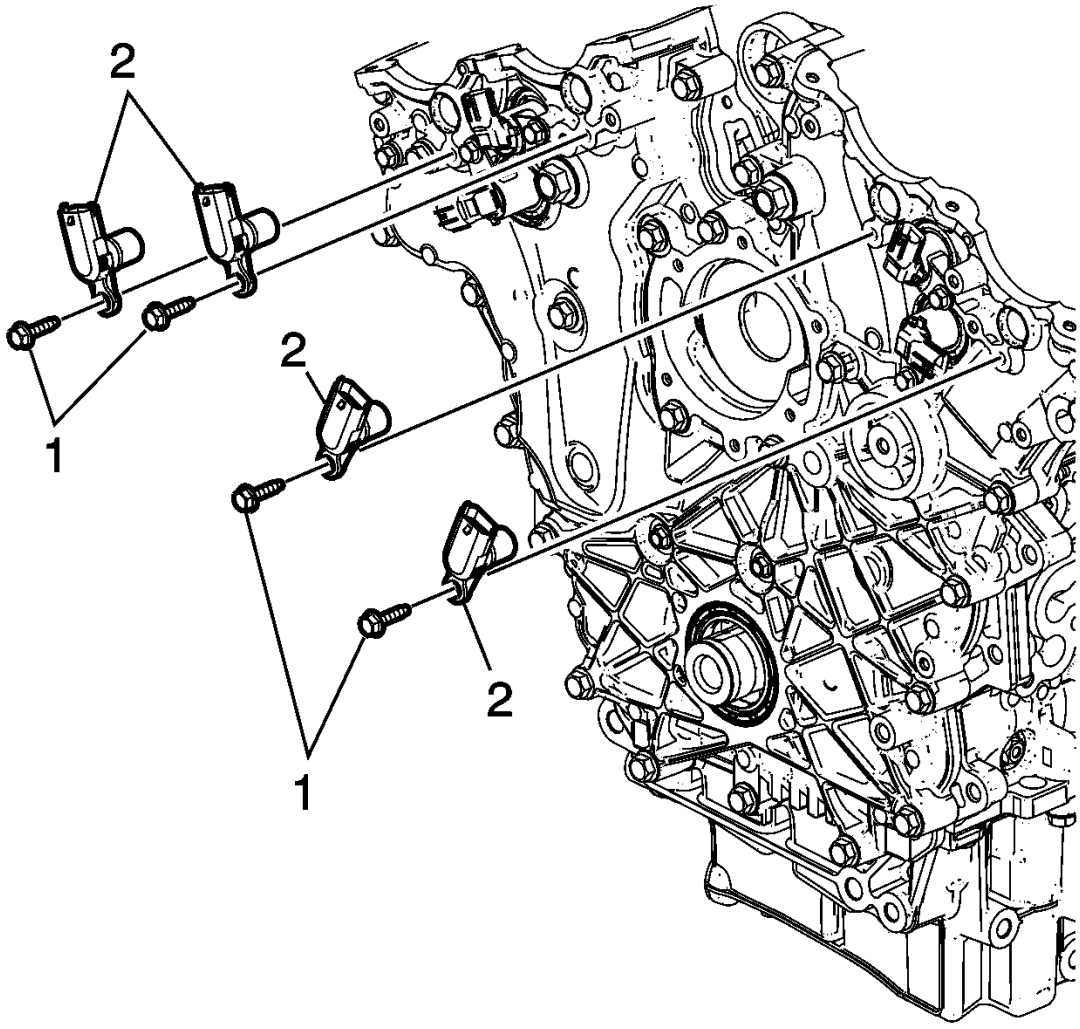

Fig. 565: Camshaft Position Sensors & Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Inspect the camshaft position sensor O-ring seals. If the seals are damaged, the entire camshaft position sensor must be replaced.**

12. Place the camshaft position sensors (2) in position on the front cover.
13. Install the camshaft position sensor bolts (1) and tighten to 10 N.m (89 lb in).

WATER PUMP INSTALLATION

Special Tools

EN-46104 Water Pump Pulley Holding Tool

For equivalent regional tools, refer to **Special Tools** .

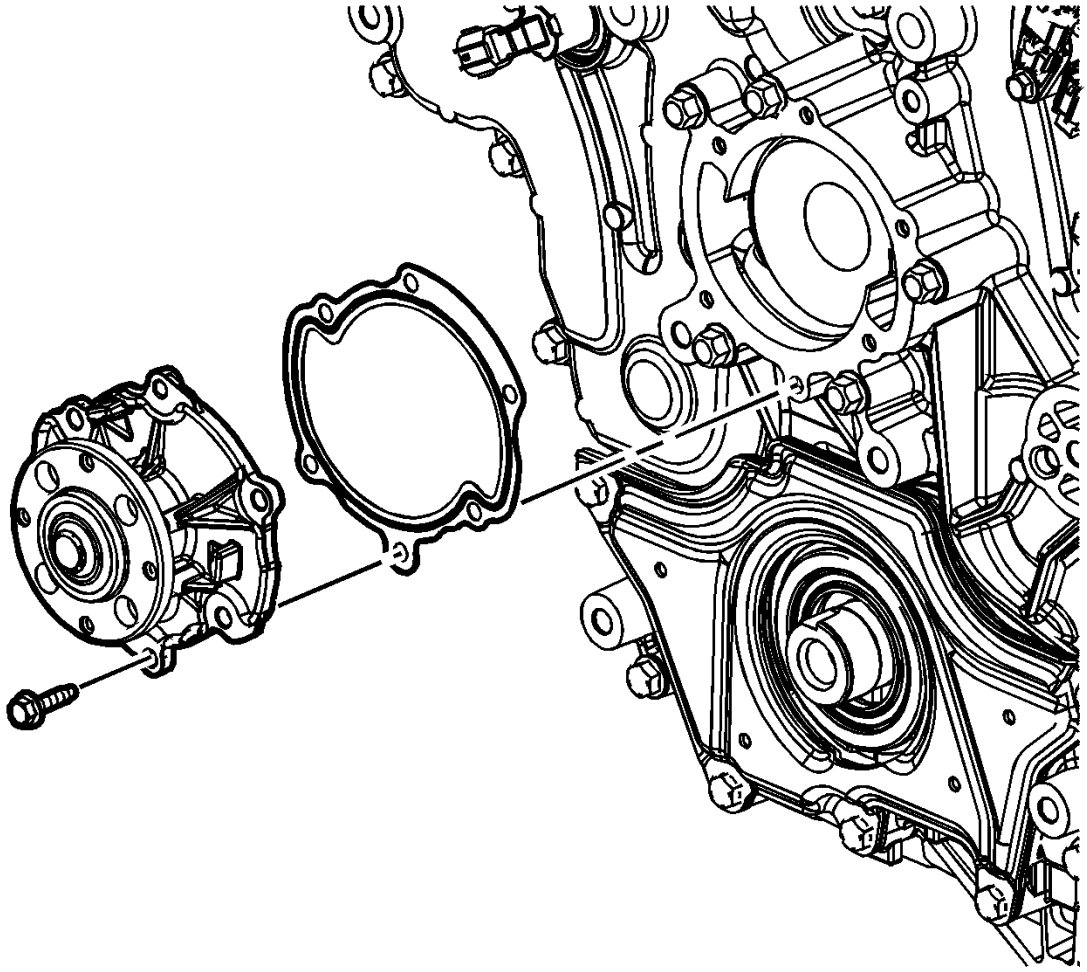

Fig. 566: View Of Water Pump Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the engine front cover and water pump are clear of old gasket material.
2. Ensure that the water pump mounting bolt holes in the front cover are completely clean and dry.
3. Place a NEW water pump gasket on the water pump.
4. Place the water pump in position on the front cover.

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

5. Install the NEW water pump bolts finger tight.

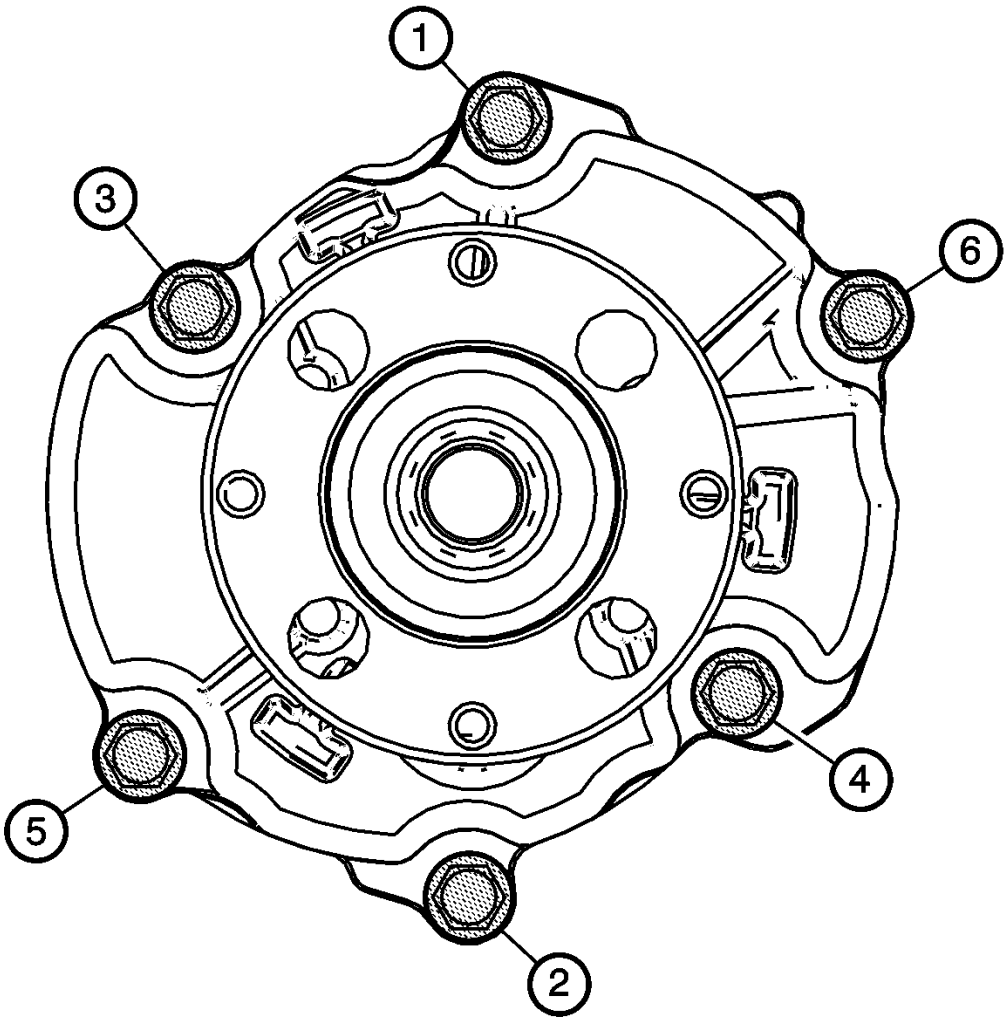

Fig. 567: Water Pump Bolts & Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Tighten the NEW water pump bolts.
    1. Tighten the bolts a first pass in the sequence shown to 10 N.m (89 lb in).
    2. Tighten the bolts a second pass in the sequence shown to 10 N.m (89 lb in).
    3. Tighten the bolts a final pass in the sequence shown an additional 45 degrees.

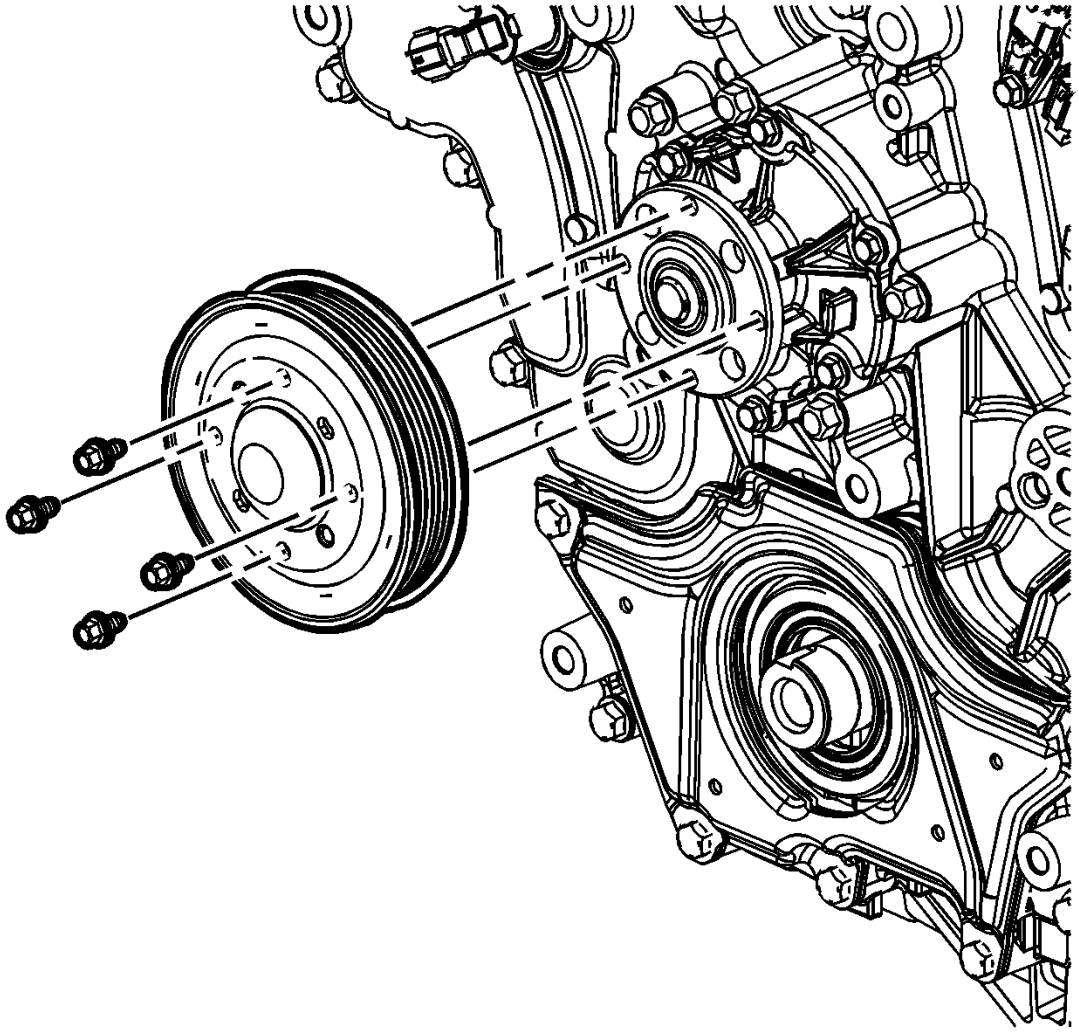

Fig. 568: View Of Water Pump Pulley Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Install the water pump pulley.
8. Loosely install the water pump pulley bolts.

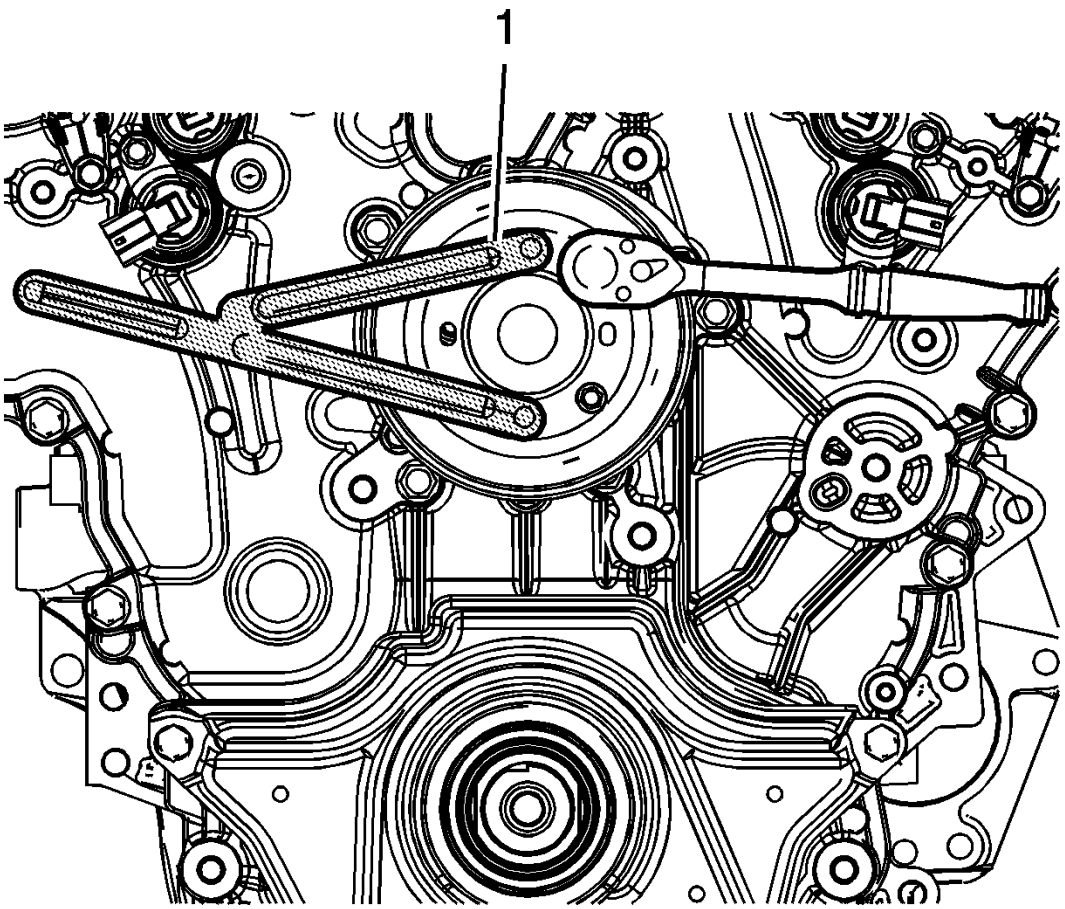

Fig. 569: Water Pump Holding Tool
Courtesy of GENERAL MOTORS COMPANY

9. Install the **EN-46104** tool (1) onto the water pump pulley and tighten the water pump pulley bolts to 10 N.m (89 lb in).

CAMSHAFT COVER INSTALLATION - LEFT SIDE

Special Tools

- **EN-46101** Spark Plug Tube Seal Guide
- **EN-48383** Camshaft Retaining Tools

For equivalent regional tools, refer to **Special Tools** .

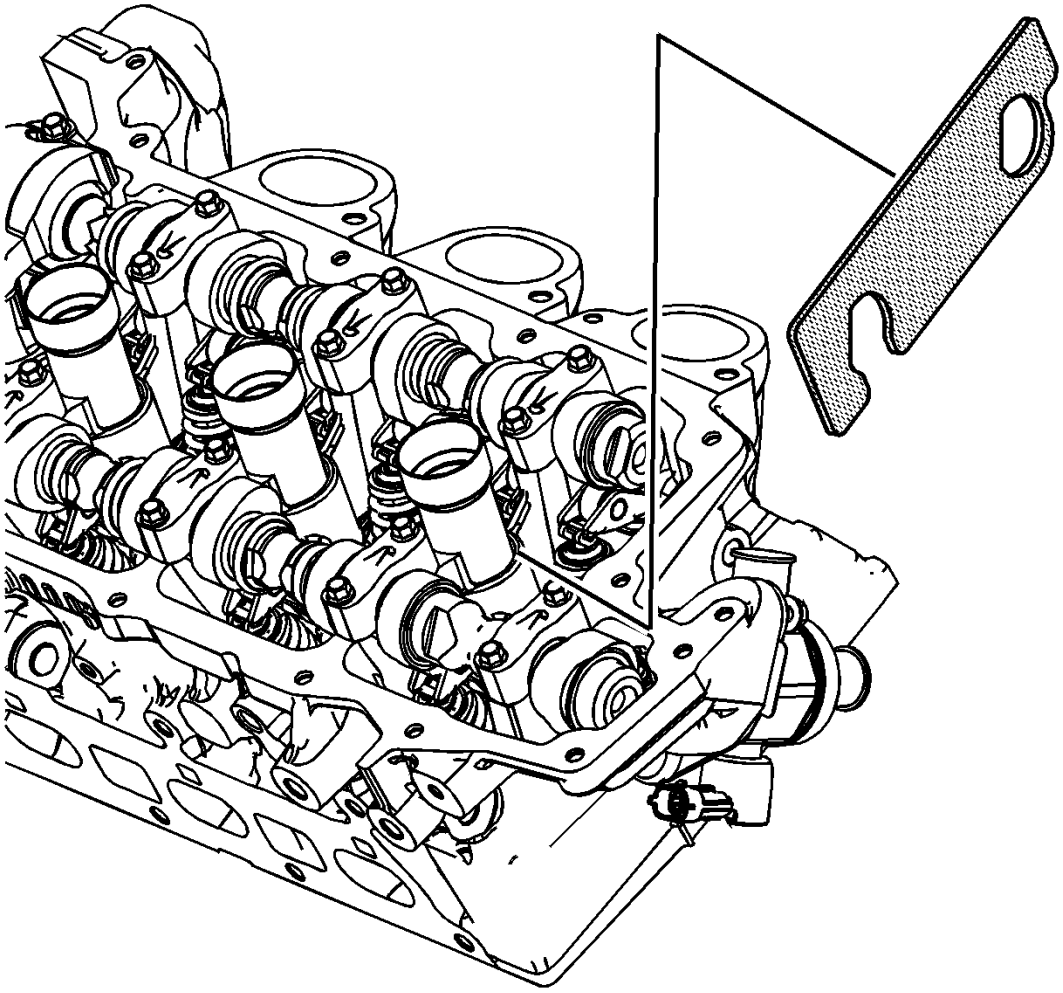

Fig. 570: Camshaft Retaining Tool & Camshaft
Courtesy of GENERAL MOTORS COMPANY

1. Remove the **EN-48383-2** from the rear of the left camshafts.

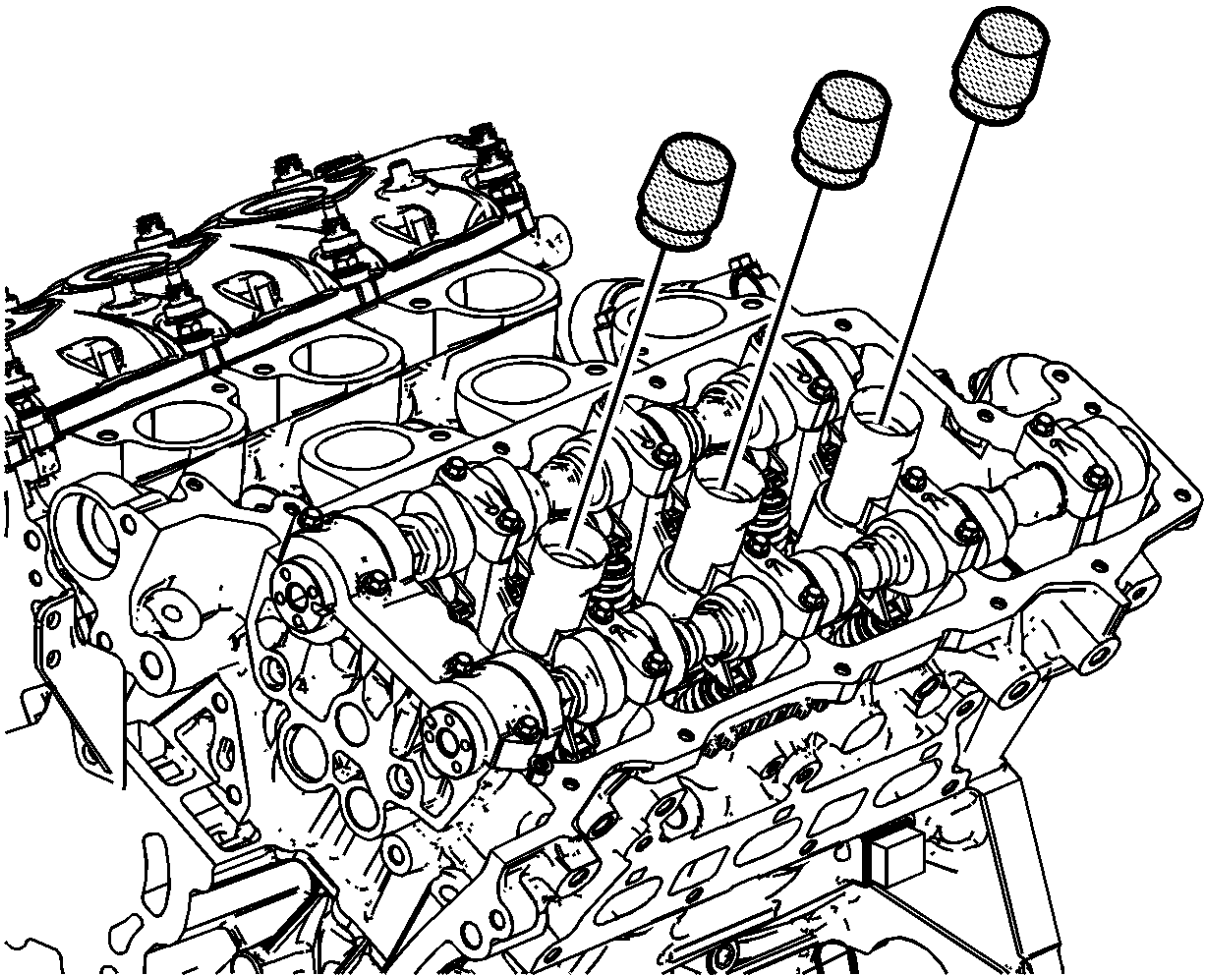

Fig. 571: View Of Spark Plug Tubes & Left Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

2. Install the **EN-46101** guide onto the spark plug tubes of the left cylinder head.

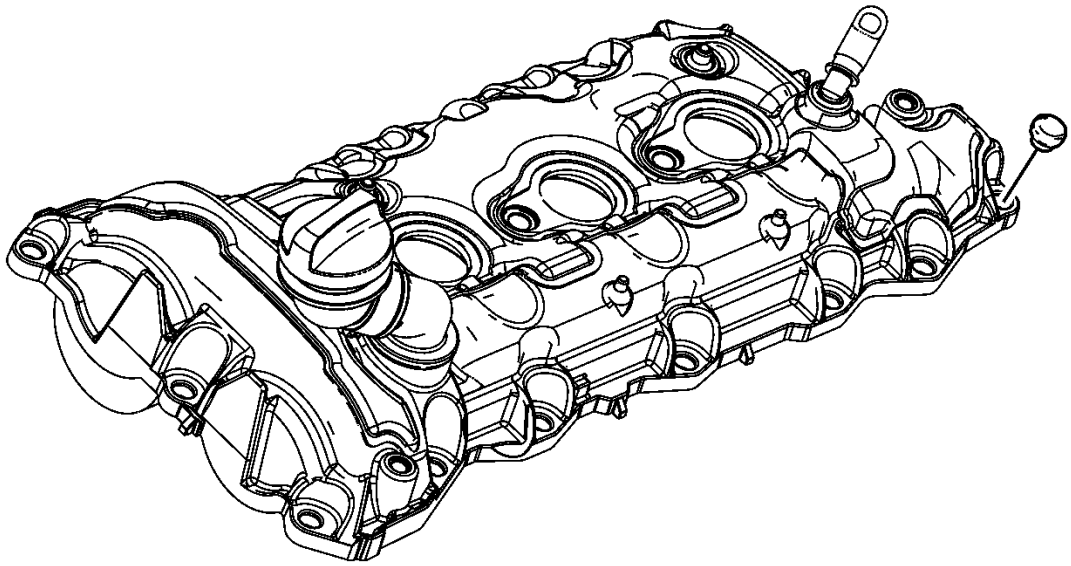

Fig. 572: View of Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

3. Install the NEW camshaft cover bolt grommets prior to installing the camshaft cover bolts.
4. Wipe the camshaft cover sealing surface on the left cylinder head with a clean, lint-free cloth.

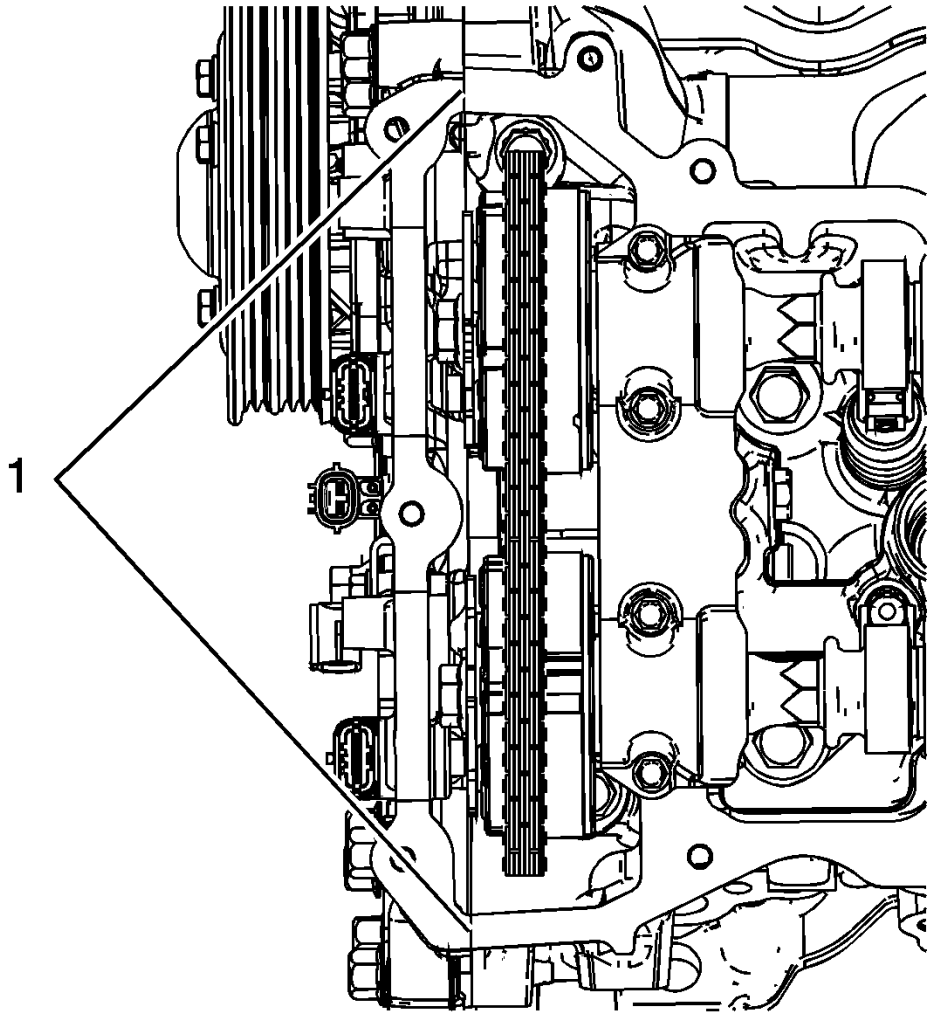

Fig. 573: Locating Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

5. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
6. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, on the engine front cover split lines (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

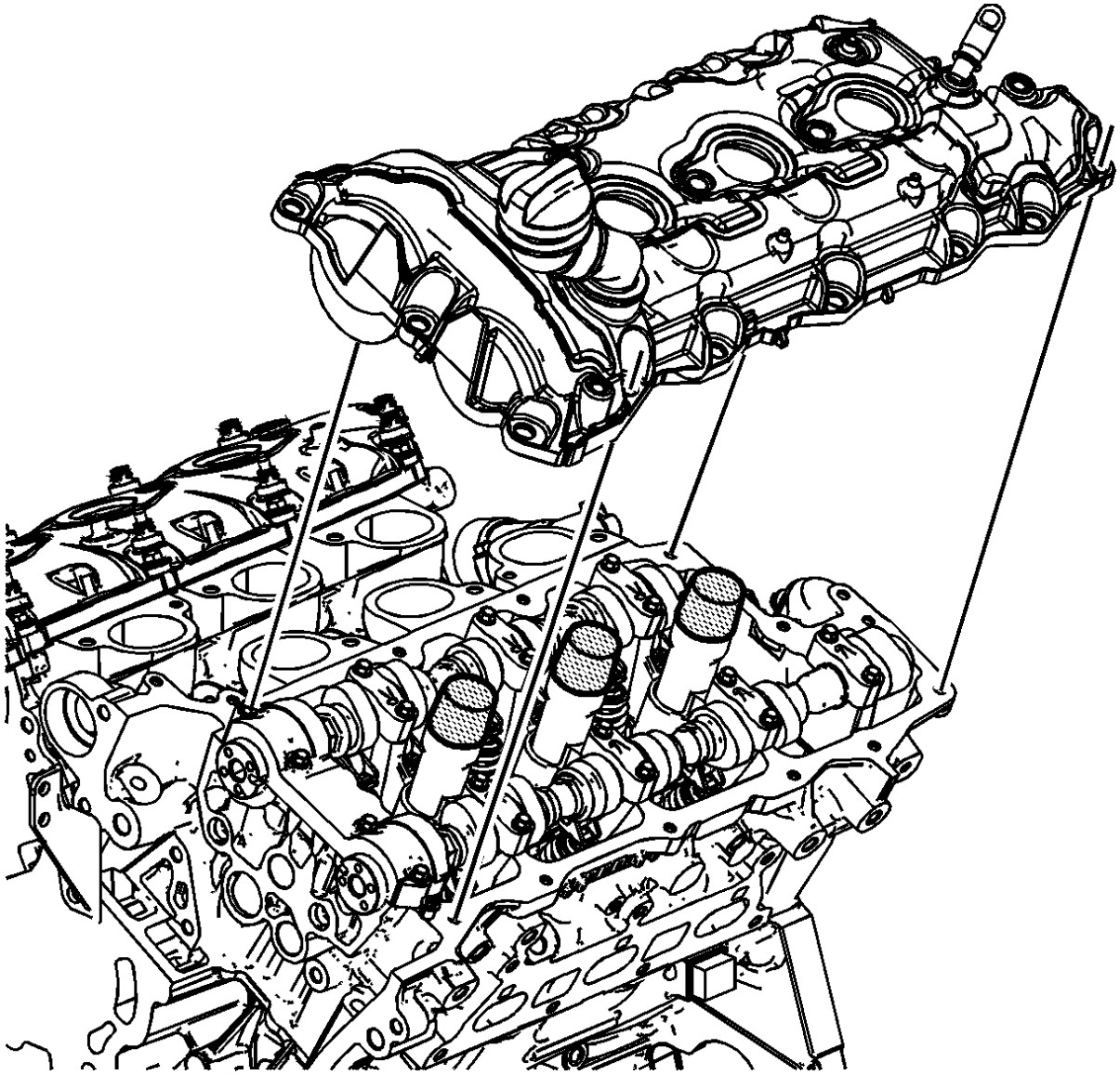

Fig. 574: View of Camshaft Cover & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

7. Place the left camshaft cover into position onto the left cylinder head.

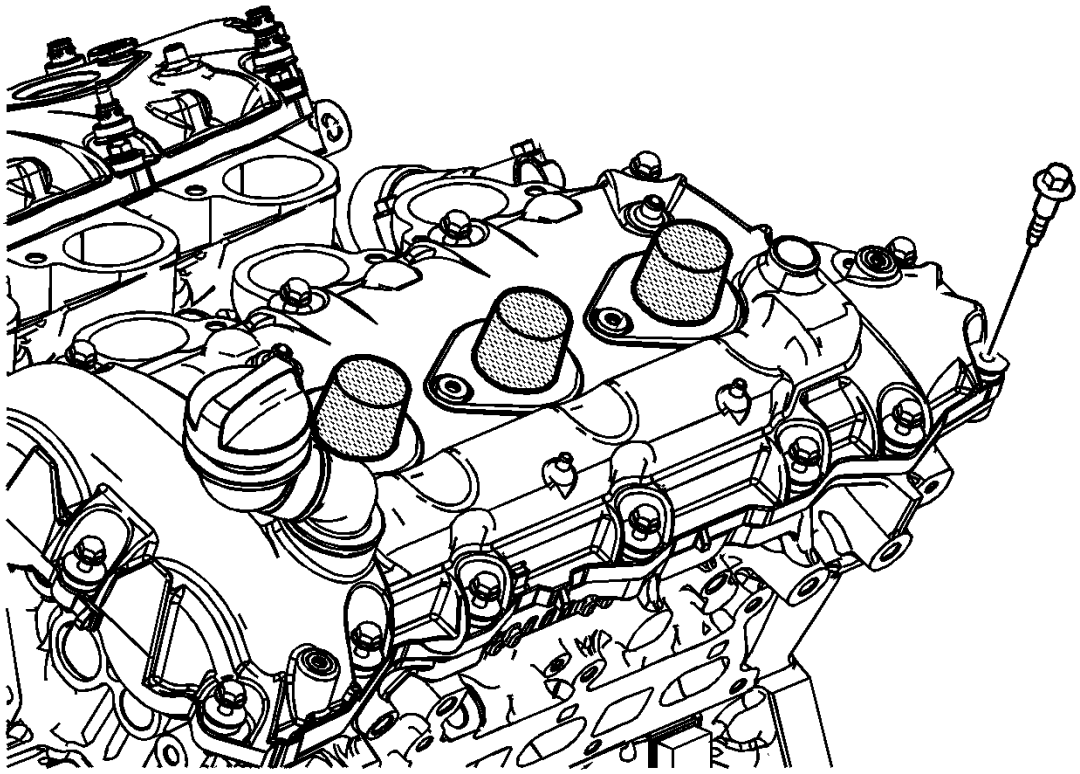

Fig. 575: View of Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Loosely install the left camshaft cover bolts.

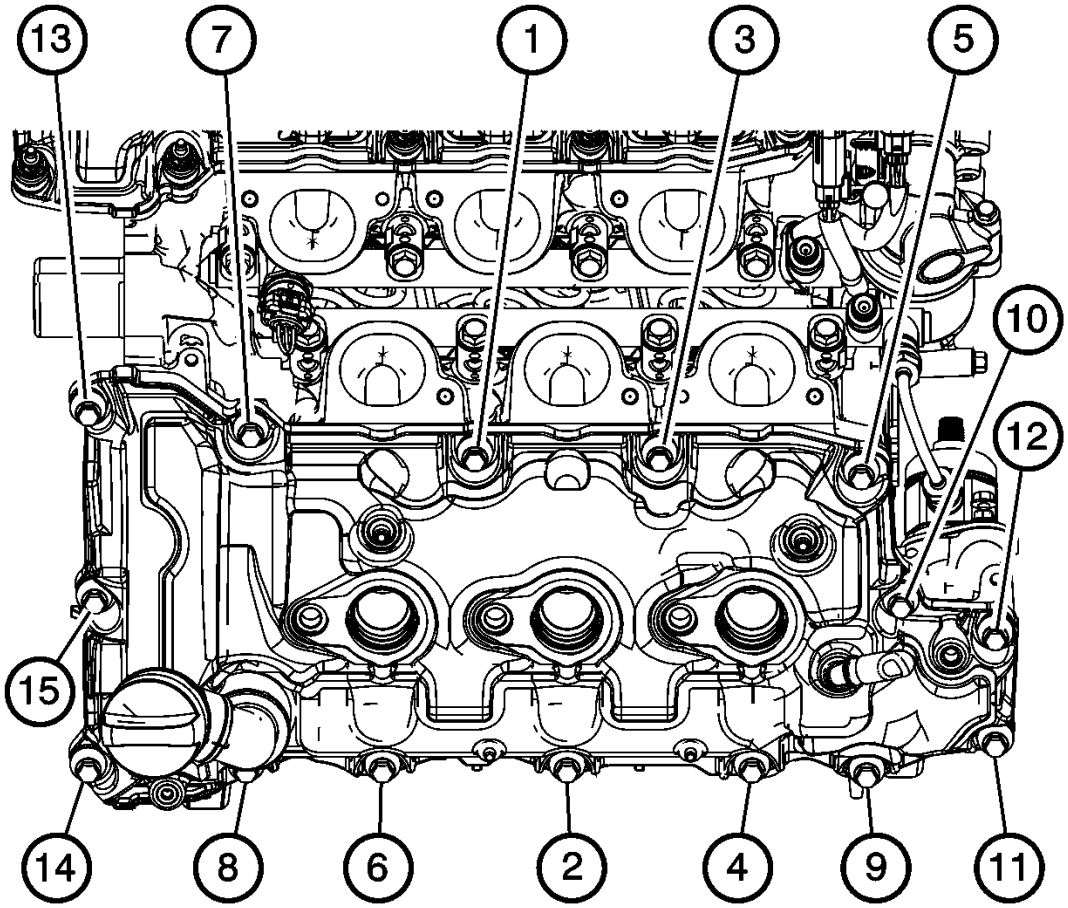

Fig. 576: Identifying Left Camshaft Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

9. Tighten the left camshaft cover bolts in the sequence shown.
    1. Tighten the left camshaft cover bolts in the sequence to 10 N.m (89 lb in).
    2. Tighten the left camshaft cover bolts a second pass in the sequence to 10 N.m (89 lb in).

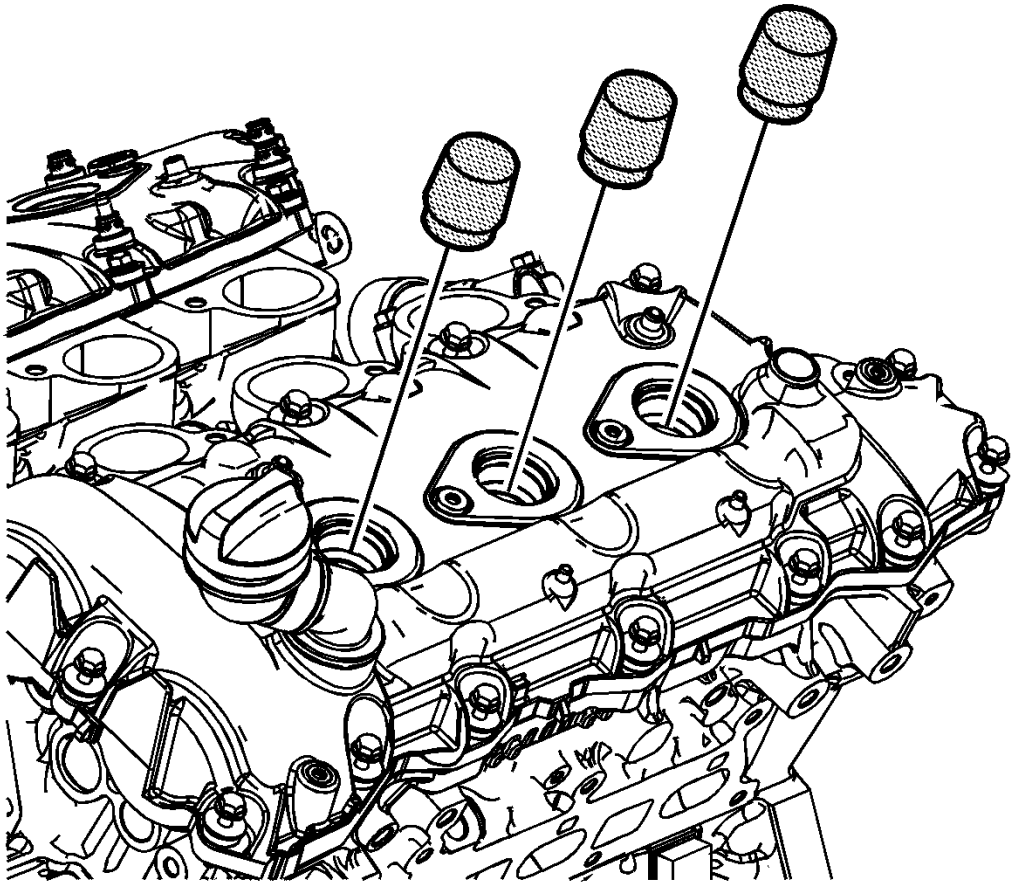

Fig. 577: View of Spark Plug Tubes & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **EN-46101** guide from the spark plug tubes of the left cylinder head.

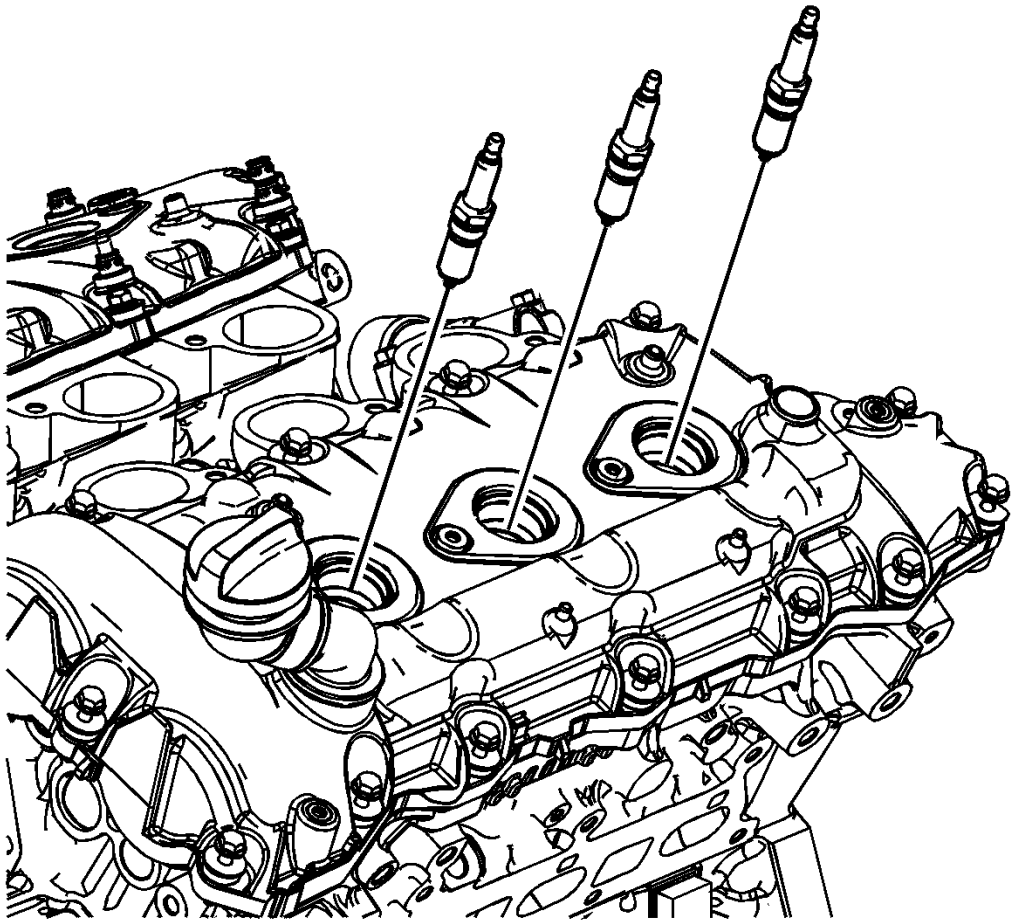

Fig. 578: Identifying Spark Plugs & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

11. Install the NEW spark plugs into the left cylinder head and tighten to 18 N.m (13 lb ft).

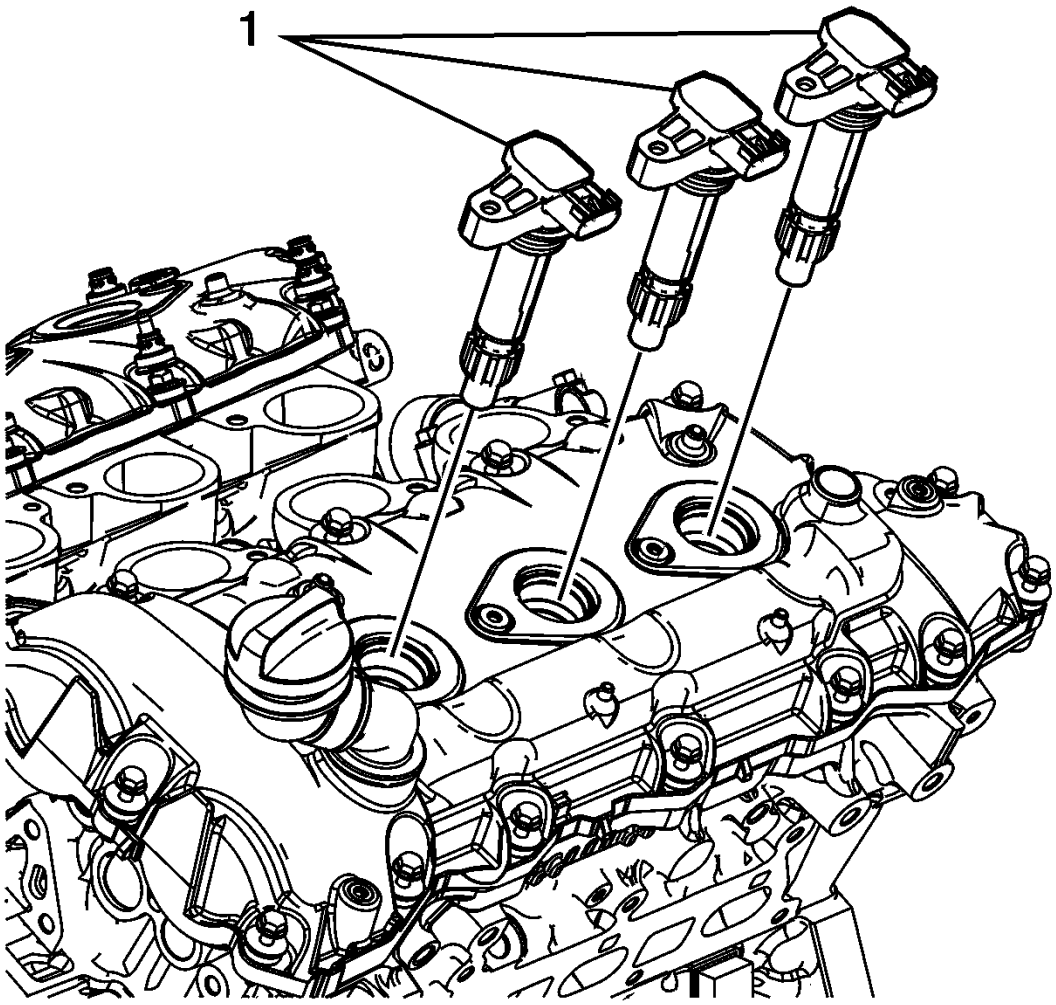

Fig. 579: View of Ignition Coils and Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

12. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:
    1. Apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
    2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
13. Install the ignition coils.

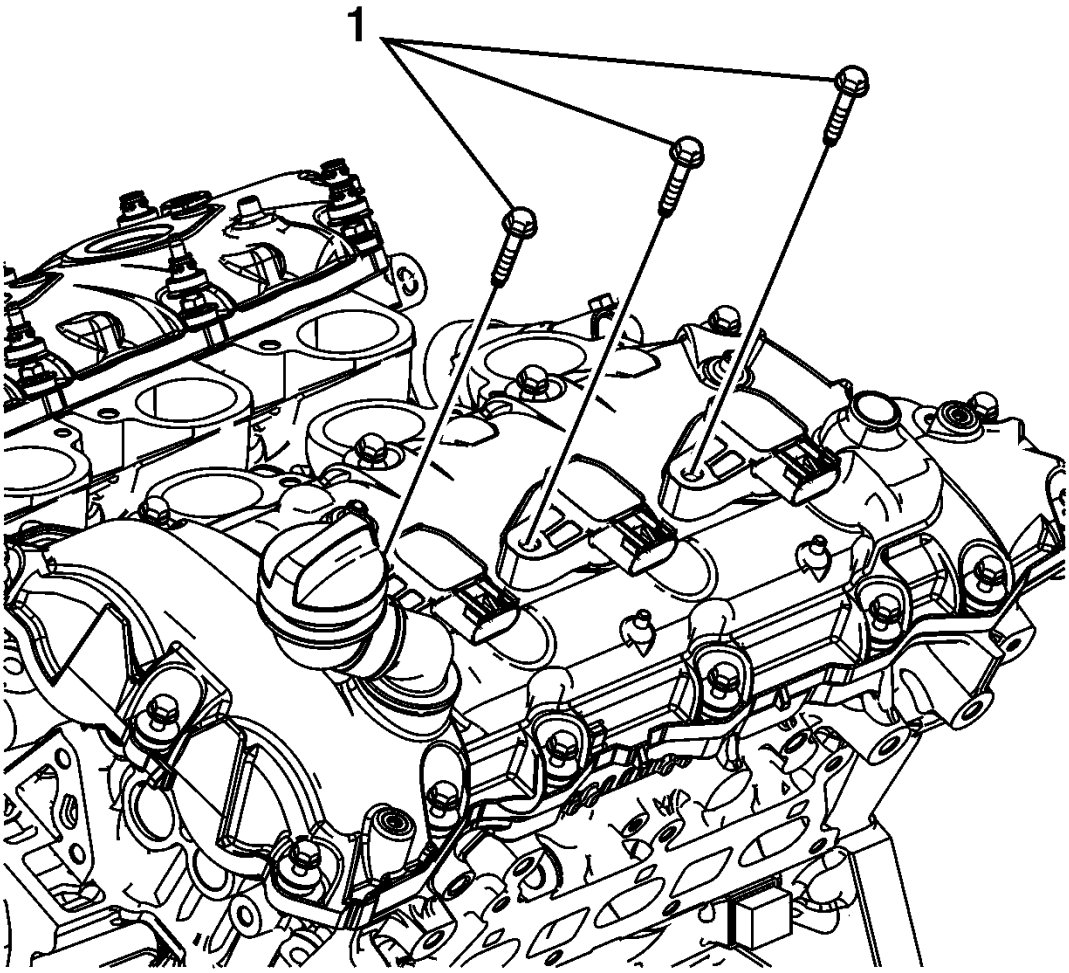

Fig. 580: View of Ignition Coil Bolts and Cylinder Heads
Courtesy of GENERAL MOTORS COMPANY

14. Install the ignition coil bolts and tighten to 10 N.m (89 lb in).

CAMSHAFT COVER INSTALLATION - RIGHT SIDE

Special Tools

EN-46101 Spark Plug Tube Seal Guide

For equivalent regional tools, refer to **Special Tools** .

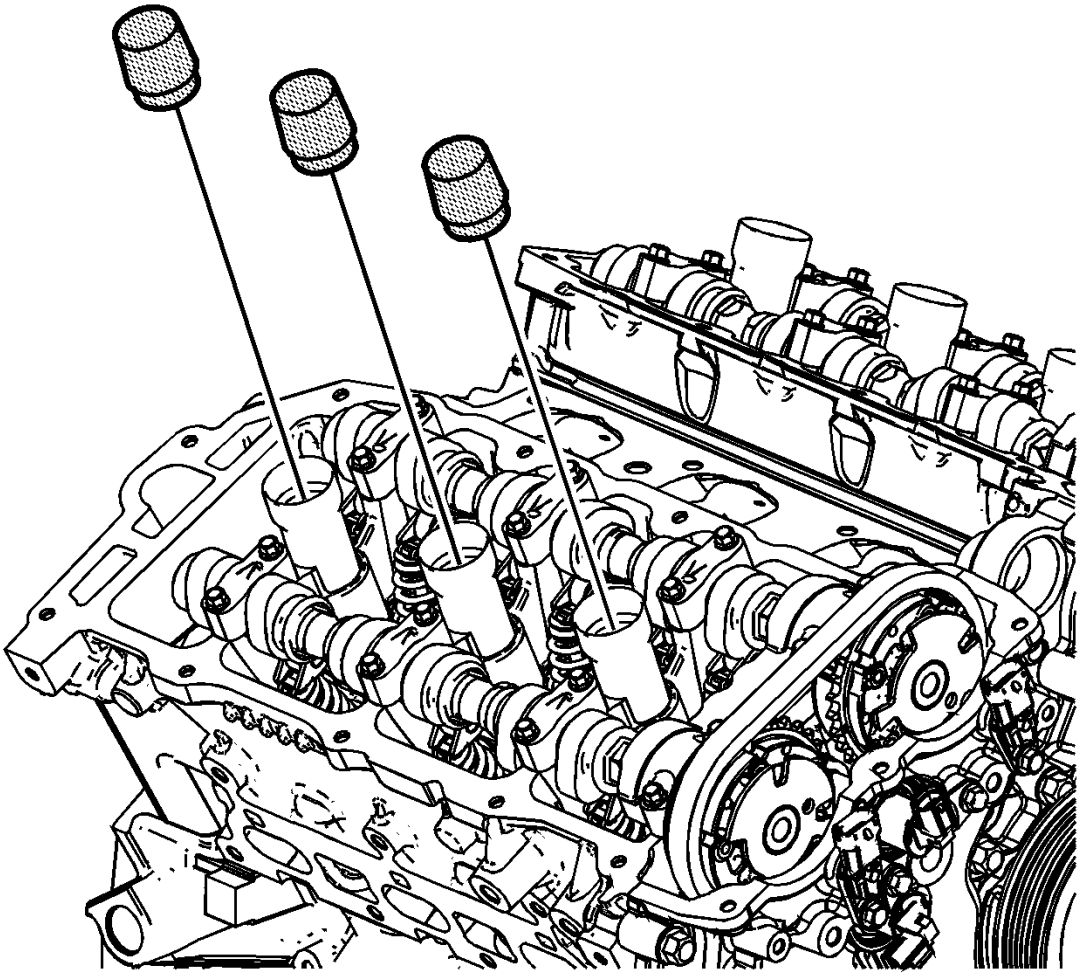

Fig. 581: Identifying Spark Plug Tubes
Courtesy of GENERAL MOTORS COMPANY

1. Install the **EN-46101** guide onto the spark plug tubes of the right cylinder head.

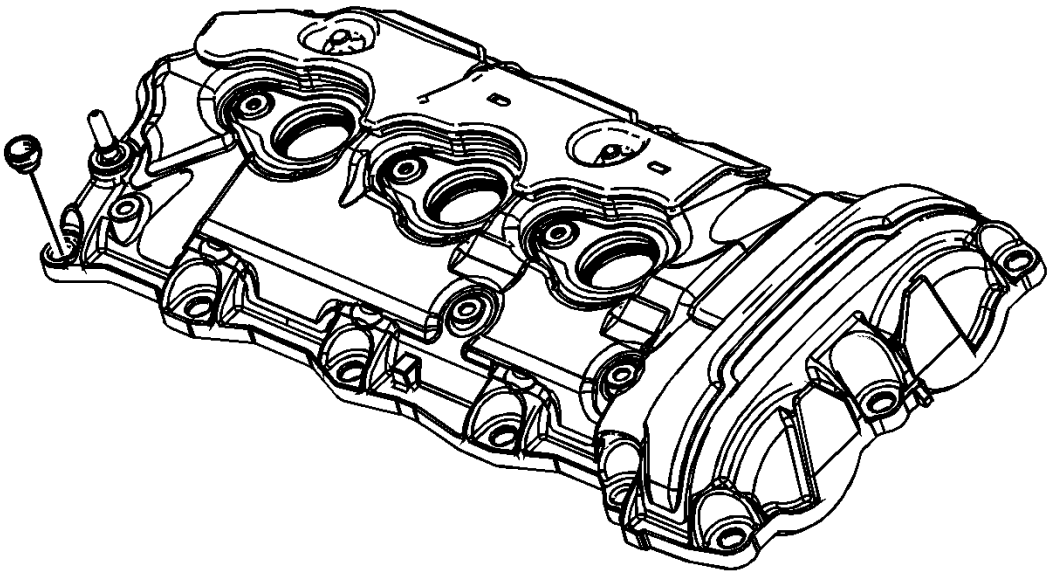

Fig. 582: View Of Right Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

2. Install the NEW camshaft cover bolt grommets prior to installing the camshaft cover bolts.
3. Wipe the camshaft cover sealing surface on the right cylinder head with a clean, lint-free cloth.

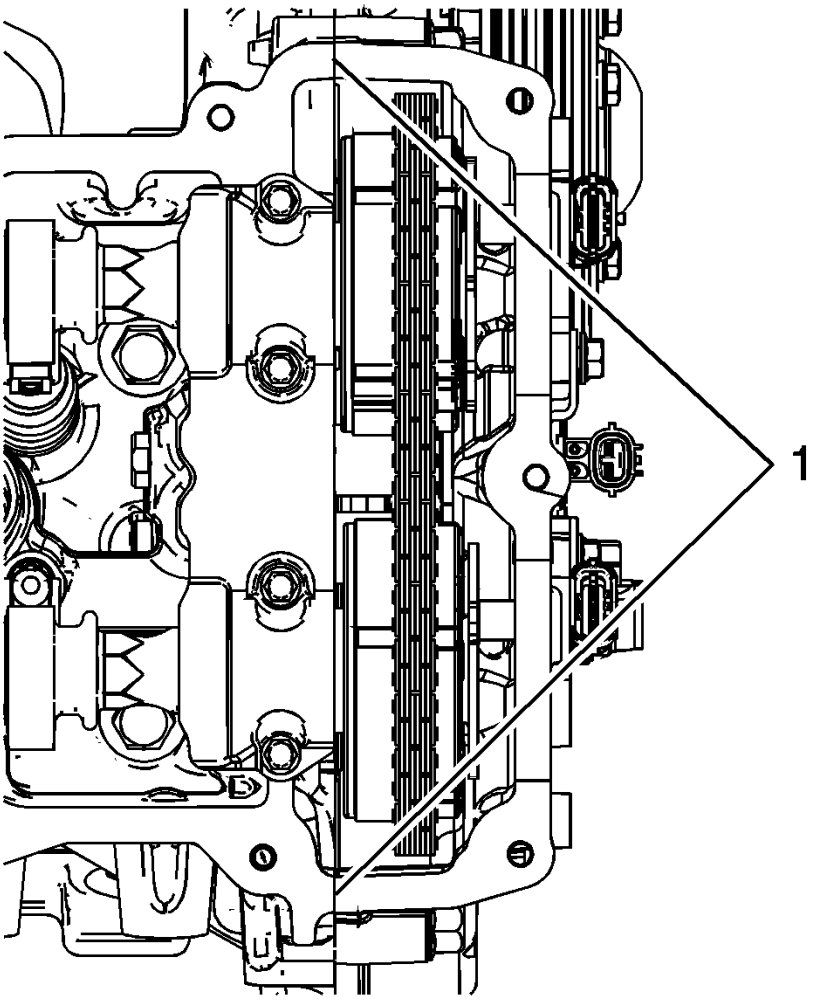

Fig. 583: Identifying Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

4. Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**
5. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, on the engine front cover split lines (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** .

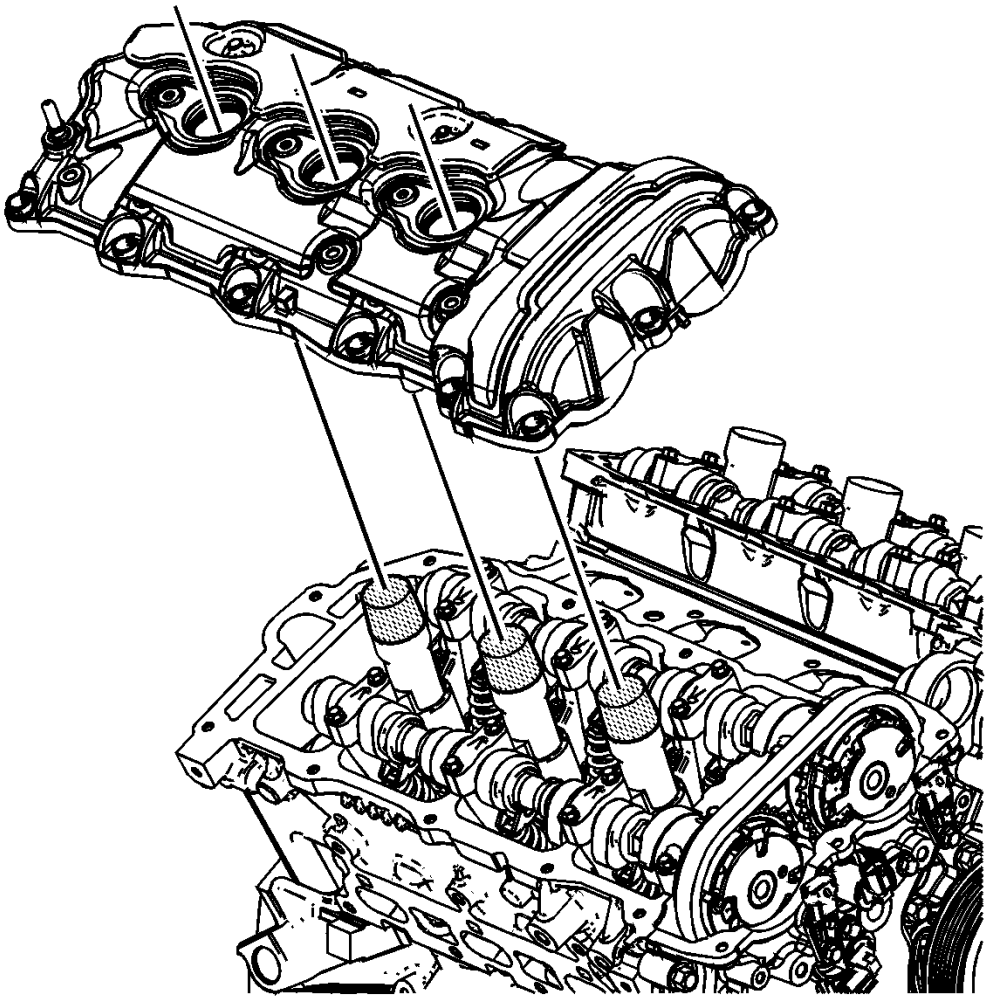

Fig. 584: View Of Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

6. Place the right camshaft cover into position onto the right cylinder head.

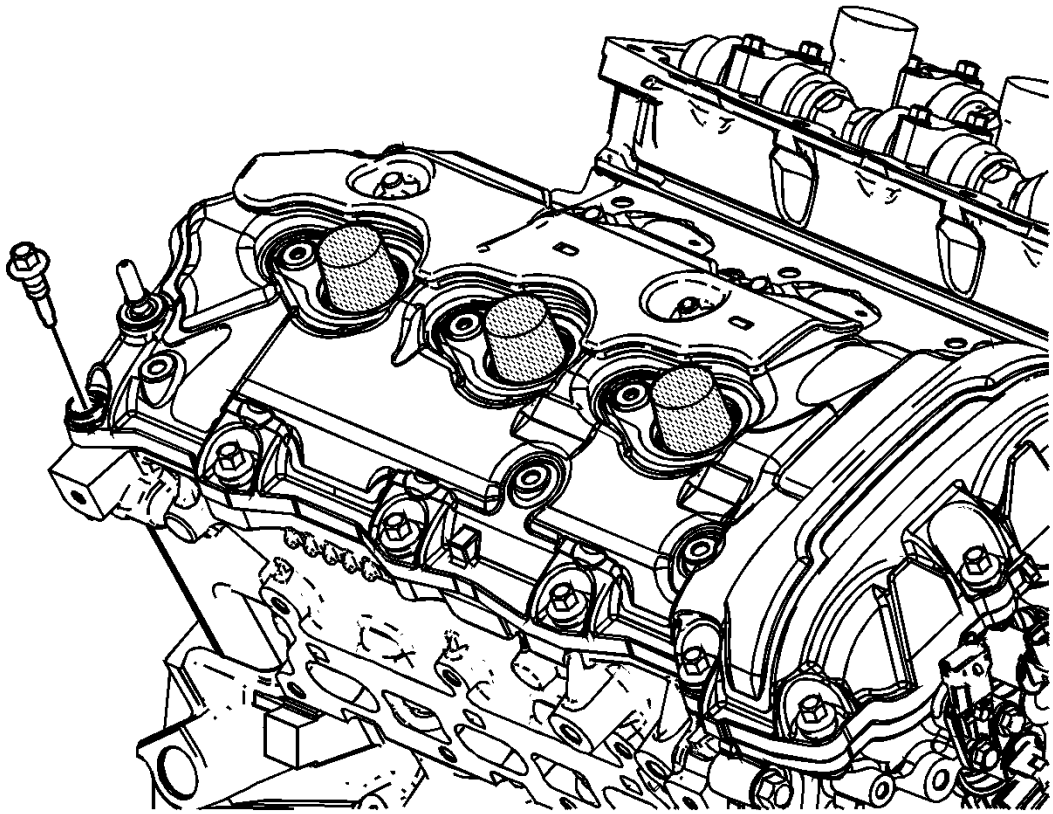

Fig. 585: Locating Right Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

7. Loosely install the right camshaft cover bolts.

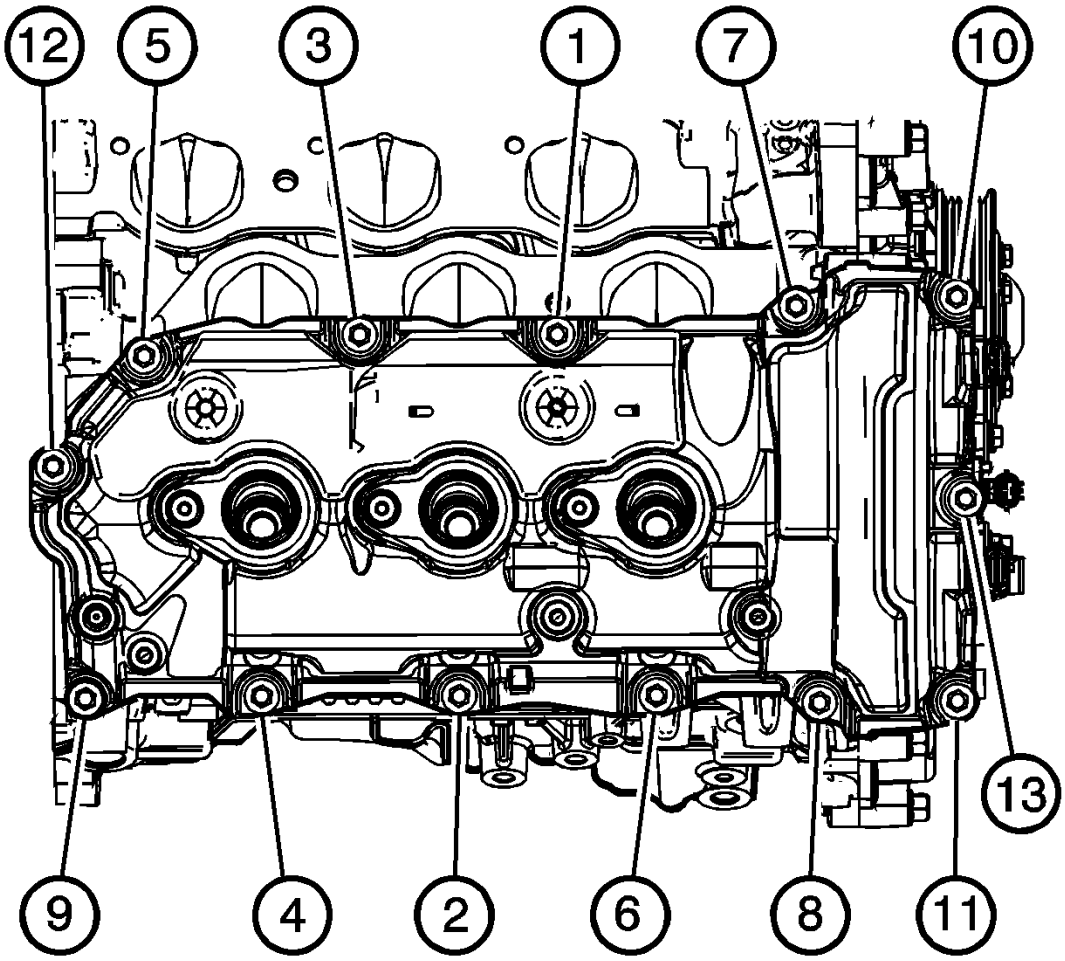

Fig. 586: Identifying Right Camshaft Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

8. Tighten the right camshaft cover bolts in the sequence shown.
    1. Tighten the right camshaft cover bolts to 10 N.m (89 lb in).
    2. Tighten the right camshaft cover bolts a second pass to 10 N.m (89 lb in).

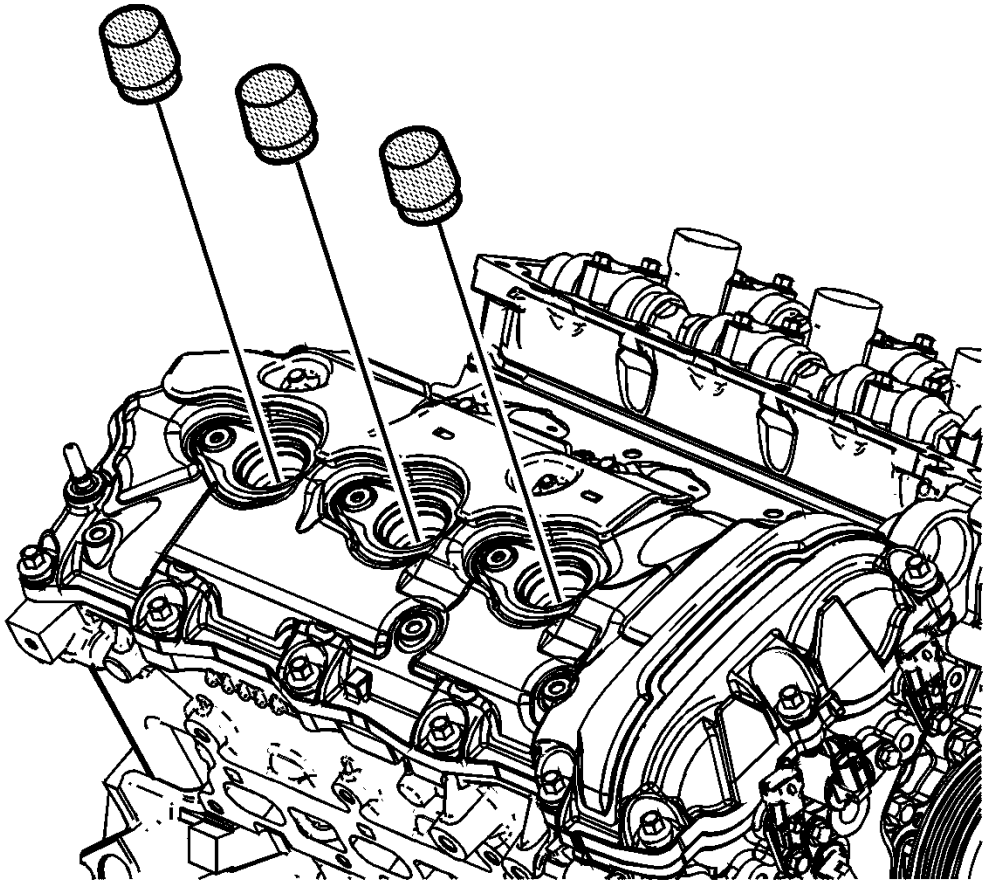

Fig. 587: View Of Spark Plug Tubes
Courtesy of GENERAL MOTORS COMPANY

9. Remove the **EN-46101** guide from the spark plug tubes of the right cylinder head.

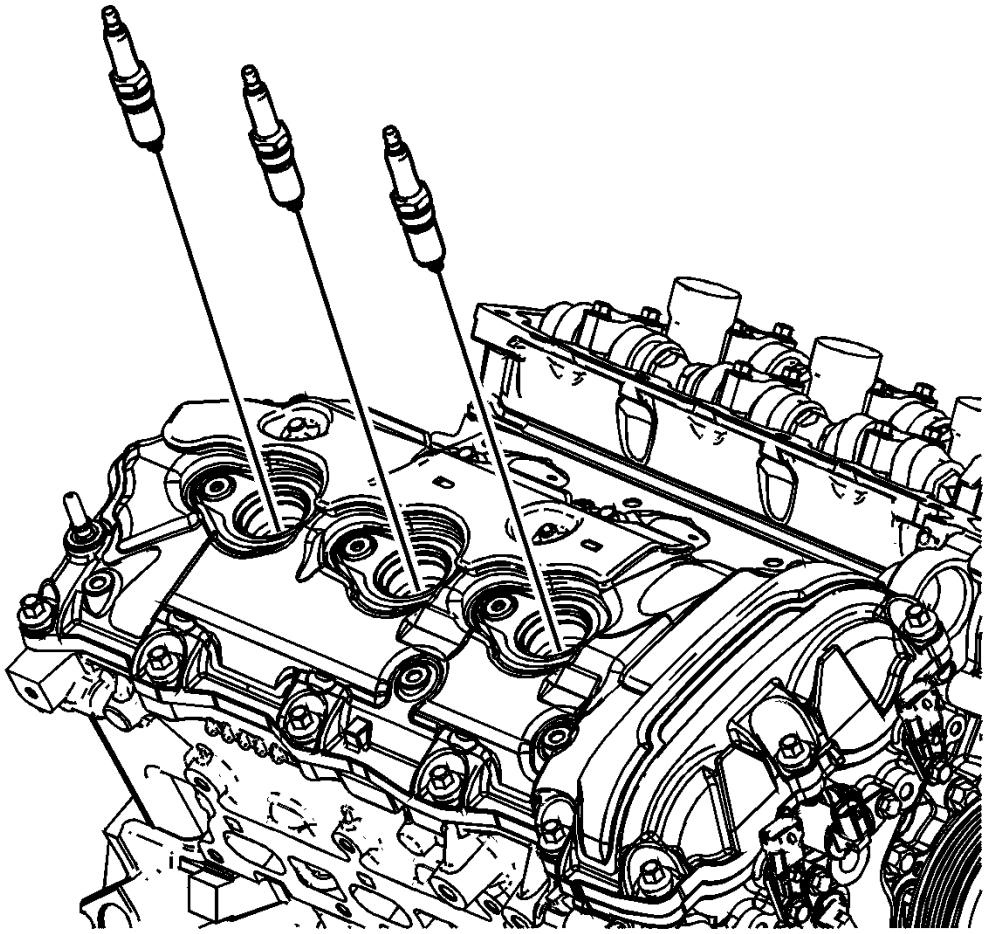

Fig. 588: View Of Spark Plugs
Courtesy of GENERAL MOTORS COMPANY

10. Install the NEW spark plugs into the right cylinder head and tighten to 18 N.m (13 lb ft).

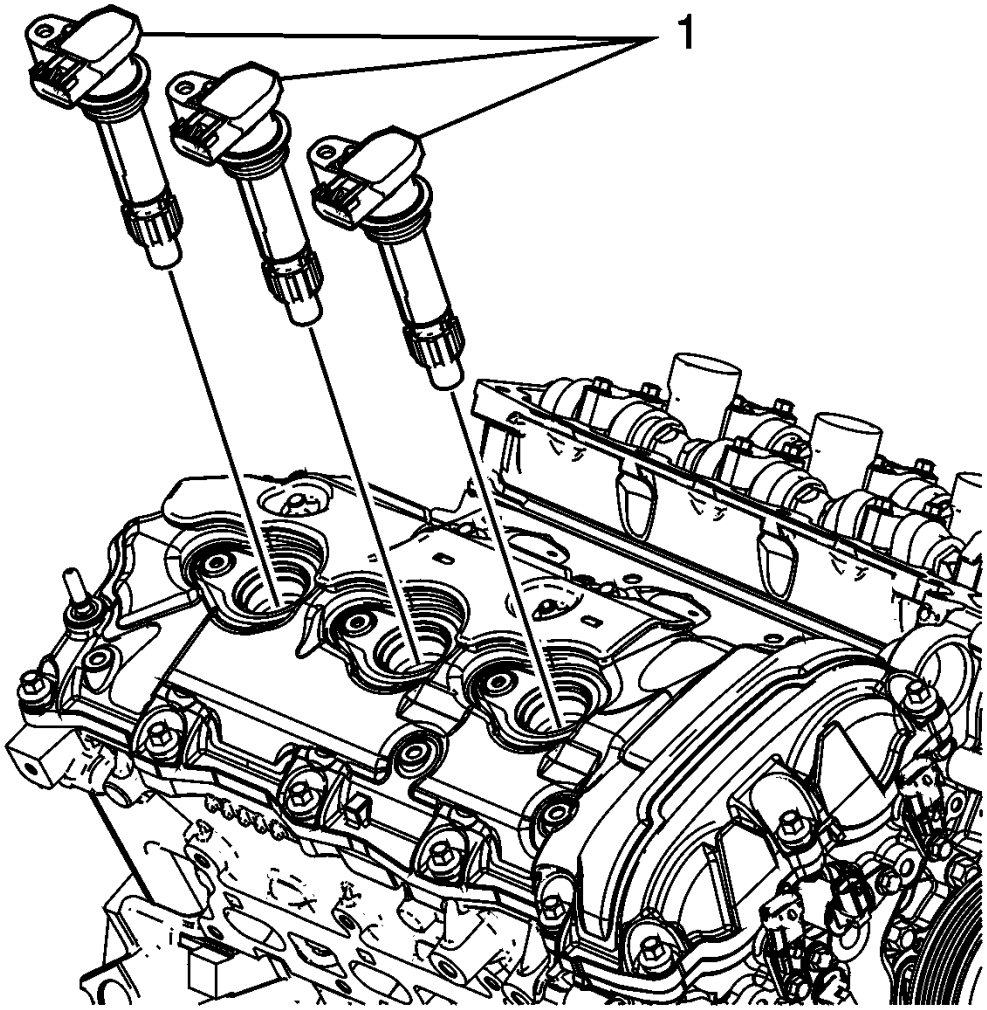

Fig. 589: View Of Ignition Coils
Courtesy of GENERAL MOTORS COMPANY

11. Inspect the inside of the ignition coil rubber boot for a thin, even coat of grease. If there is no grease present or additional grease is necessary, complete the following procedure:
    1. Apply a thin coating of dielectric grease evenly to the inside of the ignition coil rubber boot, up to a depth of 15 mm from the end of the boot. Refer to **Adhesives, Fluids, Lubricants, and Sealers** .
    2. Remove any excess grease from around the end of the boot, and ensure there is not an excessive amount within the boot.
12. Install the ignition coils.

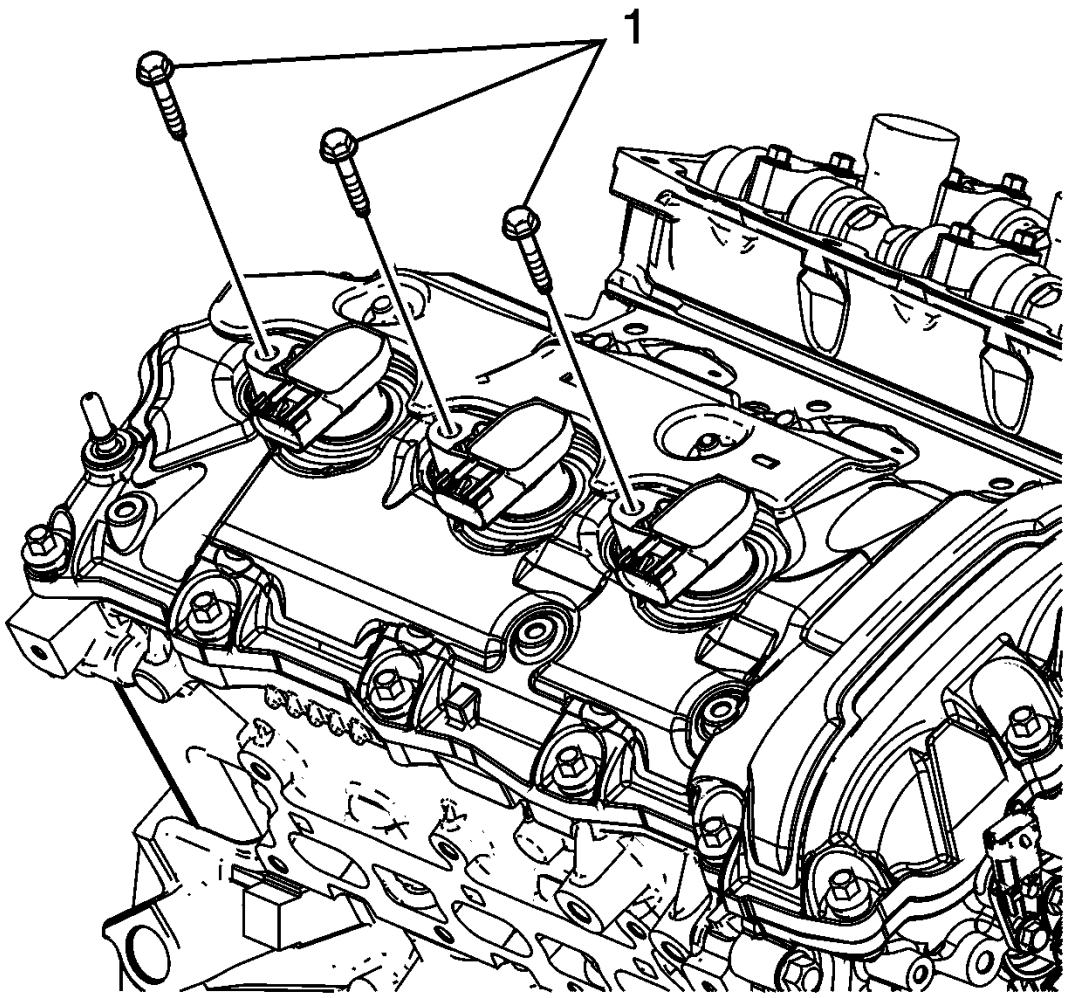

Fig. 590: Identifying Ignition Coil Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Install the ignition coil bolts and tighten to 10 N.m (89 lb in).

INTAKE MANIFOLD INSTALLATION

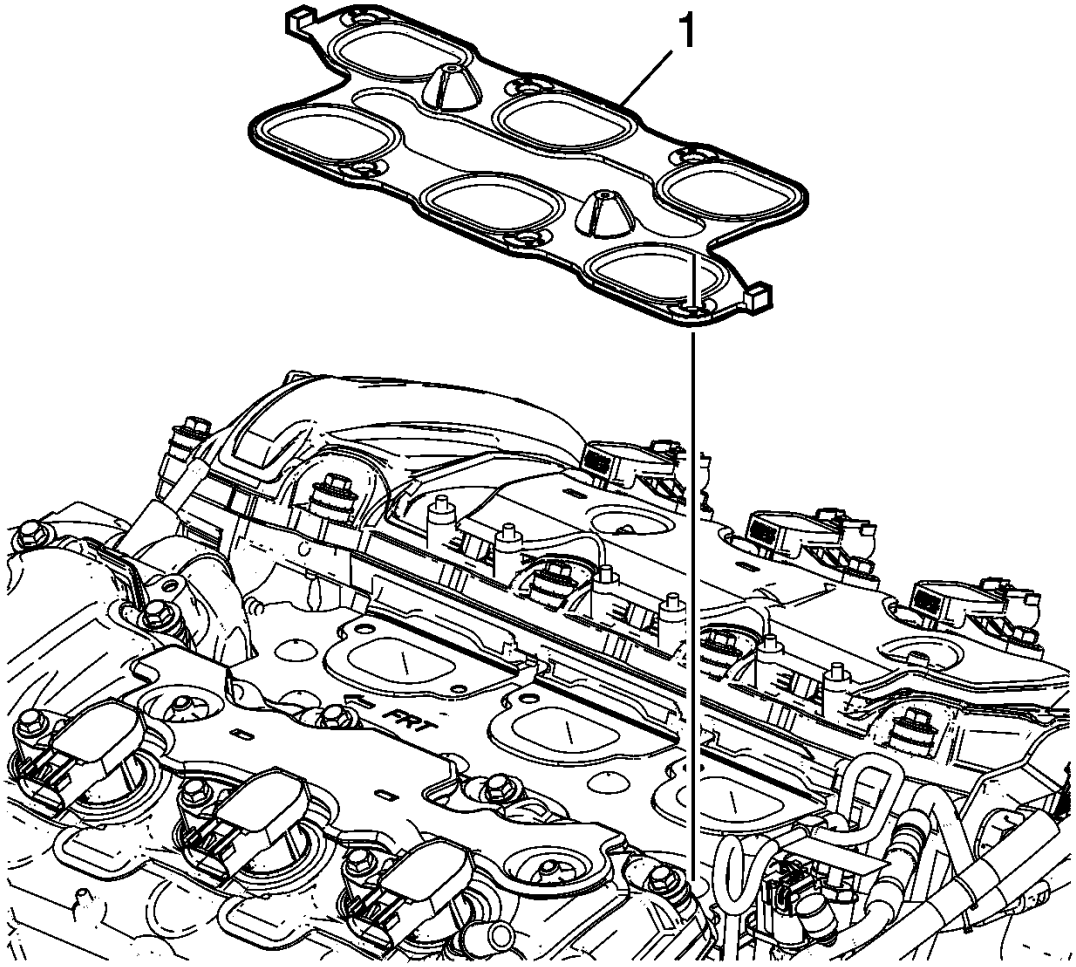

Fig. 591: Intake Manifold Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW intake manifold gasket (1).

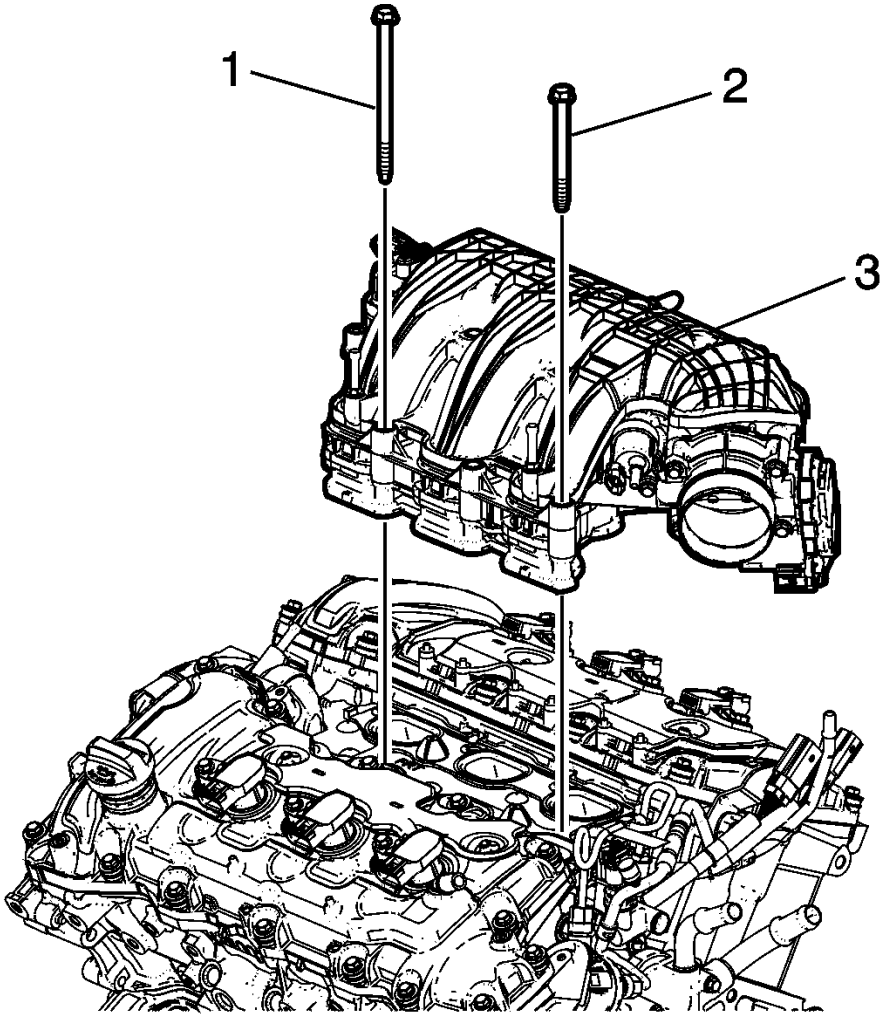

Fig. 592: Intake Manifold Assembly And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake manifold assembly (3).
3. Install the intake manifold bolts (1, 2).

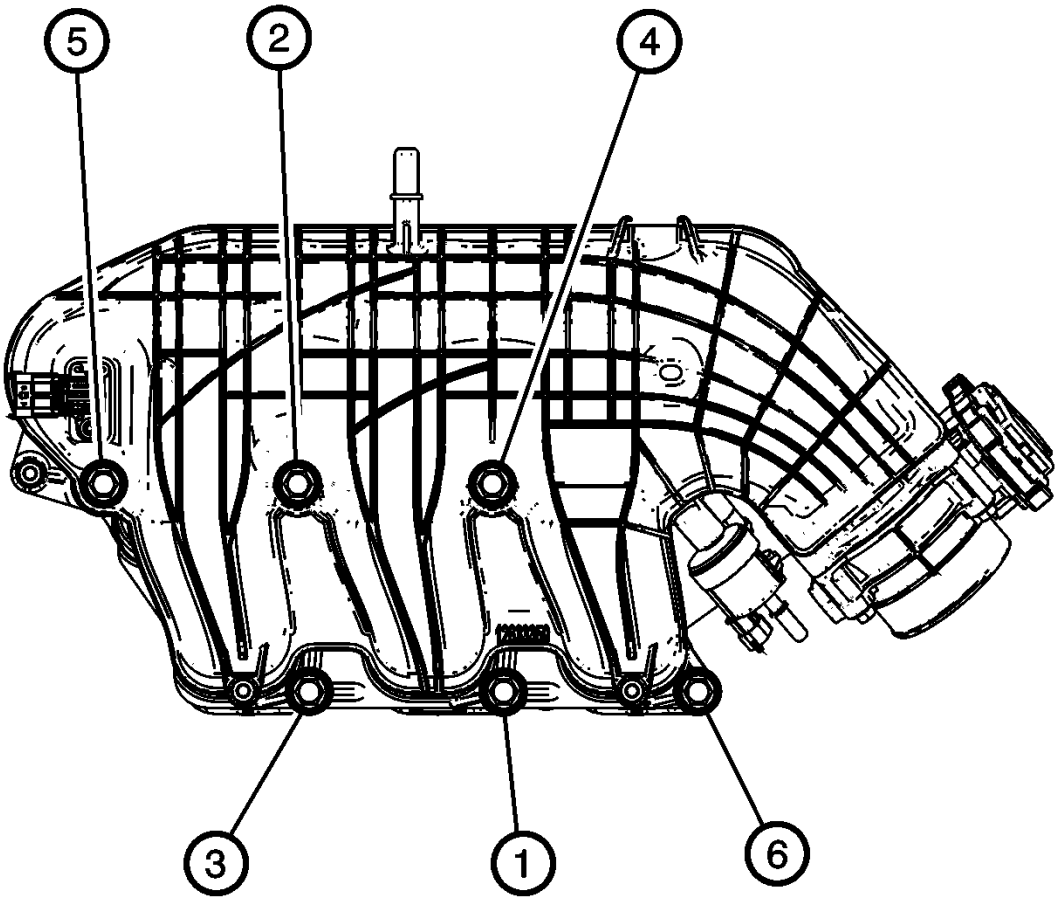

Fig. 593: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the intake manifold bolts in the sequence shown.
5. Tighten the intake manifold bolts in sequence to 25 N.m (18 lb ft).
6. Tighten the intake manifold bolts a second pass in sequence to 25 N.m (18 lb ft).

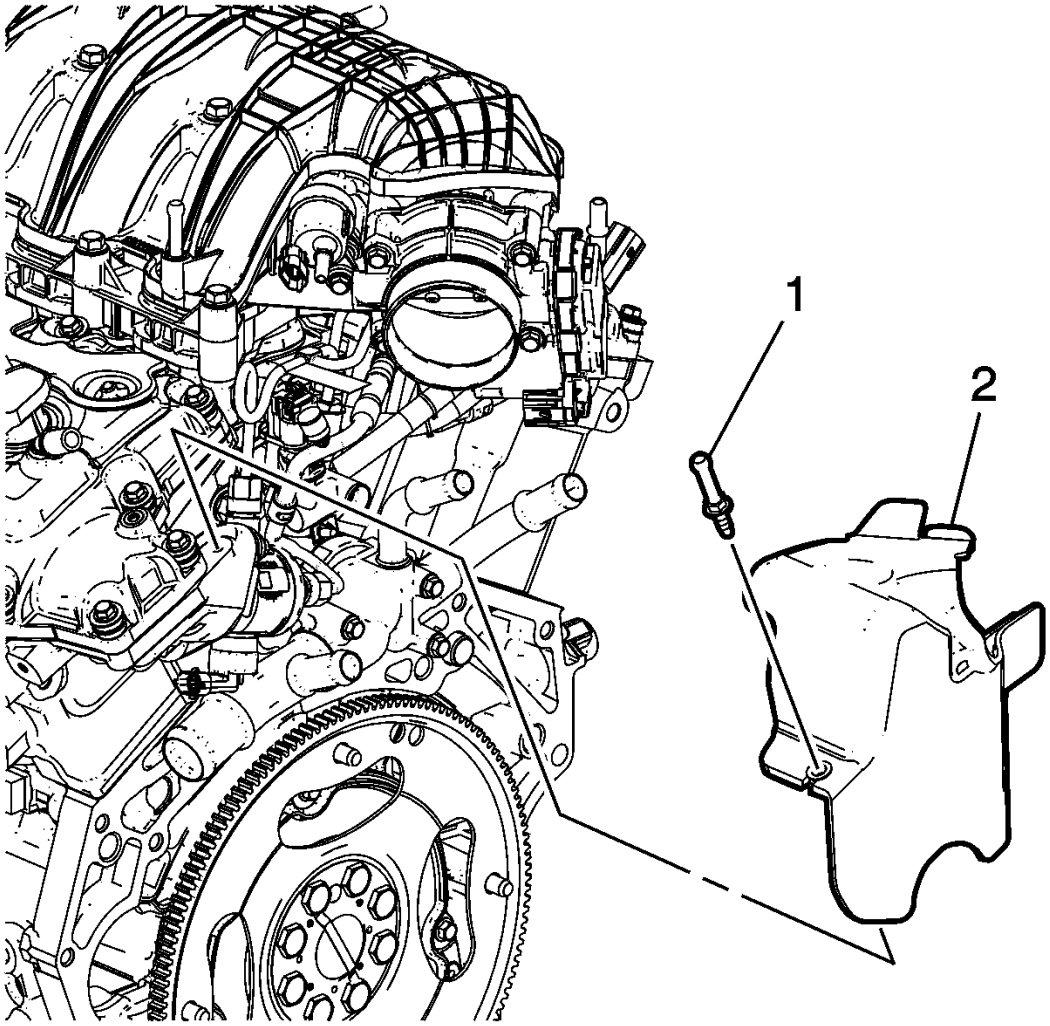

Fig. 594: Fuel Pump Cover And Stud
Courtesy of GENERAL MOTORS COMPANY

7. Install the engine rear noise shield (2).
8. Install the engine rear noise shield stud (1) and tighten to 10 N.m (89 lb in).

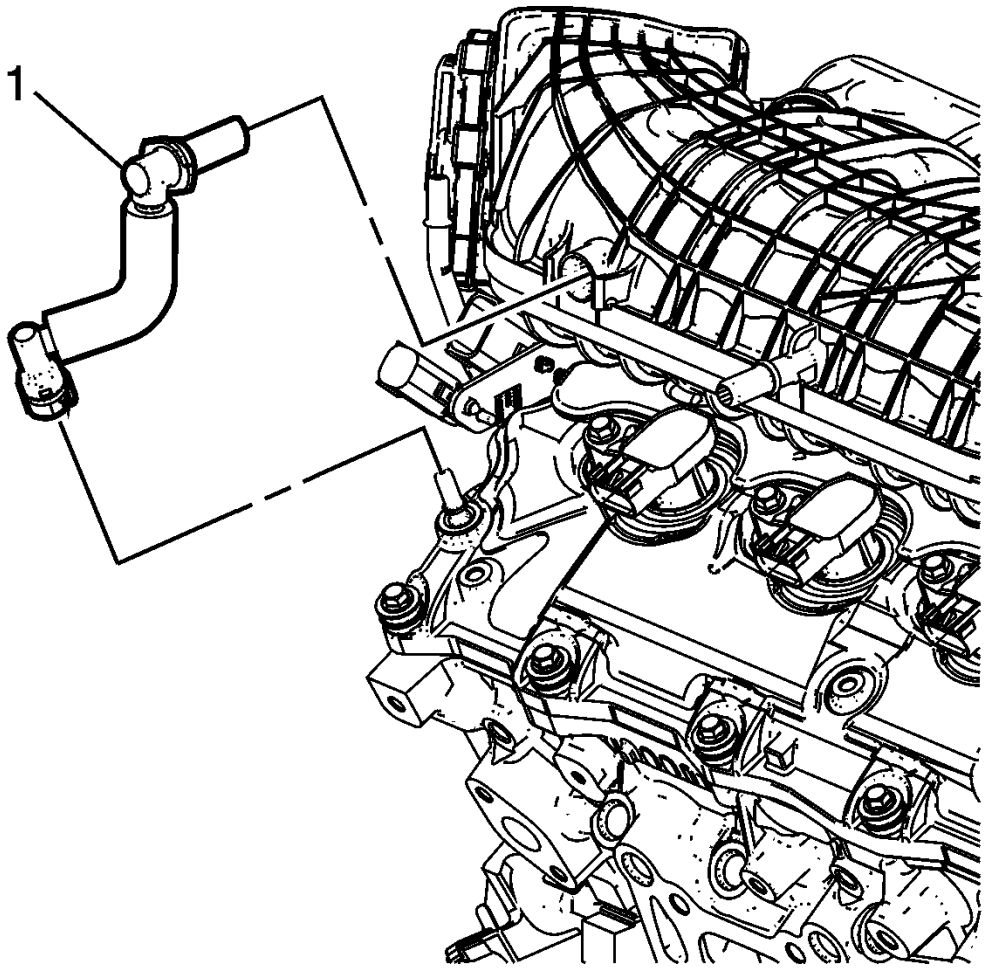

Fig. 595: Positive Crankcase Ventilation Tube
Courtesy of GENERAL MOTORS COMPANY

9. Connect the positive crankcase ventilation (PCV) tube assembly (1) to the upper intake manifold and the right camshaft cover.

AUTOMATIC TRANSMISSION FLEX PLATE INSTALLATION

Special Tools

- **EN-45059** Angle Meter
- **EN-46106** Engine Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

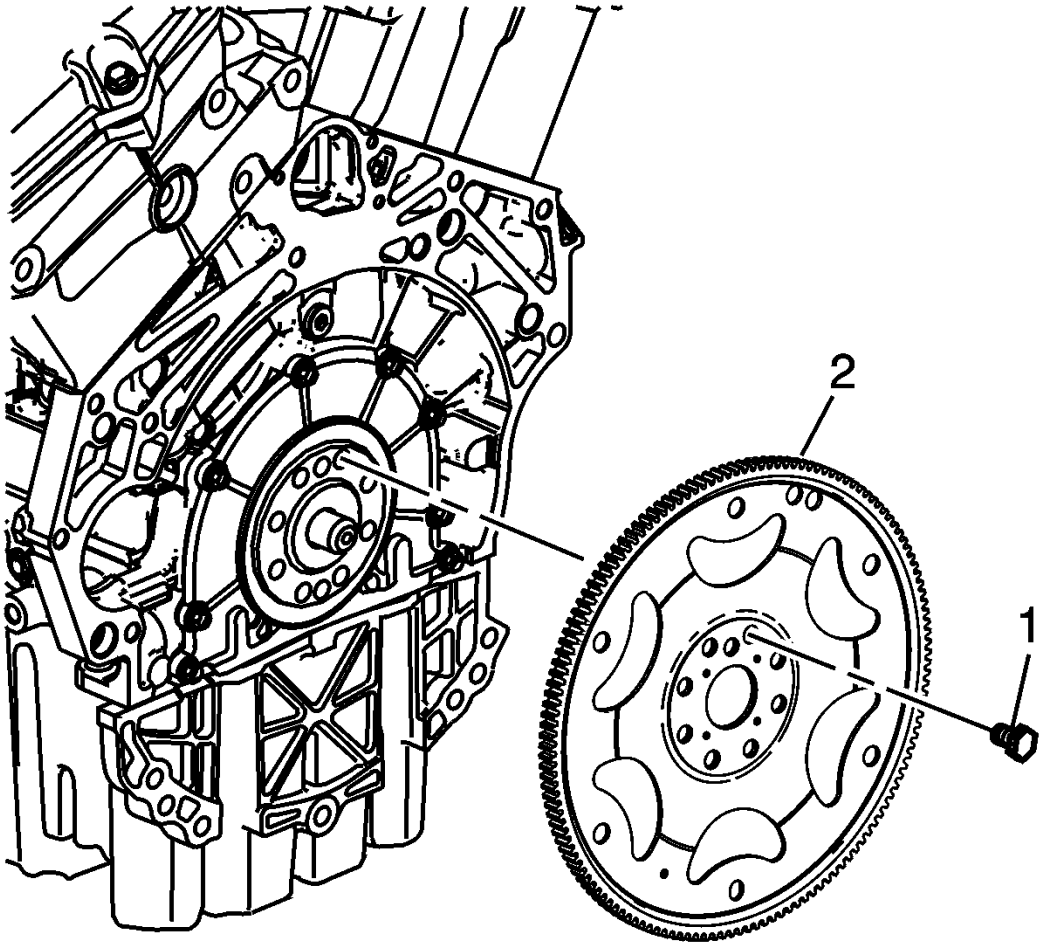

Fig. 596: View Of Engine Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Place the flex plate (2) in position on the crankshaft.

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

2. Install 2 NEW bolts (1) in location at the top and bottom of the flex plate bolt pattern allowing the flex plate (2) to hang in position.

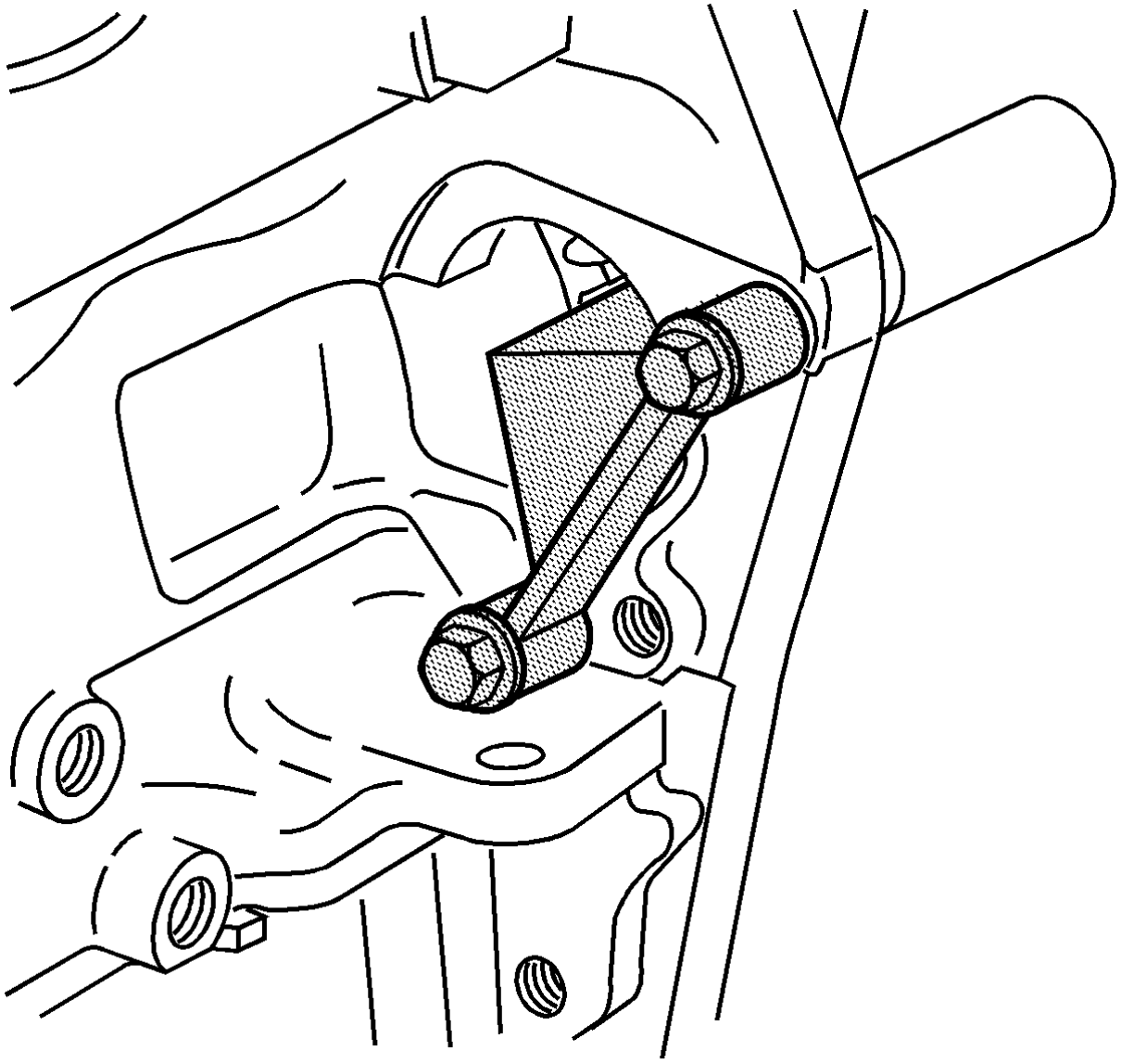

Fig. 597: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-46106** tool.

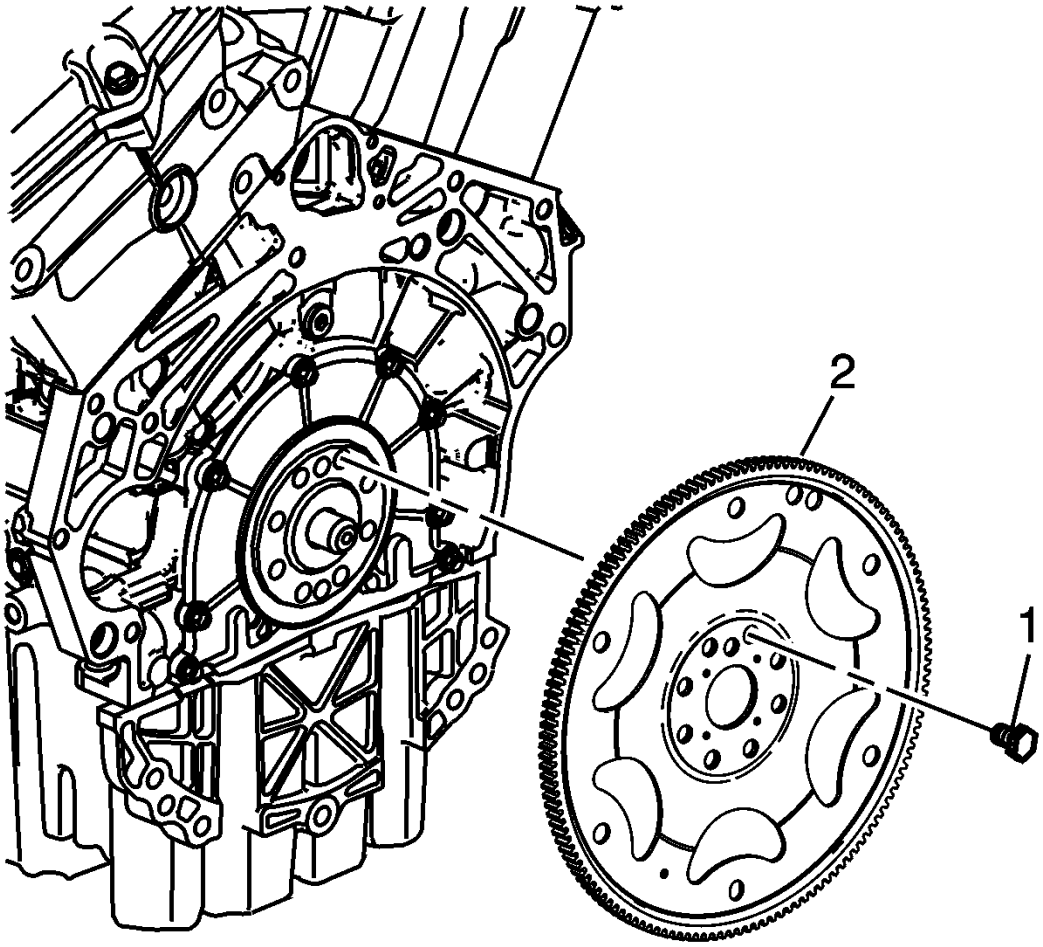

Fig. 598: View Of Engine Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the remaining NEW flex plate bolts (1).
    1. Tighten the NEW flex plate bolts (1) to 30 N.m (22 lb ft).
    2. Tighten the NEW flex plate bolts (1) an additional 45 degrees using the **EN-45059** meter.

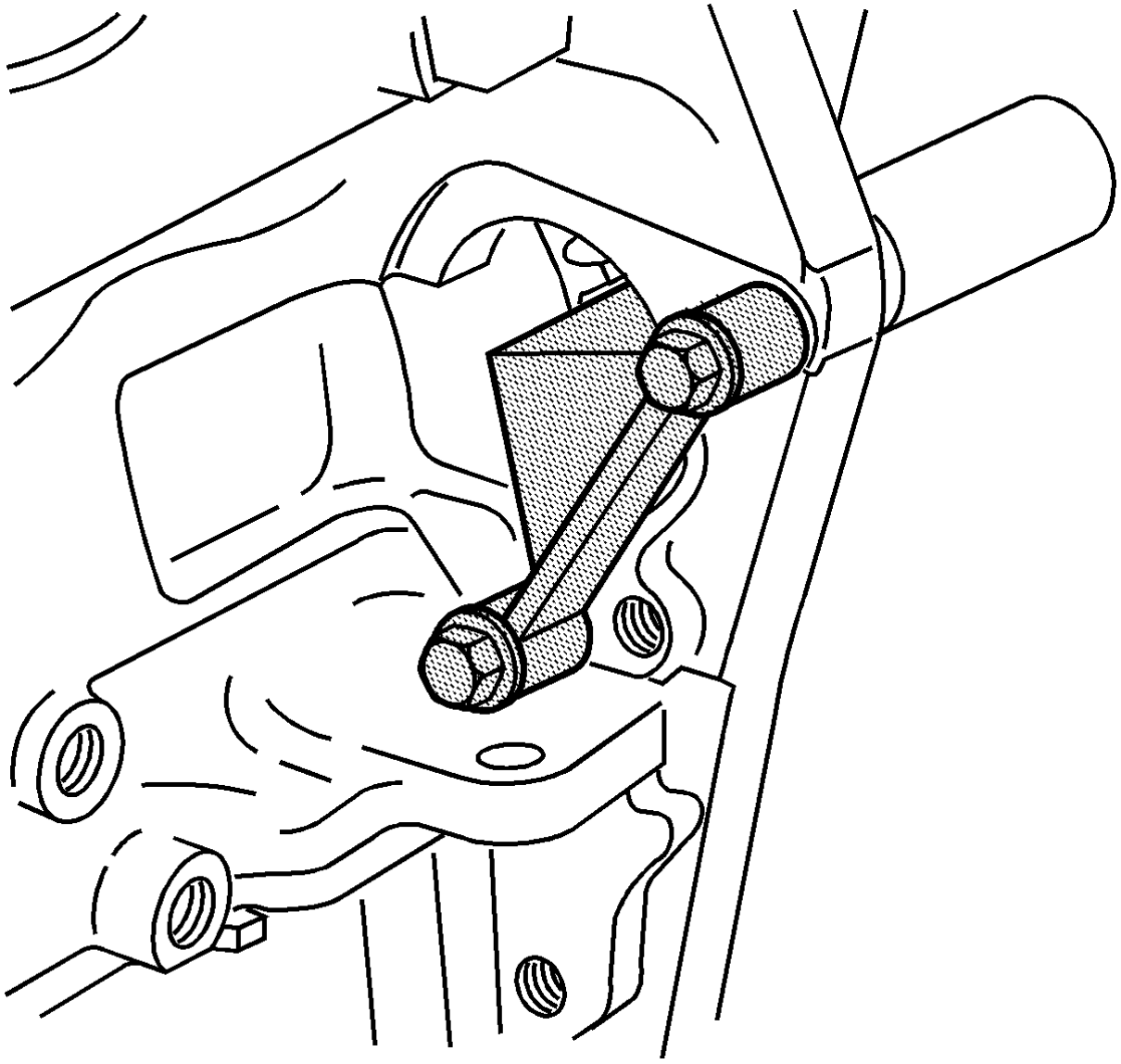

Fig. 599: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-46106** tool.

ENGINE FLYWHEEL INSTALLATION

Special Tools

- **EN-45059** Angle Meter
- **EN-46106** Engine Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

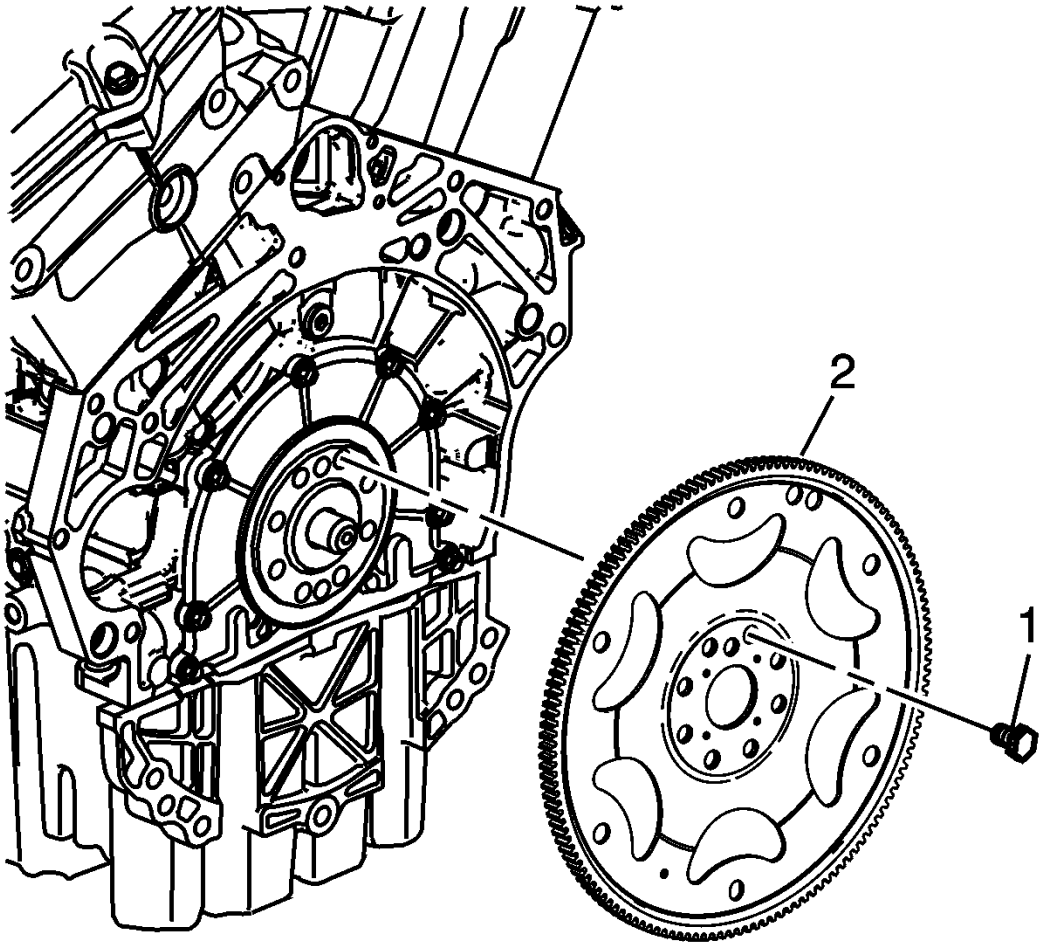

Fig. 600: View Of Engine Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Place the flex plate (2) in position on the crankshaft.

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

2. Install 2 NEW bolts (1) in location at the top and bottom of the flex plate bolt pattern allowing the flex plate (2) to hang in position.

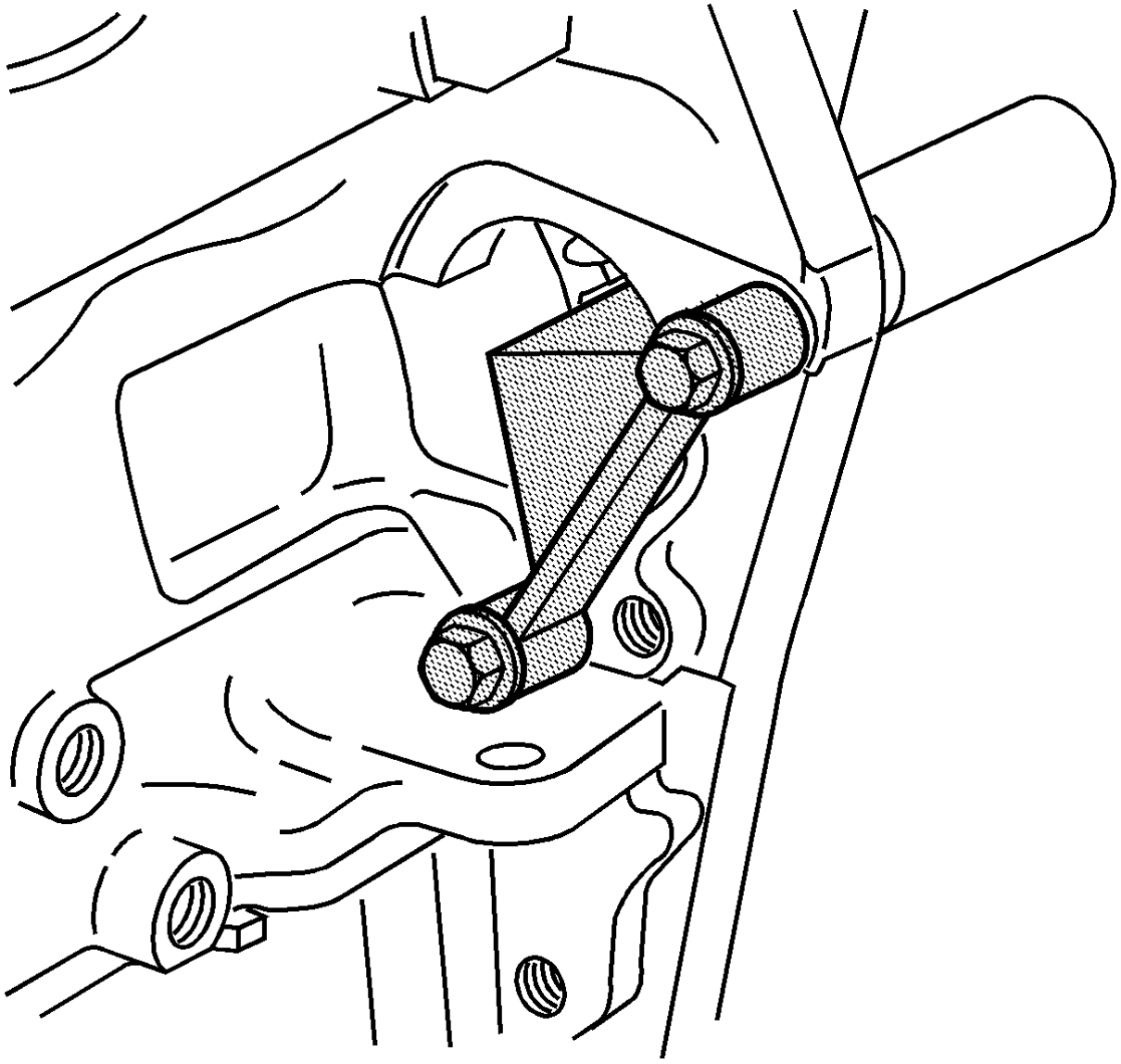

Fig. 601: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

3. Install the **EN-46106** tool.

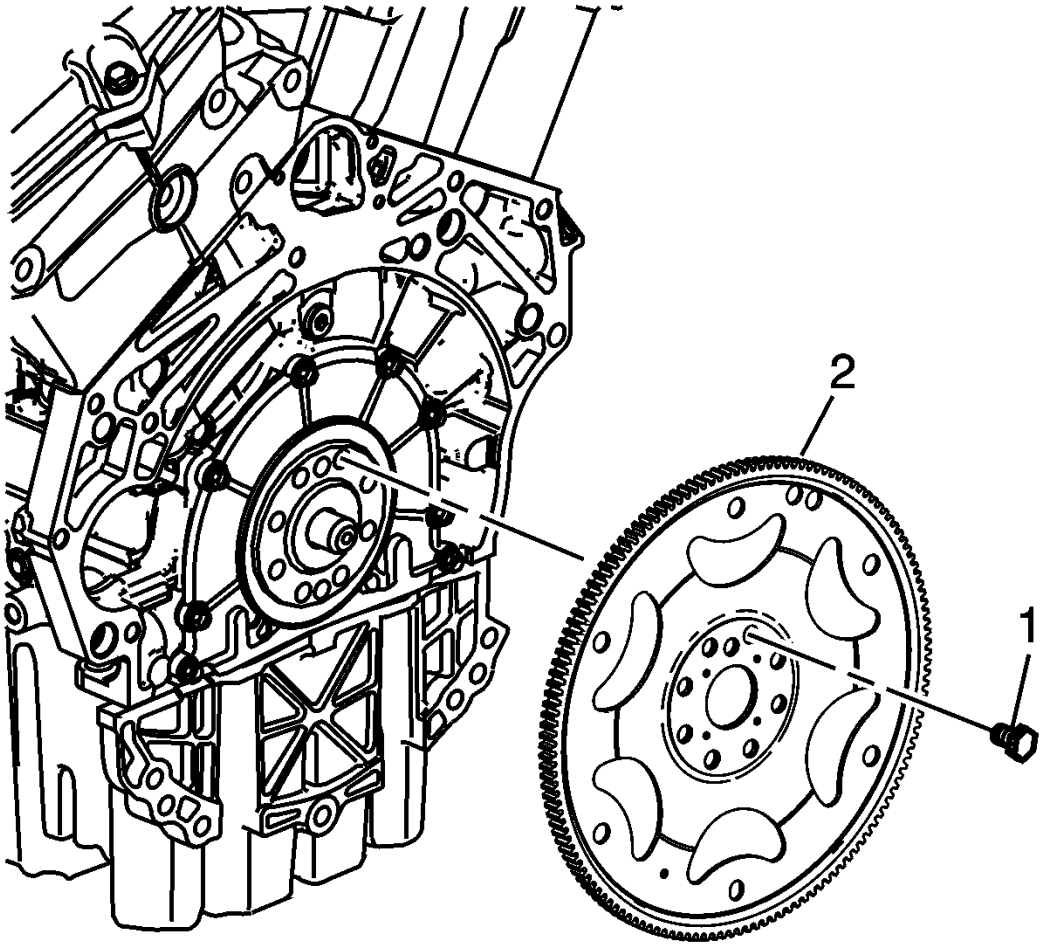

Fig. 602: View Of Engine Flywheel Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the remaining NEW flex plate bolts (1).
    1. Tighten the NEW flex plate bolts (1) to 30 N.m (22 lb ft).
    2. Tighten the NEW flex plate bolts (1) an additional 45 degrees using the **EN-45059** meter.

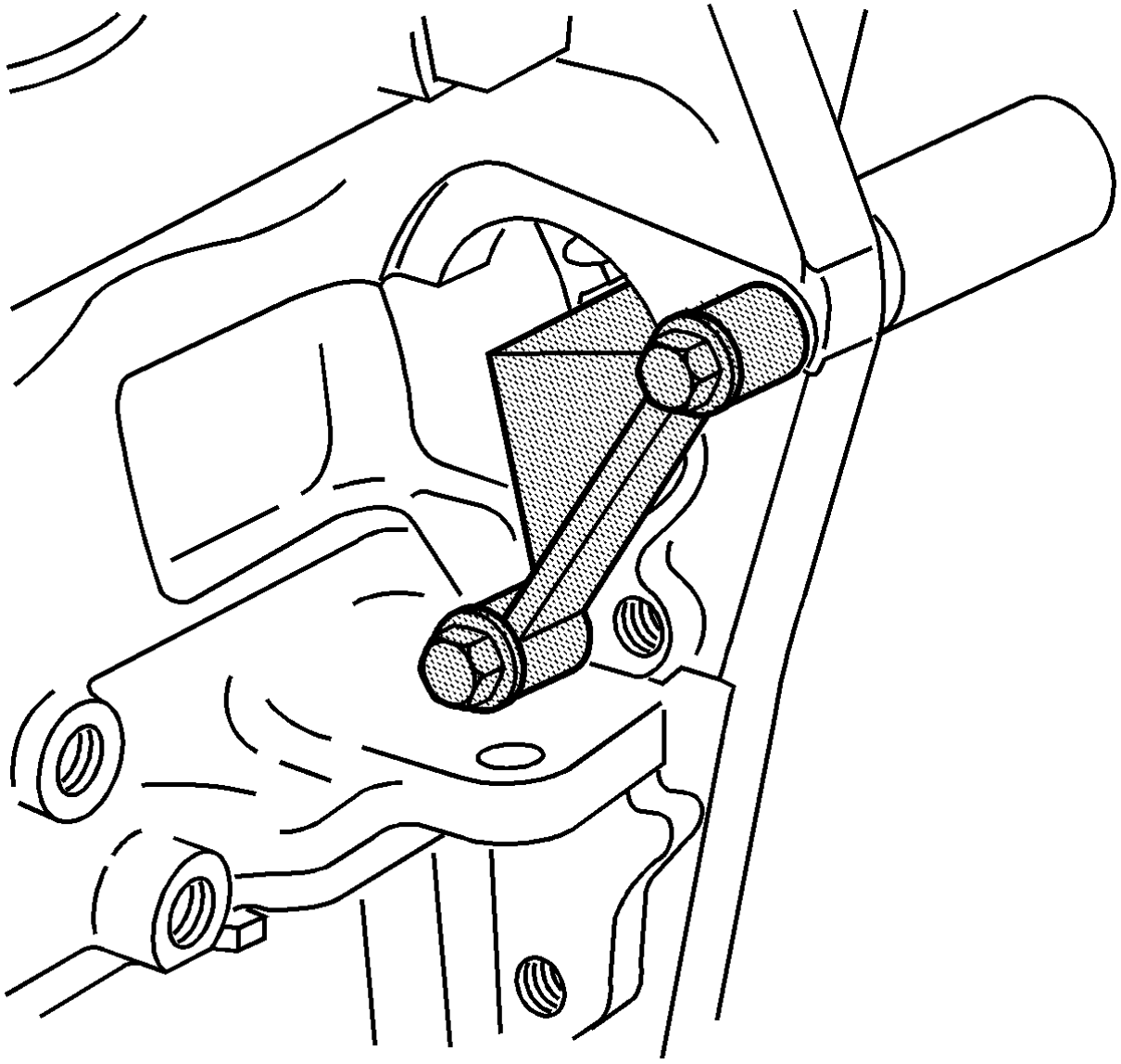

Fig. 603: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-46106** tool.

CRANKSHAFT BALANCER INSTALLATION

Special Tools

- **EN 41998-B** Crankshaft Balancer Installer
- **EN 45059** Angle Meter
- **EN 46106** Engine Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

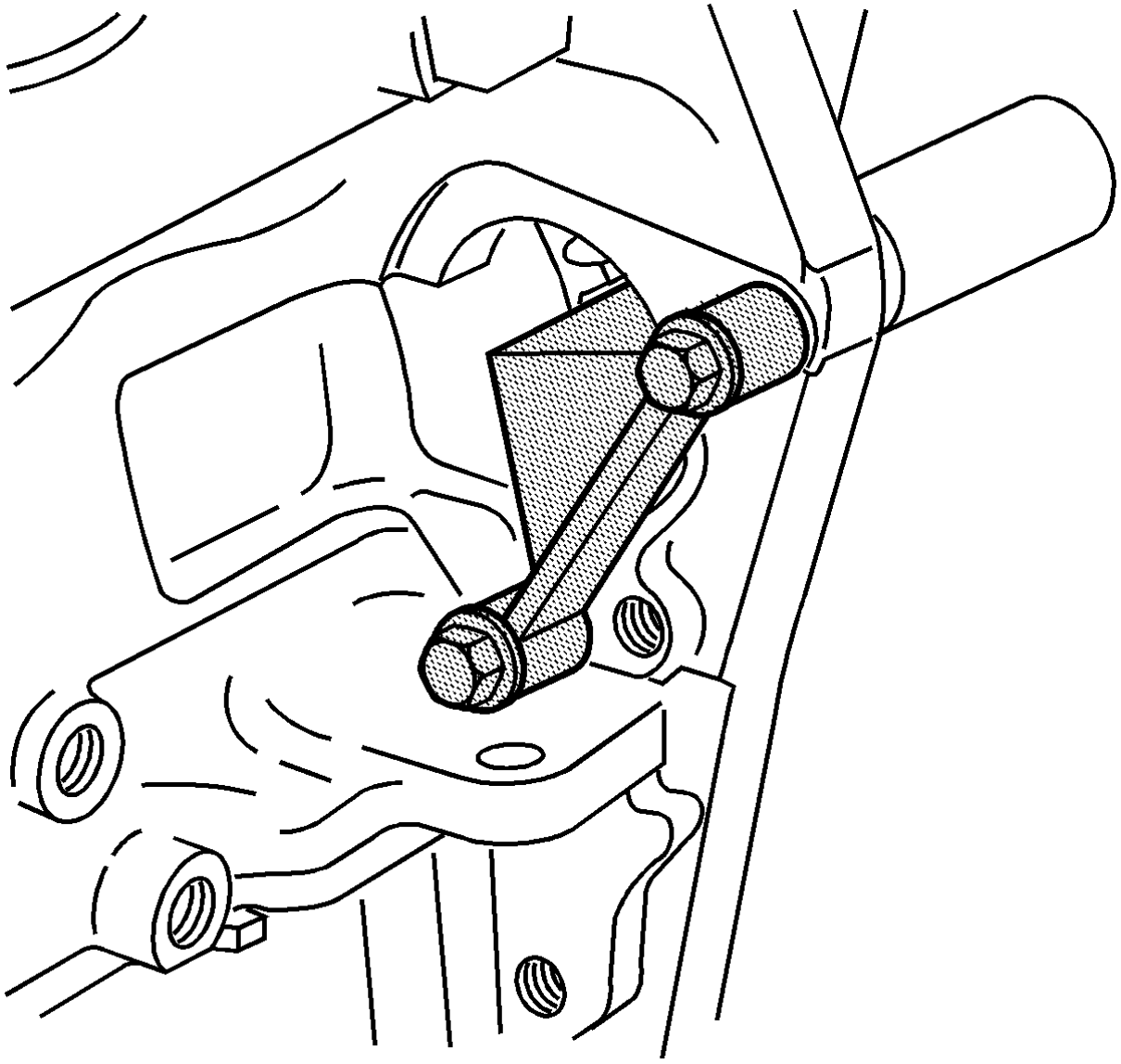

Fig. 604: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

1. The **EN 46106** tool must be installed onto the flywheel.
2. Use the **EN 41998-B** installer , nut, bearing and washer to install the crankshaft balancer.

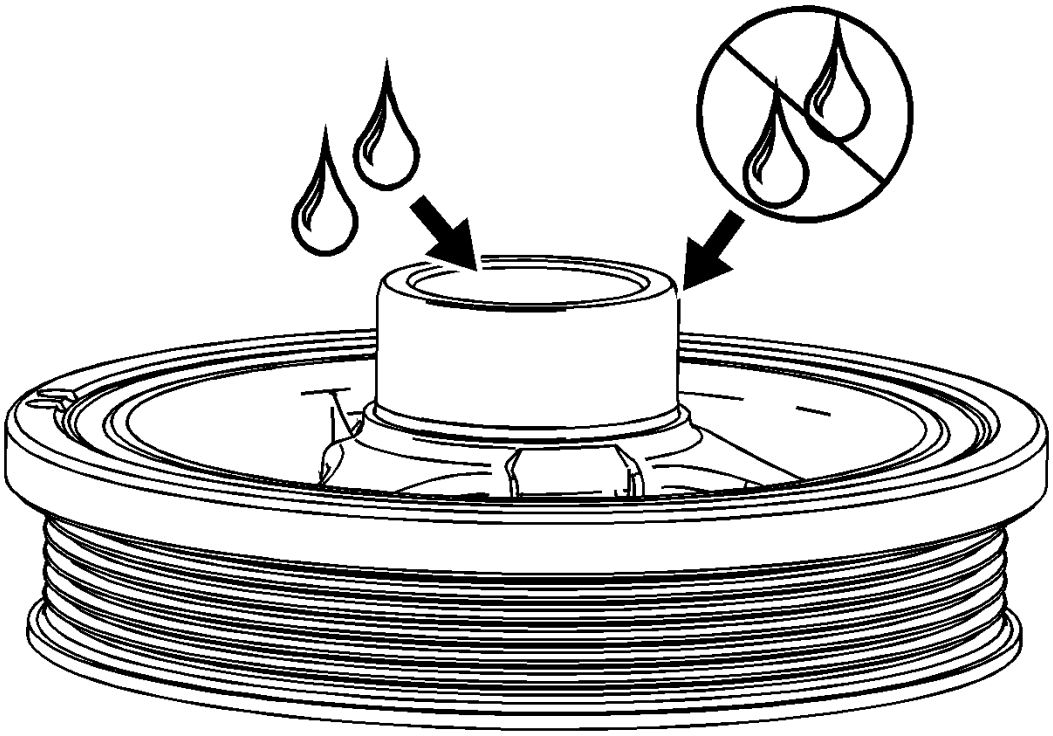

Fig. 605: Identifying Lubrication & Non-Lubrication Areas On Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.**

3. Apply lubricant to the inside of the crankshaft balancer hub bore.

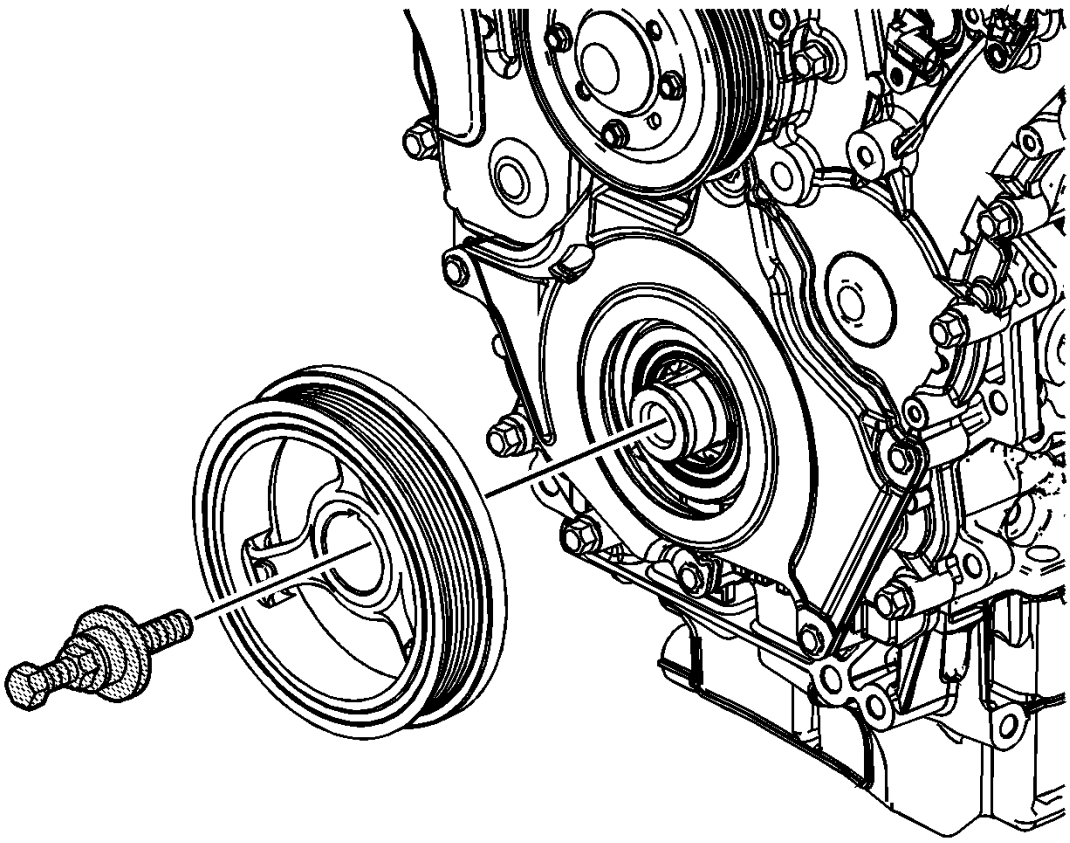

Fig. 606: View Of Crankshaft Balancer & Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Place the crankshaft balancer in position on the crankshaft.
5. Thread the **EN 41998-B** installer in the crankshaft. Ensure you engage at least 10 threads of the **EN 41998-B** installer before pressing the crankshaft balancer in place.
6. Push the crankshaft balancer into position by tightening the nut on the **J 41998-B** installer until the large washer bottoms out on the crankshaft end.
7. Remove the **EN 41998-B** installer.

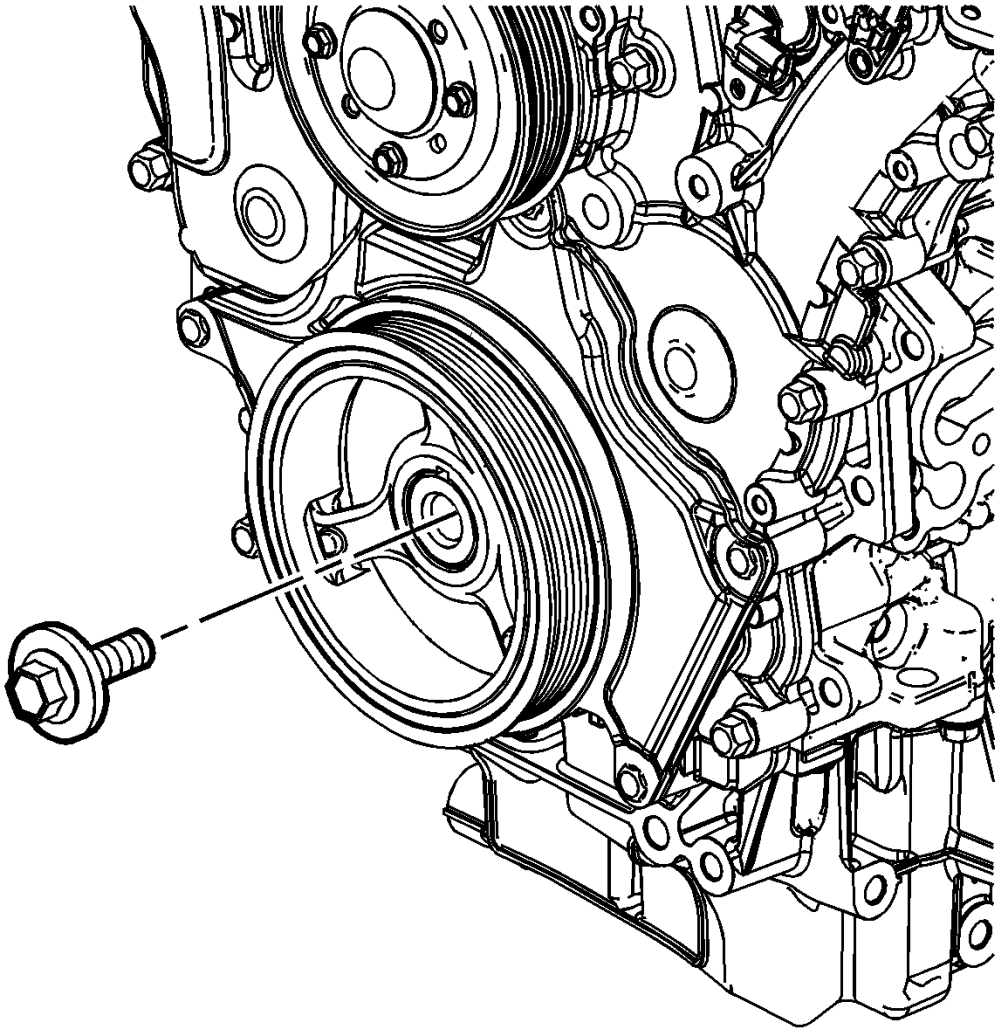

Fig. 607: View Of Crankshaft Balancer Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

8. Install the NEW crankshaft balancer bolt.

CAUTION: Refer to Fastener Caution .

9. Tighten the crankshaft balancer bolt.
    1. Tighten the crankshaft balancer bolt to 100 N.m (74 lb ft).
    2. Tighten the crankshaft balancer bolt an additional 150 degreesusing the **EN 45059** meter.

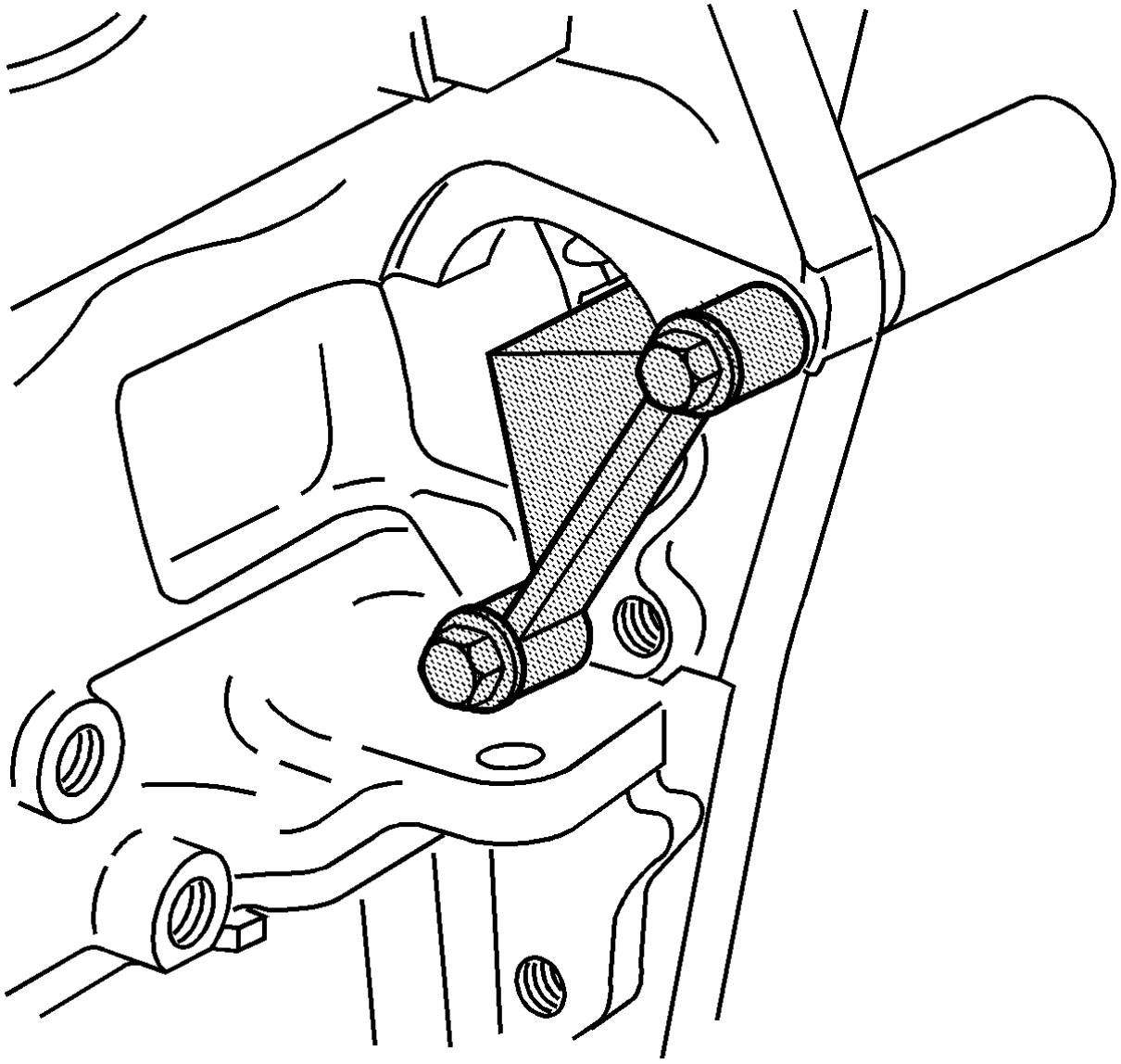

Fig. 608: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **EN 46106** tool.

OIL FILTER ADAPTER INSTALLATION

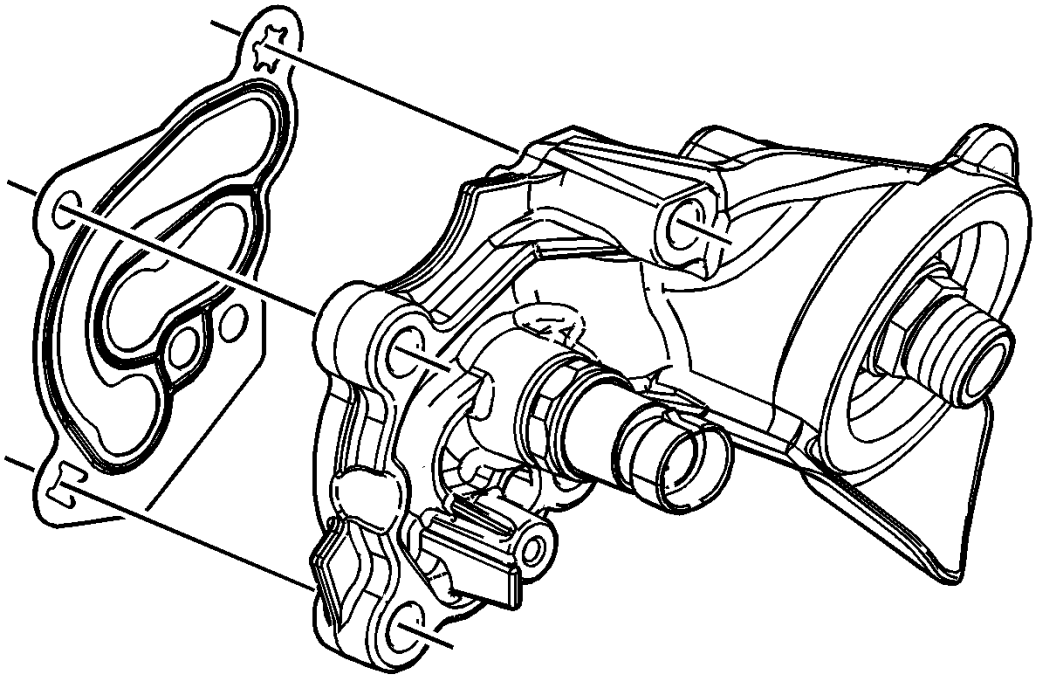

Fig. 609: Identifying Oil Filter Adapter & Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Position a NEW oil filter adapter gasket onto the oil filter adapter.

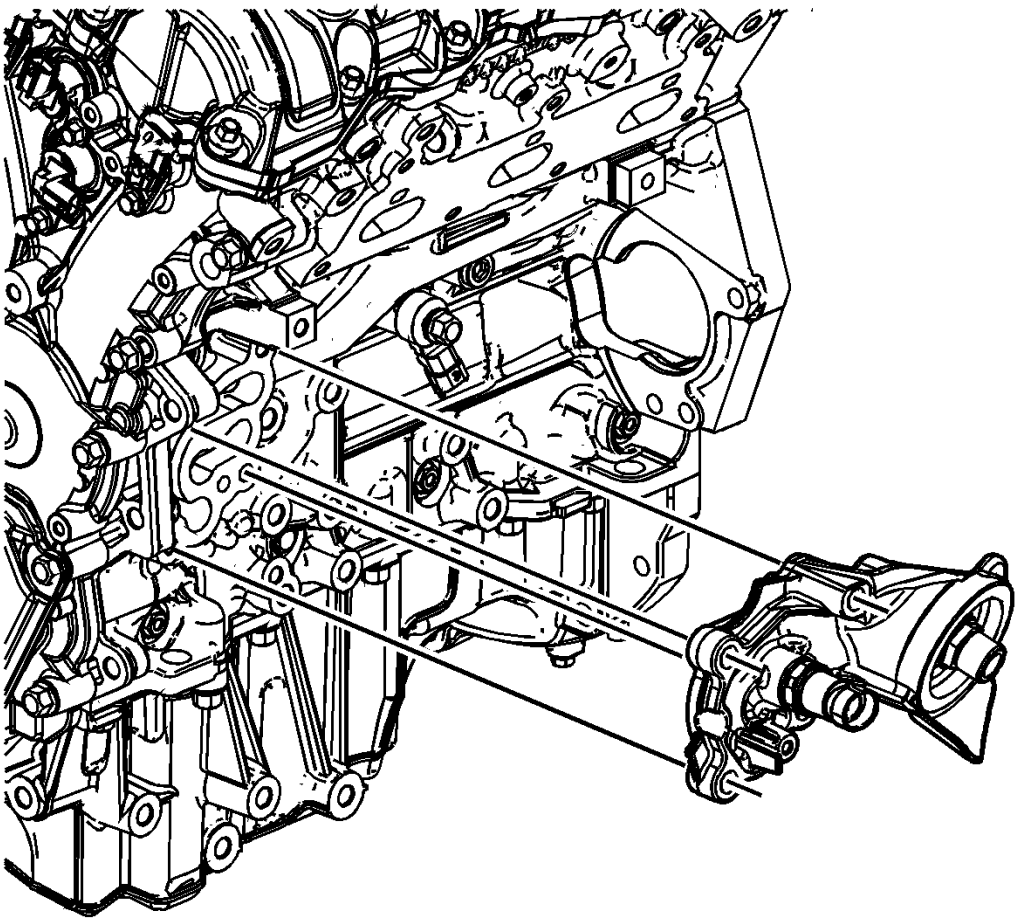

Fig. 610: Removing/Installing Oil Filter Adapter
Courtesy of GENERAL MOTORS COMPANY

2. Place the oil filter adapter into position.

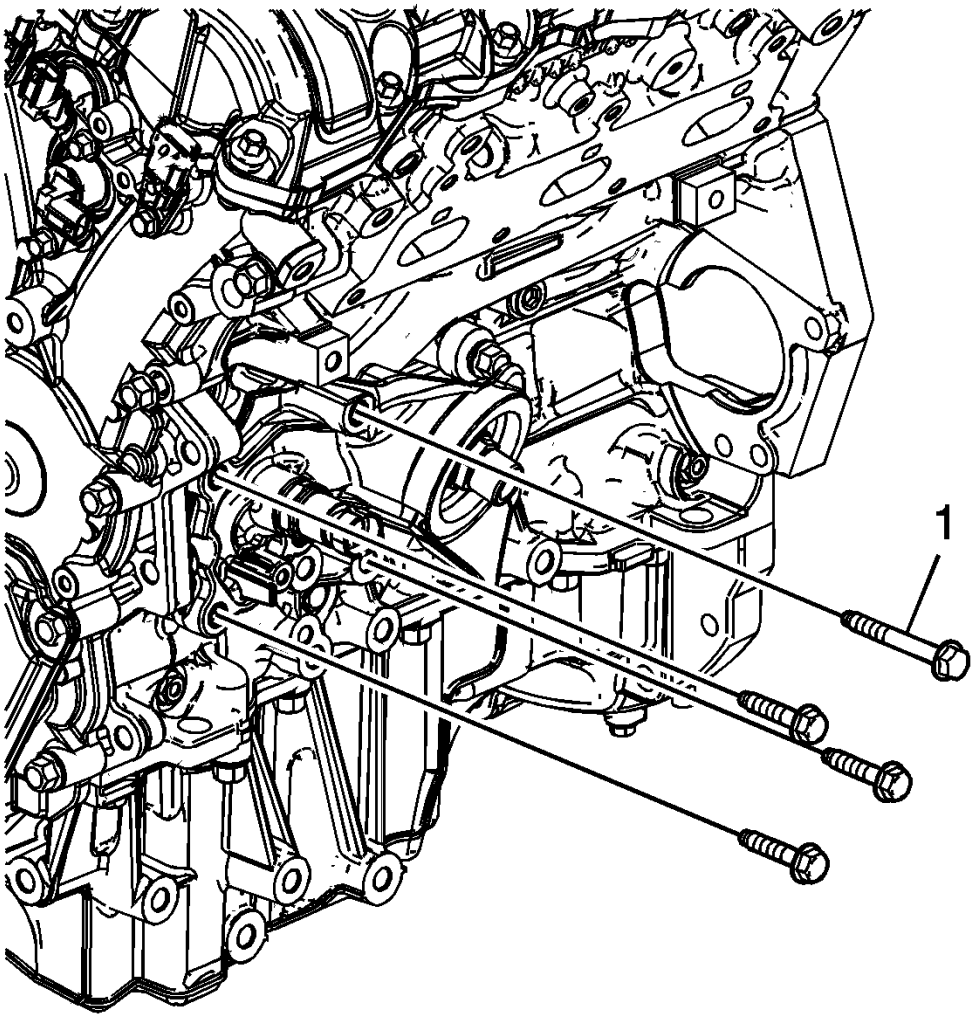

Fig. 611: Identifying Oil Filter Adapter Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the oil filter adapter bolts. Ensure the longer bolts (1) is installed in the upper rear position and tighten the oil filter adapter bolts to 23 N.m (17 lb ft).

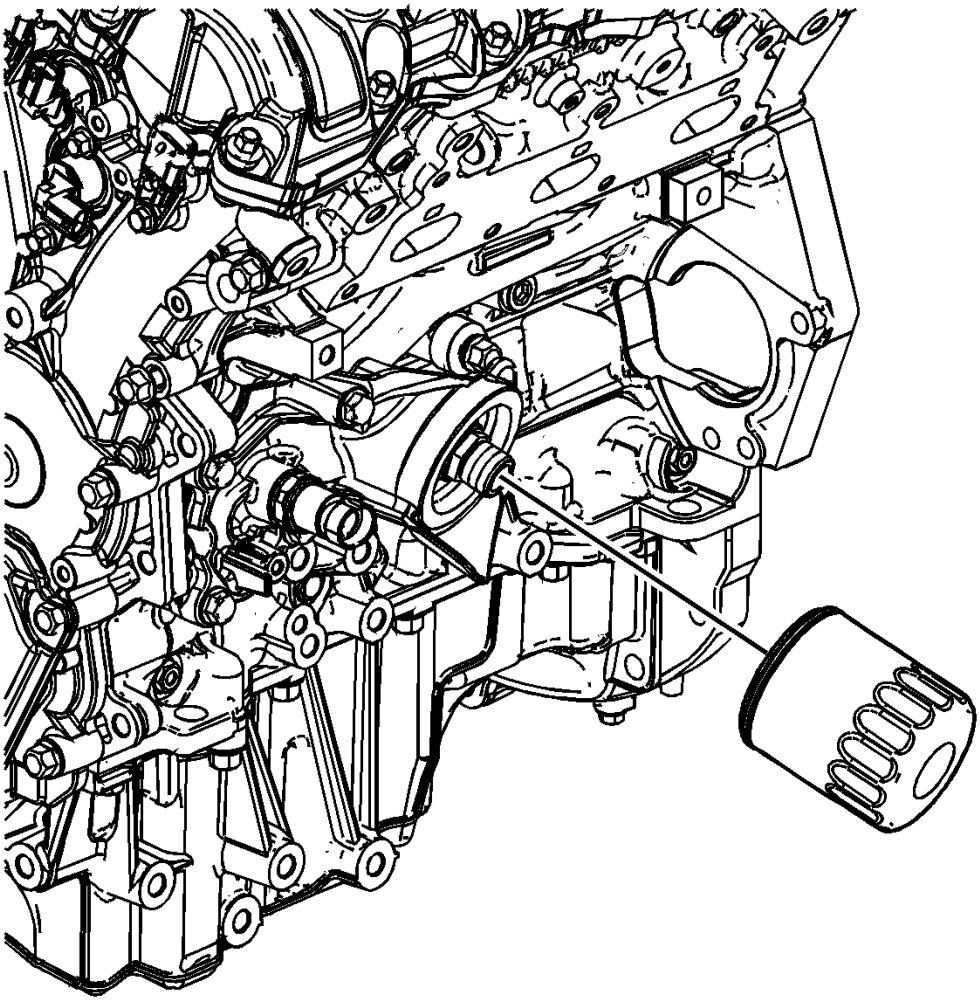

Fig. 612: Identifying Oil Filter
Courtesy of GENERAL MOTORS COMPANY

4. Install a NEW oil filter and tighten 3/4 to 1 full turn after gasket makes contact with the sealing surface on the filter mounting flange.

OIL LEVEL INDICATOR AND TUBE INSTALLATION (LF1, LFW OR LFX)

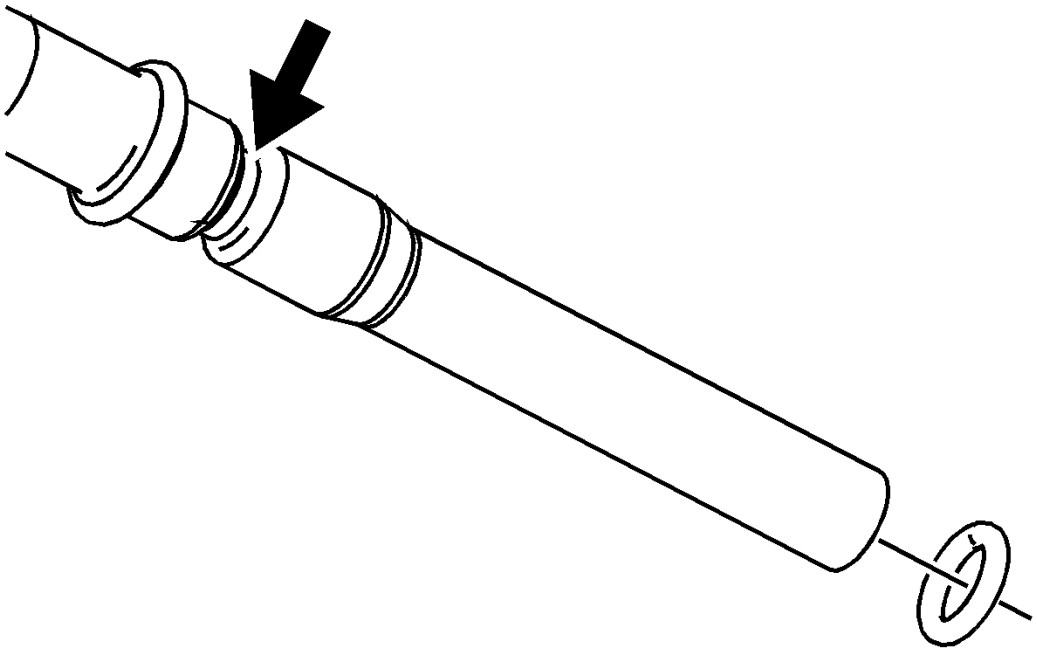

Fig. 613: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW O-ring on the oil level indicator tube.

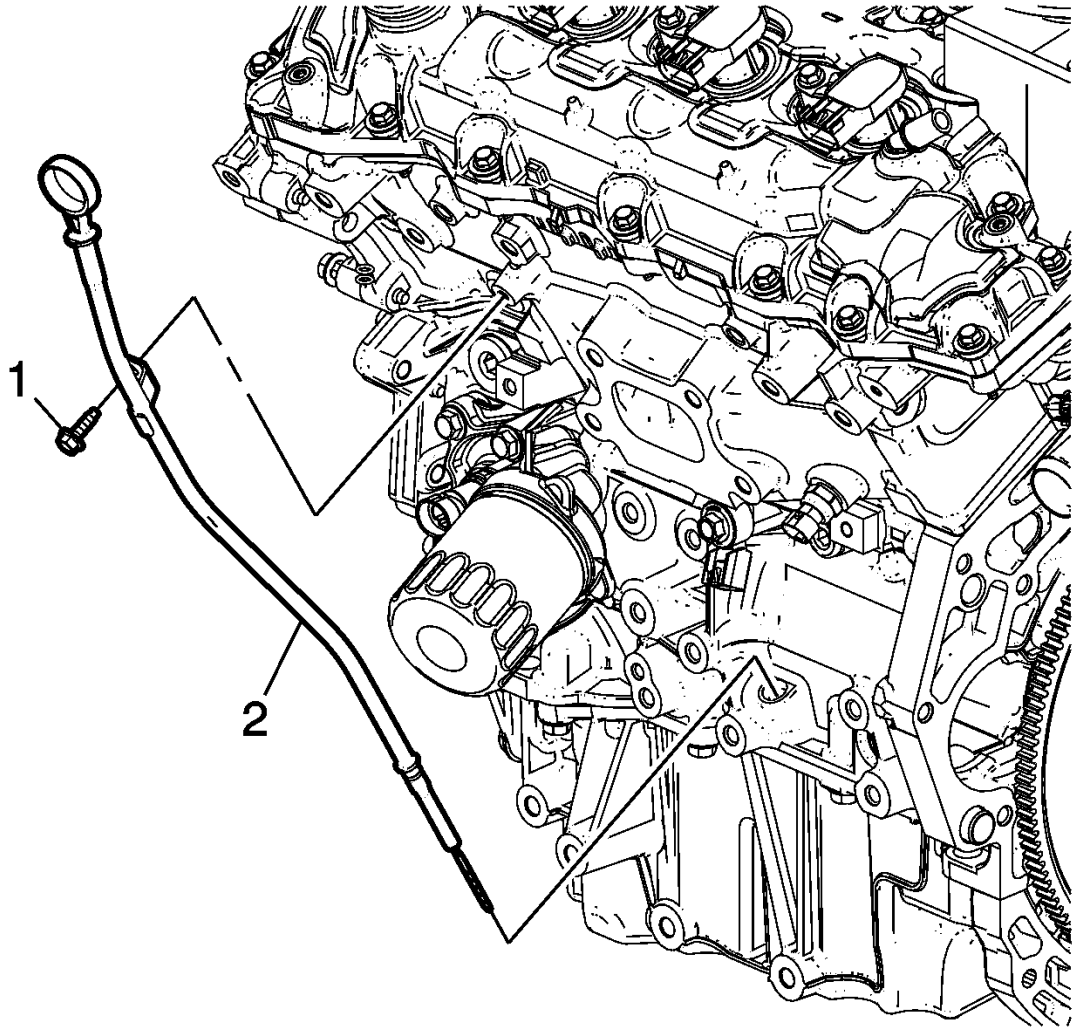

Fig. 614: Oil Level Indicator Tube Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil level indicator and tube (2) by sliding the tube down through the lower crankcase hole.

CAUTION: Refer to Fastener Caution .

3. Install the oil level indicator tube bracket bolt (1) and tighten to 10 N.m (89 lb in).

ENGINE COOLANT THERMOSTAT HOUSING INSTALLATION

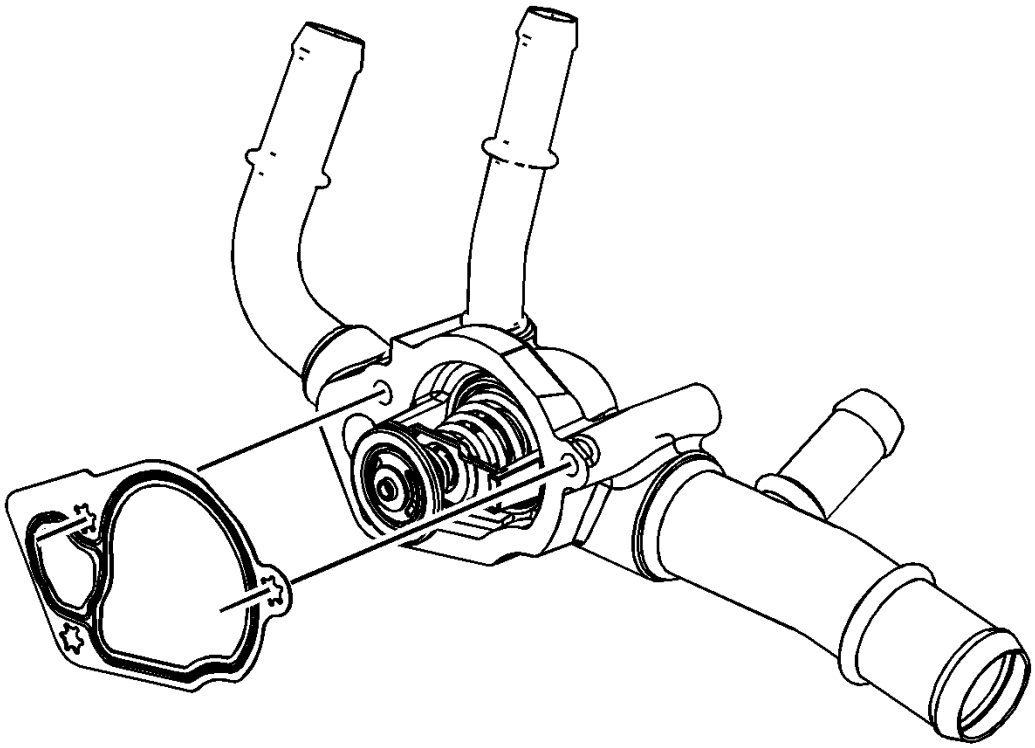

Fig. 615: Identifying Thermostat Housing Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW gasket onto the thermostat housing.

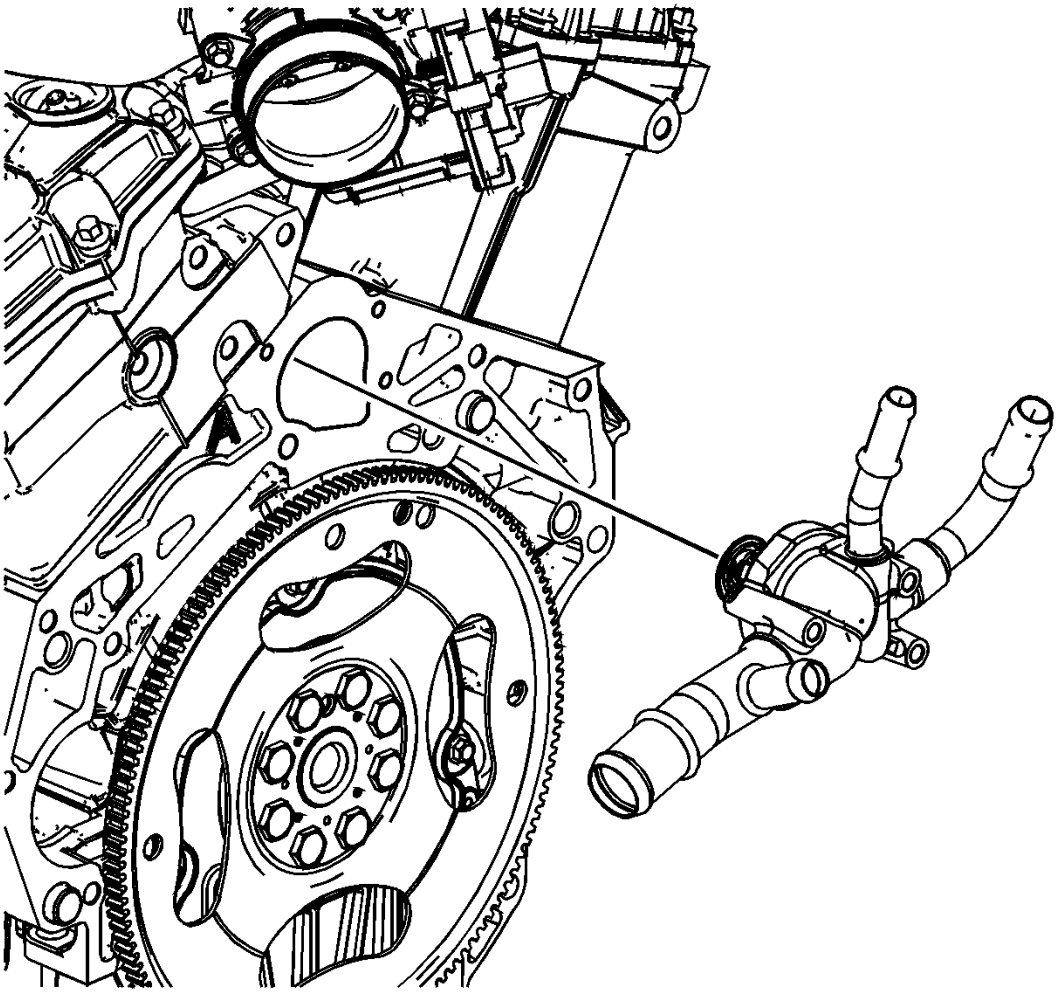

Fig. 616: Identifying Thermostat Housing
Courtesy of GENERAL MOTORS COMPANY

2. Install the thermostat housing.

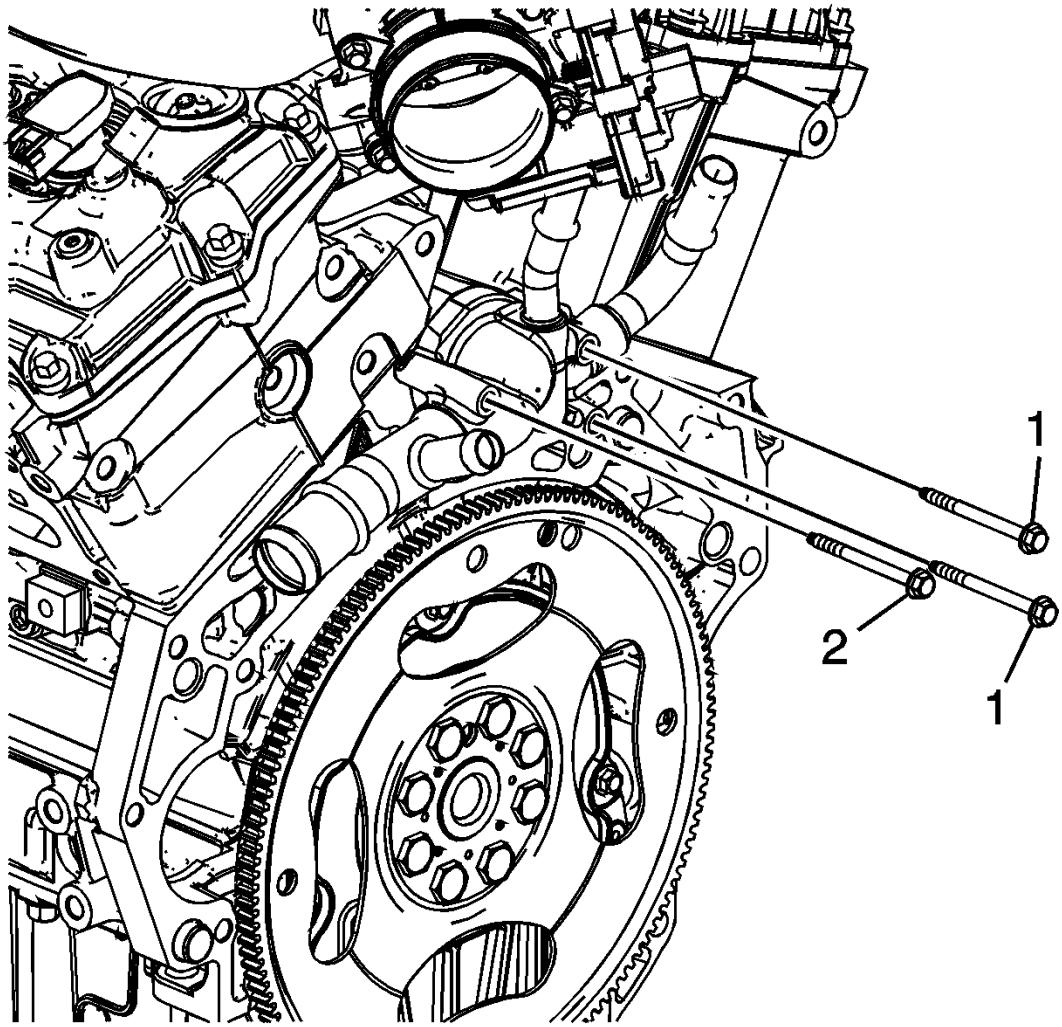

Fig. 617: Identifying Thermostat Housing Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the thermostat housing bolts. Ensure to install the short bolts (1) and the long bolt (2) in the proper position and tighten to 10 N.m (89 lb in).

WATER OUTLET INSTALLATION

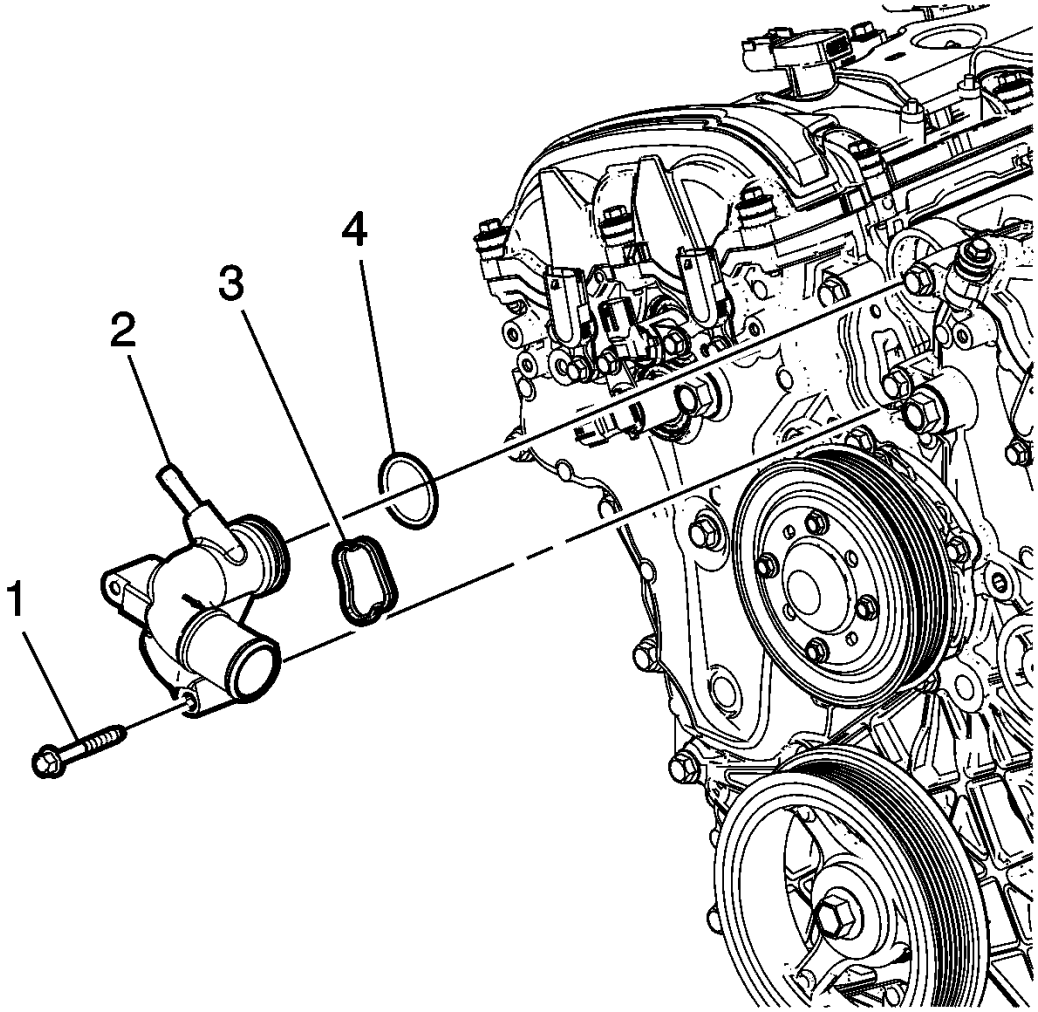

Fig. 618: Water Outlet, Seals And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW water outlet seals (3) and (4).
2. Install the water outlet (2).

CAUTION: Refer to Fastener Caution .

3. Install the water outlet bolts (1) and tighten to 10 N.m (89 lb in).

DRIVE BELT TENSIONER INSTALLATION

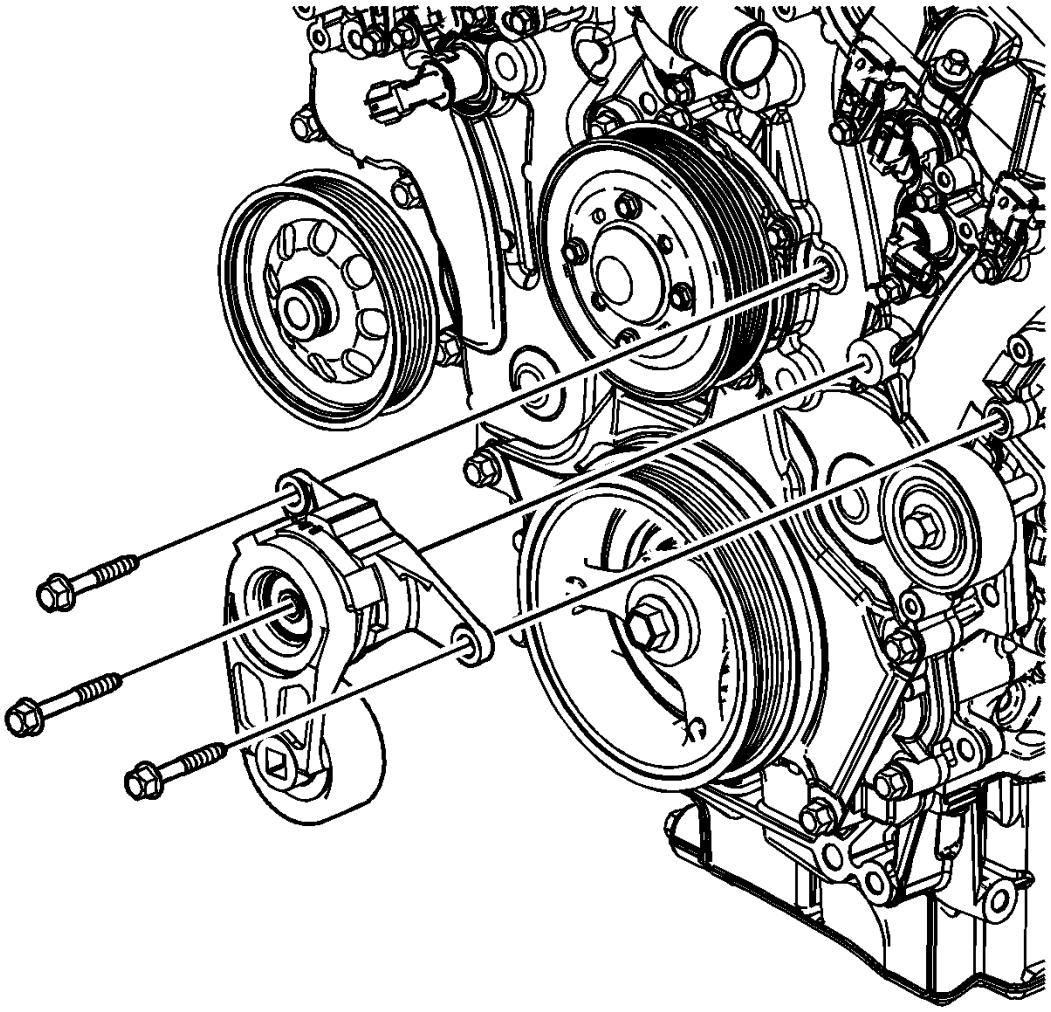

Fig. 619: Locating Drive Belt Tensioner Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Place the left drive belt tensioner assembly in position to the engine front cover.

CAUTION: Refer to Fastener Caution .

2. Install the left drive belt tensioner bracket bolts and tighten to 25 N.m (18 lb ft).

ENGINE PRELUBING

NOTE: This procedure is not used in Europe.

Special Tools

- **EN 21867-6** Oil Pressure Adapter Fitting
- **EN 45299** Engine Preluber

For equivalent regional tools, refer to **Special Tools**

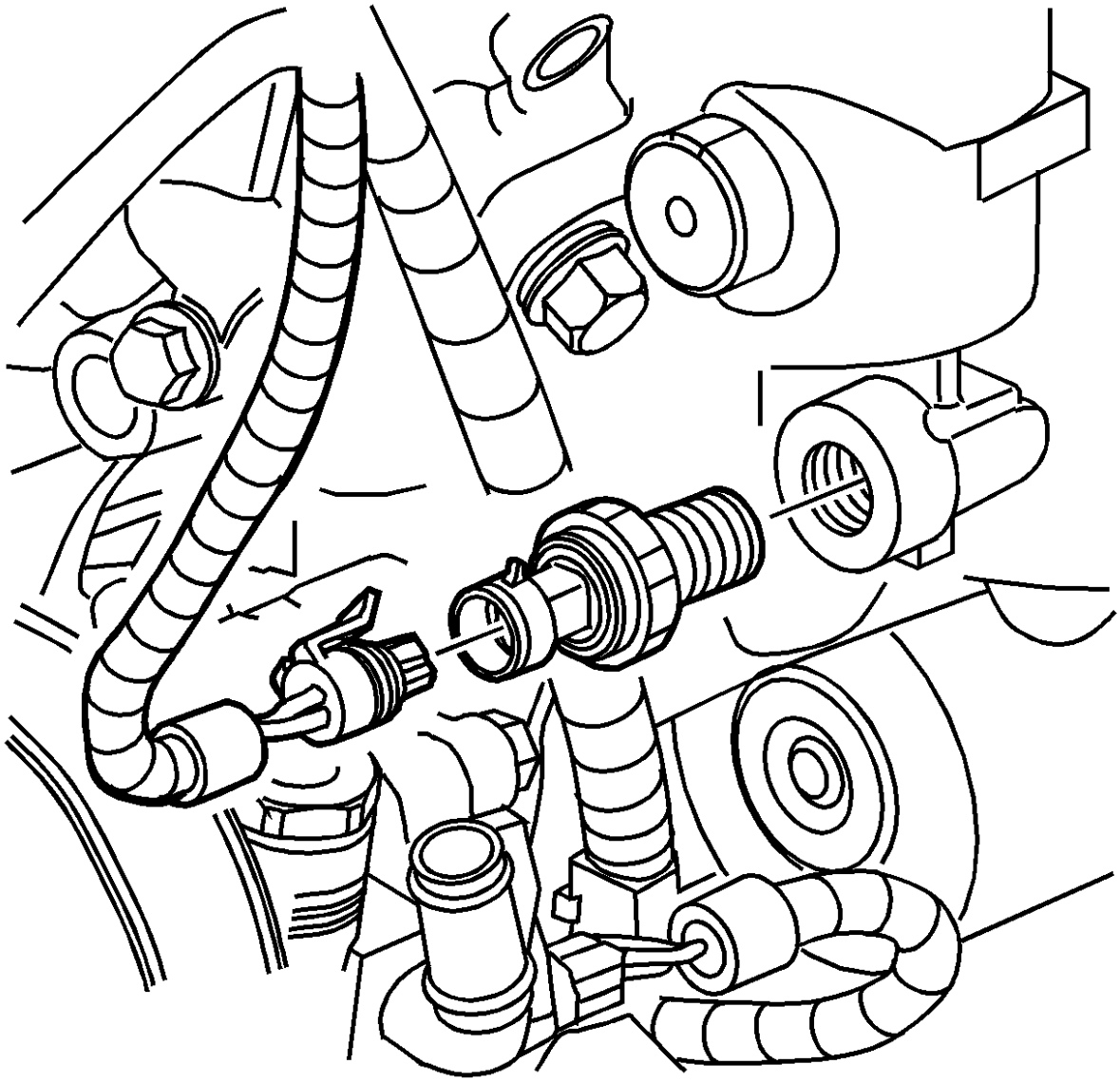

Fig. 620: View Of Oil Pressure Sending Unit
Courtesy of GENERAL MOTORS COMPANY

NOTE: **A constant and continuous flow of clean engine oil is required in order to properly prime the engine. Be sure to use an approved engine oil as specified in the owners manual.**

1. Remove the oil filter cap.
2. Install the NEW oil filter cartridge.
3. Lubricate the threads of the oil filter cap with clean engine oil.

CAUTION: **Refer to Fastener Caution .**

4. Install the oil filter cap and tighten to 25 N.m (18 lb ft).
5. Remove the oil pressure sending unit from the oil filter adapter.
6. Install the **EN 21867-6** fitting.

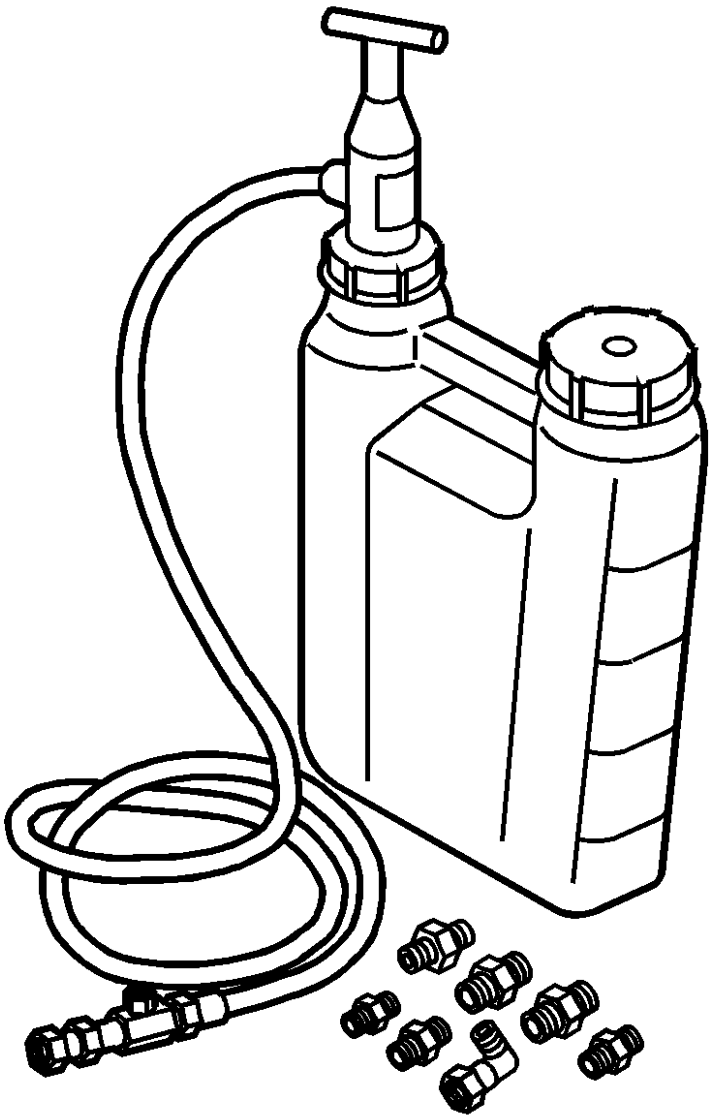

Fig. 621: Preluber Flexible Hose
Courtesy of GENERAL MOTORS COMPANY

7. Install the flexible hose to the adapter and open the valve.
8. Pump the handle on the **EN 45299** preluber in order to flow a minimum of 1-1.9 liters (1-2 quarts) of engine oil. Observe the flow of engine oil through the flexible hose and into the engine assembly.
9. Close the valve and remove the flexible hose and adapter from the engine.
10. Install the oil pressure sending unit and tighten to 20 N.m (15 lb ft).
11. Top-off the engine oil to the proper level.

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REPAIR INSTRUCTIONS - ON VEHICLE

DRIVE BELT REPLACEMENT

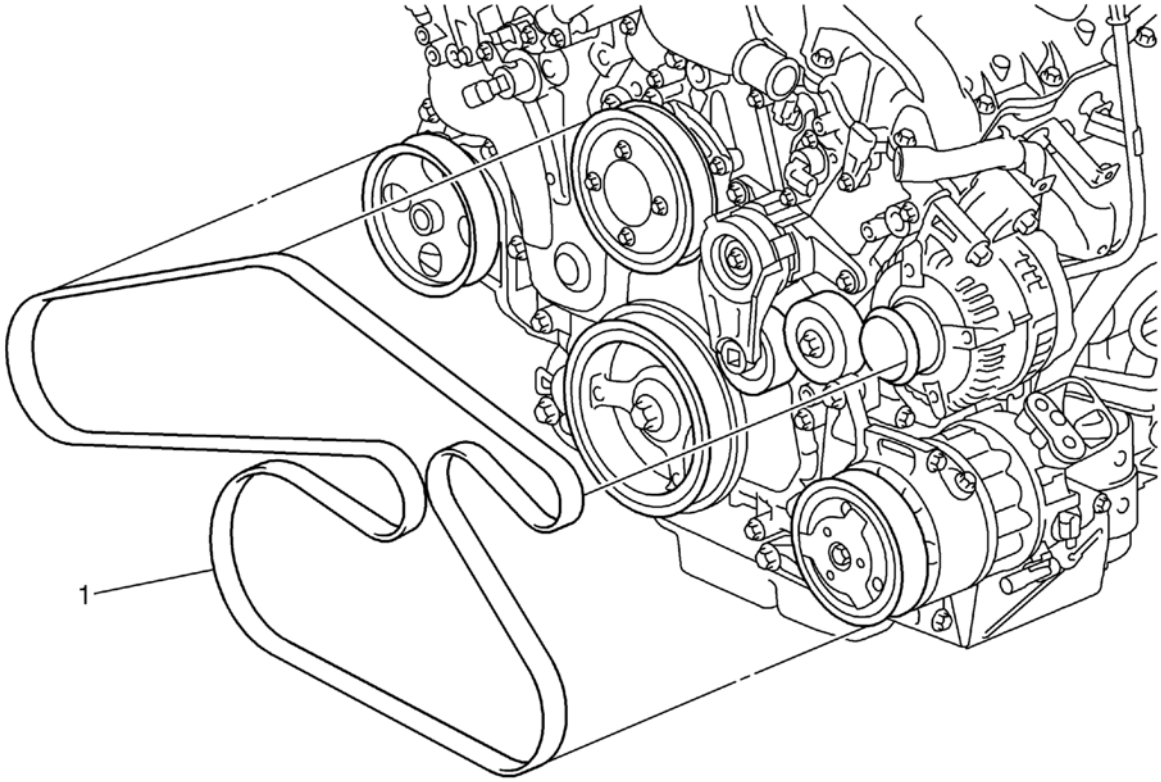

Fig. 1: Drive Belt Routing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Remove the right side engine splash shield. Refer to **Engine Splash Shield Replacement (Right)** **Engine Splash Shield Replacement (Left)** .	
1	Drive Belt **Procedure** 1. Rotate the drive belt tensioner clockwise to release the drive belt tension. 2. Slide the drive belt off of the belt idler pulley. 3. Slowly release the drive belt tensioner.

DRIVE BELT TENSIONER REPLACEMENT

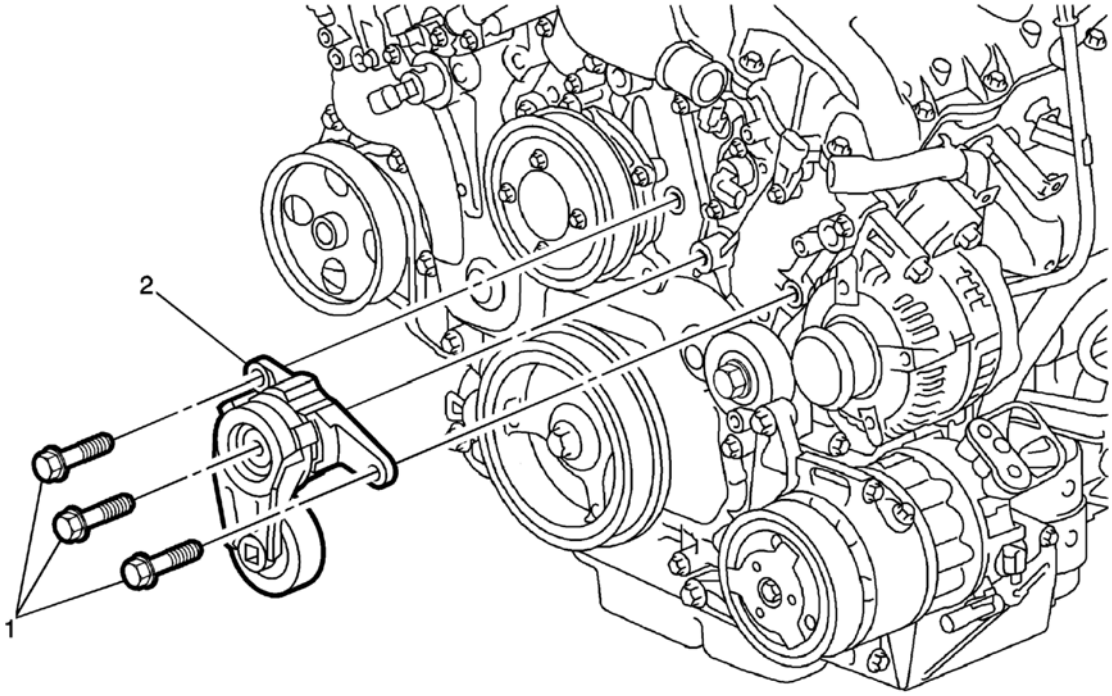

Fig. 2: Drive Belt Tensioner
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the drive belt. Refer to **Drive Belt Replacement**. 2. Remove the drive belt idler. Refer to **Drive Belt Idler Pulley Replacement**	
1	Drive Belt Tensioner Fastener (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (19 lb ft)
2	Drive Belt Tensioner

DRIVE BELT IDLER PULLEY REPLACEMENT

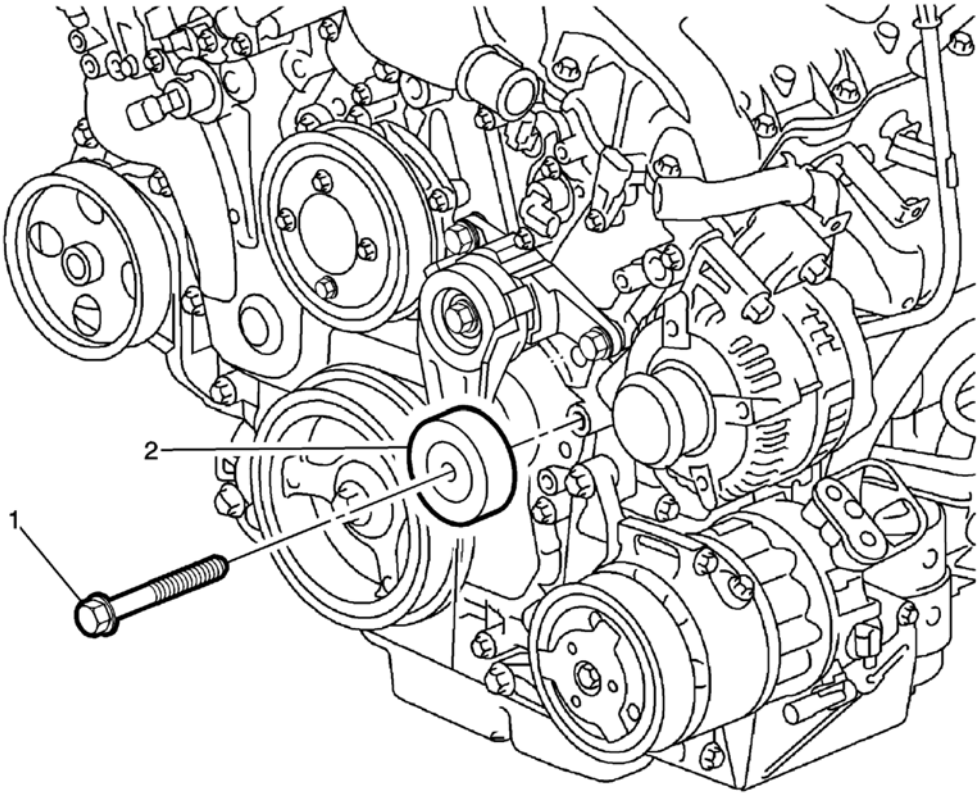

Fig. 3: Drive Belt Idler Pulley
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the drive belt. Refer to **Drive Belt Replacement**.	
1	Drive Belt Idler Pulley Fastener **CAUTION:** **Refer to Fastener Caution .** **Tighten** 58 N.m (43 lb ft)
2	Drive Belt Idler Pulley

ENGINE SUPPORT FIXTURE

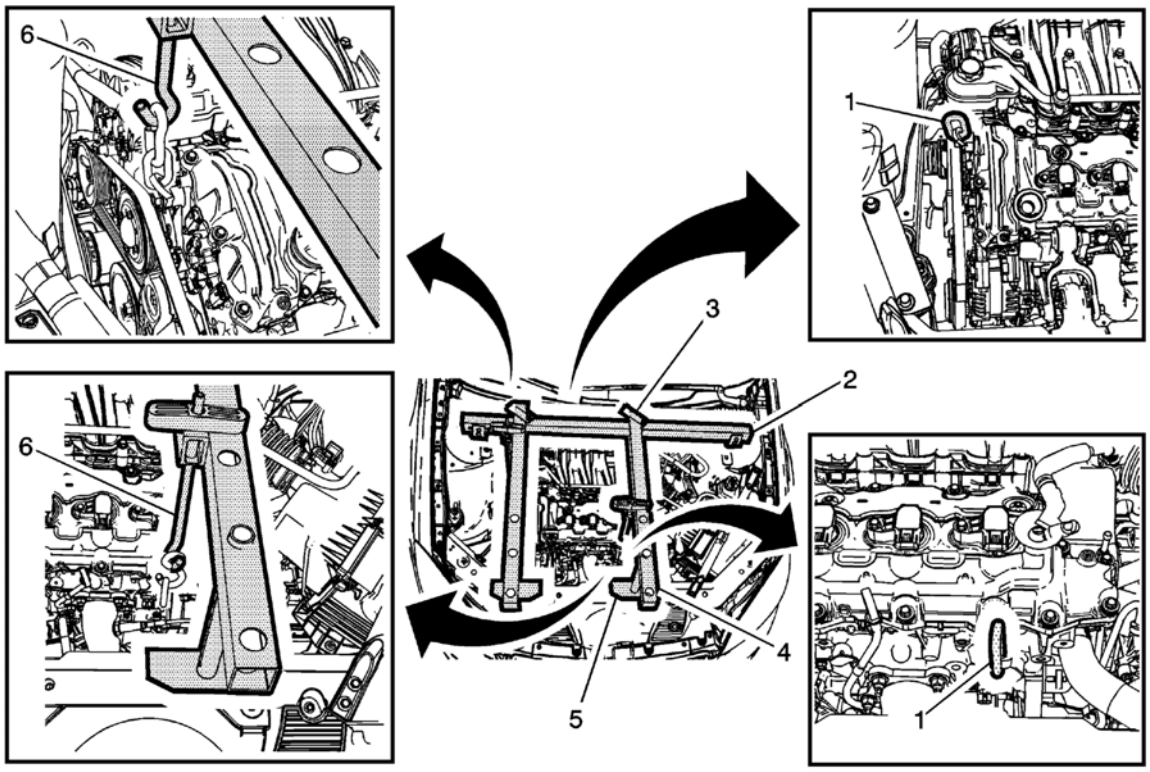

Fig. 4: Engine Support Fixture Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**. 2. Remove the front fender upper diagonal brace. Refer to **Front Fender Upper Diagonal Brace Replacement** . 3. Remove the water outlet. Refer to **Water Outlet Replacement** . **Special Tools** • **J-284678-B** Main Support Beam • **J-28467-23A** Cross Bracket • **J-28467-14A** Radiator Tube Shelf Assembly • **J-36857** Engine Lift Bracket • **J-28467-8A** Hook Assembly For equivalent regional tools, refer to **Special Tools** .	
1	Engine Lift Bracket (Qty: 2) **Procedure** If the engine is not equipped with engine lift bracket, install **J-36857** lift bracket in place.
2	Main Support Beam
3	Cross Bracket (Qty: 2)

Callout	Component Name
4	Strut Tower Support Assembly (Qty: 2) **Procedure** Adjust the length of the strut tower support assembly.
5	Radiator Tube Shelf Assembly (Qty: 2)
6	Hook Assembly (Qty: 2)

ENGINE MOUNT INSPECTION

NOTE: **Before replacing any engine mount due to suspected fluid loss, verify that the source of the fluid is the engine mount, not the engine or accessories.**

1. Install the engine support fixture. Refer to **Engine Support Fixture**.
2. Observe the engine mount while raising the engine. Raising the engine removes the weight from the engine mount and creates slight tension on the rubber.
3. Replace the engine mount if the engine mount exhibits any of the following conditions:
   - The hard rubber is covered with heat check cracks.
   - The rubber is separated from the metal plate of the engine mount.
   - The rubber is split through the center of the engine mount.
   - The engine mount itself is leaking fluid.
4. For engine mount replacement. Refer to **Engine Front Mount Replacement**, or **Engine Rear Mount Replacement**.

ENGINE FRONT MOUNT REPLACEMENT

Removal Procedure

1. Install the engine support fixture. Refer to **Engine Support Fixture**.
2. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging** .

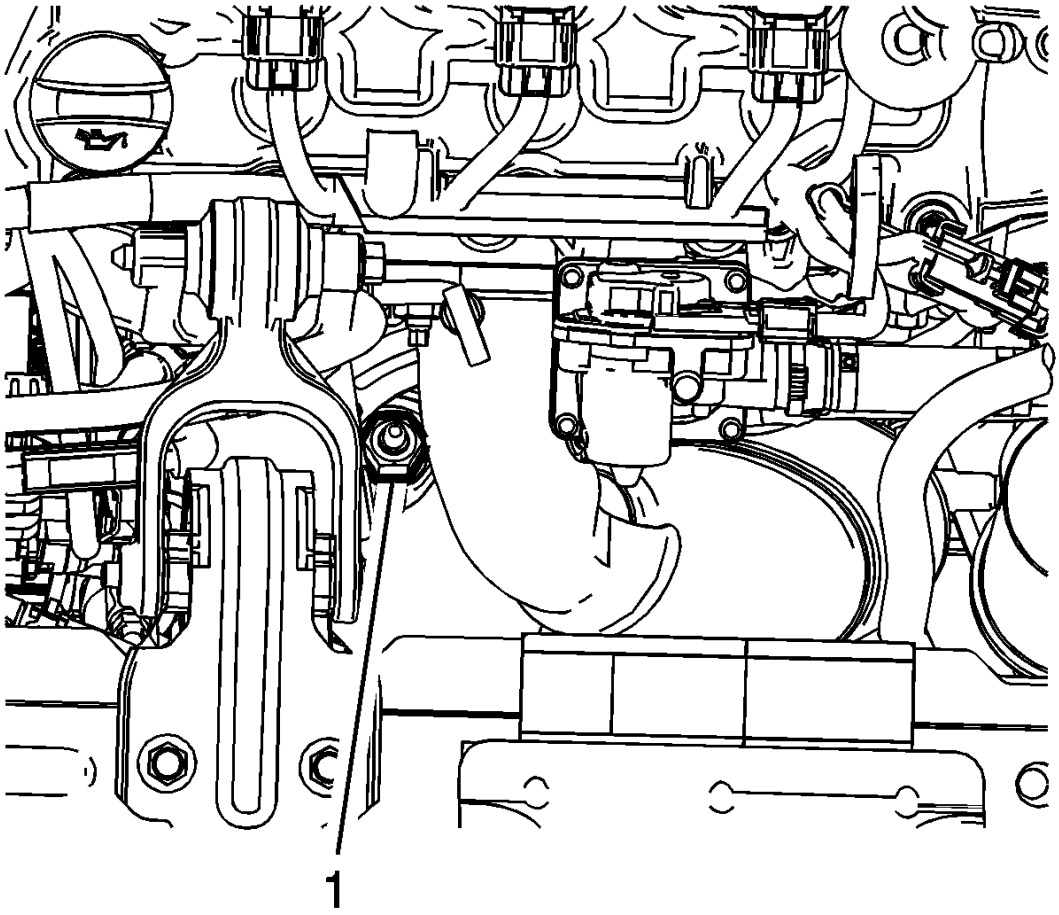

Fig. 5: Upper Engine Mount Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Remove the upper engine mount fastener (1).

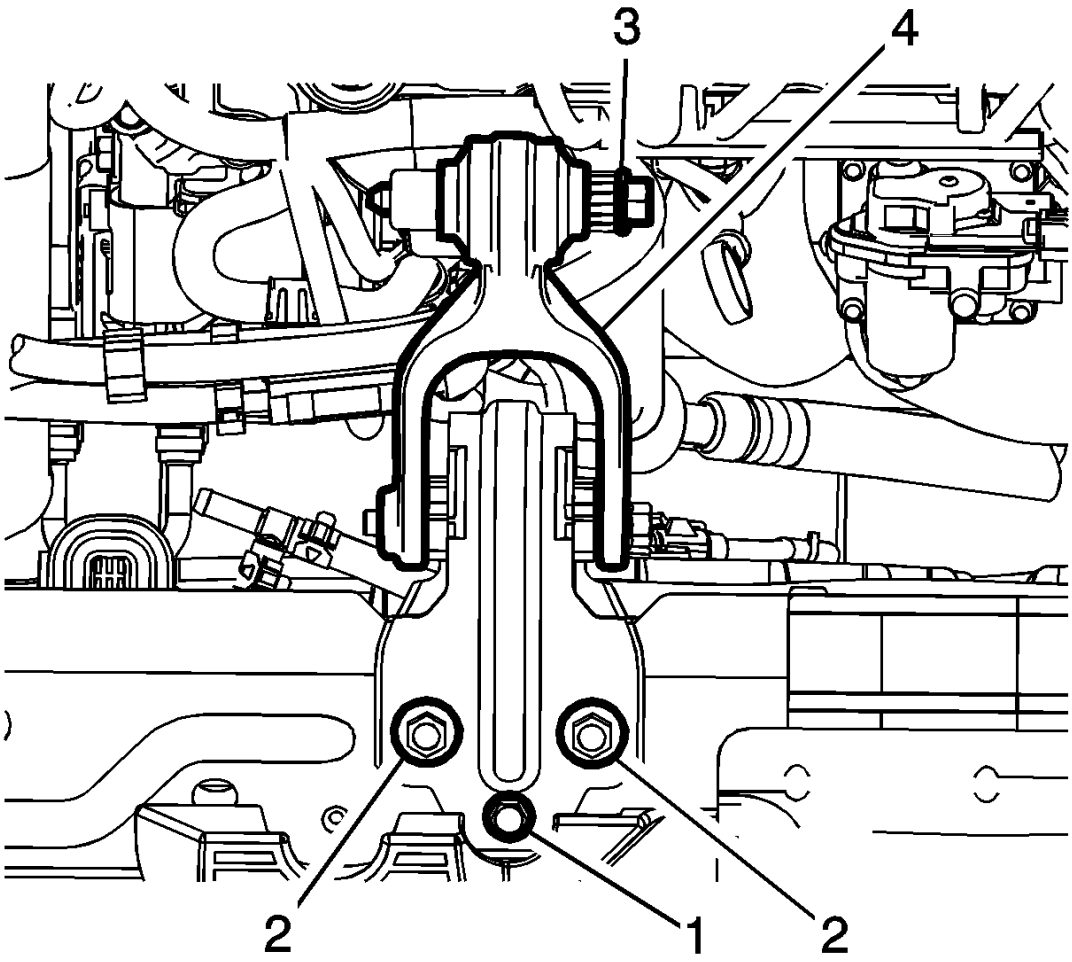

Fig. 6: Engine Strut And Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine strut fastener (3).
5. Raise and support the vehicle
6. Remove the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .

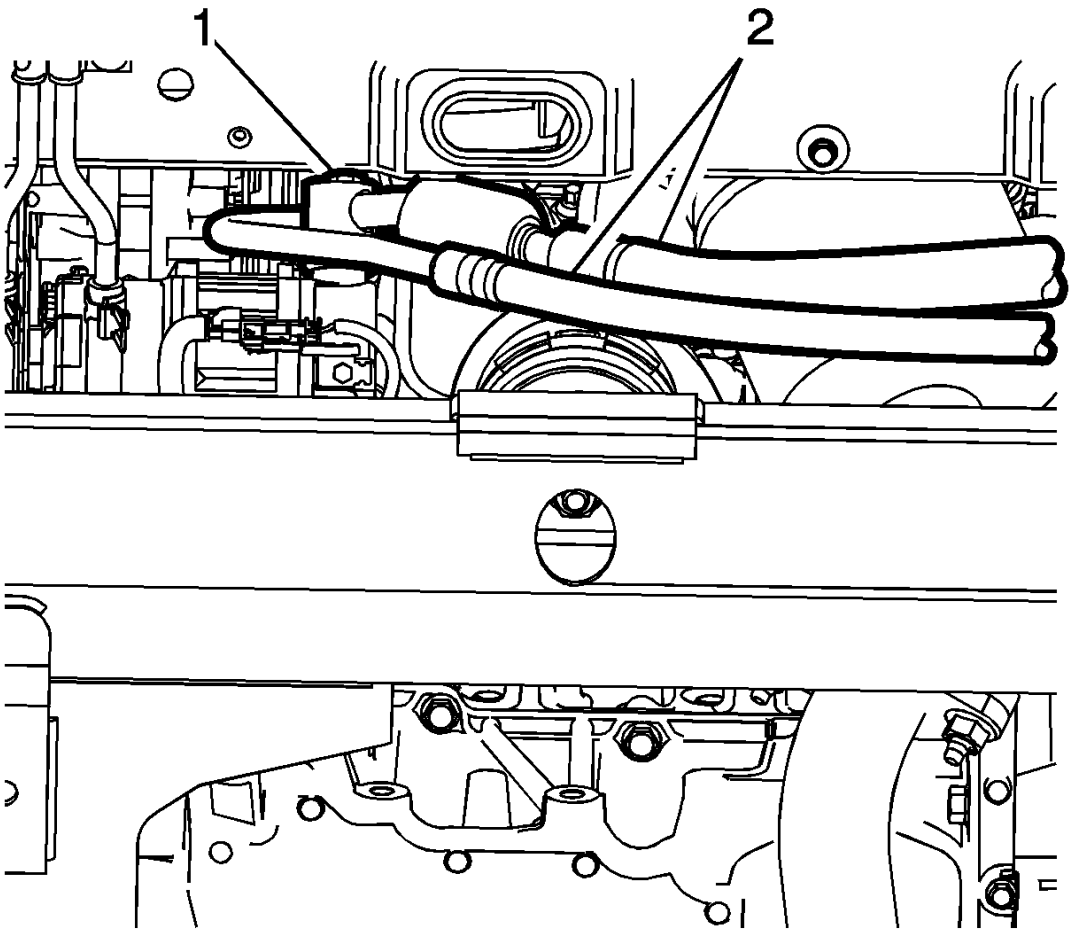

Fig. 7: Air Conditioning Line And Air Conditioning Compressor Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Remove the air conditioning line (2) to air conditioning compressor fastener (1).
8. Position air conditioning line out of the way.

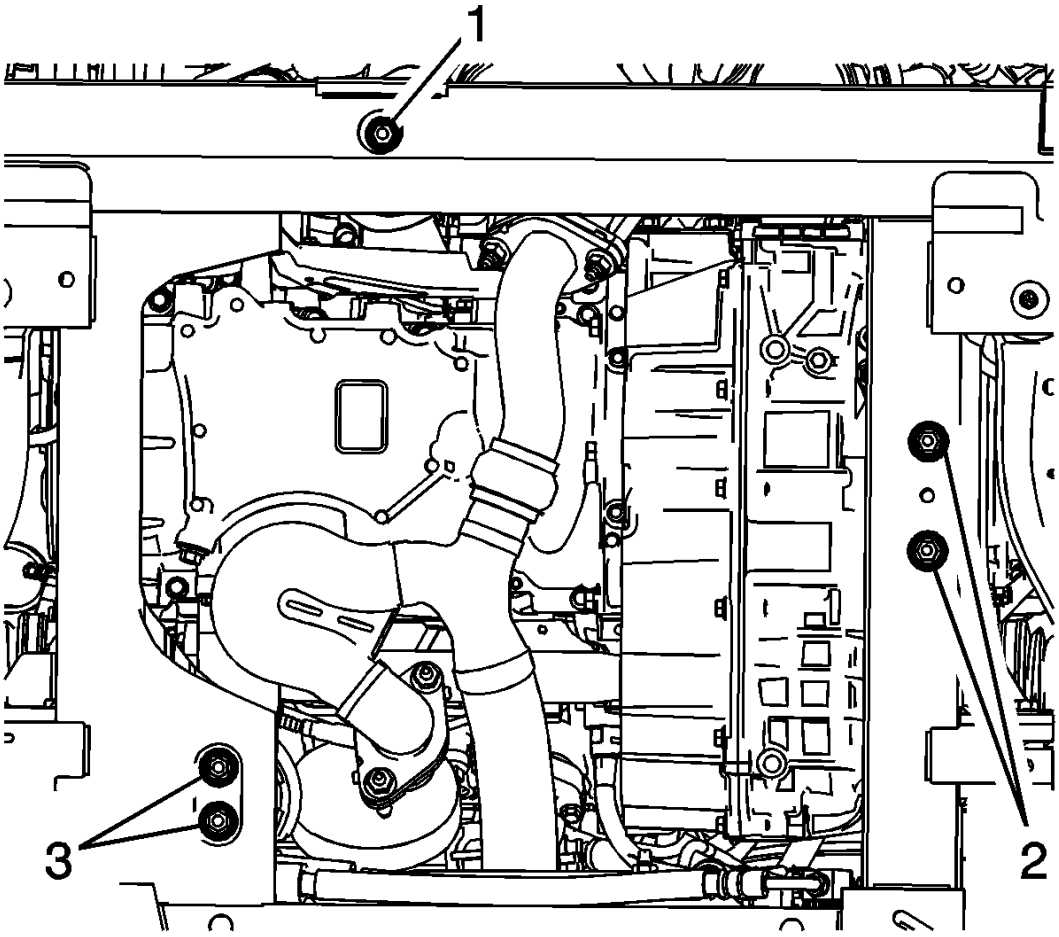

Fig. 8: Engine Mount Fasteners
Courtesy of GENERAL MOTORS COMPANY

9. Remove the front engine mount to sub frame fastener (1).
10. Remove the rear engine mount to frame fasteners (3).
11. Loosen the transmission mount fasteners (2).
12. Lower the vehicle.
13. Using the engine support fixture, carefully raise the engine enough to clear the upper front engine mount bracket.

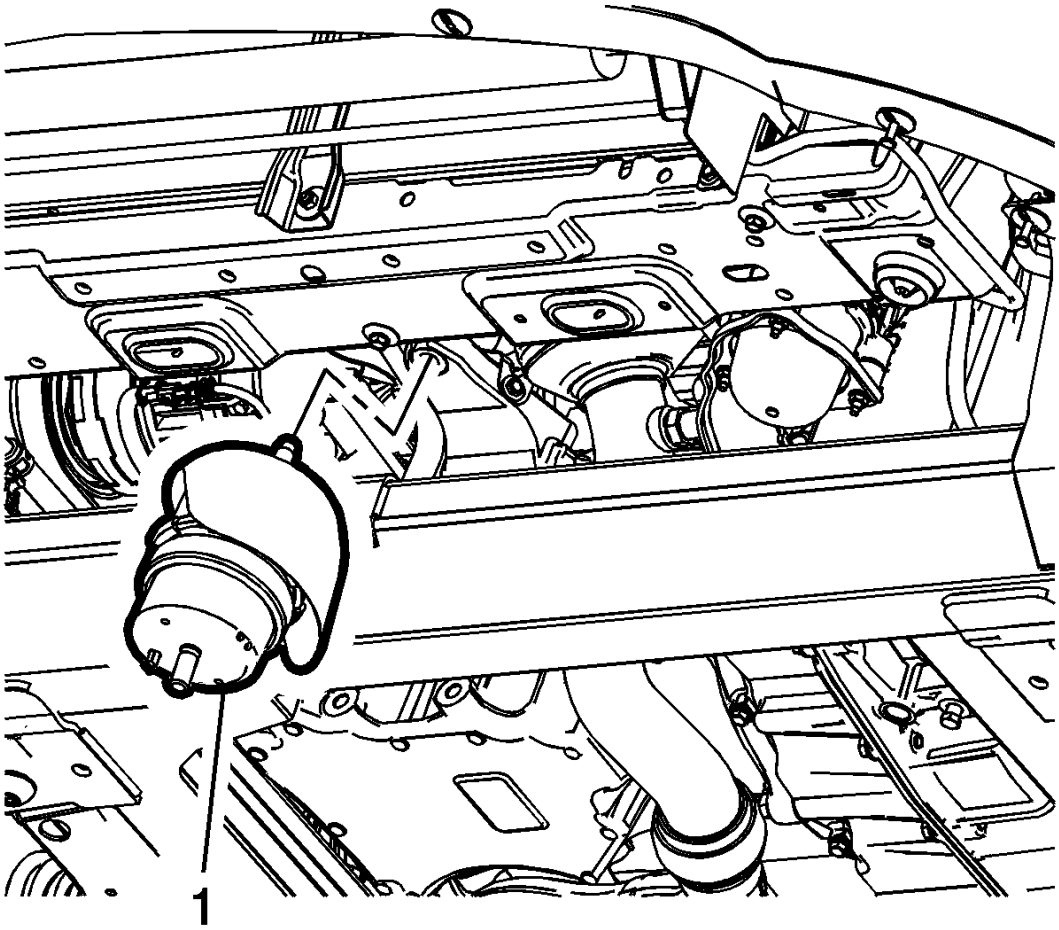

Fig. 9: Front Engine Mount
Courtesy of GENERAL MOTORS COMPANY

14. Remove the front engine mount (1).

Installation Procedure

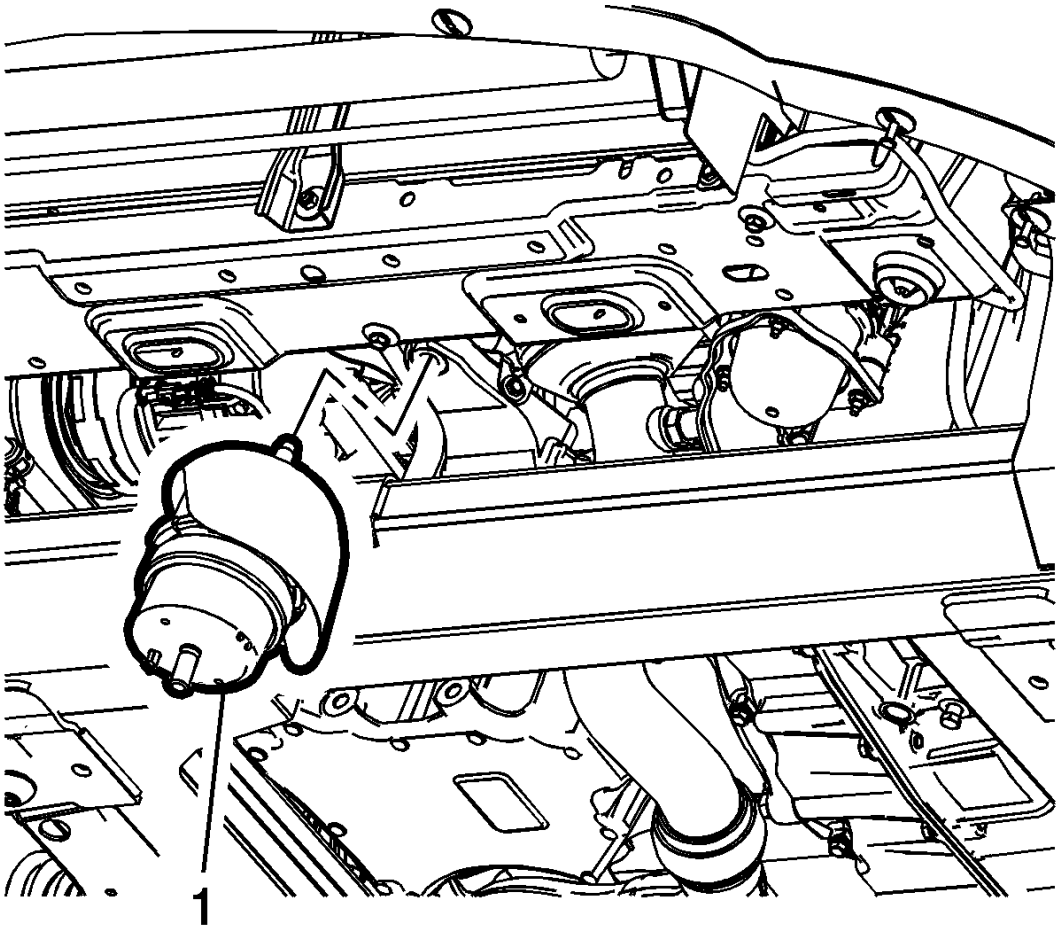

Fig. 10: Front Engine Mount
Courtesy of GENERAL MOTORS COMPANY

1. Install the front engine mount (1).
2. Using the engine support fixture, carefully lower the engine onto the front mount and ensure the rear engine mount aligns with the sub frame holes.
3. Raise the vehicle.

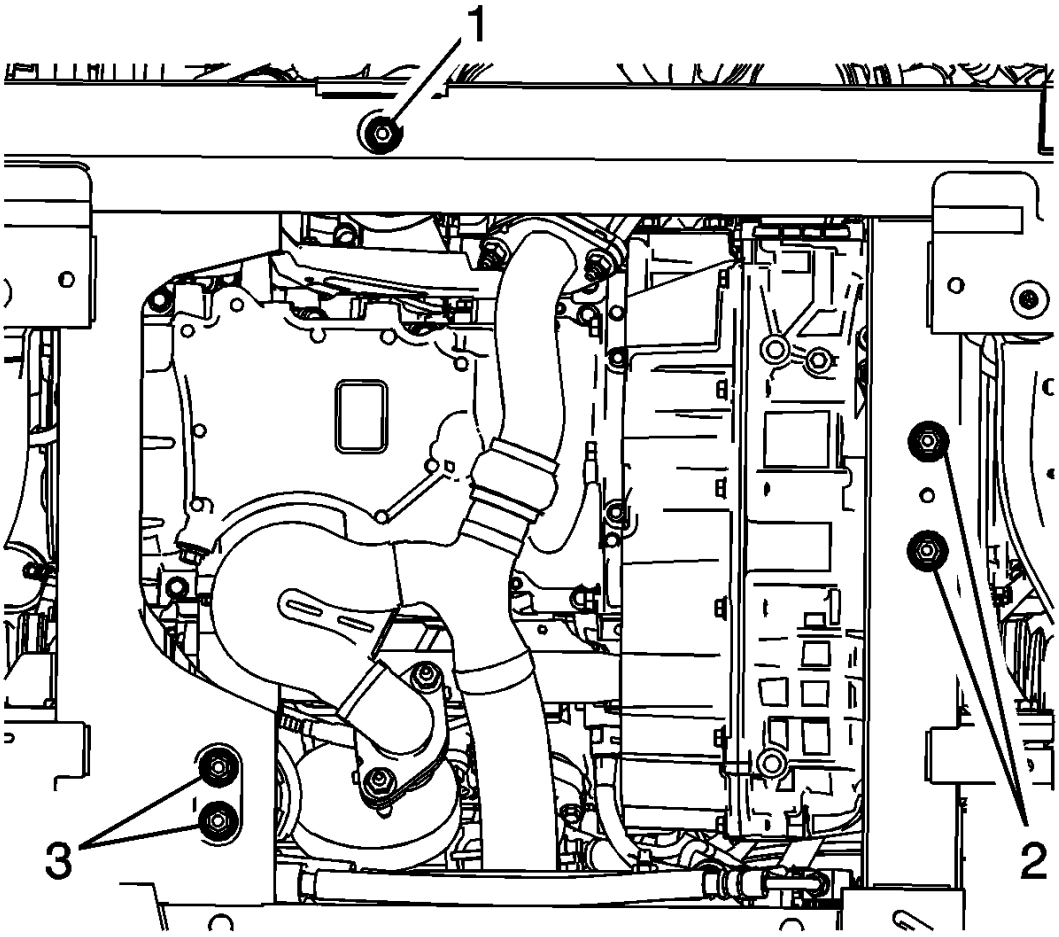

Fig. 11: Engine Mount Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the front engine mount to sub frame fastener (1) and tighten to 80 N.m (59 lb ft).
5. Install the rear engine mount to frame fasteners (3) and tighten to 52 N.m (38 lb ft).
6. Tighten the transmission mount fasteners (2) to 52 N.m (38 lb ft).

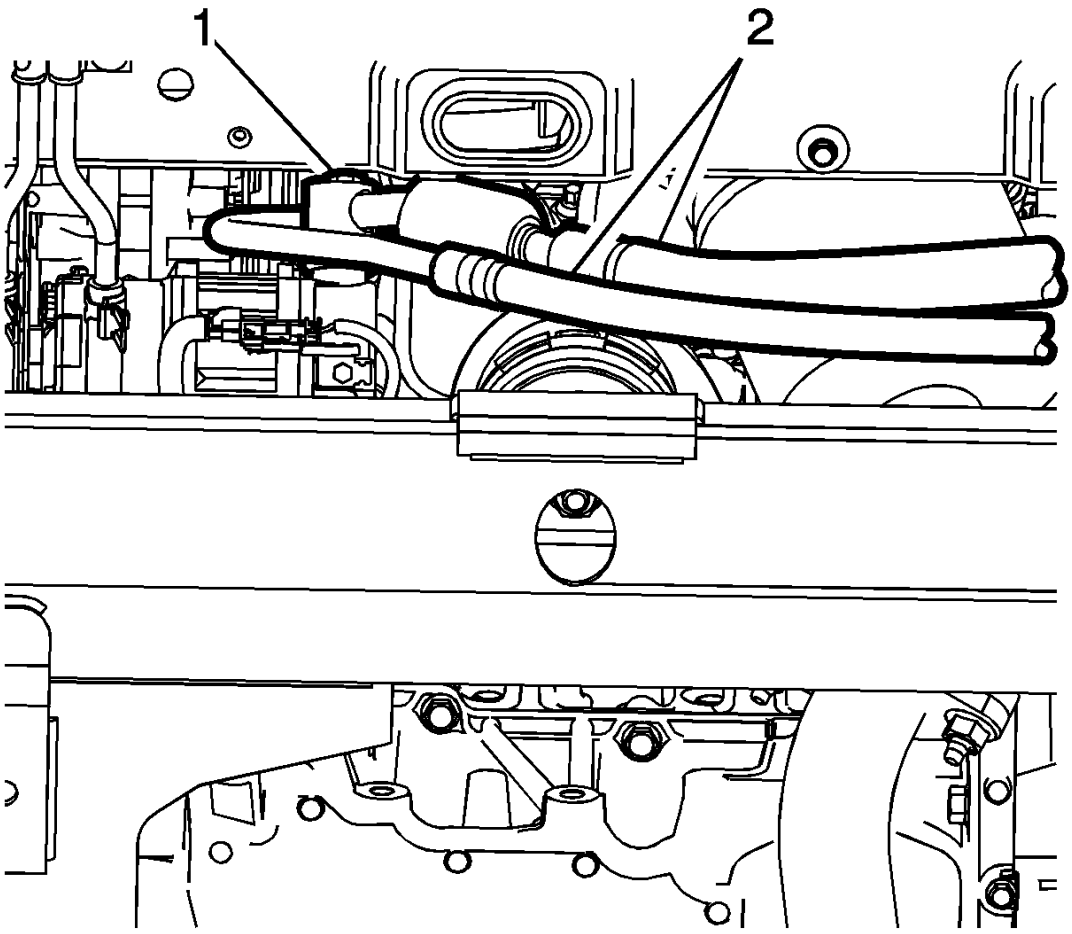

Fig. 12: Air Conditioning Line And Air Conditioning Compressor Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Position the air conditioning line (2) to air conditioning compressor and install the fastener (1).
8. Tighten the air conditioning line fastener to 17 N.m (12.5 lb ft).
9. Install the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
10. Lower the vehicle.

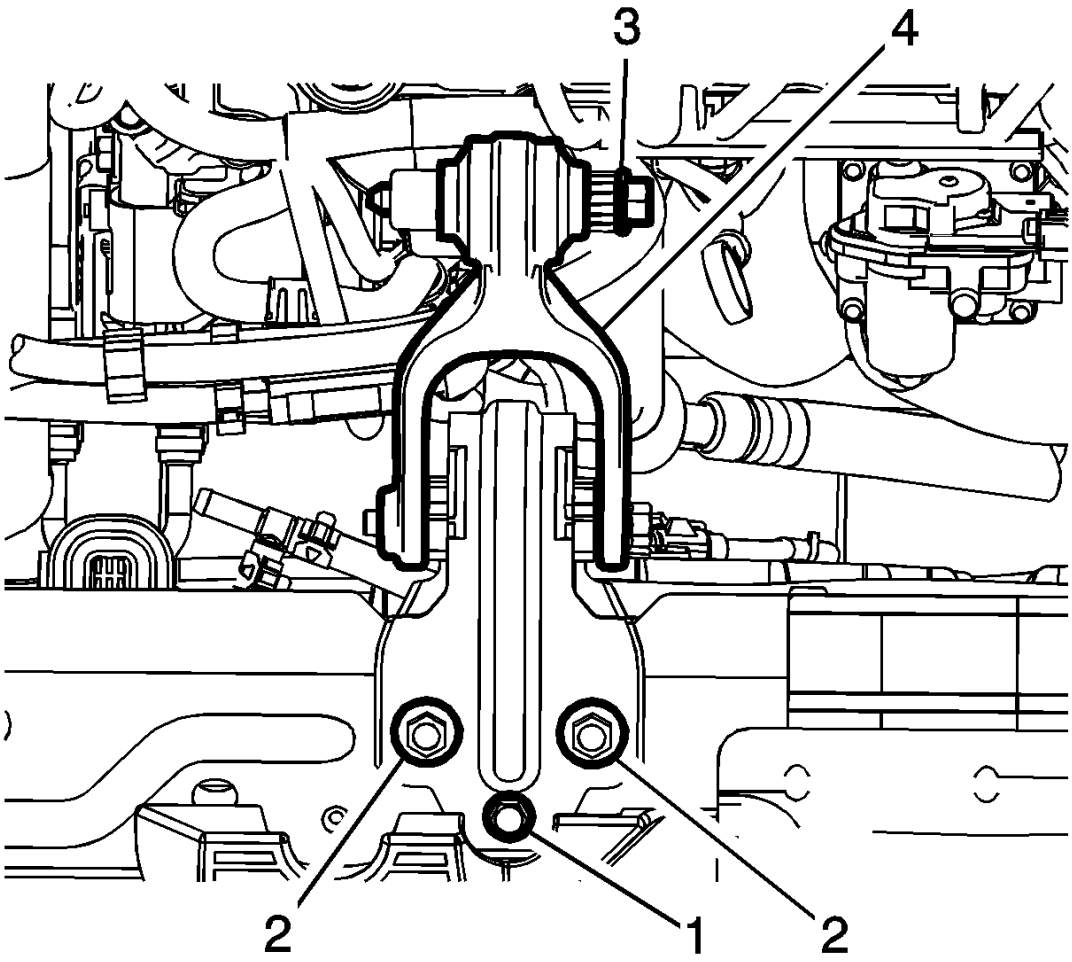

Fig. 13: Engine Strut And Fastener
Courtesy of GENERAL MOTORS COMPANY

11. Install the engine strut fastener (3) and tighten to 48 N.m (35 lb ft).

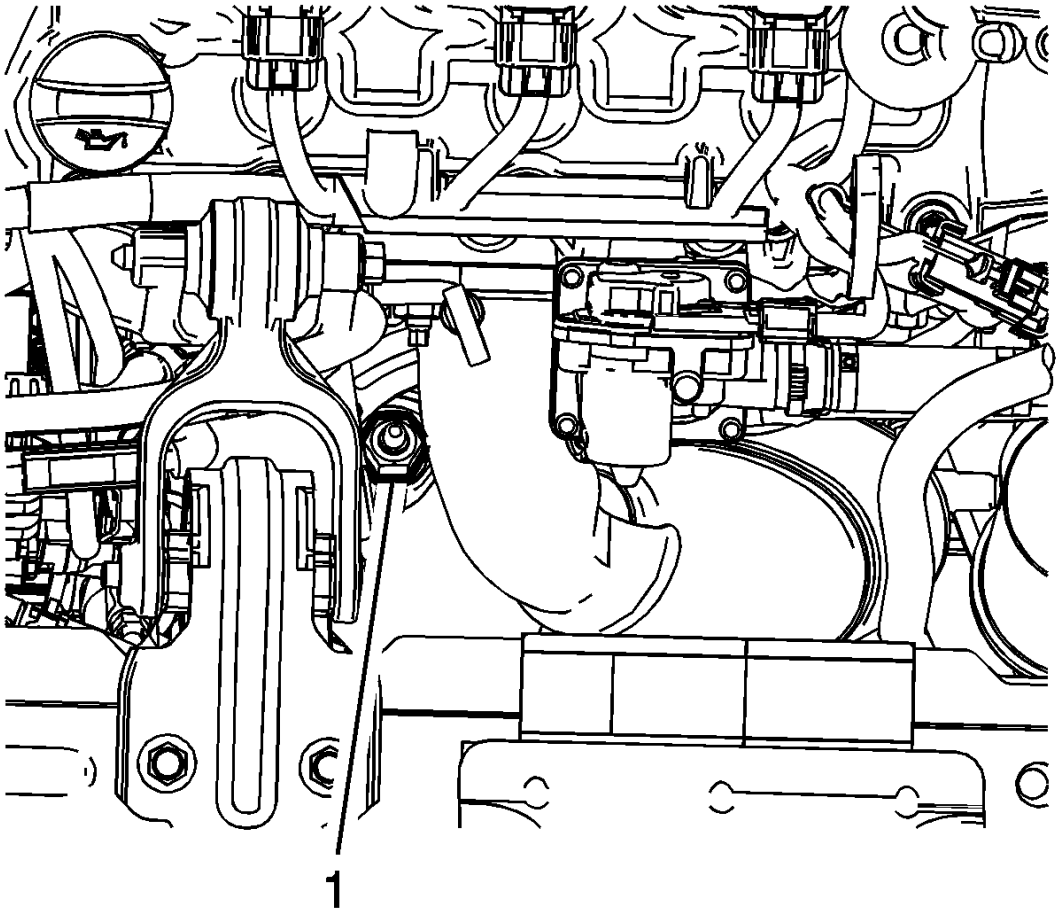

Fig. 14: Upper Engine Mount Fastener
Courtesy of GENERAL MOTORS COMPANY

12. Install the upper engine mount fastener (1) and tighten to 74 N.m (55 lb ft).
13. Evacuate and recharge the air conditioning system. Refer to **Refrigerant Recovery and Recharging** .

ENGINE REAR MOUNT REPLACEMENT

Removal Procedure

1. Install the engine support fixture. Refer to **Engine Support Fixture**.

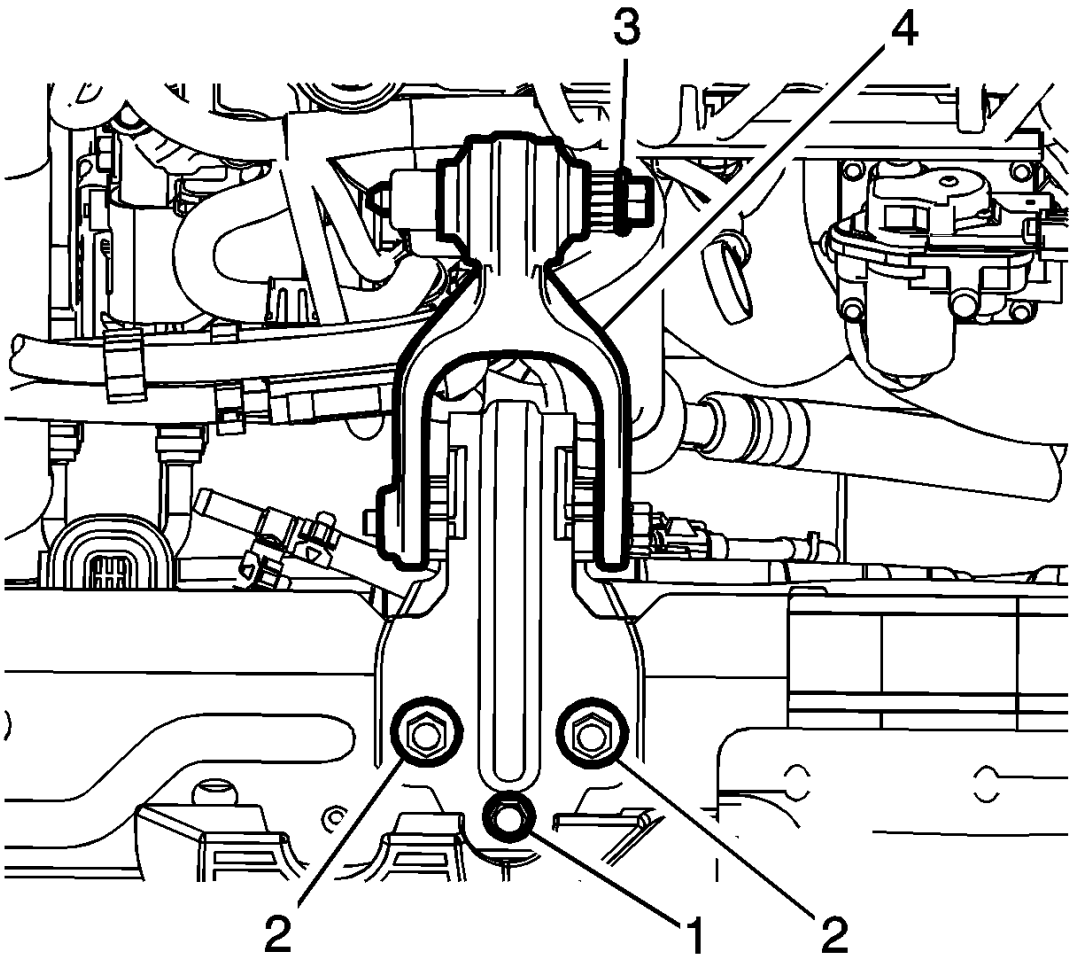

Fig. 15: Engine Strut And Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine strut fastener (3).
3. Raise and support the vehicle.
4. Remove the right side engine splash shield. Refer to **Engine Splash Shield Replacement (Right)** **Engine Splash Shield Replacement (Left)** .
5. Remove the radiator air lower deflector and baffle. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .

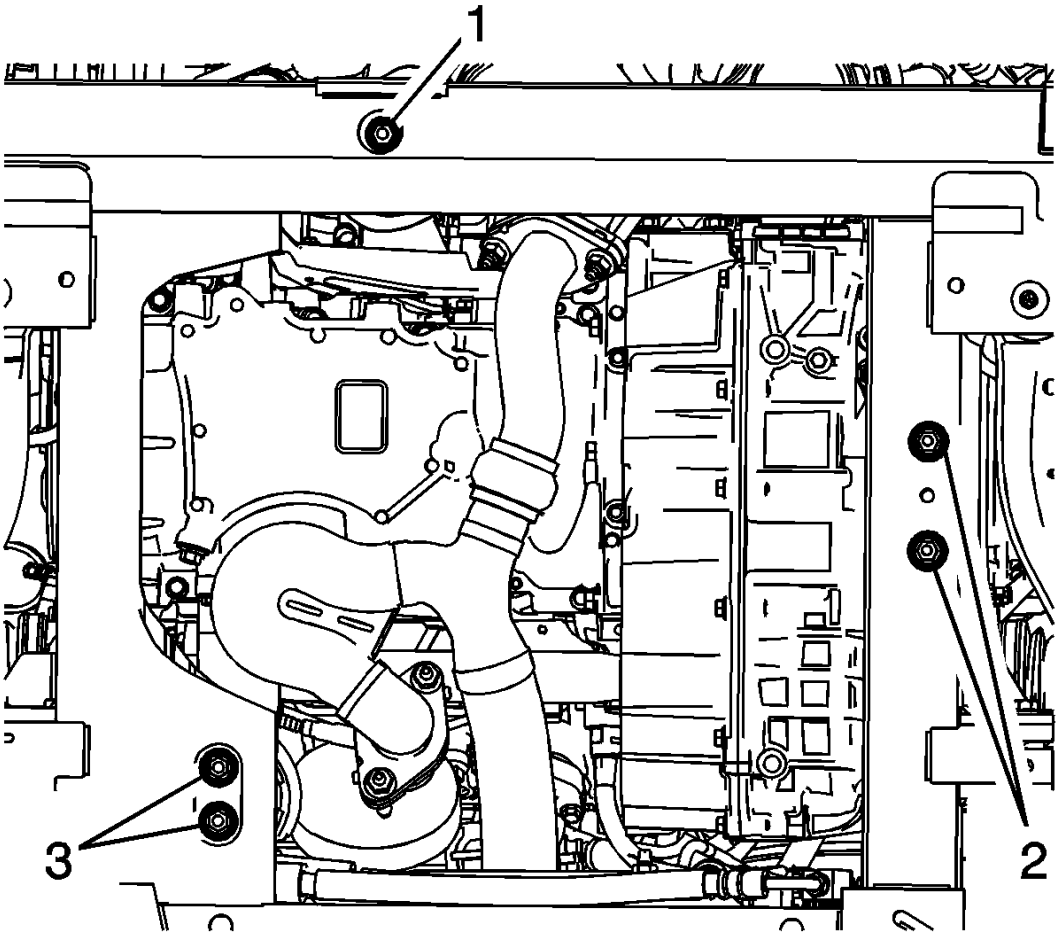

Fig. 16: Engine Mount Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the front engine mount to sub frame fastener (1).
7. Remove the rear engine mount to frame fasteners (3).
8. Loosen the transmission mount fasteners (2).

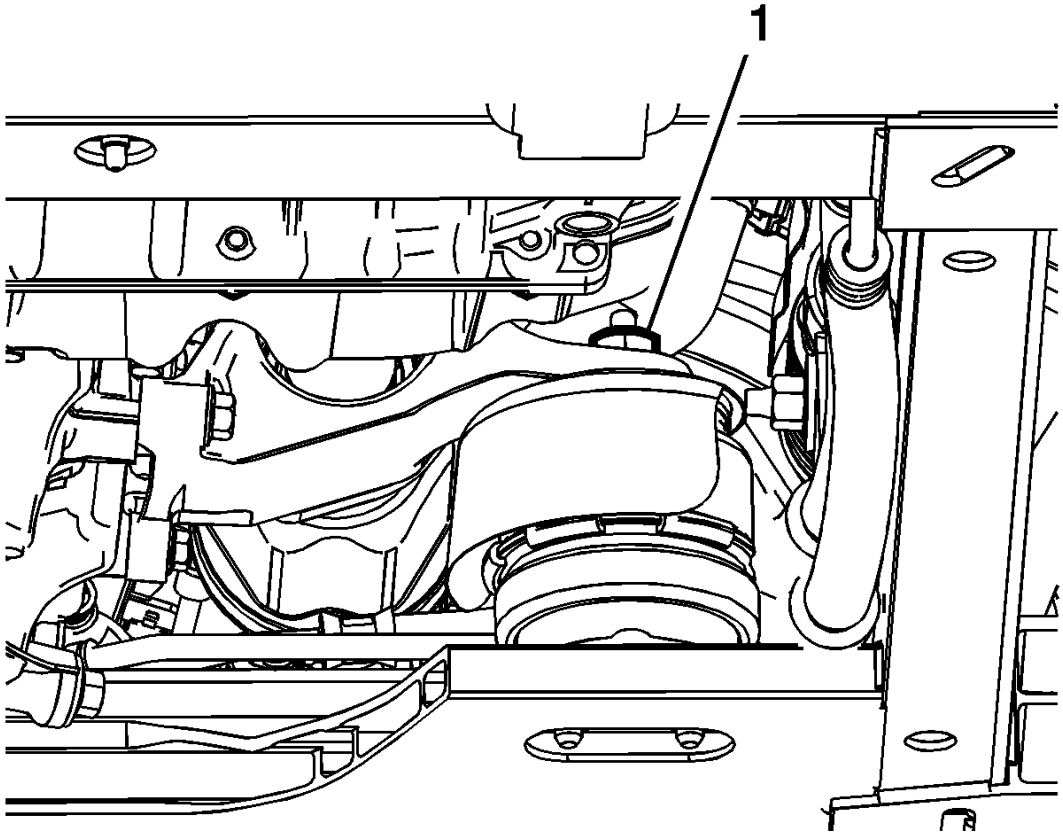

Fig. 17: Rear Engine Mount Upper Fastener
Courtesy of GENERAL MOTORS COMPANY

9. Remove the rear engine mount upper fastener (1).
10. Lower the vehicle.
11. Using the engine support fixture, carefully raise the engine enough to clear the upper rear engine mount bracket.

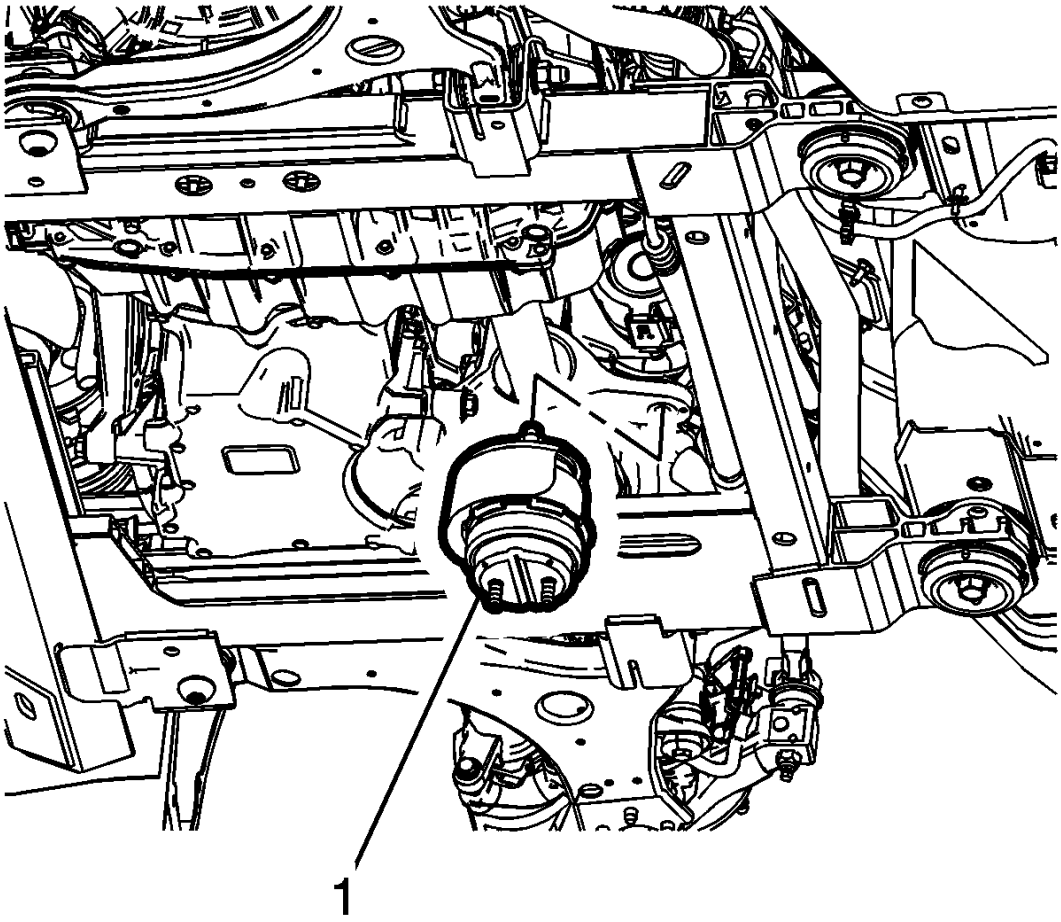

Fig. 18: Rear Engine Mount
Courtesy of GENERAL MOTORS COMPANY

12. With a suitable pry tool, pry the rear engine mount away from the rear engine mount bracket.
13. Remove the rear engine mount (1).

Installation Procedure

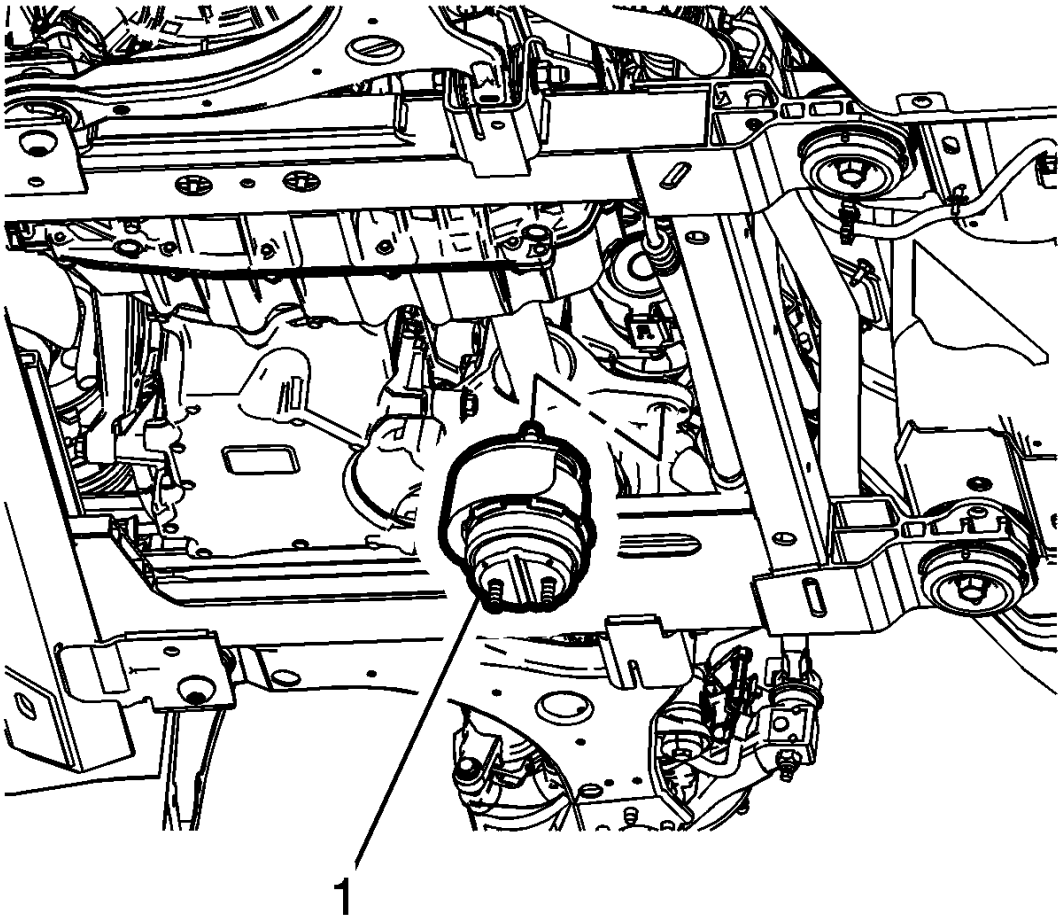

Fig. 19: Rear Engine Mount
Courtesy of GENERAL MOTORS COMPANY

1. Install the rear engine mount (1).
2. Loosely install upper rear engine mount fastener to hold the engine mount to the engine bracket.
3. Using the engine support fixture, carefully lower the engine onto the rear mount and ensure the front engine mount aligns with the sub frame hole.
4. Raise the vehicle.
5. Adjust the rear engine mount with a suitable pry tool if necessary.
6. Lower the vehicle.
7. Lower the engine using the engine support fixture to allow the rear engine mount to fully seat onto the frame.
8. Raise vehicle.
9. Adjust the front engine mount, rear engine mount and transmission mount into proper position.

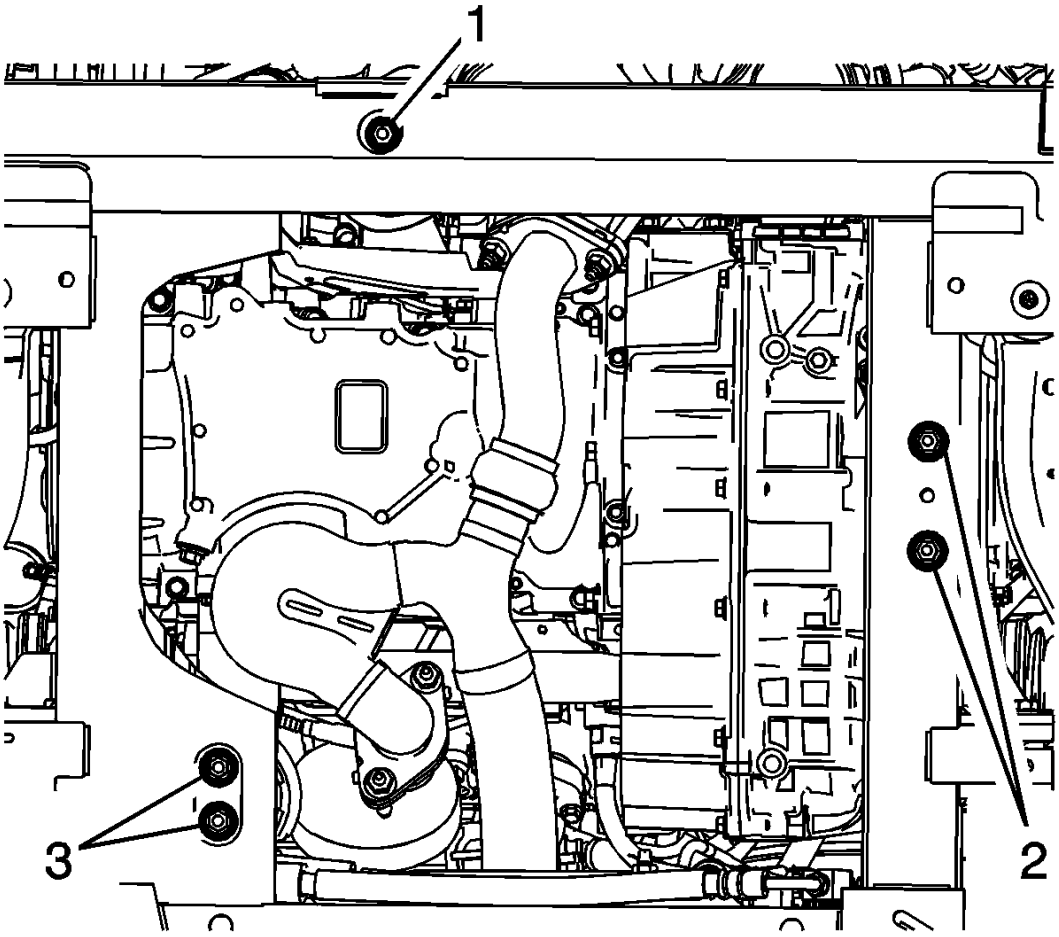

Fig. 20: Engine Mount Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

10. Install the front engine mount to sub frame fastener (1) and tighten to 80 N.m (59 lb ft).
11. Install the rear engine mount to frame fasteners (3) and tighten to 52 N.m (38 lb ft).
12. Tighten the transmission mount fasteners (2) to 52 N.m (38 lb ft).

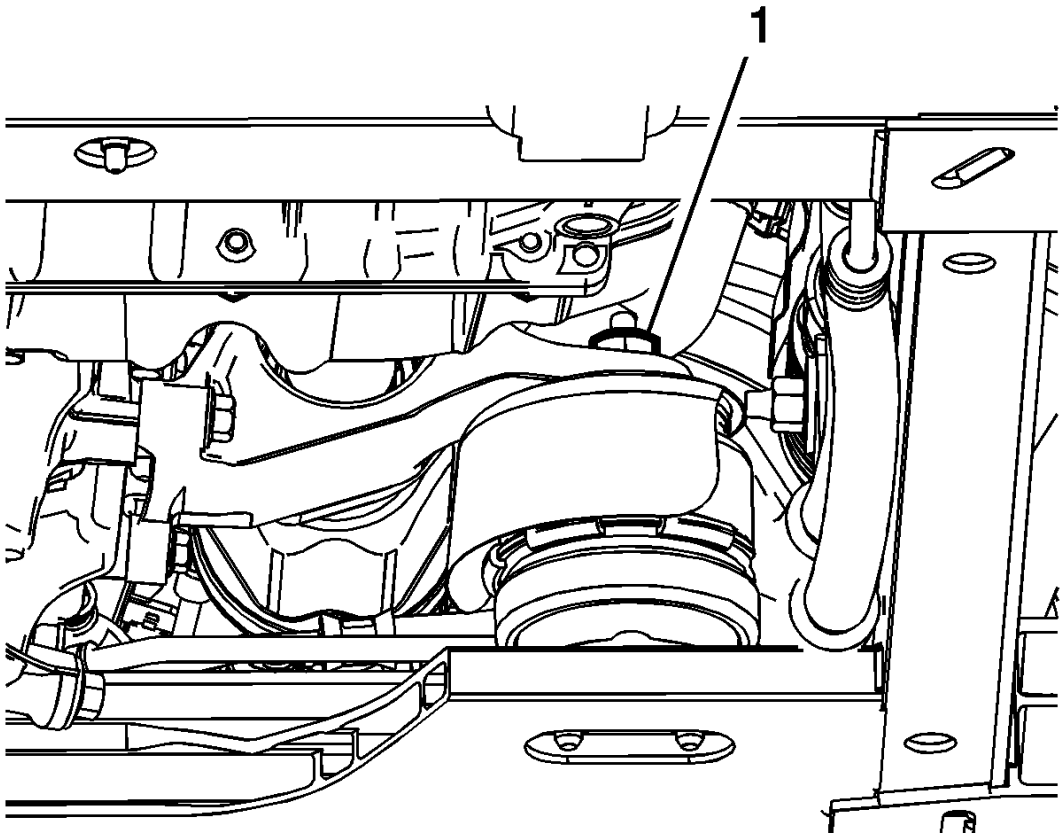

Fig. 21: Rear Engine Mount Upper Fastener
Courtesy of GENERAL MOTORS COMPANY

13. Install the upper rear engine mount fastener (1) and tighten to 100 N.m (74 lb ft).
14. Install the radiator air lower deflector and baffle. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
15. Install the right side engine splash shield. Refer to **Engine Splash Shield Replacement (Right)** **Engine Splash Shield Replacement (Left)** .
16. Lower the vehicle.

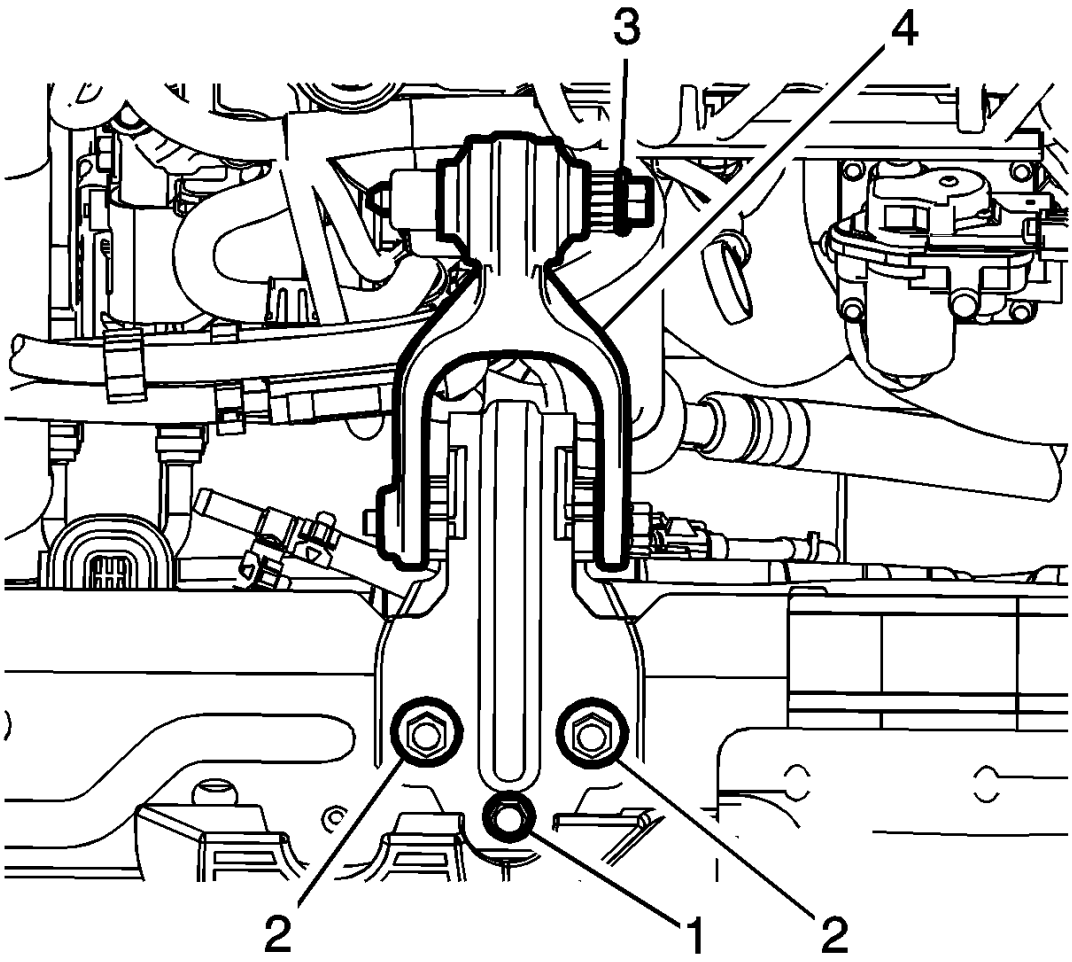

Fig. 22: Engine Strut And Fastener
Courtesy of GENERAL MOTORS COMPANY

17. Install the engine strut fastener (3) and tighten to 48 N.m (35 lb ft).
18. Remove the engine support fixture. Refer to **Engine Support Fixture**.

ENGINE FRONT MOUNT BRACKET REPLACEMENT

Removal Procedure

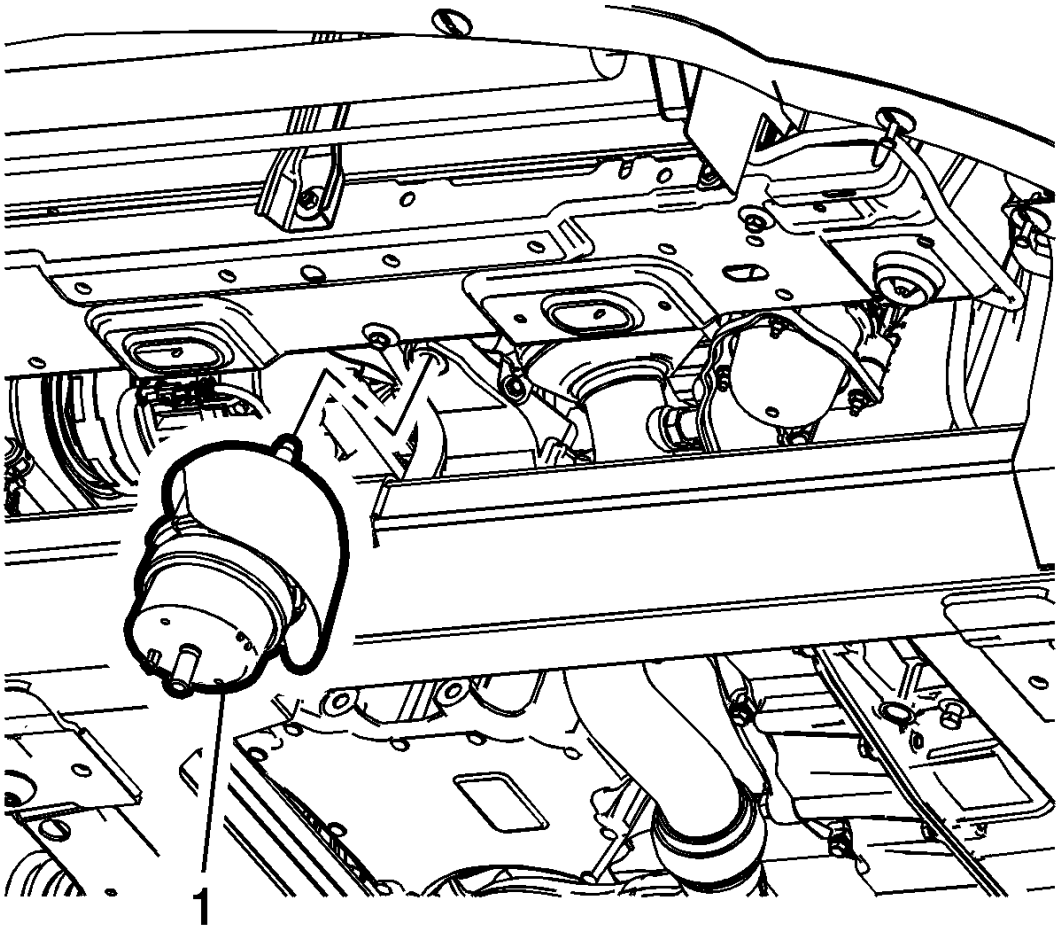

Fig. 23: Front Engine Mount
Courtesy of GENERAL MOTORS COMPANY

1. Remove the front engine mount (1). Refer to **Engine Front Mount Replacement**.

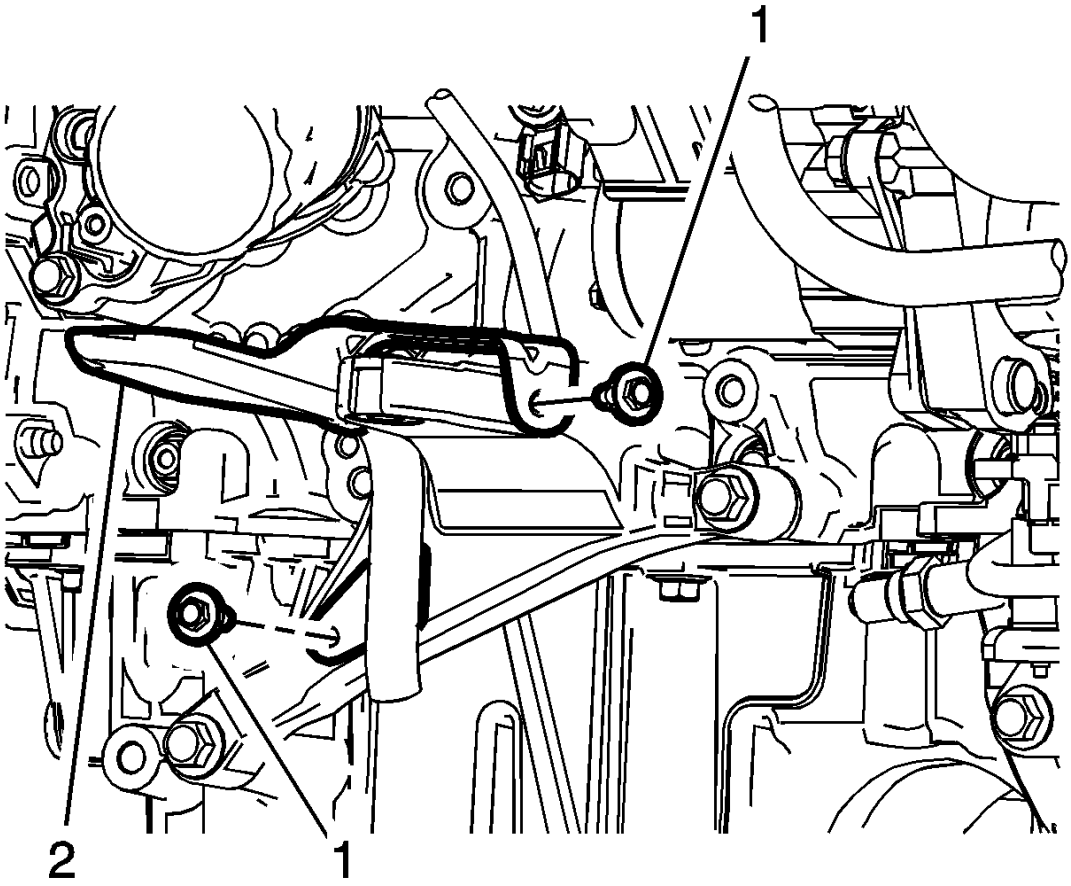

Fig. 24: Oil Deflector And Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Remove the two oil deflector fasteners (1).
3. Remove the oil deflector (2).

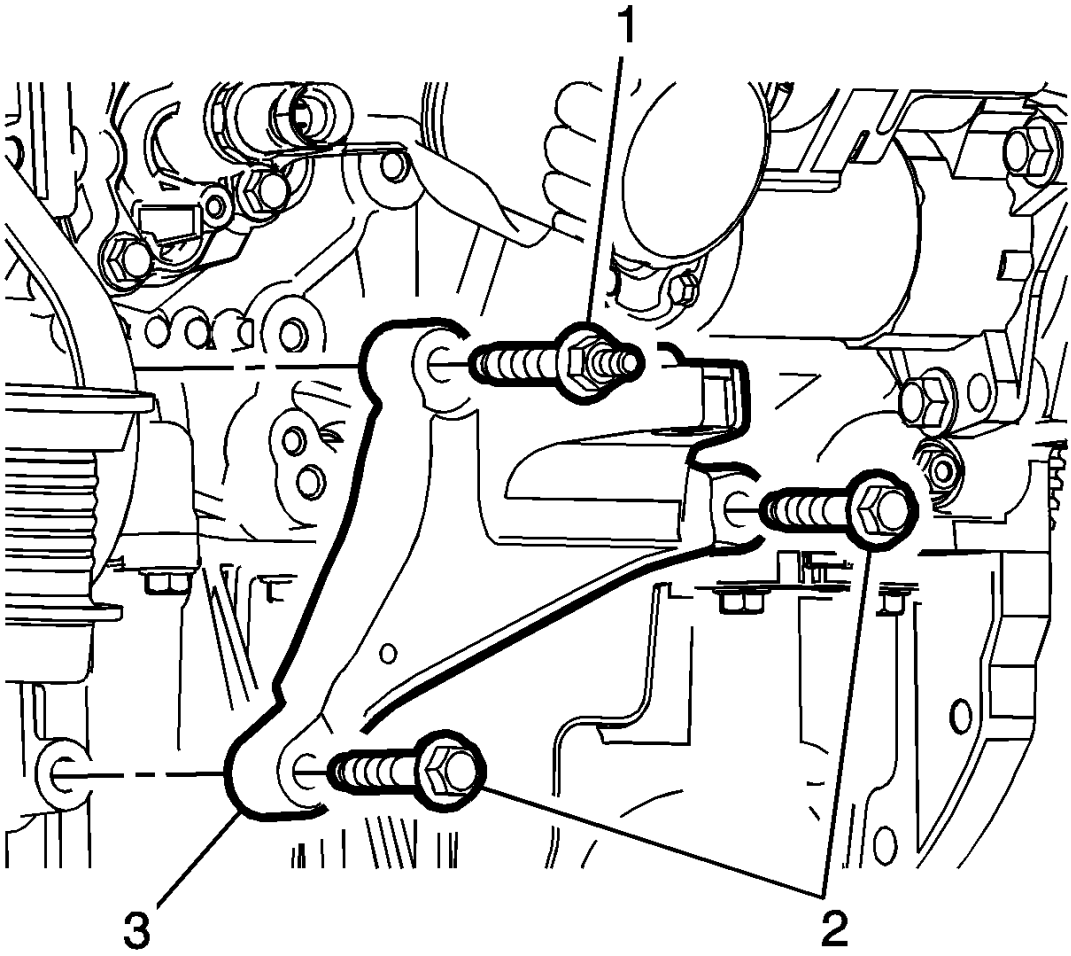

Fig. 25: Front Engine Mount Bracket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the front engine mount bracket fastener (1).
5. Remove the two front engine mount bracket fasteners (2).
6. Remove the front engine mount bracket (3).

Installation Procedure

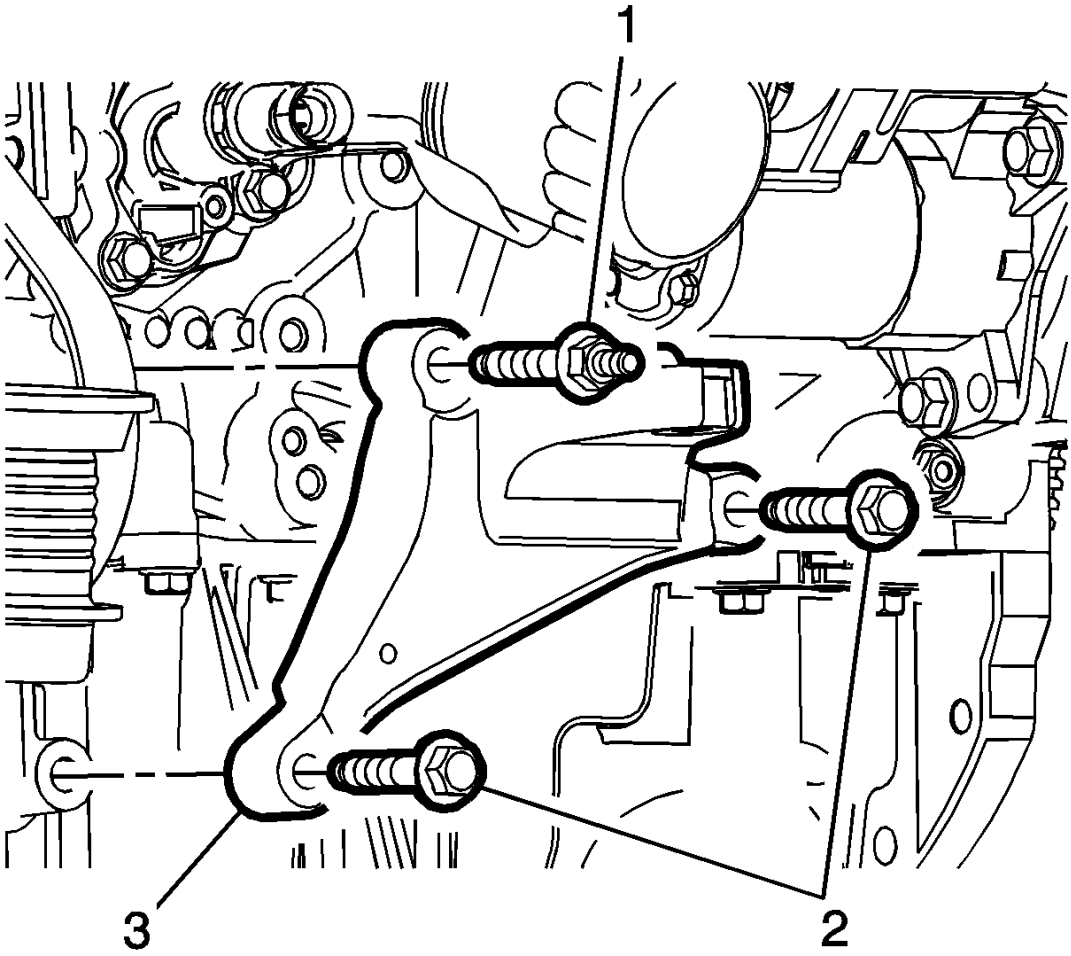

Fig. 26: Front Engine Mount Bracket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Install the front engine mount bracket (3).

CAUTION: Refer to Fastener Caution .

2. Install the two front engine mount bracket fasteners (2) and tighten to 58 N.m (43 lb ft).
3. Install the front engine mount bracket fastener (1) and tighten to 58 N.m (43 lb ft).

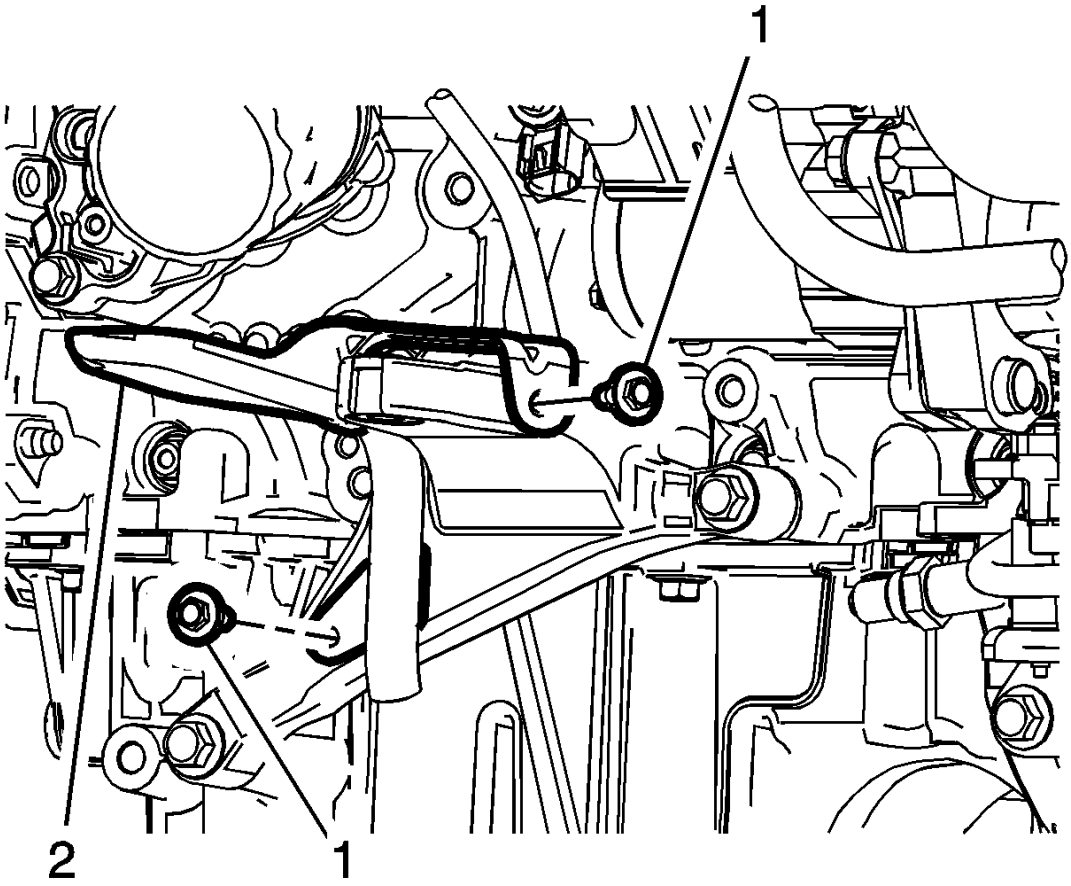

Fig. 27: Oil Deflector And Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the oil deflector (2).
5. Install the two oil deflector fasteners (1) and tighten to 10 N.m (89 lb in).

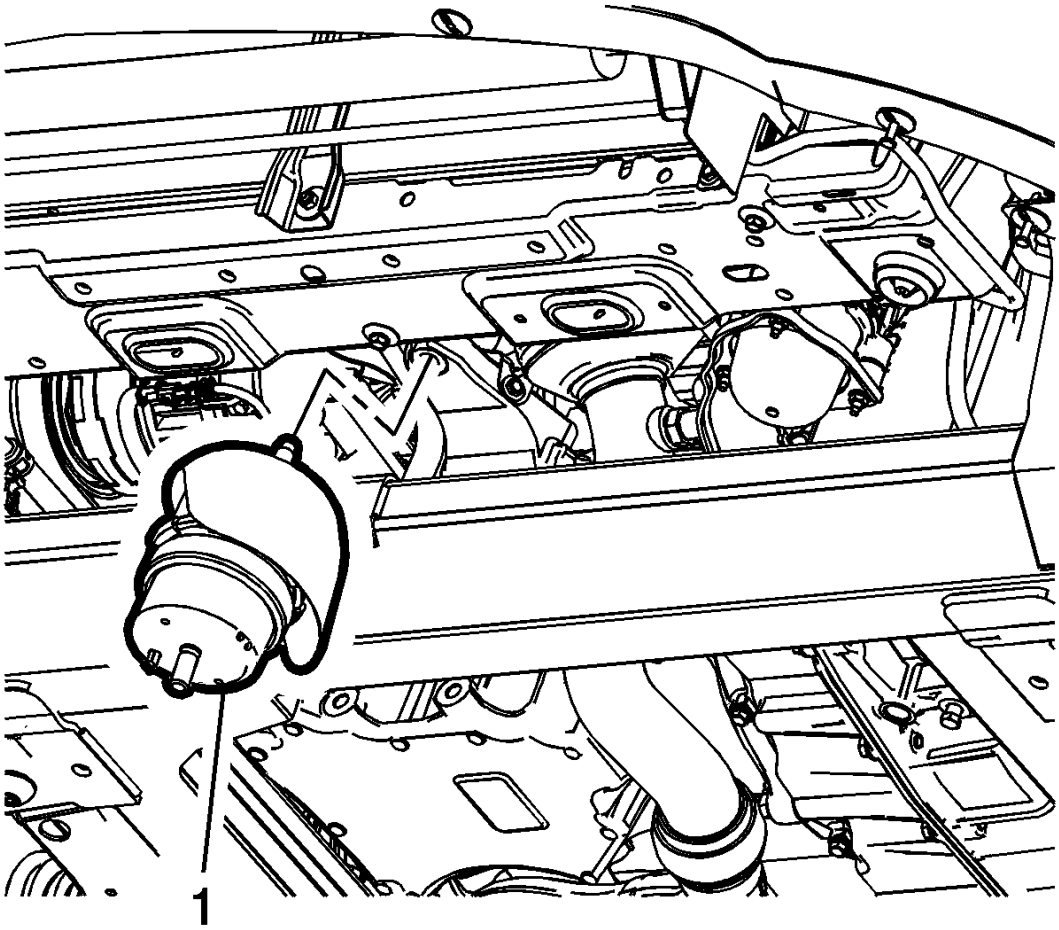

Fig. 28: Front Engine Mount
Courtesy of GENERAL MOTORS COMPANY

6. Install the front engine mount (1). Refer to **Engine Front Mount Replacement**.

ENGINE REAR MOUNT BRACKET REPLACEMENT

Removal Procedure

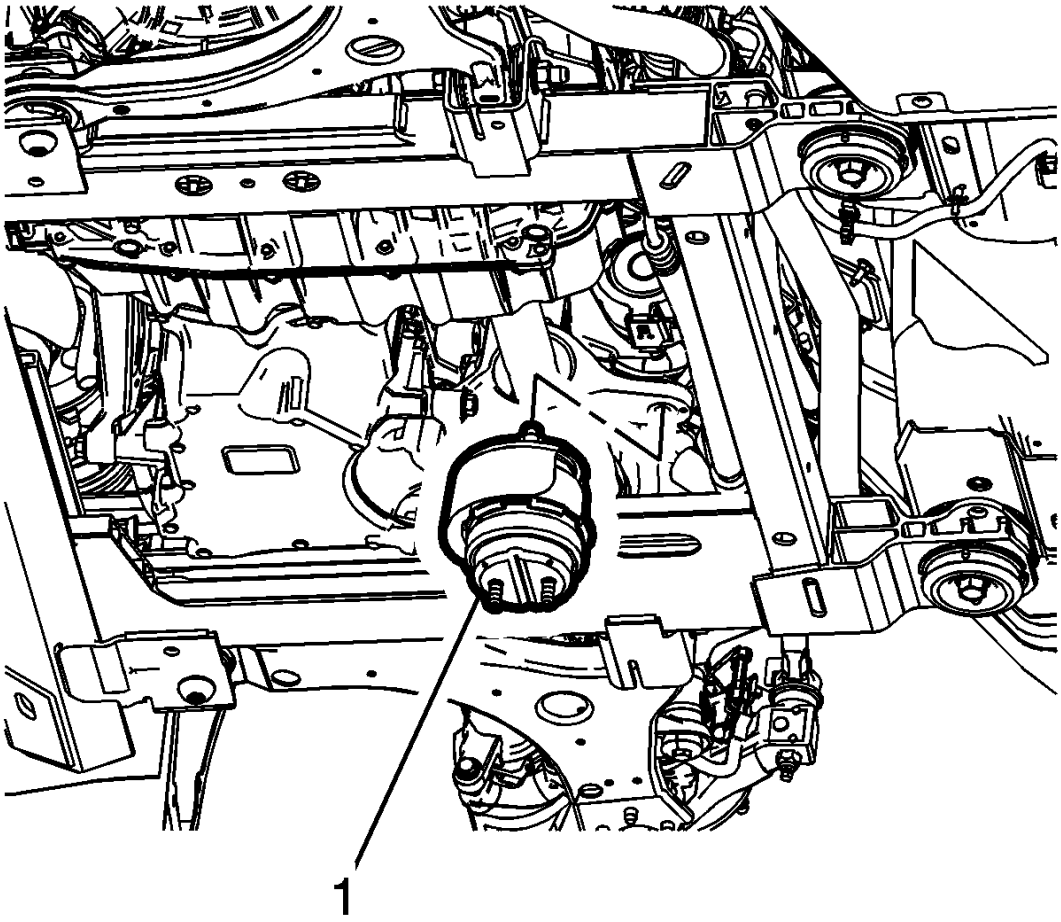

Fig. 29: Rear Engine Mount
Courtesy of GENERAL MOTORS COMPANY

1. Remove the rear engine mount (1). Refer to **Engine Rear Mount Replacement**.

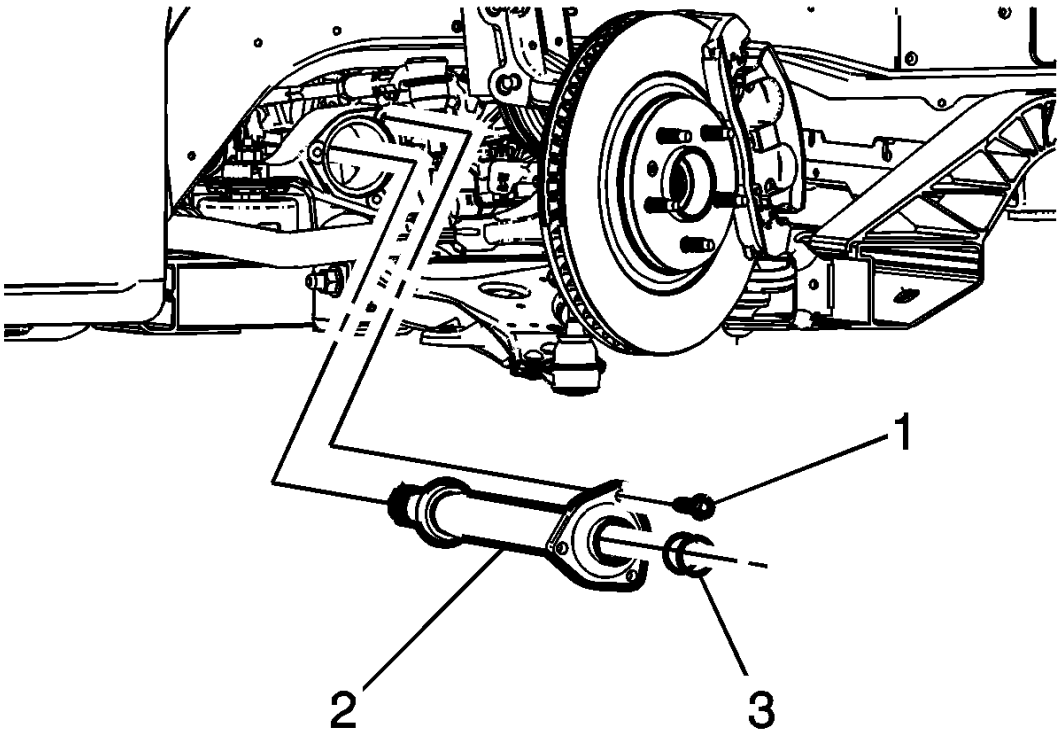

Fig. 30: Front Wheel Intermediate Shaft
Courtesy of GENERAL MOTORS COMPANY

2. Remove the front wheel intermediate shaft (2). Refer to **Front Wheel Drive Intermediate Shaft Replacement** .

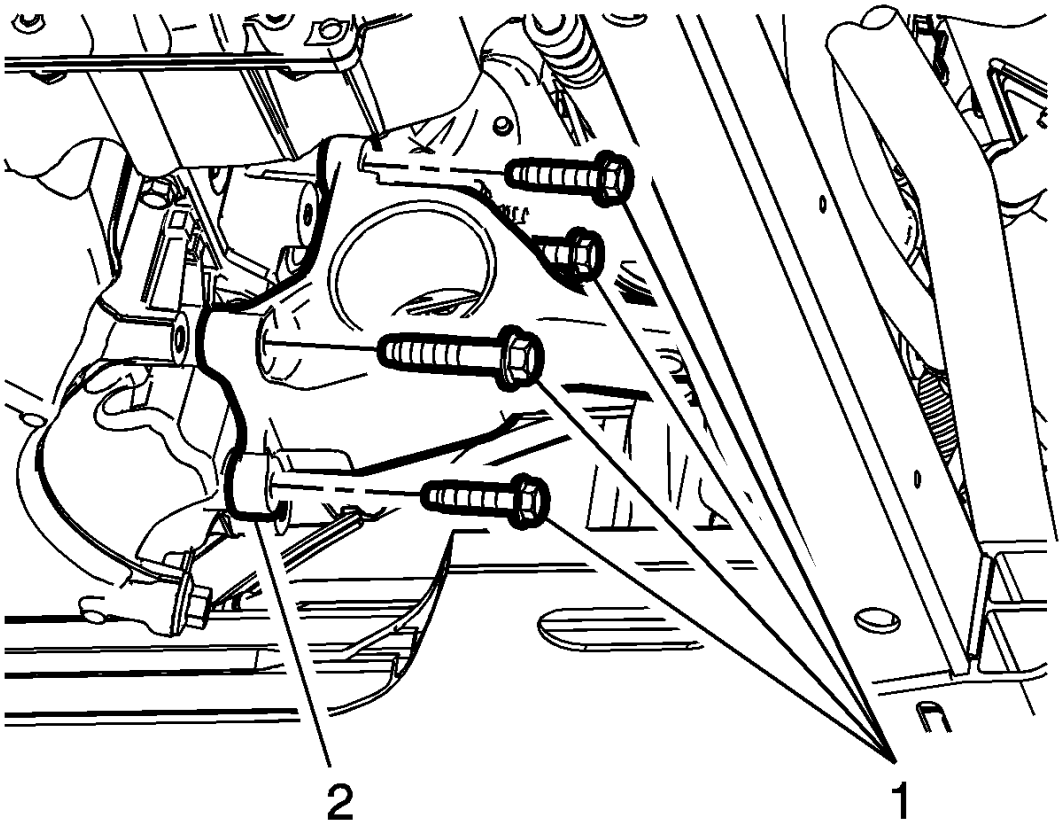

Fig. 31: Rear Engine Mount Bracket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

3. Remove the four rear engine mount bracket fasteners (1).
4. Remove the rear engine mount bracket (2).

Installation Procedure

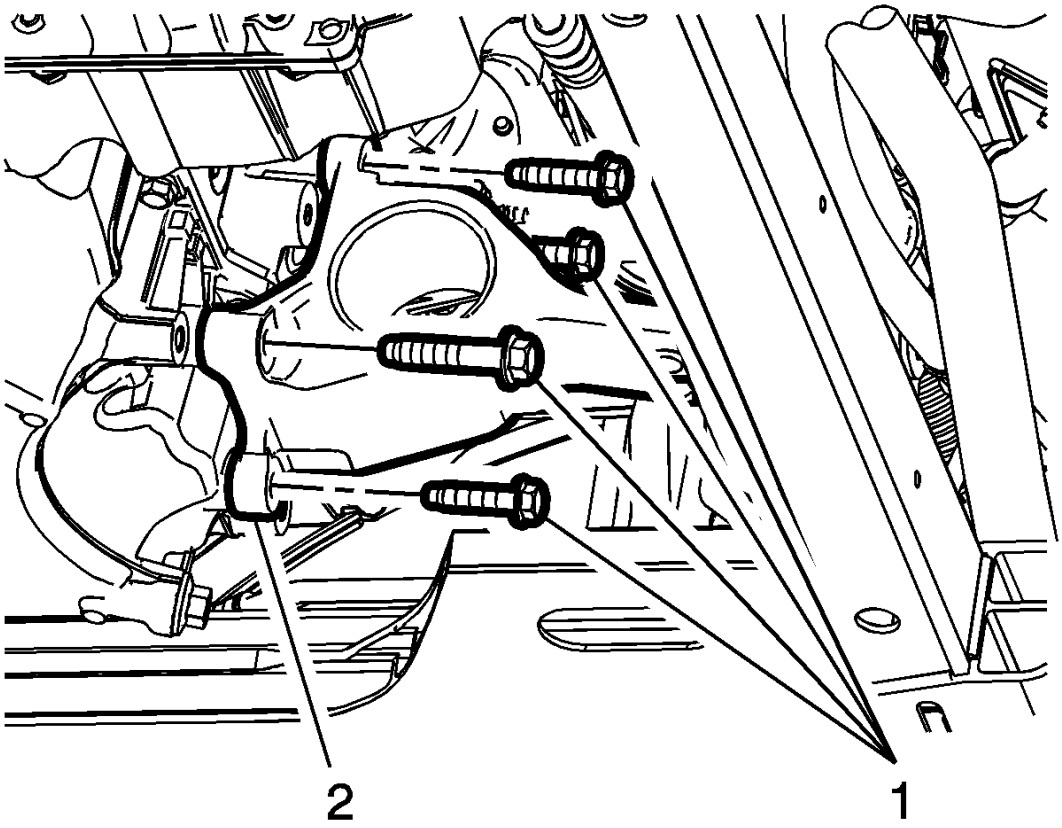

Fig. 32: Rear Engine Mount Bracket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Install the rear engine mount bracket (2).

CAUTION: Refer to Fastener Caution .

2. Install the four rear engine mount bracket fasteners (1) and tighten to 58 N.m (43 lb ft).

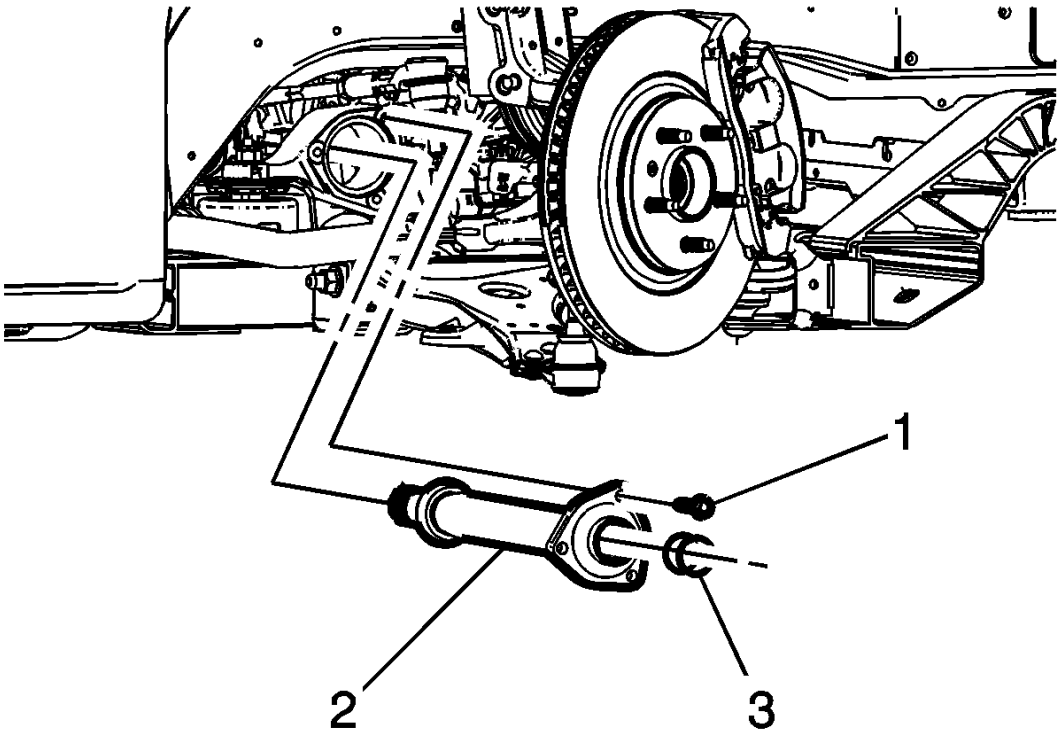

Fig. 33: Front Wheel Intermediate Shaft
Courtesy of GENERAL MOTORS COMPANY

3. Install the front wheel intermediate shaft (2). Refer to **Front Wheel Drive Intermediate Shaft Replacement** .

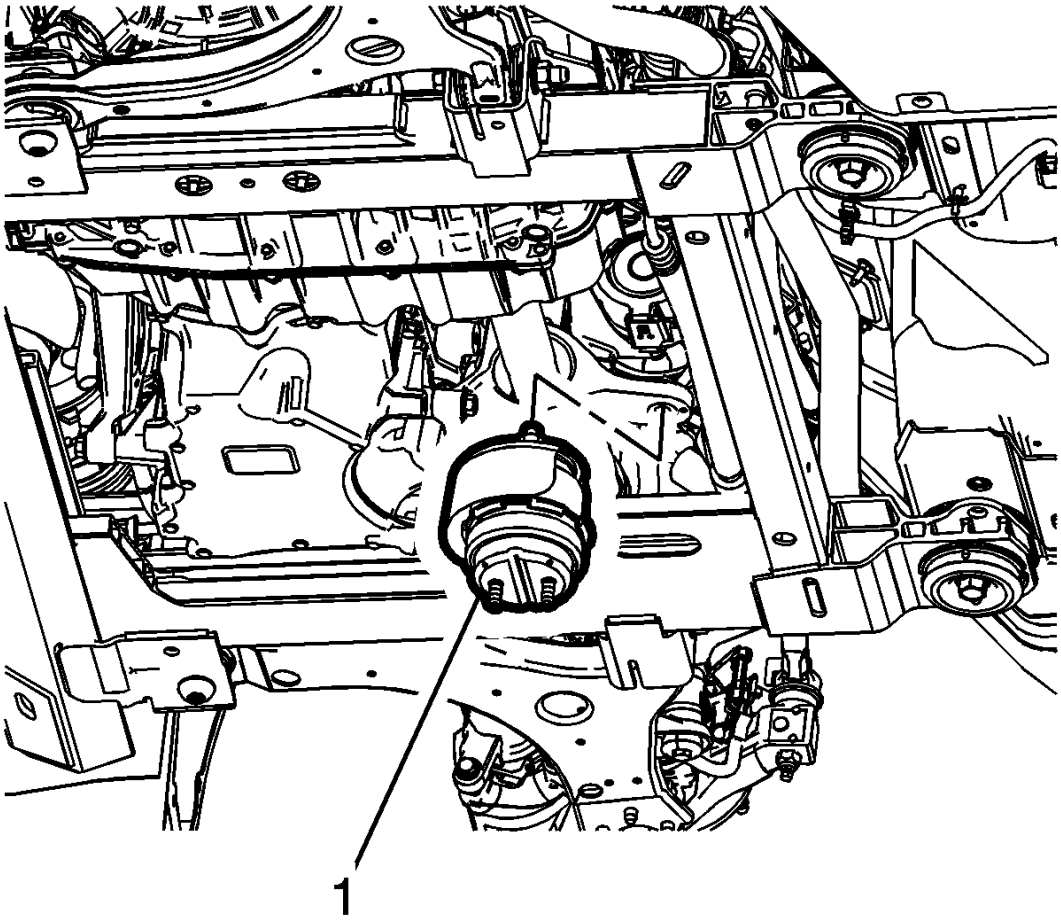

Fig. 34: Rear Engine Mount
Courtesy of GENERAL MOTORS COMPANY

4. Install the rear engine mount (1). Refer to **Engine Rear Mount Replacement**.

ENGINE MOUNT STRUT REPLACEMENT - RIGHT SIDE

Removal Procedure

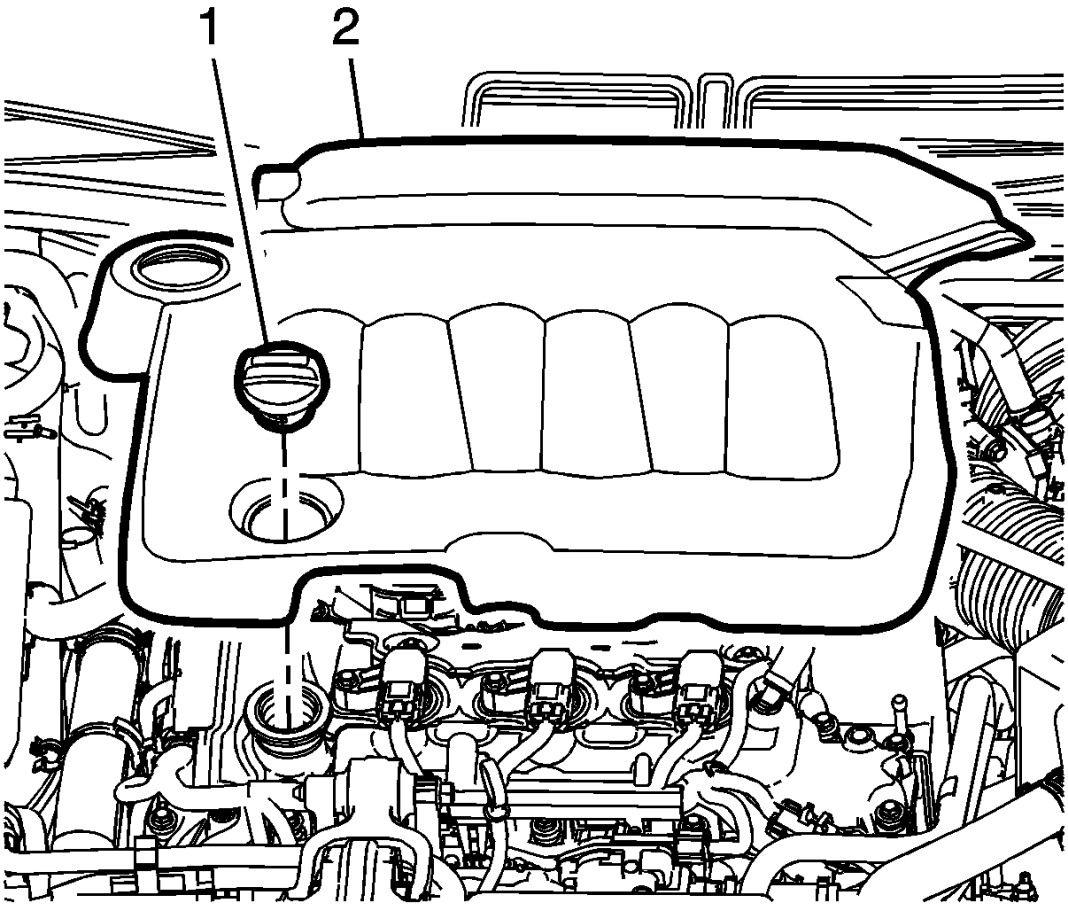

Fig. 35: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.
2. Remove the radiator air upper baffle and deflector. Refer to **Radiator Air Upper Baffle and Deflector Replacement** .

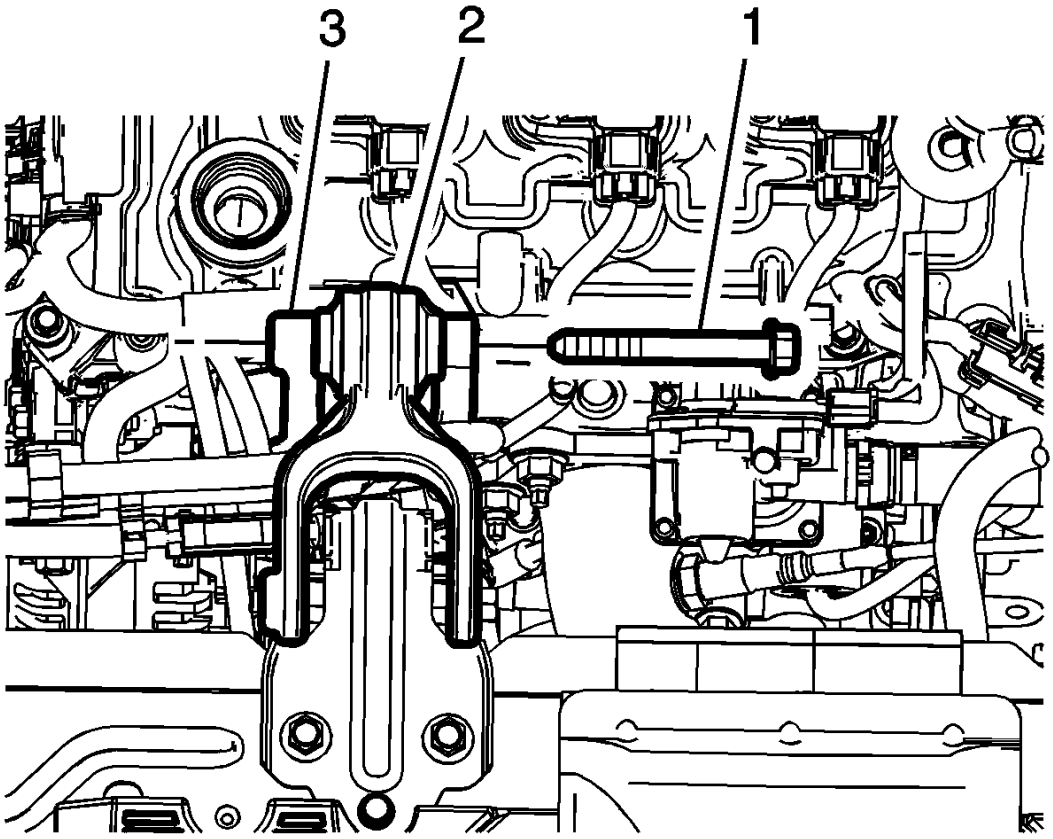

Fig. 36: Engine Strut To Engine Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine strut to engine bracket bolt (1).

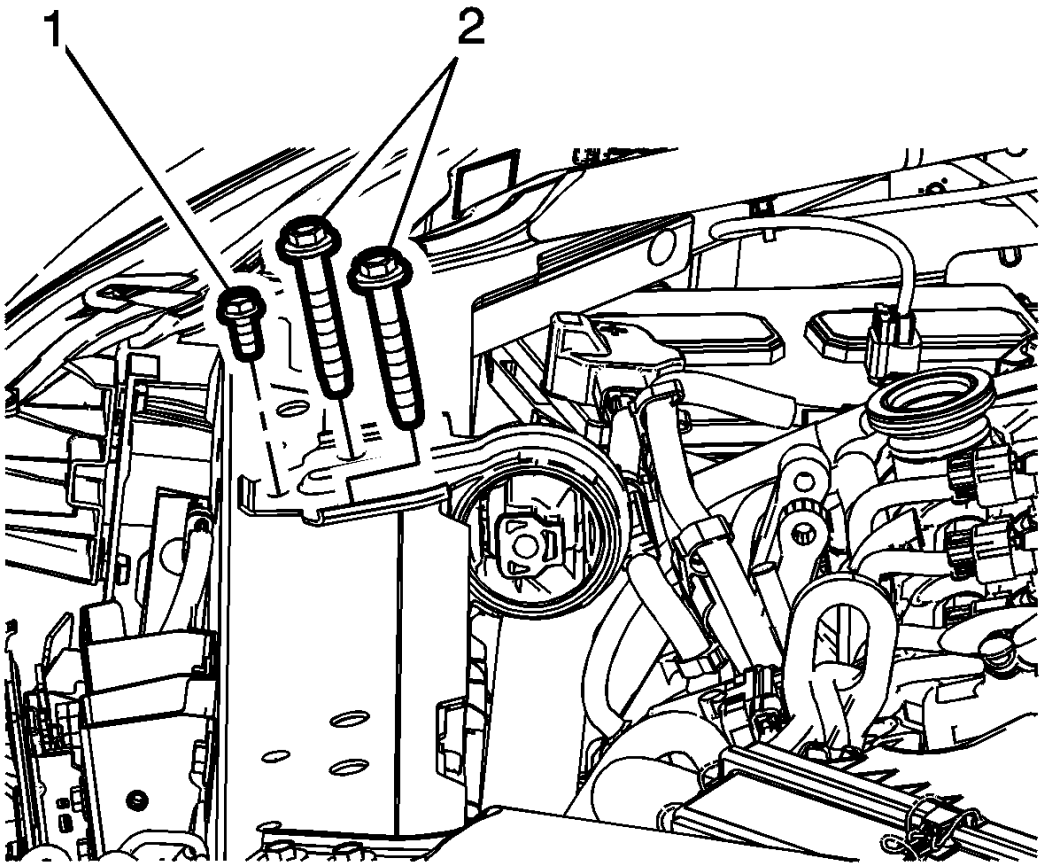

Fig. 37: Engine Strut To Body Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the engine strut to body bolts (1 and 2).

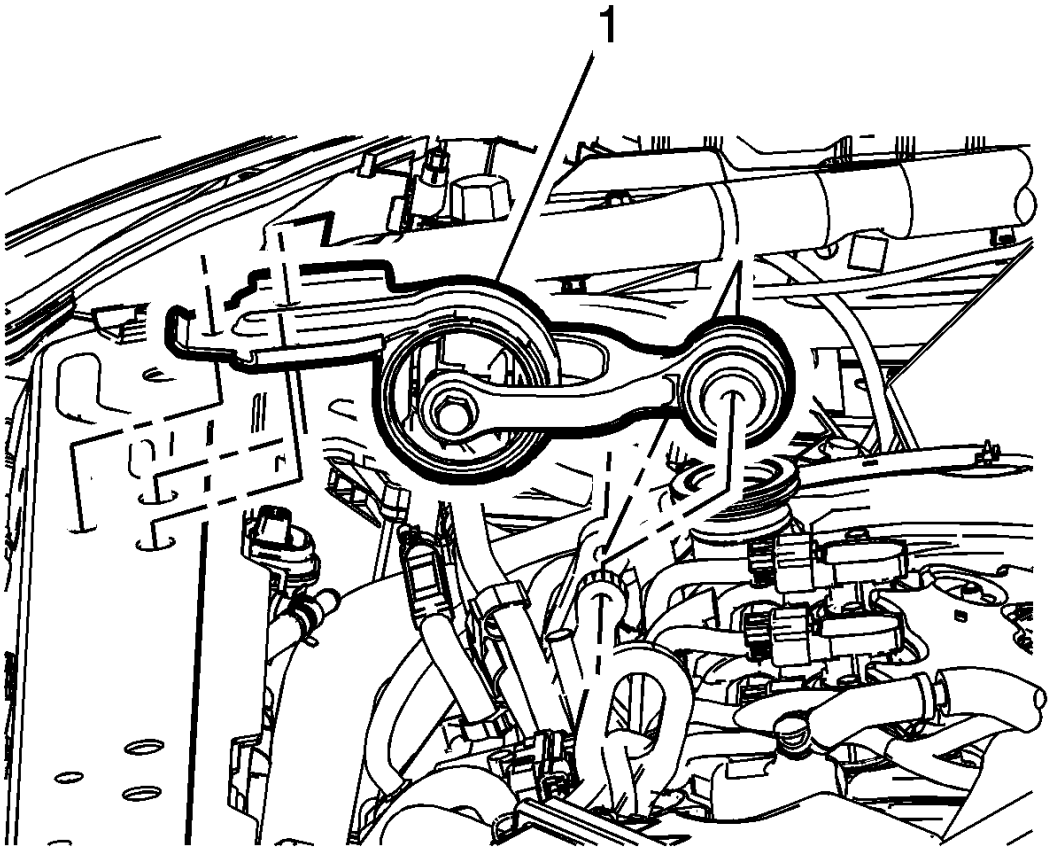

Fig. 38: Engine Strut Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine strut assembly (1).

Installation Procedure

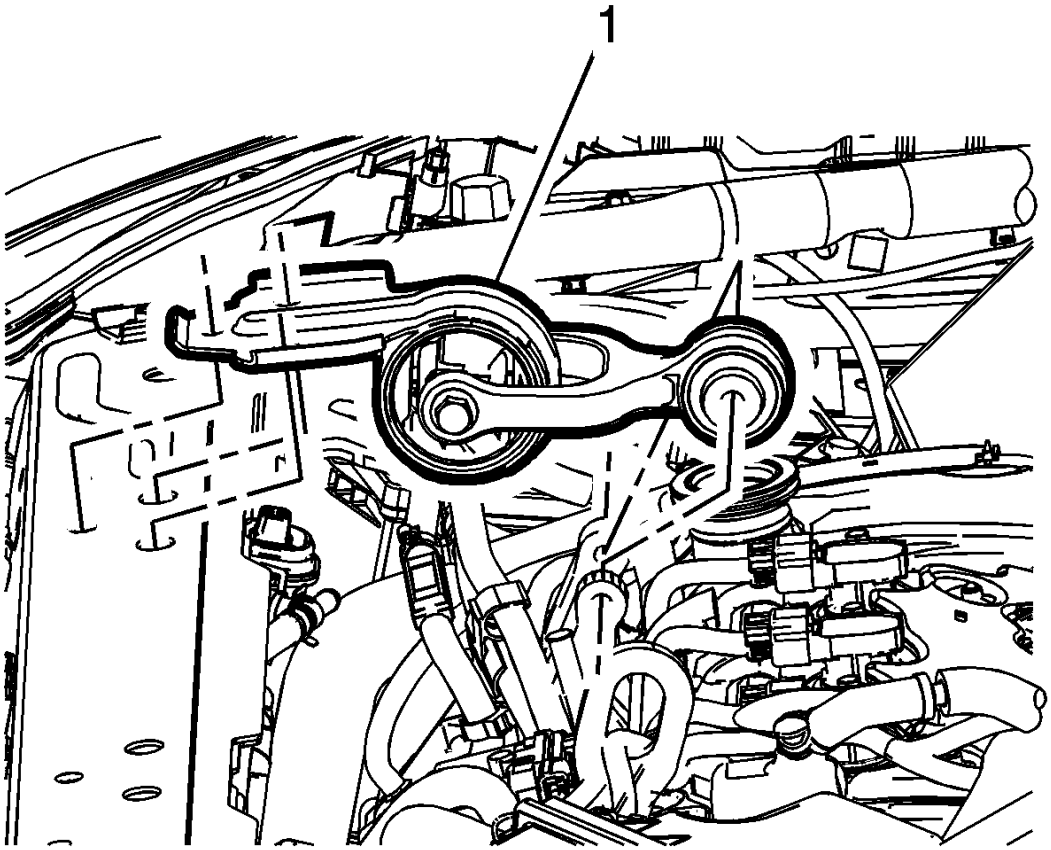

Fig. 39: Engine Strut Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine strut assembly (1) into position.

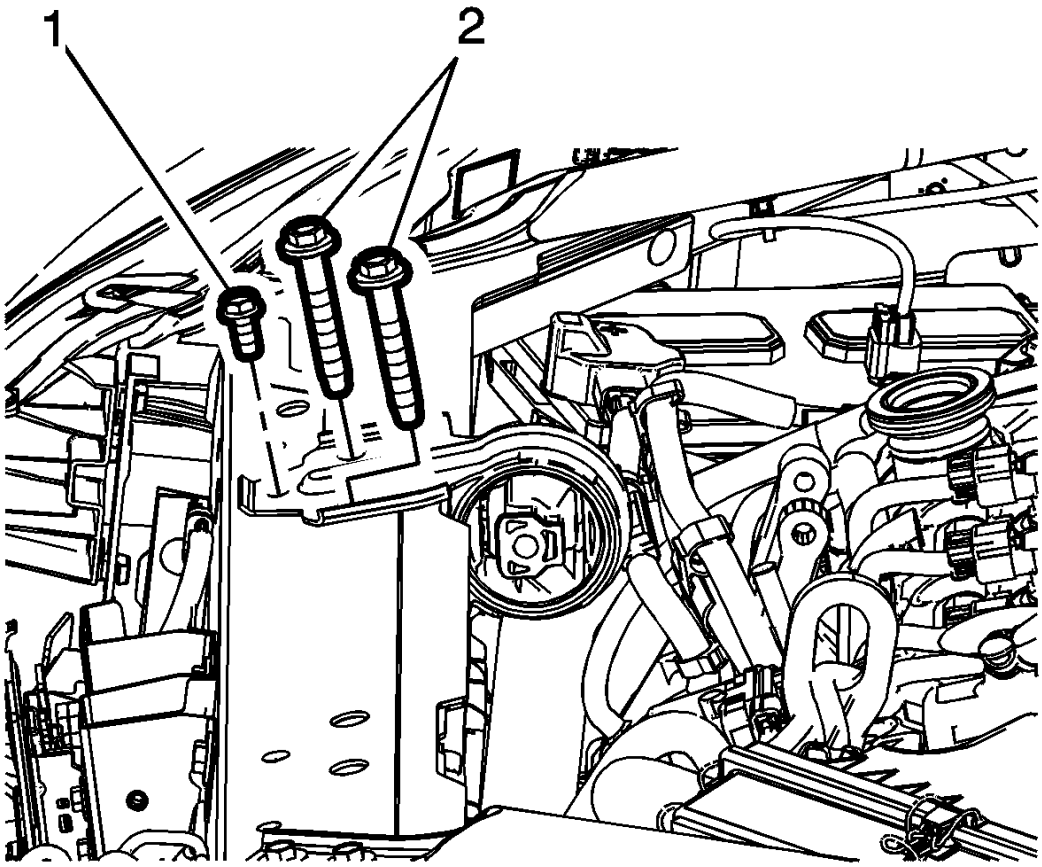

Fig. 40: Engine Strut To Body Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Install the engine strut to body bolts (1 and 2) hand tight.

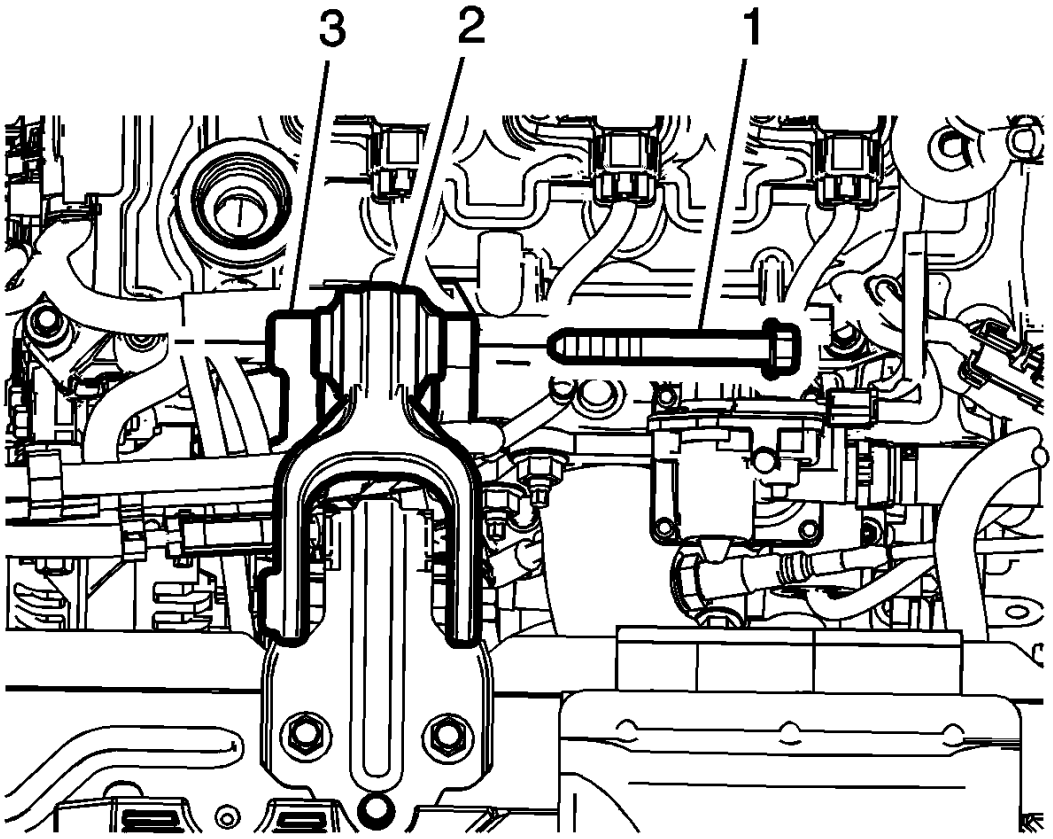

Fig. 41: Engine Strut To Engine Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install the engine strut (1) to engine strut bracket (3) bolt (2) hand tight.

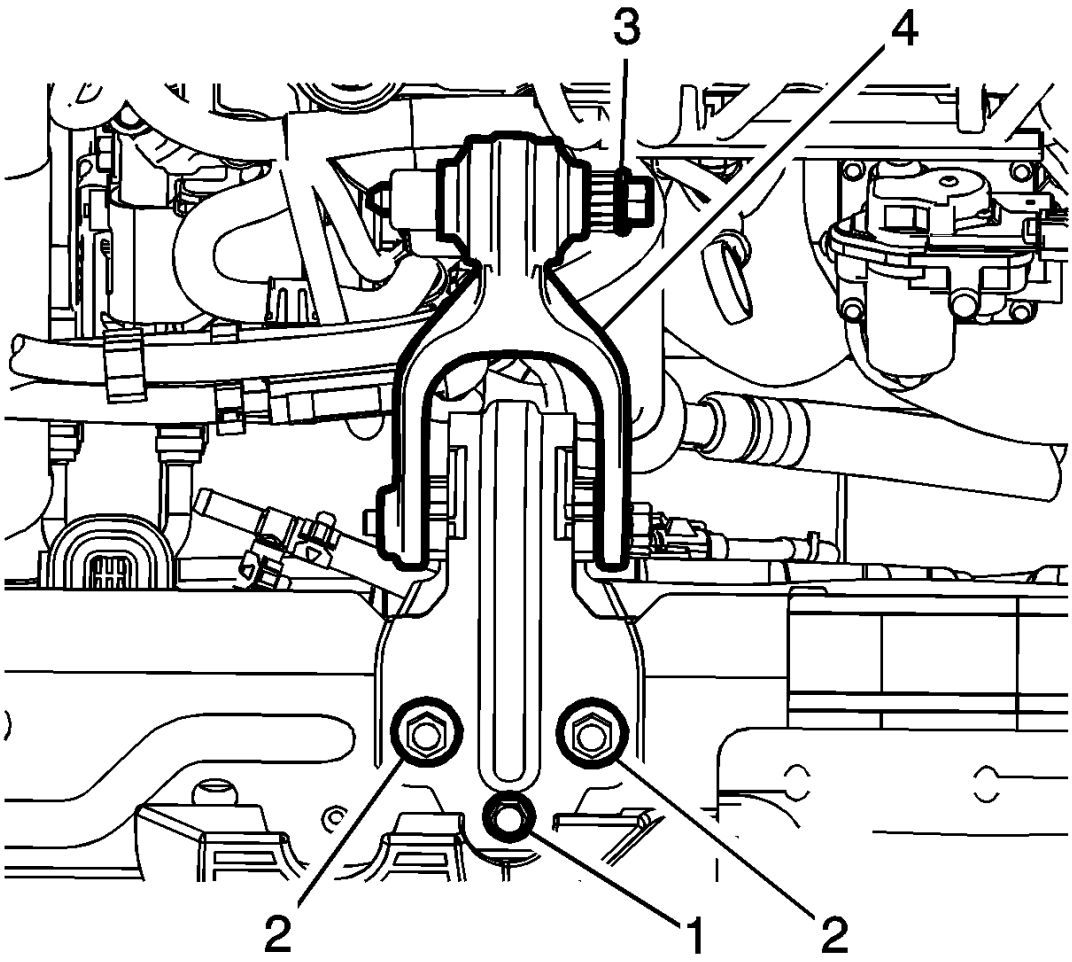

Fig. 42: Engine Strut And Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Tighten the engine strut fasteners as follows:
    - Engine strut to body bolt (1) to 26 N.m (19 lb ft)
    - Engine strut to body bolts (2) to 58 N.m (43 lb ft)
    - Engine strut to engine mount bracket bolt (3) to 48 N.m (35 lb ft)
5. Install the radiator air upper baffle and deflector. Refer to **Radiator Air Upper Baffle and Deflector Replacement** .

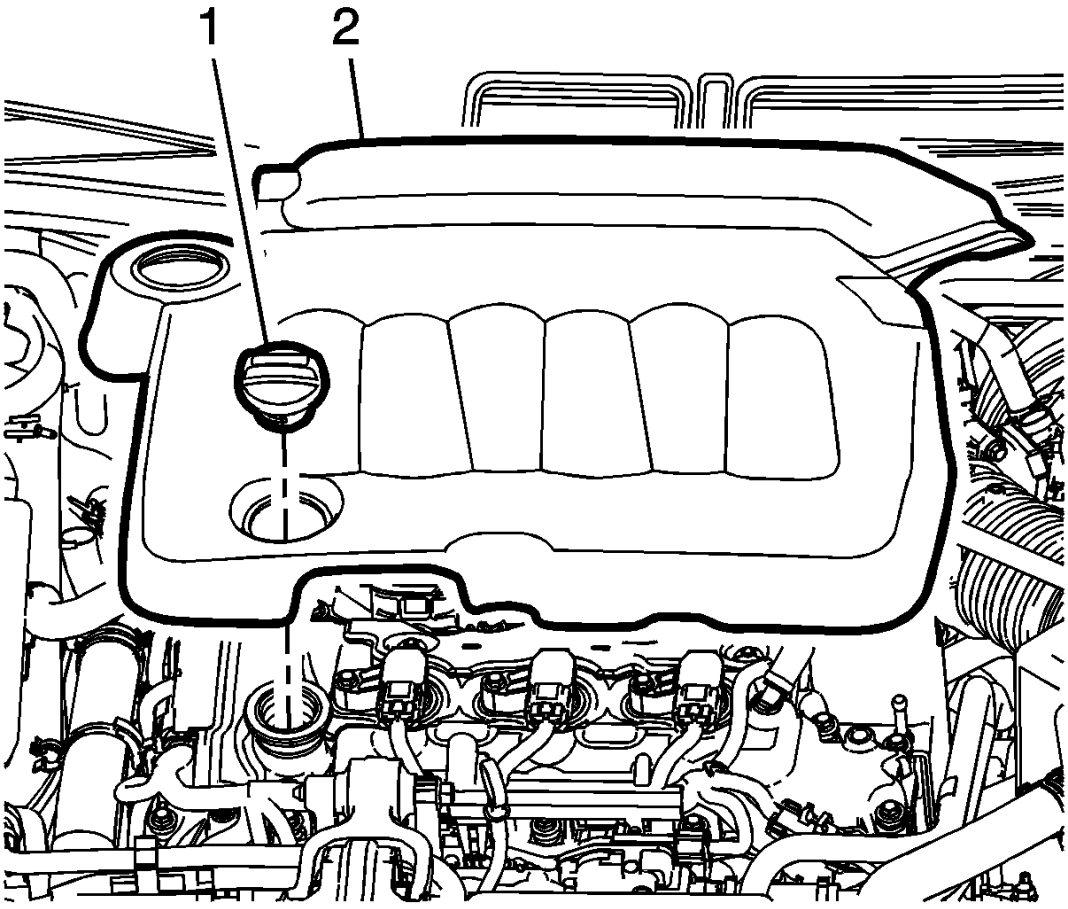

Fig. 43: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

6. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

ENGINE MOUNT STRUT BRACKET REPLACEMENT - RIGHT SIDE

Removal Procedure

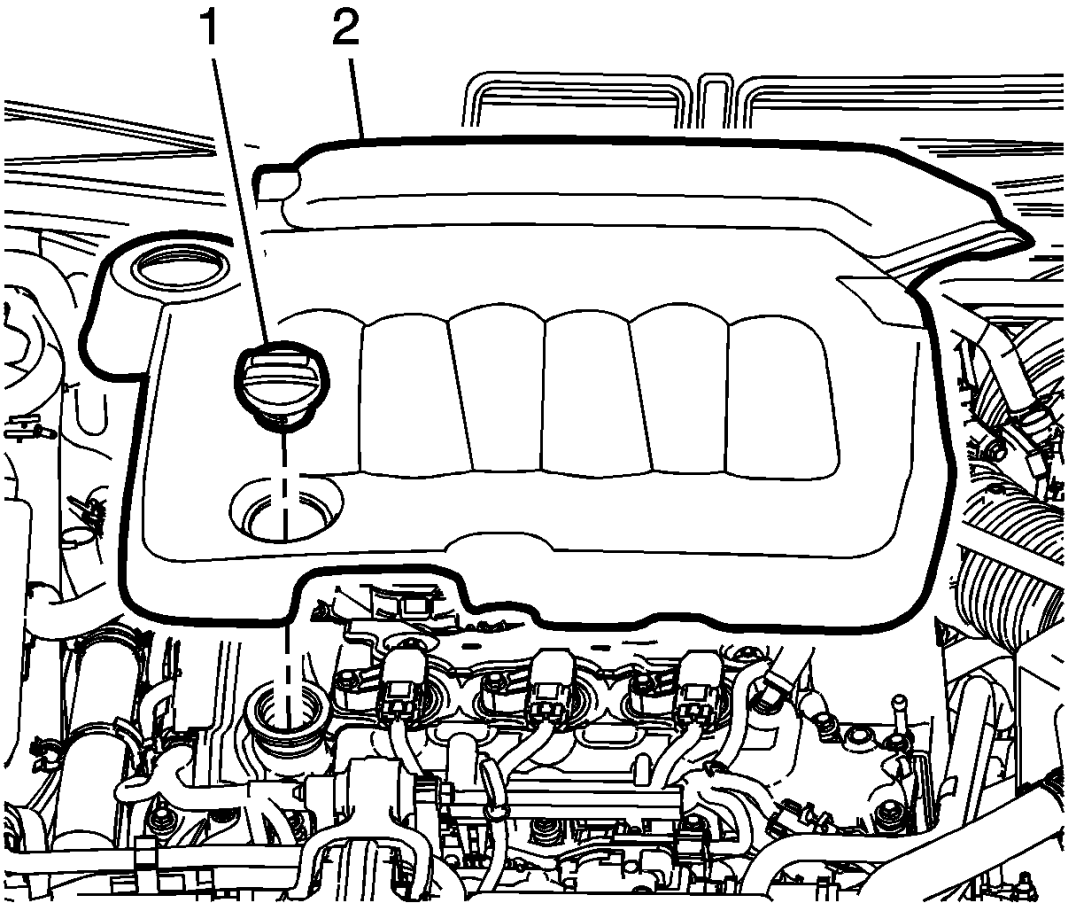

Fig. 44: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.
2. Remove the radiator air upper baffle and deflector. Refer to **Radiator Air Upper Baffle and Deflector Replacement** .

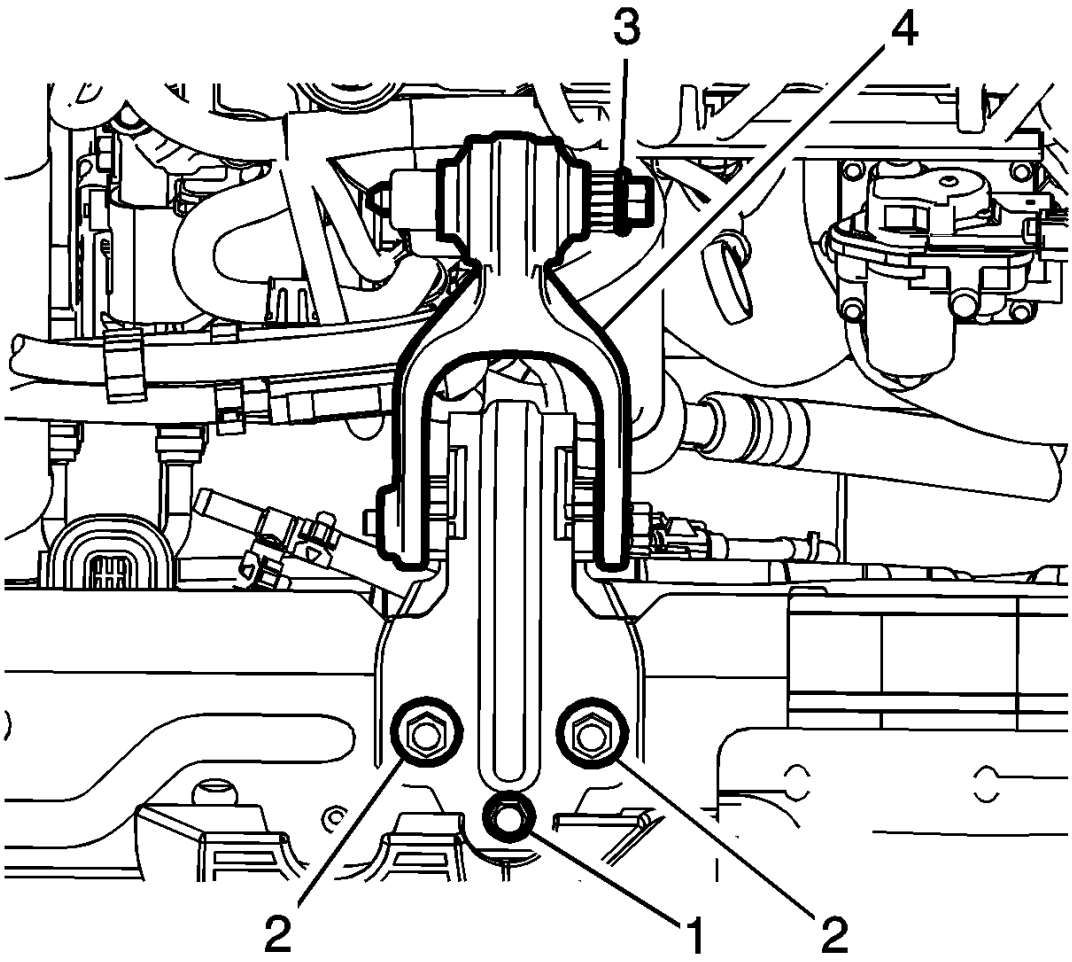

Fig. 45: Engine Strut And Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine mount strut (4). Refer to **Engine Mount Strut Replacement - Right Side**

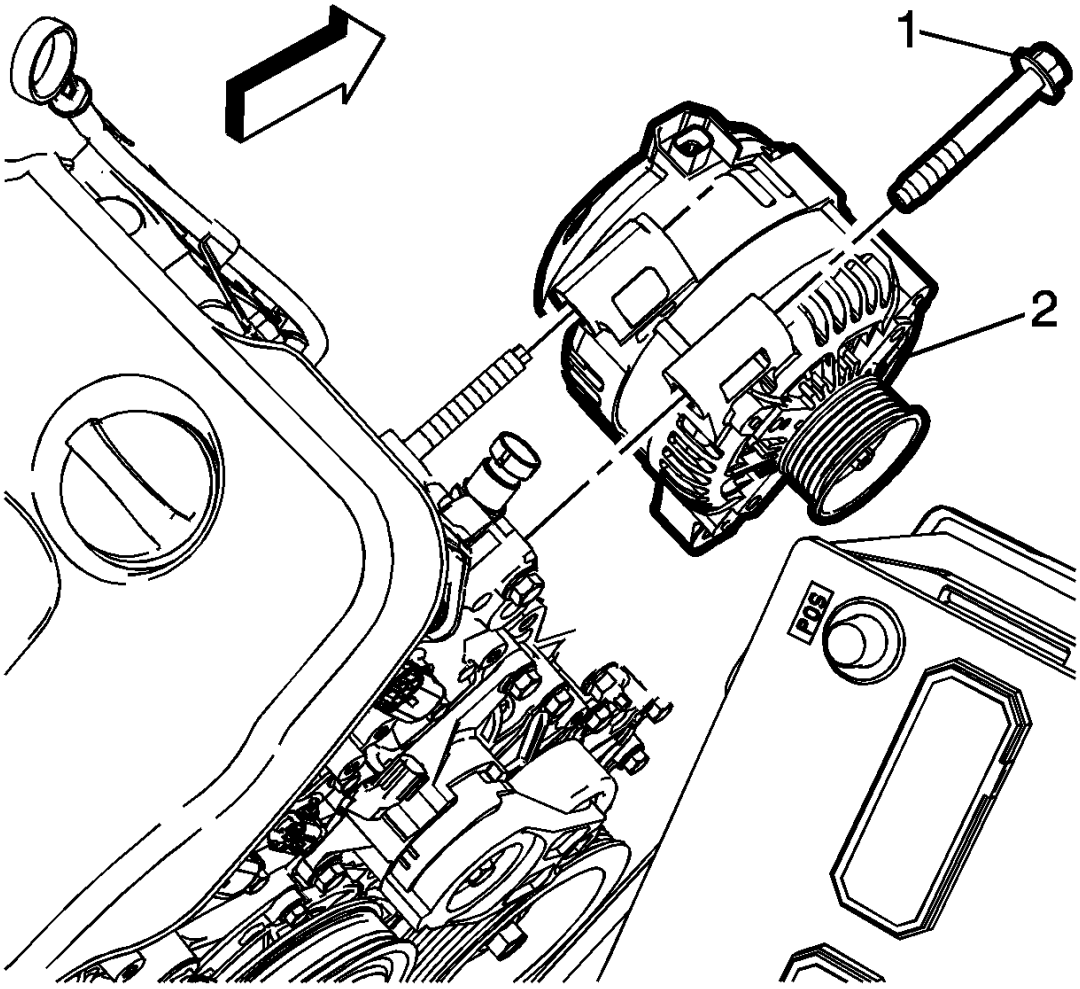

Fig. 46: Generator And Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Remove the generator (2). Refer to **Generator Replacement** .

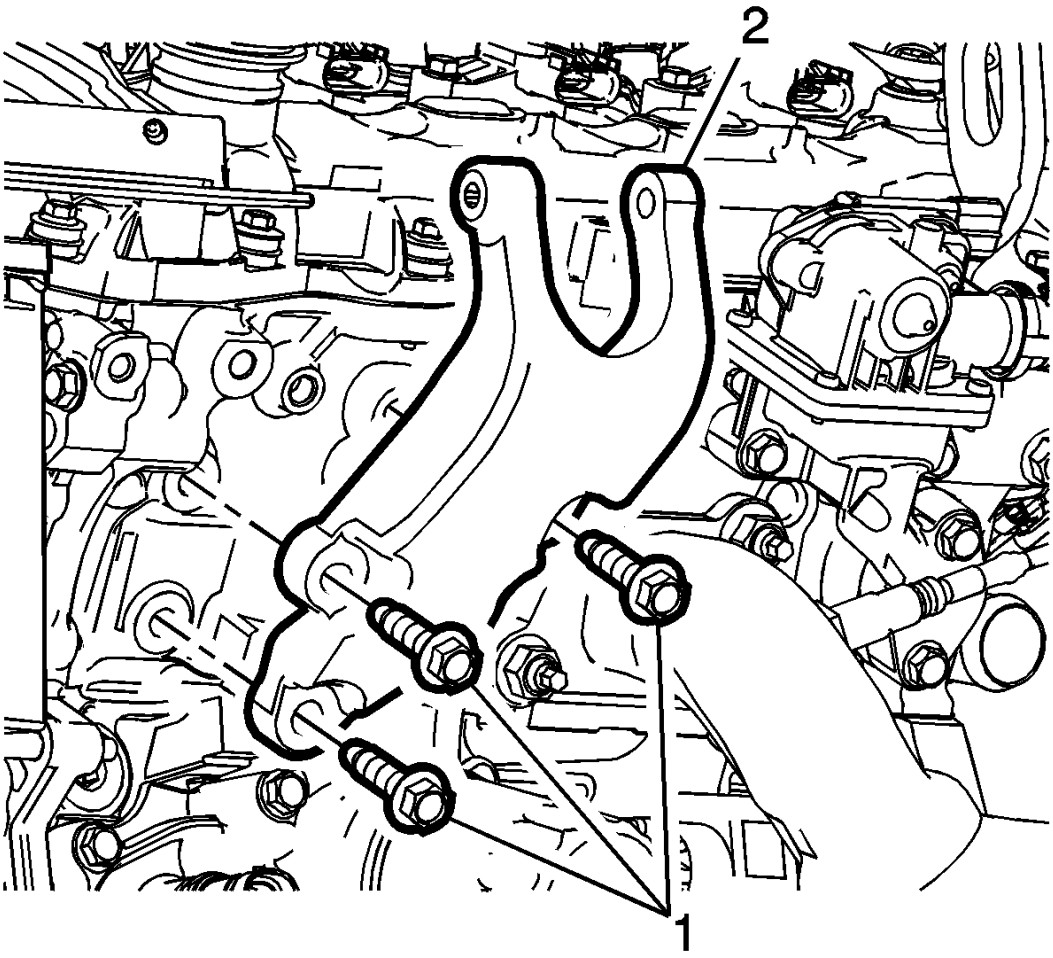

Fig. 47: Engine Strut Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine strut bracket to engine bolts (1) and discard bolts.
6. Remove the engine strut bracket (2).

Installation Procedure

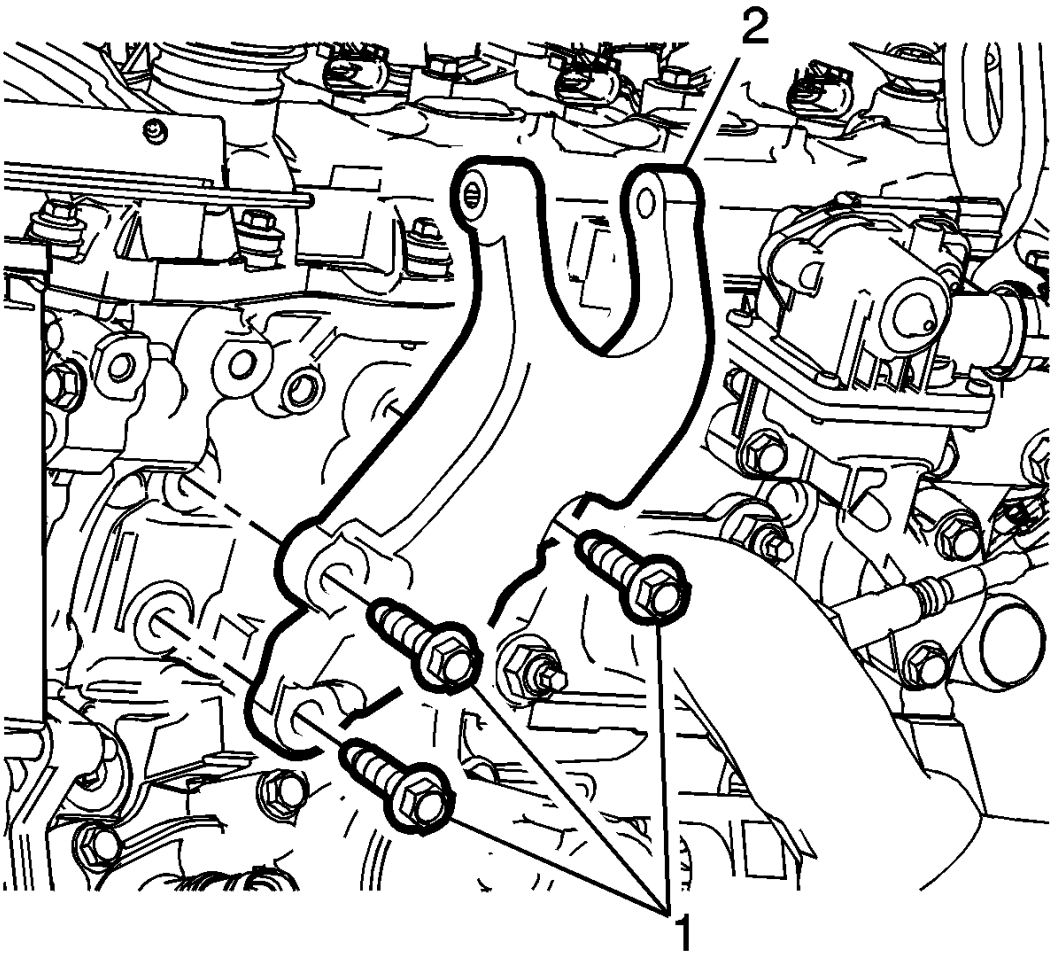

Fig. 48: Engine Strut Bracket And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the engine strut bracket assembly (2) into position.

CAUTION: Refer to Fastener Caution .

2. Instal New bolts (1) and tighten to 60 N.m (44 lb ft), plus an additional 90 to 105 degrees.

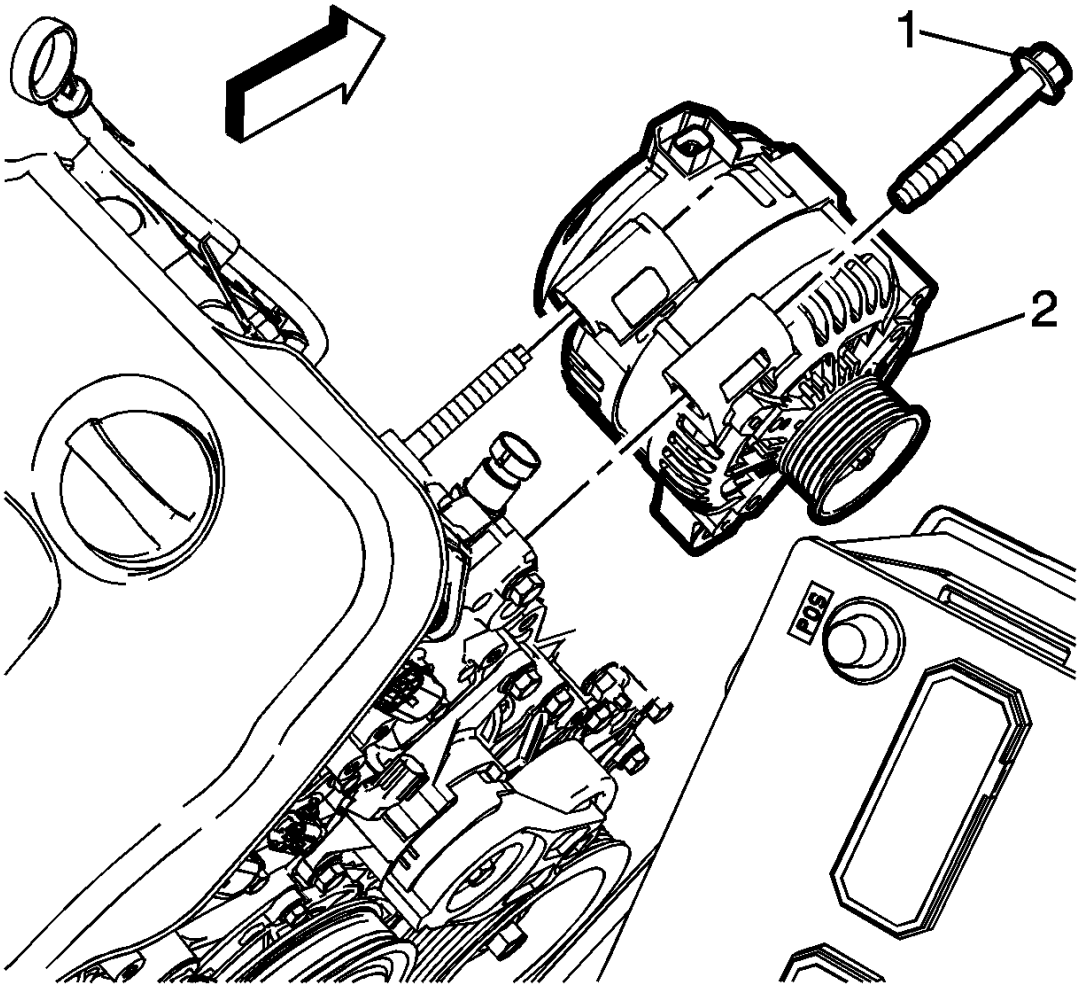

Fig. 49: Generator And Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Install the generator (2). Refer to **Generator Replacement** .

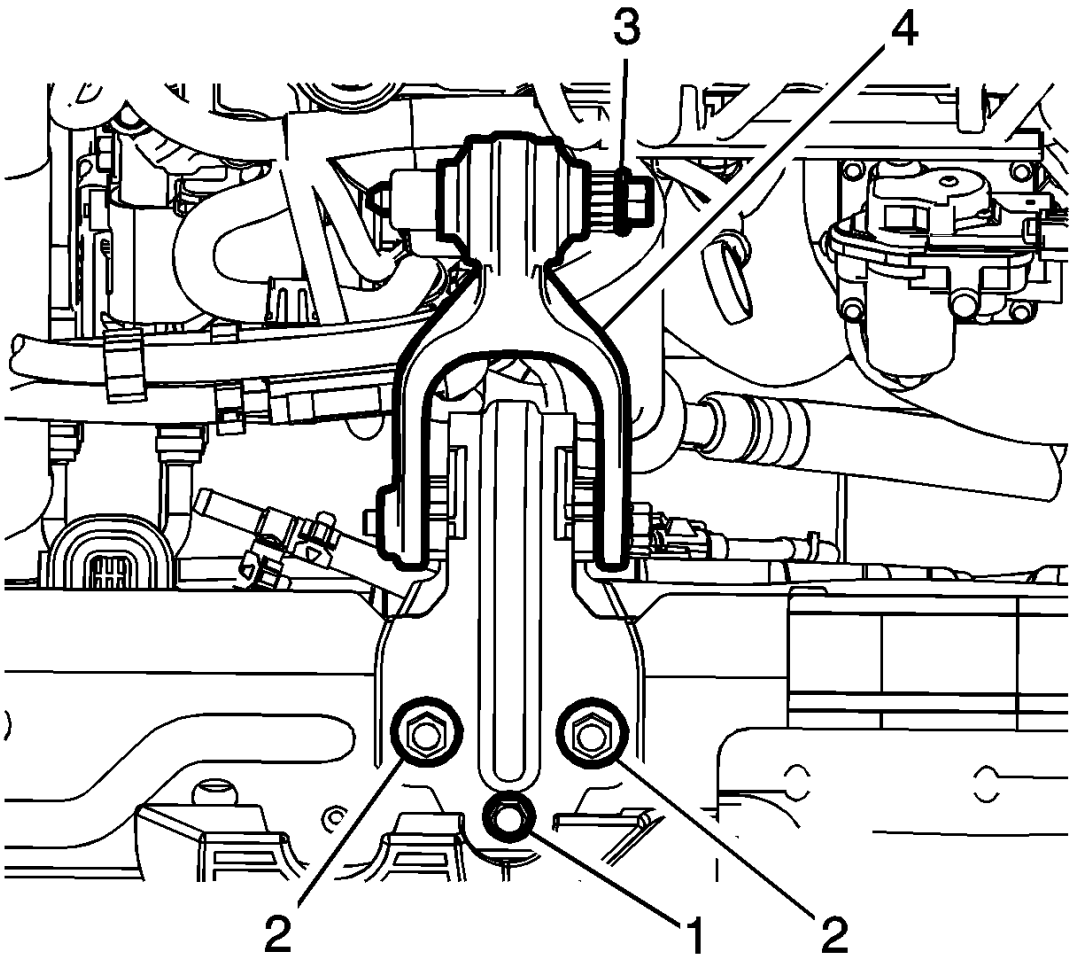

Fig. 50: Engine Strut And Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Install the engine mount strut (4). Refer to **Engine Mount Strut Replacement - Right Side**
5. Install the radiator air upper baffle and deflector. Refer to **Radiator Air Upper Baffle and Deflector Replacement** .

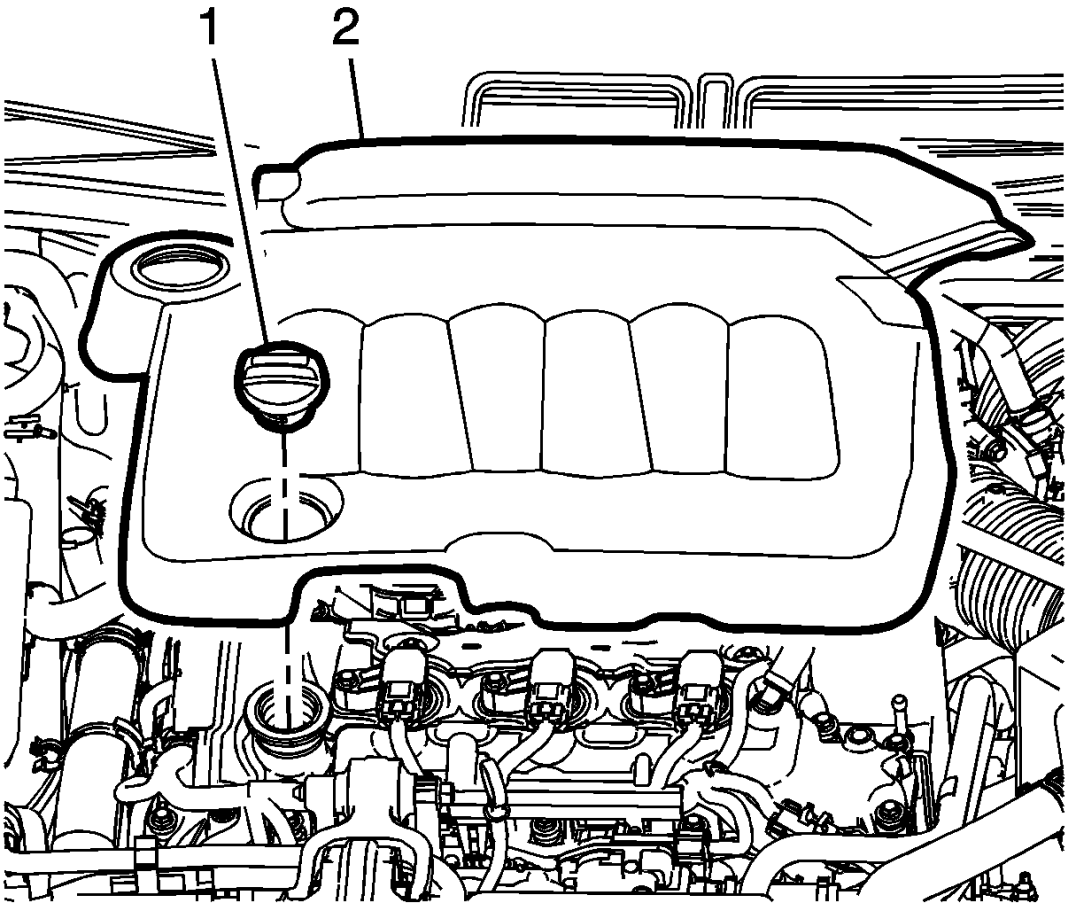

Fig. 51: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

6. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

INTAKE MANIFOLD COVER REPLACEMENT

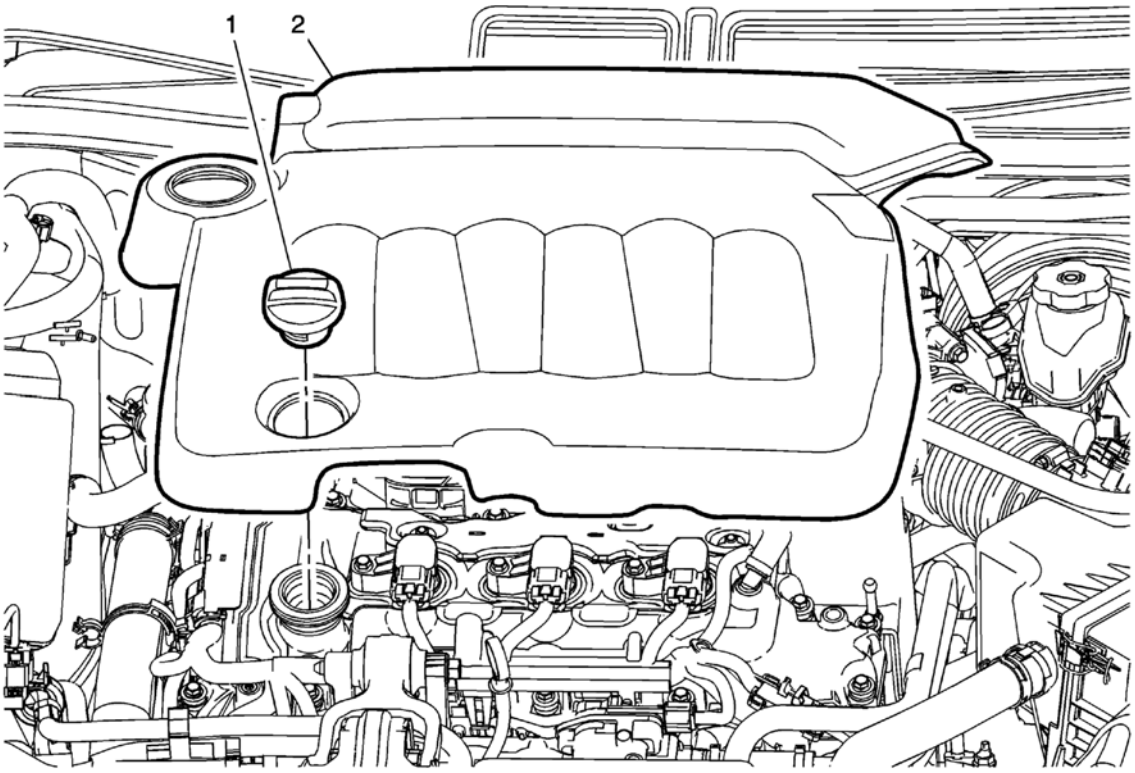

Fig. 52: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Oil Filler Cap
2	Intake Manifold Cover **Procedure** Grasp cover on outside edges and lift up to release from retainers.

POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - FRONT

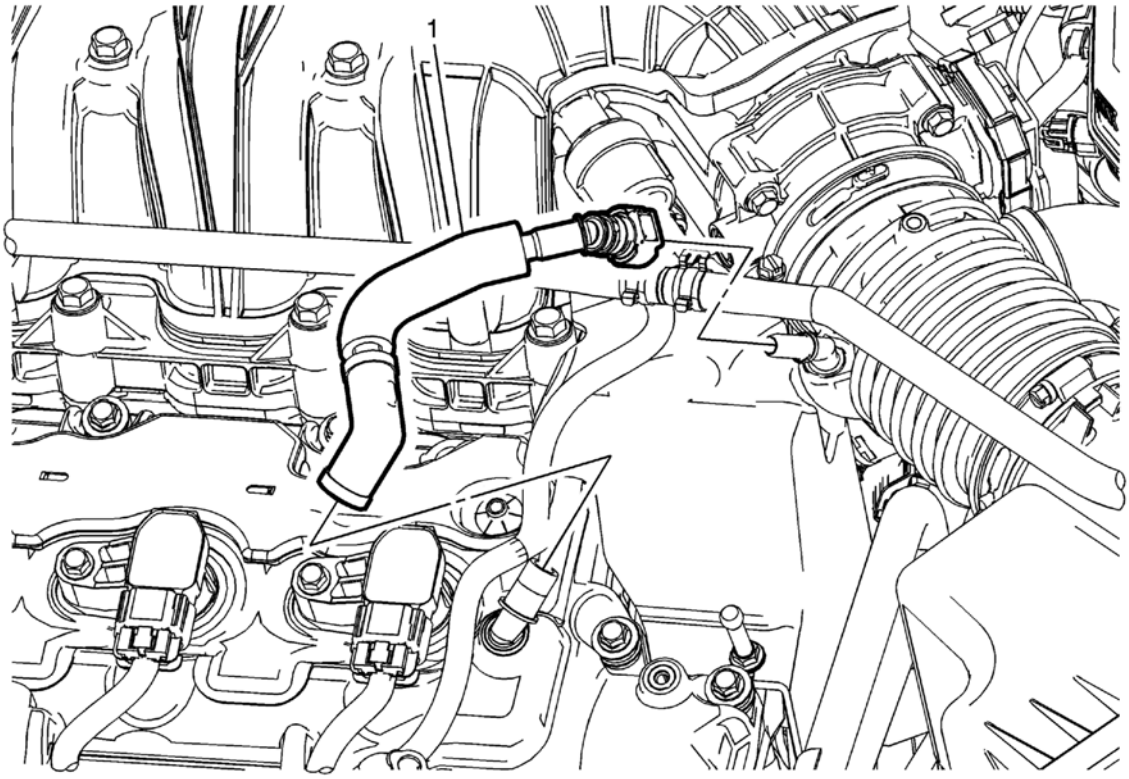

Fig. 53: Positive Crankcase Ventilation Tube - Front
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.	
1	Positive Crankcase Ventilation Tube **Procedure** Remove tube from valve cover and air cleaner outlet tube. Refer to **Plastic Collar Quick Connect Fitting Service** .

POSITIVE CRANKCASE VENTILATION TUBE REPLACEMENT - REAR

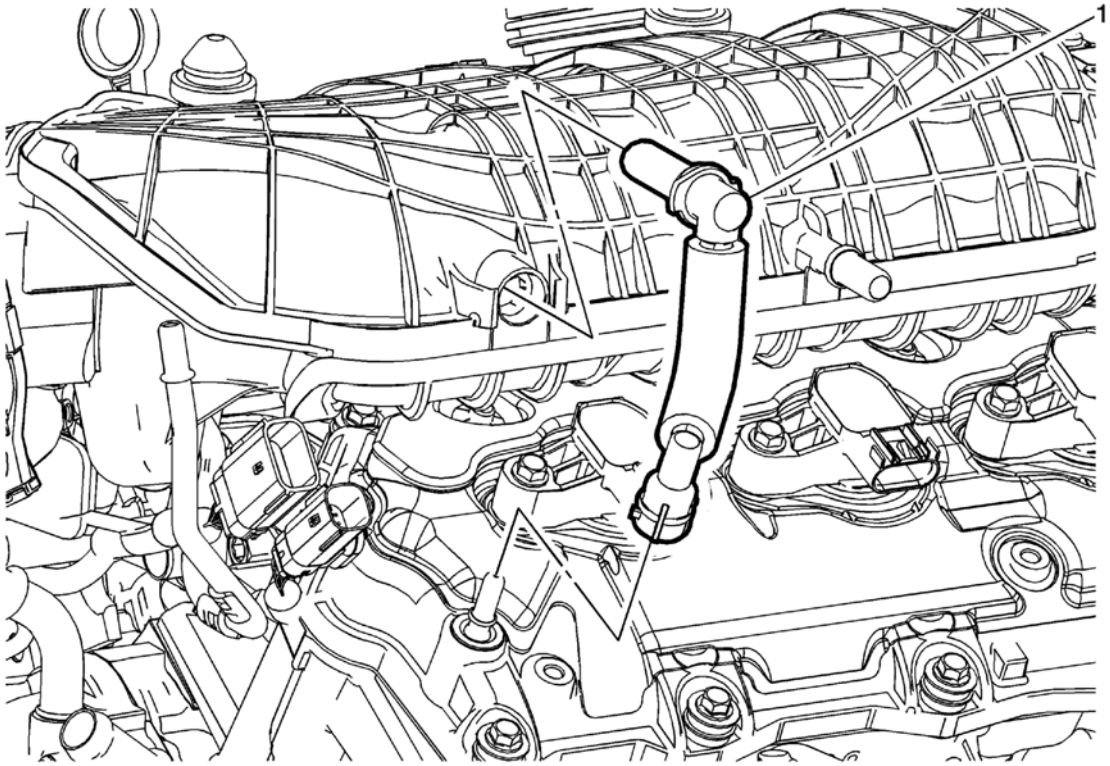

Fig. 54: Positive Crankcase Ventilation Tube - Rear
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement**.	
1	Positive Crankcase Ventilation Tube **Procedure** Remove tube from valve cover and intake manifold. Refer to **Plastic Collar Quick Connect Fitting Service** .

INTAKE MANIFOLD REPLACEMENT

Removal Procedure

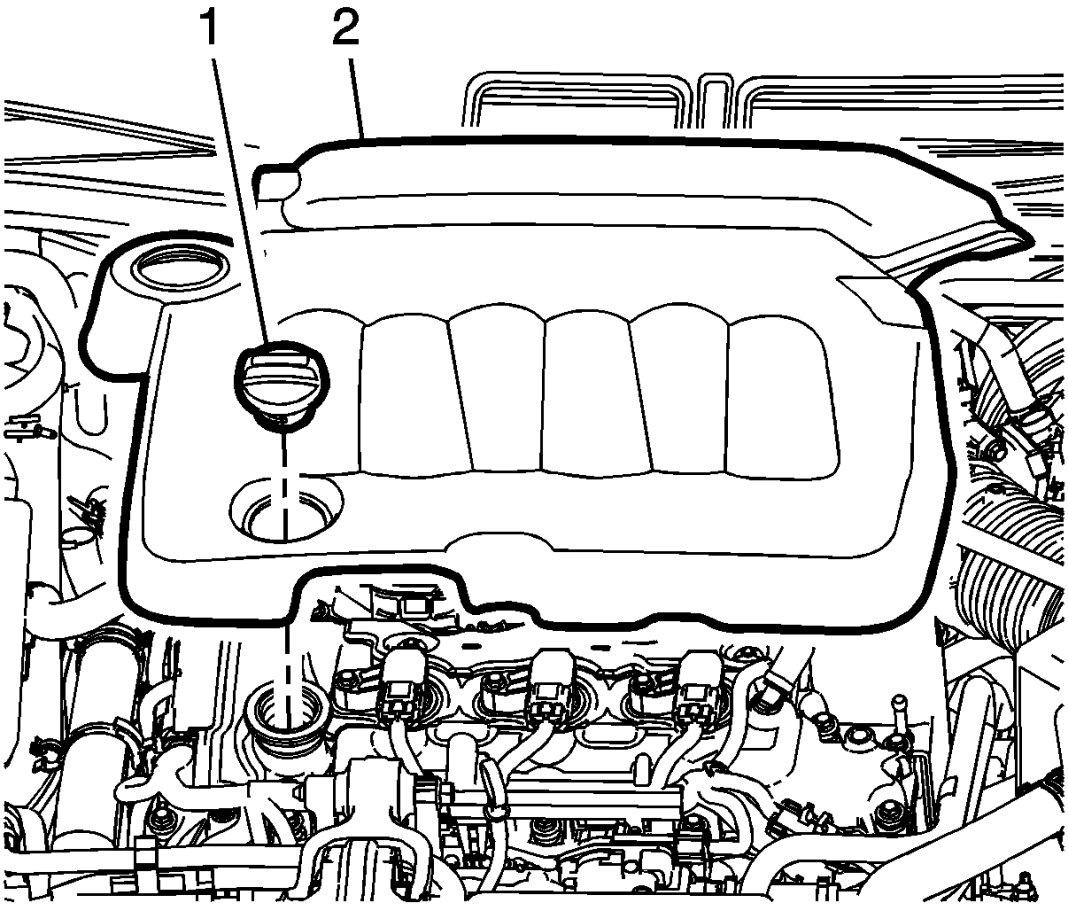

Fig. 55: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**

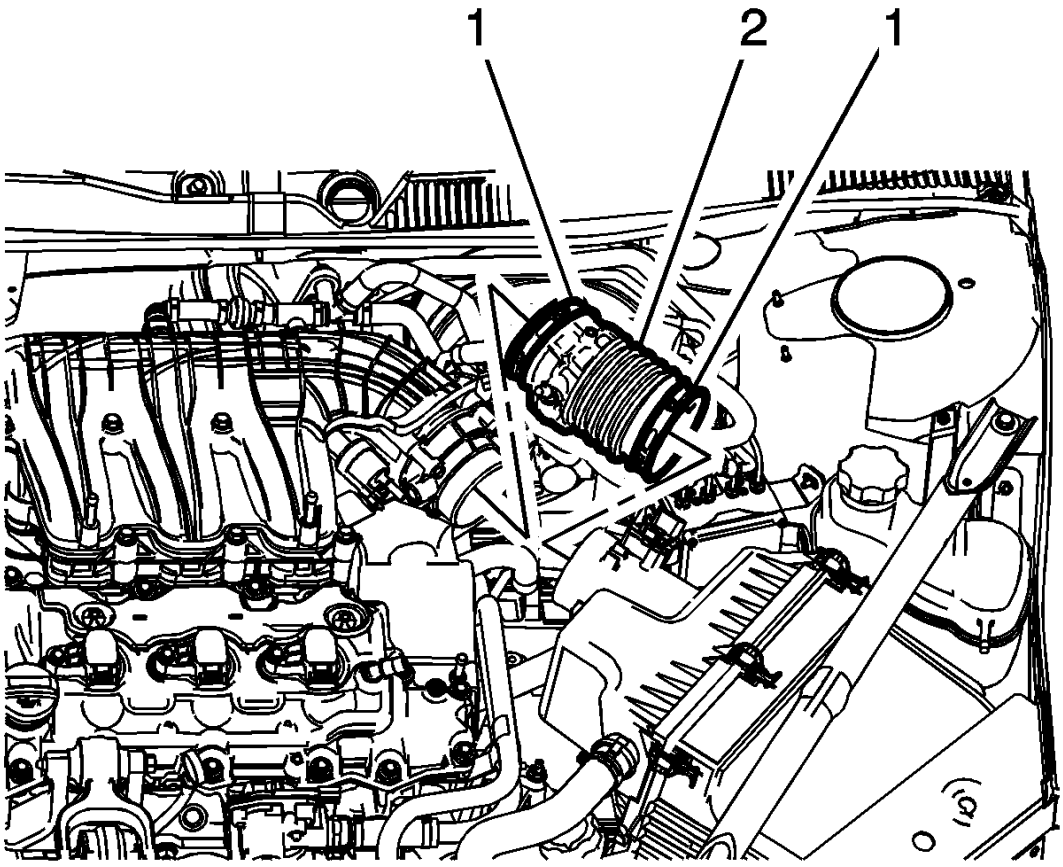

Fig. 56: Air Cleaner Outlet Duct And Clamps
Courtesy of GENERAL MOTORS COMPANY

2. Loosen the clamps (1) and remove the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement**

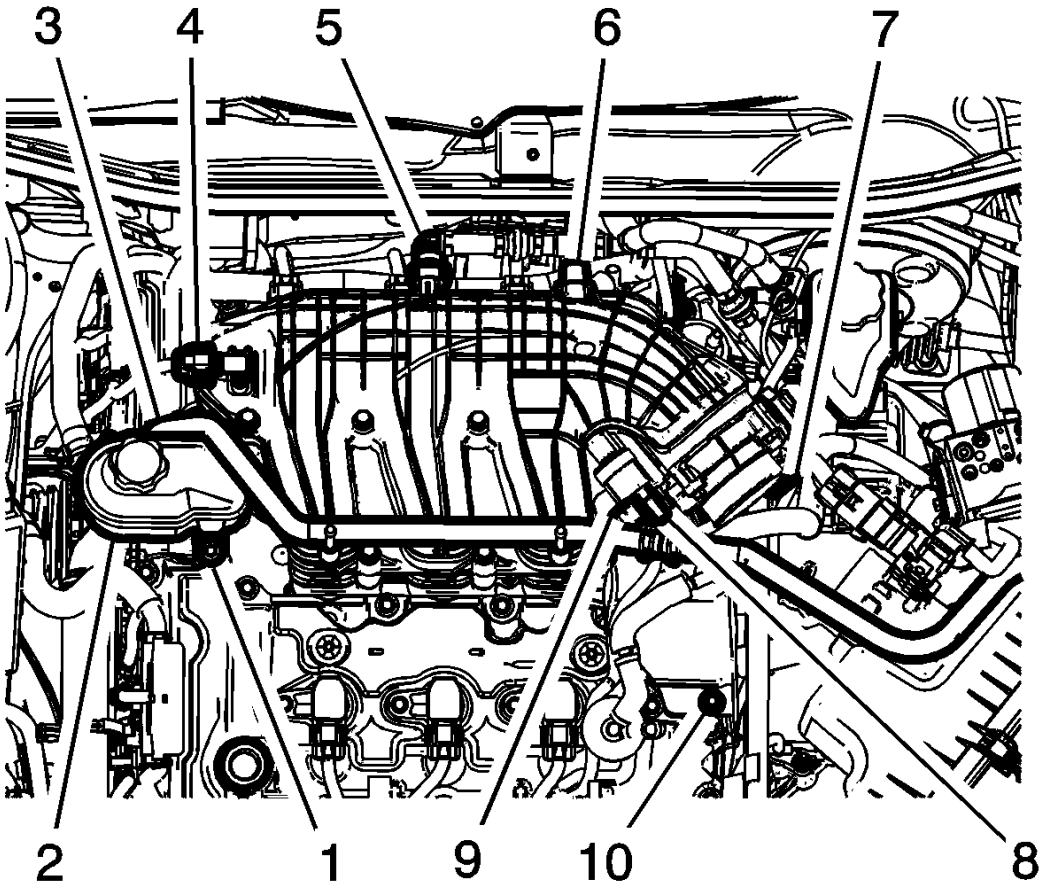

Fig. 57: Locating Intake Manifold Components
Courtesy of GENERAL MOTORS COMPANY

3. Remove the power steering reservoir bolt (1) and position the reservoir (2) out of the way.
4. Disconnect the surge tank hose (3) from the intake manifold and position out of the way.
5. Disconnect the MAP sensor (4).
6. Disconnect the brake booster vacuum hose (5) from the intake manifold.
7. Disconnect the positive crankcase ventilation tube (6) from the intake manifold.
8. Disconnect the throttle body connector (7).
9. Remove the evaporative emission hose (8) and connector (9) from the EVAP solenoid.
10. Remove the fuel pump cover bolt (10).
11. Remove the fuel pump cover.

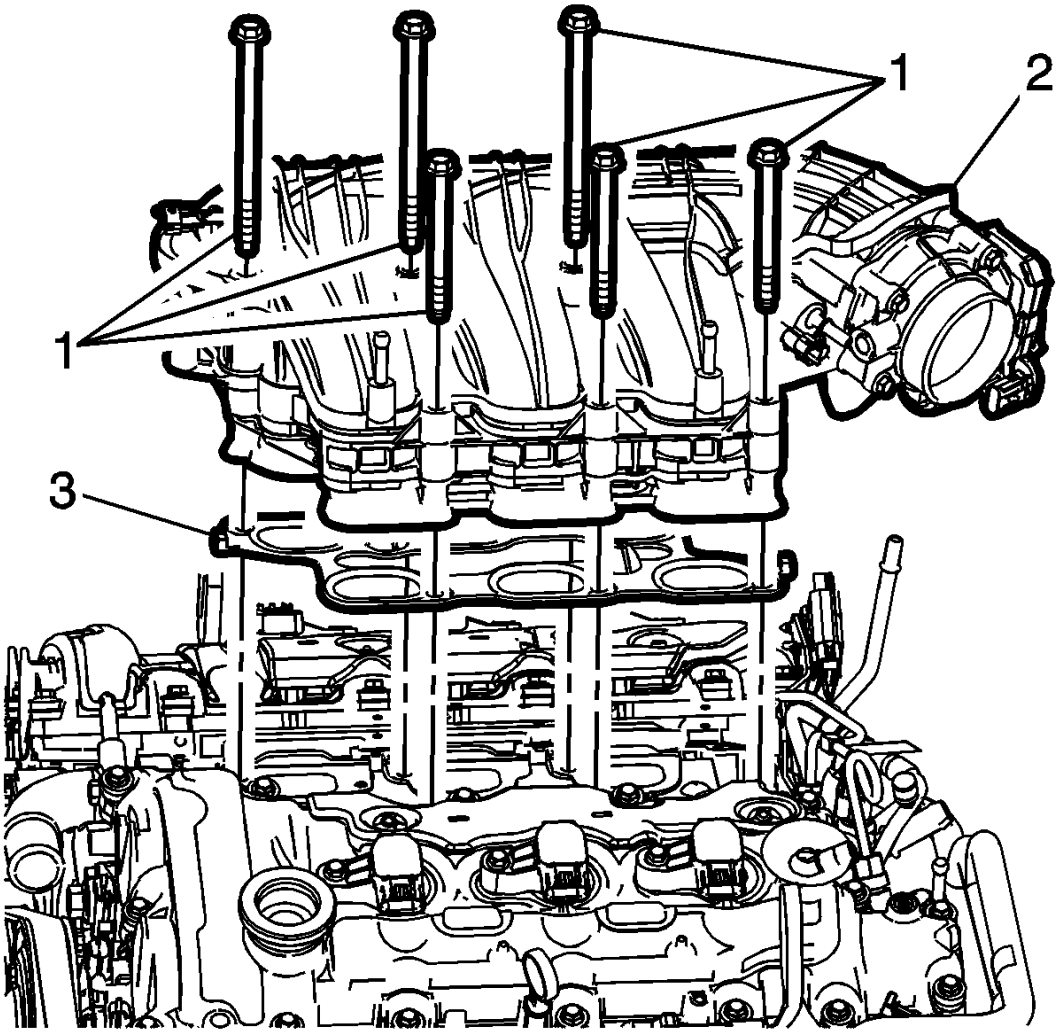

Fig. 58: Intake Manifold Assembly, Gasket And Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Remove the intake manifold bolts (1).
13. Remove the intake manifold assembly (2).
14. Remove and discard the intake manifold gasket (3).
15. Transfer parts as needed.

Installation Procedure

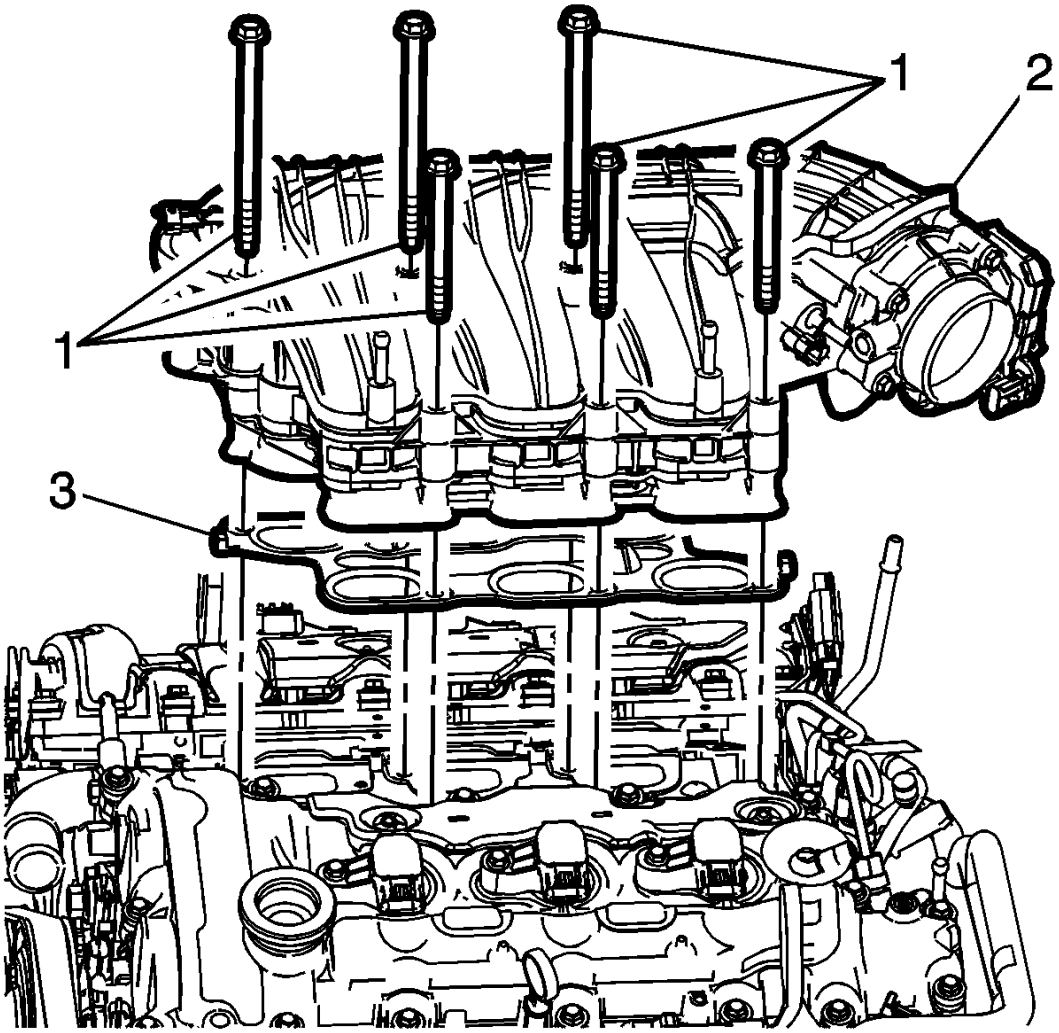

Fig. 59: Intake Manifold Assembly, Gasket And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW intake manifold gasket (3).
2. Install the intake manifold assembly (2).

CAUTION: Refer to Fastener Caution

3. Install the intake manifold bolts (1).

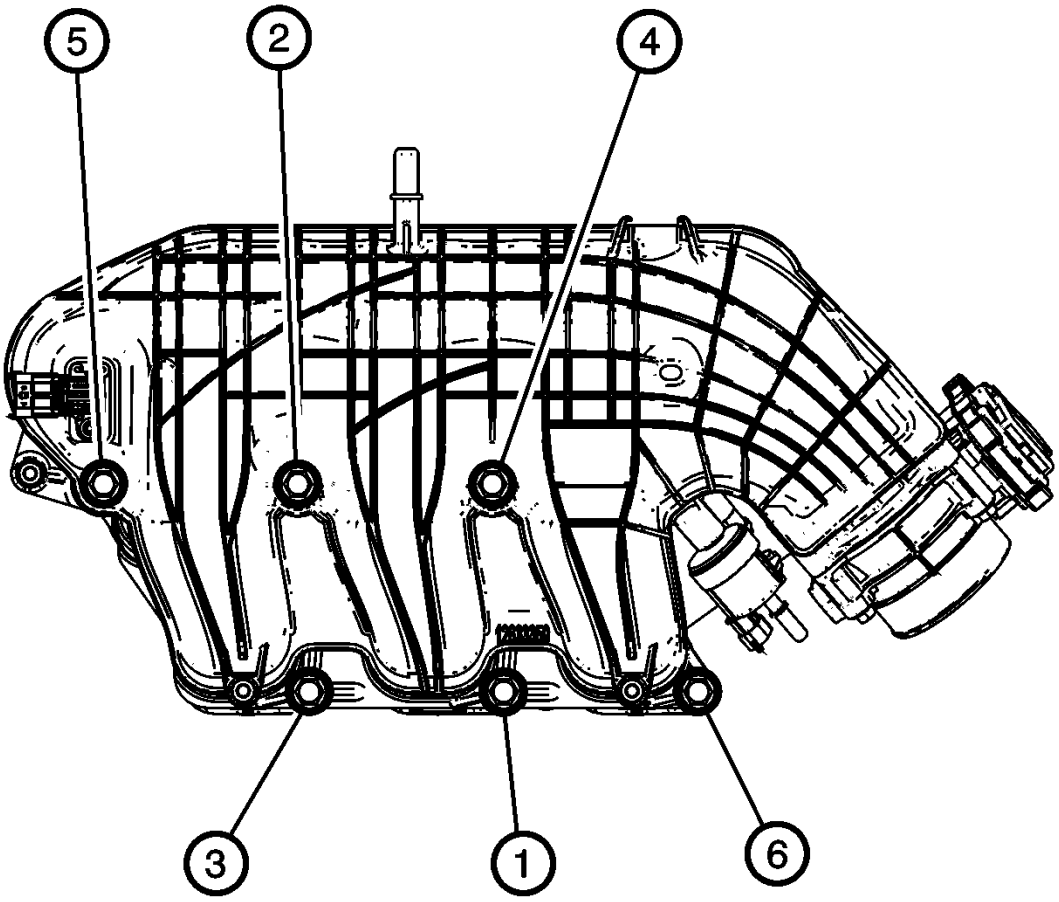

Fig. 60: Intake Manifold Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

4. Tighten the intake manifold bolts in the sequence shown.
5. Tighten the intake manifold bolts in sequence to 25 N.m (18 lb ft).
6. Tighten the intake manifold bolts a second pass in sequence to 25 N.m (18 lb ft).

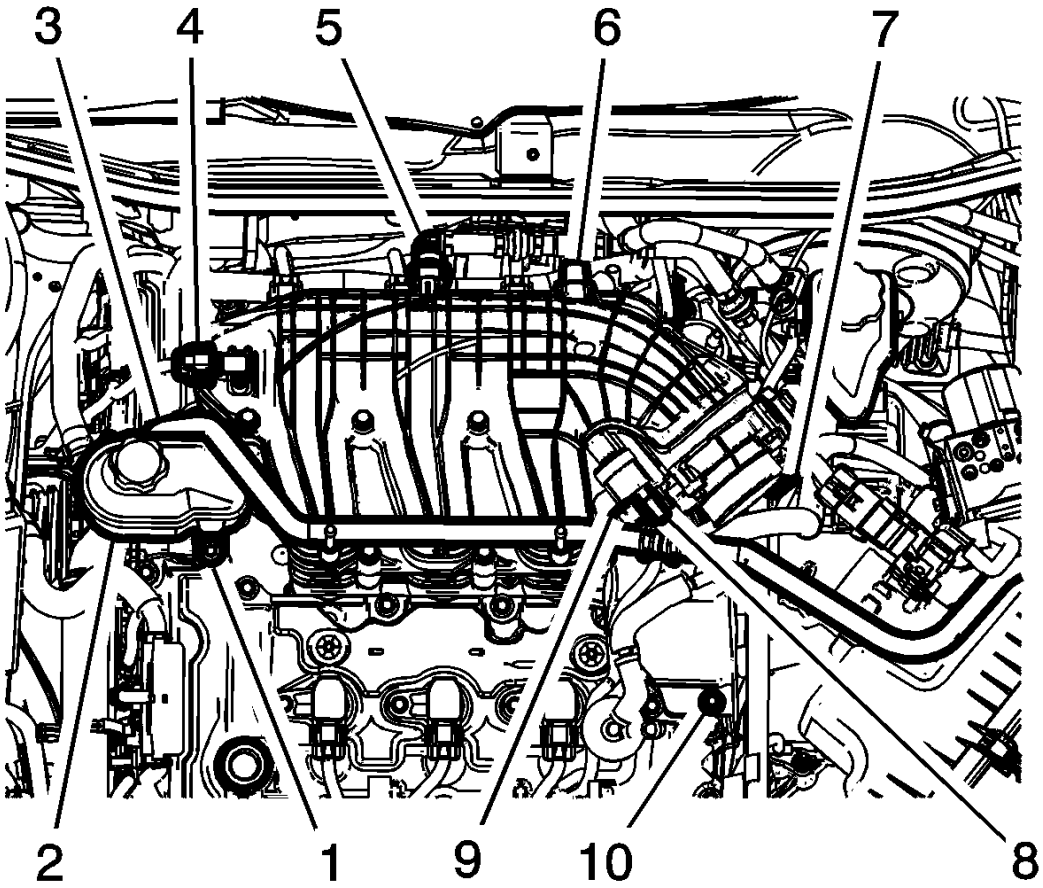

Fig. 61: Locating Intake Manifold Components
Courtesy of GENERAL MOTORS COMPANY

7. Install the fuel pump cover.
8. Install the fuel pump cover bolt (10) and tighten to 10 N.m (89 lb in).
9. Connect the EVAP hose (8) and connector (9) to the EVAP solenoid.
10. Connect the throttle body connector (7).
11. Connect the PCV tube (6) to the intake manifold.
12. Connect the brake vacuum booster hose (5) to the intake manifold.
13. Connect the MAP sensor (4).
14. Connect the surge tank hose (3) to the intake manifold.
15. Position the power steering reservoir (2) and install the bolt (1).

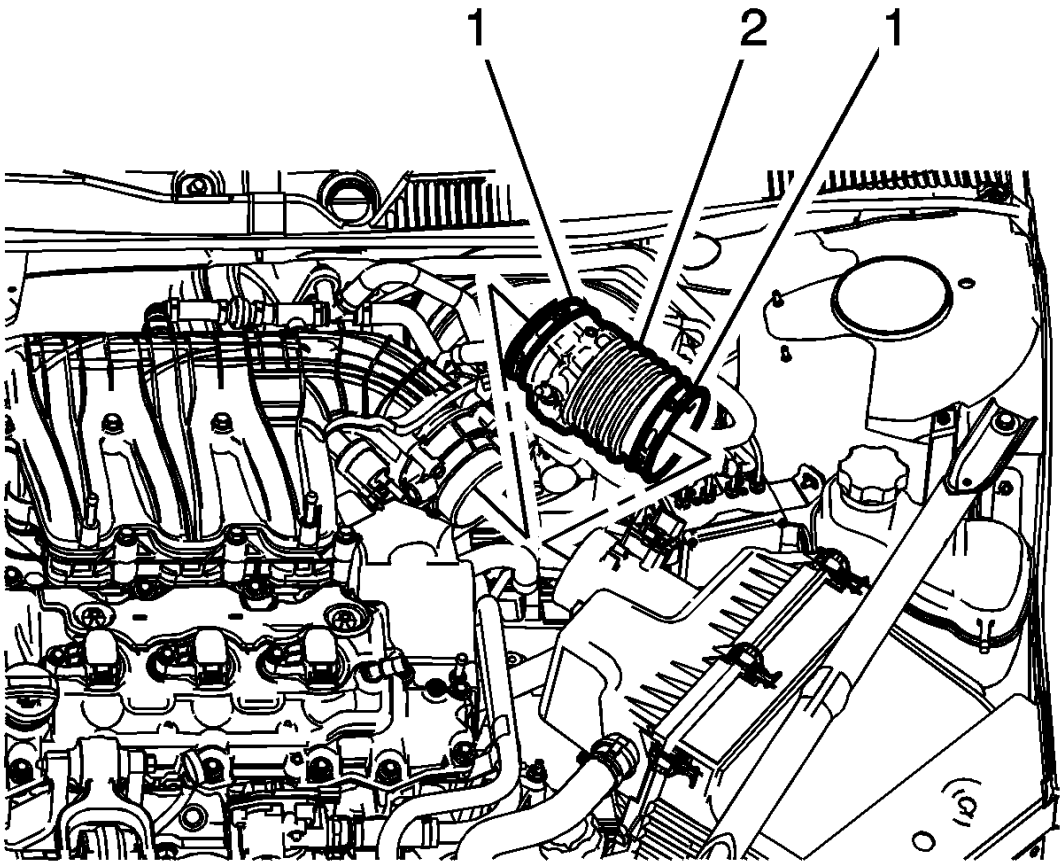

Fig. 62: Air Cleaner Outlet Duct And Clamps
Courtesy of GENERAL MOTORS COMPANY

16. Install the air cleaner outlet duct (2) and tighten the clamps (1). Refer to **Air Cleaner Outlet Duct Replacement**

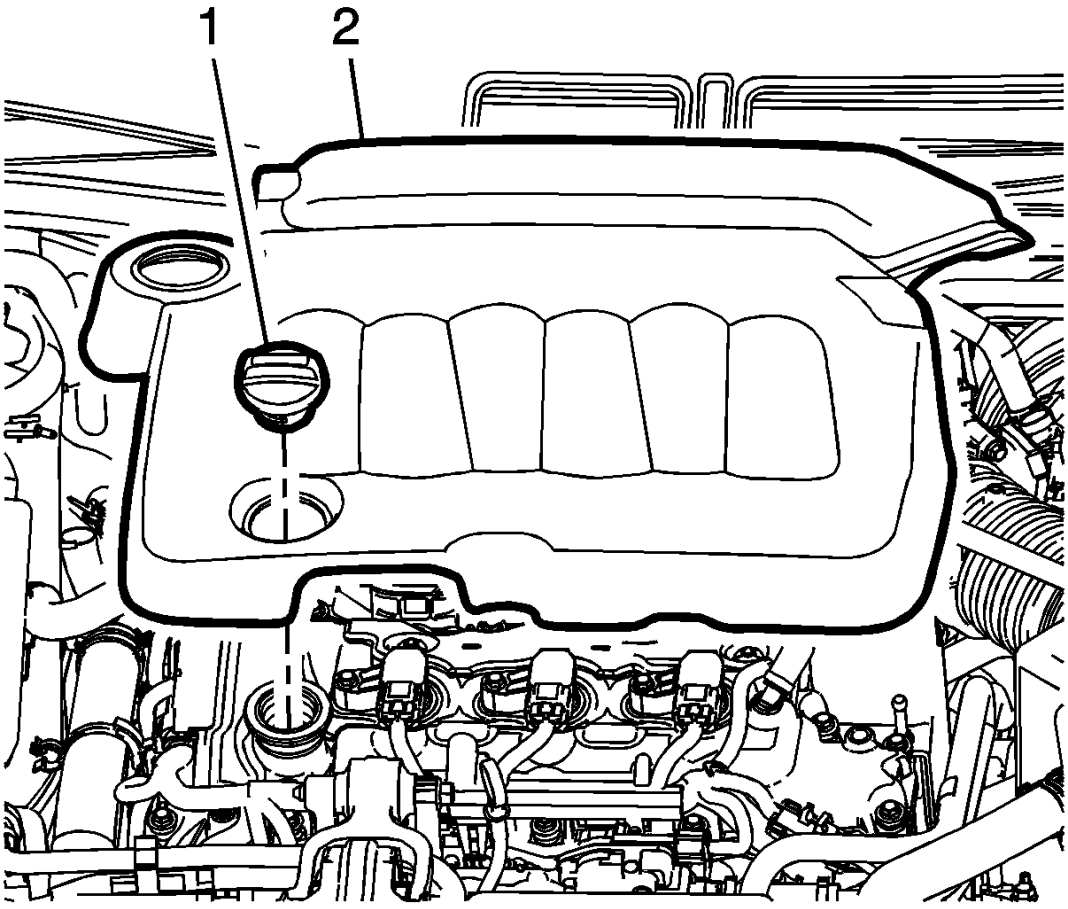

Fig. 63: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

17. Install intake manifold cover. Refer to **Intake Manifold Cover Replacement**.

OIL LEVEL INDICATOR TUBE REPLACEMENT

Removal Procedure

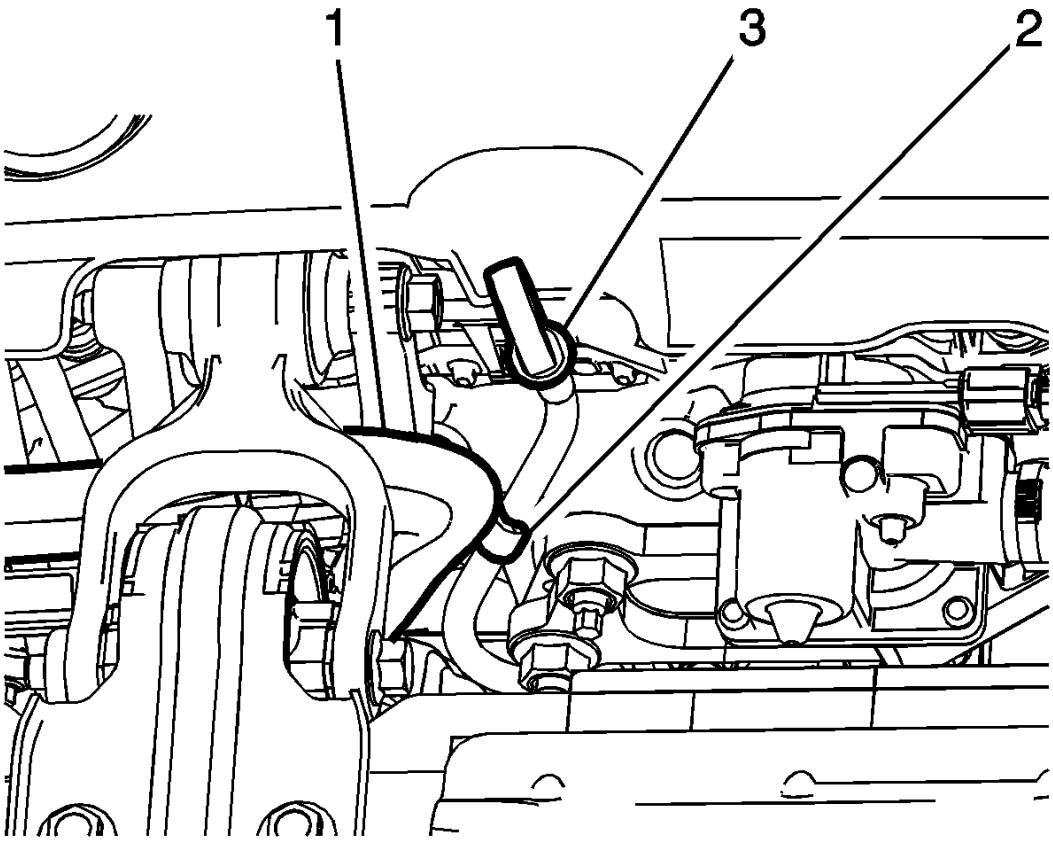

Fig. 64: Oil Level Indicator, Oil Level Indicator Tube Bracket And Battery Cables
Courtesy of GENERAL MOTORS COMPANY

1. Remove the battery cables (1) from the oil level indicator tube bracket (2).
2. Remove the oil level indicator (3).

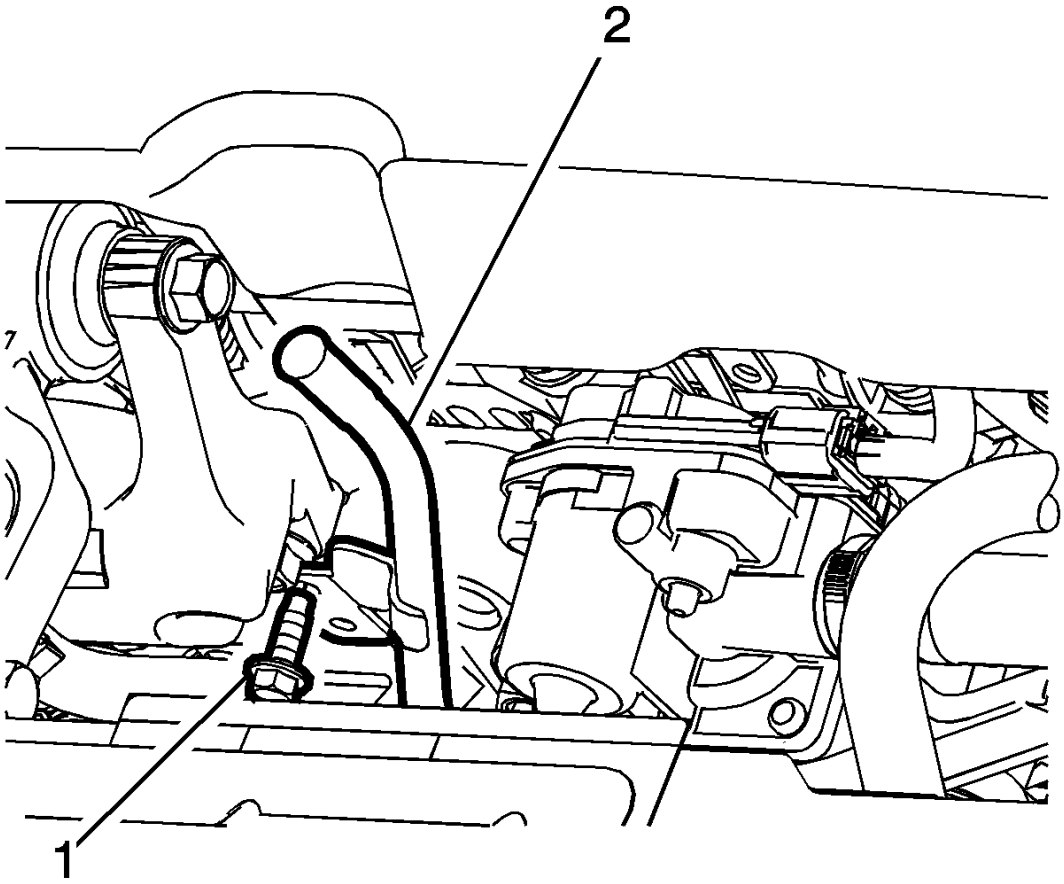

Fig. 65: Oil Level Indicator Tube And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Remove the oil level indicator tube bolt (1).
4. Remove the oil level indicator tube (2) by sliding the tube out from the lower crankcase hole.

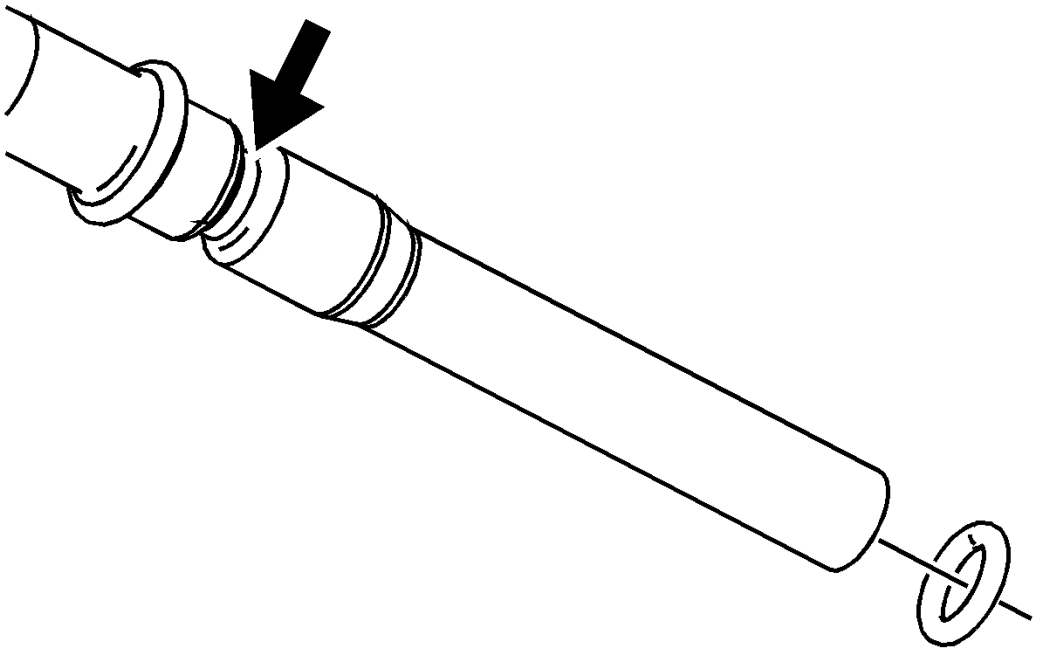

Fig. 66: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

5. Remove and discard the O-ring from the oil level indicator tube if damaged.

Installation Procedure

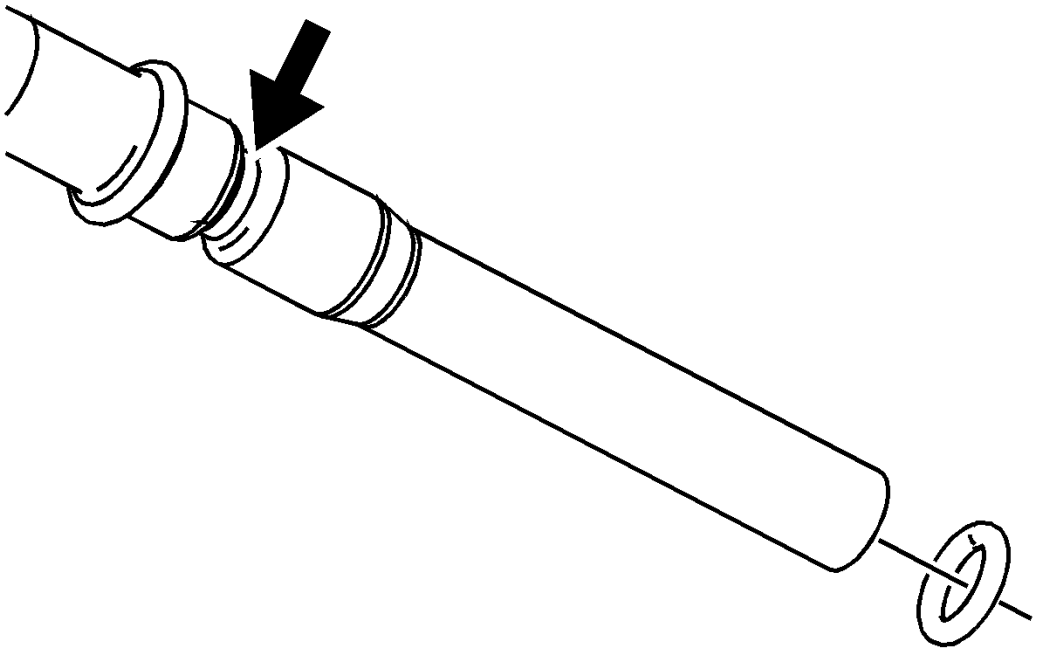

Fig. 67: View Of Oil Level Indicator Tube O-Ring
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW O-ring on the oil level indicator tube.
2. Lubricate the O-ring with clean engine oil.

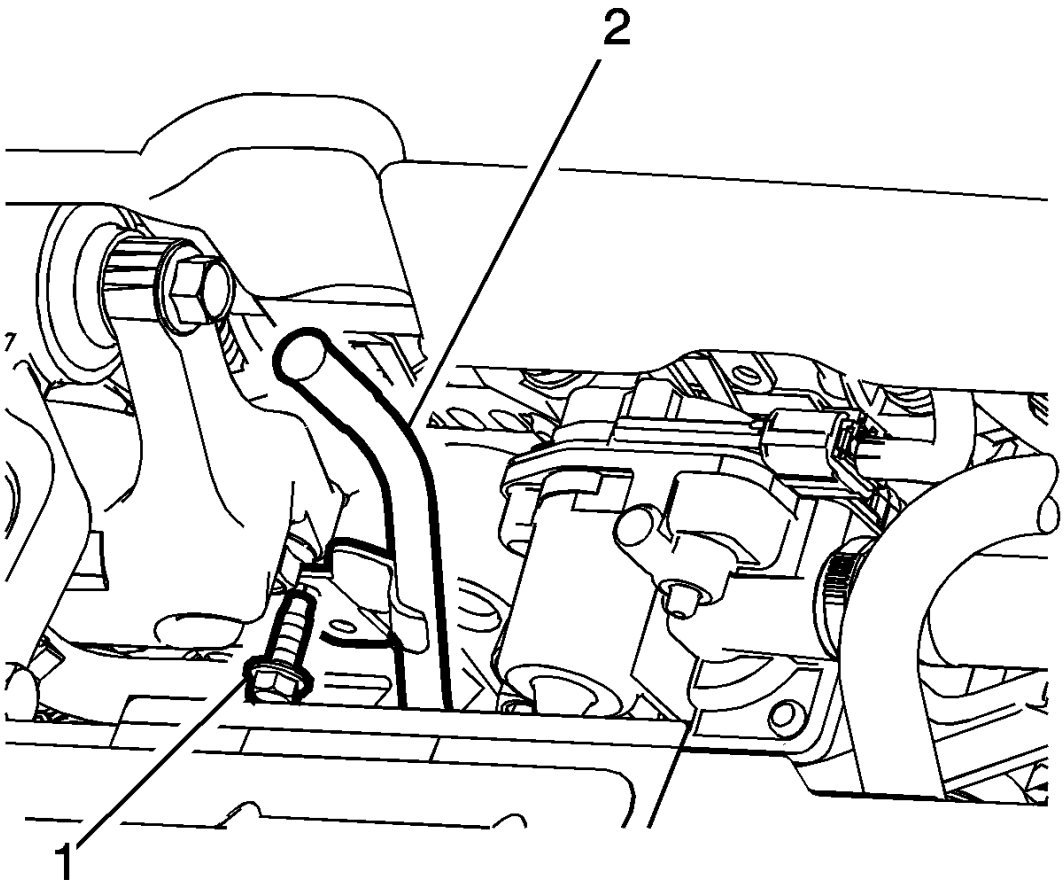

Fig. 68: Oil Level Indicator Tube And Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install the oil level indicator tube (2) by sliding the tube down through the lower crankcase hole.

CAUTION: Refer to Fastener Caution .

4. Install the oil level indicator tube bracket bolt (1) and tighten to 10 N.m (89 lb in).

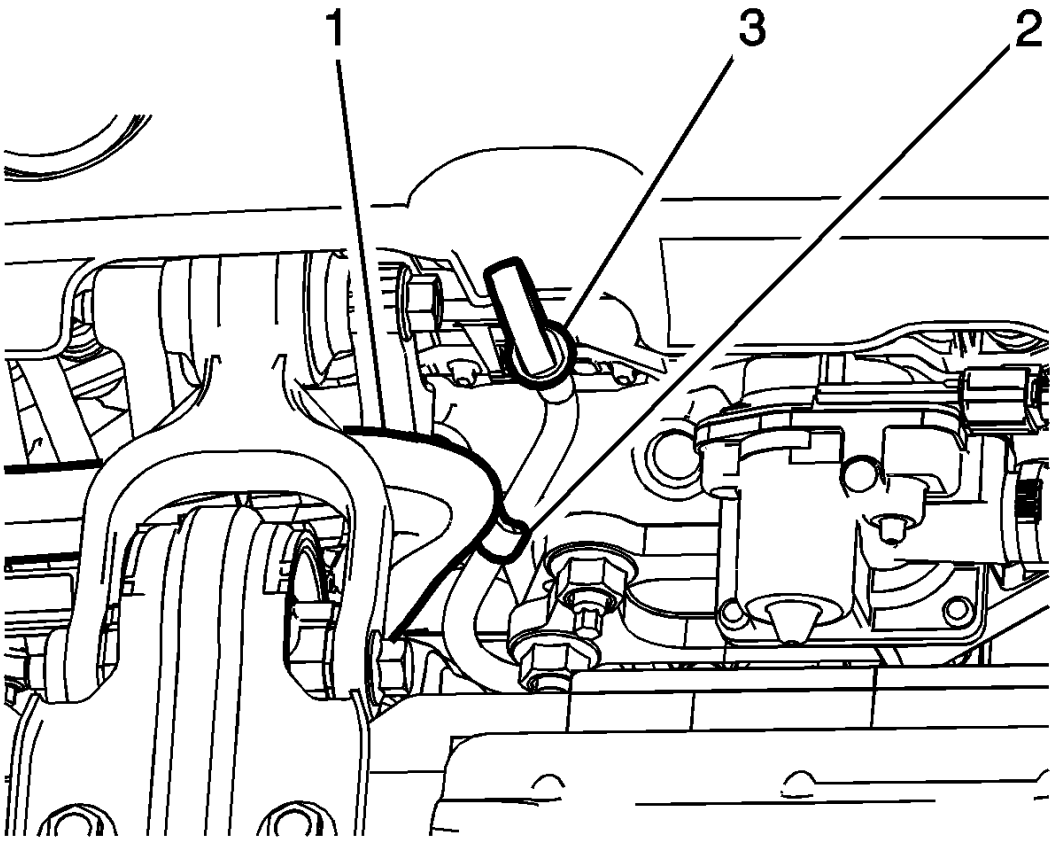

Fig. 69: Oil Level Indicator, Oil Level Indicator Tube Bracket And Battery Cables
Courtesy of GENERAL MOTORS COMPANY

5. Install the oil level indicator (3).
6. Secure the battery cables (1) to the oil level indicator tube bracket (2).

OIL FILTER ADAPTER REPLACEMENT

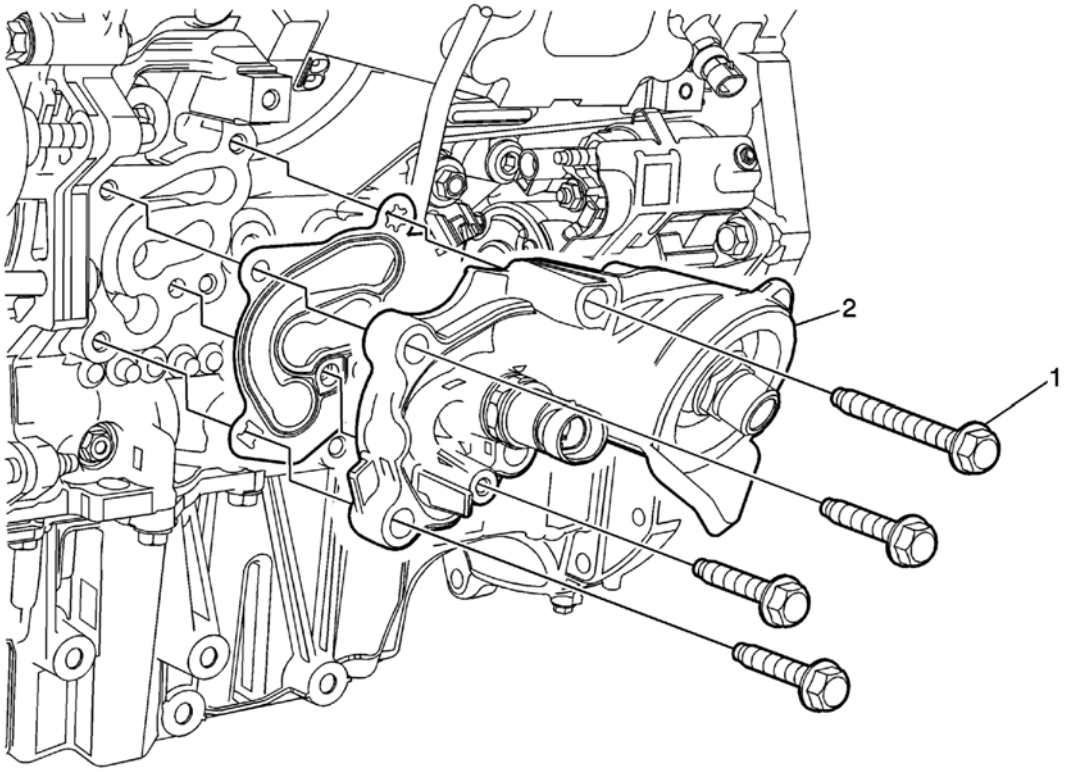

Fig. 70: Oil Filter Adapter & Fasteners
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the generator. Refer to **Generator Replacement** . 2. Remove the bolts from the air conditioning compressor without disconnecting the air conditioning lines and position out of the way. Refer to **Air Conditioning Compressor Replacement** . 3. Remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**. 4. Remove the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .	
1	Oil Filter Adapter Fastener (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
2	Oil Filter Adapter **Procedure**

Callout	Component Name
	1. Replace oil filter adapter gasket. 2. Disconnect electrical connector as needed. 3. Transfer components as necessary.

CRANKSHAFT BALANCER REPLACEMENT

Special Tools

- **EN-38416-2** Crankshaft Button
- **EN-41816** Crankshaft Balancer Remover
- **EN-41998-B** Crankshaft Balancer Installer
- **EN-45059** Angle Meter
- **EN-46106** Flywheel Holding Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the drive belt. Refer to **Drive Belt Replacement**.
2. Remove the engine mount. Refer to **Engine Mount Strut Replacement - Right Side**.
3. Remove the starter. Refer to **Starter Replacement** .

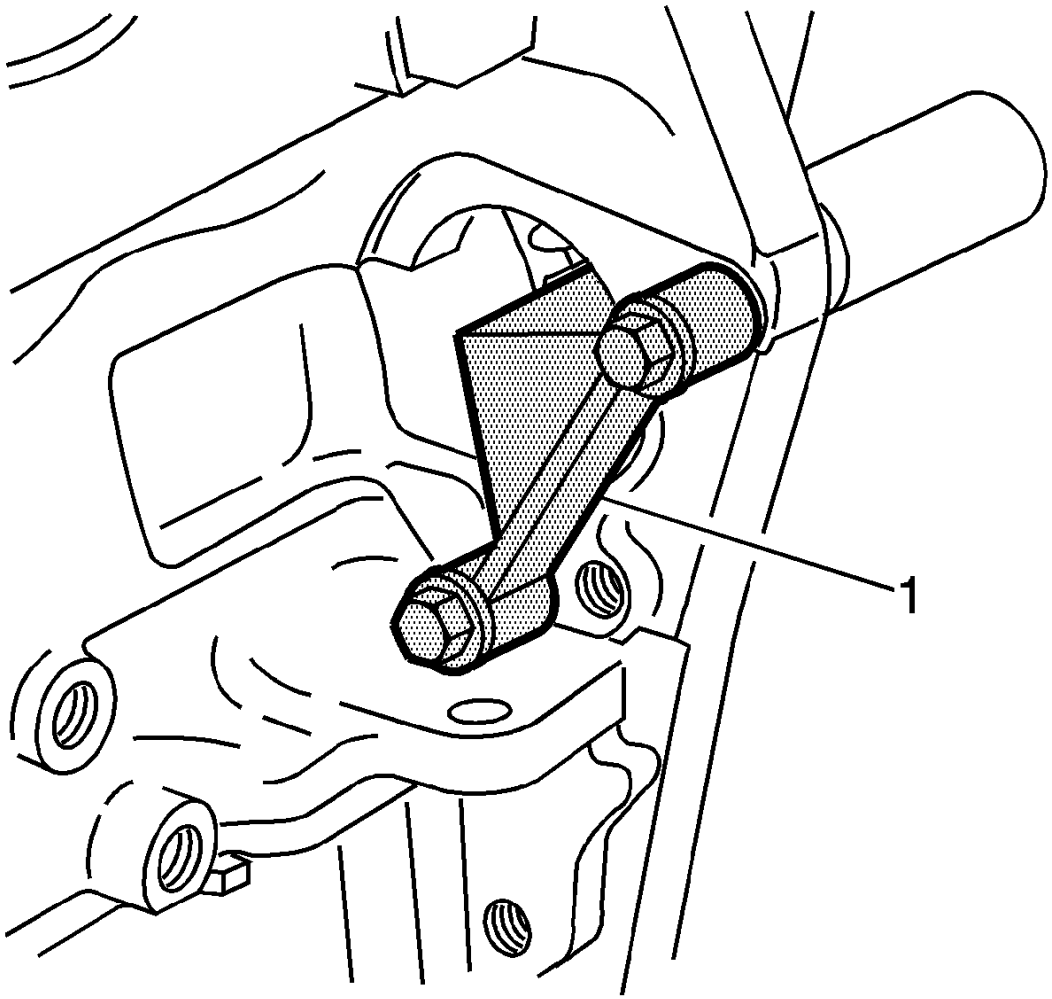

Fig. 71: Flywheel Holding Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-46106** tool (1) through the starter mounting hole.

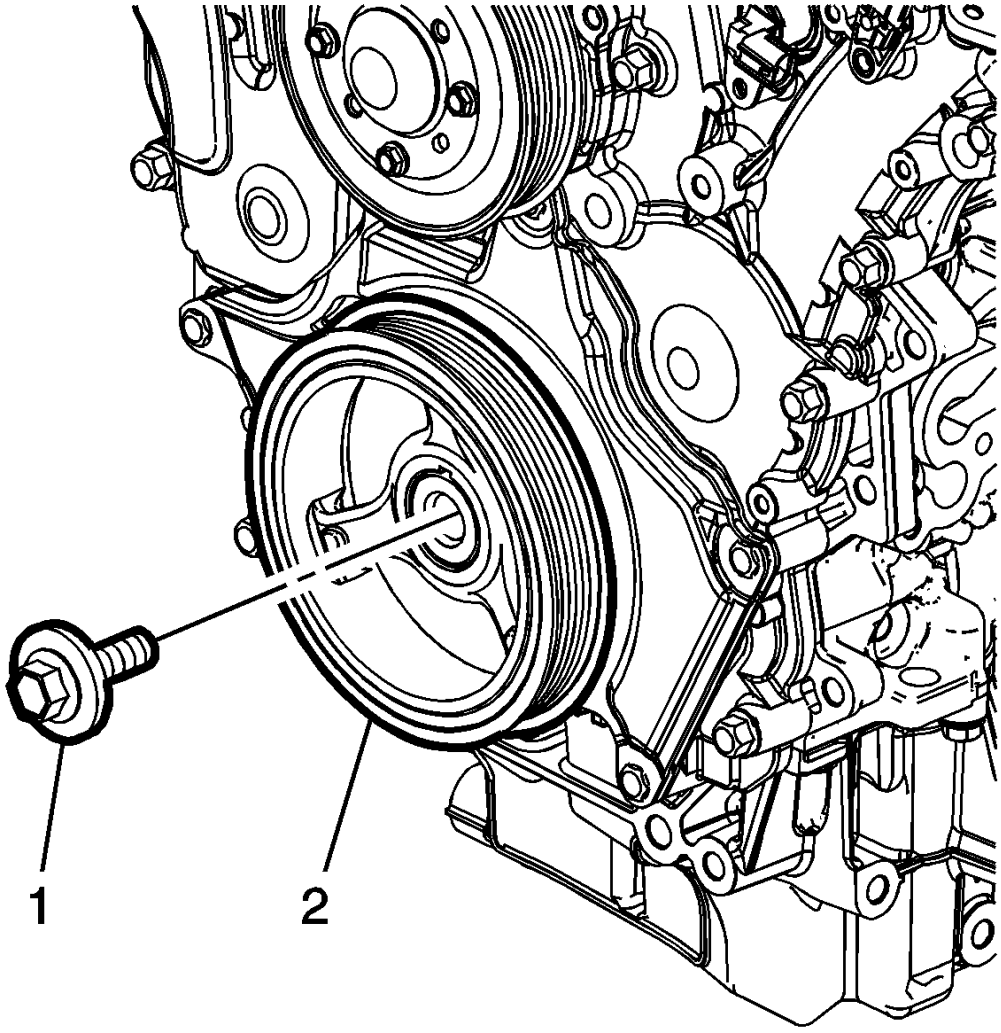

Fig. 72: Crankshaft Balancer And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Using engine support fixture, lower engine approximately two inches.
6. Remove the crankshaft balancer bolt (1). Discard the bolt.

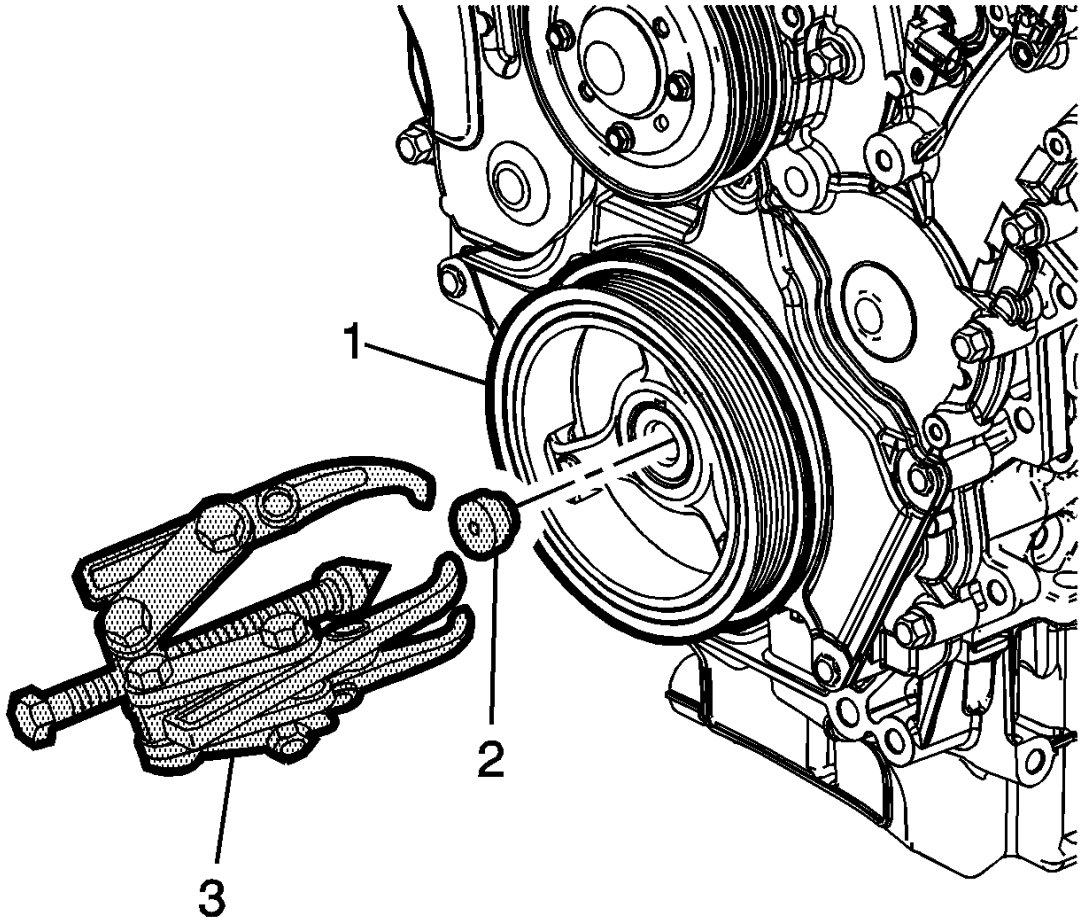

Fig. 73: Crankshaft Balancer & Removal Tools
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-38416-2** button (2) in the nose of the crankshaft.
8. Install the **EN-41816** remover (3) in order to remove the crankshaft balancer (1).
9. Tighten the center bolt of the **EN-41816** remover in order to pull the crankshaft balancer off of the crankshaft.
10. Remove the **EN-41816** remover from the crankshaft balancer.

Installation Procedure

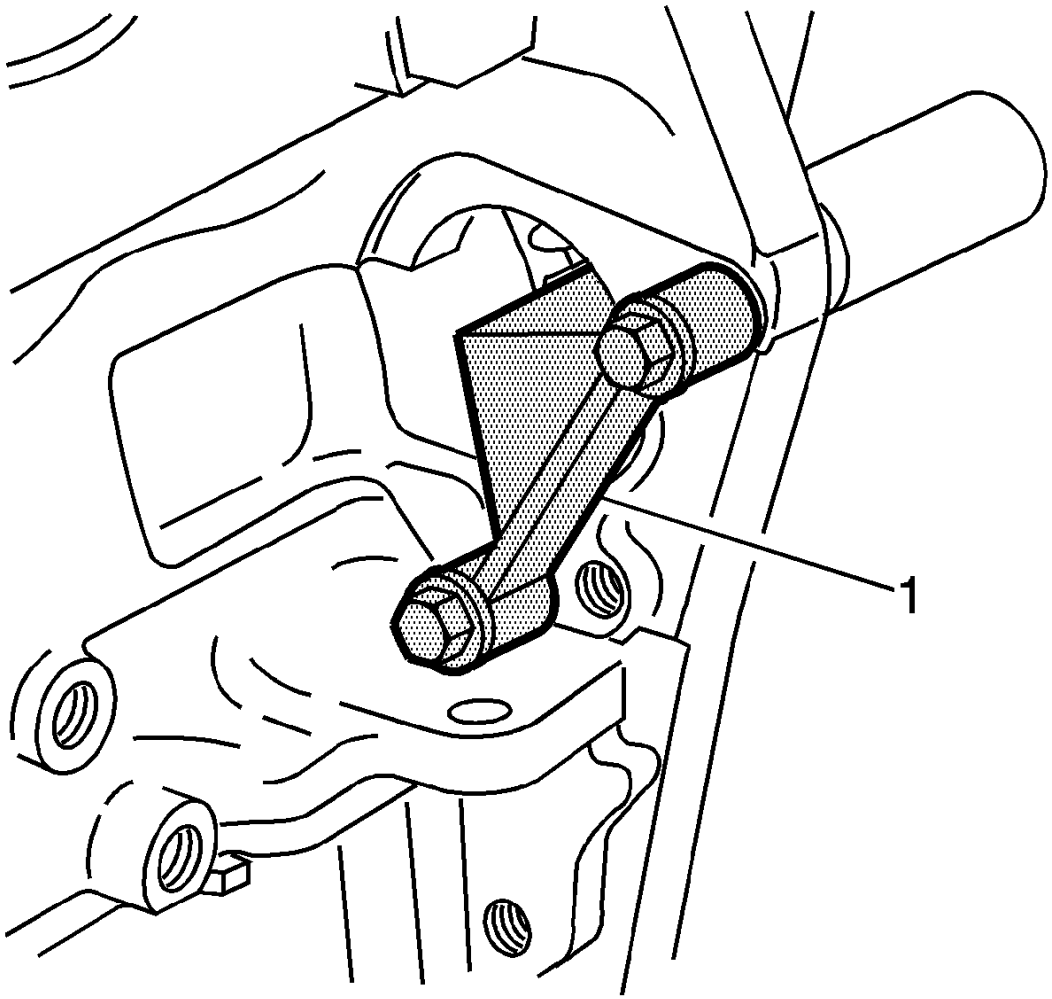

Fig. 74: Flywheel Holding Tool
Courtesy of GENERAL MOTORS COMPANY

1. The **EN-46106** tool (1) must be installed onto the flywheel.
2. Use the **EN-41998-B** installer , nut, bearing and washer to install the crankshaft balancer.

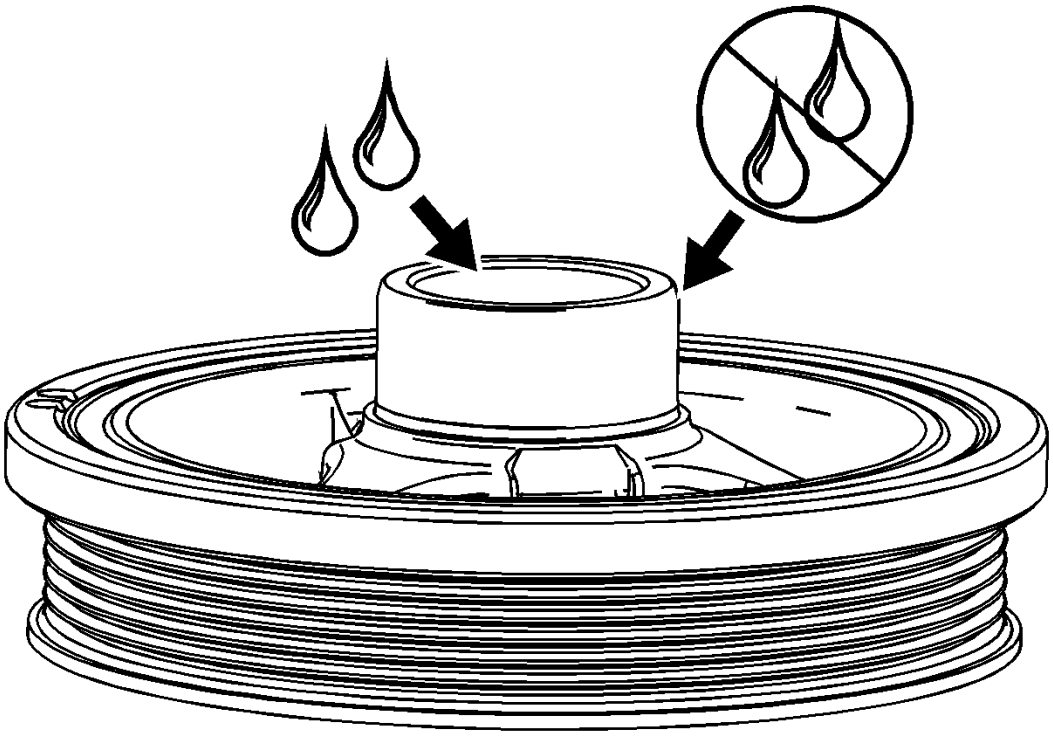

Fig. 75: Identifying Lubrication & Non-Lubrication Areas On Crankshaft Balancer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not lubricate the crankshaft front oil seal or crankshaft balancer sealing surfaces. The crankshaft balancer is installed into a dry seal.**

3. Apply lubricant to the inside of the crankshaft balancer hub bore.

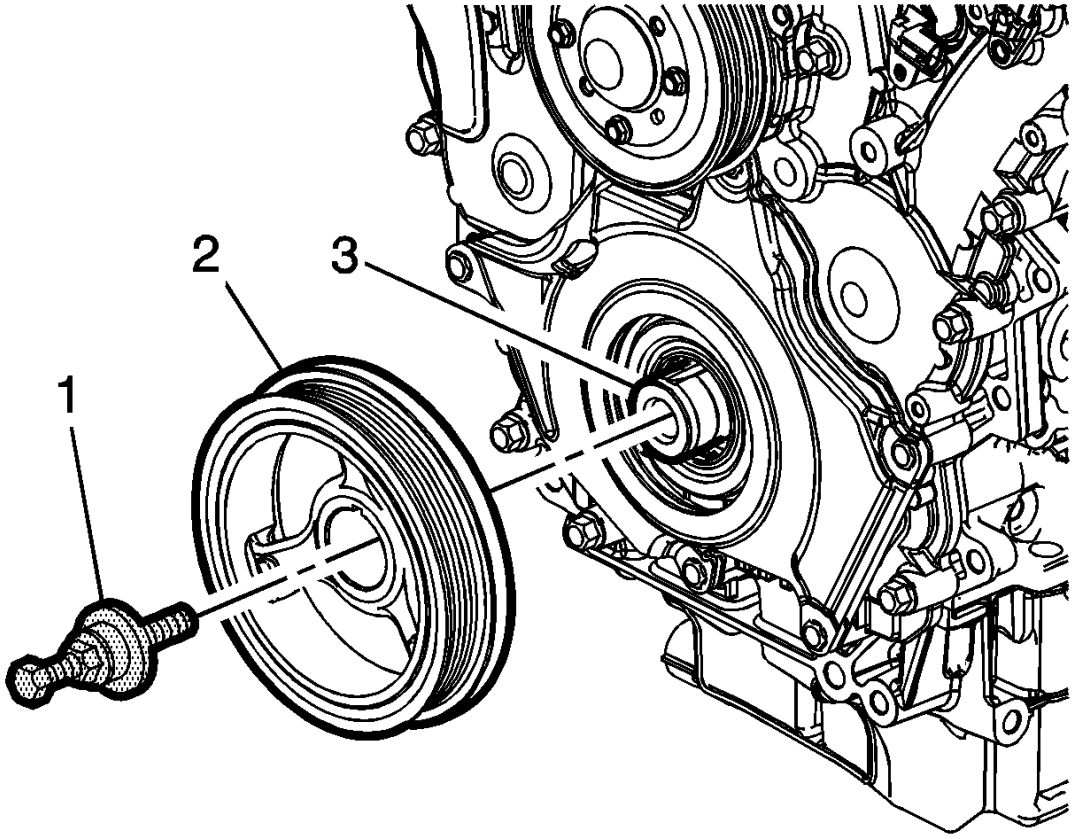

Fig. 76: Crankshaft, Balancer & Installer
Courtesy of GENERAL MOTORS COMPANY

4. Place the crankshaft balancer (2) in position on the crankshaft (3).
5. Thread the **EN-41998-B** installer (1) in the crankshaft. Ensure you engage at least 10 threads of the **EN-41998-B** installer before pressing the crankshaft balancer in place.
6. Push the crankshaft balancer into position by tightening the nut on the **EN-41998-B** installer until the large washer bottoms out on the crankshaft end.
7. Remove the **EN-41998-B** installer.

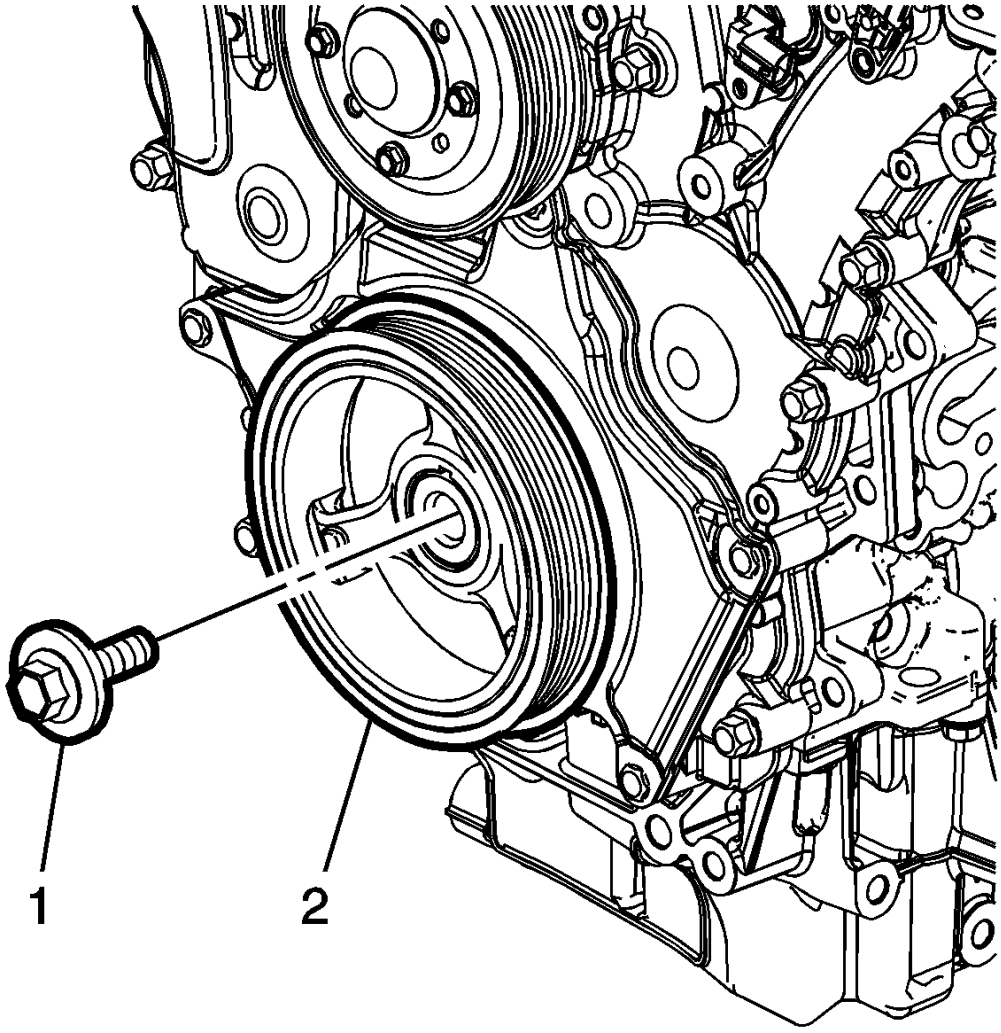

Fig. 77: Crankshaft Balancer And Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Always install a new crankshaft balancer retaining bolt (1) and washer.**

8. Install the NEW crankshaft balancer bolt (1).

CAUTION: **Refer to Fastener Caution .**

9. Tighten the crankshaft balancer bolt to 100 N.m (74 lb ft) and an additional 150 degrees using the **EN-45059** meter.

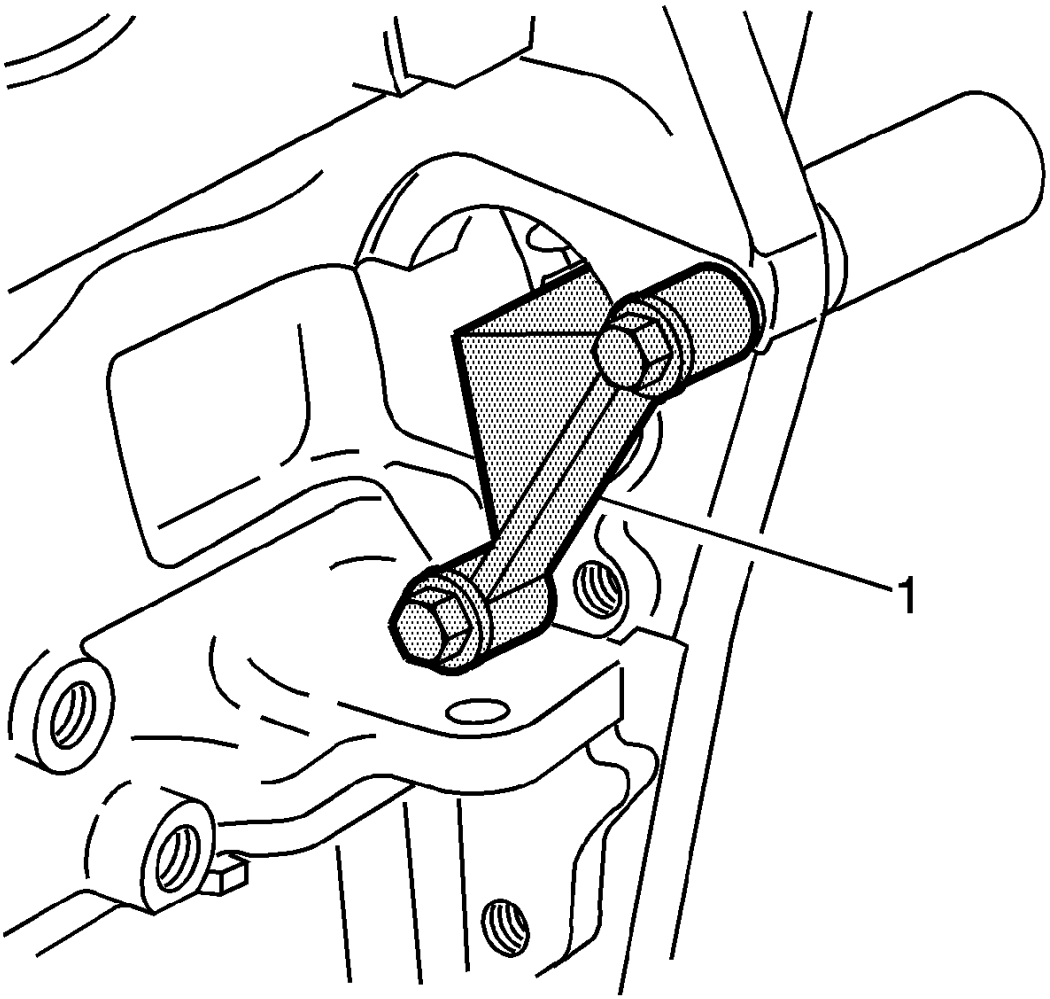

Fig. 78: Flywheel Holding Tool
Courtesy of GENERAL MOTORS COMPANY

10. Remove the **EN-46106** tool (1) .
11. Install the starter. Refer to **Starter Replacement** .
12. Install the drive belt. Refer to **Drive Belt Replacement**.
13. Install the engine mount. Refer to **Engine Mount Strut Replacement - Right Side**.

CRANKSHAFT FRONT OIL SEAL REPLACEMENT

Special Tools

EN-29184 Oil Seal Installer

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

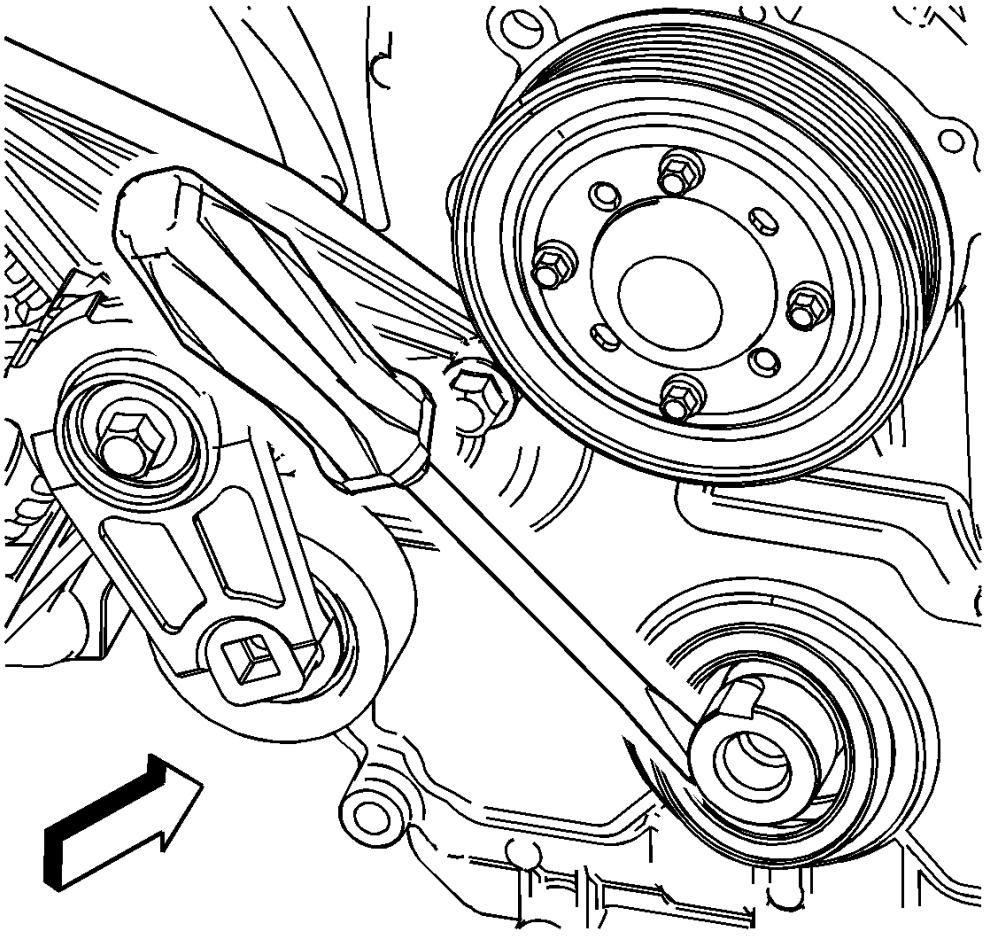

Fig. 79: Removing Crankshaft Front Oil Seal
Courtesy of GENERAL MOTORS COMPANY

1. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
2. Remove the crankshaft front oil seal using a suitable flat blade tool.

Installation Procedure

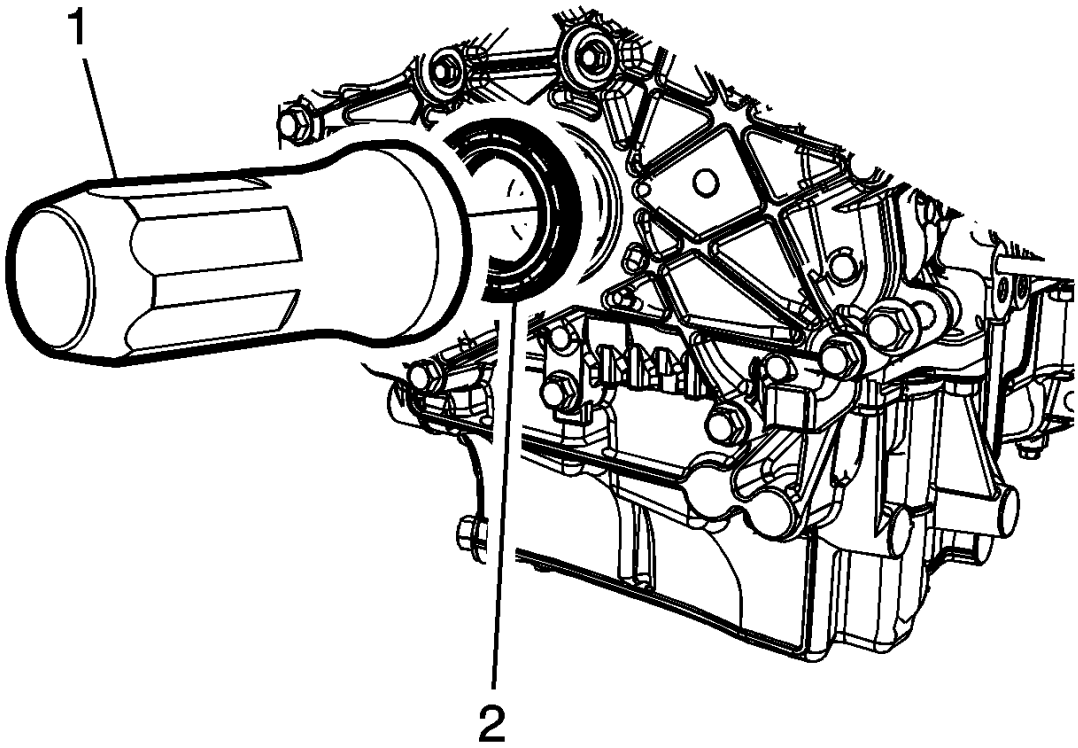

Fig. 80: Crankshaft Front Oil Seal And Installer
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not lubricate the crankshaft front oil seal or the crankshaft balancer sealing surfaces.**

1. Use the **EN-29184** installer (1) or equivalent to install the crankshaft front oil seal (2).
2. Install the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.

CAMSHAFT COVER REPLACEMENT - LEFT SIDE

Special Tools

EN-46101 Spark Plug Tube Seal Guide

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

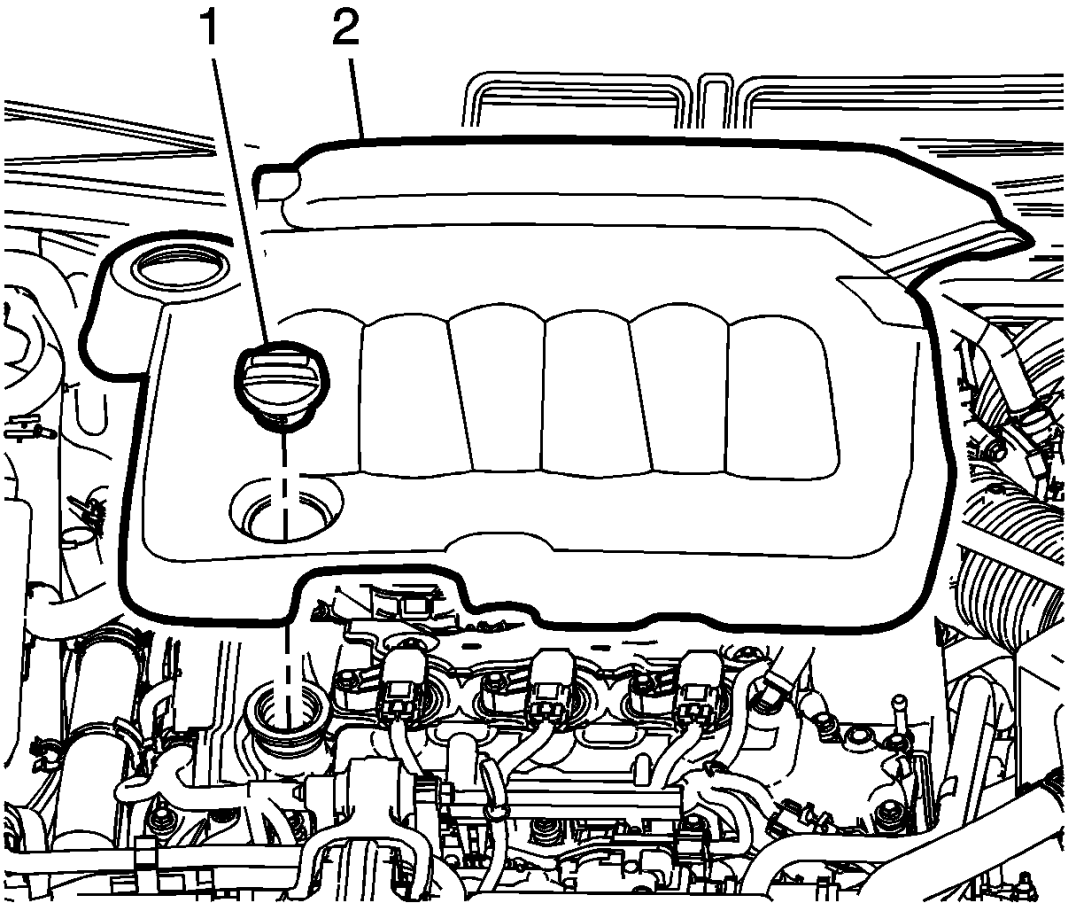

Fig. 81: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold cover (1). Refer to **Intake Manifold Cover Replacement**

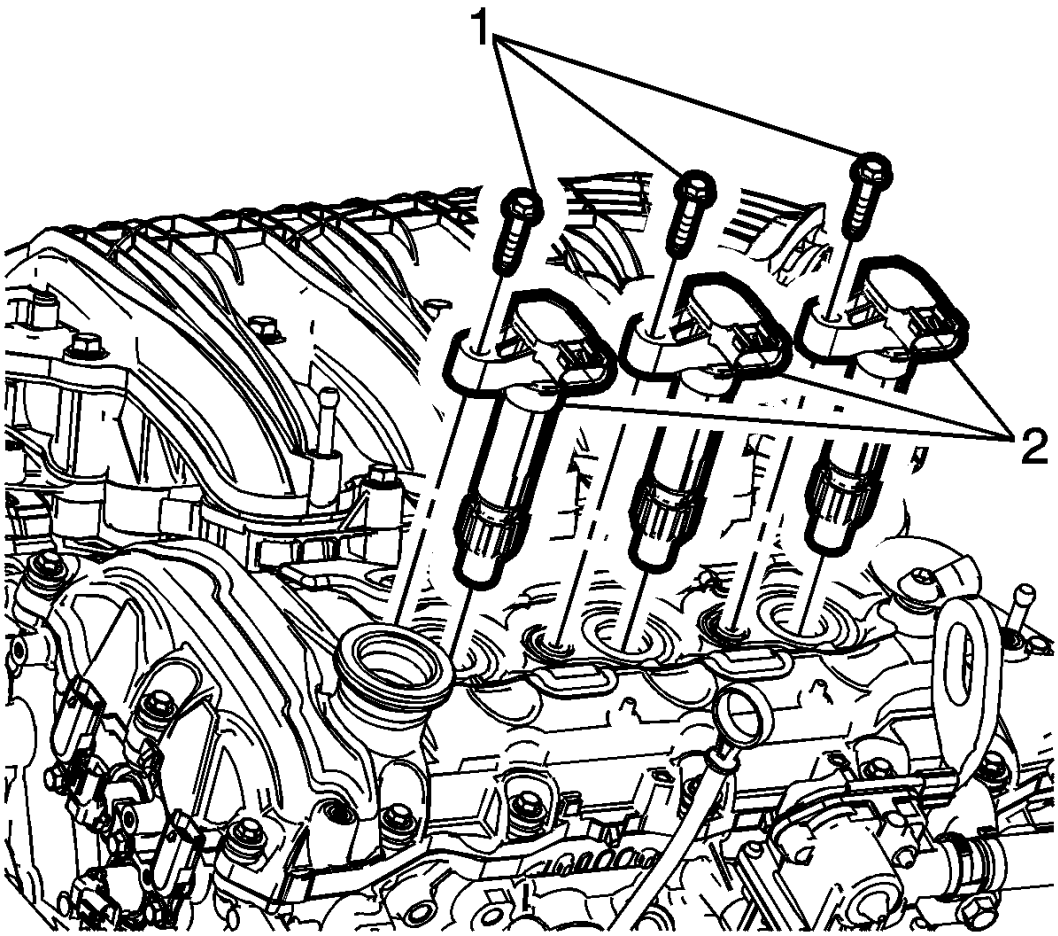

Fig. 82: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the ignition coil bolts (1) and remove the ignition coils (2). Refer to **Ignition Coil Replacement - Bank 2** .
3. Disconnect and remove the engine harness from the camshaft cover.

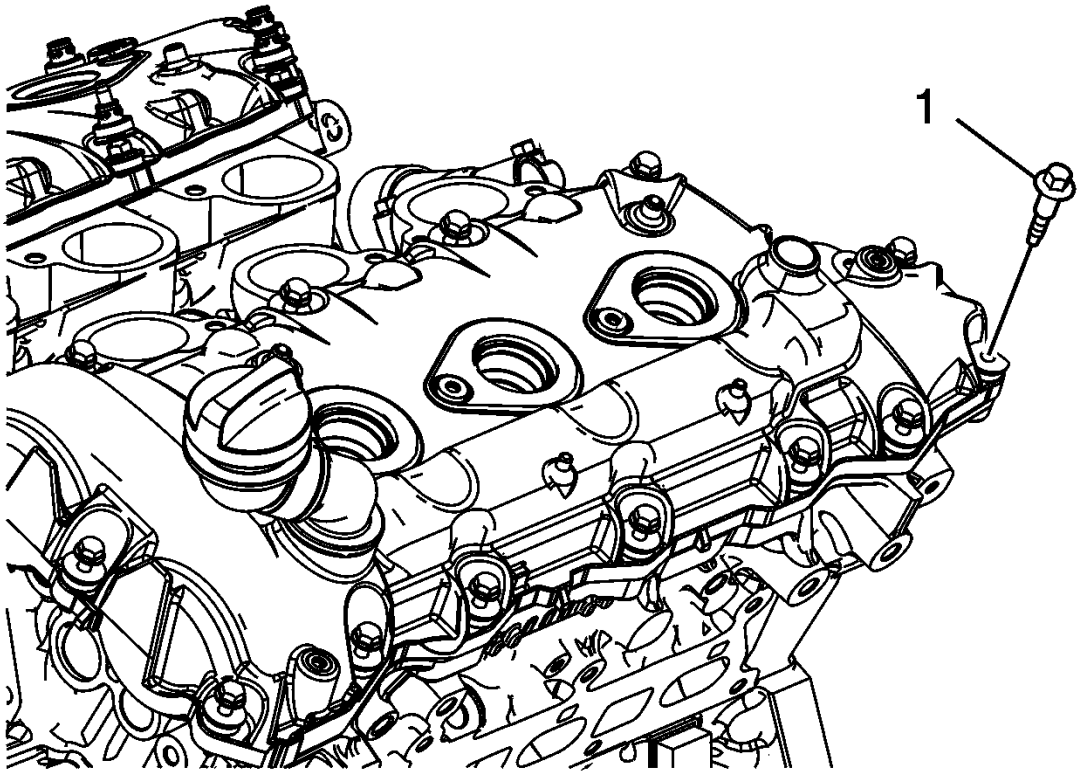

Fig. 83: View of Camshaft Cover and Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left camshaft cover bolts.
5. Remove the left camshaft cover from the left cylinder head.
6. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection**

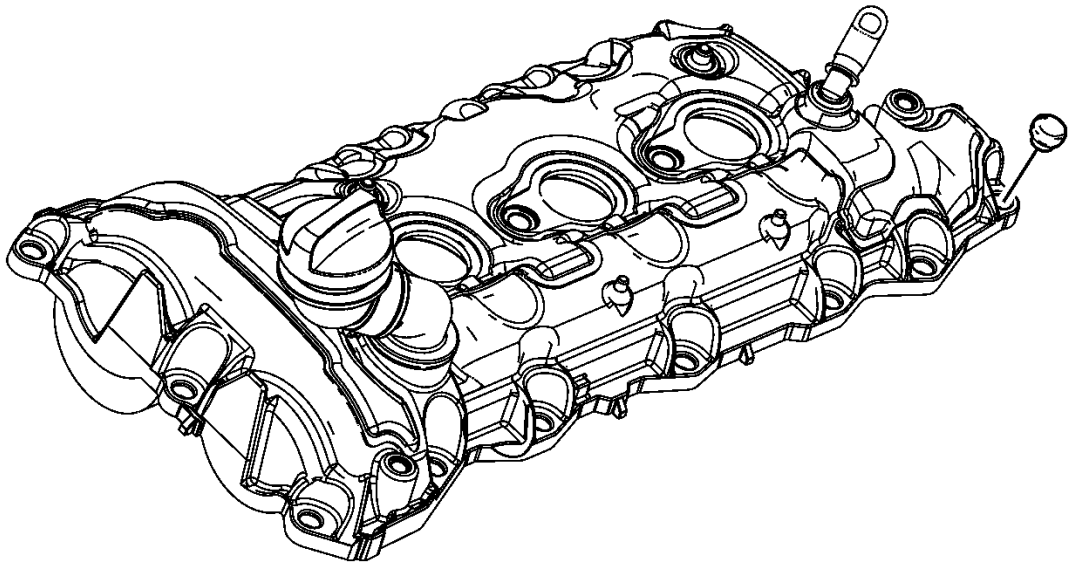

Fig. 84: View of Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-46101** guide onto the spark plug tubes of the left cylinder head.

Installation Procedure

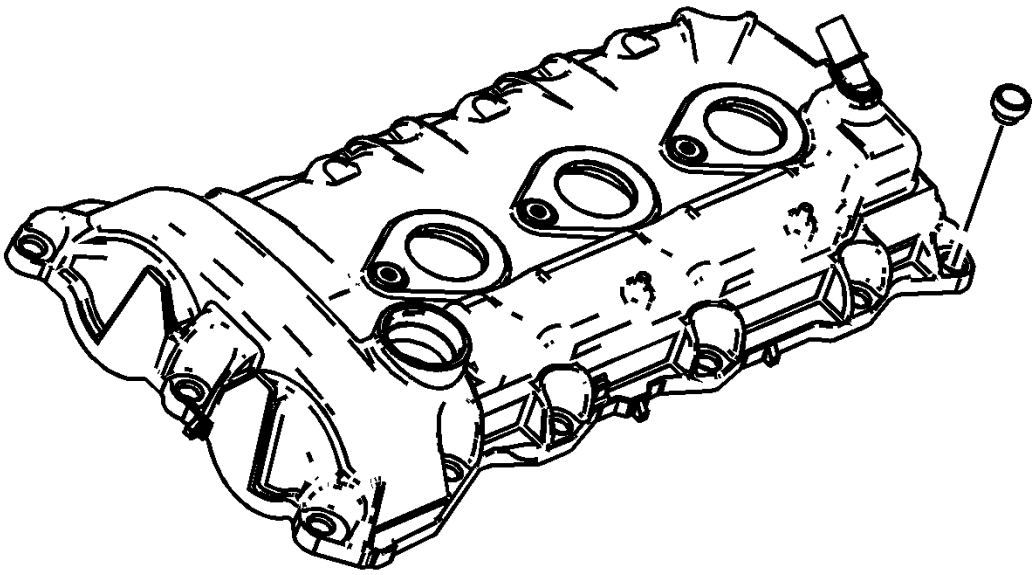

Fig. 85: Identifying Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

1. Install new camshaft cover bolt grommets prior to installing the camshaft cover bolts.

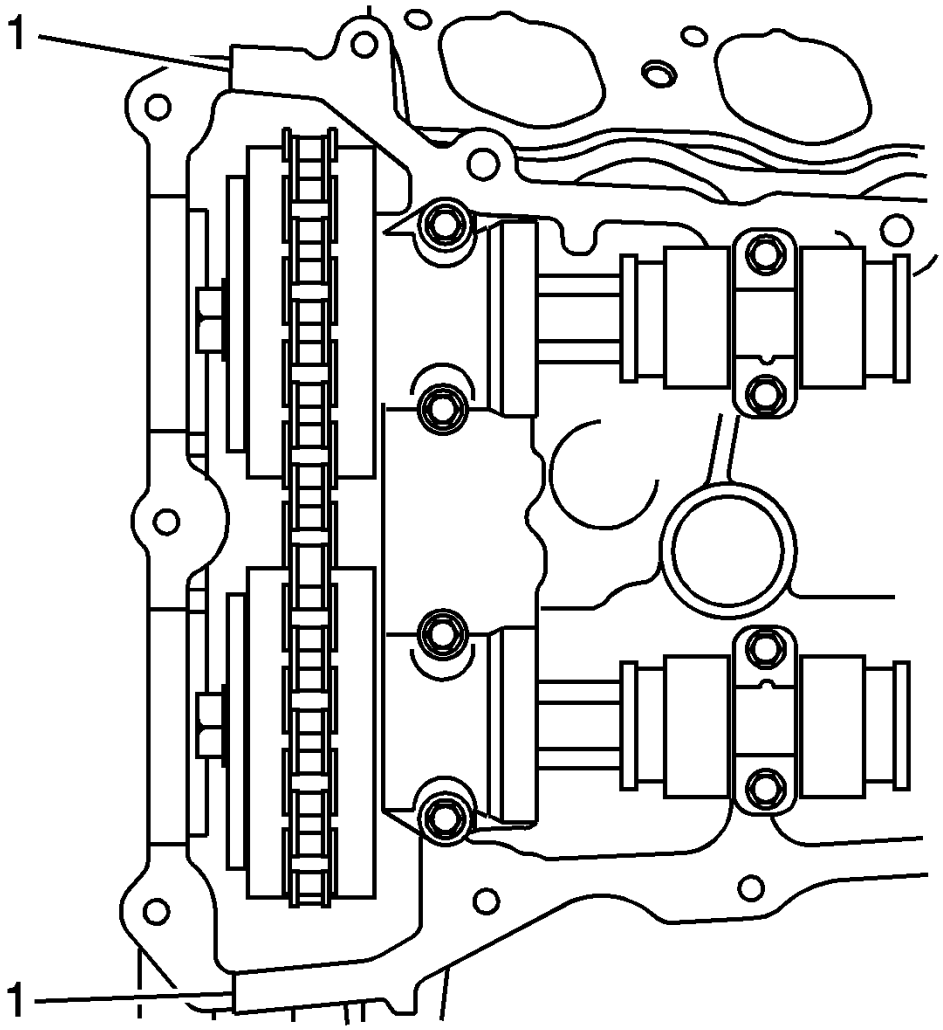

Fig. 86: Locating Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

2. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant equivalent, on the engine front cover split lines (1).

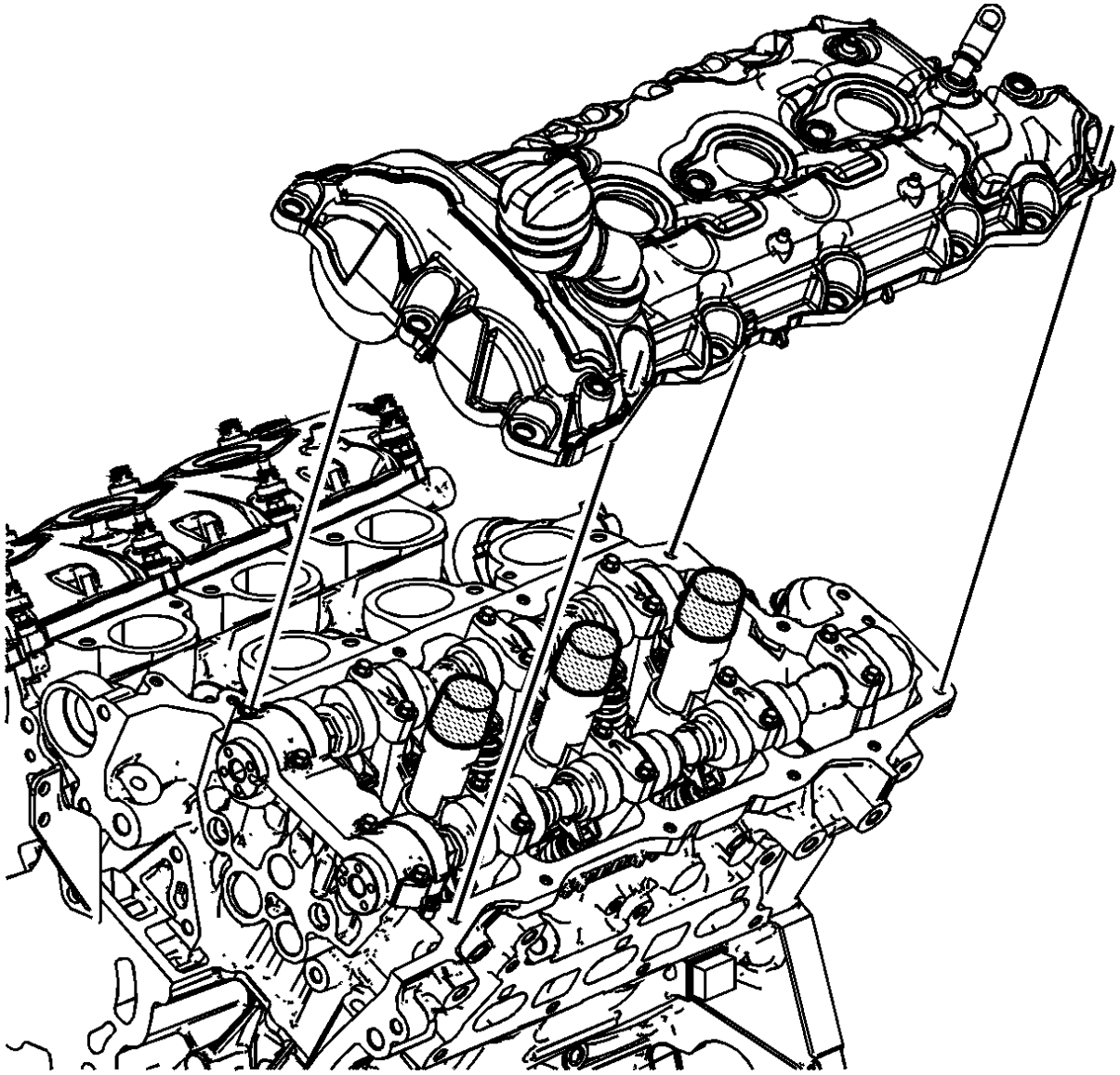

Fig. 87: View of Camshaft Cover & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

3. Place the left camshaft cover into position onto the left cylinder head.

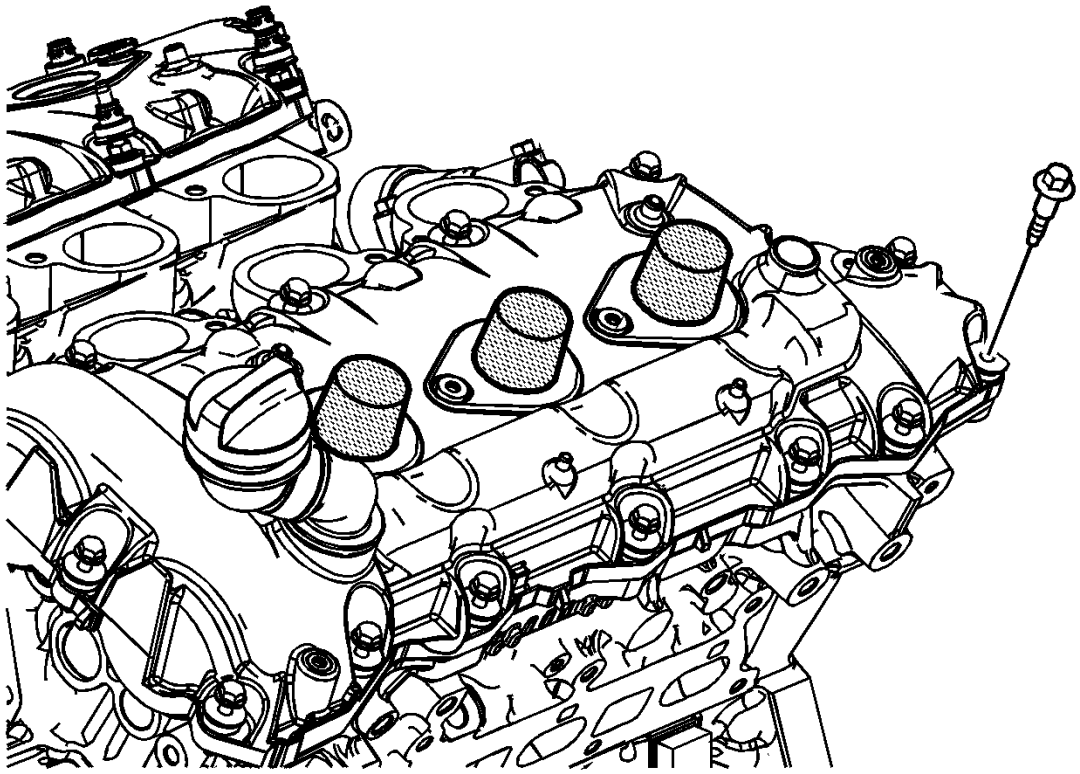

Fig. 88: View of Camshaft Cover & Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Loosely install the left camshaft cover bolts.

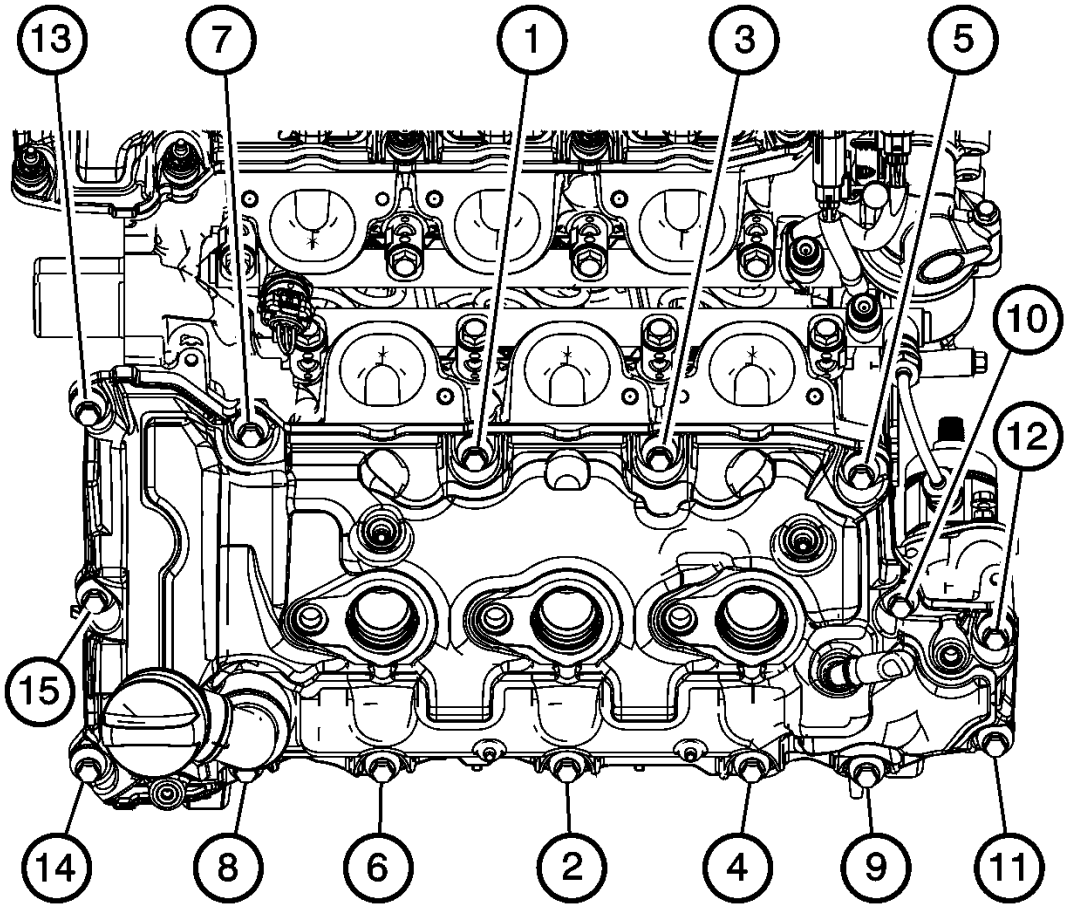

Fig. 89: Identifying Left Camshaft Cover Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the left camshaft cover bolts in the sequence shown to 10 N.m (89 lb in).
6. Connect and install the engine harness to the camshaft cover.

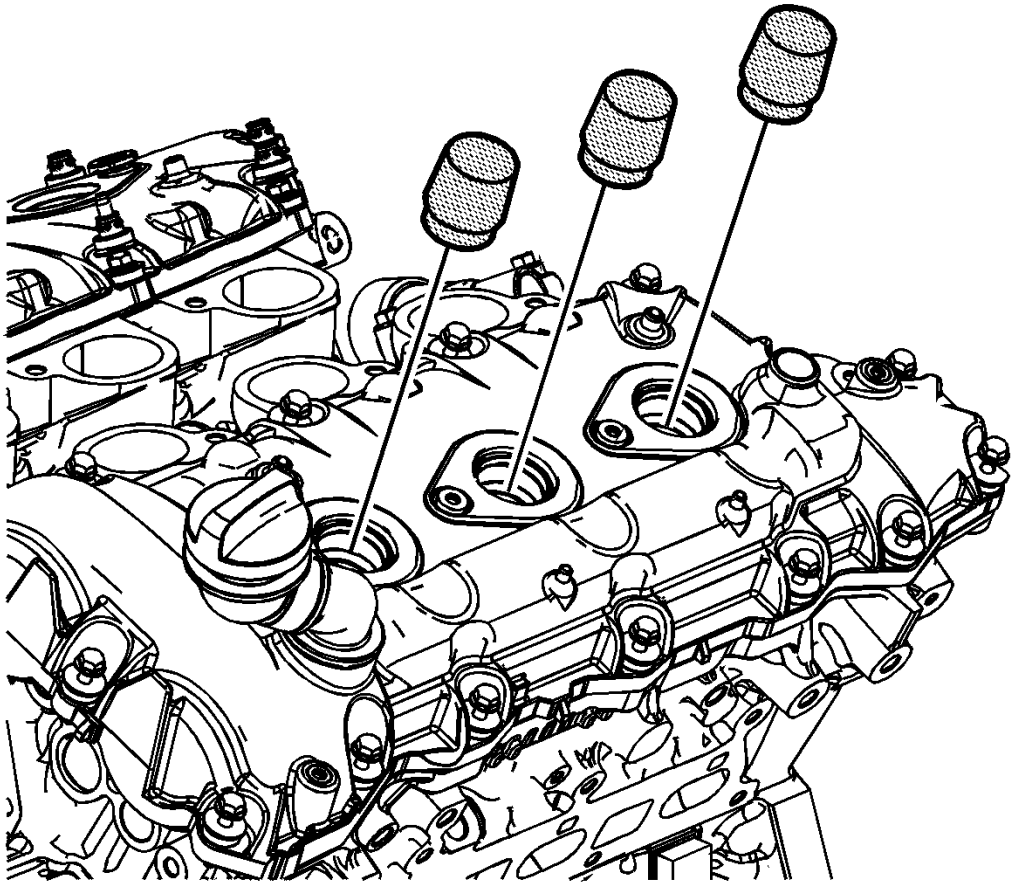

Fig. 90: View of Spark Plug Tubes & Cylinder Head
Courtesy of GENERAL MOTORS COMPANY

7. Remove the **EN-46101** guide from the spark plug tubes of the left cylinder head.

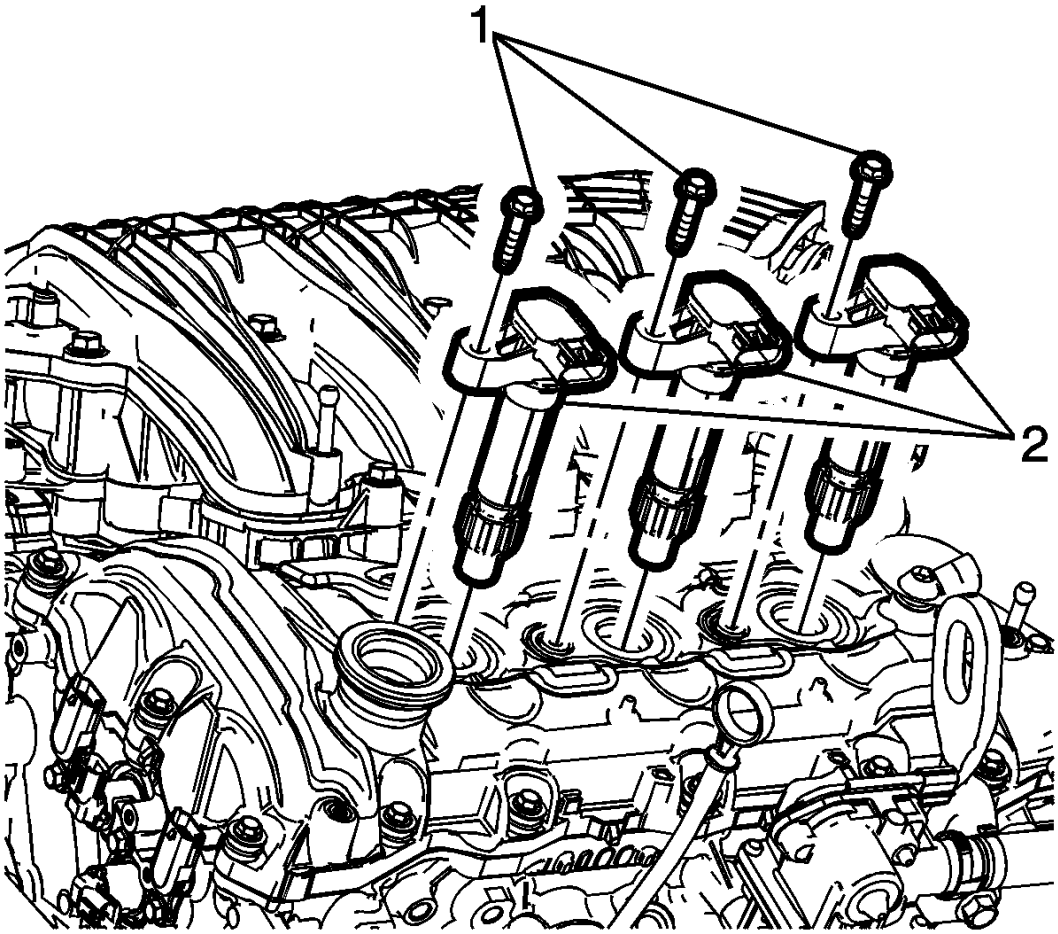

Fig. 91: Ignition Coils And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the ignition coils (2) and ignition coil bolts (1). Refer to **Ignition Coil Replacement - Bank 2** .

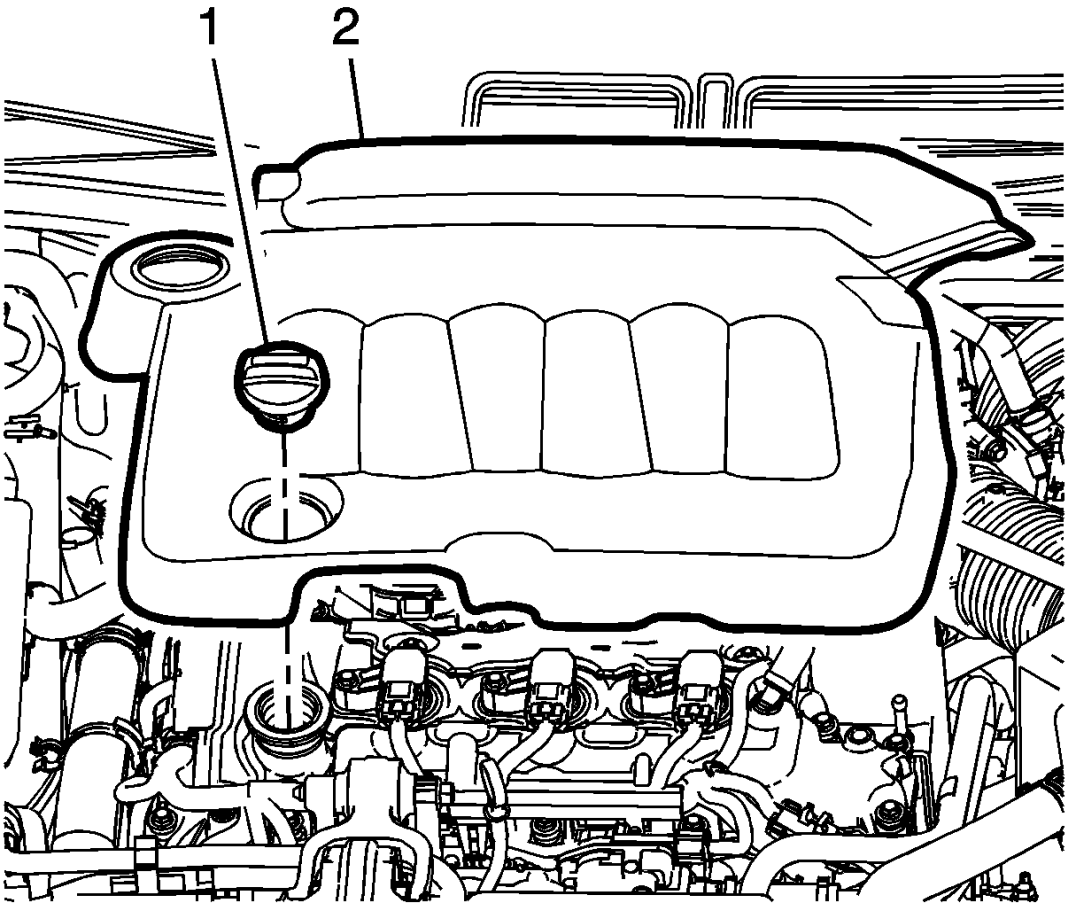

Fig. 92: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

9. Install the intake manifold cover (1). Refer to **Intake Manifold Cover Replacement**

CAMSHAFT COVER REPLACEMENT - RIGHT SIDE

Special Tools

EN-46101 Spark Plug Tube Seal Guide

For equivalent regional tools, refer to **Special Tools**

Removal Procedure

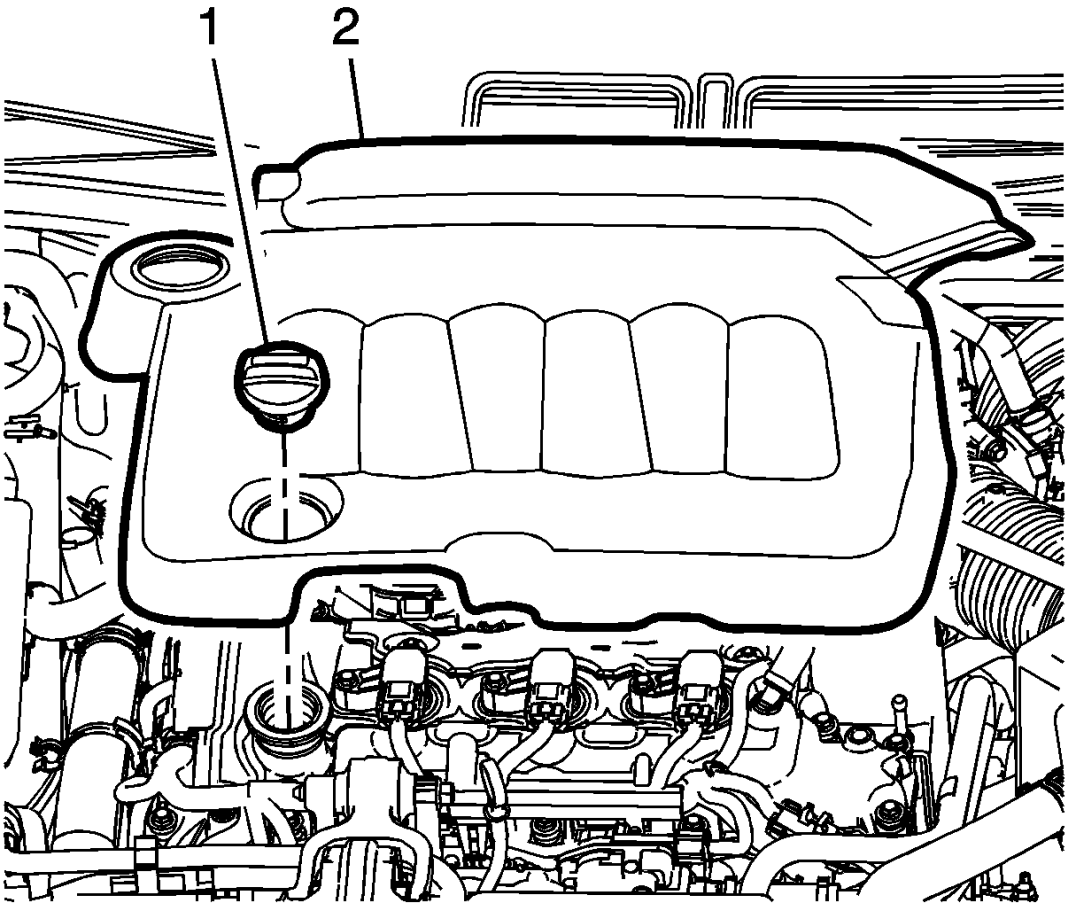

Fig. 93: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

1. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

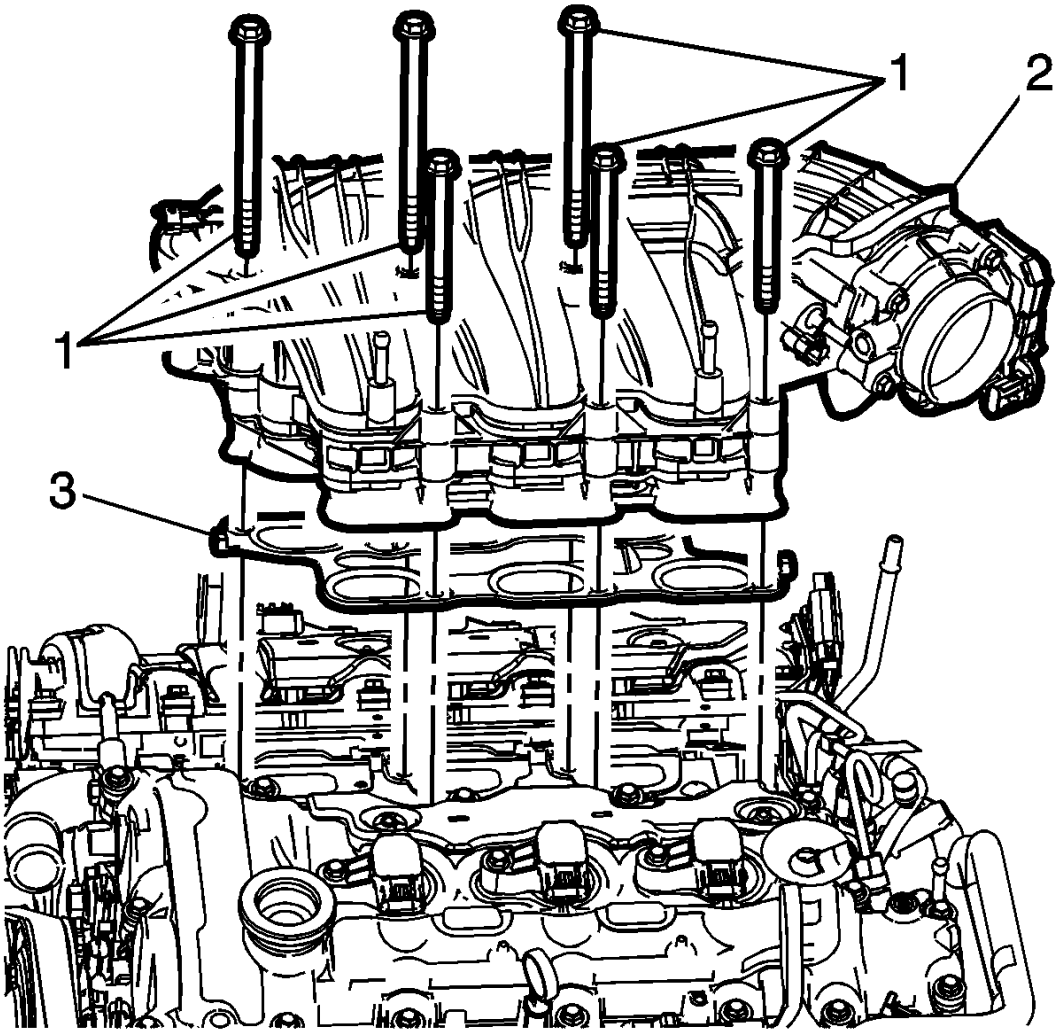

Fig. 94: Intake Manifold Assembly, Gasket And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake manifold bolts (1), intake manifold (2) and gasket (3). Refer to **Intake Manifold Replacement**.

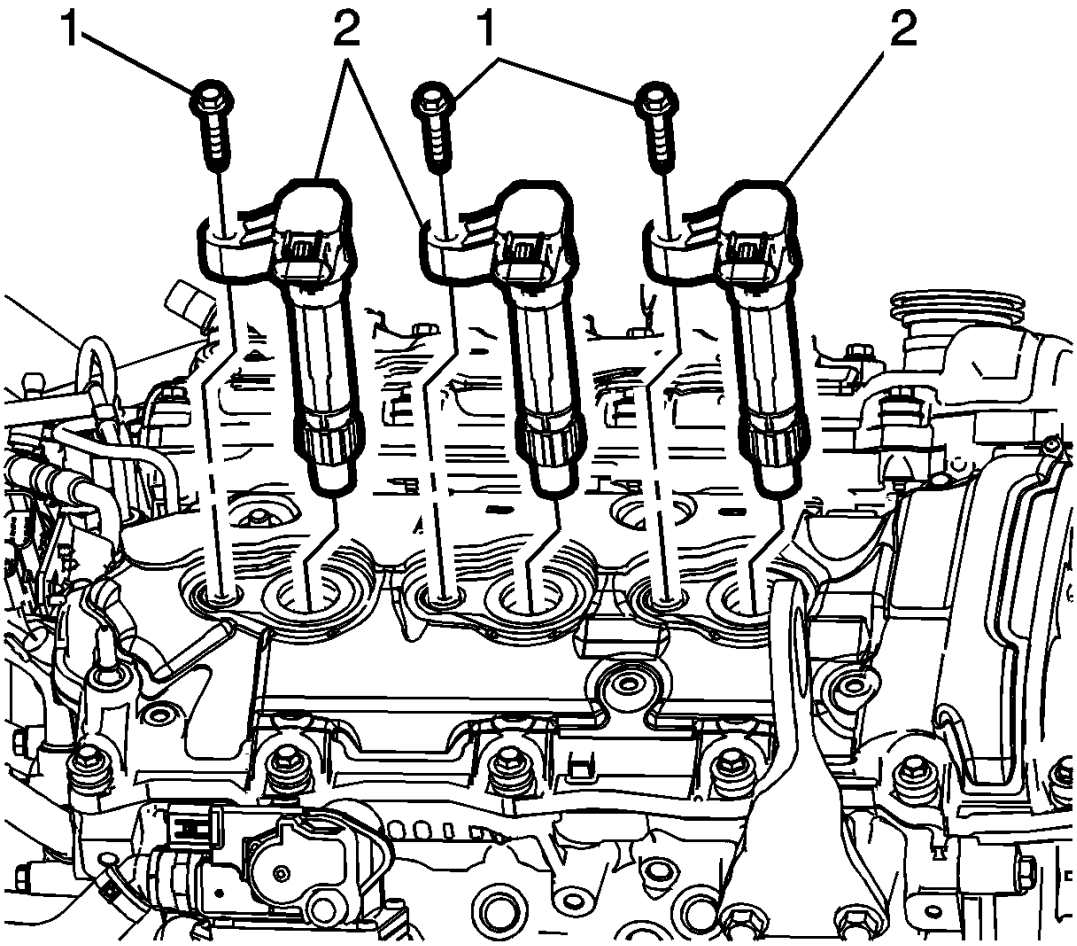

Fig. 95: Ignition Coils And Right Bank Ignition Coil Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the right bank ignition coil bolts (1) and remove the ignition coils (2). Refer to **Ignition Coil Replacement - Bank 1**
4. Disconnect and remove the engine harness from the camshaft cover.

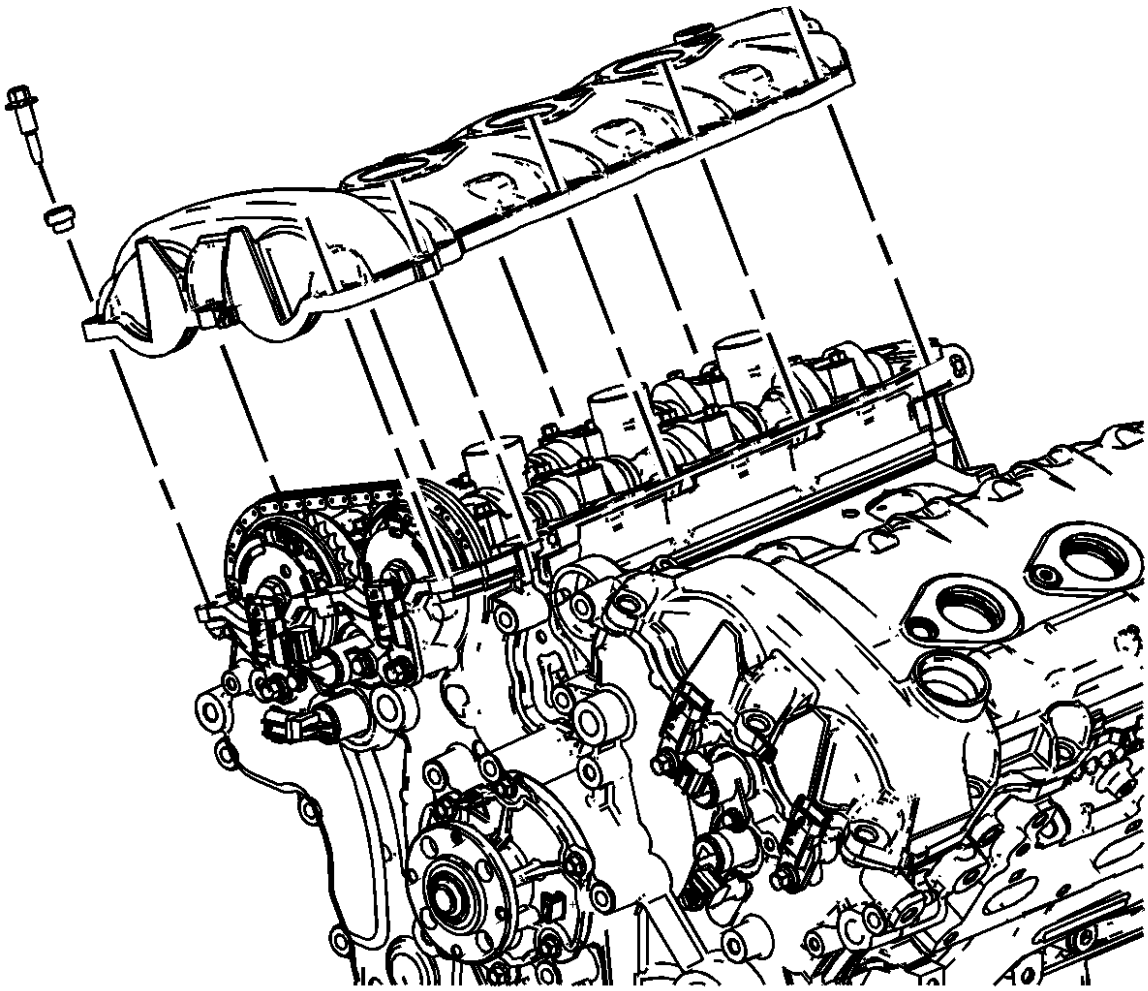

Fig. 96: Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right camshaft cover bolts.
6. Remove the right camshaft cover from the right cylinder head.
7. Clean the mating surfaces of the cylinder head and the camshaft cover. Refer to **Camshaft Cover Cleaning and Inspection**

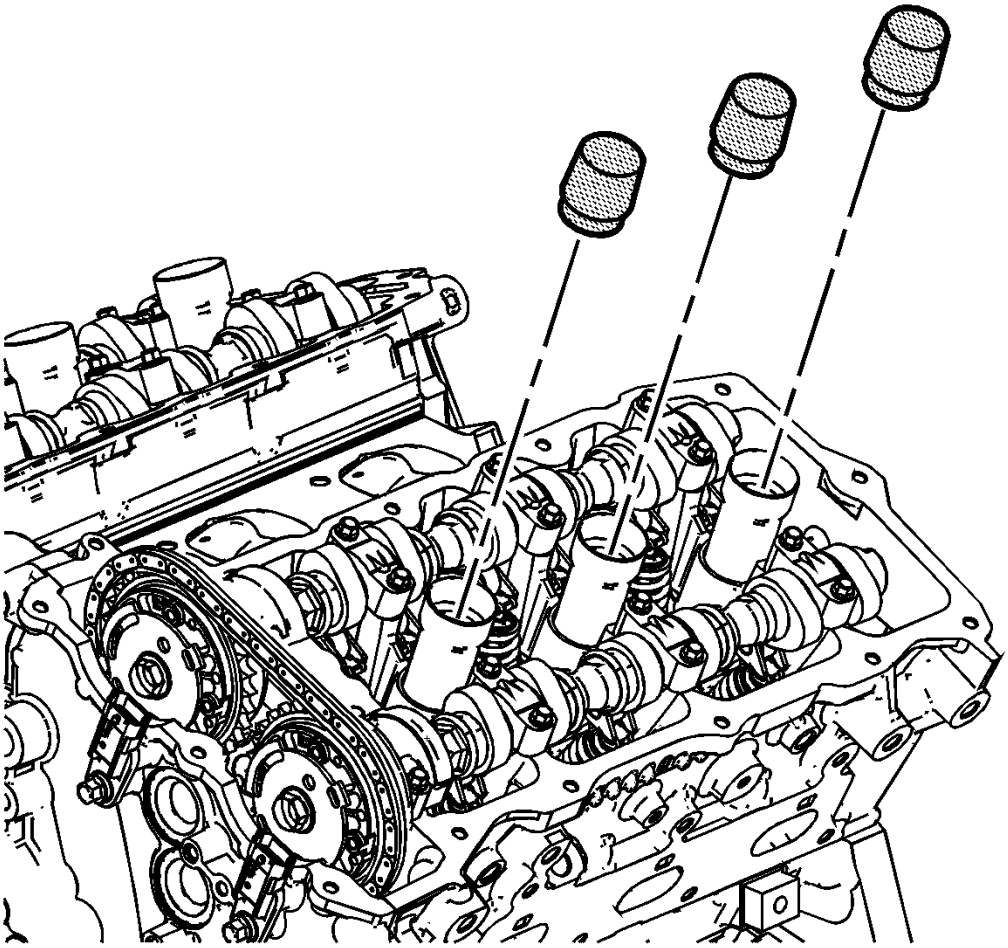

Fig. 97: Plugging Spark Plug Holes
Courtesy of GENERAL MOTORS COMPANY

8. Install the **EN-46101** guide onto the spark plug tubes of the right cylinder head.

Installation Procedure

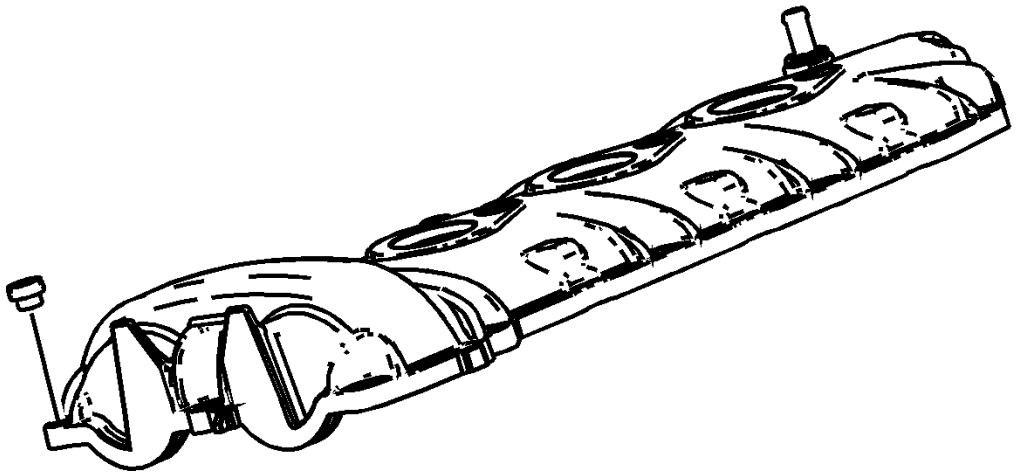

Fig. 98: Locating Camshaft Cover Bolt Grommets
Courtesy of GENERAL MOTORS COMPANY

1. Install new camshaft cover bolt grommets prior to installing the camshaft cover bolts.

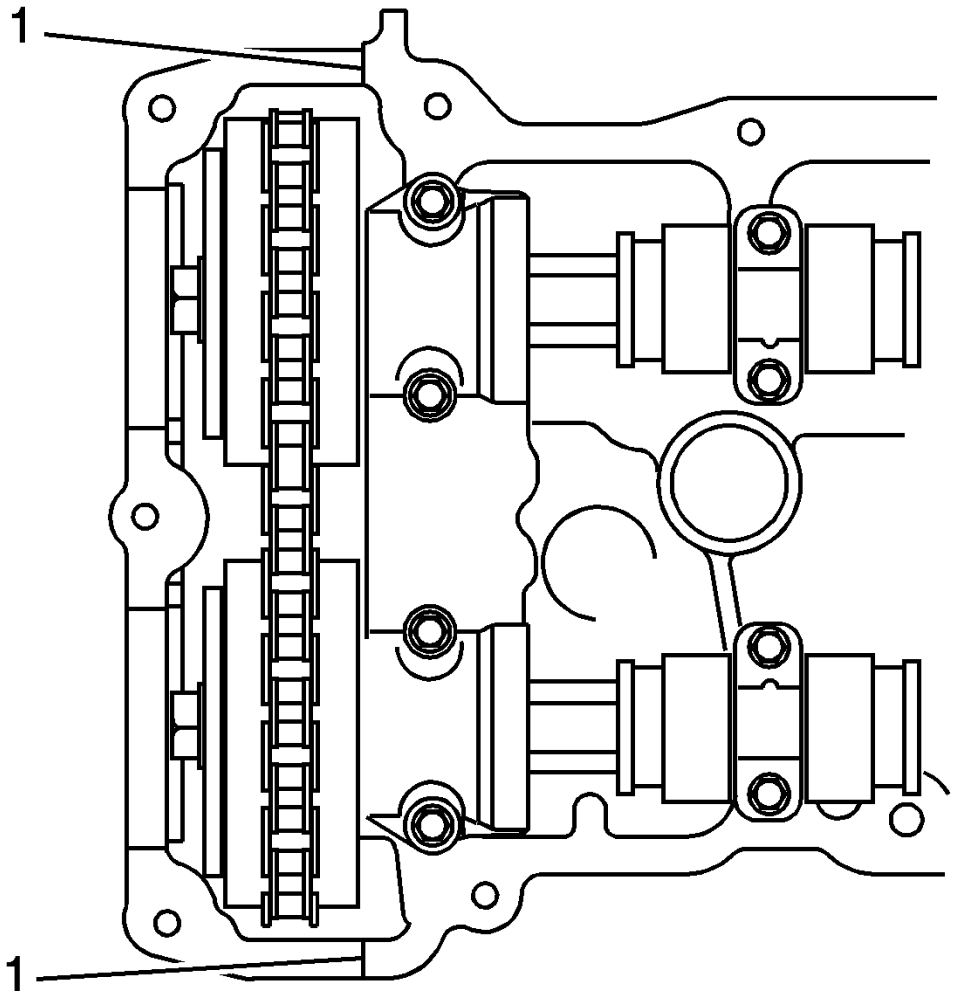

Fig. 99: Identifying Engine Front Cover Split Lines
Courtesy of GENERAL MOTORS COMPANY

2. Place a bead 8 mm (0.3150 in) in diameter by 4 mm (0.1575 in) in height of RTV sealant, on the engine front cover split lines (1).

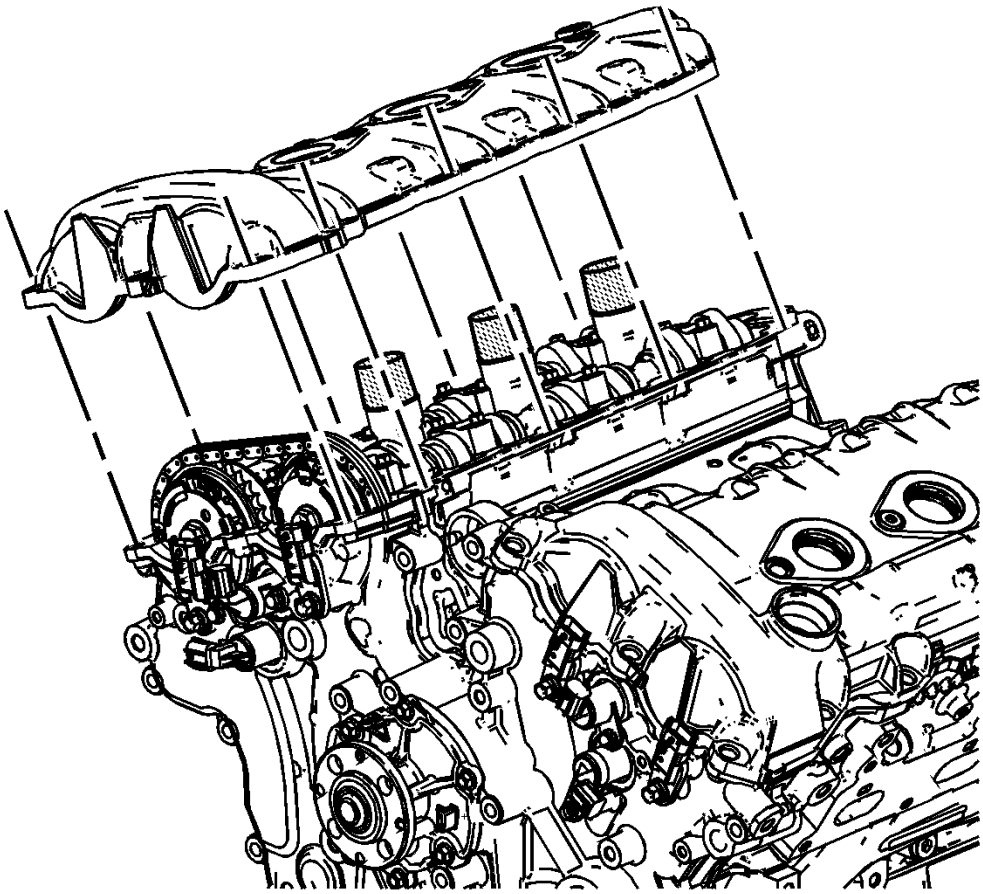

Fig. 100: View Of Right Camshaft Cover
Courtesy of GENERAL MOTORS COMPANY

3. Place the right camshaft cover into position onto the right cylinder head.

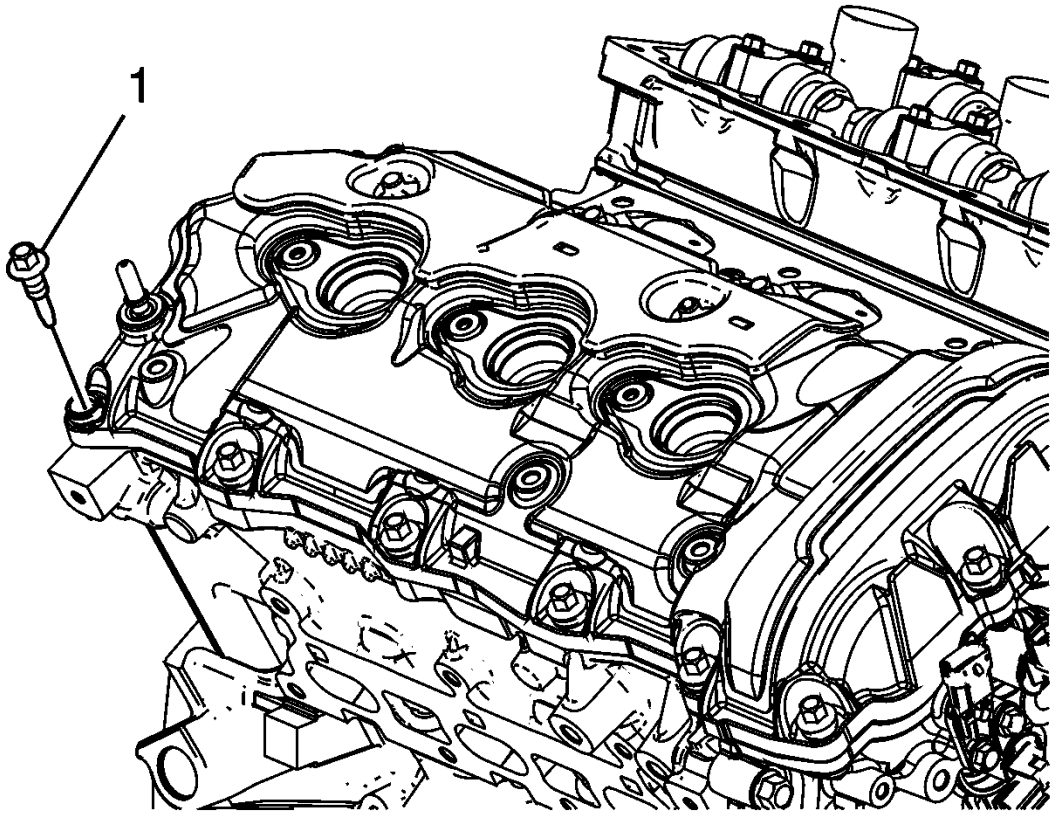

Fig. 101: View Of Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution

4. Loosely install the right camshaft cover bolts.

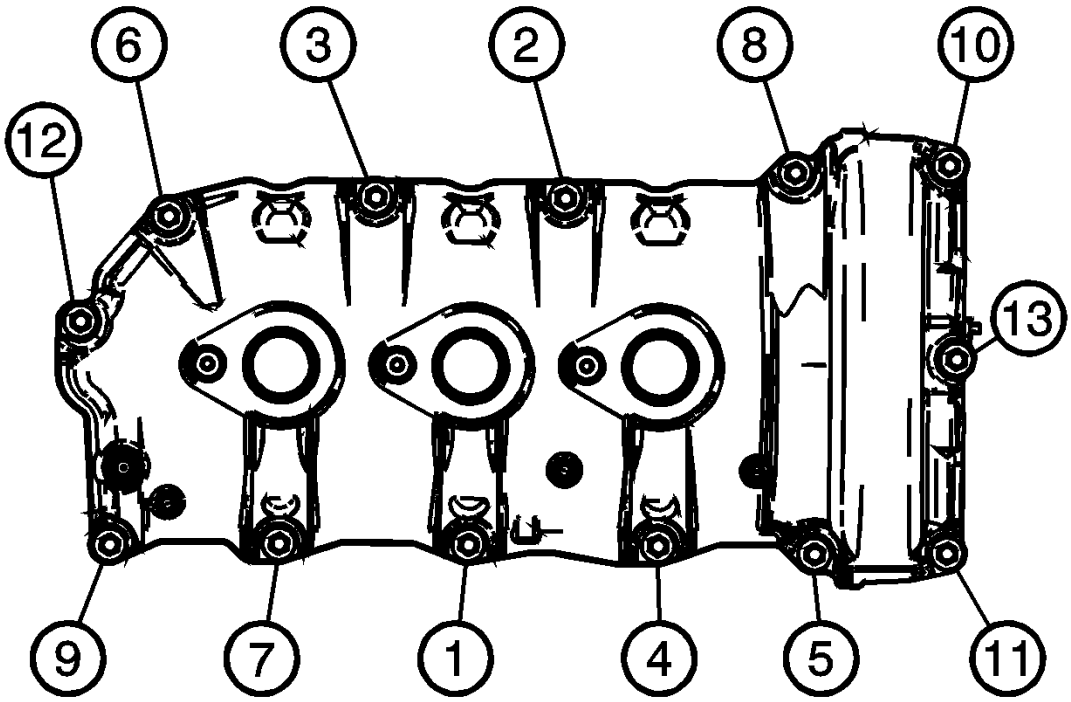

Fig. 102: Tightening Sequence for Right Camshaft Cover Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the right camshaft cover bolts in the sequence shown to 10 N.m (89 lb in).
6. Connect and install the engine harness to the camshaft cover.

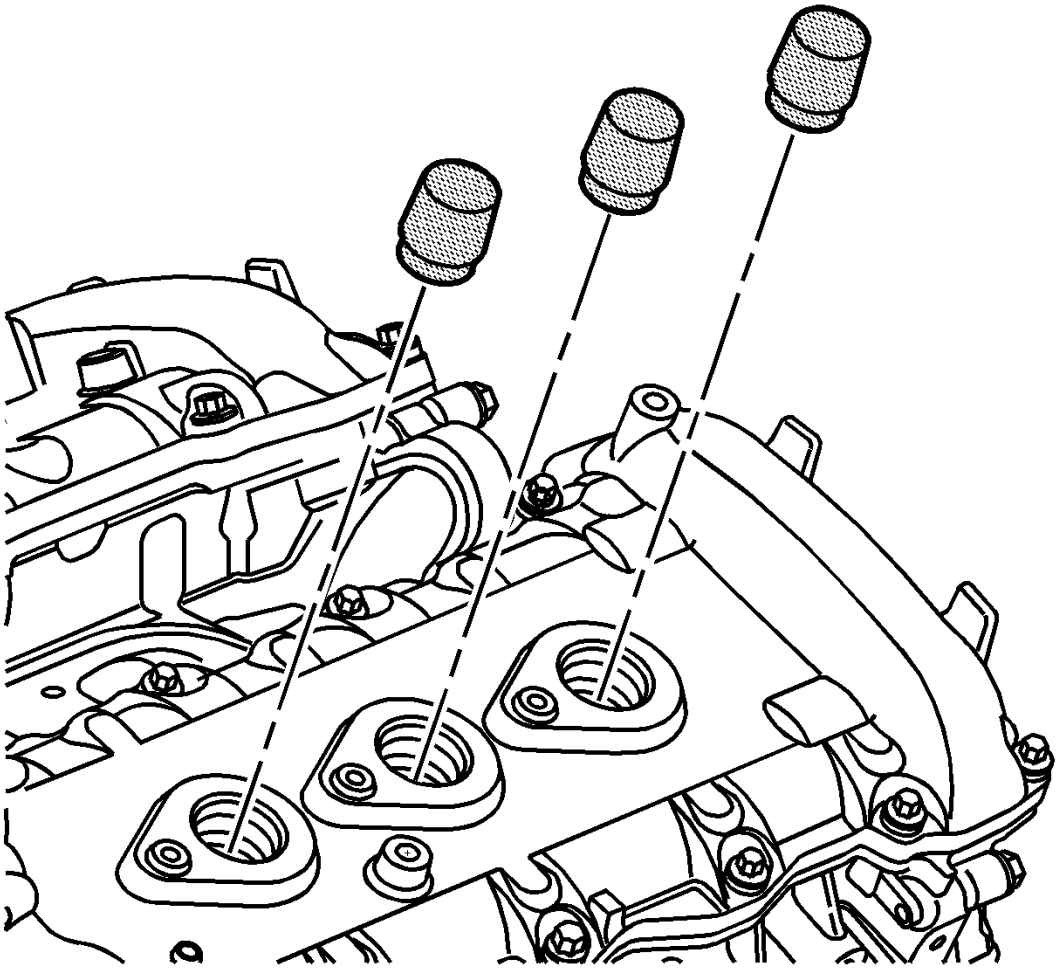

Fig. 103: Spark Plug Tube Seal Guides
Courtesy of GENERAL MOTORS COMPANY

7. Remove the **EN-46101** guide from the spark plug tubes of the right cylinder head.

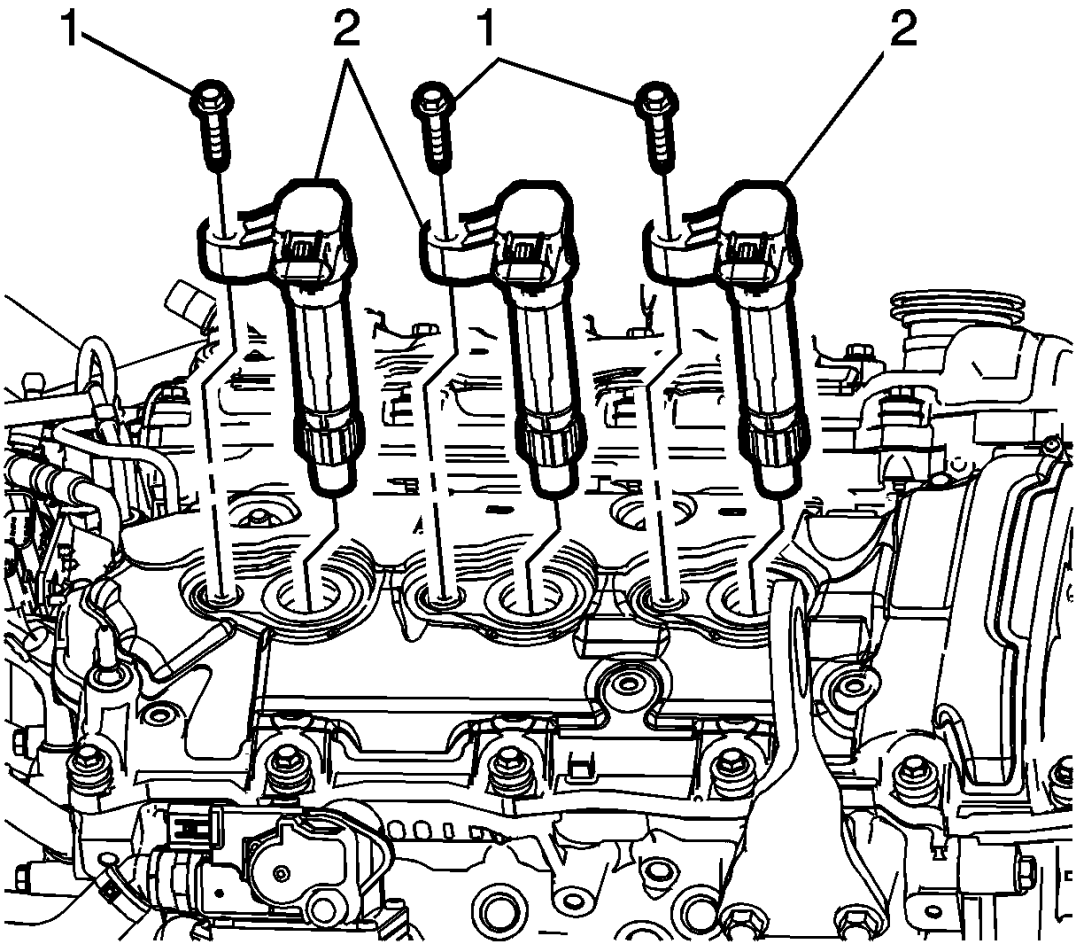

Fig. 104: Ignition Coils And Right Bank Ignition Coil Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the ignition coils (2) and install the ignition coil bolts (1). Refer to **Ignition Coil Replacement - Bank 1**

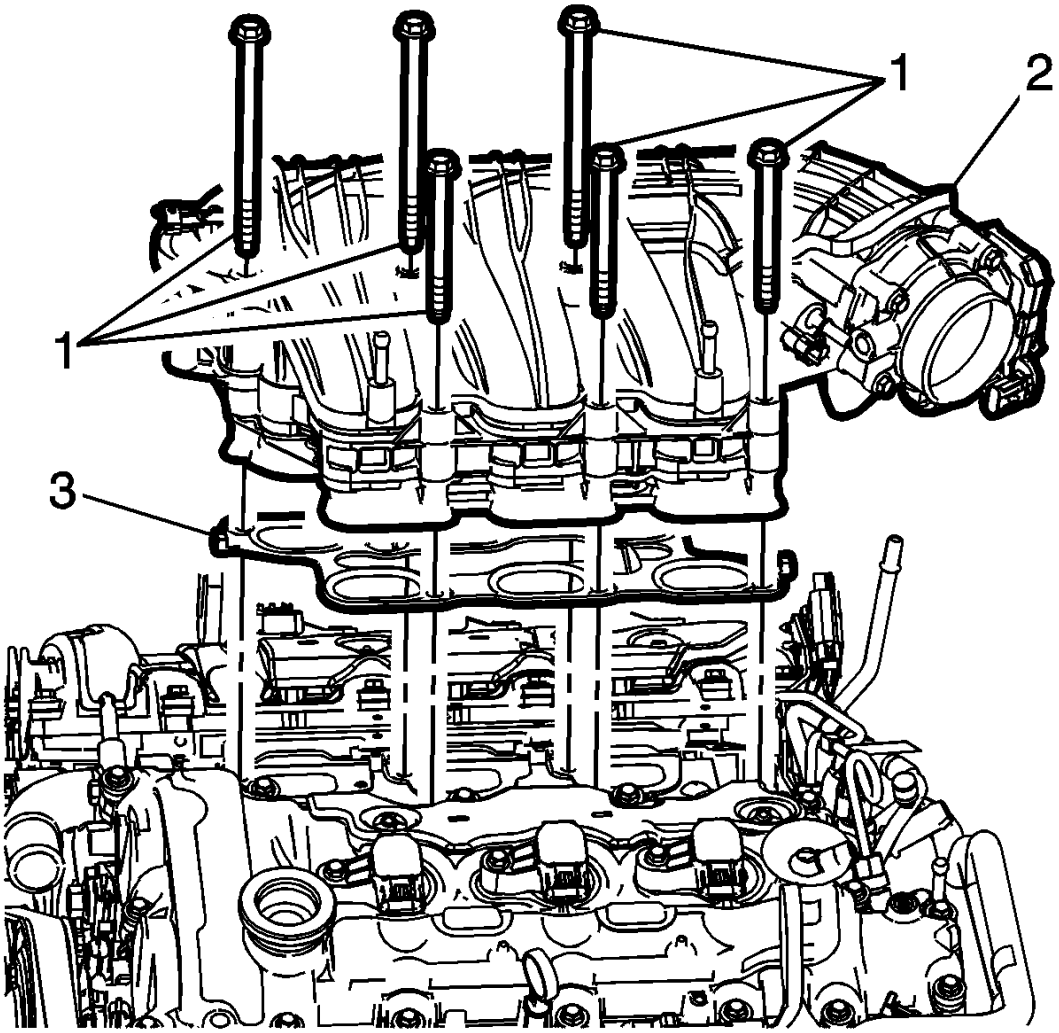

Fig. 105: Intake Manifold Assembly, Gasket And Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Install the intake manifold gasket (3), intake manifold (2) and bolts (1). Refer to **Intake Manifold Replacement**.

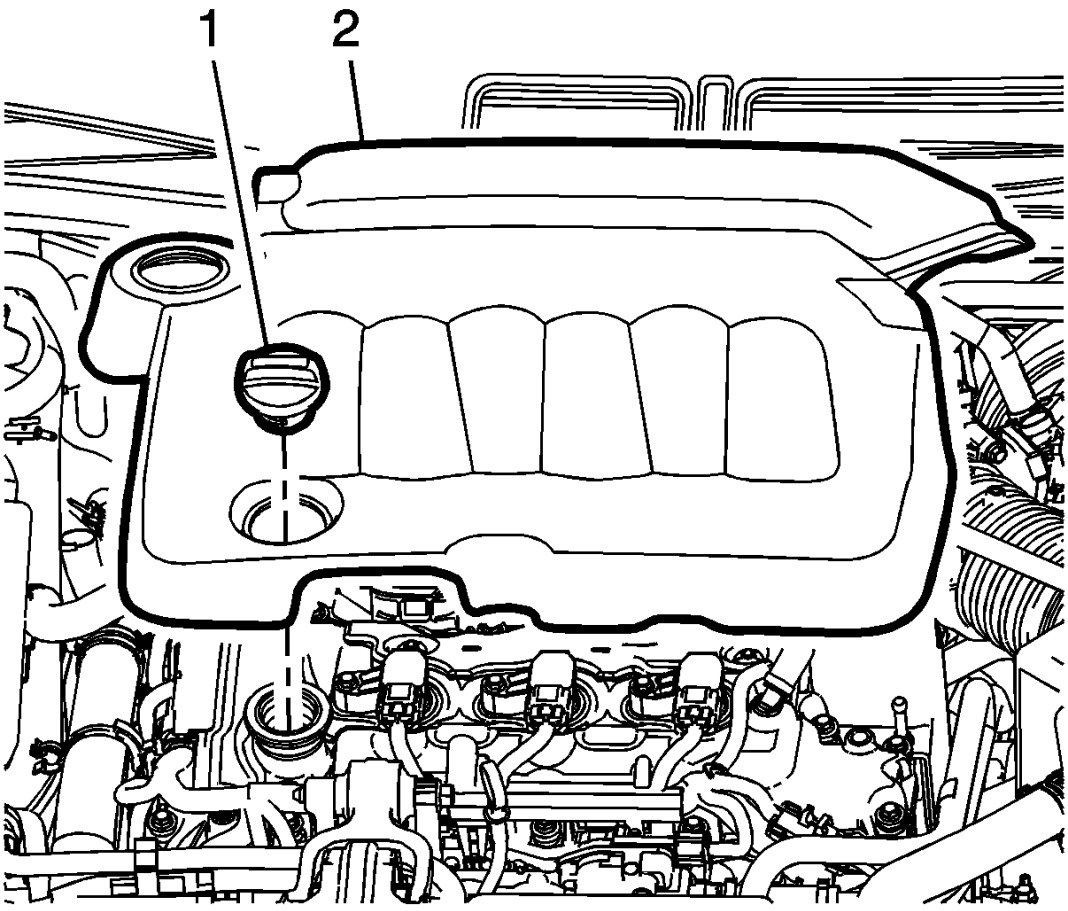

Fig. 106: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

10. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.

ENGINE FRONT COVER REPLACEMENT

Special Tools

EN-46109 Engine Front Cover Installation Guide Pins

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the intake manifold. Refer to **Intake Manifold Replacement**.
2. Remove the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side**, and **Camshaft Cover Replacement - Right Side**.
3. Drain the engine coolant. Refer to **Cooling System Draining and Filling** .
4. Disconnect the purge vent hose from the water outlet.

5. Remove the water outlet with the radiator hose and reposition aside. Refer to **Water Outlet Replacement** .
6. Remove the crankshaft balancer. Refer to **Crankshaft Balancer Replacement**.
7. Remove the camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** , **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** , **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** , and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
8. Remove the generator. Refer to **Generator Replacement** .
9. Remove the water pump pulley only.
10. Remove the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
11. Remove the camshaft position actuator solenoid valves from the front cover. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .

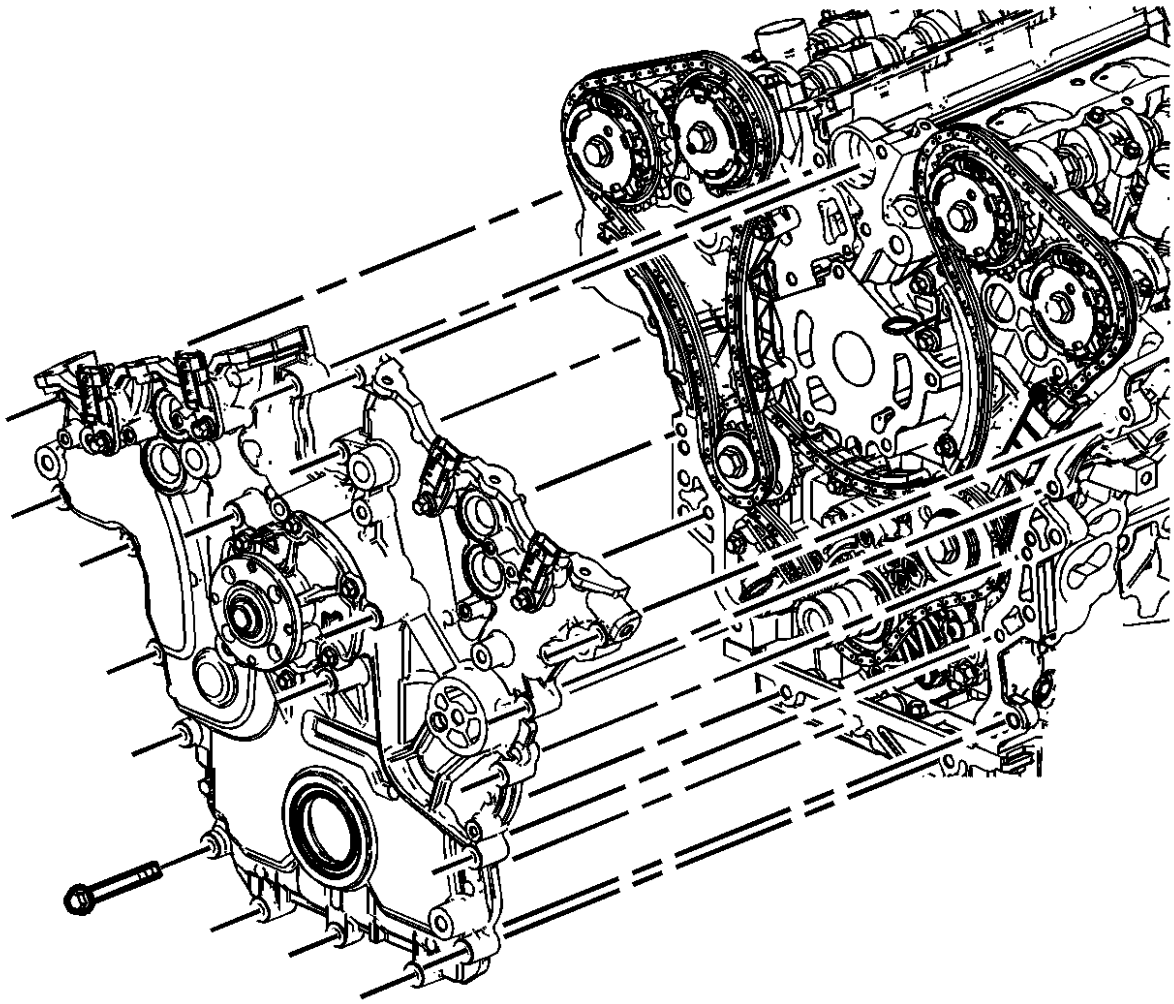

Fig. 107: Engine Front Cover

.

Courtesy of GENERAL MOTORS COMPANY

NOTE: **There are a total of 22 M8 bolts that must be removed and 3 optional M12 bolts that may need to be removed before the front cover will separate from the engine block.**

12. Remove the engine front cover with the water pump. Refer to **Engine Front Cover Removal** .
13. Disassemble the engine front cover. Refer to **Engine Front Cover Disassemble** .

NOTE: **Do NOT use sharp and/or metal gasket scrapers in order to clean the sealing surfaces.**

14. Carefully clean the engine front cover sealing surfaces. Refer to **Engine Front Cover Cleaning and Inspection** .

NOTE: **Insert a piece of cardboard between the oil pan front and the oil pump in order to prevent any contaminants from falling into the oil pan.**

15. Carefully clean the engine front cover sealing surfaces. Refer to **Engine Front Cover Cleaning and Inspection** .
16. Use compressed air in order to remove any engine coolant from the engine cooling passages and from the top of the oil pan scraper (windage tray).

Installation Procedure

1. Assemble the engine front cover. Refer to **Engine Front Cover Assemble** .

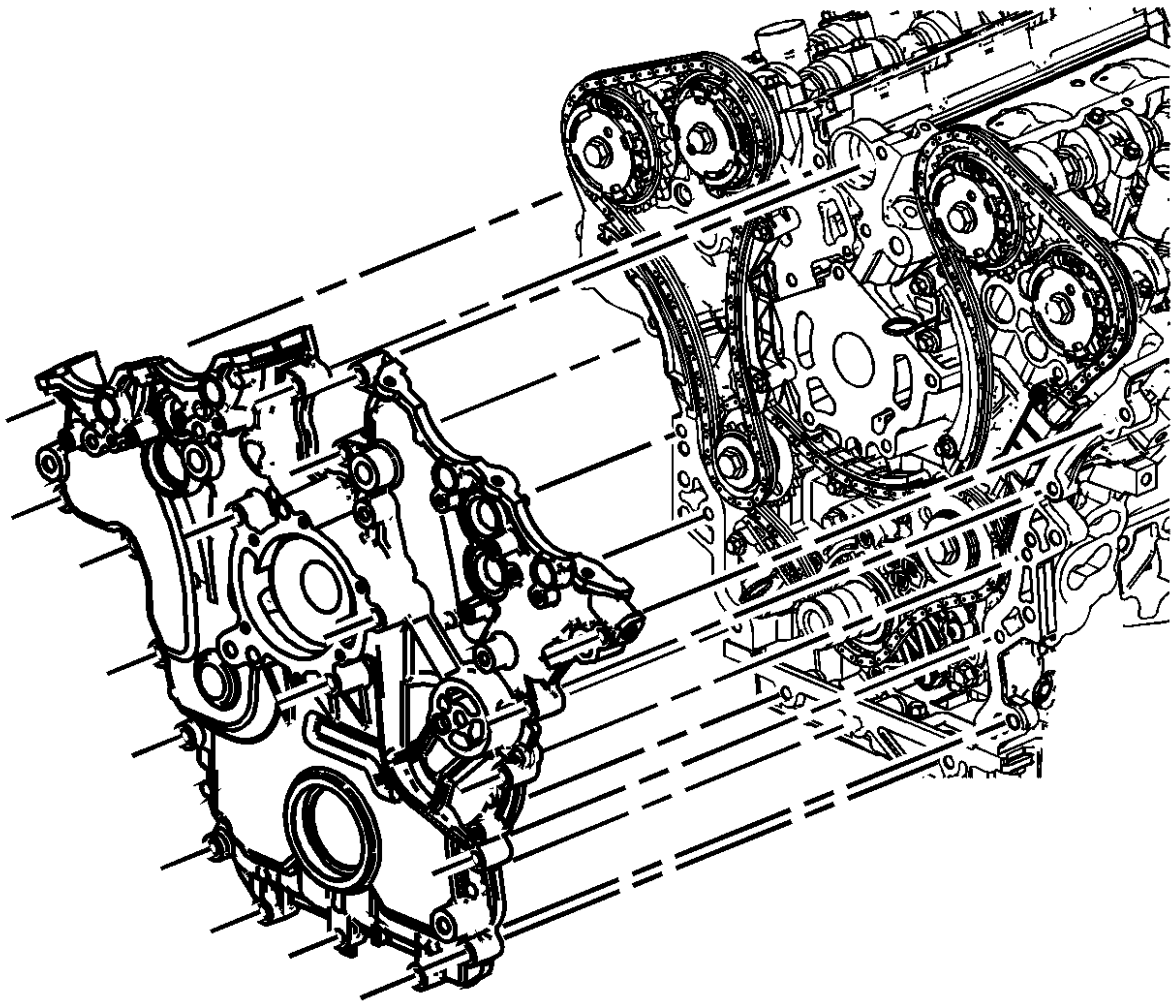

Fig. 108: View Of Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

2. Use the **EN-46109** pins in order to install the engine front cover. Refer to **Engine Front Cover Installation** .
3. Install the camshaft position actuator solenoid valves to the front cover. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** , **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
4. Install the camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** , **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** , **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** , and **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
5. Install the crankshaft balancer. Refer to **Crankshaft Balancer Installation** .
6. Install the generator bracket with the generator and the belt tensioner. Refer to **Generator Replacement** .
7. Install the water outlet. Refer to **Water Outlet Replacement** .

8. Install the purge vent hose to the water outlet.
9. Fill the cooling system. Refer to **Cooling System Draining and Filling** .
10. Install the water pump pulley.
11. Install the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement**.
12. Install the camshaft covers. Refer to **Camshaft Cover Replacement - Left Side**, and **Camshaft Cover Replacement - Right Side**.
13. Install the intake manifold. Refer to **Intake Manifold Replacement**.
14. Fill the cooling system. Refer to **Cooling System Draining and Filling** .

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Removal** .
3. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** . Replace components as necessary.

Installation Procedure

1. Install the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Installation** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right side secondary camshaft drive chain components. Refer to **Camshaft Timing Chain Components Removal** .
3. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** . Replace components as necessary.

Installation Procedure

1. Ensure the stage 1 alignment position to the stage 2 alignment position is correct. Refer to **Camshaft Timing Chain Components Installation** .
2. Install the right side secondary camshaft intermediate drive chain. Refer to **Camshaft Timing Chain Components Installation** .

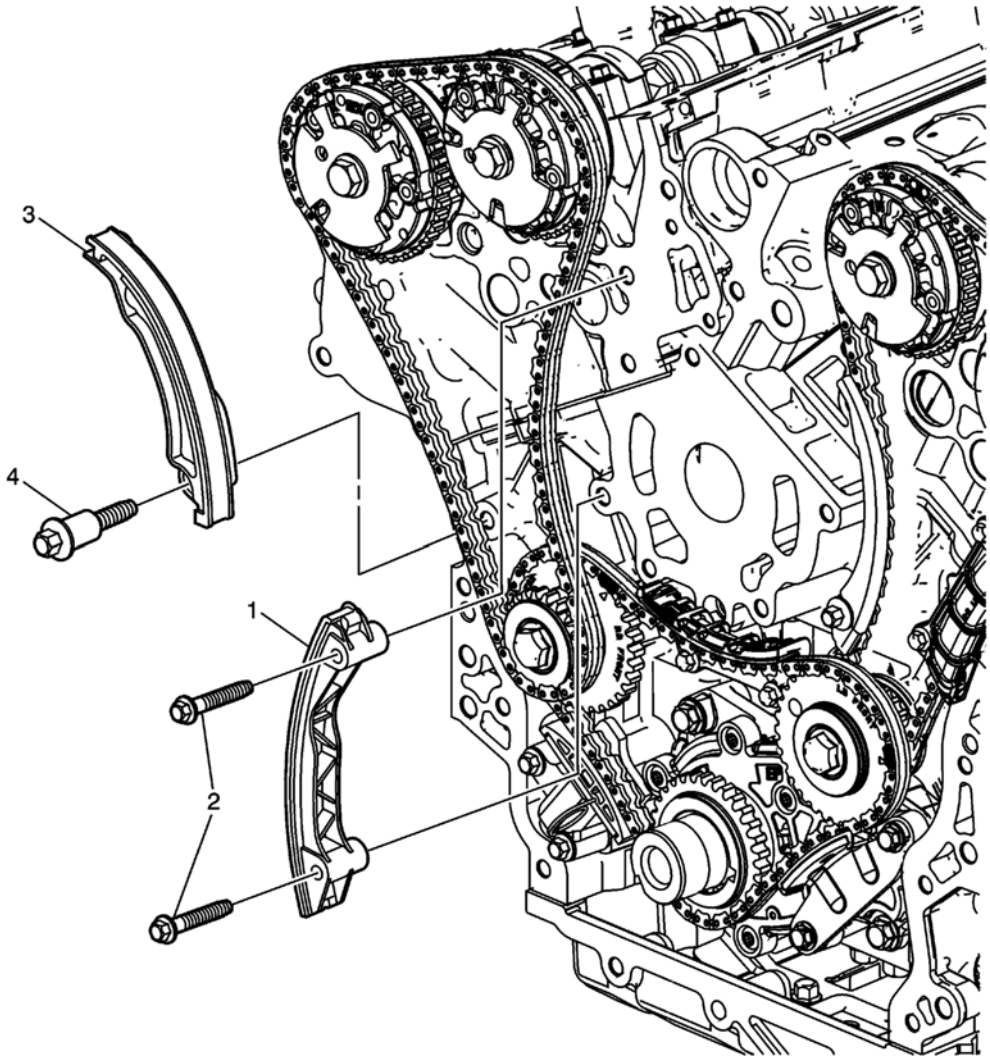

Fig. 109: Secondary Camshaft Drive Chain Guide And Shoe - Right Side
Courtesy of GENERAL MOTORS COMPANY

3. Install the right side secondary camshaft drive chain guide (1) and shoe (3). Tighten bolts (2 and 4) to 25 N.m (18 lb ft).
4. Install the right side secondary camshaft drive chain tensioner. Refer to **Camshaft Timing Chain Components Installation** .
5. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the left bank secondary camshaft drive chain tensioner. Refer to **Camshaft Timing Chain Components Removal** .
3. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** .

Installation Procedure

1. Install the left bank secondary camshaft drive chain tensioner. Refer to **Camshaft Timing Chain Components Installation** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right side secondary camshaft drive chain tensioner. Refer to **Camshaft Timing Chain Components Removal** .
3. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** . Replace components as necessary.

Installation Procedure

1. Install the right side secondary camshaft drive chain tensioner. Refer to **Camshaft Timing Chain Components Installation** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the left side secondary camshaft drive chain tensioner, shoe, and guide. Refer to **Camshaft Timing Chain Components Removal** .
3. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** . Replace components as necessary.

Installation Procedure

1. Install the left side secondary camshaft drive chain shoe, guide, and tensioner. Refer to **Camshaft Timing Chain Components Installation** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

SECONDARY TIMING CHAIN TENSIONER SHOE REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
2. Remove the right side secondary camshaft drive chain tensioner, shoe, and guide. Refer to **Camshaft Timing Chain Components Removal** .
3. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection** . Replace components as necessary.

Installation Procedure

1. Install the right side secondary camshaft drive chain shoe, guide, and tensioner. Refer to **Camshaft**

Timing Chain Components Installation .

2. Install the engine front cover. Refer to Engine Front Cover Replacement.

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.
2. Remove the left side secondary camshaft drive chain tensioner, shoe, and guide. Refer to Camshaft Timing Chain Components Removal .
3. Clean and inspect all of the camshaft timing drive components. Refer to Camshaft Timing Drive Components Cleaning and Inspection . Replace components as necessary.

Installation Procedure

1. Install the left side secondary camshaft drive chain shoe, guide, and tensioner. Refer to Camshaft Timing Chain Components Installation .
2. Install the engine front cover. Refer to Engine Front Cover Replacement.

SECONDARY TIMING CHAIN GUIDE REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.
2. Remove the right side secondary camshaft drive chain tensioner, shoe, and guide. Refer to Camshaft Timing Chain Components Removal .
3. Clean and inspect all of the camshaft timing drive components. Refer to Camshaft Timing Drive Components Cleaning and Inspection . Replace components as necessary.

Installation Procedure

1. Install the right side secondary camshaft drive chain shoe, guide, and tensioner. Refer to Camshaft Timing Chain Components Installation .
2. Install the engine front cover. Refer to Engine Front Cover Replacement.

PRIMARY CAMSHAFT DRIVE CHAIN AND SPROCKETS REPLACEMENT

Removal Procedure

1. Remove the engine front cover. Refer to Engine Front Cover Replacement.
2. Remove the right side camshaft timing chain components. Refer to Camshaft Timing Chain Components Removal .

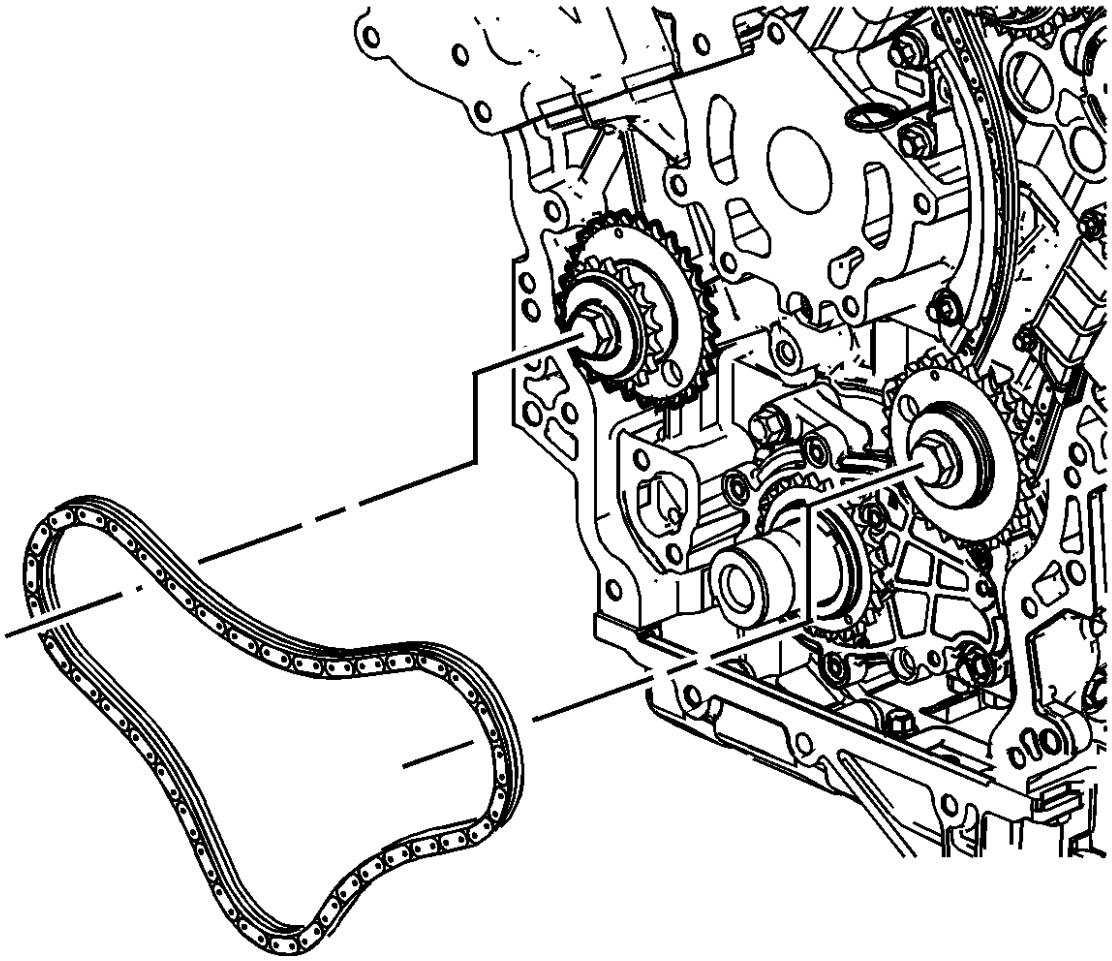

Fig. 110: View Of Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS COMPANY

3. Remove the primary camshaft drive chain. Refer to **Camshaft Timing Chain Components Removal** .
4. Clean and inspect all of the camshaft timing drive components. Refer to **Camshaft Timing Drive Components Cleaning and Inspection**

Installation Procedure

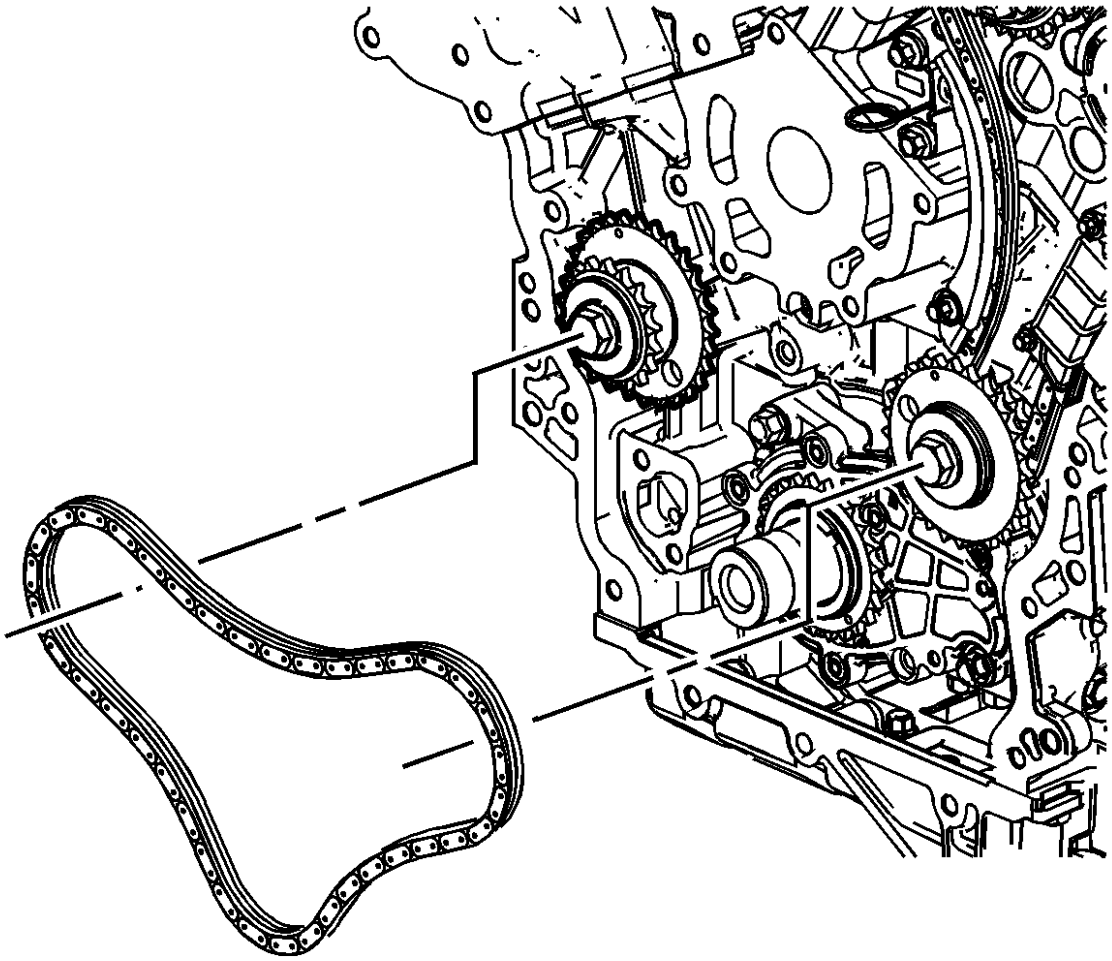

Fig. 111: View Of Primary Camshaft Timing Chain
Courtesy of GENERAL MOTORS COMPANY

1. Install the primary camshaft timing chain. Refer to **Camshaft Timing Chain Components Installation** .
2. Install the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Installation** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

TIMING CHAIN IDLER SPROCKET REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove spark plugs. Refer to **Spark Plug Replacement** .
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Removal** .

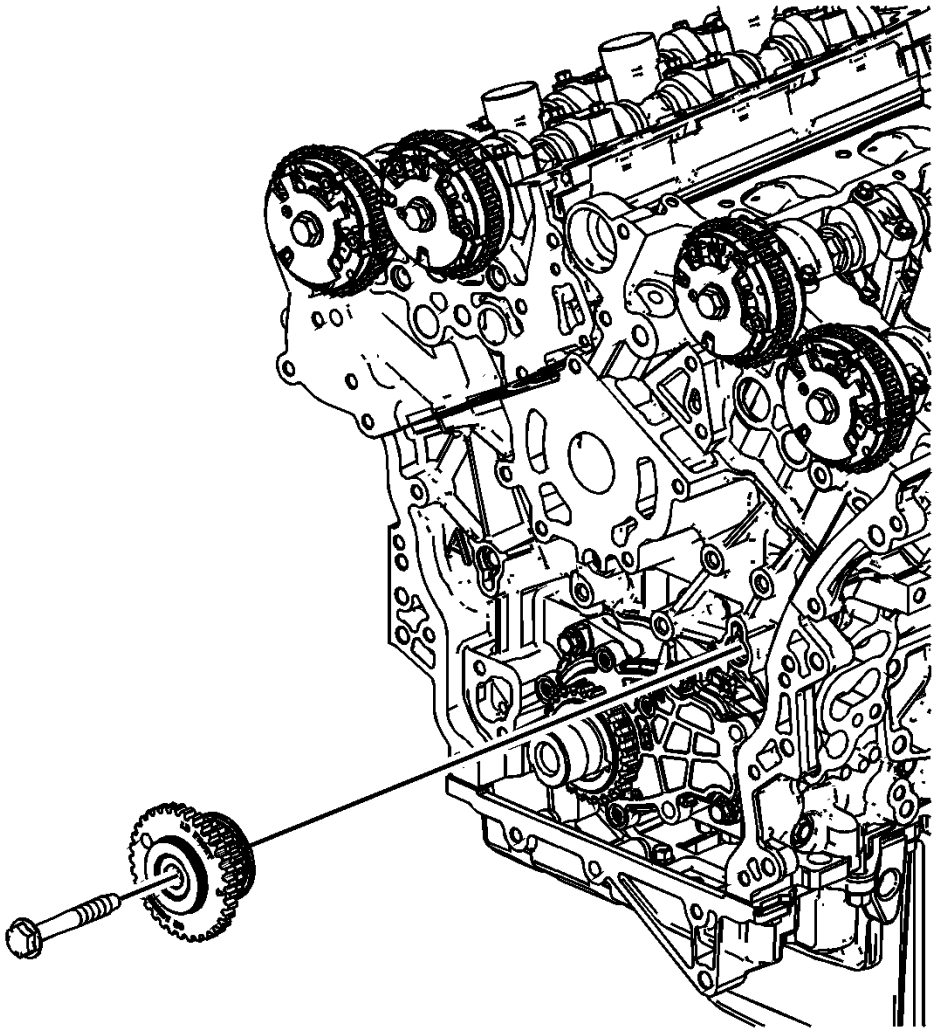

Fig. 112: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Removal - Left Side** .

Installation Procedure

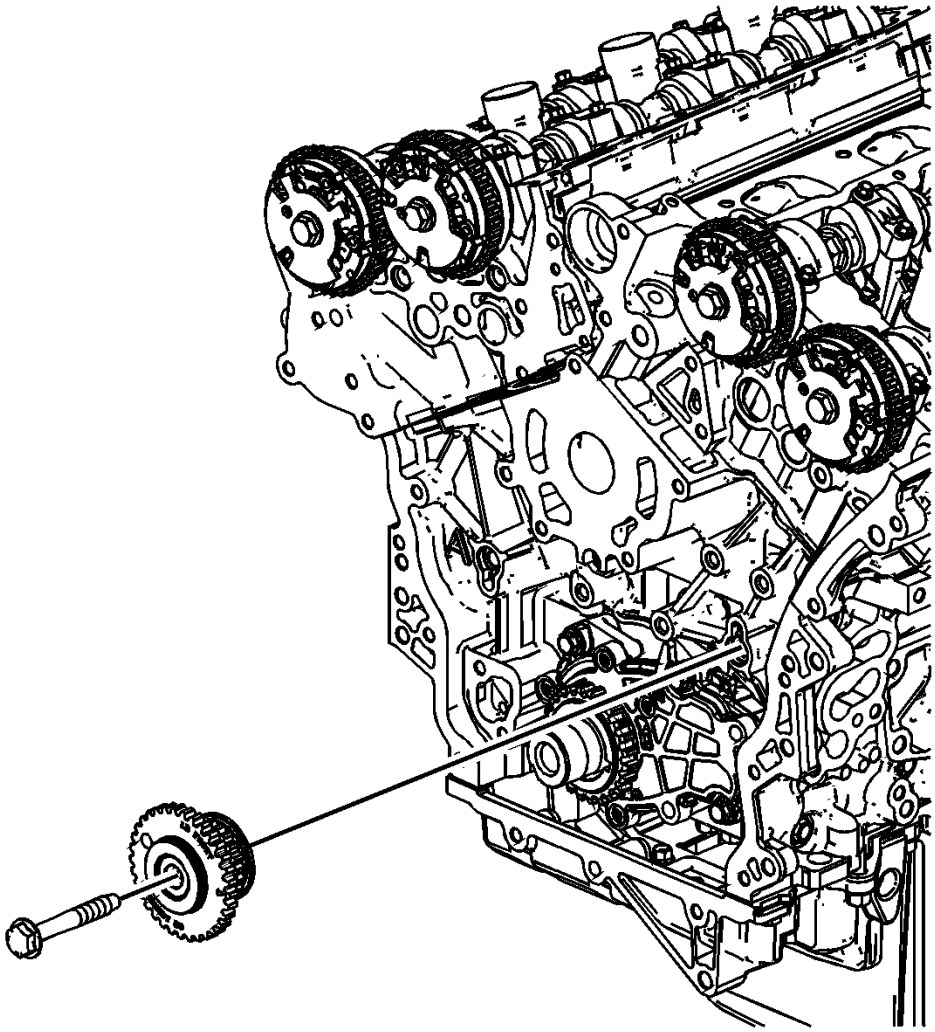

Fig. 113: View Of Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the left intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Installation - Left Side** .
2. Install the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Installation** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
4. Install spark plugs. Refer to **Spark Plug Replacement** .

TIMING CHAIN IDLER SPROCKET REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove spark plugs. Refer to **Spark Plug Replacement** .
2. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.
3. Remove the right side secondary camshaft drive chain components. Refer to **Camshaft Timing Chain Components Removal** .
4. Remove the primary camshaft drive chain components. Refer to **Camshaft Timing Chain Components**

Removal .

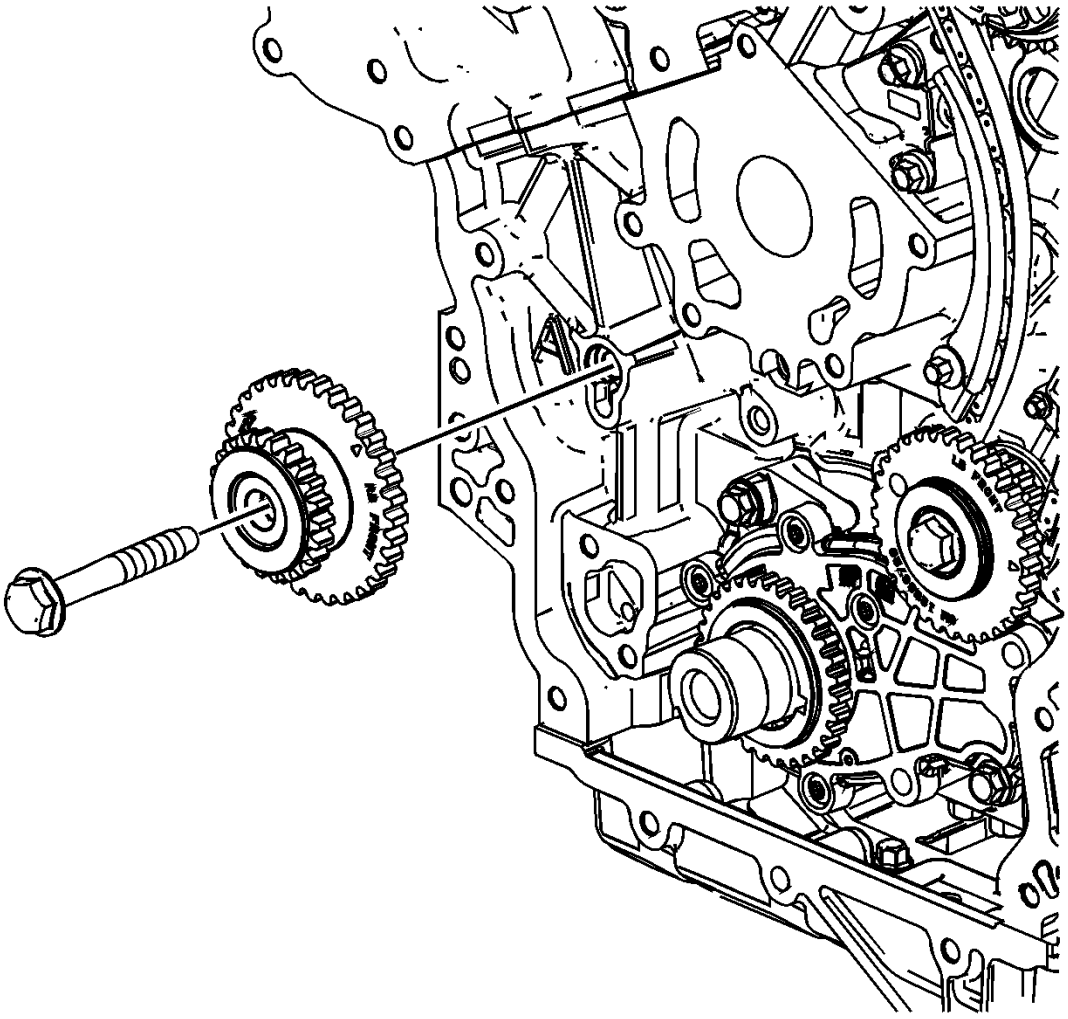

Fig. 114: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the right intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Removal - Right Side** .

Installation Procedure

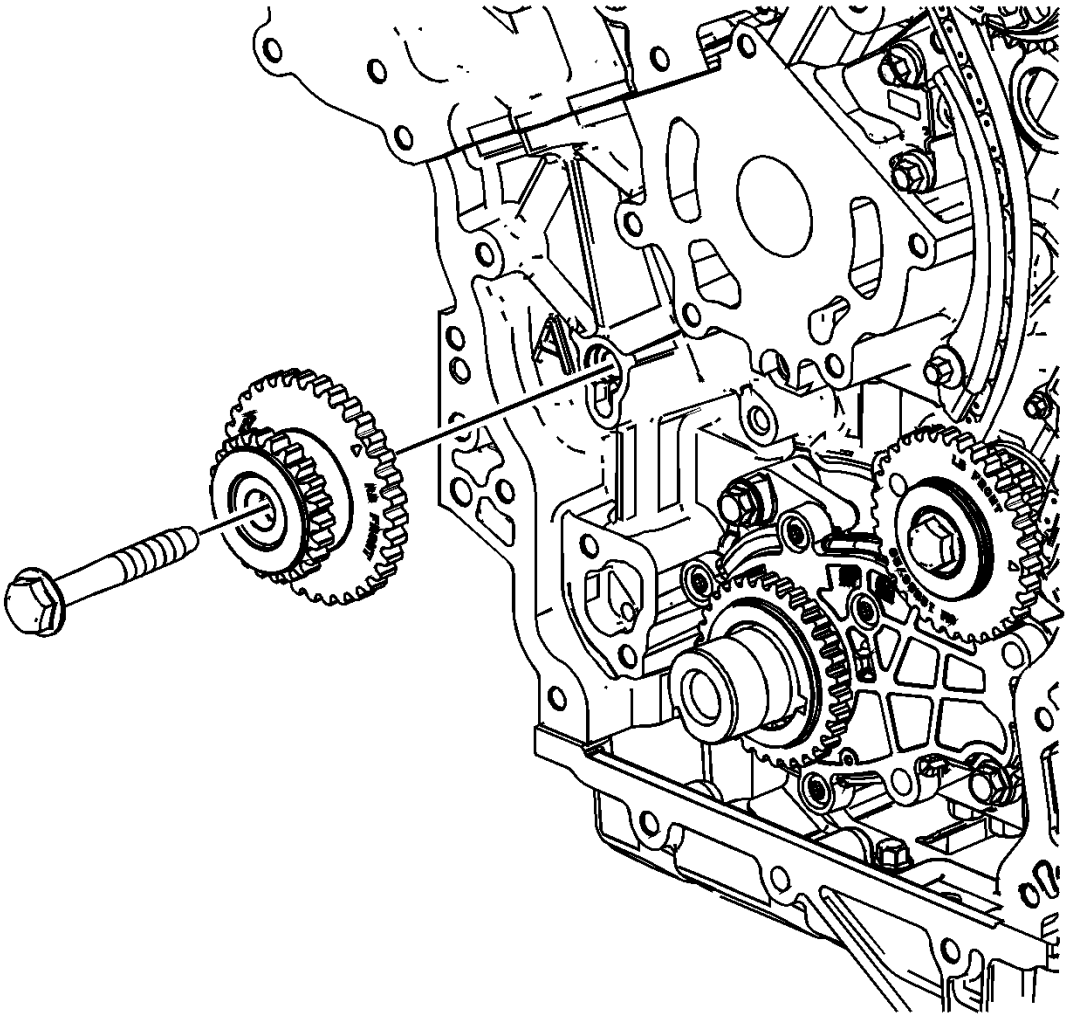

Fig. 115: Identifying Camshaft Intermediate Drive Chain Idler & Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the left intermediate drive chain idler sprocket. Refer to **Timing Chain Idler Sprocket Installation - Right Side** .
2. Install the camshaft timing chain components. Refer to **Camshaft Timing Chain Components Installation** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.
4. Install spark plugs. Refer to **Spark Plug Replacement** .

PRIMARY CAMSHAFT INTERMEDIATE DRIVE CHAIN TENSIONER REPLACEMENT

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

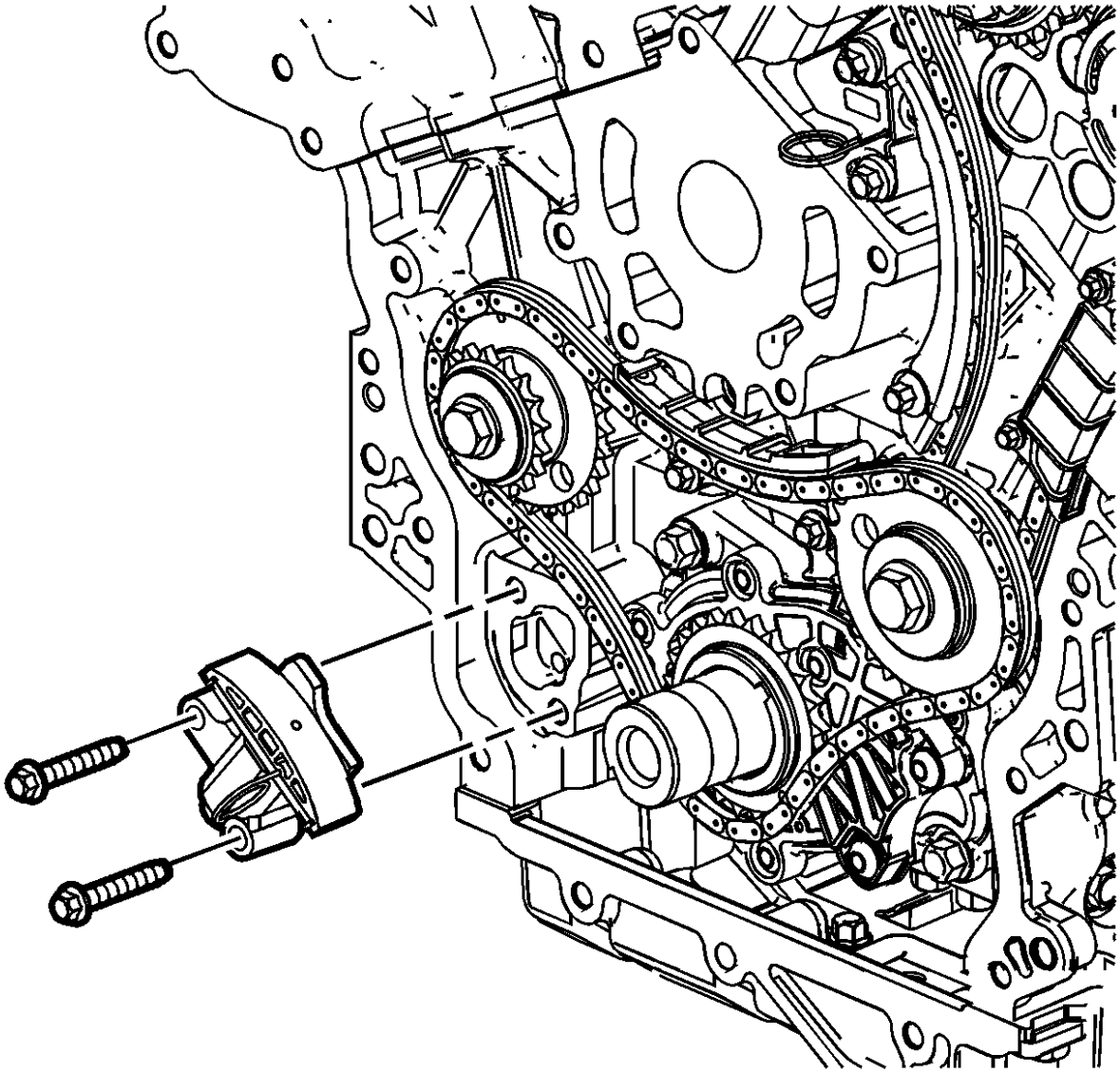

Fig. 116: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the entire camshaft timing system is not in Stage 2, Timing Chain Alignment Diagram , mark the timing chain and sprockets in order to ensure proper reassembly.**

2. Remove the primary camshaft drive chain tensioner. Refer to **Camshaft Timing Chain Components Removal** .

Installation Procedure

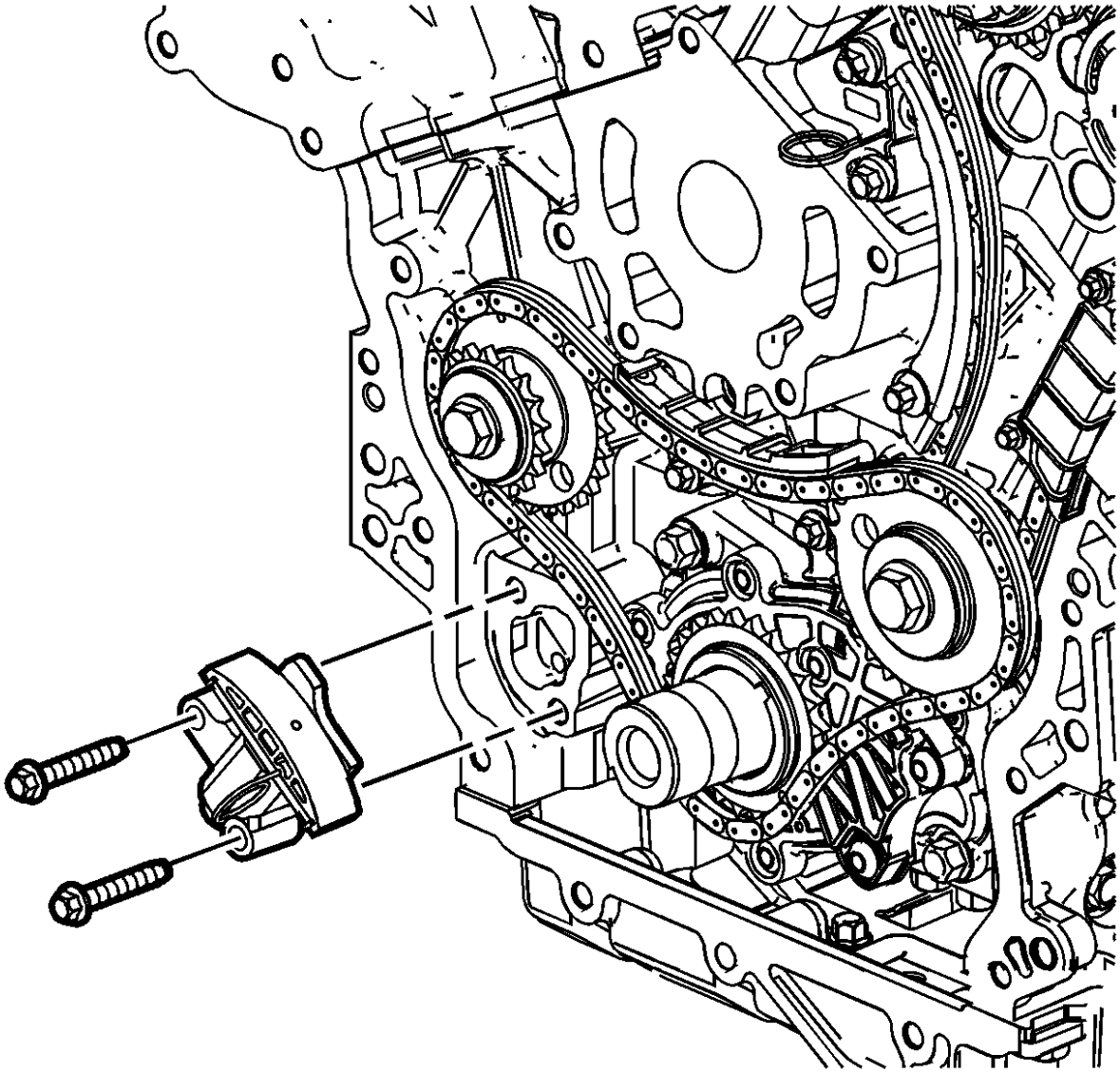

Fig. 117: View Of Primary Camshaft Drive Chain Tensioner
Courtesy of GENERAL MOTORS COMPANY

1. Install the primary camshaft drive chain tensioner. Refer to **Camshaft Timing Chain Components Installation** .
2. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - LOWER

Removal Procedure

1. Remove the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.

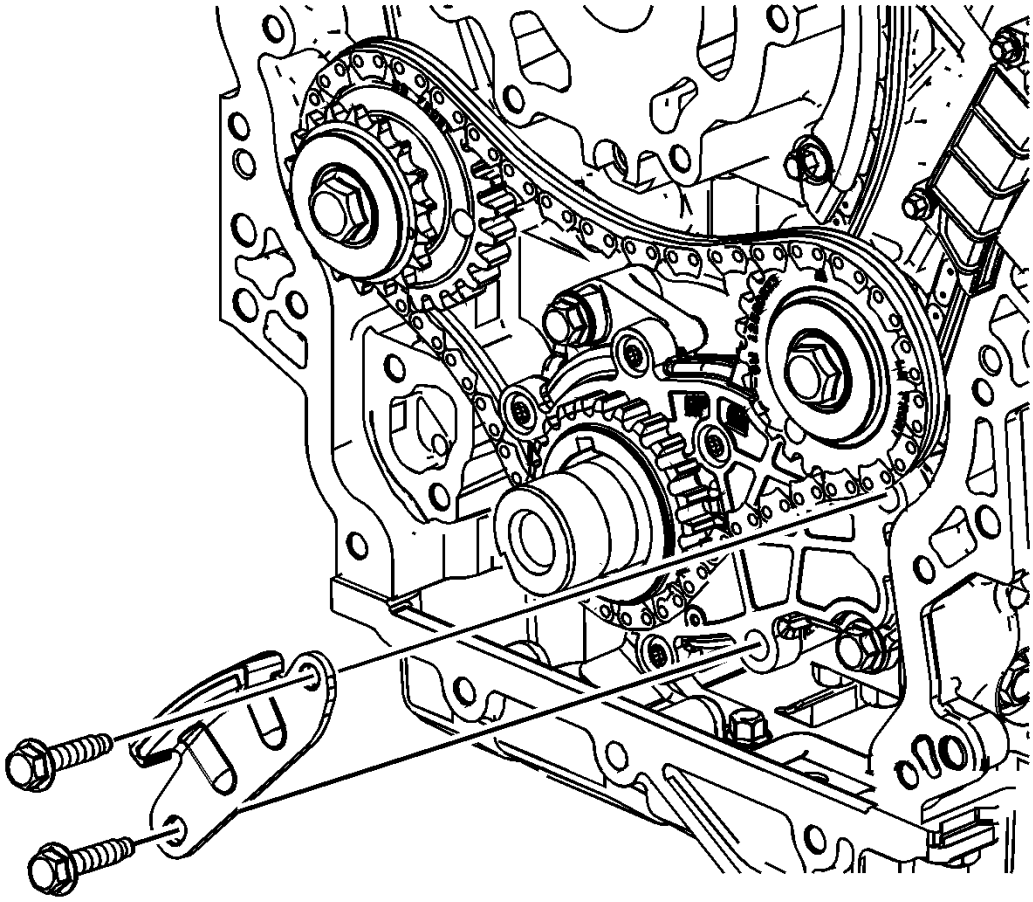

Fig. 118: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the primary camshaft drive chain lower guide bolts.
3. Remove the primary camshaft drive chain lower guide.

Installation Procedure

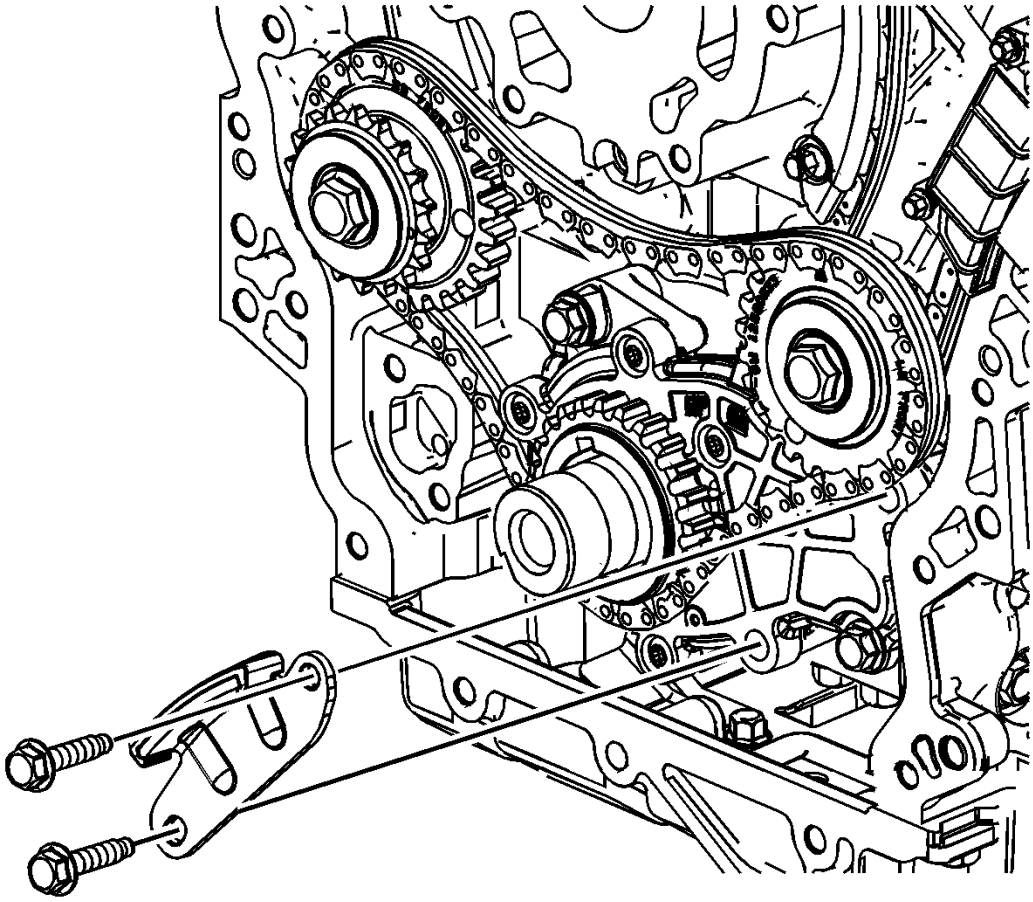

Fig. 119: View Of Primary Camshaft Drive Chain Lower Guide Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the primary camshaft drive chain lower guide to the oil pump.

CAUTION: Refer to Fastener Caution .

2. Install the primary camshaft drive chain lower guide bolts and tighten to 25 N.m (18 lb ft).
3. Install the primary camshaft drive chain tensioner. Refer to **Primary Camshaft Intermediate Drive Chain Tensioner Replacement**.

PRIMARY TIMING CHAIN GUIDE REPLACEMENT - UPPER

Removal Procedure

1. Remove the engine front cover. Refer to **Engine Front Cover Replacement**.

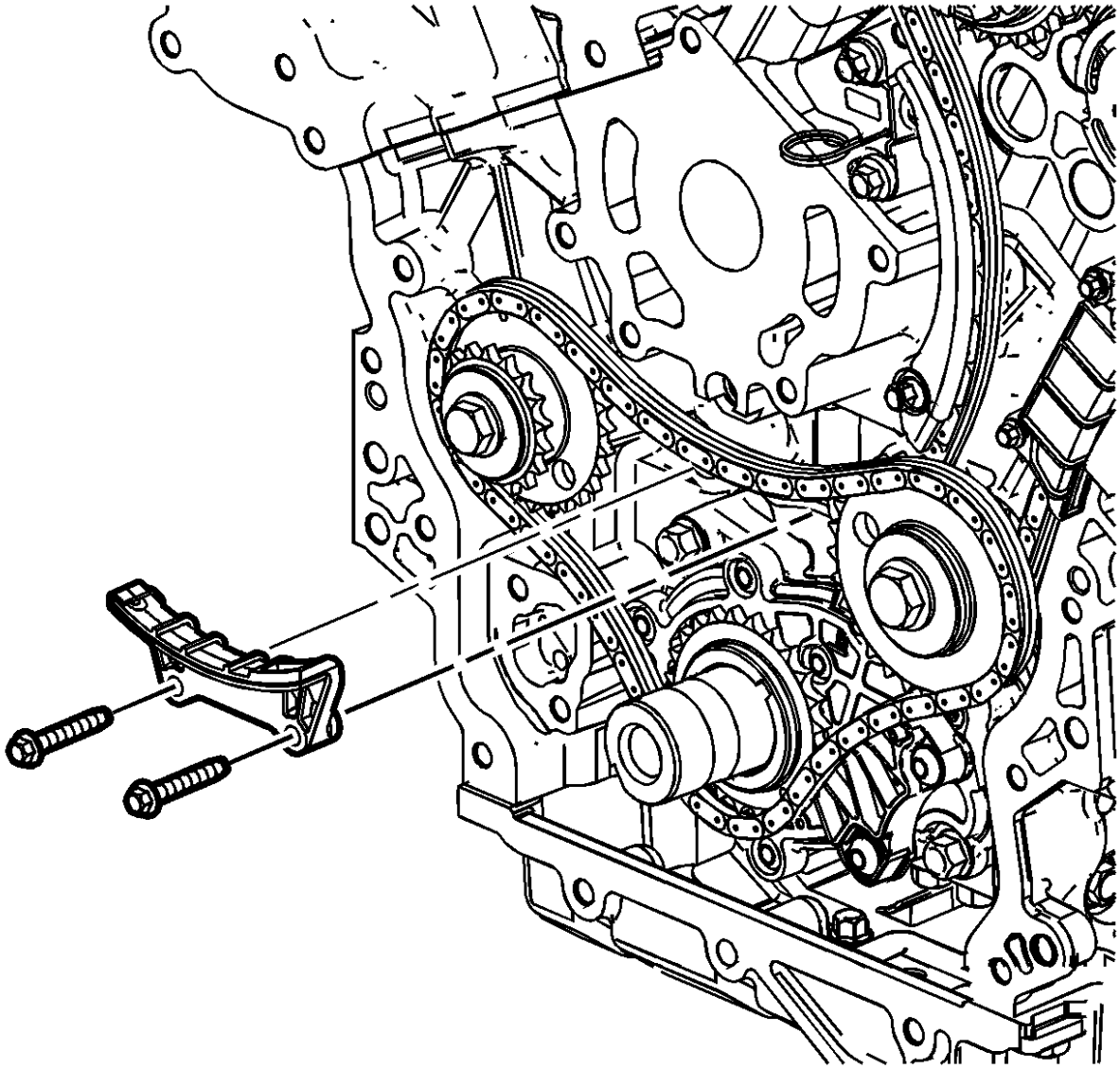

Fig. 120: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

2. Remove the primary camshaft drive chain tensioner. Refer to **Camshaft Timing Chain Components Removal** .
3. Remove the primary upper camshaft drive chain guide. Refer to **Camshaft Timing Chain Components Removal** .

Installation Procedure

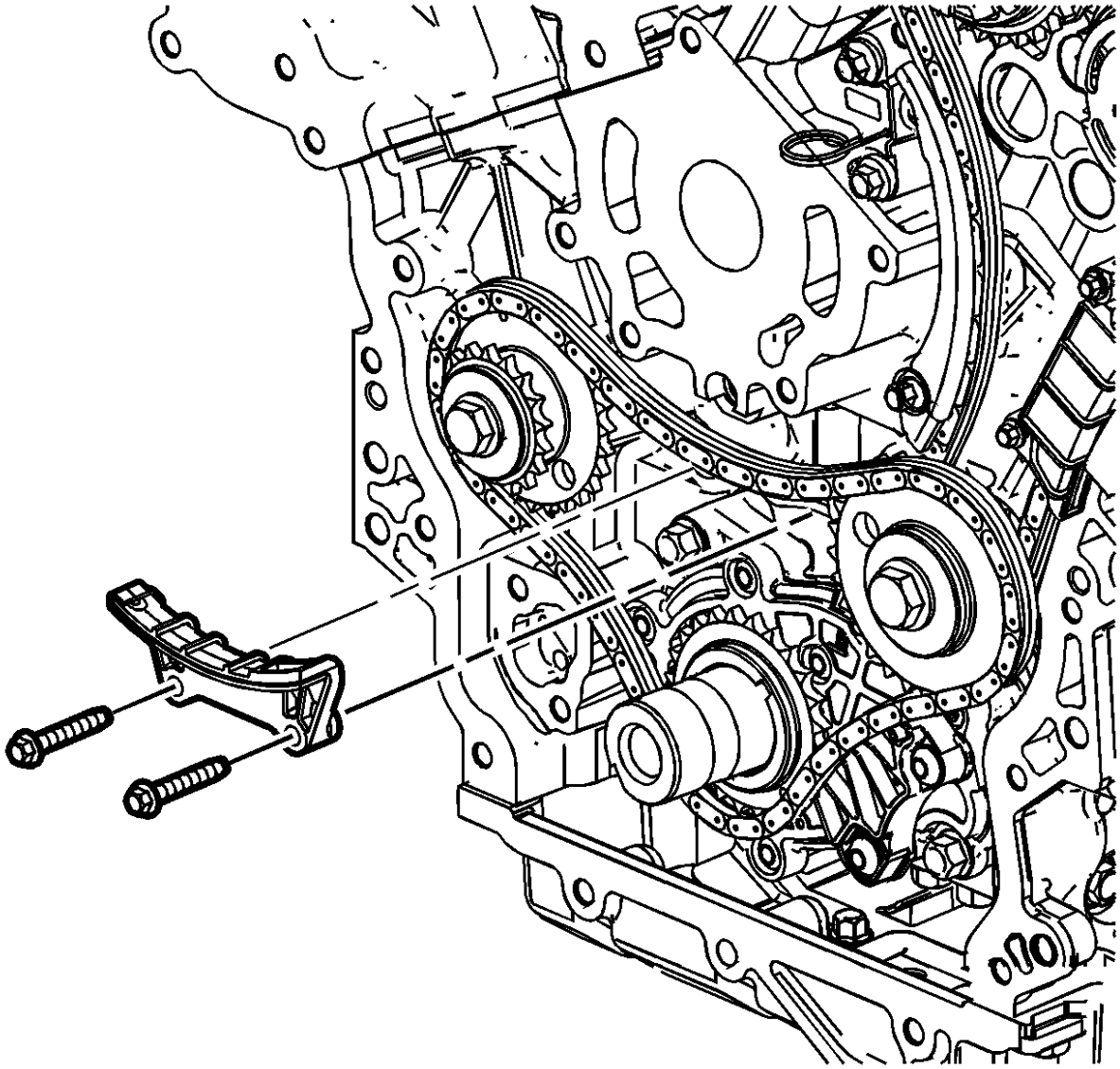

Fig. 121: View Of Upper Primary Camshaft Drive Chain Guide
Courtesy of GENERAL MOTORS COMPANY

1. Install the primary upper camshaft drive chain guide. Refer to **Camshaft Timing Chain Components Installation** .
2. Install the primary camshaft drive chain tensioner. Refer to **Camshaft Timing Chain Components Installation** .
3. Install the engine front cover. Refer to **Engine Front Cover Replacement**.

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 1

Special Tools

- **EN49982-1** Timing Chain Retainer
- **EN49982-2** Timing Chain Retainer

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

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1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
2. Remove the camshaft position actuator solenoid valve solenoid - intake. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** .
3. Remove the intake camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
4. Remove the exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** .
5. Remove the camshaft position actuator solenoid valve solenoid - exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** .
6. Rotate engine clockwise using crankshaft dampener retaining bolt until the flats at the rear ends of the camshafts are pointing up. This puts the camshafts on "base circle" and will reduce their tendency to rotate from valve spring pressure when the camshaft position actuators/drive chains are removed.

   NOTE: **Do NOT remove or back out the camshaft position actuator bolt(s) significantly, simply break them loose from their fully-torqued position. The position actuators must stay firmly attached until the retaining tools are in place, but they should be broken loose while the chain is still tight and in position.**

7. Loosen intake and/or exhaust camshaft position actuator retaining bolts, depending on which camshaft position actuator and/or camshaft you will be servicing. If servicing both camshaft position actuators and/or camshafts, loosen both bolts.

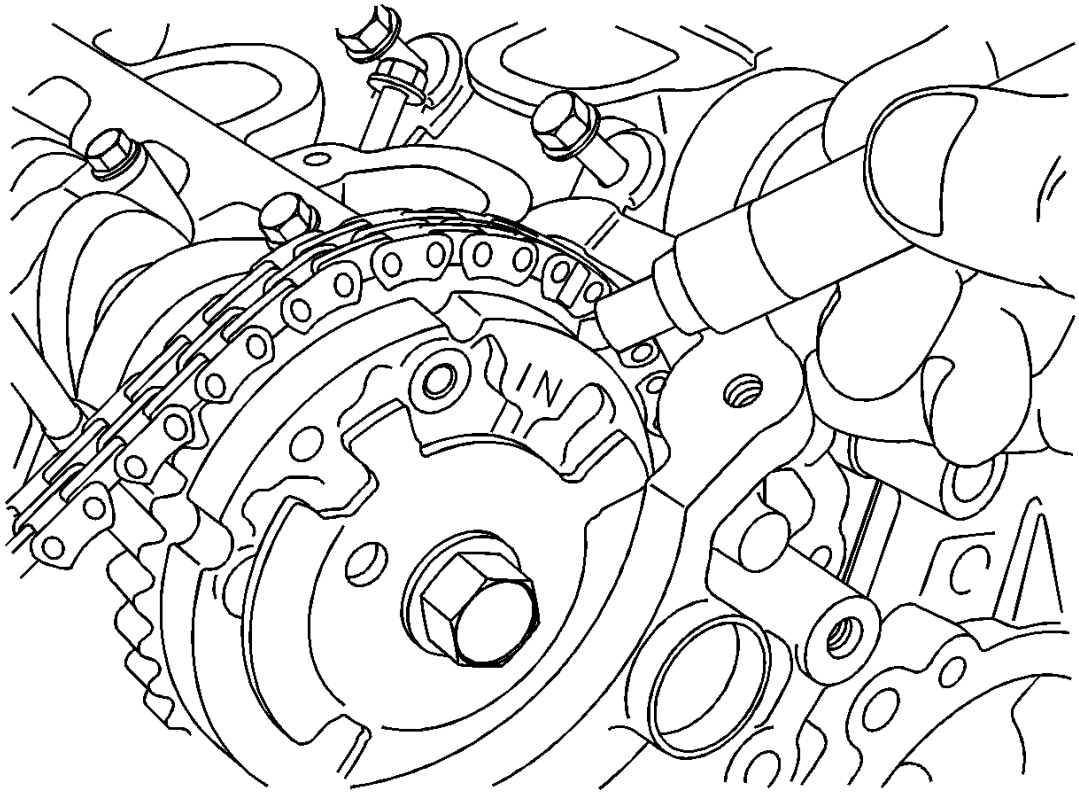


Fig. 122: Marking Position Of Chain To Camshaft Position Actuator - Intake
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Be certain to clearly mark the position of the chain to the camshaft position actuator(s). Though the engine does not need to be set to a specific timing mark before starting the procedure, the relationship of the chain to the actuator(s) is critical and must be reestablished on assembly.**

8. Mark the position of the chain to the camshaft position actuator - intake.

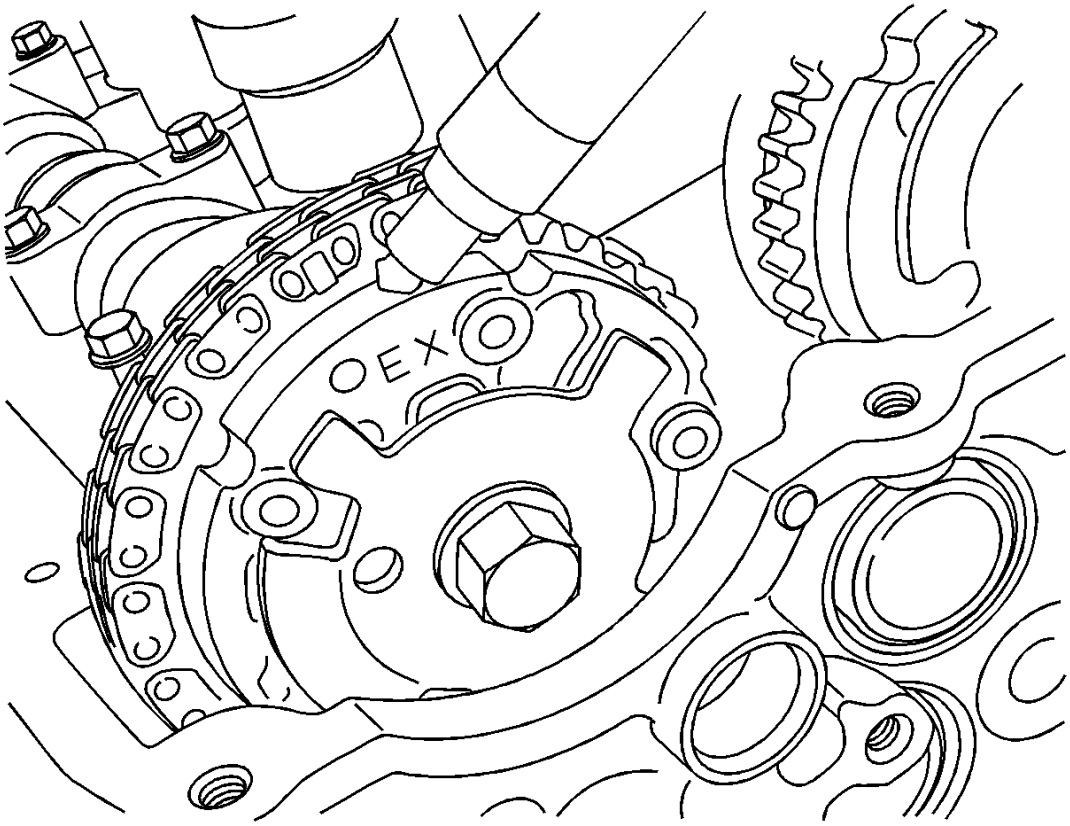


Fig. 123: Marking Position Of Chain To Camshaft Position Actuator - Exhaust
Courtesy of GENERAL MOTORS COMPANY

9. Mark the position of the chain to the camshaft position actuator - exhaust.

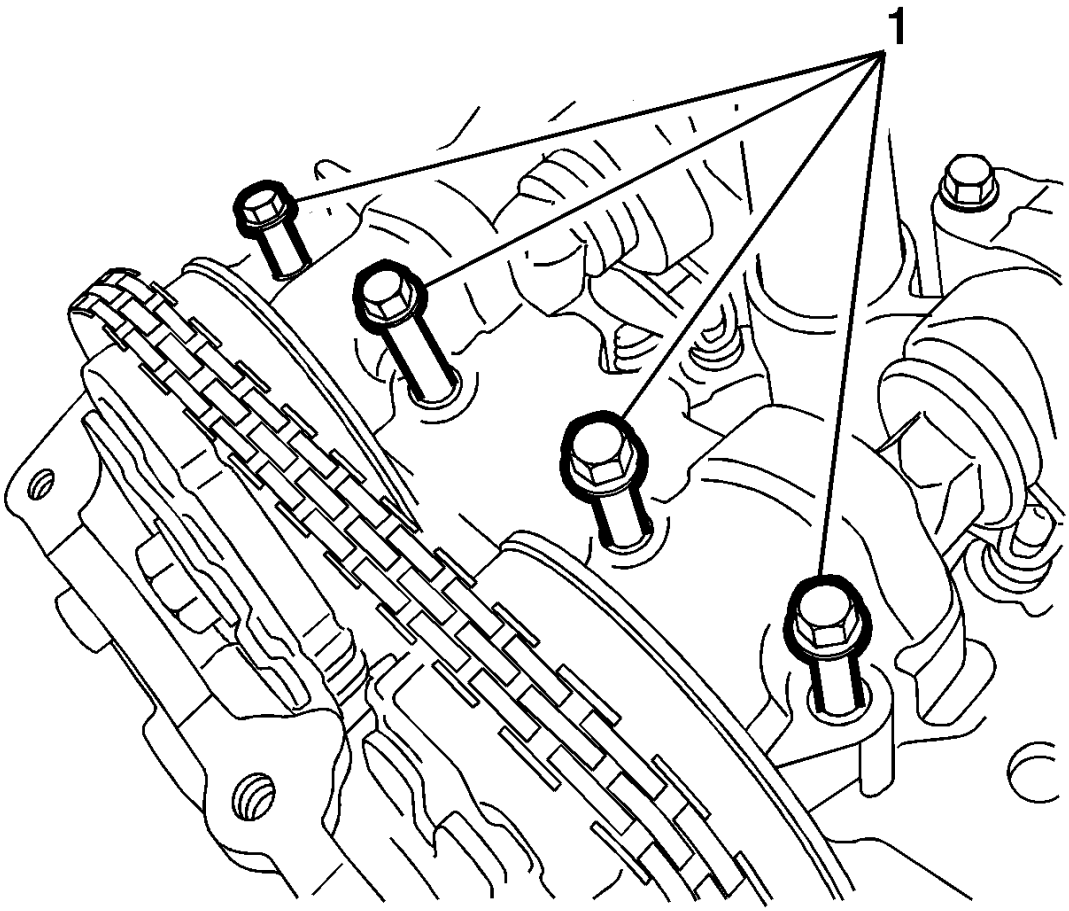


Fig. 124: Camshaft Front Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

10. Remove camshaft front cap bolts (1).

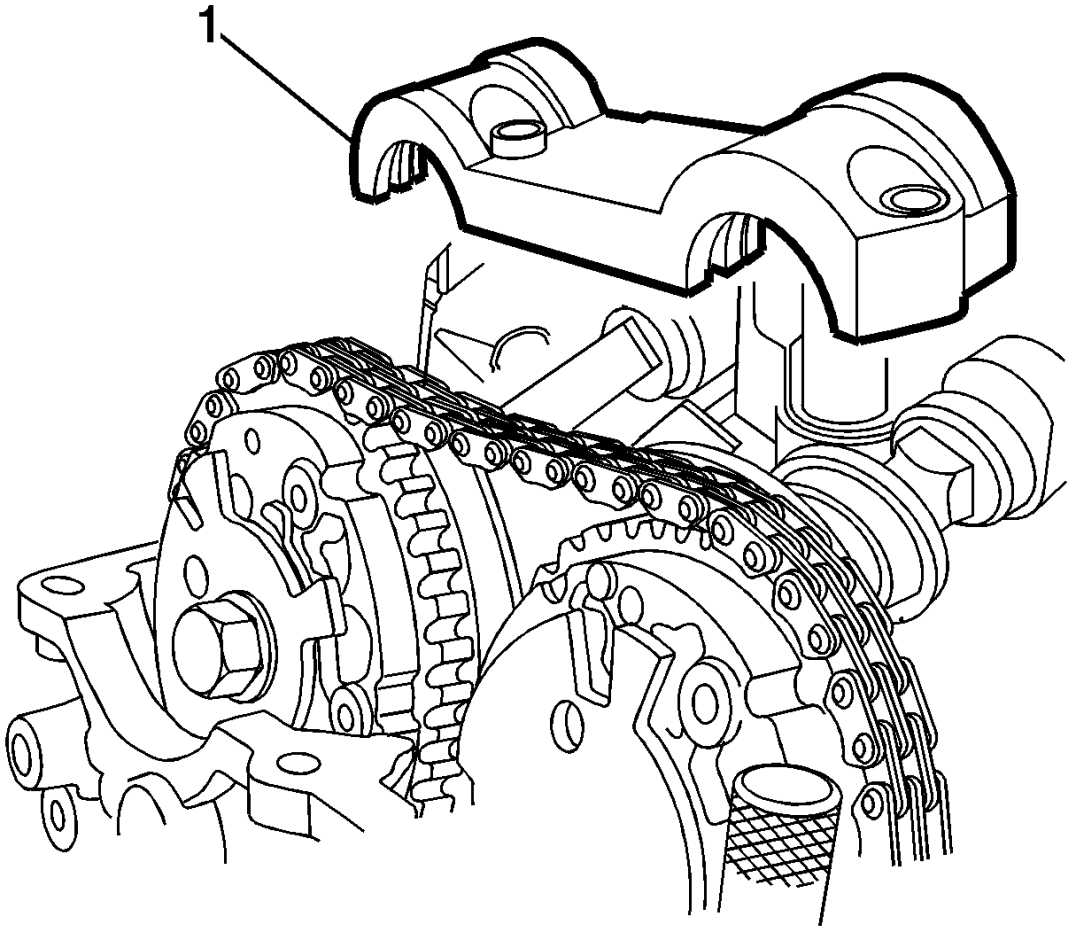


Fig. 125: Camshaft Front Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT remove or loosen any other camshaft bearing caps at this time, even if you intend to eventually remove the camshaft.**

11. Remove the camshaft front cap (1).

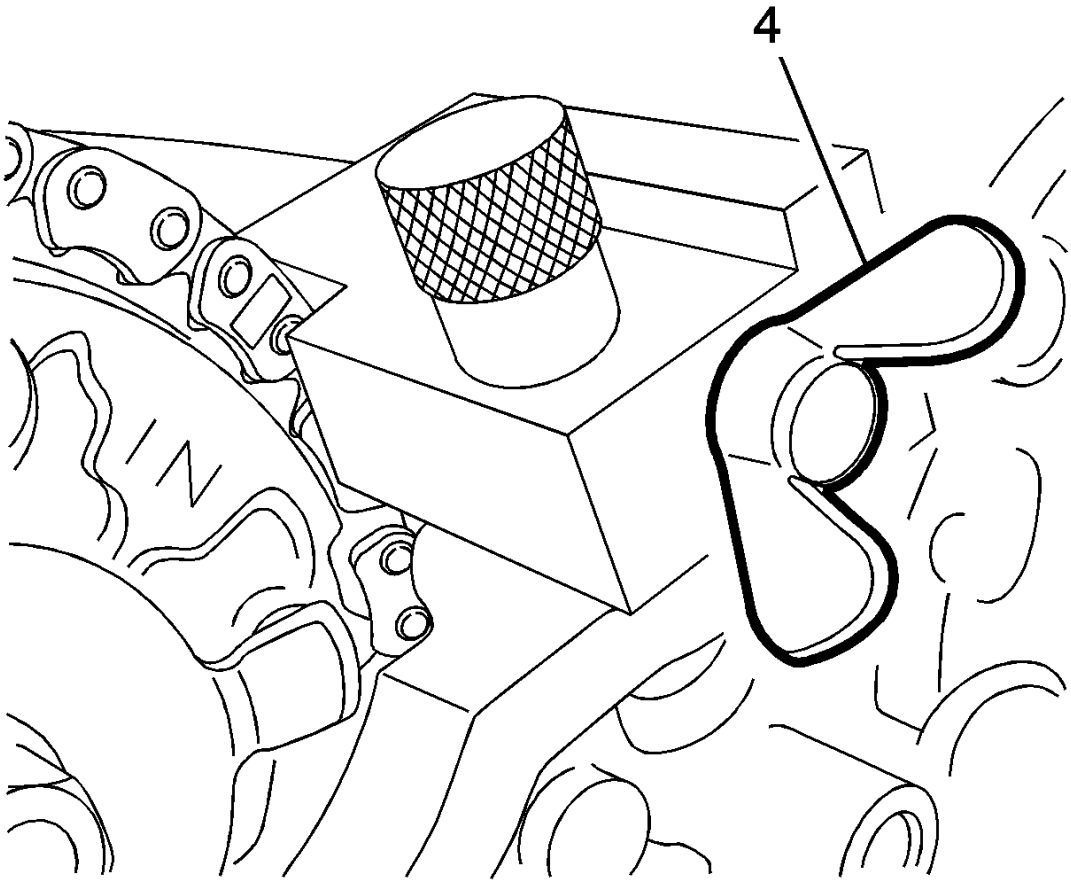


Fig. 126: Retainer Wingnut
Courtesy of GENERAL MOTORS COMPANY

12. Loosen wingnut (4) to open the clamping area of **EN49982-1** retainer.

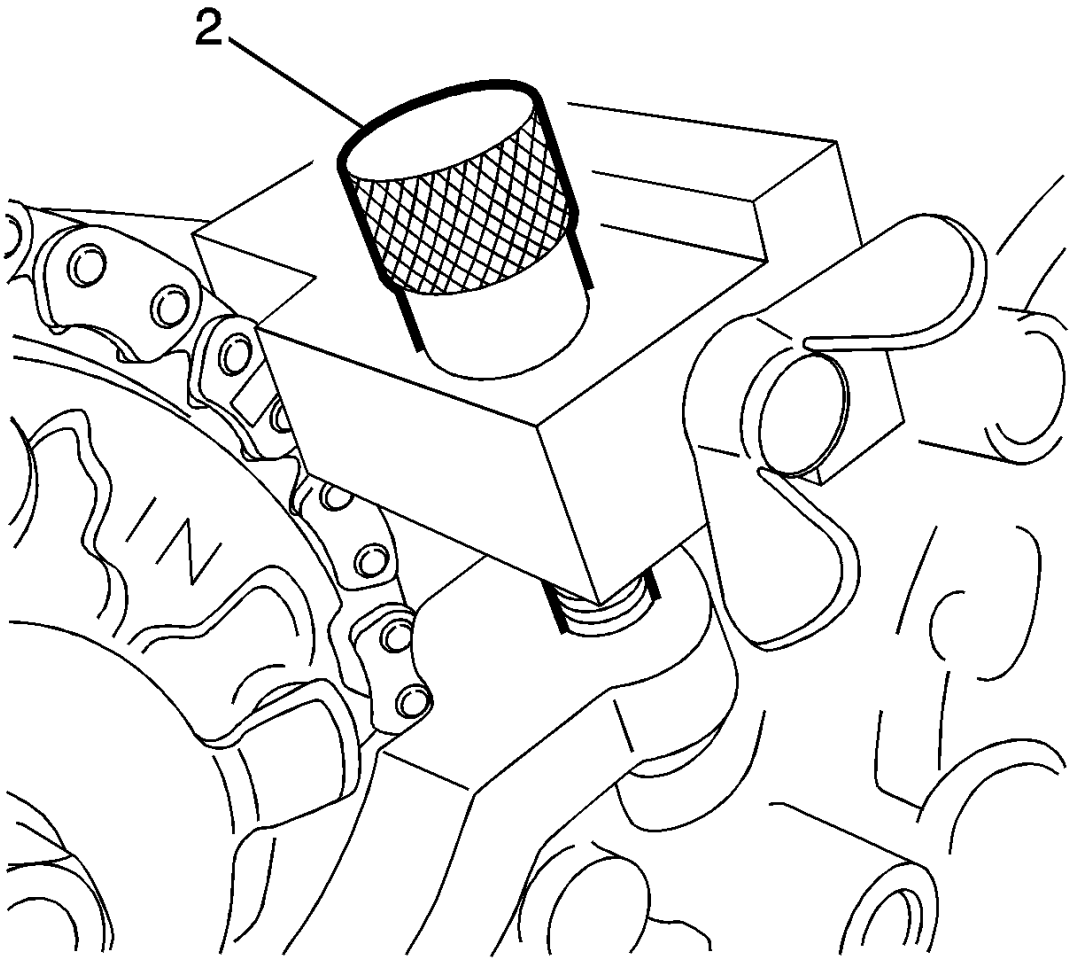


Fig. 127: Retainer Thumbscrew
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT overtighten the thumbscrew. The EN49982-1 retainer should be able to slide slightly via the slot the screw goes through. This fore/aft movement will allow easier removal and installation of the chain later.**

13. Install **EN49982-1** retainer intake side chain holder onto front cover by screwing in the thumbscrew (2) on the **EN49982-1** retainer finger-tight.

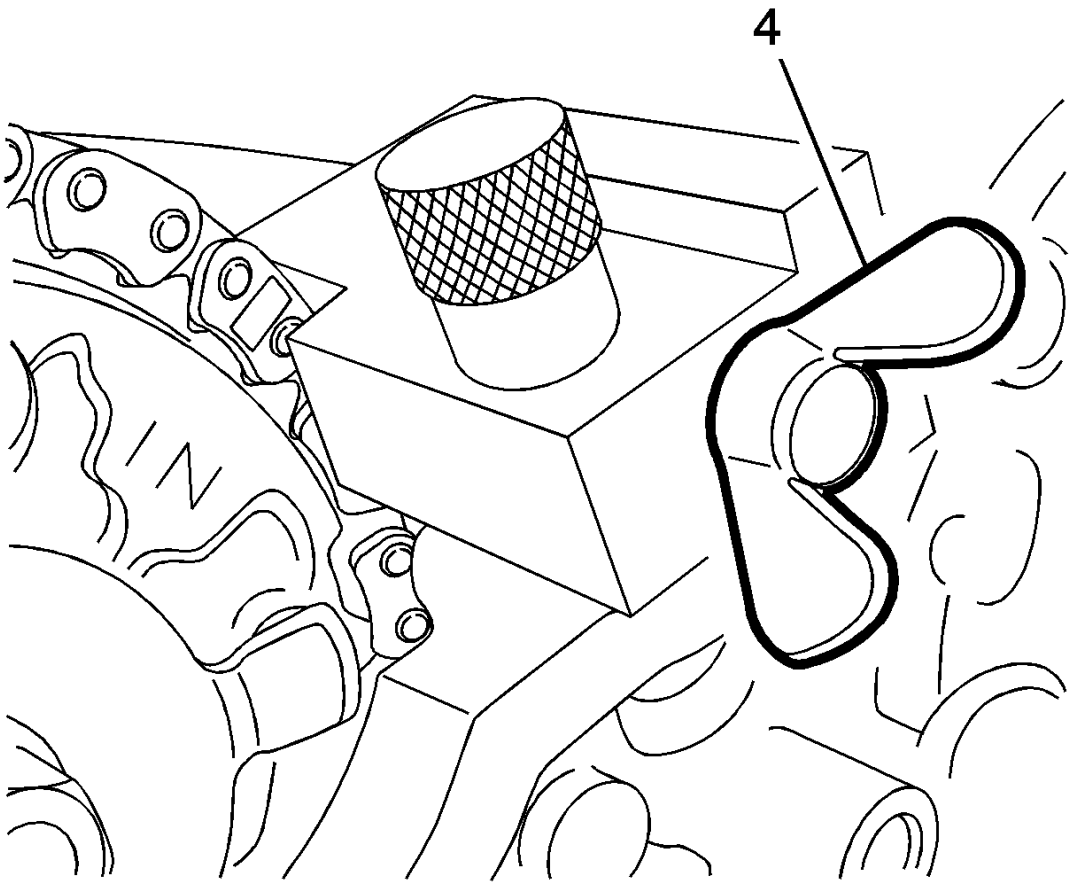


Fig. 128: Retainer Wingnut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT tighten the wingnut with a tool of any kind. Firm finger-tightening is sufficient.**

14. Tighten wingnut (4) so **EN49982-1** retainer closes over and firmly grasps timing chain.

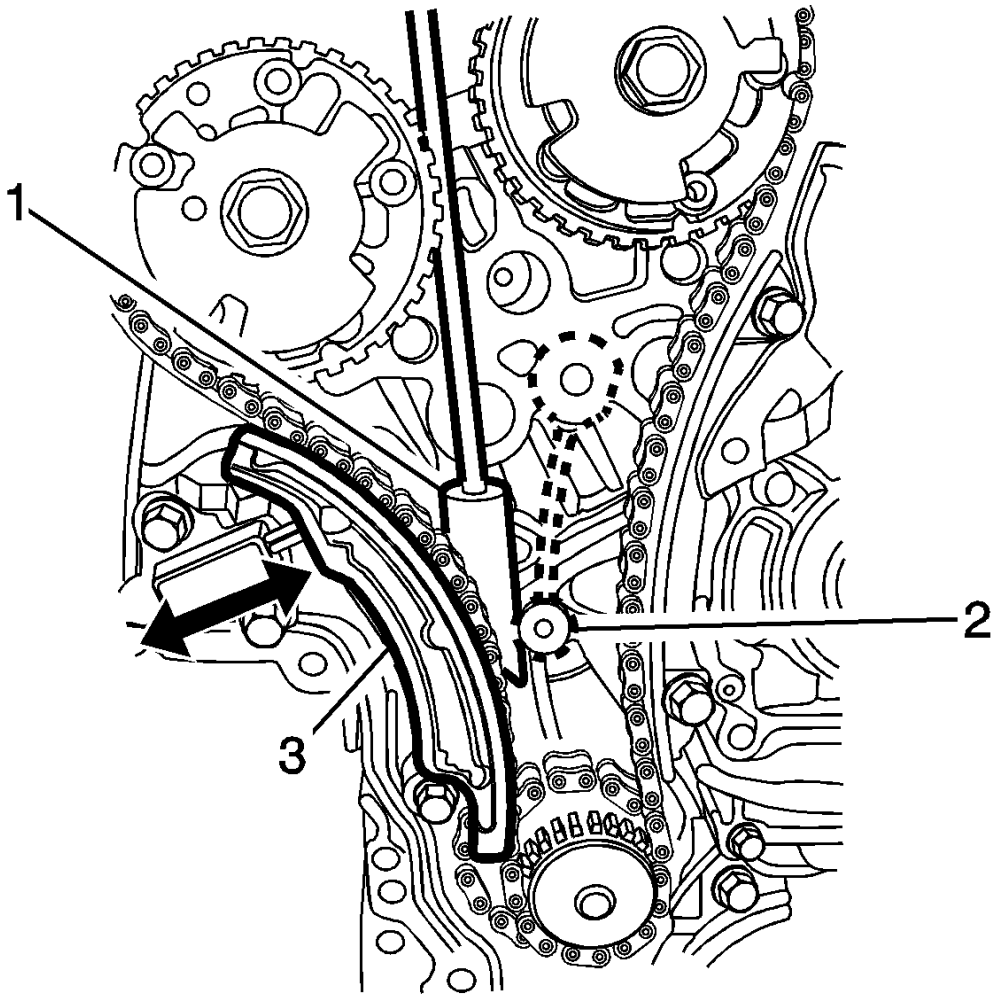


Fig. 129: Retainer Wedge
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The engine front cover is removed for clarity in the following graphics, but is NOT required to be removed to perform the procedure.**

15. **EN49982-2** retainer (1) will be installed in the following steps such that it wedges between an internal rib (2) that is cast into the inside of the front cover (shown in dotted line above) and the timing chain and spring-loaded tensioner shoe (3), holding the chain in position. The wedge will be left in place during the cam position actuator and/or camshaft service.

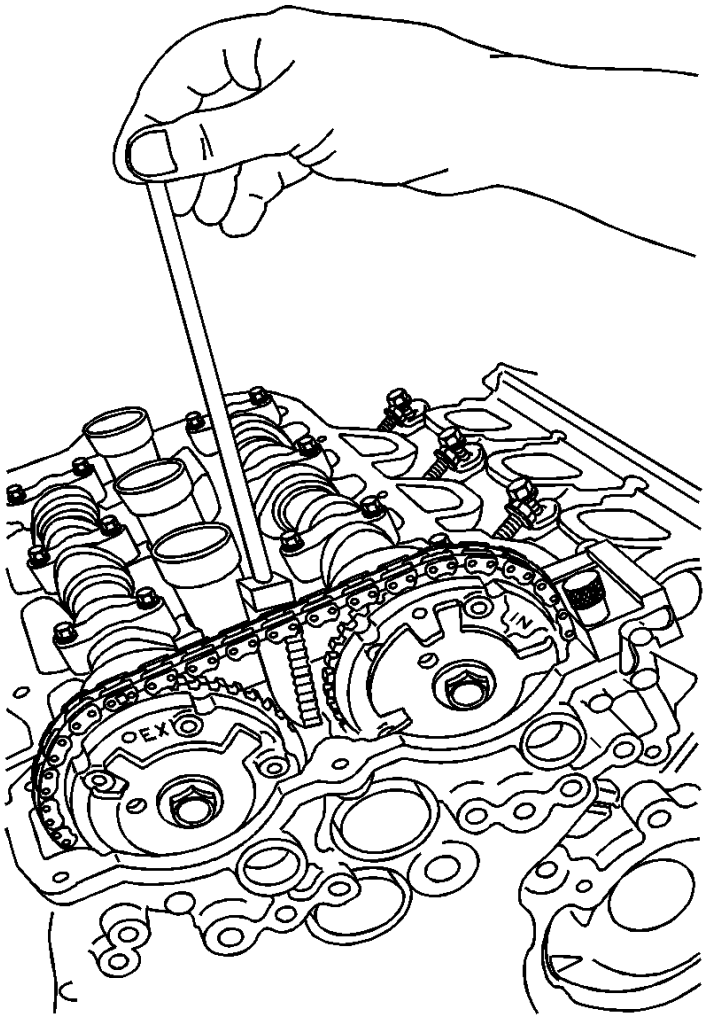


Fig. 130: Inserting Retainer
Courtesy of GENERAL MOTORS COMPANY

16. Insert the **EN49982-2** retainer between the two camshaft position actuators with the "teeth" on the **EN49982-2** retainer facing toward the front cover.

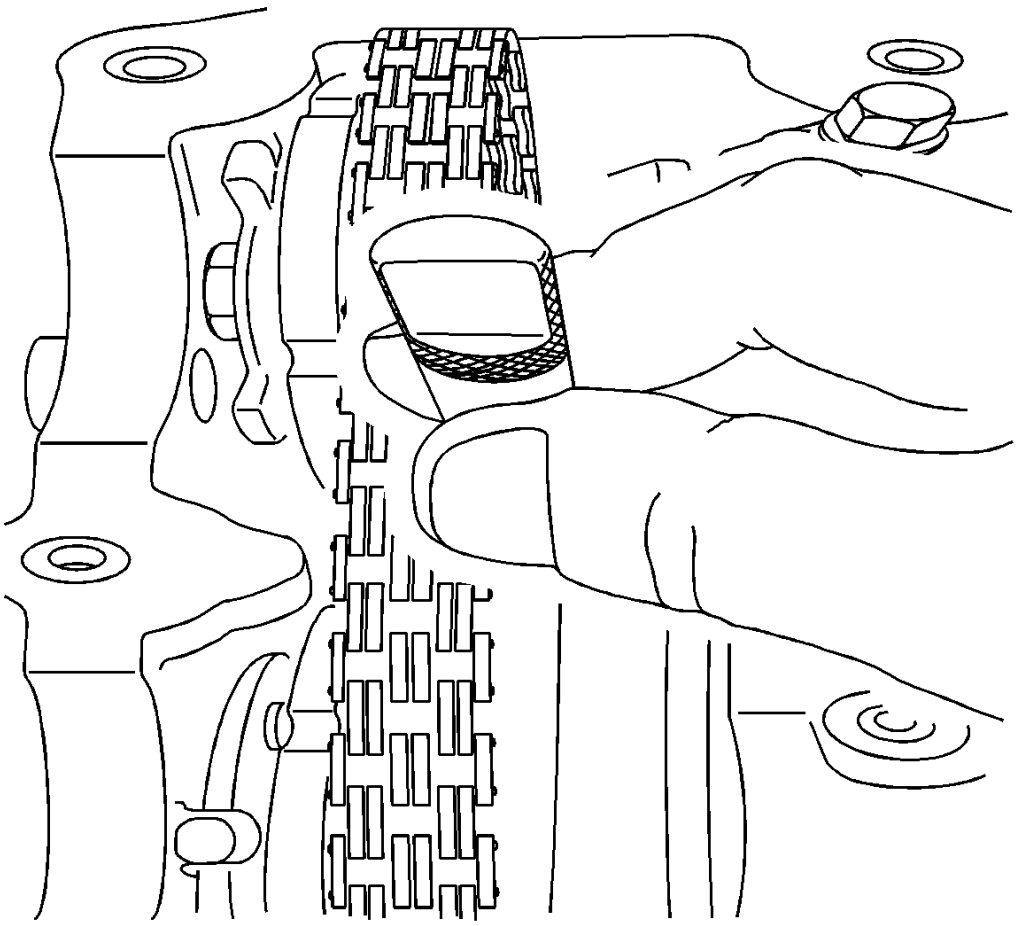


Fig. 131: Orienting Retainer Teeth
Courtesy of GENERAL MOTORS COMPANY

17. Once the wedge portion of **EN49982-2** retainer is below the camshaft position actuators, rotate the **EN49982-2** retainer until the flat in the handle faces toward the intake camshaft position actuator. This orients the "teeth" toward the chain.

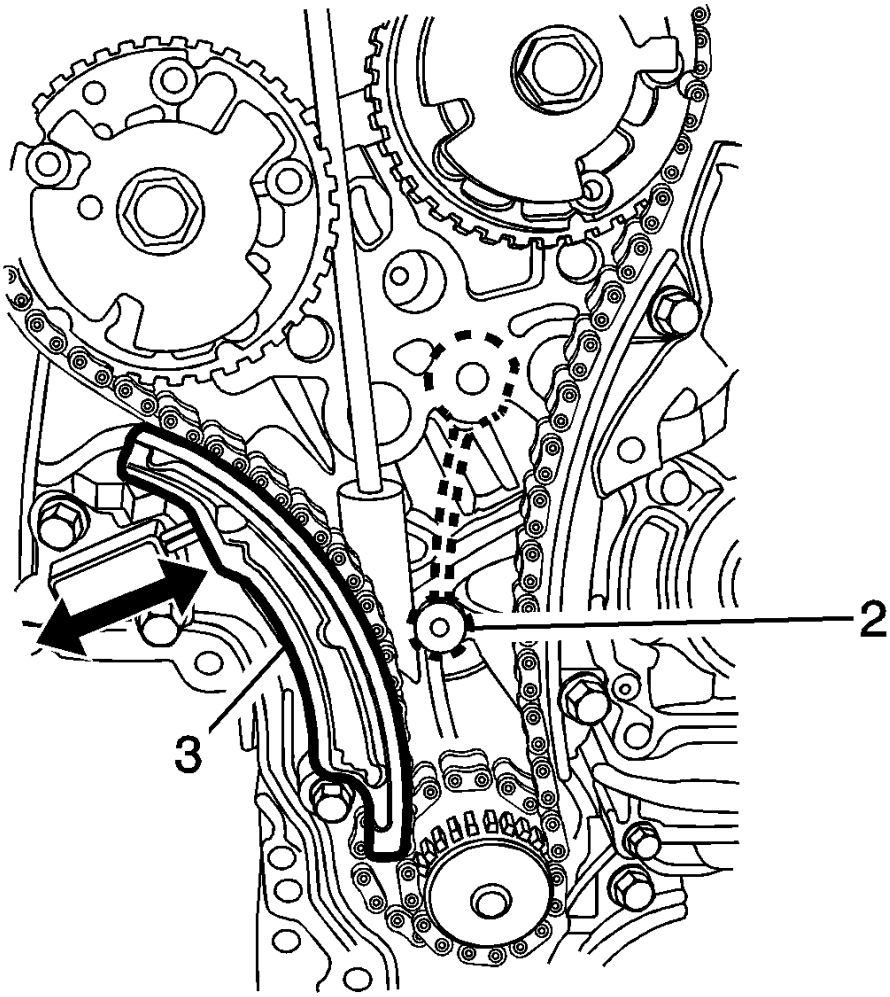


Fig. 132: Wedge, Timing Chain & Belt Casting
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not try to force the wedge into position, simply ensure it is loosely engaged in the timing chain and in the correct overall position.**

18. Drop the wedge down until it begins to engage the timing chain and the belt casting (2).

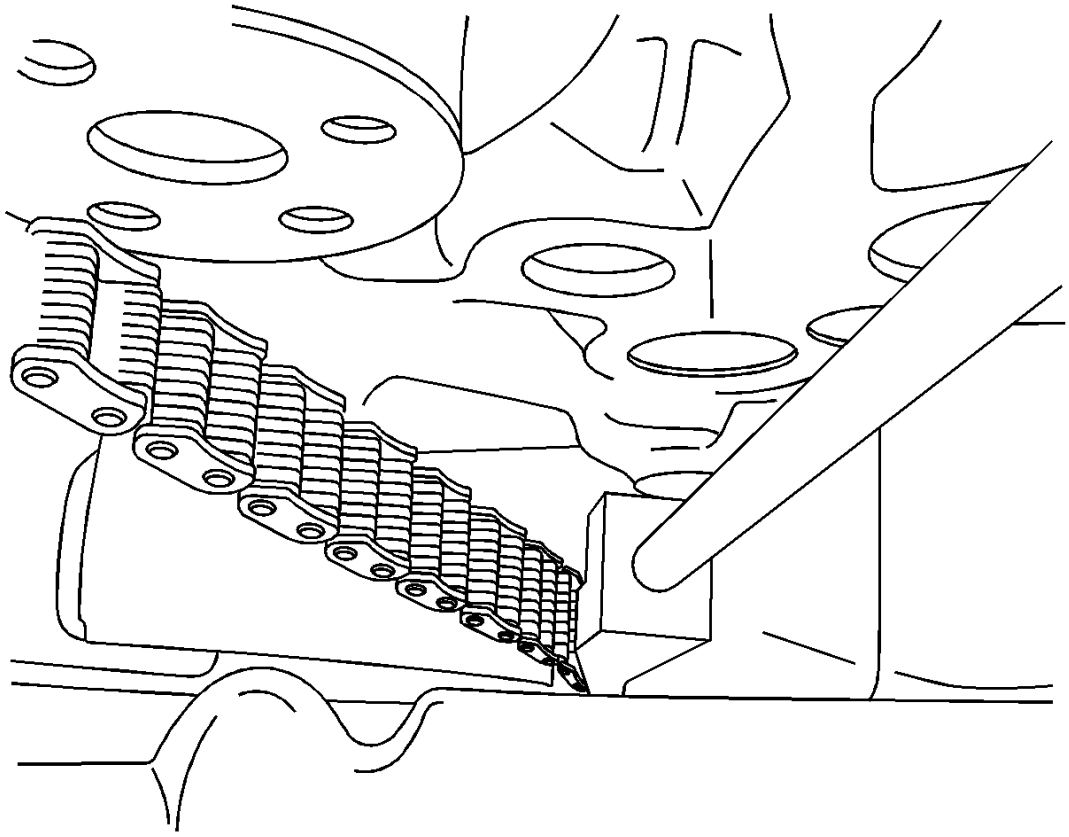


Fig. 133: Positioning Wedge
Courtesy of GENERAL MOTORS COMPANY

19. If possible shine a strong light down from above, between the camshaft position actuators, and see the wedge in overall position as shown in the above graphic.

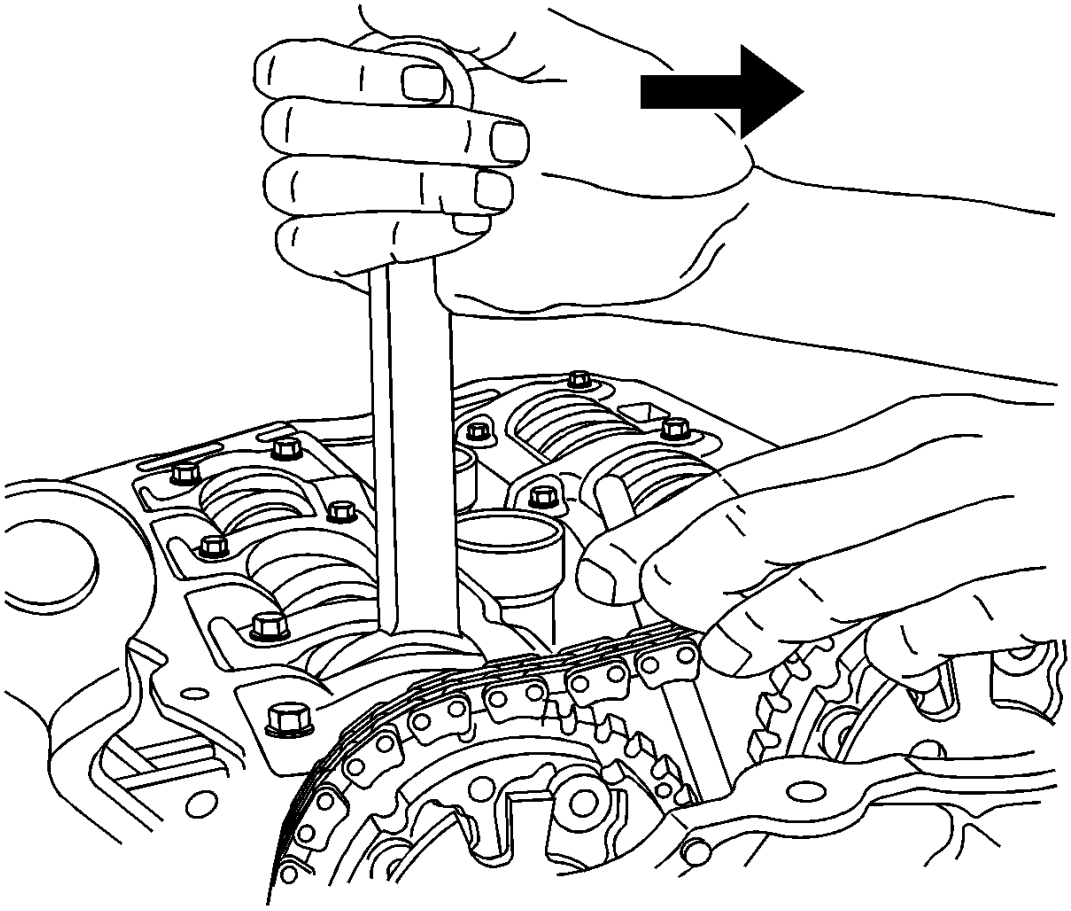


Fig. 134: Rotating Camshaft
Courtesy of GENERAL MOTORS COMPANY

20. Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft toward the intake camshaft while pushing down on the handle of the **EN49982-2** retainer.

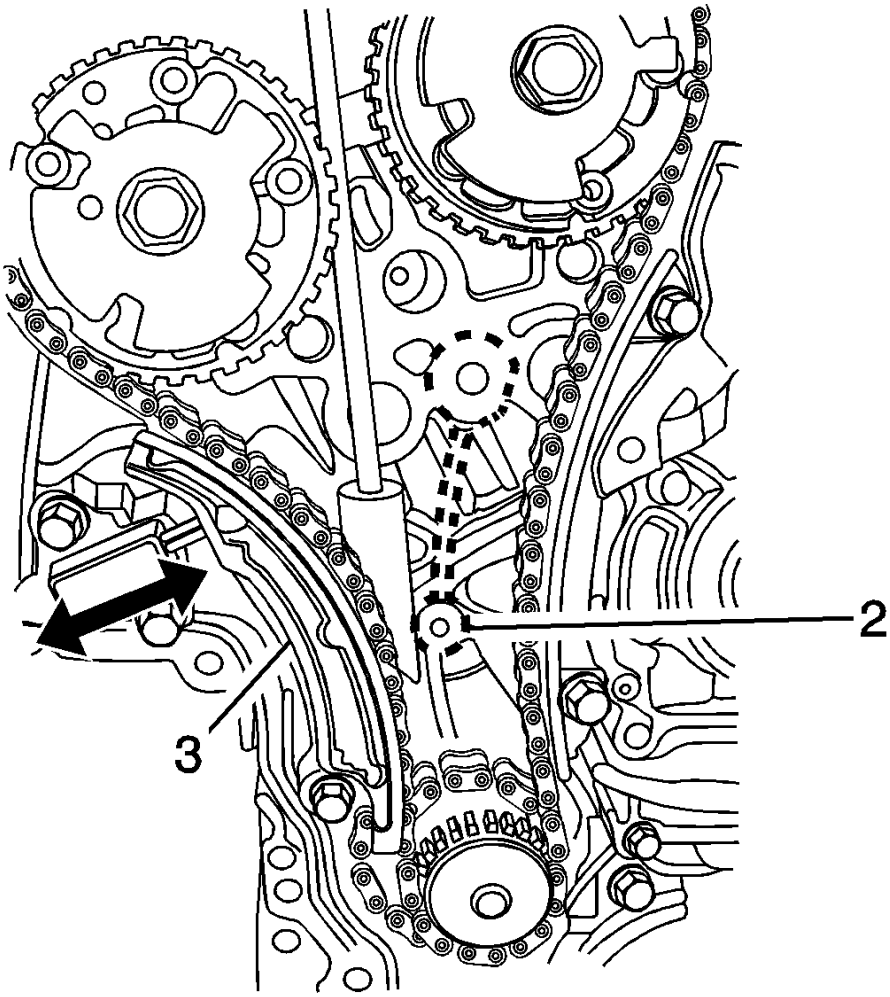


Fig. 135: Opening Gap Between Chain & Internal Rib In Front Cover
Courtesy of GENERAL MOTORS COMPANY

21. This rotation of the camshaft will compress the tensioner shoe (3) against the spring force of the tensioner, opening up a gap between the chain and the internal rib in the front cover. The wedge will then drop into this gap. You will feel a distinct click as the teeth engage the chain.

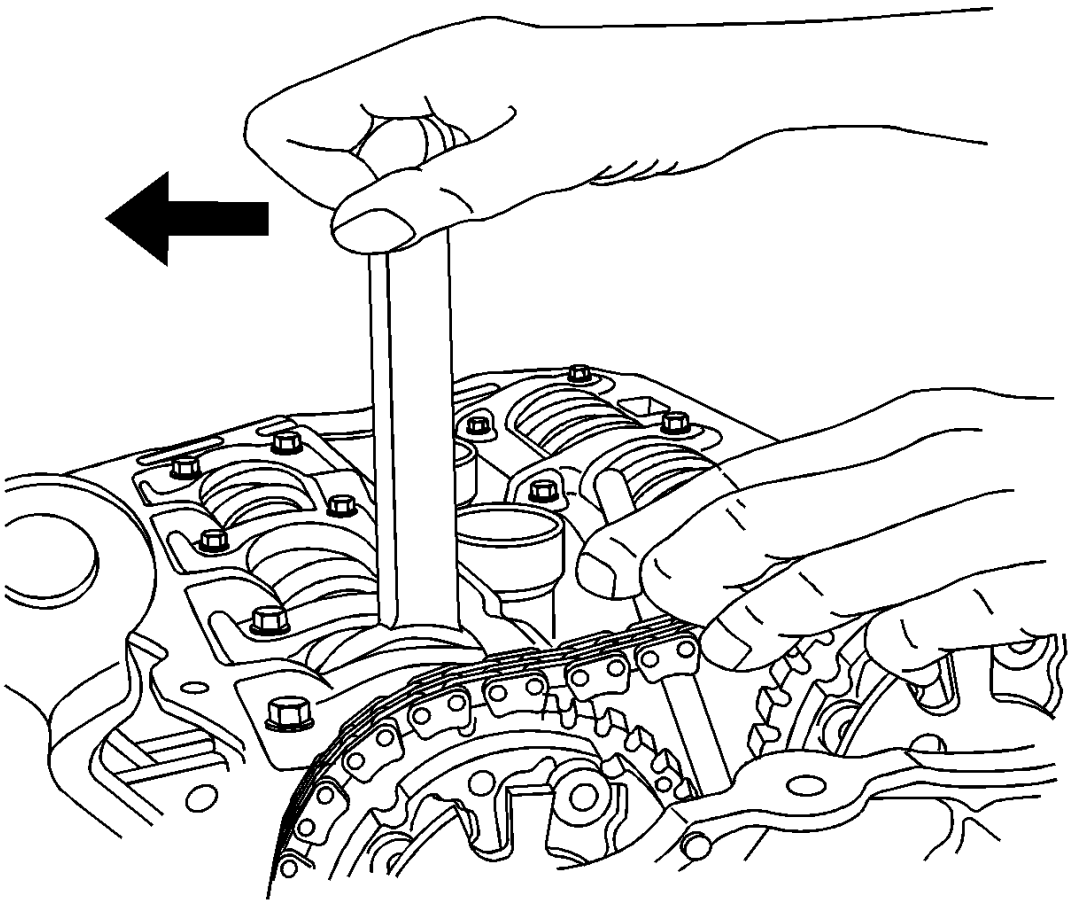


Fig. 136: Releasing Force On Wrench
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Be sure the EN49982-2 is captured firmly as described before continuing. This is critical to ensuring the camshaft drive chains stay properly timed.

22. Release the force on the wrench, allowing the spring tension to close the tensioner shoe against the wedge portion of **EN49982-2** retainer. You should be able to lightly tug on the **EN49982-2** retainer and it should stay in position. Repeat Steps 20 and 21 if necessary to re-insert the **EN49982-2** retainer until you are certain it is in position and will stay in position.

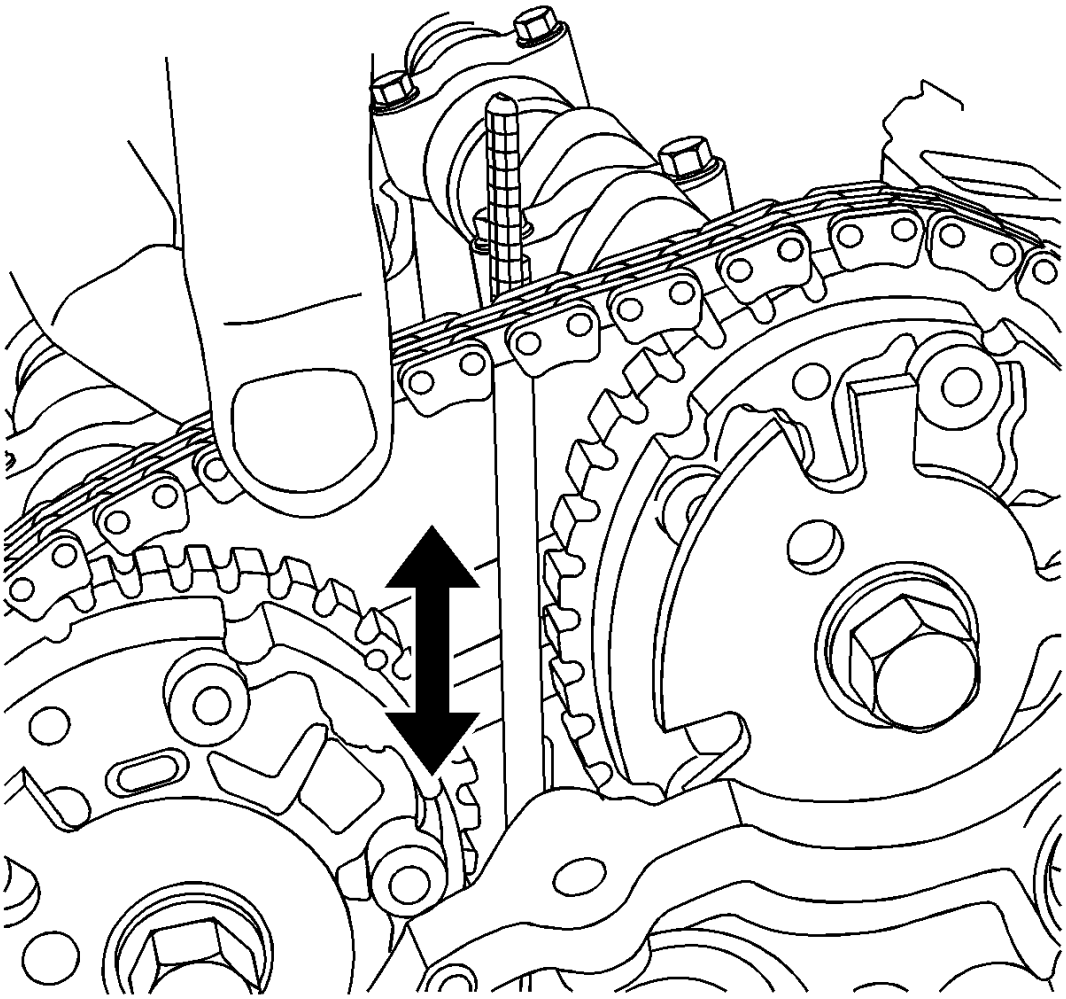


Fig. 137: Slack In Timing Drive Chain
Courtesy of GENERAL MOTORS COMPANY

23. With **EN49982-2** retainer in position and with the 20 mm wrench removed, there should now be some slack in the timing drive chain as indicated in the graphics shown.

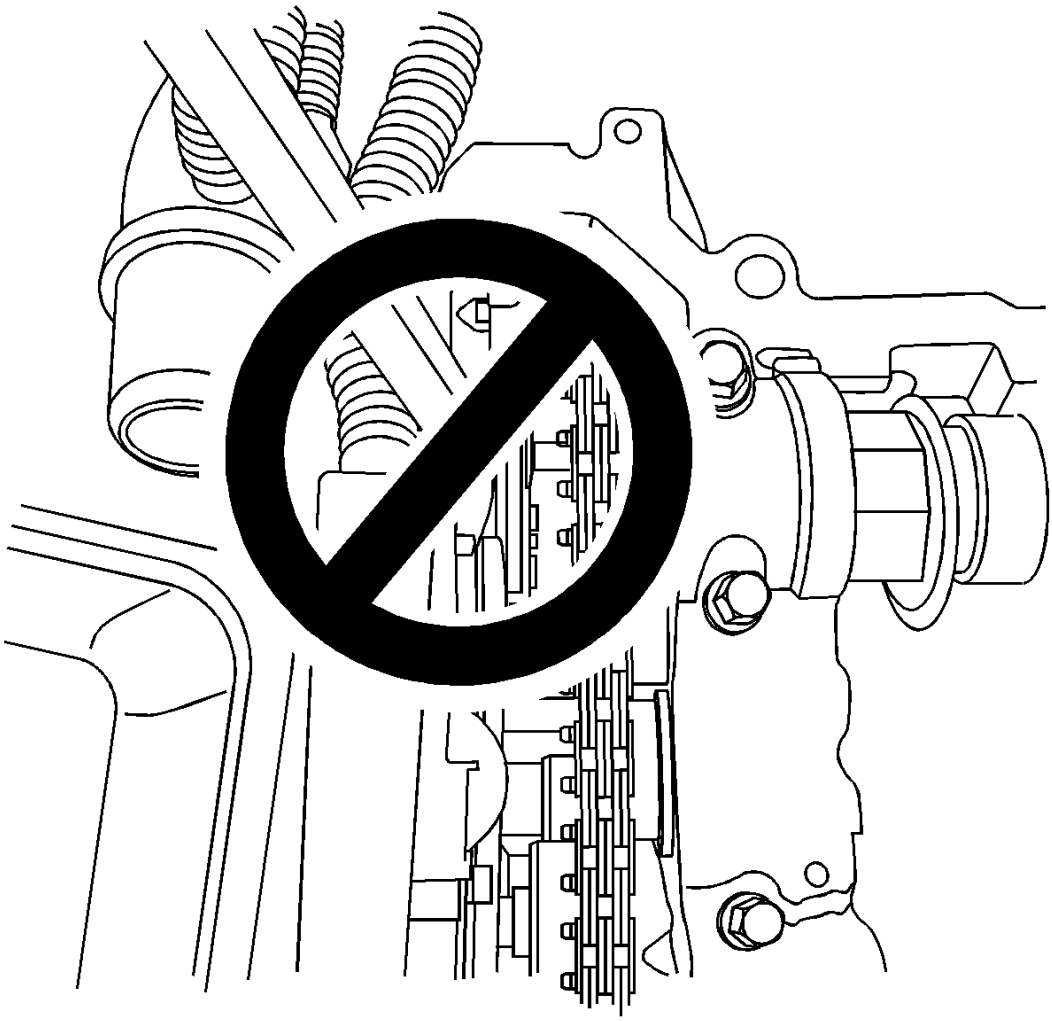


Fig. 138: Do Not Pry Warning
Courtesy of GENERAL MOTORS COMPANY

24. Do not pry against the face of the camshaft position actuators or the position actuator retaining bolt.

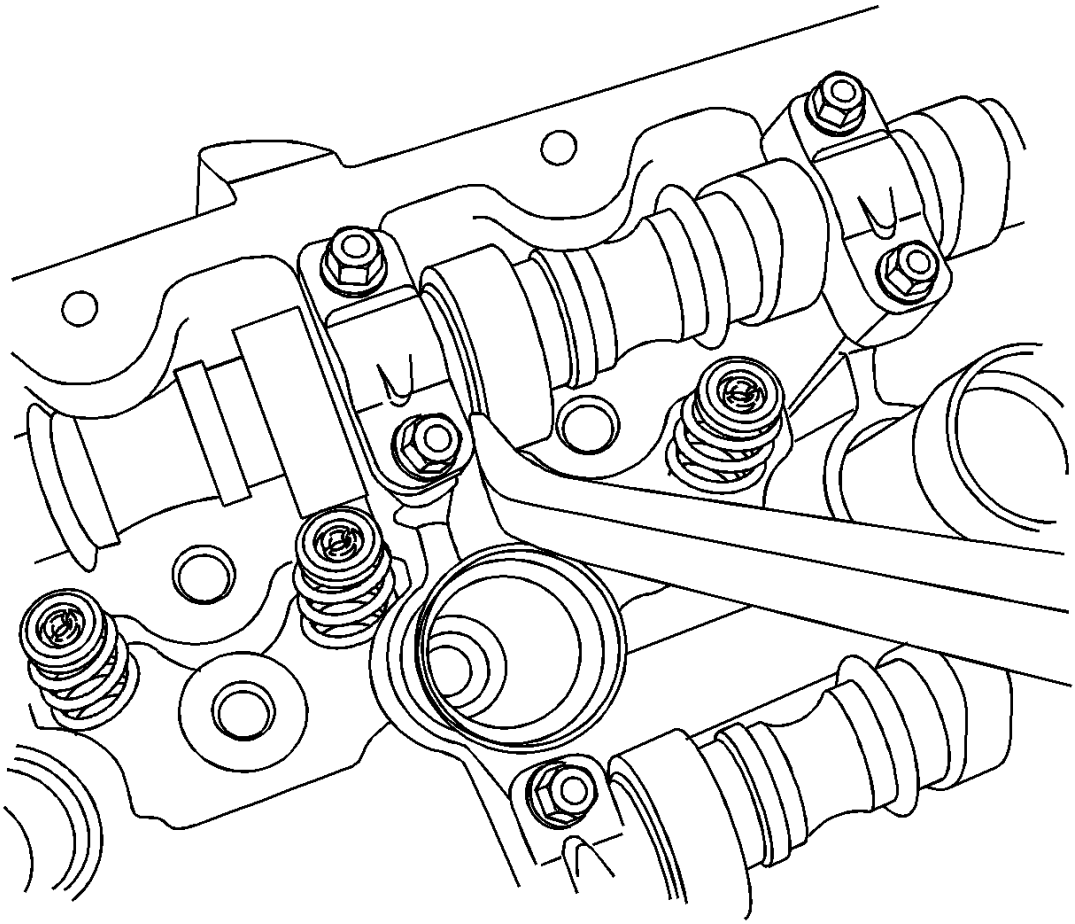


Fig. 139: Prying Camshaft Forward
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not pry against the face of the camshaft position actuators or the position actuator retaining bolts as the position actuators will be damaged.

25. Position a screwdriver or small pry bar between a camshaft cap and camshaft lobe. Carefully move/pry the camshafts as far as possible toward the rear/flywheel end of the engine.

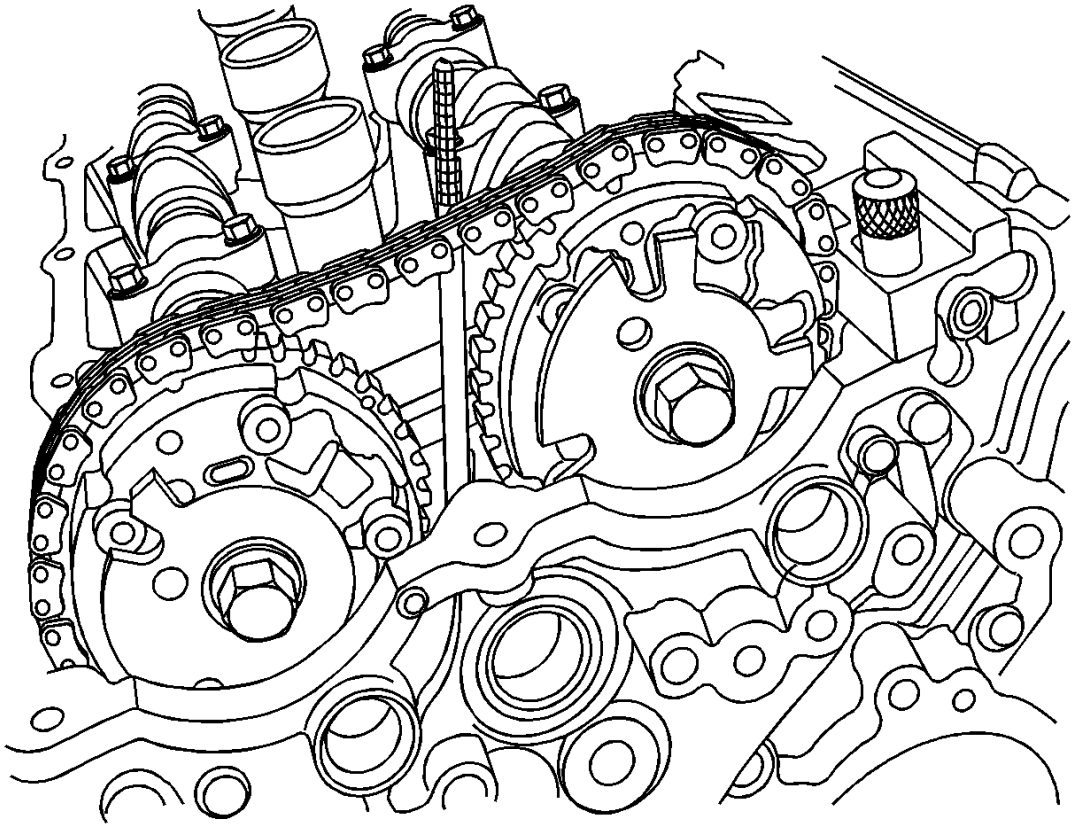


Fig. 140: Retainer Position
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not move or disturb the EN49982 retainer components after their installation or the timing chains may be lost inside the front cover.**

26. The **EN49982-1** retainer and **EN49982-2** retainer should be in position as shown, they must be left in position during the servicing of the camshaft position actuator(s) and/or camshaft(s).

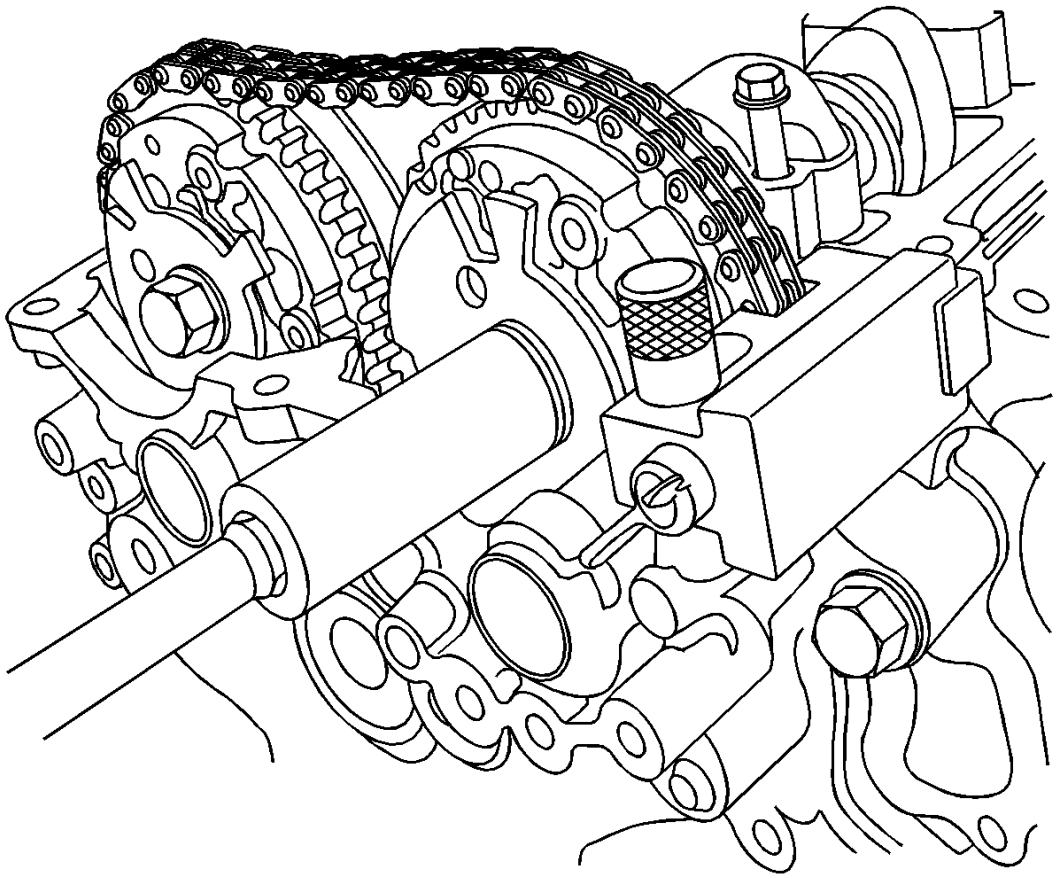


Fig. 141: Intake Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

27. To remove the intake camshaft position actuator, remove the loosened retaining bolt. To remove only the exhaust camshaft position actuator, skip the steps for removing the intake camshaft position actuator. However, the **EN49982-1** retainer MUST be installed as discussed even if the intake side will not be serviced or the timing of the camshaft chains will be lost.

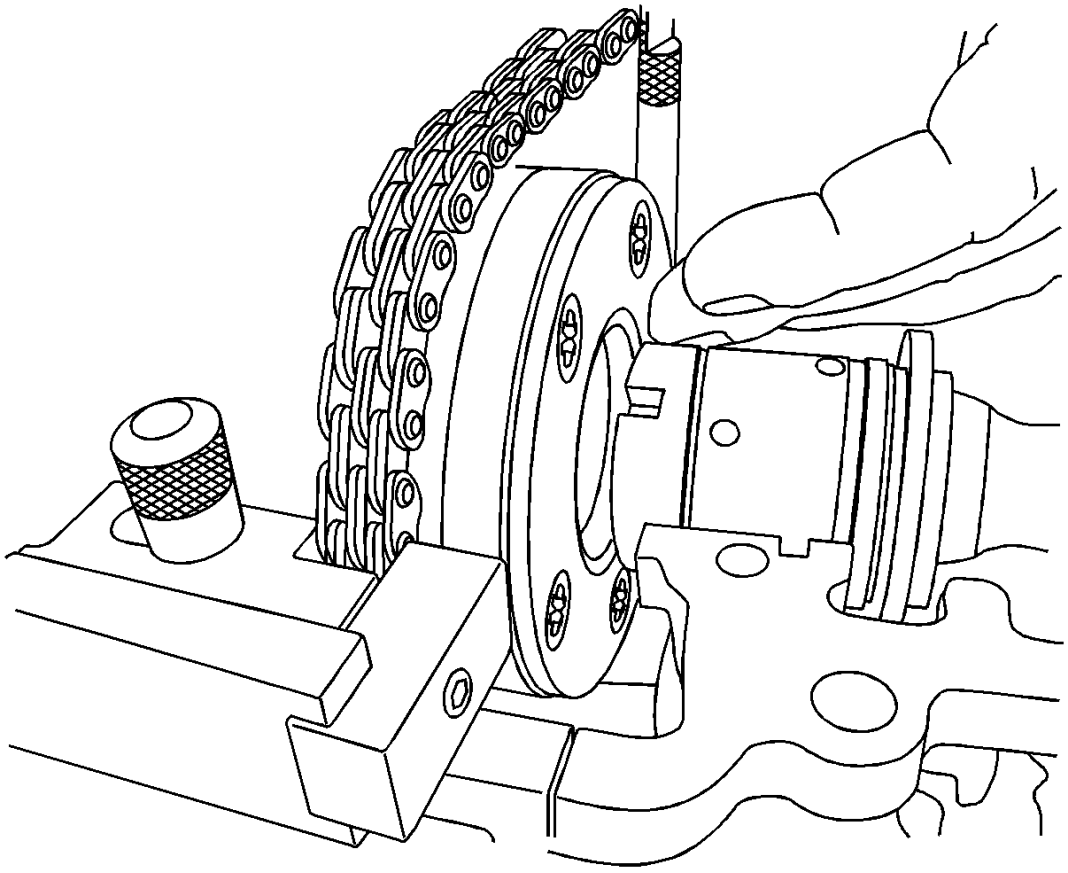


Fig. 142: Sliding Camshaft Position Actuator Off End Of Intake Camshaft
Courtesy of GENERAL MOTORS COMPANY

28. Slide the camshaft position actuator forward and off the end of the intake camshaft. The slot in the **EN49982-1** retainer will allow the tool to move forward enough to disengage the camshaft position actuator from the front of the camshaft. Remove the plastic thrust washer when removing the camshaft position actuator from the end of the camshaft.

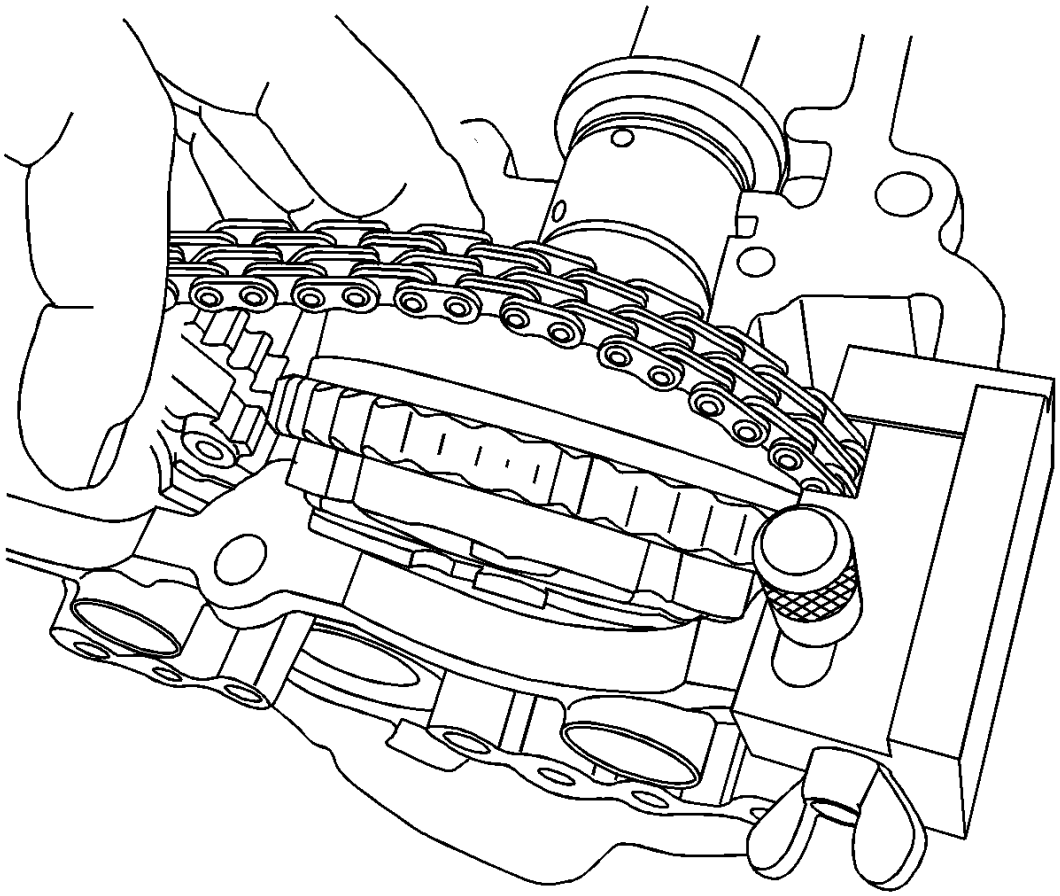


Fig. 143: Tilting Camshaft Position Actuator Forward
Courtesy of GENERAL MOTORS COMPANY

29. Tilt the camshaft position actuator forward and out/away from the engine.

NOTE: **DO NOT remove the EN49982 retainers. They are holding the cam chains to maintain their properly-timed positions.**

30. Allow the chain to rest on the **EN49982-1** retainer and **EN49982-2** retainer in position during service.

Installation Procedure

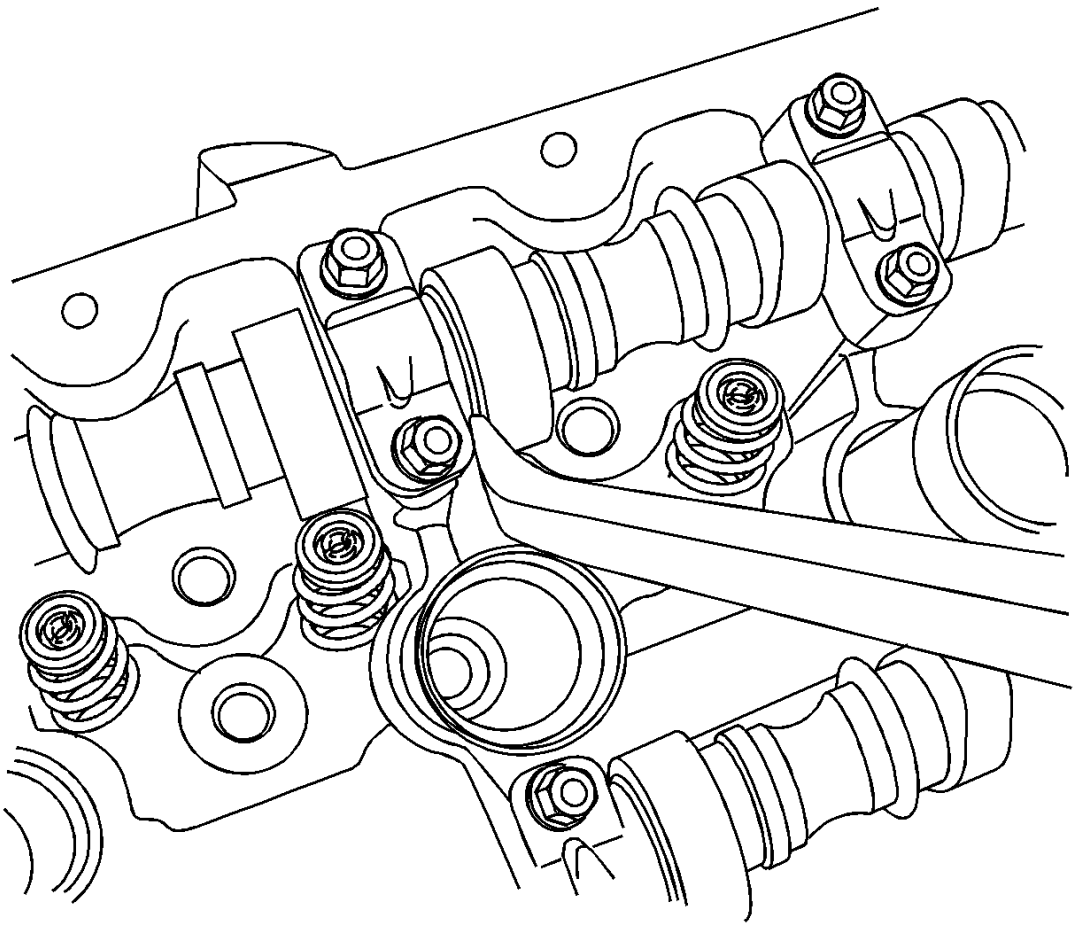


Fig. 144: Prying Camshaft Forward
Courtesy of GENERAL MOTORS COMPANY

1. It may help to carefully pry the camshaft forward and to move the **EN49982-1** retainer backward via the slot to reengage the position actuator to the camshaft. The dowel pin on the camshaft position actuator must be aligned with the slot in the camshaft nose for reassembly.

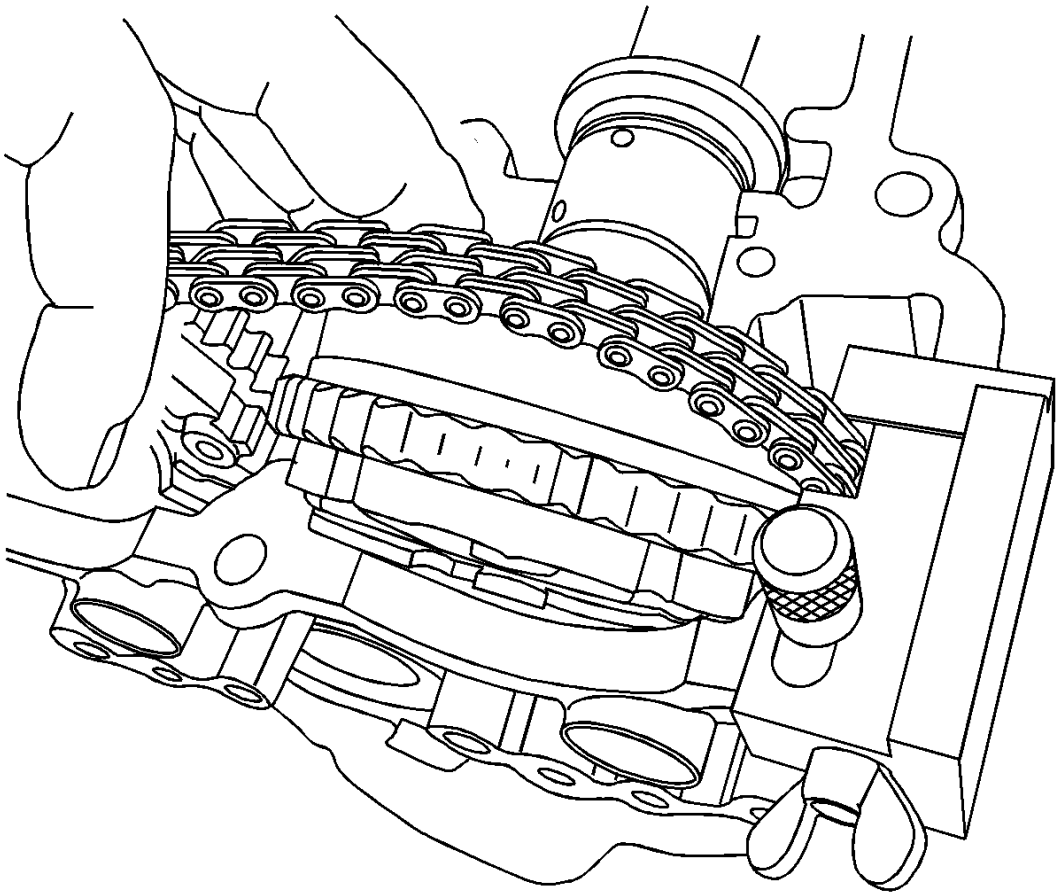


Fig. 145: Tilting Camshaft Position Actuator Forward
Courtesy of GENERAL MOTORS COMPANY

2. Install the intake camshaft position actuator first by inserting the actuator between the timing chain and front cover. Tilt the actuator in and engage the chain while aligning the marks you made on the chain and position actuator.

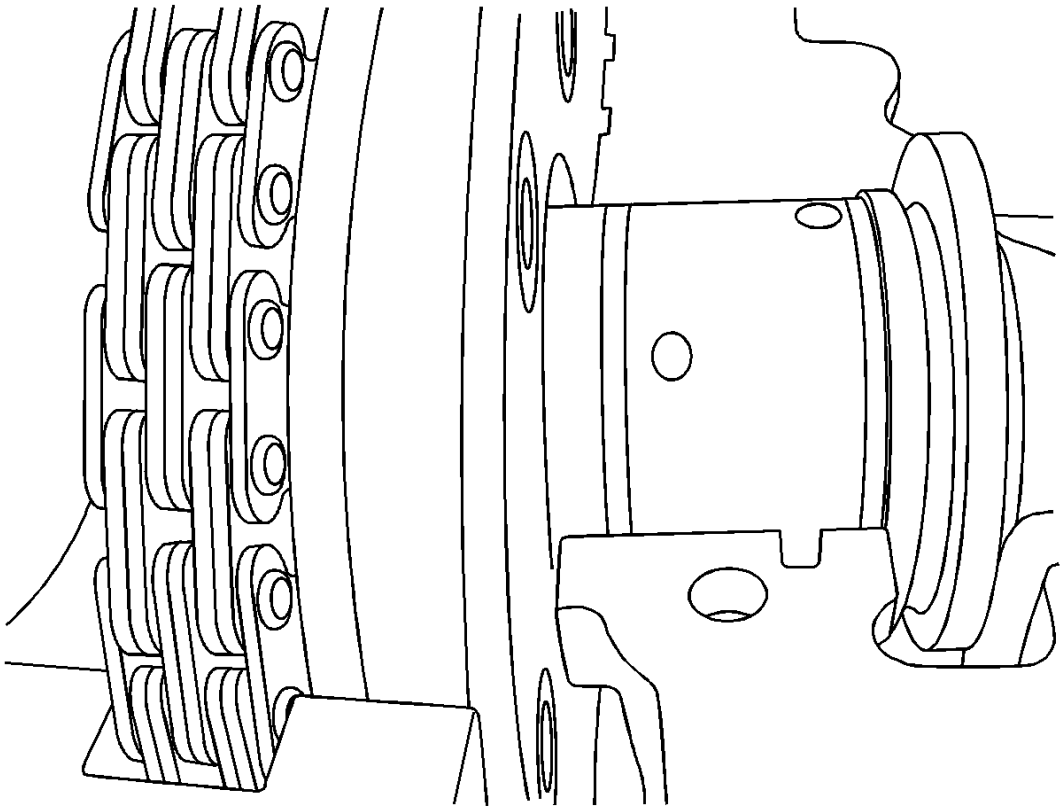


Fig. 146: Fitting Camshaft Position Actuator
Courtesy of GENERAL MOTORS COMPANY

3. Ensure the camshaft position actuator fits snugly to the end of the camshaft.

CAUTION: Refer to Fastener Caution .

4. Install the intake camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
5. Install the exhaust camshaft position actuator retaining bolt, and lightly tighten the bolt to hold the camshaft actuator in place. DO NOT torque at this time.
6. Double-check that the marks on both the intake and exhaust camshaft position actuators to ensure that they are aligned with their respective paint marks on the chain.

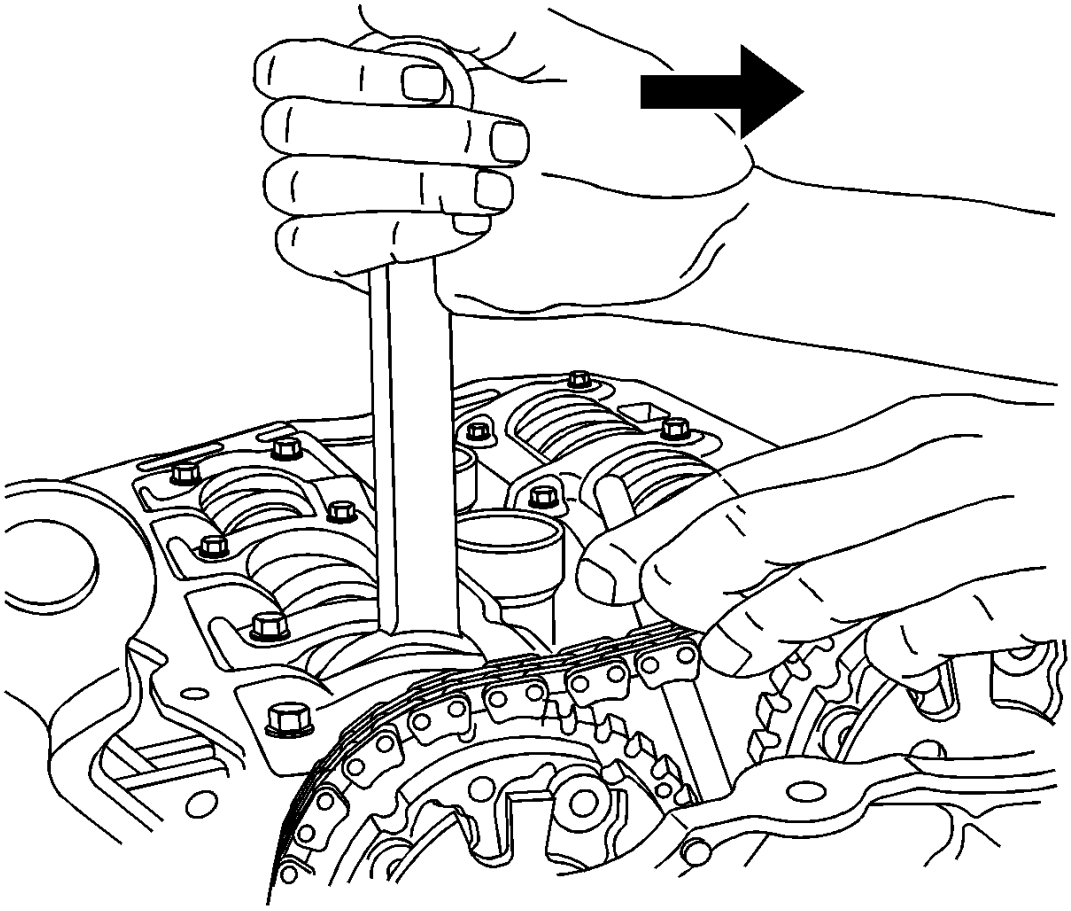


Fig. 147: Rotating Camshaft
Courtesy of GENERAL MOTORS COMPANY

7. Using a 20 mm wrench on the cast hexagonal portion of the exhaust camshaft, rotate the camshaft clockwise while pulling up on the handle of the **EN49982-2** retainer.
8. Remove EN49982-2 retainer.
9. Release the pressure on the wrench. The timing chain should now be tight and should lose the slack the wedge was providing.

NOTE: **Double-check the marks on the camshaft position actuators and chains to ensure they are correct.**

10. Torque one or both camshaft position actuator retaining bolts to 58 N.m (43 lb ft).

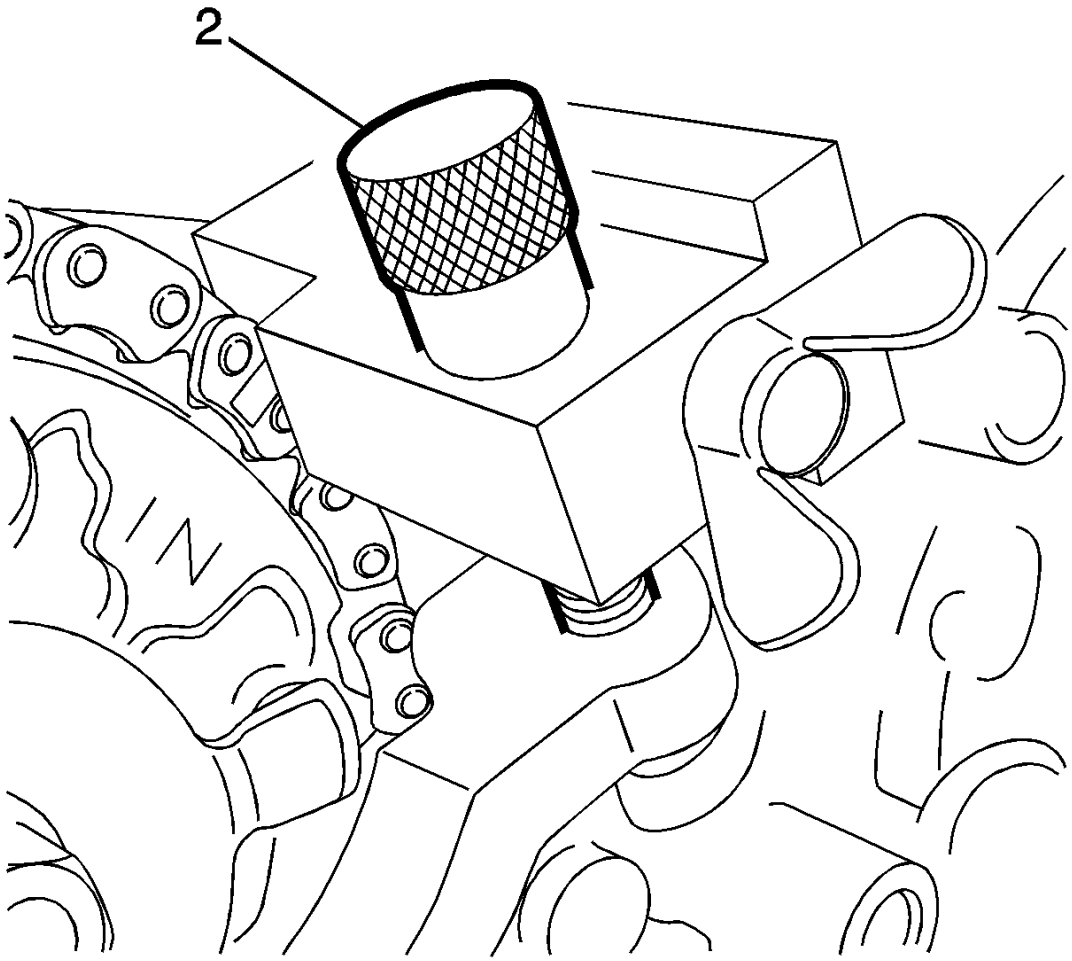


Fig. 148: Retainer Thumbscrew
Courtesy of GENERAL MOTORS COMPANY

11. Unscrew the wingnut on **EN49982-1** retainer to release timing chain, and then remove **EN49982-1** retainer from the front cover by unscrewing the thumbscrew (2).

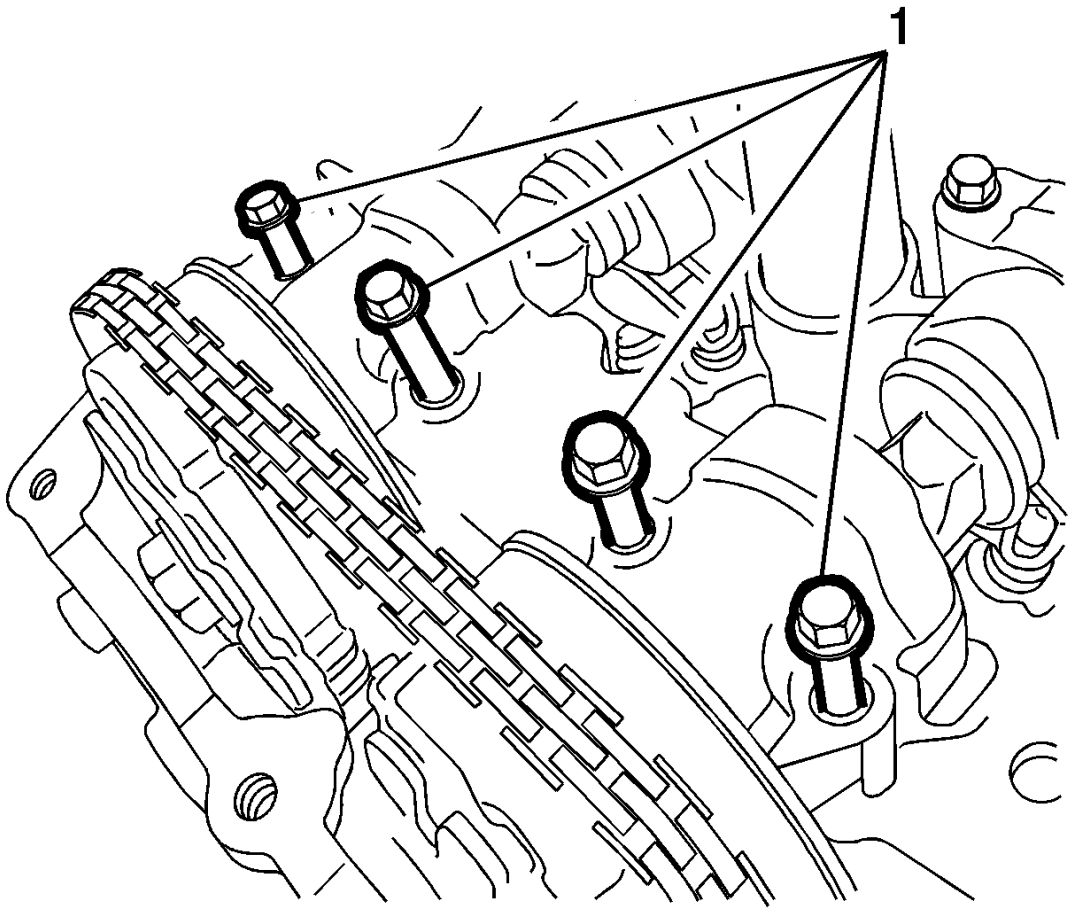


Fig. 149: Camshaft Front Cap And Bolts
Courtesy of GENERAL MOTORS COMPANY

12. Install camshaft front cap and bolts (1).
13. Tighten the camshaft front cap outer bolts to 10 N.m (89 lb in).
14. Tighten the camshaft front cap inner bolts to 10 N.m (89 lb in).
15. Install the camshaft position actuator solenoid valve solenoid - exhaust. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Exhaust** .
16. Install the camshaft position actuator solenoid valve solenoid-intake. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 1 (Right Side) Intake** .
17. Install the intake camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Intake** .
18. Install the exhaust camshaft position sensor. Refer to **Camshaft Position Sensor Replacement - Bank 1 (Right Side) Exhaust** .
19. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

CAMSHAFT POSITION ACTUATOR REPLACEMENT - BANK 2

Special Tools

EN-48313 Timing Chain Retention Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

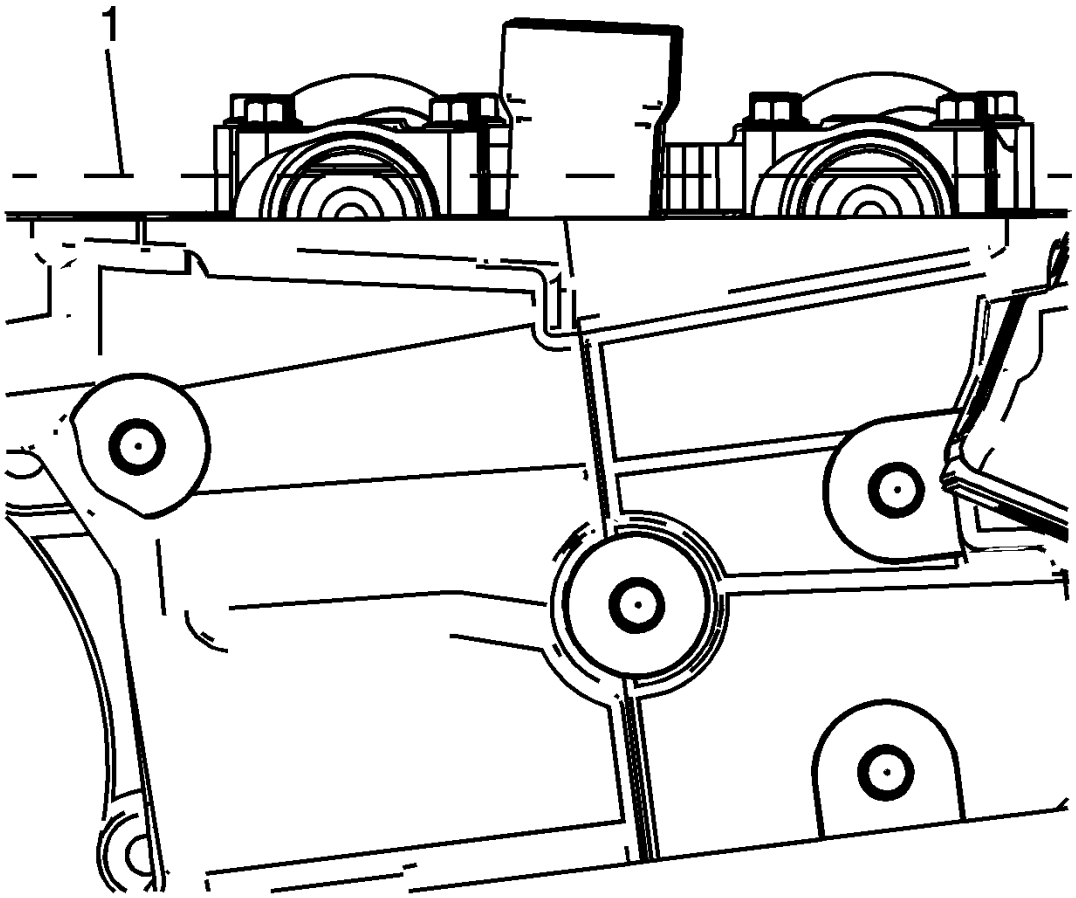


Fig. 150: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS COMPANY

1. Remove the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
2. Remove the left intake and exhaust camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** .
3. Remove the left intake and exhaust camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .

NOTE: **Rotate the crankshaft balancer bolt in a clockwise direction ONLY.**

4. Rotate the crankshaft balancer using the balancer bolt until the camshafts are in a neutral (low tension)

position. The camshafts will be parallel with the camshaft cover rail (1).

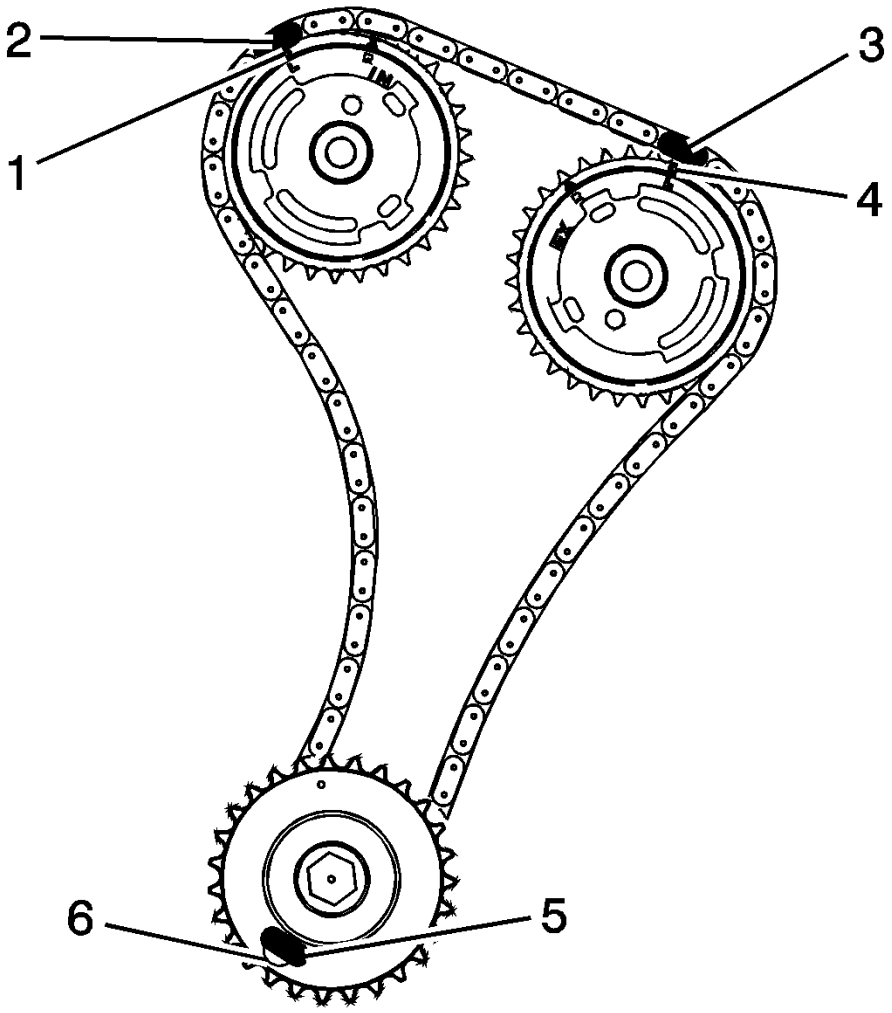


Fig. 151: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the camshaft timing chain and the camshaft position actuators are marked for proper assembly.**

5. Use a paint stick to create an alignment mark on one of the timing chain links (2) and the adjacent tooth on the exhaust camshaft position actuator (1).
6. Use a paint stick to create an alignment mark on one of the timing chain links (3) and the adjacent tooth on the intake camshaft position actuator (4).

CAUTION: **Refer to Torque Reaction Against Timing Drive Chain Caution .**

7. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.

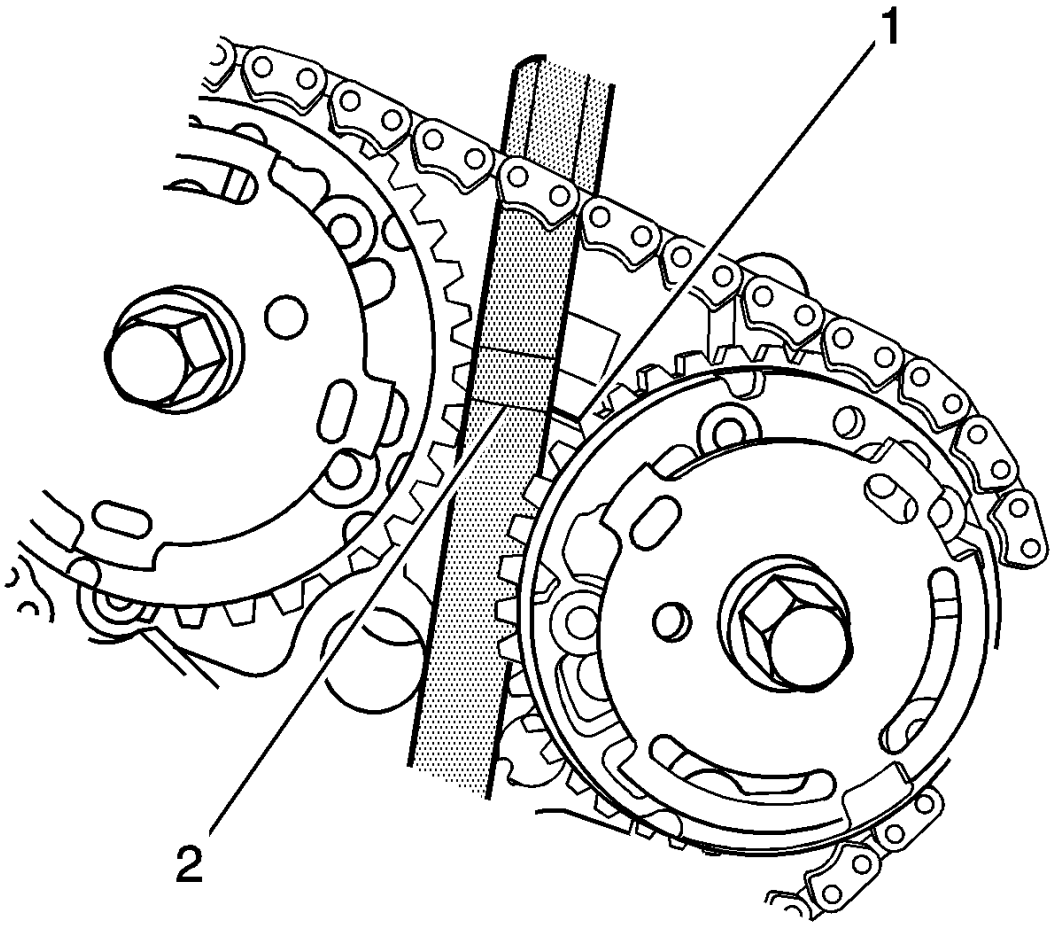


Fig. 152: Inserting Timing Chain Rentention Tool
Courtesy of GENERAL MOTORS COMPANY

8. Unscrew the **EN-48313** tool so that the legs of the tool are retracted.
9. Insert the **EN-48313** tool between the camshaft actuators, rearward of the timing chain until the bottom line that is scribed in the body of the tool (2) is adjacent to the top surface of the cylinder head (1). This is the approximate installed position.

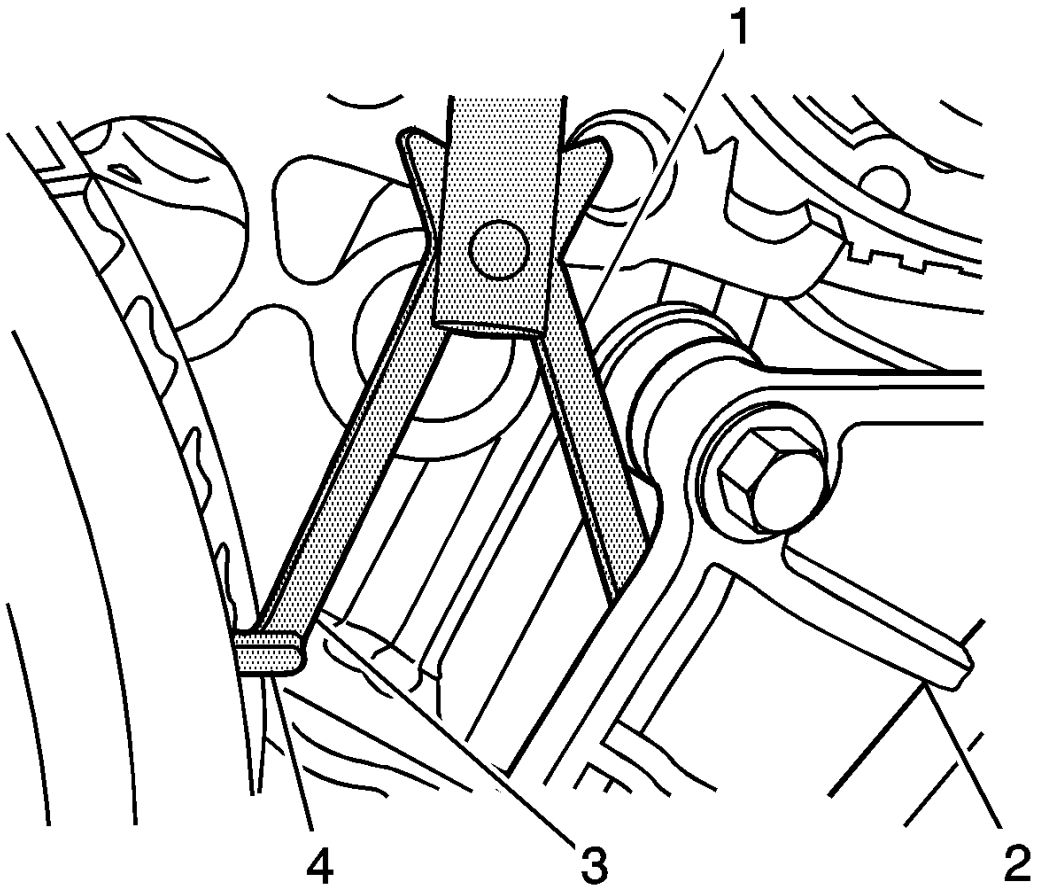


Fig. 153: View Of Feet, Legs & Timing Chain Guide
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The engine front cover is removed for clarity in the following graphics, but NOT required to perform the procedure.**

10. Ensure that the feet (4) on the legs of the tool are facing the front of the engine.
11. Partially expand the legs (1, 3) of the **EN-48313** tool by turning the T-shaped handle clockwise.
12. Insert the leg of the tool (1) behind the timing chain guide (2).
13. Continue expanding the **EN-48313** tool until the legs (1, 3) contact the timing chain. Do not tighten at this time.

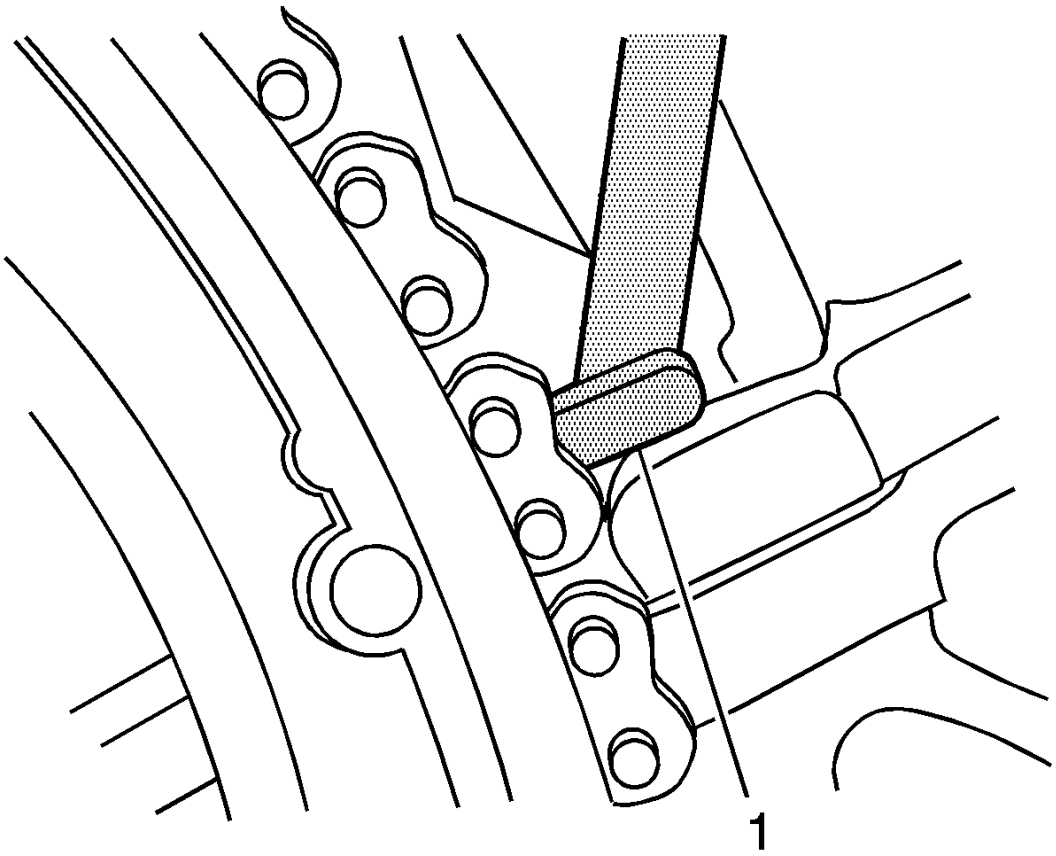


Fig. 154: Foot of Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the foot (1) of the EN-48313 tool is engaged into one of the link pockets to prevent tool slippage during tightening of the EN-48313 tool.**

14. Hand tighten the **EN-48313** tool.
15. Use an open end wrench on the hex cast into the left intake and exhaust camshafts and rotate the camshafts toward each other in order to create slack in the chain between the actuators.

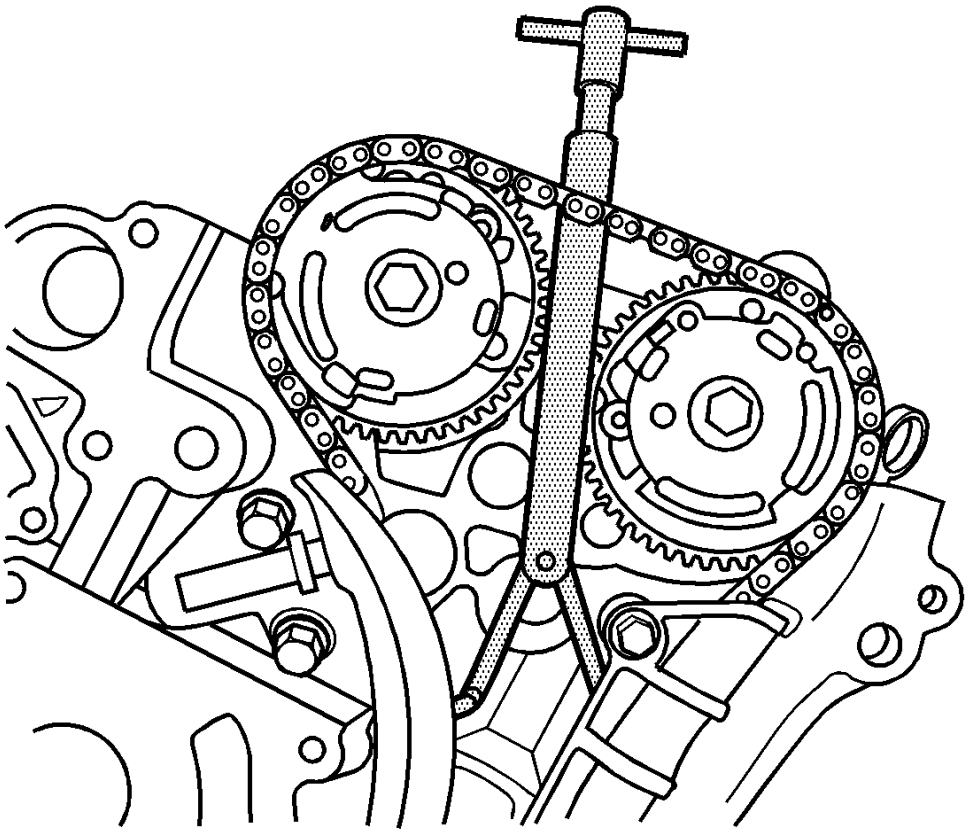


Fig. 155: Timing Chain Retention Tool
Courtesy of GENERAL MOTORS COMPANY

16. The **EN-48313** tool is now properly installed to hold the timing chain in position.

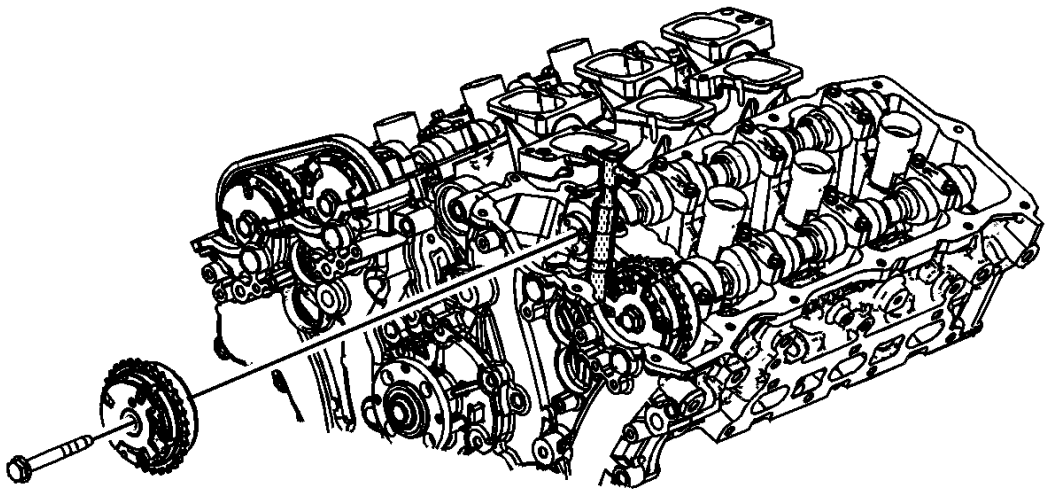


Fig. 156: View Of Exhaust Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

17. Use an open end wrench on the hex cast into the camshaft in order to prevent engine rotation when loosening the camshaft position actuator bolt.
18. If replacing the exhaust camshaft position actuator, then remove the bolt and the actuator.
19. If replacing the intake camshaft position actuator, then remove the bolt and the actuator.
20. If removing both the exhaust and intake camshaft actuators, the timing chain can be draped over the **EN-48313** tool once the actuators have been removed.
21. Rotate the actuator in order to align the opening in the actuator reluctor wheel with the cam sensor boss in the front cover, to allow actuator removal.
22. Remove the camshaft thrust washer.

Installation Procedure

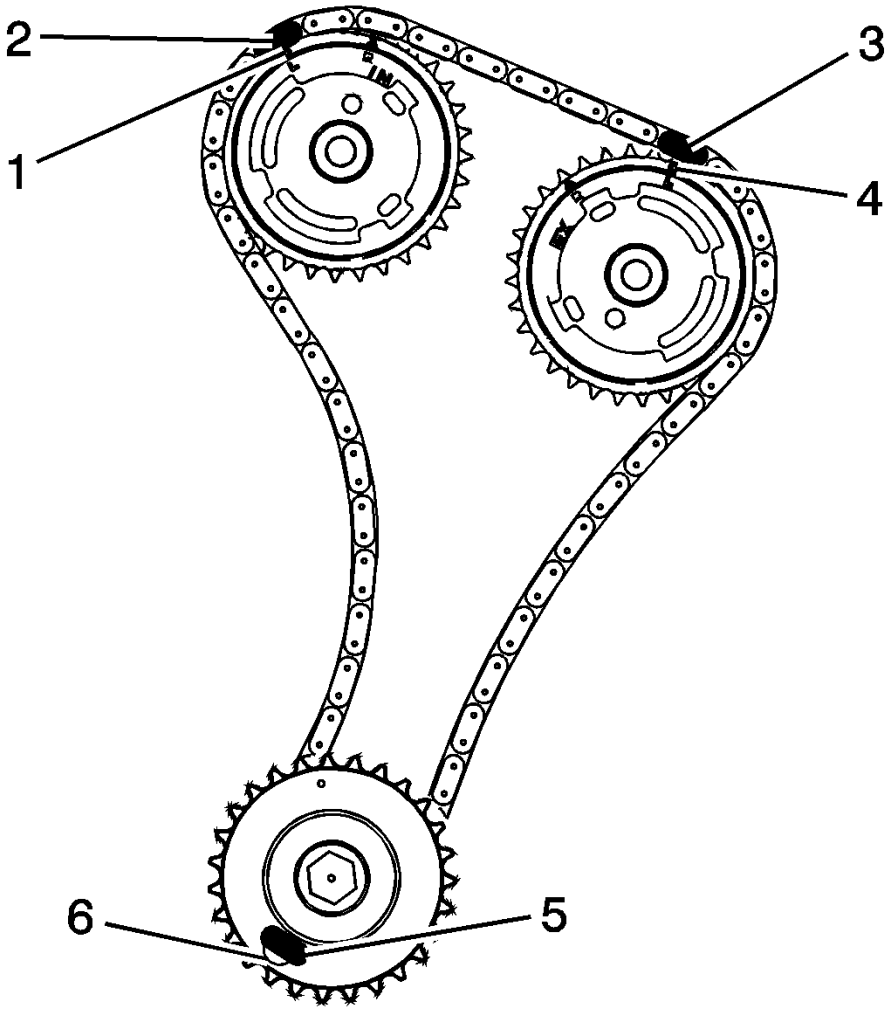


Fig. 157: Locating Left Secondary Camshaft Drive Chain Timing Marks
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the camshaft timing chain and the camshaft position actuators are marked for proper assembly.**

1. Align the exhaust camshaft actuator alignment mark (1) to the timing chain alignment mark (2) made during disassembly.
2. Ensure that the intake camshaft actuator alignment mark (4) and the timing chain alignment mark (3) are also aligned.
3. Position the exhaust camshaft actuator to the camshaft and install the actuator bolt hand tight.
4. Remove the **EN-48313** tool.

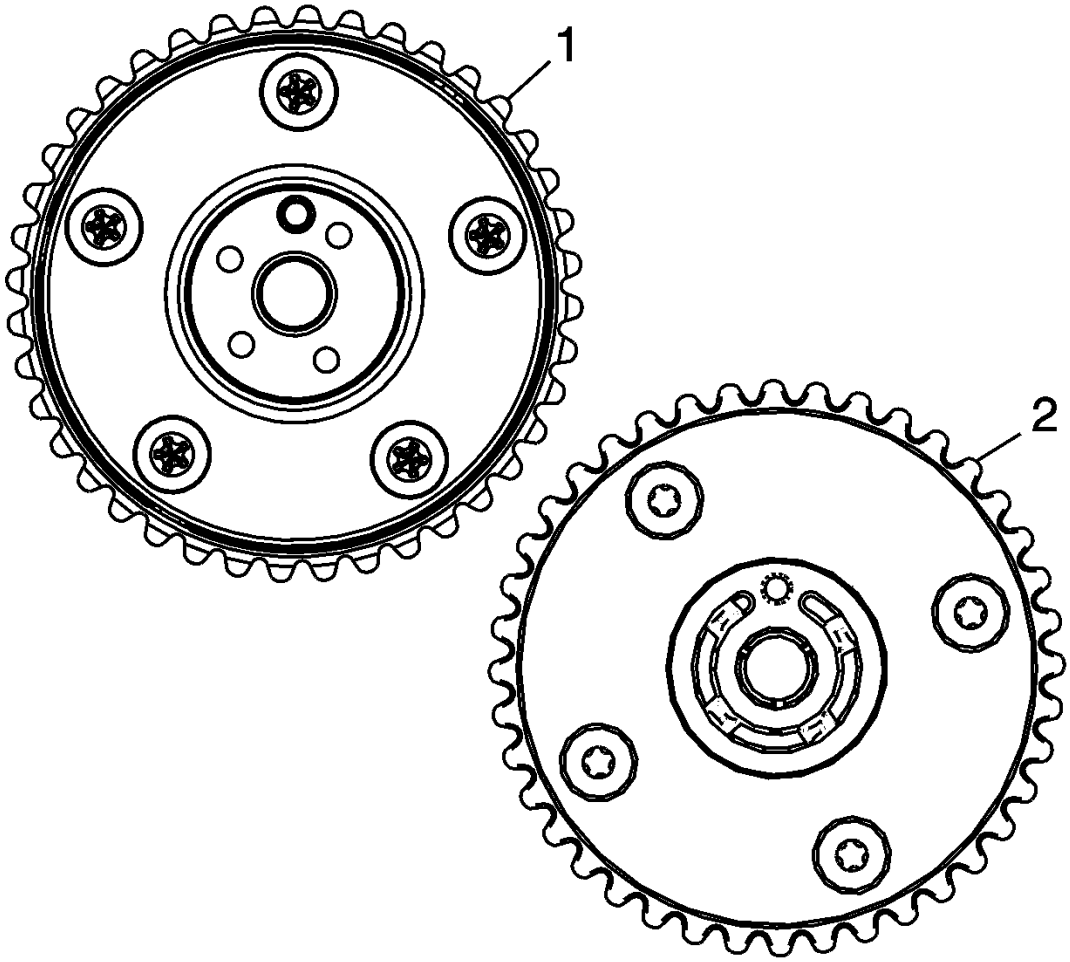


Fig. 158: Identifying Camshaft Position Actuators
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **The camshaft position actuator will vary depending on application.**
- **Camshaft thrust washers must only be installed on applications that had thrust washers present during removal of the camshaft position actuators. Do not install washers on applications if they are not already present.**

5. If equipped, ensure the proper camshaft thrust washer is used. Use a 1.6 mm (0.063 in) thrust washer on applications that have 5 attaching screws on the back side of the camshaft position actuator (1). Use a 1.1 mm (0.043 in) thick thrust washer with yellow speckles on applications that have 4 attaching screws on the back side of the camshaft position actuator (2).
6. Install the thrust washer, if applicable.

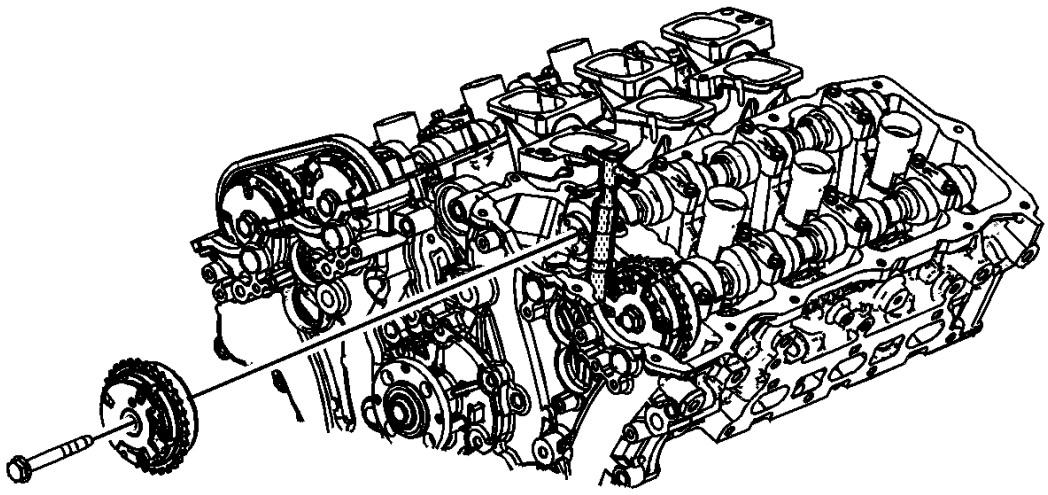


Fig. 159: View Of Exhaust Camshaft Position Actuator Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. If the exhaust camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).
8. If the intake camshaft position actuator has been replaced, then tighten the bolt to 58 N.m (43 lb ft).
9. If both the exhaust and intake has been replaced, then tighten bolt to 58 N.m (43 lb ft).
10. Install the left intake and exhaust camshaft position actuator solenoids. Refer to **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Actuator Solenoid Valve Solenoid Replacement - Bank 2 (Left Side) Exhaust** .
11. Install the left intake and exhaust camshaft position sensors. Refer to **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Intake** , and **Camshaft Position Sensor Replacement - Bank 2 (Left Side) Exhaust** .
12. Install the left camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
13. Install the intake manifold. Refer to **Intake Manifold Replacement**.

SETTING CAMSHAFT TIMING

NOTE: **Setting the camshaft timing is necessary whenever the camshaft drive system has been disturbed such that the relationship between any chain and sprocket has been lost. Even when only one sprocket is involved, multiple crankshaft rotations will not produce conditions where correct timing can be confirmed.**

Follow the left bank secondary camshaft drive chain replacement procedures to reset the camshaft timing. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.

CAMSHAFT REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the fuel pump. Refer to **Fuel Pump Replacement** .
2. Remove the camshaft position actuators. Refer to **Camshaft Position Actuator Replacement - Bank 2**.

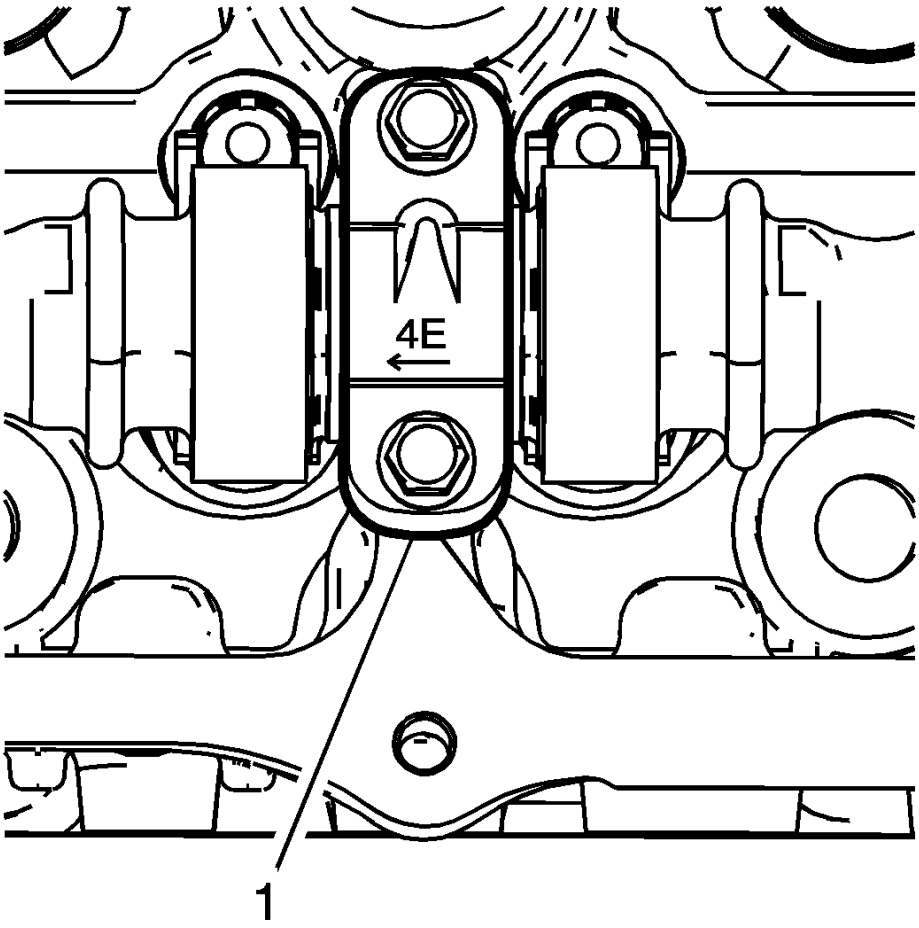


Fig. 160: Bearing Caps
Courtesy of GENERAL MOTORS COMPANY

3. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:
   - The raised feature must always be oriented toward the center of the cylinder head.

- The I indicates the intake camshaft.
- The E indicates the exhaust camshaft.
- The number indicates the journal position from the front of the engine.

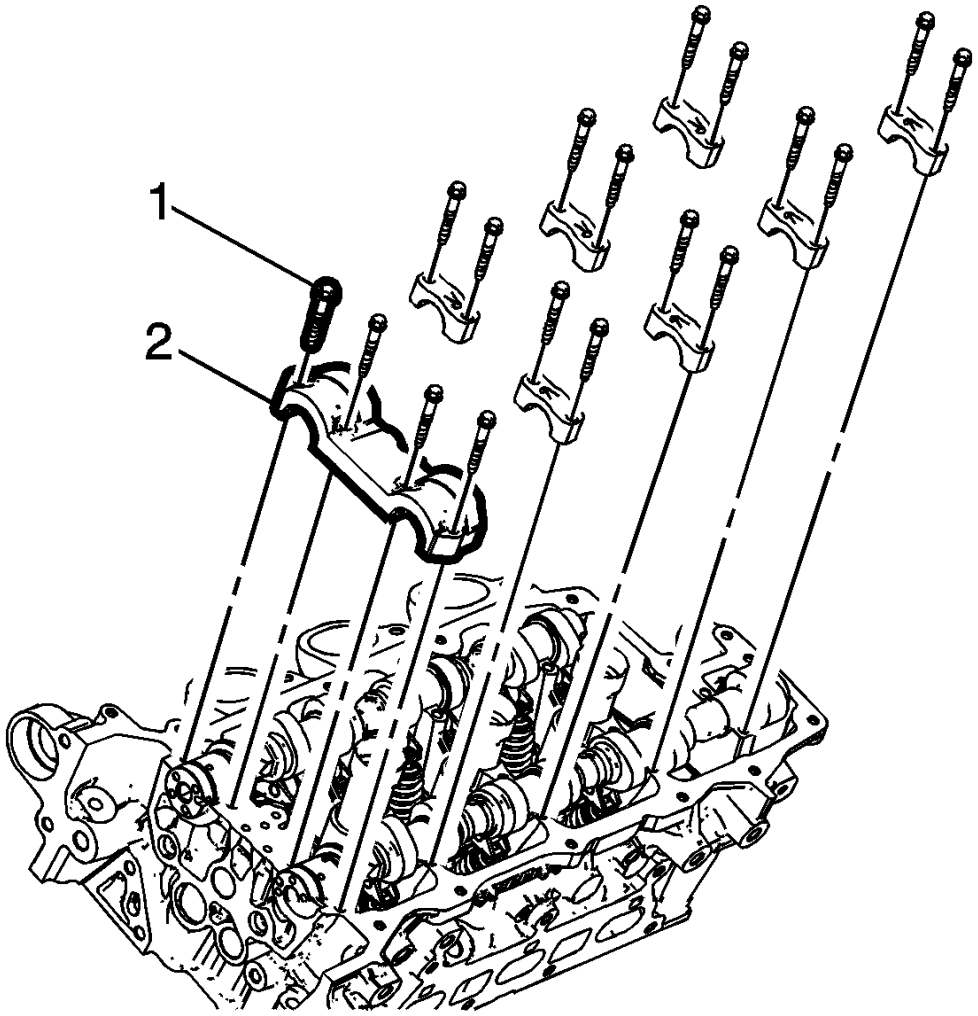


Fig. 161: Bearing Cap Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the camshaft bearing cap bolts (1).
5. Remove the camshaft bearing caps (2).

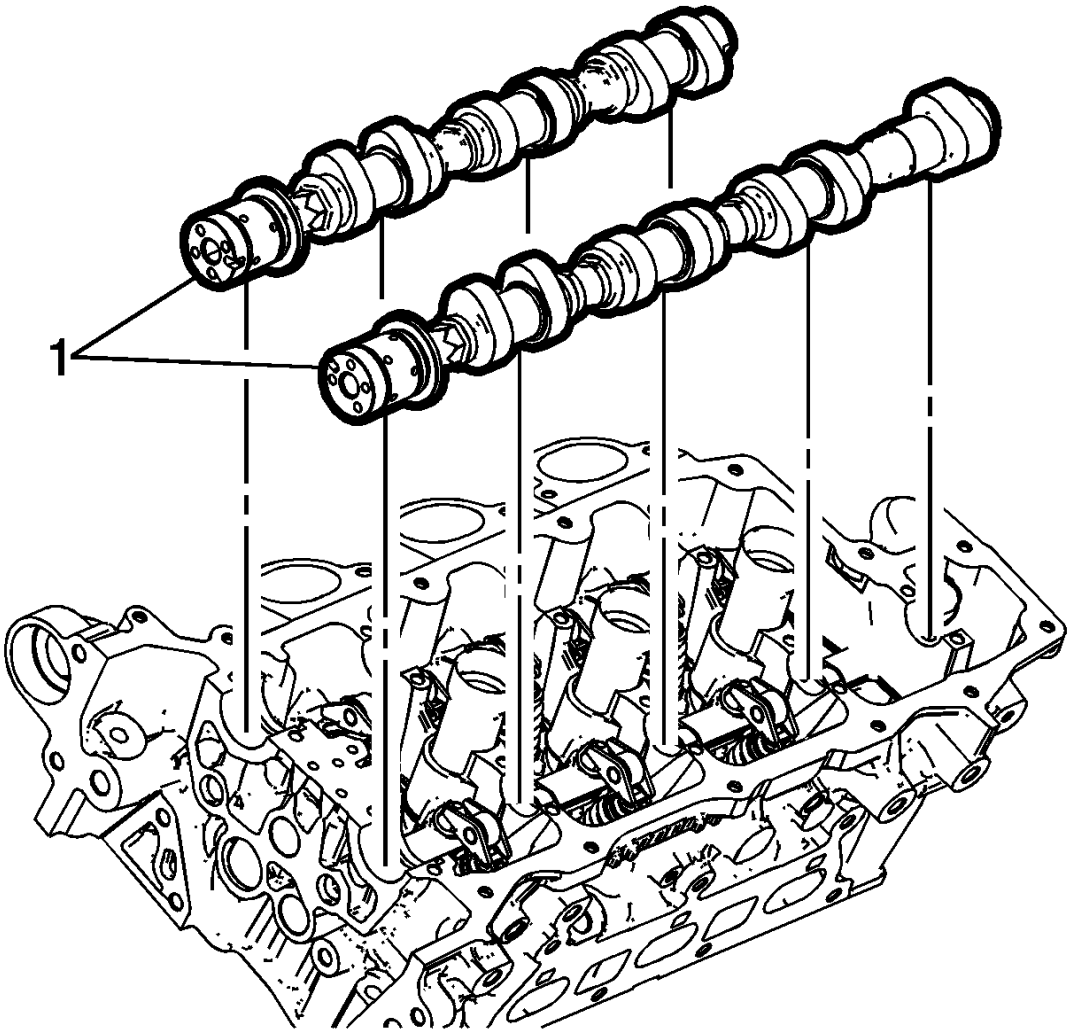


Fig. 162: Camshafts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Mark the camshafts upon removal to ensure installation is in the correct position.**

6. Remove the camshafts (1).

Installation Procedure

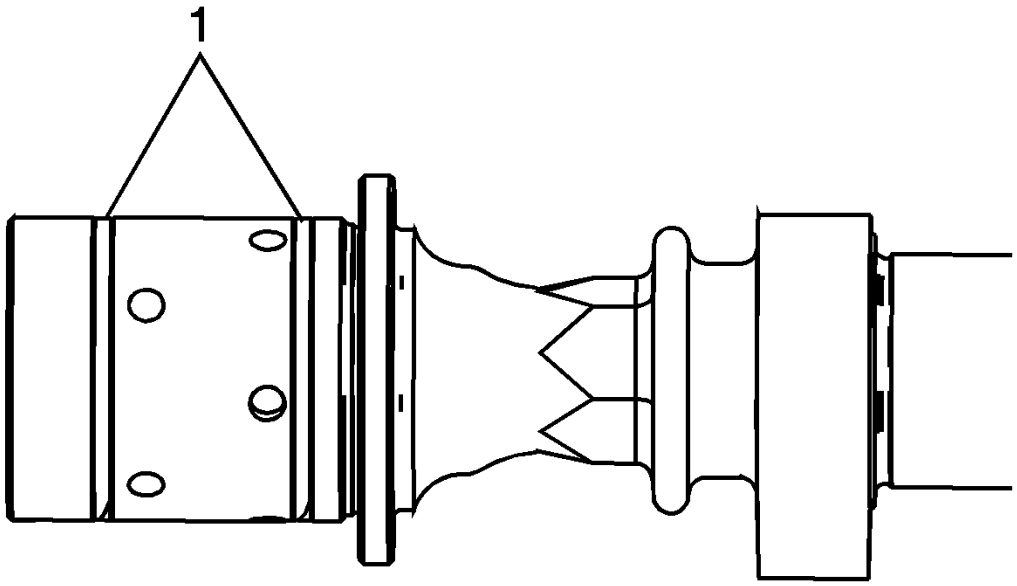


Fig. 163: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

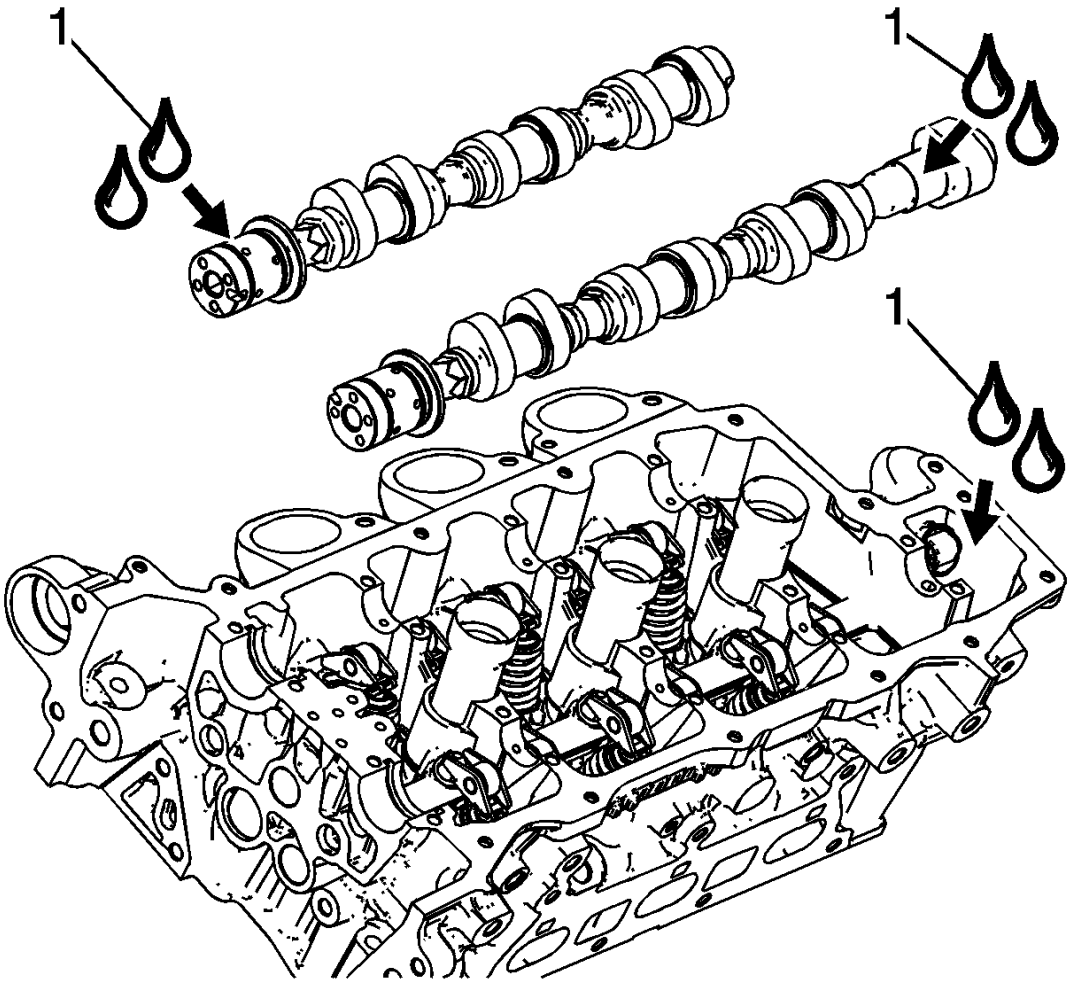


Fig. 164: Camshaft Journal Lubrication Points
Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant (1) to the camshaft journals and the left cylinder head camshaft carriers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

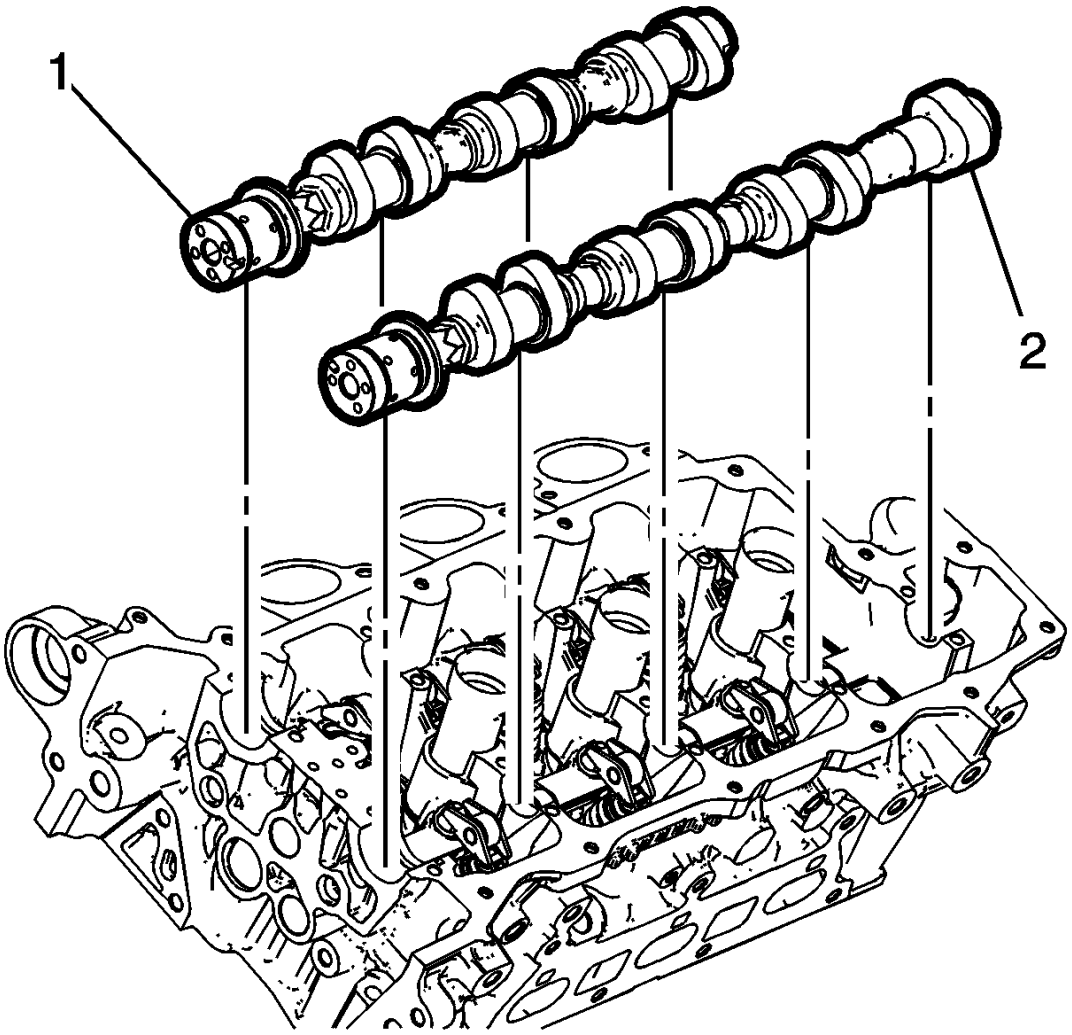


Fig. 165: Camshaft Intake And Exhaust Positioning Points
Courtesy of GENERAL MOTORS COMPANY

3. Place the left intake (1) and left exhaust (2) camshafts in position in the left cylinder head.

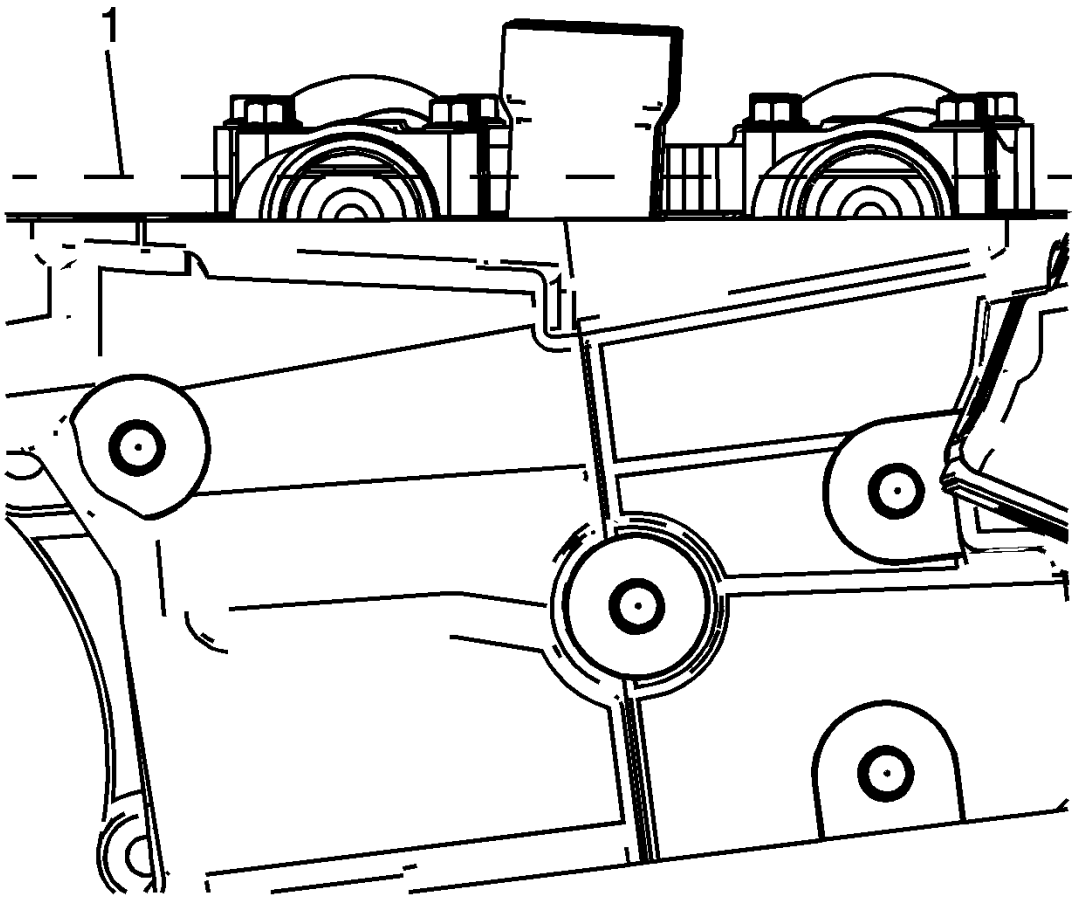


Fig. 166: View Of Camshaft Flats Parallel With Camshaft Cover Rail
Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the left cylinder head camshaft cover rail.

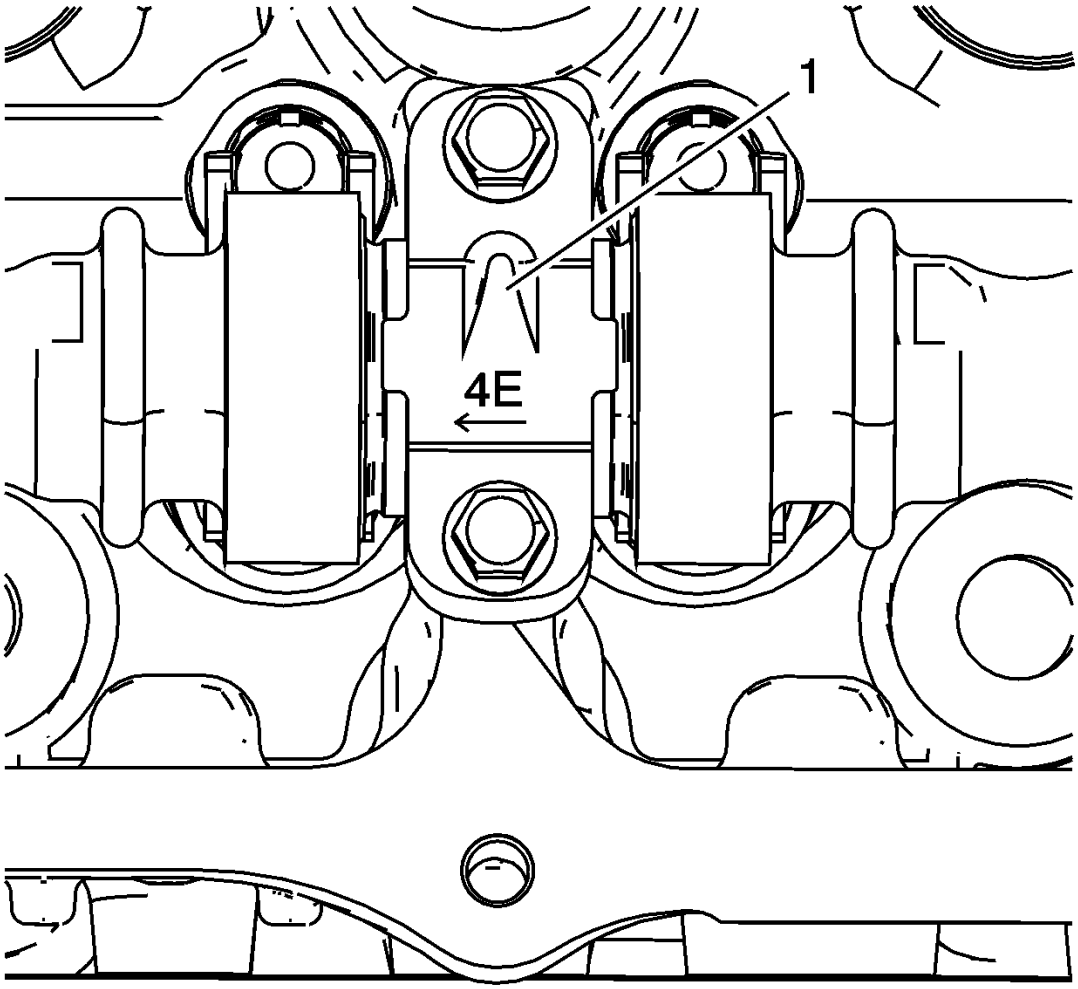


Fig. 167: Left Cylinder Head Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the left cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature (1) must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number 2, 4, 6 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

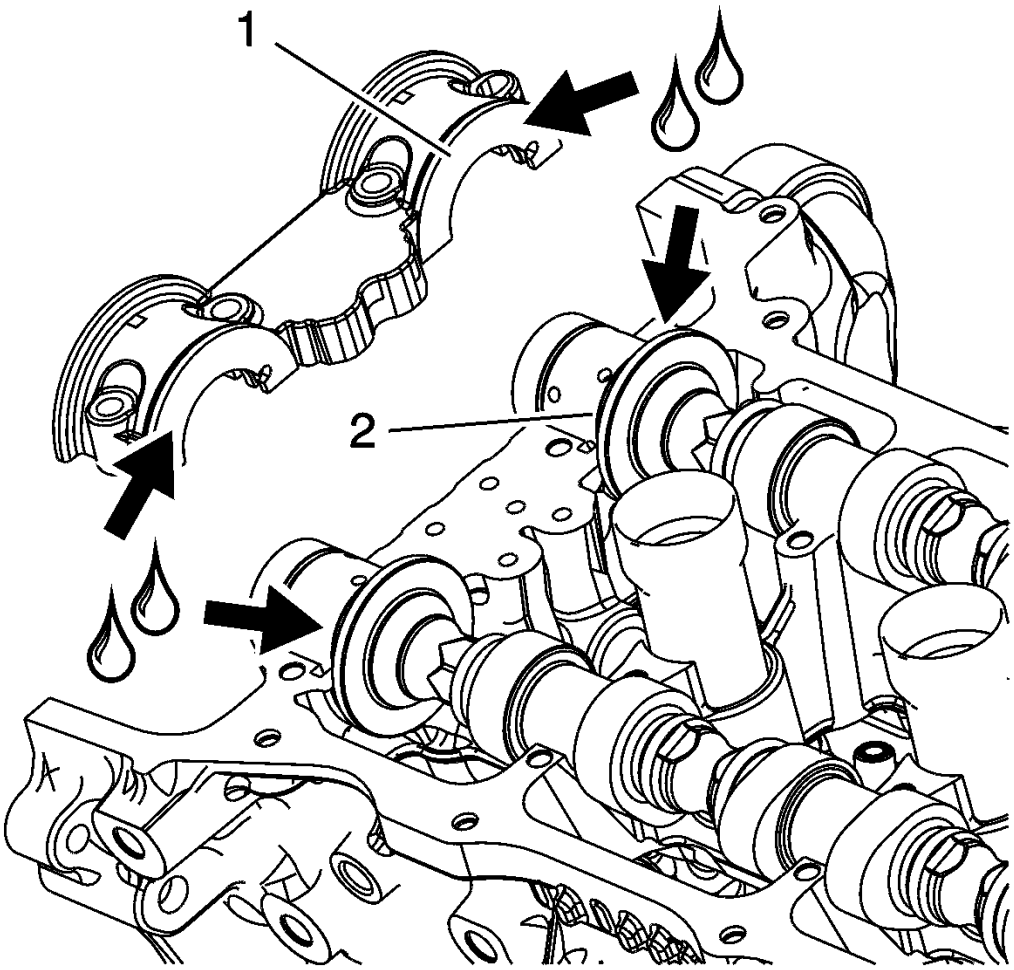


Fig. 168: Camshaft Bearing Cap And Camshaft Thrust Surface
Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

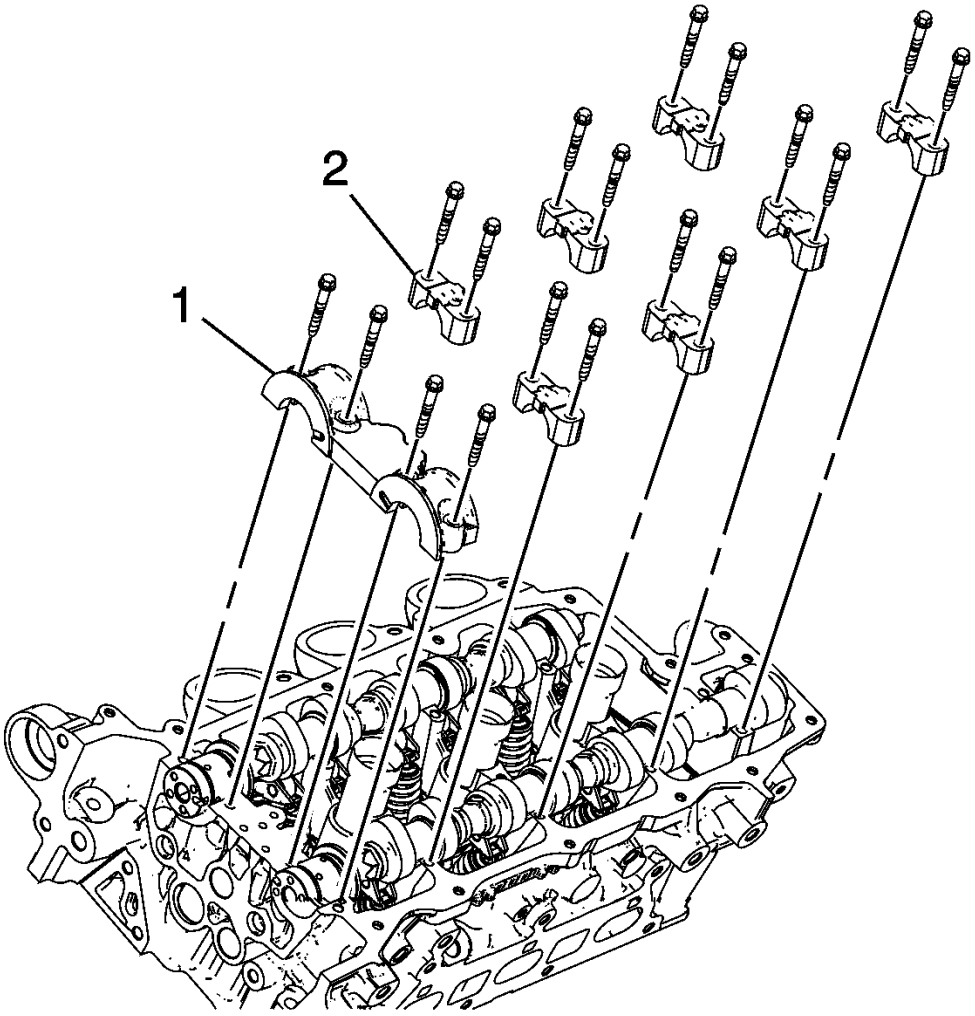


Fig. 169: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust cap (1) in the first journal of the left cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

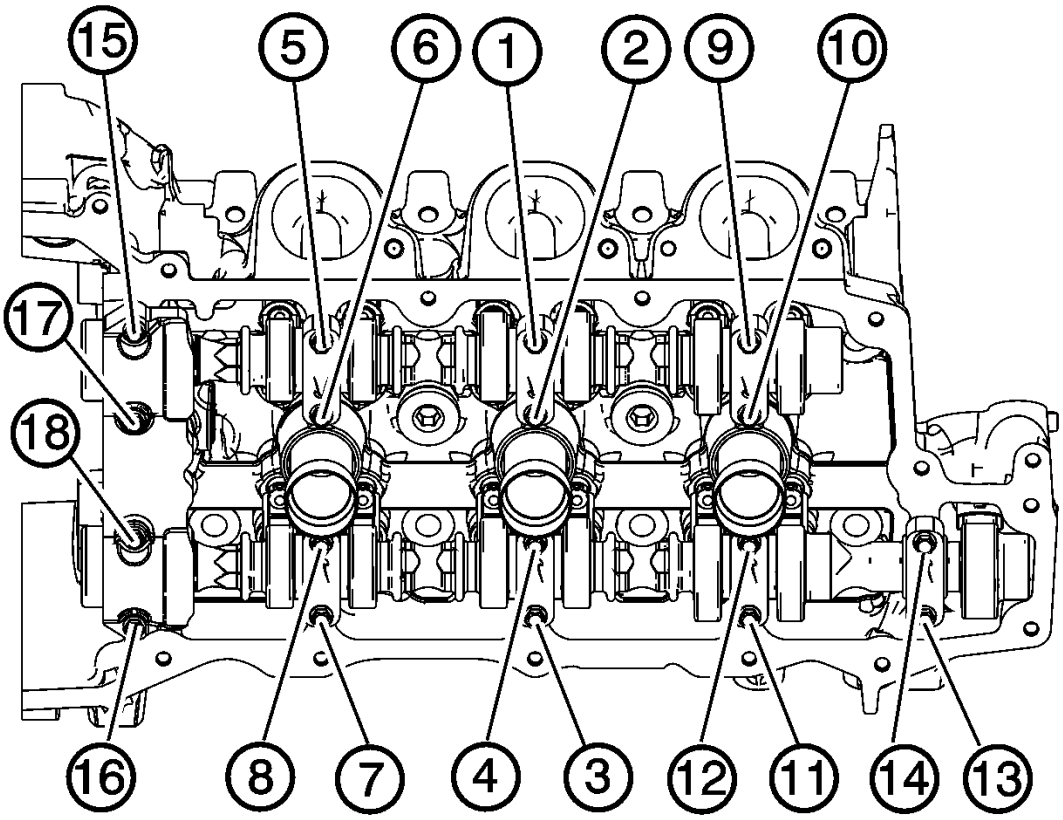


Fig. 170: Identifying Camshaft Bearing Cap Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts 1, 2 and the center exhaust camshaft bearing cap bolts 3, 4.
13. Retighten the center camshaft bearing cap bolts 1, 2, 3, 4 and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).
14. Install the camshaft position actuators. Refer to **Camshaft Position Actuator Replacement - Bank 2**.
15. Install the fuel pump. Refer to **Fuel Pump Replacement** .

CAMSHAFT REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the camshaft position actuators. Refer to **Camshaft Position Actuator Replacement - Bank 1** .

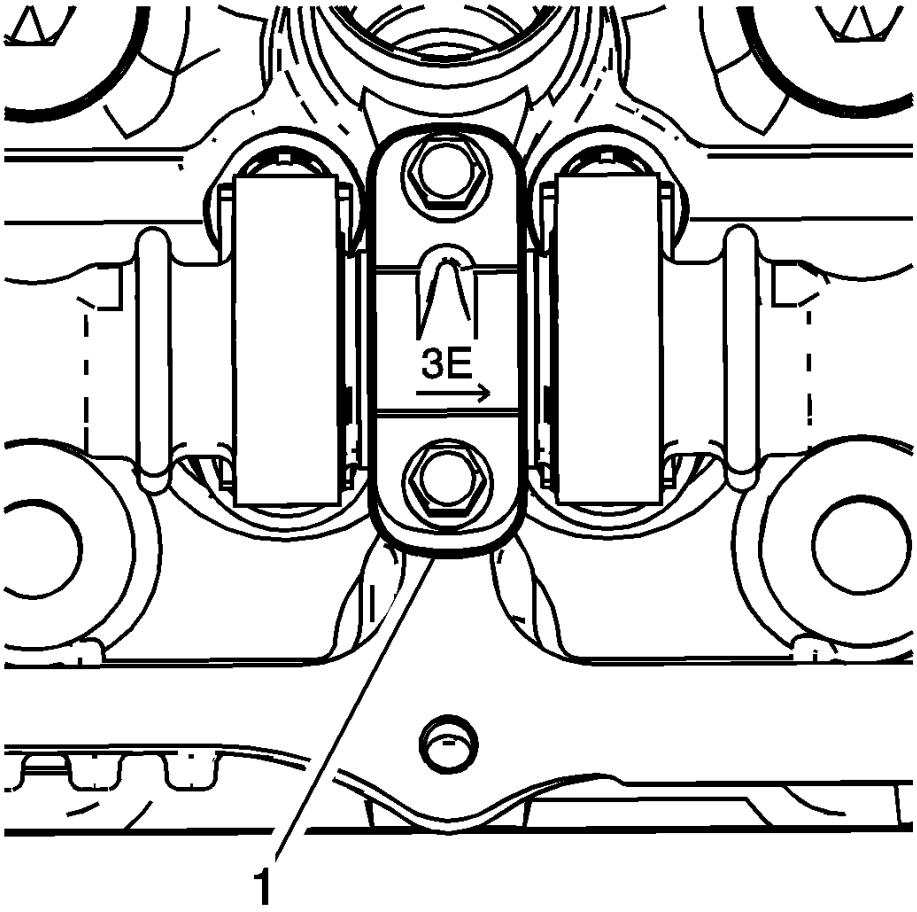


Fig. 171: Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

2. Observe the markings on the bearing caps (1). Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number indicates the journal position from the front of the engine.

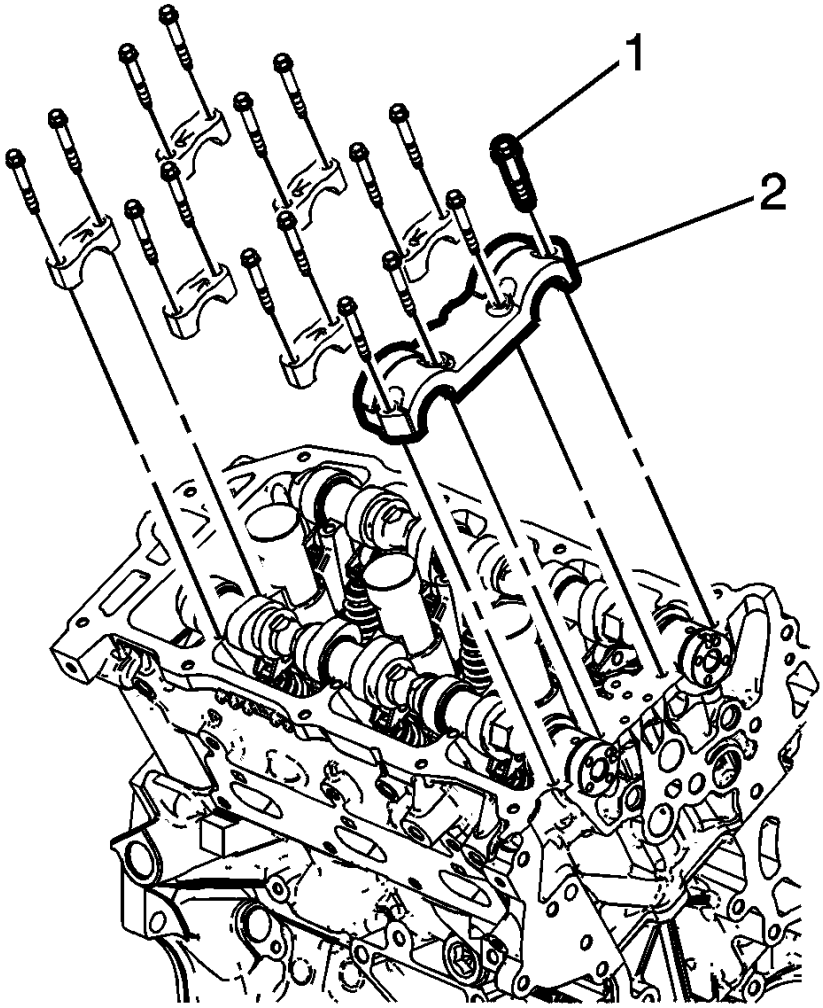


Fig. 172: Camshaft Bearing Caps & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Remove the camshaft bearing cap bolts (1).
4. Remove the camshaft bearing caps (2).

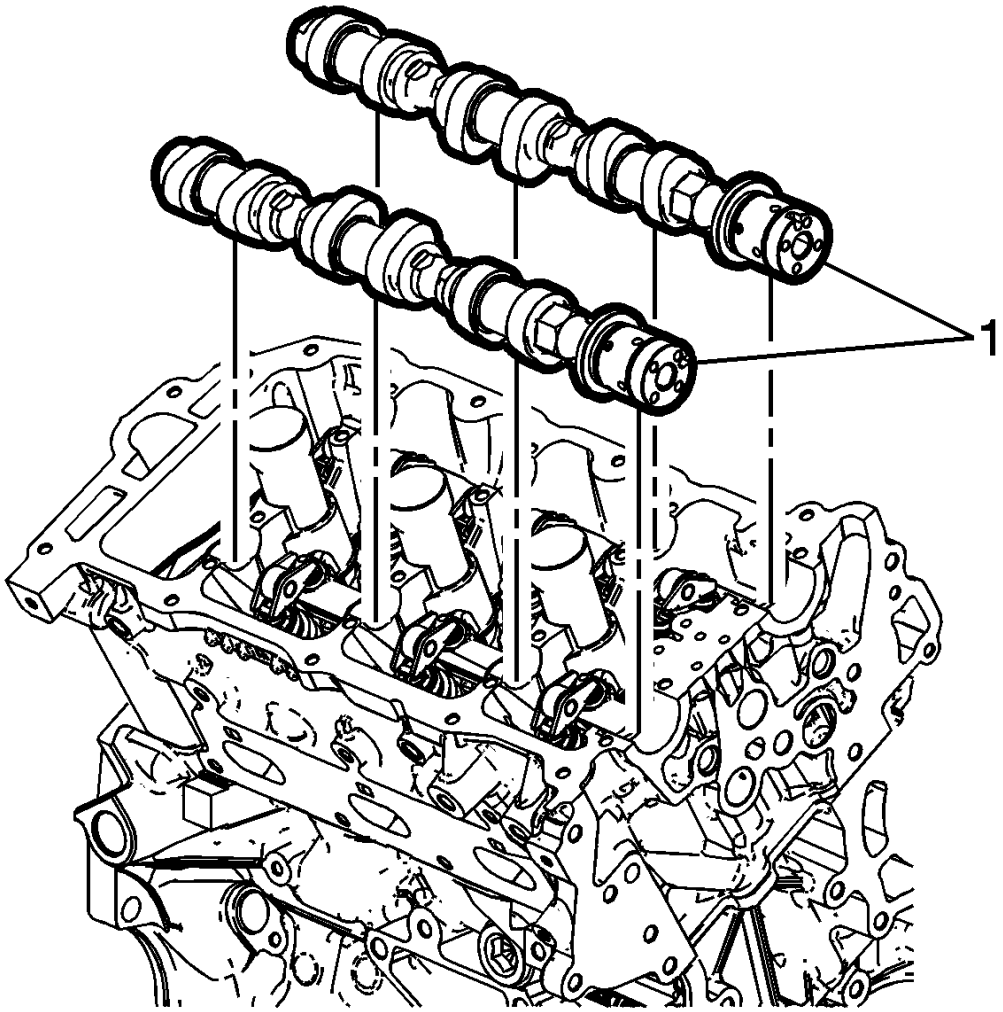


Fig. 173: Camshafts
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Mark the camshafts upon removal to ensure installation is in the correct position.

5. Remove the camshafts (1).

Installation Procedure

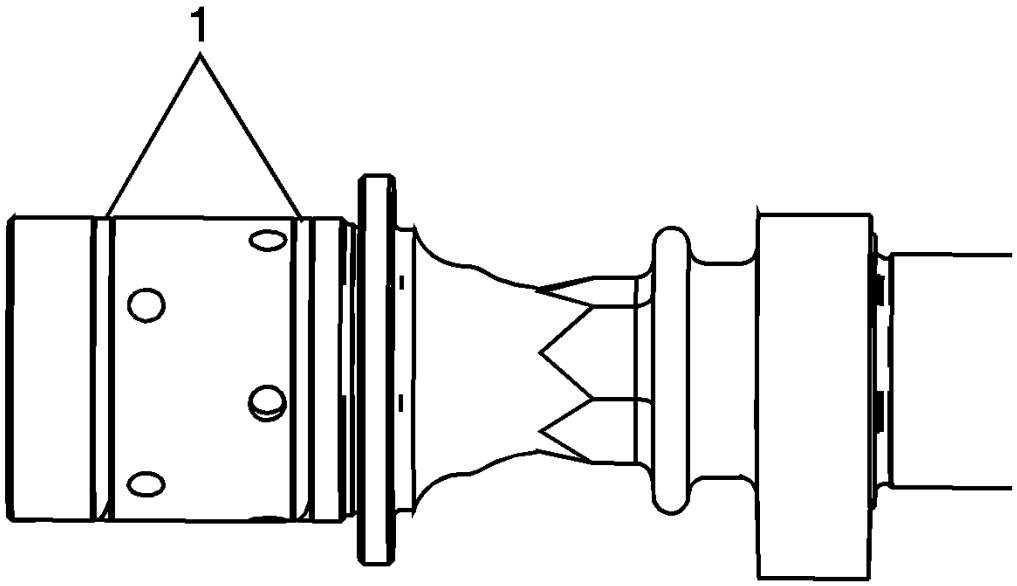


Fig. 174: Locating Camshaft Sealing Rings In Camshaft Grooves
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the camshaft sealing rings (1) are in place in the camshaft grooves. Camshaft sealing rings must be in place below the surface of the camshaft journal in order to avoid being pinched between the cylinder head and the camshaft caps.

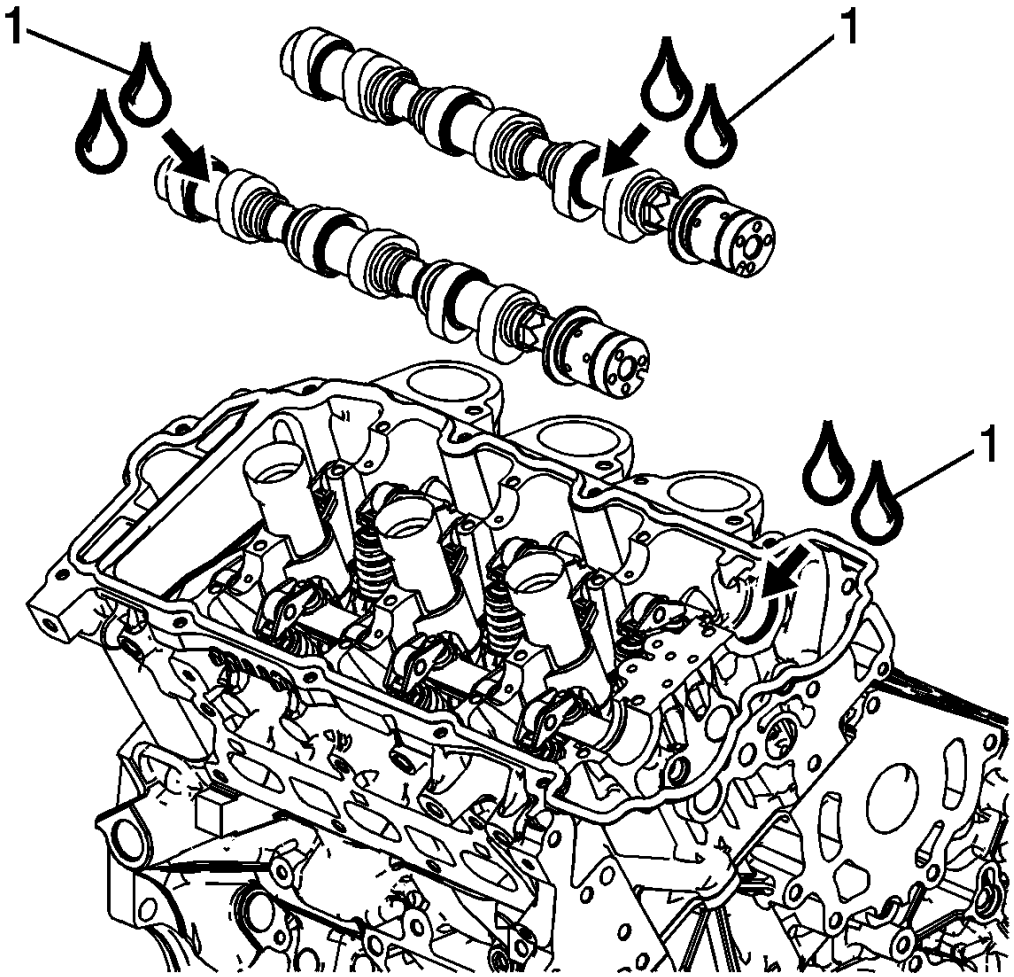


Fig. 175: Right Cylinder Head Camshaft Lubrication Points
Courtesy of GENERAL MOTORS COMPANY

2. Apply a liberal amount of lubricant (1) to the camshaft journals and the right cylinder head camshaft carriers. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

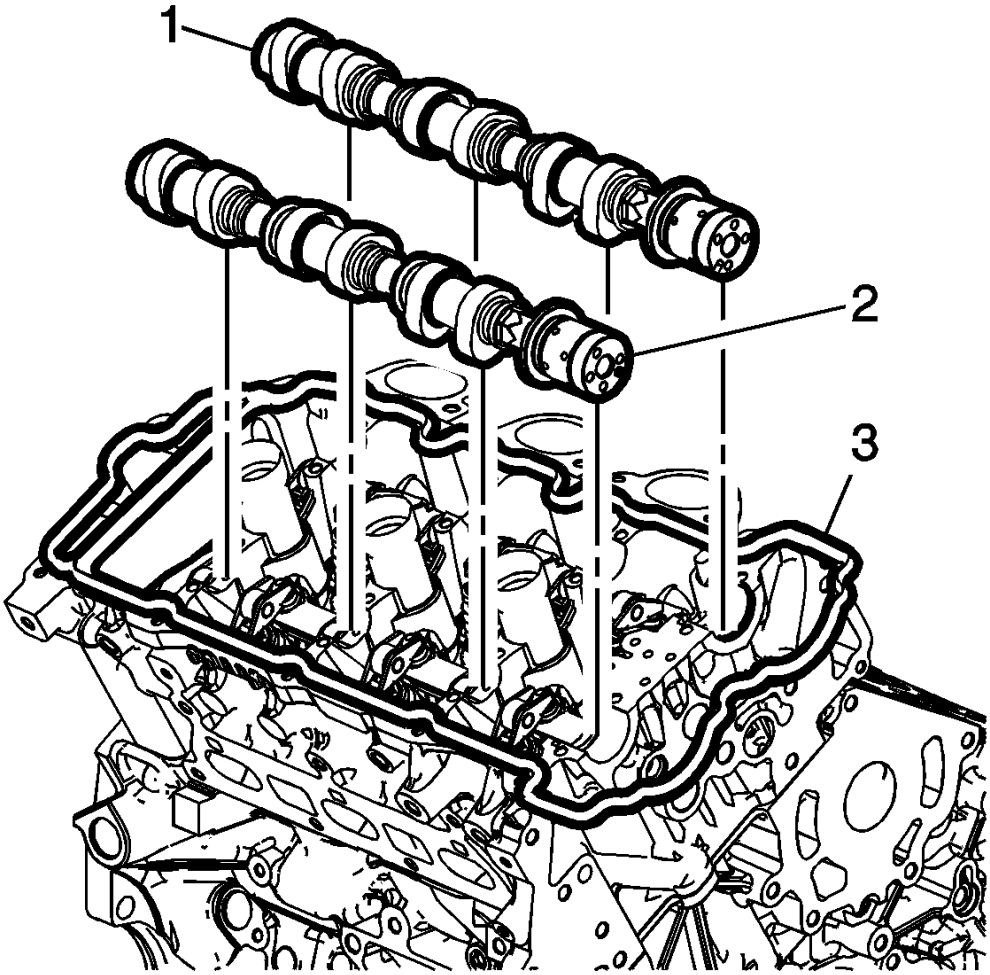


Fig. 176: Right Cylinder Head Camshaft Intake & Exhaust Points
Courtesy of GENERAL MOTORS COMPANY

3. Place the right intake (1) and right exhaust (2) camshafts in position in the right cylinder head (3).

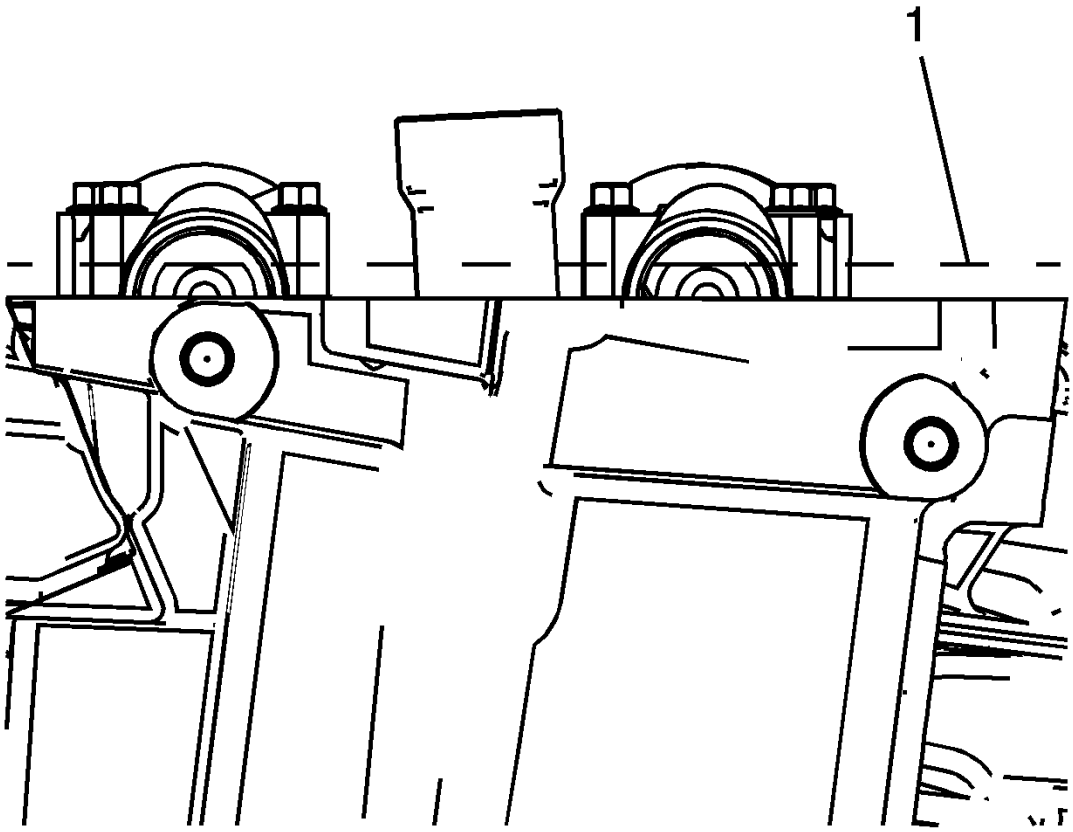


Fig. 177: Identifying Camshaft Neutral (Low Tension) Position
Courtesy of GENERAL MOTORS COMPANY

4. Position the camshaft lobes in a neutral position with the flats on the back of the camshafts up and parallel (1) with the right cylinder head camshaft cover rail.

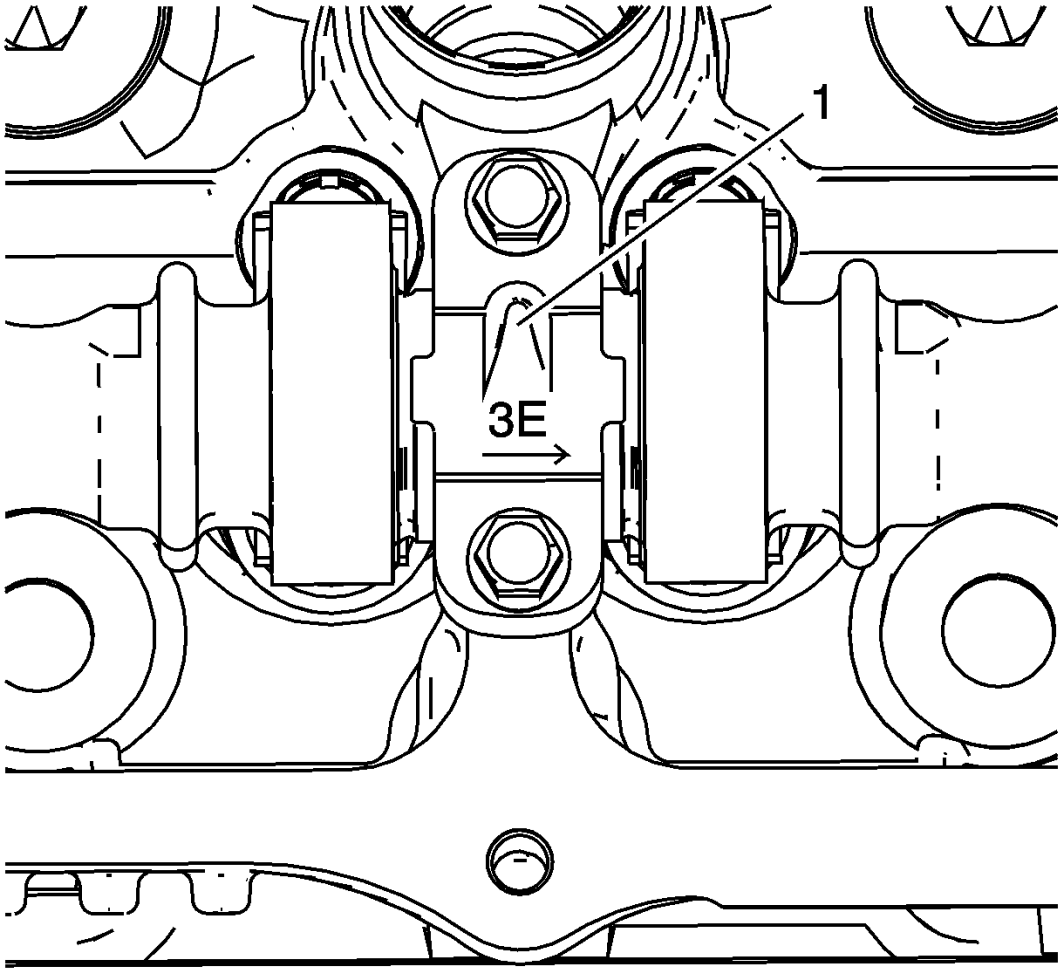


Fig. 178: Right Cylinder Head Camshaft Bearing Cap Markings
Courtesy of GENERAL MOTORS COMPANY

5. Observe the markings on the right cylinder head camshaft bearing caps. Each bearing cap is marked in order to identify its location. The markings have the following meanings:
    - The raised feature (1) must always be oriented toward the center of the cylinder head.
    - The I indicates the intake camshaft.
    - The E indicates the exhaust camshaft.
    - The number 1, 3, 5 indicates the cylinder position from the front of the engine.
6. Apply a liberal amount of lubricant to the camshaft bearing caps. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

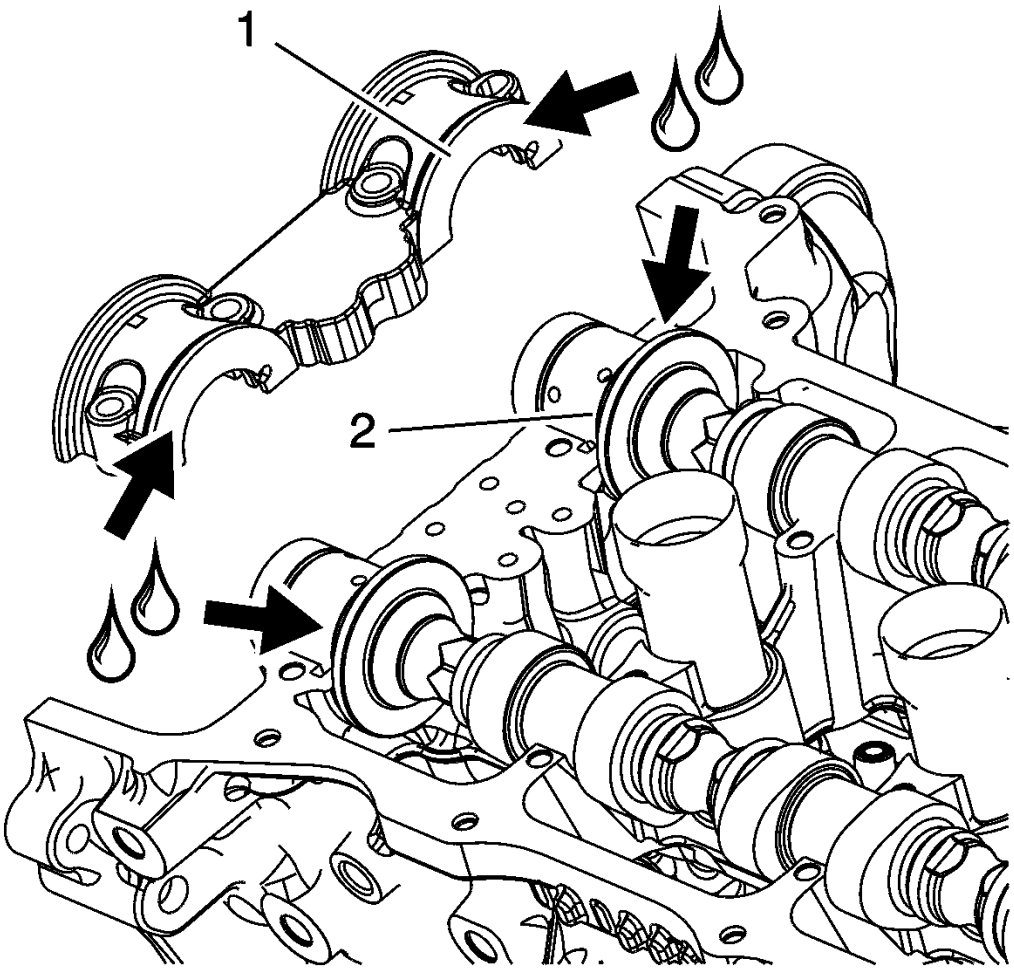


Fig. 179: Camshaft Bearing Cap And Camshaft Thrust Surface
Courtesy of GENERAL MOTORS COMPANY

7. Apply a liberal amount of lubricant to the camshaft bearing cap (1) and camshaft thrust surface (2). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for recommended lubricant.

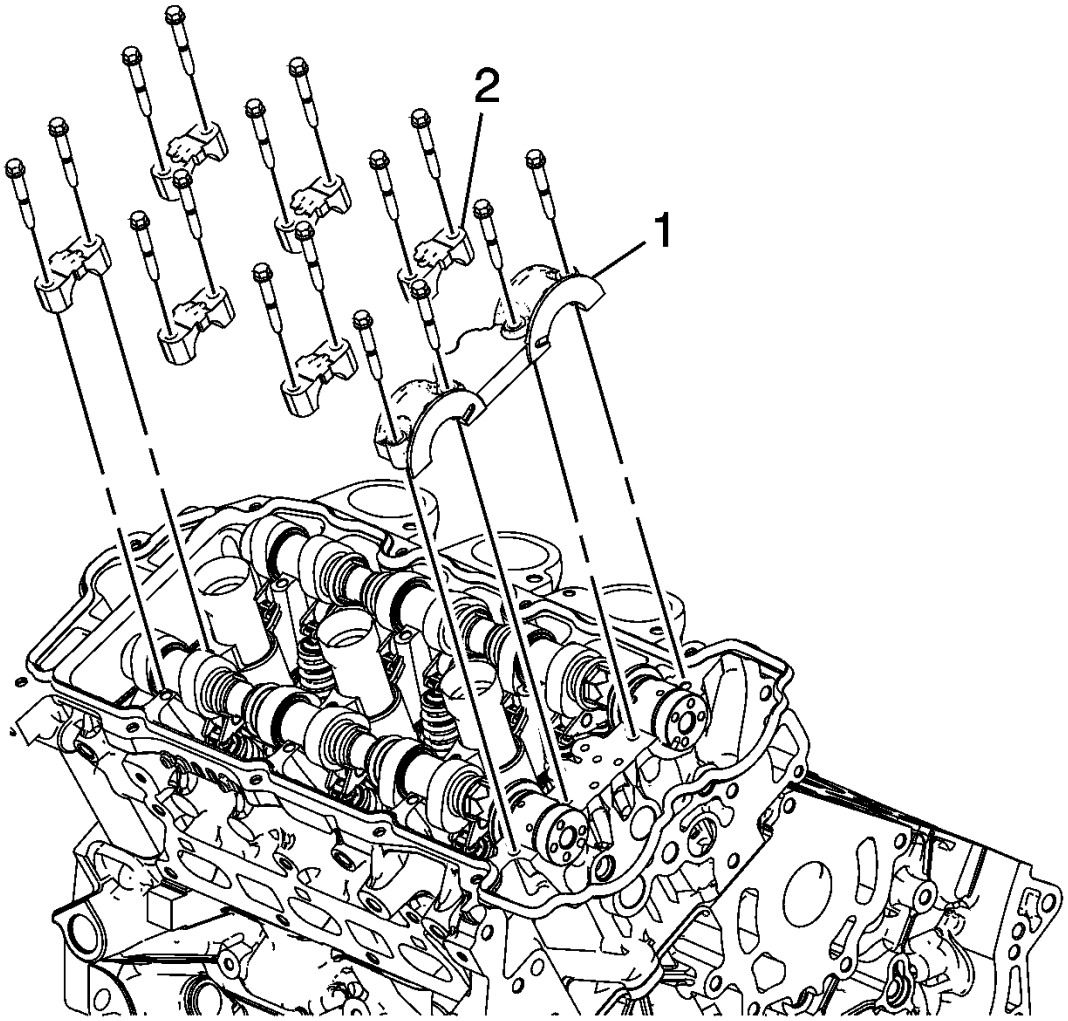


Fig. 180: Camshaft Bearing Caps And Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the camshaft bearing thrust caps (1) in the first journal of the right cylinder head.
9. Install the remaining bearing caps (2) with their orientation mark toward the center of the cylinder head.
10. Hand start all the camshaft bearing cap bolts.

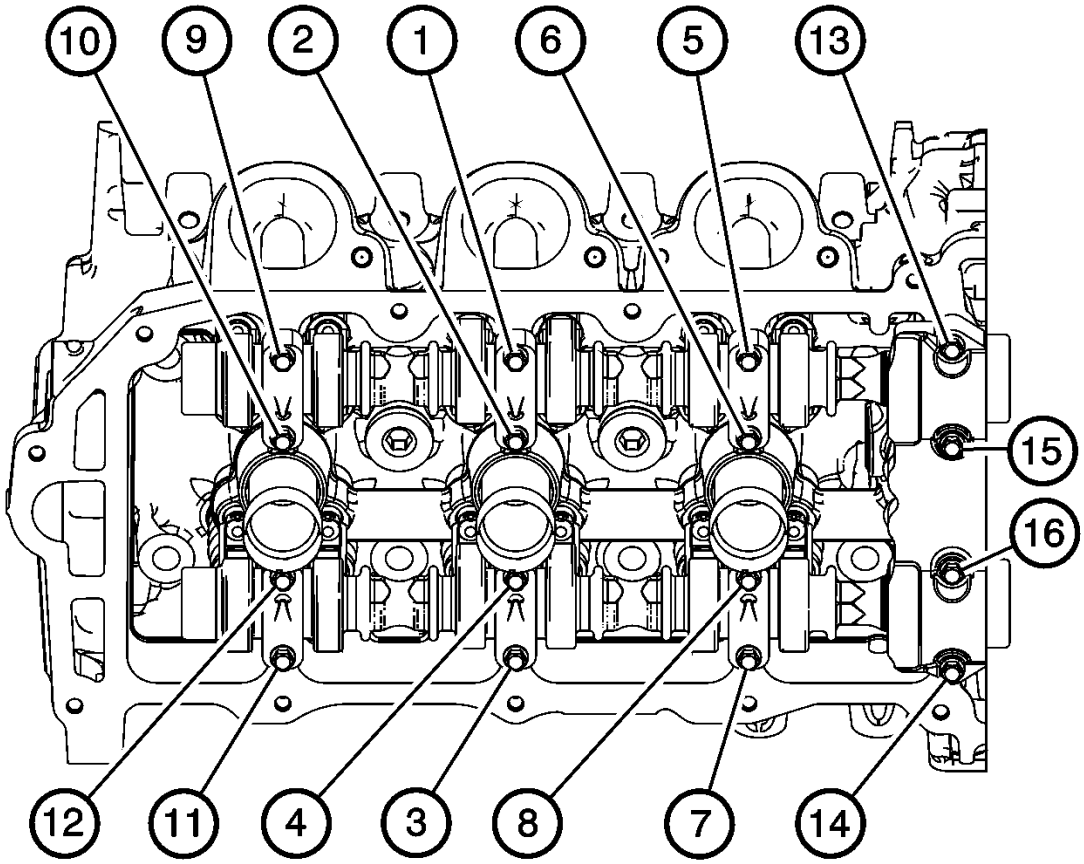


Fig. 181: Camshaft Bearing Cap Bolts Tighten Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

CAUTION: This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component.

11. Tighten the camshaft bearing cap bolts in the sequence shown and tighten to 10 N.m (89 lb in).
12. Loosen the center intake camshaft bearing cap bolts (1, 2) and the center exhaust camshaft bearing cap bolts (3, 4).
13. Retighten the center camshaft bearing cap bolts (1, 2, 3, 4) and retighten the camshaft bearing cap bolts to 10 N.m (89 lb in).
14. Install the camshaft position actuators. Refer to **Camshaft Position Actuator Replacement - Bank 1** .

VALVE ROCKER ARM REPLACEMENT - LEFT SIDE

Removal Procedure

1. Remove the applicable camshaft(s). Refer to **Camshaft Replacement - Left Side**.

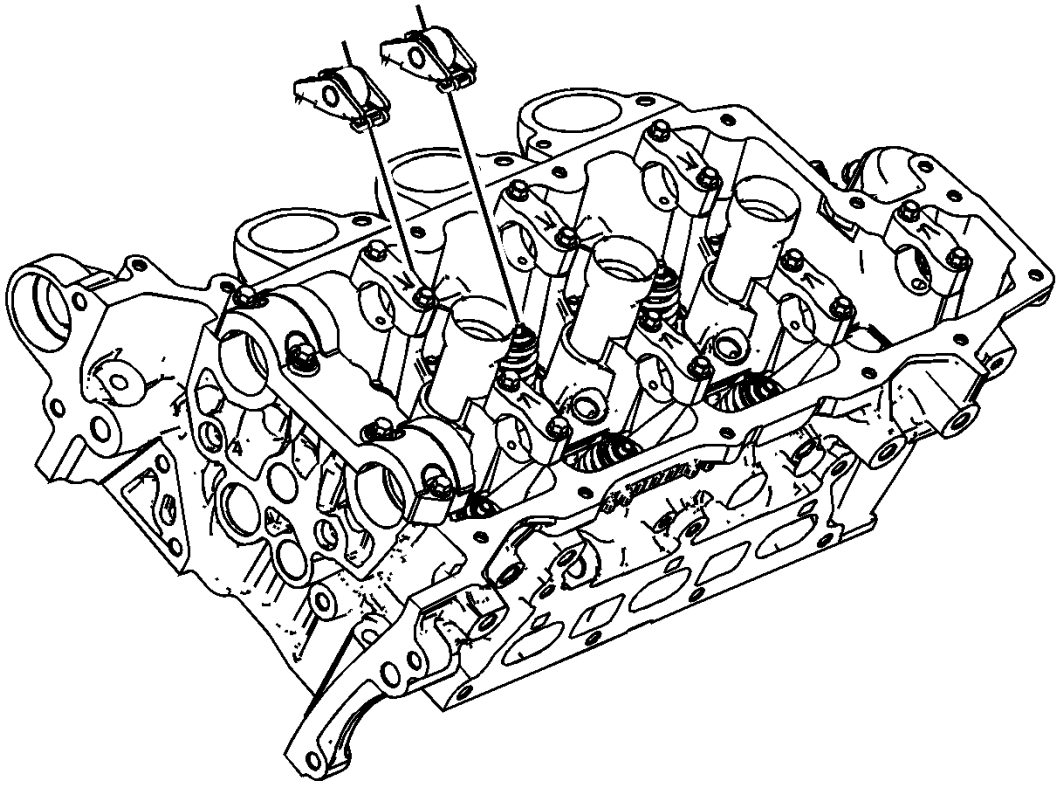


Fig. 182: View of Rocker Arm Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Remove the rocker arms.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Replace as necessary. Refer to **Camshaft Cleaning and Inspection** , and **Valve Rocker Arm Cleaning and Inspection** .
4. Clean and inspect the valve lifters and replace as necessary. Refer to **Valve Lifter Cleaning and Inspection**

Installation Procedure

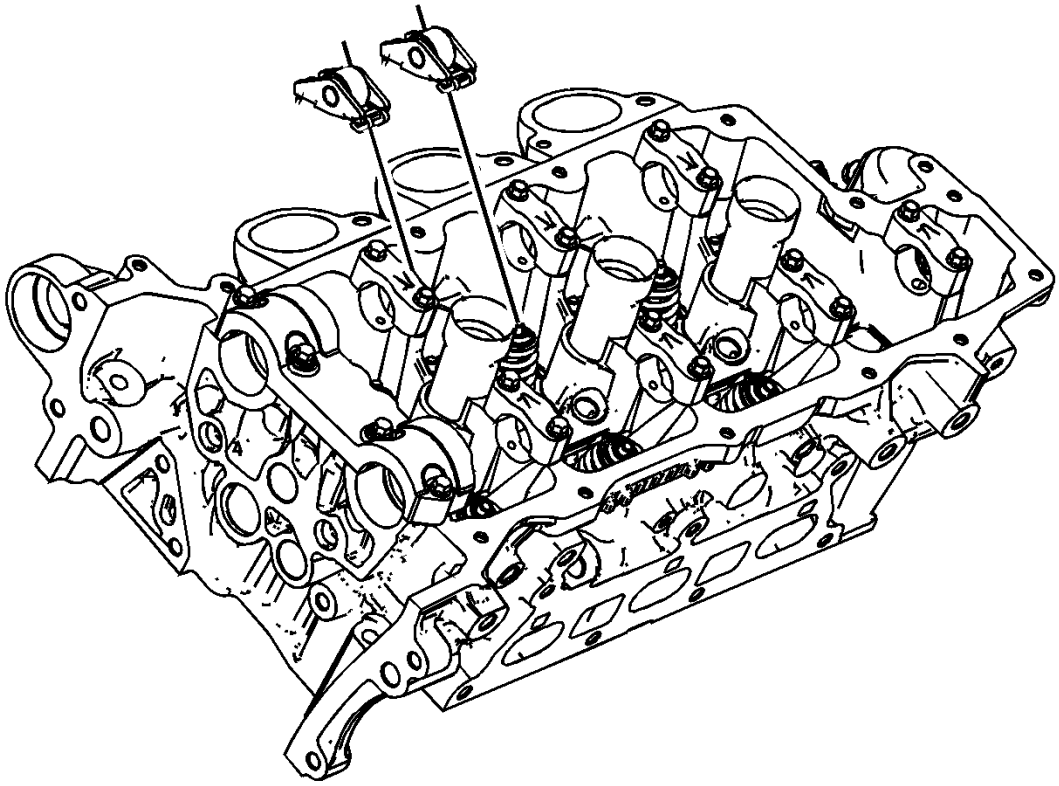


Fig. 183: View of Rocker Arm Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the rocker arms. Refer to **Valve Rocker Arm Installation - Left Side** .
2. Install the camshaft(s). Refer to **Camshaft Replacement - Left Side**.

VALVE ROCKER ARM REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the applicable camshaft(s). Refer to **Camshaft Replacement - Right Side**.

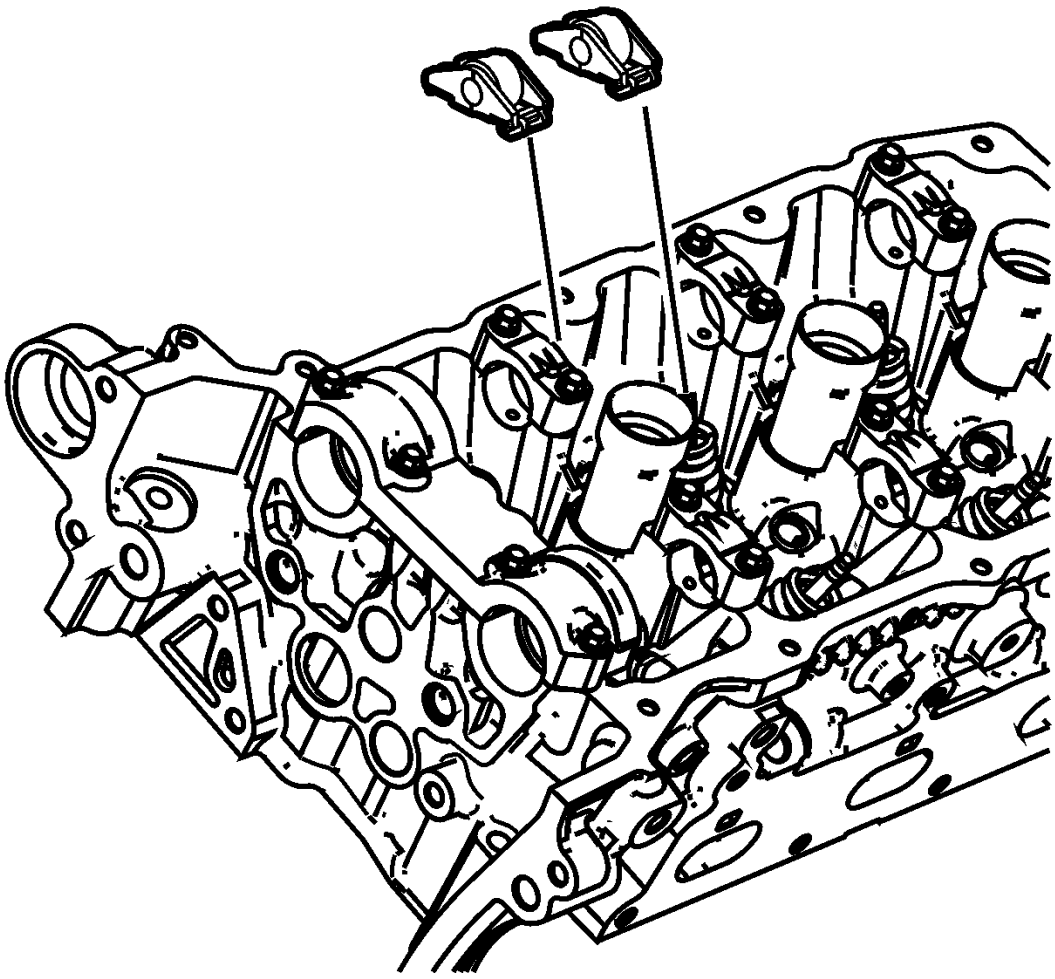


Fig. 184: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

2. Remove the rocker arms.
3. Clean and inspect the camshaft(s) and the rocker arm(s). Replace as necessary. Refer to **Camshaft Cleaning and Inspection** , and **Valve Rocker Arm Cleaning and Inspection** .
4. Clean and inspect the valve lifters and replace as necessary. Refer to **Valve Lifter Cleaning and Inspection**

Installation Procedure

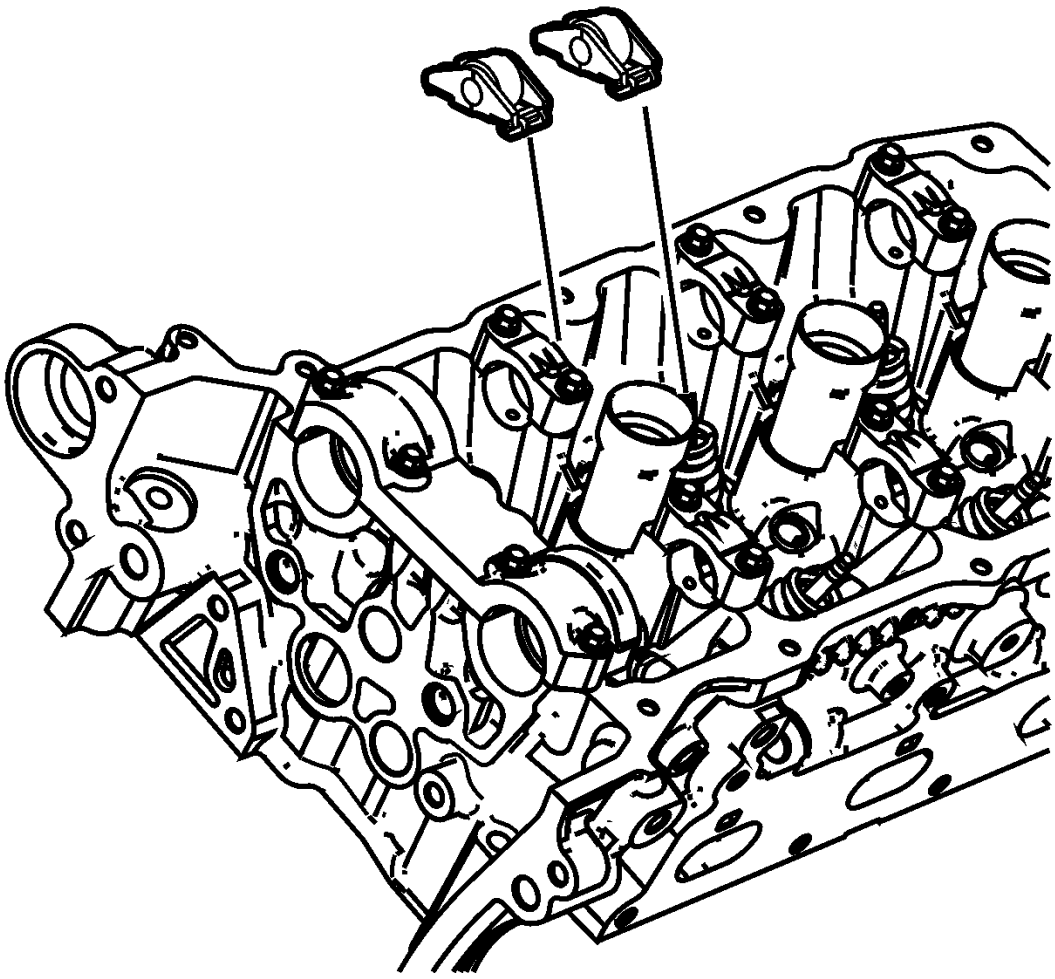


Fig. 185: View Of Valve Rocker Arm
Courtesy of GENERAL MOTORS COMPANY

1. Install the rocker arms. Refer to **Valve Rocker Arm Installation - Right Side** .
2. Install the camshaft(s). Refer to **Camshaft Replacement - Right Side**.

VALVE LIFTER REPLACEMENT - LEFT SIDE

Removal Procedure

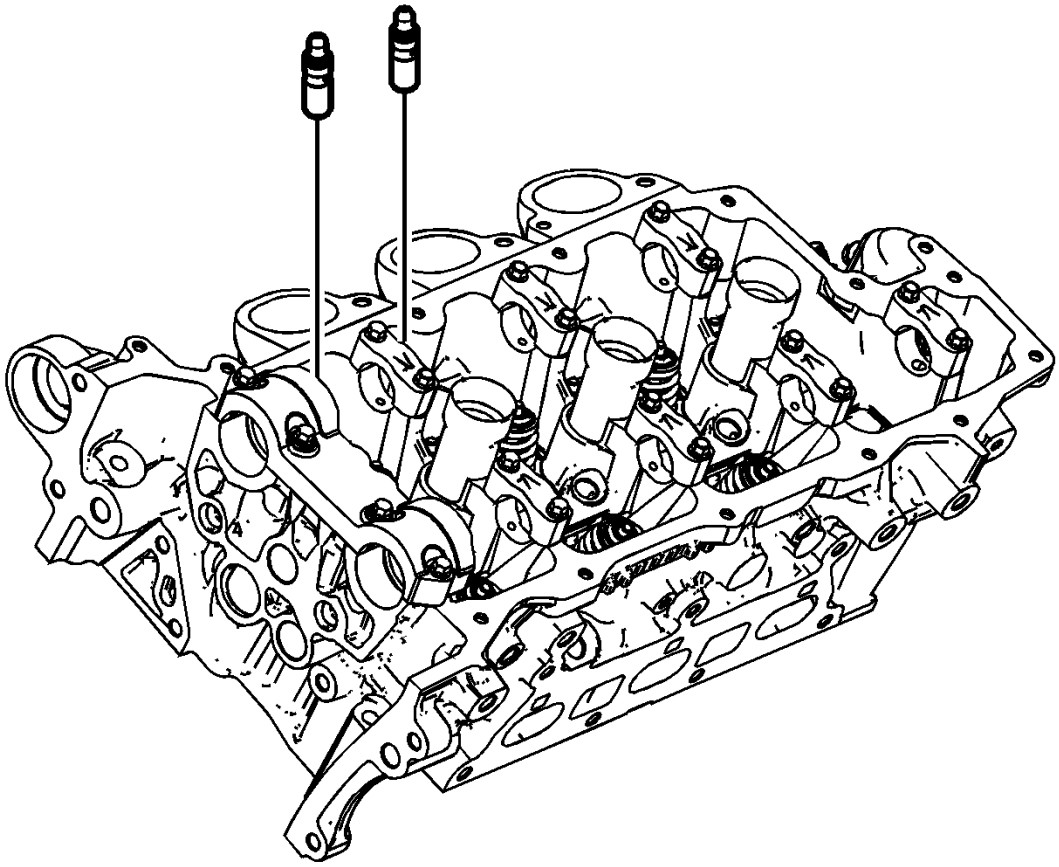


Fig. 186: Valve Lifter Removal - Left Side
Courtesy of GENERAL MOTORS COMPANY

1. Remove the applicable camshafts. Refer to **Camshaft Replacement - Left Side**.
2. Remove the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
3. Remove the lifters. Refer to **Valve Lifter Removal - Left Side**
4. Clean and inspect the camshafts, rocker arms and lifters. Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** , and **Valve Lifter Cleaning and Inspection** .
5. Clean and inspect the rocker arm. Refer to **Valve Rocker Arm Cleaning and Inspection**

Installation Procedure

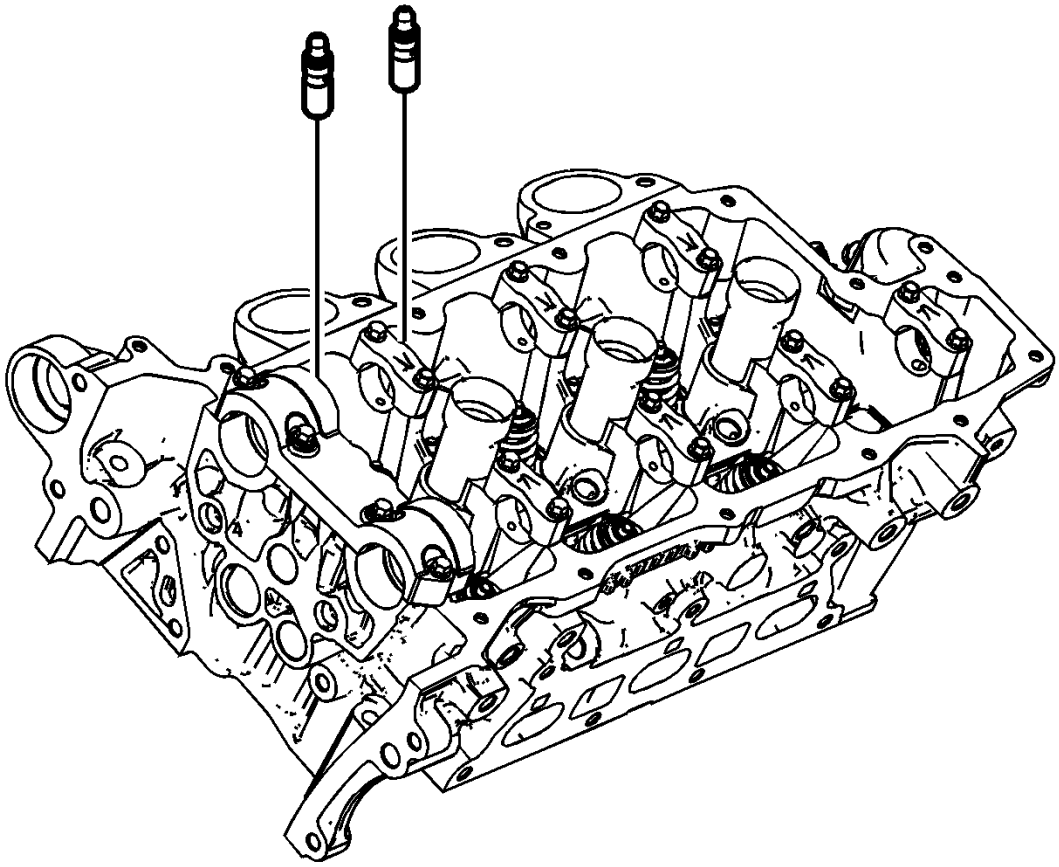


Fig. 187: Valve Lifter Removal - Left Side
Courtesy of GENERAL MOTORS COMPANY

1. Install the lifters.
2. Install the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
3. Install the camshafts. Refer to **Camshaft Replacement - Left Side**.

VALVE LIFTER REPLACEMENT - RIGHT SIDE

Removal Procedure

1. Remove the applicable camshaft(s). Refer to **Camshaft Replacement - Right Side**.
2. Remove the rocker arms. Refer to **Valve Rocker Arm Removal - Right Side** .

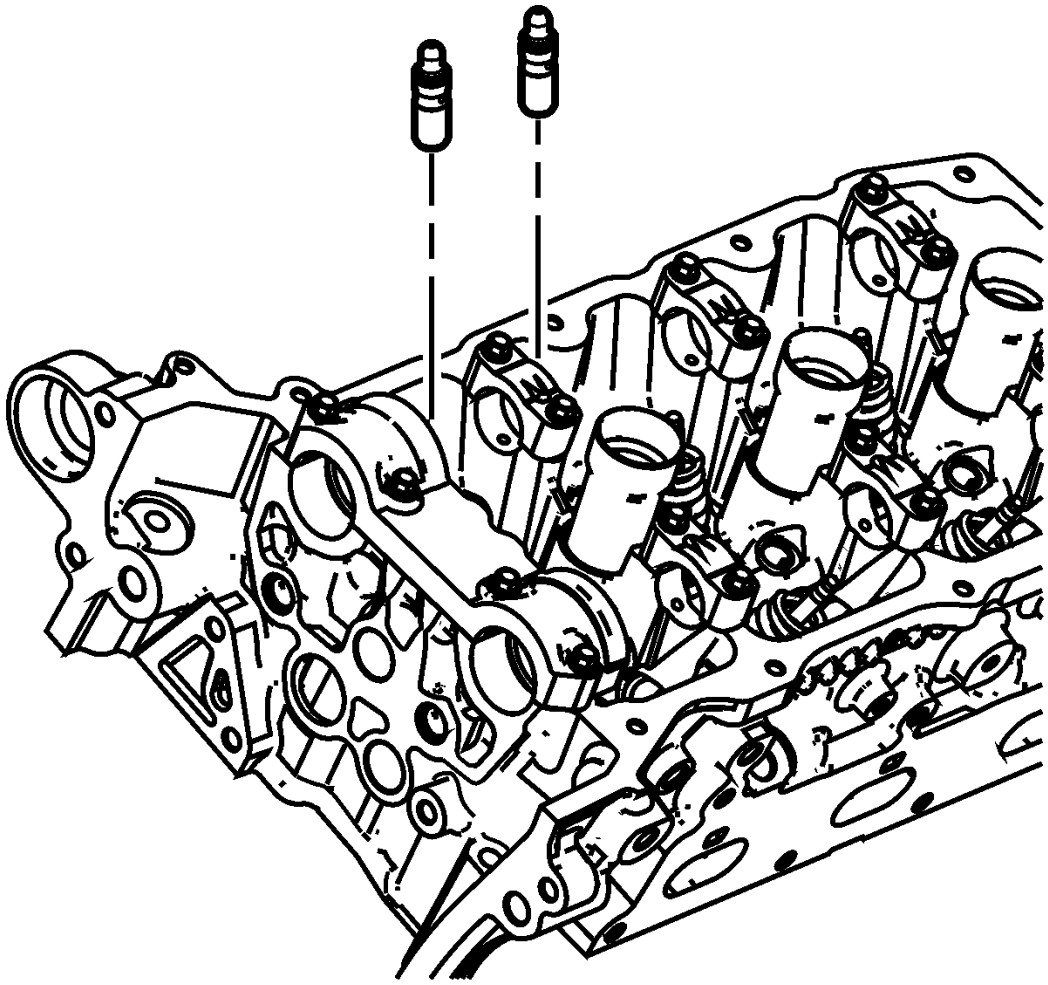


Fig. 188: View Of Stationary Hydraulic Lash Adjuster (SHLAs)
Courtesy of GENERAL MOTORS COMPANY

3. Remove the lifters. Refer to **Valve Lifter Removal - Right Side** .
4. Clean and inspect the camshaft(s) and the rocker arm(s) and lifter. Repair or replace as necessary. Refer to **Camshaft Cleaning and Inspection** , **Valve Lifter Cleaning and Inspection** , and **Valve Rocker Arm Cleaning and Inspection** .

Installation Procedure

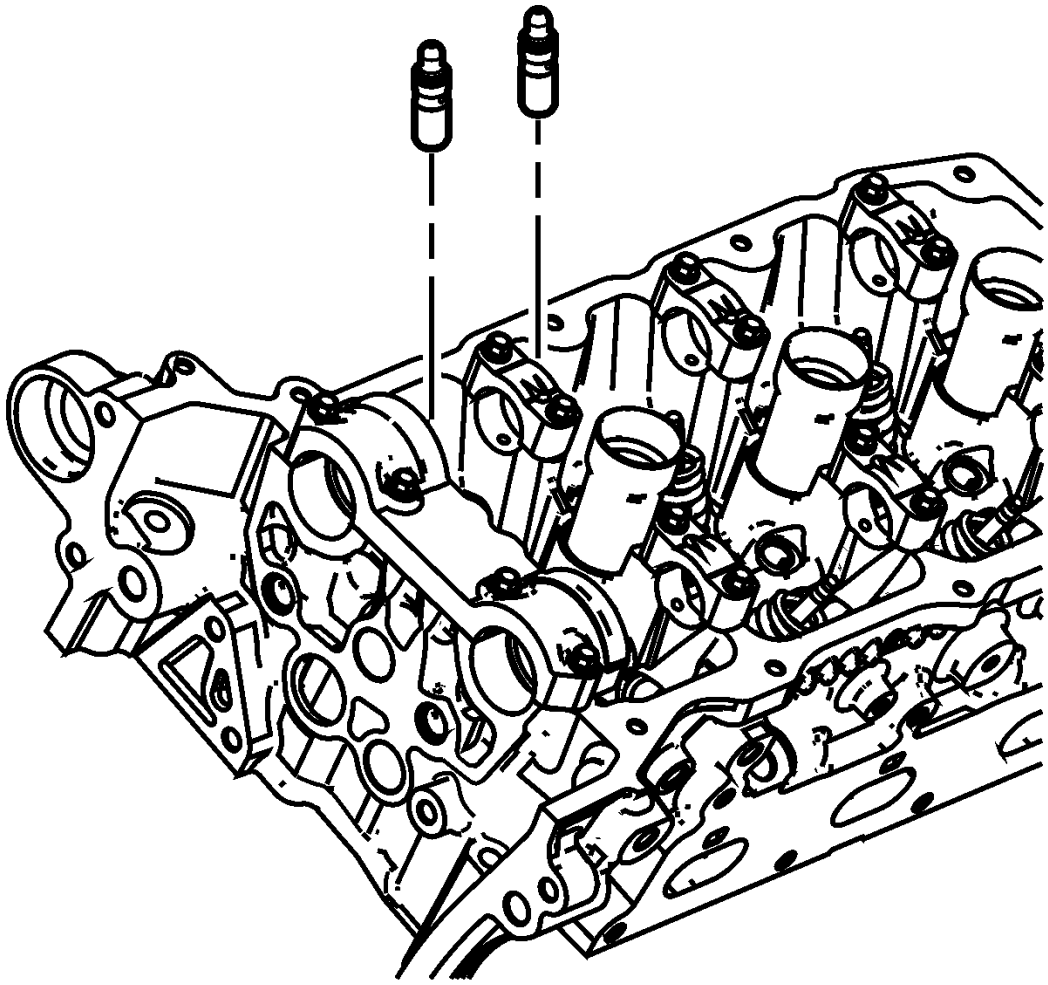


Fig. 189: View Of Stationary Hydraulic Lash Adjuster (SHLAs)
Courtesy of GENERAL MOTORS COMPANY

1. Install the lifters. Refer to **Valve Lifter Installation - Right Side** .
2. Install the rocker arms. Refer to **Valve Rocker Arm Installation - Right Side** .
3. Install the applicable camshaft(s). Refer to **Camshaft Replacement - Right Side**.

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - LEFT SIDE

Special Tools

- **EN-39313** Spark Plug Port Adapter
- **EN-46106** Flywheel Holding Tool
- **EN-46110** On-Vehicle Valve Spring Compressor
- **EN-46116** Valve Stem Seal Remover/Installer

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

NOTE: **This procedure is not used in Brazil.**

1. Remove the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
2. Remove the starter motor. Refer to **Starter Replacement** .

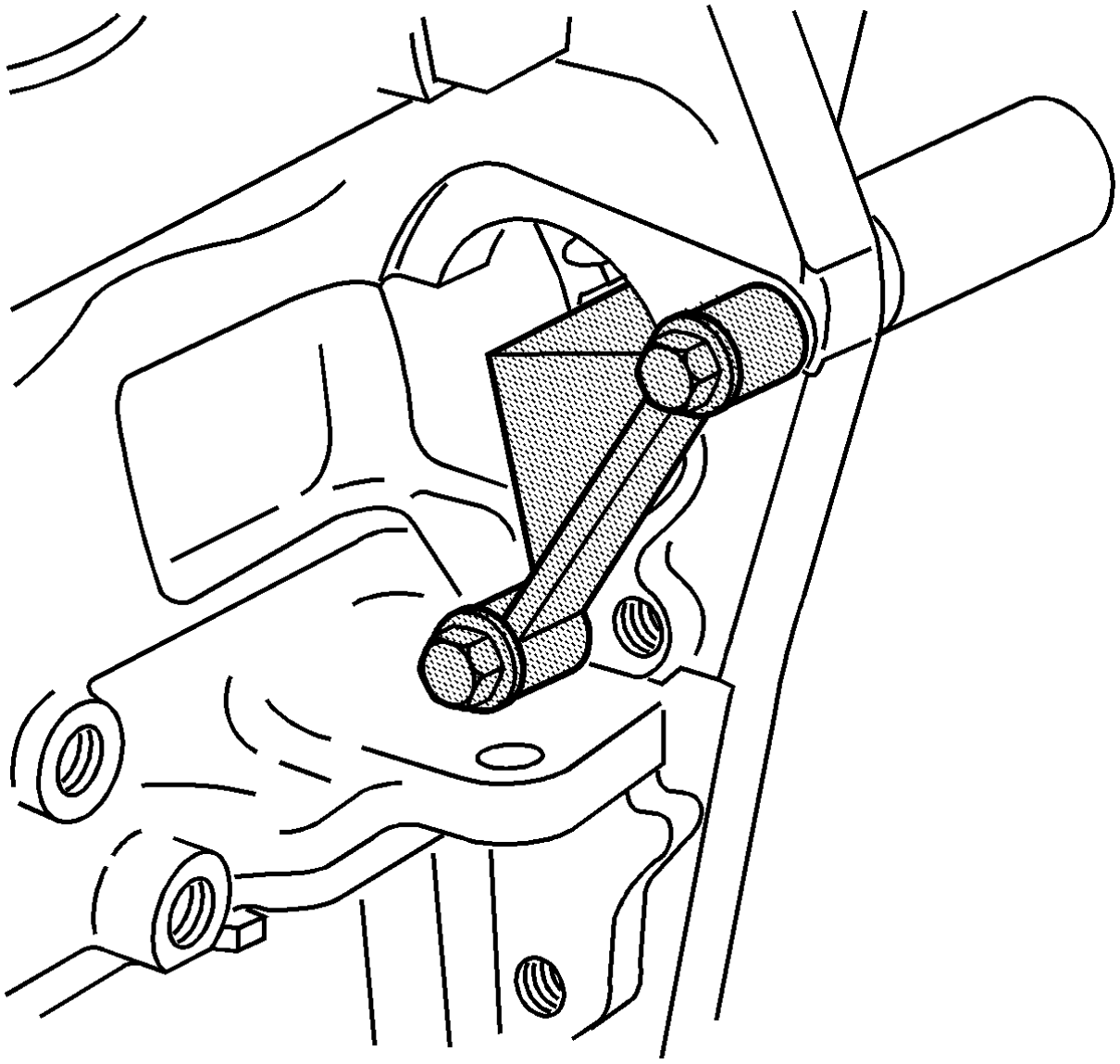


Fig. 190: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the EN-46106 tool is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft timing system may be required.**

3. Install the **EN-46106** tool in order to prevent crankshaft rotation.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Install the **EN-39313** adapter to the applicable cylinder.
6. Connect the **EN-39313** adapter to a compressed air source.

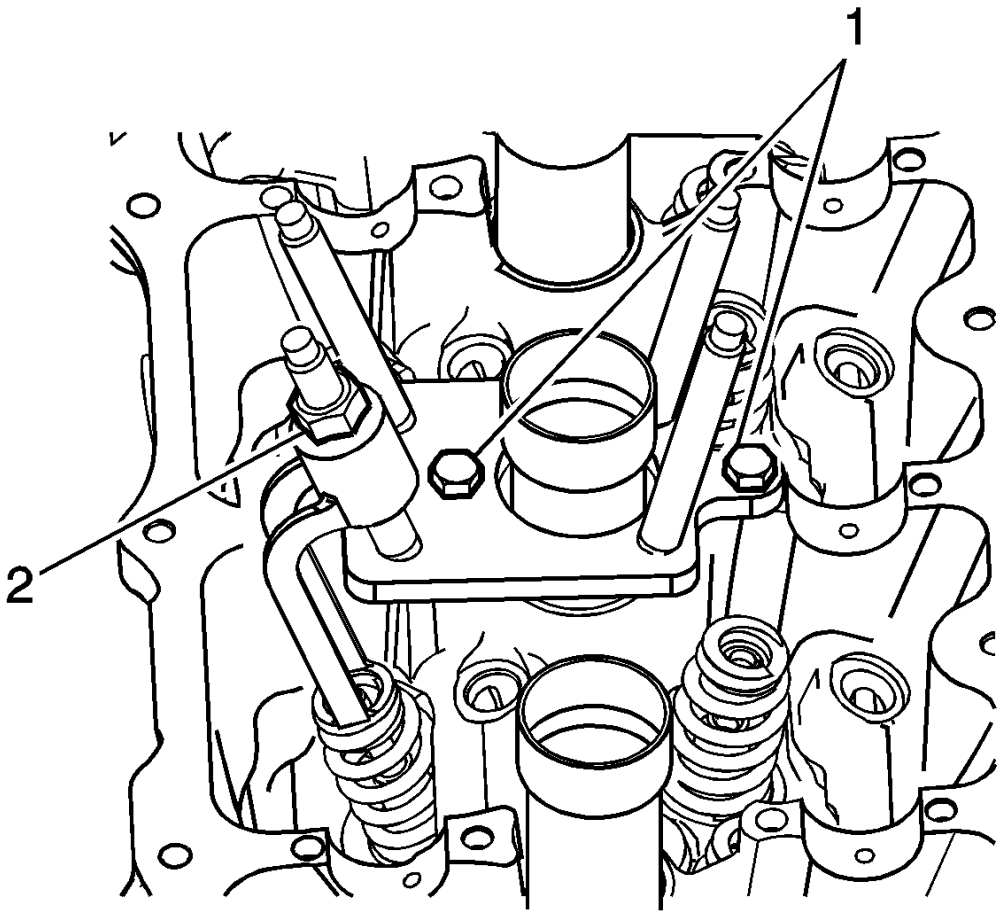


Fig. 191: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-46110** compressor above the applicable cylinder as shown.
8. Tighten the **EN-46110** compressor nut (2).

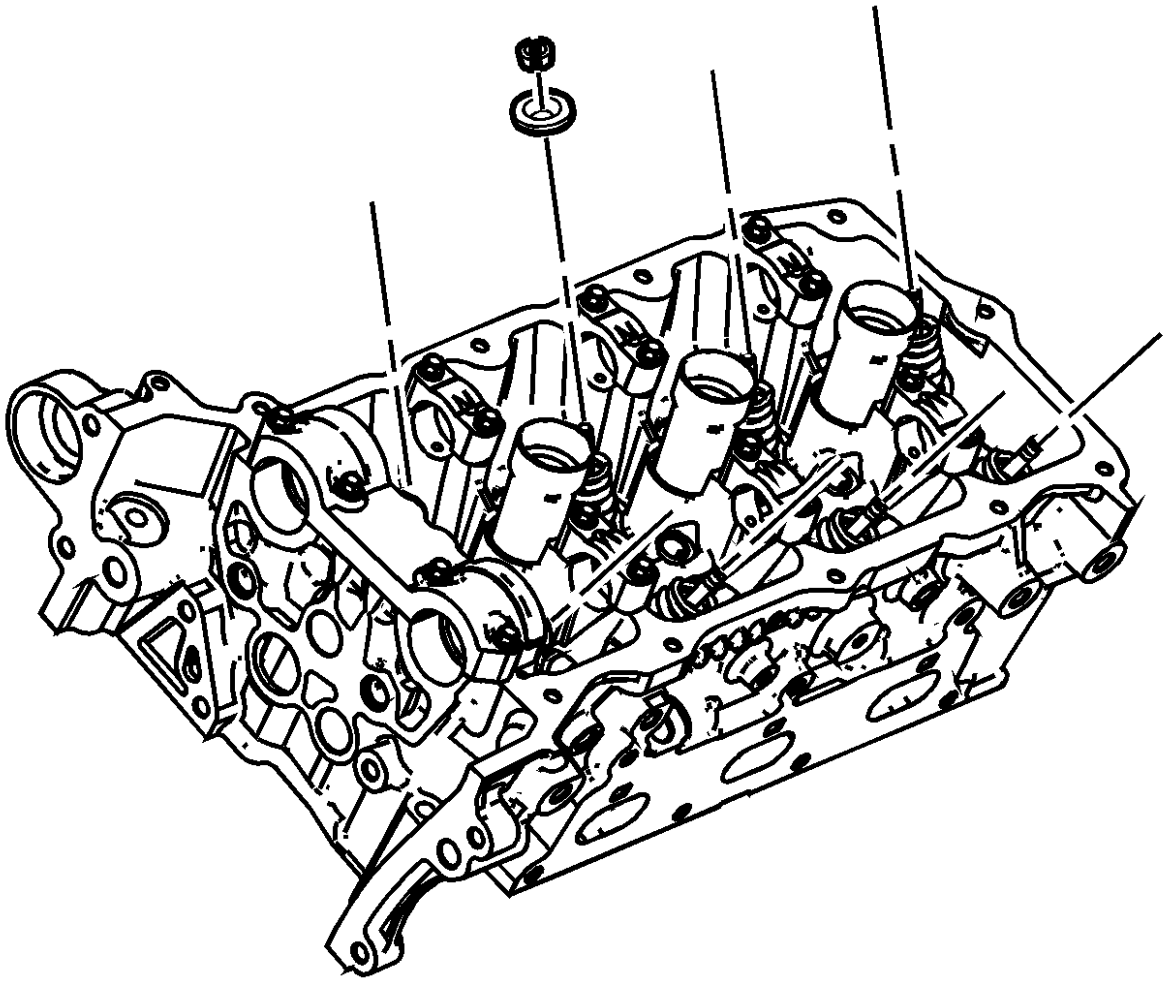


Fig. 192: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

9. Remove the valve keepers.
10. Loosen the **EN-46110** compressor nut.
11. Remove the valve spring retainer.

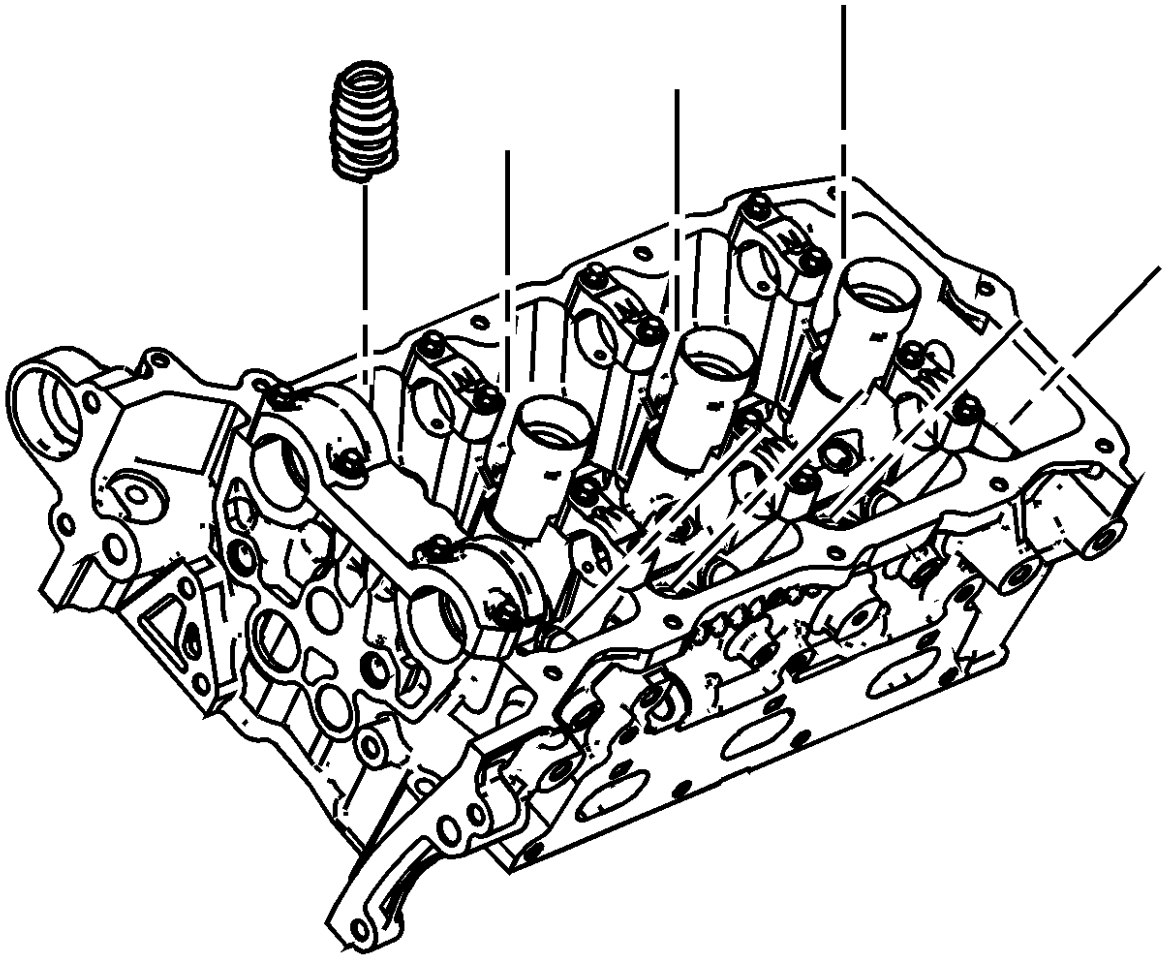


Fig. 193: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

12. Remove the valve spring.

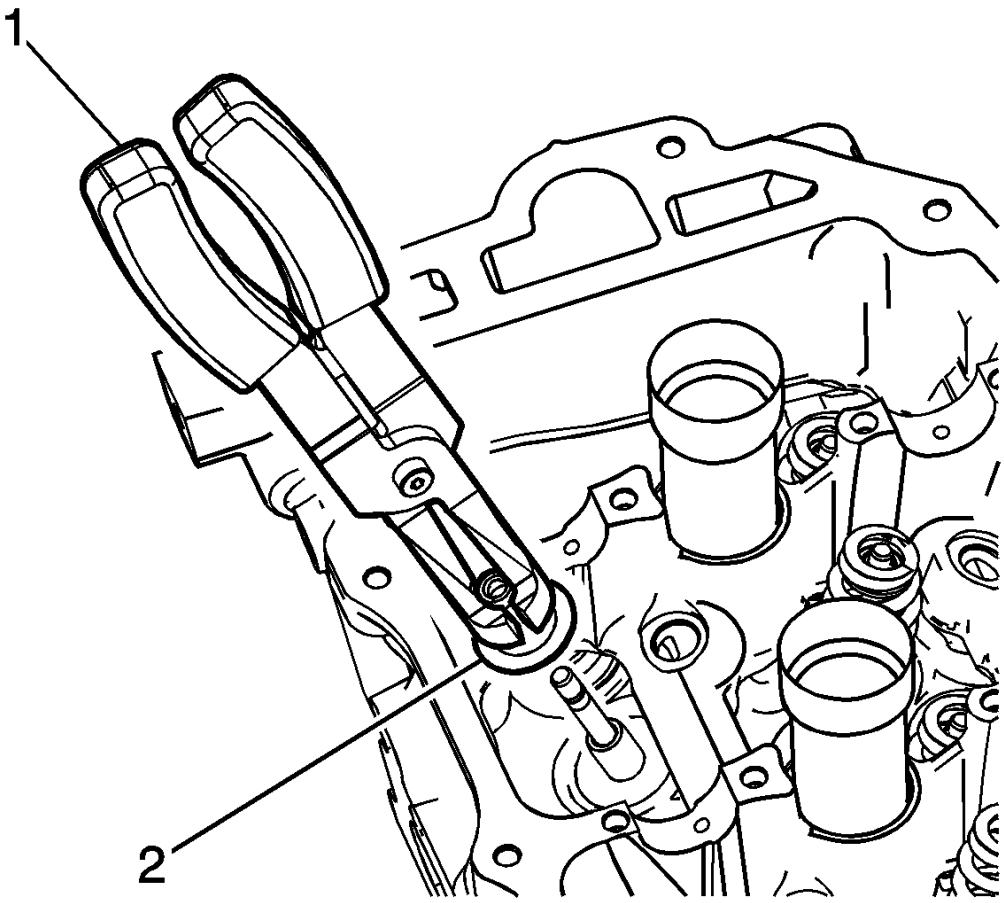


Fig. 194: Valve Stem Oil Seal Removal/Installation
Courtesy of GENERAL MOTORS COMPANY

13. Use the **EN-46116** remover/installer (1) in order to remove the valve stem seal (2).

Installation Procedure

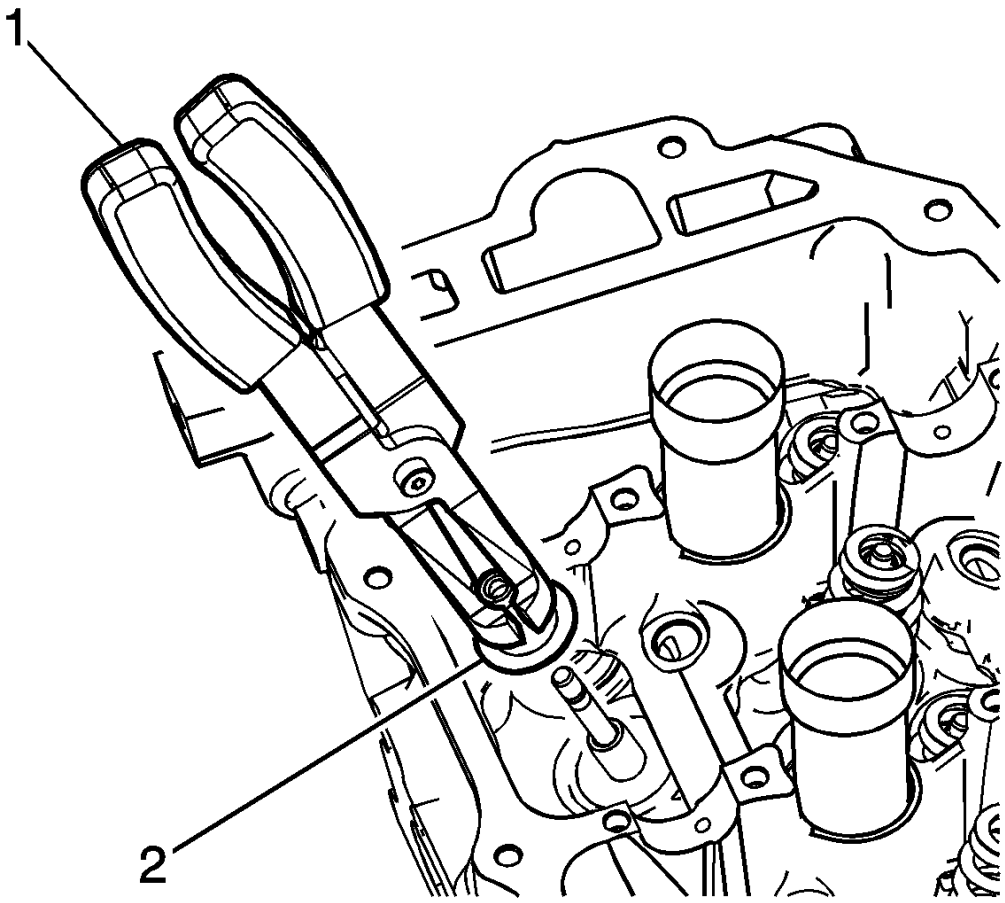


Fig. 195: Valve Stem Oil Seal Removal/Installation
Courtesy of GENERAL MOTORS COMPANY

1. Use the **EN-46116** remover/installer (1) in order to install the valve stem seal (2).

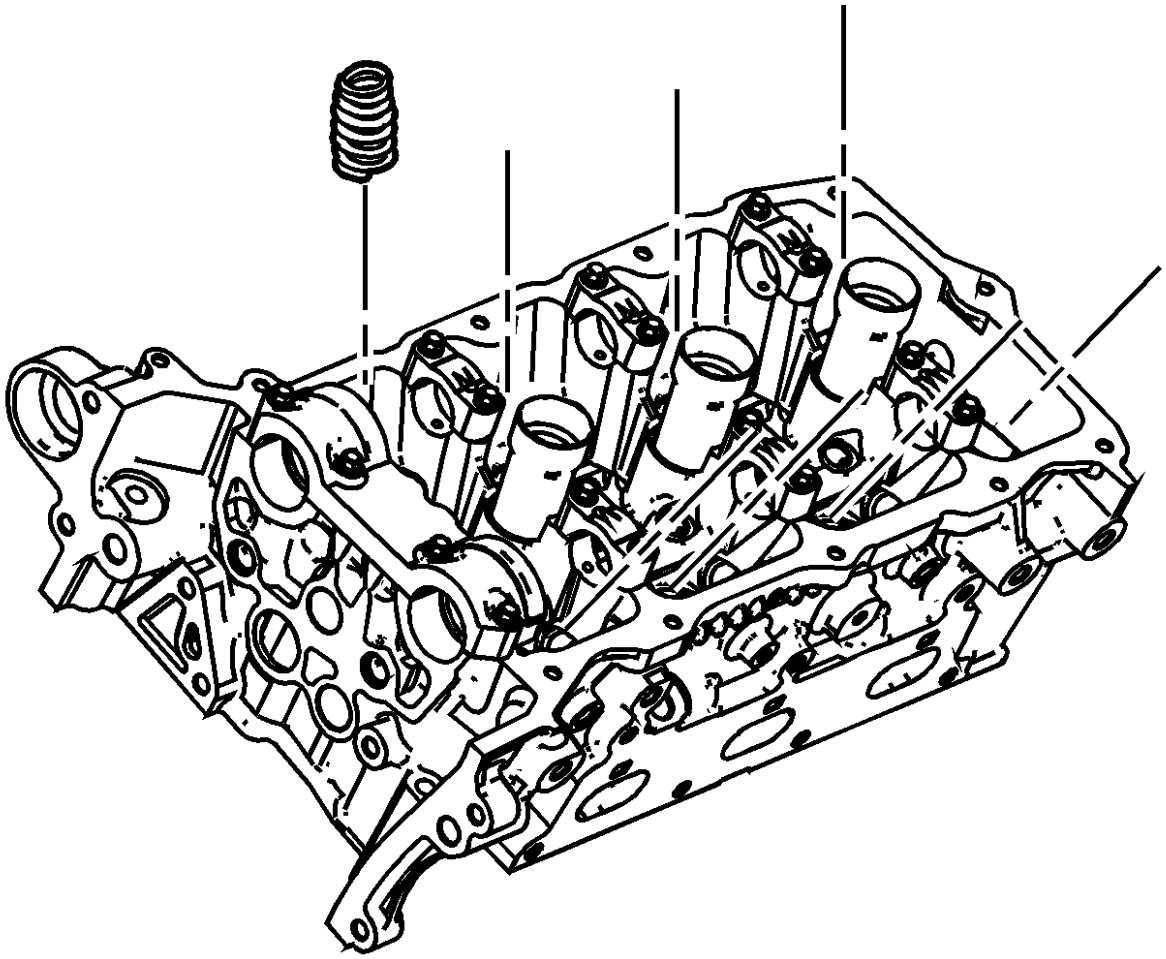


Fig. 196: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

2. Install the valve spring.
3. Install the valve spring retainer.

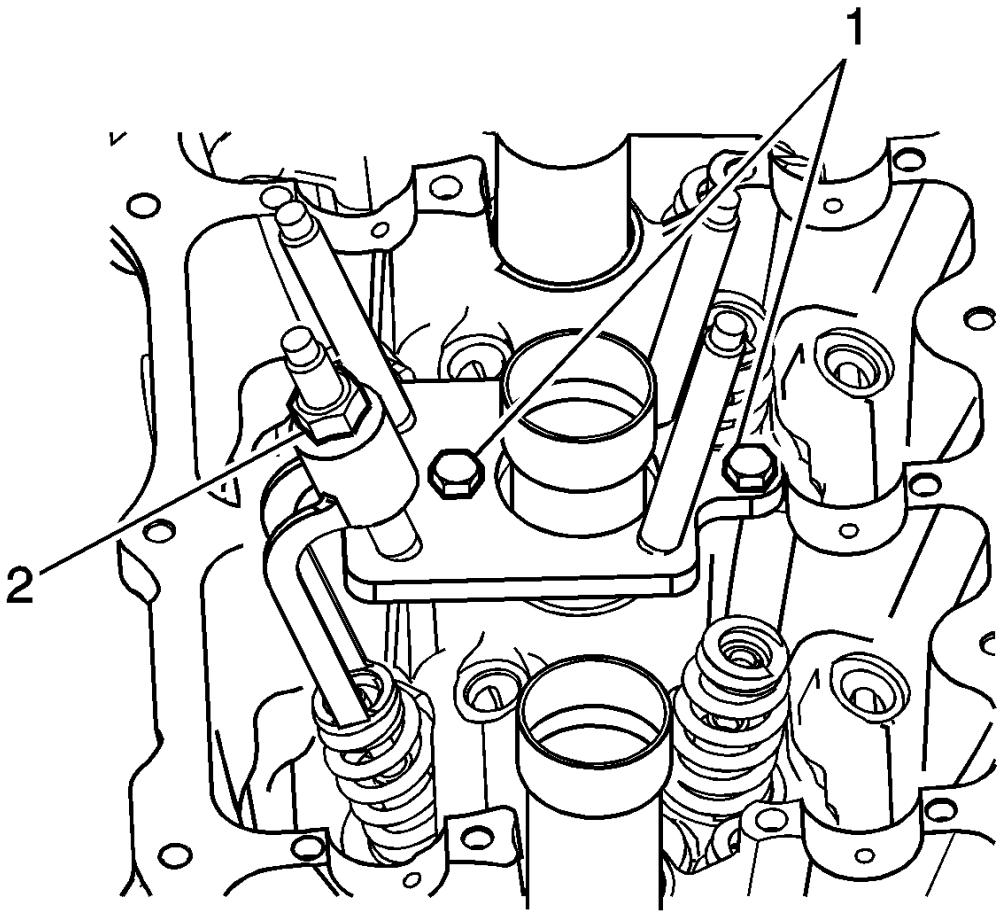


Fig. 197: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-46110** compressor above the applicable valve spring as shown.

   Tighten the **EN-46110** compressor nut (2).

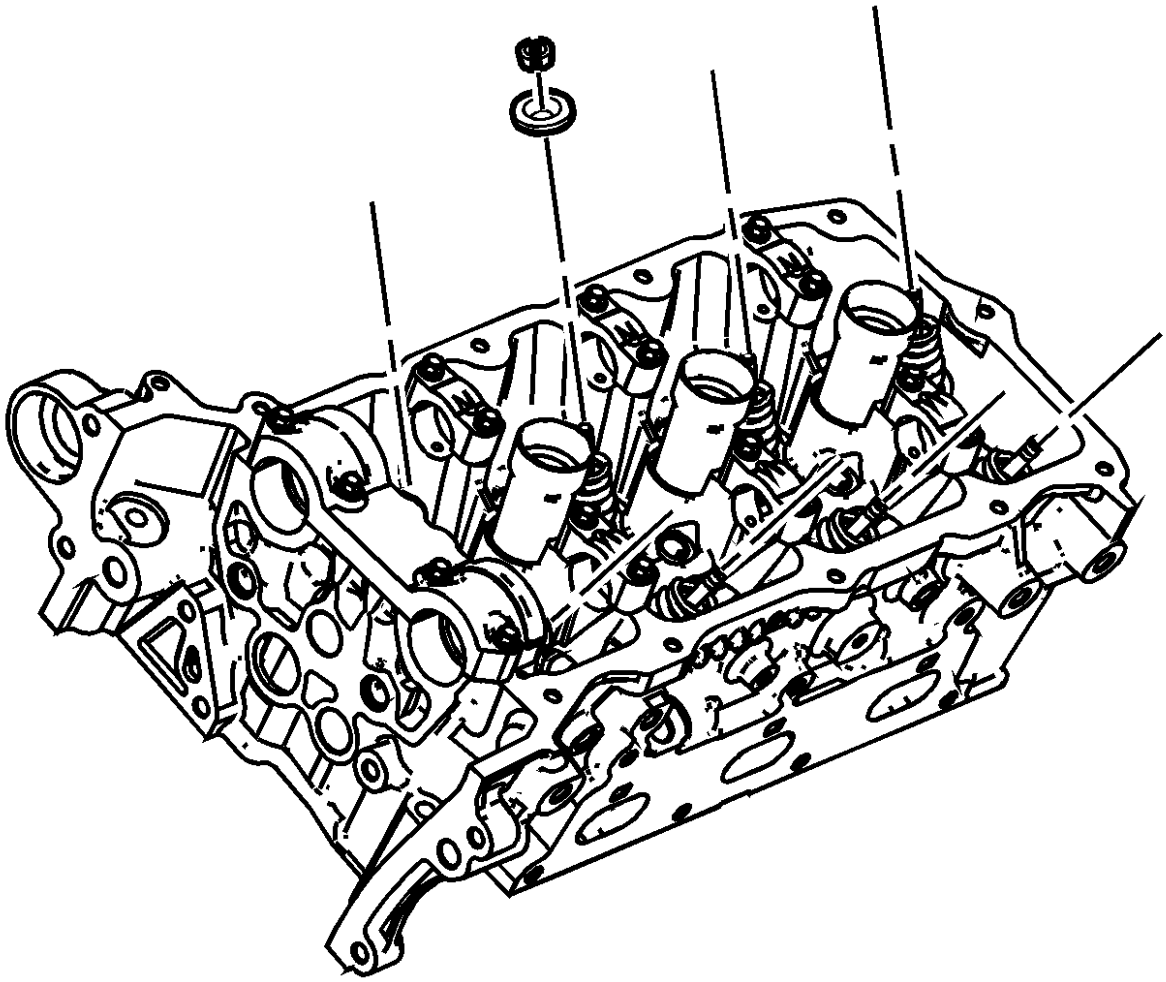


Fig. 198: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring keepers.
6. Remove the **EN-46110** compressor.
7. Disconnect the **EN-39313** adapter from the compressed air source.
8. Remove the **EN-39313** adapter.
9. Install the spark plugs. Refer to **Spark Plug Replacement** .
10. Install the rocker arms. Refer to **Valve Rocker Arm Replacement - Left Side**.
11. Remove the **EN-46106** tool in order to prevent crankshaft rotation.
12. Install the starter motor. Refer to **Starter Replacement** .

VALVE STEM OIL SEAL AND VALVE SPRING REPLACEMENT - RIGHT SIDE

Special Tools

- **EN-39313** Spark Plug Port Adapter

- **EN-46106** Flywheel Holding Tool
- **EN-46110** On-Vehicle Valve Spring Compressor
- **EN-46116** Valve Stem Seal Remover/Installer

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

NOTE: **This procedure is not used in Brazil.**

1. Remove the rocker arms. Refer to **Valve Rocker Arm Replacement - Right Side**.
2. Remove the starter motor. Refer to **Starter Replacement** .

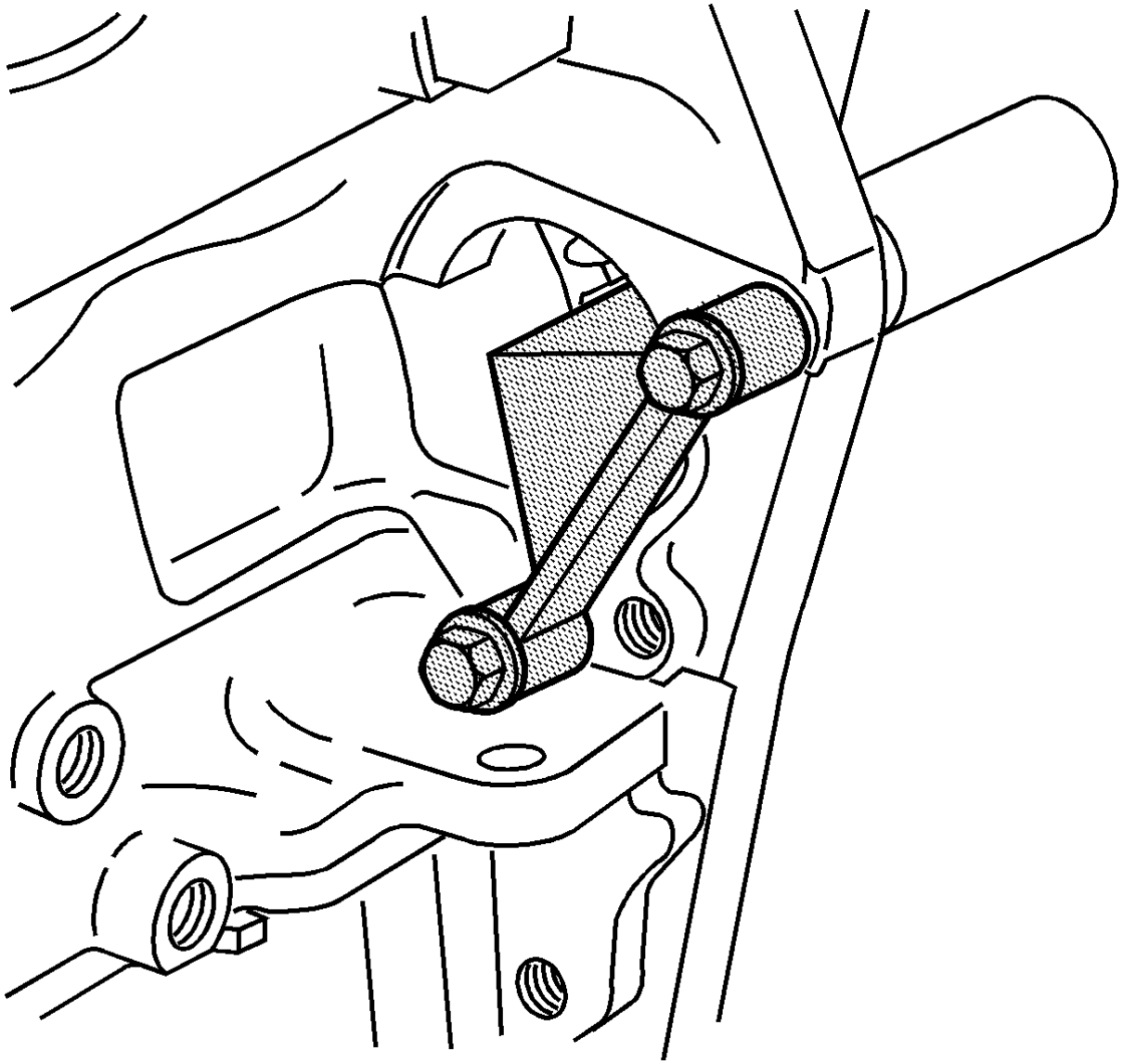


Fig. 199: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the EN-46106 tool is not installed, the crankshaft may rotate. If the crankshaft rotates, disassembly and reassembly of the entire camshaft**

timing system may be required.

3. Install the **EN-46106** tool in order to prevent crankshaft rotation.
4. Remove the spark plug from the applicable cylinder. Refer to **Spark Plug Replacement** .
5. Install the **EN-39313** adapter to the applicable cylinder.
6. Connect the **EN-39313** adapter to a compressed air source.

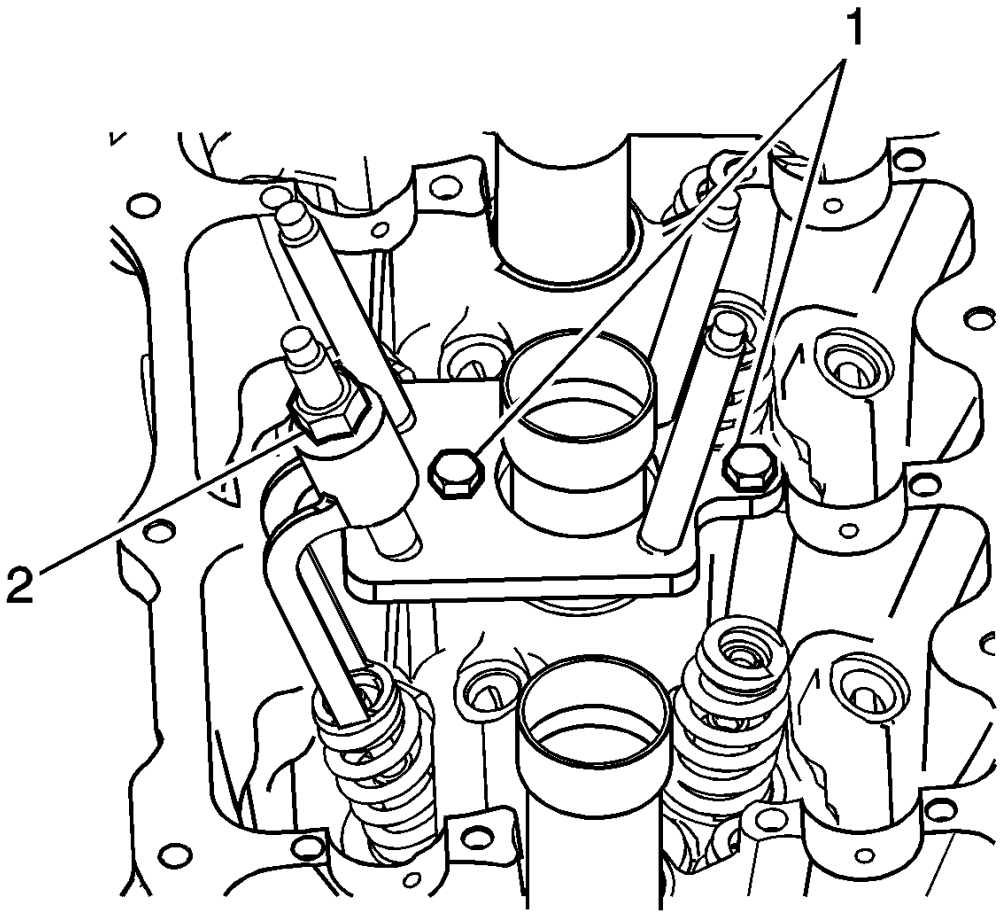


Fig. 200: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

7. Install the **EN-46110** compressor above the applicable cylinder as shown.
8. Tighten the **EN-46110** compressor nut (2).

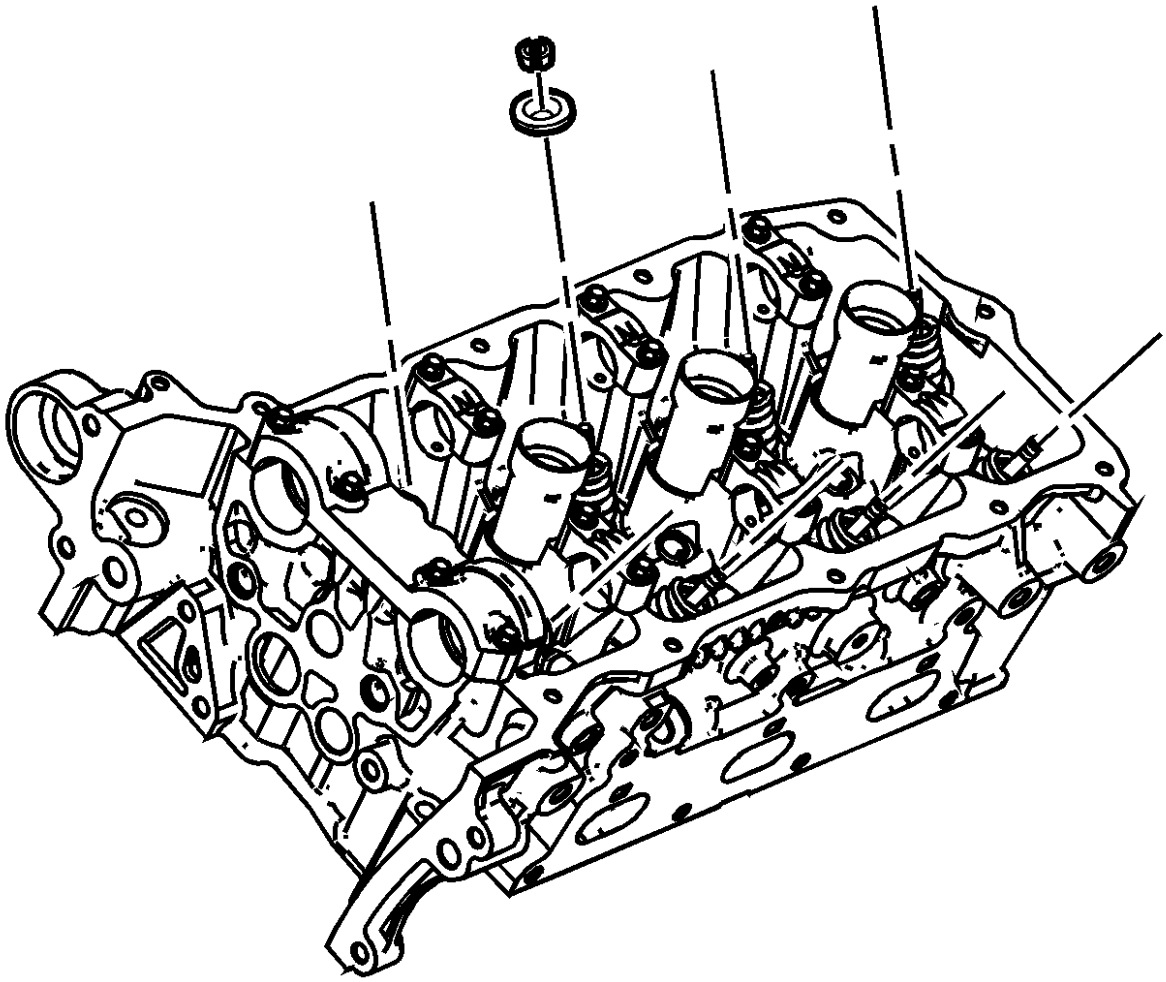


Fig. 201: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

9. Remove the valve keepers.
10. Loosen the **EN-46110** compressor nut.
11. Remove the valve spring retainer.

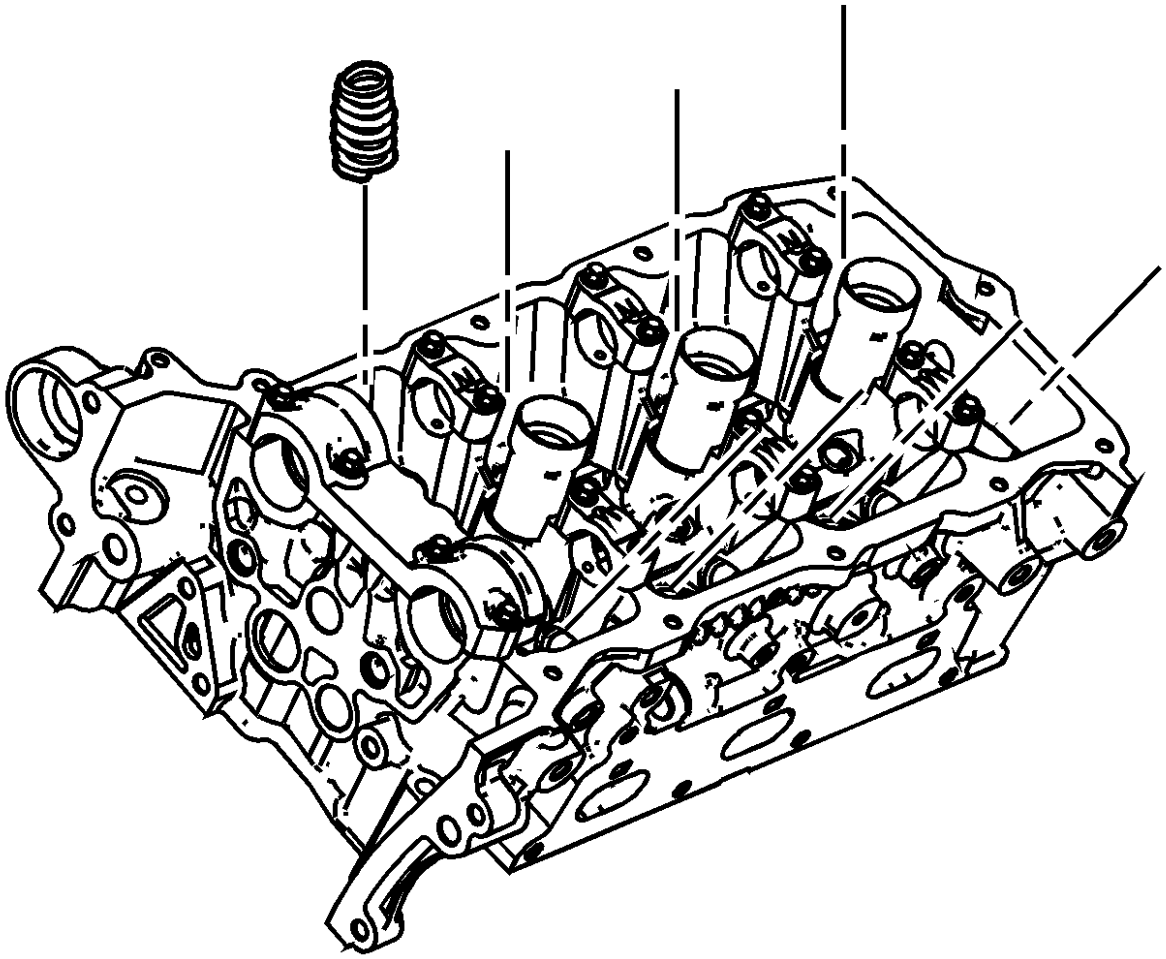


Fig. 202: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

12. Remove the valve spring.

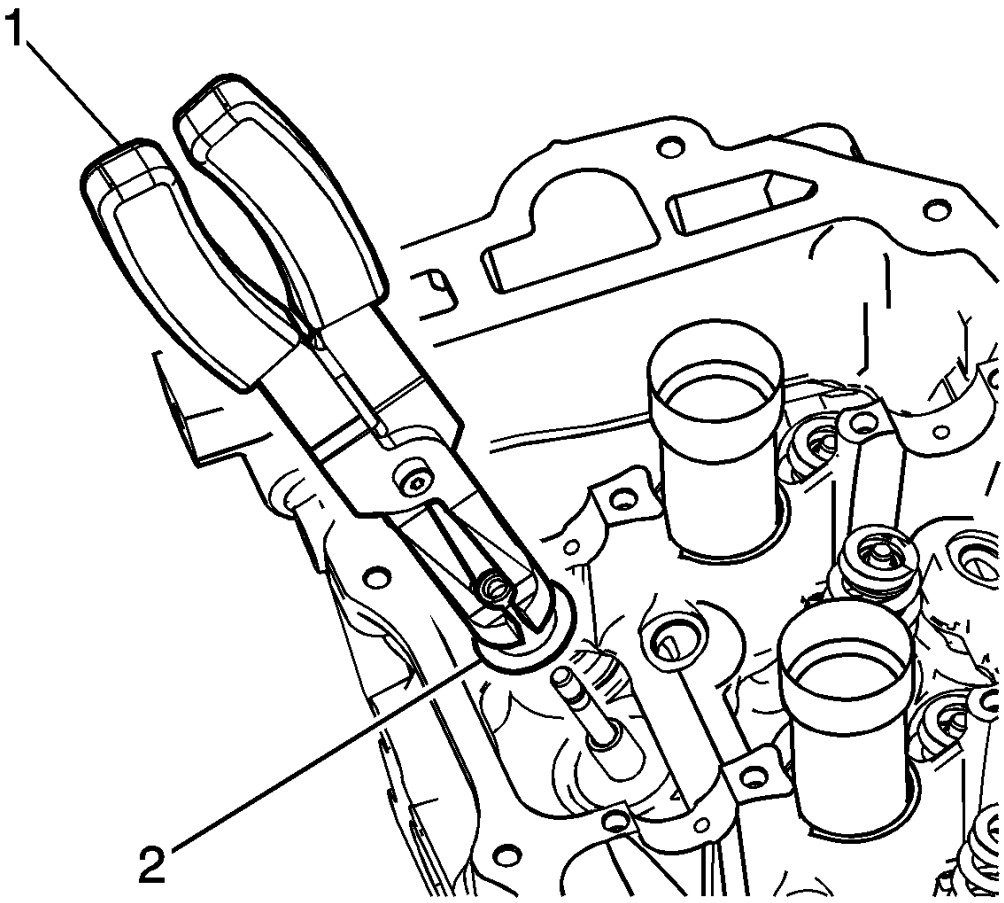


Fig. 203: Valve Stem Oil Seal Removal/Installation
Courtesy of GENERAL MOTORS COMPANY

13. Use the **EN-46116** remover/installer (1) in order to remove the valve stem seal (2).

Installation Procedure

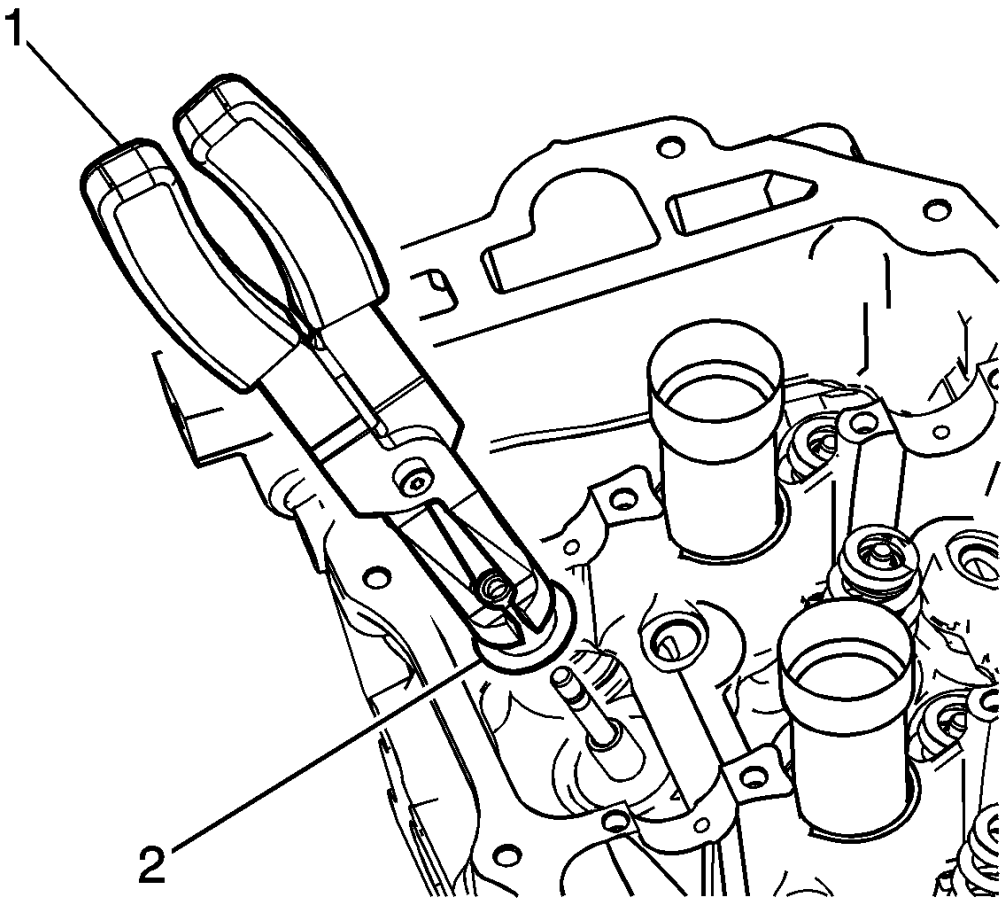


Fig. 204: Valve Stem Oil Seal Removal/Installation
Courtesy of GENERAL MOTORS COMPANY

1. Use the **EN-46116** remover/installer (1) in order to install the valve stem seals (2).

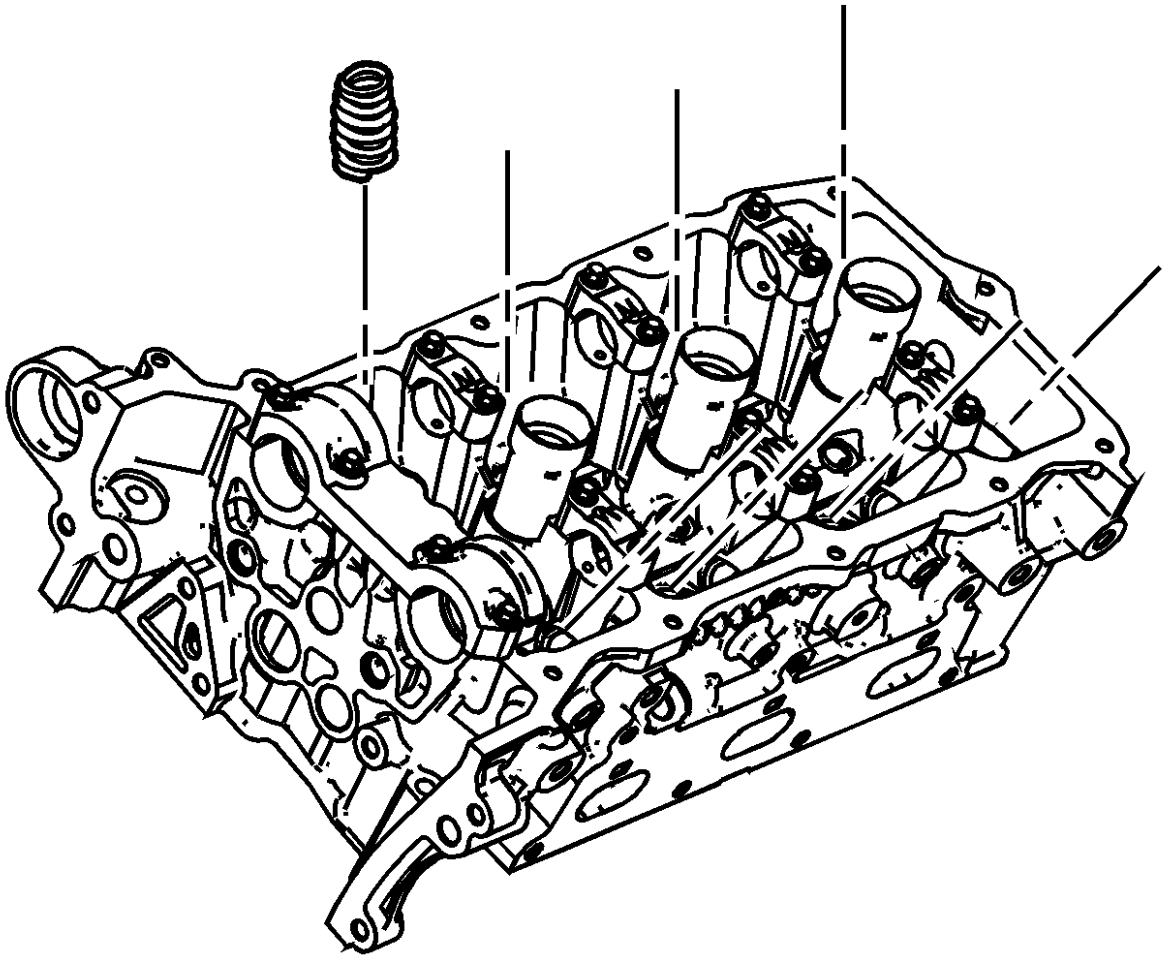


Fig. 205: View Of Valve Spring
Courtesy of GENERAL MOTORS COMPANY

2. Install the valve spring.
3. Install the valve spring retainer.

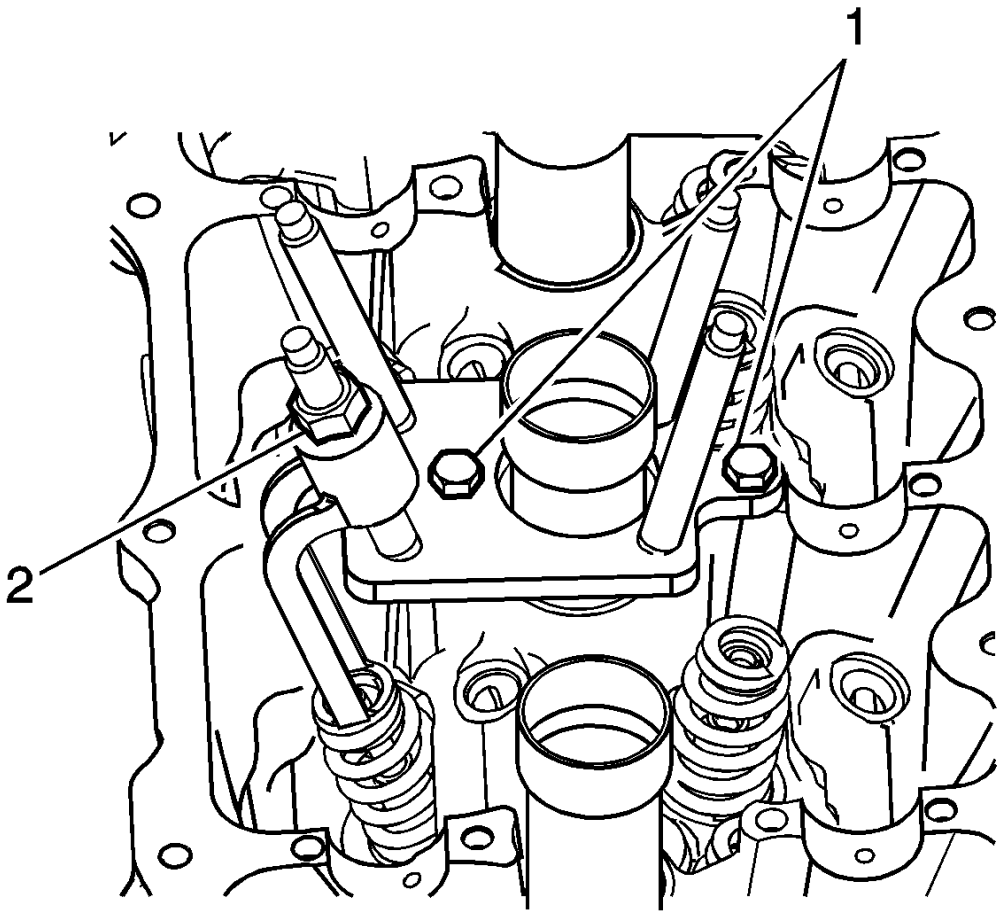


Fig. 206: View Of Installed Valve Spring Compressor Tool
Courtesy of GENERAL MOTORS COMPANY

4. Install the **EN-46110** compressor above the applicable valve spring as shown.

   Tighten the **EN-46110** compressor nut (2).

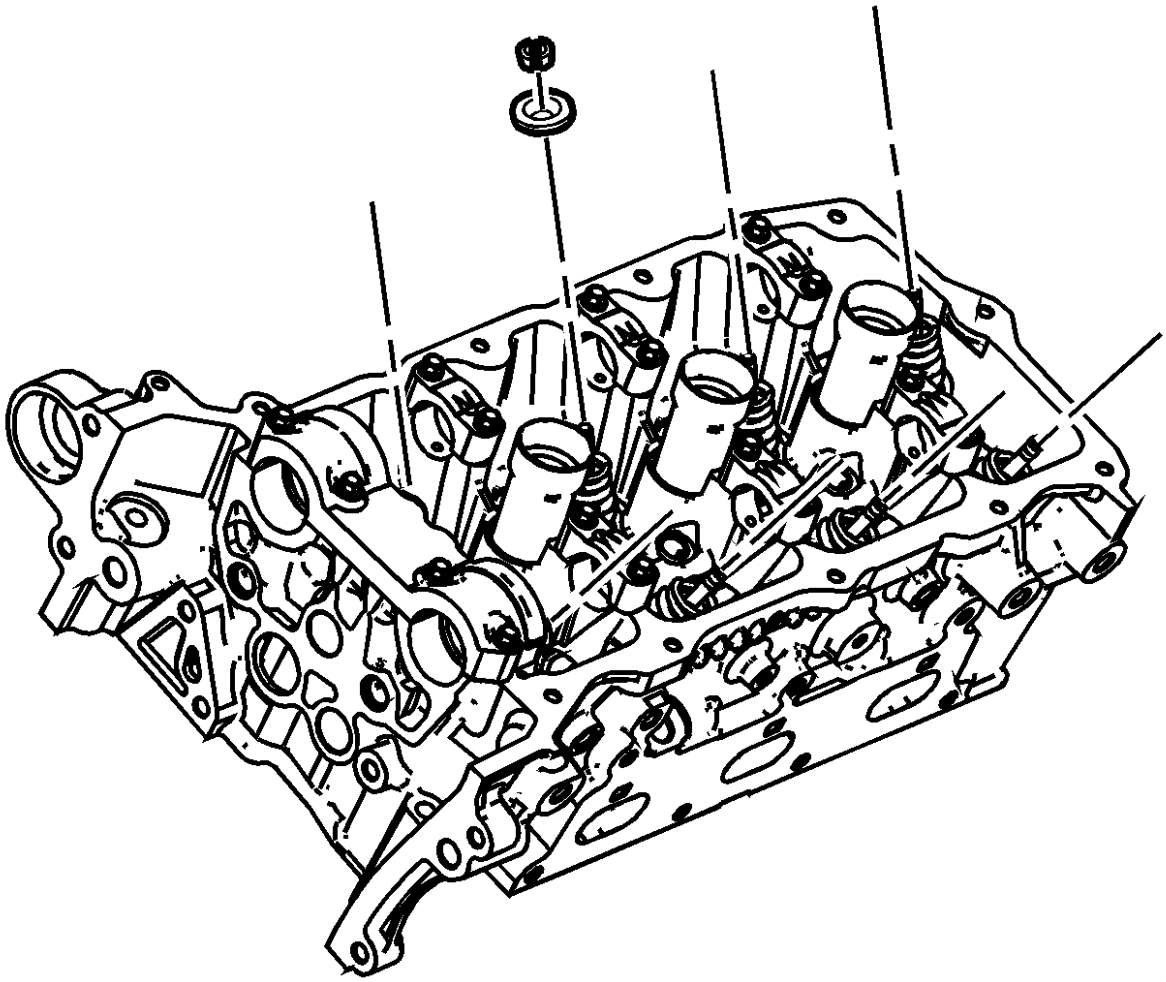


Fig. 207: View Of Valve Spring Keepers
Courtesy of GENERAL MOTORS COMPANY

5. Install the valve spring keepers.
6. Remove the **EN-46110** compressor.
7. Disconnect the **EN-39313** adapter from the compressed air source.
8. Remove the **EN-39313** adapter.
9. Install the spark plugs. Refer to **Spark Plug Replacement** .
10. Install the rocker arms . Refer to **Valve Rocker Arm Replacement - Right Side**.
11. Remove the **EN-46106** tool.
12. Install the starter motor. Refer to **Starter Replacement** .

CYLINDER HEAD REPLACEMENT - LEFT SIDE (LFX)

Special Tools

EN-45059 Angle Meter

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
2. Remove the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.
3. Remove the fuel pump. Refer to **Fuel Pump Replacement** .
4. Remove the oil filter adaptor. Refer to **Oil Filter Adapter Replacement**.
5. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Left Side (Front)** .
6. Remove the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.
7. Remove the ground wire bolt and wire from the cylinder head.

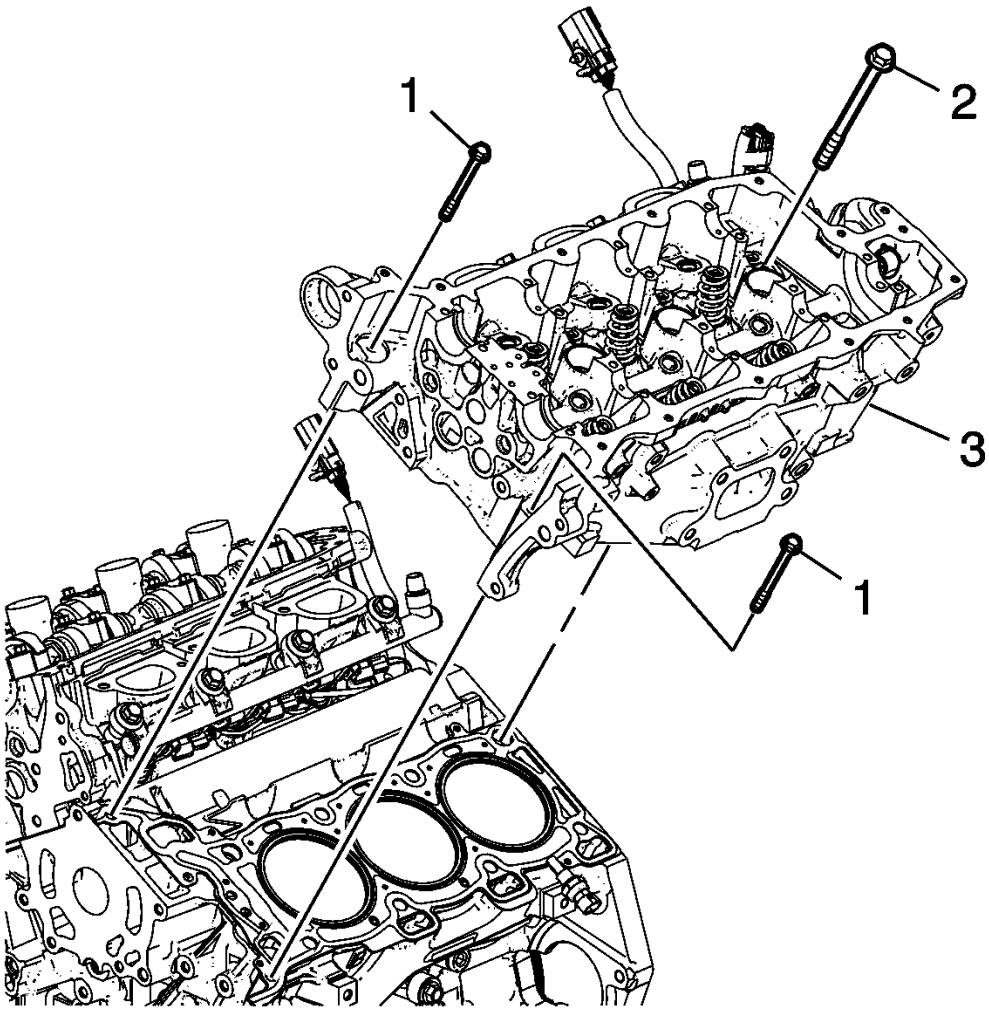


Fig. 208: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the 2 front M8 left cylinder head bolts (1).
9. Remove the left cylinder head bolts (2).
10. Remove the left cylinder head (3).

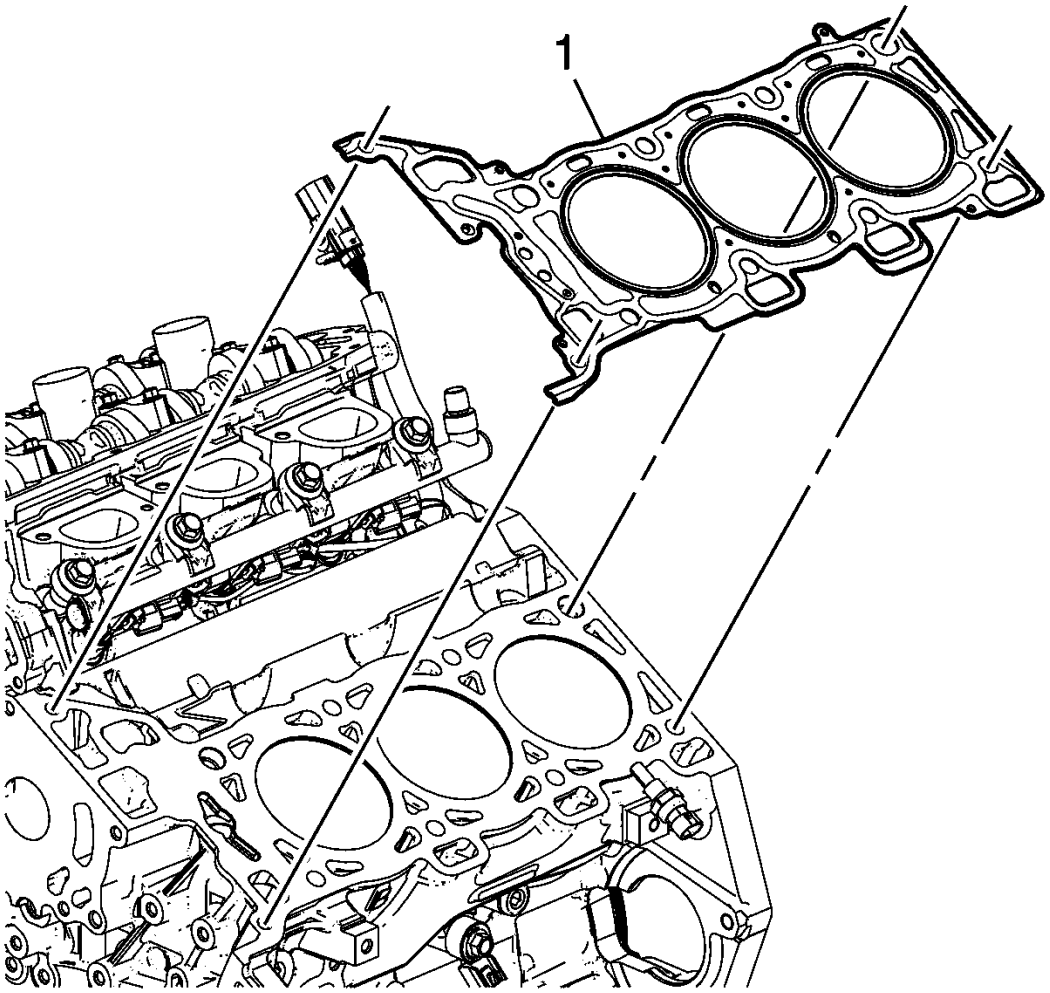


Fig. 209: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

11. Remove and discard the left cylinder head gasket (1).
12. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** , and **Engine Block Cleaning and Inspection** .
13. Disassemble the cylinder head if needed. Refer to **Cylinder Head Disassemble (LFX)** .

Installation Procedure

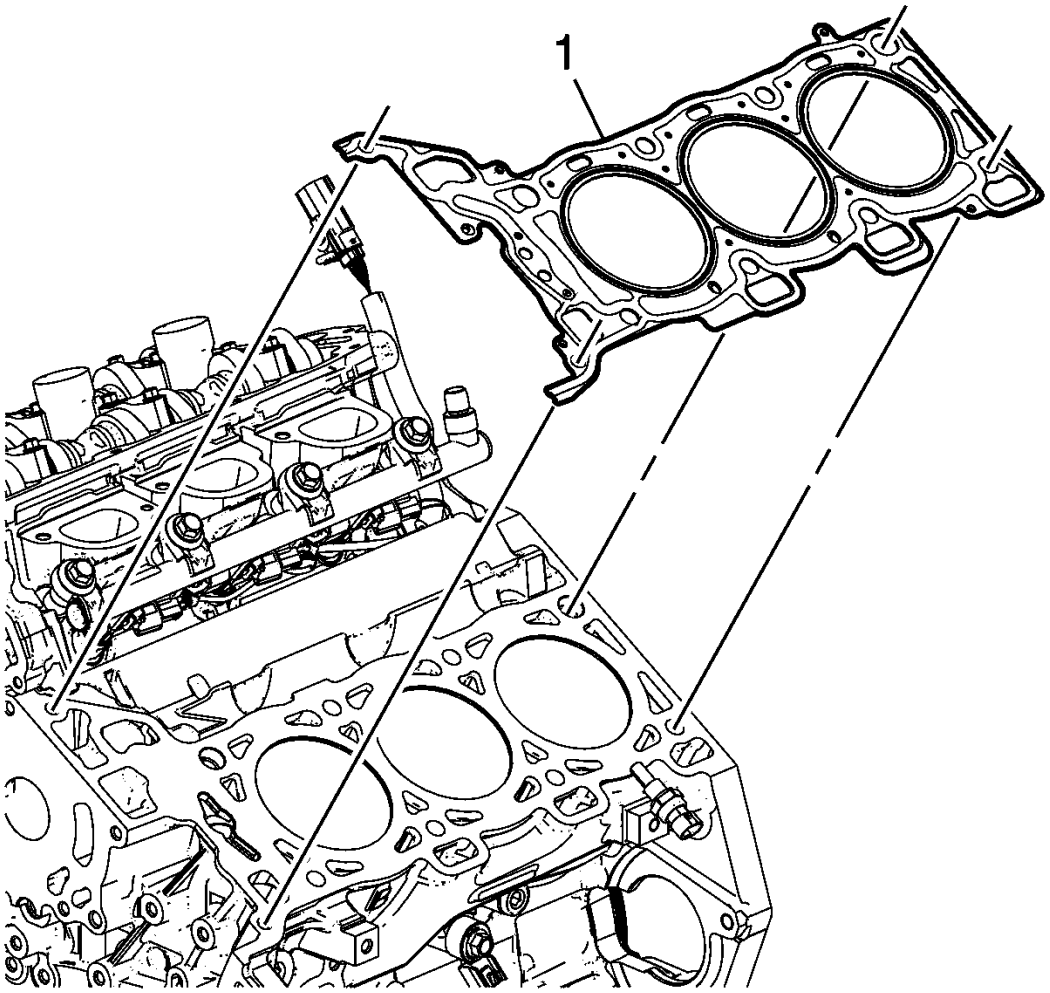


Fig. 210: View Of Left Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
2. Install a NEW left cylinder head gasket (1) using the deck face locating pins for retention.

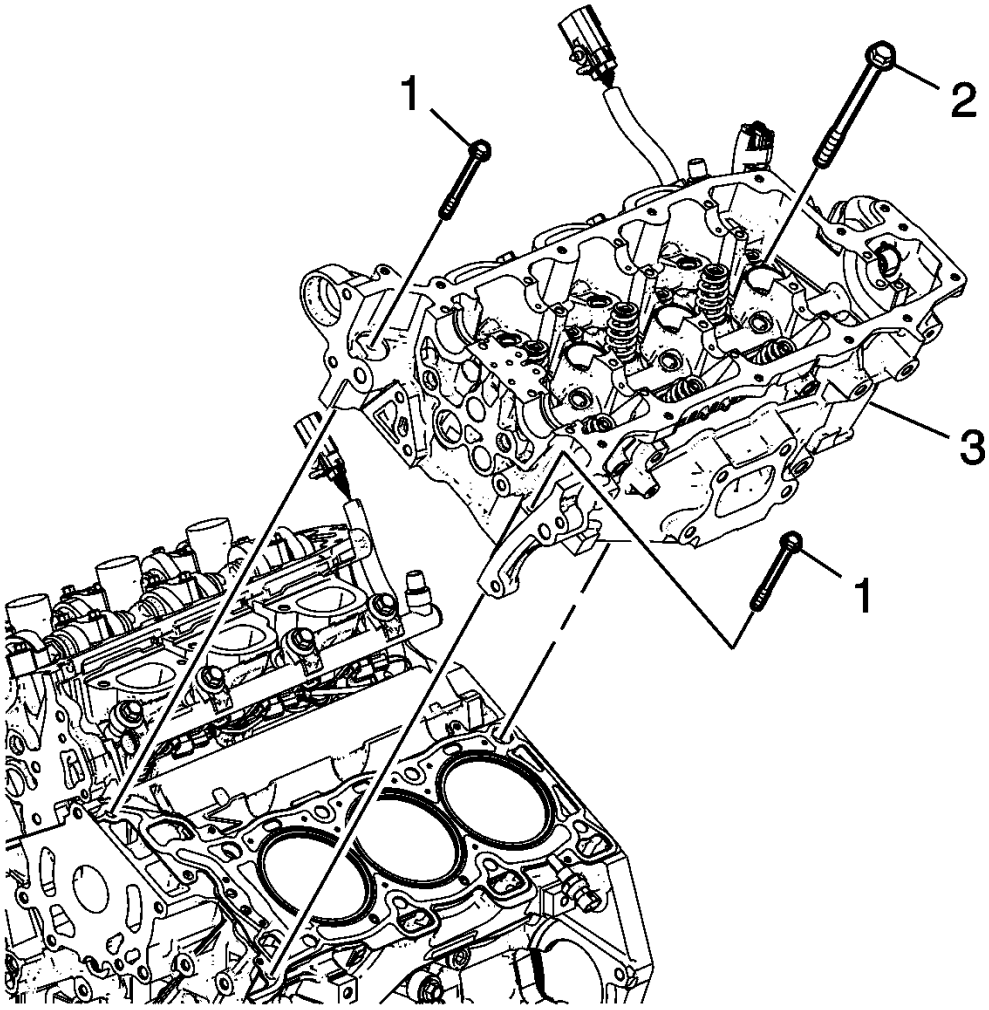


Fig. 211: View Of Left Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Align the left cylinder head (3) with the deck face locating pins.
4. Place the left cylinder head in position on the deck face.

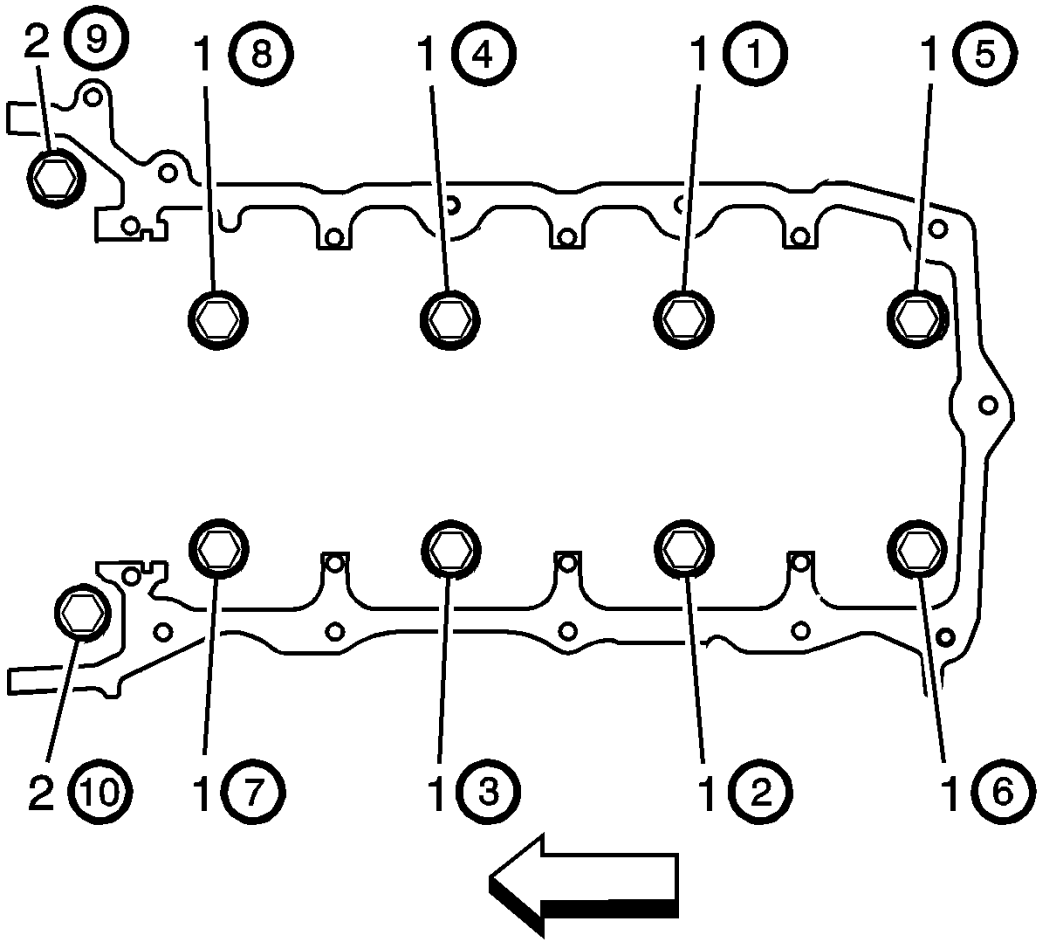


Fig. 212: Identifying M11 Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE:

- **DO NOT allow oil on the cylinder head bolt bosses.**
- **DO NOT reuse the old cylinder head bolts.**

5. Install the NEW M11 cylinder head bolts (1).
    1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
    2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **EN-45059** meter.
6. Install the 2 NEW front M8 left cylinder head bolts (2).
    1. Tighten the M8 cylinder head bolts a first pass to 15 N.m (11 lb ft).
    2. Tighten the M8 cylinder head bolts a second pass in sequence an additional 75 degrees using the **EN-45059** meter.
7. Install the left bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Left Side**.

8. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Left Side**.
9. Install the fuel pump. Refer to **Fuel Pump Replacement** .
10. Install the oil filter adaptor. Refer to **Oil Filter Adapter Replacement**.
11. Install the exhaust manifold. Refer to **Catalytic Converter Replacement - Left Side (Front)** .
12. Install the oil level indicator tube. Refer to **Oil Level Indicator Tube Replacement**.

CYLINDER HEAD REPLACEMENT - RIGHT SIDE (LFX)

Special Tools

EN-45059 Angle Meter

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.
2. Remove the fuel feed pipe. Refer to **Fuel Feed Pipe Replacement** .
3. Remove the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement** .
4. Remove the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.
5. Remove the catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (Rear)** .
6. Remove the heater inlet and outlet hoses. Refer to **Heater Inlet Hose Replacement** , and **Heater Outlet Hose Replacement** .
7. Remove the two ground wires attached to the front and rear of the cylinder head.

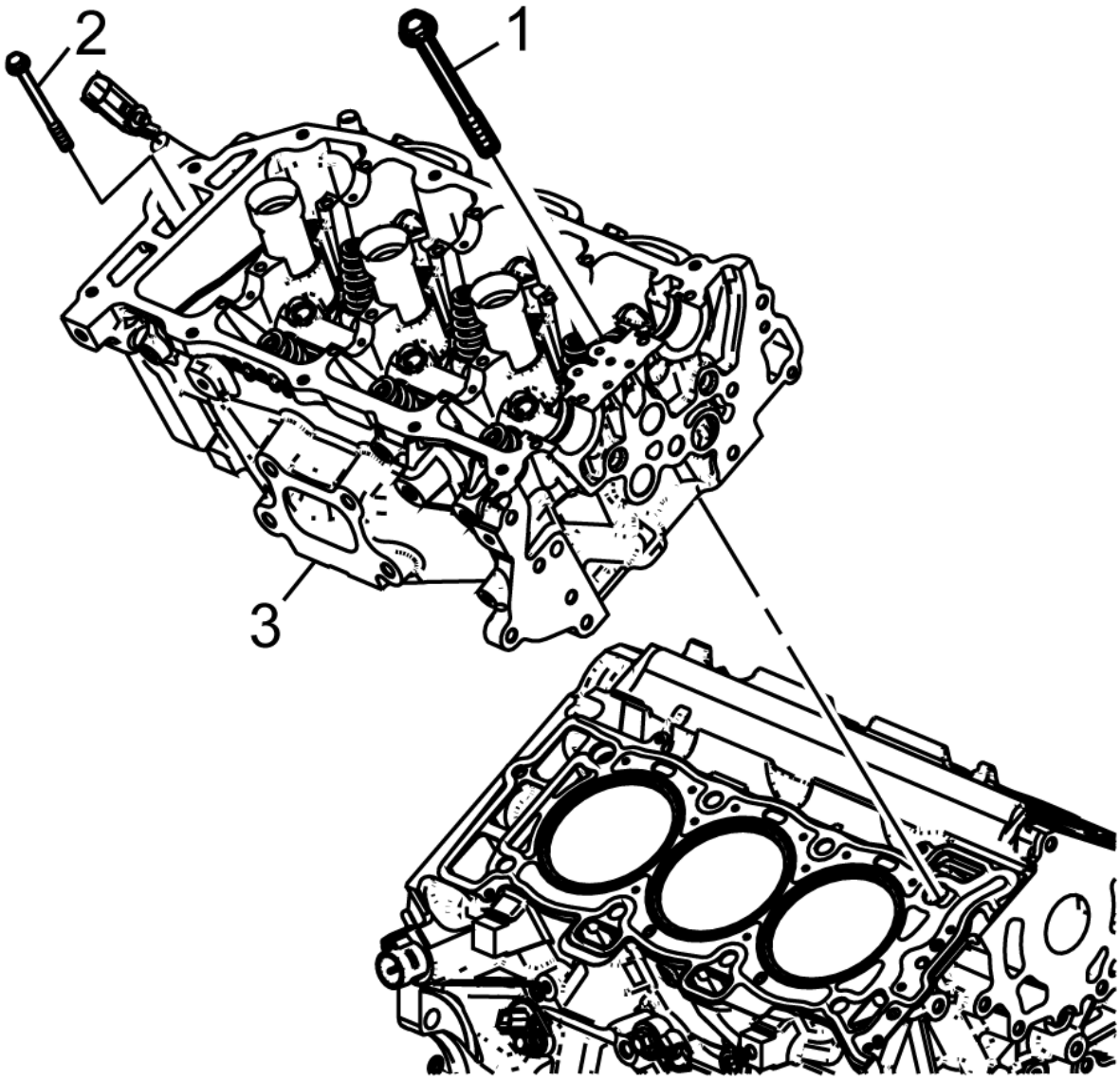


Fig. 213: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the right cylinder head bolts (1).
9. Remove the right cylinder head (2).

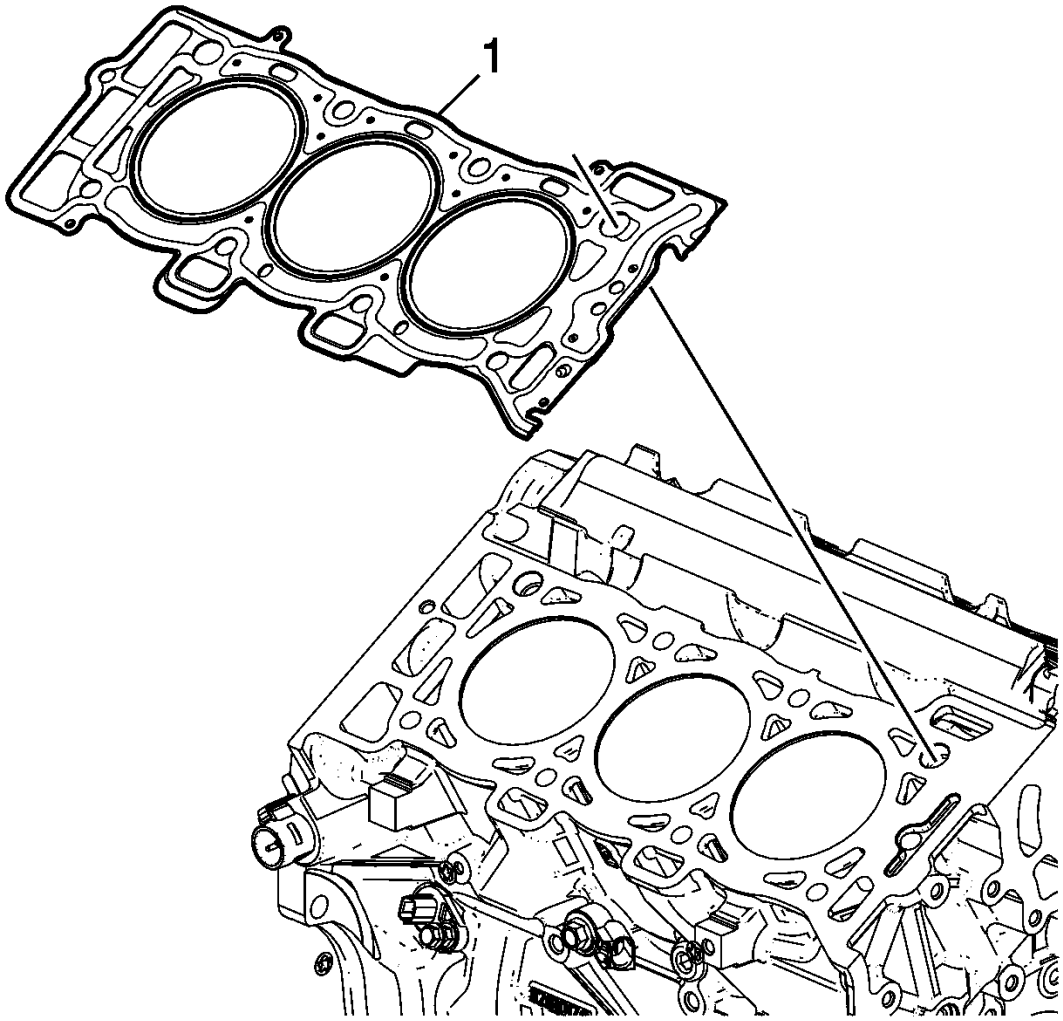


Fig. 214: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

10. Remove and discard the cylinder head gasket (1).
11. Clean and inspect the cylinder head and the engine block sealing surfaces. Refer to **Cylinder Head Cleaning and Inspection** , and **Engine Block Cleaning and Inspection** .
12. Disassemble the cylinder head if needed . Refer to **Cylinder Head Disassemble (LFX)** .

Installation Procedure

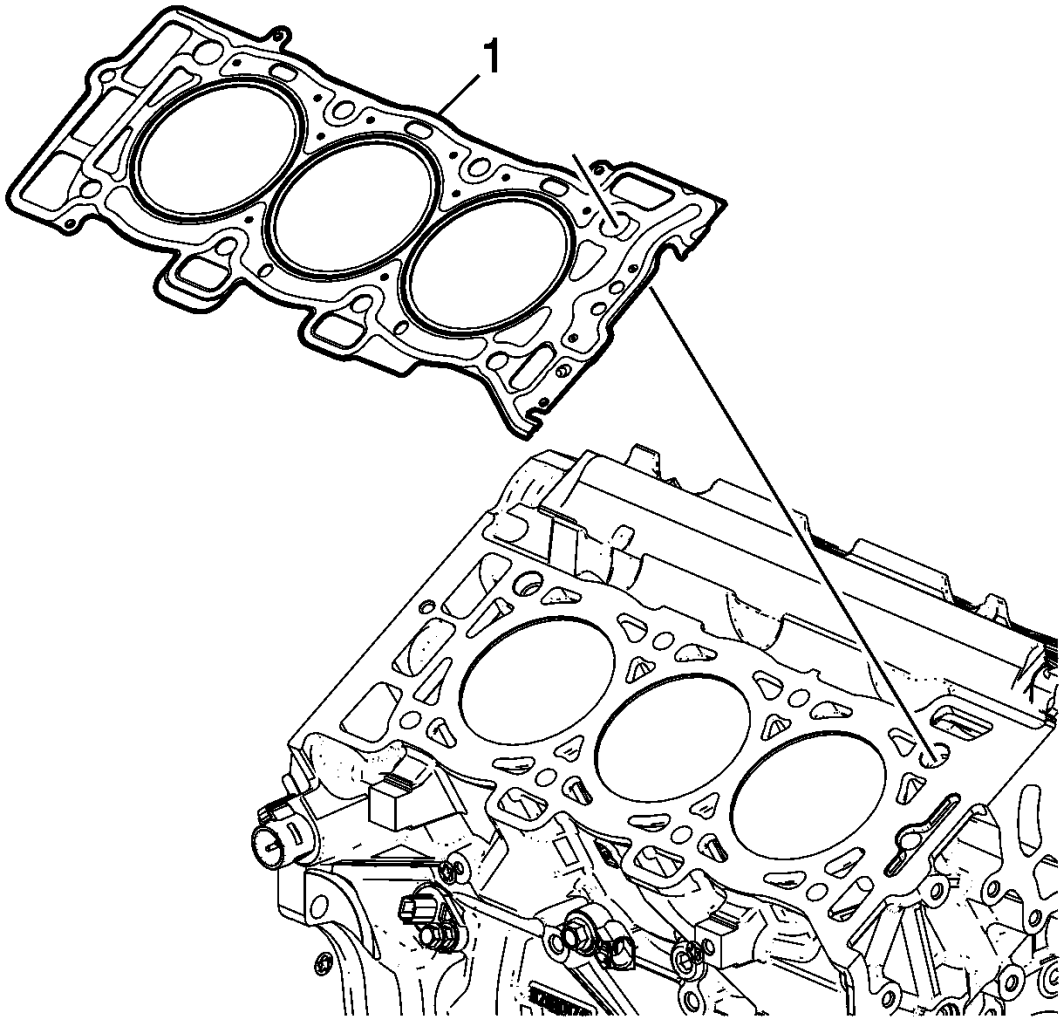


Fig. 215: View Of Right Cylinder Head Gasket
Courtesy of GENERAL MOTORS COMPANY

1. Ensure the cylinder head locating pins are securely mounted in the cylinder block deck face.
2. Install a NEW right cylinder head gasket (1) using the deck face locating pins for retention.

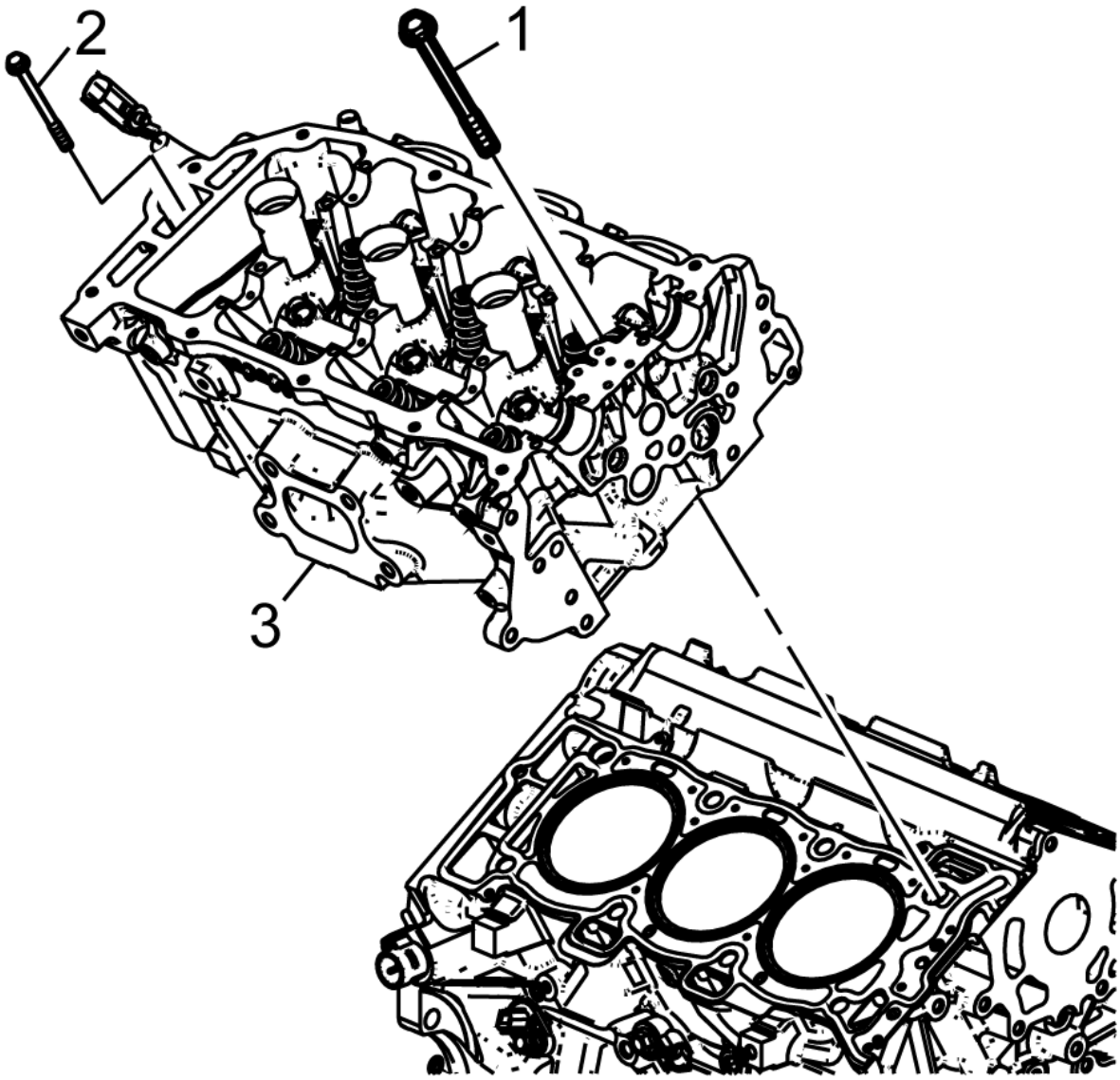


Fig. 216: View Of Right Cylinder Head & Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Align the right cylinder head (2) with the deck face locating pins.
4. Place the right cylinder head in position on the deck face.

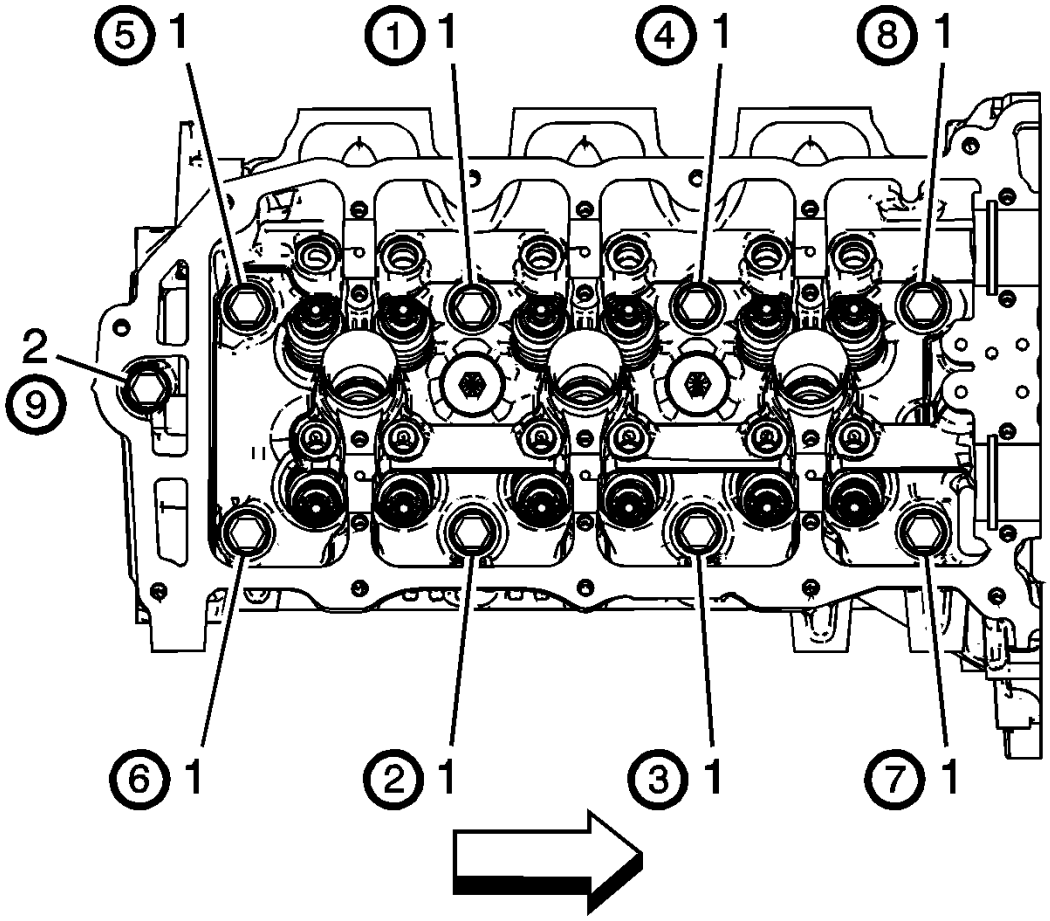


Fig. 217: Identifying M11 Cylinder Head Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE:

- **DO NOT allow oil on the cylinder head bolt bosses.**
- **DO NOT reuse the old cylinder head bolts.**

5. Install the NEW M11 cylinder head bolts (1).
    1. Tighten the M11 cylinder head bolts a first pass in sequence to 30 N.m (22 lb ft).
    2. Tighten the M11 cylinder head bolts a second pass in sequence an additional 150 degrees using the **EN-45059** meter.
6. Install the NEW M8 cylinder head bolt (2).
    1. Tighten the M8 cylinder head bolt a first pass to 15 N.m (11 lb ft).
    2. Tighten the M8 cylinder head bolt a second pass an additional 75 degrees using the **EN-45059** meter.
7. Install the right bank secondary timing chain. Refer to **Secondary Camshaft Intermediate Drive Chain Replacement - Right Side**.

8. Install the two ground wires to the front and rear of the cylinder head and tighten to 25 N.m (18 lb ft).
9. Install the heater inlet and outlet hoses. Refer to **Heater Inlet Hose Replacement** , and **Heater Outlet Hose Replacement** .
10. Install the catalytic converter. Refer to **Catalytic Converter Replacement - Right Side (Rear)** .
11. Install the fuel feed intermediate pipe. Refer to **Fuel Feed Intermediate Pipe Replacement** .
12. Install the fuel feed pipe. Refer to **Fuel Feed Pipe Replacement** .
13. Install the camshaft cover. Refer to **Camshaft Cover Replacement - Right Side**.

ENGINE FLYWHEEL REPLACEMENT

Removal Procedure

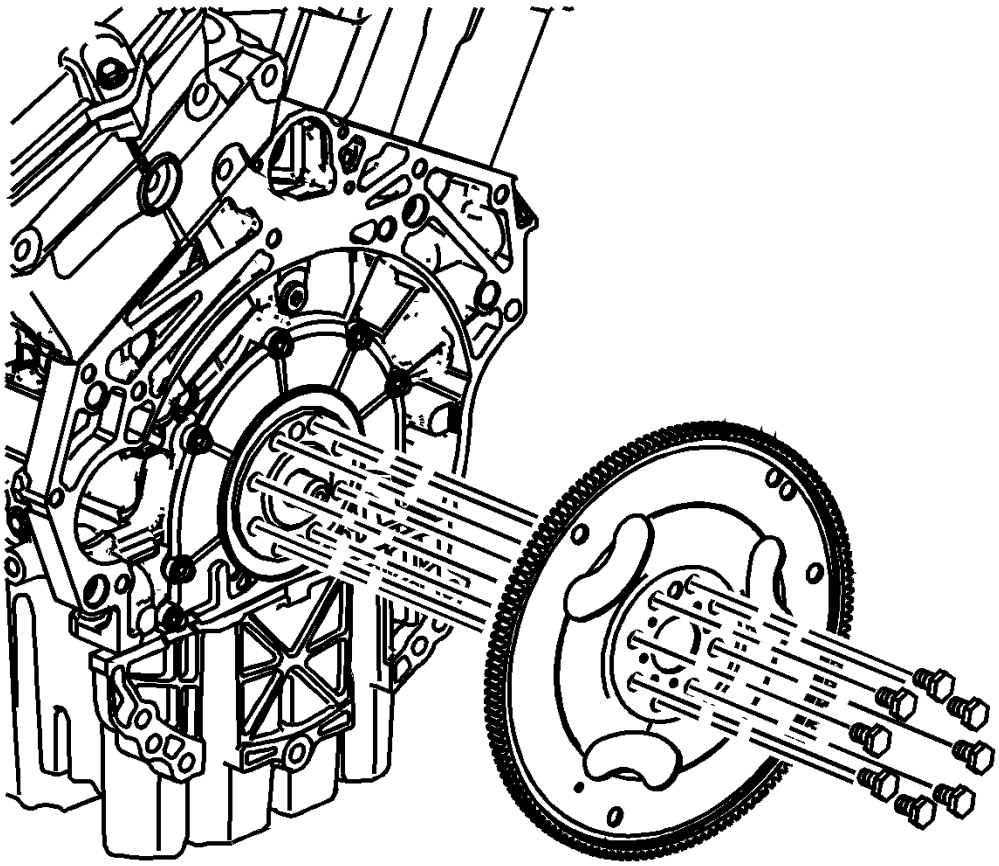


Fig. 218: View Of Engine Flywheel
Courtesy of GENERAL MOTORS COMPANY

1. Remove the transmission. Refer to **Transmission Replacement** .
2. Remove the flywheel.
3. Clean and inspect the flywheel. Refer to **Engine Flywheel Cleaning and Inspection** , . If the flywheel teeth are damaged, inspect the starter for proper operation. Replace the starter if you find excessive wear

or damage to the starter drive. Refer to **Starter Replacement** .

Installation Procedure

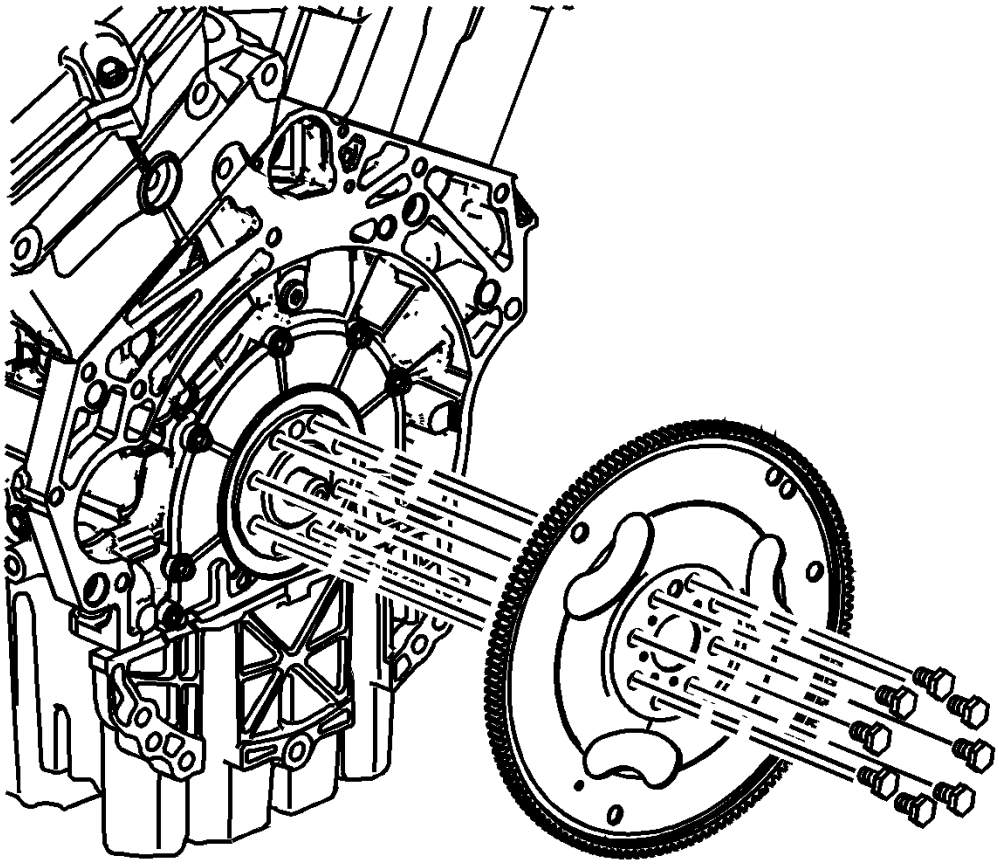


Fig. 219: View Of Engine Flywheel
Courtesy of GENERAL MOTORS COMPANY

1. Position the flywheel to the crankshaft.

CAUTION: Refer to Fastener Caution .

2. Install the flywheel bolts and tighten to 30 N.m (22 lb ft)plus and additional 45 degrees.
3. Install the transmission. Refer to **Transmission Replacement** .

AUTOMATIC TRANSMISSION FLEX PLATE REPLACEMENT

Special Tools

EN-46106 Holding Tool

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Remove the transmission. Refer to **Transmission Replacement** .

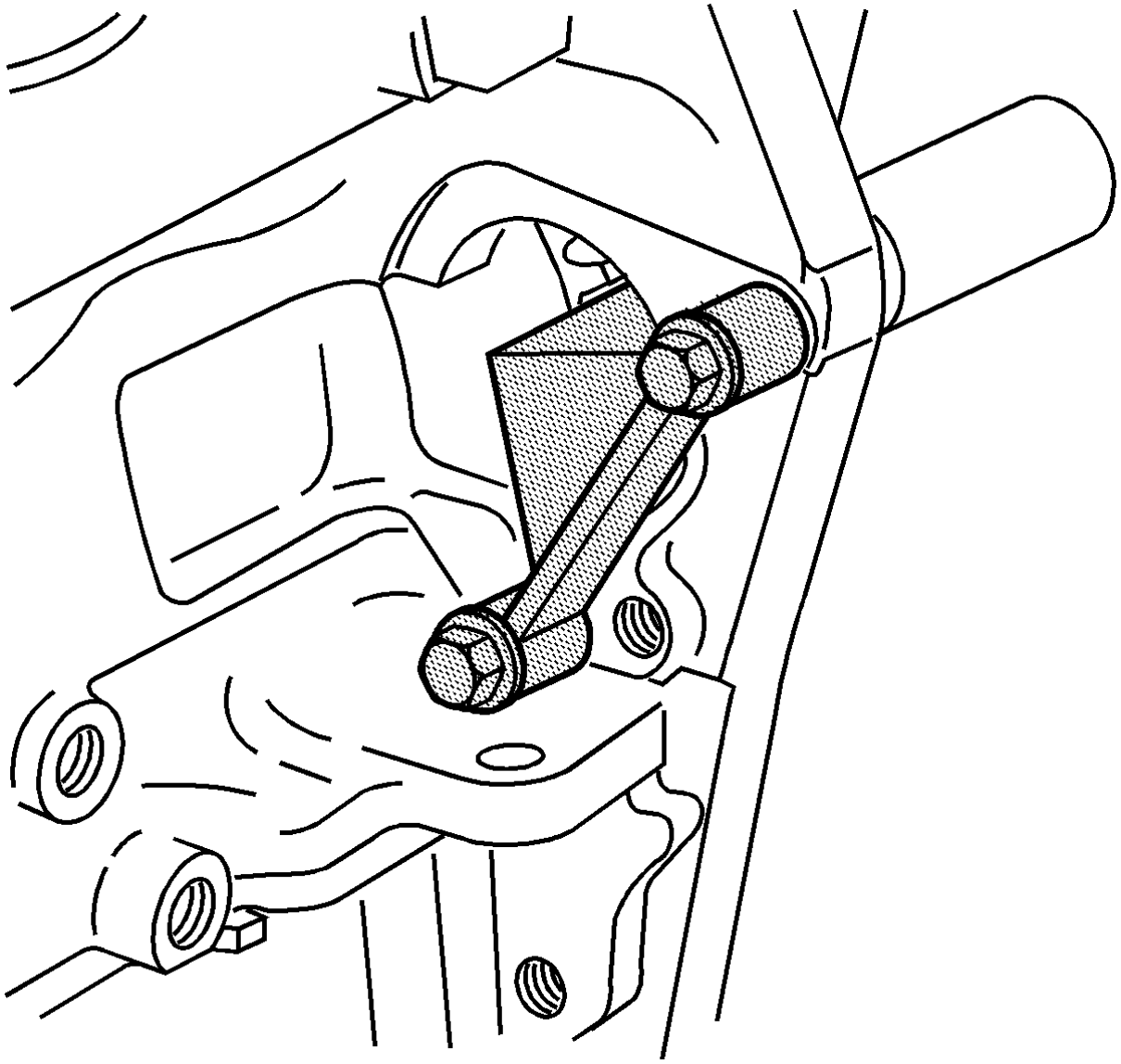


Fig. 220: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

2. Remove the starter. Refer to **Starter Replacement**
3. Install the **EN 46106** Holding Tool through the starter mounting hole.

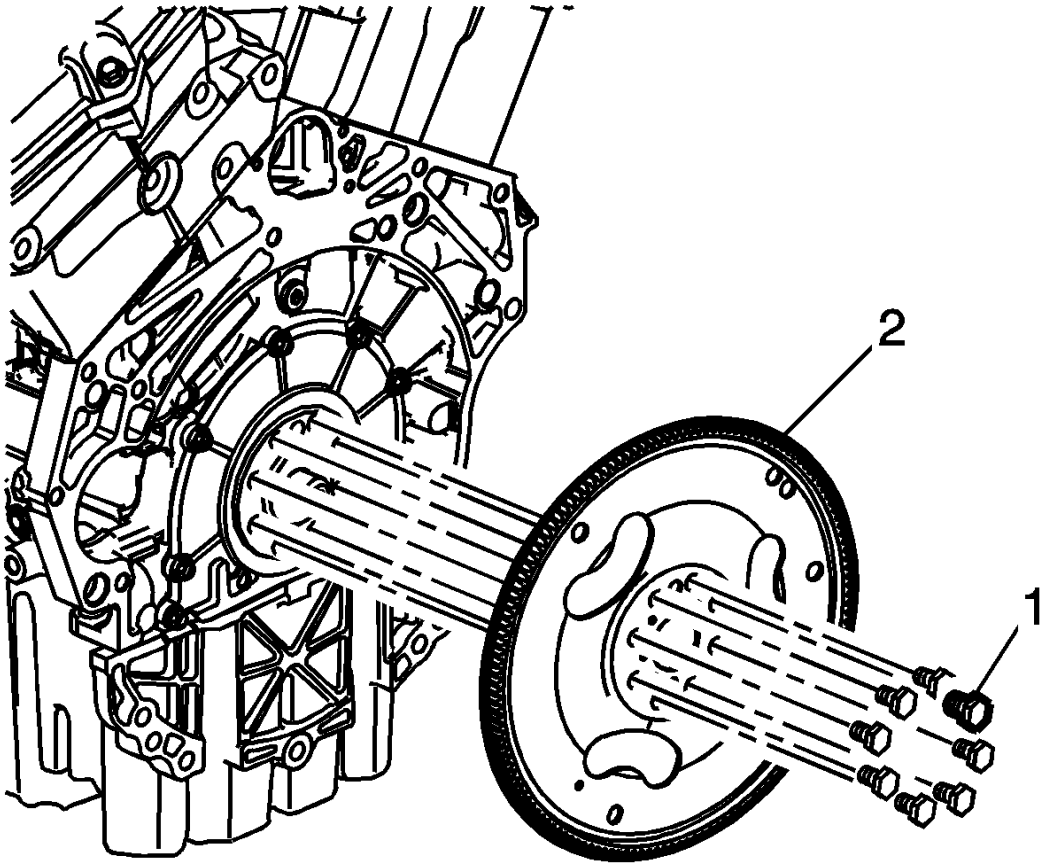


Fig. 221: Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the flex plate bolts (1) and discard.
5. Remove the flex plate (2).
6. Clean and inspect the flex plate. Refer to **Automatic Transmission Flex Plate Cleaning and Inspection** , . If the flex plate teeth are damaged, inspect the starter for proper operation. Replace the starter if you find excessive wear or damage to the starter drive. Refer to **Starter Replacement** .

Installation Procedure

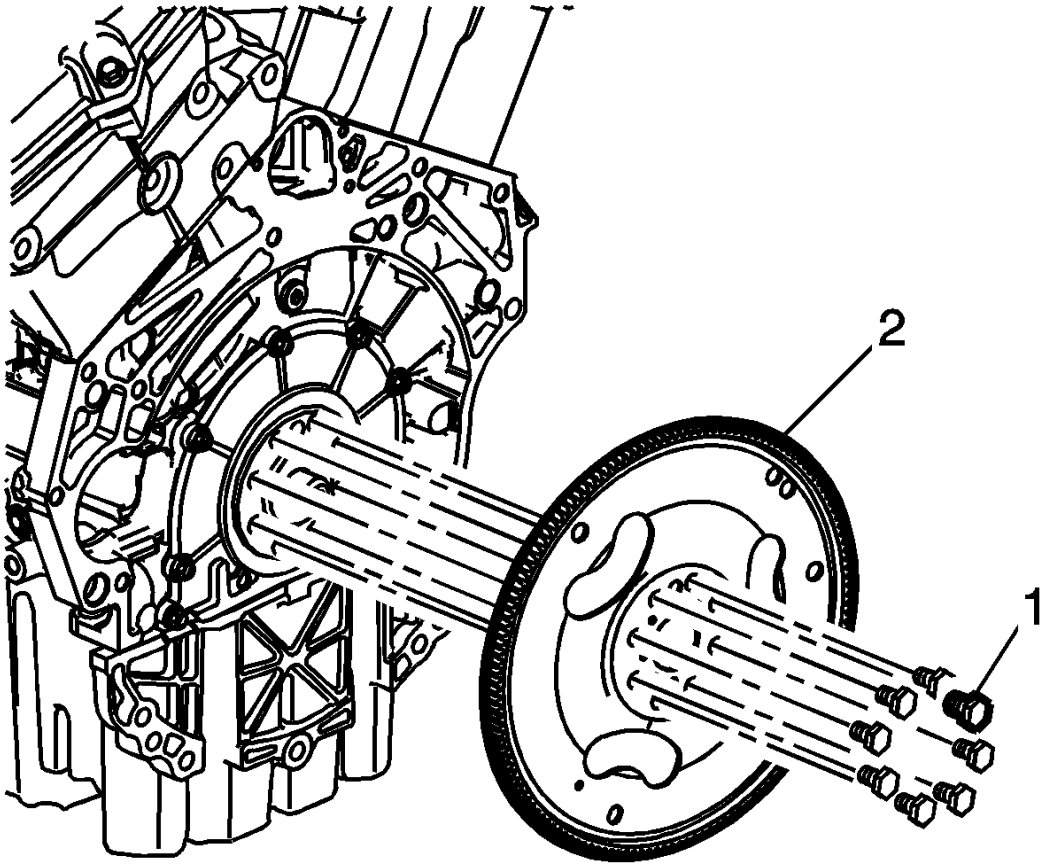


Fig. 222: Flex Plate And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the flex plate (2) to the crankshaft.

CAUTION: Refer to Fastener Caution .

2. Install NEW flex plate bolts (1) and tighten to 30 N.m (22 lb ft) plus and additional 45 degrees.

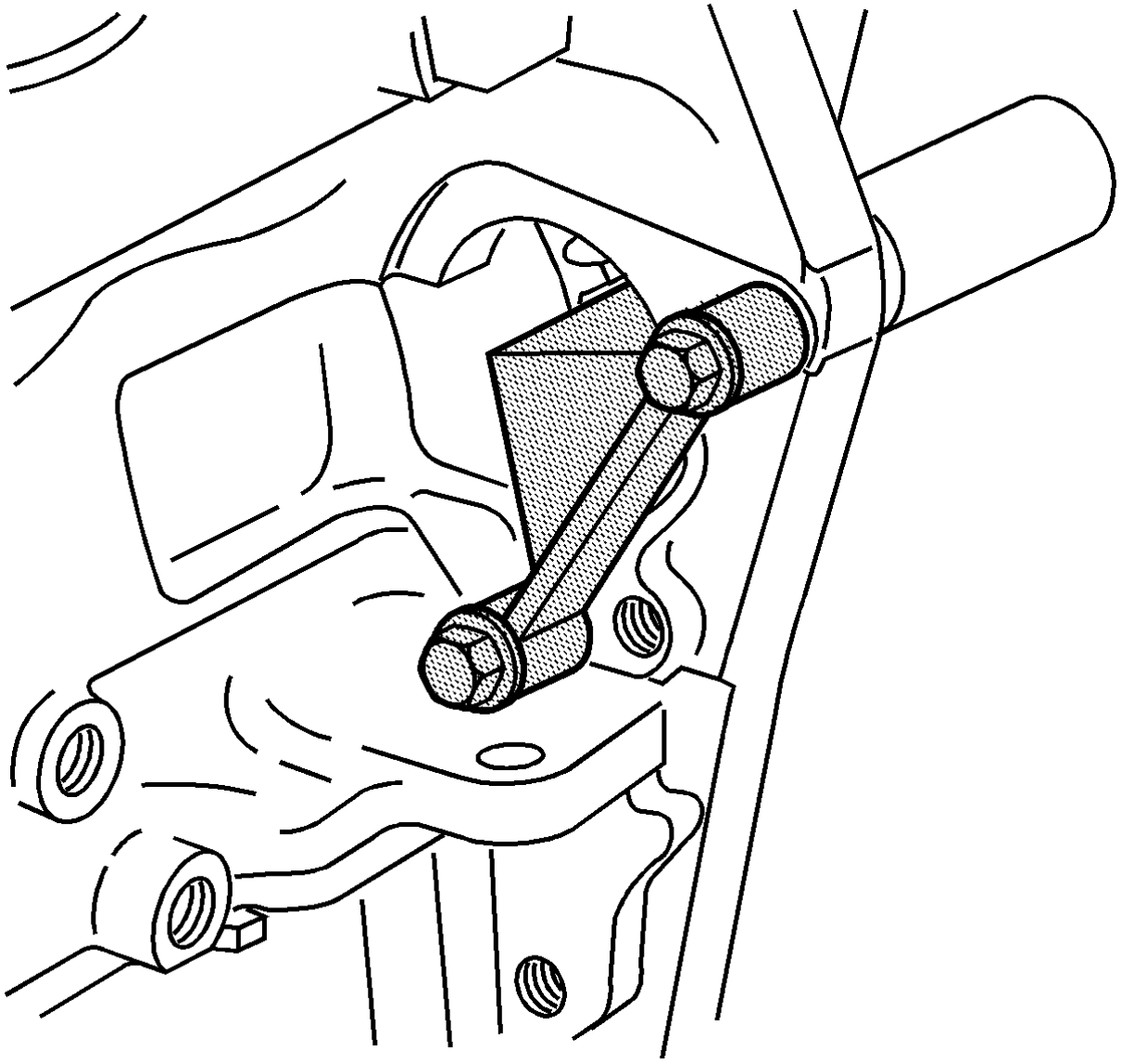


Fig. 223: Flywheel Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

3. Remove the **EN 46106** Holding Tool.
4. Install the starter. Refer to **Starter Replacement**
5. Install the transmission. Refer to **Transmission Replacement** .

CRANKSHAFT REAR OIL SEAL AND HOUSING REPLACEMENT

Removal Procedure

1. Remove the engine flywheel. Refer to **Engine Flywheel Replacement**.
2. Remove the oil pan. Refer to **Oil Pan Replacement**.

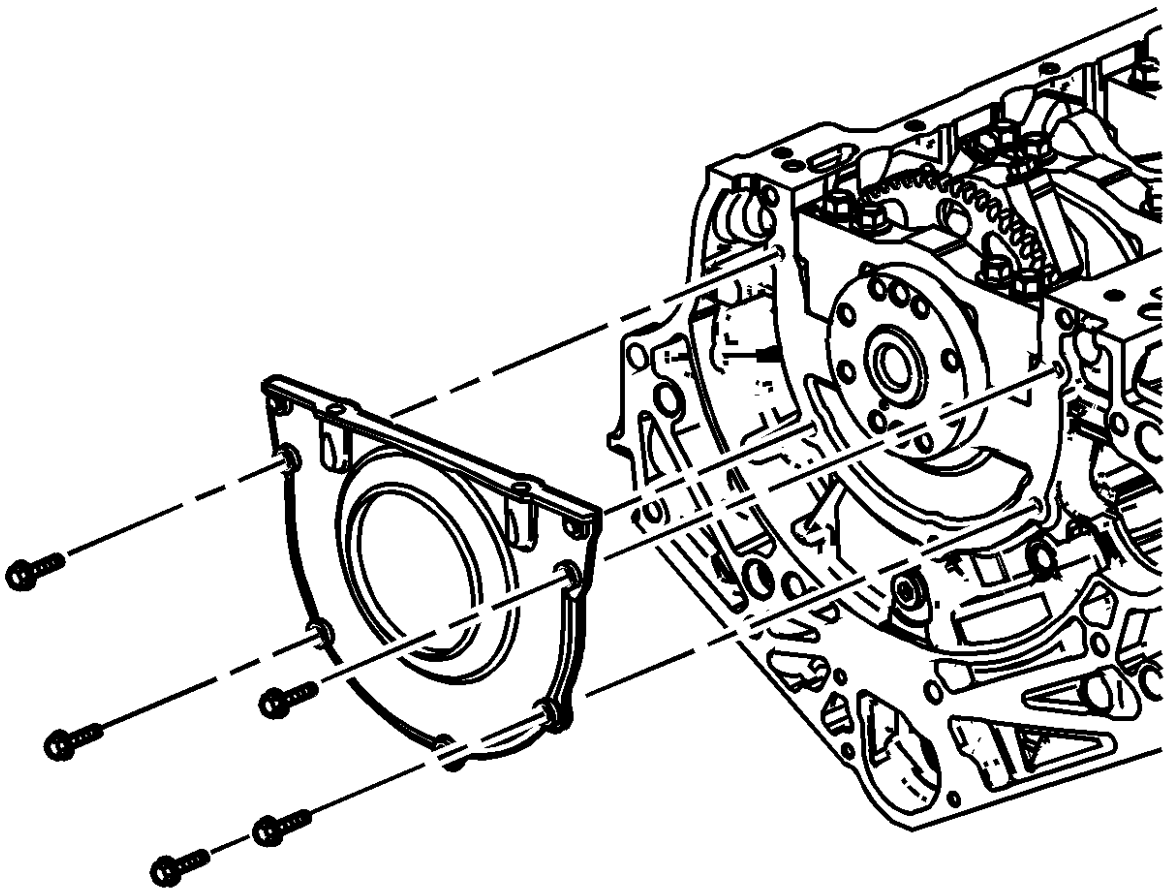


Fig. 224: View Of Crankshaft Rear Oil Seal And Housing
Courtesy of GENERAL MOTORS COMPANY

3. Remove the crankshaft rear oil seal and housing. Refer to **Crankshaft Rear Oil Seal and Housing Removal** .

Installation Procedure

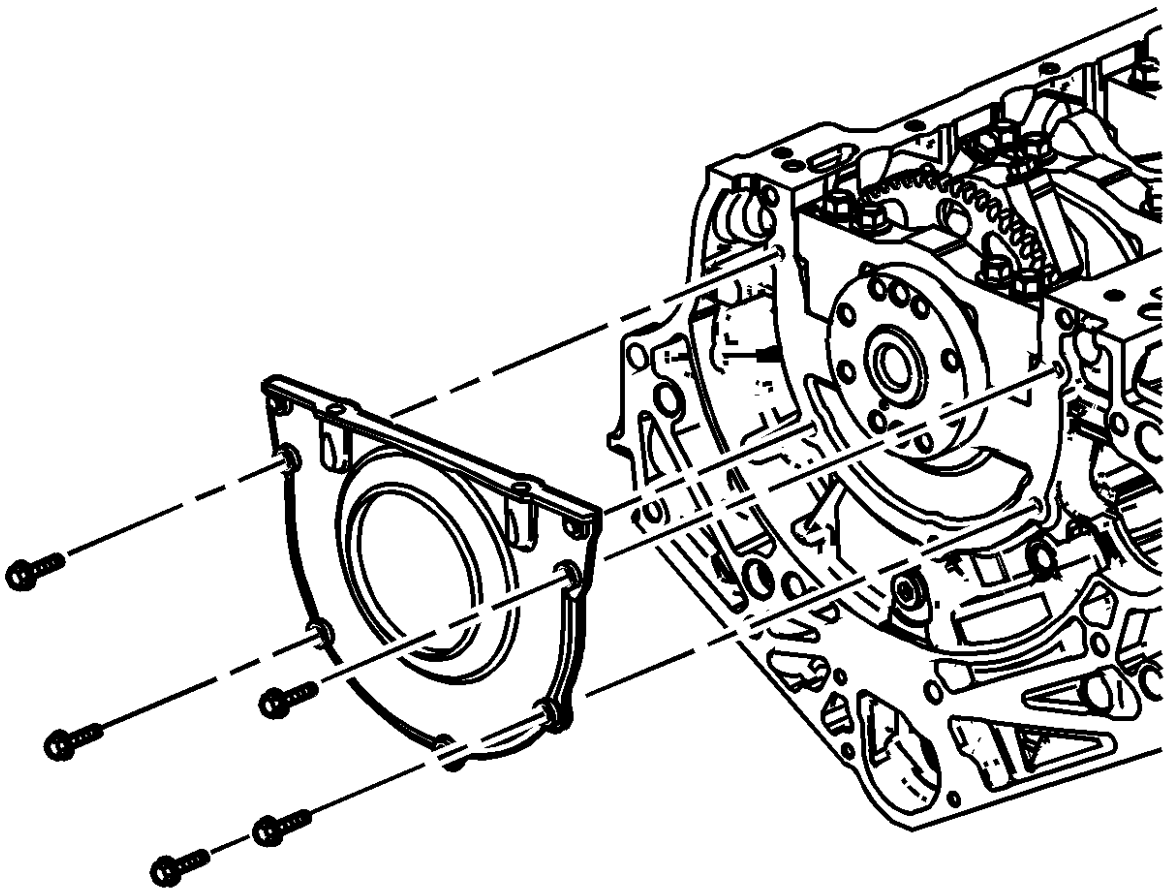


Fig. 225: View Of Crankshaft Rear Oil Seal And Housing
Courtesy of GENERAL MOTORS COMPANY

1. Install the crankshaft rear oil seal and housing. Refer to **Crankshaft Rear Oil Seal and Housing Installation** .
2. Install the oil pan. Refer to **Oil Pan Replacement**.
3. Install the engine flywheel. Refer to **Engine Flywheel Replacement**.

OIL PUMP REPLACEMENT

Removal Procedure

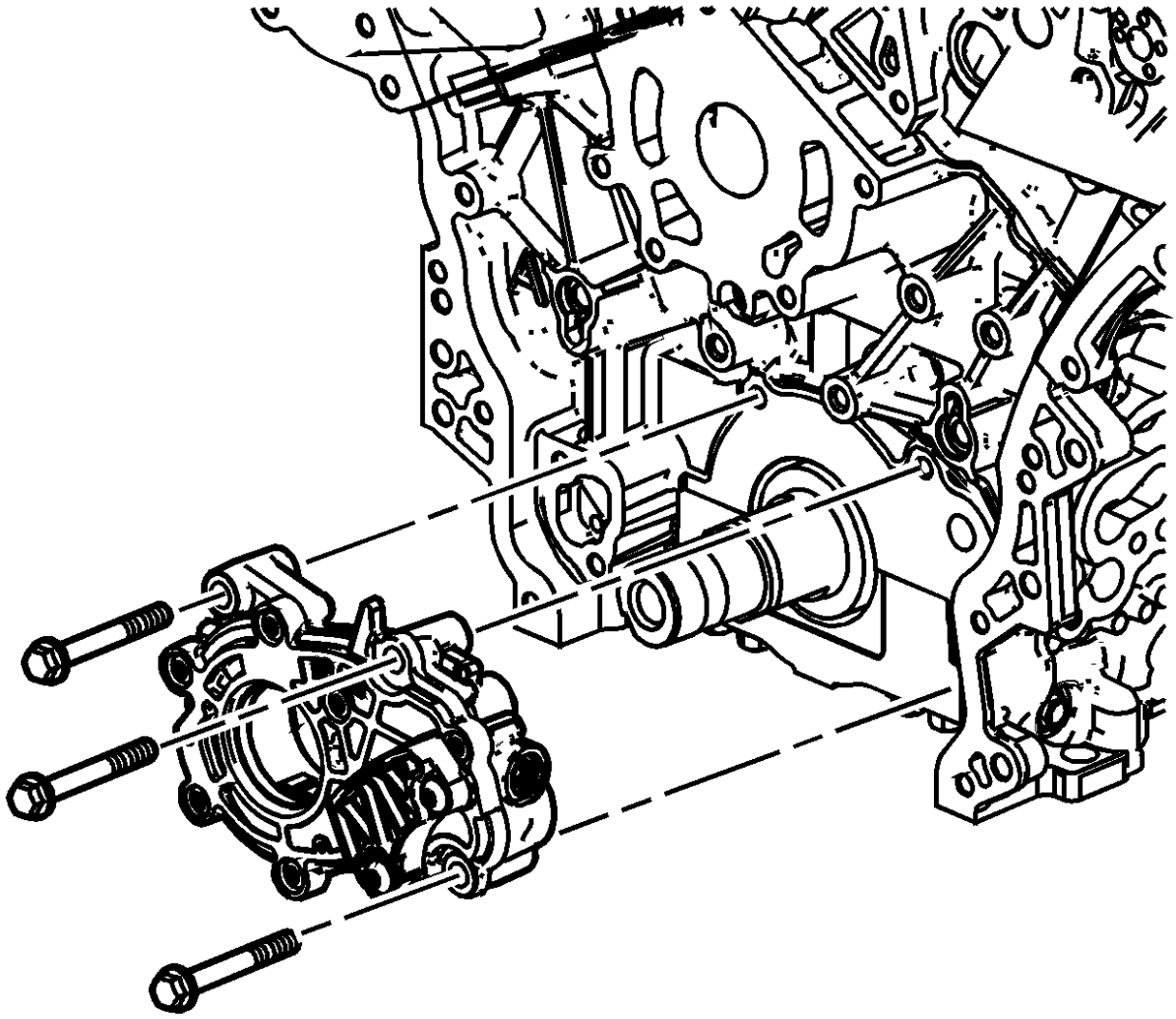


Fig. 226: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not remove the left bank idler sprocket.**

1. Remove the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement**.
2. Remove the crankshaft sprocket. Refer to **Crankshaft Sprocket Removal** .
3. Remove the oil pump bolts and the oil pump.

Installation Procedure

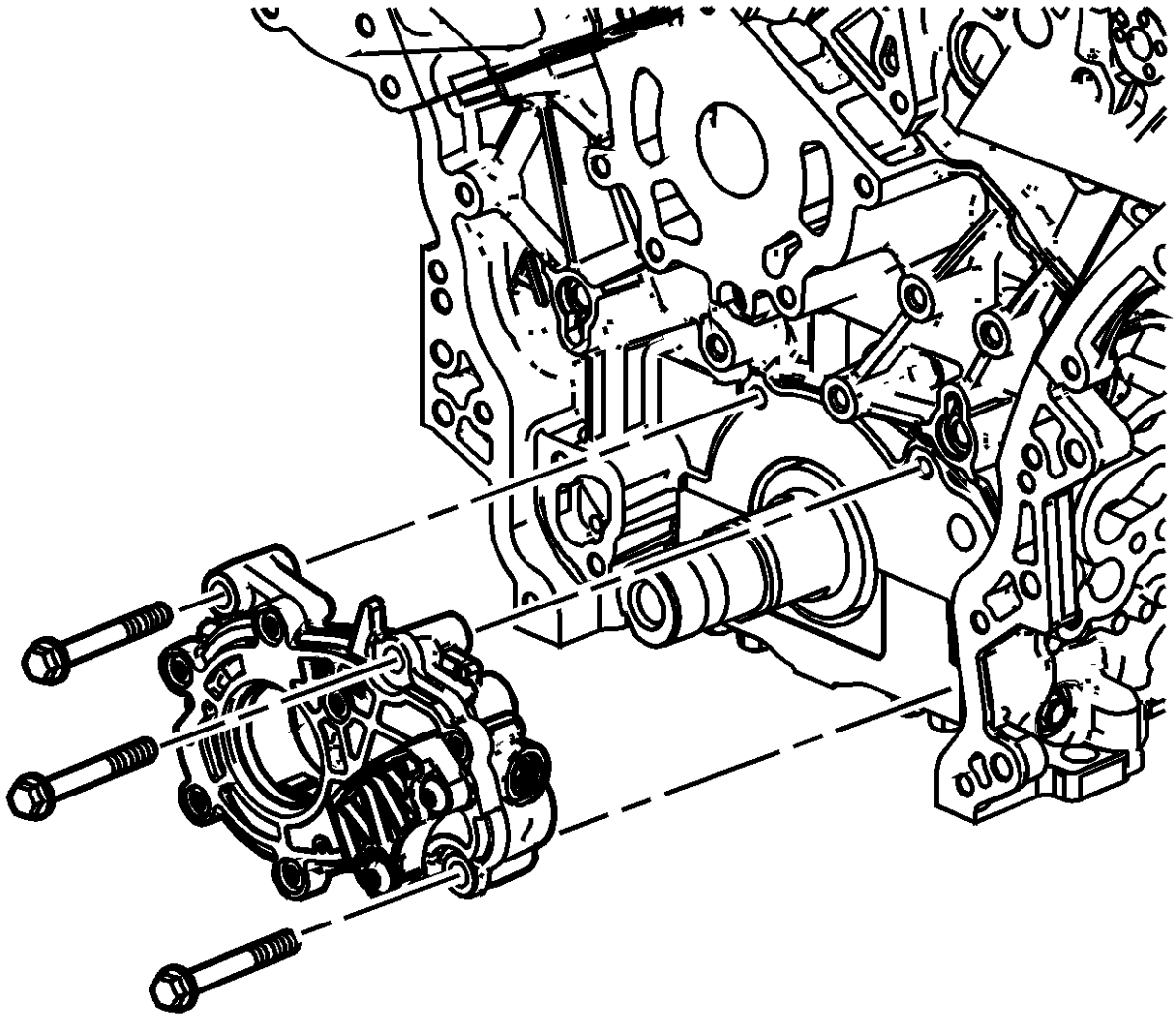


Fig. 227: View Of Oil Pump & Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Install the oil pump and bolts. Refer to **Oil Pump Installation**
2. Install the crankshaft sprocket. Refer to **Crankshaft Sprocket Installation** .
3. Install the primary timing chain. Refer to **Primary Camshaft Drive Chain and Sprockets Replacement**.

OIL PAN REPLACEMENT

Special Tools

EN-46109 Guide Pin Set

For equivalent regional tools, refer to **Special Tools** .

Removal Procedure

1. Drain the engine oil and remove the oil filter. Refer to **Engine Oil and Oil Filter Replacement**.

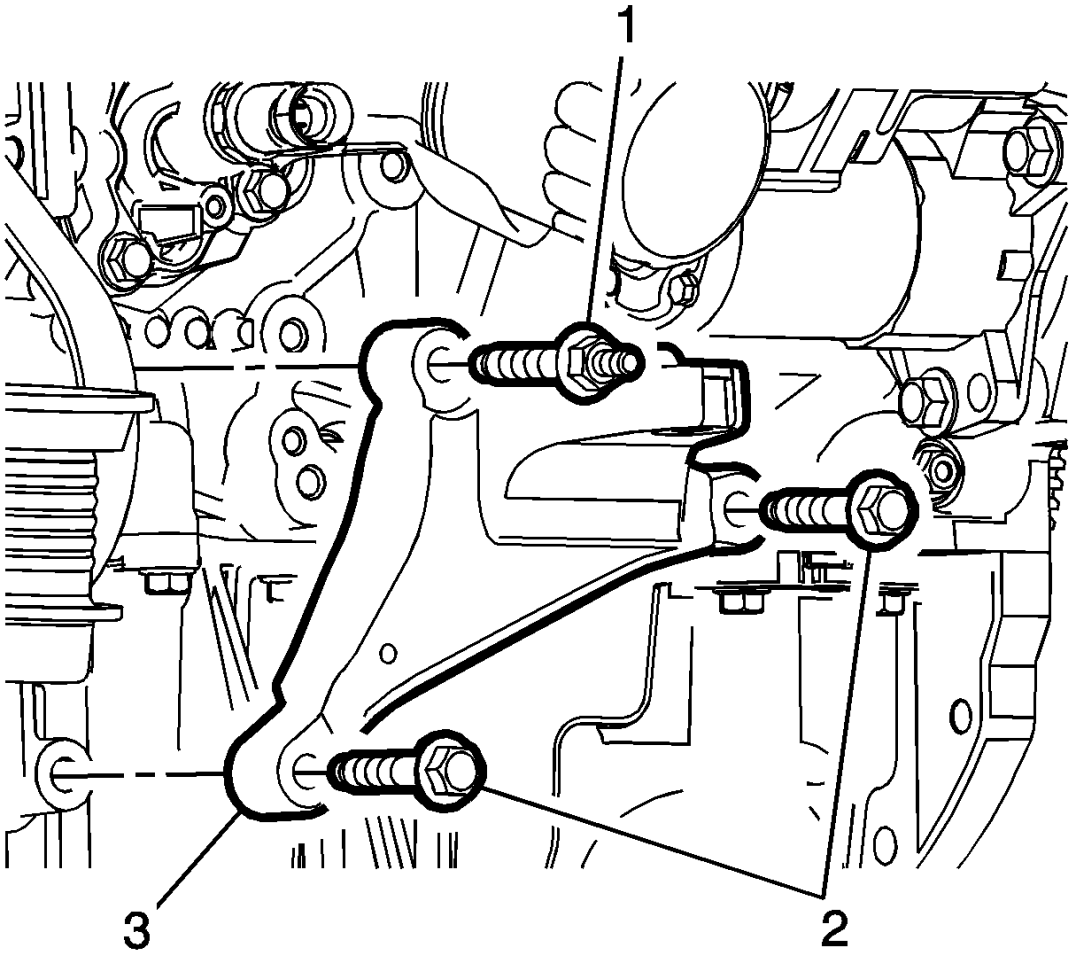


Fig. 228: Front Engine Mount Bracket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Remove the engine front mount bracket (3). Refer to **Engine Front Mount Bracket Replacement**.

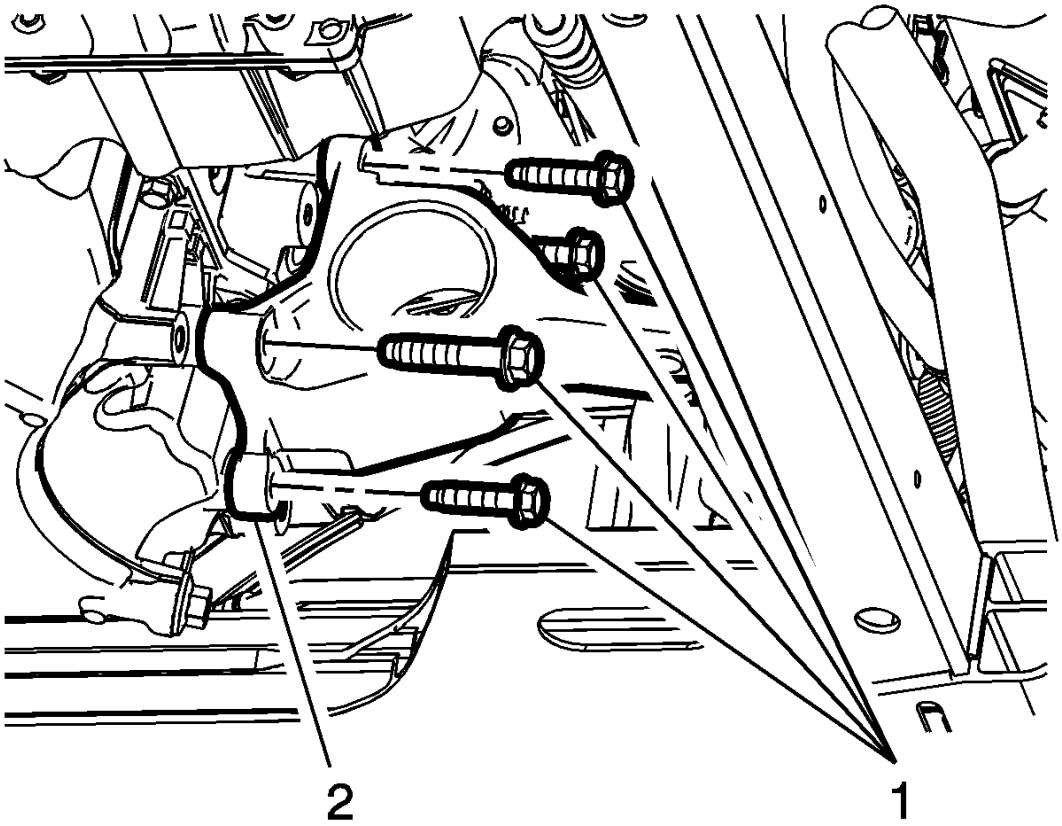


Fig. 229: Rear Engine Mount Bracket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine rear mount bracket (2). Refer to **Engine Rear Mount Bracket Replacement**.
4. Remove the front cover. Refer to **Engine Front Cover Replacement**.

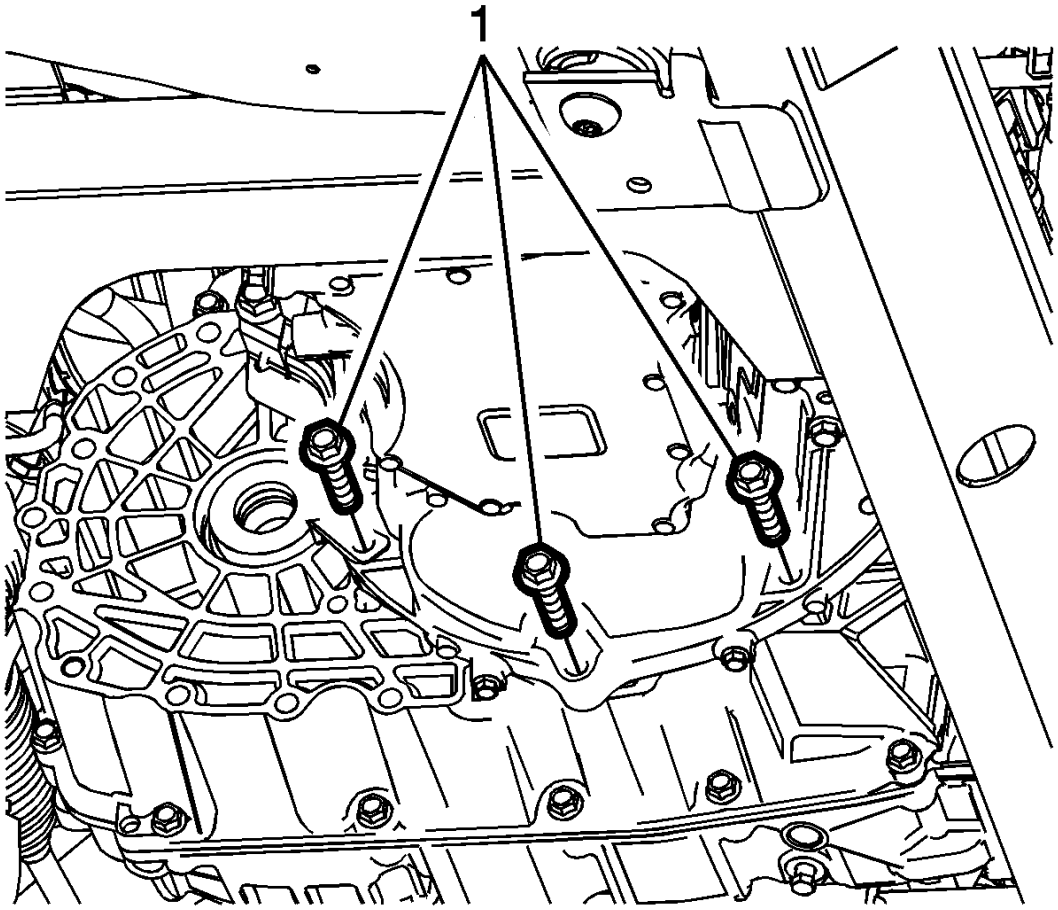


Fig. 230: Engine Oil Pan To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil pan to transmission bolts (1).

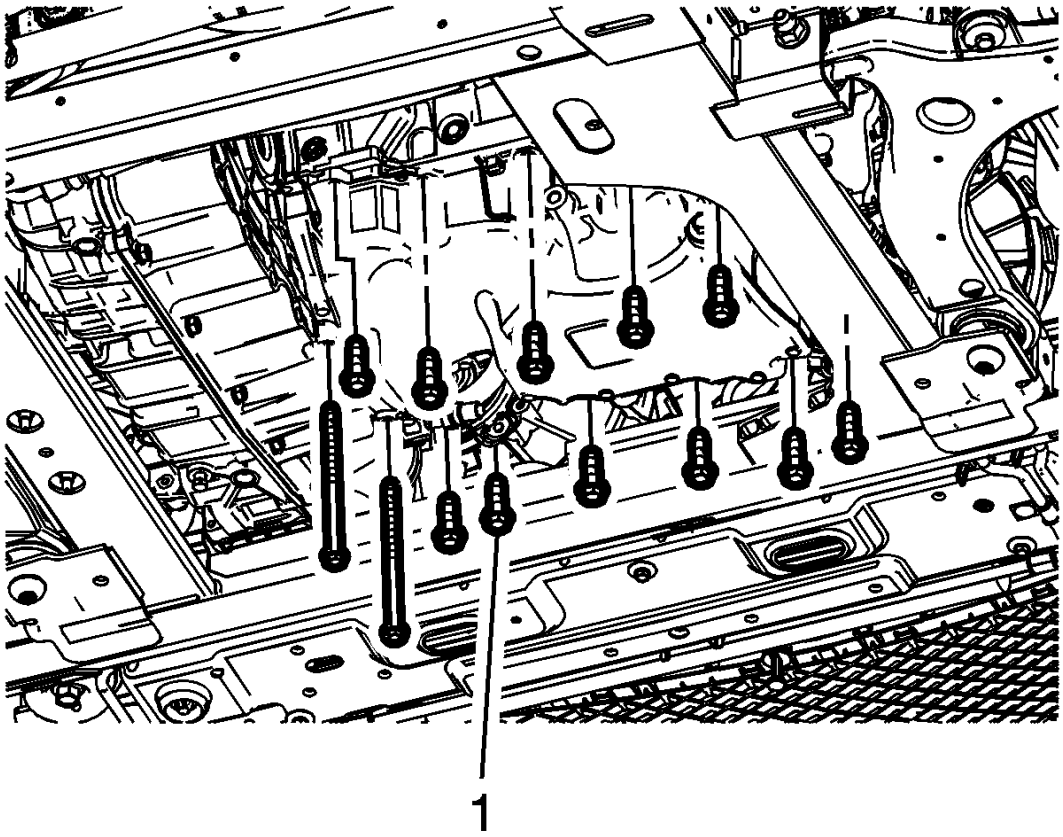


Fig. 231: Engine Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil pan bolts (1).

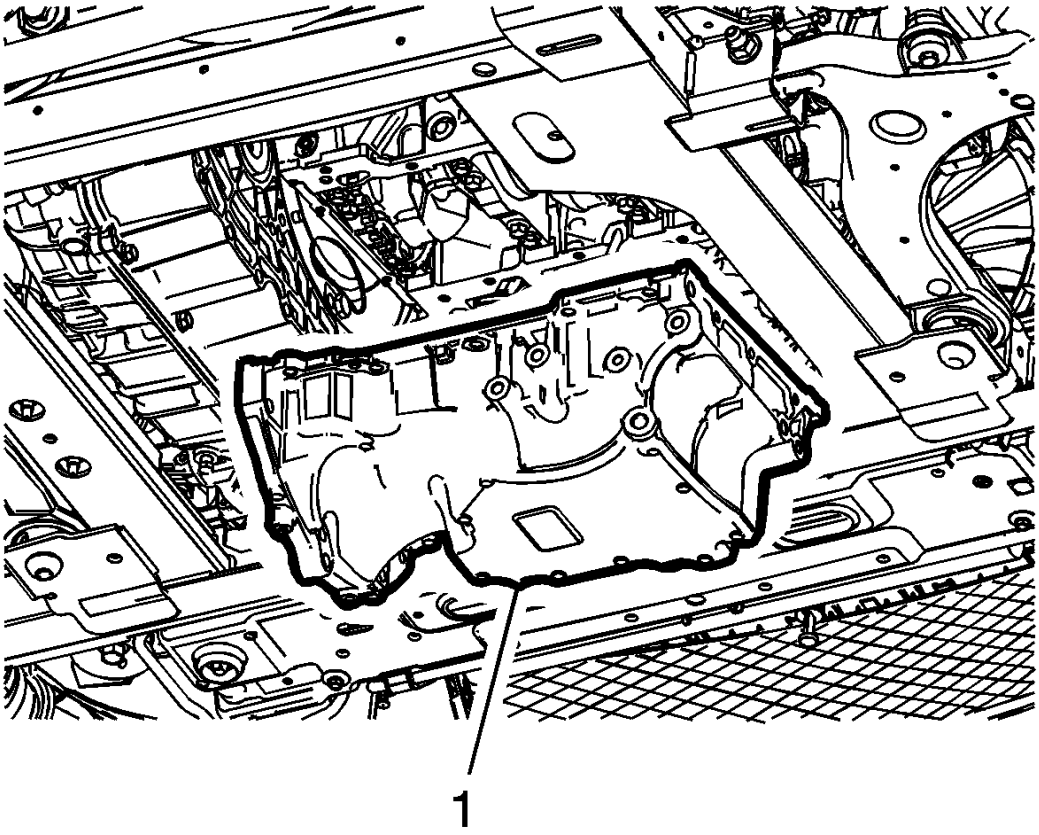


Fig. 232: Engine Oil Pan
Courtesy of GENERAL MOTORS COMPANY

7. Remove the oil pan (1).
8. Disassemble the oil pan. Refer to **Oil Pan Disassemble** .
9. Clean the oil pan and the engine block gasket surface. Refer to **Oil Pan Cleaning and Inspection** .

Installation Procedure

1. Assemble the oil pan. Refer to **Oil Pan Assemble** .

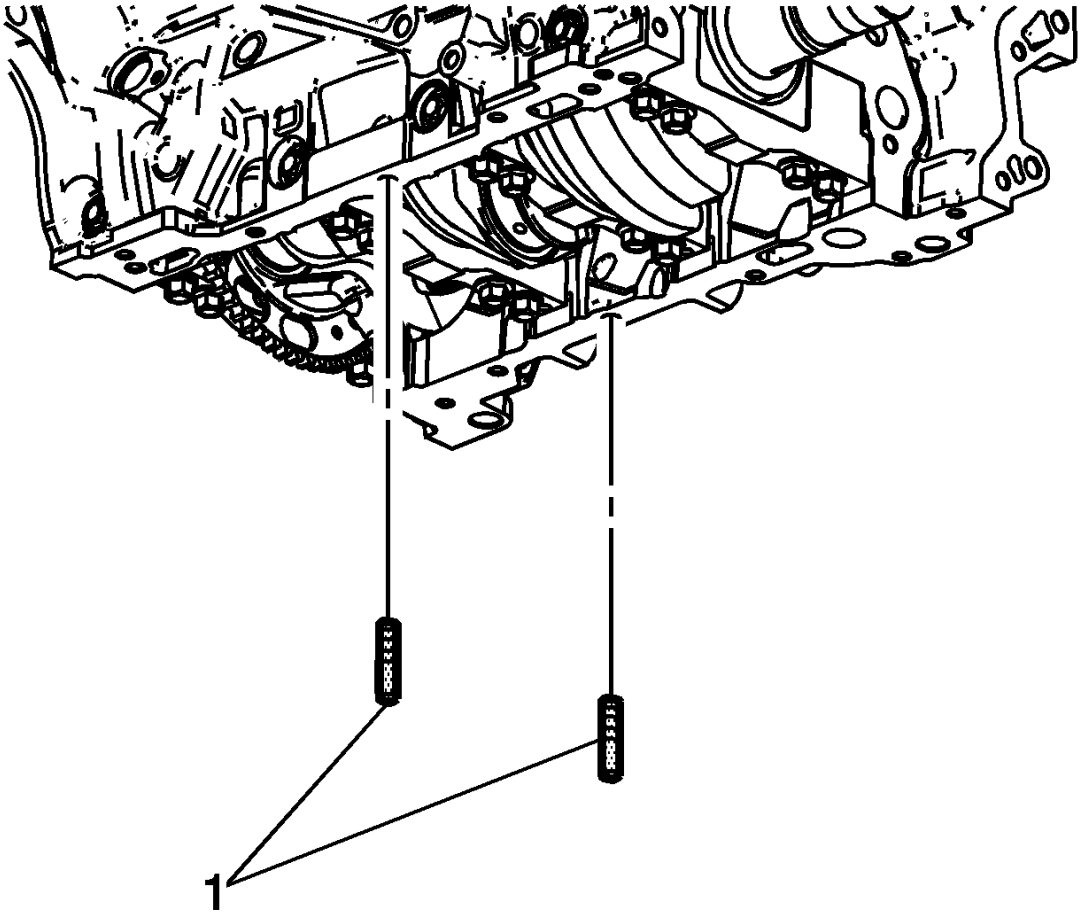


Fig. 233: 8 mm (0.315 in) Guides
Courtesy of GENERAL MOTORS COMPANY

2. Install the 8 mm (0.315 in) guides (1) from the **EN-46109** set into the center oil pan rail bolt hole on each side of the engine block.

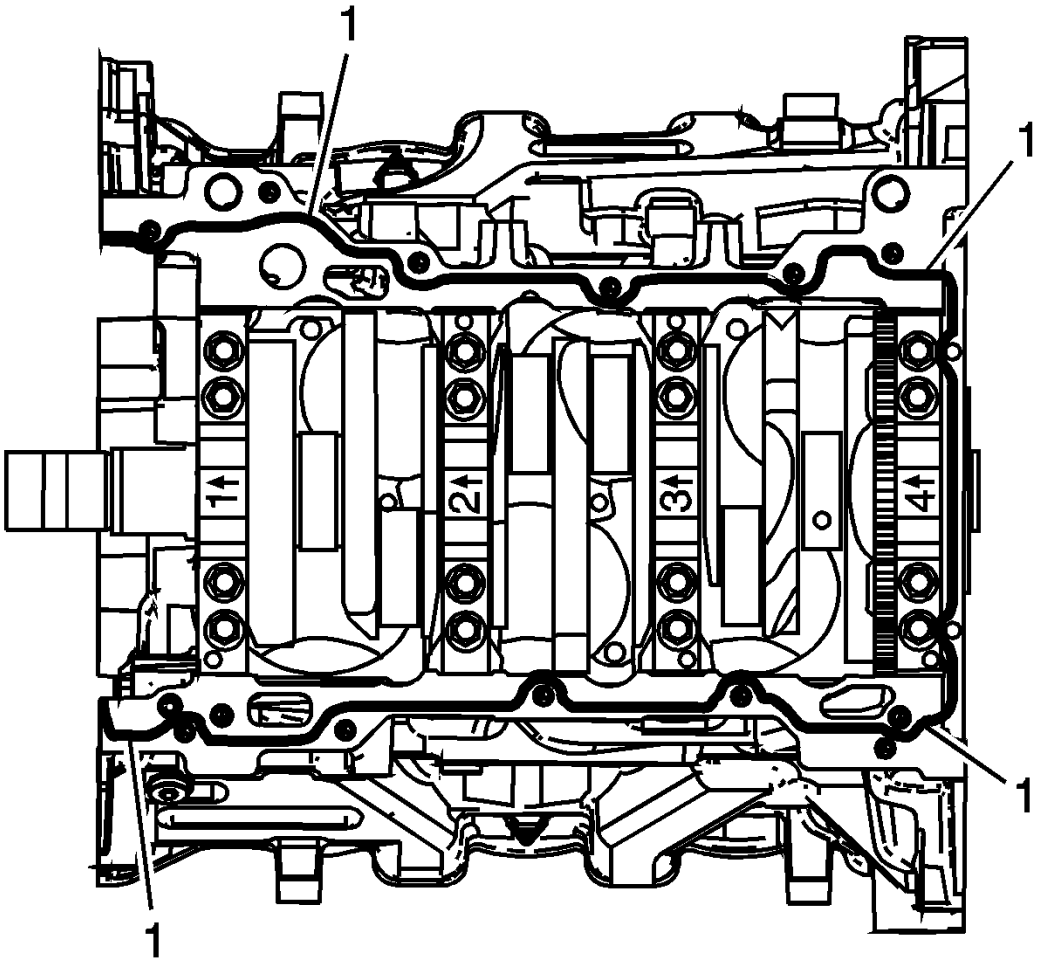


Fig. 234: Identifying Sealant Application Locations On Block Pan Rail & Crankshaft Rear Oil Seal Housing

Courtesy of GENERAL MOTORS COMPANY

3. Place a 3 mm (0.118 in) bead (1) of RTV sealant , on the block pan rail and the crankshaft rear oil seal housing.

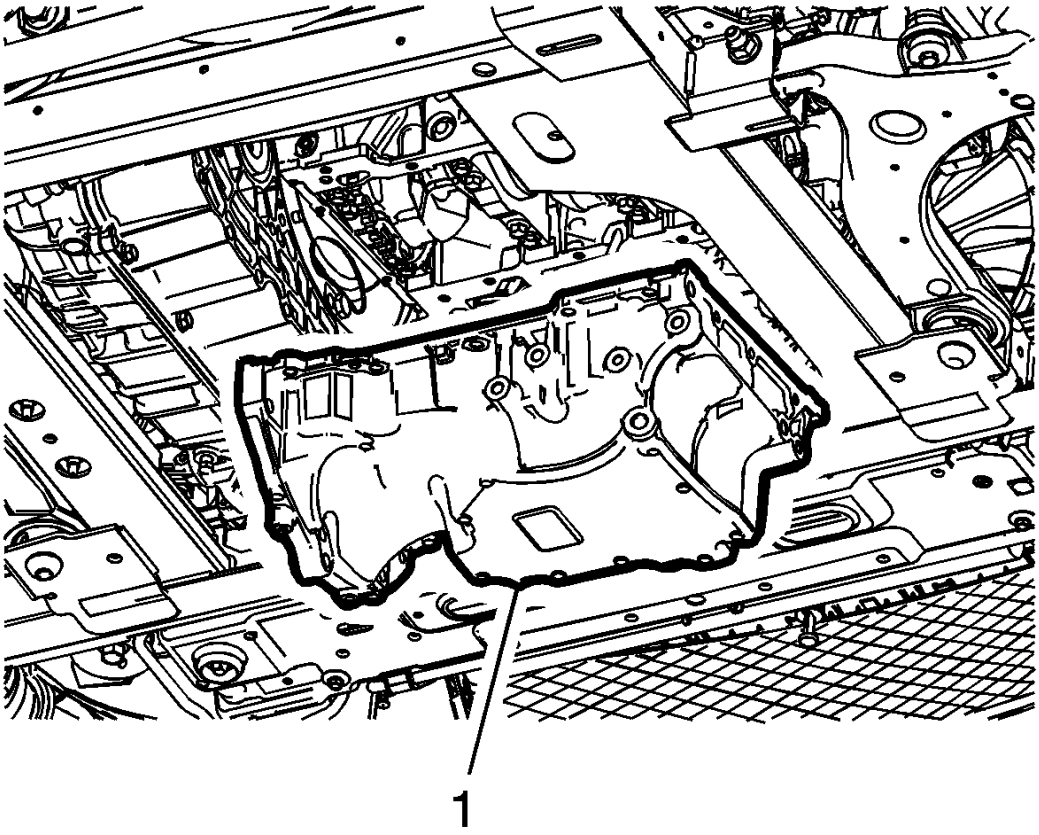


Fig. 235: Engine Oil Pan
Courtesy of GENERAL MOTORS COMPANY

4. Position the oil pan (1) onto the engine block.

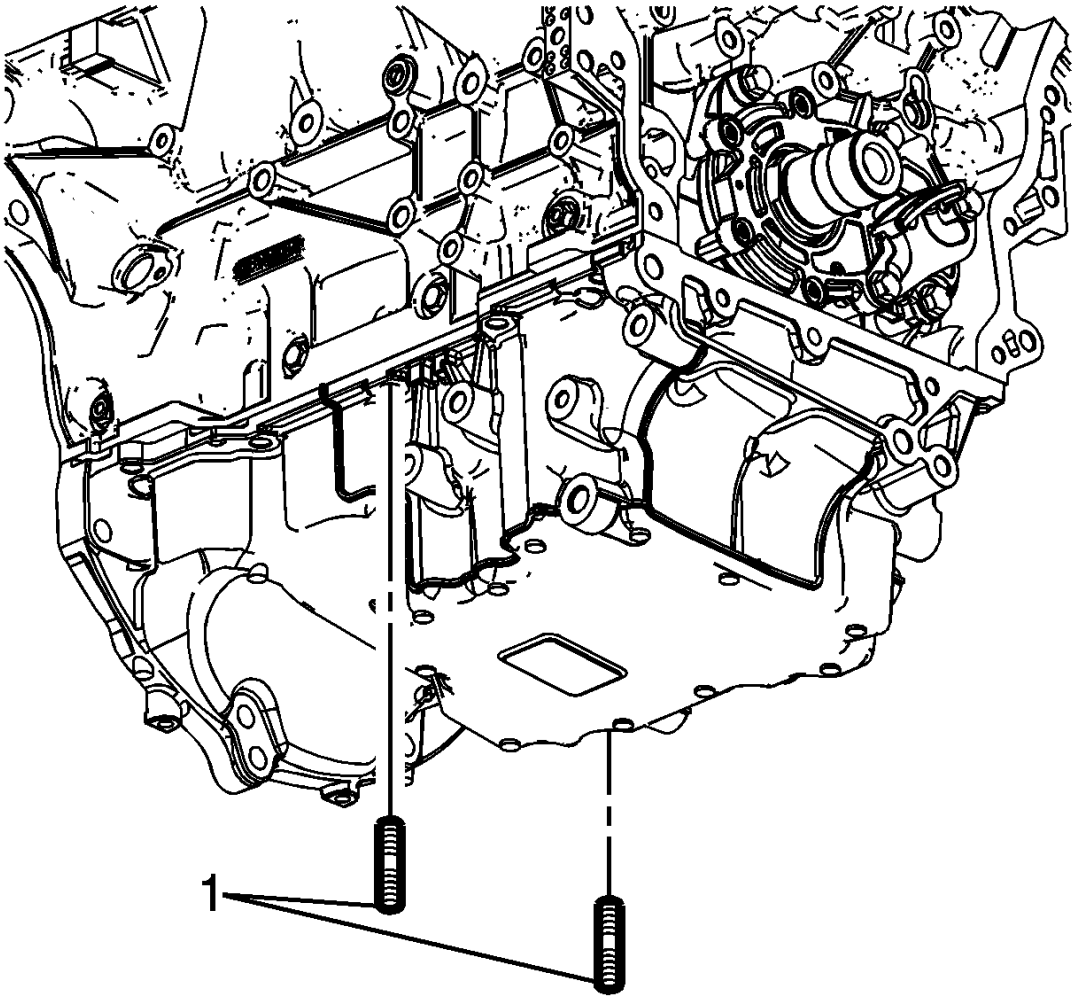


Fig. 236: 8 mm (0.315 in) Guides
Courtesy of GENERAL MOTORS COMPANY

5. Remove the **EN-46109** set 8 mm (0.315 in) guides (1) from the engine block.

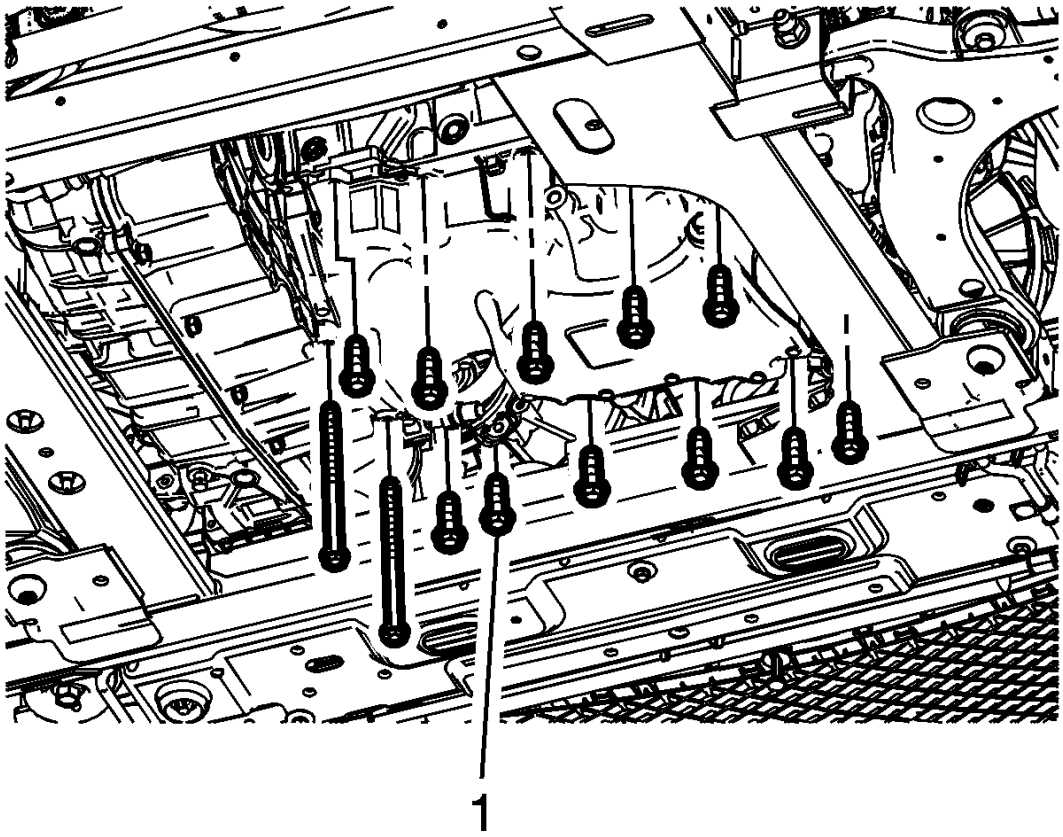


Fig. 237: Engine Oil Pan Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Loosely install the oil pan bolts (1).

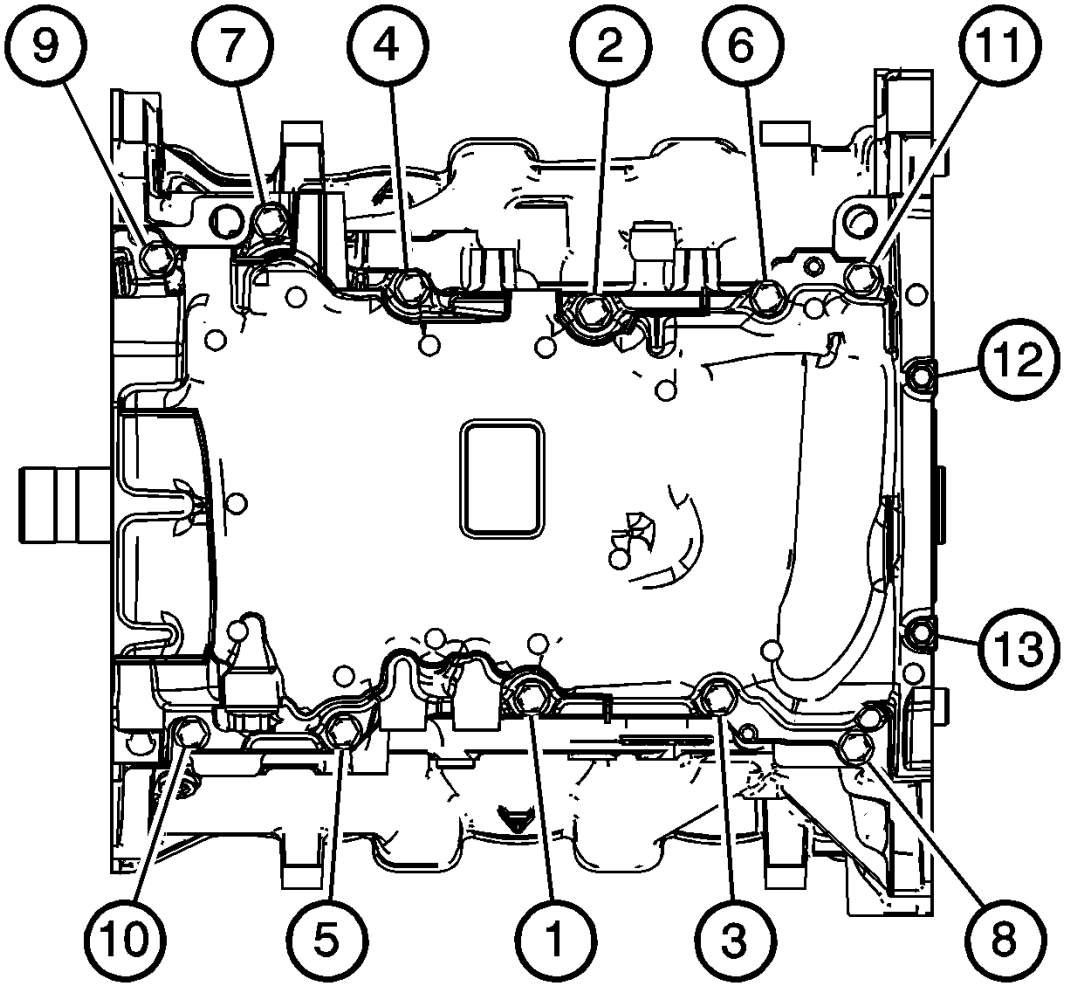


Fig. 238: Identifying Oil Pan Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. Tighten the oil pan bolts in sequence.
    1. The 8 mm bolts (1-11) to 23 N.m (17 lb ft).
    2. The 6 mm bolts (12, 13) to 10 N.m (89 lb in).

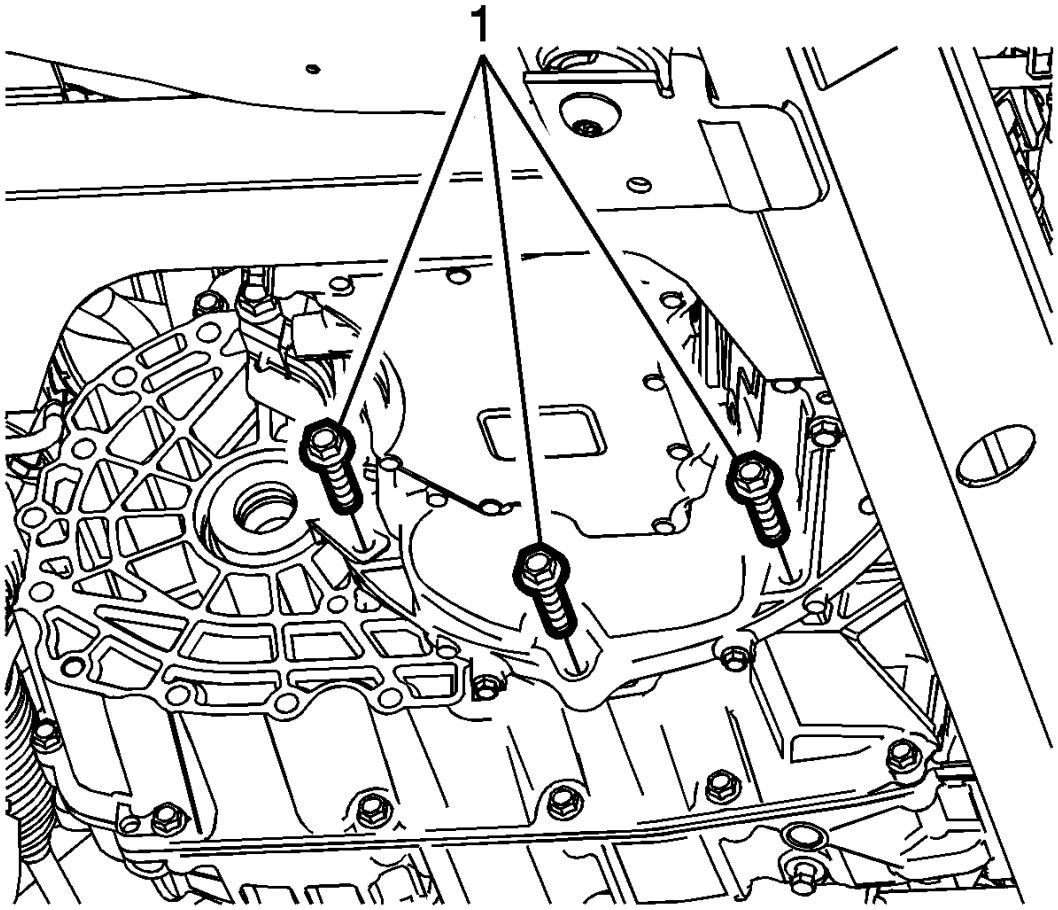


Fig. 239: Engine Oil Pan To Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Install the oil Pan to transmission bolts (1) and tighten to 23 N.m (17 lb ft).
9. Install engine front cover. Refer to **Engine Front Cover Replacement**.

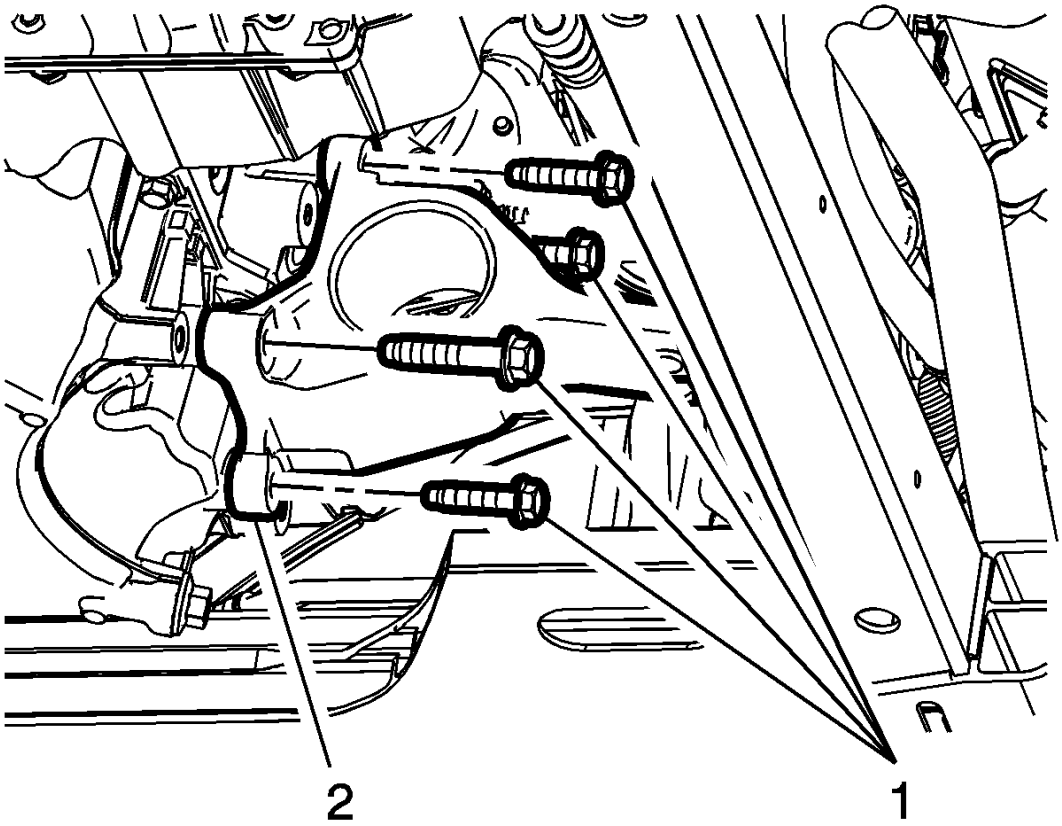


Fig. 240: Rear Engine Mount Bracket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Install the engine rear mount bracket (2). Refer to **Engine Rear Mount Bracket Replacement**.

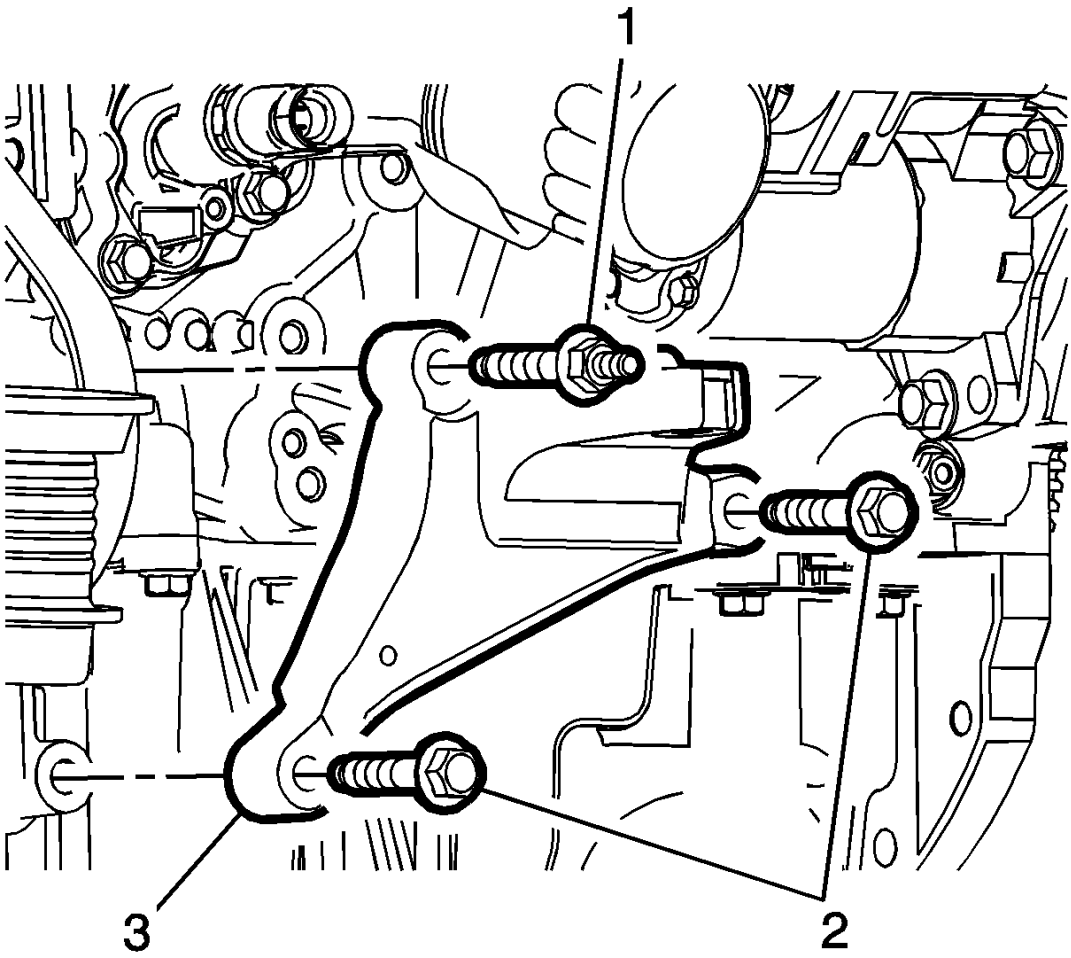


Fig. 241: Front Engine Mount Bracket And Fasteners
Courtesy of GENERAL MOTORS COMPANY

11. Install the engine front mount bracket (3). Refer to **Engine Front Mount Bracket Replacement**.
12. Refill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

ENGINE OIL PRESSURE SENSOR AND/OR SWITCH REPLACEMENT (LFX)

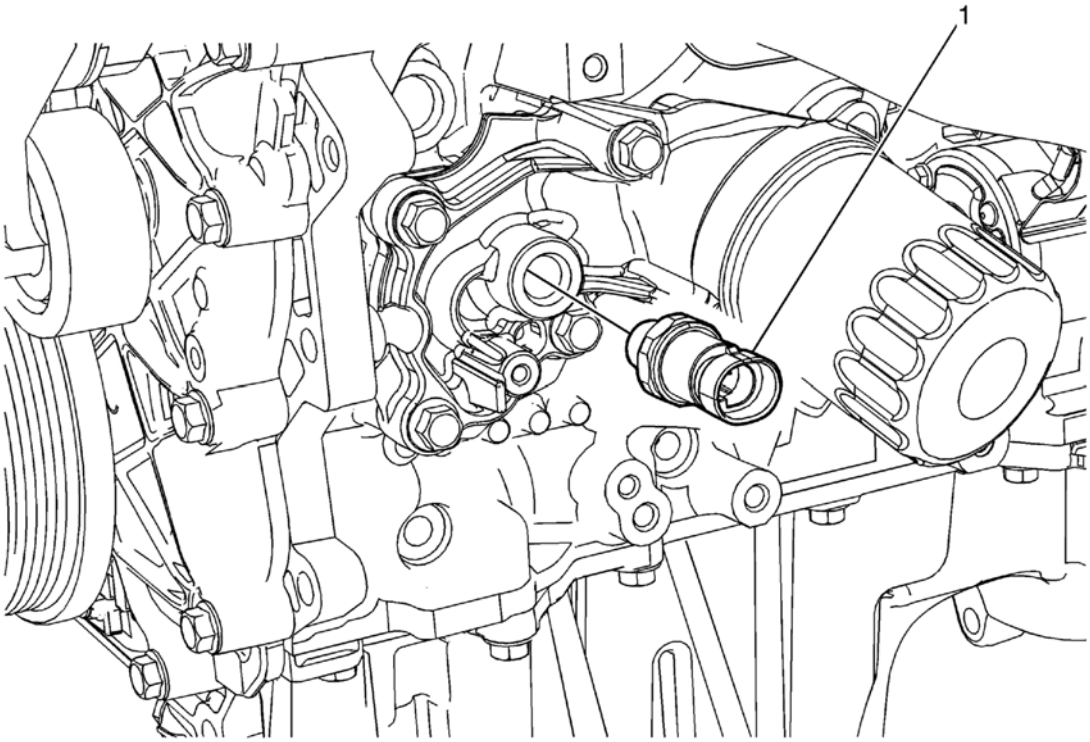


Fig. 242: Engine Oil Pressure Sensor And/Or Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure **Remove the generator. Refer to Generator Replacement .**	
1	Engine Oil Pressure Sensor and/or Switch **CAUTION:** **Refer to Component Fastener Tightening Caution .** **Procedure** 1. Disconnect the oil pressure sensor electrical connector. 2. Transfer components as necessary. **Tighten** 20 N.m (15 lb ft) **Special Tools** **EN-41712** Oil Pressure Switch Socket For equivalent regional tools, refer to **Special Tools** .

OIL PUMP SUCTION PIPE AND SCREEN ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the oil pan. Refer to **Oil Pan Replacement**.

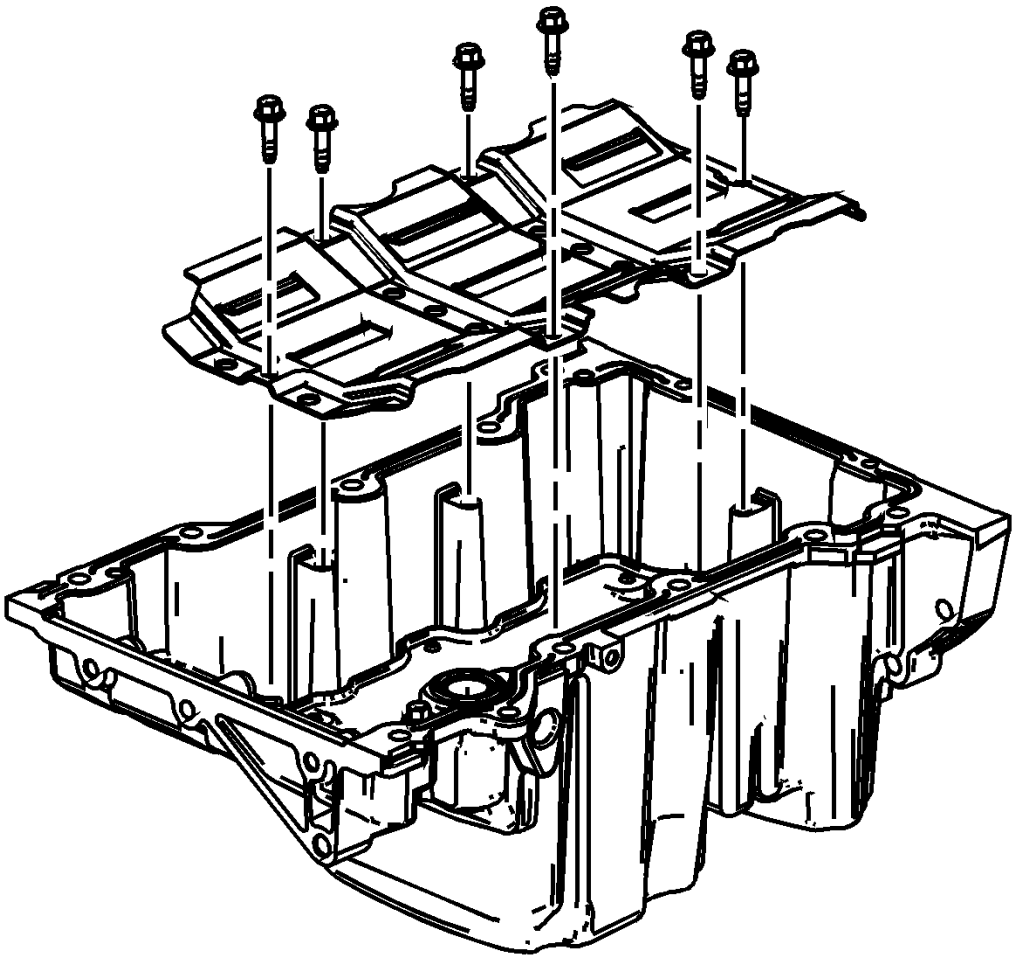


Fig. 243: View Of Oil Pan Scraper And Bolts
Courtesy of GENERAL MOTORS COMPANY

2. Remove the oil pan scraper bolts.
3. Remove the oil pan scraper.

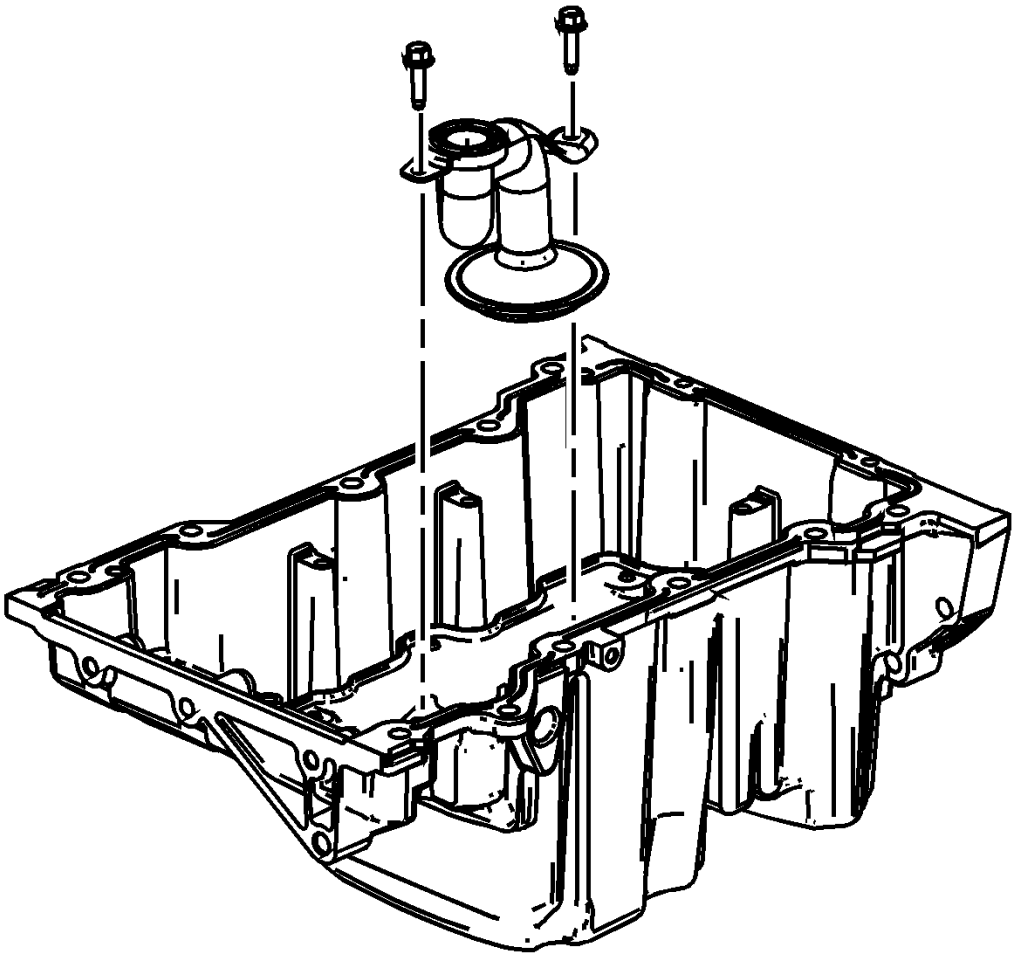


Fig. 244: View Of Oil Suction Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Remove the oil suction pipe bolts.
5. Remove the oil suction pipe.

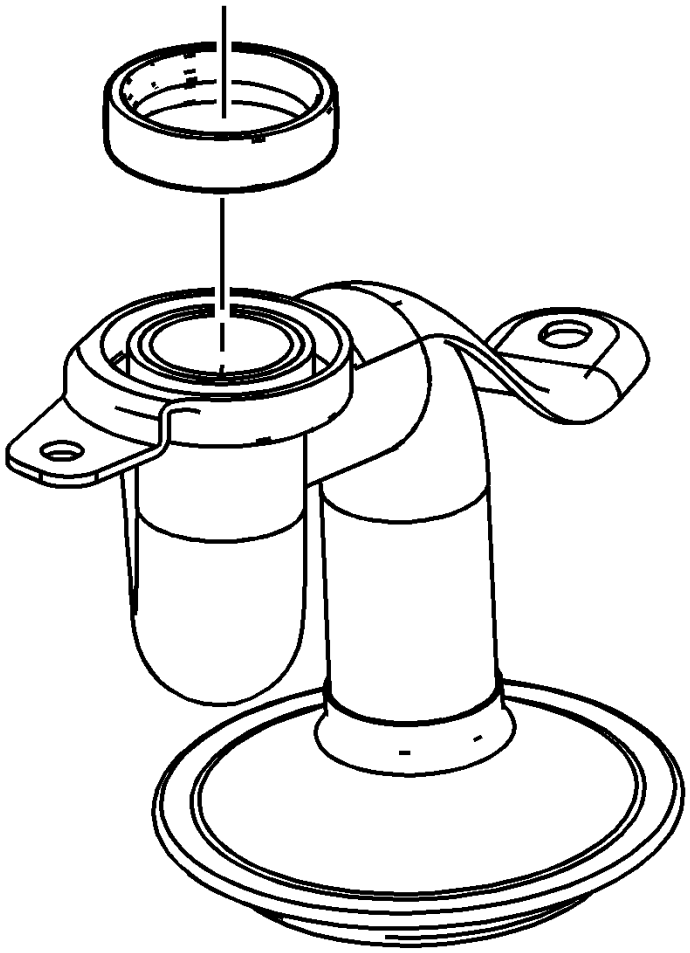


Fig. 245: View Of Oil Suction Tube Seal & Oil Suction Tube
Courtesy of GENERAL MOTORS COMPANY

6. Remove the oil suction tube seal from the oil suction tube. Discard the oil suction tube seal.

Installation Procedure

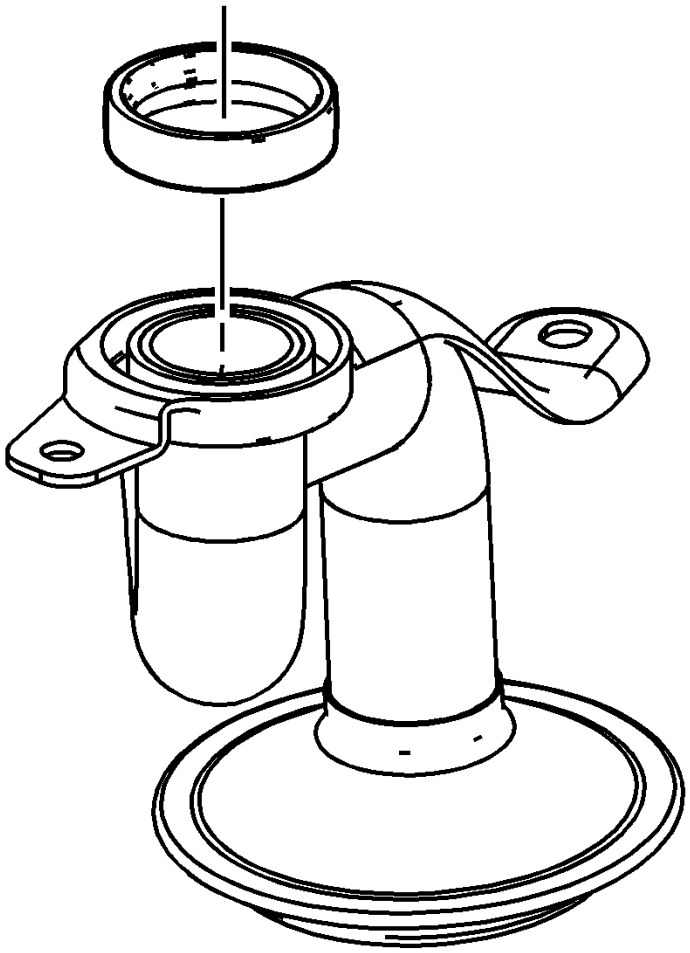


Fig. 246: View Of Oil Suction Tube Seal & Oil Suction Tube
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW oil suction tube seal onto the oil suction tube. DO NOT reuse the old oil suction tube seal.

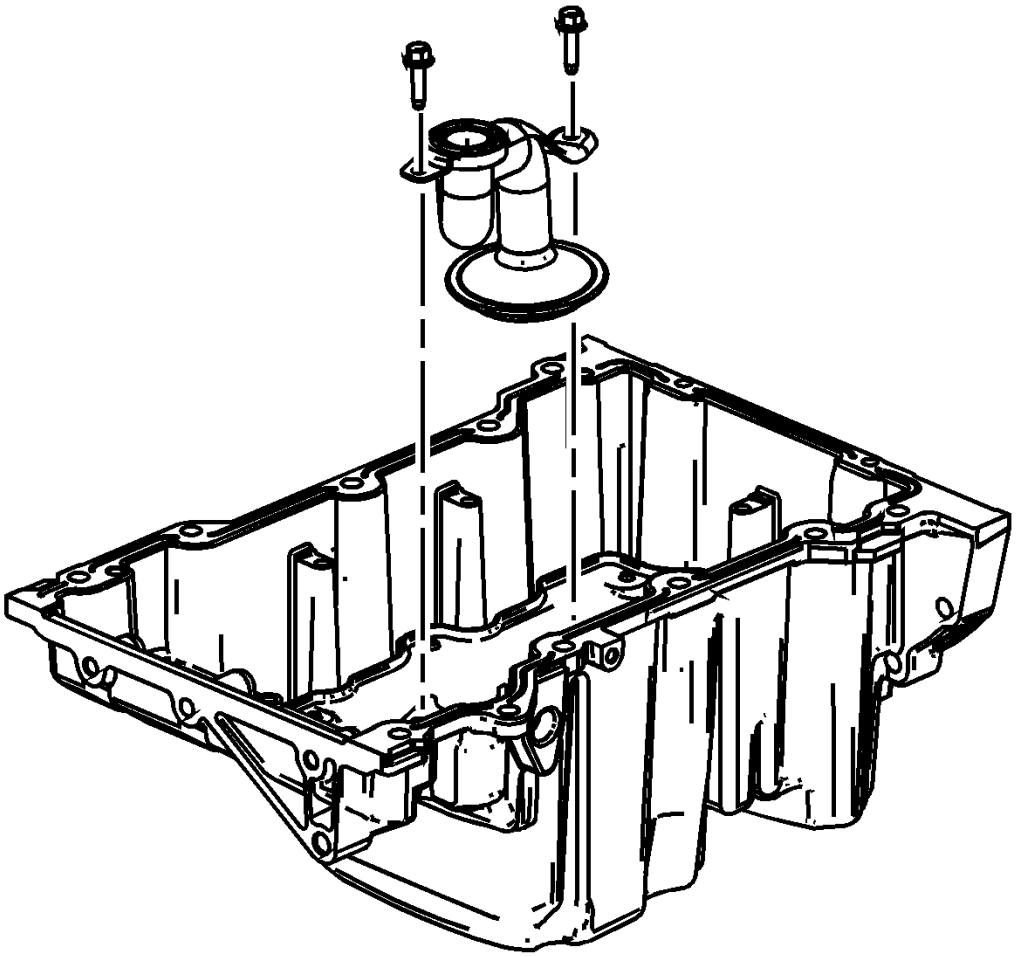


Fig. 247: View Of Oil Suction Pipe
Courtesy of GENERAL MOTORS COMPANY

2. Install the oil suction pipe.

CAUTION: Refer to Fastener Caution .

3. Install the oil suction pipe bolts and tighten to 10 N.m (89 lb in).

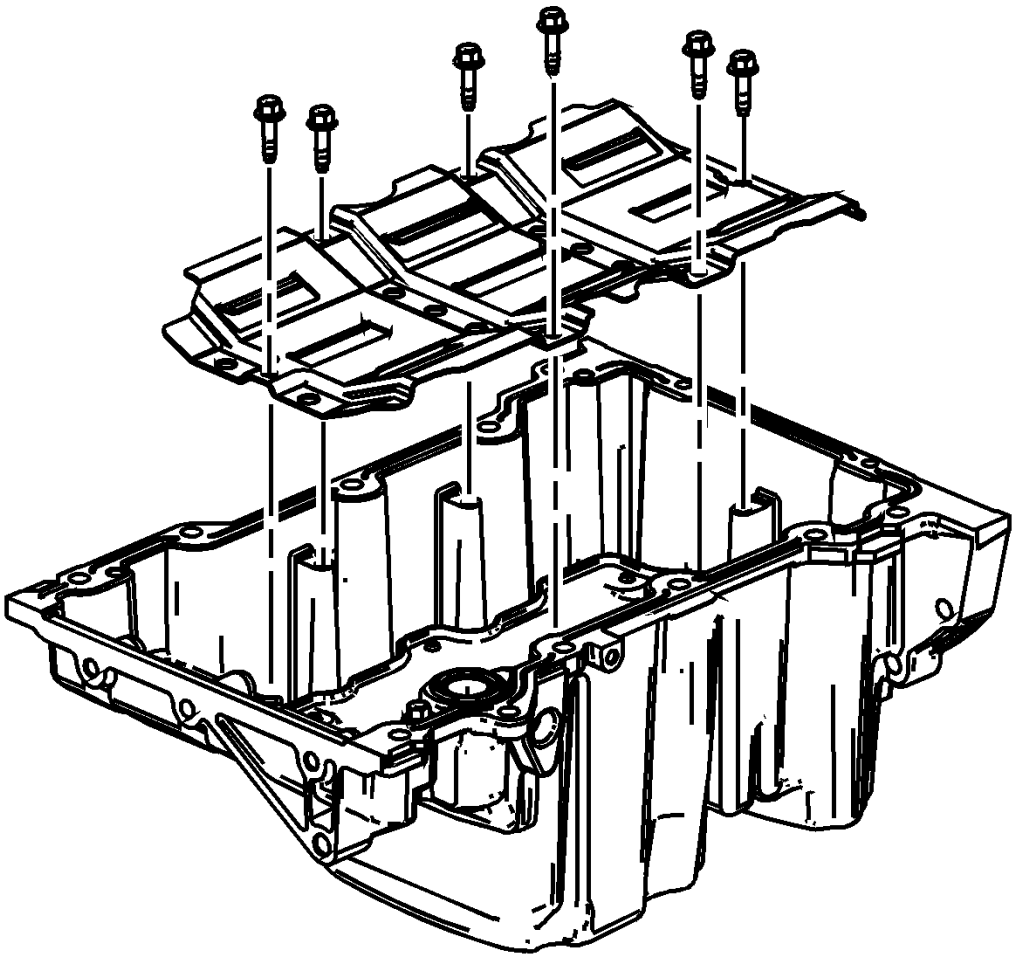


Fig. 248: View Of Oil Pan Scraper And Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Install the oil pan scraper.
5. Install the oil pan scraper bolts and tighten to 10 N.m (89 lb in).
6. Install the oil pan. Refer to **Oil Pan Replacement**.

ENGINE REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

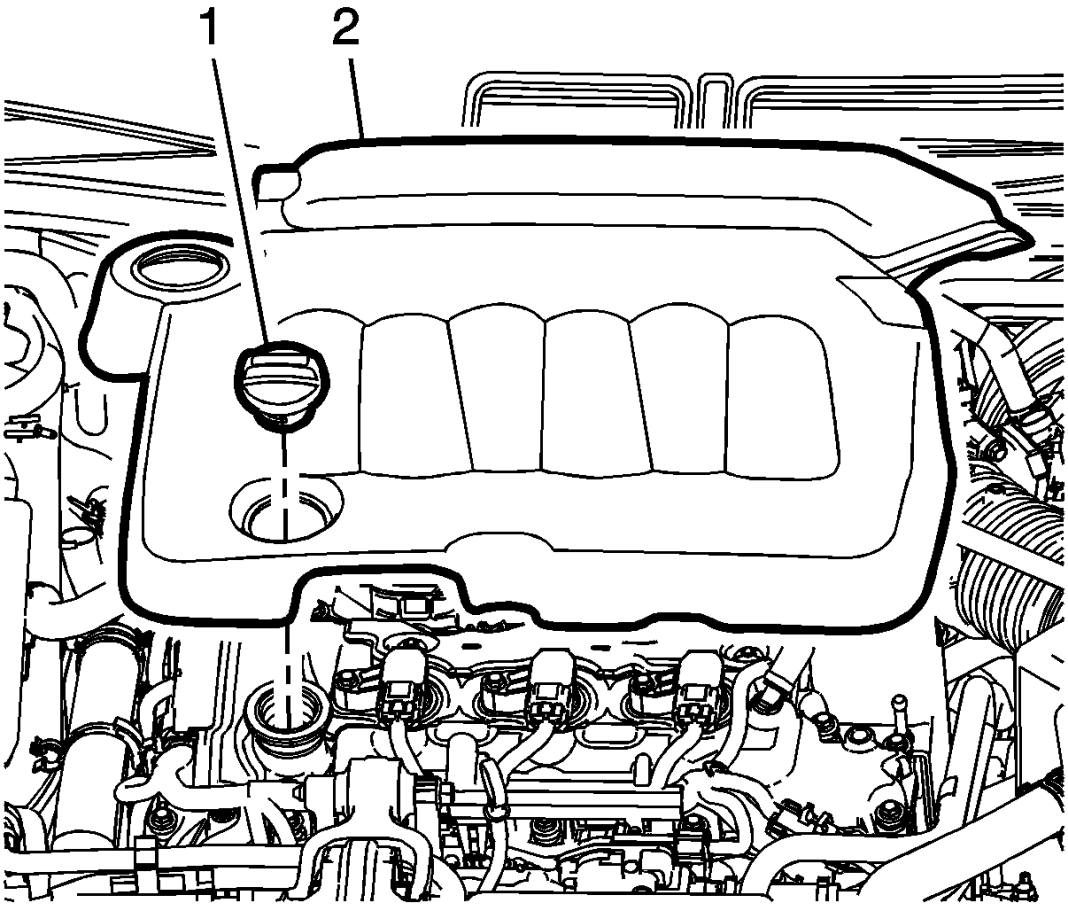


Fig. 249: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

2. Remove the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.
3. Drain the cooling system. Refer to **Cooling System Draining and Filling** .
4. Relieve fuel system pressure. Refer to **Fuel Pressure Relief (Without CH 48027)** **Fuel Pressure Relief (CH 48027)** **Fuel Pressure Relief (High Side)** .

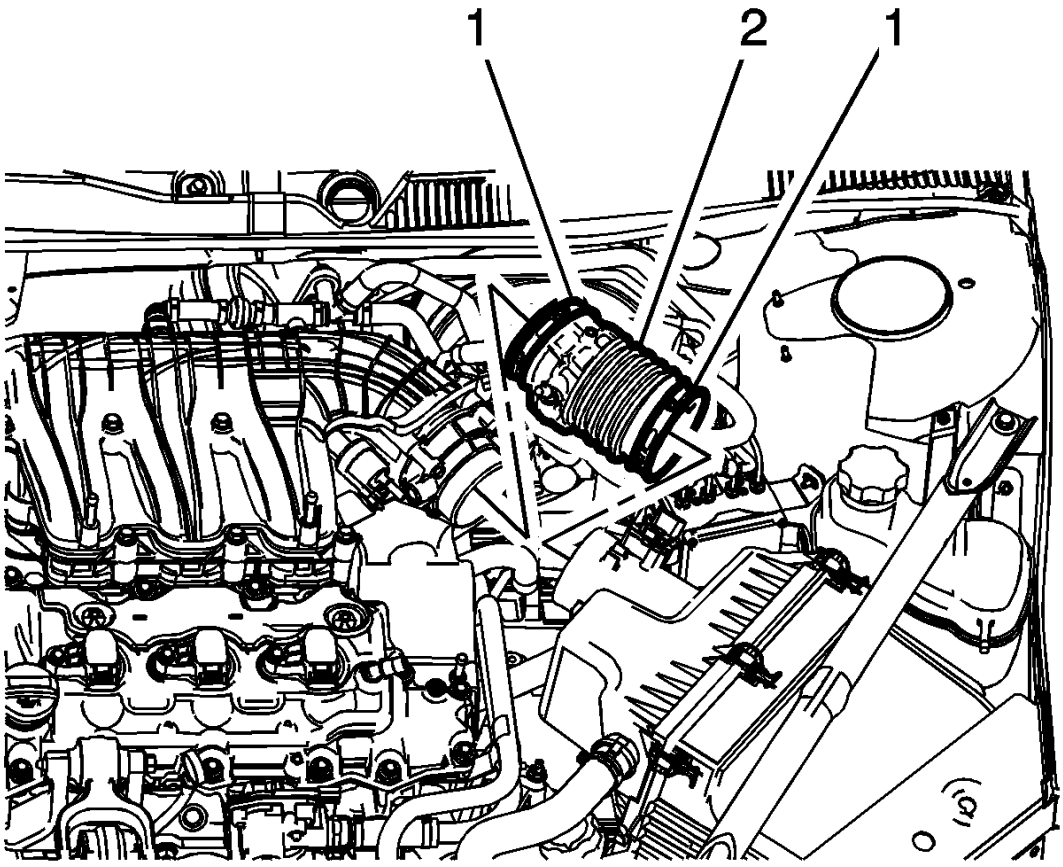


Fig. 250: Air Cleaner Outlet Duct And Clamps
Courtesy of GENERAL MOTORS COMPANY

5. Remove the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .
6. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
7. Remove the drive belt. Refer to **Drive Belt Replacement**.

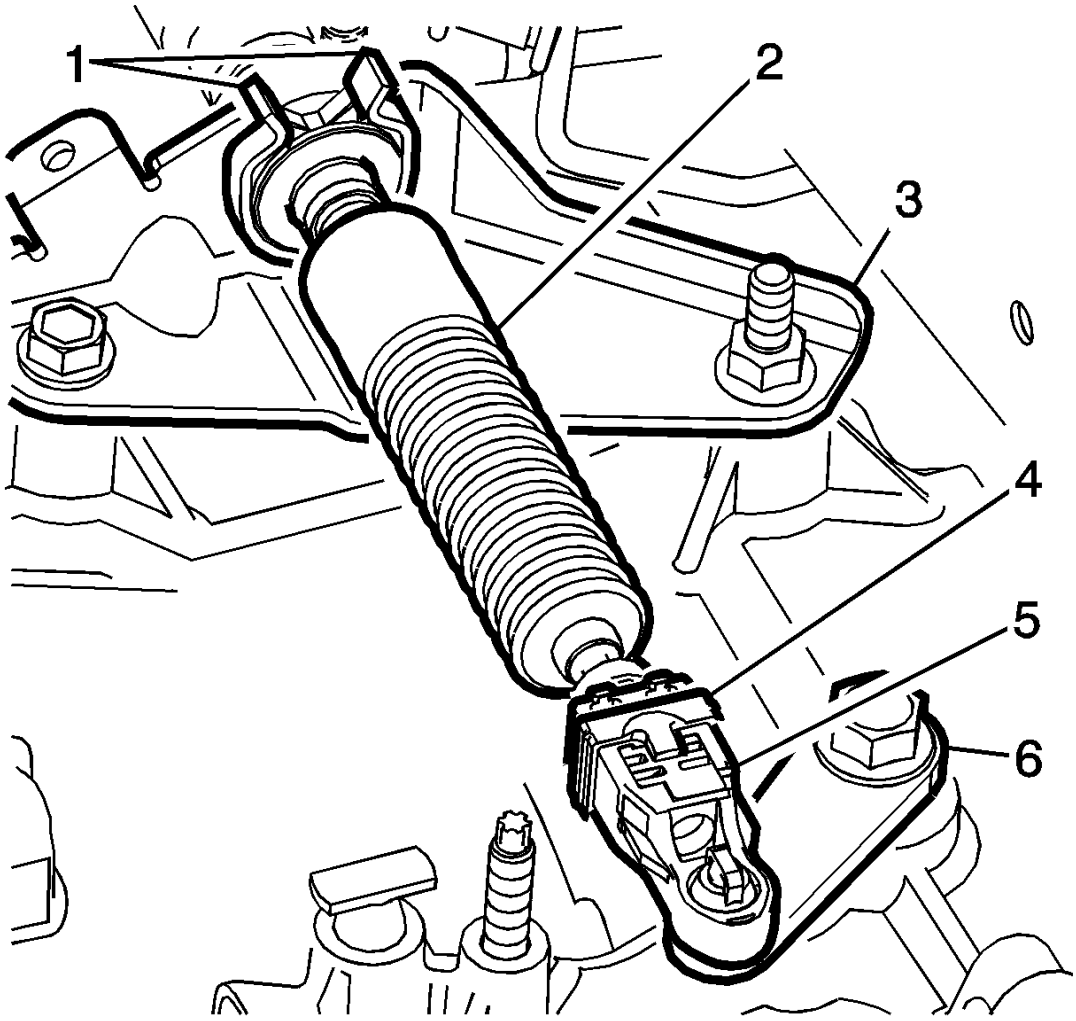


Fig. 251: Transmission Shifter Cable
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the transmission shiftier cable (2) from the transmission. Refer to **Range Selector Lever Cable Replacement (Column Shift)** **Range Selector Lever Cable Replacement (Floor Shift)** .

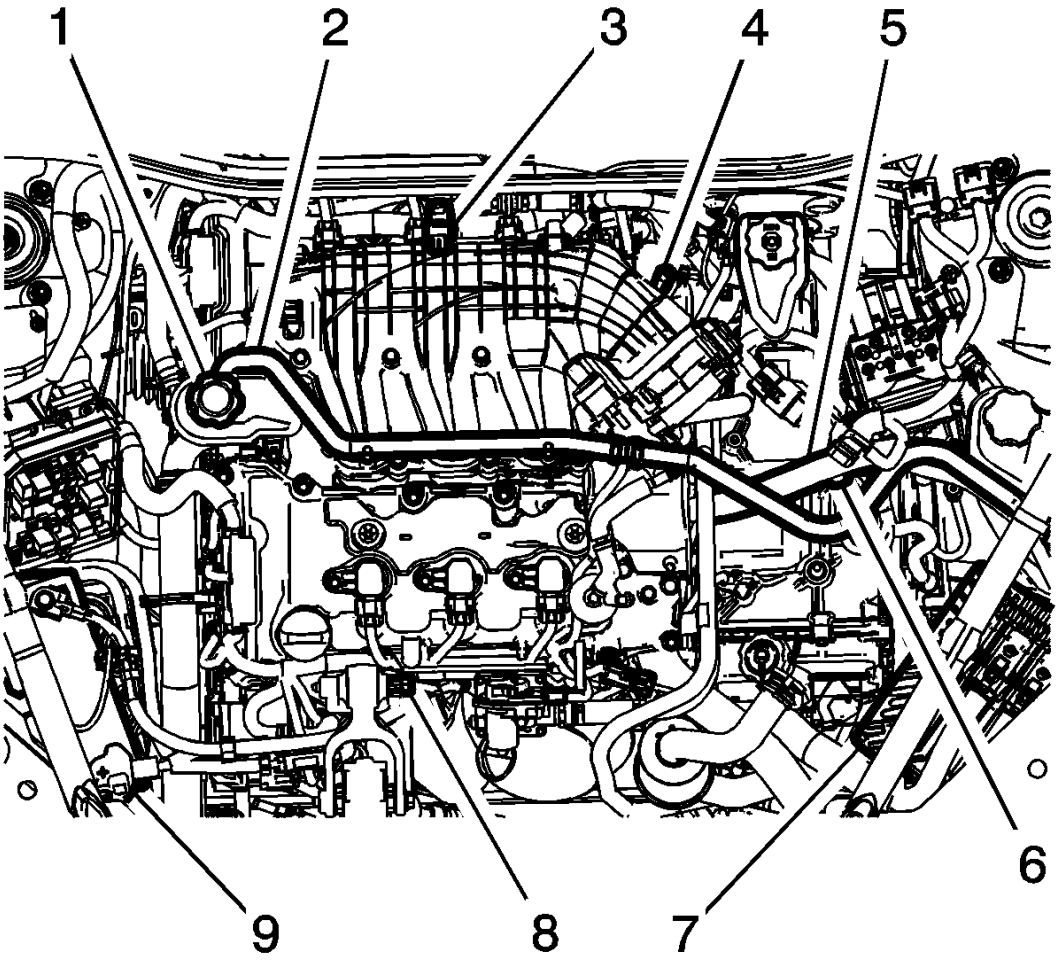


Fig. 252: Locating Engine Components
Courtesy of GENERAL MOTORS COMPANY

9. Remove and reposition the power steering fluid reservoir (1). Refer to **Power Steering Fluid Reservoir Replacement**
10. Disconnect the surge tank inlet hose (2) from the engine and position aside.
11. Disconnect the brake booster vacuum hose (3) and position aside.
12. Disconnect the fuel pump fuel feed hose from the fuel feed pipe (4). Refer to **Metal Collar Quick Connect Fitting Service** .
13. Disconnect the surge tank outlet hose (5) from the engine and position aside.
14. Disconnect the ground wire terminals (6) from the transmission.
15. Disconnect the ECM connectors (7) and place the harness on the engine.
16. Remove the engine strut bolt (8).
17. Disconnect the positive battery cable (9) in position cable on the engine.

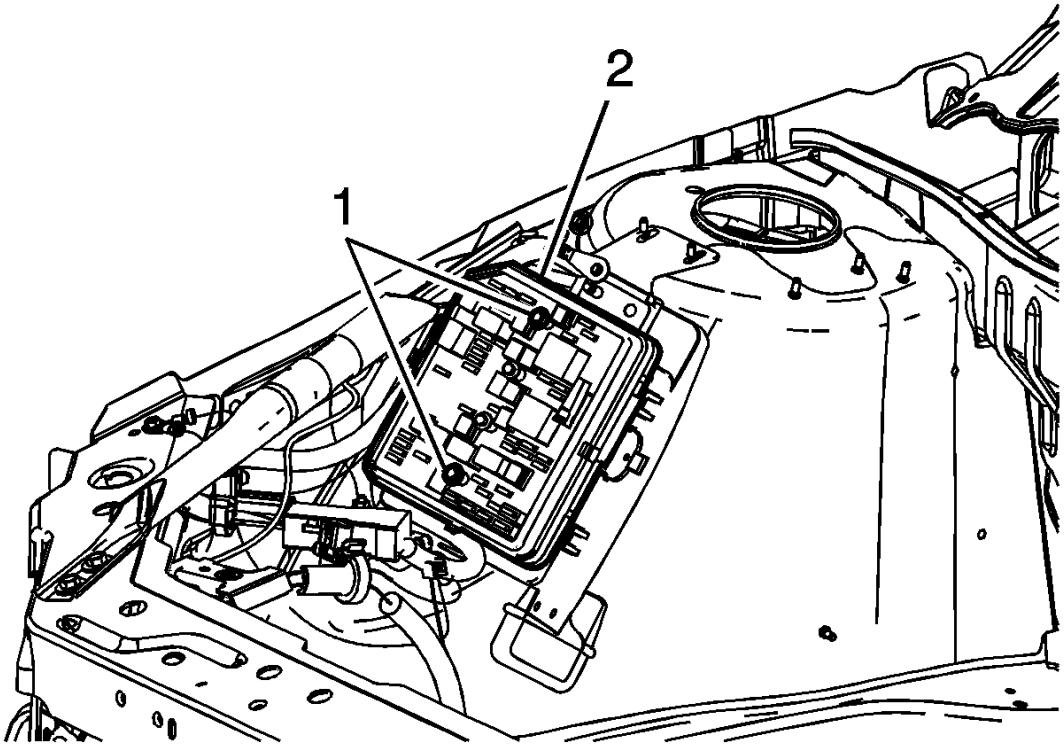


Fig. 253: Identifying Fasteners & Electrical Center Board
Courtesy of GENERAL MOTORS COMPANY

18. Remove the accessory wiring junction block circuit board (2). Refer to **Accessory Wiring Junction Block Replacement** .
19. Remove the engine harness connector and position on the engine.

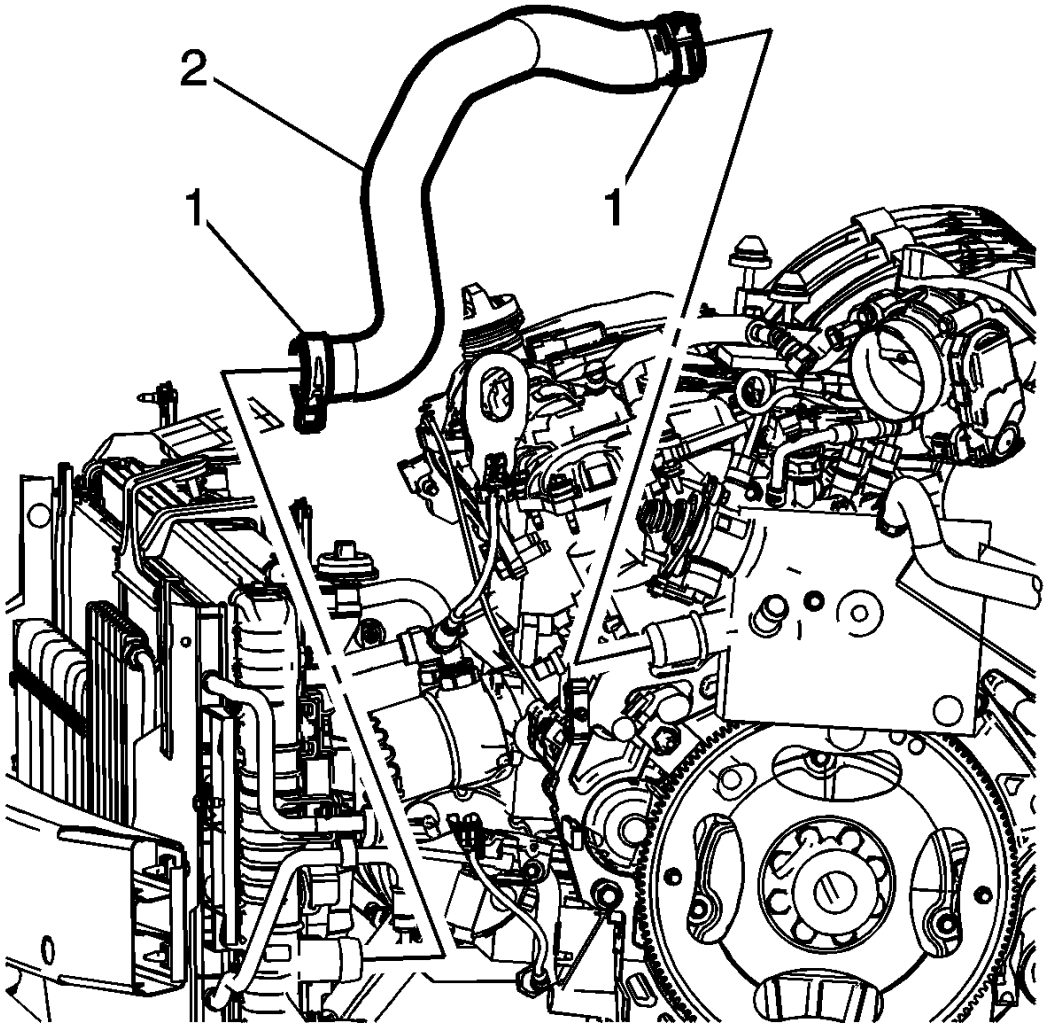


Fig. 254: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

20. Disconnect the radiator outlet hose (2) from the engine. Refer to **Radiator Outlet Hose Replacement** .

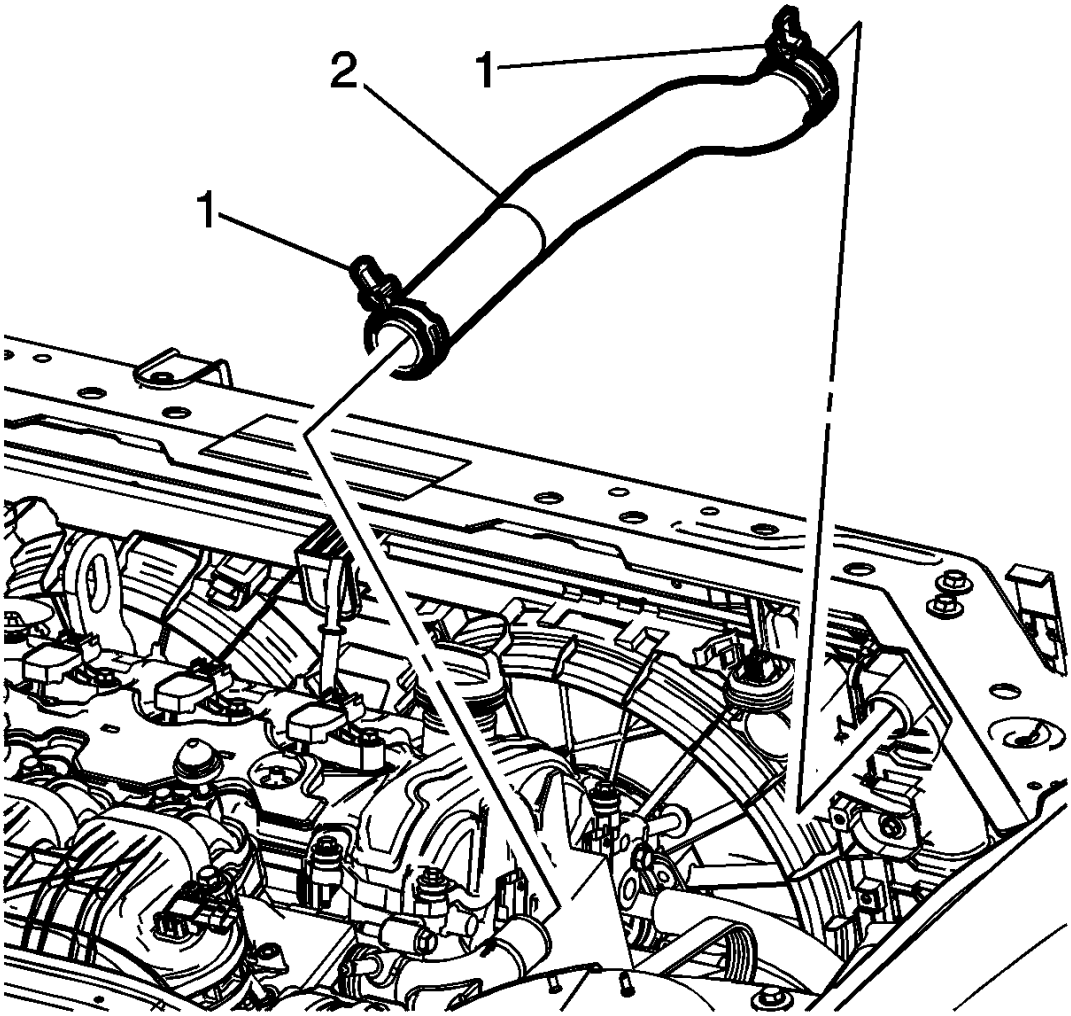


Fig. 255: Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

21. Disconnect the radiator inlet hose (2) from the engine. Refer to **Radiator Inlet Hose Replacement** .
22. Disconnect the heater inlet and outlet hoses from the heater core. Refer to **Heater Outlet Hose Replacement** , and **Heater Inlet Hose Replacement** .
23. Place the vehicle on the hoist.
24. Remove the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
25. Remove both front wheels. Refer to **Tire and Wheel Removal and Installation** .

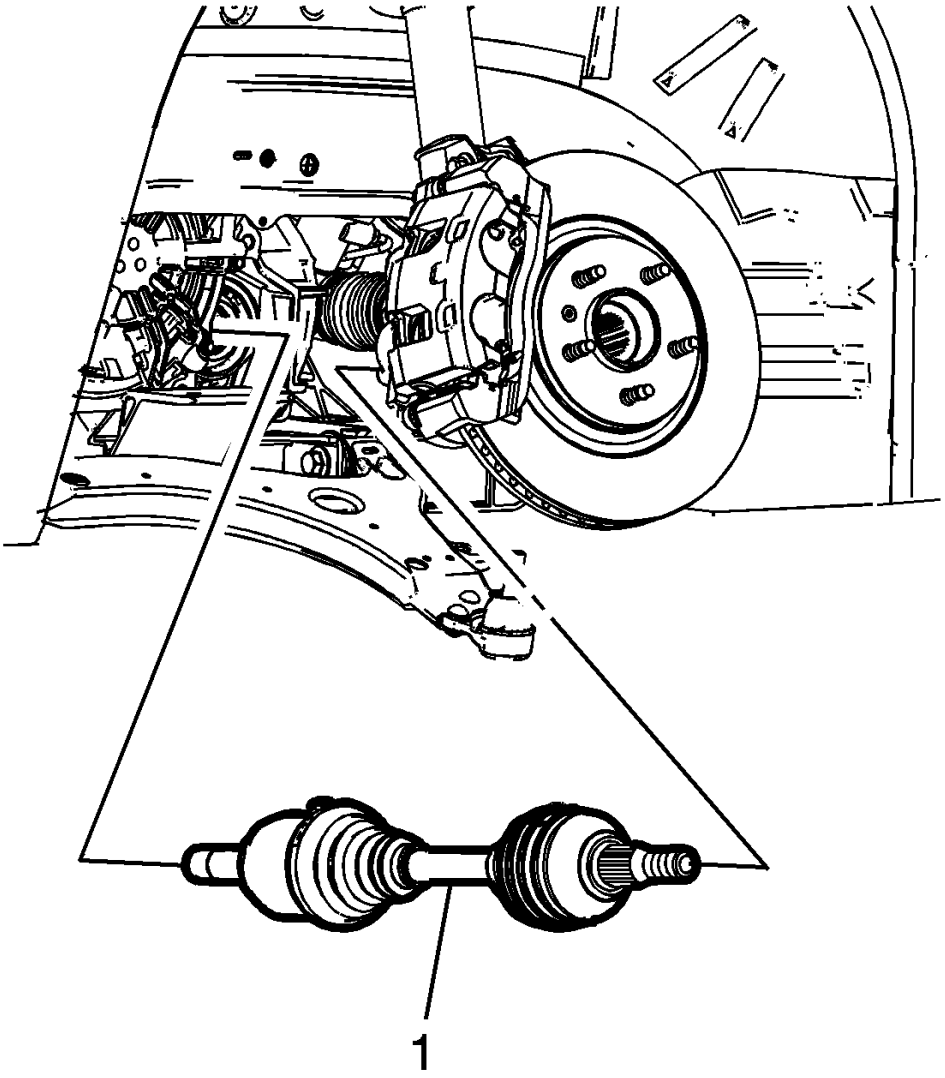


Fig. 256: Left And Right Wheel Drive Shafts
Courtesy of GENERAL MOTORS COMPANY

26. Remove the left and right wheel drive shafts (2). Refer to **Wheel Drive Shaft Replacement (Left Side)** **Wheel Drive Shaft Replacement (Right Side)** .

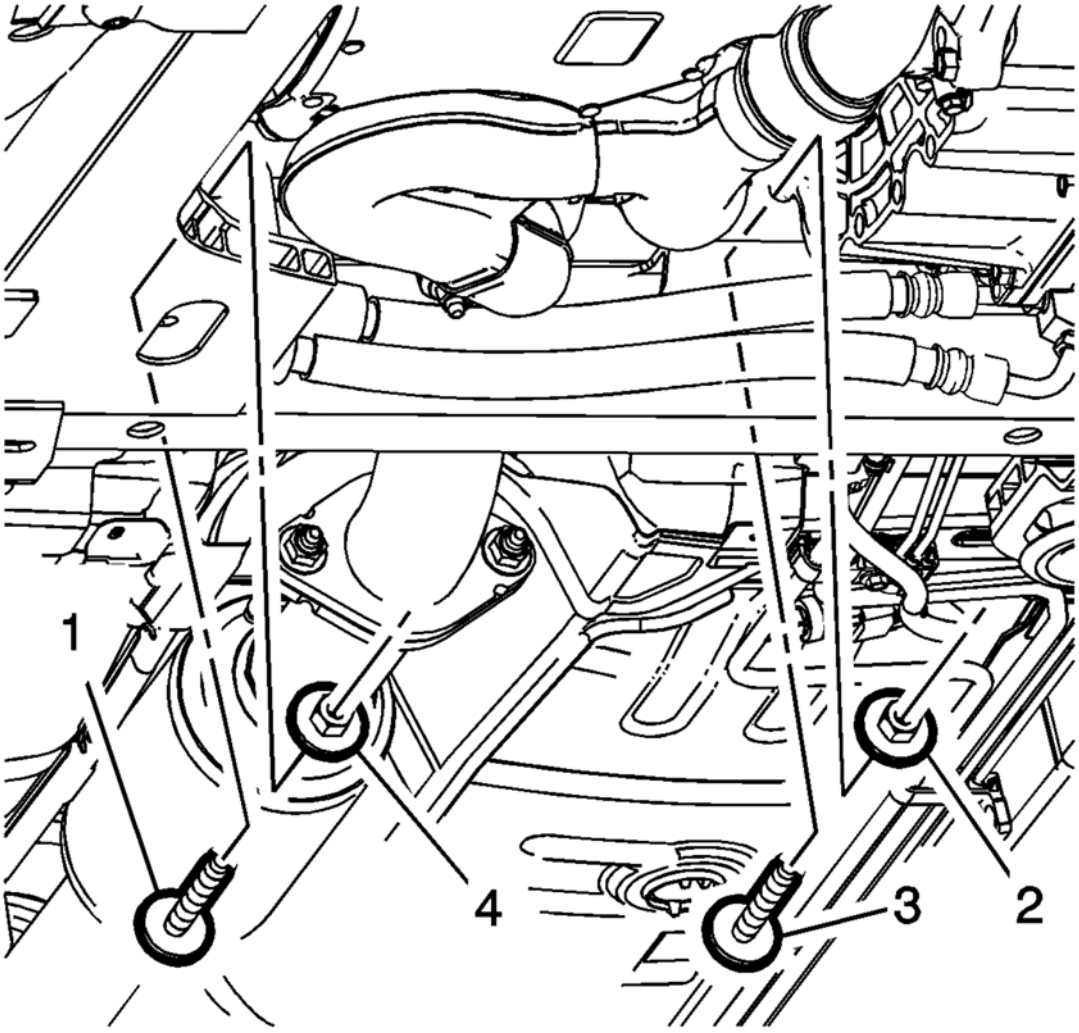


Fig. 257: Steering Gear Bolts And Nuts
Courtesy of GENERAL MOTORS COMPANY

27. Remove the steering gear bolts (1 and 3) and secure steering gear to the vehicle body. Refer to **Steering Gear Replacement** .

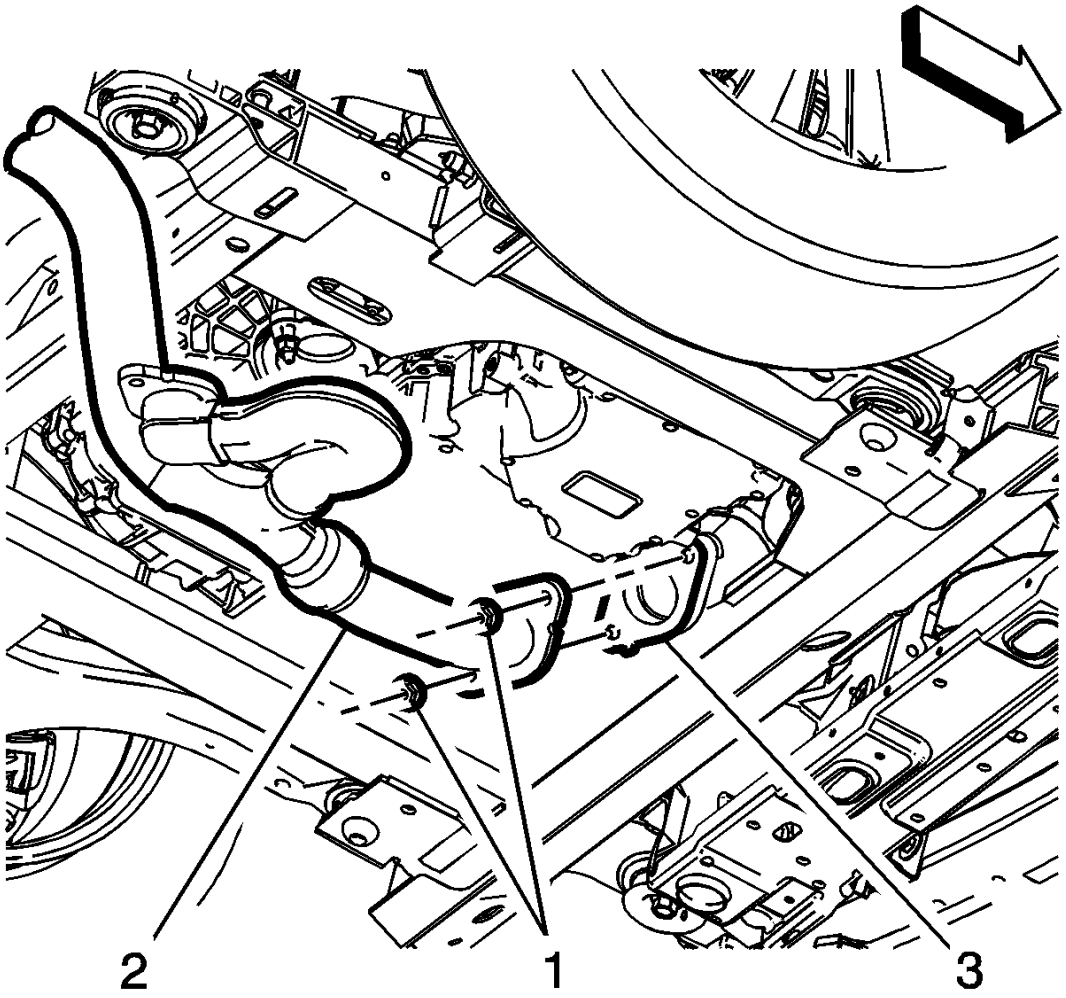


Fig. 258: Front Exhaust Pipe
Courtesy of GENERAL MOTORS COMPANY

28. Remove the front exhaust pipe (2). Refer to **Exhaust Front Pipe Replacement** .

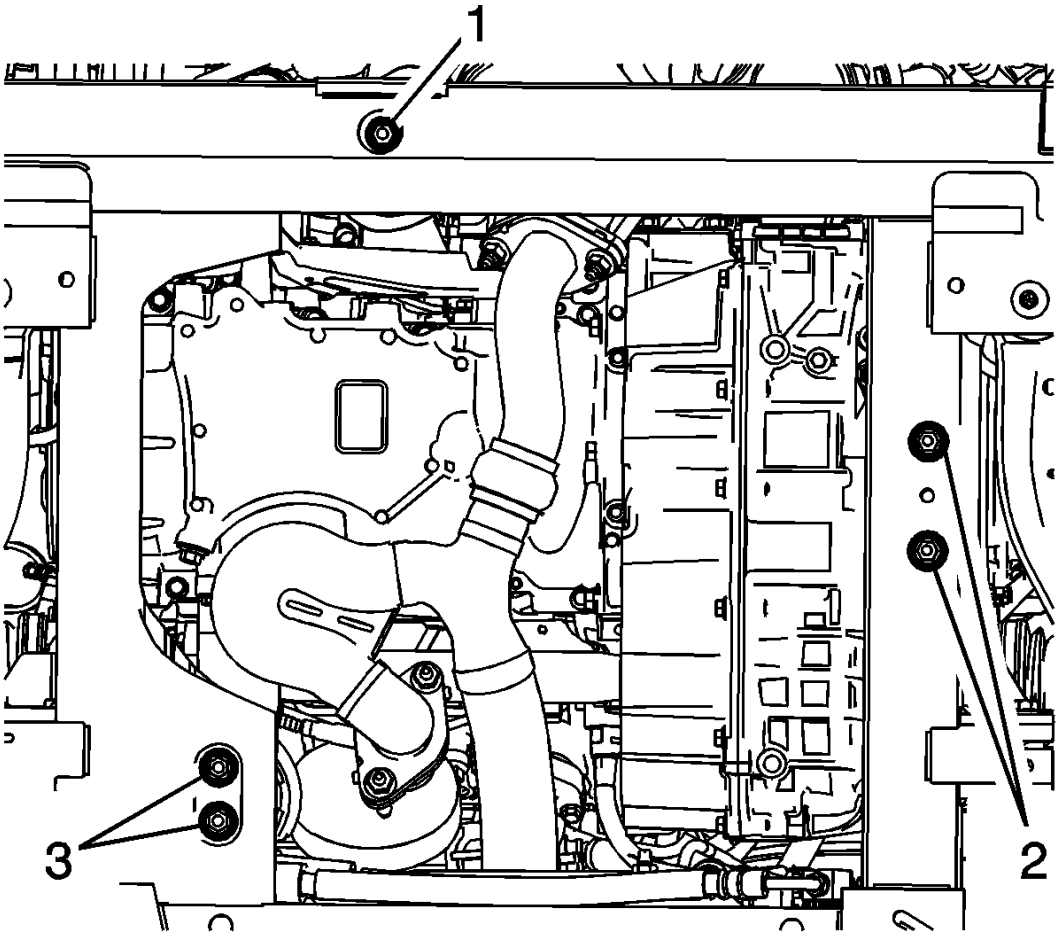


Fig. 259: Engine Mount Fasteners
Courtesy of GENERAL MOTORS COMPANY

29. Remove the lower engine mount fasteners (1-3).
30. Disconnect the transmission fluid cooler pipes . Refer to **Fluid Cooler Inlet Hose Replacement** , and **Fluid Cooler Outlet Hose Replacement** .

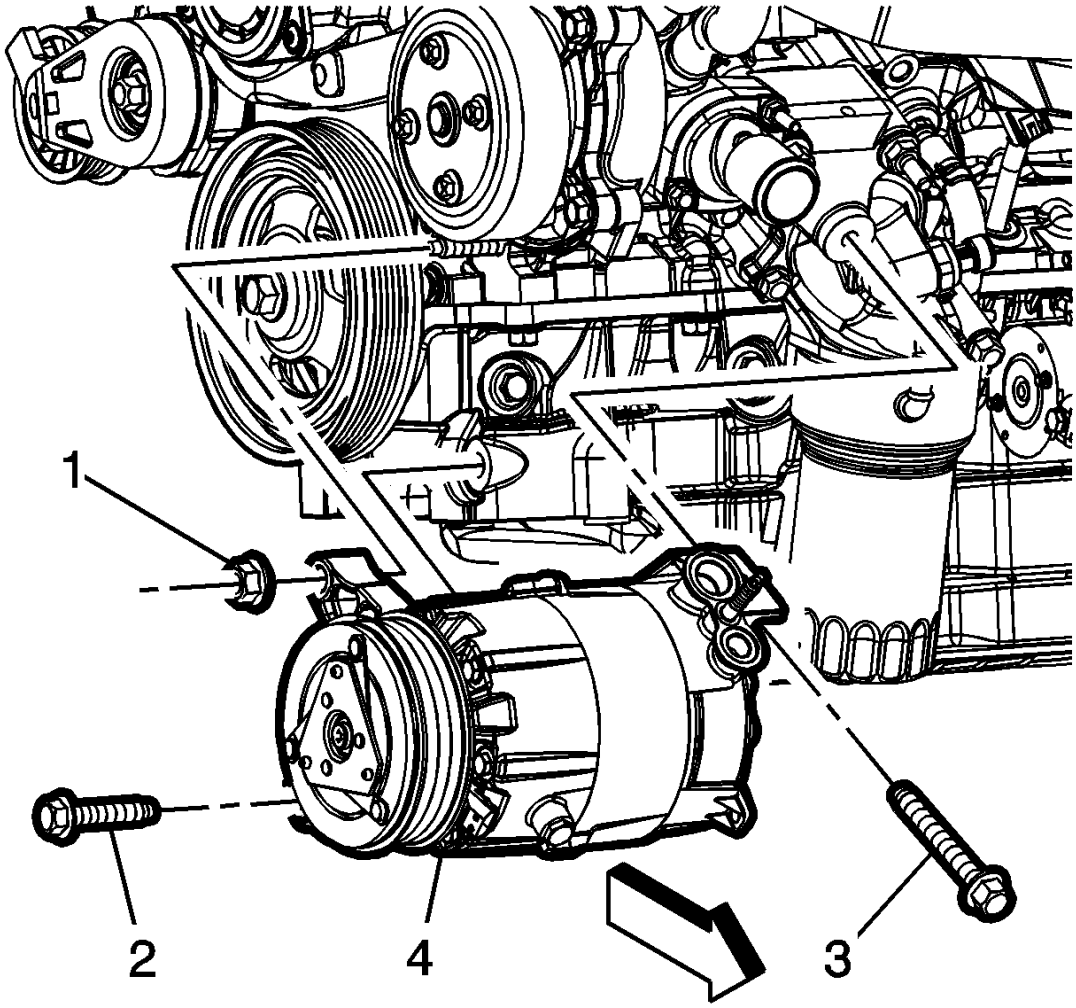


Fig. 260: Air Conditioning Compressor Fasteners
Courtesy of GENERAL MOTORS COMPANY

31. Remove the air conditioning compressor fasteners (1-3) and using mechanics wire, secure the compressor to the radiator support.

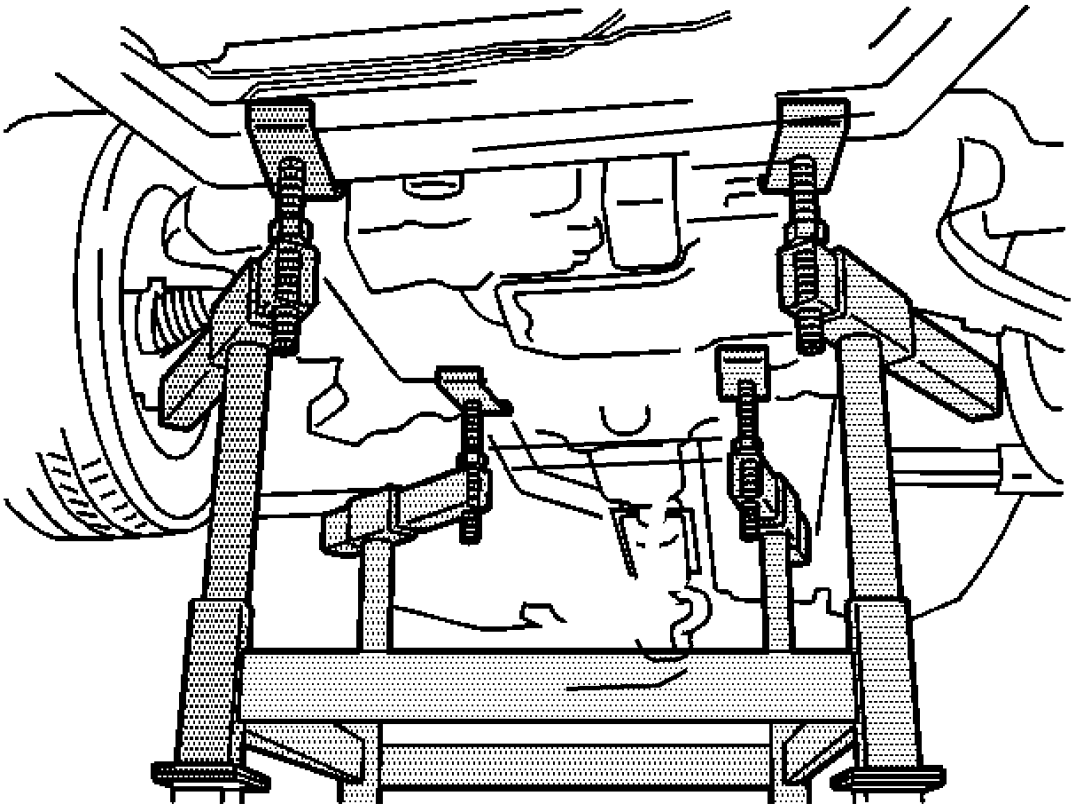


Fig. 261: Identifying Utility Stand
Courtesy of GENERAL MOTORS COMPANY

32. Position a suitable engine support table under the vehicle and carefully lower the vehicle until the engine cradle is supported by the table.

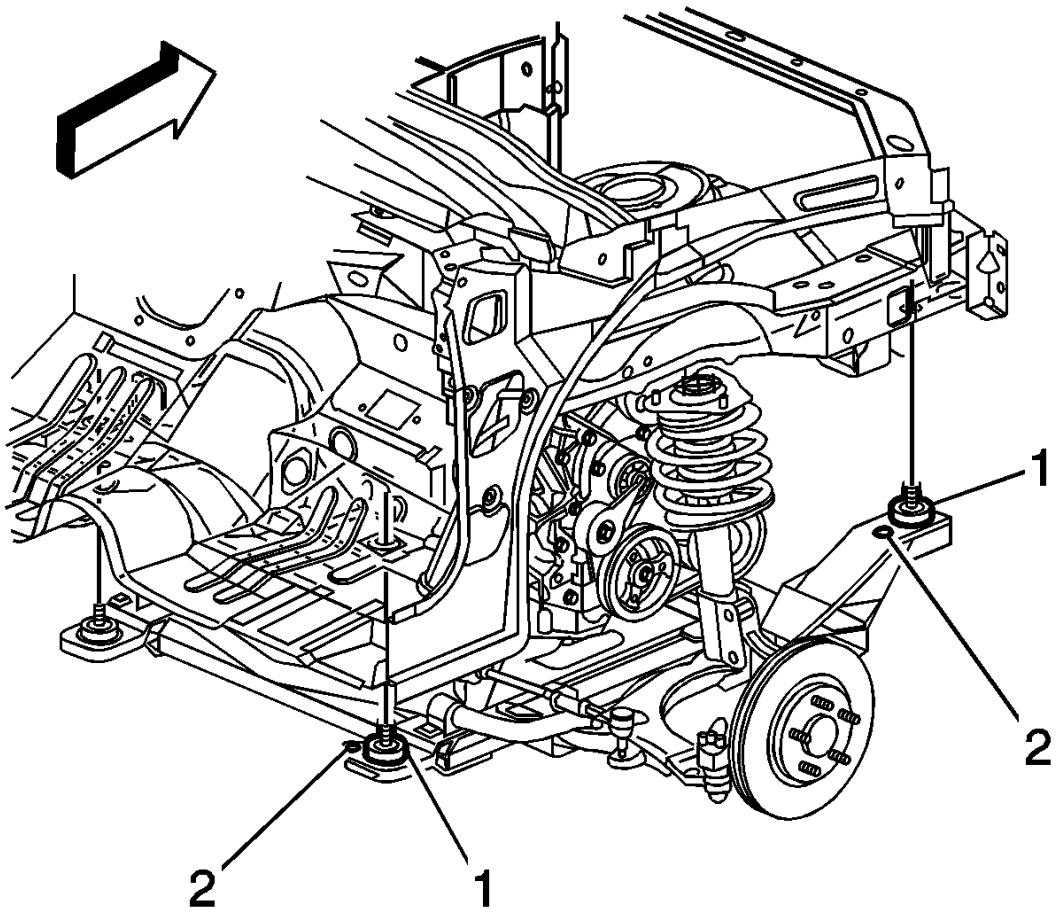


Fig. 262: Frame Securing Bolts
Courtesy of GENERAL MOTORS COMPANY

33. Remove the front and rear frame to the body bolts (1). Refer to **Frame Replacement**
34. Carefully raise the vehicle from the powertrain.
35. Disconnect and reposition harnesses as required.
36. Lift the powertrain assembly off the frame and place on the floor.
37. Separate the engine from the transmission. Refer to **Transmission Replacement** .
38. Disconnect electrical connectors as necessary.

Installation Procedure

1. Install the engine to the transmission. Refer to **Transmission Replacement** .
2. Place the powertrain assembly on the frame.
3. Place the powertrain and frame assembly on a suitable engine support table.
4. Position the powertrain assembly under the vehicle

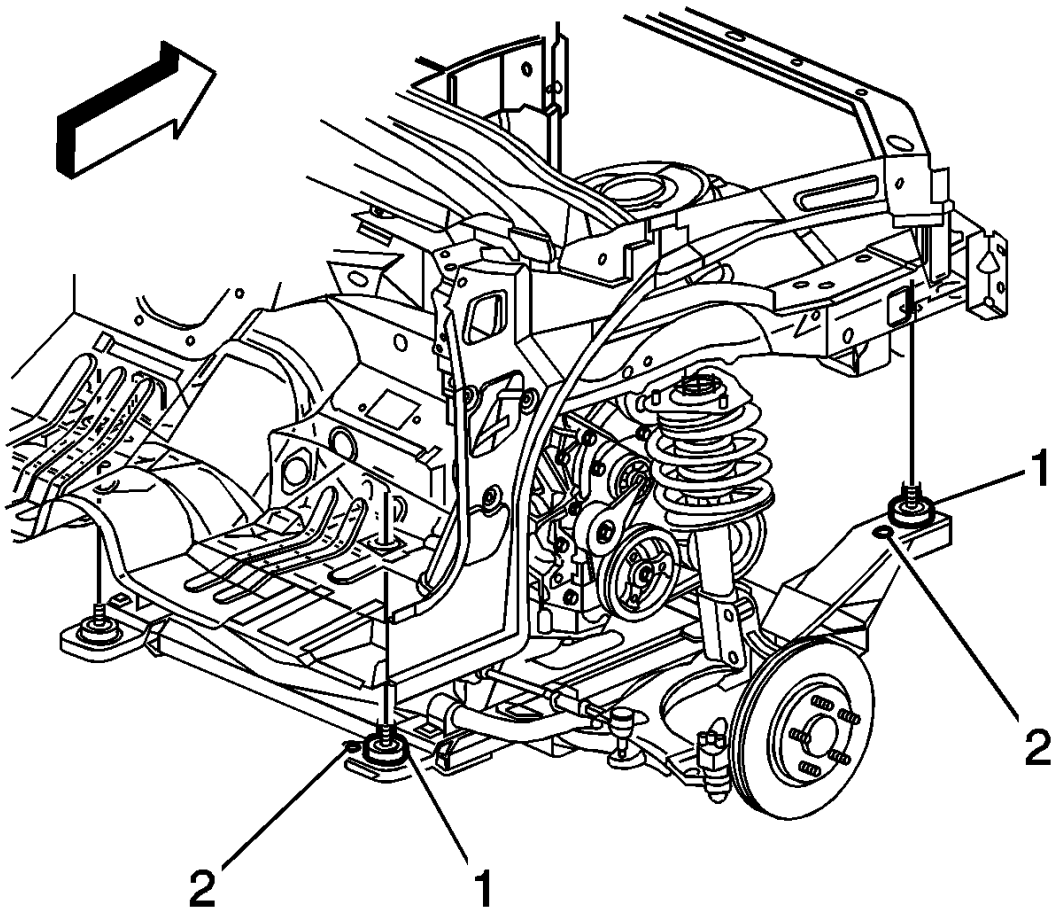


Fig. 263: Frame Securing Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Install the front and rear frame to the body bolts (1). Refer to **Frame Replacement**
6. Remove the engine support table.

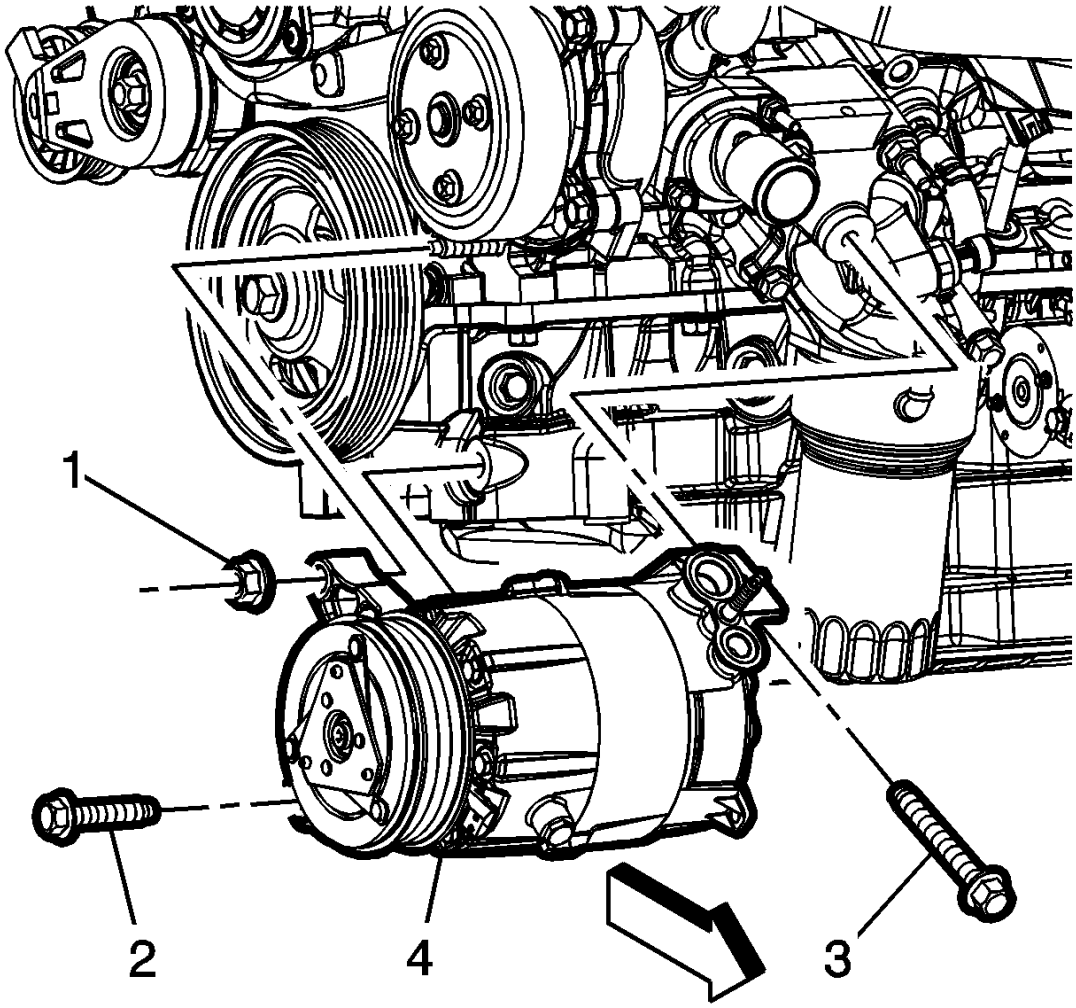


Fig. 264: Air Conditioning Compressor Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Cut the wire and position the air conditioning compressor.
8. Install the air conditioning fasteners (1-3) and tighten as shown in **Air Conditioning Compressor Replacement** .
9. Connect the transmission fluid cooler pipes . Refer to **Fluid Cooler Inlet Hose Replacement** , and **Fluid Cooler Outlet Hose Replacement** .

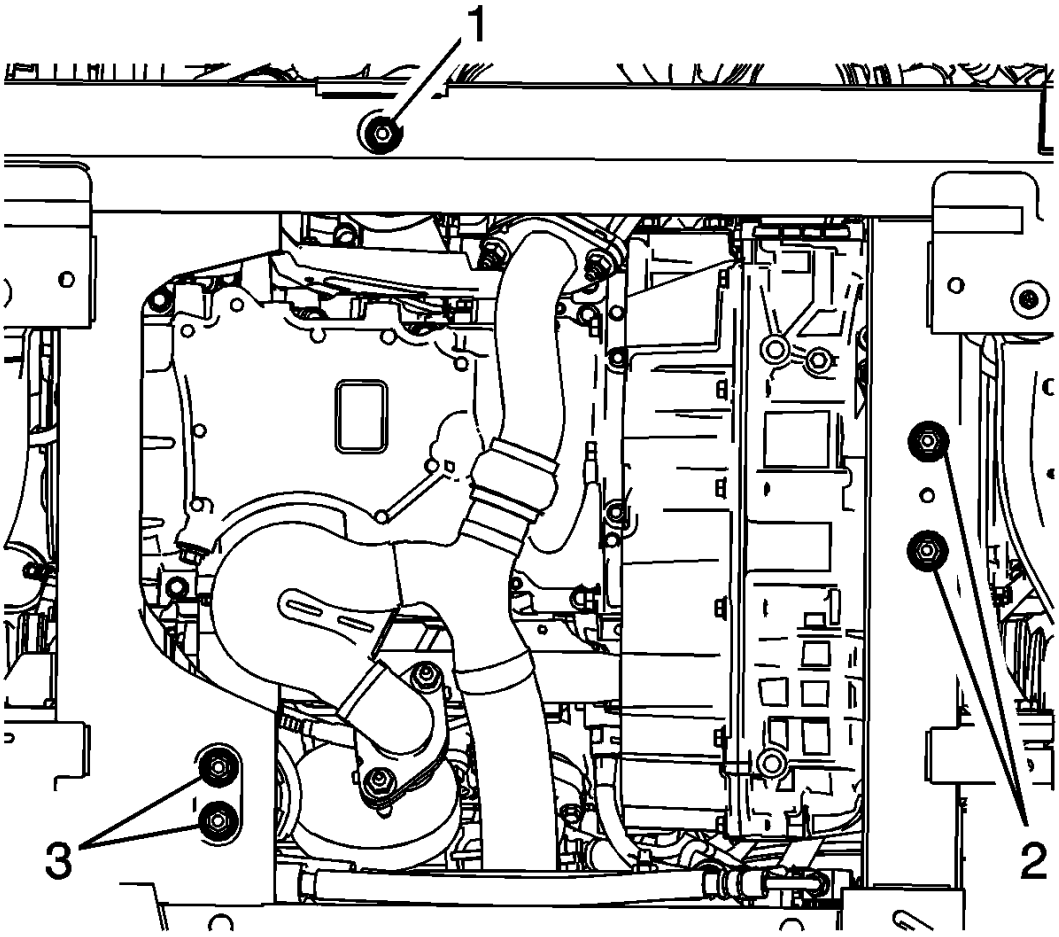


Fig. 265: Engine Mount Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Install the lower engine mount fasteners (1-3). Refer to **Engine Front Mount Replacement**, **Engine Rear Mount Replacement**, and **Transmission Mount Replacement - Left Side** .

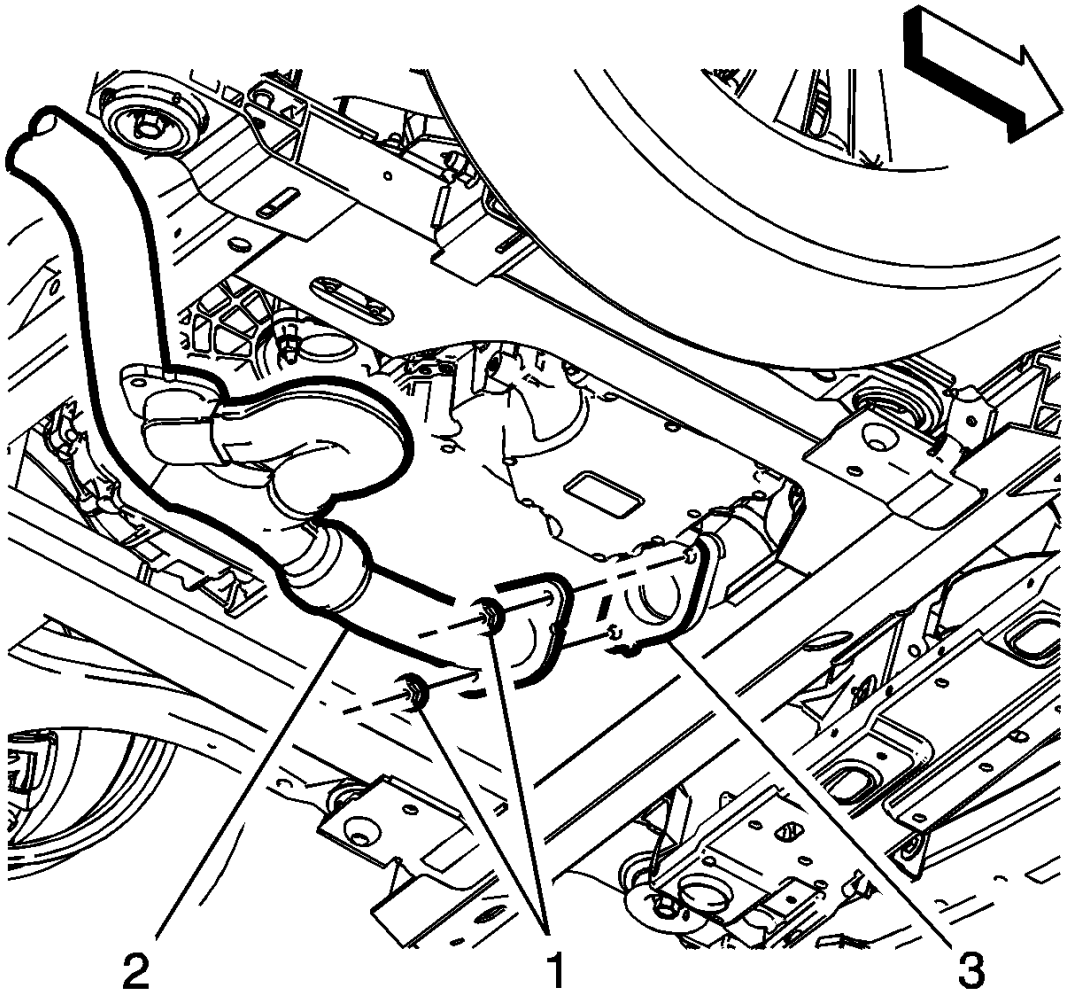


Fig. 266: Front Exhaust Pipe
Courtesy of GENERAL MOTORS COMPANY

11. Install the front exhaust pipe (2). Refer to **Exhaust Front Pipe Replacement** .

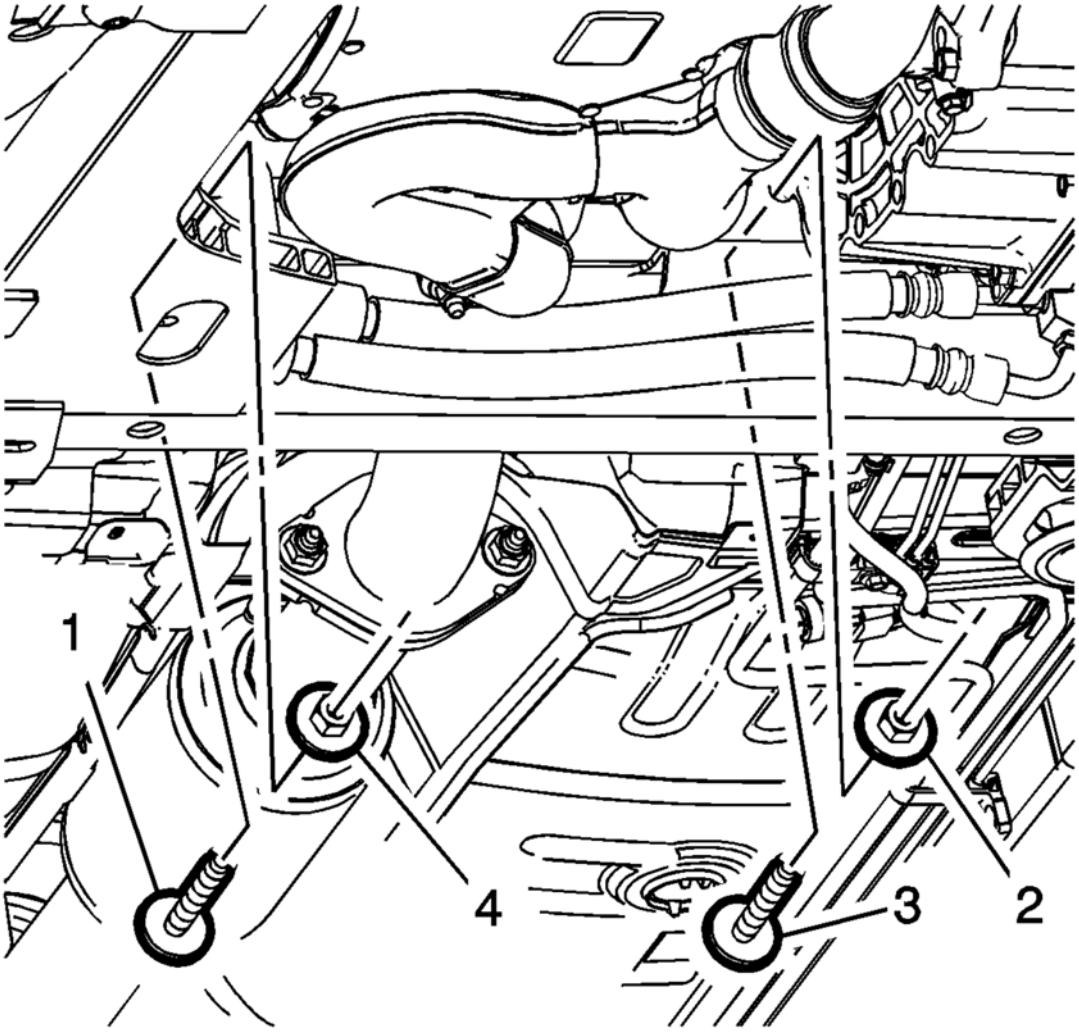


Fig. 267: Steering Gear Bolts And Nuts
Courtesy of GENERAL MOTORS COMPANY

12. Place the steering gear in position and install the steering gear bolts (1 and 3). Refer to **Steering Gear Replacement** .

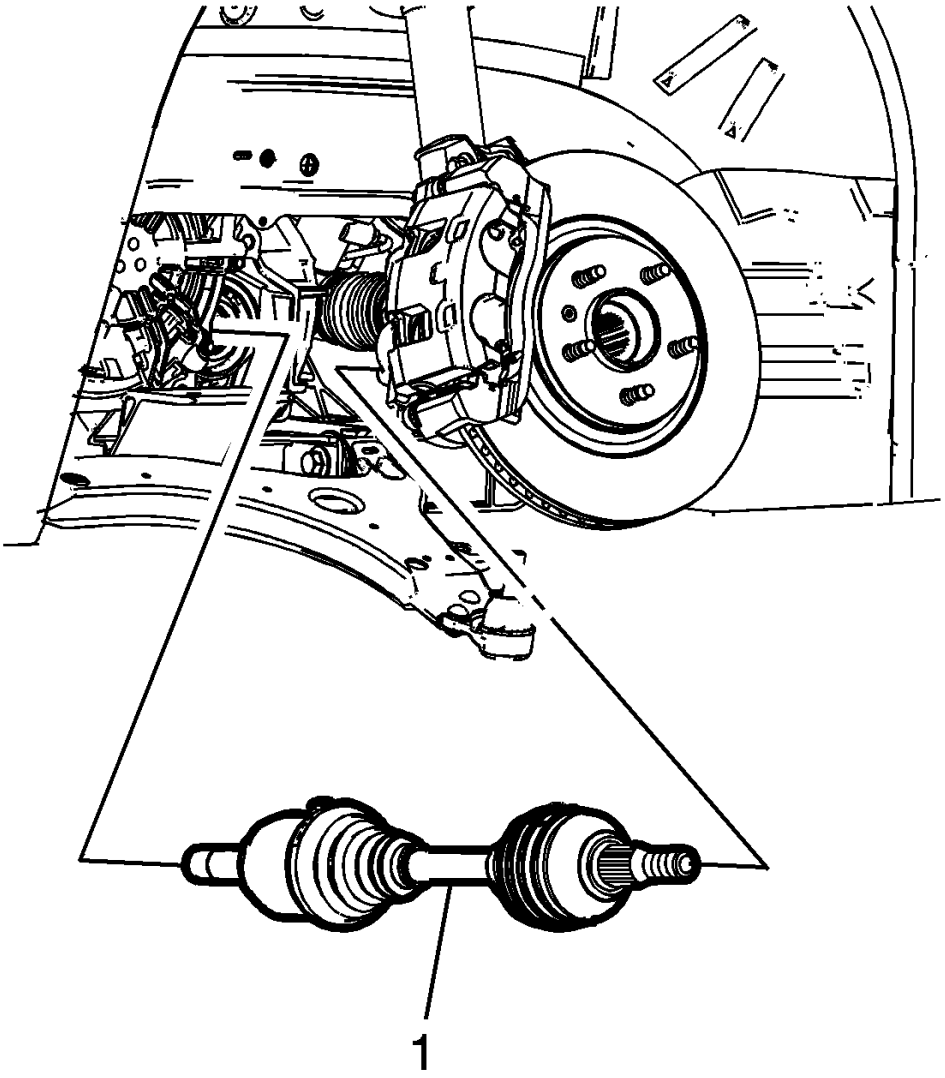


Fig. 268: Left And Right Wheel Drive Shafts
Courtesy of GENERAL MOTORS COMPANY

13. Install the left and right wheel drive shafts (2). Refer to **Wheel Drive Shaft Replacement (Left Side)** **Wheel Drive Shaft Replacement (Right Side)** .
14. Install the front wheels. Refer to **Tire and Wheel Removal and Installation** .

15. Install the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
16. Lower the vehicle.
17. Connect the heater inlet and outlet hoses to the heater core. Refer to **Heater Outlet Hose Replacement** , and **Heater Inlet Hose Replacement** .

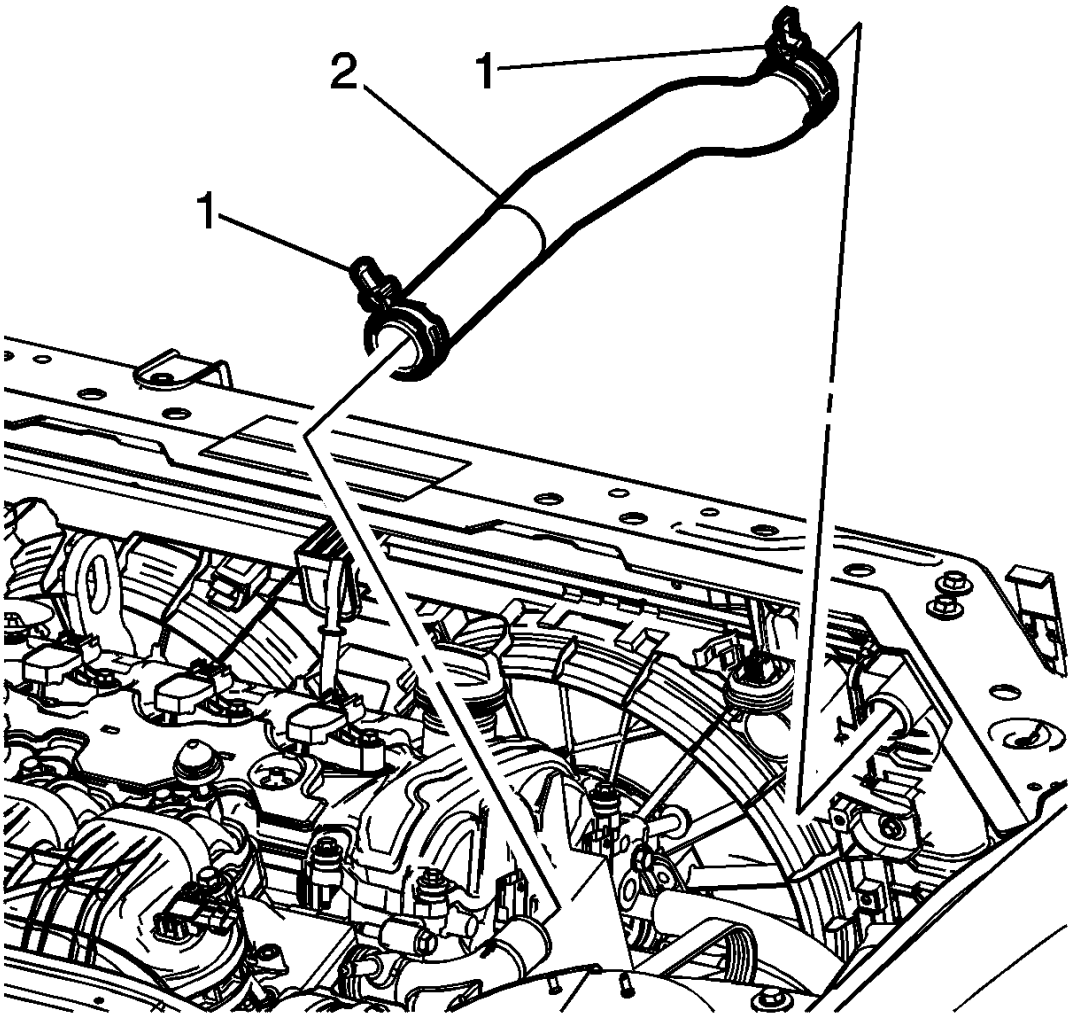


Fig. 269: Radiator Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

18. Connect the radiator inlet hose (2) from the engine. Refer to **Radiator Inlet Hose Replacement** .

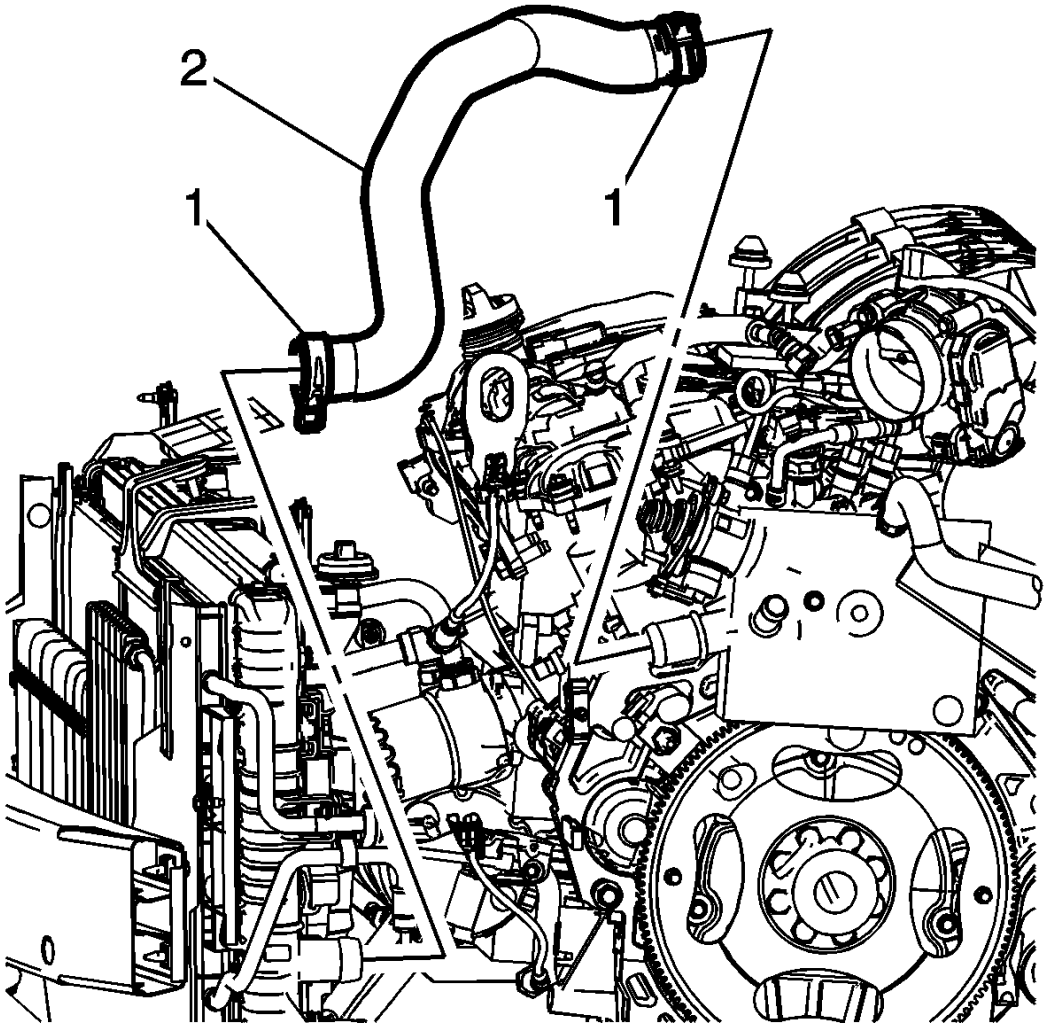


Fig. 270: Radiator Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

19. Connect the radiator outlet hose (2) from the engine. Refer to **Radiator Outlet Hose Replacement** .

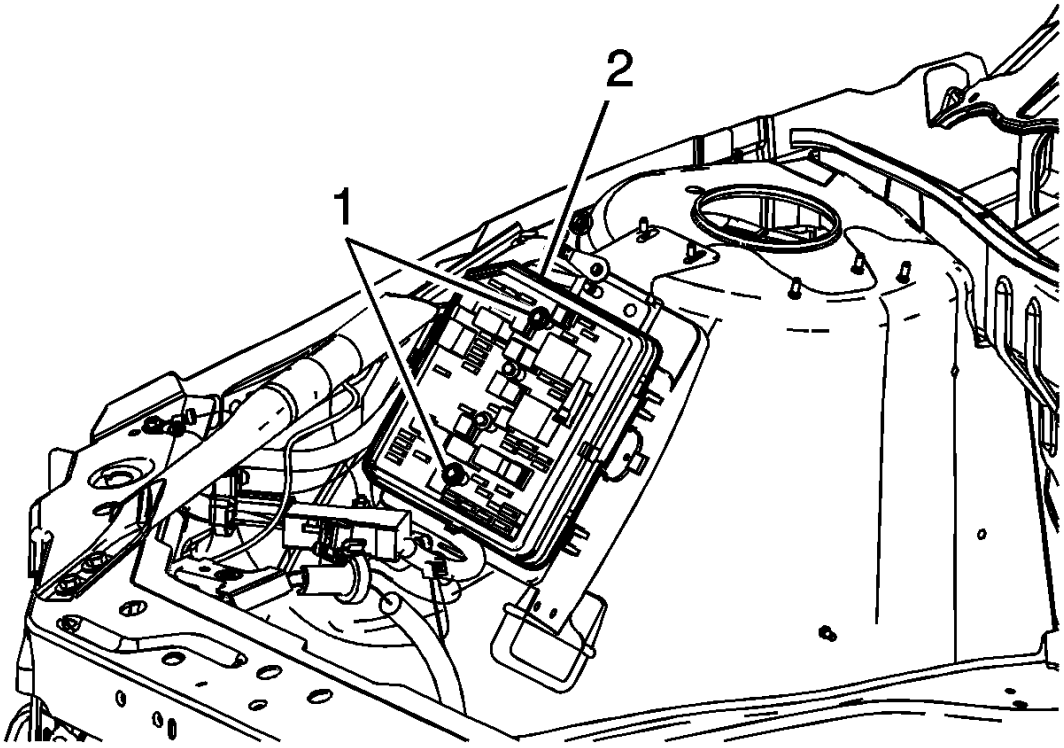


Fig. 271: Identifying Fasteners & Electrical Center Board
Courtesy of GENERAL MOTORS COMPANY

20. Position the engine harness connector in the accessory wiring junction block.
21. Install the accessory wiring junction block circuit board (2). Refer to **Accessory Wiring Junction Block Replacement** .

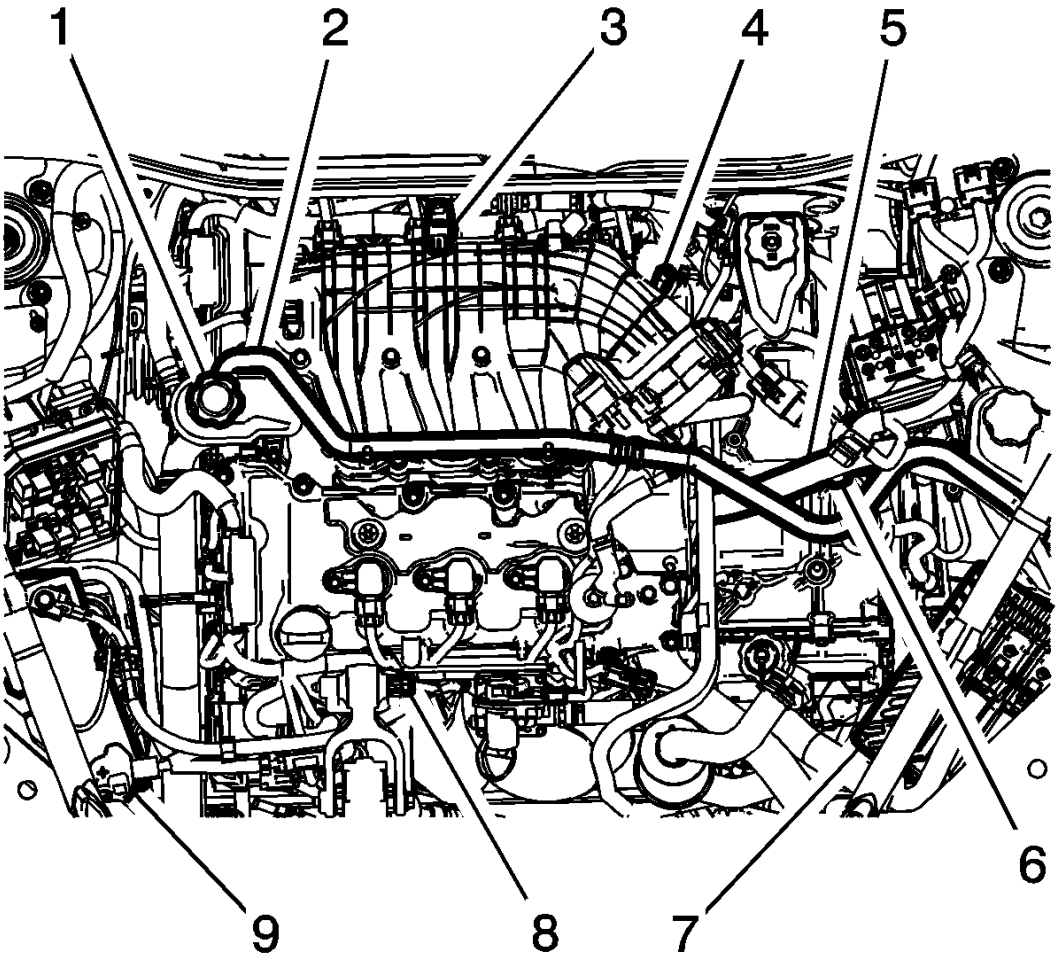


Fig. 272: Locating Engine Components
Courtesy of GENERAL MOTORS COMPANY

22. Install the power steering fluid reservoir (1). Refer to **Power Steering Fluid Reservoir Replacement**
23. Connect the surge tank inlet hose (2) to the engine.
24. Connect the brake booster vacuum hose (3).
25. Connect the fuel pump fuel feed hose to the fuel feed pipe (4). Refer to **Metal Collar Quick Connect Fitting Service** .
26. Connect the surge tank outlet hose (5) to the engine.
27. Connect the ground wire terminals (6) to the transmission.
28. Connect the ECM connectors (7) to the ECM.
29. Install the engine strut bolt (8).
30. Connect the positive battery cable (9) in position cable on the engine.

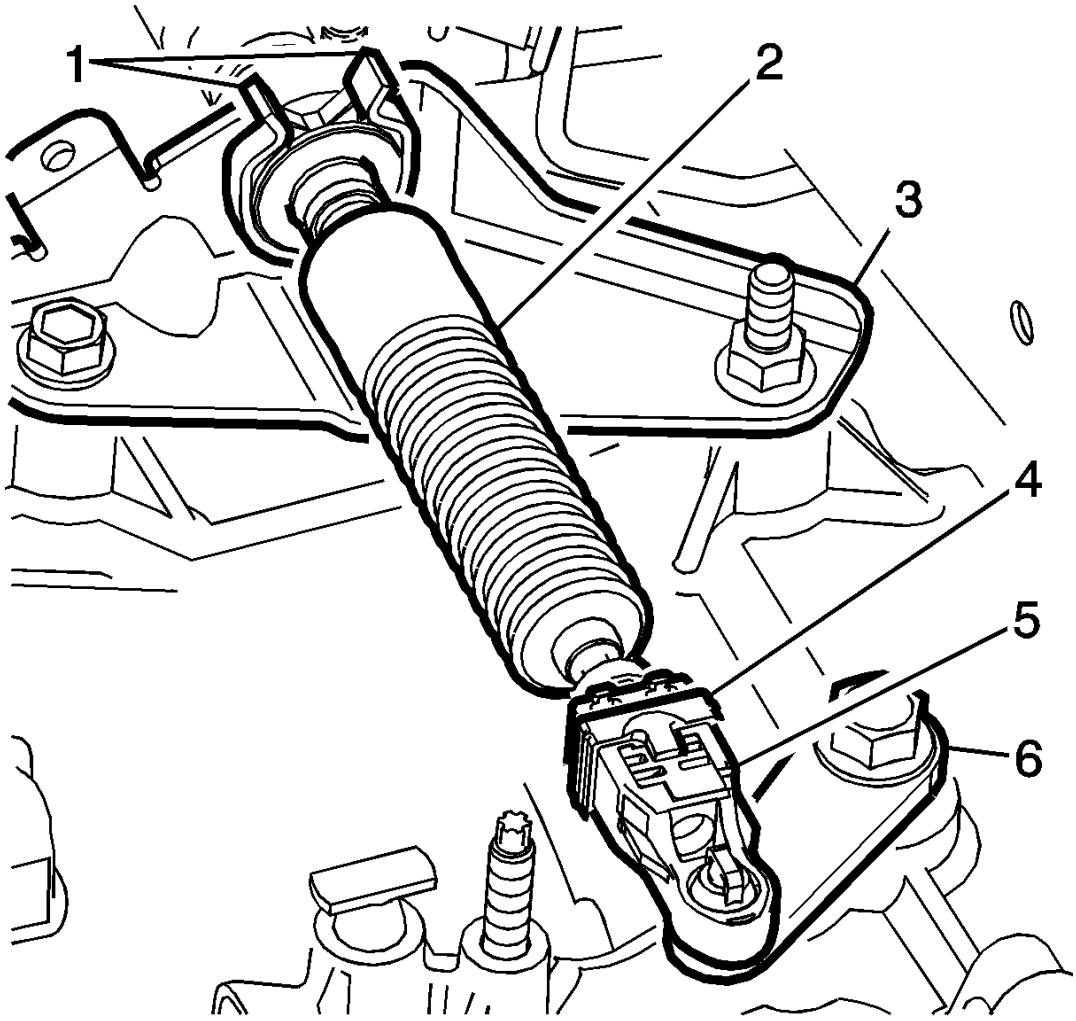


Fig. 273: Transmission Shifter Cable
Courtesy of GENERAL MOTORS COMPANY

31. Connect the transmission shiftier cable (2) to the transmission. Refer to **Range Selector Lever Cable Replacement (Column Shift)** **Range Selector Lever Cable Replacement (Floor Shift)** .
32. Install the drive belt. Refer to **Drive Belt Replacement**.
33. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .

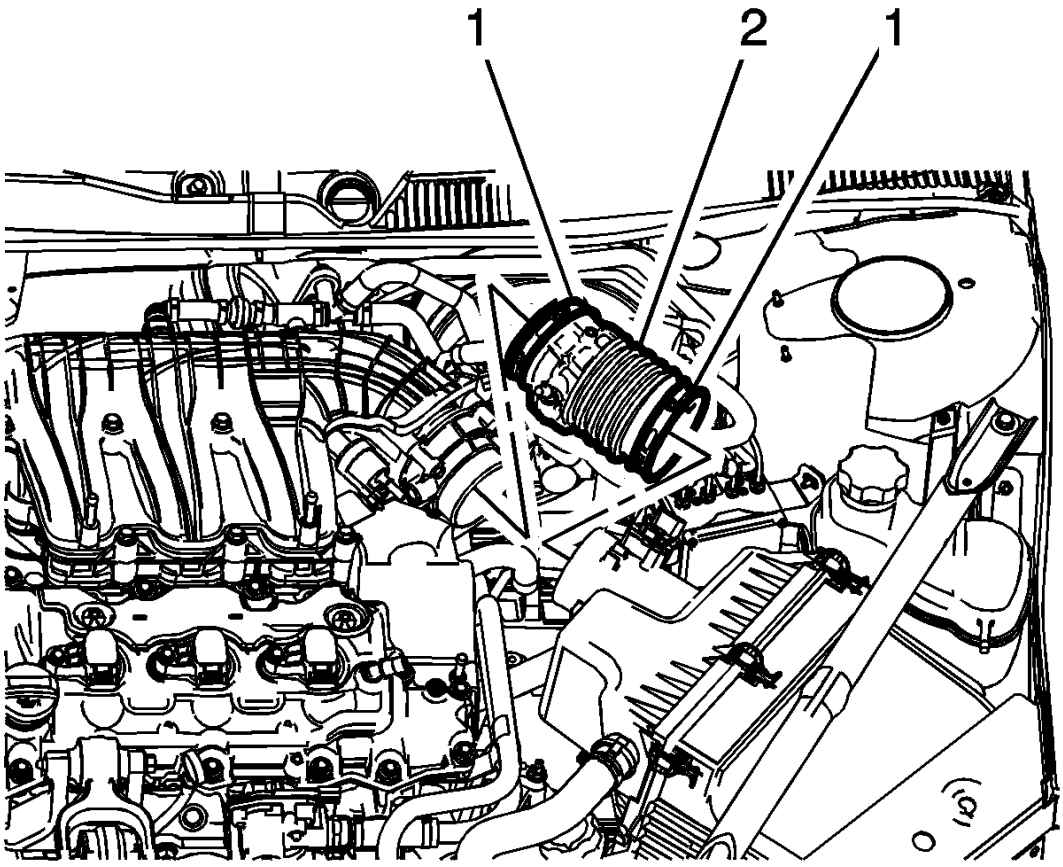


Fig. 274: Air Cleaner Outlet Duct And Clamps
Courtesy of GENERAL MOTORS COMPANY

34. Install the air cleaner outlet duct (2). Refer to **Air Cleaner Outlet Duct Replacement** .
35. Fill the cooling system. Refer to **Cooling System Draining and Filling** .
36. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** .
37. Fill the vehicle with coolant. Refer to **Cooling System Draining and Filling** .

NOTE: **Prelube is necessary if the engine is replaced or overhauled.**

38. If the engine is replaced with a new engine or has been overhauled, perform the Engine Prelubing procedure. Refer to **Engine Prelubing** .
39. If prelubing has not been performed, fill the engine oil. Refer to **Engine Oil and Oil Filter Replacement**.

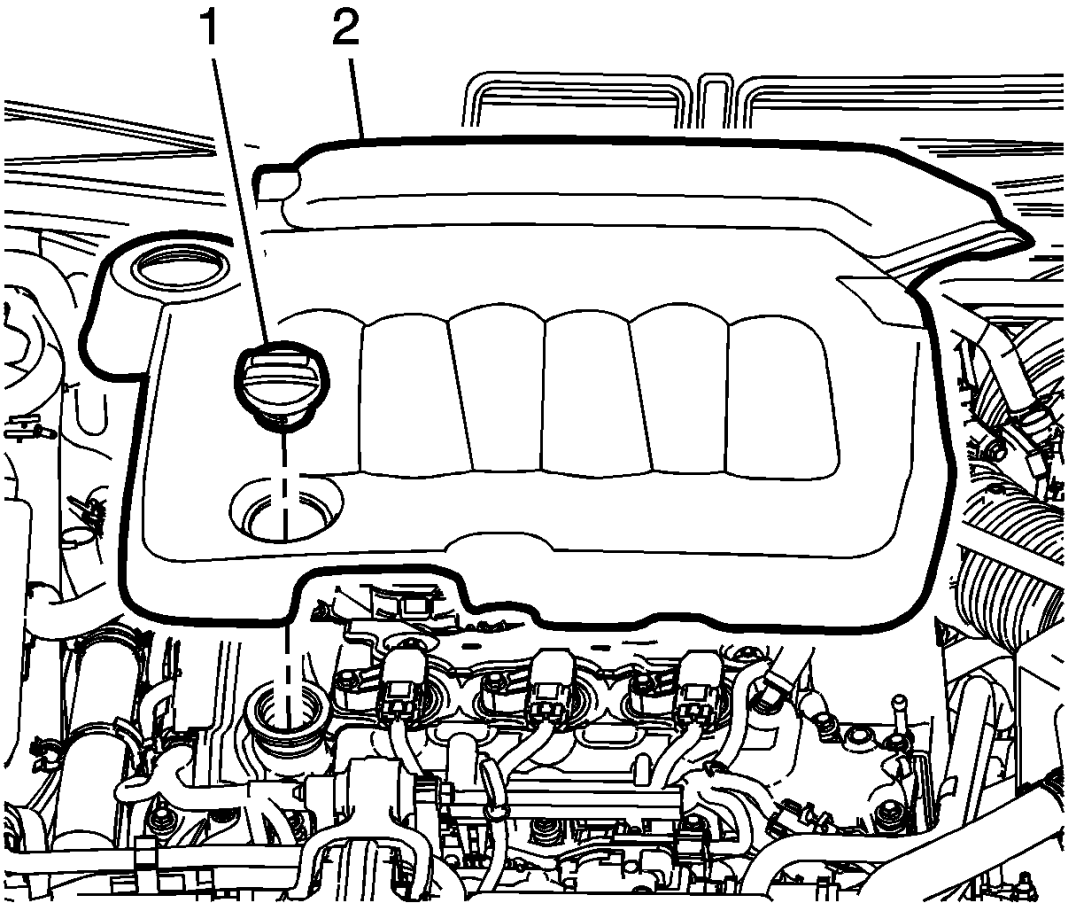


Fig. 275: Intake Manifold Cover
Courtesy of GENERAL MOTORS COMPANY

40. Install the intake manifold cover (2). Refer to **Intake Manifold Cover Replacement**.
41. Run the engine and check for leaks.

ENGINE OIL AND OIL FILTER REPLACEMENT

Removal Procedure

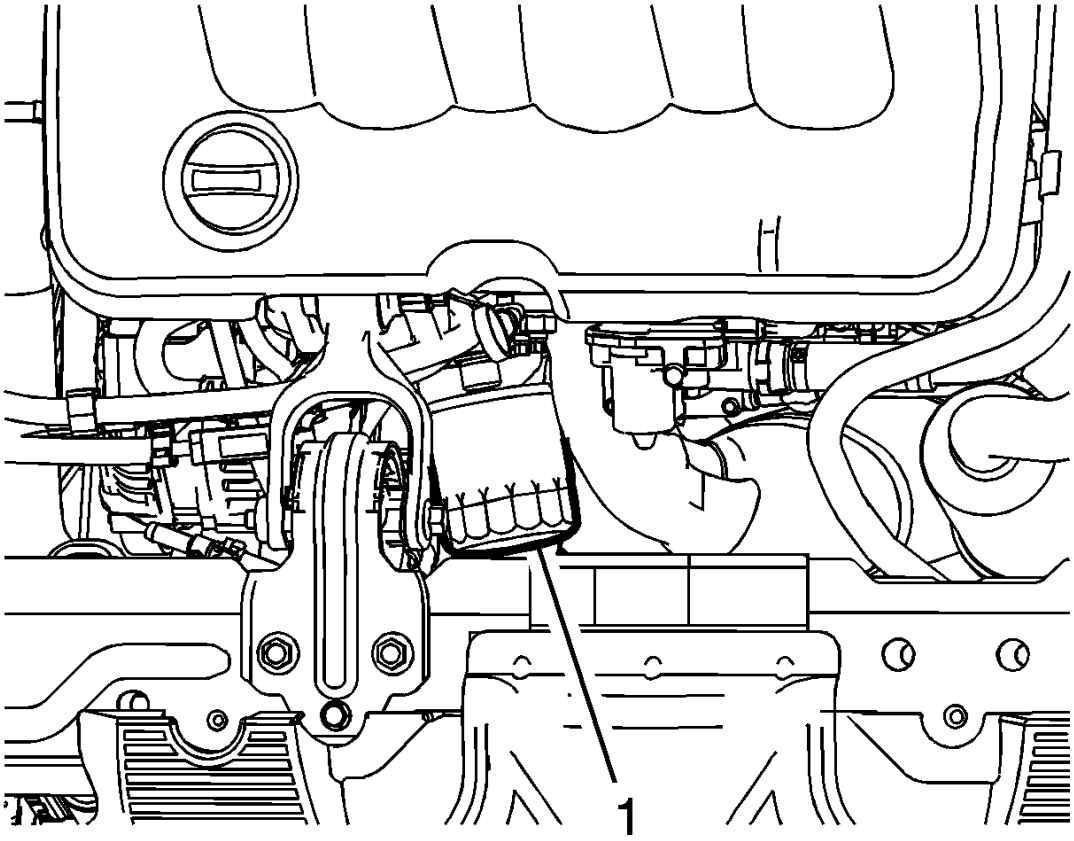


Fig. 276: Engine Oil Filter Drain Deflector
Courtesy of GENERAL MOTORS COMPANY

NOTE: **This vehicle is equipped with an oil filter drain deflector. This is used to prevent engine oil from draining onto the front engine mount. With this deflector in place, the oil filter is easier to access from under the hood.**

1. Place a drain pan under the oil filter drain deflector.

WARNING: **Refer to Hot Exhaust System Warning .**

2. Remove the oil filter (1). Allow the oil to drain completely.

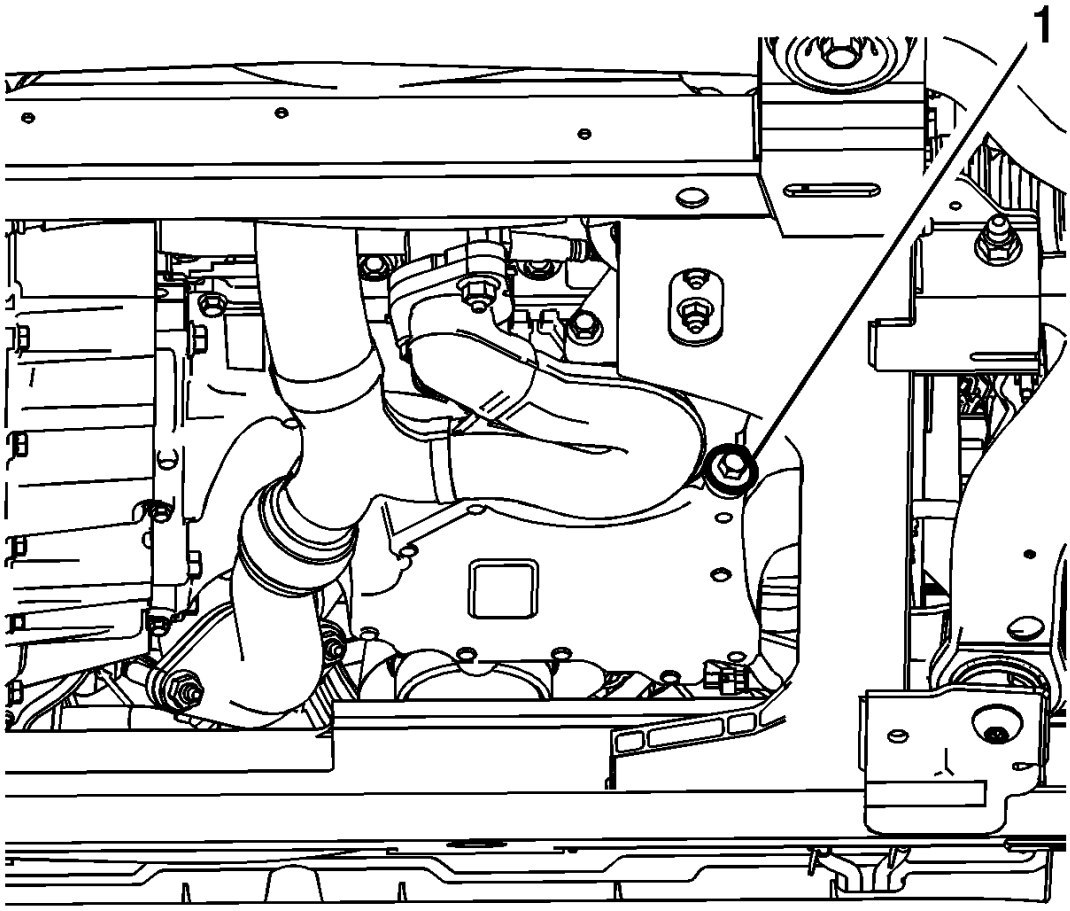


Fig. 277: Engine Oil Pan Drain Plug
Courtesy of GENERAL MOTORS COMPANY

3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Place a drain pan under the oil pan drain plug .
5. Remove the oil pan drain plug (1). Allow the oil to drain completely.

Installation Procedure

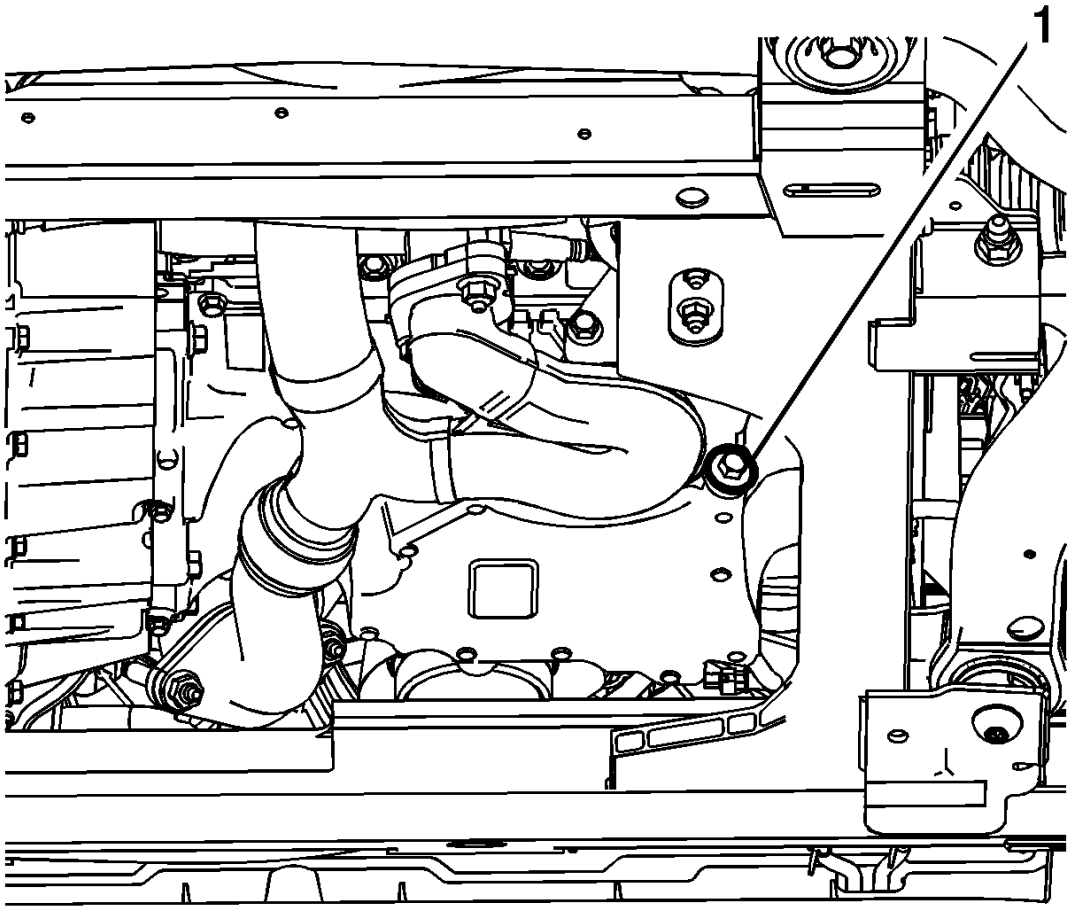


Fig. 278: Engine Oil Pan Drain Plug
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Clean and inspect the oil pan drain plug seal, replace parts as necessary.

1. Install the oil pan drain plug (1) and tighten to 20 N.m (15 lb ft).
2. Lower the vehicle.

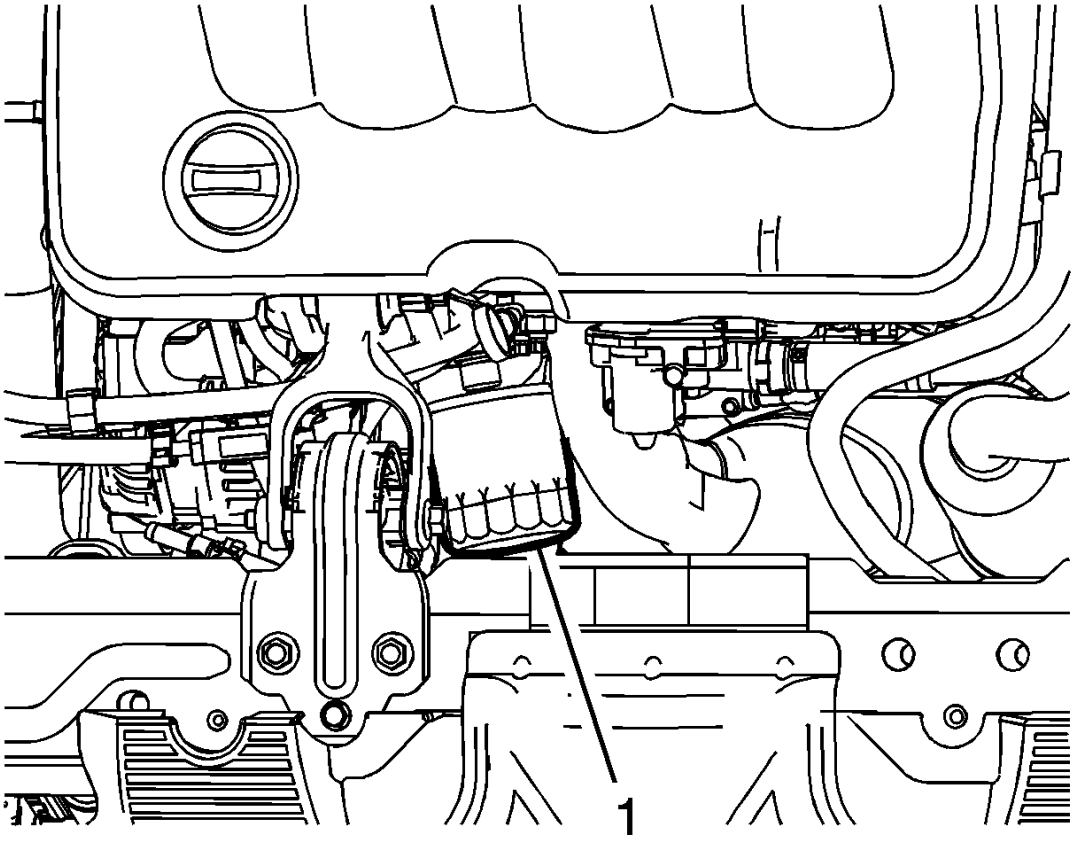


Fig. 279: Engine Oil Filter Drain Deflector
Courtesy of GENERAL MOTORS COMPANY

3. Lubricate the NEW oil filter gasket with clean engine oil.
4. Install a NEW oil filter and tighten 3/4 to 1 full turn after the gasket makes contact with the sealing surface on the filter mounting flange.
5. Refill the engine oil. Refer to **Approximate Fluid Capacities** .
6. Start the engine and inspect for leaks.

Article GUID: A00737165

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

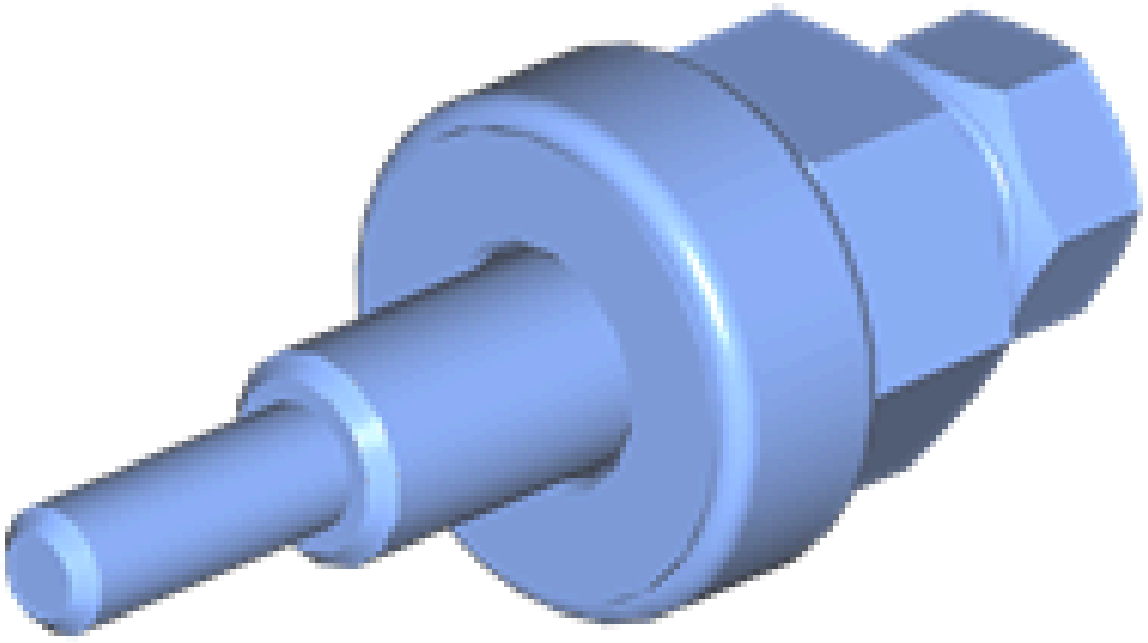
Illustration	Tool Number/Description
	CH-25033-C J-25033-C Pulley Installer

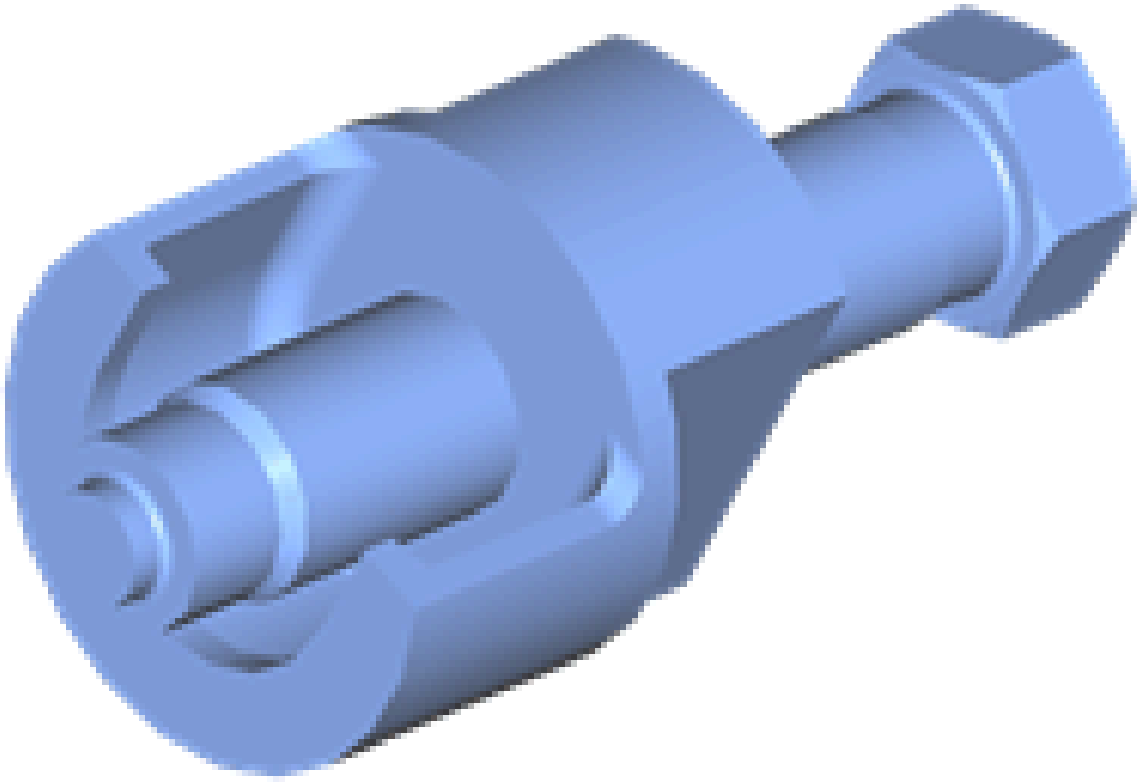
Illustration	Tool Number/Description
	CH-25034-C J-25034-C Pulley Remover

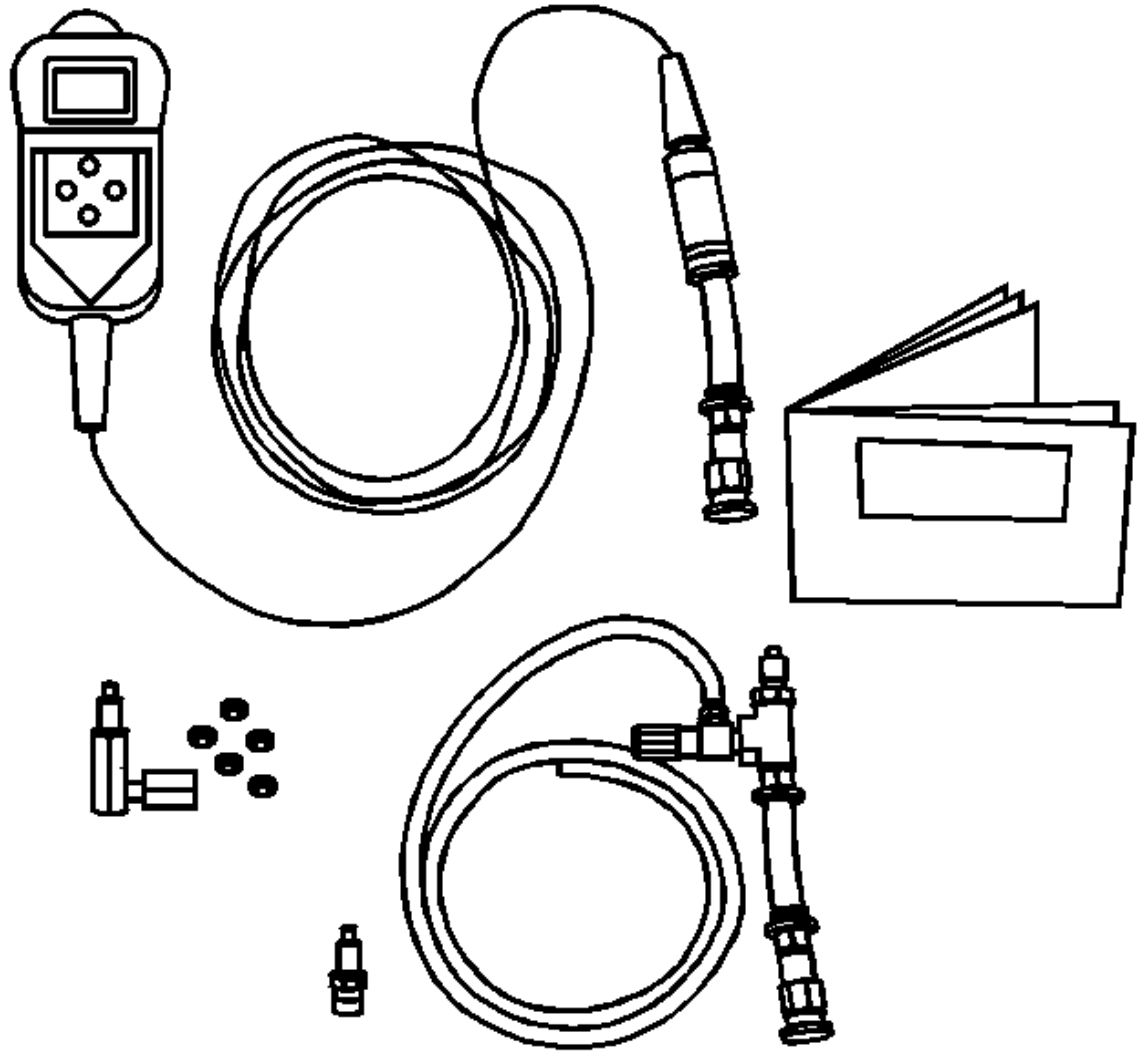
Illustration	Tool Number/Description
	CH-48027 DW-100-010 EN-49495 J-21867 Digital Pressure Gauge South America Use Local Equivalent

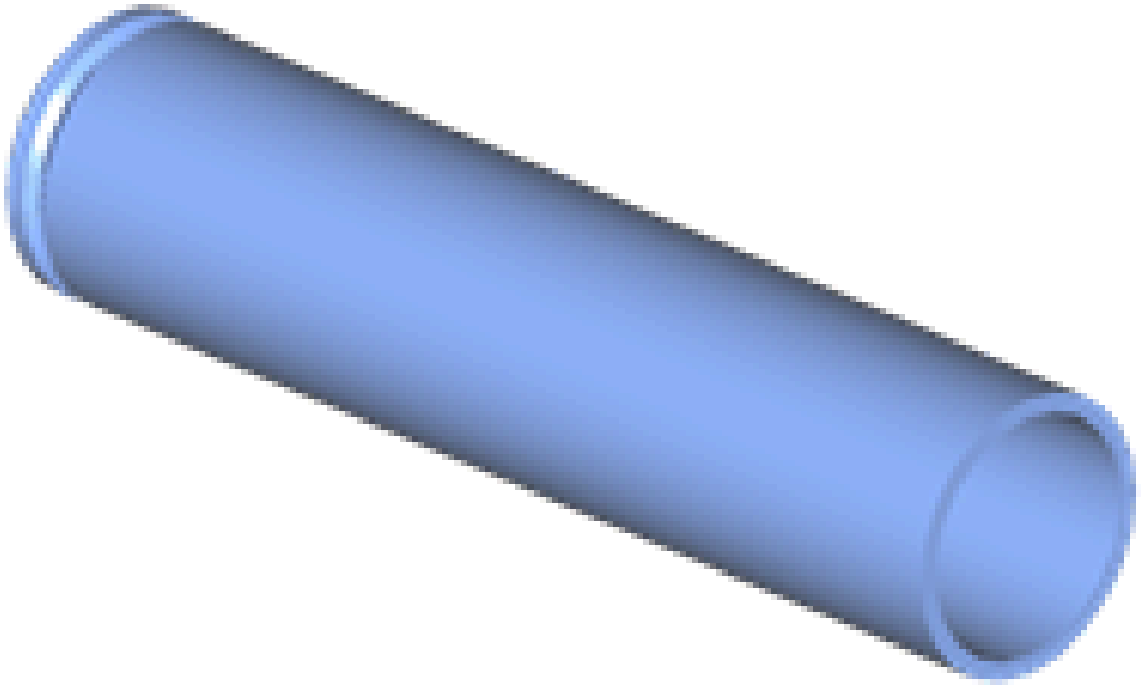
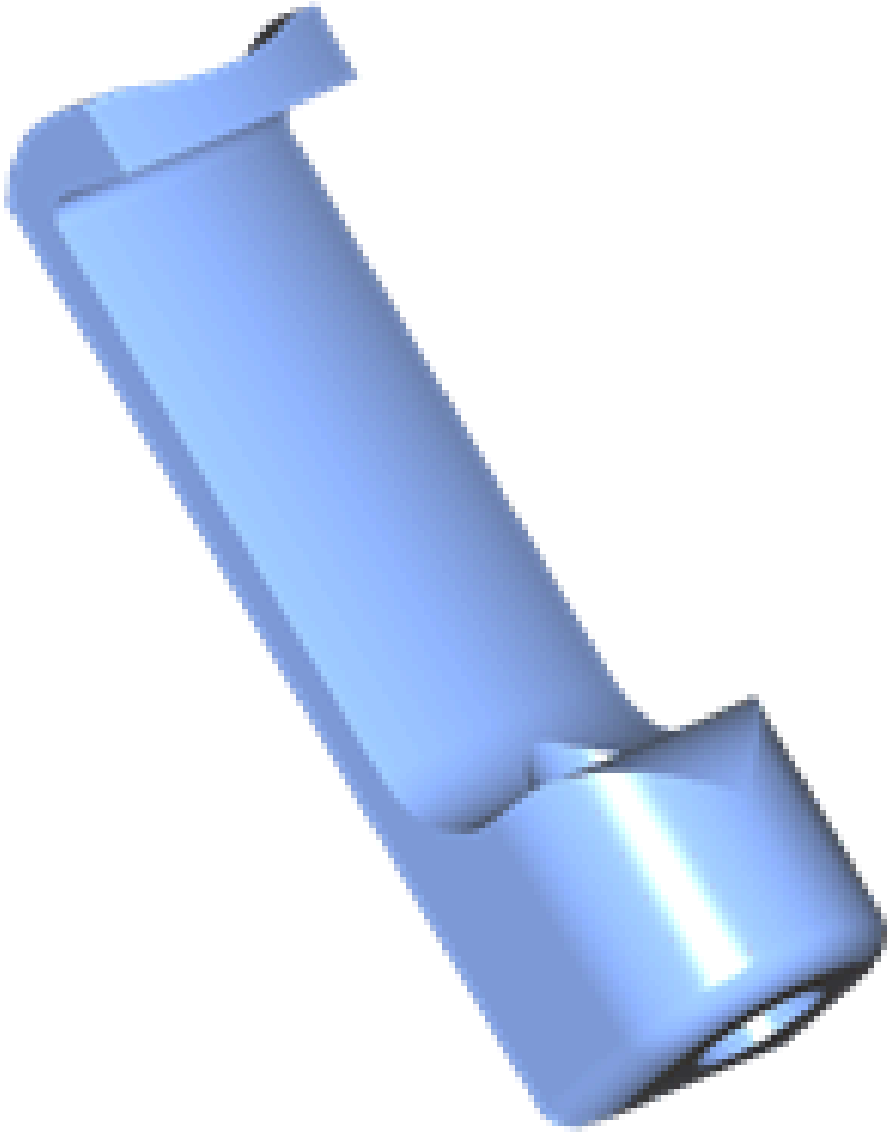
Illustration	Tool Number/Description
	DT-5590 J-5590 J-24254 Bearing and Seal Driver

Illustration	Tool Number/Description
	DT-23129 J-23129 Universal Seal Remover

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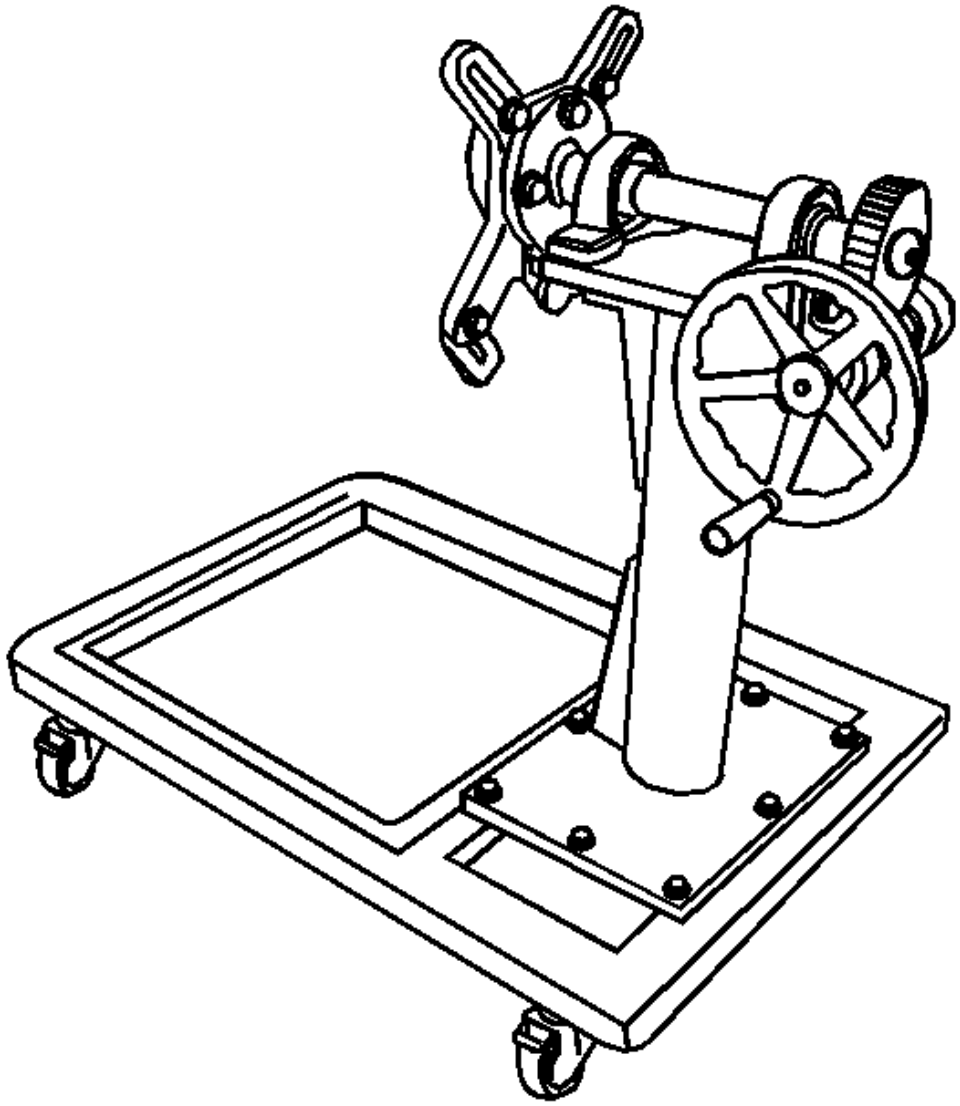
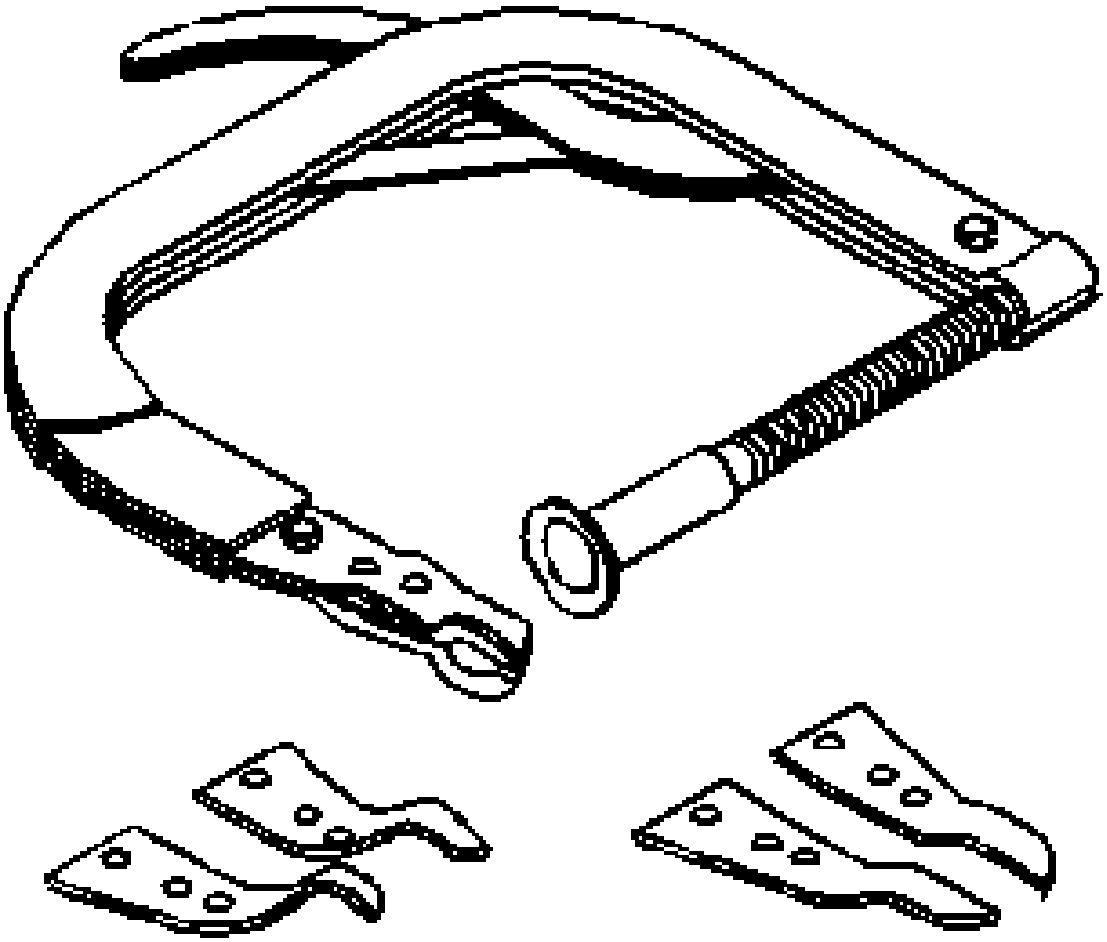
	DW-110-030 Engine Overhaul Stand

Illustration	Tool Number/Description
	EN-8062 J-8062 Valve Spring Compressor - Head Off

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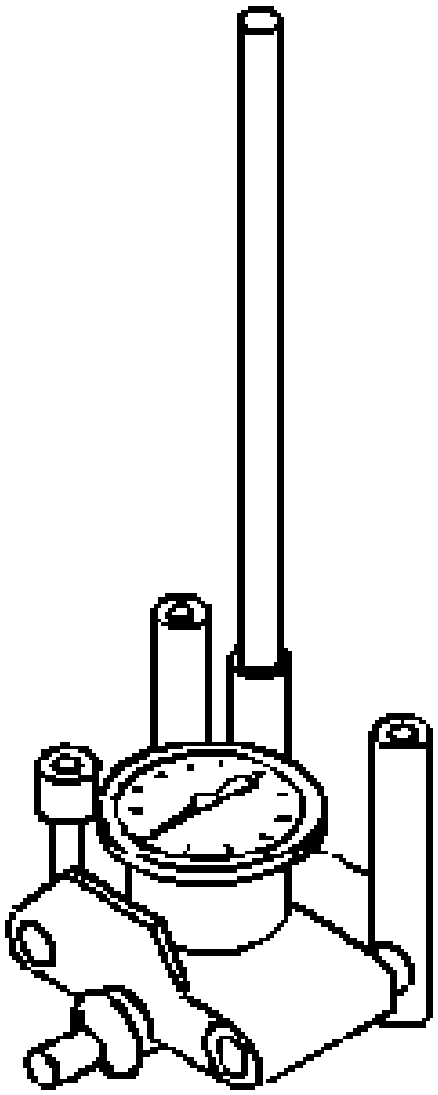
	EN-8087 J-8087 Cylinder Bore Gauge South America Use Local Equivalent

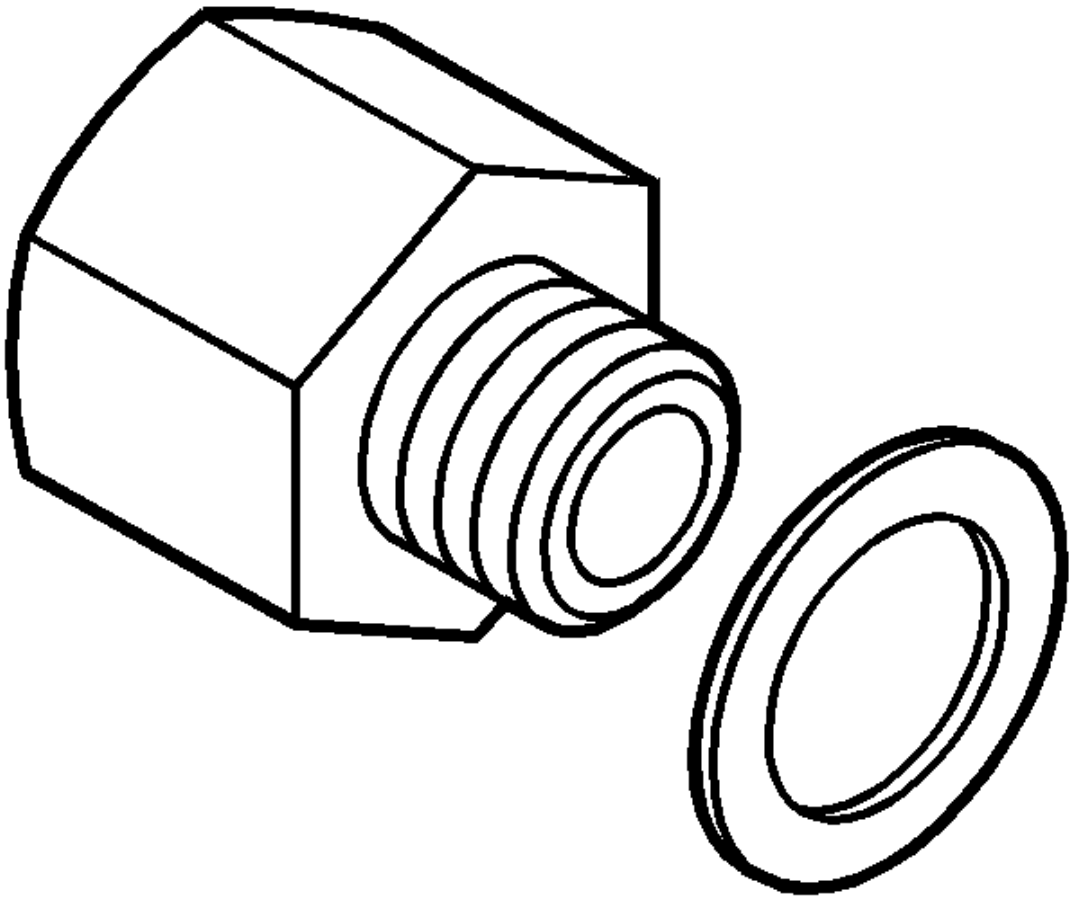
Illustration	Tool Number/Description
	EN-21867-6 J-21867-6 83 93 852 Oil Pressure Adapter Fitting South America Use Local Equivalent

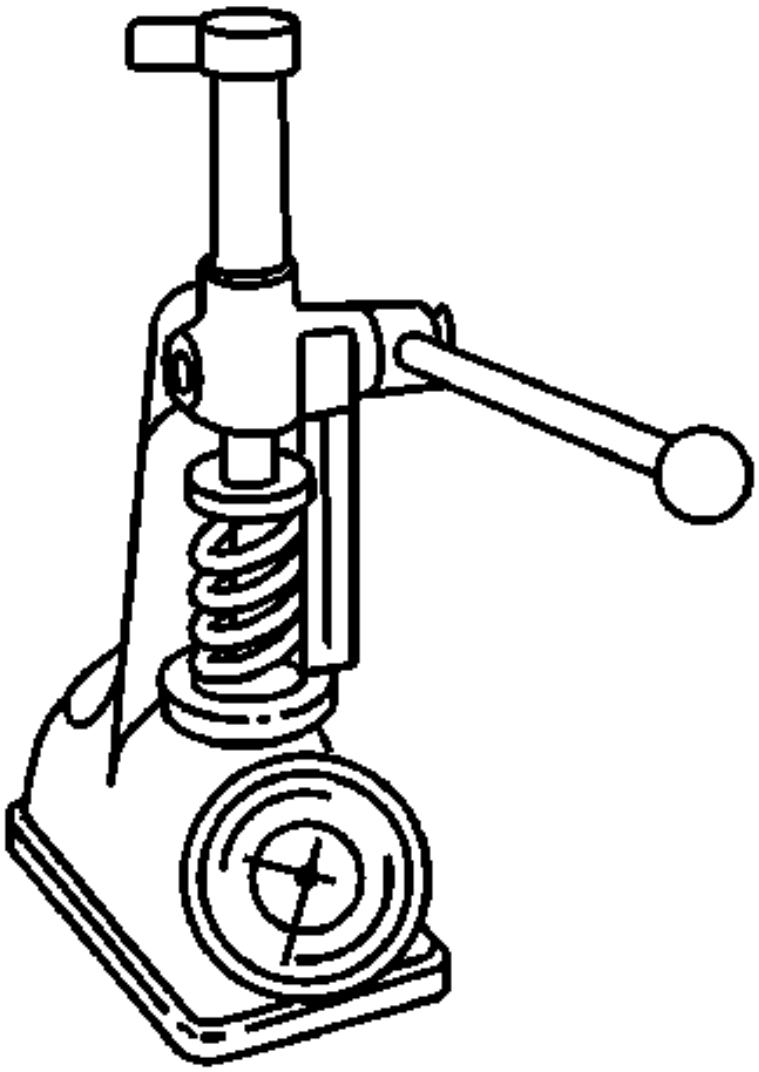
Illustration	Tool Number/Description
	EN-22738-B J-22738-B Valve Spring Tester South America Use Local Equivalent

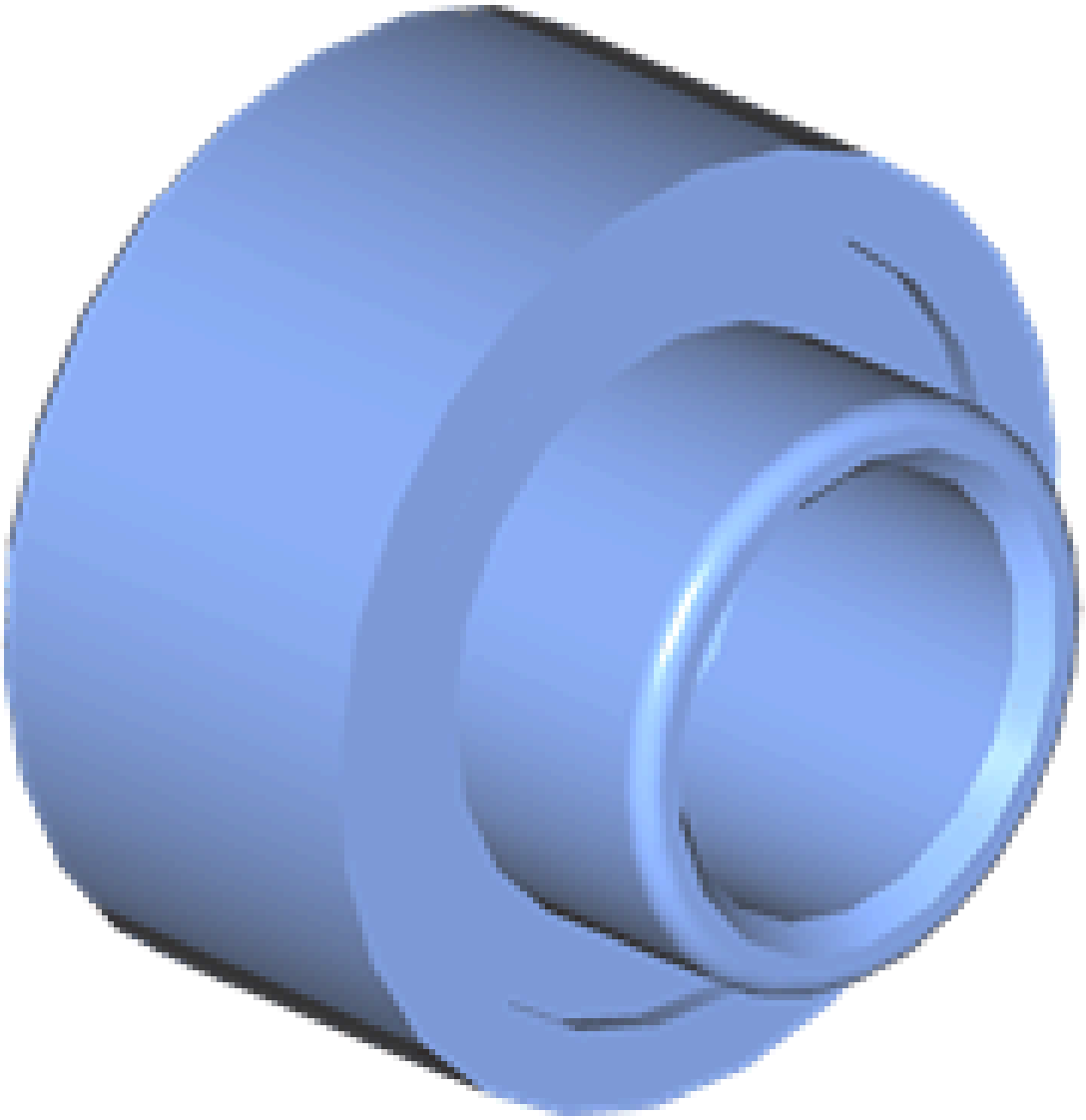
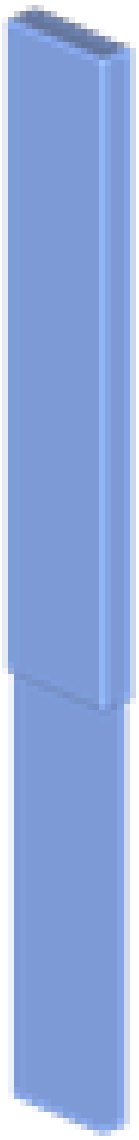
Illustration	Tool Number/Description
	EN-24254-A J-24254-A J-24254 Oil Seal Installer

Illustration	Tool Number/Description
	EN-28410 J-28410 Gasket Remover South America Use Local Equivalent

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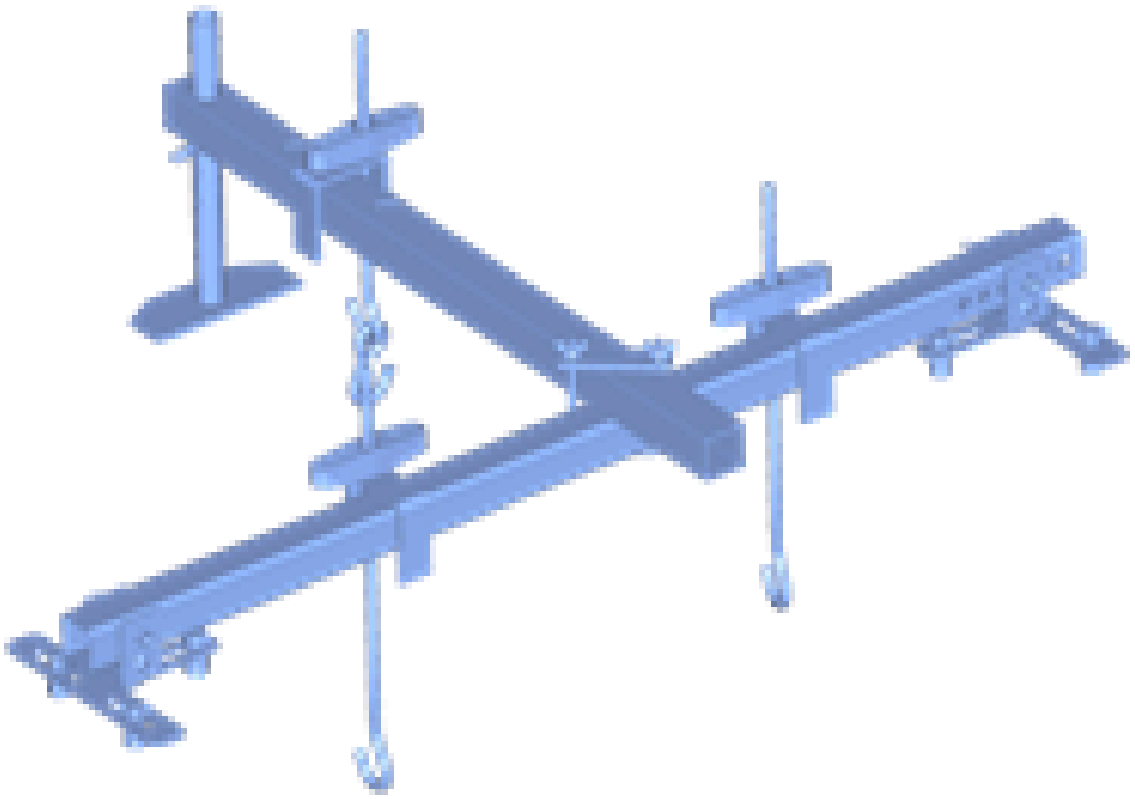
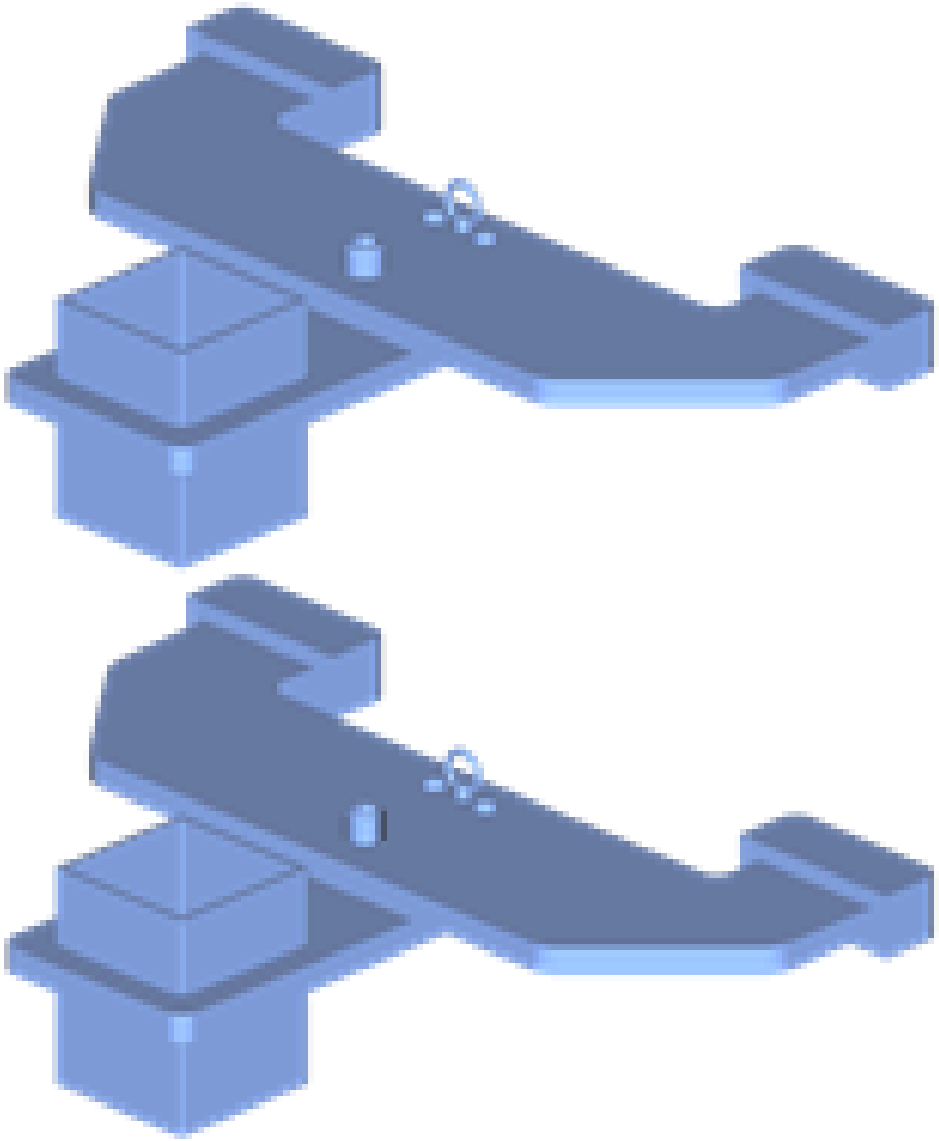
	EN-28467-B DW-110-060 J-28467-B X-0206951 L-0906004 Universal Engine Support Fixture

Illustration	Tool Number/Description
	EN-28467-501 J-28467-501 Engine Support Fixture Adapters

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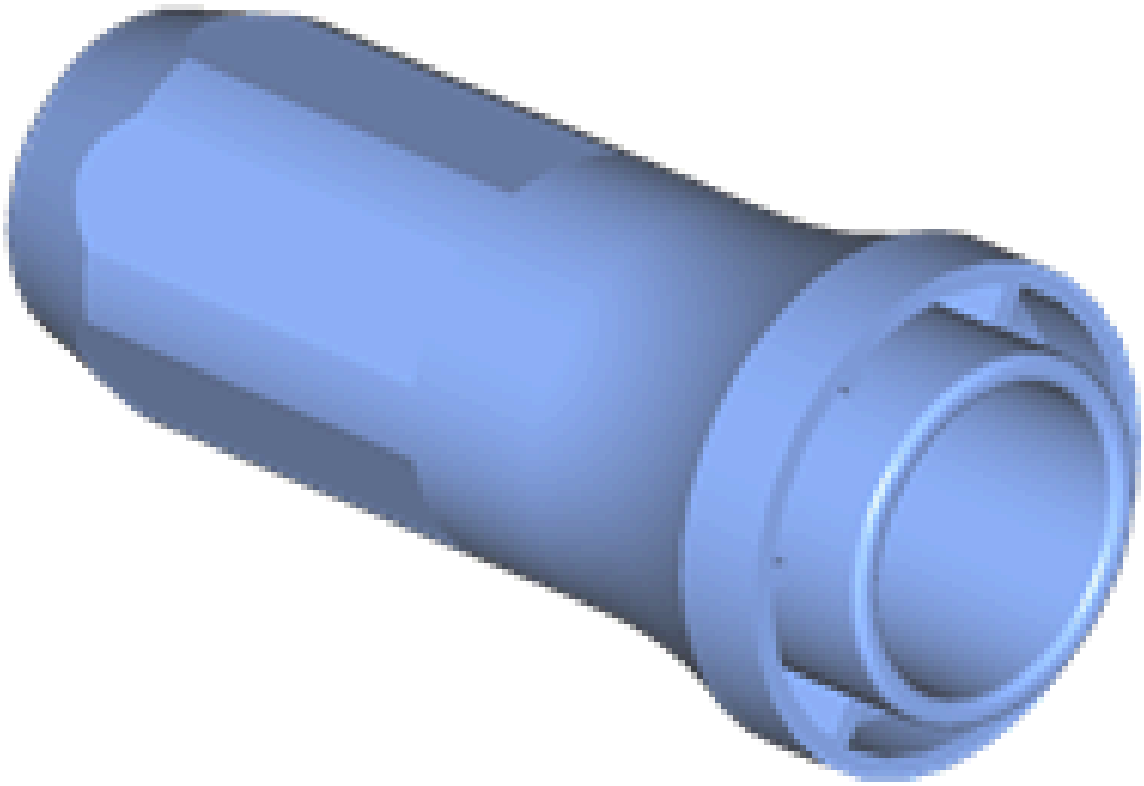	EN-29184 EN-47635 & J-41998-B EN-47635 J-29184 V-0506019 Oil Seal Installer

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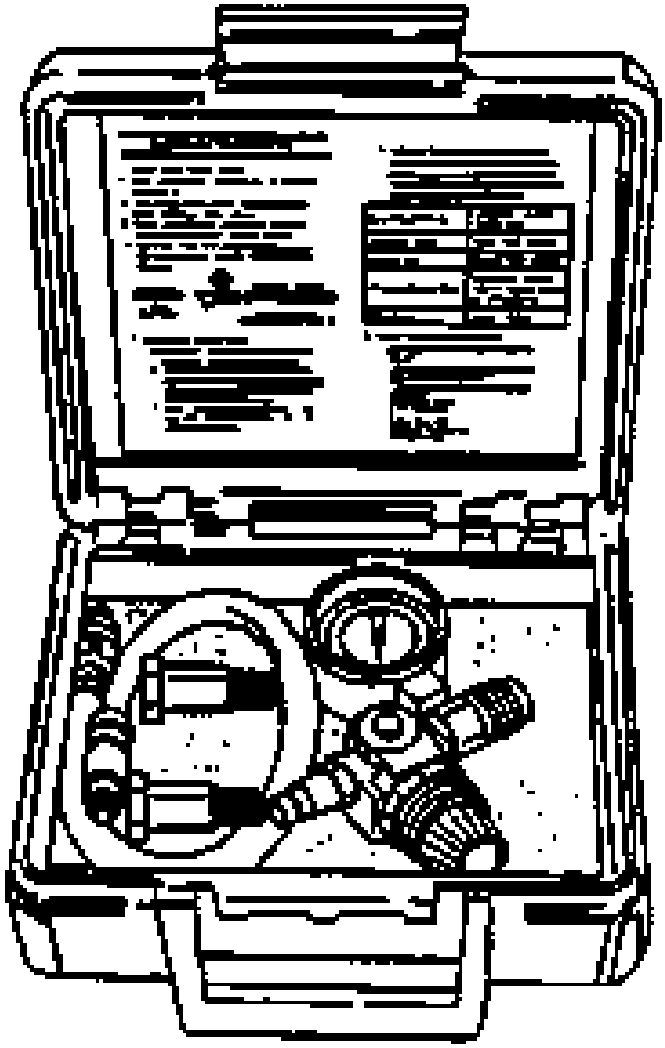
	EN-35667-A J-35667-A Cylinder Head Leakdown Tester South America Use Local Equivalent

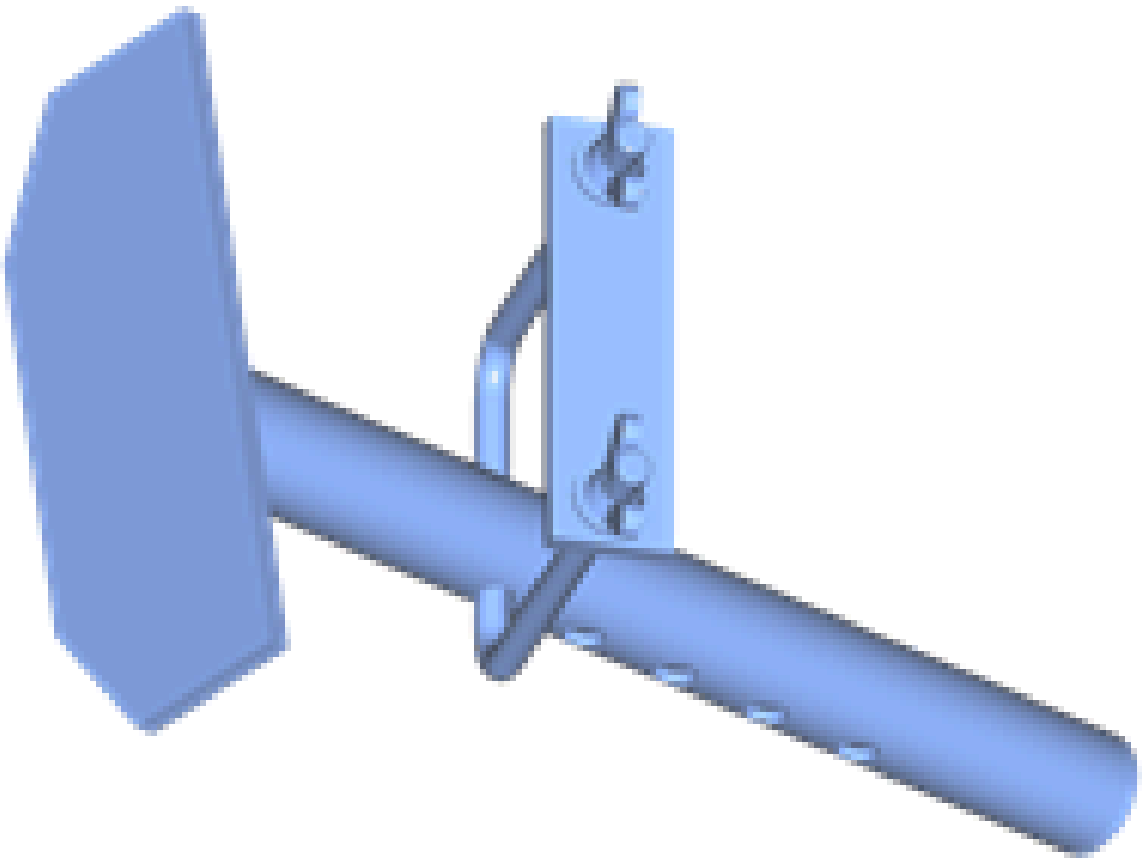
Illustration	Tool Number/Description
	EN-36462-A J-36462-A X-0206951 L-0906004 Engine Support Adapter Leg

Illustration	Tool Number/Description
	EN-36857 J-36857 Engine Lift Bracket

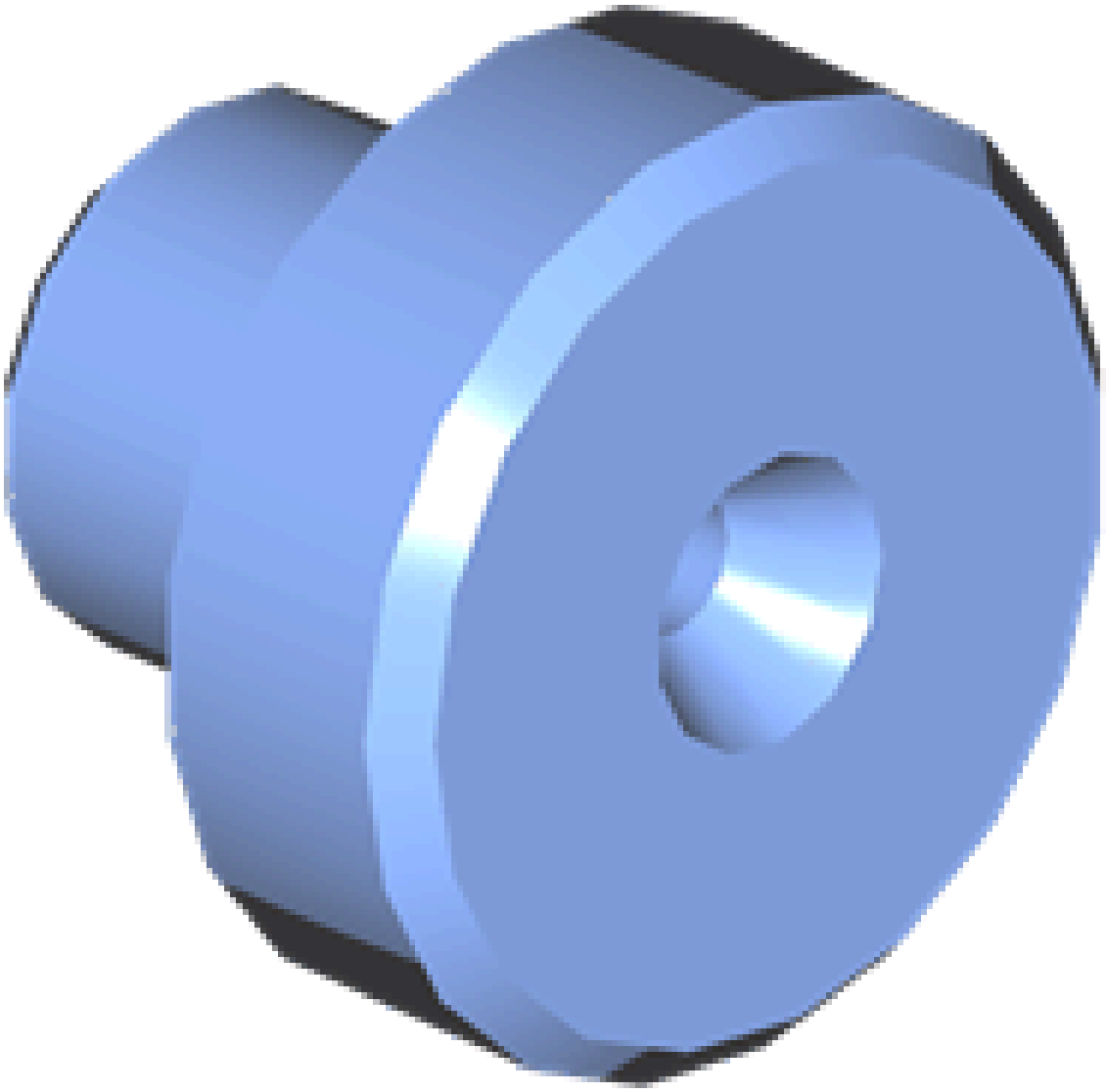
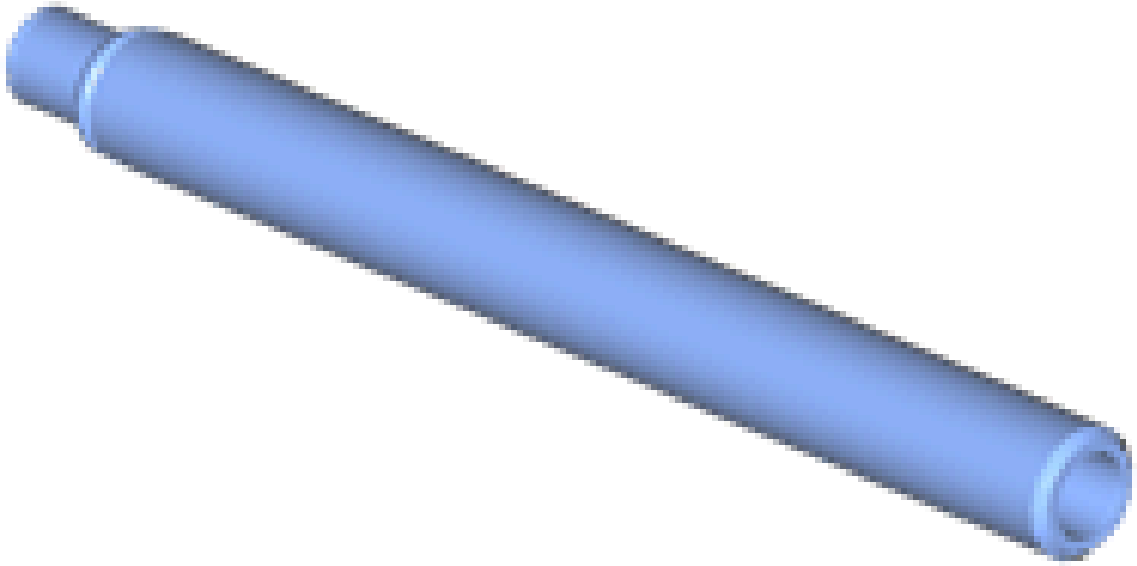
Illustration	Tool Number/Description
	EN-38416-2 J-38416-2 6-9806636 Crankshaft Button

Illustration	Tool Number/Description
	EN-39313 J-39313 V-0506023 Spark Plug Port Adapter

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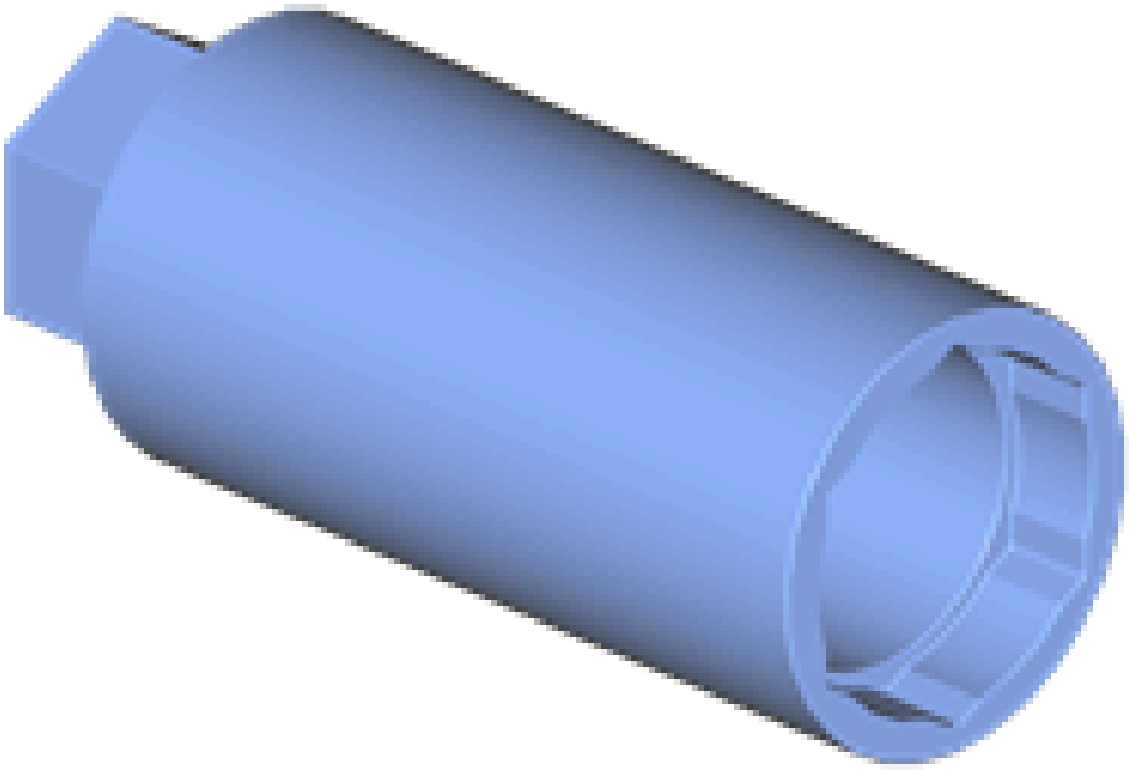
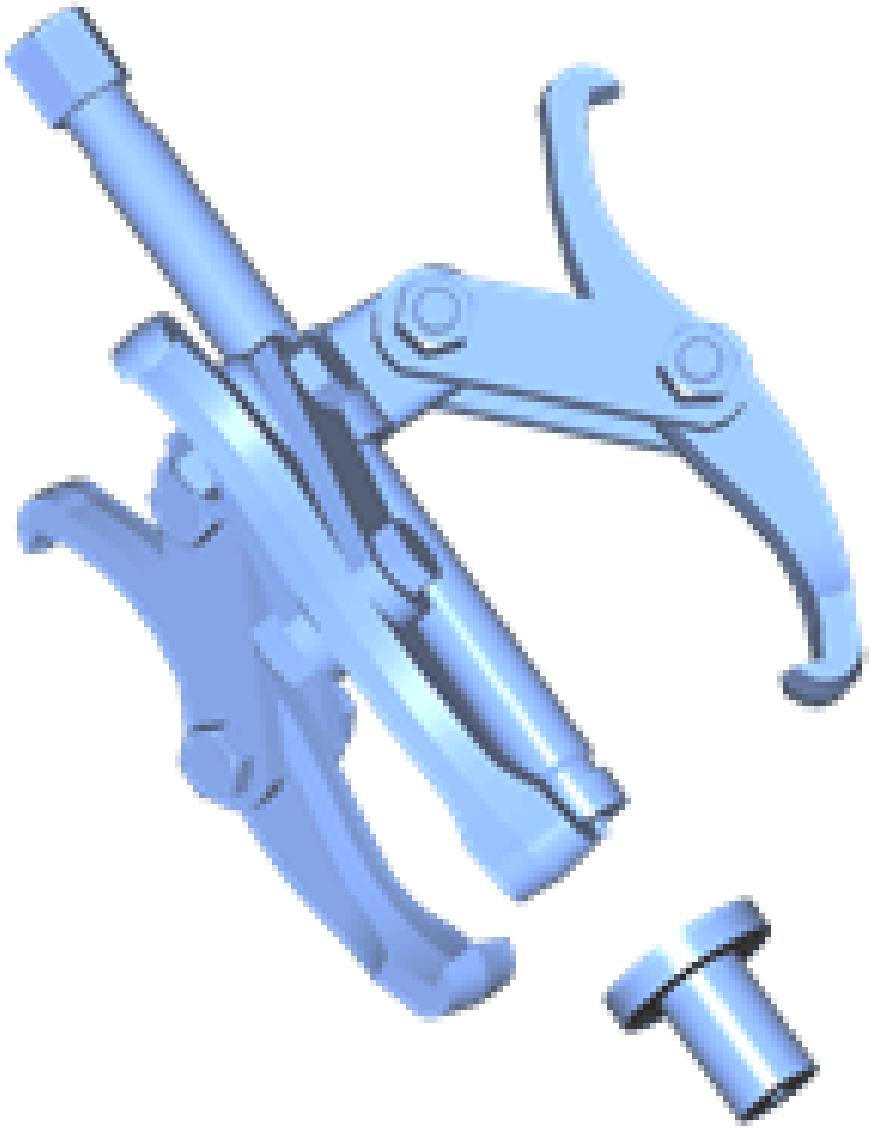
	EN-41712 J-41712 Oil Pressure Switch Socket South America Use Local Equivalent

Illustration	Tool Number/Description
	EN-41816 J-41816 6-9806636 Crankshaft Balancer Remover

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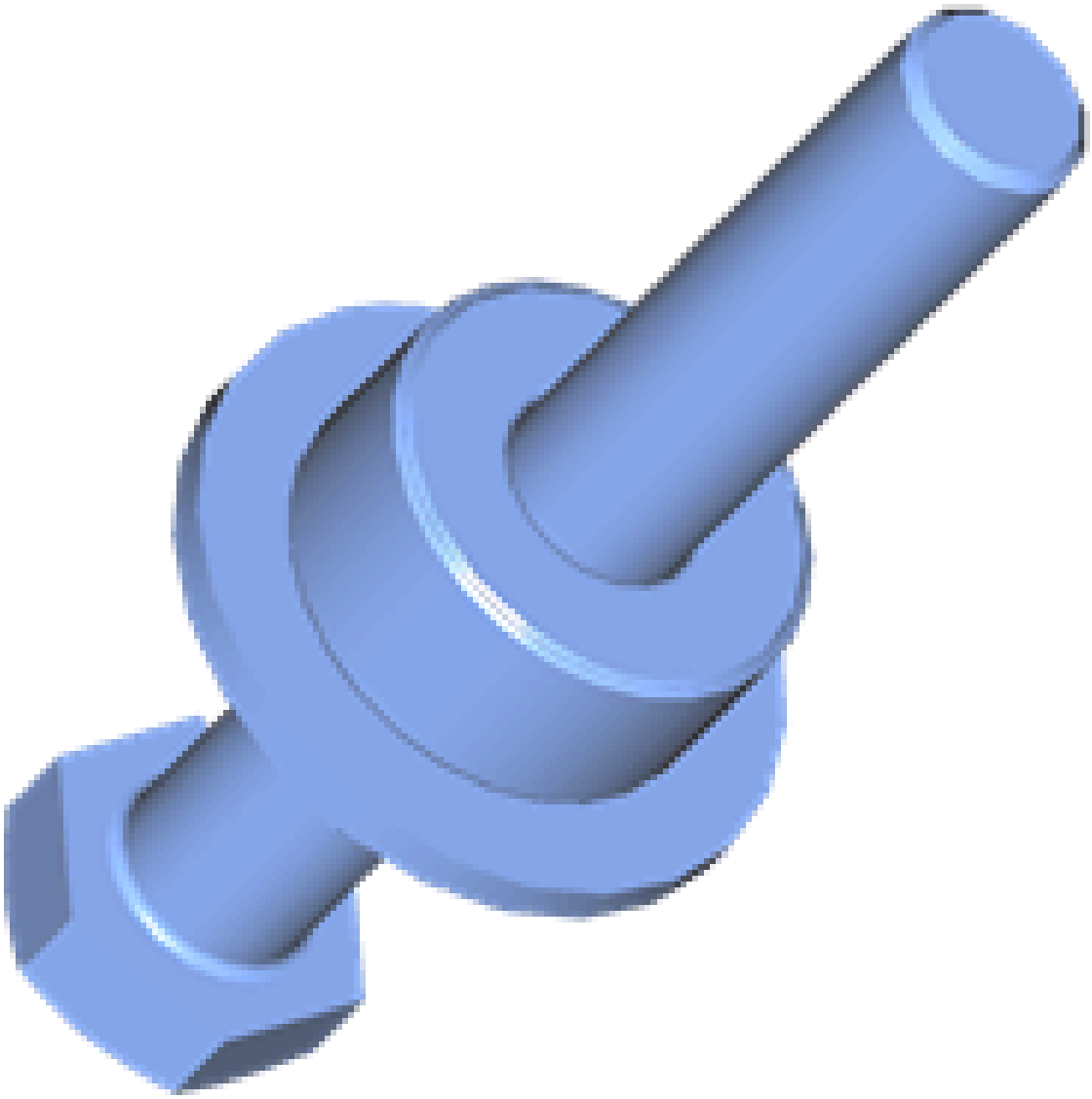
	EN-41998-B J-41998-B J-41998 Crankshaft Balancer Installer South America Use Local Equivalent

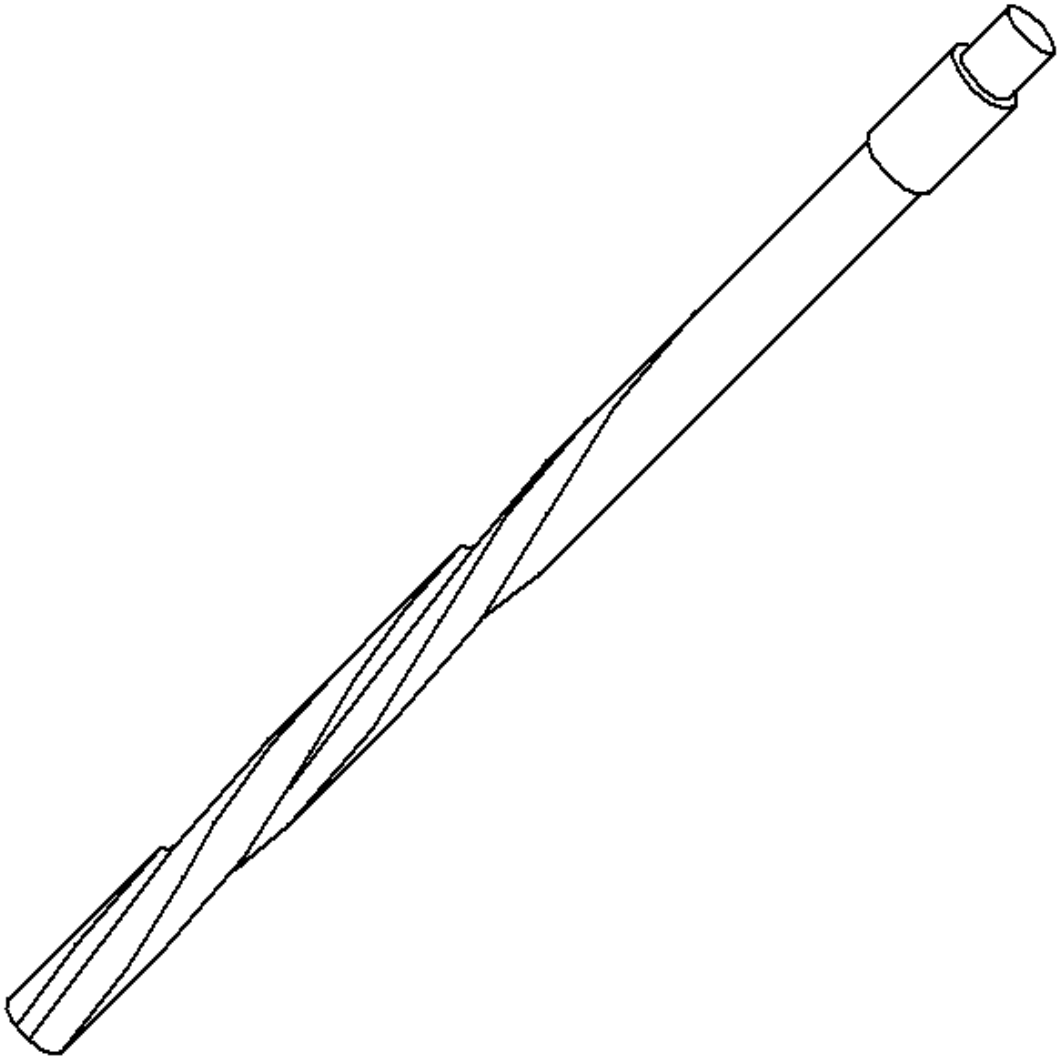
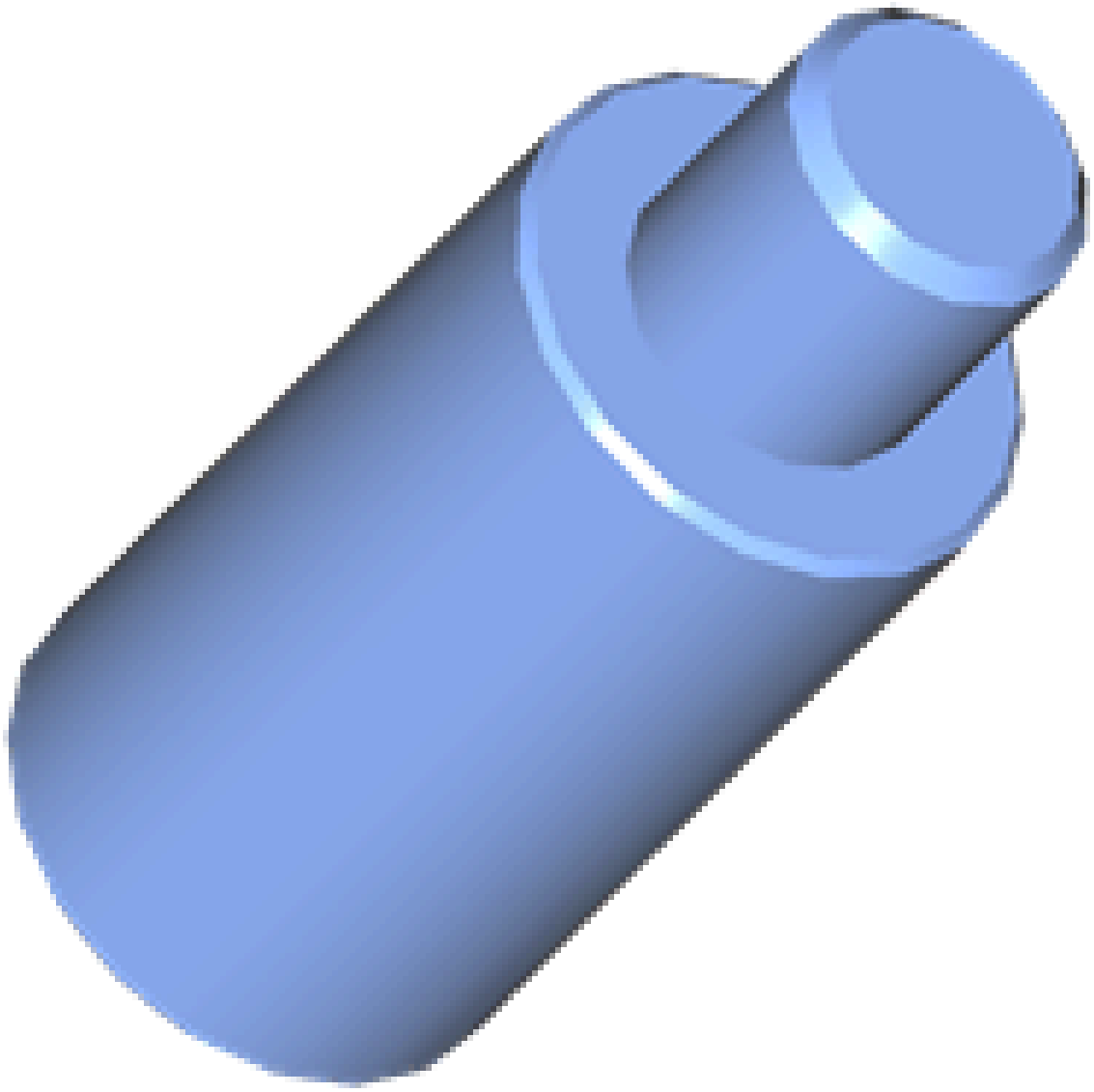
Illustration	Tool Number/Description
	EN-42096 Valve Guide Reamer

Illustration	Tool Number/Description
	EN-42183 J-42183 M-840911-A Driver Handle

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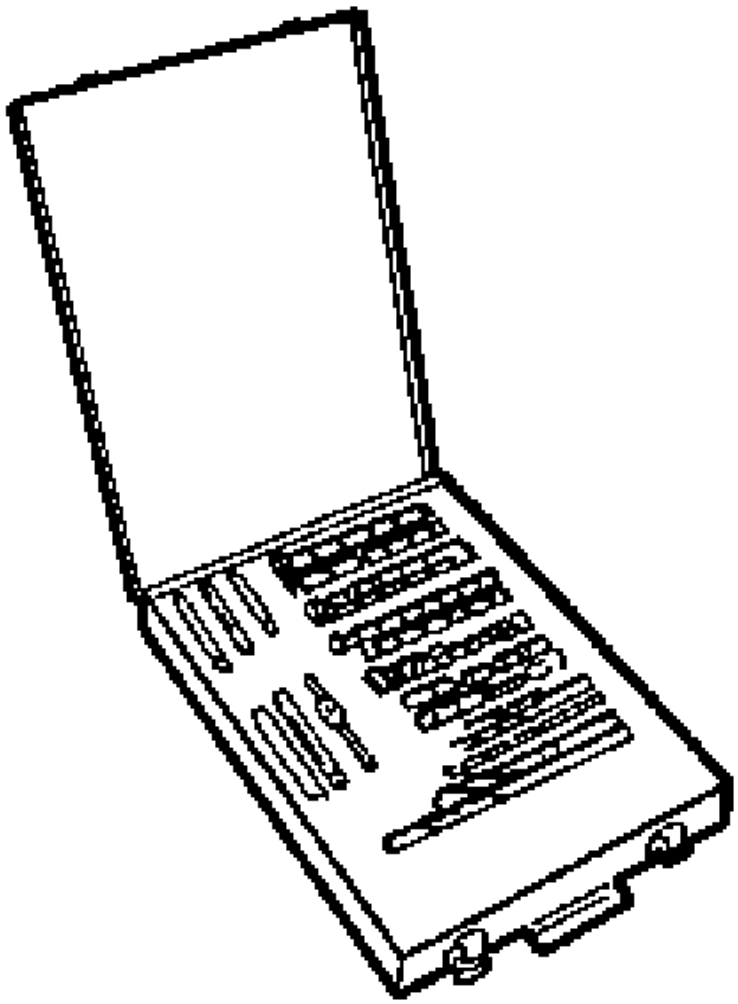	EN-42385-700 J-42385-700 High Feature Thread Repair Kit South America Use Local Equivalent

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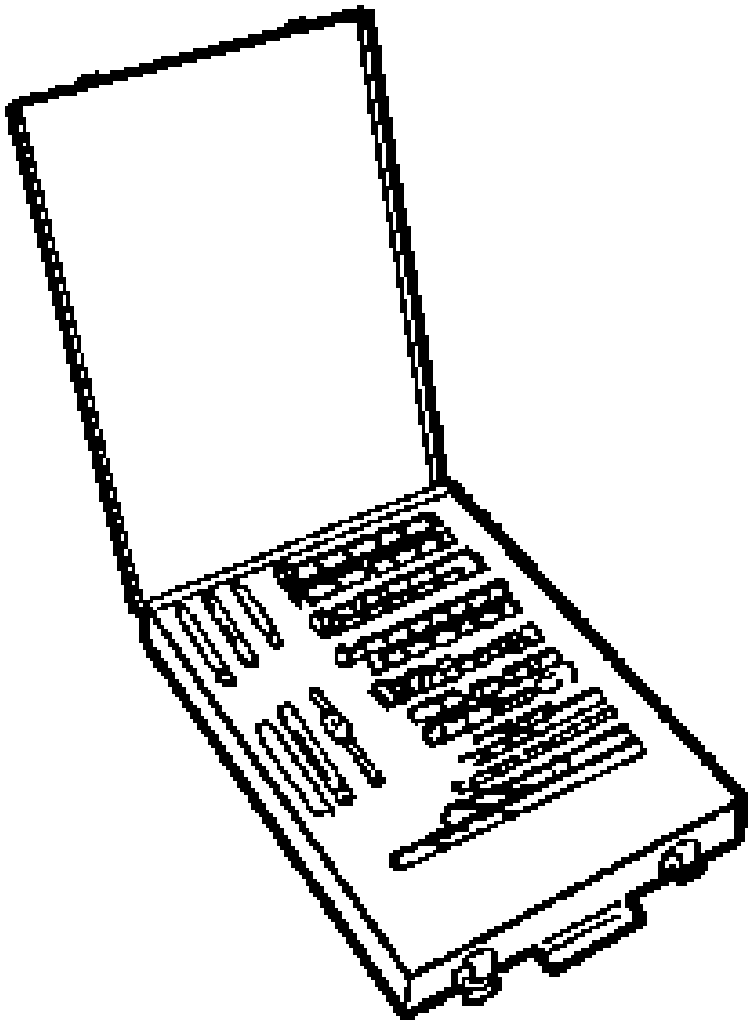	EN-42385-2000 J-42385-2000 Thread Insert Kit South America Use Local Equivalent

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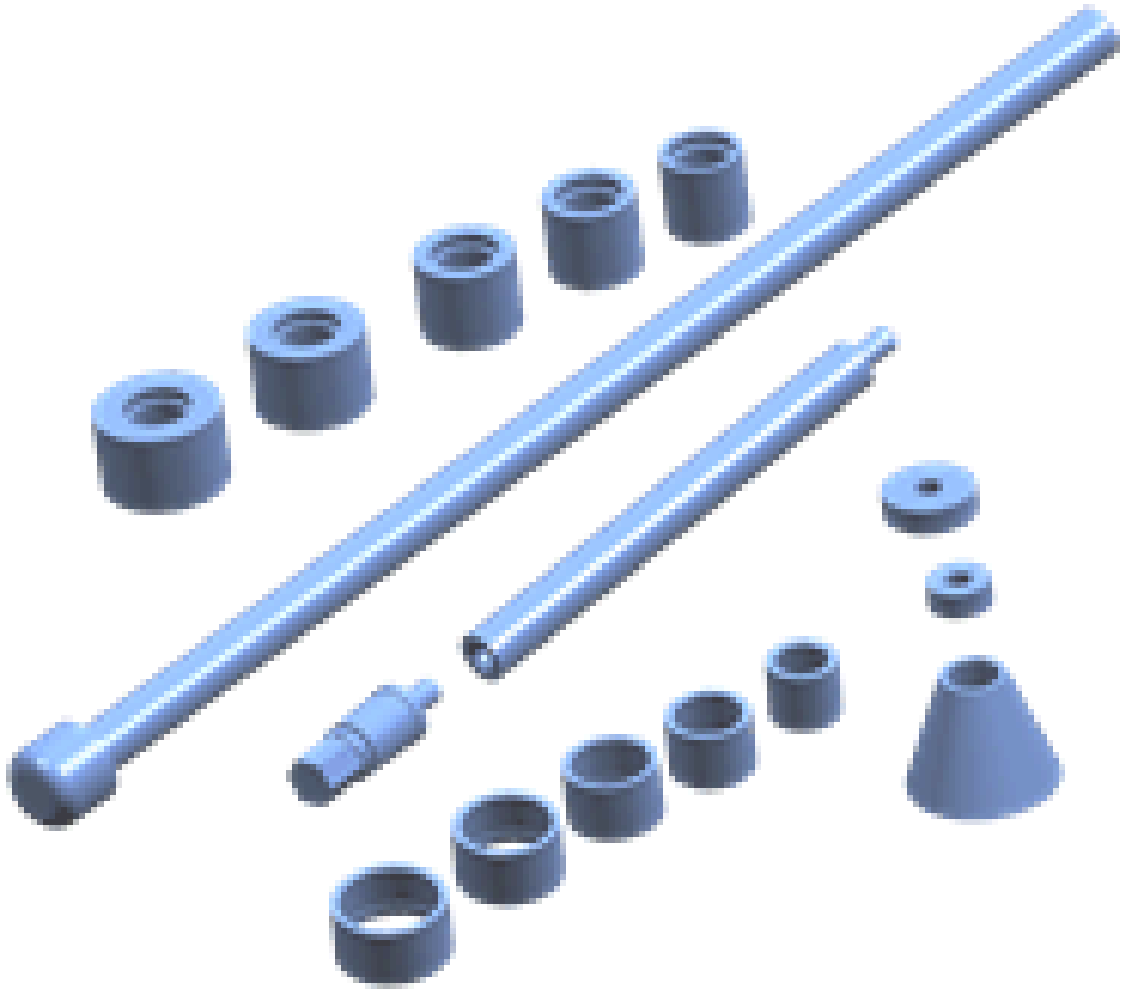	EN-43690-A J-43690-A Rod Bearing Clearance Checking Tool South America Use Local Equivalent

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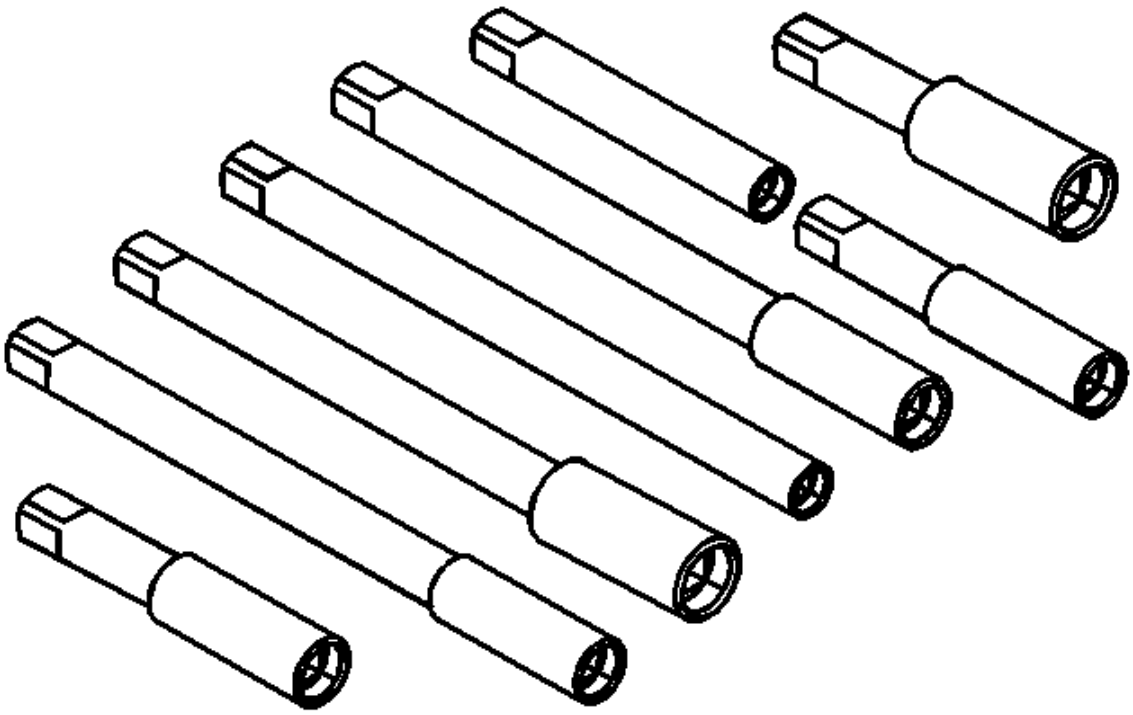	EN-43965 J-43965 Thread Repair Extension Kit South America Use Local Equivalent

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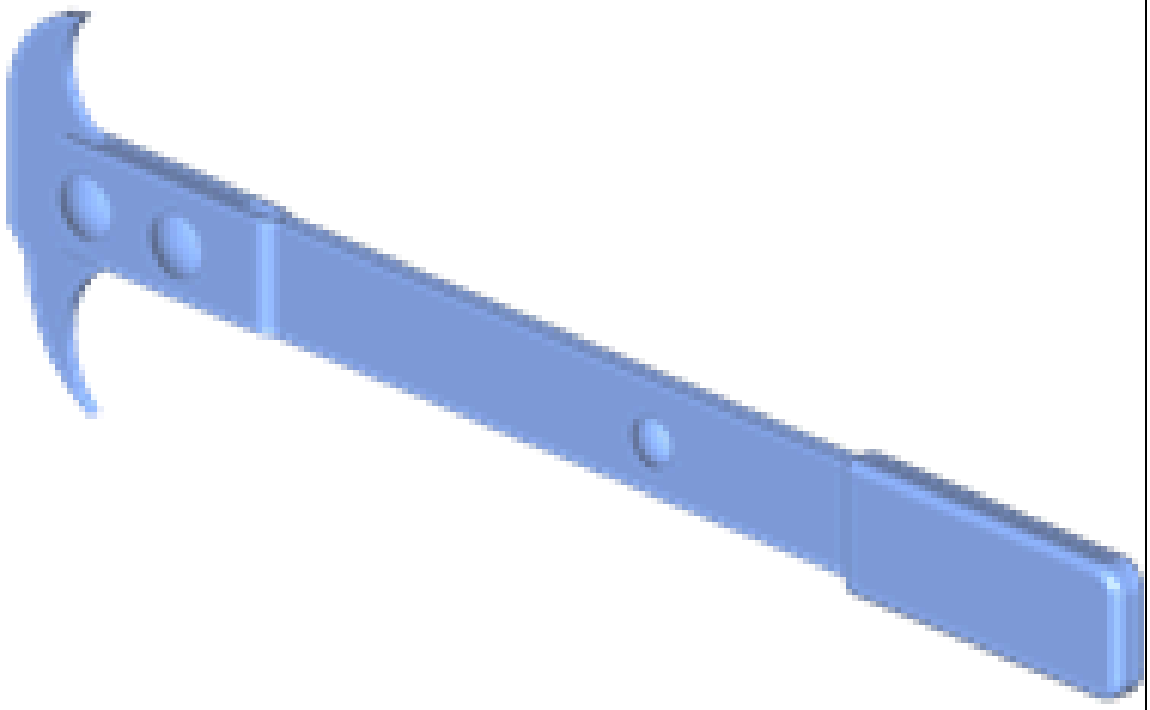
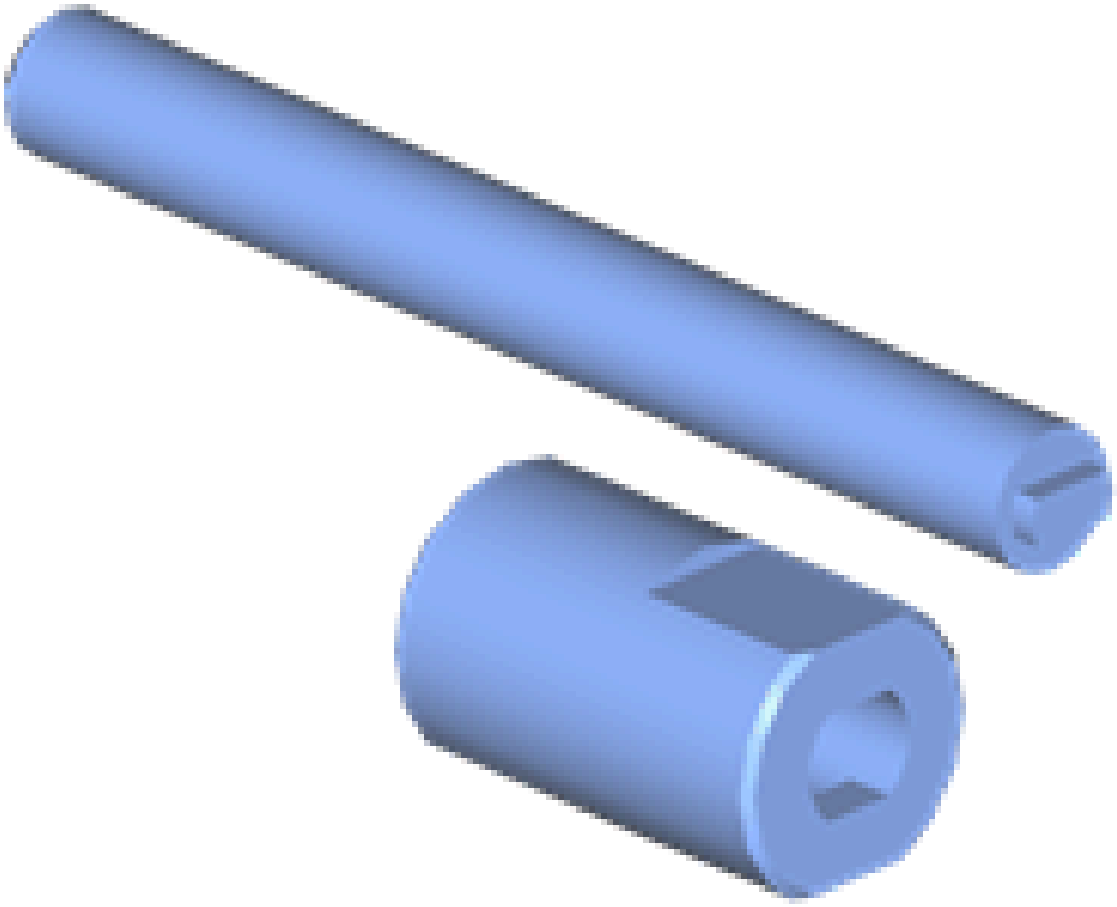
	EN-45000 J-45000 KM-45000 87 91 360 Seal Remover South America Use Local Equivalent

Illustration	Tool Number/Description
	EN-45027 J-45027 Tensioner Tool South America Use Local Equivalent

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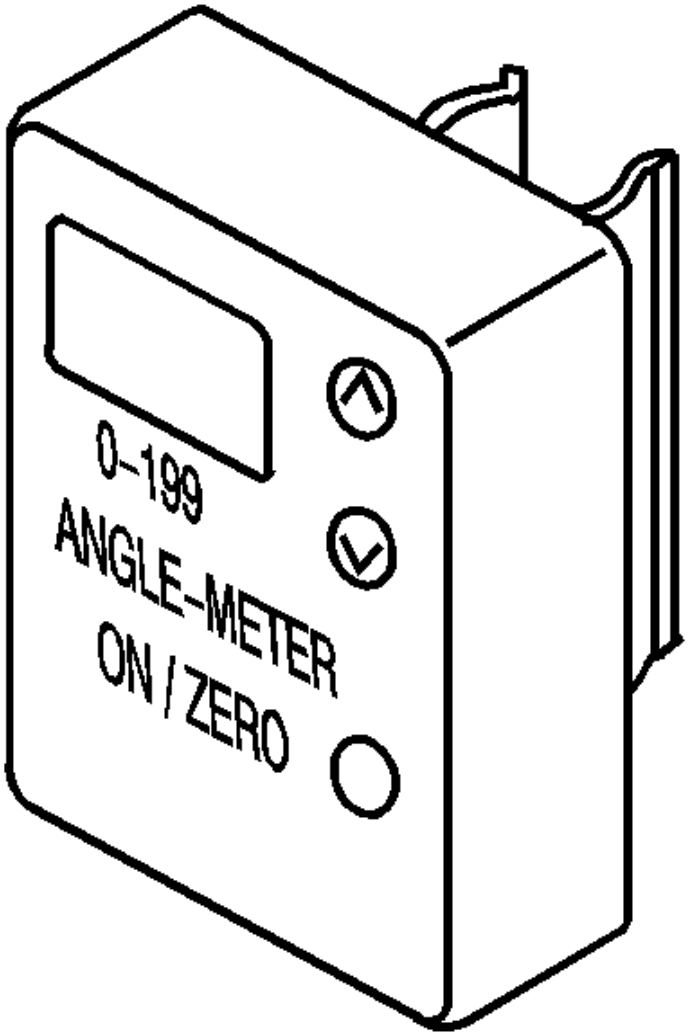	EN-45059 J-45059 KM-470-B Angle Meter South America Use Local Equivalent

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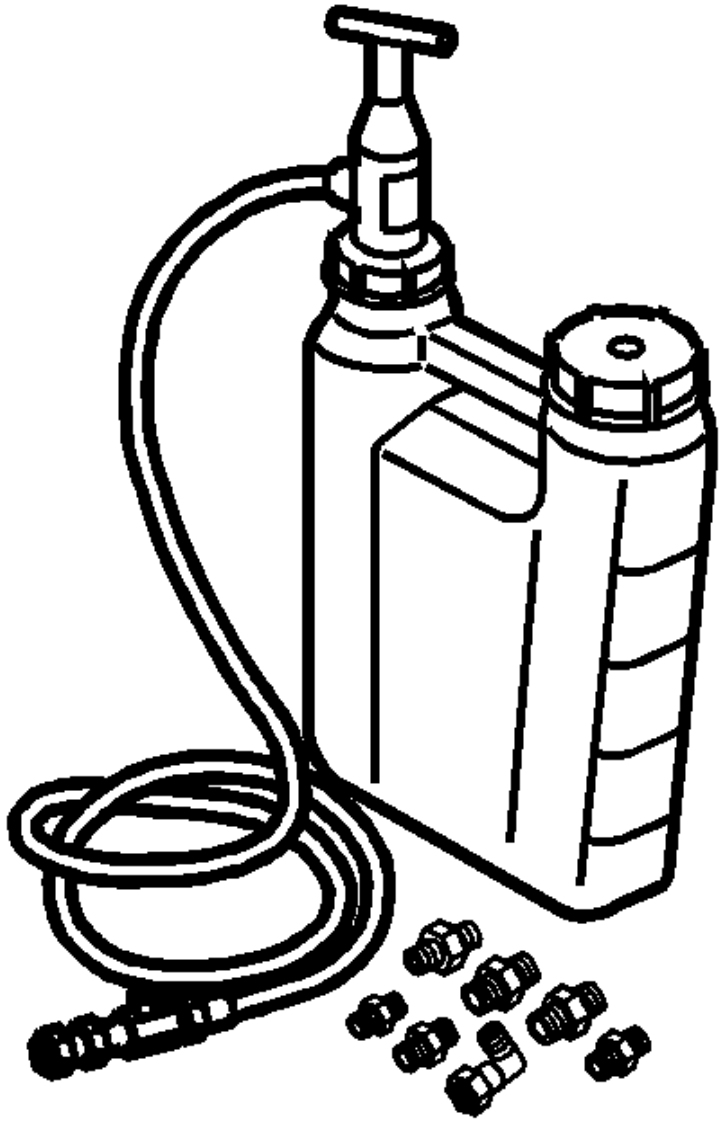	EN-45299 J-45299 Engine Preluber South America Use Local Equivalent

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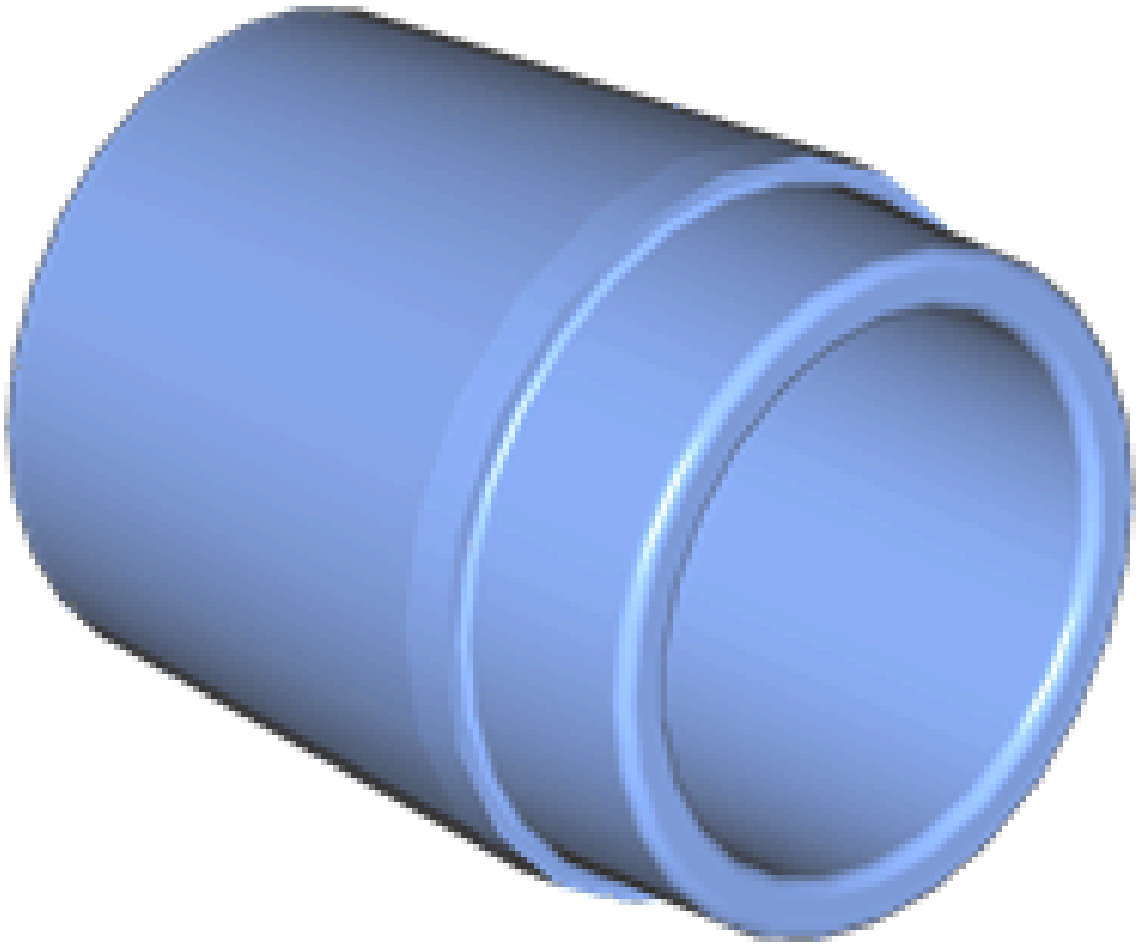
	EN-46101 J-46101 Spark Plug Tube Seal Guide

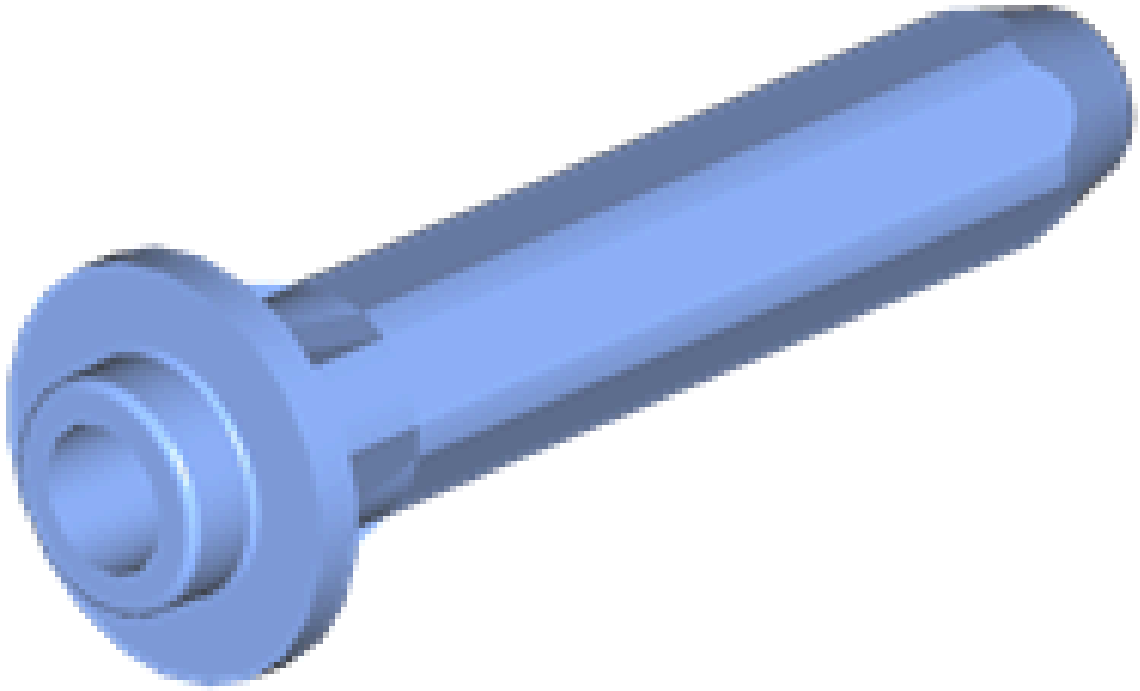
Illustration	Tool Number/Description
	EN-46103 J-46103 Camshaft Actuator Valve Seal Installer

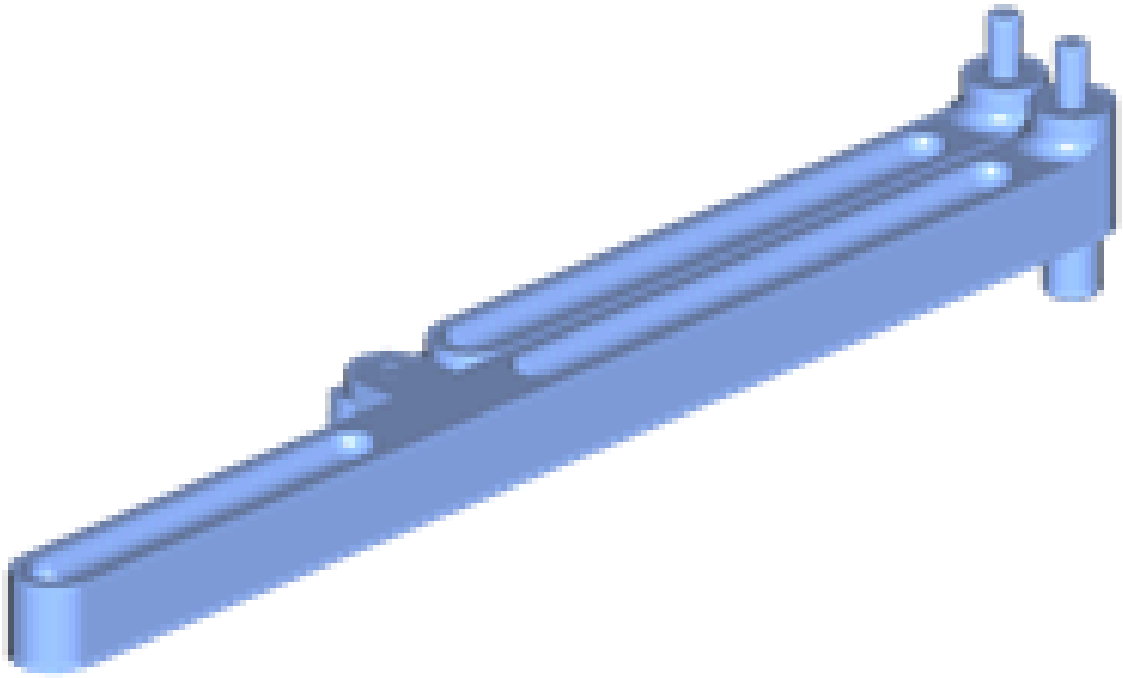
Illustration	Tool Number/Description
	EN-46104 J-46104 V-0506022 Water Pump Pulley Holding Tool

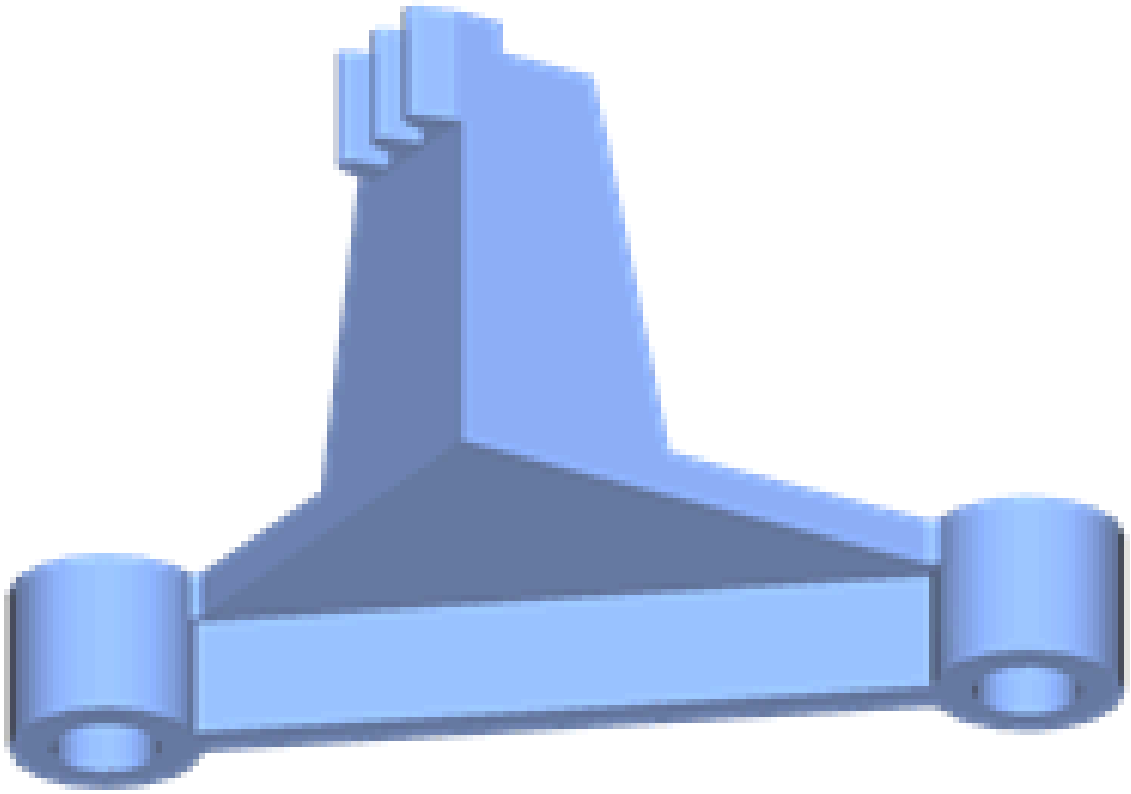
Illustration	Tool Number/Description
	EN-46106 EN-50638 J-46106 KM-652 Flywheel Holding Tool

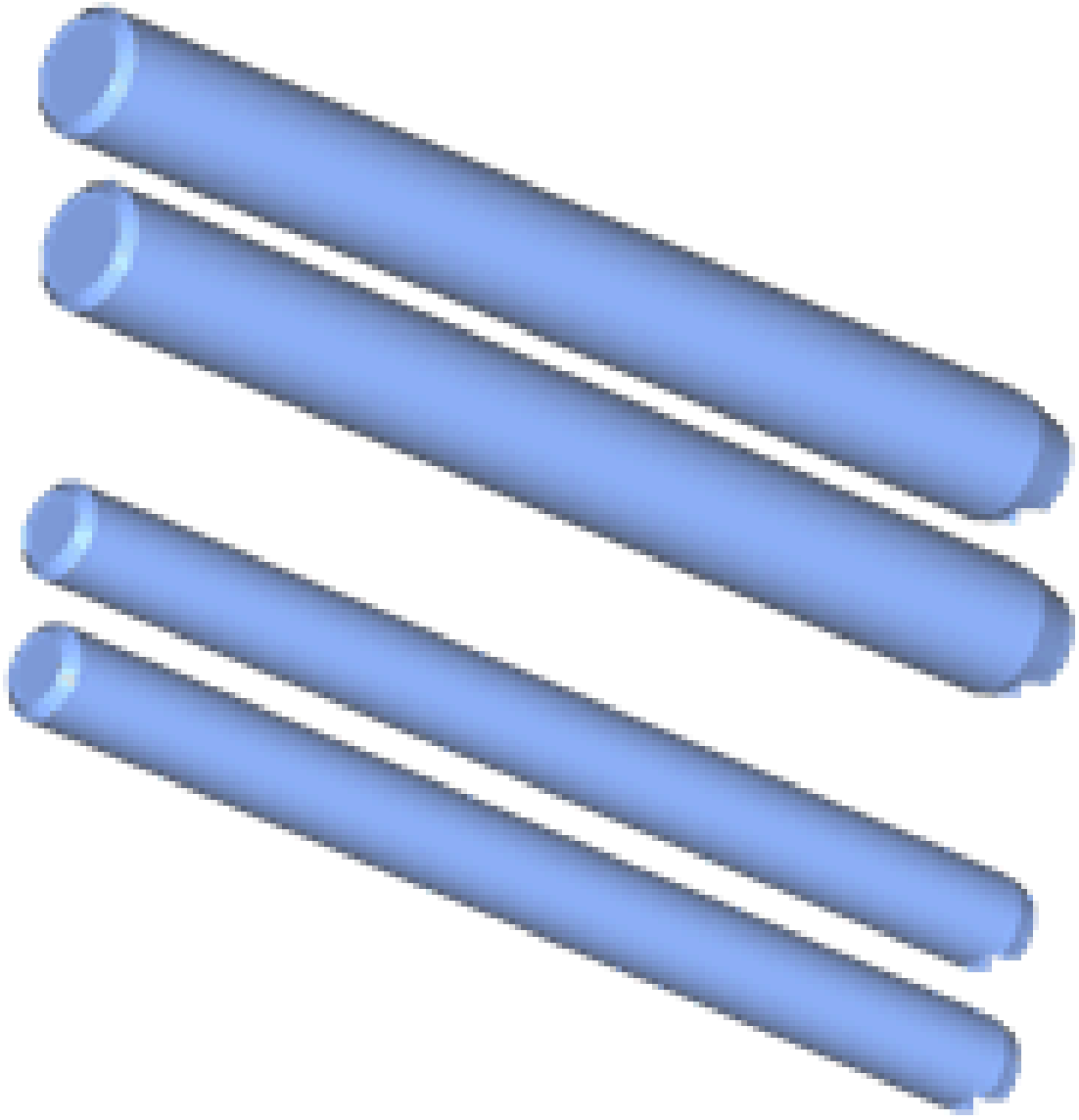
Illustration	Tool Number/Description
	EN-46109 J-46109 V-0506033 Guide Pins

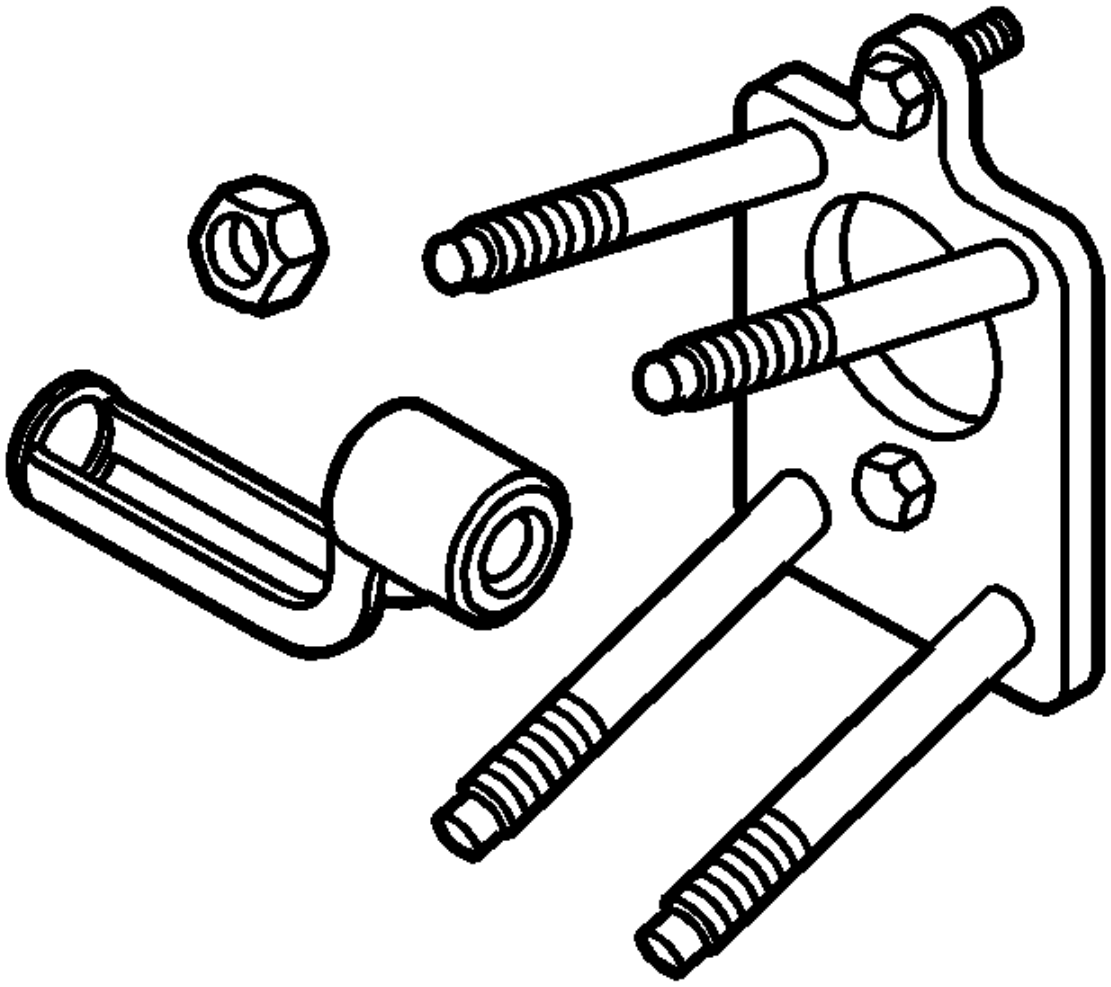
Illustration	Tool Number/Description
	EN-46110 EN-46110-EU J-46110-EU On-Vehicle Valve Spring Compressor South America Use Local Equivalent

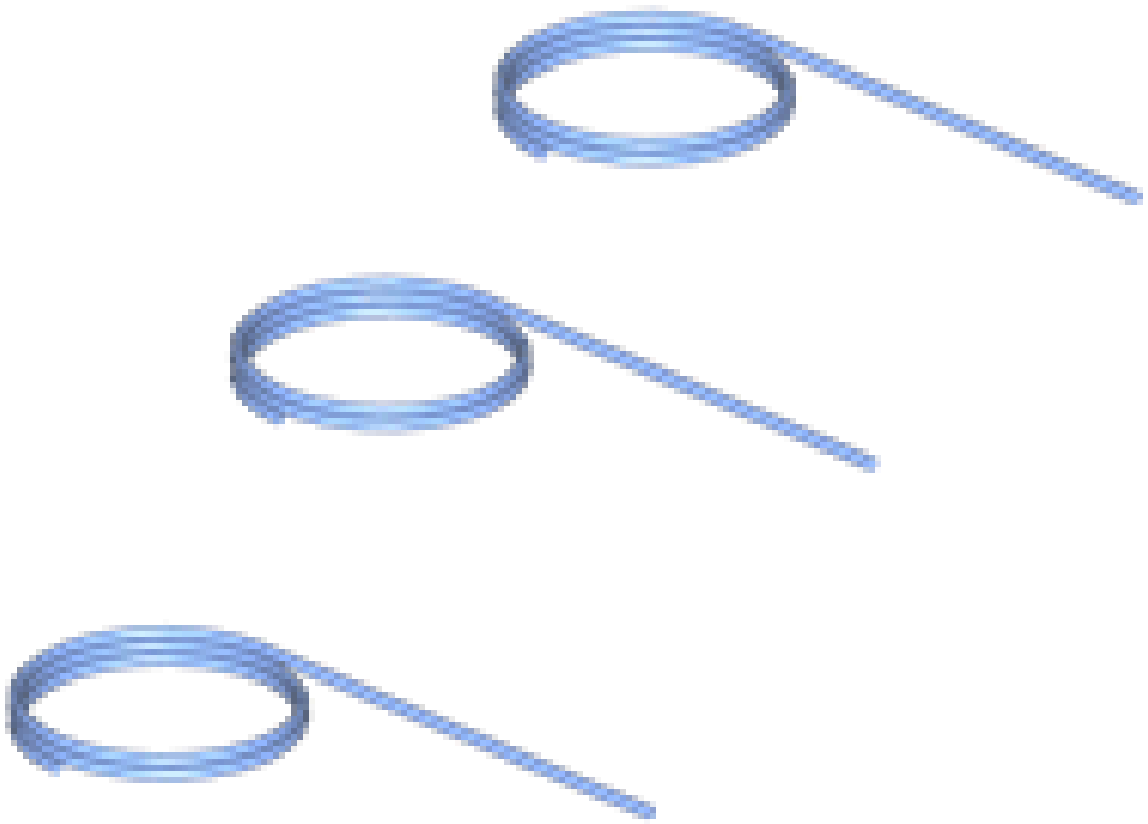
Illustration	Tool Number/Description
	EN-46112 Tensioner Retraction Pins South America Use Local Equivalent

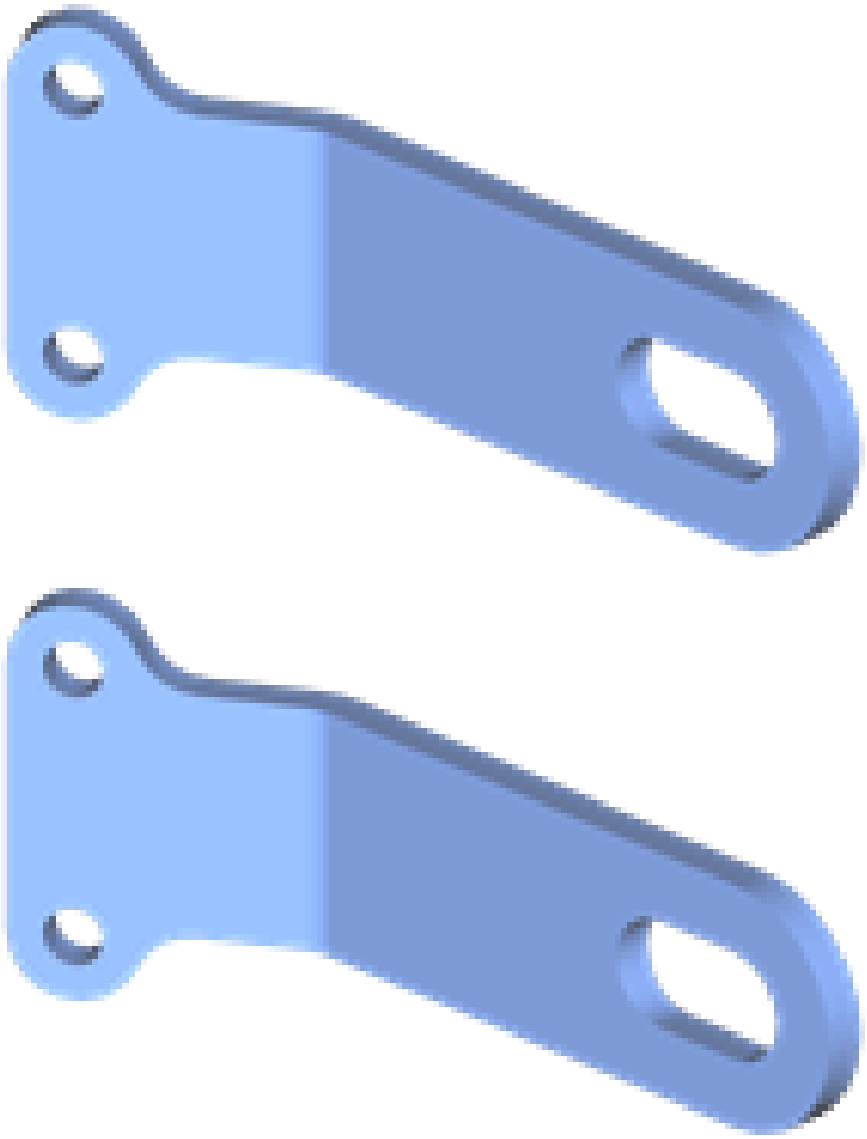
Illustration	Tool Number/Description
	EN-46114 Engine Lift Brackets

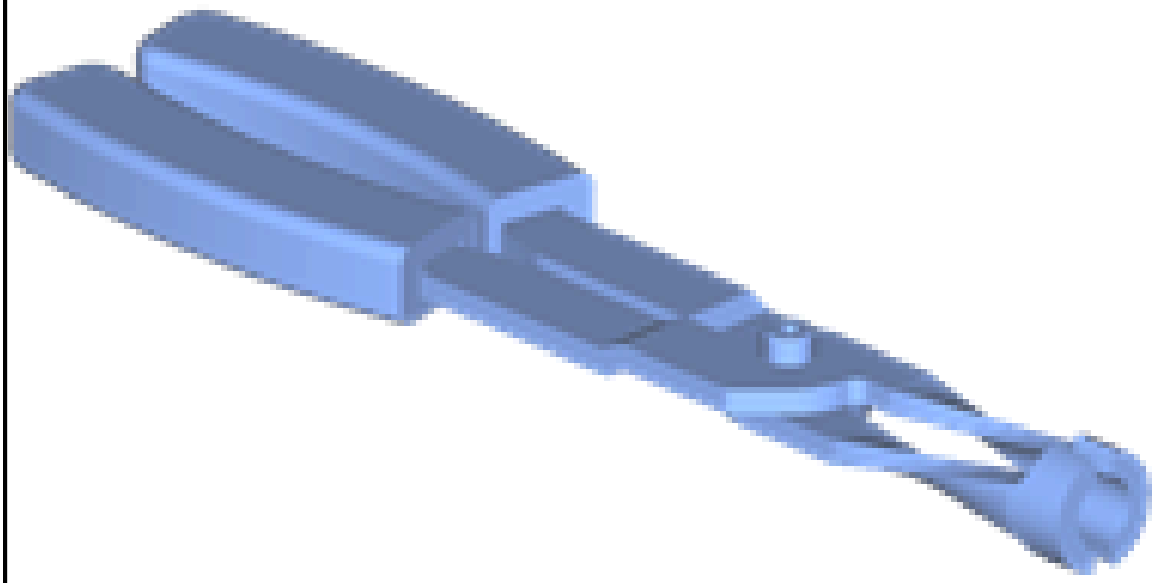
Illustration	Tool Number/Description
	EN-46116 KM-840 (Remover) /EN-47986 (Installer) 83 94 157 V-0506032 Valve Stem Seal Remover/Installer

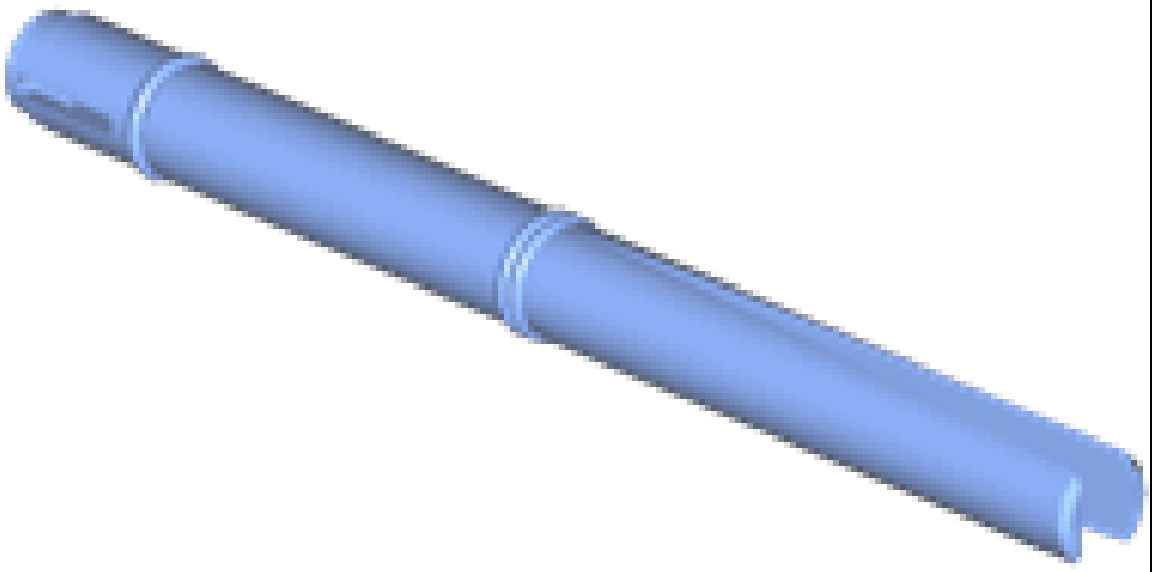
Illustration	Tool Number/Description
	EN-46117 Valve Stem Key Remover/Installer South America Use Local Equivalent

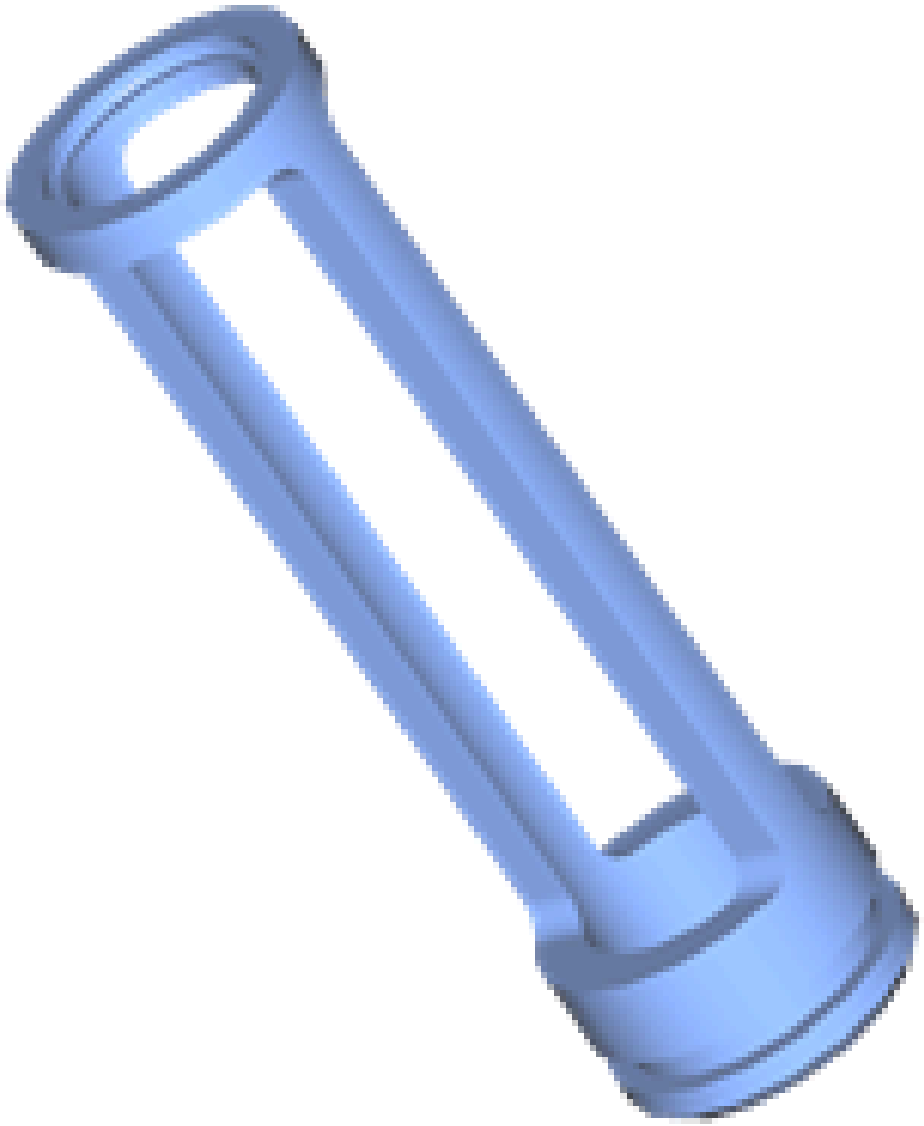
Illustration	Tool Number/Description
	EN-46119 V-0506034 Off-Vehicle Valve Spring Compressor Adapter

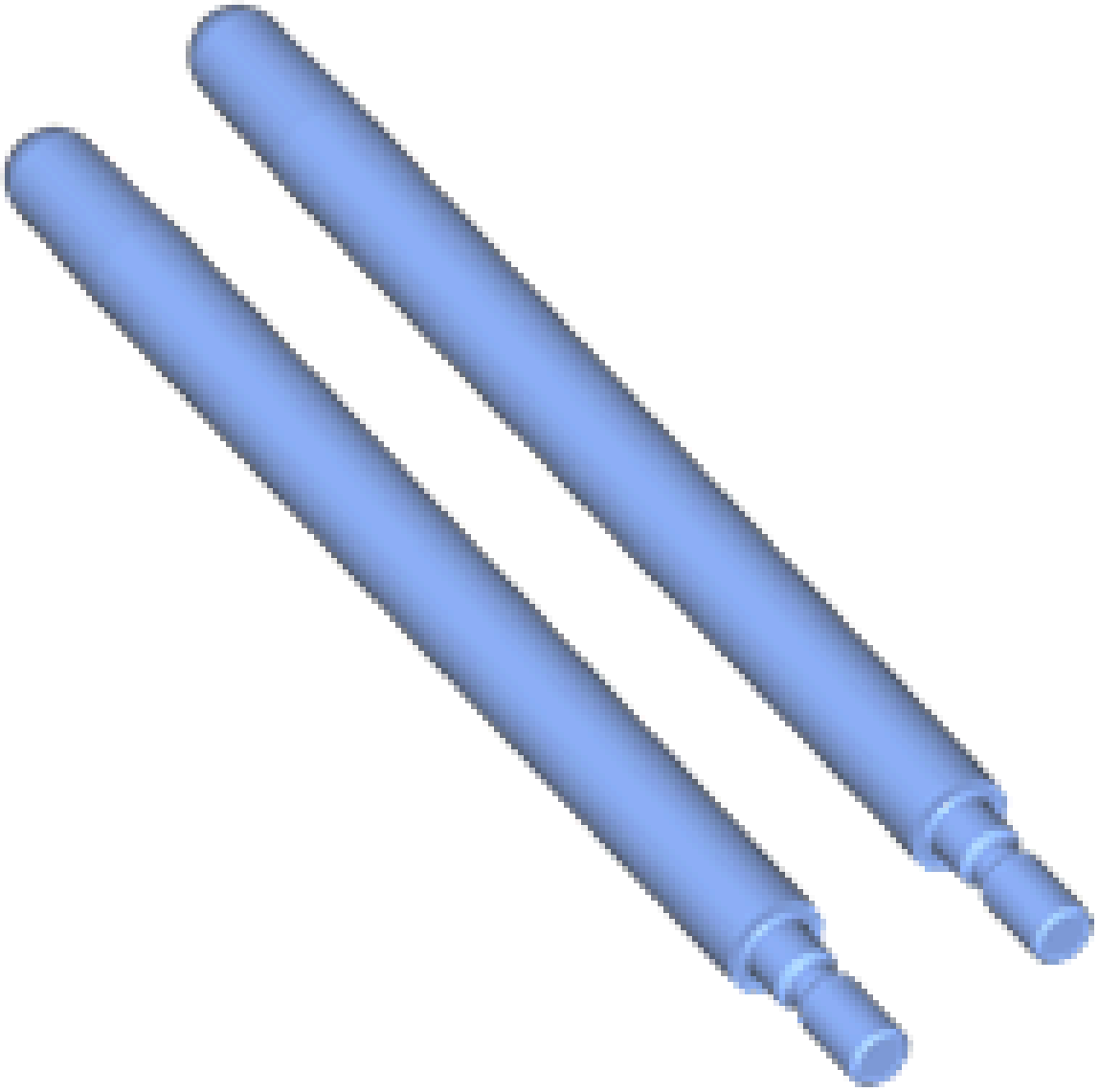
Illustration	Tool Number/Description
	EN-46121 V-0506030 Connecting Rod Guide Pin Set

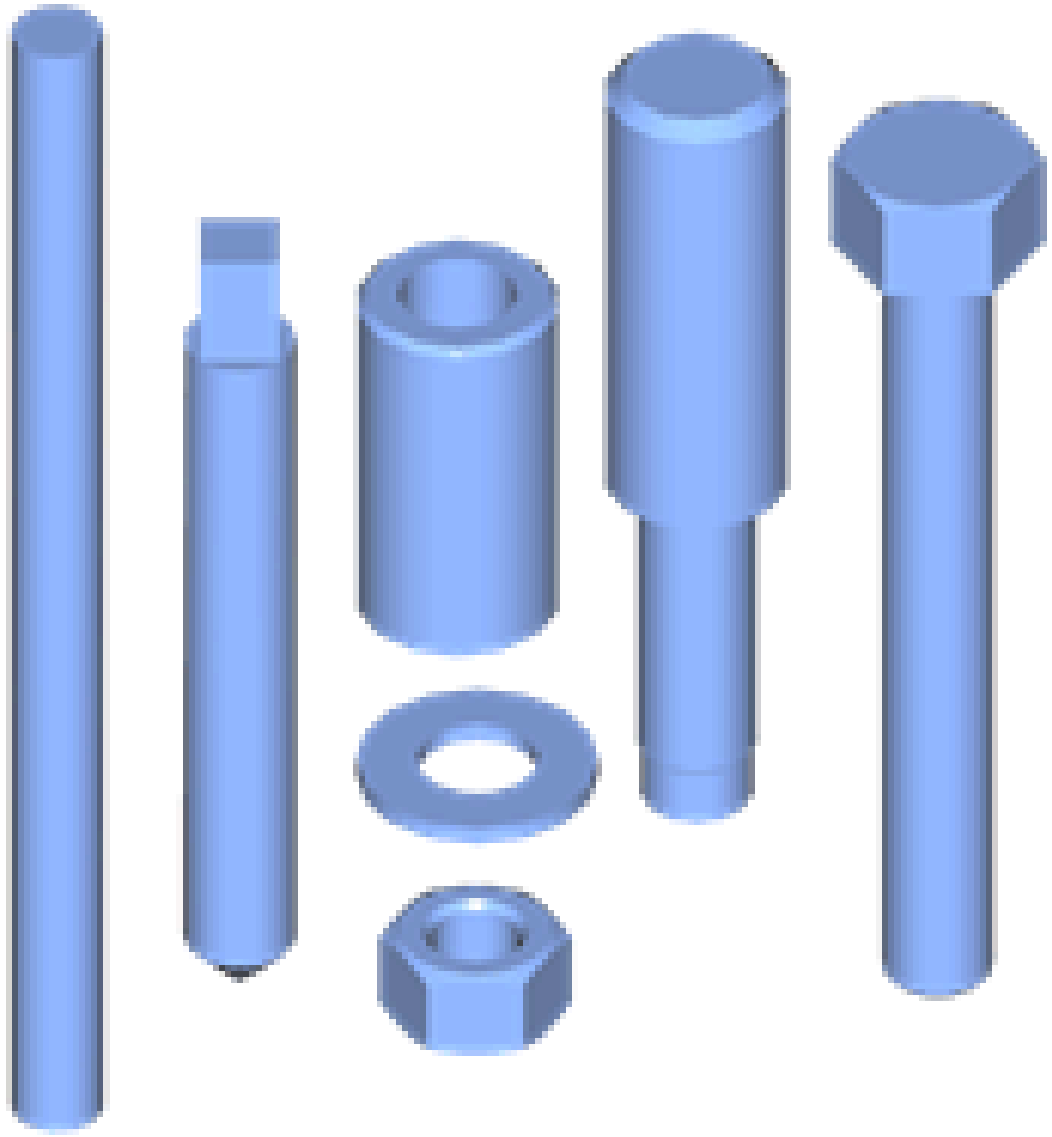
Illustration	Tool Number/Description
	EN-46122 Camshaft Position Actuator Check-Ball Valve Remover/Installer South America Use Local Equivalent

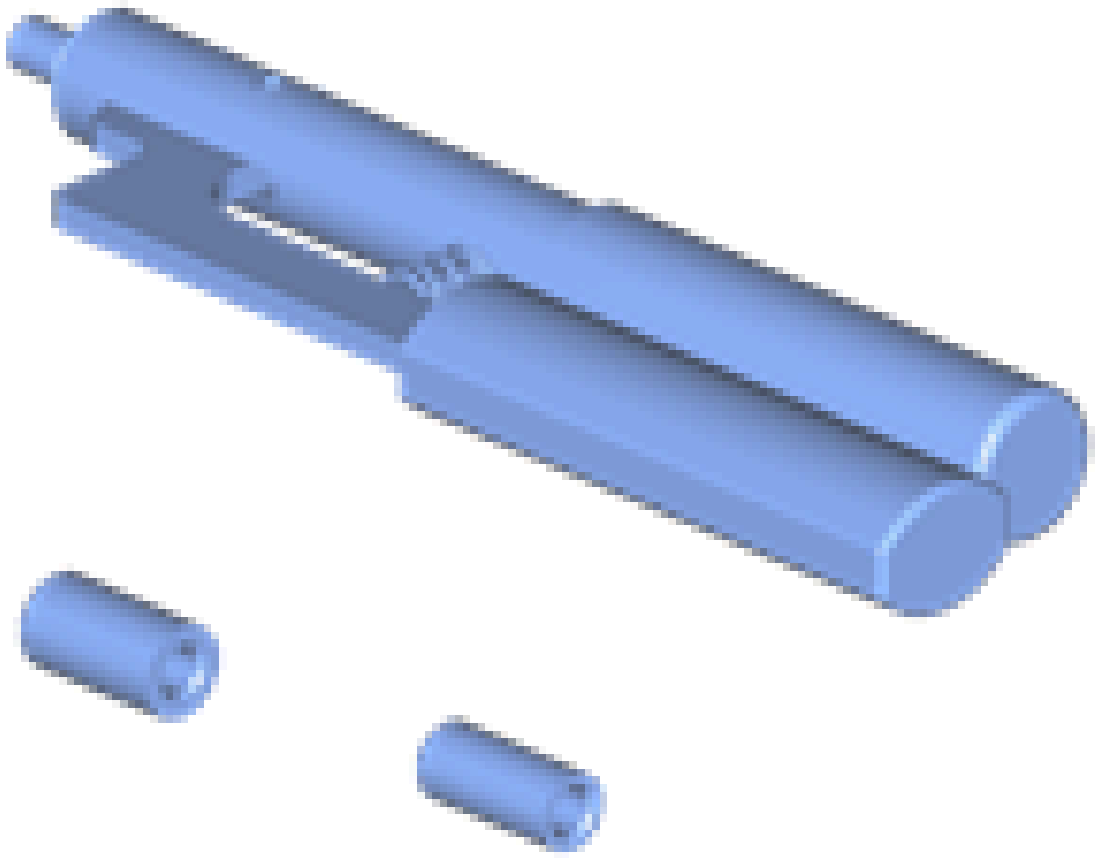
Illustration	Tool Number/Description
	EN-46745 J-43654 Piston Pin Clip Remover/Installer South America Use Local Equivalent

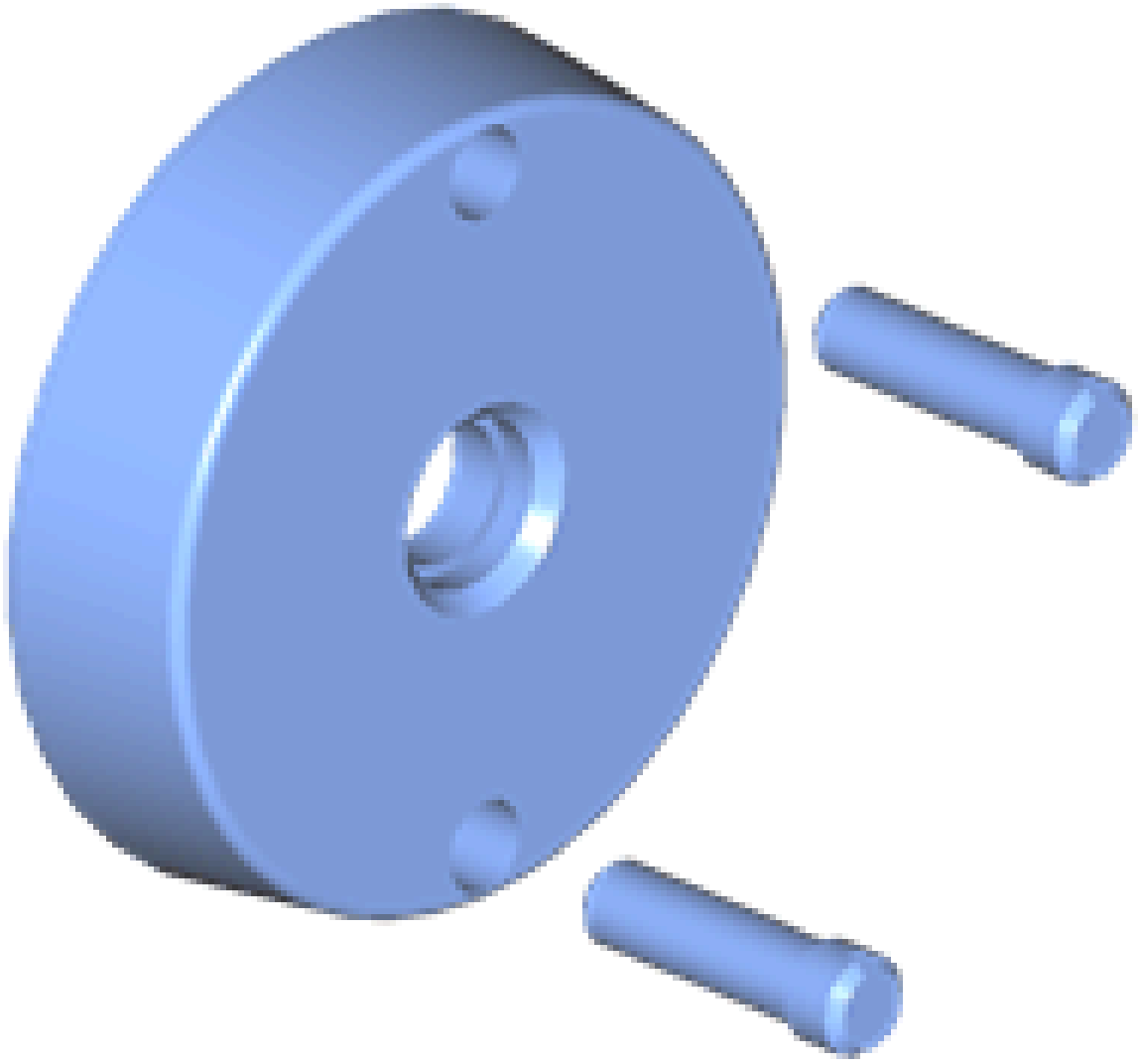
Illustration	Tool Number/Description
	EN-47839 V-0506024 Crankshaft Rear Oil Seal Installation Tool

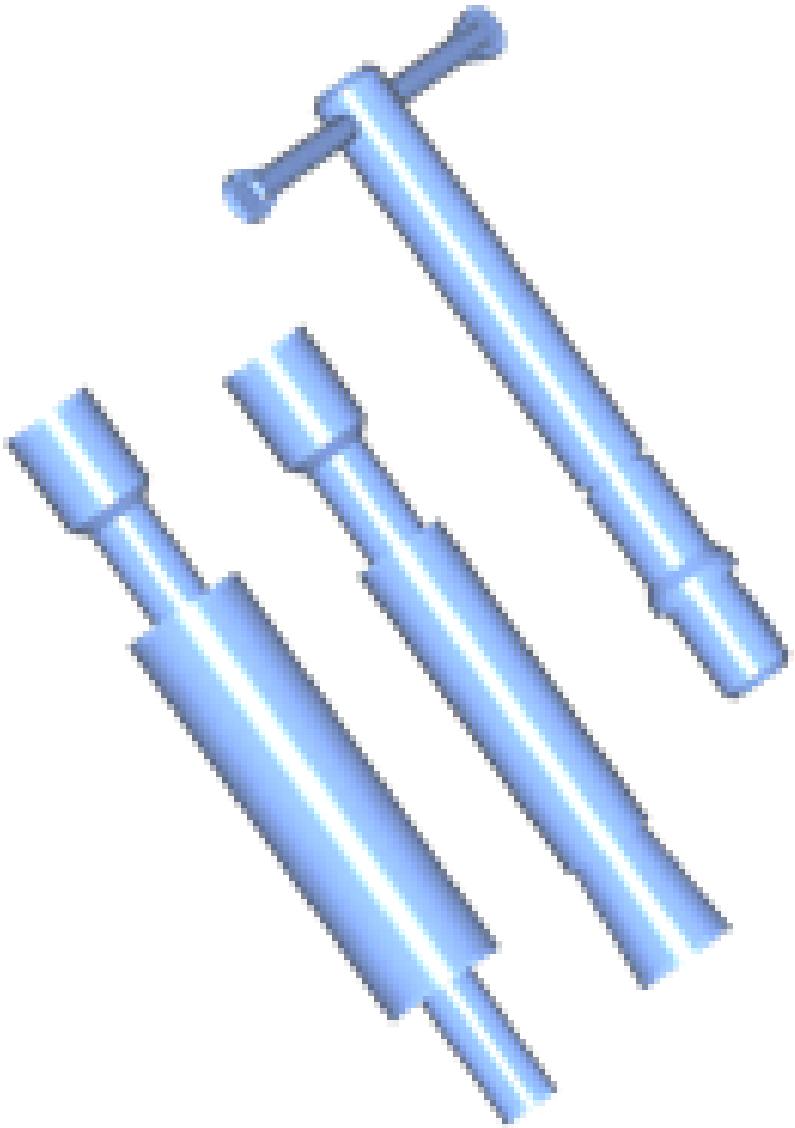
Illustration	Tool Number/Description
	EN-47909 Injector Bore and Sleeve Cleaning Kit

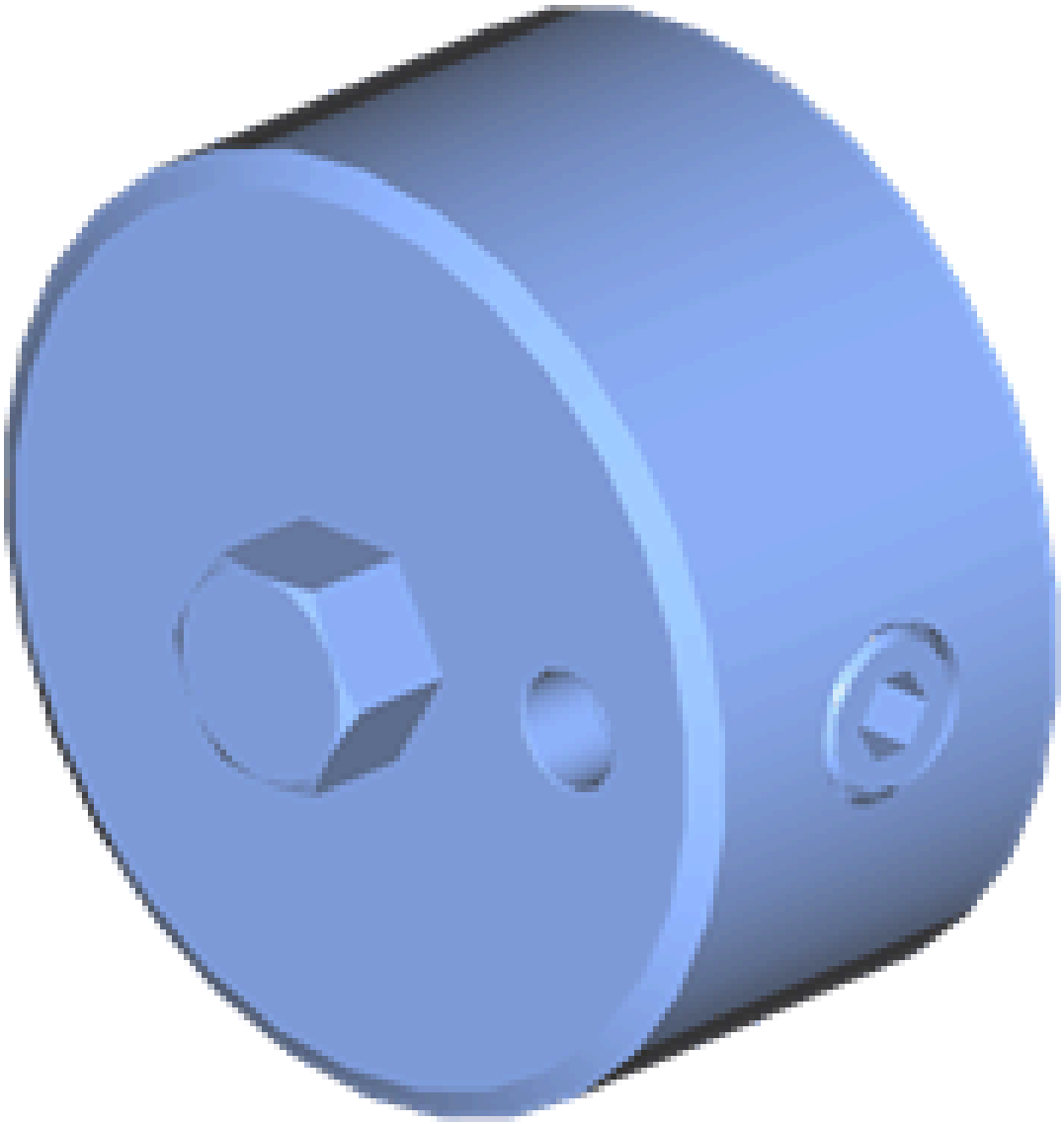
Illustration	Tool Number/Description
	EN-47971 J-42907 Oil Pressure Gauge Adapter

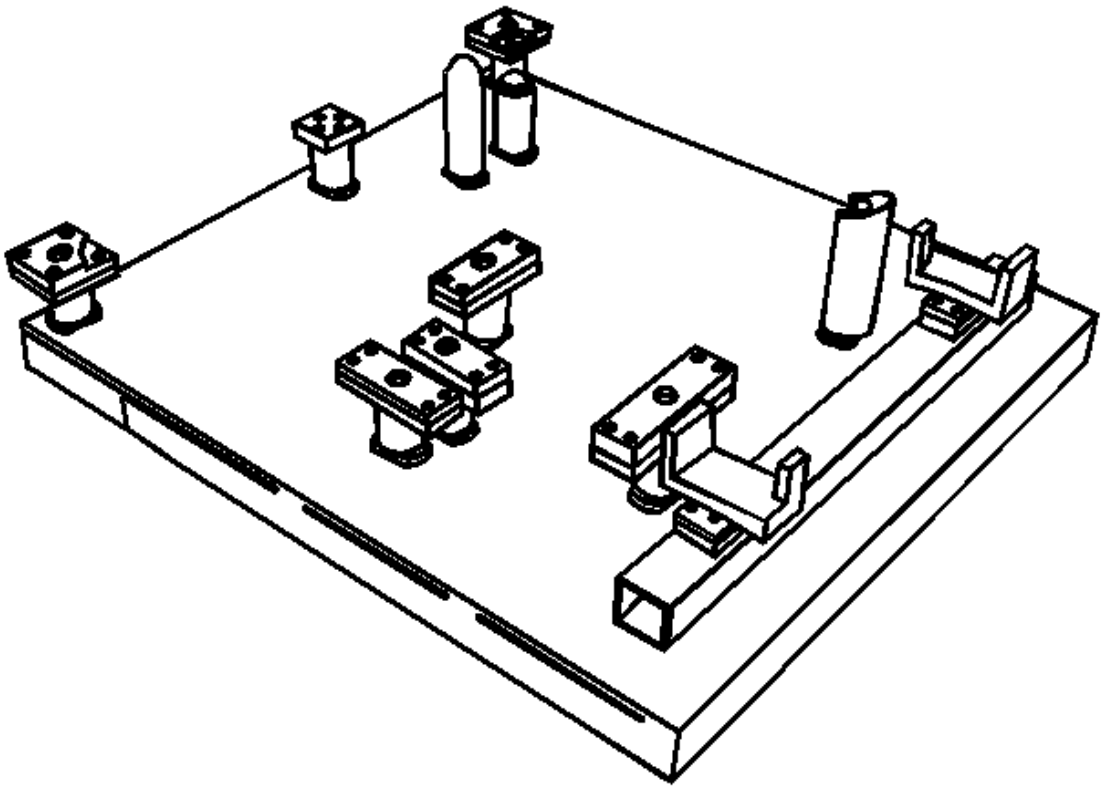
Illustration	Tool Number/Description
	EN-48243 Engine Assembly Remove/Install Pallet

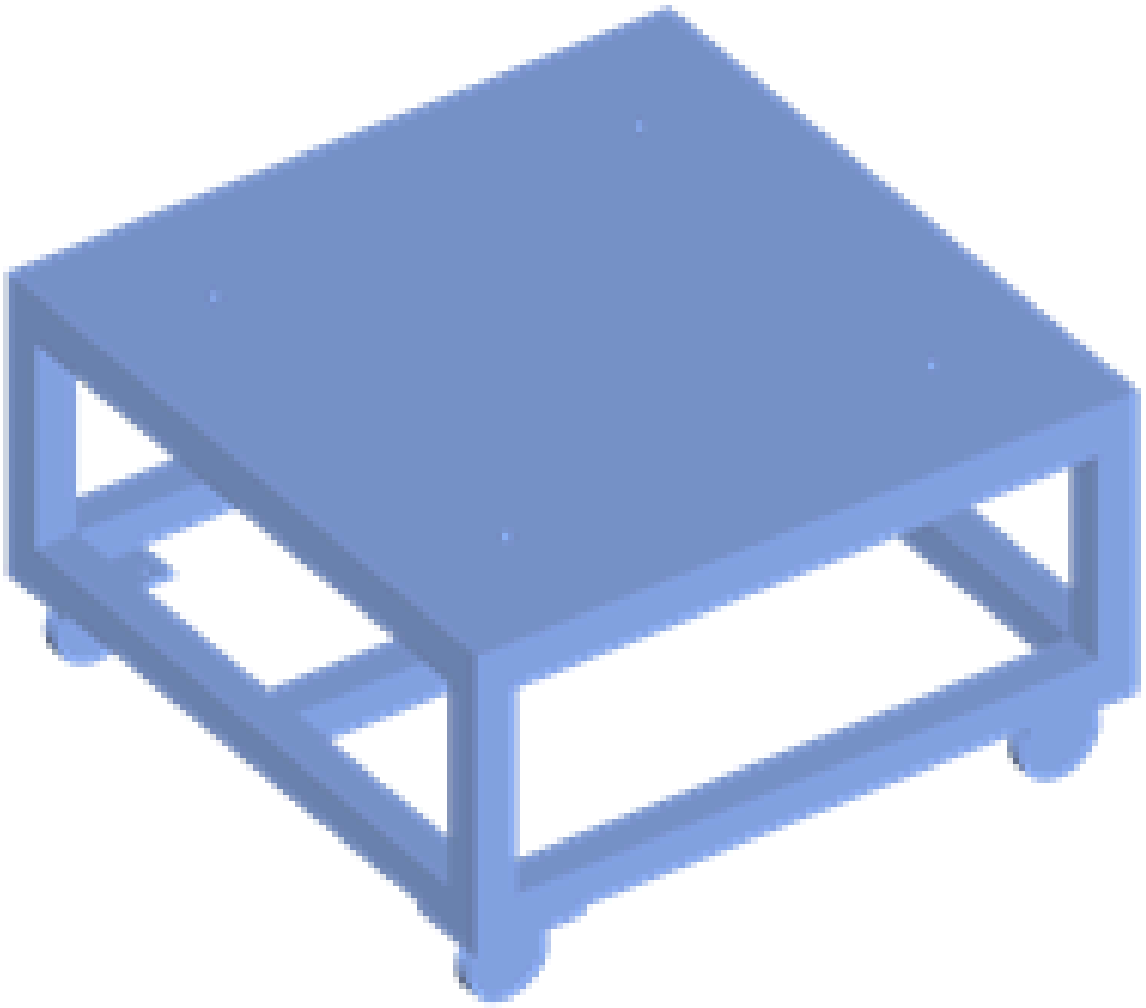
Illustration	Tool Number/Description
	EN-48244 Engine Assembly Remove/Install Pallet Supporter

Illustration	Tool Number/Description
	EN-48313 Timing Chain Retention Tool

Illustration	Tool Number/Description
	EN-48383 Camshaft Retaining Tool

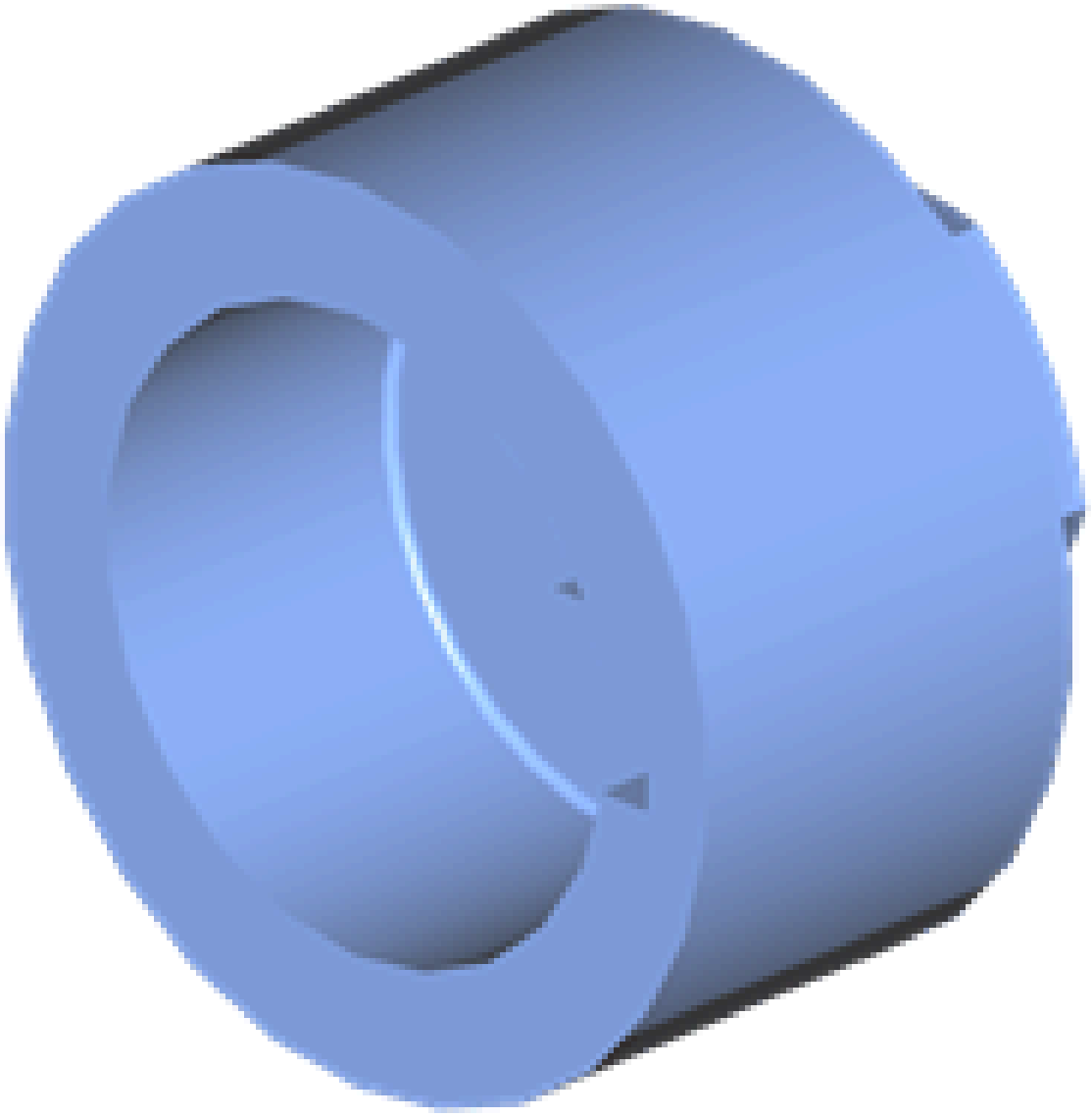
Illustration	Tool Number/Description
	EN-48589-A EN-48589 Crankshaft Rotation Socket

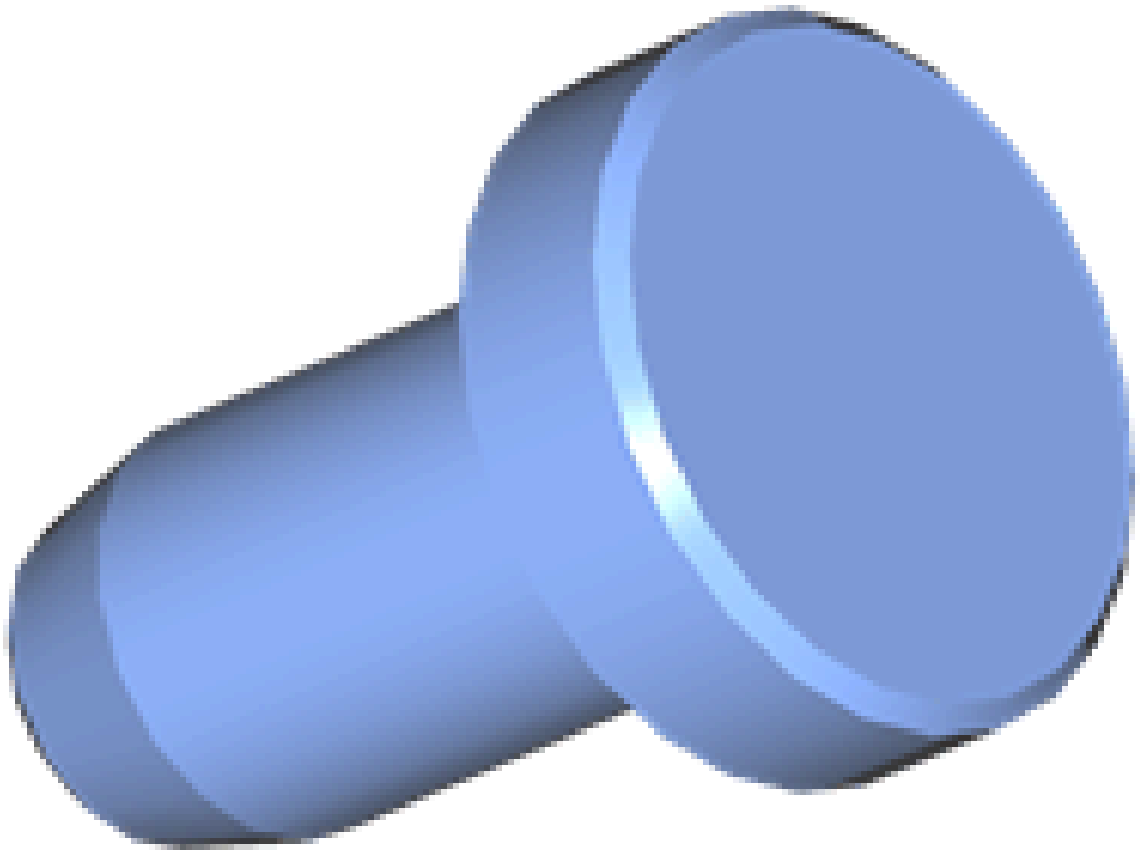
Illustration	Tool Number/Description
	EN-48896 HP Fuel Pump Installation Alignment Gauge

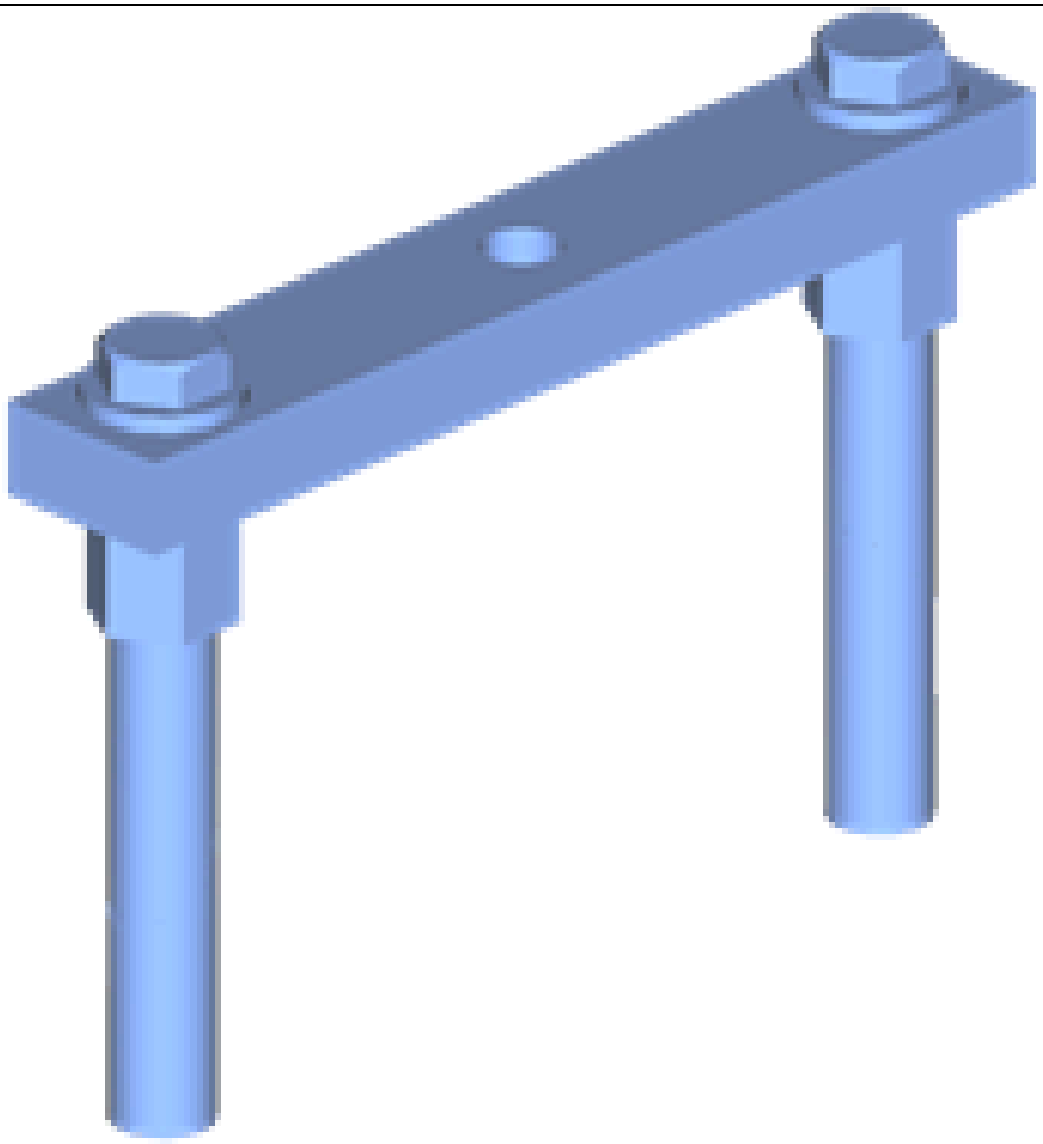
Illustration	Tool Number/Description
	EN-49102 J-41818 & EN-47985 V-0506025 Crankshaft Bearing Cap Remover

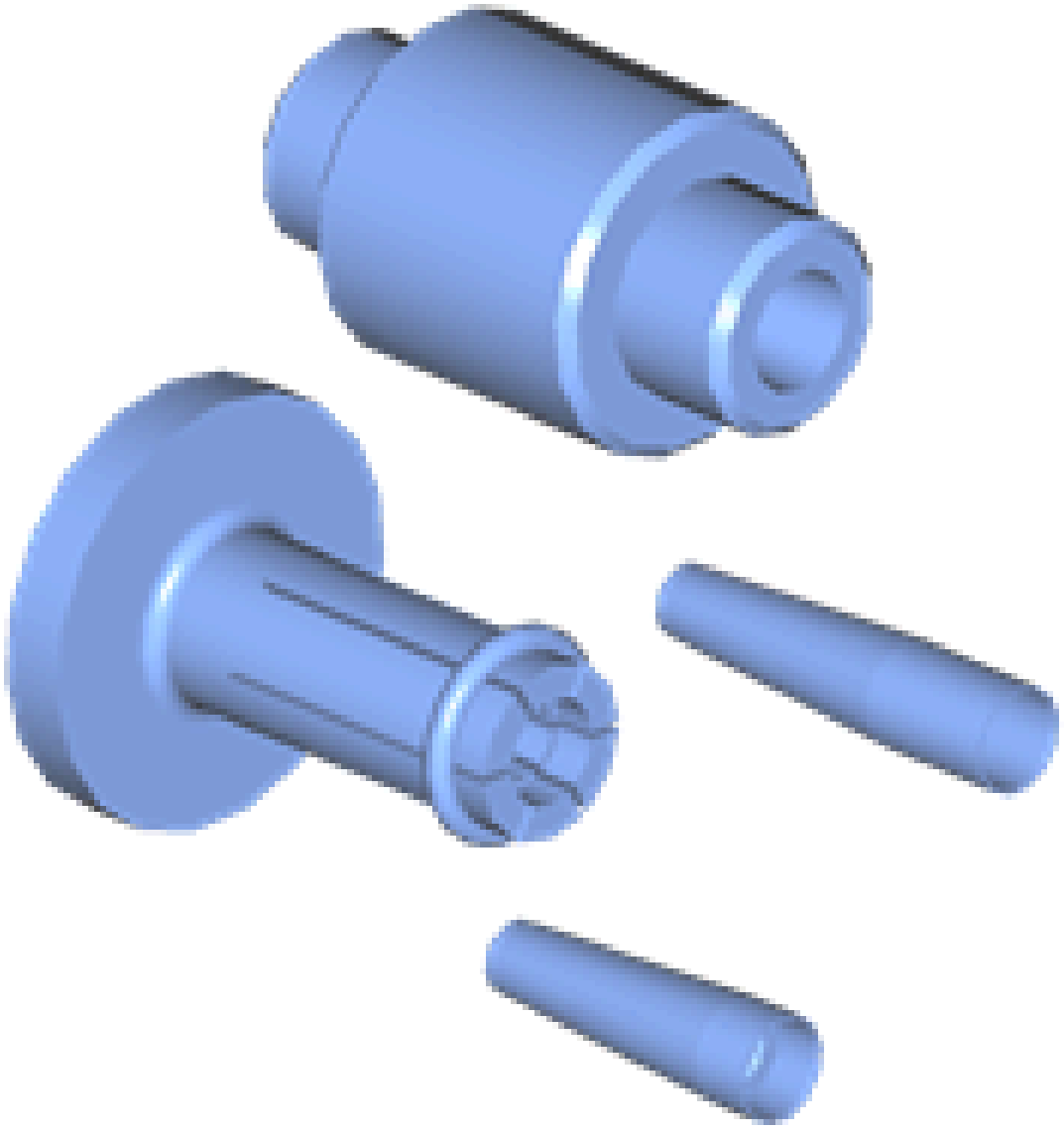
Illustration	Tool Number/Description
	EN-49245 EN-48266 and EN-49245-1 Injector Seal Installer Kit

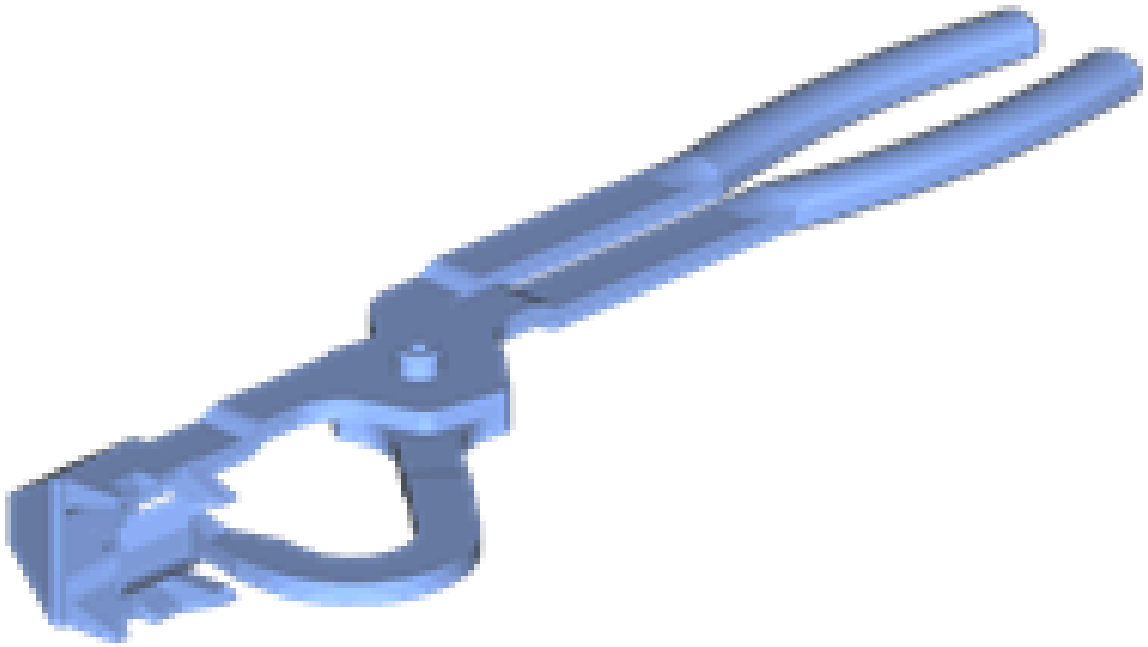
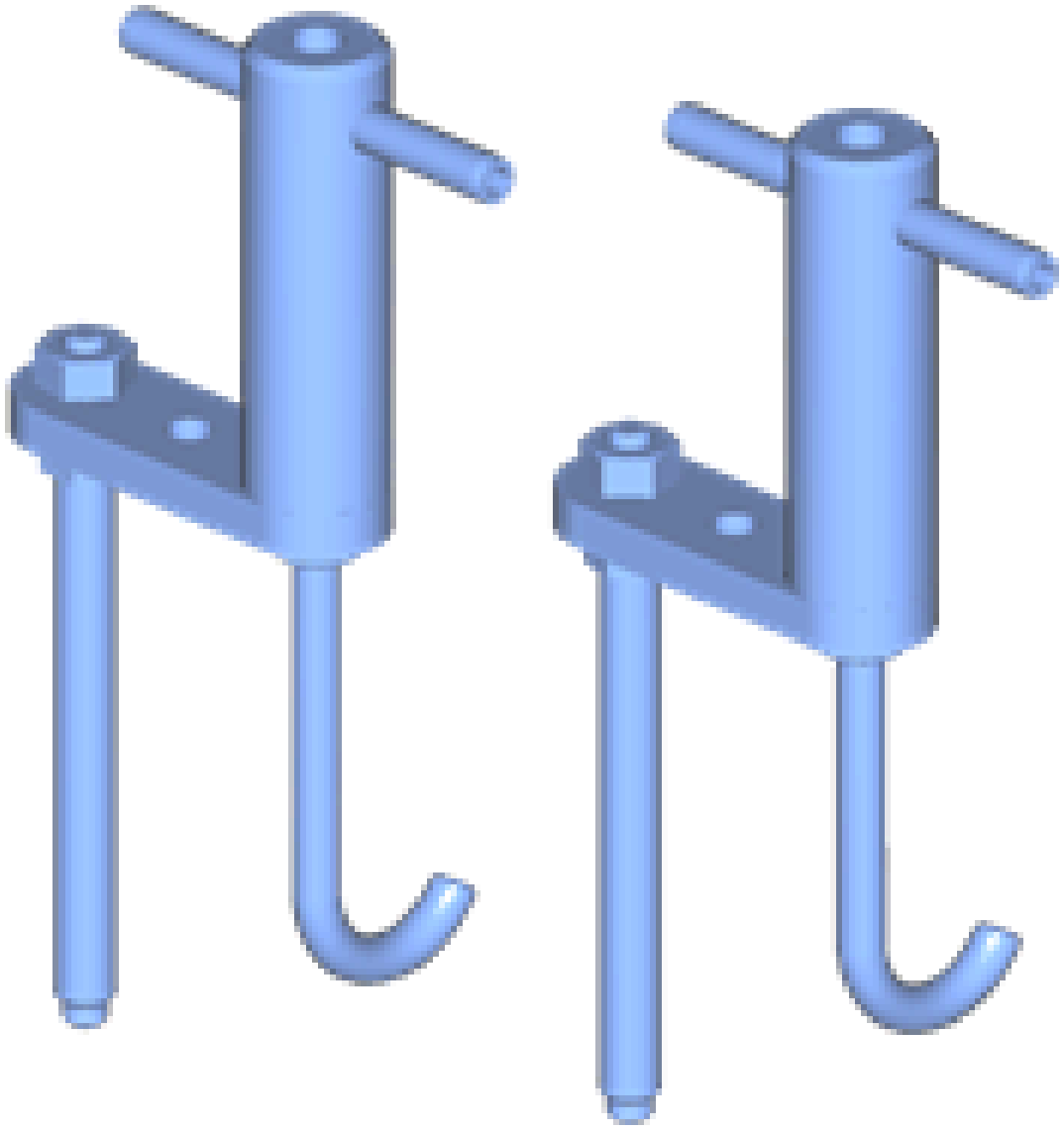
Illustration	Tool Number/Description
	EN-49247 Injector Retaining Clip Installer

Illustration	Tool Number/Description
	EN-49248 Injector Rail Assembly Remover

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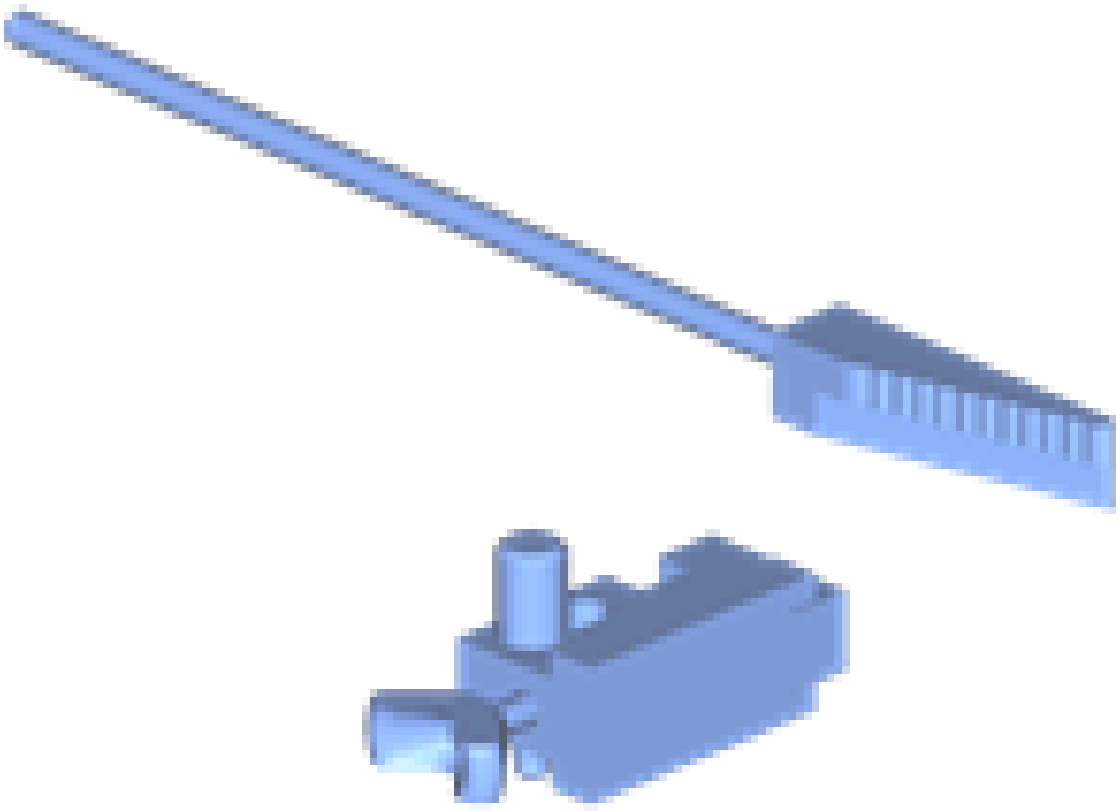
	EN-49982 Timing Chain Retainer

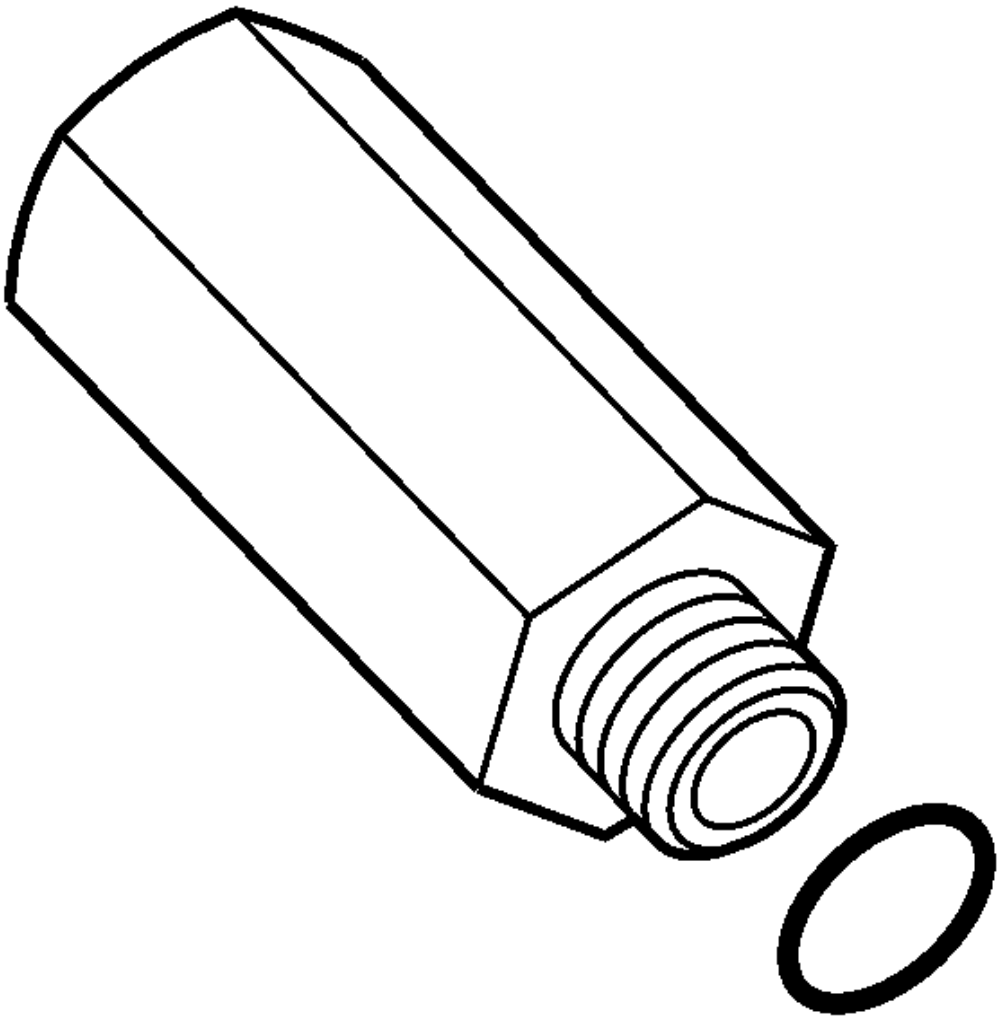
Illustration	Tool Number/Description
	EN-50789 Oil Pressure Adapter Fitting

Illustration	Tool Number/Description
	GE-6125-1B J-6125-1B KM-7004 M-680770 Slide Hammer Adapter

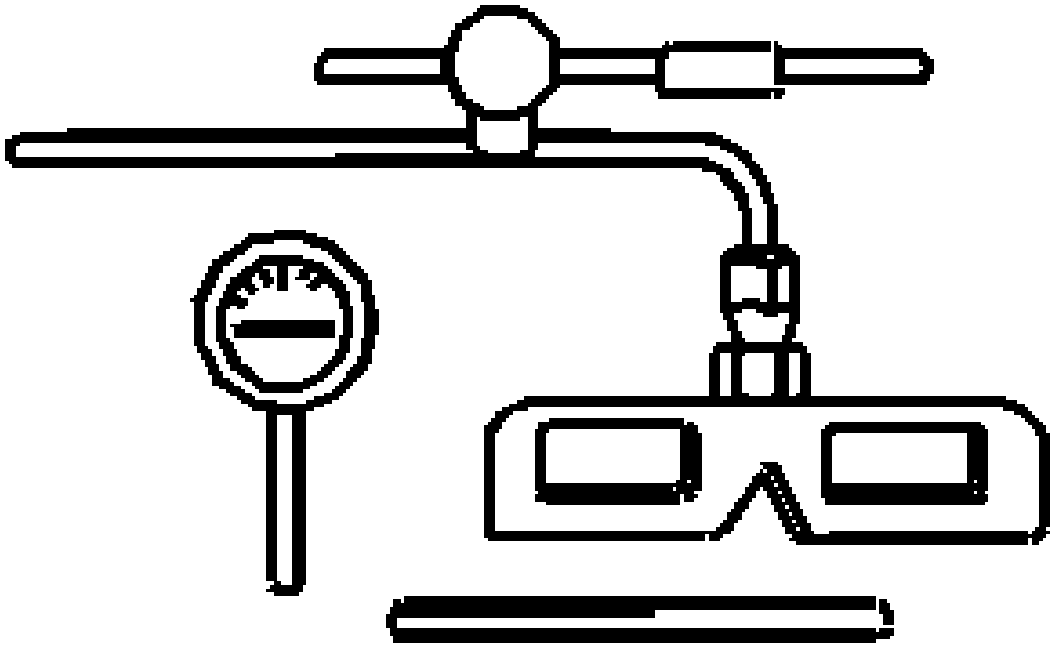
Illustration	Tool Number/Description
	GE-7872 J-7872 Magnetic Base Dial Indicator South America Use Local Equivalent

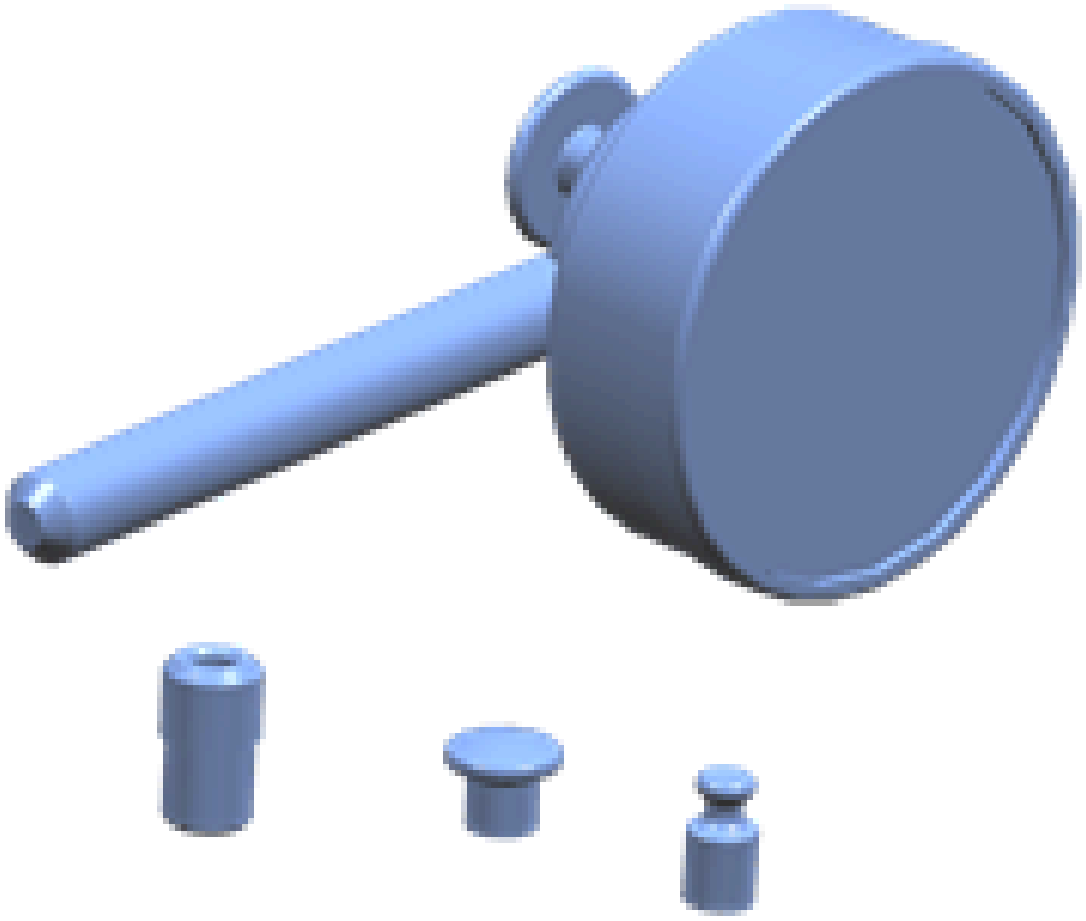
Illustration	Tool Number/Description
	GE-8001 J-8001 Dial Indicator Set South America Use Local Equivalent

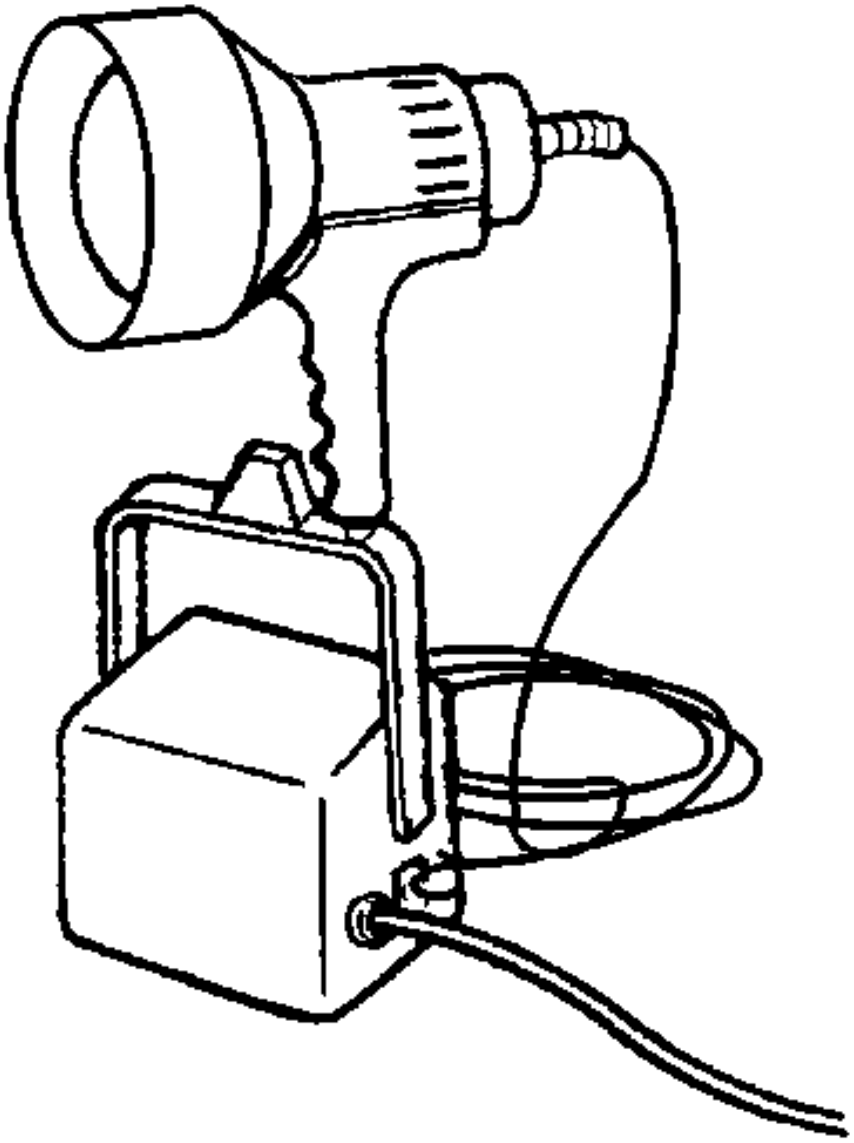
Illustration	Tool Number/Description
	GE-28428-E J-28428-E High Intensity Black Light Kit South America Use Local Equivalent

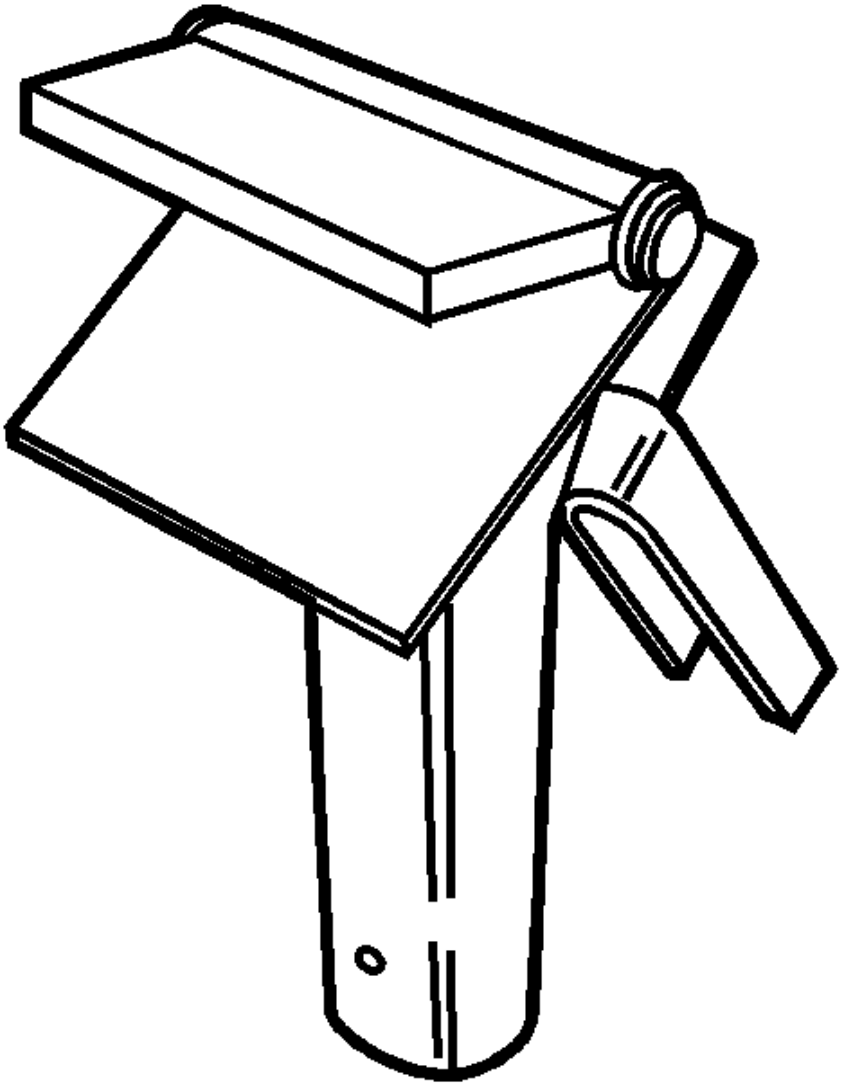
Illustration	Tool Number/Description
	GE-48326 Sealant Dispenser

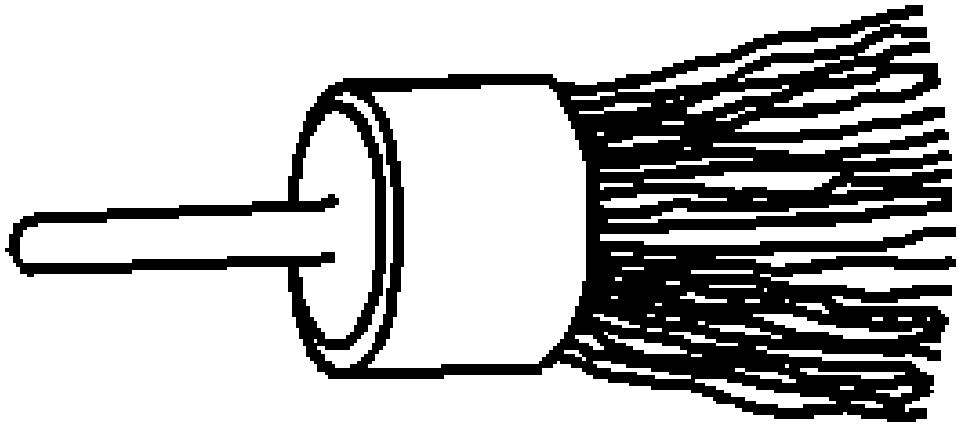
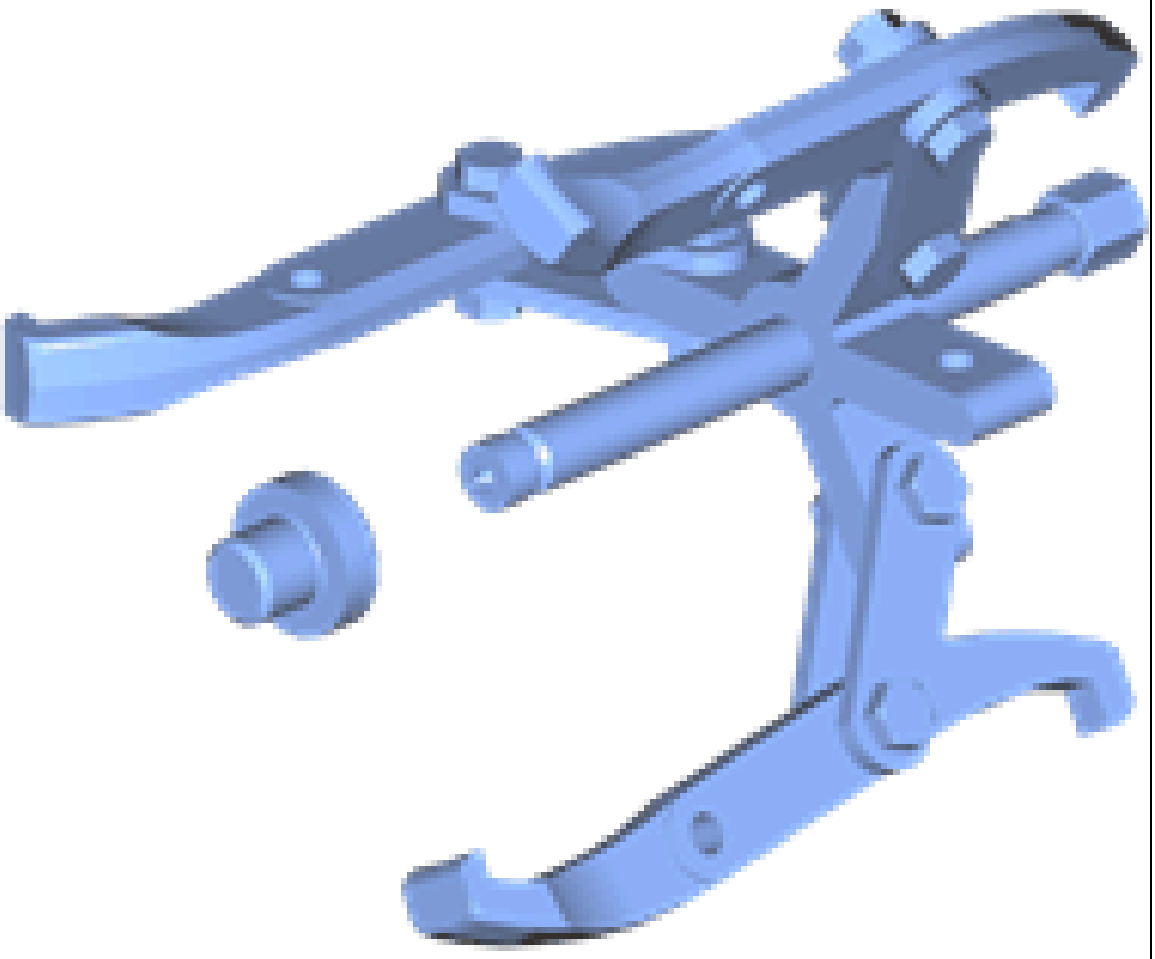
Illustration	Tool Number/Description
	GE-8358 J-8358 Carbon Removal Brush South America Use Local Equivalent

Illustration	Tool Number/Description
	J-38416-B Crankshaft Balancer Remover

Article GUID: A00737153

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Automatic Transmission Flex Plate Bolt		
• First Pass	30 N.m (1)	22 lb ft (1)
• Final Pass	45 Degrees	
Barometric (BARO) Sensor Bolt	10 N.m	89 lb in
Camshaft Cap Bolt	10 N.m	89 lb in
Camshaft Cover Bolt	10 N.m	89 lb in
Camshaft Intermediate Drive Sprocket Bolt- Idler Sprocket	58 N.m	43 lb ft
Camshaft Position Actuator		
• Camshaft Bolt	58 N.m	43 lb ft
• Oil Control Valve Bolt	10 N.m	89 lb in
Camshaft Position Sensor Bolt	10 N.m	89 lb in
Close Out Cover Bolt	10 N.m	89 lb in
Connecting Rod Bolt		
• First Pass	25 N.m (1)	18 lb ft (1)
• Final Pass	110 Degrees	
Coolant Drain Plug - M14	50 N.m	37 lb in
Coolant Drain Plug - M20	75 N.m	55 lb in
Coolant Outlet Bolt	10 N.m	89 lb in
Crankshaft Balancer Bolt		
• First Pass	100 N.m (1)	74 lb ft (1)
• Final Pass	150 Degrees	
Crankshaft Main Bearing Bolt		
Inner		
• First Pass	20 N.m (1)	15 lb ft (1)

Application	Specification	
	Metric	English
• Final Pass	80 Degrees	
Outer		
• First Pass	15 N.m (1)	11 lb ft (1)
• Final Pass	110 Degrees	
Side		
• First Pass	30 N.m (1)	22 lb ft (1)
• Final Pass	60 Degrees	
Crankshaft Position Sensor Bolt	10 N.m	89 lb in
Crankshaft Position Sensor/Right Exhaust Manifold Lower Heat Shield		
• M6- Bolt	10 N.m	89 lb in
• M10- Bolt	58 N.m	43 lb ft
Crankshaft Rear Oil Seal Housing Bolt	10 N.m	89 lb in
Cylinder Head Bolt- M8		
• First Pass	15 N.m (1)	11 lb ft (1)
• Final Pass	75 Degrees	
Cylinder Head Bolt- M11		
• First Pass	30 N.m (1)	22 lb ft (1)
• Final Pass	150 Degrees	
Cylinder Head Core Hole Plug	75 N.m	55 lb ft
Drive Belt Tensioner Bolt	25 N.m	18 lb ft
Engine Coolant Temperature (ECT) Sensor	30 N.m	22 lb ft
Engine Front Cover Stud	15 N.m	11 lb ft
Engine Front Cover Bolt- M6	15 N.m	11 lb ft
Engine Front Cover Bolt- M8		
• First Pass	20 N.m	14 lb ft
• Final Pass	60 Degrees	
Engine Front Cover Bolt- M12	65 N.m	48 lb ft
Engine Mount		

Application	Specification	
	Metric	English
• Bracket Bolt to Engine Block- M8	22 N.m	16 lb ft
• Bracket Bolt to Engine Block- M10	58 N.m	43 lb ft
• Engine Mount Strut Bolts	58 N.m	43 lb ft
• Engine Mount Strut Bracket Bolts- to Engine	90 N.m	66 lb ft
• Front Lower Engine Mount Nut- to Frame	75 N.m	55 lb ft
• Front Upper Engine Mount Nut- to Engine Mount	90 N.m	66 lb ft
• Rear Upper Engine Mount Nut- to Engine Mount	60 N.m	44 lb ft
Evaporative (EVAP) Purge Valve Bolt/Ball Stud	10 N.m	89 lb in
Exhaust Crossover Pipe Nuts	34 N.m	25 lb ft
Fuel Feed Pipe Bolt	50 N.m	37 lb ft
Fuel Feed Pipe Nut	28 N.m	21 lb ft
Fuel Pump Bolts - High Pressure		
• First Pass:<!--Used for torque specification-->	15 N.m (1)	11 lb ft (1)
• Final Pass:<!--Used for torque specification-->	60 Degrees	
Fuel Rail Bolt	25 N.m	18 lb ft
Fuel Rail Crossover Pipe Fitting	28 N.m	21 lb ft
Fuel Rail Support Bracket	10 N.m	89 lb in
Heater Inlet/Outlet Pipe Assembly Bolt	10 N.m	89 lb in
Idler Pulley Bolt	58 N.m	43 lb ft
Ignition Coil Bolt	10 N.m	89 lb in
Intake Manifold		
• Upper-to-Cylinder Head Bolt- Long	25 N.m	18 lb ft
• Upper-to-Cylinder Head Bolt- Short	25 N.m	18 lb ft
• Upper-to-Lower Intake Manifold Bolt	25 N.m	18 lb ft
Knock Sensor Bolt	25 N.m	18 lb ft
Manifold Absolute Pressure Sensor (MAP) Bolt	4 N.m	35 lb in
Oil Filter	3/4 to 1 full turn after gasket makes contact with the sealing surface on the filter mounting flange	

Application	Specification	
	Metric	English
Oil Filter Housing Adapter Bolt	23 N.m	17 lb ft
Oil Gallery Plug	31 N.m	23 lb ft
Oil Level Indicator Tube Bolt	10 N.m	89 lb in
Oil Pan Bolt- Block M8	25 N.m	18 lb ft
Oil Pan Bolt- Crankshaft Rear Oil Seal Housing M6	10 N.m	89 lb in
Oil Pan Drain Plug	25 N.m	18 lb ft
Oil Pan Windage Tray Bolt	10 N.m	89 lb in
Oil Pressure Sender	20 N.m	15 lb ft
Oil Pump Bolt	25 N.m	18 lb ft
Oxygen Sensor Pump Converter Pipe	42 N.m	31 lb ft
PCV Tube Bracket Bolt/Ball Stud	10 N.m	89 lb in
Piston Oil Cooling Nozzle Bolt	10 N.m	89 lb in
Primary Camshaft Drive Chain		
• Left Lower Guide Bolt- Oil Pump- Second Design	25 N.m	18 lb ft
• Tensioner Bolt	25 N.m	18 lb ft
• Upper Guide Bolt	25 N.m	18 lb ft
Secondary Air Injection (SAI) Check Valve Bolt	25 N.m	18 lb ft
Secondary Camshaft Drive Chain		
• Guide Bolt	25 N.m	18 lb ft
• Shoe Bolt	25 N.m	18 lb ft
• Tensioner Bolt	25 N.m	18 lb ft
Spark Plug	18 N.m	13 lb ft
Starter Motor		
• Bolt	58 N.m	43 lb ft
• Cable Nut	10 N.m	89 lb in
Suction Screen Bolt	10 N.m	89 lb in
Suction Tube Bolt	10 N.m	89 lb in
Thermostat Housing Bolt	10 N.m	89 lb in
Throttle Body Bolt	10 N.m	89 lb in
Torque Converter Bolt	60 N.m	44 lb ft
Transmission		

Application	Specification	
	Metric	English
• Mount Bolt to Transmission- RPO	60 N.m	45 lb ft
• To Engine Bolt	50 N.m	37 lb ft
• Range Selector Lever Nut	9.5 N.m	84 lb in
Water Pump Bolt		
• First Pass	10 N.m (1)	89 lb in (1)
• Second Pass	10 N.m	89 lb in
• Final Pass	45 Degrees	
Water Pump Pulley Bolt	10 N.m	89 lb in
1. Use NEW fastener.		

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
3.0L (LFW) and 3.6L (LFX, LFR, and LLT)		
• Oil Capacity - with Filter	5.7 Liters	6.0 Quarts
• Oil Capacity - without Filter	5.2 Liters	5.5 Quarts

ENGINE MECHANICAL SPECIFICATIONS

Application	Specification	
	Metric	English
General		
• Engine Type	V-6	
• Displacement	3.6 Liter	220 cu in
• RPO	LFX	
• VIN	3	
• Bore	94 mm	3.7008 in

Application	Specification	
	Metric	English
• Stroke	85.6 mm	3.37 in
• Compression Ratio	11.5:1	
• Firing Order	1-2-3-4-5-6	
• Spark Plug Gap	0.95-1.10 mm	0.0375-0.0433 in
Block		
• Crankshaft Main Bearing Bore Diameter	72.867-72.881 mm	2.8688-2.8693 in
• Cylinder Bore Diameter	93.992-94.008 mm	3.7005-3.7011 in
• Cylinder Bore Out-of-Round - Production Max.	0.026 mm	0.001 in
• Cylinder Bore Taper	0.020 mm	0.0008 in
Camshaft		
• Camshaft Bearing Inside Diameter - Front Number 1	35.000-35.020 mm	1.3779-1.3787 in
• Camshaft Bearing Inside Diameter - Middle and Rear Number 2-4	27.000-27.020 mm	1.0630-1.0638 in
• Camshaft End Play	0.072-0.490 mm	0.0028-0.0190 in
• Camshaft Journal Diameter - Front Number 1	34.936-34.960 mm	1.3754-1.3764 in
• Camshaft Journal Diameter - Middle and Rear Number 2-4	26.936-26.960 mm	1.0605-1.0614 in
• Camshaft Journal Out-of-Round	0.006 mm	0.0002 in
• Camshaft Journal to Bore Clearance	0.040-0.084 mm	0.0016-0.0033 in
• Camshaft Lobe Lift - Exhaust	42.425-42.725 mm	1.6703-1.6821 in
• Camshaft Lobe Lift - Intake	42.385-42.685 mm	1.6687-1.6805 in
• Camshaft Runout - Front and Rear Number 1 and 4	0.025 mm	0.0010 in

Application	Specification	
	Metric	English
• Camshaft Runout - Middle 2 and 3	0.050 mm	0.0020 in
• Valve Lift - Exhaust	10.8 mm	0.4252 in
• Valve Lift - Intake	10.8 mm	0.4252 in
Connecting Rod		
• Connecting Rod Bearing Clearance	0.010-0.070 mm	0.0004-0.0026 in
• Connecting Rod Bore Diameter - Bearing End	59.620-59.636 mm	2.3472-2.3479 in
• Connecting Rod Bore Diameter - Pin End - Production	24.009-24.019 mm	0.9452-0.9456 in
• Connecting Rod Bore Diameter - Pin End - Service Maximum	24.021 mm	0.9457 in
• Connecting Rod Length - Center to Center	152.400 mm	6.0000 in
• Connecting Rod Side Clearance	0.095-0.355 mm	0.00037-0.0140 in
• Connecting Rod Width - Bearing End		
• Production	21.775 mm	0.8573 in
• Service	21.725-21.825 mm	0.8553-0.8593 in
• Connecting Rod Width - Pin End		
• Production	21.775 mm	0.8573 in
• Service	21.725-21.825 mm	0.8553-0.8593 in
Crankshaft		
• Connecting Rod Journal Diameter	55.992-56.008 mm	2.2044-2.2050 in
• Connecting Rod Journal Out-of-Round	0.005 mm	0.0002 in
• Connecting Rod Journal Taper	0.005 mm	0.0002 in

Application	Specification	
	Metric	English
• Connecting Rod Journal Width		
• Production	22.000 mm	0.8661 in
• Service	21.920-22.080 mm	0.8630-0.8693 in
• Crankshaft End Play	0.100-0.330 mm	0.0039-0.0130 in
• Crankshaft Main Bearing Clearance	0.031-0.069 mm	0.0012-0.0027 in
• Crankshaft Main Journal Diameter	67.992-68.008 mm	2.6768-2.6775 in
• Crankshaft Main Journal Out-of-Round	0.005 mm	0.0002 in
• Crankshaft Main Journal Taper	0.005 mm	0.0002 in
• Crankshaft Main Journal Thrust Wall		
• Runout	0.000-0.040 mm	0.0000-0.0016 in
• Square	0.000-0.010 mm	0.0000-0.0004 in
• Crankshaft Main Journal Width, #2, 4		
• Production	24.000 mm	0.9449 in
• Service	23.900-24.100 mm	0.9409-0.9488 in
• Crankshaft Main Journal Width, #3		
• Production	24.400 mm	0.9606 in
• Service	24.360-24.440 mm	0.9591-0.9622 in
• Crankshaft Pilot Bearing Bore Diameter	20.965-20.995 mm	0.8254-0.8266 in
• Crankshaft Rear Flange Runout	0.025 mm	0.0010 in
• Crankshaft Reluctor Ring Runout - Maximum	1.500 mm	0.0591 in

Application	Specification	
	Metric	English
• Crankshaft Runout	0.030 mm	0.0012 in
• Crankshaft Thrust Bearing Clearance	0.076-0.305 mm	0.0030-0.0120 in
• Crankshaft Thrust Surface - Height Diameter	95.000 mm	3.7401 in
• Crankshaft Thrust Surface Runout	0.040 mm	0.0016 in
Cylinder Head		
• Valve Guide Bore - Exhaust	6.000-6.020 mm	0.2362-0.2370 in
• Valve Guide Bore - Intake	6.000-6.020 mm	0.2362-0.2370 in
• Valve Guide Installed Height	14.050-14.550 mm	0.5531-0.5728 in
• Valve Lifter Bore Diameter	12.008-12.030 mm	0.4728-0.4736 in
Lubrication System		
• Oil Pressure - Minimum @ Idle	69 kPa	10 psi
• Oil Pressure - Minimum @ 2,000 RPM	138 kPa	20 psi
• Piston Cooling Jet Valve Opening Pressure	1.7-2.3 bar	25-33 psi
Piston Rings		
• Piston Ring End Gap		
• First Compression Ring - Nominal	0.150-0.250 mm	0.0059-0.0098 in
• First Compression Ring - Maximum, Ring in Bore	0.290 mm	0.0114 in
• Second Compression Ring - Nominal	0.300-0.450 mm	0.0118-0.0177 in
• Second Compression Ring - Maximum, Ring in Bore	0.490 mm	0.0193 in
• Oil Control Ring	0.150-0.350 mm	0.0059-0.0138 in
• Piston Ring to Groove Clearance		

Application	Specification	
	Metric	English
• First Compression Ring	0.030-0.075 mm	0.0012-0.0030 in
• Second Compression Ring	0.015-0.060 mm	0.0006-0.0024 in
• Oil Control Ring	0.030-0.170 mm	0.0012-0.0067 in
• Piston Ring Thickness		
• First Compression Ring	0.975-0.990 mm	0.0384-0.0390 in
• Second Compression Ring	1.170-1.195 mm	0.0461-0.0470 in
• Oil Control Ring	1.360-1.480 mm	0.0535-0.0583 in
Pistons and Pins		
• Piston		
• Piston Diameter - Measured Over Skirt Coating	93.976-94.014 mm	3.6998-3.7013 in
• Piston Diameter - Service Limit Minimum w/more than 10K miles	93.926 mm	3.6979 in
• Piston Pin Bore Diameter	24.004-24.009 mm	0.9450-0.9452 in
• Piston Ring Groove Width - First Compression Ring	1.020-1.050 mm	0.0402-0.0413 in
• Piston Ring Groove Width - Second Compression Ring	1.210-1.230 mm	0.0476-0.0484 in
• Piston Ring Groove Width - Oil Control Ring	1.510-1.530 mm	0.0594-0.0602 in
• Piston to Bore Clearance - Production; Measured at Skirt Coating	0.022-0.032 mm	0.0009-0.0013 in
• Piston to Bore Clearance - Service Limit Maximum, w/more than 10k miles	0.050 mm	0.0020 in
• Pin		

Application	Specification	
	Metric	English
• Piston Pin Clearance to Connecting Rod Bore - Production	0.009-0.022 mm	0.0004-0.0009 in
• Piston Pin Clearance to Connecting Rod Bore - Service Maximum	0.030 mm	0.0012 in
• Piston Pin Clearance to Piston Pin Bore - Production	0.004-0.012 mm	0.0002-0.0005 in
• Piston Pin Clearance to Piston Pin Bore - Service Maximum	0.015 mm	0.0006 in
• Piston Pin Diameter	23.997-24.000 mm	0.9448-0.9449 in
• Piston Pin Length	52.600-53.100 mm	2.0709-2.0906 in
Valve System		
• Valves		
• Valve Face Angle	44.25 degrees	
• Valve Face Runout	0.0500 mm	0.0020 in
• Valve Face Width - Exhaust	DO NOT GRIND, REPLACE VALVE	DO NOT GRIND, REPLACE VALVE
• Valve Face Width - Intake	DO NOT GRIND, REPLACE VALVE	DO NOT GRIND, REPLACE VALVE
• Valve Head Diameter - Exhaust	30.470-30.730 mm	1.1996-1.2098 in
• Valve Head Diameter - Intake	38.170-38.430 mm	1.5028-1.5130 in
• Valve Installed Height	35.23-36.69 mm	1.3870-1.4445 in
• Valve Length - Exhaust	95.11 mm	3.74 in
• Valve Length - Intake	100.630 mm	3.9618 in
• Valve Seat Angle - Seating Surface	45 degrees	
• Valve Seat Angle - Relief Surface	30 degrees	

Application	Specification	
	Metric	English
• Valve Seat Angle - Undercut Surface	60 degrees	
• Valve Seat Roundness- Maximum	0.025 mm	0.0010 in
• Valve Seat Runout - Maximum	0.080 mm	0.0031 in
• Valve Seat Width - Exhaust Seating Surface	1.400-1.800 mm	0.0551-0.0709 in
• Valve Seat Width - Exhaust Relief Surface	0.700-0.900 mm	0.0276-0.0354 in
• Valve Seat Width - Intake Seating Surface	1.000-1.400 mm	0.0394-0.0551 in
• Valve Seat Width - Intake Relief Surface	0.500-0.700 mm	0.0197-0.0276 in
• Valve Stem Diameter - Exhaust	5.945-5.965 mm	0.2341-0.2348 in
• Valve Stem Diameter - Intake	5.945-5.965 mm	0.2341-0.2348 in
• Valve Stem-to-Guide Clearance - Exhaust	0.035-0.075 mm	0.0014-0.0030 in
• Valve Stem-to-Guide Clearance - Intake	0.035-0.075 mm	0.0014-0.0030 in
• Valve Lifters - Stationary Hydraulic Lash Adjuster (SHLA)		
• Valve Lifter (SHLA) Diameter	11.989-12.000 mm	0.4720-0.4724 in
• Valve Lifter (SHLA)-to-Bore Clearance	0.008-0.041 mm	0.0003-0.0016 in
• Rocker Arms		
• Valve Rocker Arm Ratio	1.68 to 1	
• Valve Rocker Arm Roller Diameter	17.750-17.800 mm	0.6988-0.7008 in
• Valve Springs		
• Valve Spring Coil Thickness	3.250 x 3.900 mm	0.1280 x 0.1535 in
• Valve Spring Diameter - Inside Top	12.200-12.700 mm	0.4803-0.5000 in

Application	Specification	
	Metric	English
• Valve Spring Diameter - Outside Top	20.250 mm	0.7972 in
• Valve Spring Diameter - Inside Bottom	17.950-18.450 mm	0.7067-0.7264 in
• Valve Spring Diameter - Outside Bottom	26.000 mm	1.0236 in
• Valve Spring Free Length	42.500-45.500 mm	1.6732-1.7913 in
• Valve Spring Installed Height - Closed	35.000 mm	1.3779 in
• Valve Spring Installed Height - Open	24.000 mm	0.9449 in
• Valve Spring Load - Closed	247-273 N	56-61 lb
• Valve Spring Load - Open	598-662 N	134-149 lb

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Block Pan Rail *	Sealant	12378521	88901148
Camshaft Prelube	Lubricant	88862586	88862827
Coolant Drain Threaded Plug	Sealant	12346004	10953480
Coolant Expansion Plugs	Threadlocker	12345382	10953489
Coolant and Oil Plug Threads	Sealant	12346004	10953480
Crankshaft Bearing Surfaces	5W-30	19293000	19286321
Crankshaft Connecting Rod Bearing Journal	5W-30	19293000	19286321
Crankshaft Prelube	5W-30	19293000	19286321
Crankshaft Rear Oil Seal Housing *	Sealant	12378521	88901148
Engine Front Cover/Split Lines *	Sealant	12378521	88901148
Engine Oil	5W-30	19293000	19386321
Fuel Injection Fuel Rail Fuel Pressure Sensor Sealing Cone/Threads	5W-30	19293000	19286321
Fuel Rail Sealing Cone/Threads	5W-30	19293000	19286321
Ignition Coils	Lubricant	19260901	19260902
Oil Gallery Threaded Plug	Sealant	12346004	10953480
Oil Pan, Engine Front Cover, Crankshaft Rear Oil Seal Housing *	Sealant	12378521 (150g cartridge)	88901148

Application	Type of Material	GM Part Number	
		United States	Canada
		88861417 (75 gram squeeze tube)	88861418
Piston Pin Bores	5W-30	19293000	19286321
Positive Crankcase Ventilation (PCV) Orifice	Sealant	12378521	88901148
Stationary Hydraulic Lash Adjuster (SHLA)	5W-30	19293000	19286321
SHLA Bores in Cylinder Head	5W-30	19293000	19286321
SHLA Pivot Spheres	5W-30	19293000	19286321
Thread Repair	Cleaner	88862650	88901247
	Threadlocker	89021297	10953488
Thread Repair Cutting Oil	Lubricant	1052864	992881
Valve Stem/Guide ID	5W-30	19293000	19286321
* Ensure proper use of room temperature vulcanizing (RTV) sealant. **Use of Room Temperature Vulcanizing (RTV) and Anaerobic Sealant**			

THREAD REPAIR SPECIFICATIONS

Left Cylinder Head Camshaft Cover Face

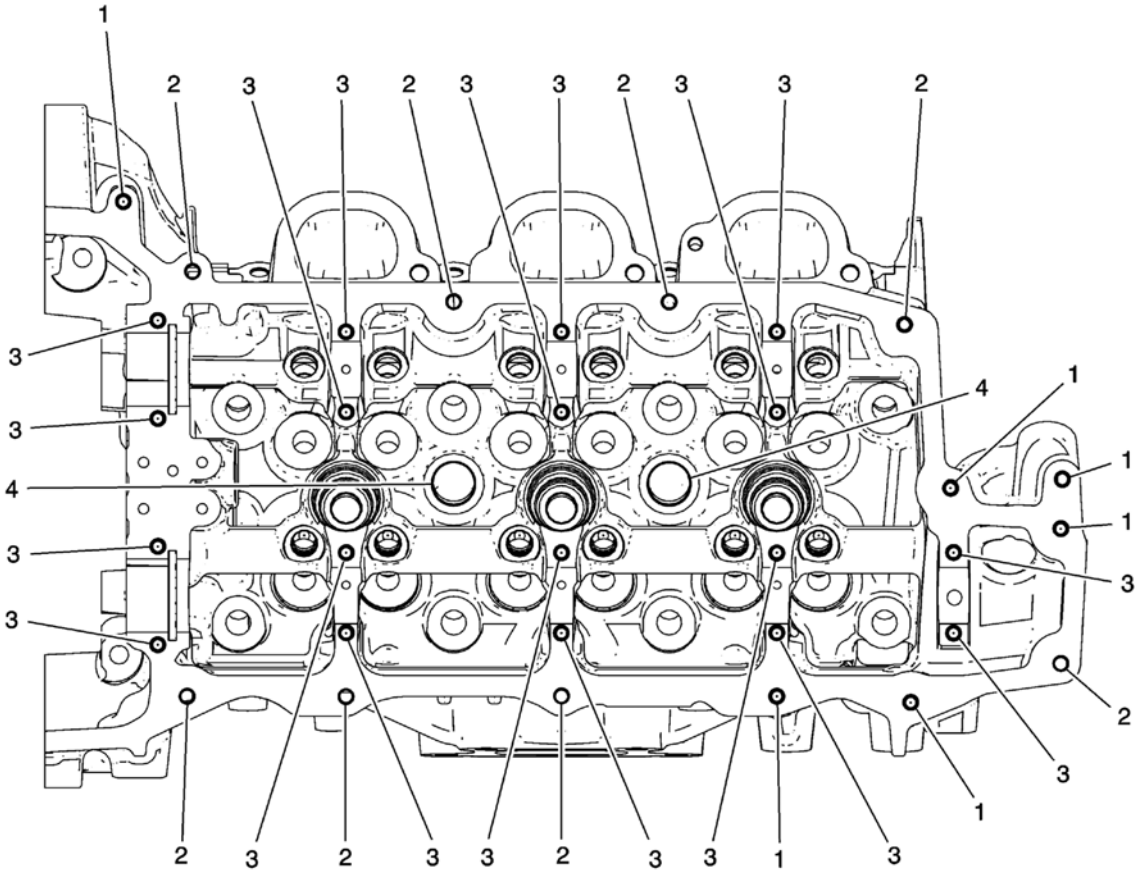


Fig. 1: Left Cylinder Head Camshaft Cover Face
Courtesy of GENERAL MOTORS COMPANY

Left Cylinder Head Camshaft Cover Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087
2	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
3	M6 x 1.0	701	N/A	N/A	203	204	205	28.5	1.1220	24.0	0.9449
4	M20 x 1.5	715	716	N/A	717	718	719	25.0	0.9842	17.0	0.6693

Left Cylinder Head Front Face

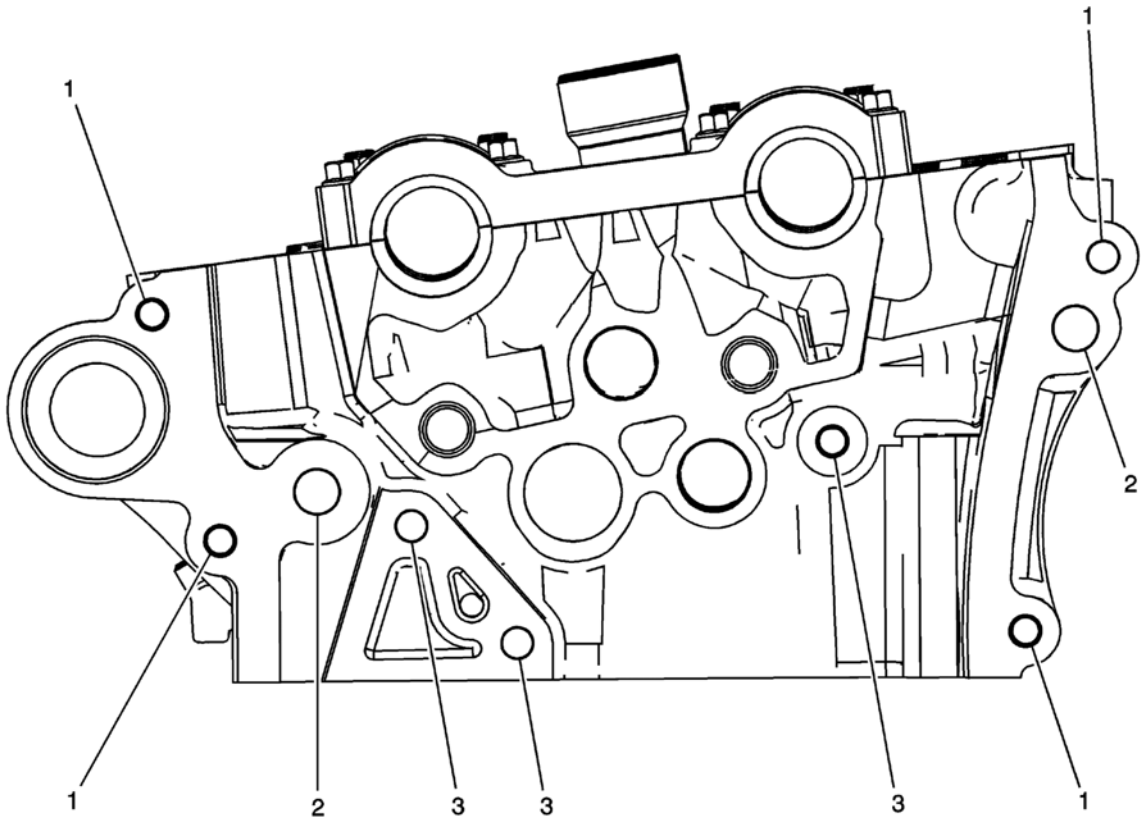


Fig. 2: Left Cylinder Head Front Face
Courtesy of GENERAL MOTORS COMPANY

Left Cylinder Head Front Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
2	M12 x 1.75	856	857	N/A	858	859	416	40.0	1.5748	32.5	1.2795
3	M8 x 1.25	206	207	N/A	208	209	210	18.0	0.7087	22.5	0.8858

Left Cylinder Head Intake Face (LLT)

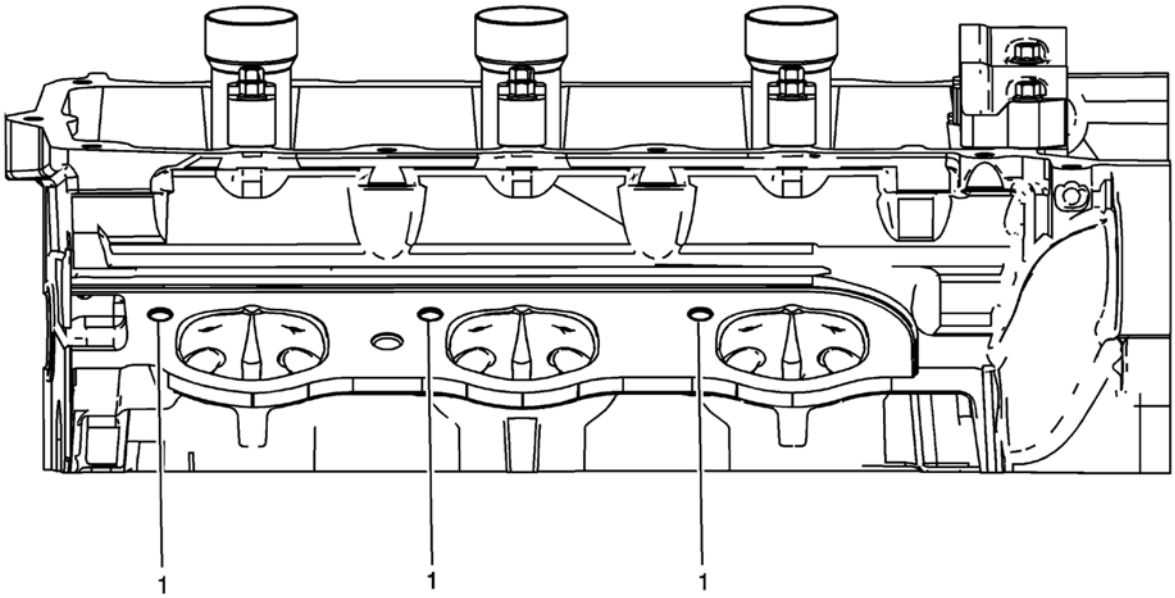


Fig. 3: Left Cylinder Head Intake Face
Courtesy of GENERAL MOTORS COMPANY

Left Cylinder Head Intake Face (LLT)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

Left Cylinder Head Intake Face (LF1)

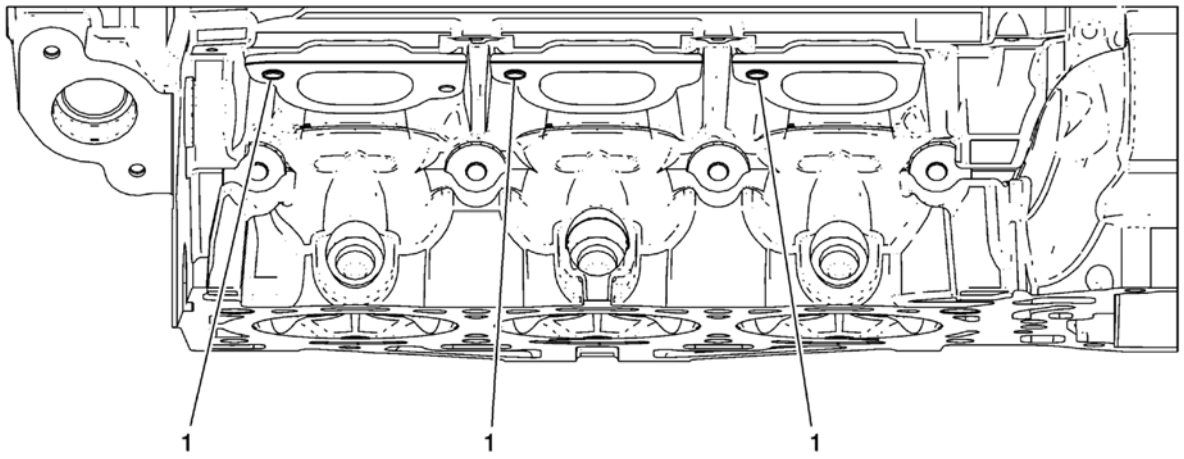


Fig. 4: View Of Left Cylinder Head Intake Face
Courtesy of GENERAL MOTORS COMPANY

Left Cylinder Head Intake Face (LF1)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
Â	Â	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

Left Cylinder Head Exhaust Face (LLT)

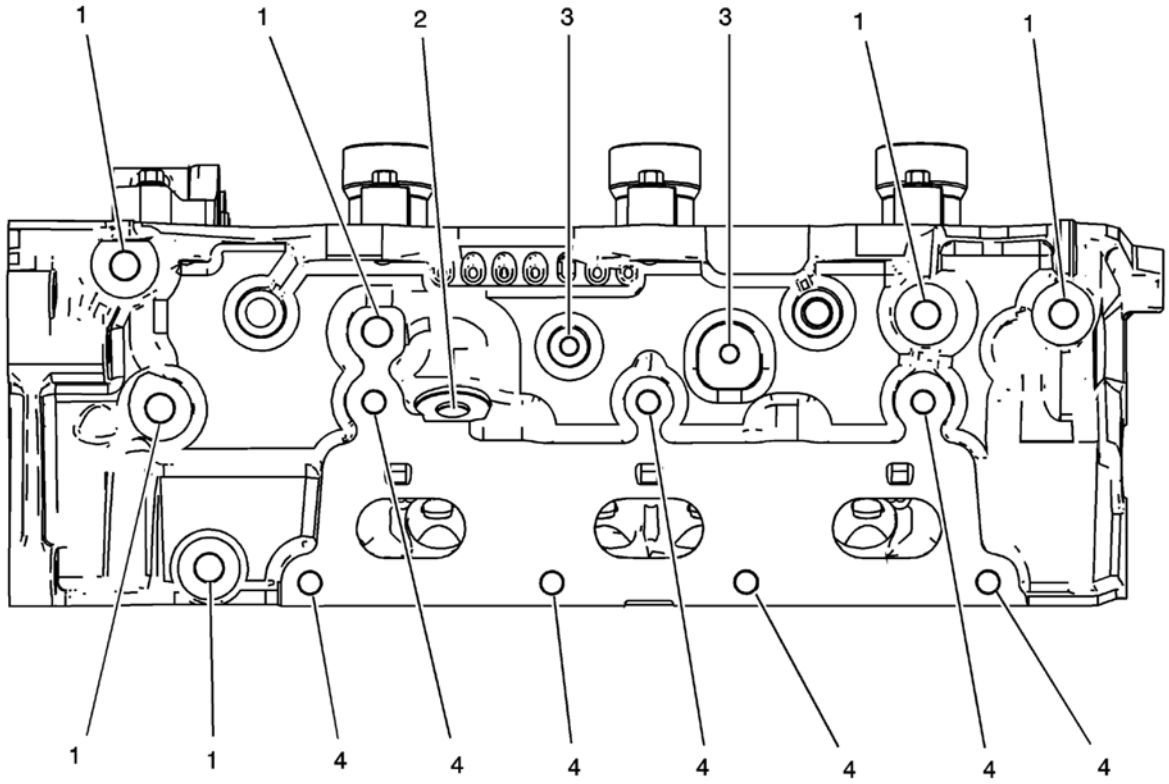


Fig. 5: Left Cylinder Head Exhaust Face
Courtesy of GENERAL MOTORS COMPANY

Left Cylinder Head Exhaust Face (LLT)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
2	M12 x 1.5	705	706	N/A	707	708	709	27.5	1.0827	13.0	0.5118
3	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.0000
4	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

Left Cylinder Head Exhaust Face (LF1)

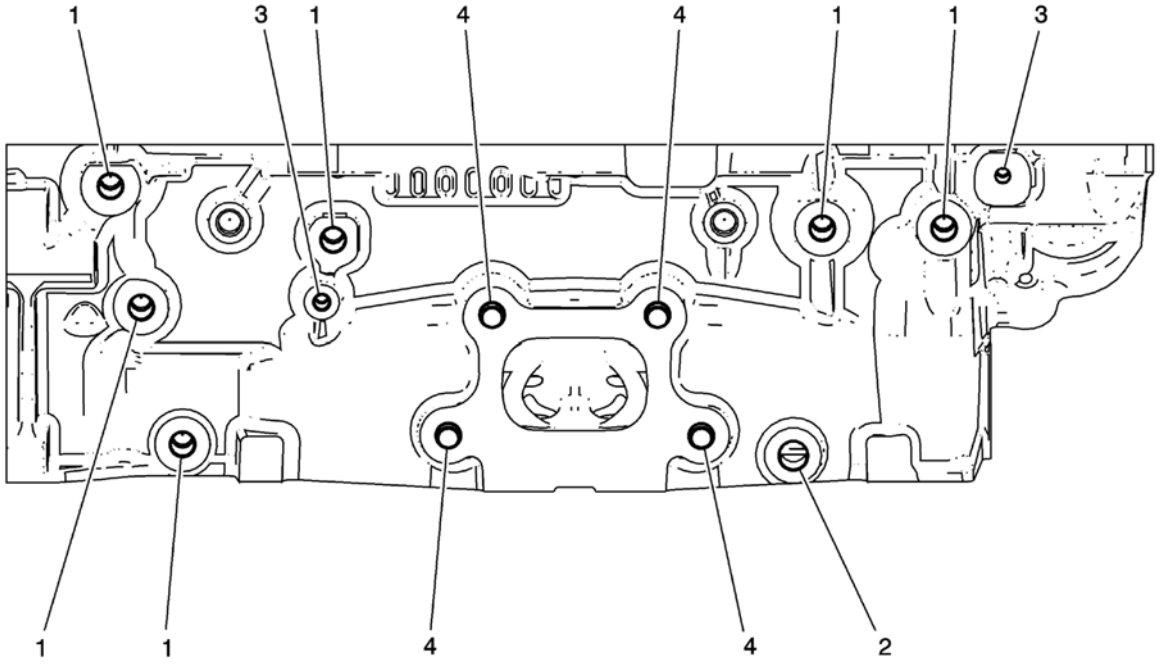


Fig. 6: View Of Left Cylinder Head Exhaust Face
Courtesy of GENERAL MOTORS COMPANY

Left Cylinder Head Exhaust Face (LF1)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
Â	Â	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
2	M12 x 1.5	705	706	N/A	707	708	709	27.5	1.0827	13.0	0.5118
3	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.0000
4	M10 x 1.5	211	212	N/A	213	214	215	26.5	1.0433	20.0	0.7874

Left Cylinder Head Rear Face (LLT)

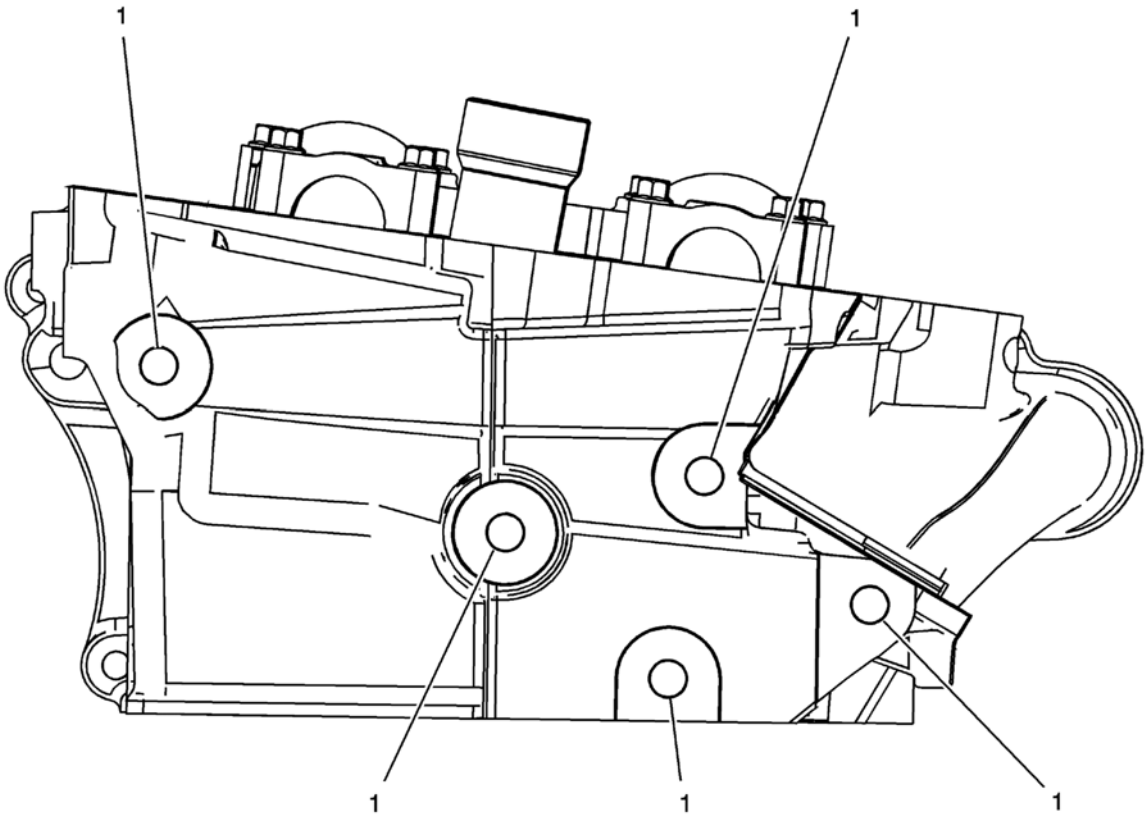


Fig. 7: Left Cylinder Head Rear Face
Courtesy of GENERAL MOTORS COMPANY

Left Cylinder Head Rear Face (LLT)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630

Left Cylinder Head Rear Face (LF1)

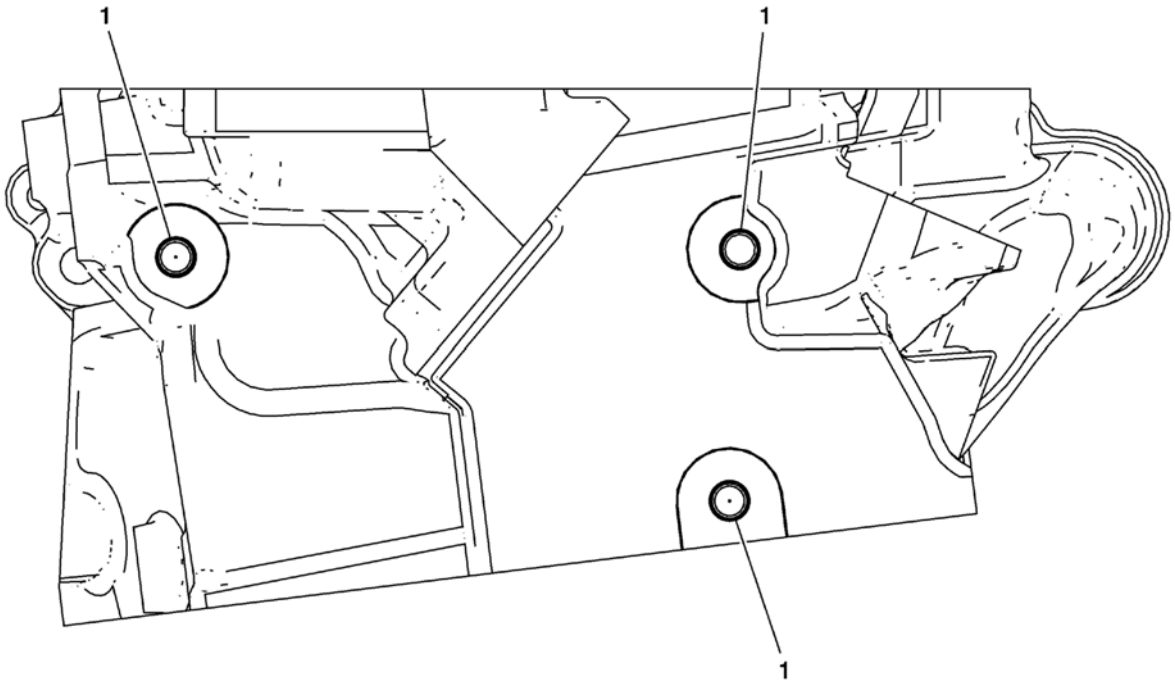


Fig. 8: View Of Left Cylinder Head Rear Face
Courtesy of GENERAL MOTORS COMPANY

Left Cylinder Head Rear Face (LF1)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
Â	Â	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630

Right Cylinder Head Camshaft Cover Face

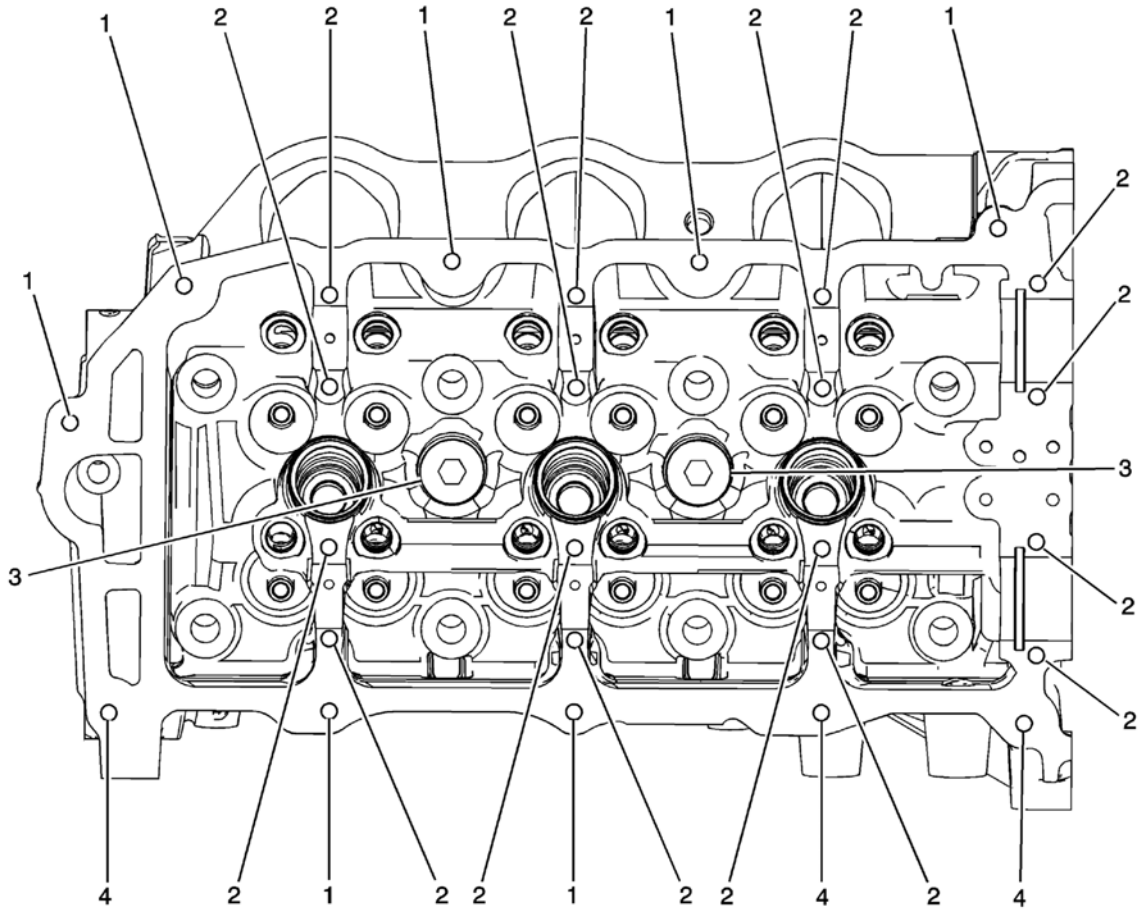


Fig. 9: Right Cylinder Head Camshaft Cover Face
Courtesy of GENERAL MOTORS COMPANY

Right Cylinder Head Camshaft Cover Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
2	M6 x 1.0	701	N/A	N/A	203	204	205	28.5	1.1220	24.0	0.9449
3	M20 x 1.5	715	716	N/A	717	718	719	25.0	0.9842	17.0	0.6693
4	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087

Right Cylinder Head Front Face

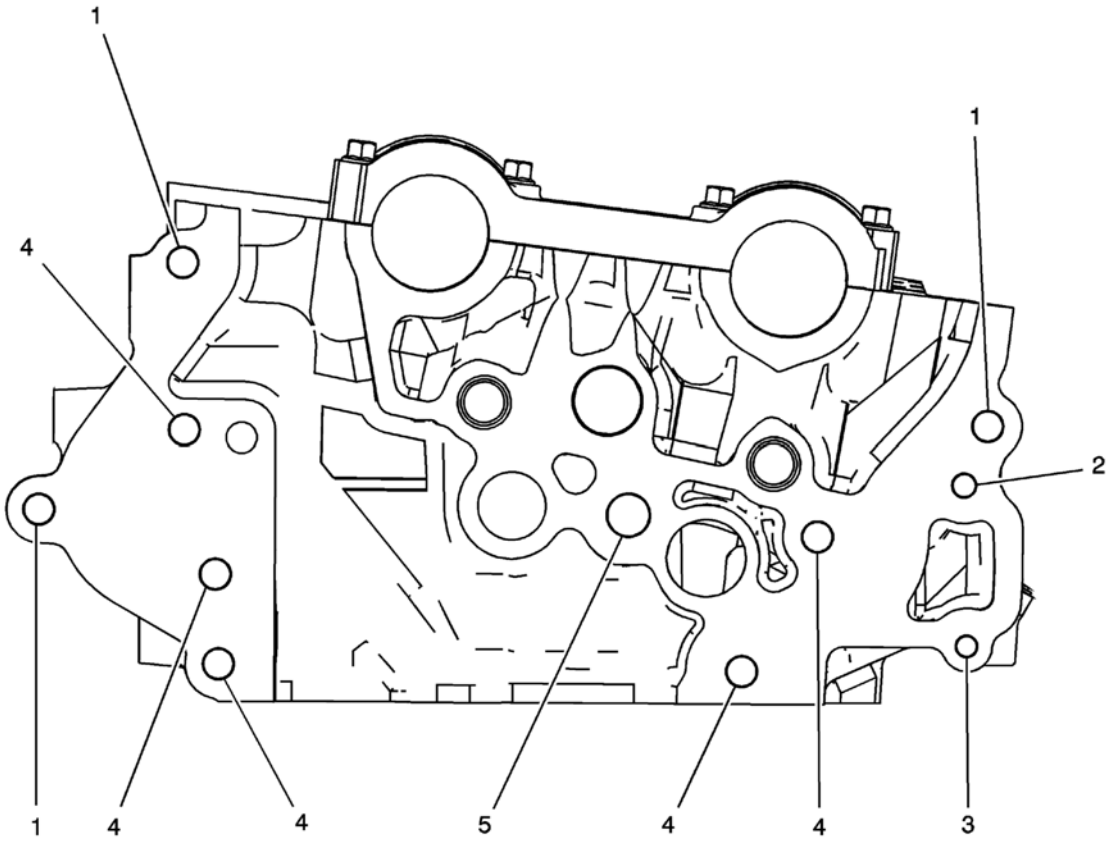


Fig. 10: Right Cylinder Head Front Face
Courtesy of GENERAL MOTORS COMPANY

Right Cylinder Head Front Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
2	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8880	18.0	0.7087
3	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
4	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
5	M12 x 1.75	856	857	N/A	858	859	416	40.0	1.5748	32.5	1.2795

Right Cylinder Head Intake Face (LLT)

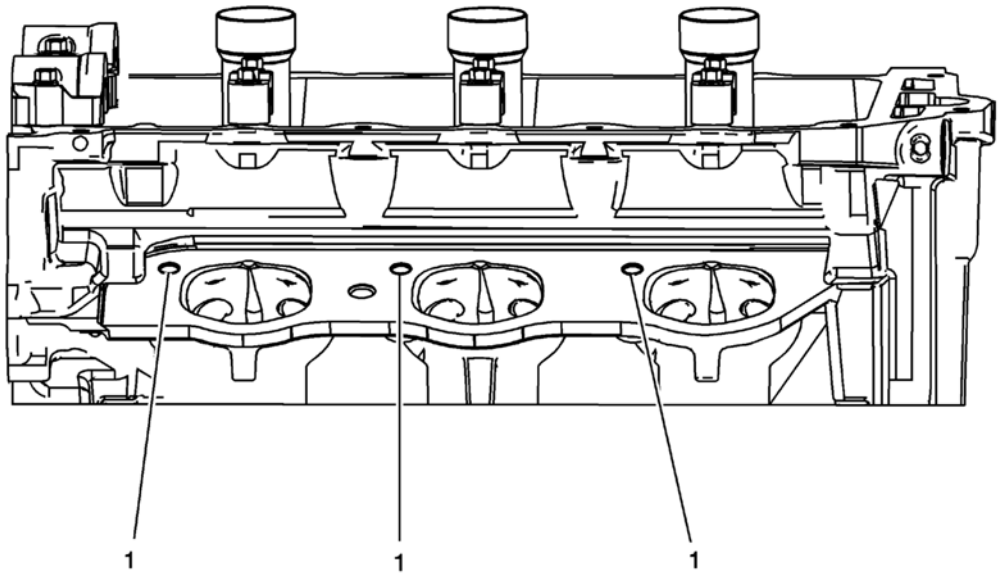


Fig. 11: Right Cylinder Head Intake Face
Courtesy of GENERAL MOTORS COMPANY

Right Cylinder Head Intake Face (LLT)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

Right Cylinder Head Intake Face (LF1)

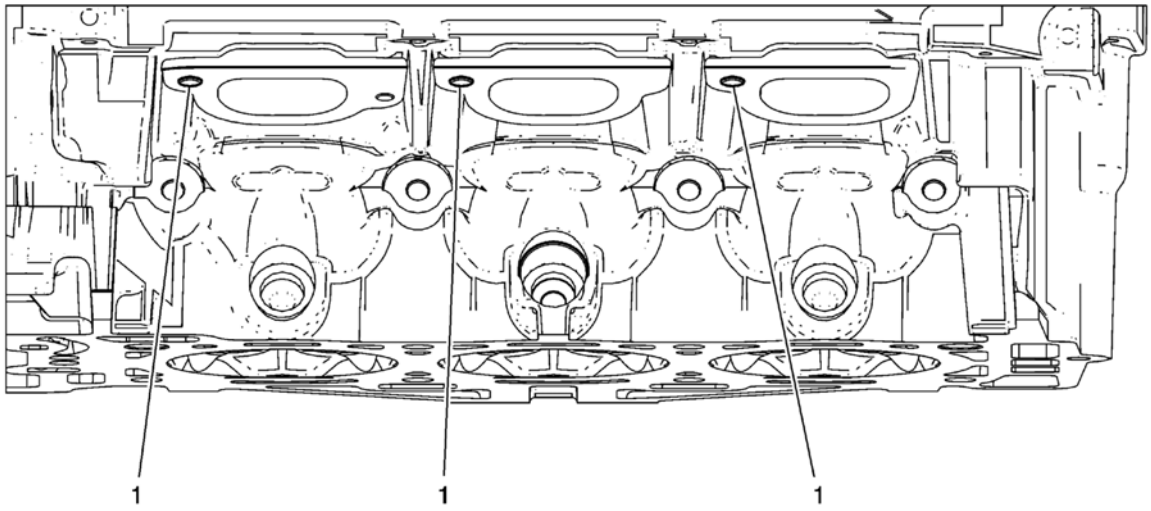


Fig. 12: View Of Right Cylinder Head Intake Face
Courtesy of GENERAL MOTORS COMPANY

Right Cylinder Head Intake Face (LF1)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
Â	Â	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

Right Cylinder Head Exhaust Face (LLT)

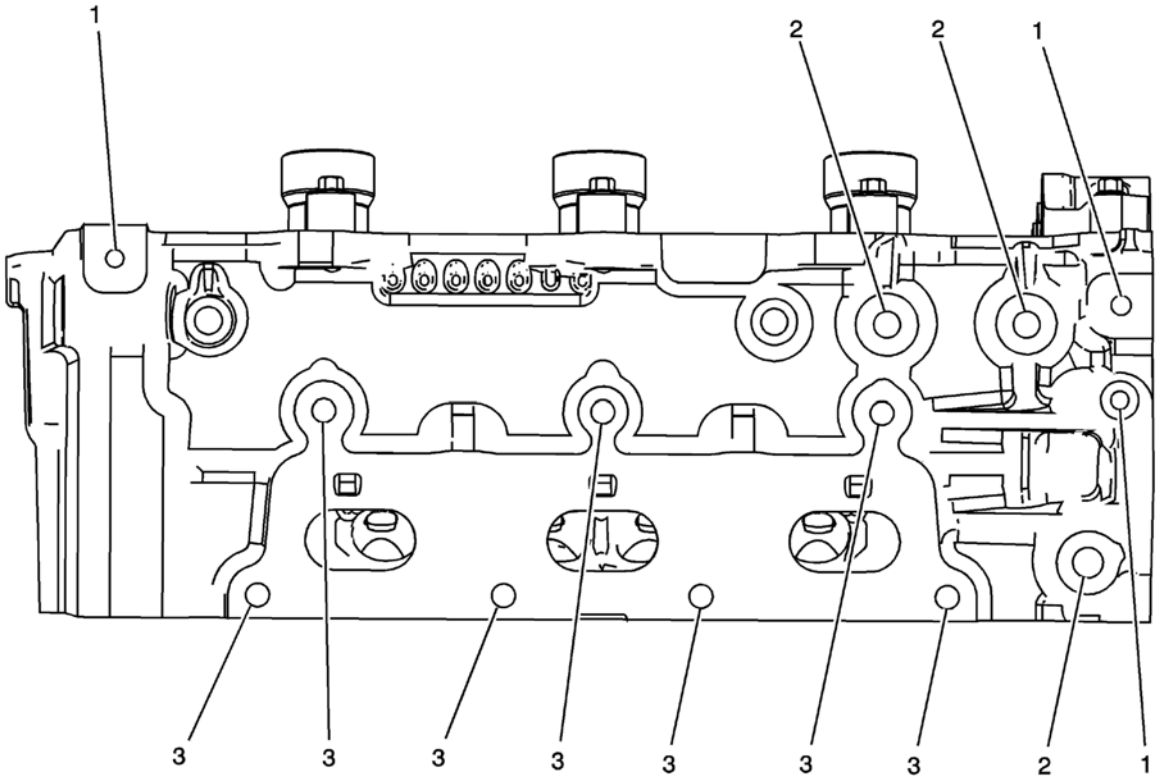


Fig. 13: Right Cylinder Head Exhaust Face
Courtesy of GENERAL MOTORS COMPANY

Right Cylinder Head Exhaust Face (LLT)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.0000
2	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
3	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

Right Cylinder Head Exhaust Face (LF1)

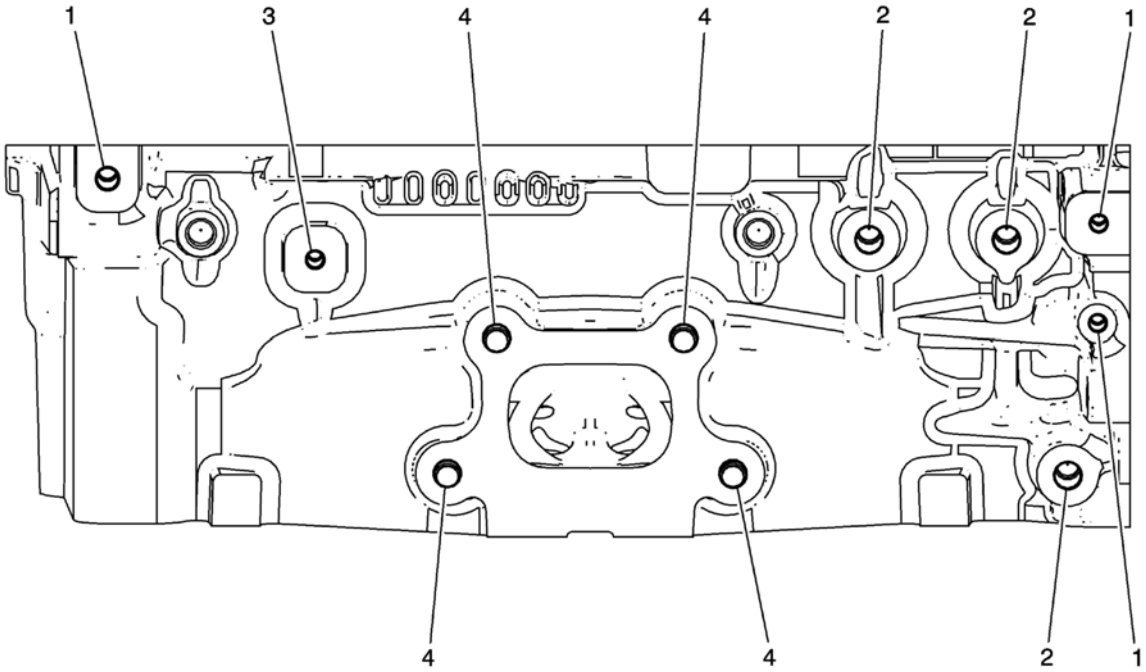


Fig. 14: View Of Right Cylinder Head Exhaust Face
Courtesy of GENERAL MOTORS COMPANY

Right Cylinder Head Exhaust Face (LF1)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
Â	Â	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.0000
2	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
3	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
4	M10 x 1.5	211	212	N/A	213	214	215	26.5	1.0433	20.0	0.7874

Right Cylinder Head Rear Face

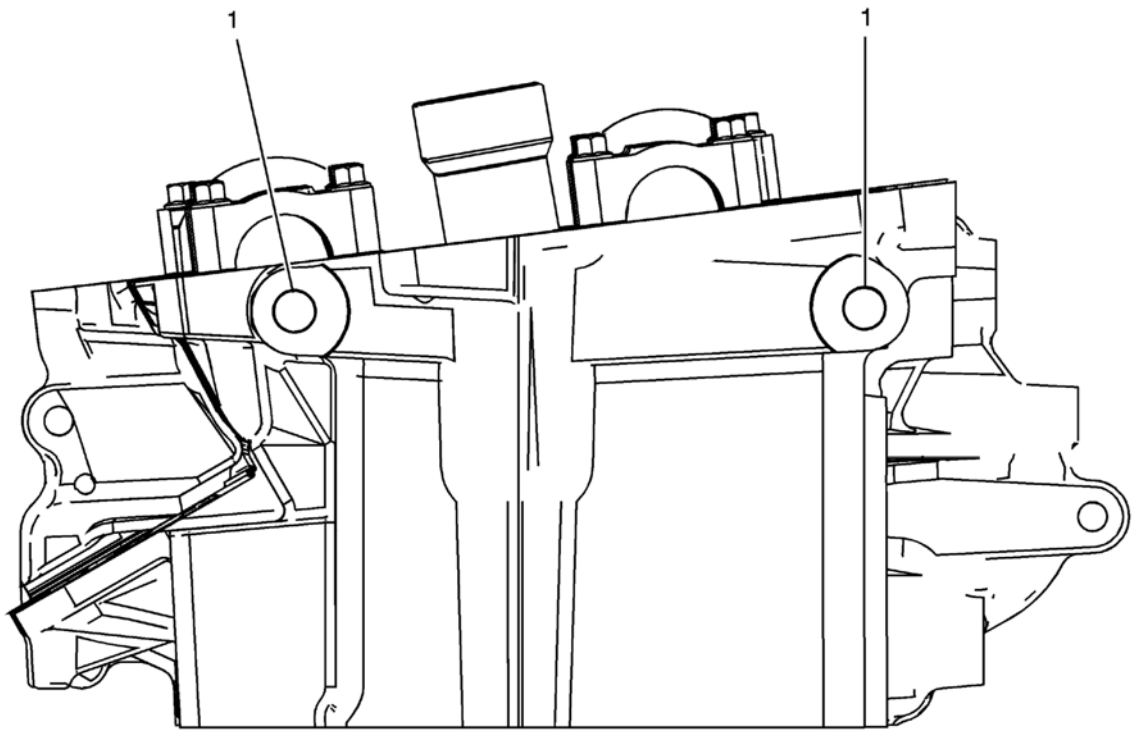


Fig. 15: Right Cylinder Head Rear Face
Courtesy of GENERAL MOTORS COMPANY

Right Cylinder Head Rear Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630

Engine Block Front

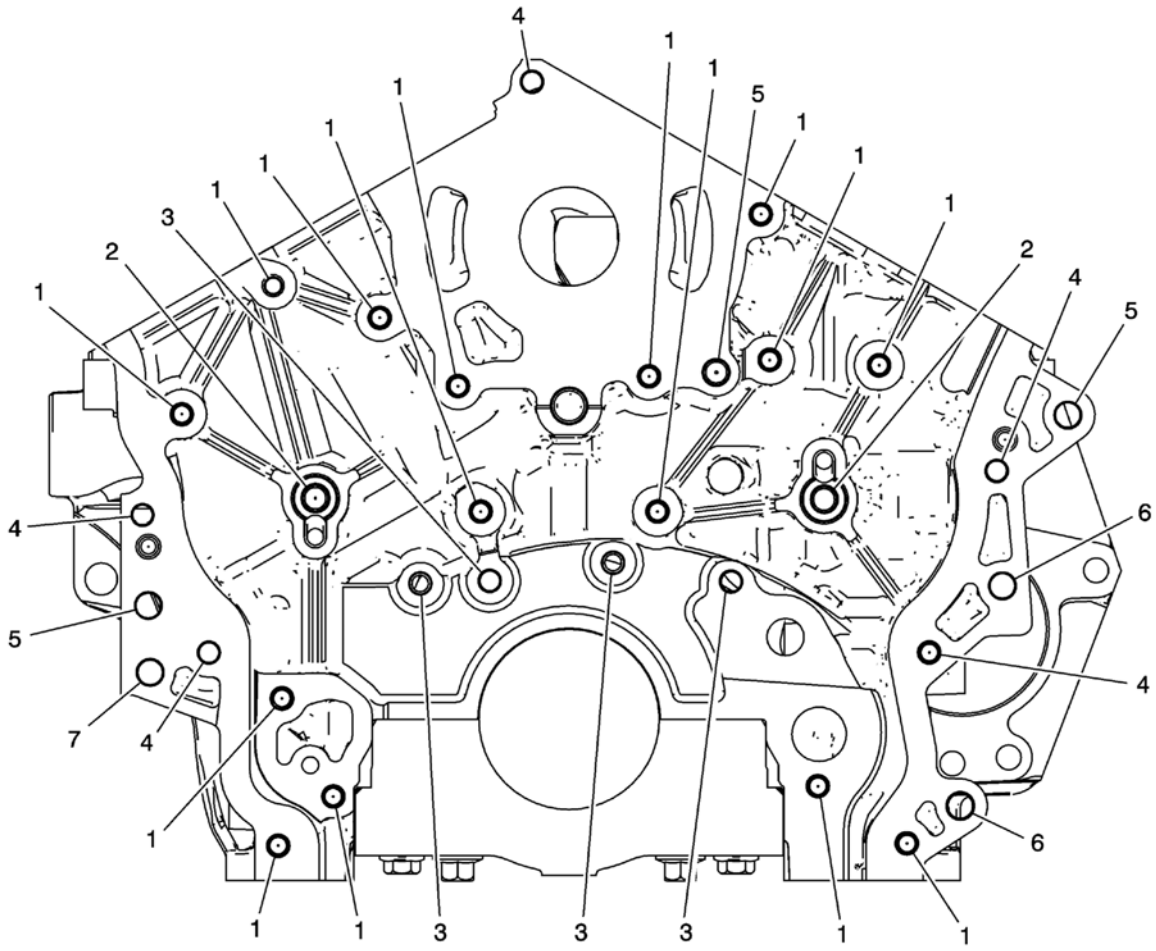


Fig. 16: Engine Block Front Thread Repair Points
Courtesy of GENERAL MOTORS COMPANY

Engine Block Front

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
2	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
3	M8 x 1.25	206	207	N/A	208	209	210	THRU		23.0	0.9055
4	M8 x 1.25	206	207	N/A	208	209	210	THRU		THRU	
5	M10 x 1.5	211	212	N/A	213	214	215	28.0	1.1024	28.0	1.1024
6	M10 x 1.5	211	212	N/A	213	214	215	THRU		20.0	0.7874

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
7	M10 x 1.5	211	212	N/A	213	214	215	THRU		28.0	1.1024

Engine Block Left Side

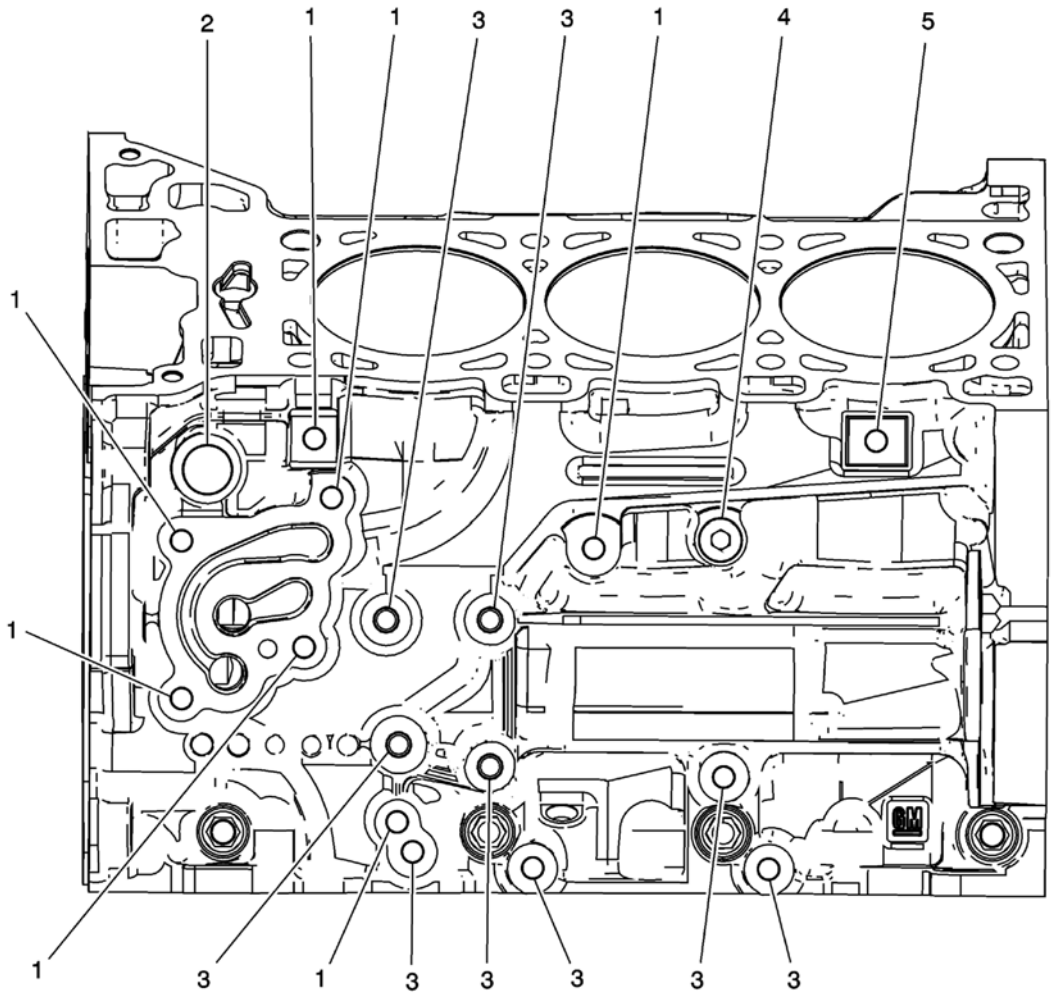


Fig. 17: Engine Block Left Side
Courtesy of GENERAL MOTORS COMPANY

Engine Block Left Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
2	M20 x 1.5	715	716	N/A	717	718	719	30.0	1.1810	20.0	0.7874

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
3	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3190	27.0	1.0630
4	M14 x 1.5	409	410	N/A	411	412	735	THRU		15.0	0.5905
5	M8 x 1.25	206	207	N/A	208	209	415	16.5	0.6496	11.0	0.4331

Engine Block Right Side

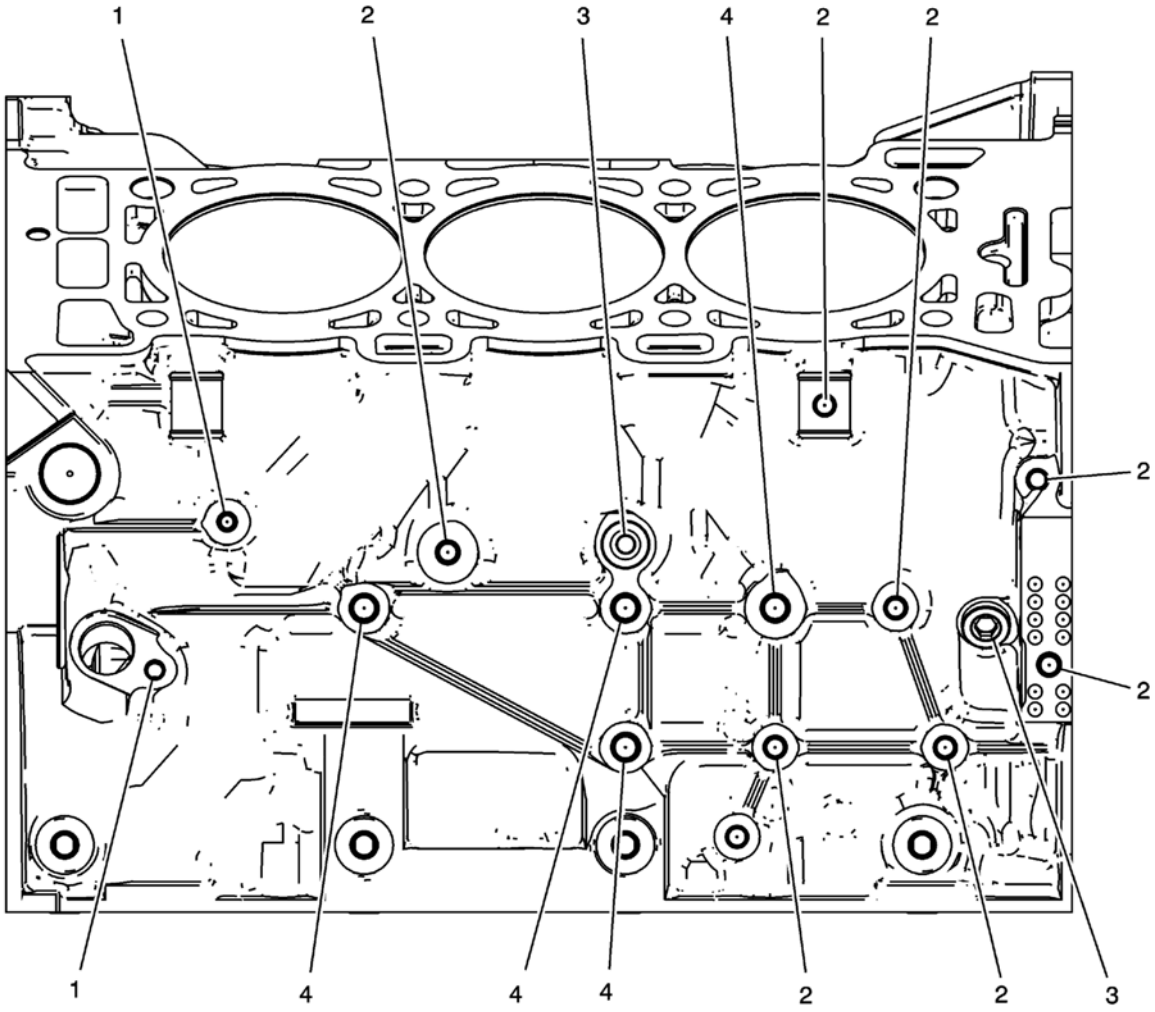


Fig. 18: Engine Block Right Side
Courtesy of GENERAL MOTORS COMPANY

Engine Block Right Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
3	M14 x 1.5	409	410	N/A	411	412	735	THRU		15.0	0.5905
4	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3190	27.0	1.0630

Engine Block Rear

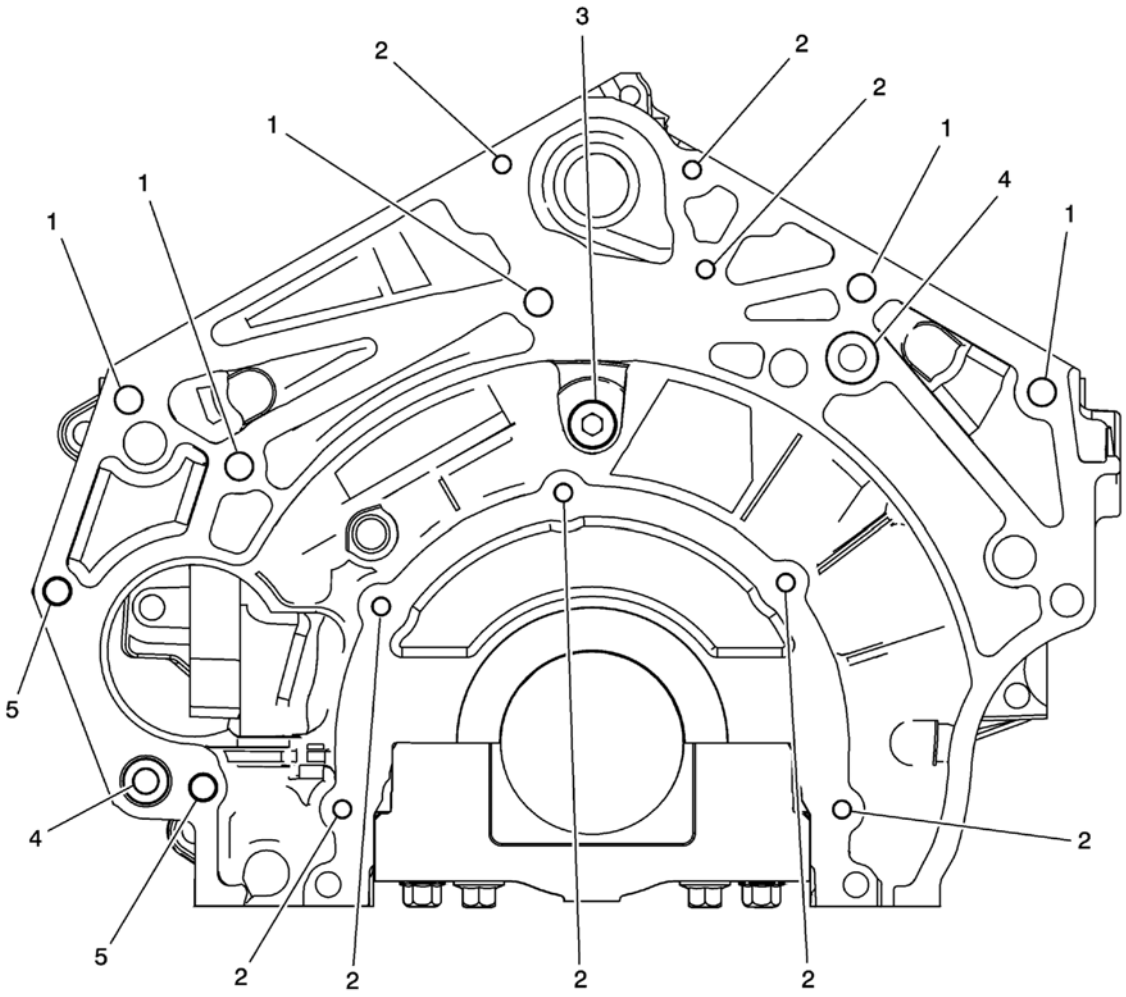


Fig. 19: Engine Block Rear
Courtesy of GENERAL MOTORS COMPANY

Engine Block Rear

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x	211	212	N/A	213	214	420	33.5	1.3190	27.0	1.0630

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
	1.5										
2	M6 x 1.0	201	202	N/A	203	204	205	22.5	0.8858	18.0	0.7087
3	M14 x 1.5	409	410	N/A	411	412	735	THRU		15.0	0.5905
4	M10 x 1.5	211	212	N/A	213	214	216	39.5	1.5551	33.0	1.2992
5	M10 x 1.5	211	212	N/A	213	214	420	THRU		THRU	

Engine Block Bottom

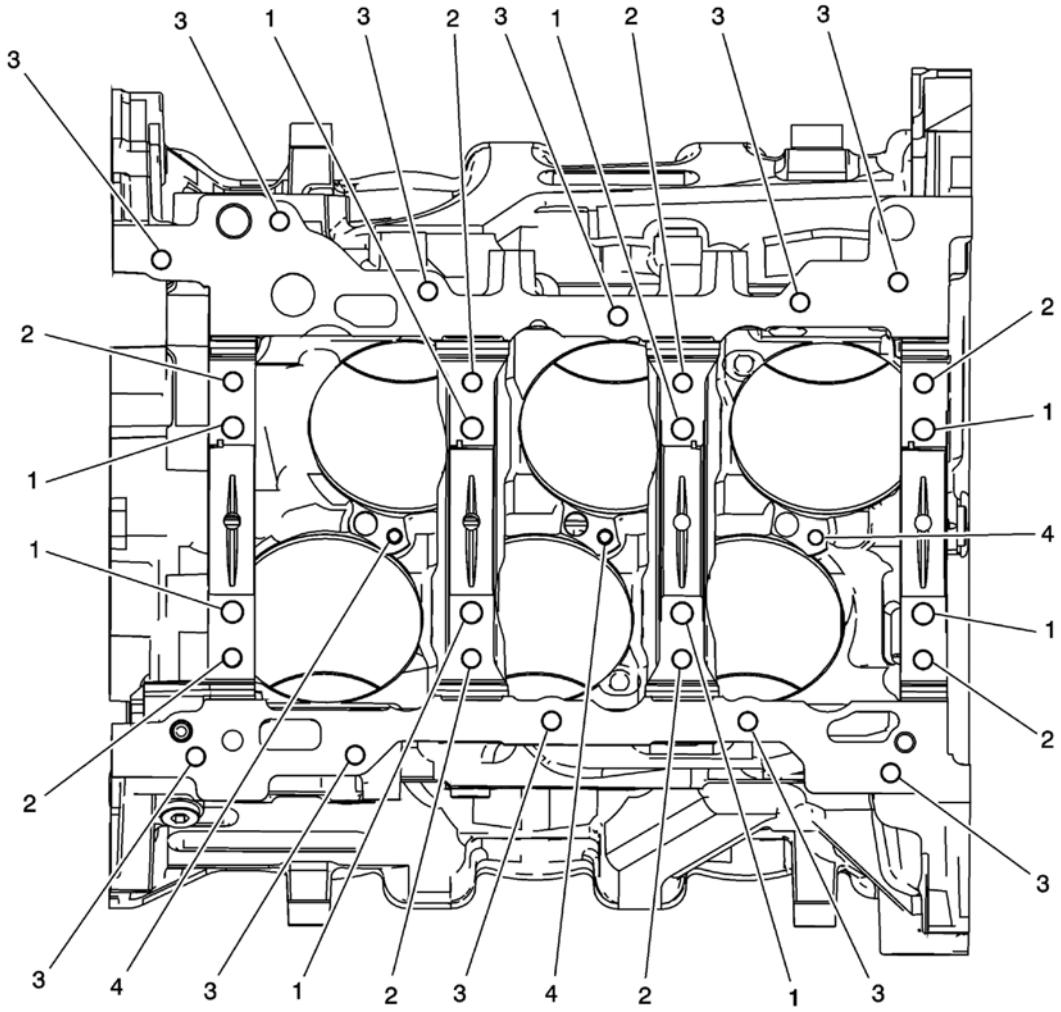


Fig. 20: Engine Block Bottom
Courtesy of GENERAL MOTORS COMPANY

Engine Block Bottom

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)	Tap Depth (Minimum)

-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 2.0	720	N/A	N/A	721	722	104	56.0	2.2047	49.0	1.9291
2	M8 x 1.25	702	N/A	N/A	703	704	620	46.0	1.8110	40.5	1.5945
3	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
4	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

Engine Block Left Deck Face

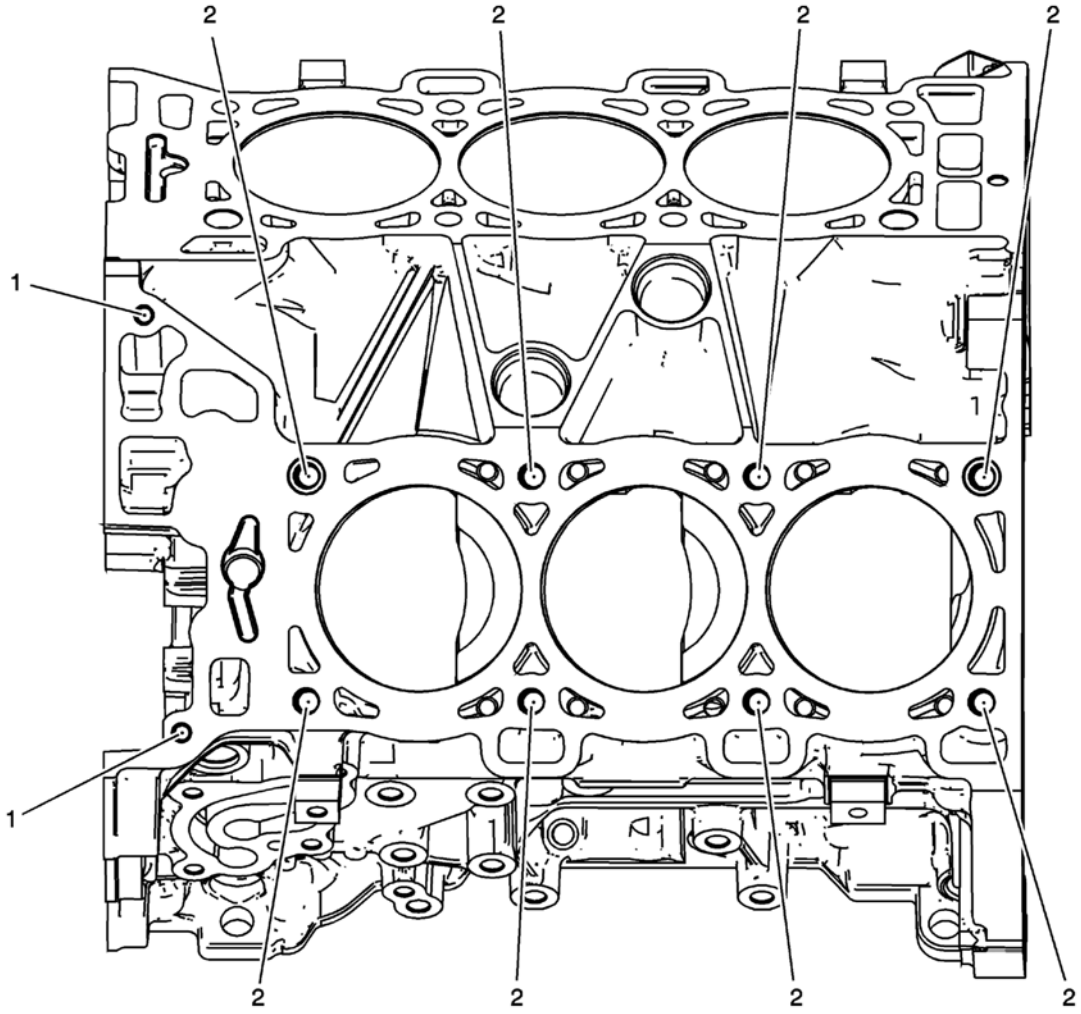


Fig. 21: Engine Block Left Deck Face Component View
Courtesy of GENERAL MOTORS COMPANY

Engine Block Left Deck Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
2	M11 x 2.0	723	N/A	N/A	724	725	108	102.5	4.0354	94.0	3.7008

Engine Block Right Deck Face

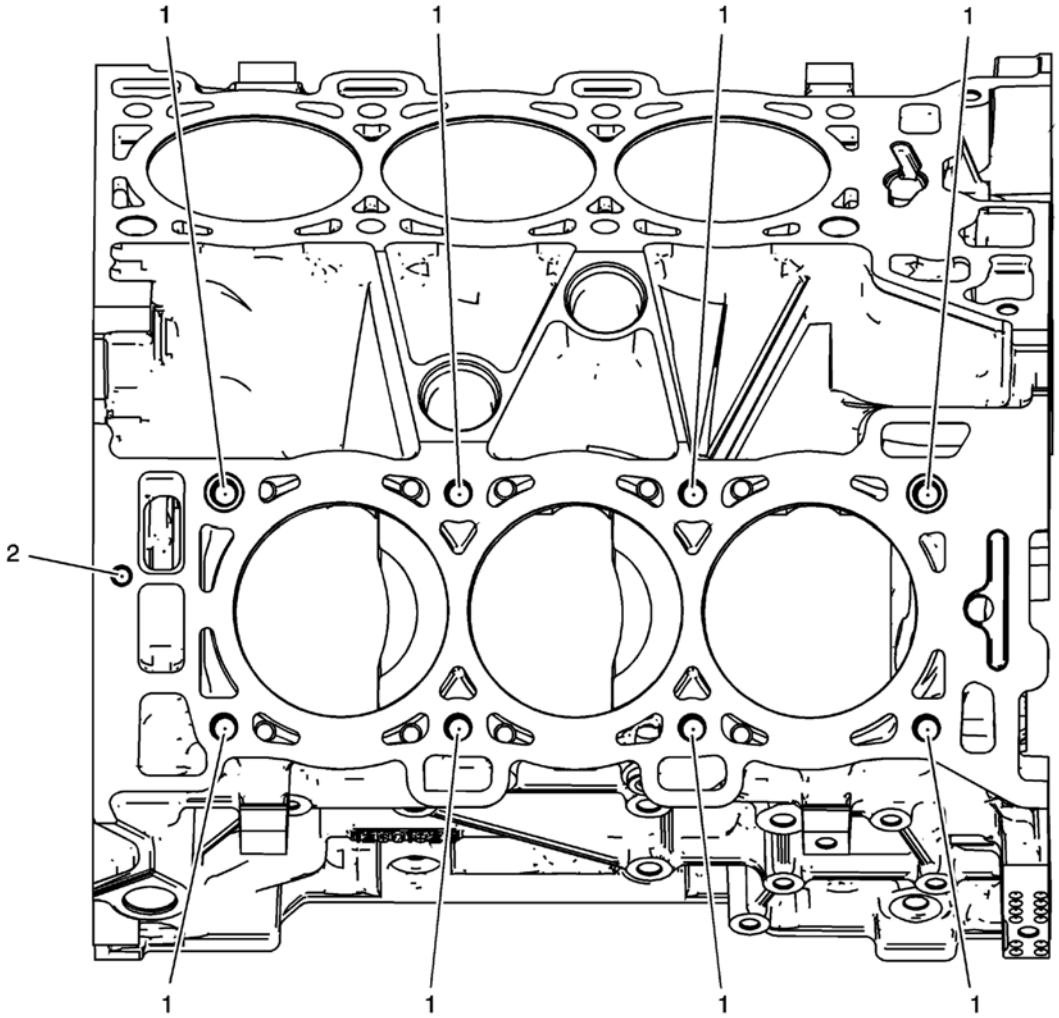


Fig. 22: Engine Block Right Deck Face Component View
Courtesy of GENERAL MOTORS COMPANY

Engine Block Right Deck Face

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M11 x 2.0	723	N/A	N/A	724	725	108	102.5	4.0354	94.0	3.7008
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055

Engine Front Cover

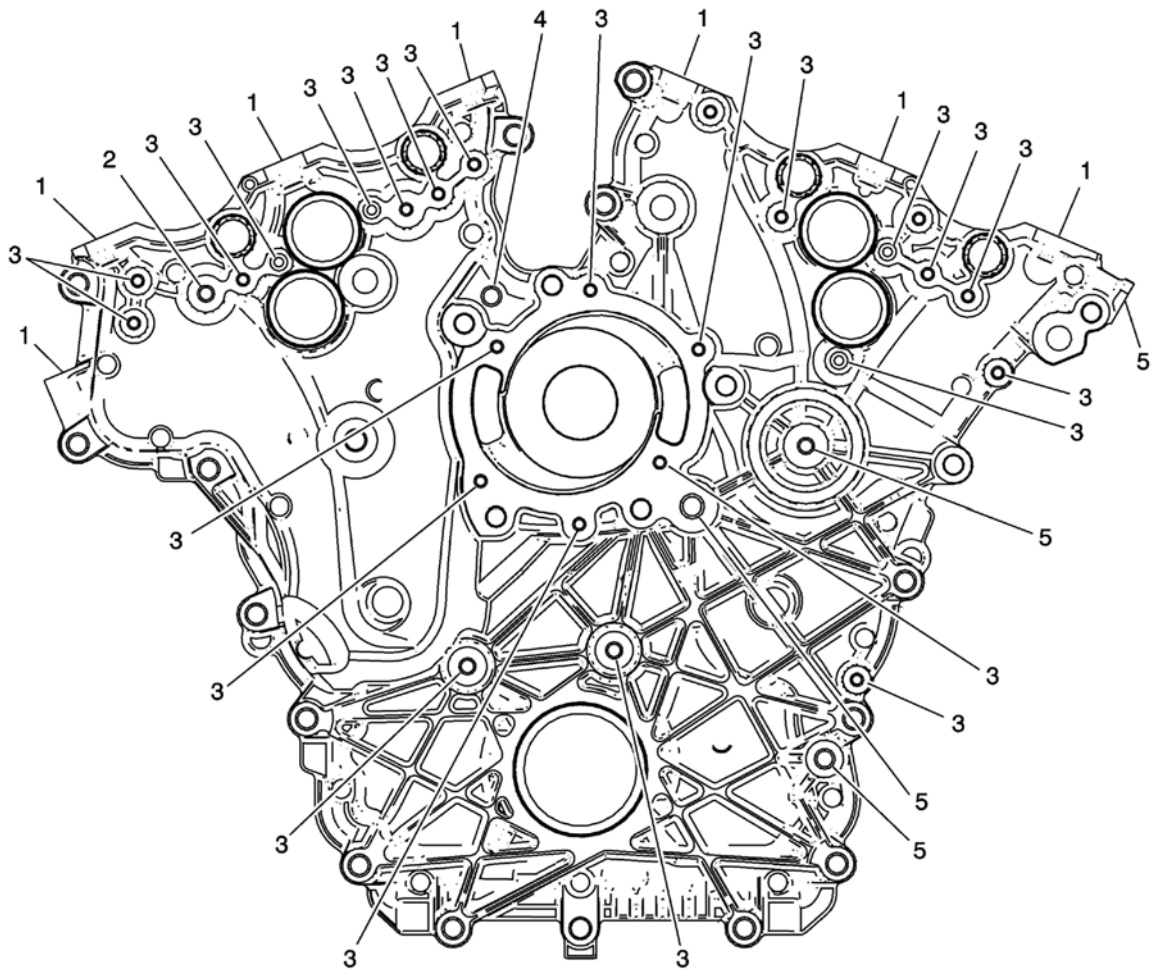


Fig. 23: Engine Front Cover
Courtesy of GENERAL MOTORS COMPANY

Engine Front Cover

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	
2	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
3	M6 x 1.0	201	202	N/A	203	204	205	21.5	0.8465	18.0	0.7087
4	M10 x 1.5	211	212	N/A	213	214	215	THRU		THRU	
5	M10 x 1.5	211	212	N/A	213	214	420	32.5	1.2795	27.0	1.0630

Intake Manifold- Top (LLT)

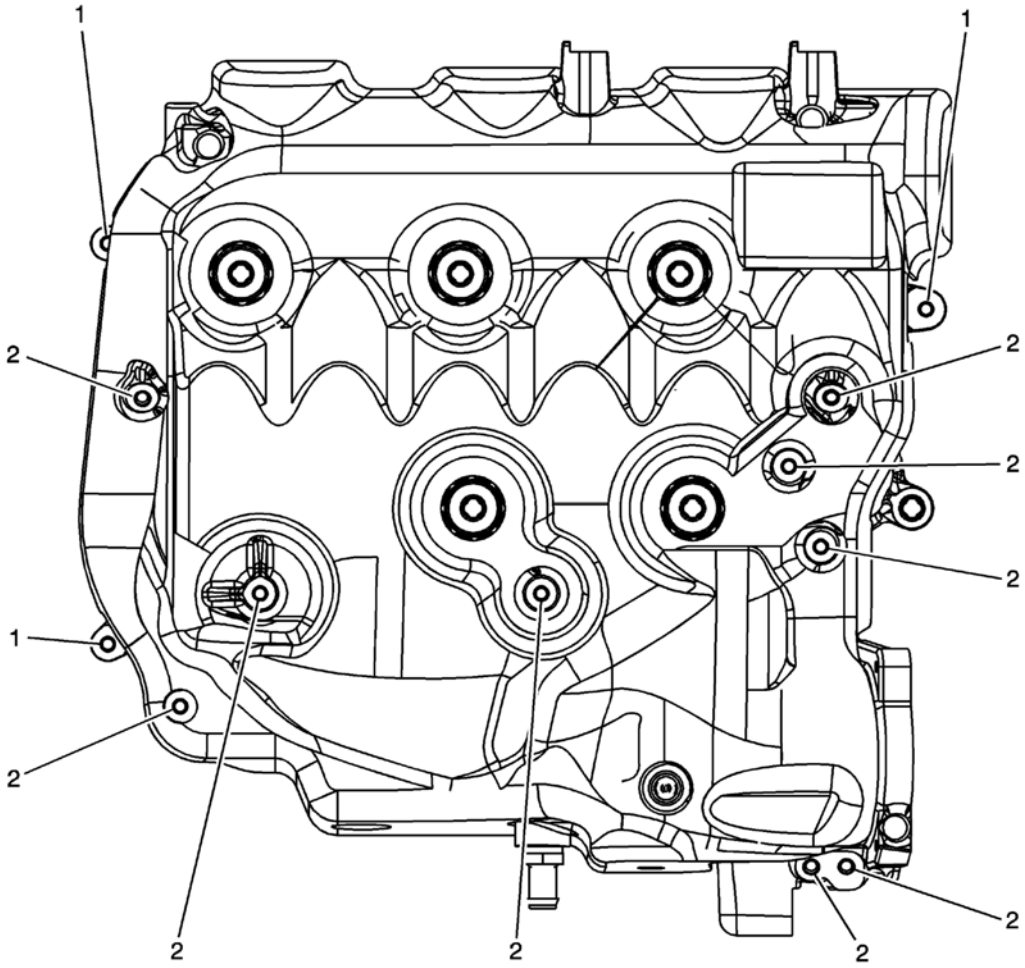


Fig. 24: View Of Intake Manifold - Top
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold - Top (LLT)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	21.5	0.8465	18.0	0.7087
2	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

Intake Manifold- Front (LLT)

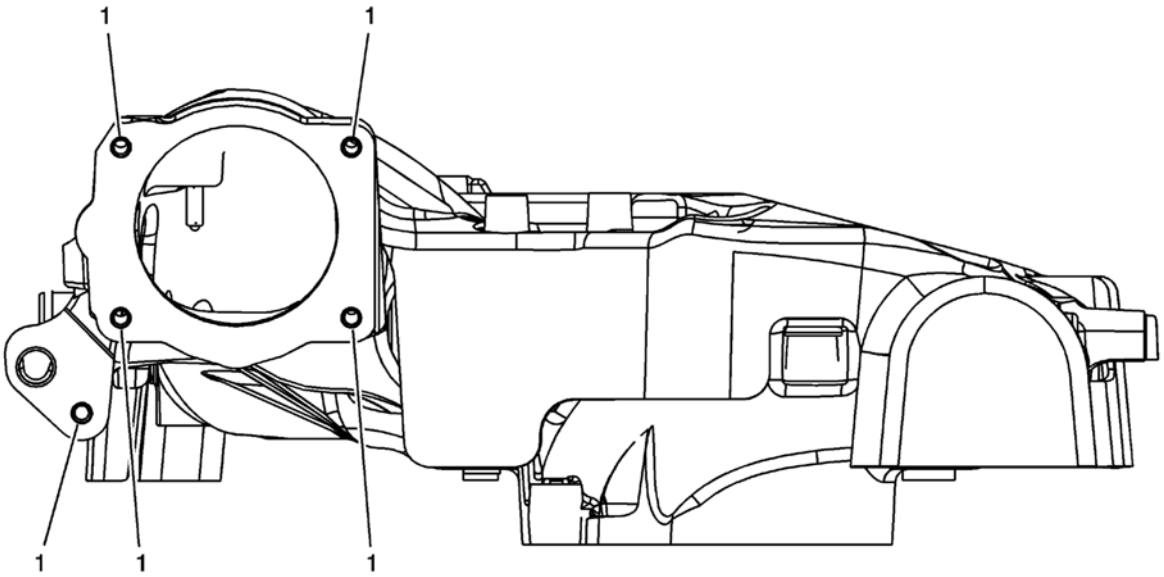


Fig. 25: View Of Intake Manifold - Front
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold - Front (LLT)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	THRU		THRU	

Intake Manifold- Left (LLT)

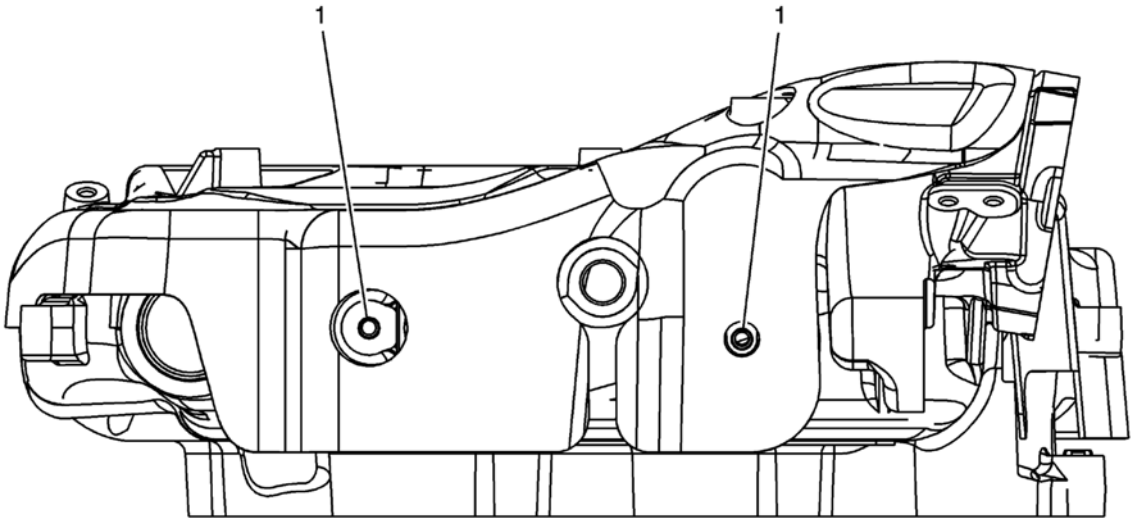


Fig. 26: View Of Intake Manifold - Left
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold - Left (LLT)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	21.5	0.8465	18.0	0.7087

Intake Manifold- Right (LLT)

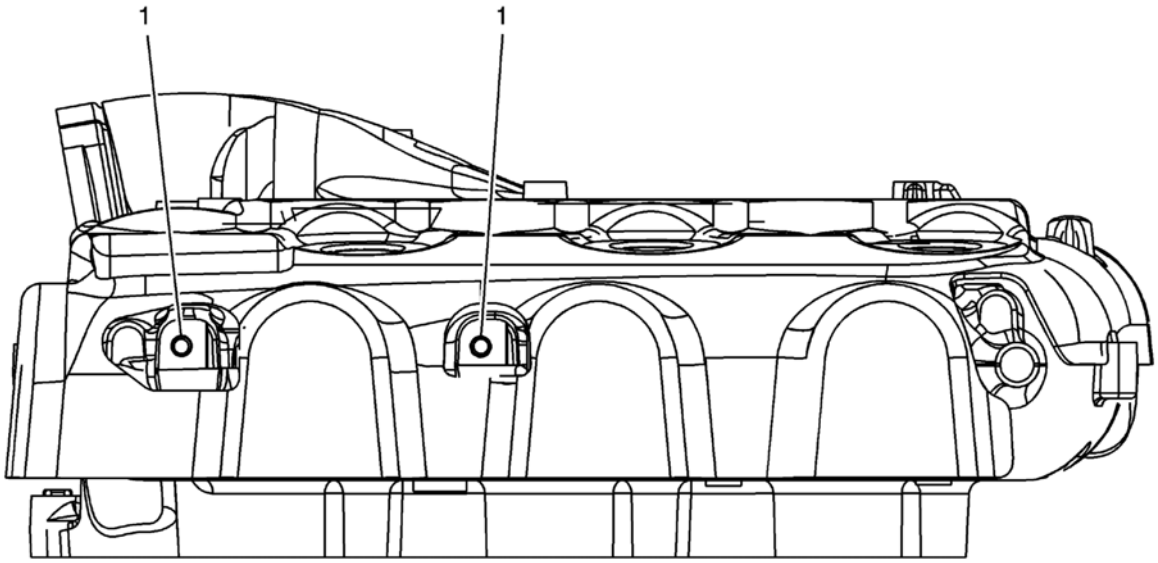


Fig. 27: View Of Intake Manifold - Right
Courtesy of GENERAL MOTORS COMPANY

Intake Manifold - Right (LLT)

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	201	202	N/A	203	204	205	21.5	0.8465	18.0	0.7087

Oil Pan Front

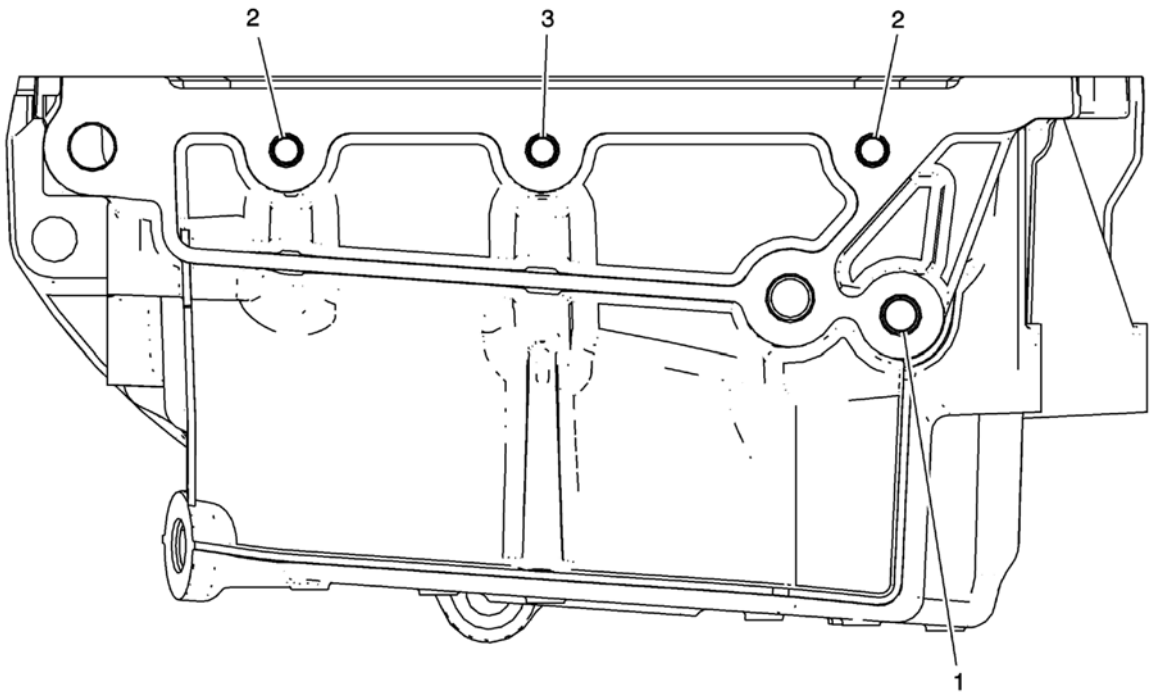


Fig. 28: View Of Oil Pan Front
Courtesy of GENERAL MOTORS COMPANY

Oil Pan Front

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M8 x 1.25	206	207	N/A	208	209	210	28.5	1.1220	23.0	0.9055
2	M10 x 1.5	211	212	N/A	213	214	215	33.5	1.3189	27.0	1.0630
3	M8 x 1.25	610	N/A	N/A	208	209	620	37.5	1.4764	32.0	1.2598

Oil Pan Left Side

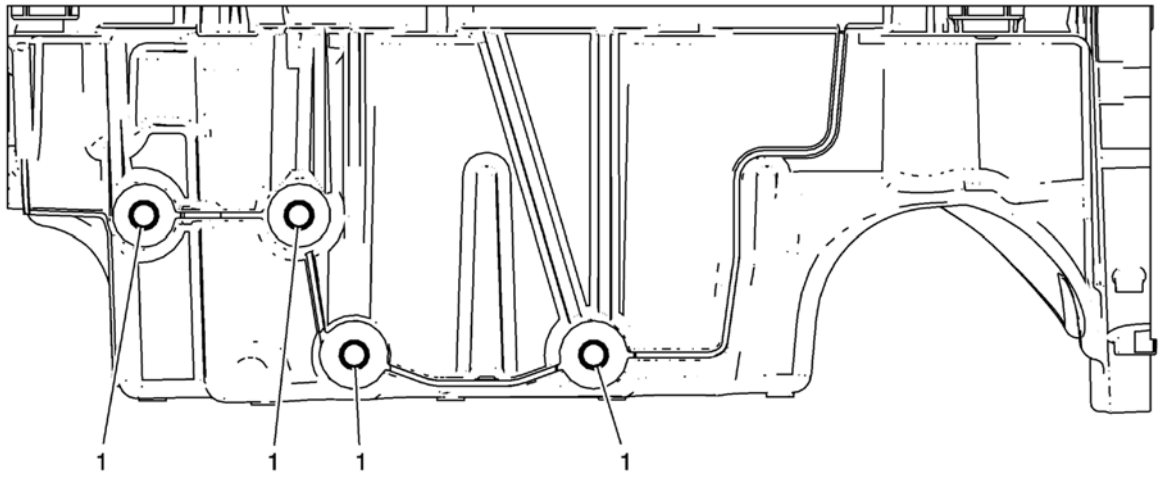


Fig. 29: View Of Oil Pan Left Side
Courtesy of GENERAL MOTORS COMPANY

Oil Pan Left Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	420	33.5	1.3189	27.0	1.0630

Oil Pan Right Side

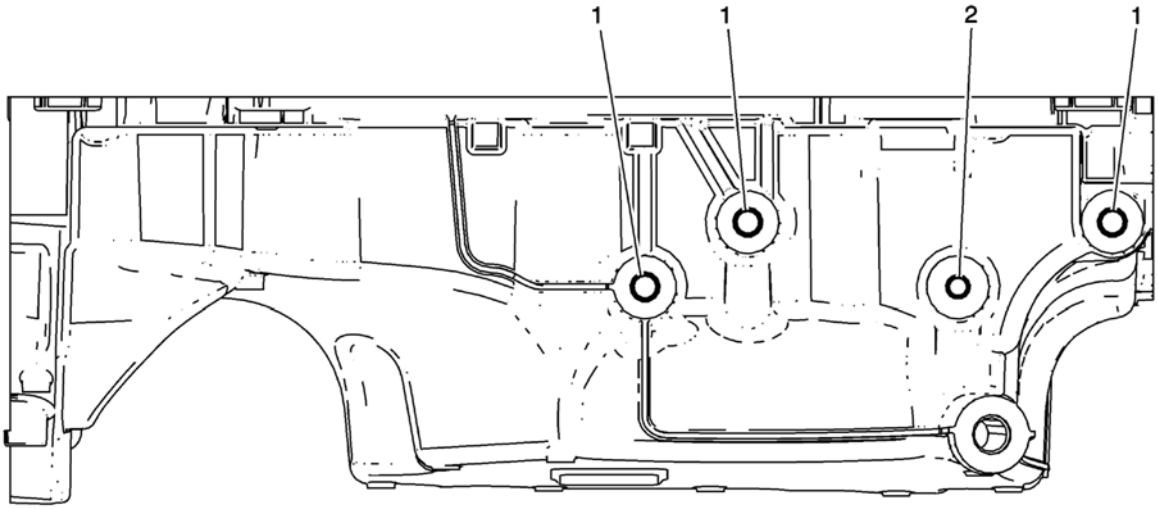


Fig. 30: View Of Oil Pan Right Side
Courtesy of GENERAL MOTORS COMPANY

Oil Pan Right Side

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M12 x 1.75	856	857	N/A	858	859	855	39.5	1.5551	32.0	1.2598
2	M12 x 1.75	856	N/A	N/A	858	859	855	39.5	1.5551	32.0	1.2598

Oil Pan Rear

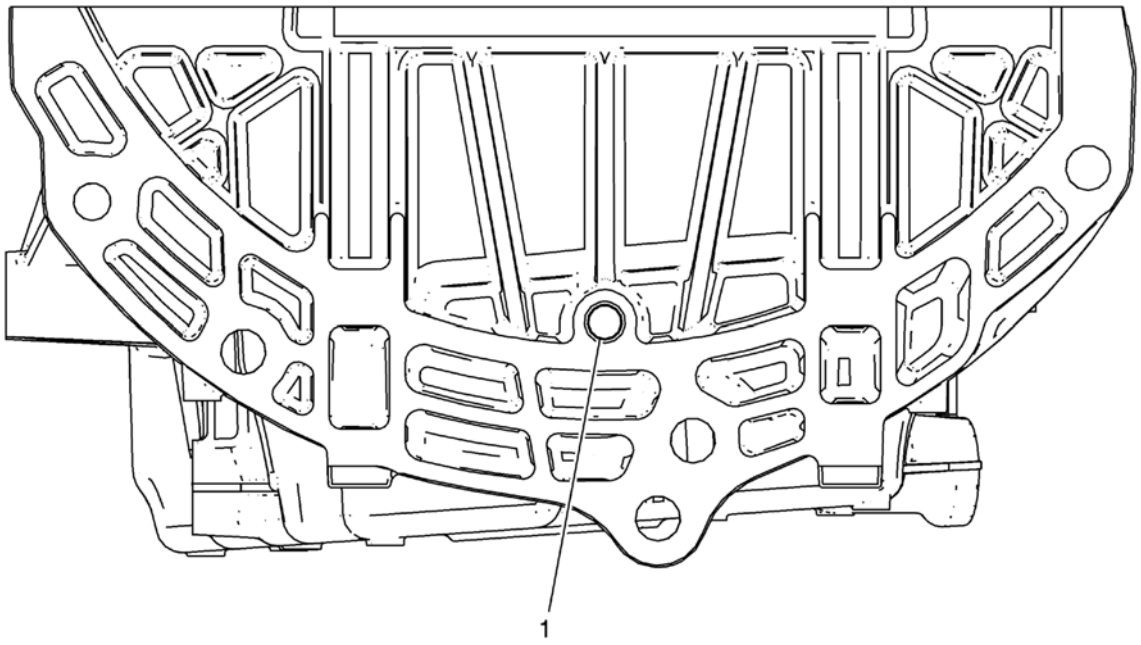


Fig. 31: View Of Oil Pan Rear
Courtesy of GENERAL MOTORS COMPANY

Oil Pan Rear

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M10 x 1.5	211	212	N/A	213	214	420	33.5	1.3189	27.0	1.0630

Oil Pan Top

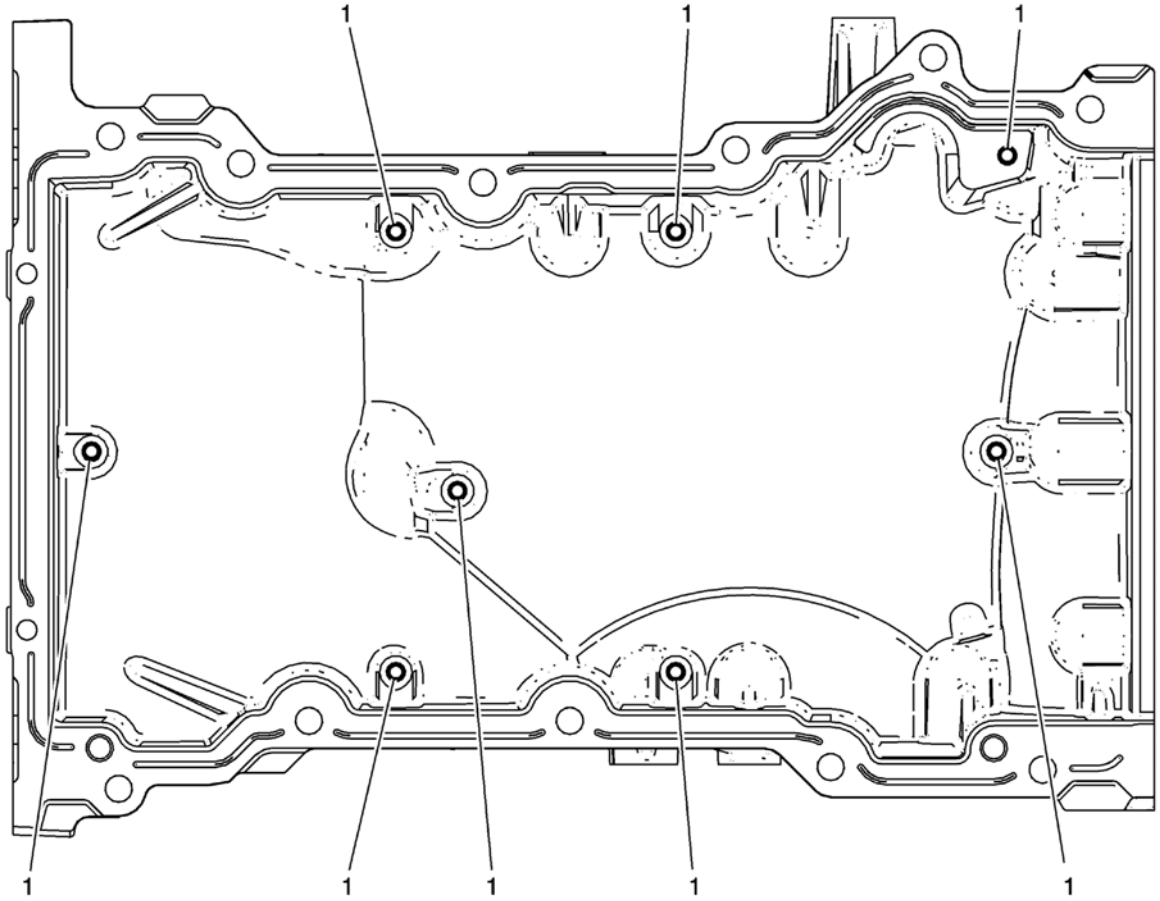


Fig. 32: View Of Oil Pan Top
Courtesy of GENERAL MOTORS COMPANY

Oil Pan Top

Hole Location	Thread Size	Drill	Counter Bore Tool	Stop Collar	Tap	Driver	Insert	Drill Depth (Maximum)		Tap Depth (Minimum)	
-	-	J 42385-						MM	(IN)	MM	(IN)
1	M6 x 1.0	701	N/A	N/A	203	204	205	28.0	1.1024	23.5	0.9252

Article GUID: A00737151

Engine

Engine Mechanical - 3.6L (LFX) -Timing Chain Alignment Diagram - Impala

TIMING CHAIN ALIGNMENT DIAGRAM

CAMSHAFT POSITION ACTUATOR TIMING MARKS

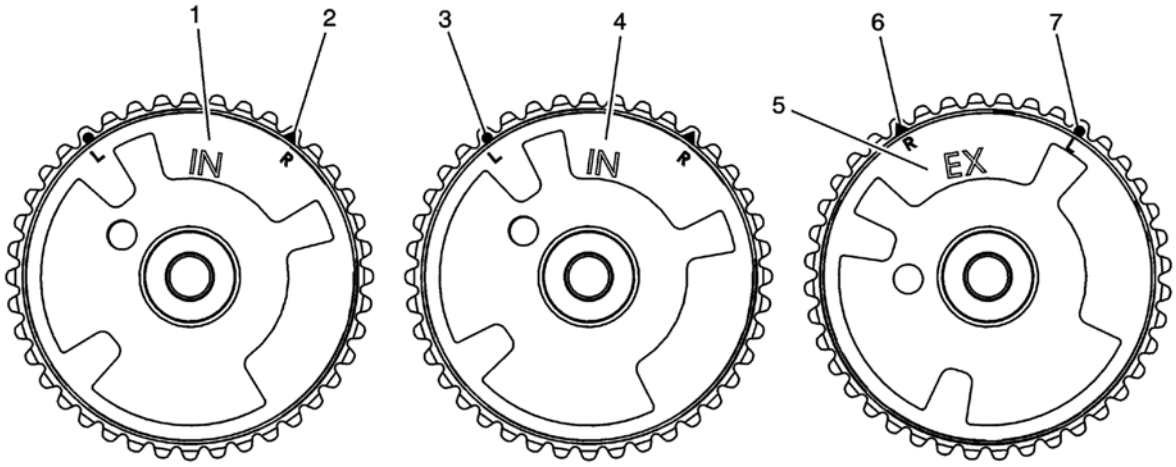


Fig. 1: Identifying Camshaft Position Actuator Timing Marks
Courtesy of GENERAL MOTORS COMPANY

STAGE ONE

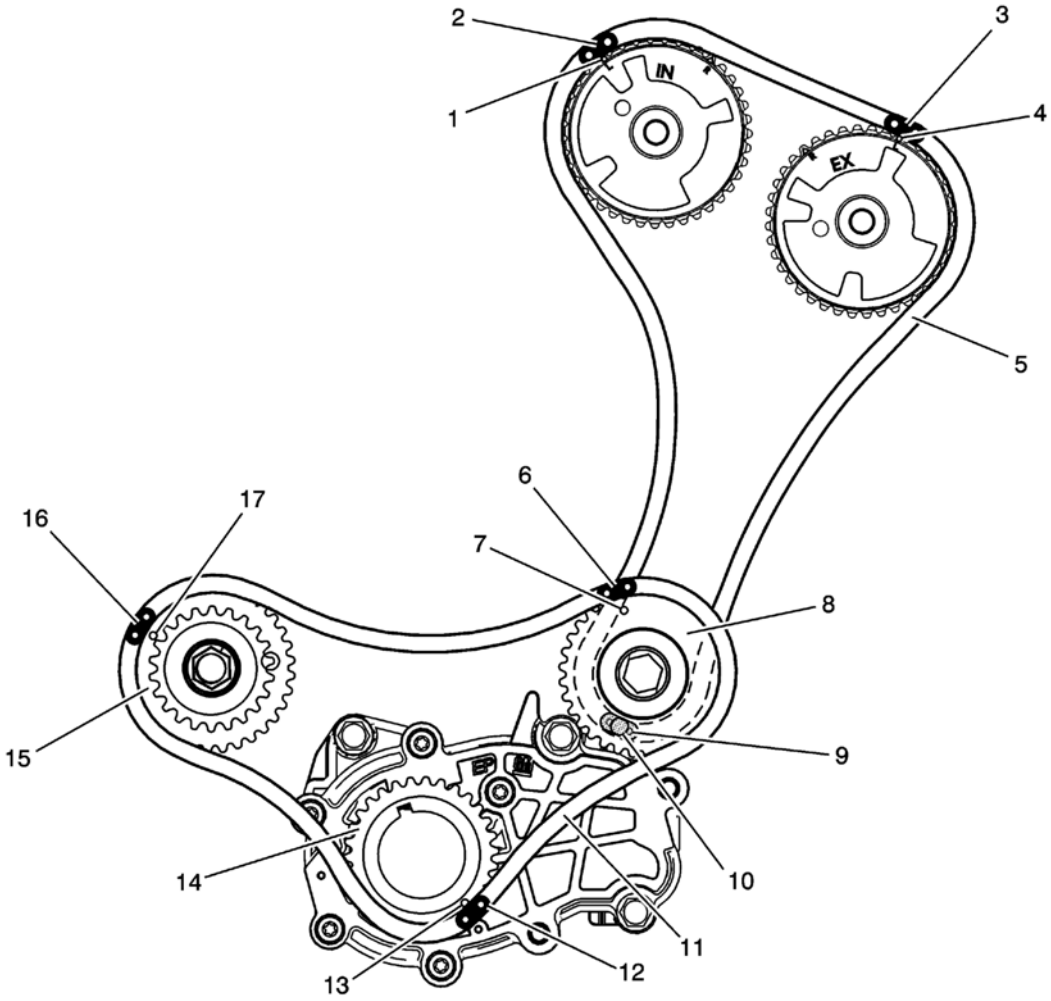


Fig. 2: Locating Stage One Timing Marks
Courtesy of GENERAL MOTORS COMPANY

STAGE TWO

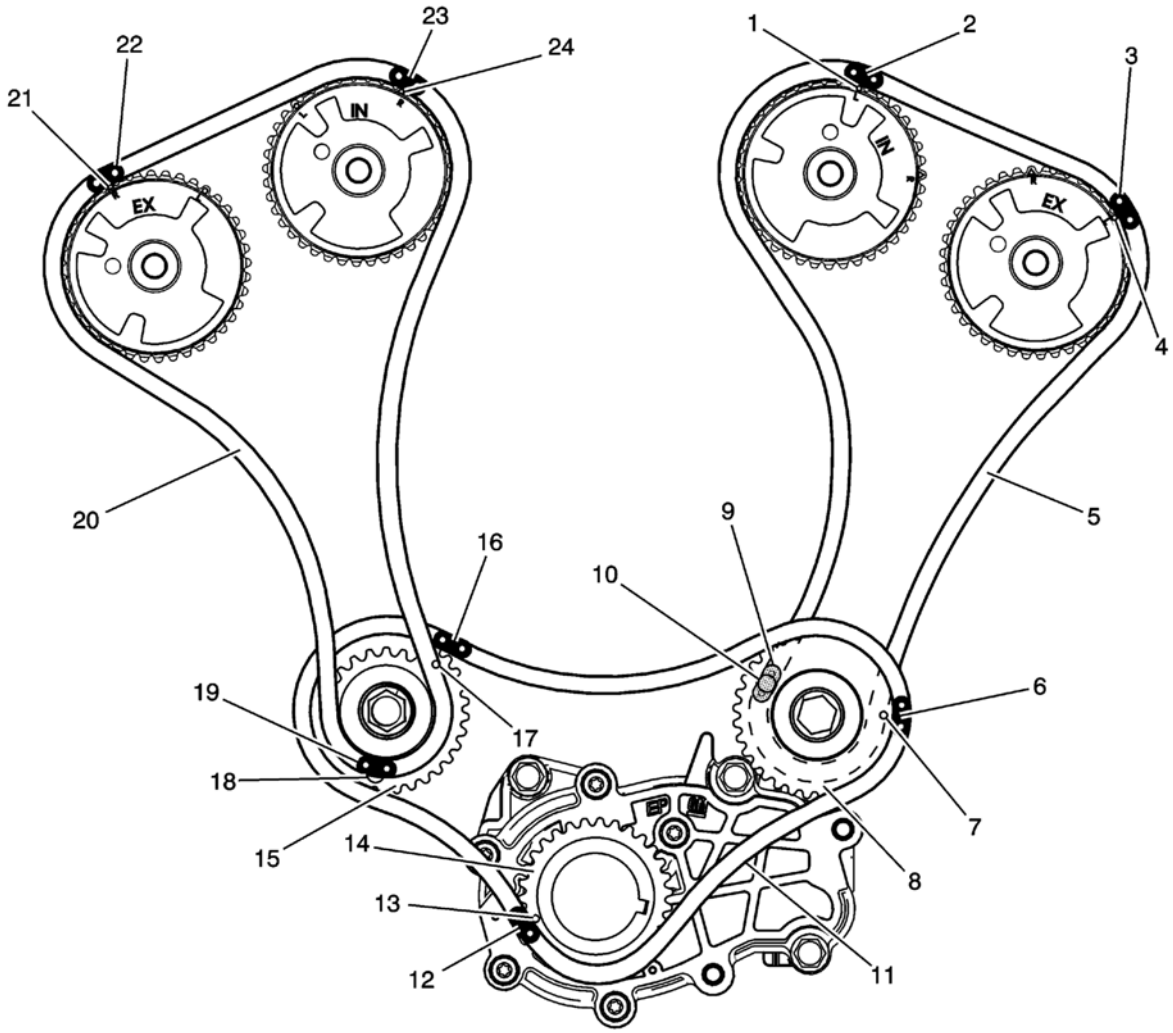


Fig. 3: Locating Stage Two Timing Marks
Courtesy of GENERAL MOTORS COMPANY

Article GUID: A00737156

SPECIFICATIONS

APPROXIMATE FLUID CAPACITIES

The following approximate capacities are given in US English and metric conversions. See **Fluid and Lubricant Recommendations** for more information. All capacities are approximate. When adding, be sure to fill to the approximate level, as recommended in this manual. Recheck fluid level after filling.

Application	Specification	
	Metric	US English
Cooling System		
• 3.6L Engines	9.6 liters	10.1 quarts
• Police Package	10.0 liters	10.6 quarts
Engine Oil With Filter		
• 3.6L Engines	5.7 liters	6.0 quarts
• Police Package	5.7 liters	6.0 quarts
Fuel Tank	66.2 liters	17.5 gallons
6T70 (MH2) Transaxle		
• Valve Body Cover Removal - Approximate Capacity	5.0 - 7.0 liters	5.3 - 7.4 quarts
• Fluid Change - Drain Plug - Approximate Capacity	4.0 - 6.0 liters	4.2 - 6.3 quarts
• Overhaul - Approximate Capacity	7.0 - 9.0 liters	7.4 - 9.5 quarts

FLUID AND LUBRICANT RECOMMENDATIONS

Usage	Fluid/Lubricant
Engine Oil	Use only engine oil licensed to the dexos1 specfication, or equivalent, of the proper SAE viscosity grade. ACDelco dexos1 Synthetic Blend is recommended. Use SAE 5W-30 viscosity grade engine oil. Cold Temperature Operation: In an area of extreme cold, where the temperature falls below -29 Â°C (-20 Â°F), an SAE 0W-30 oil may be used. An oil of this viscosity grade will provide easier cold starting for the engine at extremely low temperatures. When selecting an oil of the appropriate viscosity grade, always select an oil of the correct specification. Refer to Owner's Manual for more information.

Usage	Fluid/Lubricant
Engine Coolant	50/50 mixture of clean, drinkable water and use only DEX-COOL Coolant.
Hydraulic Brake System	DOT 3 Hydraulic Brake Fluid GM P/N 88862806 (Canadian P/N 88862807)
Windshield Washer	Automotive windshield washer fluid that meets regional freeze protection requirements.
Power Steering System	GM Power Steering Fluid GM P/N 89021184 (Canadian P/N 89021186)
Automatic Transmission	DEXRONÂ®-VI Automatic Transmission Fluid
Key Lock Cylinders	Multi-Purpose Lubricant, Superlube GM P/N 12346241 (Canadian P/N 10953474)
Hood Latch Assembly, Secondary Latch, Pivots, Spring Anchor, and Release Pawl	Lubriplate Lubricant Aerosol GM P/N 89021668 (Canadian P/N 89021674) or lubricant meeting requirements of NLGI #2, Category LB or GC-LB
Hood and Hood Hinges	Multi-Purpose Lubricant, Superlube GM P/N 12346241 (Canadian P/N 10953474)
Weatherstrip Conditioning	Weatherstrip Lubricant GM P/N 3634770 (Canadian P/N 10953518) or Dielectric Silicone Grease GM P/N 12345579 (Canadian P/N 10953481)

MAINTENANCE ITEMS

Maintenance Procedure	Link
Approximate Fluid Capacities	**Approximate Fluid Capacities**
Fluid and Lubricant Recommendations	**Fluid and Lubricant Recommendations**
Maintenance Replacement Parts	**Maintenance Replacement Parts**
GM Oil Life System Resetting	**GM Oil Life System Resetting**
Tire Rotation	**Tire Rotation**
Tire Pressure Indicator Sensor Learn	**Tire Pressure Indicator Sensor Learn**
Passenger Compartment Air Filter Replacement	**Passenger Compartment Air Filter Replacement**
Brake Pad Inspection	**Brake Pad Inspection**
Cooling System Draining and Filling	**Cooling System Draining and Filling**
Hydraulic Brake System Bleeding	**Hydraulic Brake System Bleeding (Manual)** **Hydraulic Brake System Bleeding (Pressure)**
Air Cleaner Element Replacement - 3.6L (LFX)	**Air Cleaner Element Replacement** - 3.6L (LFX)
Spark Plug Replacement - 3.6L (LFX)	**Spark Plug Replacement** - 3.6L (LFX)
Drive Belt Replacement - 3.6L (LFX)	**Drive Belt Replacement** - 3.6L (LFX)
Automatic Transmission Fluid Drain and Fill - 6T70 (MH2)	**Transmission Fluid Drain and Fill** - 6T70 (MH2)

MAINTENANCE REPLACEMENT PARTS

Replacement parts identified below by name, part number, or specification can be obtained from your dealer.

Part	GM Part Number	ACDelco Part Number

Part	GM Part Number	ACDelco Part Number
Engine Air Cleaner/Filter	10350737	A2962C
Engine Oil Filter	89017525	PF63
Passenger Compartment Air Filter	15284938	CF132
Spark Plugs	12622561	41-109
Wiper Blades		
• Driver Side - 55.0 cm (21.7 in)	15941731	-
• Passenger Side - 55.0 cm (21.7 in)	15941732	-

MAINTENANCE

MAINTENANCE SCHEDULE (NORTH AMERICAN EMISSIONS)

The Maintenance Schedule information will only be found in the Owner's Manual.

Refer to the Maintenance Schedule subsection of the Owner's Manual, or you may be able to use the Search information function using the words Scheduled Maintenance.

GM OIL LIFE SYSTEM RESETTING

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL SOON message will come on. Change the engine oil as soon as possible within the next 600 miles (1 000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

If the system is ever reset accidentally, change the engine oil at 3,000 miles (5 000 km) since last oil change.

How to Reset the Engine Oil Life System

To reset the Engine Oil Life System, do the following:

1. Display the OIL LIFE REMAINING on the driver information center (DIC).
2. Press and hold the SET/RESET button on the DIC for more than five seconds. The oil life will change to 100 percent.

If the CHANGE ENGINE OIL SOON message comes back on when you start the vehicle the Engine Oil Life System has not reset. Repeat the procedure.

Article GUID: A00737182

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Battery Hold Down Fastener	18 N.m	13 lb ft
Battery Positive-to-Battery Positive Post Clamp	10 N.m	89 lb in
Battery Negative-to-Battery Negative Post Clamp	6 N.m	53 lb in
Battery Tray Fastener	5 N.m	44 lb in
Engine Harness Ground Terminal -to- Battery Negative Engine Ground Stud Fastener	20 N.m	15 lb ft
Generator Mounting Fasteners	58 N.m	43 lb ft
Generator Output BAT + Terminal Fastener	20 N.m	15 lb ft
Negative Battery Cable Engine Block Ground Stud/Fastener	50 N.m	37 lb ft
Negative Battery Cable Upper Tie Bar Ground Fastener	10 N.m	89 lb in
Positive Battery Cable Underhood Fuse Block Terminal Fastener	15 N.m	11 lb ft
Starter Heat Shield Fastener	5 N.m	44 lb in
Starter Mounting Fastener	58 N.m	43 lb ft
Starter Solenoid "BAT" Terminal Nut	10 N.m	89 lb in

SCHEMATIC WIRING DIAGRAMS

STARTING AND CHARGING WIRING SCHEMATICS

Starter

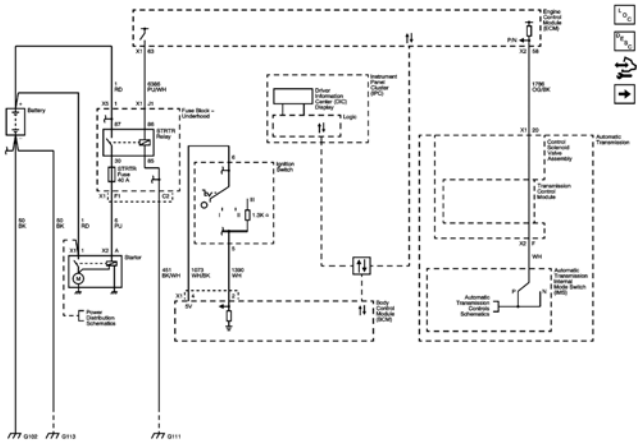


Fig. 1: Starter Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Generator

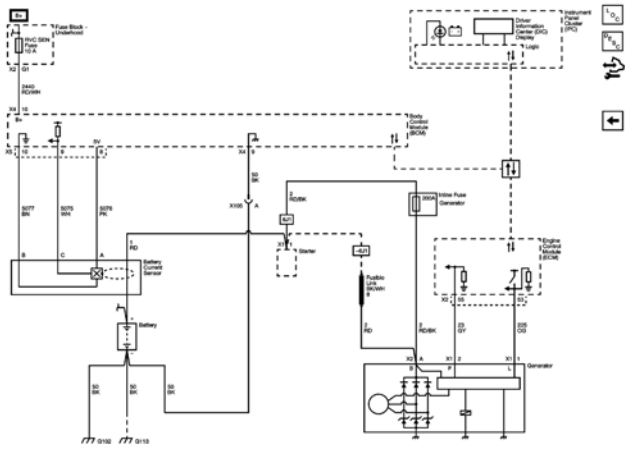


Fig. 2: Generator Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, OR P0563: DEVICE POWER

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1325 03

Device Power Circuit Voltage Below Threshold

DTC B1325 07

Device Power Circuit Voltage Above Threshold

DTC B1330 03

Device Power 2 Circuit Voltage Below Threshold

DTC B1420 00

Device Voltage 1

DTC B1424 00

Device Voltage Low

DTC B1517 03

Battery Voltage Below Threshold

DTC B1517 07

Battery Voltage Above Threshold

DTC B1517 5A

Battery Voltage Plausibility Failure

DTC C0800 03

Device Power 1 Circuit Voltage Below Threshold

DTC C0800 07

Device Power 1 Circuit Voltage Above Threshold

DTC C0800 11

Device Power 1 Circuit High Input

DTC C0800 0D

Device Power 1 Circuit High Resistance

DTC C0895 00

Device Voltage

DTC C0899 00

Device Voltage Low

DTC C0899 03

Device Voltage Low

DTC C0900 00

Device Voltage High

DTC P0560

System Voltage

DTC P0562

System Voltage Low Voltage

DTC P0563

System Voltage High Voltage

Circuit/System Description

The vehicle control modules or sensors monitor the system voltage to verify the system voltage is within the normal operating range.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The control module or sensor detects a system voltage of less than approximately 9 V for approximately 5 seconds.

Action Taken When the DTC Sets

- A driver information center message and/or warning indicator may be displayed.
- The control module may be temporarily disabled.

Conditions for Clearing the DTC

The system voltage returns to normal operating range.

Diagnostic Aids

- A high or low voltage DTC set or voltage value in multiple modules/sensors indicates a concern in the charging system.
- A possible cause of this DTC could be overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify the battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
   - **If battery voltage is less than 12.4 V or more than 12.8 V**

     Refer to **Battery Inspection/Test**.

   - **If battery voltage is between 12.4 and 12.8 V**
3. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
4. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.
   - **If the voltage is not at least 1 V greater than the voltage measured in step 1 or is greater than 15 V.**

     Refer to **Charging System Test**.

   - **If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**
5. Verify the appropriate control module scan tool B+ and ignition voltage parameters are within 1 V of the battery voltage.
   - **If not within 1 V of the battery voltage**

     Refer to Circuit/System Testing.

   - **If within 1 V of the battery voltage**
6. All OK.

Circuit/System Testing

NOTE: **Use the schematic to identify the following:**

- **Control modules the vehicle is equipped with**
- **The control module's ground, B+, and Ignition circuit terminal IDs and connectors**

NOTE: **Some control module ground circuits may require up to 20 min after the ignition is turned off before achieving a resistance reading of less than 5 Ω. In most cases the readings will drop below 20 Ω within 1 min indicating the control module is going to sleep.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connectors at the appropriate control module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between each ground circuit terminal and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the appropriate control module.

- **If the test lamp illuminates**

4. Ignition ON.
5. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ignition circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for infinite resistance between the ignition circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, replace the appropriate control module.
   - **If the test lamp illuminates**
6. Replace the control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control module replacement, setup, and programming

DTC B1405: DEVICE VOLTAGE REFERENCE OUTPUT 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1405

Device Voltage Reference Output 2 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Current Sensor Supply Voltage	B1516	B1516	-	B1516
Battery Current Sensor Signal	B1405	B1405	-	B1405
Battery Current Sensor Low Reference	-	B1516	-	B1516

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the body control module (BCM). It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Conditions for Running the DTC

- The ignition is ON.
- The engine is running.

Conditions for Setting the DTC

The BCM detects a duty cycle of PWM input signal is less than 4 percent or more than 96 percent for more 33 seconds.

Action Taken When the DTC Sets

The DTC sets as current , no driver indication or message is displayed.

Conditions for Clearing the DTC

The DTC clears as current status when the battery sensed current returns to normal range for more than 5 seconds.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B1405

1. Ignition OFF, disconnect the harness connector at the battery current sensor.
2. Ignition OFF, test for less than 5.0 ohms between the low reference circuit terminal B and ground.
   - If greater than specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the BCM.
3. Ignition ON, test for 4.8-5.2 volts between the battery current sensor supply voltage circuit terminal A and ground.
   - If less than the specified range , test the battery current sensor supply voltage circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
   - If greater than the specified range , test the battery current sensor supply voltage circuit for a short to voltage. If the circuit tests normal, replace the BCM.
4. Ignition ON, test for 4.8-5.2 volts between the battery current sensor signal circuit terminal C and ground.
   - If less than the specified range, test the battery current sensor signal circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
   - If greater than the specified range, test the battery current sensor signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the battery current sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Battery Current Sensor Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B1424: DEVICE 1 VOLTAGE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1424 00

Device 1 Voltage Low

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B1424 00	B1424 00	-	-
Ground	-	B1424 00	-	-

Circuit/System Description

The theft deterrent module (TDM) monitors the battery positive (B+) voltage available to it. If the voltage at the TDM is between 6-9 V, and the voltage being reported by a serial data message is greater than 9 V, then DTC B1424 00 sets.

Conditions for Running the DTC

- The Ignition is in Accessory or Run
- The diagnostic runs every 100 milliseconds.

Conditions for Setting the DTC

- Voltage at the B+ circuit is between 6 and 9 V.
- Reported battery voltage received via serial data is valid and is greater than 9 V.
- The above conditions have been met for 2 seconds.

Action Taken When the DTC Sets

- Security Indicator turns ON.
- The driver information center (DIC) displays the SERVICE THEFT DETERRENT SYSTEM message.

Conditions for Clearing the DTC

- This DTC passes when the battery voltage at the TDM is greater than 9 V, or if the voltage reported by serial data is less than 9 V.
- A history DTC clears after 100 consecutive ignition cycles, if no failures are reported by this diagnostic.

Diagnostic Aids

A low voltage DTC in multiple modules indicates a concern in the charging system.

Reference Information

Schematic Reference

Immobilizer Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Immobilizer Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals.The voltage should be between 12.6 and 15.0 V.
   - If the battery voltage is not within the specified range, refer to **Charging System Test**
2. Ignition OFF, disconnect the harness connector at the theft deterrent module (TDM).
3. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 Ω between the ground circuit terminal 3 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Ignition ON , verify a test lamp illuminates between the B+ circuit terminal 1 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. If the circuits test normal, replace the TDM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for TDM replacement, set up, and programming

DTC B1516: BATTERY CURRENT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1516 08

Battery Current Sensor Signal Invalid

DTC B1516 66

Battery Current Sensor Wrong Mounting Position

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Current Sensor Supply Voltage	B1516 08	B1516 08	-	B1516 08
Battery Current Sensor Signal	B1405	B1405	-	B1405
Battery Current Sensor Low Reference	-	B1516 08	-	B1516 08

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the body control module (BCM). It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Conditions for Running the DTC

- The ignition is ON.
- The engine is running.

Conditions for Setting the DTC

B1516 08

The BCM detects a duty cycle of PWM input signal is less than 4 percent or more than 96 percent for more 33 seconds.

B1516 66

The BCM detects the battery current sensor is improperly installed.

Action Taken When the DTC Sets

The DTC sets as current , no driver indication or message is displayed.

Conditions for Clearing the DTC

The DTC clears as current status when the battery sensed current returns to normal range for more than 5 seconds.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Testing

B1516 08

1. Ignition OFF, disconnect the harness connector at the battery current sensor.
2. Ignition OFF, test for less than 5.0 ohms between the low reference circuit terminal B and ground.
   - If greater than specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the BCM.
3. Ignition ON, test for 4.8-5.2 volts between the battery current sensor supply voltage circuit terminal A and ground.
   - If less than the specified range , test the battery current sensor supply voltage circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
   - If greater than the specified range , test the battery current sensor supply voltage circuit for a short to voltage. If the circuit tests normal, replace the BCM.
4. Ignition ON, test for 4.8-5.2 volts between the battery current sensor signal circuit terminal C and ground.
   - If less than the specified range, test the battery current sensor signal circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
   - If greater than the specified range, test the battery current sensor signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the battery current sensor.

B1516 66

When diagnosing B1516 66 verify that the battery current sensor is installed securely and positioned in the correct current flow direction.

- If the battery current sensor is not, remove and reinstall the sensor properly.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Battery Current Sensor Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B151A: LOW BATTERY CAPACITY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B151A 58

Low Battery Capacity Detected

Circuit/System Description

The body control module (BCM) monitors the battery voltage level during an engine crank event to detect a low battery voltage condition.

Conditions for Running the DTC

The vehicle is ON

Conditions for Setting the DTC

A minimum crank battery voltage is less than the minimum crank battery voltage threshold for 16 consecutive crank events.

Action Taken When the DTC Sets

A driver information center message is displayed.

Conditions for Clearing the DTC

The DTC will clear if the minimum crank voltage is greater than the minimum crank voltage threshold during a crank event.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

- Refer to the **Battery Inspection/Test**.
- Refer to the **Charging System Test**.

DTC B1527: PARASITIC LOAD

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1527 00

Parasitic Load

Circuit/System Description

The body control module (BCM) monitors the state of charge of the electrical system.

Conditions for Running the DTC

The ignition is in Accessory or Run mode.

Conditions for Setting the DTC

The state of charge at ignition ON is 30% lower than when the engine was running and battery drain is more than 2 A.

Action Taken When the DTC Sets

There is no battery telltale illuminated or DIC message displayed.

Conditions for Clearing the DTC

- The DTC will clear if the fault does not return after 50 consecutive ignition cycles.
- The DTC will clear when run state of charge is greater than or equal to 80%.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Refer to **Battery Electrical Drain/Parasitic Load Test**.

DTC P0615, P0616, OR P0617: STARTER RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0615

Starter Relay Control Circuit

DTC P0616

Starter Relay Control Circuit Low Voltage

DTC P0617

Starter Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0616	P0615	P0617	-
Ground	-	P0615	-	-

Circuit/System Description

When the ignition switch is placed in the CRANK position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the CRANK position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch pedal is depressed or the transmission is in Park/Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter motor.

Conditions for Running the DTC

- The ignition is in the CRANK position.
- The system voltage is between 9.5-18 V.

Conditions for Setting the DTC

The ECM detects improper voltage on the control circuit of the starter relay.

Action Taken When the DTC Sets

DTC P0615, P0616, and P0617 are C type DTCs.

Conditions for Clearing the DTC

DTC P0615, P0616, and P0617 are C type DTCs.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR27 Starter Relay. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 85 and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 87 and ground.
   - **If the test lamp does not illuminate**
   1. Ignition OFF.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify cable connection to Battery
   - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85.
6. Verify the test lamp turns ON and OFF when commanding the KR27 Starter Relay ON and OFF with a scan tool.
   - **If the test lamp is always OFF**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If the test lamp is always ON**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If the test lamp turns ON and OFF**
7. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30.
8. Verify the M64 Starter Motor is activated.
   - **If the M64 starter motor does not activate and the circuit fuse is good**
   1. Ignition OFF, disconnect the harness connector at the M64 starter motor.
   2. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the M64 Starter Motor.
   - **If the M64 starter motor does not activate and the circuit fuse is open**

1. Ignition OFF, disconnect the harness connector at the M64 starter motor.
2. Test for infinite resistance between the control circuit terminal X2 A and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the M64 Starter Motor.

- **If the M64 starter motor activates**

9. Test or replace the KR27 Starter Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR27 Starter Relay.
2. Test for 60-180 Ω between terminals 85 and 86.
    - **If less than 60 or greater than 180 Ω**

      Replace the relay.

    - **If between 60-180 Ω**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - **If less than infinite resistance**

      Replace the relay.

    - **If infinite resistance**
4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 Ω between terminals 30 and 87.
    - **If 2 Ω or greater**

      Replace the relay.

    - **If less than 2 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Starter Replacement**
- **Control Module References** for control module replacement, programming, and setup.

DTC P0621: GENERATOR L-TERMINAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0621

Generator L-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator turn on control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle controls the voltage regulator to turn the field circuit on and off. The ECM monitors the state of the generator turn on control circuit. The ECM should detect low voltage on the generator turn on control circuit when the ignition is ON and the engine is off, or when the charging system malfunctions. With the engine running, the ECM should detect on the generator turn on control circuit, a high voltage when the duty cycle voltage is commanded high, and a low voltage when the duty cycle voltage is commanded low.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s).
- The engine is running for the run test.

Conditions for Setting the DTC

- Ignition ON, engine OFF - The ECM detects greater than 3.5 V on the generator control circuit for 5 s.
- Engine running - The ECM detects a low voltage for 15 s on the generator control circuit when the duty cycle voltage is commanded high.
- Engine running - The ECM detects a high voltage for 15 s on the generator control circuit when the duty cycle voltage is commanded low.

Action Taken When the DTC Sets

DTC P0621 is a type C DTC.

Conditions for Clearing the DTC

- Ignition ON, engine OFF- Low voltage.
- Engine running - A control signal duty cycle is detected.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
2. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
3. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X2, B X2 or 1 X2, and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
   - **If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Test for 1 V or greater between the control circuit terminal 1 X1 and ground.
   - **If less than 1 V**
   1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the control circuit end to end.
      - If greater than 2 Ω, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If 1V or greater**
4. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module, Ignition ON
5. Test for less than 1 V between the G13 Generator control circuit terminal 1 X1 and ground.
   - **If greater than 1 V**

     Repair the short to voltage on the circuit.

   - **If 1V or less**
6. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0622: GENERATOR F-TERMINAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0622

Generator F-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings on and off. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is off, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5-99%.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s)
- Engine running at less than 3,000 RPM

Conditions for Setting the DTC

- DTC P0621 is not set
- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s), the ECM detects a PWM signal that is greater than 65% for 5 s
- Engine running at less than 3,000 RPM-The ECM detects a PWM signal that is less than 5% for 30 s

Action Taken When the DTC Sets

DTC P0622 is a type C DTC

Conditions for Clearing the DTC

- Ignition ON, Engine OFF- Low / no PWM signal detected
- Engine running - A 5-90% duty cycle is detected

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **Do not have a battery charger connected during the generator testing.**

1. Engine running.
2. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is between 5-90%.
   - **If not between 5-90%**

     Refer to Circuit/System Testing.

   - **If between 5-90%**
3. Verify the scan tool Generator F-Terminal Signal parameter changes when commanding the headlamps ON and OFF.
   - **If the parameter does not change**

     Refer to Circuit/System Testing.

   - **If the parameter changes**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X2, B X2 or 1 X2, and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance, test or replace the G13 Generator.
   - **If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.
   - **If 5% or greater**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
   2. Test for less than 1 V between the signal circuit terminal 2 and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If less than 5%**
4. Install a 3 A fused jumper wire between the signal circuit terminal 2 and B+, engine running.
5. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is greater than 95%.
   - **If 95% or less**
   1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the signal circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the signal circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 95%**
6. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Replacement**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P1668: GENERATOR L-TERMINAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1668

Generator L-Terminal Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Generator L- Terminal	P1668	P1668	P1668	-

Circuit/System Description

The engine control module (ECM) uses the generator turn ON signal circuit to control the load of the generator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON signal circuit. The ECM should detect low voltage on generator turn ON signal circuit when the ignition is ON and the engine is OFF, or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn ON signal circuit. The ECM performs tests to determine the status of the generator turn ON signal circuit.

Conditions for Running the DTC

- No generator, crankshaft position (CKP) sensors, or camshaft position (CMP) sensor DTCs are set.
- The ignition ON, engine OFF for the ignition on test.
- The engine running for the run test.

Conditions for Setting the DTC

- During the ignition ON test, the ECM detects high voltage on the generator turn on signal circuit for at least 5 seconds.
- During the RUN test, the ECM detects low voltage on the generator turn on signal circuit for at least 15 seconds.

Action Taken When the DTC Sets

DTC P1668 is a C type DTC.

Conditions for Clearing the DTC

DTC P1668 is a C type DTC.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the generator.
2. Ignition ON, test for less than 1 volt between the generator turn on signal circuit and ground.
   - If greater than the specified value, test the generator turn on signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
3. Engine Running, test for greater than 3.5 volts between the generator turn on signal and ground.
   - If less than the specified value, test the generator turn on signal circuit for a short to ground, an open/ high resistance. If the circuit tests normal, replace the ECM.
4. If the circuit tests normal, test or replace the generator.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Module References for ECM replacement, setup, and programming
- Generator Replacement

SYMPTOMS - ENGINE ELECTRICAL

NOTE: **The following steps must be completed before using the symptom tables.**

- Perform Diagnostic System Check - Vehicle before using the Symptom Tables in order to verify that all of the following are true:
  - There are no DTCs set.
  - The control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. Refer to one of the following system operations:
  - Battery Description and Operation
  - Charging System Description and Operation
  - Electrical Power Management Description and Operation
  - Starting System Description and Operation

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the starting and charging systems. Refer to Checking Aftermarket Accessories .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to Testing for Intermittent Conditions and Poor Connections .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Battery Inspection/Test
- Battery Electrical Drain/Parasitic Load Test
- Charging System Test
- Generator Noise Diagnosis
- Starter Solenoid Does Not Click
- Starter Solenoid Clicks, Engine Does Not Crank
- Engine Cranks Slowly
- Starter Noise Diagnosis

BATTERY INSPECTION/TEST

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Aids

NOTE: **For Warranty repairs -**

You must use regionally required battery test equipment for warranty repairs.

For accurate test results the battery must be disconnected from the vehicle and the equipment connected directly to the battery posts. When setting up the equipment, select "Out of Vehicle" and then the correct battery type (Flooded, AGM or Stop/Start AGM) and rated CCA (both from the battery label) must be entered.

- **Failure to obtain the correct connections during the test may result in a failed test on a good battery.**
- **Use the Out of Vehicle test (battery disconnected with test equipment connected directly to the posts) for each battery when testing a vehicle with dual batteries.**

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 50313 Battery Tester

Circuit/System Testing

WARNING: Unless directed otherwise, the ignition must be OFF with the key removed, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStarÂ® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÂ® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÂ®module). Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÂ® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Verify the C1 Battery or C1B Battery - Auxiliary (if equipped) case is not cracked, broken, or damaged, which may be indicated by battery acid leakage.
   - **If there is any apparent damage**

     Replace the C1 Battery or C1B Battery - Auxiliary.

   - **If there is no damage**
2. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in **Fastener Specifications**.
   - **If the battery cables need to be cleaned or tightened**

     Clean as required and tighten as specified.

   - **If the battery cables are clean and tight**
3. Disconnect battery from the vehicle. There is no need to remove the battery from the vehicle.
4. Connect the EL-50313 directly to the battery terminal posts.
5. Select "Charging," "Diagnostic" and "Out of Vehicle" when setting up the test.
6. Select the proper battery type, Flooded, AGM or Stop/Start AGM.
7. Enter the CCA as shown on the battery label.
8. Verify the test result is not REPLACE BATTERY or BAD CELL-REPLACE

   NOTE: Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular time. The test code may occasionally repeat when you retest the same battery. More often, each test will result in a different code. Use the test code from the Out of Vehicle test.

   - **If the test result is REPLACE BATTERY or BAD CELL-REPLACE**

     Replace the C1 Battery or C1B Battery - Auxiliary.

   - **If the test result is not REPLACE BATTERY or BAD CELL-REPLACE**
9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Battery Replacement

BATTERY CHARGING

Special Tools

EL 50313 Battery Tester

For equivalent regional tools, refer to **Special Tools**.

Diagnostic Aids

- The charging area should be well ventilated.
- Do not charge a battery that appears to be frozen. Allow the battery to warm to room temperature and test it using the **EL 50313** Battery Tester before charging.
- An AGM battery may be damaged if charged to more than 14.5 V.
- A Flooded Cell battery may be damaged if charged to more than 16.5 V.
- Vehicles with dual batteries must be charged individually which will result in two printouts.

Battery State of Charge

NOTE: **Using voltage to determine the batteries state of charge is only accurate after the battery has been at rest for 24 hours. This is enough time for the acid in each cell to equalize. If the battery has been charged or discharged in the past 24 hours, the battery state of charge will only be an estimate.**

The maintenance-free batteries state of charge is estimated by reading the voltage of the battery across the battery terminals. Because the voltage is affected by current flow into or out of the battery, the engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the batteries state of charge:

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
   - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.
   - If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.
3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.

   NOTE: **The table is accurate to 10 percent only after the battery has been at rest for 12 hours.**

4. Measure the battery voltage at the battery terminals. Refer to the following table to determine the state of charge according to the estimated battery temperature:

Battery Voltage	% Charge at 0Â°C (32Â°F)	% Charge at 25Â°C (75Â°F)
12.75 V	100%	100%
12.7 V	100%	90%
12.6 V	90%	75%
12.45 V	75%	65%
12.2 V	65%	45%
12.0 V	40%	20%

Use the state of charge information as follows:

- A battery with a state of charge that is below 65 percent must always be recharged before returning it to service or continuing storage.
- A battery with a state of charge that is 65 percent or greater is generally considered to be charged enough in order to be returned to normal service or in order to continue storage. However, if the battery is being used in slow traffic or with short drive times, or if the temperature is very hot or very cold, the battery should be fully charged, to at least 90 percent, before returning it to service or continuing storage.

Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

- The battery charger capacity-The higher the charger amperage, the less time it will take to charge the battery.
- The state of charge of the battery-A completely discharged battery requires more than twice as much charging time as a half charged battery. In a discharged battery with a voltage below 11 V, the battery has a very high internal resistance and may only accept a very low current at first. Later, as the charging current causes the acid content to increase in the electrolyte, the charging current will increase. Extremely discharged batteries may not activate the reversed voltage protection in some chargers. Refer to the manufacturer's instructions for operating this circuitry.
- The temperature of the battery-The colder the battery is, the more time it takes to recharge the battery. The charging current accepted by a cold battery is very low at first. As the battery warms, the charging current will increase.

Charging Procedure

CAUTION: **Turn OFF the ignition when connecting or disconnecting the battery cables, the battery charger or the jumper cables. Failure to do so may damage the ECM/PCM or other electronic components.**

CAUTION: **Refer to Fastener Caution .**

When charging side-terminal batteries with the battery cables connected, connect the charger to the positive cable bolt and to a ground located away from the battery. When charging side-terminal batteries with the battery cables disconnected, install the battery side terminal adapters and connect the charger to the adapters.

1. Ensure that all of the battery terminal connections are clean and tight.
2. Connect the charger positive lead to the battery positive terminal on the battery or the remote jumper stud underhood.

   CAUTION: **Do not connect the negative charger lead to the housings of other vehicle electrical accessories or equipment. The action of the battery charger may damage such equipment.**

3. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery. If the negative battery cable is disconnected and a terminal adapter is being used, connect directly to the adapter.
4. Select "Charging," "PDI" and "In Vehicle" when setting up the charger.
5. Select the proper battery type, Flooded, AGM, Spiral AGM or Stop/Start AGM.
6. Enter the CCA as shown on the battery label.

BATTERY ELECTRICAL DRAIN/PARASITIC LOAD TEST

12 V Battery

The following procedure is for the 12 V battery only.

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

Components most likely to cause a parasitic draw on the vehicles battery are switches, relays, and control modules. After the ignition is turned OFF the control modules will begin to go to sleep shut OFF. All control modules do not go to sleep at the same time, some may take up to 30 min or longer after turning the ignition off before going to sleep. Other modules may periodically wake up then go back to sleep. These are all normal conditions.

Diagnostic Aids

- Rule out any possible aftermarket equipment causing an unacceptable parasitic current drain. Aftermarket accessories installed into the courtesy lamp circuit can cause the inadvertent power timer in the body control module (BCM) to keep resetting. This may cause the BCM to remain awake and cause a current drain on the battery.
- Rule out customer driving habits such as regular short trips that do not allow enough time to properly charge the battery. Refer to **Battery Description and Operation**.
- Verify that the battery and charging system are in proper working order. Refer to **Battery Charging**, and **Charging System Test**.
- A battery discharging for no apparent reason while the vehicle is parked can be caused by an intermittent draw, such as a module waking up, or a continuous draw, such as a dome light or stuck relay.
- Some systems and modules such as OnStarÂ®, and regulated voltage control, if equipped, are designed to wake up, perform a task, and go back asleep at regular intervals. Refer to **Body Control System Description and Operation** for the system or modules description and operation.
- An engine off natural vacuum evaporative test can occur if the engine control module (ECM) determines the drive cycle has met the appropriate criteria immediately after key off. The ECM will stay awake and the vent solenoid will stay energized for as long as 45 min. The typical current draw for this is about 1 A.
- Digital OnStar generation 6 and later vehicle communication interface module do not "wake up" every 10 min for the first 48 h as the generation 5 and prior. generation 6 and later vehicle communication interface module current draw is very low, less than 40 mA, so the OnStar system is left in that state for up to the first 48 h. Parasitic draw of up to 40 mA with an occasional spike as high as 80 mA through the vehicle communication interface module for the first 48 h is normal.
- Some automatic climate control systems can remain in a semi awake state for up to three hours, actual draw amounts vary by vehicle platform but are typically not greater than 50 mA.
- An extremely low mA current level is consumed by the remote keyless entry receiver for monitoring purposes, actual system wake up only occurs when the fobs for the vehicle are used. When other devices on the same remote keyless entry operating frequency are activated, such as the 4 tire pressure monitoring sensors and other vehicle FOBs in the vicinity, the remote keyless entry receiver will have a 100 mA spike. These spikes are normal and occur too briefly to have a significant effect on battery drain. Competing signals may cause remote keyless entry performance issues such as jamming but should not cause excessive battery draw.
- If an excessive current draw is not present during initial testing, continue periodic testing over a 1-2 hour period to see if the current draw increases and stays above an unacceptable level.

NOTE: **The battery specification listed below is a generic specification. Refer to the label on the original battery when testing the battery.**

- The battery run down time will vary depending on the batteries reserve capacity. If the reserve capacity is higher, then the battery run down time may be longer. If the reserve capacity is lower, then the battery run down time may be shorter. The graph below indicates roughly how many days a 690 cold cranking amperage battery with a 110 min reserve capacity starting at 80% state of charge will last with a constant current draw until it reaches 50% state of charge. Differences in battery reserve capacity and temperature will affect the results.

Current Drain	Days
25 mA	33
50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 38758 Parasitic Draw Test Switch

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

NOTE:

- **Most vehicle systems will go to sleep within 30 min but it can take up to 2 h before all systems power down allowing the parasitic draw test to pass. An occasional increase in the parasitic draw is normal as long as it returns within 1 s.**
- **Closing the door latches/ajar switch while leaving the doors open is recommended, this allows the vehicle systems to perform in a "doors closed" mode while allowing vehicle interior access that may be needed to complete the diagnostic steps.**
- **Locking doors will arm the vehicle content theft deterrent system if equipped. Failure to arm the system may cause a theft system fault to not be present during testing.**
- **There are many things that can prevent the vehicle from completely going to sleep and passing the parasitic draw test. Make sure all the conditions listed below are met before performing the parasitic current draw test.**
  - **Ignition OFF**
  - **Key out of the ignition switch - when not equipped with keyless access and start**
  - **Retained Accessory Power OFF - open and close the driver door after ignition OFF**
  - **Scan tool not communicating with a vehicle control module - in some cases it may need to be disconnected from the DLC**
  - **All access doors closed**
  - **Headlamps OFF - auto headlamps disabled**
  - **Any delay lighting OFF**
  - **If equipped with an under hood lamp disable it**

- **HVAC after blow OFF**
- **Any accessory that can work with ignition OFF inactive or OFF**
- **Wait up to 2 min or longer, after all other listed conditions are met**

Using an Inductive Pickup Probe

1. Connect an inductive pickup probe to the negative battery cable that can read down to 1 mA.
2. Ignition OFF, as the vehicle systems shut down test for less than 30 mA of parasitic current drain.
   - If greater than the specified range, refer to Circuit/System Testing.

Using the EL 38758 Parasitic Draw Test Switch

WARNING: **Refer to Battery Disconnect Warning .**

CAUTION: **When a fused jumper wire or digital multimeter is connected to the test switch terminals, always turn the test switch ON before opening any access door, turning the ignition on, or turning any accessory on. This is to prevent damaging the jumper wire or digital multimeter fuse.**

NOTE: **The switch knob on the EL 38758 switch is marked ON and OFF. When the switch knob is in the ON position, the circuit is closed and electrical current will pass through the switch. When the switch knob is in the OFF position, the circuit is open and electrical current will not pass through the switch.**

1. Ignition OFF, disconnect the battery negative cable from the battery. Refer to Battery Negative Cable Disconnection and Connection.
2. Turn the **EL 38758** switch knob to the OFF position.
3. Install the male end of the **EL 38758** switch to the battery ground terminal.
4. Install the battery negative cable to the female end of the **EL 38758** switch.
5. Turn the **EL 38758** switch knob to the ON position.
6. Road test the vehicle and activate all of the accessories such as the radio and air conditioning.
7. Ignition OFF, connect a 10 A fused jumper wire to the test switch tool terminals.
8. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the jumper wire.
9. Check the fuse in the jumper wire. The fuse should be OK.
   - Failed: If the jumper wire fuse is blown, refer to Circuit/System Testing.
   - Passed
10. Turn the **EL 38758** switch knob to the ON position. Remove the fused jumper wire.
11. Connect a DMM set to the 10 A DC scale between the test switch tool terminals.
12. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the DMM.
13. As the vehicle systems shut down test for less than 30 mA of parasitic current drain.
    - If greater than the specified range, refer to Circuit/System Testing.

Circuit/System Testing

NOTE:

- **Removing or installing a fuse, relay, or connector, to determine the area causing high parasitic draw may wake up control modules. You must wait for the control modules to go back to sleep before retesting. It is best to install any removed or disconnected components after the diagnosis is completed.**
- **Fuses for power mode master components such as the BCM should be removed last to avoid misdiagnosis.**
- **If a scan tool is connected to the DLC, either disconnect it or subtract the scan tool current draw from the DMM reading to get the actual vehicle parasitic current draw.**

If the vehicle has an unacceptable amount of parasitic current draw, remove each fuse one at a time until the current draw falls to an acceptable level. A drop of more than 10-20 mA, when disabling a single system or circuit, is an indication of an overly high current draw that could be causing the battery drain. Refer to Power Distribution Schematics to diagnose exactly which circuit of the suspect system is causing the high parasitic drain. The following is a list of common components that could cause a high current draw:

- Stuck switch
- Stuck relay
- Control module

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for control module replacement, programming and setup

CHARGING SYSTEM TEST

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Reference Information

Description and Operation

Charging System Description and Operation

Electrical Information Reference

Testing for Intermittent Conditions and Poor Connections

Circuit/System Verification

Engine ON, observe the charge indicator on the instrument panel cluster (IPC) or message in the driver information center (DIC). The charge indicator on the IPC should be turned OFF and the DIC should not display charging system message

- If the charge indicator is not on the IPC and a charging system message is not displayed on the DIC, refer to Testing for Intermittent Conditions and Poor Connections .
- If the charge indicator is on the IPC or a charging system message is displayed on the DIC, refer to Circuit/System Testing.

Circuit/System Testing

1. Ignition ON, verify that no generator or battery current sensor DTCs are set that would cause a charging system concern.
   - If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, measure the voltage across the battery terminals. The voltage should read 12.0 volts or greater at room temperature.
   - If not within specified value, refer to **Battery Inspection/Test**.
3. Connect a carbon pile tester to the battery.
4. Start the engine and increase the engine speed to 2,500 RPM. Observe the voltage reading on the tester. The voltage should read between 12.6 - 15.0 volts.
   - If not within specified range, replace the generator.
5. Adjust the carbon pile tester to the specified load test output value according to the C1 battery designation..
   - If not within specified value, replace the generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Generator Replacement

GENERATOR NOISE DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Aids

Noise from a generator may be due to electrical or mechanical noise. Electrical noise or magnetic whine usually varies with the electrical load placed on the generator and is a normal operating characteristic of all generators. When diagnosing a noisy generator, it is important to remember that loose or misaligned components around the generator may transmit the noise into the passenger compartment and that replacing the generator may not solve the problem.

Circuit/System Testing

1. Start the engine, verify the noise can be heard. Compare the concern to a similar vehicle.
2. Inspect the generator, generator mounting, wiring harness, heater hoses, A/C lines or other accessory equipment that may misrouted or may be the cause of the noise to be transmitted into the passenger compartment.
3. Ignition OFF, remove the engine drive belt. Verify the generator, idler pulley and tensioner pulley spin freely.
   - If any of the pulleys do not spin freely, replace the affected component.
4. Loosen all generator mounting bolts and ensure the generator is properly aligned. Tighten mounting bolts to specification, refer to **Generator Replacement**.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Drive Belt Replacement**
- **Drive Belt Tensioner Replacement**
- **Drive Belt Idler Pulley Replacement**
- **Generator Replacement**

STARTER SOLENOID DOES NOT CLICK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ terminal 87	1	1	-	-
ECM Park/ Neutral Signal	2	1	-	-
Coil Control terminal 86	-	1	3	-
Control Output terminal 30	1	1	3	-
Coil Ground terminal 85	-	1	-	-
1. No crank 2. Cranks in any gear 3. Cranks all the time				

Circuit/System Description

When the ignition switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 volts to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that no starter relay, theft deterrent, engine, or automatic transmission DTCs are set that would cause the ECM not to enable engine starting.
   - If DTCs are set, refer to Diagnostic Trouble Code (DTC) List - Vehicle .
2. Ignition ON, observe the scan tool BCM Current Power Mode parameter. Place ignition switch in the crank position, the parameter should display Crank Request.
   - If not the specified value, refer to Power Mode Mismatch
3. Transmission range selector in park , verify the scan tool ECM PNP Switch and TCM IMS parameters display Park/Neutral.
   - If the TCM IMS parameter does not indicate Park/Neutral. Refer to Transmission Internal Mode Switch Logic
   - If the ECM Park/Neutral parameter does not indicate Park/Neutral. Refer to ECM Park Switch Circuit Malfunction.
4. Transmission range selector in park or neutral, attempt to start the vehicle. The starter relay should click and the engine should begin cranking.
   - If the STRTR relay does not click or the engine does not crank, refer to Starter Relay Circuit Malfunction.
5. Ignition ON, observe the scan tool ECM Crankshaft Position Sensor Active Counter is not incrementing.
   - If the Crankshaft Position Sensor Active Counter is incrementing, replace the Crankshaft Position Sensor.

Circuit/System Testing

ECM Park Switch Circuit Malfunction

1. Ignition OFF, disconnect the harness connector at the AT X1 20-Way Connector.
2. Ignition ON, install a 3A fused jumper wire between the signal circuit terminal 20 X1 and ground. Verify the scan tool ECM PNP switch parameter displays Park/Neutral.
   - If not the specified value, test the signal circuit terminal 20 X1 for an open/high resistance. If the circuit tests normal, replace the ECM.
3. If all circuits test normal, test or replace the internal mode switch (IMS).

Starter Relay Circuit Malfunction

1. Ignition OFF, disconnect the starter relay.
2. Ignition OFF, test for less than 3.0 ohms between the relay ground circuit terminal 85 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp illuminates between the relay switch B+ circuit terminal 87 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Ensure the parking brake is applied and the transmission is in PARK. Momentarily install a 40A fused jumper wire between the relay switch B+ circuit terminal 87 and the relay controlled output circuit terminal 30. The starter solenoid should engage and the engine should begin cranking.
   - If the solenoid does not engage, test the relay controlled output circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the starter motor.
5. Connect a test lamp between the relay coil control circuit terminal 86 and the relay coil ground circuit terminal 85.
6. With transmission range selector in park or neutral, cycle the ignition between the OFF and CRANK position. The test lamp should turn ON and OFF when changing between the commanded states.
   - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
   - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the starter relay.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Crankshaft Position Sensor Replacement
- Relay Replacement (Attached to Wire Harness) Relay Replacement (Within an Electrical Center)
- Starter Replacement
- Control Module References for ECM replacement, setup, and programming.

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ terminal 87	1	1	-	-
ECM Park/ Neutral Signal	2	1	-	-
Coil Control terminal 86	-	1	3	-
Control Output terminal 30	1	1	3	-
Coil Ground terminal 85	-	1	-	-
1. No crank 2. Cranks in any gear 3. Cranks all the time				

Circuit/System Description

When the ignition switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 volts to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify that no starter relay, theft deterrent, or automatic transmission DTCs are set that would cause the ECM not to enable engine starting.
   - If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition ON, observe the scan tool BCM Current Power Mode parameter. Place ignition switch in the crank position, the parameter should display Crank Request.
   - If not the specified value, refer to **Power Mode Mismatch**
3. Transmission range selector in park , verify the scan tool ECM PNP Switch and TCM IMS parameters display Park/Neutral.
   - If the TCM IMS parameter does not indicate Park/Neutral. Refer to **Transmission Internal Mode Switch Logic**
   - If the ECM Park/Neutral parameter does not indicate Park/Neutral. Refer to ECM Park Switch Circuit Malfunction.
4. Transmission range selector in park or neutral, attempt to start the vehicle. The starter relay should click and the engine should begin cranking.
   - If the STRTR relay does not click or the engine does not crank, refer to Starter Relay Circuit Malfunction.

Circuit/System Testing

ECM Park Switch Circuit Malfunction (4T65-E)

1. Ignition OFF, disconnect the harness connector at the AT Inline 20-Way Connector.
2. Ignition ON, install a 3A fused jumper wire between the signal circuit terminal W and ground. Verify the scan tool ECM PNP switch parameter displays Park/Neutral.
   - If not the specified value, test the signal circuit terminal W for an open/high resistance. If the circuit tests normal, replace the ECM.
3. If all circuits test normal, test or replace the internal mode switch (IMS).

Starter Relay Circuit Malfunction

1. Ignition OFF, disconnect the starter relay.
2. Ignition OFF, test for less than 3.0 ohms between the relay ground circuit terminal 85 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify a test lamp illuminates between the relay switch B+ circuit terminal 87 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Ensure the parking brake is applied and the transmission is in PARK. Momentarily install a 40A fused jumper wire between the relay switch B+ circuit terminal 87 and the relay controlled output circuit terminal 30. The starter solenoid should engage and the engine should begin cranking.
   - If the solenoid does not engage, test the relay controlled output circuit for a short to ground or an open/high resistance. If the circuit tests normal, test or replace the starter motor.
5. Connect a test lamp between the relay coil control circuit terminal 86 and the relay coil ground circuit terminal 85.
6. With transmission range selector in park or neutral, cycle the ignition between the OFF and CRANK position. The test lamp should turn ON and OFF when changing between the commanded states.
   - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
   - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the starter relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Starter Replacement**
- **Control Module References** for ECM replacement, setup, and programming.

ENGINE CRANKS SLOWLY

Inspect the following items:

- Battery-Perform the Battery Inspection/Test. Refer to **Battery Inspection/Test**.
- Wiring-Inspect the wiring for damage. Inspect all connections to the starter motor, the solenoid, the battery, and all ground connections. Refer to:
  - **Circuit Testing**
  - **Wiring Repairs**
  - **Testing for Intermittent Conditions and Poor Connections**
  - **Connector Repairs**
- Engine-Verify that the engine is not seized.

If the battery, the wiring, and the engine are functioning properly, and the engine continues to crank slowly, replace the starter motor. Refer to **Starter Replacement**.

STARTER NOISE DIAGNOSIS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The PG starter motors are non-repairable. They have pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the

starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

Reference Information

Description and Operation

Charging System Description and Operation

Circuit/System Verification

Start the engine. Listen to the starter noise while the engine is cranking. Compare the concern to a similar vehicle.

Circuit/System Testing

1. Remove the flywheel inspection cover.
2. Inspect the flywheel for the following:
   - Loose flywheel bolts
   - Chipped gear teeth
   - Missing gear teeth
   - Bent flywheel
   - Debris in the bell housing
   - If not within specifications, remove the debris, tighten the flywheel bolts, or repair or replace the flywheel.
3. If all inspections were within specification, replace the starter motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Engine Flywheel Replacement**
- **Starter Replacement**

REPAIR INSTRUCTIONS

BATTERY NEGATIVE CABLE DISCONNECTION AND CONNECTION

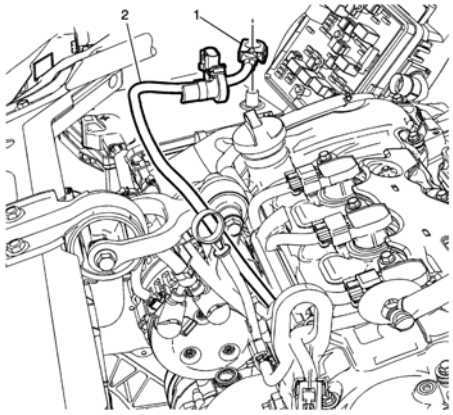


Fig. 3: Battery Negative Cable
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Battery Negative Post Clamp **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 6 N.m (53 lb in)
2	Battery Negative Cable

BATTERY CURRENT SENSOR REPLACEMENT

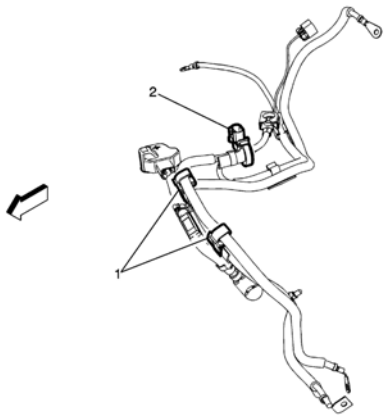


Fig. 4: Battery Current Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the battery positive and negative cable. Refer to **Battery Positive and Negative Cable Replacement**.	
1	Battery Positive and Negative Cable Retainers
2	Battery Current Sensor **Procedure** The battery current sensor is part of the battery positive and negative cable. **NOTE:** **If the battery current sensor needs to be replaced, replace the battery positive and negative cable.**

BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the underhood fuse block cover.

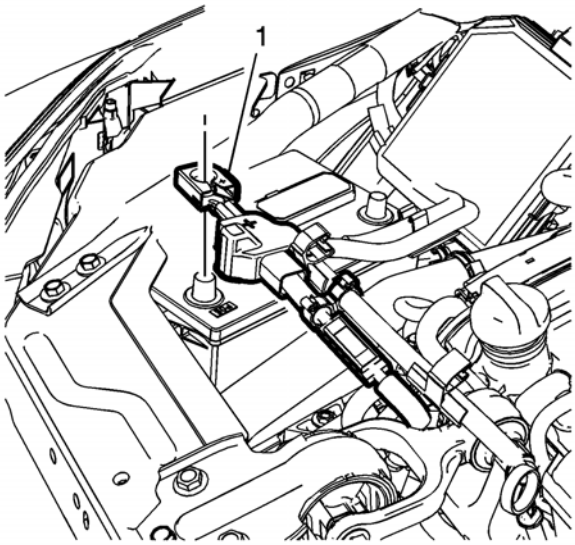


Fig. 5: Battery Positive Clamp
Courtesy of GENERAL MOTORS COMPANY

3. Remove the protective boot on the battery positive cable.
4. Release the battery positive clamp (1) and remove the battery positive cable from the battery post.

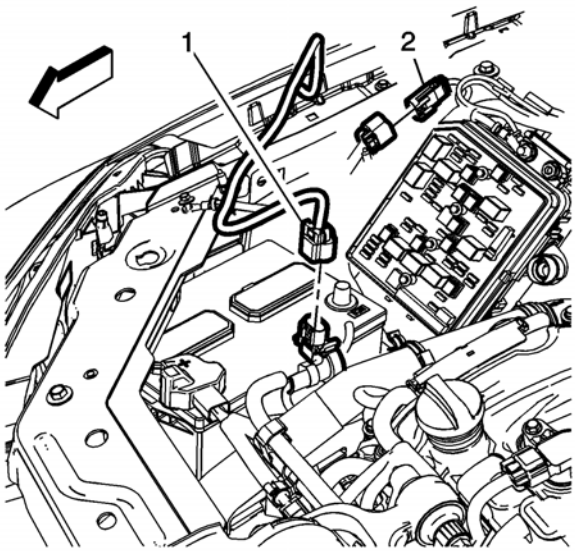


Fig. 6: Battery Current Sensor And Instrument Panel Harness Connector
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the battery current sensor (1) and the instrument panel harness connector (2), from the battery positive and negative cable harness.

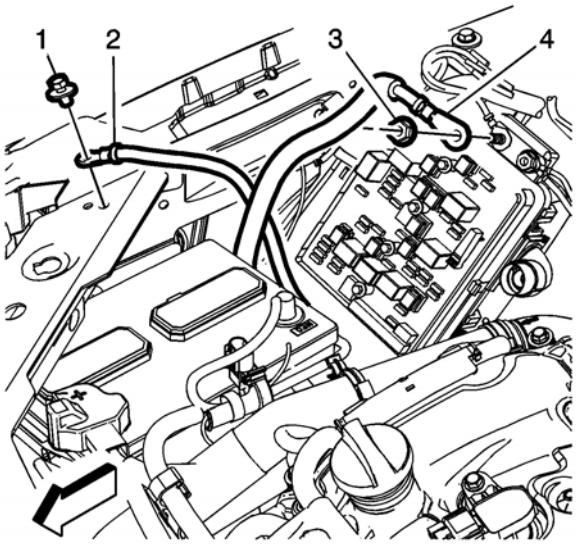


Fig. 7: Battery Negative Cable, Battery Positive Cable And Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Remove the battery negative ground terminal fastener (1) and remove the battery negative cable (2).
7. Remove the battery positive fuse block fastener (3) and remove the battery positive cable (4).

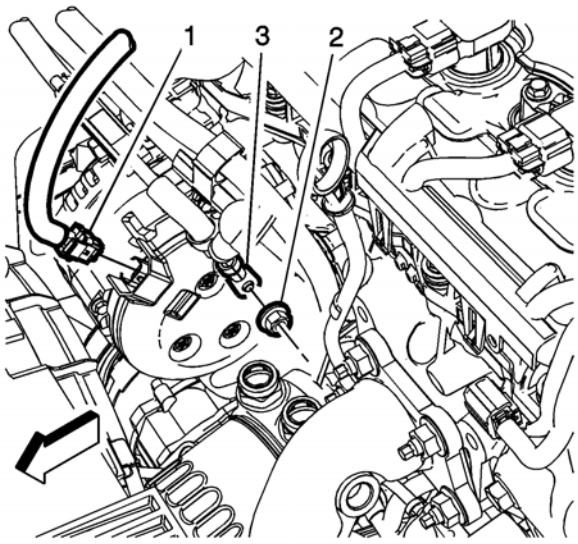


Fig. 8: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Remove the battery positive protective boot from the battery positive terminal at the back of the generator.
9. Remove the battery positive fastener (2) and the battery positive cable (3) from the generator.
10. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
11. Remove the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .

NOTE: **Do not discharge the air conditioning system.**

12. Remove the air conditioning compressor and set aside. Refer to **Air Conditioning Compressor Replacement** .

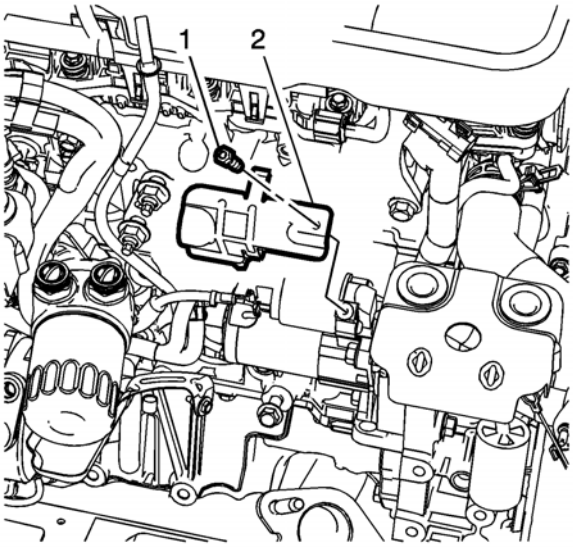


Fig. 9: Starter Heat Shield And Fastener
Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the engine coolant temperature (ECT) sensor connector. Refer to **Engine Coolant Temperature Sensor Replacement** .
14. Remove the starter heat shield fastener (1) and the starter heat shield (2).

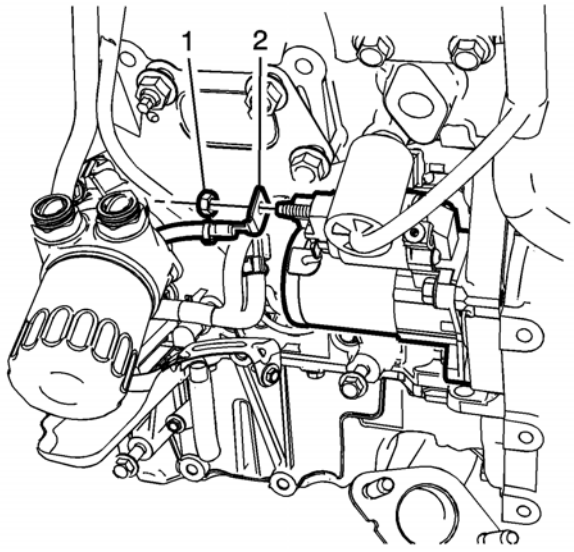


Fig. 10: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

15. Remove the starter battery positive fastener (1) and the battery positive cable (2), from the starter.

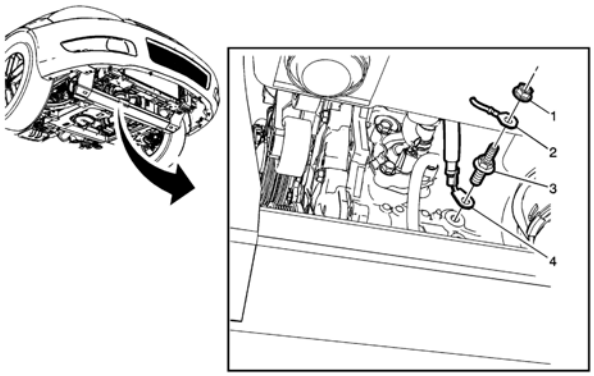


Fig. 11: Battery Negative Cable Terminal, Engine Harness Ground Terminal, Fastener And Stud
Courtesy of GENERAL MOTORS COMPANY

16. Remove the engine harness ground fastener (1) and the engine harness ground terminal (2).
17. Remove the battery negative cable ground stud (3) and the battery negative cable terminal (4) from the engine block.

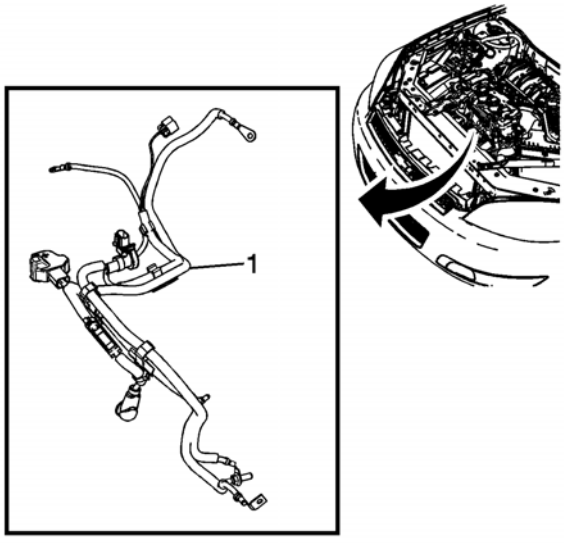


Fig. 12: Battery Positive And Negative Cable
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Observe how the battery positive and negative cable was routed within the engine compartment.**

18. Remove the battery positive and negative cable (1) from the vehicle.

Installation Procedure

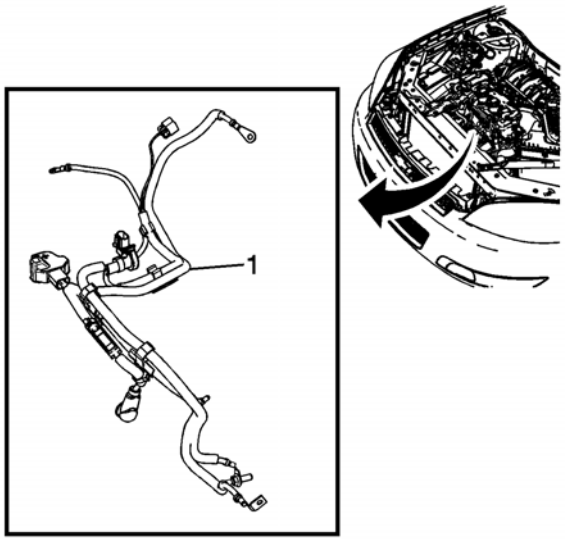


Fig. 13: Battery Positive And Negative Cable
Courtesy of GENERAL MOTORS COMPANY

1. Route the battery positive and negative cable (1) into the front engine compartment.

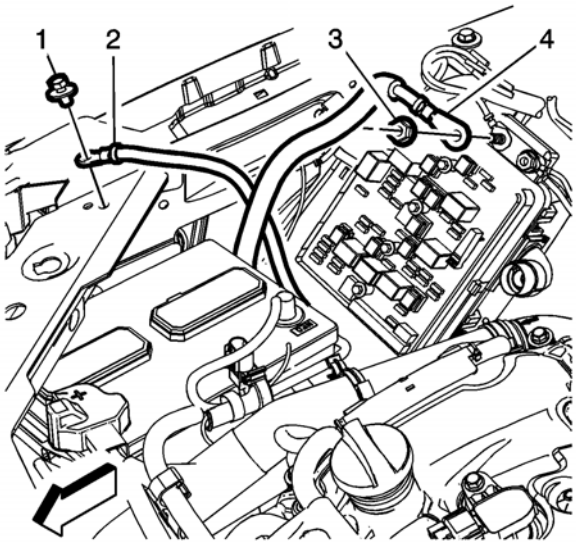


Fig. 14: Battery Negative Cable, Battery Positive Cable And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install the battery negative cable ground terminal (2) to the upper tie bar and tighten the fastener (1) to 10 N.m (89 lb in).
3. Install the battery positive cable terminal (4) to the underhood fuse block stud (1) and tighten the fastener (3) to 15 N.m (11 lb ft).
4. Install the underhood fuse block cover.

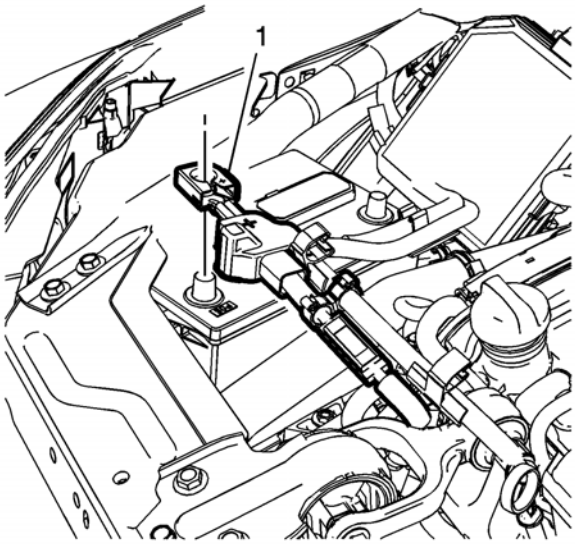


Fig. 15: Battery Positive Clamp
Courtesy of GENERAL MOTORS COMPANY

5. Connect the battery positive cable clamp (1) to the battery post and reinstall the protective boot.

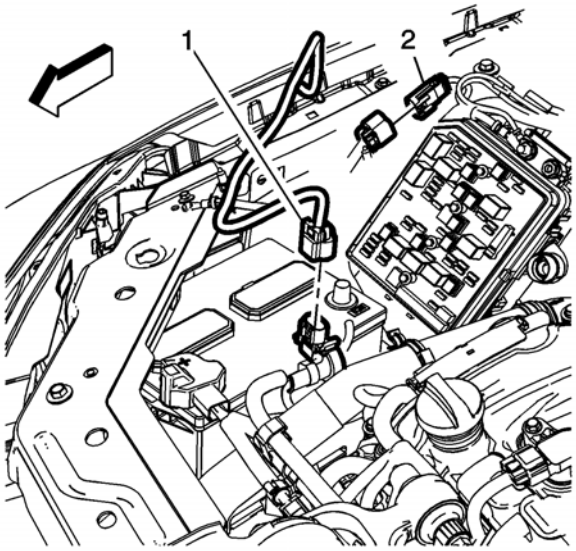


Fig. 16: Battery Current Sensor And Instrument Panel Harness Connector
Courtesy of GENERAL MOTORS COMPANY

6. Connect the battery current sensor connector (1) and the instrument panel harness connector (2).

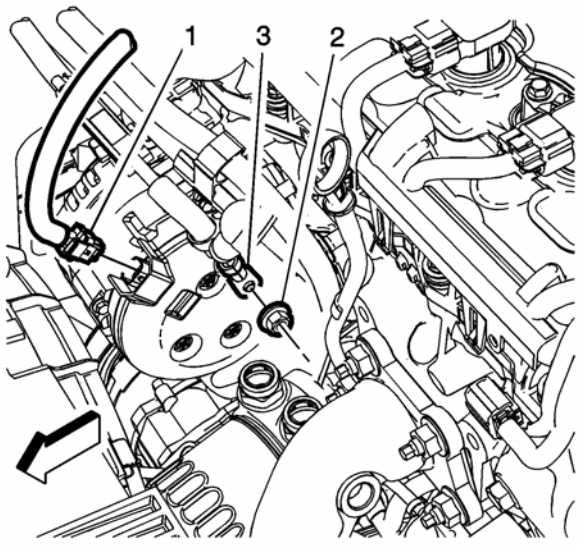


Fig. 17: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Install the battery positive terminal (3) to the back of the generator and tighten the fastener (2) to 20 N.m (15 lb ft).
8. Install the protective boot onto the generator stud.

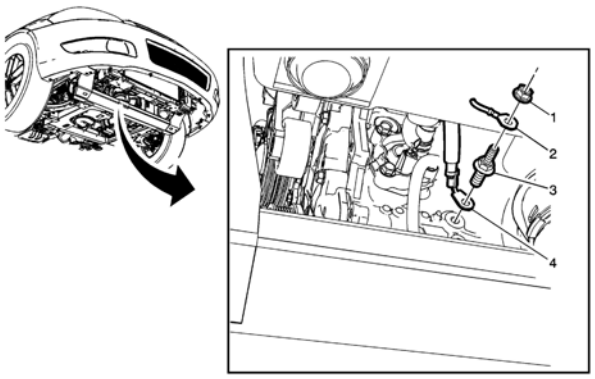


Fig. 18: Battery Negative Cable Terminal, Engine Harness Ground Terminal, Fastener And Stud
Courtesy of GENERAL MOTORS COMPANY

9. Install the battery negative cable terminal (4) and the stud (3) to the engine block. Tighten the stud (3) to 50 N.m (37 lb ft).
10. Install the engine harness terminal (2) to the stud (3) and tighten the fastener (1) to 20 N.m (15 lb ft).

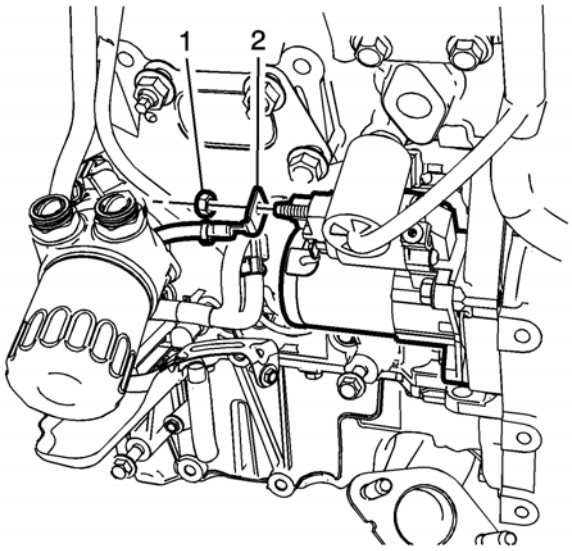


Fig. 19: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

11. Install the battery positive terminal (2) to the starter and tighten the fastener (1) to 10 N.m (89 lb in).

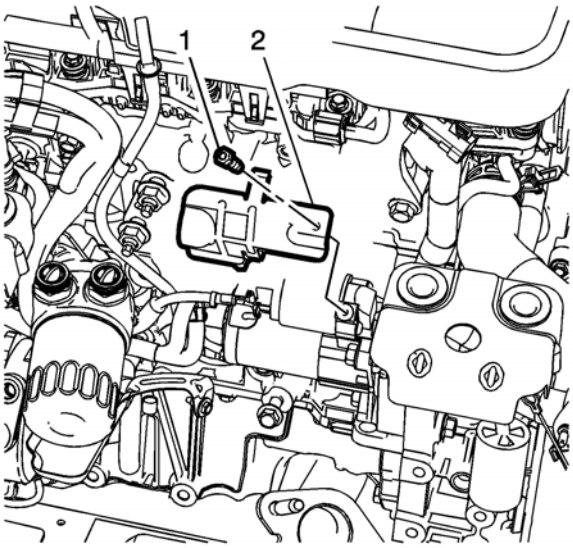


Fig. 20: Starter Heat Shield And Fastener
Courtesy of GENERAL MOTORS COMPANY

12. Install the starter heat shield (2) and tighten the fastener (1) to 5 N.m (44 lb in).
13. Connect the engine coolant temperature (ECT) sensor.
14. Install the air conditioning compressor. Refer to **Air Conditioning Compressor Replacement** .
15. Install the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
16. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the accessory wiring junction block. Refer to **Accessory Wiring Junction Block Replacement** .
3. Remove the right front diagonal brace. Refer to **Front Fender Upper Diagonal Brace Replacement** .

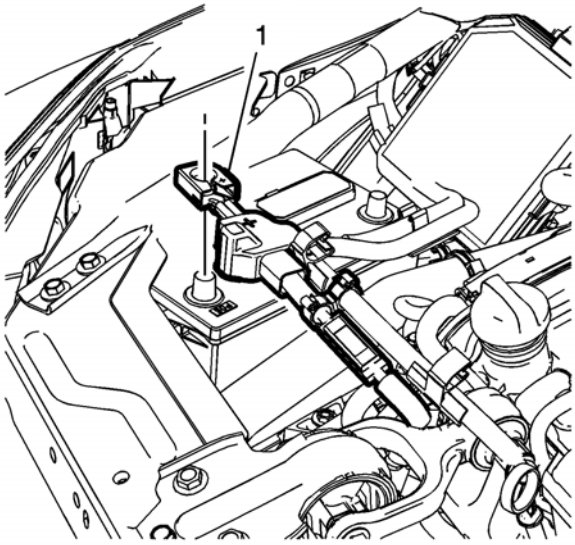


Fig. 21: Battery Positive Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Open the positive battery cable terminal cover and release the positive cable clamp (1).
5. Remove the positive battery cable from the battery.

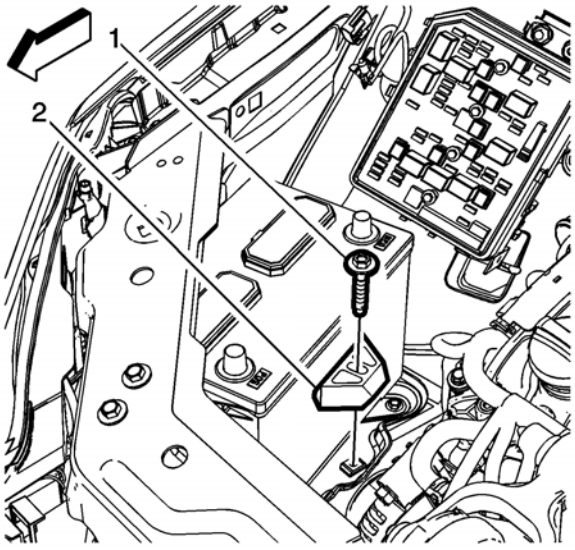


Fig. 22: Retainer And Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Remove the battery hold down fastener (1) and hold down retainer (2).

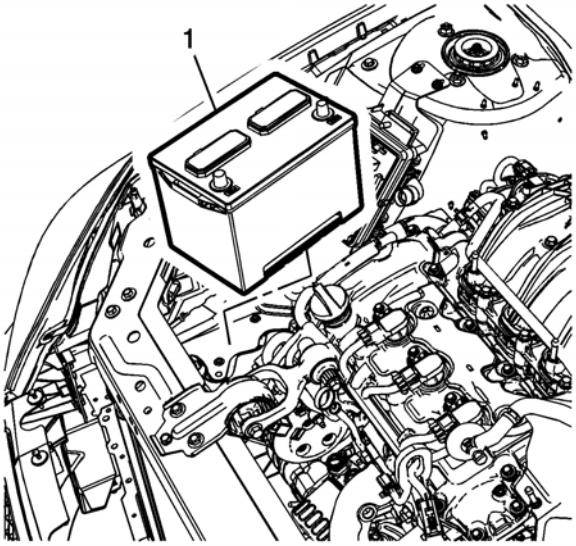


Fig. 23: Battery
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not tip the battery more than 40 degrees during removal.**

7. Remove the battery (1).

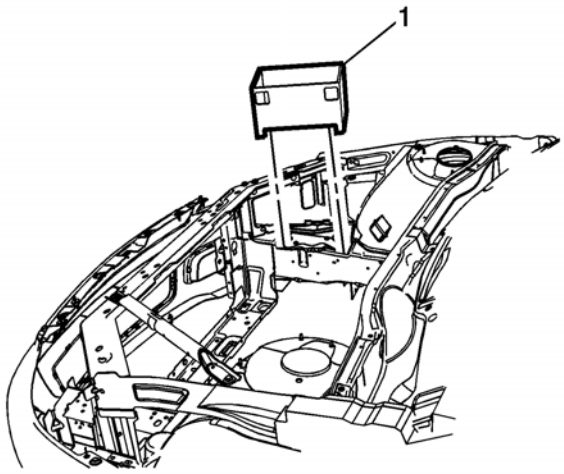


Fig. 24: Battery Insulator
Courtesy of GENERAL MOTORS COMPANY

8. Remove the battery insulator.

Installation Procedure

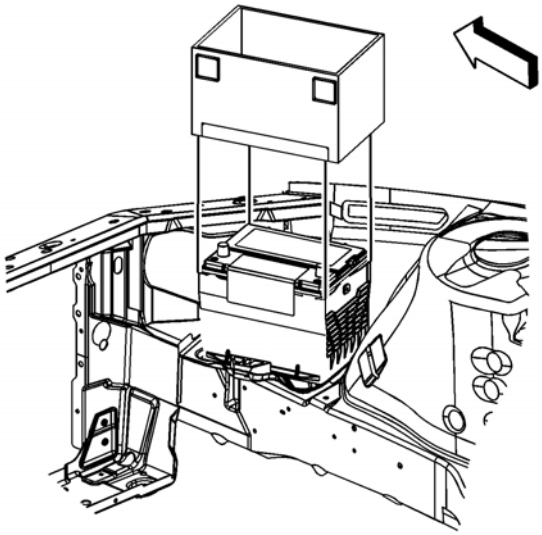


Fig. 25: View Of Battery Insulator
Courtesy of GENERAL MOTORS COMPANY

1. Install the battery insulator.

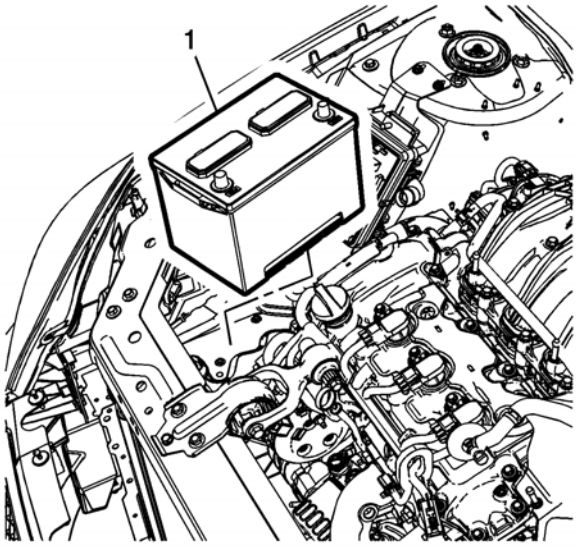


Fig. 26: Battery
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not tip the battery more than 40 degrees during installation.**

2. Install the battery (1).

CAUTION: **Refer to Fastener Caution .**

3. Install the battery hold down retainer and tighten the fastener to 18 N.m (13 lb ft).

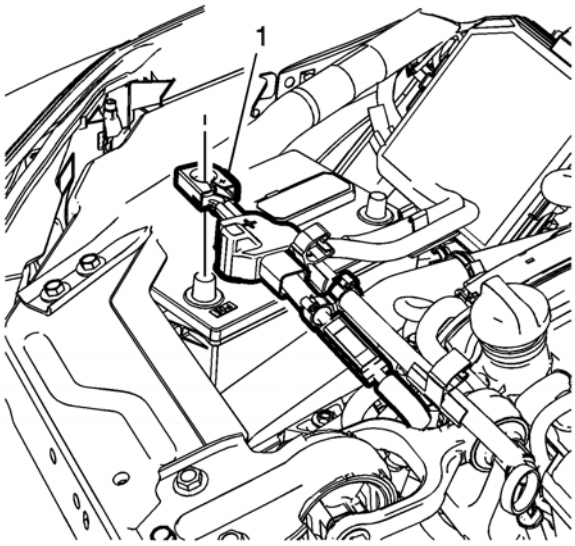


Fig. 27: Battery Positive Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Install the positive battery cable clamp (1) to the battery positive post and tighten to 10 N.m (89 lb in).
5. Install the battery positive cover.
6. Install the accessory wiring junction block. Refer to **Accessory Wiring Junction Block Replacement** .
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
8. Install the right front diagonal brace. Refer to **Front Fender Upper Diagonal Brace Replacement** .

BATTERY TRAY REPLACEMENT

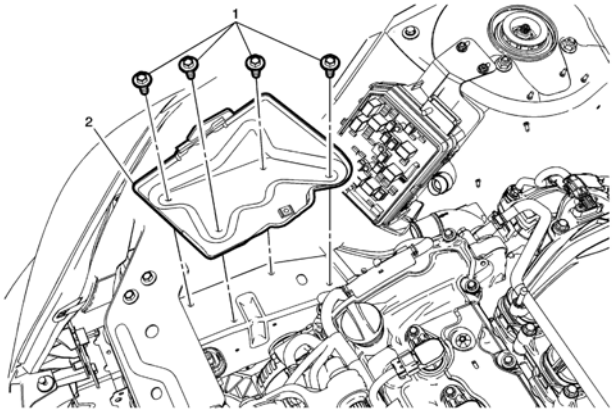


Fig. 28: Battery Tray & Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the battery.Refer to Battery Replacement	
1	Bolt (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 5 N.m (44 lb in).
2	Battery Tray **TIP:** Unclip the harness retainers from the battery tray.

STARTER REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
4. Lower the vehicle.

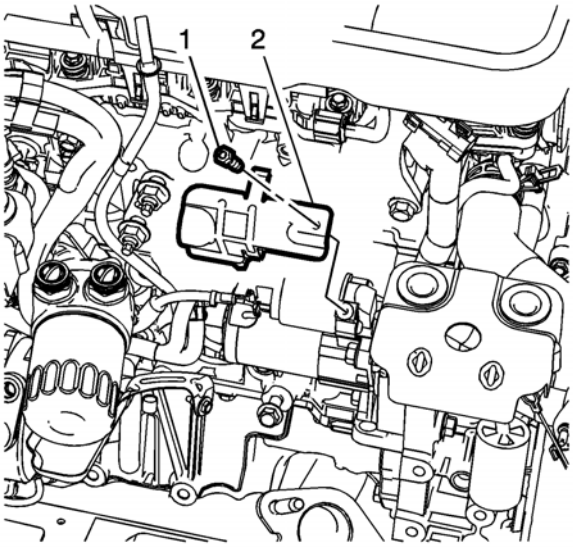


Fig. 29: Starter Heat Shield And Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine coolant temperature sensor connector. Refer to **Engine Coolant Temperature Sensor Replacement** .
6. Remove the bank 2 knock sensor. Refer to **Knock Sensor Replacement - Bank 2** .
7. Remove the starter heat shield fastener (1) and the starter heat shield (2).

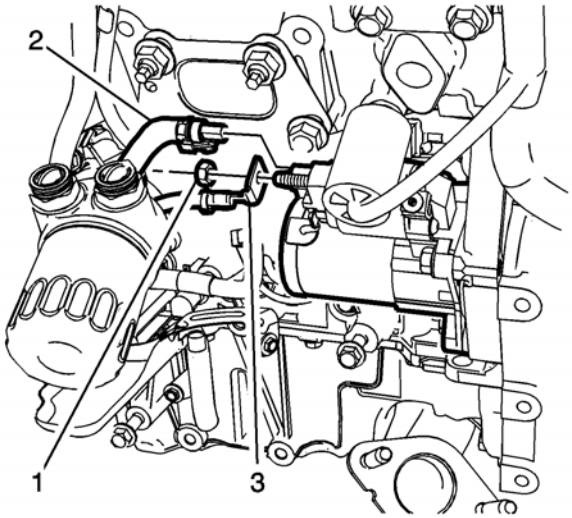


Fig. 30: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the battery positive cable fastener (1), from the starter.
9. Remove the battery positive cable (3) from the starter.

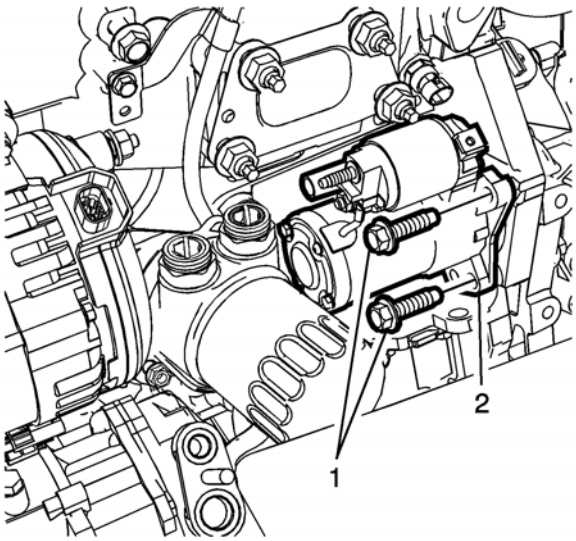


Fig. 31: Starter And Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Remove the top starter mounting fastener (1) and reposition the starter.
11. Disconnect the engine harness connector and remove the lower starter fastener (1).
12. Remove the starter (2).

Installation Procedure

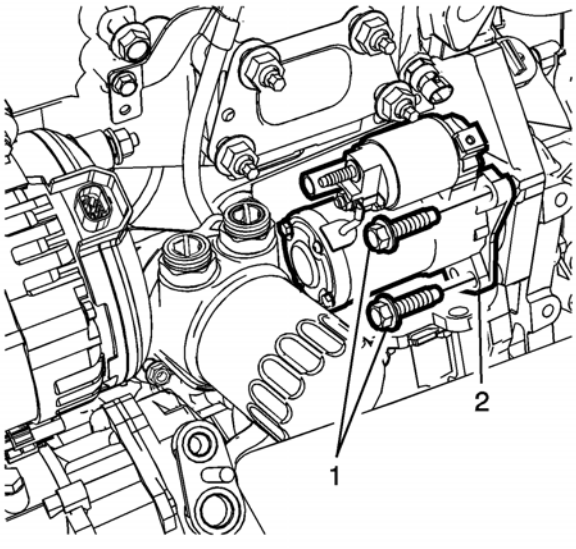


Fig. 32: Starter And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Position the starter (2), connect the engine harness connector and loosely install the top fastener (1).
2. Install the bank 2 knock sensor. Refer to **Knock Sensor Replacement - Bank 2** .

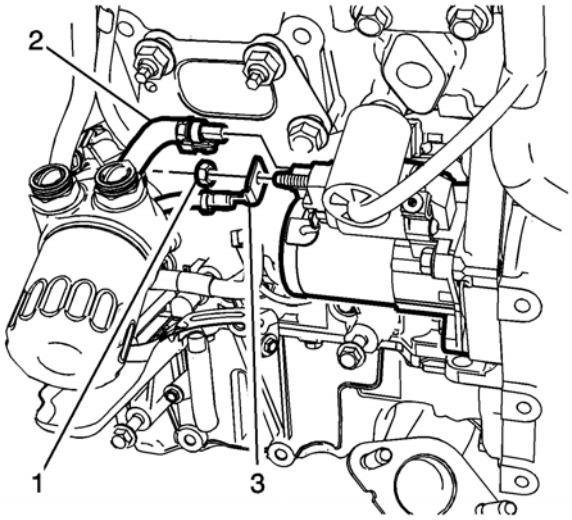


Fig. 33: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Install the battery positive cable terminal (3) to the starter.
4. Tighten the battery positive cable fastener (1) to 10 N.m (89 lb in).
5. Raise the vehicle.

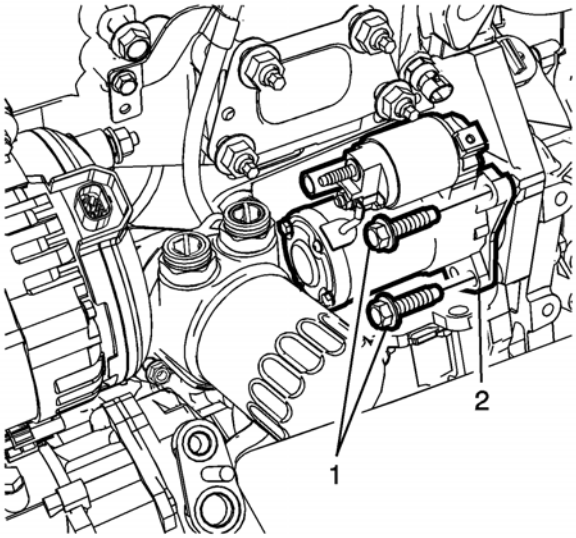


Fig. 34: Starter And Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Install the lower starter fastener (1) and tighten to 58 N.m (43 lb ft).
7. Lower the vehicle.
8. Tighten the upper starter fastener (1) to 58 N.m (43 lb ft).

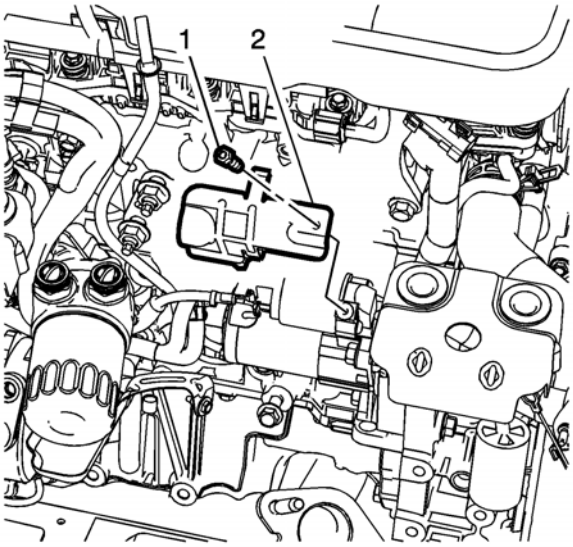


Fig. 35: Starter Heat Shield And Fastener
Courtesy of GENERAL MOTORS COMPANY

9. Install the starter heat shield (2) and tighten the starter heat shield fastener (1) to 5 N.m (44 lb in).
10. Install the engine coolant temperature sensor connector. Refer to **Engine Coolant Temperature Sensor Replacement** .
11. Install the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
12. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

GENERATOR REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement** .
3. Remove the right engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side** .

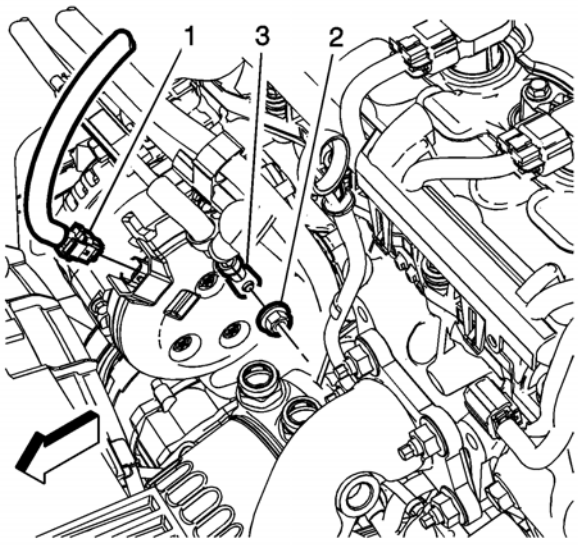


Fig. 36: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the engine harness connector (1) and remove the battery positive fastener (2).
5. Remove the battery positive cable (3).

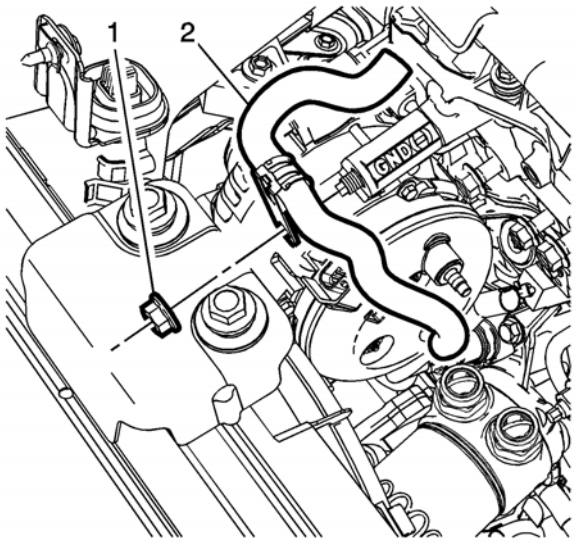


Fig. 37: Engine Harness And Generator Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Remove the generator fastener (1) and the engine harness (2), from the generator.

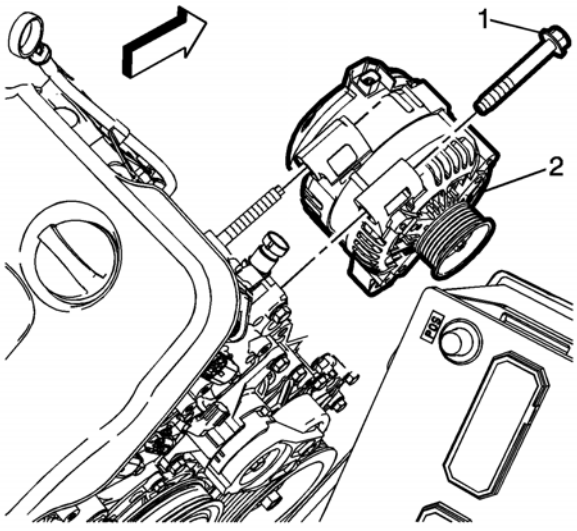


Fig. 38: Generator And Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Remove the generator mounting fastener (1) and remove the generator (2).

Installation Procedure

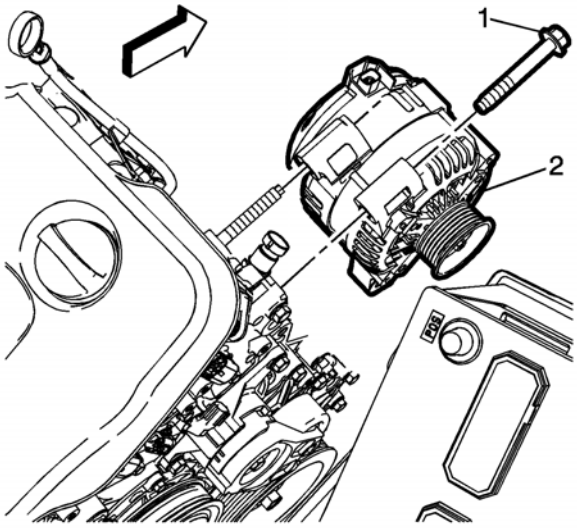


Fig. 39: Generator And Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the generator (2) and tighten the fastener (1) to 58 N.m (43 lb ft).

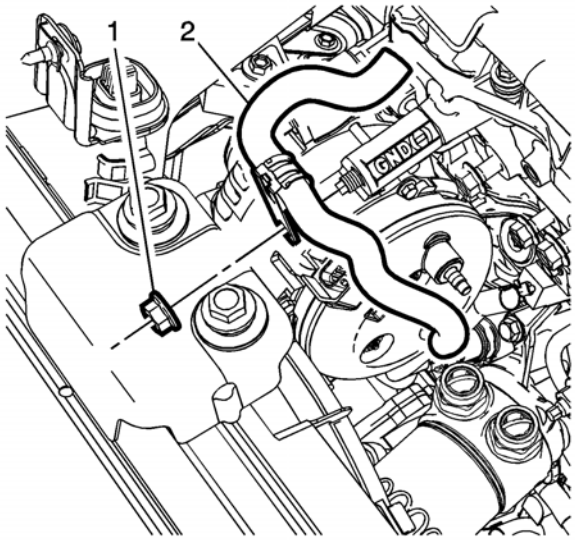


Fig. 40: Engine Harness And Generator Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Install the engine harness (2) to the generator mounting stud and tighten the fastener (1) to 58 N.m (43 lb ft).

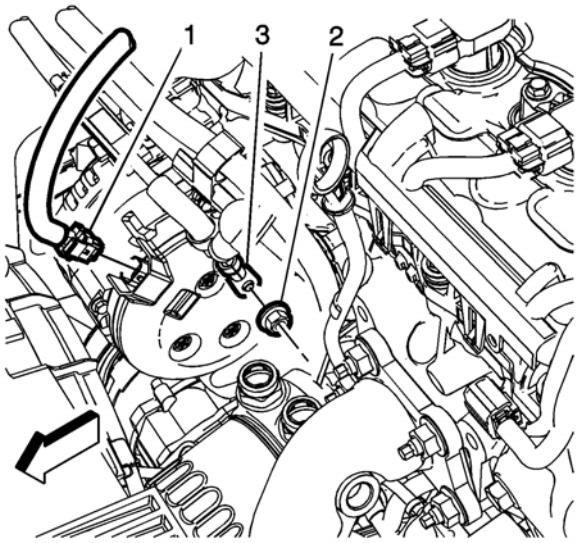


Fig. 41: Battery Positive Cable And Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Connect the engine harness connector (1) to the generator and install the battery positive terminal (3) to the generator stud. Tighten the fastener (2) to 20 N.m (15 lb ft).
4. Install the right engine mount strut. Refer to **Engine Mount Strut Replacement - Right Side** .
5. Install the drive belt idler pulley. Refer to **Drive Belt Idler Pulley Replacement** .
6. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

WARNING: Batteries produce explosive gases, contain corrosive acid, and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:

- **Always shield your eyes and avoid leaning over the battery whenever possible.**
- **Do not expose the battery to open flames or sparks.**
- **Do not allow the battery electrolyte to contact the eyes or the skin. Flush immediately and thoroughly any contacted areas with water and get medical help.**
- **Follow each step of the jump starting procedure in order.**
- **Treat both the booster and the discharged batteries carefully when using the jumper cables.**

Batteries that are no longer wanted must be disposed of by an approved battery recycler and must never be thrown in the trash or sent to a landfill.

Batteries that are not part of the vehicle itself, not the battery under the hood, must only be transported on public streets for business purposes via approved hazardous material transportation procedures.

Battery storage, charging and testing facilities in repair shops must meet various requirements for ventilation, safety equipment, material segregation, etc.

The maintenance free battery is standard. There are no vent plugs in the cover. The battery is completely sealed except for 2 small vent holes in the side. These vent holes allow the small amount of gas that is produced in the battery to escape.

The battery has 3 functions as a major source of energy:

- Engine cranking
- Voltage stabilizer
- Alternate source of energy with generator overload

Battery Low Start Vehicle Message

The body control module (BCM) monitors battery positive voltage to determine battery state of charge. If one or more of the BCM battery positive voltage terminals measure less than approximately 11.6V compared to the BCM ground circuits, this message will display and four chimes may sound. Start the vehicle immediately. If the vehicle is not started and the battery continues to discharge, the climate controls, heated seats, and audio systems will shut off and the vehicle may require a jump start. These systems will function again after the vehicle is started.

Battery Ratings

A battery has 2 ratings:

- Cold cranking amperage
- Amperage hours

When a battery is replaced use a battery with similar ratings. See battery specification label on the original battery.

Amperage Hours

The amperage hour rating tells you how much amperage is available when discharged evenly over a 20 hour period. The amperage hour rating is cumulative, so in order to know how many constant amperage the battery will output for 20 h, you have to divide the amperage hour rating by 20. Example: If a battery has an amperage hour rating of 74, dividing by 20 = 3.75. Such a battery can carry a 3.75 A load for 20 hours before dropping to 10.5 V. (10.5 V is the fully discharged level, at which point the battery needs to be recharged.) A battery with an amperage hour rating of 55 will carry a 2.75 A load for 20 hours before dropping to 10.5 V.

Cold Cranking Amperage

The cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. The cold cranking amperage rating is the minimum amperage the battery must maintain for 30 seconds at -18Â°C (0Â°F) while maintaining at least 7.2 V. See battery label for the cold cranking amperage rating of this battery.

CHARGING SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management Overview

The electrical power management system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems with the battery and generator. This electrical power management system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life, and minimize the system's impact on fuel economy. The electrical power management system performs 3 functions:

- It monitors the battery voltage and estimates the battery condition.
- It takes corrective actions by boosting idle speeds, and adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during ignition-off and during ignition-on. During ignition-off the state-of-charge of the battery is determined by measuring the open-circuit voltage. The state-of-charge is a function of the acid concentration and the internal resistance of the battery, and is estimated by reading the battery open circuit voltage when the battery has been at rest for several hours.

The state-of-charge can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates state-of-charge based on adjusted net amp hours, battery capacity, initial state-of-charge, and temperature.

While running, the battery degree of discharge is primarily determined by a battery current sensor, which is integrated to obtain net amp hours.

In addition, the electrical power management function is designed to perform regulated voltage control to improve battery state-of-charge, battery life, and fuel economy. This is accomplished by using knowledge of the battery state-of-charge and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

The Charging System Description and Operation is divided into 3 sections. The first section describes the charging system components and their integration into the electrical power management. The second section describes charging system operation. The third section describes the instrument panel cluster operation of the charge indicator, driver information center messages, and voltmeter operation.

Charging System Components

Generator

The generator is a serviceable component. If there is a diagnosed failure of the generator it must be replaced as an assembly. The engine drive belt drives the generator. When the rotor is spun it induces an alternating current (AC) into the stator windings. The AC voltage is then sent through a series of diodes for rectification. The rectified voltage has been converted into a direct current (DC) for use by the vehicles electrical system to maintain electrical loads and the battery charge. The voltage regulator integral to the generator controls the output of the generator. It is not serviceable. The voltage regulator controls the amount of current provided to the rotor. If the generator has field control circuit failure, the generator defaults to an output voltage of 13.8 V.

Body Control Module (BCM)

The body control module (BCM) is a GMLAN device. It communicates with the engine control module (ECM) and the instrument panel cluster for electrical power management (electrical power management) operation. The BCM determines the output of the generator and sends the information to the ECM for control of the generator turn on signal circuit. It monitors the generator field duty cycle signal circuit information sent from the ECM for control of the generator. It monitors a battery current sensor, the battery positive voltage circuit, and estimated battery temperature to determine battery state of charge. The BCM performs idle boost.

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to either the negative or positive battery cable at the battery. The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the BCM. It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Engine Control Module (ECM)

When the engine is running, the generator turn-on signal is sent to the generator from the ECM, turning on the regulator. The generator's voltage regulator controls current to the rotor, thereby controlling the output voltage. The rotor current is proportional to the electrical pulse width supplied by the regulator. When the engine is started, the regulator senses generator rotation by detecting AC voltage at the stator through an internal wire. Once the engine is running, the regulator varies the field current by controlling the pulse width. This regulates the generator output voltage for proper battery charging and electrical system operation. The generator field duty terminal is connected internally to the voltage regulator and externally to the ECM. When the voltage regulator detects a charging system problem, it grounds this circuit to signal the ECM that a problem exists. The ECM monitors the generator field duty cycle signal circuit, and receives control decisions based on information from the BCM.

Instrument Panel Cluster

The instrument panel cluster provides the customer notification in case a concern with the charging system. There are 2 means of notification, a charge indicator and a driver information center message of SERVICE BATTERY CHARGING SYSTEM if equipped.

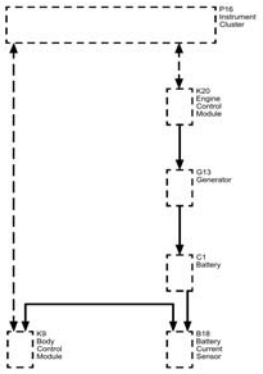


Fig. 42: Charging System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DB	Serial Data - GMLAN Low Speed
DB	Serial Data - GMLAN Low Speed
P16	P16 Instrument Cluster
K20	K20 Engine Control Module
G13	G13 Generator
C1	C1 Battery
B18	B18 Battery Current Sensor
K9	K9 Body Control Module

Charging System Operation

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 6 modes of operation and they include:

- Battery Sulfation Mode
- Charge Mode
- Fuel Economy Mode
- Headlamp Mode
- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the generator through the generator turn ON signal circuit. The ECM monitors the generator performance though the generator field duty cycle signal circuit. The signal is a pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes. The following table shows the commanded duty cycle and output voltage of the generator:

Commanded Duty Cycle	Generator Output Voltage
10%	11 V
20%	11.56 V
30%	12.12 V
40%	12.68 V
50%	13.25 V
60%	13.81 V
70%	14.37 V
80%	14.94 V
90%	15.5 V

The generator provides a feedback signal of the generator voltage output through the generator field duty cycle signal circuit to the ECM. This information is sent to the body control module (BCM). The signal is PWM signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-99 percent. Between 0-5 percent and 100 percent are for diagnostic purposes.

Battery Sulfation Mode

The BCM will enter this mode when the interpreted generator output voltage is less than 13.2 V for 45 minutes. When this condition exists the BCM will enter Charge Mode for 2-3 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

Charge Mode

The BCM will enter Charge Mode when ever one of the following conditions are met.

- The wipers are ON for more than 3 seconds.
- GMLAN (Climate Control Voltage Boost Mode Request) is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0Â°C (32Â°F).
- Battery State of Charge is less than 80 percent.
- Vehicle speed is greater than 145 km/h (90 mph)
- Current sensor fault exists.
- System voltage was determined to be below 12.56 V

When any one of these conditions is met, the system will set targeted generator output voltage to a charging voltage between 13.9-15.5 V, depending on the battery state of charge and estimated battery temperature.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the estimated battery temperature is at least 0Â°C (32Â°F) but less than or equal to 80Â°C (176Â°F), the calculated battery current is less than 15 amperes and greater than -8 amperes, and the battery state-of-charge is greater than or equal to 80 percent. Its targeted generator output voltage is the open circuit voltage of the battery and can be between 12.5-13.1 V. The

BCM will exit this mode and enter Charge Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp Mode when ever the headlamps are ON (high or low beams). Voltage will be regulated between 13.9-14.5 V.

Start Up Mode

When the engine is started the BCM sets a targeted generator output voltage of 14.5 V for 30 seconds.

Voltage Reduction Mode

The BCM will enter Voltage Reduction Mode when the calculated ambient air temperature is above 0Â°C (32Â°F). The calculated battery current is less than 1 ampere and greater than -7 amperes, and the generator field duty cycle is less than 99 percent. Its targeted generator output voltage is 12.9 V. The BCM will exit this mode once the criteria are met for Charge Mode.

Instrument Panel Cluster Operation

Charge Indicator Operation

The instrument panel cluster illuminates the charge indicator and displays a warning message in the driver information center if equipped, when the one or more of the following occurs:

- The engine control module (ECM) detects that the generator output is less than 11 V or greater than 16 V. The instrument panel cluster receives a GMLAN message from the ECM requesting illumination.
- The instrument panel cluster determines that the system voltage is less than 11 V or greater than 16 V for more than 30 seconds. The instrument panel cluster receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.
- The instrument panel cluster performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

Display Message: BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM

The BCM and the ECM will send a serial data message to the driver information center for the BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

Electrical Power Management

The electrical power management is used to monitor and control the charging system and alert the driver of possible problems within the charging system. The electrical power management system makes the most efficient use of the generator output, improves the battery state-of-charge, extends battery life, and manages system electrical loads.

The load shed operation is a means of reducing electrical loads during a low voltage or low battery state-of-charge condition.

The idle boost operation is a means of improving generator performance during a low voltage or low battery state-of-charge condition.

Each electrical power management function, either idle boost or load shed, is activated in incremental steps. For example, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate electrical power management are outlined below:

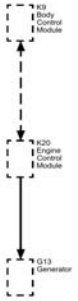


Fig. 43: Electrical Power Management Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DD	Serial Data - GMLAN High Speed
K9	K9 Body Control Module
K20	K20 Engine Control Module
G13	G13 Generator

Idle Boost and Load Shed With Current Sensor

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15Â°C (5Â°F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 Ah	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 11 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -10Â°C (14Â°F)	Greater Than 12 V	Battery has a net loss less than 0.2 Ah	First level Idle boost request cancelled
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 Ah	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 11 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 Ah	Second level Idle boost request cancelled
Load Shed 1 Start	-	-	Battery has a net loss of 4 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Load Shed 1 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12 V	Battery has a net loss of less than 2 Ah	Clear Load Shed 1
Idle Boost 3 Start	-	-	Battery has a net loss of 10 Ah	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 11 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6.0 Ah	Third level Idle boost request cancelled
Load Shed 2 Start	-	-	Battery has a net loss greater than 12 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12 V	Battery has a net loss of less than 8 Ah	Clear Load Shed 2
Load Shed 3 Start	-	Less Than 11.9 V	Battery has a net loss greater than 20 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.6 V	Battery has a net loss of less than 13 Ah	Clear Load Shed 3

Idle Boost and Load Shed Without Current Sensor (based on battery voltage)

Function	Battery Temperature Calculation	Battery Voltage Calculation	Action Taken
Idle Boost 1 Start	Less Than -15Â°C (5Â°F)	Less Than 13 V	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 12.6 V	First level Idle boost requested
Idle Boost 1 End	Greater Than -15Â°C (5Â°F)	-	First level Idle boost request cancelled
Idle Boost 1 End	-	Greater Than 13 V	First level Idle boost request cancelled
Idle Boost 2 Start	-	Less Than 12.4 V	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12.5 V	Second level Idle boost request cancelled
Load Shed 1 Start	-	Less Than 12.3 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12.4 V	Clear Load Shed 1
Idle Boost 3 Start	-	Less Than 10 V	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12.3 V	Third level Idle boost request cancelled
Load Shed 2 Start	-	Less Than 12.1 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12.2 V	Clear Load Shed 2
Load Shed 3 Start	-	Less Than 11.9 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.0 V	Clear Load Shed 3

STARTING SYSTEM DESCRIPTION AND OPERATION

The starter motors are non-repairable starter motors. They have pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened.

When the ignition switch is released from the START position, the START relay opens and battery voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, causes the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter circuit is turned off.

Circuit Description (Key Start)

When the ignition switch is placed in the Start position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the Start position. The BCM then sends a message to the engine control module (ECM) notifying it that CRANK has been requested. The ECM verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 V to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

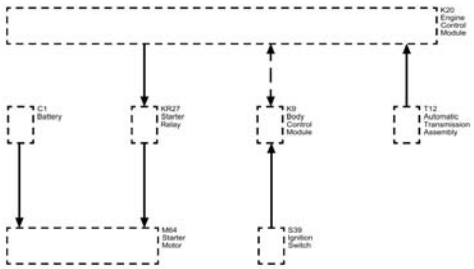


Fig. 44: Starting System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DD	Serial Data - GMLAN High Speed
K20	K20 Engine Control Module
C1	C1 Battery
KR27	KR27 Starter Relay
K9	K9 Body Control Module
T12	T12 Automatic Transmission Assembly
M64	M64 Starter Motor
S39	S39 Ignition Switch

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

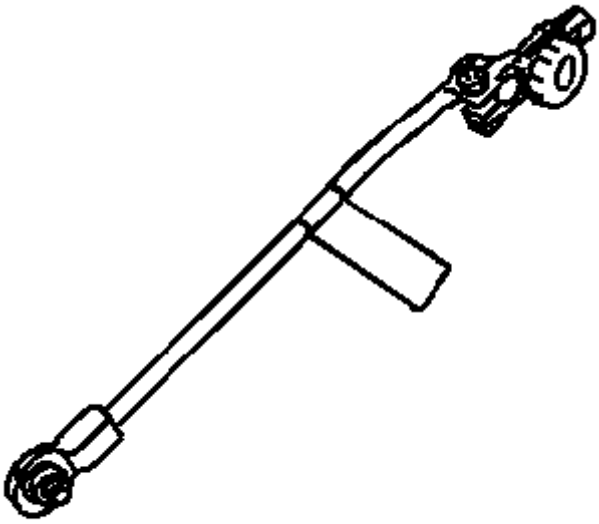
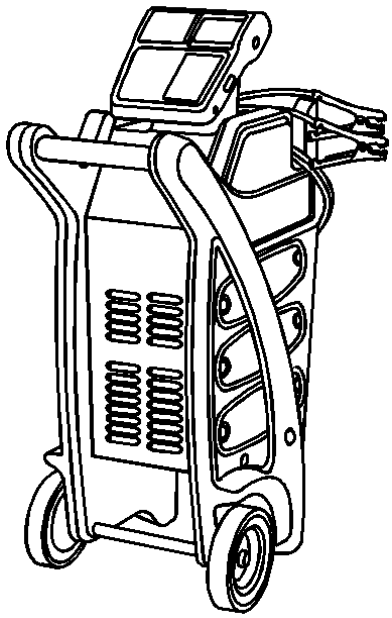
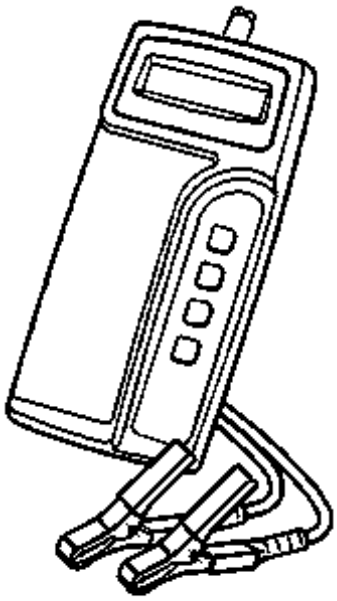
Illustration	Tool Number/Description
	EL 38758 EL 50074 J 38758 Parasitic Draw Test Switch

Illustration	Tool Number/Description
 	BC 800 W BC 800 WP EL 50313 EL 42000 EL 50076 J 42000 Battery Tester

Article GUID: A00737176

GENERAL INFORMATION

Anti-Lock Brake Safety Precautions

* PLEASE READ THIS FIRST *

This article is intended for general information purposes only. This information may not apply to all makes and models. If vehicle is equipped with Anti-Lock Brake System (ABS), refer to appropriate ANTI-LOCK BRAKE SYSTEM article in the BRAKES section for description, operation, depressurizing, testing, system bleeding, trouble shooting and servicing of specific system.

ANTI-LOCK BRAKE SAFETY PRECAUTIONS

WARNING: Failure to depressurize ABS could lead to physical injury.

- NEVER open a bleeder valve or loosen a hydraulic line while ABS is pressurized.
- NEVER disconnect or reconnect any electrical connectors while ignition is on. Damage to ABS control unit may result.
- **DO NOT** attempt to bleed hydraulic system without first referring to the appropriate ANTI-LOCK BRAKE SYSTEM article in the BRAKES section.
- Only use specially designed brake hoses/lines on ABS equipped vehicles.
- **DO NOT** tap on speed sensor components (sensor, sensor rings). Sensor rings must be pressed into hubs, NOT hammered into hubs. Striking these components can cause demagnetization or a loss of polarization, affecting the accuracy of the speed signal returning to the ABS control unit.
- **DO NOT** mix tire sizes. Increasing the width, as long as tires remain close to the original diameter, is acceptable. Rolling diameter must be identical for all 4 tires. Some manufacturers recommend tires of the same brand, style and type. Failure to follow this precaution may cause inaccurate wheel speed readings.
- **DO NOT** contaminate speed sensor components with grease. Only use recommended coating, when system calls for an anti-corrosion coating.
- When speed sensor components have been removed, ALWAYS check sensor-to-ring air gaps when applicable. These specifications can be found in each appropriate article.
- ONLY use recommended brake fluids. **DO NOT** use silicone brake fluids in an ABS equipped vehicle.
- When installing transmission devices (CB's, telephones, etc.) on ABS equipped vehicles, **DO NOT** locate the antenna near the ABS control unit (or any control unit).
- Disconnect all on-board computers, when using electric welding equipment.
- **DO NOT** expose the ABS control unit to prolonged periods of high heat (185 Â°F/85Â°C for 2 hours is generally considered a maximum limit).

Article GUID: A00044069

ATEQ TPMS RESET PROCEDURE (WITH RPO UH3)

GM - Procedure 09

ATEQ TPMS RESET PROCEDURE (WITH RPO UH3)

NOTE: **Unless otherwise stated, on most tire pressure sensor equipped vehicles, low tire pressure indicator lights and messages can be cleared by inflating tires to the specified pressure and driving at least 25 mph or more for a few minutes. A sensor activation tool (TPMS3) can be used in place of driving.**

NOTE: **If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.**

NOTE: **When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPMS. See appropriate manufacturer service information.**

NOTE: **The TPMS will cancel the learn mode if more then 2 minutes have passed and no sensors have been learned, or if the ignition switch is turn to the LOCK/OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.**

NOTE: **Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.**

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition switch to ON/RUN position. Apply parking brake.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the Learn Mode has been enabled.
4. Starting with left front tire, hold the TPMS3 against the side wall of the tire, within 3 inches of the valve stem. Press TEST button on the TPMS3 until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to LOCK/OFF position to exit Learn Mode.

BARTEC TPMS RESET PROCEDURE

Preferred Method: OBD

(Tech400SD/500/PRO Series ONLY)

1. Inflate tires to placard.
2. Following on tool prompts, read all sensor IDs using tool.
3. Following on tool prompts, connect tool to OBDII port. Tool will prompt you to ensure the key is ON/engine OFF.
4. Continue to follow the tool prompts until the tool indicates relearn is successful.

NOTE: **Vehicle may need to be driven to refresh pressure reading on the dash.**

Alternate Method: Stationary

1. Set parking brake.
2. Turn ignition to ON/RUN.
3. Press the MENU button until "VEHICLE INFORMATION MENU" is displayed.
4. Once you are in the VEHICLE INFORMATION MENU, navigate till DIC displays the vehicle's tire inflation pressures and positions.
5. Press the SET/CLR button.
6. Highlight YES.

NOTE: **If above not in menu, use RKE and press lock and unlock button down until horn chrips.**

7. Activate the left front sensor. Once the sensor has been activated, the horn will chirp. Repeat procedure: RF, RR, LR. Horn should chirp twice.

NOTE: **Refer to TIA chart for more info.**

Article GUID: A00860051

GENERAL INFORMATION

Clutch Trouble Shooting

* PLEASE READ THIS FIRST *

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

ALL MODELS

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

CLUTCH TROUBLE SHOOTING

Problem & Possible Cause	Action
Clutch Chatters/Grabs	
Incorrect Pedal Adjustment	Adjust Free Play
Worn Input Shaft Spline	Replace Input Shaft
Binding Pressure Plate	Replace Pressure Plate
Binding Throw-Out Lever	Check Throw-Out Lever, Check Throw-Out Bearing, Check Bearing Retainer
Uneven Pressure Plate Contact With Flywheel	Align/Replace Worn Parts
Transmission Misaligned	Align Transmission
Worn Pressure Plate	Replace Clutch Assembly
Oil-Saturated Disc	Replace Clutch Assembly, Repair Oil Leak
Loose Engine Mounts	Replace Engine Mounts
Clutch Pedal Sticks Down	
Clutch Cable Binding	Replace Clutch Cable
Weak Pressure Plate Springs	Replace Clutch Assembly
Binding Clutch Linkage	Lubricate Linkage
Broken Clutch Pedal Return Spring	Replace Return Spring
Clutch Will Not Release	
Oil-Saturated Disc	Replace Clutch Assembly, Repair Oil Leak
Defective Disc Face	Replace Clutch Assembly
Disc Sticking on Input Shaft Splines	Replace Disc/Input Shaft
Binding Pilot Bearing	Replace Pilot Bearing
Faulty Clutch Master Cylinder	Replace Master Cylinder
Faulty Clutch Slave Cylinder	Replace Slave Cylinder
Blown Clutch Hose	Replace Hose

Problem & Possible Cause	Action
Sticky Throw-Out Bearing Sleeve	Clean/Lube Sleeve
Clutch Cable Binding	Replace Clutch Cable
Broken/Loose Bellhousing	Check Bellhousing
Rattling/Squeaking	
Broken Throw-Out Lever Return Spring	Replace Return Spring
Faulty Throw-Out Bearing	Replace Throw-Out Bearing
Faulty Clutch Disc	Replace Clutch Disc
Faulty Pilot Bearing	Replace Pilot Bearing
Worn Throw-Out Bearing	Replace Throw-Out Bearing
Dry Bearing Retainer Slide For Throw-Out Bearing Sleeve	Lubricate Slide
Slipping	
Faulty Pressure Plate	Replace Clutch Assembly
Worn Clutch Disc	Replace Clutch Assembly
Incorrect Alignment	Realign Clutch Assembly
Faulty Clutch Slave Cylinder	Replace Slave Cylinder
No Pedal Pressure	
Leaky Hydraulic System	Check Clutch Master Cylinder, Check Clutch Slave Cylinder
	Check Clutch Hose
Broken Clutch Cable	Replace Clutch Cable
Faulty Throw-Out Lever	Replace Throw-Out Lever
Broken Clutch Linkage	Repair Clutch Linkage
Noisy Clutch Pedal	
Faulty Safety Switch	Check/Replace Switch
Noisy Self-Adj. Ratchet	Replace Ratchet
Dry Throw-Out Bearing	Replace Throw-Out Bearing
Dry Pilot Bearing	Replace Pilot Bearing
Worn Input Shaft	Replace Input Shaft

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GENERAL INFORMATION

Commonly Used Abbreviations

* PLEASE READ THIS FIRST *

NOTE: **This article is intended for general information purposes only. This information may not apply to all makes and models. Not all abbreviations are covered as manufacturers add new ones every day.**

"A"

A

Amperes

ABS

Anti-Lock Brakes

ABRS

Air Bag Restraint System

AC

Alternating Current

A/C

Air Conditioning

ACCS

A/C Cycling Switch

ACCUM

Accumulator

ACCY

Accessory

ACT

Air Charge Temperature Sensor

ADJ

Adjust or Adjustable

ADV

Advance

AFS

Airflow Sensor

AI

Air Injection

AIR or A.I.R.

Air Injection Reactor

AIS

Air Injection System

Alt.

Alternator or Altitude

Amp./amp/amps

Ampere

ASCS

Air Suction Control Solenoid

ASD

Auto Shutdown

ASDM

Air Bag System Diagnostic Module

ASV

Air Suction Valve

A/T

Automatic Transmission/Transaxle

ATC

Automatic Temperature Control

ATDC

After Top Dead Center

ATF

Automatic Transmission Fluid

ATS

Air Temperature Sensor

Aux.

Auxiliary

Avg.

Average

AXOD

Automatic Transaxle Overdrive (Ford Models Only)

"B"

BAC

By-Pass Air Control

BAP

Barometric Absolute Pressure Sensor

BARO

Barometric

Batt.

Battery

Bbl.

Barrel (Example: 4-Bbl.)

BCM

Body Control Module

BHP

Brake Horsepower

BMAP

Barometric and Manifold Absolute Pressure Sensor

BOO

Brake On-Off Switch

B/P

Backpressure

BPS

Barometric Pressure Sensor

BPT

Backpressure Transducer

BTDC

Before Top Dead Center

BTSI

Brake Transmission Shift Interlock

BTU

British Thermal Unit

BVSV

Bimetallic Vacuum Switching Valve

"C"

Â° C

Celsius (Degrees)

Calif.

California

CANP

Canister Purge

CARB

California Air Resources Board

CAT

Catalytic Converter

CB

Circuit Breaker

CBD

Closed Bowl Distributor

cc

cubic centimeter

CCC

Close Coupled Catalyst

CCC

Computer Command Control

CCD

Computer Controlled Dwell

CCOT

Cycling Clutch Orifice Tube

CCW

Counterclockwise

CDI

Capacitor Discharge Ignition

CEC

Computerized Engine Control

CID

Cubic Inch Displacement

cm

Centimeter

CMP

Camshaft Position Sensor

CO

Carbon Monoxide

CO_2

Carbon Dioxide

Cont.

Continued

CONV

Convertible

CP

Canister Purge

CKP

Crankshaft Position Sensor

CTS

Coolant Temperature Sensor

Cu. In.

Cubic Inch

CVC

Constant Vacuum Control

CV

Check Valve or Constant Velocity

CW

Clockwise

CYL or Cyl.

Cylinder

C^3 I

Computer Controlled Coil Ignition

C^4

Computer Controlled Catalytic Converter

"D"

"D"

Drive

DC

Direct Current Or Discharge

DDD

Dual Diaphragm Distributor

Def.

Defrost

Defog.

Defogger

DERM

Diagnostic Energy Reserve Module

DFI

Digital Fuel Injection

Diag.

Diagnostic

DTC

Diagnostic Trouble Code

DIC

Driver Information Center

DIS

Distributorless Ignition System

DIST

Distribution

DLC

Data Link Connector

DOC

Diesel Oxidation Catalyst

DOHC

Double Overhead Cam

DOT

Department of Transportation

DPF

Diesel Particulate Filter

DRB-II

Diagnostic Readout Box

DVOM

Digital Volt-Ohmmeter

"E"

EACV

Electric Air Control Valve

EATX

Electronic Automatic Transaxle

EBCM

Electronic Brake Control Module

EBL

Electronic Back Light

ECM

Engine Control Module

ECT

Engine Coolant Temperature Sensor

EDIS

Electronic Distributorless Ignition System

EEC

Electronic Engine Control

EECS

Evaporative Emission Control System

EEPROM

Electronically Erasable PROM

EFE

Early Fuel Evaporation

EGO

Exhaust Gas Oxygen Sensor

EGR

Exhaust Gas Recirculation

EOT

Engine Oil Temperature

ESA

Electronic Spark Advance

ESC

Electronic Spark Control

EST

Electronic Spark Timing

EVAP

Fuel Evaporative System

EVIC

Electronic Vehicle Information Center

EVP

EGR Valve Position Sensor

EWMA

Exponentially Weighted Moving Average (MODE 6)

Exc.

Except

"F"

Â° F

Fahrenheit (Degrees)

F/B

Fuse Block

Fed.

Federal

FI

Fuel Injection

FICU

Fuel Injection Control Unit

FIPL

Fuel Injector Pump Lever

FLI

Fuel Level Indicator

FPR-VSV

Fuel Pressure Regulator Vacuum Switching Valve

Ft. Lbs.

Foot Pounds

FWD

Front Wheel Drive

"G"

g

grams

Gals.

gallons

GND or GRND

Ground

"H"

HAC

High Altitude Compensation

HC

Hydrocarbons

H/D

Heavy Duty

HO2S

Heated Exhaust Gas Oxygen Sensor

Hg

Mercury

Hgt.

Height

HLDT

Headlight

HO

High Output

HO2S

Heated Oxygen Sensor

HP

High Performance

HSC

High Swirl Combustion

HSO

High Specific Output

HTR

Heater

Hz

Hertz (Cycles Per Second)

"I"

IAC

Idle Air Control

IACV

Idle Air Control Valve

IAT

Intake Air Temperature

IC

Integrated Circuit

ID

Identification

I.D.

Inside Diameter

IFS

Independant Front Suspension

IFS

Inertia Fuel Shutoff (Ford)

Ign.

Ignition

IMRC

Intake Manifold Runner Control

In.

Inches

INCH Lbs.

Inch Pounds

in. Hg

Inches of Mercury

Inj.

Injector

IP

Instrument Panel

IRS

Independant Rear Suspension

ISC

Idle Speed Control

IVD

Interactive Vehicle Dynamics (Ford)

IVSV

Idle Vacuum Switching Valve

"J"

J/B

Junction Block

"K"

KAPWR

Keep Alive Power

k/ohms

kilo-ohms (1000 ohms)

kg

Kilograms (weight)

kg/cm^2

Kilograms Per Square Centimeter

KM/H

Kilometers Per Hour

KOEO

Key On, Engine Off

KOER

Key On, Engine Running

KS

Knock Sensor

kW

Kilowatt

kV

Kilovolt

"L"

L

Liter

lbs. (Lbs. when used in table)

Pounds

LCD

Liquid Crystal Display

L/D

Light Duty

LDP

Leak Detection Pump (Part of EVAP system.)

LED

Light Emitting Diode

LH

Left Hand

"M"

mA

Milliamps

MA or MAF

Mass Airflow

MAFS

Mass Airflow Sensor

MAP

Manifold Absolute Pressure

MAT

Manifold Air Temperature

Mem.

Memory

MEM-CAL

Memory Calibration Chip

mfd.

Microfarads

MFI

Multiport Fuel Injection

MICU

Multiplex Integrated Control Unit (Acura/Honda)

MIL

Malfunction Indicator Light

MPI

Multi-Point (Fuel) Injection

mm

Millimeters

MPH

Miles Per Hour

mV

Millivolts

"N"

NA

Not Available

NAC

NOx Adsorber Catalyst

NCA

No Color Available (Wiring Diagrams)

NGS

New Generation Star

N.m

Newton Meter

No.

Number

Nos.

Numbers

NOx

Oxides of Nitrogen

"O"

O_2

Oxygen

OBD

On-Board Diagnostics

OC

Oxidation Catalyst

OD

Overdrive

O.D.

Outside Diameter

OHC

Overhead Camshaft

OSS

Output Speed Sensor

O/S

Oversize

oz.

Ounce

ozs.

Ounces

"P"

"P"

Park

P/C

Printed Circuit

PCM

Powertrain Control Module

PCS

Purge Control Solenoid

PC-SOL

Purge Control Solenoid

PCV

Positive Crankcase Ventilation

PFI

Port Fuel Injection

PGM-FI

Programmed Fuel Injection

PID

Parameter Identification

PIP

Profile Ignition Pick-up

PNP

Park Neutral Position Switch

P/N

Park/Neutral

PRNDL

Park Reverse Neutral Drive Low

PROM

Programmable Read-Only Memory

psi

Pounds Per Square Inch

P/S

Power Steering

PSPS

Power Steering Pressure Switch

PTC

Positive Temperature Coefficient

PTO

Power Take-Off

Pts.

Pints

Pwr.

Power

"Q"

Qts.

Quarts

"R"

RABS

Rear Anti-Lock Brake System

RECIRC

Recirculation

RH

Right Hand

RPM

Revolutions Per Minute

RWAL

Rear Wheel Anti-Lock Brake

RWD

Rear Wheel Drive

"S"

SAS

Steering Angle Sensor

SBC

Single Bed Converter

SBEC

Single Board Engine Controller

SDARS

Satellite Digital Audio Radio Service

SES

Service Engine Soon

SFI

Sequential (Port) Fuel Injection

SIL

Shift Indicator Light

SIR

Supplemental Inflatable Restraint

SOHC

Single Overhead Cam

SOL or Sol.

Solenoid

SPFI

Sequential Port Fuel Injection

SPK

Spark Control

SPOUT

Spark Output

SRI

Service Reminder Indicator

SRS

Supplemental Restraint System (Air Bag)

STAR

Self-Test Automatic Readout

STO

Self-Test Output

SUB-O_2

Sub Oxygen Sensor

Sw.

Switch

Sys.

System

"T"

TAB

Thermactor Air By-Pass

TAC

Throttle Actuator Module

TAD

Thermactor Air Diverter

TBC

Body Control Module (General Motors)

TBI

Throttle Body Injection

TCC

Torque Converter Clutch

TDC

Top Dead Center

Temp.

Temperature

TFI

Thick Film Ignition

THERMAC

Thermostatic Air Cleaner

TPM

Tire Pressure Monitor

TPMS

Tire Pressure Monitor System

TPS

Throttle Position Sensor/Switch

TS

Temperature Sensor

TV

Thermovalve

TWC

Three-Way Catalyst

"V"

V

Valve

Vac.

Vacuum

VAF

Vane Airflow

VAPS

Variable Assist Power Steering

VCC

Viscous Converter Clutch

VCRM

Variable Control Relay Module

VIN

Vehicle Identification Number

VM

Vacuum Modulator

Volt.

Voltage

VOM

Volt-Ohmmeter (Analog)

VRV

Vacuum Regulator Valve

VSS

Vehicle Speed Sensor

VSV

Vacuum Switching Valve

"W"

W/

With

W/O

Without

WAC

Wide Open Throttle A/C Switch

WOT

Wide Open Throttle

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GENERAL INFORMATION

Dangers, Warnings, and Cautions - Impala

INTRODUCTION

DEFINITION OF DANGER, WARNING, CAUTION, AND NOTE

The diagnosis and repair procedures in a GM Service Manual contain both general and specific Dangers, Warnings, Cautions, Notes or Importants. GM is dedicated to the presentation of service information that helps the technician to diagnose and repair the systems necessary for the proper operation of the vehicle, however, certain procedures may present a hazard to the technician if they are not followed in the recommended manner . Dangers, Warnings, Cautions and Notes or Importants are elements designed to prevent these hazards, however, not all hazards can be foreseen. This information is placed at strategic locations within the service manual. This information is designed to prevent the following from occurring:

- Serious bodily injury or death to the technician
- Damage to the vehicle
- Unnecessary vehicle repairs
- Unnecessary component replacement
- Improper repair or replacement of vehicle components.
- Any warning or caution that appears in this service category is referenced from the individual service categories.

DANGER Defined

When encountering a DANGER, you will be asked to take a necessary action or not to take a prohibited action. If a DANGER is not heeded, the following consequences may occur:

- Serious bodily injury or death to the technician
- Serious bodily injury or death to other technicians in the workplace area

WARNING Defined

When encountering a WARNING, you will be asked to take a necessary action or not to take a prohibited action. If a WARNING is not heeded, the following consequences may occur:

- Serious bodily injury to the technician
- Serious bodily injury to other technicians in the workplace area
- Serious bodily injury to the driver and/or passenger(s) of the vehicle, if the vehicle has been improperly repaired

CAUTION Defined

CAUTIONS call special attention to a necessary action or to a prohibited action. If a CAUTION is not heeded, the following consequences may occur:

- Damage to the vehicle

- Unnecessary vehicle repairs
- Unnecessary component replacement
- Improper operation or performance of the system or component under repair
- Damage to any systems or components which are dependent upon the proper operation of the system or component under repair
- Improper operation or performance of any systems or components which are dependent upon the proper operation or performance of the system or component under repair
- Damage to fasteners, basic tools, or special tools
- The leakage of coolant, lubricant, or other vital fluids

NOTE or IMPORTANT Defined

NOTE and IMPORTANT statements emphasize a necessary characteristic of a diagnostic or repair procedure. NOTE or IMPORTANT statements are designed to do the following:

- Clarify a procedure
- Present additional information for accomplishing a procedure
- Give insight into the reason or reasons for performing a procedure in the manner recommended
- Present information that will help to accomplish a procedure in a more effective manner
- Present information that gives the technician the benefit of past experience in accomplishing a procedure with greater ease

APPROVED EQUIPMENT FOR COLLISION REPAIR WARNING

WARNING: To avoid personal injury when exposed to welding flashes or to galvanized (Zinc Oxide) metal toxic fumes while grinding/cutting on any type of metal or sheet molded compound, you must work in a properly ventilated area, wearing an approved respirator, eye protection , earplugs, welding gloves, and protective clothing. In addition when grinding aluminum components, always use an extraction system to remove high dust concentration due to risk of explosion.

ASSISTANT DRIVING WARNING

WARNING: An assistant should drive the vehicle while the technician checks for the location of the reported condition. Otherwise, personal injury could result.

AUTOMATIC TRANSMISSION RANGE SELECTOR CABLE WARNING

WARNING: The automatic transaxle range selector cable is made out of two cable sections. After initial connection never separate the two metal couplings from one another. Integrity of the connection of the two metal couplings will be lost if separation of the two metal couplings occurs. When servicing the transaxle remove the cable at the automatic transaxle range selector lever and at the automatic transaxle range selector cable bracket. If either section of the cable needs to be replaced, replace both of the cable sections. Loss of connection integrity of the two metal couplings can cause loss of transaxle shift control

which could result in personal injury.

BATTERY DISCONNECT WARNING

WARNING: **Unless directed otherwise, the ignition must be OFF with the key removed, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.**

For Vehicles equipped with OnStarÂ® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÂ® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÂ®module). Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÂ® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

BRAKE DUST WARNING

WARNING: **Avoid taking the following actions when you service wheel brake parts:**

- **Do not grind brake linings.**
- **Do not sand brake linings.**
- **Do not clean wheel brake parts with a dry brush or with compressed air.**

Some models or aftermarket brake parts may contain asbestos fibers which can become airborne in dust. Breathing dust with asbestos fibers may cause serious bodily harm. Use a water-dampened cloth in order to remove any dust on brake parts. Equipment is available commercially in order to perform this washing function. These wet methods prevent fibers from becoming airborne.

BRAKE FLUID IRRITANT WARNING

WARNING: **Brake fluid may irritate eyes and skin. In case of contact, take the following actions:**

- **Eye contact-rinse thoroughly with water.**
- **Skin contact-wash with soap and water.**
- **If ingested-consult a physician immediately.**

CLEANING SOLVENT WARNING

WARNING: **Bodily injury may occur if the cleaning solvent is inhaled or exposed to the skin.**

COLLISION SECTIONING WARNING

WARNING: **Sectioning should be performed only in the recommended areas. Failure to do so may compromise the structural integrity of the vehicle and cause personal injury if the vehicle is in a collision.**

EYE PROTECTION WARNING

WARNING: **Approved safety glasses and gloves should be worn when performing this procedure to reduce the chance of personal injury.**

FOAM SOUND DEADENERS WARNING

WARNING: **Foam sound deadeners must be removed from areas within 152.4 mm (6 in) of where flame is to be used for body repairs. When reinstalling foam sound deadeners, avoid inhaling fumes as bodily injury may result.**

FUEL AND EVAPORATIVE EMISSION PIPE WARNING

WARNING: **In order to reduce the risk of fire and personal injury observe the following items:**

- **Replace all nylon fuel pipes that are nicked, scratched or damaged during installation, do not attempt to repair the sections of the nylon fuel pipes**
- **Do not hammer directly on the fuel harness body clips when installing new fuel pipes. Damage to the nylon pipes may result in a fuel leak.**
- **Always cover nylon vapor pipes with a wet towel before using a torch near them. Also, never expose the vehicle to temperatures higher than 115Â°C (239Â°F) for more than one hour, or more than 90Â°C (194Â°F) for any extended period.**
- **Apply a few drops of clean engine oil to the male pipe ends before connecting fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. (During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.)**

FUEL PIPE FITTING WARNING

WARNING: **Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings. This will ensure proper reconnection and prevent a possible fuel leak. Always replace O-rings.**

FUEL RAIL STOP BRACKET INSTALLATION WARNING

WARNING: **The fuel rail stop bracket must be installed onto the engine assembly. The stop bracket serves as a protective shield for the fuel rail in the event of a vehicle frontal crash. If the fuel rail stop bracket is not installed and the vehicle is involved in a frontal crash, fuel could be sprayed possibly causing a fire and personal injury from burns.**

GASOLINE/GASOLINE VAPORS WARNING

WARNING: **Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.**

GLASS AND SHEET METAL HANDLING WARNING

WARNING: **When working with any type of glass or sheet metal with exposed or rough edges, wear approved safety glasses and gloves in order to reduce the chance of personal injury.**

HALOGEN BULB WARNING

WARNING: **Halogen bulbs contain gas under pressure. Handling a bulb improperly could cause it to shatter into flying glass fragments. To help avoid personal injury:**

- **Turn off the lamp switch and allow the bulb to cool before changing the bulb.**
- **Leave the lamp switch OFF until the bulb change is complete.**
- **Always wear eye protection when changing a halogen bulb.**
- **Handle the bulb only by its base. Avoid touching the glass.**
- **Keep dirt and moisture off the bulb.**
- **Properly dispose of the used bulb.**
- **Keep halogen bulbs out of the reach of children.**

HOT EXHAUST SYSTEM WARNING

WARNING: **While engine is operating, the exhaust system will become extremely hot. To prevent burns avoid contacting a hot exhaust system.**

MOVING PARTS AND HOT SURFACES WARNING

WARNING: **Avoid contact with moving parts and hot surfaces while working around a running engine in order to prevent physical injury.**

PARKING BRAKE AND DRIVE WHEELS WARNING

WARNING: **Apply the parking brake and block the drive wheels before performing this procedure in order to prevent bodily injury.**

RELIEVING FUEL PRESSURE WARNING

WARNING: **Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.**

ROAD TEST WARNING

WARNING: **Road test a vehicle under safe conditions and while obeying all traffic laws. Do not attempt any maneuvers that could jeopardize vehicle control. Failure to adhere to these precautions could lead to serious personal injury and vehicle damage.**

SAFETY GLASSES AND COMPRESSED AIR WARNING

WARNING: **Wear safety glasses when using compressed air in order to prevent eye injury.**

SAFETY GLASSES WARNING

WARNING: **Wear safety glasses in order to avoid eye damage.**

SIR DEPLOYED INFLATOR MODULES ARE HOT WARNING

WARNING: **After deployment, the metal surfaces of the SIR component may be very hot. To help avoid a fire or personal injury:**

- **Allow sufficient time for cooling before touching any metal surface of the SIR component.**
- **Do not place the deployed SIR component near any flammable objects.**

SIR INFLATABLE MODULE DEPLOYMENT OUTSIDE VEHICLE WARNING

WARNING: **When you are deploying an inflator module for disposal, perform the deployment procedures in the order listed. Failure to follow the procedures in the order listed may result in personal injury.**

SIR INFLATOR MODULE COIL WARNING

WARNING: **Improper routing of the wire harness assembly may damage the inflatable restraint steering wheel module coil. This may result in a malfunction of the coil, which may cause personal injury.**

SIR INFLATOR MODULE DISPOSAL WARNING

WARNING: **In order to prevent accidental deployment and the risk of personal injury, do not dispose of an undeployed inflator module as normal shop waste. Undeployed inflator modules contain substances that could cause severe illness or personal injury if their sealed containers are damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed inflator module. Failure to observe the following disposal methods may be a violation of appropriate country, regional or local laws.**

SIR INFLATOR MODULE HANDLING AND STORAGE WARNING

WARNING: **When carrying an undeployed inflator module:**

- **Do not carry the inflator module by the wires or connector.**
- **Make sure the air bag opening points away from you.**

When storing an undeployed inflator module:

- **Make sure the air bag opening points away from the surface on which the inflator module rests.**
- **Provide free space for the air bag to expand in case of an accidental deployment.**
- **When storing a steering column, do not rest the column with the air bag opening facing down and the column vertical. Lay the column on its side.**

Failure to observe these guidelines may result in personal injury.

SIR WARNING

WARNING: **This vehicle is equipped with a Supplemental Inflatable Restraint (SIR) System. Failure to follow the correct procedure could cause the following conditions:**

- **Air bag deployment**
- **Personal injury**
- **Unnecessary SIR system repairs**

In order to avoid the above conditions, observe the following guidelines:

- **Refer to Master Electrical Components List in order to determine if you are performing service on or near the SIR components or the SIR wiring.**
- **If you are performing service on or near the SIR components or the SIR wiring, disable the SIR system. Refer to SIR DISABLING AND ENABLING .**

WINDOW RETENTION WARNING

WARNING: **When replacing stationary windows, use a urethane adhesive system meeting GM Specification, to maintain original installation integrity. Failure to use the urethane adhesive kit will result in poor retention of the window which may allow unrestrained occupants to be ejected from the vehicle resulting in**

personal injury.

WORK STALL TEST WARNING

WARNING: **One or more of the following guidelines may apply when performing specific required tests in the work stall:**

- **When a test requires spinning the drive wheels with the vehicle jacked up, adhere to the following precautions:**
  - **Do not exceed 56 km/h (35 mph) when spinning one drive wheel with the other drive wheel stopped. This limit is necessary because the speedometer indicates only one-half the actual vehicle speed under these conditions. Personal injury may result from excessive wheel spinning.**
  - **If all of the drive wheels are spinning at the same speed, do not exceed 112 km/h (70 mph). Personal injury may result from excessive wheel spinning.**
  - **All persons should stay clear of the rotating components and the balance weight areas in order to avoid possible personal injury.**
  - **When running an engine in the repair stall for an extended period of time, use care not to overheat the engine and the transmission.**
- **When a test requires jacking up the vehicle and running with the wheels and brake rotors removed, adhere to the following precautions:**
  - **Support the suspension at normal ride height.**
  - **Do not apply the brake with the brake rotors removed.**
  - **Do not place the transmission in PARK with the drive axles spinning.**
  - **Turn Off the ignition in order to stop the powertrain components from spinning.**
- **When running an engine in the work stall, use the exhaust removal system to prevent breathing dangerous gases.**

BELT DRESSING CAUTION

CAUTION: **Do not use belt dressing on the drive belt. Belt dressing causes the breakdown of the composition of the drive belt. Failure to follow this recommendation will damage the drive belt.**

BRAKE FLUID EFFECTS ON PAINT AND ELECTRICAL COMPONENTS CAUTION

CAUTION: **Avoid spilling brake fluid onto painted surfaces, electrical connections, wiring, or cables. Brake fluid will damage painted surfaces and cause corrosion to electrical components. If any brake fluid comes in contact with painted surfaces, immediately flush the area with water. If any brake fluid comes in contact with electrical connections, wiring, or cables, use a clean shop cloth to wipe away the fluid.**

CLEAN, DRY, LOW PRESSURE GAS SOURCE CAUTION

CAUTION: **Use the Evaporative Emission (EVAP) System Tester (EEST) GE 41413-A in order to provide a clean, dry, low pressure nitrogen gas source. Do not substitute any other pressurized source, gas or otherwise. Damage may result to the EVAP system, test equipment or cause a safety risk.**

CLEARCOAT/ULTRAVIOLET SCREENERS CAUTION

CAUTION: **Removing more than 0.5 mils of the clearcoat can result in early paint failure. The clearcoat contains ultraviolet screeners. Do not finesse sand more than what is required to remove the defect.**

COMPONENT FASTENER TIGHTENING CAUTION

CAUTION: **Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors, or sealants are identified in the service procedure. Some replacement components may come with these coatings already applied. Do not use these coatings on components unless specified. These coatings can affect the final torque, which may affect the operation of the component. Use the correct torque specification when installing components in order to avoid damage.**

COVER AND PLUG OPENINGS CAUTION

CAUTION: **Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering the open pipes and passages.**

EXTERIOR TRIM EMBLEM REMOVAL CAUTION

CAUTION: **Use a plastic, flat-bladed tool to prevent paint damage when removing an emblem/name plate.**

FASTENER CAUTION

CAUTION: **Use the correct fastener in the correct location. Replacement fasteners must be the correct part number for that application. Do not use paints, lubricants, or corrosion inhibitors on fasteners, or fastener joint surfaces, unless specified. These coatings affect fastener torque and joint clamping force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems. When using fasteners that are threaded directly into plastic, use extreme care not to strip the mating plastic part(s). Use hand tools only, and do not use any kind of impact or power tools. Fastener should be hand tightened, fully seated, and not stripped.**

FUEL AND EVAPORATIVE EMISSION HOSE/PIPE CONNECTION CLEANING CAUTION

CAUTION: **Clean all of the following areas before performing any disconnections in order to avoid possible contamination in the system:**

- **The fuel pipe connections**
- **The hose connections**
- **The areas surrounding the connections**

HEATED OXYGEN AND OXYGEN SENSOR CAUTION

CAUTION: **Do not remove the pigtail from either the heated oxygen sensor (HO2S) or the oxygen sensor (O2S). Removing the pigtail or the connector will affect sensor operation.**

Handle the oxygen sensor carefully. Do not drop the HO2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Do not use cleaning solvents of any type.

Do not repair the wiring, connector or terminals. Replace the oxygen sensor if the pigtail wiring, connector, or terminal is damaged..

This external clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors, or terminals could result in the obstruction of the air reference and degraded sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- **Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor causing poor performance.**
- **Do not damage the sensor pigtail and harness wires in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.**
- **Ensure the sensor or vehicle lead wires are not bent sharply or kinked. Sharp bends or kinks could block the reference air path through the lead wire.**
- **Do not remove or defeat the oxygen sensor ground wire, where applicable. Vehicles that utilize the ground wired sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will cause poor engine performance.**
- **Ensure that the peripheral seal remains intact on the vehicle harness connector in order to prevent damage due to water intrusion. The engine harness may be repaired using an appropriate crimp and splice seals terminal repair kit. Under no circumstances should repairs be soldered since this could result in the air reference being obstructed.**

HEATED OXYGEN SENSOR RESISTANCE LEARN RESET CAUTION

CAUTION: **When replacing the HO2S perform the following:**

- **A code clear with a scan tool, regardless of whether or not a DTC is set**
- **HO2S heater resistance learn reset with a scan tool, where available**

Perform the above in order to reset the HO2S resistance learned value and avoid possible HO2S failure.

HVAC MODULE DRAIN TUBE CAUTION

CAUTION: **Always ensure the HVAC module drain tube is properly installed and secure following a repair. Residual moisture/water can collect inside the HVAC module. The residual moisture or water should not contact electrical modules, electrical connections, wiring, cables or carpeting. Use clean and absorbent shop clothes to protect these components while removing or installing the HVAC module drain tube and/or HVAC module. Moisture/water is a by-product of normal A/C system operation and can result in interior odors or corrosion/damage to electrical components.**

INSTALLING HOSES WITHOUT TWISTS OR BENDS CAUTION

CAUTION: **The inlet and outlet hoses must not be twisted during installation. Do not bend or distort the inlet or outlet hoses to make installation easier. Failure to follow these procedures could result in component damage.**

PAINT DAMAGE CAUTION

CAUTION: **To avoid paint damage, protect the area surrounding the part which you are removing or installing.**

PIPE WRENCH POSITIONING CAUTION

CAUTION: **The pipe wrench must be placed at the valve end of the steering gear and positioned up against the inner tie rod housing. Placing the pipe wrench in any other location will cause damage to the steering gear.**

SEALANT CAUTION

CAUTION: **Do not allow the RTV sealant to enter any blind threaded hole. RTV sealant that is allowed to enter a blind threaded hole can cause hydraulic lock of the fastener when the fastener is tightened. Hydraulic lock of a fastener can lead to damage to the fastener and/or the components. Hydraulic lock of a fastener can also prevent the proper clamping loads to be obtained when the fastener is tightened. Improper clamping loads can prevent proper sealing of the components allowing leakage to occur. Preventing proper fastener tightening can allow the components to loosen or separate leading to extensive engine damage.**

SILICON CONTAMINATION OF HEATED OXYGEN SENSORS CAUTION

CAUTION: **Contamination of the oxygen sensor can result from the use of an inappropriate RTV sealant (not oxygen sensor safe) or excessive engine coolant or oil consumption. Remove the HO2S and visually inspect the portion of the sensor exposed to the exhaust stream in order to check for contamination. If contaminated, the portion of the sensor exposed to the exhaust stream will have a white powdery coating. Silicon contamination causes a high but false HO2S signal voltage (rich exhaust indication). The control module will then reduce the amount of fuel delivered to the engine, causing a severe driveability problem. Eliminate the source of contamination before replacing the oxygen sensor.**

TEST PROBE CAUTION

CAUTION: **Do not insert test equipment probes (DMM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616-F GM Approved Terminal Release Tool Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.**

When using the J-35616-F GM Approved Terminal Release Tool Kit , ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616-F GM Approved Terminal Release Tool Kit label on the inside of the J-35616-F GM Approved Terminal Release Tool Kit for the correct adapter along with the connector end view for terminal size.

THREE-WAY CATALYTIC CONVERTER DAMAGE CAUTION

CAUTION: **In order to avoid damaging the replacement three-way catalytic converter, correct the engine misfire or mechanical fault before replacing the three-way catalytic converter.**

TORQUE REACTION AGAINST TIMING DRIVE CHAIN CAUTION

CAUTION: **A wrench must be used on the hex of the camshaft when loosening or tightening in order to prevent component damage. Failure to prevent the torque reaction against the timing drive chain can lead to timing drive chain failure.**

TRANSMISSION OVERFILL CAUTION

CAUTION: **Check the transmission fluid level immediately after adding fluid and before vehicle operation. Do not overfill the transmission. An overfilled transmission may result in foaming or fluid to be expelled out the vent tube when the vehicle is operated. Overfilling will result in possible damage to the transmission.**

VALVE LIFTER PRIMING CAUTION

CAUTION: **Ensure each valve lifter is filled with clean engine oil and the valve lifter does not tip over (plunger down) before the installation of the valve lifters. The loss of oil in the valve lifter lower pressure chamber or the dry stroking/cycling of the valve lifter plunger will allow air to travel into the high pressure chamber of the valve lifter. Air in the high pressure chamber of the valve lifter may not be purged causing extensive engine component damage.**

Article GUID: A00737155

GENERAL INFORMATION

Drive Axle Noise Diagnosis

* PLEASE READ THIS FIRST *

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

UNRELATED NOISES

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

Some driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires and other parts of the vehicle. Make sure that cause of trouble actually is in the drive axle before adjusting, repairing, or replacing any parts.

NON-DRIVE AXLE NOISES

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

A few conditions can sound just like drive axle noise and have to be considered in pre-diagnosis. The 4 most common noises are exhaust, tires, CV/universal joints and trim moldings.

In certain conditions, the pitch of exhaust gases may sound like gear whine. At other times, it may be mistaken for a wheel bearing rumble.

Tires, especially radial and snow tires, can have a high-pitched tread whine or roar, similar to gear noise. Also, some non-standard tires with an unusual tread construction may emit a roar or whine.

Defective CV/universal joints may cause clicking noises or excessive driveline play that can be improperly diagnosed as drive axle problems.

Trim and moldings can also cause a whistling or whining noise. Ensure that none of these components are causing the noise before disassembling the drive axle.

GEAR NOISE

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

A "howling" or "whining" noise from the ring and pinion gear can be caused by an improper gear pattern, gear

damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

Before disassembling axle to diagnose and correct gear noise, make sure that tires, exhaust, and vehicle trim have been checked as possible causes.

CHUCKLE

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

This is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 40 MPH and usually can be heard until vehicle comes to a complete stop. The frequency varies with the speed of the vehicle.

A chuckle that occurs on the driving phase is usually caused by excessive clearance due to differential gear wear, or by a damaged tooth on the coast side of the pinion or ring gear. Even a very small tooth nick or a ridge on the edge of a gear tooth is enough to cause the noise.

This condition can be corrected simply by cleaning the gear tooth nick or ridge with a small grinding wheel. If either gear is damaged or scored badly, the gear set must be replaced. If metal has broken loose, the carrier and housing must be cleaned to remove particles that could cause damage.

KNOCK

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This is very similar to a chuckle, though it may be louder, and occur on acceleration of deceleration. Knock can be caused by a gear tooth that is damaged on the drive side of the ring and pinion gears. Ring gear bolts that are hitting the carrier casting can cause knock. Knock can also be due to excessive end play in the axle shafts.

CLUNK

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

Clunk is a metallic noise heard when an automatic transmission is engaged in Reverse or Drive, or when throttle is applied or released. It is caused by backlash somewhere in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, check the total axle backlash as follows:

1. Raise vehicle on a frame or twinpost hoist so that drive wheels are free. Clamp a bar between axle companion flange and a part of the frame or body so that flange cannot move.
2. On conventional drive axles, lock the left wheel to keep it from turning. On all models, turn the right wheel slowly until it is felt to be in drive condition. Hold a chalk marker on side of tire about 12" from

center of wheel. Turn wheel in the opposite direction until it is again felt to be in drive condition.

3. Measure the length of the chalk mark, which is the total axle backlash. If backlash is one inch or less, clunk will not be eliminated by overhauling drive axle.

BEARING WHINE

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings. Pinion bearings operate at driveshaft speed. Roller wheel bearings may whine in a similar manner if they run completely dry of lubricant. Bearing noise will occur at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

BEARING RUMBLE

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

Bearing rumble sounds like marbles being tumbled. It is usually caused by a malfunctioning wheel bearing. The lower pitch is because the wheel bearing turns at only about 1/3 of driveshaft speed.

CHATTER ON TURNS

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

This is a condition where the whole front or rear vibrates when vehicle is moving. The vibration is easily felt and heard. Extra differential thrust washers installed during axle repair can cause a condition of partial lock-up that creates the chatter.

AXLE SHAFT NOISE

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

Axle shaft noise is similar to gear noise and pinion bearing whine. Axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes. Noise will persist with transmission in neutral while vehicle is moving at problem speed.

If vehicle displays this noise condition, remove suspect axle shafts and replace axle bearings. Re-evaluate vehicle for noise before removing any internal components.

VIBRATION

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

Vibration is a high-frequency trembling, shaking or grinding condition (felt or heard) that may be constant or variable in level and con occur during the total operating speed range of the vehicle.

The types of vibrations that can be felt in the vehicle can be divided into 3 main groups:

- Vibrations of various unbalanced rotating parts of the vehicle.
- Resonance vibrations of the body and frame structures caused by rotating of unbalance parts.
- Tip-in moans of resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

Article GUID: A00002193

GENERAL INFORMATION

Electrostatic Discharge (ESD) Warning - Basic Information

* PLEASE READ THIS FIRST *

NOTE: **This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.**

INTRODUCTION

NOTE: **This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.**

All Electrostatic Discharge (ESD) sensitive components contain solid state circuits (transistors, diodes, semiconductors) that may become damaged when contacted with an electrostatic charge. The following information applies to all ESD sensitive devices. The ESD symbol shown in Fig. **Fig. 1** may be used on schematics to indicate which components are ESD sensitive. See **Fig. 1**. Although different manufactures may display different symbols to represent ESD sensitive devices, the handling and measuring precautions and procedures are the same.

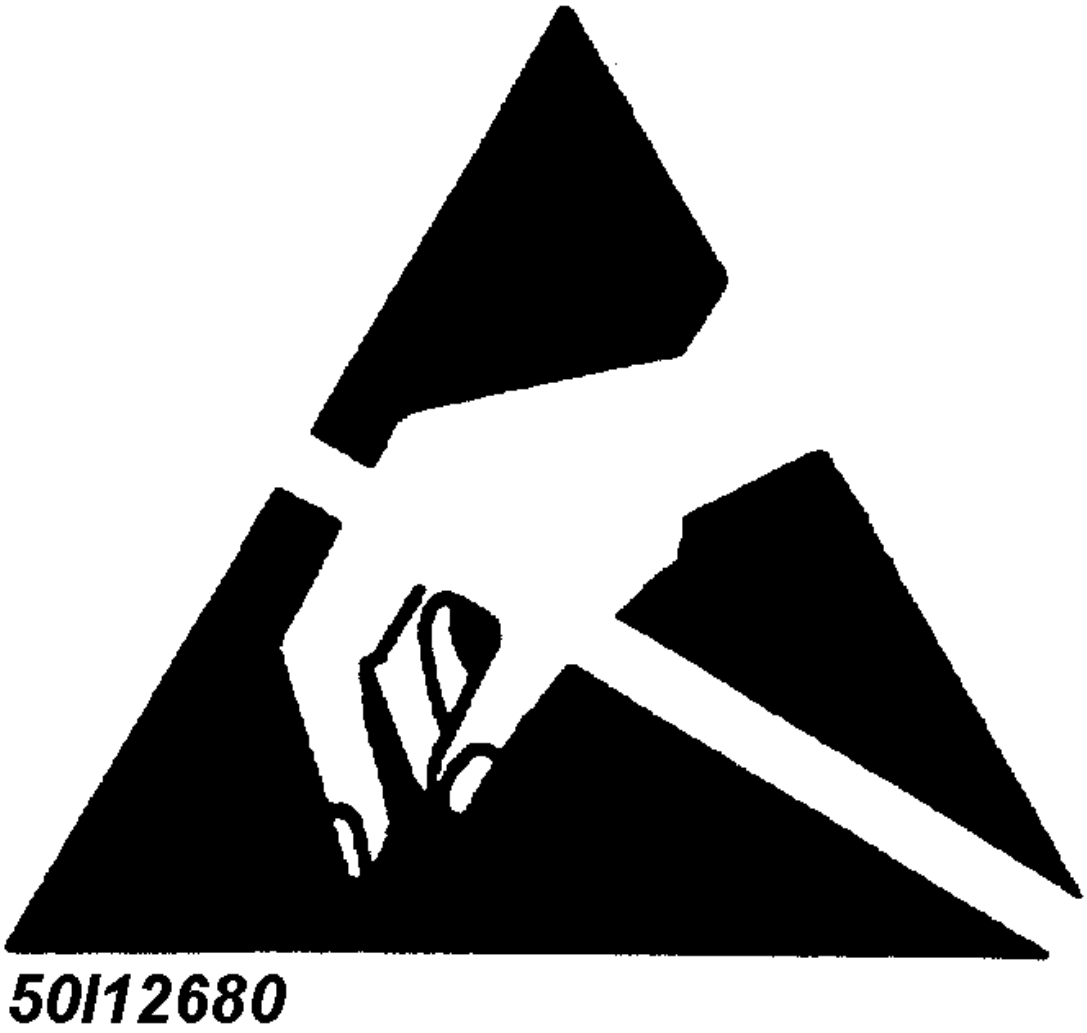

Fig. 1: Sample ESD Symbol

HANDLING STATIC-SENSITIVE CIRCUITS/DEVICES

NOTE: **This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.**

When handling an electronic part that is ESD sensitive, the technician should follow these guidelines to reduce any possible electrostatic charge build-up on the technician's body and the electronic part.

1. Always touch a known good ground source before handling the part. This should be repeated while handling the part and more frequently after sitting down from a standing position, sliding across the seat or walking a distance.
2. Avoid touching electrical terminals of the part, unless instructed by a diagnostic procedure.
3. DO NOT open the package of a new part until it is time to install the part.

4. Before removing the part from its package, ground the package to a known good ground source.

CHECKING STATIC-SENSITIVE CIRCUITS/DEVICES

NOTE: This article is intended for general information purposes only. Contents are generic in nature and all information may or may not apply to all vehicles.

1. Solid State circuits in electronic devices are shown greatly simplified in schematics. See **Fig. 2**. Due to the simplification of the electronic devices on the schematic, resistance measurements could be misleading or could lead to an electrostatic discharge. Always follow the recommended diagnostic procedure.

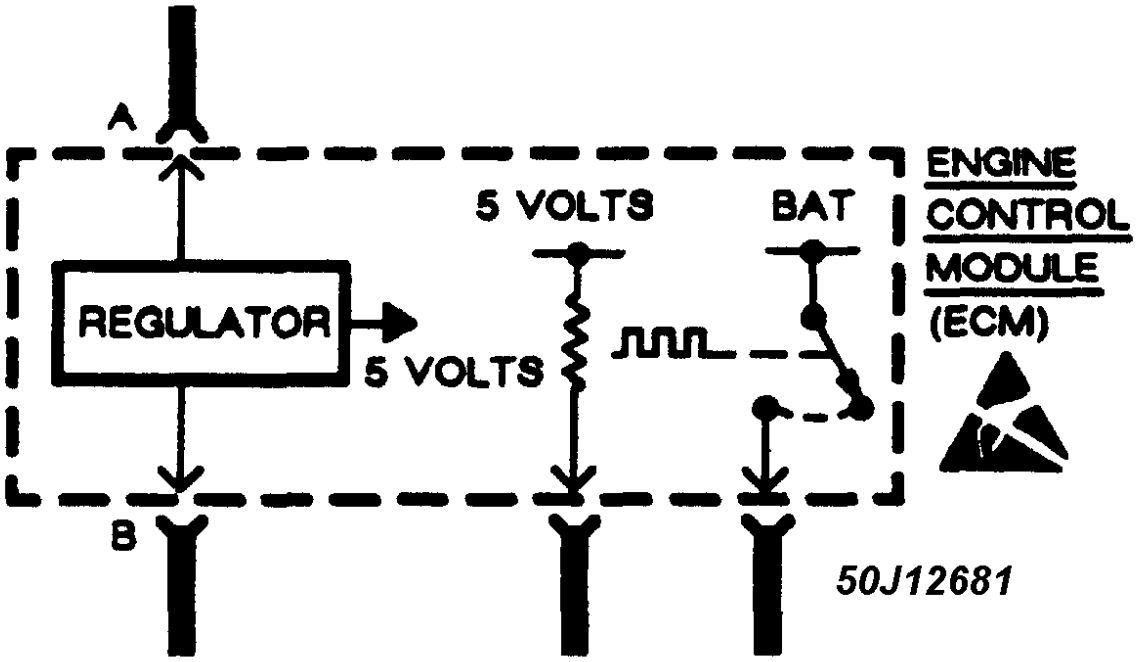

Fig. 2: Sample Schematic Showing Typical ESD Sensitive Device

2. Only measure resistance at the terminals of the devices when instructed by the recommended diagnostic procedure.
3. When using a voltmeter, be sure to connect the ground lead first.

Article GUID: A00130228

EMISSION CONTROL ABBREVIATIONS

Gasoline & Diesel

"A"

A/C

Air Conditioning

A/C-ISUS

A/C Idle Speed-Up Solenoid

A/F

Air/Fuel

AAI

Air Assist Injector

ACL

Air Cleaner (Thermostatic Air Cleaner)

ACL-BMS

ACL Bimetallic Sensor

ACL-CKV

ACL Check Valve

ACL-DV

ACL Delay Valve

ACL-ESC

Electronic Spark Control

ACL-PVS

ACL Ported Vacuum Switch

ACL-RDV

ACL Reverse Delay Valve

ACL-RDVS

ACL Reverse Delay Valve (Single)

ACL-TCV

ACL Thermal Control Valve

ACL-TS

ACL Temperature Sensor

ACL-TSOV

ACL Temperature Sensor Override Valve

ACL-TVS

ACL Thermal Vacuum Switch

ACL-TVV

ACL Thermal Vacuum Valve

ACL-VCDV

ACL Vacuum Control Delay Valve

ACL-VCV

ACL Vacuum Control Valve

ACL-VM

ACL Vacuum Motor

ACL-WP

ACL Wax Pellet Type Motor

ADS

Anti-Dieseling Solenoid

AFR

Air/Fuel Ratio Sensor

AFS

Air/Fuel Ratio Sensor

AIH

Air Intake Heaters

AIH-TS

AIH Temperature Sensor

AIR

Air Injection System

AIS

Air Injection System

AIS-ACV

AIS Air Control Valve

AIS-AF

Air Injection System Air Filter

AIS-AMV

AIS Air Management Valve

AIS-ASV

AIS Air Switching Valve

AIS-BPV

AIS By-Pass Valve

AIS-CC

AIS Computer Controlled

AIS-CKV

AIS Check Valve

AIS-CSV

AIS Control Solenoid Valve

AIS-CV

AIS Combination Valve

AIS-DV

AIS Diverter Valve

AIS-IMCV

AIS Intake Manifold Change-Over Valve

AIS-MCV

AIS Manifold Change-Over Valve

AIS-OWV

AIS One Way Valve

AIS-PAF

AIS Pulse Air Feeder

AIS-PM

AIS Pump Motor

AIS-PV

AIS Pneumatic Valve

AIS-RV

AIS Relief Valve

AIS-SAV

AIS Secondary Air Valve

AIS-SOL

AIS Solenoid

AIS-SV

AIS Solenoid Valve

AIS-VCV

AIS Vacuum Control Valve

AIS-VSV

AIS Vacuum Switching Valve

AIS-VT

AIS Vacuum Tank

AIS-VCV

AIS Vacuum Control Valve

AIS-VSV

AIS Vacuum Switching Valve

AIV

Air Injection Valve

AIV-SOL

Air Injection Valve Solenoid

ALVW

Adjusted Loaded Vehicle Weight

AMV

Air Management Valve

AP

Air Pump Injection System

AP-ABV

Air Pump Air Bypass Valve

AP-ACV

AP Air Control Valve

AP-AMV

AP Air Management Valve

AP-ASRV

AP Air Switching Relief Valve

AP-ASS

AP Air Switching Solenoid

AP-ASV

AP Air Switching Valve

AP-BP

AP By-Pass Valve

AP-BPV

AP By-Pass Valve

AP-CKV

AP Check Valve

AP-CS

AP Control Solenoid

AP-CV

AIR Cut-Off Valve

AP-DCTO

AP Dual Coolant Temperature Override

AP-DLY

AP Delay Valve

AP-DV

AP Diverter Valve

AP-EADV

AP Electric Air Control Diverter Valve

AP-EAMR

AP Electric Air Management Relay

AP-EAMS

AP Electric Air Management Solenoid

AP-EAP

AP Electric Air Pump

AP-EC

AP Electromagnetic Clutch

AP-ERLY

AP Electric Air Pump Relay

AP/PAIR

Pulsed Secondary Air Injection

AP-RDV

AP Reed Valve

AP-RV

AP Relief Valve

AP-SOL

AP Solenoid

AP-SOV

AP Shut-Off Valve

AP-SV

AP Solenoid Valve

AP-SWV

AP Switchover Valve

AP-TV

AP Transmitting Valve

AP-VCS

AP Vacuum Control Solenoid

AP-VCSV

AP Vacuum Controlled Air Shut-Off Valve

AP-VCV

AP Vacuum Control Valve

AP-VSV

AP Vacuum Switching Valve

A/T

Automatic Transmission

ATCV

Air Temperature Control Valve

"B"

BP/EGR

Backpressure EGR System

BP/EGR-BPS

BP/EGR Backpressure Sensor

BP/EGR-BPT

BP/EGR Backpressure Transducer

BP/EGR-BPV

BP/EGR Backpressure Valve

BP/EGR-BS

BP/EGR Bleed Solenoid

BP/EGR-BVSV

BP/EGR Bimetallic Vacuum Switching Valve

BP/EGR-C

BP/EGR Controller

BP/EGR-CLR

BP/EGR Cooler

BP/EGR-CS

BP/EGR Control Solenoid

BP/EGR-CTO

BP/EGR Coolant Temperature Override

BP/EGR-CV

BP/EGR Control Valve

BP/EGR-DCTO

BP/EGR Dual Coolant Temperature Override

BP/EGR-DS

BP/EGR Diagnostic Solenoid

BP/EGR-DSOL

BP/EGR Duty Solenoid

BP/EGR-DTVSW

BP/EGR Distributor Thermal Vacuum Switch

BP/EGR-DV

BP/EGR Delay Valve

BP/EGR-EET

BP/EGR Electric Transducer

BP/EGR-EPV

BP/EGR External Pressure Valve

BP/EGR-FDV

BP/EGR Forward Delay Valve

BP/EGR-LCV

BP/EGR Vacuum Control Valve

BP/EGR-LC

BP/EGR Load Control Valve

BP/EGR-OVS

BP/EGR Orifice Valve Sensing

BP/EGR-PS

BP/EGR Position Sensor

BP/EGR-PT

BP/EGR Pressure Tranducer

BP/EGR-PVS

BP/EGR Ported Vacuum Switch

BP/EGR-RES

BP/EGR Reservoir

BP/EGR-RST

BP/EGR Restrictor

BP/EGR-SOL

BP/EGR Solenoid

BP/EGR-TCTVS

BP/EGR Torque Converter Thermal Vacuum Switch

BP/EGR-TCV

BP/EGR Thermal Control Valve

BP/EGR-TCVLV

BP/EGR Temperature Control Valve

BP/EGR-T

BP/EGR Temperature Sensor

BP/EGR-TS

BP/EGR Temperature Sensor

BP/EGR-TVC

BP/EGR Thermal Control Valve

BP/EGR-TVS

BP/EGR Thermal Vacuum Switch

BP/EGR-TVV

BP/EGR Thermal Vacuum Valve

BP/EGR-VC

BP/EGR Diagnostic Valve

BP/EGR-VCV

BP/EGR Vacuum Control Valve

BP/EGR-VM

BP/EGR Vacuum Modulator

BP/EGR-VRV

BP/EGR Vacuum Regulator Valve

BP/EGR-VS

BP/EGR Vacuum Switch

BP/EGR-VSOL

BP/EGR Vent Solenoid

BP/EGR-VSV

BP/EGR Vacuum Switching Valve

"C"

C-4

Computer Controlled Catalytic Converter

CAC

Charge Air Cooler

CAS

Clean Air System

CB

Crankcase Breather

CB-VC

Crankcase Breather-Vapor Canister

CBPS

Coasting By-Pass System

CBVC

Crankcase Breather Vapor Canister

CCIEV

Coolant Controlled Idle Enrichment Valve

CCO

Computerized Engine Controls

CCS

Controlled Combustion System

CCV

Closed Crankcase Ventilation

CD-REGVLV

Crankcase Depression Regulator Valve

CDRV

Crankcase Depression Relief Valve

CEAB

Cold Engine Air Bleed

CEAB-TVS

CEAB Thermal Vacuum Switch

CEAB-TVV

CEAB Thermal Vacuum Valve

CEC

Computerized Engine Controls

CESS

Cold Engine Sensor Switch

CETS

Cold Engine Temperature Switch

CFI

Continuous Fuel Injection

CMH

Cold Mixture Heater

CNG

Compressed Natural Gas

CO

Carbon Monoxide

CO2

Carbon Dioxide

CPI

Central Port Injection

CRV

Coasting Richer Valve

CSI

Central Sequential Injection

CTAVS

Cold Temperature Activated Vacuum System

CTOX

Continous Trap Oxidizer

CVOT

Crankcase Ventilation Orifice Tube

CVOT-CKV

Crankcase Ventilation Orifice Tube Check Valve

"D"

DCLV

Deceleration Valve

DCS

Deceleration Control System

DDI

Direct Diesel Injection

DFI

Direct Diesel Injection

DI

Direct Injection

DKV

Deceleration Kick Valve

DLCV

Deceleration Mixture Control Valve

DM-TL

Diagnostic Module Tank Leakage

DMS

Dual Manifold System

DOC

Diesel Oxidation Catalyst

DOHC

Dual Overhead Cam

DPD

Dual Point Distributor

DPF

Diesel Particulate Filter

DPF/TWC

Combination Diesel Particulate Filter and Three Way Catalyst

DPFE

Differential Pressure Feedback EGR Valve

DPFEGR

Differential Pressure Feedback EGR Valve

DTM

Deceleration Throttle Modulator

"E"

EAIR

Electric Air Injection System

EAIR-DV

EAIR Diverter Valve

EC

Computerized Engine Controls

ECM

Electronic Control Module

ECU

Electronic Control Unit

EDC

Electronic Diesel Control

EDS

Electronic Diesel System

EEC

Electronic Engine Control

EFE

Early Fuel Evaporation

EFE-CKV

EFE Check Valve

EFE-CV

EFE Control Valve

EFE-DTVS

EFE Delay Thermal Vacuum Switch

EFE-HTR

EFE Heater

EFE-HCV

EFE Heat Control Valve

EFE-OTS

EFE Oil Temperature Switch

EFE-PTC

EFE Positive Temperature Coefficient (Intake Heater Grid)

EFE-PVS

EFE Ported Vacuum Switch

EFE-SOL

EFE Solenoid

EFE-TVS

EFE Thermal Vacuum Switch

EFE-TVV

EFE Thermal Vacuum Valve

EFE-VSV

EFE Vacuum Switching Valve

EFI

Electronic Fuel Injection

EFI-MA

EFI Mass Airflow Sensor

EFI-MAF

EFI Mass Airflow Sensor

EGR

Exhaust Gas Recirculation System

EGR-BCS

EGR Boost Check Solenoid

EGR-BPBV

EGR By-Pass Backpressure Valve

EGR-BPT

EGR Backpressure Transducer

EGR-BPV

EGR By-Pass Valve

EGR-BS

EGR Bleed Solenoid

EGR-BSSV

EGR Boost Sensor Solenoid Valve

EGR-BV

EGR Bypass Valve

EGR-BVSV

EGR Bimetallic Vacuum Switching Valve

EGR-C

EGR Controller

EGR-CC

EGR Coolant Controlled

EGR-CLR

EGR Cooler

EGR-VSOL

EGR Vacuum Solenoid

EGR-CKV

EGR Check Valve

EGR-CS

EGR Control Solenoid

EGR-CSOL

EGR Cut-Off Solenoid

EGR-CSV

EGR Control Solenoid

EGR-CTO

EGR Coolant Temperature Override

EGR-CTS

EGR Charge Temperature Sensor

EGR-CTSW

EGR Charge Temperature Switch

EGR-CTTS

EGR Coolant Temperature Thermoswitch

EGR-CV

EGR Control Valve

EGR-CVCV

EGR Constant Vacuum Control Valve

EGR-CVS

EGR Control Vent Solenoid

EGR-DC

EGR Digital Control

EGR-DCTO

EGR Dual Coolant Temperature Override

EGR-DPFE

Differential Pressure Feedback EGR Sensor

EGR-DPFS

EGR Differential Pressure Feedback Sensor

EGR-DS

EGR Diagnostic Solenoid

EGR-DSOL

EGR Duty Solenoid

EGR-DTVS

EGR Delay Thermal Vacuum Switch

EGR-DTVSW

EGR Distributor Thermal Vacuum Switch

EGR-DV

EGR Delay Valve

EGR-EPRS

EGR Exhaust Pressure Regulator Solenoid

EGR-EPRV

EGR Exhaust Pressure Regulator Valve

EGR-EPV

EGR External Pressure Valve

EGR/EVAP-CSV

EGR/EVAP Control Solenoid Valve

EGR-EVR

EGR Vacuum Regulator

EGR-EVRV

EGR Electronic Vacuum Regulator Valve

EGR-FDV

EGR Forward Delay Valve

EGR-FJS

EGR Floor Jet System

EGR-FPS

EGR Feedback Pressure Sensor

EGR-LCV

EGR Load Control Valve

EGR-MAP

EGR Manifold Absolute Pressure Sensor

EGR-PFE

EGR-PFE Sensor

EGR-PS

EGR Position Sensor

EGR-PSW

EGR Pulse Switch

EGR-PVS

EGR Ported Vacuum Switch

EGR-REG

EGR Regulator

EGR-RES

EGR Reservoir

EGR-RST

EGR Restrictor

EGR-SC

EGR Signal Converter

EGR-SEC

EGR, Secondary

EGR-SEN

EGR Sensor

EGR-SM

EGR Stepper Motor

EGR-SOL

EGR Solenoid

EGR-SU

EGR Switchover Valve

EGR-SUB

Sub-EGR Valve

EGR-SV

EGR Switchover Valve

EGR-SVV

EGR Solenoid Vacuum Valve

EGR-T

EGR Temperature Sensor

EGR-TC

EGR Transmission Controlled

EGR-TCTVS

EGR Torque Converter Thermal Vacuum Switch

EGR-TCV

EGR Thermal Control Valve

EGR-TCVLV

EGR Temperature Control Valve

EGR-TRANS

EGR Transducer

EGR-TS

EGR Temperature Sensor

EGR-TSW

EGR Temperature Switch

EGR-TV

EGR Thermal Valve

EGR-TVD

EGR Throttle Valve Diaphragm

EGR-TVS

EGR Thermal Vacuum Switch

EGR-TVSOL

EGR Throttle Valve Solenoid

EGR-TVV

EGR Thermal Vacuum Valve

EGR-V

EGR Valve

EGR-VA

EGR Vacuum Amplifier

EGR-VCV

EGR Vacuum Control Valve

EGR-VM

EGR Vacuum Modulator

EGR-VR

EGR Vacuum Regulator

EGR-VRS

EGR Vacuum Regulator Solenoid

EGR-VRSV

EGR Vacuum Regulator Solenoid Valve

EGR-VRV

EGR Vacuum Regulator Valve

EGR-VS

EGR Vacuum Switch

EGR-VSDV

EGR Vacuum Switch Dump Valve

EGR-VSEN

EGR Vacuum Sensor

EGR-VSOL

EGR Vent Solenoid

EGR-VSS

EGR Vacuum Switching Solenoid

EGR-VST

EGR Vacuum Surge Tank

EGR-VSV

EGR Vacuum Switching Valve

EGR-VVCS

EGR Venturi Vacuum Control System

EGRB

EGR Boost Sensor

EGRC

EGR Control Solenoid

EGRC-BPT

EGR Control Backpressure Transducer

EGRC-SV

EGR Control Solenoid Valve

EHOC

Electronically Heated Oxidation Catalyst

EHTWC

Electronically Heated Three-Way Catalyst

EI

Electronic Ignition System

EIS

Electronic Ignition System

ELB

Electronic Lean Burn

EPR

Exhaust Pressure Regulator

EPR-SOL

EPR Solenoid

ESA

Electronic Spark Advance

ESIM

Evaporative System Integrity Monitor

EVAP

Fuel Evaporative System

EVAP-AAC

EVAP Auxiliary Air Control

EVAP-BPSV

EVAP By-Pass Solenoid Valve

EVAP-BVSV

EVAP Bimetallic Vacuum Switching Valve

EVAP-CAV

EVAP Canister Air Valve

EVAP-CCV

EVAP Control Canister Close Valve

EVAP-CCVSV

EVAP Control Canister Vent Shut Valve

EVAP-CCVVSV

EVAP Closed Canister Valve Vacuum Switching Valve

EVAP-CDCV

EVAP Canister Drain Cut Valve

EVAP-CKV

EVAP Check Valve

EVAP-CPCS

EVAP Canister Purge Control Solenoid

EVAP-CPCSV

EVAP Canister Purge Control Solenoid Valve

EVAP-CPCV

EVAP Canister Purge Control Valve

EVAP-CPRV

EVAP Canister Purge Regulator Valve

EVAP-CPSV

EVAP Canister Vent Shut Valve

EVAP-CPT

EVAP Canister Purge Timer

EVAP-CPTVS

EVAP Canister Purge Thermal Vacuum Switch

EVAP-CPV

EVAP Canister Vent Valve

EVAP-CPVCSV

EVAP Canister Purge Volume Control

EVAP-CPVCV

EVAP Canister Purge Volume Control Valve

EVAP-CPVDV

EVAP Canister Purge Vacuum Delay Valve

EVAP-CPVR

EVAP Canister Purge Valve Resonator

EVAP-CS

EVAP Control Solenoid

EVAP-CSPS

EVAP Control System Pressure Sensor

EVAP-CSPV

EVAP Canister Purge Valve

EVAP-CST

EVAP Canister Surge Tank

EVAP-CSV

EVAP Control Solenoid Valve

EVAP-CT

EVAP Catch Tank

EVAP-CV

EVAP Control Solenoid Valve

EVAP-CVCS

EVAP Canister Vent Control Solenoid

EVAP-CVCSV

EVAP Canister Vent Control Solenoid Valve

EVAP-CVCV

EVAP Canister Vent Control Valve

EVAP-CVS

EVAP Canister Vent Solenoid

EVAP-CVSV

EVAP Carburetor Vent Switching Valve

EVAP-CVV

EVAP Canister Vent Valve

EVAP-DCTO

EVAP Dual Coolant Temperature Override

EVAP-DF

EVAP Drain Filter

EVAP-DPS

EVAP Differential Pressure Sensor

EVAP-DV

EVAP-Drain Valve

EVAP-ESIM

Evaporative System Integrity Monitor

EVAP-EV

EVAP Emission Valve

EVAP-FBVV

EVAP Fuel Bowl Vent Valve

EVAP-FBVS

EVAP Fuel Bowl Vent Solenoid

EVAP-FCV

EVAP Fuel Cut Valve

EVAP-FLS

EVAP Fuel Level Sensor

EVAP-FOLV

EVAP Fuel Overflow Limiter Valve

EVAP-FR/FTPS

EVAP Rollover Valve/Fuel Tank

EVAP-FS

EVAP Flow Switch

EVAP-FSV

EVAP Flow Switchover Valve

EVAP-FTCV

EVAP Tank Pressure Control Valve

EVAP-FTEV

EVAP Fuel Tank EVAP Valve

EVAP-FTPCSV

EVAP Fuel Tank Pressure Control Solenoid Valve

EVAP-FTPS

EVAP Fuel Tank Pressure Sensor

EVAP-FTS

EVAP Fuel Temperature Sensor

EVAP-FVCV

EVAP Fuel Vapor Control Valve

EVAP-FVS

EVAP Fuel Vapor Separator

EVAP-FVTS

EVAP Fuel Vapor Temperature Sensor

EVAP-FVV

EVAP Fuel Vent Valve

EVAP-FVVV

EVAP Fuel Vapor Vent Valve

EVAP-FWV

EVAP Fuel Vent Valve

EVAP-IVS

EVAP Inner Vent Solenoid

EVAP-LDAF

EVAP Leak Detection Pump Air Filter

EVAP-LDP

EVAP Leak Detection Pump

EVAP-LDPAF

EVAP Leak Detection Pump Air Filter

EVAP-LDPF

EVAP Leak Detection Pump Filter

EVAP-LDPVV

EVAP Leak Detection Pump Vent Valve

EVAP-LSEP

EVAP Liquid Separator

EVAP-NVLD

EVAP Natural Vacuum Leak Detection

EVAP-ORVR

Evaporative On-Board Refueling Vapor Recovery System

EVAP-ORVRCV

Evaporative On-Board Refueling Vapor Recovery Check Valve

EVAP-ORVRFTVRV

EVAP-ORVR Fuel Tank Vapor Recirculation

EVAP-OVCV

EVAP Outer Vent Control Valve

EVAP-OWV

EVAP One-Way Valve

EVAP-PCDV

EVAP Purge Control Diaphram Valve

EVAP-PCS

EVAP Purge Control Solenoid Valve

EVAP-PCSV

EVAP Purge Cut-Off Solenoid Valve

EVAP-PFS

EVAP Purge Flow Sensor

EVAP-PFSVVSV

EVAP Purge Flow Switching Valve Vacuum Switching Valve

EVAP-PPS

EVAP Proportional Purge Solenoid

EVAP-PR

EVAP Purge Resonator

EVAP-PRRV

EVAP Pressure Relief Rollover Valve

EVAP-PRV

EVAP Pressure Relief Valve

EVAP-PS

EVAP Purge Solenoid

EVAP-PSOL

EVAP Purge Solenoid

EVAP-PSSV

EVAP Pressure Switching Solenoid

EVAP-PSVVSV

EVAP Pressure Switching Valve Vacuum Switching Valve

EVAP-PV

EVAP Purge (Frequency) Valve

EVAP-PVS

EVAP Ported Vacuum Switch

EVAP-RV

EVAP Rollover Valve

EVAP-RV/FTPS

EVAP Rollover Valve/Fuel Tank

EVAP-RVSV

EVAP Rollover Vapor Separator Valve

EVAP-SNR

EVAP Canister Sensor

EVAP-SOL

EVAP Solenoid

EVAP-SOV

EVAP Shutoff Valve

EVAP-SSV

EVAP Shut-Off Solenoid Valve

EVAP-SV

EVAP Solenoid Valve

EVAP-TC

EVAP Trap Canister

EVAP-TS

EVAP Temperature Switch

EVAP-TPBPV

EVAP Tank Pressure By-Pass Valve

EVAP-TPCS

EVAP Tank Pressure Control Solenoid

EVAP-TPCV

EVAP Tank Pressure Control Valve

EVAP-TRWV

EVAP Tree-Way Valve

EVAP-TV

EVAP Thermal Valve

EVAP-TVS

EVAP Thermal Vacuum Switch

EVAP-TVV

EVAP Thermal Vacuum Valve

EVAP-TWV

EVAP Two-Way Valve

EVAP-VC

EVAP Vapor Canister

EVAP-VCAT

EVAP Vapor Canister Air Tank

EVAP-VCF

EVAP Vapor Canister Filter

EVAP-VCSV

EVAP Vapor Canister Shut-off Valve

EVAP-VCTV

EVAP Vacuum Control Valve

EVAP-VCV

EVAP Vacuum Canister Valve

EVAP-VCVS

EVAP Vapor Canister Vent Solenoid

EVAP-VLFR

EVAP Vent Line Flow Restrictor

EVAP-VM

EVAP Vacuum Motor

EVAP-VMV

EVAP Vapor Management Valve

EVAP-VPS

EVAP Vapor Pressure Sensor

EVAP-VPSVSV

EVAP Vapor Pressure Sensor Vacuum Switching Valve

EVAP-VS

EVAP Vacuum Sensor

EVAP-VSOL

EVAP Ventilation Solenoid

EVAP-VSOL/LDP

EVAP Ventilation Solenoid/Leak Detection Pump

EVAP-VST

EVAP Vacuum Surge Tank

EVAP-VSV

EVAP Vacuum Switching Valve

EVAP-VV

EVAP Ventilation Valve

EVRS

EGR Vacuum Regulator Solenoid

"F"

FBC

Feedback Carburetor

FCOV

Fuel Change Over Valve

FF

Flex Fuel

FF-CKV

Fuel Fill Check Valve

FF-FCV

Fuel Tank Fuel Cut-Off Valve

FF-FLVV

Fuel Tank Fill Limit Vent Valve

FFC-PVRV

Fuel Fill Cap Pressure Vacuum Relief Valve

FGOV

Fuel Gravity/Overflow Valve

FGVV

Fuel Gravity Vent Valve

FI

Fuel Injected

FICD

Fast Idle Control Device

FISR

Fast Idle Solenoid Relay

FLV

Fill Limit Valve

FLVV

Fill Limiting Vent Valve

FP-CKV

Fill Pipe Check Valve

FP-RV

Fill Pipe Rollover Valve

FR

Fill Pipe Restrictor

FT-FLVV

Fuel Tank Fill Limit Vent Valve

FT-GVV

Fuel Tank Grade Vent Valve

FT-OPRV

Fuel Tank Over Pressure Vent Valve

FT-PCV

Fuel Tank Pressure Control Valve

FT-VCV

Fuel Tank Vapor Control Valve

FT-VRV

Fuel Tank Vapor Recirculation Valve

FTCV

Fuel Tank Check Valve

FTDPS

Fuel Tank Differential Pressure Sensor

FTEV

Fuel Tank EVAP Valve

FTPS

Fuel Tank Pressure Sensor

FTT

Fuel Tank Temperature Sensor

FTTS

Fuel Tank Temperature Sensor

FTV/LSV

Fuel Tank Vapor/Liquid Seperation Valve

FTVCV

Fuel Tank Vapor Control Valve

FTVPRV

Fuel Tank Ventilation Pressure Retention Valve

FVPS

Fuel Vapor Pressure Sensor

FTVV

Fuel Tank Vent Valve

FVV

Fuel Vapor Valve

"G"

GVWR

Gross Vehicle Weight Rating

"H"

HAC

High Altitude Compensator

HAFS

Heated Air Fuel Ratio Sensor

HAI

Hot Air Intake

HAS

High Altitude System

HC

Hydrocarbons

HCAC-VSV

Hydrocarbon Absorber Catalyst Vacuum Switching Valve

HDC

Heavy Duty Cooling

HDC-CTO

HDC Coolant Temperature Override

HFM-SFI

Hot Film Engine Management SFI

HIC

Hot Idle Compensator

HIM

Heated Intake Manifold

HO

High Output

HO2S

Heated Oxygen Sensor

HP

High Performance

HP

Horsepower

HPCA

Housing Pressure Cold Advance

HSC

High Swirl Combustion

"I"

IAC

Idle Air Control Valve

IACV-SW

IACV Switch

ICOM

Idle Compensator

IDI

Indirect Diesel Injection

IES

Idle Enrichment System

IMCO

Improved Combustion System

"K"

KS

Knock Sensor

"L"

LH-SFI

Hot Wire Sequential Multiport Fuel Injection

LVFD

Liquid/Vapor Fuel Discriminator

LVW

Loaded Vehicle Weight

"M"

MD-TICS

Timing & Injection rate Control System

MDP

Manifold Differential Pressure sensor

ME-SFI

Motor Electronics Sequential Fuel Injection

MFI

Multiport Fuel Injection

MFI-MAF

MFI Mass Airflow Sensor

MFLS

Main Fuel Level Sensor

MI

Mechanical Fuel Injection

MIL

Malfunction Indicator Light

M/T

Manual Transmission

"N"

NAC

Nitrogen Oxides (NOx) Adsorbing Catalyst

NLV

Non-Linear Valve

NOS

NOx Sensor

NOx

NOx Emission Control

NOxATWC

NOx Adsorptive TWC

NOxC

Nitrogen Oxide Catalyst

NOxS

Nitrogen Oxide Sensor

NOxTWC

NOx Adsorptive TWC

NSC

Nitrogen Oxides (NOx) Storage Catalyst

"O"

OBD

On-Board Diagnostic System

PBD (F)/(P)

Full/Partial On-Board Diagnostic

OC

Oxidation Catalytic Converter

OHC

Overhead Cam

ORVR

On-Board Refueling Vapor Recovery

ORVR-COV

ORVR Cut-Off Valve

ORVR-CV

ORVR Control Valve

ORVR-FAV

ORVR Fresh Air Valve

ORVR-FMV

ORVR Flow Management Valve

ORVR-FTVCV

ORVR Fuel Tank Vapor Control Valve

ORVR-FTVRV

ORVR Fuel Tank Vapor Recirculation Valve

ORVR-FVRS

ORVR Fuel Vapor Recovery System

ORVR-FVV

ORVR Fuel Vent Valve

ORVR-LV

ORVR Leveling Valve

ORVR-OCKV

ORVR Overfill Check Valve

ORVR-RCV

ORVR Refueling Control Valve

ORVR-VCV

ORVR Vapor Cut Valve

ORVR-VRV

ORVR Vapor Recirculating Valve

ORVR-VSV

ORVR Vent Shut Valve

ORVR-VV

ORVR Vent Valve

OVCV

Outer Vent Control Valve

O2S

Oxygen Sensor

"P"

PAIR

Pulsed Secondary Air Injection

PAIR-ABV

PAIR Anti-Backfire Valve

PAIR-ACOV

PAIR Air Cut-Off Valve

PAIR-ACS

PAIR Air Control Solenoid

PAIR-ACV

PAIR Air Control Valve

PAIR-AIV

PAIR Air Injection Valve

PAIR-ASCS

PAIR Air Suction Control Solenoid

PAIR-ASOV

PAIR Air Shutoff Valve

PAIR-ASS

PAIR Air Switching Solenoid

PAIR-ASV

PAIR Air Switching Valve

PAIR-ASVL

PAIR Air Suction Valve

PAIR-AVCS

PAIR Air Valve Control Solenoid

PAIR-CSV

PAIR Control Solenoid Valve

PAIR-CKV

PAIR Check Valve

PAIR-DV

PAIR Diverter Valve

PAIR-PAF

PAIR Pulse Air Feeder

PAIR-PAV

PAIR Pulse Air Valve

PAIR-RES

PAIR Resonator

PAIR-RV

PAIR Reed Valve

PAIR-SCSV

PAIR Swirl Control Solenoid Valve

PAIR-SCV

PAIR Swirl Control Valve

PAIR-SOL

PAIR Solenoid

PAIR-VSV

PAIR Vacuum Switching Valve

PCM

Powertrain Control Module

PCV

Positive Crankcase Ventilation

PCV-DOV

PCV Dual Orifice Valve

PCV-HCB

PCV Heated Crankcase Breather

PCV-HE

PCV Heating Element

PCV-PRV

PCV Pressure Regulator Valve

PCV-SOL

PCV Solenoid

PEVR

Power Enrichment Vacuum Regulator

PPM

Parts Per Million

PTOX

Periodic Trap Oxidizer

PURCV

Purge Crankcase Ventilation

PVCS

Ported Valve Control System

PVCS-A

PVCS Actuator

PVCS-CS

PVCS Control Solenoid

PVLCS

Power Valve Control System

"R"

RC

NOx Reduction Catalyst

ROV

Rollover Valve

"S"

SAI-SV

Secondary Air Injection Shutoff Valve

SAIR-CV

Secondary Air Injection Control Valve

SC

Supercharged or Super Charger

SC MFI

Supercharged Multiport Fuel Injection

SCR

Selective Catalytic Reduction

SCSV

Swirl Control Solenoid Valve

SCV

Swirl Control Valve

SCV-A

SCV Actuator

SFI

Sequential Multiport Fuel Injection

SFI-MAF

SFI Mass Airflow Sensor

SFLS

Sub-Fuel Level Sensor

SOHC

Single Overhead Cam

SPK

Spark Controls

SPK-AVM

SPK Advance Vacuum Modulator

SPK-BVSV

SPK Bimetal Vacuum Switching Valve

SPK-CC

SPK Computer Controlled

SPK-CKV

SPK Check Valve

SPK-CSSA

SPK Cold Start Spark Advance System

SPK-CSSH

SPK Cold Start Spark Hold System

SPK-CTO

SPK Coolant Temperature Override

SPK-DAVS

SPK Distributor Vacuum Advance Solenoid

SPK-DCKV

SPK Distributor Check Valve

SPK-DCTO

SPK Dual Coolant Temperature Override

SPK-DDD

SPK Dual Diaphragm Distributor

SPK-DMV

SPK Distributor Modulator Valve

SPK-DPD

SPK Dual Point Distributor

SPK-DPVS

SPK Distributor Ported Vacuum Switch

SPK-DRCV

SPK Distributor Retard Control Valve

SPK-DRS

SPK Distributor Retard Solenoid

SPK-DSVMV

SPK Distributor Spark Vacuum Modulator Valve

SPK-DTVS

SPK Distributor Thermal Vacuum Switch

SPK-DTVV

SPK Distributor Thermal Vacuum Valve

SPK-DV

SPK Delay Valve

SPK-DVA

SPK Distributor Vacuum Advance

SPK-DVAS

SPK Distributor Vacuum Advance Solenoid

SPK-DVCS

SPK Distributor Vacuum Control Solenoid

SPK-DVCSW

SPK Distributor Vacuum Controlled Switch

SPK-DVCV

SPK Distributor Vacuum Control Valve

SPK-DVDV

SPK Distributor Vacuum Delay Valve

SPK-DVRS

SPK Distributor Vacuum Retard Switch

SPK-DVRV

SPK Distributor Vacuum Regulating Valve

SPK-DVVV

SPK Distributor Vacuum Vent Valve

SPK-EAVS

SPK Electronically Actuated Vacuum Switch

SPK-EDM

SPK Electronic Distributor Modulator

SPK-EI

SPK Electronic Ignition

SPK-ESA

SPK Electronic Spark Advance

SPK-ESC

SPK Electronic Spark Control (Retard)

SPK-ESS

SPK Electronic Spark Selection

SPK-EST

SPK Electronic Spark Timing

SPK-FDV

SPK Forward Delay Valve

SPK-HPCA

SPK Housing Pressure Cold Advance

SPK-ITCS

SPK Ignition Timing Control System

SPK-ITVS

SPK Ignition Timing Vacuum Switch

SPK-NLVR

SPK Non-Linear Vacuum Regulator

SPK-OSAC

SPK Orifice Spark Advance Control

SPK-PVA

SPK Ported Vacuum Advance

SPK-PVS

SPK Ported Vacuum Switch

SPK-RDO

SPK Retard Delay Orifice

SPK-RDV

SPK Reverse Delay Valve

SPK-RDVD

SPK Reverse Delay Valve (Dual)

SPK-RDVLV

SPK Retard Delay Valve

SPK-RDVS

SPK Reverse Delay Valve (Single)

SPK-RETS

SPK Retard Switch

SPK-SC

SPK Speed Controlled

SPK-SDV

SPK Spark Delay Valve

SPK-SOL

SPK Solenoid

SPK-SRRV

SPK Spark Relay Regulator Valve

SPK-TAVIA

SPK Temperature Activated Vacuum Ignition Advance

SPK-TCS

SPK Transmission Controlled Spark

SPK-TCSYS

SPK Timing Control System

SPK-TIDC

SPK Thermostatic Ignition Distributor Control

SPK-TV

SPK Thermal Valve

SPK-TVS

SPK Thermal Vacuum Switch

SPK-VACTO

SPK Vacuum Advance Coolant Temperature Override

SPK-VAS

SPK Vacuum Advance Solenoid

SPK-VAV

SPK Vacuum Advance Valve

SPK-VR

SPK Vacuum Retard

SPK-VRSW

SPK Vacuum Retard Switch

SPK-VSV

SPK Vacuum Switching Valve

SPK-VTCS

SPK Vacuum Timing Control System

SPL

Smoke Puff Limiter

SRI

Service Reminder Indicator

SSCA

Stepped Speed Control Actuator

SSCS

Stepped Speed Control Solenoid

STS

Service Throttle Soon Light

STVS

Secondary Throttle Valve System

SUB-HO2S

Sub-Heated Oxygen Sensor (after CAT)

SUB-O2S

Sub-Oxygen Sensor

SUB-TWC

Sub Three-Way Catalytic Converter

"T"

TAA

Turbo Air-To-Air

TAA

Throttle Actuator Assembly

TAB

Thermactor Air By-Pass

TAD

Thermactor Air Diverter

TAC

Thermostatic Air Cleaner

TBI

Throttle Body Injection

TBPCS

Throttle By-Pass Control System

TC

Turbo Charger

TCC

Torque Converter Clutch

TCCL

Torque Converter Control

TCD

Throttle Closing Dashpot

TC-DV

TC Delay Valve

TC-TVC

TC Thermal Vacuum Switch

TC-VS

TC Vacuum Switch

TD

Thermactor Diverter

TFT

Tank Fuel Temperature Sensor

THOS2

Third Heated Oxygen Sensor

TICV

Thermal Ignition Control Valve

TIV

Thermal Idle Valve

TK

Throttle Kicker

TLUC

Transmission Lock-Up Converter

TLUC-TVS

TLUC Thermal Vacuum Switch

TLUC-VS

TLUC Vacuum Switch

TM

Throttle Modulator

TOS

Throttle Opener System

TP

Throttle Positioner

TPI

Tuned Port Fuel Injection

TPV

Throttle Poppet Valve

TR

Thermal Reactor

TRC

Throttle Return Control

TRCS

Throttle Return Control Solenoid

TRCTL

Throttle Return Control Throttle Lever Actuator

TRSCV

Throttle Return Solenoid Control Valve

TRTVV

Temperature Regulator Thermal Vacuum Valve

TRVV

Transmission Vacuum Valve

TSOL

Throttle Solenoid

TVISD

Throttle Vacuum Idle Speed Diaphragm

TVM

Transmission Vacuum Modulator

TVS

Thermal Vacuum Switch

TWC

Three-Way Catalytic Converter

TWC+OC

Three-Way + Oxidation Catalytic Converter

"V"

VA

Vacuum Advance Unit

VAC-AMP

Vacuum Amplifier

VA-CTO

VA Coolant Temperature Override

VC

Vapor Canister

VCV

Vacuum Cut Valve

VCV-BV

VCV By-Pass Valve

VLFR

Vent Line Flow Restrictor/Anti-Trickle Fill Valve

"W"

WU

Warm-Up Catalyst

WU-OC

Warm-Up Oxidation Converter

WU-TWC

Warm-Up Three-Way Catalytic Converter

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GENERAL INFORMATION

Engine Overhaul Procedures

* PLEASE READ THIS FIRST *

NOTE: **Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.**

Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

DESCRIPTION

Examples used in this article are general in nature and do not necessarily relate to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of cleaning, inspection, and assembly processes are included.

ENGINE IDENTIFICATION

Engine may be identified from Vehicle Identification Number (VIN) stamped on a metal tab. Metal tab may be located in different locations depending on manufacturer. Engine identification number or serial number is located on cylinder block. Location varies with each manufacturer.

INSPECTION PROCEDURES

*** PLEASE READ THIS FIRST ***

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GENERAL

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section for complete overhaul procedures and specifications for the vehicle being repaired.

Engine components must be inspected to meet manufacturer's specifications and tolerances during overhaul. Proper dimensions and tolerances must be met to obtain proper performance and maximum engine life.

Micrometers, depth gauges and dial indicator are used for checking tolerances during engine overhaul. Magnaflux, Magnaglo, dye-check, ultrasonic and x-ray inspection procedures are used for parts inspection.

MAGNETIC PARTICLE INSPECTION

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Magnaflux & Magnaglo

Magnaflux is an inspection technique used to locate material flaws and stress cracks. Component is subjected to a strong magnetic field. Entire component or a localized area can be magnetized. Component is coated with either a wet or dry material that contains fine magnetic particles.

Cracks which are outlined by the particles cause an interruption of magnetic field. Dry powder method of Magnaflux can be used in normal lighting and crack appears as a bright line.

Fluorescent liquid is used along with a Black light in the Magnaglo Magnaflux system. Darkened room is required for this procedure. The crack will appear as a glowing line. Complete demagnetizing of component upon completion is required on both procedures. Magnetic particle inspection applies to ferrous materials only.

PENETRANT INSPECTION

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Zyglo

The Zyglo process coats material with a fluorescent dye penetrant. Component is often warmed to expand cracks that will be penetrated by the dye. Using darkened room and Black light, component is inspected for cracks. Crack will glow brightly.

Developing solution is often used to enhance results. Parts made of any material, such as aluminum cylinder heads or plastics, may be tested using this process.

Dye Check

Penetrating dye is sprayed on the previously cleaned component. Dye is left on component for 5-45 minutes, depending upon material density. Component is then wiped clean and sprayed with a developing solution. Surface cracks will show up as a bright line.

ULTRASONIC INSPECTION

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If an expensive part is suspected of internal cracking, ultrasonic testing is used. Sound waves are used for component inspection.

X-RAY INSPECTION

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This form of inspection is used on highly stressed components. X-ray inspection may be used to detect internal and external flaws in any material.

PRESSURE TESTING

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Cylinder heads can be tested for cracks using a pressure tester. Pressure testing is performed by plugging all but one of the holes of cylinder head and injecting air or water into the open passage.

Leaks are indicated by the appearance of wet or damp areas when using water. When air is used, it is necessary to spray the head surface with a soap solution. Bubbles will indicate a leak. Cylinder head may also be submerged in water heated to specified temperature to check for cracks created during heat expansion.

CLEANING PROCEDURES

* PLEASE READ THIS FIRST *

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GENERAL

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All components of an engine do not have the same cleaning requirements. Physical methods include bead blasting and manual removal. Chemical methods include solvent blast, solvent tank, hot tank, cold tank and steam cleaning of components.

BEAD BLASTING

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Manual removal of deposits may be required prior to bead blasting, followed by some other cleaning method. Carbon, paint and rust may be removed using bead blasting method. Components must be free of oil and grease prior to bead blasting. Beads will stick to grease or oil soaked areas causing area not to be cleaned.

Use air pressure to remove all trapped residual beads from component after cleaning. After cleaning internal engine parts made of aluminum, wash thoroughly with hot soapy water. Component must be thoroughly cleaned as glass beads will enter engine oil resulting in bearing damage.

CHEMICAL CLEANING

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Solvent tank is used for cleaning oily residue from components. Solvent blasting sprays solvent through a siphon gun using compressed air.

The hot tank, using heated caustic solvents, is used for cleaning ferrous materials only. DO NOT clean aluminum parts such as cylinder heads, bearings or other soft metals using the hot tank. After cleaning, flush parts with hot water.

A non-ferrous part will be ruined and caustic solution will be diluted if placed in the hot tank. Always use eye protection and gloves when using the hot tank.

Use of a cold tank is for cleaning aluminum cylinder heads, carburetors and other soft metals. A less caustic and unheated solution is used. Parts may be left in the tank for several hours without damage. After cleaning, flush parts with hot water.

Steam cleaning, with boiling hot water sprayed at high pressure, is recommended as the final cleaning process when using either hot or cold tank cleaning.

COMPONENT CLEANING

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SHEET METAL PARTS

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being repaired.

Examples of sheet metal parts are rocker covers, front and side covers, oil pan and bellhousing dust cover. Glass bead blasting or hot tank may be used for cleaning.

Ensure all mating surfaces are flat. Deformed surfaces should be straightened. Check all sheet metal parts for cracks and dents.

INTAKE & EXHAUST MANIFOLDS

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Using solvent cleaning or bead blasting, clean manifolds for inspection. If intake manifold has an exhaust crossover, all carbon deposits must be removed. Inspect manifolds for cracks, burned or eroded areas, corrosion and damage to fasteners.

Exhaust heat and products of combustion cause threads of fasteners to corrode. Replace studs and bolts as necessary. On "V" type intake manifolds, sheet metal oil shield must be removed for proper cleaning and inspection. Ensure all manifold parting surfaces are flat and free of burrs.

CYLINDER HEAD REPLACEMENT

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REMOVAL

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Remove intake and exhaust manifolds and valve cover. Cylinder head and camshaft carrier bolts (if equipped) should be removed only when engine is cold. On many aluminum cylinder heads, removal while hot will cause cylinder head warpage. Mark rocker arm or overhead cam components for location.

Remove rocker arm components or overhead cam components. Components must be installed in original location. Individual design rocker arms may utilize shafts, ball-type pedestal mounts or no rocker arms. For all design types, wire components together and identify according to corresponding valve. Remove cylinder head bolts. Note length and location. Some applications require cylinder head bolts be removed in proper sequence to prevent cylinder head damage. See **Fig. 1**. Remove cylinder head.

INSTALLATION

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Ensure all surfaces and head bolts are clean. Check that head bolt holes of cylinder block are clean and dry to prevent block damage when bolts are tightened. Clean threads with tap to ensure accurate bolt torque.

Install head gasket on cylinder block. Some manufacturers may recommend sealant be applied to head gasket prior to installation. Note that all holes are aligned. Some gasket applications may be marked so that certain area faces upward. Install cylinder head using care not to damage head gasket. Ensure cylinder head is fully seated on cylinder block.

Some applications require head bolts be coated with sealant prior to installation. This is done if head bolts are exposed to coolant passages. Some applications require head bolts be coated with light coat of engine oil.

Install head bolts. Head bolts should be tightened in proper steps and sequence to specification. See **Fig. 1**. Install remaining components. Tighten all bolts to specification. Adjust valves if required. See VALVE ADJUSTMENT.

NOTE: **Some manufacturers require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.**

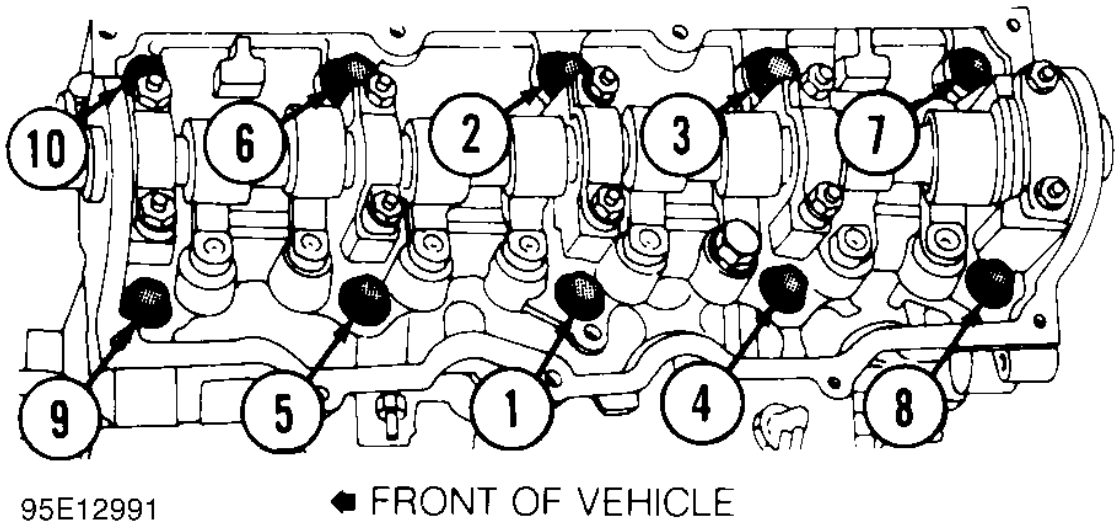

Fig. 1: Typical Cylinder Head Tightening or Loosening Sequence

VALVE ADJUSTMENT

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Engine specifications will indicate valve train clearance and temperature at which adjustment is to be made on most models. In most cases, adjustment will be made with a cold engine. In some cases, both a cold and a hot clearance will be given for maintenance convenience.

On some models, adjustment is not required. Rocker arms are tightened to specification and valve lash is automatically set. On some models with push rod actuated valve train, adjustment is made at push rod end of rocker arm while other models do not require adjustment.

Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer's specifications.

Some models require hydraulic lifter to be bled down and clearance measured. Push rods of different length can be used to obtain proper clearance. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge.

Overhead cam engines designed without rocker arms actuate valves directly on a cam follower. A hardened, removable disc is installed between the cam lobe and lifter. Clearance will be checked between cam heel and

adjusting disc in proper sequence using a feeler gauge. Engine will be rotated to obtain all valve adjustments.

On overhead cam engines designed with rocker arms, adjustment is made at valve end of rocker arm. Ensure valve to be adjusted is riding on heel of cam on all engines. Clearance will be checked between tip of rocker arm and tip of valve stem in proper sequence using a feeler gauge. Adjustment is made by rotating adjusting screw until proper clearance is obtained. Lock nut is then tightened. Engine will be rotated to obtain all valve adjustments to manufacturer's specifications.

CYLINDER HEAD OVERHAUL

*** PLEASE READ THIS FIRST ***

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CYLINDER HEAD DISASSEMBLY

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Mark valves for location. Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator, valve spring, spring seat and valve. See **Fig. 2**.

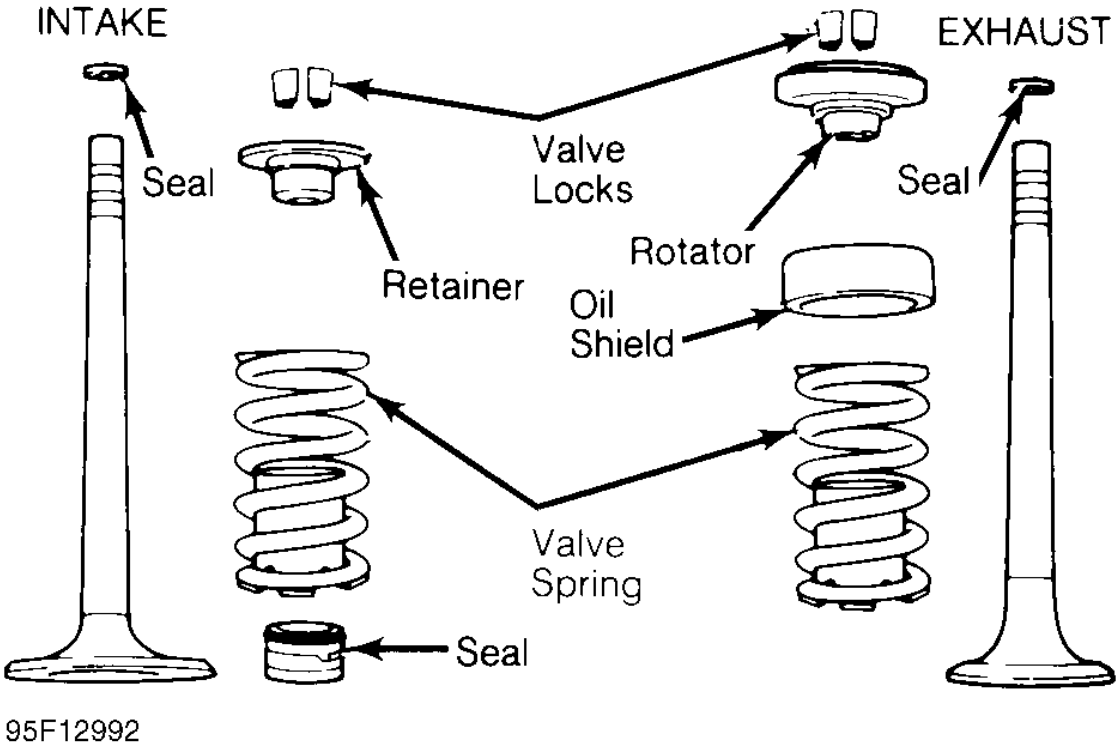

Fig. 2: Exploded View of Valve Assemblies

CYLINDER HEAD CLEANING & INSPECTION

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Clean cylinder head and valve components using approved cleaning methods. Inspect cylinder head for cracks, damage or warped gasket surface. Place straightedge across gasket surface. Determine clearance at center of straightedge. Measure across both diagonals, longitudinal center line and across cylinder head at several points. See **Fig. 3**.

On cast iron cylinder heads, if warpage exceeds .003" (.08 mm) in a 6" span, or .006" (.15 mm) over total length, cylinder head must be resurfaced. On most aluminum cylinder heads, if warpage exceeds .002" (.05 mm) in any area, cylinder head must be resurfaced. Warpage specification may vary by manufacturer. If warpage exceeds specification on some cylinder heads, cylinder head must be replaced.

Cylinder head thickness should be measured to determine amount of material which can be removed before replacement is required. Cylinder head thickness must not be less than the manufacturer's specification.

If cylinder head required resurfacing, it may not align properly with intake manifold. On "V" type engines, misalignment is corrected by machining intake manifold surface that contacts cylinder head. Cylinder head may be machined on surface that contacts intake manifold. Using oil stone, remove burrs or scratches from all sealing surfaces.

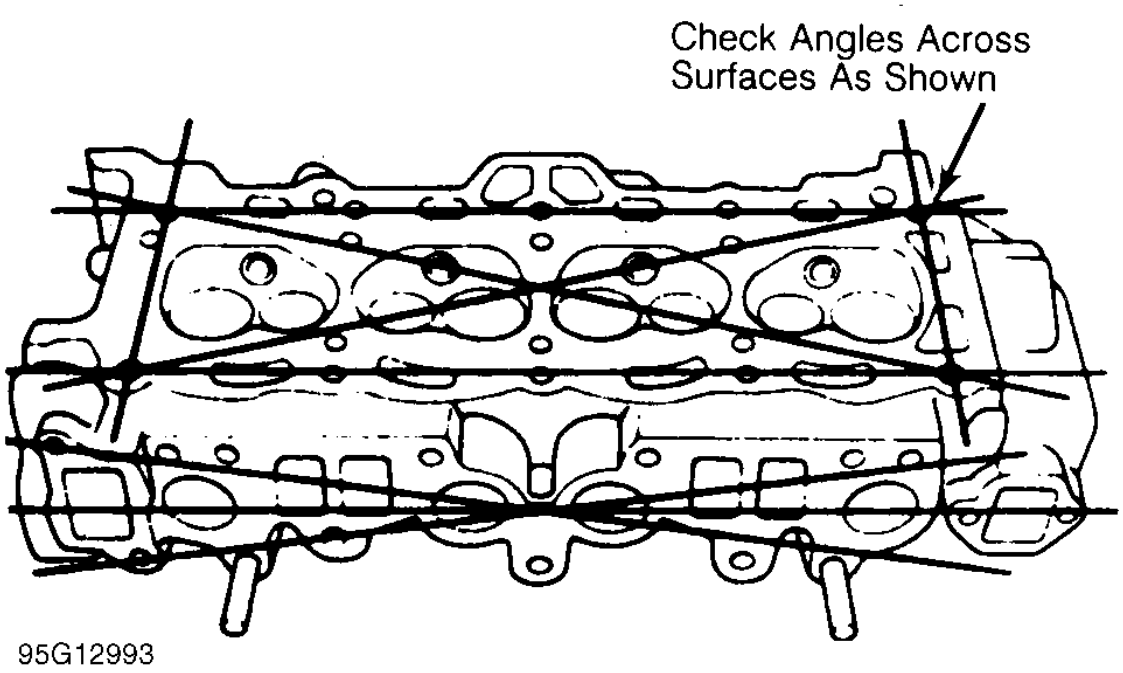

Fig. 3: Checking Cylinder Head for Warpage

VALVE SPRINGS

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Inspect valve springs for corroded or pitted valve spring surfaces which may lead to breakage. Polished spring ends caused by a rotating spring indicate that spring surge has occurred. Replace springs showing evidence of these conditions.

Inspect valve springs for squareness using a 90-degree straightedge. See **Fig. 4**. Replace valve spring if out-of-square exceeds manufacturer's specification.

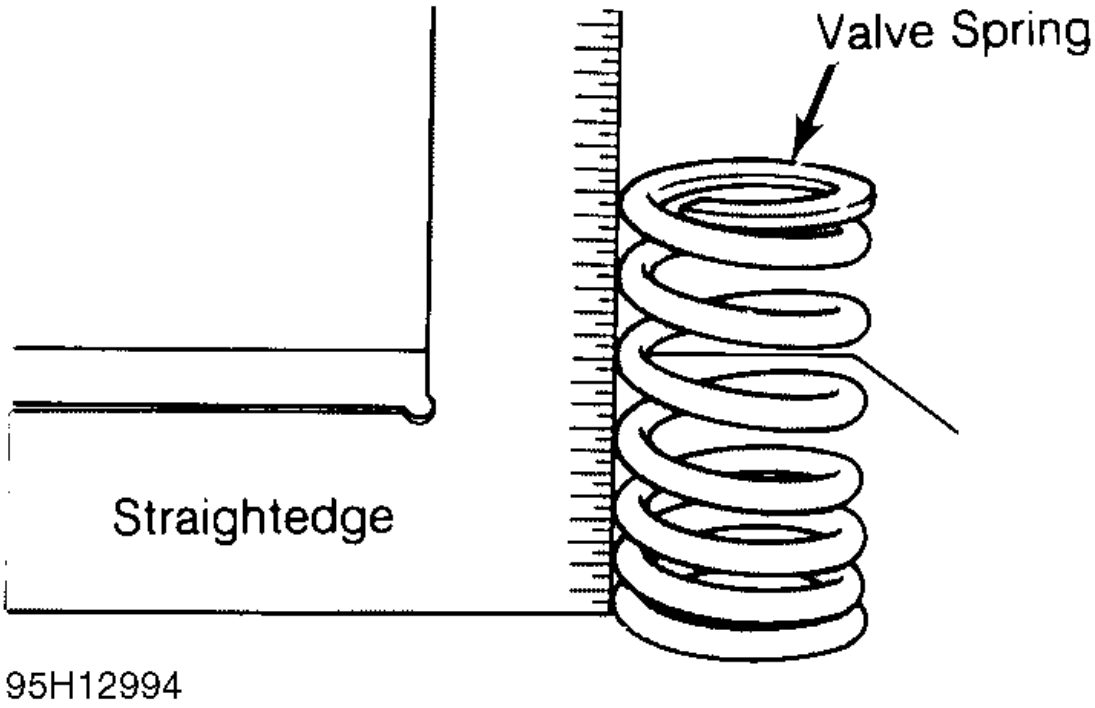

Fig. 4: Checking Valve Spring Squareness

Using vernier caliper, measure free length of all valve springs. Replace springs if not within specification. Using valve spring tester, test valve spring pressure at installed and compressed heights. See **Fig. 5**.

Usually compressed height is installed height minus valve lift. Replace valve spring if not within specification. It is recommended to replace all valve springs when overhauling cylinder head. Valve springs may need to be installed with color coded end or small coils at specified area according to manufacturer.

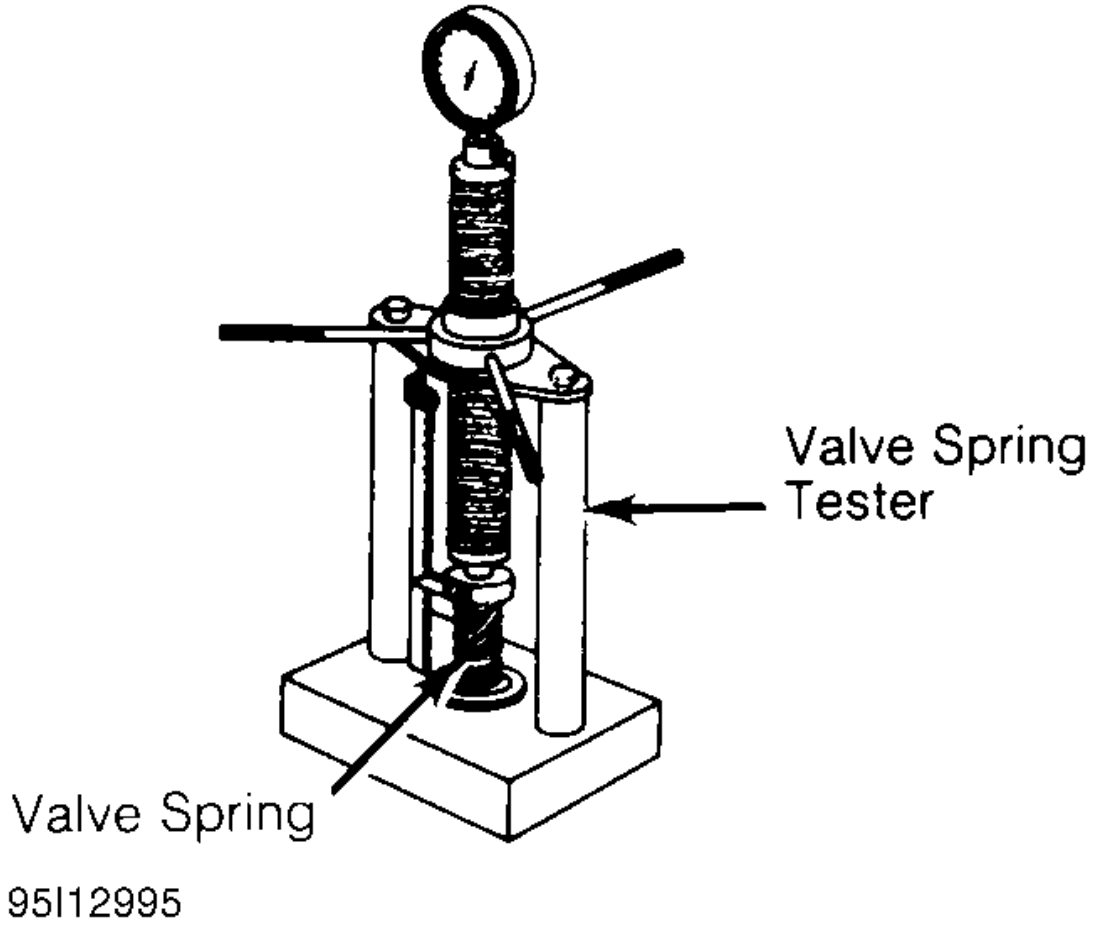

Fig. 5: Checking Valve Spring Pressure

VALVE GUIDE

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Measuring Valve Guide Clearance

Check valve stem-to-guide clearance. Ensure valve stem diameter is within specification. Install valve in valve guide. Install dial indicator assembly on cylinder head with tip resting against valve stem just above valve guide. See **Fig. 6**.

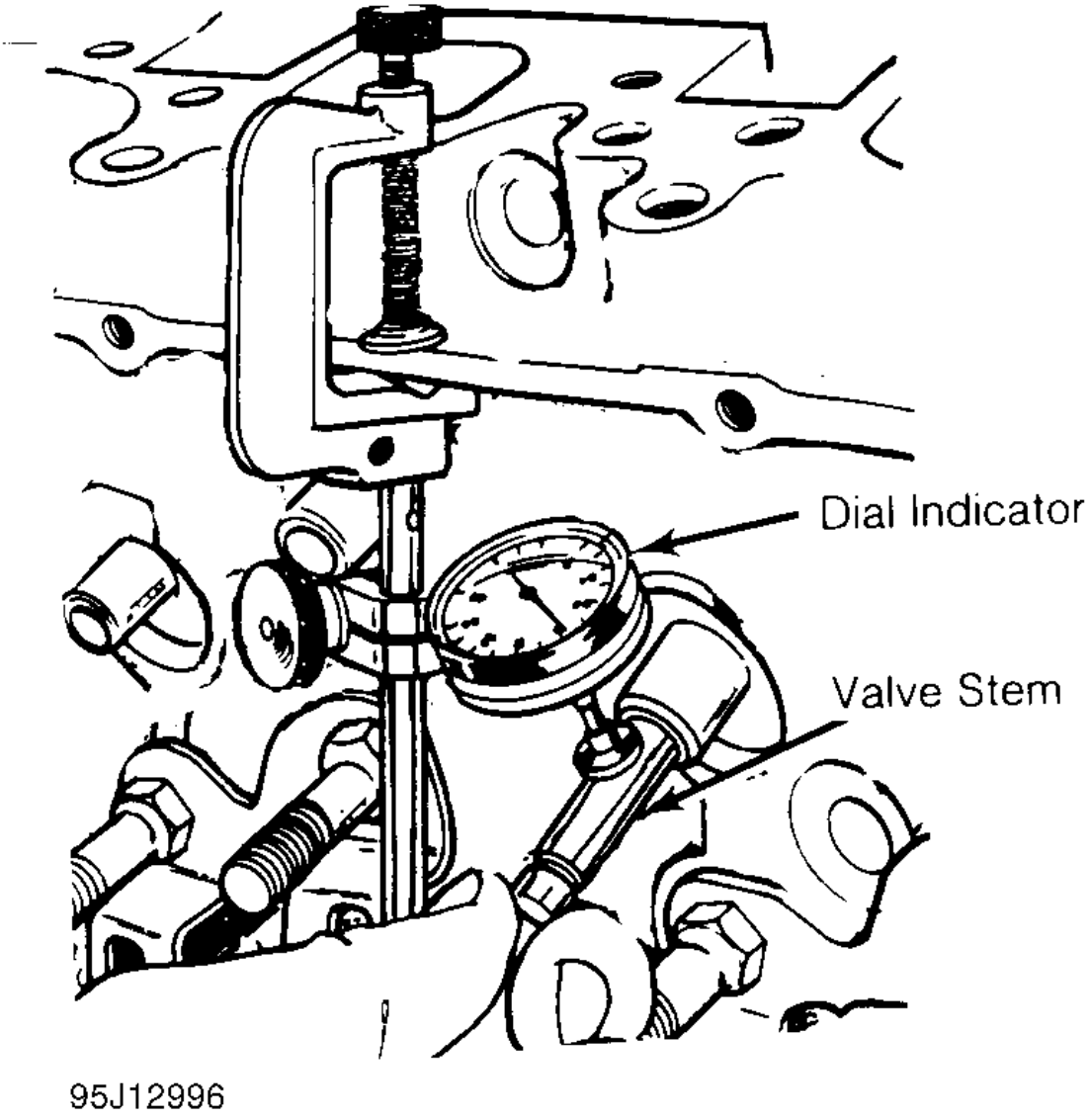

Fig. 6: Measuring Valve Stem-to-Guide Clearance

Lower valve approximately 1/16" below valve seat. Push valve stem against valve guide as far as possible. Adjust dial indicator to zero. Push valve stem in opposite direction and note reading. Clearance must be within specification.

If valve guide clearance exceeds specification, valves with oversize stems may be used and valve guides are reamed to larger size or valve guide must be replaced. On some applications, a false guide is installed, then reamed to proper specification. Valve guide reamer set is used to ream valve guide to obtain proper clearance for new valve.

Reaming Valve Guide

Select proper reamer for size of valve stem. Reamer must be of proper length to provide clean cut through entire

length of valve guide. Install reamer in valve guide and rotate to cut valve guide. See **Fig. 7**.

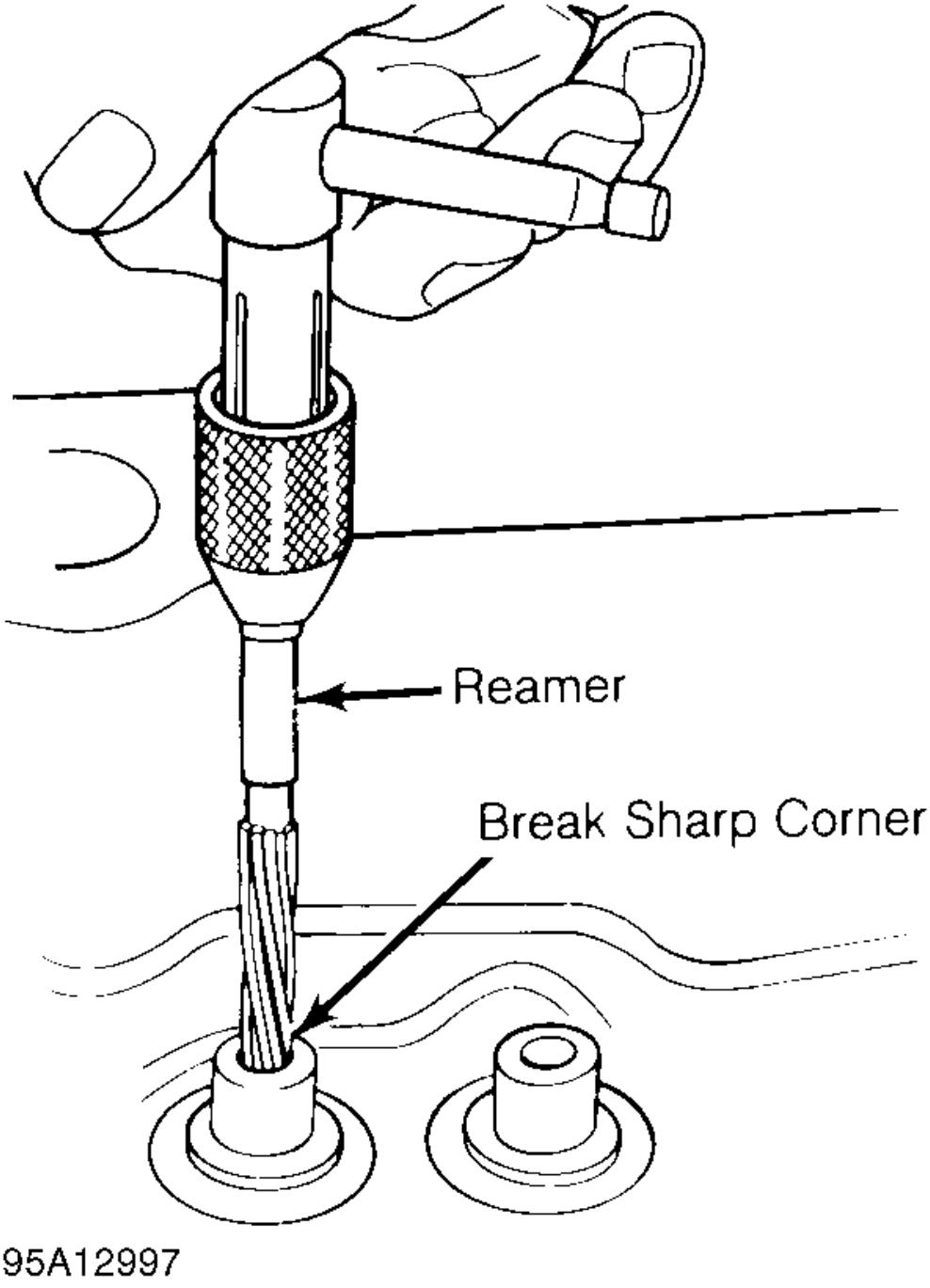

Fig. 7: Reaming Valve Guides

Replacing Valve Guide

Replace valve guide if clearance exceeds specification. Valve guides are either pressed, hammered or shrunk in

place, depending upon cylinder head design and type of metal used.

Remove valve guide from cylinder head by pressing or tapping on a stepped drift. See **Fig. 8**. Once valve guide is installed, distance from cylinder head to top of valve guide must be checked. This distance must be within specification.

Aluminum heads are often heated before installing valve guide. Valve guide is sometimes cooled in dry ice prior to installation. Combination of a heated cylinder head and cooled valve guide ensures a tight guide fit upon assembly. The new guide must be reamed to specification.

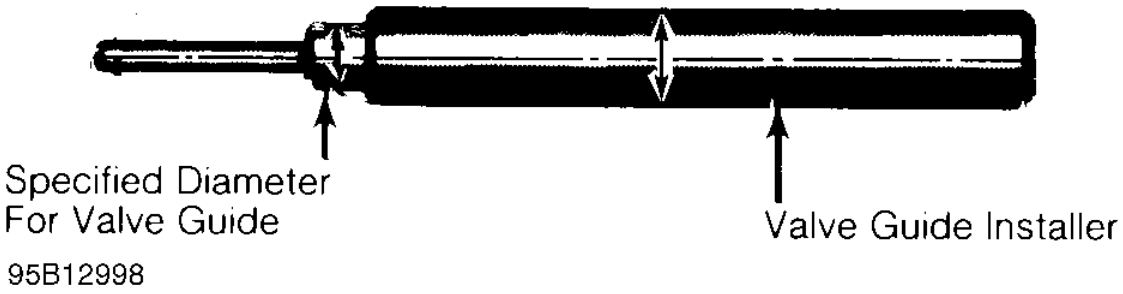

Fig. 8: Typical Valve Guide Remover & Installer

VALVES & VALVE SEATS

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Valve Grinding

Valve stem O.D. should be measured in several areas to indicate amount of wear. Replace valve if not within specification. Valve margin area should be measured to ensure that valve can be ground. See **Fig. 9**.

If valve margin is less than specification, the valves will be burned. Valve must be replaced. Due to minimum margin dimensions during manufacture, some new type valves cannot be reground. Some manufacturers use stellite coated valves that must NOT be machined. Valves can only be lapped into valve seat.

CAUTION: **Some valves are sodium filled. Extreme care must be used when disposing of damaged or worn sodium-filled valves.**

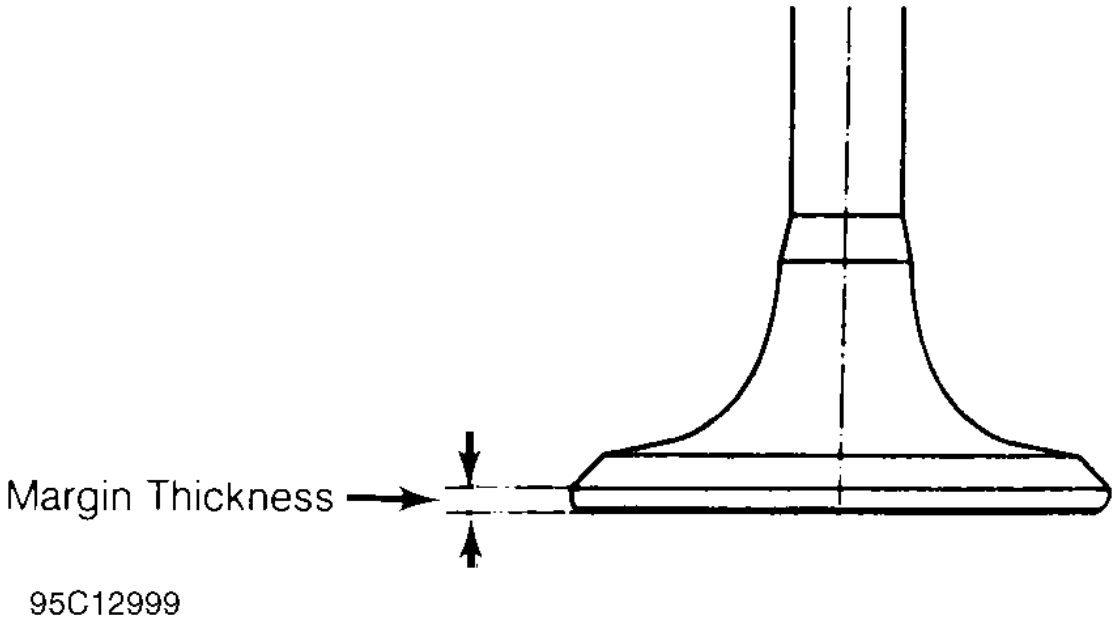

Fig. 9: Measuring Valve Head Margin

Resurface valve to proper angle specification using valve grinding machine. Follow manufacturer's instructions for valve grinding machine. Specifications may indicate a different valve face angle than seat angle. Measure valve margin after grinding. Replace valve if not within specification. Valve stem tip can be refinished using valve grinding machine.

Valve Lapping

During valve lapping of recently designed valves, be sure to follow manufacturer's recommendations. Surface hardening and materials used with some valves do not permit lapping. Lapping process will remove excessive amounts of the hardened surface.

Valve lapping is done to ensure adequate sealing between valve face and seat. Use either a hand drill or lapping stick with suction cup attached.

Moisten and attach suction cup to valve. Lubricate valve stem and guide. Apply a thin coat of fine valve grinding compound between valve and seat. Rotate lapping tool between the palms or with hand drill.

Lift valve upward off the seat and change position often. This is done to prevent grooving of valve seat. Lap valve until a smooth polished seat is obtained. Thoroughly clean grinding compound from components. Valve-to-valve seat concentricity should be checked. See **VALVE SEAT CONCENTRICITY**.

CAUTION: Valve guides must be in good condition and free of carbon deposits prior to valve seat grinding. Some engines contain an induction hardened valve seat. Excessive material removal will damage valve seats.

Valve Seat Grinding

Select coarse stone of correct size and angle for seat to be ground. Ensure stone is true and has a smooth surface. Select correct size pilot for valve guide dimension. Install pilot in valve guide. Lightly lubricate pilot shaft. Install stone on pilot. Move stone off and on the seat approximately 2 times per second during grinding operation.

Select a fine stone to finish grinding operation. Various angle grinding stones are used to center and narrow the valve seat as required. See **Fig. 10**.

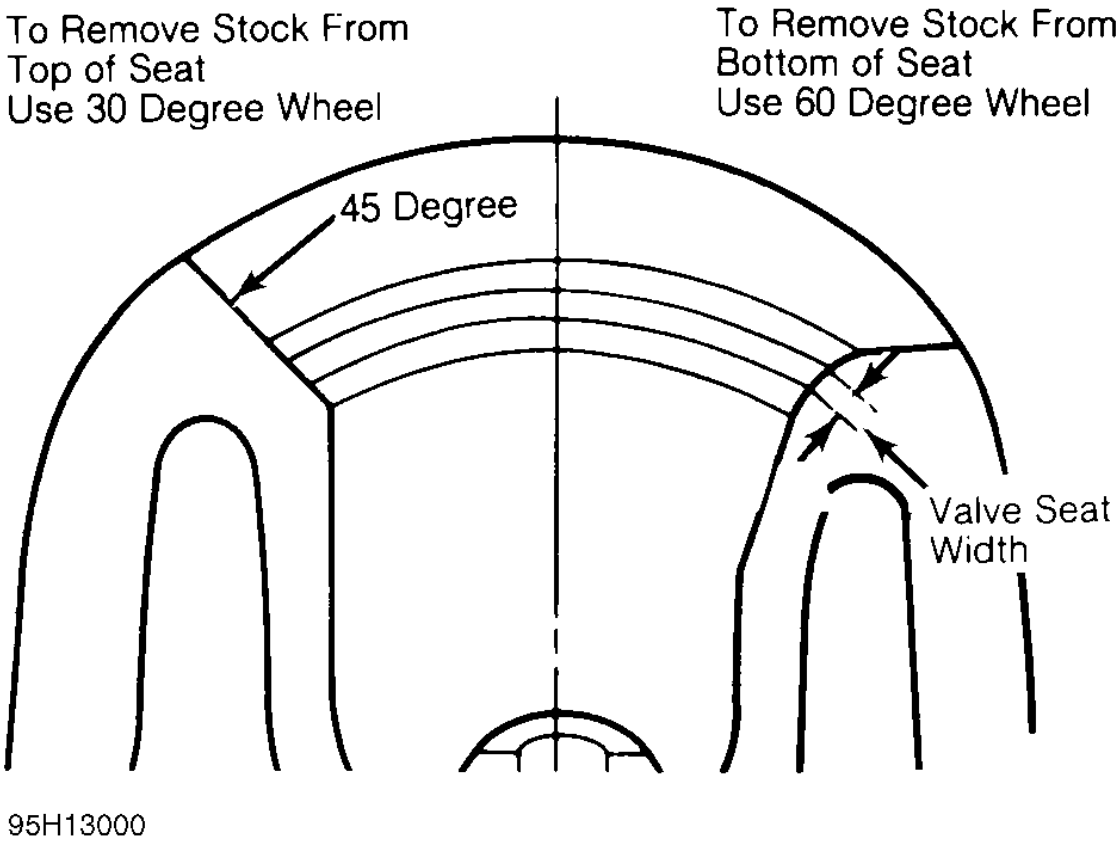

Fig. 10: Adjusting Valve Seat Width

Valve Seat Replacement

Replacement of valve seat inserts is done by cutting out the old insert and machining an oversize insert bore. Replacement oversize insert is usually cooled and the cylinder head is sometimes warmed. Valve seat is pressed into the head. This operation requires specialized machine shop equipment.

Valve Seat Concentricity

Using dial gauge, install gauge pilot in valve guide. Position gauge arm on the valve seat. Adjust dial indicator to zero. Rotate arm 360 degrees and note reading. Runout should not exceed specification.

To check valve-to-valve seat concentricity, coat valve face lightly with Prussian Blue dye. Install valve and rotate it on valve seat. If pattern is even and entire seat is coated at valve contact point, valve is concentric with

the valve seat.

CYLINDER HEAD REASSEMBLY

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Valve Stem Installed Height

Valve stem installed height must be checked when new valves are installed or when valves or valve seats have been ground. Install valve in valve guide. Measure distance from tip of valve stem to spring seat. See **Fig. 11**. Distance must be within specification to allow sufficient clearance for valve operation.

Remove valve and grind valve stem tip if height exceeds specification. Valve tips are surface hardened. DO NOT remove more than .010" (.25 mm) from tip. Chamfer sharp edge of reground valve tip. Recheck valve stem installed height.

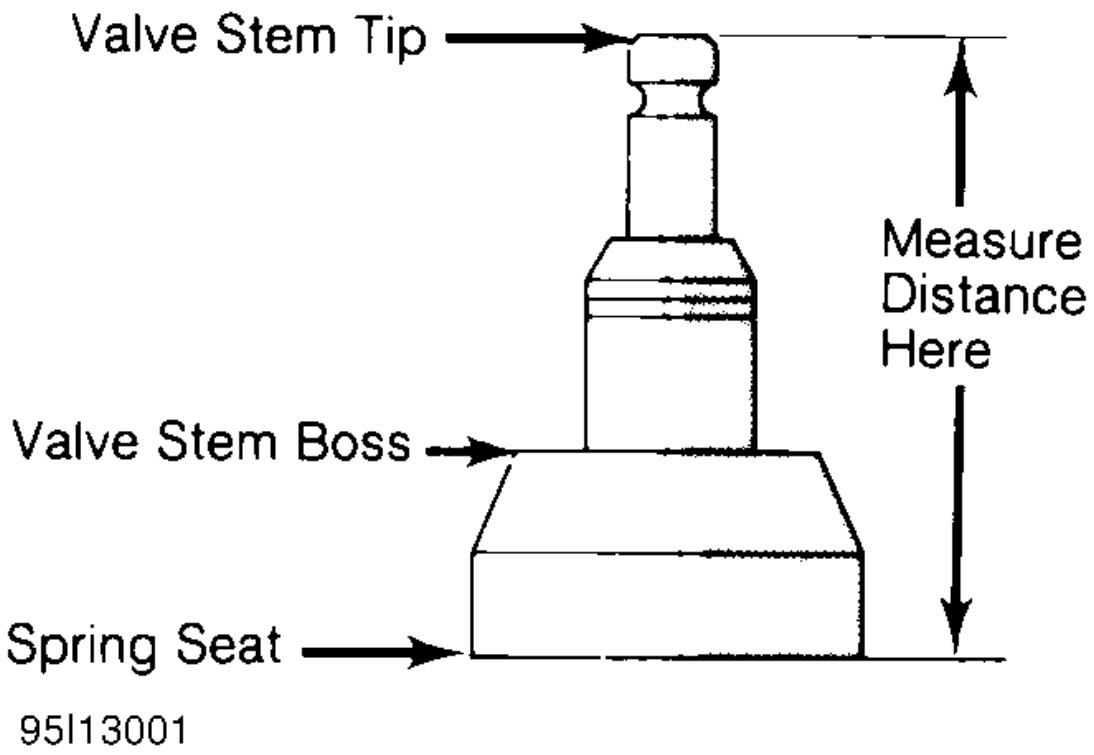

Fig. 11: Measuring Valve Stem Installed Height

VALVE STEM OIL SEALS

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Valve stem oil seals must be installed on valve stem. See **Fig. 2**. Seals are needed due to pressure differential at the ends of valve guides. Atmospheric pressure above intake guide, combined with manifold vacuum below guide, causes oil to be drawn into the cylinder.

Exhaust guides also have pressure differential created by exhaust gas flowing past the guide, creating a low pressure area. This low pressure area draws oil into the exhaust system.

Some manufacturers require that special color code or specified height valve stem oil seal be installed in designated area.

Replacement (On-Vehicle)

Mark rocker arm or overhead cam components for location. Remove rocker arm components or overhead cam components. Components must be installed in original location. Remove spark plugs. Valve stem oil seals may be replaced by holding valves against seats using air pressure.

Air pressure must be installed in cylinder using an adapter for spark plug hole. An adapter can be constructed by welding air hose connection to spark plug body with porcelain removed.

Rotate engine until piston is at top of stroke. Install adapter in spark plug hole. Apply a minimum of 140 psi (9.8 kg/cm^2) line pressure to adapter. Air pressure should hold valve closed. If air pressure does not hold valve closed, check for damaged or bent valve. Cylinder head must be removed for service.

Using valve spring compressor, compress valve springs. Remove valve locks. Carefully release spring compressor. Remove retainer or rotator and valve spring. Remove valve stem oil seal.

If oversize valves have been installed, oversize oil seals must be used. Coat valve stem with engine oil. Install protective sleeve over end of valve stem. Install new oil seal over valve stem and seat on valve guide. Remove protective sleeve. Install spring seat, valve spring and retainer or rotator. Compress spring and install valve locks. Remove spring compressor. Ensure valve locks are fully seated.

Install rocker arms or overhead cam components. Tighten all bolts to specification. Adjust valves if required. Remove adapter. Install spark plugs, valve cover and gasket.

VALVE SPRING INSTALLED HEIGHT

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Valve spring installed height should be checked during reassembly. Measure height from lower edge of valve spring to the upper edge. DO NOT include valve spring seat or retainer. Distance must be within specification. If valves and/or seats have been ground, a valve spring shim may be required to correct spring height. See **Fig. 12**.

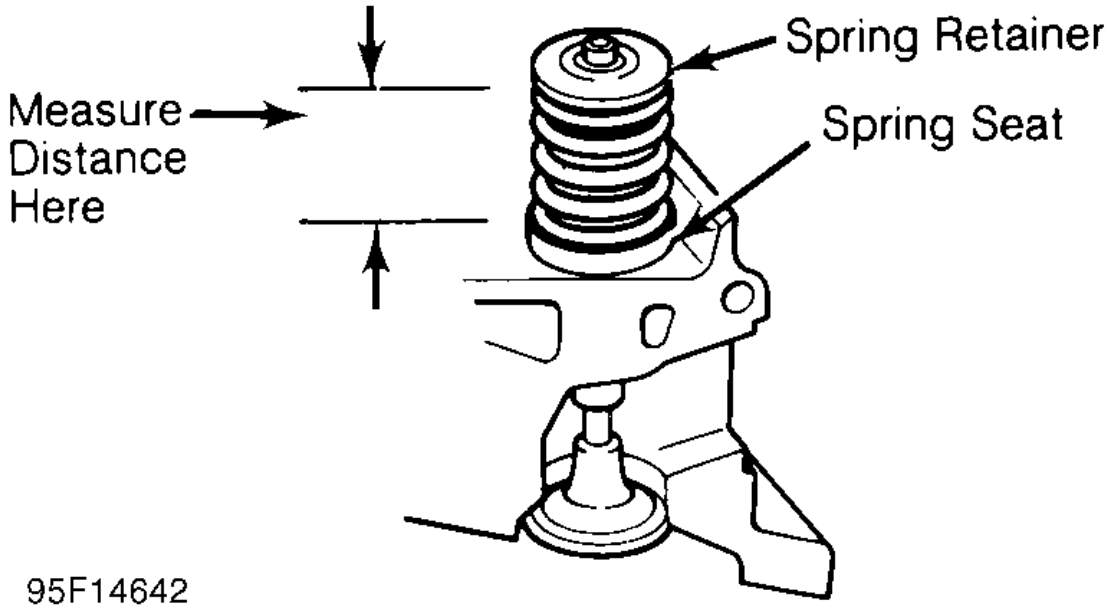

Fig. 12: Measuring Valve Spring Installed Height

ROCKER ARMS & ASSEMBLIES

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Rocker Studs

Rocker studs are either threaded or pressed in place. Threaded studs are removed by locking 2 nuts on the stud. Unscrew the stud by turning the jam nut. Coat new stud threads with Loctite and install. Tighten to

specification.

Pressed-in stud can be removed using a stud puller. Ream stud bore to proper specification and press in a new oversize stud. Pressed-in studs are often replaced by cutting threads in the stud bore to accept a threaded stud.

Rocker Arms & Shafts

Mark rocker arms for location. Remove rocker arm retaining bolts. Remove rocker arms. Inspect rocker arms, shafts, bushings and pivot balls (if equipped) for excessive wear. Inspect rocker arms for wear in valve stem contact area. Measure rocker arm bushing I.D. Replace bushings if excessively worn.

The rocker arm valve stem contact point may be reground, using special fixture for valve grinding machine. Remove minimum amount of material as possible. Ensure all oil passages are clear. Install rocker arm components in original location. Ensure rocker arm is properly seated in push rod. Tighten bolts to specification. Adjust valves if required. See **VALVE ADJUSTMENT**.

PUSH RODS

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Remove rocker arms. Mark push rods for location. Remove push rods. Push rods can be steel or aluminum, solid or hollow. Hollow push rods must be internally cleaned to ensure oil passage to rocker arms is cleaned. Check push rods for damage, such as loose ends on steel tipped aluminum types.

Check push rod for straightness. Roll push rod on a flat surface. Using feeler gauge, check clearance at center. Replace push rod if bent. The push rod can also be supported at each end and rotated. A dial indicator is used to detect a bent area in the push rod.

Lubricate ends of push rod and install push rod in original location. Ensure push rod is properly seated in lifter. Install rocker arm. Tighten bolts to specification. Adjust valves if required. See **VALVE ADJUSTMENT**.

LIFTERS

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Hydraulic Lifters

Before replacing a hydraulic lifter for noisy operation, ensure noise is not caused by worn rocker arms or valve tips. Also ensure sufficient oil pressure exists. Hydraulic lifters must be installed in original location. Remove rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold, cylinder head or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use a hydraulic lifter remover or magnet. Different type lifters are used. See **Fig. 13**.

On sticking lifters, disassemble and clean lifter. DO NOT mix lifter components or positions. Parts are select-fitted and are not interchangeable. Inspect all components for wear. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore for damage and lack of lubrication. On roller type lifters, inspect roller for flaking, pitting, loss of needle bearings and roughness during rotation.

Measure lifter body O.D. in several areas. Measure lifter bore I.D. Ensure components or oil clearance is within specification. Some models offer oversize lifters. Replace lifter if damaged.

If lifter check valve is not operating, obstructions may be preventing it from closing or valve spring may be broken. Clean or replace components as necessary.

Check plunger operation. Plunger should drop to bottom of the body by its own weight when assembled dry. If plunger is not free, soak lifter in solvent to dissolve deposits.

Lifter leak-down test can be performed on lifter. Lifter must be filled with special test oil. New lifters contain special test oil. Using lifter leak-down tester, perform leak-down test following manufacturer's instructions. If leak-down time is not within specifications, replace lifter assembly.

Lifters should be soaked in clean engine oil several hours prior to installation. Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. See **Fig. 13**. Install lifter in original location. Install remaining components. Valve lash adjustment is not required on most hydraulic lifters. Preload of hydraulic lifter is automatic. Some models may require adjustment.

NOTE: **Some manufacturers require that a crankcase conditioner be added to engine oil and engine operated for specified amount of time to aid in lifter break-in procedure if new lifters or camshaft are installed.**

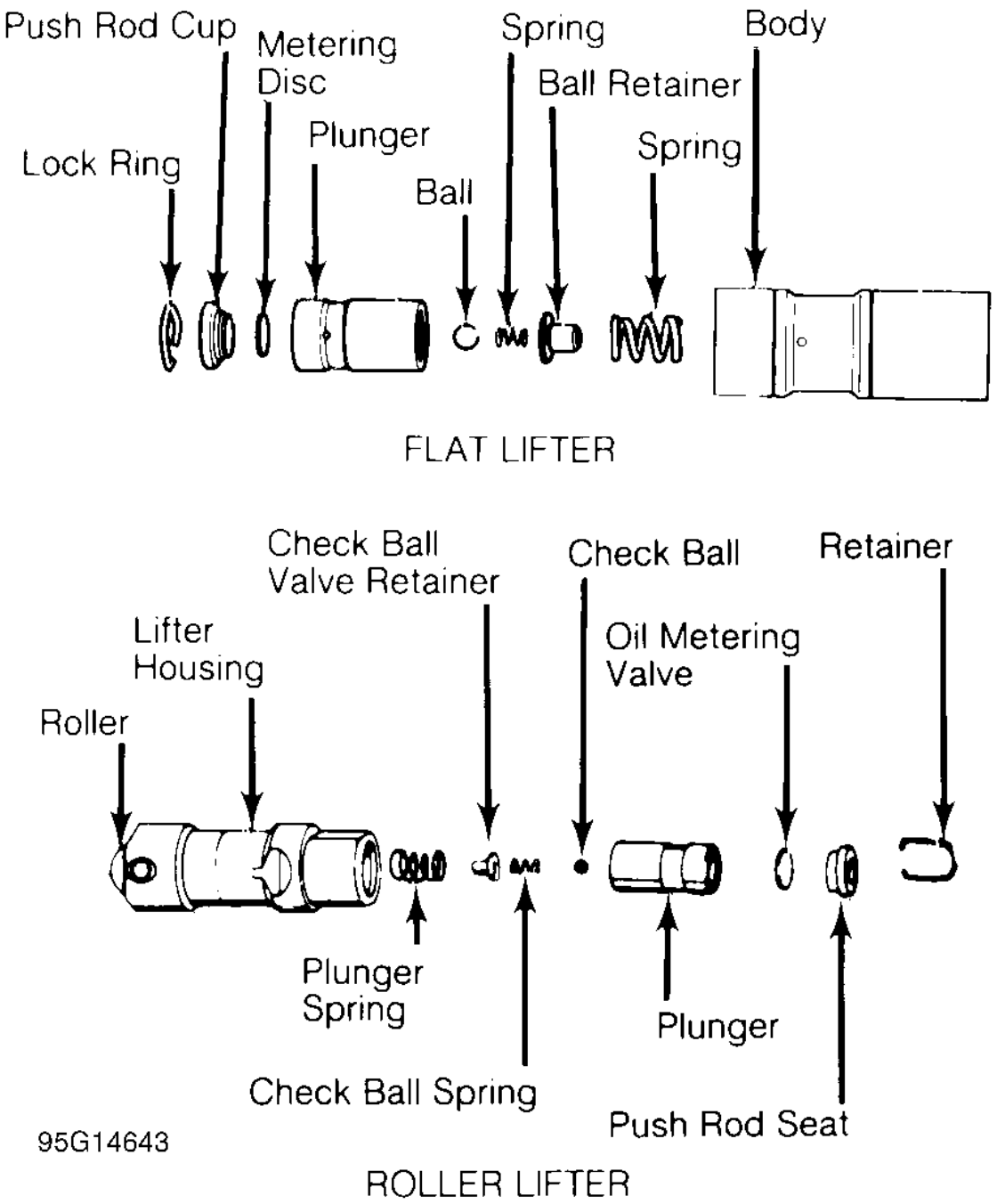

Fig. 13: Typical Hydraulic Valve Lifter Assemblies

Mechanical Lifters

Lifter assemblies must be installed in original locations. Remove rocker arm assembly and push rod. Mark components for location. Some applications require intake manifold or lifter cover removal. Remove lifter retainer plate (if used). To remove lifters, use lifter remover or magnet.

Inspect push rod contact area and lifter body for scoring or signs of wear. If body is scored, inspect lifter bore

for damage and lack of lubrication. Note amount of wear in lifter body-to-camshaft contact area. Surface must have smooth and convex contact face. If wear is apparent, carefully inspect cam lobe.

Coat lifter base, roller (if equipped) and lifter body with ample amount of Molykote or camshaft lubricant. Install lifter in original location. Install remaining components. Tighten bolts to specification. Adjust valves. See **VALVE ADJUSTMENT**.

PISTONS, CONNECTING RODS & BEARINGS

*** PLEASE READ THIS FIRST ***

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RIDGE REMOVAL

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Ridge in cylinder wall must be removed prior to piston removal. Failure to remove ridge prior to removing pistons will cause piston damage in piston ring lands or grooves.

With piston at bottom dead center, place rag in bore to trap metal chips. Install ridge reamer in cylinder bore. Adjust ridge reamer using manufacturer's instructions. Remove ridge using ridge reamer. DO NOT remove an excessive amount of material. Ensure ridge is completely removed.

PISTON & CONNECTING ROD REMOVAL

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Note top of piston. Some pistons may contain a notch, arrow or be marked FRONT. Piston must be installed in

proper direction to prevent damage with valve operation.

Check that connecting rod and cap are numbered for cylinder location and which side of cylinder block the number faces. Proper cap and connecting rod must be installed together. Connecting rod cap must be installed on connecting rod in proper direction to ensure bearing lock procedure. Mark connecting rod and cap if necessary. Pistons must be installed in original location.

Remove cap retaining nuts or bolts. Remove bearing cap. Install tubing protectors on connecting rod bolts. This protects cylinder walls from scoring during removal. Ensure proper removal of ridge. Push piston and connecting rod from cylinder. Connecting rod boss can be tapped with a wooden dowel or hammer handle to aid in removal.

PISTON & CONNECTING ROD

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Disassembly

Using ring expander, remove piston rings. Remove piston pin retaining rings (if equipped). Note direction of piston installation on connecting rod. On pressed type piston pins, special fixtures and procedures according to manufacturer must be used to remove piston pins. Follow manufacturer's recommendations to avoid piston distortion or breakage.

Cleaning

Remove all carbon and varnish from piston. Pistons and connecting rods may be cleaned in cold type chemical tank. Using ring groove cleaner, clean all deposits from ring grooves. Ensure all deposits are cleaned from ring grooves to prevent ring breakage or sticking. DO NOT attempt to clean pistons with wire brush.

Inspection

Inspect pistons for nicks, scoring, cracks or damage in ring areas. Connecting rod should be checked for cracks using Magnaflux procedure. Piston diameter must be measured in manufacturer's specified area.

Using telescopic gauge and micrometer, measure piston pin bore of piston in 2 areas, 90 degrees apart. This is done to check diameter and out-of-round.

Install proper bearing cap on connecting rod. Ensure bearing cap is installed in proper location. Tighten bolts or nuts to specification. Using inside micrometer, measure inside diameter in 2 areas, 90 degrees apart.

Connecting rod I.D. and out-of-round must be within specification. Measure piston pin bore I.D. and piston pin O.D. All components must be within specification. Subtract piston pin diameter from piston pin bore in piston and connecting rod to determine proper fit.

Connecting rod length must be measured from center of crankshaft journal inside diameter to center of piston pin bushing using proper caliper. Connecting rods must be the same length. Connecting rods should be checked on an alignment fixture for bent or twisted condition. Replace all components which are damaged or not within specification.

PISTON & CYLINDER BORE FIT

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Ensure cylinder is checked for taper, out-of-round and properly honed prior to checking piston and cylinder bore fit. See **CYLINDER BLOCK**. Using dial bore gauge, measure cylinder bore.

Measure piston skirt diameter at 90 degree angle to piston pin at specified area by manufacturer. Subtract piston diameter from cylinder bore diameter to determine piston-to-cylinder clearance. Clearance must be within specification. Mark piston for proper cylinder location.

ASSEMBLING PISTON & CONNECTING ROD

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Install piston on connecting rod for corresponding cylinder. Ensure reference marking on top of piston corresponds with connecting rod and cap number. See **Fig. 14**.

Lubricate piston pin and install in connecting rod. Ensure piston pin retainers are fully seated (if equipped). On pressed type piston pins, follow manufacturer's recommended procedure to avoid distortion or breakage.

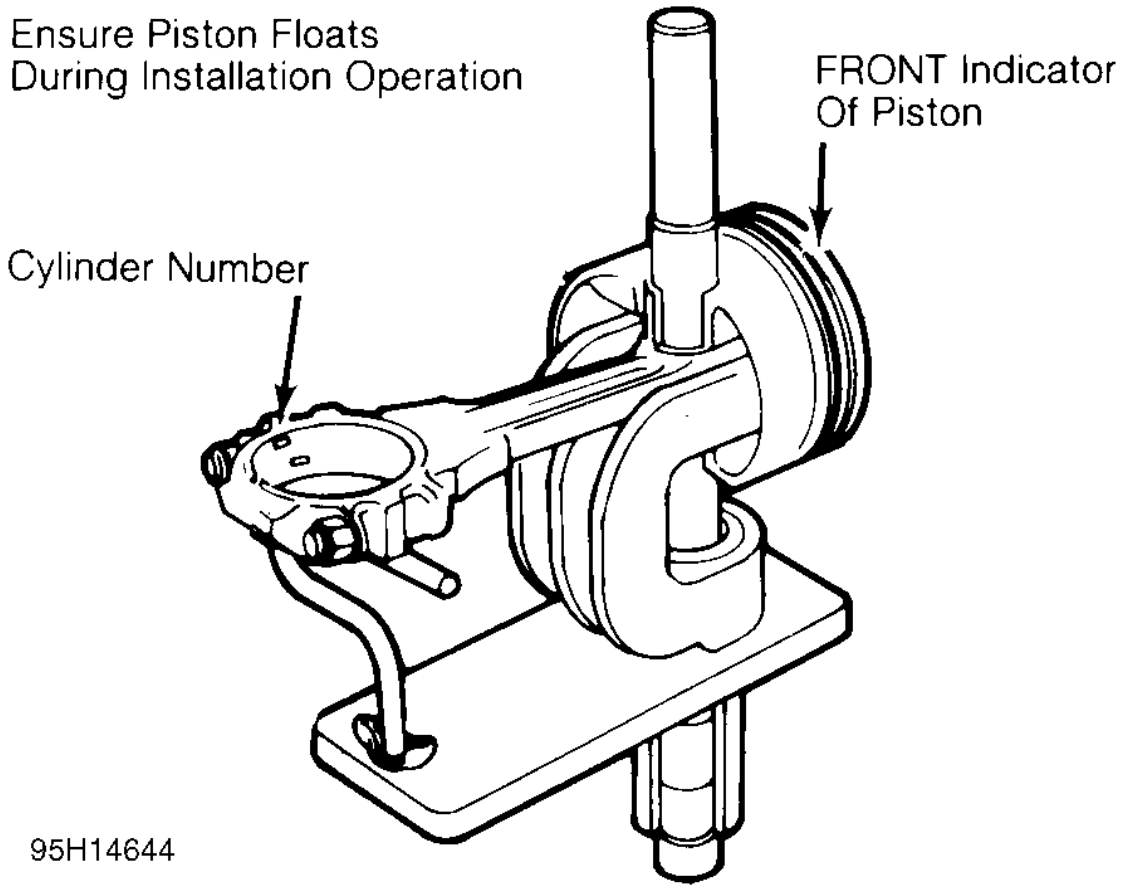

Fig. 14: Installing Typical Piston Pin

CHECKING PISTON RING CLEARANCES

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Piston rings must be checked for side clearance and end gap. To check end gap, install piston ring in cylinder in which it is to be installed. Using an inverted piston, push ring to bottom of cylinder in smallest cylinder diameter.

Using feeler gauge, check ring end gap. See **Fig. 15**. Piston ring end gap must be within specification. Ring breakage will occur if insufficient ring end gap exists.

Some manufacturers permit correcting insufficient ring end gap by using a fine file while other manufacturers

recommend using another ring set. Mark rings for proper cylinder installation after checking end gap.

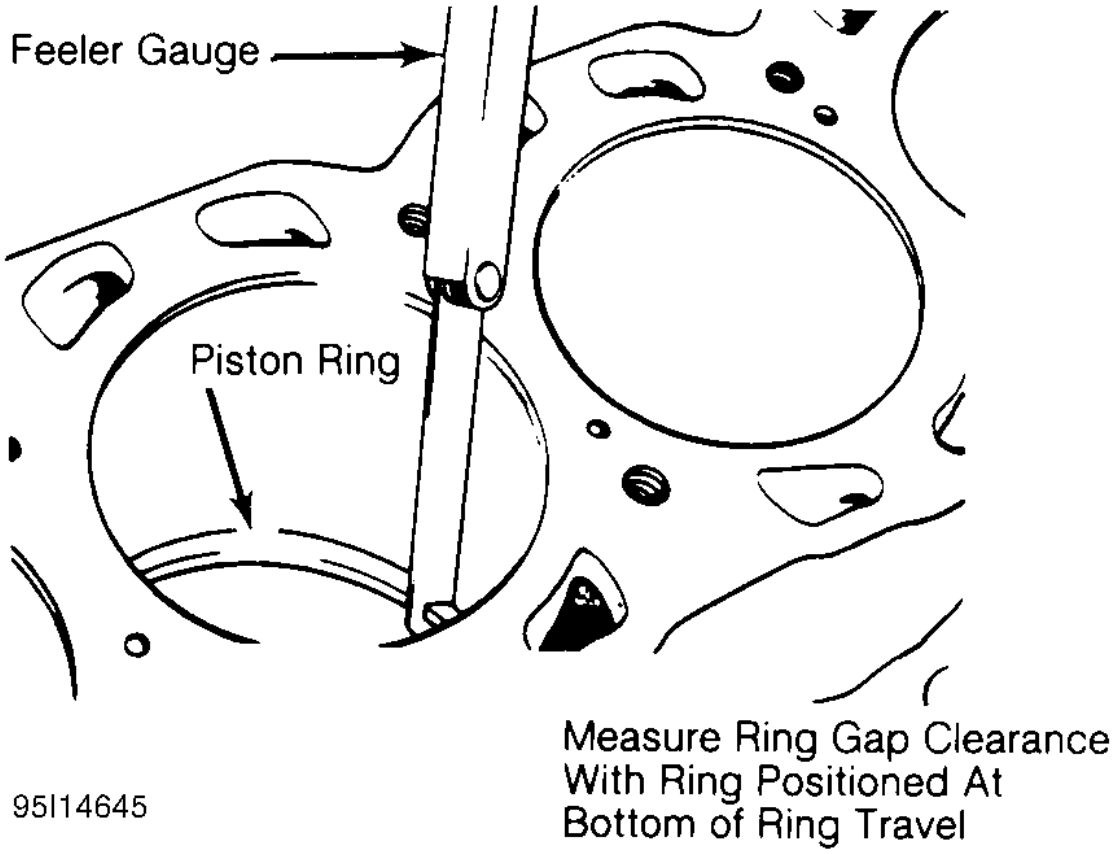

Fig. 15: Checking Piston Ring End Gap

For checking side clearance, install rings on piston. Using feeler gauge, measure clearance between piston ring and piston ring land. Check side clearance in several areas around piston. Side clearance must be within specification.

If side clearance is excessive, piston ring grooves can be machined to accept oversize piston rings (if available). Normal practice is to replace piston.

PISTON & CONNECTING ROD INSTALLATION

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Cylinders must be honed prior to piston installation. See **CYLINDER HONING** under CYLINDER BLOCK.

Install upper connecting rod bearings. Lubricate upper bearings with engine oil. Install lower bearings in rod caps. Ensure bearing tabs are properly seated. Position piston ring gaps according to manufacturer's recommendations. See **Fig. 16**. Lubricate pistons, rings and cylinder walls.

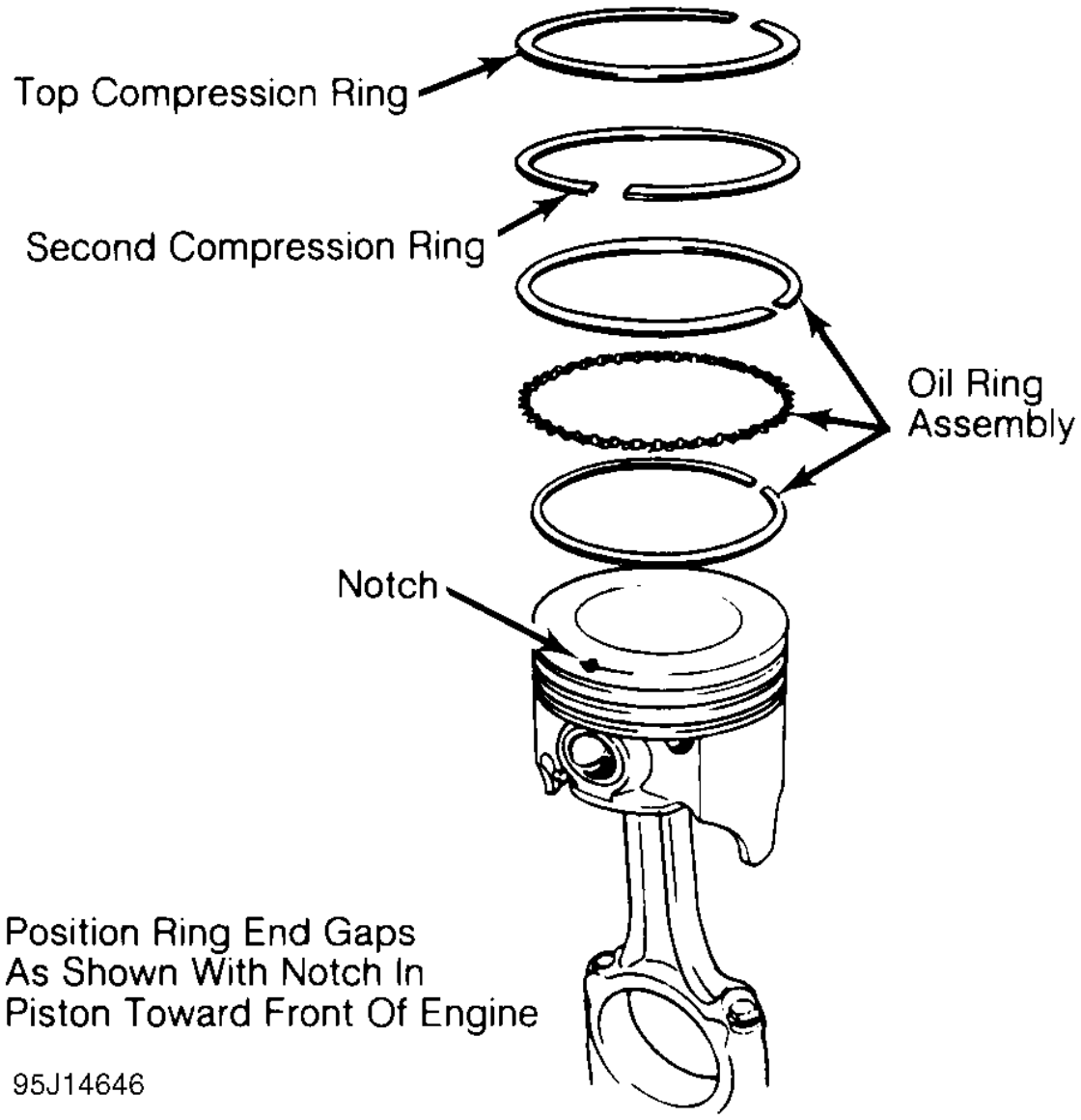

Fig. 16: Positioning Typical Piston Ring End Gap

Install ring compressor. Use care not to rotate piston rings. Compress rings with ring compressor. Install plastic tubing protectors over connecting rod bolts. Install piston and connecting rod assembly. Ensure piston notch, arrow or FRONT mark is toward front of engine. See **Fig. 17**.

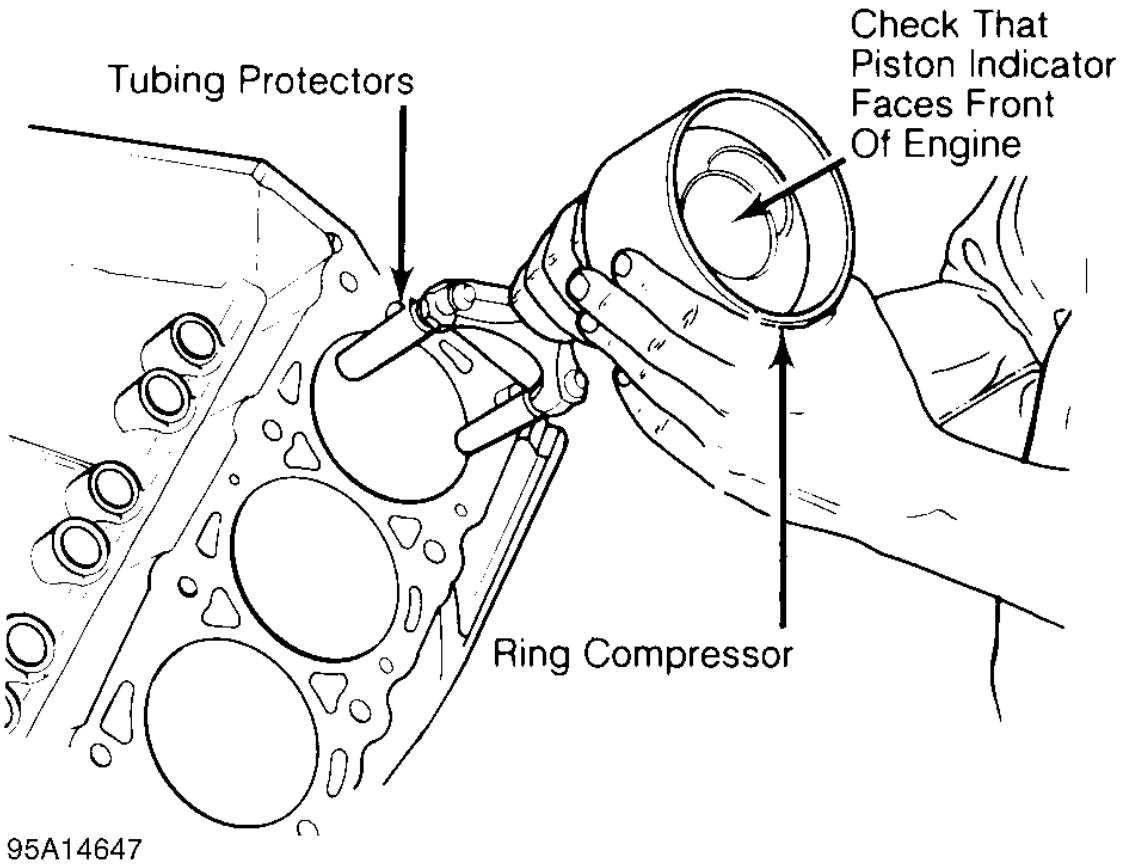

Fig. 17: Installing Piston & Connecting Rod Assembly

Carefully tap piston into cylinder until rod bearing is seated on crankshaft journal. Remove protectors. Install rod cap and bearing. Lightly tighten connecting rod bolts. Repeat procedure for remaining cylinders. Check bearing clearance. See **MAIN & CONNECTING ROD BEARING CLEARANCE**.

Once clearance is checked, lubricate journals and bearings. Install bearing caps. Ensure marks are aligned on connecting rod and cap. Tighten rod nuts or bolts to specification. Ensure rod moves freely on crankshaft. Check connecting rod side clearance. See **CONNECTING ROD SIDE CLEARANCE**.

CONNECTING ROD SIDE CLEARANCE

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Position connecting rod toward one side of crankshaft as far as possible. Using feeler gauge, measure clearance

between side of connecting rod and crankshaft. See **Fig. 18**. Clearance must be within specification.

Check for improper bearing installation, wrong bearing cap or insufficient bearing clearance if side clearance is insufficient. Connecting rod may require machining to obtain proper clearance. Excessive clearance usually indicates excessive wear at crankshaft. Crankshaft must be repaired or replaced.

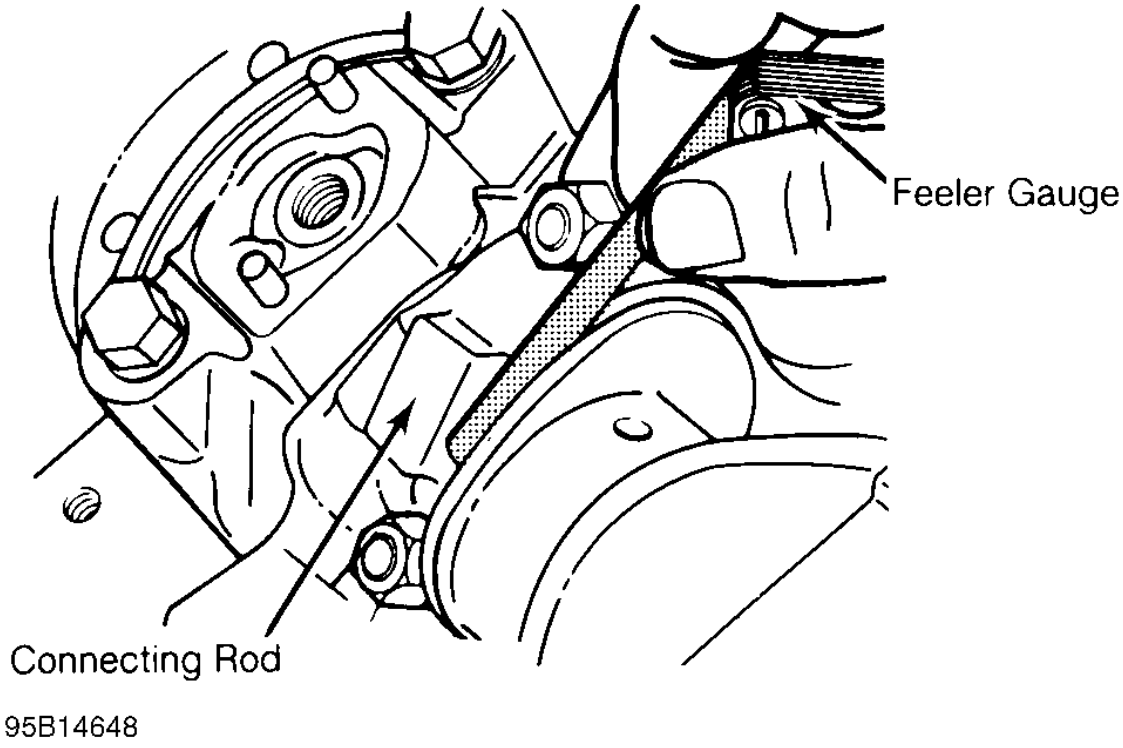

Fig. 18: Measuring Connecting Rod Side Clearance

MAIN & CONNECTING ROD BEARING CLEARANCE

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Plastigage Method

Plastigage method may be used to determine bearing clearance. Plastigage can be used with an engine in service or during reassembly. Plastigage material is oil soluble.

Ensure journals and bearings are free of oil or solvent. Oil or solvent will dissolve material and false reading will be obtained. Install small piece of Plastigage along full length of bearing journal. Install bearing cap in

original location. Tighten bolts to specification.

CAUTION: DO NOT rotate crankshaft while Plastigage is installed. Bearing clearance will not be obtained if crankshaft is rotated.

Remove bearing cap. Compare Plastigage width with scale on Plastigage container to determine bearing clearance. See **Fig. 19**. Rotate crankshaft 90 degrees. Repeat procedure. This is done to check journal eccentricity. This procedure can be used to check oil clearance on both connecting rod and main bearings.

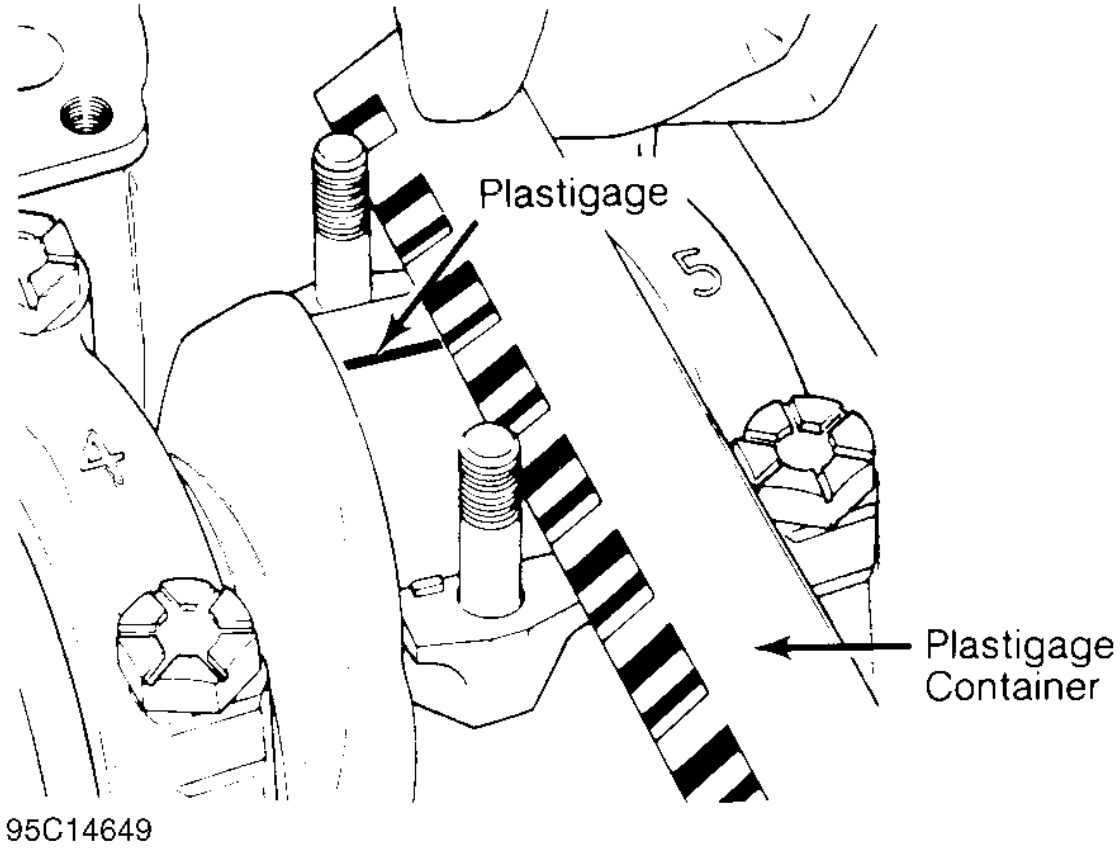

Fig. 19: Measuring Bearing Clearance

Micrometer & Telescopic Gauge Method

A micrometer is used to determine journal diameter, taper and out-of-round dimensions of the crankshaft. See **CLEANING & INSPECTION** under CRANKSHAFT & MAIN BEARINGS in this article.

With crankshaft removed, install bearings and caps in original location on cylinder block. Tighten bolts to specification. On connecting rods, install bearings and caps on connecting rods. Install proper connecting rod cap on corresponding rod. Ensure bearing cap is installed in original location. Tighten bolts to specification.

Using a telescopic gauge and micrometer or inside micrometer, measure inside diameter of connecting rod and main bearings bores. Subtract each crankshaft journal diameter from the corresponding inside bearing bore

diameter. This is the bearing clearance.

CRANKSHAFT & MAIN BEARINGS

* PLEASE READ THIS FIRST *

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REMOVAL

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Ensure all main bearing caps are marked for location on cylinder block. Some main bearing caps have an arrow stamped on them. The arrow must face timing belt or timing chain end of engine. Remove main bearing cap bolts. Remove main bearing caps. Carefully remove crankshaft. Use care not to bind crankshaft in cylinder block during removal.

CLEANING & INSPECTION

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Thoroughly clean crankshaft using solvent. Dry with compressed air. Ensure all oil passages are clear and free of sludge, rust, dirt and metal chips.

Inspect crankshaft for scoring and nicks. Inspect crankshaft for cracks using Magnaflux procedure. Inspect rear seal area for grooving or damage. Inspect bolt hole threads for damage. If pilot bearing or bushing is used, check pilot bearing or bushing fit in crankshaft. Inspect crankshaft gear for damaged or cracked teeth. Replace gear if damaged. Ensure oil passage plugs are tight (if equipped).

Using micrometer, measure all journals in 4 areas to determine journal taper, out-of-round and undersize. See **Fig. 20**. Some crankshafts can be reground to the next largest undersize, depending on the amount of wear or damage. Crankshafts with rolled fillet cannot be reground and must be replaced.

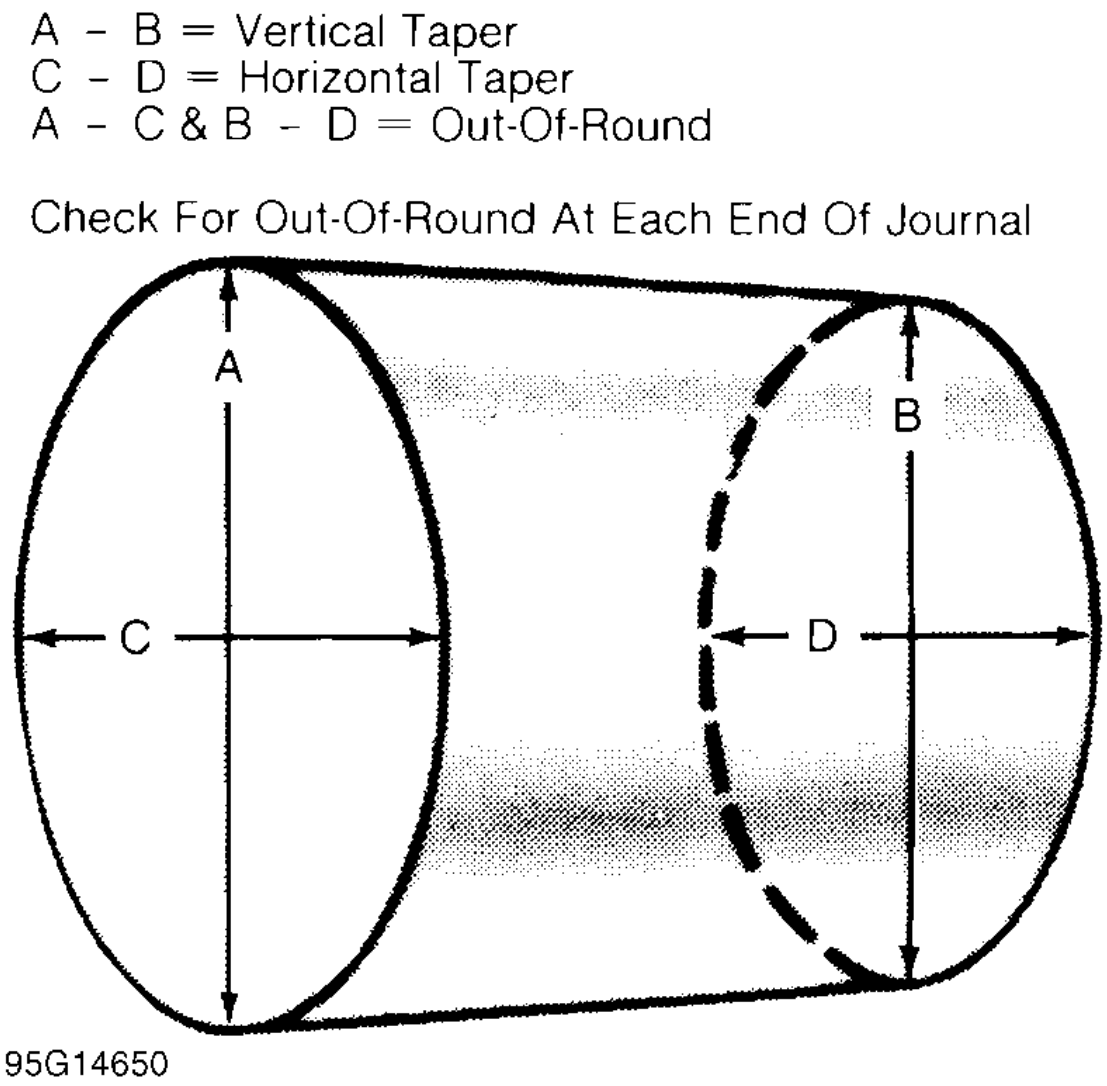

Fig. 20: Measuring Crankshaft Journals

Crankshaft journal runout should be checked. Install crankshaft in "V" blocks or bench center. Position dial indicator with tip resting on the main bearing journal area. See **Fig. 21**. Rotate crankshaft and note reading. Journal runout must not exceed specification. Repeat procedure on all main bearing journals. Crankshaft must be replaced if runout exceeds specification.

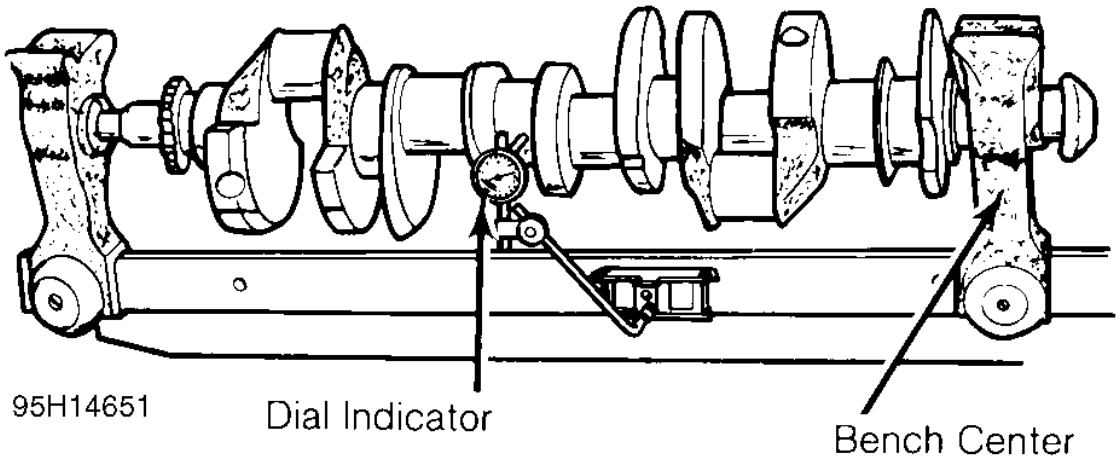

Fig. 21: Measuring Crankshaft Main Bearing Journal Runout

INSTALLATION

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Install upper main bearing in cylinder block. Ensure lock tab is properly located in cylinder block. Install bearings in main bearing caps. Ensure all oil passages are aligned. Install rear seal (if removed).

Ensure crankshaft journals are clean. Lubricate upper main bearings with clean engine oil. Carefully install crankshaft. Check each main bearing clearance using Plastigage method. See **MAIN & CONNECTING ROD BEARING CLEARANCE**.

Once clearance is checked, lubricate lower main bearing and journals. Install main bearing caps in original location. Install rear seal in rear main bearing cap (if removed). Some rear main bearing caps require sealant to be applied in corners to prevent oil leakage.

Install and tighten all bolts except thrust bearing cap to specification. Tighten thrust bearing cap bolts finger tight only. Some models require that thrust bearing be aligned. On most applications, crankshaft must be moved rearward then forward. Procedure may vary with manufacturer. Thrust bearing cap is then tightened to specification. Ensure crankshaft rotates freely. Crankshaft end play should be checked. See **CRANKSHAFT END PLAY**.

CRANKSHAFT END PLAY

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Dial Indicator Method

Crankshaft end play can be checked using dial indicator. Mount dial indicator on rear of cylinder block. Position dial indicator tip against rear of crankshaft. Ensure tip is resting against flat surface.

Pry crankshaft rearward. Adjust dial indicator to zero. Pry crankshaft forward and note reading. Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversize thrust bearings.

Feeler Gauge Method

Crankshaft end play can be checked using feeler gauge. Pry crankshaft rearward. Pry crankshaft forward. Using feeler gauge, measure clearance between crankshaft and thrust bearing surface. See **Fig. 22**.

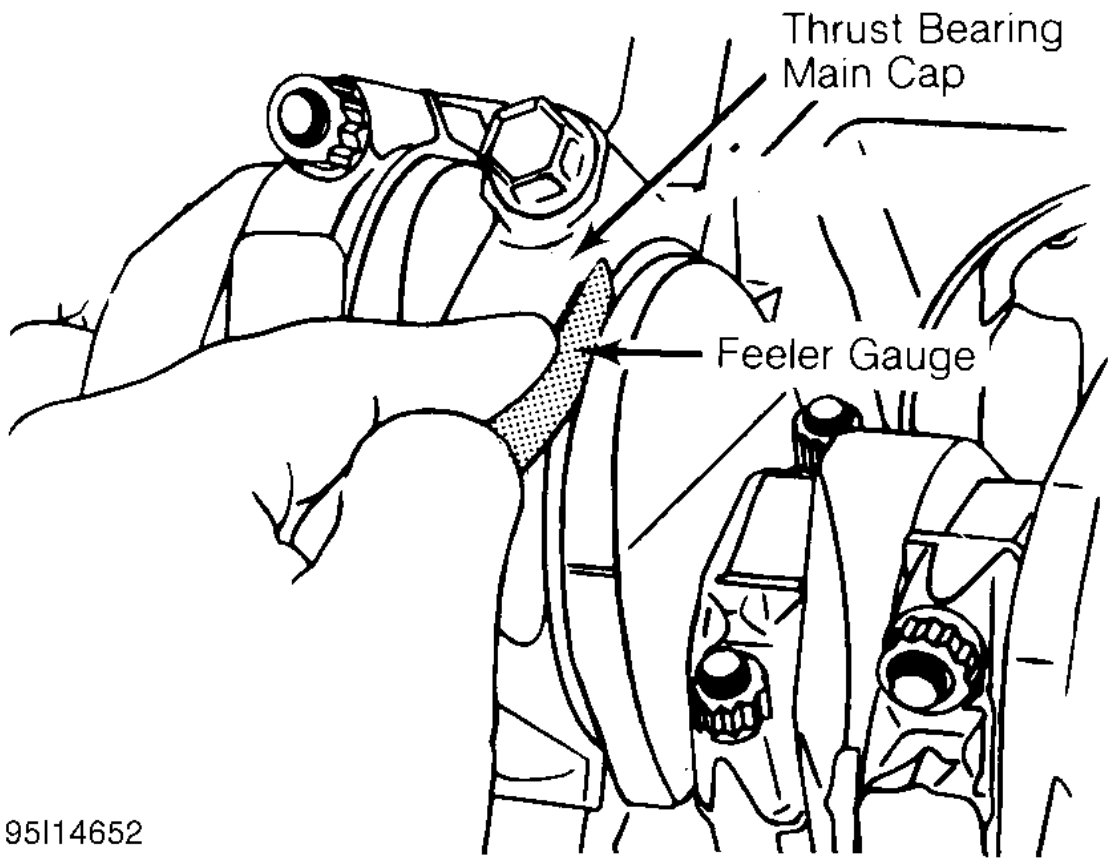

Fig. 22: Checking Crankshaft End Play

Crankshaft end play must be within specification. If end play is not within specification, check for faulty thrust bearing installation or worn crankshaft. Some applications offer oversize thrust bearings.

CYLINDER BLOCK

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Block Cleaning

Only cast cylinder blocks should be hot tank cleaned. Aluminum cylinder blocks should be cleaned using cold tank method. Cylinder block is cleaned in order to remove carbon deposits, gasket residue and water jacket scale. Remove oil gallery plugs, freeze plugs and cam bearings before cleaning block.

Block Inspection

Visually inspect the block. Check suspected areas for cracks using the Dye Penetrant inspection method. Block may be checked for cracks using the Magnaflux method.

Cracks are most commonly found at the bottom of cylinders, main bearing saddles, near expansion plugs and between cylinders and water jackets. Inspect lifter bores for damage. Inspect all head bolt holes for damaged threads. Threads should be cleaned using tap to ensure proper head bolt torque. Consult machine shop concerning possible welding and machining (if required).

Cylinder Bore Inspection

Inspect bore for scoring or roughness. Cylinder bore is dimensionally checked for out-of-round and taper using dial bore gauge. For determining out-of-round, measure cylinder parallel and perpendicular to the block center line. Difference in the 2 readings is the bore out-of-round. Cylinder bore must be checked at top, middle and bottom of piston travel area.

Bore taper is obtained by measuring bore at the top and bottom. If wear has exceeded allowable limits, block must be honed or bored to next available oversize piston dimension.

Cylinder Honing

Cylinder must be properly honed to allow new piston rings to properly seat. Cross-hatching at correct angle and depth is critical to lubrication of cylinder walls and pistons.

A flexible drive hone and power drill are commonly used. Drive hone must be lubricated during operation. Mix equal parts of kerosene and SAE 20W engine oil for lubrication.

Apply lubrication to cylinder wall. Operate cylinder hone from top to bottom of cylinder using even strokes to

produce 45 degree cross-hatch pattern on the cylinder wall. DO NOT allow cylinder hone to extend below cylinder during operation.

Recheck bore dimension after final honing. Wash cylinder wall with hot soapy water to remove abrasive particles. Blow dry with compressed air. Coat cleaned cylinder walls with lubricating oil.

Deck Warpage

Check deck for damage or warped gasket surface. Place a straightedge across gasket surface of the deck. Using feeler gauge, measure clearance at center of straightedge. Measure across width and length of cylinder block at several points.

If warpage exceeds specifications, deck must be resurfaced. If warpage exceeds manufacturer's maximum tolerance for material removal, replace block.

NOTE: **Some manufacturers recommend that a total amount of material (cylinder head and cylinder block) can only be removed before components must be replaced.**

Deck Height

Distance from crankshaft center line to block deck is called the deck height. Measure and record front and rear main journals of crankshaft. To compute this distance, install crankshaft and retain with center main bearing and cap only. Measure distance from crankshaft journal to block deck, parallel to cylinder center line.

Add one half of main bearing journal diameter to distance from crankshaft journal to block deck. This dimension should be checked at front and rear of cylinder block. Both readings should be the same.

If difference exceeds specification, cylinder block must be repaired or replaced. Deck height and warpage should be corrected at the same time.

Main Bearing Bore & Alignment

For checking main bearing bore, remove all bearings from cylinder block and main bearing caps. Install main bearing caps in original location. Tighten bolts to specification. Using inside micrometer, measure main bearing bore in 2 areas 90 degrees apart. Determine bore size and out-of-round. If diameter is not within specification, block must be align-bored.

For checking alignment, place a straightedge along center line of main bearing saddles. Check for clearance between straightedge and main bearing saddles. Block must be align-bored if clearance exists.

Expansion Plug Removal

Drill hole in center of expansion plug. Remove with screwdriver or punch. Use care not to damage sealing surface.

Expansion Plug Installation

Ensure sealing surface is free of burrs. Coat expansion plug with sealer. Using wooden dowel or pipe of slightly smaller diameter, install expansion plug. Ensure expansion plug is evenly located.

Oil Gallery Plug Removal

Remove threaded oil gallery plugs using appropriate wrench. Soft press-in plugs are removed by drilling into plug and installing a sheet metal screw. Remove plug with slide hammer or pliers.

Oil Gallery Plug Installation

Ensure threads or sealing surface is clean. Coat threaded oil gallery plugs with sealer and install. Replacement soft press-in plugs are installed with a hammer and drift.

CAMSHAFT

* PLEASE READ THIS FIRST *

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

CLEANING & INSPECTION

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Clean camshaft with solvent. Ensure all oil passages are clear. Inspect cam lobes and bearing journals for pitting, flaking or scoring. Using micrometer, measure bearing journal O.D.

Support camshaft at each end with "V" blocks. Position dial indicator with tip resting on center bearing journal. Rotate camshaft and note camshaft runout reading. If reading exceeds specification, replace camshaft.

Check cam lobe lift by measuring base circle of camshaft using micrometer. Measure again at 90-degree angle to tip of cam lobe. Cam lift can be determined by subtracting base circle diameter from tip of cam lobe measurement.

Different lift dimensions are given for intake and exhaust cam lobes. Reading must be within specification. Replace camshaft if cam lobes or bearing journals are not within specification.

Inspect camshaft gear for chipped, eroded or damaged teeth. Replace gear if damaged. On camshafts using thrust plate, measure distance between thrust plate and camshaft shoulder. Replace thrust plate if not within specification.

CAMSHAFT BEARINGS

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Removal & Installation

Remove camshaft rear plug. Camshaft bearing remover is assembled with shoulder resting against bearing to be removed according to manufacturer's instructions. Tighten puller nut until bearing is removed. Remove remaining bearings, leaving front and rear bearings until last. These bearings act as a guide for camshaft bearing remover.

To install new bearings, puller is rearranged to pull bearings toward the center of block. Ensure all lubrication passages of bearing are aligned with cylinder block. Coat new camshaft rear plug with sealant. Install camshaft rear plug. Ensure plug is even in cylinder block.

CAMSHAFT INSTALLATION

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Lubricate bearing surfaces and cam lobes with ample amount of Molykote or camshaft lubricant. Carefully install camshaft. Use care not to damage bearing journals during installation. Install thrust plate retaining bolts (if equipped). Tighten bolts to specification. On overhead camshafts, install bearing caps in original location. Tighten bolts to specification. On all applications, check camshaft end play.

CAMSHAFT END PLAY

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Using dial indicator, check camshaft end play. Position dial indicator on front of engine block or cylinder head. Position indicator tip against camshaft. Push camshaft toward rear of cylinder head or engine and adjust indicator to zero.

Move camshaft forward and note reading. Camshaft end play must be within specification. End play may be adjusted by relocating gear, shimming thrust plate or replacing thrust plate depending on each manufacturer.

TIMING CHAINS & BELTS

* PLEASE READ THIS FIRST *

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

TIMING CHAINS

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Timing chains will stretch during operation. Limits are placed upon amount of stretch before replacement is required. Timing chain stretch will alter ignition timing and valve timing.

To check timing chain stretch, rotate crankshaft to eliminate slack from one side of timing chain. Mark reference point on cylinder block. Rotate crankshaft in opposite direction to eliminate slack from remaining side of timing chain. Force other side of chain outward and measure distance between reference point and timing chain. See **Fig. 23**. Replace timing chain and gears if not within specification.

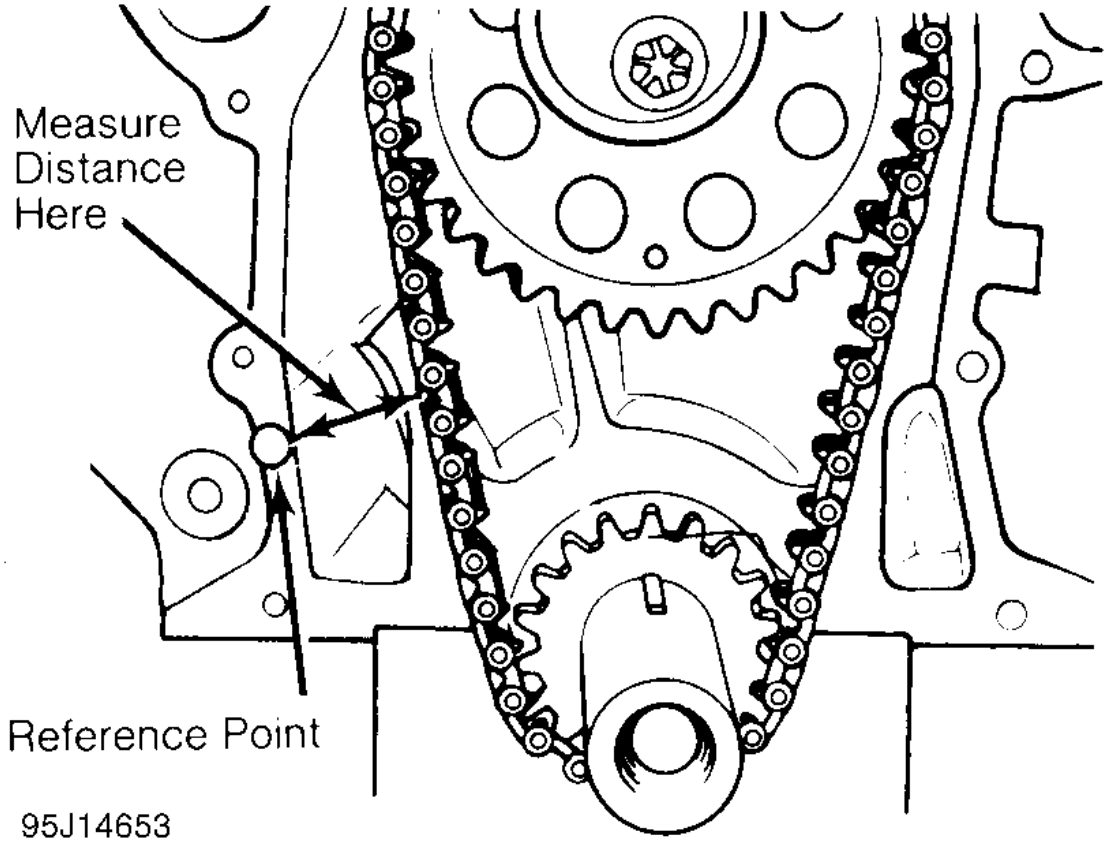

Fig. 23: Measuring Timing Chain Stretch

Timing chains must be installed so timing marks on camshaft gear and crankshaft gear are aligned according to manufacturer. See **Fig. 24**.

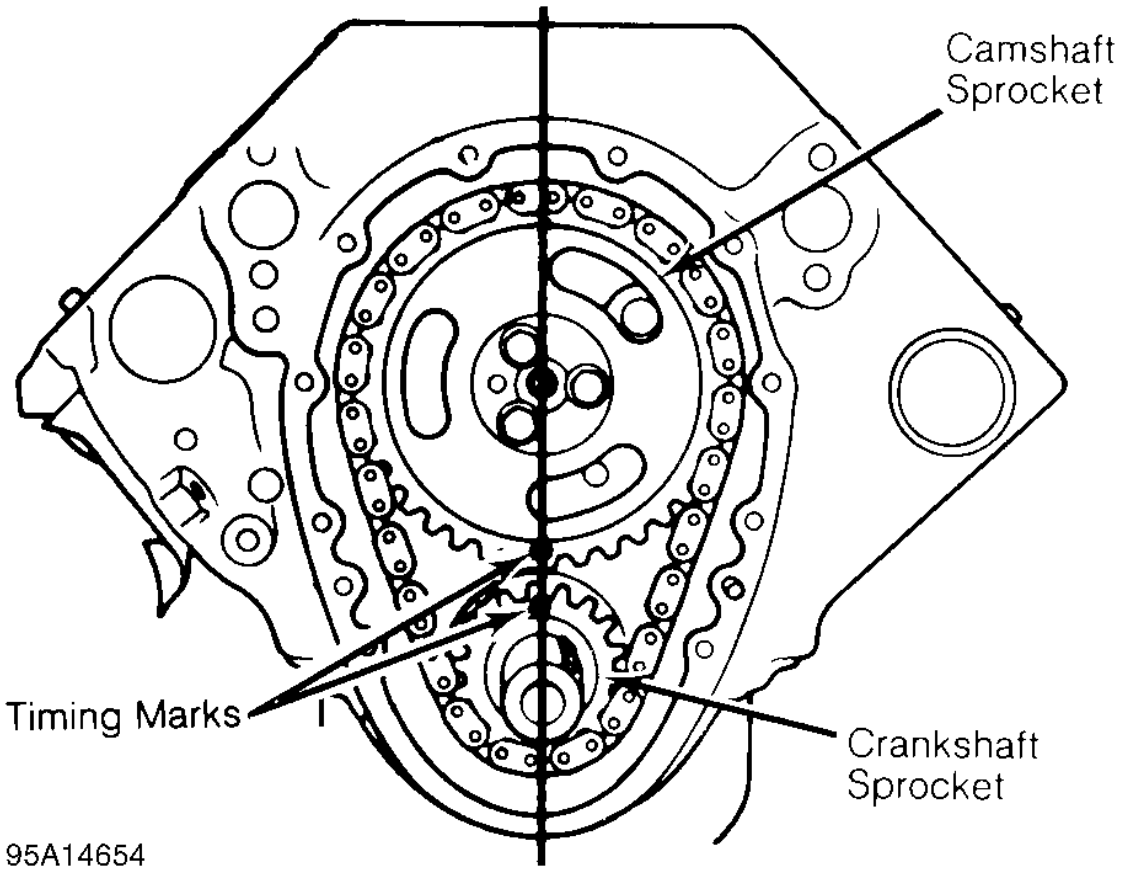

Fig. 24: Typical Gear Timing Mark Alignment

TIMING BELTS

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Cogged tooth belts are commonly used on overhead cam engines. Inspect belt teeth for rounded corners or cracking. Replace belt if it is cracked, damaged, missing teeth or oil soaked.

Used timing belt must be installed in original direction of rotation. Inspect all sprocket teeth for wear. Replace all worn sprockets. Sprockets are marked for timing purposes. Engine is positioned so that crankshaft sprocket mark will be upward. Camshaft sprocket is aligned with reference mark on cylinder head or timing belt cover and then timing belt can be installed. See **Fig. 25**.

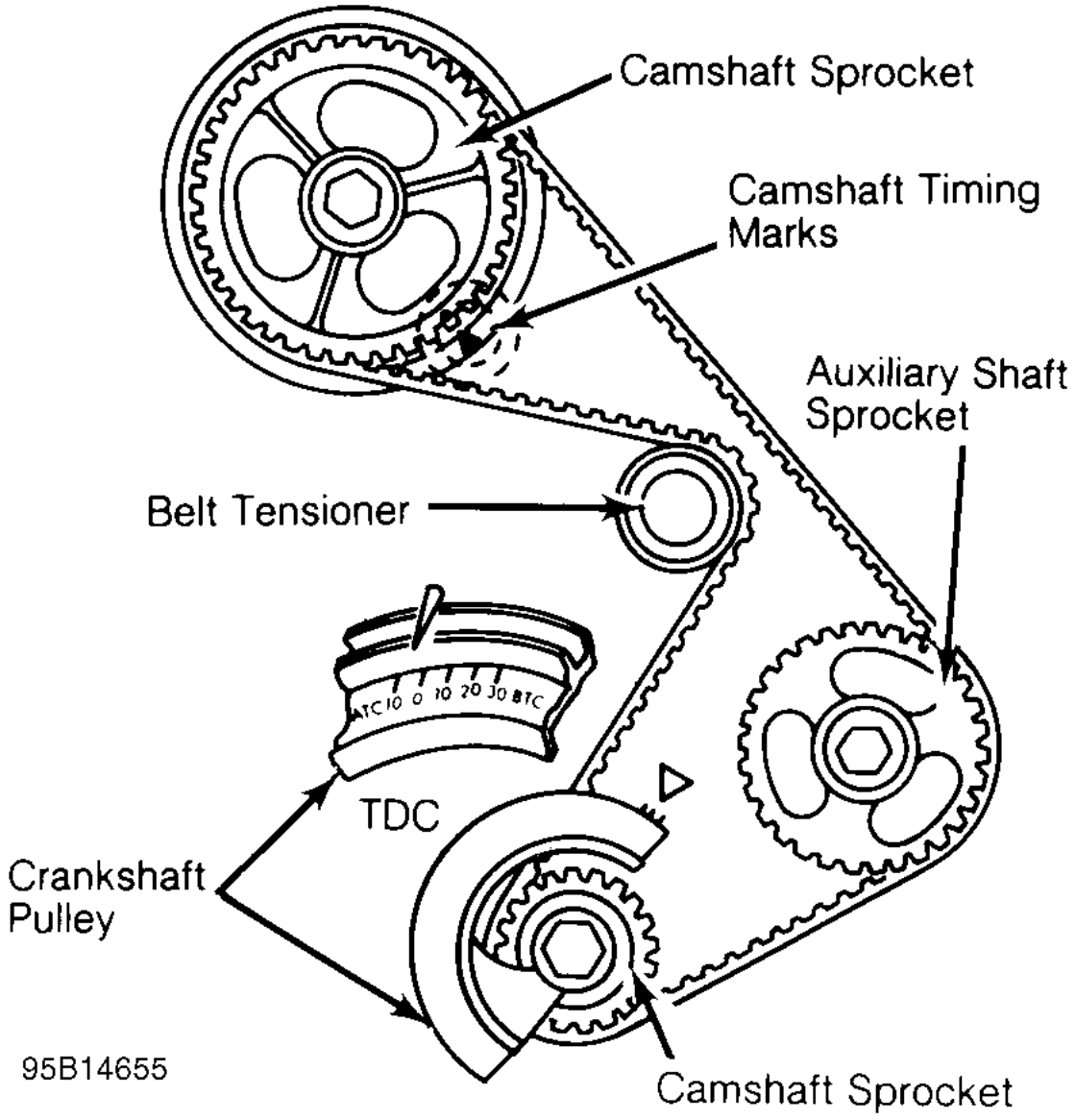

Fig. 25: Typical Camshaft Belt Sprocket Alignment

TENSION ADJUSTMENT

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If guide rails are used with spring loaded tensioners, ensure at least half of original rail thickness remains.

Spring loaded tensioner should be inspected for damage.

Ensure all timing marks are aligned. Adjust belt tension using manufacturer's recommendations. Belt tension may require checking using tension gauge. See **Fig. 26**.

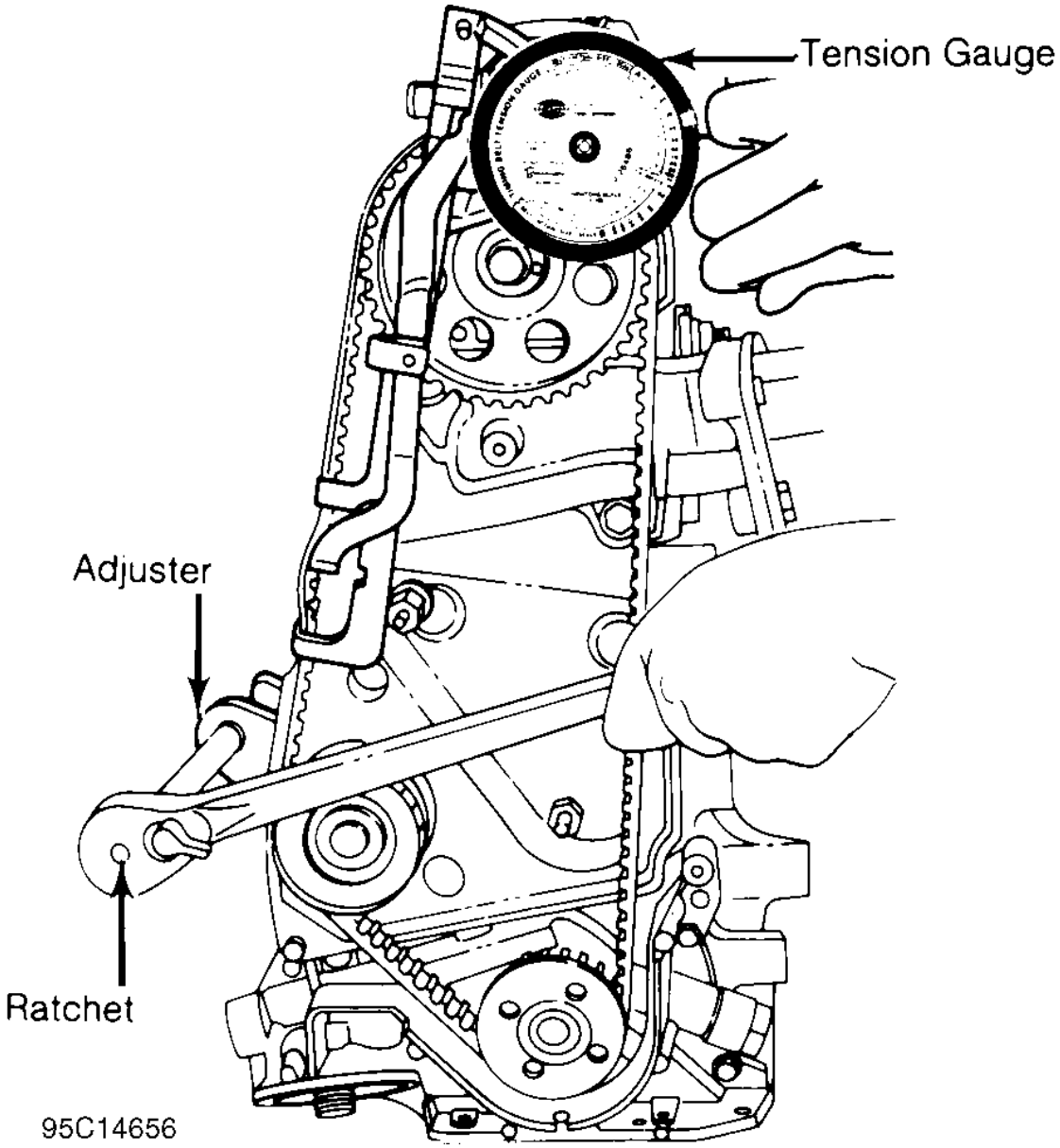

Fig. 26: Adjusting Typical Timing Belt Tension

TIMING GEARS

*** PLEASE READ THIS FIRST ***

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to a specific engine or system. Illustrations and procedures have been chosen to guide mechanic through engine overhaul process. Descriptions of processes of cleaning, inspection, assembly and machine shop practice are included.

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TIMING GEAR BACKLASH & RUNOUT

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

On engines where camshaft gear operates directly on crankshaft gear, gear backlash and runout must be checked. To check backlash, install dial indicator with tip resting on tooth of camshaft gear. Rotate camshaft gear as far as possible. Adjust indicator to zero. Rotate camshaft gear in opposite direction as far as possible and note reading.

To determine timing gear runout, mount dial indicator with tip resting on face edge of camshaft gear. Adjust indicator to zero. Rotate camshaft gear 360 degrees and note reading. If backlash or runout exceeds specification, replace camshaft and/or crankshaft gear.

REAR MAIN OIL SEAL INSTALLATION

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One-Piece Type Seal

For one-piece type oil seal installation, coat block contact surface of seal with sealer if seal is not factory coated. Ensure seal surface is free of burrs. Lubricate seal lip with engine oil and press seal into place using proper oil seal installer. See **Fig. 27**.

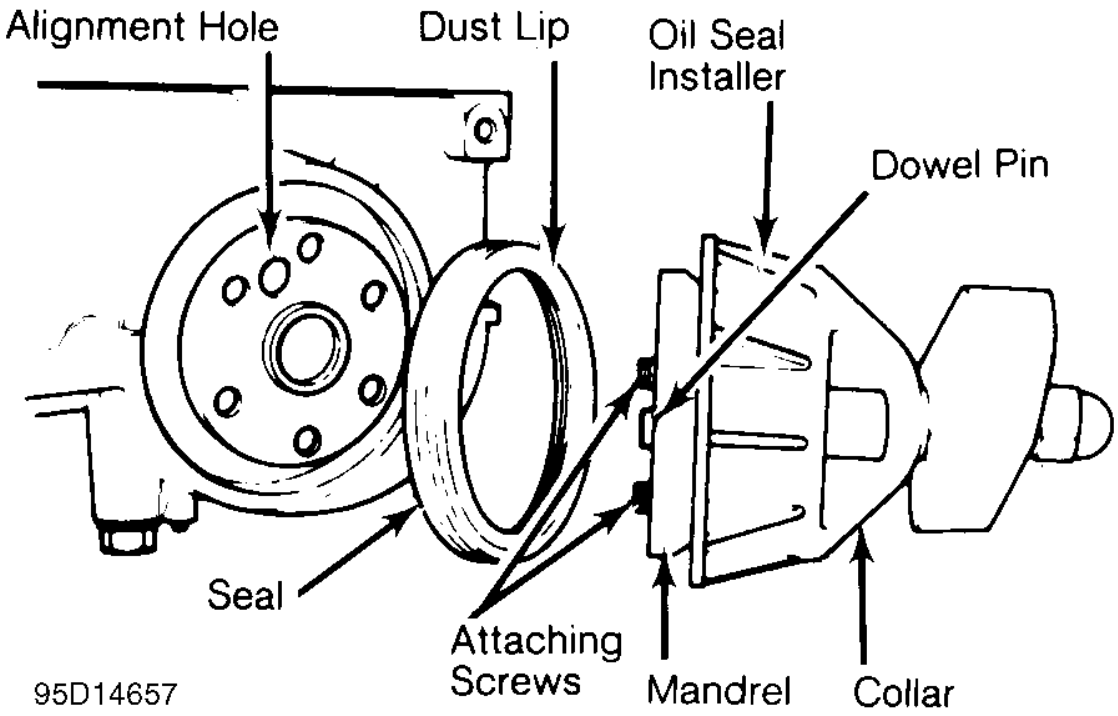

Fig. 27: Installing Typical One-Piece Oil Seal

Rope Type Seal

For rope type rear main oil seal installation, press seal lightly into seat area. Using seal installer, fully seat seal in bearing cap or cylinder block.

Trim seal ends even with cylinder block parting surface. Some applications require sealer to be applied on main bearing cap before installing. See **Fig. 28**.

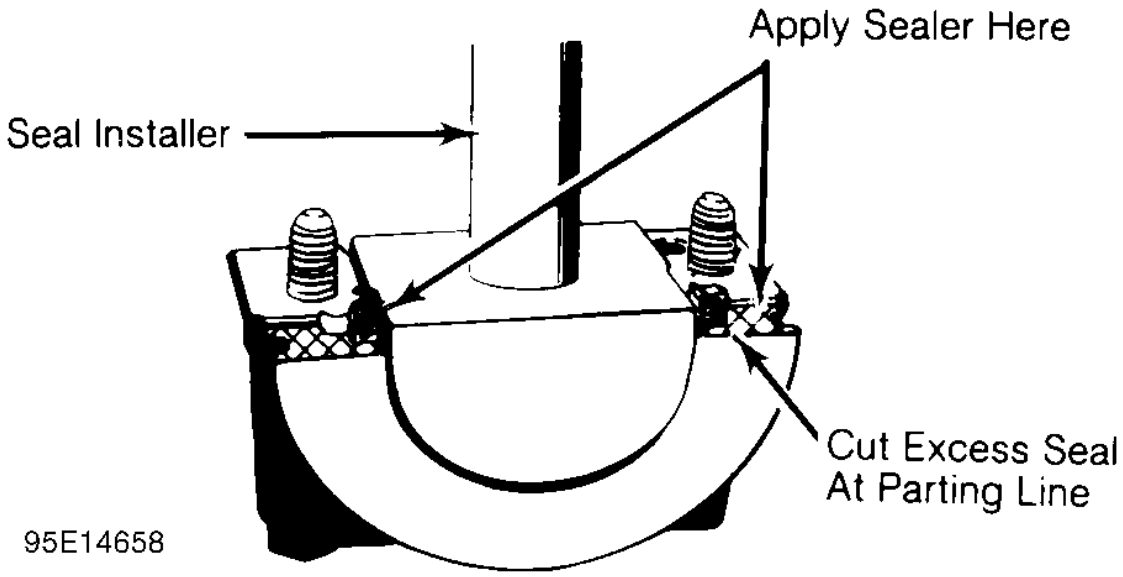

Fig. 28: Installing Typical Rope Seal

Split-Rubber Type Seal

Follow manufacturer's procedures when installing split-rubber type rear main oil seals. Installation procedures vary with manufacturer and engine type. See **Fig. 29**.

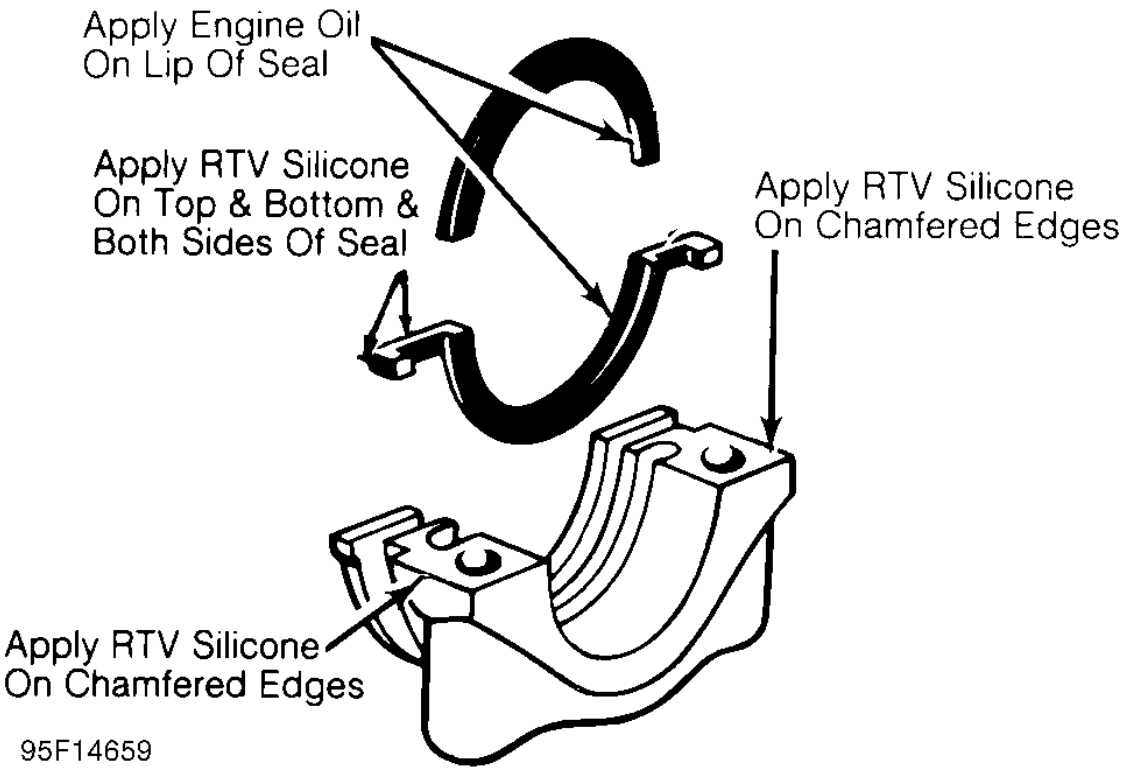

Fig. 29: Installing Typical Split-Rubber Seal

OIL PUMP

*** PLEASE READ THIS FIRST ***

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ROTOR TYPE

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle

being repaired.

Mark oil pump rotor locations before removing. See **Fig. 30**. Remove outer rotor and measure thickness and diameter. Measure inner rotor thickness. Inspect shaft for scoring or wear. Inspect rotors for pitting or damage. Inspect cover for grooving or wear. Replace worn or damaged components.

Measure outer rotor-to-body clearance. Replace pump assembly if clearance exceeds specification. Measure clearance between rotors. See **Fig. 31**. Replace shaft and both rotors if clearance exceeds specification.

Install rotors in pump body. Position straightedge across pump body. Using feeler gauge, measure clearance between rotors and straightedge. Pump cover wear is measured using a straightedge and feeler gauge. Replace pump if clearance exceeds specification.

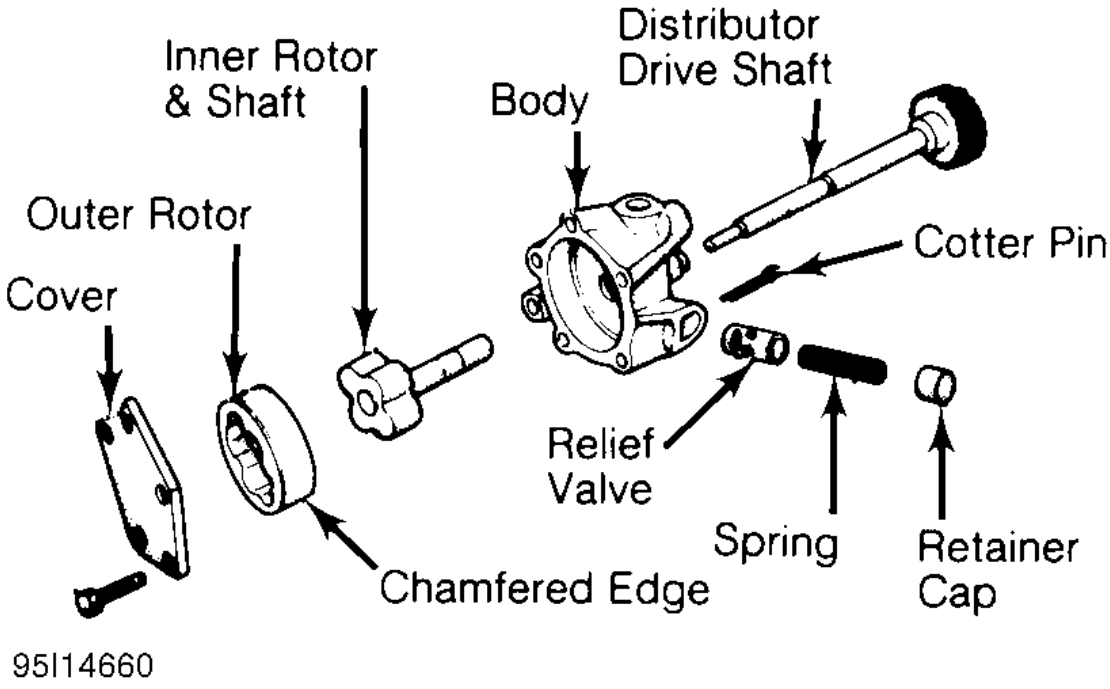

Fig. 30: Typical Rotor Type Oil Pump

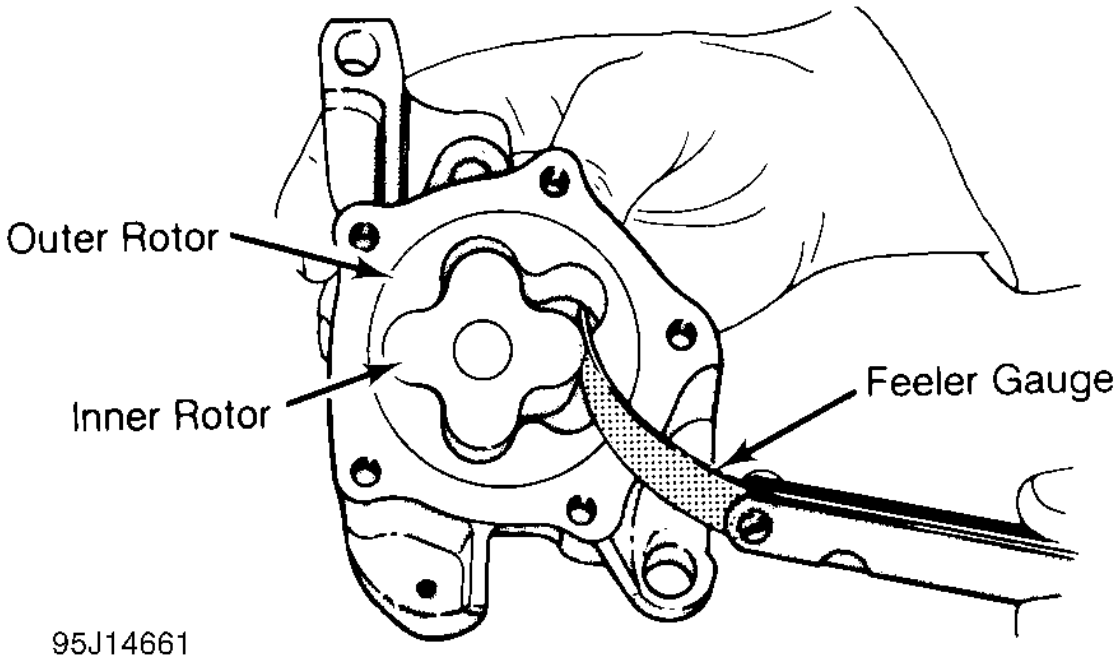

Fig. 31: Measuring Rotor Clearance

GEAR TYPE

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Mark oil pump gear location before removing. See **Fig. 32**. Remove gears from pump body. Inspect gears for pitting or damage. Inspect cover for grooving or wear. Measure gear diameter and length. Measure gear housing cavity depth and diameter. See **Fig. 33**. Replace worn or damaged components.

Pump cover wear is measured using a straightedge and feeler gauge. Replace pump or components if warpage or wear exceeds specification, or mating surface of pump cover is scratched or grooved.

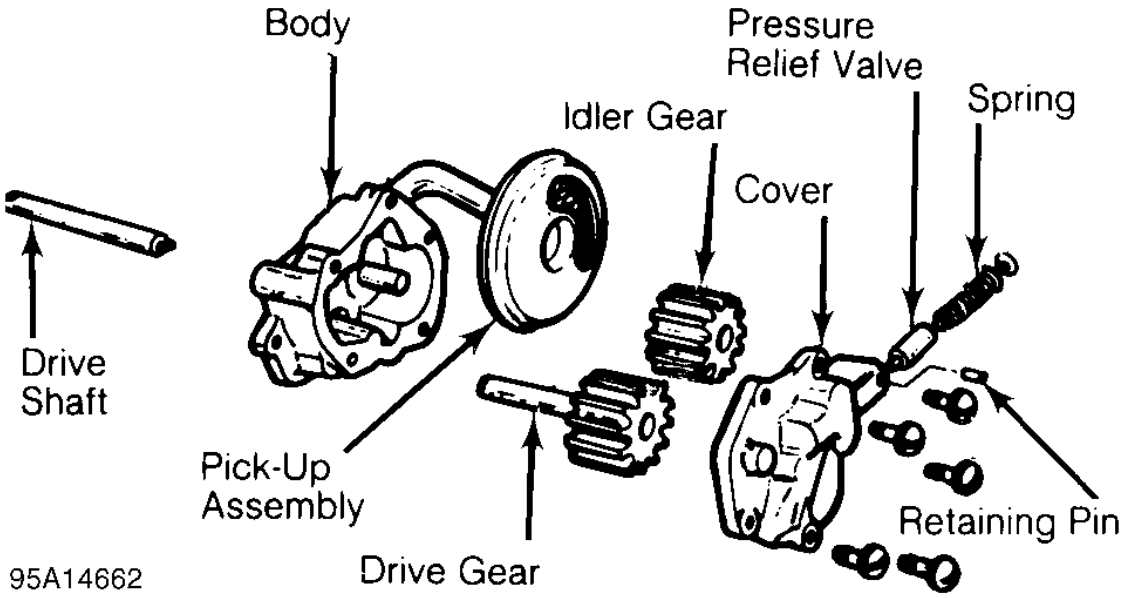

Fig. 32: Typical Gear Type Oil Pump

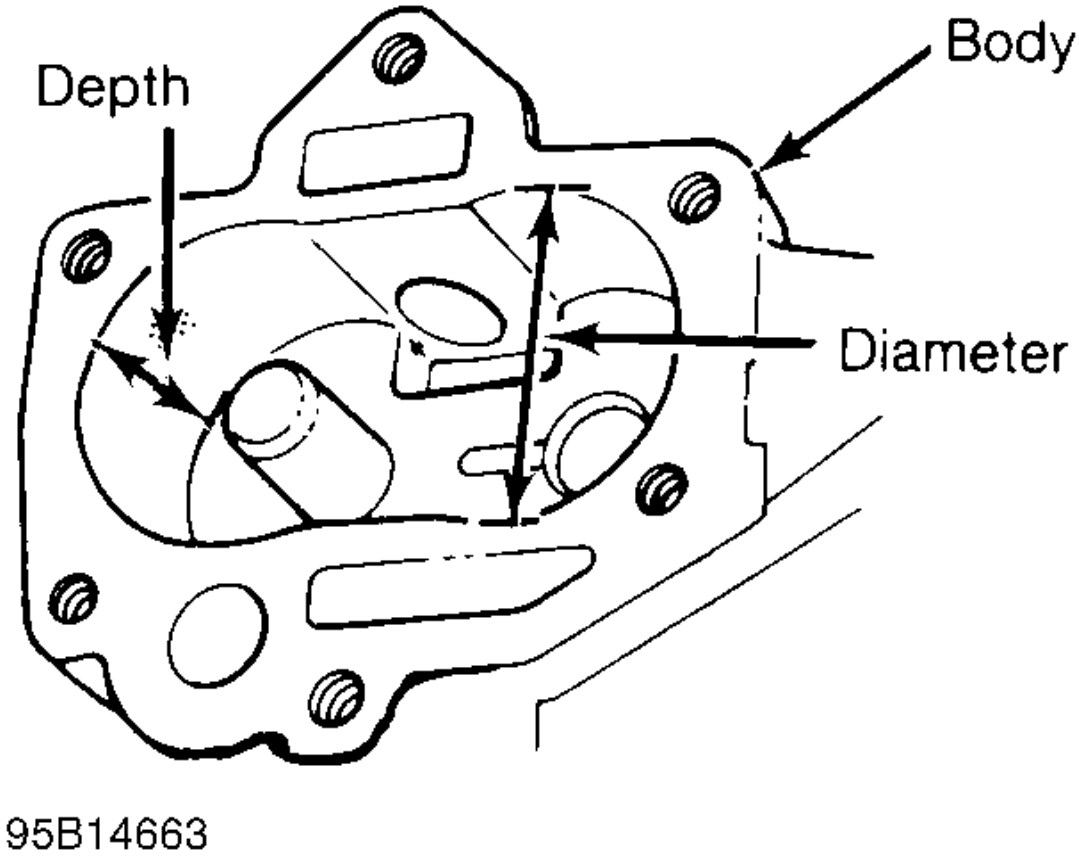

Fig. 33: Measuring Oil Pump Gear Cavity

BREAK-IN PROCEDURE

*** PLEASE READ THIS FIRST ***

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ENGINE PRE-OILING

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Pre-oil engine prior to operation to prevent engine damage. Lightly oiled oil pump will cavitate unless oil pump cavities are filled with engine oil or petroleum jelly.

Engine pre-oiling can be done using pressure oiler (if available). Connect pressure oiler to cylinder block oil passage such as oil pressure sending unit. Operate pressure oiler long enough to ensure correct amount of oil has filled crankcase. Check oil level while pre-oiling.

If pressure oiler is not available, disconnect ignition system. Remove oil pressure sending unit and replace with oil pressure test gauge. Using starter motor, rotate engine starter until gauge shows normal oil pressure for several seconds. DO NOT crank engine for more than 30 seconds to avoid starter motor damage. Ensure oil pressure has reached the most distant point from the oil pump.

NOTE: **If new lifters or camshaft are installed, some manufacturers require that a crankcase conditioner be added to engine oil. The engine should be operated for specified amount of time to aid in lifter break-in procedure.**

INITIAL START-UP

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Start engine and operate engine at low speed while checking for coolant, fuel and oil leaks. Stop engine. Recheck coolant and oil level. Adjust if necessary.

CAMSHAFT

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Break-in procedure is required when new or reground camshaft has been installed. Operate and maintain engine speed between 1500-2500 RPM for approximately 30 minutes. Procedure may vary due to manufacturer's recommendations.

PISTON RINGS

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Piston rings require a break-in procedure to ensure seating of rings to cylinder walls. Serious damage may occur to rings if correct procedures are not followed.

Extremely high piston ring temperatures are obtained during break-in process. If rings are exposed to excessively high RPM or high cylinder pressures, ring damage can occur. Follow piston ring manufacturer's recommended break-in procedure.

FINAL ADJUSTMENTS

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Always refer to appropriate engine overhaul article, if available, in the ENGINES section for complete overhaul procedures and specifications for the vehicle being repaired.

Check or adjust ignition timing and dwell (if applicable). Adjust valves (if necessary). Adjust idle speed and mixture. Retighten cylinder heads (if required). If cylinder head or block is aluminum, retighten bolts when engine is cold. Follow the engine manufacturer's recommended break-in procedure and maintenance schedule for new engines.

NOTE: **Some manufacturers require that head bolts be retightened after specified amount of operation. This must be done to prevent head gasket failure.**

Article GUID: A00025128

GENERAL INFORMATION

Engine Performance Diagnostic Routine Outline

* PLEASE READ THIS FIRST *

NOTE: **This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the ENGINE PERFORMANCE category.**

WHERE DOES DRIVEABILITY DIAGNOSIS START?

PERFORM BASIC INSPECTION

NOTE: **This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the ENGINE PERFORMANCE category.**

1. Verify Customer Complaint
2. Check for Relevant Technical Service Bulletins (TSBs)
3. Perform Visual Inspection **(See Basic Diagnostic Procedures)**
4. Test Engine Sub-Systems **(See Basic Diagnostic Procedures)**
    - Mechanical Condition (Compression)
    - Ignition Output
    - Fuel Delivery
5. Check Air Induction System For Leaks
6. Check & Adjust Basic Engine Settings**(See On-Vehicle Adjustments)**
    - Ignition Timing
    - Idle Speed

CHECK FOR TROUBLE CODES

NOTE: **This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the ENGINE PERFORMANCE category.**

1. Check for Diagnostic Trouble Codes (DTCs).**(See Self-Diagnostics)**
2. Repair cause of DTCs.
3. Clear PCM memory and repeat self-test.

DIAGNOSE SYMPTOM

NOTE: **This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the ENGINE PERFORMANCE category.**

1. If no self-diagnostics available, or no trouble codes present, identify symptom.
2. See trouble shooting procedure to identify problem. **(See Trouble Shooting - No Codes)**

TEST SYSTEM

NOTE: **This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the ENGINE PERFORMANCE category.**

1. Perform required tests. **(See Systems & Component Testing)**
2. Verify complaint is repaired.

Article GUID: A00002341

GENERAL INFORMATION

Engine Performance Safety Precautions

- Always refer to Emission Decal in engine compartment before servicing vehicle. If manual and decal differ, always use decal specifications.
- Do not allow or create a condition of misfire in more than one cylinder for an extended period of time. Damage to converter may occur due to loading converter with unburned air/fuel mixture.
- Always turn ignition off and disconnect negative battery cable BEFORE disconnecting or connecting computer or other electrical components.
- DO NOT drop or shock electrical components such as computer, airflow meter, etc.
- DO NOT use fuel system cleaning compounds that are not recommended by the manufacturer. Damage to gaskets, diaphragm materials and catalytic converter may result.
- Before performing a compression test or cranking engine using a remote starter switch, disconnect coil wire from distributor and secure it to a good engine ground, or disable ignition.
- Before disconnecting any fuel system component, ensure fuel system pressure is released.
- Use a shop towel to absorb any spilled fuel to prevent fire.
- DO NOT create sparks or have an open flame near battery.
- If any fuel system components such as hoses or clamps are replaced, ensure they are replaced with components designed for fuel system use.
- Always reassemble throttle body components with new gaskets, "O" rings and seals.
- If equipped with an inertia switch, DO NOT reset switch until fuel system has been inspected for leaks.
- Wear safety goggles when drilling or grinding.
- Wear proper clothing which protects against chemicals and other hazards.

Article GUID: A00002342

GENERAL INFORMATION

Gear Tooth Contact Patterns

* PLEASE READ THIS FIRST *

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

INSPECTION

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

Wipe lubricant from internal parts. Rotate gears and inspect for wear or damage. Mount dial indicator to housing and check backlash at several points around ring gear. Backlash must be within specification at all points. If no defects are found, check gear tooth pattern contact.

NOTE: **Drive pattern should be well centered on ring gear teeth. Coast pattern should be centered, but may be slightly toward toe of ring gear teeth.**

GEAR TOOTH CONTACT PATTERN

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

1. Paint ring gear teeth with marking compound. Wrap cloth or rope around drive pinion flange to act as brake. Rotate gear until clear contact pattern is obtained.
2. Contact pattern will indicate whether correct pinion bearing mounting shim has been installed and if drive gear backlash has been set properly. Backlash between drive gear pinion must be maintained within specified limits until correct tooth pattern is obtained.

ADJUSTMENTS

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

GEAR BACKLASH & PINION SHIM CHANGES

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

1. With no change in backlash, moving pinion further from ring gear moves drive pattern toward heel and top of tooth, and moves coast pattern toward toe and top of tooth.
2. With no change in backlash, moving pinion closer to ring gear moves drive pattern toward toe and bottom of tooth, and moves coast pattern toward heel and bottom of tooth.
3. With no change in pinion shim thickness, an increase in backlash moves ring gear further from pinion. Both drive and coast patterns move toward heel and top of tooth.
4. With no change in pinion shim thickness, a decrease in backlash moves ring gear closer to pinion gear. Both drive and coast patterns move toward toe and bottom of tooth.

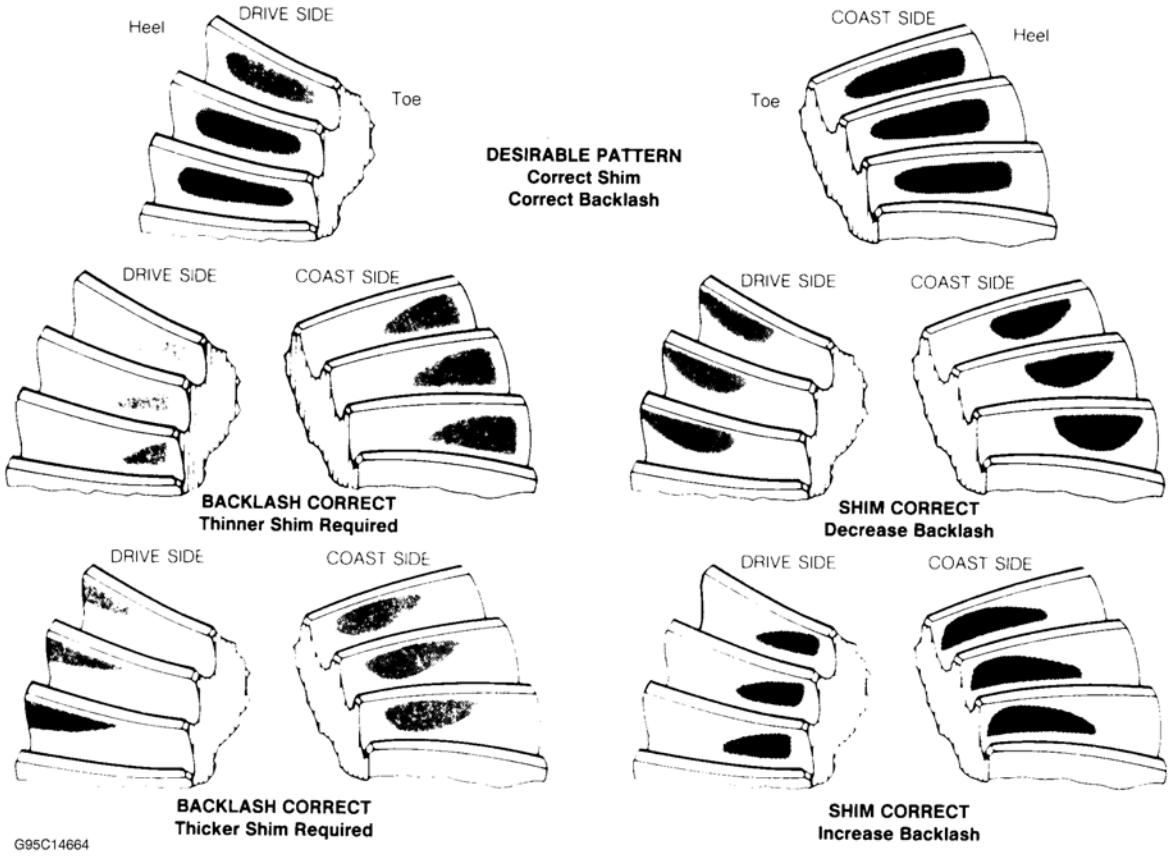

Fig. 1: Drive Axle Gear Tooth Patterns

Article GUID: A00091462

GENERAL INFORMATION

General Cooling System Service

* PLEASE READ THIS FIRST *

This article is generic in nature and all information does not apply to all vehicles including those without a liquid cooling system. For vehicle specific information, see the appropriate articles in the ENGINE category.

DESCRIPTION

The liquid cooling system consists of a radiator, water pump, thermostat, electric or belt-driven cooling fan, pressure cap, heater, and various connecting hoses and cooling passages in the engine block and cylinder head.

MAINTENANCE

DRAINING

Remove radiator cap and open heater control valve to maximum heat position. Open drain cocks or remove plugs in bottom of radiator and engine block. In-line engines usually have one plug or drain cock, while "V" type engines have 2, one in each bank of cylinders.

FLUSHING

CAUTION: Some manufacturers use an aluminum and plastic radiator. Flushing solution must be compatible with aluminum.

Radiator

Connect flushing gun to water outlet of radiator. Disconnect water inlet hose. To prevent flooding engine, use a hose connected to radiator inlet. Use air in short bursts to prevent damage to radiator. Continue flushing until water runs clear.

Engine Block

To flush engine, remove thermostat. Connect flushing gun to water outlet of radiator. Use air in short bursts to prevent damage to radiator. Continue flushing until water runs clear.

REFILLING

To prevent air from being trapped in engine block, engine should be running when refilling cooling system. After system is full, continue running engine until thermostat is open, then recheck fill level. Do not overfill system.

TESTING

THERMOSTAT

1. Remove and inspect thermostat for corrosion and proper seating of valve. If okay, suspend thermostat and

thermometer in a 50/50 mixture of coolant and water. See **Fig. 1**. DO NOT allow thermostat or thermometer to touch bottom or container. Heat water until thermostat begins to open.

2. Read temperature on thermometer. This is the initial opening temperature and should be within specification. Continue heating water until thermostat is fully open and note temperature. This is the fully open temperature. If either reading is not to specification, replace thermostat.

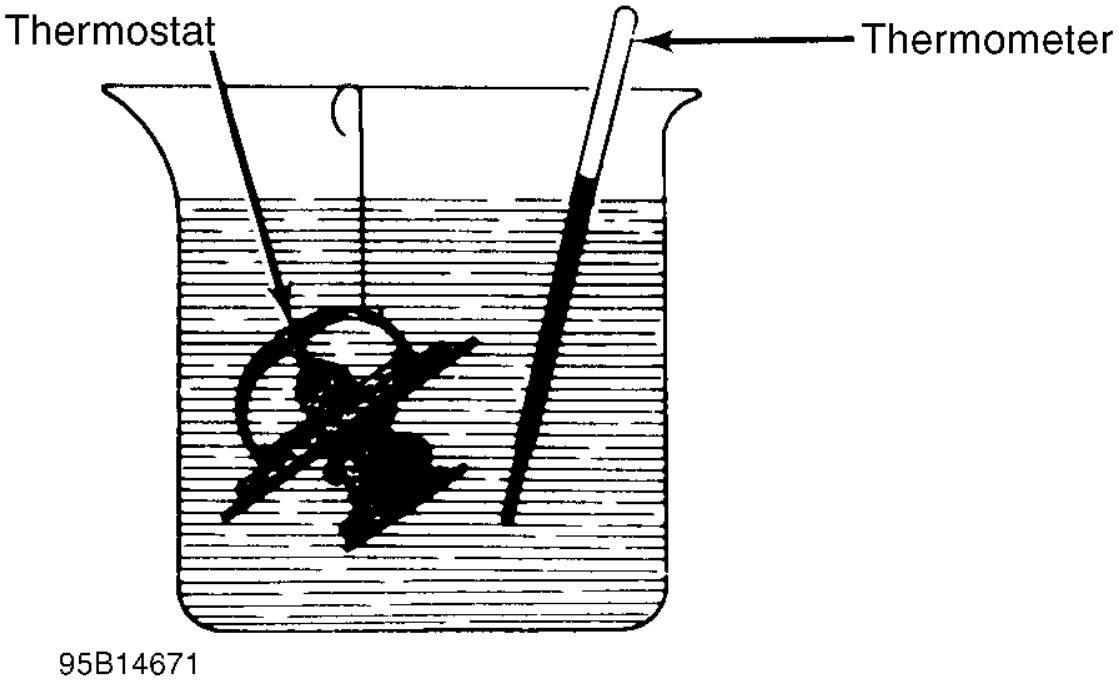

Fig. 1: Testing Thermostat in Coolant/Water Solution

PRESSURE TESTING

A pressure tester is used to check both radiator cap and complete cooling system. Follow pressure tester manufacturer instructions and test components as follows:

Radiator Cap

Visually inspect radiator cap. If cap looks okay, connect pressure tester to cap. See **Fig. 2**. Pressurize tester to full radiator cap specification. Replace cap if it fails to hold pressure.

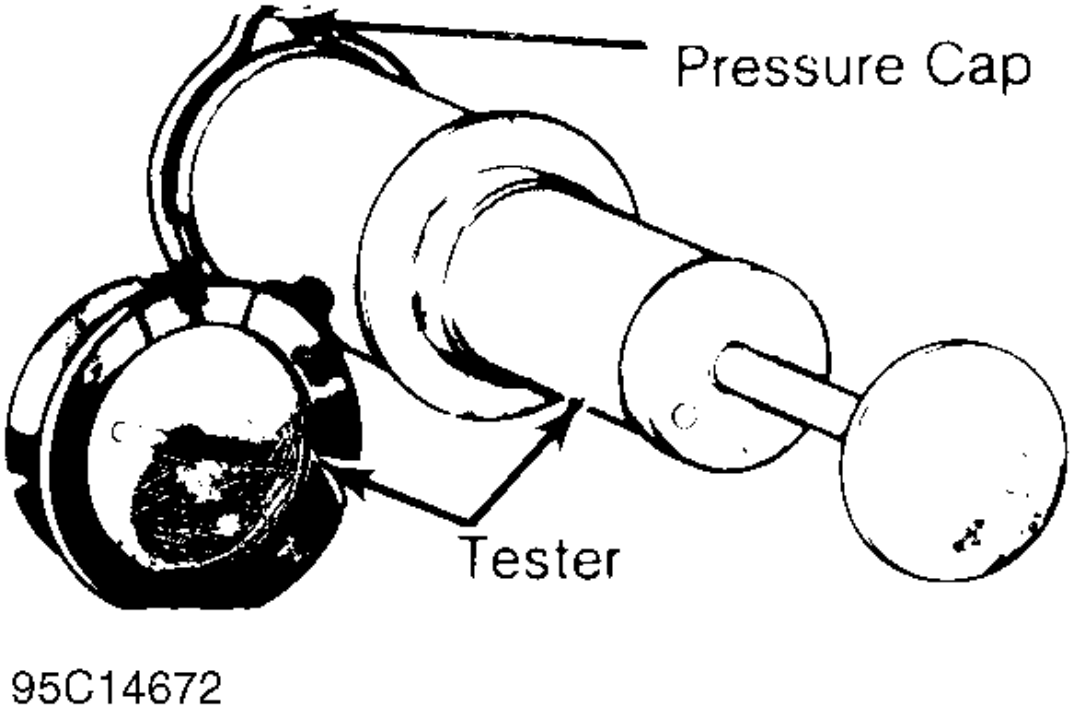

Fig. 2: Pressure Testing Radiator Cap

Cooling System

1. Turn ignition off and allow engine to cool. Ensure radiator if filled to correct level. Remove cap and attach pressure tester to radiator. Pressurize tester to full radiator rating specification.
2. If pressure drops, check for external leaks. If no leaks are found, start engine and allow to idle. If pressure builds up immediately, check cylinder head and block for cracks. If pressure does not build up immediately, go to next step.

CAUTION: DO NOT allow excess pressure to build in cooling system or damage may result.

3. Using pressure tester, pump cooling system up to pressure specified on radiator cap. If pump gauge pointer vibrates, compression or combustion leak into cooling system is indicated. Isolate leak by shorting each spark plug wire to cylinder block. Gauge pointer vibration will stop or decrease when leaking cylinder is shorted.

Article GUID: A00002185

INTRODUCTION

ARROWS AND SYMBOLS

This service manual uses various symbols in order to describe different service operations.

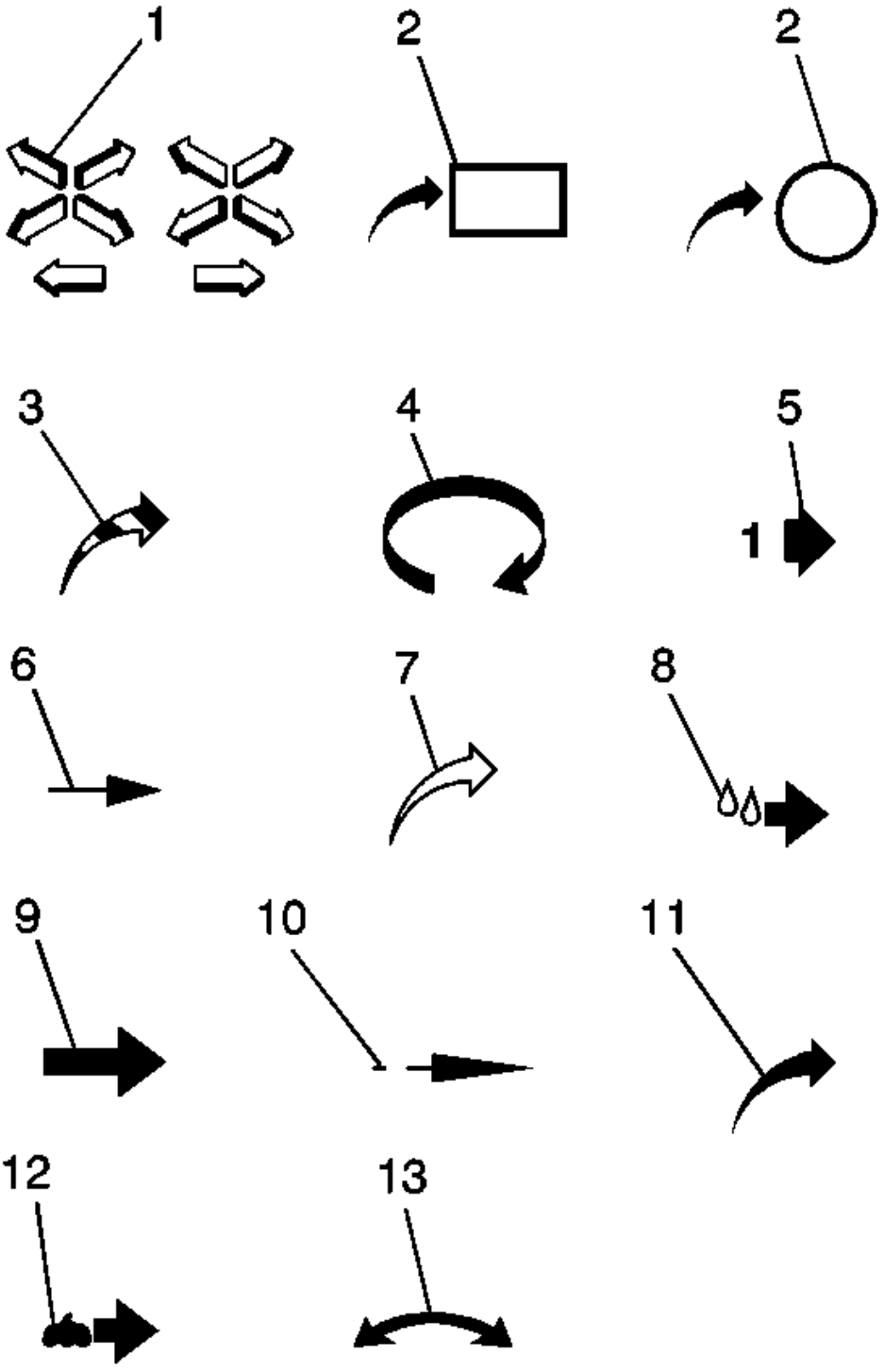

Fig. 1: Identifying Different Service Operations Symbols
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front of Vehicle
2	View Detail

Callout	Component Name
2	View Detail
3	Ambient Air Mixed with Another Gas or Indicate Temperature Change
4	Motion or Direction
5	View Angle
6	Dimension (1:2)
7	Ambient/Clean Air Flow or Cool Air Flow
8	Lubrication Point- Oil or Fluid
9	Task Related
10	Sectioning (1:3)
11	Gas Other Than Ambient Air or Hot Air Flow
12	Lubrication Point- Grease or Jelly
13	Multidirectional Arrow

ACRONYMS AND UNITS

Acronyms

Acronym	Meaning	Definition
2WD	Two-Wheel Drive	Indicates that a vehicle has 2 driven wheels OR that a 4WD vehicle uses only 2 wheels for propulsion. So it can be the description of a vehicle configuration OR the operational mode of the drivetrain.
4WD	Four-Wheel Drive	Four-wheeled vehicle with a drivetrain that allows all four wheels to receive power from the engine simultaneously which provides better control on various surfaces. Can be used to describe the configuration of the vehicle OR as the operational mode of the drivetrain. 4WD vehicles usually can turn 2 wheels off to be in a 2WD mode. See also AWD.
A/C	Air Conditioning	The cooling and dehumidification of indoor air for thermal comfort.
A/D	Analog to Digital	Used in context of converting electrical analog signals to digital signals.
ABS	Antilock Braking System	System on motor vehicles which prevents the wheels from locking while braking which helps the driver maintain control in heavy braking conditions.
AC	Alternating Current	An electrical current whose magnitude and direction vary cyclically.
AM	Amplitude Modulation	Method of impressing data onto an alternating-current (AC) carrier waveform.
APP	Accelerator Pedal Position	A pedal that controls the throttle valve.
AWD	All-Wheel Drive	All-wheel-drive systems are designed to function on all types of surfaces, both on- and off-road, and most of them cannot be switched off. This can also be called full-time four wheel drive. See also 4WD.

Acronym	Meaning	Definition
AWG	American Wire Gauge	American wire gauge is a standardized wire gauge system used since 1857 predominantly in the United States for the diameters of round, solid, nonferrous, electrically conducting wire. E.g. a wire of AWG10 has a diameter of 2.588mm, AWG20 corresponds to a diameter of 0.812mm.
B+	Battery Positive Voltage	The electrical potential on the positive terminal of the battery.
BARO	Barometric Pressure	Atmospheric pressure as measured by a barometer.
BCM	Body Control Module	This module supplies vehicle occupants with visual and audible information and controls various vehicle functions,
BECM	Battery Energy Control Module	Control module used to regulate the battery voltage.
BPP	Brake Pedal Position	Position of the foot pedal that moves a piston in the master brake cylinder.
CAN	Controller Area Network	Serial data connection between control modules by Bosch
CCM	Chassis Control Module	The module that controls various vehicle functions on the Chassis, like Engine/Trans Mount, Active Grille Air Shutter, Load Leveling, etc•••
CD	Compact Disc	A small optical disk on which data such as music, text, or graphic images is digitally encoded.
CNG	Compressed Natural Gas	This a substitute for gasoline or diesel fuel. It is made by compressing natural gas (which is mainly composed by methane (CH4), in a percentage range of 70% to 98%)
CO	Carbon Monoxide	This is a product of the incomplete combustion of carbon-containing compounds, at room temperature this is a gas. It consists of one carbon atom covalently bonded to one oxygen atom.
CO2	Carbon Dioxide	Chemical compound composed of two oxygen atoms covalently bonded to a single carbon atom.
CPA	Connector Position Assurance	Part of an electrical connector that prevents the connector from moving out of its socket. Usually needs to be pressed to unlock the connector when disconnecting it.
CPP	Clutch Pedal Position	A lever operated with the foot that controls the coupling that connects or disconnects driving and driven parts of a driving mechanism.
CV	Constant Velocity	Used in conjunction with CV joints, which connect two shafts at an angle while both shafts always have the same rotational speed without variations.
CVT	Continuously Variable Transmission	A transmission in which the ratio of the rotational speeds of two shafts, as the input shaft and output

Acronym	Meaning	Definition
		shaft of a vehicle or other machine, can be varied continuously within a given range, providing an infinite number of possible ratios which improves fuel economy.
D	Drive	D on the transmission gear selector lever.
DAB	Digital Audio Broadcast	Technology for broadcasting of audio using digital radio (carries information via digital signal) transmission.
DC	Direct Current	Continuous current, constant flow of electric charge.
DLC	Data Link Connector	This is an electronic connector typically located underneath the driver's side dashboard, just above the pedals. The connector has 16 pins.
DMM	Digital Multimeter	Electronic measuring instrument that combines several functions in one unit. The most basic instruments include an ammeter, voltmeter, and ohmmeter.
DOHC	Dual Overhead Camshaft	Dual overhead camshafts (DOHC) are higher performance engines, they produce more power, and can run at higher speeds because they allow an engine to have four valves per cylinder. Each camshaft operates two of the valves, one camshaft handles the intake valves, and one handles the exhaust valves
DPF	Diesel Particulate Filter	Device designed to remove diesel particulate matter or soot from the exhaust gas of a diesel engine.
DRL	Daytime Running Lamps	White lights mounted on the front of an automobile that automatically switch on when the key is turned and are intended for daytime use, to increase the visibility of the automobile.
DSCC	Distance Sensing Cruise Control	A type of cruise control that automatically maintains the distance between vehicles.
DSP	Digital Signal Processor	A specialized microprocessor designed specifically for digital signal processing, generally in real-time computing.
DTC	Diagnostic Trouble Code	An electronic signal stored in an automotive computer, indicating the presence of a fault detected by that computer.
DVD	DVD	A popular optical disc storage media format the size of a CD. Used mainly for movies but also for data. DVD has no spelled out version (officially it does not mean Digital Video Disc or Digital Versatile Disc, it just means DVD).
EBCM	Electronic Brake Control Module	This module contains a microprocessor and software for antilock braking system operation.

Acronym	Meaning	Definition
ECM	Engine Control Module	This electronic module works with a vehicle's sensors and engine control devices to insure that the engine operates at maximum efficiency and performance. It performs three vital functions. Receives electronic signals from engine sensors. Analyzes the data and makes an engine performance decision (based on the pre-set parameters within the unit). Sends an "output command" to an actuator that adjusts engine performance.
ECT	Engine Coolant Temperature	A measure of how hot or cold the fluid which flows through the engine in order to prevent its overheating, transferring the heat produced by the device to other devices that utilize or dissipate it.
EEPROM	Electrically Erasable Programmable Read-Only Memory	A non-volatile storage chip used in computers and other devices to store small amounts of volatile data, e.g. calibration tables or device configuration.
EGR	Exhaust Gas Recirculation	Is an NOx (nitrogen oxide and nitrogen dioxide) reduction technique used in most gasoline and diesel engines. EGR works by recirculating a portion of an engine's exhaust gas back to the engine cylinders.
EMI	Electromagnetic Interference	Electromagnetic interference (also called radio frequency interference) is a disturbance that affects an electrical circuit due to either electromagnetic conduction or electromagnetic radiation emitted from an external source.
ESD	Electrostatic Discharge	The sudden and momentary electric current that flows between two objects at different electrical potentials.
EV	Electric Vehicle	A category of vehicles that only have an electric drive system.
EVAP	Evaporative Emission	A system that controls the fuel fumes in the fuel tank.
FM	Frequency Modulation	In telecommunication this is a way to convey information over a carrier wave by varying its frequency.
FWD	Front-Wheel Drive	A form of engine/transmission layout used in motor vehicles, where the engine drives the front wheels only.
GMLAN	General Motors Local Area Network	A local-area network is a computer network covering a small geographic area, like a home or vehicle. This specific type of LAN connects several controllers inside the vehicle and was developed by General Motors.
GPS	Global Positioning System	Satellite-based navigation system made up of a network of 24 satellites placed into orbit by the U.S. Department of Defense.

Acronym	Meaning	Definition
GSM	Global System for Mobile Communications	Globally accepted standard for digital cellular communication.
GVW	Gross Vehicle Weight	Maximum total weight of a road vehicle or trailer that is loaded, including the weight of the vehicle itself plus fuel, passengers, cargo, and trailer tongue weight.
HD	Heavy Duty	Robust design to accommodate large work loads.
HID	High Intensity Discharge	A type of light that produces a bright light by using gas filled bulbs. (gas is usually mercury, metal halide, and high-pressure sodium) Uses very little battery power and is a very "cool" light.
HO2S	Heated Oxygen Sensor	Heated oxygen sensors have an internal heater circuit that brings the sensor up to operating temperature more quickly than an unheated sensor. An oxygen sensor must be hot (about 600-650Â°F) before it will generate a voltage signal. The hot exhaust from the engine will provide enough heat to bring an O2 sensor up to operating temperature.
HVAC	Heating Ventilation Air Conditioning	This system is sometimes referred to as climate control. Ventilation air ducts installed throughout a vehicle that supply conditioned air to a room through rectangular or round outlet vents.
I^2C	Inter-Integrated Circuit	Serial data connection between Integrated Circuits (microchips) inside a control module invented by Phillips
IAT	Intake Air Temperature	Temperature of the air entering intake air flow system of the engine.
ICE	Internal Combustion Engine	An engine in which the combustion of fuel and an oxidizer (typically air) occurs in a confined space called a combustion chamber.
ID	Identification	Number or Code that identifies a component or control module. Can be written on the part or be transmitted on a bus or via radio.
ISP	Internet Service Provider	A company that furnishes corporations and individual consumers with various services, mainly access to the Internet.
ISS	Input Shaft Speed	Rotational speed of the input shaft of a transmission.
LAN	Local Area Network	Standard network connection PC's.
LCD	Liquid Crystal Display	A thin, flat display device made up of any number of color or monochrome pixels arrayed in front of a light source or reflector.
LED	Light Emitting Diode	Small light bulbs that fit easily into an electrical circuit they do not have a filament that will burn out, and they do not get especially hot. They are

Acronym	Meaning	Definition
		illuminated solely by the movement of electrons in a semiconductor material.
LIN	Local Interconnect Network	Computer networking bus system used within automotive network architectures. Similar to CAN, but cheaper and less powerful.
LPG	Liquefied Petroleum Gas	A mixture of mainly propane and butane, produced commercially and stored under pressure to keep it in a liquid state.
MAF	Mass Air Flow	The amount of air drawn into the engine
MAP	Manifold Absolute Pressure	Pressure in the engine intake system after the throttle valve referenced to a perfect vacuum.
MDI	Multiple Diagnostics Interface	A device used by GM dealers that enables a PC to communicate with the control modules in a vehicle.
MIL	Malfunction Indicator Lamp	An indicator of the internal status of a car engine.
MOST	Media Oriented Systems Transport	Serial communication bus to transmit audio and video information.
N	Neutral	A state of the transmission in which it is not engaged.
NiMH	Nickel Metal Hydride	A type of rechargeable battery that uses a hydrogen absorbing alloy for the negative electrode.
NOx	Nitrogen Oxides	Refers to any of the following oxygen compounds of nitrogen or a mixture of them. Nitric Oxide, Nitrogen dioxide, Nitrous Oxide, Dinitrogen trioxide, Dinitrogen tetroxide, Dinitrogen pentoxide.
O2	Oxygen	A colorless, odorless, tasteless, gaseous chemical element with the chemical symbol O and atomic number 8.
O2S	Oxygen Sensor	An electronic device that measures the proportion of oxygen (O2) in the gas or liquid being analyzed.
OBD	On-Board Diagnostic	A generic term referring to a vehicle's self-diagnostic and reporting capability.
OEM	Original Equipment Manufacturer	A producer that provides a product to its customers, who proceed to modify or bundle it before distributing it to their customers.
OSS	Output Shaft Speed	Rotational speed of the output shaft of a transmission.
P	Park	A state in which the transmission is set so one can leave the vehicle.
PCB	Printed Circuit Board	A thin plate on which chips and other electronic components are placed.
PCM	Powertrain Control Module	A control module that features the functions of both, the engine and the transmission control module.
PCMCIA	Personal Computer Memory Card Industry Association	An international standards body and trade association with over 100 member companies that was founded in 1989 to establish standards for Integrated Circuit cards and to promote interchangeability among

Acronym	Meaning	Definition
		mobile computers where ruggedness, low power, and small size were critical.
PIN	Personal Identification Number	A secret numeric password shared between a user and a system that can be used to authenticate the user to the system.
PPE	Personal Protective Equipment	Protective clothing, helmets, goggles, or other garment designed to protect the wearer's body from injury.
PRNDL	Park, Reverse, Neutral, Drive, Low	Park, Reverse, Neutral, Drive, Low (automatic transmission positions).
PTC	Positive Temperature Coefficient	Refers to materials that experience an increase in electrical resistance when their temperature is raised.
PTO	Power Take-Off	A splined driveshaft, usually on a tractor or truck that can be used to provide power to an attachment or separate machine. This mechanism allows implements to draw energy from the tractor's engine.
PVC	Polyvinyl Chloride	A thermoplastic copolymer.
PWM	Pulse Width Modulation	Square shaped type of signal that carries the information in the ratio between on and off times.
R	Reverse	Rearward: directed or moving toward the rear;
RAM	Random Access Memory	A type of computer data storage. It today takes the form of integrated circuits that allow the stored data to be accessed in any order.
RCT	Radiator Coolant Temperature	This is the heat intensity of the radiator coolant measured in degrees. The radiator is a part of the cooling system that removes the engine heat. Coolant is a mixture of water and antifreeze (ethylene glycol) which lowers the freezing point of the water in the coolant system, this fluid also picks up heat from the engine and transfers it to the air.
RDS	Radio Data System	A standard from the European Broadcasting Union for sending small amounts of digital information using conventional FM radio broadcasts.
RF	Radio Frequency	A frequency or rate of oscillation within the range of about 3 Hz and 300 GHz. This range corresponds to frequency of alternating current electrical signals used to produce and detect radio waves.
ROM	Read-Only Memory	A class of storage media used in computers and other electronic devices. Data stored in ROM cannot be modified.
RPO	Regular Production Option	A three digit/letter code given to parts, assemblies, and systems originally installed on the vehicle. These RPO codes designate options and are assigned by General Motors.

Acronym	Meaning	Definition
RSA	Rear Seat Audio	An auxiliary set of controls that operate the main audio system from the rear seat. Rear passengers can also operate a different media source than the front passengers.
RWD	Rear-Wheel Drive	A common engine/transmission layout in which the engine is in the front of the vehicle, but the front mid-engine, rear mid-engine and rear engine layouts are also used.
SCV	Speed Controlled Volume	The volume control is set for a desired sound level in the vehicle as the vehicle increases its speed, the sound level is adjusted.
SDM	Sensing and Diagnostic Module	The name given to air bag modules used in General Motors vehicles.
SIM	Subscriber Identity Module	Part of a removable smart card Integrated Circuit Card. This is used for mobile cellular telephone devices such as mobile computers and mobile phones. SIM cards securely store the service-subscriber key used to identify a subscriber. The SIM card allows users to change phones by simply removing the SIM card from one mobile phone and inserting it into another mobile phone or broadband telephony device.
SIR	Supplemental Inflatable Restraint	Technical term for the air bag. Air bag is a stretchable membrane, which inflates during an automobile accident to provide cushioning to the passenger's head and torso to prevent injury to the passengers.
SPI	Serial Peripheral Interface	This is an interface that enables the serial (one bit at a time) exchange of data between two devices. An SPI operates in full duplex mode. This means that data can be transferred in both directions at the same time. It is a standard bus technology like CAN or I2C.
SPS	Service Programming System	System that enables repair facilities to update the software in control modules.
SUV	Sport Utility Vehicle	A passenger vehicle which combines the towing capacity of a pickup truck with the passenger-carrying space of a minivan.
SVS	Service Vehicle Soon	Indicator lamp or symbol for a malfunction related to a vehicle component or system.
TA	Traffic Announcement	Message spoken on radio regarding the movement of vehicles or pedestrians through an area or along a route. The buttons on radios that enable this announcements are also often labeled TA.
TAC	Throttle Actuator Control	A motor which moves the engine throttle plate or valve, controlled by the engine control module. A throttle plate limits the amount of air entering a internal combustion gasoline engine.

Acronym	Meaning	Definition
TAP	Transmission Adaptive Pressure	The transmission control module learns each component's characteristics and adjusts fluid pressure accordingly.
TCC	Torque Converter Clutch	Resides in a torque converter to connect an engine to an automatic transmission. The clutch is applied when conditions are correct to achieve a 1:1 ratio of engine crankshaft to transmission input shaft.
TCM	Transmission Control Module	A module that controls electronic automatic transmissions. It uses sensors from the vehicle as well as data provided by the Engine Control Module to calculate how and when to change gears in the vehicle for optimum performance, fuel economy and shift quality.
TDC	Top Dead Center	The piston is in its highest position relative to the combustion chamber.
TIS	Techline Information System	The PC-based global dealership diagnostic software that provides the technician the ability to reference the most recent service information via the service department's computer.
TPA	Terminal Position Assurance	An additional locking mechanism inside an electric connector that holds the pins in place.
TV	Television	A telecommunication system for broadcasting and receiving moving pictures and sound over a distance.
USB	Universal Serial Bus	A type of communication bus connection between a computer and a peripheral device.
VCI	Vehicle Communications Interface	A diagnostic tool that communicates to modules of multiple communication protocols in a vehicle by converting vehicle serial data into PC serial data communication.
VIN	Vehicle Identification Number	Used by manufacturers to uniquely identify motor vehicles using 17 characters.
VSCM	Vehicle Stability Control Module	This module uses information from several sensors to detect a loss of vehicle traction, then works with the antilock brake system to apply individual brakes to help keep the vehicle on its intended path.
VSS	Vehicle Speed Sensor	Sends data regarding how fast the car is traveling at the moment of driving. It is designed to be able to record the rate at which the vehicle's crankshaft is spinning.
WOT	Wide Open Throttle	When the throttle blade or valve is at its maximum open position, allowing maximum air to enter an internal combustion gasoline engine.
WLAN	Wireless Local Area Network	Standard to transmit digital data via radio frequency.

Acronym	Meaning	Definition
XM	XM (Satellite Radio)	XM Satellite Radio Holdings (XM) is one of two satellite radio services in the United States and Canada. XM provides pay-for-service radio, analogous to cable television. Its service includes 73 different music channels, 39 news, sports, talk, and entertainment channels, 21 regional traffic and weather channels and 23 play-by-play sports channels (2008).
XML	Extensible Markup Language	A markup language that defines a set of rules for encoding documents in a format that is both human-readable and machine-readable.

Units

Unit	Meaning	Definition
m^2	Square Meter	Area
A	Ampere	Electrical
Ah	Ampere Hour	Electrical
C	Coulomb	Electrical
dBm	Decibel Meter	Electrical
dBmV	Decibel Millivolt	Electrical
mV/DIV	Millivolts per Division	Electrical
mV/s	Millivolts per Second	Electrical
Ω	Ohm	Electrical
V	Volt	Electrical
V/DIV	Volts per Division	Electrical
V/ms	Volts per Millisecond	Electrical
W	Watt	Electrical
mm^3 /stroke	Cubic Millimeters per Stroke	Flow
gal/h	Gallons per Hour	Flow
g/s	grams per second	Flow
g/stroke	Grams per Stroke	Flow
kg/100km	Kilograms per 100 Kilometer	Flow
kg/h	Kilograms per Hour	Flow
km/L	kilometer/liter	Flow
L/100km	Liters per 100 Kilometers	Flow
L/h	Liters per Hour	Flow
L/min	Liters per Minute	Flow
MPG	Miles per Gallon	Flow
mg/s	Milligrams per Second	Flow
mg/stroke	Milligrams per stroke	Flow
ft	feet	Length
in	Inch	Length

Unit	Meaning	Definition
m	Meter	Length
mi	Mile	Length
bar	Bar	Mechanical
bar/min	Bars per Minute	Mechanical
in. H2O	Inches of Water	Mechanical
in. H2O/s	Inches of Water per second	Mechanical
kPa/s	Kilopascals per Second	Mechanical
N	Newton	Mechanical
Â	Newton Meter	Mechanical
Pa	Pascal	Mechanical
Pa/s	Pascals per Second	Mechanical
lb ft	Pound Foot	Mechanical
PSI	Pound-Force per Square Inch	Mechanical
Counts	Counts	Misc.
Cycles	Cycles	Misc.
dB	Decibel	Misc.
Â°	Degree	Misc.
Â°C	Degree Centigrade	Misc.
Â°CA	Degree Crankshaft Angle	Misc.
Â°F	Degree Fahrenheit	Misc.
Â°/s	Degree per Second	Misc.
Hz	Hertz	Misc.
kbit/s	Kilobit per second	Misc.
lx	Lux	Misc.
ppm	Parts per Million	Misc.
%	Percent	Misc.
%/min	Percents per Minute	Misc.
%/sec	Percents per Second	Misc.
Pulses	Pulses	Misc.
:1	Ratio	Misc.
RPM	Revolutions per Minute	Misc.
Steps	Steps	Misc.
W/m^2	Watts per Square Meter	Misc.
g	g (Acceleration)	Movement
km/h	Kilometers per Hour	Movement
m/s	Meters per Second	Movement
m/s^3	Meters per Second Cubed	Movement
m/s^2	Meters per Second Squared	Movement
MPH	Miles per Hour	Movement
mm/s	Millimeters per Second	Movement

Unit	Meaning	Definition
d	Day	Time
h	Hour	Time
hh:mm:ss	Hour:Minute:Second	Time
ms/DIV	Milliseconds per Division	Time
min	Minute	Time
s	Second	Time
s/DIV	Seconds per Division	Time
yy-mm-dd	Year-Month-Day (2 digits)	Time
yyyy-mm-dd	Year-Month-Day (4 digits, preferred)	Time
m^3	Cubic Meter	Volume
gal	Gallon	Volume
L	Liter	Volume
mL	milliliters	Volume
US gal	US Gallon	Volume
US pt	US Pint	Volume
US qt	US Quart	Volume
kg	Kilogram	Weight

CUSTOMER CONCERN VERIFICATION SHEETS

The GM Customer Concern Verification Sheets have been designed to improve communications between the service customer and the technician. The more clearly the technician understands the concern and its symptoms, the more likely the concern will be fixed right the first time.

The GM-wide Customer Concern Verification Sheets are available in GM GlobalConnect. The Customer Concern Verification Sheets may be printed and reproduced locally.

TRAINING

Dealers

All U.S. GM Dealers participating in the Center of Learning / GM Service Technical College (STC) Programs can enroll through the Center of Learning website at https://www.centerlearning.com. Within the website, there are individual training paths that are designed to assist in planning the training needs for each individual and their job role. Dealers who have questions about Center of Learning Training should contact the Center of Learning help desk at 1-888-748-2687. The help desk is available Monday through Friday, 8:00 am - 9:00 pm Eastern Standard Time, excluding holidays. For GM Access support, contact the GM Access Help Desk at 1-888-337-1010.

Fleets

GM Fleet customers with GM Warranty In-Shop agreements are able to participate in service technical training through the Center of Learning/GM Service Technical College (STC).

Assistance for GM fleet registered customers using GM STC training is provided by the Center of Learning help desk at 1-888-748-2687. The help desk is available Monday through Friday, 8:00 am-9:00 pm Eastern

Standard Time, excluding holidays. For GM Access support, contact the GM Access Help Desk at 1-888-337-1010.

Most GM STC course materials have associated charges.

To purchase authentic GM STC Training Materials, contact the GM Training Materials Headquarters at 1-800-393-4831.

Non-GM Dealer Technicians

Technician training for non-GM dealers is available through ACDelco. This training is for ACDelco PSC and Fleet program members employed in the automotive or truck service industry.

ACDelco courses are available at approved GM STC Training Centers. Availability and schedules can be obtained by calling 1-800-825-5886 (prompt 1) or contact us via the web at www.acdelcotechconnect.com and select the Training tab. Seminars are also offered through the ACDelco Warehouse Distribution channel. Contact your Local ACDelco representative or distributor directly for more information.

VEHICLE, ENGINE AND TRANSMISSION ID AND VIN LOCATION, DERIVATIVE AND USAGE

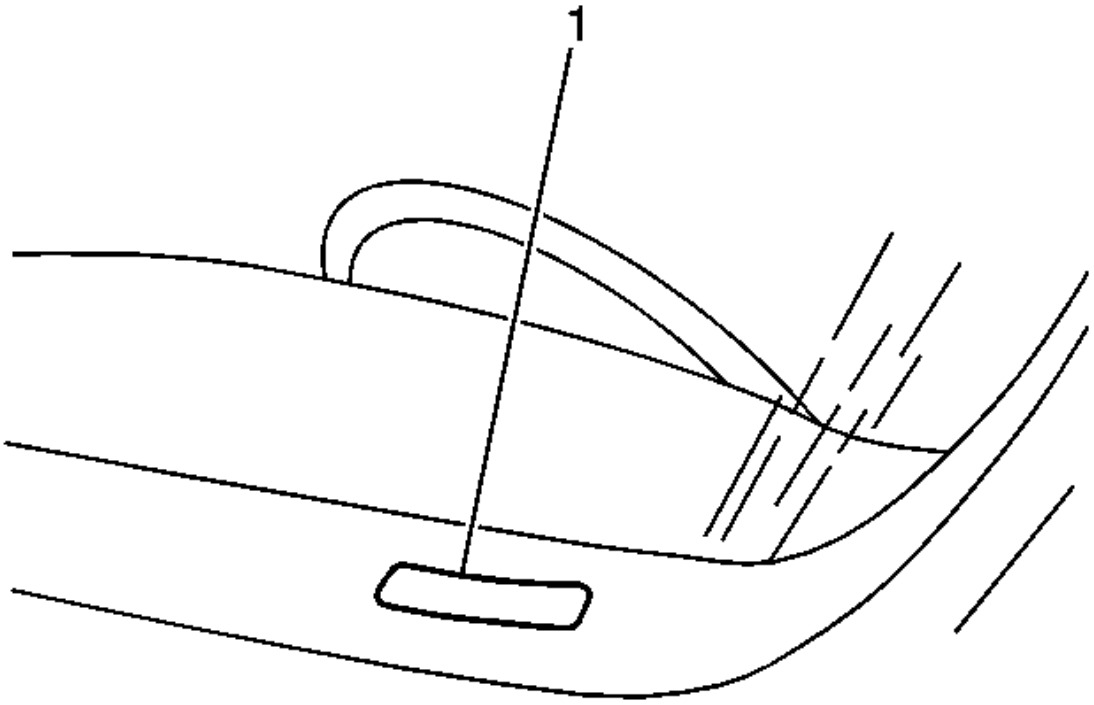

Fig. 2: View Of VIN Plate Location
Courtesy of GENERAL MOTORS COMPANY

Vehicle Identification Number (VIN) System

Position	Definition	Character	Description
The vehicle identification number (VIN) plate (1) is the legal identifier of the vehicle. The VIN plate is located on the upper left corner of the instrument panel (I/P) and can be seen through the windshield from the outside of the vehicle.			
1	Region of Build	2	Canada
2	Manufacturer	G	General Motors
3	Vehicle Brand/Type	1	Chevrolet Passenger Car
4 5	Carline/Series	W/A	Impala Limited LS Fleet
		W/B	Impala Limited LT Fleet
		W/C	Impala Limited LTZ
		W/D	Impala Limited Police Vehicle
6	Body Type	5	Sedan, 4-door, 6 Window, Notchback
7	Restraint System	E	Active Manual Belts, Airbags - Driver and Passenger - Front (1st row), Front Seat Side (1st row), Roof Side (all seating rows)
8	Engine Code	3	RPO LFX Engine - Gas, 6 Cylinder, 3.6L, V6, SIDI, DOHC,VVT, E85 Max, ALUM, GM
9	Check Digit	-	Check Digit
10	Model Year	F	2015
11	Plant Location	1	Oshawa #2, ONT, Canada
12-17	Plant Sequence Number	-	Plant Sequence Number

VIN Derivative Characters

Position	Definition	Character	Description
All engines and transmissions are stamped with a partial vehicle identification number (VIN). This table identifies the different VIN derivative characters and their respective positions.			
1	Division	2	Chevrolet
2	Model Year	F	2015
3	Plant Location	1	Oshawa #2, ONT, Canada
4-9	Plant Sequence Number	-	Plant Sequence Number
A VIN derivative can be used to determine if a vehicle contains the original engine or transmission by matching the VIN derivative positions to their accompanying positions in the complete VIN.			

VIN Positions

VIN Derivative Position	Equivalent VIN Position
1	3
2	10
3	11

VIN Derivative Position	Equivalent VIN Position
4-9	12-17

VEHICLE CERTIFICATION, TIRE PLACARD, ANTI-THEFT, AND SERVICE PARTS ID LABEL

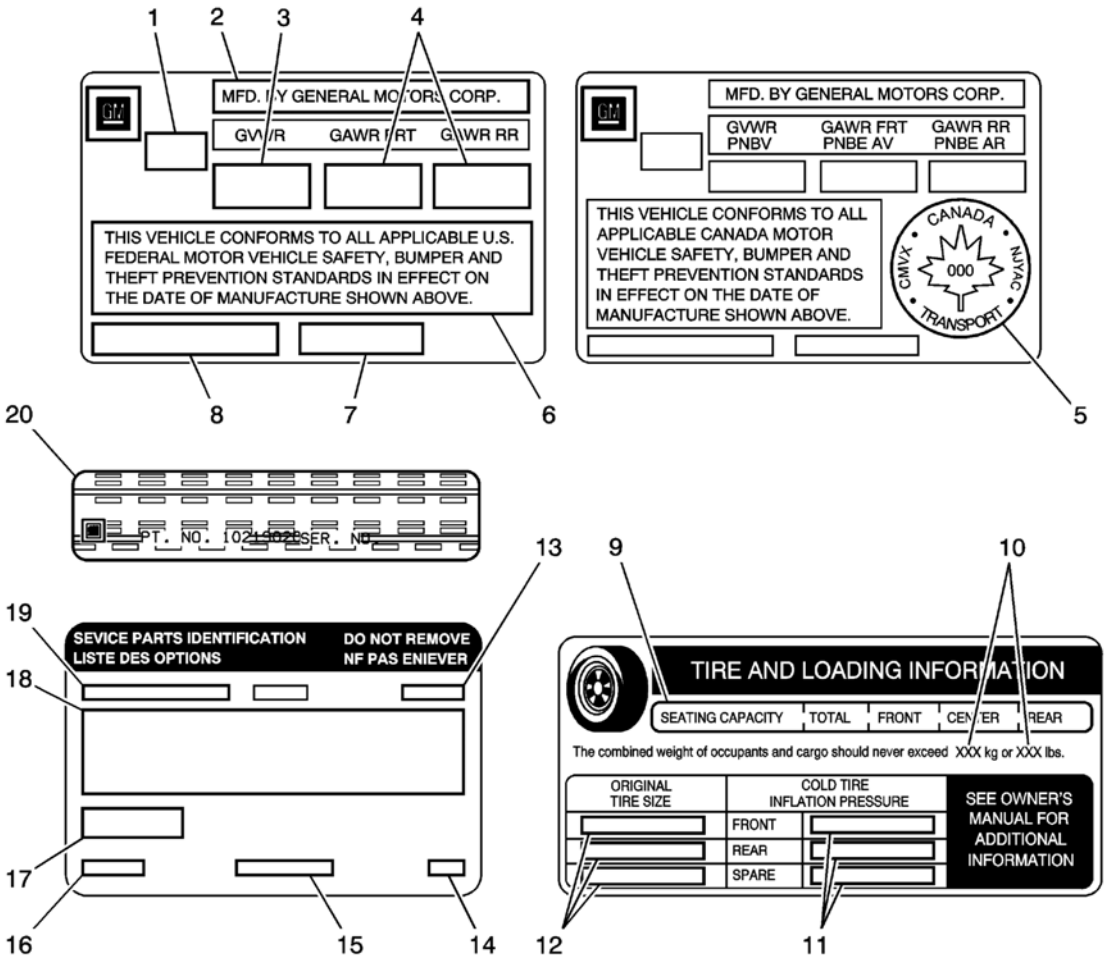

Fig. 3: Identifying Vehicle Certification, Tire Place Card, Anti-Theft & Service Parts ID Labels
Courtesy of GENERAL MOTORS COMPANY

Callout	Description

Vehicle Certification Label
The vehicle certification label is located on the driver door and displays the following assessments:
• Gross vehicle weight rating (GVWR)
• Gross axle weight rating (GAWR), front and rear
• The gross vehicle weight (GVW) is the weight of the vehicle and everything it carries. The gross vehicle weight must not exceed the GVWR. Include the following items when figuring the GVW:
  • The base vehicle weight (factory weight)
  • The weight of all vehicle accessories
  • The weight of the driver and the passengers	

Callout	Description
	• The weight of the cargo
1	Name of Manufacturer
2	Gross Vehicle Weight Rating
3	Gross Axle Weight Rating (Front, Rear)
4	Canadian Safety Mark (w/RPO Z49)
5	Certification Statement
6	Vehicle Class Type (Pass Car, etc.)
7	Vehicle Identification Number
8	Date of Manufacture (Mo/Yr)
Tire Placard The tire placard label is located on the driver side center pillar, below the door latch, and displays the following assessments:	
9	Specified Occupant Seating Positions
10	Maximum Vehicle Capacity Weight
11	Tire Pressure, Front, Rear, and Spare (Cold)
12	Original Equipment Tire Size
Service Parts ID Label The vehicle service parts identification label is located in the instrument panel (I/P) compartment. The label is use to help identify the vehicle original parts and options.	
13	Vehicle Identification Number
14	Engineering Model Number (Vehicle Division, Line and Body Style)
15	Interior Trim Level and Decor
16	Exterior (Paint Color) WA Number
17	Paint Technology
18	Special Order Paint Colors and Numbers
19	Vehicle Option Content
Anti-Theft Label	
20	The Federal law requires that General Motors label certain body parts on this vehicle with the VIN. The purpose of the law is to reduce the number of motor vehicle thefts by helping in the tracing and recovery of parts from stolen vehicles. Labels are permanently affixed to an interior surface of the part. The label on the replacement part contains the letter R, the manufacturer's logo, and the DOT symbol. The anti-theft label must be covered before any painting, and rustproofing procedures, and uncovered after the procedures. Failure to follow the precautionary steps may result in liability for violation of the Federal Vehicle Theft Prevention Standard and possible suspicion to the owner that the part was stolen.

RPO CODE DESCRIPTION

The following table provides the description of the Regular Production Option (RPO) codes that are available on the vehicle. The vehicle's RPO list is printed on the Service Parts Identification Label.

RPO	Description

RPO	Description
17U	PRIMARY COLOR EXTERIOR, SWITCHBLADE SILVER MET (09)
192	TRIM COMBINATION LEATHER, EBONY (02) (00)
19C	TRIM COMBINATION CLOTH, EBONY (C) (00)
19E	TRIM COMBINATION CLOTH, EBONY (C)
19G	TRIM COMBINATION CLOTH, EBONY (G) (04)
19I	INTERIOR TRIM EBONY (I) (00)
41U	PRIMARY COLOR EXTERIOR, BLACK (97)
50U	PRIMARY COLOR EXTERIOR, OLYMPICS WHITE (02)
6A3	COVERING - FLOOR MAT, FRONT AND REAR, HD.
6B2	HANDLE - REAR DOOR, INOPERATIVE
6B7	WIRING PROVISIONS - ROOF PANEL ACCESS HOLE CENTER
6C7	LAMP - DOME PASS
6C8	CABLE - RG58 A/U COAX RADIO ANTENNA
6E2	CYLINDER UNIT - SINGLE KEY SYSTEM, CODED DF81
6E8	CYLINDER UNIT - SINGLE KEY SYSTEM, CODED NU97
6F5	WIRING PROVISIONS - ROOF
6J1	WIRING PROVISIONS - IGNITION AND MAIN POWER SUPPLY
6J3	WIRING PROVISIONS - HEADLAMP FLASHER, GRILLE LAMPS AND SPEAKERS
6J4	WIRING PROVISIONS - HORN/SIREN CIRCUIT
6J5	WIRING PROVISIONS - ROOF PANEL ACCESS HOLE RH SI
6J6	LAMP PACKAGE - EMERGENCY VEHICLE R/WDO PANEL
6J7	FLASHER - HEADLAMP
6N5	HANDLE - INOPERATIVE, REAR WINDOW
6N6	LOCK CONTROL - REAR DOOR, INOPERATIVE
702	TRIM COMBINATION-LEATHER, LT NEUTRAL (2) (05)
70C	TRIM COMBINATION-CLOTH, LT NEUTRAL (C) (05)
70I	PRIMARY COLOR-EXTERIOR, VICTORY RED (9260)
7B3	SUSPENSION SYSTEM - SPECIAL HANDLING
7M9	COOLING SYSTEM - STEERING OIL AND ENGINE OIL
7X6	SPOTLAMP - LEFT, PILLAR MOUNTED, HALOGEN
7X7	SPOTLAMP - LEFT AND RIGHT, PILLAR MOUNTED, HALOGEN
7X8	SPOTLAMP - PROVISIONS, LEFT
7X9	SPOTLAMP - PROVISIONS, LEFT AND RIGHT
7Y6	SWITCH - DOME LAMP, DOOR JAMB INOPERATIVE
832	TRIM COMBINATION LEATHER, TITANIUM (2) (06)
83C	TRIM COMBINATION CLOTH, TITANIUM (C) (06)
83I	INTERIOR TRIM TITANIUM (06)
8X1	VEHICLE LABEL - FASTEN SEAT BELTS
9C1	SEO VEHICLE - POLICE CAR
9C3	SEO VEHICLE - POLICE CAR, LIMITED CONTENT

RPO	Description
9G8	EQUIPMENT - DAYTIME RUNNING LAMP AND HEADLAMPS CONTROL, DELETE
A75	SEAT CUSHION - BACK FRONT, HD
A76	SEAT CUSHION - BACK REAR, HD
A98	LOCK CONTROL REAR COMPARTMENT - LID, REMOTE CONTROL ELECTRIC RELEASE, IGNITION POWERED
AG1	ADJUSTER FRONT SEAT - POWER, MULTIDIRECTIONAL, DRIVER
AG2	ADJUSTER PASSENGER SEAT - POWER MULTIDIRECTIONAL
AH5	ADJUSTER FRONT SEAT - POWER, 8-WAY, NO MEMORY, DRIVER
AL0	SENSOR INDICATOR - INFLATABLE RESTRAINT, FRONT PASSENGER/CHILD PRESENCE DETECTOR
AM9	SEAT REAR - SPLIT BACK, FOLDING
AMF	LOCK CONTROL - ADDITIONAL, PROGRAMMABLE, REMOTE ENTRY, MULTIPLE UNITS
AN3	SEAT FRONT - INDIVIDUAL (NON BKT)
AP3	LOCK CONTROL, ENTRY - REMOTE, KEYLESS ENTRY, START
AR9	SEAT - FRONT BUCKET, DELUXE
AT8	RESTRAINT PROVISIONS - CHILD, REAR SEAT, REAR FACING
AXJ	VEHICLE TYPE PASSENGER CAR
AY0	RESTRAINT SYSTEM - SEAT, INFLATABLE, DRIVER AND PASS FRT, SEAT SIDE, ROOF SIDE
B34	COVERING FRONT - FLOOR MATS, CARPETED INSERT
B35	COVERING REAR - FLOOR MATS, CARPETED INSERT
B3B	ORNAMENTATION - INTERIOR, SPORT
B3V	TEST - EXTENDED WATER
B42	COVERING - FLOOR MAT, LUGGAGE COMPARTMENT, FITTED
B86	MOLDING BODY SIDE - BODY COLOR
B9V	HANDLING CHARGE - OSHAWA ASSEMBLY TO KERR INDUSTRIES IN OSHAWA, BACK TO OSHAWA ASSEMBLY
BAG	PARTS PACKAGE - EXPORT
BDR	LOCK CYLINDER - RR COMPT
BZP	ORNAMENTATION - INTERIOR, WOODGRAIN
C67	HVAC SYSTEM - AIR CONDITIONER FRONT, ELECTRONIC CONTROLS
CAV	ACCESSORY-TRAY - TRUNK/CARGO AREA
CF5	ROOF - SUN GLASS, SLIDING ELECTRIC
CJ3	HVAC SYSTEM - AIR CONDITIONER FRONT, MANUAL TEMPERATURE CONTROL, AUXILIARY TEMPERATURE CONTROL
CW7	COUNTRY - PUERTO RICO/US VIRGIN ISLANDS
D55	CONSOLE - FRONT COMPARTMENT, FLOOR
D81	SPOILER - REAR, AERO WING
DD6	MIRROR INSIDE REAR VIEW - LIGHT SENSITIVE, DUAL READING LAMPS

RPO	Description
DG7	MIRROR OUTSIDE - LH AND RH, REMOTE CONTROL, ELECTRIC, COLOR
DH6	MIRROR INSIDE FRONT VAN - LH AND RH SUNSHADE, ILLUMINATED
DK2	MIRROR O/S LH & RH, REMOTE CONTROL, ELECTRIC, HEATED, COLOR
EF7	COUNTRY - UNITED STATES OF AMERICA (USA)
EXP	EXPORT
F71	RATIO-TRANSAXLE FINAL DRIVE 2.44
FAS	ACCESSORY-NAVIGATION SYSTEM - PORTABLE - LEVEL 2
FAW	ACCESSORY-NAVIGATION SYSTEM - PORTABLE - LEVEL 3
FE1	SUSPENSION SYSTEM - SOFT RIDE
FE2	SUSPENSION SYSTEM - RIDE, HANDLING
FE3	SUSPENSION SYSTEM - SPORT
FE9	CERTIFICATION - EMISSION, FEDERAL
FHS	VEHICLE FUEL - GASOLINE E85
GAM	VEHICLE - GOVERNMENT (G.S.A. SALES)
GBE	PRIMARY COLOR-EXTERIOR, CRYSTAL CLARET TINTCOAT (G) 505Q
GLJ	PRIMARY COLOR-EXTERIOR, ASHEN GRAY METALLIC 810T
I15	ENGINEERING YEAR-2015
IKC	TRIM-INTERIOR DESIGN (KC)
IP2	TRIM-INTERIOR DESIGN (P2)
IPC	TRIM-INTERIOR DESIGN (PC)
IPE	TRIM-INTERIOR DESIGN (PE)
IPG	TRIM-INTERIOR DESIGN (PG)
JA9	BRAKE - HEAVY WEIGHT, DISC/DISC
JB9	BRAKE - LIGHT WEIGHT, DISC/DISC
JL9	BRAKE SYSTEM - POWER FRONT AND REAR DISC, ANTILOCK FRONT AND REAR WHEEL
K05	HEATER - ENGINE BLOCK
KA1	HEATER - SEAT, FRT
KD1	COOLING SYSTEM - TRANSMISSION, OIL
KG4	GENERATOR - 150 AMP
KW7	GENERATOR-170 AMP
LFX	ENGINE - GAS, 6 CYL, 3.6L, SIDI, DOHC, VVT, E85 MAX, ALUM, GM
MH2	TRANSMISSION - AUTOMATIC 6-SPEED, HMD, 6T70
MX0	MERCHANDISED TRANSMISSION - AUTOMATIC PROVISIONS, O/D
NB8	EMISSION OVERRIDE - CALIFORNIA SYSTEM
NC7	EMISSION OVERRIDE - FEDERAL SYSTEM
NE1	CERTIFICATION - EMISSION, GEOGRAPHICALLY RESTRICTED REGISTRATION FOR VEHICLES UP TO 14,000 LBS GVW
NK5	STEERING WHEEL - STANDARD

RPO	Description
NP5	STEERING WHEEL - LEATHER-WRAPPED
NT7	EMISSION SYSTEM - FEDERAL, TIER 2
NU5	EMISSION SYSTEM - CALIFORNIA, BIN 4
OST	PLANT CODE - OSHAWA 2, ONT, CANADA
QCF	TIRE SPARE-P235/55R17 SL 98 W BW AL3
QCL	TIRE SPARE-T125/70R17 SL 98M BW SPR
QDG	TIRE ALL - P235/50R18-97W BW R/PE ST TL HWY
QPX	TIRE ALL - P225/60R16-97S BW R/PE ST TL ALS
QVS	TIRE ALL-P225/55R17 SL 95T BW AL2
QWM	TIRE ALL-P235/55R17 SL 98W BW AL3
RS7	WHEEL-17 X 6.5, J, ALUMINUM, DESIGN 1
RSF	WHEEL-17 X 7.5, J, STEEL, DESIGN 1
RSX	WHEEL-18 X 7.0, J, ALUMINUM, DESIGN 1
RUF	WHEEL SPARE-17 X 7.5, J, STEEL, DESIGN 1
RV5	WHEEL-16 X 6.5, J, ALUMINUM, DESIGN 2
RV9	WHEEL SPARE-17 X 4.0, T, STEEL, DESIGN 1
RVZ	WHEEL SPARE-16 X 4.0, T, STEEL, DESIGN 1
RWP	ACCESSORY-CABLE - PORTABLE MUSIC PLAYER
RWS	ACCESSORY-FLOOR MATS - CARPET
RWV	ACCESSORY-CARGO AREA ORGANIZER - FIXED
RXH	ACCESSORY-CENTER CAP - WHEEL - DESIGN 1
RXJ	ACCESSORY-CENTER CAP - WHEEL - DESIGN 2
RYH	ACCESSORY-DVD PLAYER SYSTEM - RSE HEADREST - SINGLE - UPGRADEABLE
S02	ACCESSORY-HEADPHONES - NOISE CANCELING
S08	ACCESSORY-HIGHWAY SAFETY KIT
S4J	ACCESSORY-LOCK - VEHICLE COVER
S5Q	ACCESSORY-NAVIGATION SYSTEM - PORTABLE
S5U	ACCESSORY-ORGANIZER - CD - DVD HOLDER - VISOR MOUNTED
S6P	ACCESSORY-REMOTE START KIT
SAO	ACCESSORY-SMOKERS PACKAGE
SB1	ACCESSORY-SPLASH GUARDS - FLAT
SB3	ACCESSORY-SPOILER - DECKLID - WING
SD5	ACCESSORY-TIRE PRESSURE MONITOR
SDS	ACCESSORY-WEATHER DEFLECTORS - SIDE WINDOW - SMOKED
SE0	ACCESSORY-WHEEL - 17" - ALUMINUM - DESIGN 1
SE1	ACCESSORY-WHEEL - 17" - ALUMINUM - DESIGN 2
SE2	ACCESSORY-WHEEL - 17" - ALUMINUM - DESIGN 3
SE4	ACCESSORY-WHEEL - 18" - ALUMINUM - DESIGN 1
SFE	ACCESSORY-WHEEL LOCKS
T53	LAMP PACKAGE - EMERGENCY VEHICLE REAR COMPARTMENT LID

RPO	Description
T96	LAMP - FOG, FRONT
U1C	RADIO - AM/FM STEREO, SEEK/SCAN, CD, CLOCK, ETR
U2E	INSTRUMENT CLUSTER - COOLANT TEMPERATURE, TRIP ODOMETER
U2K	DIGITAL AUDIO SYSTEM - S-BAND
U77	ANTENNA - REAR WINDOW, RADIO
UA6	THEFT DETERRENT SYSTEM
UE0	COMMUNICATION SYSTEM-VEHICLE - NONE
UE1	COMMUNICATION SYSTEM - VEHICLE, G.P.S. 1
UG1	OPENER GARAGE DOOR, UNIVERSAL
UH8	CLUSTER - INSTRUMENT, COOLANT TEMPERATURE, TRIP ODOMETER, TACHOMETER
UJM	TIRE PRESS INDICATOR MANUAL LEARN
UK3	CONTROL - STEERING WHEEL, ACCESSORY
UN9	RADIO EQUIPMENT - SUPPRESSION
UPF	WIRELESS INTERFACE - SHORT RANGE, VOICE REC
UQ3	SPEAKER SYSTEM - ENHANCED AUDIO
US8	RADIO - AM/FM STEREO, SEEK/SCAN, CD, AUTO TONE, CLOCK, ETR, MP3, RDS
UT7	PROVISION - AUXILIARY ELECTRICAL SYSTEM GROUND
UW6	SPEAKER SYSTEM - 6, CUSTOM
VAV	ACCESSORY-FLOOR MATS - ALL WEATHER
VC4	LABEL - PRICE/FUEL ECON, PUERTO RICO AND VIRGIN ISLANDS
VG6	LABEL INFORMATION - BUMPER IMPACT, 5 MPH, CALIFORNIA
VH3	LABEL INFORMATION - BUMPER IMPACT, 5 MPH, HAWAII
VK3	LICENSE PLATE FRONT - FRONT MOUNTING PACKAGE,
VL7	LABEL INFORMATION - BUMPER IMPACT, 5 MPH, FRONT AND REAR, NEW YORK
VM3	LABEL INFORMATION - CONSUMER, CONTAINS BUMPER IMPACT STANDARD FOR FRONT, 5 MPH AND REAR 5 MPH
VQG	ACCESSORY-WEATHER PROTECTION PACKAGE
VQK	ACCESSORY-SPLASH GUARDS - CUSTOM MOLDED
VQZ	ACCESSORY-EXHAUST TIP - DESIGN 1
VT7	OWNERS MANUAL - ENGLISH LANGUAGE
VY7	KNOB-TRANS CONT LEVER, LEATHER
W2D	ACCESSORY-CARGO NET
WL9	MODEL CONVERSION - POLICE VEHICLE
WMF	VIN MODEL YEAR-2015
WX7	WIRING PROVISIONS
Y3N	MODEL CONVERSION - LT FLEET
Y3P	MODEL CONVERSION - LS FLEET
YF5	CERTIFICATION - EMISSION, CALIFORNIA

RPO	Description
YM8	IDENTIFICATION-LIMITED PERSONALIZATION OPTION (LPO)
Z64	MODEL CONVERSION - LTZ
ZFH	TIRE SPARE - COMPACT, T125/70D16

FASTENERS

Metric Fasteners

This vehicle provides fastener dimensions using the metric system. Most metric fasteners are approximate in diameter to equivalent English fasteners. Make replacements using fasteners of the same nominal diameter, thread pitch, and strength.

A number marking identifies the OE metric fasteners except cross-recess head screws. The number also indicates the strength of the fastener material. A PosidriveÂ® or Type 1A cross-recess identifies a metric cross-recess screw. For best results, use a Type 1A cross-recess screwdriver, or equivalent, in PosidriveÂ® recess head screws.

GM Engineering Standards and North American Industries have adopted a portion of the ISO-defined standard metric fastener sizes. The purpose was to reduce the number of fastener sizes used while retaining the best thread qualities in each thread size. For example, the metric M6.0 X 1 screw, with nearly the same diameter and 25.4 threads per inch replaced the English 1/4-20 and 1/4-28 screws. The thread pitch is midway between the English coarse and fine thread pitches.

Fastener Strength Identification

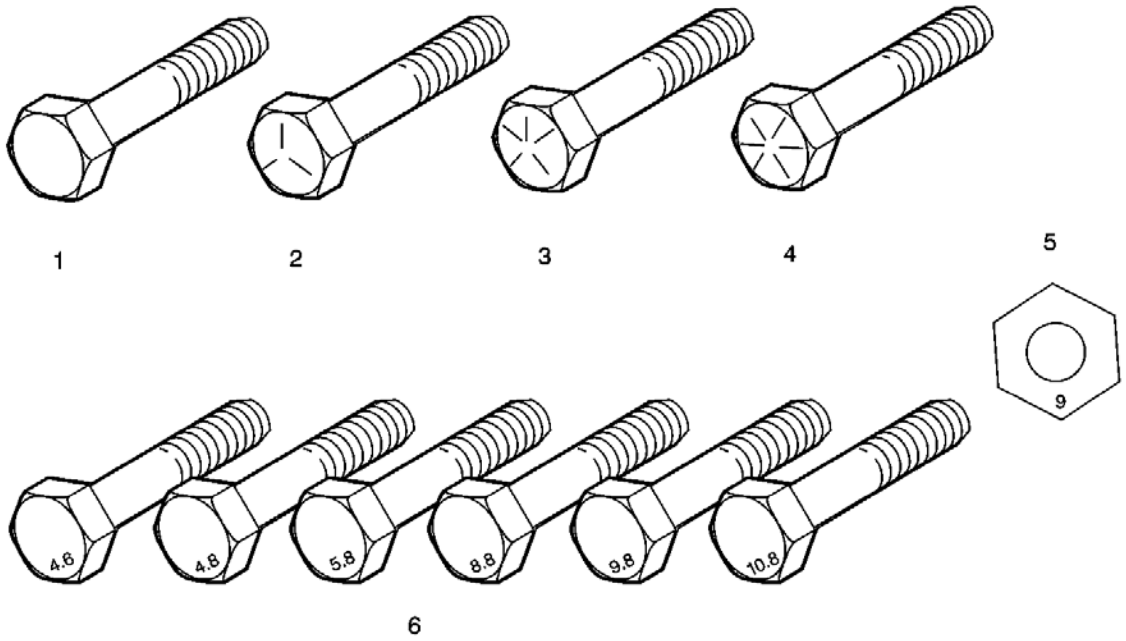

Fig. 4: Identifying Fastener Strength Marks
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	English Bolt, Grade 2 (Strength Class)
2	English Bolt, Grade 5 (Strength Class)
3	English Bolt, Grade 7 (Strength Class)
4	English Bolt, Grade 8 (Strength Class)
5	Metric Nut, Strength Class 9
6	Metric Bolts, Strength Class Increases as Numbers Increase

The most commonly used metric fastener strength property classes are 9.8 and 10.9. The class identification is embossed on the head of each bolt. The English, inch strength classes range from grade 2 to grade 8. Radial lines are embossed on the head of each bolt in order to identify the strength class. The number of lines on the head of the bolt is 2 lines less than the actual grade. For example, a grade 8 bolt will have 6 radial lines on the bolt head. Some metric nuts are marked with a single digit strength identification number on the nut face.

The correct fasteners are available through GM SPO. Many metric fasteners available in the aftermarket parts channels are designed to metric standards of countries other than the United States, and may exhibit the following:

- Lower strength
- No numbered head marking system
- Wrong thread pitch

The metric fasteners on GM products are designed to new, international standards. The following are the common sizes and pitches, except for special applications:

- M6.0 X 1
- M8 X 1.25
- M10 X 1.5
- M12 X 1.75
- M14 X 2.00
- M16 X 2.00

Prevailing Torque Fasteners

Prevailing torque fasteners create a thread interface between the fastener and the fastener counterpart in order to prevent the fastener from loosening.

All Metal Prevailing Torque Fasteners

These fasteners accomplish the thread interface by a designed distortion or deformation in the fastener.

Nylon Interface Prevailing Torque Fasteners

These fasteners accomplish the thread interface by the presence of a nylon material on the fastener threads.

Adhesive Coated Fasteners

These fasteners accomplish the thread interface by the presence of a thread-locking compound on the fastener threads. Refer to the appropriate repair procedure in order to determine if the fastener may be reused and the applicable thread-locking compound to apply to the fastener.

Adhesive Coated Fasteners

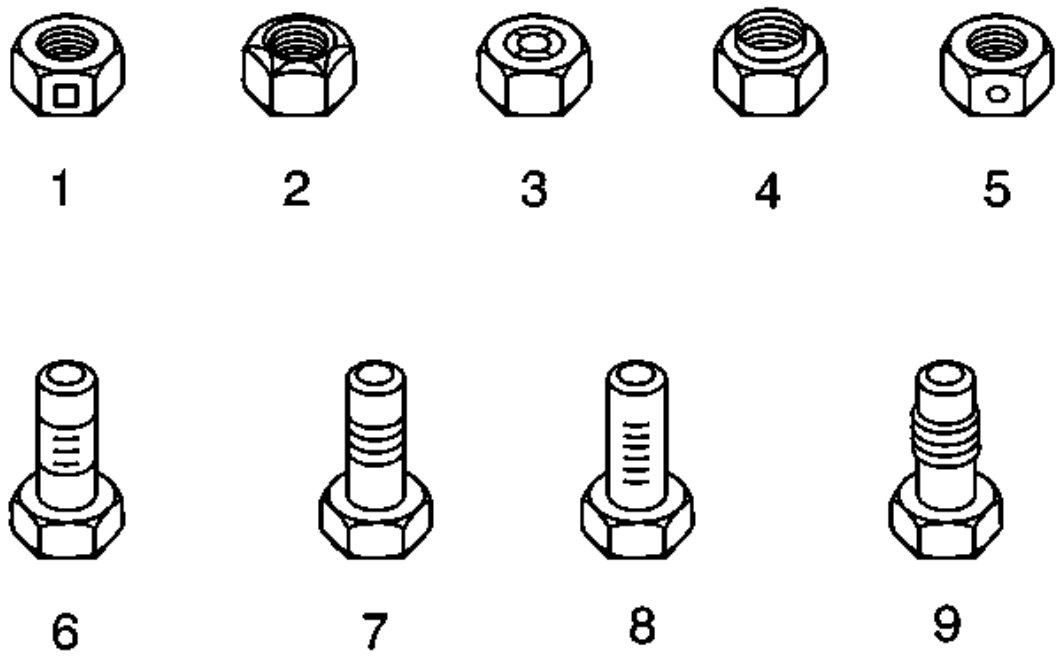

Fig. 5: Identifying Adhesive Coated Fasteners
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Prevailing Torque Nut, Center Lock Type
2	Prevailing Torque Nut, Top Lock Type
3	Prevailing Torque Nut, Nylon Patch Type
4	Prevailing Torque Nut, Nylon Washer Insert Type
5	Prevailing Torque Nut, Nylon Insert Type
6	Prevailing Torque Bolt, Dry Adhesive Coating Type
7	Prevailing Torque Bolt, Thread Profile Deformed Type
8	Prevailing Torque Bolt, Nylon Strip Type

Callout	Component Name
9	Prevailing Torque Bolt, Out-of-Round Thread Area Type

A prevailing torque fastener may be reused ONLY if:

- The fastener and the fastener counterpart are clean and not damaged
- There is no rust on the fastener
- The fastener develops the specified minimum torque against its counterpart prior to the fastener seating

Metric Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
• 6 mm	0.4	4 lb in
• 8 mm	0.8	7 lb in
• 10 mm	1.4	12 lb in
• 12 mm	2.1	19 lb in
• 14 mm	3	27 lb in
• 16 mm	4.2	37 lb in
• 20 mm	7	62 lb in
• 24 mm	10.5	93 lb in
Nylon Interface Prevailing Torque Fasteners		
• 6 mm	0.3	3 lb in
• 8 mm	0.6	5 lb in
• 10 mm	1.1	10 lb in
• 12 mm	1.5	13 lb in
• 14 mm	2.3	20 lb in
• 16 mm	3.4	30 lb in
• 20 mm	5.5	49 lb in

Application	Specification	
	Metric	English
• 24 mm	8.5	75 lb in

English Prevailing Torque Fastener Minimum Torque Development

Application	Specification	
	Metric	English
All Metal Prevailing Torque Fasteners		
• 1/4 in	0.5	4.5 lb in
• 5/16 in	0.8	7.5 lb in
• 3/8 in	1.3	11.5 lb in
• 7/16 in	1.8	16 lb in
• 1/2 in	2.3	20 lb in
• 9/16 in	3.2	28 lb in
• 5/8 in	4	36 lb in
• 3/4 in	7	62 lb in
Nylon Interface Prevailing Torque Fasteners		
• 1/4 in	0.3	3 lb in
• 5/16 in	0.6	5 lb in
• 3/8 in	1	9 lb in
• 7/16 in	1.3	12 lb in
• 1/2 in	1.8	16 lb in
• 9/16 in	2.5	22 lb in
• 5/8 in	3.4	30 lb in
• 3/4 in	5	45 lb in

THREAD INSERTS

General Purpose Thread Repair Kits.

These kits are available commercially.

Repair Procedure

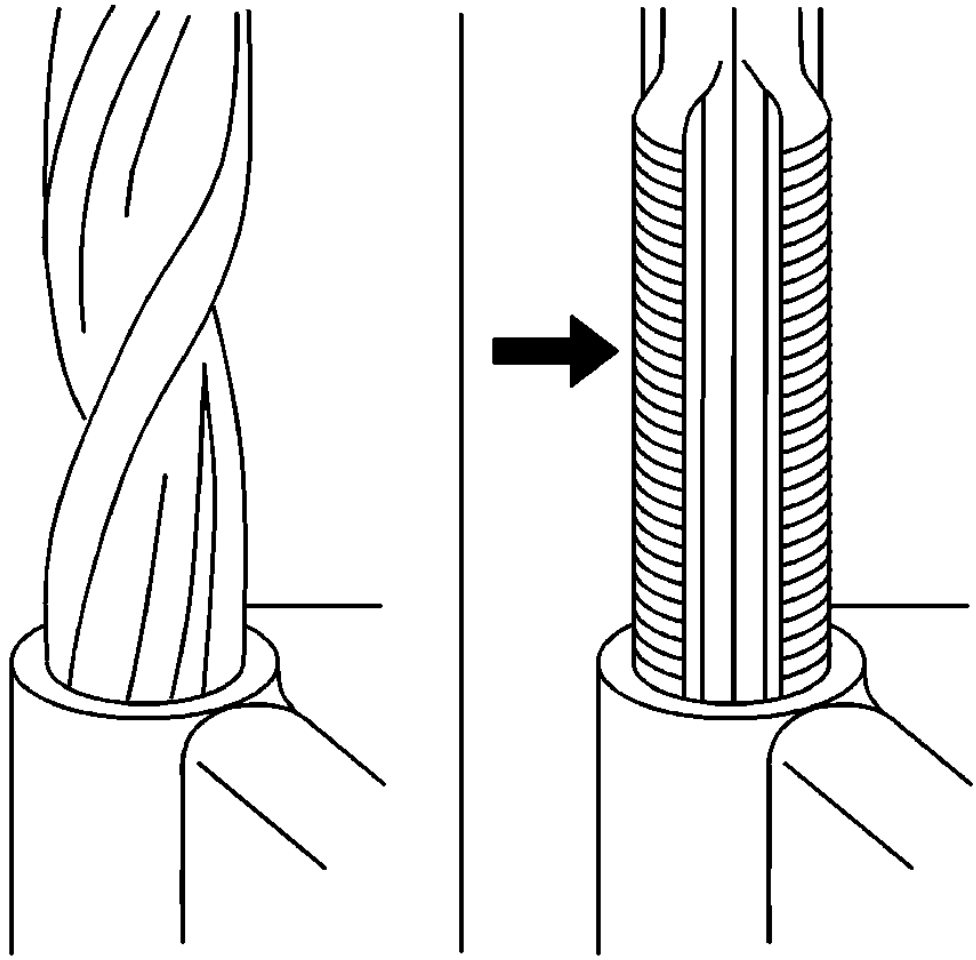

Fig. 6: Drilling & Tapping Damaged Threads
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Safety Glasses Warning .**

NOTE: **Refer to the thread repair kit manufacturer's instructions regarding the size of the drill and tap to use.**

Avoid any buildup of chips. Back out the tap every few turns and remove the chips.

1. Determine the size, the pitch, and the depth of the damaged thread. If necessary, adjust the stop collars on the cutting tool and tap to the required depth.

2. Drill out the damaged threads. Clean out any chips.
3. Lubricate the tap with light engine oil. Tap the hole. Clean the threads.

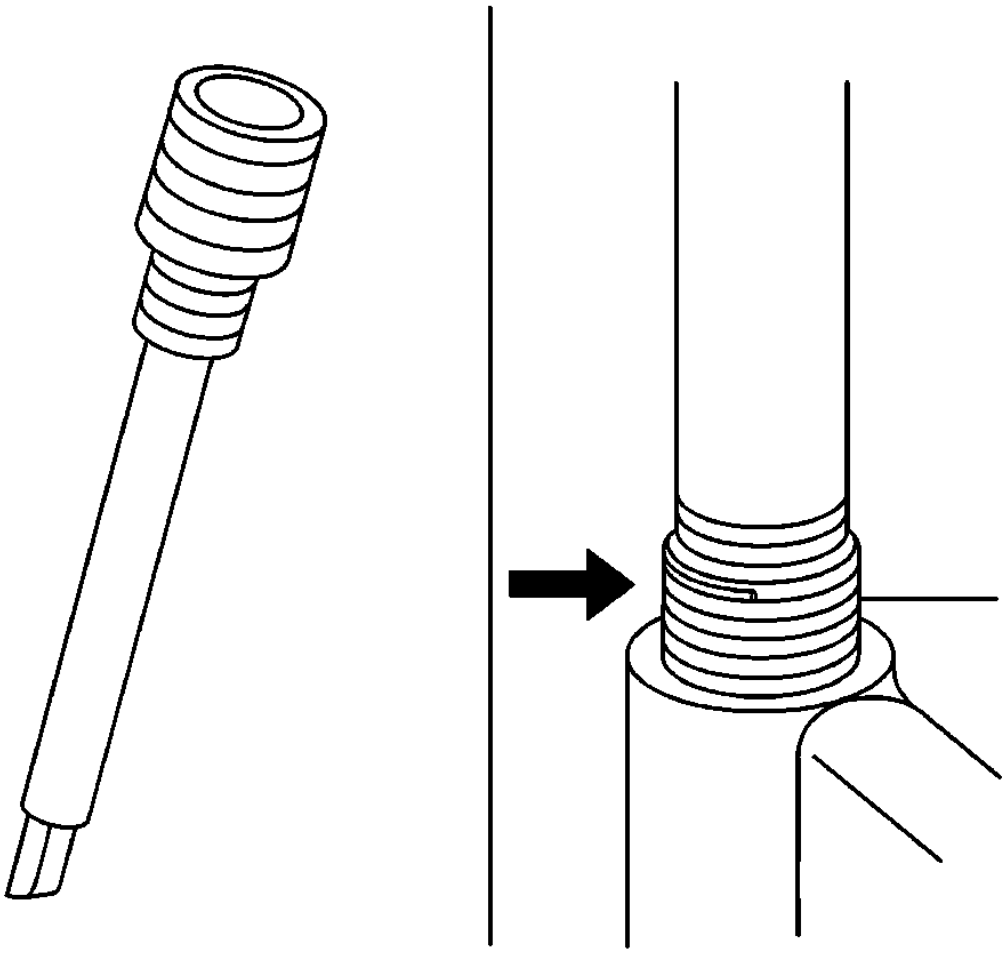

Fig. 7: View Of Thread Insert
Courtesy of GENERAL MOTORS COMPANY

4. Thread the thread insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.

NOTE: **The insert should be flush to one turn below the surface.**

5. Lubricate the insert with light engine oil, except when installing in aluminum and install the insert.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift.

REGISTERED AND NON-REGISTERED TRADEMARKS

Listed below are Registered Trademarks (Â®) or Non-Registered Trademarks (™) which may appear in this service manual.

A
ACÂ®
ACCUTURNÂ®
ACDelcoÂ®
Active Fuel Management™
AcuzincÂ®
AirbankÂ®
AllisonÂ®
AMMCOÂ®
AUTOFUSEÂ®
AUTOTRACÂ®
B
BendixÂ®
BluetoothÂ®
BON-AMIÂ®
BoschÂ®
BoseÂ®
C
CaterpillarÂ®
CATÂ®
C-QuamÂ®
D
DelcoÂ®
Delco BoseÂ®
Delco ElectronicsÂ®
Delco FreedomÂ®
Delco LOC IIÂ®
Delco MoraineÂ®
Delco RemyÂ®
Delco SoundÂ®
Delco SupremeÂ®
Delco TechÂ®
DELCOREÂ®
DelphiÂ®
DEX-COOLÂ®
DEXOILÂ®
DEXRONÂ®
DEXSTEER™
DNRÂ®
DolbyÂ®
DRÂ®
DuracellÂ®

DuraguardÂ®
DurastopÂ®
Duramax™
E
Eaton CorporationÂ®
EMDÂ®
ETRÂ®
F
FLO-LITEÂ®
G
General MotorsÂ®
GMÂ®
GM Goodwrench ServiceÂ®
GM OptikleenÂ®
GM Parts™
GM PassÂ®
GM UltraliteÂ®
GMACÂ®
GoodwrenchÂ®
GTPÂ®
H
Homelink™
HYDRA-MATICÂ®
I
IlluminationÂ®
INSTA-TRACÂ®
IntuneÂ®
L
LOCTITE™
Lord Fusor™
M
MAGNASTEERÂ®
MaxifuseÂ®
MetripackÂ®
MicropackÂ®
MinifuseÂ®
Mr GoodwrenchÂ®
N
NorthstarÂ®
O
OnStarÂ®
OptikleenÂ®

P
PASS-KEYÂ®
PASS-KEYIIÂ®
PASSLOCK™
PK3Â®
PosidriveÂ®
ProÂ®
Q
Quad 4Â®
R
RAINSENSE™
Rapid FireÂ®
S
ScotchBrite™
Scotchguard™
SignalsÂ®
Sikkens™
Soft-RayÂ®
Solar-RayÂ®
StabilitrakÂ®
SunrayceÂ®
SuperlubeÂ®
SycloneÂ®
T
Tech 2Â®
TechlineÂ®
TeflonÂ®
TefzelÂ®
Theft-IÂ®
TheftlockÂ®
TiltmasterÂ®
TORXÂ®
TransjelÂ®
TransguideÂ®
Twilight SentinelÂ®
U
UltraliteÂ®
V
VelcroÂ®
W
Weatherpack™

KEY AND LOCK CYLINDER CODING

Special Tools

BO-48370 Lock Cylinder Cap Installer

Ignition Lock Cylinder

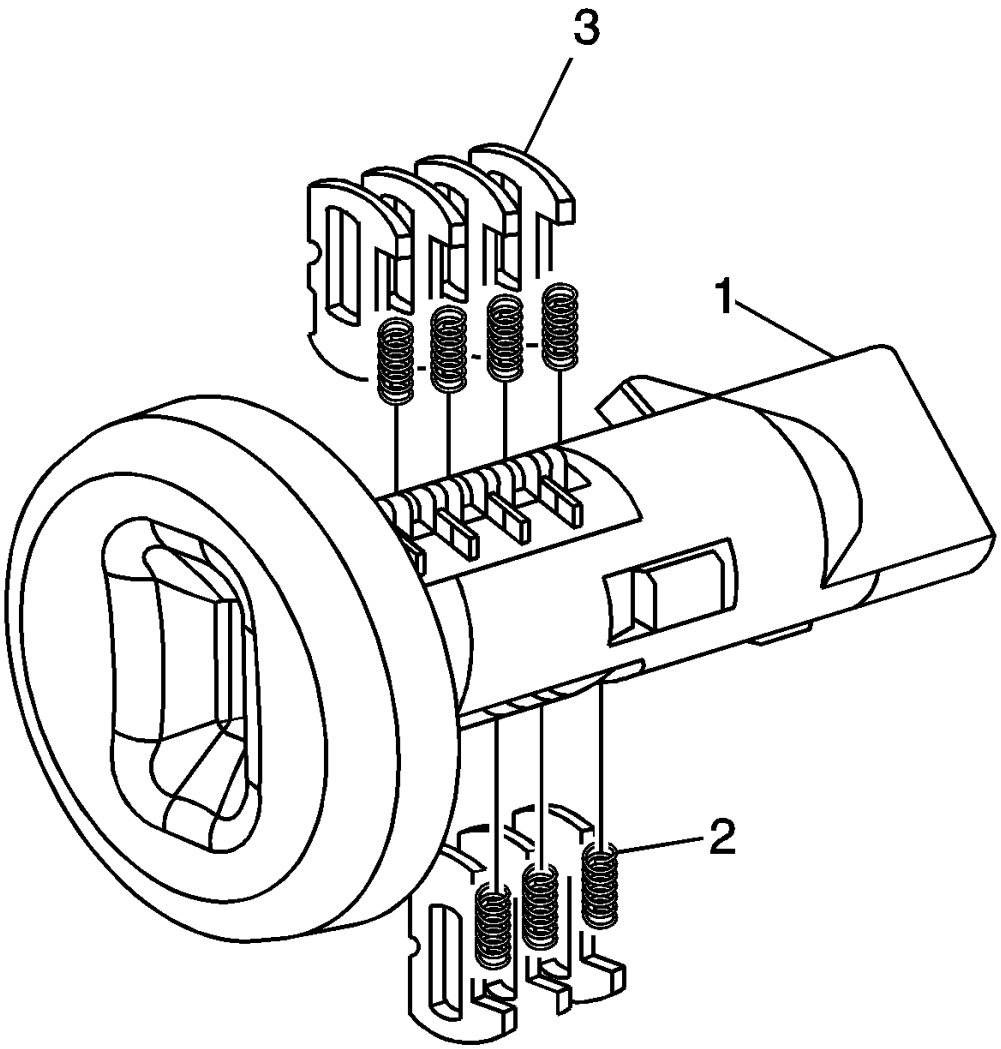

Fig. 8: Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

The ignition lock cylinder uses only 7 of the 10 cut positions, 3 through 9. The ignition cylinder tumblers are all located on alternate sides of the cylinder (1). They are snap-in and self-retaining. It follows the key code with the first tumbler being the first depth of the key code, closest to the head of the key.

1. Hold the ignition cylinder assembly (1) so the side with the 4 tumblers spring pocket of the cylinder is facing up.
2. Insert the tumbler springs (2) into each of the spring pockets of the cylinder assembly.
3. The first tumbler (3) to be loaded will be the third key cut position, the third number in the key code. Install the first tumbler in the slot nearest the head of the lock cylinder. Install the remaining tumblers for cuts 5, 7 and 9 following the key code and same process. Press the tumblers in place until they are secure.
4. Rotate cylinder assembly so the 3 tumblers springs pocket of the cylinder is facing up. Insert tumbler springs (2) into each of the spring pockets of the cylinder assembly.
5. The first tumbler (3) to be loaded will be the fourth key cut position, the fourth number in the key code. Install the first tumbler in the slot nearest the head of the lock cylinder. Install the remaining tumblers for cuts 6 and 8 following the key code and same process. Press the tumblers in place until they are secure.
6. Inspect for correct loading of the tumblers by inserting the key into cylinder. The side bar should drop flush with the lock cylinder body diameter.
7. Lightly lubricate the outside surfaces in the tumbler area of the lock body and down the key slot using the provided grease. Insert and extract the key 5 times to lubricate the keyway.
8. Line-up the lock to the run position. Insert lock in steering column. Rotate lock to key out position and remove key. Insert key and rotate lock 3 times to distribute the grease from the lock to column housing inside diameter.

Front Side Door Lock Cylinder

The front side door lock cylinder uses 8 of the 10 key cut positions, 3 through 10 when counting from the key head. The tumbler orientations alternate in adjacent locations from side to side with 4 on each side.

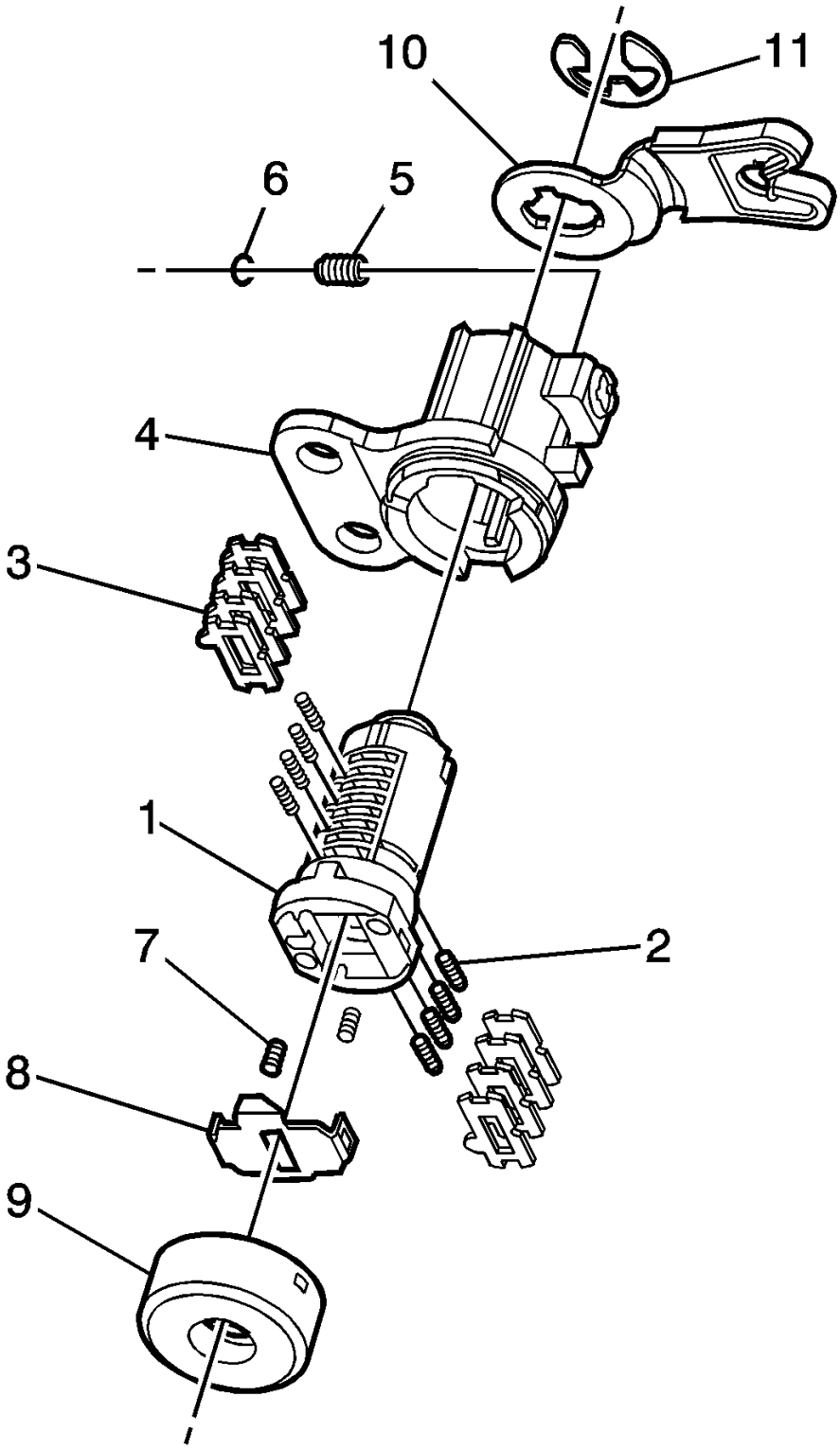

Fig. 9: Front Side Door Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The front side door lock cylinder tumblers (3) are not self-retaining and must be held in place if the key in not fully inserted into the lock cylinder or until the cylinder (1) is assembled into the case assembly (4). Left side shown, right side opposite.**

1. Hold the uncoded cylinder (1) positioned so the side with the rotational stop lug is facing upward, as shown.
2. Insert one tumbler spring (2) each into the 4 tumbler spring holes.
3. The first tumbler to be loaded will be key cut position 3, the third number in the key code. Determine the cut depth at this position and install the corresponding tumbler (3) into the tumbler slot nearest the front of the lock cylinder assembly (1), the end where the key is inserted.
4. In the same manner, determine the cut depth and corresponding tumbler and install the 3 remaining tumblers (3) into the tumbler slots located at key cut positions 5, 7, and 9.
5. Check the correct loading by holding the tumblers (3) in position and fully inserting the matching key into the cylinder (1). All tumblers should be flush with the outside diameter of the cylinder.
6. Rotate the cylinder (1) so the side with the rotational stop lug is facing downward and then remove the matching key. Remember the tumblers (3) are not self-retaining and must be held in place.
7. Insert one tumbler spring (2) each into the 4 tumbler spring holes.
8. The first tumbler to be loaded will be key cut position number 4. Determine the cut depth at this position and install the corresponding tumbler (3) into the tumbler slot nearest the front of the cylinder assembly.
9. In the same manner, determine the cut depth and corresponding tumbler and install the 3 remaining tumblers (3) into the tumbler slots located at key cut positions 6, 8, and 10.
10. Check for correct loading by holding the tumblers (3) in position and fully inserting the matching key into the cylinder (1). All tumblers should be flush with the outside diameter of the cylinder.
11. Lightly lubricate the tumbler (3) surfaces using the lubrication provided.
12. Hold the case assembly (4), left side shown, right side opposite, with the pre-staked detent spring retainer facing downward.
13. First insert one detent spring (5) and then one detent ball (6) into the detent spring hole located to the rear and inside of the cylinder case assembly (4). The detent spring and detent ball are not self-retaining and must be held in place until the coded cylinder is installed into the case assembly.

WARNING: Wear safety glasses in order to avoid eye damage.

14. With the matching key fully inserted into the coded cylinder, install the coded cylinder into the case assembly (4). Make sure the detent spring (5) and detent ball (6) are held in place until the coded cylinder is fully installed. The detent ball should line up with the V-shaped groove on the rear of the cylinder, which will prevent the detent spring and detent ball from falling out of the case assembly.
15. Remove the matching key being careful to keep the coded cylinder (1) fully inserted into the case assembly (4).
16. Insert one shutter spring (7) each into the two shutter spring holes located on the front face of the cylinder (1).
17. Install the shutter assembly (8) into the recessed area on the front face of the cylinder (1). Be sure that the ends of the pin on the shutter assembly are positioned in the pin cavities located in the front face of the cylinder.
18. Install the lock cylinder cap (9) by aligning the drain hole in the cap with the bottom of the case assembly (4). Snap the cap into place with light hand pressure. Be sure the cap is securely retained on the case assembly. Also, be sure that the shutter springs (7) push the shutter assembly (8) up against the inside surface of the cap.

19. Install the lever (10), left side shown, right side opposite, onto the end of the cylinder (1).
20. Install the retaining ring (11) in the groove at the end of the cylinder (1) to secure the lever (10) to the cylinder.

Rear Compartment Lid Lock Cylinder - Police Vehicles 9C1 and 9C3

The rear compartment lid lock cylinder uses 8 of the 10 key cut positions, 3-10 when counting from the key head. The tumbler orientations alternate in adjacent locations from side to side with 4 on each side.

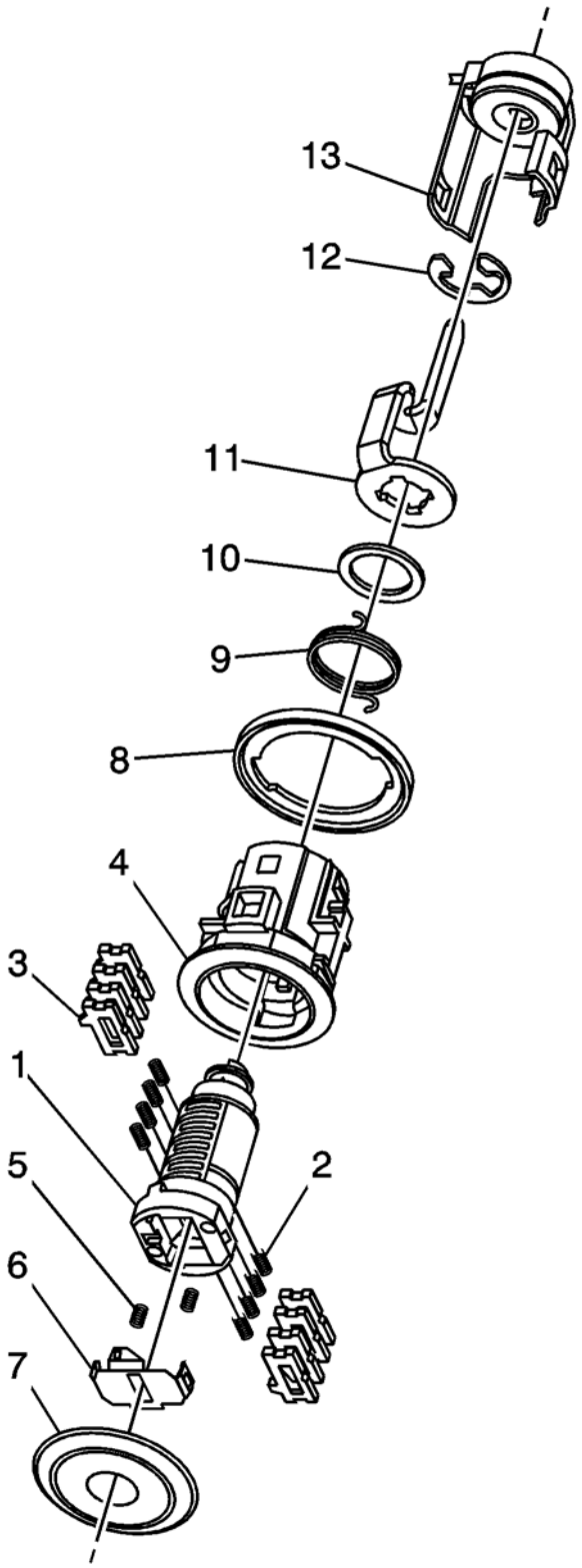

Fig. 10: Identifying Rear Compartment Lid Lock Cylinder Components (1 Of 2)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The rear compartment lid lock cylinder tumblers (3) are not self-retaining and must be held in place if the key is not fully inserted into the lock cylinder or until the cylinder (1) is assembled into the case (4).**

1. Hold the uncoded cylinder (1) positioned so the side with the drain hole is facing downward.
2. Insert one tumbler spring (2) each into the 4 tumbler spring holes.
3. The first tumbler to be loaded will be key cut position number 3, the third number in the key code. Determine the cut depth at this position and install the corresponding tumbler (3) into the tumbler slot nearest the front of the cylinder (1), the end where the key is inserted.
4. In the same manner, determine the cut depth and corresponding tumbler and install the 3 remaining tumblers (3) into the tumbler slots located at key cut positions 5, 7, and 9.
5. Check for correct loading by holding the tumblers (3) in position and fully inserting the matching key into the cylinder (1). All tumblers should be flush with the outside diameter of the cylinder.
6. Rotate the cylinder (1) so that the side with the drain hole is facing upward and then remove the matching key. Remember the tumblers (3) are not self-retaining and must be held in place.
7. Insert one tumbler spring (2) each into the 4 tumbler spring holes.
8. The first tumbler to be loaded will be key cut position number 4. Determine the cut depth at this position and install the corresponding tumbler (3) into the open tumbler slot nearest the front of the cylinder.
9. In the same manner, determine the cut depth and corresponding tumbler and install the 3 remaining tumblers into the tumbler slots located at key cut positions 6, 8, and 10.
10. Check for correct loading by holding the tumblers (3) in position and fully inserting the matching key into the cylinder (1). All tumblers should be flush with the outside diameter of the cylinder.
11. Lightly lubricate tumbler (3) surfaces using the lubrication provided.
12. With the matching key fully inserted into the coded cylinder, install the coded cylinder into the case (4).
13. Remove the matching key being careful to keep the coded cylinder (1) fully inserted into the case (4).
14. Insert one shutter spring (5) each into the 2 shutter spring holes located on the front face of the cylinder (1).
15. Install the shutter assembly (6) into the recessed area on the front face of the cylinder (1). Be sure that the ends of the pin on the shutter assembly are positioned in the pin cavities located in the front face of the cylinder.

NOTE: **Be careful not to scratch or dent the cosmetic surface of the cap or damage the lock cylinder in any way while staking the cap.**

16. Stake the cap (7) onto the head of the case (4) by using the appropriate staking tool **BO-48370** lock cylinder cap installer. Ensure proper orientation and set the cylinder assembly (14), (which includes the case (4), coded cylinder (1), shutter springs (5), and shutter assembly (6)) and the cap (7) into the staking cup (15) and clamp into vise. Remove any debris and install the cleaned staking ram (16) into staking cup (15) and with a dead blow hammer, hit the staking ram (16) with moderate force 2 or 3 times. Check to determine if cap is securely staked to the cylinder assembly (14). Repeat previous step until cap is securely staked to the cylinder assembly. Remove assembly from the staking cup (15). If necessary, insert the removal punch (17) into the opposite end of the staking cup and tap lightly. Confirm that the shutter springs (5) push the shutter assembly (6) up against the inside surface of the cap (7).

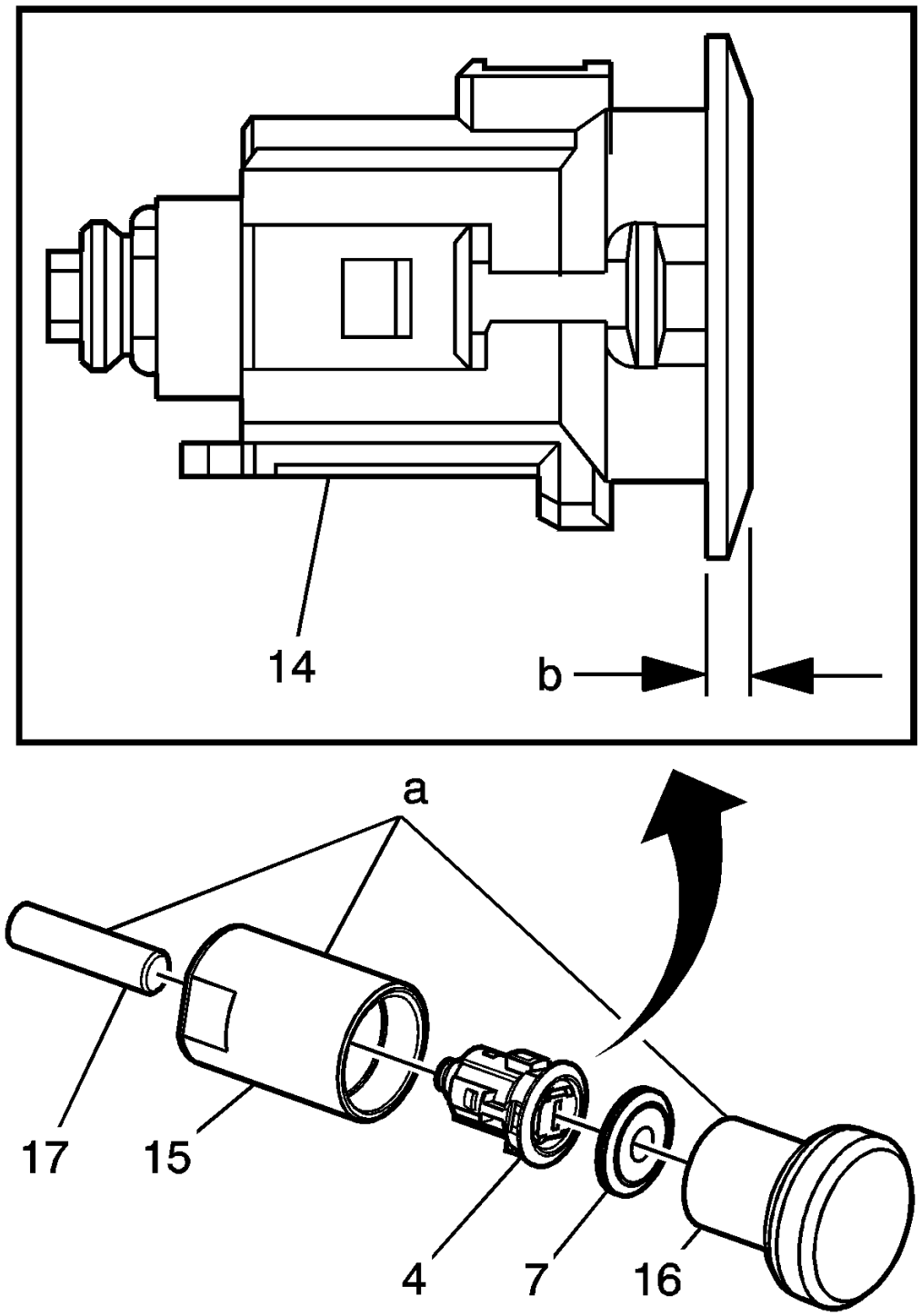

Fig. 11: Identifying Rear Compartment Lid Lock Cylinder Components (2 Of 2)
Courtesy of GENERAL MOTORS COMPANY

17. Install the gasket (8) over the end of the cylinder assembly and slide it all the way up the case (4) until it seats behind the cap (7).
18. Install the return spring (9) over the back end of the cylinder (1) with the straight hook facing the rear of the case (4). Engage the straight hook of the return spring with the hook feature on the rear of the case.

19. Install the spacer (10) and lever (11) onto the end of the cylinder (1).
20. Install the retaining ring (12) in the groove at the end of the cylinder (1) to secure the lever (11) to the cylinder. Engage the bent hook of the return spring (9) with the lever.
21. Install the theft deterrent switch (13) onto the end of the cylinder (1) and snap the switch legs onto the case (4). Be sure the theft deterrent switch is engaged with the end of the cylinder and is securely attached to the case.
22. Check the operation of the lock assembly. The return spring (9) should provide a counterclockwise snap back.

LIFTING AND JACKING THE VEHICLE

WARNING: **To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed and strap the vehicle to the hoist.**

WARNING: **To avoid any vehicle damage, serious personal injury or death, always use the jackstands to support the vehicle when lifting the vehicle with a jack.**

CAUTION: **Perform the following steps before beginning any vehicle lifting or jacking procedure:**

- **Remove or secure all of the vehicle contents in order to avoid any shifting or any movement that may occur during the vehicle lifting or jacking procedure.**
- **The lifting equipment or the jacking equipment weight rating must meet or exceed the weight of the vehicle and any vehicle contents.**
- **The lifting equipment or the jacking equipment must meet the operational standards of the lifting equipment or jacking equipment manufacturer.**
- **Perform the vehicle lifting or jacking procedure on a clean, hard, dry, level surface.**
- **Perform the vehicle lifting or jacking procedure only at the identified lift points. DO NOT allow the lifting equipment or jacking equipment to contact any other vehicle components.**

Failure to perform the previous steps could result in damage to the lifting equipment or the jacking equipment, the vehicle, and/or the vehicle contents.

Automotive Lift and Floor Jack Contact Points

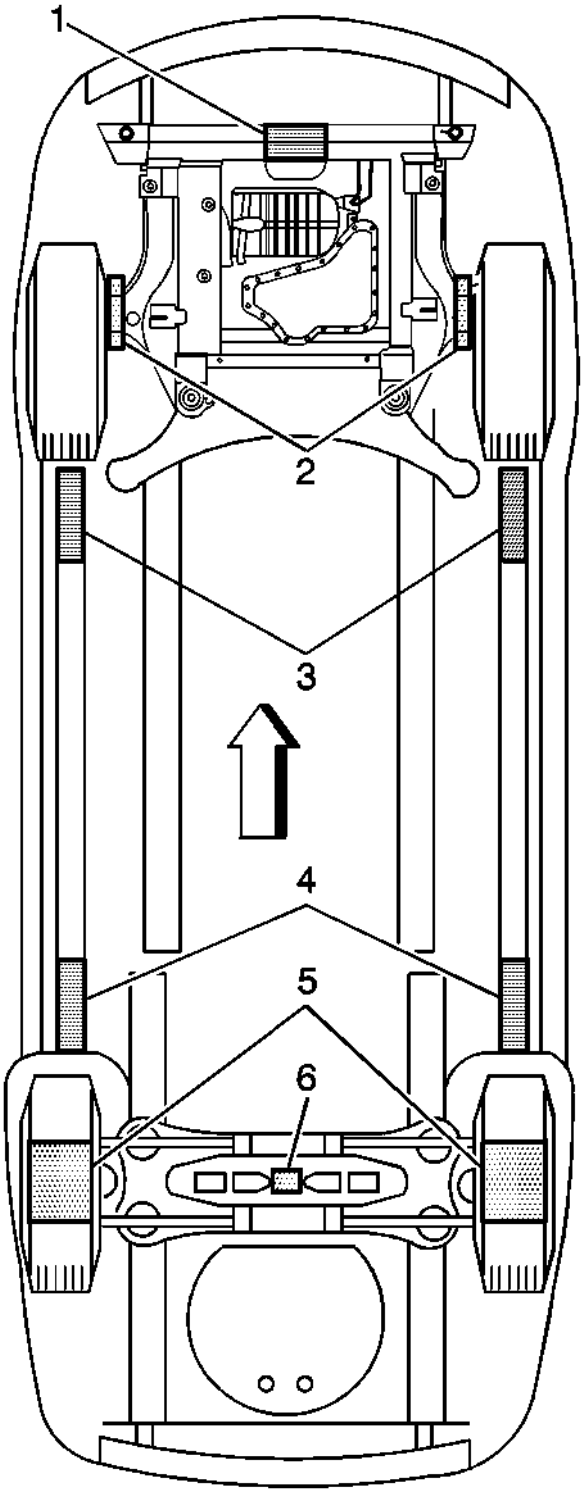

Fig. 12: Automotive Lift and Floor Jack Contact Points
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Floor Jacking-Front Location
2	Suspension Contact Lift-Front Location

Callout	Component Name
3	Frame Contact Lift-Front Location
4	Frame Contact Lift-Rear Location
5	Suspension Contact Lift-Rear Location
6	Floor Jacking-Rear Location

Vehicle Lifting-Frame Contact Lift

Front Lift Pads

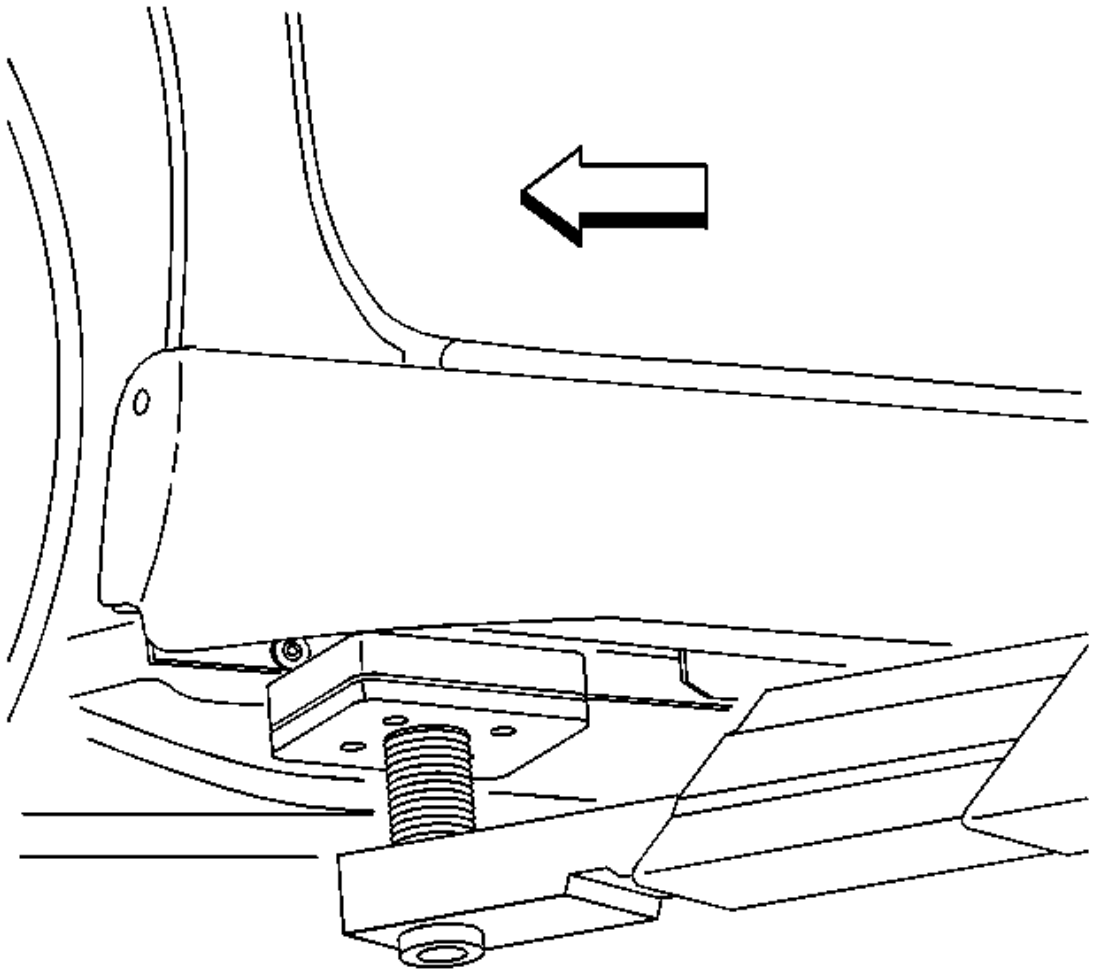

Fig. 13: Positioning Front Hoist Pads
Courtesy of GENERAL MOTORS COMPANY

When lifting the vehicle with a frame-contact lift, place the front lift pads at the front pinchweld flanges.

Rear Lift Pads

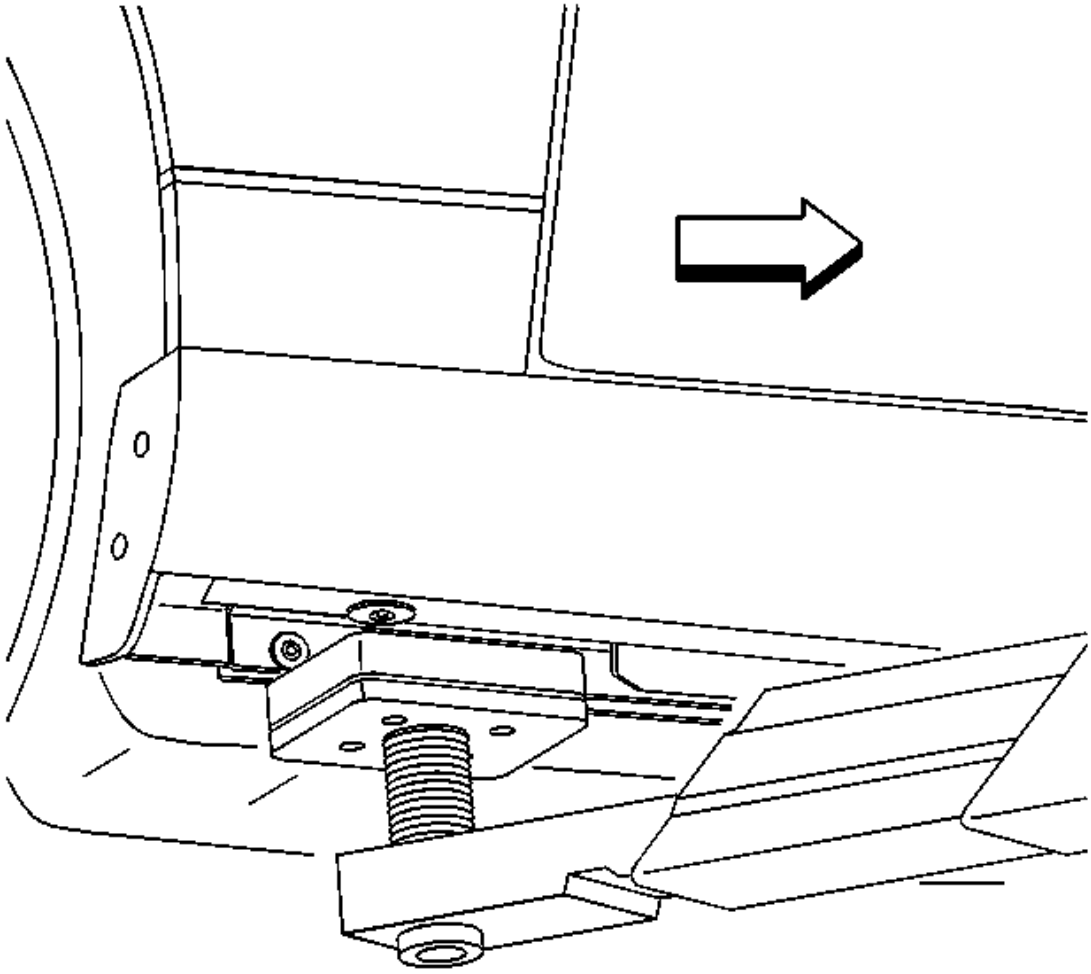

Fig. 14: Positioning Rear Hoist Pads
Courtesy of GENERAL MOTORS COMPANY

When lifting the vehicle with a frame-contact lift, place the rear lift pads at the rear pinchweld flanges.

Vehicle Lifting-Suspension Contact Lift

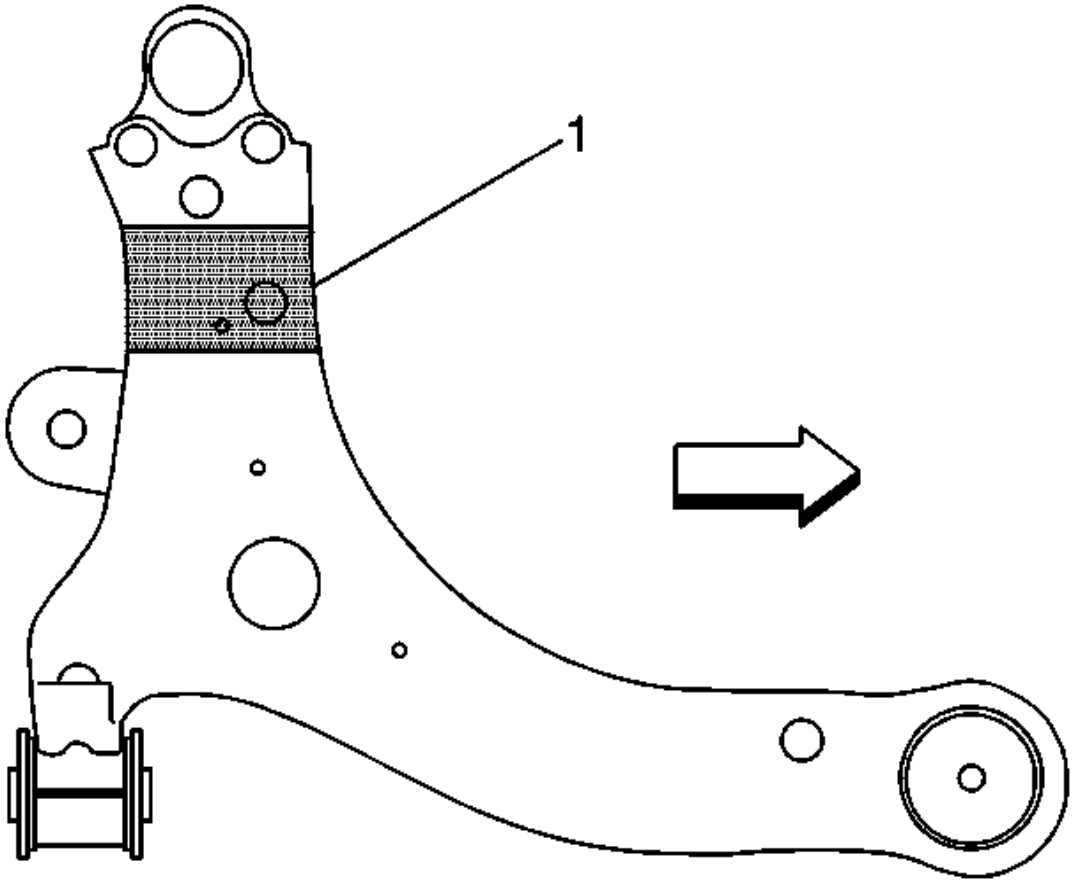

Fig. 15: Identifying Front Post Lift Points At The Lower Control Arms
Courtesy of GENERAL MOTORS COMPANY

When lifting the vehicle with a suspension-contact lift, place the front post lift points at the lower control arms in the area shown (1). Lift the rear of the vehicle with the rear post lift points ONLY under the rear wheels.

Vehicle Jacking

Under the Front Frame

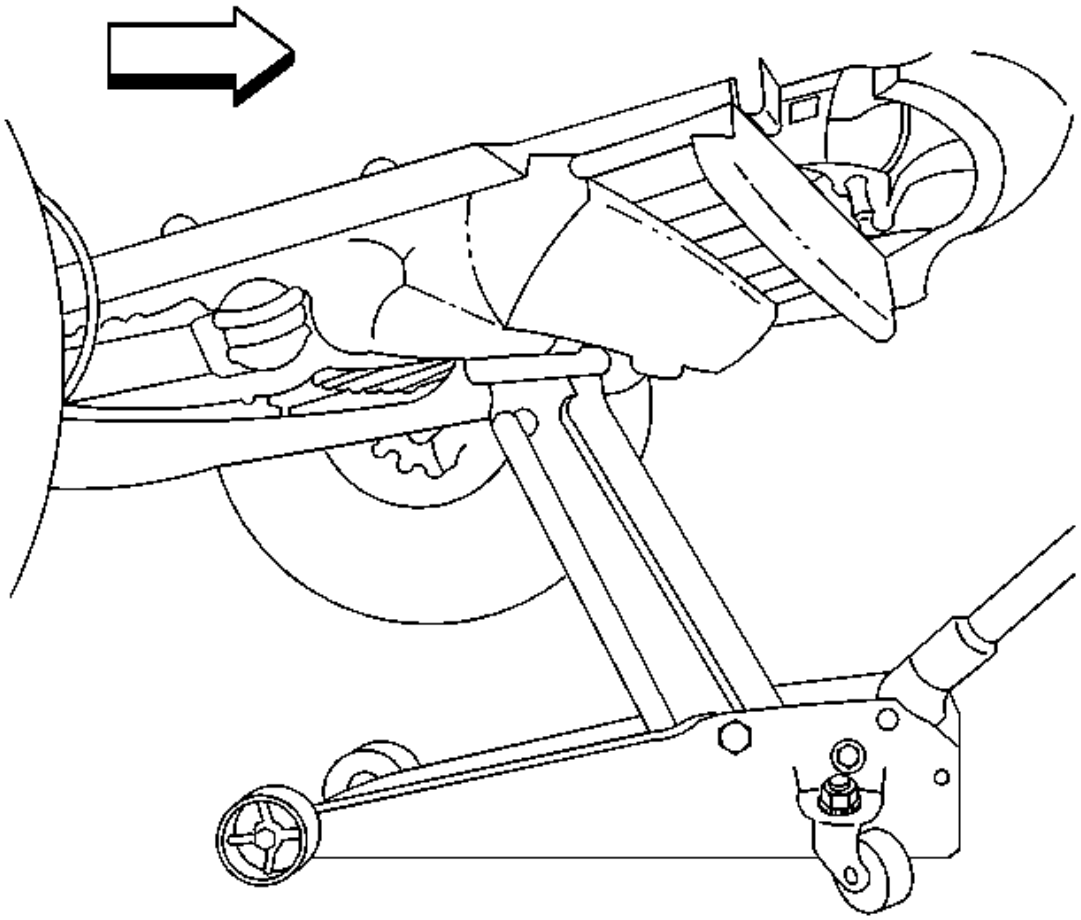

Fig. 16: Placing Jack Under Front Frame
Courtesy of GENERAL MOTORS COMPANY

When lifting the front of the vehicle with a floor jack, place the floor jack lift pad at the center of the front frame.

Under the Center of the Rear Suspension

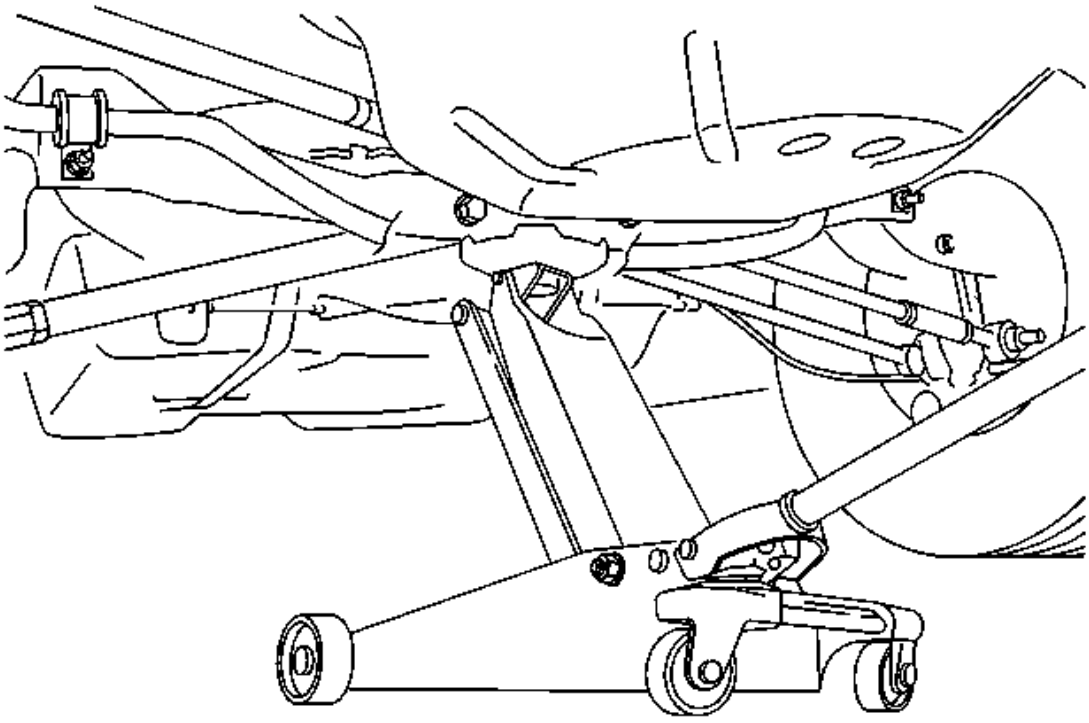

Fig. 17: Placing Jack Under Center Of Rear Suspension
Courtesy of GENERAL MOTORS COMPANY

Lift the rear of the vehicle by placing the floor jack lift pad at the center of the rear suspension.

Supporting the Vehicle with Jackstands

NOTE: **Place jackstands ONLY under strong and stable vehicle structures.**

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS ORDERING INFORMATION

Special Tools

The special service tools shown in this service manual that have product numbers beginning with J, BO, GE, CH, DT, EN, EL, SA, OR KM are available for worldwide distribution.

US, Canada and Caribbean only:

NOTE: **For Special Service tools only - see different location below for diagnostic tools & equipment.**

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Article GUID: A00737180

SPECIFICATIONS

APPROXIMATE FLUID CAPACITIES

The following approximate capacities are given in US English and metric conversions. See **Fluid and Lubricant Recommendations** for more information. All capacities are approximate. When adding, be sure to fill to the approximate level, as recommended in this manual. Recheck fluid level after filling.

Application	Specification	
	Metric	US English
Cooling System		
• 3.6L Engines	9.6 liters	10.1 quarts
• Police Package	10.0 liters	10.6 quarts
Engine Oil With Filter		
• 3.6L Engines	5.7 liters	6.0 quarts
• Police Package	5.7 liters	6.0 quarts
Fuel Tank	66.2 liters	17.5 gallons
6T70 (MH2) Transaxle		
• Valve Body Cover Removal - Approximate Capacity	5.0 - 7.0 liters	5.3 - 7.4 quarts
• Fluid Change - Drain Plug - Approximate Capacity	4.0 - 6.0 liters	4.2 - 6.3 quarts
• Overhaul - Approximate Capacity	7.0 - 9.0 liters	7.4 - 9.5 quarts

FLUID AND LUBRICANT RECOMMENDATIONS

Usage	Fluid/Lubricant
Engine Oil	Use only engine oil licensed to the dexos1 specfication, or equivalent, of the proper SAE viscosity grade. ACDelco dexos1 Synthetic Blend is recommended. Use SAE 5W-30 viscosity grade engine oil. Cold Temperature Operation: In an area of extreme cold, where the temperature falls below -29 Â°C (-20 Â°F), an SAE 0W-30 oil may be used. An oil of this viscosity grade will provide easier cold starting for the engine at extremely low temperatures. When selecting an oil of the appropriate viscosity grade, always select an oil of the correct specification. Refer to Owner's Manual for more information.

Usage	Fluid/Lubricant
Engine Coolant	50/50 mixture of clean, drinkable water and use only DEX-COOL Coolant.
Hydraulic Brake System	DOT 3 Hydraulic Brake Fluid GM P/N 88862806 (Canadian P/N 88862807)
Windshield Washer	Automotive windshield washer fluid that meets regional freeze protection requirements.
Power Steering System	GM Power Steering Fluid GM P/N 89021184 (Canadian P/N 89021186)
Automatic Transmission	DEXRONÂ®-VI Automatic Transmission Fluid
Key Lock Cylinders	Multi-Purpose Lubricant, Superlube GM P/N 12346241 (Canadian P/N 10953474)
Hood Latch Assembly, Secondary Latch, Pivots, Spring Anchor, and Release Pawl	Lubriplate Lubricant Aerosol GM P/N 89021668 (Canadian P/N 89021674) or lubricant meeting requirements of NLGI #2, Category LB or GC-LB
Hood and Hood Hinges	Multi-Purpose Lubricant, Superlube GM P/N 12346241 (Canadian P/N 10953474)
Weatherstrip Conditioning	Weatherstrip Lubricant GM P/N 3634770 (Canadian P/N 10953518) or Dielectric Silicone Grease GM P/N 12345579 (Canadian P/N 10953481)

MAINTENANCE ITEMS

Maintenance Procedure	Link
Approximate Fluid Capacities	**Approximate Fluid Capacities**
Fluid and Lubricant Recommendations	**Fluid and Lubricant Recommendations**
Maintenance Replacement Parts	**Maintenance Replacement Parts**
GM Oil Life System Resetting	**GM Oil Life System Resetting**
Tire Rotation	**Tire Rotation**
Tire Pressure Indicator Sensor Learn	**Tire Pressure Indicator Sensor Learn**
Passenger Compartment Air Filter Replacement	**Passenger Compartment Air Filter Replacement**
Brake Pad Inspection	**Brake Pad Inspection**
Cooling System Draining and Filling	**Cooling System Draining and Filling**
Hydraulic Brake System Bleeding	**Hydraulic Brake System Bleeding (Manual)** **Hydraulic Brake System Bleeding (Pressure)**
Air Cleaner Element Replacement - 3.6L (LFX)	**Air Cleaner Element Replacement** - 3.6L (LFX)
Spark Plug Replacement - 3.6L (LFX)	**Spark Plug Replacement** - 3.6L (LFX)
Drive Belt Replacement - 3.6L (LFX)	**Drive Belt Replacement** - 3.6L (LFX)
Automatic Transmission Fluid Drain and Fill - 6T70 (MH2)	**Transmission Fluid Drain and Fill** - 6T70 (MH2)

MAINTENANCE REPLACEMENT PARTS

Replacement parts identified below by name, part number, or specification can be obtained from your dealer.

Part	GM Part Number	ACDelco Part Number

Part	GM Part Number	ACDelco Part Number
Engine Air Cleaner/Filter	10350737	A2962C
Engine Oil Filter	89017525	PF63
Passenger Compartment Air Filter	15284938	CF132
Spark Plugs	12622561	41-109
Wiper Blades		
• Driver Side - 55.0 cm (21.7 in)	15941731	-
• Passenger Side - 55.0 cm (21.7 in)	15941732	-

MAINTENANCE

MAINTENANCE SCHEDULE (NORTH AMERICAN EMISSIONS)

The Maintenance Schedule information will only be found in the Owner's Manual.

Refer to the Maintenance Schedule subsection of the Owner's Manual, or you may be able to use the Search information function using the words Scheduled Maintenance.

GM OIL LIFE SYSTEM RESETTING

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL SOON message will come on. Change the engine oil as soon as possible within the next 600 miles (1 000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

If the system is ever reset accidentally, change the engine oil at 3,000 miles (5 000 km) since last oil change.

How to Reset the Engine Oil Life System

To reset the Engine Oil Life System, do the following:

1. Display the OIL LIFE REMAINING on the driver information center (DIC).
2. Press and hold the SET/RESET button on the DIC for more than five seconds. The oil life will change to 100 percent.

If the CHANGE ENGINE OIL SOON message comes back on when you start the vehicle the Engine Oil Life System has not reset. Repeat the procedure.

Article GUID: A00737182

GENERAL INFORMATION

Manual Transmission Trouble Shooting

* PLEASE READ THIS FIRST *

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

INTRODUCTION

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

There are many times when the transmission is incorrectly blamed for shifting problems or noises that are actually caused by other reasons. Shift difficulties are frequently caused by conditions outside of the transmission or transaxle. Typical conditions include: shift linkage, shift cables, alignment of engine to transmission, worn engine mounts or clutch problems. Drive train noises may come from many sources such as tires, road surfaces, wheel bearings, differentials, engine or exhaust system. Repairing or overhauling transmission will not cure these problems.

No manufacturer makes a perfectly quiet transmission. Gear rollover noise is present in most constant mesh transmissions and will tend to disappear when the clutch is disengaged or transmission is placed in gear. If clutch is properly adjusted, clutch release bearing noise will disappear when release bearing is moved enough to slide release bearing away from pressure plate.

Trouble shooting can be helped by driving vehicle on a smooth level road to help eliminate tire and body noise. Note whether noise occurs on acceleration, coasting, deceleration or steady driving conditions. Some problems may only occur when transmission is either hot or cold. Gear lubricant that is too thick can cause hard shifting on cold mornings before engine is warm and vehicle has been driven.

MANUAL TRANSMISSION/TRANSAXLE TROUBLE SHOOTING

Condition	Possible Cause
Noisy In Forward Gears	Low Gear Oil Level, Loose Bellhousing Bolts, Worn Bearings Or Gears
Clunk On Deceleration (FWD Only)	Loose Engine Mounts, Worn Inboard CV Joints, Worn Differential Pinion Shaft, Oversized Side Gear Hub Counterbore in Case
Gear Clash When Shifting Forward Gears	Clutch Out Of Alignment, Shift Linkage Damaged Or Out Of Adjustment, Gears Or Synchronizers Damaged, Low Gear Oil Level
Transmission Noisy When Moving (RWD Only); Quiet In Neutral With Clutch Engaged	Worn Rear Output Shaft Bearing
Gear Rattle	Worn Bearings, Worn Gear Oil, Low Gear Oil, Worn Gears

Condition	Possible Cause
Steady Ticking At Idle (Increases With RPM)	Broken Tooth On A Gear
Gear Clash When Shifting Forward Gears	Worn Or Broken Synchronizers, Faulty Clutch
Loud Whine In Reverse	Normal Condition (1)
Noise When Stepping On Clutch	Faulty Release Bearing, Worn Pilot Bearing
Ticking Or Screeching As Clutch Is Engaged	Faulty Release Bearing, Uneven Pressure Plate Fingers
Click Or Snap When Clutch Is Engaged	Worn Clutch Fork, Worn Pivot Ball, Worn Or Broken Front Bearing Retainer
Transmission Shifts Hard	Clutch Not Releasing, Incorrect Gear Oil, Shift Mechanism Binding, Clutch Installed Backward
Will Not Shift Into One Gear, Shifts Into All Others	Bent Shift Fork, Worn Detent Balls
Locked Into Gear, Cannot Shift	Clutch Adjustment, Worn Detent Balls
Transmission Jumps Out Of Gear	Pilot Bearing Worn, Bent Shift Fork, Worn Gear Teeth Or Face, Excessive Gear Train End Play, Worn Synchronizers, Missing Detent Ball Spring, Shift Mechanism Worn Or Out Of Adjustment, Engine Or Transmission Mount Bolts Loose, Transmission Not Aligned
Shift Lever Rattle	Worn Detents Or Shift Lever, Worn Shift Fork, Worn Synchronizer Sleeves
Shift Lever Hops Under Acceleration	Worn Engine Or Transmission Mounts
(1) Most units use spur cut gears in Reverse and are naturally noisy.	

Article GUID: A00010942

GENERAL INFORMATION

Parasitic Load Explanation & Test Procedures

* PLEASE READ THIS FIRST *

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

GENERAL INFORMATION

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

The term Parasitic Load refers to electrical devices that continue to use or draw current after the ignition switch is turned to OFF position. This small amount of continuous battery draw is expressed in milliamps (mA). On Chrysler vehicles, a typical Parasitic Load should be no more than 30 milliamps (0.030 amps). On Ford Motor Co. and General Motors vehicles produced after 1980, a typical Parasitic Load should be no more than 50 milliamps (0.050 amps).

Vehicles produced since 1980 have memory devices that draw current with ignition off for as long as 20 minutes before shutting down the Parasitic Drain. When Parasitic Load exceeds normal specifications, the vehicle may exhibit dead battery and no-start condition.

Follow test procedure for checking Parasitic Loads to completion. A brief overview of a suggested test procedure is included along with some typical Parasitic Load specifications. Refer to GENERAL MOTORS PARASITIC LOAD TABLE chart.

TESTING FOR PARASITIC LOAD

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

CAUTION: **Always turn ignition off when connecting or disconnecting battery cables, battery chargers or jumper cables. DO NOT turn test switch to OFF position (which causes current to run through ammeter or vehicle electrical system).**

NOTE: **Memory functions of various accessories must be reset after the battery is reconnected.**

The battery circuit must be opened to connect test switch (shunt) and ammeter into the circuit. When a battery cable is removed, timer circuits within the vehicle computer are interrupted and immediately begin to discharge. If in doubt about the condition of the ammeter fuse, test it with an ohmmeter prior to beginning test. An open fuse will show the same reading (00.00) as no parasitic drain. Begin test sequence with the meter installed and

on the 10-amp scale. Select lower scale to read parasitic draw.

CHRYSLER IGNITION OFF DRAW (IOD) TEST

To test for excessive IOD, verify that all electrical accessories are OFF. Turn off all lights, remove ignition key, and close all doors and decklid. If the vehicle is equipped with electronic accessories (illuminated entry, automatic load leveler, body computer, or high line radio), allow the system to automatically shut off (time out), up to 3 minutes.

1. Raise the hood and disconnect both battery cables, negative first.

CAUTION: IOD greater than 3 amps may damage millampmeter.

2. Reconnect the negative cable and connect a typical 12-volt test light (low wattage bulb) between the positive cable clamp and the positive battery post. Remove the engine compartment lamp bulb. If the test light does not light, proceed to step 3. If the test light does light, proceed to step, 4. The test light will indicate IOD greater than 3 amps. After higher amperage IOD has been corrected, proceed to step 3.
3. ith 12-volt test light still connected (not lit), connect an ammeter (milliampere scale) between the positive cable clamp and the positive battery post, disconnect test light, refer to instructions provided with ammeter being used. A reading of 30 milliamperes or less indicates normal electrical draw. If ammeter reads more than 30 milliamperes, excessive IOD must be corrected.
4. Locate the fuse panel and remove fuses or circuit breakers one at a time, and observe ammeter after each fuse or circuit breaker is removed. If test light goes out and the reading drops below 30 milliamperes when a certain fuse or circuit breaker is removed, that circuit may have a defect.
5. If IOD is detected after all fuses and circuit breakers have been removed, disconnect the 60-way connector at the Single Module Engine Control (SMEC), located outboard of the battery.
6. If excessive IOD is detected after all fused circuits and SMEC have been verified, disconnect the B+ terminal from the alternator. If reading drops below 30 milliamperes, reinstall all fuses and circuit breakers, reconnect B+ terminal at alternator, reconnect battery, and perform alternator diagnostics.
7. Install engine compartment lamp bulb.

TEST PROCEDURE USING TEST SWITCH

1. Turn ignition off. Remove negative battery terminal cable. Install Disconnect Tool (J-38758) test switch male end to negative battery cable. Turn test switch knob to OFF position (current through meter). Install negative battery cable to the female end of test switch.
2. Turn test switch knob to ON position (current through switch). Road test vehicle with vehicle accessories on (radio, air conditioner, etc). After road test, turn ignition switch to LOCKED position and remove key. Connect ammeter terminals to test switch terminals. See **Fig. 1**. Select 10-amp scale.
3. Turn off all electrical accessories. Turn off interior lights, underhood lamp, trunk light, illuminated entry, etc. To avoid damaging ammeter or obtaining a false meter reading, all accessories must be off before turning test switch knob to OFF position.
4. Turn test switch knob to OFF position to allow current to flow through ammeter. If meter reads wrong polarity, turn test switch to ON position and reverse leads. Turn test switch to OFF position. Observe current reading. If reading is less than 2 amps, turn test switch to ON position to keep electrical circuits powered-up.

5. Select low amp scale. Switch lead to the correct meter position. Turn test switch to OFF position and compare results to normal current draw. See **GENERAL MOTORS PARASITIC LOAD TABLE (MILLIAMPS)**. If current draw is unusually high for the vehicle's overall electrical system, remove system fuses one at a time until current draw returns to normal.
6. Turn test switch to ON position each time door is opened or fuse is removed. Turn switch to OFF position to read current draw value through meter. When the cause of excessive current drain has been located and repaired, remove test switch and reconnect negative battery cable to the negative battery terminal.

INTERMITTENT PARASITIC LOAD PROBLEMS

Intermittent parasitic load can occur because of a memory device that does not power down with ignition off. With an intermittent parasitic load, battery draw can be greater than 1.0 amp.

To find an intermittent problem requires that an ammeter and Disconnect Tool (J-38758) test switch be connected and left in the circuit. See **Fig. 1**. Road test vehicle. After road test, turn ignition off and remove key.

Monitor the milliamps scale for 15-20 minutes after ignition is turned off. This allows monitoring memory devices to determine if they time out and stop drawing memory current. The test switch is needed to protect ammeter when the vehicle is started.

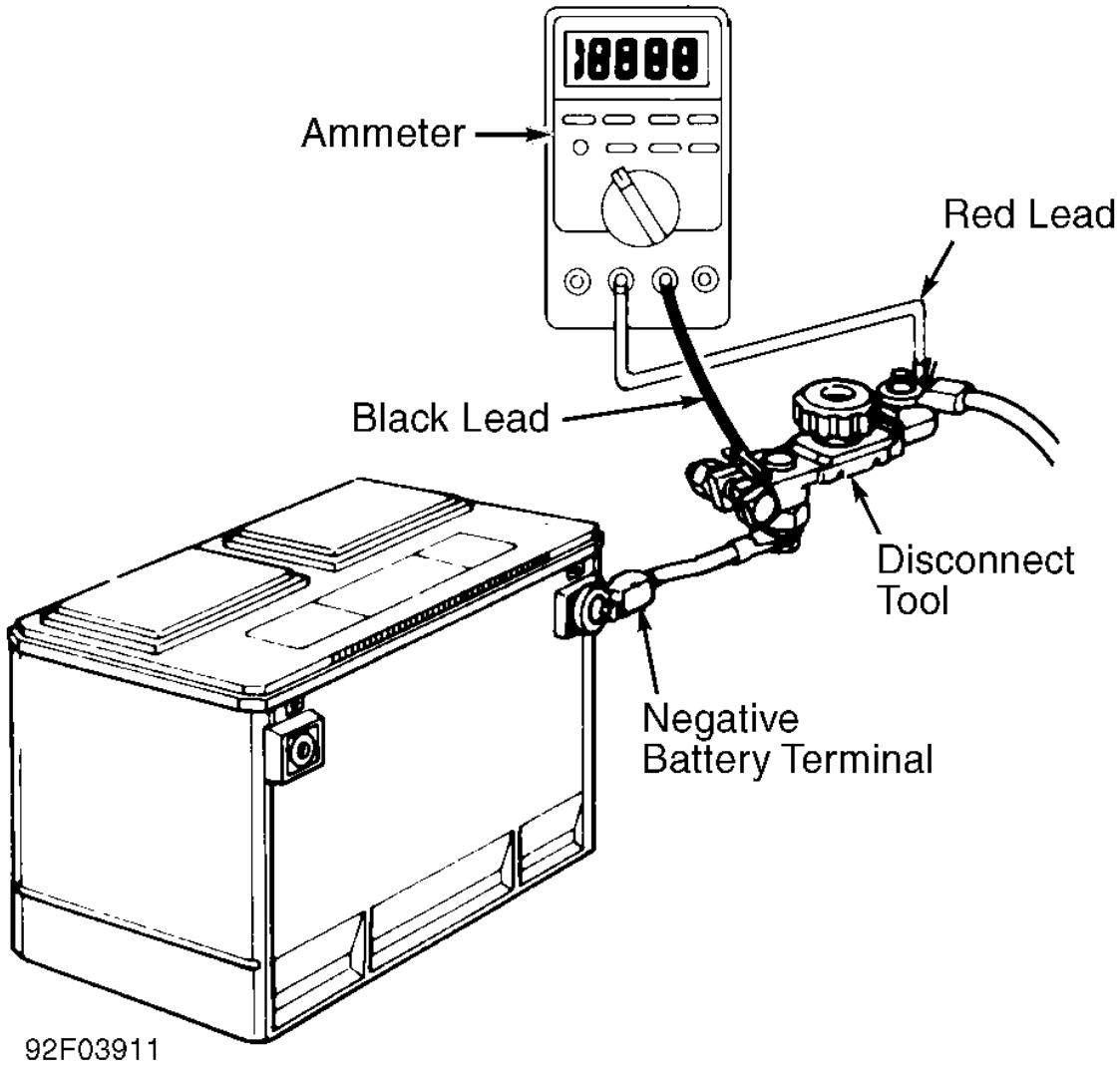


Fig. 1: Connecting Kent-Moore Disconnect Tool (J-38758)
Courtesy of GENERAL MOTORS CORP.

GENERAL MOTORS PARASITIC LOAD

Component	Normal Draw	Maximum Draw	Time-Out (Minutes)
Anti-Theft System	0.4	1.0	.....
Auto Door Lock	1.0	1.0	.....
Body Control Module	3.6	12.4	20
Central Processing System	1.6	2.7	20
Electronic Control Module	5.6	10.0	.....
Electronic Level Control	2.0	3.3	20
Heated Windshield Module	0.3	0.4	.....

Component	Normal Draw	Maximum Draw	Time-Out (Minutes)
HVAC Power Module	1.0	1.0	.....
Illuminated Entry	1.0	1.0	1
Light Control Module	0.5	1.0	.....
Oil Level Module	0.1	0.1	.....
Multi-Function Chime	1.0	1.0	.....
Pass Key Decoder Module	0.75	1.0	.....
Power Control Module	5.0	7.0	.....
Retained Accessory Power	3.8	3.8	.....
Radio	7.0	8.0	15
Twilight Sentinel Module	1.0	1.0	.....
Voltage Regulator	1.4	2.0	.....

DIODE CHECK & SOLENOID TEST

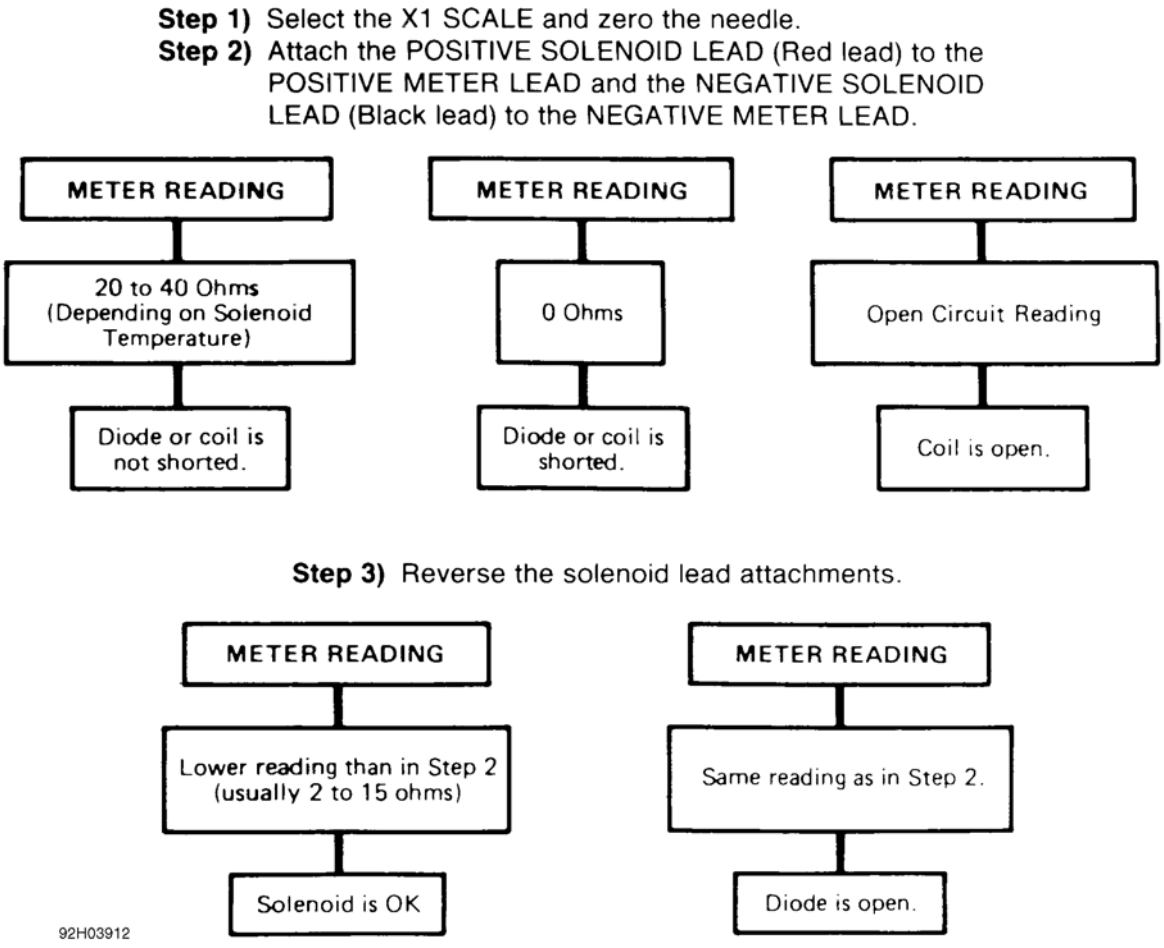


Fig. 2: Diode Check & Solenoid Test
Courtesy of GENERAL MOTORS CORP.

QUAD DRIVER TEST

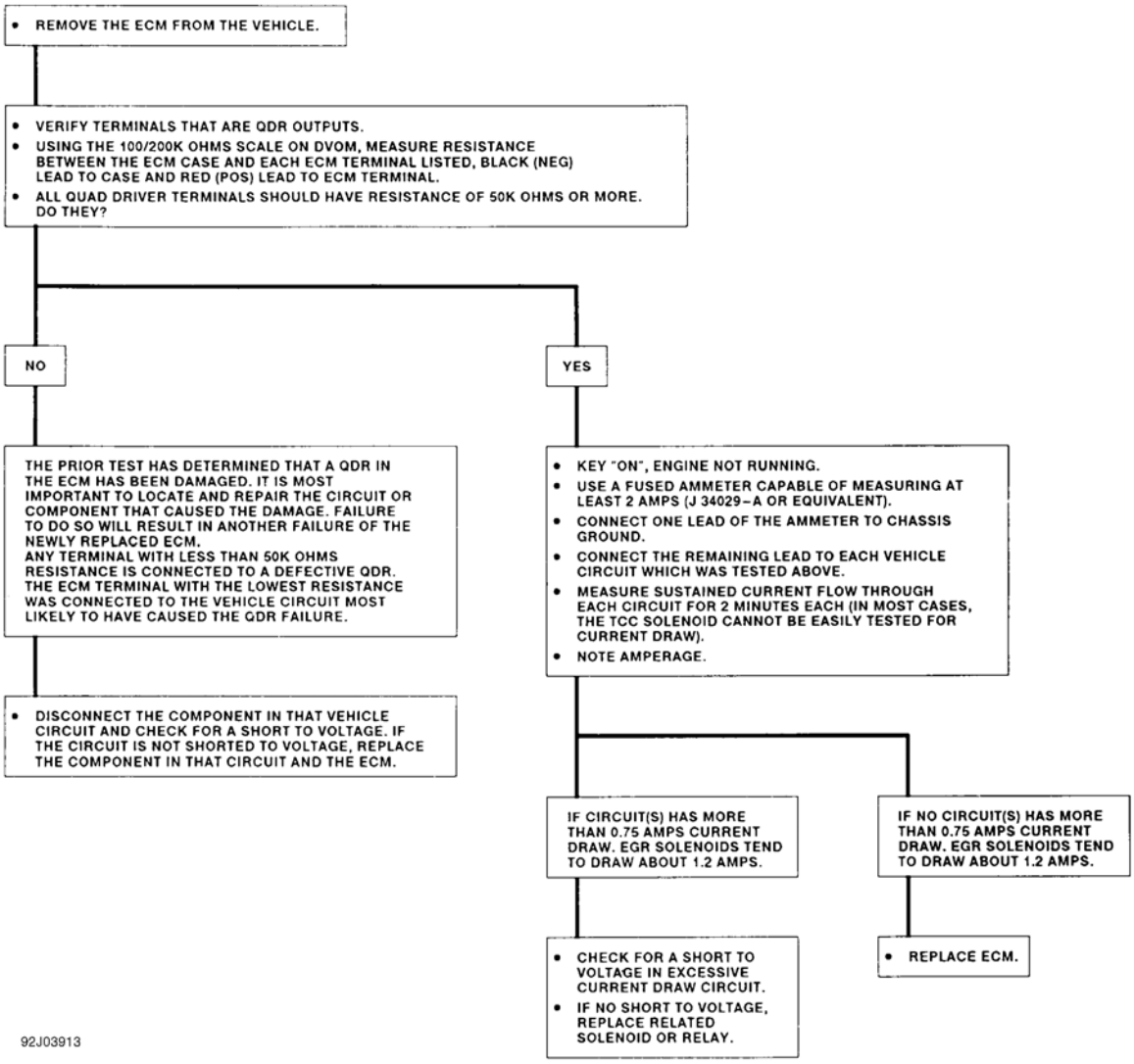


Fig. 3: Quad Driver Test
Courtesy of GENERAL MOTORS CORP.

Article GUID: A00002347

DIAGNOSTIC INFORMATION AND PROCEDURES

CONTROL MODULE REFERENCES

Reference Information

- Data Link References
- Diagnostic System Check - Vehicle
- Diagnostic Trouble Code (DTC) List - Vehicle
- Symptoms - Vehicle

Code	Control Module/Scan Tool Information	Schematic	Repair Instruction	Programming and Setup
A11	Radio Scan Tool Information	Radio/Navigation System Schematics	Radio Replacement	Radio Programming and Setup
A12	Digital Radio Receiver Scan Tool Information	Radio/Navigation System Schematics	Digital Radio Receiver Replacement	Digital Radio Receiver Programming and Setup
K9	Body Control Module Scan Tool Information	Body Control System Schematics	Body Control Module Replacement	Body Control Module Programming and Setup
K17	Electronic Brake Control Module Scan Tool Information	Antilock Brake System Schematics	Electronic Brake Control Module Replacement	Electronic Brake Control Module Programming and Setup
K20	K20 Engine Control Module: Scan Tool Information	Engine Controls Schematics	Engine Control Module Replacement	K20 Engine Control Module: Programming and Setup
K29	Driver Seat and Passenger Seat Heater Control Module Scan Tool Information	Heated/Cooled Seat Schematics	Front Seat Heater Control Module Replacement (Impala)	Heated Seat Control Module Programming and Setup
K33	Heating, Ventilation and Air Conditioning Control Module Scan Tool Information	HVAC Schematics	Blower Motor Control Module Replacement	HVAC System Control Module Programming and Setup

Code	Control Module/Scan Tool Information	Schematic	Repair Instruction	Programming and Setup
K36	Inflatable Restraint Sensing and Diagnostic Module Scan Tool Information	SIR Schematics	Airbag Sensing and Diagnostic Module Replacement	Inflatable Restraint Sensing and Diagnostic Module Programming and Setup
K38	Chassis Control Module Scan Tool Information AKA: Fuel Pump Control Module	Engine Controls Schematics	Fuel Pump Flow Control Module Replacement	Chassis Control Module Programming and Setup AKA: Fuel Pump Control Module
K61	Sunroof Control Module	Sunroof Schematics	Sunroof Motor/Actuator Replacement	Sunroof Control Module Programming and Setup
K71	Control Solenoid Valve and Transmission Control Module Assembly Transmission Control Module Scan Tool Information	Automatic Transmission Controls Schematics	Control Solenoid Valve and Transmission Control Module Assembly Replacement	Control Solenoid Valve and Transmission Control Module Assembly Programming and Setup
K73	Communication Interface Module Scan Tool Information	OnStar/Telematics Schematics	Communication Interface Module Replacement	Communication Interface Module Programming and Setup
K77	Remote Control Door Lock Receiver Scan Tool Information	Remote Function Schematics	Remote Control Door Lock Receiver Replacement	Remote Control Door Lock Receiver Programming and Setup
K85	Inflatable Restraint Passenger Presence System Scan Tool Information	SIR Schematics	Inflatable Restraint Passenger Presence System Replacement - Front	Passenger Presence System Programming and Setup
K89	Immobilizer Control Module Theft Deterrent Module Scan Tool Information	Immobilizer Schematics	Theft Deterrent Module Replacement	Theft Deterrent Module Programming and Setup
P16	Instrument Cluster Scan Tool Information	Instrument Cluster Schematics	Instrument Cluster Replacement	Instrument Cluster Programming and Setup

Code	Control Module/Scan Tool Information	Schematic	Repair Instruction	Programming and Setup
S25	Garage Door Opener	Remote Function Schematics	Garage Door Opener Transmitter Replacement	Garage Door Opener Programming and Setup
T3	Audio Amplifier	Radio/Navigation System Schematics	Radio Speaker Amplifier Replacement	Audio Amplifier Programming and Setup

REPAIR INSTRUCTIONS

AUDIO AMPLIFIER PROGRAMMING AND SETUP

This device requires no programming or setup.

BODY CONTROL MODULE PROGRAMMING AND SETUP

Introduction

A new Body Control Module (BCM) must be programmed with the latest operating software and vehicle calibrations. Ensure that the following conditions exist in order to prepare for BCM programming:

- The battery is fully charged.
- The ignition switch is in the ON position.
- The Data Link Connector (DLC) is accessible.
- All control modules and devices are connected.

The procedures below are designed to program the Body Control Module (BCM) correctly during BCM related service. Before you start, read these procedures carefully and completely.

Programming the BCM

NOTE: **The vehicle will not start and many other functions may not operate properly if a replacement BCM is not properly set up. The following procedures must be completed.**

NOTE: **After the procedure is completed, the personalization settings of the BCM are set to default settings. Inform the customer that the personalization must be set again.**

1. Programming the BCM-Refer to Service Programming System (SPS).
2. Brake Pedal Position (BPP) Sensor calibration-Refer to Brake Pedal Position Sensor Calibration .
3. Learning the Restraints ID-Navigate to Body Control Module > Configuration/Reset Functions > Setup SDM Part Number in BCM, then follow the instructions on the screen.

NOTE: **After any programming or setup, perform the following to avoid future misdiagnosis:**

1. Turn the ignition OFF for 10 s.
2. Connect the scan tool to the Data Link Connector.
3. Turn the ignition ON, with the engine OFF.
4. Use the scan tool in order to retrieve history DTCs from all control modules.
5. Clear all history DTCs.

CHASSIS CONTROL MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select K38 Chassis Control Module - Programming and follow the on-screen instructions.

4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
5. With a scan tool, perform the Suspension Sensor Trim Height Calibration, if applicable.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
    - **If the control module cannot be reprogrammed**
    1. Ignition OFF for one minute, ignition ON.
    2. Verify the control module can be reprogrammed.
        - If the control module cannot be reprogrammed, replace the control module.
        - If the control module can be reprogrammed.
    3. All OK.
    - **If the control module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for Control Module replacement, programming and setup

COMMUNICATION INTERFACE MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**

- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Diagnostic Aids

- Before beginning any programming first determine which Generation of the Telematics Communication Interface Control Module you are working with. One way to accomplish this is by using a scan tool. The Telematics Communication Interface Control Module Generation will be listed under the Selected Vehicle Configuration section, in addition the Generation (9 or 10) can be determined from the Module ID data table. Additional programming steps may be necessary depending on the generation of the module.
- It is critical to use the service replacement Communication Interface Module only in the vehicle for which it was ordered.
- Failure to perform the following procedures will result in a red LED, DTC(s) being set, and limited or incomplete OnStarÂ® services.
- An OnStarÂ® button press to the OnStarÂ® call center is required to complete the procedure.
- To fully activate an OnStarÂ® module, both the setup and activation request procedures must be completed on all vehicles with and without an active OnStarÂ® subscription to insure the unit has been setup properly for the vehicle it has been installed into and also to update the OnStarÂ® with the correct unit information.
- If the vehicle is equipped with RPO VV4 the Telematics Communication Interface Control Module WiFi Enable (Gen 10 only) Programming step must be performed AFTER the Programming and Service Activation step. Failure to complete this step in the proper sequence will result in WiFi being disabled.
- To initialize the Turn-by-Turn feature, the vehicle must first be driven In open sky condition at speeds greater than 10 mph (16 kph) or more for a minimum of 5 miles (8 km) , and perform at least 2 left and 2 right 90 degree turns coming to complete stops prior to each turn.
- On vehicles up fitted with TTY capabilities, it is necessary to perform a power cycle of the OnStarÂ® Interface Module (OTIM), and toggle the TTY mode after completing the Communication Interface Module installation and setup procedures.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install **EL-49642** SPS programming support tool .
2. Access the Service Programming System (SPS) and follow the on-screen instructions.

NOTE:

- **Due to a change in SPS you must select 'Reprogram ECU', for Telematics Communication Interface Control Module Programming from the Selected Programming Process even if**

the unit is being replaced.

- **If 'Replace and Program ECU' is selected the Telematics Communication Interface Control Module will not be listed in the Supported Controllers screen. You must go back and select 'Reprogram ECU'.**

3. In the SPS Supported Controllers screen, select Telematics Communication Interface Control Module Programming and Service Activation and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
5. After Telematics Communication Interface Control Module Programming and Service Activation, if the vehicle is equipped with RPO VV4, on the Supported Controllers screen select Telematics Communication Interface Control Module WiFi Enable (Gen 10 only) Programming and follow the on-screen instructions.

NOTE: **The WiFi Enable step must be performed AFTER the Programming and Service Activation step, or WiFi will not function. If Programming and Service Activation step is performed after the WiFi Enable step, WiFi will be disabled.**

6. Press the OnStarÂ® Blue Button to call OnStarÂ® and have the system activated. If the customer refused OnStarÂ® services (terms and conditions) and the vehicle is equipped with RPO VV4 have the OnStarÂ® consultant turn off the WiFi demo message that occurs after every ignition on event.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
   - **If the control module cannot be reprogrammed**
   1. Ignition OFF for one minute, ignition ON.
   2. Verify the control module can be reprogrammed.
      - If the control module cannot be reprogrammed, replace the control module.
      - If the control module can be reprogrammed.
   3. All OK.
   - **If the control module can be reprogrammed**
3. All OK.

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly**

configured with the correct calibration software, the control module will not control all of the vehicle features properly.

- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required, install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module

To program a replacement transmission control module (TCM), perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Transmission Control Module - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
5. With a scan tool, perform the Reset Transmission Adapts. Refer to **Reset Transmission Adapts** .

Reprogram Control Module

To reprogram an existing TCM, perform the following procedure:

1. Access the Service Programming System (SPS) and follow the on-screen instructions.
2. On the SPS Supported Controllers screen, select Transmission Control Module - Programming and follow the on-screen instructions.
3. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

4. With a scan tool, perform the Reset Transmission Adapts. Refer to **Reset Transmission Adapts** .

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
    - **If the control module cannot be reprogrammed**
    1. Ignition OFF for one minute, ignition ON.
    2. Verify the control module can be reprogrammed.
        - If the control module cannot be reprogrammed, replace the control module.
        - If the control module can be reprogrammed.
    3. All OK.
    - **If the control module can be reprogrammed**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Refer to **Control Module References** for control module replacement, programming, and setup.

DIGITAL RADIO RECEIVER PROGRAMMING AND SETUP

Each of the following service procedures requires programming or setup procedures to be performed on the digital radio receiver.

XM™ Activation

IMPORTANT: After replacement of an XM™ receiver, call XM™ radio to deactivate the receiver that has been removed from the vehicle. The vehicle must be parked in view of a satellite within 24 hours after an activation call.

1. Radio ON, tune to the XM™ channel 0 and record the radio ID. The radio ID will be required for activation of the new receiver. The customer's name, address and phone number may also be needed for account verification.
2. Call XM™ radio to deactivate the faulty receiver and activate the new receiver.
    - US: 1-800-556-3600
    - Canada: 1-877-438-9677
3. Park the vehicle outside in an area with an unobstructed view of the southern sky.
4. Leave the vehicle outside with the ignition switch in the ACC position and the radio ON, tune to the XM™ channel 1 for 30 minutes to activate XM™ service.
5. Once activated, the radio will receive the remaining XM™ channels.

ELECTRONIC BRAKE CONTROL MODULE PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Special Tools

EL-49642 SPS Programming Support Tool

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing Electronic Brake Control Module (EBCM), perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Electronic Brake Control Module - Programming and follow the on-screen instructions.
4. On the SPS Supported Controllers screen, select Electronic Brake Control Module - Configuration and follow the on-screen instructions.
5. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.
6. With a scan tool, perform the Steering Angle Sensor Centering. Refer to **Steering Angle Sensor Centering** .
7. With a scan tool, perform the Yaw Rate Sensor Recalibration. Refer to **Vehicle Yaw Sensor Learn** .

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
    - **If the control module cannot be reprogrammed**
    1. Ignition OFF for one minute, ignition ON.
    2. Verify the control module can be reprogrammed.
        - If the control module cannot be reprogrammed, replace the control module.
        - If the control module can be reprogrammed.
    3. All OK.
    - **If the control module can be reprogrammed**
3. All OK.

K20 ENGINE CONTROL MODULE: PROGRAMMING AND SETUP

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the control module is not properly configured with the correct calibration software, the control module will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector (DLC). If there is an interruption during programming, programming failure or control module damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. When required install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply. DO NOT connect a battery charger.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**
- **Note the engine oil life remaining percentage.**

Replace and Program Control Module

To program a replacement K20 Engine Control Module (ECM), perform the following procedure:

1. Install **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. Before removing the old control module, perform the SPS function Prepare Control Module for Removal, if available.

> **NOTE:** **The Prepare Control Module for Removal function can only be performed when communication with the old control module is still possible.**

4. Replace the ECM.
5. Perform the SPS function K20 Engine Control Module - Programming and follow the on-screen instructions.
6. Clear the DTCs after completing the Programming procedure.
7. Perform the SPS function Immobilizer Learn and follow the on-screen instructions. Refer to **Immobilizer System Component Programming** .
8. Perform the SPS function K20 Engine Control Module - Configuration & Setup and follow the on-screen instructions.
9. Clear DTCs after completing the Configuration & Setup procedure.

Reprogram Control Module

To reprogram an existing K20 Engine Control Module, perform the following procedure:

1. Install **EL-49642** SPS programming support tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. Clear DTCs after completing the Programming procedure.

> **NOTE:** **If vehicle fails to start during Configuration and Setup, perform the SPS Function Immobilizer Learn and follow the on-screen instructions.**

4. Perform the SPS function Engine Control Module - Configuration & Setup and follow the on-screen instructions, if available.
5. Clear DTCs after completing the Configuration & Setup procedure.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following:

1. Ignition ON. Ensure the control module, DLC, and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
    - **If the control module cannot be reprogrammed**
    1. Ignition OFF for one minute, ignition ON.

2. Verify the control module can be reprogrammed.
    - If the control module cannot be reprogrammed, replace the K20 Engine Control Module.
- **If the control module can be reprogrammed**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for ECM replacement, programming and setup.

GARAGE DOOR OPENER PROGRAMMING AND SETUP

Replace and Program ECU or Reprogram ECU

This ECU does not require SPS programming but does require the following setup procedures after a new ECU is installed:

The customer must learn the device they wish to control. This must be done at the device (garage door opener, electric gate, etc.) and cannot be performed at a dealership. Refer to the vehicle owner's manual for programming instructions.

HEATED SEAT CONTROL MODULE PROGRAMMING AND SETUP

Heated Seat Module Replacement

If the heated seat module is replaced or if the module needs to be reprogrammed, refer to **Service Programming System (SPS)**.

HVAC SYSTEM CONTROL MODULE PROGRAMMING AND SETUP

Each of the following service procedures may require programming or setup procedures to be performed on the HVAC control module or HVAC actuators.

HVAC Control Module Replacement

If the HVAC control module is replaced, the following procedure must be performed: Reprogram the HVAC control module. Refer to **Service Programming System (SPS)**.

HVAC Control Module Reprogramming

Do not reprogram the HVAC control module unless directed by a service procedure or a service bulletin.

Reprogram the HVAC control module. Refer to **Service Programming System (SPS)**.

Actuator Replacement

If an actuator is replaced, the following procedure must be performed: Re-Calibrating Actuators. Refer to **Actuator Recalibration** .

INFLATABLE RESTRAINT SENSING AND DIAGNOSTIC MODULE PROGRAMMING AND SETUP

NOTE: **The air bag indicator light may remain ON after the body control module (BCM), or inflatable restraint sensing and diagnostic module (SDM) is replaced, and during the programming procedure for the BCM until after the procedure is completed. When installing a new SDM, there may be several DTCs set prior to programming. Once programmed, these DTCs should be in history and can be cleared.**

1. Ignition ON, program the SDM. Refer to **Service Programming System (SPS)**.
2. In the Inflatable Restraint Sensing and Diagnostic Module, Configuration / Reset Functions menu, select Setup SDM Part Number in BCM. Follow the scan tool on screen instructions.
3. In the Inflatable Restraint Sensing and Diagnostic Module, Configuration / Reset Functions menu, select Configure New Module. Follow the scan tool on screen instructions. If during this procedure a fault is detected, the SDM will not allow this procedure to complete. Repair any existing DTCs, then use the scan tool to command the Configuration / Reset Function again.
4. Cycle the ignition from OFF to ON. Verify no DTCs are set. If any DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

INSTRUMENT CLUSTER PROGRAMMING AND SETUP

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the ECU is not properly configured with the correct calibration software, the ECU will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or ECU damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install the EL-49642 tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Replace and Program ECU or Reprogram ECU

To program a replacement or an existing ECU, perform the following procedure:

1. Install **EL-49642** tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select Instrument Cluster - Programming and follow the on-screen instructions.
4. On the SPS Supported Controllers screen, select Instrument Cluster - Setup and follow the on-screen instructions.
5. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. DO NOT turn the ignition OFF. Ensure that all ECU, DLC and programming tool connections are secure and the TIS terminal operating software is up to date.
2. Attempt to reprogram the ECU.
3. If the ECU can still not be programmed, turn the ignition OFF for at least one minute.
4. Turn the ignition ON and attempt to reprogram the ECU. The ECU should program.
    - If the ECU still cannot be programmed, replace the ECU.

PASSENGER PRESENCE SYSTEM PROGRAMMING AND SETUP

Passenger Presence System Preload Test

The passenger presence system (PPS) consists of an electronic control module, a sensor mat in the seat, a harness, and PASSENGER AIR BAG ON/OFF indicators. The passenger presence detection system transmits and receives a low-level electric field. The measured capacitance value of this field is used to determine the type of occupant sitting in the front passenger seat. If the measured capacitance is less than a calibrated value, then the passenger presence module will send a hard wire signal to the inflatable restraint sensing and diagnostic module to disable the passenger instrument panel air bag. If the measured capacitance is greater than a calibrated value, then the passenger presence module will send a serial data signal to the inflatable restraint sensing and diagnostic module to enable the passenger instrument panel air bag. The passenger presence detection system module will notify the customer of the enable/disable status by illuminating one of the PASSENGER AIR BAG ON/OFF indicator. If the passenger seat bottom cushion, seat bottom trim, or heater pad has been serviced, reinstalled, or removed for any reason, the procedure below will check for any preloads on the passenger presence system. A service replacement passenger presence system module does not require an unlock procedure prior to an initial preload test.

NOTE:

- **Before the passenger presence system can be checked for preloads the front passenger seat must be completely empty of all items. The presence of any items on the front passenger seat will affect the calibration and operation of the passenger presence system.**
- **DTC B0081 will set if the preload system test is performed with:**
    - **An aftermarket seat heater located too close to the sensor mat**
    - **A scan tool, laptop, or other electronic device is in the seat**

- The seat is damp or wet
- An object or person is in the seat

- **When the preload test is perform, the instrument panel cluster and dash lights will begin illuminating at varying intensity. This is normal operation during the preload test procedure and does not indicate additional system faults.**
- **The Diagnostic Repair Verification must be performed after successfully completing the preload test procedure to ensure the system is functioning properly.**

Passenger Presence System Preload System Test

1. Empty the front outboard passenger seat (this system is susceptible to conductive material).
2. With the scan tool, perform the Passenger Presence Sensor Learn procedure.
3. Using the scan tool, check for DTC B0081 in history. If the test fails or DTC B0081 11 is current, confirm that the seat is empty. Perform the passenger presence sensor learn test again. If the test fails again, for heated seats, ensure that the sensor pad is on top of the heater element. Once the test successfully completes, cycle the Vehicle OFF.
4. Perform the **Diagnostic Repair Verification** after successfully completing the preload test procedure to ensure the system is functioning properly.

RADIO PROGRAMMING AND SETUP

NOTE:

- **DO NOT program a control module unless directed to by a service procedure or a service bulletin. If the ECU is not properly configured with the correct calibration software, the ECU will not control all of the vehicle features properly.**
- **Ensure the programming tool is equipped with the latest software and is securely connected to the data link connector. If there is an interruption during programming, programming failure or ECU damage may occur.**
- **Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming. Install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12 V jumper or booster pack disconnected from the AC voltage supply.**
- **Turn OFF or disable systems that may put a load on the vehicles battery such as; interior lights, exterior lights (including daytime running lights), HVAC, radio, etc.**
- **During the programming procedure, follow the SPS prompts for the correct ignition switch position.**
- **Clear DTCs after programming is complete. Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Diagnostic Aids

- During radio programming you may be required to select multiple calibrations dependant upon vehicle equipment. Have the vehicle build/RPO information available during the following procedure to ensure the correct calibrations are selected.
- The XM satellite radio (if equipped) is integrated into the radio. If XM was activated in the previous radio, the replacement radio will require additional activation steps after programming to transfer customer subscription information.

Reference Information

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

Replace and Program Control Module or Reprogram Control Module

To program a replacement or an existing control module, perform the following procedure:

1. Install **EL-49642** SPS Programming Support Tool.
2. Access the Service Programming System (SPS) and follow the on-screen instructions.
3. On the SPS Supported Controllers screen, select A11 Radio - Programming and follow the on-screen instructions.
4. At the end of programming, choose the "Clear All DTCs" function on the SPS screen.

XM Activation (If Equipped)

NOTE: **After replacement of an XM receiver, call XM radio to deactivate the receiver that has been removed from the vehicle.**

1. Turn the radio ON, tune to the XM channel 0, and record the radio ID. The radio ID will be needed for activation of the receiver.
2. From the USA, Call XM radio at 1-800-556-3600 to activate the receiver. From Canada, call 1-877-438-9677.
3. Park the vehicle outside in an area with an unobstructed view of the southern sky.
4. Leave the vehicle outside with the ignition switch in the ACC position and the radio on for 30 minutes to activate XM service.
5. Once activated, the radio will receive the remaining XM channels.

Unsuccessful Programming Recovery

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. Ignition ON. Ensure the control module, DLC and programming tool connections are secure and the SPS software is up to date.
2. Verify the control module can be reprogrammed.
    - **If the control module cannot be reprogrammed**
    1. Ignition OFF for one minute, ignition ON.

2. Verify the control module can be reprogrammed.
    - If the control module cannot be reprogrammed, replace the control module.
    - If the control module can be reprogrammed.
3. All OK.

- **If the control module can be reprogrammed**

3. All OK.

REMOTE CONTROL DOOR LOCK RECEIVER PROGRAMMING AND SETUP

NOTE:

- **When replacing the remote control door lock receiver (RCDLR), the tire pressure monitoring (TPM) information can be learned to the new RCDLR in one of two ways. These two methods are reflected in the selections below. Only choose one of the methods; it is not required to do both methods when replacing the RCDLR.**
- **If you choose to perform the Copy and Restore TPM Information procedure, Step 1 must be performed BEFORE removing the old RCDLR. This procedure requires that specific TPM information be extracted from the old RCDLR prior to its removal.**

Remote Control Door Lock Receiver Replacement (Copy and Restore TPM Information)

This procedure will learn the TPM information to the new RCDLR using the Copy and Restore function on the scan tool. This procedure will extract the TPM Tire Type information as well as the sensor data from the existing RCDLR prior to its replacement and store this information in the scan tool. After RCDLR replacement and SPS programming, the tire type and sensor data stored in the scan tool is written to the new RCDLR, negating the need to perform the tire type setup and sensor learn procedure.

This procedure should be considered as the first programming choice when replacing an RCDLR. The Copy and Restore procedure eliminates the possibility of incorrectly inputting the tire type or learning stray TPM sensors.

NOTE: **This step must be performed prior to the removal or replacement of the old RCDLR.**

1. Using a scan tool, navigate to the Copy and Restore TPM Information procedure and copy the existing TPM information from the RCDLR using the outline below. Follow the on-screen instructions.
    - Remote Control Door Lock Receiver
    - Configure/Reset Functions
    - Copy and Restore TPM Information
2. At this point, install the new RCDLR.
3. Program the RCDLR. Refer to **Service Programming System (SPS)**.
4. Using a scan tool, navigate to the Copy and Restore TPM Information procedure to restore the TPM information. Follow the on-screen instructions.
5. Program the keyless entry transmitters - Refer to **Remote Control Door Lock Transmitter Learn** .

6. Perform the 10-Minute Immobilizer Relearn procedure. Refer to **Immobilizer System Component Programming**

   When performing the relearn procedure, select Theft Deterrent Learn - Keyless Ignition (with rotary switch) on the SPS terminal.

Remote Control Door Lock Receiver Replacement (TPM Sensor Learn)

This procedure will learn TPM information to the new RCDLR by manually inputting the tire type using the scan tool and performing the TPM sensor learn. This procedure should be performed if the above Copy and Paste procedure can not be completed. An example of this would be an RCDLR that is unable to communicate with the scan tool and is required to be replaced.

1. RCDLR Programming-Refer to **Service Programming System (SPS)**.
2. Keyless Entry Transmitter Programming-Refer to **Remote Control Door Lock Transmitter Learn** .
3. Tire Type Setup:
   1. Install a scan tool.
   2. Select Remote Control Door Lock Receiver Configuration/Reset Functions.
   3. Select Tire Type/Pressure Selection.
   4. Follow the on-sceen instructions.
4. Perform the 10-Minute Immobilizer Relearn procedure. Refer to **Immobilizer System Component Programming** .

   When performing the relearn procedure, select Theft Deterrent Learn - Keyless Ignition (with rotary switch) on the SPS terminal.

5. Tire Pressure Monitoring Sensor Learn-Refer to **Tire Pressure Indicator Sensor Learn** .

SERVICE PROGRAMMING SYSTEM (SPS)

Special Tools

EL-49642 SPS Programming Support Tool

For equivalent regional tools, refer to **Special Tools**.

For step-by-step control module programming instructions, please refer to the techline information system (TIS) terminal.

Review the information below to ensure proper programming protocol.

NOTE:

- **DO NOT program a control module unless you are directed by a service procedure or you are directed by a General Motors service bulletin. Programming a control module at any other time will not permanently correct a customers concern.**
- **It is essential that the TIS terminal, MDI, and/or Scan Tool, is equipped with the latest software before performing service programming.**
- **Stable battery voltage is critical during programming. Any fluctuation,**

spiking, over voltage or loss of voltage will interrupt programming. When required, install the EL-49642 SPS Programming Support Tool to maintain system voltage. If not available, connect a fully charged 12V jumper or booster pack disconnected from the AC voltage supply.

- **Some modules will require additional programming/setup events to be performed before or after programming.**
- **Some vehicles may require the use of a CANDi or MDI module for programming.**
- **Review the appropriate service information for these procedures.**
- **DTCs may set during programming. Clear DTCs after programming is complete.**
- **Clearing powertrain DTCs will set the Inspection/Maintenance (I/M) system status indicators to NO.**

Ensure the following conditions are met before programming a control module:

- Vehicle system voltage:
  - There is not a charging system concern. All charging system concerns must be repaired before programming a control module.
  - Battery voltage is greater than 12 volts but less than 16 volts. The battery must be fully charged before programming the control module.
  - Turn OFF or disable any system that may put a load on the vehicles battery, such as the following components:
    - Interior lights
    - Exterior lights including daytime running lights (DRL)-Applying the parking brake, on most vehicles, disables the DRL system
    - Heating, ventilation, and air conditioning (HVAC) systems
    - Engine cooling fans
    - Radio, etc.
- The ignition switch must be in the proper position. SPS prompts you to turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the programming procedure, unless instructed to do so.
- Make certain all tool connections are secure, including the following components and circuits:
  - Scan Tool
    - The RS-232 communication cable port
    - The connection at the data link connector (DLC)
    - The voltage supply circuits
  - MDI
    - The USB, Ethernet or Wireless communication port
    - The connection at the data link connector (DLC)
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the

programming procedure, programming failure or control module damage may occur.

In the event of an interrupted or unsuccessful programming event, perform the following steps:

1. DO NOT turn the ignition OFF. Ensure that all control module and DLC connections are secure and the TIS terminal operating software is up to date.
2. Attempt to reprogram the control module.
3. If the control module can still not be programmed, turn the ignition OFF for at least one minute.
4. Turn the ignition ON and attempt to reprogram the control module. The control module should program.
    - If the control module still cannot be programmed, replace the control module.

After successfully programming the control module, ensure that all post programming procedures are performed; refer to **Control Module References** for the appropriate control module Programming and Setup document for any required procedures.

SUNROOF CONTROL MODULE PROGRAMMING AND SETUP

When replacing the sunroof motor/control module, the sunroof motor/actuator initialization/teach procedure must be followed. Refer to **Sunroof Motor/Actuator Initialization/Teach Process** before starting the repair procedure.

THEFT DETERRENT MODULE PROGRAMMING AND SETUP

1. Connect a scan tool to the vehicle in the Pass-thru arrangement.
2. Turn ON the ignition, with the engine OFF.
3. Ensure that all power consuming devices are turned OFF on the vehicle.
4. On the Techline Terminal, select Service Programming System and follow the Techline Terminal on-screen instructions. Go to TDM Theft Deterrent Module from the controller list and select the appropriate on-screen calibration options.
5. After the programming has completed, turn the ignition OFF for 30 seconds.
6. Turn ON the ignition with the engine OFF.
7. On the Techline Terminal, go to V.T.D. Vehicle Theft Deterrent Learn from the controller list and select Vehicle Theft Deterrent Learn, ECM or PK3 Replaced. Follow the on-screen instructions.
8. At this point the scan tool must remain connected for the duration of the 10-minute relearn procedure.

NOTE:

- **The Techline Terminal will initially display 12 Minutes. The first 2 minutes allow the scan tool to initialize the appropriate control module. The remaining 10 minutes is the relearn timer.**
- **On some vehicles the security indicator may be illuminated for the duration of the 10-minute relearn procedure.**

9. Observe the scan tool, after approximately 12 minutes the scan tool will display "Programming Successful, Turn OFF Ignition". The vehicle is now ready to relearn the key information and/or the passwords on the next ignition switch transition from OFF to CRANK.
10. Turn OFF the ignition and wait 2 minutes.

11. With a master vehicle key, turn the ignition to the RUN position for 15 seconds, then start the vehicle. The TDM and ECM have now relearned the pre-release password and the challenge/response data.
12. With a scan tool, clear any DTCs.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

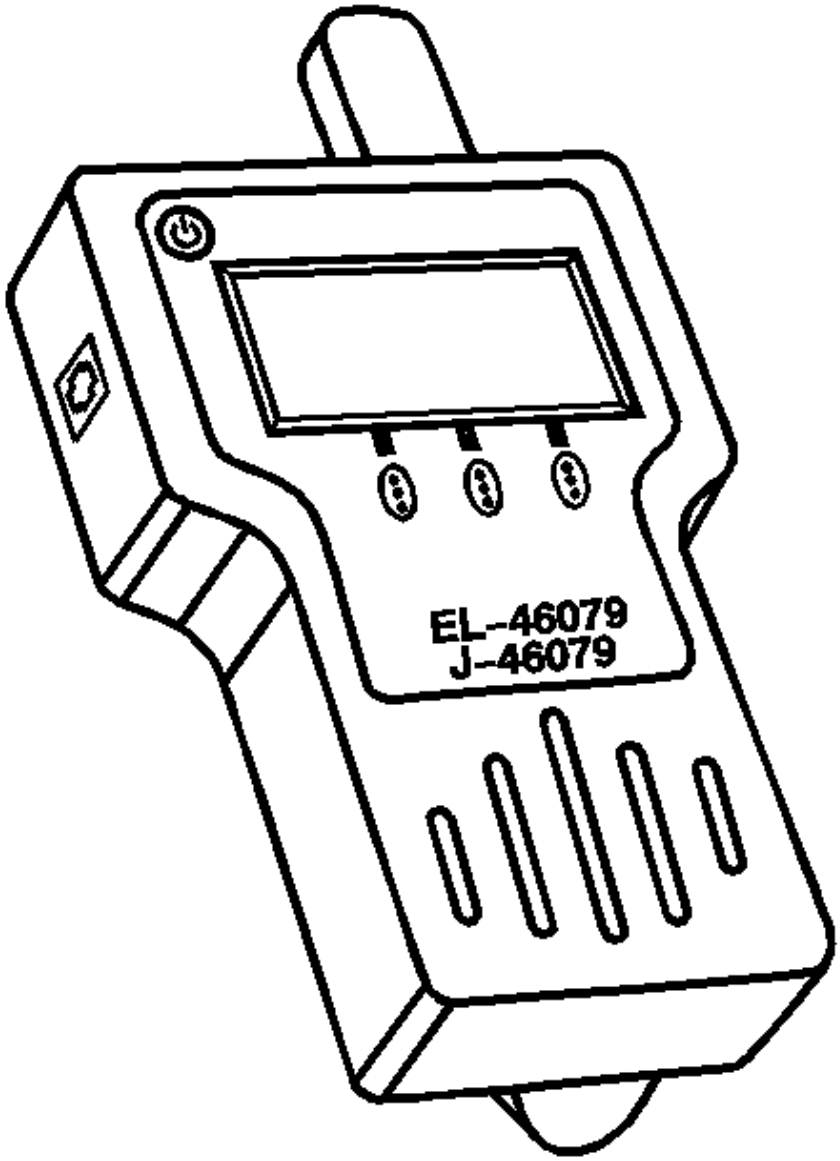
Illustration	Tool Number/ Description
	EL 46079 J 46079 Tire Pressure Monitor Diagnostic Tool

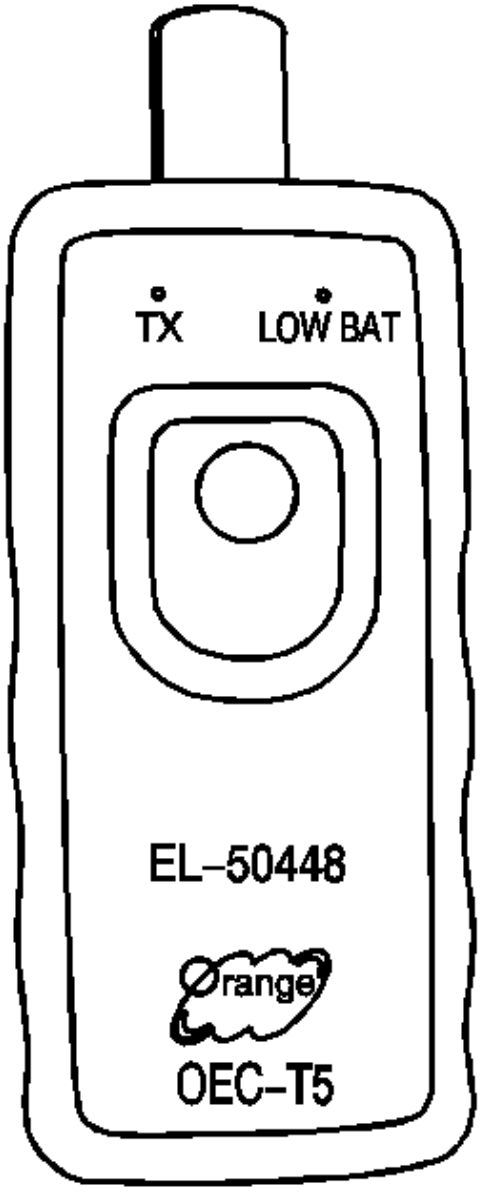
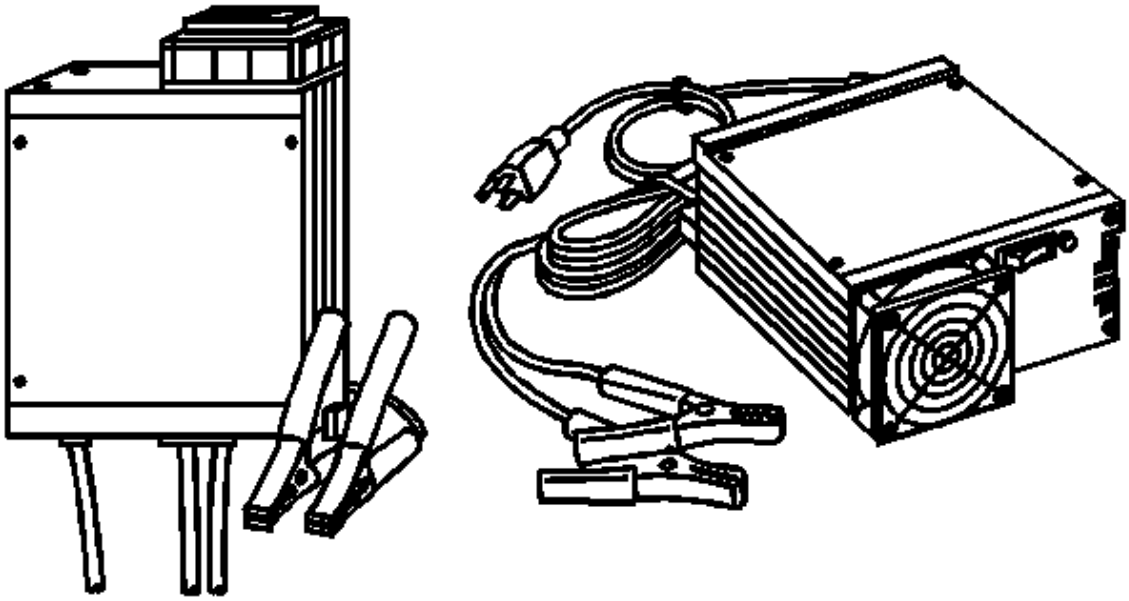
Illustration	Tool Number/ Description
	EL 50448 Tire Pressure Monitor Sensor Activation Tool

Illustration	Tool Number/ Description
	EL 49642 EL 50113 Europe- Use recommended equivalent workshop equipment SPS Programming Support Tool

Article GUID: A00737162

GENERAL INFORMATION

Symptom Check List Worksheets

* PLEASE READ THIS FIRST *

NOTE: **This article is intended for general information purposes only. It does not apply specifically to one make or model.**

PURPOSE

NOTE: **This article is intended for general information purposes only. It does not apply specifically to one make or model.**

WHY USE THE SYMPTOM CHECK LIST WORKSHEETS?

One of the most difficult and critical lines of communication is between the service customer and the technician. The clearer the technician understands the customer's concerns, the more likely the problem will be "fixed right the first time".

The Symptom Check List Worksheets in this article are designed to improve this communication. When used consistently, they can be helpful in reducing shop comebacks, increasing technician productivity, and producing satisfied customers. They also provide other benefits:

- Reduce "No Trouble Found" problems
- Increase customer involvement
- Customer perceive that "they really care and listen"
- Save time during peak write-up periods
- Reduce recontacting customers for additional information
- Improve night drop information
- Insure all the right questions are asked at write-up

MAKING THE WORKSHEETS A PART OF YOUR NORMAL ROUTINE

The following information contains ideas that may be helpful in forming habits that promote daily use of the Symptom Check Lists:

- HAVE THE SERVICE ADVISER FILL OUT THE FORM(S) WITH THE CUSTOMER WHENEVER POSSIBLE.
- Place them in your night drop for the customer to fill out, along with an instruction sheet to help them understand what to do.
- Hand out the worksheets to customers while they wait in line during the peak morning rush and ask them to fill it out. It will save time for all concerned and improve the quality of information received from the customer.
- Make sure it is attached to the hard copy when it goes to the technician.
- Place a copy with the final repair papers and review it with the customer at delivery.

- Put a new worksheet in the glovebox of all departing customers.
- Require that you personally see a copy of all worksheets filled out for shop comebacks.
- Hold a shop meeting to get employee buy-in and their ideas on how to make it effective in your shop.

There are many other ways to utilize the concept, but as with every other idea, successful implementation depends on employee involvement and buy-in.

SYMPTOM CHECK LIST WORKSHEETS

CONDENSED VERSION - ALL ON ONE PAGE

NOTE: **Have the service adviser fill out this form with the customer whenever possible.**

DRIVEABILITY WORKSHEET

(To Be Filled Out By Vehicle Owner)

Name: _____ **Date:** _____ **Make:** _____

Model: _____ **Year:** _____ **Engine:** _____ **Mileage:** _____

FAULT CHARACTERISTICS – SYMPTOMS – DESCRIPTION OF PROBLEM (Please Check All That Apply In All Categories)	
Starting Problems	☐ Will Not Crank ☐ Cranks, But Won't Start ☐ Starts, But Takes A Long Time
Engine Quits/ Running Problems	**Quits:** ☐ Right After Starting ☐ When Put Into Gear ☐ Right After Vehicle Comes To A Stop ☐ During Steady Speed Driving ☐ While Idling ☐ During Acceleration ☐ When Parking
Poor Idling Conditions	**Idle Speed:** ☐ Is Too Slow At All Times ☐ Is Too Slow With A/C On ☐ Is Too Fast ☐ Is Rough Or Uneven ☐ Fluctuates Up and Down
Poor Running Conditions	☐ Runs Rough ☐ Lacks Power ☐ Hesitates Or Stumbles On Acceleration ☐ Bucks and Jerks ☐ Engine Knocks, Pings, Rattles ☐ Backfires ☐ Poor Fuel Economy ☐ Misfires or Cuts Out ☐ Surges and/or Chuggles ☐ Dieseling or Run-On ☐ Engine Light Always On ☐ Engine Light On Sometimes ☐ Fuel, Gas, or Sulfur Smell
Auto. Transmission Problems	☐ Improper Shifting (early/late) ☐ Changes Gear Randomly On Its Own ☐ Vehicle Does Not Move When In Gear
Poor Handling	☐ Pulls To One Side ☐ Hard Steering ☐ Vehicle Shakes and/or Vibrates While Moving
Noise Problems	**Explain:**
Odor Problems	**Explain:**
Problem Frequency	☐ Always ☐ Often ☐ Occasionally
Usually Occurs	☐ Morning ☐ Afternoon ☐ Anytime
Engine Temp.	☐ Cold ☐ Warm ☐ Hot
Vehicle Speed	☐ Low ☐ Cruising ☐ High
Driving Conditions During Occurrence	☐ Short – Less Than 2 Miles ☐ 2-10 Miles ☐ Long – More Than 10 Miles ☐ Stop & Go ☐ While Turning ☐ While Braking ☐ At Gear Engagement ☐ With A/C Operating ☐ With Headlights On ☐ During Acceleration ☐ During Deceleration ☐ Mostly Downhill ☐ Mostly Uphill ☐ Mostly Level ☐ Mostly Curvy ☐ Rough Road
Driving Habits	☐ Drive Hard Before Engine Is Warmed ☐ Allow Engine To Warm ☐ Mostly City Driving ☐ Highway ☐ Park Vehicle Inside ☐ Outside **Drive Per Day:** ☐ Less Than 10 Miles ☐ 10-50 ☐ More Than 50 **Fuel Octane:** ☐ 87 ☐ 89 ☐ 91 ☐ More Than 91 **Brand:** _____ ☐ Gasohol ☐ Propane Conversion
Outside Weather	☐ Cold ☐ Warm ☐ Hot ☐ Wet/Rainy ☐ Fog ☐ Snow/Hail ☐ Dust/Dirt ☐ Dry ☐ Humid

Fig. 1: Entire Vehicle - Symptom Check List For Customer

FULL VERSION - ALL ON FOUR PAGES

NOTE: **Have the service adviser fill out these forms with the customer whenever possible.**

Dear Valued Customer:
Our goal is to fix your problem correctly and get you back on the road as soon as possible in the unlikely event you experience a problem with your vehicle. Help us identify the exact nature of the concern by taking a few moments to complete the appropriate section of this diagnostic worksheet. Thank you.

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO.:**

DIAGNOSTIC WORKSHEET

DRIVEABILITY - ENGINE - AUTOMATIC TRANSMISSION

SYMPTOM (CHECK ALL THAT APPLY)
ENGINE

- ☐ "Service Engine Soon"/"Malfunction Indicator Light" on
- ☐ Hard start/no start (cranks OK)
- ☐ Won't crank
- ☐ Engine stalls
- ☐ Engine miss
- ☐ Miss while driving
- ☐ Hesitates, stumbles or sags
- ☐ Rough idle
- ☐ Idle is too high ☐ Idle is too low
- ☐ Poor power/performance
- ☐ Surge or chuggle, buck - jerk - skip
- ☐ Poor gas mileage ☐ Highway ☐ City
- ☐ Pings, detonates
- ☐ Suphur, rotten egg odor
- ☐ Backfires (popping noise) - underhood/tailpipe
- ☐ Exhaust smoke ☐ Increased oil consumption
- ☐ Runs on after key is turned off
- ☐ Speed fluctuates without moving accelerator
- ☐ Engine noise (explain): _____

(whine, rattle, groan, clunk, etc)

- ☐ Other: _____

TRANSMISSION

- ☐ Does not shift properly ☐ Hard shift
- ☐ Will not shift ☐ Up ☐ Down
- ☐ Will not shift into overdrive
- ☐ Engine starts in other than "P" or "N"
- ☐ Noise (describe): _____

(whine, rattle, groan, clunk, buzz, etc.)

- ☐ Shifts into gear too early
- ☐ Overdrive doesn't work with speed control, but is otherwise OK
- ☐ Highway speed - shudder, surge, etc.
- ☐ Other: _____

EXPLAIN: _____

OPERATING CONDITIONS (CHECK ALL THAT APPLY)
HOW OFTEN DOES IT OCCUR? (Engine and/or Transmission)

- ☐ Always ☐ Few seconds ☐ Few minutes
- ☐ Few hours ☐ Few days ☐ Few weeks
- ☐ Few months ☐ Variable ☐ Only during event
- ☐ Every _____ to ___ miles ☐ Unknown
- ☐ Other (explain): _____
- ☐ Just started ☐ Getting better ☐ Getting worse
- ☐ Since new

WHEN DOES IT OCCUR? (Engine and/or Transmission)
When Engine Temperature is:

- ☐ Cold ☐ Warm ☐ Hot
- ☐ All the time ☐ Only during warmup

Weather Conditions:

- ☐ Very cold - below 0 degrees F ☐ Cold - 0 to 32 degrees F
- ☐ Cool - 32 to 60 degrees F ☐ Warm - 60 to 80 degrees F
- ☐ Hot - Above 80 degrees F ☐ Any environment
- ☐ Raining ☐ Dry ☐ Humid
- ☐ Snow/ice ☐ Wet roads ☐ Other (explain below)

Driving Conditions:

- ☐ Light throttle ☐ Medium throttle ☐ Hard throttle
- ☐ Starting ☐ At idle ☐ Decelerating
- ☐ Over bumps ☐ When shifting ☐ While turning
- ☐ Cruising steady at _____ MPH ☐ While braking
- ☐ Anytime ☐ Uphill ☐ Downhill
- ☐ Highway ☐ City/town ☐ Stop and go
- ☐ Between _____ MPH and _____ MPH
- ☐ Only with A/C or Defrost on

What Type of Fuel? **What Brand?** _____

- ☐ Regular UL ☐ Mid range UL ☐ Premium Unleaded
- ☐ Gasohol ☐ Ethanol ☐ Methanol
- ☐ Diesel #1 ☐ Diesel #2 ☐ Various brands

When Gear Selector is in:

- ☐ Park/Neutral ☐ Reverse ☐ Overdrive
- ☐ Drive/3 ☐ Drive/2 ☐ Drive/1

Between Gears:

- ☐ Park to R or D ☐ Rev/Drive ☐ First/Second
- ☐ Second/Third ☐ Third/Overdrive

50G15061

Fig. 2: Symptom Check List - Page 1

BRAKES - STEERING - SUPPLEMENT

SYMPTOM

- ☐ Vehicle pulls right - When _____
- ☐ Vehicle pulls left - When _____
- ☐ Steering wheel vibrates at ____ MPH
- ☐ Excessive play in steering
- ☐ Erratic steering when braking
- ☐ Poor steering wheel return after cornering
- ☐ Suspension bottoms out
- ☐ Leans or sways in corners
- ☐ Brake light on
- ☐ Traction control light on
- ☐ Uneven tire wear
- ☐ Sits uneven
- ☐ "Dog" tracks
- ☐ ABS light on
- ☐ Soft ride

Hard to steer

- ☐ Effort
- ☐ Wanders
- ☐ Steering wheel off center

Shimmy/vibration (check box below for location)

- ☐ Front
- ☐ Rear
- ☐ Don't know
- ☐ Seat
- ☐ Floor
- ☐ Other _____

Brake pedal

- ☐ Noise
- ☐ Pulses
- ☐ Squeaks
- ☐ Hard
- ☐ Mushy
- ☐ Excessive travel

WHEN DOES IT OCCUR?

- ☐ Cold days
- ☐ Hot days
- ☐ Wet/rain
- ☐ All the time
- ☐ Intermittent
- ☐ Parking manuevers
- ☐ At road speed
- ☐ Accelerating
- ☐ Decelerating

EXPLAIN: _____

SQUEAK - RATTLE - NOISE CONDITIONS

AREA OF NOISE

☐ Engine Compartment	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Front Suspension	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Rear Suspension	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Passenger Compartment	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Instrument Panel	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Doors	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Rear seat area	☐ Console	☐ Other _____		

NOISE SOUNDS LIKE

- ☐ Knocks
- ☐ Hard metal
- ☐ Light metal
- ☐ Roars
- ☐ Ticking
- ☐ Whine
- ☐ Squeaks
- ☐ Rattles
- ☐ Scraping
- ☐ Other _____

HOW OFTEN DOES IT OCCUR?

- ☐ Continuous
- ☐ Often
- ☐ Intermittent
- ☐ Just started
- ☐ Since new

WHEN DOES IT OCCUR?

- ☐ All the time
- ☐ Speed
- ☐ RPM
- ☐ Only moving
- ☐ On turns
- ☐ Braking
- ☐ Hard throttle
- ☐ Light throttle
- ☐ Decelerate
- ☐ Steady speed
- ☐ Idle in gear
- ☐ Idle out of gear
- ☐ Hot days
- ☐ Cold days
- ☐ Humid or rainy
- ☐ Temperature _____
- ☐ Heavy bumps
- ☐ Light bumps
- ☐ Smooth pavement

EXPLAIN: _____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:

VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50H15062

Fig. 3: Symptom Check List - Page 2

AIR CONDITIONING - HEATER - VENTILATION

SYSTEM OR AREA AFFECTED

☐ Air conditioner ☐ Heater ☐ Defroster ☐ Vent ☐ Bi-Level ☐ Fan/blower
☐ Max A/C ☐ Automatic Temperature Control ☐ Mix/blend ☐ Economy ☐ All

SYMPTOM

☐ Does not work ☐ Blows wrong temperature air ☐ No air comes out of vents ☐ Rapid cycling
☐ Noisy (explain) ☐ Broken ☐ Odor ☐ Air comes from wrong outlets ☐ Blows fuse
☐ Leaks ☐ Insufficient heat or cool ☐ Other (explain below)

WHEN DOES IT OCCUR?

☐ All the time ☐ Hot ☐ Cold ☐ Intermittent ☐ Right after startup
☐ When change controls only ☐ Other (explain below) ☐ Fan blower speed High / Med / Low

EXPLAIN: _____

_____

ELECTRICAL - RADIO - TAPE/CD PLAYER

SYMPTOM - MUSIC SYSTEM

☐ Does not work ☐ Noisy ☐ Static ☐ Won't load ☐ Won't eject ☐ Poor reception
☐ Controls do not work ☐ Blows fuse ☐ Other (explain below)

SYSTEM AFFECTED

☐ Radio only ☐ AM ☐ FM ☐ FM stereo ☐ Graphic equalizer
☐ Tape player ☐ CD player ☐ Whole system ☐ Steering wheel buttons ☐ Phone
☐ Speakers ☐ Front ☐ Rear ☐ Left ☐ Right
☐ Antenna ☐ Clock ☐ Radio or player controls ☐ Rear seat controls

ALL OTHER ELECTRICAL ITEMS OR ACCESSORIES
Please list the complaint accessory or item and check any applicable symptom(s) from the list that follows:

_____ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

_____ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

_____ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)

WHEN DOES IT OCCUR? ☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

☐ All the time ☐ Hot ☐ Cold ☐ Just after starting - malfunctions for a while
☐ Intermittent ☐ After runs for _____ minutes ☐ Rough roads or bumps only
☐ Other (explain below)

EXPLAIN: _____

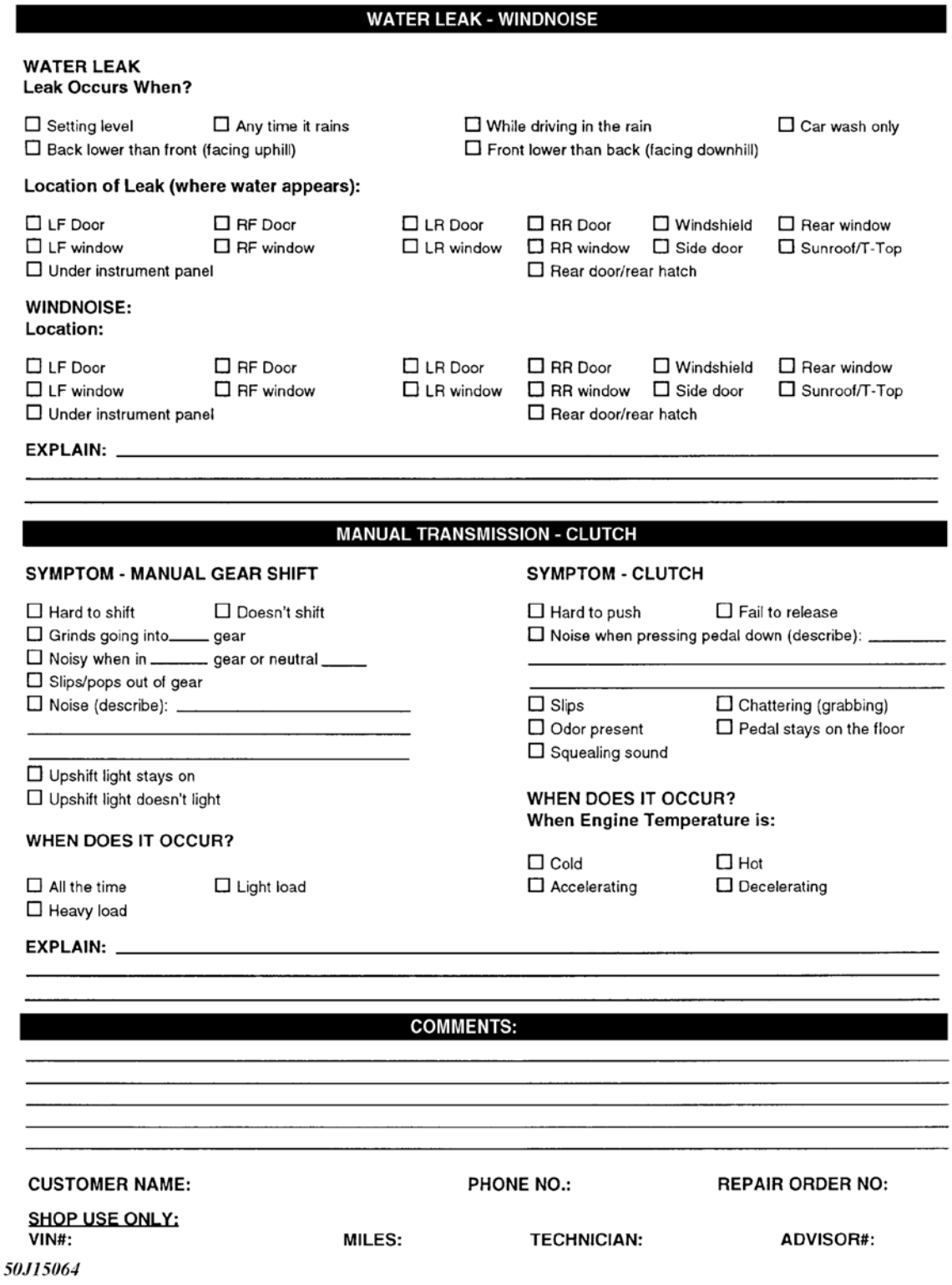
_____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50I15063

Fig. 4: Symptom Check List - Page 3



WATER LEAK - WINDNOISE

WATER LEAK
Leak Occurs When?

☐ Setting level ☐ Any time it rains ☐ While driving in the rain ☐ Car wash only
☐ Back lower than front (facing uphill) ☐ Front lower than back (facing downhill)

Location of Leak (where water appears):

☐ LF Door ☐ RF Door ☐ LR Door ☐ RR Door ☐ Windshield ☐ Rear window
☐ LF window ☐ RF window ☐ LR window ☐ RR window ☐ Side door ☐ Sunroof/T-Top
☐ Under instrument panel ☐ Rear door/rear hatch

WINDNOISE:
Location:

☐ LF Door ☐ RF Door ☐ LR Door ☐ RR Door ☐ Windshield ☐ Rear window
☐ LF window ☐ RF window ☐ LR window ☐ RR window ☐ Side door ☐ Sunroof/T-Top
☐ Under instrument panel ☐ Rear door/rear hatch

EXPLAIN: _____

MANUAL TRANSMISSION - CLUTCH

SYMPTOM - MANUAL GEAR SHIFT

☐ Hard to shift ☐ Doesn't shift
☐ Grinds going into____ gear
☐ Noisy when in _____ gear or neutral _____
☐ Slips/pops out of gear
☐ Noise (describe): _____

☐ Upshift light stays on
☐ Upshift light doesn't light

WHEN DOES IT OCCUR?

☐ All the time ☐ Light load
☐ Heavy load

SYMPTOM - CLUTCH

☐ Hard to push ☐ Fail to release
☐ Noise when pressing pedal down (describe): _____

☐ Slips ☐ Chattering (grabbing)
☐ Odor present ☐ Pedal stays on the floor
☐ Squealing sound

WHEN DOES IT OCCUR?
When Engine Temperature is:

☐ Cold ☐ Hot
☐ Accelerating ☐ Decelerating

EXPLAIN: _____

COMMENTS:

CUSTOMER NAME: PHONE NO.: REPAIR ORDER NO:

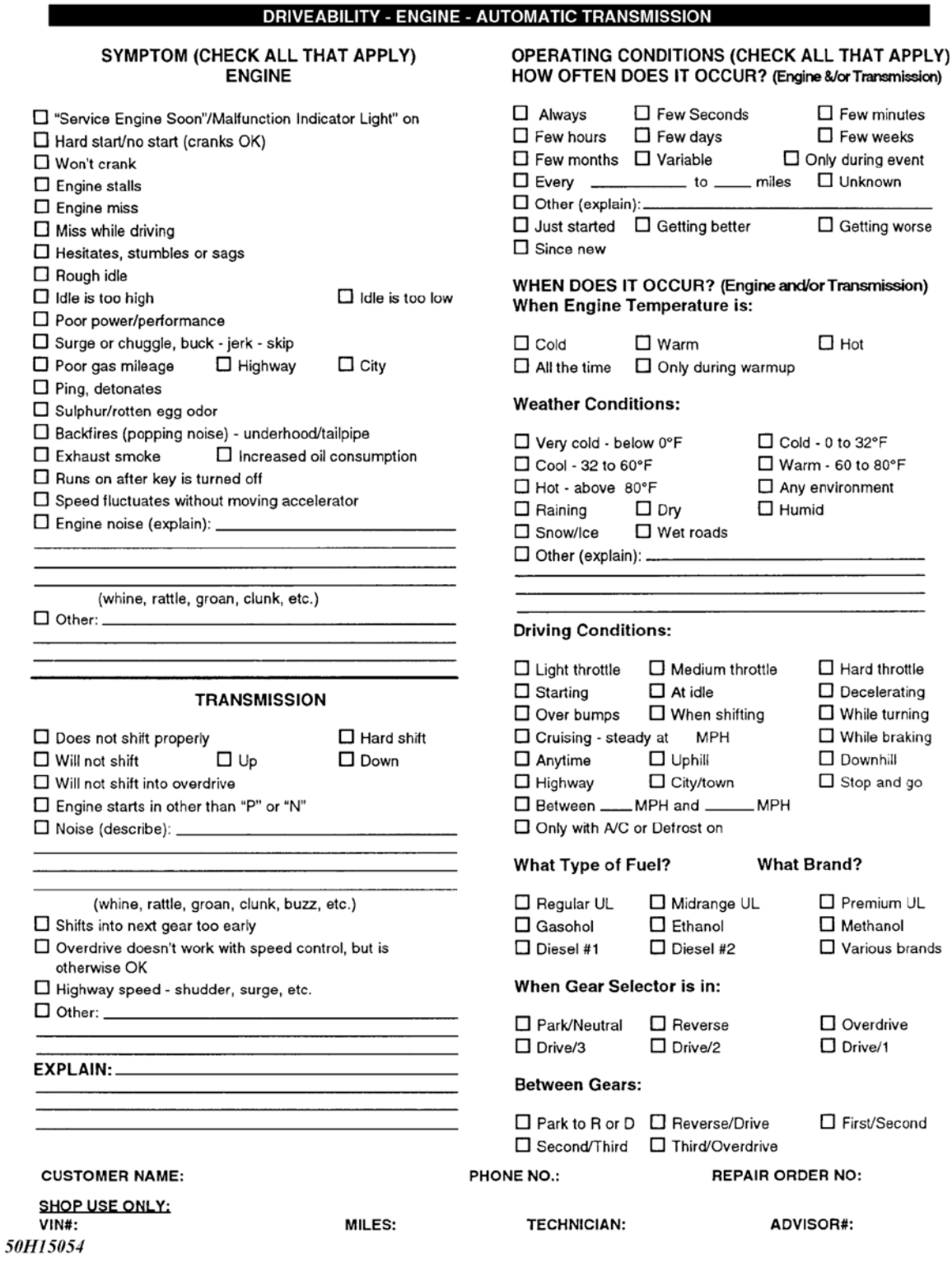
SHOP USE ONLY:
VIN#: MILES: TECHNICIAN: ADVISOR#:

50J15064

Fig. 5: Symptom Check List - Page 4

INDIVIDUAL SYSTEM-BASED CHECK LISTS

NOTE: **Have the service adviser fill out these forms with the customer whenever possible.**



DRIVEABILITY - ENGINE - AUTOMATIC TRANSMISSION

SYMPTOM (CHECK ALL THAT APPLY)
ENGINE

- ☐ "Service Engine Soon"/Malfunction Indicator Light" on
- ☐ Hard start/no start (cranks OK)
- ☐ Won't crank
- ☐ Engine stalls
- ☐ Engine miss
- ☐ Miss while driving
- ☐ Hesitates, stumbles or sags
- ☐ Rough idle
- ☐ Idle is too high ☐ Idle is too low
- ☐ Poor power/performance
- ☐ Surge or chuggle, buck - jerk - skip
- ☐ Poor gas mileage ☐ Highway ☐ City
- ☐ Ping, detonates
- ☐ Sulphur/rotten egg odor
- ☐ Backfires (popping noise) - underhood/tailpipe
- ☐ Exhaust smoke ☐ Increased oil consumption
- ☐ Runs on after key is turned off
- ☐ Speed fluctuates without moving accelerator
- ☐ Engine noise (explain): _____

(whine, rattle, groan, clunk, etc.)

- ☐ Other: _____

TRANSMISSION

- ☐ Does not shift properly ☐ Hard shift
- ☐ Will not shift ☐ Up ☐ Down
- ☐ Will not shift into overdrive
- ☐ Engine starts in other than "P" or "N"
- ☐ Noise (describe): _____

(whine, rattle, groan, clunk, buzz, etc.)

- ☐ Shifts into next gear too early
- ☐ Overdrive doesn't work with speed control, but is otherwise OK
- ☐ Highway speed - shudder, surge, etc.
- ☐ Other: _____

EXPLAIN: _____

OPERATING CONDITIONS (CHECK ALL THAT APPLY)
HOW OFTEN DOES IT OCCUR? (Engine &/or Transmission)

- ☐ Always ☐ Few Seconds ☐ Few minutes
- ☐ Few hours ☐ Few days ☐ Few weeks
- ☐ Few months ☐ Variable ☐ Only during event
- ☐ Every _____ to ____ miles ☐ Unknown
- ☐ Other (explain): _____
- ☐ Just started ☐ Getting better ☐ Getting worse
- ☐ Since new

WHEN DOES IT OCCUR? (Engine and/or Transmission)
When Engine Temperature is:

- ☐ Cold ☐ Warm ☐ Hot
- ☐ All the time ☐ Only during warmup

Weather Conditions:

- ☐ Very cold - below 0°F ☐ Cold - 0 to 32°F
- ☐ Cool - 32 to 60°F ☐ Warm - 60 to 80°F
- ☐ Hot - above 80°F ☐ Any environment
- ☐ Raining ☐ Dry ☐ Humid
- ☐ Snow/Ice ☐ Wet roads
- ☐ Other (explain): _____

Driving Conditions:

- ☐ Light throttle ☐ Medium throttle ☐ Hard throttle
- ☐ Starting ☐ At idle ☐ Decelerating
- ☐ Over bumps ☐ When shifting ☐ While turning
- ☐ Cruising - steady at MPH ☐ While braking
- ☐ Anytime ☐ Uphill ☐ Downhill
- ☐ Highway ☐ City/town ☐ Stop and go
- ☐ Between ____ MPH and _____ MPH
- ☐ Only with A/C or Defrost on

What Type of Fuel? What Brand?

- ☐ Regular UL ☐ Midrange UL ☐ Premium UL
- ☐ Gasohol ☐ Ethanol ☐ Methanol
- ☐ Diesel #1 ☐ Diesel #2 ☐ Various brands

When Gear Selector is in:

- ☐ Park/Neutral ☐ Reverse ☐ Overdrive
- ☐ Drive/3 ☐ Drive/2 ☐ Drive/1

Between Gears:

- ☐ Park to R or D ☐ Reverse/Drive ☐ First/Second
- ☐ Second/Third ☐ Third/Overdrive

CUSTOMER NAME: PHONE NO.: REPAIR ORDER NO:

SHOP USE ONLY:
VIN#: MILES: TECHNICIAN: ADVISOR#:

50H15054

Fig. 6: Engine Driveability & Automatic Transmission

BRAKES - STEERING - SUSPENSION

SYMPTOM

- ☐ Vehicle pulls right - When _____
- ☐ Vehicle pulls left - When _____
- ☐ Steering wheel vibrates at ____ MPH
- ☐ Excessive play in steering
- ☐ Erratic steering when braking
- ☐ Poor steering wheel return after cornering
- ☐ Suspension bottoms out
- ☐ Leans or sways in corners
- ☐ Brake light on
- ☐ Traction control light on
- ☐ Uneven tire wear
- ☐ Sits uneven
- ☐ "Dog" tracks
- ☐ ABS light on
- ☐ Soft ride

Hard to steer

- ☐ Effort
- ☐ Wanders
- ☐ Steering wheel off center

Shimmy/vibration (check box below for location)

- ☐ Front
- ☐ Rear
- ☐ Don't know
- ☐ Seat
- ☐ Floor
- ☐ Other _____

Brake pedal

- ☐ Noise
- ☐ Pulses
- ☐ Squeaks
- ☐ Hard
- ☐ Mushy
- ☐ Excessive travel

WHEN DOES IT OCCUR?

- ☐ Cold days
- ☐ Hot days
- ☐ Wet/rain
- ☐ All the time
- ☐ Intermittent
- ☐ Parking manuevers
- ☐ At road speed
- ☐ Accelerating
- ☐ Decelerating

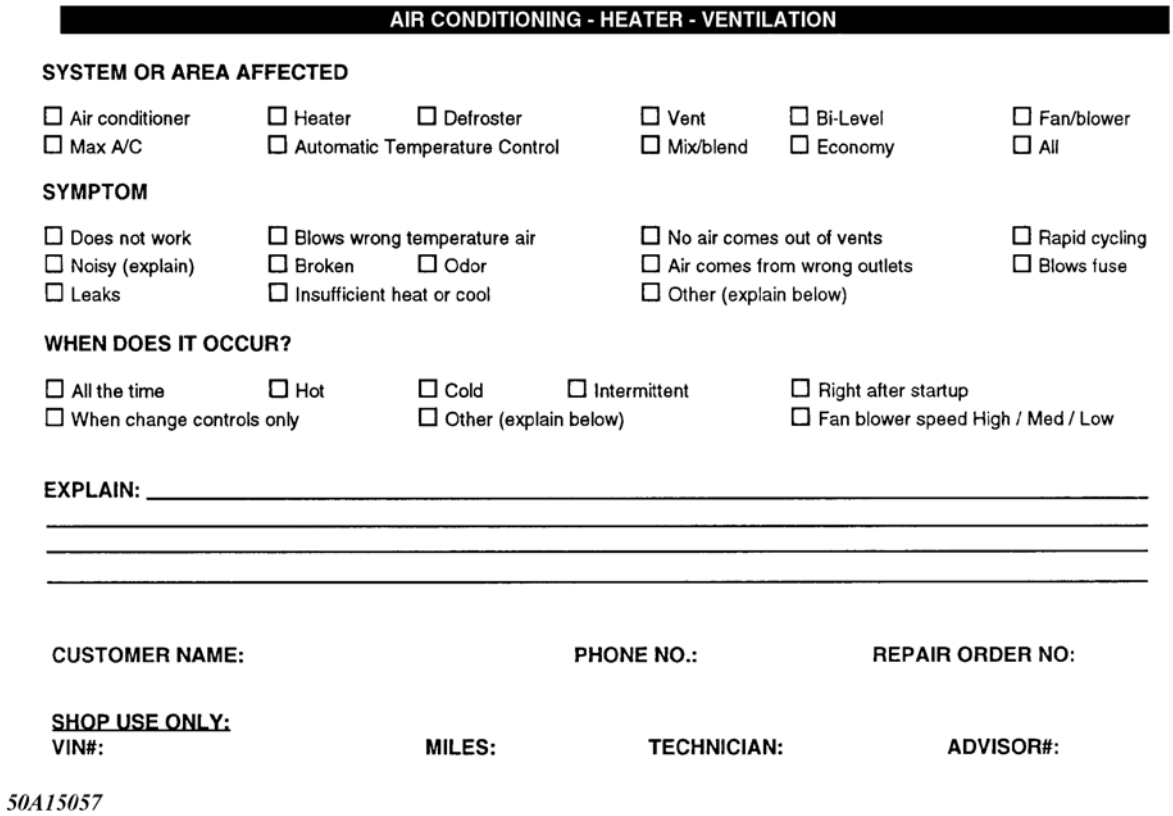
EXPLAIN: _____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50C15059

Fig. 7: Brakes, Steering, & Suspension



AIR CONDITIONING - HEATER - VENTILATION

SYSTEM OR AREA AFFECTED

☐ Air conditioner ☐ Heater ☐ Defroster ☐ Vent ☐ Bi-Level ☐ Fan/blower
☐ Max A/C ☐ Automatic Temperature Control ☐ Mix/blend ☐ Economy ☐ All

SYMPTOM

☐ Does not work ☐ Blows wrong temperature air ☐ No air comes out of vents ☐ Rapid cycling
☐ Noisy (explain) ☐ Broken ☐ Odor ☐ Air comes from wrong outlets ☐ Blows fuse
☐ Leaks ☐ Insufficient heat or cool ☐ Other (explain below)

WHEN DOES IT OCCUR?

☐ All the time ☐ Hot ☐ Cold ☐ Intermittent ☐ Right after startup
☐ When change controls only ☐ Other (explain below) ☐ Fan blower speed High / Med / Low

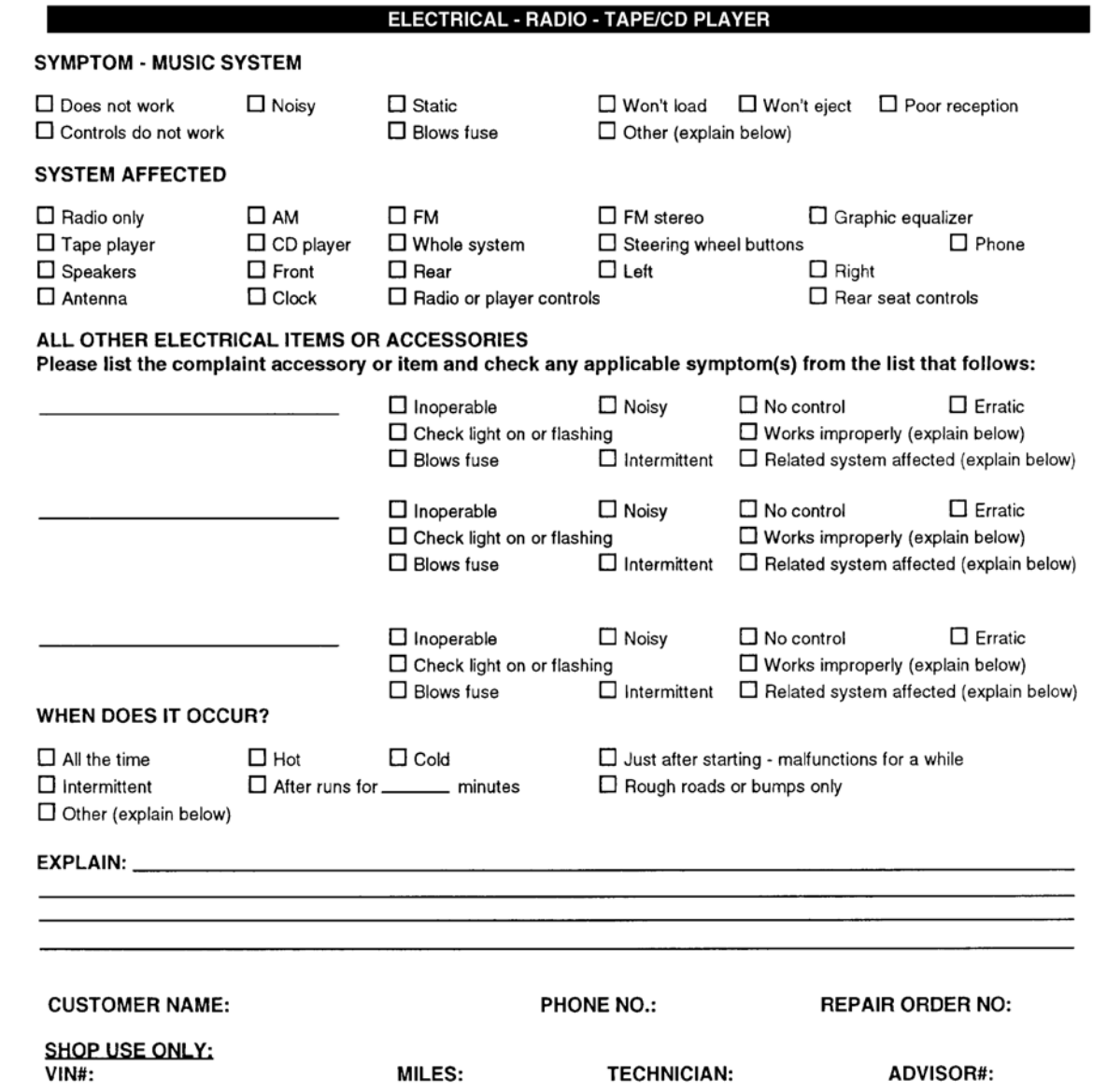
EXPLAIN: _____

CUSTOMER NAME: PHONE NO.: REPAIR ORDER NO:

SHOP USE ONLY:
VIN#: MILES: TECHNICIAN: ADVISOR#:

50A15057

Fig. 8: Air Conditioning, Heater & Ventilation



ELECTRICAL - RADIO - TAPE/CD PLAYER

SYMPTOM - MUSIC SYSTEM

☐ Does not work ☐ Noisy ☐ Static ☐ Won't load ☐ Won't eject ☐ Poor reception
☐ Controls do not work ☐ Blows fuse ☐ Other (explain below)

SYSTEM AFFECTED

☐ Radio only ☐ AM ☐ FM ☐ FM stereo ☐ Graphic equalizer
☐ Tape player ☐ CD player ☐ Whole system ☐ Steering wheel buttons ☐ Phone
☐ Speakers ☐ Front ☐ Rear ☐ Left ☐ Right
☐ Antenna ☐ Clock ☐ Radio or player controls ☐ Rear seat controls

ALL OTHER ELECTRICAL ITEMS OR ACCESSORIES
Please list the complaint accessory or item and check any applicable symptom(s) from the list that follows:

_____ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

_____ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

_____ ☐ Inoperable ☐ Noisy ☐ No control ☐ Erratic
☐ Check light on or flashing ☐ Works improperly (explain below)
☐ Blows fuse ☐ Intermittent ☐ Related system affected (explain below)

WHEN DOES IT OCCUR?

☐ All the time ☐ Hot ☐ Cold ☐ Just after starting - malfunctions for a while
☐ Intermittent ☐ After runs for _____ minutes ☐ Rough roads or bumps only
☐ Other (explain below)

EXPLAIN: _____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50B15058

Fig. 9: Electrical, Radio & Tape/CD Player

MANUAL TRANSMISSION - CLUTCH

SYMPTOM - MANUAL GEAR SHIFT

☐ Hard to shift ☐ Doesn't shift
☐ Grinds going into_____ gear
☐ Noisy when in _____ gear or neutral _____
☐ Slips/pops out of gear
☐ Noise (describe): _____
_____
_____
☐ Upshift light stays on
☐ Upshift light doesn't light

WHEN DOES IT OCCUR?

☐ All the time ☐ Light load
☐ Heavy load

SYMPTOM - CLUTCH

☐ Hard to push ☐ Fail to release
☐ Noise when pressing pedal down (describe): _____
_____
_____
☐ Slips ☐ Chattering (grabbing)
☐ Odor present ☐ Pedal stays on the floor
☐ Squealing sound

WHEN DOES IT OCCUR?
When Engine Temperature is:

☐ Cold ☐ Hot
☐ Accelerating ☐ Decelerating

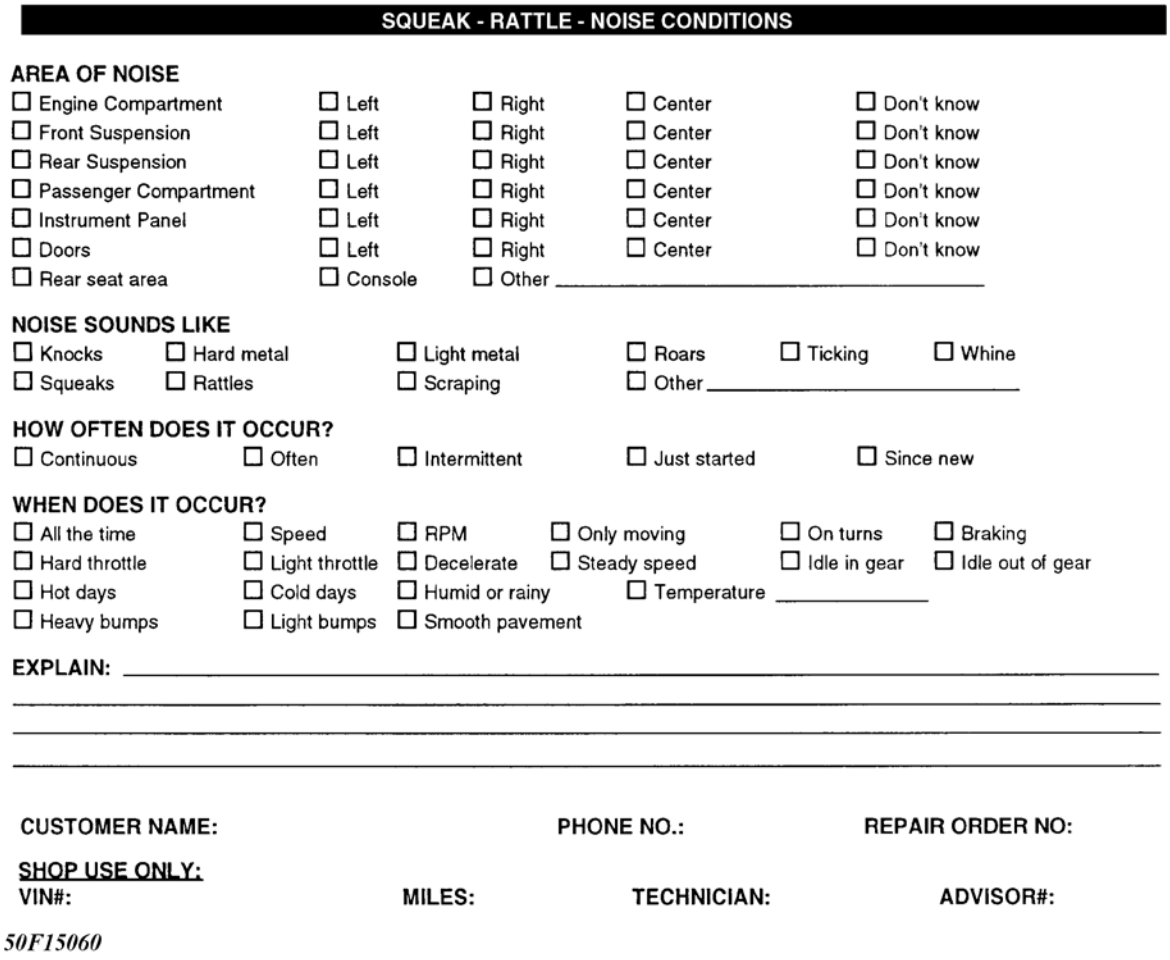
EXPLAIN: _____
_____
_____
_____
_____
_____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50J15056

Fig. 10: Manual Transmission & Clutch



SQUEAK - RATTLE - NOISE CONDITIONS

AREA OF NOISE

☐ Engine Compartment	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Front Suspension	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Rear Suspension	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Passenger Compartment	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Instrument Panel	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Doors	☐ Left	☐ Right	☐ Center	☐ Don't know
☐ Rear seat area	☐ Console	☐ Other _____		

NOISE SOUNDS LIKE

☐ Knocks	☐ Hard metal	☐ Light metal	☐ Roars	☐ Ticking	☐ Whine
☐ Squeaks	☐ Rattles	☐ Scraping	☐ Other _____		

HOW OFTEN DOES IT OCCUR?

☐ Continuous	☐ Often	☐ Intermittent	☐ Just started	☐ Since new

WHEN DOES IT OCCUR?

☐ All the time	☐ Speed	☐ RPM	☐ Only moving	☐ On turns	☐ Braking
☐ Hard throttle	☐ Light throttle	☐ Decelerate	☐ Steady speed	☐ Idle in gear	☐ Idle out of gear
☐ Hot days	☐ Cold days	☐ Humid or rainy	☐ Temperature _____		
☐ Heavy bumps	☐ Light bumps	☐ Smooth pavement			

EXPLAIN: _____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50F15060

Fig. 11: Squeak, Rattle, & Noise Conditions

WATER LEAK - WINDNOISE

WATER LEAK
Leak Occurs When?

☐ Setting level ☐ Any time it rains ☐ While driving in the rain ☐ Car wash only
☐ Back lower than front (facing uphill) ☐ Front lower than back (facing downhill)

Location of Leak (where water appears):

☐ LF Door ☐ RF Door ☐ LR Door ☐ RR Door ☐ Windshield ☐ Rear window
☐ LF window ☐ RF window ☐ LR window ☐ RR window ☐ Side door ☐ Sunroof/T-Top
☐ Under instrument panel ☐ Rear door/rear hatch

WINDNOISE:
Location:

☐ LF Door ☐ RF Door ☐ LR Door ☐ RR Door ☐ Windshield ☐ Rear window
☐ LF window ☐ RF window ☐ LR window ☐ RR window ☐ Side door ☐ Sunroof/T-Top
☐ Under instrument panel ☐ Rear door/rear hatch

EXPLAIN: _____

CUSTOMER NAME: **PHONE NO.:** **REPAIR ORDER NO:**

SHOP USE ONLY:
VIN#: **MILES:** **TECHNICIAN:** **ADVISOR#:**

50I15055

Fig. 12: Water Leak & Wind Noise

Article GUID: A00130105

TIRE PRESSURE MONITOR SYSTEMS

GM - Chevrolet - Impala - 2008-18

DESCRIPTION & OPERATION

NOTE: **If a tire pressure sensor or the RCDLR is replaced, or if wheels have been rotated, tire pressure sensor must be relearned. See RESET PROCEDURES.**

TIRE PRESSURE MONITOR (TPM) SYSTEM

The Tire Pressure Monitor (TPM) system alerts the driver of a large tire pressure change in any of the 4 tires, while the vehicle is being driven. The system will also display individual tire pressures and their locations on the Driver Information Center (DIC).

The TPM system uses the Body Control Module (BCM), Instrument Panel Cluster (IPC), Driver Information Center (DIC), Remote Control Door Lock Receiver (RCDLR), a Radio Frequency (RF) transmitting pressure sensor in each wheel/tire assembly, and the serial data circuit to perform the system functions.

When vehicle is stationary, the sensors go into stationary mode. In this mode, the sensors sample the tire pressure once every 30 seconds and only transmit if the tire pressure changes, to minimize sensor battery consumption. As vehicle speed increases, the sensors go into drive mode, in which they transmit once every 60 seconds. Each sensor takes a pressure measurement sample continuously; if the tire pressure increases or decreases by more than 1.2 psi (8.3 kPa,) the sensor will transmit in re-measure mode in stationary mode or drive mode.

The RCDLR receives and translates the data contained in each sensor transmission, then sends the tire pressure and tire location data to DIC. When TPM system detects a significant loss or gain of tire pressure, a "CHECK TIRE PRESSURE" message will appear on the DIC (if equipped), and the low tire pressure warning indicator is displayed on the IPC.

The RCDLR has the ability to detect malfunctions within the TPM system. Any malfunctions detected will cause the DIC to display a "SERVICE TIRE MONITOR" warning message.

TIRE PRESSURE MONITOR WARNING INDICATORS

When the TPM system detects a significant loss of tire pressure, the "CHECK TIRE PRESSURE" message is displayed on the DIC and the low tire pressure indicator is displayed on the instrument panel. Both the message and indicator can be cleared by adjusting the tires to their recommended pressures and driving the vehicle above 25 mph (40 km/h) for at least 2 minutes. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system.

The RCDLR has the ability to detect malfunctions within the TPM system. Any malfunctions detected will cause the DIC to display a "SERVICE TIRE MONITOR" warning message. See appropriate manufacturer service information.

TPMS RESET PROCEDURES

NOTE: **If a tire pressure sensor or the RCDLR is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.**

When the TPM system detects a significant loss of tire pressure, the "CHECK TIRE PRESSURE" message is displayed on the DIC and the low tire pressure indicator is displayed on the instrument panel. Both the message and indicator can be cleared by adjusting the tires to their recommended pressures and driving the vehicle above 25 mph (40 km/h) for at least 2 minutes.

TIRE PRESSURE SENSOR RELEARN

NOTE: **Once the learn mode has been enabled, each of the sensor's unique identification (ID) codes can be learned into the RCDLR's memory. When a sensor's ID has been learned, the RCDLR sends a serial data message to the BCM to sound a horn chirp. This verifies the sensor has transmitted its ID and the RCDLR has received and learned it. The RCDLR must learn the sensor IDs in the proper order to determine correct sensor location. The first learned ID is assigned to left front, the second to right front, third to right rear and fourth to left rear.**

NOTE: **Each turn signal will illuminate one at a time indicating which location is to be learned next.**

NOTE: **Each sensor takes a pressure measurement sample once every 30 seconds while in stationary mode. If the tire pressure increases or decreases by more than 1.2 psi (8.3 kPa) from the last pressure measurement, another measurement will occur immediately to verify the change in pressure. If a pressure change has indeed occurred, the sensor transmits a learn mode. When the RCDLR receives a learn mode transmission while in sensor learn mode, it will assign that sensor's ID to the location on the vehicle relative to the order in which it was learned.**

NOTE: **The TPM system will cancel the learn mode if more then 2 minutes have passed and no sensors have been learned, or if the ignition switch is turn to the OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.**

NOTE: **In the following procedures, a TPM Special Tool (EL-46079 or EL-50448) may be used in place of increasing/decreasing pressures to enable sensor. To use, place activator antenna against the tire sidewall close to the wheel rim at the valve stem location, then press and release the ACTIVATE button.**

NOTE: **If a TPM Sensor Activation Tool is used, and vehicle is having trouble entering relearn mode, check batteries in activation tool. Low batteries may allow some functions to work, but not allow vehicle to perform learn function. When the internal battery is fresh (fully charged), the indicator is "full" or all dark. When**

the battery is depleted, the indicator shows "empty" or all light.

The learn mode can be enabled using any one of the following three methods:

- **Using Keyless Entry System**
- **Using Scan Tool**
- **Using Driver Information Center (DIC)**

NOTE: **Before proceeding with the steps below, ensure that no other sensor learn procedure is being performed simultaneously and that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.**

Using Keyless Entry System

1. Turn ignition switch to ACCY position. Apply parking brake.
2. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the learn mode has been enabled.

   NOTE: **The left front turn signal will also illuminate to indicate the learn mode has been enabled.**

3. Activate the sensors by one of the following methods:

   Increase/Decrease Method: Starting with left front tire, increase or decrease the pressure for 8-10 seconds, then wait for a horn chirp sounds. The horn chirp may occur before the 8-10 second pressure increase/decrease time period has been reached, or up to 30 seconds after the 8-10 second pressure increase/decrease time period has been reached.

   Sensor Activation Tool Method: Starting with the left front tire, hold the scan tool against the tire wall aiming upward with the antenna. Press the activate button and wait for a horn chirp. After the horn has chirped, the turn signal will illuminate indicating the next location to be learned.

4. After horn chirp has sounded and the right turn signal has illuminated, repeat procedure for the next 3 sensors in the following order: right front, right rear and left rear.
5. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position. Adjust all tire pressures to specification.

Using Scan Tool

NOTE: **Before proceeding with the steps below, ensure that no other sensor learn procedure is being performed simultaneously and that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.**

1. Connect scan tool. Turn ignition switch to RUN position. Apply parking brake.
2. Using scan tool, select "SPECIAL FUNCTIONS".
3. Select "SENSOR LEARN MODE ENABLE", and press ENTER key.
4. Press ON soft key. A double horn chirp will sound, indicating the learn mode has been enabled.

NOTE: **The left front turn signal will also illuminate to indicate the learn mode has been enabled.**

5. Activate the sensors by one of the following methods:

   Increase/Decrease Method: Starting with left front tire, increase or decrease the pressure for 8-10 seconds, then wait for a horn chirp sounds. The horn chirp may occur before the 8-10 second pressure increase/decrease time period has been reached, or up to 30 seconds after the 8-10 second pressure increase/decrease time period has been reached.

   Sensor Activation Tool Method: Starting with the left front tire, hold the scan tool against the tire wall aiming upward with the antenna. Press the activate button and wait for a horn chirp. After the horn has chirped, the turn signal will illuminate indicating the next location to be learned.

6. After horn chirp has sounded, repeat procedure for the next 3 sensors in the following order: right front, right rear and left rear.
7. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position. Adjust all tire pressures to specification.

Using Driver Information Center (DIC)

NOTE: **Before proceeding with the steps below, ensure that no other sensor learn procedure is being performed simultaneously and that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.**

2007-13

1. Turn ignition switch to RUN position. Apply parking brake.
2. Press the "INFO" button on the DIC (located on the instrument panel, to the right of the instrument panel cluster), until the "RELEARN TIRE POSITIONS" message display on the DIC. Then press the "SET/RESET" button on the DIC until a double horn chirp sounds and the DIC displays "TIRE LEARNING ACTIVE". This will indicate the learn mode has been enabled.
3. Proceed to **All Models** , below.

2014-

1. Turn the ignition to ON/RUN with the engine off or place the vehicle power mode in ON/ RUN/START.
2. Make sure the Tire Pressure info page option is turned on.

NOTE: **The info pages on the DIC can be turned on and off through the Settings menu.**

3. Use the DIC controls on the right side of the steering wheel to scroll to the Tire Pressure screen under the DIC info page.
4. Press and hold the Set/Reset button (check-mark symbol) located in the center of the DIC controls.
5. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
6. Proceed to **All Models** , below.

All Models

1. Activate the sensors by one of the following methods:

   Increase/Decrease Method: Starting with left front tire, increase or decrease the pressure for 8-10 seconds, then wait for a horn chirp sounds. The horn chirp may occur before the 8-10 second pressure increase/decrease time period has been reached, or up to 30 seconds after the 8-10 second pressure increase/decrease time period has been reached.

   Sensor Activation Tool Method: Starting with the left front tire, hold the scan tool against the tire wall aiming upward with the antenna. Press the activate button and wait for a horn chirp. After the horn has chirped, the turn signal will illuminate indicating the next location to be learned.

2. After horn chirp has sounded and the right turn signal has illuminated, repeat procedure for the next 3 sensors in the following order: right front, right rear and left rear.
3. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position. Adjust all tire pressures to specification.

DISMOUNTING/MOUNTING PROCEDURES

CAUTION: The tire should be dismounted from the wheel using the tire changer manufacturer's instructions. Use the following information to avoid damage during the dismounting/mounting procedures.

NOTE: If vehicle's tires are replaced with those not having a TPC Spec number, the TPM system may give an inaccurate low pressure warning. Non-TPC Spec tires may give a low pressure warning that is higher or lower than the proper warning level achieved by TPC Spec numbered tires.

NOTE: If a tire pressure sensor or the RCDLR is replaced, or if wheels have been rotated, tire pressure sensor must be relearned. See RESET PROCEDURES.

TIRE PRESSURE SENSOR

CAUTION: DO NOT inject any tire liquid or aerosol tire sealant into tires, as this may cause a malfunction of the tire pressure sensors. If any tire sealant is noted upon tire dismounting, replace the sensor. Also remove all residual liquid sealant from the inside of the tire and wheel surfaces.

Removal

1. Raise vehicle on a suitable support. Remove tire/wheel assembly from vehicle.
2. Dismount tire from wheel following tire changer manufacturer's instructions while paying special attention to the following to avoid damaging tire pressure sensor:
   - Place the sensor's cap and valve on a dry, clean surface after removal. The cap is aluminum and the valve is nickel-plated to prevent corrosion. DO NOT substitute a cap or valve made of any other material.
   - Position the bead breaking fixture 90 degrees from valve stem when separating tire bead from

wheel.

- Position the mounting/dismounting head so tire iron (or pry bar) can be inserted slightly clockwise of sensor body when prying tire bead up and over the mounting/dismounting head.
- Using tire machine, rotate tire/wheel assembly clockwise when transferring the tire bead to the outside of the wheel rim.
- Repeat items for inner bead.

3. Remove TORX screw from the tire pressure sensor. See **Fig. 1**.
4. Pull screw and tire pressure sensor from the tire pressure valve stem.
5. Remove the tire pressure valve stem from rim.

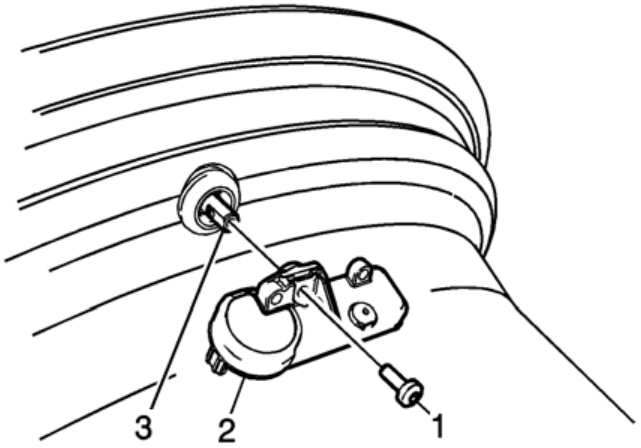


Fig. 1: Exploded View Of Tire Pressure Sensor
Courtesy of GENERAL MOTORS CORP.

Installation

1. Clean any dirt or debris. Assemble the tire pressure sensor to the new tire pressure valve stem. Install new TORX screw. Tighten the screw to 11.5 INCH lbs. (1.3 N.m)
2. Apply tire soap to the tire pressure valve stem.
3. Use tire valve stem mounting tool, and pull the valve stem through the wheel hole in a parallel direction.
4. Before installing tire on the wheel, note the following items to avoid tire pressure sensor damage upon tire mounting:
   - Position the mounting/dismounting head 180 degrees from valve stem.
   - Position the bead transition area 45 degrees counterclockwise of valve stem.
   - Using tire machine, rotate tire/wheel assembly clockwise when transferring tire bead to the inside of the wheel rim.
   - Repeat items for outer bead.
5. Install tire on wheel. Install tire/wheel assembly on vehicle. learn tire pressure sensor. See **RESET PROCEDURES**.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Component	Ft. Lbs. (N.m)

Component	Ft. Lbs. (N.m)
Wheel Nut (2008-12)	100 (140)
Wheel Nut (2014-)	111 (150)
	INCH Lbs. (N.m)
Clamp-In Style Nut	62 (7)
Snap-In Style TORX Screw	89 (10)

Article GUID: A00281684

TRACTION CONTROL, 4WD, & AWD

Chevrolet - 1980-18

TRACTION CONTROL DISABLE

WARNING: **Placing a non-compatible vehicle on a single-axle dynamometer could result in a safety hazard to technicians and damage to vehicle. Vehicles which use All-Wheel Drive (AWD) or traction control may not be clearly marked. Use common sense and take all necessary precautions when placing any vehicle on the dynamometer. Determine between full-time 4WD and All-Wheel Drive (AWD) for testing purposes. The following tables include information related to full-time 4WD and AWD vehicles, and how to disable the traction control system (if disengageable).**

WARNING: **DO NOT operate vehicle on a 2-wheel dynamometer if the DO NOT TEST column is marked.**

CHEVROLET - CARS

Application	FWD	RWD	Part Time 4WD	Full Time 4WD	AWD	TCS	Do Not Test
Camaro							
1994-02	...	X	...	...	...	X (1)	...
2010-17	...	X	...	...	...	X (9)	...
Caprice							
2011-15	...	X	...	...	...	X (7)	...
2016-17	...	X	...	...	...	X (14)	...
Cavalier							
1995-00	X	...	...	...	...	X (2)	...
2001-05	X	...	...	...	...	X (3)	...
Cobalt							
2007-10	X	...	...	...	...	X (4)	...
Corvette							
1992-97	...	X	...	...	...	X (5)	...
1998-04	...	X	...	...	...	X (10)	...
2005-13	...	X	...	...	...	X (10)(11)	...
2014-17	...	X	...	...	...	X (11)(15)	...
Cruze							
2011-17	...	X	...	...	...	X (9)	...
Impala							
2000-10	X	...	...	...	...	X (6)	...

Application	FWD	RWD	Part Time 4WD	Full Time 4WD	AWD	TCS	Do Not Test
2011-13	X	...	...	...	...	X (12)	...
2014-17	...	X	...	...	...	X (9)	...
Impala Limited							
2014-16	X	...	...	...	...	X (12)	...
Malibu							
2004-07 (& 2008 Classic)	X	...	...	...	...	X (7)	...
2008-12	X	...	...	...	...	X (12)	...
2013-17	X	...	...	...	...	X (9)	...
Monte Carlo							
2000-07	X	...	...	...	...	X (8)	...
Sonic							
2012-17	X	...	...	...	...	X (9)	...
Spark							
2013-15	X	...	...	...	...	X (9)	...
2016-17	X	...	...	...	...	X (14)	...
SS							
2014-15	...	X	...	...	...	X (9)	...
2016-17	...	X	...	...	...	X (15)	...
Volt							
2011	X	...	...	...	...	X (13)	X
2012-15	X	...	...	...	...	X (14)	...
2016-17	X	...	...	...	...	X (9)	...

(1) Press ASR button, located on console. ASR OFF indicator light will illuminate when system is disabled.

(2) ETS system will not operate when A/T selector is in 1 or 2 position. ETS indicator light will stay on when system is disabled.

(3) Traction control is disabled when transaxle is in 1st or 2nd gear only. TRAC OFF indicator light will illuminate when system is disabled.

(4) To turn the ETS off, shift to L (Low) or R (Reverse). The ETS indicator/warning light will come on and stay on and the TRACTION OFF message will be displayed when the gear shift is in L (Low).

(5) Press sliding car icon on the console. The TCS indicator will illuminate when system is disabled.

(6) Press TRAC OFF button on left side of dash. Chime will sound. SERVICE TRACTION SYSTEM indicator light will illuminate when system is disabled.

(7) Press TC button near A/C-heater controls or in front of the shift lever. Indicator light will illuminate when system is disabled.

(8) Press TRAC ON/OFF button on instrument panel or center console. TRACTION CONTROL

Application	FWD	RWD	Part Time 4WD	Full Time 4WD	AWD	TCS	Do Not Test

indicator light will illuminate when system is disabled.

(9) Press and hold the TCS/StabiliTrak button until the Traction Control Off light and the StabiliTrak Off light come on in the instrument panel cluster. The TCS/StabiliTrak button is located near the shift lever.

(10) The TCS Switch allows the driver to shut off the TCS and Active Handling (RPO JL4 - if equipped), by pressing and releasing the switch. If the vehicle is equipped with Active Handling, the TCS switch can be pressed and held for 5 seconds; this places the system in Competitive driving mode. Competitive driving mode turns the TCS off but still allows Active Handling to be active. The switch is located in the center console.

(11) If the Tire Pressure Monitor (TPM) system detects a flat tire and the Driver Information Center (DIC) displays TIRE FLAT, or if the TPM system is malfunctioning and the DIC displays SERVICE TIRE MONITOR, the Active Handling System cannot be turned off by the driver. If the Active Handling System is off, it will be turned back on automatically.

(12) The ESC/TCS button is located on the instrument panel or on console. Press and hold the ESC/TCS button briefly to disable both traction control and ESC. TRACTION OFF and ESC OFF messages will appear, and the ESC/TCS light will be on solid.

(13) Traction Control system turns on automatically whenever the vehicle is on and cannot be turned off.

(14) Press and hold the TCS/StabiliTrak button until the Traction Control Off light and the StabiliTrak Off light come on in the instrument panel cluster. The TCS/StabiliTrak button is located on the overhead console or to the left of the steering wheel.

(15) Press and hold the TCS/StabiliTrak button until the Traction Control Off light and the StabiliTrak Off light come on in the instrument panel cluster. The TCS/StabiliTrak button is located on the center console.

CHEVROLET - TRUCKS

Application	FWD	RWD	Part Time 4WD	Full Time 4WD	AWD	TCS	Do Not Test
Astro							
1990-05 (AWD)	...	...	...	...	(1)	...	...
Avalanche							
2002-13	...	X	...	...	...	X (2)	...
2003-13	...	...	X (4)	...	...	X (3)	...
Blazer (2002-05 Jimmy Canadian)							
1980-94	...	X	X (4)	...	...	...	...
1995-05 (4WD)	...	X	X (4)	...	...	...	...
1995-98 (AWD)	...	...	...	...	X (1)	...	...
Captiva Sport							
2012-15 (AWD)	...	...	...	...	X	...	X

Application	FWD	RWD	Part Time 4WD	Full Time 4WD	AWD	TCS	Do Not Test
2012-15 (FWD)	X	...	...	...	...	X (10)	...
City Express							
2015-17	X	...	...	...	...	X (13)	...
Colorado							
2004-12	...	X	X (4)	...	...	X (3)	...
2015-17	...	X	X (4)	...	...	X (12)	...
Equinox							
2005-17 (AWD)	...	...	...	...	X	...	X
2005-17 (FWD)	X	...	...	...	...	X (9)	...
Express (Chevy Express/ Cutaway/ RV)							
2004-11 (RWD)	...	X	...	...	...	X (9)	...
2003-14 (AWD)	...	...	...	...	X	...	X
2012-17 (RWD)	...	X	...	...	...	X (10)	...
HHR							
2008-10	X	...	...	...	...	X (7)	...
K10-30 & K1500-3500 Series							
1980-00	...	X	X (4)	...	...	...	...
LUV							
1980-82	...	X	X (4)	...	...	...	...
Silverado (All Configurations)							
2003-05 (AWD)	...	...	...	...	X	...	X
1999-17	...	X	X (4)	...	...	X (7)	...
SSR							
2003-06	...	X	...	...	...	X (5)	...
Suburban							
1980-99	...	X	X (4)	...	...	...	...
2000-17	...	X	X (4)	...	...	X (7)	...
Tahoe							
1995-99	...	X	X (4)	...	...	...	...
2000-17	...	X	X (4)	...	...	X (7)	...
Tracker							
1998-04	...	X	X (4)	...	...	...	...
TrailBlazer							
2002-09	...	X	X (4)	...	...	X (8)	...
2006-09 (AWD)	...	...	...	...	X	...	X
Traverse							
2009-17 (AWD)	...	...	...	...	X	...	X

Application	FWD	RWD	Part Time 4WD	Full Time 4WD	AWD	TCS	Do Not Test
2009-17 (FWD)	X	...	...	...	...	X (8)	...
Trax							
2015-17	...	...	...	...	X	...	X
2015-17	X	...	...	...	...	X (12)	...
T10 & T15 Pickup							
1982-01	...	X	X (4)	...	...	...	...
Uplander & Montana SV6							
2006-08 (AWD)	...	...	...	...	X	...	X
Venture							
1997-05	X	...	...	...	...	X (8)	...
2002-05 (AWD)	...	...	...	...	X	...	X

(1) All wheel drive is optional.

(2) Press switch with sliding car icon, located left of steering wheel on instrument panel. TRACTION OFF will illuminate when system is disabled.

(3) Traction Assist (TAS) or Traction Control (TCS) can be turned off by pressing TAS or TCS button on instrument panel. TCS light on instrument panel will illuminate.

(4) 4WD With Shift Lever Selector: Shift transfer case to 2WD or 2H mode. 4WD With A/T or M/T Push Button Shift Selector: Press button on instrument panel to select 2HI position. Switch indicator light will flash until new position is active. Indicator light will stay on.

(5) Information from manufacturer is not available.

(6) Press TRACTION ASSIST switch located on dashboard, left of steering wheel. TRACTION OFF indicator light will illuminate when system is disabled.

(7) To turn off both TCS and StabiliTrak, press and hold the TRACTION OFF button until the traction off light and the StabiliTrak OFF light come on and stay on in the instrument cluster.

(8) Press traction control switch located on instrument panel or center console. When the TCS is turned off, the StabiliTrak light goes on, and an appropriate traction control off message will be displayed on the DIC.

(9) Press the TRACTION OFF button (located on the instrument panel or center console) for more than five seconds to turn off StabiliTrak and TCS. The StabiliTrak light comes on the instrument panel cluster when the system is turned off.

(10) Press the TRACTION OFF button (located on the instrument panel) once to turn off the Traction Control System (TCS). Press and hold the StabiliTrak button for more than five seconds to turn off StabiliTrak and TCS. The StabiliTrak light comes on the instrument panel cluster when the system is turned off.

(11) Press TRACTION OFF button located on instrument panel. The appropriate message displays on Driver Information Center (DCI).

(12) The button for TCS and StabiliTrak is on the center stack. To turn off only TCS, press and release the TRACTION OFF button. The Traction Off Light displays in the instrument cluster. To turn off both TCS and StabiliTrak, press and hold the TRACTION OFF button until the Traction Off Light

Application	FWD	RWD	Part Time 4WD	Full Time 4WD	AWD	TCS	Do Not Test
and StabiliTrak Off Light come on and stay on in the instrument cluster. To turn TCS and StabiliTrak on again, press and release the TRACTION OFF button. (13) To turn off TCS and Electronic Stability Control, press and release the TRACTION OFF button. The Electronic Stability Control (ESC) Off Light comes on and stays on in the instrument cluster. The TRACTION OFF button is on the instrument panel, to the left of the steering wheel.							

Article GUID: A00164026

GENERAL INFORMATION

Trouble Shooting - Basic Procedures

* PLEASE READ THIS FIRST *

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.**

ACCESSORIES & ELECTRICAL

CHARGING SYSTEM TROUBLE SHOOTING

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.**

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.**

BASIC CHARGING SYSTEM TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Vehicle Will Not Start	
Dead battery	Check battery cells, alternator belt tension and alternator output
Loose or corroded battery connections	Check all charging system connections
Ignition circuit or switch malfunction	Check and replace as necessary
Alternator Light Stays On With Engine Running	
Loose or worn alternator drive belt	Check alternator drive tension and condition, See Belt Adjustment in TUNE-UP article in the TUNE-UP section
Loose alternator wiring connections	Check all charging system connections
Short in alternator light wiring	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Defective alternator stator or diodes	See Bench Tests in ALTERNATOR article
Defective regulator	See Regulator Check in ALTERNATOR article
Alternator Light Stays Off With Ignition Switch ON	

CONDITION & POSSIBLE CAUSE	CORRECTION
Blown fuse	See WIRING DIAGRAMS
Defective alternator	See Testing in ALTERNATOR article
Defective indicator light bulb or socket	See Indicator Warning Lights in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Alternator Light Stays OFF With Ignition Switch ON	
Short in alternator wiring	See On-Vehicle Tests in ALTERNATOR article
Defective rectifier bridge	See Bench Tests in ALTERNATOR article
Lights or Fuses Burn Out Frequently	
Defective alternator wiring	See On-Vehicle Tests in ALTERNATOR article
Defective regulator	See Regulator Check in ALTERNATOR article
Defective battery	Check and replace as necessary
Ammeter Gauge Shows Discharge	
Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in TUNE-UP article in the TUNE-UP section
Defective wiring	Check all wires and wire connections
Defective alternator or regulator	See Bench Tests and On-Vehicle Tests in ALTERNATOR article
Defective ammeter, or improper ammeter wiring connection	See Testing in STANDARD INSTRUMENTS in the ACCESSORIES & EQUIPMENT section
Noisy Alternator	
Loose drive pulley	Tighten drive pulley attaching nut
Loose mounting bolts	Tighten all alternator mounting bolts
Worn or dirty bearings	See Bearing Replacement ALTERNATOR article
Defective diodes or stator	See Bench Test in ALTERNATOR article
Battery Does Stay Charged	
Loose or worn drive belt	Check alternator drive belt tension and condition. See Belt Adjustment in appropriate TUNE-UP article in the TUNE-UP section
Loose or corroded battery connections	Check all charging system connections
Loose alternator connections	Check all charging system connections
Defective alternator or battery	See On-Vehicle Tests and Bench Tests in ALTERNATOR article
Add-on electrical accessories exceeding alternator capacity	Install larger alternator
Battery Overcharged-Uses Too Much Water	
Defective battery	Check alternator output and repair as necessary
Defective alternator	See On-Vehicle Test and Bench Tests in ALTERNATOR article
Excessive alternator voltage	Check alternator output and repair as necessary

IGNITION SYSTEM TROUBLE SHOOTING

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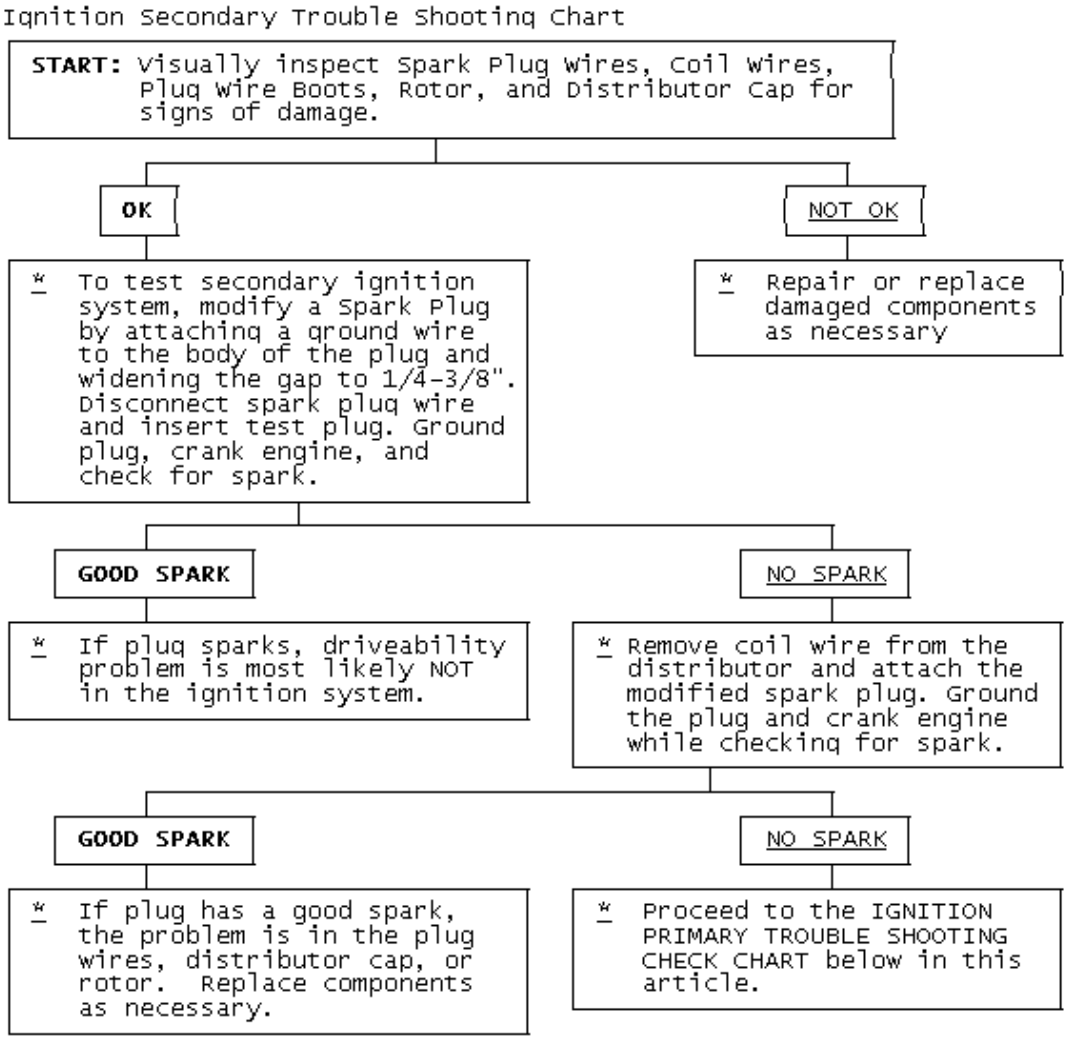

Fig. 1: Ignition Secondary Trouble Shooting Chart

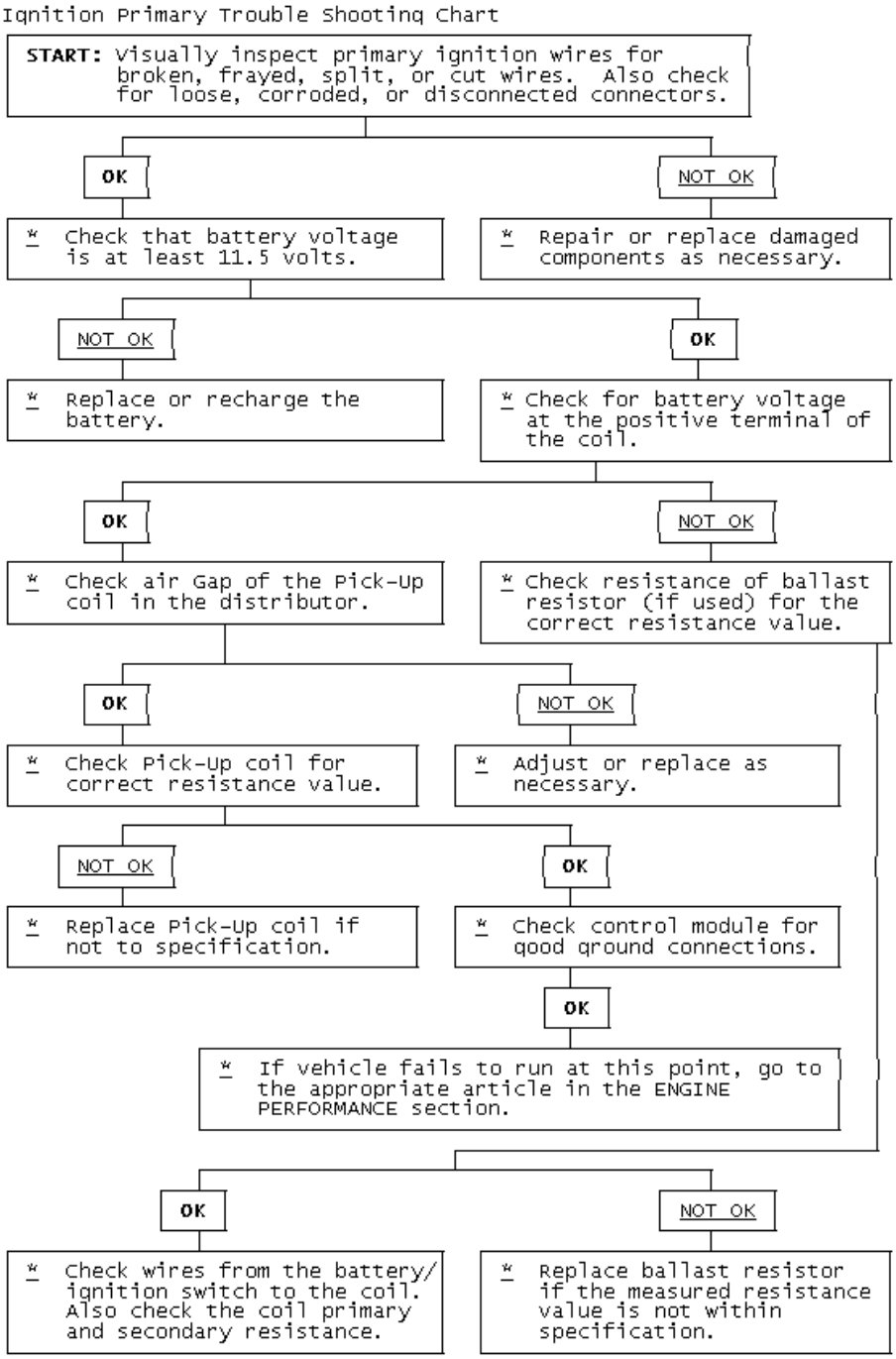

Fig. 2: Ignition Primary Trouble Shooting Chart

STARTER TROUBLE SHOOTING

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symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC STARTER TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	
Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
Ignition switch faulty or misadjusted	Adjust or replace ignition switch
Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
Starter relay or starter defective	See Testing in STARTER article
Open solenoid pull-in wire	Testing in STARTER article
Starter Does Not Operate and Headlights Dim	
Weak battery or dead cell	Charge or replace battery as necessary
Loose or corroded battery connections	Check that battery connections are clean and tight
Internal ground in starter windings	See Testing in STARTER article
Grounded starter fields	See Testing in STARTERS
Armature rubbing on pole	See STARTER article shoes
Starter Turns but Engine Does Not Rotate	
Starter clutch slipping	See STARTER article
Broken clutch housing	See STARTER article
Pinion shaft rusted or dry	See STARTER article
Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	
Faulty overrunning clutch	See STARTER article
Broken clutch housing	See STARTER article
Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
Armature shaft sheared or reduction gear teeth stripped	See STARTER article
Weak battery	Charge or replace battery as necessary
Faulty solenoid	See On-Vehicle Tests in STARTER article
Poor grounds	Check all ground connections for tight and clean connections
Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	
Battery weak or defective	Charge or replace battery as necessary
Engine overheated	See ENGINE COOLING SYSTEM article
Engine oil too heavy	Check that proper viscosity oil is used

CONDITION & POSSIBLE CAUSE	CORRECTION
Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
Current draw too low or too high	See Bench Tests in STARTER article
Bent armature, loose pole shoes screws or worn bearing	See STARTER article
Burned solenoid contacts	Replace solenoid
Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	
Engine timing too far advanced	See Ignition Timing in TUNE-UP article
Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
Broken starter clutch	See STARTER article
Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
Weak drive assembly thrust spring	See STARTER article
Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	
Defective point assembly	See Testing in STARTER article
Poor point assembly ground	See Testing in STARTER article
Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	
Dead battery	Charge or replace battery as necessary
Faulty wiring	Check all wiring and connections leading to relay
Neutral safety switch faulty	Replace neutral safety switch
Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	
Starter motor loose on mountings	Tighten starter attach bolts
Worn drive end bushing	See STARTER article
Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch	Replace ignition switch contacts sticking
Starter Relay Operates but Solenoid Does Not	
Faulty solenoid switch, switch connections or relay	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	
Weak battery	Charge or replace battery as necessary

CONDITION & POSSIBLE CAUSE	CORRECTION
Solenoid contacts corroded	Clean contacts or replace solenoid
Faulty wiring	Check all wiring leading to solenoid
Broken connections inside switch cover	Repair connections or replace solenoid
Open hold-in wire	solenoid
Low Current Draw	
Worn brushes or weak brush springs	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	
Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	
Distance too small between starter pinion and flywheel	Flywheel runout contributes to the intermittent nature

AIR CONDITIONING & HEAT

AIR CONDITIONING TROUBLE SHOOTING

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BASIC AIR CONDITIONING TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Compressor Not Working	Compressor clutch circuit open.
.....	Compressor clutch coil inoperative.
.....	Poor clutch ground connection.
.....	Fan belts loose.
.....	Thermostatic switch inoperative.
.....	Thermostatic switch not adjusted.
.....	Ambient temperature switch open.
.....	Superheat fuse blown.
Excessive Noise or Vibration	Missing or loose mounting bolts.
.....	Bad idler pulley bearings.
.....	Fan belts not tightened correctly.
.....	Compressor clutch contacting body.
.....	Excessive system pressure.
.....	Compressor oil level low.
.....	Damaged clutch bearings.
.....	Damaged reed valves.
.....	Damaged compressor.

CONDITION	POSSIBLE CAUSE
Insufficient or No Cooling; Compressor Working	Expansion valve inoperative.
.....	Heater control valve stuck open.
.....	Low system pressure.
.....	Blocked condenser fins.
.....	Blocked evaporator fins.
.....	Vacuum system leak.
.....	Vacuum motors inoperative.
.....	Control cables improperly adjusted.
.....	Restricted air inlet.
.....	Mode doors binding.
.....	Blower motor inoperative.
.....	Temperature above system capacity.

HEATER SYSTEM TROUBLE SHOOTING

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BASIC HEATER SYSTEM TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Insufficient, Erratic, or No Heat	Low Coolant Level
.....	Incorrect thermostat.
.....	Restricted coolant flow through core.
.....	Heater hoses plugged.
.....	Misadjusted control cable.
.....	Sticking heater control valve.
.....	Vacuum hose leaking.
.....	Vacuum hose blocked.
.....	Vacuum motors inoperative.
.....	Blocked air inlet.
.....	Inoperative heater blower motor.
.....	Oil residue on heater core fins.
.....	Dirt on heater core fins.
Too Much Heat	Improperly adjusted cables.
.....	Sticking heater control valve.
.....	No vacuum to heater control valve.
.....	Temperature door stuck open.

CONDITION	POSSIBLE CAUSE
Air Flow Changes During Acceleration	Vacuum system leak.
.....	Bad check valve or reservoir.
Air From Defroster At All Times	Vacuum system leak.
.....	Improperly adjusted control cables.
.....	Inoperative vacuum motor.
Blower Does Not Operate Correctly	Blown fuse.
.....	Blower motor windings open.
.....	Resistors burned out.
.....	Motor ground connection loose.
.....	Wiring harness connections loose.
.....	Blower motor switch inoperative.
.....	Blower relay inoperative.
.....	Fan binding or foreign object in housing.
.....	Fan blades broken or bent.

BRAKES

BRAKE SYSTEM TROUBLE SHOOTING

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BRAKE SYSTEM TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Brakes Pull Left or Right	
Incorrect tire pressure	Inflate tires to proper pressure
Front end out of alignment	See WHEEL ALIGNMENT
Mismatched tires	Check tires sizes
Restricted brake lines or hoses	Check hose routing
Loose or malfunctioning caliper	See DISC BRAKES or BRAKE SYSTEM
Bent shoe or oily linings	See DRUM BRAKES or BRAKE SYSTEM
Malfunctioning rear brakes	See DRUM, DISC BRAKES or BRAKE SYSTEM
Loose suspension parts	See SUSPENSION
Noises Without Brakes Applied	
Front linings worn out	Replace linings
Dust or oil on drums or rotors	See DRUM, DISC BRAKES or BRAKE SYSTEM
Noises With Brakes Applied	

CONDITION & POSSIBLE CAUSE	CORRECTION
Insulator on outboard shoe damaged	See DISC BRAKES or BRAKE SYSTEM
Incorrect pads or linings	Replace pads or linings
Brake Rough, Chatters or Pulsates	
Excessive lateral runout	Check rotor runout
Parallelism not to specifications	Reface or replace rotor
Wheel bearings not adjusted	See SUSPENSION
Rear drums out-of-round	Reface or replace drums
Disc pad reversed, steel against rotor	Remove and reinstall pad
Excessive Pedal Effort	
Malfunctioning power unit	See POWER BRAKES or BRAKE SYSTEM
Partial system failure	Check fluid and pipes
Worn disc pad or lining	Replace pad or lining
Caliper piston stuck or sluggish	See DISC BRAKES or BRAKE SYSTEM
Master cylinder piston stuck	See MASTER CYLINDERS or BRAKE SYSTEM
Brake fade due to incorrect pads for linings	Replace pads or linings
Linings or pads glazed	Replace pads or linings
Worn drums	Reface or replace drums
Excessive Pedal Travel	
Partial brake system failure	Check fluid and pipes
Insufficient fluid in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
Air trapped in system	See BRAKE BLEEDING or BRAKE SYSTEM
Rear brakes not adjusted	See Adjustments in DRUM BRAKES or BRAKE SYSTEM
Bent shoe or lining	See DRUM BRAKES or BRAKE SYSTEM
Plugged master cylinder cap	See MASTER CYLINDERS or BRAKE SYSTEM
Improper brake fluid	Replace brake fluid
Pedal Travel Decreasing	
Compensating port plugged	See MASTER CYLINDERS or BRAKE SYSTEM
Swollen cup in master cylinder	See MASTER CYLINDERS or BRAKE SYSTEM
Master cylinder piston not returning	See MASTER CYLINDERS or BRAKE SYSTEM
Weak shoe retracting springs	See DRUM BRAKES BRAKE SYSTEM
Wheel cylinder piston sticking	See DRUM BRAKES or BRAKE SYSTEM
Dragging Brakes	
Master cylinder pistons not returning	See MASTER CYLINDERS BRAKE SYSTEM
Restricted brake lines or hoses	Check line routing
Incorrect parking brake adjustment	See DRUM BRAKES BRAKE SYSTEM

CONDITION & POSSIBLE CAUSE	CORRECTION
Parking Brake cables frozen	See DRUM BRAKES BRAKE SYSTEM
Incorrect installation of inboard disc pad	Remove and replace correctly
Power booster output rod too long	See POWER BRAKE UNITS BRAKE SYSTEM
Brake pedal not returning freely	See DISC, DRUM BRAKES BRAKE SYSTEM
Brakes Grab or Uneven Braking Action	
Malfunction of combination valve	See CONTROL VALVE or BRAKE SYSTEM
Malfunction of power brake unit	See POWER BRAKE UNITS or BRAKE SYSTEM
Binding brake pedal	See DISC, DRUM BRAKES or BRAKE SYSTEM
Pulsation or Roughness	
Uneven pad wear caused by caliper	See DISC BRAKES or BRAKE SYSTEM
Uneven rotor wear	See DISC BRAKES or BRAKE SYSTEM
Drums out-of-round	Reface or replace drums

ENGINE MECHANICAL

COOLING SYSTEM TROUBLE SHOOTING

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COOLING SYSTEM TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Overheating	
Coolant Leak	Fill/Pressure Test System
A/C Condenser Fins Clogged	Remove/Clean Condenser
Radiator Fins Clogged	Remove/Clean Radiator
Thermostat Stuck Closed	Replace Thermostat
Clogged Cooling System Passages	Clean/Flush Cooling System
Water Pump Malfunction	Replace Water Pump
Fan Clutch Malfunction	Replace Fan Clutch
Retarded Ignition Timing	Reset Ignition Timing
Cooling Fan Malfunction	Test Cooling Fan/Circuit
Cooling Fan Motor Malfunction	Test Fan Motor
Cooling Fan Relay Malfunction	Test Fan Relay
Faulty Radiator Cap	Replace Radiator Cap
Broken/Slipping Fan Belt	Replace Fan Belt
Restricted Exhaust	Repair Exhaust System
Corrosion	

CONDITION & POSSIBLE CAUSE	CORRECTION
Impurities In Coolant	Clean/Flush System
Coolant Leakage	
Damaged hose	Replace Hose
Leaky Water Pump	Replace Water Pump
Damaged Radiator Seam	Replace/Repair Radiator
Leaky Thermostat Cover	Replace Thermostat Cover
Cylinder Head Problem	Check Head/Head Gasket
Leaky Freeze Plugs	Replace Freeze Plugs
Recovery System Inoperative	
Loose and/or Defective Radiator Cap	Replace Radiator Cap
Overflow Tube Clogged and/or Leaking	Repair Tube
Recovery Bottle Vent Restricted	Clean Vent
No Heater Core Flow	
Collapsed Heater Hose	Replace Heater Hose
Plugged Heater Core	Clean/Replace Heater Core
Faulty Heater Valve	Replace Heater Valve

GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING

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BASIC GASOLINE ENGINE - MECHANICAL TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Lopes At Idle	
Intake manifold-to-head leaks	Replace manifold gasket, See ENGINES
Blown head gasket	Replace head gasket, See ENGINES
Worn timing gears, chain or sprocket	Replace gears, chain or sprocket
Worn camshaft lobes	Replace camshaft, See ENGINES
Overheated engine	Check cooling system, See COOLING
Blocked crankcase vent valve	Remove restriction
Leaking EGR valve	Repair leak and/or replace valve
Faulty fuel pump	Replace fuel pump
Engine Has Low Power	
Leaking fuel pump	Repair leak and/or replace fuel pump
Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
Sticking valves or weak valve springs	Check valve train components, See ENGINES
Incorrect valve timing	Reset valve timing, See ENGINES
Worn camshaft lobes	Replace camshaft, See ENGINES

CONDITION & POSSIBLE CAUSE	CORRECTION
Blown head gasket	Replace head gasket. See ENGINES.
Clutch slipping	Adjust pedal and/or replace components, See ENGINES
Engine overheating	Check cooling system, See COOLING
Auto. Trans. pressure regulator valve faulty	Replace pressure regulator valve
Auto. Trans. fluid level too low	Add fluid as necessary
Improper vacuum diverter valve operation	Replace vacuum diverter valve
Vacuum leaks	Inspect vacuum system and repair as required
Leaking piston rings	Replace piston rings, See ENGINES
Faulty High Speed Operation	
Low fuel pump volume	Replace fuel pump
Leaking valves or worn	Replace valves and/or springs, See ENGINES
Incorrect valve timing	Reset valve timing,See ENGINES
Intake manifold restricted	Remove restriction
Worn distributor shaft	Replace distributor
Faulty Acceleration	
Improper fuel pump stroke	Remove pump and reset pump stroke
Incorrect ignition timing	Reset ignition timing, See TUNE-UP
Leaking valves	Replace valves, See ENGINES
Worn fuel pump diaphragm or piston	Replace diaphragm or piston
Intake Backfire	
Improper ignition timing	Reset ignition timing, See TUNE-UP
Faulty accelerator pump discharge	Replace accelerator pump
Improper choke operation	Check choke and adjust as required
Defective EGR valve	Replace EGR valve
Fuel mixture too lean	Reset air/fuel mixture, See TUNE-UP
Choke valve initial clearance too large	Reset choke valve initial clearance
Exhaust Backfire	
Vacuum leak	Inspect and repair vacuum system
Faulty vacuum diverter valve	Replace vacuum diverter valve
Faulty choke operation	Check choke and adjust as required
Exhaust system leak	repair exhaust system leak
Engine Detonation	
Ignition timing too far advanced	Reset ignition timing, See TUNE-UP
Faulty ignition system	Check ignition timing, See TUNE-UP
Spark plugs loose or faulty	Retighten or replace plugs
Fuel delivery system clogged	Inspect lines, pump and filter for clog
EGR valve inoperative	Replace EGR valve
PCV system inoperative	Inspect and/or replace hoses or valve
Vacuum leaks	Check vacuum system and repair leaks
Excessive combustion chamber deposits	Remove built-up deposits

CONDITION & POSSIBLE CAUSE	CORRECTION
Leaking, sticking or broken valves	Inspect and/or replace valves
External Oil Leakage	
Fuel pump improperly seated or worn gasket	Remove pump, replace gasket and seat properly
Oil pan gasket broken or pan bent	Straighten pan and replace gasket
Timing chain cover gasket broken	Replace timing chain cover gasket
Rear main oil seal worn	Replace rear main oil seal
Oil pan drain plug not seated properly	Remove and reinstall drain plug
Camshaft bearing drain hole blocked	Remove restriction
Oil pressure sending switch leaking	Remove and reinstall sending switch
Excessive Oil Consumption	
Worn valve stems or guides	Replace stems or guides, See ENGINES
Valve "O" ring seals damaged	Replace "O" ring seals, See ENGINES
Plugged oil drain back holes	Remove restrictions
Improper PCV valve operation	Replace PCV valve
Engine oil level too high	Remove excess oil
Engine oil too thin	Replace thicker oil
Valve stem oil deflectors damaged	Replace oil deflectors
Incorrect piston rings	Replace piston rings, See ENGINES
Piston ring gaps not staggered	Reinstall piston rings, See ENGINES
Insufficient piston ring tension	Replace rings, See ENGINES
Piston ring grooves or oil return	slots clogged Replace piston rings, See ENGINES
Piston rings sticking in grooves	Replace piston rings, See ENGINES
Piston ring grooves excessively worn	Replace piston and rings, See ENGINES
Compression rings installed upside down	Replace compression rings correctly, See ENGINES
Worn or scored cylinder walls	Rebore cylinders or replace block
Mismatched oil ring expander and rail	Replace oil ring expander and rail, See ENGINES
Intake gasket dowels too long	Replace intake gasket dowels
Excessive main or connecting rod bearing clearance	Replace main or connecting rod bearings, See ENGINES
No Oil Pressure	
Low oil level	Add oil to proper level
Oil pressure sender or gauge broken	Replace sender or gauge
Oil pump malfunction	Remove and overhaul oil pump, See ENGINES
Oil pressure relief valve sticking	Remove and reinstall valve
Oil pump passages blocked	Overhaul oil pump, See ENGINES
Oil pickup screen or tube blocked	Remove restriction
Loose oil inlet tube	Tighten oil inlet tube
Loose camshaft bearings	Replace camshaft bearings, See ENGINES

CONDITION & POSSIBLE CAUSE	CORRECTION
Internal leakage at oil passages	Replace block or cylinder head
Low Oil Pressure	
Low engine oil level	Add oil to proper level
Engine oil too thin	Remove and replace with thicker oil
Excessive oil pump clearance	Reduce oil pump clearance, See ENGINES
Oil pickup tube or screen blocked	Remove restrictions
Main, rod or cam bearing clearance excessive	Replace bearing to reduce clearance, See ENGINES
High Oil Pressure	
Improper grade of oil	Replace with proper oil
Oil pressure relief valve stuck closed	Eliminate binding
Oil pressure sender or gauge faulty	Replace sender or gauge
Noisy Main Bearings	
Inadequate oil supply	Check oil delivery to main bearings
Excessive main bearing clearance	Replace main bearings, See ENGINES
Excessive crankshaft end play	Replace crankshaft, See ENGINES
Loose flywheel or torque converter	Tighten attaching bolts
Loose or damaged vibration damper	Tighten or replace vibration damper
Crankshaft journals out-of-round	Re-grind crankshaft journals
Excessive belt tension	Loosen belt tension
Noisy Connecting Rods	
Excessive bearing clearance or missing bearing	Replace bearing, See ENGINES
Crankshaft rod journal out-of-round	Re-grind crankshaft journal
Misaligned connecting rod or cap	Remove rod or cap and realign
Incorrectly tightened rod bolts	Remove and re-tighten rod bolts
Noisy Pistons and Rings	
Excessive piston-to-bore clearance	Install larger pistons, See ENGINES
Bore tapered or out-of-round	Rebore block
Piston ring broken	Replace piston rings, See ENGINES
Piston pin loose or seized	Replace piston pin, See ENGINES
Connecting rods misaligned	Realign connecting rods
Ring side clearance too loose or tight	Replace with larger or smaller rings
Carbon build-up on piston	Remove carbon
Noisy Valve Train	
Worn or bent push rods	Replace push rods, See ENGINES
Worn rocker arms or bridged pivots	Replace push rods, See ENGINES
Dirt or chips in valve lifters	Remove lifters and remove dirt/chips
Excessive valve lifter leak-down	Replace valve lifters, See ENGINES
Valve lifter face worn	Replace valve lifters, See ENGINES
Broken or cocked valve springs	Replace or reposition springs
Too much valve stem-to-guide clearance	Replace valve guides, See ENGINES

CONDITION & POSSIBLE CAUSE	CORRECTION
Valve bent	Replace valve, See ENGINES
Loose rocker arms	Retighten rocker arms, See ENGINES
Excessive valve seat run-out	Reface valve seats, See ENGINES
Missing valve lock	Install new valve lock
Excessively worn camshaft lobes	Replace camshaft, See ENGINES
Plugged valve lifter oil holes	Eliminate restriction or replace lifter
Faulty valve lifter check ball	Replace lifter check ball, See ENGINES
Rocker arm nut installed upside down	Remove and reinstall correctly
Valve lifter incorrect for engine	Remove and replace valve lifters
Faulty push rod seat or lifter plunger	Replace plunger or push rod
Noisy Valves	
Improper valve lash	Re-adjust valve lash, See ENGINES
Worn or dirty valve lifters	Clean and/or replace lifters
Worn valve guides	Replace valve guides, See ENGINES
Excessive valve seat or face run-out	Reface seats or valve face
Worn camshaft lobes	Replace camshaft, See ENGINES
Loose rocker arm studs	Re-tighten rocker arm studs, See ENGINES
Bent push rods	Replace push rods, See ENGINES
Broken valve springs	Replace valve springs, See ENGINES
Burned,Sticking or Broken Valves	
Weak valve springs or warped valves	Replace valves and/or springs, See ENGINES
Improper lifter clearance	Re-adjust clearance or replace lifters
Worn guides or improper guide clearance	Replace valve guides, See ENGINES
Out-of-round valve seats or improper seat width	Re-grind valve seats
Gum deposits on valve stems, seats or guide	Remove deposits
Improper spark timing	Re-adjust spark timing
Broken Pistons/Rings	
Undersize pistons	Replace with larger pistons, See ENGINES
Wrong piston rings	Replace with correct rings, See ENGINES
Out-of-round cylinder bore	Re-bore cylinder bore
Improper connecting rod alignment	Remove and realign connecting rods
Excessively worn ring grooves	Replace pistons, See ENGINES
Improperly assembled piston pins	Re-assemble pin-to-piston, See ENGINES
Insufficient ring gap clearance	Install new rings, See ENGINES
Engine overheating	Check cooling system
Incorrect ignition timing	Re-adjust ignition timing, See TUNE-UP
Excessive Exhaust Noise	
Leaks at manifold to head, or to pipe	Replace manifold or pipe gasket
Exhaust manifold cracked or broken	Replace exhaust manifold, See ENGINES

ENGINE PERFORMANCE

CARBURETOR TROUBLE SHOOTING:

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BASIC COLD START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Choke not closing	Check choke operation, see FUEL SYSTEMS
Choke linkage bent	Check linkage, see FUEL SYSTEM
Engine Starts, Then Dies	
Choke vacuum kick setting too wide	Check setting and adjust see, FUEL SYSTEMS
Fast idle RPM too low	Reset RPM to specification, see TUNE-UP
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
Vacuum leak	Inspect vacuum system for leaks
Low fuel pump outlet	Repair or replace pump, see FUEL SYSTEMS
Low carburetor fuel level	Check float setting see FUEL SYSTEM
Engine Quits Under Load	
Choke vacuum kick setting incorrect	Reset vacuum kick setting,see FUEL SYSTEMS
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEM
Incorrect hot fast idle speed RPM	Reset fast idle RPM, see TUNE-UP
Engine Starts, Runs Up, Then Idles, Slowly With Black Smoke	
Choke vacuum kick set too narrow	Reset vacuum kick, see FUEL SYSTEMS
Fast idle cam index incorrect	Reset fast idle cam index, see FUEL SYSTEMS
Hot fast idle RPM too low	Reset fast idle RPM, see TUNE-UP

BASIC HOT START SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Engine flooded	Allow fuel to evaporate

BASIC COLD ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Stalls in Gear	
Choke vacuum kick setting incorrect	Reset choke vacuum kick, see FUEL SYSTEMS
Fast idle RPM incorrect	Reset fast idle RPM, see TUNE-UP
Fast idle cam index incorrect	Reset fast idle cam see FUEL SYSTEMS
Acceleration Sag or Stall	
Defective choke control switch	Replace choke control switch
Choke vacuum kick setting incorrect	Reset choke vacuum kick see, FUEL SYSTEMS
Float level incorrect (too low)	Adjust float level, FUEL SYSTEMS

CONDITION & POSSIBLE CAUSE	CORRECTION
Accelerator pump defective	Repair or replace pump see FUEL SYSTEMS
Secondary throttles not closed	Inspect lockout adjustment, see FUEL SYSTEMS
Sag or Stall After Warmup	
Defective choke control switch	Replace choke control switch, see FUEL SYSTEMS
Defective accelerator pump	Replace pump, see FUEL SYSTEMS
Float level incorrect (too low)	Adjust float level, see FUEL SYSTEMS
Backfiring & Black Smoke	
Plugged heat crossover system	Remove restriction

BASIC WARM ENGINE DRIVEABILITY SYMPTOMS TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Hesitation With Small Amount of Gas Pedal Movement	
Vacuum leak	Inspect vacuum lines
Accelerator pump weak or inoperable	Replace pump, see FUEL SYSTEMS
Float level setting too low	Reset float level, see,FUEL SYSTEMS
Metering rods sticking or binding	Inspect and/or replace rods, see FUEL SYSTEMS
Carburetor idle or transfer system plugged	Inspect system and remove restriction
Frozen or binding heated air inlet	Inspect heated air door for binding
Hesitation With Heavy Gas Pedal Movement	
Defective accelerator pump	Replace pump, see FUEL SYSTEMS
Metering rod carrier sticking or binding	Remove restriction
Large vacuum leak	Inspect vacuum system and repair leak
Float level setting too low	Reset float level, see FUEL SYSTEMS
Defective fuel pump, lines or filter	Inspect pump, lines and filter
Air door setting incorrect	Adjust air door setting, see FUEL

DIESEL ENGINE TROUBLE SHOOTING

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.**

NOTE: **Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.**

BASIC DIESEL ENGINE TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Crank	
Bad battery connections or dead batteries	Check connections and/or replace batteries

CONDITION & POSSIBLE CAUSE	CORRECTION
Bad starter connections or bad starter	Check connections and/or replace starter
Engine Cranks Slowly, Won't Start	
Bad battery connections or dead batteries	Check connections and/or replace batteries
Engine oil too heavy	Replace engine oil
Engine Cranks Normally, But Will Not Start	
Glow plugs not functioning	Check glow plug system, see FUEL SYSTEMS
Glow plug control not functioning	Check controller, see FUEL SYSTEMS
Fuel not injected into cylinders	Check fuel injectors, see FUEL SYSTEMS
No fuel to injection pump	Check fuel delivery system
Fuel filter blocked	Replace fuel filter
Fuel tank filter blocked	Replace fuel tank filter
Fuel pump not operating	Check pump operation and/or replace pump
Fuel return system blocked	Inspect system and remove restriction
No voltage to fuel solenoid	Check solenoid and connections
Incorrect or contaminated fuel	Replace fuel
Incorrect injection pump timing	Re-adjust pump timing, see FUEL SYSTEMS
Low compression	Check valves, pistons, rings, see ENGINES
Injection pump malfunction	Inspect and/or replace injection pump
Engine Starts, Won't Idle	
Incorrect slow idle adjustment	Reset idle adjustment, see TUNE-UP
Fast idle solenoid malfunctioning	Check solenoid and connections
Fuel return system blocked	Check system and remove restrictions
Glow plugs go off too soon	See glow plug diagnosis in FUEL SYSTEMS
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
No fuel to injection pump	Check fuel delivery system
Incorrect or contaminated fuel	Replace fuel
Low compression	Check valves, piston, rings, see ENGINES
Injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
Fuel solenoid closes in RUN position	Check solenoid and connections
Engines Starts/Idles Rough W/out Smoke or Noise	
Incorrect slow idle adjustment	Reset slow idle, see TUNE-UP
Injection line fuel leaks	Check lines and connections
Fuel return system blocked	Check lines and connections
Air in fuel system	Bleed air from system
Incorrect or contaminated fuel	Replace fuel
Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS
Engines Starts and Idles Rough W/out Smoke or Noise, But Clears After Warm-Up	
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
Engine not fully broken in	Put more miles on engine
Air in system	Bleed air from system
Injector nozzle malfunction	Check nozzles, see FUEL SYSTEMS

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Idles Correctly, Misfires Above Idle	
Blocked fuel filter	Replace fuel filter
Injection pump timing incorrect	Reset pump timing, see FUEL SYSTEMS
Incorrect or contaminated fuel	Replace fuel
Engine Won't Return To Idle	
Fast idle adjustment incorrect	Reset fast idle, see TUNE-UP
Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
External linkage binding	Check linkage and remove binding
Fuel Leaks On Ground	
Loose or broken fuel line	Check lines and connections
Internal injection pump seal leak	Replace injection pump, see FUEL SYSTEMS
Cylinder Knocking Noise	
Injector nozzles sticking open	Test injectors, see FUEL SYSTEMS
Very low nozzle opening pressure	Test injectors and/or replace
Loss of Engine Power	
Restricted air intake	Remove restriction
EGR valve malfunction	Replace EGR valve
Blocked or damaged exhaust system	Remove restriction and/or replace components
Blocked fuel tank filter	Replace filter
Restricted fuel filter	Remove restriction and/or replace filter
Block vent in gas cap	Remove restriction and/or replace cap
Tank-to-injection pump fuel supply blocked	Check fuel lines and connections
Blocked fuel return system	Remove restriction
Incorrect or contaminated fuel	Replace fuel
Blocked injector nozzles	Check nozzle for blockage, see FUEL SYSTEMS
Low compression	Check valves, rings, pistons, see ENGINES
Loud Engine Noise With Black Smoke	
Basic timing incorrect	Reset timing, see FUEL SYSTEMS
EGR valve malfunction	Replace EGR valve
Internal injection pump malfunction	Replace injection pump, see FUEL SYSTEMS
Incorrect injector pump housing pressure	Check pressure, see FUEL SYSTEMS
Engine Overheating	
Cooling system leaks	Check cooling system and repair leaks
Belt slipping or damaged	Check tension and/or replace belt
Thermostat stuck closed	Remove and replace thermostat, see ENGINE COOLING
Head gasket leaking	Replace head gasket
Oil Light on at Idle	
Low oil pump pressure	Check oil pump operation, see ENGINES
Oil cooler or line restricted	Remove restriction and/or replace cooler
Engine Won't Shut Off	

CONDITION & POSSIBLE CAUSE	CORRECTION
Injector pump fuel solenoid does not return fuel valve to OFF position	Remove and check solenoid and replace if needed

VACUUM PUMP DIAGNOSIS

CONDITION & POSSIBLE CAUSE	CORRECTION
Excessive Noise	
Loose pump-to-drive assembly screws	Tighten screws
Loose tube on pump assembly	Tighten tube
Valves not functioning properly	Replace valves
Oil Leakage	
Loose end plug	Tighten end plug
Bad seal crimp	Remove and re-crimp seal

FUEL INJECTION TROUBLE SHOOTING

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BASIC FUEL INJECTION TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start (Cranks Normally)	
Cold start valve inoperative	Test valve and circuit
Poor connection;vacuum or wiring	Check vacuum and electrical connections
Contaminated fuel	Test fuel for water or alcohol
Defective fuel pump relay or circuit	Test relay and wiring
Battery too low	Charge and test battery
Low fuel pressure	Test pressure regulator and fuel pump, check for restricted lines and filters
No distributor reference pulses	Repair ignition system as necessary
Open coolant temperature sensor circuit	Test sensor and wiring
Shorted W.O.T. switch in T.P.S.	Disconnect W.O.T. switch, engine should start
Defective ECM	Replace ECM
Fuel tank residual pressure valve leaks	Test for fuel pressure drop after shut down
Hard Starting	
Disconnected hot air tube to air cleaner	Reconnect tube and test control valve
Defective Idle Air Control (IAC) valve	Test valve operation and circuit
Shorted, open or misadjusted T.P.S.	Test and adjust or replace T.P.S.
EGR valve open	Test EGR valve and control circuit
Poor Oxygen sensor signal	Test for shorted or circuit
Incorrect mixture from PCV system	Test PCV for flow, check sealing of oil filter cap

CONDITION & POSSIBLE CAUSE	CORRECTION
Poor High Speed Operation	
Low fuel pump volume	Faulty pump or restricted fuel lines or filters
Poor MAP sensor signal	Test MAP sensor, vacuum hose and wiring
Poor Oxygen sensor signal	Test for shorted or open sensor or circuit
Open coolant temperature sensor circuit	Test sensor and wiring
Faulty ignition operation	Check wires for cracks or poor con- nections, test secondary voltage with oscilloscope
Contaminated fuel	Test fuel for water or alcohol
Intermittent ECM ground	Test ECM ground connection for resistance
Restricted air cleaner	Replace air cleaner
Restricted exhaust system	Test for exhaust manifold back pressure
Poor MAF sensor signal	Check leakage between sensor and manifold
Poor VSS signal	If tester for ALCL hook-up is available check that VSS reading matches speedometer
Ping or Knock on Acceleration	
Poor Knock sensor signal	Test for shorted or open sensor or circuit
Poor Baro sensor signal	Test for shorted or open sensor or circuit
Improper ignition timing	See VEHICLE EMISSION CONTROL LABEL (where applicable)
Check for engine overheating problems	Low coolant, loose belts or electric cooling fan inoperative

NOTE: **For additional electronic fuel injection trouble shooting information, see the appropriate article in the ENGINE PERFORMANCE section (not all vehicles have Computer Engine Control articles). Information is provided there for diagnosing fuel system problems on vehicles with electronic fuel injection.**

IGNITION SYSTEM TROUBLE SHOOTING

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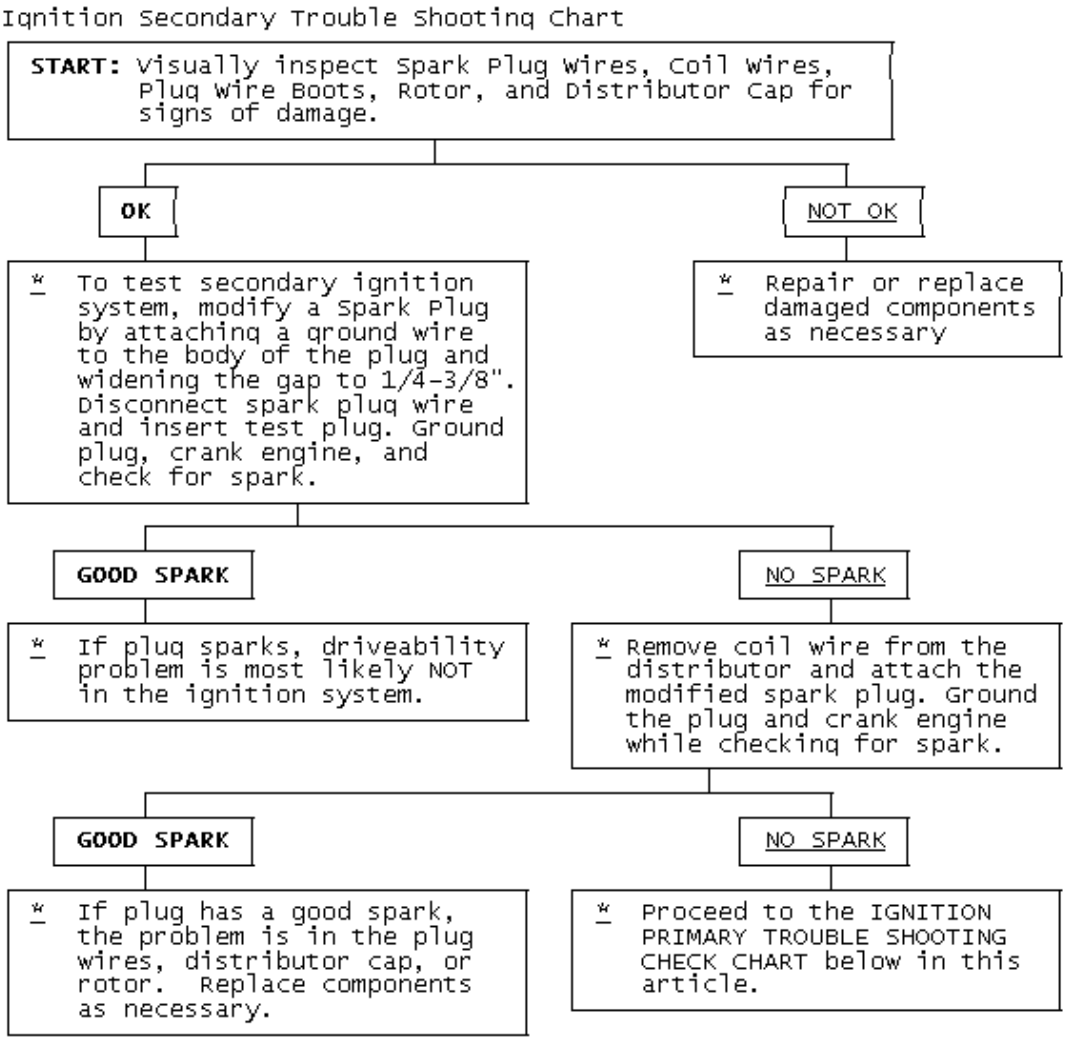

Fig. 3: Ignition Secondary Trouble Shooting Chart

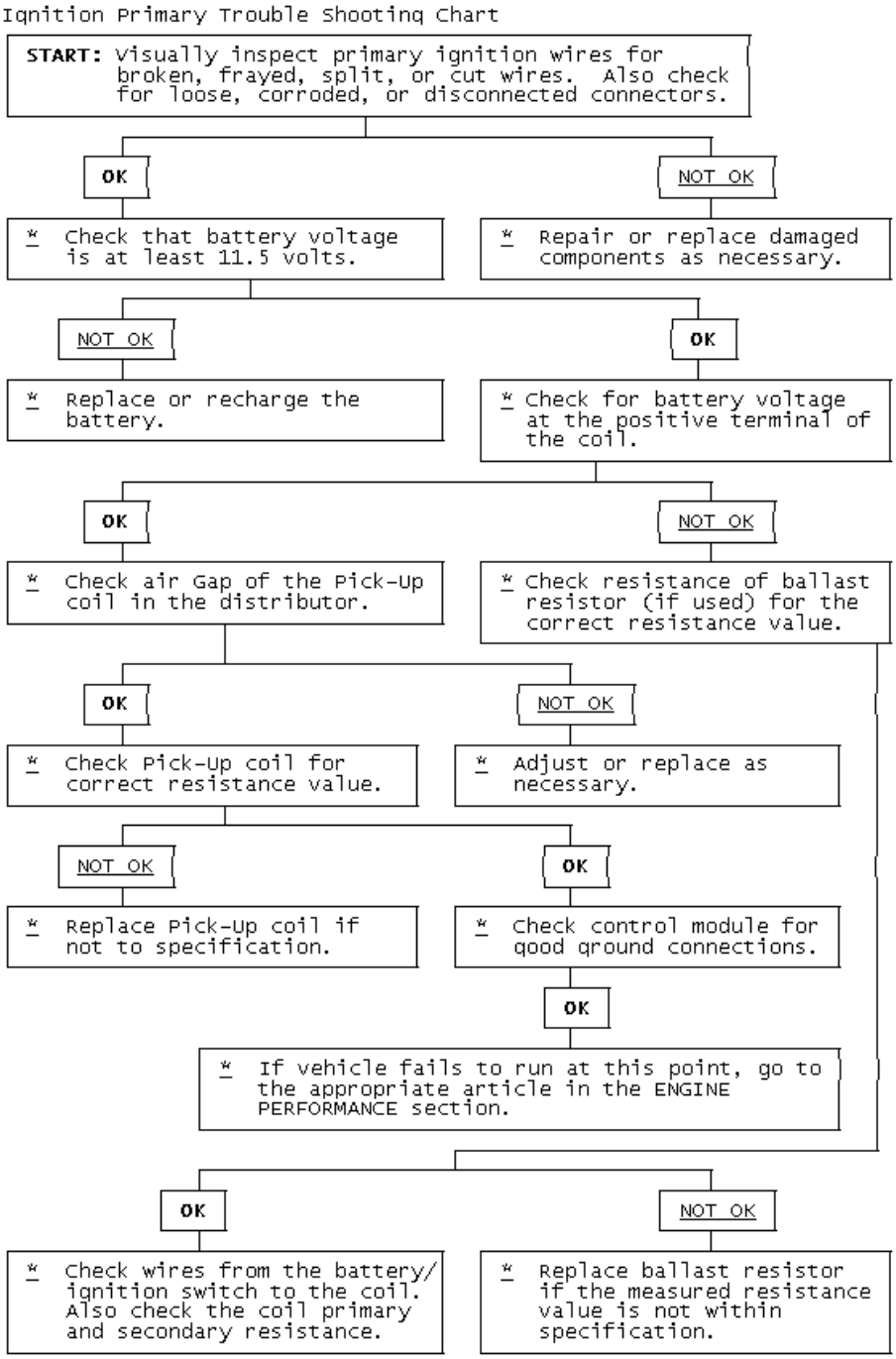

Fig. 4: Ignition Primary Trouble Shooting Chart

STARTER TROUBLE SHOOTING

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem**

symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC STARTER TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Starter Fails to Operate	
Dead battery or bad connections between starter and battery	Check battery charge and all wires and connections to starter
Ignition switch faulty or misadjusted	Adjust or replace ignition switch
Open circuit between starter switch ignition terminal on starter relay	Check and repair wires and connections as necessary
Starter relay or starter defective	See Testing in STARTER article
Open solenoid pull-in wire	See Testing in STARTER article
Starter Does Not Operate and Headlights Dim	
Weak battery or dead cell	Charge or replace battery as necessary
Loose or corroded battery connections	Check that battery connections are clean and tight
Internal ground in starter windings	See Testing in STARTER article
Grounded starter fields	See Testing in STARTERS
Armature rubbing on pole shoes	See STARTER article
Starter Turns but Engine Does Not Rotate	
Starter clutch slipping	See STARTER article
Broken clutch housing	See STARTER article
Pinion shaft rusted or dry	See STARTER article
Engine basic timing incorrect	See Ignition Timing in TUNE-UP article
Broken teeth on engine flywheel	Replace flywheel and check for starter pinion gear damage
Starter Will Not Crank Engine	
Faulty overrunning clutch	See STARTER article
Broken clutch housing	See STARTER article
Broken flywheel teeth	Replace flywheel and check for starter pinion gear damage
Armature shaft sheared or reduction gear teeth stripped	See STARTER article
Weak battery	Charge or replace battery as necessary
Faulty solenoid	See On-Vehicle Tests in STARTER article
Poor grounds	Check all ground connections for tight and clean connections
Ignition switch faulty or misadjusted	Adjust or replace ignition switch as necessary
Starter Cranks Engine Slowly	
Battery weak or defective	Charge or replace battery as necessary
Engine overheated	See ENGINE COOLING SYSTEM article
Engine oil too heavy	Check that proper viscosity oil is used

CONDITION & POSSIBLE CAUSE	CORRECTION
Poor battery-to-starter connections	Check that all between battery and starter are clean and tight
Current draw too low or too high	See Bench Tests in STARTER article
Bent armature, loose pole shoes screws or worn bearings	See STARTER article
Burned solenoid contacts	Replace solenoid
Faulty starter	Replace starter
Starter Engages Engine Only Momentarily	
Engine timing too far advanced	See Ignition Timing in TUNE-UP article
Overrunning clutch not engaging properly	Replace overrunning clutch. See STARTER article
Broken starter clutch	See STARTER article
Broken teeth on engine flywheel	Replace flywheel and check starter pinion gear for damage
Weak drive assembly thrust spring	See STARTER article
Weak hold-in coil	See Bench Tests in STARTER article
Starter Drive Will Not Engage	
Defective point assembly	See Testing in STARTER article
Poor point assembly ground	See Testing in STARTER article
Defective pull-in coil	Replace starter solenoid
Starter Relay Does Not Close	
Dead battery	Charge or replace battery as necessary
Faulty wiring	Check all wiring and connections leading to relay
Neutral safety switch faulty	Replace neutral safety switch
Starter relay faulty	Replace starter relay
Starter Drive Will Not Disengage	
Starter motor loose on mountings	Tighten starter attach bolts
Worn drive end bushing	See STARTER article
Damaged engine flywheel teeth	Replace flywheel and starter pinion gear for damage
Drive yolk return spring broken or missing	Replace return spring
Faulty ignition switch	Replace ignition switch
Insufficient clearance between winding leads to solenoid terminal and main contact in solenoid	Replace starter solenoid
Starter clutch not disengaging	Replace starter clutch
Ignition starter switch contacts sticking	Replace ignition switch
Starter Relay Operates but Solenoid Does Not	
Faulty solenoid switch, switch connections or relay	Check all wiring between relay and solenoid or replace relay or solenoid as necessary
Broken lead or loose soldered connections	Repair wire or wire connections as necessary
Solenoid Plunger Vibrates When Switch is Engaged	

CONDITION & POSSIBLE CAUSE	CORRECTION
Weak battery	Charge or replace battery as necessary
Solenoid contacts corroded	Clean contacts or replace solenoid
Faulty wiring	Check all wiring leading to solenoid
Broken connections inside switch cover	Repair connections or replace solenoid
Open hold-in wire	Replace solenoid
Low Current Draw	
Worn brushes or weak	Replace brushes or brush springs as necessary
High Pitched Whine During Cranking Before Engine Fires but Engine Fires and Cranks Normally	
Distance too great between starter pinion and flywheel	Align starter or check that correct starter and flywheel are being used
High Pitched Whine After Engine Fires With Key released. Engine Fires and Cranks Normally	
Distance too small between starter pinion and flywheel	Flywheel runout contributes to the intermittent nature

TUNE-UP TROUBLE SHOOTING - GAS ENGINE VEHICLES

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. The purpose of this Trouble Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.**

BASIC SPARK PLUG TROUBLE SHOOTING CHARTS

CONDITION & POSSIBLE CAUSE	CORRECTION
Normal Spark Plug Condition	
Light Tan or Gray deposits	No Action
Electrode not burned or fouled	No Action
Gap tolerance not changed	No Action
Cold Fouling or Carbon Deposits	
Overrich air/fuel mixture	Adjust air/fuel mixture, see ENGINE PERFORMANCE section
Faulty choke	Replace choke assembly, see ENGINE PERFORMANCE section
Clogged air filter	Clean and/or replace air filter
Incorrect idle speed or dirty carburetor	Reset idle speed and/ or clean carburetor
Faulty ignition wires	Replace ignition wiring
Prolonged operation at idle	Shut engine off during long idle
Sticking valves or worn valve guide seals	Check valve train
Wet Fouling or Oil Deposits	
Worn rings and pistons	Install new rings and pistons
Excessive cylinder wear	Rebore or replace block
Excessive valve guide clearance	Worn or loose bearing
Gap Bridged	

CONDITION & POSSIBLE CAUSE	CORRECTION
Deposits in combustion chamber becoming fused to electrode	Clean combustion chamber of deposits
Blistered Electrode	
Engine overheating	Check cooling system
Wrong type of fuel	Replace with correct fuel
Loose spark plugs	Retighten spark plugs
Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Pre-Ignition or Melted Electrodes	
Incorrect type of fuel	Replace with correct fuel
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Burned valves	Replace valves
Engine Overheating	Check cooling system
Wrong type of spark plug, too hot	Replace with correct spark plug, see ENGINE PERFORMANCE
Chipped Insulators	
Severe detonation	Check for over-advanced timing or combustion
Improper gapping procedure	Re-gap spark plugs
Rust Colored Deposits	
Additives in unleaded fuel	Try different fuel brand
Water In Combustion Chamber	
Blown head gasket or cracked head	Repair or replace head or head gasket

NOTE: **Before diagnosing an electronic ignition system, ensure that all wiring is connected properly between distributor, wiring connector and spark plugs. Ignition problem will show up either as: Engine Will Not Start or Engine Runs Rough.**

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS

CONDITION & POSSIBLE CAUSE	CORRECTION
Engine Won't Start	
Open circuit between distributor and bulkhead connector	Repair circuit
Open circuit between bulkhead connector and ignition switch	Repair circuit
Open circuit between ignition switch and starter solenoid	Repair circuit
Engine Runs Rough	
Fuel lines leaking or clogged	Tighten fitting, remove restriction
Initial timing incorrect	Reset ignition timing see ENGINE PERFORMANCE
Centrifugal advance malfunction	Repair distributor advance

CONDITION & POSSIBLE CAUSE	CORRECTION
Defective spark plugs or wiring	Replace plugs or plug wiring
Component Failure	
Spark arc-over on cap, rotor or coil	Replace cap, rotor or or coil
Defective pick-up coil	Replace pick-up coil
Defective ignition coil	Replace ignition coil
Defective vacuum unit	Replace vacuum unit
Defective control module	Replace control module

BASIC ELECTRONIC IGNITION TROUBLE SHOOTING CHARTS - USING OSCILLOSCOPE PATTERNS

CONDITION & POSSIBLE CAUSE	CORRECTION
Firing Voltage Lines are the Same, but Abnormally High	
Retarded ignition timing	Reset ignition timing, see ENGINE PERFORMANCE section
Fuel mixture too lean	Readjust carburetor, see ENGINE PERFORMANCE
High resistance in coil wire	Replace coil wire
Corrosion in coil tower terminal	Clean and/or replace coil
Corrosion in distributor coil terminal	Clean and/or replace distributor cap
Firing Voltage Lines are the Same but Abnormally Low	
Fuel mixture too rich	Readjust carburetor, see ENGINE PERFORMANCE
Breaks in coil wire causing arcing	Replace coil wire
Cracked coil tower causing arcing	Replace coil
Low coil output	Replace coil
Low engine compression	Determine cause and repair
One or More, But Not All Firing Voltage Lines are Higher Than Others	
Carburetor idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
EGR valve stuck open	Clean and/or replace valve
High resistance in spark plug wires	Replace spark plug wires
Cracked or broken spark plug insulator	Replace spark plugs
Intake vacuum leak	Repair leak
Defective spark plugs	Replace spark plugs
Corroded spark plug terminals	Replace spark plugs
One or More, But Not All Firing Voltage Lines Are Lower Than Others	
Curb idle mixture not balanced	Readjust carburetor, see ENGINE PERFORMANCE
Breaks in plug wires	Replace plug wires causing arcing
Cracked coil tower causing arcing	Replace coil
Low compression	Determine cause and repair
Defective spark plugs	Replace spark plugs

CONDITION & POSSIBLE CAUSE	CORRECTION
Corroded spark plugs	Replace spark plugs
Cylinders Not Firing	
Cracked distributor cap terminals	Replace distributor cap
Shorted spark plug wire	Determine cause and repair
Mechanical problem in engine	Determine cause and repair
Defective spark plugs	Replace spark plugs
Spark plugs fouled	Replace spark plugs

BASIC DRIVEABILITY PROBLEMS TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Hard Starting	
Binding carburetor linkage	Eliminate binding
Binding choke linkage	Eliminate binding
Binding choke piston	Eliminate binding
Restricted choke vacuum	Check vacuum lines for blockage
Worn or dirty needle valve and seat	Clean carburetor, see ENGINE PERFORMANCE
Float sticking	Readjust or replace float see the ENGINE PERFORMANCE section
Incorrect choke adjustment	Reset choke adjustment see ENGINE PERFORMANCE
Defective coil	Replace coil
Improper spark plug gap	Regap spark plugs
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Detonation	
Over-advanced ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Defective spark plugs	Replace spark plugs
Fuel lines clogged	Clean fuel lines
EGR system malfunction	Check and repair EGR system
PCV system malfunction	Repair PCV system
Vacuum leaks	Check and repair vacuum system
Loose fan belts	Tighten or replace fan belts, see ENGINE PERFORMANCE
Restricted airflow	Remove restriction
Vacuum advance malfunction	Check distributor operation
Dieseling	
Binding carburetor linkage	Eliminate binding
Binding throttle linkage	Eliminate blinding
Binding choke linkage or fast idle cam	Eliminate binding

CONDITION & POSSIBLE CAUSE	CORRECTION
Defective idle solenoid	Replace idle solenoid see ENGINE PERFORMANCE
Improper base idle speed	Reset idle speed, see see ENGINE PERFORMANCE
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Incorrect idle mixture setting	Reset idle mixture, see ENGINE PERFORMANCE
Faulty Acceleration	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Engine cold and choke too lean	Adjust choke and allow engine to warm-up
Defective spark plugs	Replace spark plugs
Defective coil	Replace coil
Faulty Low Speed Operation	
Clogged idle transfer slots	Clean idle transfer slots, see FUEL
Restricted idle air bleeds and passages	Disassemble and clean carburetor, see FUEL
Clogged air cleaner	Replace air filter
Defective spark plugs	Replace spark plugs
Defective ignition wires	Replace ignition wire see ENGINE PERFORMANCE
Defective distributor cap	Replace distributor cap
Faulty High Speed Operation	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Defective distributor centrifugal advance	Replace advance mechanism
Defective distributor vacuum advance	Replace advance unit
Incorrect spark plugs or plug gap	Check gap and/or replace spark plugs
Faulty choke operation	Check choke and repair as required
Clogged vacuum passages	Remove restrictions
Improper size or clogged main jet	Check jet size and clean, see FUEL
Restricted air cleaner	Check filter and replace as necessary
Defective distributor cap, rotor or coil	Replace cap, rotor or coil
Misfire at All Speeds	
Defective spark plugs	Replace spark plugs
Defective spark plug wires	Replace spark plug wires
Defective distributor cap, rotor, or coil	Replace cap, rotor, or coil
Cracked or broken vacuum hoses	Replace vacuum hoses
Vacuum leaks	Repair vacuum leaks
Fuel lines clogged	Remove restriction
Hesitation	
Cracked or broken vacuum	Replace vacuum hoses hoses

CONDITION & POSSIBLE CAUSE	CORRECTION
Vacuum leaks	Repair Vacuum leaks
Binding carburetor linkage	Eliminate binding
Binding throttle linkage	Eliminate binding
Binding choke linkage or fast idle cam	Eliminate binding
Improper float setting	Readjust float setting, see FUEL
Cracked or broken ignition wires	Replace ignition wires
Rough Idle, Missing or Stalling	
Incorrect curb idle or fast idle speed	Reset idle speed, see see ENGINE PERFORMANCE
Incorrect basic timing	Reset ignition timing see ENGINE PERFORMANCE
Improper idle mixture adjustment	Reset idle mixture, see ENGINE PERFORMANCE
Improper feedback system operation	Check feedback system see ENGINE PERFORMANCE
Incorrect spark plug gap	Reset spark plug gap, see ENGINE PERFORMANCE
Moisture in ignition components	Dry components
Loose or broken ignition wires	Replace ignition wires
Damaged distributor cap or or rotor	Replace distributor cap or rotor
Faulty ignition coil	Replace ignition coil
Fuel filter clogged or worn	Replace fuel filter
Damaged idle mixture screw	Replace idle mixture screw, see FUEL
Improper fast idle cam adjustment	Reset fast idle cam adjustment, see TUNE- see ENGINE PERFORMANCE
Improper EGR valve operation	Replace EGR valve
Faulty PCV valve air flow	Replace PCV valve
Choke binding or improper choke setting	Reset choke or eliminate binding
Vacuum leak	Repair vacuum leak
Improper float bowl fuel level	Reset float adjustment, see FUEL
Clogged air bleed or idle passages	Clean carburetor passages, see FUEL
Clogged or worn air cleaner filter	Replace air filter
Faulty choke vacuum diaphragm	Replace diaphragm, see ENGINE PERFORMANCE
Exhaust manifold heat valve inoperative	Replace heat valve
Improper distributor spark advance	Check distributor operation
Leaking valves or valve components	Check and repair valvetrain
Improper carburetor mounting	Remove and remount carburetor
Excessive play in distributor shaft	Replace distributor
Loose or corroded wiring connections	Repair or replace as required
Engine Surges	
Improper PCV valve airflow	Replace PCV valve

CONDITION & POSSIBLE CAUSE	CORRECTION
Vacuum leaks	Repair vacuum leaks
Clogged air bleeds	Remove restriction
EGR valve malfunction	Replace EGR valve
Restricted air cleaner filter	Replace air filter
Cracked or broken vacuum hoses	Replace vacuum hoses
Cracked or broken ignition wires	Replace ignition wires
Vacuum advance malfunction	Check unit and replace as necessary
Defective or fouled spark plugs	Replace spark plugs
Ping or Spark Knock	
Incorrect ignition timing	Reset ignition timing see ENGINE PERFORMANCE
Distributor centrifugal or vacuum advance malfunction	Check operation and replace as necessary
Carburetor setting too lean	Readjust mixture setting, see ENGINE PERFORMANCE
Vacuum leak	Eliminate vacuum leak
EGR valve malfunction	Replace EGR valve
Poor Gasoline Mileage	
Cracked or broken vacuum	Replace vacuum hoses hoses
Vacuum leaks	Repair vacuum leaks
Defective ignition wires	Replace wires
Incorrect choke setting	Readjust setting, see ENGINE PERFORMANCE
Defective vacuum advance	Replace vacuum advance
Defective spark plugs	Replace spark plugs
Binding carburetor power piston	Eliminate binding
Dirt in carburetor jets	Clean and/or replace jets
Incorrect float adjustment	Readjust float setting, see FUEL
Defective power valve	Replace power valve, see ENGINE PERFORMANCE
Incorrect idle speed	Readjust idle speed
Engine Stalls	
Improper float level	Readjust float level
Leaking needle valve and seat	Replace needle valve and seat
Vacuum leaks	Eliminate vacuum leaks

VACUUM PUMP - DIESEL TROUBLE SHOOTING

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NOTE: **Diesel engines mechanical diagnosis is the same as gasoline engines for items such as noisy valves, bearings, pistons, etc. The following trouble shooting covers only items pertaining to diesel engines.**

VACUUM PUMP (DIESEL) TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Excessive Noise	
Loose pump-to-drive assembly screws	Tighten screws
Loose tube on pump assembly	Tighten tube
Valves not functioning properly	Replace valves
Oil Leakage	
Loose end plug	Tighten end plug
Bad seal crimp	Remove and re-crimp seal

MANUAL TRANSMISSION

MANUAL TRANSMISSION TROUBLE SHOOTING

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MANUAL TRANSMISSION/TRANSAXLE TROUBLE SHOOTING

Condition	Possible Cause
Noisy In Forward Gears	Low gear oil level, Loose bell housing bolts, Worn bearings or gears
Clunk On Deceleration (FWD Only)	Loose engine mounts, Worn inboard CV joints, Worn differential pinion shaft, Side gear hub counterbore in case worn oversize
Gear Clash When Shifting Forward Gears	Clutch Out Of Adjustment, Shift linkage damaged or out of adjustment, Gears or synchronizers damaged, Low gear oil level
Transmission Noisy When Moving (RWD Only) Quiet In Neutral With Clutch Engaged	Worn rear outputshaft bearing
Gear Rattle	Worn bearings, Wrong gear oil, Low gear oil, Worn gears
Steady Ticking At Idle (Increases With RPM)	Broken tooth on gear
Gear Clash When Shifting Forward Gears	Worn or broken synchronizers
Loud Whine In Reverse	Normal condition (1)
Noise When Stepping On Clutch	Bad release bearing, Worn pilot bearing
Ticking Or Screeching As Clutch Is Engaged	Faulty release bearing, Uneven pressure plate fingers

Condition	Possible Cause
Click Or Snap When Clutch Is Engaged	Worn clutch fork, Worn or broken front bearing retainer
Transmission Shifts Hard	Clutch not releasing, Shift mechanism binding, Clutch installed backwards
Will Not Shift Into One Gear, Shifts Into All Others	Bent shift fork, Worn detent balls
Locked Into Gear, Cannot Shift	Clutch adjustment, Worn detent balls
Transmission Jumps Out Of Gear	Pilot bearing worn, Bent shift fork, Worn gear teeth or face, Excessive gear train end play, Worn synchronizers, Missing detent ball spring, Shift mechanism worn or out of adjustment, Engine or transmission mount bolts loose or out of adjustment, Transmission not aligned
Shift Lever Rattle	Worn shift lever or detents, Worn shift forks, Worn synchronizers sleeve
Shift Lever Hops Under Acceleration	Worn engine or transmission mounts
(1) Most units use spur cut gears in reverse and are noisy	

POWERTRAIN

CLUTCH TROUBLE SHOOTING

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BASIC CLUTCH TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Chattering or Grabbing	
Incorrect clutch adjustment	Adjust clutch
Oil, grease or glaze on facings	Disassemble and clean or replace
Loose "U" joint flange	See DRIVE AXLES article
Worn input shaft spline	Replace input shaft
Binding pressure plate	Replace pressure plate
Binding release lever	See CLUTCH article
Binding clutch disc hub	Replace clutch disc
Unequal pressure plate contact	Replace worn/misaligned components
Loose/bent clutch disc	Replace clutch disc
Incorrect transmission alignment	Realign transmission
Worn pressure plate, disc or flywheel	Replace damaged components
Broken or weak pressure springs	Replace pressure plate
Sticking clutch pedal	Lubricate clutch pedal & linkage

CONDITION & POSSIBLE CAUSE	CORRECTION
Incorrect clutch disc facing	Replace clutch disc
Engine loose in chassis	Tighten all mounting bolts
Failure to Release	
Oil or grease on clutch facings	Clean or replace clutch clutch disc
Incorrect release lever or pedal adjustment	See CLUTCH article
Worn or broken clutch facings	Replace clutch disc
Bent clutch disc or pressure plate	Replace damaged components
Clutch disc hub binding on input shaft	Clean or replace clutch disc and/or input shaft
Binding pilot bearing	Replace pilot bearing
Sticking release bearing sleeve	Replace release bearing and/or sleeve
Binding clutch cable	See CLUTCH article
Defective clutch master	Replace master cylinder
Defective clutch slave	Replace slave cylinder
Air in hydraulic system	Bleed hydraulic system
Rattling	
Weak or broken release lever spring	Replace spring and check alignment
Damaged pressure plate	Replace pressure plate
Broken clutch return spring	Replace return spring
Worn splines on clutch disc or input shaft	Replace clutch disc and/or input shaft
Worn clutch release bearing	Replace release bearing
Dry or worn pilot bearing	Lubricate or replace pilot bearing
Unequal release lever contact	Align or replace release lever
Incorrect pedal free play	Adjust free play
Warped or damaged clutch disc	Replace damaged components
Slipping	
Pressure springs worn or	Release pressure plate
Oily, greasy or worn facings	Clean or replace clutch disc
Incorrect clutch alignment	Realign clutch assembly
Warped clutch disc or pressure plate	Replace damaged components
Binding release levers or clutch pedal	Lubricate and/or replace release components
Squeaking	
Worn or damaged release	Replace release bearing
Dry or worn pilot or release bearing	Lubricate or replace assembly
Pilot bearing turning in crankshaft	Replace pilot bearing and/or crankshaft
Worn input shaft bearing	Replace bearing and seal
Incorrect transmission alignment	Realign transmission
Dry release fork between pivot	Lubricate release fork and pivot
Heavy and/or Stiff Pedal	
Sticking release bearing sleeve	Replace release bearing and/or sleeve
Dry or binding clutch pedal hub	Lubricate and align components
Floor mat interference with pedal	Lay mat flat in proper area

CONDITION & POSSIBLE CAUSE	CORRECTION
Dry or binding ball/fork pivots	Lubricate and align components
Faulty clutch cable	Replace clutch cable
Noisy Clutch Pedal	
Faulty interlock switch	Replace interlock switch
Self-adjuster ratchet noise	Lubricate or replace self-adjuster
Speed control interlock switch	Lubricate or replace interlock switch
Clutch Pedal Sticks Down	
Binding clutch cable	See CLUTCH article
Springs weak in pressure plate	Replace pressure plate
Binding in clutch linkage	Lubricate and free linkage
Noisy	
Dry release bearing	Lubricate or replace release bearing
Dry or worn pilot bearing	Lubricate or replace bearing
Worn input shaft bearing	Replace bearing
Transmission Click	
Weak springs in pressure	Replace pressure plate plate
Release fork loose on ball stud	Replace release fork and/or ball stud
Oil on clutch disc damper	Replace clutch disc
Broken spring in slave cylinder	Replace slave cylinder

DRIVE AXLE - NOISE DIAGNOSIS

Unrelated Noises

Some driveline trouble symptoms are also common to the engine, transmission, wheel bearings, tires, and other parts of the vehicle. Ensure cause of trouble actually is in the drive axle before adjusting, repairing, or replacing any of its parts.

Non-Drive Axle Noises

A few conditions can sound just like drive axle noise and have to be considered in pre-diagnosis. The 4 most common noises are exhaust, tires, CV/universal joints and wheel trim rings.

In certain conditions, the pitch of the exhaust gases may e gear whine. At other times, it may be mistaken for a wheel bearing rumble.

Tires, especially radial and snow, can have a high-pitched tread whine or roar, similar to gear noise. Also, some non-standard tires with an unusual tread construction may emit a roar or whine.

Defective CV/universal joints may cause clicking noises or excessive driveline play that can be improperly diagnosed as drive axle problems.

Trim and moldings also can cause a whistling or whining noise. Ensure none of these components are causing the noise before disassembling the drive axle.

Gear Noise

A "howling" or "whining" noise from the ring and pinion gear can be caused by an improper gear pattern, gear damage, or improper bearing preload. It can occur at various speeds and driving conditions, or it can be continuous.

Before disassembling axle to diagnose and correct gear ke sure that tires, exhaust, and vehicle trim have been checked as possible causes.

Chuckle

This is a particular rattling noise that sounds like a stick against the spokes of a spinning bicycle wheel. It occurs while decelerating from 40 MPH and usually can be heard until vehicle comes to a complete stop. The frequency varies with the speed of the vehicle.

A chuckle that occurs on the driving phase is usually caused ive clearance due to differential gear wear, or by a damaged tooth on the coast side of the pinion or ring gear. Even a very small tooth nick or a ridge on the edge of a gear tooth is enough the cause the noise.

This condition can be corrected simply by cleaning the gear tooth nick or ridge with a small grinding wheel. If either gear is damaged or scored badly, the gear set must be replaced. If metal has broken loose, the carrier and housing must be cleaned to remove particles that could cause damage.

Knock

This is very similar to a chuckle, though it may be louder, and occur on acceleration or deceleration. Knock can be caused by a gear tooth that is damaged on the drive side of the ring and pinion gears. Ring gear bolts that are hitting the carrier casting can cause knock. Knock can also be due to excessive end play in the axle shafts.

Clunk

Clunk is a metallic noise heard when an automatic transmission is engaged in Reverse or Drive, or when throttle is applied or released. It is caused by backlash somewhere in the driveline, but not necessarily in the axle. To determine whether driveline clunk is caused by the axle, check the total axle backlash as follows:

1. Raise vehicle on a frame or twinpost hoist so that drive wheels are free. Clamp a bar between axle companion flange and a part of the frame or body so that flange cannot move.
2. On conventional drive axles, lock the left wheel to keep it from turning. On all models, turn the right wheel slowly until it is felt to be in Drive condition. Hold a chalk marker on side of tire about 12" from center of wheel. Turn wheel in the opposite direction until it is again felt to be in Drive condition.
3. Measure the length of the chalk mark, which is the total axle backlash. If backlash is one inch or less, drive axle is not the source of clunk noise.

Bearing Whine

Bearing whine is a high-pitched sound similar to a whistle. It is usually caused by malfunctioning pinion bearings. Pinion bearings operate at drive shaft speed. Roller wheel bearings may whine in a similar manner if they run completely dry of lubricant. Bearing noise will occur at all driving speeds. This distinguishes it from gear whine, which usually comes and goes as speed changes.

Bearing Rumble

Bearing rumble sounds like marbles being tumbled. It is usually caused by a malfunctioning wheel bearing. The

lower pitch is because the wheel bearing turns at only about 1/3 of drive shaft speed.

Chatter On Turns

This is a condition where the entire front or rear of vehicle vibrates when vehicle is moving. The vibration is plainly felt as well as heard. Extra differential thrust washers installed during axle repair can cause a condition of partial lock-up that creates this chatter.

Axle Shaft Noise

Axle shaft noise is similar to gear noise and pinion bearing whine. Axle shaft bearing noise will normally distinguish itself from gear noise by occurring in all driving modes (Drive, cruise, coast and float), and will persist with transmission in Neutral while vehicle is moving at problem speed.

If vehicle displays this noise condition, remove suspect parts, replace wheel seals and install a new set of bearings. Re-evaluate vehicle for noise before removing any internal components.

Vibration

Vibration is a high-frequency trembling, shaking or grinding condition (felt or heard) that may be constant or variable in level and can occur during the total operating speed range of the vehicle.

The types of vibrations that can be felt in the vehicle can d into 3 main groups:

- Vibrations of various unbalanced rotating parts of the vehicle.
- Resonance vibrations of the body and frame structures caused by rotating of unbalanced parts.
- Tip-in moans of resonance vibrations from stressed engine or exhaust system mounts or driveline flexing modes.

DRIVE AXLE - RWD TROUBLE SHOOTING

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DRIVE AXLE (RWD) TROUBLE SHOOTING

CONDITION & POSSIBLE CAUSE	CORRECTION
Knocking or Clunking	
Differential Side Gear Clearance	Check Clearance
Worn Pinion Shaft	Replace Pinion Shaft
Axle Shaft End Play	Check End Play
Missing Gear Teeth	Check Differential/Replace Gear
Wrong Axle Backlash	Check Backlash
Misaligned Driveline	Realign Driveline
Clinking During Engagement	

CONDITION & POSSIBLE CAUSE	CORRECTION
Side Gear Clearance	Check Clearance
Ring and Pinion Backlash	Check Backlash
Worn/Loose Pinion Shaft	Replace Shaft/Bearing
Bad "U" Joint	Replace "U" Joint
Sticking Slip Yoke	Lube Slip Yoke
Broken Rear Axle Mount	Replace Mount
Loose Drive Shaft Flange	Check Flange
Click/Chatter On Turns	
Differential Side Gear Clearance	Check Clearance
Wrong Turn On Plates (1)	Replace Clutch Plates
Wrong Differential Lubricant (1)	Change Lubricant
Knock Or Click	
Flat Spot on Rear Wheel Bearing	Replace Wheel Bearing
Low Vibration At All Speeds	
Faulty Wheel Bearing	Replace Wheel Bearing
Faulty "U" Joint	Replace "U" Joint
Faulty Drive Shaft	Balance Drive Shaft
Faulty Companion Flange	Replace Flange
Faulty Slip Yoke Flange	Replace Flange
(1) Limited slip differential only.	

FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING

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BASIC FWD AXLE SHAFTS & CV JOINTS TROUBLE SHOOTING CHART

CONDITION	POSSIBLE CAUSE
Grease Leaks	CV boot torn or cracked
Clicking Noise on Cornering	Damaged outer CV
Clunk Noise on Acceleration	Damaged inner CV
Vibration or Shudder on Acceleration	Sticking, damaged or worn CV Misalignment or spring height

STEERING & SUSPENSION

MANUAL STEERING GEAR TROUBLE SHOOTING

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Shooting information is to provide a list of common causes to problem symptoms. For model-specific Trouble Shooting, refer to SUBJECT, DIAGNOSTIC, or TESTING articles available in the section(s) you are accessing.

BASIC MANUAL STEERING GEAR TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise in Rack and Pinion	
Rack and pinion mounting bracket loose	Tighten all mounting bolts
Lack of/or incorrect lubricant	Correct as necessary
Steering gear mounting bolts loose	Tighten all mounting bolts
Excessive Play	
Front wheel bearing improperly adjusted	See FRONT SUSPENSION article
Loose or worn steering linkage	See STEERING LINKAGE article
Loose or worn steering gear shift	See MANUAL STEERING GEAR article
Steering arm loose on gear shaft	See MANUAL STEERING GEAR article
Steering gear housing bolts loose	Tighten all mounting bolts
Steering gear adjustment too loose	See MANUAL STEERING GEAR article
Steering arms loose on knuckles	Tighten and check steering linkage
Rack and pinion mounting loose	Tighten all mounting bolts
Rack and pinion out of adjustment	See adjustment in STEERING article
Tie rod end loose	Tighten and check steering linkage
Excessive Pitman shaft-to-ball nut lash	Repair as necessary
Poor Returnability	
Lack of lubricant in ball joint or linkage	Lubricate and service systems
Binding in linkage or ball joints	See STEERING LINKAGE and SUSPENSION article
Improper front end alignment	See WHEEL ALIGNMENT article
Improper tire pressure	Inflate to proper pressure
Tie rod binding	Inflate to proper pressure
Shaft seal rubbing shaft	See STEERING COLUMN article
Excessive Vertical Motion	
Improper tire pressure	Inflate to proper pressure
Tires, wheels or rotors out of balance	Balance tires then check wheels and rotors
Worn or faulty shock absorbers	Check and replace if necessary
Loose tie rod ends or steering	Tighten or replace if necessary
Loose or worn wheel bearings	See SUSPENSION article
Steering Pulls to One Side	
Improper tire pressure	Inflate to proper pressure
Front tires are different sizes	Rotate or replace if necessary
Wheel bearings not adjusted properly	See FRONT SUSPENSION article
Bent or broken suspension components	See FRONT SUSPENSION article
Improper wheel alignment	See WHEEL ALIGNMENT article

CONDITION & POSSIBLE CAUSE	CORRECTION
Brakes dragging	See BRAKES article
Instability	
Low or uneven tire pressure	Inflate to proper pressure
Loose or worn wheel bearings	See FRONT SUSPENSION article
Loose or worn idler arm bushing	See FRONT SUSPENSION article
Loose or worn strut bushings	See FRONT SUSPENSION article
Incorrect front wheel alignment	See WHEEL ALIGNMENT article
Steering gear not centered	See MANUAL STEERING GEARS article
Springs or shock	Check and replace if necessary
Improper cross shaft	See MANUAL STEERING GEARS article

POWER STEERING TROUBLE SHOOTING

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BASIC POWER STEERING TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Rattle or Chucking Noise	
Pressure hoses touching engine parts	Adjust to proper clearance
Loose Pitman shaft	Adjust or replace if necessary
Tie rods ends or Pitman arm loose	Tighten and check system
Rack and pinion mounts loose	Tighten all mounting bolts
Free play in worm gear	See POWER STEERING GEAR article
Loose sector shaft or thrust bearing adjustment	See POWER STEERING GEAR
Free play in pot coupling	See STEERING COLUMN article
Worn shaft serrations	See STEERING COLUMN article
Growl in Steering Pump	
Excessive pressure in hoses	Restricted hoses, see POWER STEERING GEAR article
Scored pressure plates	See POWER STEERING GEAR article
Scored thrust plates or rotor	See POWER STEERING GEAR article
Extreme wear of cam ring	See POWER STEERING GEAR article
Rattle in Steering Pump	
Vanes not installed	See POWER STEERING PUMP article
Vanes sticking in rotor	See POWER STEERING PUMP article
Swish noise in Pump	
Defective flow control valve	See POWER STEERING PUMP article
Groan in Steering Pump	

CONDITION & POSSIBLE CAUSE	CORRECTION
Air in fluid	See POWER STEERING PUMP article
Poor pressure hose connection	Tighten and check, replace if necessary
Squawk When Turning	
Damper "O" ring on valve spool cut	See POWER STEERING PUMP article
Moan or Whine in Pump	
Pump shaft bearing scored	Replace bearing and fluid
Air in fluid or fluid level low	See POWER STEERING PUMP article
Hose or column grounded	Check and replace if necessary
Cover "O" ring missing or damaged	See POWER STEERING PUMP article
Valve cover baffle missing or damaged	See POWER STEERING PUMP article
Interference of components in pump	See POWER STEERING PUMP article
Loose or poor bracket alignment	Correct or replace if necessary
Hissing When Parking	
Internal leakage in steering gear	Check valved assembly first
Chirp in Steering Pump	
Loose or worn power steering belt	Adjust or replace if necessary
Buzzing When Not Steering	
Noisy pump	See POWER STEERING PUMP article
Free play in steering shaft bearing	See STEERING COLUMN article
Bearing loose on shaft serrations	See STEERING COLUMN article
Clicking Noise in Pump	
Pump slippers too long	See POWER STEERING PUMP article
Broken slipper springs	See POWER STEERING PUMP article
Excessive wear or nicked rotors	See POWER STEERING PUMP article
Damaged cam contour	See POWER STEERING PUMP article
Poor Return of Wheel	
Wheel rubbing against turn signal	See STEERING COLUMN SWITCHES article
Flange rubbing steering gear adjuster	See STEERING COLUMN article
Tight or frozen steering shaft bearing	See STEERING COLUMN article
Steering gear out of adjustment	See POWER STEERING GEAR article
Sticking or plugged spool valve	See POWER STEERING PUMP article
Improper front end alignment	See WHEEL ALIGNMENT article
Wheel bearings worn or loose	See FRONT SUSPENSION article
Ties rods or ball joints binding	Check and replace if necessary
Intermediate shaft joints binding	See STEERING COLUMN article
Kinked pressure hoses	Correct or replace if necessary
Loose housing head spanner nut	See POWER STEERING GEAR article
Damaged valve lever	See POWER STEERING GEAR article
Sector shaft adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article

CONDITION & POSSIBLE CAUSE	CORRECTION
Worm thrust bearing adjusted too tight	See ADJUSTMENTS in POWER STEERING GEAR article
Reaction ring sticking in cylinder	See POWER STEERING GEAR article
Reaction ring sticking in housing head	See POWER STEERING GEAR article
Steering pump internal leakage	See POWER STEERING PUMP article
Steering gear-to-column misalignment	See STEERING COLUMN article
Lack of lubrication in linkage	Service front suspension
Lack of lubrication in ball joints	Service front suspension
Increased Effort When Turning Wheel Fast Foaming, Milky Power Steering Fluid, Low Fluid Level or Low Pressure	
High internal pump leakage	See POWER STEERING PUMP article
Power steering pump belt slipping	Adjust or replace if necessary
Low fluid level	Check and fill to proper level
Engine idle speed to low	Adjust to correct setting
Air in pump fluid system	See POWER STEERING PUMP article
Pump output low	See POWER STEERING PUMP article
Steering gear malfunctioning	See POWER STEERING GEAR article
Wheel Surges or Jerks	
Low fluid level	Check and fill to proper level
Loose fan belt	Adjust or replace if necessary
Insufficient pump pressure	See POWER STEERING PUMP article
Sticky flow control valve	See POWER STEERING PUMP article
Linkage hitting oil pan at full turn	Replace bent components
Kick Back or Free Play	
Air in pump fluid system	See POWER STEERING PUMP article
Worn poppet valve in steering gear	See POWER STEERING PUMP article
Excessive over center lash	See POWER STEERING GEAR article
Thrust bearing out of adjustment	See POWER STEERING GEAR article
Free play in pot coupling	See POWER STEERING PUMP article
Steering gear coupling loose on shaft	See POWER STEERING PUMP article
Steering disc mounting bolts loose	Tighten or replace if necessary
Coupling loose on worm shaft	Tighten or replace if necessary
Improper sector shaft adjustment	See POWER STEERING GEAR article
Excessive worm piston side play	See POWER STEERING GEAR article
Damaged valve lever	See POWER STEERING GEAR article
Universal joint loose	Tighten or replace if necessary
Defective rotary valve	See POWER STEERING GEAR article
No Power When Parking	
Sticking flow control valve	See POWER STEERING PUMP article
Insufficient pump pressure output	See POWER STEERING PUMP article
Excessive internal pump leakage	See POWER STEERING PUMP article

CONDITION & POSSIBLE CAUSE	CORRECTION
Excessive internal gear leakage	See POWER STEERING PUMP article
Flange rubs against gear adjust plug	See STEERING COLUMN article
Loose pump belt	Adjust or replace if necessary
Low fluid level	Check and add proper amount of fluid
Engine idle too low	Adjust to correct setting
Steering gear-to-column misaligned	See STEERING COLUMN article
No Power, Left Turn	
Left turn reaction seal "O" ring worn	See POWER STEERING GEAR article
Left turn reaction seal damaged/missing	See POWER STEERING GEAR article
Cylinder head "O" ring damaged	See POWER STEERING PUMP article
No Power, Right Turns	
Column pot coupling bottomed	See STEERING COLUMN article
Right turn reaction seal "O" ring worn	See POWER STEERING GEAR article
Right turn reaction seal damaged	See POWER STEERING GEAR article
Internal leakage through piston end plug	See POWER STEERING GEAR article
Internal leakage through side plugs	See POWER STEERING GEAR article
Lack of Effort in Turning	
Left and/or right reaction seal sticking in cylinder head	Replace, see POWER STEERING GEAR article
Wanders to One Side	
Front end alignment incorrect	See WHEEL ALIGNMENT article
Unbalanced steering gear valve	See POWER STEERING GEAR article
Low Pressure Due to Steering Pump	
Flow control valve stuck or inoperative	See POWER STEERING PUMP article
Pressure plate not flat against cam ring	See POWER STEERING PUMP article
Extreme wear of cam ring	Replace and check adjustments
Scored plate, thrust plate or rotor	See POWER STEERING PUMP article
Vanes not installed properly	See POWER STEERING PUMP article
Vanes sticking in rotor slots	See POWER STEERING PUMP article
Cracked/broken thrust or pressure plate	See POWER STEERING PUMP article

STEERING COLUMN TROUBLE SHOOTING

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BASIC STEERING COLUMN TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Noise in Steering	

CONDITION & POSSIBLE CAUSE	CORRECTION
Coupling pulled apart	See STEERING COLUMNS article
Column not correctly aligned	See STEERING COLUMNS article
Broken lower joint	Replace joint
Horn contact ring not	See STEERING COLUMN article
Bearing not lubricated	See STEERING COLUMN article
Shaft snap ring not properly seated	Reseat or replace snap ring
Plastic spherical joint not lubricated	See STEERING COLUMN article
Shroud or housing loose	Tighten holding screws
Lock plate retaining ring not seated	See STEERING COLUMN article
Loose sight shield	Tighten holding screws
High Steering Shaft Effort	
Column assembly misaligned	See STEERING COLUMN article
Improperly installed dust shield	Adjust or replace
Tight steering universal joint	See STEERING COLUMN article
High Shift Effort	
Column is out of alignment	See STEERING COLUMN article
Improperly installed dust shield	Adjust or replace
Seals or bearings not lubricated	See STEERING COLUMNS article
Mounting bracket screws too long	Replace with new shorter screws
Burrs on shift tube	Remove burrs or replace tube
Lower bowl bearing assembled wrong	See STEERING COLUMN article
Shift tube bent or broken	Replace as necessary
Improper adjustment of shift levers	See STEERING COLUMN article
Improper Trans. Shifting	
Sheared shift tube joint	Replace as necessary
Sheared lower shaft lever	Replace as necessary
Improper shift lever adjustment	See STEERING COLUMN article
Improper gate plate adjustment	See STEERING COLUMN article
Excess Play in Column	
Instrument panel bracket bolts loose	Tighten bolts and check bracket
Broken weld nut on jacket	See STEERING COLUMN article
Instrument bracket capsule sheared	See STEERING COLUMN article
Column bracket/jacket bolts loose	Tighten bolts and check bracket
Steering Locks in Gear	
Release lever mechanism	See STEERING COLUMN article

SUSPENSION TROUBLE SHOOTING

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BASIC SUSPENSION TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Front End Noise	
Loose or worn wheel	See Wheel Bearing Adjustment in SUSPENSION
Worn shocks or shock mountings	Replace struts or strut mountings
Worn struts or strut mountings	Replace struts or strut mountings
Loose or worn lower control arm	See SUSPENSION
Loose steering gear-to-frame bolts	See STEERING
Worn control arm bushings	See SUSPENSION
Ball joints not lubricated	Lubricate ball joints & see Ball Joint Checking in SUSPENSION
Front Wheel Shake, Shimmy, or Vibration	
Tires or wheels out of balance	Check tire balance
Incorrect wheel alignment	See WHEEL ALIGNMENT
Drive shaft unbalanced	Check drive shaft balance
Loose or worn wheel bearings	See WHEEL ALIGNMENT
Loose or worn tie rod ends	See SUSPENSION
Worn upper ball joints	See Ball Joint Checking in SUSPENSION
Worn shock absorbers	Replace shock absorbers
Worn strut bushings	Replace strut bushings
Car Pulls to One Side	
Mismatched or uneven tires	Check tire condition
Broken or sagging springs	See SUSPENSION
Loose or worn strut bushings	See SUSPENSION
Improper wheel alignment	See WHEEL ALIGNMENT
Improper rear axle alignment	Check rear axle alignment
Power steering gear unbalanced	See STEERING
Front brakes dragging	See BRAKES
Abnormal Tire Wear	
Unbalanced tires	Check tire balance & rotation
Sagging or broken springs	See SUSPENSION
Incorrect front end alignment	See WHEEL ALIGNMENT
Faulty shock absorbers	Replace chock absorbers
Scuffed Tires	
Toe-In incorrect	See WHEEL ALIGNMENT
Suspension arm bent or twisted	See appropriate SUSPENSION article
Springs Bottom or Sag	
Bent or broken springs	See SUSPENSION
Leaking or worn shock absorbers	Replace shock absorbers

CONDITION & POSSIBLE CAUSE	CORRECTION
Frame misalignment	Check frame for damage
Spring Noises	
Loose "U" Bolts	See SUSPENSION
Loose or worn bushings	See SUSPENSION
Worn or missing interliners	See SUSPENSION
Shock Absorber Noise	
Loose shock mountings	Check & tighten mountings
Worn bushings	Replace bushings
Air in system	Bleed air from system
Undercoating on shocks	Remove undercoating
Car Leans or Sways on Corners	
Loose stabilizer bar	See SUSPENSION
Faulty shocks or mountings	Replace shocks or mountings
Broken or sagging springs	See SUSPENSION
Shock Absorbers Leaking	
Worn seals or reservoir tube crimped	See SUSPENSION
Broken Springs	
Loose "U" bolts	See SUSPENSION
Inoperative shock absorbers	Replace shock absorbers

WHEEL ALIGNMENT TROUBLE SHOOTING

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BASIC WHEEL ALIGNMENT TROUBLE SHOOTING CHART

CONDITION & POSSIBLE CAUSE	CORRECTION
Premature Tire Wear	
Improper tire inflation	Check tire pressure
Front alignment out of tolerance	See ALIGNMENT SPECS in WHEEL ALIGNMENT section
Suspension components worn	See SUSPENSION section
Steering system components worn	See STEERING section
Improper standing height	See WHEEL ALIGNMENT
Uneven or sagging springs	See SUSPENSION section
Bent wheel	See WHEEL ALIGNMENT
Improper torsion bar adjustment	See SUSPENSION section
Loose or worn wheel bearings	See WHEEL BEARING ADJ. in SUSPENSION section

CONDITION & POSSIBLE CAUSE	CORRECTION
Worn or defective shock	Replace shock absorbers
Tires out of balance	Check tire balance
Pulls to One Side	
Improper tire inflation	Check tire pressure
Brake dragging	See BRAKE section
Mismatched tires	See WHEEL ALIGNMENT
Broken or sagging spring	See SUSPENSION section
Broken torsion bar	See SUSPENSION section
Power steering valve not centered	See STEERING section
Front alignment out of tolerance	See WHEEL ALIGNMENT section
Defective wheel bearing	See WHEEL BEARINGS in SUSPENSION section
Uneven sway bar links	See SUSPENSION section
Frame bent	Check for frame damage
Steering system bushing worn	See STEERING section
Hard Steering	
Idler arm bushing too tight	See STEERING LINKAGE in STEERING section
Ball joint tight or seized	See SUSPENSION section
Steering linkage too tight	See STEERING LINKAGE in STEERING section
Power steering fluid low	Add proper amount of fluid
Power steering drive belt loose	See STEERING section
Power steering pump defective	See STEERING section
Steering gear out of adjustment	See STEERING section
Incorrect wheel alignment	See WHEEL ALIGNMENT
Damaged steering gear	See STEERING section
Damaged suspension	See SUSPENSION section
Bent steering knuckle or supports	See SUSPENSION section
Vehicle "Wanders"	
Strut rod or control arm bushing worn	See SUSPENSION section
Loose or worn wheel bearings	See WHEEL BEARINGS in SUSPENSION section
Improper tire inflation	Check tire pressure
Stabilizer bar missing or defective	See SUSPENSION section
Wheel alignment out of tolerance	See Adjustment in WHEEL ALIGNMENT section
Broken spring	See SUSPENSION section
Defective shock absorber	Replace shock absorbers
Worn steering & suspension components	See SUSPENSION section
Front End Shimmy	

CONDITION & POSSIBLE CAUSE	CORRECTION
Tire out of balance/round	Check tire balance
Excessive wheel runout	See WHEEL ALIGNMENT
Insufficient or improper caster	See WHEEL ALIGNMENT section
Worn suspension or steering components	See SUSPENSION section
Defective shock absorbers	Replace shock absorber
Wheel bearings worn or loose	See WHEEL BEARING ADJ. in SUSPENSION section
Power steering reaction Bracket loose	See STEERING section
Steering gear box (rack) mounting loose	See STEERING section
Steering gear adjustment loose	See STEERING section
Worn spherical joints	See SUSPENSION section
Toe-In Not Adjustable	
Lower control arm bent	See SUSPENSION section
Frame bent	Check frame for damage
Camber Not Adjustable	
Control arm bent	See SUSPENSION section
Frame bent	Check frame for damage
Hub & bearing not seated properly	See SUSPENSION section

Article GUID: A00027342

GENERAL INFORMATION

TROUBLE SHOOTING

* PLEASE READ THIS FIRST *

NOTE: **This article is generic in nature and all information does not apply to all vehicles. For vehicle specific information, see the appropriate articles in the ENGINE PERFORMANCE category.**

ENGINE PERFORMANCE

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TUNE-UP TROUBLE SHOOTING

Problem & Possible Cause	Action
Carbon Fouled Plugs	
Clogged Air Filter	Replace Air Filter
Incorrect Idle Speed	Reset Idle Speed
Faulty Ignition Wiring	Replace Ignition Wiring
Sticky Valves/Worn Valve Seal	Check Valve Train
Fuel Injection Operation	Check Fuel Injection
Wet/Oil Fouled Plugs	
Worn Rings/Pistons	Overhaul/Replace Engine
Excessive Cylinder Wear	Overhaul/Replace Engine
Plug Gap Bridged	
Combustion Chamber Carbon Deposits	Clean Combustion Chamber
Blistered Electrode	
Engine Overheating	Check Cooling System
Loose Spark Plugs	Clean/Torque Plugs
Over-Advanced Timing	Reset Timing
Wrong Plug Heat Range	Install Correct Plug
Melted Electrodes	
Incorrect Timing	Reset Timing
Burned Valves	Replace Valves
Engine Overheating	Check Cooling System
Wrong Plug Heat Range	Install Correct Plug
Engine Won't Start	
Loose Connections	Check Connections
No Power	Check Fuses/Battery
Loose/Worn Timing Belt/Chain/Gears	Check Belt/Chain/Gears

Problem & Possible Cause	Action
Engine Runs Rough	
Leaky/Clogged Fuel Injectors	Repair Fuel Injectors
Leaky/Clogged Fuel Lines	Repair Fuel Lines
Clogged Fuel Filter	Replace Fuel Filter
Incorrect Timing	Reset Timing/Check Advance
Faulty Plugs/Wires	Replace Plugs/Wires
Uneven Compression	Overhaul/Replace Engine
Poor Acceleration	
Incorrect Ignition Timing	Reset Timing
Leaky Valves	Check Compression
Component Failure	
Spark Arcing	Replace Faulty Part
Defective Pick-Up Coil	Replace Pick-Up Coil
Defective Ignition Coil	Replace Ignition Coil
Defective Control Unit	Replace Control Unit
Ignition Diagnosis By Scope Pattern	
All Firing Lines Abnormally High	
Retarded Ignition Timing	Reset Ignition Timing
Lean Air/Fuel Mixture	Adjust Fuel Mixture
High Secondary Resistance	Repair Secondary Ignition
All Firing Lines Abnormally Low	
Rich Air/Fuel Mixture	Adjust Air/Fuel Mixture
Arcing Coil Wire	Replace Coil Wire
Cracked Coil	Replace Coil
Low Coil Output	Replace Coil
Low Compression	Check/Repair Engine
Several High Firing Lines	
Fuel Mixture Unbalanced	Check Fuel System
EGR Valve Stuck Open	Clean/Replace EGR Valve
High Plug Wire Resistance	Replace Plug Wire
Cracked/Broken Plugs	Replace Plugs
Intake Vacuum Leak	Repair Leak
Several Low Firing Lines	
Fuel Mixture Unbalanced	Adjust Fuel Mixture
Plug Wires Arcing	Replace Plug Wires
Cracked Coil Arcing	Replace Coil
Uneven Compression	Check/Repair Engine
Faulty Spark Plugs	Replace Plugs
Cylinders Not Firing	
Cracked Distributor Cap	Replace Cap
Shorted Plug Wires	Replace Plug Wires

Problem & Possible Cause	Action
Mechanical Engine Fault	Check/Repair Engine
Spark Plugs Fouled	Replace Plugs
Carbon Track in Distributor Cap	Replace Cap
Hard Starting	
Defective Ignition Coil(s)	Replace Coil(s)
Fouled Spark Plugs	Replace Plugs
Incorrect Timing	Reset Ignition Timing

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FUEL INJECTION TROUBLE SHOOTING

Problem & Possible Cause	Action
Cold Start Valve Inoperative	Test Cold Start Valve
Poor Vacuum/Electrical Connection	Repair Connections
Contaminated Fuel	Test Fuel for Water/Alcohol
Bad Fuel Pump Relay/Circuit	Test Relay/Wiring
Battery Voltage Low	Charge/Test Battery
Low Fuel Pressure	Test Press. Regulator/Pump
No Distributor Reference Pulse	Repair Ignition System
Coolant Temp. Sensor Defective	Test Temp. Sensor/Circuit
No Power To Injectors	Check Injector Fuse/Relay
Hard Starting	
Defective Idle Air Control (IAC)	Test IAC and Circuit
EGR Valve Open	Test EGR Valve/Control Circuit
Restricted Fuel Lines	Inspect/Replace Fuel Lines
Poor MAP Sensor Signal	Test MAP Sensor/Circuit
Engine Stalls During Parking Maneuver	Check P.S. Press. Switch
Rough Idle	
Dirty Fuel Injectors	Clean/Replace Injectors
Poor MAP Sensor Signal	Test MAP Sensor/Circuit
Intermittent Fuel Injector Operation	Check Harness Connectors
Erratic Vehicle Speed Sensor Inputs	Harness Too Close to Plug Wires
Poor O_2 Sensor Signal	Test O_2 Sensor/Circuit
Faulty PCV System	Check PCV Valve and Hoses
Poor Acceleration	
Weak Fuel Pump	Replace Fuel Pump
Dirty Fuel Injectors	Clean/Replace Injectors
Excessive Intake Valve Deposits	Clean Intake System
Poor High Speed Operation	

Problem & Possible Cause	Action
Low Fuel Pump Volume	Faulty Fuel Pump/Filter
Poor MAP Sensor Signal	Test Speed Sensor/Circuit
Acceleration Ping/Knock	
Faulty EGR System	Check EGR Valve and Hoses
Poor Knock Sensor Signal	Test Knock Sensor/Circuit
Poor Baro Sensor Signal	Test Baro Sensor/Circuit
Improper Ignition Timing	Adjust Timing
Engine Overheating	Check Cooling System
Poor Quality Fuel	Use Different Fuel
Carbon Build-Up	Decarbon Engine

Article GUID: A00002343

SPECIFICATIONS

BODY CONTROL MODULE SCAN TOOL INFORMATION

Body Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Definition
Operating Conditions: Engine ON			
Accy/RAP Relay Command	-	On	The scan tool displays On or Off. This is the commanded state of the RAP relay. The scan tool displays ON when the BCM provides voltage to the RAP relay control circuit.
All Door Lock Cmd.	-	Off	The scan tool displays On or Off. This is the Lock output from the body control module (BCM) to all door lock actuators. When either door lock switch is operated to the Lock position the parameter is displayed as ON.
Ambient Light Sensor	-	Varies	This displays Volts. This is the current voltage at the ambient light sensor.
Ambient Light Status	-	Varies	The scan tool displays Night, Day, Unknown or Invalid. This is the state of the ambient light sensor.
Auto Hdlp. Disable Sw.	-	Inactive	The scan tool displays Active or Inactive. This is the state of the auto headlamp disable switch.
Backup Lamps	-	Off	The scan tool displays On or Off. This output of the BCM is displayed as ON when the backup lamps are turned ON.
Batt. Low at Start	-	No	The scan tool displays Yes or No. Yes is displayed if the state of the battery charge is low during cranking.
Batt. Open Ckt. Tested	-	No	The scan tool displays Yes or No.
Batt. Open Ckt. Voltage	-	Varies	This displays Volts. This is the voltage input to the BCM and is compared to the battery high resolution voltage for determining

Parameter	System State	Expected Value	Definition
			RVC charging voltage.
Batt. Voltage High Res.	-	Varies	This displays Volts. This is the voltage measured on a discreet high resolution voltage sense circuit to the BCM.
Battery Current	-	Varies	This displays amps. This parameter displays the information sent to the BCM from the battery current sensor to be used for determining RVC charging voltage.
Battery Sulfation Mode	-	Inactive	The scan tool displays Active or Inactive. The BCM will enter this mode when the interpreted generator output voltage is less than 13.2 volts for 45 minutes. In this mode the BCM will set a targeted output voltage of 13.8 volts for 5 minutes.
Battery Voltage	-	Varies	This displays Volts. This parameter displays the amount of battery voltage available to the body control module (BCM).
Battery Voltage	-	Normal	This displays Normal or Out of Range. This is the current state of the system voltage.
BPP Sensor	-	Varies	This displays Counts. This numeric value is the current brake pedal position.
BPP Sensor Reference	-	Varies	This displays Counts. This numeric value is the BPP sensor reference.
BPPS High During Learn	-	No	The scan tool displays Yes or No. If a short to battery positive voltage is detected in the stop lamp switch signal circuit during calibration, then the scan tool will display YES.
BPPS Learned Home Position	-	Varies	This displays Counts. This numeric value is the BPP sensor learned home position.
BPPS Low During Learn	-	No	The scan tool displays Yes or No. If a short to ground is detected in the stop lamp switch signal circuit during calibration, then the scan tool will display YES.

Parameter	System State	Expected Value	Definition
BPPS Move During Learn	-	No	The scan tool displays Yes or No. If the brake pedal is moved during calibration, the scan tool will display YES.
BPPS Status	-	Learned	The scan tool displays Invalid, Learned and Invalid, Undecided, Learning and Learned. This is the state of the BPPS calibration in the BCM.
Brake Applied Output Signal	-	Off	The scan tool displays On or Off. This output of the BCM is displayed as ON when the brake pedal is applied.
BTSI Fault	-	Not Present	The scan tool displays Present or Not Present. Present is displayed if the BCM senses a brake transmission shift interlock (BTSI) fault.
Calculated Brake Pedal Position	-	Varies	This displays Counts. This numeric value is the current brake pedal position.
Content Theft Mode	-	Varies	The scan tool displays True or False. This is the mode of the content theft system.
Courtesy Lamp PWM Cmd.	-	Varies	This displays percent. This is the current dimming percentage of the courtesy lamps.
Crank Abort	-	False	The scan tool displays True or False. This is the state of the crank abort.
Cruise Control Switch	-	Off	The scan tool displays Off, On, Resume, Set, Error or Cancel. This is the state of the cruise control switch as monitored by the body control module (BCM).
CTD Status	-	Disarmed	The scan tool displays Disarmed, Armed, Arm Delay or Alarm Active. The scan tool displays the current arming status of the content theft system.
CTD Trigger History 1-3	-	None	The scan tool displays None, Drvr. Door, Psgr. Door, LR Door, RR Door, Rear Closure, Mid Closure, Tonneau, Hood, Ignition, Intrusion, Inclination, Remote, Batt.

Parameter	System State	Expected Value	Definition
			Reconnect, Power Mode, Tamper, or Glass Break. The scan tool displays the input which previously caused a content theft alarm.
Ctsy. Lamp Actv. Reason	-	Varies	The scan tool displays Off, Panic, Manual, Air Bag, Door Open, RFA, RFA Theft, Door Closed, Exit or Manual Defeat. This is the reason for courtesy lamp activation.
Current CTD Trigger	-	None	The scan tool displays None, Drvr. Door, Psgr. Door, LR Door, RR Door, Rear Closure, Mid Closure, Tonneau, Hood, Ignition, Intrusion, Inclination, Remote, Batt. Reconnect, Power Mode, Tamper, or Glass Break. The scan tool displays the current input which has cause a content theft alarm.
Current Power Mode	-	Run	The scan tool displays Off, Accessory, Run or Crank Request. This parameter displays the power mode defined by the power mode master and communicated to the modules that require this information. This parameter should match the actual ignition switch position.
Desired Battery Voltage	-	Varies	This displays Volts. This is the desired battery voltage.
Dimming Control Reference	-	Varies	This displays Volts. This is the dimming control reference voltage.
Dimming Control Signal	-	Varies	This displays percent. This is the dimming control percentage.
Dimming Control Signal	-	Varies	This displays Volts. This is the dimming control signal voltage.
Door Key Cyl. Unlock Switch	-	Inactive	This displays Active or Inactive. The scan tool displays the current status of the door key cylinder unlock switch.
Door Lock Requestor	-	Varies	The scan tool displays Power Lock, Door Key Cyl., Rear Closure, Emergency, Keyless Entry, Passive Keyless, Remote, Delayed Lock, Relocking, Anti-Lockout, Exterior Sw. or Auto Locks. This is the

Parameter	System State	Expected Value	Definition
			current state of the door lock request as monitored by the BCM.
Driver Door Ajar Sw.	-	Door Closed	The scan tool displays Door Ajar or Door Closed. When the driver door is open or latched and not completely closed, the scan tool will display Door Ajar.
Driver Door Lock Sw.	-	Inactive	The scan tool displays Active or Inactive. This is the state of the driver door lock switch.
Driver Door Open Sw.	-	Closed	The scan tool displays Open or Closed. When the driver door is open, the scan tool will display Open.
Driver Door Unlock Sw.	-	Inactive	The scan tool displays Active or Inactive. This is the state of the driver door unlock switch.
Driver Identification	-	Varies	The scan tool displays Unknown or Driver 1-7. The scan tool displays the driver which has disarmed the content theft system.
DRL Relay Command	-	On	The scan tool displays On or Off. This output of the BCM is displayed as ON when the BCM turns ON the DRL lamps.
Drvr. Door Unlock Cmd.	-	Off	The scan tool displays On or Off. This is the state of the driver door unlock system.
Drvr. 1 RVS Status	-	Off	The scan tool displays On or Off. On is displayed if driver 1 has performed a remote vehicle start request.
Drvr. 2 RVS Status	-	Off	The scan tool displays On or Off. On is displayed if driver 2 has performed a remote vehicle start request.
Estimated Battery Temp.	-	Varies	This displays Â°C (Â°F). This is the current estimated battery temperature.
Flash to Pass Switch	-	Inactive	The scan tool displays Active or Inactive. When the multifunction switch is placed on the FTP position, the scan tool will display Active.

Parameter	System State	Expected Value	Definition
Front Fog Lamp Relay Command	-	Off	The scan tool displays On or Off. This output of the BCM is displayed as ON when the fog lamps are turned ON.
Front Fog Lamp Switch	-	Inactive	The scan tool displays Active or Inactive. When the fog lamp switch is placed in the ON position, the scan tool will display Active.
Fuel Economy Mode	-	Active	The scan tool displays Active or Inactive. This is the state of the fuel economy mode.
Hazard Lamp Switch	-	Inactive	The scan tool displays Active or Inactive. When the hazard switch is placed in the ON position, the scan tool will display Active.
Headlamp Switch	-	Inactive	The scan tool displays Active or Inactive. This is the state of the headlamp switch.
High Beam Relay Command	-	Off	The scan tool displays On or Off. This is the state of the high beam relay.
High Beam Select Switch	-	Inactive	The scan tool displays Active or Inactive. When the headlamp dimmer switch is placed in the HIGH position, the scan tool will display Active.
Hood Ajar Switch	-	Closed	The scan tool displays Ajar or Closed. When the hood is open or latched and not completely closed, the scan tool will display Ajar.
Hood Closed Switch	-	Active	The scan tool displays Active or Inactive. The scan tool displays the status of the hood closed portion of the hood ajar switch.
Hood Open Switch	-	Inactive	The scan tool displays Active or Inactive. The scan tool displays the status of the hood open portion of the hood ajar switch.
Hood Switch Fault	-	Not Present	The scan tool displays Present or Not Present. Present is displayed if the BCM senses a hood switch fault.
Horn Relay Command	-	Off	The scan tool displays On or Off. The horn output indicates the state that the control module has

Parameter	System State	Expected Value	Definition
			commanded for the relay.
HS Comm. Cmd.	-	Off	The scan tool displays On or Off. The scan tool displays the commanded state of the serial data communication enable circuit output. The scan tool displays ON when the BCM provides voltage to the circuit.
Idle Boost Level 2 Counter	-	Varies	This numeric value is the number of level 2 idle boosts requested by the RVC system to maintain proper battery charging at idle.
Idle Boost Level 3 Counter	-	Varies	This numeric value is the number of level 3 idle boosts requested by the RVC system to maintain proper battery charging at idle.
Ign. Off/Run/Crank	-	Run	The scan tool displays Key In/Off, Key Out/ACC, Crank or Run. The BCM uses this data input signal from the off/run/crank voltage circuits in order to determine the power mode (ignition switch position).
Ignition Accessory/Run	-	Active	The scan tool displays Active or Inactive. The BCM uses this data input signal from the accessory voltage circuits in order to determine the power mode (ignition switch position). Active is displayed when the ignition switch is in the Accy or Run positions.
Ignition Run/Crank	-	Active	The scan tool displays Active or Inactive. The BCM uses this data input signal from the ignition 1 voltage circuits in order to determine the power mode (ignition switch position). Active is displayed when the ignition switch is in the Run or Crank positions.
Ignition Switch Fault	-	No	The scan tool displays Yes or No. Yes is displayed if the BCM senses an ignition switch fault.
Incandescent Dimming PWM Cmd.	-	Varies	This displays percent. This is the current incandescent dimming percentage.

Parameter	System State	Expected Value	Definition
Int. Trunk/Liftglass Sw.	-	Inactive	The scan tool displays Active or Inactive. This is the state of the interior trunk or liftglass release switch.
Key Capture Solenoid Cmd.	-	Off	The scan tool displays On or Off. This is the state of the key capture solenoid.
Key in Ignition	-	Yes	The scan tool displays Yes or No. This is the state of the key in ignition.
Key in Ignition Status	-	Key In	The scan tool displays Key In or Key Out. The scan tool displays the ignition key in/out status.
LED Dimming PWM Cmd.	-	Varies	This displays percent. This is the current LED dimming percentage.
Left Rear Door Ajar Sw.	-	Door Closed	The scan tool displays Door Closed or Door Ajar. When the left rear door is open or latched and not completely closed, the scan tool will display Door Ajar.
Left Turn Signal Switch	-	Inactive	The scan tool displays Active or Inactive. When the turn signal switch is placed in the LEFT turn position, the scan tool will display Active.
LF Turn Signal	-	Off	The scan tool displays On or Off. This output of the BCM is displayed as ON when the left turn signal is turned ON.
Load Shed Lvl 2 Counter	-	Varies	This numeric value is the number of level 2 load sheds requested by the RVC system to maintain proper battery charging at idle.
Load Shed Lvl 3 Counter	-	Varies	This numeric value is the number of level 3 load sheds requested by the RVC system to maintain proper battery charging at idle.
Low Beam Relay Command	-	Off	The scan tool displays On or Off. This output of the BCM is displayed as ON when the low beam headlamps are turned ON.
LR Turn Signal	-	Off	The scan tool displays On or Off. This output of the BCM is displayed as ON when the left turn signal is turned ON or when the

Parameter	System State	Expected Value	Definition
			brakes are applied.
Off/Run/Crank Reference	-	Varies	This displays volts. This is the current off/run/crank reference voltage.
Off/Run/Crank Signal	-	Varies	This displays volts. This is the current off/run/crank signal voltage.
Parasitic Current	-	Varies	This displays amps. This is the state of the parasitic draw on the battery.
Park Brake Switch	-	Released	The scan tool displays Applied or Released. When the park brake is applied, the scan tool will display Applied.
Park Lamp Relay Cmd.	-	Off	The scan tool displays On or Off. This output of the BCM is displayed as ON when the park lamps are turned ON.
Parklamp Switch	-	Off	The scan tool displays On or Off. When the headlamp switch is in the PARK position, the scan tool will display ON.
Passenger Door Ajar Sw.	-	Door Closed	The scan tool displays Door Closed or Door Ajar. When the front passenger door is open or latched and not completely closed, the scan tool will display Door Ajar.
Passenger Door Open Sw.	-	Closed	The scan tool displays Open or Closed. When any passenger door other than the drivers door is open, the scan tool will display Open.
Powertrain HS Comm. Cmd.	-	Off	The scan tool displays On or Off. The scan tool displays the commanded state of the accessory wake up serial data circuit output. The scan tool displays ON when the BCM provides voltage to the circuit. This voltage output acts as a wake up signal for the powertrain control module(s).
Prev. State of Charge	-	Varies	The scan tool displays 0-100%. The scan tool displays the state of charge from the previous ignition off cycle.
Psgr. Door Lock Sw.	-	Inactive	The scan tool displays Active or Inactive. This is the state of the passenger door lock switch.

Parameter	System State	Expected Value	Definition
Psgr. Door Unlock Sw.	-	Inactive	The scan tool displays Active or Inactive. This is the state of the passenger door unlock switch.
Psgr. Door(s) Unlock Cmd.	-	Off	The scan tool displays On or Off. This is the state of the passenger doors unlock system.
Rear Closure Ajar Sw.	-	Inactive	The scan tool displays Active or Inactive. When the rear compartment is open or latched and not completely closed, the scan tool will display Active.
Regulator Setpoint	-	Varies	This displays percent. This is the set point of the voltage regulator as determined by the RVC system.
Remaining Starts 0	-	Varies	The scan tool displays True or False. True is displayed if there are no remaining starts.
Remote Start Attempts 0	-	Varies	The scan tool displays True or False. True is displayed if there are no remote start attempts.
RF Turn Signal	-	Off	The scan tool displays On or Off. This output of the BCM is displayed as ON when the right turn signal is turned ON.
Right Rear Door Ajar Sw.	-	Door Closed	The scan tool displays Door Closed or Door Ajar. When the right rear door is open or latched and not completely closed, the scan tool will display Door Ajar.
Right Turn Signal Switch	-	Inactive	The scan tool displays Active or Inactive. When the turn signal switch is placed in the RIGHT turn position, the scan tool will display Active.
RR Turn Signal	-	Off	The scan tool displays On or Off. This output of the BCM is displayed as ON when the right turn signal is turned ON or when the brakes are applied.
Run/Crank Relay Command	-	Off	The scan tool displays On or Off. The scan tool displays the commanded state of the run/crank relay. The scan tool displays ON when the BCM provides voltage to the run/crank relay control circuit.

Parameter	System State	Expected Value	Definition
Run Abort	-	False	The scan tool displays True or False. True is displayed if a run abort was executed.
Shift Lock Solenoid Command	-	Off	The scan tool displays On or Off. This is the state of the shift lock solenoid.
Start Up State of Charge	-	Varies	The scan tool displays 1-100%. The scan tool displays the state of charge at initial ignition ON cycle.
State of Charge	-	Varies	The scan tool displays 0-100%. The scan tool displays the present state of charge.
State of Charge Low	-	No	The scan tool displays YES/NO. The scan tool displays YES if the present state of charge is low.
Stop Lamp Relay Command	-	Off	The scan tool displays On or Off. This is the state of the stop lamp relay.
SWC Bank 1 Status	-	Idle	The scan tool displays Idle or Switch 1-10. This is the state of the steering wheel controls (SWC) bank 1.
Theft LED	-	Off	The scan tool displays On, Off, Flash Slow or Flash Fast. The scan tool displays the current status of the theft indicator as controlled by the CTD system.
Traction Control Switch	-	Inactive	The scan tool displays Active or Inactive. This is the state of the traction control switch.
Trunk Release Solenoid Command	-	Off	The scan tool displays On or Off.
Valet Switch	-	Inactive	The scan tool displays Active or Inactive. This is the state of the valet switch.
Washer Relay Cmd.	-	Off	The scan tool displays On or Off. When the windshield washer system is active, the scan tool displays the BCM the commanded output state of the windshield washer relay as On.
Windshield Washer Switch	-	Inactive	The scan tool displays Active or Inactive. When the washer switch is pressed, the scan tool displays the switch input to the BCM as Active.

Parameter	System State	Expected Value	Definition
			The BCM then commands the wiper relay ON and keeps it ON until 2 wipe cycles have completed after the switch has been released.
Windshield Wiper Switch	-	Off	The scan tool displays Off, Intermittent, Low, High or Switch Fault. When the windshield wiper system is active, the scan tool will display Intermittent or Low as selected. The scan tool will display Switch Fault if the BCM senses an invalid wiper switch input.
Wiper Delay Setting	-	Varies	This displays a numeric value. The scan tool displays 0/1-5. When the wiper switch is in the Delay mode, the scan tool will display the wiper switch delay position 1-5 as selected.
Wiper High Speed Relay Cmd.	-	Off	The scan tool displays On or Off. When the wiper system is in the active state, the scan tool displays the BCM commanded output to the wiper high relay as On.
Wiper High Speed Switch	-	Inactive	The scan tool displays Active or Inactive. When the wiper switch is in the high speed position, this parameter displays the switch input to the BCM as Active.
Wiper Park Switch	-	Inactive	The scan tool displays Active or Inactive. The body control module (BCM) uses this input to determine the position of the wipers. When the wipers are in the PARK or down position, the wiper motor park switch signal circuit of the BCM is pulled low and the scan tool will display Active.
Wiper Relay Cmd.	-	Off	The scan tool displays On or Off. When the windshield wiper system is active, the scan tool displays the BCM commanded output state of the wiper relay as On.

Body Control Module Scan Tool Output Controls

Scan Tool Output	Description

Control	
Accy/RAP Relay	This output control is used to command the Accy/RAP relay On and Off.
Backup Lamps	This output control is used to command the backup lamps On and Off.
BPP Sensor Calibration	This output control is used to command the BCM to calibrate the brake pedal position (BPP) sensor to zero.
Courtesy Lamp	This output control is used to command the foot wells and courtesy lamps On and Off.
Driver Door Unlock	The BCM momentarily pulses only the driver door lock motor. The driver door should unlock when ON is selected.
DRL	This output control is used to command the daytime running lamps On and Off.
Fog Lamps	This output control is used to command the fog lamps On and Off.
High Beams	This output control is used to command the high beam headlights On and Off.
Horn	This output control is used to command the horn On and Off.
Incandescent Dimming	The BCM dims the incandescent dimming from 0-100 percent when you select INCREASE or DECREASE by 20 percent increments.
LED Dimming	The BCM dims the LED dimming from 0-100 percent when you select INCREASE or DECREASE by 20 percent increments.
LF Turn Signal	This output control is used to command the left front turn signal On and Off.
Lock Rear Doors	This output control is used to command the rear doors to lock.
Low Beams	This output control is used to command the low beam headlights On and Off.
LR Turn Signal	This output control is used to command the left rear turn signal On and Off.
Parking Lamps	This output control is used to command the parking lamps On and Off.
RF Turn Signal	This output control is used to command the right front turn signal On and Off.
RR Turn Signal	This output control is used to command the right rear turn signal On and Off.
Run/Crank Relay	This output control is used to command the run/crank relay On and Off.
Setup SDM Primary Key in BCM	This output control is used to set up the SDM primary key into the BCM.
Shift Lock Solenoid	This output control is used to command the shift lock solenoid On and Off.
Trunk Release	This output control is used to command the trunk release solenoid On and Off.
Unlock Rear Doors	This output control is used to command the rear doors to unlock.
Wiper High Speed Relay	This output control is used to command the wiper high speed relay On and Off.
Wiper Relay	This output control is used to command the wiper relay On and Off.
Wiper Washer Motor	This output control is used to command the wiper washer motor On and Off.

CHASSIS CONTROL MODULE SCAN TOOL INFORMATION

Chassis Control Module (CCM) Scan Tool Data Parameters for Fuel System

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine Idling at Normal Operating Temperature/Vehicle is in Park or Neutral			
Desired Fuel Pressure	-	306.8 kPa (44.5 psi)	This displays kPa (psi). This is the desired fuel pressure.

Parameter	System State	Expected Value	Description
Fuel Pump Command	-	On	The scan tool displays On or Off. This is the current state of the fuel pump command.
Fuel Pump Signal Command	-	Varies	This displays %. This is the commanded fuel pump signal measured in percentage.
Fuel Pressure Sensor	-	296.4-310.3 kPa (43-45 psi)	This displays kPa (psi). This is the current pressure at the fuel pressure sensor.
Fuel Pressure Sensor	-	2.00-3.00 Volts	This voltage can vary depending on the engine application, engine load, operating conditions and other factors. This display is in Volts. This is the fuel pressure sensor voltage.
Ignition 1 Signal	-	Varies	This displays Volts. This is the current ignition 1 signal.
LT Fuel Pump Trim	-	Varies	This displays a numeric value. This is the long term (LT) fuel pump trim.
ST Fuel Pump Trim	-	Varies	This displays a numeric value. This is the short term (ST) fuel pump trim.

Chassis Control Module (CCM) Scan Tool Output Controls for Fuel System

Output Control	Description
Fuel Pressure Control	This output control is used to control the fuel pressure.
Fuel Pump	This output control is used to command the fuel pump ON and OFF.
Fuel Pump Trim Reset	This output control is used to reset the fuel pump trim.

CCM Scan Tool Parameters for Active Grille Air Shutters (If Equipped)

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine Idling at Normal Operating Temperature / Vehicle is in Park or Neutral			
Active Grille Air Shutter Position Command (Single Shutter System)	-	Varies	This displays %. This is the commanded active grille air shutter position.
Active Grille Air Shutter Position (Single Shutter	-	Varies	This displays %. This is the actual active grille air

Parameter	System State	Expected Value	Description
System)			shutter position.
Active Grille Air Shutter 1 Position Command (Dual Shutter System)	-	Varies	This displays %. This is the commanded active grille air shutter position.
Active Grille Air Shutter 1 Position (Dual Shutter System)	-	Varies	This displays %. This is the actual active grille air shutter position.
Active Grille Air Shutter 2 Position Command (Dual Shutter System)	-	Varies	This displays %. This is the commanded active grille air shutter position.
Active Grille Air Shutter 2 Position (Dual Shutter System)	-	Varies	This displays %. This is the actual active grille air shutter position.

CCM Scan Tool Output Controls for Active Grille Air Shutters (If Equipped)

Output Control	Description
Active Grille Air Shutter System (Single Shutter System)	This output control is used to perform the Active Grille Air Shutter Actuator test. It is used to cycle the active grille air shutter open and closed. The test result will display pass or fail based on the ability of the louvers to cycle open and closed.
Active Grille Air Shutter 1 (Dual Shutter System)	This output control is used to perform the Active Grille Air Shutter Actuator test. It is used to cycle the active grille air shutter open and closed. The test result will display pass or fail based on the ability of the louvers to cycle open and closed.
Active Grille Air Shutter 2 (Dual Shutter System)	This output control is used to perform the Active Grille Air Shutter Actuator test. It is used to cycle the active grille air shutter open and closed. The test result will display pass or fail based on the ability of the louvers to cycle open and closed.

CCM Scan Tool Parameters for Active Engine Mounts (If Equipped)

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine Idling at Normal Operating Temperature / Vehicle is in Park or Neutral			
Engine Mount Actuator Output 1	-	On/Off	The scan tool will display On/Off. This is the engine mount actuator commanded state.
Engine Mount Actuator Output 2	-	On/Off	The scan tool will display On/Off. This is the engine mount actuator commanded state.
Engine Mount Actuator Control Circuit 1 Status (2014 model year only)	-	Passed	The scan tool displays Passed/Short to Battery/Short to Ground/Open This is the engine mount actuator control circuit 1 condition.

Parameter	System State	Expected Value	Description
Engine Mount Actuator Control Circuit 2 Status (2014 model year only)	-	Passed	The scan tool displays Passed/Short to Battery/Short to Ground/Open This is the engine mount actuator control circuit 2 condition.

CCM Scan Tool Output Controls for Active Engine Mounts (If Equipped)

Output Control	Description
Engine Mount Actuator Output 1	This output control is used to turn the engine mount actuator 1 On and Off.
Engine Mount Actuator Output 2	This output control is used to turn the engine mount actuator 2 On and Off.

CCM Scan Tool Parameters for Exhaust Flow Control Valves (If Equipped)

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine Idling at Normal Operating Temperature / Vehicle is in Park or Neutral			
Exhaust Flow Control Valve Command	-	Open/Closed	Exhaust Flow Valve Commanded State
Exhaust Flow Control Valve Command	-	%	Exhaust Flow Valve Commanded Duty Cycle (0%-100%)
Exhaust Flow Control Valve Performance Mode	-	Active/Inactive	Exhaust Flow Valve Control Status
Exhaust Flow Control Valve Rumble Mode	-	Active/Inactive	Exhaust Flow Valve Control Status
Exhaust Flow Control Valve	-	Active/Inactive	Exhaust Flow Valve Control Status
Cylinder Deactivation Exhaust Flow Valve Command	-	Open/Closed/Disabled	Exhaust Flow Valve Commanded State
Cylinder Deactivation Exhaust Flow Control Valve	-	Active/Inactive	Exhaust Flow Valve Control Status
Cylinder Deactivation Exhaust Flow Control Valve 1 Position	-	Open range is 4 - 28 degrees Closed range is 64 - 93 degrees	Cylinder Deactivation Exhaust Flow Control Valve 1 actual position in degrees
Cylinder Deactivation Exhaust Flow Control Valve 2 Position	-	Open range is 4 - 28 degrees Closed range is 64 - 93 degrees	Cylinder Deactivation Exhaust Flow Control Valve 2 actual position in degrees

CCM Scan Tool Output Controls for Exhaust Flow Control Actuators (If Equipped)

Output Control	Description
Exhaust Flow Control Valve Command	This output control is used to cycle the exhaust flow control valve open and closed.
Cylinder Deactivation Exhaust Flow Valve Command	This output control is used to cycle the cylinder deactivation exhaust flow control valve open and closed.

CCM Scan Tool Parameters for Trailer Brake Control System (If Equipped)

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine Idling at Normal Operating Temperature / Vehicle is in Park or Neutral			
ABS Active Signal	-	OK	The scan tool displays Ok/Not Ok. The scan tool displays Ok when no problems are found with the ABS Active Signal serial data message from the electronic brake control module to the chassis control module.
Antilock Braking System	-	Inactive	The scan tool displays Active/Inactive. The scan tool displays Inactive when the ABS system is not functioning.
Automatic Brake Control Gain Request From EBCM	-	0-100%	The scan tool displays a number between 0-100%.
Automatic Brake Request From EBCM	-	No	The scan tool displays Yes/No. This is a request from the EBCM to apply the trailer brakes.
Automatic-Brake Torque	-	Nm	The scan tool displays a numerical value.
Automatic-Brake Torque Signal	-	Ok	The scan tool displays Ok/Not Ok. The scan tool displays Ok when no problems are found with the Automatic Brake Torque Signal serial data message to the chassis control module.
Automatic Braking Active Signal	-	Ok	The scan tool displays Ok/Not OK. The scan tool displays OK when no problems are found with the Automatic Braking Active

Parameter	System State	Expected Value	Description
			Signal serial data message to the chassis control module.
Automatic Braking Event	-	Not Detected	The scan tool displays Detected/Not Detected. This parameter represents a command to apply the trailer brakes from the adaptive cruise control system.
Brake Master Cylinder Pressure Sensor	-	Varies	The scan tool will display brake fluid pressure in the master cylinder. The scan tool will display a kPa or psi signal received from the chassis control module.
Brake Pressure Signal	-	OK	The scan tool will display Ok/Not Ok. The scan tool will display a serial data message received from the chassis control module.
Brake Request from EBCM	-	Ok	The scan tool displays Ok/Not Ok. The scan tool displays Ok when no problems are found with the Brake Request signal serial data message from the electronic brake control module to the chassis control module.
Desired Trailer Brake Control Duty Cycle	-	0-100%	The scan tool displays a number between 0-100%. This number represents a duty cycle request signal from the chassis control module to the trailer brake power module.
Deviation Between Manual Trailer Brake Apply Request Signal 1 and 2	-	Varies	The scan tools displays a percentage difference between the Apply Request Signal 2 and Redundant Request Signal 1.
Driver Initiated Brake Event	-	Not Detected	The scan tool displays Detected/Not Detected. The scan tool detects when the driver has applied the trailer brakes.

Parameter	System State	Expected Value	Description
Induced Voltage by Trailer Brake Coil	-	0-20 V	The scan tool displays a voltage. This number represents the actual voltage supplied by the trailer brake power module to the trailer brakes.
Manual Trailer Brake Apply Request Signal 1	-	Varies	The scan tool displays a percentage. This represents a brake apply signal between the chassis control module and the trailer brake power module.
Manual Trailer Brake Apply Request Signal 2	-	Varies	The scan tool displays a percentage. This represents a brake apply signal between the chassis control module and the trailer brake power module.
Stop Lamp Signal	-	Not Requested	The scan tool displays Requested/Not Requested. This is the brake pedal position sensor signal from the BCM to the chassis control module.
Trailer Brake Automatic Control State	-	Normal	The scan tool displays Normal/Active/Temporarily Inhibited/Temporarily Limited/Permanently Failed/Communication Failed/Disabled by Calibration. This represents the operational state of the chassis control module.
Trailer Brake Control Duty Cycle	-	0-100%	The scan tool displays a percentage. This is the pulse width modulated output signal from the trailer brake power module to the trailer brakes.
Trailer Brake Control Output Circuit	-	Okay	The scan tool displays Unknown/Short to Battery/Short to Ground/Okay. This represents the state of health of the output circuit from the

Parameter	System State	Expected Value	Description
			trailer brake power module to the trailer brakes.
Trailer Brake Control Output Circuit	-	0-20 V	The scan tool displays a voltage. This represents the voltage supplied by the trailer brake power module to the trailer brakes.
Trailer Brake Power Control Module	-	De-Energized	The scan tool displays Energized/De-Energized. This represents the state of the trailer brake power module.
Trailer Brake Power Control Module Battery Voltage	-	Varies	The scan tool displays a voltage. This represents the battery voltage supplied to the trailer brake power module.
Trailer Brake Type	-	Undefined	The scan tool displays Undefined when a trailer is not connected to the vehicle. The scan tool displays Electromagnetic Brakes or Electrohydraulic Brakes when a trailer is connected to the vehicle. The type displayed is based on what is detected by the chassis control module.
Trailer Brake User Gain	-	Varies	The scan tool displays percent of full gain setting. The scan tool displays 0-100%. Each full gain setting represents an increment of approximately 10 percent of full gain setting. Approximately 40% will be indicated with a gain setting of 4.0, 65% will be indicated with a gain setting of 6.5, etc.
Trailer Brake User Gain Switch	-	Varies	The scan tool displays percent of full gain setting. The scan tool displays 0-100%. Each full gain setting represents an

Parameter	System State	Expected Value	Description
			increment of approximately 10 percent of full gain setting. Approximately 40% will be indicated with a gain setting of 4.0, 65% will be indicated with a gain setting of 6.5, etc.
Vehicle Speed	-	Varies	The scan tool displays 0-327 km/h (0-204 mph). The scan tool displays 0 km/h (0 mph) when the vehicle is not moving. This is the vehicle speed serial data message from the ECM.
Vehicle Stability Enhancement System Signal	-	Ok	The scan tool displays Ok/Not Ok. The scan tool displays Ok when no problems are found with the Vehicle Stability Enhancement System signal to the chassis control module.
Wheel Speed Signal	-	Ok	The scan tool displays Ok/Not Ok. The scan tool displays Ok when no problems are found with the Wheel Speed signal from the EBCM to the chassis control module.

Chassis Control Module (CCM) Scan Tool Output Controls for Trailer Brake Control System (If Equipped)

Output Control	Description
Trailer Brake Control Signal	This output control is used to turn the trailer brake power control module on and off.
Trailer Brake Duty Cycle	This output control is used to control the trailer brake apply signal from trailer brake power control module.

CCM Scan Tool Parameters for Vehicle Level Control (If Equipped)

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON			
Left Rear Vehicle Level Position Sensor	-	.25-4.75 Volts	This displays Volts. This is the level position sensor voltage.

Parameter	System State	Expected Value	Description
Right Rear Vehicle Level Position Sensor	-	.25-4.75 Volts	This displays Volts. This is the level position sensor voltage.
Vehicle Level Control Compressor Over Temperature	-	No	This displays Yes or No. This will display Yes if the compressor is overheated.
Excessive Compressor Activity	-	No	This displays Yes or No. This will display Yes if the compressor activity is excessive.
Vehicle Level Control Status	-	Normal	This displays Normal/Uneven Surface or Hoisted/Overloaded/Failed.
Vehicle Level Control Compressor	-	Varies	This displays On or Off. This will display if the compressor is on or off.
Vehicle Level Control Exhaust Valve	-	Varies	This displays Open or Closed. This will display if the exhaust valve is open or closed.
Vehicle Level Control Pressure Sensor	-	.4-4.8 Volts	This displays Volts. This is the level control pressure sensor voltage.
Vehicle Leveling Sensors Supply Voltage	-	4.9-5.1 Volts	This displays Volts. This is the leveling sensors supply voltage.
Vehicle Level Control Pressure Sensor Supply Voltage	-	4.9-5.1 Volts	This displays Volts. This is the level control pressure sensor supply voltage.
Vehicle Level Trim Height Status	-	Learned/Not Learned	This displays if the level trim height status

CCM Scan Tool Output Controls for Vehicle Level Control (If Equipped)

Output Control	Description
Suspension Position Sensor Trim Height	This output control is used to learn the trim height.
Vehicle Level Control Compressor Relay	This output control is used to command the compressor ON and OFF.
Vehicle Level Control Exhaust Valve	This output control is used to command the exhaust valve ON and OFF.

CCM Scan Tool Parameters for Transmission Cooling Fan (If Equipped)

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON/Engine Idling at Normal Operating Temperature / Vehicle is in Park			

Parameter	System State	Expected Value	Description
or Neutral			
Transmission Cooling Fan Circuit High Voltage Test Status	-	OK	Malfunction/Not Run/OK
Transmission Cooling Fan Circuit Open Test Status	-	OK	Malfunction/Not Run/OK
Transmission Cooling Fan Circuit Low Voltage Status	-	OK	Malfunction/Not Run/OK
Transmission Cooling Fan Command	-	Yes/No	The scan tool displays Yes/No. This shows if the transmission cooling fan is being commanded ON.
Transmission Cooling Fan Duty Cycle	-	0 - 100%	The scan tool displays a percentage. This is the transmission cooling fan ON duty cycle.

CCM Scan Tool Output Controls for Transmission Cooling Fan (If Equipped)

Output Control	Description
Transmission Cooling Fan Duty Cycle	This output control is used to control the transmission cooling fan.

COMMUNICATION INTERFACE MODULE SCAN TOOL INFORMATION

Vehicle Communication Interface Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON			
GPS Data:			
• Dead Reckoning Calibration Status	-	Calibrated or Not Calibrated	Indicates the dead reckoning calibration status.
• Position Calibration Method	-	Varies	Indicates the method used to determine current location. (0) GPS, (1) Wheel Speed Dead Reckoning only, (2) Combined Wheel Speed and GPS, (3) Gyro only, (4) Combined Gyro and GPS, (5) No Fix
• Month	-	MM	This displays the current month.
• Day	-	DD	This displays the current day of the month.

Parameter	System State	Expected Value	Description
• Year	-	YY	This displays the current year.
• Hour	-	HH	This displays the GPS current hour (24 hour format - GMT).
• Minute	-	MM	This displays the GPS current minute.
• Second	-	SS	This displays the GPS current second.
• GPS Signal	-	Varies	The scan tool displays Yes or No. Yes is displayed if there is a GPS signal received by the vehicle communication interface module.
Signal Strength Data:			
• Current Transceiver Identifier	-	Varies	The scan tool displays a 2-5 digit value. This is the transceiver identification number.
• GSM Signal Strength	-	Varies	The scan tool displays 0-127. This is the vehicle communication interface module signal strength.
• Signal Type	-	Digital	This is the signal type received by the vehicle communication interface module.
Bluetooth Data:			
• Bluetooth	-	Enabled	Indicates if the Bluetooth system is enabled or disabled.
• Bluetooth Link Status	-	Varies	Indicates the current link status. (0) Unconnected, (1) connected / Idle, (2)Call active, (3) 3 way calling active
• Bluetooth Link Quality	-	Varies	The scan tool displays a decimal value between 0 and 255.
• Bluetooth Phone to Telematics Communication Interface Control Module Authentication Status	-	Active or Inactive	Displays the bluetooth phone to vehicle communication interface module authentication status.
• Bluetooth Phone to Telematics Communication Interface Control Module Communication Status	-	Active or Inactive	Displays the bluetooth phone to vehicle communication interface module status.

Parameter	System State	Expected Value	Description
• Bluetooth Phone Voice Recognition Status	-	Active or Inactive	Displays the bluetooth phone to voice recognition status.

Vehicle Communication Interface Module Scan Tool Output Controls

Output Control	Description
B1000 Information	This shows the data recorded when DTC B1000 was set in the vehicle communication interface module.
Green Indicator	The vehicle communication interface module illuminates the green LED when ON is selected.
Phone Call Test	When ON is selected, vehicle communication interface module commands OnStar to connect to the OnStar Center.
Red Indicator	The vehicle communication interface module illuminates the red LED when ON is selected.
Preferred Roaming List Update	The vehicle communication interface module performs a preferred roaming list (PRL) update when this is selected.
Remote Vehicle Speed Limiting Reset	This function resets the speed limiting feature.

DIGITAL RADIO RECEIVER SCAN TOOL INFORMATION

Digital Radio Receiver Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON/Engine OFF/Radio ON		
Battery Voltage	Varies	This displays volts. This is the voltage input supplied to the digital radio receiver.
Ignition Counter	Varies	This displays the number of times the ignition has been cycled from the OFF to ON position.
Power Mode	Run	The scan tool displays Reserved, Off Battery Save, Off Asleep, Off Awake, Unlock, RAP Unlock, Accessory, Run, Crank, or RAP. The status of the vehicle power mode (ignition switch).

DRIVER SEAT AND PASSENGER SEAT HEATER CONTROL MODULE SCAN TOOL INFORMATION

Heated Seat Module Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Driver Seat Heat Status	Inactive	The scan tool displays Active or Inactive. Active is displayed when the module commands seat heating ON.
Driver Seat HVC Level	Varies	The scan tool displays High, Medium or Low. This is the current level of seat heating as requested by the heated seat switch.

Parameter	Expected Value	Definition
Driver Seat HVC Mode	Varies	The scan tool displays Off, Back& Cushion, Back Only, or Cool. This is the current mode of operation for the driver seat.
Passenger Seat Heat Status	Inactive	The scan tool displays Active or Inactive. Active is displayed when the module commands seat heating ON.
Passenger Seat HVC Level	Varies	The scan tool displays High, Medium or Low. This is the current level of seat heating as requested by the heated seat switch.
Passenger Seat HVC Mode	Varies	The scan tool displays Off, Back& Cushion, Back Only, or Cool. This is the current mode of operation for the passenger seat.
Seat Heat Supply Voltage	Inactive	The scan tool displays Active or Inactive. Active is displayed when the module commands seat heating ON.

ELECTRONIC BRAKE CONTROL MODULE SCAN TOOL INFORMATION

Electronic Brake Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Definition
Operating Conditions: Ignition ON			
ABS Active	-	No	The scan tool displays Yes or No. The scan tool displays Yes if the ABS system is performing antilock braking.
ABS Failed	-	No	The scan tool displays Yes or No. Yes is displayed if there is an ABS fault.
Battery Voltage Signal	-	Varies	This displays volts. This is the voltage supplied to the EBCM.
Brake Fluid Level Status	-	OK	The scan tool displays OK or Low. This is the state of the brake fluid level sensor.
Brake Pressure Sensor Input	-	Varies	The scan tool displays 0-5 Volts. This voltage signal indicates the master cylinder hydraulic pressure applied to the system
BPP Signal	-	Released	The scan tool displays Applied or Released. The scan tool displays the applied state of the brake pedal position sensor.
Delivered Torque	-	0%	The scan tool displays 0-100%. The duty cycle of the signal is used to transmit how much engine torque the ECM is delivering. Normal values are between 10-90 percent duty cycle. The signal is at low values (approximately 10 percent) at idle and at higher values under driving conditions.
DRP Active	-	No	The scan tool displays Yes or No. The scan tool displays if the EBCM is performing dynamic rear proportioning.

Parameter	System State	Expected Value	Definition
DRP Disabled	-	No	The scan tool displays Yes or No. The scan tool displays if the EBCM is no longer able to perform dynamic rear proportioning.
Engine Drag Control Failed	-	No	The scan tool displays Yes or No. Indicates if the EBCM disabled engine drag control due to a malfunction.
Lateral Accelerometer Input	-	0.0 m/s^2	The scan tool displays m/s^2. This is the current rate of the vehicle acceleration or deceleration as reported by the lateral accelerometer sensor.
LF Wheel Speed Sensor	-	0 km/h (0 mph)	This displays km/h (mph). This is the current speed of the left front wheel speed sensor.
LF Inlet Solenoid Command	-	Off	The scan tool displays On or Off. On is displayed when the left front inlet valve solenoid is commanded on.
LF Outlet Solenoid Command	-	Off	The scan tool displays On or Off. On is displayed when the left front outlet valve solenoid is commanded on.
LR Wheel Speed Sensor	-	0 km/h (0 mph)	This displays km/h (mph). This is the current speed of the left rear wheel speed sensor.
LR Inlet Solenoid Command	-	Off	The scan tool displays On or Off. On is displayed when the left rear inlet valve solenoid is commanded on.
LR Outlet Solenoid Command	-	Off	The scan tool displays On or Off. On is displayed when the left rear outlet valve solenoid is commanded on.
Panic Brake Assist Failed	-	No	The scan tool displays Yes or No. Indicates if the EBCM disabled Panic Brake Assist due to a malfunction.
Pump Motor Command Voltage	-	Varies	This displays Volts. The scan tool displays the voltage applied to the ABS pump motor.
Requested Torque	-	0%	The scan tool displays 0-100%. The duty cycle of the signal is used to transmit how much torque the EBCM is requesting the ECM to deliver. Normal values are between 10-90 percent duty cycle. The signal should be at 90 percent duty cycle when traction control is not active and at lower values (approximately 10 percent) when traction control is active.
RF Inlet Solenoid	-	Off	The scan tool displays On or Off. On is displayed when the right front inlet valve solenoid is commanded on.
RF Outlet Solenoid	-	Off	The scan tool displays On or Off. On is displayed when the right front outlet valve

Parameter	System State	Expected Value	Definition
			solenoid is commanded on.
RF Wheel Speed Sensor	-	0 km/h (0 mph)	This displays km/h (mph). This is the current speed of the right front wheel speed sensor.
RR Inlet Solenoid Command	-	Off	The scan tool displays On or Off. On is displayed when the right rear inlet valve solenoid is commanded on.
RR Outlet Solenoid Command	-	Off	The scan tool displays On or Off. On is displayed when the right rear outlet valve solenoid is commanded on.
RR Wheel Speed Sensor	-	0 km/h (0 mph)	This displays km/h (mph). This is the current speed of the right rear wheel speed sensor.
Steering Position Sensor Signal	-	Varies	This displays degrees. This is the signal received from the steering angle sensor.
TCS Active	-	No	The scan tool displays Yes or No. The scan tool displays if the EBCM is requesting torque reduction from the ECM.
TCS Failed	-	No	The scan tool displays Yes or No. The scan tool displays if the EBCM is no longer able to perform traction control.
VSES Active	-	No	The scan tool displays Yes or No. The scan tool displays Yes when VSES is active, and No when VSES is inactive.
VSES Failed	-	No	The scan tool will display Yes or No depending on the state of the ABS indicator.
Yaw Rate Sensor Input	-	0.0 Â°/sec	The scan tool displays the signal received from the yaw rate sensor .

Electronic Brake Control Module Scan Tool Output Controls

Scan Tool Output Control	Description
Automated Bleed	This is used in order to bleed ABS hydraulics. Refer to **Antilock Brake System Automated Bleed** .
Steering Angle Sensor Centering	This is used to center the steering angle sensor.

K20 ENGINE CONTROL MODULE: SCAN TOOL INFORMATION

Engine Control Module Scan Tool Data

Parameter	System State	Expected Value	Description
This is a comprehensive list. Not all parameters listed are available for all applications. **Base Operating Conditions:** Engine Idling/Radiator Hose Hot/Park or Neutral/Closed Loop			
5 V Reference 1, 2, 3, 4 or 5	Engine Idling	5 Volts	This parameter displays the voltage sensed on the 5 V reference circuits

Parameter	System State	Expected Value	Description
			at the control module. The scan tool will display a higher value at higher voltage. The scan tool will display a lower value at lower voltage.
5 V Reference 1, 2, 3, 4 or 5 Circuit Status	Engine Idling	OK	This parameter will display OK if the circuit is good or Malfunction if a short to ground, short to B+ is present.
A/C Compressor Clutch Inhibit Reason History 1 or 2	Ignition ON	None	This parameter displays one of the following if an A/C Compressor Clutch Inhibit reasons is detected. High Side Fluid Pressure, Engine Speed, Battery Voltage, Engine Stall, Engine Speed Stabilization, Wide Open Throttle, Vehicle Launch Performance, High Coolant Temperature, AC Relay Fault, Hybrid Request, AutoStop Request, High Power Electronics Coolant Temperature, High Transmission Fluid Temperature, Full Pedal Power Limit Applied, Airbag deployed, Battery Power Limit Exceeded, Powertrain Diagnostics, AC Compressor Fault, Serial Communication Fault, or Low Brake Vacuum.
A/C Compressor Clutch Relay Command	Engine Idling	Off	This parameter displays when the A/C Compressor Clutch relay is commanded ON or OFF.
A/C Compressor Clutch Relay Control Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the status of the relay control circuit. It can display OK, Malfunction or Not Run.
A/C Compressor Clutch Relay Control Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the status of the relay control circuit. It can display OK, Malfunction or Not Run.
A/C Compressor Clutch Relay Control Circuit Open Test Status	Engine Idling	OK	This parameter displays the status of the relay control circuit. It can display OK, Malfunction or Not Run.
A/C Disabled - A/C Pressure Out of Range	A/C ON	No	This parameter displays whether the A/C pressure is out of range for normal operation as determined by

Parameter	System State	Expected Value	Description
			the control module.
A/C Disengage 1-8 History	A/C ON	Reason for A/C Disengagement	The parameter displays reason for the last 8 air conditioning (A/C) compressor disengagements in order from 1 to 8 with 8 being the most recent. There are 8 possible causes for the A/C compressor to disengage.
A/C High Side Pressure Sensor	A/C OFF	0.75-1.5 Volts*	This parameter displays the voltage signal from the A/C high side pressure sensor input to the control module. * Varies with temperature, humidity, and altitude.
	A/C ON	1.3-2.5 Volts*	
A/C High Side Pressure Sensor	A/C OFF	450-827 kPa (65-120 psi)*	This parameter displays the pressure from the A/C high side pressure sensor signal circuit to the control module. * Varies with temperature, humidity, and altitude.
	A/C ON	827-2,350 kPa (120-341 psi)*	
A/C OFF for WOT	A/C ON	No	This parameter displays whether the control module is commanding the A/C compressor clutch relay OFF for wide open throttle (WOT).
A/C Request Signal	A/C ON	No	This parameter displays the state of the A/C request input to the control module from the heating, ventilation, and air conditioning (HVAC) controls.
Accelerator Pedal Position	Engine Idling	0-100 %	This parameter displays the angle of the accelerator pedal position (APP) as calculated by the control module using the signals from the APP sensors.
Accelerator Pedal Position When Engine Overspeed Detected	Engine Idling	%	This parameter displays the accelerator pedal position (APP) observed upon initial detection of an overspeed condition. This value will be updated upon each overspeed condition.
Air/Fuel Equivalence Ratio Command	Engine Idling	Varies:1	This parameter should display 1.0 when in Closed Loop fuel control.
Alternative Fuel Injector 1, 2, 3, 4, 5, 6, 7 or 8 Command	Ignition ON	On / Off	This parameter contains the commanded state of the alternative fuel injector 1 output (the output is

Parameter	System State	Expected Value	Description
			considered to be commanded on if the injector is enabled while the engine is running or cranking).
Alternative Fuel Injector 1 Control Circuit High Voltage Test Status	Ignition ON	OK, Malfunction, Not Run	This parameter displays the state of the Alternative Fuel Injector 1 control circuit. The parameter displays Malfunction if the Alternative Fuel Injector 1 control circuit is shorted to voltage.
Alternative Fuel Injector 1 Control Circuit Low Voltage Test Status	Ignition ON	OK, Malfunction, Not Run	This parameter displays the state of the Alternative Fuel Injector 1 control circuit. The parameter displays Malfunction if the Alternative Fuel Injector 1 control circuit is shorted to ground.
Alternative Fuel Injector Pulse Width Bank 1	Ignition ON	ms	This parameter displays the alternative fuel injector pulse width (on time) commanded to each cylinder on bank 1.
Alternative Fuel Injector Pulse Width Bank 2	Ignition ON	ms	This parameter displays the alternative fuel injector pulse width (on time) commanded to each cylinder on bank 2.
Alternative Fuel Rail Pressure	Ignition ON	kPa / PSI	This parameter displays the fuel rail pressure calculated as the difference between alternative fuel rail absolute pressure and ambient air pressure (barometric pressure). This measurement is a "gauge pressure." (Gauge = Absolute - Ambient) Range 0 to 2048 kPa.
Alternative Fuel Rail Pressure	Ignition ON	Volts	This parameter displays the alternative fuel rail pressure sensor analog input as a percentage of its reference voltage.
Alternative Fuel Rail Pressure Sensor	Ignition ON	kPa	This parameter displays an 'undefaulted' fuel rail pressure relative to manifold vacuum. This is intended for gaseous fuel injection alternative fuel applications (CNG/LPG Mono-Fuel and Bi-Fuel).
Alternative Fuel Rail Temperature	Ignition ON	Â°C (Â°F)	This parameter displays the undefaulted alternative fuel rail temperature measured by a sensor.

Parameter	System State	Expected Value	Description
			Range is -40 to 215Â°C.
Alternative Fuel Shutoff Valve 1 or 2 Control Circuit Command	Ignition ON	On / Off	This parameter displays the commanded state of the alternative fuel shutoff valve 1 output (the output is considered to be commanded on if the shutoff valve is enabled while the engine is running or cranking).
Alternative Fuel Shutoff Valve 1 or 2 Control Circuit High Voltage Test Status	Ignition ON	OK, Malfunction, Not Run	This parameter displays the state of the Alternative Fuel Shutoff Valve 1 or 2 control circuit. The parameter displays Malfunction if the Alternative Fuel Shutoff Valve is shorted to voltage.
Alternative Fuel Tank Pressure	Ignition ON	Volts	This parameter displays the alternative fuel tank pressure sensor analog input as a percentage of its reference voltage.
Ambient Air Temperature	Engine Idling	Varies	This parameter displays temperature from the input of the Intake Air Temperature Sensor.
Ambient Air Temperature	Ignition ON	Â°C (Â°F) Varies	This parameter displays the outside air temperature as calculated by the control module.
Ambient Air Temperature When Recommended Maximum Fuel Alcohol Content Exceeded	-	Â°C (Â°F)	This parameter displays the ambient air temperature when the recommended maximum fuel alcohol content was exceeded.
Ambient Humidity	Ignition ON	%	This parameter displays the current ambient humidity level.
APP Sensor 1	Accelerator pedal not actuated	0.98 Volts	This parameter displays the actual voltage on the accelerator pedal position (APP) sensor 1 signal circuit as measured by the control module.
	Accelerator pedal fully actuated	4.25 Volts	
APP Sensor 1 and 2	Ignition ON	Agree	This parameter displays Disagree if the control module detects the signal voltage from APP sensor 1 is not in correct relationship to APP sensor 2. The scan tool displays Agree under the normal operating conditions.
APP Sensor 1 Circuit Status	Engine Idling	OK	APP Sensor 1 Out of Range indicates that the sensed accelerator pedal position 1 sensor value is

Parameter	System State	Expected Value	Description
			currently out of range or that a Malfunction has been detected based upon the sensed accelerator pedal position 1 sensor value being out of range
APP Sensor 1 Learned Applied Position	Ignition ON	78 %	This parameter contains the learned maximum (fully applied) accelerator pedal position relating to absolute accelerator pedal position (no correction or normalization based upon learned minimum or maximum positions) from accelerator pedal position sensor 1.
APP Sensor 1 Learned Released Position	Ignition ON	0.98 Volts	This parameter indicates the accelerator pedal sensor 1 signal at its minimum learned position (pedal released) as a percentage of its reference voltage. (The minimum learned position is automatically updated periodically as determined by the calibration.
APP Sensor 1 Position	Pedal Released	0 %	This parameter contains the displacement determined from accelerator pedal position sensor 1 (corrected and normalized based upon its learned minimum and maximum positions).
	Pedal Fully Applied	99 %	
APP Sensor 2	Ignition ON	Volts	This parameter contains the accelerator pedal position sensor 2 analog input as a percentage of its reference voltage
APP Sensor 2	Accelerator pedal not actuated	0.49 Volts	This parameter displays the actual voltage on the accelerator pedal position (APP) sensor 2 signal circuit as measured by the control module.
	Accelerator pedal fully actuated	2.14 Volts	
APP Sensor 2 Circuit Status	Ignition ON	OK	APP Sensor 2 Out of Range indicates that the sensed accelerator pedal position 2 sensor value is currently out of range or that a malfunction has been detected (and latched) based upon the sensed accelerator pedal position 2 sensor value being out of range

Parameter	System State	Expected Value	Description
APP Sensor 2 Learned Applied Position	Ignition ON	78 %	This parameter contains the learned maximum (fully applied) accelerator pedal position relating to absolute accelerator pedal position (no correction or normalization based upon learned minimum or maximum positions) from accelerator pedal position sensor 2.
APP Sensor 2 Learned Released Position	Ignition ON	0.49 Volts	This parameter indicates the accelerator pedal sensor 2 signal at its minimum learned position (pedal released) as a percentage of its reference voltage. (The minimum learned position is automatically updated periodically as determined by the engine control module.
APP Sensor 2 Position	Pedal Released	0 %	This parameter contains the displacement determined from accelerator pedal position sensor 2 (corrected and normalized based upon its learned minimum and maximum positions).
	Pedal Fully Applied	100 %	
APP Sensors	Pedal Released	0 %	This parameter contains the accelerator pedal position resulting directly from the settling of differences of the accelerator pedal position sensors (prior to any compensation to determine driver intent).
	Pedal Fully Applied	99 %	
Autostart/Autostop Disable Mode	-	Active	This parameter displays "Active" when all conditions for allowing the autostart/autostop mode are present (no inhibit conditions exist), this parameter displays "Inactive" when all conditions for allowing the autostart/autostop mode are not present.
Autostart Inhibit Reason Autostart/Autostop Malfunction	Engine Idling	No	This parameter displays that a immediate stop was commanded due to a Autostart/Autostop malfunction.
Autostart Inhibit Reason	Engine Idling	No	The scan tool displays Yes if one of the following Autostart Inhibit Reason is detected. Control Function Active, Crank Abort,

Parameter	System State	Expected Value	Description
			Driver Exited Vehicle, ECM Malfunction, ECM Request, Engine Coolant Temperature Out of Range, Hood Ajar, Hybrid/EV Power Conditions, Hybrid/EV Battery Pack Contactor Open, Hybrid/EV Battery Pack Power Low, Hybrid/EV Battery Pack State of Charge Low, Hybrid/EV Battery Pack Voltage Low, Hybrid/EV Propulsion System Inactive, Not Commanded, Run/Crank Not Active, System Malfunction, Transmission Range.
Autostart Reason	Engine Idling	No	This parameter displays Yes if one of the following Autostart Reason is detected. A/C Request, Acceleration Request, Accelerator Pedal Pressed, Auxiliary Transmission Fluid Pump Not Available, Brake Booster Weak Vacuum, Brake Pedal Released, Clutch Pedal Applied, Control Function Active, Drive Motor Inverter Temperature High, Drive Motor Temperature High, Driver Exited Vehicle, ECM Request, Engine Coolant Temperature Out of Range, Hood Ajar, Hybrid/EV Battery Module Voltage Low, Hybrid/EV Battery Pack Power Low, Hybrid/EV Battery Pack State of Charge Low, Hybrid/EV Battery Pack Temperature, Hybrid/EV Battery Pack Voltage Low, Hybrid/EV Propulsion System Inactive, Ignition Switch Start, Inclination, Invalid Data Received, Low Voltage Battery Discharge Current High, Low Voltage Battery State of Function Low, Low Voltage Battery State of Health Low, Low Voltage Battery Voltage Low, Maximum Autostop Time Exceeded, Minimum Engine Run Time Not met, Reduced Engine Power Active, Remote Vehicle Start

Parameter	System State	Expected Value	Description
			Request, Stop/Start Select Switch, System Malfunction, System Optimization, System Voltage Low, TCM Demand, Tow/Haul Mode Switch ON, Transmission Fluid Temperature Out of Range, Transmission In Reverse, Transmission Range, Vehicle Speed Too High.
Autostop Disable Reason	Engine Idling	No	The scan tool displays Yes if one of the following Autostop Disable Reason is detected. 12 V Start Counter Exceeded, A/C Request, Acceleration Request, Accelerator Pedal Pressed, Auxiliary Transmission Fluid Pump Not Available, Brake Booster Weak Vacuum, Brake Pedal Released, Clutch Pedal Applied, Control Function Active, Drive Motor Inverter Temperature High, Drive Motor Temperature High, ECM Request, Engine Coolant Temperature Out of range, Engine Speed High, Generator Load High, Hood Ajar Hybrid/EV Battery Module Voltage Low, Hybrid/EV Battery Pack Power Low, Hybrid/EV Battery Pack State of Charge Low, Hybrid/EV Battery Pack Temperature, Hybrid/EV Battery Pack Voltage Low, Hybrid/EV Propulsion System Inactive, Idle Boost Mode Active, Ignition Switch Start, Intake Manifold Weak Vacuum, Invalid Data Received, Low Voltage Battery Discharge Current High, Low Voltage Battery State of Charge Low, Low Voltage Battery State of Function Low, Low Voltage Battery State of Health Low, Low Voltage Battery Temperature Out of Range, Low Voltage Battery Voltage Low, Maximum Vehicle Stop Time Exceeded, Minimum

Parameter	System State	Expected Value	Description
			Engine Run Time Not Met, Reduced Engine Power Active, Remote Vehicle Start Request, Run/Crank Not Active, Stop/Start Select Switch, System Optimization, System Voltage Low, TCM Request, Tow/Haul Mode Switch ON, Transmission Fluid Temperature Out of Range, Transmission in Reverse, Transmission Range, Vehicle Inclination, Vehicle Speed Threshold Not Reached, Vehicle Speed Too High, Wheel Slip Detected.
Axle Torque	Engine Idling	Â	This parameter displays the Axle Torque value sent from the hybrid control processor (HCP) to the ECM and anti-lock brake system (ABS) module.
BARO	Engine Idling	65-104 kPa (8-16 psi)	This parameter displays the barometric pressure. The control module uses the barometric pressure sensor input for fuel control to compensate for altitude differences.
BARO Sensor	Engine Idling	2.5-4.0 Volts	This parameter displays the barometric pressure sensor voltage.
Battery State of Charge	Ignition ON	%	This parameter displays the Battery State of Charge (SOC). SOC is a calculated value provided by an intelligent battery sensor (IBS).
Battery State of Health	Ignition ON	%	This parameter displays the Battery State of Health (SOH). SOH is a calculated value provided by an intelligent battery sensor (IBS).
Boost Pressure	Engine Idling	kPa	This parameter shows the Turbocharger boost pressure in kPa.
Boost Pressure Sensor	Engine Idling	kPa	This parameter shows the Turbocharger boost pressure in kPa.
Boost Pressure Sensor	-	Volts	This parameter displays the turbocharger boost pressure sensor in voltage.
Brake Booster Pressure Sensor	Engine Idling	Volts	This parameter displays the brake booster vacuum pressure analog input as a percentage of its

Parameter	System State	Expected Value	Description
			reference voltage.
Brake Booster Pressure Sensor	Engine Idling	kPa	This parameter displays the undefaulted, unfiltered brake booster vacuum pressure measured by a sensor.
Brake Pedal Position Circuit Signal	Ignition ON	Closed	This parameter displays the serial data message of the brake signal from the electronic brake and traction control module (EBTCM).
Brake Pedal Position Circuit Signal	-	Released	This parameter displays the displacement of the brake pedal.
Brake Pedal Position Sensor	Ignition ON	%	This parameter displays the displacement of the brake pedal, where 0% corresponds to the brake pedal being released and 100% corresponds to the brake pedal being fully applied.
Brake Pedal Position Sensor	Ignition ON	Volts	This parameter displays the brake pedal position as indicated by the analog sensor as a percentage of its reference voltage.
Brake Pedal Position Sensor Fully Released Learn Status	Ignition ON	Complete	This parameter displays the brake pedal fully released learn position status.
Brake Pedal Position Sensor Learned Released Position	Ignition ON	Volts	This parameter displays the position learned for the brake pedal position sensor when the brake pedal is fully released.
Brake Pedal Position Sensor Signal	Ignition ON	Released	This parameter displays the serial data message of the brake position sensor signal from the electronic brake and traction control module (EBTCM).
Calculated Air Flow	Engine Idling	G/S	This parameter contains the mass airflow determined from the speed density (MAP based) calculation of air mass per cylinder.
Calculated BARO	Engine Idling	kPa/psi 97.2 kPa/14.1 psi at idle	This parameter contains an estimate of barometric pressure, used to correlate with sensed ambient air pressure in the Barometric Pressure Correlation Diagnostic.
Calculated Catalyst Temperature or	Engine Idling	Approximately 552Â°C (1026Â°F)	This parameter contains the estimated catalyst temperature (as a function of engine speed, engine

Parameter	System State	Expected Value	Description
Calculated Catalyst Temperature Bank 1 or Bank 2			airflow, and fuel ethanol percentage) for use in the oxygen sensor and catalyst monitor diagnostic algorithms.
Calculated Engine Oil Temperature	Engine Idling	105Â°C (221Â°F)	This parameter displays the estimated engine oil temperature (as a function of engine coolant temperature and other parameters).
Calibration History Buffer	Ignition ON	Unlocked	This parameter displays locked when the buffer has been locked against further updates due to detection of a non-production calibration.
Calibration Verification Number History 1-10	Ignition ON	#	This parameter displays the history entries for the primary calibration part in the controller.
Camshaft Position Active Counter	Ignition ON	Counts	This parameter displays a rolling count of the number of primary cam position sensor pulses.
Camshaft Position Sensor	Engine Idling	0 RPM	This parameter displays the speed of the engine as calculated by the signal from a camshaft position (CMP) sensor. This parameter will always display 0 unless a condition with the CKP sensor or CKP reluctor exists. If a CKP condition exists the control module will use a valid CMP sensor signal to determine engine speed and crank/camshaft position.
Camshaft Position Signal Output Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the state of the Camshaft Position Signal Output Circuit. The parameter displays Malfunction if the Camshaft Position Signal Output Circuit is shorted to voltage.
Camshaft Position Signal Output Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the Camshaft Position Signal Output Circuit. The parameter displays Malfunction if the Camshaft Position Signal Output Circuit is shorted to ground.
Camshaft Position Signal Output Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the Camshaft Position Signal Output Circuit. The parameter

Parameter	System State	Expected Value	Description
			displays Malfunction if the Camshaft Position Signal Output Circuit is open.
Catalyst Monitor Complete	Engine Idling	Yes/No	This parameter indicates the status of the Catalyst. The scan tool displays YES when the diagnostic is complete. And NO if the diagnostic has not run, or a malfunction is detected in the catalyst.
Catalyst Monitor Complete This Ignition Cycle	Engine Idling	Yes/No	This parameter indicates the status of the catalyst monitor diagnostic. Catalyst Monitor Test Running indicates yes or no when the catalyst monitor diagnostic is actively running a test.
Catalyst Monitor Enabled	Engine Idling	Yes/No	The scan tool displays YES when the Catalyst Monitor is Enabled. If the scan tool displays NO this could indicate a malfunction in the Catalyst Monitor circuit.
Catalyst Monitor Enabled this Ignition Cycle	Engine Idling	Yes-No	This parameter displays the monitor enable status during the current driving/monitoring cycle.
Catalyst Monitor Not At Idle Test Conditions Met	Engine Idling	Yes/No	This parameter indicates the status of the catalyst monitor diagnostic. Catalyst Monitor Test Running indicates yes or no when the catalyst monitor diagnostic is actively running a test.
Catalyst Monitor Test Counter or Catalyst Monitor Test Counter Bank 1 or 2	Engine Idling	Counts	This parameter contains the number of repeated results of the catalyst monitor diagnostic test that have been performed since a code clear (used to determine if a sufficient number of tests have run to report a passing condition).
Catalyst Monitor Test Result or Catalyst Monitor Test Result Bank 1 or 2	Engine Idling	No Decision/Failed /Passed	This parameter indicates the status of the catalyst monitor diagnostic. Multiple tests may run before the diagnostic reports a "Pass" or "Fail" and will be tracked by Catalyst Monitor Diagnostic Test Counter. When this Parameter reports a "Pass" or "Fail", the diagnostic is complete for the current trip and

Parameter	System State	Expected Value	Description
			will not attempt any further tests.
Catalyst Monitor Test State	Engine Idling	Active/Inactive	This parameter indicates the status of the catalyst monitor diagnostic by displaying active or inactive. This test will only run with the engine at idle.
Change Engine Oil Indicator Command	Ignition ON	Off	This parameter sends a signal through the serial communication to inform the driver to change the engine oil. It is based on a calibrated amount of time.
Charge Air Cooler Coolant Pump Relay Command	Ignition ON	Off	This parameter displays the commanded state of the intercooler pump relay command.
Charge Air Cooler Coolant Pump Relay Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the charge air cooler coolant pump control circuit. The parameter displays Malfunction if the charge air cooler coolant pump control circuit is shorted to voltage.
Charge Air Cooler Coolant Pump Relay Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the charge air cooler coolant pump control circuit. The parameter displays Malfunction if the charge air cooler coolant pump control circuit is shorted to ground.
Charge Air Cooler Coolant Pump Relay Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the charge air cooler coolant pump control circuit. The parameter displays Malfunction if the charge air cooler coolant pump control circuit is open.
Clutch Pedal Starter Inhibit Switch (If Equipped)	Engine Idling	On	This parameter displays ON when the clutch pedal is released.
Clutch Pedal Switch (If Equipped)	Engine Idling	Released	This parameter displays the state of the clutch pedal as determined by the control module from the clutch pedal switch.
Cold Startup	Ignition ON	No	This parameter displays whether the engine meets the conditions for a cold startup during the present ignition cycle. The scan tool displays Yes when the conditions for a cold startup are met during the

Parameter	System State	Expected Value	Description
			ignition cycle. The scan tool displays No when the conditions for a cold startup are not met during the present ignition cycle. Conditions for a cold startup require the coolant temperature and the intake air temperature to be below a predetermined temperature and within a certain range of each other. These conditions must occur after the engine was warmed up to a specific temperature during the previous ignition cycle.
Component Monitor Complete	Ignition ON	Yes/No	This parameter displays Yes when the Component Monitor is Complete. The engine control module looks at many input and output components to make this determination. If a malfunction is detected the scan tool will display No.
Component Monitor Enabled	Ignition ON	Yes/No	This parameter displays Yes when Component Monitor is Enabled. And No when it is not Enabled.
Cooling Fan Command	-	%	This parameter displays the amount of fan power commanded as a percentage of the total fan power available.
Cooling Fan Motor Command	-	%	This parameter displays the commanded duty cycle for the cooling fan.
Cooling Fan Relay 1 Command	Ignition ON	On	This parameter displays the commanded state of the fan relay 1 control circuit. The cooling fan relay 1 should be ON when the scan tool indicates the FC Relay 1 Command is ON. The cooling fan relay 1 should be OFF when the scan tool indicates the FC Relay 1` Command is OFF.
Cooling Fan Relays 2 and 3 Command	Ignition ON	On	This parameter displays the commanded state of the fan relay 2 output.
Cooling Fan Relay 1 Control Circuit Open Test	Ignition ON	OK	This parameter displays the state of the cooling fan relay control circuit.

Parameter	System State	Expected Value	Description
Status			The parameter displays Malfunction if the cooling fan relay control circuit is open.
Cooling Fan Relay 1, or 2 and 3 Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the cooling fan relay control circuit. The parameter displays Malfunction if the cooling fan relay control circuit is shorted to voltage.
Cooling Fan Relay 1, or 2 and 3 Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the cooling fan relay control circuit. The parameter displays Malfunction if the cooling fan relay control circuit is shorted to ground.
Cooling Fan Speed	Ignition ON	Varies	This parameter displays the current state of the cooling fan speed. (For example OFF, Low, Medium, or High) rather than rotational speed.
CPP Learn Status	Ignition ON	Learned	This parameter displays the status of the procedure used to learn the clutch pedal fully applied position.
CPP Learned Apply Position	Ignition ON	Volts	This parameter displays the position learned for the clutch pedal position sensor when the clutch pedal is fully applied during the associated learn procedure.
CPP Learned Release Position	Ignition ON	Volts	This parameter displays the position learned for the clutch pedal position sensor when the clutch pedal is released.
CPP Sensor	Ignition ON	Volts	This parameter displays the clutch pedal position sensor analog input as a percentage of its reference voltage.
CPP Sensor	Ignition ON	%	This parameter displays the position learned for the clutch pedal position sensor when the clutch pedal is fully applied during the associated learn procedure.
Crank Request Signal	Ignition switch not in the crank position	No	This parameter displays whether the ignition switch has been cycled to the crank position requesting the control module to activate the starter relay.
	Ignition switch in the crank position	Yes	

Parameter	System State	Expected Value	Description
Crankshaft Position Active Counter	Engine Idling	0-255 Counts	This parameter displays an incrementing counter when the control module receives a signal from the crankshaft position sensor (CKP).
Crankshaft Position Learned Apply Position	Ignition ON	Volts	This parameter displays the position learned for the clutch pedal position (CPP) sensor when the clutch pedal is fully applied during the associated learn procedure.
Crankshaft Position Learned Release Position	Ignition ON	Volts	This parameter displays the position learned for the clutch pedal position sensor when the clutch pedal is released.
Crankshaft Position Resync Counter	Engine Idling	0 Counts	This parameter displays the number of times the control module has to resynchronize with the CKP sensor. The parameter will begin to increment if the control module does not detect a CKP reference pulse. The parameter will reset to 0 after the ignition is switched OFF.
Crankshaft Position Sensor	Engine Idling	RPM	This parameter displays engine speed.
Crankshaft Position Sensor	Ignition ON	Volts	This parameter displays the displacement of the clutch pedal (corrected and normalized based upon its learned released and fully applied positions), where 0% corresponds to the clutch pedal being released and 100% corresponds to the clutch pedal being fully applied.
Crankshaft Position Sensor	Ignition ON	%	This parameter displays the clutch pedal position sensor analog input as a percentage of its reference voltage.
Crankshaft Position Signal Output Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the crankshaft position signal output circuit. The parameter displays Malfunction if the crankshaft position signal output circuit is shorted to voltage.
Crankshaft Position Signal Output Circuit	Ignition ON	OK	This parameter displays the state of the crankshaft position signal output

Parameter	System State	Expected Value	Description
Low Voltage Test Status			circuit. The parameter displays Malfunction if the crankshaft position signal output circuit is shorted to ground.
Crankshaft Position Signal Output Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the crankshaft position signal output circuit. The parameter displays Malfunction if the crankshaft position signal output circuit is open.
Crankshaft Position Variation Learn	Ignition ON	Not Learned	This parameter displays if the crank angle learned this key cycle.
Crankshaft Position Variation Learn Crank Pulse to Cylinder Count	Ignition ON	Counts	This parameter displays the number of attempts to learn the crank angle sensing error (CASE) during the current key cycle.
Crankshaft Position Variation Learn Crank Pulse to Cylinder Count	Ignition ON	Agree	This parameters displays the number of crank pulses observed over an engine cycle did not equal the number of cylinders for the engine at some point during the CASE learn cycle.
Crankshaft Position Variation Learn Required Engine Speed	Ignition ON	In Range	This parameter displays that the engine speed required to complete the CASE learn process has not been achieved.
Crankshaft Position Variation Learn Status	Ignition ON	Complete	This parameter displays the status of the crank angle sensing error (CASE) learn algorithm.
Cruise Control	Cruise ON	Active	This parameter displays the status of the cruise control system as determined by the control module.
Cruise Control Acceleration Switch	Ignition ON	Active, Inactive, Invalid	This parameter Indicates the state of the cruise control speed ACCEL switch. This signal is based upon the state of the cruise control speed ACCEL switch received over serial communication from the platform electronics.
Cruise Control Cancel Switch	Cruise ON	Inactive	This parameter displays the status of the cruise control cancel switch.
Cruise Control Disengage 1-8 History	Cruise ON	Reason for Cruise Disengagement	The parameter displays the last 8 cruise control disengages in order from 1 to 8, with 8 being the most recent. There are approximately 30

Parameter	System State	Expected Value	Description
			possible causes for the cruise control to disengage.
Cruise Control Inhibit Reason	Cruise OFF	Off	The parameter displays the reason the cruise control system cannot engage.
	Cruise ON	Park/Neutral	
Cruise Control ON/OFF Switch	Cruise ON	On	The engine control module (ECM) monitors the signal circuit of the cruise control switch. A closed switch is displayed as ON.
Cruise Control Resume/Accelerator Switch	Cruise ON	On	The scan tool displays ON, when the cruise ON/OFF switch is ON and the resume/accel (+) button is pressed, the ECM detects a predetermined voltage value for the resume/accel. switch.
Cruise Control Set/Coast Switch	Cruise ON	On	The scan tool displays ON, when the cruise ON/OFF switch is ON and the ECM detects a predetermined voltage value for the set/coast (-) switch.
Cruise Control Switch	Cruise ON	Inactive	The engine control module (ECM) monitors the signal circuit of the cruise control switch. A closed switch is displayed as Active.
Current Fuel Type	Ignition ON	Varies	This parameter displays the current fuel type such as Not available, Gasoline/petrol, Methanol, Ethanol, Diesel, Liquefied Petroleum Gas, Compressed Natural Gas, Propane, Battery/electric, Bi-fuel, or Hybrid.
Current Gear	Transmission in Park/Neutral	P/N	This parameter displays the transmission gear commanded by the transmission control module.
	Transmission not in Park/Neutral	Reverse/1st-5th	
Current Gear When Engine Overspeed Detected	Engine Idling	Varies	This parameter displays the transmission actual gear observed upon initial detection of an overspeed condition.
Cycles of Misfire Data	Engine Running	0-3,000 counts	This parameter displays the number of cylinder firing events recorded by the control module.
Cylinder 1,2,3,4,5,6,7,8 Current Misfire Counter	Engine Idling	Counts	The scan tool displays a range of 0-255 counts. This parameter displays the number of misfires that have been detected during the last

Parameter	System State	Expected Value	Description
			255 cylinder firing events. The counters may normally display some activity, but the activity should be nearly equal for all of the cylinders, and in low numbers.
Cylinder 1,2,3,4,5,6,7, or 8 History Misfire Counter	Engine Running	Counts	The scan tool displays a range of 0-65,535 counts. The misfire history counters display the total level of misfire that has been detected on each cylinder. The misfire history counters will not update or show any activity until a misfire DTC P0300 has become active. The misfire history counters will update every 255 cylinder firing events.
Cylinder 1, 2, 3, 4, 5, 6, 7 or 8 Injector Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the injector control circuit. The parameter displays Malfunction if the injector control circuit is shorted to voltage.
Cylinder 1, 2, 3, 4, 5, 6, 7 or 8 Injector Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the injector control circuit. The parameter displays Malfunction if the injector control circuit is shorted to ground.
Cylinder 1, 2, 3, 4, 5, 6, 7 or 8 Injector Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the injector control circuit. The parameter displays Malfunction if the injector control circuit is open.
Cylinder 1, 2, 3, 4, 5, 6, 7 or 8 Injector Flow Identifier	Ignition ON	OK	This parameter displays the End of Line Injector Adjustment (EIA) for the fuel injector. This value shall be used by the ECM for adjustment to actual fuel injected quantity compared to nominal for the injector.
Cylinder 1-6 Injector Control Circuit Status	Engine Idling	OK	This parameter displays the state of the fuel injector control circuit.
Cylinder 1-6 Injector Disabled Misfire Detected	Engine Idling	No	This parameter displays the injector that has been disabled by the misfire catalyst converter protection calibration.
Cylinder 1-6 Knock Detected	Engine Idling	No	This parameter displays yes if a knock has been detected in an individual cylinder.

Parameter	System State	Expected Value	Description
Deceleration Fuel Cut-Off	Engine Idling	Inactive	This parameter displays the status of the operating mode of the control module used to turn OFF the fuel injectors and the EVAP canister purge valve during certain deceleration conditions.
Desired Boost Pressure	-	kPa	This parameter displays the desired turbocharger boost pressure.
Desired ECT	Ignition ON	Â°C (Â°F)	This parameter displays the desired engine coolant temperature in degrees.
Desired Exhaust Camshaft Position or Desired Exhaust Camshaft Position Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays the desired exhaust camshaft angle as commanded by the control module.
	Engine speed at 2000 RPM	10 Degrees	
Desired Fuel Rail Pressure	Engine Idling	Varies 3.4 mPa to 5.5 mPa (500 to 800 psi)	This parameter displays the desired Fuel Rail Pressure commanded by the control module.
Desired Idle Speed	Engine Idling	Approximately 650 RPM	This parameter displays the desired engine idle speed as commanded by the control module. The desired idle speed varies depending on engine load.
Desired Intake Camshaft Position or Desired Intake Camshaft Position Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays the desired intake camshaft angle as commanded by the control module.
	Engine speed at 2000 RPM	10 Degrees	
Desired Throttle Position	Engine Idling	%	Commanded Throttle Actuator Control.
Distance Since DTC Cleared	Engine Idling	0 Km/mi	This parameter displays in kilometers or miles the distance traveled since a DTC was cleared.
Distance Since First Malfunction	Engine Idling	0 Km/mi	This parameter displays in kilometers or miles the distance traveled since a Malfunction occurred.
Distance Since Last Malfunction	Engine Idling	0 Km/mi	This parameter displays the distance accumulated since last malfunction was captured. This parameter is only meaningful within the context of a failure record or freeze frame.

Parameter	System State	Expected Value	Description
Distance Since Last Oil Level Warning	Engine Idling	0 Km/mi	This parameter displays in kilometers or miles the distance traveled since the last oil level warning Malfunction occurred.
Distance Since Last Oil Pressure Warning	Engine Idling	0 Km/mi	This parameter displays in kilometers or miles the distance traveled since the last oil pressure warning Malfunction occurred.
Distance Since Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	0 Km/mi	This parameter displays in kilometers or miles the distance Since Recommended Maximum Fuel Alcohol Content Exceeded.
Distance This Driving Cycle	Ignition ON	km / miles	This parameter displays the distance a vehicle has traveled in the current driving cycle.
Distance with MIL On	Ignition ON	km / miles	This parameter displays the accumulated distance driven with the malfunction indicator lamp (MIL) on.
Drag Control Status	Vehicle Moving	Active/Inactive	EDC Active (Drag Active) control mode is indicated when the requested torque signal is above the driver requested value while the traction control system signal input is active.
Driver Requested Axle Torque	Engine Idling	Â	This parameter displays a (desired) output value after comparing engine load as an input to the hybrid control processor and engine control module.
Drop-Throttle Detected while Traction Control Active	Engine Idling	No	This parameter displays if the Drop Throttle Control Mode is active while the Traction Control System Data Control Signal input is active.
Drop-Throttle Status	Engine Idling	Inactive	This parameter displays the Drop Throttle Control Mode is active when the Requested Torque Signal indicates greater than 90 percent duty cycle while the Traction Control System Data Control Signal input is active.
ECM Authentication Status	Ignition ON	Valid	ECM Authentication Status indicates the result of the comparison between the last received immobilizer response and

Parameter	System State	Expected Value	Description
			the expected response calculated into the ECM.
ECM Challenge Status	Ignition ON	Valid	This parameter displays the immobilizer system status of the ECM challenge. This indicates whether the currently calculated ECM challenge is valid.
ECM in Immobilizer Fail Enable Mode	Ignition ON	Yes / No	This parameter displays that a serial communication failure has been detected after the receipt of the correct VTD password.
ECM Response Source	Ignition ON	Ignition Switch Start	ECM Response Source indicates the source used to calculate the ECM response.
Economy Mode Indicator Command	Ignition ON	Off	This parameter indicates the status of the serial data signal used to illuminate the economy mode indicator lamp.
ECT Sensor	Ignition ON	88 to 105Â°C (190 to 221Â°F)	This parameter displays the temperature of the engine coolant based on input to the control module from the engine coolant temperature (ECT) sensor.
ECT vs. IAT Sensor Temperature at Last ECT vs. RCT Malfunction Detection	Ignition ON	Agree	This parameter displays that the temperature values of the ECT and IAT sensors did not agree at the time of the most recent failure of the ECT/RCT rationality diagnostic.
EGR/Camshaft Position Monitor Complete	Ignition ON	Yes/No	This parameter displays the status of the EGR/Camshaft Position Monitor. The parameter will display Yes when the EGR/Camshaft Position Monitor is complete.
EGR/Camshaft Position Monitor Complete This Ignition Cycle	Engine Idling	Yes/No	This parameter displays Yes or No of the completion status during the current driving/monitoring cycle of emission related monitors.
EGR/Camshaft Position Monitor Enabled	Ignition ON	Yes/No	This parameter displays the status of the EGR/Camshaft Position Monitor. The parameter will display Yes when the EGR/Camshaft Position Monitor is Enabled.
EGR/Camshaft Position Monitor Enabled This Ignition Cycle	Engine Idling	Yes/No	This parameter displays Yes or No of the completion status during the current driving/monitoring cycle of

Parameter	System State	Expected Value	Description
			emission related monitors.
Electric Power Management Inhibit Reason	Engine Idling	None	This parameter displays the reason for the source of the Regulated Voltage Control (RVC) override command. RVC lowers system operating voltage to reduce system electrical load and improve fuel economy performance. The following is a list of possible reasons: • None • Control Function • Active/Fuel System • On-board Diagnostic System • Air Flow Measurement System • Cylinder Deactivation System • System Transmission Control Module
Engine Autostopped	-	No	This parameter displays the status of the internal combustion engine (ICE) in vehicles incorporating ICE autostart/stop functionality.
Engine Calibration Part Number History 1-10	Ignition ON	#	This parameter displays the engine calibration part number history.
Engine Calibration Part Number History 1-10 Counter	Ignition ON	#	This parameter displays the number of times the engine controller had been calibrated.
Engine Controls Ignition Relay Command	Ignition ON	Off	This parameter displays the state of the control circuit for control module power relay as commanded by the control module.
Engine Controls Ignition Relay Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the Engine Controls Ignition Relay control circuit. The parameter displays Malfunction if the Engine Controls Ignition Relay control circuit is shorted to voltage.
Engine Controls Ignition Relay Controls Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the Engine Controls Ignition Relay control circuit. The parameter displays Malfunction if the Engine

Parameter	System State	Expected Value	Description
			Controls Ignition Relay control circuit is shorted to ground.
Engine Controls Ignition Relay Controls Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the Engine Controls Ignition Relay control circuit. The parameter displays Malfunction if the Engine Controls Ignition Relay control circuit is open.
Engine Controls Ignition Relay Feedback Signal	Ignition ON	12.0-14.9 Volts	This parameter displays the voltage available at the engine controls ignition relay terminal of the engine control module.
Engine Coolant Thermostat Heater Command	Ignition ON	%	This parameter displays the commanded duty cycle for the engine coolant thermostat.
Engine Coolant Thermostat Heater Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the engine coolant thermostat heater control circuit. The parameter displays Malfunction if the engine coolant thermostat heater control circuit is shorted to voltage.
Engine Coolant Thermostat Heater Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the engine coolant thermostat heater control circuit. The parameter displays Malfunction if the engine coolant thermostat heater control circuit is shorted to ground.
Engine Coolant Thermostat Heater Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the engine coolant thermostat heater control circuit. The parameter displays Malfunction if the engine coolant thermostat heater control circuit is open.
Engine Load	Engine Idling	25-45 %	This parameter displays the calculated engine load in percent based on inputs to the control module from various engine sensors.
	Engine speed at 2,500 RPM	40-60 %	
Engine Load During Misfire History 1-10	Ignition ON	%	This parameter displays the engine load during the last misfire event.
Engine Off	-	No	This parameter displays the status of the internal combustion engine (ICE) in vehicles incorporating ICE autostart/stop functionality.

Parameter	System State	Expected Value	Description
Engine OFF Time	Engine Idling	0:00:00 Seconds - Varies	This parameter displays the amount of time that has elapsed since the engine was last cycled OFF.
Engine Oil Absolute Pressure Sensor	Engine Idling	kPa/PSI	This parameter displays the undefaulted, unfiltered measured engine oil pressure read by an oil absolute pressure sensor.
Engine Oil Level Switch	Engine Idling	OK	This parameter displays the status of the engine oil level switch as determined by the control module. The control module uses this information to turn on the low engine oil lamp if the engine oil level remains approximately 1 quart low for a sufficient amount of time. The scan tool will display Low when the engine oil level is low. The scan tool will display OK when the engine oil level is correct.
Engine Oil Life Remaining	Engine Idling	0-100 %	This parameter displays the percent of engine oil life remaining. The controller calculates the engine oil life by monitoring engine load, coolant temperature, and engine speed.
Engine Oil Pressure	Engine Idling	kPa/PSI	This parameter displays the actual engine oil pressure measured by a sensor.
Engine Oil Pressure Control Solenoid Valve Command	Ignition ON	High Pressure/Low Pressure	This parameter displays the commanded state of the variable displacement oil pump output.
Engine Oil Pressure Control Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the engine oil pressure control solenoid valve control circuit. The parameter displays Malfunction if the engine oil pressure control solenoid valve control circuit is shorted to voltage.
Engine Oil Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the engine oil pressure control solenoid valve control circuit. The parameter displays Malfunction if the c engine oil pressure control solenoid valve control circuit is shorted to ground.

Parameter	System State	Expected Value	Description
Engine Oil Pressure Control Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the engine oil pressure control solenoid valve control circuit. The parameter displays Malfunction if the engine oil pressure control solenoid valve control circuit is open.
Engine Oil Pressure Sensor	Engine Idling	OK	This parameter displays the engine oil pressure as determined by engine oil pressure sensor.
Engine Oil Temperature Sensor	Ignition ON	CÂ° (Â°F)	This parameter displays engine oil temperature as measured by a sensor connected to the ECM.
Engine Oil Temperature When Engine Overspeed Detected	Engine Idling	Temperature	This parameter displays the temperature of the engine oil as determined by the control module.
Engine Overspeed	Engine Idling	Not Present	This parameter displays if an Engine Overspeed is Present or Not Present.
Engine Overspeed Counter	Ignition ON	Counts	This parameter displays the accumulated number of engine overspeed detection events.
Engine Run Time	Engine Idling	0:00:00 Increments when the engine is operating	This parameter displays the time elapsed since the engine was started.
Engine Running	-	No	This parameter displays the status of the internal combustion engine (ICE) in vehicles incorporating ICE autostart/stop functionality.
Engine Serial Number	Ignition ON	#	This parameter displays the engine serial number.
Engine Shutdown Counter - Excessive Idle Time	Ignition ON	Counts	This parameter displays the count of engine shutdowns due to excessive idle time.
Engine Shutdown Counter - High Coolant Temperature	Ignition ON	Counts	This parameter displays the count of engine shutdowns due to high coolant temperature.
Engine Shutdown Counter - Low Coolant Level	Ignition ON	Counts	This parameter displays the count of engine shutdowns due to low coolant level.
Engine Shutdown Counter - Low Oil Level	Ignition ON	Counts	This parameter displays the count of engine shutdowns due to low oil level.

Parameter	System State	Expected Value	Description
Engine Speed	Engine Cranking	Greater than 60 RPM	This parameter displays the speed of the engine crankshaft rotation from information received from the crankshaft position (CKP) sensor. If there is a CKP sensor DTC, the ECM calculates the engine speed from one of the camshaft position (CMP) sensors.
	Engine Idling	550-700 RPM	
Engine Speed During Misfire History 1-5	Ignition ON	RPM	This parameter displays the last 5 engine speeds during misfire events.
Engine Speed When Engine Overspeed Detected	Engine Idling	RPM	This parameter displays the engine speed observed upon initial detection of an overspeed condition. This value will be updated after each overspeed condition.
Engine Stalled	Ignition ON	No	This parameter displays that the internal combustion engine has stopped running unintentionally.
Engine Starting	Ignition ON	No	This parameter displays that the internal combustion engine is being started (in transition from engine OFF to engine running).
Engine Stopping	Ignition ON	No	Engine Stopping indicates that the internal combustion engine is stopping (in transition from engine running to engine off, OR in transition from engine running to engine failed).
Engine Torque Command	Engine Idling	Â	This parameter displays the commanded predicted engine torque value, which is the torque request for the slow response air path (control of the throttle).
EVAP Malfunction History	Engine Running	None	This parameter displays the result of the evaporative emission (EVAP) system as determined by the control module. The scan tool will display the following: • None • Excess Vacuum • Purge Valve Leak • Small Leak • Weak Vacuum

Parameter	System State	Expected Value	Description
			• No Test Result
EVAP Monitor Complete	Engine Running	Yes/No	This parameter displays if the most recent evaporative emissions diagnostic test is complete.
EVAP Monitor Complete This Ignition Cycle	Engine Running	Yes/No	This parameter displays the diagnostic monitor completion status during the current driving/monitoring cycle.
EVAP Monitor Enabled	Engine Running	Yes/No	This parameter displays if the evaporative emissions diagnostic test is enabled.
EVAP Monitor Enabled This Ignition Cycle	Engine Running	Yes/No	This parameter displays the diagnostic monitor enable status during the current driving/monitoring cycle.
EVAP Purge Solenoid Valve Command	Engine Idling	%	This parameter displays the commanded duty cycle for the canister purge output.
EVAP Purge Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the evaporative emission (EVAP) purge solenoid control circuit. The parameter displays Malfunction if the EVAP purge solenoid control circuit is shorted to voltage.
EVAP Purge Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the evaporative emission (EVAP) purge solenoid control circuit. The parameter displays Malfunction if the EVAP purge solenoid control circuit is shorted to ground.
EVAP Purge Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the evaporative emission (EVAP) purge solenoid control circuit. The parameter displays Malfunction if the EVAP purge solenoid control circuit is open.
EVAP Vent Solenoid Command	Engine Idling	Not Venting	This parameter displays the state of the control circuit for evaporative emission (EVAP) vent solenoid as commanded by the control module.
EVAP Vent Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the EVAP vent solenoid control circuit. The parameter displays Malfunction if the EVAP vent

Parameter	System State	Expected Value	Description
			solenoid control circuit is shorted to voltage. This parameter may not change if the scan tool is used to command the EVAP vent solenoid ON.
EVAP Vent Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the EVAP vent solenoid control circuit. The parameter displays Malfunction if the EVAP vent solenoid control circuit is shorted to ground. This parameter may not change if the scan tool is used to command the EVAP vent solenoid ON.
EVAP Vent Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the EVAP vent solenoid control circuit. The parameter displays Malfunction if the EVAP vent solenoid control circuit is open. This parameter may not change if the scan tool is used to command the EVAP vent solenoid ON.
Exhaust Camshaft Position	Engine Idling	Â°	This parameter displays the position of the exhaust camshaft in terms of degrees of camshaft rotation (retard) from the park position (a value of zero represents the park position).
Exhaust Camshaft Position Active Counter or Exhaust Camshaft Position Active Counter Bank 1 or 2	Engine Idling	0-255	This parameter displays an incrementing counter when the control module receives a signal from the exhaust camshaft position (CMP) sensor.
Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status or Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the exhaust camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is shorted to voltage.

Parameter	System State	Expected Value	Description
Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status or Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the exhaust camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is shorted to ground.
Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status or Exhaust Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the exhaust camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is open.
Exhaust Camshaft Position or Exhaust Camshaft Position Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays the actual exhaust camshaft position in degrees.
	Engine speed at 2000 RPM	10 Degrees	
Exhaust Camshaft Position Command or Exhaust Camshaft Position Command Bank 1 or 2	Engine Idling	20 %	This parameter displays the on-time or duty cycle of the exhaust camshaft position (CMP) actuator solenoid valve as commanded by the control module.
	Engine speed at 2000 RPM	50 %	
Exhaust Camshaft Position Variance or Exhaust Camshaft Position Variance Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays in degrees, the difference between the desired exhaust camshaft position and the actual exhaust camshaft position.
	Engine speed at 2000 RPM	0 Degrees	
Extended Travel Brake Pedal Position Signal	Engine Idling	Released	This parameter displays the status of the Extended Travel Brake Pedal Position sensor.
Extended Travel Brake Pedal Switch	Ignition ON	Released	This parameter displays the undebounced / undefaulted state of the extended travel brake switch input to the ECM

Parameter	System State	Expected Value	Description
Freeze Frame DTC	Ignition ON	#	This parameter displays the diagnostic trouble code (DTC) that caused the freeze frame to be stored.
Fuel Alcohol Content	Engine Idling	%	This parameter displays the percentage of alcohol in the fuel. The value is calculated by the ECM using the fuel composition sensor input.
Fuel Alcohol Content When Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	%	This parameter displays a percentage of Fuel Alcohol Content When Recommended Maximum Fuel Alcohol Content Exceeded.
Fuel Composition Learn	Engine Idling	Inactive	This parameter displays Active or Inactive. Active will be displayed if the ECM is learning the alcohol content of the fuel.
Fuel Composition Sensor	Engine Idling	Hz	This parameter displays the frequency of the fuel composition sensor input. This value can be used to determine fuel composition or sensor malfunction.
Fuel Consumed Since Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	Liters	This parameter displays in Liters the Fuel Consumed Since Recommended Maximum Fuel Alcohol Content Exceeded.
Fuel Control Loop Status	Engine Idling	Closed	Fuel Closed Loop Active indicates that oxygen sensor 1 of each bank is being used as feedback to adjust the amount of fuel delivered to the engine.
Fuel Economy	Engine Idling	Liters per Hour	This parameter displays the instant fuel consumption rate of the engine in liters per hour.
Fuel Economy Mode	Ignition ON	Inactive	This parameter indicates if the economy mode algorithm has activated economy mode.
Fuel Economy Mode Request	Ignition ON	Off	This parameter indicates if the driver of the vehicle has requested economy mode by pressing the economy mode switch.
Fuel Economy Mode Switch	Ignition ON	OK	This parameter displays the state of the fuel economy mode switch circuit. The parameter displays Malfunction if the fuel economy

Parameter	System State	Expected Value	Description
			mode switch circuit is shorted to voltage.
Fuel Economy Mode Switch	Ignition ON	OK	This parameter displays the state of the fuel economy mode switch circuit. The parameter displays Malfunction if the fuel economy mode switch circuit is shorted to ground.
Fuel Economy Mode Switch	Ignition ON	OK	This parameter displays the state of the fuel economy mode switch circuit. The parameter displays Malfunction if the fuel economy mode switch circuit is open.
Fuel Economy Mode Switch	Ignition ON	Volts	This parameter displays the economy mode switch reference voltage.
Fuel Enrichment-Hot Catalyst	Engine Running	Inactive	Fuel Enrichment Catalyst Protection Active indicates fuel is being added to cool the catalytic converter.
Fuel Enrichment-Hot Coolant	Engine Running	Inactive	Hot Coolant Enrichment Active indicates that the conditions to enable hot coolant enrichment are active and that a richer than stoichiometric air/fuel ratio is being commanded in order to help cool the engine when a system malfunction is causing the engine to run at extreme temperatures.
Fuel Injector Driver Supply Voltage	Ignition ON	Volts	This parameter displays the injector driver circuit boost supply voltage.
Fuel Level Sensor	Ignition ON	Volts	This parameter displays the unfiltered fuel level sensor analog input for the primary fuel tank as a percentage of its reference voltage.
Fuel Level Sensor Left Tank (If Equipped)	Ignition ON	0-5 Volts	This parameter displays the voltage signal received by the control module from the secondary fuel level sensor in the left side of the fuel tank.
Fuel Level Sensor Reference Command	Engine Idling	%	This parameter displays the percentage of time that the power supply for the fuel level sensor is on. This percentage is minimized when the fuel has high ethanol content and is maximized when the

Parameter	System State	Expected Value	Description
			fuel has low ethanol content.
Fuel Level Sensor Right Tank (If Equipped)	Ignition ON	0-5 Volts	This parameter displays the voltage signal received by the control module from the primary fuel level sensor in the right side of the fuel tank.
Fuel Maintenance Mode	Ignition ON	Active / Inactive	This parameter displays if the Fuel Maintenance Mode is currently active.
Fuel Maintenance Mode Counter	Ignition ON	Counts	This parameter displays the cumulative number of fuel maintenance mode events over the life of the controller.
Fuel Mode Active	Ignition ON	Gaseous, Gasoline	This parameter displays if the fuel mode algorithm has activated the alternative fuel mode.
Fuel Mode Driver Request	Ignition ON	Gaseous, Gasoline	This parameter displays if the driver of the vehicle has selected one of the two specific fuel modes (alternative fuel, or petrol fuel)
Fuel Mode Indication On	Ignition ON	Gaseous, Gasoline	This parameter displays the status of the signal used to illuminate the fuel mode indicator lamp.
Fuel Mode Indicator Lamp Command	Ignition ON	On / Off	This parameter displays the commanded state of the fuel mode indicator lamp.
Fuel Mode Indicator Lamp Control Circuit High Voltage Test Status	Ignition ON	OK, Malfunction, Not Run	This parameter displays the state of the Fuel Mode Indicator Lamp control circuit. The parameter displays Malfunction if the Fuel Mode Indicator Lamp control circuit is shorted to voltage.
Fuel Mode Indicator Lamp Control Circuit Low Voltage Test Status	Ignition ON	OK, Malfunction, Not Run	This parameter displays the state of the Fuel Mode Indicator Lamp control circuit. The parameter displays Malfunction if the Fuel Mode Indicator Lamp control circuit is shorted to ground.
Fuel Mode Indicator Lamp Control Circuit Open Test Status	Ignition ON	OK, Malfunction, Not Run	This parameter displays the state of the Alternative Fuel Injector 1 control circuit. The parameter displays Malfunction if the Alternative Fuel Injector 1 control circuit is open.

Parameter	System State	Expected Value	Description
Fuel Mode Switch	Ignition ON	mV	This parameter displays the Fuel Mode Switch circuit in voltage.
Fuel Mode Switch Both States Latched	Ignition ON	True, False	This parameter displays true once both the on and off switch states are observed and will remain latched for the current ignition cycle.
Fuel Mode Switch State	Ignition ON	Fault Low, On, Indeterminate, Off, Fault High	This parameter displays the raw fuel mode switch state information.
Fuel Pressure Regulator Control Circuit Command	Engine Cranking or Running	On	This parameter displays the commanded state of the fuel pressure regulator 1 low side output (the output is considered to be commanded ON if the regulator is enabled while the engine is running or cranking).
Fuel Pressure Regulator Control Circuit High Voltage Test	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to voltage in the circuit.
Fuel Pressure Regulator Control Circuit Low Voltage Test	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to ground in the circuit.
Fuel Pressure Regulator Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an open in the circuit.
Fuel Pressure Regulator High Control Circuit	Engine Idling	%	This parameter displays the commanded duty cycle for the fuel

Parameter	System State	Expected Value	Description
Command			pressure regulator 1 solenoid output.
Fuel Pressure Regulator High Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator high control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to voltage in the circuit.
Fuel Pressure Regulator High Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator high control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to ground in the circuit.
Fuel Pressure Regulator High Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pressure regulator high control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an open in the circuit.
Fuel Pressure Sensor	Engine Idling	kPa/PSI	For Port Fuel Injected (PFI) systems, this Parameter displays fuel rail pressure at the engine. For high pressure fuel systems, this Parameter indicates the low side fuel pressure before the high pressure pump.
Fuel Pressure Sensor	-	Volts	This parameter displays the fuel supply pressure sensor analog input as a percentage of its reference voltage.
Fuel Pump Enable Command	Ignition ON	On	This parameter displays the commanded state of the fuel pump output (the output is considered to be commanded ON if its duty cycle is not zero).

Parameter	System State	Expected Value	Description
Fuel Pump Enable Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pump control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to voltage in the circuit.
Fuel Pump Enable Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pump control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an short to ground in the circuit.
Fuel Pump Enable Circuit Open Test Status	Ignition ON	OK	This parameter displays the status of the output driver for the fuel pump control circuit. The scan tool will display OK if the circuit is operating correctly or Not Run if a diagnosis has not been made. The scan tool will display Malfunction if there is an open in the circuit.
Fuel Pump Relay Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the fuel pump relay control circuit. The parameter displays Malfunction if the fuel pump relay control circuit is shorted to voltage.
Fuel Pump Relay Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the fuel pump relay control circuit. The parameter displays Malfunction if the fuel pump relay control circuit is shorted to ground.
Fuel Pump Relay Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the fuel pump relay control circuit. The parameter displays Malfunction if the fuel pump relay control circuit is open.
Fuel Rail Pressure Regulator Command (If Equipped)	Engine idling	36 Degrees	The scan tool displays in degrees, the Fuel Rail Pressure Regulator ON time as commanded by the control module.

Parameter	System State	Expected Value	Description
Fuel Rail Pressure Sensor	Engine Idling	1.9-5.0 MPa/279-725 PSI	This parameter displays the high side fuel pressure after the high pressure pump.
Fuel Rail Pressure Sensor	Engine Idling	0 to 5 Volts	This parameter displays the voltage signal received by the control module from the fuel rail pressure (FRP) sensor.
Fuel Rail Pressure Sensor Initial Learn	-	Complete	This parameter displays the if the Fuel Rail Pressure Sensor First Time Adaptation is Complete
Fuel Rail Pressure Sensor Learn	-	Active	This parameter displays the current state of the fuel rail pressure sensor learn condition.
Fuel Rail Pressure Sensor Learn Inhibit	-	No	This parameter displays the reason for the fuel rail pressure sensor learn to be inhibited. These include: Assembly Plant Mode Counter Not Programmed, Assembly Plant Suspension, Barometric Pressure Sensor DTC, Barometric Pressure Too Low, Clutch Pedal Applied, Clutch Pedal Position Sensor DTC, Desired Fuel Rail Pressure Too Low, DTC Present, Engine in Catalyst Warm-Up Mode, Engine Not Synchronized, Engine Stopped, Fuel Pressure Spike, Fuel Level Too Low, Fuel Pressure Regulator Control Circuit DTC, Fuel Pump Control Function Active, Fuel Pump is Off, Fuel Rail Pressure Control Function Active, Fuel Rail Pressure Sensor DTC, Fuel System in Open Loop Operation, Fuel Temperature Out of Range, Idle Test Failed, Injector Flow Test in Progress, Intake Air Temperature Too Low, Low Pressure Fuel System Malfunction, Low Pressure Fuel System Pressure Too Low, Minimum Engine Run Time Not Met, Minimum Normal Fuel Pressure Control Time Not Met, Minimum Run Time, Time After New Engine Mode Not Met, Minimum Time After Drive Not

Parameter	System State	Expected Value	Description
			Met, Minimum Time for Released Accelerator Pedal Not Met, New Engine Mode, Not in Control of Idle Speed, Other Diagnostics Active, Sensor Reading Too High Test Failed, Some Cylinders Are Turned Off, Stuck Sensor Test Failed, Vehicle Speed Too High
Fuel Rail Pressure Sensor Learn Status	-	Complete	This parameter displays several signals associated with the status of the power mode and starter systems.
Fuel Rail Pressure Sensor Learned Value	-	kPa	This parameter displays the fuel rail pressure learned value at the fuel rail pressure sensor.
Fuel System Monitor Complete	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and noncontinuous legislated emission related monitor.
Fuel System Monitor Complete This Ignition Cycle	Ignition ON	No	This parameter displays the completion status of the fuel system monitor during the current driving / monitoring cycle.
Fuel System Monitor Enabled	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and noncontinuous legislated emission related monitor.
Fuel System Monitor Enabled This Ignition Cycle	Ignition ON	No	This parameter displays the enable status of the fuel system monitor during the current driving / monitoring cycle.
Fuel Tank Pressure Sensor	Ignition ON, engine OFF	kPa/psi	This parameter displays the pressure/vacuum inside the fuel tank. A negative value indicates a vacuum, while a positive value indicates a pressure.
Fuel Tank Pressure Sensor	-	mmHg / in H2O	This parameter displays the fuel tank pressure in mmHg/in H2O at the fuel tank pressure sensor.
Fuel Tank Pressure Sensor	Ignition ON, engine OFF	0-5 Volts	This parameter displays the voltage signal received by the control module from the fuel tank pressure

Parameter	System State	Expected Value	Description
			(FTP) sensor.
Fuel Tank Rated Capacity	Ignition ON	Varies	This parameter displays the capacity of the fuel tank in liters or gallons. The rated capacity displayed by the scan tool will varies with vehicle type.
Fuel Trim Cylinder Balance Test or Fuel Trim Cylinder Balance Test Bank 1-2	Ignition ON	Inactive	This parameter indicates the current state of the fuel trim cylinder balance test.
Fuel Trim Cylinder Balance Test Counter or Fuel Trim Cylinder Balance Test Counter Bank 1-2	Ignition ON	Counts	This parameter displays the number of Air Fuel Imbalance Monitor tests that have been performed since a code clear or non volatile memory (NVM) reset.
Fuel Trim Cylinder Balance Test Status Bank 1-2	Ignition ON	No Result	This parameter indicates the current state of the fuel trim cylinder balance test.
Fuel Trim Learn	Engine Idling	Enabled	This parameter displays Enabled when conditions are appropriate for enabling long term fuel trim corrections. This indicates that the long term fuel trim is adapting continuing amounts of short term fuel trim. If the scan tool displays Disabled, then long term fuel trim will not respond to changes in short term fuel trim.
Fuel Trim Learn	-	Enabled	This parameter displays if the fuel trim learn is enabled.
Fuel Trim Memory Cell	Engine Idling	Counts 0 250	This parameter displays long term fuel corrections that is active based upon the current operating conditions (MAP, engine speed, purge duty cycle, A/C compressor state, and transmission range).
Fuel Trim Memory Cell	-	#	This parameter displays the intake air temperature (measured by a sensor located near the throttle body) recorded at power-up (Run/Crank transition from low to high).

Parameter	System State	Expected Value	Description
Fuel Trim System Test State	Engine Idling	Complete	This parameter displays the current state of the fuel adjustment system diagnostic.
Fuel Trim System Test State	-	Complete	This parameter displays the state of the fuel trim system test.
Fuel Volatility	Engine Idling	Varies	This parameter indicates the rate the fuel can be vaporized in the cylinder as calculated by the control module. The scan tool will display HIGH when the fuel volatility is high. The scan tool will display LOW when the fuel volatility is low.
Generator F Terminal Signal	Engine Idling	0-100 %	This parameter displays the amount of generator ON-time as commanded by the control module. The higher the percentage the greater the generator output.
Generator Indicator Command	Engine Idling	On	This parameter displays On or Off associated with the status of the generator.
Generator L Terminal Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the state of the generator L circuit terminal. The parameter displays Malfunction if the generator L circuit is shorted to voltage.
Generator L Terminal Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the generator L circuit terminal. The parameter displays Malfunction if the generator L circuit is shorted to ground.
Generator L Terminal Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the generator L circuit terminal. The parameter displays Malfunction if the generator L circuit is open.
Generator L-Terminal Command	Engine Idling	0-100 %	This parameter displays the control modules commanded state of the voltage regulator on the generator.
Generator L-Terminal Signal Command	Ignition ON	On / Off	This parameter displays the commanded state of the generator L-terminal output.
Heated Catalyst Monitor Complete	Engine Idling	Yes	This parameter indicates the status of the heated catalyst. The scan tool displays Yes when the diagnostic is complete. And No if the diagnostic has not ran or a malfunction is

Parameter	System State	Expected Value	Description
			detected in the heated catalyst.
Heated Catalyst Monitor Enabled	Engine Idling	Yes	This parameter indicates the status of the heated catalyst monitor diagnostic. Catalyst Monitor Test Running indicates Yes or No when the heated catalyst monitor diagnostic is actively running a test.
Hood Position Switch	Ignition ON	Closed	This parameter displays the current position of the hood.
HO2S Sensor 1 or HO2S Bank 1 Sensor 1 or Bank 2 Sensor 1	Engine Idling	0.00-1.00 Volts	This parameter displays the voltage output from the HO2S to the control module. A lower voltage indicates a lean exhaust, while a higher voltage indicates a rich exhaust.
HO2S Sensor 2 or HO2S Bank 1 Sensor 2 or Bank 2 Sensor 2	Engine Idling	0.00-1.00 Volts	This parameter displays the voltage output from the HO2S to the control module. A lower voltage indicates a lean exhaust, while a higher voltage indicates a rich exhaust.
HO2S Heater Sensor 1 or HO2S Heater Bank 1 Sensor 1 or Bank 2 Sensor 1	Engine Idling	mA	This parameter display the current feedback for the oxygen sensor heater output for sensor 1.
HO2S Heater Sensor 2 or HO2S Heater Bank 1 Sensor 2 or Bank 2 Sensor 2	Engine Idling	mA	This parameter display the current feedback for the oxygen sensor heater output for sensor 2.
HO2S Heater Command or HO2S Heater Command Bank 1 or 2 Sensor 1 or 2	Engine Idling	Off	This parameter display the state of the HO2S heater control circuit as commanded by the control module.
HO2S Heater Command Bank 1 or 2 Sensor 1 or 2 Heater Command	Engine Idling	0-100 %	This parameter displays the HO2S heater ON time in percentage, as commanded by the control module.
HO2S Heater Control Circuit High Voltage Test Status or HO2S Heater Control Circuit High Voltage Test Status Bank 1 Sensor 1 or Bank 2 Sensor 1	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is shorted to voltage.

Parameter	System State	Expected Value	Description
HO2S Heater Control Circuit High Voltage Test Status or HO2S Heater Control Circuit High Voltage Test Status Bank 1 Sensor 2 or Bank 2 Sensor 2	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is shorted to voltage.
HO2S Heater Control Circuit Low Voltage Test Status or HO2S Heater Control Circuit Low Voltage Test Status Bank 1 Sensor 1 or Bank 2 Sensor 1	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is shorted to ground.
HO2S Heater Control Circuit Low Voltage Test Status or HO2S Heater Control Circuit Low Voltage Test Status Bank 1 Sensor 2 or Bank 2 Sensor 2	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is shorted to ground.
HO2S Heater Control Circuit Open Test Status or HO2S Heater Control Circuit Open Test Status Bank 1 Sensor 1 or Bank 2 Sensor 1	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is open.
HO2S Heater Control Circuit Open Test Status or HO2S Heater Control Circuit Open Test Status Bank 1 Sensor 2 or Bank 2 Sensor 2	Engine Idling	OK	This parameter displays the state of the oxygen sensor heater control circuit. The parameter displays Malfunction if the oxygen sensor heater control circuit is open.
HO2S/Heater Monitor Complete This Ignition Cycle	Engine Idling	Yes/No	This parameter displays the diagnostic monitor completion status during the current driving/monitoring cycle.
HO2S Heater Monitor Enabled	Ignition ON	No	This parameter displays the current state of the H02S heater monitor.

Parameter	System State	Expected Value	Description
HO2S/Heater Monitor Enabled This Ignition Cycle	Engine Idling	Yes/No	This parameter displays the diagnostic monitor enable status during the current driving/monitoring cycle.
Humidity Sensor Intake Air Temperature Signal	Ignition ON	Hz	This parameter displays the frequency of the humidity sensor's intake air temperature (IAT) sensor input.
IAT Sensor 1	Ignition ON	-39Â° to +140Â°C (-38Â° to +284Â°F)	This parameter displays the temperature of the air entering the air induction system based on input to the control module from the intake air temperature (IAT) sensor.
IAT Sensor 2	Engine Idling	Hz	This parameter displays the frequency of the humidity sensor's intake air temperature (IAT) sensor input to the engine control module.
IAT Sensor 2	-	Â°C (Â°F)	This parameter displays the temperature of the air entering the engine as calculated by the control module based on the input from the intake air temperature (IAT) sensor 2. The scan tool will display a low value when the air temperature is low, and a high value when the air temperature is high.
IAT Sensor 3	-	Â°C (Â°F)	This parameter displays the temperature of the air entering the engine as calculated by the control module based on the input from the intake air temperature (IAT) sensor 3. The scan tool will display a low value when the air temperature is low, and a high value when the air temperature is high.
Idle Speed Correction	Ignition ON	RPM	This parameter displays the engine idle speed correction within a restricted range to address complaints of vehicle vibration.
Ignition 1 Signal	Ignition ON	B+	This parameter displays B+ when the control module detects a voltage at the ignition 1 input terminal.
Ignition Accessory Signal	Ignition ON	On	This parameter displays On when the control module detects a voltage at the ignition accessory input

Parameter	System State	Expected Value	Description
			terminal.
Ignition Coil 1,2,3,4,5,6,7, or 8 Control Circuit High Voltage Test Status	Engine Running	OK	This parameter displays the state of the Ignition control circuit. The parameter displays Malfunction if the Ignition control circuit is shorted to voltage.
Ignition Coil 1,2,3,4,5,6,7, or 8 Control Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the Ignition control circuit. The parameter display Malfunctions if the Ignition control circuit is shorted to ground.
Ignition Coil 1,2,3,4,5,6,7, or 8 Control Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the Ignition control circuit. The parameter displays if Malfunction the Ignition control circuit is open.
Ignition Coil Supply Voltage or Ignition Coil Supply Voltage Bank 1 or 2	Engine Idling	On	This parameter displays ON when voltage is supplied to the Ignition coil.
Ignition Cycles Since Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	Counts	This parameter displays the number of Ignition Cycles since Recommended Maximum Fuel Alcohol Content Exceeded.
Ignition Cycles with Malfunction Since 1st Malfunction	Ignition ON	Counts	This parameter contains the number of ignition cycles with a failure reported since the first ignition cycle with a failure reported.
Ignition Cycles Without Completed Test Since 1st Malfunction	Engine Idling	Counts	This parameter displays the number of ignition cycles without a pass or a failure reported since the first ignition cycle with a failure reported.
Ignition Cycles Without Malfunction Since Last Malfunction	Engine Idling	Counts	This parameter displays the number of ignition cycles with a pass reported and no malfunctions reported since the first ignition cycle with a malfunction reported.
Ignition Cycles without Malfunction Since Last Malfunction	Ignition ON	Counts	This parameter contains the number of ignition cycles with a pass reported and no failures reported since the first ignition cycle with a failure reported.
Ignition Off Time	Ignition ON	hh:mm:ss	This parameter displays the time that the ignition has been OFF.

Parameter	System State	Expected Value	Description
Ignition Timing	Engine Idling	Degrees	This parameter displays the final spark advance in terms of a crankshaft angle.
Immobilizer Auto Learn Counter	Ignition ON	Counts	This parameter displays the number of auto-learn cycles that have been successfully completed within the immobilizer system.
Immobilizer Automatic Learn Timer	Ignition ON	h/m/s	This parameter displays the time elapsed within the current auto-learn cycle within the immobilizer system.
Immobilizer ECM Identifier	Ignition ON	OK	This parameter displays that the immobilizer control module (ICM) has received the correct powertrain identifier.
Immobilizer Environment Device 1-4	Ignition ON	OK	This parameter displays that the associated device is OK or unknown or its identification is pending to the immobilizer control module (ICM).
Immobilizer Fuel Disable	Ignition ON	Inactive	This parameter displays if the vehicle is immobilized by the ECM.
Immobilizer Module Environment Identification	Ignition ON	Inactive	This parameter displays that the ICM has not received the powertrain identifier or has received the wrong powertrain identifier.
Immobilizer Module Fuel Disable	Ignition ON	Inactive	This parameter displays if the vehicle is immobilized by the ICM.
Immobilizer Module Identification	Ignition ON	Complete	This parameter indicates that the ICM has not received the powertrain identifier or has received the wrong powertrain identifier.
Immobilizer Module Security Code Programmed	Ignition ON	Yes	This parameter indicates that the ICM security code has been programmed (i.e., the immobilizer device is locked).
Immobilizer Password Learn	Ignition ON	Active/Inactive	Learning Enabled indicates that learning of immobilizer code information is enabled.
Immobilizer Password Learn Scan Tool Delay	Engine Idling	Active/Inactive	Scan tool Learn Delay Active indicates that the security code has been accepted but the scan tool learn delay is active and will not allow learning enabled, programming security code, or

Parameter	System State	Expected Value	Description
			resetting security code.
Immobilizer Password Programmed	Ignition ON	Yes	This parameter indicates that the ICM password has been programmed.
Immobilizer Post-Release Passive State	Ignition ON	Active / Inactive	This parameter displays that the immobilizer algorithm is in the post release passive state.
Immobilizer Post-Release State	Ignition ON	Active / Inactive	This parameter displays that the immobilizer algorithm is in the post release passive state.
Immobilizer Pre-Release State	Ignition ON	Active / Inactive	This parameter displays that the immobilizer algorithm is in the pre release active state.
Immobilizer Release State	Ignition ON	Active / Inactive	This parameter displays that the immobilizer algorithm is in the release active state.
Immobilizer Security Code Accepted	Engine Idling	Yes/No	Security Code Accepted displaying Yes indicates' that the received security code is correct.
Immobilizer Security Code Function	Engine Idling	Present/Not Present	This parameter indicates if the ECU supports the immobilizer security code strategy.
Immobilizer Security Code Lockout	Engine Idling	Yes/No	Security Code Lockout Active indicates that the security code has not passed and lockout is active.
Immobilizer Security Code Lockout Active Timer	Engine Idling	ms	This parameter displays the time elapsed since the immobilizer security code lockout has been activated either due to a battery disconnect or an incorrect immobilizer security code being entered.
Immobilizer Security Code Programmed	Ignition ON	Yes/No	Security Code Programmed indicates that the security code has been programmed.
Immobilizer Security Code Programming Counter	Ignition ON	Counts	This parameter displays the number of times a new immobilizer security code has been programmed through secure access. This counter can only be incremented.
Immobilizer Security Code Reset Counter	Ignition ON	Counts	This parameter displays the number of times the immobilizer security code has been reset to the default value through secure access. This counter can only be incremented.

Parameter	System State	Expected Value	Description
Immobilizer Security Information Programmed	Ignition ON	Yes/No	This parameter displays the status of the immobilizer system.
Immobilizer Security Level	Ignition ON	#	This parameter displays the current immobilizer security level. If the correct security code is entered, the security level will remain at or be reset to a level of 10. If an incorrect security code is entered, the security level will be set to a level of 9.
Immobilizer Transponder Identification	Ignition ON	Active / Inactive	This parameter displays that the transponder identification process is active within the ICM.
Immobilizer Transponder Key	Ignition ON	OK	This parameter displays that the transponder key is correct for the ICM.
Immobilizer Transponder Key Identification	Ignition ON	OK	This parameter displays that the transponder key identification process is active within the ICM.
Immobilizer System Status	Ignition ON	Varies	This parameter displays the status of the immobilizer system, the following maybe displayed. Standby, Immobilized at Startup, Immobilized, No Response, Immobilized Negative Response, Immobilized, Incorrect Response, Post-Release State, Pre-Release State, Release State.
Immobilizer Valid Response Received Time	Ignition ON	ms	This parameter displays the actual time observed for a valid immobilizer response.
Initialized Fuel Alcohol Content	Ignition ON	%	This parameter displays the initialized fuel composition to be used as a starting point for the fuel composition algorithm.
Injector Duty Cycle or Injector Duty Cycle Bank 1 or 2	Engine idling	0.82-1.50 ms	This parameter displays the amount of fuel injector ON time or pulse width as commanded by the control module.
Inspection/Maintenance Drive Cycle Complete	Engine Idling	Yes/No	Inspection/Maintenance Drive Cycle Complete means that all required components of the standard drive cycle have completed.
Inspection/Maintenance Drive Cycle Idle Time Complete	Engine Idling	Yes/No	Inspection/Maintenance Drive Cycle Idle Time Complete indicates that the engine idle time

Parameter	System State	Expected Value	Description
			requirement is complete.
Inspection/Maintenance Drive Cycle Idle Timer	Engine Idling	hh:mm:ss	This parameter displays the Inspection/Maintenance Drive Cycle Idle Timer.
Inspection/Maintenance Drive Cycle Propulsion System Active Time Complete	Engine Idling	Yes/No	This parameter displays the Inspection/Maintenance Drive Cycle Propulsion System Active Time Complete. The parameter displays Yes when the Inspection/Maintenance Drive Cycle Propulsion System Active Time is Complete.
Inspection/Maintenance Drive Cycle Propulsion System Active Timer	Engine Idling	hh:mm:ss	This parameter displays the total accumulated time in which the propulsion system has been active after the 1st time the engine is started.
Inspection/Maintenance Drive Cycle Vehicle Speed Time Complete	Engine Idling	Yes/No	This parameter displays Yes when the Vehicle Speed Time Complete indicates that the vehicle has been above 25 mph for five minutes.
Inspection/Maintenance Drive Cycle Vehicle Speed Timer	Engine Idling	hh:mm:ss	This parameter displays the total accumulated time in which the vehicle speed has been greater than 25 mph after the 1st time the engine is started.
Intake Air Humidity Sensor	Engine Idling	%	This parameter displays the raw duty cycle signal from the relative humidity sensor electronics, which represents the relative humidity of the intake air.
Intake Camshaft Position	Engine Idling	Â°	This parameter displays the position of the intake camshaft for bank 1 in terms of degrees of camshaft rotation (advance) from the park position (a value of zero represents the park position).
Intake Camshaft Position Active Counter or Intake Camshaft Position Active Counter Bank 1 or 2	Engine Idling	0-255	This parameter displays an incrementing counter when the control module receives a signal from the intake camshaft position (CMP) sensor.

Parameter	System State	Expected Value	Description
Intake Camshaft Position Actuator Oil Pressure	Engine Idling	kPa	This parameter displays the oil pressure at the intake camshaft position actuator.
Intake Camshaft Position Actuator Oil Pressure Sensor	Engine Idling	Volts	This parameter displays the intake camshaft position actuator pressure sensor in voltage.
Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status or Intake Camshaft Position Actuator Solenoid Valve Control Circuit High Voltage Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the intake camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is shorted to voltage.
Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status or Intake Camshaft Position Actuator Solenoid Valve Control Circuit Low Voltage Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the intake camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is shorted to ground.
Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status or Intake Camshaft Position Actuator Solenoid Valve Control Circuit Open Test Status Bank 1 or 2	Engine Idling	OK	This parameter displays the state of the intake camshaft actuator solenoid control circuit. The parameter displays Malfunction if the camshaft actuator solenoid control circuit is open.
Intake Camshaft Position or Intake Camshaft Position Bank 1 or 2	Engine Idling	0 Degrees	This parameter displays the actual intake camshaft position in degrees.
	Engine speed at 2000 RPM	10 Degrees	
Intake Camshaft Position Commanded or Intake Camshaft Position Commanded Bank 1 or 2	Engine Idling	20 %	This parameter displays the ON-time or duty cycle of the intake camshaft position (CMP) actuator solenoid valve as commanded by the control module.
	Engine speed at 2000 RPM	50 %	
Intake Camshaft Position	Engine Idling	0 Degrees	This parameter displays in degrees,

Parameter	System State	Expected Value	Description
Variance or Intake Camshaft Position Variance Bank 1 or 2	Engine speed at 2000 RPM	0 Degrees	the difference between the desired intake camshaft position and the actual intake camshaft position.
Intake Manifold Pressure	Engine Idling	kPa/psi	This parameter displays the engine intake manifold vacuum pressure calculated as the difference between ambient air pressure (barometric pressure) and intake manifold absolute pressure (MAP).
Intake Manifold Tuning Control Valve Control Circuit Command	Ignition ON	On	This parameter displays the commanded state of the intake manifold tuning valve output.
Intake Manifold Tuning Control Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the intake manifold tuning control valve control circuit. The parameter displays Malfunction if the intake manifold tuning control valve control circuit is shorted to voltage.
Intake Manifold Tuning Control Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the skip shift solenoid actuator control circuit. The parameter displays Malfunction if the skip shift solenoid actuator control circuit is shorted to ground.
Intake Manifold Tuning Control Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the skip shift solenoid actuator control circuit. The parameter displays Malfunction if the skip shift solenoid actuator control circuit is open.
Intake Manifold Tuning Control Valve Feedback Signal	Ignition ON	%	This parameter displays the duty cycle of the PWM feedback from the intake manifold tuning electronics, which represents the position of the intake manifold tuning valve.
Intake Manifold Tuning Control Valve Learn	Ignition ON	Inactive	This parameter displays that the intake manifold tuning electronics are currently learning the hard stop position for the intake manifold tuning valve.
Intake Manifold Tuning Control Valve Position	Ignition ON	Closed	This parameter displays whether the intake manifold tuning valve is in an open, closed, or intermediate

Parameter	System State	Expected Value	Description
			position based upon the PWM feedback from the intake manifold tuning electronics.
Intake Rocker Arm Solenoid Valve 1-2 Command	Engine Idling	Off	This parameter displays the intake rocker arm solenoid valve command ON/OFF status.
Intake Rocker Arm Solenoid Valve 1-2 Command	Engine Idling	High Lift/Low Lift	This parameter displays the intake rocker arm solenoid valve command status.
Intake Rocker Arm Solenoid Valve 1-2 Control Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the state of the intake rocker arm solenoid valve control circuit. The parameter displays Malfunction if the intake rocker arm solenoid valve circuit is shorted to voltage.
Intake Rocker Arm Solenoid Valve 1-2 Control Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the intake rocker arm solenoid valve control circuit. The parameter displays Malfunction if the intake rocker arm solenoid valve control circuit is shorted to ground.
Intake Rocker Arm Solenoid Valve 1-2 Control Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the intake rocker arm solenoid valve control circuit. The parameter displays Malfunction if the intake rocker arm solenoid valve control circuit is open.
ISS/OSS Supply Voltage	Engine Idling	OK	This parameter displays the state of the ISS/OSS Supply Voltage circuit.
Knock Retard	Engine Idling	0 Degrees	This parameter indicates the amount of spark advance the control module removes from the ignition control (IC) spark advance in response to the signal from the knock sensors.
Long Fuel Pump Trim	-	#	This parameter displays a numeric value. This is the long term (LT) fuel pump trim.
Long Term Fuel Trim or Long Term Fuel Trim Bank 1 or 2	Engine Idling	0 %	This parameter displays the commanded Long Term Fuel Trim correction by the control module for cruise and acceleration conditions.
Long Term Fuel Trim Test Average or Long Term Fuel Trim	Engine Idling	0 %	This parameter displays the filtered long term closed loop fuel correction. This value is compared to thresholds to determine if the fuel

Parameter	System State	Expected Value	Description
Test Average Bank 1 or 2			adjustment system diagnostic is passing or failing or if an excess purge vapor test should be executed.
Long Term Fuel Trim Test Average without Purge or Long Term Fuel Trim Test Average without Purge Bank 1 or 2	Engine Idling	0 %	This parameter displays the filtered non purge long term closed loop fuel correction. This value is compared to thresholds to determine if the fuel adjustment system diagnostic is passing, failing, or indeterminate during normal purge-OFF operation as well as during the intrusive excess purge vapor test.
Long Term Secondary O2 Sensor Fuel Trim Bank 1 or 2	Ignition ON	%	This parameter displays the Long Term Secondary O2 Sensor Fuel Trim for Bank 1 or 2.
Low Engine Oil Level Indicator Command	Engine Idling	Off	The scan tool displays On or Off. This is the state of the low engine oil level indicator as monitored by the ECM.
Low Engine Oil Pressure Indicator Command	Engine Idling	Off	This parameter displays the commanded state of the low EOP lamp control circuit by the control module.
MAF Performance Test	Engine Idling	OK	This parameter displays the status of the MAF performance test by the engine control module. The scan tool will display OK if no malfunction is found. The scan tool will display malfunction if the engine control module detects a malfunction during the test.
MAF Sensor	Engine Idling	3.0-8.3 g/s	This parameter displays in grams per second, the measured quantity of air flowing into the engine during all operating conditions.
	Engine speed at 2,500 RPM	11.88 g/s	
MAF Sensor	Engine Idling	2,000-2,500 Hz	The scan tool displays a range of 0-65,555 hertz. This parameter displays the frequency signal input to the control module, and represents measured quantity of air flowing into the engine during all operating conditions.
MAF When Engine Overspeed Detected	Engine Idling	g/s	This parameter indicates the quantity calculated by the control module based on a signal from the

Parameter	System State	Expected Value	Description
			MAF sensor at the time an overspeed was detected.
MAP Performance Test 1	Engine Idling	OK	MAP Test 1 Residual Out of Tolerance indicates that the filtered MAP Test 1 residual (the difference between the measured intake manifold pressure and the intake manifold pressure predicted from the intake manifold model using the mass airflow predicted from the throttle model) exceeds a failure threshold.
MAP Performance Test 2	Engine Idling	OK	MAP Test 2 Residual Out of Tolerance indicates that the filtered MAP Test 2 residual (the difference between the measured intake manifold pressure and the intake manifold pressure predicted from the intake manifold model using the measured mass airflow) exceeds a failure threshold.
MAP Sensor	Engine Idling	kPa/psi	This parameter displays the actual engine intake manifold absolute pressure (MAP).
MAP Sensor	Engine Idling	0.4-2.0 Volts	The parameter displays The MAP sensor voltage as it measures the change in the intake manifold pressure which results from engine load and speed changes. As the intake manifold pressure increases, the air density in the intake also increases and additional fuel is required.
Maximum Engine Speed When Engine Overspeed Detected	Engine Idling	RPM	This parameter displays the Maximum Engine Speed When Engine Overspeed Detected.
MIL Command	Engine Idling	Off	This parameter displays the commanded state of the malfunction indicator lamp (MIL) control circuit by the control module.
MIL Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the MIL control circuit. The parameter displays Malfunction if the MIL control circuit is shorted to voltage.

Parameter	System State	Expected Value	Description
MIL Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the MIL control circuit. The parameter displays Malfunction if the MIL control circuit is shorted to ground.
MIL Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the MIL control circuit. The parameter displays Malfunction if the MIL control circuit is open.
MIL Requested	Engine Idling	No	This parameter displays the reason the engine control module illuminated the MIL. The scan tool will display Yes when the MIL is requested as a result of an A or B type DTC. The scan tool will display No if the MIL is illuminated for another reason, such as transmission DTCs.
MIL Requested by DTC	Engine Idling	No	This parameter indicates the reason the control module illuminated the MIL. The scan tool will display YES when the MIL is requested as a result of an A or B type DTC. The scan tool will display NO if the MIL is illuminated for another reason, such as transmission DTCs.
Misfire Diagnostic Engine Load	Engine Idling	%	This parameter displays the engine load used within the misfire diagnostic (calculated as the ratio of the mass of air predicted to be in the cylinder two firing events into the future to the maximum possible mass of air in the cylinder based on the current ambient air pressure and charge temperature).
Misfire Diagnostic Engine Speed	Engine Idling	RPM	This parameter displays the engine speed used within the misfire diagnostic. This engine speed is the maximum engine speed observed over the previous engine cycle.
Misfire Engine Load History 1-5	Engine Idling	%	This parameter displays the specific engine load when the engine was operating for one of the last five misfire events .

Parameter	System State	Expected Value	Description
Misfire Engine Speed History 1-5	Engine Idling	RPM	This parameter displays the specific engine speed when the engine was operating for one of the last five misfire events .
Misfire Monitor Complete	Engine Idling	Yes/No	This parameter displays the status of the Misfire Monitor. The parameter will display Yes when the Misfire Monitor is Complete.
Misfire Monitor Complete This Ignition Cycle	Ignition ON	No	This parameter displays the completion status of the misfire monitor during the current driving / monitoring cycle.
Misfire Monitor Enabled	Engine Idling	Yes/No	This parameter displays the status of the Misfire Monitor. The parameter will display Yes when the Misfire Monitor is Enabled.
Misfire Monitor Enabled This Ignition Cycle	Ignition ON	No	This parameter displays the enable status of the misfire monitor during the current driving / monitoring cycle.
Neutral Position Sensor	-	%	This parameter displays the current state of the neutral position sensor in degrees.
Number of Calibration History Events Stored	Ignition ON	Counts	This parameter displays the history entries for the primary calibration in the controller.
Number of DTC(s)	Engine Idling	0	This parameter indicates the number of diagnostic trouble codes (DTCs).
O2S/HO2S Monitor Complete	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and non continuous legislated emission related monitor.
O2S/HO2S Monitor Complete This Ignition Cycle	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and non continuous legislated emission related monitor.
O2S/HO2S Monitor Enabled	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and non continuous

Parameter	System State	Expected Value	Description
			legislated emission related monitor.
O2S/HO2S Monitor Enabled This Ignition Cycle	Engine Idling	Yes/No	This parameter displays the enable and completion status during the current driving/monitoring cycle of each continuous legislated emission related monitor and non continuous legislated emission related monitor.
Odometer at Engine Shutdown - Excessive Idle Time	Ignition ON	km / miles	This parameter displays the odometer reading at an engine shutdown due to excessive idle time.
Odometer at Engine Shutdown - High Coolant Temperature	Ignition ON	km / miles	This parameter displays the odometer reading at an engine shutdown due to high coolant temperature.
Odometer at Engine Shutdown - Low Coolant Level	Ignition ON	km / miles	This parameter displays the odometer reading at an engine shutdown due to low coolant level.
Odometer at Engine Shutdown - Low Oil Level	Ignition ON	km / miles	This parameter displays the odometer reading at an engine shutdown due to low oil level.
Odometer When Engine Overspeed Detected	Engine Idling	km/miles	This parameter displays the kilometers or miles of the Odometer When Engine Overspeed Detected.
Oil Level Warning Counter City	Ignition ON	Counts	This parameter displays a rolling count of oil level debounce events for the city calibration.
Oil Level Warning Counter Country Road	Ignition ON	Counts	This parameter displays a rolling count of oil level debounce events for the country road calibration
Oil Level Warning Counter Highway	Ignition ON	Counts	This parameter displays a rolling count of oil level debounce events for the highway calibration.
Output Shaft Speed Sensor	Engine Idling	RPM	This parameter displays the transmission output speed.
Park/Neutral Position Switch (If Equipped)	Engine Idling	Park/Neutral	This parameter indicates the range selection of the automatic transmission as calculated by the control module based on input from the PNP switch. The scan tool will display, In Gear, Park, or Neutral depending on the PNP switch position.

Parameter	System State	Expected Value	Description
Park/Neutral Position Switch (RPO=MO5)	Engine Idling	Active/Inactive	This parameter indicates the status of the Park/Neutral Position (PNP) Switch. When in Park, the PNP Switch is closed and the scan tool will display active. When in Reverse, Neutral, or Drive, the PNP Switch is open and the scan tool will display inactive.
Power Enrichment	Engine Idling	Inactive	This parameter indicates if the control module has detected conditions appropriate to operate in Power Enrichment mode. The scan tool will display Active if the mode is in operation, and Inactive if the mode is not in operation. The control module enters Open Loop operation and increases injector pulse width when in power enrichment mode.
Power Mode	Engine Idling	Run	This parameter displays the state of the System Power Mode. This signal is based upon the state of the system power mode received over serial communication from the vehicle electronics. If the serial data signal not received, the Parameter will display Off.
Radiator Coolant Temperature Sensor	-	Varies CÂ° (FÂ°)	This parameter displays the undefaulted radiator coolant temperature measured by a sensor located in the coolant outlet of the radiator.
RCT vs. IAT Sensor Temperature at Last ECT vs. RCT Malfunction Detection	Engine Idling	Agree	This parameter displays that the temperature values of the RCT and IAT sensors did not agree at the time of the most recent failure of the ECT/RCT rationality diagnostic.
Recommended Maximum Fuel Alcohol Content	Engine Idling	%	This parameter displays the percentage of the Recommended Maximum Fuel Alcohol Content.
Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	No	This parameter displays Yes or No if the Recommended Maximum Fuel Alcohol Content Exceeded.
Recommended Maximum Fuel Alcohol Content	Engine Idling	%	This parameter displays the percentage of the Recommended

Parameter	System State	Expected Value	Description
When Recommended Maximum Fuel Alcohol Content Exceeded			Maximum Fuel Alcohol Content When Recommended Maximum Fuel Alcohol Content Exceeded.
Reduced Engine Power	Engine Idling	Inactive	This parameter displays Active if the control module is commanding reduced engine power due to a throttle actuator control (TAC) system condition.
Reduced Engine Power History	Engine Idling	Throttle Malfunction, Cooling Fan Malfunction, Engine Over-temperature Protection Active, Engine Oil Temperature Too High, Remote Vehicle Speed Limiting, Engine Calibration Malfunction, Engine Oil Life, High Pressure Fuel System Malfunction	This parameter displays the last reason that Powertrain has illuminated the Reduced Engine Power (REP) indication.
Redundant Odometer Memory	Engine Idling	Present	ECU Odometer Programmed indicates if the ECU odometer value has been programmed.
Refueling Events Since Recommended Maximum Fuel Alcohol Content Exceeded	Engine Idling	Counts	This parameter displays the number Refueling Events Since Recommended Maximum Fuel Alcohol Content Exceeded.
Remaining Fuel in Tank	Engine Idling	%	This parameter displays the total fuel level as a percentage of the rated capacity of the fuel tank.
Remaining Fuel in Tank	Engine Idling	Liters/Gallons	This parameter displays the actual total fuel volume contained in the fuel tank.
Remote Vehicle Start Disable History 1-8	Engine Cranking	Reason for RVS Disable	These parameters displays the last eight reasons the control module disabled remote vehicle start (RVS).
Remote Vehicle Start Request Signal	Ignition ON	Off	Remote Vehicle Start Request indicates the state of the request received over serial communication from the remote vehicle start (RVS) system to start the vehicle in remote

Parameter	System State	Expected Value	Description
			mode.
Replicated Transmission OSS Signal	Ignition ON	RPM	This parameter displays the Replicated Transmission Output Speed (Replicated TOS) received from the Transmission Control Module.
Reverse Inhibit Solenoid Actuator Command	Ignition ON	Allowed	This parameter displays that the driver is inhibited from shifting into reverse.
Reverse Inhibit Solenoid Actuator Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the reverse inhibit solenoid actuator control circuit. The parameter displays Malfunction if the reverse inhibit solenoid actuator control circuit is shorted to voltage.
Reverse Inhibit Solenoid Actuator Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the reverse inhibit solenoid actuator control circuit. The parameter displays Malfunction if the reverse inhibit solenoid actuator control circuit is shorted to ground.
Reverse Inhibit Solenoid Actuator Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the reverse inhibit solenoid actuator control circuit. The parameter displays Malfunction if the reverse inhibit solenoid actuator control circuit is open.
Reverse Position Switch	Engine Idling	Off	This parameter displays if the manual transmission shifter is in reverse.
Secondary Air Injection Monitor Enabled	Engine Idling	Yes	This parameter displays the status of the secondary air injection monitor.
Secondary Air Injection Pressure	Engine Idling	kPa	This parameter displays the normalized secondary air injection system pressure.
Secondary Air Injection Pressure Sensor	Engine Idling	kPa	This parameter displays the unfiltered secondary air injection system pressure.
Secondary Air Injection Pressure Sensor	Engine Idling	Volts	This parameter displays the secondary air injection system pressure analog input as a percentage of its reference voltage.

Parameter	System State	Expected Value	Description
Secondary Air Injection Pressure Sensor Variance	Engine Idling	kPa	This parameter displays the weighted average pressure error (difference between the predicted and actual secondary air injection system pressure) during the secondary air injection on test (phase 1).
Secondary Air Injection Pump Relay Command	Engine Idling	Off	This parameter displays the commanded state of the secondary air injection pump output.
Secondary Air Injection Pump Relay Control Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection pump relay control circuit. The parameter displays Malfunction if the secondary air injection pump relay control circuit is shorted to voltage.
Secondary Air Injection Pump Relay Control Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection pump relay control circuit. The parameter displays Malfunction if the secondary air injection pump relay control circuit is shorted to ground.
Secondary Air Injection Pump Relay Control Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection pump relay control circuit. The parameter displays Malfunction if the secondary air injection pump relay control circuit is open.
Secondary Air Injection Solenoid Valve Command	Engine Idling	Off	This parameter displays the commanded state of the secondary air injection valve output.
Secondary Air Injection Solenoid Valve Control Circuit High Voltage Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection solenoid valve control circuit. The parameter displays Malfunction if the secondary air injection solenoid valve control circuit is shorted to voltage.
Secondary Air Injection Solenoid Valve Control Circuit Low Voltage Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection solenoid valve control circuit. The parameter displays Malfunction if the secondary air injection solenoid valve control circuit is shorted to ground.

Parameter	System State	Expected Value	Description
Secondary Air Injection Solenoid Valve Control Circuit Open Test Status	Engine Idling	OK	This parameter displays the state of the secondary air injection solenoid valve control circuit. The parameter displays Malfunction if the secondary air injection solenoid valve control circuit is open.
Short Term Fuel Pump Trim	-	#	This parameter displays a numeric value. This is the short term (ST) fuel pump trim.
Short Term Fuel Trim or Short Term Fuel Trim Bank 1 or Bank 2	Engine Idling	-5 % to +5 %	This parameter displays the short-term correction to the fuel delivery by the control module in response to oxygen sensor 1 or 2. If the oxygen sensor indicates a lean air/fuel mixture, the control module will add fuel increasing the short term fuel trim above 0. If the oxygen sensor indicates a rich air/fuel mixture, the control module will reduce fuel decreasing the short term fuel trim below 0.
Short Term Fuel Trim Test Average or Short Term Fuel Trim Test Average Bank 1 or Bank 2	Engine Idling	%	This parameter display's the filtered short term closed loop fuel correction. This value is compared to thresholds to determine if the fuel adjustment system diagnostic is passing or failing or if an excess purge vapor test should be executed.
Short Term Secondary O2 Sensor Fuel Trim Bank 1 or 2	Ignition ON	%	This parameter displays the Short Term Secondary O2 Sensor Fuel Trim for Bank 1 or 2.
Skip Shift Solenoid Actuator Command	Ignition ON	No Skip	This parameter indicates that the skip shift solenoid is commanded on, inhibiting the driver from shifting up to one of the next highest gears.
Skip Shift Solenoid Actuator Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the skip shift solenoid actuator control circuit. The parameter displays Malfunction if the skip shift solenoid actuator control circuit is shorted to voltage.
Skip Shift Solenoid Actuator Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the skip shift solenoid actuator control circuit. The parameter

Parameter	System State	Expected Value	Description
			displays Malfunction if the skip shift solenoid actuator control circuit is shorted to ground.
Skip Shift Solenoid Actuator Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the skip shift solenoid actuator control circuit. The parameter displays Malfunction if the skip shift solenoid actuator control circuit is open.
Specific Humidity	Ignition ON	%	This parameter shows the current specific humidity level.
Start-Up ECT	Ignition ON	-39Â° to +140Â°C (-38Â° to +284Â°F)	This parameter displays the temperature of the engine coolant on start-up based on input to the control module from the ECT sensor.
Start-Up IAT Sensor or Start-Up IAT Sensor 1 or 2	Ignition ON	-39Â° to +140Â°C (-38Â° to +284Â°F)	This parameter displays the temperature of the intake air at start in the air induction system based on input to the control module from the IAT sensor.
Starter Relay Command	Ignition switch not in the crank position	Off	This parameter indicates whether the control module is commanding the starter relay to go On or Off.
	Ignition switch in the crank position	On	
Starter Relay Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the starter relay control circuit. The parameter displays Malfunction if the starter relay control circuit is shorted to voltage. This parameter may not change if the scan tool is used to command the relay control circuit On.
Starter Relay Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the starter relay control circuit. The parameter displays Malfunction if the starter relay control circuit is shorted to ground. This parameter may not change if the scan tool is used to command the relay control circuit On.
Starter Relay Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the starter relay control circuit. The parameter displays Malfunction if

Parameter	System State	Expected Value	Description
			the starter relay control circuit is open. This parameter may not change if the scan tool is used to command the relay control circuit On.
Supercharger Bypass Solenoid Valve Command	Ignition ON	%	This parameter displays the commanded duty cycle for the supercharger boost solenoid output.
Supercharger Bypass Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the supercharger bypass solenoid valve control circuit. The parameter displays Malfunction if the supercharger bypass solenoid valve control circuit is shorted to voltage.
Supercharger Bypass Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the supercharger bypass solenoid valve control circuit. The parameter displays Malfunction if the supercharger bypass solenoid valve control circuit is shorted to ground.
Supercharger Bypass Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the supercharger bypass solenoid valve control circuit. The parameter displays Malfunction if the supercharger bypass solenoid valve control circuit is open.
Supercharger Inlet Pressure	Engine Idling	kPa	This parameter displays the supercharger inlet vacuum pressure calculated as the difference between ambient air pressure (barometric pressure) and supercharger inlet absolute pressure (SCIAP).
Supercharger Inlet Pressure Sensor	Engine Idling	kPa	This parameter displays the unfiltered supercharger inlet absolute pressure (SCIAP).
Supercharger Inlet Pressure Sensor	Engine Idling	Volts	This parameter displays the supercharger inlet absolute pressure (SCIAP) analog input as a percentage of its reference voltage.
SVS Indicator Command	Ignition ON	Off	This parameter displays that the Service Vehicle Soon lamp is being commanded on due to the failure of a non emission related diagnostic test.

Parameter	System State	Expected Value	Description
System Off	Ignition ON	No	This parameter displays that the vehicle is waiting for a key crank to happen (key crank not done yet).
TAC Forced Engine Shutdown	Ignition ON	No	This parameter indicates the status of the TAC motor by the control module. The scan tool will display Yes if the engine has been shut down due to a throttle control fault.
TAC Motor	Ignition ON	Enabled	This parameter indicates the status of the throttle actuator control (TAC) motor driver in the control module. The scan tool will display Enabled if TAC motor operation is allowed. The scan tool will display Disabled if the control module detects a condition that affects TAC motor operation.
TAC Motor Command	Ignition ON	%	This parameter displays the commanded duty cycle for the throttle actuator output.
TCC/Cruise Control Brake Pedal Switch	Ignition ON	Applied / Released	This parameter indicates the state of the TCC/Cruise Control Brake Pedal Switch.
Throttle Body Idle Air Flow Compensation	Engine Idling	%	This parameter displays the percent compensation of the Learned Airflow Variation Calibration. This value indicates the current amount of airflow compensation in response to engine intake airflow restrictions. It can also be used as feedback for the Learned Airflow Adapts Reset Trigger Device Control.
Throttle Position	Ignition ON	0-100 %	This parameter displays the desired throttle position angle commanded by the control module.
Throttle Position Performance Test	Engine Idling	OK	Throttle Position Residual Out of Tolerance indicates that the filtered throttle position residual (the product of the MAF residual and the MAP Test 1 residual) exceeds a failure threshold.
Throttle Position Sensor 1	Ignition ON	3.7-4.3 Volts	This parameter displays the actual voltage on the TP sensor 1 signal circuit as measured by the control module.

Parameter	System State	Expected Value	Description
Throttle Position Sensor 1 Learned Minimum	Ignition ON	0.51 Volts	This parameter displays the learned minimum value of throttle position (TP) sensor 1 as recorded by the control module during the last learn procedure.
Throttle Position Sensor 1 or 2 Position	Ignition ON	%	This parameter displays the actual voltage on the TP sensor 2 signal circuit as measured by the control module.
Throttle Position Sensor 2	Ignition ON	0.5-0.8 Volts	This parameter displays the voltage signal sent to the control module from TP sensor 2 of the throttle assembly. The TP sensor 2 is a range of values indicating a low voltage when the throttle is closed to a high voltage when the throttle plate is fully open.
Throttle Position Sensor 2 Learned Minimum	Ignition ON	0.51 Volts	This parameter displays the learned minimum value of TP sensor 2 as recorded by the control module during the last learn procedure.
Throttle Position Sensors 1 and 2	Ignition ON	Agree	This parameter displays Disagree when the control module detects that TP sensor 1 voltage signal is not within the correct relationship to TP sensor 2. The scan tool displays Agree under the normal operating conditions.
Tire Size	Ignition ON	Rev/km	This parameter displays the vehicle tire circumference in centimeters.
Torque Delivered Signal	Vehicle Moving	/Lb/Ft	This parameter displays the engine torque based upon the airflow through the engine and the torque losses due to spark retard and fuel shutoff. Since this is a steady state engine torque, it does not include the inertial component of engine torque.
Torque Management Ignition Timing Retard	Engine Idling	Degrees	This parameter displays the total spark retard (in terms of a crankshaft angle).
Torque Request Inhibit - Fuel	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.

Parameter	System State	Expected Value	Description
Torque Request Inhibit - Ignition Timing	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Torque Request Inhibit - Ignition Timing Advance	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Torque Request Inhibit - Minimum Idle	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Torque Request Inhibit - Minimum Torque	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Torque Request Inhibit - TAC	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Torque Request Inhibit - TAC Limit	Engine Idling	No	This parameter displays the existing condition in the ECM causing the transmission torque request to be limited.
Total Alternative Fuel Level Percentage	Ignition ON	%	This parameter displays the undefaulted, total alternative fuel level as a percentage of the rated (advertised) capacity of the alternative fuel tank(s).
Total Engine Overspeed Time	Engine Idling	ms	This parameter displays the Total Engine Overspeed Time.
Total Knock Retard	Engine Idling	0Â°	This parameter displays how much ignition spark timing is being retarded due to all control systems monitored by the control module.
Total Misfire	Engine Idling	0	This parameter displays the total number of cylinder firing events that the control module detected as misfires for the last 200 crankshaft revolution sample period.
Traction Control Status	Ignition ON	Inactive	This parameter displays Active if the electronic brake and traction control module (EBTCM) is commanding traction control.

Parameter	System State	Expected Value	Description
Transmission Fluid Pressure Accumulator Solenoid Valve Command	Ignition ON	On/Off	This parameter displays the position of the Transmission Fluid Pressure Accumulator Solenoid Valve Control.
Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK, Malfunction, Not Run	This parameter displays the state of the Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit. The parameter displays Malfunction if the Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit is shorted to voltage.
Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK, Malfunction, Not Run	This parameter displays the state of the Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit. The parameter displays Malfunction if the Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit is shorted to ground.
Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK, Malfunction, Not Run	This parameter displays the state of the Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit. The parameter displays Malfunction if the Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit is open.
Transmission Fluid Temperature Sensor	Ignition ON	Â°C (Â°F)	This parameter displays the undefaulted, unfiltered transmission oil / fluid temperature measured by a sensor.
Turbocharger 1 Turbine Inlet Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger 1 turbine inlet valve control circuit. The parameter displays Malfunction if the turbocharger 1 turbine inlet valve control circuit is shorted to voltage.
Turbocharger 1 Turbine Inlet Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger 1 turbine inlet valve control circuit. The parameter displays Malfunction if the turbocharger 1 turbine inlet valve control circuit is open.

Parameter	System State	Expected Value	Description
Turbocharger 1 Turbine Inlet Valve Duty Cycle	Ignition ON	%	This parameter displays the commanded duty cycle for the turbocharger 1 turbine inlet valve in a percentage.
Turbocharger Bypass Solenoid Valve Command	Ignition ON	%	This parameter displays the commanded duty cycle for the turbocharger bypass solenoid valve in a percentage.
Turbocharger Bypass Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger bypass solenoid valve control circuit. The parameter displays Malfunction if the turbocharger bypass solenoid valve control circuit is shorted to voltage.
Turbocharger Bypass Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger bypass solenoid valve control circuit. The parameter displays Malfunction if the turbocharger bypass solenoid valve control circuit is shorted to ground.
Turbocharger Bypass Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger bypass solenoid valve control circuit. The parameter displays Malfunction if the turbocharger bypass solenoid valve control circuit is open.
Turbocharger Wastegate Solenoid Valve Command	Ignition ON	%	This parameter displays the commanded duty cycle for the turbocharger wastegate solenoid valve in a percentage.
Turbocharger Wastegate Solenoid Valve Control Circuit High Voltage Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger wastegate solenoid valve control circuit. The parameter displays Malfunction if the turbocharger wastegate solenoid valve control circuit is shorted to voltage.
Turbocharger Wastegate Solenoid Valve Control Circuit Low Voltage Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger wastegate solenoid valve control circuit. The parameter displays Malfunction if the turbocharger wastegate solenoid valve control circuit is shorted to ground.

Parameter	System State	Expected Value	Description
Turbocharger Wastegate Solenoid Valve Control Circuit Open Test Status	Ignition ON	OK	This parameter displays the state of the turbocharger wastegate solenoid valve control circuit. The parameter displays Malfunction if the turbocharger wastegate solenoid valve control circuit is open.
Upshift Indicator Command	Vehicle Moving	Off	This parameter displays On when commanded by the engine control module.
Variable Valve Lift Low Lift Disable History 1-8	Engine Idling	Varies	This parameter displays the reason for the last 8 variable valve lift disable history reasons.
Variable Valve Lift Low Lift Inhibit - Reason	Engine Idling	Varies	This parameter lists the reason the variable valve lift low lift may be inhibited. These include; 4WD Low State Invalid, A/C Compressor Clutch On, Acceleration Request, Brake Booster Pressure Sensor DTC, Brake Booster Weak Vacuum, Calculated Torque, Camshaft Position Sensor DTC, Control Function Active, Crankshaft Position Sensor DTC, ECT, ECT Sensor DTC, Engine Controls Ignition Relay DTC, Engine Not Synchronized, Engine Off, Engine Oil Pressure, Engine Oil Pressure Control Solenoid Valve Stuck Off, Engine Oil Pressure Control Test Active, Engine Oil Pressure Sensor DTC, Engine Oil Temperature, Engine Overtemperature Protection, Engine Power Not Requested, Engine Speed, Engine Torque Capacity, Fuel Alcohol Content Learn In Progress, Fuel Alcohol Content Too High, Fuel System Disabled, Green Engine Mode, HO2S 2 Test, Hot Coolant Mode, Hybrid/EV Powertrain Control Module Request, IAT Sensor DTC, Ignition Voltage, MAP Sensor DTC, Maximum Throttle Exceeded, Minimum Time After TAC DTC, Misfire DTC, Oil Aeration. On-Board Diagnostic System, Rocker

Parameter	System State	Expected Value	Description
			Arm Solenoid Valve DTC, RPM Limit, TAC System DTC, Transmission Gear, Transmission Range, Transmission Shifting, Vehicle Speed Too Low, VSS DTC.
Variable Valve Lift System Command	-	Low Lift	This parameter displays the current state of the variable valve lift system command.
Vehicle Speed Sensor	Vehicle Moving	Km/h mph	This parameter displays the speed of the vehicle as calculated by the transmission control module (TCM) from information received from the vehicle speed sensor (VSS).
Vehicle Speed When Engine Overspeed Detected	Engine Idling	Km/h mph	This parameter displays the Vehicle Speed When Engine Overspeed Detected.
VIN Programming Counter	Ignition ON	Counts	This parameter displays the number of times the VIN has been programmed. This counter can only be incremented.
Warm Ups Since DTC Cleared	Engine Idling	Counts	This parameter indicates the number of warm up cycles that have occurred Since DTCs were cleared. The scan tool will display a higher counts as more warm up cycles have occurred since the DTCs were cleared.
Warm Ups without Emission Malfunctions	Engine Idling	Counts	This parameter displays the number of OBD defined warm up cycles since the last emissions related (fault type A or B) fail report or MIL request. Emissions related DTCs are cleared from memory when this counter reaches 40.
Warm Ups without Non Emission Malfunctions	Engine Idling	Counts	This parameter displays the number of OBD defined warm up cycles since the last non emissions related (fault type C) fail report. Non emissions related DTCs are cleared from memory when this counter reaches 40.
Weight Percent Water in Air	Engine Idling	%	This parameter displays the calculated value of weight per cent water (specific humidity) in the intake air.

Parameter	System State	Expected Value	Description
Wide Open Throttle	Engine Idling	No	This parameter displays the throttle status commanded by the control module. The scan tool will display Yes if the vehicle throttle is commanded to 100 percent.
Wide Open Throttle	Ignition ON	No	This parameter displays the desired throttle position exceeds a WOT threshold (selected specifically for service).

Engine Control Module (ECM) Scan Tool Output Controls

Output Control	Description
This is a comprehensive list. Not all output controls listed are available for all applications.	
A/C Compressor Clutch Relay	This device control is used to override the state of the air conditioning compressor output.
Active Grill Air Shutter 1 or 2 Commanded Position	This device control is used to command the position of the active grill air shutter 1 or 2 output. 0% equals fully closed, 100% equals fully open.
Alternative Fuel High Pressure Shutoff Valve Control	This device control is used to override the state of the alternative fuel shutoff valve 1 output.
Alternative Fuel Injector Disable Control	This device control is used with the engine running to override the state of the alternative fuel injector outputs. This device control is used to disable alternative fuel injectors in order to cut off alternative fuel to the associated cylinders.
Alternative Fuel Injector Flow Control	This device control is used to trigger a single Alternative fuel injector to be commanded on for a calibrated number of pulses (e.g. 25) in order to test the flow of the Alternative fuel injector.
Alternative Fuel Low Pressure Shutoff Valve Control	This device control is used to verify functionality of the Alternative Fuel Low Pressure Fuel Shutoff Valve system by allowing the Alternative Fuel Low Pressure Fuel Shutoff Valve output to be commanded to a specific Alternative Fuel Rail Pressure.
Alternative Fuel System Leak Test - Service Bay Test	This device control will signal the ECM to begin the Alternative Fuel System Leak Test.
Autostart/Autostop	This device control is used to override the internal combustion engine (ICE) running state.
BiFuel System - Fuel Mode Selection	When this CPID is active, the fuel mode is commanded to the selection made in "Fuel Mode Selection."
Brake Pedal Position Learn	This device control is used to reset the brake pedal fully released learned position to its initialized value after a brake system repair.
Compression Test	This device control is used to set up the internal combustion engine for a compression test. The fuel pump, fuel injectors, and spark are all disabled. The throttle is opened to a Wide Open Throttle (WOT) position. For conventional engine vehicles, the extended crank feature is not active, and for strong hybrid vehicles, the Hybrid Powertrain Control Module is configured to crank at the speed specified in the device control

Output Control	Description
	command. Engine cranking is completely controlled by the technician either through the ignition key or through a remote starter switch as applicable. The device control limits and rejects will apply normally upon entry to the device control. Once the device control is active, the limits will be monitored (to prevent unwanted starter operation, for example), but in the case of a limit exceeded or a tester disconnect, device control of the fuel and spark will not be released until the Power Mode switches to Accessory or OFF. This will prevent unexpected fuel and spark operation in the case of a device control abort.
Cooling Fan Relay 1	This function activates the cooling fan relay 1. The normal commanded state of the fan relay is NONE. The relay command status can also be monitored on the scan tool data parameter Cooling Fan Relay 1 Command. The control module allows cooling fan relay control when the following conditions are met: • The Ignition is ON or the engine is running. • A/C compressor operation is not requested. • The engine coolant temperature is less than 106Â°C (224Â°F).
Cooling Fan Relay 1,2 and 3	This function activates the cooling fan relay 1, 2 and 3. The normal commanded state of the fan relays is NONE. The relay command status can also be monitored on the scan tool data parameters Cooling Fan Relay 1 Command and Cooling Fan Relays 2 and 3 Command. The control module allows cooling fan relay control when the following conditions are met: • The Ignition is ON or the engine is running. • A/C compressor operation is not requested. • The engine coolant temperature is less than 106Â°C (224Â°F).
Cooling Fan 2 and 3	This function activates the cooling fan relay 2 and relay 3. The normal commanded state of the fan relays is NONE. The relay command status can also be monitored on the scan tool data parameter 2 and 3 Command. The control module allows cooling fan relay control when the following conditions are met: • The Ignition is ON or the engine is running. • A/C compressor operation is not requested. • The engine coolant temperature is less than 106Â°C (224Â°F).
Crankshaft Position Variation Learn	This device control is used to activate the crankshaft position variation learn algorithm which calculates the reference pulse correction factors for the misfire diagnostic.
Cylinder Power Balance	**NOTE:**

Output Control	Description
	The Misfire Current and Misfire History parameters may not increment when using this function. This function disables the selected fuel injector. The normal commanded state is None. The scan tool initiates the test when the following conditions are met: • The engine is operating and the engine idle is stable. • The vehicle speed is 0 km/h (0 mph). • There are no DTCs set for the vehicle speed sensor. If the fuel injector was disabled for 30 seconds, fuel injector control is not allowed again on the same fuel injector for 60 seconds.
Depressurize Fuel System	When the low pressure fuel pump is used in conjunction with a separate high pressure fuel pump for Direct Injection (DI) engines, this device control can be used to reduce the high fuel pressure to a low working level. The high fuel pressure control shall monitor the low pressure "Fuel Pump Device Control with Engine Running" such that when the low pressure pump is commanded OFF the high pressure pump will be controlled to a low pressure value. This combination shall be held until either the FPMR device control is released, or the engine stalls.
Engine Controls Ignition Relay	This device control is used to override the state of the Powertrain Relay.
Engine Coolant Thermostat Heater	This device control is used to override the state of the Engine Coolant Thermostat Heater.
Engine Oil Life Reset	This DID contains the engine oil remaining life determined from an algorithm based upon the effective engine revolutions and the distance driven since the last oil change. This DID may be used to reset the engine oil remaining life to 100 % after an oil change or to any other value when replacing a control module.
Engine Oil Pressure Control Solenoid Valve	This device control is used to override the state of the variable displacement oil pump. When the variable displacement oil pump is turned on, the oil pump will be commanded to a low pressure state.
Engine Speed	This function controls the idle speed override in 25 RPM, 100 RPM, and 500 RPM increments, from the base idle speed to 1,400 RPM. The scan tool initiates the test when the following conditions are met: • The transmission is in park or neutral.

Output Control	Description
	• The engine speed is less than 1,000 RPM. The engine speed will remain in the commanded state until cancelled by the scan tool.
EVAP Purge/Seal	**NOTE:** **The EVAP Purge and Vent Solenoid Command parameters may not change states when using this output control.** This function activates both the EVAP purge solenoid valve and EVAP vent solenoid to seal the EVAP system. When activated, the purge valve is commanded to 0 percent and the vent valve is commanded ON, Not-venting. The normal commanded state for both solenoids is None. Both of the solenoids remain in the commanded state until cancelled by the scan tool or the FTP sensor exceeds -24 mm Hg (-12 inch H20).
EVAP Purge Solenoid Valve	**NOTE:** **The EVAP Purge Solenoid Command parameter may not change states when using this output control.** This function controls the evaporative emission (EVAP) purge solenoid valve. The normal commanded state is NONE. The system will increase or decrease the amount of purge by changing the duty cycle of the purge valve in 10 percent increments within a range of 0-100 percent. The system remains in the commanded state until cancelled by the scan tool or the fuel tank pressure (FTP) sensor exceeds -24 mm Hg (-12 inch H20).

Output Control	Description
EVAP Test	This device control is used to activate the evaporative emissions service bay test.
EVAP Vent Solenoid Valve	**NOTE:** **The EVAP Vent Solenoid Command parameter may not change states when using this output control.** This function controls the EVAP vent solenoid. The normal commanded state is NONE. When commanded ON, the vent valve switches to Not-venting. The system remains in the commanded state unless one of the following conditions occur: • Cancelled by the scan tool • The EVAP canister purge solenoid is more than 0 percent, and the FTP sensor exceeds -24 mm Hg (-12 inch H20).
Exhaust Camshaft Position Actuator or Exhaust Camshaft Position Actuator Bank 1	This device control is used to override the state of the exhaust cam phase output. The commanded camshaft position is expressed in terms of degrees of camshaft rotation (retard for exhaust camshaft) from the park position (a camshaft position of zero represents the park position).
Exhaust Camshaft Position Actuator or Exhaust Camshaft Position Actuator Bank 2	This device control is used to override the state of the exhaust cam phase output. The commanded camshaft position is expressed in terms of degrees of camshaft rotation (retard for exhaust camshaft) from the park position (a camshaft position of zero represents the park position).
Exhaust Camshaft Position Actuator Solenoid Valve or Exhaust Camshaft Position Actuator Solenoid Valve Bank 1	This device control is used to override the state of the exhaust cam phase solenoid output.
Exhaust Camshaft Position Actuator Solenoid Valve or Exhaust Camshaft Position Actuator Solenoid Valve Bank 2	This device control is used to override the state of the exhaust cam phase solenoid output.

Output Control	Description
Fuel Composition Reset	**NOTE:** **Do not use this output control unless the actual alcohol content of the fuel in the tank is 10 percent or less. This will reset the learned alcohol composition to 0 percent in the engine control module (ECM).**
Fuel Control Loop Status	This function controls the heated oxygen sensor (HO2S) loop status. The commanded states include NONE, OPEN, and CLOSED. The normal commanded state is NONE. The loop status changes as commanded, OPEN or CLOSED. The system remains in the commanded state until cancelled by the scan tool.
Fuel Injector Balance Test (If Available)	This function enables the fuel injector in order to verify the correct fuel injector flow. The ECM will pulse the selected fuel injector when the following conditions are met: • All instruction on the scan tool is complete. • A fuel injector is selected. • The ignition is ON with the engine OFF. The selected fuel injector can only be flowed/pulsed once per ignition cycle.
Fuel Mode Indicator Lamp System	This device control is used to verify the functionality of the Fuel Mode Indicator Lamp.
Fuel Pressure	This function allows control of the fuel rail pressure (FRP) regulator which is integral to the high pressure fuel pump. The system will Increase or Decrease the fuel rail pressure in increments, as commanded within an approximate range of 1862-17,237 kPa (270-2500 psi). The scan tool initiates the test when the following conditions are met:

Output Control	Description
	• The engine is operating • The ignition voltage is 10-18 V • The vehicle speed is 0 mph • DTC P0700 is not set The system remains in the commanded state for about 30 seconds or until cancelled by the scan tool or the ECM detects a vehicle speed.
Fuel Pressure Regulator	**NOTE:** **As this is an electrical circuit test, a regulator solenoid commanded to ON does not necessarily equate to the regulator state at maximum fuel pressure.** This device control is intended for use on a Direct Injection (DI) high pressure fuel supply system to activate the fuel pressure regulator at ignition ON, engine OFF. Both the low side and high side of the regulator are controlled together. Commanding the regulator to ON will modulate the high side driver to a calibratible Maximum Duty Cycle.
Fuel Pump Enable	This function controls the fuel pump. The normal commanded state is NONE. The scan tool initiates the test when the following conditions are met: • There are no vehicle speed sensor DTCs set. • The vehicle speed is 0 km/h (0 mph). When commanded ON/OFF, the engine control module (ECM) turns the fuel pump ON/OFF. If the engine is running and the fuel pump is commanded OFF, the engine will stall. The system remains in the commanded state for about 2 seconds or until cancelled by the scan tool or the ECM detects a vehicle speed.
Fuel Pump Speed	This device control is used to override the normal control of the fuel pump output. The device control is a service diagnostic aid that is used to determine if the fuel pump system is functioning properly. Different limit

Output Control	Description
	checks are used when the engine is and is not running for the operation of the fuel pump.
Fuel Rail Pressure	This device control is intended for use on a Direct Injection (DI) high pressure fuel supply system to override the commanded fuel high pressure output from the powertrain controller.
Fuel Trim Enable	This function disables the control modules ability to learn new fuel trim parameters. The commanded states are NONE, ENABLED, DISABLED. The normal commanded state is NONE. The system remains in the commanded state until cancelled by the scan tool.
Fuel Trim Reset	This function is used to reset the learned fuel trim values to their initial values.
Generator L-Terminal	Commands the generator L terminal ON and OFF.
Heater Coolant Pump	This device control is used to override the state of the heater core pump relay output.
HO2S Heater Sensor 1 or HO2S Heater Bank 1 Sensor 1	This device control is used to override the duty cycle of the oxygen sensor heaters. With the engine OFF, this device control is intended to be used as a discrete control for circuit diagnosis. With the engine OFF, none of the oxygen sensor heaters can be commanded ON for more than 3.0 seconds, after which the selected oxygen sensor heater must be disabled for a limited duration (typically 60 seconds) before it may be enabled again. With the engine running, this device control is used to operate the oxygen sensor heaters at the various duty cycles available to the engine controller.
HO2S Heater Sensor 2 or HO2S Heater Bank 1 Sensor 2	This device control is used to override the duty cycle of the oxygen sensor heaters. With the engine OFF, this device control is intended to be used as a discrete control for circuit diagnosis. With the engine OFF, none of the oxygen sensor heaters can be commanded ON for more than 3.0 seconds, after which the selected oxygen sensor heater must be disabled for a limited duration (typically 60 seconds) before it may be enabled again. With the engine running, this device control is used to operate the oxygen sensor heaters at the various duty cycles available to the engine controller.
HO2S Heater Bank 2 Sensor 1	This device control is used to override the duty cycle of the oxygen sensor heaters. With the engine OFF, this device control is intended to be used as a discrete control for circuit diagnosis. With the engine OFF, none of the oxygen sensor heaters can be commanded ON for more than 3.0 seconds, after which the selected oxygen sensor heater must be disabled for a limited duration (typically 60 seconds) before it may be enabled again. With the engine running, this device control is used to operate the oxygen sensor heaters at the various duty cycles available to the engine controller.
HO2S Heater Bank 2 Sensor 2	This device control is used to override the duty cycle of the oxygen sensor heaters. With the engine OFF, this device control is intended to be used as a discrete control for circuit diagnosis. With the engine OFF, none of the oxygen sensor heaters can be commanded ON for more than

Output Control	Description
	3.0 seconds, after which the selected oxygen sensor heater must be disabled for a limited duration (typically 60 seconds) before it may be enabled again. With the engine running, this device control is used to operate the oxygen sensor heaters at the various duty cycles available to the engine controller.
HO2S Heater Learn	This device control is used to trigger the reset of the learned resistances for the oxygen sensor heaters following a replacement in service. The learned resistances are reset to a calibration used to prevent overheating of the sensors until more accurate resistances may be learned following an extended engine OFF time (typically 12 or more hours).
Idle Ignition Timing	Disables and enables idle spark advance with the engine running.
Idle Learn	This function allows the throttle position and the idle speed to be relearned by the ECM, once the following conditions have been met. • The ignition is ON with the engine OFF. • The ECT is between 5-85Â°C (41-185Â°F). • No throttle actuator control (TAC) system DTCs are set.
Ignition Timing Retard	This device control is used to retard the spark angle from the software calculated spark angle. For example, if the software calculated spark angle was 15 degrees advanced and this device control requested a 3 degree retard, the commanded spark angle that would be delivered would be 12 degrees advanced.
Intake Air Heater	This device control is used to override the state of the intake air heater.
Intake Camshaft Position Actuator or Intake Camshaft Position Actuator Bank 1	This device control is used to override the state of the intake cam phase output. The commanded camshaft position is expressed in terms of degrees of camshaft rotation (advance for intake camshafts) from the park position (a camshaft position of zero represents the park position).
Intake Camshaft Position Actuator or Intake Camshaft Position Actuator Bank 2	This device control is used to override the state of the intake cam phase output. The commanded camshaft position is expressed in terms of degrees of camshaft rotation (advance for intake camshafts) from the park position (a camshaft position of zero represents the park position).
Intake Camshaft Position Actuator Solenoid Valve or Intake Camshaft Position Actuator Solenoid Valve Bank 1	This device control is used to override the state of the intake cam phase solenoid output.
Intake Camshaft Position Actuator Solenoid Valve or Intake Camshaft Position Actuator Solenoid Valve Bank	This device control is used to override the state of the intake cam phase solenoid output.

Output Control	Description
2	
Intake Rocker Arm Solenoid Valve 1-2 or 1 and 2	When the engine is running, this device control may be used to command intake valve opening to low or high (high being default when the solenoid is not energized) valve lift mode either in cylinder pairs or as a system.
Malfunction Indicator Lamp (MIL)	This function controls the malfunction indicator lamp (MIL). The normal commanded state is NONE. When commanded ON/OFF, the ECM turns the MIL ON/OFF. The system remains in the commanded state until cancelled by the scan tool.
Mass Air Flow Sensor Supply Voltage	This device control is used to override the state of the mass air flow sensor supply voltage output.
Misfire Graphic	This function clears the misfire graphics from the scan tool.
Oil Life Reset	This output control is used to reset the engine oil life monitor from 0 to 100 %.
Remote Vehicle Start Disable History Reset	This function clears the remote vehicle start (RVS) disable history. When RESET is selected the reason the control module did not allow RVS in the last 8 attempts is cleared.
Secondary Air Injection Pump Relay	This device control is used to turn the AIR Pump ON or OFF.
Secondary Air Injection Solenoid Valve	This device control is used to turn the AIR Valve ON or OFF.
Secondary Air Injection Test	This device control is used to trigger the secondary air injection (SAI) diagnostic service bay test, which causes the on board SAI diagnostic to execute until it is completed or aborted.
Starter Relay (If Available)	Commands the starter relay ON and OFF.
Throttle Position	This device control is used to override the commanded throttle position.
Throttle Sweep	This function moves the Throttle plate slowly from a closed position to wide open position, aiding diagnosis of TAC motor.
Transmission Fluid Pressure Accumulator Solenoid Valve	This device control is used to override the state of the Transmission Fluid Pressure Accumulator Solenoid Valve.
Turbocharger Bypass Solenoid Valve	This device control is used to control the duty cycle for the turbocharger A compressor bypass.
Turbocharger Wastegate Solenoid Valve	This device control is used to control the duty cycle for the turbocharger A wastegate.

HEATING, VENTILATION AND AIR CONDITIONING CONTROL MODULE SCAN TOOL INFORMATION

HVAC Control Module Scan Tool Data Parameters

Parameter	System State	Expected Value	Definition
Operating Conditions : Engine ON			
A/C Head Pressure	-	Normal	The scan tool displays Normal or Out of Range.

Parameter	System State	Expected Value	Definition
A/C LED	-	Varies	The scan tool displays On or Off. This is the current state of the A/C indicator LED.
A/C Request	-	No	The scan tool displays Yes or No. Yes is displayed if the air conditioning is requested.
Ambient Air Temperature	-	Normal	The scan tool displays Normal or Out of Range.
Ambient Air Temp. Sensor	-	Varies	The scan tool displays Â°C (Â°F). This is the outside air temperature.
Battery Voltage	-	Normal	The scan tool displays Normal or Out of Range.
Blower Motor Speed Command	-	Varies	The scan tool displays 0-100 percent. This is the numeric value in percent of the blower motor speed as commanded by the HVAC module.
Blower Speed	-	Normal	The scan tool displays Normal or Off.
Coolant Temperature	-	Varies	This displays Â°C (Â°F). This is the current temperature of the engine coolant.
Driver Heated Seat Switch	-	Inactive	The scan tool displays Inactive or Active. This is the current state of the driver heated seat switch.
Driver Temp. Dr. Motor Command	-	Varies	This displays counts. This is the numeric value of the driver temperature door commanded by the HVAC module.
Driver Temp. Dr. Position	-	Varies	This displays counts . This is the current value of the driver temperature door as monitored by the HVAC module.
Engine Coolant Temp	-	Normal	The scan tool displays Normal or Out of Range.
Engine Running	-	Yes	The scan tool displays Yes or No.
Mode Dr. Motor Command	-	Varies	This displays counts. This is the numeric value of the mode door commanded by the HVAC module.
Mode Door Position	-	Varies	This displays counts . This is the current value of the mode door as monitored by the HVAC module.
Mode Select Position	-	Varies	The scan tool displays Invalid, Auto, Panel, Bi-Level, Heater,

Parameter	System State	Expected Value	Definition
			Htr./Def., or Defrost. This is the current position of the mode select switch.
Outside Air LED	-	Off	The scan tool displays On or Off. This is the current state of the outside air indicator LED.
Outside Air Temp.	-	Varies	This displays Â°C (Â°F). This is the raw value of the outside air temperature.
Passenger Heated Seat Switch	-	Inactive	The scan tool displays Inactive or Active. This is the current state of the passenger heated seat switch.
Psgr. Temp. Dr. Motor Command	-	Varies	This displays counts. This is the numeric value of the passenger temperature door commanded by the HVAC module.
Psgr. Temp. Dr. Position	-	Varies	This displays counts . This is the current value of the passenger temperature door as monitored by the HVAC module.
Rear Defrost LED	-	Varies	The scan tool displays On or Off. This is the current state of the rear defrost indicator LED.
Rear Defrost State	-	Off	The scan tool displays On or Off. This is the current state of the rear defroster.
Recirculation Dr. Motor Command	-	Varies	This displays counts. This is the numeric value of the recirculation door commanded by the HVAC module.
Recirculation Dr. Position	-	Varies	This displays counts . This is the current value of the recirculation door as monitored by the HVAC module.
Recirculation LED	-	Varies	The scan tool displays On or Off. This is the current state of the recirculation mode indicator LED.
Temperature Dr. Motor Command	-	Varies	This displays counts. This is the numeric value of the temperature door commanded by the HVAC module.
Temperature Dr. Position	-	Varies	This displays counts . This is the current value of the temperature door as monitored by the HVAC module.

Parameter	System State	Expected Value	Definition
Vehicle Speed	-	Varies	This displays the current vehicle speed in MPH.

HVAC Control Module Scan Tool Output Controls

Scan Tool Output Control	Description
A/C LED	This command allows you to turn the A/C LED On and Off.
A/C Request	This command allows you to turn the A/C relay On and Off. When the A/C relay is commanded On, the A/C compressor clutch should be engaged.
Air Inlet Door Position	The scan tool displays On or Off selections. The selection drives the actuator to its minimum or maximum positions.
All Status LEDs	This command allows you to turn the all HVAC status LEDs On and Off.
Blower Motor	The scan tool displays Off or On selections. This function allows you to command the blower motor to its maximum or minimum speeds.
Driver Heated Seat LED	This command allows you to turn the driver heated seat LED On and Off.
Left Temp. Door Position	The scan tool displays On or Off selections. The selection drives the actuator to its minimum or maximum positions.
Mode Door Position	The scan tool displays On or Off selections. The selection drives the actuator to its minimum or maximum positions.
Psgr. Heated Seat LED	This command allows you to turn the passenger heated seat LED On and Off.
Rear Defog LED	This command allows you to turn the rear defog LED On and Off.
Recalibrate All Motors	When ON is selected, all air temp and mode actuators have the capability to perform a recalibration.
Recirc. LED	This command allows you to turn the recirculation LED On and Off.
Right Temp. Door Position	The scan tool displays On or Off selections. The selection drives the actuator to its minimum or maximum positions.

INFLATABLE RESTRAINT PASSENGER PRESENCE SYSTEM SCAN TOOL INFORMATION

Passenger Presence System Scan Tool Data Parameters

Parameter	System State	Expected Value	Definition
Operating Conditions : Ignition ON			
Battery Voltage Signal	-	Varies	The scan tool displays 0-20 volts. This is the system voltage measured by the PPS between the battery input and ground.
Passenger Classification	-	Empty	The scan tool displays Unknown, Calibrating, Empty Seat, Small 1, Small 2, Large or Re-Zero. The scan tool displays the calculated seat occupant status or need to re-zero.

Parameter	System State	Expected Value	Definition
Passenger Status	-	No Info	The scan tool displays No Info., Valid, Invalid Class., Invalid Pos., Invalid Data or Inval. Class & Pos. The scan tool displays the calculated seat occupant status including relationship to seat position.
Power Mode	-	Run	The scan tool displays Off, Accessory, Run or Crank Request. The scan tool displays the current vehicle power mode.
PPS Enable Status	-	Enabled	The scan tool displays Disabled or Enabled. The scan tool displays the current status of the PPS system. This information is sent to the SDM for deactivation of the deployment loops related to the passenger airbags. PPS Enable Status and SDM Enable status should match.
PPS Fault Status	-	No Fault	The scan tool displays No Fault, Plant Mode, Fault, Mismatch or Test Enable. The scan tool displays the current condition of the PPS system to determine if the SDM or PPS is causing the PPS Disabled condition.
PPS Primary Key	-	Varies	The scan tool displays primary key that the PPS has stored to memory.
Pressure Sensor	-	Varies	The scan tool displays the voltage determined by the weight/position of the seat occupant.
Primary Key Status	-	Valid	The scan tool displays Unknown, Valid or Invalid. The scan tool displays the status of the primary key based on the comparison between the SDM and the PPS. If the Status is other than Valid the PPS will not allow activation and should set a DTC.
Received Primary Key	-	Varies	The scan tool displays what the PPS received from the BCM as the primary key. The PPS then compares it to what it has stored to determine the Primary Key Status. The PPS Primary Key and Received

Parameter	System State	Expected Value	Definition
			Primary Key should match.
Seat Belt Tension Sensor	-	Varies	The scan tool displays voltage which is used to determine whether a child infant seat is mounted in the passenger seat or not.
SDM Enable Status	-	Enabled	The scan tool displays the current status of the PPS system within the SDM. When disabled, SDM will default to deactivate the deployment loops related to the passenger airbags. PPS Fault Status and SDM Fault status should match.

INFLATABLE RESTRAINT SENSING AND DIAGNOSTIC MODULE SCAN TOOL INFORMATION

Supplemental Inflatable Restraint Scan Tool Data Parameters

Parameter	System State	Expected Value	Definition
Operating Conditions : Ignition ON			
Active Switch	-	Enabled	The scan tool displays Enabled or Disabled. This is the state of the SIR active switch.
Active Switch	-	Learned	The scan tool displays Learned or Unlearned. Learned is displayed if the SIR learned the active switch.
Battery Voltage Signal	-	Varies	The scan tool displays 0-20 volts. This is the system voltage measured by the SDM between the battery input and ground.
Deployment Loop 1-12	-	Enabled	The scan tool displays Enabled or Disabled. This is the state of the SIR loop.
Deployment Loop 1-12	-	Learned	The scan tool displays Learned or Not Learned. Learned is displayed if the SIR has that number loop learned.
Driver Seat Belt Switch	-	Unbuckled	The scan tool displays Buckled or Unbuckled. This is the state of the driver seat belt.
Driver Seat Belt Type	-	Varies	The scan tool displays Switch or Sensor. The scan tool displays whether the driver seat uses a switch or a sensor for the seat belt buckle.

Parameter	System State	Expected Value	Definition
Driver Seat Position Sensor	-	Enabled	The scan tool displays Enabled or Disabled. This is the state of the driver seat position sensor.
Driver Seat Position Sensor	-	Learned	The scan tool displays Learned or Unlearned. Learned is displayed if the SIR learned the driver seat position sensor.
Driver Seat Position Sensor	-	Varies	The scan tool displays whether the driver seat is in the Forward or Rearward position to determine if the airbag should activate single or dual stage deployment as necessary.
Impact Sensor 1-6	-	Enabled	The scan tool displays Enabled or Disabled. This is the state of the sensor.
Impact Sensor 1-6	-	Learned	The scan tool displays Learned or Unlearned. Learned is displayed if the SIR has that sensor learned.
Loop 1-12 Type	-	Varies	The scan tool displays Not Used, LF Stage 1, RF Stage 1, LF Stage 2, RF Stage 2, LF Preten., RF Preten., LF Side Bag, RF Side Bag, Lt. Roof Stage1, Rt. Roof Stage1, Lt. Roof Stage2, Rt. Roof Stage2, Lt. Roof Stage3 or Rt. Roof Stage3. This is the type of loop.
Passenger Seat Belt Switch	-	Unbuckled	The scan tool displays Buckled or Unbuckled. This is the state of the passenger seat belt.
PPS Options	-	Varies	The scan tool displays Not Present, Manual, Auto or Auto. + Man. This is the current enabled option of the passenger presence system.
PPS Status	-	Enabled	The scan tool displays Enabled or Disabled. This is the state of the passenger presence system.
PPS Status	-	Learned	The scan tool displays Learned or Unlearned. Learned is displayed if the SIR has learned the passenger presence system.
Primary Key Status	-	Valid	The scan tool displays Unknown, Valid or Invalid. The scan tool displays the status of the primary key based on the comparison

Parameter	System State	Expected Value	Definition
			between the BCM and the SDM. If the Status is other than Valid the SDM will not allow activation and should set a DTC.
Psgr. Seat Belt Sensor	-	Enabled	The scan tool displays Enabled or Disabled. This is the state of the passenger seat belt sensor.
Psgr. Seat Belt Sensor	-	Learned	The scan tool displays Learned or Unlearned. Learned is displayed if the SIR learned the passenger seat belt sensor.
Psgr. Seat Belt Sensor	-	Varies	This displays mA. This is the amount of current supplied to the passenger seat belt sensor.
Psgr. Seat Belt Type	-	Varies	The scan tool displays Switch or Sensor. The scan tool displays whether the passenger seat uses a switch or a sensor for the seat belt buckle.
Psgr. Seat Position Sensor	-	Enabled	The scan tool displays Enabled or Disabled. This is the state of the passenger seat position sensor.
Psgr. Seat Position Sensor	-	Learned	The scan tool displays Learned or Unlearned. Learned is displayed if the SIR learned the passenger seat position sensor.
Psgr. Seat Position Sensor	-	Inactive	The scan tool displays Rearward or Forward. The scan tool displays whether the passenger seat is in the Forward or Rearward position to determine if the airbag should activate single or dual stage deployment as necessary.
Received Primary Key	-	Varies	The scan tool displays what the SDM received from the BCM as the primary key. The SDM then compares it to what it has stored to determine the Primary Key Status. The SDM Primary Key and Received Primary Key should match.
Received VIN Digits 2-5	-	Varies	The scan tool displays the Secondary Key which includes digits 2 though 5 of the VIN that the BCM sends to the SDM.

Parameter	System State	Expected Value	Definition
Received VIN Digits 6-7	-	Varies	The scan tool displays the Secondary Key which includes digits 6 and 7 of the VIN that the BCM sends to the SDM.
Rollover Sensor	-	Enabled	The scan tool displays Enabled or Disabled. This is the state of the rollover sensor.
Rollover Sensor	-	Learned	The scan tool displays Learned or Unlearned. Learned is displayed if the SIR learned the rollover sensor.
Run/Crank	-	Active	This displays volts. This is the current power mode of the SDM.
Secondary Key Status	-	Valid	The scan tool displays Unknown, Valid or Invalid. This determines if the VIN stored in SDM memory matches what is stored in the BCM.
Sensor 1-6 Type	-	Varies	The scan tool displays Not Used, EFS LF, EFS Center, EFS RF, SIS Left Row 1, SIS Right Row 1, SIS Left Row 2 or SIS Right Row 2. This is the type of SIR sensor.
SDM Primary Key	-	Varies	The scan tool displays the primary key that the SDM has stored to memory.
SIR Warning Indicator	-	Off	The scan tool displays On or Off. This is the status of the SIR warning indicator.

Supplemental Inflatable Restraint Scan Tool Output Controls

Scan Tool Output Control	Description
Setup New SDM	This output control is used to set up a new SDM.
Setup SDM Primary Key in BCM	This output control is used to set up a new SDM primary key in the BCM.

INSTRUMENT CLUSTER SCAN TOOL INFORMATION

Instrument Panel Cluster Scan Tool Data Parameters

Parameter	System State	Expected Value	Definition
Operating Conditions: Ignition ON			
Battery Voltage	-	Varies	This displays volts. The scan tool displays the system voltage of the vehicle.

Parameter	System State	Expected Value	Definition
Brake Fluid	-	OK	The scan tool displays OK or Low. This is the state of the brake fluid level.
Brake Fluid Switch	-	Varies	This displays volts. This is the voltage status of the brake fluid switch.
DIC Fuel Info.	-	Inactive	The scan tool displays Active or Inactive. This is the state of the DIC Fuel Info. switch.
DIC Information Switch	-	Inactive	The scan tool displays Active or Inactive. This is the state of the DIC Information switch.
DIC Personalization	-	Off	The scan tool displays Active or Inactive. This is the status of the driver information center (DIC) personalization functions as monitored by the IPC.
Heated Washer Fluid Ind. Signal	-	Inactive	The scan tool displays Active or Inactive. This is the status of the heated washer fluid indicator signal as monitored by the IPC.
Ignition 1 Input	-	Active	The scan tool displays Active or Inactive. This is the state of the Ignition 1 input to the IPC.
Ignition Cycle Counter	-	Varies	The scan tool displays counts. This is the number of times the ignition has been cycled from the OFF to ON position.
Passenger Seatbelt Indicator Commanded	-	Off	This displays On or Off. This is the state of the seatbelt indicator command as monitored by the IPC.
Passenger Seatbelt Indicator Status	-	Off	This displays On or Off. This is the status of the seatbelt indicator status as monitored by the IPC.
Trip Reset Switch	-	Inactive	The scan tool displays Active or Inactive. This is the state of the trip reset switch.
Washer Fluid Level	-	OK	The scan tool displays OK or Low. This is the state of the washer fluid level.

Instrument Panel Cluster Scan Tool Output Controls

Scan Tool Output Control	Description

Scan Tool Output Control	Description
Dimming	The IPC increases or decreases the dimming intensity in increments of 20 percent between a range of 0-100 percent.
Display Test	The IPC illuminates all of the indicators for 7 seconds when you select ON.
Display(s) Test	The instrument panel cluster (IPC) drives all of the gauges at or below minimum for a few seconds when you select ON, then drives all of the gauges at or above maximum for a few seconds. The IPC Display Test will end after one cycle of the gauges sweep.

RADIO SCAN TOOL INFORMATION

Radio Scan Tool Data Parameters

Parameter	System State	Expected Value	Definition
Operating Conditions : Ignition ON			
Antenna Module	-	Enabled	This scan tool displays Enabled or Disabled. This is the state of the antenna module.
Auxiliary Audio Input	-	Present	The scan tool displays Present or Not Present. This is the state of the auxiliary audio input.
DRR	-	Present	The scan tool displays Present or Not Present. This is indicates if the digital radio receiver present.
Ign. Cycles Since last DTC	-	Varies	The scan tool displays the number of ignition cycles since the last DTC.
Phone Signal	-	Present	The scan tool displays Present or Not Present. This is the state of the phone signal.
Power Mode	-	Run	The scan tool displays Off, Accessory, Run or Crank Request. This is the state of the ignition switch.
Power Mode Config.	-	Normal Mode	The scan tool displays Bench Mode or Normal Mode. This is the configuration of the power mode.
Signal Strength	-	Varies	This displays dBuV. This is the signal strength of the radio.
Theft Armed	-	Learned VIN	The scan tool displays Learned VIN or No VIN. The Scan tool displays Learned VIN when the theft mode has been turned ON by recognizing a valid VIN.

Parameter	System State	Expected Value	Definition
Theft Lock Status	-	Inactive	The scan tool displays Active or Inactive. This is the state of the theft lock system.
Video Display	-	Varies	The scan tool displays Present or Not Present. This is the state of the video display.

Radio Scan Tool Output Controls

Scan Tool Output Control	Description
Left Front Speaker	Commanding the speaker ON will turn OFF all speakers except this speaker. Commanding the speaker OFF enables all speakers.
Left Rear Speaker	Commanding the speaker ON will turn OFF all speakers except this speaker. Commanding the speaker OFF enables all speakers.
Right Front Speaker	Commanding the speaker ON will turn OFF all speakers except this speaker. Commanding the speaker OFF enables all speakers.
Right Rear Speaker	Commanding the speaker ON will turn OFF all speakers except this speaker. Commanding the speaker OFF enables all speakers.

REMOTE CONTROL DOOR LOCK RECEIVER SCAN TOOL INFORMATION

Remote Control Door Lock Receiver Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Ignition ON			
Battery Voltage Signal	-	Varies	The scan tool displays the current system battery voltage.
Fob 1-4 Battery	-	OK	The scan tool displays OK or Low. This is the state of the indicated fob battery.
Fob 1-4 Function	-	None	The scan tool displays None, Lock, Dr Door Unlock, All Door Unlock, R Closure Rel., Lt Sliding Ctrl., Rt Sliding Ctrl., Panic, Fuel Door, Power Window, Power Top, Engine Start, Engine Stop, Fob Program, Locate, R Closure Close, R Closure Open, R Closure Stop, Double Lock, R Closure Start or Lt Sliding Stop. The scan tool indicates the last keyless entry function received by the keyless entry transmitter programmed to the indicated slot number.
Fob 1-4 Programmed	-	Yes	The scan tool displays Yes or No. Yes is displayed if a fob has been programmed to the indicated slot number.
Front Placard	-	Varies	This displays Counts.

Parameter	System State	Expected Value	Description
Last Fob Used	-	Varies	The scan tool displays None, Fob 1, Fob 2, Fob 3, Fob 4 or Fob 5. This was the last Fob used, as monitored by the RCDLR.
Last Key Pressed On Fob	-	Varies	The scan tool displays Unlock, Lock, Panic, remote Start, Rear Closure, Left Slide Door, Right Slide Door, Learn, or No Key Press. The scan tool indicates the last keyless entry function received by a valid keyless entry transmitter.
Learn in Progress	-	No	The scan tool displays Yes or No. Yes is displayed when the TPM system is in learn mode.
LF Pressure Sensor Mode	-	Stationary	The scan tool displays Off, Learn, Re-measure, Drive, Stationary, or Wakeup. This is the state of the left front pressure sensor.
LF Pressure Status	-	Normal	The scan tool displays Unknown, Normal, Low, Flat or High. This is the state of the left front tire pressure.
LF Tire Press. Sensor Status	-	Normal	The scan tool displays Normal or Failed. This is the state of the left front tire pressure sensor.
LF Tire Pressure Sensor Battery Status	-	OK	The scan tool displays OK or Low. This is the condition of the left front tire pressure sensor battery.
LF Tire Pressure	-	Varies	This displays kPa (psi). This is the amount of pressure in the left front tire.
LR Pressure Sensor Mode	-	Stationary	The scan tool displays Off, Learn, Re-measure, Drive, Stationary, or Wakeup. This is the state of the left rear pressure sensor.
LR Pressure Status	-	Normal	The scan tool displays Unknown, Normal, Low, Flat or High. This is the state of the left rear tire pressure.
LR Tire Press. Sensor Status	-	Normal	The scan tool displays Normal or Failed. This is the state of the left rear tire pressure sensor.
LR Tire Pressure Sensor Battery Status	-	OK	The scan tool displays OK or Low. This is the condition of the left rear tire pressure sensor battery.
LR Tire Pressure	-	Varies	This displays kPa (psi). This is the amount of pressure in the left rear tire.
Rear Placard	-	Varies	This displays Counts.

Parameter	System State	Expected Value	Description
RF Pressure Sensor Mode	-	Stationary	The scan tool displays Off, Learn, Re-measure, Drive, Stationary, or Wakeup. This is the state of the right front pressure sensor.
RF Pressure Status	-	Normal	The scan tool displays Unknown, Normal, Low, Flat or High. This is the state of the right front tire pressure.
RF Tire Press. Sensor Status	-	Normal	The scan tool displays Normal or Failed. This is the state of the right front tire pressure sensor.
RF Tire Pressure Sensor Battery Status	-	OK	The scan tool displays OK or Low. This is the condition of the right front tire pressure sensor battery.
RF Tire Pressure	-	Varies	This displays kPa (psi). This is the amount of pressure in the right front tire.
RR Pressure Sensor Mode	-	Stationary	The scan tool displays Off, Learn, Re-measure, Drive, Stationary, or Wakeup. This is the state of the right rear pressure sensor.
RR Pressure Status	-	Normal	The scan tool displays Unknown, Normal, Low, Flat or High. This is the state of the right rear tire pressure.
RR Tire Press. Sensor Status	-	Normal	The scan tool displays Normal or Failed. This is the state of the right rear tire pressure sensor.
RR Tire Pressure Sensor Battery Status	-	OK	The scan tool displays OK or Low. This is the condition of the right rear tire pressure sensor battery.
RR Tire Pressure	-	Varies	This displays kPa (psi). This is the amount of pressure in the right rear tire.
Selected Front Tire Type	-	Varies	The scan tool displays N/A, P-Metric (S), P-Metric (X), Load Range C, Load Range D or Load Range E. This indicates the type of front tires that were last selected for the vehicle.
Selected Rear Tire Type	-	Varies	The scan tool displays N/A, P-Metric (S), P-Metric (X), Load Range C, Load Range D or Load Range E. This indicates the type of rear tires that were last selected for the vehicle.
TPM Indicator/Message	-	Off	the scan tool displays Off or On. This indicates if the TPM system has requested a warning message or indicator lamp to be activated.

Parameter	System State	Expected Value	Description
TPM System Enabled	-	Yes	The scan tool displays Yes or No. Yes is displayed if the TPM system is enabled.

Remote Control Door Lock Receiver Scan Tool Output Controls

Output Control	Description
Key Fob Button Test	The RCDLR monitors the incoming RF communications to ensure all keyless entry transmitter functions are operating properly.

THEFT DETERRENT MODULE SCAN TOOL INFORMATION

Theft Deterrent Module Scan Tool Data Parameters

Parameter	Expected Value	Definition
Operating Conditions: Ignition ON		
Auto Learn Counter	Varies	This displays Counts. This is the number of times the auto learn procedure was carried out by the TDM.
Auto. Learn Timer	Varies	This displays minutes. This is the amount of minutes the TDM took to auto learn.
Battery Reconnect	No	The scan tool displays Yes or No. Yes is displayed if the battery was recently reconnected.
Fleet Vehicle	No	The scan tool displays Yes or No. Yes is displayed if the vehicle is a fleet vehicle.
Fuel Continue	No	The scan tool displays Yes or No.
Fuel Disable Ignition Off	Yes	The scan tool displays Yes or No. Yes is displayed if the fuel is disabled during ignition OFF.
Fuel Disable Timeout	No	The scan tool displays Yes or No. Yes is displayed if the fuel disable timed out.
Ignition Voltage Signal	Present	The scan tool displays Present or Not Present. Present is displayed if there is an ignition voltage signal to the TDM.
Immobilization	Inactive	The scan tool displays Active or Inactive. This is the state of the immobilizer system.
Immobilizer Programmed	Yes	The scan tool displays Yes or No. This is the state of the immobilizer system programming.
Incorrect VIN 1	No Error	The scan tool displays Unknown, No Error, ECM/PCM, TCM, EBCM, DSCC, TBCM, ESCM, ASCM, BCM, BCM Aux., SDM, PPS, ROS, PIDM, IPC, DIC, HUD, Chime, Radio, Amp., CDX, RSA, DRR, Onstar, HVAC, RCC, DDM, PDM, LRDM, RRDM, LGM, PSDM, MSM, HVSM, RCDLR, SOD, TDM or SCLM. The module displayed has an incorrect VIN programmed into that module.
Incorrect VIN 2	No Error	The scan tool displays Unknown, No Error, ECM/PCM, TCM, EBCM, DSCC, TBCM, ESCM, ASCM, BCM,

Parameter	Expected Value	Definition
		BCM Aux., SDM, PPS, ROS, PIDM, IPC, DIC, HUD, Chime, Radio, Amp., CDX, RSA, DRR, Onstar, HVAC, RCC, DDM, PDM, LRDM, RRDM, LGM, PSDM, MSM, HVSM, RCDLR, SOD, TDM or SCLM. The module displayed has an incorrect VIN programmed into that module.
Incorrect VIN 3	No Error	The scan tool displays Unknown, No Error, ECM/PCM, TCM, EBCM, DSCC, TBCM, ESCM, ASCM, BCM, BCM Aux., SDM, PPS, ROS, PIDM, IPC, DIC, HUD, Chime, Radio, Amp., CDX, RSA, DRR, Onstar, HVAC, RCC, DDM, PDM, LRDM, RRDM, LGM, PSDM, MSM, HVSM, RCDLR, SOD, TDM or SCLM. The module displayed has an incorrect VIN programmed into that module.
Incorrect VIN 4	No Error	The scan tool displays Unknown, No Error, ECM/PCM, TCM, EBCM, DSCC, TBCM, ESCM, ASCM, BCM, BCM Aux., SDM, PPS, ROS, PIDM, IPC, DIC, HUD, Chime, Radio, Amp., CDX, RSA, DRR, Onstar, HVAC, RCC, DDM, PDM, LRDM, RRDM, LGM, PSDM, MSM, HVSM, RCDLR, SOD, TDM or SCLM. The module displayed has an incorrect VIN programmed into that module.
Incorrect VIN 5	No Error	The scan tool displays Unknown, No Error, ECM/PCM, TCM, EBCM, DSCC, TBCM, ESCM, ASCM, BCM, BCM Aux., SDM, PPS, ROS, PIDM, IPC, DIC, HUD, Chime, Radio, Amp., CDX, RSA, DRR, Onstar, HVAC, RCC, DDM, PDM, LRDM, RRDM, LGM, PSDM, MSM, HVSM, RCDLR, SOD, TDM or SCLM. The module displayed has an incorrect VIN programmed into that module.
Incorrect VIN 6	No Error	The scan tool displays Unknown, No Error, ECM/PCM, TCM, EBCM, DSCC, TBCM, ESCM, ASCM, BCM, BCM Aux., SDM, PPS, ROS, PIDM, IPC, DIC, HUD, Chime, Radio, Amp., CDX, RSA, DRR, Onstar, HVAC, RCC, DDM, PDM, LRDM, RRDM, LGM, PSDM, MSM, HVSM, RCDLR, SOD, TDM or SCLM. The module displayed has an incorrect VIN programmed into that module.
Incorrect VIN 7	No Error	The scan tool displays Unknown, No Error, ECM/PCM, TCM, EBCM, DSCC, TBCM, ESCM, ASCM, BCM, BCM Aux., SDM, PPS, ROS, PIDM, IPC, DIC, HUD, Chime, Radio, Amp., CDX, RSA, DRR, Onstar, HVAC, RCC, DDM, PDM, LRDM, RRDM, LGM, PSDM, MSM, HVSM, RCDLR, SOD, TDM or SCLM. The module displayed has an incorrect VIN programmed

Parameter	Expected Value	Definition
		into that module.
Incorrect VIN 8	No Error	The scan tool displays Unknown, No Error, ECM/PCM, TCM, EBCM, DSCC, TBCM, ESCM, ASCM, BCM, BCM Aux., SDM, PPS, ROS, PIDM, IPC, DIC, HUD, Chime, Radio, Amp., CDX, RSA, DRR, Onstar, HVAC, RCC, DDM, PDM, LRDM, RRDM, LGM, PSDM, MSM, HVSM, RCDLR, SOD, TDM or SCLM. The module displayed has an incorrect VIN programmed into that module.
Incorrect VIN 9	No Error	The scan tool displays Unknown, No Error, ECM/PCM, TCM, EBCM, DSCC, TBCM, ESCM, ASCM, BCM, BCM Aux., SDM, PPS, ROS, PIDM, IPC, DIC, HUD, Chime, Radio, Amp., CDX, RSA, DRR, Onstar, HVAC, RCC, DDM, PDM, LRDM, RRDM, LGM, PSDM, MSM, HVSM, RCDLR, SOD, TDM or SCLM. The module displayed has an incorrect VIN programmed into that module.
Incorrect VIN 10	No Error	The scan tool displays Unknown, No Error, ECM/PCM, TCM, EBCM, DSCC, TBCM, ESCM, ASCM, BCM, BCM Aux., SDM, PPS, ROS, PIDM, IPC, DIC, HUD, Chime, Radio, Amp., CDX, RSA, DRR, Onstar, HVAC, RCC, DDM, PDM, LRDM, RRDM, LGM, PSDM, MSM, HVSM, RCDLR, SOD, TDM or SCLM. The module displayed has an incorrect VIN programmed into that module.
Learn Coded Key	No	The scan tool displays Yes or No.
Master Keys Learned	Varies	This displays Counts. This is the number of master keys learned by the TDM.
PCM Authentication Status	Valid	The scan tool displays Unknown, Incorrect, Negative or Valid. This is the state of the PCM authentication.
PCM Auto. Learn Timer	Inactive	The scan tool displays Active or Inactive. This is the current state of the ECM auto learn timer.
PCM Password Learning	Enabled	The scan tool displays Enabled or Disabled. This is the state of the password learning in the ECM.
PCM Release Status	Release	The scan tool displays Unknown, Post Release, Pre-Release or Release. This is the release status of the ECM.
Power Mode	Run	The scan tool displays Off, Accessory, Run or Crank Request. This is the state of the ignition switch.
Powertrain DTC	No	The scan tool displays Yes or No. Yes is displayed if there is a powertrain DTC stored in the ECM or TCM.
Previous TDM State	Varies	The scan tool displays Asleep, Wakeup, Normal, Learn Passkey, Tamper, Monitor Key, Fail Pending, Fail Enabled, Lrn Keys Stdby, Learn More Keys, Learn Pending, Auto Learn, Auto. Lrn. Done, No Coded Key,

Parameter	Expected Value	Definition
		Check Second Key, VIN Check, OnStar, Bypass, Override or VIN Timer. This was the last state of the TDM.
Security Code Programmed	No	The scan tool displays Yes or No. Yes is displayed if a security code is programmed.
Start Disabled	No	The scan tool displays Yes or No. Yes is displayed if the starter is disabled.
Substitution Detection Status	Pass	The scan tool displays Pass or Fail. Pass is displayed if the TDM does not sense a module with incorrect VIN programming.
Tamper Status	Inactive	The scan tool displays Active or Inactive. This is the state of the tamper system.
TDM State	Varies	The scan tool displays Asleep, Wakeup, Normal, Learn Passkey, Tamper, Monitor Key, Fail Pending, Fail Enabled, Lrn Keys Stdby, Learn More Keys, Learn Pending, Auto Learn, Auto. Lrn. Done, No Coded Key, Check Second Key, VIN Check, OnStar, Bypass, Override, or VIN Timer. This was the last state of the TDM.
Telltale Status	Off	The scan tool displays On, Off, Flash or Invalid. This is the state of the security indicator.
Theft Problem	No	The scan tool displays Yes or No. Yes is displayed if there is a theft problem.
Total Keys Learned	Varies	This displays Counts. This is the number of total keys learned by the TDM.
Transponder Key	Present	The scan tool displays Present or Not Present. Present is displayed when a transponder is present. This does not mean that this is a valid or learned transponder, but only that a transponder is present.
Valid Key	Yes	The scan tool displays Yes or No. Yes is displayed if a valid key was used as monitored by the TDM.
Valid VIN	Yes	The scan tool displays Yes or No. Yes is displayed if the VIN is valid.
VIN Learned	Yes	The scan tool displays Yes or No. Yes is displayed if the VIN was learned.
VIN Message Received	Yes	The scan tool displays Yes or No. Yes is displayed if the VIN message is received

TRANSMISSION CONTROL MODULE SCAN TOOL INFORMATION

The Transmission Control Module Scan Tool Data List contains all transmission related parameters that are available on the scan tool. The list is arranged in alphabetical order. A given parameter may appear in any one of the data lists, and in some cases may appear more than once, or in more than one data list in order to group certain related parameters together.

The values below represent a typical display recorded from a properly functioning system.

Only the parameters listed below are used/referenced in this manual for diagnosis. If a scan tool displays other parameters, those values are not recommended by General Motors for use in diagnosis.

If all values are within the expected range described below, refer to **Symptoms - Automatic Transmission** for diagnosis.

The scan tool values from a properly functioning transmission may be used for comparison with the transmission you are diagnosing. The values below represent a typical display recorded from a properly functioning system.

Scan Tool Data Parameters

Parameter	System State	Expected Value	Description
Operating Conditions: Engine at idle, upper radiator hose hot, closed throttle, transmission in Park, closed loop operation, accessories OFF, brake pedal not applied.			
1-2 Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last adaptable 1-2 shift. The shift time is based on the gear ratio change after the commanded 1-2 shift.
2-3 Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last adaptable 2-3 shift. The shift time is based on the gear ratio change after the commanded 2-3 shift.
3-4 Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last adaptable 3-4 shift. The shift time is based on the gear ratio change after the commanded 3-4 shift.
4-5 Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last adaptable 4-5 shift. The actual shift time is obtained by measuring the time required for the input shaft to decelerate from the previous ratio to the current ratio.
5-6 Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last 5-6 shift. The shift time is base on the gear ratio change after the commanded 5-6 shift.
Brake Switch	-	Released	This parameter displays the status of the brake switch circuit input. Applied indicates a zero voltage input, brake pedal applied. Released indicates a voltage input, brake pedal released. The scan tool displays Applied or Released.
Calc. Throttle Position	-	%, Varies	This parameter displays a calculated value, which is determined by the accelerator pedal position and the actual

Parameter	System State	Expected Value	Description
			throttle position, used to optimize transmission controls. It represents the driver's intended request for torque or acceleration. The range is 0-100%, where 0% represents an idle or coast request and 100% represents a request for wide open throttle (WOT).
Commanded Gear	-	1	This parameter displays the current commanded state of the shift solenoid valves. The scan tool displays 1, 2, 3, 4 or 5
Driver Shift Control	-	Inactive	This parameter displays Active or Inactive. The scan tool displays Active when the gear selector is in the sport (S) position, which enables TAP shift. The scan tool displays Inactive when the gear selector is not in the S position, TAP shift disabled.
Driver Shift Request	-	None	This parameter displays the current request from the TAP Shift System. This parameter will display up shift, downshift or invalid depending on the amount of voltage measured at the remote shift selector input and also will display none when there is no request.
ECT	-	Â°C (Â°F), Varies	This parameter displays the input signal from the engine coolant temperature (ECT) sensor. ECT is high at 151Â°C (304Â°F) when the signal voltage is low (0 V). ECT is low at -40Â°C (-40Â°F) when the signal voltage is high (5 V).
Engine Speed	-	RPM, Varies	This parameter displays the rotational speed of the engine expressed as revolutions per minute.
Engine Torque	-	Y, Varies	This parameter displays a calculated value based on engine load, throttle position, mass air flow, and other engine inputs. This parameter is accurate to within 15 lb ft of actual measured engine torque.
Gear Ratio	-	Ratio, Varies	This parameter displays the actual transmission gear ratio. The scan tool displays the gear ratio calculated from the automatic transmission input shaft speed sensor (AT ISS) and the automatic

Parameter	System State	Expected Value	Description
			transmission output shaft speed sensor (AT OSS) inputs.
High Side Driver 1	-	Enabled	This parameter displays the High Side Driver 1 status on the scan tool. When the High Side Driver 1 is commanded OFF this displays Disabled, when the High Side Driver 1 is commanded ON this displays Enabled.
High Side Driver 1 CKT Status	-	OK	This parameter displays the High Side Driver 1 circuit status on the scan tool. If the voltage is low when the solenoid is commanded OFF, the scan tool will display Open/Short to GND. If the voltage is high when the solenoid is commanded ON, the scan tool will display Short to Volts. If no circuit fault is present the scan tool will display OK.
Ignition Voltage	-	Volts, 12-14	This parameter displays the system voltage measured at the ignition feed.
IMS	-	Park	This parameter displays PARK, PARK/REVERSE, REVERSE, REVERSE/NEUTRAL, NEUTRAL, NEUTRAL/DRIVE 4, DRIVE 4, DRIVE 4/DRIVE 3, DRIVE 3, DRIVE 3/DRIVE 2, DRIVE 2, DRIVE 2/DRIVE 1, DRIVE 1 or INVALID. The IMS Range display represents a decoded status of the four inputs from the IMS. The combination of IMS inputs are used to determine what position the manual valve is in at any time.
IMS A/B/C/P	-	Varies	This parameter displays the status of the four A/B/C/P inputs from the automatic transmission internal mode switch. I indicates an ignition voltage signal and LOW indicates a 0 voltage signal. The scan tool will display HI/LOW, HI/LOW, HI/LOW, HI/LOW.
ISS/OSS Supply Voltage	-	OK	This parameter displays OK, Out of Range.
Last Shift Time	-	Seconds, Varies	This parameter displays the actual time of the last up shift. This value is only accurate if the shift was adaptable.

Parameter	System State	Expected Value	Description
Line PC Sol. Pressure Command	-	kPa (psi), Varies	This parameter displays kPa (psi).
PC Sol. 2 Pressure Command	-	kPa (psi), Varies	This parameter displays kPa (psi).
PC Sol. 3 Pressure Command	-	kPa (psi), Varies	This parameter displays kPa (psi).
PC Sol. 4 Pressure Command	-	kPa (psi), Varies	This parameter displays kPa (psi).
PC Sol. 5 Pressure Command	-	kPa (psi), Varies	This parameter displays kPa (psi).
Replicated OSS CKT Status	-	OK	This parameter displays OK, Open/Short to GND, Short to Volts, or Indeterminate.
Shift Sol. 1 CKT Status	-	OK	This parameter displays OK, Open/Short to GND, Short to Volts, or Indeterminate.
Shift Solenoid 1	-	On	This parameter displays the commanded state of the reverse, 1st shift solenoid valve (S1). The scan tool displays On/Off.
Shift Sol. 2 CKT Status	-	OK	This parameter displays OK, Open/Short to GND, Short to Volts, or Indeterminate.
Shift Solenoid 2	-	On	This parameter displays the commanded state of the 2-3, 3-4 shift solenoid valve (S2). The scan tool displays On/Off.
TCC Slip Speed	-	RPM, Varies	This parameter displays the difference between transmission input speed and engine speed. A negative value indicates that the engine speed is less than the input speed, deceleration. A positive value indicates that the engine speed is greater than the input speed, acceleration. A value of zero indicates that the engine speed is equal to the input speed, TCC applied.
TCM Temperature	-	Â°C (Â°F) Varies	This parameter displays results in Â°C (Â°F)
TFP Switch 1	-	HI/LOW	This parameter displays the state of the first clutch oil pressure switch. The scan tool displays HI/LOW.
TFP Switch 3	-	HI/LOW	This parameter displays state of the 3rd clutch oil pressure switch. The scan tool displays HI/LOW.

Parameter	System State	Expected Value	Description
TFP Switch 4	-	HI/LOW	This parameter displays state of the 4th clutch oil pressure switch. The scan tool displays HI/LOW.
TFP Switch 5	-	HI/LOW	This parameter displays state of the fifth clutch oil pressure switch. The scan tool displays HI/LOW.
Trans. Fluid Temp.	-	Â°C (Â°F) Varies	This parameter displays the input signal of the transmission fluid temperature sensor. Transmission fluid temperature is high 151Â°C (304Â°F) when signal voltage is low, 0 V, and transmission fluid temperature is low -40Â°C (-40Â°F) when signal voltage is high, 5 V.
Transmission ISS	-	RPM, Varies	This parameter displays the rotational speed of the transmission input shaft. The scan tool displays input shaft speed is revolutions per minute (RPM).
Transmission OSS	-	RPM, Varies	This parameter displays the rotational speed of the transmission output shaft expressed as revolutions per minute.

Scan Tool Output Controls

Output Control	Description

TCC Control Solenoid	• The transmission control module (TCM) commands the torque converter clutch pressure control (TCC PC) solenoid pressure in order to apply and release the TCC.
	• When the ignition is ON, and the engine is OFF, there are no limits to this control. The solenoid remains ON until commanded OFF and vice versa.
	• When the engine is running, the following control limits apply:
	  • If the transmission range is Park, and the transmission is in hot mode, the TCC PC solenoid may not be commanded OFF. If the solenoid is requested OFF, the message "TCC OFF command disabled in Hot Mode" appears on the scan tool display.
	  • The TCC PC solenoid may not be commanded OFF for more than a calibrated amount of time. If the solenoid is commanded OFF, for a certain amount of time, the message "TCC OFF time has been exceeded" appears on the scan tool display.

Shift Solenoid	• The TCM commands Shift Solenoid 1 and Shift Solenoid 2 ON and OFF.

Output Control	Description

	• When the ignition is ON, and the engine is OFF, there are no limits to this control. The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is determined by the TCM.
	• When the engine is running, the following control limits apply:
	  • The transmission range must be in Park or Neutral. If the transmission range is not Park or Neutral, the message "Engine running and transmission range is not Park/Neutral" appears on the scan tool display.
	  • The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is determined by the TCM.
	  • Transmission range DTCs must not be active. If a transmission range DTC is active, the message "Engine running with transmission DTC present" appears on the scan tool display.

Line PC Solenoid	• The scan tool is used to request pressure in increments of 200 kPa (30 psi) from 200-2200 kPa (30-320 psi). The TCM will then command the solenoid to achieve a pressure within a range based on the requested pressure. Refer to **Solenoid Valve Pressure** .
	• When the ignition is ON, and the engine is ON, the pressure request may be controlled within calibrated limits. There are no limits to the output control when the engine is OFF.
	• When the engine is running, the following control limits apply:
	  • When the transmission range is Park or Neutral, the pressure request may be controlled within calibrated limits. The engine speed must be less than 1,500 RPM. If the engine speed is greater than 1,500 RPM, the message "TR in park/neutral and engine speed over 1,500 RPM" appears on the scan tool display.
	  • When the transmission range is not Park or Neutral, the requested pressure can only be controlled equal to or greater than the pressure determined by the TCM. The TCM does not allow a pressure to be selected that may cause damage to the transmission. If the requested pressure is less than allowed by the TCM, the message "Requested pressure for the Line PC Solenoid is too low" appears on the scan tool display.
	  • Transmission range DTCs must not be active. If a transmission range DTC is active, the message "Engine running with transmission DTC present" appears on the scan tool display.

Clutch PC Solenoids	• The TCM commands the pressure control solenoids in order to apply and release the clutches.

Output Control	Description

	• When the ignition is ON, and the engine is OFF, there are no limits to this control. The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is determined by the TCM.
	• When the engine is running, the following control limits apply:
	  • The transmission range must be in Park or Neutral. If the transmission range is not Park or Neutral, the message "Engine running and transmission range is not Park/Neutral" appears on the scan tool display.
	  • The solenoid remains ON until commanded OFF, and vice versa. When the output control is exited, the solenoid state is determined by the TCM.
	  • Transmission range DTCs must not be active. If a transmission range DTC is active, the message "Engine running with transmission DTC present" appears on the scan tool display.

Shift Transmission	• The TCM commands upshifts and downshifts. The scan tool Commanded Gear parameter should correspond with the shift solenoid combination. Refer to the **Shift Solenoid Valve State and Gear Ratio** table.
	• When the ignition is ON, and the engine is OFF, there are no limits to this control. The scan tool shift solenoid states change to match the Commanded Gear selected.
	• When the engine is running, the following control limits apply:
	  • The TCM does not allow a shift if it causes the engine RPM to exceed a calibrated limit. If a gear is requested and the engine speed is too high, the message "Engine speed too high" appears on the scan tool display.
	  • The TCM does not allow a 3-2 or 2-1 downshift if the vehicle speed exceeds a calibrated limit. If either downshift is requested and the vehicle speed is too high, the message "Eng. is on and veh. speed too hi for 3-2 or 2-1 downshift" appears on the scan tool display.
	  • The TCM does not allow a 4-3 downshift if the vehicle speed exceeds a calibrated limit. If a 4-3 downshift is requested and the vehicle speed is too high, the message "Vehicle speed too high" appears on the scan tool display.
	  • The TCM does not allow an upshift if the vehicle speed exceeds a calibrated limit. If an upshift is requested and the vehicle speed is too high, the message "Vehicle speed too high" appears on the scan tool display.
	  • The TCM does not allow an upshift that is greater than the current selected transmission range (PRNDL). For example,

Output Control	Description
	3rd gear is not allowed if the transmission range is D2. If an upshift is requested that is greater than the current selected transmission range, the message "Eng. running and gear request is greater than the current TR" appears on the scan tool display.
High Side Driver 1	• The TCM commands the driver for the solenoid voltage supply ON and OFF. • When the ignition is ON, and the engine is OFF, there are no limits to this control. • High side drivers may not be commanded ON and OFF with the scan tool if the engine is running.

Service Cleaning Procedure	• The scan tool is used to start and stop the transmission cleaning procedure algorithm.
	• The following control limits apply:
	  • The engine must be running. The message "Engine not Running" will appear on the scan tool if this control is attempted without the engine running.
	  • There cannot be active transmission DTCs. The message "Transmission Fault present" will appear on the scan tool if this control is attempted with transmission DTCs active.
	  • The transmission range must be Park or Neutral. The message "Transmission not in PARK or NEUTRAL" will appear on the scan tool if this control is attempted with the transmission in any range other than Park or Neutral.
	  • The vehicle speed cannot exceed 5 mph. The message "Vehicle Speed too high" will appear on the scan tool if this control is attempted with a vehicle speed greater than 8 km/h (5 mph).
	  • The engine speed cannot exceed 2500 RPM. The message "Engine Speed too high" will appear on the scan tool if this control is attempted with an engine speed greater than 2500 RPM.
	  • The transmission oil temperature must be at a normal operating temperature. The message "Transmission oil temperature out of range" will appear on the scan tool if this control is attempted without a transmission oil temperature between 70-110Â°C (158-230Â°F).

Reset Transmission Adapts	• The scan tool is used to start and stop the transmission Fast Learn Adapt algorithm. • The following control limits apply:

Output Control	Description
	• The engine must be running. The message "Engine not Running" will appear on the scan tool if this control is attempted without the engine running. • There cannot be active transmission DTCs. The message "Transmission Fault present" will appear on the scan tool if this control is attempted with transmission DTCs active.

DIAGNOSTIC INFORMATION AND PROCEDURES

STRATEGY BASED DIAGNOSIS

The goal of Strategy Based Diagnosis is to provide guidance when you create a plan of action for each specific diagnostic situation. Following a similar plan for each diagnostic situation, you will achieve maximum efficiency when you diagnose and repair vehicles. Although each of the Strategy Based Diagnosis steps are numbered, you are not required to complete every step in order to successfully diagnose a customer concern. The first step of your diagnostic process should always be Understand and Verify the Customer's Concern. The final step of your diagnostic process should be to Repair and verify the Fix. Refer to the steps listed below for the correct Strategy Based Diagnosis.

NOTE: **For additional information on the following steps refer to the corresponding numbered paragraphs listed below.**

1. Understand and verify the customers concern.
2. Verify the vehicle is not operating as designed:
    - **If the vehicle is operating as designed review the suggestions listed below:**
    - Check Identical Vehicle
    - Customer Misunderstanding of System - Explain operation to customer or refer to owners or service manual
    - Customer dissatisfaction - Submit a Field Product Report
    - **If the vehicle is not operating as designed**
3. Perform preliminary checks - Visual inspections and operational
    - **If the customers concern is found, refer to step 7**
    - **If the customers concern is not found**
4. Perform the Diagnostic System Check - Vehicle, determine the diagnostic service category to perform.
    - **If the customers concern is found, refer to step 7**
    - **If the customers concern is not found**
5. Check for related Bulletins, Recalls and Preliminary Information.
    - **If the customers concern is found, refer to step 7**
    - **If the customers concern is not found**
6. Follow the diagnostic path listed below:
    1. Current DTC - Follow DTC Diagnostics

2. Symptom no DTC - Follow Symptom Diagnostics
3. No published diagnostic - Analyze and develop diagnostics or call Technical Assistance
4. Intermittent/History DTC - See diagnostic detail below

7. Isolate the root cause then repair and verify the fix.
8. Re-examine the concern.
   - **If the vehicle is not repaired, refer to step 1**
   - **If the vehicle is repaired**
9. All OK.

Additional Information

1. Understand and Verify the Customer's Concern: The first part of this step is to obtain as much information as possible from the customer. Are there aftermarket accessories on the vehicle? When does the condition occur? Where does the condition occur? How long does the condition last? How often does the condition occur? In order to verify the concern, the technician should be familiar with the normal operation of the system and refer to the owner or service manual for any information needed.
2. Vehicle Operating as Designed: This condition exists when the vehicle is found to operate normally. The condition described by the customer may be normal. Compare with another like vehicle that is operating normally under the same conditions described by the customer. Explain your findings and the operation of the system to the customer. If the customer is dissatisfied submit a Field Product Report.
3. Preliminary Checks: Conduct a thorough visual inspection. Review the service history. Detect unusual sounds or odors. Gather diagnostic trouble code (DTC) information in order to achieve an effective repair.
4. Perform Published Diagnostic System Check- Vehicle: The **Diagnostic System Check - Vehicle** verifies the proper operation of the system. This will lead the technician in an organized approach to diagnostics and identify what category of diagnostic to perform.
5. Check for related Bulletins, Recalls and Preliminary Information (PI).
6. Diagnostic categories:
   1. Current DTC: Follow the designated DTC diagnostic in order to make an effective repair. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.
   2. Symptom - No DTC: Select the appropriate symptom diagnostic. Follow the diagnostic steps or suggestions in order to complete the repair. Refer to **Symptoms - Vehicle**.
   3. No Published Diagnostics: Analyze the Concern. Develop a plan for the diagnostics. The service manual schematics will help you to see system power, ground, input, and output circuits. You can also identify splices and other areas where multiple circuits are tied together. Look at component locations to see if components, connectors or harnesses may be exposed to extreme temperature, moisture, or corrosives (road salt, battery acid, oil or other fluids). Utilize the wiring diagrams, system description and operation, and system circuit description.
   4. Intermittent/History DTC: An intermittent condition is one that does not occur continuously, may be difficult to duplicate, and will only occur when certain conditions are met. Generally, an intermittent is caused by faulty electrical connections and wiring, malfunctioning components, electromagnetic/radio frequency interference, driving conditions, or aftermarket equipment. The following approaches/tools may prove to be beneficial in locating and repairing an intermittent condition or history DTC.
      - Combining technicians knowledge with the available service information.

- Evaluate the symptoms and conditions described by the customer.

  North America - The GM Customer Concern Verification Sheets have been designed to improve communications between the service customer and the technician. The more clearly the technician understands the concern and its symptoms, the more likely the concern will be fixed right the first time. The blank CCVS can be found in GM Global Connect under Service, Service Forms.

- Follow the suggestions on **Testing for Intermittent Conditions and Poor Connections** .
- Use a tool with data capturing capabilities like scan tool, digital multi-meter, or (if available) a vehicle data recorder.

7. Isolate the Root Cause then Repair and Verify Fix: After isolating the root cause, make the repairs and validate for the correct operation by performing the **Diagnostic Repair Verification**. Verifying that the DTC or symptom has been corrected may involve road testing the vehicle.
8. Re-examine the Concern: If a technician cannot successfully find or isolate the concern, a re-evaluation is necessary. Re-verify the concern. The concern could be an intermittent or normal condition.

DIAGNOSTIC PROCEDURE INSTRUCTIONS

The following is an instructional overview of all categories which may be included in a diagnostic procedure.

Diagnostic Instructions

- A link to the **Diagnostic System Check - Vehicle** is provided here. This procedure should be performed prior to performing other diagnostic procedures, as this prevents misdiagnosis where there are integrated system dependencies.
- A link to the **Strategy Based Diagnosis** is provided here. This provides an overview on how a technician should diagnose a vehicle.
- A link to the **Diagnostic Procedure Instructions** is provided here. This information is an instructional overview of all categories which may be included in a diagnostic procedure.

DTC Descriptor

Lists all DTCs and descriptors that are diagnosed within the procedure.

If the DTC supports symptom bytes they will either be listed with the DTC or there will be a link to the symptom byte list.

Diagnostic Fault Information

The Diagnostic Fault Information table identifies each circuit that makes up an electrical subsystem and the associated circuit faults. DTCs and symptoms are listed in the table for all circuit fault modes. This information can be used to diagnose an electrical fault, or as a quick visual aid showing how the different DTCs and symptoms apply for the subsystem being diagnosed.

All DTCs and symptoms shown in this table are not necessarily diagnosed during this procedure.

An example table from an engine coolant temperature (ECT) procedure:

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0117	P0118, P0119	P0118*, P0119	P0128, P111E
Low Reference	-	P0118, P0119	-	P0128
*Internal control module or component damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

The Typical Scan Tool Data table identifies a scan tool data parameter and its value in reference to potential circuit faults.

An example table from an ECT procedure:

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine=Idling - At normal operating temperature. **Parameter Normal Range:** 85 to 105Â°C (190 to 221Â°F)			
Signal	140Â°C (248Â°F)	-40Â°C (-40Â°F)	-40Â°C (-40Â°F)
Low Reference	-	-40Â°C (-40Â°F)	-

Circuit/System Description

Circuit/System Description identifies circuits, components, and describes how the circuit/system normally functions.

Conditions for Running the DTC

Conditions for Running the DTC, identifies what conditions must be present to allow the diagnostic to run.

Conditions for Setting the DTC

Conditions for Setting the DTC, identifies the conditions that must be present in order to fail the diagnostic and when to set the DTC.

Actions Taken When the DTC Sets

Actions Taken When the DTC sets, identifies the default actions taken when a control module sets a DTC.

Conditions for Clearing the DTC

Conditions for Clearing the DTC, identifies the conditions that must be met in order to clear the DTC.

Diagnostic Aids

Diagnostic Aids are suggestions which explain other methods to diagnose the condition. It also provides unique information about the system to assist the technician in finding and repairing a vehicle condition.

Reference Information

Reference Information includes links providing additional information to be used with the diagnostic procedure.

For example:

- Schematic Reference
- Connector End View Reference
- Component View Reference
- Description and Operation
- Electrical Information Reference
- DTC Type Reference
- Scan Tool Reference
- Special Tools

Circuit/System Verification

The Circuit/System Verification, when supported, needs to be performed prior to the Circuit/System Testing. It will determine the following conditions:

- If a higher priority concern needs to be addressed first (E.g. other DTCs)
- If other conditions are present (E.g. low fluid level)
- If the condition is current
- If the condition is intermittent
- If the system is all Ok

NOTE: **Any diagnostic step that asks if a DTC is "set" refers to a Set, Current, Present, Active DTC status. This does not include any other DTC status. For example History, Not Run, Passed and Failed.**

Circuit/System Verification is a non-intrusive procedure outlining how to verify that a system or a portion of a system is functioning correctly. During the verification process, the vehicle is kept intact and tested as a complete system. The verification is used to assist the technician in determining whether a condition is current, intermittent, or not present (All Ok). When a condition is determined to be intermittent a technician can use the **Testing for Intermittent Conditions and Poor Connections** link in Electrical Information Reference for additional testing information.

The technician should be able to identify if the fault is occurring on the input (signal) circuit or on the output (control) circuit when applicable.

Component Codes

The component codes are a language independent method of identifying a common component between different areas in the service information. The component codes work regardless on how the actual component name was translated.

The component codes used on the schematics will have the base code with an extension to identify location or quantity. For example the ABS wheel speed sensors are identified on the schematic with a base code (B5) and a location extension (LF, RF, LR, and RR) as seen below:

- B5LF Wheel Speed Sensor - Left Front

- B5RF Wheel Speed Sensor - Right Front
- B5LR Wheel Speed Sensor - Left Rear
- B5LR Wheel Speed Sensor - Left Rear

The diagnostic procedures will use the base code (B5) for a wheel speed sensor but may or may not use the extension identifying location (LF, RF, LR, and RR).

Example:

Disconnect the harness connector at the appropriate B5 Wheel Speed Sensor.

Or

Disconnect the appropriate electrical connector: B5 Wheel Speed Sensor

This is done so the diagnostic procedure can be common for all four wheel speed sensors and not have to take into account part location or quantity.

When the diagnostic states "the appropriate" it is up to the technician to identify which component is being diagnosed either by the symptom (Driver's door lock is inoperative) or the DTC descriptor (DTC C0585 04: Left Rear Door Latch Circuit Open).

Circuit/System Testing

NOTE: **Performing the Circuit/System Verification category first will aid in determining if a vehicle condition currently exists.**

Circuit/System Testing is a step by step, positive-flow, testing sequence which allows the technician to perform each test step, in sequence, until a fault is detected. If the result of a numbered test step is NOT achieved, the Right Repair Arrow below the failed test will identify what actions need to take place. If the result of a numbered test step is achieved, the normal flow is to proceed to the next numbered test step, as indicated by the Down Pass Arrow.

Intrusive diagnostics are performed to locate the system fault. System harness connections are disconnected from the component or control module to test individual circuit functions. The component or control module will be used to assist in verifying the circuit function. When a test does not pass, the repair steps (Right Repair Arrow) will indicate what circuit faults to test. For example a short to voltage, short to ground, or open/high resistance.

When testing for individual circuit faults, the technician is expected to perform terminal inspections such as connection surfaces and terminal tension at both the harness and the component or control module. When a condition is determined to be intermittent a technician can use the **Testing for Intermittent Conditions and Poor Connections** , or **Circuit Testing** link in Electrical Information Reference for additional information.

The component and control module will also be diagnosed during the test steps. A retest of a component or control module should always be performed before replacement. For example, reconnect all components and control modules and retest the system to verify the condition still exists before replacing components or control modules.

Component Testing

Component Testing may offer a static and/or dynamic component tests. These tests can be used to verify if a component is operating correctly to avoid unnecessary replacement.

Testing control modules in this category will not be offered. In most cases, the control module is used to verify the harness circuits in the Circuit/System Testing category and a retest of the control module should always be performed before replacement.

Repair Instructions

Repair Instructions provides a link to **Diagnostic Repair Verification**. This link describes how to verify the vehicle is repaired.

All links to repair, replacement, or programming procedures are located here.

Repair Verification

Repair Verification describes how to verify the vehicle is repaired when additional instructions are needed beyond what is in the Diagnostic Repair Verification.

DIAGNOSTIC SYSTEM CHECK INSTRUCTIONS

The following is an overview of instructions for the general information and 13 step System Verification included in the Diagnostic System Check - Vehicle procedure.

Diagnostic Instructions

A link to **Strategy Based Diagnosis** is provided as an overview on how a technician should diagnose a vehicle.

A link to the Diagnostic System Check Instructions is provided. This provides an overview of instructions and examples for the general information and 13 step System Verification included in the Diagnostic System Check - Vehicle procedure. The examples in this document are intended to give the technician a general idea of what the test step is referring to. They are not intended to list every possible condition or situation.

Diagnostic Systems Check steps are listed by priority to guide the technician to the appropriate diagnostic procedure to correct the customer concern. There are many ways to determine the priority of diagnosing a vehicle concern. Some faults can cause customer perceived symptoms in areas unrelated to the fault. Using an example from the System Check, after reading DTCs, the technician is asked to verify there are no Electronic Control Unit Internal Performance Faults present. It is important that any internal performance issues are addressed prior to continuing through the System Check. There is no benefit addressing other DTCs that could be set due to an internal fault to a control module. If the fault is present, performing the diagnostic procedure for that fault will likely correct the customer perceived concern and possibly eliminate other DTCs that may be set.

Not all steps of the Diagnostic System Check have to be performed. The Diagnostic System Check tries to prioritize the test steps with the highest priority faults first. The technician is then lead to another document to do the actual diagnosis or repair. The strategy is to repair higher level faults that may be the cause of other system or component level symptoms. Additionally, the Diagnostic System Check can only be used for a single fault at a time. If additional faults are present, the technician must perform the diagnostic system check for each concern until all customer concerns are corrected.

Once a repair has been completed, General Motors diagnostic strategy is to always have the technician verify that the customer concern has been corrected. This is to prevent comebacks and to ensure customer satisfaction

with their dealership experience. Therefore a link has been provided to **Diagnostic Repair Verification** procedure for the technician to verify the customer concern has been corrected.

There are some assumptions made when General Motors prepares service information. They include the following areas which are presumed to function as designed:

- The 12-volt battery is fully charged. General Motors assumes the majority of vehicles brought in for repair will be able to start and be driven into the service stall. If the vehicle has a dead battery, it is slow cranking or for any other reason the technician feels the customer concern may be battery related, a link is provided to **Battery Inspection/Test** . This procedure will guide the technician through inspecting and verifying the battery functions properly.
- Fuses should not be open. General Motors does not call out in diagnostic procedures to verify a fuse. The technician is expected to find an open fuse when the diagnostic test step states to check for an open circuit condition. Therefore a link has been provided to **Power Distribution Schematics** , and **Electrical Center Identification Views** for technicians to reference power sources and fuse locations if they feel there may be loss of power due to an open fuse condition.
- Ground circuits are clean, tight, and in the correct location. General Motors assumes that the original ground circuits have not been compromised. The technician is expected to find a poor ground connection when the diagnostic test step states to test the ground circuit for an open/high resistance. Therefore a link has been provided to **Ground Distribution Schematics** , and **Harness Routing Views** for technicians to reference ground locations and which ground circuits may be related to the customer concern.
- All connections/connectors are fully seated. General Motors assumes that all connections are properly installed. The technician is expected to find an open or poor connection when the diagnostic test step asks to test the circuit for an open/high resistance. Therefore a link has been provided to **COMPONENT CONNECTOR END VIEWS - INDEX** for technicians to reference which connections may be related to the customer concern.
- There are no aftermarket devices that affect the operation of the system. General Motors can only author diagnostic and repair information for vehicle systems and components that are original equipment or genuine GM Accessories. Aftermarket equipment can negatively affect original equipment operation and lead a technician's diagnosis of a concern in the wrong direction. Therefore a link has been provided to **Checking Aftermarket Accessories** that guides a technician through the possible causes of vehicle problems related to aftermarket accessories.
- The scan tool powers up. General Motors assumes that power is available at the Data Link Connector and the scan tool will power on. Therefore a link has been provided to **Scan Tool Does Not Power Up** if the technician finds that the scan tool does not power on.

Diagnostic System Check

1. VERIFY CUSTOMER CONCERN-This step is to obtain as much information as possible from the customer. Are there aftermarket accessories on the vehicle? When does the condition occur? Where does the condition occur? How long does the condition last? How often does the condition occur? Review the service history of the vehicle for previous repairs that could help diagnose the current concern.

   Now that the technician understands the customer concern, they should validate the concern on the vehicle. In order to verify the concern, the technician should be familiar with the normal operation of the system and refer to the owner or service manual for any information needed. Inspect the visible system components for obvious damage or conditions that could cause the concern. Conduct a thorough visual

inspection. Detect unusual sounds or odors.

The condition described by the customer may be normal. If the technician finds the vehicle to operate normally, compare with another like vehicle that is operating normally, under the same conditions described by the customer. If this is the case, explain your findings and the operation of the system to the customer. If the customer is dissatisfied, submit a Field Product Report.

2. BULLETIN SEARCH-By searching for related bulletins, recall/field actions and preliminary information documents, a procedure for a known field issue may resolve the customer concern with little or no diagnosis necessary saving the technician diagnostic time.
3. MECHANICAL CONCERNS-This step is designed to take the technician directly to a list of symptom diagnostic procedures. The technician is asked to verify the symptoms exhibited by the system are mechanical in nature and not related to an electrical system, see some examples below. If the technician feels the concern could be related to an electrical system, they should continue through the Diagnostic System Check to verify the electrical functionality of vehicle. If the technician feels the concern is exclusively related to a mechanical system, a link to **Symptoms - Vehicle** is provided to select the appropriate symptom diagnostic procedure for the customer concern.

   Examples:

   - Brake noise or diagnosing irregular pad wear
   - Water leak diagnosis
   - Engine or transmission fluid leak diagnosis
   - Manual window or door lock diagnosis
   - Vehicle vibration diagnosis
   - Exhaust noise or leak diagnosis
4. VEHICLE POWER UP VERIFICATION-The technician is asked in this step to turn the ignition key ON and verify that the vehicle powers up. The technician should look for clues that multiple vehicle systems are receiving vehicle powermode messages, such as the cluster waking up, the radio powers on, the HVAC blower is operational, windshield wipers turn on, etc, with the key ON. This would be a rare condition as both the powermode master and back-up powermode master would have to be inoperable, however, if the vehicle does not power up, a link to **Power Mode Mismatch** is provided.
5. CONTROL MODULE COMMUNICATION and DTC CHECK-The technician is asked in this step to record the following three pieces of data on the Repair Order; any control module that the scan tool determined is not communicating, any DTC and symptom byte set current or history, and the control module that has set the DTC.

   This is considered a setup step for the rest of the Diagnostic System Check. The technician is not expected to do anything other than record the three pieces of data provided by the scan tool on the Repair Order. This provides the information needed to complete the rest of the diagnostic system check.

   To complete this step, the technician is asked to utilize the scan tool Vehicle DTC Information function. This function will query every possible control module on the vehicle requesting all DTCs. During the DTC query, the scan tool will try to establish communication with each control module. If the scan tool can communicate with the control module during the DTC request, it will display PRESENT and provide the number of DTCs set in the control module. If the scan tool cannot communicate with a control module, it will only display NOT COMMUNICATING. Since the scan tool cannot determine if a given

control module should be present or not, the technician is asked in a future step to verify that the vehicle was not built with control modules listed as NOT COMMUNICATING.

If the scan tool cannot establish communications with ALL of the vehicles control modules, a link to **Data Link References** is provided. A faulty control module or fault with the serial data circuit can cause no communication with all of the control modules on the vehicle. If any control module communicates on the serial data circuit, continue through the Diagnostic System check, as a future step will address any specific non communicating or group of non communicating control modules.

Once the scan tool has completed the routine, the technician should review each control module that has set a DTC and document them on the Repair Order. When reviewing the DTCs, the technician should take notice if any DTCs are powertrain related, and if so, navigate in the scan tool to the Powertrain area and utilize the Capture Info function. This will upload any Freeze Frame/Failure Records stored in the control module to the scan tool in case the data is lost from the control module. As an example, if the technician commands a Clear DTCs function on a powertrain controller, all diagnostic information stored in the controller is erased. This includes Freeze Frame/Failure Records and Inspection/Maintenance System Status indicators, if required for your region.

6. CONTROL MODULE INTERNAL PERFORMANCE FAULTS-The technician is asked to review the DTCs recorded in step 5 and verify there are no control module internal performance faults set current. This type of fault may be the cause of other symptoms or DTCs displayed by the vehicle. By addressing this fault first, the technician may find the other concerns are resolved. The technician should always follow the diagnostic procedure for these types of faults prior to replacing any control module. If the technician finds a control module has an internal performance fault, a link is provided to **Diagnostic Trouble Code (DTC) List - Vehicle** to select the appropriate DTC diagnostic procedure.

   Examples:

   - B1000 Electronic Control Unit Performance
   - B101D ECU Hardware Performance
   - C0550 Electronic Control Unit Performance
   - C056D ECU Hardware Performance
   - C0570 Auxiliary Electronic Control Unit Performance
   - P0606 Control Module Internal Performance
   - P0607 Control Module Performance
7. CONTROL MODULE COMMUNICATION VERIFICATION-This step is used to ensure the control modules that are NOT COMMUNICATING were not built on the vehicle. To understand if the vehicle was built with that option, we provide a link to the **Data Link References** , document where Regular Production Options (RPOs) are listed next to the names of optional ECU's and can be compared to those the vehicle was built with. If the technician determines that a control that is NOT COMMUNICATING should be present, the technician is asked to follow the appropriate diagnostic procedure listed in the **Data Link References** document.
8. COMMUNICATION and POWERMODE FAULTS-This step is asking the technician to look for communication DTCs or DTCs related to control modules powering up based on power mode, communication enable or wake-up circuits. See in the below table some examples of the DTCs the technician should diagnose prior to continuing through the Diagnostic System Check. The technician should review the list of DTCs recorded in step 4 and verify that none of these type of DTCs are present.

If so, the technician is referred to the **Diagnostic Trouble Code (DTC) List - Vehicle** to select the appropriate DTC diagnostic procedure.

Examples:

- U0140 Lost Communication With Body Control Module
- U0164 Lost Communication With HVAC Control Module
- U0170 Lost Communication With Passenger Presence Detection Module
- U0402 Invalid Data Received From Transmission Control Module
- U0452 Invalid Data Received From Inflatable Restraint Sensing and Diagnostic Module
- U1814 Powertrain High Speed Communication Enable Circuit
- B1428 Ignition Switched Power Run/Crank Relay Circuit
- B137B Accessory Power Module Wake Up Circuit
- C0897 Control Module Power Moding
- P2536 Ignition Accessory Switch Circuit

9. POWER MODE VERIFICATION-This step verifies the Power Mode Master is receiving the proper output state of the ignition switch. The technician should use the main power mode input, this being either the ignition key or, on vehicles equipped with Passive Entry Passive Start, the push button switch. The test should not be performed using a key fob, if the MIL is illuminated the powertrain controller may disable this input. The technician is asked to perform the test with the driver door open. This ensures the retained accessory power mode is inactive during this test which could result in different scan tool readings. The technician is only asked to verify the current Power Mode parameter in the power mode data display list. If the parameter does not match the actual ignition switch position, a link is provided to perform the **Power Mode Mismatch** diagnostic procedure.
10. ENGINE CRANK and RUN VERIFICATION-Here the technician is asked to verify that the engine cranks and runs. The technician should use the main power mode input, this being either the ignition key or, on vehicles equipped with Passive Entry Passive Start, the push button switch, to complete this step. The test should not be performed using a key fob, if the MIL is illuminated the powertrain controller may disable this input. The technician should know at this point whether the engine cranks and runs without having to actually performing this test step. One of the follow has probably already occurred and this step can be skipped: The technician drove the vehicle into the stall or verified when checking the Crank and Run parameter in step 8. If the technician has not already somehow verified the engine cranks in previous steps, the technician should perform this test step. Regardless of how this step was performed, if the engine does not crank, a link is provided to **Engine Does Not Crank**, or if the engine cranks but does not run, a link is provided to **Engine Cranks But Does Not Run** for the technician to choose the correct diagnostic procedure for the actual engine application being used.
11. REMAINING DTC REVIEW-Here the technician is asked to review any remaining DTCs that were not addressed in previous steps. The technician is asked first to verify there are no control module supply voltage, system voltage or 5V circuit DTCs present. Control modules, systems or components with insufficient or zero voltage can cause one or multiple symptoms to exist on the vehicle. Control module voltage issues could also be the cause of failures during a programming event. The technician should correct voltage issues prior to addressing any programming or configuration DTCs. The technician should then check for any ECU programming, setup or configuration DTCs. By programming software or configuring a control module, the technician could correct the customer concern unobtrusively. The remaining DTCs, which are usually specific system or component faults, are diagnosed last. They can

include ECU input and output circuit DTCs or individual circuit faults that usually cause single symptoms or failure modes on the vehicle and can be fixed following the proper DTC diagnostic procedure. In general, the technician should think about what DTCs or faults could be caused by another DTC or fault. A failed sensor may set a component DTC and then the system may set a DTC indicating the system cannot operate properly. By correcting the sensor fault, the system may now operate properly and the system level DTC will transition to history. Refer to the examples within each category below to understand the differences between these DTCs. If DTCs of these type are current, the technician is referred to **Diagnostic Trouble Code (DTC) List - Vehicle** to choose the correct DTC diagnostic procedure.

1. Voltage DTCs
    - B1325 Device Power 1 Circuit
    - C0875 Device Voltage Reference Input 2 Circuit
    - C1001 Adaptive Cruise Control Indicators Supply Voltage Circuit
    - P0641 5-Volt Reference Circuit
    - P0787 Downshift Timing Solenoid Control Circuit Low Voltage
2. Programming, Setup, Configuration or Software Performance DTCs
    - B3943 Steering Column Lock has Not Learned Column Integration Module
    - B101E ECU Software Performance
    - B1019 System Configuration Error
    - C0558 Calibration Data Not Programmed
    - P0630 VIN Not Programmed or Mismatched - Powertrain Control Module (PCM)
3. Component related DTCs
    - B0013 Driver Frontal Deployment Loop Stage 2
    - B0163 Passenger Compartment Temp Sensor Circuit
    - C0045 Left Rear Wheel Speed Sensor Circuit
    - P0565 Cruise Control Switch Circuit
    - P0751 1-2 Shift Solenoid (SS) Valve Performance
4. System related DTCs
    - B1010 System Sensors Data Mismatch
    - C0176 System Thermal Error
    - C0561 System Disabled Information Stored
    - P1564 Vehicle Acceleration Too High - Cruise Control Disabled
    - P1625 Transmission Control Module (TCM) System Reset
5. Any other remaining DTCs-The technician should diagnose and correct any other DTCs that are left that were not from the categories above.

12. EMISSION RELATED INSPECTION/MAINTENANCE TESTING CONCERNS-Several regions require that a vehicle pass on-board diagnostic system tests and the inspection/maintenance emission tests in order to renew license plates or vehicle registration. This is accomplished by viewing the Inspection/Maintenance System Status display on a scan tool. Using a scan tool, the technician can observe the Inspection/Maintenance System Status in order to verify that the vehicle meets the criteria that comply with the local area requirements. If inspection and maintenance checks are required in your

region, and the customer concern is related to not passing an Inspection/Maintenance test, a link is provided to **Inspection/Maintenance System Check** where the technician can choose the appropriate Inspection/Maintenance System Check for the actual engine application being used.

13. SYMPTOM DIAGNOSIS-At this step, the diagnostics are assuming that the only information the technician has available to diagnose the customer concern are symptoms of a problem. There are no DTCs set current or history. There may be a Driver Information Center display message or a system indicator to aid in identifying the root cause. The technician should evaluate the symptoms and conditions described by the customer and perform the symptoms diagnostics for the area of customer concern. A link is provided to **Symptoms - Vehicle** which contains a list of all symptoms related to this service manual publication.

DIAGNOSTIC STARTING POINT - VEHICLE

Begin the system diagnosis with **Diagnostic System Check - Vehicle**. The Diagnostic System Check - Vehicle will provide a complete strategy to locate and repair a mechanical or electrical vehicle fault. Not following this strategy may cause additional diagnostic time and/or misdiagnosis.

The Diagnostic System Check - Vehicle will provide the following strategy:

- When to verify the customer concern and identify related bulletins, recalls and preliminary information
- When to identify a control module that is not communicating, a control module that has set a DTC, and the DTC diagnostic priority
- When to address power mode concerns
- When to verify the engine cranks and runs
- When to diagnose symptom related concerns

DIAGNOSTIC SYSTEM CHECK - VEHICLE

Diagnostic Instructions

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic System Check Instructions** provides an overview of each diagnostic step.
- Continue through the Diagnostic System Check until you are directed to follow a particular diagnostic or repair procedure. Once a repair has been completed, perform the **Diagnostic Repair Verification** and verify the customer concern has been corrected.

The diagnostic procedures within this manual are developed on the assumption that the following areas function as designed:

- The 12 V battery is fully charged and cables are clean and tight. Refer to **Battery Inspection/Test** .
- Fuses are not open. Refer to **Power Distribution Schematics** , and **Electrical Center Identification Views** .
- Ground circuits for the area of customer concern are clean, tight, and in the correct location. Refer to **Ground Distribution Schematics** , and **Harness Routing Views** .
- All connections/connectors for the area of concern are fully seated. Refer to **COMPONENT CONNECTOR END VIEWS - INDEX** .
- There are no aftermarket devices that affect the operation of the system. Refer to **Checking Aftermarket**

Accessories .

- The scan tool powers up. Refer to Scan Tool Does Not Power Up .

Diagnostic System Check

1. VERIFY CUSTOMER CONCERN-Understand and validate the customer concern. Inspect the visible system components for obvious damage or conditions that may cause the concern.
2. BULLETIN SEARCH-Check for related bulletins, recall/field actions and preliminary information.
3. MECHANICAL CONCERNS-Verify the symptom is not exclusively a mechanical concern.
   - **If the symptom is exclusively a mechanical concern**

     Refer to Symptoms - Vehicle.

   - **If the symptom is not a mechanical concern**

   NOTE: **Do not clear any DTCs unless instructed to do so by a diagnostic procedure. If any DTC is Powertrain related, select Capture Info to store DTC and Freeze Frame/Failure Records to the scan tool.**

4. VEHICLE POWER UP VERIFICATION-Ignition ON, verify the vehicle powers up.
   - **If the vehicle does not power up**

     Refer to Power Mode Mismatch .

   - **If the vehicle powers up**
5. CONTROL MODULE COMMUNICATION and DTC CHECK-Using a scan tool, perform the Vehicle DTC Information function and verify at least one control module communicates with the scan tool. Record on the Repair Order the following information:
   - Any control module that is not communicating.
   - Any DTC, including symptom byte, and the control module that has set the DTC.
   - **If the scan tool does not communicate with any control module on the vehicle**

     Refer to Data Link References .

   - **If the scan tool communicates with any control module**
6. CONTROL MODULE INTERNAL PERFORMANCE FAULTS-Verify there are no current control module Internal Hardware Performance DTCs set.
   - **If any DTC of this type is set**

     Refer to Diagnostic Trouble Code (DTC) List - Vehicle.

   - **If no DTC of this type is set**
7. CONTROL MODULE COMMUNICATION VERIFICATION-Verify the vehicle is not built with any control module listed as not communicating with the scan tool, refer to Data Link References .
   - **If the vehicle is built with a control module that is not communicating**

     Refer to Data Link References .

- **If all control modules the vehicle is built with are communicating**

8. COMMUNICATION and POWERMODE FAULTS-Verify there are no current control module Power Mode or Communication DTCs set.
   - **If any DTC of this type is set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.

   - **If no DTC of this type is set**

NOTE: **The engine may start during this test. Ensure the vehicle is out of gear and the parking brake is applied. Turn the engine OFF as soon as the crank power mode parameter has been observed.**

9. POWER MODE VERIFICATION-Driver door open, observe the scan tool Power Mode parameter while cycling the ignition switch through all the power modes. Verify the current Power Mode parameter matches the actual ignition switch positions.
   - **If the Power Mode parameter does not match the actual ignition switch positions**

     Refer to **Power Mode Mismatch** .

   - **If the Power Mode parameter matches the actual ignition switch positions**
10. ENGINE CRANK and RUN VERIFICATION-Verify that the engine cranks and runs.
    - **If the engine does not crank**

      Refer to **Engine Does Not Crank**.

    - **If the engine does not run**

      Refer to **Engine Cranks But Does Not Run**.

    - **If the engine cranks and runs**
11. REMAINING DTC REVIEW-Verify there are no other DTCs set.
    - **If other DTCs are set**

      Diagnose them in the order listed below. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.

      1. Voltage DTCs
      2. Programming, Setup, Configuration or Software Performance DTCs
      3. Component related DTCs
      4. System related DTCs
      5. Any remaining DTCs

    - **If no other DTCs are set**
12. EMISSION RELATED INSPECTION/MAINTENANCE TESTING CONCERNS-If inspection and maintenance checks are required in your region, verify the customer concern is not related to inspection/maintenance testing.
    - **If the customer concern is related to inspection/maintenance testing**

Refer to **Inspection/Maintenance System Check**.

- **If the customer concern is not related to inspection/maintenance testing**

13. SYMPTOM DIAGNOSIS-Diagnose any remaining customer concern. Refer to **Symptoms - Vehicle**.

POWERTRAIN DIAGNOSTIC TROUBLE CODE (DTC) TYPE DEFINITIONS

Emissions Related DTCs

Action Taken When the DTC Sets - Type A

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Action Taken When the DTC Sets - Type B

- The control module illuminates the MIL on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

- The following applies to misfire DTCs:
  - If the control module detects a low level or an emission level misfire condition during 2 consecutive trips, the control module illuminates the MIL.
  - If the control module detects a high level or catalyst damaging misfire, the control module flashes the MIL at a rate of once per second.
  - If the control module detects a misfire during 2 non-consecutive trips, the stored conditions are compared with the current conditions. The control module illuminates the MIL when the following conditions occur:
    - The engine load is within 20 percent of the previous test that failed.
    - The engine speed is within 375 RPM of the previous test that failed.
    - The engine coolant temperature is in the same range of the previous test that failed.
- The following applies to fuel trim DTCs:
  - If the control module detects a fuel trim condition during 2 consecutive trips, the control module illuminates the MIL.
  - If the control module detects a fuel trim condition during 2 non-consecutive trips, the stored conditions are compared with the current conditions. The control module illuminates the MIL when the following conditions occur:
    - The engine load is within 20 percent of the previous test that failed.
    - The engine speed is within 375 RPM of the previous test that failed.
    - The engine coolant temperature is in the same range of the previous test that failed.

Conditions for Clearing the MIL/DTC - Type A or Type B

- The control module turns OFF the MIL after 4 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Non-Emissions Related DTCs

Action Taken When the DTC Sets - Type C

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The MIL will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center, if equipped, may display a message.

Conditions for Clearing the DTC - Type C

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

DIAGNOSTIC TROUBLE CODE (DTC) LIST - VEHICLE

This master DTC list includes all applicable DTCs in alphanumeric order.

DTC	Diagnostic Procedure
B0005	Wiring Systems and Power Management - **DTC B0005**
B0012	Supplemental Inflatable Restraints - **DTC B0012 or B0013**
B0013	Supplemental Inflatable Restraints - **DTC B0012 or B0013**
B0014	Supplemental Inflatable Restraints - **DTC B0014, B0021, B0031, or B0038**
B0015	Supplemental Inflatable Restraints - **DTC B0015, B001A, B001B, or B0022**
B0016	Supplemental Inflatable Restraints - **DTC B0016, B0018, B0023, or B0025**
B0018	Supplemental Inflatable Restraints - **DTC B0016, B0018, B0023, or B0025**
B0019	Supplemental Inflatable Restraints - **DTC B0019 or B0020**
B001A	Supplemental Inflatable Restraints - **DTC B0015, B001A, B001B, or B0022**
B001B	Supplemental Inflatable Restraints - **DTC B0015, B001A, B001B, or B0022**
B0020	Supplemental Inflatable Restraints - **DTC B0019 or B0020**
B0021	Supplemental Inflatable Restraints - **DTC B0014, B0021, B0031, or B0038**
B0022	Supplemental Inflatable Restraints - **DTC B0015, B001A, B001B, or B0022**
B0023	Supplemental Inflatable Restraints - **DTC B0016, B0018, B0023, or B0025**

DTC	Diagnostic Procedure
B0025	Supplemental Inflatable Restraints - **DTC B0016, B0018, B0023, or B0025**
B0031	Supplemental Inflatable Restraints - **DTC B0014, B0021, B0031, or B0038**
B0038	Supplemental Inflatable Restraints - **DTC B0014, B0021, B0031, or B0038**
B0052	Supplemental Inflatable Restraints - **DTC B0052**
B0055	Supplemental Inflatable Restraints - **DTC B0055**
B0056	Supplemental Inflatable Restraints - **DTC B0056-B0058**
B0057	Supplemental Inflatable Restraints - **DTC B0056-B0058**
B0058	Supplemental Inflatable Restraints - **DTC B0056-B0058**
B0074	Supplemental Inflatable Restraints - **DTC B0074**
B0081	Supplemental Inflatable Restraints - **DTC B0081**
B0083	Supplemental Inflatable Restraints - **DTC B0083-B0088**
B0084	Supplemental Inflatable Restraints - **DTC B0083-B0088**
B0085	Supplemental Inflatable Restraints - **DTC B0083-B0088**
B0086	Supplemental Inflatable Restraints - **DTC B0083-B0088**
B0087	Supplemental Inflatable Restraints - **DTC B0083-B0088**
B0088	Supplemental Inflatable Restraints - **DTC B0083-B0088**
B0158	HVAC - Manual - **DTC B0158**
B0223	HVAC - Manual - **DTC B0223, B0233, B0248, B0268, B0408, B0418, or B0428**
B0233	HVAC - Manual - **DTC B0223, B0233, B0248, B0268, B0408, B0418, or B0428**
B0248	HVAC - Manual - **DTC B0223, B0233, B0248, B0268, B0408, B0418, or B0428**
B0268	HVAC - Manual - **DTC B0223, B0233, B0248, B0268, B0408, B0418, or B0428**
B0283	Fixed and Moveable Windows - **DTC B0283**
B0408	HVAC - Manual - **DTC B0223, B0233, B0248, B0268, B0408, B0418, or B0428**
B0418	HVAC - Manual - **DTC B0223, B0233, B0248, B0268, B0408, B0418, or B0428**
B0428	HVAC - Manual - **DTC B0223, B0233, B0248, B0268, B0408, B0418, or B0428**
B1001	Supplemental Inflatable Restraints - **DTC B1001 (SDM)** **DTC B1001 (PPS)**
B1008	Remote Functions - **DTC B1008**
B1019	Supplemental Inflatable Restraints - **DTC B1019**
B1025	Cellular, Entertainment, and Navigation - **DTC B1025, B1035, B1045, or B1055**
B1035	Cellular, Entertainment, and Navigation - **DTC B1025, B1035, B1045, or B1055**
B1045	Cellular, Entertainment, and Navigation - **DTC B1025, B1035, B1045, or B1055**
B1055	Cellular, Entertainment, and Navigation - **DTC B1025, B1035, B1045, or B1055**
B1259	Cellular, Entertainment, and Navigation - **DTC B1259**
B1287	Cellular, Entertainment, and Navigation - **DTC B1287**
B1325	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**
B1330	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**
B1370	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1370	Supplemental Inflatable Restraints - **DTC B1370**

DTC	Diagnostic Procedure
B1371	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1372	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1373	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1374	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1375	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1376	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1377	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1378	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1379	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1380	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1381	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1382	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1383	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1384	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1385	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1386	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1387	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1388	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1389	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1395	Lighting - **DTC B1395**
B1405	12 V Starting and Charging - **DTC B1405**
B1420	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**

DTC	Diagnostic Procedure
B1424	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**
B1428	Wiring Systems and Power Management - **DTC B1428**
B1440	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1441	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1442	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1443	Wiring Systems and Power Management - **DTC B1370-B1379, B1380-B1389, or B1440-B1443**
B1446	Cellular, Entertainment, and Navigation - **DTC B1446 or B1447**
B1447	Cellular, Entertainment, and Navigation - **DTC B1446 or B1447**
B1475	Wiring Systems and Power Management - **DTC B1475**
B1516	12 V Starting and Charging - **DTC B1516**
B1517	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**
B151A	12 V Starting and Charging - **DTC B151A**
B1527	12 V Starting and Charging - **DTC B1527**
B1529	Secondary and Configurable Customer Controls - **DTC B1529**
B2455	Cellular, Entertainment, and Navigation - **DTC B2455**
B2470	Cellular, Entertainment, and Navigation - **DTC B2470**
B2476	Cellular, Entertainment, and Navigation - **DTC B2476 or B2482**
B2482	Cellular, Entertainment, and Navigation - **DTC B2476 or B2482**
B2485	Cellular, Entertainment, and Navigation - **DTC B2485**
B2530	Lighting - **DTC B2530**
B2545	Lighting - **DTC B2545**
B2575	Lighting - **DTC B2575**
B257A	Lighting - **DTC B257A**
B2580	Lighting - **DTC B2580**
B2585	Lighting - **DTC B2585**
B2600	Lighting - **DTC B2600**
B2610	Lighting - **DTC B2610**
B2615	Lighting - **DTC B2615**
B261A	Lighting - **DTC B261A**
B2625	Lighting - **DTC B2625**
B2645	Lighting - **DTC B2645**
B2652	Lighting - **DTC B2652**
B2705	Shift Lock Control - **DTC B2705**
B2976	Vehicle Access - **DTC B2976**
B3006	Bolted Exterior Body Panels and Closures - **DTC B3006**

DTC	Diagnostic Procedure
B302A	Immobilizer - **DTC B302A**
B3031	Immobilizer - **DTC B3031**
B3055	Immobilizer - **DTC B3055**
B3060	Immobilizer - **DTC B3060**
B3105	Remote Functions - **DTC B3105**
B3109	Remote Functions - **DTC B3109, B3110, B3111, or B3112**
B3110	Remote Functions - **DTC B3109, B3110, B3111, or B3112**
B3111	Remote Functions - **DTC B3109, B3110, B3111, or B3112**
B3112	Remote Functions - **DTC B3109, B3110, B3111, or B3112**
B3125	Vehicle Access - **DTC B3125, B3130, or B3135**
B3130	Vehicle Access - **DTC B3125, B3130, or B3135**
B3135	Vehicle Access - **DTC B3125, B3130, or B3135**
B3265	Vehicle Access - **DTC B3265**
B3445	Lighting - **DTC B3445 or B3884**
B3567	Displays and Gauges - **DTC B3567**
B3600	Lighting - **DTC B3600**
B3622	Secondary and Configurable Customer Controls - **DTC B3622**
B3715	Wipers and Washers - **DTC B3715**
B3794	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
B3873	Wipers and Washers - **DTC B3873**
B3875	Wipers and Washers - **DTC B3875**
B3884	Lighting - **DTC B3445 or B3884**
B3922	Wipers and Washers - **DTC B3922**
B3933	HVAC - Manual - **DTC B3933**
B3935	Immobilizer - **DTC B3935**
B393B	HVAC - Manual - **DTC B393B**
B3976	Immobilizer - **DTC B3976**
C0035	Antilock Brake System - **DTC C0035-C0050**
C0036	Antilock Brake System - **DTC C0035-C0050**
C0037	Antilock Brake System - **DTC C0035-C0050**
C0038	Antilock Brake System - **DTC C0035-C0050**
C0039	Antilock Brake System - **DTC C0035-C0050**
C0040	Antilock Brake System - **DTC C0035-C0050**
C0041	Antilock Brake System - **DTC C0035-C0050**
C0042	Antilock Brake System - **DTC C0035-C0050**
C0043	Antilock Brake System - **DTC C0035-C0050**
C0044	Antilock Brake System - **DTC C0035-C0050**
C0045	Antilock Brake System - **DTC C0035-C0050**
C0046	Antilock Brake System - **DTC C0035-C0050**
C0047	Antilock Brake System - **DTC C0035-C0050**

DTC	Diagnostic Procedure
C0048	Antilock Brake System - **DTC C0035-C0050**
C0049	Antilock Brake System - **DTC C0035-C0050**
C0050	Antilock Brake System - **DTC C0035-C0050**
C0110	Antilock Brake System - **DTC C0110**
C0131	Antilock Brake System - **DTC C0131**
C0161	Antilock Brake System - **DTC C0161**
C0179	Antilock Brake System - **DTC C0179**
C0186	Antilock Brake System - **DTC C0186**
C0196	Antilock Brake System - **DTC C0196**
C0201	Antilock Brake System - **DTC C0201**
C0242	Antilock Brake System - **DTC C0242 or P0856**
C0245	Antilock Brake System - **DTC C0245**
C0267	Hydraulic Brakes - **DTC C0267**
C0277	Lighting - **DTC C0277 or C0890**
C027B	Hydraulic Brakes - **Auxiliary Brake Booster Pump Malfunction - DTC C027B**
C0292	Antilock Brake System - **DTC C0292**
C0297	Lighting - **DTC C0297**
C0558	Antilock Brake System - **DTC C0558**
C0561	Antilock Brake System - **DTC C0561**
C0563	Antilock Brake System - **DTC C0563**
C0569	Tire Pressure Monitoring - **DTC C0569**
C0710	Antilock Brake System - **DTC C0710**
C0750	Tire Pressure Monitoring - **DTC C0750, C0755, C0760, or C0765**
C0755	Tire Pressure Monitoring - **DTC C0750, C0755, C0760, or C0765**
C0760	Tire Pressure Monitoring - **DTC C0750, C0755, C0760, or C0765**
C0765	Tire Pressure Monitoring - **DTC C0750, C0755, C0760, or C0765**
C0800	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**
C0890	Lighting - **DTC C0277 or C0890**
C0895	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**
C0899	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**
C0900	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**
C1100	Hydraulic Brakes - **DTC C1100**
P0010	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P0011	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0011, P0014, P0021, or P0024**
P0013	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**

DTC	Diagnostic Procedure
P0014	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0011, P0014, P0021, or P0024**
P0016	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0016, P0017, P0018, or P0019**
P0017	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0016, P0017, P0018, or P0019**
P0018	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0016, P0017, P0018, or P0019**
P0019	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0016, P0017, P0018, or P0019**
P0020	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P0021	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0011, P0014, P0021, or P0024**
P0023	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P0024	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0011, P0014, P0021, or P0024**
P0068	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0068 or P1101**
P0089	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0089, P00C6, P228C, or P228D**
P0090	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0090-P0092, P00C8, P00C9, or P00CA**
P0091	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0090-P0092, P00C8, P00C9, or P00CA**
P0092	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0090-P0092, P00C8, P00C9, or P00CA**
P0096	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0096 or P0111**
P0097	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0097, P0098, or P0099**
P0098	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0097, P0098, or P0099**
P0099	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0097, P0098, or P0099**
P00C6	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0089, P00C6, P228C, or P228D**
P00C8	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0090-P0092, P00C8, P00C9, or P00CA**
P00C9	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0090-P0092, P00C8, P00C9, or P00CA**
P00CA	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0090-P0092, P00C8, P00C9, or P00CA**
P00F4	Engine Controls and Fuel - 3.6L (LFX) - **DTC P00F4-P00F6**
P00F5	Engine Controls and Fuel - 3.6L (LFX) - **DTC P00F4-P00F6**
P00F6	Engine Controls and Fuel - 3.6L (LFX) - **DTC P00F4-P00F6**
P0101	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0101**
P0102	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0102 or P0103**
P0103	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0102 or P0103**
P0106	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0106**
P0107	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0107 or P0108**
P0108	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0107 or P0108**
P0111	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0096 or P0111**
P0112	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0112, P0113, or P0114**
P0113	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0112, P0113, or P0114**
P0114	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0112, P0113, or P0114**
P0116	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0116**
P0117	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0117, P0118, or P0119**
P0118	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0117, P0118, or P0119**
P0119	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0117, P0118, or P0119**

DTC	Diagnostic Procedure
P0121	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135**
P0122	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135**
P0123	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135**
P0128	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0128**
P0171	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0171, P0172, P0174, or P0175**
P0172	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0171, P0172, P0174, or P0175**
P0174	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0171, P0172, P0174, or P0175**
P0175	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0171, P0172, P0174, or P0175**
P0178	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0178**
P0179	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0179**
P018B	Engine Controls and Fuel - 3.6L (LFX) - **DTC P018B-P018D (Chassis Control Module)**
P018C	Engine Controls and Fuel - 3.6L (LFX) - **DTC P018B-P018D (Chassis Control Module)**
P018D	Engine Controls and Fuel - 3.6L (LFX) - **DTC P018B-P018D (Chassis Control Module)**
P0191	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0191**
P0192	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0192 or P0193**
P0193	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0192 or P0193**
P0201	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0202	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0203	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0204	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0205	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0206	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0222	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135**
P0223	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135**
P0231	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0231, P0232, or P023F (Chassis Control Module)**

DTC	Diagnostic Procedure
P0232	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0231, P0232, or P023F (Chassis Control Module)**
P023F	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0231, P0232, or P023F (Chassis Control Module)**
P025A	Engine Controls and Fuel - 3.6L (LFX) - **DTC P025A (Chassis Control Module)**
P0261	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0262	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0264	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0265	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0267	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0268	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0270	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0271	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0273	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0274	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0276	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0277	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0201, P0202, P0203, P0204, P0205, P0206, P0261, P0262, P0264, P0265, P0267, P0268, P0270, P0271, P0273, P0274, P0276, or P0277**
P0300	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0300-P0306**
P0301	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0300-P0306**
P0302	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0300-P0306**

DTC	Diagnostic Procedure
P0303	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0300-P0306**
P0304	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0300-P0306**
P0305	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0300-P0306**
P0306	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0300-P0306**
P0315	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0315**
P0324	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0324, P0326, P0331, P06B6, or P06B7**
P0325	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0325, P0327, P0328, P0330, P0332, or P0333**
P0326	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0324, P0326, P0331, P06B6, or P06B7**
P0327	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0325, P0327, P0328, P0330, P0332, or P0333**
P0328	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0325, P0327, P0328, P0330, P0332, or P0333**
P0330	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0325, P0327, P0328, P0330, P0332, or P0333**
P0331	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0324, P0326, P0331, P06B6, or P06B7**
P0332	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0325, P0327, P0328, P0330, P0332, or P0333**
P0333	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0325, P0327, P0328, P0330, P0332, or P0333**
P0335	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0335 or P0336**
P0336	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0335 or P0336**
P0340	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391**
P0341	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391**
P0345	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391**
P0346	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391**
P0351	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P0352	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P0353	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P0354	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P0355	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P0356	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**

DTC	Diagnostic Procedure
P0365	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391**
P0366	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391**
P0390	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391**
P0391	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0340, P0341, P0345, P0346, P0365, P0366, P0390, or P0391**
P0442	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0442**
P0443	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0443, P0458, or P0459**
P0446	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0446**
P0449	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0449, P0498, or P0499**
P0451	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0451-P0454**
P0452	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0451-P0454**
P0453	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0451-P0454**
P0454	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0451-P0454**
P0455	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0455**
P0458	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0443, P0458, or P0459**
P0459	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0443, P0458, or P0459**
P0461	Displays and Gauges - **DTC P0461**
P0462	Displays and Gauges - **DTC P0462**
P0463	Displays and Gauges - **DTC P0463**
P0464	Displays and Gauges - **DTC P0464**
P0480	Engine Cooling - **DTC P0480, P0481, P0691, P0692, P0693, or P0694**
P0481	Engine Cooling - **DTC P0480, P0481, P0691, P0692, P0693, or P0694**
P0496	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0496**
P0498	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0449, P0498, or P0499**
P0499	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0449, P0498, or P0499**
P0506	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0506 or P0507**
P0507	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0506 or P0507**
P050D	Engine Controls and Fuel - 3.6L (LFX) - **DTC P050D**
P0513	Immobilizer - **DTC P0513**
P0520	Displays and Gauges - **DTC P0520**
P0532	HVAC - Manual - **DTC P0532 or P0533**
P0533	HVAC - Manual - **DTC P0532 or P0533**
P0560	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**
P0562	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**
P0563	12 V Starting and Charging - **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**

DTC	Diagnostic Procedure
P0564	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P0565	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P0567	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P0568	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P056C	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P0571	Cruise Control - **DTC P0571**
P0572	Cruise Control - **DTC P0572 or P0573**
P0573	Cruise Control - **DTC P0572 or P0573**
P0575	Cruise Control - **DTC P0575**
P057B	Engine Controls and Fuel - 3.6L (LFX) - **DTC P057B-P057D**
P057C	Engine Controls and Fuel - 3.6L (LFX) - **DTC P057B-P057D**
P057D	Engine Controls and Fuel - 3.6L (LFX) - **DTC P057B-P057D**
P0580	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P0581	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P05CC	Engine Controls and Fuel - 3.6L (LFX) - **DTC P05CC-P05CF**
P05CD	Engine Controls and Fuel - 3.6L (LFX) - **DTC P05CC-P05CF**
P05CE	Engine Controls and Fuel - 3.6L (LFX) - **DTC P05CC-P05CF**
P05CF	Engine Controls and Fuel - 3.6L (LFX) - **DTC P05CC-P05CF**
P0601	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)**
P0601	Automatic Transmission - 6T70 (MH2) - **DTC P0601-P0604 or P062F**
P0602	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)**
P0602	Automatic Transmission - 6T70 (MH2) - **DTC P0601-P0604 or P062F**
P0603	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)**
P0603	Automatic Transmission - 6T70 (MH2) - **DTC P0601-P0604 or P062F**
P0604	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)**
P0604	Automatic Transmission - 6T70 (MH2) - **DTC P0601-P0604 or P062F**
P0606	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)**
P0615	12 V Starting and Charging - **DTC P0615, P0616, or P0617**
P0616	12 V Starting and Charging - **DTC P0615, P0616, or P0617**
P0617	12 V Starting and Charging - **DTC P0615, P0616, or P0617**

DTC	Diagnostic Procedure
P0621	12 V Starting and Charging - **DTC P0621**
P0622	12 V Starting and Charging - **DTC P0622**
P0628	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0628**
P062B	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)**
P062F	Automatic Transmission - 6T70 (MH2) - **DTC P0601-P0604 or P062F**
P062F	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)**
P0630	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)**
P0633	Immobilizer - **DTC P0633**
P0634	Automatic Transmission - 6T70 (MH2) - **DTC P0634**
P0641	Engine Controls and Fuel - 3.6L (LFX) - Chassis Control Module - **DTC P0641 or P06A6 (Chassis Control Module)**
P0641	Engine Controls and Fuel - 3.6L (LFX) - ECM - **DTC P0641, P0651, P0697, or P06A3 (ECM)**
P0645	HVAC - Manual - **DTC P0645, P0646, or P0647**
P0646	HVAC - Manual - **DTC P0645, P0646, or P0647**
P0647	HVAC - Manual - **DTC P0645, P0646, or P0647**
P064A	Engine Controls and Fuel - 3.6L (LFX) - **DTC P1255 or P064A (Chassis Control Module)**
P0650	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0650, P263A, or P263B**
P0651	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0641, P0651, P0697, or P06A3 (ECM)**
P0658	Automatic Transmission - 6T70 (MH2) - **DTC P0658 or P0659**
P0659	Automatic Transmission - 6T70 (MH2) - **DTC P0658 or P0659**
P0667	Automatic Transmission - 6T70 (MH2) - **DTC P0667, P0668, or P0669**
P0668	Automatic Transmission - 6T70 (MH2) - **DTC P0667, P0668, or P0669**
P0669	Automatic Transmission - 6T70 (MH2) - **DTC P0667, P0668, or P0669**
P0685	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0685-P0687, P0689, P0690, or P1682**
P0686	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0685-P0687, P0689, P0690, or P1682**
P0687	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0685-P0687, P0689, P0690, or P1682**
P0689	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0685-P0687, P0689, P0690, or P1682**
P0690	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0685-P0687, P0689, P0690, or P1682**
P0691	Engine Cooling - **DTC P0480, P0481, P0691, P0692, P0693, or P0694**
P0692	Engine Cooling - **DTC P0480, P0481, P0691, P0692, P0693, or P0694**
P0693	Engine Cooling - **DTC P0480, P0481, P0691, P0692, P0693, or P0694**
P0694	Engine Cooling - **DTC P0480, P0481, P0691, P0692, P0693, or P0694**
P0697	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0641, P0651, P0697, or P06A3 (ECM)**
P069E	Engine Controls and Fuel - 3.6L (LFX) - **DTC P069E**
P06A3	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0641, P0651, P0697, or P06A3 (ECM)**
P06A6	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0641 or P06A6 (Chassis Control Module)**

DTC	Diagnostic Procedure
P06AC	Automatic Transmission - 6T70 (MH2) - **DTC P06AC-P06AE**
P06AD	Automatic Transmission - 6T70 (MH2) - **DTC P06AC-P06AE**
P06AE	Automatic Transmission - 6T70 (MH2) - **DTC P06AC-P06AE**
P06B6	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0324, P0326, P0331, P06B6, or P06B7**
P06B7	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0324, P0326, P0331, P06B6, or P06B7**
P0700	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0700**
P0703	Cruise Control - **DTC P0703**
P0711	Automatic Transmission - 6T70 (MH2) - **DTC P0711-P0713**
P0712	Automatic Transmission - 6T70 (MH2) - **DTC P0711-P0713**
P0713	Automatic Transmission - 6T70 (MH2) - **DTC P0711-P0713**
P0716	Automatic Transmission - 6T70 (MH2) - **DTC P0716 or P0717**
P0717	Automatic Transmission - 6T70 (MH2) - **DTC P0716 or P0717**
P0722	Automatic Transmission - 6T70 (MH2) - **DTC P0722 or P0723**
P0723	Automatic Transmission - 6T70 (MH2) - **DTC P0722 or P0723**
P0741	Automatic Transmission - 6T70 (MH2) - **DTC P0741 or P0742**
P0742	Automatic Transmission - 6T70 (MH2) - **DTC P0741 or P0742**
P0751	Automatic Transmission - 6T70 (MH2) - **DTC P0751 or P0752**
P0752	Automatic Transmission - 6T70 (MH2) - **DTC P0751 or P0752**
P0756	Automatic Transmission - 6T70 (MH2) - **DTC P0756**
P0776	Automatic Transmission - 6T70 (MH2) - **DTC P0776 or P0777**
P0777	Automatic Transmission - 6T70 (MH2) - **DTC P0776 or P0777**
P0796	Automatic Transmission - 6T70 (MH2) - **DTC P0796 or P0797**
P0797	Automatic Transmission - 6T70 (MH2) - **DTC P0796 or P0797**
P0815	Automatic Transmission - 6T70 (MH2) - **DTC P0815, P0816, or P0826**
P0816	Automatic Transmission - 6T70 (MH2) - **DTC P0815, P0816, or P0826**
P0826	Automatic Transmission - 6T70 (MH2) - **DTC P0815, P0816, or P0826**
P0842	Automatic Transmission - 6T70 (MH2) - **DTC P0842 or P0843**
P0843	Automatic Transmission - 6T70 (MH2) - **DTC P0842 or P0843**
P0851	Automatic Transmission - 6T70 (MH2) - **DTC P0851**
P0856	Antilock Brake System - **DTC C0242 or P0856**
P0872	Automatic Transmission - 6T70 (MH2) - **DTC P0872 or P0873**
P0873	Automatic Transmission - 6T70 (MH2) - **DTC P0872 or P0873**
P0877	Automatic Transmission - 6T70 (MH2) - **DTC P0877 or P0878**
P0878	Automatic Transmission - 6T70 (MH2) - **DTC P0877 or P0878**
P0961	Automatic Transmission - 6T70 (MH2) - **DTC P0961-P0963**
P0962	Automatic Transmission - 6T70 (MH2) - **DTC P0961-P0963**
P0963	Automatic Transmission - 6T70 (MH2) - **DTC P0961-P0963**
P0965	Automatic Transmission - 6T70 (MH2) - **DTC P0965-P0967**
P0966	Automatic Transmission - 6T70 (MH2) - **DTC P0965-P0967**
P0967	Automatic Transmission - 6T70 (MH2) - **DTC P0965-P0967**
P0969	Automatic Transmission - 6T70 (MH2) - **DTC P0969-P0971**

DTC	Diagnostic Procedure
P0970	Automatic Transmission - 6T70 (MH2) - **DTC P0969-P0971**
P0971	Automatic Transmission - 6T70 (MH2) - **DTC P0969-P0971**
P0973	Automatic Transmission - 6T70 (MH2) - **DTC P0973 or P0974**
P0974	Automatic Transmission - 6T70 (MH2) - **DTC P0973 or P0974**
P0976	Automatic Transmission - 6T70 (MH2) - **DTC P0976 or P0977**
P0977	Automatic Transmission - 6T70 (MH2) - **DTC P0976 or P0977**
P0989	Automatic Transmission - 6T70 (MH2) - **DTC P0989 or P0990**
P0990	Automatic Transmission - 6T70 (MH2) - **DTC P0989 or P0990**
P1101	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0068 or P1101**
P1255	Engine Controls and Fuel - 3.6L (LFX) - **DTC P1255 or P064A (Chassis Control Module)**
P1258	Engine Cooling - **DTC P1258**
P135A	Engine Controls and Fuel - 3.6L (LFX) - **DTC P135A or P135B**
P135B	Engine Controls and Fuel - 3.6L (LFX) - **DTC P135A or P135B**
P150C	Engine Controls and Fuel - 3.6L (LFX) - **DTC P150C**
P1516	Engine Controls and Fuel - 3.6L (LFX) - **DTC P1516, P2101, P2119, or P2176**
P155A	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P155B	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P155C	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P1629	Immobilizer - **DTC P1629**
P162B	Immobilizer - **DTC P162B**
P162C	Cruise Control - **Cruise Control Malfunction - DTC B3794, P0564, P0565, P0567, P0568, P056C, P0580, P0581, P155A-P155C, or P162C**
P1631	Immobilizer - **DTC P1631**
P1632	Immobilizer - **DTC P1632**
P163A	Engine Controls and Fuel - 3.6L (LFX) - **DTC P163A**
P1668	12 V Starting and Charging - **DTC P1668**
P1682	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0685-P0687, P0689, P0690, or P1682**
P16A0	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135**
P16A1	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135**
P16A2	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135**
P16F3	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)**
P1761	Automatic Transmission - 6T70 (MH2) - **DTC P1761**
P182E	Automatic Transmission - 6T70 (MH2) - **DTC P182E or P1915**
P1915	Automatic Transmission - 6T70 (MH2) - **DTC P182E or P1915**

DTC	Diagnostic Procedure
P2088	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P2089	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P2090	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P2091	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P2092	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P2093	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P2094	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P2095	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0010, P0013, P0020, P0023, P2088, P2089, P2090, P2091, P2092, P2093, P2094, or P2095**
P2096	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2096 or P2098**
P2097	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2097 or P2099**
P2098	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2096 or P2098**
P2099	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2097 or P2099**
P2101	Engine Controls and Fuel - 3.6L (LFX) - **DTC P1516, P2101, P2119, or P2176**
P2119	Engine Controls and Fuel - 3.6L (LFX) - **DTC P1516, P2101, P2119, or P2176**
P2122	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2122, P2123, P2127, P2128, or P2138**
P2123	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2122, P2123, P2127, P2128, or P2138**
P2127	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2122, P2123, P2127, P2128, or P2138**
P2128	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2122, P2123, P2127, P2128, or P2138**
P2135	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0121-P0123, P0222, P0223, P16A0-P16A2, or P2135**
P2138	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2122, P2123, P2127, P2128, or P2138**
P2147	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P2148	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P2150	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P2151	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P2153	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P2154	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P2156	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**

DTC	Diagnostic Procedure
P2157	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P216B	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P216C	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P216E	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P216F	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2147, P2148, P2150, P2151, P2153, P2154, P2156, P2157, P216B, P216C, P216E, or P216F**
P2176	Engine Controls and Fuel - 3.6L (LFX) - **DTC P1516, P2101, P2119, or P2176**
P2199	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2199**
P219A	Engine Controls and Fuel - 3.6L (LFX) - **DTC P219A or P219B**
P219B	Engine Controls and Fuel - 3.6L (LFX) - **DTC P219A or P219B**
P2269	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2269**
P228C	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0089, P00C6, P228C, or P228D**
P228D	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0089, P00C6, P228C, or P228D**
P2300	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2301	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2303	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2304	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2306	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2307	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2309	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2310	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2312	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2313	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2315	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2316	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0351-P0356, P2300, P2301, P2303, P2304, P2306, P2307, P2309, P2310, P2312, P2313, P2315, or P2316**
P2534	Wiring Systems and Power Management - **DTC P2534 or P2535**
P2535	Wiring Systems and Power Management - **DTC P2534 or P2535**

DTC	Diagnostic Procedure
P2537	Wiring Systems and Power Management - **DTC P2537**
P2544	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2544**
P258A	Hydraulic Brakes - **DTC P258A-P258D**
P258B	Hydraulic Brakes - **DTC P258A-P258D**
P258C	Hydraulic Brakes - **DTC P258A-P258D**
P258D	Hydraulic Brakes - **DTC P258A-P258D**
P262B	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0601-P0604, P0606, P062B, P062F, P0630, P16F3, or P262B (ECM)**
P2635	Engine Controls and Fuel - 3.6L (LFX) - **DTC P2635 (Chassis Control Module)**
P263A	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0650, P263A, or P263B**
P263B	Engine Controls and Fuel - 3.6L (LFX) - **DTC P0650, P263A, or P263B**
P2714	Automatic Transmission - 6T70 (MH2) - **DTC P2714 or P2715**
P2715	Automatic Transmission - 6T70 (MH2) - **DTC P2714 or P2715**
P2719	Automatic Transmission - 6T70 (MH2) - **DTC P2719-P2721**
P2720	Automatic Transmission - 6T70 (MH2) - **DTC P2719-P2721**
P2721	Automatic Transmission - 6T70 (MH2) - **DTC P2719-P2721**
P2723	Automatic Transmission - 6T70 (MH2) - **DTC P2723 or P2724**
P2724	Automatic Transmission - 6T70 (MH2) - **DTC P2723 or P2724**
P2728	Automatic Transmission - 6T70 (MH2) - **DTC P2728-P2730**
P2729	Automatic Transmission - 6T70 (MH2) - **DTC P2728-P2730**
P2730	Automatic Transmission - 6T70 (MH2) - **DTC P2728-P2730**
P2762	Automatic Transmission - 6T70 (MH2) - **DTC P2762, P2763, or P2764**
P2763	Automatic Transmission - 6T70 (MH2) - **DTC P2762, P2763, or P2764**
P2764	Automatic Transmission - 6T70 (MH2) - **DTC P2762, P2763, or P2764**

SYMPTOM BYTE LIST

Symptom Byte	Symptom Byte Description	Symptom Byte Definition
(00-0F) General Electrical Failures This category includes standard wiring failure modes (for example, shorts and opens), direct current (DC) quantities related by Ohm's Law and quantities related to amplitude, frequency or rate of change, and wave shape.		
00	-	This sub type is used for failures that cannot be assigned to a specific sub type. No additional information is available.
01	Short to Battery	This sub type is used for failures where the Electronic Control Unit measures vehicle system (battery positive) potential for greater than a specified time period or when some other value is expected.
02	Short to Ground	This sub type is used for failures where the Electronic Control Unit measures ground (battery negative) potential for greater than a specified

Symptom Byte	Symptom Byte Description	Symptom Byte Definition
		time period or when some other value is expected.
03	Low Voltage	This sub type is used for failures where the Electronic Control Unit measures a voltage below a specified range but not necessarily a short to ground.
04	Open	This sub type is used for failures where the Electronic Control Unit determines an open circuit via lack of bias voltage, low current flow, no change in state of an input in response to an output, etc.
05	High Voltage/Open	This sub type is used for failures where the condition detected by the Electronic Control Unit is the same for either indicated failure mode.
06	Low Voltage/Open	This sub type is used for failures where the condition detected by the Electronic Control Unit is the same for either indicated failure mode.
07	High Voltage	This sub type is used for failures where the Electronic Control Unit measures a voltage above a specified range but not necessarily a short to battery.
08	Performance - Signal Invalid	This sub type is used for failures where the value of the signal is not plausible given the operating conditions.
09	Too Fast Transitions	This sub type is used for failures where the signal transitions more quickly than is reasonably allowed.
0A	Too Slow Transitions	This sub type is used for failures where the signal transitions more slowly than is reasonably allowed.
0B	High Current	This sub type is used for failures where the Electronic Control Unit measures current flow above a specified range.
0C	Low Current	This sub type is used for failures where the Electronic Control Unit measures current flow below a specified range.
0D	High Resistance	This sub type is used for failures where the Electronic Control Unit infers a circuit resistance above a specified range.
0E	Low Resistance	This sub type is used for failures where the Electronic Control Unit infers a circuit resistance below a specified range.
0F	Signal Erratic	This sub type is used for failures where the signal is momentarily implausible (not long enough for

Symptom Byte	Symptom Byte Description	Symptom Byte Definition
		Signal Invalid) or discontinuous.
(10-1F) Additional General Electrical Failures This category includes the overflow from category 0.		
10	-	Currently not used.
11	High Input	This sub type is used for failures where some circuit quantity is above a specified range.
12	Low Input	This sub type is used for failures where some circuit quantity is below a specified range.
13	Low Voltage/High Temperature	This sub type is used for failures where a temperature sensor with a negative temperature coefficient detects a voltage below a specified range.
14	High Voltage/Low Temperature	This sub type is used for failures where a temperature sensor with a negative temperature coefficient detects a voltage above a specified range.
15	Performance - Signal Rising Time Failure	This sub type is used for failures where the signal rise time is outside a specified range.
16	Performance - Signal Falling Time Failure	This sub type is used for failures where the signal fall time is outside a specified range.
17	Performance - Signal Shape/Waveform Failure	This sub type is used for failures where the shape of the signal (plot of the amplitude with respect to time) is not correct (for example, improper circuit impedance.)
18	Low Signal Amplitude	This sub type is used for failures where the Electronic Control Unit measures a signal voltage below a specified range but not necessarily a short to ground (for example, gain too low).
19	High Signal Amplitude	This sub type is used for failures where the Electronic Control Unit measures a signal voltage above a specified range but not necessarily a short to battery (for example, gain too high).
1A	Performance - Bias Level Out of Range	This sub type is used for failures where the Electronic Control Unit applies a bias voltage to a circuit upon which is superimposed a signal voltage (for example, Oxygen Sensor Circuit.)
1B	Signal Cross Coupled	This sub type is used for failures where the Electronic Control Unit detects a circuit shorted to another circuit when both circuits are controlled by the Electronic Control Unit.
1C	-	Currently not used.
1D	-	Currently not used.
1E	-	Currently not used.

Symptom Byte	Symptom Byte Description	Symptom Byte Definition
1F	Erratic	This sub type is used for failures where the Electronic Control Unit momentarily detects one of the conditions defined above but not long enough to set a specific sub type.
(20-2F) FM / PWM Failures This category includes faults related to Frequency Modulated (FM) and Pulse Width Modulated (PWM) inputs and outputs of the Electronic Control Unit and faults where position is determined by counts.		
20	-	Currently not used.
21	Incorrect Period	This sub type is used for failures where the Electronic Control Unit measures an incorrect duration for one cycle of the output.
22	Too Short Low-Time	This sub type is used for failures where the Electronic Control Unit detects the low pulse is too narrow with respect to time.
23	Too Long Low-Time	This sub type is used for failures where the Electronic Control Unit detects the low pulse is too wide with respect to time.
24	Too Short High-Time	This sub type is used for failures where the Electronic Control Unit detects the high pulse is too narrow with respect to time.
25	Too Long High-Time	This sub type is used for failures where the Electronic Control Unit detects the high pulse is too wide with respect to time.
26	Low Frequency	This sub type is used for failures where the Electronic Control Unit detects too few cycles in a given time period.
27	High Frequency	This sub type is used for failures where the Electronic Control Unit detects too many cycles in a given time period.
28	Incorrect Frequency	This sub type is used for failures where the Electronic Control Unit measures an incorrect number of cycles in a given time period.
29	Too Few Pulses	This sub type is used for failures where the Electronic Control Unit measures too few pulses (for example, position is calibrated in counts from one extreme to the other).
2A	Too Many Pulses	This sub type is used for failures where the Electronic Control Unit measures too many pulses (for example, position is calibrated in counts from one extreme to the other).
2B	Missing Reference	This sub type is used for failures where the Electronic Control Unit does not detect a reference for a signal circuit or a group of signal circuits.

Symptom Byte	Symptom Byte Description	Symptom Byte Definition
2C	-	Currently not used.
2D	-	Currently not used.
2E	-	Currently not used.
2F	-	Currently not used.
(30-3F) Electronic Control Unit Internal Failures This category includes faults related to memory, software, and internal electrical circuitry; requiring component replacement.		
30	-	Currently not used.
31	Internal Checksum Error	This sub type is used by the Electronic Control Unit to indicate an incorrect checksum calculation where memory type is not specified.
32	General Memory Malfunction	This sub type is used by the Electronic Control Unit to indicate a memory failure where memory type is not specified.
33	Special Memory Malfunction	This sub type is used by the Electronic Control Unit to indicate a memory failure where the specific memory type is not defined in this category.
34	RAM Malfunction	This sub type is used by the Electronic Control Unit to indicate a Random Access Memory (RAM) failure.
35	ROM Malfunction	This sub type is used by the Electronic Control Unit to indicate a Read Only Memory (ROM) failure.
36	EEPROM Performance/Malfunction	This sub type is used by the Electronic Control Unit to indicate an Electrically Erasable Programmable Read Only Memory (EEPROM) failure.
37	Software Malfunction	This sub type is used by the Electronic Control Unit to indicate a failure in the execution of operational software
38	Supervision Software Malfunction	This sub type is used by the Electronic Control Unit to indicate a loop time error in the execution of the operational software.
39	Internal Malfunction	This sub type is used by the Electronic Control Unit to indicate the detection of an internal circuit failure.
3A	Incorrect Component Installed	This sub type is used by the Electronic Control Unit to indicate a mismatch between the hardware connected to the Electronic Control Unit and the hardware expected by the Electronic Control Unit.

Symptom Byte	Symptom Byte Description	Symptom Byte Definition
3B	Self-Test Malfunction	This sub type is used by the Electronic Control Unit to indicate a sensor self-test failure launched by an Electronic Control Unit command.
3C	Internal Communication Malfunction	This sub type is used by the Electronic Control Unit to indicate loss of an internal communication line, for example, between microprocessors in a dual microprocessor configuration.
3D	-	Currently not used.
3E	-	Currently not used.
3F	-	Currently not used.
(40-4F) Electronic Control Unit Programming Failures This category includes faults related to operational software, calibrations, and options; remedied by programming the Electronic Control Unit.		
40	-	Currently not used.
41	Not Programmed	This sub type is used to indicate that only boot software is present in the Electronic Control Unit.
42	Calibration Not Programmed	This sub type is used to indicate that operational software is present but calibration data is not.
43	EEPROM Incorrect Programming	This sub type is used to indicate an EEPROM error that may be remedied by reprogramming the module.
44	Security Access Not Activated	This sub type is used to indicate that programming was attempted without unlocking the Electronic Control Unit.
45	Variant Not Programmed	This sub type is used to indicate the need to enter (program) the sub system option content.
46	Configuration Not Programmed	This sub type is used to indicate the need to enter (program) the vehicle option content.
47	VIN Not Programmed	This sub type is used to indicate the need to enter (program) the vehicle identification number (VIN).
48	Security Code Not Programmed	This sub type is used to indicate the need to enter (program) the theft / security code.
49	RAM Incorrect Programming	This sub type is used by the Electronic Control Unit to indicate a Random Access Memory (RAM) error remedied by reprogramming.
4A	Programming Checksum Error	This sub type is used by the Electronic Control Unit to indicate an incorrect checksum calculation where memory type is not specified.
4B	Calibration Not Learned	This sub type is used by the Electronic Control Unit to indicate that a password, operational range, etc. for a sensor or actuator must be learned by the Electronic Control Unit.

Symptom Byte	Symptom Byte Description	Symptom Byte Definition
4C	DTC Memory Full	This sub type is used by the Electronic Control Unit to indicate that more DTCs have been detected than can be accommodated by the memory allocated for DTC storage.
4D	Stack Overflow	This subtype is used by the Electronic Control Unit to indicate that more memory has been used in a stack than is allocated to a program.
4E	-	Currently not used.
4F	-	Currently not used.
(50-5F) Algorithm Based Failures This category includes faults based on comparing two or more input parameters for plausibility or comparing a single parameter to itself with respect to time.		
50	-	Currently not used.
51	-	Currently not used.
52	-	Currently not used.
53	Low Temperature	This sub type is used for failures where the Electronic Control Unit calculates a low temperature condition based upon the duration of certain operating parameters.
54	High Temperature	This sub type is used for failures where the Electronic Control Unit calculates a high temperature condition based upon the duration of certain operating parameters.
55	Too Few Transitions	This sub type is used for failures where the Electronic Control Unit monitors a parameter over time within specified limits and detects fewer than the expected number of transitions.
56	Too Many Transitions	This sub type is used for failures where the Electronic Control Unit monitors a parameter over time within specified limits and detects more than the expected number of transitions.
57	-	Currently not used.
58	Performance	This sub type is used for failures where the Electronic Control Unit does not see the expected change to a parameter or group of parameters in response to a particular event.
59	Protection Time-Out	This sub type is used for failures where the Electronic Control Unit detects a function is active for greater than a specified time period.
5A	Not Plausible	This sub type is used for failures where the Electronic Control Unit compares two or more input parameters for plausibility.
5B	-	Currently not used.
5C	-	Currently not used.

Symptom Byte	Symptom Byte Description	Symptom Byte Definition
5D	-	Currently not used.
5E	-	Currently not used.
5F	-	Currently not used.
(60-6F) Mechanical Failures This category includes faults detected by inappropriate motion in response to an Electronic Control Unit controlled output.		
60	-	Currently not used.
61	Stuck	This sub type is used for failures where the Electronic Control Unit does not detect any motion in response to energizing a motor, solenoid, relay, etc.
62	Stuck Open	This sub type is used for failures where the Electronic Control Unit does not detect any motion upon commanding the operation of a motor, solenoid, relay, etc., to close some piece of equipment.
63	Stuck Closed	This sub type is used for failures where the Electronic Control Unit does not detect any motion upon commanding the operation of a motor, solenoid, relay, etc., to open some piece of equipment.
64	Slip Detected	This sub type is used for failures where the Electronic Control Unit detects excessive duration to command a motor, solenoid, relay, etc., to move a piece of equipment to a desired position.
65	Emergency Position Not Achievable	This sub type is used for failures where the Electronic Control Unit is unable to command a motor, solenoid, relay, etc., to move a piece of equipment to the emergency position.
66	Incorrect Mounting	This sub type is used for failures where the server detects incorrectly mounted components, for example, acceleration sensor showing a position error of 90Â°.
67	Incorrect Assembly	This sub type is used for failures where the control module has detected that the component has been incorrectly installed (for example, hydraulic pipes crossed over, circuits cross wired) or polarity errors.
68	-	Currently not used.
69	-	Currently not used.
6A	-	Currently not used.
6B	-	Currently not used.
6C	-	Currently not used.

Symptom Byte	Symptom Byte Description	Symptom Byte Definition
6D	-	Currently not used.
6E	-	Currently not used.
6F	-	Currently not used.
(70-7F) Bus Signal / Message Failures This category includes faults related to bus hardware and signal integrity. This category is also used when the physical input for a signal is located in one Electronic Control Unit and another Electronic Control Unit diagnoses the circuit.		
70	-	Currently not used.
71	Invalid Data	This sub type is used by the Electronic Control Unit to indicate a signal was received with the corresponding validity bit equal to Invalid or post processing of the signal determines it is invalid.
72	Message Counter Incorrect	This sub type is used by the Electronic Control Unit to indicate a signal was received without the corresponding rolling count value being properly updated.
73	Parity Error	This sub type is used by the Electronic Control Unit to indicate a message was processed with an incorrect parity calculation.
74	Bus Signal Checksum Error	This sub type is used by the Electronic Control Unit to indicate a message was processed with an incorrect protection (checksum) calculation.
75	Serial Data Link High Input	This sub type is used for failures where some circuit quantity, reported via serial data, is above a specified range.
76	Serial Data Link Low Input	This sub type is used for failures where some circuit quantity, reported via serial data, is below a specified range.
77	-	Currently not used.
78	-	Currently not used.
79	-	Currently not used.
7A	-	Currently not used.
7B	-	Currently not used.
7C	-	Currently not used.
7D	-	Currently not used.
7E	-	Currently not used.
7F	Bus Signal Erratic	This sub type is used for failures where the signal, reported via serial data, is momentarily implausible or discontinuous.
(80-FF) Reserved Unique System Specific - See specific diagnostic procedures for symptom byte information if these symptom bytes are used.		

SYMPTOMS - VEHICLE

Body Repair

Symptoms - Bolted Exterior Body Panels and Closures

Body Systems

- **Symptoms - Fixed and Moveable Windows**
- **Symptoms - Horns**
- **Symptoms - Lighting**
- **Symptoms - Mirrors**
- **Symptoms - Vehicle Access**
- **Symptoms - Wiper/Washer Systems**

Brakes

- **Symptoms - Antilock Brake System**
- **Symptoms - Hydraulic Brakes**
- **Symptoms - Park Brake**

Driver Information and Entertainment

- **Symptoms - Cellular Communication**
- **Symptoms - Entertainment**
- **Symptoms - Displays and Gauges**
- **Symptoms - Secondary and Configurable Customer Controls**

Engine

- **Symptoms - Engine Electrical**
- **Symptoms - Cruise Control**
- **Symptoms - Engine Controls**
- **Symptoms - Engine Cooling**
- **Symptoms - Engine Mechanical**
- **Symptoms - Engine Exhaust**

General Information

Symptoms - Vibration Diagnosis and Correction

HVAC

Symptoms - HVAC Systems - Manual

Power and Signal Distribution

- **Symptoms - Data Communications**
- **Symptoms - Power Outlets**
- **Symptoms - Wiring Systems**

Roof

Symptoms - Roof

Safety and Security

- **Symptoms - Immobilizer**
- **Symptoms - Remote Functions**
- **Symptoms - Seat Belts**
- **Symptoms - SIR**
- **Symptoms - Theft Deterrent**

Seats

- **Symptoms - Power Seats**
- **Symptoms - Seat Heating and Cooling**

Steering

- **Symptoms - Power Steering System**
- **Symptoms - Steering Wheel and Column**

Suspension

- **Symptoms - Suspension General Diagnosis**
- **Symptoms - Tire Pressure Monitoring**

Transmission

- **Symptoms - Automatic Transmission**
- **Symptoms - Automatic Transmission Shift Lock Control**

ENGINE DOES NOT CRANK

Refer to the appropriate diagnostic procedure below for the symptom observed.

- **Starter Solenoid Does Not Click**
- **Starter Solenoid Clicks, Engine Does Not Crank**
- **Engine Cranks Slowly**

ENGINE CRANKS BUT DOES NOT RUN

Refer to the appropriate diagnostic procedure below for the vehicle being serviced.

Engine Cranks But Does Not Run - 3.6L engine

INSPECTION/MAINTENANCE SYSTEM CHECK

Refer to the appropriate diagnostic procedure below for the vehicle being serviced.

Inspection/Maintenance System Check - 3.6L engine

DIAGNOSTIC REPAIR VERIFICATION

NOTE: **After a repair has been made, some DTCs require the ignition to be turned Off and then back On before the scan tool function will clear the DTC.**

1. Ignition/Vehicle Off.
2. Install any components or connectors that have been removed or replaced during diagnosis.
3. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
4. Ignition On/Vehicle in Service Mode.
5. Clear the DTCs.
6. Ignition/Vehicle Off for greater than 60s.
7. Perform the Circuit/System Verification and verify the result ends with an All OK.—If available

   or

   If the repair was related to a DTC, duplicate the Conditions for Running the DTC and use the Freeze Frame/Failure Records, if applicable, in order to verify the DTC does not set.If the DTC sets or another DTC is present, refer to:**Diagnostic Trouble Code (DTC) List - Vehicle**

   or

   If the repair was symptom related, duplicate the conditions under which the customer concern occurred to verify the repair.If the customer concern reoccurs or another symptom is present, refer to:**Symptoms - Vehicle**

Article GUID: A00737158

GENERAL INFORMATION

Vibration Diagnosis and Correction - Impala

SPECIFICATIONS

TIRE AND WHEEL RUNOUT SPECIFICATIONS

Application	Specification	
	Metric	English
Tire and Wheel Assembly- Lateral and Radial		
• Off-Vehicle	1.27 mm	0.050 in
• On-Vehicle	1.52 mm	0.060 in
Wheel, Aluminum		
• Lateral	0.762 mm	0.030 in
• Radial	0.762 mm	0.030 in
Wheel, Steel		
• Lateral	1.143 mm	0.045 in
• Radial	1.015 mm	0.040 in
Wheel Hub/Axle Flange- Guideline	0.132 mm	0.0052 in
Wheel Stud- Guideline	0.25 mm	0.010 in

DIAGNOSTIC INFORMATION AND PROCEDURES

VIBRATION DIAGNOSIS, STARTING POINT, AND CORRECTION

The information contained in this Vibration Diagnosis and Correction section is designed to cover various vehicle designs and configurations. Not all content will apply to all vehicles.

NOTE: **The following steps must be completed before using the analysis tables or the symptom tables.**

1. Perform the **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)** table before using the other Vibration Analysis tables or the Symptom tables in order to effectively diagnose the customer's concern.

   The use of Vibration Analysis - Road Testing will first provide duplication of virtually any vibration concern and then identify the correct procedure for diagnosing the area of concern which has been duplicated.

2. Review the following Vibration Diagnostic Process.
3. Review the general descriptions to familiarize yourself with vibration theory and terminology, the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) , or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , and

the **EL-38792-VS** Vibrate Software. Reviewing this information will help you determine whether the condition described by the customer is a potential operating characteristic or not.

Refer to the following:

- **Vibration Theory and Terminology**
- **Oscilloscope Diagnostic Kit Description and Operation**
- **Electronic Vibration Analyzer (EVA) Description and Operation**
- **Vibrate Software Description and Operation**
- **Reed Tachometer Description**

Vibration Diagnostic Process

NOTE: **Using the following steps of the vibration diagnostic process will help you to effectively narrow-down and pin-point the search for the specific source of a vibration concern and to arrive at an accurate repair.**

1. Gather specific information on the customer's vibration concern.
2. Perform the road testing steps in sequence as identified in Vibration Analysis - Road Testing in order to duplicate the customer's concern and evaluate the symptoms of the concern under changing conditions. Observe what the vibration feels like and what it sounds like. Observe when the symptoms first appear, when they change, and when they cease.
3. Determine if the customer's vibration concern is truly an abnormal condition or something that is potentially an operating characteristic of the vehicle.
4. Systematically eliminate or "rule-out" possible vehicle systems.
5. Focus diagnostic efforts on the remaining vehicle system and systematically eliminate or "rule-out" possible components of that system.
6. Make a repair on the remaining component, or components, which have not been eliminated systematically, and must therefore be the cause of the vibration.
7. Verify that the customer's concern has been eliminated or at least brought to an acceptable level.
8. Again perform the road testing steps in sequence as identified in Vibration Analysis - Road Testing in order to verify that the vehicle did not have more than one vibration occurring.

Preliminary Visual/Physical Inspection

- Inspect for aftermarket equipment and modifications which could affect the operation of the vehicle rotating component systems.
- Inspect the easily accessible or visible components of the vehicle rotating component systems for obvious damage or conditions which could cause the symptom.
- Inspect the tire inflation pressures for the proper pressure.

Diagnostic Aids

Improper component routing or isolation, or components which are worn or faulty may be the cause of intermittent conditions that are difficult to duplicate. If the vibration concern could not be duplicated by following the steps of the Vibration Diagnostic Process, refer to **Vibration Diagnostic Aids**.

VIBRATION ANALYSIS - ROAD TESTING (EL-38792-A ELECTRONIC VIBRATION ANALYZER)

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5

Obtaining rotational speed for the components rotating at tire/wheel speed is critical to systematically eliminating specific vehicle component groups. These component rotational speeds can be generated by using the **J-38792-VS** Vibrate Software , or through calculating them manually.

10

NOTE: **Be certain to OBSERVE for disturbances that match the customer's description FIRST, then look at the J-38792-A Electronic Vibration Analyzer 2 (EVA 2) frequency which corresponds with that disturbance.**

Proper location of the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) , sensor onto the component which is most excited by the vibration disturbance is critical to obtaining an accurate frequency reading.

This test will duplicate virtually any disturbance which occurs while the vehicle is in motion.

11

Accelerate to a speed high enough above the speed of the disturbance to allow for the time needed to shift into NEUTRAL and for the engine to decrease in RPM to idle speed, before coasting down through the disturbance range.

12

This test will either eliminate or confirm the engine as a contributing cause of the customer concern.

Step	Action	Yes	No
WARNING: **Refer to Road Test Warning .**			
1	Did you review the Diagnostic Starting Point - Vibration Diagnosis?	Go to **Step 2**	Go to **Vibration Diagnosis, Starting Point, and Correction**
2	Did the customer concern indicate that the vibration occurs ONLY while the vehicle is standing still?	Go to **Step 6**	Go to **Step 3**
3	Visually inspect the tire and wheel assemblies, steering components and suspension components for any possible faults. Are the tire and wheel assemblies, steering components and suspension components in good working condition?	Go to **Step 5**	Go to **Step 4**
4	**NOTE:** **Do NOT operate the vehicle until the faults are**	Go to **Step 5**	Go to **Step 3**

Step	Action	Yes	No
	corrected. Correct the faults with the tire and wheel assemblies, steering components, and/or the suspension components before proceeding .Did you correct the faults with the tire and wheel assemblies, steering components, and/or the suspension components?		
5	1. Obtain the drive axle final drive ratio. 2. If the **J-38792-VS** Vibrate Software , IS available, obtain the transmission gear ratios. 3. If the **J-38792-VS** Vibrate Software is NOT available, take note of the tire size on each axle, then calculate the tire rotational speed for each size tire used. Refer to **Component Rotational Speed Calculation**. Did you obtain the powertrain ratios for use with the **J-38792-VS** Vibrate Software , or calculate the component rotational speeds, if **J-38792-VS** Vibrate Software is NOT available?	Go to **Step 6**	-
6	1. Install a scan tool. 2. With the scan tool, bring up the Powertrain Control Module data list and select Engine Speed. Is the scan tool operating properly?	Go to **Step 7**	**Diagnostic Starting Point - Vehicle**
7	Using the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) , is the preferred method for gathering necessary vibration frequency data. If the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) is not available, the necessary vibration frequency data will have to be obtained based on symptoms observed during testing. Review **Symptoms - Vibration Diagnosis and Correction** to become familiar with the possible frequency ranges. Review Symptoms - Vibration Diagnosis and Correction, as necessary throughout the remainder of diagnostics. Is the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) available for use?	Go to **Step 8**	Go to **Step 9**
8	Install the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2). Is the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) operating properly?	Go to **Step 9**	Go to **Electronic Vibration Analyzer (EVA) Description and Operation**
9	Did the customer concern indicate that the vibration occurs ONLY while the vehicle is standing still?	Go to **Vibration Analysis - Engine**	Go to **Step 10**
10	1. Install the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) sensor, if available, to the component identified by the customer as most	Go to **Step 11**	Go to **Vibration Diagnostic Aids**

Step	Action	Yes	No
	respondent to the vibration. If no component was identified, install the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) sensor, if available, to the steering column. You may have to move the sensor to other locations later. 2. Select a smooth, level road and slowly accelerate the vehicle up to highway speed. 3. Observe the vehicle for disturbances that match the customer's description and note the following conditions: • The vehicle speed • The engine RPM • The transmission gear range and the specific gear • The vibration frequency reading, if detected by the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) • The feel and/or sound of the disturbance 4. If the vibration seems to excite a particular component of the vehicle more than the steering column, then move the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) sensor, if available, onto that component and repeat steps 2 and 3. Were you able to duplicate the customer's concern?		
11	1. Accelerate the vehicle to a speed higher than the speed at which the disturbance occurs. **NOTE:** **If the vehicle is equipped with an automatic transmission, let the vehicle coast to a stop before shifting back into gear.** 2. Shift the vehicle into NEUTRAL and allow the vehicle to coast down through the disturbance range. Does the disturbance still occur while coasting-down in NEUTRAL?	Go to **Step 13**	Go to **Step 12**

Step	Action	Yes	No
12	1. Select a smooth, level road and slowly accelerate the vehicle up to the speed at which the disturbance occurs. 2. Decelerate and safely downshift by one gear range. 3. Operate the vehicle at the same VEHICLE SPEED at which the disturbance occurs. Does the same disturbance still occur while going the same vehicle speed in a lower gear range?	Go to **Vibration Analysis - Hub and/or Axle Input**	Go to **Vibration Analysis - Engine**
13	If the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) is not available, refer to **Symptoms - Vibration Diagnosis and Correction**. Did the **J-38792-A** Electronic Vibration Analyzer 2 (EVA 2) detect a dominant frequency?	Go to **Step 14**	Go to **Symptoms - Vibration Diagnosis and Correction**
14	1. If the **J-38792-VS** Vibrate Software IS available, use the drive axle final drive ratio, the specific transmission gear ratio, and the engine RPM to make a comparison to the dominant frequency reading recorded. 2. If the **J-38792-VS** Vibrate Software is NOT available, compare the dominant frequency reading recorded to the component rotational data which you calculated previously. Does the frequency data clearly fall within the tire/wheel parameters ONLY?	Go to **Vibration Analysis - Tire and Wheel**	Go to **Symptoms - Vibration Diagnosis and Correction**

VIBRATION ANALYSIS - ROAD TESTING (CH-51450-NVH OSCILLOSCOPE)

Special Tools

- **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH)
- **EL-47955** Multi Diagnostic Interface (MDI)

For equivalent regional tools, refer to **Special Tools and Equipment**.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

NOTE: **Be certain to OBSERVE for disturbances that match the customers description FIRST, then look at the CH-51450-NVH Oscilloscope Diagnostic Kit (w/NVH) frequency which corresponds with that disturbance.**

10

Proper location of the **CH-51450-NVH** oscilloscope accelerometer onto the component which is most excited by the vibration disturbance is critical to obtaining an accurate frequency reading.

This test will duplicate virtually any disturbance which occurs while the vehicle is in motion.

11

Accelerate to a speed high enough above the speed of the disturbance to allow for the time needed to shift into NEUTRAL and for the engine to decrease in RPM to idle speed before coasting down through the disturbance range.

12

This test will either eliminate or confirm the engine as a contributing cause of the customer concern.

Step	Action	Yes	No
1	Did you review the Diagnostic Starting Point - Vibration Diagnosis?	Go to **Step 2**	Go to **Diagnostic Starting Point - Vehicle**
2	Did the customer concern indicate that the vibration occurs ONLY while the vehicle is standing still?	Go to **Step 6**	Go to **Step 3**
3	Visually inspect the tire and wheel assemblies, steering components and suspension components for any possible faults. Are the tire and wheel assemblies, steering components and suspension components in good working condition?	Go to **Step 5**	Go to **Step 4**
4	**NOTE:** **Do NOT operate the vehicle until the faults are corrected.** Correct the faults with the tire and wheel assemblies, steering components, and/or the suspension components before proceeding.Did you correct the faults with the tire and wheel assemblies, steering components, and/or the suspension components?	Go to **Step 5**	Go to **Step 3**
5	Obtain the drive axle final drive ratio. Did you obtain the drive axle final drive ratio?	Go to **Step 6**	-
6	Install the **CH-51450-NVH** Oscilloscope and the **EL-47955** MDI. Is the **CH-51450-NVH** Oscilloscope operating properly?	Go to **Step 7**	**Oscilloscope Diagnostic Kit Description and Operation**
7	Did the customer concern indicate that the vibration occurs ONLY while the vehicle is standing still?	Go to **Vibration Analysis - Engine**	Go to **Step 8**
8	Did the customer concern indicate that the vibration occurs ONLY during heavy acceleration at launch?	Go to **Step 9**	Go to **Step 10**
9	1. Install the **CH-51450-NVH-TA183** accelerometer to the pinion area of the drive axle. Route the accelerometer cable clear of rotating parts and loosely secure the wire clear of moving parts. If it	Go to **Vibration Analysis - Hub and/or Axle Input**	Go to **Step 10**

Step	Action	Yes	No
	is not possible to install the **CH-51450-NVH-TA183** accelerometer to the drive axle, install the accelerometer to an exposed portion of the floor panel or seat track in the area that the customer noted is most respondent to the vibration. 2. Select a smooth, level road. 3. With the vehicle at a stand-still, apply the brake pedal and place the transmission in the lowest forward gear. **NOTE:** **Do not accelerate to the point of causing the drive wheels to squeal, slip, or hop. This would obscure the results of the test.** 4. Release the brake pedal and accelerate aggressively to 32 km/h (20 mph). 5. Observe the vehicle for disturbances that match the customers description and note the following conditions: • The vibration frequency reading, if detected, by the **CH-51450-NVH** Oscilloscope • The feel and/or sound of the disturbance 6. If a reading could not be obtained by the **CH-51450-NVH** Oscilloscope, move the **CH-51450-NVH-TA183** accelerometer to another part that is respondent to the vibration and repeat Steps 3-5. Were you able to duplicate the customer concern?		
10	1. Install the **CH-51450-NVH-TA183** accelerometer to the component identified by the customer as most respondent to the vibration. If no component was identified, install the **CH-51450-NVH-TA183** accelerometer to the drivers side right seat rail. You may have to move the sensor to other locations later. 2. Select a smooth, level road and slowly accelerate the vehicle up to highway speed.	Go to **Step 11**	Go to **Vibration Diagnostic Aids**

Step	Action	Yes	No
	3. Observe the vehicle for disturbances that match the customers description and note the following conditions or take a snapshot using the **CH-51450-NVH** software: • The vehicle speed • The engine RPM • The transmission gear range and the specific gear • The vibration frequency reading, if detected, by the **CH-51450-NVH** Oscilloscope • The feel and/or the sound of the disturbance 4. If the vibration seems to excite a particular component of the vehicle more than the sear rail, move the **CH-51450-NVH-TA183** accelerometer onto that component and repeat Steps 2 and 3. Were you able to duplicate the customer concern?		
11	1. Accelerate the vehicle to a speed higher than the speed at which the disturbance occurs. **NOTE:** **If the vehicle is equipped with a continuously variable type automatic transmission, let the vehicle coast to a stop before shifting back into gear.** 2. Shift the vehicle into NEUTRAL and allow the vehicle to coast down through the disturbance range. Does the disturbance still occur while coasting down in NEUTRAL?	Go to **Step 13**	Go to **Step 12**

Step	Action	Yes	No
12	1. Select a smooth, level road and slowly accelerate the vehicle up to the speed at which the disturbance occurs. 2. Decelerate and safely downshift by one gear range. 3. Operate the vehicle at the same VEHICLE SPEED at which the disturbance occurs. Does the same disturbance still occur while going the same vehicle speed in a lower gear range?	Go to **Vibration Analysis - Hub and/or Axle Input**	Go to **Vibration Analysis - Engine**
13	If the **CH-51450-NVH** Oscilloscope is not available, refer to **Symptoms - Vibration Diagnosis and Correction**. Did the **CH-51450-NVH** Oscilloscope detect a dominant frequency?	Go to **Step 14**	Go to **Symptoms - Vibration Diagnosis and Correction**
14	Does the frequency data clearly fall within the tire/wheel parameters ONLY?	Go to **Vibration Analysis - Tire and Wheel**	Go to **Symptoms - Vibration Diagnosis and Correction**

COMPONENT ROTATIONAL SPEED CALCULATION

Special Tools

- **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH)
- **EL-38792-A** Electronic Vibration Analyzer (EVA) 2
- **EL-47955** Multi Diagnostic Interface (MDI)

For equivalent regional tools, refer to **Special Tools and Equipment**.

NOTE: **If using the CH-51450-NVH Oscilloscope Diagnostic Kit (w/NVH) , the component rotation is integrated into the tool. The diameter of the pulley will need to be measured and manually entered into the NVH software.**

Tire Rotational Speed

Determining Tire Revolutions Per Second at 8 km/h (5 mph) - Using EVA

Tire and wheel assembly rotational speed can be obtained through using the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2. Perform the following steps using the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 to obtain the rotational speed at 8 km/h (5 mph). Use the Enter key to advance and the Exit key to backup.

1. On the Main Menu screen, select Auto Mode.
2. On the Suspected Source screen, select Vehicle Speed.
3. On the Tire Info Source screen, select Manual Entry.
4. On the Tire Width screen, enter the specific width of the tires.

   For example: For a P245/45/R18 tire, enter 245.

5. On the Aspect Ratio screen, enter the specific aspect ratio of the tires.

For example: For a P245/45/R18 tire, enter 0.45.

6. On the Rim Diameter screen, enter the specific rim diameter size.

   For example: For a P245/45/R18 tire, enter 18.0.

7. On the Driveshaft Configuration screen, enter FWD, even if the vehicle is a rear wheel drive.
8. The next screen will display the tire size just entered for confirmation.

   For example: 245 0.45 18.0 -Front Wheel Drive. If the tire size displayed is correct, press Enter.

9. On the Vehicle Speed Units screen, press Enter, disregard mph or km/h.
10. Press the Exit key several times slowly while watching the backwards progression of the screens. Stop at the Tire Info Source screen.
11. On the Tire Info Source screen, select RPS at 5 mph.
12. The next screen will display the revolutions per second (RPS) at 8 km/h (5 mph) for that specific tire size.

    For example: The P245/45/R18 will display 1.08 RPS.

Calculating Tire Revolutions Per Second at 8 km/h (5 mph) - Without Ocilloscope or EVA

If the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 is not available, the tire and wheel assembly rotational speed can be calculated approximately by performing the following steps.

1. Convert the rim diameter size from inches to centimeters.

   For example: For a P245/45/R18 tire, the rim diameter of 18 in X 2.54 converts to 45.72 cm.

2. Calculate the radius of the rim by dividing the rim diameter by 2.

   For example: For a P245/45/R18 tire, the rim diameter of 18 is converted to 45.72 cm divided by 2 = rim radius 22.86 cm.

3. Calculate the approximate tire sidewall height by multiplying the specific tire tread width by the aspect ratio, then reduce 7 percent from the amount by multiplying by 93 percent to approximate load on the tire reducing the sidewall height.

   For example: For a P245/45/R18 tire, tread width 245 mm X aspect ratio as a decimal 0.45 = 110 mm X 0.93 = approximate sidewall height 102.30 mm.

4. Convert the calculated approximate tire sidewall height from millimeters to centimeters.

   For example: For a P245/45/R18 tire, approximate sidewall height 102.30 mm converts to 10.23 cm.

5. Calculate the approximate tire and wheel assembly radius by adding the rim radius and approximate sidewall height, both in cm.

   For example: For a P245/45/R18 tire, rim radius 22.86 cm + 10.23 cm = approximate tire and wheel assembly radius 33.09 cm.

6. Calculate the approximate circumference of the tire and wheel assembly by multiplying 2 X pi, or 6.283185 X the approximate tire and wheel assembly radius.

For example: For a P245/45/R18 tire, 6.283185 X approximate tire and wheel assembly radius 33.09 cm = approximate tire and wheel assembly circumference 207.911 cm.

7. Calculate the approximate revolutions per kilometer by dividing the number of cm in 1 km, 100,000 cm by the approximate tire and wheel assembly circumference.

   For example: For a P245/45/R18 tire, 100,000 cm divided by approximate tire and wheel assembly circumference 207.911 cm = approximate revolutions per kilometer 480.975.

8. Calculate the approximate revolutions per second (RPS), or Hz, by dividing the approximate revolutions per kilometer by the number of seconds to travel 1 km at a speed of 8 km per hour, 450 seconds.

   For example: For a P245/45/R18 tire, approximate revolutions per kilometer 480.975 divided by the number of seconds to travel 1 km at a speed of 8 km per hour, 450 seconds = approximate RPS, or Hz 1.069 rounded to 1.07.

Calculating Tire Revolutions Per Second, or Hz at Concern Speed

A size P235/75R15 tire rotates ONE complete revolution per second (RPS), or 1 Hz, at a vehicle speed of 8 km/h (5 mph). This means that at 16 km/h (10 mph), the same tire will make TWO complete revolutions in one second, 2 Hz, and so on.

1. Determine the rotational speed of the tires in revolutions per second (RPS), or Hertz (Hz), at 8 km/h (5 mph), based on the size of the tires. Refer to the preceding Tire Rotational Speed information.

   For example: According to the Tire Rotational Speed information, a P245/45R18 tire makes 1.08 revolutions per second (Hz) at a vehicle speed of 8 km/h (5 mph). This means that for every increment of 8 km/h (5 mph) in vehicle speed, the tire's rotation increases by 1.08 revolutions per second, or Hz.

2. Determine the number of increments of 8 km/h (5 mph) that are present, based on the vehicle speed in km/h (mph) at which the disturbance occurs.

   For example: Assume that a disturbance occurs at a vehicle speed of 96 km/h (60 mph). A speed of 96 km/h (60 mph) has 12 INCREMENTS of 8 km/h (5 mph):

   96 km/h (60 mph) divided by 8 km/h (5 mph) = 12 increments

3. Determine the rotational speed of the tires in revolutions per second, or Hz, at the specific vehicle speed in km/h (mph) at which the disturbance occurs.

   For example: To determine the tire rotational speed at 96 km/h (60 mph), multiply the number of increments of 8 km/h (5 mph) by the revolutions per second, or Hz, for one increment:

   12 increments X 1.08 Hz = 12.96 Hz, rounded to 13 Hz

   NOTE: **If the EL-38792-A Electronic Vibration Analyzer (EVA) 2 is not available, compare the calculated rotational speed to the frequency range associated with the symptoms of the vibration concern. Refer to Symptoms - Vibration Diagnosis and Correction.**

4. Compare the rotational speed of the tires at the specific vehicle speed at which the disturbance occurs, to the dominant frequency recorded on the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 during testing. If the frequencies match, then a first-order disturbance related to the rotation of the tire/wheel assemblies is present.

If the frequencies do not match, then the disturbance may be related to a higher order of tire/wheel assembly rotation.

5. To compute higher order tire/wheel assembly rotation related disturbances, multiply the rotational speed of the tires at the specific vehicle speed at which the disturbance occurs, by the order number:

   13 Hz X 2, for second order = 26 Hz second-order tire/wheel assembly rotation related

   13 Hz X 3, for third order = 39 Hz third-order tire/wheel assembly rotation related

   If any of these computations match the frequency of the disturbance, a disturbance of that particular order, relating to the rotation of the tire/wheel assemblies and/or driveline components, also rotating at the same speed, is present.

Component Rotational Speed Worksheet

Utilize the following worksheet as an aid in calculating the first, second and third order of tire/wheel assembly rotational speed related disturbances that may be present in the vehicle.

If after completing the Tire/Wheel Rotation Worksheet, the frequencies calculated do NOT match the dominant frequency of the disturbance recorded during testing, either recheck the data, or attempt to rematch the figures allowing for 1 1/2 -8 km/h (1-5 mph) of speedometer error.

If the possible tire/wheel assembly rotational speed related frequencies still do not match the dominant frequency of the disturbance, the disturbance is most likely torque/load sensitive.

If after completing the Tire/Wheel Rotation Worksheet, one of the frequencies calculated DOES match the dominant frequency of the disturbance, the disturbance is related to the rotation of that component group - tire/wheel assembly related.

TIRE/WHEEL ROTATION WORKSHEET

Vehicle Information

Complaint Speed: _____ mph Year: _____ Model: _____
Symptom: _____ VIN: _____
Frequency: _____ Engine: _____ Trans: _____
Engine Speed: _____ rpm Tire Size: _____ Axle Ratio: _____ : ___
Gear: _____ TPC Spec: _____

Tire/Wheel Speed

Vibration Occurs at:	[ ]	mph ÷ 8 (km/h) 5 (mph)		=	[ ]	increments of 8 km/h / 5 mph
						Tire/Wheel Speed, RPS (Hz)
8 km/h / 5 mph increments	[ ]	x	[ ] tire RPS * at 8 km/h / 5 mph (from table)	=	[ ]	**1st order**
1st order	[ ]	x 2		=	[ ]	**2nd order**
1st order	[ ]	x 3		=	[ ]	**3rd order**

*RPS revolutions per second; equates to cycles per second (Hz).

Fig. 1: Tire/Wheel Rotation Worksheet
Courtesy of GENERAL MOTORS COMPANY

VIBRATION ANALYSIS - TIRE AND WHEEL

Test Description

The numbers below refer to the step numbers in the diagnostic table:

4

A build-up of foreign material on a tire and wheel assembly and/or a damaged, abnormally or excessively worn tire and wheel assembly could cause a vibration disturbance.

6

Tire and wheel assemblies that exhibit excessive runout when measured while mounted on the vehicle, may or may not be contributing to, or causing a vibration disturbance. On-vehicle runout, if present, could contribute to, or cause a vibration disturbance, but the cause of the on-vehicle runout may not be the tire and wheel assemblies.

7

Tire and wheel assemblies that exhibit excessive runout when measured off of the vehicle could cause a vibration disturbance.

9

Tire and wheel assemblies that exhibit marginal runout-within acceptable limits, but close to the maximum-when measured off of the vehicle could still be contributing to a vibration disturbance, if its mating hub/axle flange also exhibits marginal runout. When the tire and wheel assembly and the hub axle flange are mounted to each other, the combined stack-up of their marginal amounts of runout could combine to produce an excessive amount of runout, which could cause a vibration disturbance.

14

Brake rotors and/or brake drums, if equipped, that exhibit excessive imbalance could contribute to, or possibly cause a vibration disturbance.

15

A hub/axle flange and/or wheel studs that exhibit excessive runout could cause a vibration disturbance.

16

When the tire and wheel assembly and the hub axle flange are mounted to each other, the combined stack-up of their marginal amounts of runout could combine to produce an excessive amount of runout, which could cause a vibration disturbance. Match-mounting or vectoring the tire and wheel assembly to the hub/axle flange will modify the amount of combined runout.

18

Force variation may be present in a tire and wheel assembly that exhibited acceptable balance and runout. Force variation, if present, could contribute to, or cause a vibration disturbance.

20

Vibration disturbances could be affected by, or possibly caused by, components that are susceptible to steering input and/or torque-load input.

22

On-vehicle balancing, or finish-balancing can be used to reduce small amounts of imbalance which may be present as a result of the combined stack-up of the tire and wheel assembly with other components which may exhibit marginal balance.

Step	Action	Yes	No
1	Has the Vibration Analysis - Road Testing table been completed?	Go to **Step 2**	Go to **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)**
2	Based on the Vibration Analysis - Road Testing table, is the concern first-order tire and wheel assembly related?	Go to **Step 4**	Go to **Step 3**

Step	Action	Yes	No
3	Based on the Vibration Analysis - Road Testing table, is the concern second-order, or higher-order tire and wheel assembly related?	Go to **Step 18**	Go to **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)**
4	Visually inspect the tire and wheel assemblies for the following: • Debris build-up, such as packed mud, undercoating, ice/snow buildup, road tar, etc. • Damage, abnormal or excessive wear Refer to **Tire and Wheel Inspection**. Do any of the tire and wheel assemblies exhibit any of the conditions listed?	Go to **Step 5**	Go to **Step 6**
5	1. Remove the debris from the tire and wheel assemblies. 2. Replace the damaged, abnormally or excessively worn wheels or tires as necessary. Did you complete the repair or replacement?	Go to **Step 23**	-
6	Measure the on-vehicle runout of the tire and wheel assemblies. Refer to **Tire and Wheel Assembly Runout Measurement - On-Vehicle**. Does the runout measurement indicate a runout concern?	Go to **Step 7**	Go to **Step 12**
7	Measure the off-vehicle runout of the tire and wheel assemblies. Refer to **Tire and Wheel Assembly Runout Measurement - Off Vehicle**. Does the runout measurement indicate a runout concern?	Go to **Step 19**	Go to **Step 8**
8	Is the vehicle equipped with run-flat tires?	Go to **Step 12**	Go to **Step 9**
9	Are any of the tire and wheel assembly runout measurements marginal; within acceptable limits, but close to the maximum?	Go to **Step 10**	Go to **Step 15**
10	**NOTE:** **Ensure that each tire and wheel assembly that is match-mounted is properly balanced**	Go to **Step 11**	Go to **Step 19**

Step	Action	Yes	No
	before reinstalling to the vehicle. 1. Match-mount the tire-to-wheel for each tire and wheel assembly with marginal runout. Refer to **Tire-to-Wheel Match-Mounting (Vectoring)**. 2. Measure the runout of each match-mounted tire and wheel assembly. Refer to **Tire and Wheel Assembly Runout Measurement - Off Vehicle**. Were you able to significantly reduce the amount of tire and wheel assembly runout?		
11	Re-measure the on-vehicle runout of the tire and wheel assemblies. Refer to **Tire and Wheel Assembly Runout Measurement - On-Vehicle**. Does the measurement indicate a runout concern?	Go to **Step 15**	Go to **Step 23**
12	Inspect the balance of the tire and wheel assemblies. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle**. Are any or the tire and wheel assemblies out of balance?	Go to **Step 13**	Go to **Step 14**
13	Balance the tire and wheel assemblies as necessary. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle**. Were you able to achieve balance?	Go to **Step 23**	Go to **Vibration Diagnostic Aids**
14	1. Inspect the brake rotors and brake drums, if equipped, for damage. 2. Inspect the balance of the brake rotors and brake drums, if equipped. Refer to **Brake Rotor/Drum Balance Inspection**. 3. Replace brake rotors and/or brake drums, if equipped, that are damaged and/or out of balance. Did you find and correct a condition?	Go to **Step 23**	Go to **Step 17**

Step	Action	Yes	No
15	1. Measure the runout of the hub/axle flanges and the wheel studs, if equipped. 2. Inspect the wheel bolts, if equipped, for straightness and damage. 3. Refer to **Hub/Axle Flange and Wheel Stud Runout Inspection**. 4. If the inspection procedure indicates a runout concern, replace the appropriate components: • Wheel studs, if equipped • Wheel bolts, if equipped • Wheel bearing/hub assembly Did you find and correct a condition?	Go to **Step 23**	Go to **Step 16**
16	1. Match-mount the tire and wheel assemblies-to-hub/axle flanges. Refer to **Tire and Wheel Assembly-to-Hub/Axle Flange Match-Mounting**. 2. Re-measure the on-vehicle runout of tire and wheel assemblies. Refer to **Tire and Wheel Assembly Runout Measurement - On-Vehicle**. Were you able to significantly reduce the amount of on-vehicle tire and wheel assembly runout?	Go to **Step 23**	Go to **Step 2**
17	Inspect for radial and lateral force variation. Refer to **Tire and Wheel Assembly Isolation Test**. Were you able to isolate one or more of the tire and wheel assemblies as the cause of the disturbance?	Go to **Step 19**	Go to **Step 20**
18	Inspect for radial and lateral force variation. Refer to **Tire and Wheel Assembly Isolation Test**. Were you able to isolate one or more of the tire and wheel assemblies as the cause of the disturbance?	Go to **Step 19**	Go to **Step 21**
19	Replace any tires and/or wheels that were isolated as the cause of the disturbance, as necessary. Did you complete the replacement?	Go to **Step 23**	-
20	Perform the Vibration Analysis - Hub/Axle Input table. Refer to **Vibration Analysis - Hub and/or Axle Input**. Did you find and correct a condition?	Go to **Step 23**	Go to **Step 22**
21	Perform the Vibration Analysis - Hub/Axle Input table. Refer to **Vibration Analysis - Hub and/or Axle Input**. Did you find and correct a condition?	Go to **Step 23**	Go to **Vibration Diagnostic Aids**
22	Finish-balance the tire and wheel assemblies on-vehicle. Refer to **Tire and Wheel Assembly Balancing - On-Vehicle**. Did you complete the on-vehicle finish balancing?	Go to **Step 23**	-

Step	Action	Yes	No
23	1. Install or connect any components that were removed or disconnected during diagnosis. 2. Perform the Vibration Analysis - Road Testing table. Refer to **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)**. Is the vibration still present?	Go to **Step 2**	System OK

VIBRATION ANALYSIS - HUB AND/OR AXLE INPUT

Test Description

The numbers below refer to the step numbers on the diagnostic table:

2

This test will determine the effect of turning input on the vibration.

6

This test will determine the effect of an initial heavy torque load on the vibration.

7

Damaged or worn wheel drive shafts may cause a noise or vibration that may be transferred into the passenger compartment.

8

Damaged or worn wheel bearings may cause a noise or vibration that may be transferred into the passenger compartment.

9

Damaged or worn suspension components may cause a noise or vibration that may be transferred into the passenger compartment.

10

Damaged or worn powertrain mounts and/or exhaust mounts may cause a noise or vibration that may be transferred into the passenger compartment.

11

Incorrect trim height may cause binding and/or interference between components that may produce a vibration.

Step	Action	Yes	No
WARNING:			

Step	Action	Yes	No
Refer to Road Test Warning .			
1	Has the Vibration Analysis - Road Testing table been completed?	Go to **Step 2**	Go to **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)**
2	1. Operate the vehicle at the speed of the vibration concern. 2. While maintaining the concern speed, drive the vehicle through slow, sweeping turns - first in one direction, then in the other direction. 3. Observe the vehicle for changes in the vibration disturbance. 4. Select a smooth, level surface, such as an empty parking lot or a remote road. 5. While maintaining the vehicle at the concern speed if possible, drive the vehicle through sharp turns; 360 degrees - first in one direction, then in the other direction. 6. Observe the vehicle for changes in the vibration disturbance. Did the characteristics of the vibration change significantly-become worse or go away-during these steps?	Go to **Step 3**	Go to **Step 6**
3	Did you hear a clicking noise and/or feel a shudder during these steps?	Go to **Step 7**	Go to **Step 4**
4	Did you hear a growling noise during these steps?	Go to **Step 8**	Go to **Step 5**
5	Did you hear a popping noise during these steps?	Go to **Step 9**	Go to **Step 12**
6	1. With the vehicle at a stand-still, apply the regular brake and place the transmission in the lowest forward gear. **NOTE:** **Do not accelerate to the point of causing the drive wheels to squeal, slip or hop-**	Go to **Step 7**	Go to **Vibration Diagnostic Aids**

Step	Action	Yes	No
	this would obscure the results of the test. 2. Release the regular brakes and accelerate aggressively to 32 km/h (20 mph). 3. Observe the vehicle for changes in the vibration disturbance. Did you feel a shudder or shaking during these steps?		
7	1. Inspect the wheel drive shafts, if equipped, for damage, abnormal and/or excessive wear. 2. If the inspection indicated that a wheel drive shaft is damaged, abnormally and/or excessively worn, replace the shaft. Did you find and correct a condition?	Go to **Step 12**	Go to **Step 9**
8	1. Inspect the wheel bearings for wear and/or damage. 2. Replace any of the wheel bearings found to be worn and/or damaged. Did you find and correct a condition?	Go to **Step 12**	Go to **Vibration Diagnostic Aids**
9	1. Inspect the following suspension components for wear, damage, looseness and/or possible contact with other vehicle components: • Struts/shock absorbers • Springs • Bushings • Insulators 2. Replace any of the suspension components found to be worn, damaged, loose and/or contacting other vehicle components. Did you find and correct a condition?	Go to **Step 12**	Go to **Step 10**
10	1. Inspect the powertrain mounts-engine, transmission, transfer case, and direct-mount differential, if equipped-and any powertrain braces for the following conditions: • Loose and/or missing fasteners • Improper alignment • Cracked, dry-rotted, and/or oil-soaked insulators • Twisted, broken, torn, and/or collapsed insulators	Go to **Step 12**	Go to **Step 11**

Step	Action	Yes	No
	• Bent, twisted, and/or deformed brackets 2. Replace powertrain mounts as necessary. 3. Inspect the exhaust system components for the following: • Loose and/or missing fasteners • Heat Shields • Joints and/or couplings: Nuts, bolts, studs, clamps, straps • Bracket and/or insulator mounting • Inadequate clearance to body and/or chassis components Inspect with the exhaust system both COLD and HOT; in NEUTRAL, FORWARD and REVERSE gears • Improper alignment • Disconnected and/or missing insulators • Cracked, dry-rotted, and/or oil-soaked insulators • Stretched, twisted, broken, torn, and/or collapsed insulators • Bent, twisted, cracked, and/or deformed brackets 4. Repair, replace, and/or realign exhaust system components as necessary. Did you find and correct a condition?		
11	Inspect the vehicle trim height and adjust as necessary. Refer to **Trim Height Inspection** . Did you find and correct a condition?	Go to **Step 12**	Go to **Vibration Diagnostic Aids**
12	1. Install or connect any components that were removed or disconnected during diagnosis. 2. Perform the Vibration Analysis - Road Testing table. Refer to **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)**. Is the vibration still present?	Go to **Step 2**	System OK

VIBRATION ANALYSIS - ENGINE

Test Description

The numbers below refer to the step numbers on the diagnostic table.

2

If powertrain related DTCs are present, there may be a powertrain performance condition present which could be a contributing cause to the customer's concern.

5

Making comparisons of the customer's vehicle with an equally equipped, same model year and type, KNOWN GOOD vehicle will help determine if certain disturbances may be characteristic of a vehicle design.

Step	Action	Yes	No
WARNING: **Refer to Work Stall Test Warning .**			
1	Has the Vibration Analysis - Road Testing table been completed?	Go to **Step 2**	Go to **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)**
2	Using a scan tool, determine if any DTCs are set. Were any DTCs set?	Go to **Vibration Diagnosis, Starting Point, and Correction**	Go to **Step 3**
3	1. Block the front wheels. 2. Apply BOTH the service brakes and the park brake. 3. With the scan tool and the **J-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available, still installed, start the engine. 4. Place the transmission in NEUTRAL or PARK. 5. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 6. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the **J-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available. 7. Place the transmission in DRIVE. 8. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 9. Record the engine RPM obtained on the	Go to **Step 4**	Go to **Vibration Diagnostic Aids**

Step	Action	Yes	No
	scan tool and the most dominant frequency reading if obtained on the **J-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available. 10. If no frequency data was obtained, or if the **J-38792-A** Electronic Vibration Analyzer (EVA) 2 , is not available, place the transmission into REVERSE, then repeat steps 8 and 9. Reverse-loading of the powertrain may increase or change the characteristics of the vibration. Were you able to duplicate the customer's concern?		
4	Did the **J-38792-A** Electronic Vibration Analyzer (EVA) 2 detect a dominant frequency, or was a significant vibration present?	Go to **Vibration Analysis - Engine/Accessory Isolation**	Go to **Step 5**
5	Compare the test results of the customer's vehicle to the results of the same tests run, at the same engine RPM, on an equally-equipped, same model year and type, KNOWN GOOD vehicle. Refer to **Vehicle-to-Vehicle Diagnostic Comparison**. 1. Install a scan tool into the known good vehicle. 2. Install the **J-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available, into the known good vehicle; place the sensor in exactly the same location as it was placed in the customer's vehicle. 3. Block the front wheels. 4. Apply BOTH the service brakes and the park brake. 5. Start the engine. 6. Place the transmission in NEUTRAL or PARK. 7. Slowly increase the engine RPM to the level at which the disturbance was most noticeable in the customer's vehicle. 8. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the **J-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available. 9. Place the transmission in DRIVE. 10. Slowly increase the engine RPM to the level	Go to **Vibration Diagnostic Aids**	Go to **Vibration Analysis - Engine/Accessory Isolation**

Step	Action	Yes	No
	at which the disturbance was most noticeable in the customer's vehicle. 11. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the **J-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available. 12. If no frequency data was obtained, or if the **J-38792-A** Electronic Vibration Analyzer (EVA) 2 , is not available, place the transmission into REVERSE, then repeat steps 10 and 11. Reverse-loading of the powertrain may increase or change the characteristics of the vibration. Did both of the vehicles exhibit the same characteristics?		

ENGINE ORDER CLASSIFICATION

Engine First Order Classification

1. Convert the engine speed in revolutions per minute (RPM), recorded during duplication of the disturbance into Hertz , revolutions per second (RPS), by dividing the RPM by 60 seconds. Refer to the following example:

   1,200 RPM divided by 60 = 20 Hz (or RPS)

2. Compare the dominant frequency in Hz, recorded during duplication of the disturbance with the engine speed just converted into Hz, to determine if they are related.
3. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine speed, converted into Hz, ARE related, then an engine FIRST ORDER related disturbance is present. Engine first order disturbances are usually related to an imbalanced component. Refer to the Engine Order Related Disturbances table.
4. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine speed, converted into Hz, are NOT related, then determine if the disturbance is related to the engine's firing frequency. Proceed to Engine Firing Frequency Classification.

Engine Firing Frequency Classification

Engine firing frequency is a term used to describe the number of firing pulses (one firing pulse = one cylinder firing) that occur during ONE complete revolution of the crankshaft, multiplied by the number of crankshaft revolutions per second, Hz.

1. Calculate the engine firing frequency.
   - To determine the firing frequency of a 4-stroke engine during ONE complete revolution of the crankshaft, multiply the engine speed, converted into Hz, by HALF of the total number of cylinders in the engine.
   - For example: The engine speed, converted into Hz, was 20 Hz; if the vehicle was equipped with a V8 engine, 4 of the 8 cylinders would actually fire during ONE complete revolution of the crankshaft.

- Multiply the converted engine speed (20 Hz) by 4 cylinders firing.

  20 Hz X 4 = 80 Hz

- The engine firing frequency for a V8 engine at the original engine speed of 1,200 RPM, recorded during duplication of the disturbance, would be 80 Hz.
- In like manner, a 6-cylinder engine would have a firing frequency of 60 Hz at the same engine speed of 1,200 RPM.

  20 Hz X 3 = 60 Hz

2. Compare the dominant frequency in Hz, recorded during duplication of the disturbance with the engine firing frequency in Hz, just calculated, to determine if they are related.
3. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine firing frequency in Hz, just calculated ARE related, then an engine FIRING FREQUENCY related disturbance is present. Engine firing frequency disturbances are usually related to improper isolation of a component. Refer to the Engine Order Related Disturbances table.
4. If the dominant frequency in Hz, recorded during duplication of the disturbance and the engine firing frequency in Hz, just calculated are NOT related, then determine if the disturbance is related to another engine order classification. Proceed to Other Engine Order Classification.

Other Engine Order Classification

1. Multiply the engine speed, converted into Hz, recorded during duplication of the disturbance by different possible order-numbers, other than 1 (first order) or the number used to determine the firing frequency of the engine.
2. Compare the dominant frequency in Hz, recorded during duplication of the disturbance with the other possible engine orders just calculated, to determine if they are related.
3. If the dominant frequency in Hz, recorded during duplication of the disturbance and one of the other engine order frequencies in Hz, just calculated ARE related, then an engine related disturbance of that order is present. If an engine related disturbance is present that is NOT related to first order or firing frequency, then it could be related to an engine driven accessory system. Proceed to Engine Driven Accessories Related to Engine Order.

Engine Driven Accessories Related to Engine Order

Engine driven accessory systems can be related to specific engine orders depending upon the relationship of the accessory pulley diameter to the crankshaft pulley diameter. For example:

- If the crankshaft pulley measured 20 cm (8 in) in diameter and one of the engine driven accessory pulleys measured 10 cm (4 in) in diameter, then that accessory pulley would rotate 2 times for every one rotation of the crankshaft pulley. If that accessory system was not isolated properly, or was not operating properly, it would be identifiable as a 2nd order engine related disturbance.
- In like manner, if an engine driven accessory pulley measured 5 cm (2 in) in diameter, then that accessory pulley would rotate 4 times for every one rotation of the crankshaft pulley. If that accessory system was not isolated properly, or was not operating properly, it would be identifiable as a 4th order engine related disturbance.

Engine driven accessories that contribute to, are excited by, or are the sole cause of a disturbance are usually doing so because of improper isolation that causes a transfer path into the passenger compartment or to another major component of the vehicle body.

Using the **EL-38792-VS** Vibrate Software , accurately measuring the diameters of the accessory pulleys and the crankshaft pulley, and performing the appropriate diagnostic procedures completely will lead to the specific accessory system which is either contributing to, or causing the customer's concern.

Engine Order Related Disturbances

Engine Order	Engine Arrangement						
	L4 W/O Balance Shaft	**L4 With Balance Shaft**	**L5**	**L6**	**60 Degree V6**	**90 Degree V6 With Balance Shaft**	**90 Degree V8**
1/2 Order Torque Sensitive	Abnormal - Likely Single Cylinder Misfire	Abnormal - Likely Single Cylinder Misfire	Abnormal - Likely Single Cylinder Misfire	Abnormal - Likely Single Cylinder Misfire	Abnormal - Likely Single Cylinder Misfire and/or EGR/Fuel Variance	Abnormal - Likely Single Cylinder Misfire and/or EGR/Fuel Variance	Abnormal - Likely Single Cylinder Misfire
1st Order	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance	Abnormal - Likely Component Imbalance
1 1/2 Order Torque Sensitive	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Abnormal - Likely Bank to Bank EGR/Fuel Variance Possible Engine Driven Accessory Related	Abnormal - Likely Bank to Bank EGR/Fuel Variance Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related
2nd Order Non Torque Sensitive	Characteristic of Engine Arrangement - Possible Powertrain Isolation Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Characteristic of Engine Arrangement - Possible Powertrain Isolation Related	Characteristic of Engine Arrangement - Possible Powertrain Isolation Related	Possible Engine Driven Accessory Related
2nd Order Torque Sensitive	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related Possible Engine Driven Accessory Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Abnormal - Likely Bank to Bank EGR/Fuel Variance Possible Engine Driven Accessory Related

Engine Order	Engine Arrangement						
	L4 W/O Balance Shaft	**L4 With Balance Shaft**	**L5**	**L6**	**60 Degree V6**	**90 Degree V6 With Balance Shaft**	**90 Degree V8**
2 1/2 Order Torque Sensitive	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related
3rd Order Torque Sensitive	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related Possible Engine Driven Accessory Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related Possible Engine Driven Accessory Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related
4th Order Torque Sensitive	Characteristic - Minimal Amount - of Engine Arrangement - Possible Powertrain Isolation Related Possible Engine Driven Accessory Related	Characteristic - Minimal Amount - of Engine Arrangement - Possible Powertrain Isolation Related Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Possible Engine Driven Accessory Related	Characteristic - ENGINE FIRING FREQUENCY - Possible Powertrain Isolation Related Possible Engine Driven Accessory Related

VIBRATION ANALYSIS - ENGINE/ACCESSORY ISOLATION

Special Tools

- **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH)
- **EL-38792-A** Electronic Vibration Analyzer (EVA) 2
- **EL-38792-25** Inductive Pickup Timing Light

- **EL-47955** Multi Diagnostic Interface MDI

For equivalent regional tools, refer to **Special Tools and Equipment**.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5

A loose, damaged, misaligned, or defective powertrain insulator and/or bracket may create a transfer path into the passenger compartment.

6

A loose, damaged, misaligned, or defective exhaust system insulator and/or bracket may create a transfer path into the passenger compartment.

7

Incorrectly seated and/or aligned powertrain components and/or exhaust system components may create a transfer path into the passenger compartment.

When loosening powertrain mounts in order to re-bed the powertrain observe the following:

Do not loosen the mount bracket-to-engine bolts/nuts, do not loosen the mount bracket-to-vehicle frame bolts/nuts if mount brackets are used.

Loosen the mount-to-mount bracket bolts/nuts if mount brackets are used, or loosen the mount-to-slotted holes in vehicle frame bolts/nuts if a direct-mount design is used.

8

Non-rotating engine driven accessory component systems can no longer produce a unique disturbance.

9

Non-rotating engine driven accessory components can no longer produce a unique disturbance. If a disturbance is still present, but the characteristics have been altered, it is possible that these component systems are acting as a transfer path for engine firing frequency or a first order engine disturbance.

If a disturbance is still present, but the characteristics have NOT been altered, it is NOT likely that these component systems are acting as a transfer path for engine firing frequency or a first order engine disturbance.

12

If the mark placed on the face of an engine driven accessory pulley seems to stand still while running this test, then that accessory system is either responding to an existing frequency, such as engine firing pulses, or creating a disturbance.

13

A loose, damaged, misaligned, or defective engine driven accessory system insulator and/or bracket may create a transfer path into the passenger compartment.

15

Removing the engine driven accessory and bracket, or brackets from the engine allows a thorough inspection to determine if any conditions are present that may create a transfer path into the passenger compartment.

Step	Action	Yes	No
WARNING: **Refer to** **Work Stall** **Test Warning** **.**			
1	Were you sent here from the Vibration Analysis - Engine table?	Go to **Step 2**	Go to **Vibration Analysis - Engine**
2	Is the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , available?	Go to **Step 3**	Go to **Step 5**
3	1. Using the engine RPM and frequency data recorded for the customer's vehicle, determine the order of engine rotation to which the disturbance is related. 2. Determine the possible causes of the disturbance as it relates to a specific order of engine rotation. Refer to **Engine Order Classification**.Does the Engine Order Classification table indicate that the disturbance is of the same order as the engine firing frequency?	Go to **Step 5**	Go to **Step 4**
4	Does the Engine Order Classification table indicate that the disturbance is likely related to engine driven accessories?	Go to **Step 8**	Go to **Step 5**
5	Inspect the powertrain mounts-engine, transmission, transfer case, and direct-mount drive axle, if equipped-and any powertrain braces for the following conditions: • Loose and/or missing fasteners • Improper alignment • Cracked, dry-rotted, and/or oil-soaked insulators • Twisted, broken, torn, and/or collapsed insulators • Bent, twisted, and/or deformed brackets Realign or replace powertrain mounts as indicated by the inspection. Did you find and correct a condition?	Go to **Step 15**	Go to **Step 6**

6	Inspect the exhaust system components for the following:
	• Loose and/or missing fasteners
	  • Heat Shields
	  • Joints and/or couplings:
		Go to **Step 15**	Go to **Step 7**

Step	Action	Yes	No
	Nuts, bolts, studs, clamps, straps • Bracket and/or insulator mounting • Inadequate clearance to body and/or chassis components Inspect with the exhaust system both COLD and HOT; in NEUTRAL, FORWARD and REVERSE gears • Improper alignment • Disconnected and/or missing insulators • Cracked, dry-rotted, and/or oil-soaked insulators • Stretched, twisted, broken, torn, and/or collapsed insulators • Bent, twisted, cracked, and/or deformed brackets Repair, replace, and/or realign exhaust system components as indicated by the inspection. Did you find and correct a condition?		
7	Perform the Powertrain Mount Balance Procedure if available or perform the following procedure to re-bed the powertrain: 1. Loosen, but do not remove, all powertrain mounts and exhaust system hangers. 2. Ensure that the exhaust flexible coupling, if equipped, moves freely. 3. Start the engine. 4. Settle the powertrain by shifting the transmission from DRIVE to REVERSE. 5. Place the transmission into NEUTRAL. 6. Turn OFF the ignition. 7. Tighten all of the loosened fasteners with the powertrain in a relaxed position. Did you complete the operation?	Go to **Step 15**	-
8	**CAUTION:** **Do not run the engine for longer than 60 seconds with the accessory**	Go to **Step 10**	Go to **Step 9**

Step	Action	Yes	No
	drive belt, or belts removed, or overheating and/or damage may result. 1. Remove the engine accessory drive belt, or belts. 2. Block the front wheels. 3. Apply BOTH the service brakes and the park brake. 4. With the scan tool still installed, start the engine. 5. Place the transmission in NEUTRAL or PARK. 6. Increase the engine RPM to the level recorded during duplication of the disturbance. 7. Allow the engine to idle, then place the transmission in DRIVE. 8. Increase the engine RPM to the level recorded during duplication of the disturbance. 9. Turn OFF the ignition. 10. Install the engine accessory drive belt, or belts. Was the disturbance significantly reduced or eliminated?		
9	Were the characteristics of the disturbance altered but still present?	Go to **Step 13**	Go to **Step 17**
10	Is the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) being used for diagnosis?	Go to **Step 11**	Go to **Step 12**
11	1. Measure the diameter of the suspected accessory pulleys, including any related idler pulleys, and enter this information into the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH). 2. Block the front wheels. 3. Apply BOTH the service brakes and the park brake. 4. With the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) and the **EL-47955** Multi Diagnostic Interface MDI still installed, start the engine. 5. Have an assistant place the transmission in NEUTRAL or PARK. 6. Slowly increase the engine RPM to the level recorded during the duplication of the disturbance, then maintain that speed. The frequency of the suspected pulleys will show up on the Record and Analyze tab within the software. 7. Turn OFF the engine.	Go to **Step 13**	Go to **Vibration Diagnostic Aids**

Step	Action	Yes	No
	Did you identify an engine driven accessory system as being related to the disturbance?		
12	1. Mark the face of the suspected accessory pulleys, including any related idler pulleys, near the outer edge with a paint mark. 2. Install the **EN-38792-25** Inductive Pickup Timing Light , to the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2. For information on the use of the EVA features, refer to **Electronic Vibration Analyzer (EVA) Description and Operation**. 3. Block the front wheels. 4. Apply BOTH the service brakes and the park brake. 5. With the scan tool and the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , still installed, start the engine. 6. Select the Smart Strobe feature on the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2. 7. Enter the recorded frequency of the disturbance as the initial frequency for strobe operation. 8. Have an assistant place the transmission in NEUTRAL or PARK. 9. Slowly increase the engine RPM to the level recorded during duplication of the disturbance, then maintain that speed. 10. Using the **EL-38792-A** Inductive Pickup Timing Light , check each of the suspected accessory pulleys to determine if any of them is related to the frequency of the disturbance. Check each of the accessory systems, both engaged and under maximum load and disengaged or under minimum load. 11. Allow the engine to idle, then place the transmission in DRIVE. 12. Slowly increase the engine RPM to the level recorded during duplication of the disturbance, then maintain that speed closely. 13. Using the **EL-38792-25** Inductive Pickup Timing Light , check each of the suspected accessory pulleys to determine if any of them is related to the frequency of the disturbance. Check each of the accessory systems, both engaged	Go to **Step 13**	Go to **Vibration Diagnostic Aids**

Step	Action	Yes	No
	and under maximum load and disengaged or under minimum load. 14. Turn OFF the ignition. Did you identify an engine driven accessory system as being related to the frequency of the disturbance?		

13	Inspect the components of the engine driven accessory system for the following:
	
	• Loose and/or missing fasteners
	  • Heat Shields, if equipped
	  • Joints and/or couplings:
	
	  Nuts, bolts, studs, clamps, straps
	
	  • Bracket and/or insulator mounting
	• Inadequate clearance to body and/or chassis components
	
	Inspect with the accessory system both under a LOAD and NOT loaded
	
	• Improper alignment
	• Bent or damaged pulleys
	• Disconnected and/or missing insulators
	• Cracked, dry-rotted, and/or oil-soaked component insulators
	• Stretched, twisted, broken, torn, and/or collapsed component insulators
	• Bent, twisted, cracked and/or deformed component brackets
	
	Repair, replace, and/or realign the engine driven accessory system components as indicated by the inspection.
	Did you find and correct a condition?
		Go to **Step 15**	Go to **Step 14**

Step	Action	Yes	No
14	1. Remove the engine driven accessory and bracket, or brackets from the engine. 2. Thoroughly inspect the accessory bracket, or brackets, bolts/nuts/studs, and the accessory itself for signs of the following: Bent, twisted, cracked and/or deformed conditions 3. Replace any of the components found to exhibit any of these conditions. 4. Reinstall the components to the engine. Did you find and correct a condition?	Go to **Step 15**	Go to **Step 19**
15	Check the vehicle to determine if the disturbance is now significantly reduced or eliminated. Perform the following steps: 1. Install a scan tool into the customer's vehicle. 2. Install the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available, into the customer's vehicle; place the sensor in exactly the same location as it was originally placed in the vehicle. 3. Block the front wheels. 4. Apply BOTH the service brakes and the park brake. 5. Start the engine. 6. Place the transmission in NEUTRAL or PARK. 7. Slowly increase the engine RPM to the level at which the disturbance was most noticeable. 8. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available. 9. Place the transmission in DRIVE. 10. Slowly increase the engine RPM to the level at which the disturbance was most noticeable. 11. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available. 12. If the disturbance has been significantly reduced or	Go to **Step 20**	Go to **Step 16**

Step	Action	Yes	No
	eliminated, confirm the results by placing the transmission into REVERSE, then repeat steps 10 and 11. Reverse-loading of the powertrain may increase or change the characteristics of the vibration. Has the disturbance been significantly reduced or eliminated?		
16	Have you investigated powertrain isolation as a possible cause of the disturbance?	Go to **Step 17**	Go to **Step 5**
17	Have you investigated engine driven accessories as a possible cause of the disturbance?	Go to **Vibration Analysis - Engine Balance**	Go to **Step 18**
18	Is the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 available?	Go to **Step 8**	Go to **Vibration Diagnostic Aids**
19	Replace the engine driven accessory component causing the disturbance. Did you complete the replacement?	Go to **Step 20**	-
20	1. Install or connect any components that were removed or disconnected during diagnosis. 2. Perform the Vibration Analysis - Road Testing table. Refer to **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)**. Is the disturbance still present?	Go to **Step 2**	System OK

VIBRATION ANALYSIS - ENGINE BALANCE

Special Tools

- **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH)
- **EL-38792-A** Electronic Vibration Analyzer (EVA) 2
- **EL-47955** Multi Diagnostic Interface MDI

For equivalent regional tools, refer to **Special Tools and Equipment**.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

4

If sufficient clearance exists to separate the transmission torque converter from the engine flywheel/flexplate, then further tests can be used to isolate the transmission from the engine.

5

An engine flywheel/flexplate that has excessive lateral runout, when combined with the mass of the transmission torque converter, can produce a disturbance.

6

An engine flywheel/flexplate that is loose at the engine crankshaft or that is cracked or damaged, when combined with the mass of the transmission torque converter, can produce a disturbance.

7

This step is designed to isolate the transmission from the engine to determine if the disturbance is related to the engine ONLY.

9

Re-indexing the transmission torque converter to the engine flywheel/flexplate alters the balance relationship between the torque converter and the rear of the engine.

11

Placing the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 sensor onto the underside of the engine oil pan along the FRONT and the REAR edge allows for a determination to be made, which will help to narrow down the cause of the disturbance.

13

An engine flywheel that has excessive lateral runout, when combined with the extra mass of the clutch pressure plate and clutch driven plate, can produce a disturbance.

14

The clutch pressure plate and the engine flywheel are marked for proper indexing of the heavy-spot of one to the light-spot of the other. Improper indexing of the pressure plate to the flywheel can produce a disturbance.

15

An engine flywheel that is loose at the engine crankshaft or that is cracked, damaged and/or missing balance weights; and/or a clutch pressure plate and clutch driven plate that has loose springs, cracks, warpage, damage and/or missing balance weights - can produce a disturbance when their mass is combined.

16

An engine flywheel that is loose at the engine crankshaft or that is cracked, damaged and/or missing balance weights; and/or a clutch pressure plate and clutch driven plate that has loose springs, cracks, warpage, damage and/or missing balance weights - can produce a disturbance when their mass is combined.

17

Re-indexing the pressure plate to the engine flywheel alters the balance relationship between the pressure plate/flywheel assembly and the rear of the engine.

18

An engine flywheel/flexplate that is damaged, misaligned, and/or imbalanced, can produce a disturbance.

19

An engine crankshaft balancer that is damaged, misaligned, and/or imbalanced, can produce a disturbance.

Step	Action	Yes	No
1	Were you sent here from the Vibration Analysis - Engine/Accessory Isolation table?	Go to **Step 2**	Go to **Vibration Analysis - Engine/Accessory Isolation**
2	Is the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , available?	Go to **Step 3**	Go to **Vibration Diagnostic Aids**
3	Is the vehicle equipped with a manual transmission?	Go to **Step 11**	Go to **Step 4**
4	1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the flywheel/flexplate-to-torque converter bolts access cover, if equipped. 3. Determine if sufficient clearance exists to separate the transmission torque converter away from the engine flywheel/flexplate and safely secure the torque converter from accidentally engaging with the flywheel/flexplate. Is there sufficient clearance to separate and safely secure the transmission torque converter away from the engine flywheel/flexplate?	Go to **Step 5**	Go to **Step 11**

Step	Action	Yes	No
5	1. With the flywheel/flexplate-to-torque converter access cover still removed, and with the vehicle still raised, mark the position of the transmission torque converter in relation to the engine flywheel/flexplate. 2. Disconnect the torque converter and move it away from the flywheel/flexplate. 3. Secure the transmission torque converter away from the engine flywheel/flexplate to avoid accidental engagement with the flywheel/flexplate. 4. Lower the vehicle, start the engine and allow the engine to idle. 5. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 6. Visually inspect the flywheel/flexplate for excessive lateral runout. 7. Lower the vehicle. 8. Turn OFF the ignition. Did the flywheel/flexplate exhibit excessive lateral runout?	Go to **Step 8**	Go to **Step 6**
6	1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Inspect the flywheel/flexplate for the following: • Looseness at the engine crankshaft • Cracks and/or damage • Missing balance weights Did the flywheel/flexplate exhibit any of the conditions listed?	Go to **Step 8**	Go to **Step 7**
7	1. With the transmission torque converter still secured away from the engine flywheel/flexplate to avoid accidental engagement with the flywheel/flexplate, lower the vehicle. 2. Block the front wheels. 3. Apply BOTH the service brakes and the park brake. 4. With the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) and the **EL-47955** Multi Diagnostic Interface MDI or the scan tool and the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 still installed, start the engine. 5. Place the transmission in NEUTRAL or PARK.	Go to **Step 9**	Go to **Step 11**

Step	Action	Yes	No
	6. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 7. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2. 8. Turn OFF the ignition. Has the disturbance been significantly reduced or eliminated?		
8	1. If the flywheel/flexplate is loose at the engine crankshaft, tighten the flywheel/flexplate mounting bolts in sequence and to specification. 2. If the flywheel/flexplate is cracked, damaged, and/or has missing balance weights, replace the damaged flywheel/flexplate. Did you complete the tightening or replacement?	Go to **Step 20**	-

Step	Action	Yes	No
9	1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Re-index the transmission torque converter to the engine flywheel/flexplate, 120 degrees from its original position. 3. Reconnect the transmission torque converter to the engine flywheel/flexplate. 4. Lower the vehicle. 5. Block the front wheels. 6. Apply BOTH the service brakes and the park brake. 7. With the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) and the **EL-47955** Multi Diagnostic Interface MDI or the scan tool and the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 still installed, start the engine. 8. Place the transmission in NEUTRAL or PARK. 9. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 10. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2. 11. If the disturbance is still noticeable, re-index the torque converter again to obtain the least amount of disturbance. Has the disturbance been significantly reduced or eliminated?	Go to **Step 20**	Go to **Step 10**
10	Replace the out-of-balance transmission torque converter. Did you complete the replacement?	Go to **Step 20**	-
11	1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Position the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) accelerometer or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 sensor onto the underside of the engine oil pan, along the FRONT edge. 3. Lower the vehicle. 4. Block the front wheels. 5. Apply BOTH the service brakes and the park brake.	Go to **Step 19**	Go to **Step 12**

Step	Action	Yes	No
	6. With the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) and the **EL-47955** Multi Diagnostic Interface MDI or the scan tool and the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , still installed, start the engine. 7. Place the transmission in NEUTRAL or PARK. 8. Slowly increase the engine RPM to the level at which the disturbance is most noticeable. 9. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 from the underside of the engine oil pan. 10. Repeat steps 1 through 9, placing the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) accelerometer or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 sensor onto the underside of the engine oil pan, along the REAR edge. Is the disturbance greater along the FRONT of the engine?		
12	Is the vehicle equipped with an automatic transmission?	Go to **Step 18**	Go to **Step 13**
13	1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the flywheel inspection cover. 3. Start the engine. Allow the engine to idle. 4. Visually inspect the engine flywheel clutch surface for excessive lateral runout. Does the engine flywheel clutch surface exhibit excessive lateral runout?	Go to **Step 18**	Go to **Step 14**
14	Inspect the clutch pressure plate to engine flywheel mounting for proper factory indexing. Is the clutch pressure plate properly indexed to the engine flywheel?	Go to **Step 16**	Go to **Step 15**
15	1. Remove the clutch pressure plate and clutch driven plate from the engine flywheel. 2. Inspect the engine flywheel for the following: • Looseness at the engine crankshaft • Cracks, warpage and/or damage • Missing balance weights	Go to **Step 18**	Go to **Step 17**

Step	Action	Yes	No
	3. Inspect the clutch pressure plate and clutch driven plate for the following: • Loose and/or damaged clutch driven plate damper springs • Loose and/or damaged clutch pressure plate diaphragm springs • Cracks, warpage and/or damage • Missing balance weights Do any of the above conditions exist?		
16	1. Remove the clutch pressure plate and clutch driven plate from the engine flywheel. 2. Inspect the engine flywheel for the following: • Looseness at the engine crankshaft • Cracks, warpage and/or damage • Missing balance weights 3. Inspect the clutch pressure plate and clutch driven plate for the following: • Loose and/or damaged clutch driven plate damper springs • Loose and/or damaged clutch pressure plate diaphragm springs • Cracks, warpage and/or damage • Missing balance weights Do any of the above conditions exist?	Go to **Step 18**	Go to **Vibration Diagnostic Aids**
17	Re-index the pressure plate to the engine flywheel. Did you complete the re-indexing?	Go to **Step 20**	-
18	Replace the engine flywheel/flexplate. Did you complete the replacement?	Go to **Step 20**	-
19	Replace the engine crankshaft balancer. Did you complete the replacement?	Go to **Step 20**	-
20	Check the vehicle to determine if the disturbance is now significantly reduced or eliminated. Perform the following steps: 1. Install or connect any components that were removed or disconnected during diagnosis. 2. Install a scan tool into the customer's vehicle. 3. Install the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available, into the customer's vehicle; place the sensor in exactly the same location as it was originally placed in the vehicle.	Go to **Step 21**	Go to **Vibration Diagnostic Aids**

Step	Action	Yes	No
	4. Block the front wheels. 5. Apply BOTH the service brakes and the park brake. 6. Start the engine. 7. Place the transmission in NEUTRAL or PARK. 8. Slowly increase the engine RPM to the level at which the disturbance was most noticeable. 9. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available. 10. Place the transmission in DRIVE. 11. Slowly increase the engine RPM to the level at which the disturbance was most noticeable. 12. Record the engine RPM obtained on the scan tool and the most dominant frequency reading if obtained on the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , if available. 13. If the disturbance has been significantly reduced or eliminated, confirm the results by placing the transmission into REVERSE, then repeat steps 11 and 12. Reverse-loading of the powertrain may increase or change the characteristics of the vibration. Has the disturbance been significantly reduced or eliminated?		
21	Perform the Vibration Analysis - Road Testing table. Refer to **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)**. Is the disturbance still present?	Go to **Vibration Diagnostic Aids**	System OK

VIBRATION DIAGNOSTIC AIDS

NOTE: **If you have not reviewed the Diagnostic Starting Point - Vibration Diagnosis and completed the Vibration Analysis tables as indicated, refer to Vibration Diagnosis, Starting Point, and Correction BEFORE proceeding.**

The diagnostic information contained in this Diagnostic Aids section will help you determine the correct course of action to take for the following 4 main conditions. Refer to the appropriate condition from this list:

- Vibration Diagnostic Aids - Vibration Intermittent or Not Duplicated
- Vibration Diagnostic Aids - Vibration Duplicated, Component Not Identified
- Vibration Diagnostic Aids - Vibration Duplicated, Difficult to Isolate/Balance Component
- Vibration Diagnostic Aids - Vibration Duplicated, Appears to Be Potential Operating Characteristic

VIBRATION DIAGNOSTIC AIDS - VIBRATION INTERMITTENT OR NOT DUPLICATED

NOTE: **If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to Vibration Diagnostic Aids BEFORE proceeding.**

If you have not been able to duplicate the vibration concern or have only been able to duplicate the concern intermittently, review the following information.

Most vibration concerns that cannot be duplicated are due to either specific conditions that are not present during the duplicating attempts, or due to not following the procedures designed to duplicate concerns properly and in the sequence indicated.

Specific Conditions Can Affect the Condition

Consider the following conditions which may not have been present while attempts were made to duplicate the vibration concern. Attempt to obtain more specific information from the customer as to the EXACT conditions that are present when they experience the vibration which they are concerned about. Attempt to duplicate the vibration concern again while recreating the EXACT conditions necessary, except those which pose a safety concern or are outside the boundaries of normal operating conditions, such as loading the vehicle beyond its designed weight ratings, etc.

Most attempts to duplicate a vibration concern are made after the vehicle has been driven to the repair facility and perhaps even sat inside the building for a time; the vehicle may be too warm to detect the concern during duplication efforts. The opposite could also occur; perhaps the vehicle has sat out in the cold for a time and fails to reach full operating temperatures during attempts to duplicate the concern.

Temperature, Ground-Out, Accessory Load

Flat Spots on Tires

Tires which have sat and been cool for a time can develop flat spots.

Irregular Wear on Tire Treads

Tires which have sat and been cool for a time will be stiffer and any irregular wear conditions will be more noticeable than they will be once the tires have warmed and softened.

Exhaust System Growth

Exhaust systems may exhibit a ground-out condition when cool which goes away once the system is hot. The opposite may be true that the exhaust system is fine when cool but a ground-out condition occurs once the system reaches operating temperatures. Exhaust systems can grow by 2 1/2 -5 cm (1-2 in) when hot.

Engine-Driven Accessory Noises

NOTE: **When a stethoscope equipped with a probe is used to assist in identifying possible vibrating components, the results must be compared to the sound quality of the**

same accessory, in a equally-equipped, same model year and type, KNOWN GOOD vehicle, and under the same conditions. Refer to Vehicle-to-Vehicle Diagnostic Comparison.

A stethoscope equipped with a probe can be used as an additional means to assist in identifying accessories which may be causing or contributing to a vibration concern.

- Belt Whipping

  An engine accessory drive belt, or belts could exhibit a whipping condition if a belt is deteriorating and deposits are building up on the underside of the belt.

- Loose Mounting Brackets or Component Ground-Out

  Engine-driven accessories such as a generator, a power steering pump, or an air conditioning compressor could exhibit noise conditions due to either loose mounting brackets or due to related components of the system in a ground-out condition during certain operation of that accessory system.

- Cold or Hot

  Accessories could exhibit noise conditions when cool which go away once they are fully warmed-up, or the opposite may be true.

- Load on an Accessory Component

  Accessories could exhibit a noise condition while under a heavy load - perhaps when combined with a cool or fully warmed-up condition.

- Bent or Misaligned Pulleys

  Bent or mis-aligned pulleys in one or more engine-driven accessory systems could contribute to a noise or vibration condition.

- Fluid Level in Accessory Systems

  Accessories could exhibit a noise condition due to an abnormal amount of fluid contained in the system of which the accessory is a part. For example:

  - An improper power steering fluid level could produce noises in the power steering system.
  - An improper air conditioning refrigerant level or an excessive amount of refrigerant oil could produce noises or possibly vibrations in the air conditioning system.

- Incorrect Fluid Type in Accessory Systems

  Accessories could exhibit a noise condition due to the incorrect type of fluid contained in the system of which the accessory is a part.

Vehicle Payload

The vibration concern may only occur when the vehicle is carrying heavy payloads or towing a trailer; the vehicle may have been empty during duplication efforts.

Heavy Payload

The vehicle may have been empty during attempts to duplicate the vibration concern, but the customer may actually experience the vibration concern while the vehicle is carrying a large payload.

Trailer Towing

The customer may experience the vibration concern only while towing a trailer.

Roadway Selection

The selection of roadways used to perform the vibration duplication procedures is likely to be in the near vicinity of the repair facility and may not provide a road surface that is similar enough to the surface on which the customer usually drives the vehicle.

The customer may only experience the vibration on a particular roadway. Perhaps the roadway is overly crowned or is very bumpy or rough.

VIBRATION DIAGNOSTIC AIDS - VIBRATION DUPLICATED, COMPONENT NOT IDENTIFIED

NOTE: **If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to Vibration Diagnostic Aids BEFORE proceeding.**

Aftermarket Add-On Accessories

Aftermarket accessories which have been added to the vehicle can actually transmit and magnify INHERENT component rotational frequencies, if the accessories were not installed correctly.

An accessory should be installed in such a way that it is isolated from becoming a possible transfer path into the rest of the vehicle. For example, if a set of running boards has been installed improperly and they are sensitive to a particular frequency of a rotating component, the running boards could begin to respond to the frequency and actually create a disturbance once the amplitude of the frequency reaches a high enough point , probably at a higher vehicle speed.

If the same set of running boards were installed properly-isolated properly-the transfer path would be removed and the disturbance would no longer be present.

VIBRATION DIAGNOSTIC AIDS - VIBRATION DUPLICATED, DIFFICULT TO ISOLATE/BALANCE COMPONENT

NOTE: **If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to Vibration Diagnostic Aids BEFORE proceeding.**

If you have duplicated the vibration concern but have had difficulty in balancing a component or isolating a component, refer to the following information.

Most vibration concerns are corrected or eliminated through correcting excessive runout of a component, correcting balance of a component or isolating a component which has come into abnormal contact with another object/component.

Components which can generate a lot of energy and are experiencing excessive runout, imbalance or ground-out can produce a vibration with a strong enough amplitude that the vibration can transmit to components which are closely related. This type of a condition is usually related to and sensitive to torque-load. The most likely system that could exhibit this type of a condition is the driveline.

VIBRATION DIAGNOSTIC AIDS - VIBRATION DUPLICATED, APPEARS TO BE POTENTIAL OPERATING CHARACTERISTIC

NOTE: **If you have not completed the Vibration Analysis tables as indicated and reviewed Vibration Diagnostic Aids, refer to Vibration Diagnostic Aids BEFORE proceeding.**

Check Service Bulletins

If BOTH of the following statements are TRUE, then check service bulletins for the condition identified. If the condition has already been identified and investigated prior to this vehicle, and has been determined to be something that is not truly an operating characteristic or that perhaps is not design-intent, there will likely be adjustments or corrections identified which will address the condition.

- You CAREFULLY followed the steps indicated through reviewing the Diagnostic Starting Point - Vibration Diagnosis and completing the Vibration Analysis tables identified and you have duplicated the vibration concern.
- You have come to the conclusion through comparison with a very equally-equipped, same model year and type, KNOWN GOOD vehicle that the customer's concern is a condition that appears to be a potential operating characteristic of the vehicle.

SYMPTOMS - VIBRATION DIAGNOSIS AND CORRECTION

NOTE: **Perform the following steps in sequence BEFORE using these symptom tables.**

1. Begin the diagnosis of a vibration concern by reviewing **Vibration Diagnosis, Starting Point, and Correction** to become familiar with the diagnostic process used to properly diagnose vibration concerns.
2. Perform the **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)** table before using these symptom tables in order to duplicate and effectively diagnose the customer's concern.

Symptom Tables

Refer to a Vibration Analysis table as indicated in the following symptom tables, based on the most dominant characteristic of the customer's vibration concern, felt or heard, that is evident during the appropriate condition of the occurrence.

Vibration Symptoms that are Felt

Category	Description	Typical Frequency Range	Condition of Occurrence	Area of Focus
Shake	Can sometimes be seen or felt in the steering wheel, seat or console. Related terminology: shimmy, wobble, waddle, shudder, hop	5-20 Hz	Vehicle Speed Sensitive Still occurs during coast down in NEUTRAL	Go to **Vibration Analysis - Tire and Wheel**
			Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to **Vibration Analysis - Hub and/or Axle Input**
			Engine Speed Sensitive	Go to **Vibration Analysis - Engine**
Roughness	Similar to the feeling of holding a jigsaw.	20-50 Hz	Vehicle Speed Sensitive Still occurs during coast down in NEUTRAL	Go to **Vibration Analysis - Tire and Wheel**

Category	Description	Typical Frequency Range	Condition of Occurrence	Area of Focus
			Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to **Vibration Analysis - Hub and/or Axle Input**
			Engine Speed Sensitive	Go to **Vibration Analysis - Engine**
Buzz	Similar to the feeling of holding an electric razor. May be felt in the hands through the steering wheel, in the feet through the floor, or in the seat of the pants.	50-100 Hz	Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to **Vibration Analysis - Hub and/or Axle Input**
			Engine Speed Sensitive	Go to **Vibration Analysis - Engine**
Tingling	May produce a "pins and needles" sensation or may put hands or feet "to sleep". Highest vibration frequency range that can still be felt.	Greater than 100 Hz	Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to **Vibration Analysis - Hub and/or Axle Input**
			Engine Speed Sensitive	Go to **Vibration Analysis - Engine**

Vibration Symptoms that are Heard

Category	Description	Typical Frequency Range	Condition of Occurrence	Area of Focus
Boom	Usually heard as an interior noise similar to the noise of a bowling ball rolling down an alley, deep thunder, or a bass drum. • Related terminology- droning, growling, moaning, roaring, rumbling, humming • May not be accompanied by a perceptible vibration or roughness	20-60 Hz	Vehicle Speed Sensitive Still occurs during coast down in NEUTRAL	Go to **Vibration Analysis - Tire and Wheel**
			Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to **Vibration Analysis - Hub and/or Axle Input**
Moan or Drone	Similar to the sound of a bumblebee or blowing air across the top of a bottle. • Related terminology- humming, buzzing, resonance • May be accompanied by a perceptible vibration such as a buzz	60-120 Hz	Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to **Vibration Analysis - Hub and/or Axle Input**
			Engine Speed Sensitive	Go to **Vibration Analysis - Engine**

Category	Description	Typical Frequency Range	Condition of Occurrence	Area of Focus
Howl	Similar to the sound of the wind howling.	120-300 Hz	Vehicle Speed Sensitive Affected by torque/load and/or steering input	Go to **Vibration Analysis - Hub and/or Axle Input**
			Engine Speed Sensitive	Go to **Vibration Analysis - Engine**
Whine	Similar to the sound of mosquitoes, turbine engines, or vacuum cleaners.	300-500 Hz	Vehicle Speed Sensitive Affected by torque/load	Go to transmission diagnostic information

VEHICLE-TO-VEHICLE DIAGNOSTIC COMPARISON

Comparing the customer's vehicle to a KNOWN GOOD vehicle that is essentially identical will help determine if the customer's concern may be characteristic of a vehicle design. To arrive at a valid conclusion, the comparison must be performed under the same conditions, using the same criteria, on a vehicle that has the same option content as the customer's vehicle.

The comparison vehicle must match the customer's vehicle in the following areas:

- Model Year
- Make
- Model
- Body style
- Powertrain configuration
- Driveline configuration
- Final drive ratio
- Tire/wheel size and type
- Suspension package
- Trailering package
- GVW rating
- Performance options
- Luxury options

TIRE AND WHEEL INSPECTION

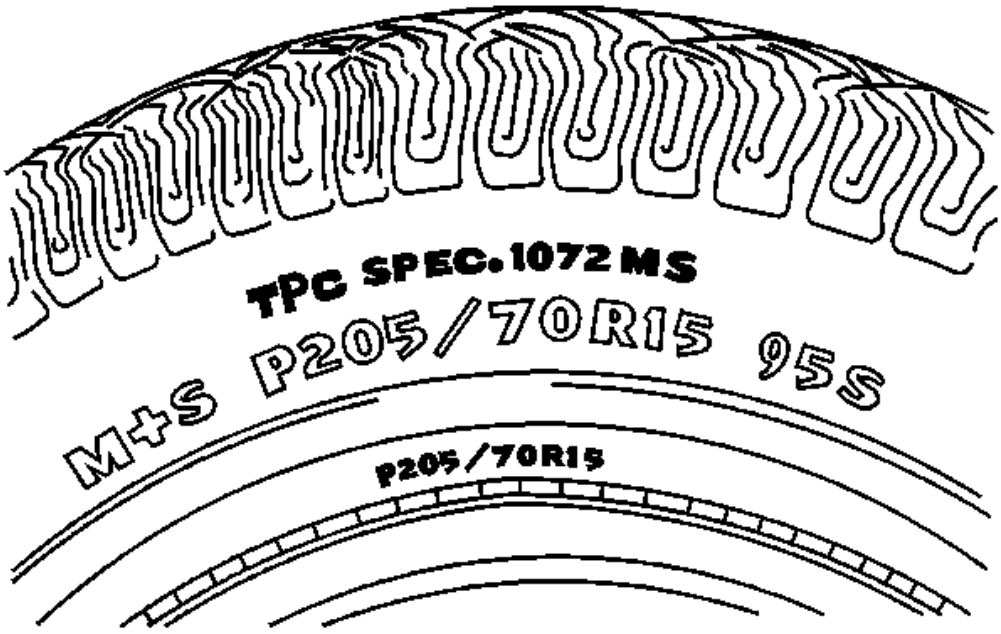


Fig. 2: Identifying Tire Performance Criteria (TPC) Rating Markings
Courtesy of GENERAL MOTORS COMPANY

The tires on all new production models have a tire performance criteria (TPC) rating number molded on the sidewall. The TPC rating will appear as a 4-digit number preceded by the letters TPC SPEC on the tire wall near the tire size. A replacement tire should have the same TPC rating.

Tire Wear

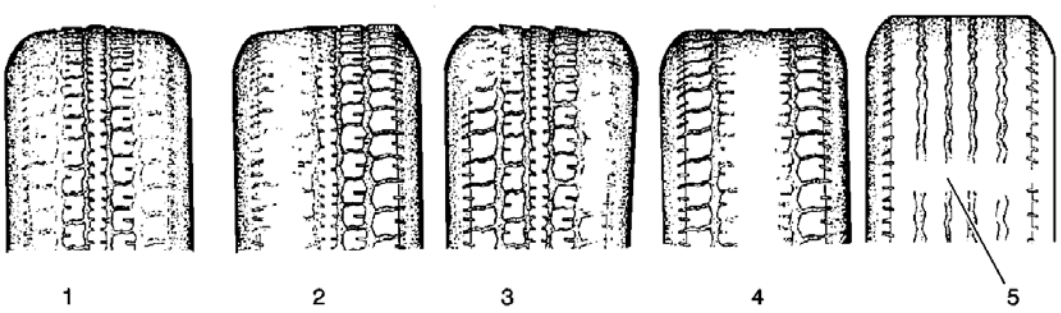


Fig. 3: Identifying Types Of Tire Wear
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Hard Cornering/Underinflation
2	Incorrect Alignment/Lack of Rotation
3	Incorrect Alignment/Non-uniform Tire
4	Heavy Acceleration/Over inflation
5	Wear Indicator

Inspect the tire and wheel assemblies for the following conditions:

- Unusual wear such as cupping, flat spots, and/or heel-and-toe wear

  These conditions can cause tire growl, tire howl, slapping noises, and/or vibrations throughout the vehicle.

- Proper inflation to specifications for the vehicle
- Bulges in the sidewalls

  Do not confuse bulges, which are an abnormal condition, with normal ply splices which are commonly seen as indentations in the sidewall.

- Bent rim flanges

TIRE AND WHEEL ASSEMBLY RUNOUT MEASUREMENT - ON-VEHICLE

1. Raise and support the vehicle.
2. Closely inspect each tire for proper and even bead seating.
3. If any of the tire beads were not properly or evenly seated, reseat the tire bead, then proceed to step 4. Refer to **Tire and Wheel Removal and Installation** .
4. Following the tire inflation placard on the drivers door, inspect and if necessary adjust the tire inflation pressures.

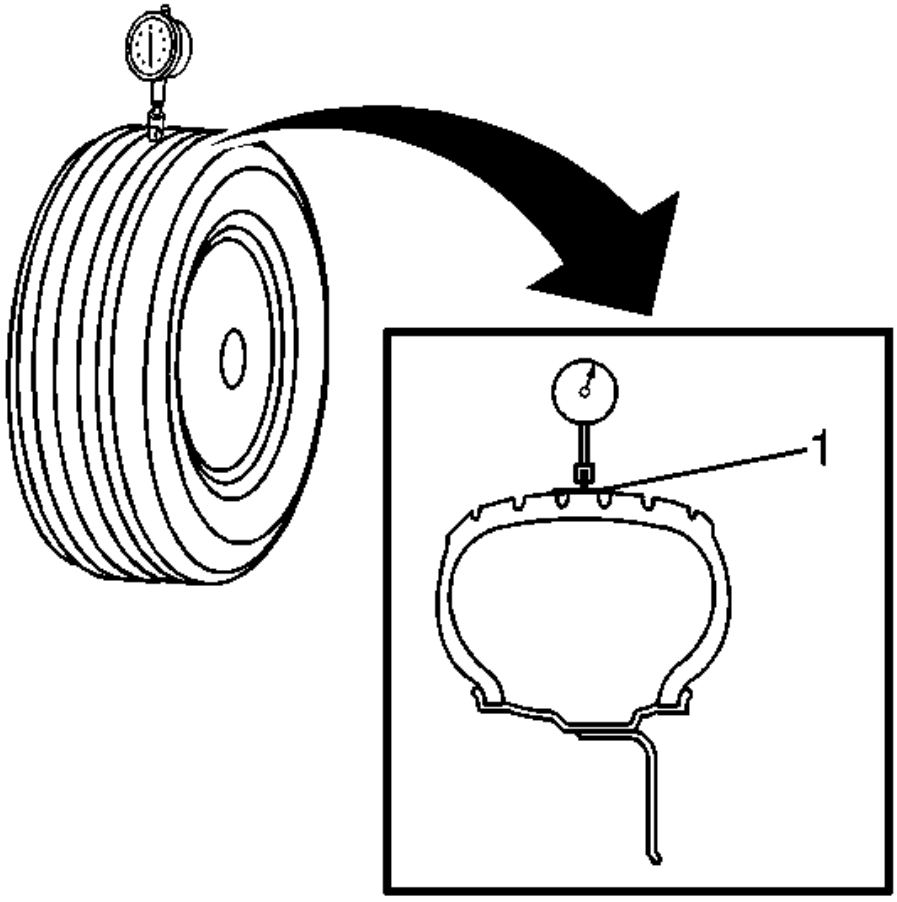


Fig. 4: Measuring Tire & Wheel Assembly Radial Runout
Courtesy of GENERAL MOTORS COMPANY

5. Wrap the circumference of each tire with tape (1) in the center tread area.

   Wrapping the tread with tape allows for a smooth and accurate reading of radial runout to be obtained.

6. Position the dial indicator on the taped portion of the tire tread such that the dial indicator is perpendicular to the tire tread surface.
7. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
8. Set the dial indicator to zero at the low spot.
9. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of radial runout.

   Specification

   Maximum tire and wheel assembly radial runout - measured on-vehicle: 1.52 mm (0.060 in)

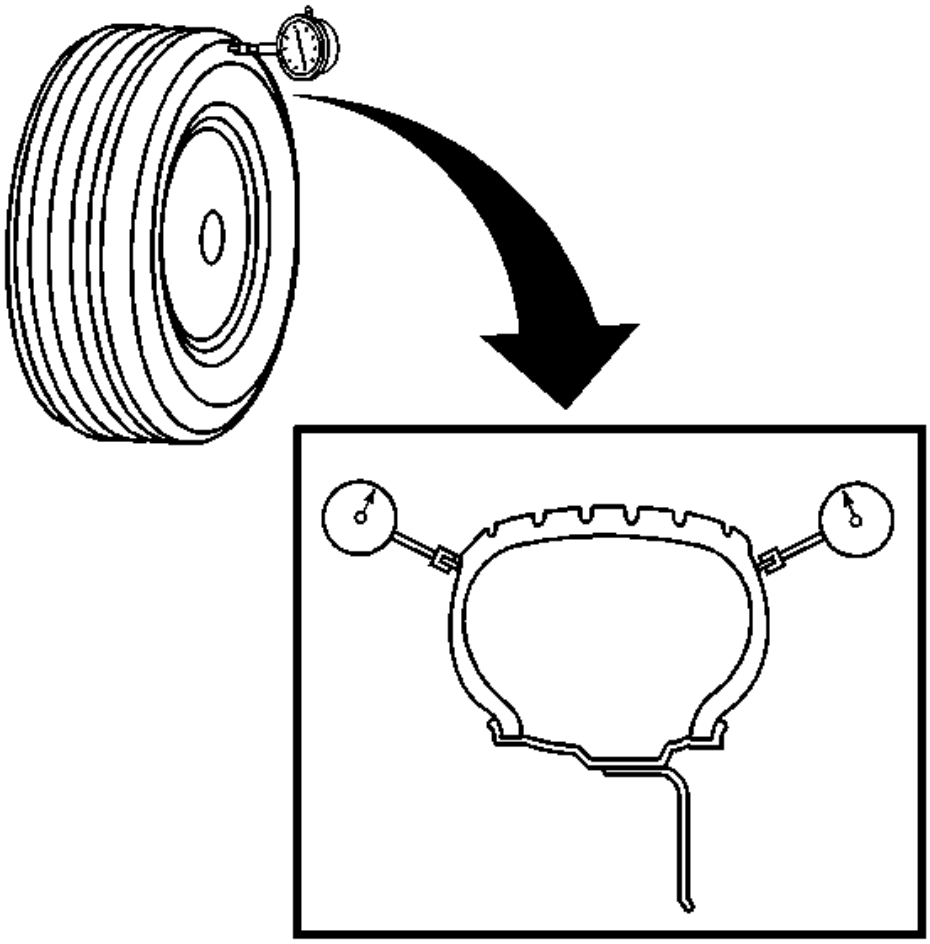


Fig. 5: Measuring Tire & Wheel Assembly Lateral Runout
Courtesy of GENERAL MOTORS COMPANY

10. Position the dial indicator on a smooth portion of the tire sidewall, as close to the tread as possible, such that the dial indicator is perpendicular to the tire sidewall surface.
11. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot. Ignore any jumps or dips due to sidewall splices.
12. Set the dial indicator to zero at the low spot.
13. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of lateral runout. Ignore any jumps or dips due to sidewall splices and attain an average runout measurement.

    Specification

    Maximum tire and wheel assembly lateral runout - measured on-vehicle: 1.52 mm (0.060 in)

14. Repeat steps 4 through 12 until all of the tire and wheel assembly radial and lateral runout measurements have been taken.
15. Lower the vehicle.

TIRE AND WHEEL ASSEMBLY RUNOUT MEASUREMENT - OFF VEHICLE

1. Raise and support the vehicle.

2. Mark the location of the wheels to the wheel studs and mark the specific vehicle position on each tire and wheel - LF, LR, RF, RR.
3. Remove the tire and wheel assemblies from the vehicle.
4. Closely inspect each tire for proper and even bead seating.
5. If any of the tire beads were not properly or evenly seated, reseat the tire bead, then proceed to step 6. Refer to **Tire and Wheel Removal and Installation** .
6. Mount a tire and wheel assembly on a spin-type wheel balancer.

   Locate the tire and wheel assembly on the balancer with a cone through the back side of the center pilot hole.

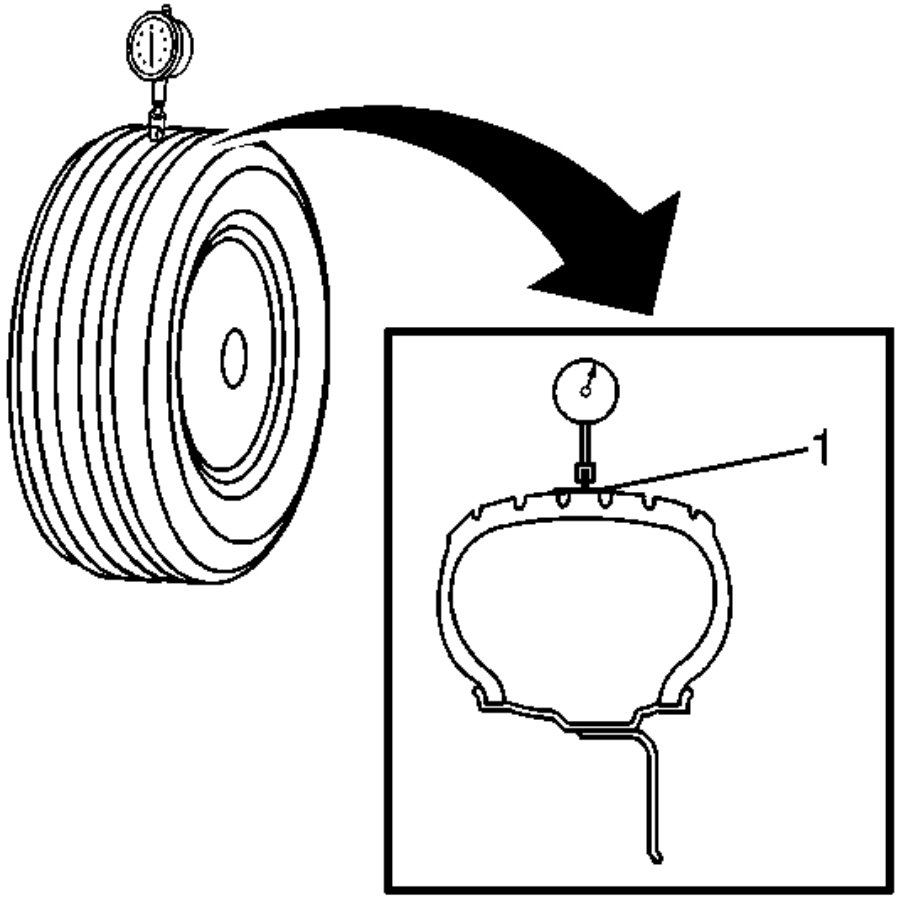


Fig. 6: Measuring Tire & Wheel Assembly Radial Runout
Courtesy of GENERAL MOTORS COMPANY

7. Wrap the outer circumference of each tire with tape (1) in the center tread area.

   Wrapping the tread with tape allows for a smooth and accurate reading of radial runout to be obtained.

8. Position the dial indicator on the taped portion of the tire tread such that the dial indicator is perpendicular to the tire tread surface.
9. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
10. Set the dial indicator to zero at the low spot.

11. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of radial runout.

    Specification

    Maximum tire and wheel assembly radial runout - measured off-vehicle: 1.27 mm (0.050 in)

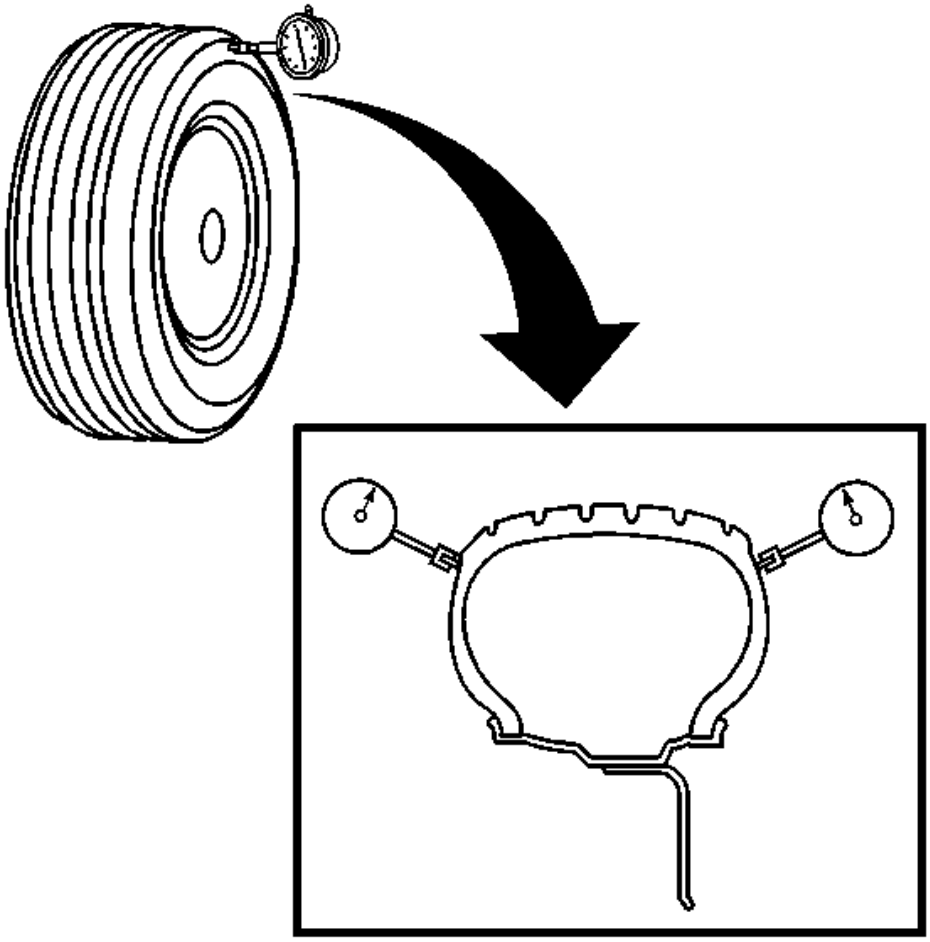


Fig. 7: Measuring Tire & Wheel Assembly Lateral Runout
Courtesy of GENERAL MOTORS COMPANY

12. Position the dial indicator on a smooth portion of the tire sidewall, as close to the tread as possible, such that the dial indicator is perpendicular to the tire sidewall surface.
13. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot. Ignore any jumps or dips due to sidewall splices.
14. Set the dial indicator to zero at the low spot.
15. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of lateral runout. Ignore any jumps or dips due to sidewall splices and attain an average runout measurement.

    Specification

    Maximum tire and wheel assembly lateral runout - measured off-vehicle: 1.27 mm (0.050 in)

16. Repeat steps 6 through 15 until all of the tire and wheel assembly radial and lateral runout measurements have

been taken.

17. If ANY of the tire and wheel assembly runout measurements were NOT within specifications, proceed to step 19.
18. If ALL of the tire and wheel assembly runout measurements WERE within specifications, then the off-vehicle tire and wheel assembly runout is considered acceptable.

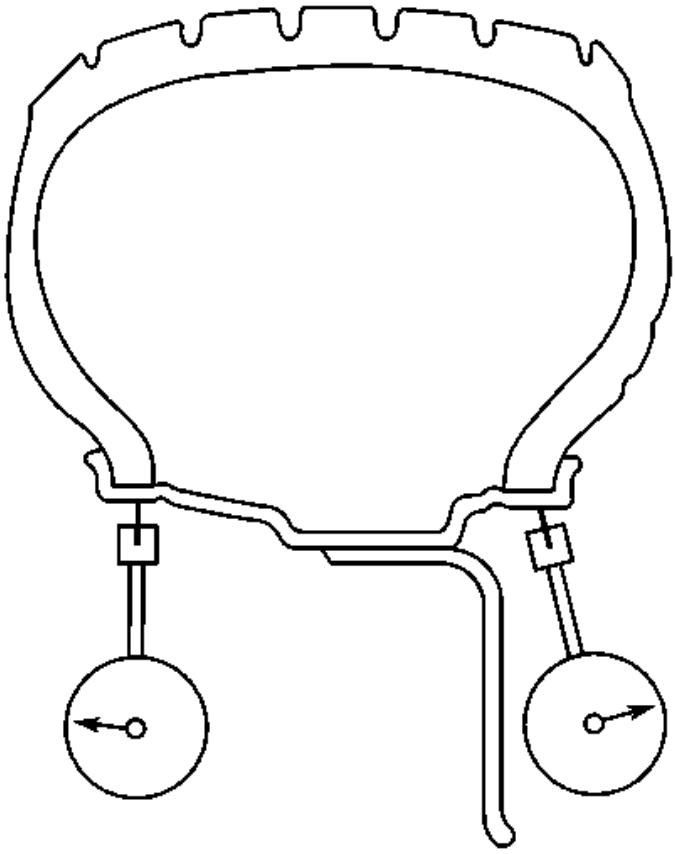


Fig. 8: Measuring Wheel Radial Runout (Off-Vehicle, Tire Mounted)
Courtesy of GENERAL MOTORS COMPANY

19. Position the dial indicator on the horizontal outer surface of the wheel rim flange - with the tire still mounted - such that the dial indicator is perpendicular to the rim flange surface.

    Wheel runout should be measured on both the inboard and outboard rim flanges, unless wheel design will not permit. Ignore any jumps or dips due to paint drips, chips, or welds.

20. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
21. Set the dial indicator to zero at the low spot.
22. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of wheel radial runout.

Specification

- Maximum aluminum wheel radial runout - measured off-vehicle, tire mounted: 0.762 mm (0.030 in)
- Maximum steel wheel radial runout - measured off-vehicle, tire mounted: 1.015 mm (0.040 in)

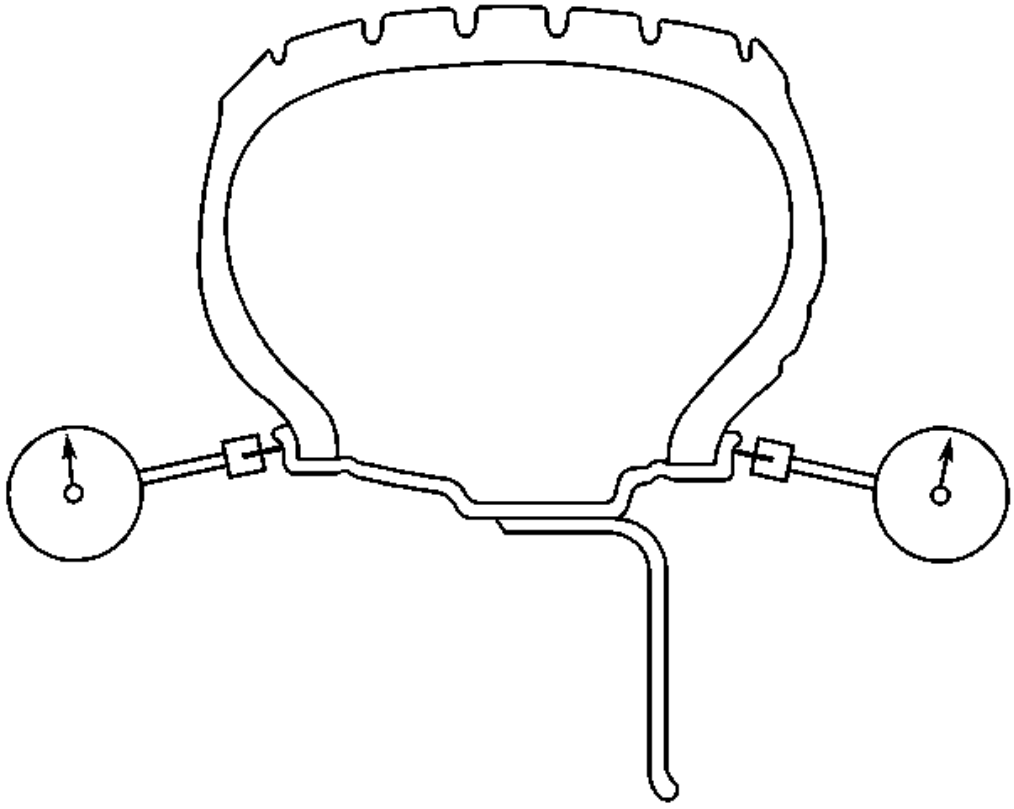


Fig. 9: Measuring Wheel Lateral Runout (Off-Vehicle, Tire Mounted)
Courtesy of GENERAL MOTORS COMPANY

23. Position the dial indicator on the vertical outer surface of the wheel rim flange - with the tire still mounted - such that the dial indicator is perpendicular to the rim flange surface.

    Wheel runout should be measured on both the inboard and outboard rim flanges, unless wheel design will not permit. Ignore any jumps or dips due to paint drips, chips, or welds.

24. Slowly rotate the tire and wheel assembly one complete revolution in order to find the low spot.
25. Set the dial indicator to zero at the low spot.
26. Slowly rotate the tire and wheel assembly one more complete revolution and measure the total amount of wheel lateral runout.

    Specification

    - Maximum aluminum wheel lateral runout - measured off-vehicle, tire mounted: 0.762 mm (0.030 in)
    - Maximum steel wheel lateral runout - measured off-vehicle, tire mounted: 1.143 mm (0.045 in)

27. Repeat steps 19 through 26 until all of the wheel radial and lateral runout measurements have been taken on each of the - tire and wheel - assemblies with assembly runout measurements which were NOT within specifications.
28. If any of the wheel runout measurements were NOT within specifications, proceed to Measuring Wheel Runout - Tire Dismounted.
29. For any of the wheel runout measurements which WERE within specifications, while the - tire and wheel - assembly runout measurements were NOT within specifications, replace the tire, then balance the assembly. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle**.
30. After replacement of any tires, always re-measure the runout of the affected tire and wheel assembly, or assemblies.
31. Using the matchmarks made prior to removal, install the tire and wheel assemblies to the vehicle.
32. Lower the vehicle.

Wheel Runout Measurement - Tire Dismounted

1. On the tire and wheel assembly, or assemblies with wheel runout measurements - tire mounted - which were NOT within specifications, mark each tire and wheel in relation to each other.
2. Dismount the tire from the wheel.
3. Mount the wheel on a spin-type wheel balancer.
4. Locate the wheel on the balancer with a cone through the back side of the center pilot hole.

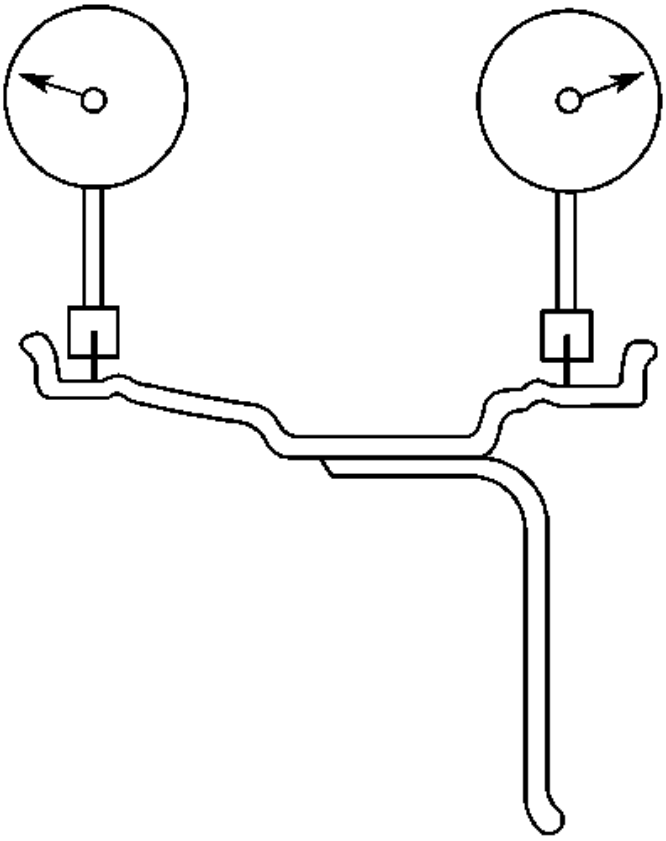


Fig. 10: Measuring Wheel Radial Runout (Off-Vehicle, Tire Dismounted)
Courtesy of GENERAL MOTORS COMPANY

5. Position the dial indicator on the horizontal inner surface of the wheel rim flange - with the tire dismounted - such that the dial indicator is perpendicular to the rim flange surface.

   Wheel runout should be measured on both the inboard and outboard rim flanges. Ignore any jumps or dips due to paint drips, chips, or welds.

6. Slowly rotate the wheel one complete revolution in order to find the low spot.
7. Set the dial indicator to zero at the low spot.
8. Slowly rotate the wheel one more complete revolution and measure the total amount of wheel radial runout.

   Specification

   - Maximum aluminum wheel radial runout - measured off-vehicle, tire dismounted: 0.762 mm (0.030 in)
   - Maximum steel wheel radial runout - measured off-vehicle, tire dismounted: 1.015 mm (0.040 in)

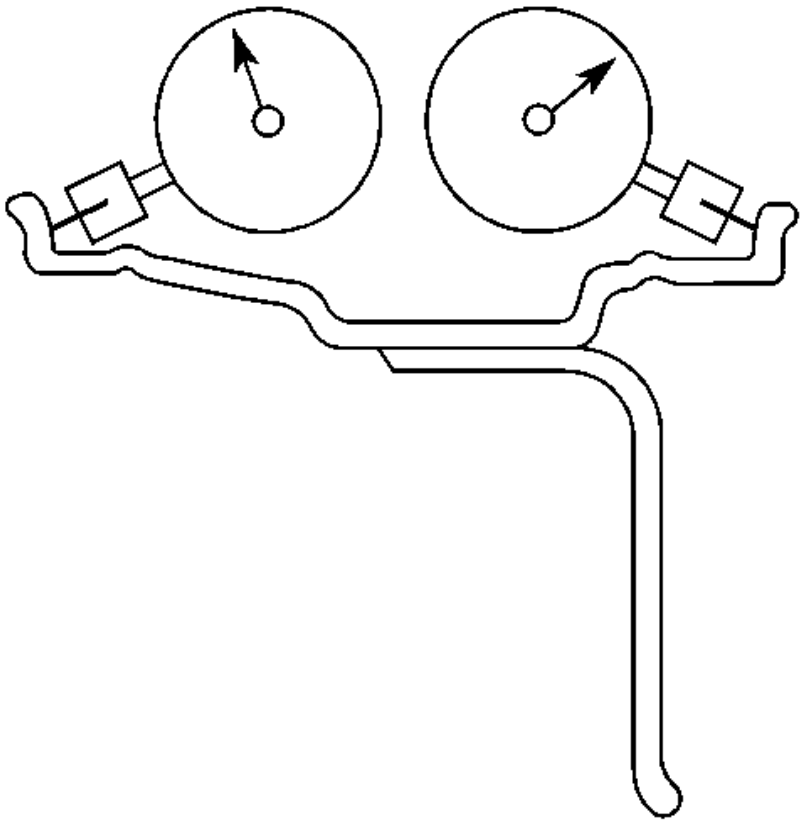


Fig. 11: Measuring Wheel Lateral Runout (Off-Vehicle, Tire Dismounted)
Courtesy of GENERAL MOTORS COMPANY

9. Position the dial indicator on the vertical inner surface of the wheel rim flange - with the tire dismounted - such

that the dial indicator is perpendicular to the rim flange surface.

Wheel runout should be measured on both the inboard and outboard rim flanges. Ignore any jumps or dips due to paint drips, chips, or welds.

10. Slowly rotate the wheel one complete revolution in order to find the low spot.
11. Set the dial indicator to zero at the low spot.
12. Slowly rotate the wheel one more complete revolution and measure the total amount of wheel lateral runout.

    Specification

    - Maximum aluminum wheel lateral runout - measured off-vehicle, tire dismounted: 0.762 mm (0.030 in)
    - Maximum steel wheel lateral runout - measured off-vehicle, tire dismounted: 1.143 mm (0.045 in)
13. Repeat steps 2 through 12 until all of the wheel radial and lateral runout measurements - tire dismounted - have been taken on each wheel with runout measurements - tire mounted - which were NOT within specifications.
14. If any of the wheel runout measurements - tire dismounted - were NOT within specifications, replace the wheel.

    Always measure the runout of any replacement wheels.

15. For any of the wheel runout measurements which WERE within specifications, while the - tire and wheel - assembly runout measurements were NOT within specifications, replace the tire, then balance the assembly. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle**.
16. Using the matchmarks made prior to dismounting the tire, or tires, mount the tire, or tires to the wheel, or wheels, then balance the assembly, or assemblies. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle**.

    Always measure the runout of any of the tire and wheel assemblies which have had the tires dismounted and mounted.

17. Using the matchmarks made prior to removal, install the tire and wheel assemblies to the vehicle.
18. Lower the vehicle.

BRAKE ROTOR/DRUM BALANCE INSPECTION

1. Support the vehicle drive axle on a suitable hoist. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assemblies from the drive axle. Refer to **Tire and Wheel Removal and Installation** .

WARNING: Refer to Work Stall Test Warning .

3. Reinstall the wheel nuts in order to retain the brake rotors.
4. Run the vehicle at the concern speed while inspecting for the presence of the vibration.

CAUTION: Do not depress the brake pedal with the brake rotors and/or the brake drums removed, or with the brake calipers repositioned away from the brake rotors, or damage to the brake system may result.

5. If the vibration is still present, remove the rotors from the drive axle, then run the vehicle back to the concern speed.
6. If the vibration is eliminated when the brake rotors are removed from the drive axle, repeat the test with one

rotor installed at a time. Replace the rotor that is causing or contributing to the vibration concern.

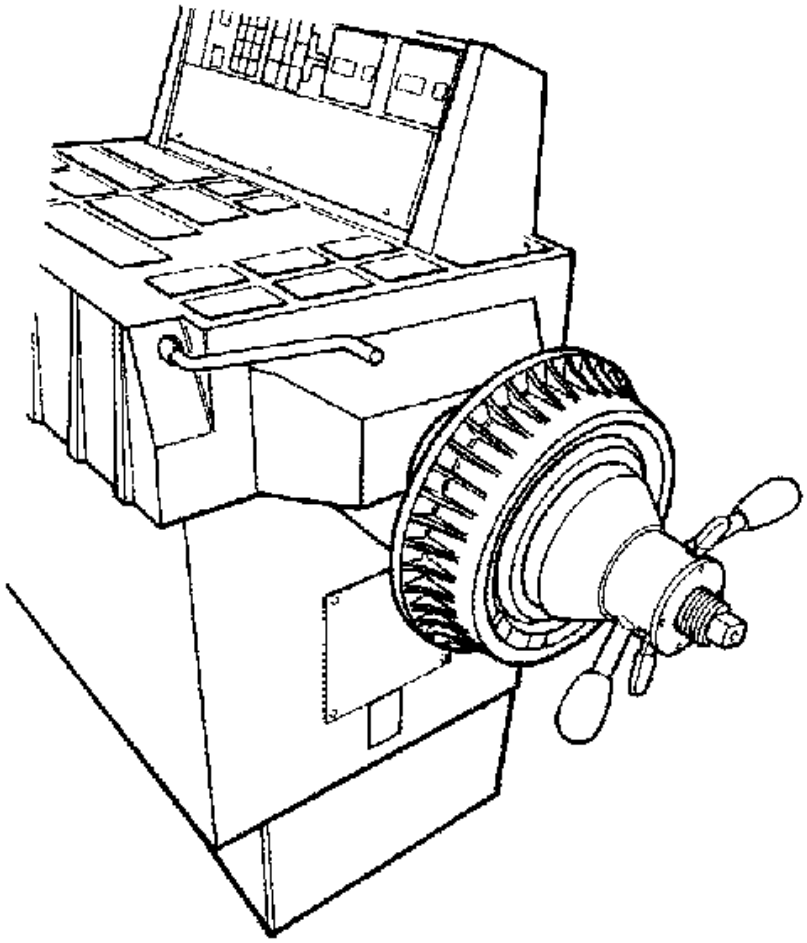


Fig. 12: Balancing Brake Drum
Courtesy of GENERAL MOTORS COMPANY

7. If a brake rotor was replaced as a result of following the previous steps, or if necessary to confirm the results obtained during the previous steps, and/or to check the non-drive axle components, perform the following:
    1. Mount the brake rotor/drum on a balancer in the same manner as a tire and wheel assembly.

        NOTE: Check brake rotors/drums for static imbalance only; ignore the dynamic imbalance readings.

    2. Inspect the rotor/drum for static imbalance.

There is not a set tolerance for brake rotor/drum static imbalance. However, any brake rotor/drum measured in this same manner which is over 21 g (3/4 oz) may have the potential to cause or contribute to a vibration. Rotors/drums suspected of causing or contributing to a vibration should be replaced. Any rotor/drum that is replaced should be checked for imbalance in the same manner.

HUB/AXLE FLANGE AND WHEEL STUD RUNOUT INSPECTION

Special Tools

GE-8001 Dial Indicator Set , or equivalent

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Mark the location of the wheels to the wheel studs and mark the specific vehicle position on each tire and wheel - LF, LR, RF, RR.
3. Remove the tire and wheel assemblies from the vehicle. Refer to **Tire and Wheel Removal and Installation** .
4. Remove the brake rotors and/or brake drums from the vehicle. Clean the mounting surfaces of the brake rotors, the brake drums, if equipped, and the hub/axle flanges of any loose debris, rust, and corrosion.

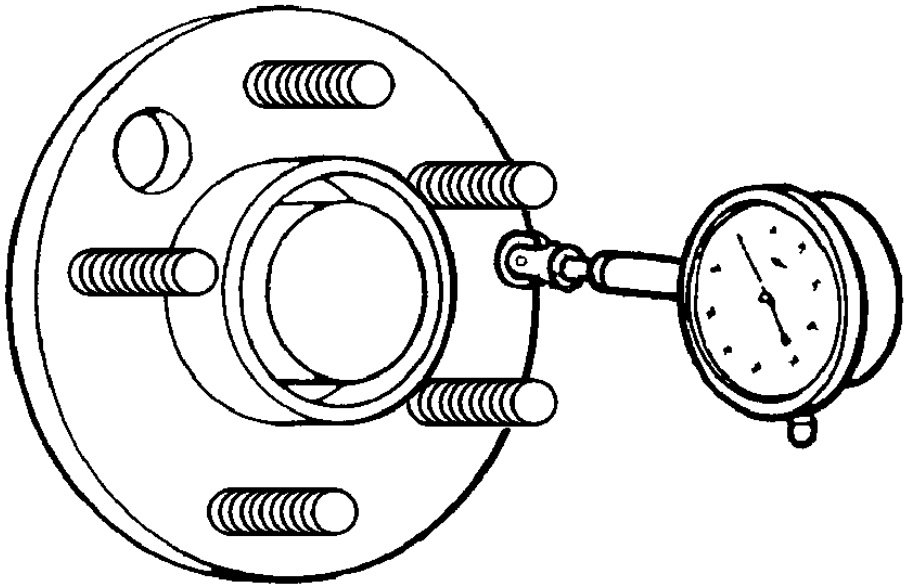


Fig. 13: Measuring Wheel Hub/Axle Flange Runout
Courtesy of GENERAL MOTORS COMPANY

5. Position the **GE-8001** Dial Indicator Set , or equivalent, on the machined surface of the wheel hub/axle flange outside of the wheel studs.
6. Rotate the hub one complete revolution in order to find the low spot.
7. Set the **GE-8001** Dial Indicator Set , or equivalent, to zero at the low spot.
8. Rotate the hub one more complete revolution and measure the total amount of wheel hub/axle flange runout.

Specification - Guideline

Wheel hub/axle flange runout tolerance guideline: 0.132 mm (0.005 in)

9. If the runout of the wheel hub/axle flange IS within specification and the vehicle is equipped with wheel studs, proceed to step 13.
10. If the runout of the wheel hub/axle flange IS within specification and the vehicle is equipped with wheel bolts, proceed to step 19.
11. If the runout of the wheel hub/axle flange is marginal, the wheel hub may or may not be the source of the disturbance.
12. If the runout of the wheel hub/axle flange is excessive, replace the wheel hub/axle flange. Measure the runout of the new wheel hub/axle flange.

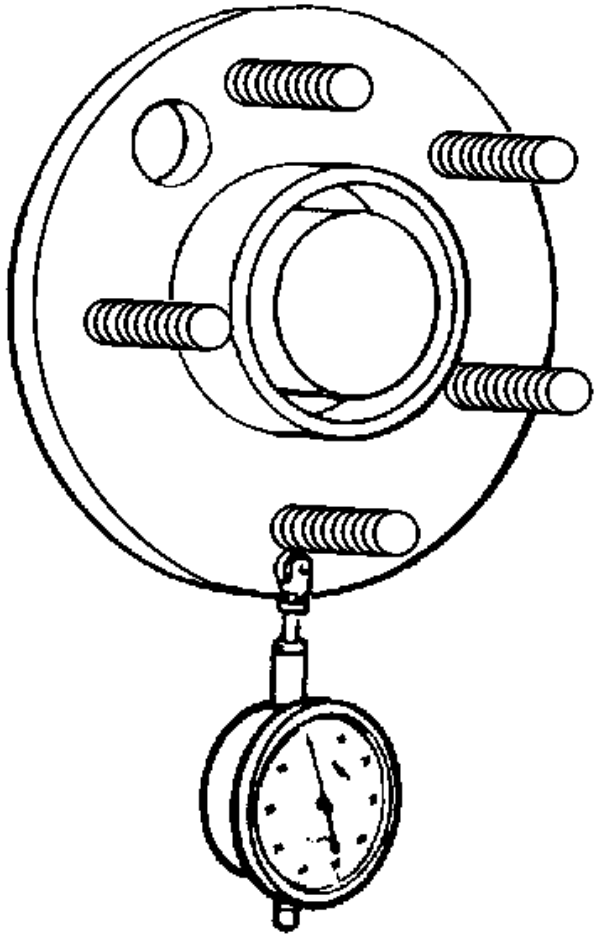


Fig. 14: Measuring Wheel Stud Runout
Courtesy of GENERAL MOTORS COMPANY

13. Position the **GE-8001** Dial Indicator Set , or equivalent, in order to contact the wheel mounting studs.

    Measure the stud runout as close to the flange as possible.

14. Turn the hub one complete revolution to register on each of the wheel studs.
15. Zero the **GE-8001** Dial Indicator Set , or equivalent, on the lowest stud.
16. Rotate the hub one more complete revolution and measure the total amount of wheel stud - stud circle - runout.

    Specification - Guideline

Wheel stud runout tolerance guideline: 0.254 mm (0.010 in)

17. If the runout of the wheel studs - stud circle - is marginal, the wheel studs may or may not be contributing to the disturbance.
18. If the runout of the wheel studs - stud circle - is excessive, replace the wheel studs as necessary. Measure the runout of the new wheel studs.
19. Inspect the threads and the tapered seat portion on each of the wheel bolts for damage.
20. Wheel bolts exibiting damaged threads and/or damaged tapered seats require replacement.
21. Place the threaded portion of each wheel bolt along a straight edge to inspect for straightness.
22. Wheel bolts that are not straight require replacement.

TIRE AND WHEEL ASSEMBLY ISOLATION TEST

Force Variation

Force variation refers to a radial or lateral movement of the tire and wheel assembly which acts much like runout, however, force variation has to do with variations in the construction of the tire. These variations in tire construction may actually cause vibration in a vehicle, even though the tire and wheel assembly runout and balance may be within specifications.

Radial Force Variation

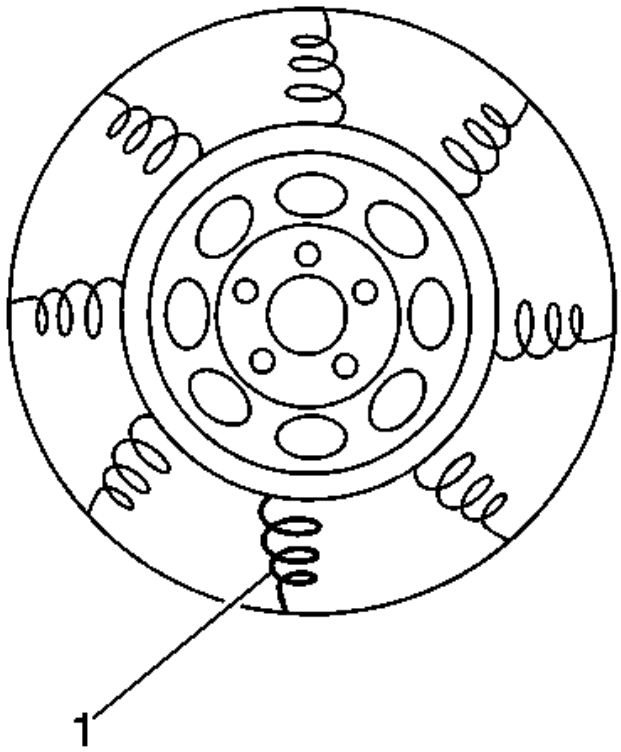


Fig. 15: Identifying Radial Force Variation
Courtesy of GENERAL MOTORS COMPANY

Radial force variation refers to the difference in the stiffness of a tire sidewall as the tire rotates and contacts the road. Tire sidewalls have some stiffness due to splices in the different plies of the tire, but these stiffness differences do not cause a problem unless the force variation is excessive. Stiff spots (1) in a tire sidewall can deflect a tire and wheel assembly upward as the assembly contacts the road.

Lateral Force Variation

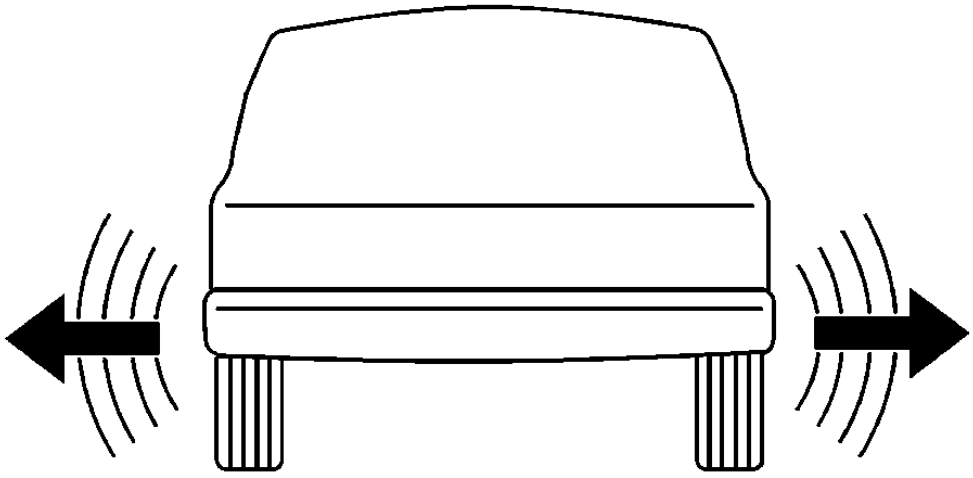


Fig. 16: Identifying Tire Wobble/Waddle
Courtesy of GENERAL MOTORS COMPANY

Lateral force variation refers to the difference in the stiffness or conformity of the belts within a tire as the tire rotates and contacts the road. Tire belts may have some stiffness or conformity differences, but these differences do not cause a problem unless the force variation is excessive. These variations in the belts of the tire can deflect the vehicle sideways or laterally. A shifted belt inside a tire may cause lateral force variation.

In most cases where excessive lateral force variation exists, the vehicle will display a wobble or waddle at low speeds, 8-40 km/h (5-25 mph), on a smooth road surface.

Isolation Test Procedure

Perform the following test in order to determine if force variation is present in the vehicle.

1. Substitute a set of KNOWN GOOD, pre-tested tire and wheel assemblies of the same size and type for the suspected original assemblies. Refer to **Tire and Wheel Removal and Installation** .
2. Road test the vehicle to determine if the vibration is still present. Refer to **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)**.
3. If the vibration is still present while using the known good set of tire and wheel assemblies, then force variation is not the cause of the vibration.
4. If the vibration is eliminated when using the known good set of tire and wheel assemblies, install one of the original tire and wheel assemblies using the matchmarks made prior to removal. Refer to **Tire and Wheel Removal and Installation** , . Road test the vehicle to determine if the vibration has returned. Refer to **Vibration Analysis - Road Testing (EL-38792-A Electronic Vibration Analyzer)Vibration Analysis - Road Testing (CH-51450-NVH Oscilloscope)**.
5. Continue the process of installing the original tire and wheel assemblies one at a time, then road testing the vehicle, until the tire and wheel assembly, or assemblies which is causing the vibration has been identified.
6. Replace the tire, or tires on the vibration-causing tire and wheel assembly, or assemblies, then balance the assembly, or assemblies. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle**.

REPAIR INSTRUCTIONS

TIRE AND WHEEL ASSEMBLY BALANCING - OFF VEHICLE

WARNING: **Failure to adhere to the following precautions before tire balancing can result in personal injury or damage to components:**

- **Clean away any dirt or deposits from the inside of the wheels.**
- **Remove any stones from the tread.**
- **Wear eye protection.**
- **Use coated weights on aluminum wheels.**

Tire and Wheel Assembly Balancer Calibration

Tire and wheel balancers can drift out of calibration over time, or can become inaccurate as a result of heavy use. There will likely not be any visual evidence that a calibration problem exists. If a balancer is not calibrated within specifications, and a tire and wheel assembly is balanced on that machine, the assembly may actually be imbalanced.

Tire and wheel assembly balancer calibration should be checked approximately every 2 weeks, if the machine is used frequently, and/or whenever the balance readings are questionable.

Tire and Wheel Assembly Balancer Calibration Test

NOTE: **If the balancer fails any of the steps in this calibration test, the balancer should be calibrated according to the manufacturer's instructions. If the balancer cannot be calibrated, contact the manufacturer for assistance.**

Inspect the calibration of the tire and wheel assembly balancer according to the manufacturer's recommendations, or perform the following test.

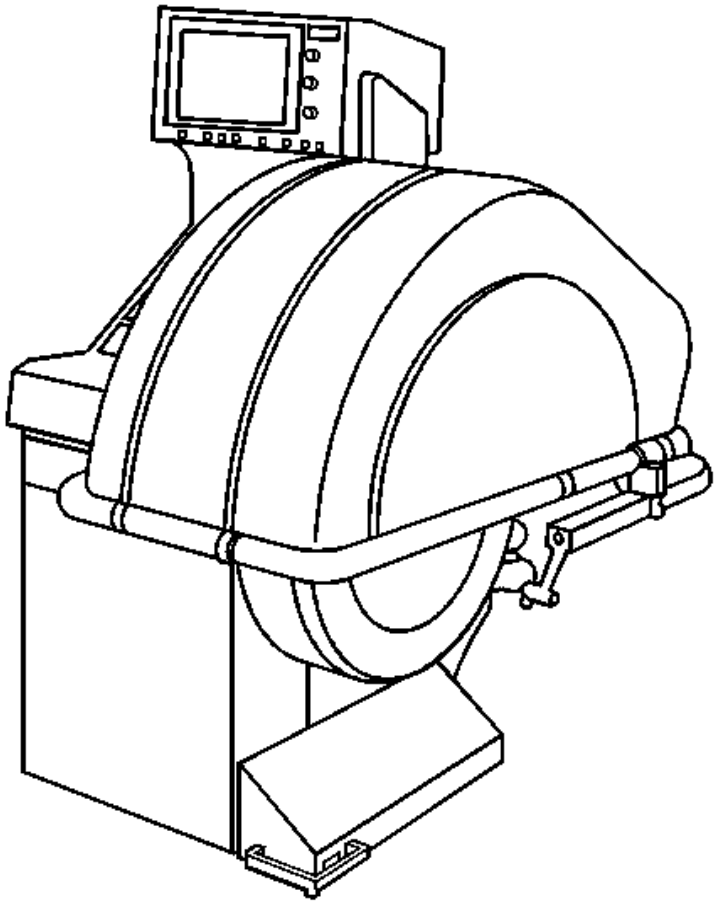


Fig. 17: View Of Tire & Wheel Assembly Balancer
Courtesy of GENERAL MOTORS COMPANY

1. Spin the balancer without a wheel or any of the adapters on the shaft.
2. Inspect the balancer readings.

   Specification

   Zero within 7 g (1/4 oz)

3. If the balancer is within the specification range, balance a tire and wheel assembly - that is within radial and lateral runout tolerances - to ZERO, using the same balancer.
4. After the tire and wheel assembly has been balanced, add an 85 g (3 oz) test weight to the wheel at any location.
5. Spin the tire and wheel assembly again. Note the readings.
   - In the static and dynamic modes, the balancer should call for 85 g (3 oz) of weight, 180 degrees opposite the test weight.
   - In the dynamic mode, the weight should be called for on the flange of the wheel opposite the test weight.
6. With the assembly imbalanced to 85 g (3 oz), cycle the balancer 5 times.
7. Inspect the balancer readings:

   Specification

Maximum variation: 7 g (1/4 oz)

8. Index the tire and wheel assembly on the balancer shaft, 90 degrees from the previous location.
9. Cycle the balancer with the assembly at the new location.
10. Inspect the balancer readings:

    Specification

    Maximum variation: 7 g (1/4 oz)

11. Repeat steps 8 through 10 until the tire and wheel assembly has been cycled and checked at each of the 4 locations on the balancer shaft.

Tire and Wheel Assembly Balancing Guidelines

NOTE: **Tire and wheel assemblies which exhibit excessive runout can produce vibrations even if the assemblies are balanced.**

It is strongly recommended that the tire and wheel assembly runout be measured and corrected if necessary BEFORE the assemblies are balanced.

If the runout of the tire and wheel assemblies has not yet been measured, refer to **Tire and Wheel Assembly Runout Measurement - Off Vehicle** before proceeding.

There are 2 types of tire and wheel balance:

Static Balance

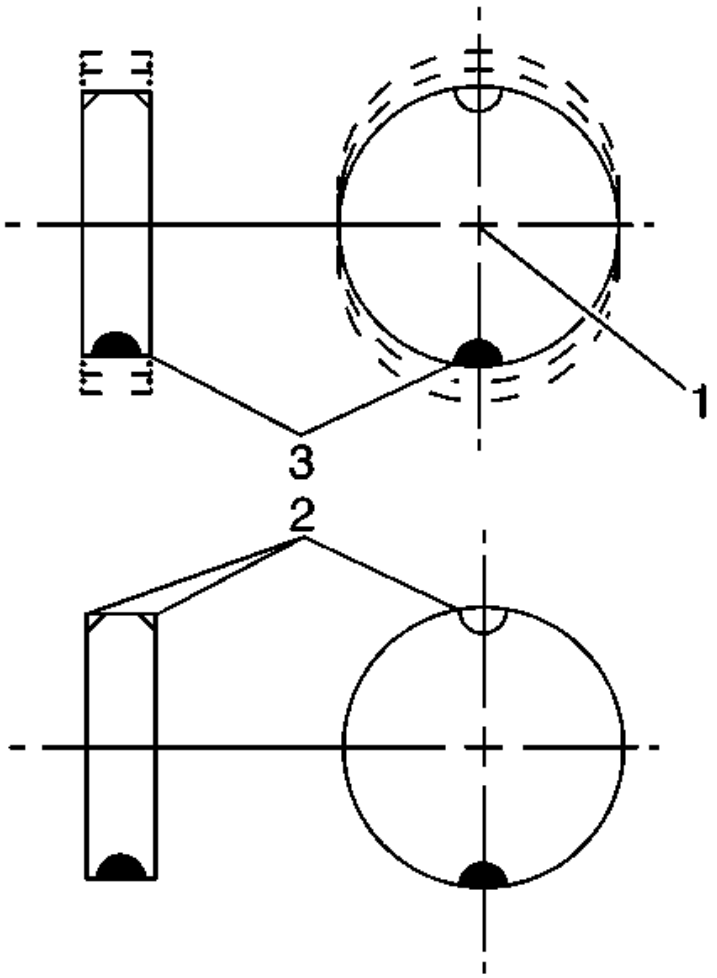


Fig. 18: View Of Static Balance
Courtesy of GENERAL MOTORS COMPANY

Static balance is the equal distribution of weight around the wheel circumference. The wheel balance weights (2) are positioned on the wheel in order to offset the effects of a heavy spot (3). Wheels that have static imbalance can produce a bouncing action called tramp.

Dynamic Balance

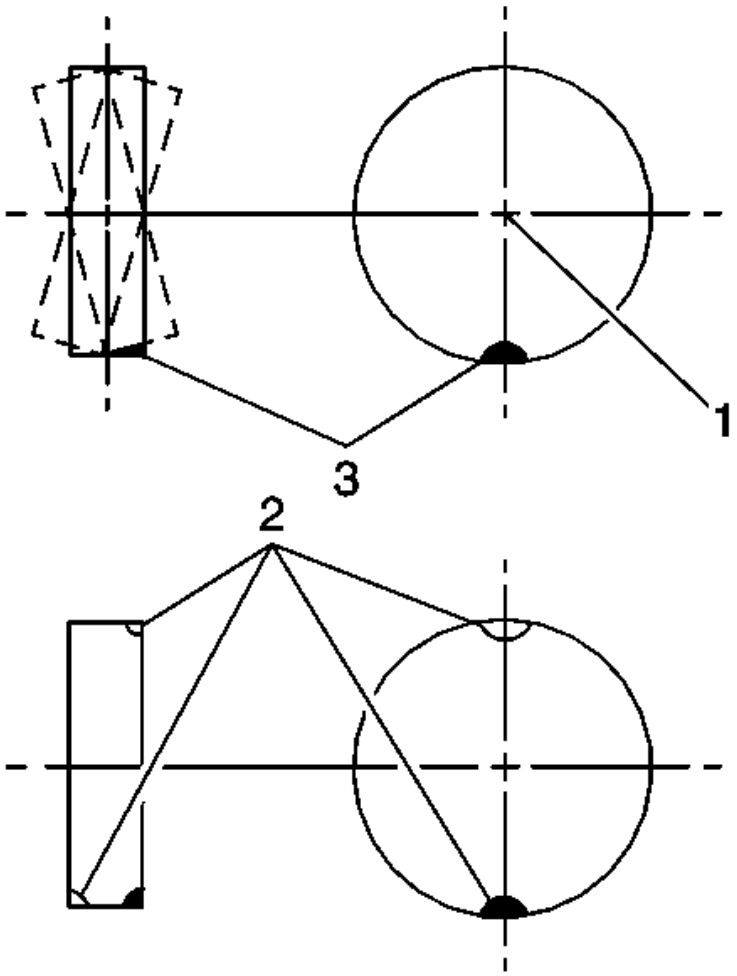


Fig. 19: View Of Dynamic Balance
Courtesy of GENERAL MOTORS COMPANY

Dynamic balance is the equal distribution of weight on each side of the tire and wheel assembly centerline. The wheel balance weights (2) are positioned on the wheel in order to offset the effects of a heavy spot (3). Wheels that have dynamic imbalance have a tendency to move from side to side and can cause an action called shimmy.

Most off-vehicle balancers are capable of checking both types of balance simultaneously.

As a general rule, most vehicles are more sensitive to static imbalance than to dynamic imbalance; however, vehicles equipped with low profile, wide tread path, high performance tires and wheels are susceptible to small amounts of dynamic imbalance. As little as 14-21 g (1/2 - 3/4 oz) imbalance is capable of inducing a vibration in some vehicle models.

Balancing Procedure

NOTE: **When balancing tire and wheel assemblies, use a known good, recently calibrated, off-vehicle, two-plane dynamic balancer set to the finest balance mode available.**

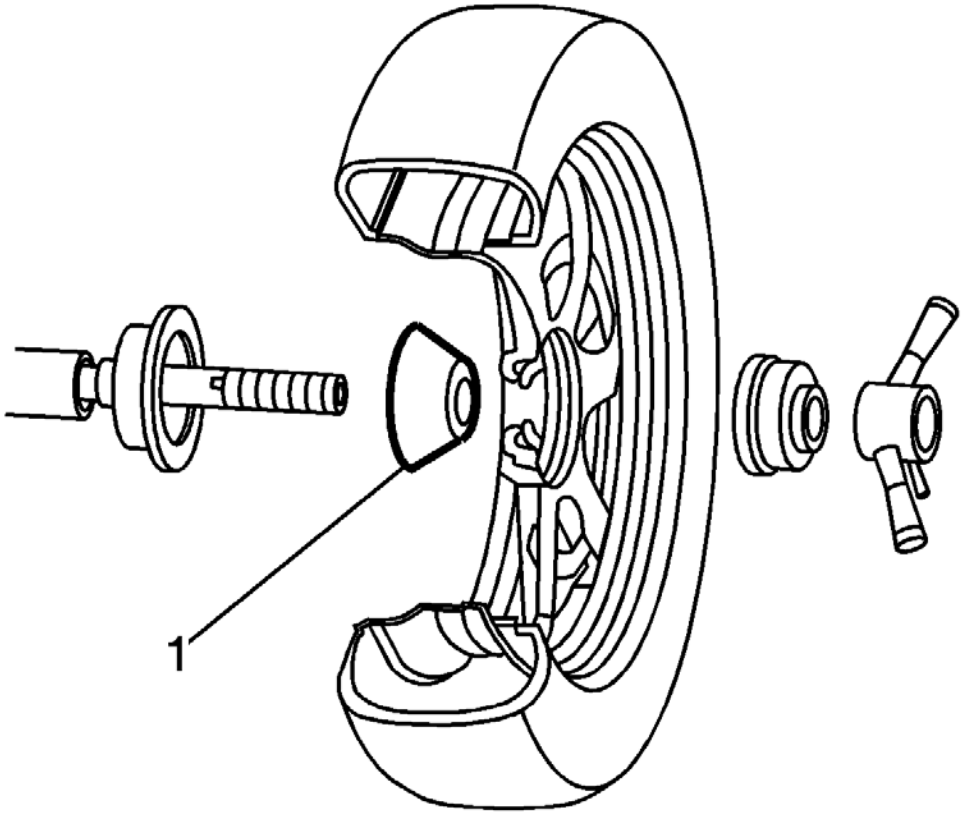


Fig. 20: Wheel Balancer Center Cone
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Carefully follow the wheel balancer manufacturers's instructions for proper mounting of the center cone (1).**

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Mark the location of the wheels to the wheel studs and mark the specific vehicle position on each tire and wheel - LF, LR, RF, RR.
3. Remove the tire and wheel assemblies one at a time and mount on a spin-type wheel balancer. Refer to **Tire and Wheel Removal and Installation** .
4. Carefully follow the wheel balancer manufacturer's instructions for proper mounting techniques to be used on different types of wheels.

   Regard aftermarket wheels, especially those incorporating universal lug patterns, as potential sources of runout and mounting concerns.

5. Be sure to use the correct type of wheel balance weights for the type of wheel rim being balanced. Be sure to use the correct type of coated wheel balance weights on aluminum wheels. Refer to Wheel Weight Usage.
6. Balance all four tire and wheel assemblies as close to zero as possible.
7. Using the matchmarks made prior to removal, install the tire and wheel assemblies to the vehicle. Refer to **Tire and Wheel Removal and Installation** .

8. Lower the vehicle.

Wheel Weight Usage

Tire and wheel assemblies can be balanced using either the static or dynamic method.

Clip-on Weights

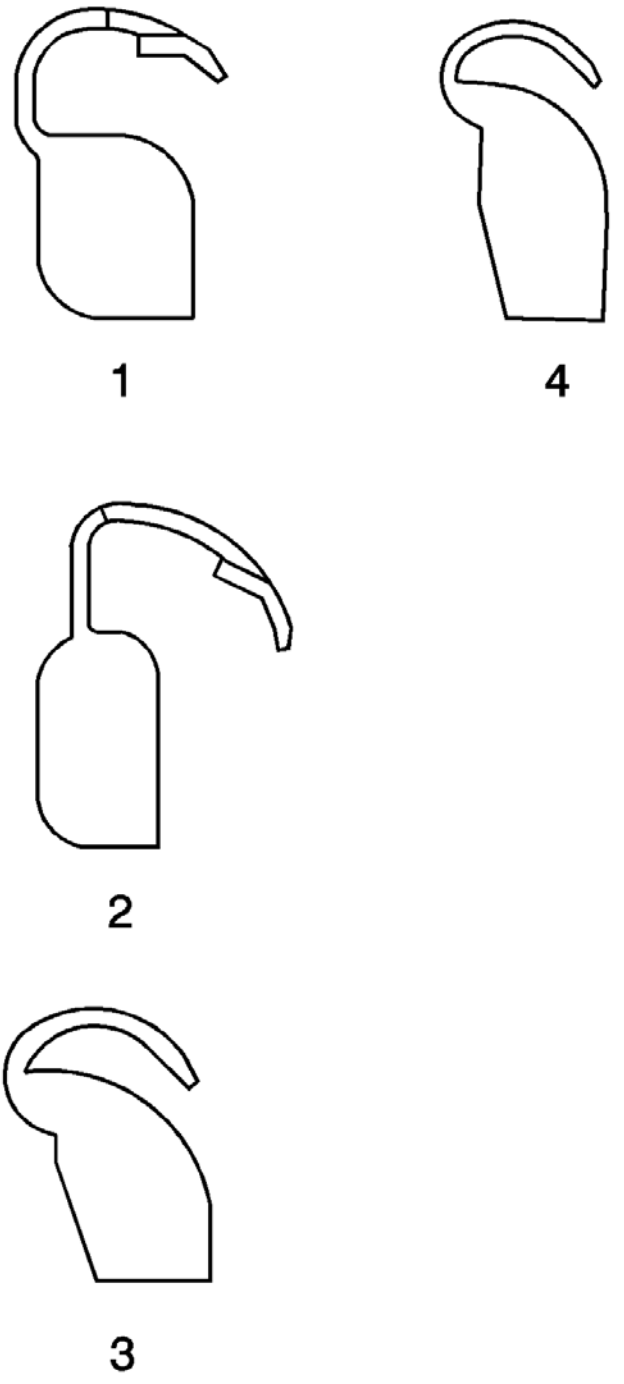


Fig. 21: Identifying Clip-On Wheel Weight Types
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When balancing factory aluminum wheels with clip-on wheel balance weights, be sure to use special polyester-coated weights. These coated weights reduce the potential for corrosion and damage to aluminum wheels.**

These coated weights reduce the potential for corrosion and damage to aluminum wheels.

- MC (1) and AW (2) series weights are approved for use on aluminum wheels.
- P (3) series weights are approved for use on steel wheels only.
- T (4) series coated weights are approved for use on both steel and aluminum wheels.

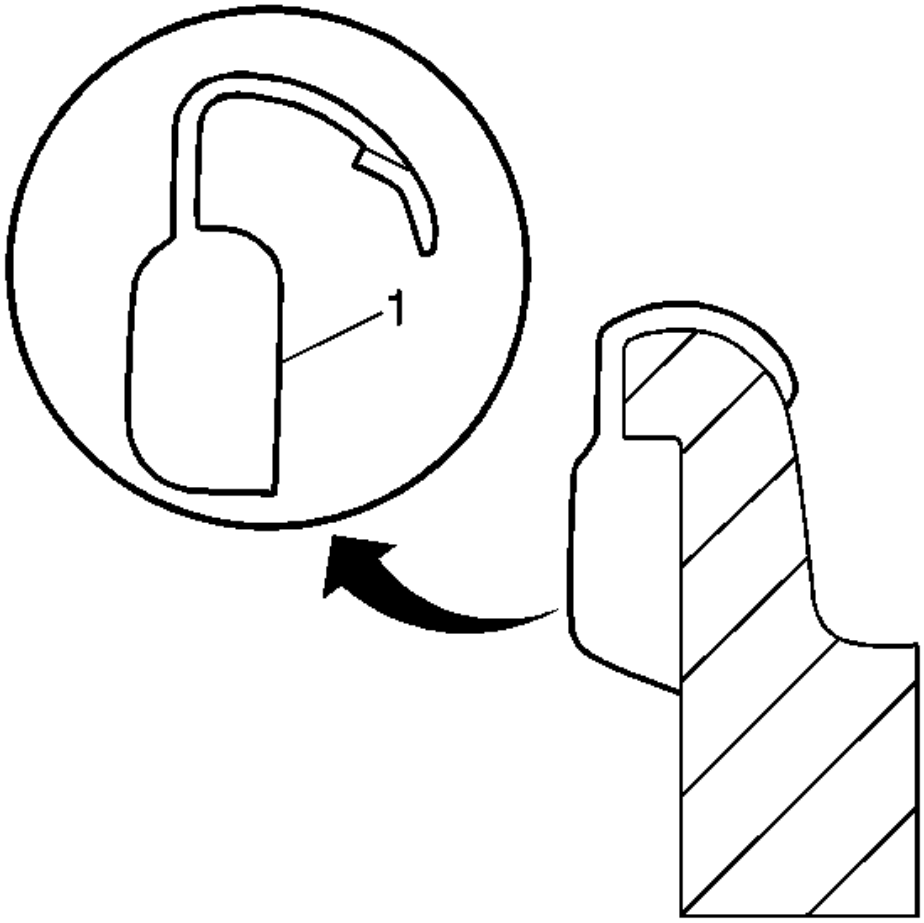


Fig. 22: Attaching Clip-On Wheel Weight
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a nylon or plastic-tipped hammer when installing coated clip-on wheel balance weights to minimize the possibility of damage to the polyester coating.**

The contour and style of the wheel rim flange will determine which type of clip-on wheel weight (1) should be used. The weight should follow the contour of the rim flange. The weight clip should firmly grip the rim flange.

Wheel Weight Placement - Clip-on Weights

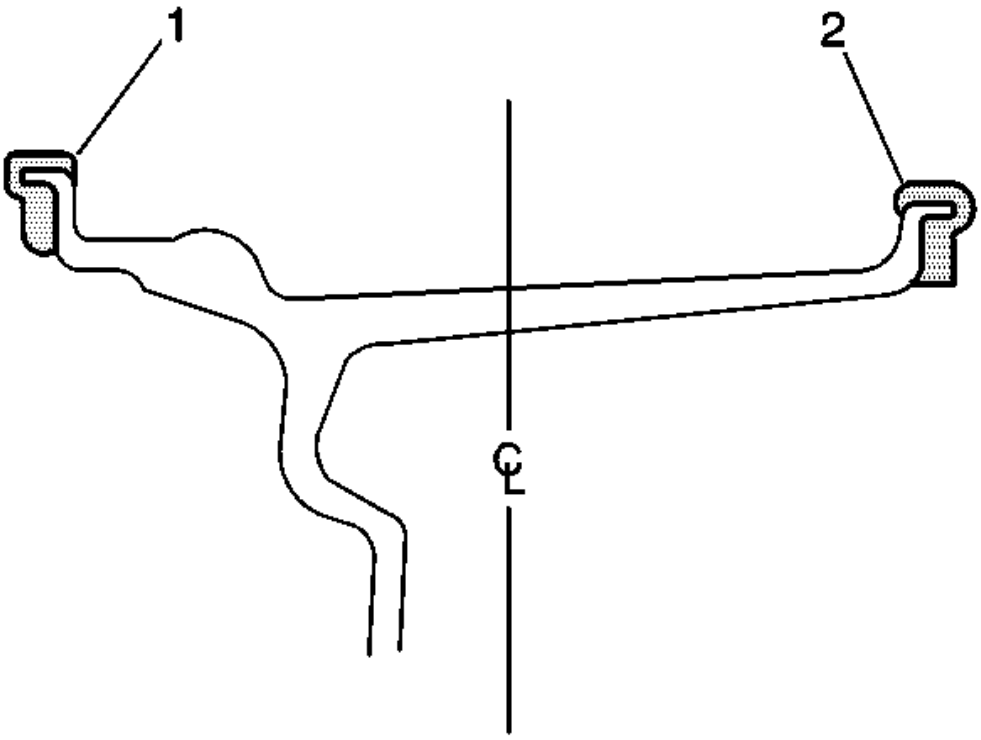


Fig. 23: Clip-On Weight Placement
Courtesy of GENERAL MOTORS COMPANY

When static balancing, locate the wheel balance weights on the inboard flange (2) if only 28 g (1 oz) or less is called for. If more than 28 g (1 oz) is called for, split the weights as equally as possible between the inboard (2) and outboard (1) flanges.

When dynamic balancing, locate the wheel balance weights on the inboard (2) and outboard (1) rim flanges at the positions specified by the wheel balancer.

Adhesive Weights

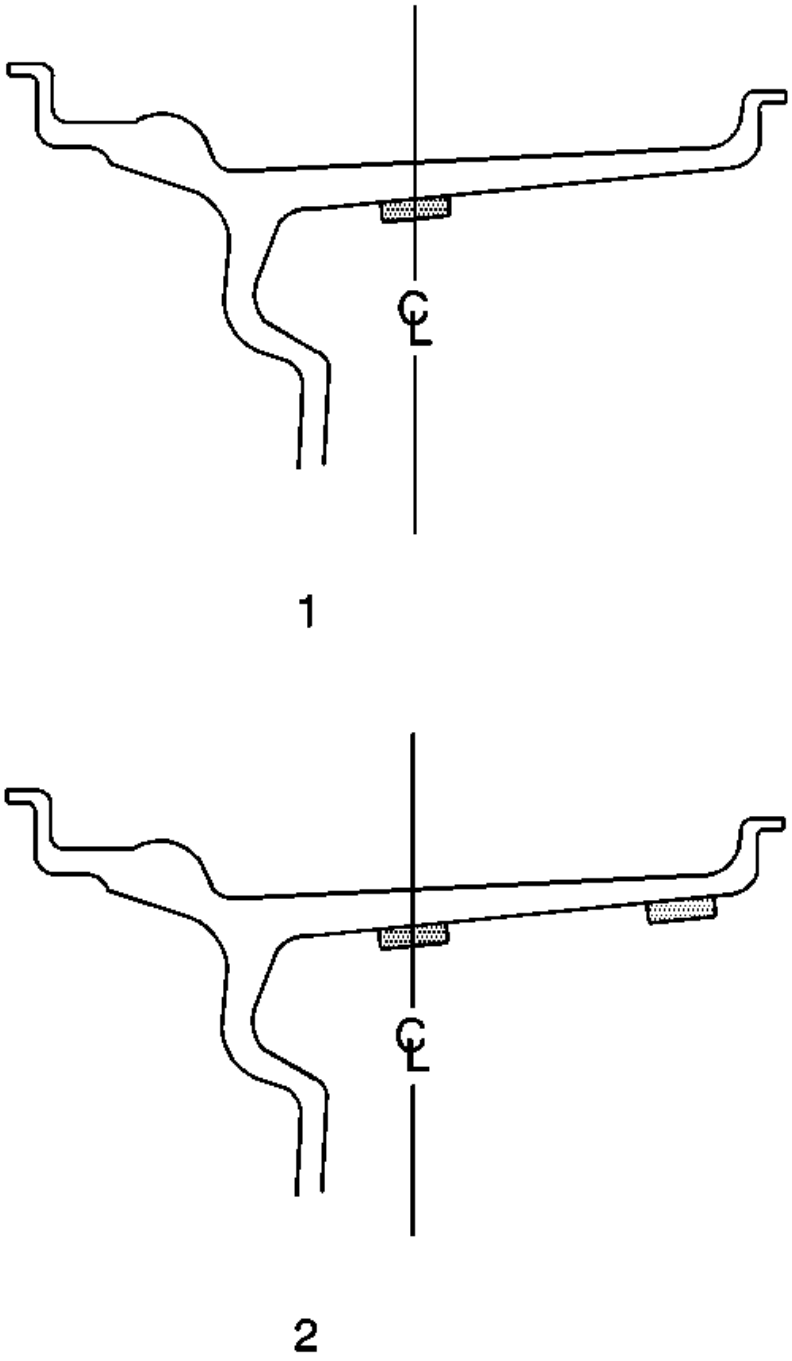


Fig. 24: Identifying Adhesive Weight Wheel Placement
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When installing adhesive balance weights on flangeless wheels, do NOT install the weight on the outboard surface of the rim.**

Adhesive wheel balance weights may be used on factory aluminum wheels. Perform the following procedure to install adhesive wheel balance weights.

1. Determine the correct areas for placement of the wheel weights on the wheel.

- When static balancing, locate the wheel balance weights along the wheel centerline (1) on the inner wheel surface if only 28 g (1 oz) or less is called for. If more than 28 g (1 oz) is called for, split the weights as equally as possible between the wheel centerline and the inboard edge of the inner wheel surface (2).
- When dynamic balancing, locate the wheel balance weights along the wheel centerline and the inboard edge of the inner wheel surface (2) at the positions specified by the wheel balancer.

2. Ensure that there is sufficient clearance between the wheel weights and brake system components.

NOTE: **Do not use abrasives to clean any surface of the wheel.**

3. Using a clean cloth or paper towel with a general purpose cleaner, thoroughly clean the designated balance weight attachment areas of any corrosion, overspray, dirt or any other foreign material.
4. To ensure there is no remaining residue, wipe the balance weight attachment areas again, using a clean cloth or paper towel with a mixture of half isopropyl alcohol and half water.
5. Dry the attachment areas with hot air until the wheel surface is warm to the touch.
6. Warm the adhesive backing on the wheel balance weights to room temperature.
7. Remove the protective covering from the adhesive backing on the back of the balance weights. DO NOT touch the adhesive surface.
8. Apply the wheel balance weights to the wheel, press into place with hand pressure.
9. Secure the wheel balance weights to the wheel with a 90 N (21 lb) force applied with a roller.

TIRE AND WHEEL ASSEMBLY BALANCING - ON-VEHICLE

Special Tools

EL-38792-A Electronic Vibration Analyzer (EVA) 2

If after following the tire and wheel vibration diagnostic process, some amount of tire and wheel vibration is still evident, an on-vehicle high-speed spin balancer may be used to perform an on-vehicle balance in an attempt to finish balance the tire and wheel assemblies, wheel hubs, brake rotors, brake drums, if equipped, and wheel trim, if equipped, simultaneously. On-vehicle balancing can also compensate for minor amounts of residual runout encountered as a result of mounting the tire and wheel assembly on the vehicle, as opposed to the balance which was achieved on the off-vehicle balancer.

In order to perform an on-vehicle balancing procedure, carefully follow the on-vehicle balancer manufacturer's specific operating instructions and carefully consider the following information before proceeding:

- Vehicles equipped with low profile, wide tread path, high performance tires and wheels are susceptible to small amounts of dynamic imbalance.
- When performing an on-vehicle balance, great care must be taken when placing the wheel balance weights on the wheels. If the wheel balance weights are not placed accurately, they can actually induce dynamic imbalance and thus increase the severity of the vibration.
- Inspect the vehicle wheel bearings to ensure that they are in good condition.
- Thoroughly inspect all on-vehicle balancing equipment and ensure that it is fully within the manufacturer's recommended specifications.
- Do not remove the off-vehicle balance weights. The purpose of on-vehicle balance is to fine tune the assembly balance already achieved off-vehicle, not to start over.
- Leave all wheel trim installed whenever possible.

- If the on-vehicle balancer calls for more than 56 g (2 oz) of additional weight, split the weight between the inboard and outboard flanges of the wheel, so as not to upset the dynamic balance of the assembly achieved in the off-vehicle balance. For wheel balance weight information, refer to **Tire and Wheel Assembly Balancing - Off Vehicle**.
- If available, tape-off an area on top of the fenders and the quarter panels, then place the vibration sensor of the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 on the fender or quarter panel above the specific tire and wheel assembly while it is being on-vehicle balanced.

  The **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 will provide a visual indication of the amplitude of the vibration, and the effect that the on-vehicle balance has on it.

TIRE-TO-WHEEL MATCH-MOUNTING (VECTORING)

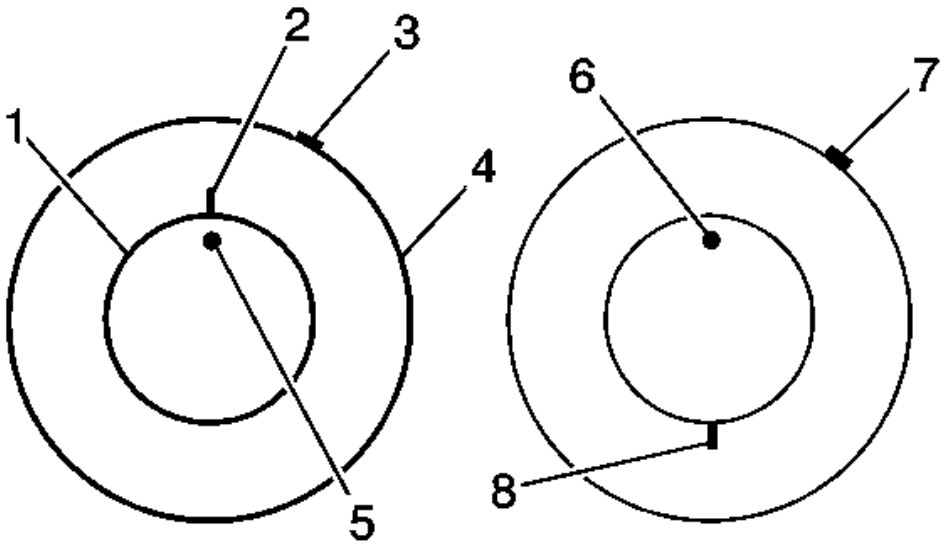


Fig. 25: View Of Tire-to-Wheel Match-Mounting
Courtesy of GENERAL MOTORS COMPANY

NOTE: **After remounting a tire to a wheel or after replacing a tire and/or a wheel, remeasure the tire and wheel assembly runout in order to verify that the amount of runout has been reduced and brought to within tolerances. Ensure that the tire and wheel assembly is properly balanced before reinstalling to the vehicle.**

1. Mark the location of the high spot (3) on the tire as determined during the off-vehicle tire and wheel assembly

runout measurement.

2. Place a reference mark (2) on the tire sidewall at the location of the valve stem (5).
    - Always refer to the valve stem as the 12 o'clock position.
    - Refer to the location of the high spot (3) by its clock position on the wheel, relative to the valve stem.
3. Mount the tire and wheel assembly on a tire machine and break down the bead. Do not dismount the tire from the wheel at this time.
4. Rotate the tire 180 degrees on the rim so that the valve stem reference mark (8) is now at the 6 o'clock position in relation to the valve stem (6). You may need to lubricate the bead in order to easily rotate the tire on the wheel.
5. Reinflate the tire and seat the bead properly.
6. Mount the assembly on the tire balancer and remeasure the runout. Mark the new location of the assembly runout high spot on the tire.
7. If the assembly runout has been reduced and is within tolerance, no further steps are necessary. Balance the tire and wheel assembly, then install the assembly to the vehicle. Refer to the following:
    - **Tire and Wheel Assembly Balancing - Off Vehicle**
    - **Tire and Wheel Removal and Installation**
8. If the clock location of the high spot remained at or near the original clock location of the high spot (7) and the assembly runout has NOT been reduced, the wheel is the major contributor to the assembly runout concern.

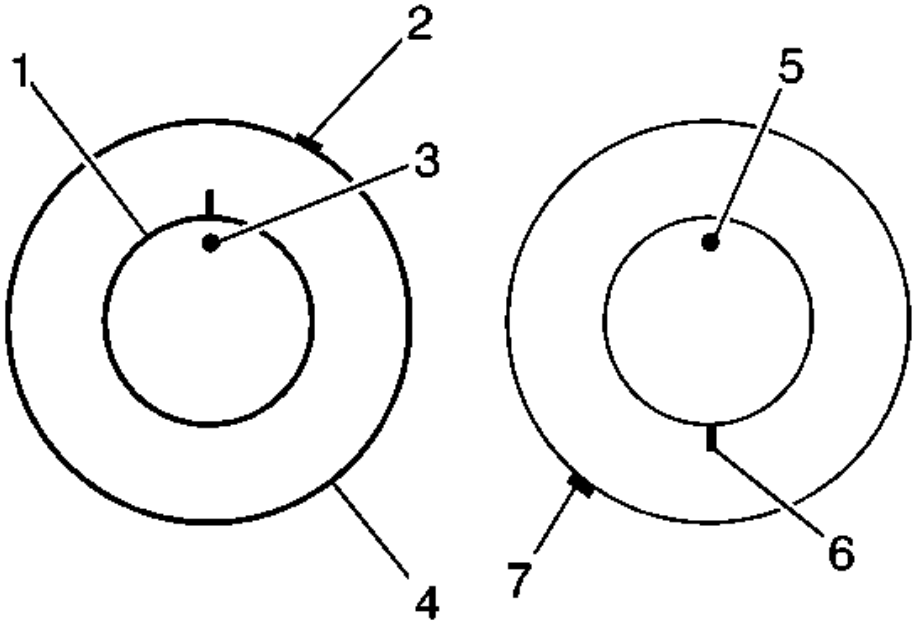


Fig. 26: View Of Match-Mounting Tire-To-Wheel
Courtesy of GENERAL MOTORS COMPANY

9. If the clock location of the high spot has moved, however the assembly runout has NOT been reduced, perform the following steps:
    1. If the clock location of the high spot (7) is now at or near a position 180 degrees from the original clock location of the high spot, the tire is the major contributor to the assembly runout concern.
    2. If the clock location of the high spot is now in-between the 2 extremes, then both the tire and the wheel are both contributing to the assembly runout concern. Rotate the tire an additional 90 degrees in both the clockwise and the counterclockwise directions to obtain the lowest amount of assembly runout.

TIRE AND WHEEL ASSEMBLY-TO-HUB/AXLE FLANGE MATCH-MOUNTING

NOTE: **After remounting a tire and wheel assembly to a hub/axle flange, remeasure the tire and wheel assembly on-vehicle runout in order to verify that the amount of runout has been reduced and brought to within tolerances.**

1. Mark the location of the high spot on the tire and wheel assembly as determined during the on-vehicle tire and wheel assembly runout measurement.
2. Place a reference mark on the wheel stud that is located closest to the wheel valve stem.
    - Always refer to the reference mark on the wheel stud as the 12 o'clock position.
    - Refer to the location of the high spot by its clock position on the tire and wheel assembly, relative to the marked wheel stud.
3. Remove the tire and wheel assembly from the hub/axle flange. Refer to **Tire and Wheel Removal and Installation** .
4. Rotate the tire and wheel assembly as close to 180 degrees as possible on the hub/axle flange, so that the wheel valve stem is now approximately at the 6 o'clock position in relation to the marked wheel stud.
5. Reinstall the wheel lug nuts to secure the tire and wheel assembly in the new position. Refer to **Tire and Wheel Removal and Installation** .
6. Remeasure the tire and wheel assembly on-vehicle runout. Mark the new location of the assembly on-vehicle runout high spot on the tire. Refer to **Tire and Wheel Assembly Runout Measurement - On-Vehicle**.
7. If the assembly on-vehicle runout has been reduced and is within tolerance, no further steps are necessary.
8. If the assembly runout has NOT been reduced, perform the following steps:
    1. If the clock location of the high spot remained at or near the original clock location of the high spot, the hub/axle flange and/or the brake rotor/drum mounting flange is the major contributor to the assembly on-vehicle runout concern.
    2. If the clock location of the high spot is now at or near a position 180 degrees from the original clock location of the high spot, the tire and wheel assembly is the major contributor to the assembly on-vehicle runout concern.
    3. If the clock location of the high spot is now in-between the 2 extremes, then both the tire and wheel assembly and the hub/axle flange are contributing to the assembly on-vehicle runout concern. Rotate the tire and wheel assembly as close to an additional 90 degrees as possible in both the clockwise and the counterclockwise directions to obtain the lowest amount of assembly on-vehicle runout.

DESCRIPTION AND OPERATION

VIBRATION THEORY AND TERMINOLOGY

Vibration Theory

The designs and engineering requirements of vehicles have undergone drastic changes over the last several years.

Vehicles are stiffer and provide more isolation from road input than they did previously. The structures of today's stiffer vehicles are less susceptible to many of the vibrations which could be present in vehicles of earlier designs, however, vibrations can still be detected in a more modern vehicle if a transfer path is created between a rotating component and the body of the vehicle.

There are not as many points of isolation from the road in many vehicles today. If a component produces a strong enough vibration, it may overcome the existing isolation and the component needs to be repaired or replaced.

The presence/absence of unwanted noise and vibration is linked to the customer's perception of the overall quality of the vehicle.

Vibration is the repetitive motion of an object, back and forth, or up and down. The following components cause most vehicle vibrations:

- A rotating component
- The engine combustion process firing impulses

Rotating components will cause vibrations when excessive imbalance or runout is present. During vibration diagnosis, the amount of allowable imbalance or runout should be considered a TOLERANCE and not a SPECIFICATION. In other words, the less imbalance or runout the better.

Rotating components will cause a vibration concern when they are not properly isolated from the passenger compartment: Engine firing pulses can be detected as a vibration if a motor mount is collapsed.

A vibrating component operates at a consistent rate (km/h, mph, or RPM). Measure the rate of vibration in question. When the rate/speed is determined, relate the vibration to a component that operates at an equal rate/speed in order to pinpoint the source. Vibrations also tend to transmit through the body structure to other components. Therefore, just because the seat vibrates does not mean the source of vibration is in the seat.

Vibrations consist of the following three elements:

- The source - the cause of the vibration
- The transfer path - the path the vibration travels through the vehicle
- The responder - the component where the vibration is felt

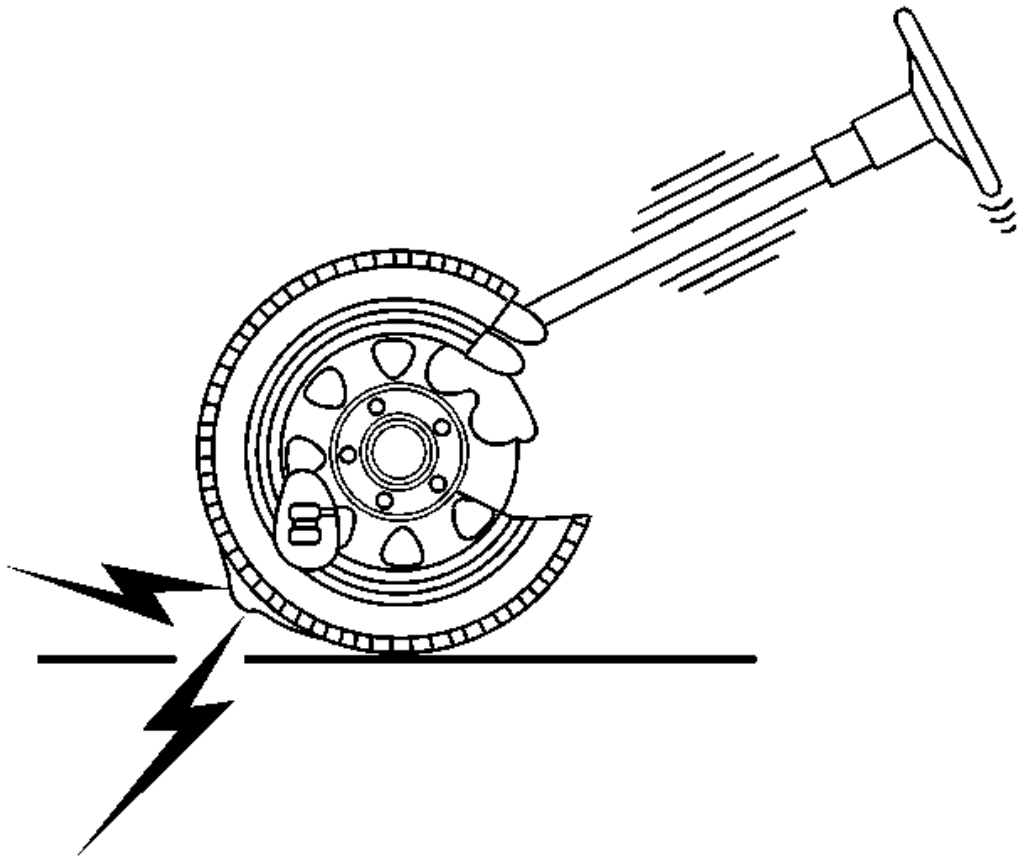


Fig. 27: Identifying Unbalanced Tire Vibration
Courtesy of GENERAL MOTORS COMPANY

In the preceding picture, the source is the unbalanced tire. The transfer path is the route the vibrations travels through the vehicle's suspension system into the steering column. The responder is the steering wheel, which the customer reports as vibrating. Eliminating any one of these three elements will usually correct the condition. Decide, from the gathered information, which element makes the most sense to repair. Adding a brace to the steering column may keep the steering wheel from vibrating, but adding a brace is not a practical solution. The most direct and effective repair would be to properly balance the tire.

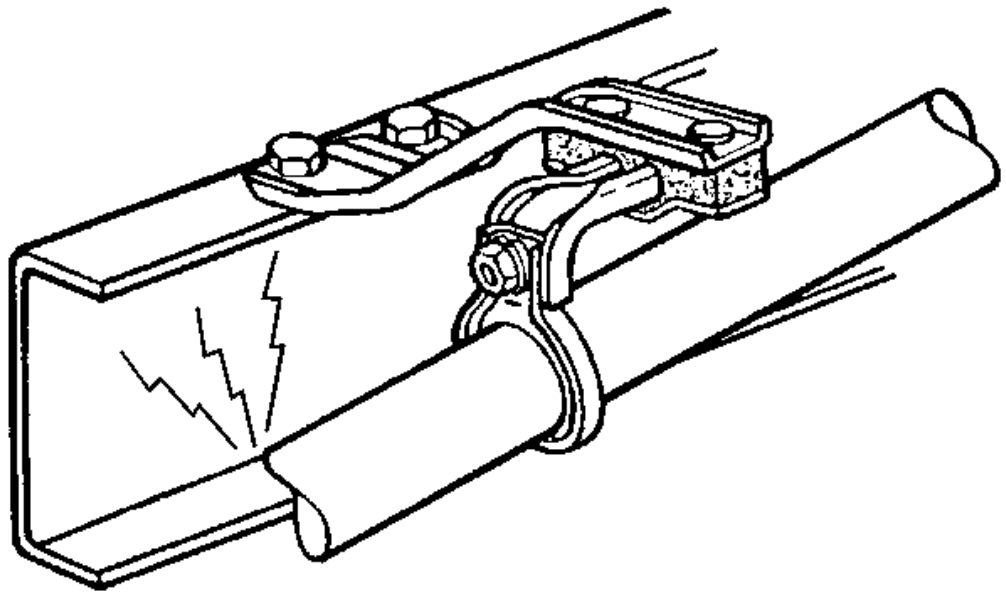


Fig. 28: Identifying Exhaust Pipe Noise
Courtesy of GENERAL MOTORS COMPANY

Vibration can also produce noise. As an example, consider a vehicle that has an exhaust pipe grounded to the frame. The source of the vibration is the engine firing impulses traveling through the exhaust. The transfer path is a grounded or bound-up exhaust hanger. The responder is the frame. The floor panel vibrates, acting as a large speaker, which produces noise. The best repair would be to eliminate the transfer path. Aligning the exhaust system and correcting the grounded condition at the frame would eliminate the transfer path.

Basic Vibration Terminology

The following are the 2 primary components of vibration diagnosis:

- The physical properties of objects
- The object's properties of conducting mechanical energy

The repetitive up and down or back and forth movement of a component cause most customer vibration complaints. The following are the common components that vibrate:

- The steering wheel
- The seat cushion
- The frame

- The IP

Vibration diagnosis involves the following simple outline:

1. Measure the repetitive motion and assign a value to the measurement in cycles per second or cycles per minute.
2. Relate the frequency back on terms of the rotational speed of a component that is operating at the same rate or speed.
3. Inspect and test the components for conditions that cause vibration.

For example, performing the following steps will help demonstrate the vibration theory:

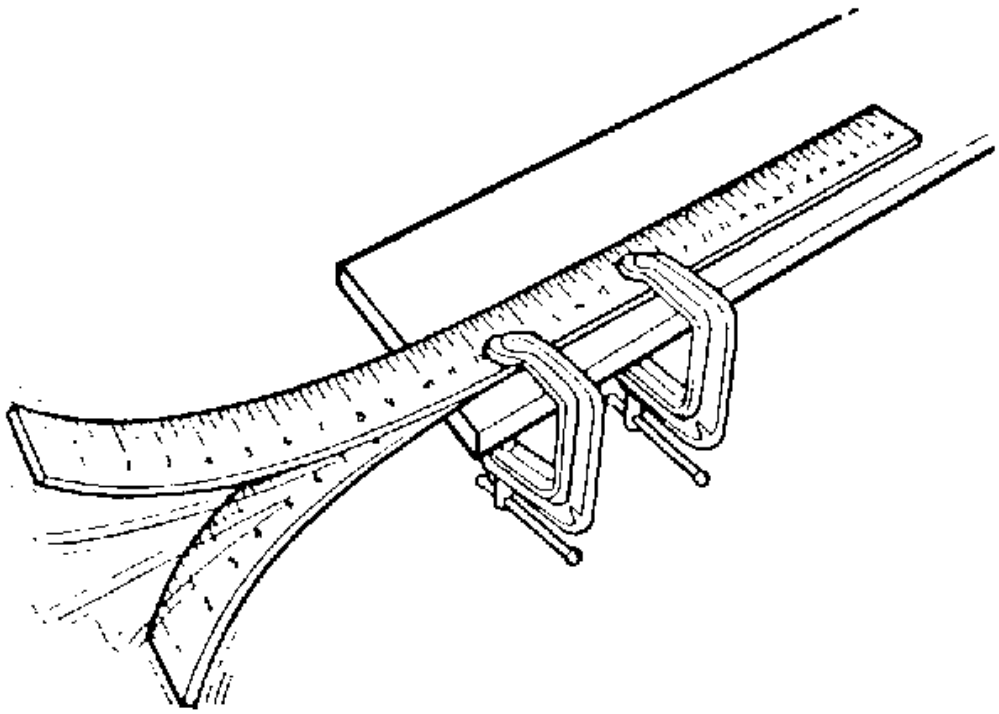


Fig. 29: Demonstrating Vibration Theory
Courtesy of GENERAL MOTORS COMPANY

1. Clamp a yardstick to the edge of a table, leaving about 50 cm (20 in) hanging over the edge of the table.
2. Pull down on the edge of the stick and release while observing the movement of the stick.

The motion of the stick occurs in repetitive cycles. The cycle begins at midpoint, continues through the lowest extreme of travel, then back past the midpoint, through the upper extreme of travel, and back to the midpoint where the cycle begins again.

The cycle occurs over and over again at the same rate, or frequency. In this case, about 10 cycles in one second. If we

measure the frequency to reflect the number of complete cycles that the yardstick made in one minute, the measure would be 10 cycles x 60 seconds = 600 cycles per minute (cpm).

We have also found a specific amount of motion, or amplitude, in the total travel of the yardstick from the very top to the very bottom. Redo the experiment as follows:

1. Reclamp the yardstick to the edge of a table, leaving about 25 cm (10 in) hanging over the edge of the table.
2. Pull down on the edge of the stick and release while observing the movement of the stick.

The stick vibrates at a much faster frequency: 30 cycles per second (1,800 cycles per minute).

Cycle

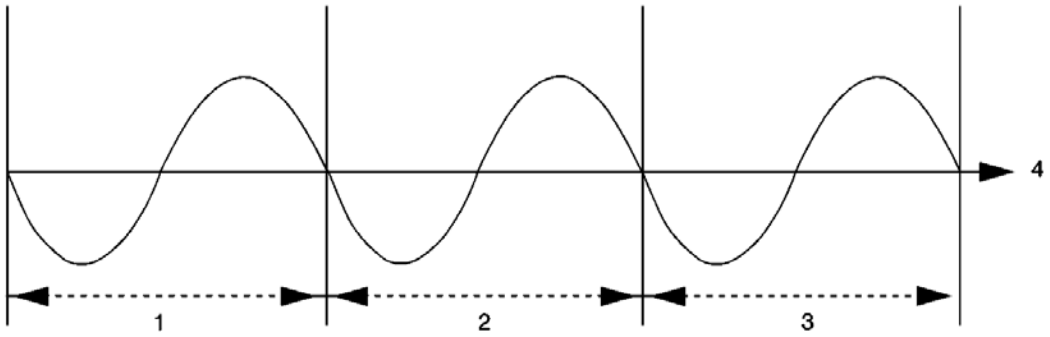


Fig. 30: Identifying Powertrain Vibration Cycles
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	1st Cycle
2	2nd Cycle
3	3rd Cycle
4	Time

Vibration Cycles in Powertrain Components

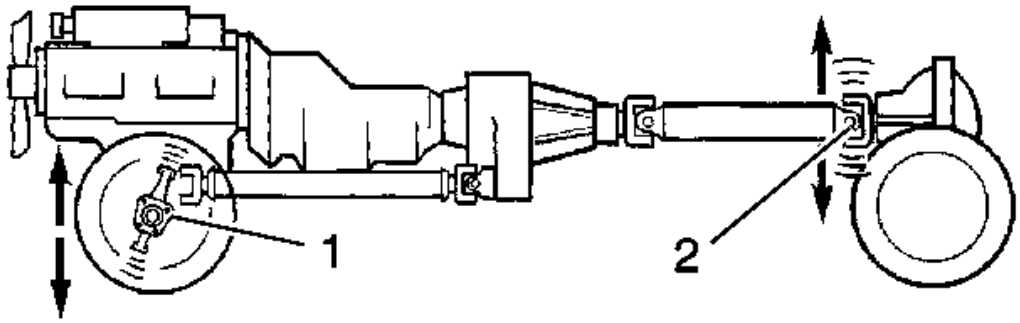


Fig. 31: Identifying Vibration Cycles In Powertrain Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Spindle
2	Pinion Nose

The word cycle comes from the same root as the word circle. A circle begins and ends at the same point, as thus, so does a cycle. All vibrations consist of repetitive cycles.

Frequency

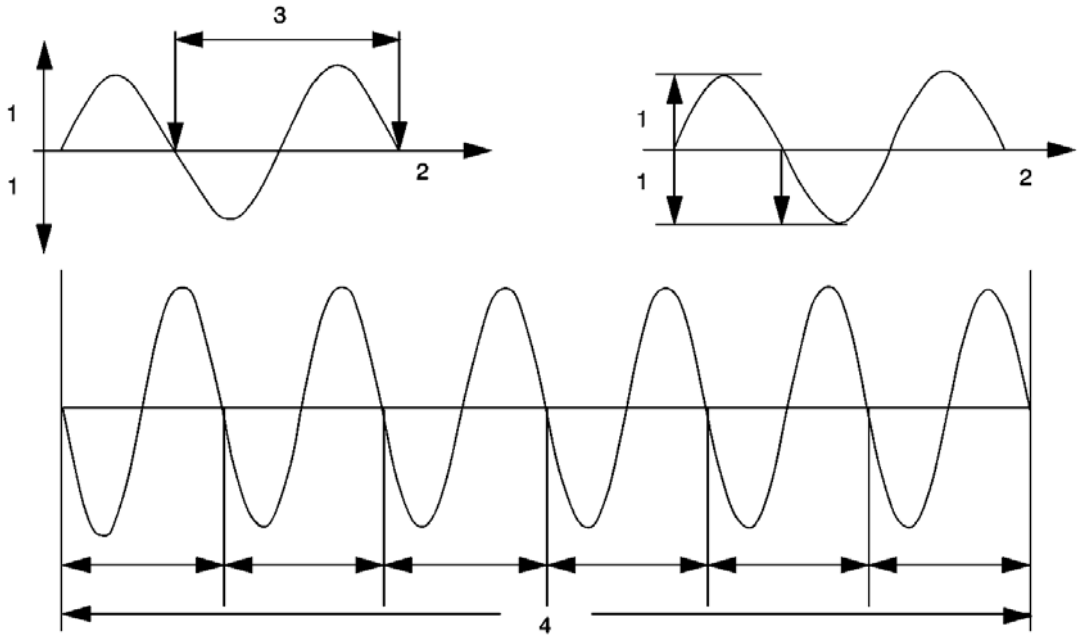


Fig. 32: Identifying Vibration Frequency
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Amplitude
2	Reference
3	Time in Seconds
4	1 Second

Frequency is defined as the rate at which an event occurs during a given period of time. With a vibration, the event is a cycle, and the period of time is 1 second. Thus, frequency is expressed in cycles per second.

The proper term for cycles per seconds is Hertz (Hz). This is the most common way to measure frequency. Multiply the Hertz by 60 to get the cycles or revolutions per minute (RPM).

Amplitude

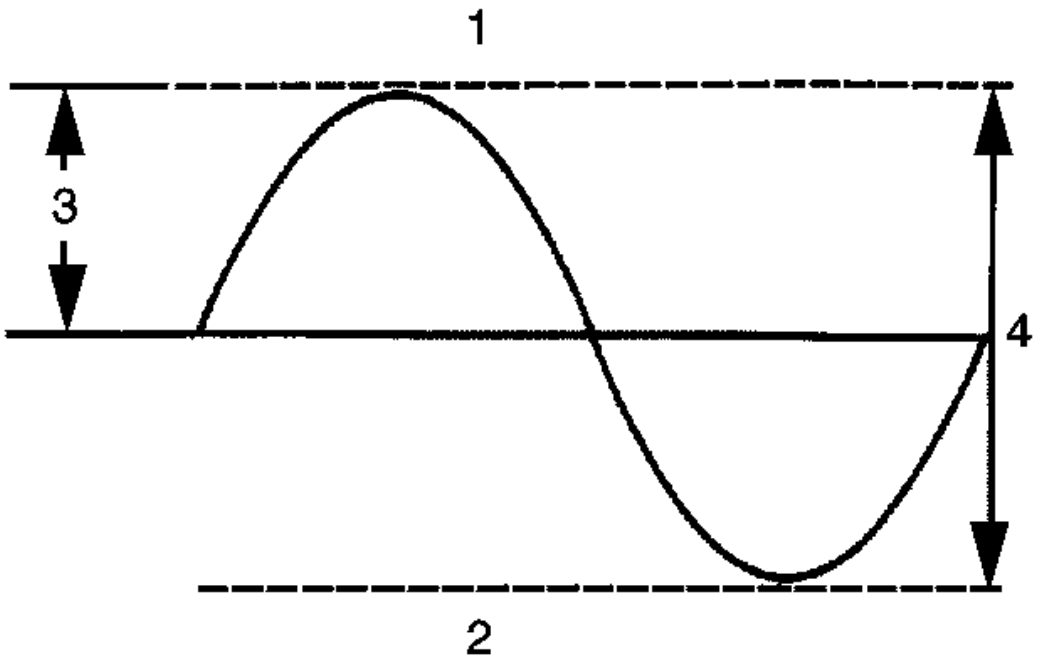


Fig. 33: Identifying Vibration Amplitude
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Maximum
2	Minimum
3	Zero-to-Peak Amplitude
4	Peak-to-Peak Amplitude

Amplitude is the maximum value of a periodically varying quantity. Used in vibration diagnostics, we are referring it to the magnitude of the disturbance. A severe disturbance would have a high amplitude; a minor disturbance would have a low amplitude.

Amplitude is measured by the amount of actual movement, or the displacement. For example, consider the vibration caused by an out-of-balance wheel at 80 km/h (50 mph) as opposed to 40 km/h (25 mph). As the speed increases, the amplitude increases.

Free Vibration

Free vibration is the continued vibration in the absence of any outside force. In the yardstick example, the yardstick continued to vibrate even after the end was released.

Forced Vibration

Forced vibration is when an object is vibrating continuously as a result of an outside force.

Centrifugal Force Due to an Imbalance

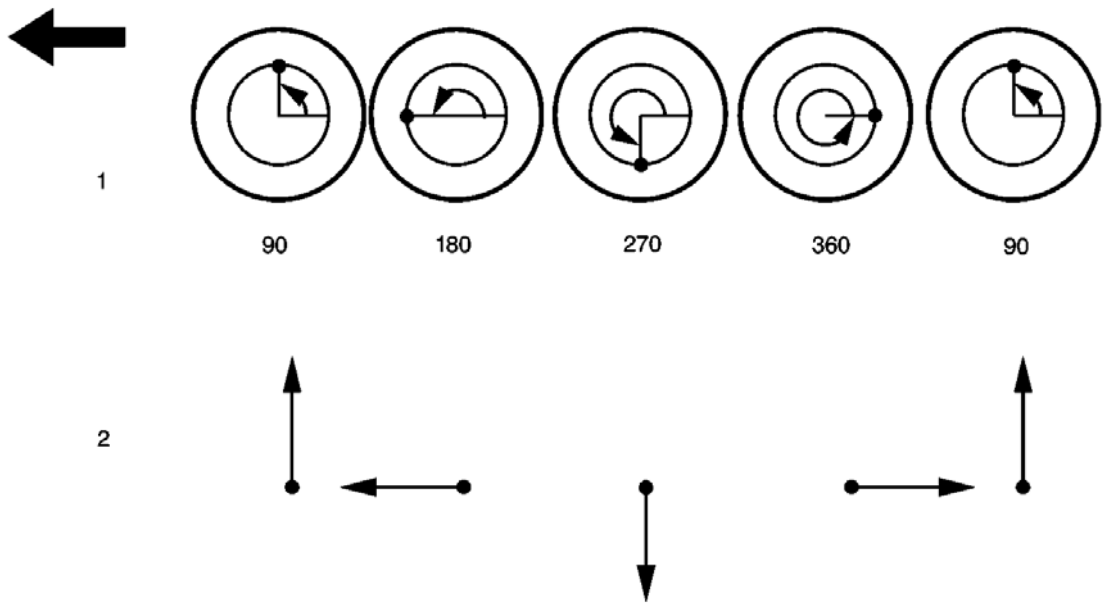


Fig. 34: Identifying Centrifugal Force Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Location of Imbalance (Degrees)
2	Centrifugal Force Acting on Spindle

A spinning object with an imbalance generates a centrifugal force. Performing the following steps will help to demonstrate centrifugal force:

1. Tie a nut to a string.
2. Hold the string. The nut hangs vertically due to gravity.
3. Spin the string. The nut will spin in a circle.

Centrifugal force is trying to make the nut fly outward, causing the pull you feel on your hand. An unbalanced tire follows the same example. The nut is the imbalance in the tire. The string is the tire, wheel, and suspension assembly. As the vehicle speed increases, the disturbing force of the unbalanced tire can be felt in the steering wheel, the seat, and the floor. This disturbance will be repetitive (Hz) and the amplitude will increase. At higher speeds, both the frequency and the amplitude will increase. As the tire revolves, the imbalance, or the centrifugal force, will alternately lift the tire up and force the tire downward, along with the spindle, once for each revolution of the tire.

Natural or Resonant Frequency

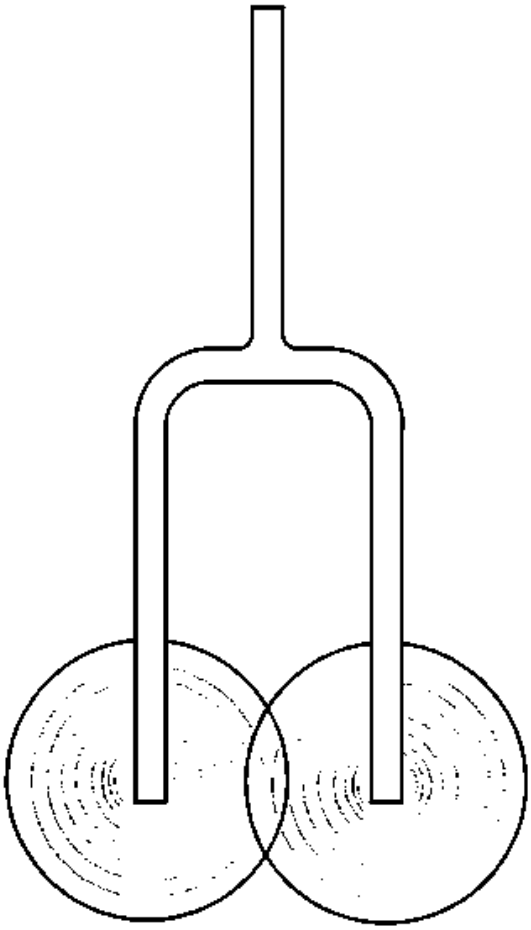


Fig. 35: View Of Natural Frequency
Courtesy of GENERAL MOTORS COMPANY

The natural frequency is the frequency at which an object tends to vibrate. Bells, guitar strings, and tuning forks are all examples of objects that tend to vibrate at specific frequencies when excited by an external force.

Suspension systems, and even engines within the mounts, have a tendency to vibrate at certain frequencies. This is why some vibration complaints occur only at specific vehicle speeds or engine RPM.

The stiffness and the natural frequency of a material have a relationship. Generally, the stiffer the material, the higher the natural frequency. The opposite is also true. The softer a material, the lower the natural frequency. Conversely, the greater the mass, the lower the natural frequency.

Resonance

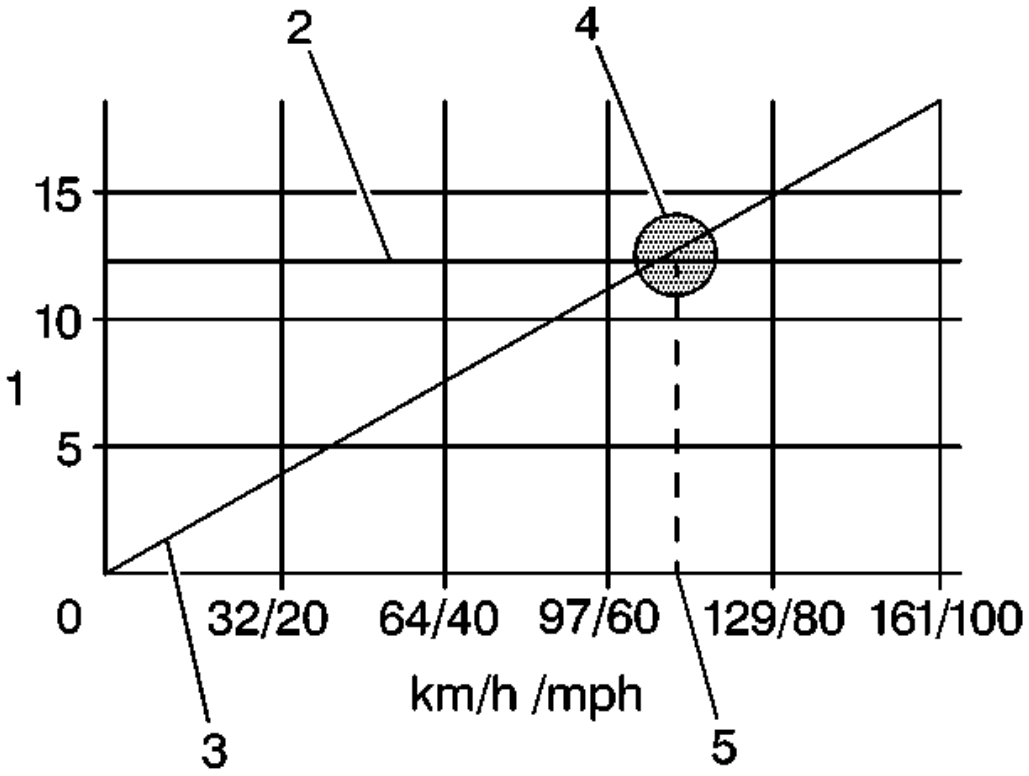


Fig. 36: Natural Frequency Of A Typical Automotive Front Suspension
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Frequency - cps
2	Suspension Frequency
3	Unbalanced Excitation
4	Point of Resonance
5	Problem Speed

All objects have natural frequencies. The natural frequency of a typical automotive front suspension is in the 10-15 Hz range. This natural frequency is the result of the suspension design. The suspension's natural frequency is the same at all vehicle speeds. As the tire speed increases along with the vehicle speed, the disturbance created by the tire increases in frequency. Eventually, the frequency of the unbalanced tire will intersect with the natural frequency of the suspension. This causes the suspension to vibrate. The intersecting point is called the resonance.

The amplitude of a vibration will be greatest at the point of resonance. While the vibration may be felt above and below the problem speed, the vibration may be felt the most at the point of resonance.

Damping

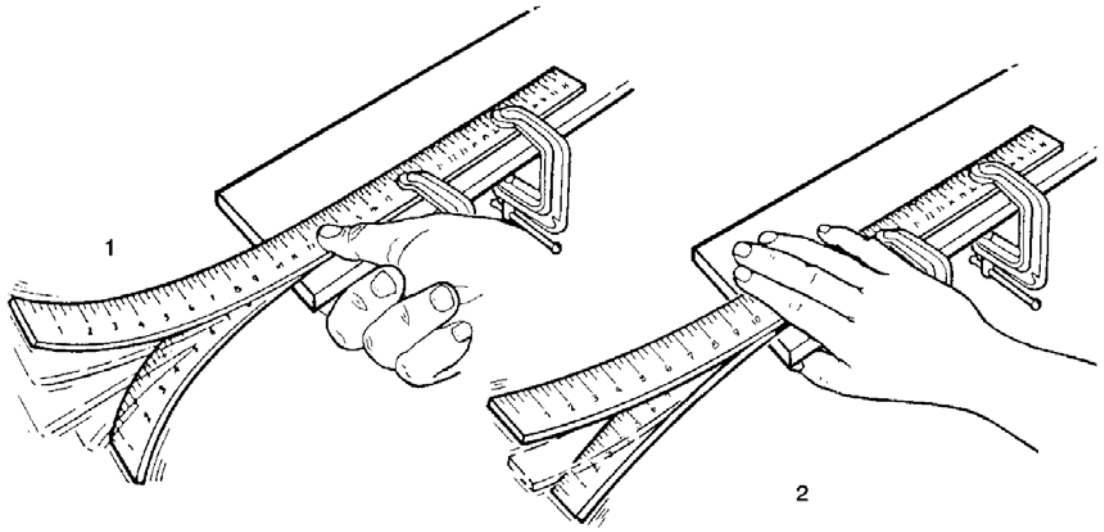


Fig. 37: Identifying Low & High Damping
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Low Damping
2	High Damping

Damping is the ability of an object or material to dissipate or absorb vibration. The automotive shock absorber is a good example. The function of the shock absorber is to absorb or dampen the oscillations of the suspension system.

Beating (Phasing)

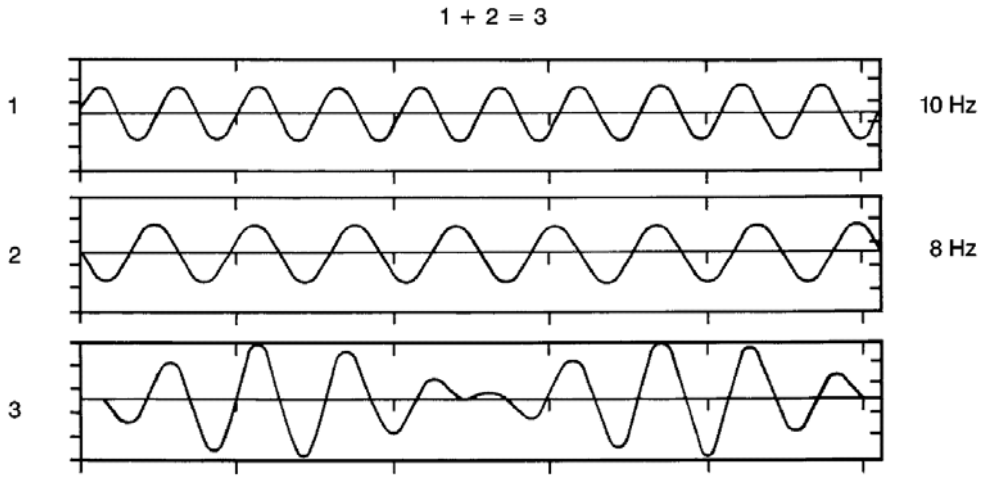


Fig. 38: Identifying Beating Or Phasing
Courtesy of GENERAL MOTORS COMPANY

Two separate disturbances that are relatively close together in frequency will lead to a condition called beating, or phasing. A beating vibration condition will increase in intensity or amplitude in a repetitive fashion as the vehicle travels at a steady speed. This beating vibration can produce the familiar droning noise heard in some vehicles.

Beating occurs when 2 vibrating forces are adding to each other's amplitude. However, 2 vibrating forces can also subtract from each other's amplitude. The adding and subtracting of amplitudes in similar frequencies is called beating. In many cases, eliminating either one of the disturbances can correct the condition.

Order

Order refers to how many times an event occurs during 1 revolution of a rotating component.

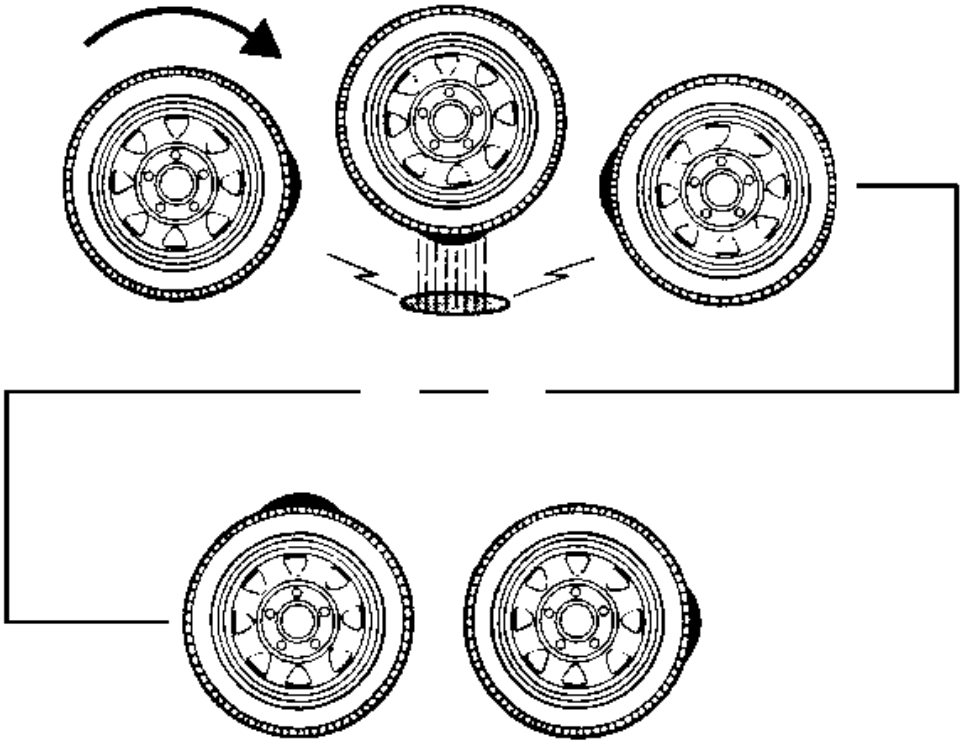


Fig. 39: Identifying First-Order Vibration
Courtesy of GENERAL MOTORS COMPANY

For example, a tire with 1 high spot would create a disturbance once for every revolution of the tire. This is called first-order vibration.

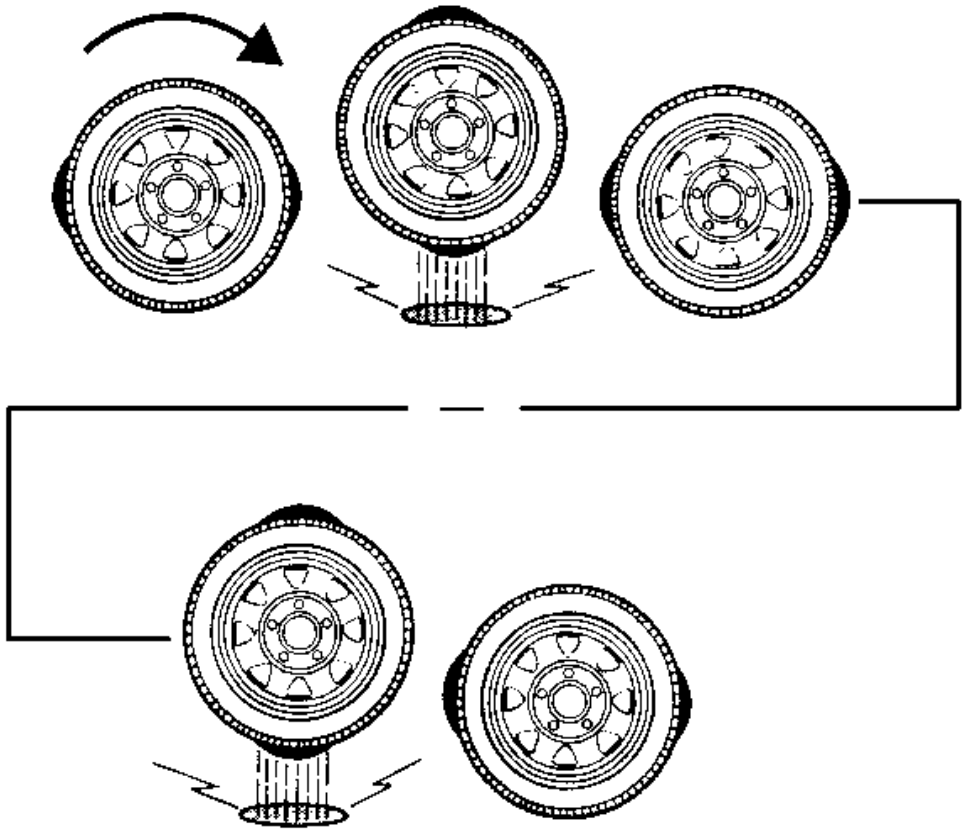


Fig. 40: Identifying Second-Order Vibration
Courtesy of GENERAL MOTORS COMPANY

An oval-shaped tire with 2 high spots would create a disturbance twice for every revolution. This is called second-order vibration. Three high spots would be third-order, and so forth. Two first-order vibrations may add or subtract from the overall amplitude of the disturbance, but that is all. Two first-order vibrations do not equal a second-order. Due to centrifugal force, an unbalanced component will always create at least a first-order vibration.

ELECTRONIC VIBRATION ANALYZER (EVA) DESCRIPTION AND OPERATION

Special Tools

- **EL-38792-25** Inductive Pickup Timing Light
- **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2)

For equivalent regional tools, refer to **Special Tools and Equipment**.

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) , is a 12-volt powered hand-held device, similar to a scan tool, which receives input from an attached vibration sensor or accelerometer and displays the most dominate input frequency(ies) (up to three) on its liquid crystal display. The vibration concern frequency(ies) are obtained through the use of the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) while following the Vibration Analysis Diagnostic Tables. The frequency(ies) obtained, when applied to the Vibration Analysis Diagnostic Tables, are used as a primary

input to help determine the source of the vibration concern.

EVA Vibration Sensor

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor incorporates a 6.1 m (20 ft) cord, that allows the sensor to be placed on virtually any component of the vehicle where a vibration concern is felt.

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) contains 2 sensor input ports which can be activated individually to allow for 2 individual vibration sensor inputs. The vibration sensors can then be placed in 2 different locations in the vehicle and their individual inputs can be read without having to stop a test, move the sensor and resume the test. The use of 2 vibration sensors can help in more quickly finding and recording an accurate frequency of the vibration concern, and in more quickly making comparisons between 2 different areas of a single component, or a vehicle system, during the diagnostic process.

EVA Vibration Sensor Placement

Proper placement of the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor (accelerometer) is critical to ensure that proper vibration readings are obtained by the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2). The vibration sensor should be placed on the specific vehicle component identified as being the most respondent to the vibration. If no component has been identified, install the sensor to the steering column as a starting point.

EVA Vibration Sensor-to-Component Attachment

NOTE: The EL-38792-A Electronic Vibration Analyzer 2 (EVA 2) vibration sensor must be attached to vehicle components in the manner indicated in order to achieve accurate frequency readings of the vibration disturbance.

The vibration sensor of the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) is designed to pickup disturbances which primarily occur in the vertical plane, since most vibrations are felt in that same up-and-down direction. The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor is therefore directional sensitive and must be attached to vehicle components such that the side of the sensor marked UP is always facing upright and the sensor body is as close to horizontal as possible. The sensor must be installed in the exact same position each time tests are repeated or comparisons are made to other vehicles.

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor can be attached to vehicle components in various ways. For non-ferrous surfaces, such as the shroud of a steering column, the sensor can be attached using putty, or hook and loop fasteners. For ferrous surfaces, the sensor can be attached using a magnet supplied with the sensor.

EVA Software Cartridge

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) uses a software cartridge, the GE-38792-60, which provides various information to the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2). The GE-38792-60 provides the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) with an additional feature which can be selected and utilized to assist in diagnosing vibration concerns.

NOTE: The Auto-Mode function of the EL-38792-A Electronic Vibration Analyzer 2 (EVA 2) cartridge, GE-38792-60, is designed to be used in SUPPORT of the Vibration Analysis Diagnostic Tables ONLY.

This support-feature is available through the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) Auto-Mode function. When selected, the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) will prompt the user to select

which one of 2 vehicle systems (vehicle speed or engine speed), is the SUSPECTED source of the vibration concern. Using the inputted vehicle data parameters along with the most dominate vibration frequency obtained, it will identify a SUSPECTED source of the vibration concern, such as first-order tire and wheel. This can be a useful feature when used in conjunction with the Vibration Analysis Diagnostic Tables, to confirm results obtained through the diagnostic process.

EVA Smart Strobe Function

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) can be used to identify some rotating components/systems which exhibit imbalance IF the component rotational speed is the dominant frequency of the vibration concern. The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) is equipped with a strobe light trigger wire which can be used with an inductive pickup timing light, **EL-38792-25** Inductive Pickup Timing Light , or equivalent included with the GE-38792-25-KIT, or available separately. Using the Smart Strobe function enables the user to input the vibration frequency to which the strobe will flash. By marking the suspected rotating component, such as a pulley, adjusting the strobe frequency to match the dominant vibration frequency at the engine RPM noted during diagnosis, and then operating the engine at that specific RPM, the mark on the object will appear to be stationary if that object is imbalanced.

EVA Strobe Balancing Function

The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) can be used to identify the light spot on a propeller shaft IF the propeller shaft rotational speed is the dominant frequency of the vibration concern. The **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) is equipped with a strobe light trigger wire which can be used with an inductive pickup timing light, **GE-38792-25** Inductive Pickup Timing Light , or equivalent included with the J-38792-25-KIT, or available separately, and in conjunction with the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor to identify the light spot on a propeller shaft and to help in making a determination as to when propeller shaft balance is obtained.

Averaging/Non-Averaging Modes

The EVA provides 2 modes of displaying the most dominate frequencies which the EVA vibration sensor (accelerometer) detects; averaging and non-averaging (instantaneous).

The averaging mode uses multiple vibration samples taken over a period of time and then displays the most dominant frequencies which have been averaged-out. Using the averaging mode minimizes the distractions caused by a sudden vibration frequency being displayed that is not related to the concern vibration, such as from pot holes or from uneven road surfaces.

The non-averaging (instantaneous) mode is more sensitive to vibration disturbances than the averaging mode. Using the non-averaging mode will generate instantaneous frequency displays which are not averaged across multiple samples over a period of time; the specific vibration frequencies that occur at a specific moment during diagnostic testing will be displayed at that moment. The non-averaging (instantaneous) mode is useful when measuring a vibration disturbance that exists for only a short period of time or during acceleration/deceleration testing.

When operating the EVA in the averaging mode along with the Auto Mode, "A" will be displayed along the top of the screen to the left of the vibration sensor input port being used. When operating the EVA in the averaging mode and the Manual Mode, "AVG" will be displayed along the top center of the screen.

When operating the EVA in the non-averaging (instantaneous) mode along with the Auto Mode, "I" will be displayed along the top of the screen to the left of the vibration sensor input port being used. When operating the EVA in the non-averaging (instantaneous) mode and the Manual Mode, the top center of the screen will be blank.

EVA Display

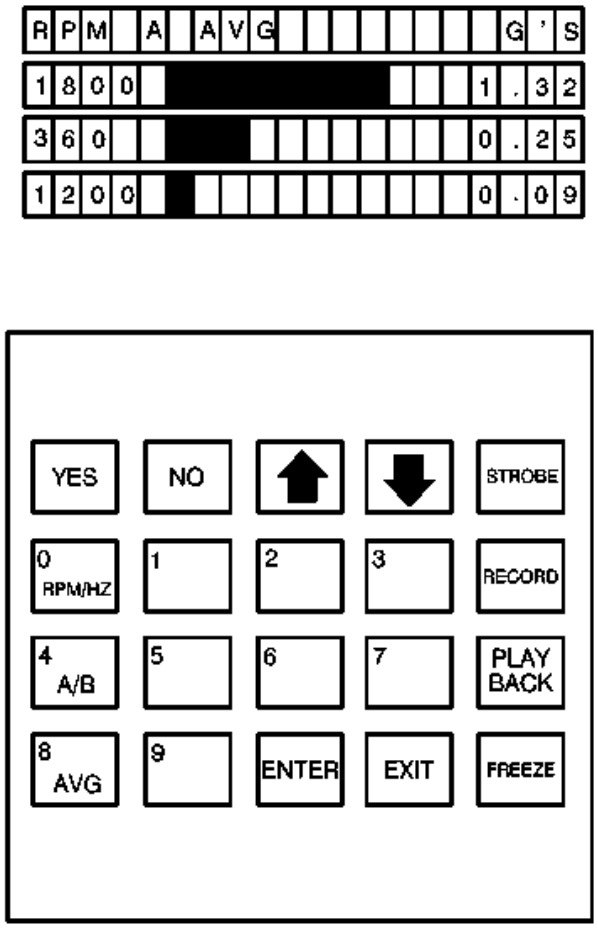


Fig. 41: View Of EVA Display
Courtesy of GENERAL MOTORS COMPANY

The most dominant input frequencies, up to three, received from the **EL-38792-A** Electronic Vibration Analyzer 2 (EVA 2) vibration sensor, are displayed in descending order of amplitude strength.

The frequency readings are displayed along the left side of the screen, followed to the right by either a bar graph or the suspected source of the vibration - depending upon the mode selected, then the amplitude reading for each frequency along the right side of the screen. The top row of the screen indicates the units of measure being displayed for the frequencies along the left side and for the amplitudes along the right side. The top row also indicates the vibration sensor input port which was selected on the keypad (A or B) and which mode was selected: averaging or non-averaging (instantaneous).

The frequency(ies) can be displayed in either revolutions per minute (RPM) or revolutions per second; Hertz (Hz). The selected display type (RPM or Hz) will be indicated at the left side of the screen, above the frequency readings.

When the AUTO MODE function is not in use, a bar graph is displayed next to each frequency to provide a quick visual indication of the relative amplitude strength.

When the AUTO MODE function is being used, the suspected source of the vibration is displayed next to each frequency to provide support to the diagnostic process.

The actual amplitude strength of each frequency is displayed at the right side of the screen and shown in G's-of-acceleration force.

OSCILLOSCOPE DIAGNOSTIC KIT DESCRIPTION AND OPERATION

Special Tools

- **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH)
- **EL-47966** Multi Diagnostic Interface MDI

For equivalent regional tools, refer to **Special Tools and Equipment**.

The **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) is an automotive oscilloscope which receives input from an attached accelerometer and displays all input frequencies on a laptop or tablet computer. The vibration concern frequency(ies) are obtained through the use of the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) hardware, while vehicle component speed data is gathered through the **EL-47966** Multi Diagnostic Interface MDI. The MDI data is integrated into the Oscilloscope software so that vibration(s) can be tied to specific vehicle components based on their speed to determine the source of the vibration concern.

Oscilloscope Inputs

The **CH-51450-TA183** accelerometer incorporates a 3 m (9.8 ft) cord that allows the sensor to be placed on virtually any component of the vehicle where a vibration concern is felt. The accelerometer uses a self-powered NVH interface module. The NVH interface module uses a replaceable battery. Input B is the default port for a single accelerometer. The cord used to connect the NVH interface module to the **CH-51450-NVH** Oscilloscope is 5 m (16.4 ft) long.

Input D is used for the **CH-51450-TA186** optical tachometer sensor which is used during driveline balancing. It incorporates a 2.5 m (8.2 ft) cord and a 5 m (16.4 ft) cord.

There is also an optional microphone that can be used with the **CH-51450-NVH** Oscilloscope.

Oscilloscope Accelerometer Placement

Proper placement of the **CH-51450-TA183** accelerometer is critical to ensure that proper vibration readings are obtained by the **CH-51450-NVH** Oscilloscope. The accelerometer should be placed on the drivers side inboard seat track. Once a baseline reading has been taken, the accelerometer can be placed on the point of the customer concern to verify what the customer is hearing or feeling.

Oscilloscope Accelerometer-to-Component Attachment

NOTE: **The CH-51450-TA183 accelerometer must be attached to vehicle components in the manner indicated in order to achieve accurate frequency readings of the vibration disturbance.**

The accelerometer of the **CH-51450-NVH** Oscilloscope is designed to pick up disturbances which primarily occur in the vertical plane, since most vibrations are felt in that same up-and-down direction. The **CH-51450-TA183** accelerometer is therefore directionally sensitive, and must be attached to vehicle components such that the cord end is always facing upright, and the sensor body is as close to horizontal as possible. The sensor must be installed in the exact same position each time tests are repeated, or comparisons are made to other vehicles.

The **CH-51450-TA183** accelerometer can be attached to vehicle components in various ways. For non-ferrous surfaces, such as the shroud of a steering column, the sensor can be attached using putty, or hook and loop fasteners. For ferrous surfaces, the sensor can be attached using the **CH-51450-TA096** magnet supplied with the sensor. For

hard aluminum surfaces, a ferrous washer can be glued on using a cyanoacrylate (super glue) and then the magnet can be used.

NVH Software Set-up

Fig. 42: Identifying NVH Software Set-Up Display Screen
Courtesy of GENERAL MOTORS COMPANY

When the NVH software is first opened and the NVH tab is selected, there is a set-up wizard within the **CH-51450-NVH** NVH software which has a step-by-step guide to ensure the **CH-51450-NVH** Oscilloscope and MDI are connected correctly, and to input the vehicle information.

Oscilloscope NVH Display

The **CH-51450-NVH** Oscilloscope display consists of three tabs:

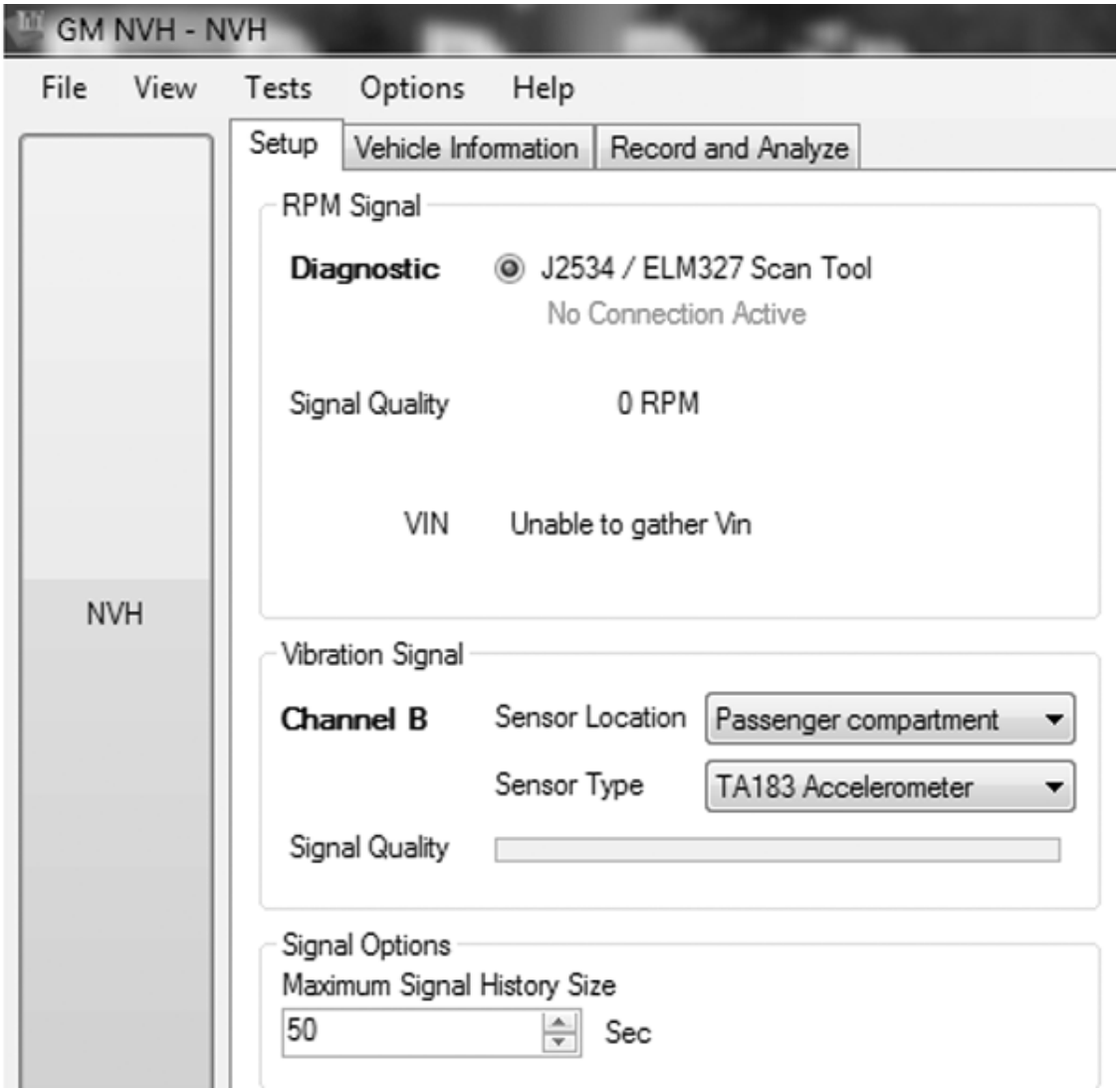


Fig. 43: Identifying Oscilloscope NVH Set-Up Display Screen
Courtesy of GENERAL MOTORS COMPANY

The first tab is set-up. The set-up information can be entered here if not already done through the set-up wizard. It can also be updated here, if necessary. A laptop or desktop computer, **EL-47966** Multi Diagnostic Interface MDI , **CH-51450-NVH** Oscilloscope , **CH-51450-TA148** NVH interface, and **CH-51450-TA183** accelerometer are needed to do a vibration analysis.

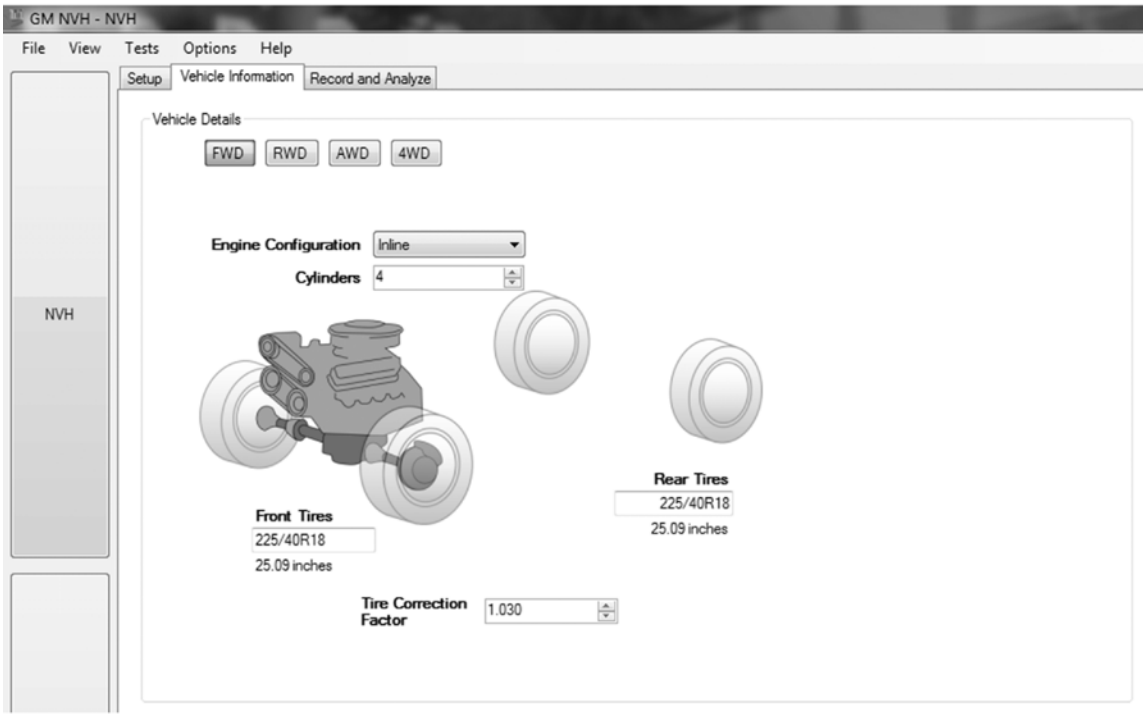


Fig. 44: Identifying Oscilloscope NVH Vehicle Information Display Screen
Courtesy of GENERAL MOTORS COMPANY

The second tab is vehicle information. The vehicle information can be entered here if not already done through the set-up wizard. It can also be updated here, if necessary.

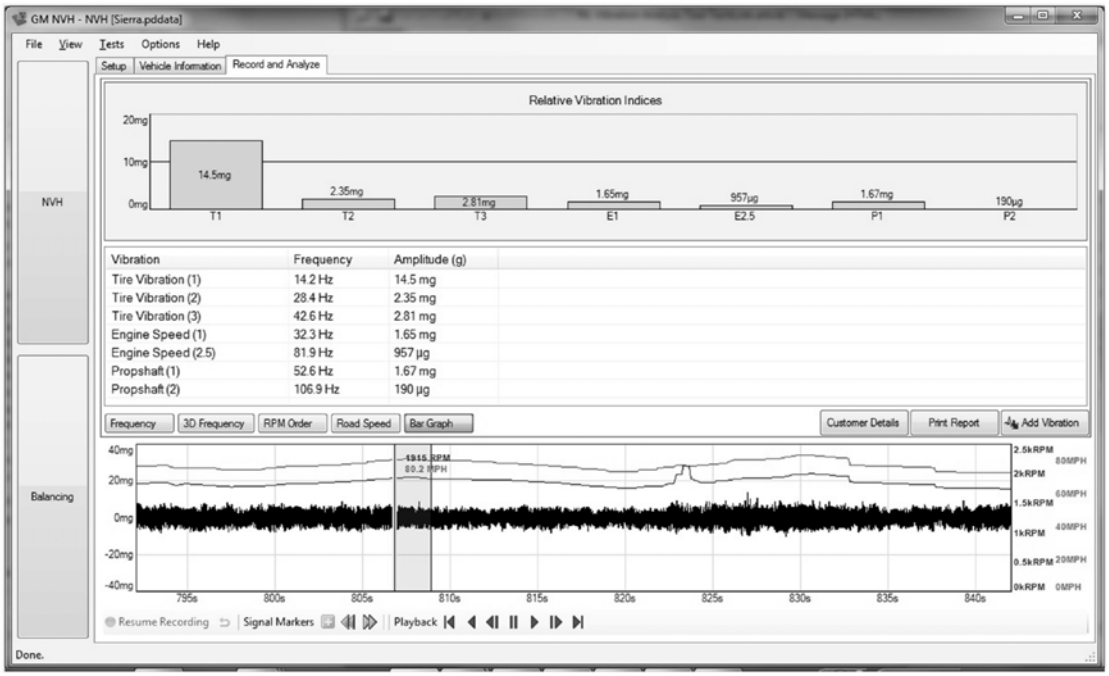


Fig. 45: Identifying Oscilloscope NVH Record And Analyze Display Screen
Courtesy of GENERAL MOTORS COMPANY

The third tab is the record and analyze tab. The standard display will show the known input frequencies received from the **CH-51450-TA183** accelerometer as a bar graph at the top of the screen. At the middle of the screen, the input frequencies are listed as text. The frequency(ies) are displayed in Hertz (Hz). If desired, the frequency(ies) can be displayed in RPM by clicking Options, then Advanced Options. The actual amplitude strength of each frequency is displayed and shown in g's of acceleration (expressed to the thousandth of a force of gravity, or "milli-g"). At the bottom of the screen, it also shows a plot of all frequency inputs along with engine speed in blue, and vehicle speed in red. The data can be saved in 50 second increments. The data can then be saved by clicking File, then Save. Files that are saved can then be loaded into the software by clicking File, then Load.

Oscilloscope Balancing

The **CH-51450-NVH** Oscilloscope with balancing software can be used to identify some rotating component/systems which exhibit imbalance IF the component rotational speed is the dominant frequency of the vibration concern. The **CH-51450-NVH** Oscilloscope is used with the **CH-51450-TA186** optical tachometer sensor. The optical tachometer sensor directly measures component rotational speed so a known weight can be added for a baseline reading. Then the oscilloscope will determine where to add a specific amount of weight to the component.

For example, the **CH-51450-NVH** Oscilloscope can be used to balance the driveline on rear wheel drive and all wheel drive vehicles. The methods that can be employed are a tuned weight approach for drivelines that use couplers and a dual hose clamp approach for drivelines that use CV or two-axis universal joints. The balancing process consists of the **CH-51450-TA186** optical tachometer sensor to directly read the driveline speed and software that directs where the weights should be placed depending on the type of driveline/propeller shaft being balanced.

Oscilloscope Balancing Software Set-up

Fig. 46: Identifying Oscilloscope Balancing Software Set-Up Display Screen
Courtesy of GENERAL MOTORS COMPANY

When the NVH software is first opened and the Balancing tab is selected, a pop-up box within the **CH-51450-NVH** balancing software will ask which type of balancing method is to be used. The two methods are pinion flange or hose clamp. Then either the wizard (which will walk through the connections and input data) or advanced configuration can be chosen to input the initial information and start the balancing procedure.

Oscilloscope Balancing Display

The propeller shaft balancing will consist of an initial run, three calibration runs, and a verification run. The software will walk through what is required for each run.

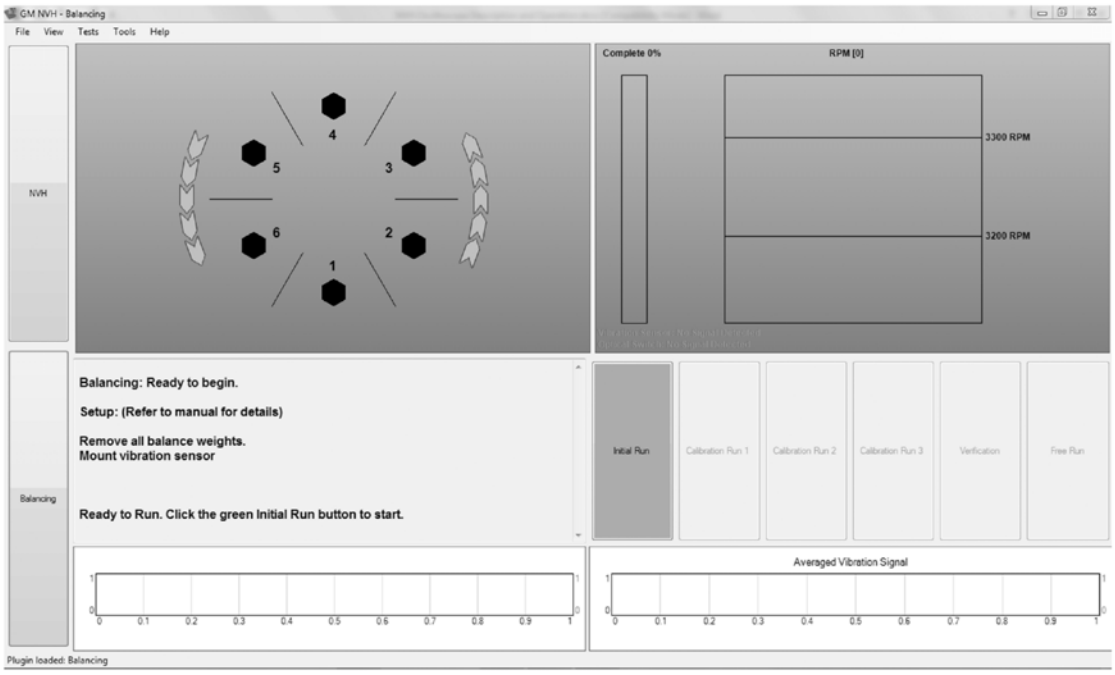


Fig. 47: Identifying Pinion Flange Balancing Screen
Courtesy of GENERAL MOTORS COMPANY

An example of the pinion flange balancing screen is shown above.

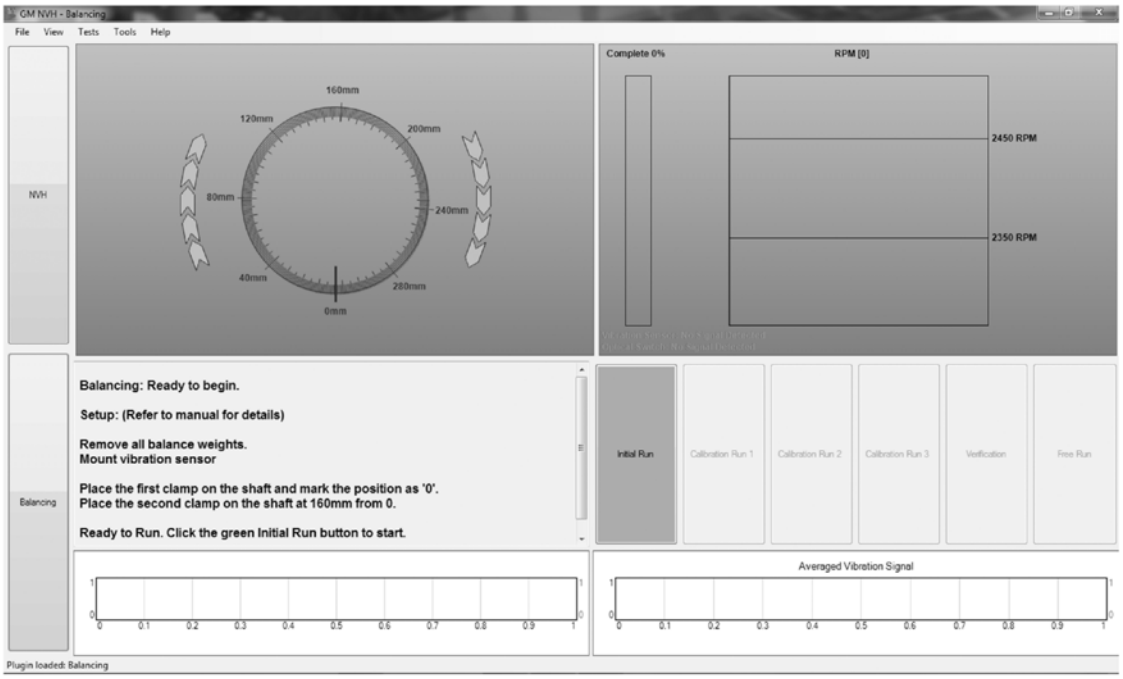


Fig. 48: Identifying Hose Clamp Balancing Screen
Courtesy of GENERAL MOTORS COMPANY

An example of the hose clamp balancing screen is shown above.

VIBRATE SOFTWARE DESCRIPTION AND OPERATION

The **EL-38792-VS** Vibrate Software , is a computer software program which is designed to be used in support of the Vibration Analysis diagnostic tables, along with the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 , and a scan tool, to help in determining the source of a vibration concern. The **EL-38792-VS** Vibrate Software is designed to provide quick calculations and produce a chart of the rotational speeds and frequency ranges for specific vehicle systems and components, based upon vehicle data parameters inputted by the user.

The **EL-38792-VS** Vibrate Software uses the vehicle data parameters, such as axle ratio, number of engine cylinders, etc. to create the base chart, depicting the relationships of the various vehicle systems and/or components. The chart view can be modified to show data related to vehicle speed only, engine speed only, or both vehicle speed and engine speed. The user can then plot the dominant frequency reading obtained on the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 which correlates with the vibration concern, and the engine RPM obtained on a scan tool which correlates with the concern. Once these pieces of data are correctly plotted, the chart will point to the source of the vibration concern, which should confirm the results obtained through the Vibration Analysis diagnostic tables.

The **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) includes a version of the vibrate software within its help file.

REED TACHOMETER DESCRIPTION

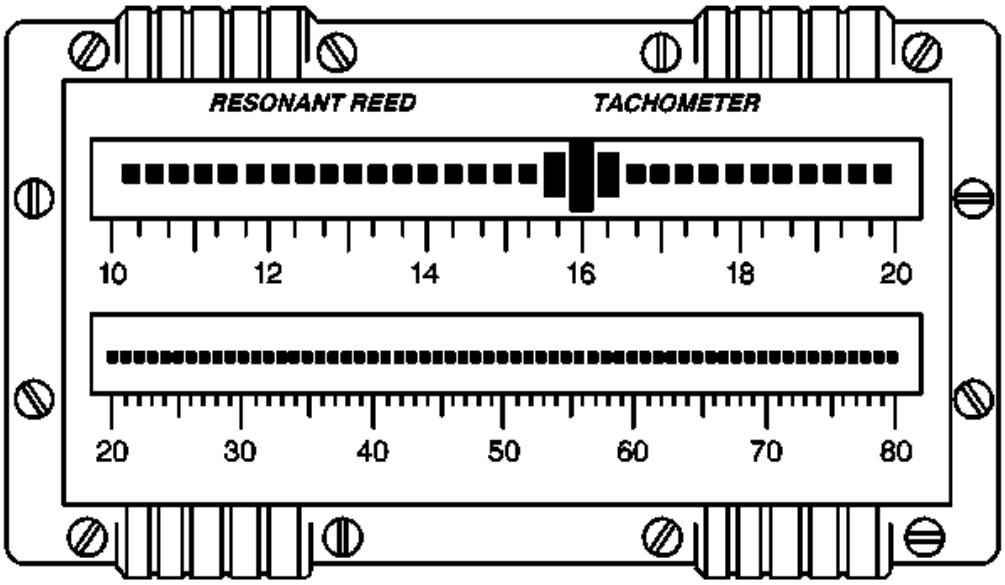


Fig. 49: Identifying Reed Tachometer
Courtesy of GENERAL MOTORS COMPANY

The reed tachometer consists of 2 rows of reeds arranged side-by-side. Each reed is tuned to vibrate or resonate when it is excited by a specific frequency. The reeds are arranged by their specific resonant frequency, increasing from left to right, ranging from 10-80 Hz. This arrangement allows for a visual display of the most dominate frequencies which fall within this range.

The reed tachometer can be a helpful diagnostic tool, however it is extremely sensitive to external inputs that are not related to the vibration concern, such as rough road surfaces, etc., and it is difficult to master its use. Due to these conditions, the reed tachometer has limited diagnostic capability.

Due to the limited diagnostic capability, limited availability and increasing costs of the reed tachometer, it is NOT recommended as the primary tool to use in diagnosing a vibration concern.

When diagnosing a vibration concern, use the **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or the **EL-38792-A** Electronic Vibration Analyzer (EVA) 2. The **CH-51450-NVH** Oscilloscope Diagnostic Kit (w/NVH) or thd **EL-38792-A** Electronic Vibration Analyzer (EVA) 2 have been designed to overcome the shortcomings to the reed tachometer. Refer to **Oscilloscope Diagnostic Kit Description and Operation**, or **Electronic Vibration Analyzer (EVA) Description and Operation**.

SPECIAL TOOLS AND EQUIPMENT

Illustration	Tool Number/Description

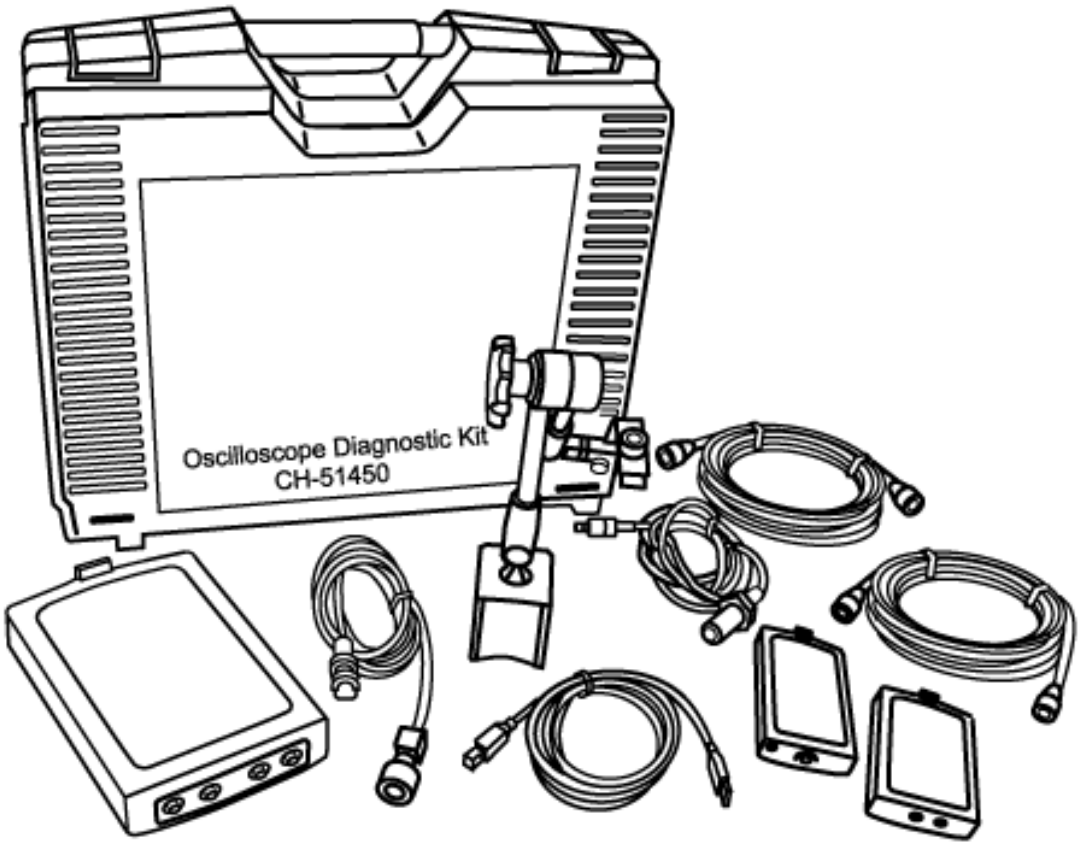
Illustration	Tool Number/Description
	CH 51450-NVH Oscilloscope Diagnostic Kit (w/NVH)

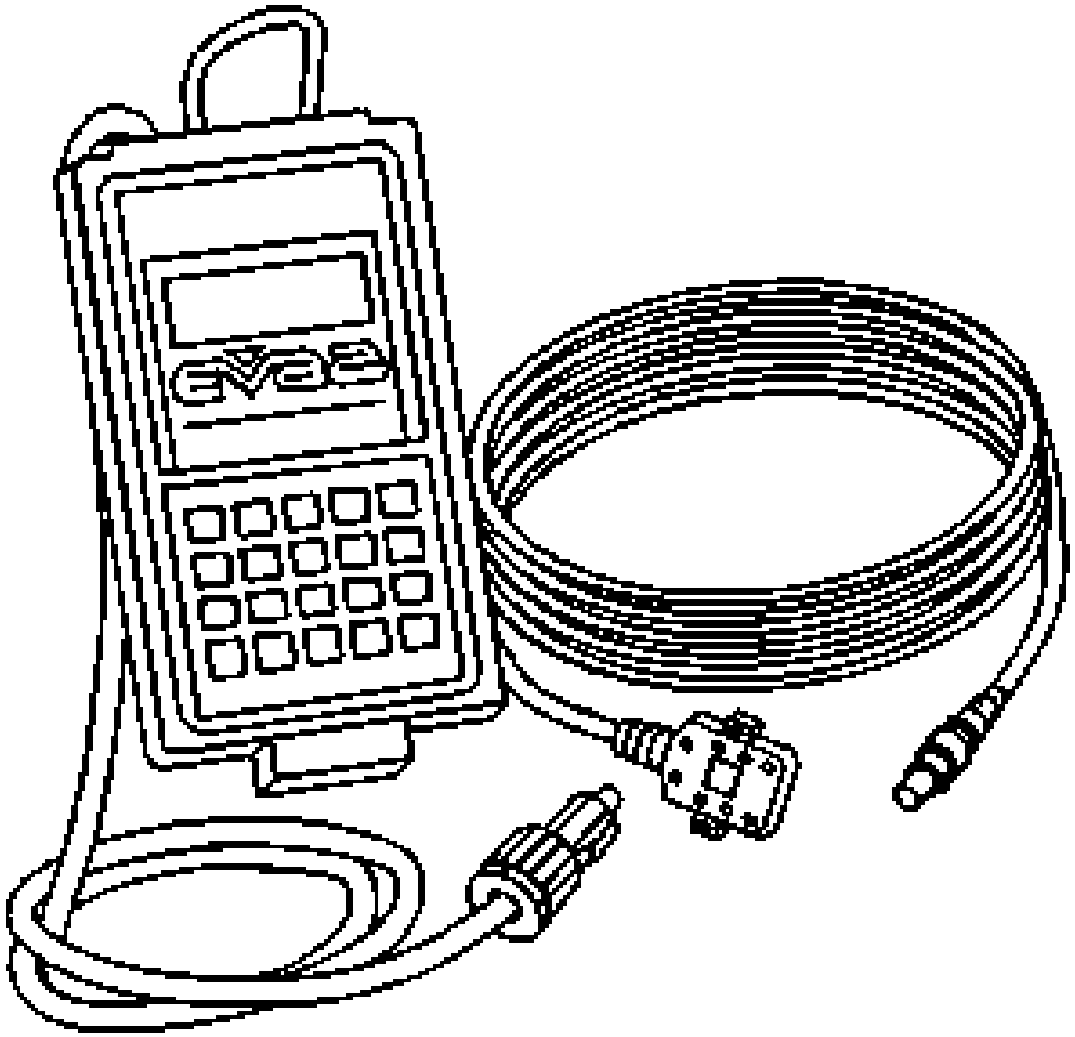
Illustration	Tool Number/Description
	EL 38792-A J 38792-A Electronic Vibration Analyzer (EVA) 2

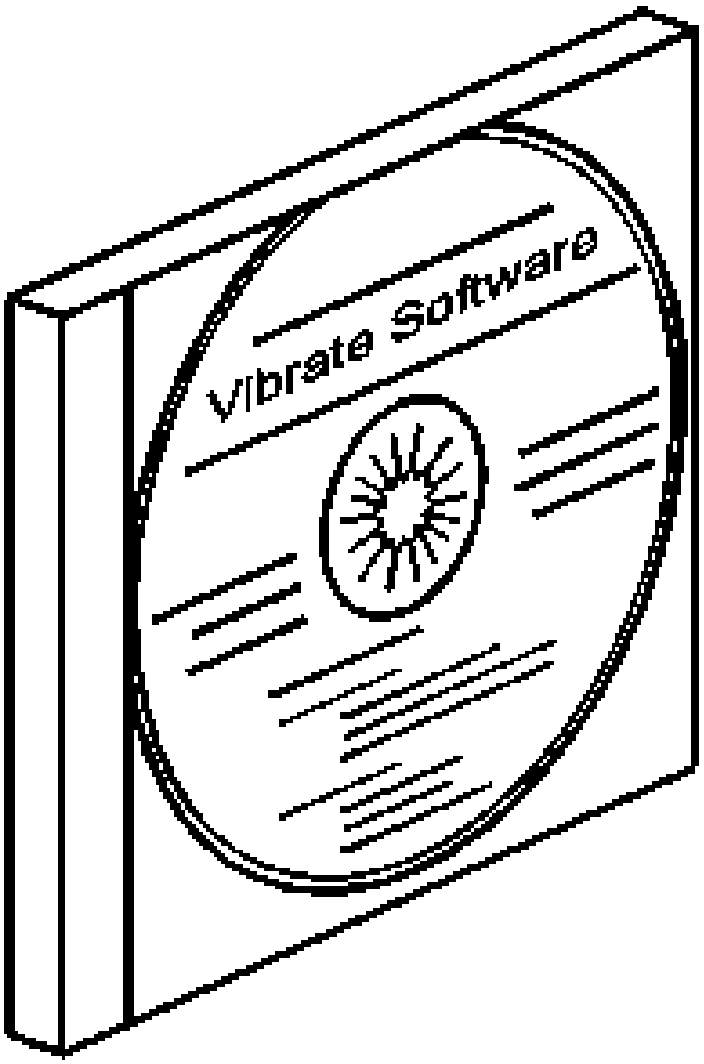
Illustration	Tool Number/Description
	EL 38792-VS J 38792-VS Vibration Software

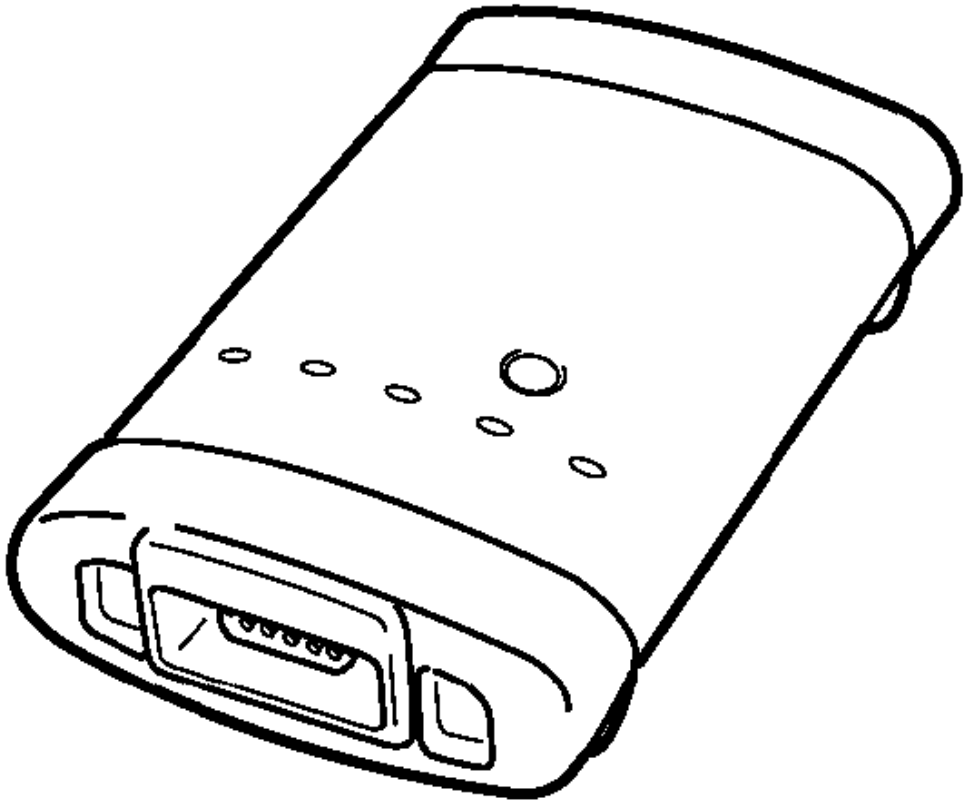
Illustration	Tool Number/Description
	EL 47955 J 2534 Multi Diagnostic Interface MDI

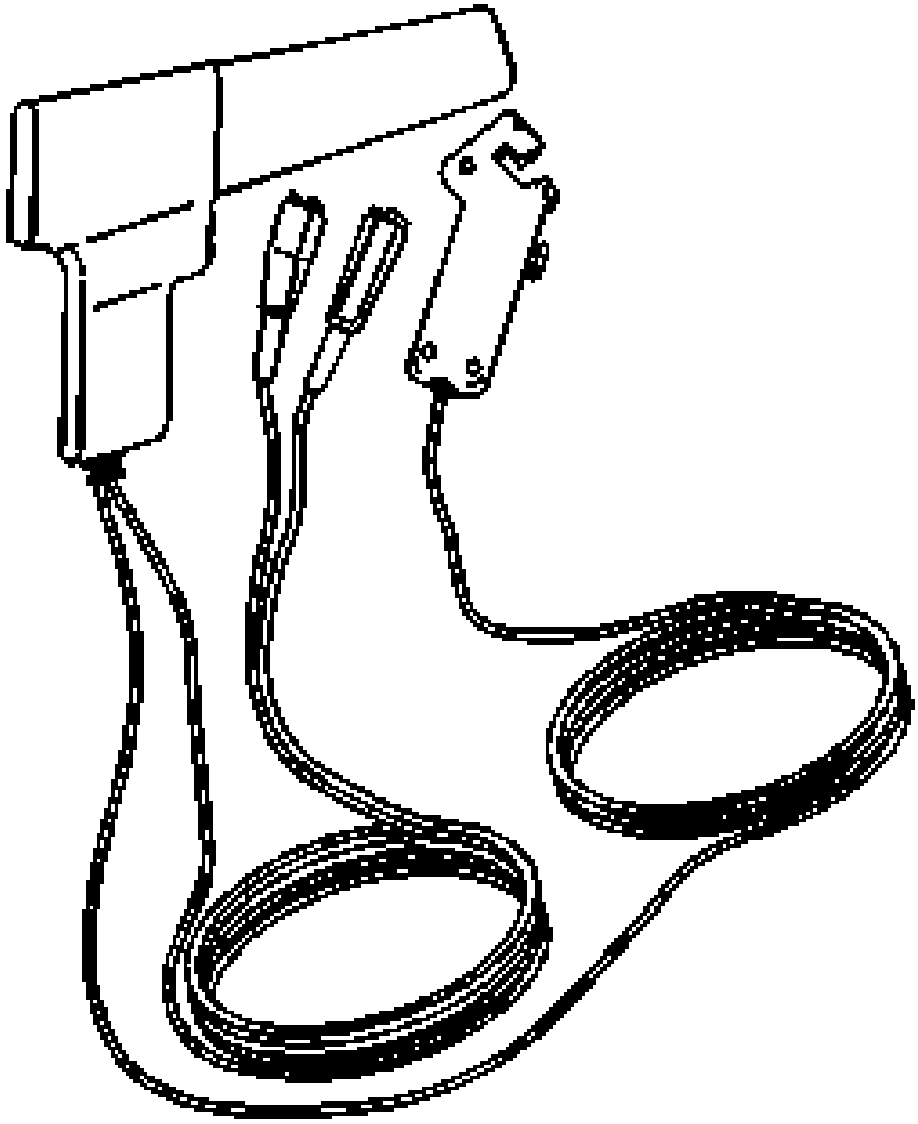
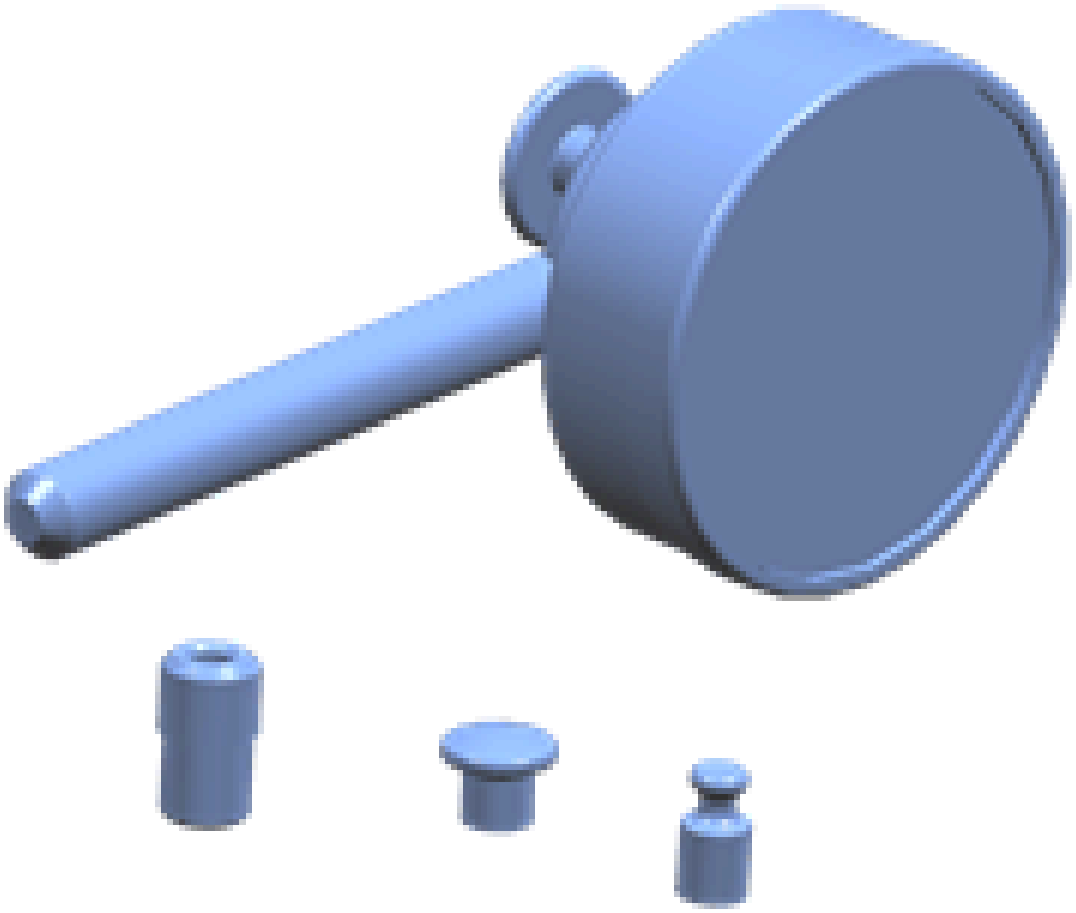
Illustration	Tool Number/Description
	EN 38792-25 J 38792-25 Inductive Pickup Timing Light

Illustration	Tool Number/Description
	GE 8001 J 8001 Dial Indicator Set

Article GUID: A00737189

GENERAL INFORMATION

Waveforms - Injector Pattern Tutorial

* PLEASE READ THIS FIRST *

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

PURPOSE OF THIS ARTICLE

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

Learning how to interpret injector drive patterns from a Lab Scope can be like learning ignition patterns all over again. This article exists to ease you into becoming a skilled injector pattern interpreter.

You will learn:

- How a DVOM and noid light fall short of a lab scope.
- The two types of injector driver circuits, voltage controlled & current controlled.
- The two ways injector circuits can be wired, constant ground/switched power & constant power/switched ground.
- The two different pattern types you can use to diagnose with, voltage & current.
- All the valuable details injector patterns can reveal.

SCOPE OF THIS ARTICLE

This is NOT a manufacturer specific article. All different types of systems are covered here, regardless of the specific year/make/model/engine.

The reason for such broad coverage is because there are only a few basic ways to operate a solenoid-type injector. By understanding the fundamental principles, you will understand all the major points of injector patterns you encounter. Of course there are minor differences in each specific system, but that is where a waveform library helps out.

If this is confusing, consider a secondary ignition pattern. Even though there are many different implementations, each still has a primary voltage turn-on, firing line, spark line, etc.

If specific waveforms are available in On Demand for the engine and vehicle you are working on, you will find them in the Engine Performance section under the Engine Performance category.

IS A LAB SCOPE NECESSARY?

INTRODUCTION

You probably have several tools at your disposal to diagnose injector circuits. But you might have questioned "Is a lab scope necessary to do a thorough job, or will a set of noid lights and a multifunction DVOM do just as well?"

In the following text, we are going to look at what noid lights and DVOMs do best, do not do very well, and when they can mislead you. As you might suspect, the lab scope, with its ability to look inside an active circuit, comes to the rescue by answering for the deficiencies of these other tools.

OVERVIEW OF NOID LIGHT

The noid light is an excellent "quick and dirty" tool. It can usually be hooked to a fuel injector harness fast and the flashing light is easy to understand. It is a dependable way to identify a no-pulse situation.

However, a noid light can be very deceptive in two cases:

- If the wrong one is used for the circuit being tested. Beware: Just because a connector on a noid light fits the harness does not mean it is the right one.
- If an injector driver is weak or a minor voltage drop is present.

Use the Right Noid Light

In the following text we will look at what can happen if the wrong noid light is used, why there are different types of noid lights (besides differences with connectors), how to identify the types of noid lights, and how to know the right type to use.

First, let's discuss what can happen if the incorrect type of noid light is used. You might see:

- A dimly flashing light when it should be normal.
- A normal flashing light when it should be dim.

A noid light will flash dim if used on a lower voltage circuit than it was designed for. A normally operating circuit would appear underpowered, which could be misinterpreted as the cause of a fuel starvation problem.

Here are the two circuit types that could cause this problem:

- Circuits with external injector resistors. Used predominately on some Asian & European systems, they are used to reduce the available voltage to an injector in order to limit the current flow. This lower voltage can cause a dim flash on a noid light designed for full voltage.
- Circuits with current controlled injector drivers (e.g. "Peak and Hold"). Basically, this type of driver allows a quick burst of voltage/current to flow and then throttles it back significantly for the remainder of the pulse width duration. If a noid light was designed for the other type of driver (voltage controlled, e.g. "Saturated"), it will appear dim because it is expecting full voltage/current to flow for the entire duration of the pulse width.

Let's move to the other situation where a noid light flashes normally when it should be dim. This could occur if a more sensitive noid light is used on a higher voltage/amperage circuit that was weakened enough to cause problems (but not outright broken). A circuit with an actual problem would thus appear normal.

Let's look at why. A noid light does not come close to consuming as much amperage as an injector solenoid. If there is a partial driver failure or a minor voltage drop in the injector circuit, there can be adequate amperage to

fully operate the noid light BUT NOT ENOUGH TO OPERATE THE INJECTOR.

If this is not clear, picture a battery with a lot of corrosion on the terminals. Say there is enough corrosion that the starter motor will not operate; it only clicks. Now imagine turning on the headlights (with the ignition in the RUN position). You find they light normally and are fully bright. This is the same idea as noid light: There is a problem, but enough amp flow exists to operate the headlights ("noid light"), but not the starter motor ("injector").

How do you identify and avoid all these situations? By using the correct type of noid light. This requires that you understanding the types of injector circuits that your noid lights are designed for. There are three. They are:

- Systems with a voltage controlled injector driver. Another way to say it: The noid light is designed for a circuit with a "high" resistance injector (generally 12 ohms or above).
- Systems with a current controlled injector driver. Another way to say it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) without an external injector resistor.
- Systems with a voltage controlled injector driver and an external injector resistor. Another way of saying it: The noid light is designed for a circuit with a low resistance injector (generally less than 12 ohms) and an external injector resistor.

NOTE: **Some noid lights can meet both the second and third categories simultaneously.**

If you are not sure which type of circuit your noid light is designed for, plug it into a known good car and check out the results. If it flashes normally during cranking, determine the circuit type by finding out injector resistance and if an external injector resistor is used. You now know enough to identify the type of injector circuit. Label the noid light appropriately.

Next time you need to use a noid light for diagnosis, determine what type of injector circuit you are dealing with and select the appropriate noid light.

Of course, if you suspect a no-pulse condition you could plug in any one whose connector fit without fear of misdiagnosis. This is because it is unimportant if the flashing light is dim or bright. It is only important that it flashes.

In any cases of doubt regarding the use of a noid light, a lab scope will overcome all inherent weaknesses.

OVERVIEW OF DVOM

A DVOM is typically used to check injector resistance and available voltage at the injector. Some techs also use it check injector on-time either with a built-in feature or by using the dwell/duty function.

There are situations where the DVOM performs these checks dependably, and other situations where it can deceive you. It is important to be aware of these strengths and weaknesses. We will cover the topics above in the following text.

Checking Injector Resistance

If a short in an injector coil winding is constant, an ohmmeter will accurately identify the lower resistance. The same is true with an open winding. Unfortunately, an intermittent short is an exception. A faulty injector with an intermittent short will show "good" if the ohmmeter cannot force the short to occur during testing.

Alcohol in fuel typically causes an intermittent short, happening only when the injector coil is hot and loaded by a current high enough to jump the air gap between two bare windings or to break down any oxides that may have formed between them.

When you measure resistance with an ohmmeter, you are only applying a small current of a few milliamps. This is nowhere near enough to load the coil sufficiently to detect most problems. As a result, most resistance checks identify intermittently shorted injectors as being normal.

There are two methods to get around this limitation. The first is to purchase an tool that checks injector coil windings under full load. The Kent-Moore J-39021 is such a tool, though there are others. The Kent-Moore costs around $240 at the time of this writing and works on many different manufacturer's systems.

The second method is to use a lab scope. Remember, a lab scope allows you to see the regular operation of a circuit in real time. If an injector is having an short or intermittent short, the lab scope will show it.

Checking Available Voltage At the Injector

Verifying a fuel injector has the proper voltage to operate correctly is good diagnostic technique. Finding an open circuit on the feed circuit like a broken wire or connector is an accurate check with a DVOM. Unfortunately, finding an intermittent or excessive resistance problem with a DVOM is unreliable.

Let's explore this drawback. Remember that a voltage drop due to excessive resistance will only occur when a circuit is operating? Since the injector circuit is only operating for a few milliseconds at a time, a DVOM will only see a potential fault for a few milliseconds. The remaining 90+% of the time the unloaded injector circuit will show normal battery voltage.

Since DVOMs update their display roughly two to five times a second, all measurements in between are averaged. Because a potential voltage drop is visible for such a small amount of time, it gets "averaged out", causing you to miss it.

Only a DVOM that has a "min-max" function that checks EVERY MILLISECOND will catch this fault consistently (if used in that mode). The Fluke 87 among others has this capability.

A "min-max" DVOM with a lower frequency of checking (100 millisecond) can miss the fault because it will probably check when the injector is not on. This is especially true with current controlled driver circuits. The Fluke 88, among others fall into this category.

Outside of using a Fluke 87 (or equivalent) in the 1 mS "min-max" mode, the only way to catch a voltage drop fault is with a lab scope. You will be able to see a voltage drop as it happens.

One final note. It is important to be aware that an injector circuit with a solenoid resistor will always show a voltage drop when the circuit is energized. This is somewhat obvious and normal; it is a designed-in voltage drop. What can be unexpected is what we already covered--a voltage drop disappears when the circuit is unloaded. The unloaded injector circuit will show normal battery voltage at the injector. Remember this and do not get confused.

Checking Injector On-Time With Built-In Function

Several DVOMs have a feature that allows them to measure injector on-time (mS pulse width). While they are accurate and fast to hookup, they have three limitations you should be aware of:

- They only work on voltage controlled injector drivers (e.g "Saturated Switch"), NOT on current controlled injector drivers (e.g. "Peak & Hold").
- A few unusual conditions can cause inaccurate readings.
- Varying engine speeds can result in inaccurate readings.

Regarding the first limitation, DVOMs need a well-defined injector pulse in order to determine when the injector turns ON and OFF. Voltage controlled drivers provide this because of their simple switch-like operation. They completely close the circuit for the entire duration of the pulse. This is easy for the DVOM to interpret.

The other type of driver, the current controlled type, start off well by completely closing the circuit (until the injector pintle opens), but then they throttle back the voltage/current for the duration of the pulse. The DVOM understands the beginning of the pulse but it cannot figure out the throttling action. In other words, it cannot distinguish the throttling from an open circuit (de-energized) condition.

Yet current controlled injectors will still yield a millisecond on-time reading on these DVOMs. You will find it is also always the same, regardless of the operating conditions. This is because it is only measuring the initial completely-closed circuit on-time, which always takes the same amount of time (to lift the injector pintle off its seat). So even though you get a reading, it is useless.

The second limitation is that a few erratic conditions can cause inaccurate readings. This is because of a DVOM's slow display rate; roughly two to five times a second. As we covered earlier, measurements in between display updates get averaged. So conditions like skipped injector pulses or intermittent long/short injector pulses tend to get "averaged out", which will cause you to miss important details.

The last limitation is that varying engine speeds can result in inaccurate readings. This is caused by the quickly shifting injector on-time as the engine load varies, or the RPM moves from a state of acceleration to stabilization, or similar situations. It too is caused by the averaging of all measurements in between DVOM display periods. You can avoid this by checking on-time when there are no RPM or load changes.

A lab scope allows you to overcome each one of these limitations.

Checking Injector On-Time With Dwell Or Duty

If no tool is available to directly measure injector millisecond on-time measurement, some techs use a simple DVOM dwell or duty cycle functions as a replacement.

While this is an approach of last resort, it does provide benefits. We will discuss the strengths and weaknesses in a moment, but first we will look at how a duty cycle meter and dwell meter work.

How A Duty Cycle Meter and Dwell Meter Work

All readings are obtained by comparing how long something has been OFF to how long it has been ON in a fixed time period. A dwell meter and duty cycle meter actually come up with the same answers using different scales. You can convert freely between them. See **RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS TABLE**.

The DVOM display updates roughly one time a second, although some DVOMs can be a little faster or slower. All measurements during this update period are tallied inside the DVOM as ON time or OFF time, and then the total ratio is displayed as either a percentage (duty cycle) or degrees (dwell meter).

For example, let's say a DVOM had an update rate of exactly 1 second (1000 milliseconds). Let's also say that it has been measuring/tallying an injector circuit that had been ON a total of 250 mS out of the 1000 mS. That is a ratio of one-quarter, which would be displayed as 25% duty cycle or 15Â° dwell (six-cylinder scale). Note that most duty cycle meters can reverse the readings by selecting the positive or negative slope to trigger on. If this reading were reversed, a duty cycle meter would display 75%.

Strengths of Dwell/Duty Meter

The obvious strength of a dwell/duty meter is that you can compare injector on-time against a known-good reading. This is the only practical way to use a dwell/duty meter, but requires you to have known-good values to compare against.

Another strength is that you can roughly convert injector mS on-time into dwell reading with some computations.

A final strength is that because the meter averages everything together it does not miss anything (though this is also a severe weakness that we will look at later). If an injector has a fault where it occasionally skips a pulse, the meter registers it and the reading changes accordingly.

Let's go back to figuring out dwell/duty readings by using injector on-time specification. This is not generally practical, but we will cover it for completeness. You NEED to know three things:

- Injector mS on-time specification.
- Engine RPM when specification is valid.
- How many times the injectors fire per crankshaft revolution.

The first two are self-explanatory. The last one may require some research into whether it is a bank-fire type that injects every 360Â° of crankshaft rotation, a bank-fire that injects every 720Â°, or an SFI that injects every 720Â°. Many manufacturers do not release this data so you may have to figure it out yourself with a frequency meter.

Here are the four complete steps to convert millisecond on-time:

1. Determine the injector pulse width and RPM it was obtained at. Let's say the specification is for one millisecond of on-time at a hot idle of 600 RPM.
2. Determine injector firing method for the complete 4 stroke cycle. Let's say this is a 360Â° bank-fired, meaning an injector fires each and every crankshaft revolution.
3. Determine how many times the injector will fire at the specified engine speed (600 RPM) in a fixed time period. We will use 100 milliseconds because it is easy to use. Six hundred crankshaft Revolutions Per Minute (RPM) divided by 60 seconds equals 10 revolutions per second. Multiplying 10 times .100 yields one; the crankshaft turns one time in 100 milliseconds. With exactly one crankshaft rotation in 100 milliseconds, we know that the injector fires exactly one time.
4. Determine the ratio of injector on-time vs. off-time in the fixed time period, then figure duty cycle and/or dwell. The injector fires one time for a total of one millisecond in any given 100 millisecond period. One hundred minus one equals 99. We have a 99% duty cycle. If we wanted to know the dwell (on 6 cylinder scale), multiple 99% times .6; this equals 59.4Â° dwell.

Weaknesses of Dwell/Duty Meter

The weaknesses are significant. First, there is no one-to-one correspondence to actual mS on-time. No manufacturer releases dwell/duty data, and it is time-consuming to convert the mS on-time readings. Besides, there can be a large degree of error because the conversion forces you to assume that the injector(s) are always firing at the same rate for the same period of time. This can be a dangerous assumption.

Second, all level of detail is lost in the averaging process. This is the primary weakness. You cannot see the details you need to make a confident diagnosis.

Here is one example. Imagine a vehicle that has a faulty injector driver that occasionally skips an injector pulse. Every skipped pulse means that that cylinder does not fire, thus unburned O2 gets pushed into the exhaust and passes the O2 sensor. The O2 sensor indicates lean, so the computer fattens up the mixture to compensate for the supposed "lean" condition.

A connected dwell/duty meter would see the fattened pulse width but would also see the skipped pulses. It would tally both and likely come back with a reading that indicated the "pulse width" was within specification because the rich mixture and missing pulses offset each other.

This situation is not a far-fetched scenario. Some early GM 3800 engines were suffering from exactly this. The point is that a lack of detail could cause misdiagnosis.

As you might have guessed, a lab scope would not miss this.

RELATIONSHIP BETWEEN DWELL & DUTY CYCLE READINGS

Dwell Meter (2)	Duty Cycle Meter
1Â°	1%
15Â°	25%
30Â°	50%
45Â°	75%
60Â°	100%

(1) These are just some examples for your understanding. It is okay to fill in the gaps.

(2) Dwell meter on the six-cylinder scale.

THE TWO TYPES OF INJECTOR DRIVERS

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

OVERVIEW

There are two types of transistor driver circuits used to operate electric fuel injectors: voltage controlled and current controlled. The voltage controlled type is sometimes called a "saturated switch" driver, while the current controlled type is sometimes known as a "peak and hold" driver.

The basic difference between the two is the total resistance of the injector circuit. Roughly speaking, if a particular leg in an injector circuit has total resistance of 12 or more ohms, a voltage control driver is used. If less than 12 ohms, a current control driver is used.

It is a question of what is going to do the job of limiting the current flow in the injector circuit; the inherent "high" resistance in the injector circuit, or the transistor driver. Without some form of control, the current flow through the injector would cause the solenoid coil to overheat and result in a damaged injector.

VOLTAGE CONTROLLED CIRCUIT ("SATURATED SWITCH")

The voltage controlled driver inside the computer operates much like a simple switch because it does not need to worry about limiting current flow. Recall, this driver typically requires injector circuits with a total leg resistance of 12 or more ohms.

The driver is either ON, closing/completing the circuit (eliminating the voltage-drop), or OFF, opening the circuit (causing a total voltage drop).

Some manufacturers call it a "saturated switch" driver. This is because when switched ON, the driver allows the magnetic field in the injector to build to saturation. This is the same "saturation" property that you are familiar with for an ignition coil.

There are two ways "high" resistance can be built into an injector circuit to limit current flow. One method uses an external solenoid resistor and a low resistance injector, while the other uses a high resistance injector without the solenoid resistor. See the left side of Fig. **Fig. 1**.

In terms of injection opening time, the external resistor voltage controlled circuit is somewhat faster than the voltage controlled high resistance injector circuit. The trend, however, seems to be moving toward use of this latter type of circuit due to its lower cost and reliability. The ECU can compensate for slower opening times by increasing injector pulse width accordingly.

NOTE: **Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.**

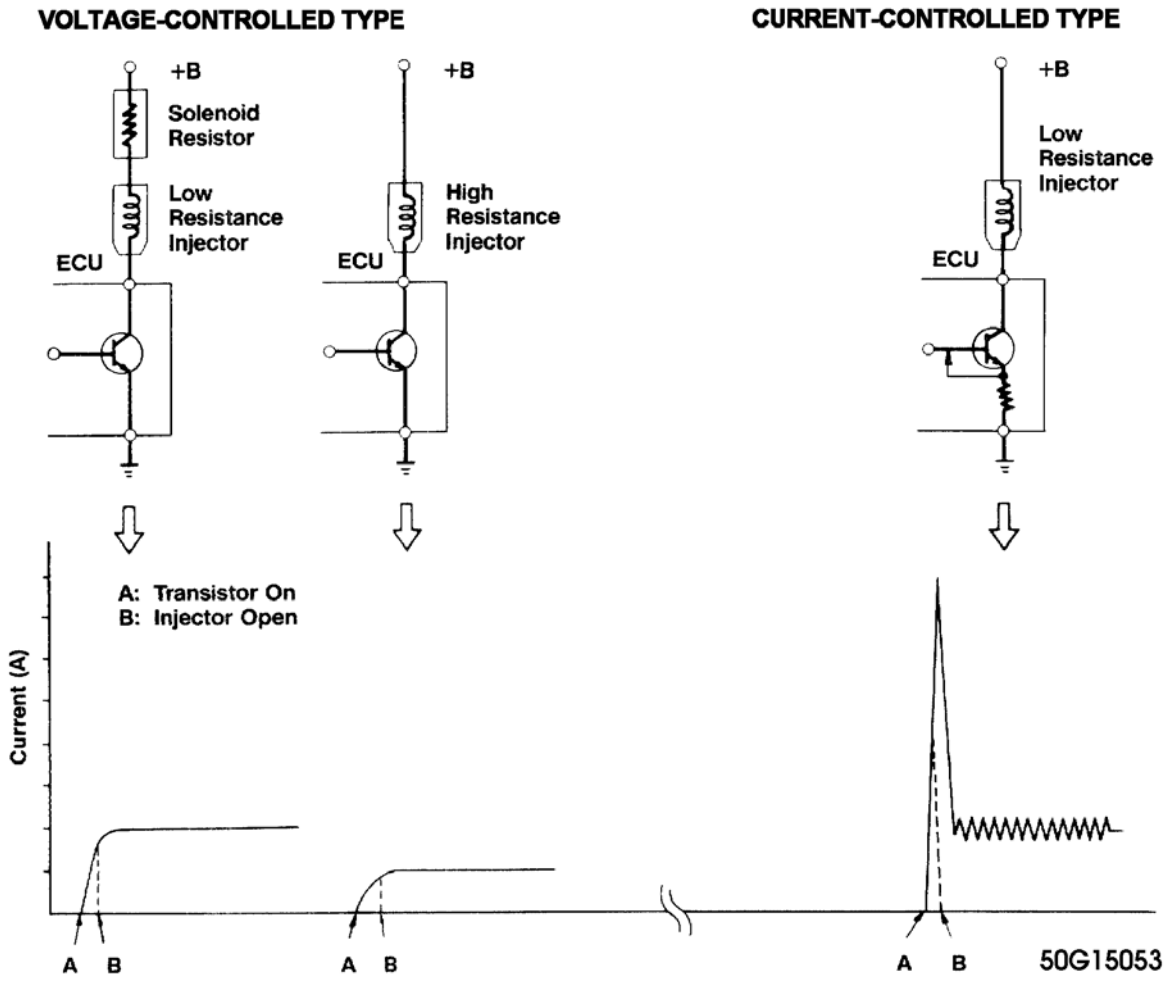


Fig. 1: Injector Driver Types - Current and Voltage

CURRENT CONTROLLED CIRCUIT ("PEAK & HOLD")

The current controlled driver inside the computer is more complex than a voltage controlled driver because as the name implies, it has to limit current flow in addition to its ON-OFF switching function. Recall, this driver typically requires injector circuits with a total leg resistance of less than 12 ohms.

Once the driver is turned ON, it will not limit current flow until enough time has passed for the injector pintle to open. This period is preset by the particular manufacturer/system based on the amount of current flow needed to open their injector. This is typically between two and six amps. Some manufacturers refer to this as the "peak" time, referring to the fact that current flow is allowed to "peak" (to open the injector).

Once the injector pintle is open, the amp flow is considerably reduced for the rest of the pulse duration to protect the injector from overheating. This is okay because very little amperage is needed to hold the injector open, typically in the area of one amp or less. Some manufacturers refer to this as the "hold" time, meaning that just enough current is allowed through the circuit to "hold" the already-open injector open.

There are a couple methods of reducing the current. The most common trims back the available voltage for the circuit, similar to turning down a light at home with a dimmer.

The other method involves repeatedly cycling the circuit ON-OFF. It does this so fast that the magnetic field never collapses and the pintle stays open, but the current is still significantly reduced. See the right side of Fig. **Fig. 1** for an illustration.

The advantage to the current controlled driver circuit is the short time period from when the driver transistor goes ON to when the injector actually opens. This is a function of the speed with which current flow reaches its peak due to the low circuit resistance. Also, the injector closes faster when the driver turns OFF because of the lower holding current.

NOTE: **Never apply battery voltage directly across a low resistance injector. This will cause injector damage from solenoid coil overheating.**

THE TWO WAYS INJECTOR CIRCUITS ARE WIRED

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

Like other circuits, injector circuits can be wired in one of two fundamental directions. The first method is to steadily power the injectors and have the computer driver switch the ground side of the circuit. Conversely, the injectors can be steadily grounded while the driver switches the power side of the circuit.

There is no performance benefit to either method. Voltage controlled and current controlled drivers have been successfully implemented both ways.

However, 95% percent of the systems are wired so the driver controls the ground side of the circuit. Only a handful of systems use the drivers on the power side of the circuit. Some examples of the latter are the 1970's Cadillac EFI system, early Jeep 4.0 EFI (Renix system), and Chrysler 1984-87 TBI.

INTERPRETING INJECTOR WAVEFORMS

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

INTERPRETING A VOLTAGE CONTROLLED PATTERN

NOTE: **Voltage controlled drivers are also known as "Saturated Switch" drivers. They typically require injector circuits with a total leg resistance of 12 ohms or more.**

NOTE: **This example is based on a constant power/switched ground circuit.**

- See **Fig. 2** for pattern that the following text describes.

Point "A" is where system voltage is supplied to the injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This can occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Note that circuits with external injector resistors will not be any different because the resistor does not affect open circuit voltage.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is HIGHLY recommended that you use the battery as your hook-up.

The points between "B" and "D" represent the time in milliseconds that the injector is being energized or held open. This line at Point "C" should remain flat. Any distortion or upward bend indicates a ground problem, short problem, or a weak driver. Alert readers will catch that this is exactly opposite of the current controlled type drivers (explained in the next section), because they bend upwards at this point.

How come the difference? Because of the total circuit resistance. Voltage controlled driver circuits have a high resistance of 12+ ohms that slows the building of the magnetic field in the injector. Hence, no counter voltage is built up and the line remains flat.

On the other hand, the current controlled driver circuit has low resistance which allows for a rapid magnetic field build-up. This causes a slight inductive rise (created by the effects of counter voltage) and hence, the upward bend. You should not see that here with voltage controlled circuits.

Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts at the top of Point "D".

If you do see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning the injector has a weak winding.

If a zener diode is not used in the computer, the spike from a good injector will be 60 or more volts.

Point "E" brings us to a very interesting section. As you can see, the voltage dissipates back to supply value after the peak of the inductive kick. Notice the slight hump? This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking because of a faulty injector

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

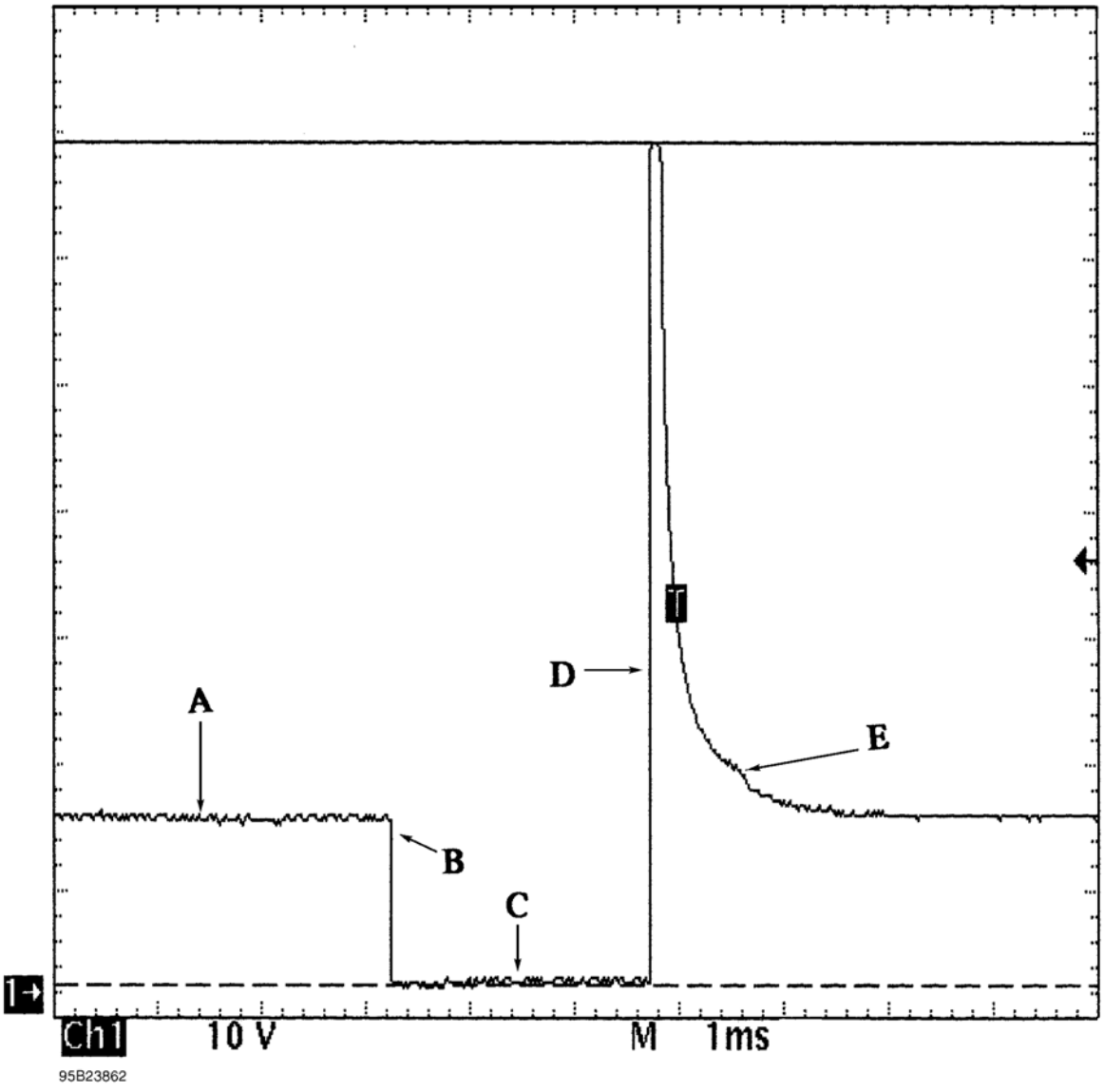


Fig. 2: Identifying Voltage Controlled Type Injector Pattern

INTERPRETING A CURRENT CONTROLLED PATTERN

NOTE: **Current controlled drivers are also known as "Peak and Hold" drivers. They typically require injector circuits with a total leg resistance with less than 12 ohm.**

NOTE: This example is based on a constant power/switched ground circuit.

- See **Fig. 3** for pattern that the following text describes.

Point "A" is where system voltage is supplied to the injector. A good hot run voltage is usually 13.5 or more volts. This point, commonly known as open circuit voltage, is critical because the injector will not get sufficient current saturation if there is a voltage shortfall. To obtain a good look at this precise point, you will need to shift your Lab Scope to five volts per division.

You will find that some systems have slight voltage fluctuations here. This could occur if the injector feed wire is also used to power up other cycling components, like the ignition coil(s). Slight voltage fluctuations are normal and are no reason for concern. Major voltage fluctuations are a different story, however. Major voltage shifts on the injector feed line will create injector performance problems. Look for excessive resistance problems in the feed circuit if you see big shifts and repair as necessary.

Point "B" is where the driver completes the circuit to ground. This point of the waveform should be a clean square point straight down with no rounded edges. It is during this period that current saturation of the injector windings is taking place and the driver is heavily stressed. Weak drivers will distort this vertical line.

Point "C" represents the voltage drop across the injector windings. Point "C" should come very close to the ground reference point, but not quite touch. This is because the driver has a small amount of inherent resistance. Any significant offset from ground is an indication of a resistance problem on the ground circuit that needs repaired. You might miss this fault if you do not use the negative battery post for your Lab Scope hook-up, so it is HIGHLY recommended that you use the battery as your hook-up.

Right after Point "C", something interesting happens. Notice the trace starts a normal upward bend. This slight inductive rise is created by the effects of counter voltage and is normal. This is because the low circuit resistance allowed a fast build-up of the magnetic field, which in turn created the counter voltage.

Point "D" is the start of the current limiting, also known as the "Hold" time. Before this point, the driver had allowed the current to free-flow ("Peak") just to get the injector pintle open. By the time point "D" occurs, the injector pintle has already opened and the computer has just significantly throttled the current back. It does this by only allowing a few volts through to maintain the minimum current required to keep the pintle open.

The height of the voltage spike seen at the top of Point "D" represents the electrical condition of the injector windings. The height of this voltage spike (inductive kick) is proportional to the number of windings and the current flow through them. The more current flow and greater number of windings, the more potential for a greater inductive kick. The opposite is also true. The less current flow or fewer windings means less inductive kick. Typically you should see a minimum 35 volts.

If you see approximately 35 volts, it is because a zener diode is used with the driver to clamp the voltage. Make sure the beginning top of the spike is squared off, indicating the zener dumped the remainder of the spike. If it is not squared, that indicates the spike is not strong enough to make the zener fully dump, meaning there is a problem with a weak injector winding.

If a zener diode is not used in the computer, the spike from a good injector will be 60 or more volts.

At Point "E", notice that the trace is now just a few volts below system voltage and the injector is in the current limiting, or the "Hold" part of the pattern. This line will either remain flat and stable as shown here, or will

cycle up and down rapidly. Both are normal methods to limit current flow. Any distortion may indicate shorted windings.

Point "F" is the actual turn-off point of the driver (and injector). To measure the millisecond on-time of the injector, measure between points "C" and "F". Note that we used cursors to do it for us; they are measuring a 2.56 mS on-time.

The top of Point "F" (second inductive kick) is created by the collapsing magnetic field caused by the final turn-off of the driver. This spike should be like the spike on top of point "D".

Point "G" shows a slight hump. This is actually the mechanical injector pintle closing. Recall that moving an iron core through a magnetic field will create a voltage surge. The pintle is the iron core here.

This pintle hump at Point "E" should occur near the end of the downward slope, and not afterwards. If it does occur after the slope has ended and the voltage has stabilized, it is because the pintle is slightly sticking. Some older Nissan TBI systems suffered from this.

If you see more than one hump it is because of a distorted pintle or seat. This faulty condition is known as "pintle float".

It is important to realize that it takes a good digital storage oscilloscope or analog lab scope to see this pintle hump clearly. Unfortunately, it cannot always be seen.

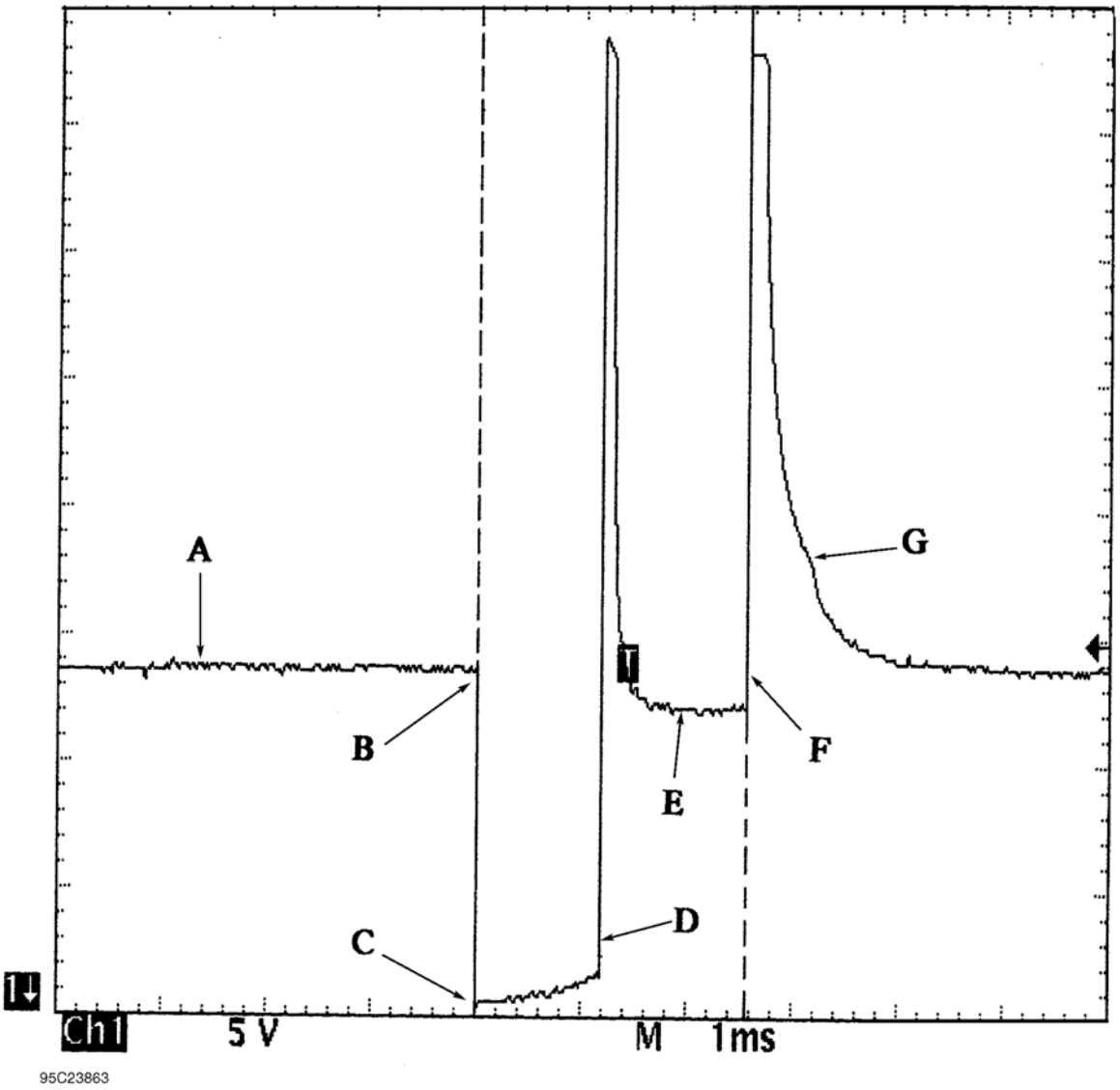


Fig. 3: Identifying Current Controlled Type Injector Pattern

CURRENT WAVEFORM SAMPLES

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

The waveform pattern shown in Fig. **Fig. 4** indicate a normal current waveform from a Ford 3.0L V6 VIN [U] engine. This voltage controlled type circuit pulses the injectors in groups of three injectors. Injectors No. 1, 3, and 5 are pulsed together and cylinders 2, 4, and 6 are pulsed together. The specification for an acceptable bank resistance is 4.4 ohms. Using Ohm's Law and assuming a hot run voltage of 14 volts, we determine that the bank would draw a current of 3.2 amps.

However this is not the case because as the injector windings become saturated, counter voltage is created

which impedes the current flow. This, coupled with the inherent resistance of the driver's transistor, impedes the current flow even more. So, what is a known good value for a dynamic current draw on a voltage controlled bank of injectors? The waveform pattern shown below indicates a good parallel injector current flow of 2 amps. See **Fig. 4**.

Note that if just one injector has a resistance problem and partially shorts, the entire parallel bank that it belongs to will draw more current. This can damage the injector driver.

The waveform pattern in Fig. **Fig. 5** indicates this type of problem with too much current flow. This is on other bank of injectors of the same vehicle; the even side. Notice the Lab Scope is set on a one amp per division scale. As you can see, the current is at an unacceptable 2.5 amps.

It is easy to find out which individual injector is at fault. All you need to do is inductively clamp onto each individual injector and compare them. To obtain a known-good value to compare against, we used the good bank to capture the waveform in Fig. **Fig. 6**. Notice that it limits current flow to 750 milliamps.

The waveform shown in Fig. **Fig. 7** illustrates the problem injector we found. This waveform indicates an unacceptable current draw of just over one amp as compared to the 750 milliamp draw of the known-good injector. A subsequent check with a DVOM found 8.2 ohms, which is under the 12 ohm specification.

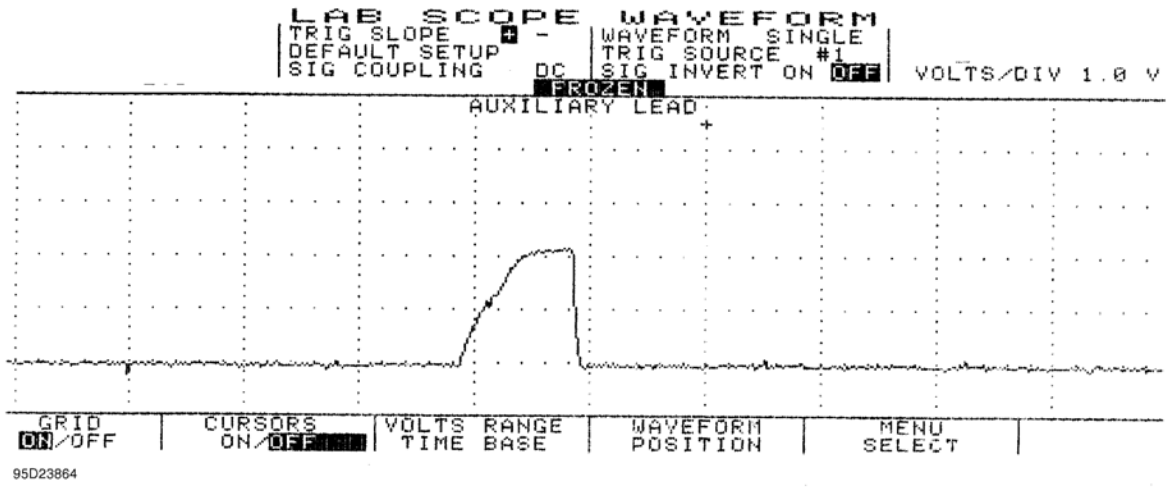


Fig. 4: Injector Bank w/Normal Current Flow - Current Pattern

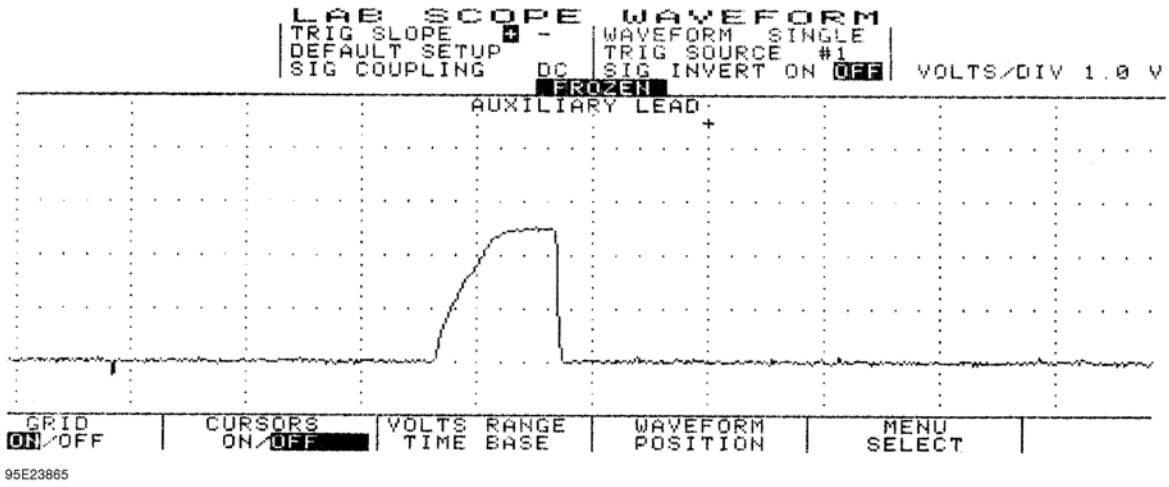


Fig. 5: Injector Bank w/Excessive Current Flow - Current Pattern

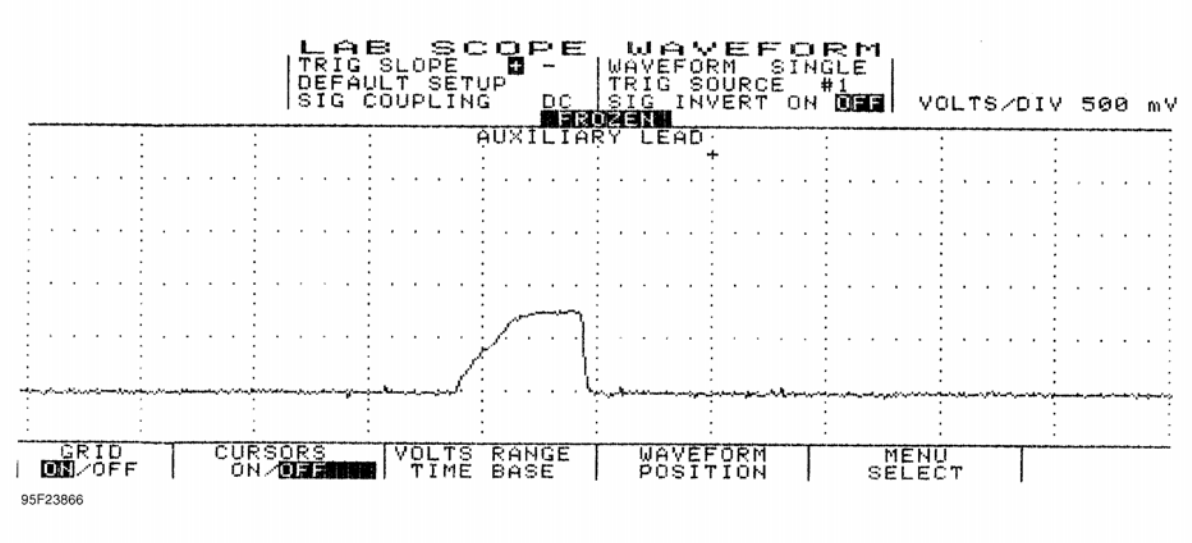


Fig. 6: Single Injector w/Normal Current Flow - Current Pattern

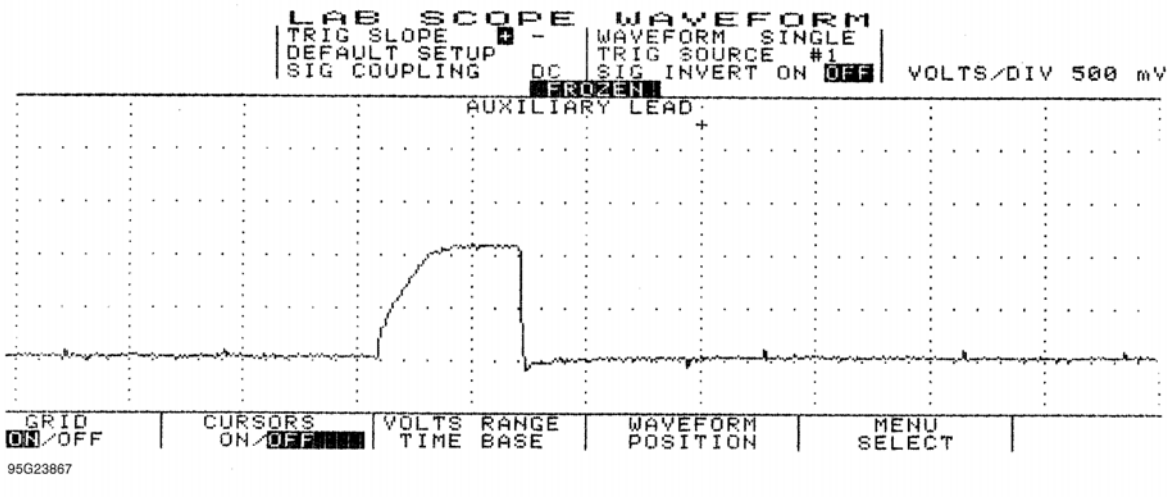


Fig. 7: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

This time we will look at a GM 3.1L V6 VIN [T]. Fig. **Fig. 8** shows the 1, 3, 5 (odd) injector bank with the current waveform indicating about a 2.6 amp draw at idle. This pattern, taken from a known good vehicle, correctly stays at or below the maximum 2.6 amps current range. Ideally, the current for each bank should be very close in comparison.

Notice the small dimple on the current flow's rising edge. This is the actual injector opening or what engineers refer to as the "set point." For good idle quality, the set point should be uniform between the banks.

When discussing Ohm's Law as it pertains to this parallel circuit, consider that each injector has specified resistance of 12.2 ohms. Since all three injectors are in parallel the total resistance of this parallel circuit drops to 4.1 ohms. Fourteen volts divided by four ohms would pull a maximum of 3.4 amps on this bank of injectors. However, as we discussed in **EXAMPLE #1** above, other factors knock this value down to roughly the 2.6 amp neighborhood.

Now we are going to take a look at the even bank of injectors; injectors 2, 4, and 6. See **Fig. 9**. Notice this bank peaked at 1.7 amps at idle as compared to the 2.6 amps peak of the odd bank (Fig. **Fig. 8**). Current flow between even and odd injectors banks is not uniform, yet it is not causing a driveability problem. That is because it is still under the maximum amperage we figured out earlier. But be aware this vehicle could develop a problem if the amperage flow increases any more.

Checking the resistance of this even injector group with a DVOM yielded 6.2 ohms, while the odd injector group in the previous example read 4.1 ohms.

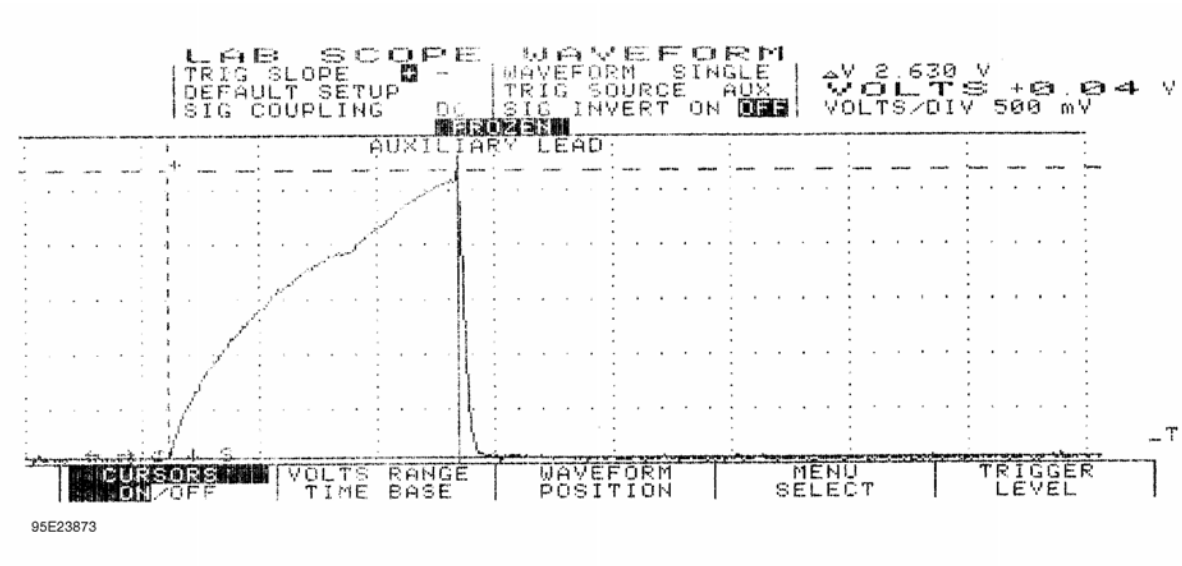


Fig. 8: Injector Odd Bank w/Normal Current Flow - Current Pattern

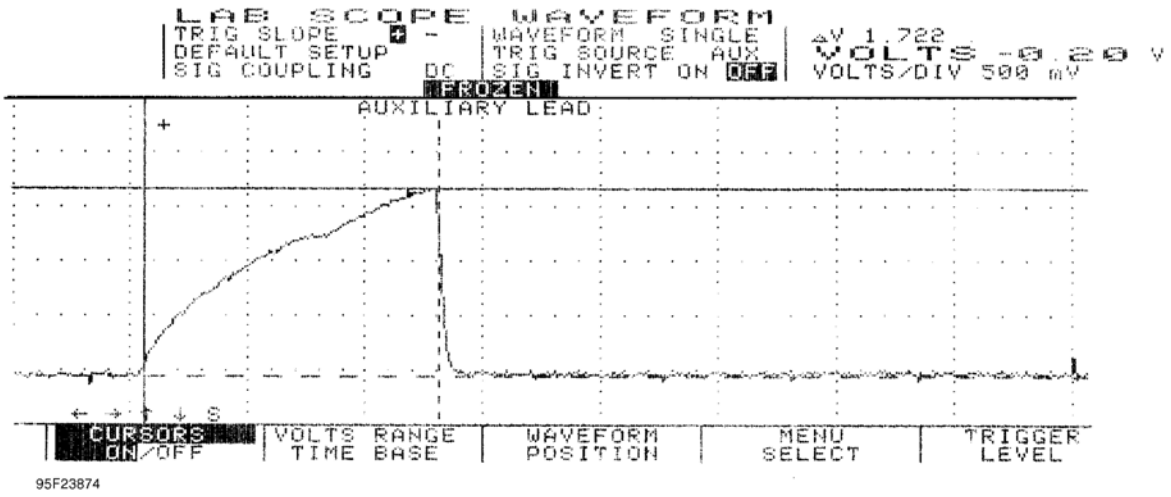


Fig. 9: Injector Even Bank w/Normal Current Flow - Current Pattern

EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

Example #3 is of a Ford 5.0L V8 SEFI. Fig. **Fig. 10** shows a waveform of an individual injector at idle with the Lab Scope set on 200 milliamps per division. Notice the dimple in the rising edge. This dimple indicates the actual opening of the injector (set point) occurred at 400 milliamps and current peaked at 750 milliamps. This is a good specification for this engine.

The next waveform pattern in Fig. **Fig. 11** shows an abnormality with another injector. With the Lab Scope set on 500 milliamps per division, you can see that the current waveform indicates a 1200 milliamp draw. This is a faulty injector.

Abnormally low resistance injectors create excessive current draw, causing rough idle, and possible computer driver damage.

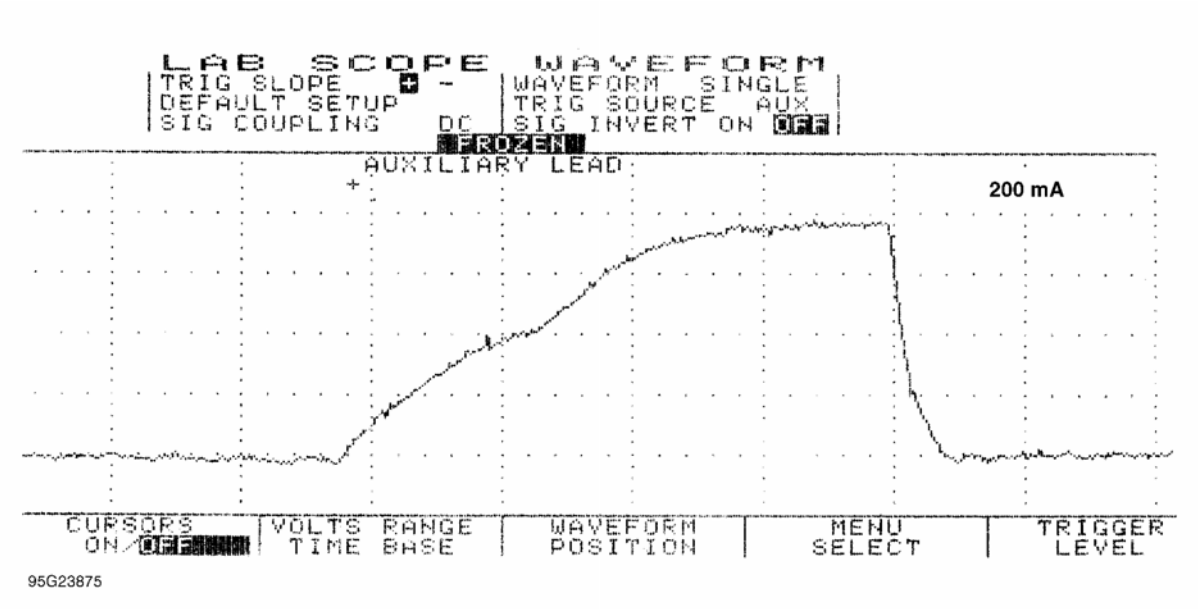


Fig. 10: Single Injector w/Normal Current Flow - Current Pattern

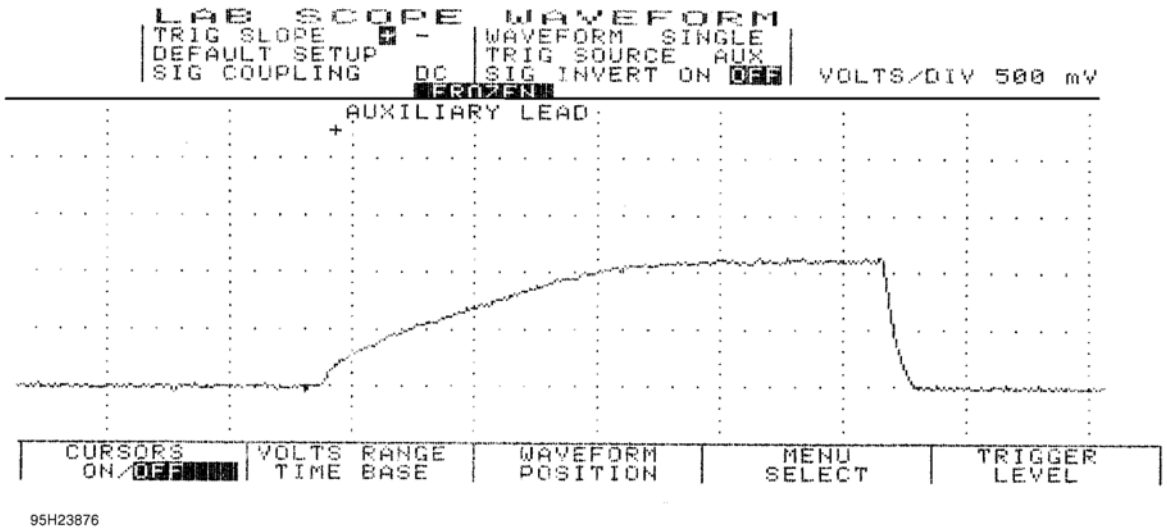


Fig. 11: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #4 - CURRENT CONTROLLED DRIVER

Example #4 is of a Ford 4.6L SEFI VIN [W]. See **Fig. 12** for the known-good waveform pattern. This Ford system is different from the one above in **EXAMPLE #3** as it peaks at 900 milliamps and the actual opening of the injector (set point) is just below 600 milliamps.

This is offered as a comparison against the Ford pattern listed above, as they are both Ford SEFI injectors but with different operating ranges. The point is that you should not make any broad assumptions for any manufacturer.

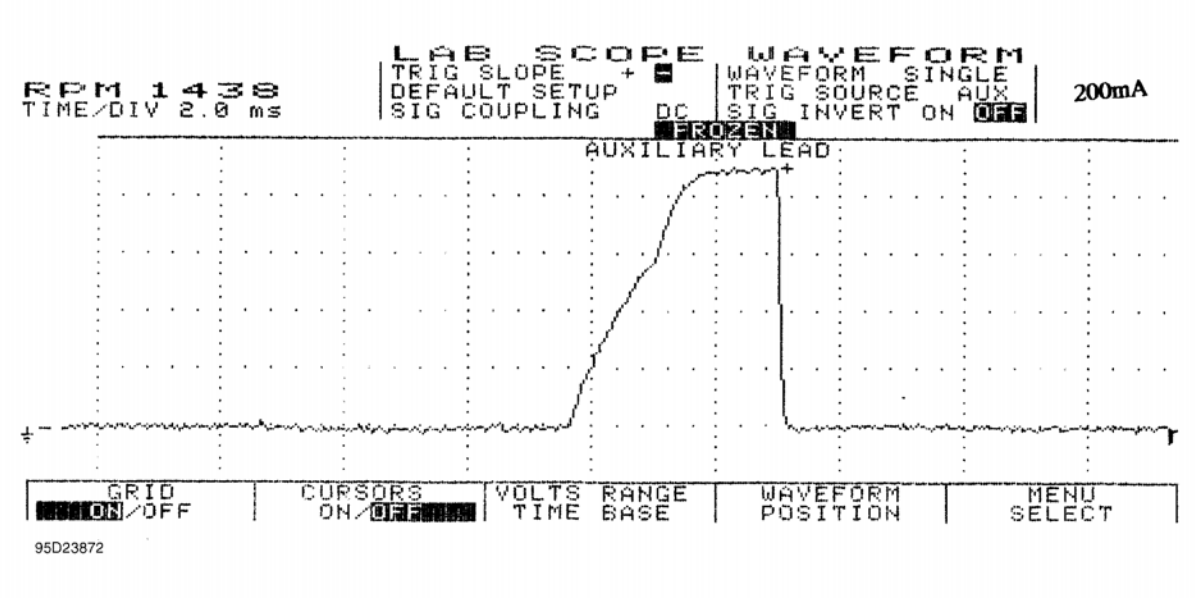


Fig. 12: Single Injector w/Normal Current Flow - Current Pattern

EXAMPLE #5 - CURRENT CONTROLLED DRIVER

The known-good waveform in Fig. **Fig. 13** is from a Chrysler 3.0L V6 PFI VIN [3]. It is a perfect example of

the peak and hold theory. The waveform shows a 1-amp per division current flow, ramping to 4 amps and then decreasing to 1-amp to hold the injector open.

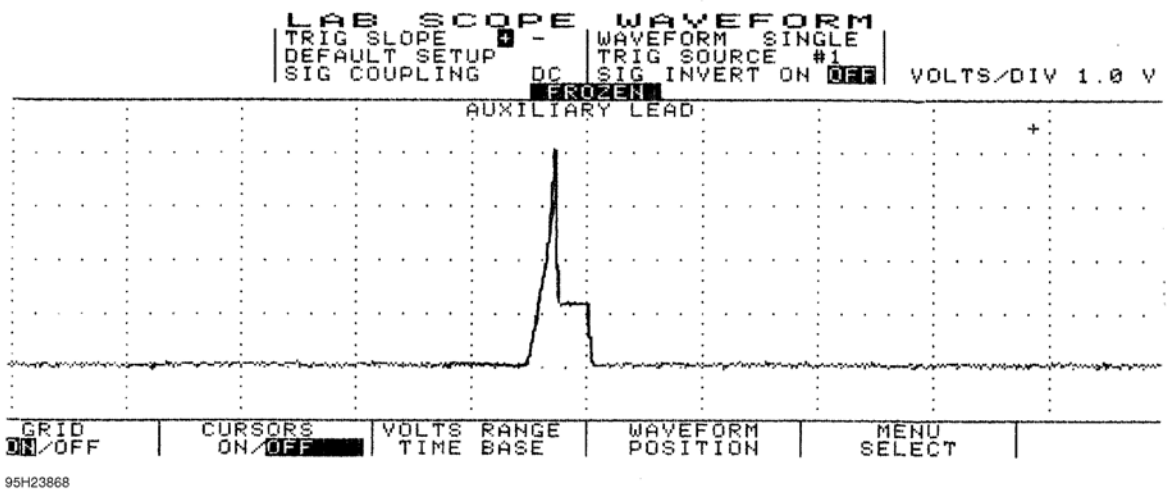


Fig. 13: Injector Bank w/Normal Current Flow - Current Pattern

EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This next known-good waveform is from a Ford 5.0L V8 CFI VIN [F]. See **Fig. 14**. The pattern, which is set on a 250 milliamps scale, indicates a 1.25 amp peak draw and a hold at 350 milliamps.

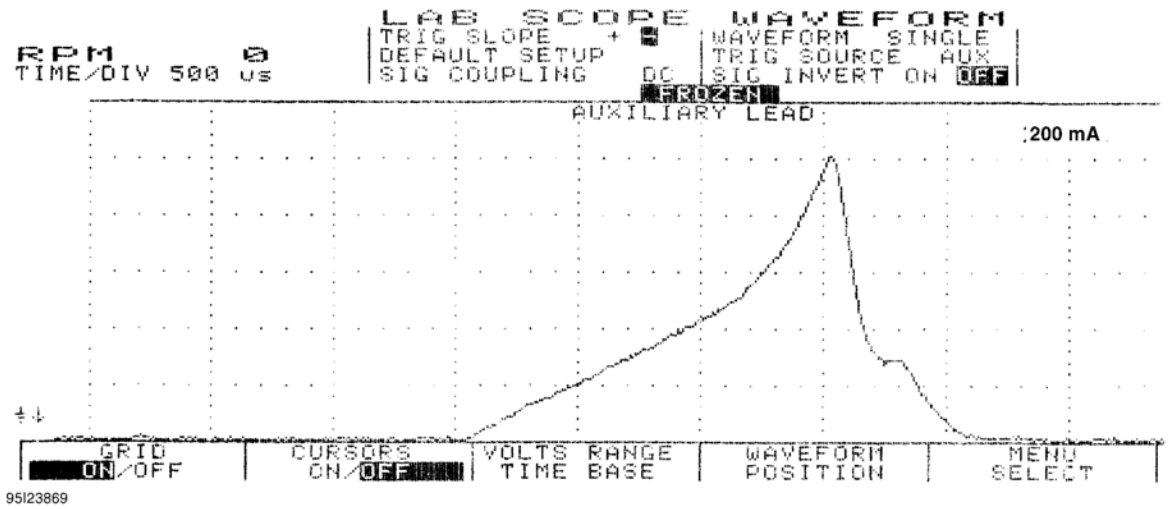


Fig. 14: Single Injector w/Normal Current Flow - Current Pattern

EXAMPLE #7 - CURRENT CONTROLLED DRIVER

The known-good current controlled type waveform in Fig. **Fig. 15** is from a GM 2.0L TBI VIN [1]. With the lab scope set at 2 amps per division, notice that this system peaks at 4 amps and holds at 1 amp.

The next waveform is from the same type of engine, except that it shows a faulty injector. See **Fig. 16**. Notice that the current went to almost 5 amps and stayed at 1 amp during the hold pattern. Excessive amounts of

current flow from bad injectors are a common source of intermittent computer shutdown. Using a current waveform pattern is the most accurate method of pinpointing this problem.

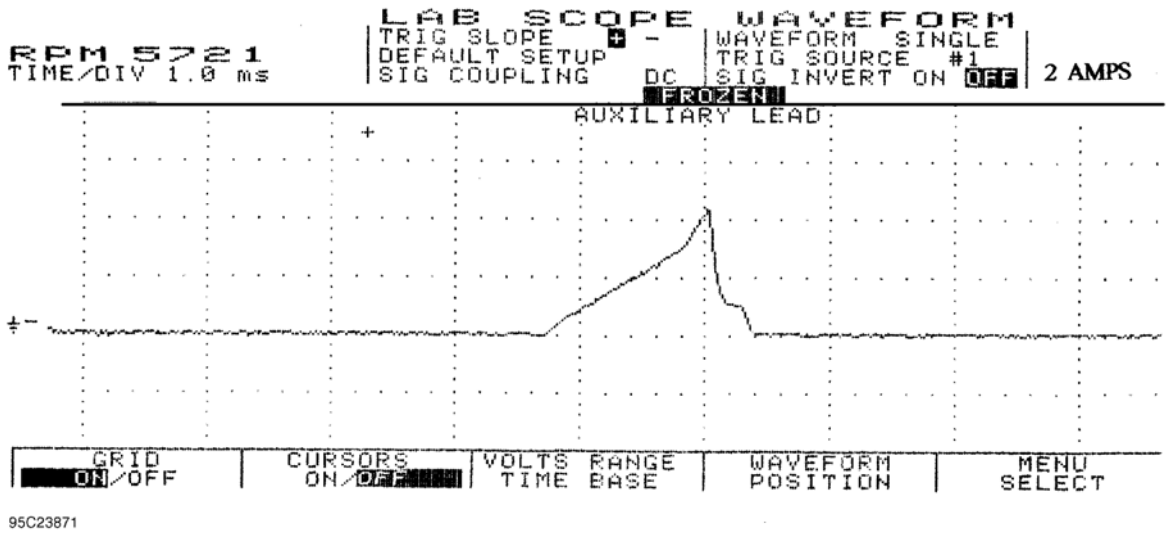


Fig. 15: Single Injector w/Normal Current Flow - Current Pattern

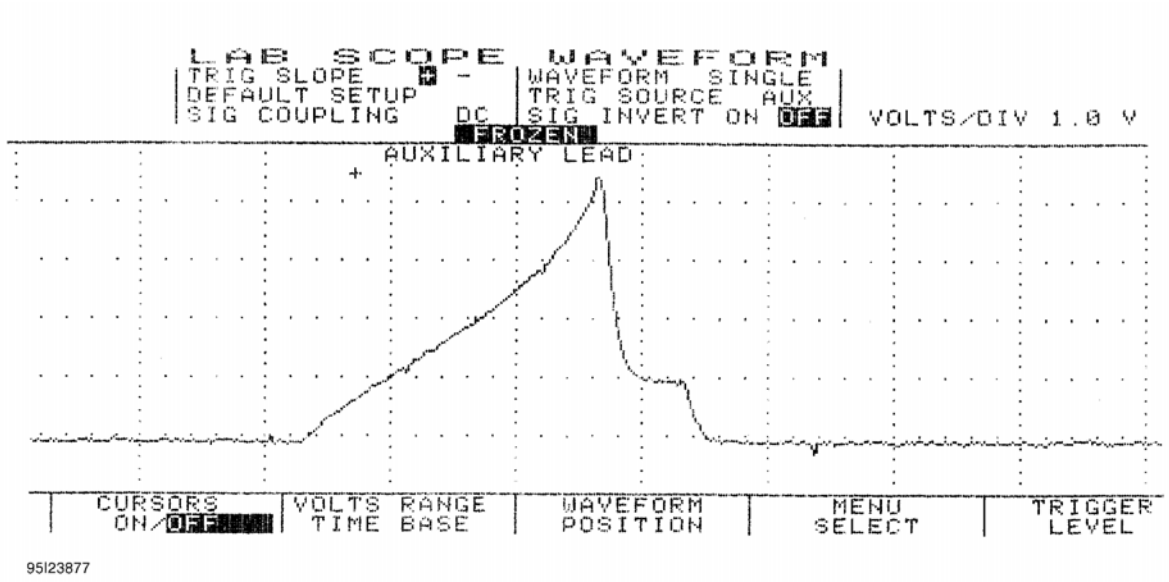


Fig. 16: Single Injector w/Excessive Current Flow - Current Pattern

EXAMPLE #8 - CURRENT CONTROLLED DRIVER

This known-good CPI system waveform from a GM 4.3L V6 CPI VIN [W] peaks at 4 amps and holds at 1-amp. See **Fig. 17** for waveform.

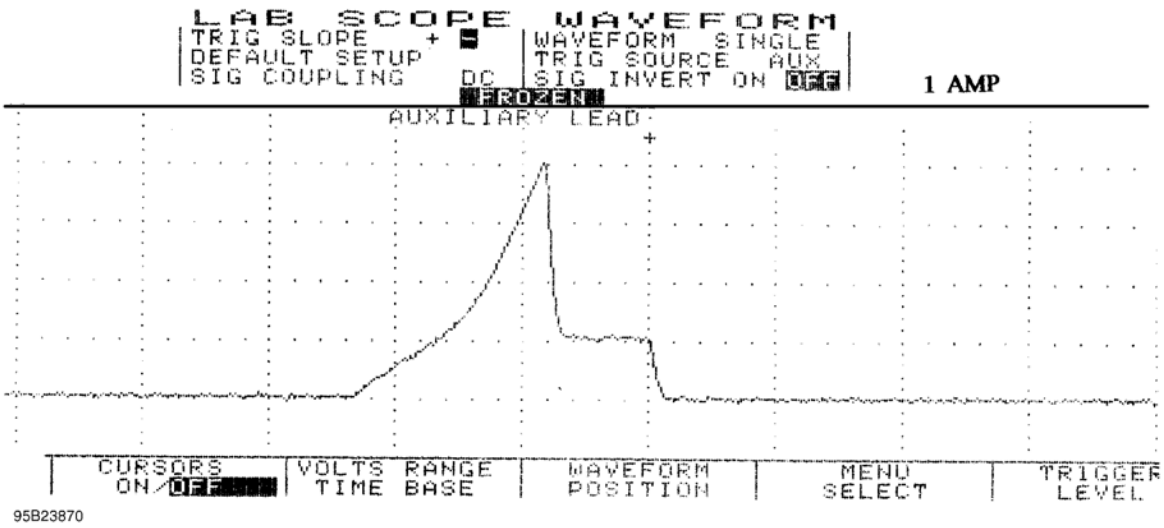


Fig. 17: Single Injector w/Normal Current Flow - Current Pattern

VOLTAGE WAVEFORM SAMPLES

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

EXAMPLE #1 - VOLTAGE CONTROLLED DRIVER

These two known-good waveform patterns are from a Ford 4.6L V8 VIN [W]. Fig. **Fig. 18** illustrates the 64 volt inductive kick on this engine, indicating no clamping is occurring. The second pattern, Fig. **Fig. 19**, was taken during hot idle, closed loop, and no load.

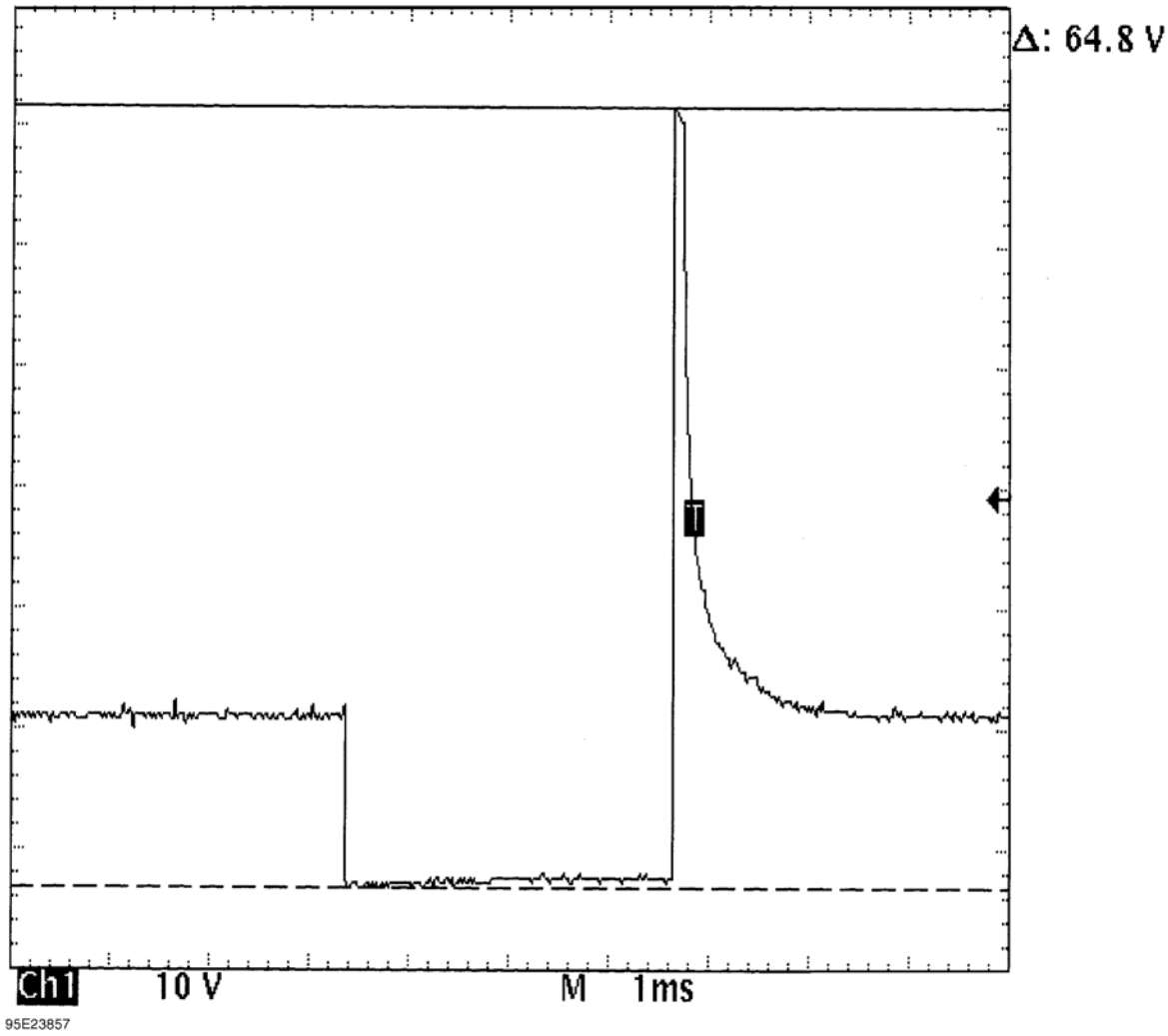


Fig. 18: Injector Bank - Known Good - Voltage Pattern

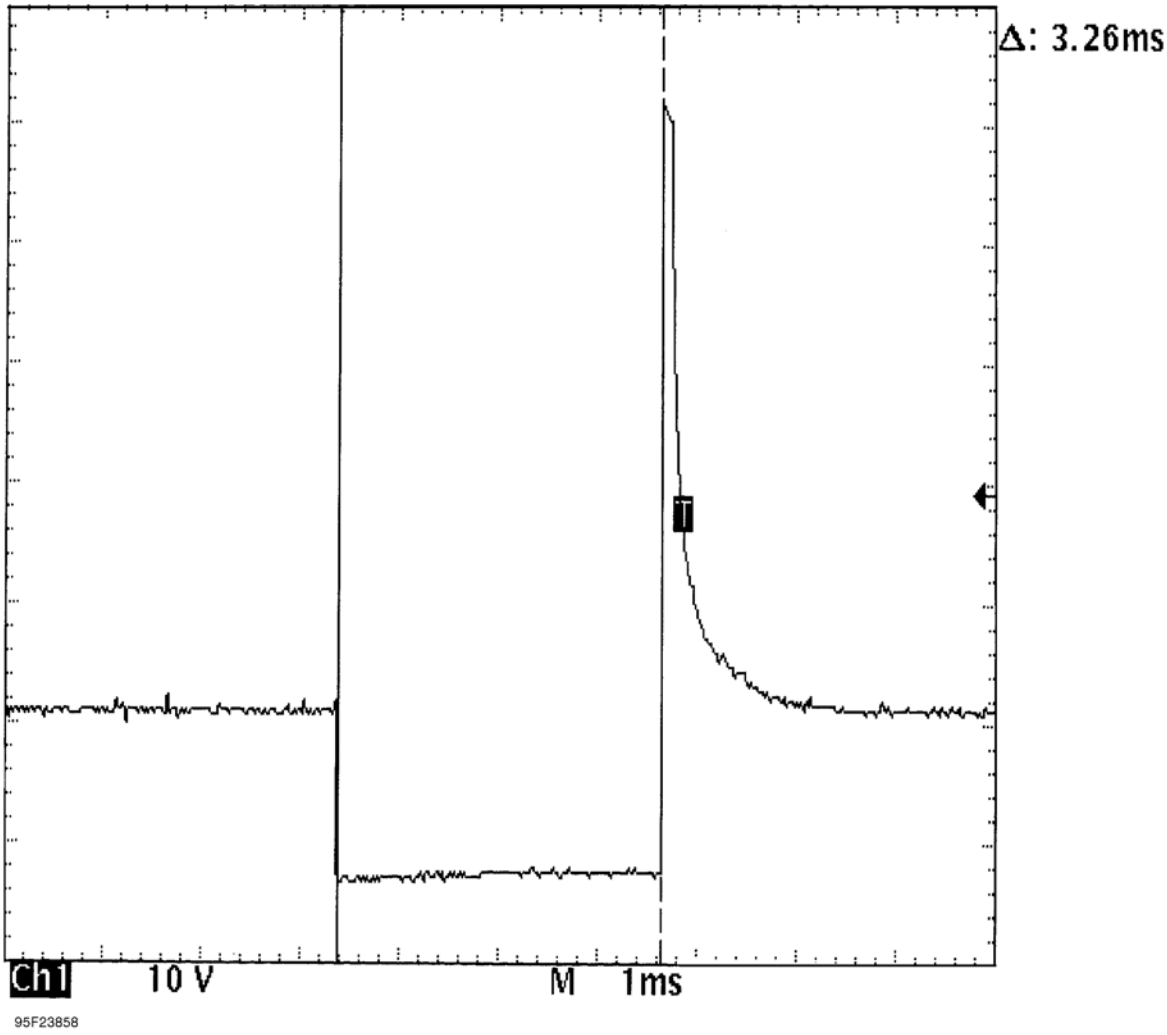


Fig. 19: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #2 - VOLTAGE CONTROLLED DRIVER

The known-good waveform pattern in Fig. **Fig. 20** is from a GM 3.8L V6 PFI VIN [3]. It was taken during hot idle, closed loop and no load.

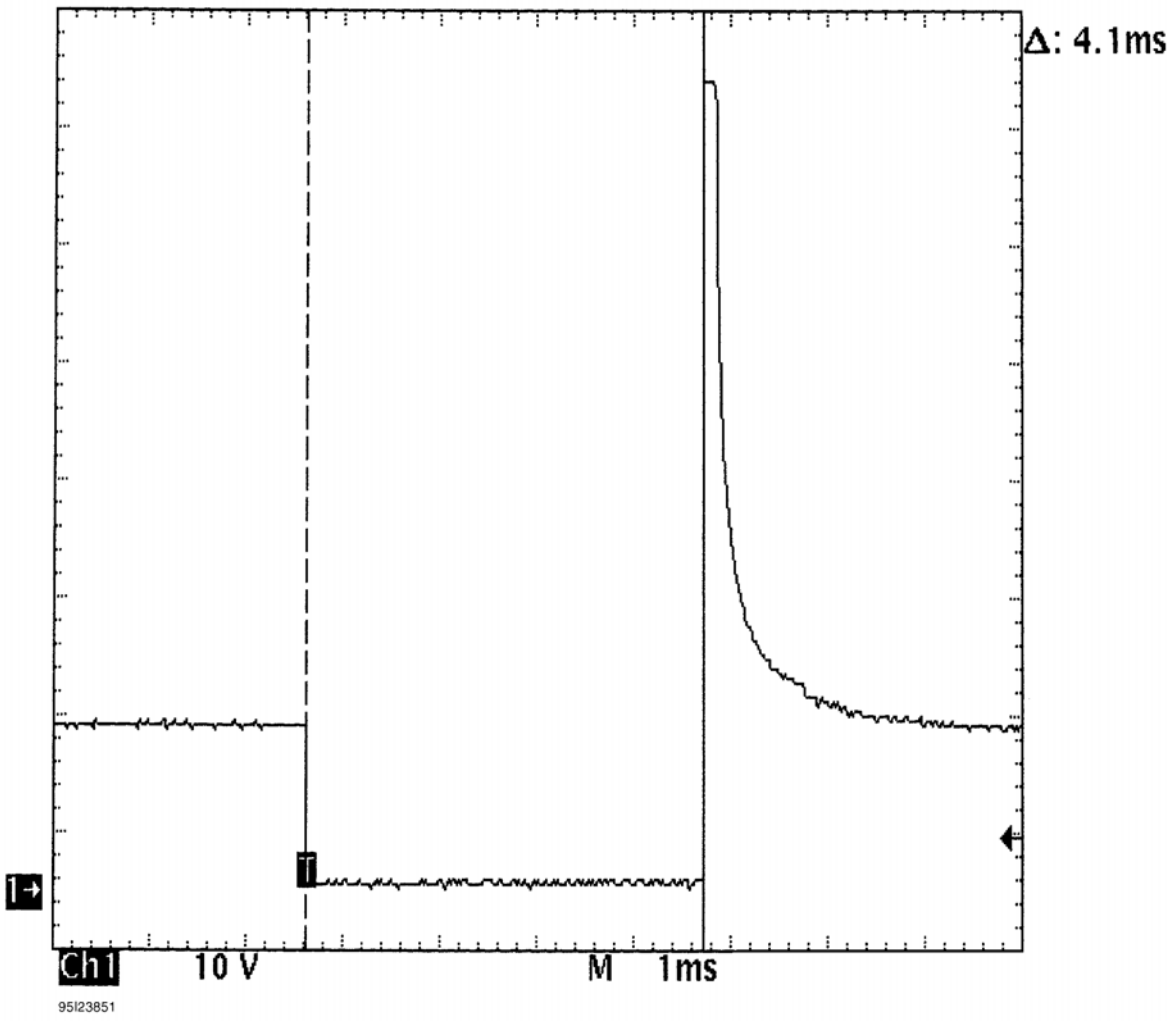


Fig. 20: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #3 - VOLTAGE CONTROLLED DRIVER

This known-good waveform pattern, Fig. **Fig. 21**, is from a GM 5.0L V8 TPI VIN [F]. It was taken during hot idle, closed loop and no load.

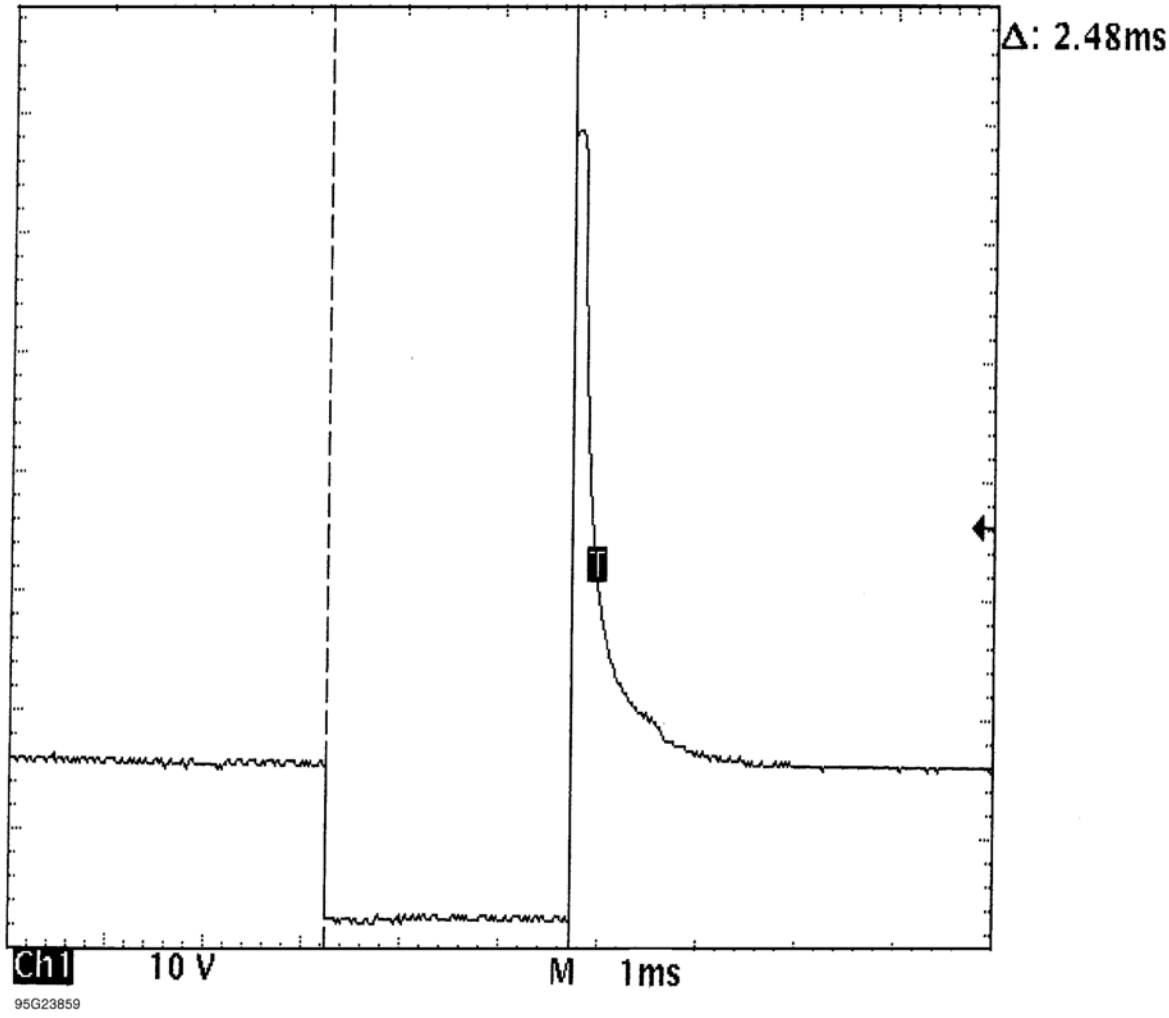


Fig. 21: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #4 - CURRENT CONTROLLED DRIVER

From 1984 to 1987, Chrysler used this type injector drive on their TBI-equipped engines. See **Fig. 22** for a known-good pattern. Instead of the ground side controlling the injector, Chrysler permanently grounds out the injector and switches the power feed side. Most systems do not work this way.

These injectors peak at 6 amps of current flow and hold at 1 amp.

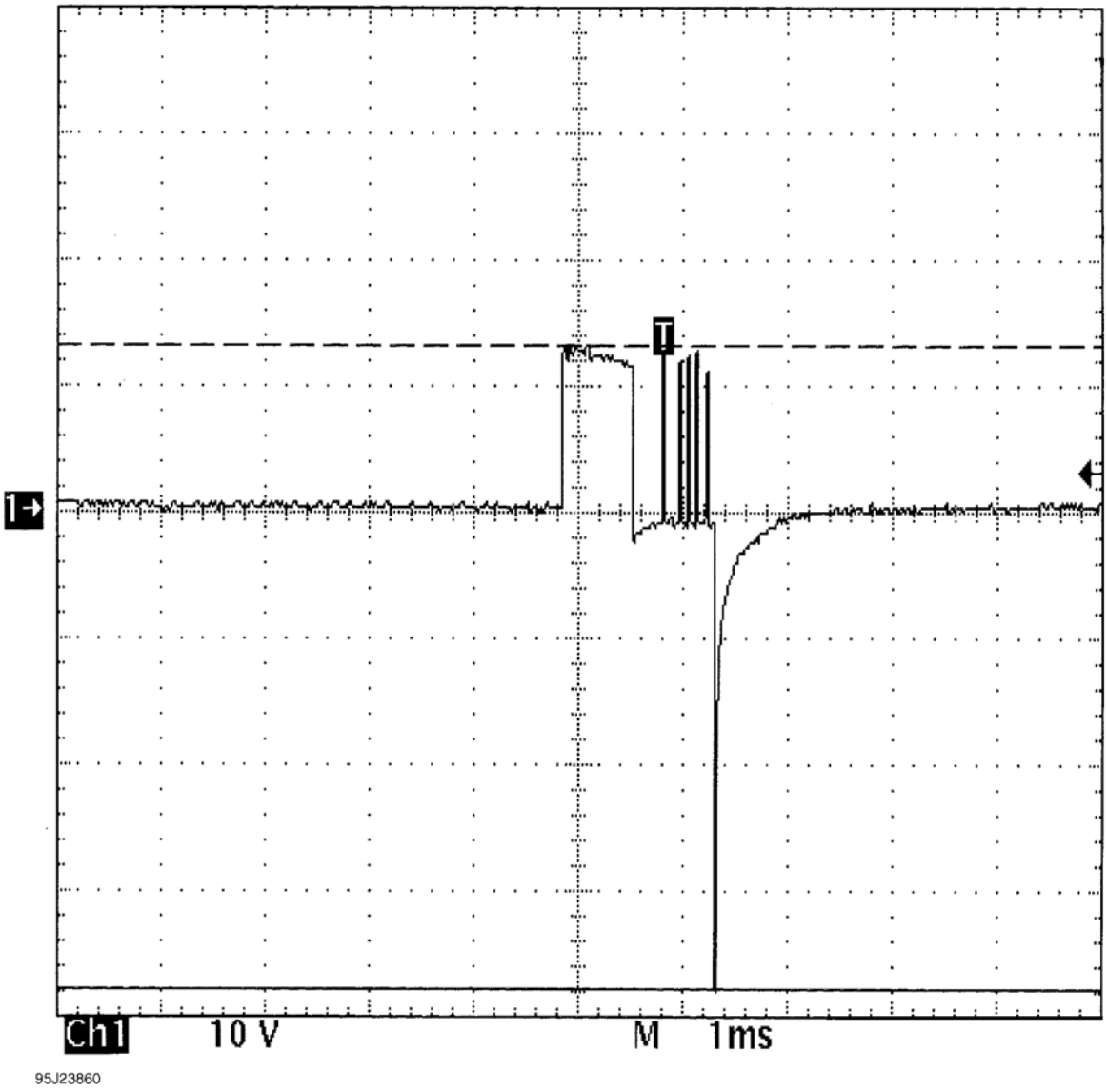


Fig. 22: Single Injector - Known Good - Voltage Pattern

EXAMPLE #5 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a Chrysler 3.0L V6 VIN [3]. The first waveform, Fig. **Fig. 23**, is a dual trace pattern that illustrates how Chrysler uses the rising edge of the engine speed signal to trigger the injectors. The second waveform, Fig. **Fig. 24**, was taken during hot idle, closed loop, and no load.

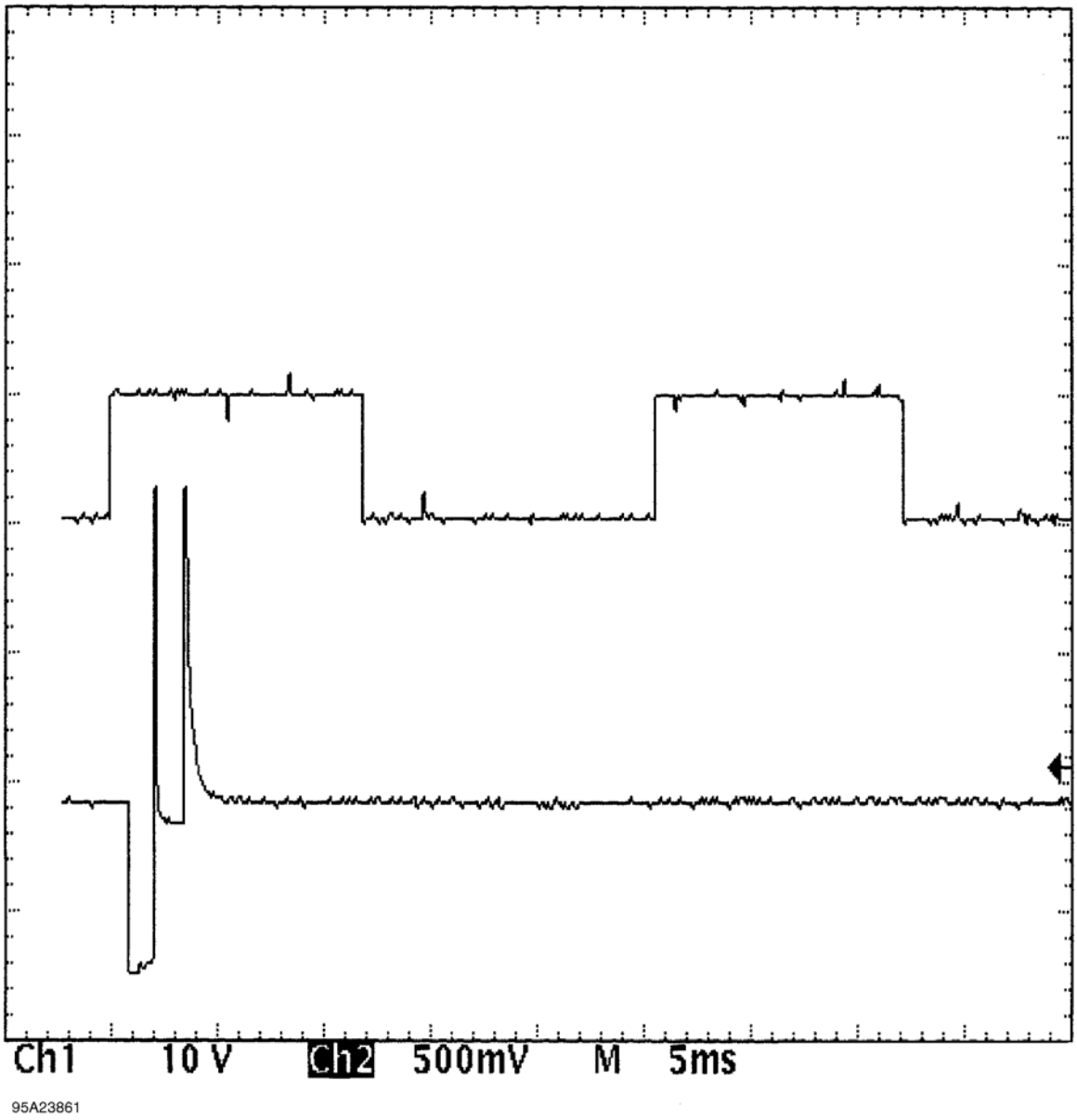


Fig. 23: Injector Bank - Known Good - Voltage Pattern

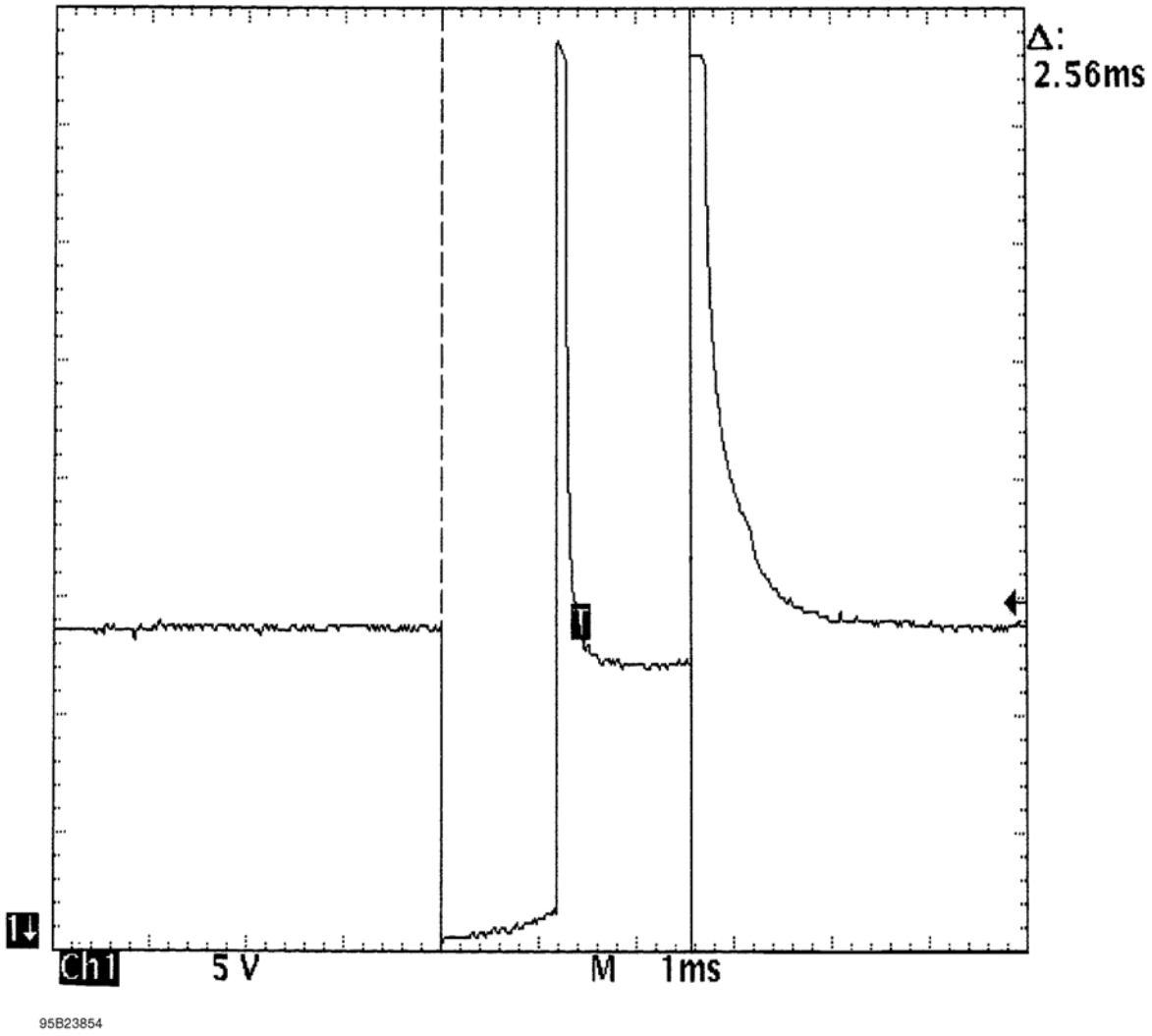


Fig. 24: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #6 - CURRENT CONTROLLED DRIVER

This known-good pattern from a Ford 3.0L V6 PFI VIN [U] illustrates that a zener diode inside the computer is used to clamp the injector's inductive kick to 35-volts on this system. See **Fig. 25**.

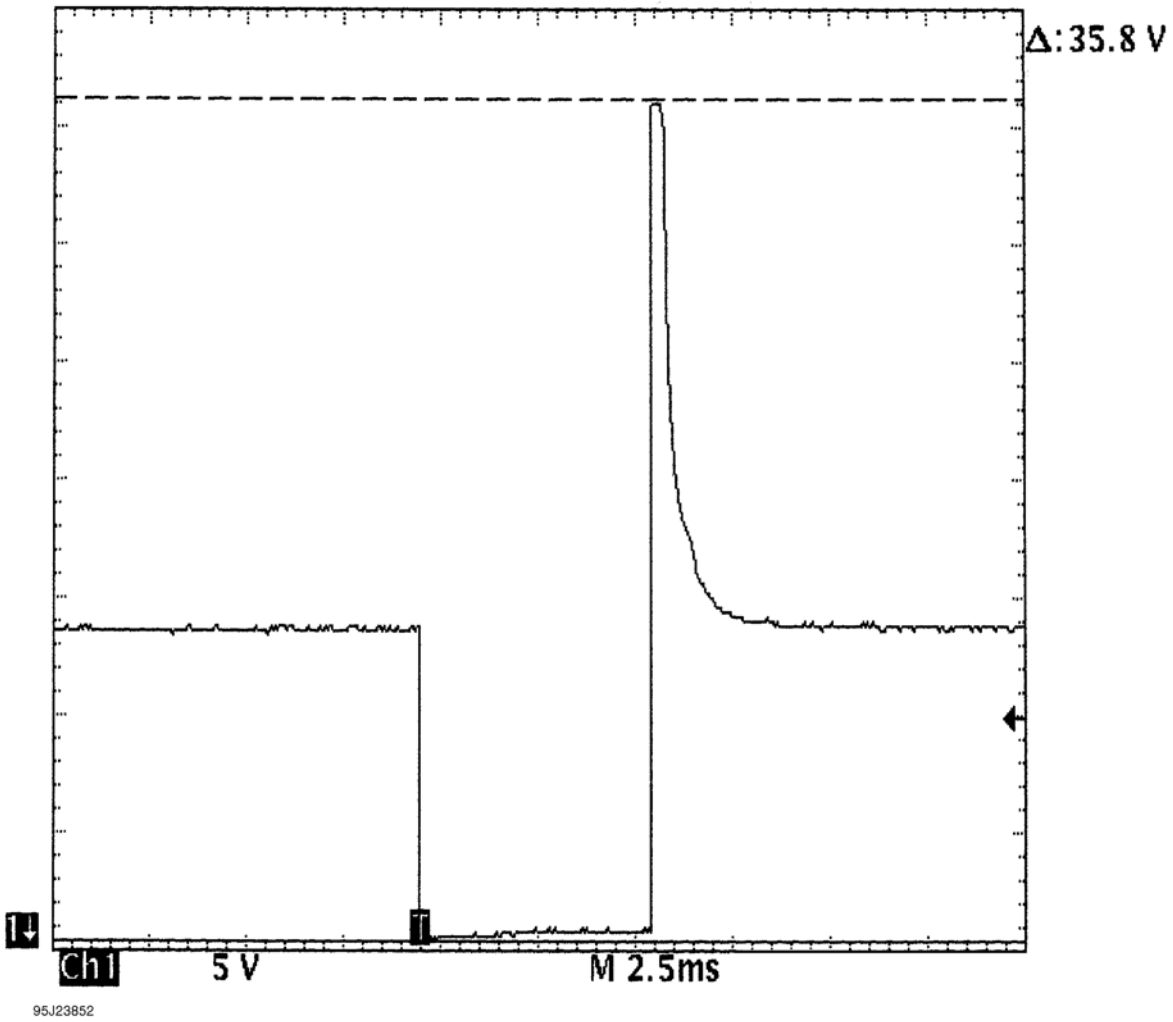


Fig. 25: Injector Bank - Known Good - Voltage Pattern

EXAMPLE #7 - CURRENT CONTROLLED DRIVER

This known-good waveform from a Ford 5.0L V8 CFI VIN [F] was taken during hot idle, closed loop, and no load. See **Fig. 26**.

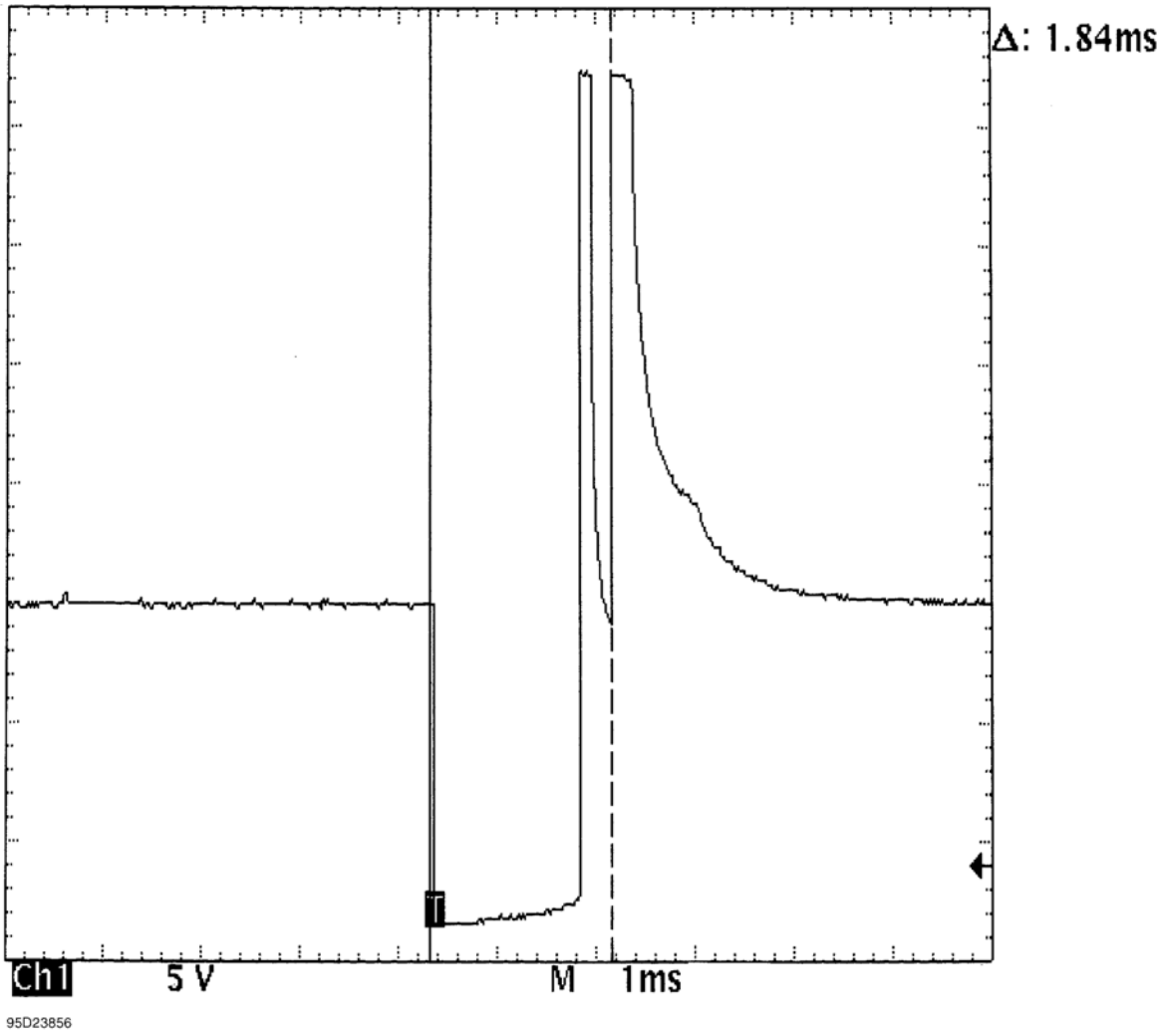


Fig. 26: Single Injector - Known Good - Voltage Pattern

EXAMPLE #8 - CURRENT CONTROLLED DRIVER

These two known-good waveform patterns are from a GM 2.0L In-Line 4 VIN [1]. Fig. **Fig. 27** illustrates the 78 volt inductive spike that indicates a zener diode is not used. The second waveform, Fig. **Fig. 28**, was taken during hot idle, closed loop, and no load.

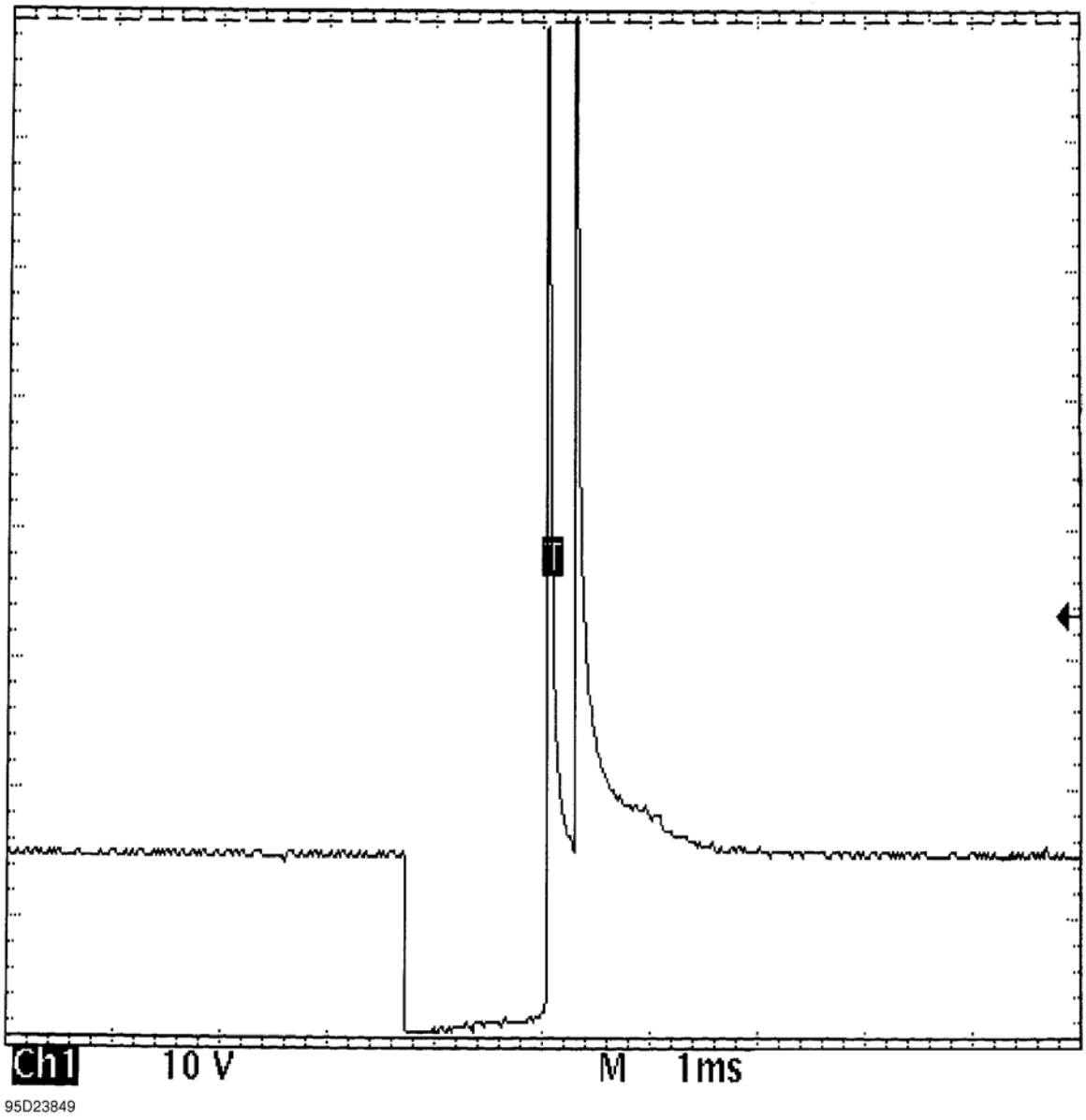


Fig. 27: Single Injector - Known Good - Voltage Pattern

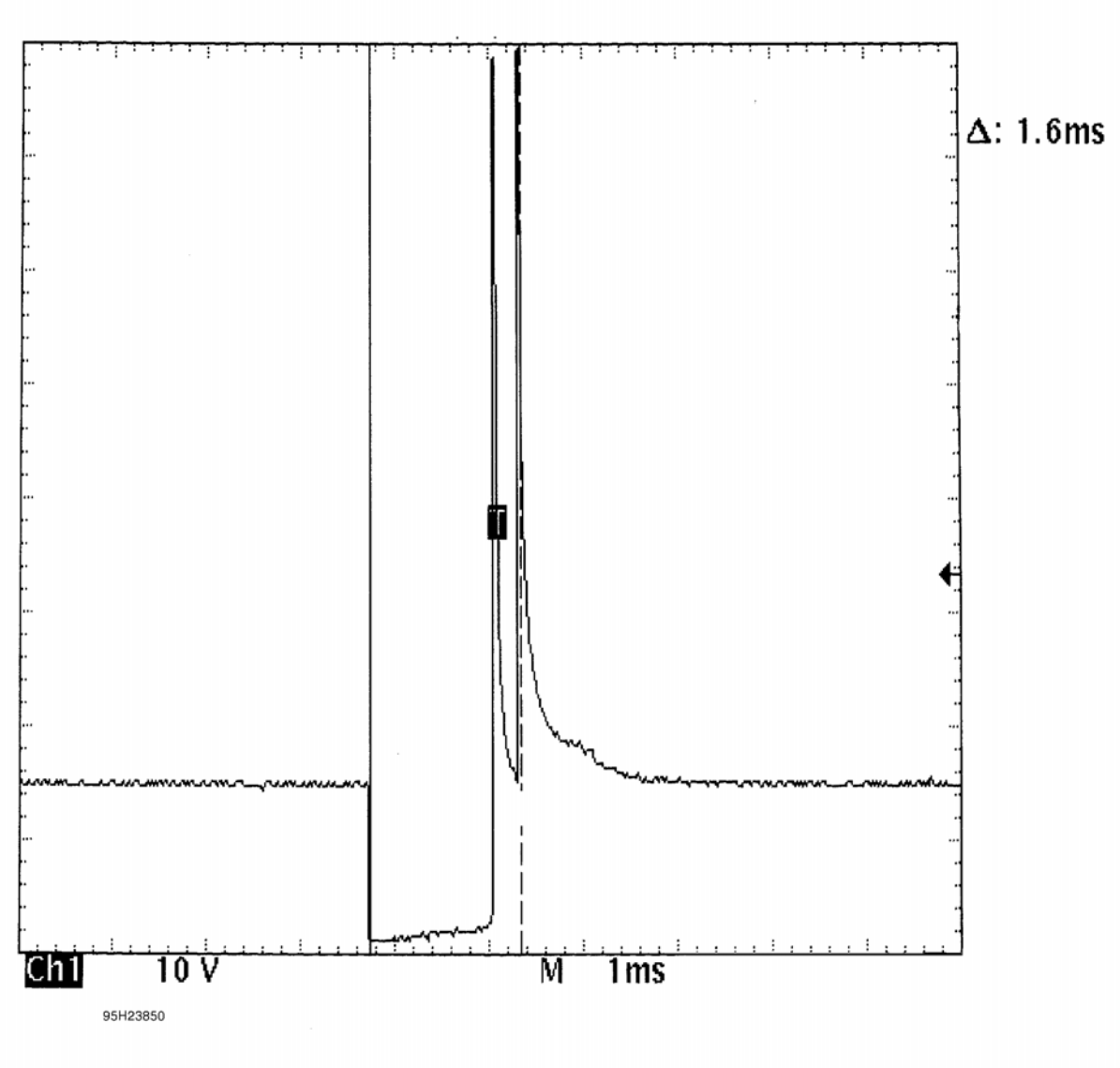


Fig. 28: Single Injector - Known Good - Voltage Pattern

Article GUID: A00010328

GENERAL INFORMATION

Wheel Alignment Theory & Operation

* PLEASE READ THIS FIRST *

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

PRE-ALIGNMENT INSTRUCTIONS

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

GENERAL ALIGNMENT CHECKS

Before adjusting wheel alignment, check the following:

- Each axle uses tires of same construction and tread style, equal in tread wear and overall diameter. Verify that radial and axial runout is not excessive. Inflation should be at manufacturer's specifications.
- Steering linkage and suspension must not have excessive play. Check for wear in tie rod ends and ball joints. Springs must not be sagging. Control arm and strut rod bushings must not have excessive play. See **Fig. 1**.

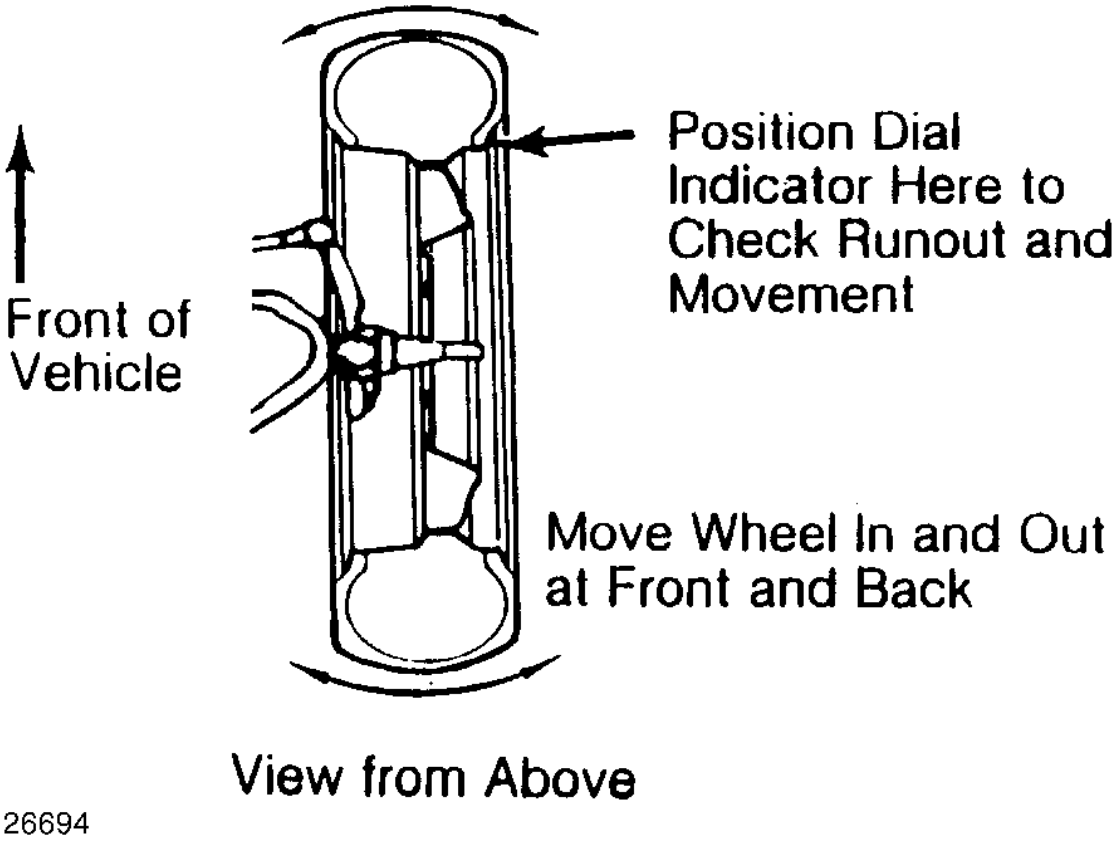


Fig. 1: Checking Steering Linkage

- Vehicle must be on level floor with full fuel tank, no passenger load, spare tire in place and no load in trunk. Bounce front and rear end of vehicle several times. Confirm vehicle is at normal riding height.
- Steering wheel must be centered with wheels in straight ahead position. If required, shorten one tie rod adjusting sleeve and lengthen opposite sleeve (equal amount of turns). See **Fig. 2**.
- Wheel bearings should have the correct preload and lug nuts must be tightened to manufacturer's specifications. Adjust camber, caster and toe-in using this sequence. Follow instructions of the alignment equipment manufacturer.

CAUTION: DO NOT attempt to correct alignment by straightening parts. Damaged parts MUST be replaced.

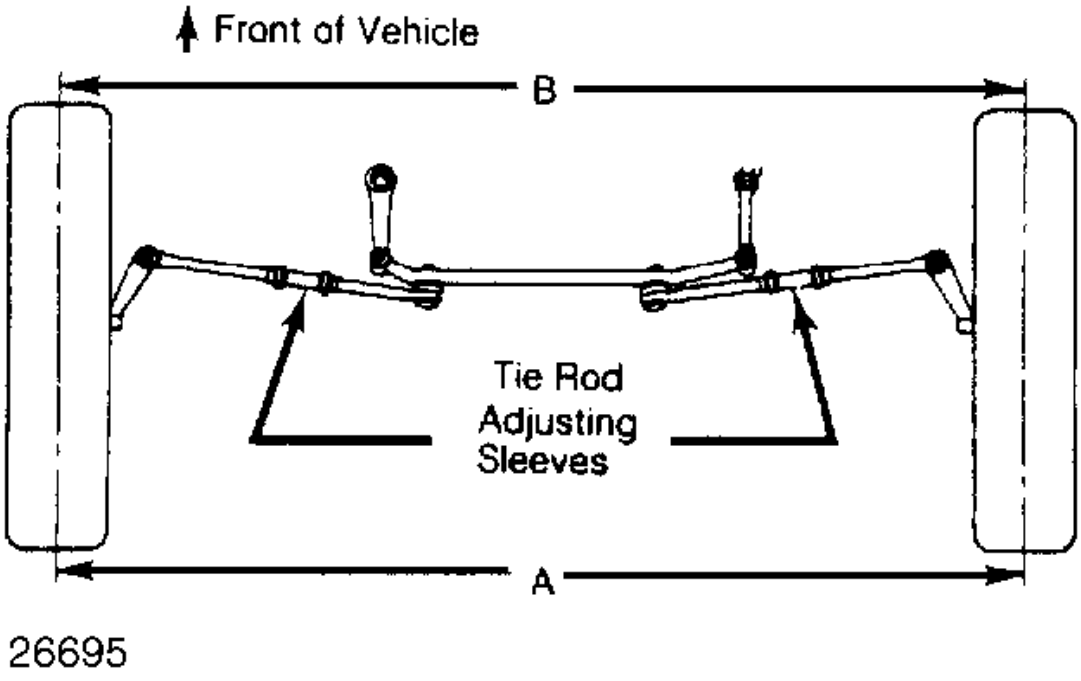


Fig. 2: Adjusting Tie Rod Sleeves (Top View)

ADJUSTMENTS

NOTE: **This is GENERAL information. This article is not intended to be specific to any unique situation or individual vehicle configuration. For model-specific information see appropriate articles where available.**

CAMBER

1. Camber is the tilting of the wheel, outward at either top or bottom, as viewed from front of vehicle. See **Fig. 3**.
2. When wheels tilts outward at the top (from centerline of vehicle), camber is positive. When wheels tilt inward at top, camber is negative. Amount of tilt is measured in degrees from vertical.

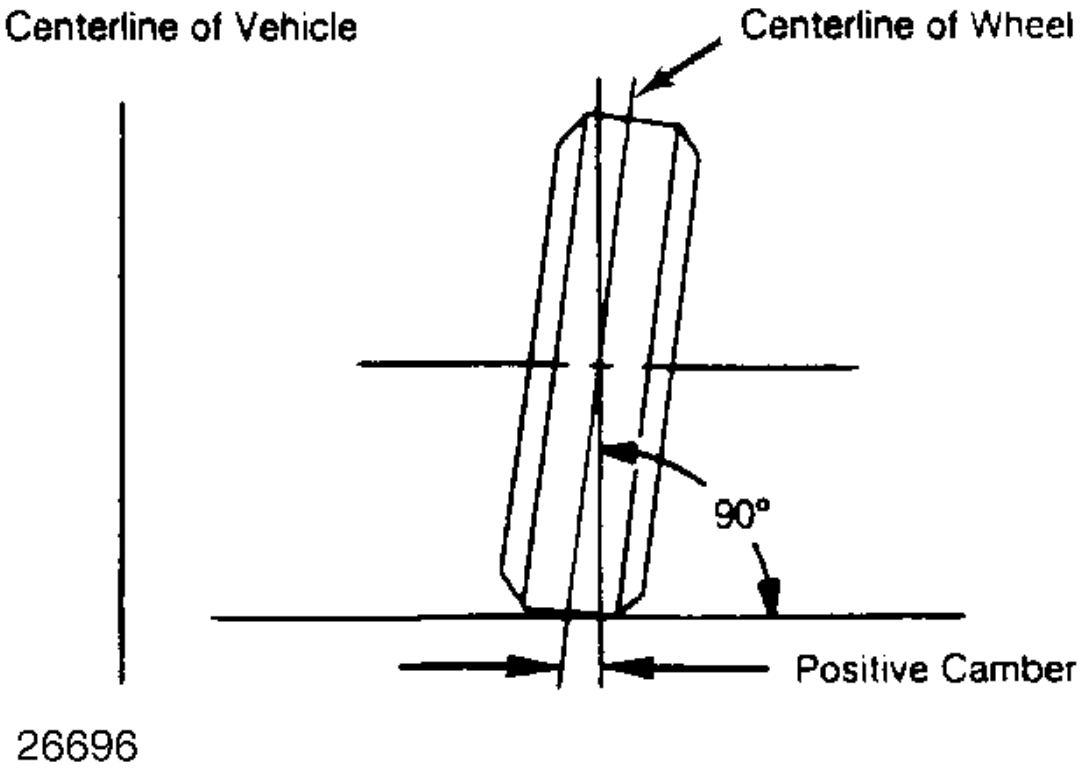


Fig. 3: Determining Camber Angle

CASTER

1. Caster is tilting of front steering axis either forward or backward from vertical, as viewed from side of vehicle. See **Fig. 4**.
2. When axis is tilted backward from vertical, caster is positive. This creates a trailing action on front wheels. When axis is tilted forward, caster is negative, causing a leading action on front wheels.

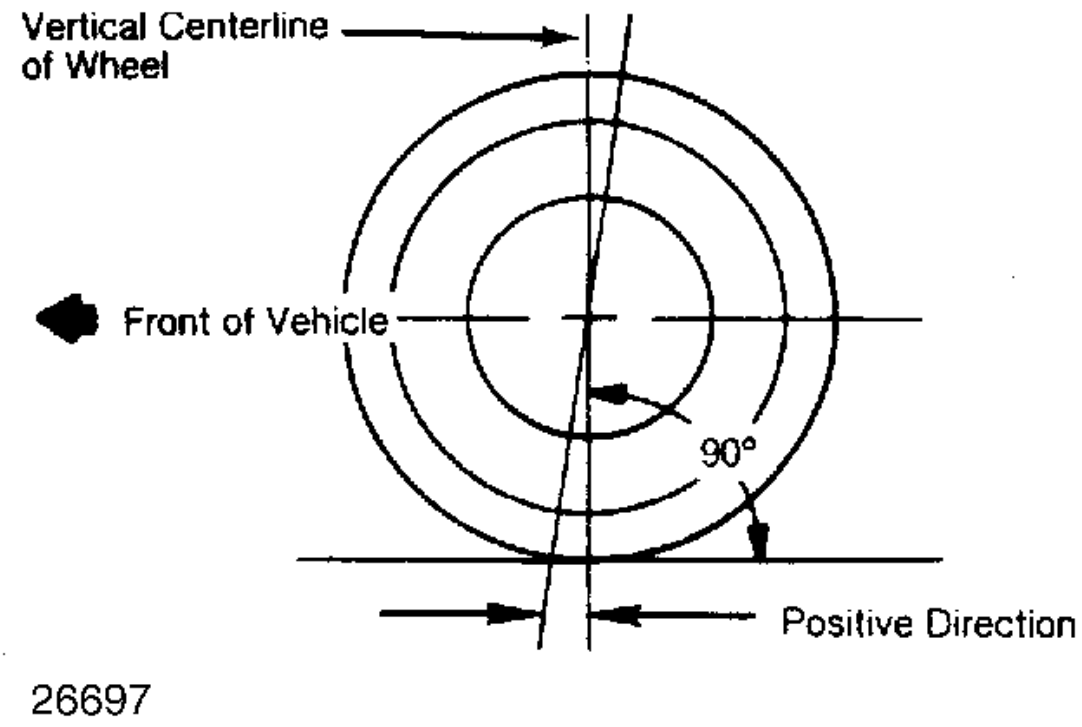


Fig. 4: Determining Caster Angle

TOE-IN ADJUSTMENT

Toe-in is the width measured at the rear of the tires subtracted by the width measured at the front of the tires at about spindle height. A positive figure would indicate toe-in and a negative figure would indicate toe-out. If the distance between the front and rear of the tires is the same, toe measurement would be zero. To adjust:

1) Measure toe-in with front wheels in straight ahead position and steering wheel centered. To adjust toe-in, loosen clamps and turn adjusting sleeve or adjustable end on right and left tie rods. See **Fig. 2** and **Fig. 5** .

2) Turn equally and in opposite directions to maintain steering wheel in centered position. Face of tie rod end must be parallel with machined surface of steering rod end to prevent binding.

3) When tightening clamps, make certain that clamp bolts are positioned so there will be no interference with other parts throughout the entire travel of linkage.

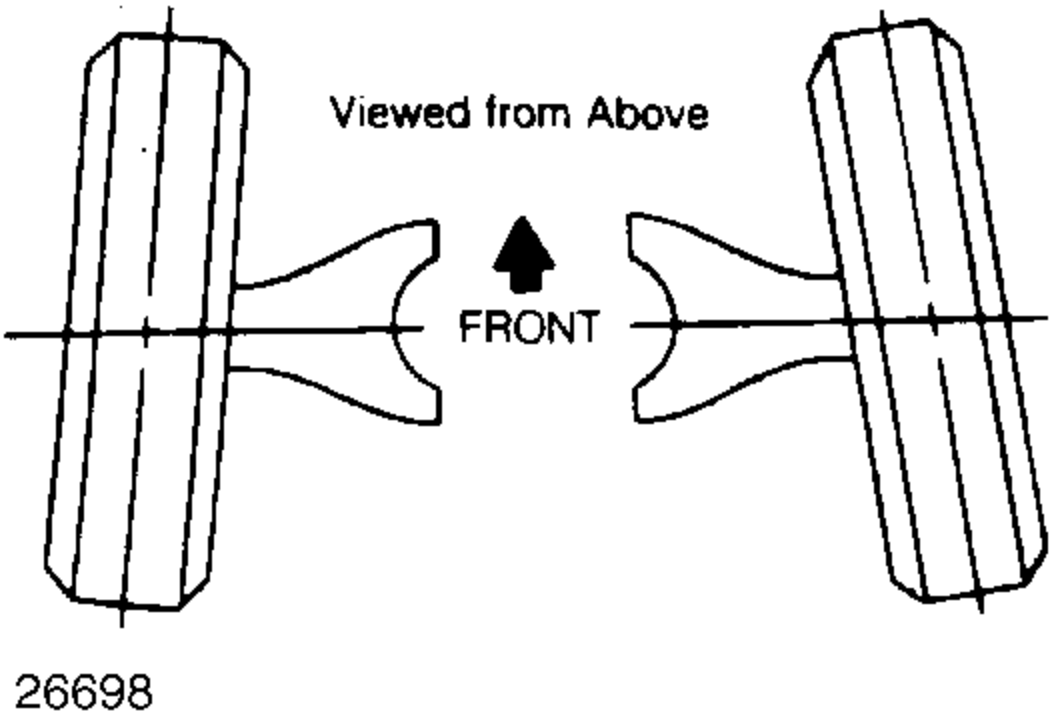


Fig. 5: Wheel Toe-In (Dimension A Less Dimension B)

TOE-OUT ON TURNS

1. Toe-out on turns (turning radius) is a check for bent or damaged parts, and not a service adjustment. With caster, camber, and toe-in properly adjusted, check toe-out with weight of vehicle on wheels.
2. Use a full floating turntable under each wheel, repeating test with each wheel positioned for right and left turns. Incorrect toe-out generally indicates a bent steering arm. Replace arm, if necessary, and recheck wheel alignment.

STEERING AXIS INCLINATION

1. Steering axis inclination is a check for bent or damaged parts, and not a service adjustment. Vehicle must be level and camber should be properly adjusted. See **Fig. 6**.
2. If camber cannot be brought within limits and steering axis inclination is correct, steering knuckle is bent. If camber and steering axis inclination are both incorrect by approximately the same amount, the upper and lower control arms are bent.

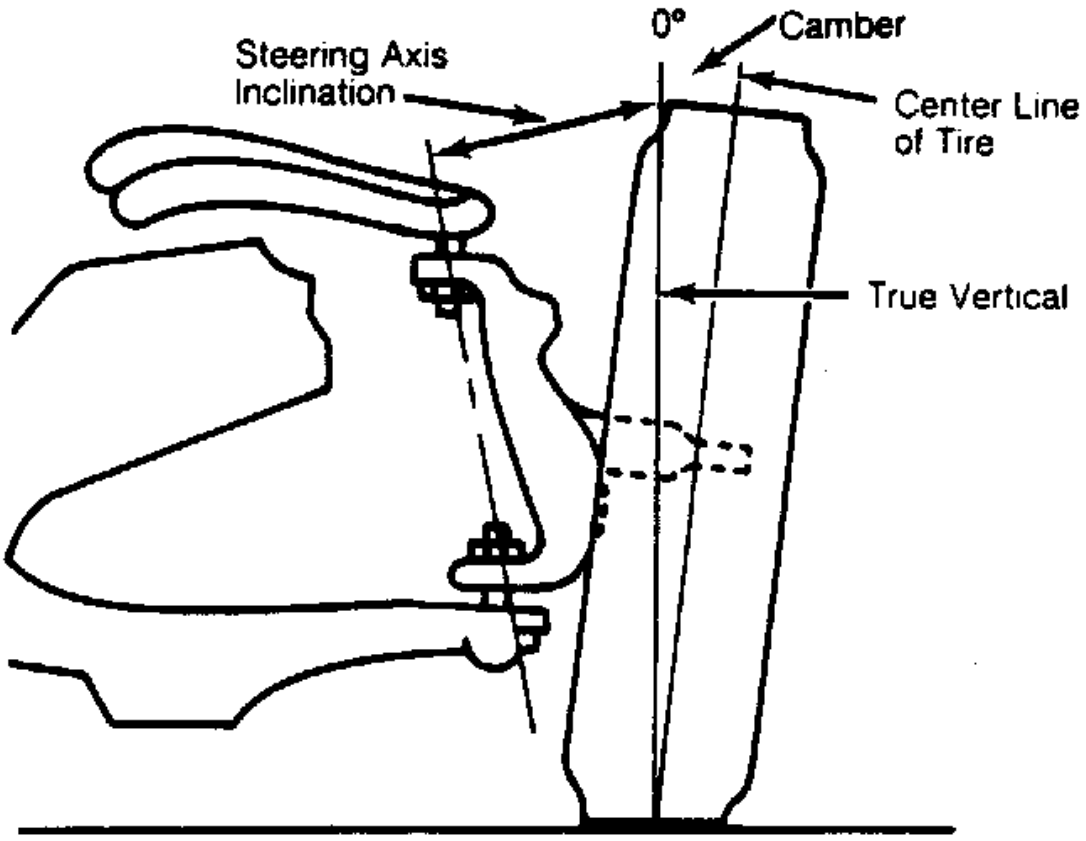


Fig. 6: Checking Steering Axis Inclination

Article GUID: A00060716

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
A/C Compressor Clutch Bolt	12 N.m	106 lb in
A/C Compressor Drain Plug	16 N.m	12 lb ft
A/C Compressor Front Bolt	50 N.m	36 lb ft
A/C Compressor Front Nut	50 N.m	36 lb ft
A/C Compressor Hose to A/C Compressor Block Fitting Nut	17 N.m	12.5 lb ft
A/C Compressor Hose to A/C Condenser Block Fitting Nut	17 N.m	12.5 lb ft
A/C Compressor Hose to Evaporator Tube Block Fitting Nut	17 N.m	12.5 lb ft
A/C Compressor Pressure Relief Valve	8 N.m	70 lb in
A/C Compressor Rear Bolt	50 N.m	36 lb ft
A/C Refrigerant Pressure Sensor	4.7 N.m	41 lb in
Air Distributor Duct Bolts	10 N.m	88 lb in
Air Distributor Duct Screw	1.5 N.m	13 lb in
Blower Motor Control Module Screws	1.5 N.m	13 lb in
Blower Motor Screws	1.5 N.m	13 lb in
Evaporator Line Block Fitting to TXV Nut	17 N.m	12.5 lb ft
Heater Core Cover Screws	1.5 N.m	13 lb in
Heater Core Outlet Cover Screws	1.5 N.m	13 lb in
HVAC Module Case Screws	1.5 N.m	13 lb in
HVAC Module to Front of Dash Nuts	10 N.m	89 lb in
Service Port Valve Core	11 N.m	98 lb in
TXV to Evaporator Screws	7 N.m	62 lb in

REFRIGERANT SYSTEM SPECIFICATIONS

Refrigerant System Capacities

Application	Specification	
	Metric	English
Abrupt Refrigerant Loss	60 ml[1]	2.0 oz[1]
PAG Oil GM P/N 12378526 for United States PAG Oil GM P/N 88900060 for Canada		
Compressor Replacement		
NOTE: **Compressor failure can**		

Application	Specification	
	Metric	English
occur if the oil removed during refrigerant recovery is not replaced. • The 7CVC service compressor is shipped with 150 ml[2] (5 oz[2]) of PAG oil.		
Condenser Replacement	30 ml[2]	1.0 oz[2]
Evaporator Replacement	90 ml[2]	3.0 oz[2]
Any Line Set (Hose/Tube or Tube Assembly) Replacement	30 ml[2]	1.0 oz[2]
• Total System PAG Oil Capacity	150.0 ml	5 oz
R-134a		
• Refrigerant Charge	0.57 kg	1.25 lbs
[1] Abrupt refrigerant loss due to large leak, hose rupture, collision, or pressure relief valve opening. Conditions that allow the refrigerant to seep or bleed off over time do not cause this oil loss. Upon replacement of a component that caused a large refrigerant loss, also add the required amount of oil for the particular component. [2] If more than the specified amount of PAG oil was drained from a component, add the amount drained.		

DIAGNOSTIC INFORMATION AND PROCEDURES

LEAK TESTING

Special Tools

- **GE-50078** Electric Leak Detector
- **GE-41447** R-134A A/C Tracer Dye-Box of 24
- **GE-42220** Universal 12V Leak Detection Lamp
- **GE-43872** Fluorescent Dye Cleaner
- **GE-46297** A/C Dye Injector Kit
- **GE-46297-12** Replacement Dye Cartridges

For equivalent regional tools. Refer to **Special Tools**.

Refrigerant Leak Testing

NOTE: **All A/C system repairs must be verified using electronic leak detection. Dye detection may take up 2 or 3 days to be reliable.**

NOTE: **General Motors vehicles are now manufactured with fluorescent dye installed**

directly into the air conditioning (A/C) system.

The fluorescent dye mixes and flows with the air conditioning oil throughout the refrigerant system.

Verifying some passive leaks may require using the **GE-50078** Electric Leak Detector , even though the A/C system contains fluorescent dye.

The only time that adding additional fluorescent dye is required, is after flushing the A/C system.

Visual Inspection

Visually trace the entire refrigerant system and look for signs of lubricant leakage, damage, and corrosion on all lines hoses and components (Oil can be an indication of a leak). Each questionable area should be checked for leaks using an electric leak detector.

Fluorescent Leak Detector

NOTE: Always use UV protective eyewear when working with UV light.

Fluorescent dye will assist in locating any leaks in the A/C system.

NOTE: Air conditioning oil is water soluble.

- Condensation on the evaporator core or the refrigerant lines may wash the air conditioning oil and fluorescent dye away from the actual leak. Condensation may also carry dye through the HVAC module drain.
- Leaks in the A/C system will be indicated in a light green or yellow color when using the leak detection lamp.

  Use the leak detection lamp in the following areas:

  - All fittings or connections that use seal washers or O-rings
  - All of the A/C components
  - The A/C compressor shaft seal
  - The A/C hoses and pressure switches
  - The HVAC module drain tube, if the evaporator core is suspected of leaking
  - The service port sealing caps

    The sealing cap is the primary seal for the service ports.

- Follow the instructions supplied with the **GE-42220** Universal 12V Leak Detection Lamp.
- To prevent false diagnosis in the future, thoroughly clean the residual dye from any area where leaks were found. Use a rag and the approved **GE-43872** Fluorescent Dye Cleaner.

Fluorescent Dye Injection

NOTE: Use only fluorescent dye approved by General Motors.

- **GE-41447 R-134A A/C Tracer Dye-Box of 24 can be poured directly into a removed A/C component.**

- **GE-46297-12 Replacement Dye Cartridges is injected into the low side port using GE-46297 A/C Dye Injector Kit.**

- Not all of the fluorescent dyes are compatible with all air conditioning oils. Some types of dye decrease the oil viscosity or may chemically react with the oil.
- R-134A leak detection dye requires time to work. Depending upon the leak rate, a leak may not become visible for between 15 minutes and 7 days.

NOTE: **Do NOT overcharge the A/C system with dye. Use only one 7.39 ml (0.25 oz) charge.**

- To prevent false diagnosis, thoroughly clean any residual dye from the service port with a rag and the approved fluorescent dye cleaner **GE-43872** Fluorescent Dye Cleaner.

Electric Leak Detector

WARNING: **Do not operate the detector in a combustible atmosphere since its sensor operates at high temperatures or personal injury and/or damage to the equipment may result.**

Ensure that the vehicle has at least 0.45 kg (1 lb) of refrigerant in the A/C refrigeration system in order to perform a leak test. Refer to **Refrigerant Recovery and Recharging** for recharging the A/C system.

NOTE: **Electronic leak detectors are sensitive to the following items:**

- **Windshield washing solutions**
- **Many solvents and cleaners**
- **Some adhesives used in the vehicle**

Clean and dry all surfaces in order to prevent a false warning. Liquids will damage the detector.

Do not use:

- Soap solutions (not effective for leak detection)
- Shop air (will introduce contamination to the refrigerant system)
- High pressure gasses i.e. nitrogen (may cause system damage)

Air movement from the engine cooling fan can affect the detectors ability to detect leaks. Always leak test with engine off and if possible after engine has reached normal operating temperature.

- All fittings and components should be checked.
- Take care not to contaminate the probe tip if the part being tested is contaminated.
- No cleaners containing solvents should be used prior to using electronic leak detector.
- Always follow the refrigerant system around in a continuous path so that no areas of potential leaks are missed. Move the tip along the refrigerant system at a rate of no more than 3 inches per second and a distance of 3/8 inch from the surface being tested. If a leak is found, always continue to test the remainder of the system.

Follow the instructions supplied with the **GE-50078** Electric Leak Detector.

AIR CONDITIONING (A/C) SYSTEM PERFORMANCE TEST (LFX)

Test Description

This test measures the operating efficiency of the A/C system under the following conditions:

- The current ambient air temperature
- The current relative humidity
- The high side pressure of the A/C system
- The low side pressure of the A/C system
- The temperature of the air being discharged into the passenger compartment

The number(s) below refer to the step number(s) on the diagnostic table.

1

This step determines if the A/C system has at least the minimum refrigerant charge required to operate the system without damage.

2

This step measures the performance of the A/C system.

3

This step is to allow for vehicle variations as well as high ambient air temperatures.

Step	Action	Value(s)	Yes	No
NOTE: • **The ambient air temperature must be at least 16Â°C (60Â°F) .** • **Do not induce additional air flow across the front of the vehicle during the test.** • **If you were sent here from a DTC**				

Step	Action	Value(s)	Yes	No
	diagnostic table, clear the DTC upon completion of this test.			
1	1. Park the vehicle inside or in the shade. 2. Open the windows in order to ventilate the interior of the vehicle. 3. If the A/C system was operating, allow the A/C system to equalize for about 2 minutes. 4. Turn OFF the ignition 5. Install the **J 43600** ACR 2000 Air Conditioning Service Center. 6. Record the ambient air temperature displayed on the **J 43600** ACR 2000 Air Conditioning Service Center. 7. Record readings of the low and high side STATIC pressures. Are both the low and high side pressures within the specified value?	Above 16Â°C (60Â°F) - 345 kPa (50 psi) Above 24Â°C (75Â°F) - 483 kPa (70 psi) Above 33Â°C (90Â°F) - 690 kPa (100 psi)	Go to **Step 2**	Go to **Leak Testing**
2	**NOTE:** **Record the relative humidity and the ambient air temperature AT THE TIME OF THE TEST.** 1. Close the vehicle doors and windows. 2. Open the driver door window 12.7-15.2 cm (5-6 in). 3. Select the following HVAC control setting: • The A/C is ON • The coldest temperature setting • The maximum blower speed • Recirculation mode • The IP panel outlet mode	-	Go to **Step 5**	Go to **Step 3**

Step	Action	Value(s)	Yes	No
	• All IP panel outlets are OPEN • The passenger side of a Dual Zone HVAC control module is turned OFF 4. Install the temperature probes of the **J 43600** ACR 2000 Air Conditioning Service Center in the left and right center panel air outlets. 5. Apply the parking brake. 6. Place the transmission in PARK 7. Start the engine. 8. Operate the A/C system for 5 minutes. 9. Inspect A/C components for the following conditions: • Abnormal frost areas • Unusual noises **NOTE:** **When performing this step it is necessary to press the RESET button on the J 43600 ACR 2000 Air Conditioning Service Center before pressing the PRINT button.** 10. Print the following information: • The panel outlet air temperatures • The low-side pressure • The high-side pressure 11. Compare the low and high side pressures and the panel output temperatures to the A/C performance table below. Does all the data recorded fall within the specified ranges of the A/C performance table?			

Step	Action	Value(s)	Yes	No
3	If the pressures and temperatures recorded do not fall within the specified ranges: 1. Continue to operate the A/C system for an additional 5 minutes. 2. Record the pressures and temperatures again. 3. Compare the low and high side pressures and the panel output temperature to the A/C performance table. Does all the data recorded fall within the specified ranges of the A/C performance table?	-	Go to **Step 5**	Go to **Step 4**
4	Perform the necessary repairs. Refer to **A/C Diagnostics Chart**. Is the action complete?	-	Go to **Step 5**	-
5	Operate the system in order to verify the test results. Did you find the same results?	-	System OK	Go to **Symptoms - HVAC Systems - Manual**

A/C Performance Table

Ambient Air Temperature	Relative Humidity	Service Port Pressure		Maximum Left Center Discharge Air Temperature
		Low Side	High Side	
13-18Â°C (55-65Â°F)	0-100%	151-213 kPa (22-31 psi)	1067-1371 kPa (129-168 psi)	7Â°C (43Â°F)
19-24Â°C (66-75Â°F)	Below 40%	151-227 kPa (22-33 psi)	1040-1329 kPa (151-193 psi)	8Â°C (45Â°F)
	Above 40%	165-241 kPa (24-35 psi)	1150-1467 kPa (167-213 psi)	8Â°C (46Â°F)
25-29Â°C (76-85Â°F)	Below 35%	172-241 kPa (25-35 psi)	1157-1391 kPa (168-202 psi)	9Â°C (48Â°F)
	35-50%	186-248 kPa (27-36 psi)	1233-1446 kPa (179-210 psi)	9Â°C (48Â°F)
	Above 50%	192-261 kPa (28-38 psi)	1281-1550 kPa (186-225 psi)	12Â°C (52Â°F)
30-35Â°C (86-95Â°F)	Below 30%	192-254 kPa (28-37 psi)	1240-1467 kPa (180-213 psi)	12Â°C (52Â°F)
	30-50%	199-268 kPa (29-39 psi)	1288-1550 kPa (187-225 psi)	13Â°C (54Â°F)
	Above 50%	206-282 kPa (30-41 psi)	1371-1646 kPa (199-239 psi)	14Â°C (57Â°F)
36-41Â°C (96-105Â°F)	Below 20%	206-275 kPa (30-40 psi)	1322-1543 kPa (192-224 psi)	13Â°C (55Â°F)

Ambient Air Temperature	Relative Humidity	Service Port Pressure		Maximum Left Center Discharge Air Temperature
		Low Side	High Side	
	20-40%	213-282 kPa (31-41 psi)	1357-1612 kPa (197-234 psi)	14Â°C (57Â°F)
	Above 40%	220-289 kPa (32-42 psi)	1433-1681 kPa (208-244 psi)	15Â°C (59Â°F)
42-46Â°C (106-115Â°F)	Below 20%	227-289 kPa (33-42 psi)	1419-1619 kPa (206-235 psi)	14Â°C (57Â°F)
	Above 20%	234-296 kPa (34-43 psi)	1460-1688 kPa (2212-245 psi)	17Â°C (61Â°F)
47-49Â°C (116-120Â°F)	Below 30%	248-310 kPa (36-45 psi)	1543-1743 kPa (224-253 psi)	18Â°C (63Â°F)

A/C DIAGNOSTICS CHART

A/C System Concern		Potential Causes
Compressor Inoperative		Electrical Wiring Issue
		No or Low Refrigerant Charge
		Compressor Internal Malfunction
		Compressor Clutch Malfunction
		A/C Pressure Sensor Malfunction
		Evaporator Air Temperature (EAT) Malfunction
		HVAC Controls Malfunction
Low Side Gauge Reading	**High Side Gauge Reading**	**Potential Causes**
Same as High Side	Same as Low Side	No or Low Refrigerant Charge
		Compressor Malfunction
		A/C Pressure Sensor Malfunction
		EAT Malfunction
		HVAC Controls Malfunction
Normal	Normal	Temperature Actuator Malfunction
		Temperature Door Malfunction
Low	Low	Low Refrigerant Charge
		Restriction between the Compressor Outlet and Low Side Port
	Low/Normal	Evaporator Freezing/EAT Malfunction
	High	Compressor Stuck at Maximum Displacement/EAT Malfunction
Normal/High	Normal/High	PAG or POE Oil Overcharge
High	Low	Restriction between the Low Side Port and Compressor Inlet
		Expansion Device Stuck Open
		Compressor has Low Displacement or Internal Malfunction

A/C System Concern		Potential Causes
	High	Malfunctioning Cooling Fans
		Refrigerant Overcharge
		Restricted Condenser Air Flow
		Air in A/C System

NOTE:

Restrictions can occur in any part of an A/C system and may result in various gauge pressure values, depending on the system design and service port locations. The use of a non-contact, infrared thermometer can help diagnose a restricted A/C system with the ability to quickly observe significant, unexpected temperature changes in components and plumbing due to debris, contamination, pinched/damaged hoses, etc.

HEATING PERFORMANCE DIAGNOSTIC

Step	Action	Yes	No
DEFINITION: Heating system performance.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to **Step 2**	Go to **Symptoms - HVAC Systems - Manual**
2	1. Start the engine. 2. Allow the engine to idle. Does the engine reach normal operating temperature?	Go to **Step 3**	Go to **Step 9**

Step	Action	Yes	No
3	**WARNING:** **Refer to Moving Parts and Hot Surfaces Warning .** 1. Allow the engine to idle. 2. Select the FLOOR mode. 3. Select the minimum blower speed. 4. Select the warmest temperature setting. 5. Feel the temperature of the inlet and outlet heater hoses at the heater core. Does the inlet heater hose feel warmer than the outlet heater hose?	Go to **Step 7**	Go to **Step 4**
4	1. Install a thermometer into the center I/P PANEL air outlet. 2. Secure a thermometer to the heater core outlet heater hose. 3. Select the PANEL mode. 4. Select the maximum blower speed. 5. Select the warmest temperature setting. 6. Record the temperature at the following locations: • The center I/P PANEL air outlet • The heater core outlet heater hose 7. Compare the recorded temperatures. Are the two temperature readings about equal?	Go to **Step 5**	Go to **Step 6**
5	1. Inspect and repair the following areas of the vehicle for cold air leaks: • The cowl • The recirculation door • The HVAC module case 2. Perform the necessary repairs. Are the repairs complete?	Go to **Step 10**	-
6	1. Inspect the temperature door operation. Refer to **Diagnostic System Check - Vehicle** . 2. Perform any necessary repairs. Are the repairs complete?	Go to **Step 10**	-

Step	Action	Yes	No
7	1. Turn OFF the engine. 2. Backflush the heater core. 3. Start the engine. 4. Select the FLOOR mode. 5. Select the minimum blower speed. 6. Select the warmest temperature setting. 7. Feel the temperature of the inlet and outlet heater hoses at the heater core. Does the inlet heater hose feel warmer than the outlet heater hose?	Go to **Step 8**	Go to **Step 10**
8	Replace the heater core. Refer to **Heater Core Replacement**. Is the repair complete?	Go to **Step 10**	-
9	Repair the low engine temperature concern. Refer to **Engine Fails To Reach Normal Operating Temperature** . Is the repair complete?	Go to **Step 10**	-
10	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to **Step 2**

DEFROSTING INSUFFICIENT

Step	Action	Yes	No
DEFINITION: Time required to defrost the windshield is longer than usual.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to **Step 2**	Go to **Symptoms - HVAC Systems - Manual**
2	1. Start the engine. 2. Select the DEFROST mode. 3. Select the maximum blower speed. Does sufficient air flow from the defroster outlets?	Go to **Step 3**	Go to **Step 10**
3	Measure the engine operating temperature. Does the engine reach normal operating temperature?	Go to **Step 4**	Go to **Step 8**
4	1. Select the minimum blower speed. 2. Select the warmest temperature setting. **WARNING:** **Refer to Moving Parts and Hot Surfaces Warning .**	Go to **Step 11**	Go to **Step 5**

Step	Action	Yes	No
	3. Feel the temperature of the inlet and outlet heater hoses at the heater core. Does the inlet heater hose feel warmer than the outlet heater hose?		
5	Test the operation of the A/C compressor clutch. Does the A/C compressor clutch engage?	Go to **Step 7**	Go to **Step 6**
6	Repair the A/C compressor clutch. Refer to **Air Conditioning Compressor Malfunction** . Is the repair complete?	Go to **Step 14**	-
7	Perform the A/C system performance test. Refer to **Air Conditioning (A/C) System Performance Test (LFX)**. Is the A/C system operating within the specifications?	Go to **Step 9**	Go to **Step 12**
8	Repair the low engine temperature concern. Refer to **Engine Fails To Reach Normal Operating Temperature** . Is the repair complete?	Go to **Step 14**	-
9	Inspect for correct operation of the recirculation door. Is the recirculation door operating correctly?	Go to **Step 14**	Go to **Step 13**
10	Repair the air delivery concern. Refer to **Diagnostic Starting Point - Vehicle** . Is the repair complete?	Go to **Step 14**	-
11	Repair the heating concern. Refer to **Heating Performance Diagnostic**. Is the repair complete?	Go to **Step 14**	-
12	Repair the A/C performance concern. Refer to **Air Conditioning (A/C) System Performance Test (LFX)**. Is the repair complete?	Go to **Step 14**	-
13	Repair the recirculation door concern. Is the repair complete?	Go to **Step 14**	-
14	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to **Step 2**

NOISE DIAGNOSIS - BLOWER MOTOR

Step	Action	Yes	No
DEFINITION: Noise originating from the blower motor.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to **Step 2**	Go to **Symptoms - HVAC Systems - Manual**
2	Inspect the air inlet grille for debris. Is debris present?	Go to **Step 8**	Go to **Step 3**
3	1. Sit inside the vehicle. 2. Close the vehicle doors and windows. 3. Turn ON the ignition, with the engine OFF.	Go to **Step 4**	Go to **Step 11**

Step	Action	Yes	No
	4. Cycle the blower motor through all of the speeds in order to determine where and when the noise occurs. Did you hear a noise during the blower operation?		
4	Inspect for excessive vibration at each blower motor speed by feeling the blower case. Is excess vibration present?	Go to **Step 6**	Go to **Step 5**
5	Listen to the blower motor at each blower speed. Is the blower motor making a squeaking or chirping noise?	Go to **Step 9**	Go to **Step 11**
6	1. Remove the blower motor. Refer to **Blower Motor Replacement**. 2. Inspect the blower motor impeller for deposits of foreign material. 3. Inspect the blower motor for deposits of foreign material. Did you find any foreign material on the blower motor or blower motor impeller?	Go to **Step 8**	Go to **Step 7**
7	Inspect the blower motor for the following conditions: 1. Cracked blades 2. A loose impeller retainer 3. Improper impeller alignment Did you find any of these conditions?	Go to **Step 9**	Go to **Step 10**
8	Remove the foreign material. Is the action complete?	Go to **Step 10**	-
9	Replace the blower motor. Refer to **Blower Motor Replacement**. Is the repair complete?	Go to **Step 11**	-
10	Install the blower motor. Refer to **Blower Motor Replacement**. Is the action complete?	Go to **Step 11**	-
11	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to **Step 2**

AIR CONDITIONING COMPRESSOR OIL DIAGNOSIS

Condition	Corrective Action
NOTE: **To avoid repeat**	

Condition	Corrective Action
compressor failure, always inspect the condition of the refrigerant oil and take the appropriate corrective action before installing the replacement compressor.	
Clean Oil no debris present	No corrective action necessary.
Clean Oil with debris present	• Inspect the suction port of the replacement compressor for presence of a suction screen. If the replacement compressor does NOT contain a suction screen, install suction screen in the line. • Replace desiccant or component containing the desiccant. • Replace desiccant filter if applicable. • Remove and inspect high pressure side filter (if applicable). • Remove, inspect, clean, or replace orifice tube. • If the system has a front orifice tube and is equipped with a filter in the rear auxiliary line, remove, inspect, clean, or replace the filter.
Dark brown/black and/or pungent/unusual odor with no debris present	• Replace desiccant or component containing the desiccant. • Replace desiccant filter if applicable. • Flush refrigerant system.
Dark brown/black and/or pungent/unusual odor with debris present	• Replace desiccant or component containing the desiccant. • Replace desiccant filter if applicable. • Flush refrigerant system. • Inspect the suction port of the replacement compressor for presence of a suction screen. If the replacement compressor does NOT contain a suction screen, install suction screen. • Remove and inspect high pressure side filter (if applicable). • Remove, inspect, clean, or replace orifice tube. • If the system has a front orifice tube and is equipped with a filter in the rear auxiliary line, remove, inspect, clean, or replace the filter.

Condition	Corrective Action
Oil Overcharge	Flush refrigerant system.
Refrigerant Contamination	Flush refrigerant system.
Hybrid Polyolester Refrigerant Oil (POE) Contamination	• Flush refrigerant system. • Replace desiccant or component containing the desiccant. • Replace desiccant filter if applicable.

NOISE DIAGNOSIS - AIR CONDITIONING (A/C) SYSTEM

Step	Action	Yes	No
DEFINITION: Noise originating from the A/C compressor, drive belt or the A/C lines.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to **Step 2**	Go to **Symptoms - HVAC Systems - Manual**
2	1. A/C system noises can be generally categorized into 3 areas: • Screeching, squealing or chirping noises • Moaning noises • Vibration/rattle noises 2. Start the engine. 3. Ensure that the A/C is ON. Is a screeching or squealing noise heard when the A/C is engaged?	Go to **Step 3**	Go to **Step 9**
3	With the engine OFF, inspect the drive belt for excessive wear. Refer to **Drive Belt Falls Off and Excessive Wear Diagnosis** Is the drive belt excessively worn?	Go to **Step 18**	Go to **Step 4**
4	Inspect the drive belt tension. Refer to **Drive Belt Tensioner Diagnosis** Is the drive belt tension correct?	Go to **Step 5**	Go to **Step 19**
5	Inspect the drive belt for excessive oil coverage. Is the drive belt covered with oil?	Go to **Step 17**	Go to **Step 6**
6	1. Start the engine. 2. Ensure that the A/C is ON. 3. Inspect the compressor and the clutch. Is the A/C compressor locked up?	Go to **Step 24**	Go to **Step 7**
7	Is the A/C compressor clutch slipping?	Go to **Step 23**	Go to **Step 8**
8	**WARNING:** **Refer to Moving Parts and**	Go to **Step 15**	Go to **Step 10**

Step	Action	Yes	No
	Hot Surfaces Warning . Using a stethoscope, listen to the A/C compressor for any abnormal noise.Is the compressor causing an abnormal noise?		
9	Does a moaning noise exist when the A/C clutch is engaged?	Go to **Step 10**	Go to **Step 12**
10	Listen to the A/C compressor components and mounting for noise concerns using a stethoscope. Are any of these components loose, damaged or excessively worn?	Go to **Step 20**	Go to **Step 11**
11	1. Idle the engine. 2. Engage the A/C compressor clutch. 3. Using a stethoscope, move around the entire refrigerant plumbing system. Listen for any abnormal noises caused by a component of the A/C system touching another component. Are any of the A/C components grounding out and causing a vibration noise?	Go to **Step 22**	Go to **Step 13**
12	Does a vibration or rattle noise exist when the A/C clutch is engaged?	Go to **Step 13**	Go to **Step 14**
13	Does the noise stop when the A/C clutch is disengaged?	Go to **Step 15**	Go to **Step 25**
14	1. Idle the engine in PARK with the A/C compressor clutch engaged. 2. Using a stethoscope, move around the entire A/C system testing for any abnormal noises caused by a component. Do any of the A/C components cause an abnormal noise?	Go to **Step 21**	Go to **Step 25**
15	Verify that the A/C system is properly charged. Refer to **Refrigerant System Specifications**. Is the A/C system properly charged?	Go to **Step 26**	Go to **Step 16**
16	Recharge the A/C system to specification. Refer to **Refrigerant Recovery and Recharging**. Is the abnormal compressor noise still present?	Go to **Step 24**	Go to **Step 26**
17	Repair the oil leak. Is the action complete?	Go to **Step 26**	-
18	Replace the drive belt. Refer to **Drive Belt Replacement** Is the action complete?	Go to **Step 26**	-
19	Replace the drive belt tensioner. Refer to **Drive Belt Tensioner Replacement** Is the action complete?	Go to **Step 26**	-

Step	Action	Yes	No
20	Repair or replace the A/C compressor mounting component. Is the action complete?	Go to **Step 26**	-
21	Repair or replace the component which is causing the moaning concern as needed. Is the action complete?	Go to **Step 26**	-
22	Correctly route or insulate the A/C component. Is the action complete?	Go to **Step 26**	-
23	Replace the A/C compressor clutch. Refer to **Air Conditioning Clutch Assembly Replacement**. Is the action complete?	Go to **Step 26**	-
24	Replace the A/C compressor. Refer to **Air Conditioning Compressor Replacement**. Is the action complete?	Go to **Step 26**	-
25	The concern may be caused by an engine related component. Refer to **Vibration Analysis - Engine** . Did you find and correct the condition?	Go to **Step 26**	-
26	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to **Step 2**

NOISE DIAGNOSIS - HVAC MODULE

Step	Action	Yes	No
DEFINITION: Noise originating from the HVAC module.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to **Step 2**	Go to **Symptoms - HVAC Systems - Manual**
2	1. Start the engine. 2. Cycle through all of the following: • Blower motor speeds • HVAC modes • Temperature control settings 3. Determine the type of noise: • Scrape, Chirping or groaning • Tick/click or Pop • Air rush/whistle Is a tick/click, chirping, groaning, air rush/whistle or scraping noise present, but decreases as blower motor speed is decreased?	Go to **Noise Diagnosis - Blower Motor**	Go to **Step 3**
3	Is a scrape, chirping, or groaning noise evident when selecting modes or temperature settings?	Go to **Step 8**	Go to **Step 4**
4	Is a tick/click or pop noise present?	Go to **Step 5**	Go to **Step 6**

Step	Action	Yes	No
5	Inspect any visible or easily accessible actuators. Are the actuators operating properly?	Go to **Step 9**	Go to **Step 14**
6	Is a air rush/whistle noise evident in all modes, but not all temperature settings?	Go to **Step 9**	Go to **Step 7**
7	Is an air rush/ whistle noise evident only in defrost or floor mode?	Go to **Step 8**	Go to **Step 1**
8	Inspect any visible or easily accessible ducts for obstructions or foreign materials. • Air Inlet • Defroster Vent • Panel Vents • Floor Vents Were any obstructions or foreign materials found?	Go to **Step 12**	Go to **Step 9**
9	Remove the lower trim panel. Refer to **Instrument Panel Lower Trim Panel Replacement** . 1. Inspect the ducts for obstructions or foreign materials. 2. Inspect the HVAC module for obstructions or foreign materials. Is the repair complete?	Go to **Step 12**	Go to **Step 10**
10	Inspect the mode valve assembly, temperature doors, and air inlet door for the following conditions. • Warping • Cracking • Sticking • Ripped seals Did you find any of these conditions?	Go to **Step 11**	Go to **Step 13**
11	Replace the appropriate door and/or seal. Is the action complete?	Go to **Step 15**	-
12	Remove any obstructions or foreign materials found. Is the action complete ?	Go to **Step 15**	-
13	Inspect the mode, temperature, and air inlet door actuators. Are the actuators operating properly?	Go to **Step 15**	Go to **Step 14**
14	Replace appropriate actuator. Is the action complete?	Go to **Step 15**	-

Step	Action	Yes	No
15	If removed, install the lower trim panel. Refer to **Instrument Panel Lower Trim Panel Replacement** . Is the action complete?	Go to **Step 16**	-
16	Operate the system to verify the repair. Did you find and correct the condition?	System OK	Go to **Step 2**

ODOR DIAGNOSIS

Step	Action	Yes	No
DEFINITION: Odor originating or noticed through the HVAC system.			
1	Were you sent here from Symptoms or another diagnostic table?	Go to **Step 2**	Go to **Symptoms - HVAC Systems - Manual**
2	1. Sit inside the vehicle. 2. Close all of the doors and windows. 3. Start the engine. 4. Allow the engine idle at normal operating temperature. 5. Select the maximum blower speed. 6. Select the PANEL air outlet mode. 7. Select the coldest temperature setting. 8. Cycle through all of the blower speeds, modes and temperatures to define what type of odor is present. • Musty smell • Coolant smell • Oil smell Does the odor have a musty smell?	Go to **Step 3**	Go to **Step 8**
3	Inspect the HVAC air inlet grille for debris. Is debris present?	Go to **Step 4**	Go to **Step 5**
4	Remove any debris. Is the action complete?	Go to **Step 15**	-
5	Inspect for wet carpeting. Is the carpet wet?	Go to **Step 6**	Go to **Step 14**
6	Inspect for the following conditions: • Water leaks around the windshield • Blockage of the HVAC module drain • Leaks around the door seals Is a leak present?	Go to **Step 7**	Go to **Step 14**

Step	Action	Yes	No
7	Repair the leak as necessary. Is the action complete?	Go to **Step 15**	-
8	Does the odor have a coolant smell?	Go to **Step 9**	Go to **Step 12**
9	Inspect the cooling system for leaks. Refer to **Loss of Coolant** . Is a leak present?	Go to **Step 10**	Go to **Step 12**
10	Inspect for coolant leaking inside the vehicle or for a film build-up on the windshield. Is the condition present?	Go to **Step 11**	Go to **Step 15**
11	Replace the heater core. Refer to **Heater Core Replacement**. Is the action complete?	Go to **Step 15**	-
12	Does the odor have an oily smell?	Go to **Step 13**	Go to **Step 15**
13	1. Inspect the engine compartment for any leaks. Refer to the following procedures: • **Oil Leak Diagnosis** for the 3.6L engine • **Fluid Leak Diagnosis** for the 6T70 transmission 2. Repair any oil leaks. Is the action complete?	Go to **Step 15**	-
14	A musty odor can be caused by mold or mildew build-up on the evaporator or the heater core or inside of the HVAC module. Refer to **Odor Correction**. Is the action complete?	Go to **Step 15**	-
15	Operate the system in order to verify the repair. Did you find and correct the condition?	System OK	Go to **Step 2**

REPAIR INSTRUCTIONS

ODOR CORRECTION

Eliminating Air Conditioning Odor

Odors may be emitted from the air conditioning system primarily at start up in hot, humid climates. The following conditions may cause the odor:

- Debris is present in the HVAC module.
- Microbial growth on the evaporator core

When the blower motor fan is turned on, the microbial growth may release an unpleasant musty odor into the passenger compartment. To remove odors of this type, the microbial growth must be eliminated. Perform the following procedure:

Deodorize the evaporator core using Deodorizing Aerosol Kit.

Perform the following steps in order to deodorize the A/C system:

1. Ensure that the plenum which draws outside air into the HVAC module is clear of debris.
2. Disable the A/C compressor clutch operation by disconnecting the clutch coil electrical connector.
3. Dry the evaporator core by performing the following steps:
    1. Start the engine.
    2. Select the warmest temperature setting.
    3. Select the recirculation mode.
    4. Run the blower motor on high for 10 minutes.
4. Locate an area in the air conditioning duct between the blower motor and the evaporator core downstream of the blower motor.
5. Drill a 3.175 mm (0.125 in) hole where the hole will not interfere with or damage the following components:
    - The blower motor
    - The evaporator core
    - Any other operating part the of system
6. Wear safety goggles and latex gloves in order to perform the following actions:
    1. Select the maximum blower speed.
    2. Insert the deodorizer extension tube into the hole to the mark on the extension tube.
    3. Use short spray bursts and vary the direction of spray for a 2-3 minute period of time.
7. Shut the engine OFF. Allow the vehicle to sit for 3-5 minutes.
8. Seal the 3.175 mm (0.125 in) hole with body sealer or RTV gasket compound.
9. Start the engine.
10. Operate the blower motor on high for 15-20 minutes to dry.
11. Reconnect the A/C compressor clutch coil electrical connector.
12. Verify proper clutch operation.

REFRIGERANT RECOVERY AND RECHARGING

Special Tools

- **J 43600** ACR 2000 Air Conditioning Service Center
- **J 45037** A/C Oil Injector

For equivalent region tools, refer to **Special Tools**.

WARNING: To prevent personal injury, avoid breathing A/C Refrigerant and lubricant vapor or mist. Work in a well ventilated area. To remove refrigerant from the A/C System, use service equipment designed for recovery that is certified to meet the requirements of the appropriate SAE Standards. If an accidental system discharge occurs, ventilate the work area before continuing service. Additional health and safety information may be obtained from the refrigerant, refrigerant recovery, and lubricant manufacturers.

WARNING: For personal protection, goggles and lint-free gloves should be worn and a clean cloth wrapped around fittings, valves, and connections when doing work that

includes opening the refrigerant system. If refrigerant comes in contact with any part of the body severe frostbite and personal injury can result. The exposed area should be flushed immediately with cold water and prompt medical help should be obtained.

CAUTION: **You must replace the desiccant if the A/C refrigerant system has been open to atmosphere for more than four hours, or if the A/C refrigerant oil has been contaminated. Failure to replace the desiccant will result in damage to the A/C refrigerant system.**

CAUTION: **R-134a is the only approved refrigerant for use in this vehicle. The use of any other refrigerant may result in poor system performance or component failure.**

CAUTION: **To avoid system damage use only R-134a dedicated tools when servicing the A/C system.**

CAUTION: **Use only Polyalkylene Glycol Synthetic Refrigerant Oil (PAG) for internal circulation through the R-134a A/C system and only 525 viscosity mineral oil on fitting threads and O-rings. If lubricants other than those specified are used, compressor failure and/or fitting seizure may result.**

CAUTION: **R-12 refrigerant and R-134a refrigerant must never be mixed, even in the smallest of amounts, as they are incompatible with each other. If the refrigerants are mixed, compressor failure is likely to occur. Refer to the manufacturer instructions included with the service equipment before servicing.**

NOTE: **For access to the left hand service port, removal of the air cleaner assembly will be necessary. Refer to Air Cleaner Assembly Replacement .**

The **J 43600** ACR 2000 Air Conditioning Service Center is a complete air conditioning service center for R-134a. The ACR 2000 recovers, recycles, evacuates and recharges A/C refrigerant quickly, accurately and automatically. The unit has a display screen that contains the function controls and displays prompts that will lead the technician through the recover, recycle, evacuate and recharge operations. R-134a is recovered into and charged out of an internal storage vessel. The ACR 2000 automatically replenishes this vessel from an external source tank in order to maintain a constant 5.45-6.82 kg (12-15 lbs) of A/C refrigerant.

The ACR 2000 has a built in A/C refrigerant identifier that will test for contamination, prior to recovery and will notify the technician if there are foreign gases present in the A/C system. If foreign gases are present, the ACR 2000 will not recover the refrigerant from the A/C system.

The ACR 2000 also features automatic air purge, single pass recycling and an automatic oil drain.

Refer to the **J 43600** ACR 2000 Air Conditioning Service Center ACR 2000 manual for operation and setup instruction. Always recharge the A/C System with the proper amount of R-134a. Refer to **Refrigerant System Specifications** for the correct amount.

A/C Refrigerant System Oil Charge Replenishing

If oil was removed from the A/C system during the recovery process or due to component replacement, the oil must be replenished. Oil can be injected into a charged system using **J 45037** A/C Oil Injector. For the proper

quantities of oil to add to the A/C refrigerant system, refer to **Refrigerant System Specifications**.

FLUSHING

Special Tools

- **J 41447** Leak Detection Dye
- **J 42220** Universal 12V Leak Detection Lamp
- **J 43600** ACR 2000 Air Conditioning Service Center
- **J 45268** Flush Adapter Kit

NOTE: **Flushing with the ACR 2000 is not intended to remove metal from the A/C system.**

Flushing is intended to remove the following:

- Contaminated PAG oil
- Desiccant, following a desiccant bag failure
- Overcharge of PAG oil
- Refrigerant contamination

NOTE: **Warmer engine or ambient temperature decreases the refrigerant recovery time during the A/C flush procedure.**

1. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging**.
2. Remove the A/C refrigerant filter. Refer to **Air Conditioning (AC) Refrigerant Filter Replacement**.
3. Remove the thermal expansion valve (TXV). Refer to **Air Conditioning Evaporator Thermal Expansion Valve Replacement**.
4. Install the stud for the **J 45268** Flush Adapter Kit kit onto the J 45268-115.
5. Install the J 45268-115 in place of the TXV.

CAUTION: **Refer to Fastener Caution .**

6. Install the TXV mounting bolts and tighten to 7 N.m (62 lb in).
7. Connect the evaporator line to the J 45268-115.
8. Install the TXV block fitting nut and tighten to 17 N.m (12.5 lb ft).
9. Remove the A/C compressor. Refer to **Air Conditioning Compressor Replacement**.
10. Install J 45268-10 to the A/C compressor hose assembly.
11. Install the nut and bolt from the **J 45268** Flush Adapter Kit kit to the J 45268-10 and compressor hose assembly and tighten the bolts to 17 N.m (12.5 lb ft).
12. Forward flow refrigerant flushing is recommended for contaminated refrigerant or PAG oil.

    Perform the following procedure:

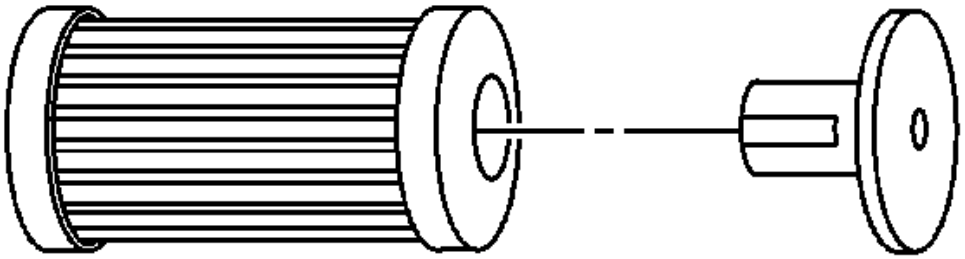


Fig. 1: View Of A/C Filter & Check Valve
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The filter inside J 45268-1 is serviceable. Remove and discard the check valve from the filter.**

1. Service the filter with ACDelco P/N GF 470, before each flush.
2. Install the port plugs J 45268-9 onto the J 45268-10.
3. Install the fitting J 45268-7 onto the J 45268-10.
4. Install the fitting J 45268-8 onto the J 45268-10.
5. Connect J 45268-1 flush filter to the suction port of J 45268-7 flush adapter.
6. Connect the blue hose from the **J 43600** ACR 2000 Air Conditioning Service Center to the J 45268-1 flush filter adapter.
7. Connect the red hose from the **J 43600** ACR 2000 Air Conditioning Service Center to the J 45268-8 flush adapter.

13. Reverse flow refrigerant flush is recommended for desiccant bag failure. Replace the A/C condenser when the A/C flush is complete and perform the following procedure:

NOTE: **The filter inside J 45268-1 is serviceable. Remove and discard the**

check valve from the filter.

1. Service the filter with ACDelco P/N GF 470, before each flush.
2. Install the port plugs J 45268-9 onto the J 45268-10.
3. Install the fitting J 45268-7 onto the J 45268-10.
4. Install the fitting J 45268-8 onto the J 45268-10.
5. Connect J 45268-1 flush filter to the discharge port of J 45268-7 flush adapter.
6. Connect the blue hose from **J 43600** ACR 2000 Air Conditioning Service Center to the J 45268-1 flush filter adapter.
7. Connect the red hose from **J 43600** ACR 2000 Air Conditioning Service Center to the J 45268-8 flush adapter.

NOTE: **Close the valve on the external refrigerant tank, before starting the flush process.**

14. Flush the A/C system. Follow the instructions supplied with the **J 43600** ACR 2000 Air Conditioning Service Center.
15. Disconnect the red hose on the **J 43600** ACR 2000 Air Conditioning Service Center from the J 45268-10.
16. Disconnect the blue hose on the **J 43600** ACR 2000 Air Conditioning Service Center from the J 45268-1.
17. Remove J 45268-1 from the J 45268-10.
18. Remove the J 45268-10 from the A/C compressor hose assembly.

NOTE: **Flushing will remove all the PAG oil from the A/C system.**

The A/C system must be replenished with the correct amount of PAG oil.

19. If you will reinstall the removed A/C compressor, perform the following procedure:
    1. Remove the A/C compressor drain plug.
    2. Drain the PAG oil from the A/C compressor. Rotate the compressor input shaft to assist in draining the PAG oil from the compressor.
    3. Install the A/C compressor drain plug and tighten to 16 N.m (12 lb ft).
    4. Add the total system capacity of PAG oil to the A/C compressor. Refer to **Refrigerant System Specifications**.
20. If you will replace the A/C compressor after flushing the system, perform the following procedure:
    1. Determine if the new service compressor is shipped with PAG oil. Refer to the **Refrigerant System Specifications**.
    2. If the service compressor is shipped with PAG oil, DO NOT drain the new PAG oil from the compressor.
    3. Deduct the amount of PAG oil shipped with the service compressor from the amount of PAG oil listed in the capacities table. Refer to **Refrigerant System Specifications**.
    4. Add the calculated amount to the compressor, as needed.

NOTE: **Flushing will remove the fluorescent leak detection dye from the A/C system.**

21. Add one bottle of **J 41447** Leak Detection Dye directly to the A/C Compressor.

22. Install the A/C compressor. Refer to **Air Conditioning Compressor Replacement**.
23. Remove J 45268-115.
24. Inspect the TXV for debris. Clean or replace as needed.
25. Install the TXV. Refer to **Air Conditioning Evaporator Thermal Expansion Valve Replacement**.
26. Install the A/C refrigerant filter. Refer to **Air Conditioning (AC) Refrigerant Filter Replacement**.
27. Evacuate and recharge the A/C system. Refer to **Refrigerant Recovery and Recharging**.
28. Leak test the fittings using **J42220** Universal 12V Leak Detection Lamp.

AIR CONDITIONING COMPRESSOR OIL BALANCING

Draining Procedure

NOTE: **Drain and measure as much of the refrigerant oil as possible from the removed compressor.**

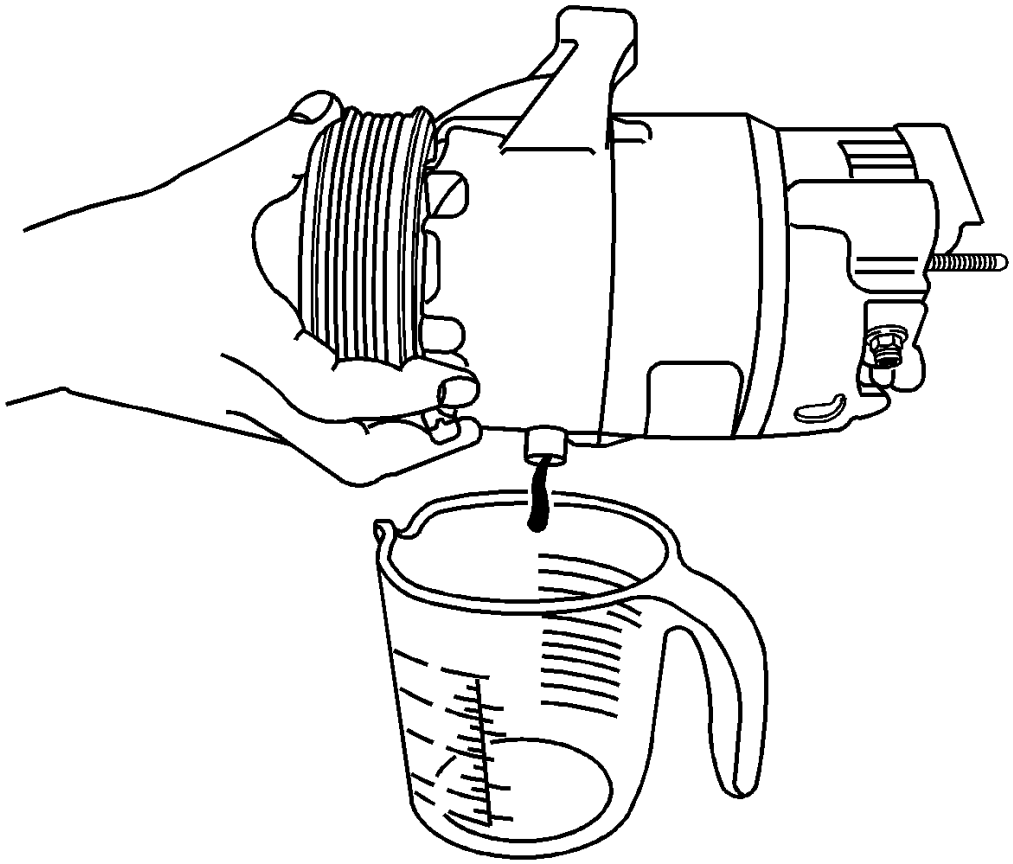


Fig. 2: Draining Oil From Compressor
Courtesy of GENERAL MOTORS COMPANY

1. Remove the compressor crankcase oil drain plug and drain the crankcase into a clean, graduated container.
2. Drain the oil from both the suction and discharge ports of the removed compressor into the same container.

Rotate the compressor shaft to assist in draining the compressor.

3. Measure and record the amount of oil drained from the removed compressor.

   This measurement will be used during installation of the replacement compressor.

4. Inspect the oil drained from the compressor. Refer to **Air Conditioning Compressor Oil Diagnosis**.
5. Properly discard the used refrigerant oil.

Balancing Procedure

NOTE: **The refrigerant oil in the A/C system must be balanced during compressor replacement.**

1. The replacement compressor is shipped with the total system capacity of refrigerant oil.

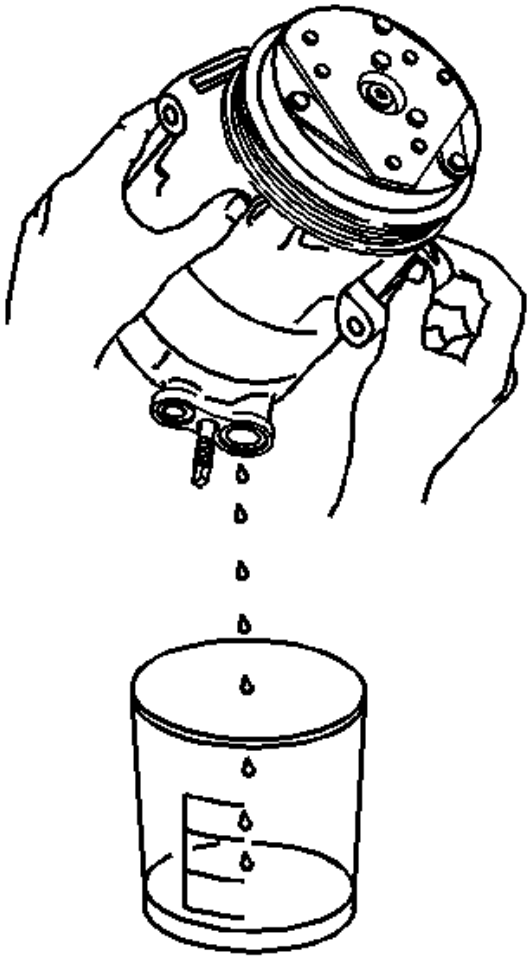


Fig. 3: Draining A/C Refrigerant Oil From Compressor
Courtesy of GENERAL MOTORS COMPANY

2. Before installing the compressor, the refrigerant oil may have to be partially drained:
   1. Refer to the amount of refrigerant oil recorded during the compressor removal.
   2. Subtract the amount recorded from the total system capacity. Refer to **Refrigerant System**

Specifications.

The difference between the total system capacity and the recorded amount is the calculated amount to be drained from the replacement compressor.

3. Drain the calculated amount of refrigerant oil from the replacement compressor.

AIR CONDITIONING COMPRESSOR REPLACEMENT

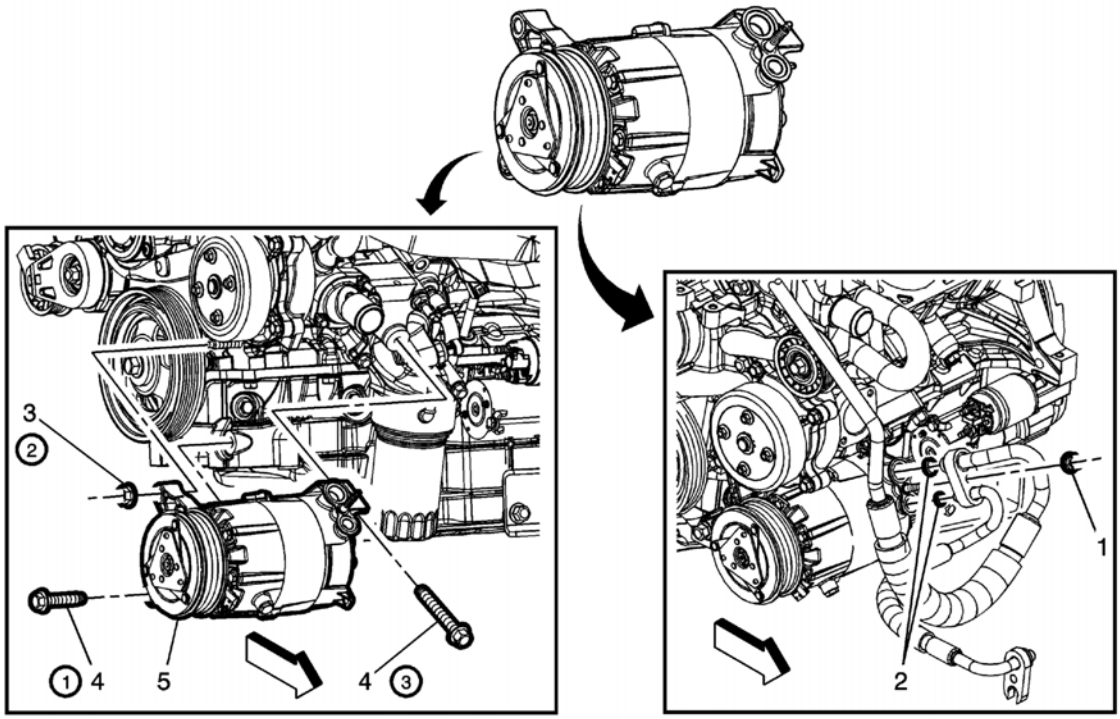


Fig. 4: Air Conditioning Compressor Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** . 2. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging**. 3. Remove the drive belt. Refer to **Drive Belt Replacement** . 4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 5. Remove the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** . 6. Disconnect the electrical connector.	
1	A/C Compressor Hose Nut **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Procedure** Remove the A/C compressor hose from the A/C compressor and cap hose. **Tighten** 17 N.m (12.5 lb ft)
2	Sealing Washer **Procedure** Remove and discard sealing washers. Refer to **Air Conditioning System Seal Replacement**.
3	A/C Compressor Nut **Procedure** Tighten in sequence with A/C compressor mounting bolts. **Tighten** 50 N.m (37 lb ft)
4	A/C Compressor Bolt **Procedure** Tighten the A/C compressor mounting bolts and nut in sequence. **Tighten** 50 N.m (37 lb ft)
5	A/C Compressor Assembly **Procedure** 1. Use a low viscosity, polyalkylene glycol (PAG) oil. Use of the incorrect oil can result in compressor failure. 2. When replacing the A/C compressor, balance the compressor oil. Refer to **Air Conditioning Compressor Oil Balancing**. 3. Using **J 39400** Electronic Halogen Leak Detector , leak test A/C compressor fittings. **Special Tools** **J 39400** Electronic Halogen Leak Detector For equivalent region tools, refer to **Special Tools**.

AIR CONDITIONING CLUTCH ASSEMBLY REPLACEMENT

Special Tools

- **J 6083** Snap Ring Pliers
- **J 37872** Compressor Clutch Holding Tool
- **J 39400-A** Halogen Leak Detector

Removal Procedure

1. Remove the compressor. Refer to **Air Conditioning Compressor Replacement**.

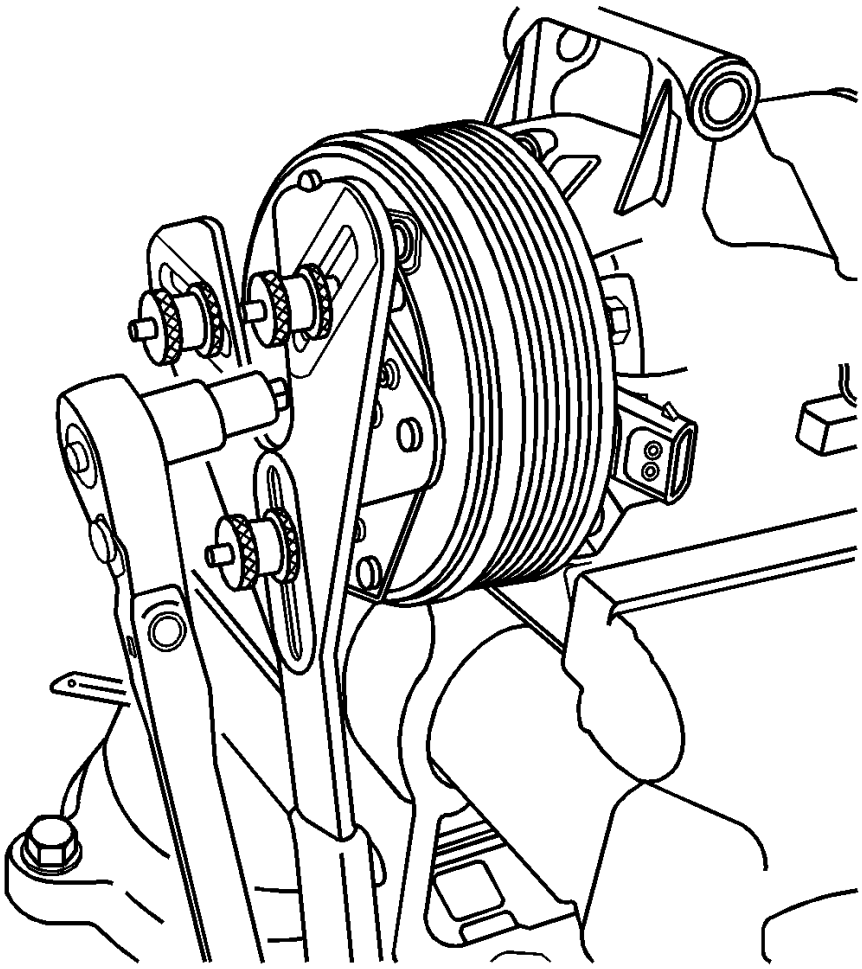


Fig. 5: Identifying Compressor Clutch Plate Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Remove the three adjustable dowels from the J 37872 Compressor Clutch Holding Tool.**

Install three 5/16 x 1 inch bolts in place of the dowels.

2. Remove and discard the compressor clutch plate bolt.

   Use the **J 37872** Compressor Clutch Holding Tool to hold the compressor clutch plate from turning.

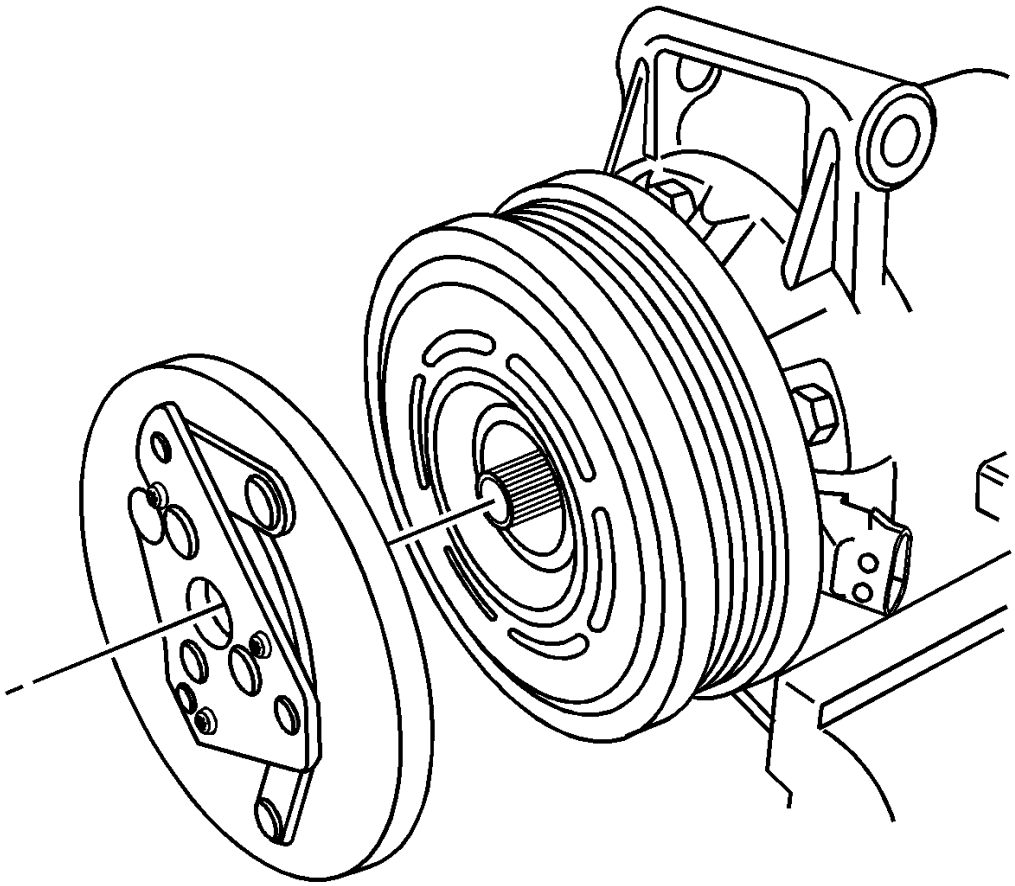


Fig. 6: Identifying Compressor Clutch Plate
Courtesy of GENERAL MOTORS COMPANY

3. Remove the compressor clutch plate from the compressor.

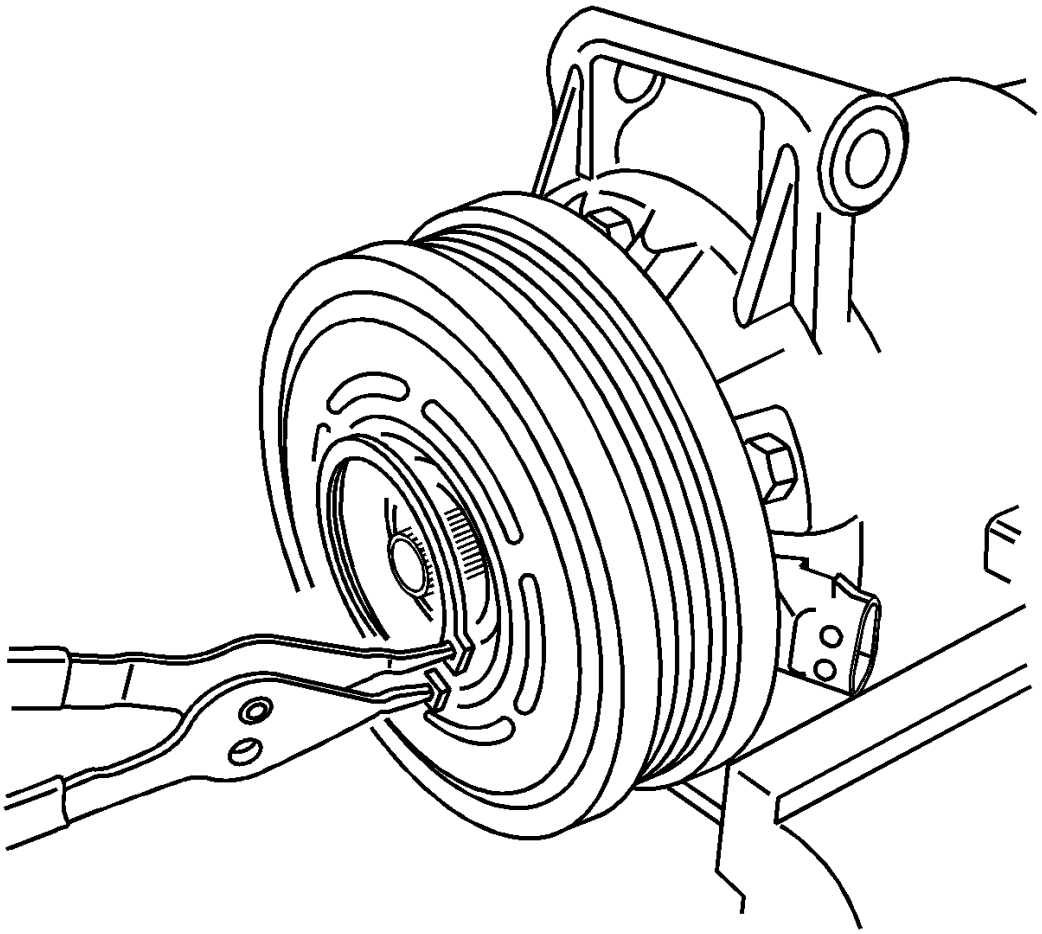


Fig. 7: View Of Compressor Pulley Snap Ring
Courtesy of GENERAL MOTORS COMPANY

4. Remove the compressor pulley snap ring using the **J 6083** Snap Ring Pliers.

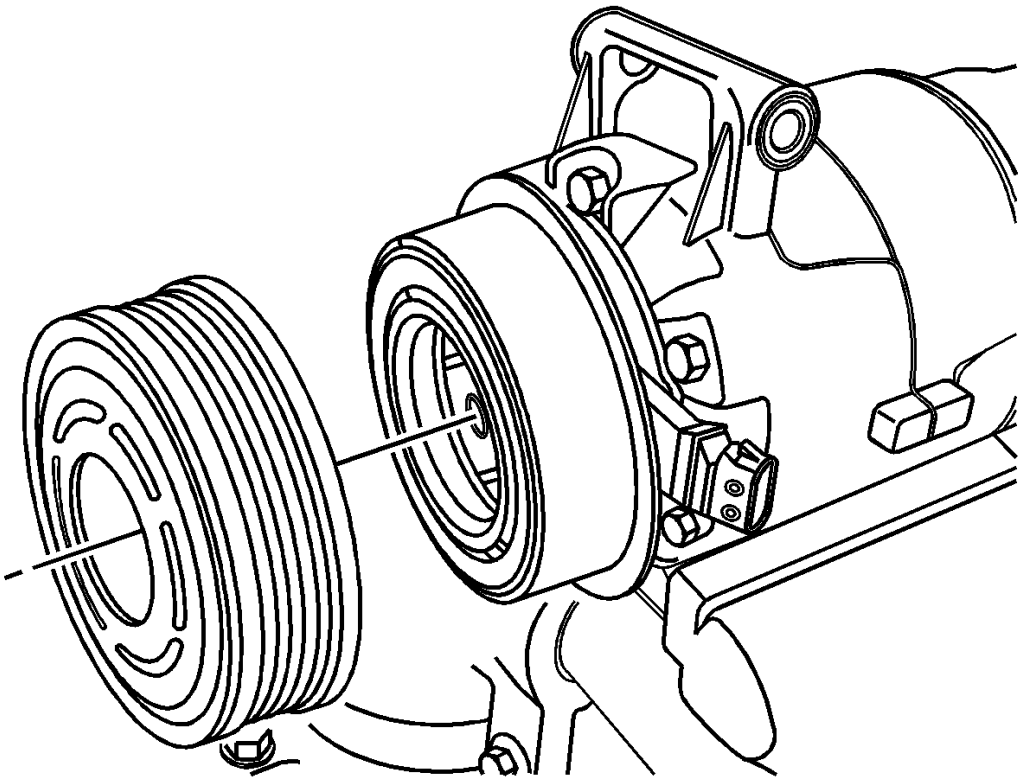


Fig. 8: Identifying Compressor Pulley
Courtesy of GENERAL MOTORS COMPANY

5. Remove the compressor pulley from the compressor.

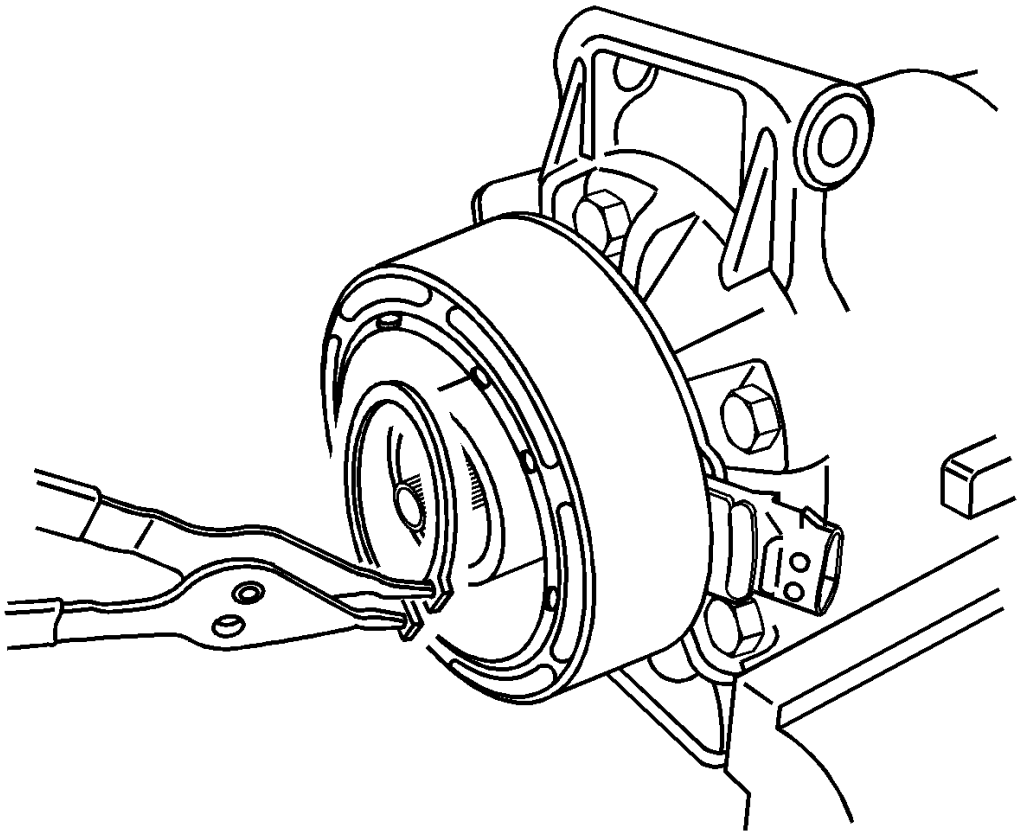


Fig. 9: Identifying Compressor Clutch Coil And Snap Ring
Courtesy of GENERAL MOTORS COMPANY

6. Remove the compressor clutch coil snap ring using the **J 6083** Snap Ring Pliers.

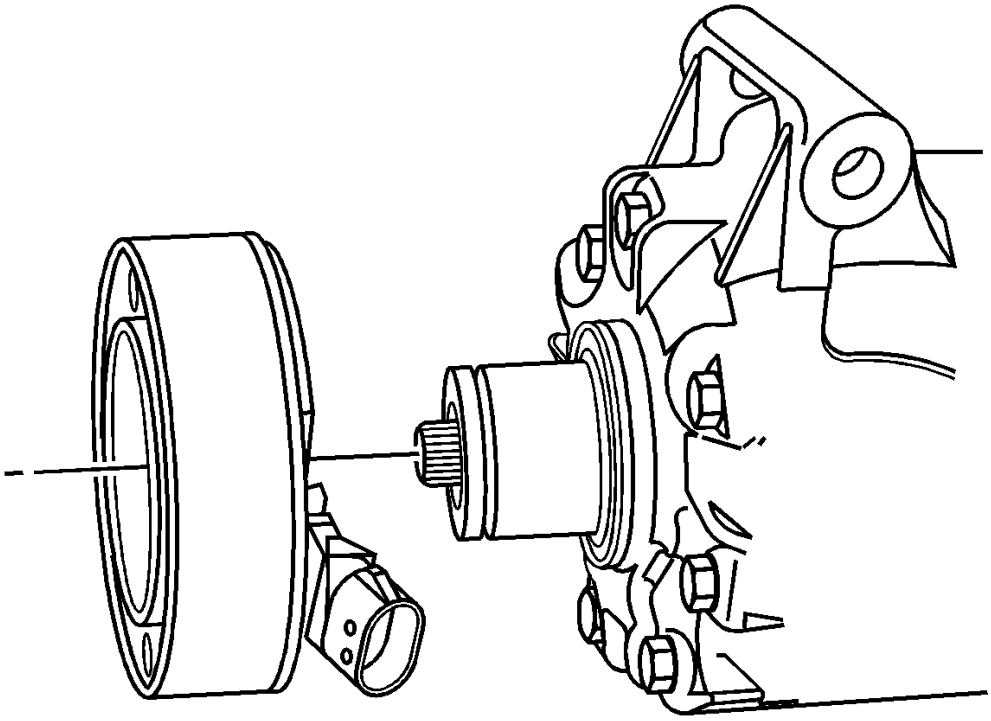


Fig. 10: Identifying Compressor Clutch Coil To Compressor
Courtesy of GENERAL MOTORS COMPANY

7. Remove the compressor clutch coil from the compressor.

Installation Procedure

1. Carefully clean the clutch plate bolt threads with a M6x1.0 tap. Carefully blow out debris with compressed air.

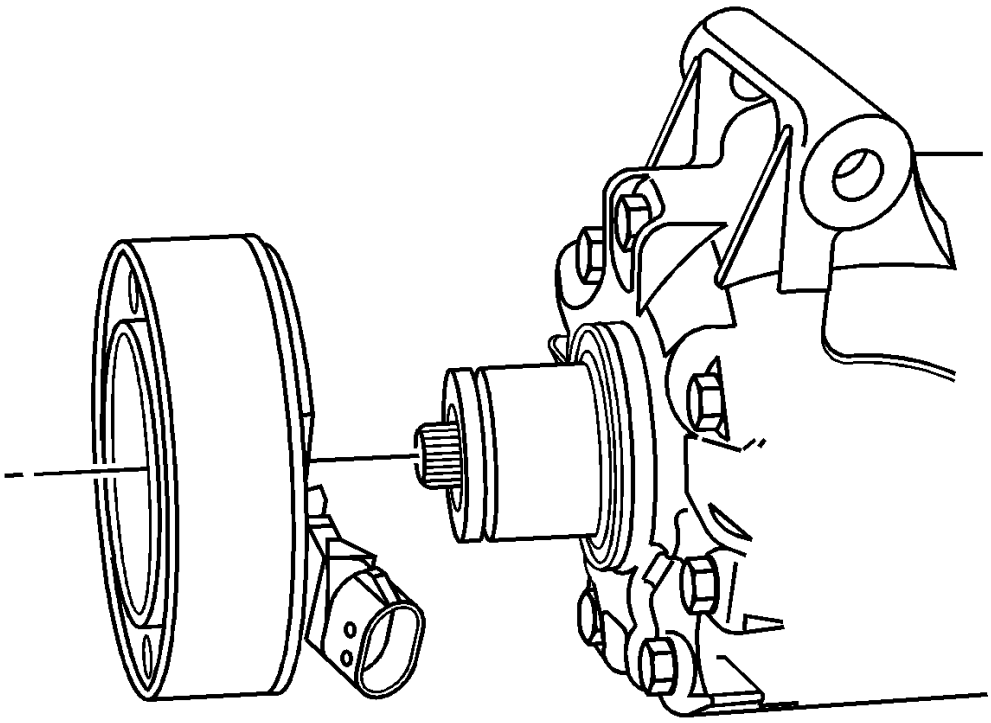


Fig. 11: Identifying Compressor Clutch Coil To Compressor
Courtesy of GENERAL MOTORS COMPANY

2. Install the compressor clutch coil to the compressor.

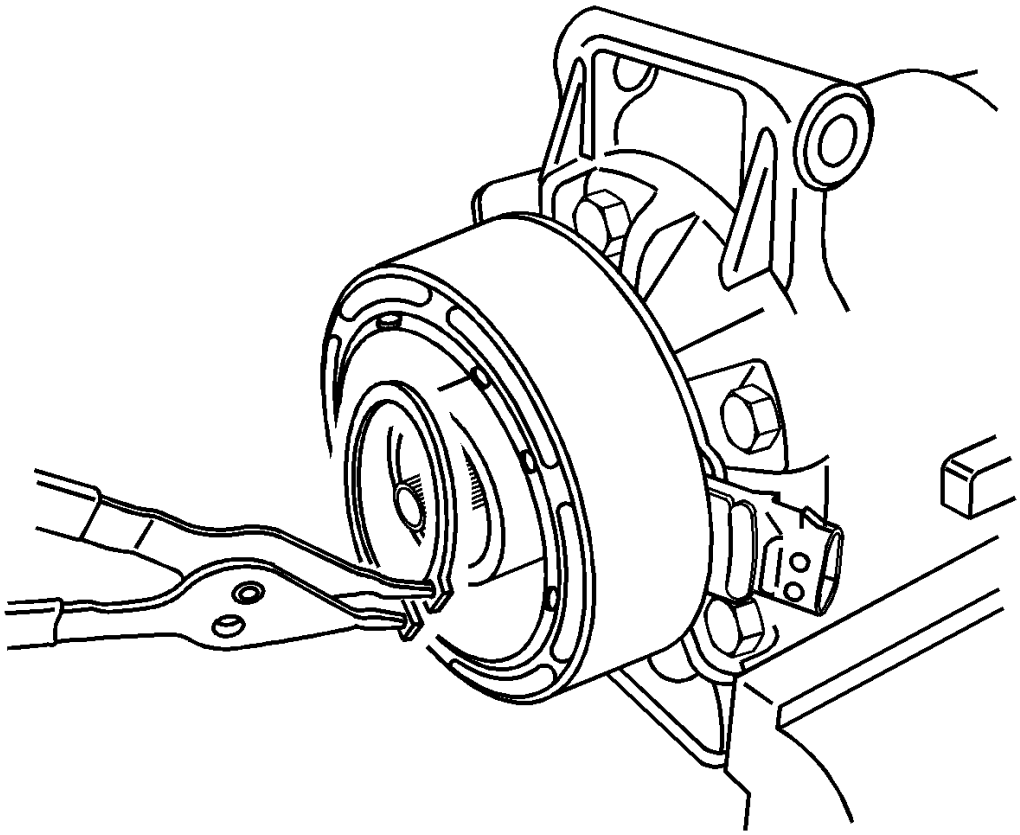


Fig. 12: Identifying Compressor Clutch Coil And Snap Ring
Courtesy of GENERAL MOTORS COMPANY

3. Install the compressor clutch coil snap ring using the **J 6083** Snap Ring Pliers.

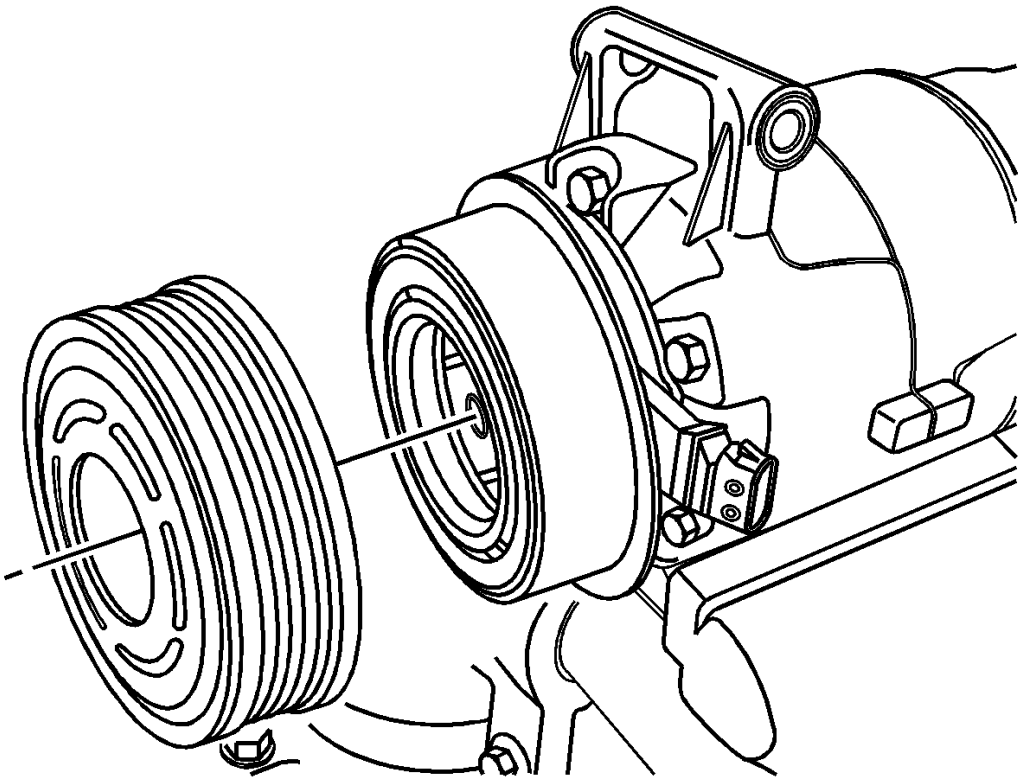


Fig. 13: Identifying Compressor Pulley
Courtesy of GENERAL MOTORS COMPANY

4. Install the compressor pulley to the compressor.

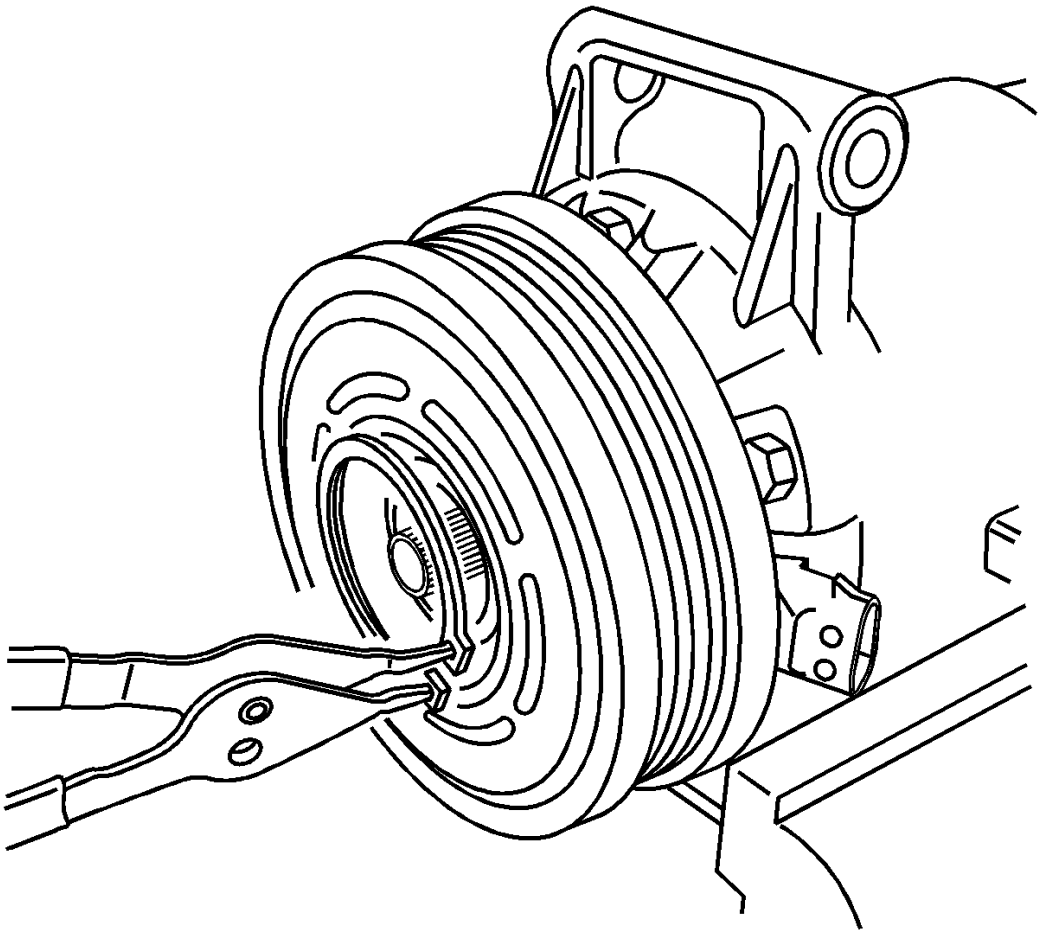


Fig. 14: View Of Compressor Pulley Snap Ring
Courtesy of GENERAL MOTORS COMPANY

5. Install the compressor pulley snap ring using the **J 6083** Snap Ring Pliers.
6. Place a small amount of oil on the 0.4 mm (0.016 in) air gap shim and place inside the clutch drive plate.

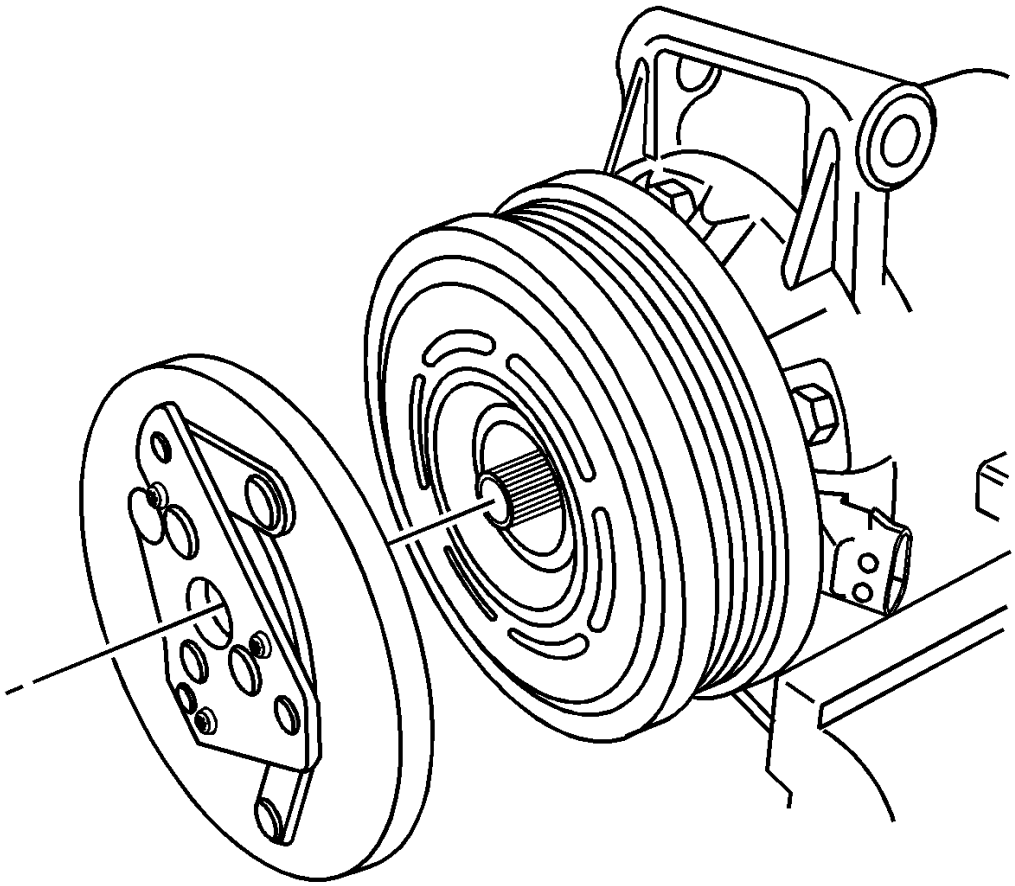


Fig. 15: Identifying Compressor Clutch Plate
Courtesy of GENERAL MOTORS COMPANY

7. Install the compressor clutch plate to the compressor.

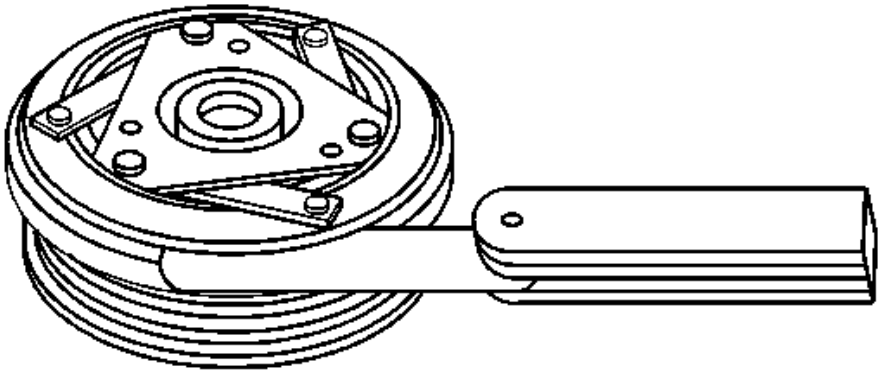


Fig. 16: Measuring Air Gap Between Pulley & Drive Plate
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Make certain that the drive plate does not drag against the pulley when the pulley is rotated.**

8. Measure the air gap between the pulley and the drive plate. Adjust the shims to achieve a 0.3-0.6 mm (0.012-0.024 in) air gap.

CAUTION: **Refer to Fastener Caution .**

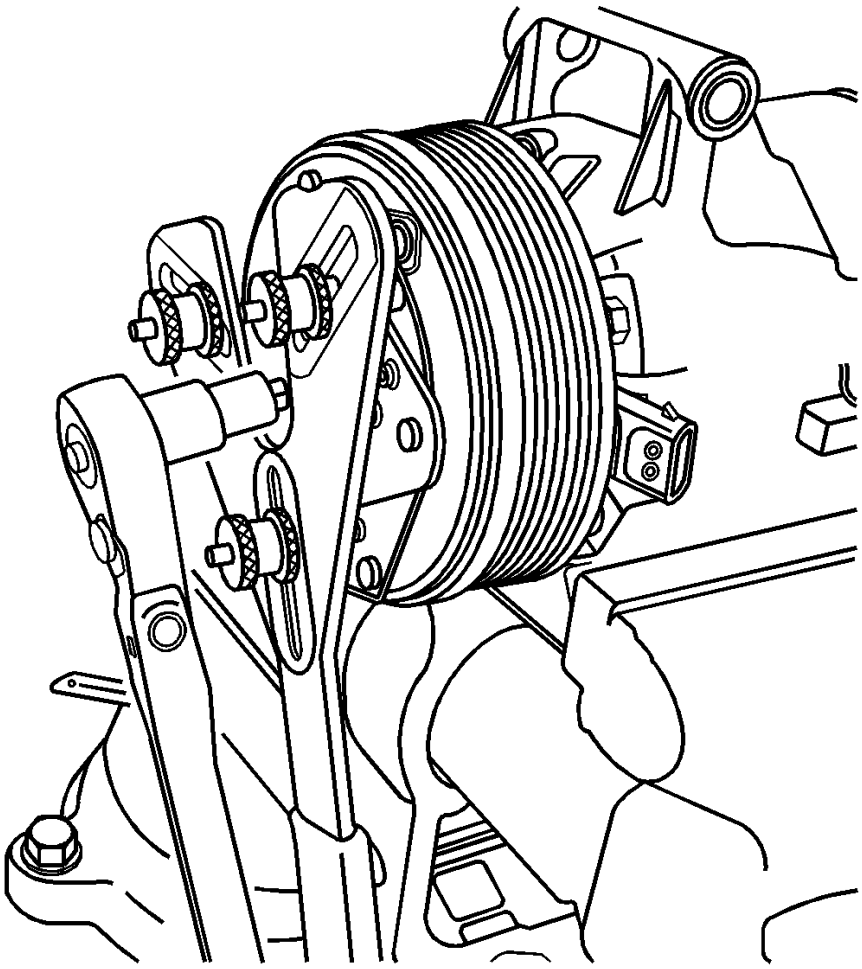


Fig. 17: Identifying Compressor Clutch Plate Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Make certain that the new drive plate bolt has colored adhesive on at least 5 threads.**

9. Install the clutch drive plate bolt.
10. Tighten the compressor clutch drive plate bolt to 12 N.m (106 lb in).

    Use the **J 37872** Compressor Clutch Holding Tool to hold the compressor clutch plate from turning.

11. Install the compressor. Refer to **Air Conditioning Compressor Replacement**.
12. Leak test the fittings using the **J 39400-A** Halogen Leak Detector.

COMPRESSOR PRESSURE RELIEF VALVE REPLACEMENT

Special Tools

J 39400-A Halogen Leak Detector

Removal Procedure

1. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

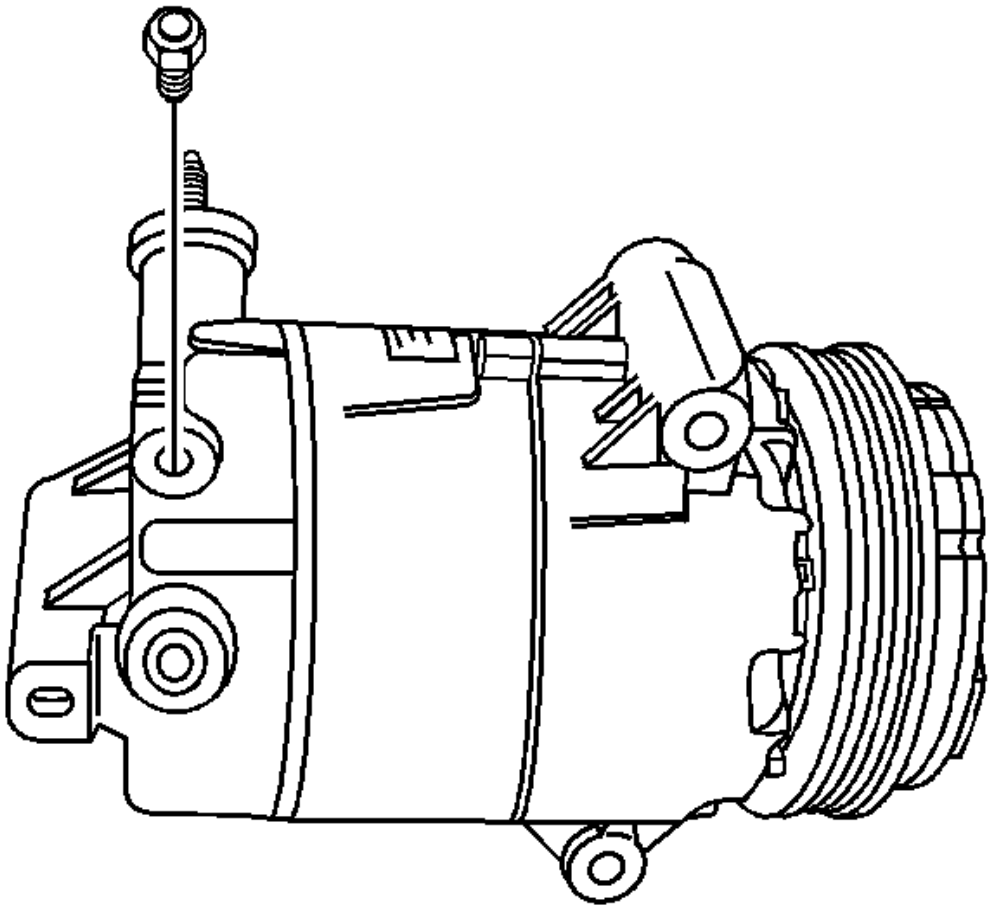


Fig. 18: Identifying Compressor Pressure Relief Valve
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Cap or tape the open A/C components immediately to prevent system contamination.**

3. Remove the high pressure relief valve.
4. Cap or tape the A/C compressor.

Installation Procedure

1. Remove the cap or tape from the A/C compressor.
2. Lubricate the O-ring on the high pressure relief valve. Refer to **Air Conditioning O-Ring Seal Replacement**.

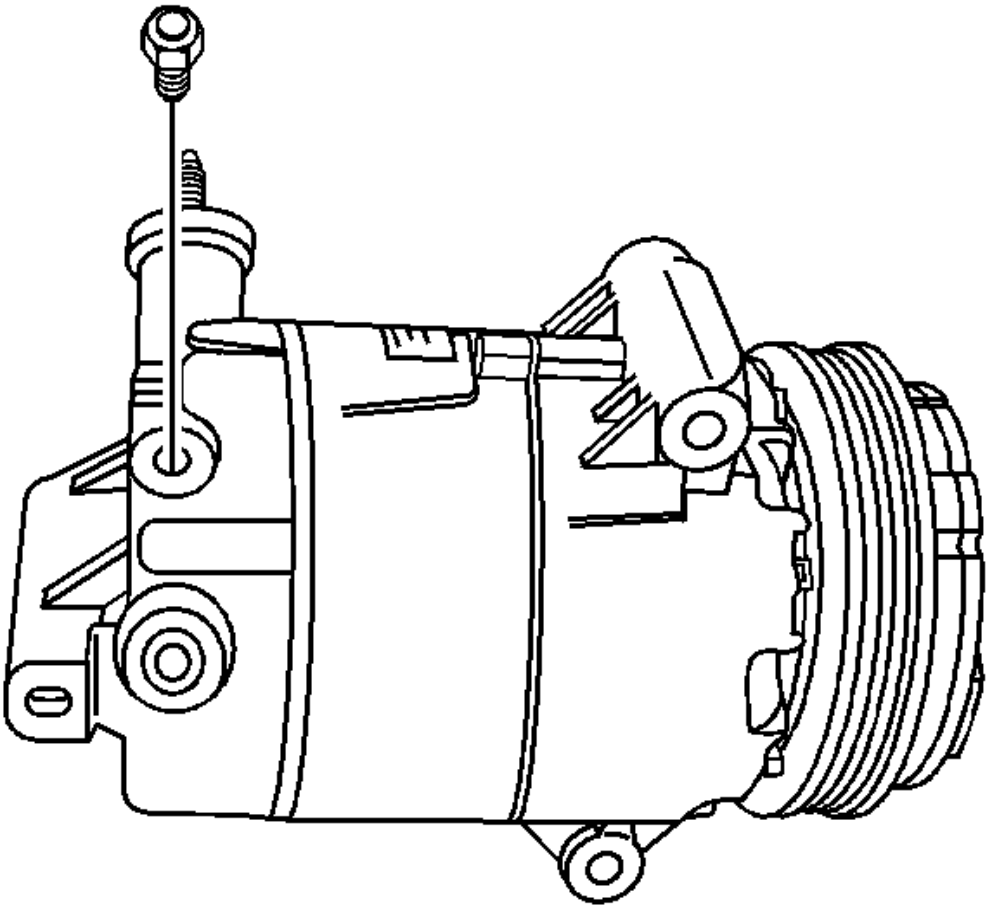


Fig. 19: Identifying Compressor Pressure Relief Valve
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the high pressure relief valve and tighten to 8 N.m (70 lb in).
4. Lower the vehicle.
5. Evacuate and recharge the refrigerant system. Refer to **Refrigerant Recovery and Recharging**.
6. Leak test the fittings of the component using **J 39400-A** Halogen Leak Detector.

AIR CONDITIONING SYSTEM SEAL REPLACEMENT

Removal Procedure

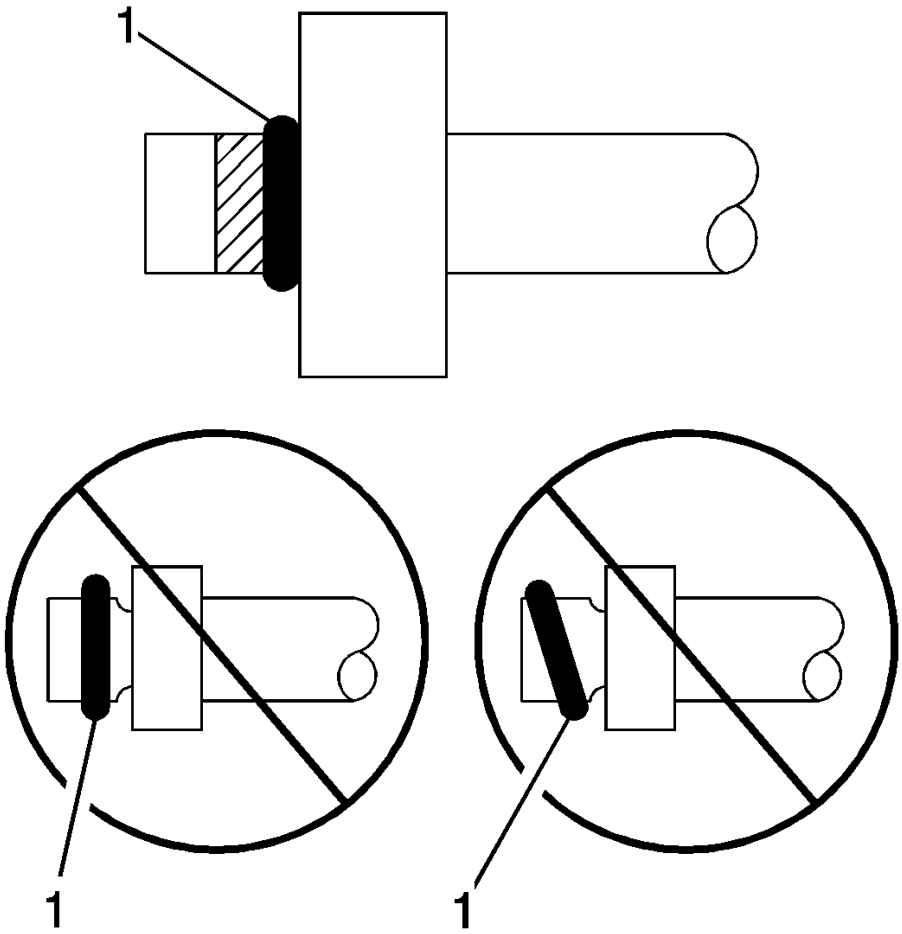


Fig. 20: Identifying Good & Bad Sealing Washer Positions
Courtesy of GENERAL MOTORS COMPANY

1. Remove the seal washer from the A/C refrigerant component.

NOTE: **Cap or tape the open A/C refrigerant components immediately to prevent system contamination.**

2. Inspect the seal washer for signs of damage to help determine the root cause of the failure.
3. Inspect the A/C refrigerant components for damage or burrs. Repair if necessary.

NOTE: **DO NOT reuse sealing washer.**

4. Discard the sealing washer.

Installation Procedure

NOTE: **Flat washer type seals do not require lubrication.**

1. Inspect the new seal washer for any signs of cracks, cuts, or damage.

   Do not use a damaged seal washer.

2. Remove the cap or tape from the A/C refrigerant components.

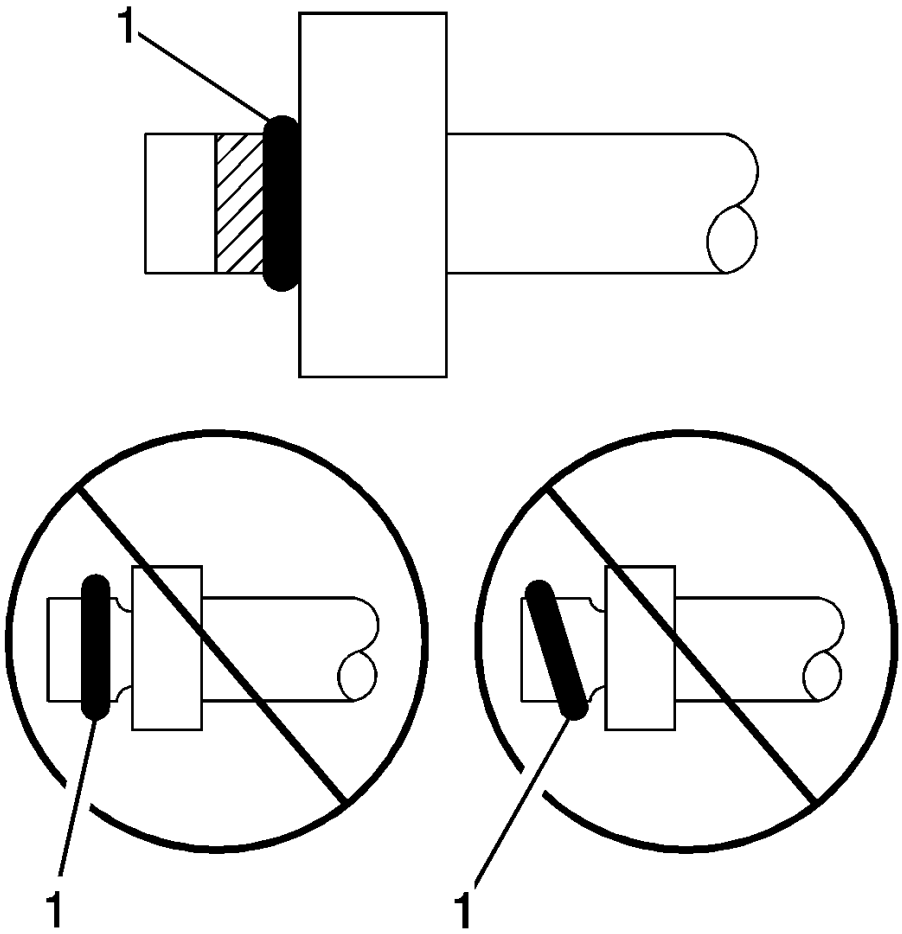


Fig. 21: Identifying Good & Bad Sealing Washer Positions
Courtesy of GENERAL MOTORS COMPANY

3. Using a lint-free clean, dry cloth, clean the sealing surfaces of the A/C refrigerant components.
4. Carefully install the new seal washer onto the A/C refrigerant component.

   The washer must completely bottom against the surface of the fitting.

   NOTE: After tightening the A/C components, there should be a slight sealing washer gap of approximately 1.2 mm (3/64 in) between the A/C line and the A/C component.

5. Assemble the remaining A/C refrigerant components. Refer to the appropriate repair procedure.

AIR CONDITIONING O-RING SEAL REPLACEMENT

Removal Procedure

1. Disassemble the A/C refrigerant components. Refer to the appropriate repair procedure.

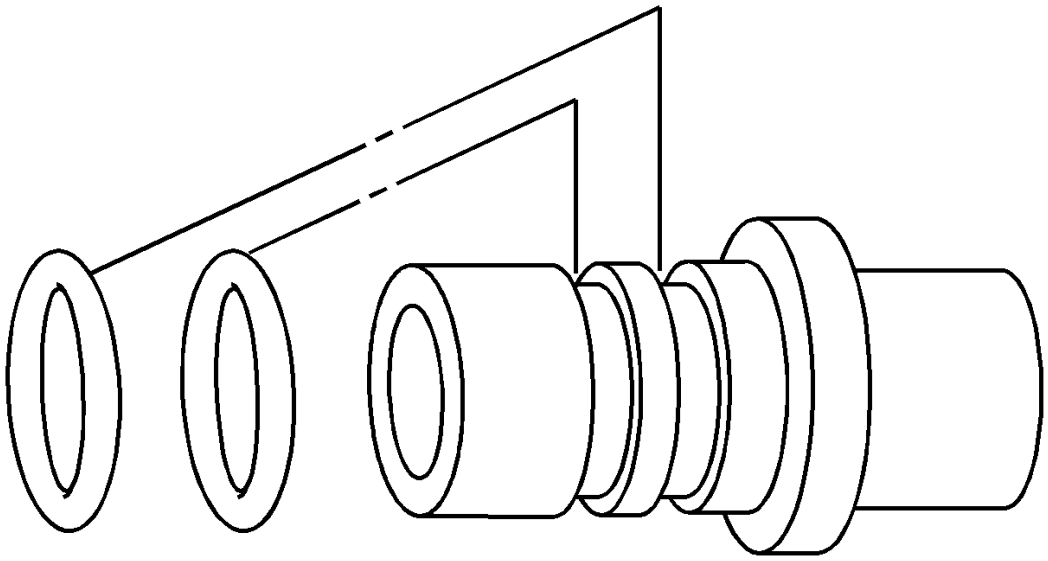


Fig. 22: Identifying O-Ring Seals & A/C Refrigerant Component
Courtesy of GENERAL MOTORS COMPANY

2. Remove the O-ring seals from the A/C refrigerant component.
3. Inspect the O-ring seals for signs of damage.
4. Inspect the A/C refrigerant components for damage or burrs. Repair if necessary.

NOTE: **Cap or tape the open A/C refrigerant components immediately to prevent system contamination.**

5. Cap or tape the A/C refrigerant components.
6. Discard the O-ring seals.

Installation Procedure

1. Inspect the new O-ring seals for any sign or cracks, cuts, or damage. Replace if necessary.
2. Remove the cap or tape from the A/C refrigerant components.
3. Using a lint-free clean, dry cloth, carefully clean the sealing surfaces of the A/C refrigerant components.

NOTE: **DO NOT allow any of the mineral base 525 viscosity refrigerant oil on the**

new O-ring seal to enter the refrigerant system.

4. Lightly coat the new O-ring seals with mineral base 525 viscosity refrigerant oil.

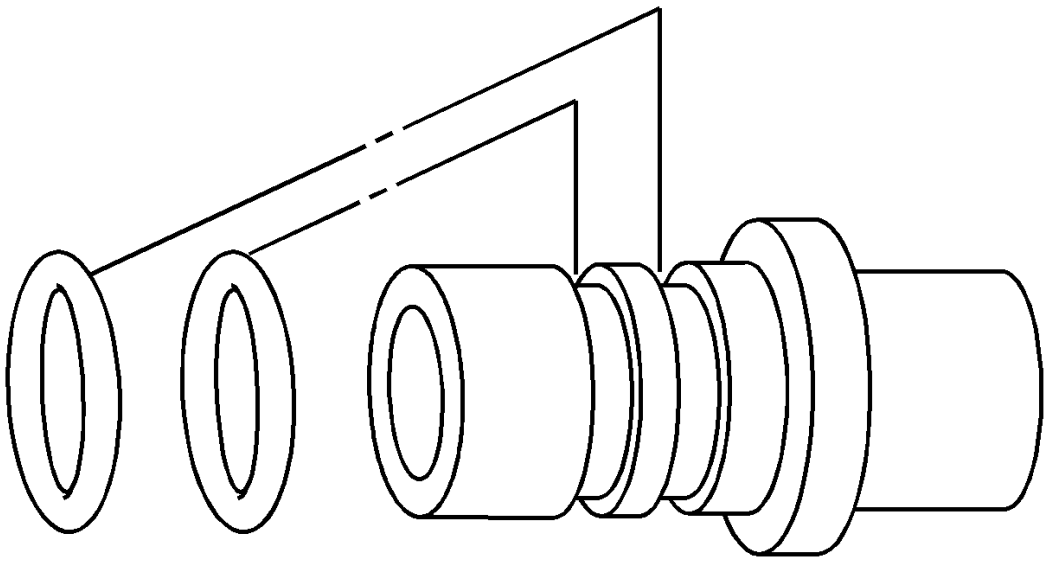


Fig. 23: Identifying O-Ring Seals & A/C Refrigerant Component
Courtesy of GENERAL MOTORS COMPANY

NOTE: **DO NOT reuse O-ring seals.**

5. Carefully slide the new O-ring seals onto the A/C refrigerant component.
6. The O-ring seals must be fully seated.
7. Assemble the A/C components.

Refer to the appropriate repair procedure.

AIR CONDITIONING LINE/TUBE CONNECTOR REMOVAL/REPLACEMENT

Special Tools

J 39400-A Halogen Leak Detector

Removal Procedure

1. Recover the refrigerant from the A/C system. Refer to **Refrigerant Recovery and Recharging**.

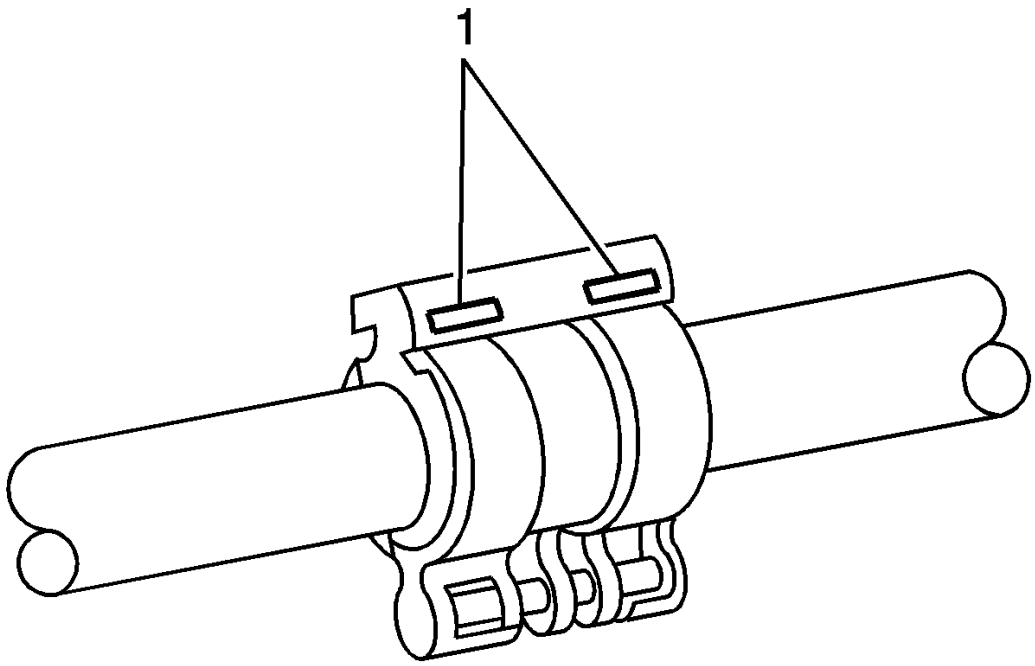


Fig. 24: A/C Coupling Assembly Locking Tab Access Slots
Courtesy of GENERAL MOTORS COMPANY

2. Locate the A/C coupling assembly's locking tab access slots (1).

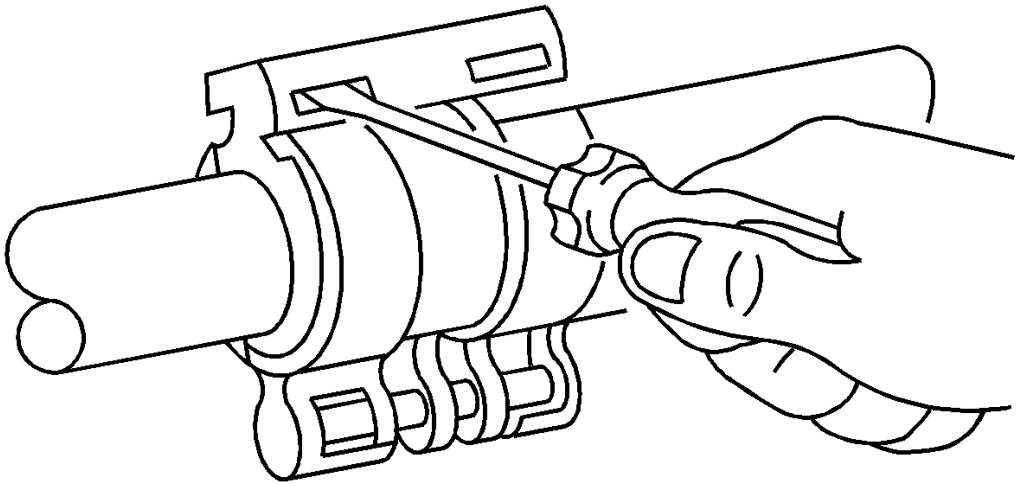


Fig. 25: Releasing First Locking Tab
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When separating the A/C coupling assembly, apply light pressure between the two halves of the coupling to prevent the locking tabs from reengaging.**

3. Carefully insert a small flat bladed screwdriver into the first locking tab access slot and gently lift the locking tab to release the lock.

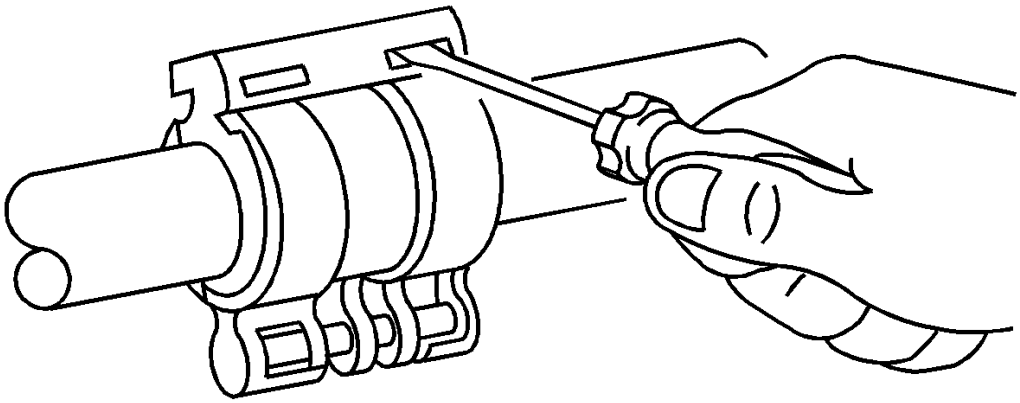


Fig. 26: Releasing Second Locking Tab
Courtesy of GENERAL MOTORS COMPANY

4. Carefully insert a small flat bladed screwdriver into the second locking tab access slot and gently lift the locking tab to release the lock.

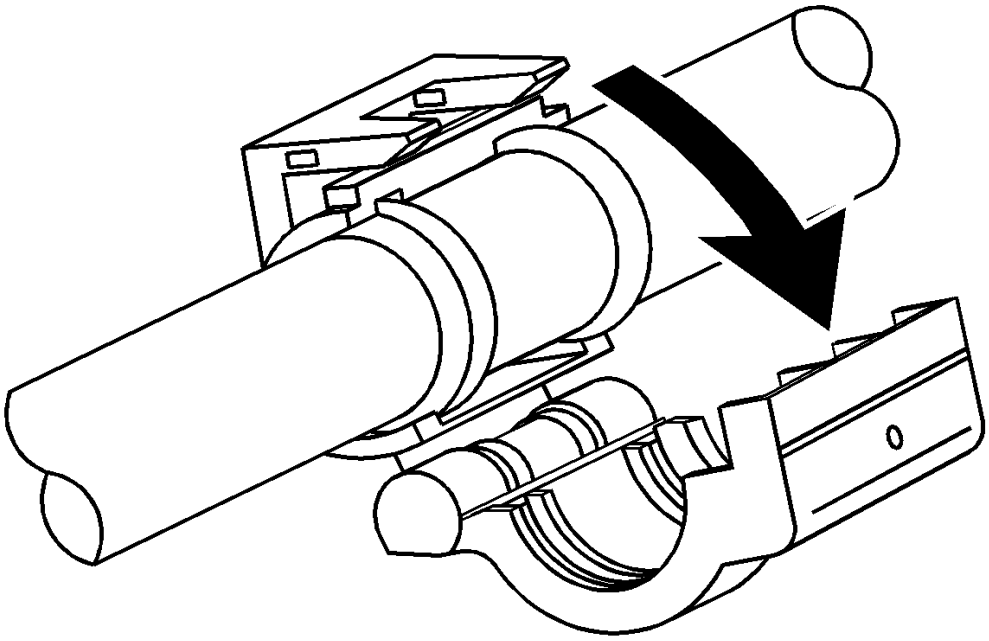


Fig. 27: A/C Coupling Assembly & A/C Refrigerant Component
Courtesy of GENERAL MOTORS COMPANY

5. Open and remove the A/C coupling assembly from the A/C refrigerant component.

Installation Procedure

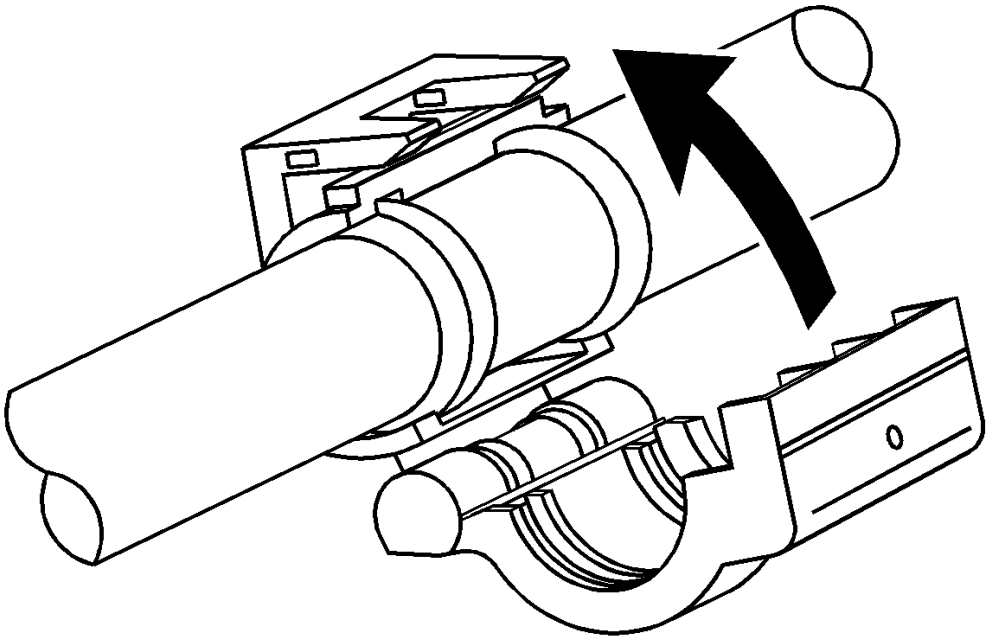


Fig. 28: Installing A/C Coupling Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Inspect the A/C coupling assembly locking tabs for damage or wear. Replace the A/C coupler assembly if any conditions exist.**

1. Install the A/C coupling assembly to the A/C refrigerant component.

NOTE: **Ensure that the A/C coupling assembly is latched securely to the A/C refrigerant component.**

2. Close the A/C coupling assembly.
3. Evacuate and recharge the A/C system. Refer to **Refrigerant Recovery and Recharging**.
4. Leak test the fittings of the component using **J 39400-A** Halogen Leak Detector.

AIR CONDITIONING COMPRESSOR HOSE REPLACEMENT

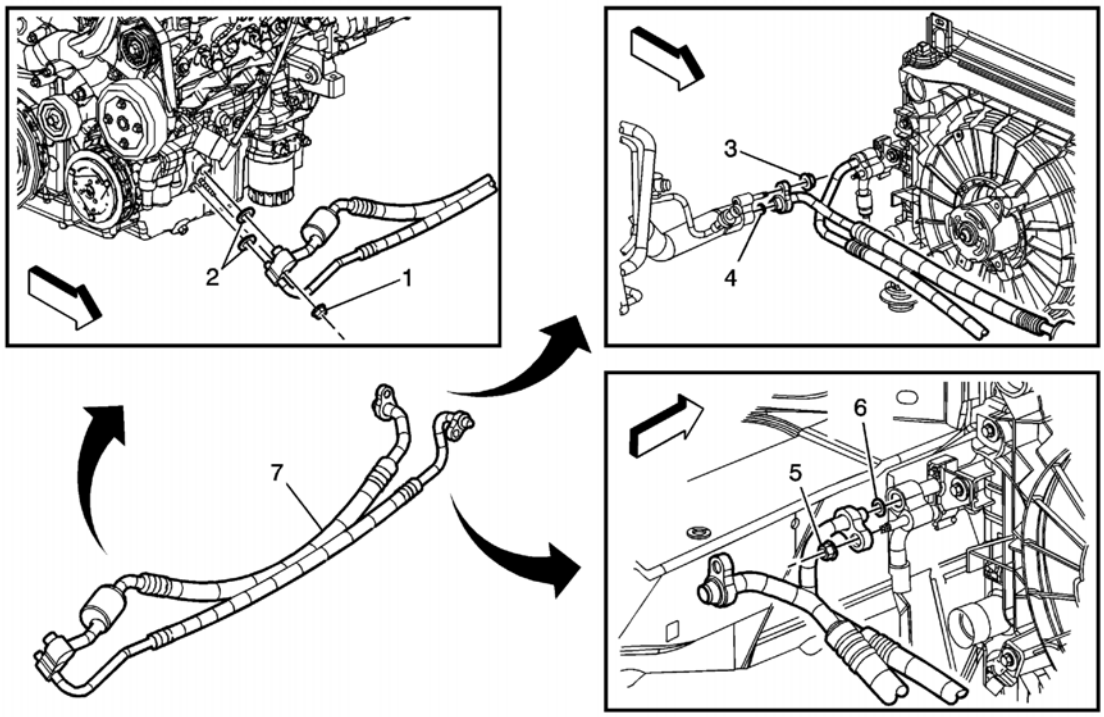


Fig. 29: Compressor Hose Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging**.	
1	A/C Compressor Hose Nut **CAUTION:** **Refer to** **Fastener Caution** **.** **Tighten** 17 N.m (12.5 lb in)
2	Sealing Washer **Procedure** Remove and discard sealing washers. Refer to **Air Conditioning System Seal Replacement**.
3	A/C Compressor Nut and Evaporator Tube **Tighten** 17 N.m (12.5 lb in)
4	Sealing Washer **Procedure** Remove and discard sealing washers. Refer to **Air Conditioning System Seal Replacement**.
5	A/C Compressor Nut and Condenser **TIP:** Use a 20 mm wrench or pliers to hold the A/C condenser block fitting, this will prevent

Callout	Component Name
	the A/C line from twisting while torquing the A/C line nut. **Tighten** 17 N.m (12.5 lb in)
6	Sealing Washer **Procedure** Remove and discard sealing washers. Refer to **Air Conditioning System Seal Replacement**.
7	A/C Compressor Hose Assembly **Procedure** Leak test the fittings. Refer to **Leak Testing**.

AIR CONDITIONING EVAPORATOR THERMAL EXPANSION VALVE TUBE REPLACEMENT

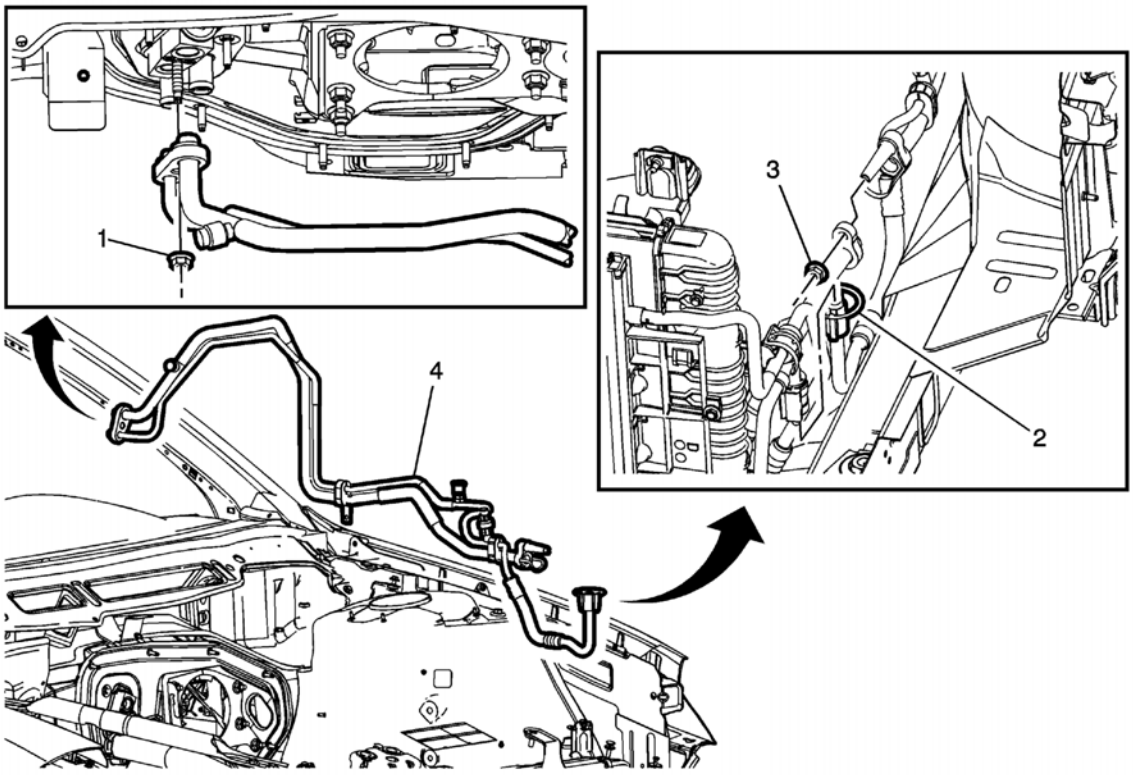


Fig. 30: Air Conditioning Evaporator Thermal Expansion Valve Tube Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. **Refrigerant Recovery and Recharging** 2. **Air Cleaner Bracket Replacement** 3. **Brake Pressure Modulator Valve Replacement** 4. **Brake Pressure Modulator Valve Bracket Replacement**	
1	A/C Compressor Nut and Evaporator Tube **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . **Tighten** 17 N.m (13 lb ft)
2	Sealing Washer **Procedure** Remove and discard the sealing washers. Air Conditioning System Seal Replacement.
3	A/C Condenser Bolt and A/C Evaporator Tube Clamp **Tighten** 10 N.m (89 lb in)
4	A/C Evaporator TXV Tube Assembly

AIR CONDITIONING (AC) REFRIGERANT FILTER REPLACEMENT

Special Tools

J 39400-A Halogen Leak Detector

Removal Procedure

1. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging**.
2. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**
3. Remove the A/C line coupling from the evaporator tube to condenser tube. Refer to **Air Conditioning Line/Tube Connector Removal/Replacement**.

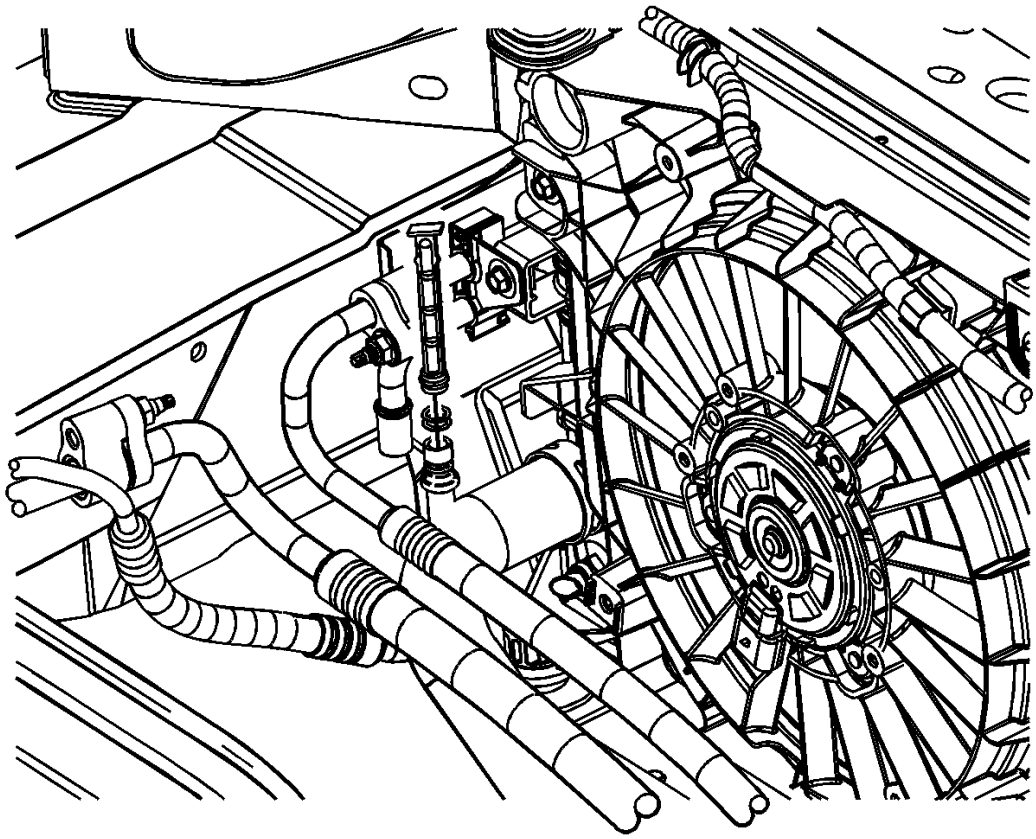


Fig. 31: Locating Air Conditioning (A/C) Refrigerant Filter
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the evaporator tube from the condenser.
5. Remove and discard the O-ring seals. Refer to **Air Conditioning O-Ring Seal Replacement**.
6. Remove the refrigerant filter from the evaporator tube.

Installation Procedure

1. Replace the O-ring seals on the evaporator tube. Refer to **Air Conditioning O-Ring Seal Replacement**.

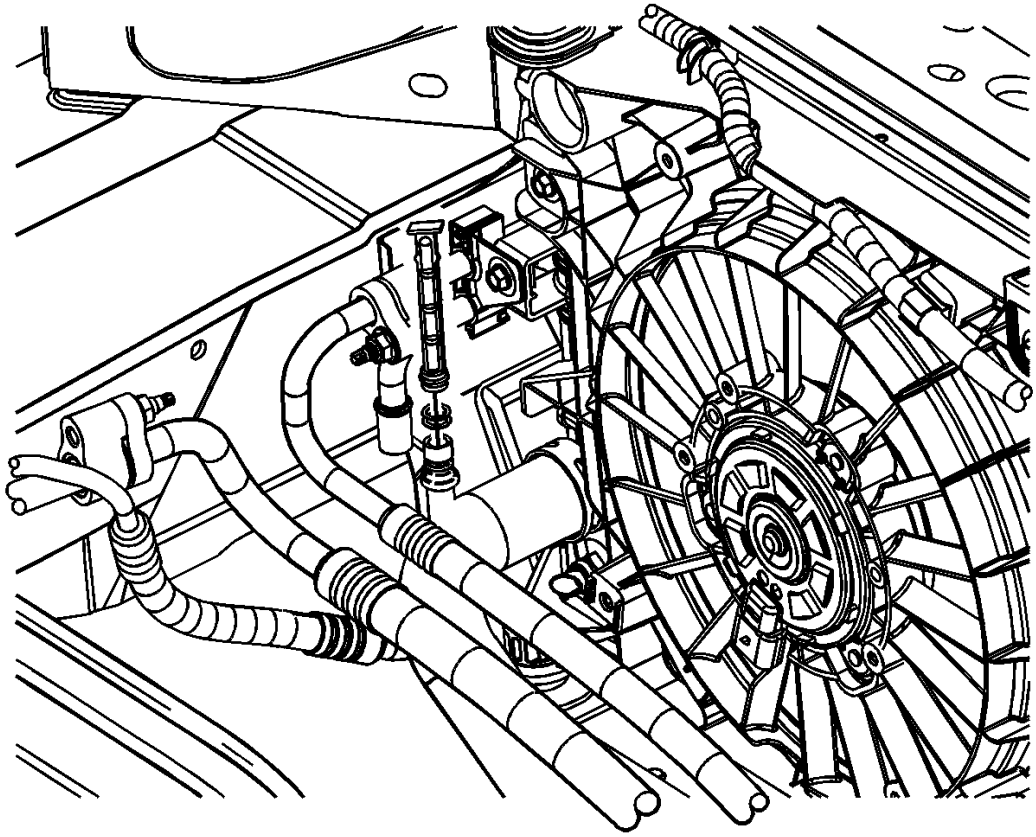


Fig. 32: Locating Air Conditioning (A/C) Refrigerant Filter
Courtesy of GENERAL MOTORS COMPANY

2. Install a new refrigerant filter to the evaporator tube.
3. Connect the evaporator tube to the condenser.
4. Install the A/C line coupling to the evaporator tube and condenser tube. Refer to **Air Conditioning Line/Tube Connector Removal/Replacement**.
5. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**
6. Evacuate and recharge the A/C system. Refer to **Refrigerant Recovery and Recharging**.
7. Leak test the fittings of the component using **J 39400-A** Halogen Leak Detector.

AIR CONDITIONING COMPRESSOR SUCTION SCREEN REPLACEMENT

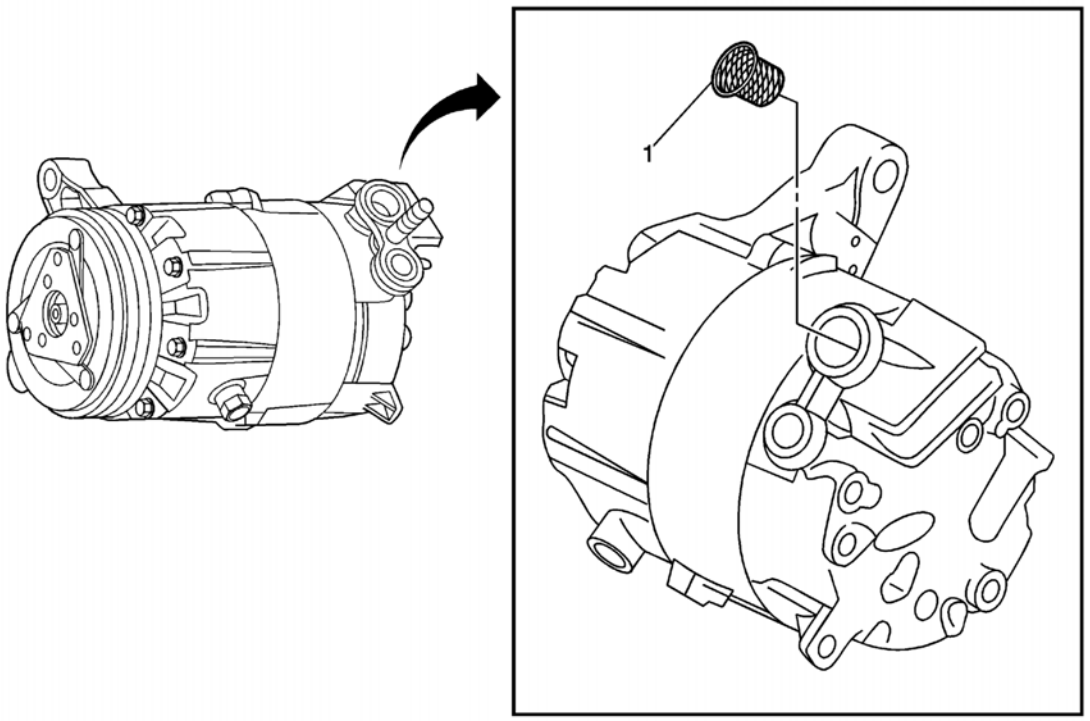


Fig. 33: Suction Screen
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the A/C compressor. Refer to **Air Conditioning Compressor Replacement**.	
1	Suction Screen **TIP:** Remove the suction screen from the A/C compressor suction port using a flat bladed tool or pick.

SERVICE PORTS REPLACEMENT

Special Tools

J 39037 Charge Valve Octagon Socket

Removal Procedure

1. Remove the service port cap.
2. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging**.

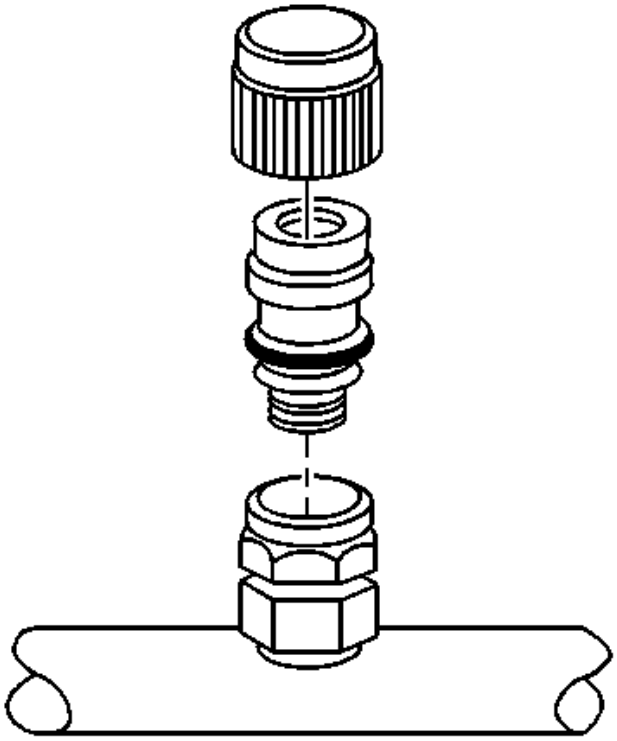


Fig. 34: View Of Service Port
Courtesy of GENERAL MOTORS COMPANY

3. Use the **J 39037** Charge Valve Octagon Socket to remove the service port.

Installation Procedure

1. Replace the O-ring. Refer to **Air Conditioning O-Ring Seal Replacement**.

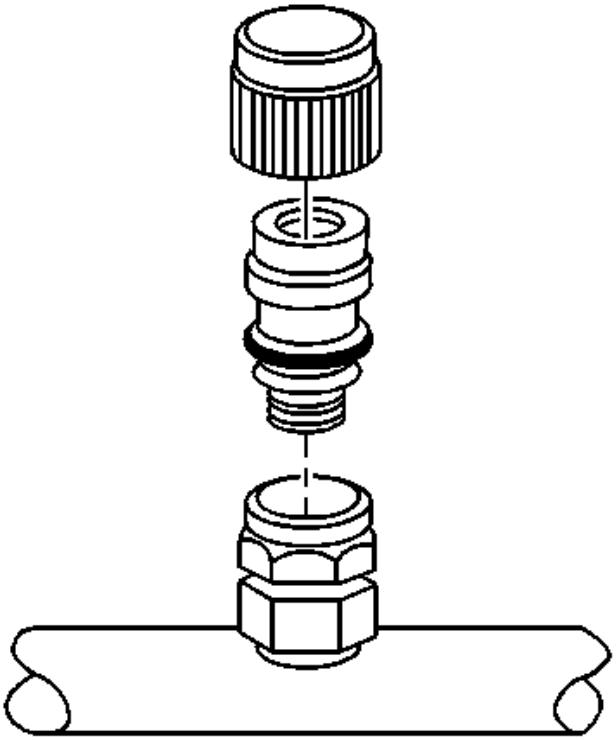


Fig. 35: View Of Service Port
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the service port valve and tighten to 11 N.m (98 lb in).
3. Evacuate and charge the system. Refer to **Refrigerant Recovery and Recharging**.
4. Leak test the A/C service port. Refer to **Leak Testing**.
5. Install the service port cap.

AIR CONDITIONING EVAPORATOR THERMAL EXPANSION VALVE REPLACEMENT

Special Tools

J 39400-A Halogen Leak Detector

Removal Procedure

1. Recover the refrigerant from the A/C system. Refer to **Refrigerant Recovery and Recharging**.

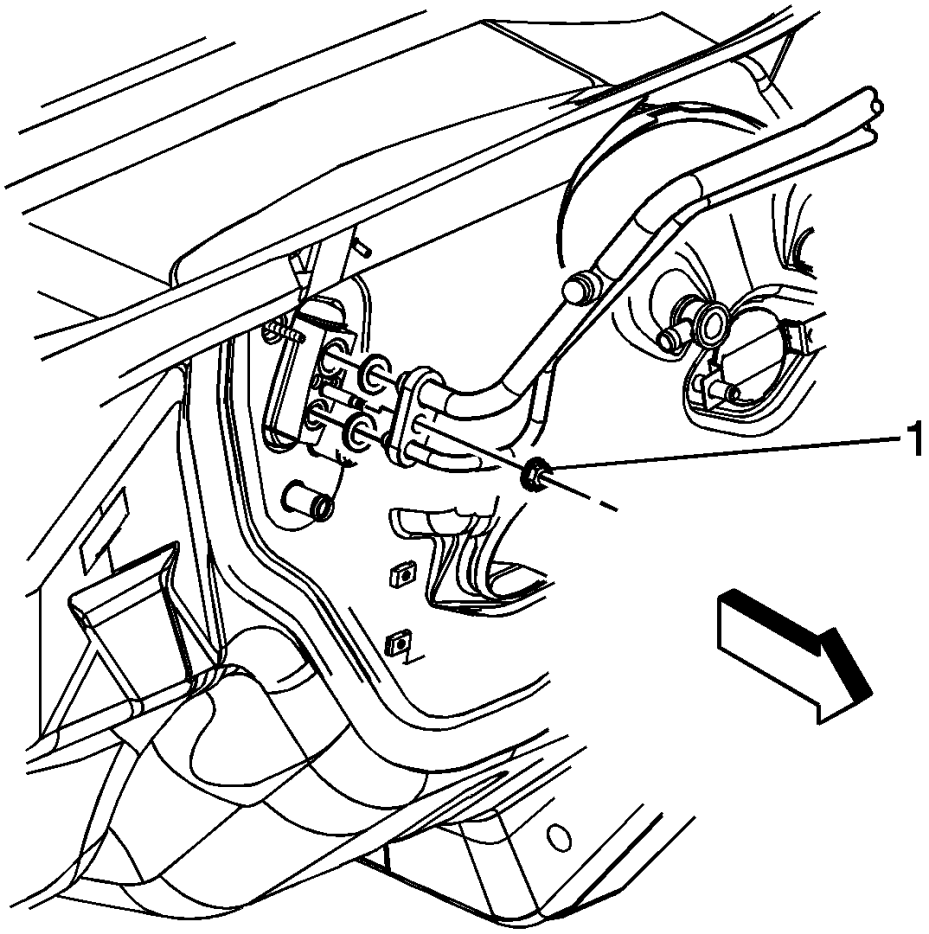


Fig. 36: Evaporator Tube And Thermostatic Expansion Valve (TXV) Nut
Courtesy of GENERAL MOTORS COMPANY

2. Remove the evaporator tube to thermal expansion valve (TXV) nut (1).
3. Disconnect the evaporator outlet and inlet tube from the TXV.
4. Remove and discard the sealing washers.

NOTE: **Cap or tape the open evaporator inlet and outlet tubes immediately to prevent contamination of the refrigerant system.**

5. Cap off the evaporator inlet and outlet tube.

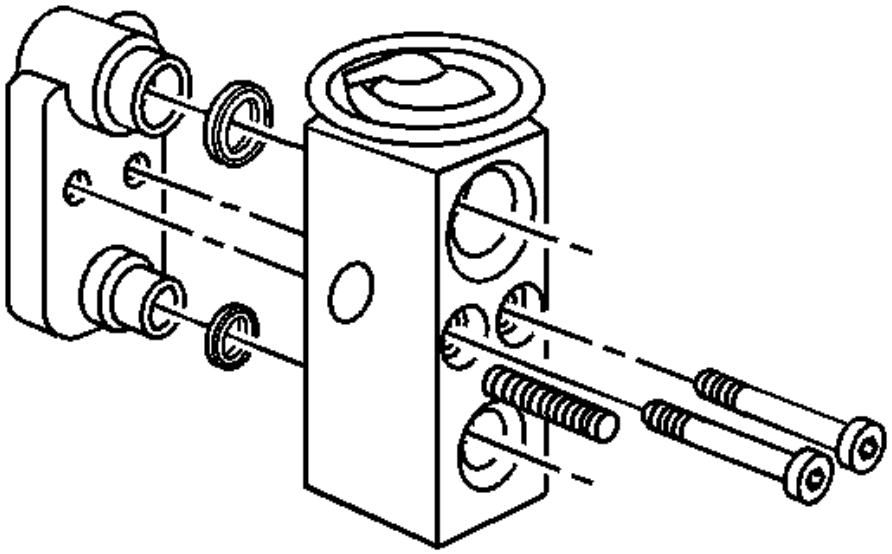


Fig. 37: View Of TXV
Courtesy of GENERAL MOTORS COMPANY

6. Remove the TXV to evaporator bolts.
7. Remove the TXV from the evaporator core.
8. Remove and discard the sealing washers.

Installation Procedure

1. Install the new sealing washers onto the evaporator core. Refer to **Air Conditioning System Seal Replacement**.

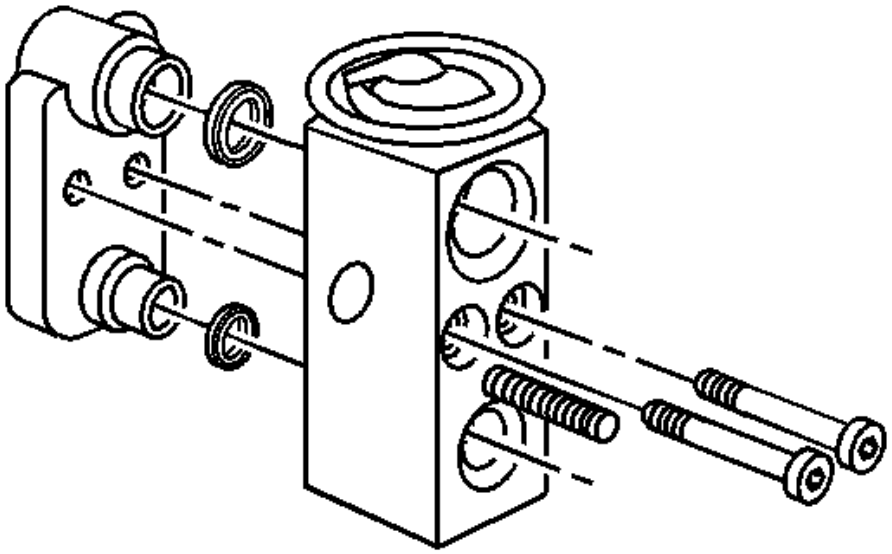


Fig. 38: View Of TXV
Courtesy of GENERAL MOTORS COMPANY

2. Install the TXV to the evaporator core.

CAUTION: Refer to Fastener Caution .

3. Install the TXV to evaporator bolts and tighten to 7 N.m (62 lb in).
4. Remove the cap or tape from the evaporator inlet and outlet tubes.
5. Install the new sealing washers onto the evaporator inlet and outlet tubes. Refer to **Air Conditioning System Seal Replacement**.
6. Install the evaporator outlet and inlet tube to the TXV.

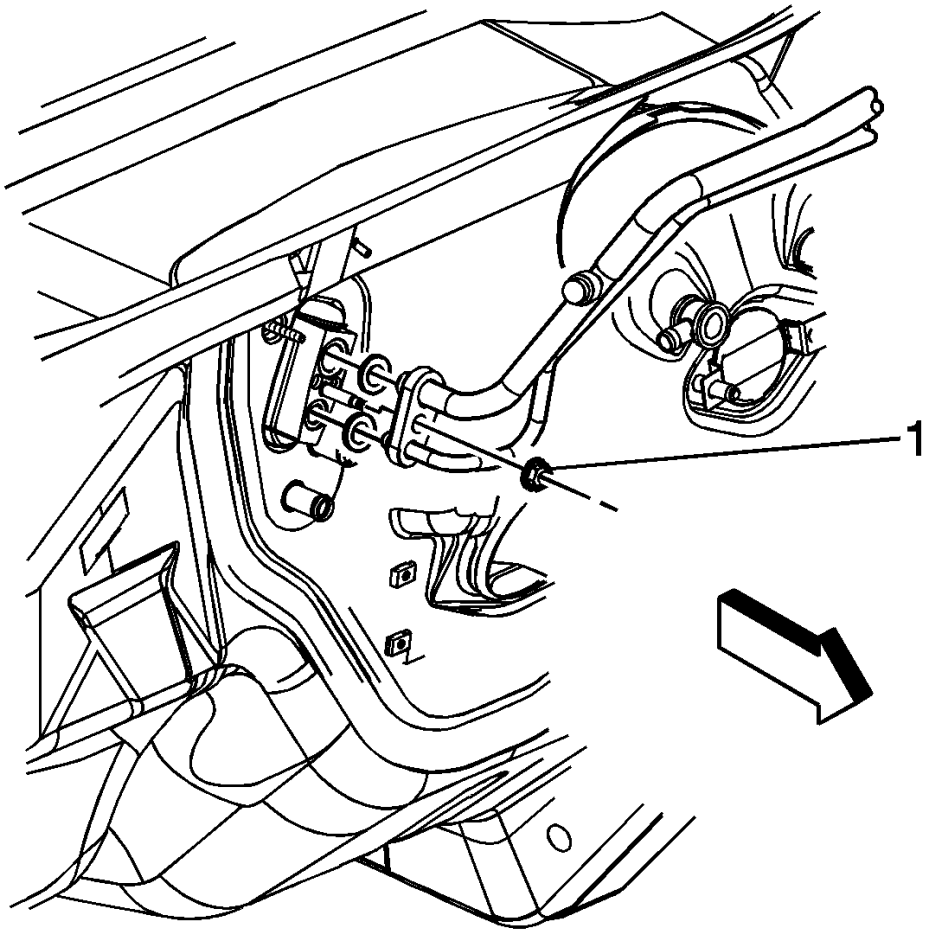


Fig. 39: Evaporator Tube And Thermostatic Expansion Valve (TXV) Nut
Courtesy of GENERAL MOTORS COMPANY

7. Install the evaporator tube nut (1) and tighten to 17 N.m (13 lb ft).
8. Evacuate and recharge the A/C system. Refer to **Refrigerant Recovery and Recharging**.
9. Leak test the fittings of the component using **J 39400-A** Halogen Leak Detector.

AIR CONDITIONING (A/C) REFRIGERANT PRESSURE SENSOR REPLACEMENT

Special Tools

J 39400-A Halogen Leak Detector

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**
2. Disconnect the electrical connector from the A/C refrigerant pressure sensor.

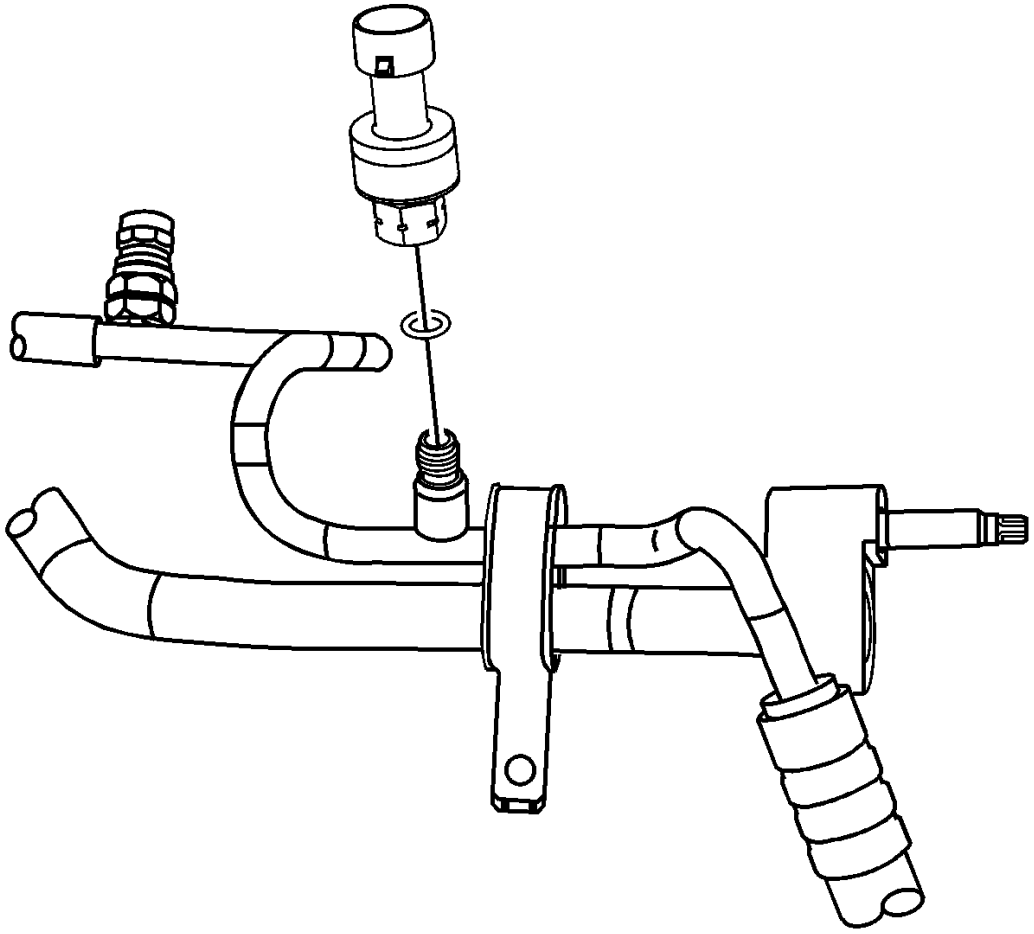


Fig. 40: Identifying Refrigerant Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

3. Remove the A/C refrigerant pressure sensor from the evaporator tube.

Installation Procedure

1. Replace the O-ring seal for the A/C refrigerant pressure sensor. Refer to **Air Conditioning O-Ring Seal Replacement**.

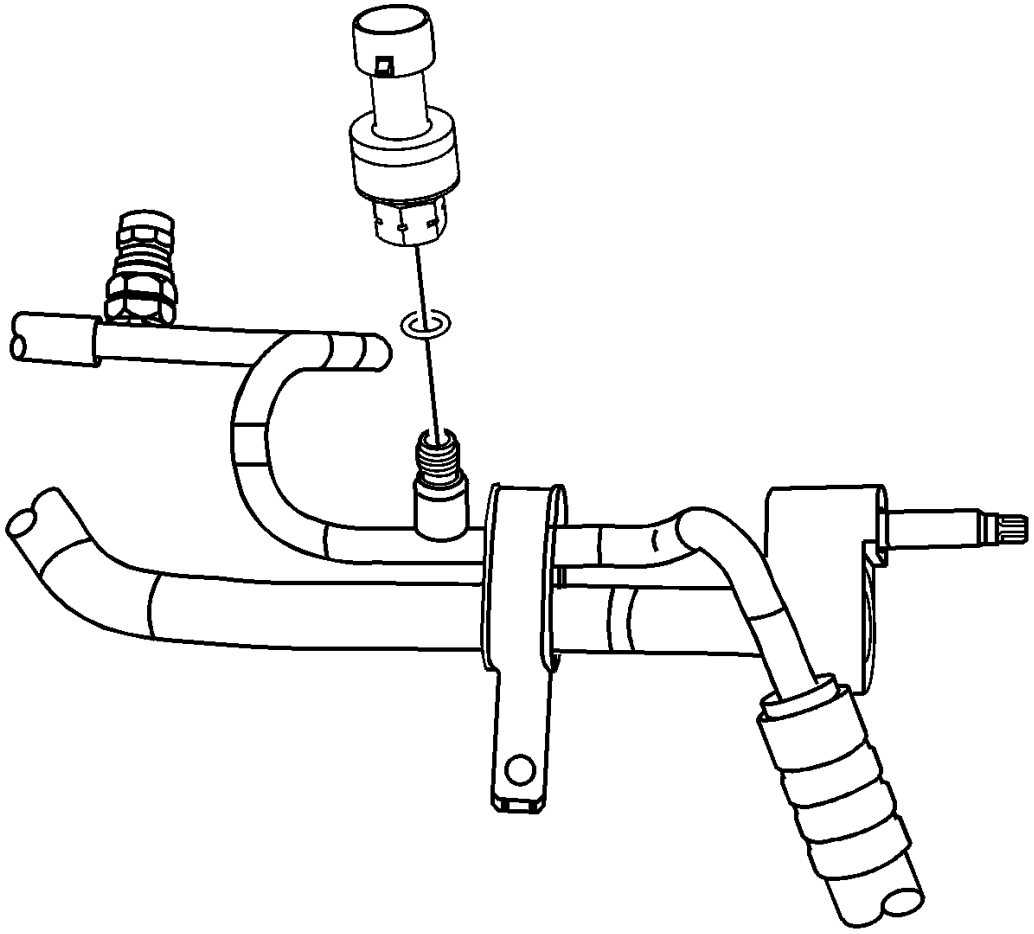


Fig. 41: Identifying Refrigerant Pressure Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the A/C refrigerant pressure sensor to the evaporator tube and tighten to 4.7 N.m (41 lb in).
3. Connect the electrical connector to the A/C refrigerant pressure sensor.
4. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement**
5. Leak test the fittings of the component using **J 39400-A** Halogen Leak Detector.

EVAPORATOR AIR TEMPERATURE SENSOR REPLACEMENT

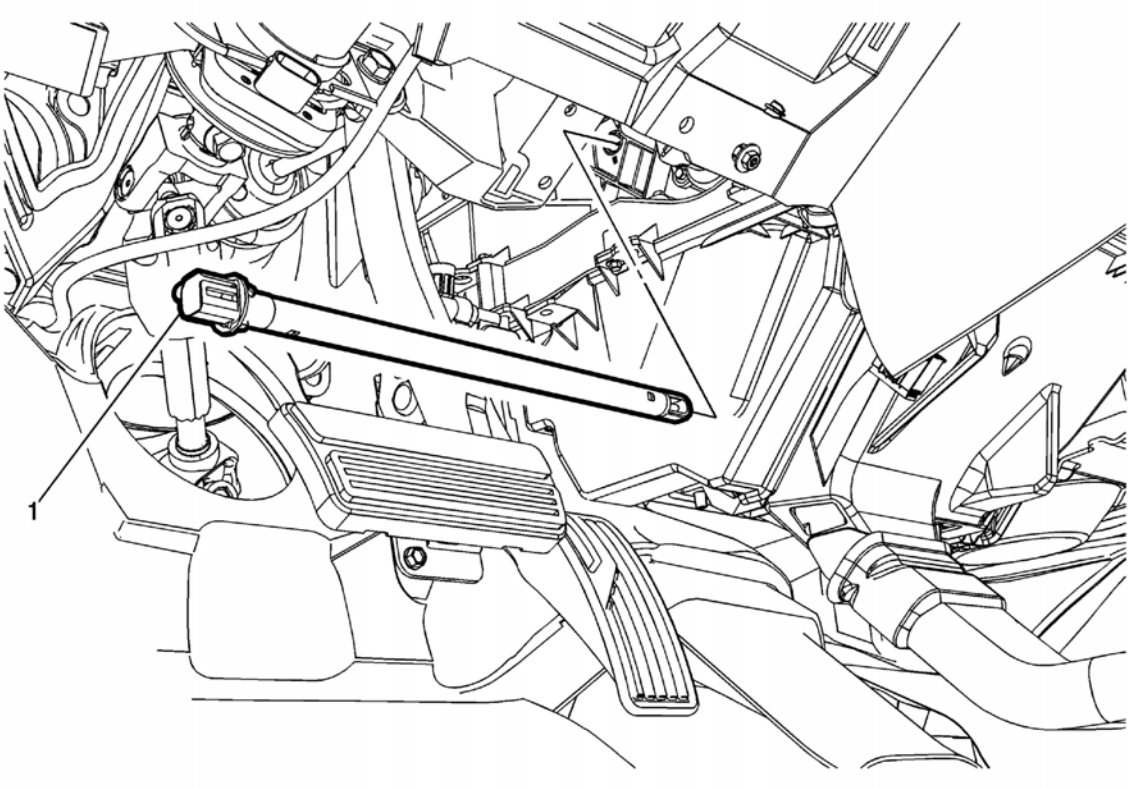


Fig. 42: Evaporator Air Temperature Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the left side Instrument Panel Insulator Panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .	
1	Air Conditioning Evaporator Air Temperature Sensor **Procedure** 1. Disconnect the air conditioning evaporator air temperature sensor connector. 2. Rotate the air conditioning evaporator air temperature sensor 1/4 of a turn counterclockwise to remove.

AIR CONDITIONING CONDENSER REPLACEMENT

Special Tools

J 39400-A Halogen Leak Detector

Removal Procedure

1. Recover the refrigerant. Refer to **Refrigerant Recovery and Recharging**.
2. Remove the radiator. Refer to **Radiator Replacement** .

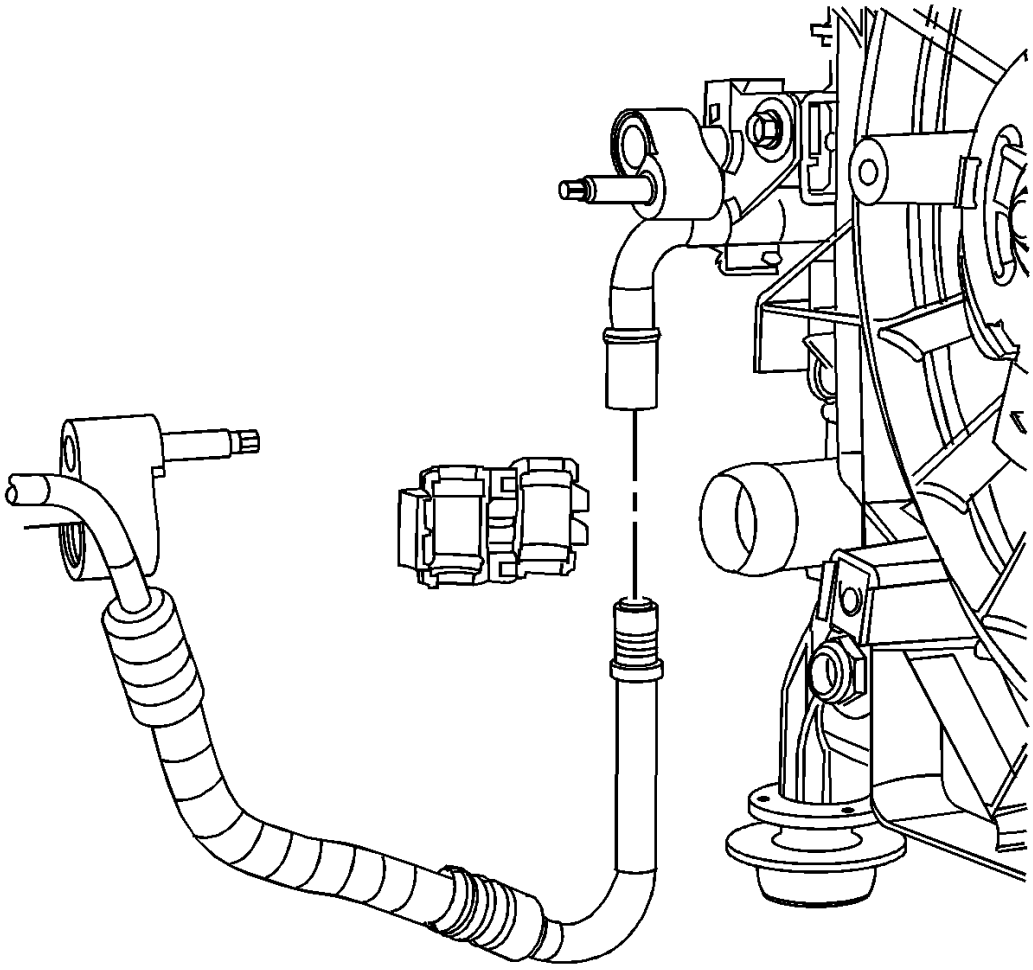


Fig. 43: View Of A/C Line Coupling At Condenser Tube
Courtesy of GENERAL MOTORS COMPANY

3. Remove the A/C line coupling from the condenser tube to evaporator tube. Refer to **Air Conditioning Line/Tube Connector Removal/Replacement**.

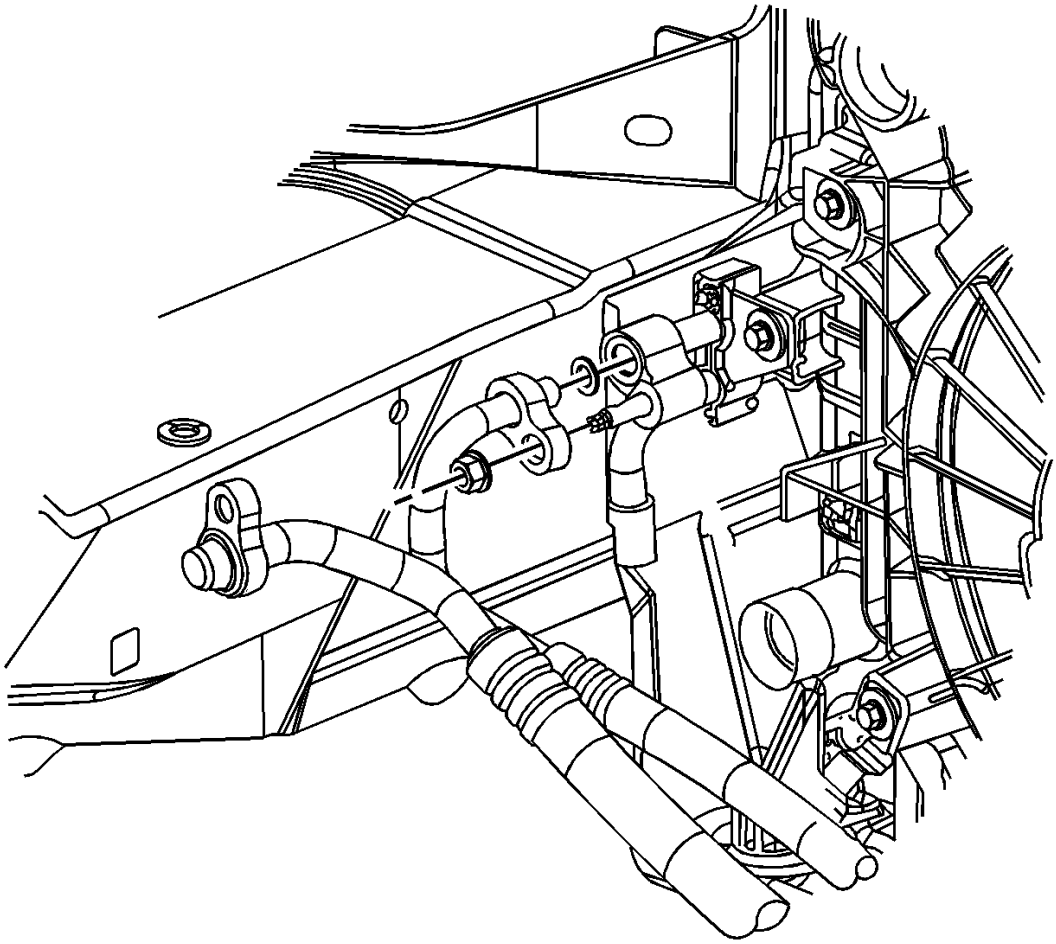


Fig. 44: Identifying A/C Compressor Hose Nut
Courtesy of GENERAL MOTORS COMPANY

4. Remove the A/C compressor line nut from the condenser and position the A/C compressor line aside.
5. Remove the condenser from the vehicle.
6. Remove and discard the O-ring seals and seal washer.

Installation Procedure

1. If replacing the condenser, add refrigerant oil to the condenser. Refer to **Refrigerant System Specifications** for system capacity information.
2. Install the condenser to the vehicle.
3. Install a new seal washer onto the A/C compressor hose. Refer to **Air Conditioning System Seal Replacement**.
4. Install new O-ring seals onto the evaporator tube. Refer to **Air Conditioning O-Ring Seal Replacement**.
5. Install the radiator. Refer to **Radiator Replacement** .

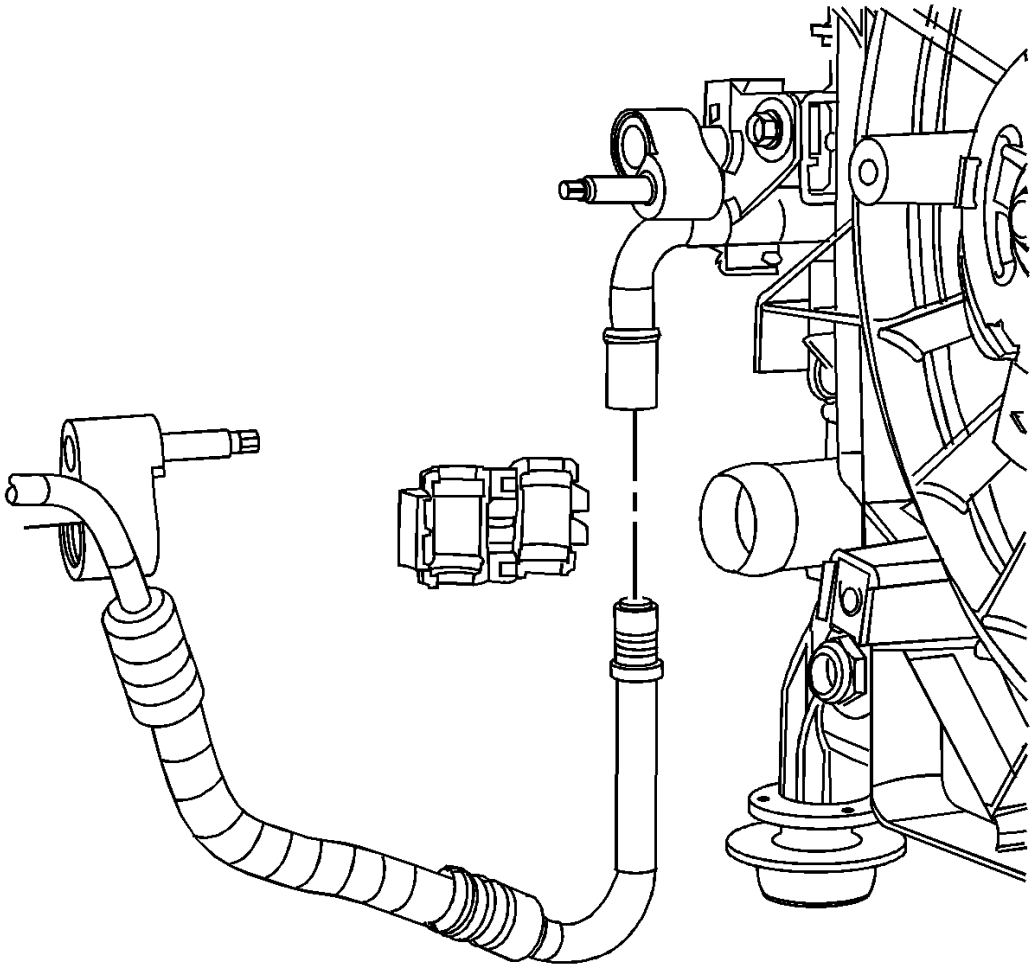


Fig. 45: View Of A/C Line Coupling At Condenser Tube
Courtesy of GENERAL MOTORS COMPANY

6. Install the evaporator tube to the condenser.
7. Install the A/C line coupling to the evaporator tube and condenser tube. Refer to **Air Conditioning Line/Tube Connector Removal/Replacement**.

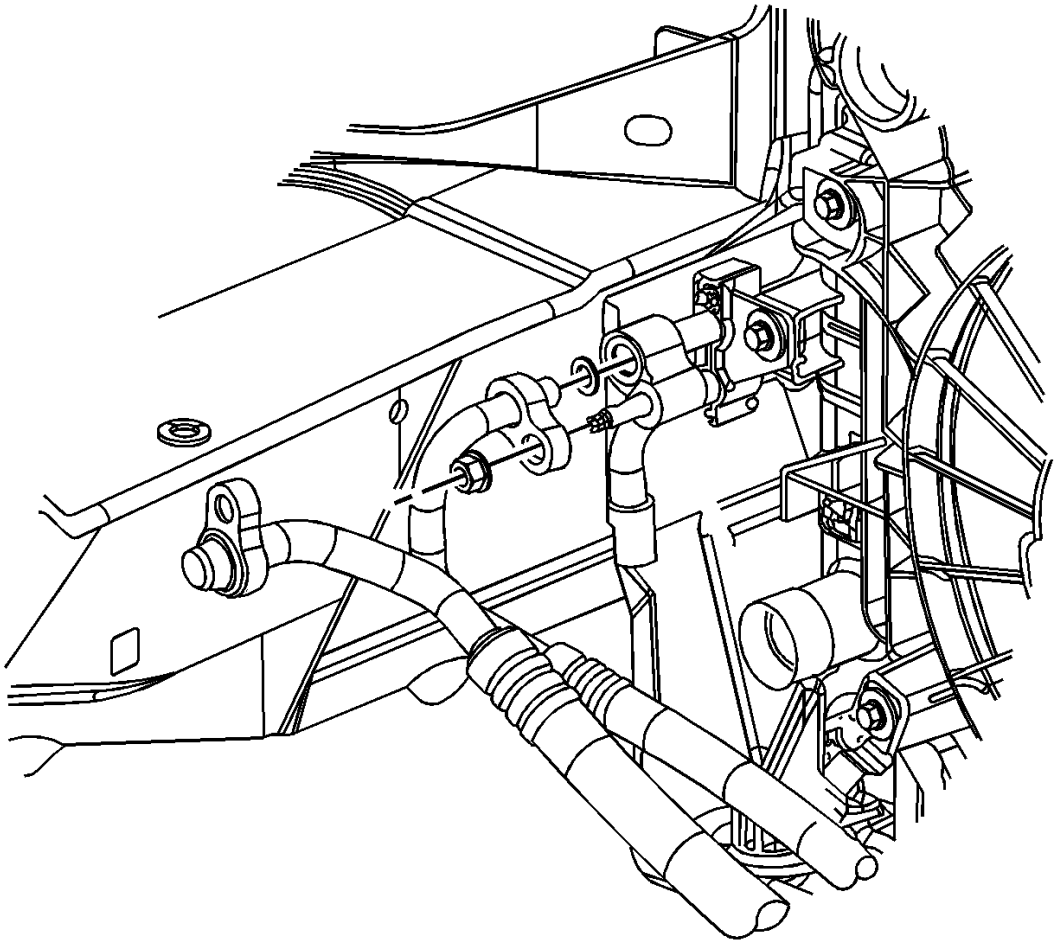


Fig. 46: Identifying A/C Compressor Hose Nut
Courtesy of GENERAL MOTORS COMPANY

8. Install the A/C compressor hose to the condenser.

CAUTION: **Refer to Fastener Caution .**

NOTE: **Use a 20 mm wrench or pliers to hold the A/C condenser block fitting, this will prevent the A/C line from twisting while torquing the A/C line nut.**

9. Install the A/C compressor hose block fitting nut to the condenser and tighten to 17 N.m (12.5 lb ft).
10. Evacuate and recharge the A/C system. Refer to **Refrigerant Recovery and Recharging**.
11. Leak test the fittings of the component using **J 39400-A** Halogen Leak Detector.

AIR CONDITIONING (A/C) EVAPORATOR CASE ASSEMBLY REPLACEMENT

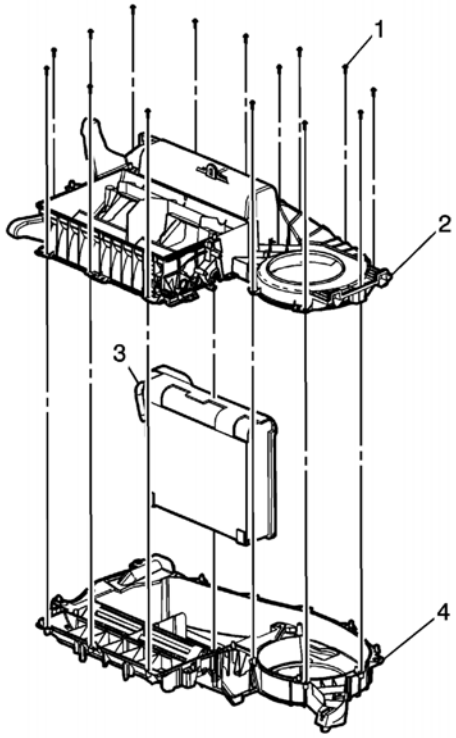


Fig. 47: Air Conditioning (A/C) Evaporator Case Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the HVAC module. Refer to **Air Conditioning and Heater Module Assembly Removal and Installation**. 2. Remove the mode valve assembly. Refer to **Mode Valve Assembly Replacement**. 3. Remove the heater core. Refer to **Heater Core Replacement**.	
1	Evaporator Case Assembly Screw (Qty: 17) **CAUTION:** **Refer to Fastener Caution .** **TIP:** Remove the heat stakes that secure the HVAC module assembly upper case to the HVAC module lower case using a small chisel. **Tighten** 1.5 N.m (13 lb in)
2	Evaporator - Upper Case
3	Air Conditioning Evaporator
4	Evaporator - Lower Case

AIR CONDITIONING AND HEATER MODULE ASSEMBLY REMOVAL AND INSTALLATION

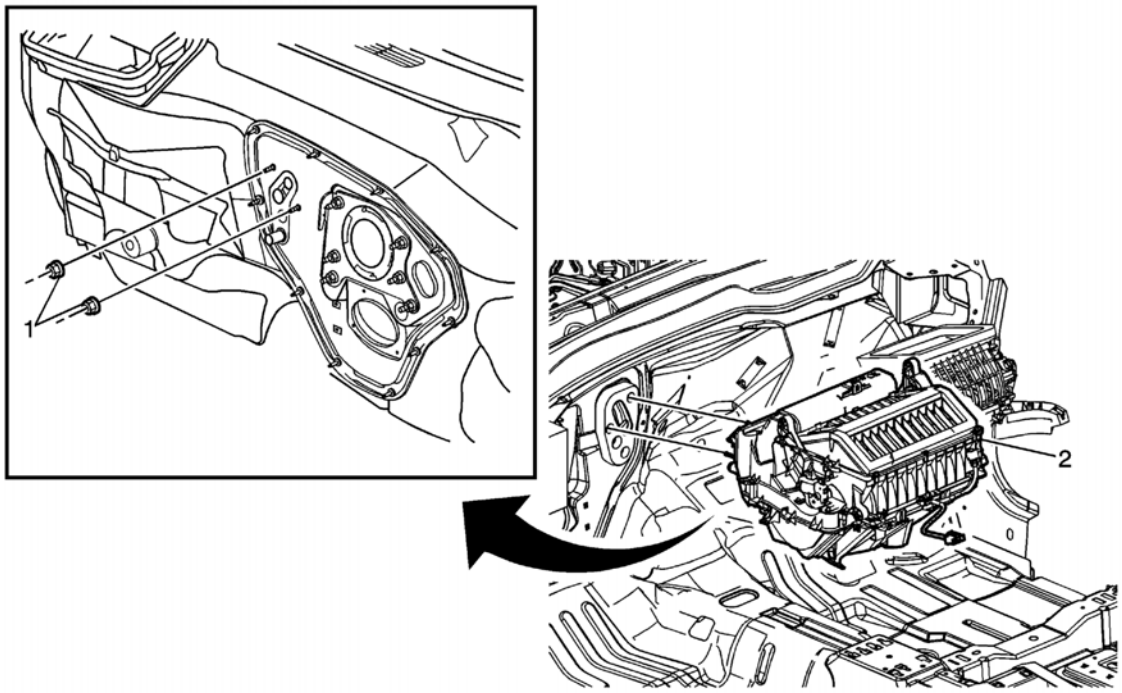


Fig. 48: HVAC Module Assembly
Courtesy of GENERAL MOTORS COMPANY

Call out	Component Name
WARNING: **Refer to** **Battery Disconnect Warning .** **CAUTION:** **Refer to** **HVAC Module Drain Tube Caution .** **Preliminary Procedure** 1. **Battery Negative Cable Disconnection and Connection** 2. **Refrigerant Recovery and Recharging** 3. **Cooling System Draining and Filling** 4. **Heater Inlet Hose Replacement** 5. **Heater Outlet Hose Replacement** 6. **Air Conditioning Evaporator Thermal Expansion Valve Tube Replacement** 7. Remove the evaporator drain tube from the evaporator case.	

Call out	Component Name
8. Instrument Panel Carrier Replacement	
1	Heater and Air Conditioning Module Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Heater and Air Conditioning Evaporator Module Assembly

AIR CONDITIONING EVAPORATOR CORE REPLACEMENT

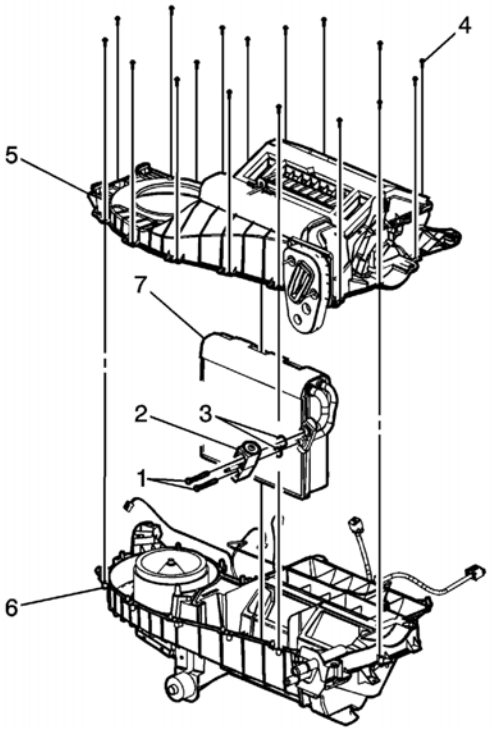


Fig. 49: Evaporator Core
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
1. Remove the HVAC module. Refer to **Air Conditioning and Heater Module Assembly Removal and Installation**. **NOTE:**	

Callout	Component Name
Leave the left temperature actuator attached to the air inlet assembly. 2. Remove the air inlet assembly. Refer to **Air Inlet Assembly Replacement**.	
1	Thermal Expansion Valve Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 7 N.m (62 lb in)
2	Thermal Expansion Valve
3	Sealing Washer **TIP:** Remove and discard sealing washers. Refer to **Air Conditioning System Seal Replacement**
4	Evaporator Case Assembly Screw (Qty: 17) **TIP:** Remove the heat stakes that secure the HVAC module assembly upper case to the HVAC module lower case using a small chisel. **Tighten** 1.5 N.m (13 lb in)
5	Evaporator - Upper Case
6	Evaporator - Lower Case
7	Air Conditioning Evaporator

HEATER INLET HOSE REPLACEMENT

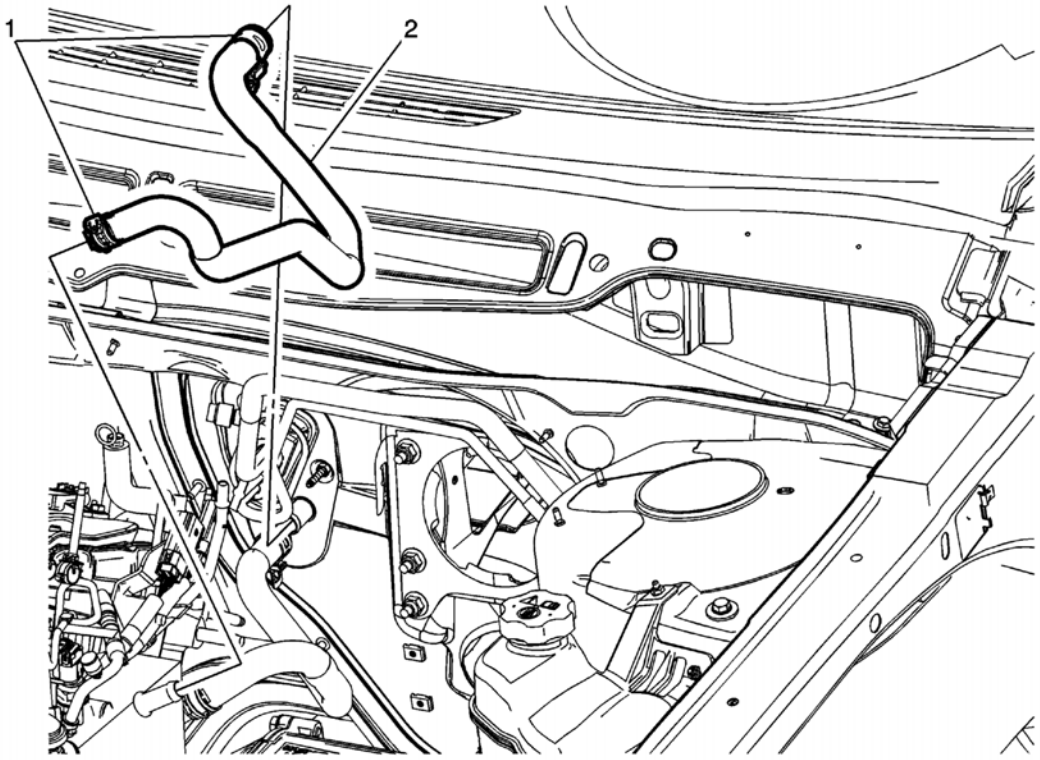


Fig. 50: Heater Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling** . 2. Remove the manifold cover replacement . Refer to **Intake Manifold Cover Replacement** . 3. Remove air cleaner assembly. Refer To **Air Cleaner Assembly Replacement** .	
1	Heater Inlet Hose Clamp (Qty: 2) **Procedure** Reposition the heater inlet hose clamp using **BO-38185** Hose Clamp Pliers. **Special Tools** **BO-38185** Hose Clamp Pliers For equivalent regional tools. Refer to **Special Tools**.
2	Heater Inlet Hose

HEATER OUTLET HOSE REPLACEMENT

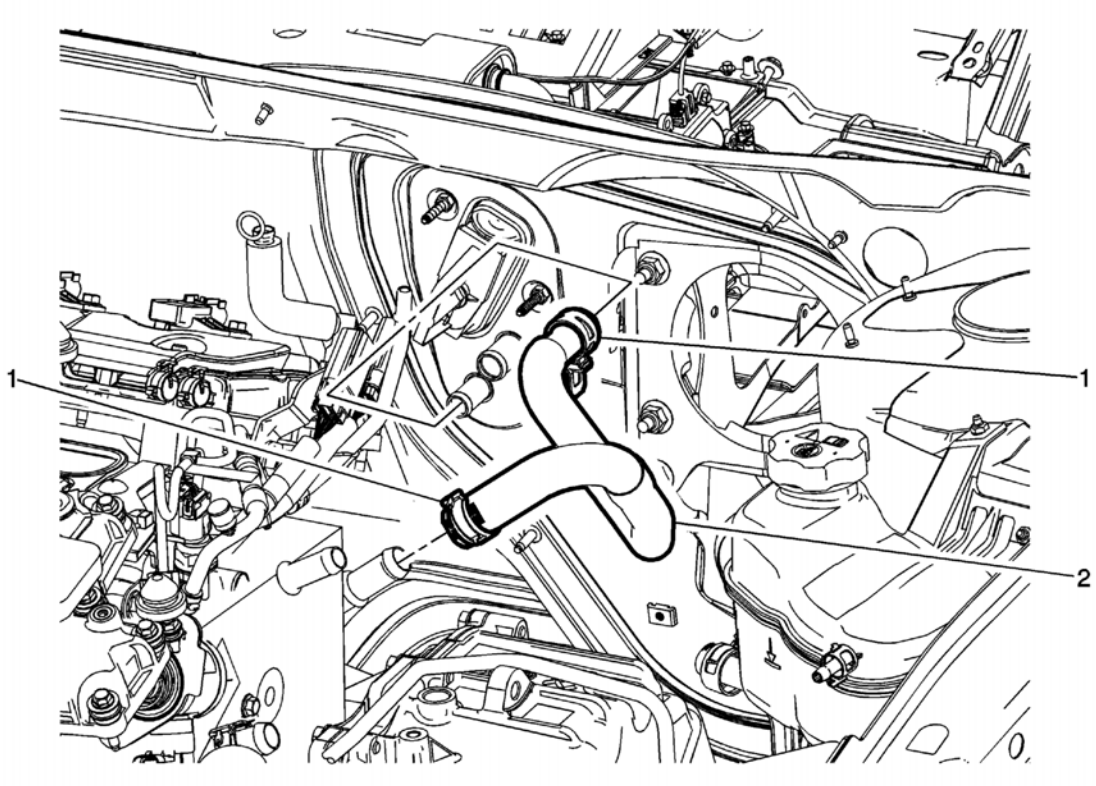


Fig. 51: Heater Outlet Hose
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Drain the cooling system. Refer to **Cooling System Draining and Filling** . 2. Remove the manifold cover. Refer to **Intake Manifold Cover Replacement** . 3. Remove air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .	
1	Heater Outlet Hose Clamp (Qty: 2) **Procedure** Reposition the heater inlet hose clamp using **BO-38185** Hose Clamp Pliers. **Special Tools** **BO-38185** Hose Clamp Pliers For equivalent regional tools. Refer to **Special Tools**.
2	Heater Outlet Hose

PASSENGER COMPARTMENT AIR FILTER REPLACEMENT

Removal Procedure

1. Reposition rear hood seal halfway to the center. Refer to **Hood Rear Seal Replacement** .
2. Remove the washer hose from the right air inlet grill panel and position aside.

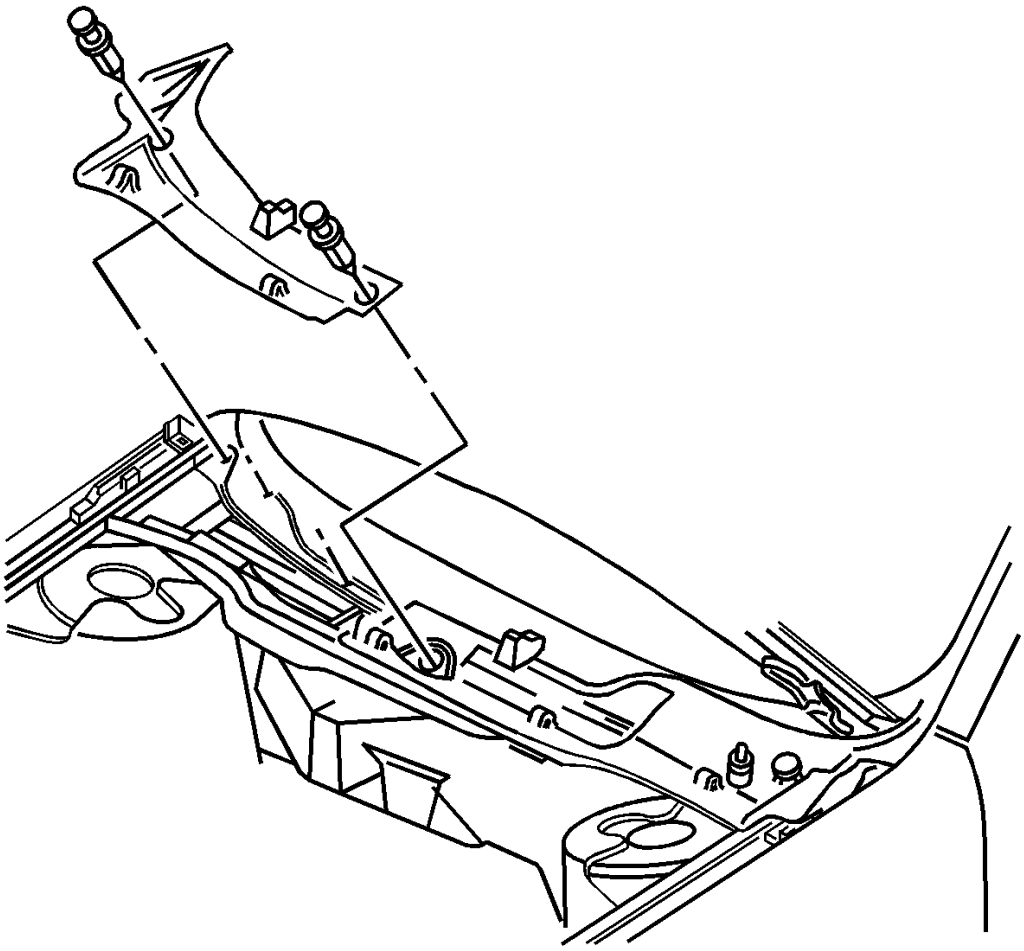


Fig. 52: Right Air Inlet Grill Panel Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Remove the 2 push pin retainers from the right air inlet grill panel.

IMPORTANT: Do not remove the third push pin retainer from the right air inlet grill panel.

4. Reposition the right air inlet grill panel on to the windshield.
5. Remove the water deflector cover.

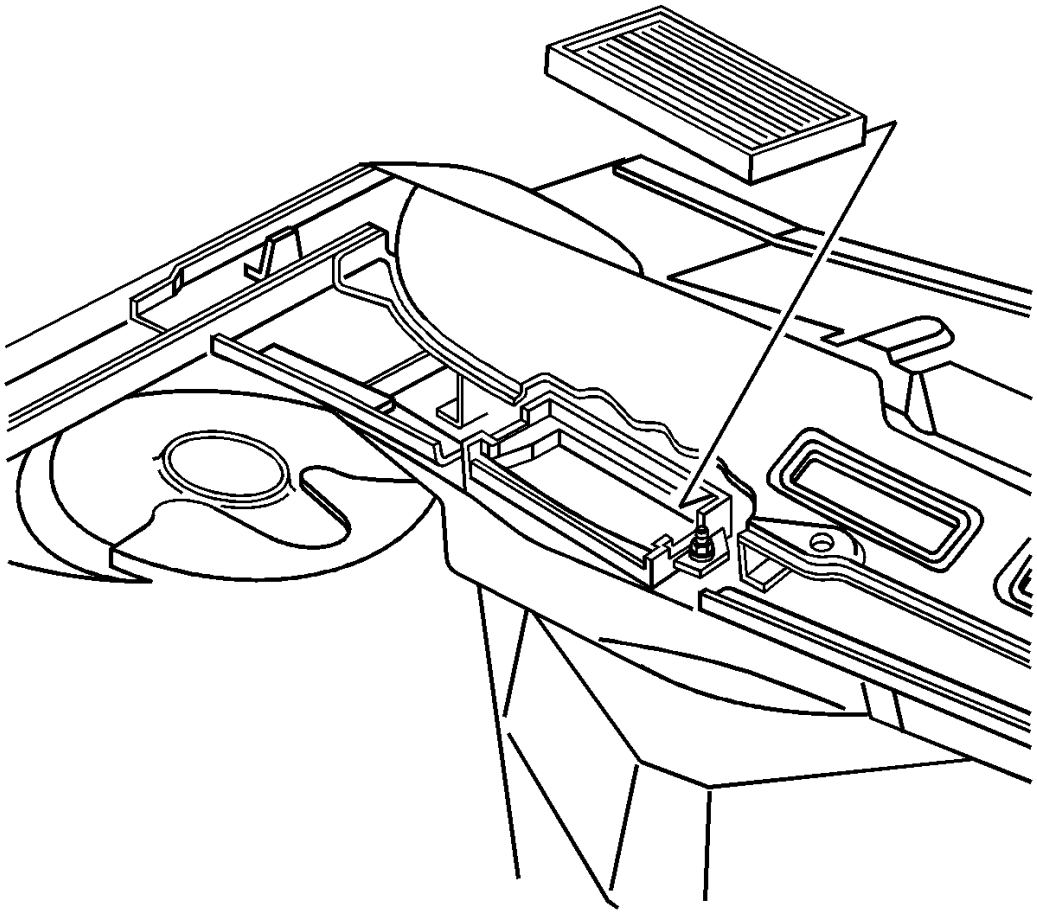


Fig. 53: View Of Passenger Compartment Air Filter
Courtesy of GENERAL MOTORS COMPANY

6. Remove the passenger compartment air filter.

Installation Procedure

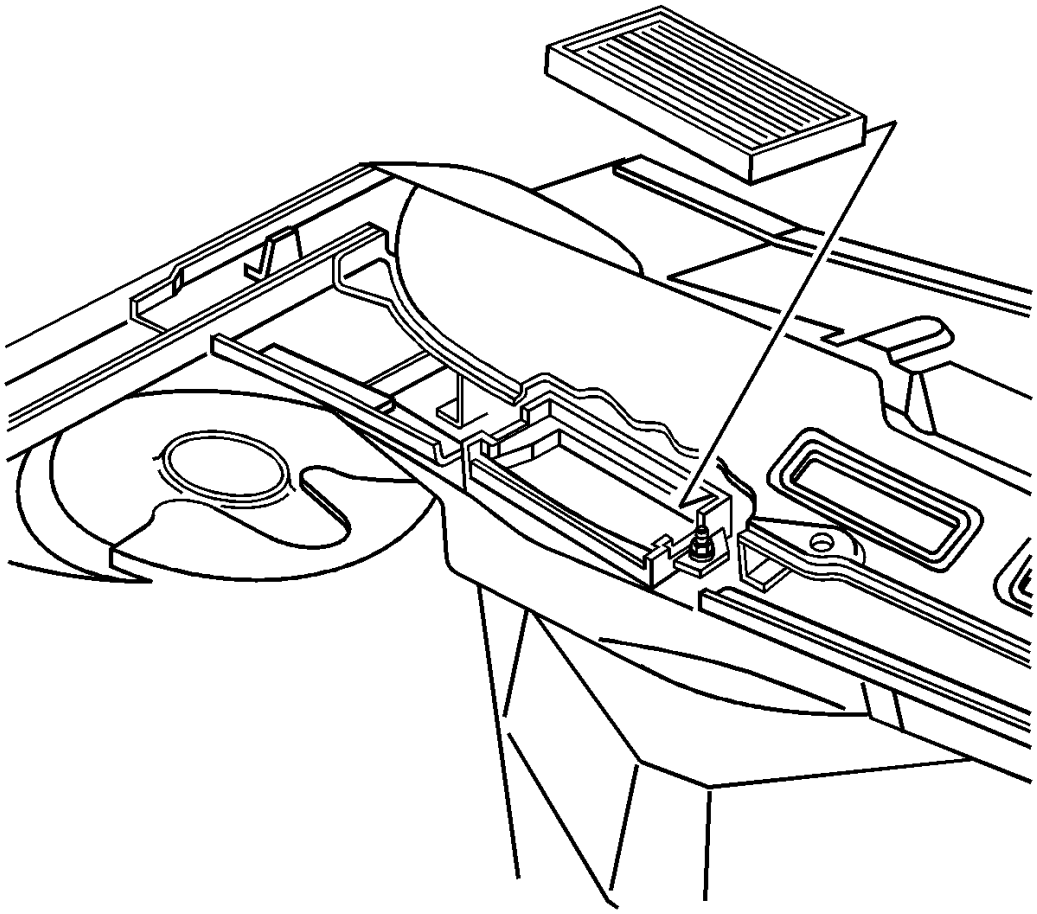


Fig. 54: View Of Passenger Compartment Air Filter
Courtesy of GENERAL MOTORS COMPANY

1. Install the passenger compartment air filter.
2. Install the water deflector cover. Ensure the three tabs of the water deflector engage the rear cowl edge.

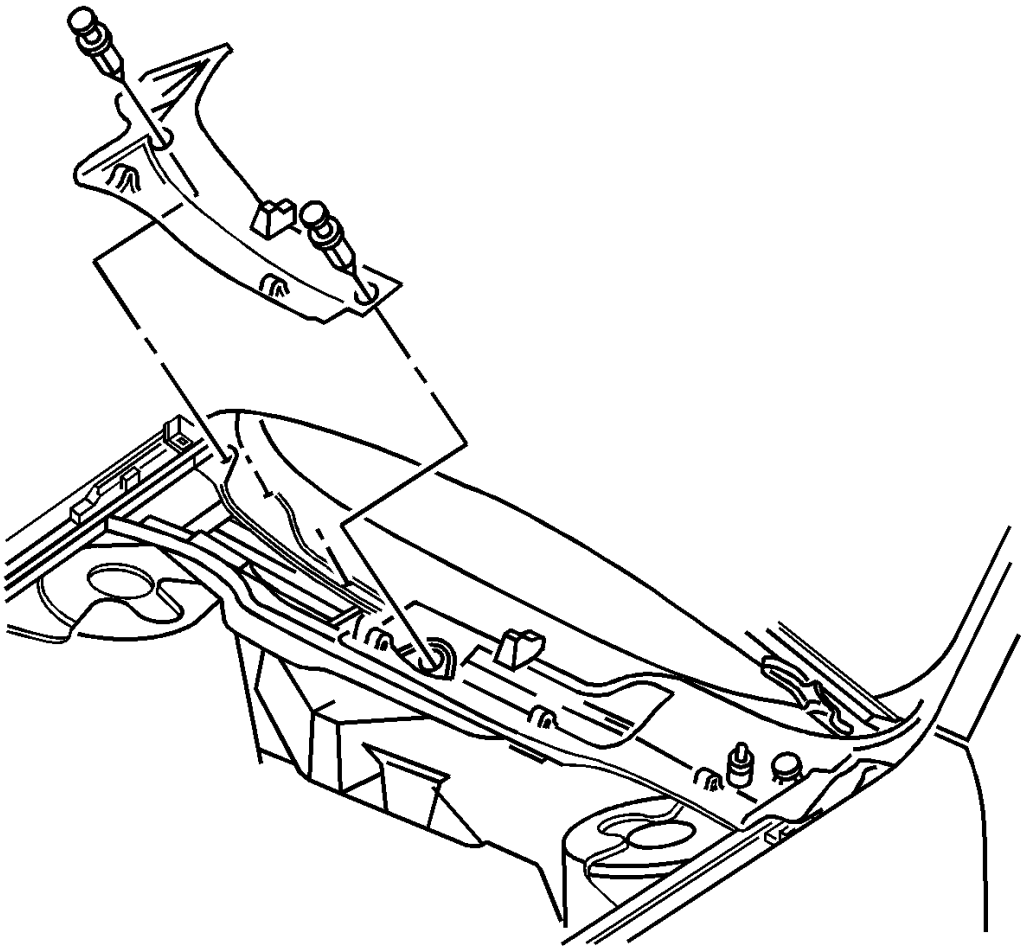


Fig. 55: Right Air Inlet Grill Panel Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Install the air inlet grill panel .
4. Install the air inlet grill panel push pin retainers .
5. Install the washer hose through the right air inlet grill panel clips.
6. Install the rear hood seal. Refer to **Hood Rear Seal Replacement** .

AIR INLET ASSEMBLY REPLACEMENT

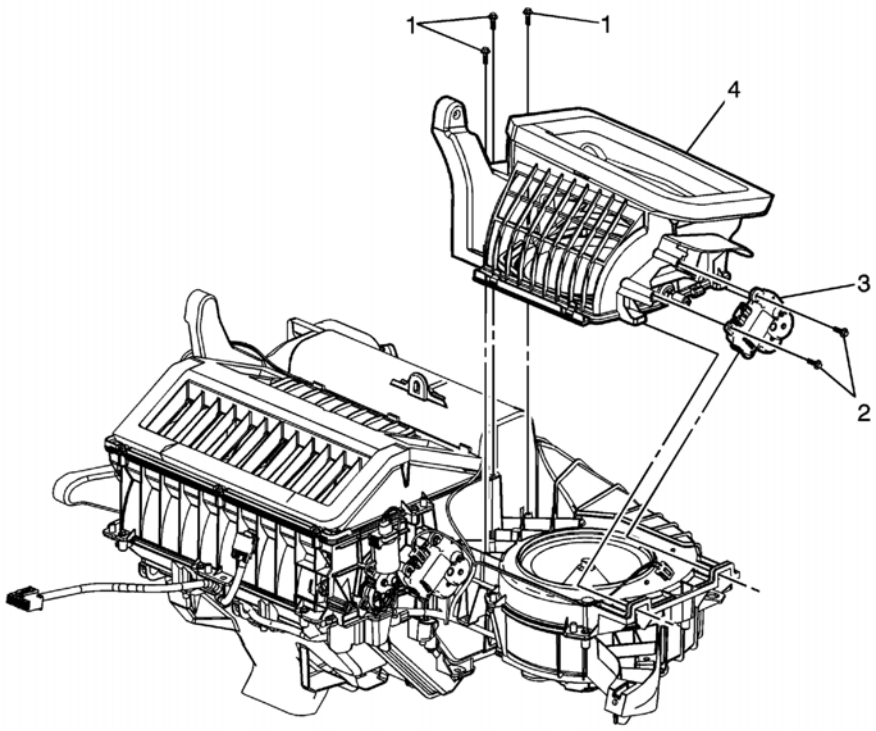


Fig. 56: Air Inlet Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the HVAC module. Refer to **Air Conditioning and Heater Module Assembly Removal and Installation**. 2. Disconnect the electrical connector from the recirculation actuator.	
1	Air Inlet Assembly Screw (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 1.5 N.m (13 lb in)
2	Recirculation Actuator Screw (Qty: 2) **Tighten** 1.5 N.m (13 lb in)
3	Recirculation Actuator
4	Air Inlet Housing Assembly

BLOWER MOTOR CONTROL MODULE REPLACEMENT

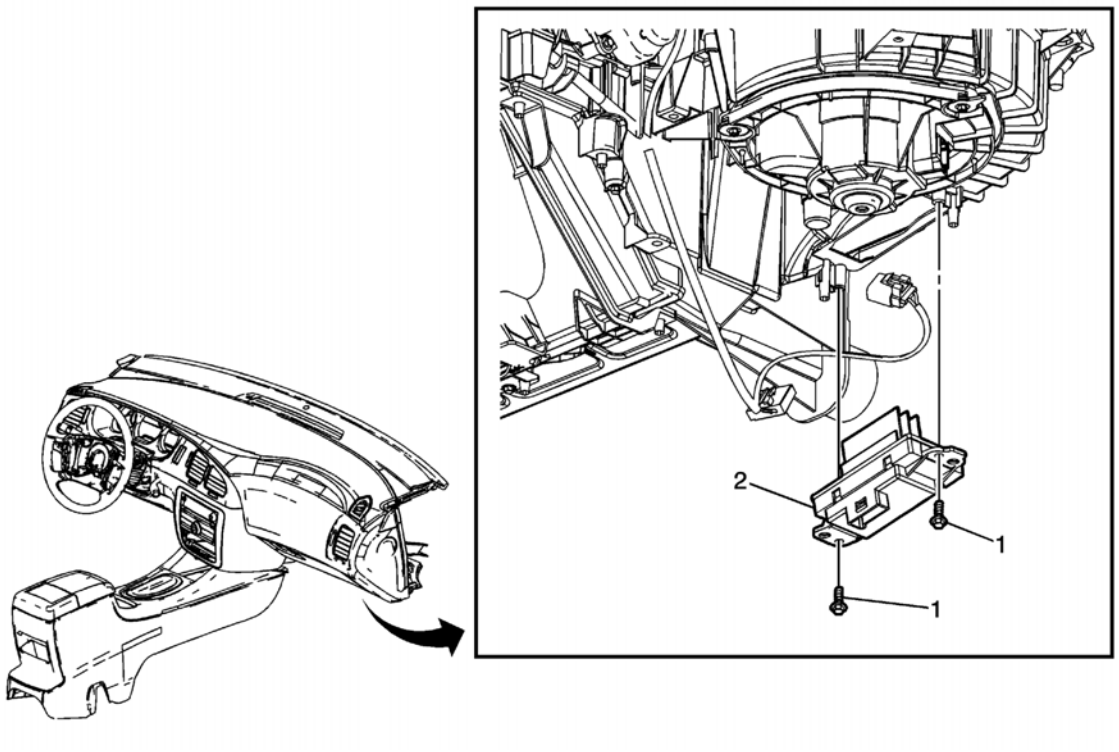


Fig. 57: Blower Control Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the right closeout insulator. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** . 2. Disconnect the blower motor resistor electrical connector.	
1	Blower Motor Resistor Screw (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **TIP:** Remove the heat stakes that secure the blower motor resistor to the HVAC module assembly using a small chisel. **Tighten** 1.5 N.m (13 lb in)
2	Blower Motor Resistor Refer to **Control Module References** for programming and setup information.

BLOWER MOTOR REPLACEMENT

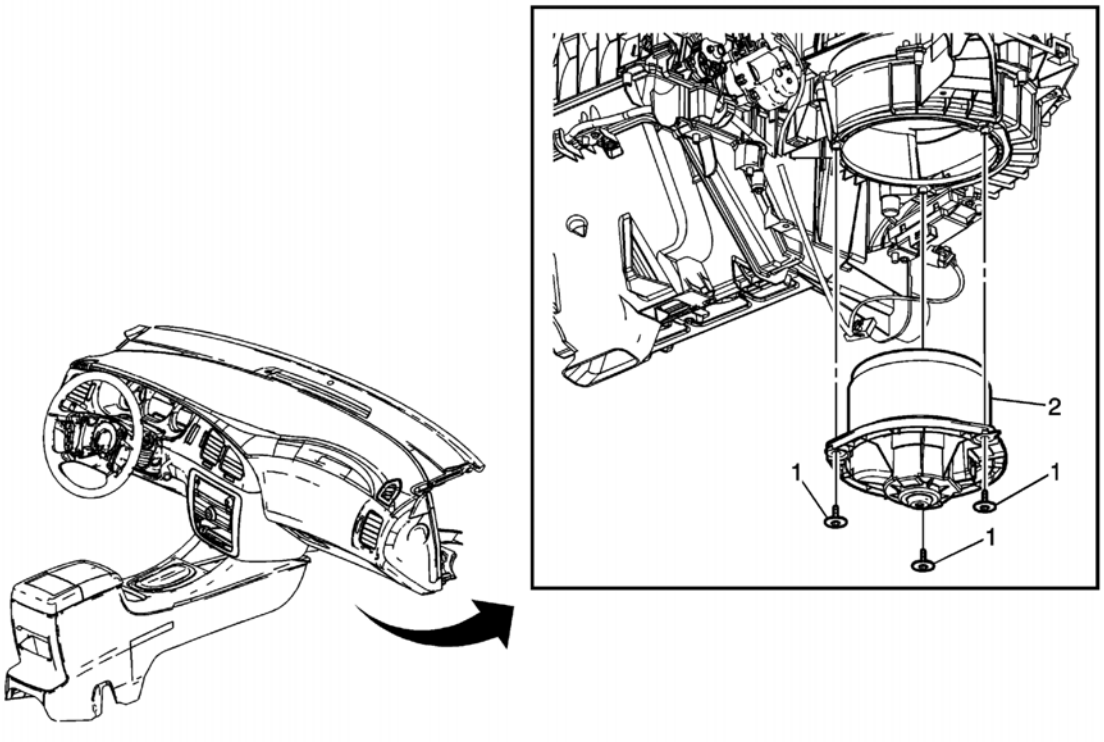


Fig. 58: Blower Motor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the right closeout insulator. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** . 2. Disconnect the blower motor electrical connector.	
1	Blower Motor Screw (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 1.5 N.m (13 lb in)
2	Blower Motor

AIR DISTRIBUTOR DUCT REPLACEMENT

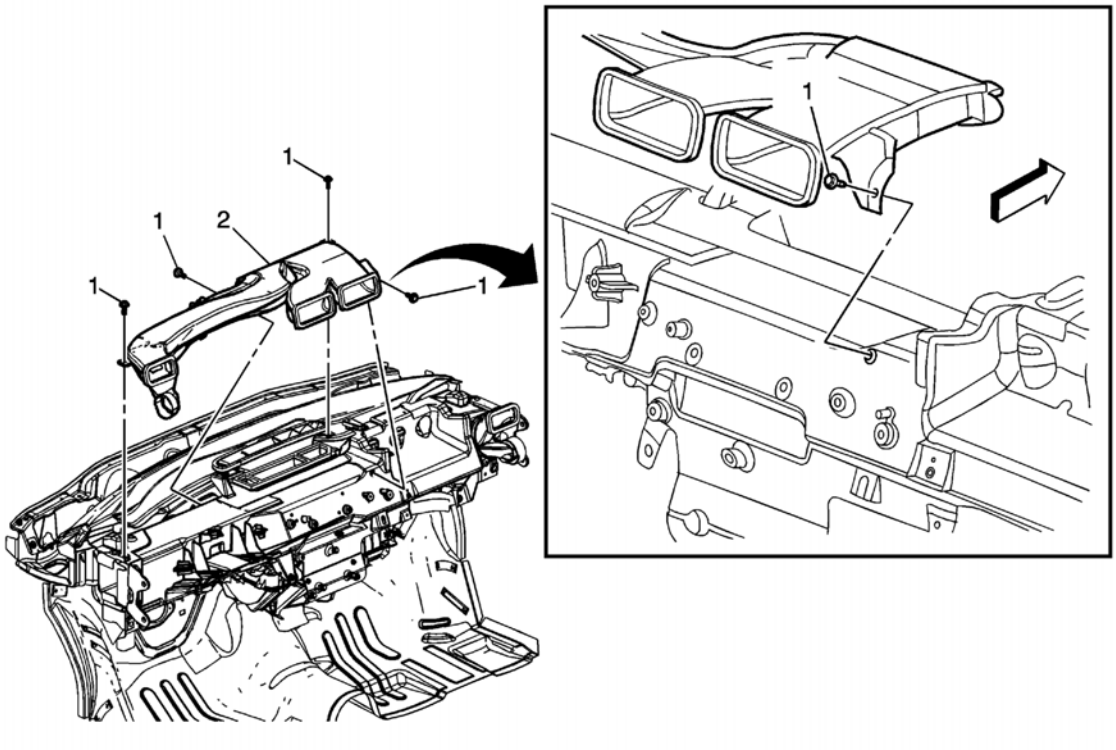


Fig. 59: Air Distributor Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the lower instrument panel trim pad. Refer to **Instrument Panel Lower Trim Panel Replacement** .	
1	Air Distributor Assembly Bolt **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 10 N.m (89 lb in)
2	Air Distributor Assembly

INSTRUMENT PANEL OUTER AIR OUTLET REPLACEMENT - RIGHT SIDE

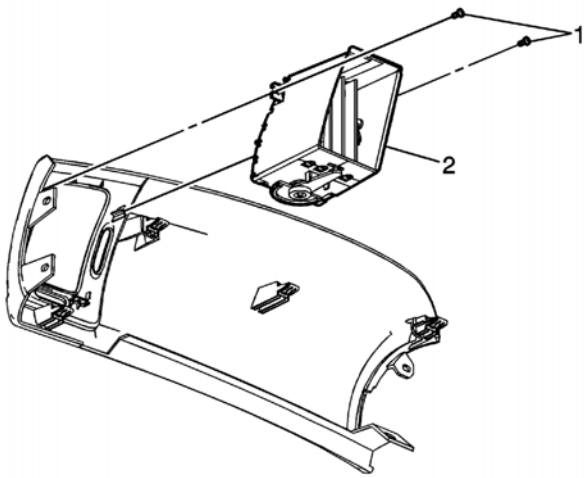


Fig. 60: Identifying Air Outlet - Instrument Panel - Right
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel trim plate. Refer to **Instrument Panel Trim Plate Replacement** .	
1	Instrument Panel Outer Air Outlet Deflector Screw (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 1.5 N.m (14 lb in)
2	Instrument Panel Outer Air Outlet Deflector - RH

INSTRUMENT PANEL OUTER AIR OUTLET UPPER DUCT REPLACEMENT - RIGHT SIDE

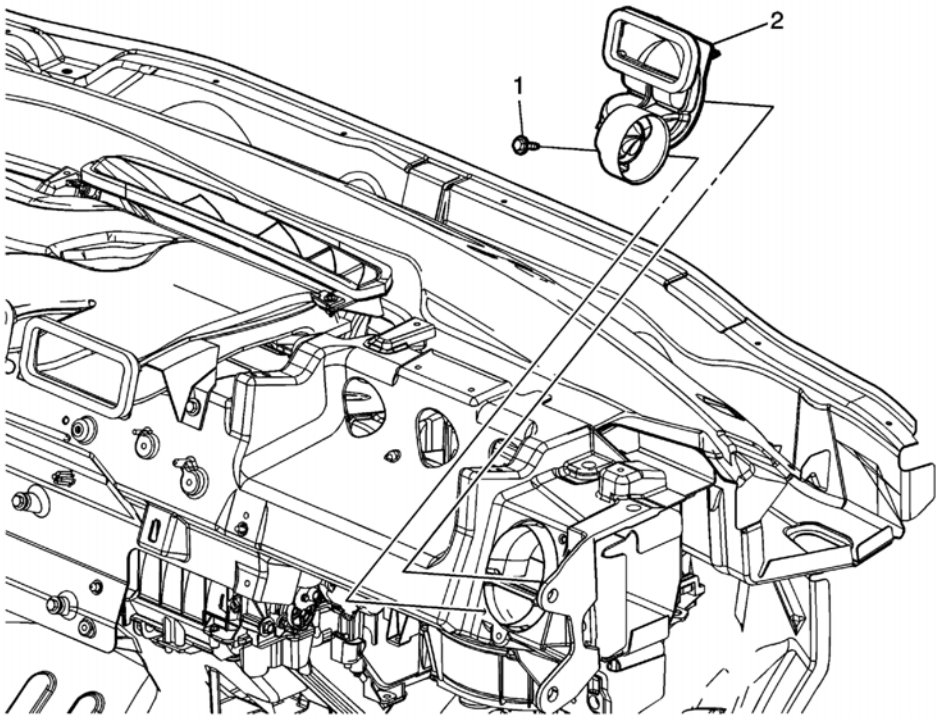


Fig. 61: Upper Right Air Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the lower instrument panel trim pad. Refer to **Instrument Panel Lower Trim Panel Replacement** .	
1	Air Distributor Right Hand Extension Duct Assembly Bolt **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 16 N.m (12 lb ft)
2	Air Distributor Right Hand Extension Duct Assembly

REAR FLOOR AIR OUTLET REPLACEMENT

Removal Procedure

1. Remove the floor carpet. Refer to **Floor Panel Carpet Replacement (Impala)** .

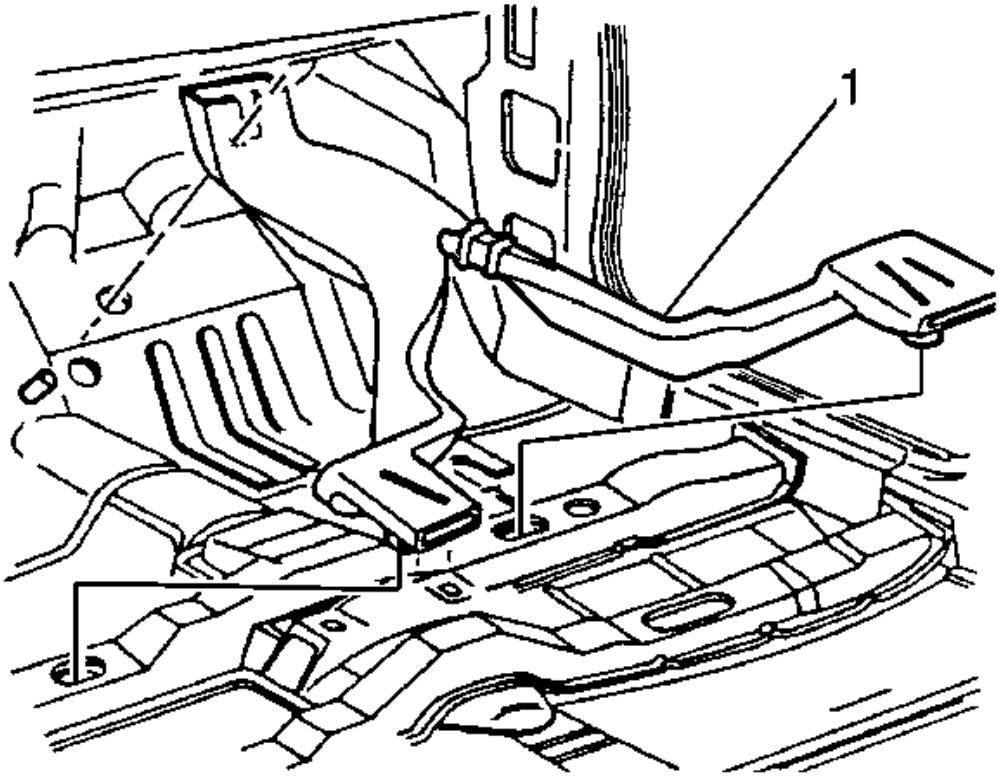


Fig. 62: Locating Rear Floor Air Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

2. Remove the rear floor air outlet duct (1) from the holes in the floor reinforcement.
3. Disconnect the rear floor air outlet duct from the heater outlet cover.
4. Remove the rear floor air outlet duct.

Installation Procedure

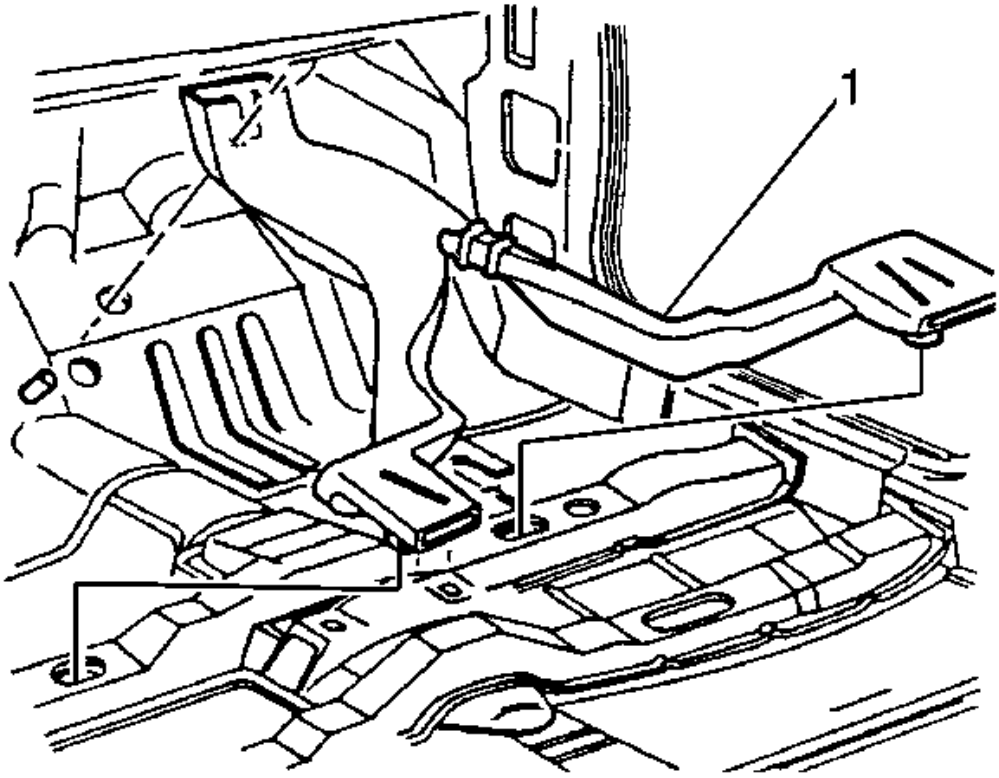


Fig. 63: Locating Rear Floor Air Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

1. Install the rear floor air outlet duct.
2. Connect the rear floor air outlet duct to the heater outlet cover.
3. Position the rear floor air outlet duct (1) into the holes in the floor reinforcement.
4. Install the floor carpet. Refer to **Floor Panel Carpet Replacement (Impala)** .

DEFROSTER AIR OUTLET DUCT REPLACEMENT

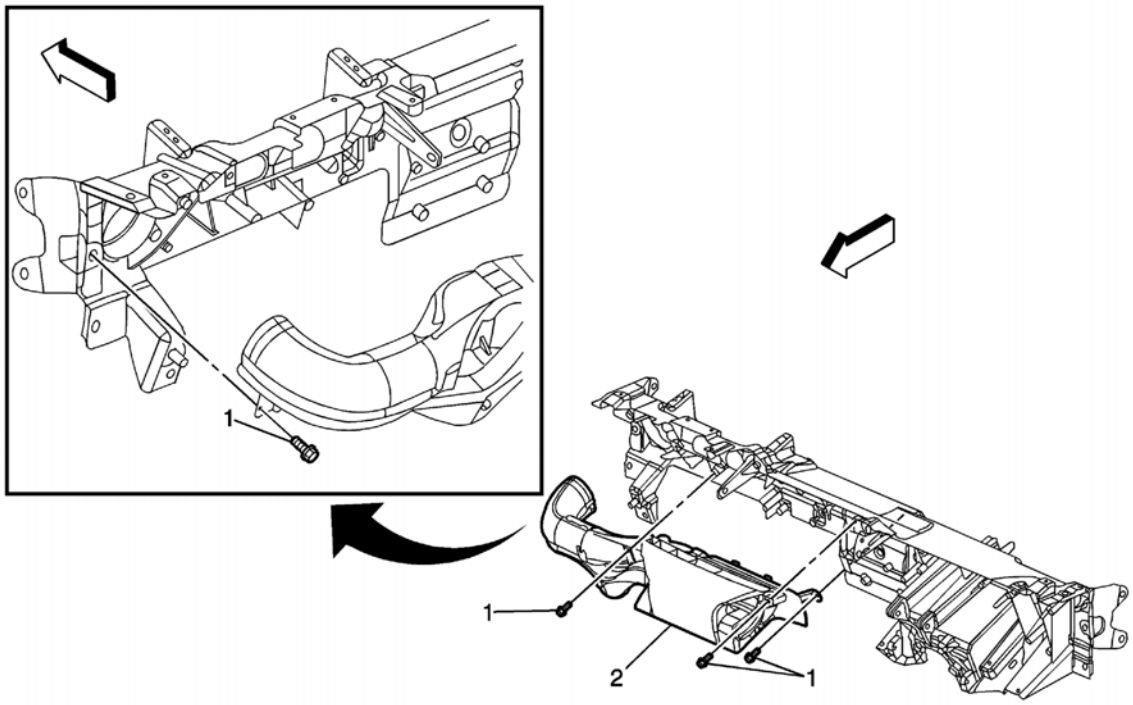


Fig. 64: Defroster Air Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the instrument panel carrier. Refer to **Instrument Panel Carrier Replacement** .	
1	Air Distributor Assembly - Windshield Defroster Nozzle Bolt (Qty: 4) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 10 N.m (89 lb in).
2	Distributor Assembly - Windshield Defroster Nozzle and Air

AIR TEMPERATURE DOOR REPLACEMENT

Removal Procedure

1. Remove the HVAC module assembly. Refer to **Air Conditioning and Heater Module Assembly Removal and Installation**.
2. Remove the screws that secure the recirculation housing to the HVAC module assembly.

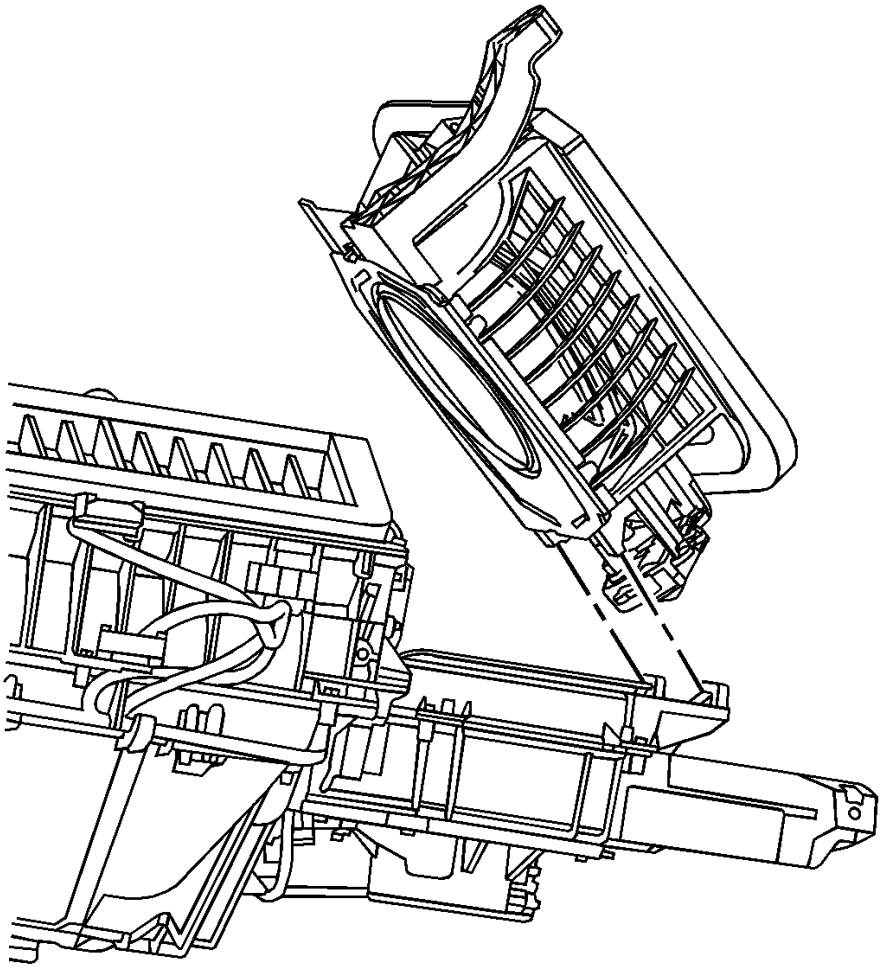


Fig. 65: Identifying Recirculation Housing
Courtesy of GENERAL MOTORS COMPANY

3. Remove the recirculation housing from the HVAC module assembly.
4. Remove the screws that secure the mode actuator to the HVAC module assembly.
5. Remove the mode actuator from the HVAC module assembly.
6. Remove the screws that secure HVAC module assembly upper case to the HVAC module assembly lower case.
7. Remove the heat stakes that secure the HVAC module assembly upper case to the HVAC module lower case using a small chisel.

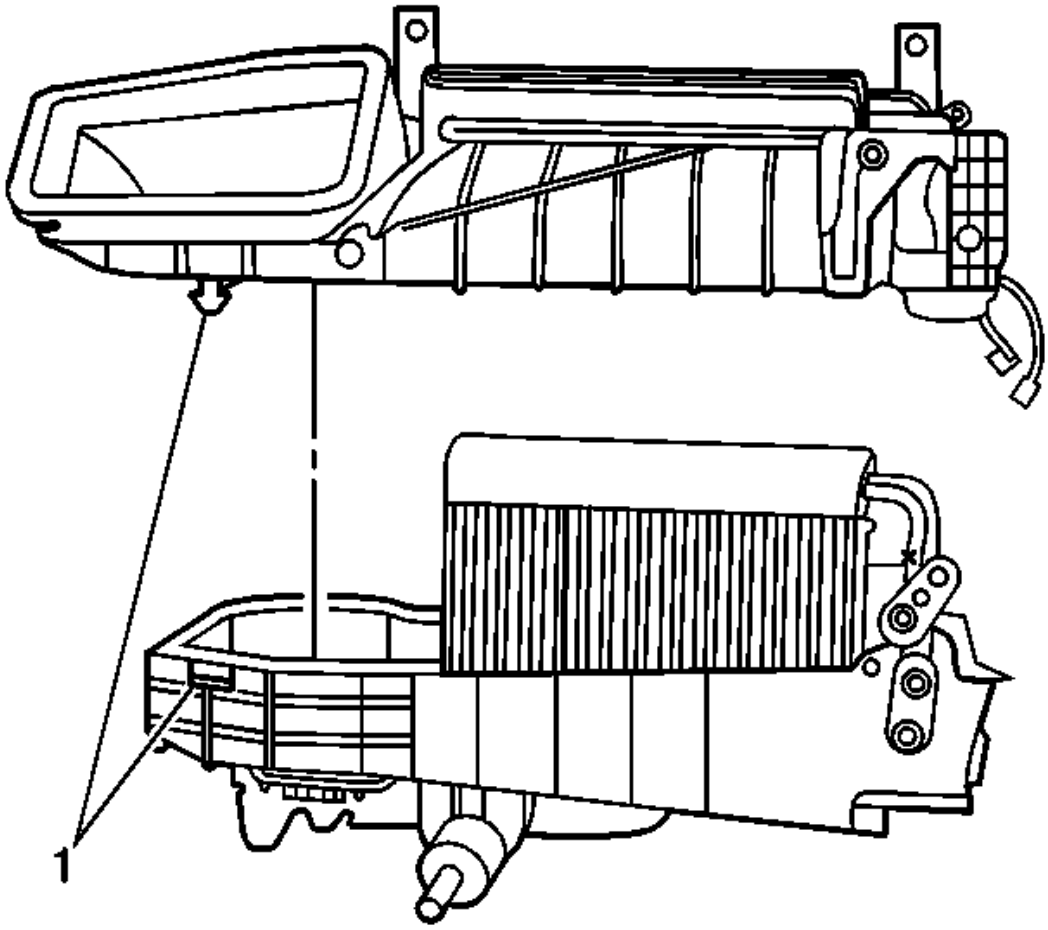


Fig. 66: View Of Upper & Lower HVAC Module Assembly Case
Courtesy of GENERAL MOTORS COMPANY

8. Separate the HVAC module assembly case (1).
9. Remove the screws that secure the air temperature actuator to the HVAC module assembly upper case.
10. Remove the air temperature actuator from the HVAC module assembly upper case.

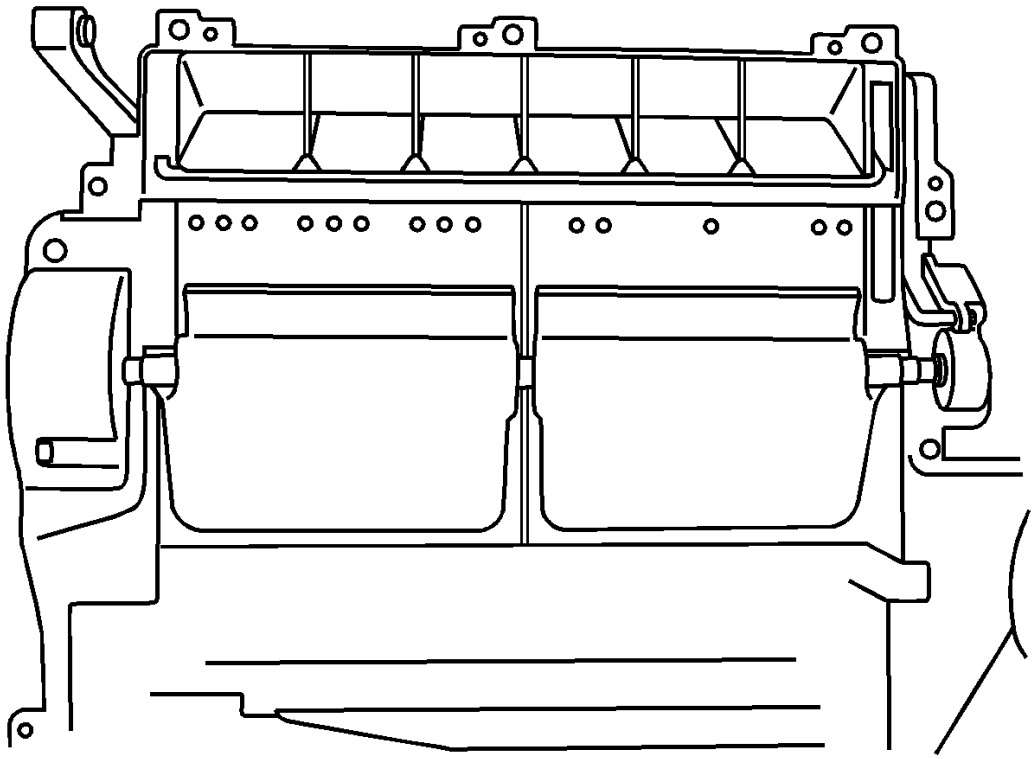


Fig. 67: Air Temperature Door - Right
Courtesy of GENERAL MOTORS COMPANY

11. Remove the air temperature door from the HVAC module assembly upper case.

Installation Procedure

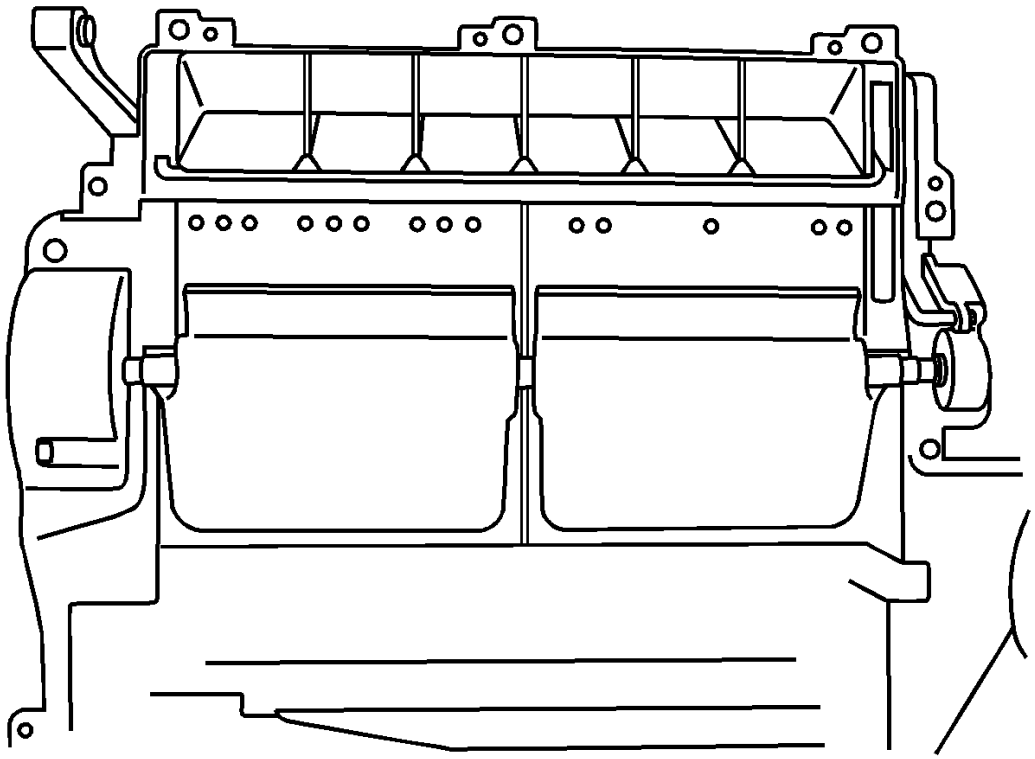


Fig. 68: Air Temperature Door - Right
Courtesy of GENERAL MOTORS COMPANY

1. Install the air temperature door to the HVAC module assembly upper case.
2. Install the air temperature actuator to the HVAC module assembly upper case.

CAUTION: Refer to Fastener Caution .

3. Install the screws that secure the air temperature actuator to the HVAC module assembly upper case.

Tighten

Tighten the screws to 1.5 N.m (13 lb in).

4. From the inside of the upper case, drill the dimples adjacent to the heat stakes using a 5.5 mm (7/32 in) drill bit.

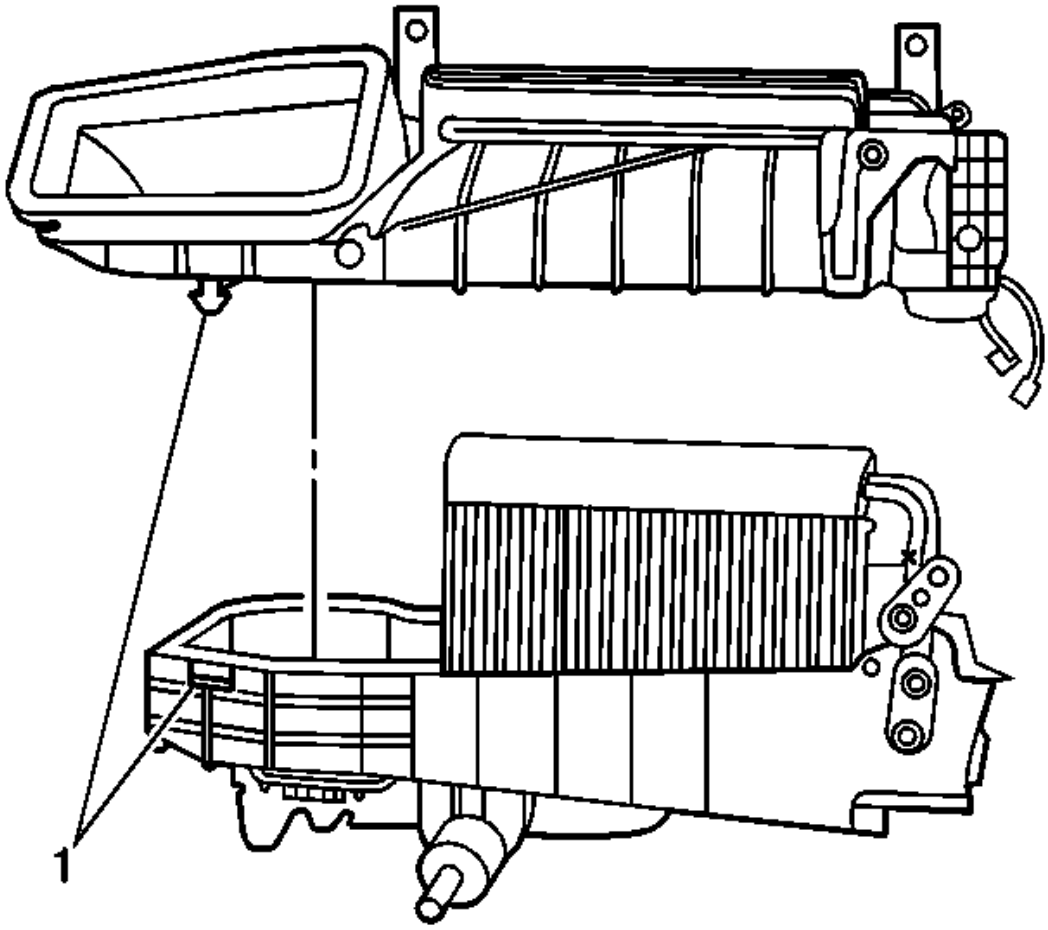


Fig. 69: View Of Upper & Lower HVAC Module Assembly Case
Courtesy of GENERAL MOTORS COMPANY

5. Align and attach the upper and lower HVAC module assembly case.
6. Install the removed screws that secure the HVAC module assembly upper case to the HVAC module assembly lower case to their original position.

   Tighten

   Tighten the screws to 1.5 N.m (13 lb in).

7. Install new screws that will secure the HVAC module assembly upper case to the HVAC module assembly lower case in the locations adjacent to the heat stakes.

   Tighten

   Tighten the screws to 1.5 N.m (13 lb in).

8. Install the mode actuator.
9. Install the screws that secure the mode actuator to the HVAC module assembly.

Tighten

Tighten the screws to 1.5 N.m (13 lb in).

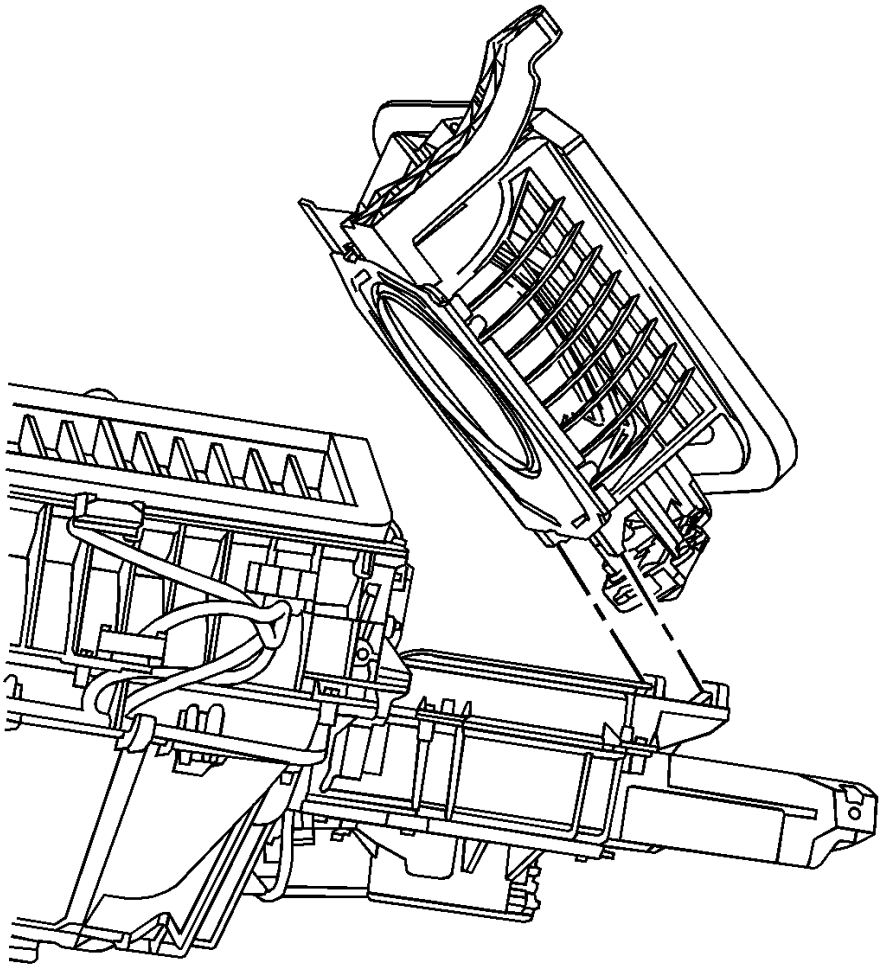


Fig. 70: Identifying Recirculation Housing
Courtesy of GENERAL MOTORS COMPANY

10. Install the recirculation housing to the HVAC module assembly.
11. Install the screws that secure the recirculation housing to the HVAC module assembly.

Tighten

Tighten the screws to 1.5 N.m (13 lb in).

12. Install the HVAC module assembly. Refer to **Air Conditioning and Heater Module Assembly Removal and Installation**.

MODE VALVE ASSEMBLY REPLACEMENT

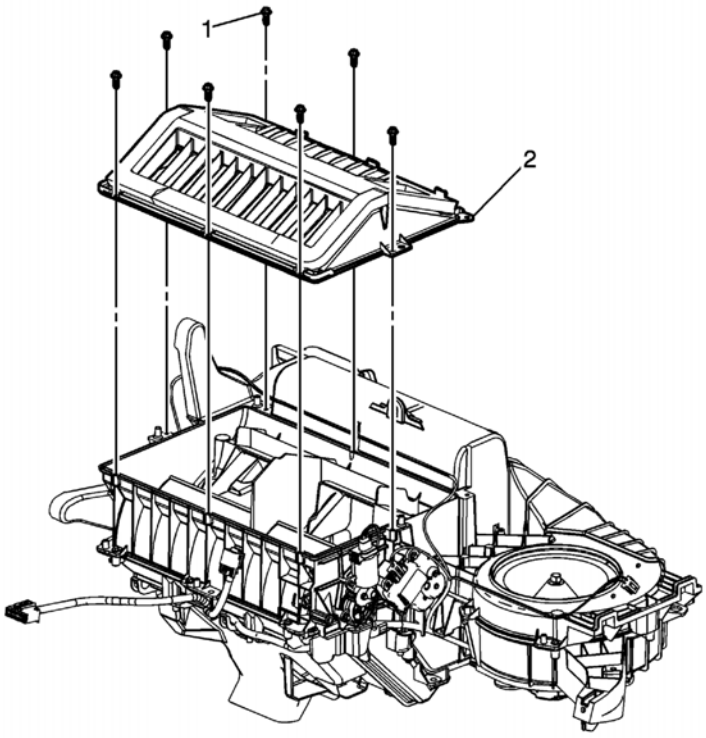


Fig. 71: Mode Valve Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the HVAC module. Refer to **Air Conditioning and Heater Module Assembly Removal and Installation**. **NOTE:** **Leave the left temperature actuator attached to the air inlet assembly.** 2. Remove the air inlet assembly. Refer to **Air Inlet Assembly Replacement**.	
1	Mode Valve Assembly Screw (Qty: 7) **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	TIP: Remove the heat stakes that secure the mode valve assembly to the HVAC module assembly upper case using a small chisel. **Tighten** 1.5 N.m (13 lb in)
2	Mode Valve Assembly

HEATER CORE COVER REPLACEMENT

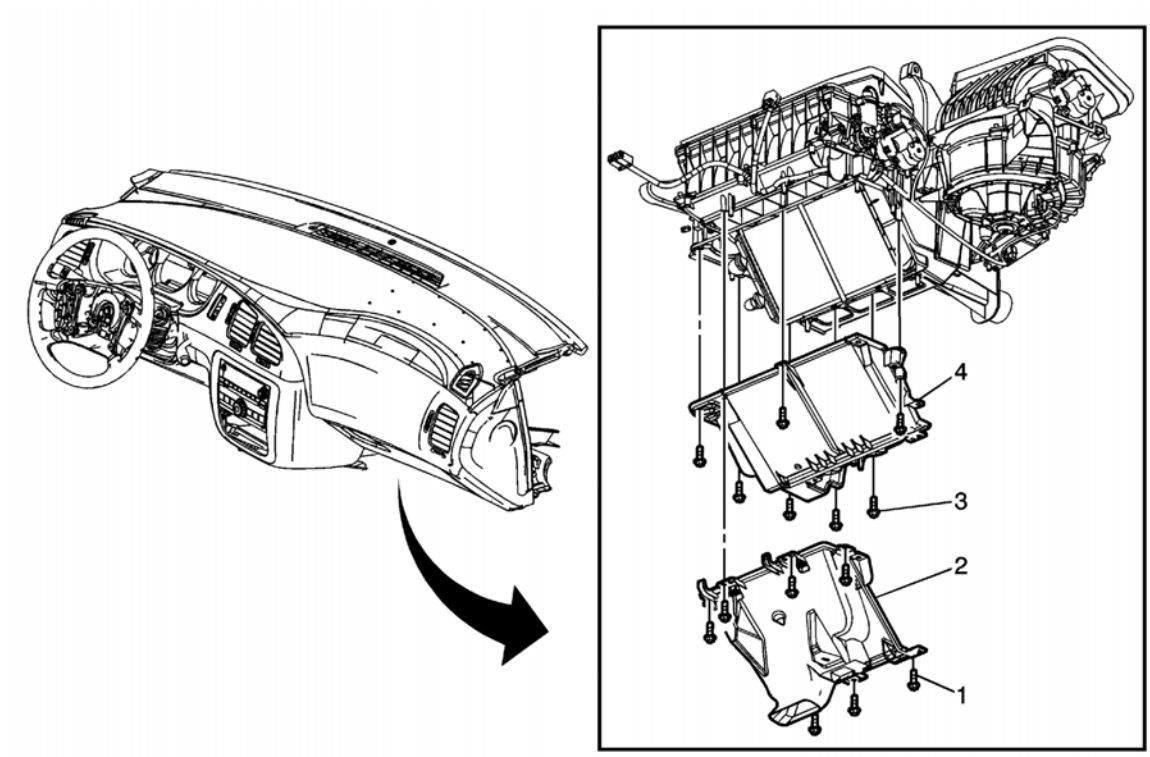


Fig. 72: Heater Core Cover
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the right closeout panel. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** . 2. Remove the left closeout panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** . 3. Remove the rear floor air outlet duct. Refer to **Rear Floor Air Outlet Replacement**.	
1	Floor Air Outlet Cover Screw (Qty: 7) **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	TIP: Remove the heat stakes that secure the HVAC module assembly upper case to the HVAC module lower case using a small chisel. **Tighten** 1.5 N.m (13 lb in)
2	Floor Air Outlet Cover
3	Heater Core Cover Screw (Qty: 7) **TIP:** Remove the heat stakes that secure the HVAC module assembly upper case to the HVAC module lower case using a small chisel. **Tighten** 1.5 N.m (13 lb in)
4	Heater Core Cover

HEATER CORE REPLACEMENT

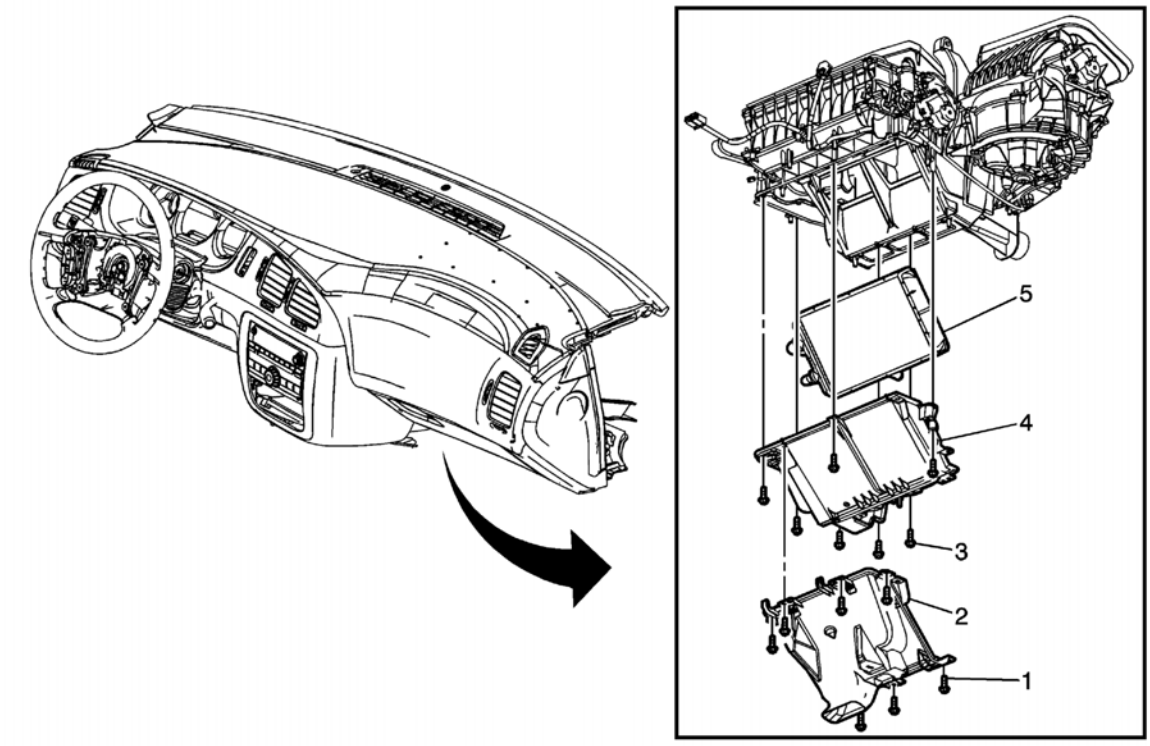


Fig. 73: Heater Core
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the right closeout panel. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** . 2. Remove the left closeout panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** . 3. Remove the rear floor air outlet duct. Refer to **Rear Floor Air Outlet Replacement**.	

Callout	Component Name
1	Floor Air Outlet Cover Screws (Qty: 7) **CAUTION:** **Refer to** **Fastener Caution .** **TIP:** Remove the heat stakes that secure the HVAC module assembly upper case to the HVAC module lower case using a small chisel. **Tighten** 1.5 N.m (13 lb in)
2	Floor Air Outlet Cover
3	Heater Core Cover Screws (Qty: 7) **TIP:** Remove the heat stakes that secure the HVAC module assembly upper case to the HVAC module lower case using a small chisel. **Tighten** 1.5 N.m (13 lb in)
4	Heater Core Cover
5	Heater Core

DESCRIPTION AND OPERATION

HEATING AND AIR CONDITIONING SYSTEM DESCRIPTION AND OPERATION

Engine Coolant

Engine coolant is the key element of the heating system. The engine thermostat controls the normal engine operating coolant temperature. The thermostat also creates a restriction for the cooling system that promotes a positive coolant flow and helps prevent cavitation. Coolant enters the heater core through the inlet heater hose, in a pressurized state. The heater core is located inside the HVAC module. The ambient air drawn through the HVAC module absorbs the heat of the coolant flowing through the heater core. The HVAC module distributes heated air to the passenger compartment for consistent passenger comfort. Opening or closing the HVAC module temperature door controls the amount of heat delivered to the passenger compartment. The coolant exits the heater core through the return heater hose and is recirculated back through the engine cooling system.

A/C Cycle

Refrigerant is the key element in an air conditioning system. R-134a is presently the only EPA approved refrigerant for automotive use. R-134a is an very low temperature gas that can transfer the undesirable heat and moisture from the passenger compartment to the outside air.

The A/C compressor is belt driven and operates when the magnetic clutch is engaged. The compressor builds pressure on the vapor refrigerant. Compressing the refrigerant also adds heat to the refrigerant. The refrigerant is discharged from the compressor, through the discharge hose, and forced to flow to the condenser and then through the balance of the A/C system. The A/C system is mechanically protected with the use of a high pressure relief valve. If the high pressure switch were to fail or if the refrigerant system becomes restricted and refrigerant pressure continued to rise, the high pressure relief will pop open and release refrigerant from the system.

Compressed refrigerant enters the condenser in a high temperature, high pressure vapor state. As the refrigerant flows through the condenser, the heat of the refrigerant is transferred to the ambient air passing through the condenser. Cooling the refrigerant causes the refrigerant to condense and change from a vapor to a liquid state.

The condenser is located in front of the radiator for maximum heat transfer. The condenser is made of aluminum and aluminum cooling fins, which allows rapid heat transfer for the refrigerant. The semi-cooled liquid refrigerant exits the condenser and flows through the liquid line, to the thermal expansion valve.

The thermal expansion valve is located in the liquid line between the condenser and the evaporator. The thermal expansion valve is the dividing point for the high and the low pressure sides of the A/C system. As the refrigerant passes through the thermal expansion valve, the pressure of the refrigerant is lowered. Due to the pressure differential of the liquid refrigerant, the refrigerant will begin to vaporize at the thermal expansion valve. The thermal expansion valve also meters the amount of liquid refrigerant that can flow into the evaporator.

Refrigerant exiting the thermal expansion valve flows into the evaporator core in a low pressure, liquid state. Ambient air is drawn through the HVAC module and passes through the evaporator core. Warm and moist air will cause the liquid refrigerant boil inside of the evaporator core. The boiling refrigerant absorbs heat from the ambient air and draws moisture onto the evaporator. The refrigerant exits the evaporator back through the thermal expansion valve and into the suction line and back to the compressor, in a vapor state completing the A/C cycle of heat removal. At the compressor, the refrigerant is compressed again and the cycle of heat removal is repeated.

The conditioned air is distributed through the HVAC module for passenger comfort. The heat and moisture removed from the passenger compartment will also change form, or condense, and is discharged from the HVAC module as water under the vehicle.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

Illustration	Tool Number/ Description
	BO-38185 J-38185 Hose Clamp Pliers

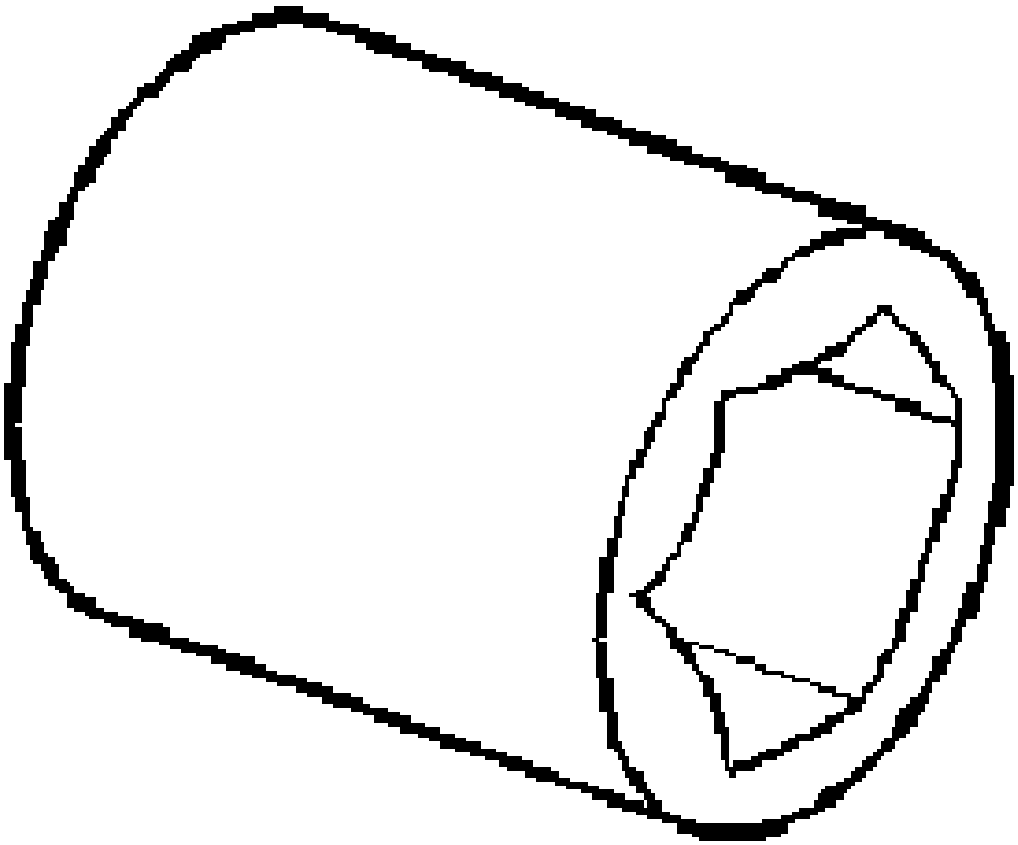
Illustration	Tool Number/ Description
	GE-39037 J-39037 Charge Valve Octagon Socket

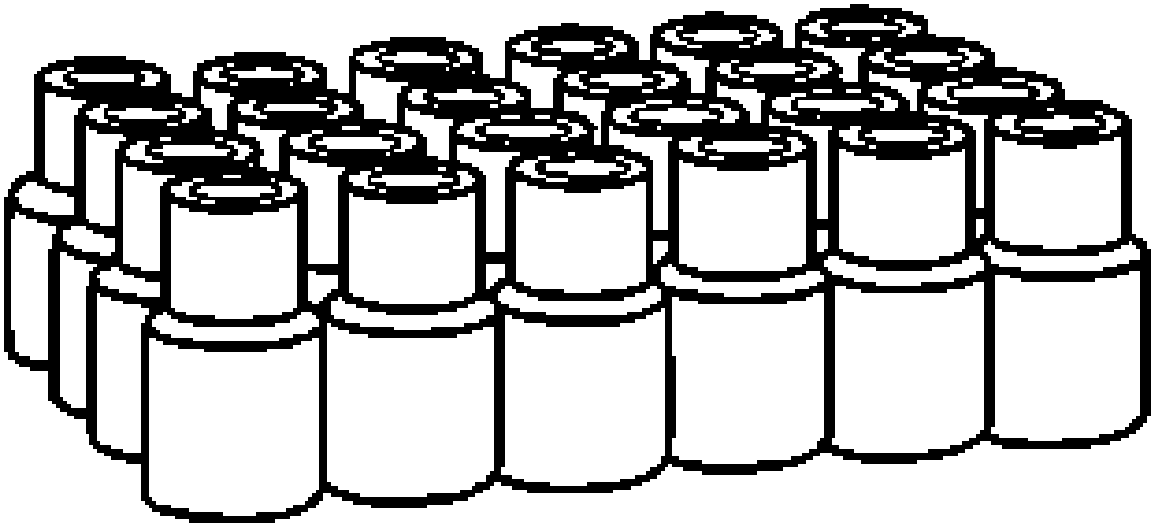
Illustration	Tool Number/ Description
	GE-41447 J-41447 R-134A A/C Tracer Dye-Box of 24

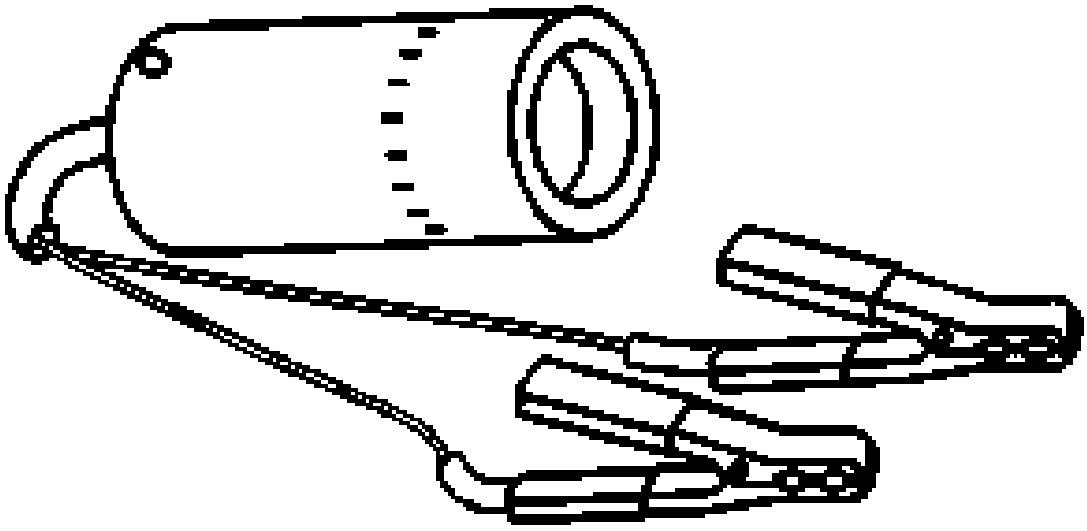
Illustration	Tool Number/ Description
	GE-42220 J-42220 Universal 12V Leak Detection Lamp

Illustration	Tool Number/ Description
	GE-43872 J-43872 Fluorescent Dye Cleaner

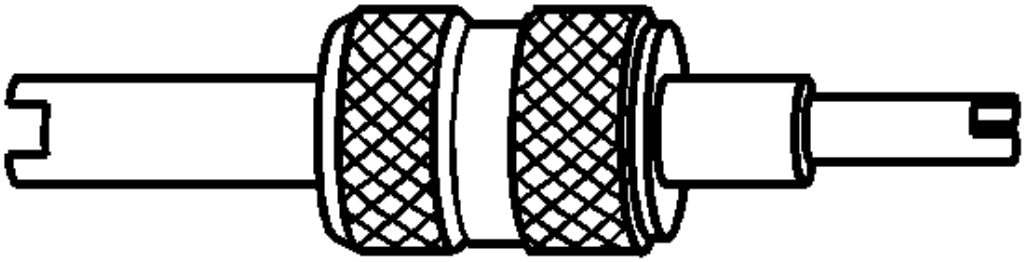
Illustration	Tool Number/ Description
	GE-46246 Valve Core Tool

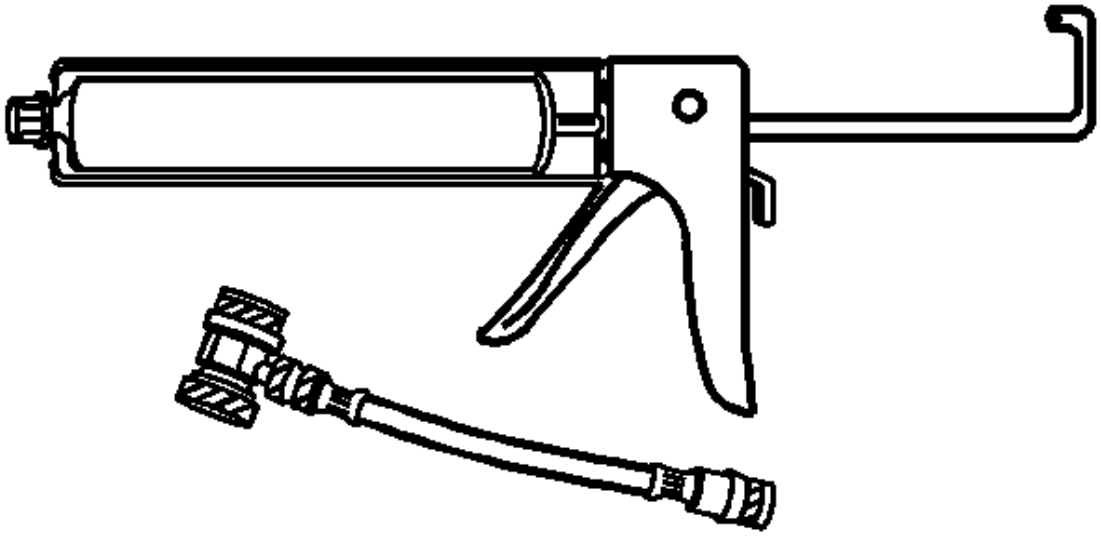
Illustration	Tool Number/ Description
	GE-46297 A/C Dye Injector Kit

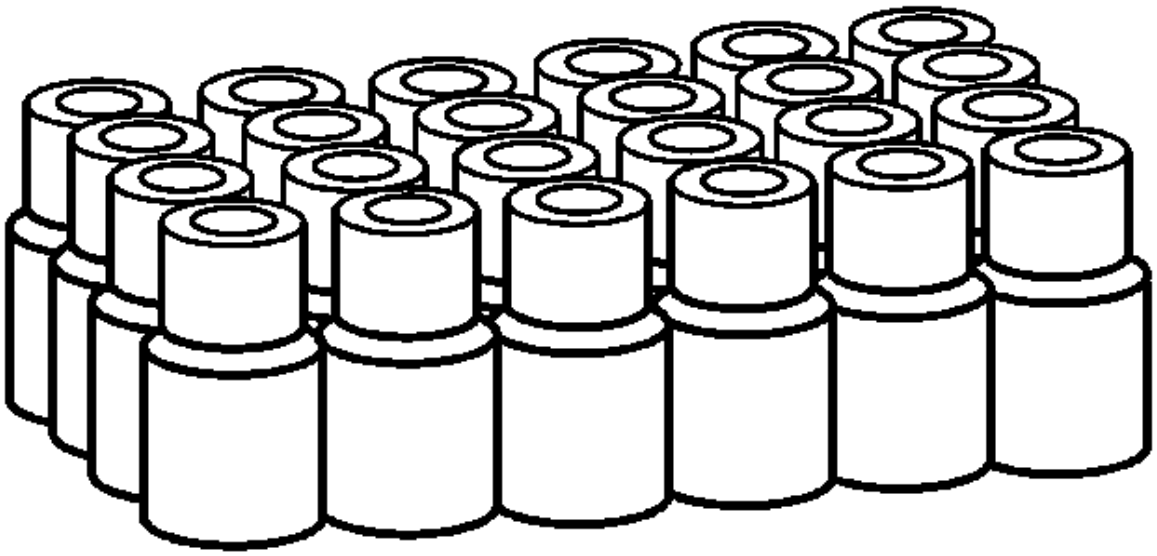
Illustration	Tool Number/ Description
	GE-46297-12 Replacement Dye Cartridges

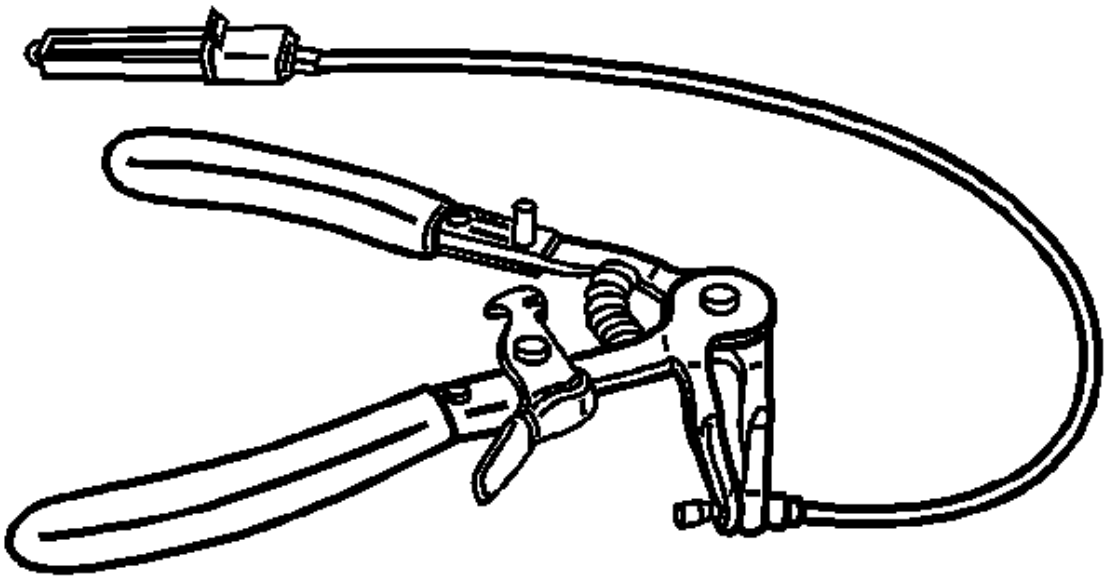
Illustration	Tool Number/ Description
	GE 47622 Hose Clamp Pliers

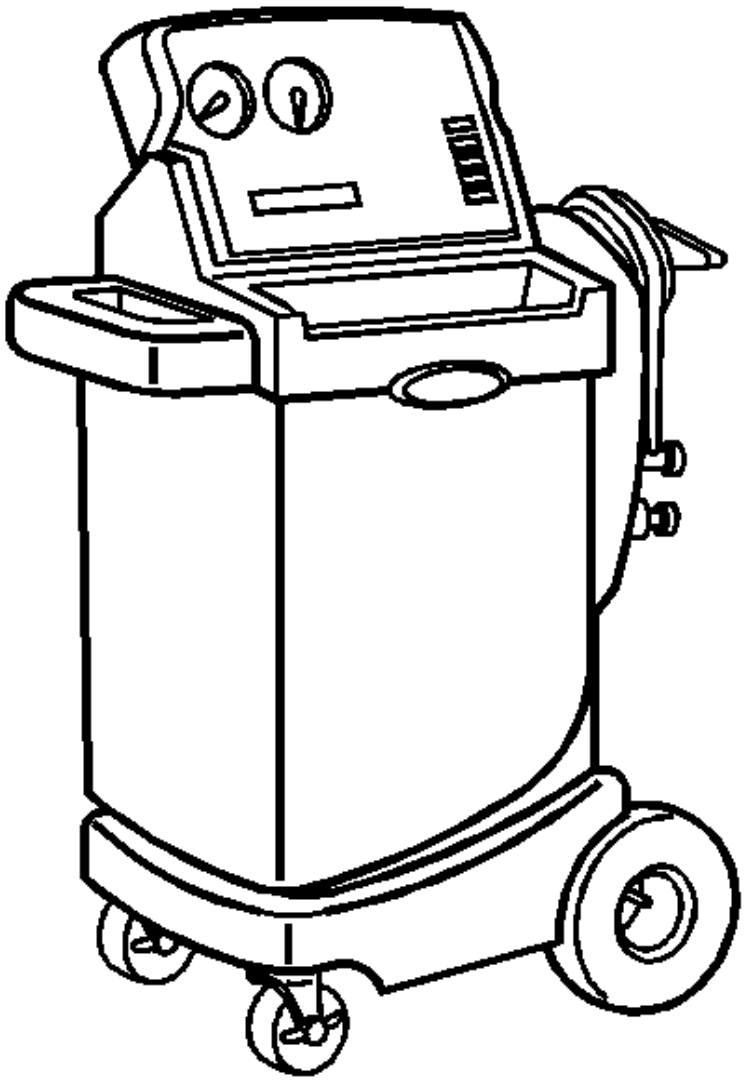
Illustration	Tool Number/ Description
	GE-48800 CoolTech A/C Recharge Machine

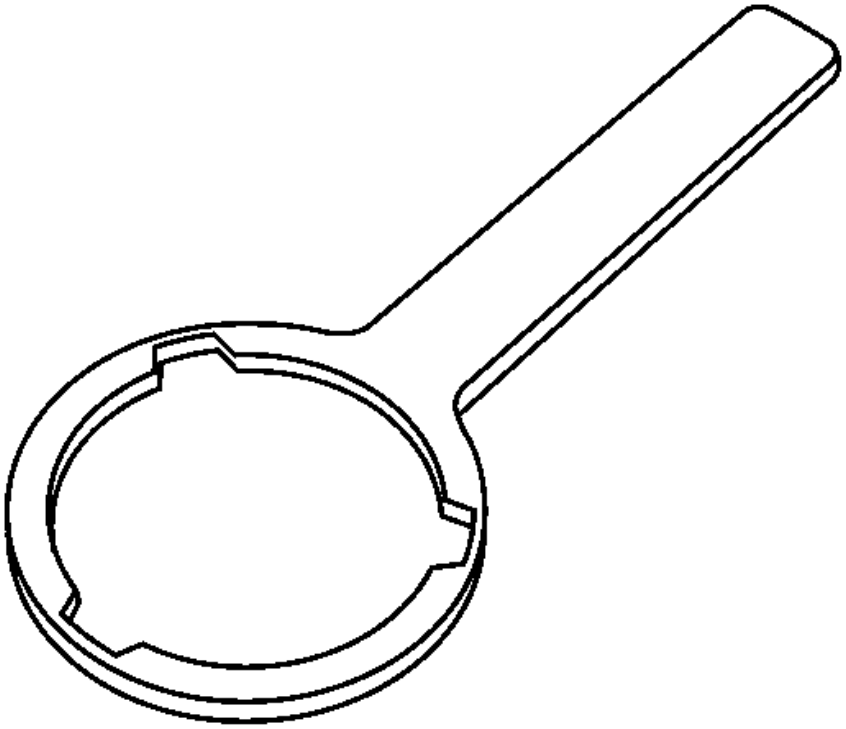
Illustration	Tool Number/ Description
	GE 48965 Holding Wrench

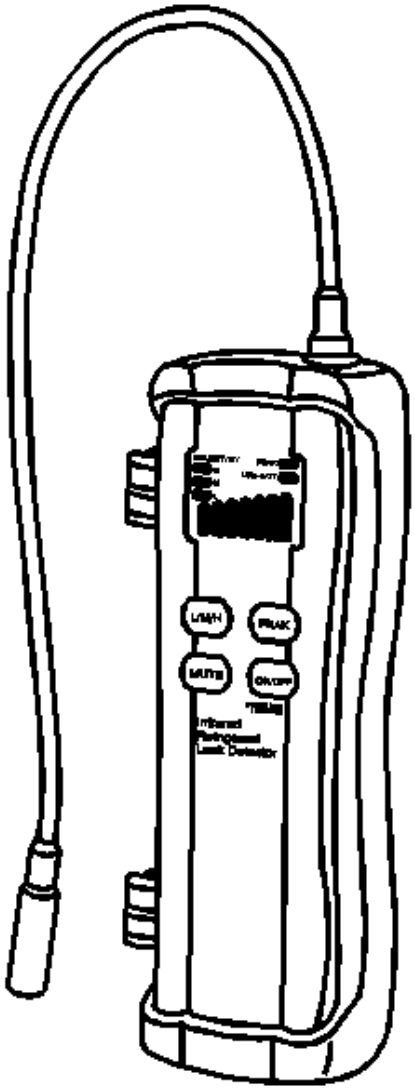
Illustration	Tool Number/ Description
	GE-50078 Infrared Refrigerant Leak Detector

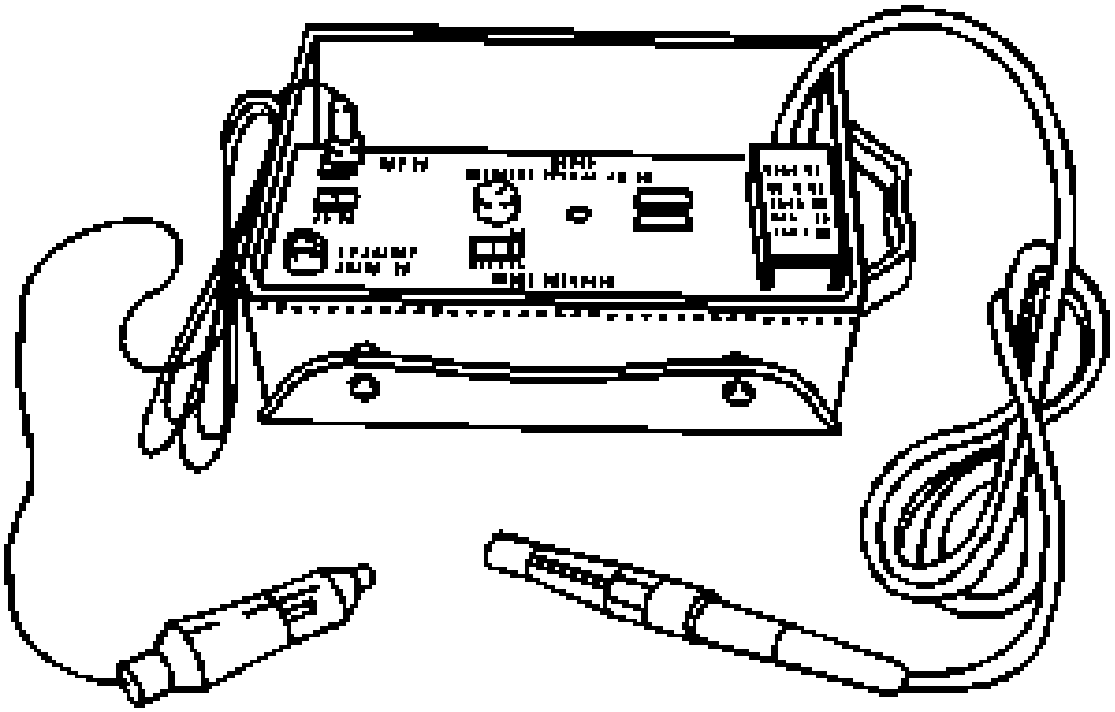
Illustration	Tool Number/ Description
	GE 39400-A J 39400-A Halogen Leak Detector

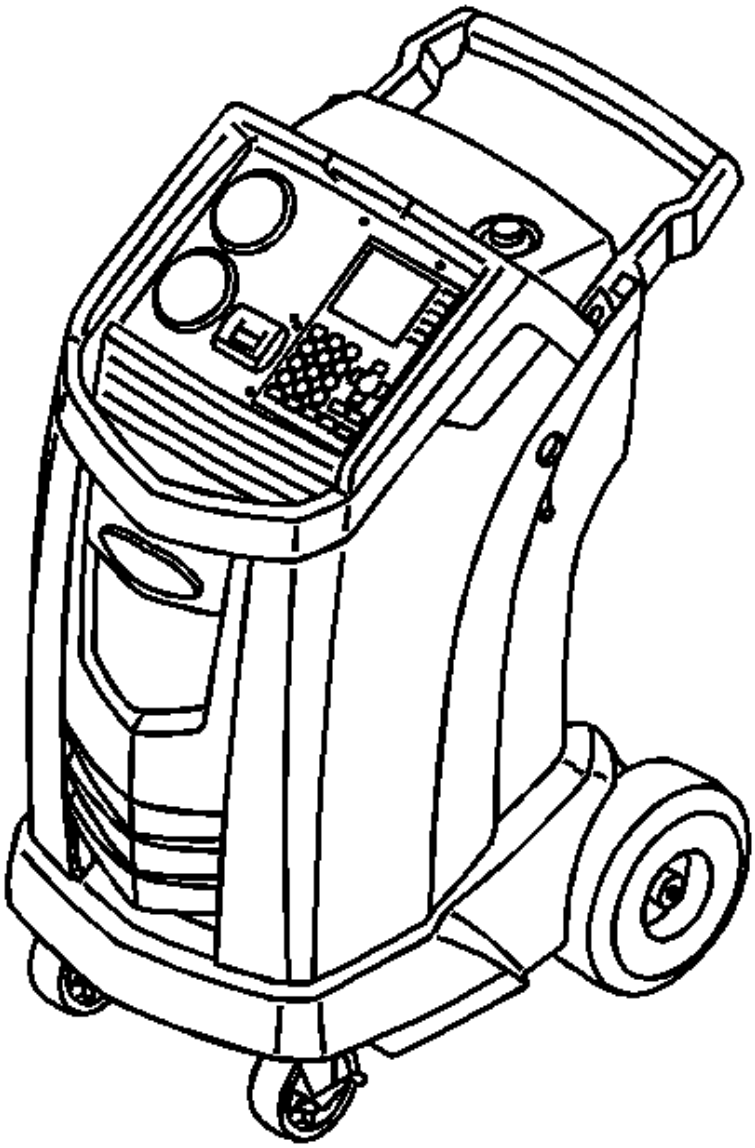
Illustration	Tool Number/ Description
	GE-50300 R-1234yf Air Conditioning Refrigerant Recovery/Recharge Cart

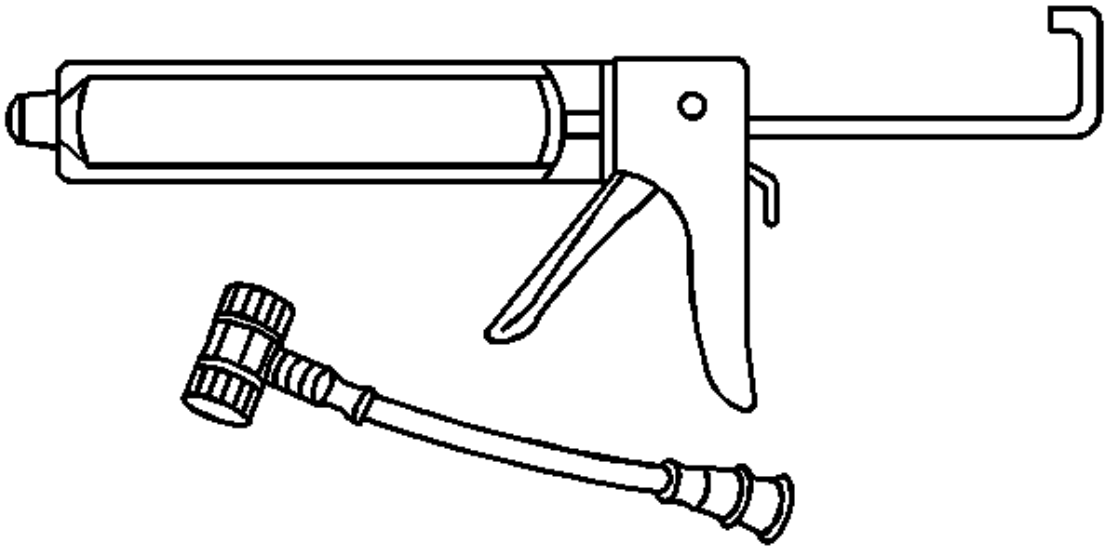
Illustration	Tool Number/ Description
	GE-50744 R-1234yf PAG Oil Injector Hose

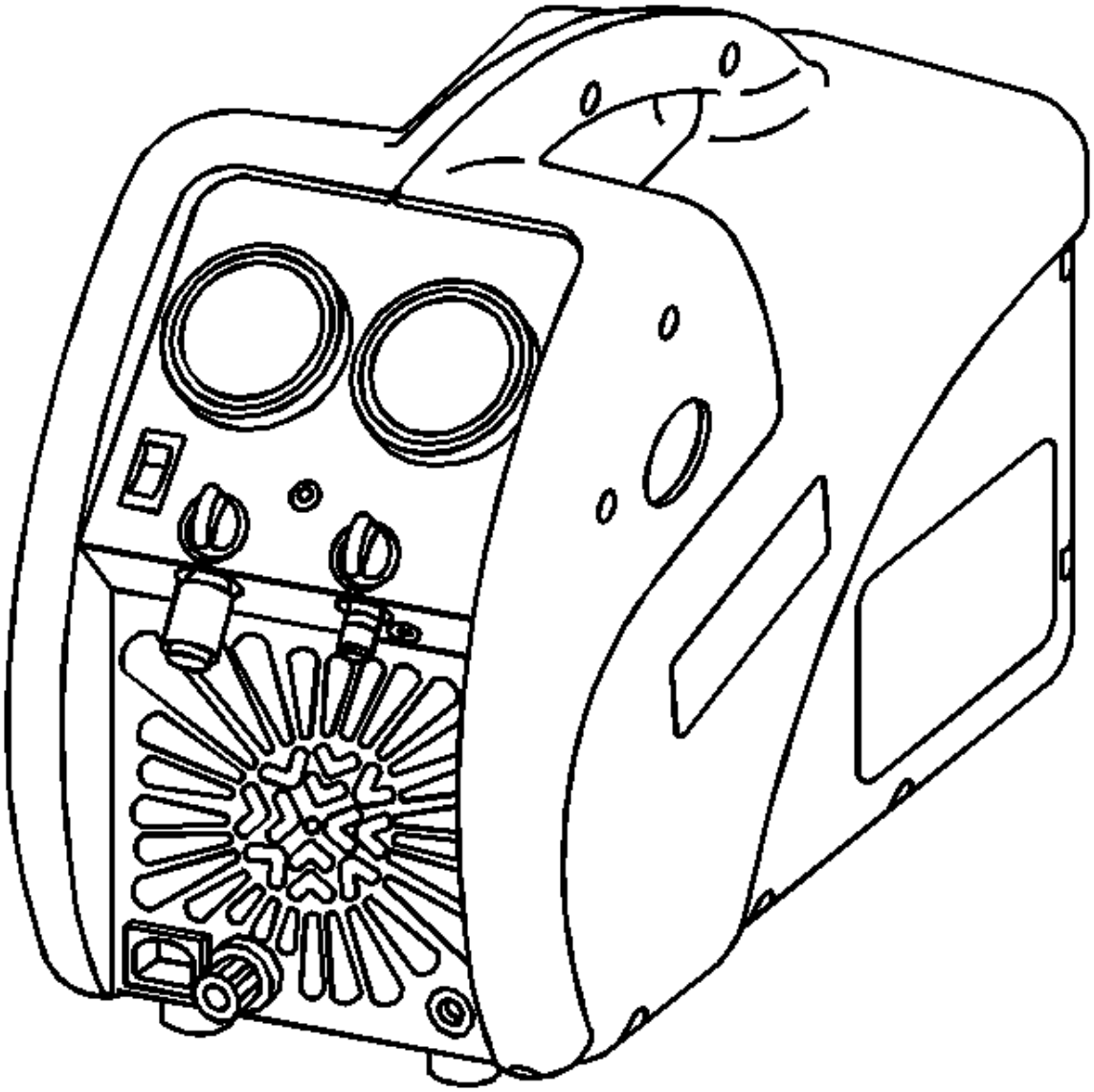
Illustration	Tool Number/ Description
	GE-50957 R-1234yf Contaminated Refrigerant Recovery

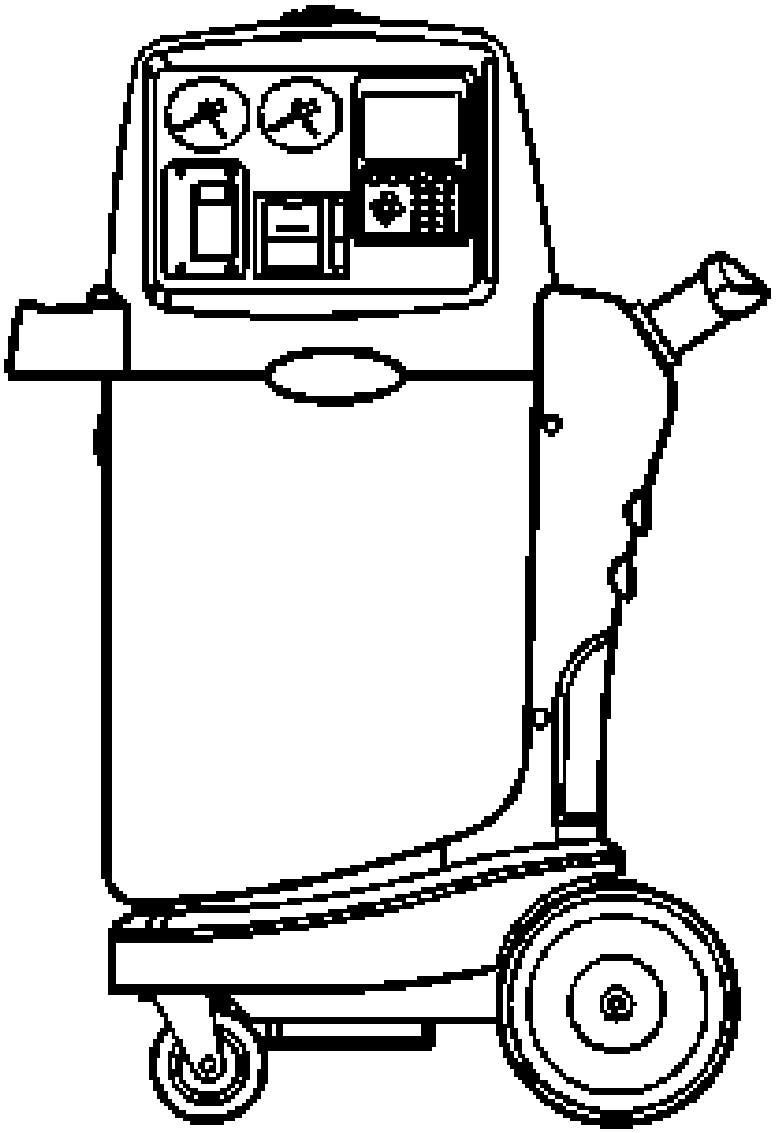
Illustration	Tool Number/ Description
	J-43600 ACR 2000 Air Conditioning Service Center

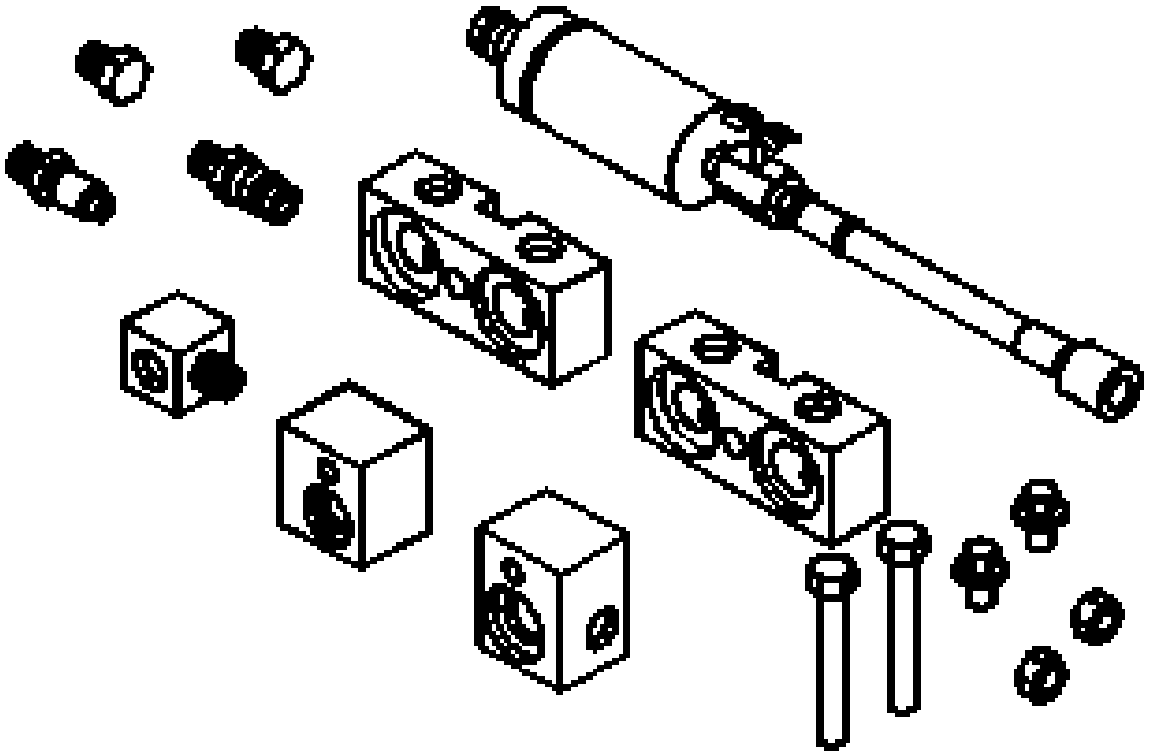
Illustration	Tool Number/ Description
	J-45268 A/C Flushing Adapter Kit

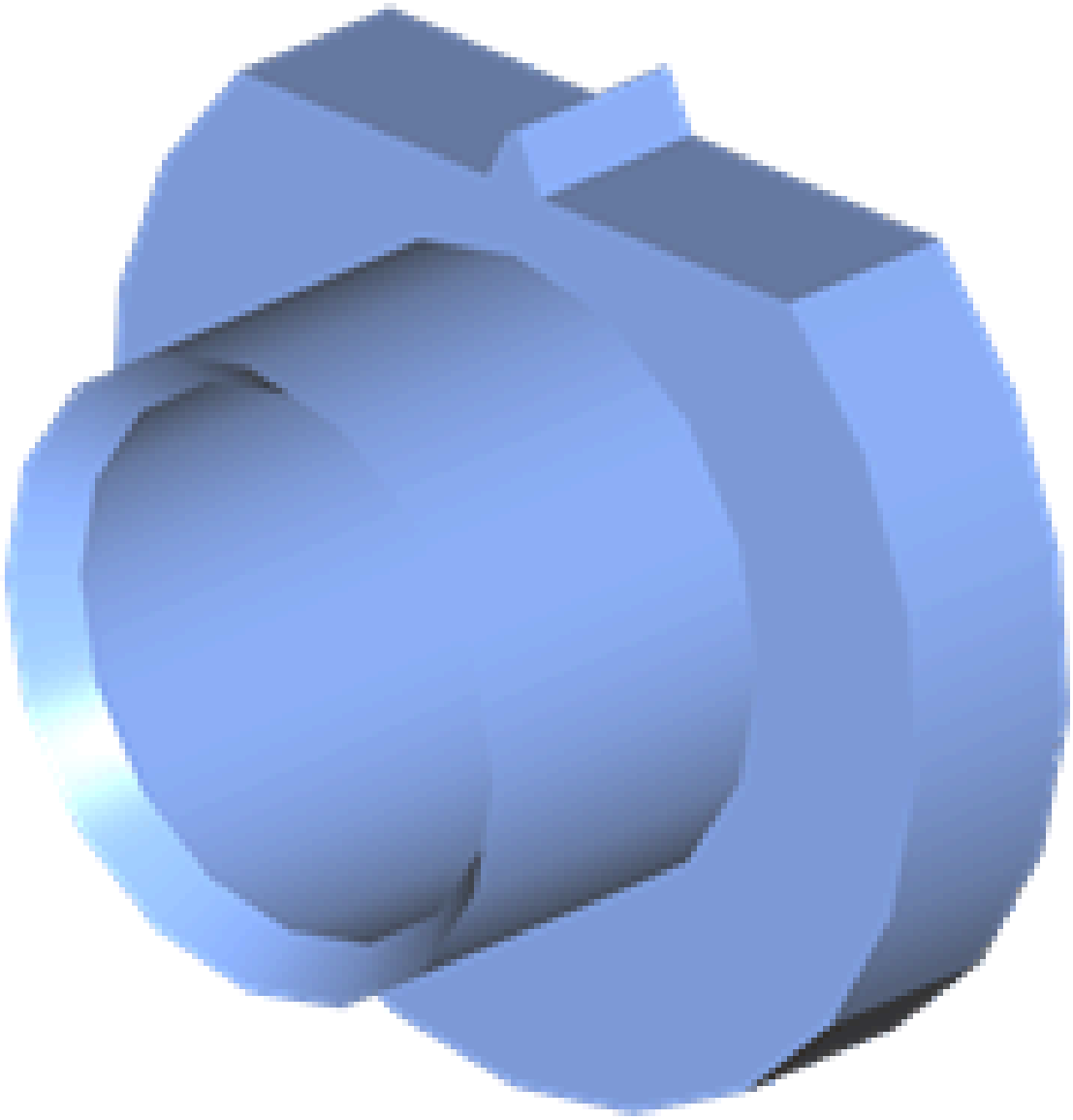
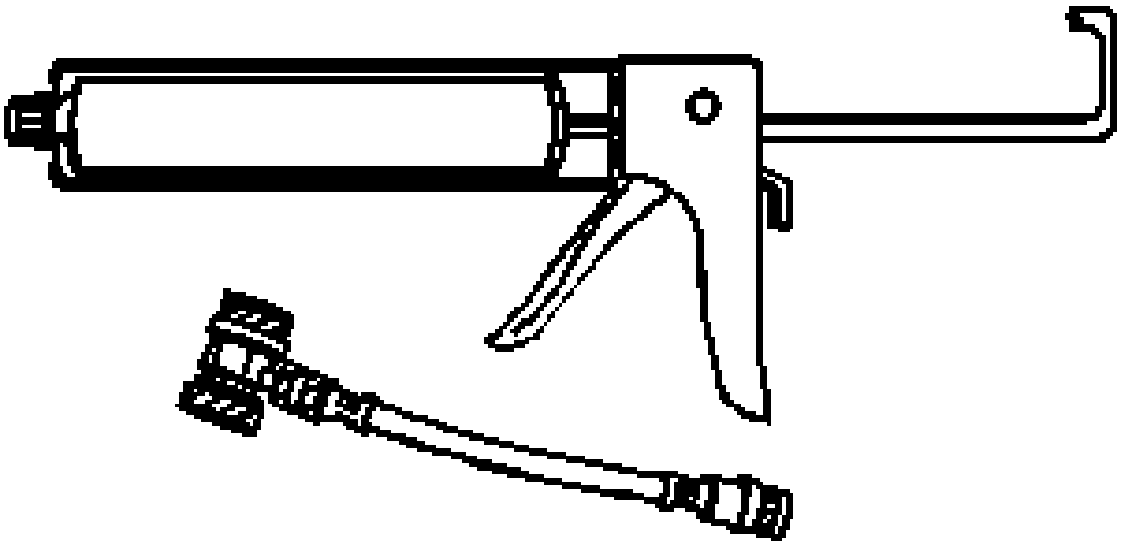
Illustration	Tool Number/ Description
	J-43181 Heater Line Q.C. Release Tool

Illustration	Tool Number/ Description
	J-45037 A/C Oil Injector

Article GUID: A00737187

HVAC

HVAC - Manual - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Heater and A/C Control Assembly Screw	1.5 N.m	13 lb in
Mode Actuator Screw	1.5 N.m	13 lb in
Recirculation Actuator Screw	1.5 N.m	13 lb in
Temperature Actuator- Left Screw	1.5 N.m	13 lb in
Temperature Actuator- Right Screw	1.5 N.m	13 lb in

SCHEMATIC WIRING DIAGRAMS

HVAC WIRING SCHEMATICS

Power, Ground, and Blower Motor Control

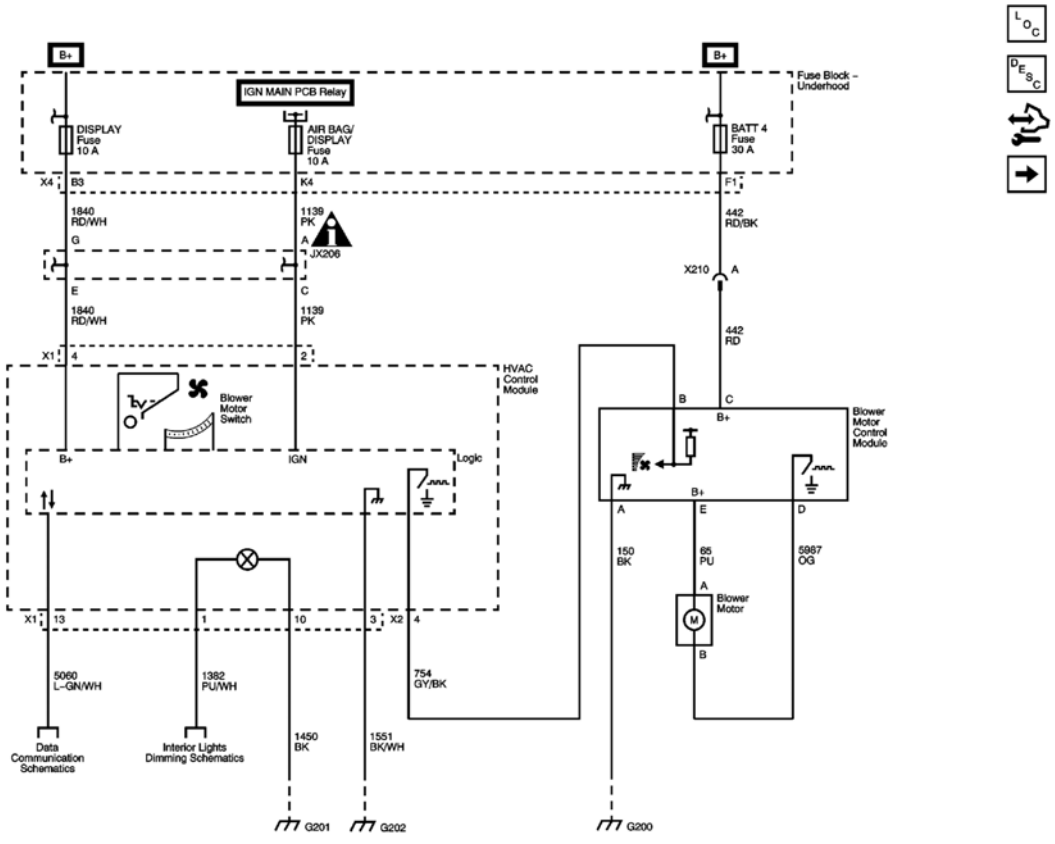


Fig. 1: Power, Ground, and Blower Motor Control Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

A/C Compressor Controls

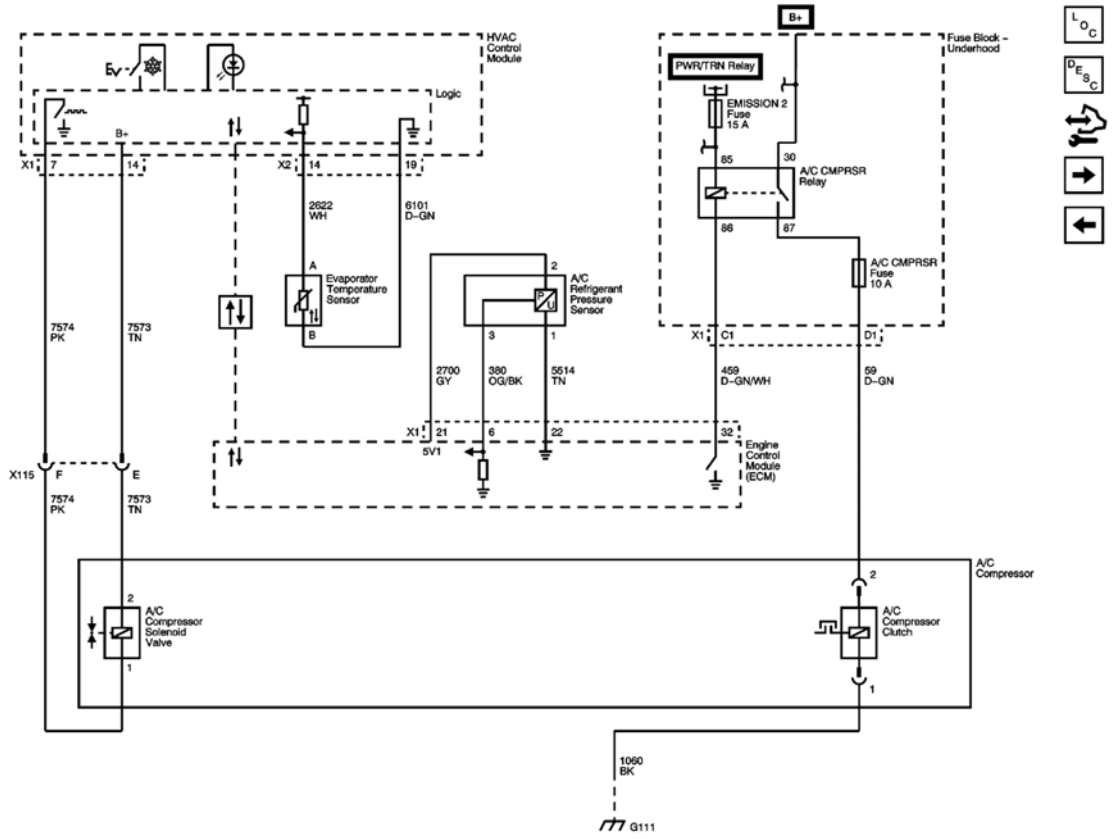


Fig. 2: A/C Compressor Controls Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Mode and Air Temperature Controls

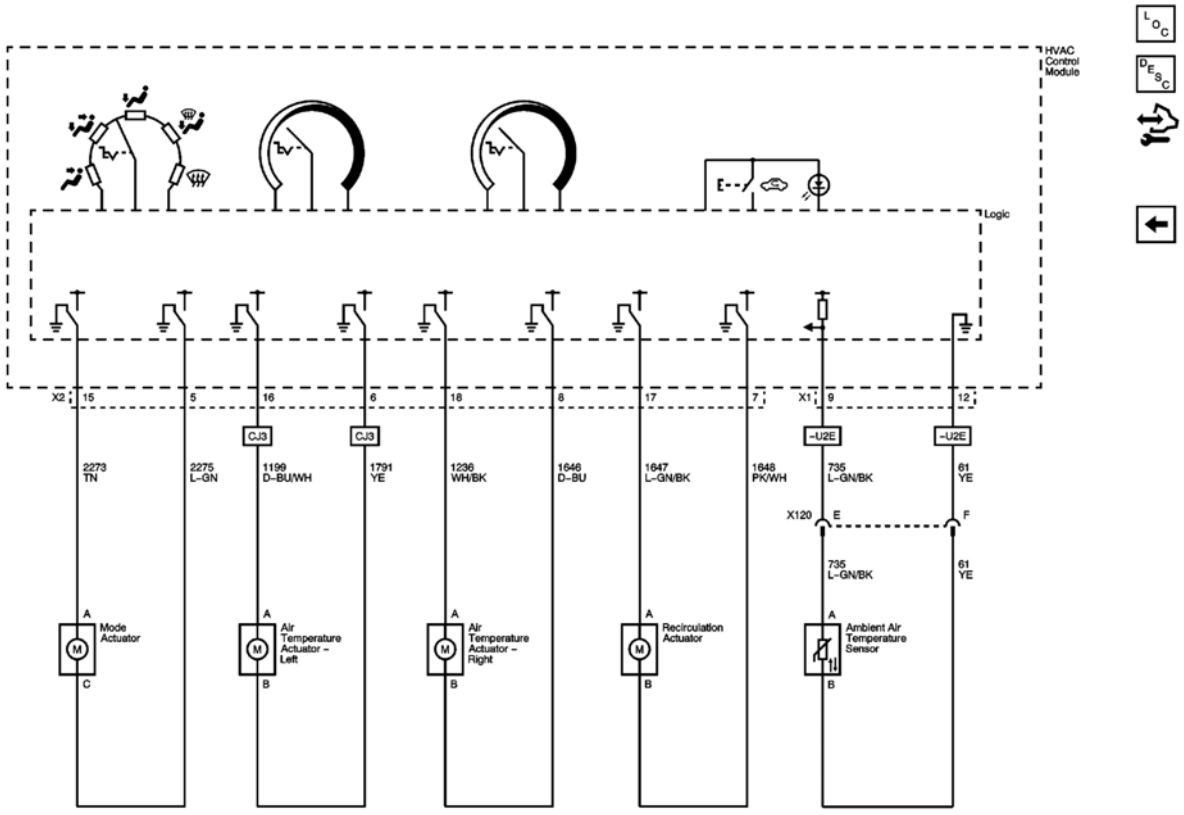


Fig. 3: Mode and Air Temperature Controls Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B0158: OUTSIDE AIR TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0158 13

Outside Air Temperature Sensor Circuit Voltage low

DTC B0158 14

Outside Air Temperature Sensor Circuit Voltage high

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ambient Air Temperature Sensor Signal	B0158 13	B0158 13	B0158 14	B0158 13,14
Low Reference	-	B0158 14	B0158 13	B0158 13,14

Circuit/System Description

The HVAC control module supplies the ambient air temperature sensor with a low reference circuit and 5-volt signal circuit. The HVAC control module determines the voltage drop across the sensor, which is proportional to temperature. As the air temperature increases, the sensor resistance decreases and the voltage signal decreases. As the air temperature decreases, the sensor resistance increases and the voltage signal increases.

Conditions for Running the DTC

The ignition is turned ON.

Conditions for Setting the DTC

The HVAC control module detects the ambient air temperature sensor signal circuit is less than -36Â°C (-38Â°F) or more than 215Â°C (419Â°F) for more than 15 seconds.

Action Taken When the DTC Sets

- The HVAC control module will display dashes for outside air temperature.
- The DIC will display SERVICE A/C SYSTEM.
- The system operates using a default value.

Conditions for Clearing the DTC

- The DTC will become history if the HVAC control module no longer detects the condition that set the DTC.
- The history DTC will clear after 50 fault-free ignition cycles.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Air Delivery Description and Operation**
- **Air Temperature Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

IMPORTANT: An instant OAT update must be performed by pressing the A/C and Recirc buttons at the same time after the system has been repaired to convert the A/C permission from out of range to normal.

1. Ignition OFF, disconnect the harness connector at the outside air temperature sensor.
2. Ignition OFF, test for less than 10 ohms of resistance between the low reference circuit terminal B and ground.
   - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the HVAC control module.
3. Ignition ON, verify the scan tool Ambient Air Temperature sensor parameter is less than -35Â°F (-37Â°C).
   - If greater than the specified range, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the HVAC control module.
4. Install a 3A fused jumper wire between the signal circuit terminal A and the low reference circuit terminal B. Verify the scan tool Ambient Air Temperature sensor parameter is greater than 180Â°F (82Â°C).
   - If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the HVAC control module.
5. If all circuits test normal, test or replace the ambient air temperature sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for HVAC control module replacement, setup and programming

DTC B0223, B0233, B0248, B0268, B0408, B0418, OR B0428: RECIRCULATE POSITION/AIR FLOW CONTROL/TEMPERATURE CONTROL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0223 04

Recirculate Position Command Circuit Open

DTC B0223 05

Recirculate Position Command Circuit Short to Battery or Open

DTC B0223 06

Recirculate Position Command Circuit Short to Ground or Open

DTC B0223 61

Recirculation Actuator Stuck

DTC B0233 04

Air Flow Control Circuit Open

DTC B0233 05

Air Flow Control Circuit Short to Battery or Open

DTC B0233 06

Air Flow Control Circuit Short to Ground or Open

DTC B0233 61

Air Flow Control Actuator Stuck

DTC B0408 04

Temperature Control 1 Circuit Open

DTC B0408 05

Temperature Control 1 Circuit Short to Battery or Open

DTC B0408 06

Temperature Control 1 Circuit Short to Ground or Open

DTC B0408 61

Temperature Control 1 Circuit Actuator Stuck

DTC B0418 04

Temperature Control 2 Circuit Open

DTC B0418 05

Temperature Control 2 Circuit Short to Battery or Open

DTC B0418 06

Temperature Control 2 Circuit Short to Ground or Open

DTC B0418 61

Temperature Control 2 Circuit Actuator Stuck

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Recirculate Position Command Circuit A	B0223 04, 06	B0223 04, 06	B0223 05, 06	B0223 61
Recirculate Position Command Circuit B	B0223 04, 06	B0223 04, 06	B0223 05, 06	B0223 61
Mode Door Control Circuit A	B0233 04, 06	B0233 04, 06	B0233 05, 06	B0233 61
Mode Door Control Circuit B	B0233 04, 06	B0233 04, 06	B0233 05, 06	B0233 61
Driver Air Temperature Door Control A Circuit	B0408 04, 06	B0408 04, 06	B0408 05, 06	B0408 61
Driver Air Temperature Door Control B Circuit	B0408 04, 06	B0408 04, 06	B0408 05, 06	B0408 61
Passenger Air Temperature Door Control A Circuit	B0418 04, 06	B0418 04, 06	B0418 05, 06	B0418 61
Passenger Air Temperature Door Control B Circuit	B0418 04, 06	B0418 04, 06	B0418 05, 06	B0418 61

Circuit/System Description

The actuator is an electronic stepper motor. The HVAC control module supplies power and ground to the actuator. The HVAC control module controls the direction of the actuator by changing the polarity of the control circuits. When the actuator reaches its desired position, both circuits are fixed to the same value 0 volts. The HVAC control module determines the door position by counting pulses, voltage fluctuations, caused by the brush to commutator action generated during normal motor operation. The HVAC control module monitors a voltage drop across an internal resistance to detect the pulses. The HVAC control module converts the pulses to counts with a range of 0-255 counts.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is between 9-16 volts.
- The HVAC module is ON.

Conditions for Setting the DTC

The actual door position differs from the commanded door position by more than 4 counts or the HVAC control module detects the door position signal circuit is shorted to ground shorted to voltage or open.

Action Taken When the DTC Sets

Driver A and driver B circuits are deactivated for the appropriate actuator.

Conditions for Clearing the DTC

- The DTC becomes history when the HVAC control module no longer detects the condition that set the DTC.
- The history DTC will clear after 50 fault-free ignition cycles.
- The DTC can be cleared with a scan tool.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Air Delivery Description and Operation**
- **Air Temperature Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate actuator.
2. Ignition ON, connect a test lamp between the control circuit terminal A and control circuit terminal B or terminal C for the mode actuator. Command the actuator in each direction. The test lamp should briefly illuminate when commanding the actuator in one direction to the other direction.
    - If the test lamp is always OFF, test the appropriate control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the HVAC control module.
    - If the test lamp continuously illuminates, test the appropriate control circuit for a short to B+. If the circuit tests normal, replace the HVAC control module.
3. If all circuits test normal, replace the appropriate actuator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Air Inlet Valve Actuator Replacement**
- **Mode Valve Actuator Replacement (Impala Limited)**
- **Temperature Valve Actuator Replacement - Left Side**
- **Temperature Valve Actuator Replacement - Right Side**
- **Control Module References** for HVAC control module setup, replacement, and programming

DTC B3933: AIR CONDITIONING EVAPORATOR TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3933 02

Air Conditioning Evaporator Temperature Sensor Circuit Short to Ground

DTC B3933 05

Air Conditioning Evaporator Temperature Sensor Circuit High Voltage/Open

DTC B3933 13

Air Conditioning Evaporator Temperature Sensor Circuit High Temperature

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	B3933 02	B3933 05	B3933 05	1
Low Reference	-	B3933 05	B3933 05	-
1. Air Temperature Malfunction				

Circuit/System Description

The evaporator air temperature sensor is 2-wire negative temperature co-efficient thermistor.

A signal and low reference circuit enables the sensor to operate. As the air temperature surrounding the sensor increases, the sensor resistance decreases. The sensor signal voltage decreases as the resistance decreases. The sensor operates within a temperature range between -40 to +85Â°C (-40 to +185Â°F). The sensor signal varies between 0-5 V. As the air temperature increases the sensor voltage will decrease. If the HVAC control module detects a malfunctioning sensor, then the control module software will use a default air temperature value. The default action ensures that the HVAC system can adjust the inside air temperature near the desired temperature

until the condition is corrected.

Conditions for Running the DTC

- Ignition ON
- The HVAC control module is ON.

Conditions for Setting the DTC

The HVAC control module detects the sensor signal out of range. The signal voltage is less than 0.1 V or greater than 4.9 V for more than 50 ms.

Action Taken When the DTC Sets

The system operates using a default value.

Conditions for Clearing the DTC

The sensor signal is within specified range between 0.1-4.9 V.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Air Delivery Description and Operation**
- **Air Temperature Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B39 Evaporator Temperature Sensor. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between the low reference circuit terminal B and ground.

- **If 10 Ω or greater**

1. Ignition OFF, disconnect the harness connector at the K33 HVAC control module.
2. Test for less than 2 Ω in the low reference circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K33 HVAC control module.

- **If less than 10 Ω**

3. Ignition ON.
4. Verify the A/C Evaporator Temperature Sensor scan tool parameter is less than -37Â°C (-35Â°F).
    - **If -37Â°C (-35Â°F) or greater**

    1. Ignition OFF, disconnect the harness connector at the K33 HVAC control module.
    2. Test for infinite resistance between the signal circuit terminal A and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K33 HVAC control module.

    - **If less than -37Â°C (-35Â°F)**

5. Install a 3 A fused jumper wire between the signal circuit and the low reference circuit terminal B.
6. Verify the A/C Evaporator Temperature Sensor scan tool parameter is greater than 115Â°C (239Â°F).
    - **If 115Â°C (239Â°F) or less**

    1. Ignition OFF, disconnect the harness connector at the K33 HVAC control module, ignition ON.
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V

    3. Ignition OFF
    4. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K33 HVAC control module.

    - **If greater than 115Â°C (239Â°F)**

7. Test or replace the B39 Evaporator Temperature Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Evaporator Air Temperature Sensor Replacement**
- **Control Module References** for HVAC control module replacement, programming, and setup.

DTC B393B: AIR CONDITIONING COMPRESSOR VALVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B393B 04

Air Conditioning Compressor Valve Control Circuit Open

DTC B393B 0B

Air Conditioning Compressor Valve Control Circuit High Current

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Electric Variable Displacement B+	B393B 0B	B393B 04	-	-
Electric Variable Displacement Control	B393B 04	B393B 04	B393B 0B	-

Circuit/System Description

This A/C system uses a conventional clutch to engage and mechanically turn the compressor and a variable displacement solenoid valve to alter the amount of displacement created by the turning of the compressor. The HVAC control module provides both switched battery voltage and a pulse width modulated ground to the variable displacement solenoid valve. When the A/C switch is pressed, the HVAC control module grounds the variable displacement solenoid using a (PWM) signal in order to determine the amount of compressor displacement. The performance of the A/C compressor is based on adjusted interior temperature and engine load.

Conditions for Running the DTC

- Ignition ON.
- The HVAC control module is ON.

Conditions for Setting the DTC

B393B 04

A PWM greater than 10% is sent but no current is read back.

B393B 0B

Measured current is above threshold of 815 mA.

Action Taken When the DTC Sets

B393B 04

The A/C compressor is disabled.

B393B 0B

- The A/C compressor is disabled.
- Output will be switched off for hardware protection.

Conditions for Clearing the DTC

The condition for setting the DTC is no longer present.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Air Temperature Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the Q46 A/C Compressor Solenoid Valve and disconnect the X1 harness connector at the K33 HVAC Control Module, ignition ON.
2. Test for less than 1 V between each control circuit listed below and ground:
    - Solenoid terminal 1
    - Solenoid terminal 2
    - **If 1 V or greater**

      Repair the short to voltage on the circuit.

    - **If less than 1 V**
3. Ignition OFF.
4. Test for infinite resistance between each control circuit listed below and ground:
    - Solenoid terminal 1
    - Solenoid terminal 2

- **If less than infinite resistance**

  Repair the short to ground on the circuit.

- **If infinite resistance**

5. Test for infinite resistance between the control circuits listed below:
   - Solenoid terminal 1
   - Solenoid terminal 2
   - **If less than infinite resistance**

     Repair the short on the circuit.

   - **If infinite resistance**
6. Test for less than 2 Ω in each control circuit end to end.
   - **If 2 Ω or greater**

     Repair the open/high resistance in the circuit.

   - **If less than 2 Ω**
7. Test the Q46 A/C Compressor Solenoid Valve or replace the G1 A/C Compressor.
8. Verify the DTC or symptom is corrected while operating the HVAC system under the Conditions for Running the DTC.
   - **If the DTC or symptom is not corrected**

     Replace the K33 HVAC Control Module.

   - **If the DTC or symptom is corrected**
9. All OK.

Component Testing

Static Test

1. Ignition OFF, disconnect the harness connector at the Q46 A/C Compressor Solenoid Valve.
2. Test for 7-15 Ω between B+ terminal 2 and control terminal 1.
   - **If less than 7 Ω or greater than 15 Ω**

     Replace the G1 A/C Compressor.

   - **If between 7-15 Ω**
3. Test for infinite resistance between each terminal and the Q46 A/C Compressor Solenoid Valve housing/case.
   - **If less than infinite resistance**

     Replace the G1 A/C Compressor.

   - **If infinite resistance**

4. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for HVAC control module replacement, programming and setup

DTC P0532 OR P0533: AIR CONDITIONING A/C REFRIGERANT PRESSURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0532

Air Conditioning A/C Refrigerant Pressure Sensor Circuit Low Voltage

DTC P0533

Air Conditioning A/C Refrigerant Pressure Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
5-Volt Reference Circuit	P0532	P0532	P0533
A/C Refrigerant Pressure Sensor Signal Circuit	P0532	P0533	P0532
Low Reference Circuit	-	P0532	P0533

Circuit/System Description

The engine control module (ECM) monitors the high side refrigerant pressure through the A/C refrigerant pressure sensor. The ECM supplies a 5-volt reference and a low reference to the sensor. Changes in the A/C refrigerant pressure cause the A/C refrigerant pressure sensor signal to the ECM to vary. When the pressure is low, the signal voltage is low. When the pressure is high, the ECM commands the cooling fans on. When pressure is too high or too low, the ECM will not allow the A/C compressor clutch to engage.

Conditions for Running the DTC

The Engine is running.

Conditions for Setting the DTC

- The ECM detects that the A/C pressure is less than 1 psi (0.01 volt).
- The ECM detects that the A/C pressure is more than 425 psi (4.90 volts).

Action Taken When the DTC Sets

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM stores the failure records.
- The A/C compressor clutch is disabled.

Conditions for Clearing the DTC

- The history DTC will clear after 40 consecutive ignition cycles have occurred without a malfunction.
- The DTC will become history if the ECM no longer detects a failure.

Diagnostic Aids

A malfunction within the refrigerant system causing high pressure can cause this DTC to set.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool A/C Refrigerant Pressure Sensor parameter. The reading should be between 0.1 volt (1 psi) and 4.90 volts (425 psi) and change with A/C refrigerant pressure changes.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the A/C refrigerant pressure sensor.
2. Ignition OFF, test for less than 10 ohms between the low reference circuit terminal 1 and ground.
    - If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the PCM.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal 2 and ground.
    - If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the PCM.
    - If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the

circuit tests normal, replace the PCM.

4. Verify the scan tool A/C High Side Pressure Sensor parameter is less than 0.1 volts (1 psi).
    - If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the PCM.
5. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 2. Verify the scan tool A/C Refrigerant High Side Pressure Sensor parameter is greater than 4.90 volts (425 psi).
    - If less than the specified range, test the signal circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the PCM.
6. If all circuits test normal, test or replace the A/C refrigerant pressure sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Air Conditioning (A/C) Refrigerant Pressure Sensor Replacement**
- **Control Module References** for the ECM replacement, setup, and programming

DTC P0645, P0646, OR P0647: AIR CONDITIONING (A/C) COMPRESSOR CLUTCH RELAY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0645

Air Conditioning (A/C) Compressor Clutch Relay Control Circuit

DTC P0646

Air Conditioning (A/C) Compressor Clutch Relay Control Circuit Low Voltage

DTC P0647

Air Conditioning (A/C) Compressor Clutch Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
A/C Relay Coil Ignition	2	2	-	-
A/C Relay Switch B+	2	2	-	-
A/C Relay Control	P0645	P0645	P0645	-
A/C Clutch Control	2	2	1	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
A/C Compressor Clutch Ground	-	2	2	-
1. A/C Clutch Always Engaged 2. A/C Clutch Inoperative				

Circuit Description

When the A/C switch is pressed, the HVAC control assembly sends a GMLAN message to the engine control module (ECM) for an A/C request. This input will request the ECM to ground the A/C compressor clutch relay control circuit, which will switch the A/C CMPRSR relay. With the relay contacts closed, battery voltage is supplied to the A/C compressor clutch assembly.

Conditions for Running the DTC

- The ignition voltage is between 11-18 volts.
- The engine speed is less than 600 RPM.
- The ECM driver transitions from ON to OFF or from OFF to ON.

Conditions for Setting the DTCs

The ECM detects an open on the control circuit of the A/C compressor clutch relay when commanded off with the engine in crank or run status.

Action Taken When the DTC Sets

The ECM will store conditions which were present when the DTC set as Failure Records data only. This information will not be stored as Freeze Frame data.

Conditions for Clearing the DTC

- A History DTC clears after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using a scan tool.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Air Delivery Description and Operation**
- **Air Temperature Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the A/C CMPRSR relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal 86 and ground.
    - If the test lamp illuminates, test the control circuit for a short to ground.
3. Verify that a test lamp illuminates between the ignition circuit terminal 85 and ground.
    - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and ignition circuit fuse is open, test or replace the relay.
4. Connect a test lamp between the ignition circuit terminal 85 and thecontrol circuit terminal 86.
5. Command the A/C relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, test or replace the A/C CMPRSR relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for ECM replacement, setup, and programming
- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

SYMPTOMS - HVAC SYSTEMS - MANUAL

IMPORTANT:

Review the system operation in order to familiarize yourself with the system functions. Refer to:

- **Air Delivery Description and Operation**
- **Air Temperature Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the HVAC System. Refer to **Checking Aftermarket Accessories** .

- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Verify the A/C compressor clutch turns freely and is not seized.
- The A/C compressor will not operate in cold outside air temperatures. Refer to **Air Temperature Description and Operation**.
- The following conditions may cause window fogging:
  - Wet carpet or mats
  - High humidity
  - Interior water leak
  - Blocked A/C evaporator drain tube
  - Maximum passenger capacity
  - Blocked body pressure relief valves
- Inspect the air distribution system for causes of reduced air flow:
  - Obstructed or dirty passenger compartment air filter, if equipped
  - Blocked or damaged air inlet or outlet vents

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Air Conditioning Compressor Malfunction**
- **Blower Motor Malfunction**

HVAC SYSTEM MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Aids

Check the following mechanical fault sources:

- Air distribution box
- Air distribution hoses/air distribution ducts

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Air Delivery Description and Operation**
- **Air Temperature Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J43600 ACR Air Conditioning Service Center

Circuit/System Verification

NOTE: **Check for bulletins before proceeding.**

1. Verify the blower motor operates properly with the blower motor switch in each speed position.
   - **If the blower motor does not operate in each speed position**

     Refer to **Blower Motor Malfunction**

   - **If the blower motor operates properly in each speed position**
2. Verify all HVAC doors move when pressing the appropriate switch.
   - Temperature
   - Bi-Level mode
   - Recirculation
   - **If any HVAC door does not move**

     Refer to **DTC B0223, B0233, B0248, B0268, B0408, B0418, or B0428**.

   - **If all HVAC doors move**
3. Install the **J43600** ACR Air Conditioning Service Center.
4. Verify the high side pressure reading on the Air Conditioning Service Center is within 10% of the scan tool A/C High Side Pressure Sensor parameter.

- **If the reading is not within 10%**

  Refer to **DTC P0532 or P0533**.

- **If the reading is within 10%**

5. Verify the A/C High Side Pressure Sensor parameter is between 269-2929 kPa (39-425 PSI).
   - **If the reading is not between 269-2929 kPa (39-425 PSI)**

     Refer to **Air Conditioning (A/C) System Performance Test (LFX)** .

   - **If the reading is between 269-2929 kPa (39-425 PSI)**
6. Engine ON, A/C system ON.
7. Verify cool air flows from the ducts with the temperature control in the coldest position.
   - **If the air is not cool**

     Verify the compressor clutch is engaged.

   - If the compressor clutch is not engaged

     Refer to **DTC P0645, P0646, or P0647**.

   - If the compressor clutch is engaged

     Refer to **Air Conditioning (A/C) System Performance Test (LFX)** , and **DTC B393B**.

   - **If the air is cool**
8. Verify warm air flows from the ducts with the temperature control in the warmest position.
   - **If the air is not warm**

     Refer to **Heating Performance Diagnostic** .

   - **If the air is warm**
9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Control Module References** for HVAC control module replacement, programming, and setup

AIR CONDITIONING COMPRESSOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
A/C Relay Coil Ignition	2	2	-	-
A/C Relay Switch B+	2	2	-	-
A/C Relay Control	P0645	P0645	P0645	-
A/C Clutch Control	2	2	1	-
A/C Compressor Clutch Ground	-	2	2	-
1. A/C Clutch Always Engaged 2. A/C Clutch Inoperative				

Circuit/System Description

When the A/C switch is pressed, the HVAC control module grounds the A/C request signal circuit. This input will request the ECM to ground the A/C compressor clutch relay control circuit, which will switch the A/C CMPRSR relay. With the relay contacts closed, battery voltage is supplied to the A/C compressor clutch assembly.

Diagnostic Aids

The following conditions must be met in order for the ECM to turn on the compressor clutch:

- Battery voltage is between 9-18 volts.
- Engine coolant temperature (ECT) is less than 123Â°C (253Â°F).
- Engine speed is less than 4760 RPM.
- Engine speed is more than 600 RPM.
- A/C high side pressure is between 2929-269 kPa (425-39 psi).
- Throttle position is less than 100 percent.
- Evaporator temperature is greater than 0Â°C (32Â°F)
- ECM does not detect excessive torque load
- ECM does not detect insufficient idle quality.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the A/C CMPRSR relay.
2. Ignition ON, verify that a test lamp does not illuminate between the control circuit terminal and ground.
    - If the test lamp illuminates, test the control circuit for a short to voltage.
3. Verify that a test lamp illuminates between the ignition circuit terminal and ground.
    - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test or replace the A/C CMPRSR relay.
4. Verify that a test lamp illuminates between the B+ circuit terminal and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse is open, test the control circuit terminal for a short to ground.
5. Disconnect the harness connector at the A/C compressor clutch.
6. Test for less than 1.0 ohm of resistance between the A/C compressor clutch ground circuit terminal A and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect the harness connector at the A/C compressor clutch.
8. Connect a 10A fused jumper wire between the B+ circuit terminal and the control circuit terminal. Verify the A/C compressor clutch is activated.
    - If the A/C compressor clutch does not activate, test the control circuit for an open/high resistance. If the circuit tests normal, test or replace the A/C compressor clutch.
9. Connect a test lamp between the ignition circuit terminal and the control circuit terminal.
10. Command the A/C relay ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
11. If all circuits test normal, test or replace the A/C CMPRSR relay.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Air Conditioning Clutch Assembly Replacement**
- **Air Conditioning Compressor Replacement**
- **Control Module References** for HVAC control module and ECM replacement, setup and programming

BLOWER MOTOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Blower Motor Speed Control Circuit at the Blower Motor Control Processor	1, 2	1	1, 2	-
Battery Positive Voltage Circuit at the Blower Motor Control Processor	-	1	-	-
Ground Circuit of the Blower Motor Control Processor	-	1	-	-
Blower Motor Low Reference Circuit (between motor and control processor)	-	1	-	-
1. Blower Motor Inoperative 2. Blower Motor Always On				

Circuit/System Description

Blower Motor Control Processor

The blower motor control module is an interface between the HVAC control module and the blower motor. The blower motor speed control, battery positive and ground circuits enable the control module to operate. The HVAC control module provides a variable voltage signal to the blower motor control module to request the selected blower speed. The blower motor control module provides a pulse width modulation (PWM) ground signal to the blower motor in order to control the blower motor speed. The module supplies 12 volts to the blower motor through the blower motor voltage supply circuit.

Diagnostic Aids

Be sure the blower motor housing is not shorted to a grounded surface causing the blower motor to always be on in high speed.

Prior to motor replacement connect a direct independent B+ and ground to verify operation.

Inspect the motor shaft for rust or other foreign material which may prohibit proper motor operation.

If the motor operates properly please reinstall it, check for PIs or TSBs, and refer to Testing for Intermittent Conditions and Poor Connections in the Electrical Information Reference section of this document.

Reference Information

Schematic Reference

HVAC Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Air Delivery Description and Operation**
- **Air Temperature Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the blower motor control module.
2. Test for less than 1.0 ohm between the ground circuit terminal A and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal C and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the B+ circuit fuse (BATT 4 30-amp) in the underhood fuse block is open, test all components connected to the B+ circuit and replace as necessary.
4. Connect a DMM between the control circuit terminal B and B+.
5. Cycle the blower motor from OFF to HIGH. The voltage should increase while changing between the commanded states.
    - If voltage remains greater than 11.5V while changing between the commanded states, test the control circuit for a short to voltage. If the circuit test normal, replace the HVAC control module.
    - If voltage remains less than 1.0V while changing between the commanded states, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the HVAC control module.
    - If voltage is between 1.0V or 11.5V and does not increase when changing between the commanded states, replace the HVAC control module.
6. Ignition OFF, reconnect the harness connector at the blower motor control module. Disconnect the harness connector at the blower motor.
7. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal A of the blower motor control module and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high

resistance. If the circuit tests normal, replace the blower motor control module.

8. Connect a test lamp between the control circuit terminal B and the B+ circuit terminal A.
9. Turn the blower motor on high speed then to low speed. The test lamp intensity should be bright when in high speed and very dim or off when the blower is on low speed.
    - If the test lamp intensity does not vary, test the control circuit for a short to voltage, short to ground, or an open/high resistance. If the circuit tests normal, replace the blower motor control module.
10. If all circuits test normal, test or replace the blower motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Blower Motor Control Module Replacement**
- **Blower Motor Replacement**
- **Control Module References** for ECM, and HVAC control module setup, replacement, and programming

ACTUATOR RECALIBRATION

Calibration Procedure

Use the following steps to perform the calibration update:

1. Install a scan tool.
2. Turn ON the ignition, with the engine OFF.
3. Select HVAC Control Module
4. Select Special Functions
5. Select recalibrate All Motors
6. Select ON, wait 60 seconds.

REPAIR INSTRUCTIONS

HEATER AND AIR CONDITIONING CONTROL REPLACEMENT

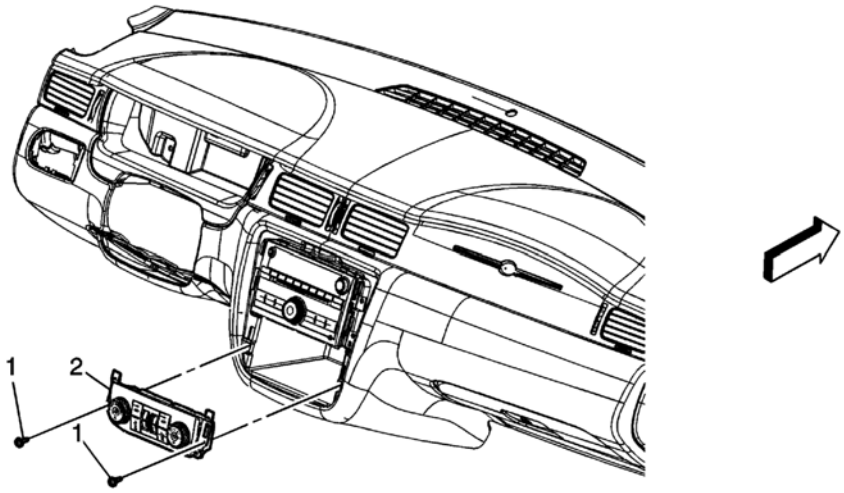


Fig. 4: HVAC Control Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the accessory trim plate. Refer to **Instrument Panel Accessory Trim Plate Replacement** .	
1	Heater and A/C Control Assembly Screw (Qty: 2) **CAUTION:** **Refer to** **Fastener** **Caution** . **TIP:** Disconnect the HVAC control assembly electrical connector. **Tighten** 1.5 N.m (13 lb in)
2	Heater and Air Conditioning Control Assembly Refer to **Control Module References** for programming and setup information.

TEMPERATURE VALVE ACTUATOR REPLACEMENT - RIGHT SIDE

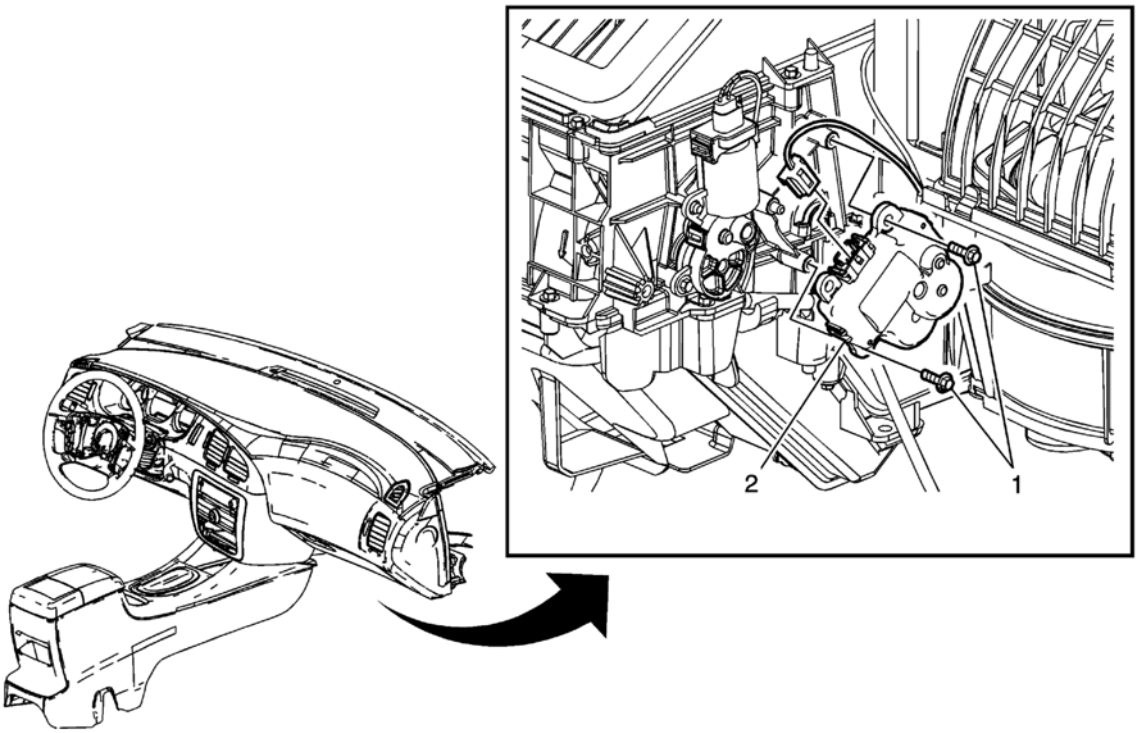


Fig. 5: Right Air Temperature Actuator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	

Callout	Component Name
1. Remove the instrument panel (I/P) compartment inner panel. Refer to **Instrument Panel Compartment Inner Panel Replacement** . 2. Disconnect the right air temperature actuator electrical connector.	
1	Temperature Actuator Screw - Right (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 1.5 N.m (13 lb in)
2	Temperature Actuator - Right **TIP:** Refer to **Control Module References** for programming and setup information.

TEMPERATURE VALVE ACTUATOR REPLACEMENT - LEFT SIDE

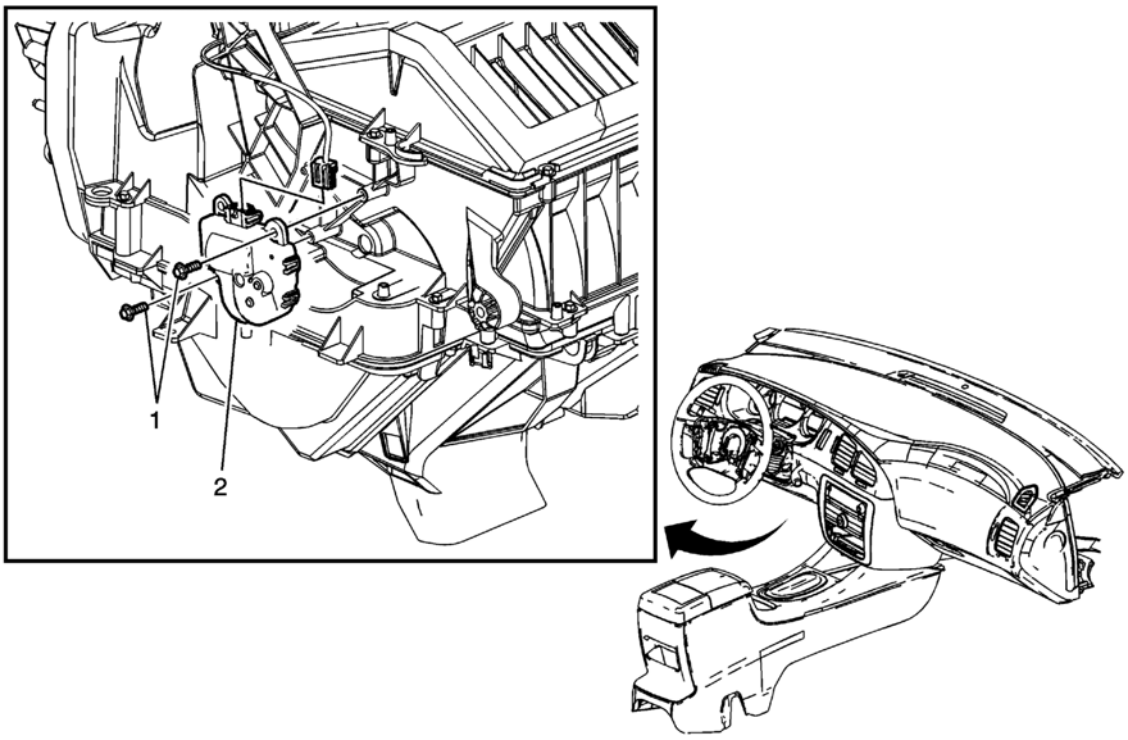


Fig. 6: Left Air Temperature Actuator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the left knee bolster bracket. Refer to **Driver Knee Bolster Bracket Replacement** .	

Callout	Component Name
2. Disconnect the left air temperature actuator electrical connector.	
1	Temperature Actuator Screw - Left (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 1.5 N.m (13 lb in)
2	Temperature Actuator - Left **TIP:** Refer to **Control Module References** for programming and setup information.

MODE VALVE ACTUATOR REPLACEMENT (IMPALA LIMITED)

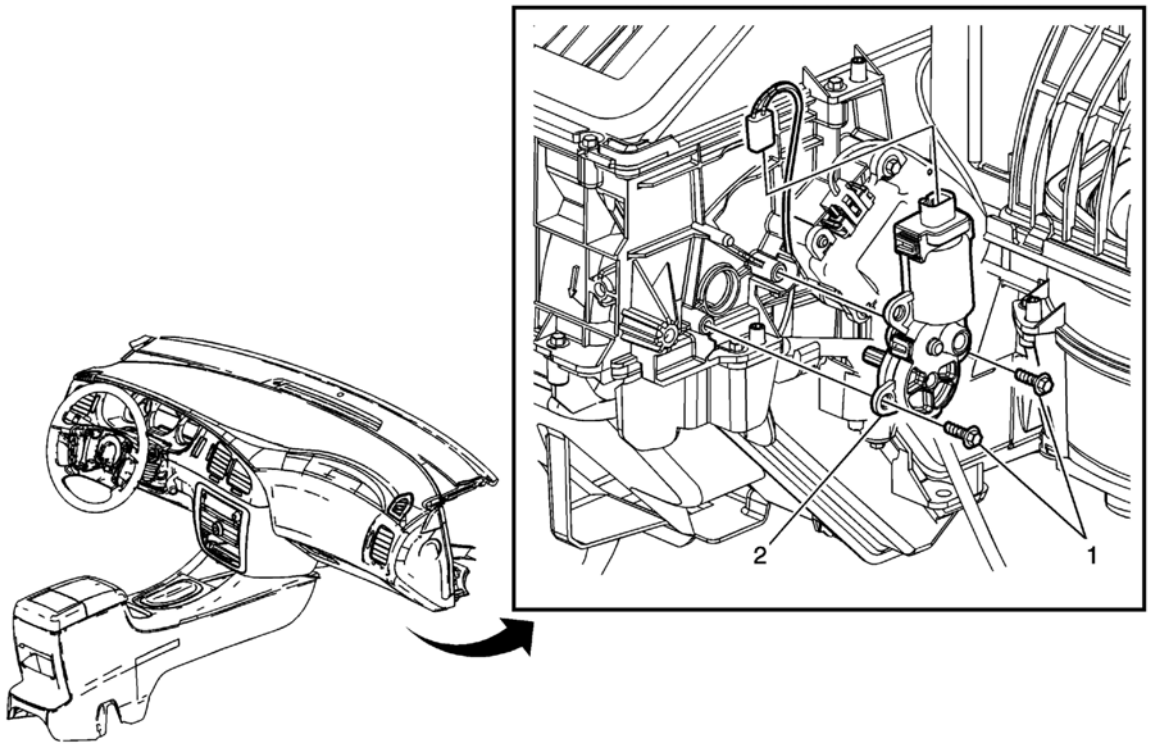


Fig. 7: Mode Actuator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the instrument panel (I/P) inner panel. Refer to **Instrument Panel Compartment Inner Panel Replacement** . 2. Disconnect the mode actuator electrical connector.	

AIR INLET VALVE ACTUATOR REPLACEMENT

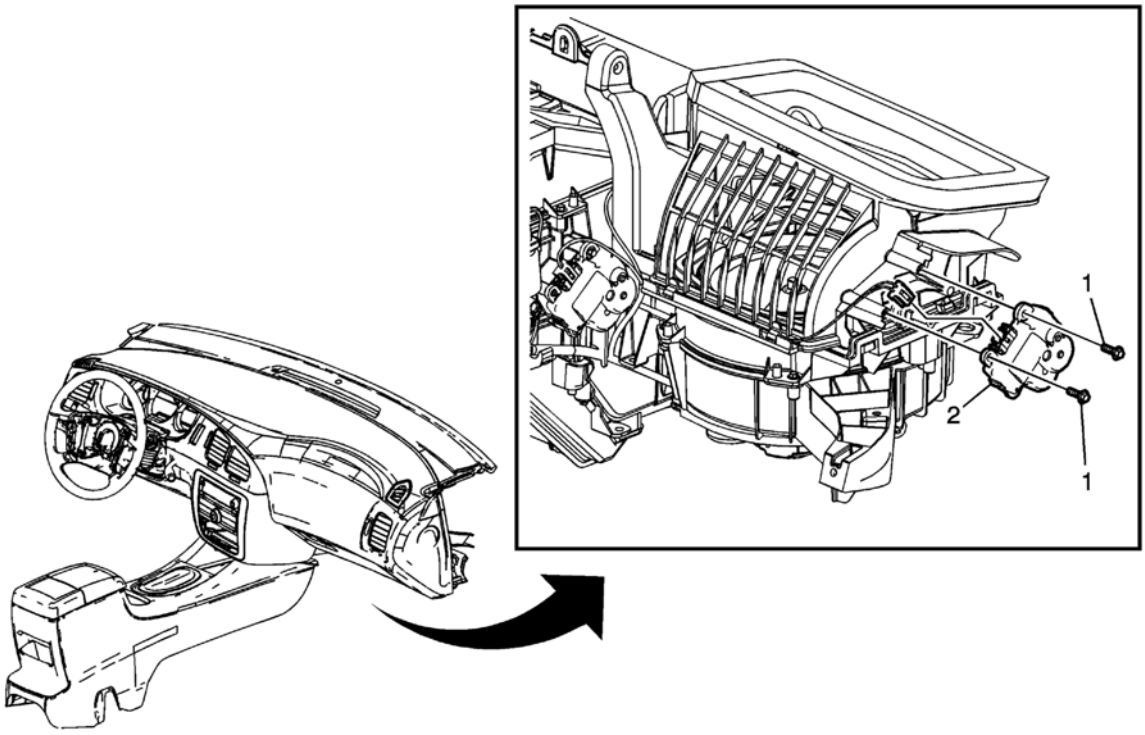


Fig. 8: Recirculation Actuator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the right closeout panel. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** . 2. Disconnect the recirculation actuator electrical connector.	
1	Recirculation Actuator Screw (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 1.5 N.m (13 lb in)
2	Recirculation Actuator **TIP:** Refer to **Control Module References** for programming and setup information.

DESCRIPTION AND OPERATION

AIR DELIVERY DESCRIPTION AND OPERATION

The air delivery controls are divided into 4 areas:

- HVAC Control Components
- Air Speed
- Air Distribution
- Recirculation Operation

HVAC Control Components

HVAC Control Module

The HVAC control module is a GMLAN device that interfaces between the operator and the HVAC system to maintain air temperature and distribution settings. The battery positive voltage circuit provides power that the control module uses for keep alive memory (KAM). If the battery positive voltage circuit loses power, all HVAC DTCs and settings will be erased from KAM. The control module supports the following features:

Feature	Availability
Afterblow	Optional
Purge	No
Personalization	No
Actuator Calibration	Yes

Mode/Recirculation Actuator

The mode/recirculation actuator is a 2 wire bi-directional electric motor. Two control circuits enable the actuator to operate. The control circuits use either a 0 or 12-volt value to coordinate the actuator movement. When the actuator is at rest, both control circuits have a value of 0 volts. In order to move the actuator, the HVAC control module grounds the appropriate control circuit for the commanded direction. The HVAC control module reverses the polarity of the control circuits to move the actuator in the opposite direction.

The HVAC control module determines the door position by counting motor pulses on one of the control circuits. These pulses are small voltage fluctuations that occur when the brush is shorted across 2 commutator contacts as the motor rotates. As the actuator shaft rotates, the HVAC control module monitors the voltage drop across an internal resistance to detect the pulses. The HVAC control module converts the pulses to counts with a range of 0-255 counts. The HVAC control module uses a range of 0-255 counts to index the actuator position.

Mode Valve Assembly

The film valve system has several operating characteristics:

- The cycle time for a mode change will vary based on the starting point of the film valve relative to the requested mode position.
- The maximum time to achieve a mode change occur when the film valve travels between vent and defrost.
- Mode change times may very slightly based on variations in system airflow, temperature and voltage.
- The amount of air rush noise heard when a mode change is requested that causes the film valve to move

through 3 or more primary modes is dependent on blower speed.

- Recalibration will typically occur when the engine is OFF. The actuator noise heard during recalibration may be more noticeable than during normal operation.

Blower Motor Control Processor

The blower motor control module is an interface between the HVAC control module and the blower motor. The blower motor speed control, battery positive and ground circuits enable the control module to operate. The HVAC control module provides a variable voltage signal to the blower motor control module to request the selected blower speed. The blower motor control module provides a pulse width modulation (PWM) ground signal to the blower motor in order to control the blower motor speed. The module supplies 12 volts to the blower motor through the blower motor voltage supply circuit.

Air Speed

The blower motor forces air to circulate within the vehicles interior. The vehicle operator determines the blower motors speed by placing the blower motor switch in a desired speed position. The blower motor will only operate if the blower motor switch is in any position other than OFF, and the ignition switch is in the RUN position, with the exception of afterblow.

Once a blower speed is selected, the blower speed remains constant, until a new speed is selected. When OnStarÂ® System is activated the blower speed will be reduced.

Afterblow

Afterblow is a feature that dries the evaporator core by operating the blower motor after the engine is turned OFF. This reduces the amount of microbial growth that can create undesirable odors.

The following conditions must be met for afterblow to operate:

- The A/C compressor operated for more than 15 minutes.
- The system voltage is at least 11 volts to start and 10 volts to continue to run.
- The ignition has been in the OFF position for at least 20 minutes.
- The outside air temperature is greater than 11Â°C (52Â°F).

Once the above conditions have been met, the blower will turn ON for 5 minutes and run at 30 percent blower speed.

Air Distribution

The HVAC control module controls the mode actuator in order to distribute airflow to a desired outlet. The mode switch provides the vehicle operator with the ability to override the automatic setting. When the mode switch is moved to heater through Defrost positions, the A/C compressor clutch engages and the recirculation actuator will be moved to the Outside Air position. When VENT is pressed, the following will occur:

- The mode valve will be moved to the Panel position.
- The recirculation actuator will follow user request if the blower is ON and the power mode is in Run.
- The A/C compressor will follow user request if the blower is ON and the power mode is in Run.

Recirculation Operation

The HVAC control module controls the air intake through the recirculation actuator. Recirculation is not available when the mode is in heater through defrost. The recirculation LED will flash 3 times indicating recirculation is not available. The operator must activate the blower for Recirculation operation. The A/C compressor will engage while in the recirculation position. Every time the vehicle or HVAC system is turned off, the system will default to outside air unless the mode is in heater through defrost position.

Remote Start

Remote Start Activation

The following describes the HVAC control head functionality upon receiving the remote start active serial data message and a power mode status is set to off/awake. The OAT sensor on manual systems, is utilized to determine the moding of the following features: Blower Mode (Bi-level, Floor, Defrost, Recirc and Rear Defrost. These features are determined by the OAT during activation sequence and are maintained for the duration of engine run time. Calibratable temperatures are utilized to provide low, mid and high temperature ranges for the selectable feature . Blower and mode have the range to select any valid feature positions. When the remote start active serial data is received, ignition-OFF loop HVAC algorithms will act the same as if a run power mode was received, i.e. re-calibration, afterblow, ignition-OFF motor positioning etc. The OFF timer and the ignition ON timer have the functionality as in the Run mode.

Remote Start De-activation

When the remote start is exited, GMLAN power mode equals run mode or remote start engine. In the case of manual settings, the displays will revert to the actual state of operation of the features, on the basis of their normal control algorithms.

AIR TEMPERATURE DESCRIPTION AND OPERATION

The air temperature controls are divided into 4 areas:

- HVAC Control Components
- Heating and A/C Operation
- Engine Coolant
- A/C Cycle

HVAC Control Components

HVAC Control Module

The HVAC control module is a GMLAN device that interfaces between the operator and the HVAC system to maintain air temperature and distribution settings. The battery positive voltage circuit provides power that the control module uses for keep alive memory (KAM). If the battery positive voltage circuit loses power, all HVAC DTCs and settings will be erased from KAM. The control module supports the following features:

Feature	Availability
Afterblow	Optional
Purge	No

Feature	Availability
Personalization	No
Actuator Calibration	Yes

Air Temperature Actuator

The air temperature actuator is a 2-wire bi-directional electric motor. Two control circuits enable the actuator to operate. The control circuits use either a 0-volt or 12-volt value to coordinate the actuator movement. When the actuator is at rest, both control circuits have a value of 0 volts. In order to move the actuator, the HVAC control module grounds the appropriate control circuit for the commanded direction. The HVAC control module reverses the polarity of the control circuits to move the actuator in the opposite direction.

The HVAC control module determines the door position by counting motor pulses on one of the control circuits. These pulses are small voltage fluctuations that occur when the brush is shorted across 2 commutator contacts as the motor rotates. As the actuator shaft rotates, the HVAC control module monitors the voltage drop across an internal resistance to detect the pulses. The HVAC control module converts the pulses to counts with a range of 0-255 counts. The HVAC control module uses a range of 0-255 counts to index the actuator position.

The HVAC control module supplies battery voltage to the A/C compressor. When the A/C switch is pressed, the HVAC control module provides a pulse width modulation (PWM) signal to the A/C compressor in order to command the performance of the A/C compressor. The performance of the A/C compressor is regulated according to adjusted interior temperature on the basis of characteristic lines. Therefore the HVAC control module grounds the A/C compressor with the PWM signal.

A/C Compressor

This A/C system uses a conventional clutch to engage and mechanically turn the compressor, and a variable displacement solenoid valve to alter the amount of displacement created by the turning of the compressor. The HVAC control module supplies battery voltage to the variable displacement solenoid valve. When the A/C switch is pressed, the HVAC control module provides a pulse width modulated (PWM) signal to the variable displacement solenoid valve in order to determine the amount of compressor displacement. The performance of the A/C compressor is regulated according to adjusted interior temperature on the basis of characteristic lines. Therefore the HVAC control module grounds the A/C compressor with the PWM signal.

The A/C compressor is belt driven and operates when the magnetic clutch is engaged. When the A/C switch is pressed, the HVAC control module sends an A/C request message to the ECM via CAN-Bus. The ECM then grounds the A/C compressor clutch relay control circuit, which will switch the A/C compressor clutch relay. Battery voltage is then supplied to the A/C compressor clutch, and the A/C compressor clutch is activated.

A/C Refrigerant Pressure Sensor

The A/C refrigerant pressure sensor is a 3-wire piezoelectric pressure transducer. A 5-volt reference, low reference, and signal circuits enable the sensor to operate. The A/C pressure signal can be between 0-5 volts. When the A/C refrigerant pressure is low, the signal value is near 0 volts. When the A/C refrigerant pressure is high, the signal value is near 5 volts.

The A/C refrigerant pressure sensor protects the A/C system from operating when an excessively high or low pressure condition exists. The powertrain control module (PCM) disables the compressor clutch under the following conditions:

- A/C pressure is more than 3034 kPa (440 psi). The clutch will be enabled after the pressure decreases to less than 2068 kPa (300 psi).
- A/C pressure is less than 241 kPa (35 psi). The clutch will be enabled after the pressure increases to more than 248 kPa (36 psi).

Outside Air Temperature Sensor

The air temperature sensor is a 2-wire negative temperature co-efficient thermistor. A signal and low reference circuit enables the sensor to operate. As the air temperature surrounding the sensor increases, the sensor resistance decreases. The sensor signal decreases as the resistance decreases. The sensor signal varies between 0-5 volts. The HVAC control module converts the signal to a range between 0-255 counts.

The ambient sensor operates within a temperature range between -30 to +51Â°C (-22 to +123.8Â°F). The driver information center (DIC) displays the ambient air temperature that it receives from the HVAC control module through a GMLAN message. If the HVAC control module has determined that the ambient temperature sensor has failed the DIC will display 86Â°C (186Â°F) if shorted to ground and -40Â°C (-40Â°F) if open or shorted to voltage.

The HVAC module controls the temperature displayed on the DIC and the instant update feature as follows:

Condition	Display
When the HVAC module A/C and RECIRCULATION buttons are pressed simultaneously.	Updates temperature display instantly.
At start up with the engine OFF more than 3 hours	Displays actual outside temperature
At start up with the engine OFF less than 3 hours	Displays last stored temperature unless temperature has decreased. The temperature reading is always instantly up dated if ambient air temperature has decreased.
Vehicle moving above 16 km/h (10 mph) for 5 minutes	Updates temperature display at a slow filtered rate.
Vehicle moving at 51 km/h (32 mph) or greater for 2.5 minutes	Updates temperature display rapidly.
When the ambient air decreases.	Updates temperature display rapidly.

Heating and A/C Operation

The purpose of the heating and A/C system is to provide heated and cooled air to the interior of the vehicle. The A/C system will also remove humidity from the interior and reduce windshield fogging. The vehicle operator can determine the passenger compartment temperature by adjusting the air temperature switch. Regardless of the temperature setting, the following can affect the rate that the HVAC system can achieve the desired temperature:

- Recirculation actuator setting
- Difference between inside and desired temperature
- Difference between ambient and desired temperature
- Blower motor speed setting

- Mode setting

The A/C system can be engaged by either pressing the A/C switch or by selecting the following modes:

- Max A/C
- Heater
- Mix-Blend
- Front Defrost

The A/C LED will not illuminate unless the driver presses the A/C request switch on the HVAC control module. Otherwise, the A/C system may be running without the A/C LED indicator illuminated while in Defrost mode. The following conditions must be met in order for the powertrain control module (PCM) to turn ON the compressor clutch:

- The ambient air temperature is above 4Â°C (40Â°F).
- The engine coolant temperature (ECT) is less than 124Â°C (255Â°F).
- The A/C pressure is between 241-3034 kPa (35-440 psi).

Once engaged, the compressor clutch will be disengaged for the following conditions:

- The throttle position is 100 percent.
- The A/C pressure is more than 3034 kPa (440 psi).
- The A/C pressure is less than 241 kPa (35 psi).
- The engine coolant temperature (ECT) is more than 124Â°C (255Â°F).
- The engine speed is more than 5480 RPM for at least 409 seconds.
- A transmission shift has occurred.
- The PCM detects excessive torque load.
- The PCM detects insufficient idle quality.
- The PCM detects a hard launch condition.
- Outside air temperature is detected to be below 38Â° F by the OAT sensor if equipped.
- The blower switch is turned OFF.

When the A/C compressor clutch is disengaged for any of these reasons, the A/C indicator LED will flash indicating A/C is not functioning. When the compressor clutch disengages, the compressor clutch diode protects the electrical system from a voltage spike.

Remote Start

Remote Start Activation

The following describes the HVAC control head functionality upon receiving the remote start active serial data message and a power mode status is set to OFF/awake. Outside ambient temperature, is utilized to determine the moding of the following features: Blower Mode (Bi-level, Floor, Defrost, Recirc and Rear Defrost. These features are determined by the OAT during activation sequence and are maintained for the duration of engine run time. Calibratable temperatures are utilized to provide low, mid and high temperature ranges for the selectable feature. Blower and mode have the range to select any valid feature positions. When the remote start

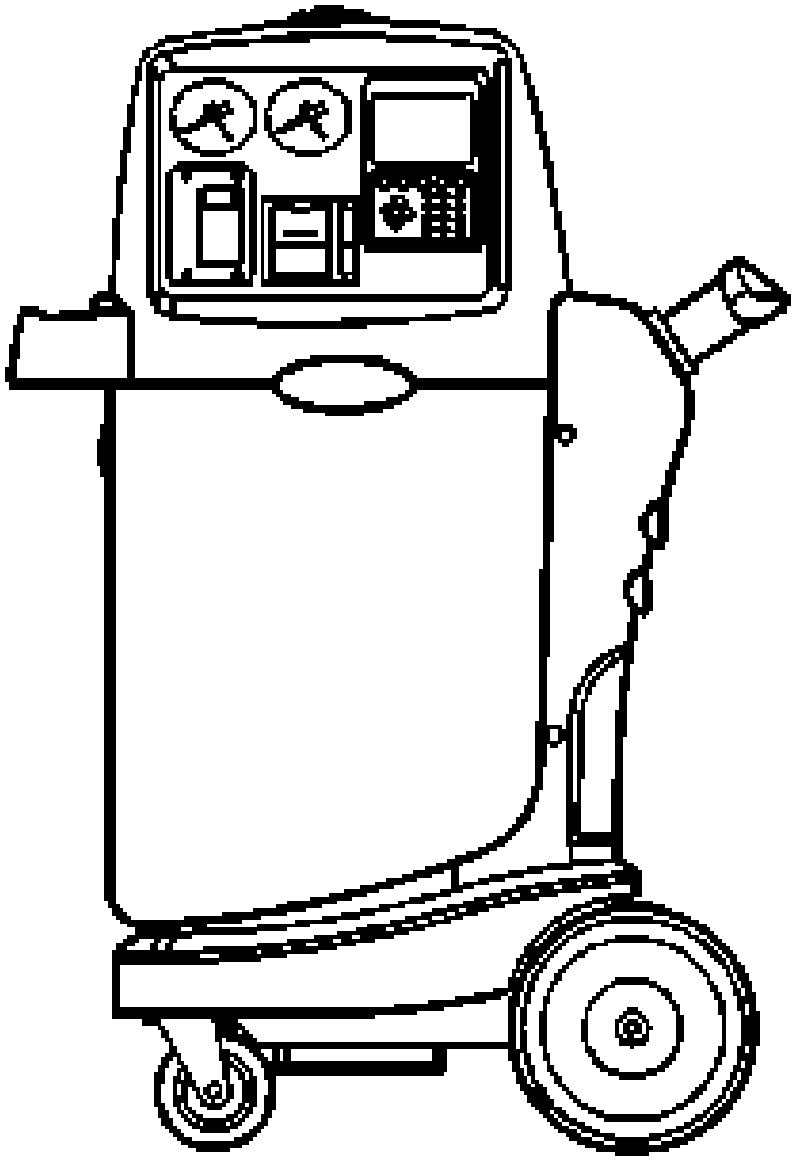
active serial data is received, ignition-OFF loop HVAC algorithms will act the same as if a run power mode was received, i.e. re-calibration, afterblow, ignition-OFF motor positioning etc. The OFF timer and the ignition ON timer have the functionality as in the Run mode.

Remote Start De-activation

When the remote start is exited, class 2 power mode equals run mode or remote start engine. In the case of manual settings, the displays will revert to the actual state of operation of the features, on the basis of their normal control algorithms.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	J 43600 ACR 2000 Air Conditioning Service Center

ACCESSORIES AND EQUIPMENT

Lighting - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Brake Pedal Position Sensor Bolt	2 N.m	18 lb in
Fog Lamp Nuts	2.5 N.m	22 lb in
Headlamp Bolts	2 N.m	18 lb in
High Mounted Stop Lamp Bolts	2 N.m	18 lb in
HVAC Control Screws	2.5 N.m	22 lb in
License Lamp Screws	2 N.m	18 lb in
Tail Lamp Screws	2 N.m	18 lb in

SCHEMATIC WIRING DIAGRAMS

HEADLIGHTS/DAYTIME RUNNING LIGHTS (DRL) WIRING SCHEMATICS

Switches

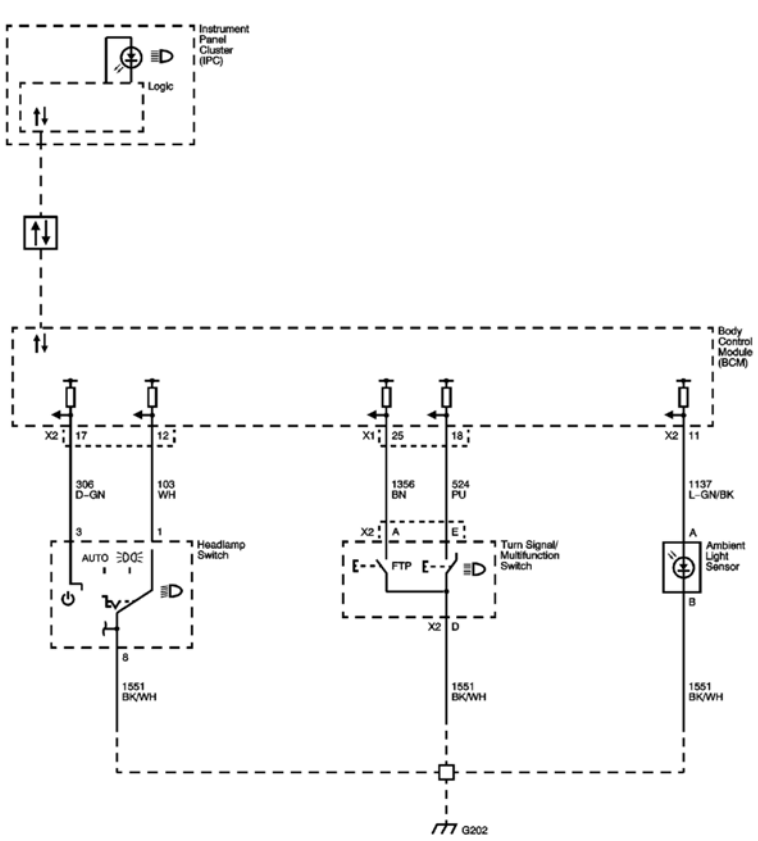


Fig. 1: Switches Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

Headlamps

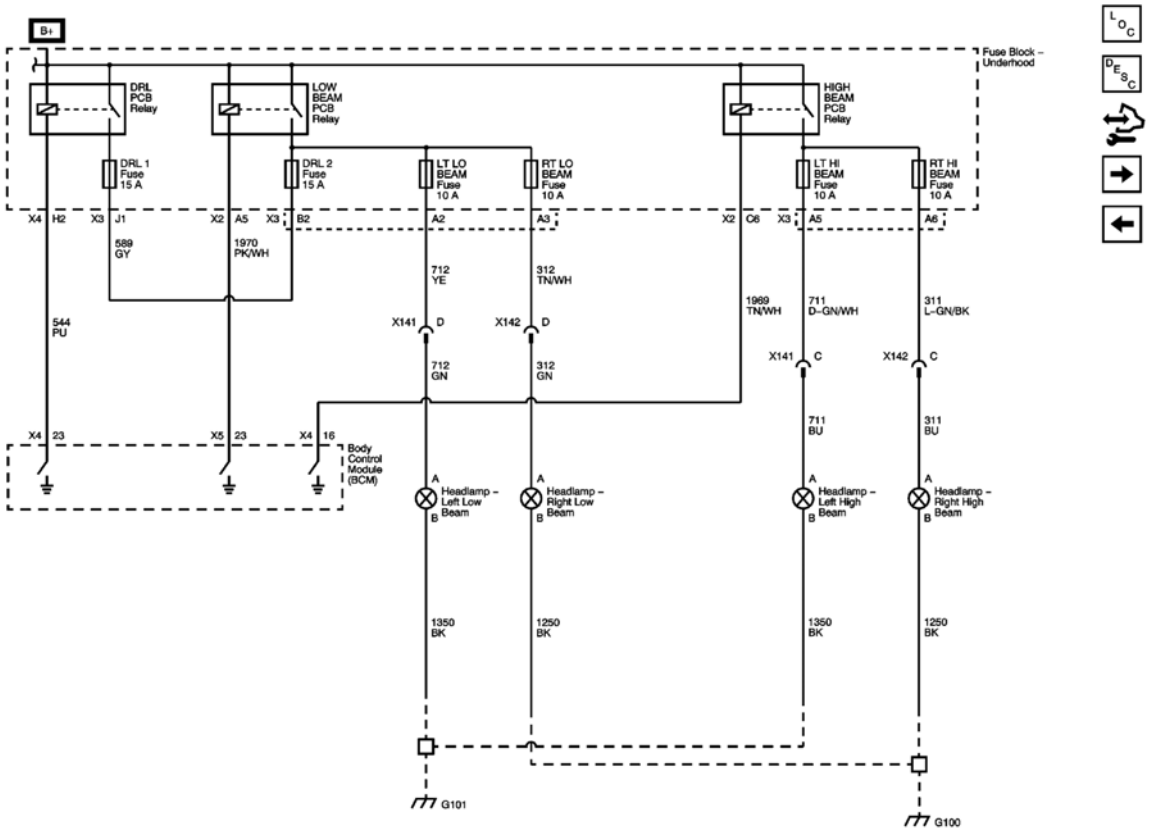


Fig. 2: Headlamps Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Headlamps (9C1 or 9C3)

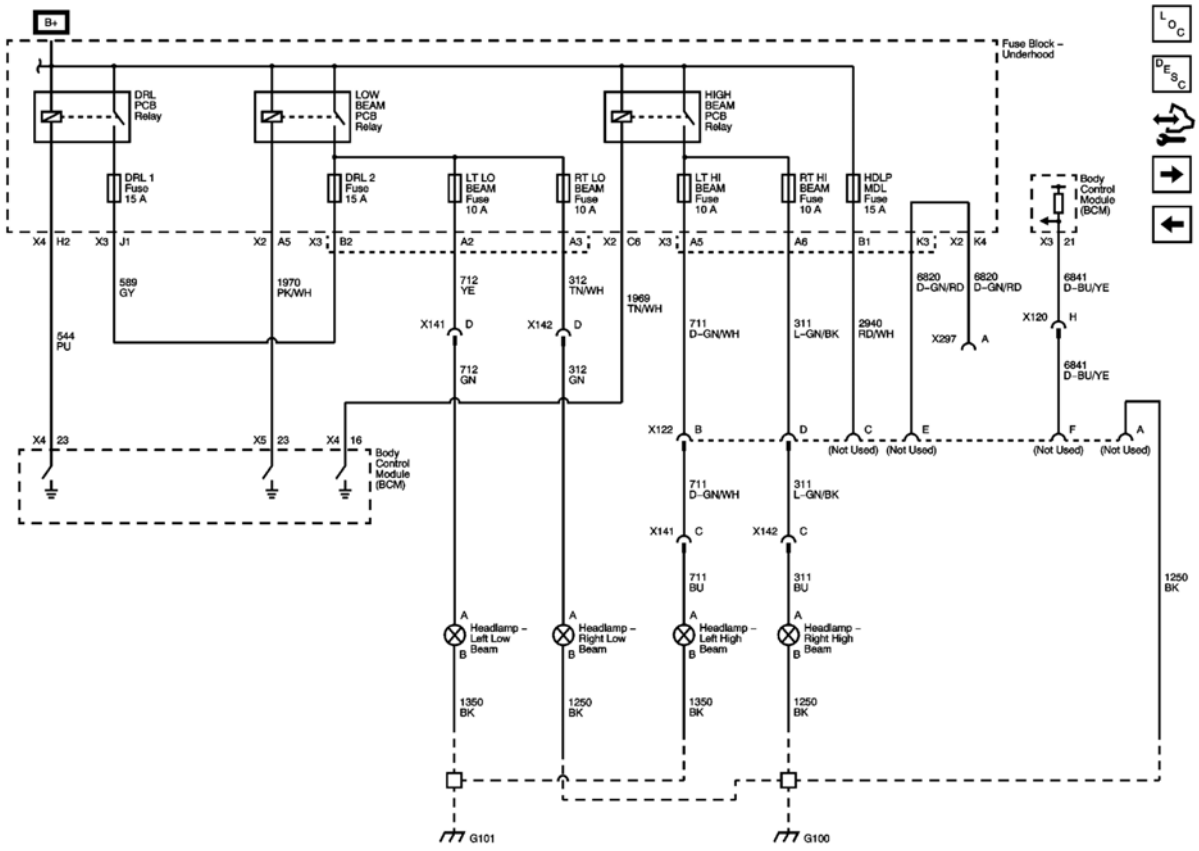


Fig. 3: Headlamps Wiring Schematic (9C1 or 9C3)

Courtesy of GENERAL MOTORS COMPANY

Headlamps (6J7)

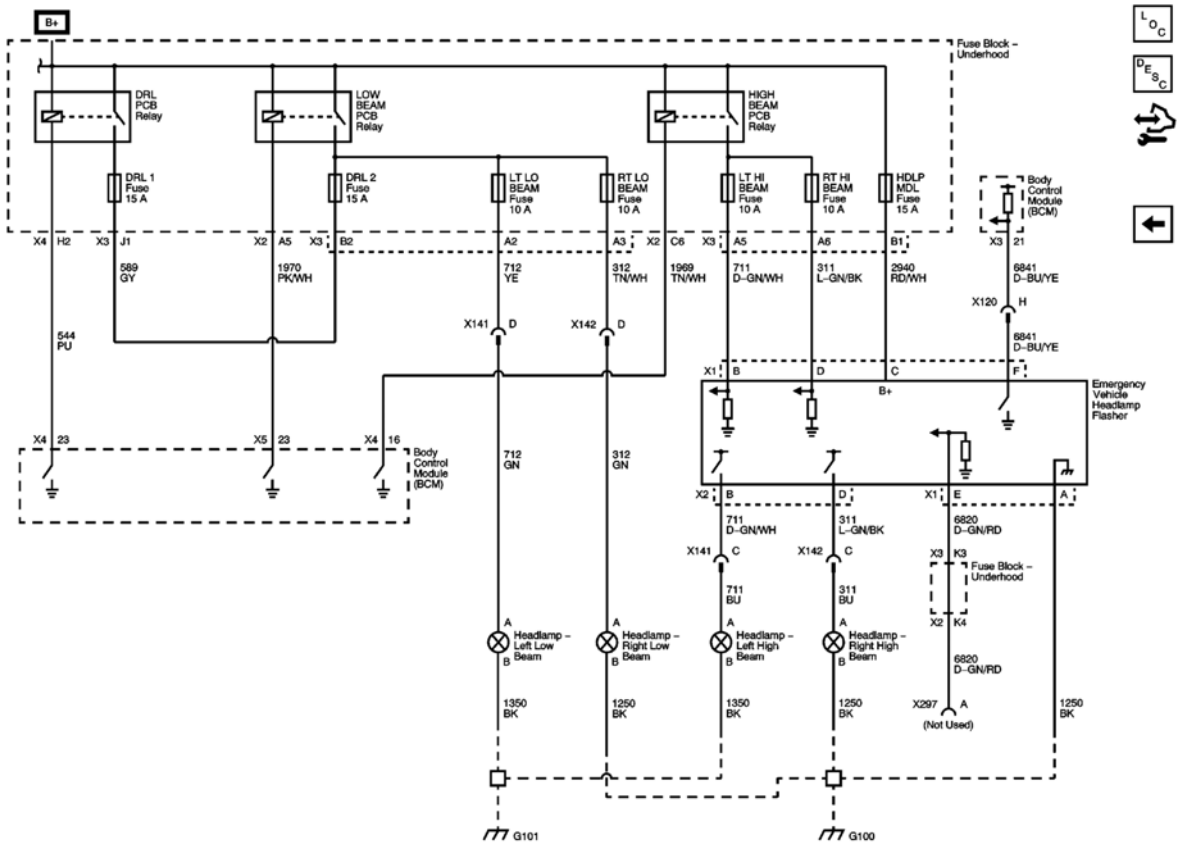


Fig. 4: Headlamps Wiring Schematic (6J7)
Courtesy of GENERAL MOTORS COMPANY

FOG LIGHTS WIRING SCHEMATICS

Fog Lights

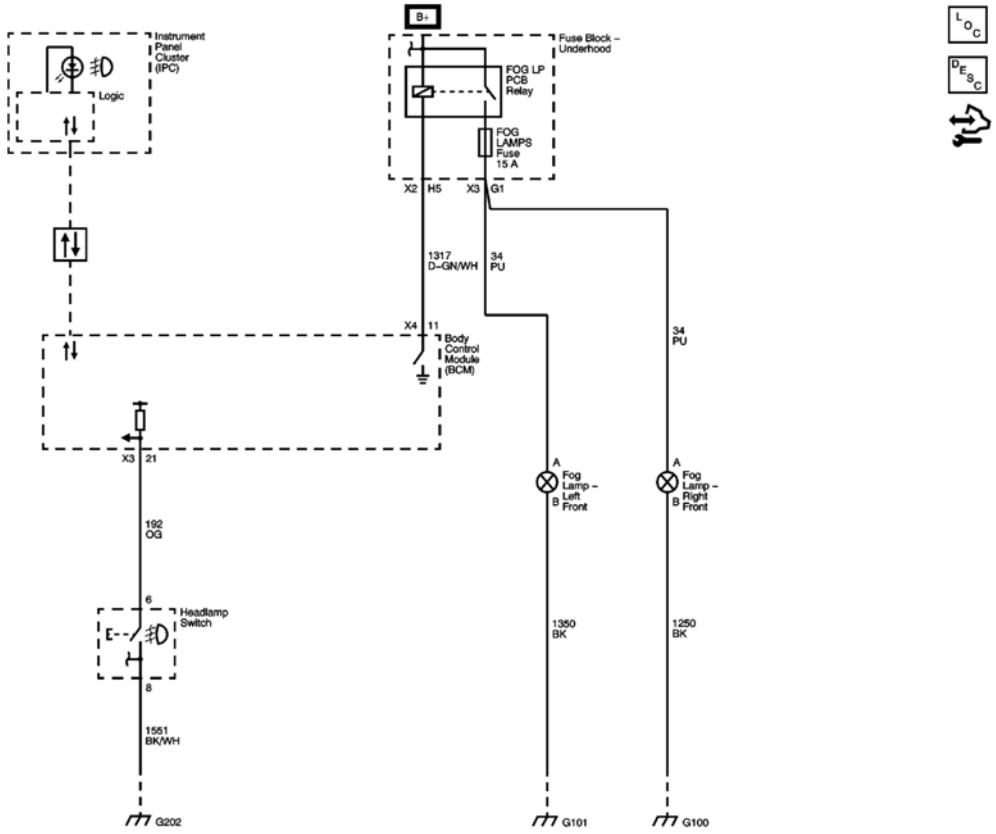


Fig. 5: Fog Lights Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

EXTERIOR LIGHTS WIRING SCHEMATICS

Turn Signal, Hazard, and Stop Lamps Inputs

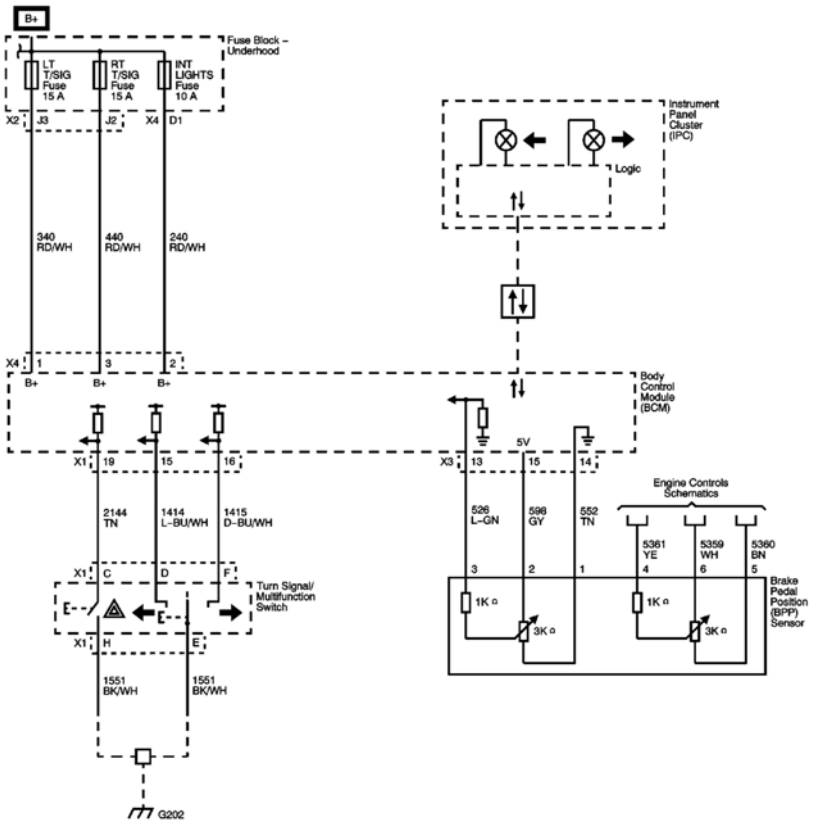


Fig. 6: Turn Signal, Hazard, and Stop Lamps Inputs Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Turn Signal, Hazard, and Stop Lamps Outputs

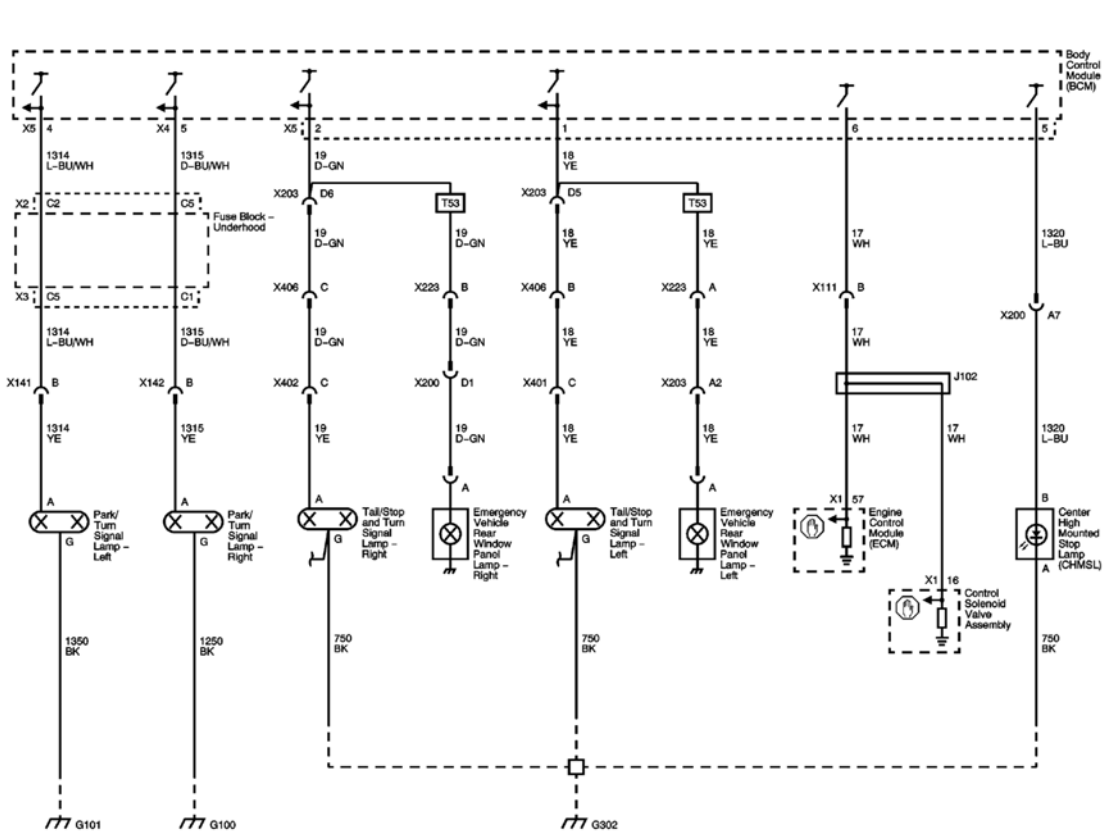


Fig. 7: Turn Signal, Hazard, and Stop Lamps Outputs Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Park Lamps (1 of 2)

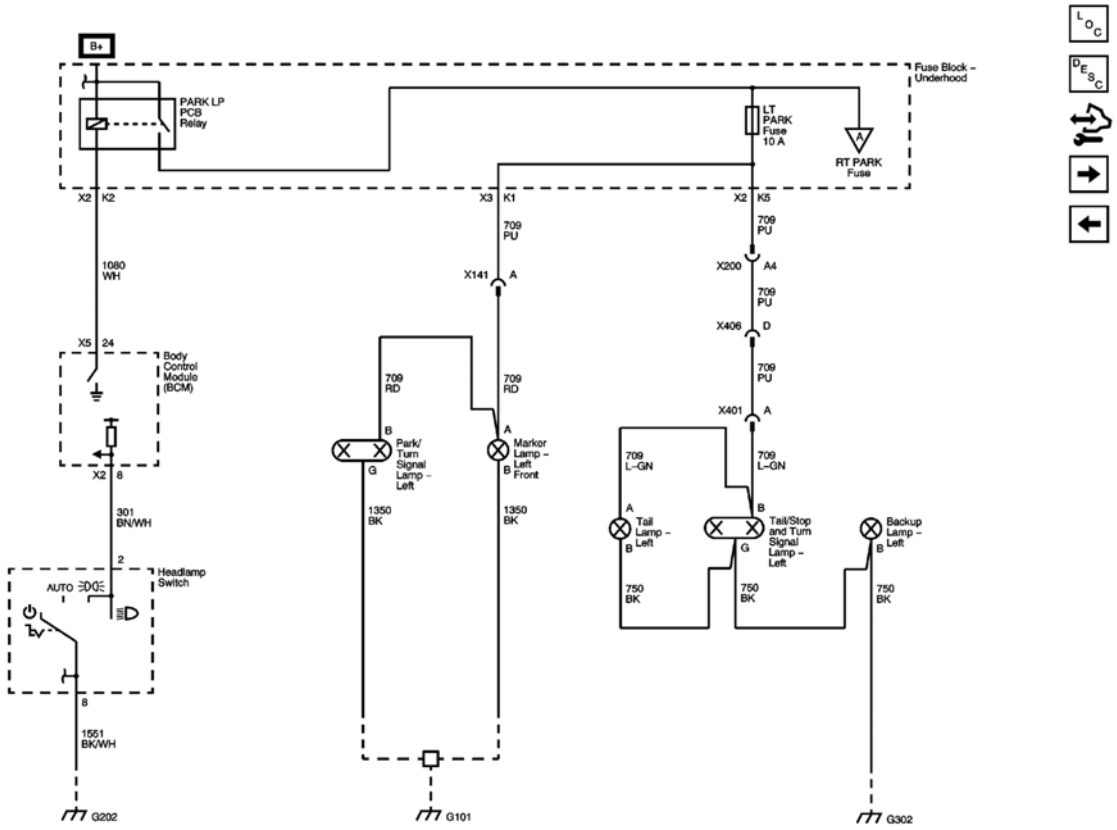


Fig. 8: Park Lamps Wiring Schematic (1 of 2)
Courtesy of GENERAL MOTORS COMPANY

Park Lamps (2 of 2)

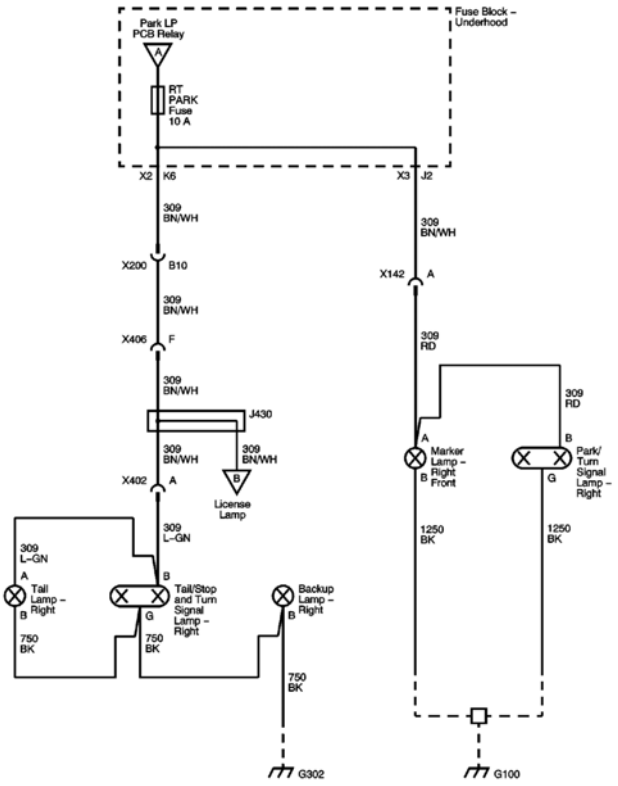


Fig. 9: Park Lamps Wiring Schematic (2 of 2)
Courtesy of GENERAL MOTORS COMPANY

Backup and License Lamps

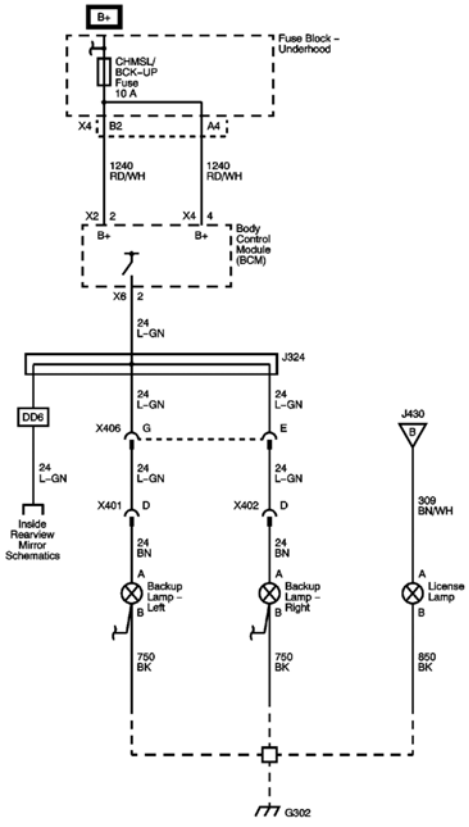


Fig. 10: Backup and License Lamps Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Emergency Vehicle Rear Compartment Lid Lamps and Spot Lamps (T53, 7X6, 7X7)

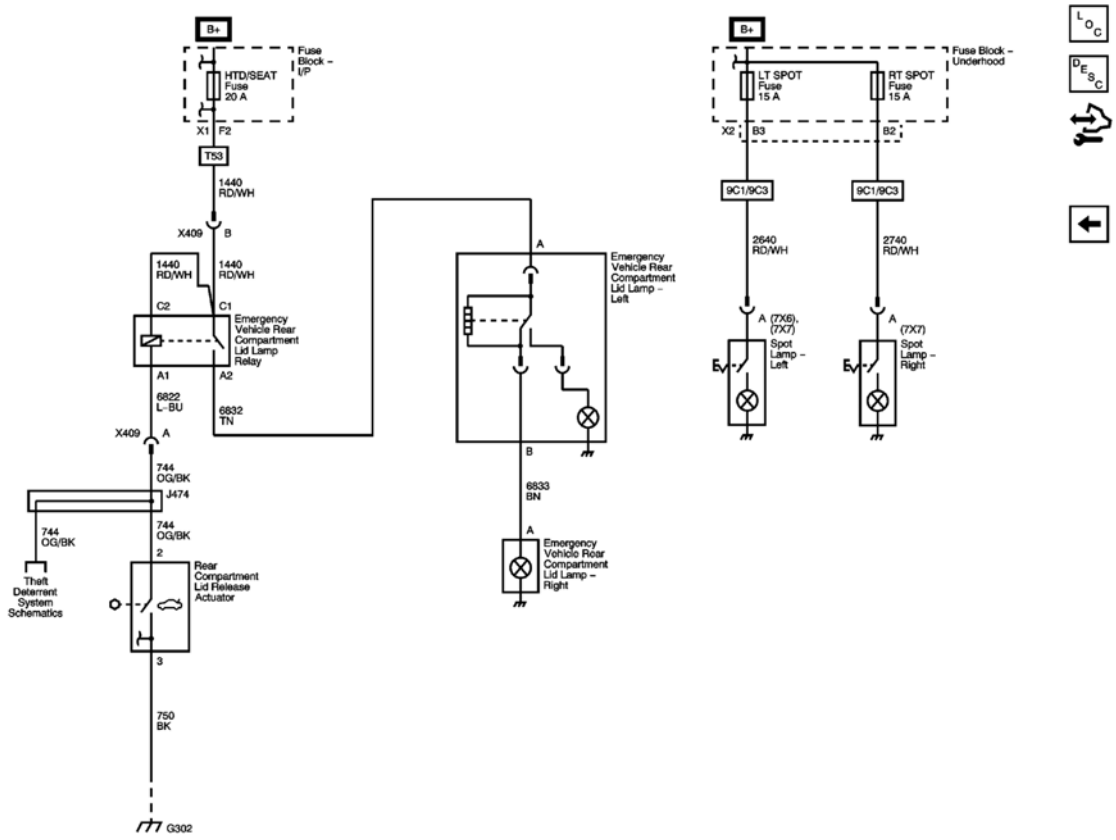


Fig. 11: Emergency Vehicle Rear Compartment Lid Lamps and Spot Lamps Wiring Schematic (T53, 7X6, 7X7)
Courtesy of GENERAL MOTORS COMPANY

INTERIOR LIGHTS WIRING SCHEMATICS

Switches

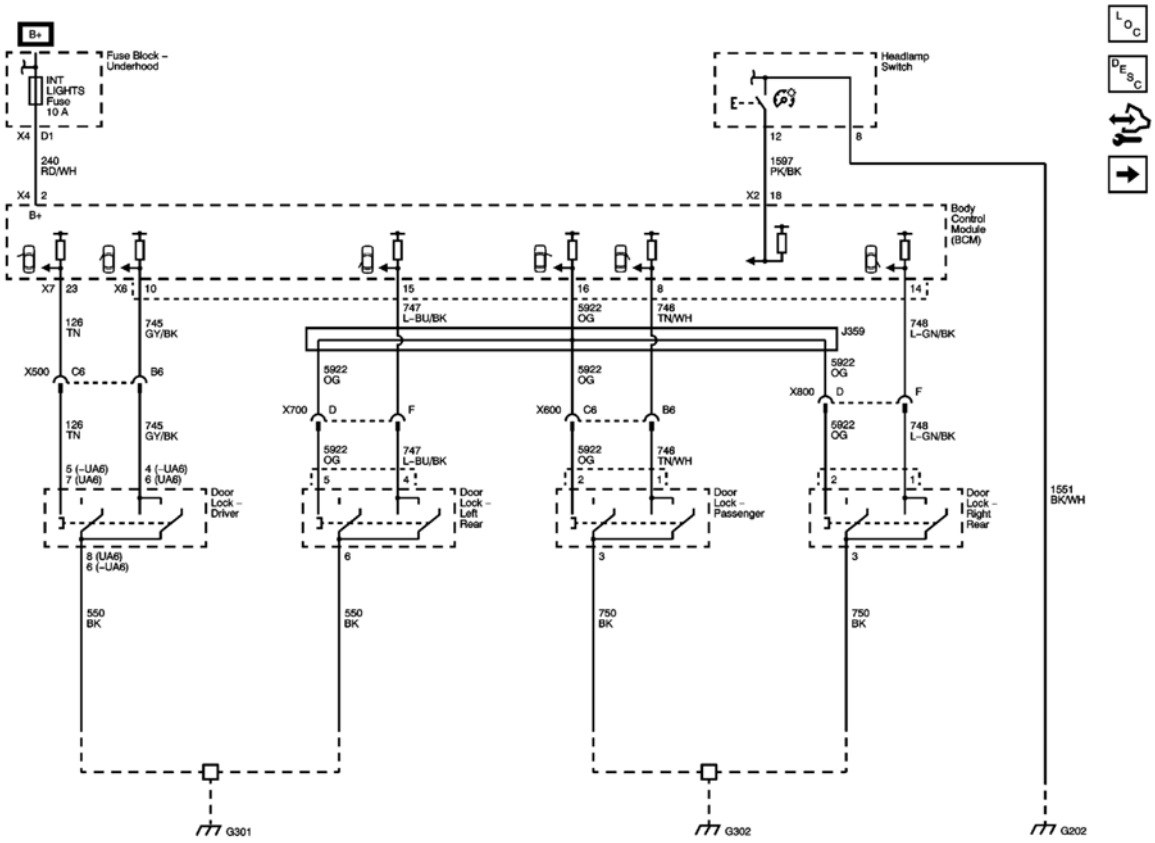


Fig. 12: Switches Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Passenger and Rear Compartment Lamps

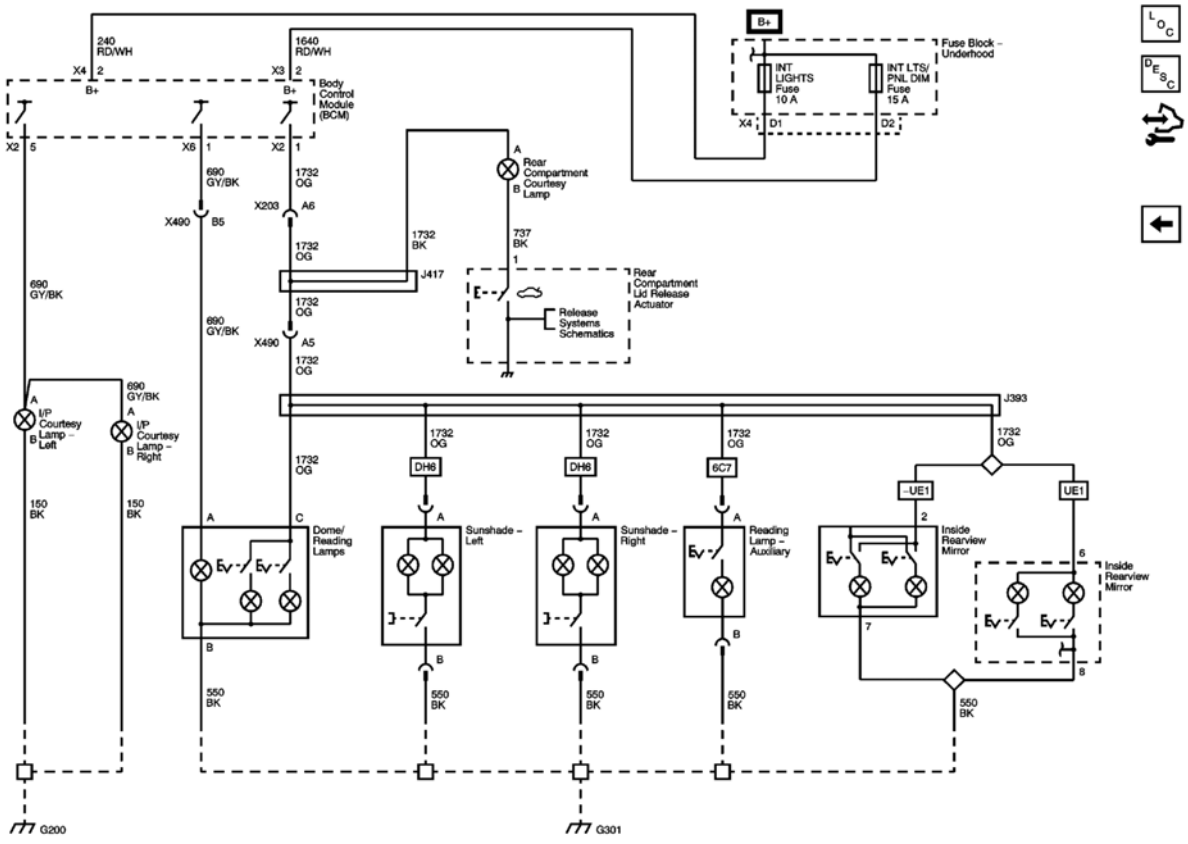


Fig. 13: Passenger and Rear Compartment Lamps Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

INTERIOR LIGHTS DIMMING WIRING SCHEMATICS

Doors, Headlamp Switch, Instrument Panel Cluster

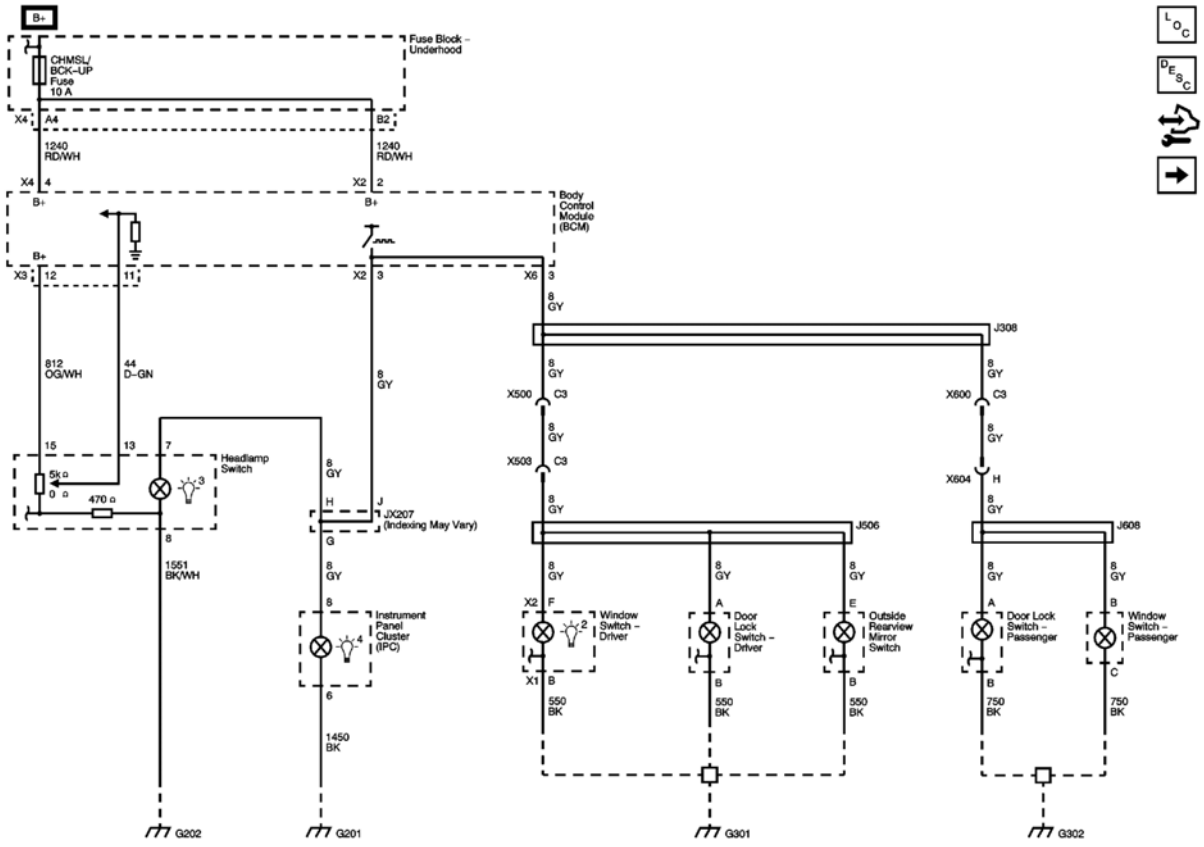


Fig. 14: Doors, Headlamp Switch, Instrument Panel Cluster Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Driver Information Center, HVAC Control Module, Steering Wheel Controls

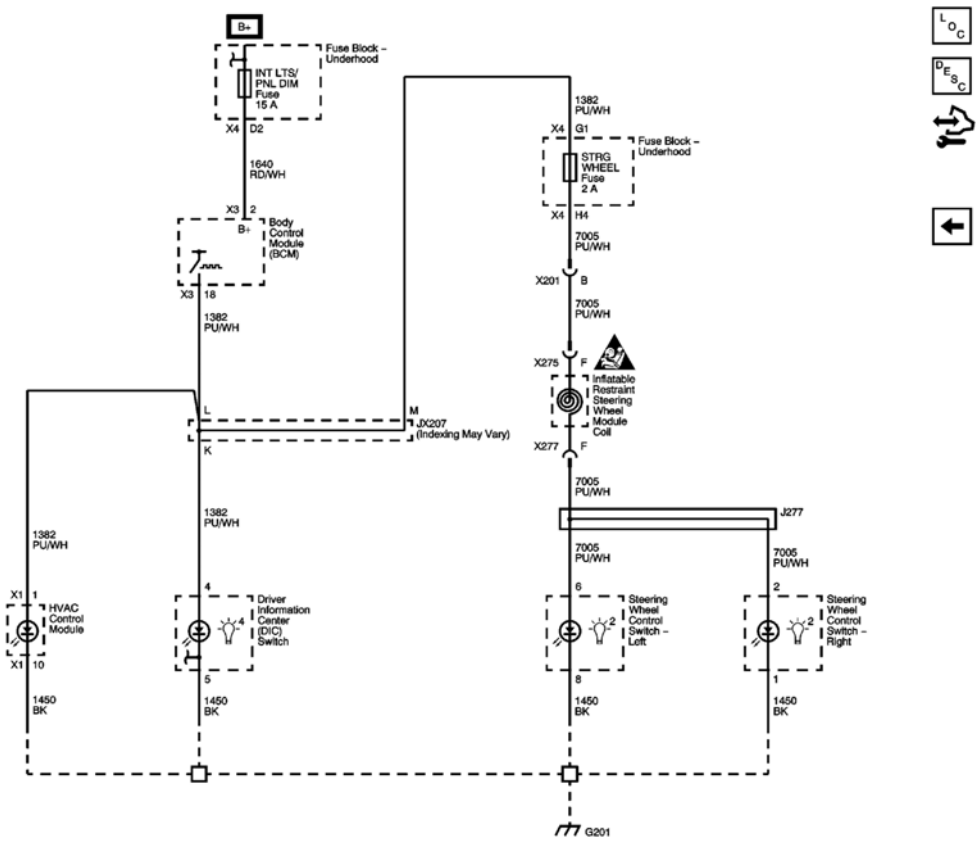


Fig. 15: Driver Information Center, HVAC Control Module, Steering Wheel Controls Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B1395: DEVICE VOLTAGE OUTPUT 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1395 03

Device Voltage Output 1 Circuit Voltage Below Threshold

DTC B1395 07

Device Voltage Output 1 Circuit Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Body Control Module (BCM) B+ Terminal 3 X3	B1395 03, B3600 03	B1395 03, B3600 03	-	-
I/P Dimmer Switch B+ Voltage Reference	B1395 03, B3600 03	B3600 03	-	B1395 07
I/P Dimmer Switch Signal	B3600 03	B3600 03	1	-
1. Interior Backlighting Malfunction				

Circuit/System Description

The instrument panel (I/P) lamp dimmer switch is used to increase and decrease the brightness of the interior backlighting components. The I/P dimmer switch provides a voltage signal that will increase as the brightness of the lights are increased and decrease as the brightness of the lights are decreased. The body control module (BCM) provides a low reference signal and a B+ voltage reference to the I/P dimmer switch. When the I/P dimmer switch is placed in the desired position, the dimmed voltage setting is applied from the I/P dimmer switch through the I/P dimmer switch signal circuit to the BCM. The BCM interprets the signal and applies a pulse width modulated (PWM) voltage to the I/P lamps supply voltage circuit and the interior backlighting components dim to the requested level.

Conditions for Running the DTC

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

B1395 03

The DTC will set for the following conditions:

- The BCM detects a short to ground in the I/P dimmer switch voltage reference circuit.
- The BCM detects a short to ground or an open/high resistance in the INT LTS/PNL DIM fuse B+ circuit.

B1395 07

The DTC will set when the BCM detects a short to voltage in the I/P dimming voltage reference circuit or the vehicles system voltage exceeds the normal operating range of 16 volts.

Actions Taken When the DTC Sets

- The I/P dimmer switch will not operate.
- The I/P dimming lamps will not illuminate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, observe the scan tool Dimming Control Reference voltage. The reading should display 2.5 volts or greater.

- If less than the specified range, refer to I/P Dimming Control Malfunction.
- If within the specified range, refer to I/P Dimmer Switch Malfunction.

Circuit/System Testing

I/P Dimmer Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the headlamp switch.
2. Ignition OFF, verify that a test lamp illuminates between B+ and the ground circuit terminal 8.
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. Ignition ON, test for B+ between the voltage reference circuit terminal 15 and ground.
    - If less than the specified value, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal 13 and the voltage reference circuit terminal 15. Verify the scan tool Dimming Control Signal parameter is greater than 2.5 volts.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the headlamp switch.

I/P Dimming Control Malfunction

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 3 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. If all circuit tests normal, replace the BCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Headlamp Switch Replacement (Impala Limited)**
- **Control Module References** for BCM replacement, setup, and programming

DTC B2530: FRONT FOG LAMP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2530 00

Front Fog Lamp Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fog Lamp Switch Signal	2	2	2	-
Fog Lamp Relay Control	1	1	B2530 00	-
Fog Lamp Control	1	1	1	-
Fog Lamp - LF Ground	-	1	-	-
Fog Lamp - RF Ground	-	1	-	-
Headlamp Switch Ground	-	2	-	-
1. Front Fog Lamps Malfunction 2. Front Fog Lamp Switch Malfunction				

Circuit/System Description

The fog lamp relay is supplied with battery voltage at all times. The fog lamp switch signal circuit is grounded momentarily by pressing the fog lamp switch. The body control module (BCM) energizes the fog lamp relay by applying ground to the fog lamp relay control circuit. When the fog lamp relay is energized, the relay switch contacts close and battery voltage is applied through the FOG LAMPS fuse to the fog lamp supply voltage circuit which illuminates the fog lamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Fog lamps ON.

Conditions for Setting the DTC

The BCM detects a short to voltage in the fog lamp relay control circuit.

Actions Taken When the DTC Sets

When the DTC is present, the fog lamps will not operate when the park lamps are ON and the front fog lamp switch is active.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Fog Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block.
2. Connect a test lamp between B+ and the control circuit terminal H5.
3. Command the Fog Lamps ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.

- If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

4. If all circuits test normal, replace the underhood fuse block.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B2545: BACKUP LAMPS

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2545 00

Backup Lamps Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Body Control Module (BCM) B+ Terminal 2 X2	B2545 00, B2652 00	B2652 00	-	-
Body Control Module (BCM) B+ Terminal 4 X4	B2545 00, B2652 00	B2545 00	-	-
Backup Lamps Control	B2545 00	1	1	-
Backup Lamp - Left Ground	-	1	-	-
Backup Lamp - Right Ground	-	1	-	-
1. Backup Lamps Malfunction				

Circuit/System Description

When the transmission is placed in the REVERSE position, the transmission control module (TCM) sends a serial data message to the body control module (BCM). The message indicates that the gear selector is in the REVERSE position. The BCM applies battery voltage to the backup lamps and inside rearview mirror. Once the driver moves the gear selector out of the REVERSE position, a message is sent by the TCM via serial data requesting the BCM to remove battery voltage from the backup lamp control circuit. The engine may need to be running for the backup lamps to function.

Conditions for Running the DTC

Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

DTC B2545 00 will set when one of the following conditions exits:

- The BCM detects a short to ground in the backup lamps control circuit.
- The BCM detects a short to ground or an open/high resistance in the BCM B+ circuit terminal 4 X4.

Actions Taken When the DTC Sets

When the DTC is present, the backup lamps will not operate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

With DD6

1. Ignition OFF, disconnect the X2 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X2 harness connector at the BCM.

4. Disconnect the X4 harness connector at the BCM.
5. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 4 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
6. Ignition OFF, connect the X4 harness connector at the BCM.
7. Disconnect the harness connector at the inside rearview mirror.
8. Connect a test lamp between the control circuit terminal 9 and ground.
9. Command the backup lamps ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
10. Ignition OFF, connect the harness connector at the inside rearview mirror.
11. Disconnect the harness connector at the inoperative backup lamp.
12. Ignition OFF, exterior lamps OFF, test for less than 5 Ω between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
13. Connect a test lamp between the control circuit terminal A and ground.
14. Command the Backup Lamps ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
15. If all circuits test normal, test or replace the inoperative backup lamp.

Without DD6

1. Ignition OFF, disconnect the X2 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X2 harness connector at the BCM.
4. Disconnect the X4 harness connector at the BCM.
5. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 4 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
6. Ignition OFF, connect the X4 harness connector at the BCM.
7. Disconnect the harness connector at the inoperative backup lamp.
8. Ignition OFF, exterior lamps OFF, test for less than 5 Ω between the ground circuit terminal B and

ground.

- If greater than the specified range, test the ground circuit for an open/high resistance.

9. Connect a test lamp between the control circuit terminal A and ground.
10. Command the Backup Lamps ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
11. If all circuits test normal, test or replace the inoperative backup lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Backup Lamp Bulb Replacement**
- **Inside Rearview Mirror Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B2575: HEADLAMP CONTROL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2575 00

Headlamp Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Flash to Pass Switch Signal	1	1	1	-
Headlamp Switch High Beam Signal	1	1	1	-
Headlamp Switch Headlamps ON Signal	B257A 00	1	B257A 00	-
Headlamp Switch Headlamps OFF Signal	B257A 00	1	B257A 00	-
Park Lamp Switch Park Lamps ON Signal	B257A 00	B257A 00	B257A 00	-
Headlamp High Beam Relay Control	1	1	B2580 00	-
Headlamp Low Beam Relay Control	1	1	B2575 00	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
LF High Beam Headlamp Control	1	1	1	-
LF Low Beam Headlamp Control	1	1	1	-
RF High Beam Headlamp Control	1	1	1	-
RF Low Beam Headlamp Control	1	1	1	-
LF Headlamp Ground	-	1	-	-
RF Headlamp Ground	-	1	-	-
Headlamp Switch Ground	-	1	-	-
Turn Signal/Multifunction Switch Ground	-	1	-	-
1. Headlamps Malfunction				

Circuit/System Description

When the headlamp switch is placed in the headlamp position, ground is applied to the body control module (BCM) through the headlamp low beam signal circuit. The BCM then applies ground to the headlamp low beam relay control circuit which energizes the low beam relay. With the low beam relay energized, the switch contacts close allowing battery voltage to flow through the LO BEAM fuses to the low beam headlamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Headlamps ON.

Conditions for Setting the DTC

The BCM detects a short to voltage in the headlamp low beam relay control circuit.

Action Taken When the DTC Sets

The low beam headlamps will not operate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block.
2. Connect a test lamp between B+ and the control circuit terminal A5.
3. Command the Low Beams ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, replace the underhood fuse block.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B257A: HEADLAMP SWITCH INPUT SIGNAL MISMATCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B257A 00

Headlamp Switch Input Signal Mismatch

Diagnostic Fault Information

Circuit	Short to	Open/High	Short to	Signal

	Ground	Resistance	Voltage	Performance
Flash to Pass Switch Signal	1	1	1	-
Headlamp Switch High Beam Signal	1	1	1	-
Headlamp Switch Headlamps ON Signal	B257A 00	1	B257A 00	-
Headlamp Switch Headlamps OFF Signal	B257A 00	1	B257A 00	-
Park Lamp Switch Park Lamps ON Signal	B257A 00	B257A 00	B257A 00	-
Headlamp High Beam Relay Control	1	1	B2580 00	-
Headlamp Low Beam Relay Control	1	1	B2575 00	-
LF High Beam Headlamp Control	1	1	1	-
LF Low Beam Headlamp Control	1	1	1	-
RF High Beam Headlamp Control	1	1	1	-
RF Low Beam Headlamp Control	1	1	1	-
LF Headlamp Ground	-	1	-	-
RF Headlamp Ground	-	1	-	-
Headlamp Switch Ground	-	1	-	-
Turn Signal/Multifunction Switch Ground	-	1	-	-
1. Headlamps Malfunction				

Circuit/System Description

When the headlamp switch is placed in the AUTO position, the body control module (BCM) receives a ground signal through the headlamp switch headlamps OFF signal circuit. The headlamp switch headlamps ON signal circuit and the park lamp switch signal circuit are both open and have no ground signal. When the headlamp switch is placed in the PARK or HEAD position, the BCM will receive a ground signal through the headlamp switch headlamps ON signal circuit and the park lamp switch signal circuit. The headlamp switch headlamps OFF signal circuit will be open and have no ground signal

Conditions for Running the DTC

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

The BCM receives a mismatched signal between the headlamps OFF signal circuit, the headlamp switch headlamps ON signal circuit, and the park lamp switch ON signal circuit.

Action Taken When the DTC Sets

The BCM disregards the headlamp switch input and defaults to automatic headlamp function.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the headlamp switch.
2. Ignition ON, test for B+ between the signal circuits listed below and ground.
    - Headlamps ON signal terminal 1
    - Park lamp ON signal terminal 2
    - Headlamp OFF signal terminal 3
    - If less than the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
3. Install a 3A fused jumper wire between the signal circuit terminal 2 and ground. Verify the scan tool Parklamp Switch parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. If all circuits test normal, test or replace the headlamp switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Headlamp Switch Replacement (Impala Limited)**
- **Control Module References** for BCM replacement, setup, and programming

DTC B2580: HEADLAMP HIGH BEAM CONTROL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2580 00

Headlamp High Beam Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Flash to Pass Switch Signal	1	1	1	-
Headlamp Switch High Beam Signal	1	1	1	-
Headlamp Switch Headlamps ON Signal	B257A 00	1	B257A 00	-
Headlamp Switch Headlamps OFF Signal	B257A 00	1	B257A 00	-
Park Lamp Switch Park Lamps ON Signal	B257A 00	B257A 00	B257A 00	-
Headlamp High Beam Relay Control	1	1	B2580 00	-
Headlamp Low Beam Relay Control	1	1	B2575 00	-
LF High Beam Headlamp Control	1	1	1	-
LF Low Beam Headlamp Control	1	1	1	-
RF High Beam Headlamp Control	1	1	1	-
RF Low Beam Headlamp Control	1	1	1	-
LF Headlamp Ground	-	1	-	-
RF Headlamp Ground	-	1	-	-
Headlamp Switch Ground	-	1	-	-
Turn Signal/Multifunction Switch Ground	-	1	-	-
1. Headlamps Malfunction				

Circuit/System Description

When the turn signal/multifunction switch is placed in the headlamps high or flash to pass (FTP) position, ground is applied to the body control module (BCM) through the headlamp high beam signal circuit or the flash to pass switch signal circuit. The BCM applies ground to the headlamp high beam relay control circuit which energizes the high beam relay. With the high beam relay energized, the switch contacts close allowing battery voltage to flow through the HI BEAM fuses to the high beam headlamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Headlamps ON.

Conditions for Setting the DTC

The BCM detects a short to voltage in the headlamp high beam relay control circuit.

Actions Taken When the DTC Sets

The high beam headlamps and flash to pass (FTP) will not operate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block.
2. Connect a test lamp between B+ and the control circuit terminal C6.
3. Command the High Beams ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high

resistance. If the circuit tests normal, replace the BCM.

4. If the circuit tests normal, replace the underhood fuse block.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B2585: PARK LAMP CONTROL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2585 00

Park Lamp Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Park Lamps ON Signal	B257A 00	B257A 00	B257A 00	-
Park Lamp Relay Control	1	1	B2585 00	-
License Lamp Control	1	1	1	-
Park Lamp Control	1	1	1	-
License Lamp Ground	-	1	-	-
Park Lamps - LF Ground	-	1	-	-
Park Lamps - RF Ground	-	1	-	-
Tail/Stop and Turn Signal Lamps - LR Ground	-	1	-	-
Tail/Stop and Turn Signal Lamps - RR Ground	-	1	-	-
Headlamp Switch Ground	-	1	-	-
1. Park, License, and/or Tail Lamps Malfunction				

Circuit/System Description

Battery positive voltage is applied at all times to both the coil and switched sides of the PARK LP Relay. When the headlamp switch is placed in either the HEAD or PARK position, ground is applied to the park lamp signal circuit to the body control module (BCM). The BCM responds by applying ground to the park lamp relay control circuit. This energizes the park lamp relay coil causing the relay switch contacts to close allowing

battery voltage to flow through the LT PARK and RT PARK fuses to all of the park, tail, license, and marker lamps.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Park lamps ON.

Conditions for Setting the DTC

The BCM detect a short to voltage in the park lamp relay control circuit.

Action Taken When the DTC Sets

The park lamps will not operate.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block.
2. Connect a test lamp between B+ and the control circuit terminal K2.
3. Command the Parking Lamps ON and OFF with a scan tool. The test lamp should turn ON and OFF

when changing between the commanded states.

- If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
- If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

4. If all circuits test normal, replace the underhood fuse block.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B2600: DAYTIME RUNNING LAM

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2600 00

Daytime Running Lamp Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ambient Light Sensor Signal	B2645 03	B2645 07	B2645 07	-
DRL Relay Control	2	2	B2600 00	-
DRL Control	2	2	2	-
LF Low Beam Headlamp Control	1	1	1	-
RF Low Beam Headlamp Control	1	1	1	-
Ambient Light Sensor Ground	-	B2645 07	-	-
LF Headlamp Ground	-	1	-	-
RF Headlamp Ground	-	1	-	-
1. Headlamps Malfunction 2. Daytime Running Lamps Malfunction				

Circuit Description

The ambient light sensor is a light sensitive transistor that varies the voltage signal to the body control module (BCM) based on outside lighting conditions. When the ambient light sensor indicates daytime conditions, the body control module (BCM) grounds the DRL relay control circuit energizing the DRL relay. With the DRL

relay energized, the switch contacts close and voltage is applied to the DRL 1 and DRL 2 fuses to the left and right low beam headlamps. Any function or condition that turns on the headlamps will cancel DRL operation.

Conditions for Running the DTCs

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

The BCM detect a short to voltage in the DRL relay control circuit.

Action Taken When the DTC Sets

The BCM will deactivate the DRL relay for the remainder of the ignition cycle.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X4 harness connector at the underhood fuse block.
2. Connect a test lamp between B+ and the control circuit terminal H2.
3. Command the DRL ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

- If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
- If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.

4. If all circuits test normal, replace the underhood fuse block.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B261A: PASSENGER COMPARTMENT DIMMING 4 CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B261A 00

Passenger Compartment Dimming 4 Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Accent Lamp Control	B261A 00	2	1	-
Accent Lamp Ground	-	2	-	-
1. Interior Accent Lighting Always ON 2. Interior Accent Lighting Always OFF				

Circuit/System Description

The instrument panel (I/P) dimmer switch is used to increase and decrease the brightness of the interior backlighting components. The I/P dimmer switch provides a voltage signal that will increase as the brightness of the light are increased and decrease as the brightness of the lights are decreased. The body control module (BCM) provides a low reference signal and a B+ voltage reference to the I/P dimmer switch. When the I/P dimmer switch is placed in the desired position, the dimmed voltage setting is applied from the I/P dimmer switch through the I/P dimmer switch signal circuit to the BCM. The BCM interprets the signal and applies the dimmed voltage to the individual accent lamps via the accent lamps control circuit.

Conditions for Running the DTC

- Battery voltage must be between 9-16 V.

- Park lamps ON.

Conditions for Setting the DTC

The BCM detects a short to ground in the accent lamp control circuit.

Actions Taken When the DTC Sets

The BCM will not illuminate the accent lamps supplied by the accent lamp control circuit.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: **Each back lighted component may need to be disconnected to isolate a short to voltage or short to ground. Use the schematic to identify the following:**

- **Back lighted components the vehicle is equipped with.**
- **Component locations on the back lighting dimming control circuit.**
- **Each components control and ground circuit terminals.**

1. Ignition OFF, disconnect the harness connector at any component with inoperative backlighting.

2. Ignition OFF, scan tool disconnected, interior lamps OFF, doors CLOSED, test for less than 5 Ω between the ground circuit and ground.
    - If greater than the specified value, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the control circuit and ground.
4. Command the Incandescent Dimming Control ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the component with the inoperative backlighting.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control module replacement, setup, and programming

DTC B2610: PASSENGER COMPARTMENT DIMMING 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2610 00

Passenger Compartment Dimming 1 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
LED Dimming Control	B2610 00	1	1	-
1. Interior Backlighting Malfunction				

Circuit/System Description

The body control module (BCM) supplies a voltage reference through the instrument panel (I/P) dimming voltage reference circuit to the interior lamp dimmer switch, which is part of the headlamp switch. When the dimmer switch is placed in a desired brightness position, reference voltage is applied through the dimmer switch rheostat and the I/P lamps dimmer switch signal circuit to the BCM. The BCM interprets this voltage signal, then applies a pulse width modulated (PWM) voltage through the LED dimming supply circuit illuminating the components listed below:

- Radio

- HVAC control module
- Driver information center (DIC) switch
- Steering wheel controls

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Park lamps ON.

Conditions for Setting the DTC

The BCM detects a short to ground on the LED dimming control circuit.

Action Taken When the DTC Sets

The BCM does not attempt to illuminate the LED lamps.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer present.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connectors at all components fed by the control circuit terminal 18 X3.

2. Ignition ON, clear the DTC with a scan tool.
3. Operate the vehicle within the conditions for running the DTC and verify the DTC does not reset.
    - If the DTC resets, test the control circuit for a short to ground. If the circuit test normal, replace the BCM.
4. Reconnect each component one at a time and verify that the DTC does not reset as current.
    - If the DTC resets as current, test or replace the component responsible for setting the DTC.
5. If all circuits and components test normal, replace the BCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Driver Information Display Switch Replacement**
- **Steering Wheel Control Switch Assembly Replacement**
- **Control Module References** for BCM, HVAC control module, and radio replacement, setup, and programming

DTC B2615: PASSENGER COMPARTMENT DIMMING 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2615 00

Passenger Compartment Dimming 2 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Body Control Module (BCM) B+ terminal 2 X4	B2615 00	B2615 00	-	-
Courtesy Lamps Control	B2615 00	1	1	-
1. Courtesy Lamps Malfunction				

Circuit/System Description

Battery voltage for the courtesy lamps is supplied at all times, from the INT LIGHTS Fuse located in the underhood fuse block, to the body control module (BCM). When the BCM receives a signal to command the courtesy lamps ON, it applies voltage through the courtesy lamps supply voltage circuits to the courtesy lamps listed below.

- The left and right I/P courtesy lamps

- Dome lamp
- Right front turn signal

Conditions for Running the DTC

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

DTC B2615 00 will set for the following conditions:

- The BCM detects a short to ground in the courtesy lamps control circuit.
- The BCM detects a short to ground or an open/high resistance in the INT LIGHTS fuse B+ circuit terminal 2 X4.

Actions Taken When the DTC Sets

The BCM will not illuminate any courtesy lamps supplied by the courtesy lamps control circuit.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X4 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X4 harness connector at the BCM.
4. Disconnect the harness connectors at the following components.
    - Left I/P Courtesy Lamp
    - Right I/P Courtesy Lamp
    - Dome Lamp - Coupe
    - Dome/Reading Lamp - Sedan
5. Ignition ON, clear the DTC with a scan tool.
6. Operate the vehicle within the conditions for running the DTC and verify the DTC does not reset.
    - If the DTC resets, test the control circuits for a short to ground. If the circuits test normal, replace the BCM.
7. Reconnect each component one at a time and verify that the DTC does not reset.
    - If the DTC resets, test or replace the component responsible for setting the DTC.
8. If all circuits and components test normal, replace the BCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Dome Lamp Replacement (Impala Limited)**
- **Instrument Panel Courtesy Lamp Bulb Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B2625: DISPLAY DIMMING PULSE WIDTH MODULATION (PWM)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2625 00

Display Dimming Pulse Width Modulation (PWM) Output Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
LED Dimming Supply	B2625 00	2	1	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
1. Interior Backlighting Does Not Dim 2. Interior Backlighting Does Not Dim				

Circuit/System Description

The body control module (BCM) supplies a voltage reference through the instrument panel (I/P) dimming voltage reference circuit to the interior lamp dimmer switch, which is part of the headlamp switch. When the dimmer switch is placed in a desired brightness position, reference voltage is applied through the dimmer switch rheostat and the I/P lamps dimmer switch signal circuit to the BCM. The BCM interprets this voltage signal then applies a pulse width modulated (PWM) voltage through the LED dimming supply circuit illuminating the HVAC control module to the requested level.

Conditions for Running the DTC

- Ignition ON.
- Park Lamps ON.

Conditions for Setting the DTC

The BCM detects a short to ground on the LED dimming supply circuit.

Action Taken When the DTC Sets

The BCM will not attempt to illuminate the LED indicator lamps control circuit.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Ignition ON, cover the ambient light sensor, vary the interior lamp dimming switch from dim to full bright. The LED lamps should dim and then become full bright.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connectors at all components fed by the LED backlight dimming supply circuit terminal 18 X3.
2. Ignition ON, clear the DTC with a scan tool.
3. Operate the vehicle within the conditions for running the DTC and verify the DTC does not reset.
    - If the DTC resets, test the LED dimming supply circuit for a short to ground. If the circuit test normal, replace the BCM.
4. Reconnect each component one at a time and verify the DTC does not reset as current.
    - If the DTC resets as current, test or replace the component responsible for setting the DTC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Radio Replacement**
- **Driver Information Display Switch Replacement**
- **Steering Wheel Control Switch Assembly Replacement**
- **Control Module References** for BCM or HVAC control module replacement, setup, and programming

DTC B2645: AMBIENT LIGHT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B2645 03

Ambient Light Sensor Circuit Voltage Below Threshold

DTC B2645 07

Ambient Light Sensor Circuit Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ambient Light Sensor Signal	B2645 03	B2645 07	B2645 07	-
Ambient Light Sensor Ground	-	B2645 07	-	-

Circuit/System Description

The ambient light sensor is used to monitor outside lighting conditions. The body control module (BCM) provides a 5-volt reference signal to the ambient light sensor. The sensor is a variable resistor, it's resistance changes as outside lighting conditions change. With the headlamp switch in the AUTO position, the BCM monitors the sensor signal circuit to determine if the outside lighting conditions are correct for either daytime running lamps (DRL) or headlamp low beam operation. In daylight conditions, the BCM will command the DRLs ON. In low light conditions, the BCM will command the low beam headlamps ON.

Conditions for Running the DTC

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

B2645 03

The DTC will set when the BCM detects a short to ground in the ambient light sensor signal circuit.

B2645 07

The DTC will set when the BCM detects a short to voltage or an open/high resistance in the ambient light sensor signal circuit.

Action Taken When the DTC Sets

- Automatic lamp control (ALC) is inoperative.
- The BCM defaults to low light status and commands the low beam headlamps ON.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the ambient light sensor.
2. Ignition OFF, test for less than 5 ohms between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Ambient Light Sensor parameter is greater than 4.65 volts.
    - If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3A fused jumper wire between the signal circuit terminal A and the ground circuit terminal B. Verify the scan tool Ambient Light Sensor parameter is less than 1.96 volts.
    - If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the ambient light sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Daytime Running Lamp (DRL) Ambient Light Sensor Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B2652: PASSENGER COMPARTMENT DIMMING 3

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2652 00

Passenger Compartment Dimming 3 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Body Control Module (BCM) B+ Terminal 2 X2	B2545 00, B2652 00	B2652 00	-	-
Body Control Module (BCM) B+, Terminal 4 X4	B2545 00, B2652 00	B2545 00	-	-
Instrument Panel Lamps Control	B2652 00	1	1	-
1. Interior backlighting Malfunction				

Circuit/System Description

The body control module (BCM) supplies a voltage reference through the instrument panel (I/P) dimming voltage reference circuit to the interior lamp dimmer switch, which is part of the headlamp switch. When the dimmer switch is placed in a desired position, reference voltage is applied through the dimmer switch rheostat and the I/P lamps dimmer switch signal circuit to the BCM. The BCM interprets this voltage signal, then applies a pulse width modulated (PWM) voltage from the CHMSL/BCK-UP fuse through the instrument panel lamp control circuit and the interior backlighting components dim to the requested level.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Park lamps ON.

Conditions for Setting the DTC

DTC B2652 00 will set for the following conditions:

- The BCM detects a short to ground in the instrument panel lamps control circuit.
- The BCM detects a short to ground or an open/high resistance in the BCM B+ circuit terminal 2 X2 or the BCM B+ circuit terminal 4 X4.

Action Taken When the DTC Sets

The BCM will not DIM or illuminate any I/P lamps supplied by the I/P lamps dimmer switch.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X2 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X2 harness connector at the BCM.
4. Disconnect the X4 harness connector at the BCM.
5. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 4 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
6. Ignition OFF, connect the X4 harness connector at the BCM.
7. Disconnect the harness connectors at the following components.
    - Headlamp Switch
    - Instrument Panel Cluster (IPC)
    - Driver Window Switch
    - Driver Door Lock Switch
    - Outside Rearview Mirror Switch
    - Passenger Window Switch
    - Passenger Door Lock Switch
8. Ignition ON, clear the DTC with a scan tool.
9. Operate the system within the Conditions for Running the DTC and verify the DTC does not reset.
    - If the DTC resets, test the control circuits for a short to ground. If the circuits test normal, replace the BCM.
10. Reconnect each component one at a time and verify that the DTC does not reset as current.
    - If the DTC resets as current, test or replace the component responsible for setting the DTC.
11. If all circuits test normal, replace the BCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Headlamp Switch Replacement (Impala Limited)**
- **Instrument Cluster Replacement**
- **Front Side Door Window Switch Replacement (Impala Limited)**
- **Door Lock Switch Replacement (Impala Limited)**
- **Power Mirror Switch Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DTC B3445 OR B3884: STOP LAMP/CENTER HIGH MOUNTED STOP LAMP (CHMSL)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B3445 00

Stop Lamp Circuit

DTC B3884 00

Center High Mounted Stop Lamp (CHMSL) Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CHMSL Control	B3445 00, B3884 00	1	1	-
CHMSL Ground	-	1	-	-
1. Center High Mounted Stop Lamp (CHMSL) Malfunction				

Battery voltage is applied at all times to the body control module (BCM) from the CHMSL/BCK-UP Fuse located in the underhood fuse block. When the brake pedal is applied and the BCM receives a brake applied signal from the brake pedal position sensor (BPPS). It then applies battery voltage from the CHMSL/BCK-UP fuse through the CHMSL voltage supply circuit to the CHMSL.

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Brakes APPLIED.

Conditions for Setting the DTC

The BCM detects a short to ground in the CHMSL control circuit when the stop lamps are being commanded ON.

Actions Taken When the DTC Sets

The BCM will not illuminate the CHMSL.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the CHMSL.
2. Ignition OFF, test for less than 10 ohms between the ground circuit terminal A and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the control circuit terminal B and ground.
4. Ignition ON, press and release the brake pedal. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

5. If all circuits test normal, test or replace the CHMSL.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **High Mount Stop Lamp Replacement (Impala Limited)**
- **Control Module References** for BCM replacement, setup, and programming

DTC B3600: PASSENGER COMPARTMENT DIMMING REQUEST

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B3600 03

Passenger Compartment Dimming Request Signal Circuit Voltage Below Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
I/P Dimming Voltage Reference	B1395 03, B3600 03	B3600 03	-	B1395 07
Instrument Panel Lamps Dimmer Switch Signal	B3600 03	B3600 03	1	-
1. Interior Backlighting Malfunction				

Circuit/System Description

The instrument panel (I/P) dimmer switch is used to increase and decrease the brightness of the interior backlighting components. The body control module (BCM) supplies a voltage reference through the instrument panel (I/P) dimming voltage reference circuit to the interior lamp dimmer switch, which is part of the headlamp switch. When the dimmer switch is placed in a desired brightness position, reference voltage is applied through the dimmer switch rheostat and the I/P lamps dimmer switch signal circuit to the BCM. The BCM interprets this voltage signal, then applies a pulse width modulated (PWM) voltage through the I/P lamps supply voltage circuit and the LED dimming supply circuit to all related interior lamps, illuminating them to the desired level of brightness.

Conditions for Running the DTC

Battery voltage must be between 9-16 volts.

Conditions for Setting the DTC

- The BCM detects a short to ground or open in the I/P dimming voltage reference circuit.

- The BCM detects a short to ground or open in the instrument panel lamps dimming signal circuit.

Actions Taken When the DTC Sets

The I/P lamps are not illuminated.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 100 consecutive malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the headlamp switch.
2. Ignition ON, test for B+ between the reference voltage circuit terminal 15 and ground.
    - If less than the specified value, test the voltage reference circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
3. Verify the scan tool Dimming Control Signal parameter is less than 0.2 volts.
    - If greater than the specified range, test the signal circuit terminal 13 for a short to voltage. If the circuit tests normal, replace the BCM
4. Install a 3A fused jumper wire between the signal circuit terminal 13 and the voltage reference circuit terminal 15. Verify the scan tool Dimming Control Signal parameter is greater than 2.75 volts.
    - If less than the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

5. If all circuits test normal, replace the headlamp switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Headlamp Switch Replacement (Impala Limited)**
- **Control Module References** for BCM replacement, setup, and programming

DTC C0277 OR C0890: BRAKE PEDAL POSITION SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0277 06

Brake Pedal Position Sensor Circuit Short to Ground or Open

DTC C0277 07

Brake Pedal Position Sensor Circuit Voltage Above Threshold

DTC C0277 09

Brake Pedal Position Sensor Circuit Rate of Change Above Threshold

DTC C0277 4B

Brake Pedal Position Sensor Calibration Not Learned

DTC C0890 03

Device Voltage Reference Output 3 Circuit Voltage Below Threshold

DTC C0890 07

Device Voltage Reference Output 3 Circuit Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Body Control Module (BCM) B+ Terminal 1 X4	1	1	-	-
Body Control Module (BCM) B+ Terminal 3 X4	2	2	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Pedal Position Sensor 5-Volt Reference	C0277 06, C0890 03	C0277 06	C0277 06	-
Brake Applied Signal	C0297 00	4	4	-
Brake Pedal Position Sensor Signal	C0277 06	C0277 06	C0277 07	C0277 09, C0277 4B
Center High Mounted Stop Lamp (CHMSL) Control	B3445 00, B3884 00	3	3	-
Left Rear Stop/Turn Lamp Control	1	1	1	-
Right Rear Stop/Turn Lamp Control	2	2	2	-
Brake Pedal Position Sensor Low Reference	-	C0277 06	1	-
Center High Mounted Stop Lamp (CHMSL) Ground	-	3	-	-
Left Rear Stop/Turn Lamp Ground	-	1	-	-
Right Rear Stop/Turn Lamp Ground	-	2	-	-
1. Stop Lamps Malfunction - Left 2. Stop Lamps Malfunction - Right 3. Center High Mounted Stop Lamp (CHMSL) Malfunction 4. Cruise Control Malfunction				

Circuit/System Description

The brake pedal position sensor is used to sense the action of the driver application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The body control module (BCM) provides a low reference signal and a 5-volt reference voltage to the brake pedal position sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery voltage to the stop lamps, center high mounted stop lamp (CHMSL), transmission control module (TCM), and engine control module (ECM).

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Brakes APPLIED.

Conditions for Setting the DTC

C0277 06

This DTC will set for the following conditions:

- The BCM detects a short to ground or an open/high resistance in the brake pedal position sensor signal circuit.

- The BCM detects a short to ground or an open/high resistance in the brake pedal position sensor 5-volt reference circuit.

C0277 07

This DTC will set for the following conditions:

- The BCM detects a short to battery voltage in the brake pedal position sensor signal circuit.
- The BCM detects a short to battery voltage in the brake pedal position sensor 5-Volt Reference circuit.

C0277 09

The BCM detects the brake pedal position sensor signal is changing faster than possible under normal operating conditions.

C0277 4B

The DTC will set when the brake pedal position sensor home position is not learned.

C0890 03

The BCM detects a short to ground in the brake pedal position sensor voltage reference circuit.

C0890 07

The BCM detects a short to battery voltage in the brake pedal position sensor voltage reference circuits.

Actions Taken When the DTC Sets

- The Service Vehicle Soon indicator is commanded ON.
- If the DTC sets while the vehicle is running, the BCM will activate the brake lights when the vehicles transmission is not in the PARK position and the vehicle is not accelerating.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- For DTC C0277 07 the ignition must be cycled before the code can be cleared.
- For DTC C0277 4B a successful brake pedal position sensor calibration has been performed.
- A history DTC will clear once 50 malfunction-free ignition cycles have occurred.
- DTC will not clear the current status until the next ignition cycle.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

C0277 06, C0277 07, C0890 03, and C0890 07

1. Ignition OFF, disconnect the harness connector at the brake pedal position sensor.
2. Ignition OFF, verify that a test lamp illuminates between B+ and the low reference circuit terminal 1.
    - If the test lamp does not illuminate, test the low reference circuit for short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal 2 and ground.
    - If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
    - If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the BCM.
4. Verify the scan tool BPP Sensor parameter is less than 100 counts.
    - If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the BCM.
5. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 2. Verify the scan tool BPP Sensor parameter is greater than 400 counts.
    - If less than the specified range, test the signal circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
6. If all circuits test normal, test or replace the brake pedal position sensor.

C0277 09

1. Replace the brake pedal position sensor.
2. Perform the brake pedal position sensor recalibration procedure. Refer to **Brake Pedal Position Sensor Calibration**.
3. Operate the vehicle within the Conditions for Running and Setting the DTC and verify the DTC does not reset.
    - If the DTC resets, replace the BCM.

C0277 4B

1. Verify that the DTC sets under the Conditions for Running and Setting.
2. Perform the brake pedal position sensor recalibration procedure. Refer to **Brake Pedal Position Sensor Calibration**.
3. Operate the vehicle within the Conditions for Running and Setting the DTC and verify the DTC does not reset.
    - If the DTC resets, replace the brake pedal position sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Brake Pedal Position Sensor Replacement**
- **Brake Pedal Position Sensor Calibration**
- **Control Module References** for BCM replacement, setup, and programming

DTC C0297: BRAKE APPLIED OUTPUT CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0297 00

Brake Applied Output Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Body Control Module (BCM) B+ Terminal 1 X4	1	1	-	-
Body Control Module (BCM) B+ Terminal 3 X4	2	2	-	-
Brake Pedal Position Sensor 5-Volt Reference	C0277 06, C0890 03	C0277 06	C0277 06	-
Brake Applied Signal	C0297 00	4	4	-
Brake Pedal Position Sensor Signal	C0277 06	C0277 06	C0277 07	C0277 09, C0277 4B
Center High Mounted Stop Lamp (CHMSL) Control	B3445 00, B3884 00	3	3	-
Left Rear Stop/Turn Lamp Control	1	1	1	-
Right Rear Stop/Turn Lamp Control	2	2	2	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Pedal Position Sensor Low Reference	-	C0277 06	1	-
Center High Mounted Stop Lamp (CHMSL) Ground	-	3	-	-
Left Rear Stop/Turn Lamp Ground	-	1	-	-
Right Rear Stop/Turn Lamp Ground	-	2	-	-
1. Stop Lamps Malfunction - Left 2. Stop Lamps Malfunction - Right 3. Center High Mounted Stop Lamp (CHMSL) Malfunction 4. Cruise Control Malfunction				

Circuit/System Description

The brake pedal position sensor is used to sense the action of the driver application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The body control module (BCM) provides a low reference signal and a 5-volt reference voltage to the brake pedal position sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery ltage to the stop lamps, center high mounted stop lamp (CHMSL), transmission control module (TCM), and engine control module (ECM).

Conditions for Running the DTC

- Battery voltage must be between 9-16 volts.
- Brakes APPLIED.

Conditions for Setting the DTC

The BCM detects a short to ground in the brake applied signal circuit.

Actions Taken When the DTC Sets

- The BCM stores the DTC to memory.
- The Service Vehicle Soon indicator is commanded ON.

Conditions for Clearing the DTC

- The condition responsible for setting the DTC no longer exists.
- A history DTC will clear once 50 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the ECM.
2. Connect a test lamp between the appropriate signal circuit terminal listed below and ground.
    - Brake applied signal terminal 7 - with LS4
    - Brake applied signal terminal 9 - with LZE, LZ4, or LZ8
3. Ignition ON, command the stop lamps ON and OFF by applying and releasing the brake pedal. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the signal circuit for a short to voltage. If the circuit test normal, replace the BCM.
    - If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
4. Ignition OFF, connect a test lamp between the appropriate signal circuit terminal listed below at the ECM harness connector and the connector terminal at the ECM.
    - Brake applied signal terminal 7 - with LS4
    - Brake applied signal terminal 9 - with LZE, LZ4, or LZ8
5. Ignition ON, command the stop lamps ON and OFF by applying and releasing the brake pedal. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp does not turn ON and OFF when commanded, replace the ECM.
6. Ignition OFF, connect the harness connector at the ECM.
7. Disconnect the harness connector at the TCM.
8. Connect a test lamp between the signal circuit terminal 42 and ground.
9. Ignition ON, command the stop lamps ON and OFF by applying and releasing the brake pedal. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the signal circuit for a short to voltage. If the circuit test normal, replace the BCM.
    - If the test lamp is always OFF, test the signal circuit for a short to ground or an open/high resistance. If the circuit test normal, replace the BCM.
10. If all circuits test normal, replace the TCM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for BCM, ECM or TCM replacement, setup and programming

SYMPTOMS - LIGHTING

NOTE: **The following steps must be completed before doing the Symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** .
    - No DTCs are set.
    - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to the following:
    - **Exterior Lighting Systems Description and Operation**
    - **Interior Lighting Systems Description and Operation**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the lighting system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Backup Lamps Malfunction**
- **Courtesy Lamps Malfunction**
- **Daytime Running Lamps Malfunction**
- **Front Fog Lamps Malfunction**
- **Hazard Lamps Malfunction**
- **Headlamps Malfunction**
- **Interior Backlighting Malfunction**
- **Park, License, and/or Tail Lamps Malfunction**
- **Stop Lamps Malfunction**
- **Turn Signal Lamps and/or Indicators Malfunction**

BACKUP LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Body Control Module (BCM) B+ Terminal 4 X4	B2545 00, B2652 00	B2545 00	-	-
Backup Lamps Control	B2545 00	1	1	-
Backup Lamp - Left Ground	-	1	-	-
Backup Lamp - Right Ground	-	1	-	-
1. Backup Lamps Malfunction				

Circuit/System Description

When the transmission is placed in the REVERSE position, the transmission control module (TCM) sends a serial data message to the body control module (BCM). The message indicates that the gear selector is in the REVERSE position. The BCM applies battery voltage to the backup lamps and inside rearview mirror. Once the driver moves the gear selector out of the REVERSE position, a message is sent by the TCM via serial data requesting the BCM to remove battery voltage from the backup lamp control circuit. The engine may need to be running for the backup lamps to function.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Command the Backup Lamps ON and OFF with a scan tool. The backup lamps should turn ON and OFF when commanded.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate backup lamp.
2. Ignition OFF, exterior lamps OFF, test for less than 5 Ω between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the control circuit terminal A and ground.
4. Command the Backup Lamps ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, BCM.
5. If all circuits test normal, test or replace the backup lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Backup Lamp Bulb Replacement**
- **Tail Lamp Replacement (Impala Limited)**
- **Inside Rearview Mirror Replacement**
- **Control Module References** for BCM replacement, setup, and programming

COURTESY LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Instrument Panel Lamps Dimmer Switch Signal	B3600 03	B3600 03	2	-
Left Front Door Open Switch Signal	4	4	3	-
Passenger Door Open Switch Signal	5	5	4	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Courtesy Lamp Control	B2615 00	1	-	-
I/P Dimming Control	B1395 00	7	-	-
Inadvertent Power Courtesy Lamp Control	B1480 00	6	1	-
Dome Lamp Ground	-	1	-	-
Door Lock Ground - Driver	-	4	-	-
Door Lock Ground - Front Passenger	-	5	-	-
Door Lock Ground - LR	-	5	-	-
Door Lock Ground - RR	-	5	-	-
Inadvertent Courtesy Lamp Ground	-	6	-	-
I/P Courtesy Lamp Ground - Left	-	2	-	-
I/P Courtesy Lamp Ground - Right	-	2	-	-
1. Dome Lamps Malfunction 2. IP Courtesy Lamps Malfunction 3. Dome Lamp Switch Malfunction 4. Door Open Switch Malfunction-Driver 5. Door Open Switch Malfunction-Passenger 6. Inadvertent Power Courtesy Lamps Malfunction 7. Interior Backlighting Malfunction				

Circuit/System Description

The INT LIGHTS fuse supplies battery voltage to the body control module (BCM). The BCM applies battery voltage to the courtesy lamps through the courtesy lamp supply voltage circuit. When any door is opened, the door open switch contacts close and the BCM receives a door-open input. If the BCM receives a door lock or unlock input, the BCM will activate the courtesy lamp supply voltage circuit, providing battery voltage to the dome lamp and instrument panel (I/P) courtesy lamps. The courtesy lamps can be manually activated by placing the interior lamp switch in the DOME position. For more detailed information concerning courtesy lamp operation refer to **Interior Lighting Systems Description and Operation**.

Inadvertent power courtesy lamp feature provides a similar function for the interior lamps as a retained accessory power feature. The BCM will energize the courtesy lamps supply voltage circuit when the BCM is in the active state (awake). When the inadvertent power courtesy lamps supply voltage circuit is energized, it supplies voltage to all the interior lights listed below. The BCM will continue to supply voltage to the interior lamps after the ignition is turned OFF so that the interior lamps may be operated.

- Dome/Reading Lamp
- Vanity Mirror Lamps
- Reading Lamp Assembly
- Inside Rearview Mirror
- Rear Compartment Courtesy Lamp

In the event that any of these lamps were to remain illuminated for a period of more than 20 minutes with the

ignition switch in the OFF position and no BCM input activity, the BCM will deactivate the inadvertent power supply voltage circuit to prevent a total battery discharge condition.

Reference Information

Schematic Reference

Interior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Door Ajar Switch parameter while opening and closing each vehicle door. The parameter should change between Door Ajar and Door Closed.
    - If the parameter does not change between the selected states, refer to **Door Ajar Indicator Malfunction** .
2. Observe the scan tool Rear Closure Ajar Sw. parameter while opening and closing the trunk. The parameter should change between Active and Inactive.
    - If the parameter does not change between the selected states, refer to **Trunk Release Malfunction** .
3. Command the Courtesy Lamps ON and OFF with a scan tool. The courtesy lamps should turn ON and OFF when changing between the commanded states.
    - If the courtesy lamps do not turn ON and OFF when commanded, refer to Dome Lamp Malfunction.
4. Turn the individual reading lamps ON and OFF with their respective switches. The reading lamps should turn ON and OFF when changing between the selected states.
    - If any reading lamp does not turn ON and OFF when selected, refer to Inadvertent Power Courtesy Lamps Malfunction.
5. Turn the left and right vanity mirror lamps ON and OFF with their respective switches. The vanity mirror lamps should turn ON and OFF when changing between the selected states.

- If any reading lamp does not turn ON and OFF when selected, refer to Inadvertent Power Courtesy Lamps Malfunction.

6. Turn the rear compartment courtesy lamp ON and OFF by opening and closing the trunk. The rear compartment courtesy lamp should turn ON and OFF when changing between the selected states.
    - If the rear compartment courtesy lamp does not turn ON and OFF when selected, refer to Inadvertent Power Courtesy Lamps Malfunction.

Circuit/System Testing

Dome Lamp Malfunction

1. Ignition OFF, disconnect the harness connector at the dome lamp.
2. Verify that a test lamp illuminates between the ground circuit terminal B and B+.
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the control circuit terminal A and ground.
4. Command the Courtesy Lamp ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the dome lamp.

Inadvertent Power Courtesy Lamps Malfunction

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X3 harness connector at the BCM and disconnect the harness connector at the appropriate courtesy lamp.
4. Verify that a test lamp illuminates between the appropriate ground circuit terminal listed below and B+.
    - Dome/Reading Lamp - terminal B
    - Left or Right Vanity Mirror - terminal B
    - Reading Lamp Assembly - terminal B
    - Inside Rearview Mirror - terminal 7 (w/o UE1)
    - Inside Rearview Mirror - terminal 8 (with UE1)
    - Rear Compartment Courtesy Lamp - terminal B
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
5. Ignition ON, verify that a test lamp illuminates between the appropriate inadvertent power courtesy lamp circuit terminal listed below and ground.
    - Dome/Reading Lamp - terminal B
    - Left or Right Vanity Mirror - terminal B

- Reading Lamp Assembly - terminal A
- Inside Rearview Mirror - terminal 2 (w/o UE1)
- Inside Rearview Mirror - terminal 6 (with UE1)
- Rear Compartment Courtesy Lamp - terminal A
- If the test lamp does not illuminate, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

6. If all circuits test normal, test or replace the courtesy lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Headlamp Switch Replacement (Impala Limited)**
- **Reading Lamp Bulb Replacement**
- **Instrument Panel Courtesy Lamp Bulb Replacement**
- **Sunshade Illuminated Mirror Lamp Bulb Replacement**
- **Dome Lamp Replacement (Impala Limited)**
- **Dome Lamp Bulb Replacement (Impala Limited)**
- **Emergency Vehicle Rear Compartment Lid Lamp Replacement (Impala Limited RPO T53)**
- **Rear Compartment Lid Lamp Lens and Bulb Replacement (Impala Limited RPO T53)**
- **Rear Compartment Courtesy Lamp Replacement**
- **Front Side Door Lock Replacement**
- **Rear Side Door Lock Replacement**
- **Inside Rearview Mirror Replacement**
- **Control Module References** for BCM replacement, setup, and programming

DAYTIME RUNNING LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ambient Light Sensor Signal	B2645 03	B2645 07	B2645 07	-
DRL Relay Control	2	2	B2600 00	-
DRL Control	2	2	2	-
LF Low Beam Headlamp Control	1	1	1	-
RF Low Beam Headlamp Control	1	1	1	-
Ambient Light Sensor Ground	-	B2645 07	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
LF Headlamp Ground	-	1	-	-
RF Headlamp Ground	-	1	-	-
1. Headlamps Malfunction 2. Daytime Running Lamps Malfunction				

Circuit Description

The ambient light sensor is a light sensitive transistor that varies the voltage signal to the body control module (BCM) based on outside lighting conditions. When the ambient light sensor indicates daytime conditions, the body control module (BCM) grounds the DRL relay control circuit energizing the DRL relay. With the DRL relay energized, the switch contacts close and voltage is applied to the DRL 1 and DRL 2 fuses to the left and right low beam headlamps. Any function or condition that turns on the headlamps will cancel DRL operation.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with a scan tool command the Low Beams ON and OFF. The low beam headlamps should turn ON and OFF when changing between the commanded states.
    - If the low beam headlamps do not turn ON and OFF when commanded, refer to **Headlamps Malfunction**.
2. Ignition ON, park brake released, verify with a scan tool the Park Brake Switch parameter displays Released.
    - If not the specified value, refer to **Brake Warning Indicator Malfunction (Without UJ1)** .

3. Ignition ON, with a scan tool command the DRL ON and OFF. The low beam headlamps should turn ON and OFF when changing between the commanded states.
    - If the low beam headlamps turn ON and OFF when commanded, refer to Ambient Light Sensor Malfunction.
    - If the low beam headlamps do not turn ON and OFF when commanded, refer to Daytime Running Lamps Malfunction.

Circuit/System Testing

Ambient Light Sensor Malfunction

1. Ignition OFF, disconnect the harness connector at the ambient light sensor.
2. Ignition OFF, test for less than 5 Ω between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Ambient Light Sensor parameter is greater than 4.65 V.
    - If less than the specified range, test the signal circuit terminal A or a short to ground. If the circuit tests normal, replace the BCM
4. Install a 3 A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool Ambient Light Sensor parameter is less than 1.96 V.
    - If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the ambient light sensor.

Daytime Running Lamps Malfunction

1. Ignition OFF, disconnect the X4 harness connector at the underhood fuse block.
2. Connect a test lamp between B+ and the control circuit terminal H2.
3. Command the DRL ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Ignition OFF, connect the X4 harness connector at the underhood fuse block.
5. Disconnect the X3 harness connector at the underhood fuse block.
6. Connect a test lamp between the control circuit terminal B2 and ground.
7. Command the DRL ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the underhood fuse block.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the underhood fuse block.
8. If all circuits test normal, replace the underhood fuse block.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Daytime Running Lamp (DRL) Ambient Light Sensor Replacement**
- **Control Module References** for BCM replacement, setup, and programming

FRONT FOG LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fog Lamp Switch Signal	2	2	2	-
Fog Lamp Relay Control	1	1	B2530 00	-
Fog Lamp Control	1	1	1	-
Fog Lamp - LF Ground	-	1	-	-
Fog Lamp - RF Ground	-	1	-	-
Headlamp Switch Ground	-	2	-	-
1. Front Fog Lamps Malfunction 2. Front Fog Lamp Switch Malfunction				

Circuit/System Description

The fog lamp relay is supplied with battery voltage at all times. The fog lamp switch signal circuit is grounded momentarily by pressing the fog lamp switch. The body control module (BCM) energizes the fog lamp relay by applying ground to the fog lamp relay control circuit. When the fog lamp relay is energized, the relay switch contacts close and battery voltage is applied through the FOG LAMPS fuse to the fog lamp supply voltage circuit which illuminates the fog lamps.

Reference Information

Schematic Reference

Fog Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Front Fog Lamp Switch parameter while activating the fog lamp switch. The parameter should change between Active and Inactive.
    - If the parameter does not change between the commanded states, refer to Fog Lamp Switch Malfunction.
2. Turn the fog lamps ON and OFF with the fog lamps switch. The fog lamps should turn ON and OFF as selected.
    - If the fog lamps do not change between the selected states, refer to Fog Lamp Malfunction.
3. Command the Display Test ON and OFF with a scan tool. The fog lamps indicator should turn ON and OFF when changing between the commanded states.
    - It the fog lamps indicator illuminates during the test, replace the BCM.
    - If the fog lamps indicator odes not illuminate during the test or remains illuminated at all times, replace the instrument cluster.

Circuit/System Testing

Fog Lamp Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the headlamp switch.
2. Ignition OFF, verify that a test lamp illuminates between B+ and the ground circuit terminal 8.
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Front Fog Lamp Switch parameter is Inactive.
    - If not the specified value, test the signal circuit terminal 6 for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3 A fused jumper wire between the signal circuit terminal 6 and the ground circuit terminal 8. Verify the scan tool Front Fog Lamp Switch parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or and open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the headlamp switch.

Fog Lamps Malfunction

1. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block.
2. Connect a test lamp between B+ and the control circuit terminal H5.
3. Command the Fog Lamps ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Ignition OFF, connect the X2 harness connector at the underhood fuse block.
5. Disconnect the harness connector at the appropriate fog lamp.
6. Ignition OFF, test for less than 5 Ω between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect a test lamp between the control circuit terminal A and ground.
8. Command the Fog Lamps ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the underhood fuse block.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the underhood fuse block.
9. If all circuits test normal, test or replace the fog lamp.

Fog Lamp Indicator Malfunction

Ignition ON, with a scan tool perform the Display Test for the instrument panel cluster (IPC) and observe the front fog lamp indicator.

- If the front fog lamp indicator illuminates during the test, replace the BCM.
- If the front fog lamp indicator does not illuminate during the test or remains illuminated at all times, replace the IPC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Headlamp Switch Replacement (Impala Limited)**
- **Front Fog Lamp Bulb Replacement**
- **Front Fog Lamp Replacement**
- **Control Module References** for BCM or IPC replacement, setup, and programming

HAZARD LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Hazard Switch Signal	1	1	1	-
Hazard Switch Ground	-	1	1	-
1. Hazard Lamps Malfunction				

Circuit/System Description

The hazard flashers may be activated in any power mode. The hazard switch is located on the turn signal/multifunction switch and is permanently grounded. When the hazard switch is placed in the ON position, ground is applied through the hazard switch signal circuit to the body control module (BCM). The BCM supplies battery voltage to all four turn signal lamps in an ON and OFF duty cycle. When the hazard switch is activated, the BCM sends a serial data message to the instrument panel cluster (IPC) requesting both turn signal indicators to be cycled ON and OFF.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the turn signal/multifunction switch.
2. Ignition OFF, verify that a test lamp illuminates between B+ and the ground circuit terminal H.

- If the test lamp does not illuminate, test the ground circuit for an open/high resistance.

3. Ignition ON, verify the scan tool Hazard Lamp Switch parameter is Inactive.
   - If not the specified value, test the signal circuit terminal C for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3 A fused jumper wire between the signal circuit terminal C and ground. Verify the scan tool Hazard Lamp Switch parameter is Active.
   - If not the specified value, test the signal circuit for a short to voltage or and open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the turn signal/multifunction switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Turn Signal Multifunction Switch Replacement**
- **Control Module References** for BCM replacement, setup, and programming

HEADLAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Flash to Pass Switch Signal	4	4	4	-
High Beam Switch Signal	4	4	1 4	-
Headlamp Switch Headlamps ON Signal	B257A 00	1	B257A 00	-
Headlamp Switch Headlamps OFF Signal	B257A 00	1	B257A 00	-
Park Lamp Switch Park Lamps ON Signal	B257A 00	B257A 00	B257A 00	-
Headlamp High Beam Relay Control	3	3	B2580 00	-
Headlamp Low Beam Relay Control	2	2	B2575 00	-
LF High Beam Headlamp Control	3	3	3	-
LF Low Beam Headlamp Control	2	2	2	-
RF High Beam Headlamp Control	3	3	3	-
RF Low Beam Headlamp Control	2	2	2	-
LF Headlamp Ground	-	2	-	-
RF Headlamp Ground	-	2	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Headlamp Switch Ground	-	1	-	-
Turn Signal/Multifunction Switch Ground	-	4	-	-
1. Headlamp Switch Malfunction 2. Headlamps Malfunction - Low Beam 3. Headlamps Malfunction - High Beam 4. Turn Signal/Multifunction Switch				

Circuit/System Description

The vehicle headlamps are controlled by the body control module (BCM) based on inputs from the headlamp switch and the turn signal/multifunction switch. The headlamp switch has four positions: Off, Auto, Park, and Headlamps. The default headlamp switch position is Auto, in which the BCM uses the ambient light sensor to determine when headlamps are needed. The Off portion of the headlamp switch is a momentary switch which overrides the automatic headlamps and will turn off the vehicle headlamps. When in the Off position, the headlamp switch grounds the headlamp switch headlamps off signal circuit, prompting the BCM to turn off the headlamps. The Park position of the headlamp switch will only illuminate the vehicle parking lamps. The Headlamp position of the headlamp switch will illuminate both the parking lamps, as well has the headlamps. With the headlamp switch in the Headlamp position, the headlamp switch headlamps on signal circuit is grounded, prompting the BCM to turn on the headlamps, regardless of other factors such as ambient light.

The headlamp high beams are controlled through the flash to pass switch and the headlamp dimmer switch, both located in the turn signal/multifunction switch. The flash to pass switch is a momentary type switch, designed to illuminate the high beams as long as the switch is held. With the switch closed, the flash to pass switch signal circuit is grounded, prompting the BCM to turn on the high beam lamps. The headlamp dimmer switch allows the operator to select between full time high or low beam operation. Unlike the flash to pass switch, it is not a momentary switch. When the headlamp dimmer switch is in the high beam position, the headlamp dimmer switch high beam signal circuit is grounded. This prompts the BCM to turn on the high beam lamps.

The BCM controls the headlamps based on the inputs explained above. When a low beam request is received, the BCM grounds the headlamp low beam relay control circuit. This energizes the coil in the LOW BEAM PCB relay, causing the relay switch to close. This then applies B+ to both low beam headlamps through the LT LO BEAM and RT LO BEAM fuses, illuminating the low beam headlamps. When a high beam request is received, the BCM grounds the headlamp high beam relay control circuit. This energizes the coil in the HIGH BEAM PCB relay, causing the relay switch to close. This then applies B+ to both high beam headlamps through the LT HI BEAM and RT HI BEAM fuses, illuminating the high beam headlamps.

Reference Information

Schematic Reference

Headlights/Daytime Running Lights (DRL) Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Headlamp Switch parameter while turning the headlamp switch ON and OFF. The reading should change between Active and Inactive.
    - If the reading does not change between the specified values, refer to Headlamp Switch Malfunction.
2. Ignition ON, observe the scan tool Auto Hdlp. Disable Sw. parameter while turning the headlamp switch ON and OFF. The reading should change between Active and Inactive.
    - If the reading does not change between the specified values, refer to Headlamp Switch Malfunction.
3. Observe the scan tool Flash to Pass Switch parameter while applying and releasing the turn signal/multifunction switch. The reading should toggle between Active and Inactive.
    - If the reading does not change between the specified values, refer to Turn Signal/Multifunction Switch Malfunction.
4. Observe the scan tool High Beam Select Switch parameter while applying and releasing the high beam select switch. The reading should toggle between Active and Inactive.
    - If the reading does not change between the specified values, refer to Turn Signal/Multifunction Switch Malfunction.
5. Command the Low Beams ON and OFF with a scan tool. The low beam headlamps should turn ON and OFF when commanded.
    - If the low beam headlamps do not turn ON and OFF when commanded, refer to Headlamps Malfunction - Low Beam.
6. Command the High Beams ON and OFF with a scan tool. The high beam headlamps should turn ON and OFF when commanded.
    - If the high beam headlamps do not turn ON and OFF when commanded, refer to Headlamps Malfunction - High Beam.
7. Command the Display Test ON and OFF with a scan tool. The high beam indicator should turn ON and OFF when changing between the commanded states.
    - If the high beam indicator illuminates during the test, replace the BCM.
    - If the high beam indicator does not illuminate during the test or remain illuminated at all times,

replace the instrument cluster.

Circuit/System Testing

Headlamp Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the headlamp switch.
2. Ignition OFF, verify that a test lamp illuminates between B+ and the ground circuit terminal 8.
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Headlamp Switch parameter is Inactive.
    - If not the specified value, test the signal circuit terminal 1 for short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool Auto Hdlp. Disable Sw. parameter is Inactive.
5. If not the specified value, test the signal circuit terminal 3 for short to ground. If the circuit tests normal, replace the BCM.
6. Install a 3 A fused jumper wire between the signal circuit terminal 1 and ground. Verify the scan tool Headlamp Switch parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
7. Install a 3 A fused jumper wire between the signal circuit terminal 3 and ground. Verify the scan tool Auto Hdlp. Disable Sw. parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
8. If all circuits test normal, test or replace the headlamp switch.

Turn Signal/Multifunction Switch Malfunction

1. Ignition OFF, disconnect the X2 harness connector at the turn signal/multifunction switch.
2. Ignition OFF, verify that a test lamp illuminates between B+ and the ground circuit terminal D.
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Flash to Pass Switch parameter is Inactive.
    - If not the specified value, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool High Beam Select Switch parameter is Inactive.
    - If not the specified value, test the signal circuit terminal E for a short to ground. If the circuit tests normal, replace the BCM.
5. Install a 3 A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool Flash to Pass Switch parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or and open/high resistance. If the circuit tests normal, replace the BCM.
6. Install a 3 A fused jumper wire between the signal circuit terminal E and ground. Verify the scan tool High Beam Select Switch parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or and open/high resistance. If

the circuit tests normal, replace the BCM.

7. If all circuits test normal, test or replace the turn signal/multifunction switch.

Headlamps Malfunction - Low Beam

1. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block.
2. Connect a test lamp between B+ and the control circuit terminal A5.
3. Command the Low Beams ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Ignition OFF, disconnect the harness connector at the appropriate low beam headlamp.
5. Ignition OFF, scan tool OFF, exterior lamps OFF, test for less than 5 Ω between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
6. Connect a test lamp between the control circuit terminal A and ground.
7. Command the Low Beams ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the underhood fuse block.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the underhood fuse block.
8. If all circuits test normal, test or replace the low beam headlamp.

Headlamps Malfunction - High Beam

1. Ignition OFF, disconnect the X2 harness connector at the underhood fuse block.
2. Connect a test lamp between B+ and the control circuit terminal C6.
3. Command the High Beams ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. Ignition OFF, disconnect the harness connector at the appropriate high beam headlamp.
5. Ignition OFF, scan tool OFF, exterior lamps OFF, test for less than 5 Ω between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
6. Connect a test lamp between the control circuit terminal A and ground.
7. Command the High Beams ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

- If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the underhood fuse block.
- If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the underhood fuse block.

8. If all circuits test normal, test or replace the high beam headlamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Accessory Wiring Junction Block Replacement**
- **Headlamp Bulb Replacement**
- **Headlamp Switch Replacement (Impala Limited)**
- **Turn Signal Multifunction Switch Replacement**
- **Headlamp Replacement**
- **Control Module References** for BCM or IPC replacement, setup and programming

INTERIOR BACKLIGHTING MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
I/P Dimming Voltage Reference	B1395 03, B3600 03	B1395 03	1, 2	-
Instrument Panel Lamps Dimmer Switch Signal	B3600 03	B3600 03	1, 2	-
Instrument Panel Lamp Control	B2652 00	1	1	-
LED Dimming Control	B2610 00	2	2	-
Headlamp Switch Ground	-	3	-	-
1. Instrument Panel Lamps Malfunction 2. LED Malfunction 3. Headlamps and Dimmer Switch Malfunction				

Circuit/System Description

The body control module (BCM) supplies a voltage reference through the instrument panel (I/P) dimming voltage reference circuit to the interior lamp dimmer switch, which is part of the headlamp switch. When the dimmer switch is placed in a desired brightness position, reference voltage is applied through the dimmer switch rheostat and the I/P lamps dimmer switch signal circuit to the BCM. The BCM interprets this voltage signal, then applies a pulse width modulated (PWM) voltage from the CHMSL/BCK-UP fuse through the

instrument panel lamp supply voltage circuit, the backlight lamp control circuit, and the LED dimming supply circuit illuminating the LED and I/P panel lamps.

Reference Information

Schematic Reference

Interior Lights Dimming Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Interior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Dimming Control Signal parameter while operating the dimmer switch from high to low. The parameter should change from a high percent to a low percent as the switch is rotated.
    - If the parameter does not change, refer to Dimmer Switch Circuit Test.
2. If the scan tool dimmer control operates normal, refer to Interior Backlighting Circuit Test.

Circuit/System Testing

Dimmer Switch Circuit Test

1. Ignition OFF, disconnect the harness connector at the headlamp switch.
2. Ignition OFF, verify that a test lamp illuminates between the ground circuit terminal 8 and B+.
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Dimming Control Signal parameter is less than 0.2 volts.
    - If greater than the specified range, test the signal circuit terminal 13 for a short to voltage. If the circuit tests normal, replace the BCM.
4. Ignition ON, test for B+ between the voltage reference circuit terminal 15 and ground.
    - If less than the specified value, test the voltage reference circuit for a short to ground or an

open/high resistance. If the circuit tests normal, replace the BCM.

5. Install a 3A fused jumper wire between the signal circuit terminal 13 and the voltage reference circuit terminal 15. Verify the scan tool Dimming Control Signal parameter is greater than 2.6 volts.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
6. If all circuits test normal, test or replace the headlamp switch.

Interior Backlighting Circuit Test

1. Ignition OFF, disconnect the X3 harness connector at the BCM.
2. Ignition ON, verify that a test lamp illuminates between the B+ circuit terminal 2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect the X3 harness connector at the BCM and disconnect the harness connector at the component with the inoperative backlighting.
4. Verify that a test lamp illuminates between the appropriate ground circuit terminal listed below and B+.
    - Headlamp Switch terminal 8
    - Instrument Panel Cluster (IPC) terminal 6
    - Driver Window Switch terminal B X1
    - Driver Door Lock Switch terminal B
    - Outside Rearview Mirror Switch terminal B
    - Passenger Window Switch terminal C
    - Passenger Door Lock Switch terminal B
    - Radio terminal 8 X1
    - HVAC Control Module terminal 10 X1
    - Driver Information Display Switch terminal 5
    - Left Steering Wheel Controls terminal 8
    - Right Steering Wheel Controls terminal 1
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
5. Connect a test lamp between the appropriate control circuit terminal listed below and ground.

    Incandescent Dimming

    - Headlamp Switch terminal 7
    - Instrument Panel Cluster (IPC) terminal 8
    - Driver Window Switch terminal F X2
    - Driver Door Lock Switch terminal A
    - Outside Rearview Mirror Switch terminal E
    - Passenger Window Switch terminal B
    - Passenger Door Lock Switch terminal A

    LED Dimming

- Radio terminal 7 X1
- HVAC Control Module terminal 1 X1
- Driver Information Display Switch terminal 4
- Left Steering Wheel Controls terminal 6
- Right Steering Wheel Controls terminal 2

6. Ignition ON, command the appropriate Incandescent Dimming or LED Dimming ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
7. If all circuits test normal, test or replace the component with the inoperative backlighting.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Headlamp Switch Replacement (Impala Limited)**
- **Front Side Door Window Switch Replacement (Impala Limited)**
- **Door Lock Switch Replacement (Impala Limited)**
- **Power Mirror Switch Replacement**
- **Steering Wheel Control Switch Assembly Replacement**
- **Driver Information Display Switch Replacement**
- **Control Module References** for BCM, HVAC, IPC, or Radio replacement, setup, and programming

PARK, LICENSE, AND/OR TAIL LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Park Lamp Switch On Signal	B257A 00, 2	B257A 00	B257A 00*, 1	-
Park Lamp Relay Control	2	1	B2585 00	-
Left Park Lamp Control	3	3	3	-
Right Park Lamp Control	4	4	4	-
Ground - Left Park Lamp	-	3	3	-
Ground - Right Park Lamp	-	4	4	-
Ground - Headlamp Switch	-	1	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
* Internal damage to the headlamp switch may occur if shorted to B+ 1. All park lamps inoperative 2. All park lamps always on 3. Left park lamps malfunction 4. Right park lamps malfunction				

Circuit/System Description

The vehicle park, license, and tail lamps are controlled by the body control module (BCM) based on an input from the headlamp switch. The headlamp switch has four positions: Off, Auto, Park, and Headlamps. The default headlamp switch position is Auto, in which the BCM uses the ambient light sensor to determine when exterior lamps are needed. The Off portion of the headlamp switch is a momentary switch which overrides the automatic lamps and will turn off the vehicle lamps. The Park position of the headlamp switch will only illuminate the vehicle parking lamps. The Headlamp position of the headlamp switch will illuminate both the parking lamps, as well as the headlamps. With the headlamp switch in the Park position, the park lamp switch on signal circuit is grounded prompting the BCM to turn ON the exterior lamps, regardless of other factors such as ambient light.

When a park lamp request is received, the BCM grounds the park lamp relay control circuit. This energizes the PARK LP PCB relay. Battery voltage is then applied through the switch side of the relay, the LT PARK and RT PARK fuses illuminating the front park, license, tail, and marker lamps.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool BCM Parklamp Switch parameter while cycling the headlamp switch between the Park and Auto positions. The parameter should change between Active and Inactive.
    - If the parameter does not change between the specified values, refer to Headlamp Switch Malfunction.
2. Command the Parking Lamps ON and OFF with a scan tool. The front park, license, and tail lamps should turn ON and OFF when changing between the commanded states.
    - If all of the lamps are always OFF or remain ON, refer to the Park Lamp Relay Malfunction.
    - If one or more of the lamps is always OFF, refer to Park Lamps Malfunction.

Circuit/System Testing

Headlamp Switch Malfunction

1. Ignition OFF, disconnect the harness connector at the headlamp switch.
2. Ignition OFF, verify that a test lamp illuminates between the ground circuit terminal 8 and B+.
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Parklamp Switch parameter is Inactive.
    - If not the specified value, test the signal circuit terminal 2 for a short to ground. If the circuit tests normal, replace the BCM.
4. Install a 3 A fused jumper wire between the signal circuit terminal 2 and ground. Verify the scan tool Parklamp Switch parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or and open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the headlamp switch.

Park Lamp Relay Malfunction

1. Ignition OFF, disconnect the harness connector X2 at the underhood fuse block.
2. Connect a test lamp between the control circuit terminal K2 and B+.
3. Ignition ON, command the Park Lamps ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the BCM.
4. If the circuit tests normal, replace the underhood fuse block.

Park Lamps Malfunction

1. Ignition OFF, disconnect the harness connector at the appropriate exterior lamp.
2. Ignition OFF, test for less than 5.0 Ω between the ground circuit terminal listed below and ground.
    - Marker Lamps terminal B
    - Tail Lamps terminal B
    - License Lamp terminal B

- Tail/Stop/Turn Signal Lamps terminal G
- Front Park/Turn Signal Lamps terminal G
- If greater than the specified range, test the ground circuit for an open/high resistance.

3. Connect a test lamp between the control circuit terminal listed below and ground.
   - Marker Lamps terminal A
   - Tail Lamps terminal A
   - License Lamp terminal A
   - Tail/Stop/Turn Signal Lamps terminal B
   - Front Park/Turn Signal Lamps terminal B
4. Ignition ON, command the Park Lamps ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
   - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the underhood fuse block.
   - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the underhood fuse block.
5. If all circuits test normal, test or replace the park lamp.

Component Testing

Headlamp Switch

NOTE: **If the switch tests open in any switch position other than Auto, test the switch signal circuits for a short to voltage before replacing the switch.**

1. Ignition OFF, disconnect the harness connector at the headlamp switch.
2. Test for infinite resistance between the signal terminal 1 and the ground terminal 8 with the switch in the Auto position.
   - If not the specified value, replace the headlamp switch.
3. Test for less than 2.0 Ω between the signal terminal 1 and the ground terminal 8 with the switch in the Headlamp ON position.
   - If greater than the specified value, replace the headlamp switch.
4. Test for infinite resistance between the signal terminal 2 and the ground terminal 8 with the switch in the Auto position.
   - If not the specified value, replace the headlamp switch.
5. Test for less than 2.0 Ω between the signal terminal 2 and the ground terminal 8 with the switch in the Park position.
   - If greater than the specified value, replace the headlamp switch.
6. Test for infinite resistance between the signal terminal 3 and the ground terminal 8 with the switch in the Auto position.
   - If not the specified value, replace the headlamp switch.
7. Test for less than 2.0 Ω between the signal terminal 3 and the ground terminal 8 with the switch in the Off position.

- If greater than the specified value, replace the headlamp switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Headlamp Switch Replacement (Impala Limited)**
- **Headlamp Bulb Replacement**
- **Tail Lamp Bulb Replacement (Impala Limited)**
- **Rear Turn Signal Lamp Bulb Replacement**
- **Rear License Plate Lamp Replacement (Impala Limited)**
- **Accessory Wiring Junction Block Replacement**
- **Control Module References** for BCM replacement, setup and programming

STOP LAMPS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Body Control Module (BCM) B+ Terminal 1 X4	1	1	-	-
Body Control Module (BCM) B+ Terminal 3 X4	2	2	-	-
Brake Pedal Position Sensor 5-Volt Reference	C0277 06, C0890 03	C0277 06	C0277 06	-
Brake Applied Signal	C0297 00	4	4	-
Brake Pedal Position Sensor Signal	C0277 06	C0277 06	C0277 07	C0277 09, C0277 4B
Center High Mounted Stop Lamp (CHMSL) Control	B3445 00, B3884 00	3	3	-
Left Rear Stop/Turn Lamp Control	1	1	1	-
Right Rear Stop/Turn Lamp Control	2	2	2	-
Brake Pedal Position Sensor Low Reference	-	C0277 06	1	-
Center High Mounted Stop Lamp (CHMSL) Ground	-	3	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Left Rear Stop/Turn Lamp Ground	-	1	-	-
Right Rear Stop/Turn Lamp Ground	-	2	-	-
1. Stop Lamps Malfunction - Left 2. Stop Lamps Malfunction - Right 3. Center High Mounted Stop Lamp (CHMSL) Malfunction 4. Cruise Control Malfunction				

Circuit/System Description

The brake pedal position sensor is used to sense the action of the driver application of the brake pedal. The brake pedal position sensor provides an analog voltage signal that will increase as the brake pedal is applied. The body control module (BCM) provides a low reference signal and a 5 V If the left and right turn signal indicators do not illuminate during the test or remain illuminated at all times, replace the instrument cluster. reference voltage to the brake pedal position sensor. When the variable signal reaches a voltage threshold indicating the brakes have been applied, the BCM will apply battery voltage to the stop lamps, center high mounted stop lamp (CHMSL), transmission control module (TCM), and engine control module (ECM).

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Brake Applied Output Signal parameter as you apply and unapply the brake pedal. The reading should cycle between OFF and ON as the brake pedal is applied and released.

- If the reading does not change as the brake pedal is applied and released, refer to Brake Pedal Position Sensor Malfunction.

2. With a scan tool, command the LR Turn Signal ON and OFF. The LR turn signal should turn ON and OFF when changing between the commanded states.
    - If the LR turn signal does not illuminate when commanded, refer to Stop Lamps Malfunction.
3. With a scan tool, command the RR Turn Signal ON and OFF. The RR turn signal should turn ON and OFF when changing between the commanded states.
    - If the RR turn signal does not illuminate when commanded, refer to Stop Lamps Malfunction.

Circuit/System Testing

Brake Pedal Position Sensor Malfunction

1. Ignition OFF, disconnect the harness connector at the brake pedal position sensor.
2. Ignition ON, verify that a test lamp does not illuminate between the low reference circuit terminal 1 and ground.
    - If the test lamp illuminates, test the low reference circuit for a short to voltage. If the circuit tests normal, replace the BCM.
3. Ignition ON, test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
    - If less than the specified range, test the 5 V reference circuit for a short to ground or an open/high resistance. If the circuit/connections test normal, replace the BCM.
    - If greater than the specified range, test the 5 V reference circuit for a short to voltage. If the circuit test normal, replace the BCM.
4. If all circuits test normal, replace the brake pedal position sensor.

Stop Lamps Malfunction

1. Ignition OFF, disconnect the X4 harness connector at the BCM.
2. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Verify that a test lamp illuminates between the B+ circuit terminal 3 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Ignition OFF, connect the X4 harness connector at the BCM.
5. Disconnect the harness connector at the appropriate stop lamp.
6. Ignition OFF, exterior lamps OFF, test for less than 5 Ω between the ground circuit terminal G and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
7. Connect a test lamp between the control circuit terminal A and ground.
8. Ignition ON, command the stop lamp ON and OFF by commanding the appropriate Rear Turn Signal parameter ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.

- If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
- If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.

9. If all circuits test normal, replace the stop lamp.

Center High Mounted Stop Lamp Malfunction

1. Ignition OFF, disconnect the harness connector at the center high mount stop lamp.
2. Ignition OFF, exterior lamps OFF, test for less than 5 Ω between the ground circuit terminal A and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the control circuit terminal B and the ground circuit terminal A.
4. Ignition ON, command the stop lamps ON and OFF by applying and releasing the brake pedal. The test lamp should turn ON and OFF when changing between the commanded states.
   - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
   - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, test or replace the center high mount stop lamp.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Brake Pedal Position Sensor Calibration**
- **Brake Pedal Position Sensor Replacement**
- **High Mount Stop Lamp Replacement (Impala Limited)**
- **Rear Turn Signal Lamp Bulb Replacement**
- **Tail Lamp Replacement (Impala Limited)**
- **Control Module References** for BCM replacement, setup, and programming

TURN SIGNAL LAMPS AND/OR INDICATORS MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+, BCM X4 terminal 1	2	2	-	-
B+, BCM X4 terminal 2	B2615 00, 5	B2615 00, 5	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+, BCM X4 terminal 3	7	7	-	-
Left Turn Signal Switch Signal	2	2	2	-
Right Turn Signal Switch Signal	3	3	3	-
Left Front Turn Signal Lamp Control	4	4	4	-
Right Front Turn Signal Lamp Control	5	5	5	-
Left Rear Stop/Turn Lamp Control	6	6	6	-
Right Rear Stop/Turn Lamp Control	7	7	7	-
Ground - Turn Signal/Multifunction Switch	-	1	-	-
Ground - LF Park/Turn Signal Lamp	-	4	-	-
Ground - RF Park/Turn Signal Lamp	-	5	-	-
Ground - Left Tail/Stop and Turn Signal Lamp	-	6	-	-
Ground - Right Tail/Stop and Turn Signal Lamp	-	7	-	-
1. All turn signals inoperative 2. Left turn signals malfunction 3. Right turn signals malfunction 4. Left front turn signal malfunction 5. Right front turn signal malfunction 6. Left rear stop/turn signal malfunction 7. Right rear stop/turn signal malfunction				

Circuit/System Description

The body control module (BCM) controls the vehicle turn signals based on inputs from the turn signal/multifunction switch. With the turn signal/multifunction switch in the left turn position, a ground path is provided on the left turn signal switch signal circuit, indicating a left turn signal request. With the turn signal/multifunction switch in the right turn position, a ground path is provided on the right turn signal switch signal circuit, indicating a right turn signal request. When the specific request is seen, the BCM will pulse the respective turn signal lamp supply voltage circuits, illuminating the turn signal lamps.

When a turn signal request is seen by the BCM, a serial data message is sent to the instrument panel cluster (IPC) requesting the respective turn signal indicator be pulsed.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Exterior Lighting Systems Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, observe the scan tool Right Turn Signal Switch and Left Turn Signal Switch parameters while cycling the turn signal switch between the right and left positions. The readings should change between Active and Inactive.
    - If the parameters do not change between the selected states, refer to Turn Signal Switch Malfunction.
2. Ignition ON, observe the right and left turn signal lamps while cycling the turn signal switch between the right and left positions. Verify the turn signal lamps turn ON and OFF.
    - If the turn signal lamps do not cycle between the selected states, refer to Turn Signal Lamp Malfunction.
3. Command the Display Test ON and OFF with a scan tool. The left and right turn signal indicators should turn ON and OFF when changing between the commanded states.
    - If the left and right turn signal indicators illuminate during the test, replace the BCM.
    - If the left and right turn signal indicators do not illuminate during the test or remain illuminated at all times, replace the instrument cluster.

Circuit/System Testing

Turn Signal Switch Malfunction

1. Ignition OFF, disconnect the harness connector X1 at the turn signal/multifunction switch.
2. Verify that a test lamp illuminates between the ground circuit terminal E and B+.
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
3. Ignition ON, verify the scan tool Left Turn Signal Switch parameter is Inactive.
    - If not the specified value, test the signal circuit terminal D for a short to ground. If the circuit tests normal, replace the BCM.
4. Verify the scan tool Right Turn Signal Switch parameter is Inactive.
    - If not the specified value, test the signal circuit terminal F for a short to ground. If the circuit tests normal, replace the BCM.
5. Install a 3 A fused jumper wire between the signal circuit terminal D and the ground circuit terminal E. Verify the scan tool Left Turn Signal Switch parameter is Active.

- If not the specified value, test the signal circuit for a short to voltage or and open/high resistance. If the circuit tests normal, replace the BCM.

6. Install a 3 A fused jumper wire between the signal circuit terminal F and the ground circuit terminal E. Verify the scan tool Right Turn Signal Switch parameter is Active.
    - If not the specified value, test the signal circuit for a short to voltage or and open/high resistance. If the circuit tests normal, replace the BCM.
7. If all circuits test normal, test or replace the turn signal/multifunction switch.

Turn Signal Lamp Malfunction

1. Ignition OFF, disconnect the harness connect X4 at the BCM.
2. Ignition ON, verify a test lamp illuminates between the B+ circuits listed below and ground.
    - B+ terminal 1
    - B+ terminal 2
    - B+ terminal 3
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance. If the circuit tests normal and the fuse is open, test the appropriate control circuit(s) listed below for a short to ground.
    - LT T/SIG Fuse - terminal 1 X5 and terminal 4 X5
    - RT T/SIG Fuse - terminal 2 X5
    - INT LIGHTS Fuse - terminal 5 X4
3. Ignition OFF, disconnect the harness connector at the appropriate turn signal lamp.
4. Verify that a test lamp illuminates between the ground circuit terminal G and B+.
    - If the test lamp does not illuminate, test the ground circuit for an open/high resistance.
5. Connect a test lamp between the control circuit terminal A and the ground circuit terminal G.
6. Ignition ON, command the appropriate turn signal ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
    - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
7. If all circuits test normal, test or replace the turn signal lamp.

Component Testing

Turn Signal/Multifunction Switch

1. Ignition OFF, disconnect the X1 harness connector at the turn signal/multifunction switch.
2. Test for infinite resistance between the signal terminals listed below and the ground circuit terminal E with the switch in the neutral position.
    - Signal terminal D
    - Signal terminal F
    - If not the specified value, replace the turn signal/multifunction switch.

NOTE: **If the switch tests open in any switch position other than Off, test the switch signal circuits for a short to voltage before replacing the switch.**

3. Test for less than 2.0 Ω between the signal terminal D and the ground terminal E with the switch in the left turn position.
    - If greater than the specified range, replace the turn signal/multifunction switch.
4. Test for less than 2.0 Ω between the signal terminal F and the ground terminal E with the switch in the left turn position.
    - If greater than the specified range, replace the turn signal/multifunction switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Headlamp Bulb Replacement**
- **Rear Turn Signal Lamp Bulb Replacement**
- **Turn Signal Multifunction Switch Replacement**
- **Control Module References** for BCM and IPC replacement, setup, and programming

REPAIR INSTRUCTIONS

BRAKE PEDAL POSITION SENSOR CALIBRATION

NOTE: **Brake system does not use a brake switch, stoplight switch or brakelight switch. System uses a Brake Pedal Position Sensor to control these functions.**

Calibration Criteria

NOTE: **Do not apply the brake pedal during the brake pedal position sensor calibration procedure. Any movement of the brake pedal during this procedure will cause the calibration procedure to fail. If this occurs, the brake pedal position sensor calibration must be repeated.**

Brake pedal position sensor calibration must be performed after the brake pedal position sensor, body control module (BCM), engine control module (ECM), or hybrid powertrain control module have been serviced. The calibration procedure will set the brake pedal position sensor home value. This value is used by the BCM and ECM/HPCM to determine the action of the driver applying the brake system and to provide this information to the vehicle subsystems via serial data.

Calibration Procedure

1. Apply the parking brake.
2. Ignition ON, engine OFF, place the transmission in the PARK position for automatic transmission or NEUTRAL position for manual transmission.
3. Install a scan tool.
4. Clear all DTCs before proceeding.
5. Navigate to the Configuration/Reset Functions menu of the BCM.

6. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.
7. Navigate to the Configuration/Reset Functions menu of the ECM/HPCM.
8. Select the Learn Functions menu.
9. Select the Brake Pedal Position Sensor Learn procedure and follow the directions displayed on the screen.

BRAKE PEDAL POSITION SENSOR REPLACEMENT

NOTE: **Brake system does not use a brake switch, stoplight switch or brakelight switch. System uses a Brake Pedal Position Sensor to control these functions.**

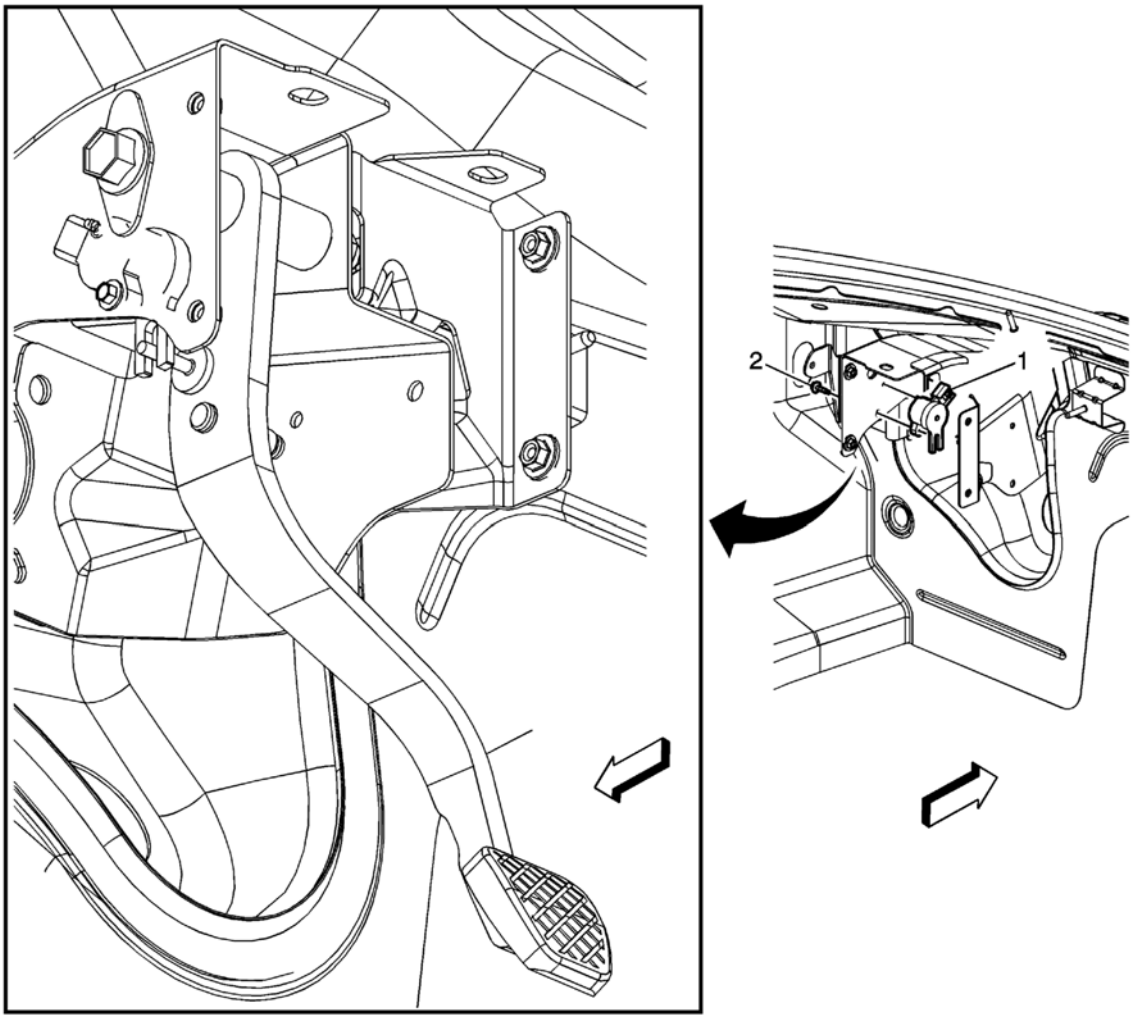


Fig. 16: Brake Pedal Position Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Brake Pedal Position Sensor Assembly **TIP:** Disconnect the electrical connector.
2	Brake Pedal Position Sensor Bolt **CAUTION:**

Callout	Component Name
	Refer to Fastener Caution . • Calibrate the position sensor. Refer to **Brake Pedal Position Sensor Calibration**. • Do not reuse the position sensor or bolt. Always use a new sensor and bolt. **Tighten** 2 N.m (18 lb in)

HEADLAMP SWITCH REPLACEMENT (IMPALA LIMITED)

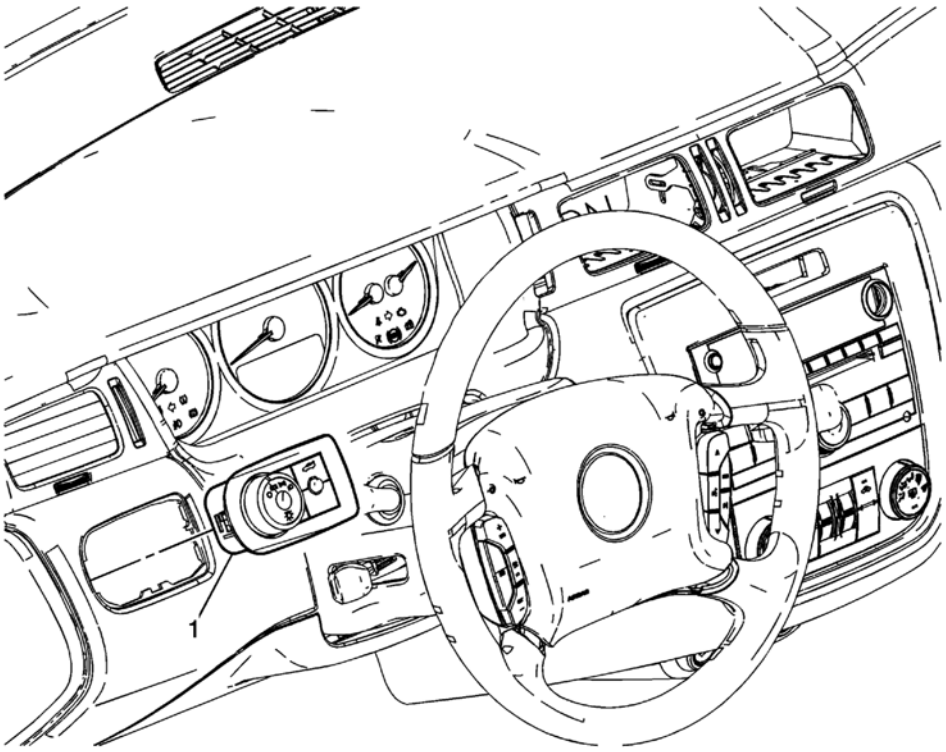


Fig. 17: View Of Traction Control Switch
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Switch Assembly, Head lamp Instrument Panel Dimmer **TIP:** Disconnect the electrical connector.

DAYTIME RUNNING LAMP (DRL) AMBIENT LIGHT SENSOR REPLACEMENT

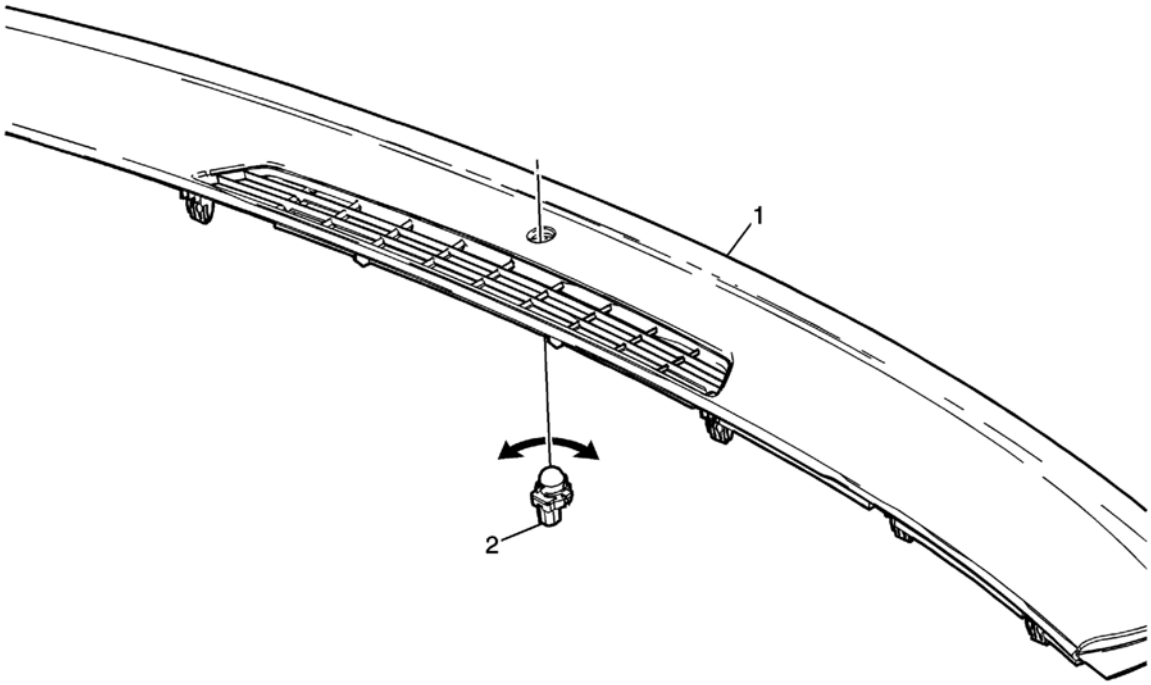


Fig. 18: Daytime Running Lamps (DRL) Ambient Light Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Instrument Panel Upper Trim Panel Refer to **Instrument Panel Upper Trim Panel Replacement** .
2	Ambient Light Sensor Assembly

EMERGENCY VEHICLE HEADLAMP FLASHER REPLACEMENT

Removal Procedure

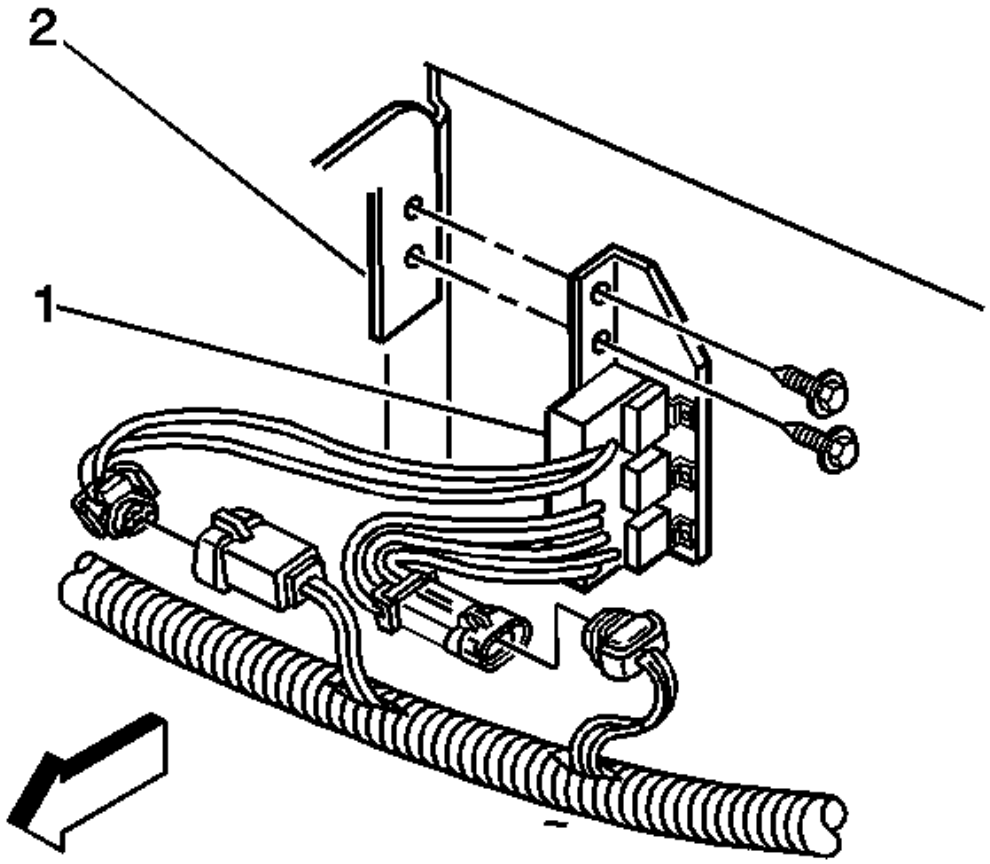


Fig. 19: Headlamp Flasher Components
Courtesy of GENERAL MOTORS COMPANY

1. Remove the upper radiator baffle. Refer to **Radiator Air Upper Baffle and Deflector Replacement** .
2. Disconnect the electrical connectors.
3. Remove the headlamp flasher bolts at the front radiator support (2).

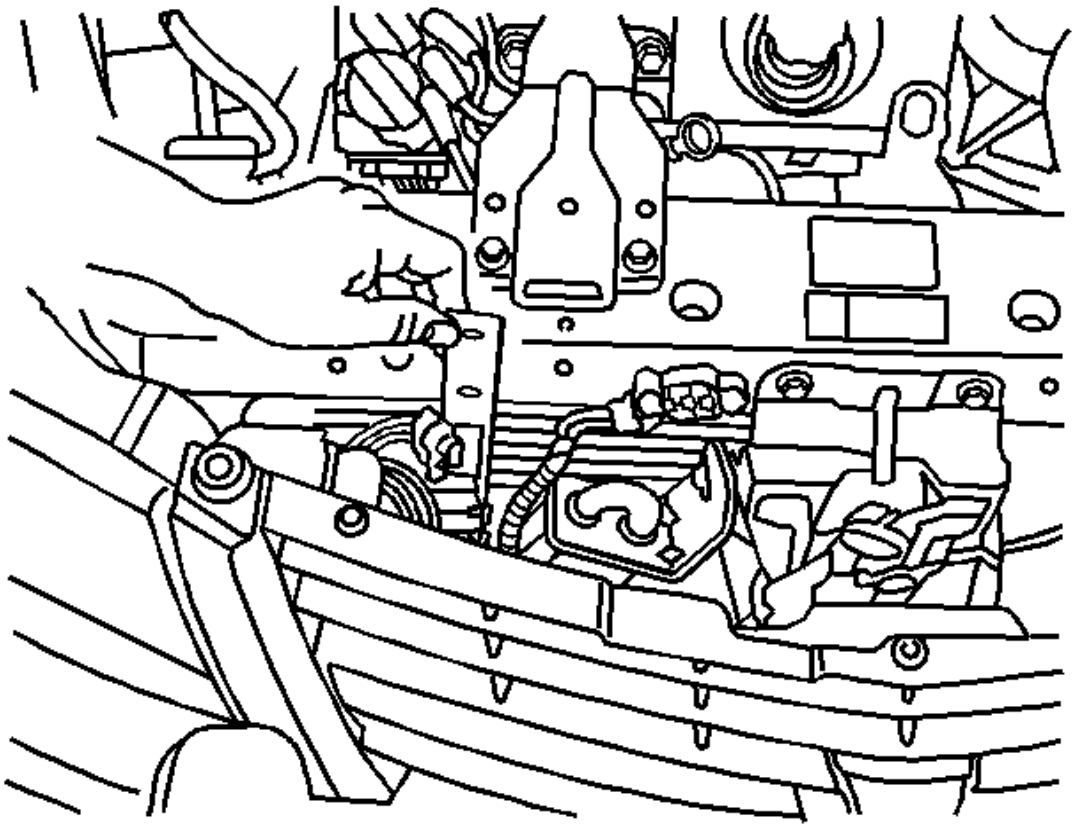


Fig. 20: Headlight Flasher
Courtesy of GENERAL MOTORS COMPANY

4. Remove the headlamp flasher.

Installation Procedure

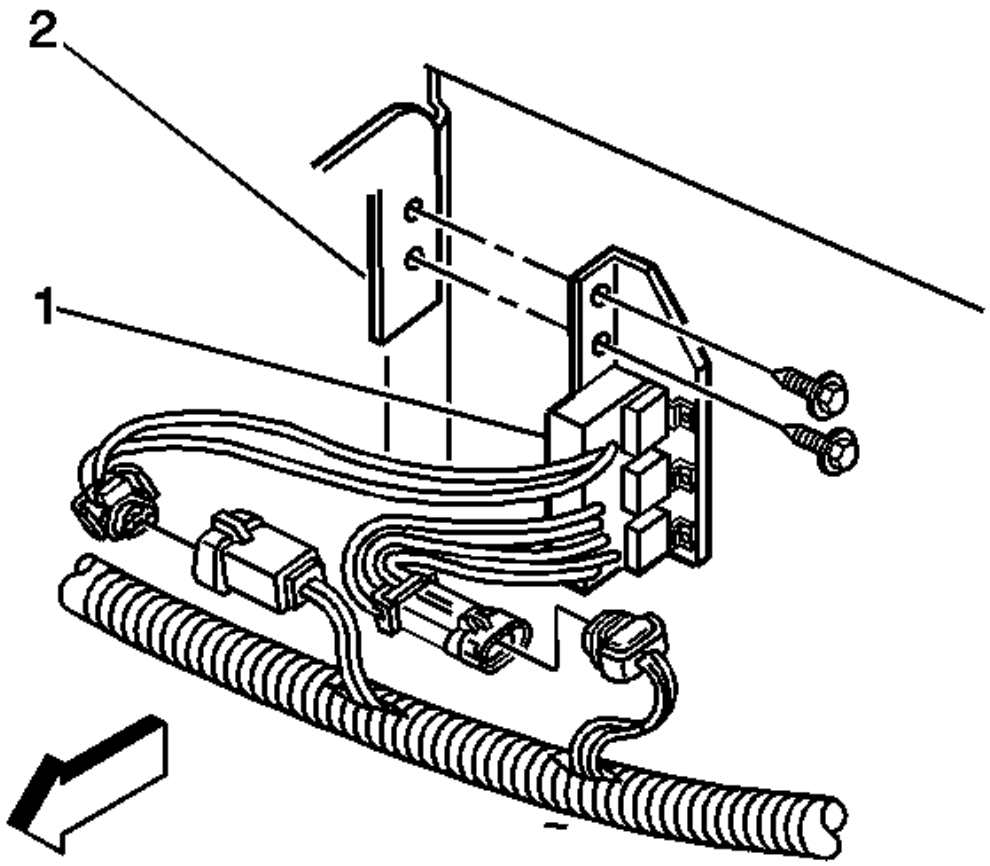


Fig. 21: Headlamp Flasher Components
Courtesy of GENERAL MOTORS COMPANY

1. Position the headlamp flasher (1) to the front radiator support (2).

CAUTION: Refer to Fastener Caution .

2. Install the headlamp flasher bolts.

Tighten

Tighten the bolts to 10 N.m (89 lb in).

3. Connect the electrical connectors.
4. Install the upper radiator baffle. Refer to **Radiator Air Upper Baffle and Deflector Replacement** .

READING LAMP BULB REPLACEMENT

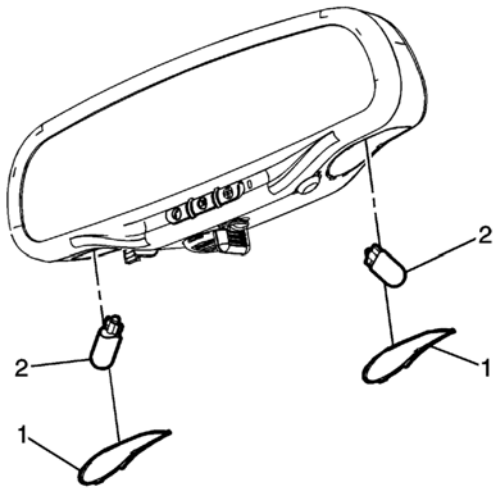


Fig. 22: Reading Lamp Bulb
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Reading Lamp Lens (Qty: 2)
2	Reading Lamp Bulb (Qty: 2)

INSTRUMENT PANEL COURTESY LAMP BULB REPLACEMENT

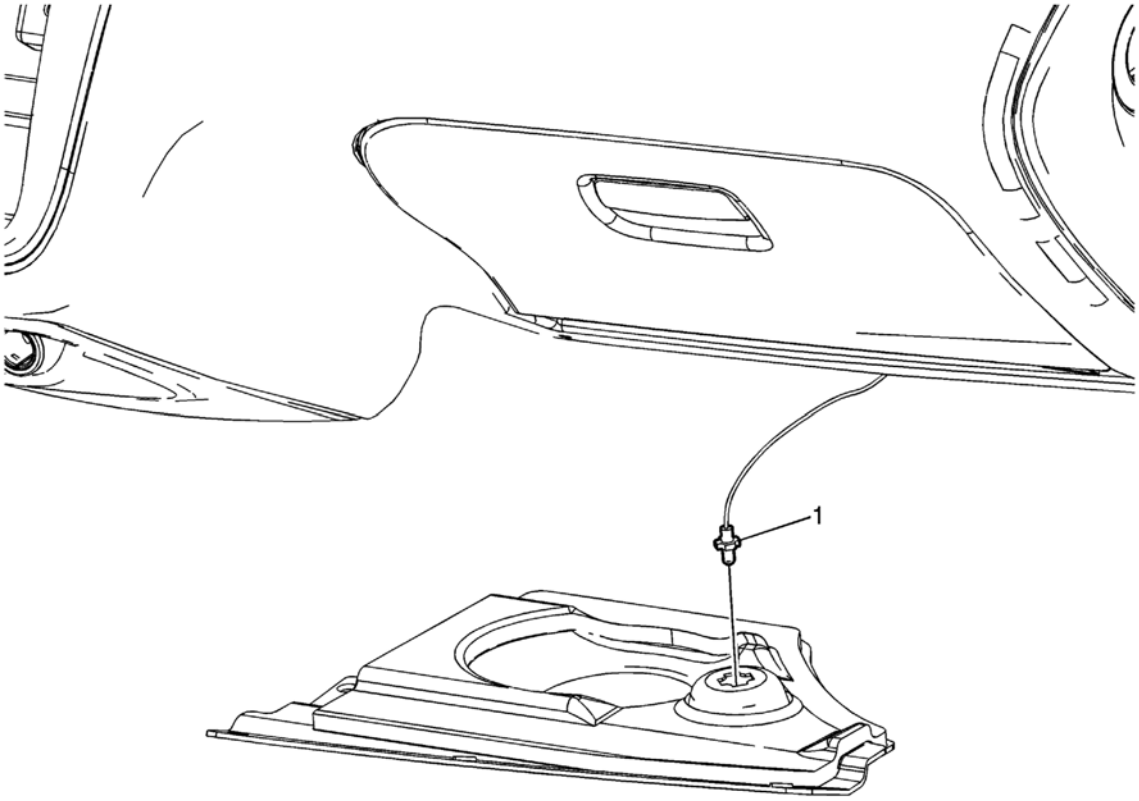


Fig. 23: Instrument Panel Courtesy Lamp
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedure** Remove the instrument panel (I/P) insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** , or **Instrument Panel Insulator Panel Replacement - Left Side** .	
1	Courtesy Lamp, Instrument Panel **TIP:** Disconnect the electrical connector.

SUNSHADE ILLUMINATED MIRROR LAMP BULB REPLACEMENT

Removal Procedure

1. Lower the sunshade and open the illuminated mirror door.
2. Insert a small flat-bladed tool at the outer edge of the lamp lens in the slot. Carefully press down to remove the lens.

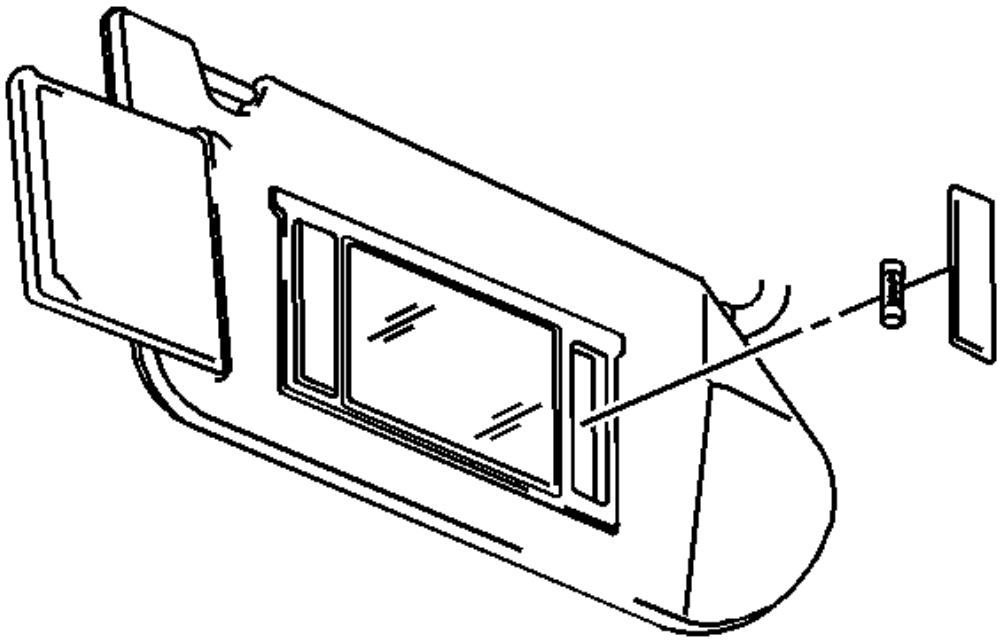


Fig. 24: Lamp Bulb
Courtesy of GENERAL MOTORS COMPANY

3. Remove the bulb.

Installation Procedure

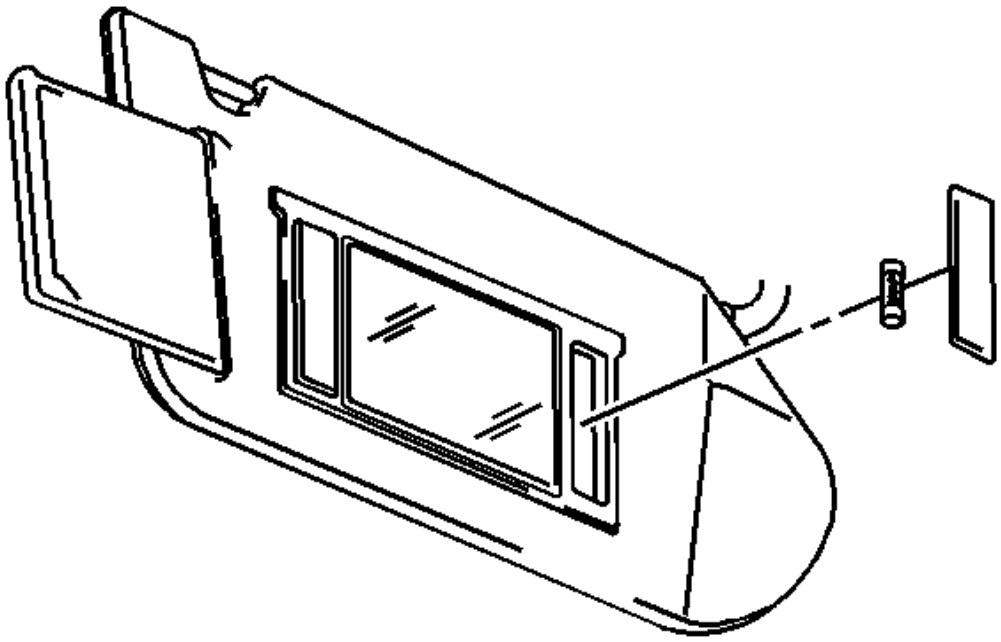


Fig. 25: Lamp Bulb
Courtesy of GENERAL MOTORS COMPANY

1. Install the bulb.
2. Align the upper lens tab to the opening. Insert the upper edge of the lens.
3. Insert a small flat-bladed tool at the outer edge of the lamp lens. Carefully press up to install the lens.
4. Close the illuminated mirror door and raise the sunshade.

DOME LAMP REPLACEMENT (IMPALA LIMITED)

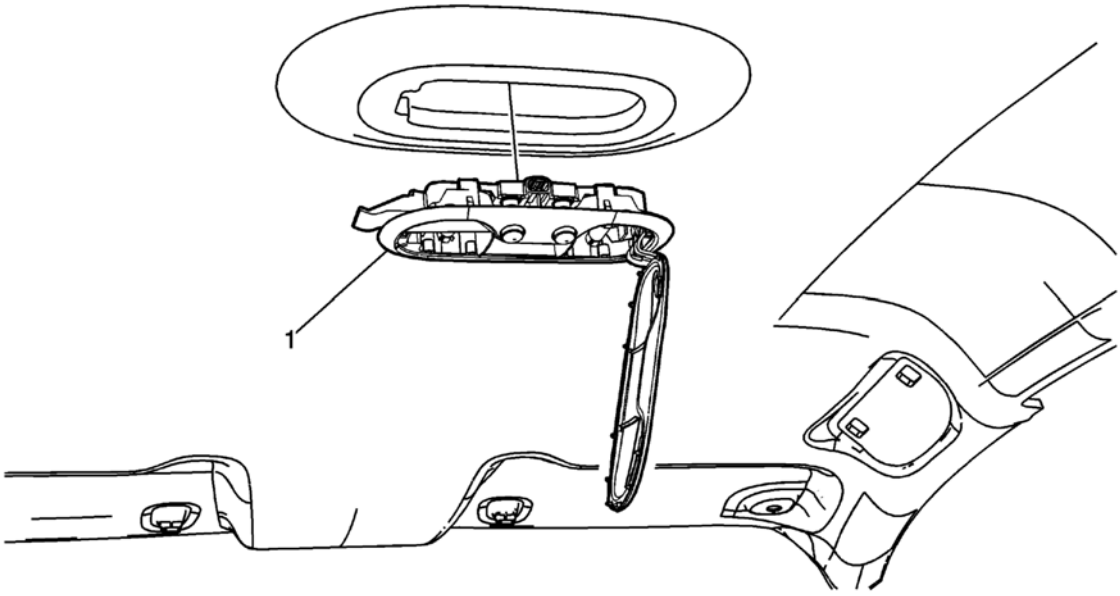


Fig. 26: Dome Light
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Lamp Assembly, Dome Reading • Pry open the driver side. • Disconnect the electrical connectors.

DOME LAMP BULB REPLACEMENT (IMPALA LIMITED)

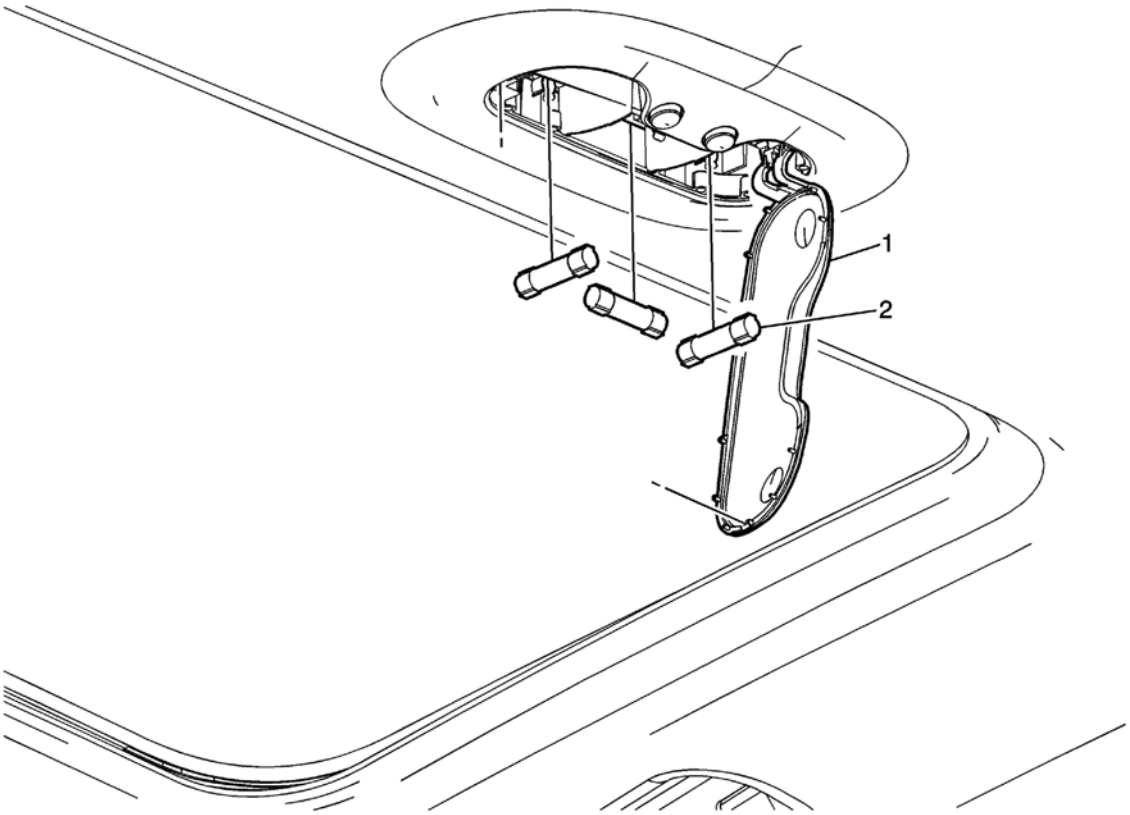


Fig. 27: Dome Lamp Bulb
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**.	
1	Lens, Dome Lamp **TIP:** Pry open the driver side.
2	Bulb, Dome lamp

HEADLAMP REPLACEMENT

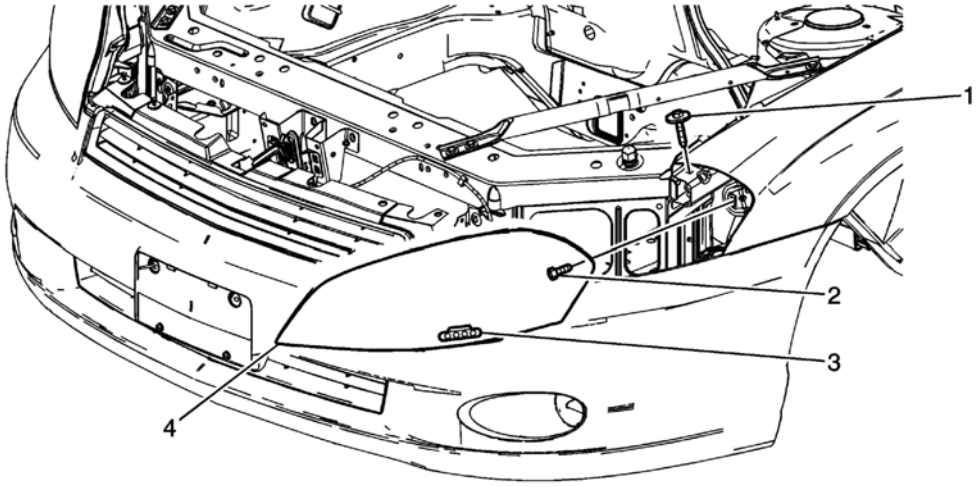


Fig. 28: Headlamp
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Open the hood. 2. Release the inner headlamp retainer by pulling the retainer upward in order to release the headlamp.	
1	Headlamp Assembly Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 6 N.m (53 lb in)
2	Headlamp Lock Pin **TIP:** Pull headlamp from the outboard edge in order to release the lock pin from the fender flange retainer.
3	Forward Lamp Harness Connector **TIP:** Disconnect the electrical connector before removing the headlamp from the vehicle.
4	Headlamp Assembly **WARNING:** **Refer to Halogen Bulb Warning .**

HEADLAMP BULB REPLACEMENT

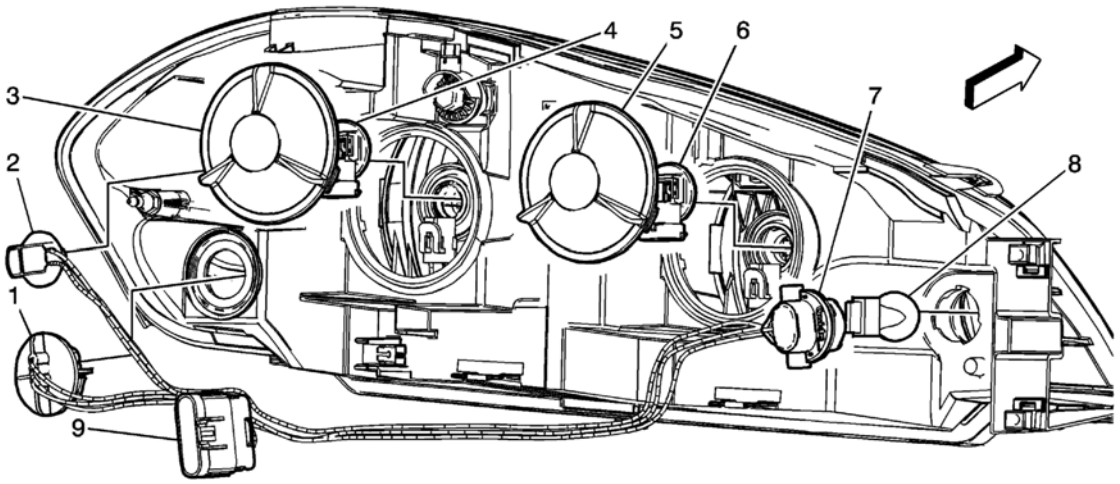


Fig. 29: Headlamp Bulb
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Open the hood. 2. Remove either the LH of RH headlamp assembly. Refer to **Headlamp Replacement**.	
1	Daytime Running and Front Park and Turn Signal Lamp Assembly **WARNING:** **Refer to Halogen Bulb Warning .**
2	Park Lamp Assembly **TIP:** Pull outward on the housing in order to access the electrical connector.
3	Headlamp Bulb Accessory Cover **TIP:** Turn the cover counterclockwise in order to remove.
4	Headlamp Bulb (LO Beam) **WARNING:** **Refer to Halogen Bulb Warning .** **TIP:** Disconnect the electrical connector from the headlamp bulb socket and turn bulb socket a quarter turn counterclockwise in order to remove.

Callout	Component Name
5	Headlamp Bulb Accessory Cover **TIP:** Turn the cover counterclockwise in order to remove.
6	Headlamp Bulb (HI Beam) **WARNING:** **Refer to Halogen Bulb Warning .** **TIP:** Disconnect the electrical connector from the headlamp bulb socket and turn bulb socket a quarter turn counterclockwise in order to remove.
7	Front Park and Turn Signal Socket **TIP:** Turn lamp socket counterclockwise in order to remove from the headlamp assembly.
8	Front Park and Turn Signal Bulb **TIP:** Pull the park and turn signal lamp bulb straight from the bulb socket.
9	Forward Lamp Harness Connector

HEADLAMP AIMING

The vehicle has a visual optical headlamp aiming system. The aim has been preset at the factory and should need no further adjustment

However, If the vehicle is damaged in an accident, the headlamp aim may be affected and adjustment may be necessary.

The vehicle should be properly prepared as follows:

- The vehicle should be placed so the headlamps are 7.6 m (25 ft) from a light colored wall or other flat surface.
- The vehicle must have all four tires on a perfectly level surface which is level all the way to the wall or other flat surface.
- The vehicle should be placed so it is perpendicular to the wall or other flat surface.
- The vehicle should not have any snow, ice or mud on it.
- The vehicle should be fully assembled and all other work stopped while headlamp aiming is being done.
- The vehicle should be normally loaded with a full tank of fuel and one person or 75 kg(160 lbs) on the driver seat.
- Tires should be properly inflated.

Headlamp aiming is done with the vehicle's low-beam headlamps. The high-beam headlamps will be correctly aimed if the low-beam headlamps are aimed properly.

The vertical headlamp aiming screws are located under the hood near the headlamps.

The adjustment screw can be turned with a 6 mm male hex.

To adjust the vertical aim on the headlamps, do the following:

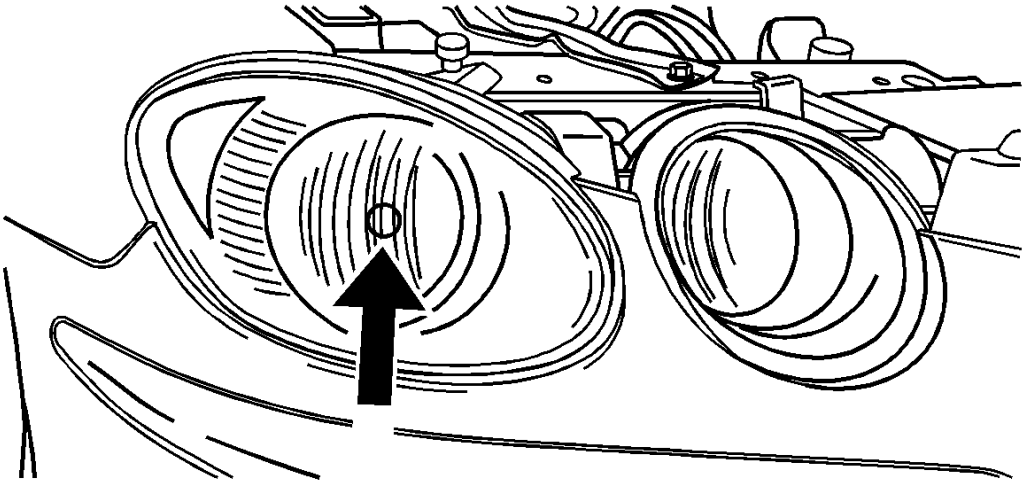


Fig. 30: Identifying Headlight Aiming Dot
Courtesy of GENERAL MOTORS COMPANY

1. Find the aim dot on the lens of the low-beam lamp.
2. Measure the distance from the ground to the aim dot on the lamp. Record the distance.
3. At the wall or other flat surface, measure from the ground upward the recorded distance from Step 2 and draw or tape a horizontal line the width of the vehicle.

CAUTION: Do not cover a headlamp to improve beam cut-off when aiming. Covering a headlamp may cause excessive heat build-up which may cause damage to the headlamp.

4. Turn on the low-beam headlamps and place a piece of cardboard or equivalent in front of the headlamp not being aimed. This should allow only the beam of light from the headlamp being aimed to be seen on the flat surface.

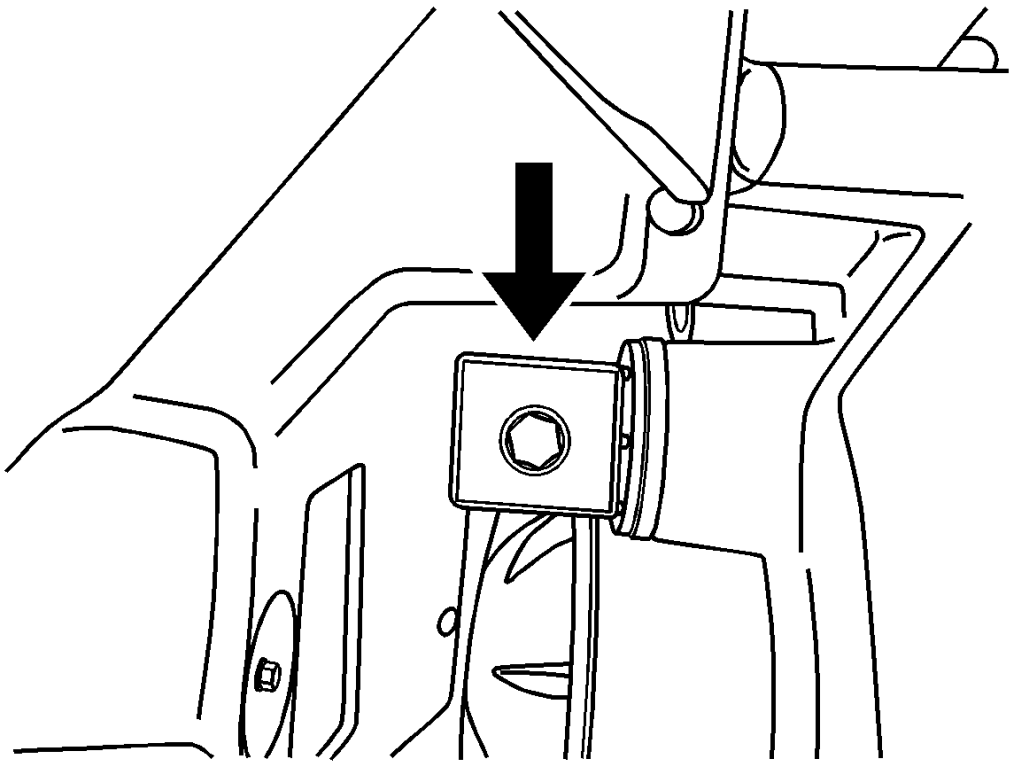


Fig. 31: Identifying Vertical Aiming Screw
Courtesy of GENERAL MOTORS COMPANY

5. Turn the vertical aiming screw until the headlamp beam is aimed to the horizontal tape line. The top edge of the cut-off should be positioned at the bottom edge of the horizontal tape line.
6. Repeat Steps 4 and 5 for the opposite headlamp.

FRONT FOG LAMP REPLACEMENT

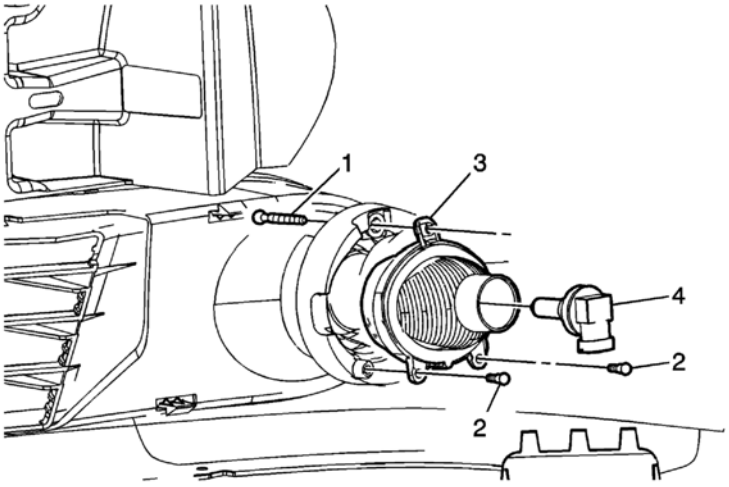


Fig. 32: Identifying Fog Lamp Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove either the LF or RF front fender liner. Refer to **Front Fender Liner Replacement** . 3. Disconnect fog lamp bulb socket electrical connector.	
1	Front Fog Lamp Adjuster Screw **Procedure** 1. Remove the adjuster screw from the fog lamp bracket and lamp assembly. 2. Count the number of turns when removing the adjuster screw for a reference upon installation. 3. Aim the fog lamp after installation. Refer to **Fog Lamp Aiming**.
2	Front Fog Lamp Screws (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 2 N.m (18 lb in)
3	Front Fog Lamp Assembly **TIP:** Remove the lamp assembly from the fog lamp bracket.
4	Front Fog Lamp Bulb

Callout	Component Name
	WARNING: **Refer to Halogen Bulb Warning .** **TIP:** Turn the bulb socket counterclockwise and remove from lamp assembly.

FRONT FOG LAMP BULB REPLACEMENT

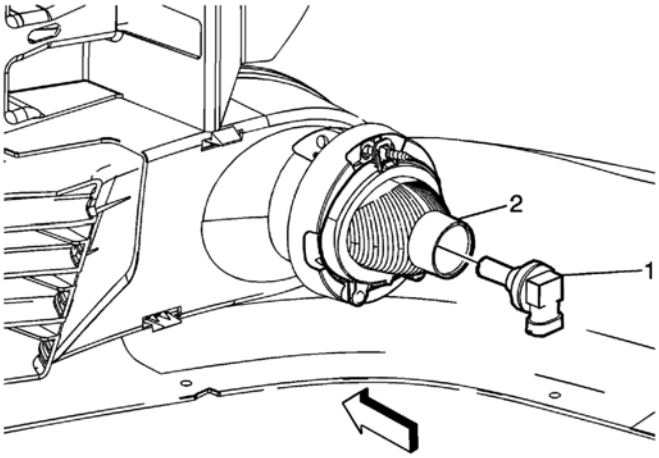


Fig. 33: Identifying Fog Lamp Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove either the LF or RF headlamp assembly. Refer to **Headlamp Replacement**. 2. Disconnect the fog lamp electrical connector.	
1	Front Fog Lamp Projector Bulb **WARNING:** **Refer to Halogen Bulb Warning .** **TIP:** Twist the bulb socket counterclockwise to remove from the lamp housing.
2	Front Fog Lamp Projector Housing

FOG LAMP AIMING

The front fog lamps must be aimed for proper illumination of the road. The front fog lamp aim should be checked when a new front fog lamp assembly is installed, or if service or repairs in the front end area may have disturbed the front fog lamp mounting.

There is no horizontal adjustment for aiming the front fog lamp assemblies on this vehicle.

1. To ensure accurate vertical front fog lamp aiming, first perform the following steps to prepare the vehicle.
    - Ensure that all the components are in place on the vehicle, if other service has been performed on the vehicle.
    - Ensure the fuel level is full.
    - Place the vehicle on a level surface 1.52 m (5 ft) away from a target screen.
    - Stop all other operations of work on the vehicle.
    - Jounce the vehicle to settle the suspension.
    - Cover the headlamps while aiming the fog lamps.
2. Turn the front fog lamps ON.

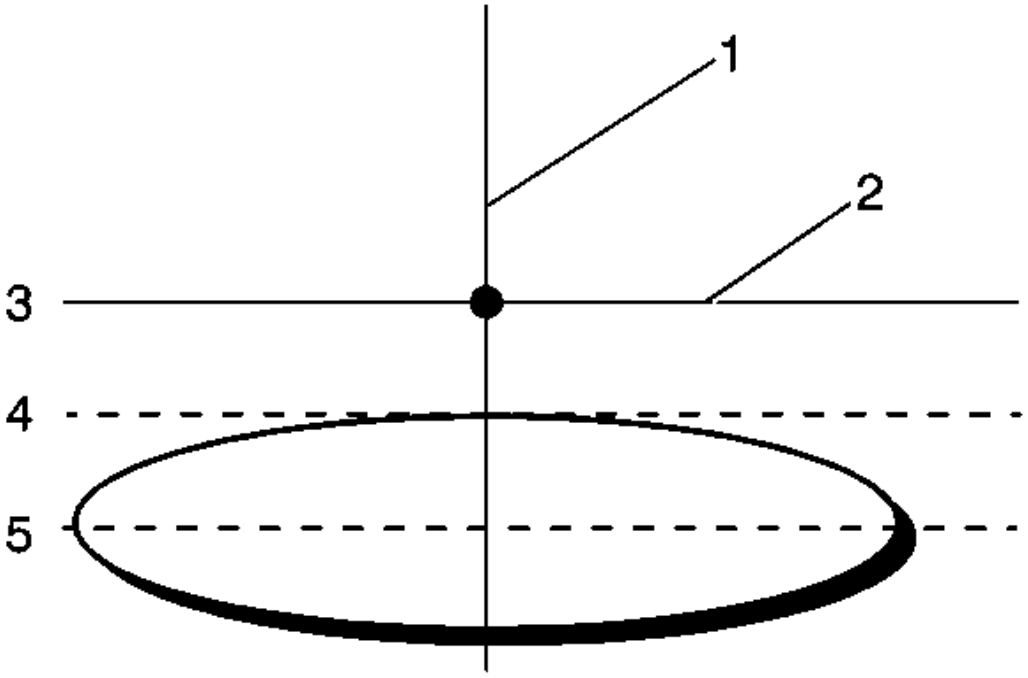


Fig. 34: Fog Lamp Aiming Pattern
Courtesy of GENERAL MOTORS COMPANY

3. Adjust the fog lamp up or down until the top edge of the high intensity zone on the screen is 102 mm (4 in) below the horizontal centerline (2), within the range of 0 mm (0 in) (3) to 203 mm (8 in) (5), below

the horizontal centerline, on the target screen.

4. Turn OFF the front fog lamps.

PARKING AND TURN SIGNAL LAMP BULB REPLACEMENT

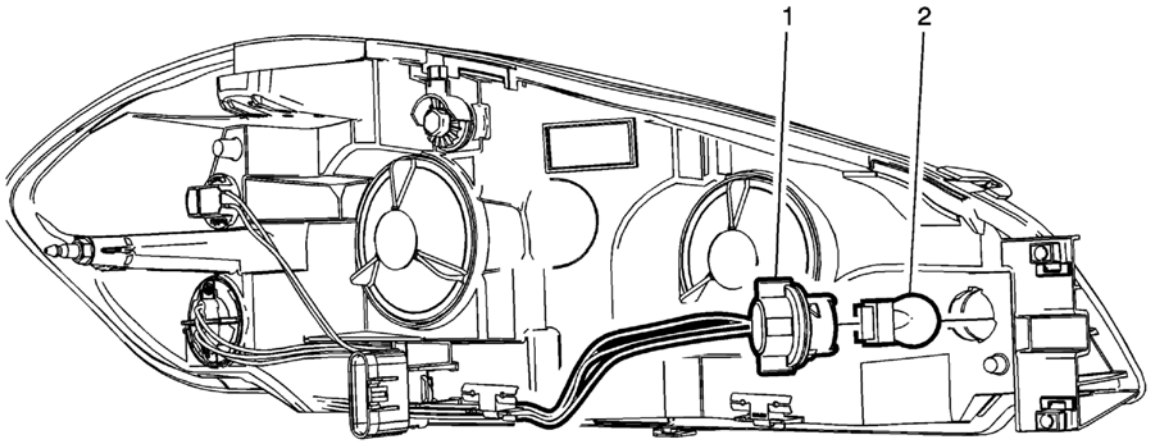


Fig. 35: Parking and Turn Signal Lamp Bulb
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Open the hood. 2. Remove either the LH of RH headlamp assembly. Refer to **Headlamp Replacement**.	
1	Front Park and Turn Signal Socket **NOTE:** **Turn the lamp socket counterclockwise in order to remove from the headlamp assembly.**
2	Front Park and Turn Signal Bulb

Callout	Component Name
	NOTE: Hold the lamp socket and pull the

HIGH MOUNT STOP LAMP REPLACEMENT (IMPALA LIMITED)

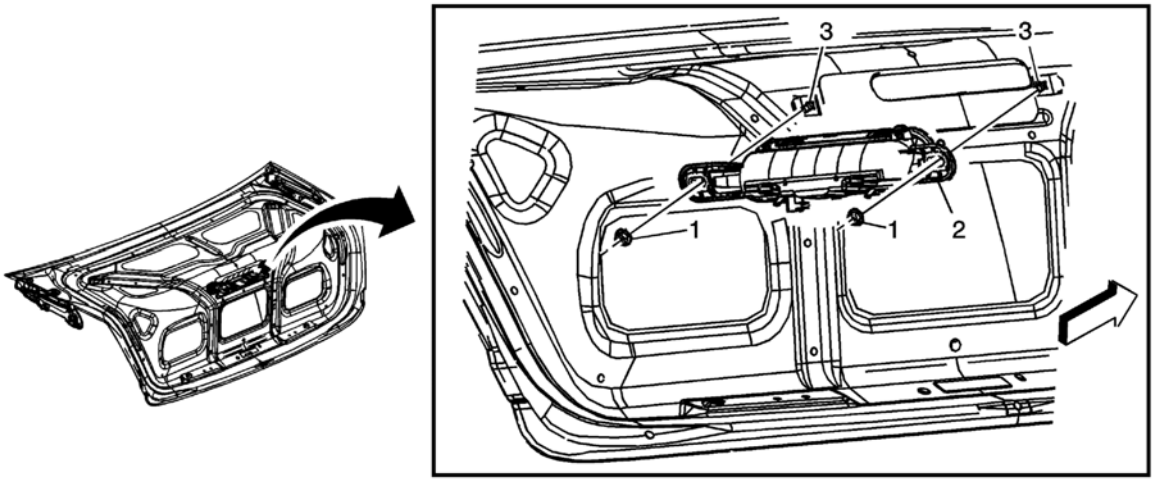


Fig. 36: High Mounted Stop Lamp
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear interior compartment lid trim. Refer to **Rear Compartment Lid Inner Panel Trim Replacement** .	
1	High Mounted Stop Lamp Assembly Nuts (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 4 N.m (35 lb in)
2	High Mounted Stop Lamp Assembly • Remove the high mounted stop lamp from the inside of the rear compartment lid mounting studs. • Disconnect the electrical connector to the high mounted stop lamp.
3	Rear Compartment Inner Panel Studs **TIP:** Ensure the studs are secure to the inner compartment panel upon reassemble.

BACKUP LAMP BULB REPLACEMENT

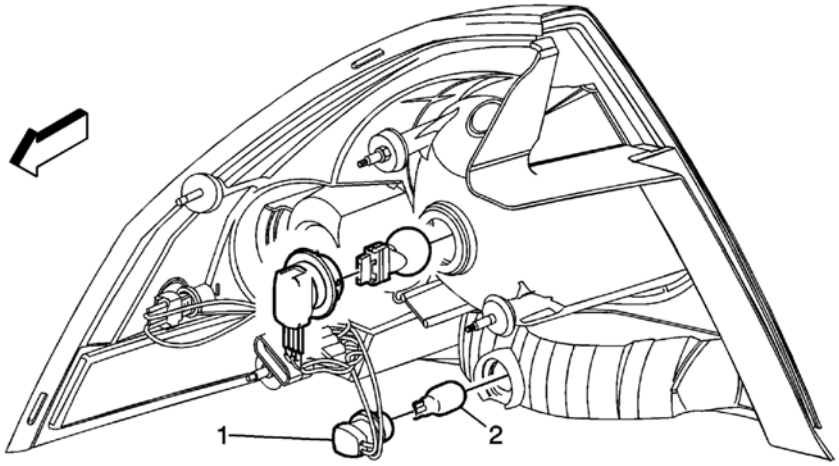


Fig. 37: Backup Lamp Bulb
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. **Preliminary Procedure** Remove either the LR or RR tail lamp assembly. Refer to **Tail Lamp Replacement (Impala Limited)**.	
1	Socket, Reverse Lamp Bulb **TIP:** Twist the socket counterclockwise a quarter turn to remove.
2	Bulb, Reverse Lamp **TIP:** Pull outward on the bulb in order to replace.

REAR LICENSE PLATE LAMP REPLACEMENT (IMPALA LIMITED)

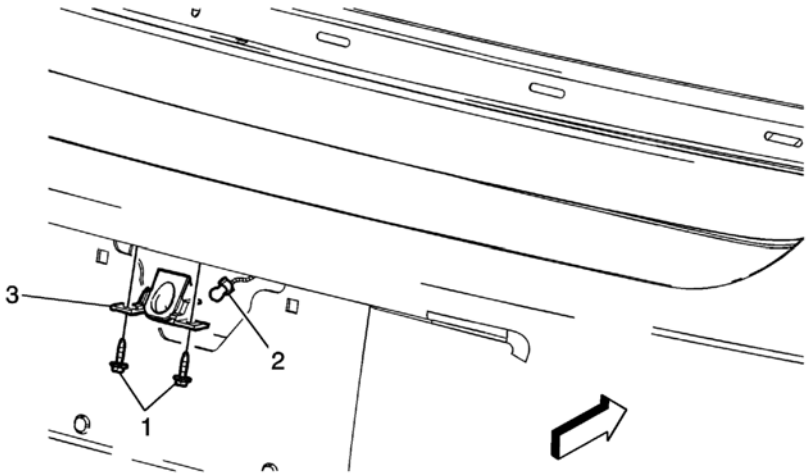


Fig. 38: Rear License Lamp
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Rear License Plate Lamp Screws (Qty: 2)

Callout	Component Name
	CAUTION: **Refer to** **Fastener** **Caution .** Tighten 2 N.m (18 lb in)
2	Rear License Lamp **Procedure** 1. Pull downward on the lamp in order to access the lamp electrical connector on the inside of the rear bumper fascia. 2. Twist the connector socket counterclockwise in order to remove from the lamp housing. 3. Pull the bulb outward to remove from the socket.
3	Rear License Plate Lens **TIP:** Snap lens into outer rear compartment lid upon installation.

TAIL LAMP REPLACEMENT (IMPALA LIMITED)

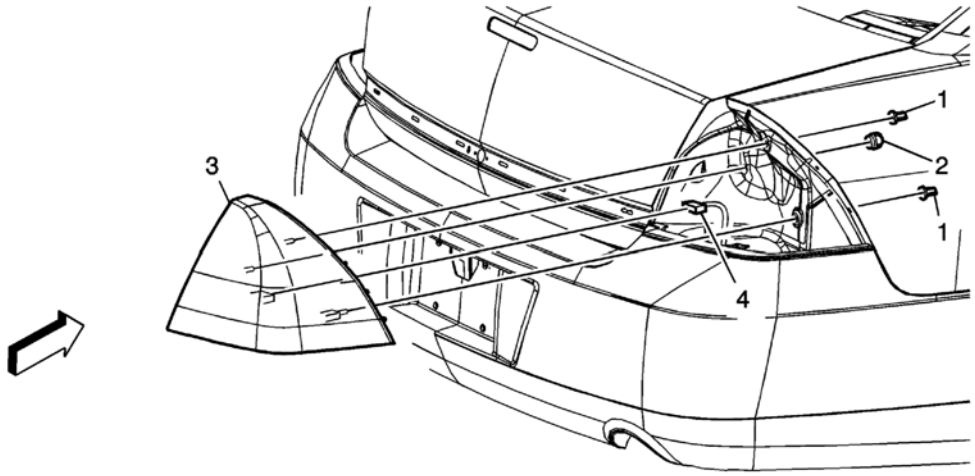


Fig. 39: Tail Lamp
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Open the rear compartment lid. 2. Remove the nut securing the rear compartment trim the backside of the tail lamp assembly. 3. Pull down the rear compartment trim liner.	
1	Tail Lamp Assembly Nuts (Qty: 2)

Callout	Component Name
	CAUTION: **Refer to** **Fastener** **Caution .** Tighten 2 N.m (18 lb in)
2	Trunk Trim Line Nut **TIP:** Ensure the trim liner nut is installed after the liner is repositioned in the rear compartment.
3	Tail Lamp Assembly **TIP:** Pull rearward to remove and connect the electrical connector and push lamp inward in order to position the lamp to the body panel.
4	Rear Lamp Harness Connector Ensure to connect the lamp harness connector before securing the lamp to the rear body panel.

TAIL LAMP BULB REPLACEMENT (IMPALA LIMITED)

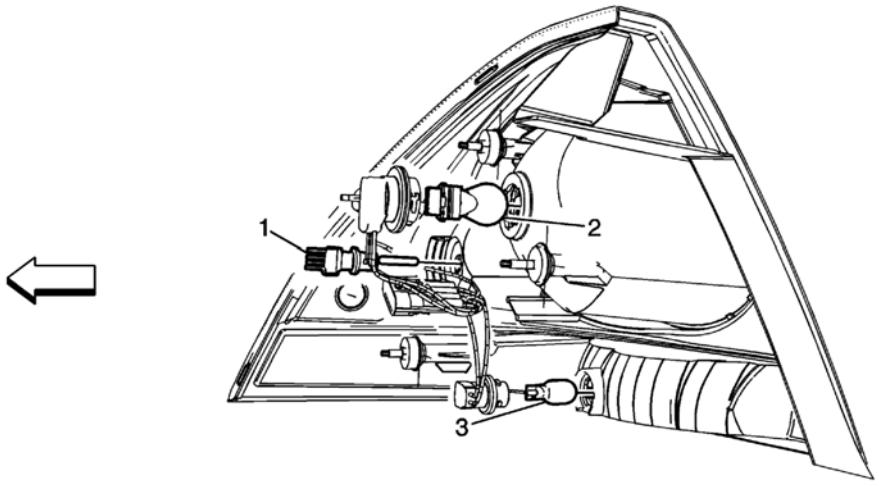


Fig. 40: Tail Lamp Bulb
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove either the LR or RR tail lamp assembly. Refer to **Tail Lamp Replacement (Impala Limited)**.	
1	Rear Park Lamp Bulb **TIP:** Turn the lamp socket counterclockwise in order to remove.
2	Park and Turn Signal Assembly Bulb **TIP:** Pull the bulb straight out of the lamp socket.
3	Rear Back Up Assembly Bulb **WARNING:**

Callout	Component Name
	Refer to Halogen Bulb Warning . **TIP:** Remove the bulb from the lamp socket by pulling the bulb straight outward from the socket.

REAR TURN SIGNAL LAMP BULB REPLACEMENT

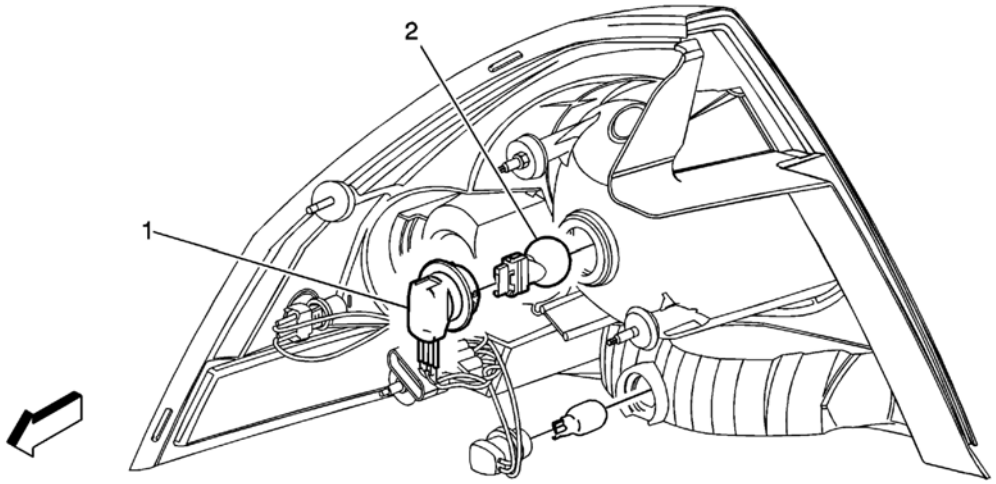


Fig. 41: Rear Turn Signal Lamp Bulb
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to Fastener Specifications. **Preliminary Procedure** Remove either the LR or RR tail lamp assembly. Refer to Tail Lamp Replacement (Impala Limited).	
1	Socket, Stop and Tail Lamp **TIP:** Twist the socket counterclockwise a quarter turn to remove.
2	Bulb, Stop and Tail Lamp **TIP:** Pull outward on the bulb in order to replace.

EMERGENCY VEHICLE REAR COMPARTMENT LID LAMP REPLACEMENT (IMPALA LIMITED RPO T53)

Removal Procedure

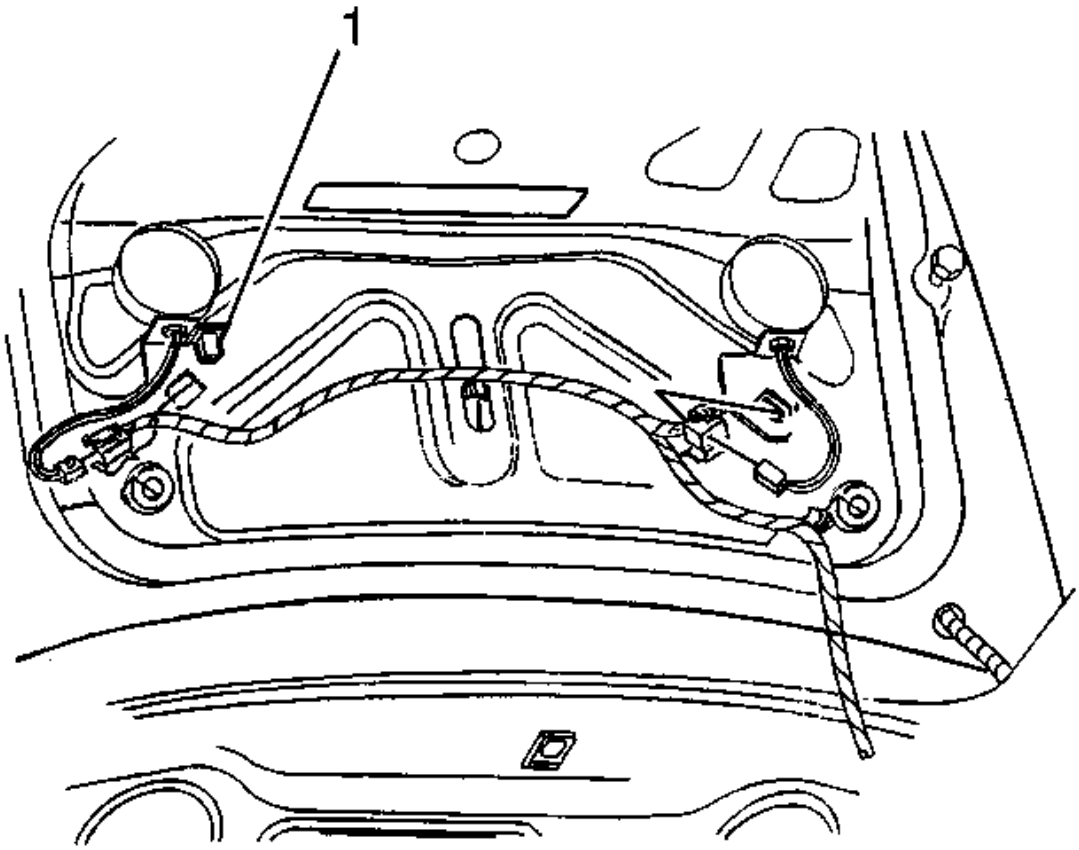


Fig. 42: Rear Compartment Lid Lamps & Flasher Fuse
Courtesy of GENERAL MOTORS COMPANY

1. Open the rear compartment.
2. Disconnect the electrical connectors from the rear compartment lid lamp(s).
3. Disconnect the electrical connector from the flasher fuse (1).
4. Remove the flasher fuse (1) if required.

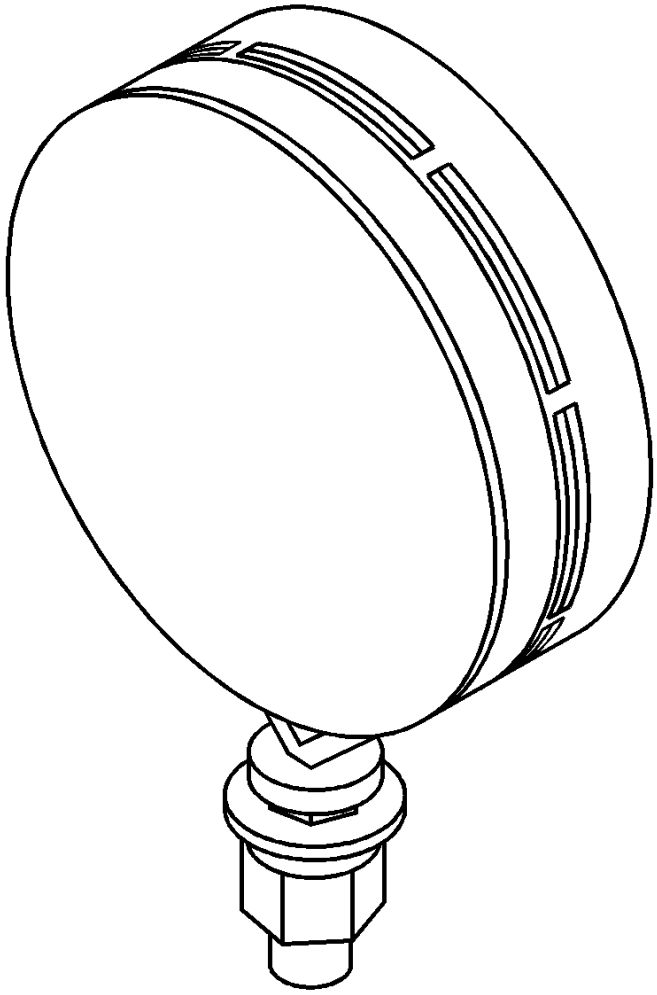


Fig. 43: Rear Compartment Lid Lamp
Courtesy of GENERAL MOTORS COMPANY

5. Remove the rear compartment lid lamp(s) from the rear compartment lid.

Installation Procedure

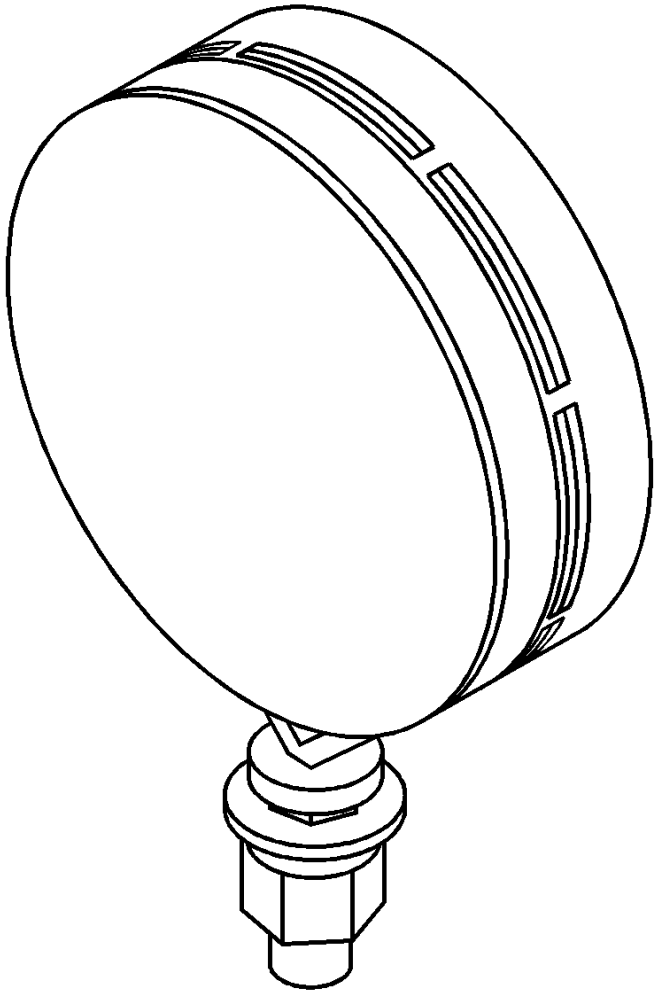


Fig. 44: Rear Compartment Lid Lamp
Courtesy of GENERAL MOTORS COMPANY

1. Position the rear compartment lid lamp(s) from the rear compartment lid.

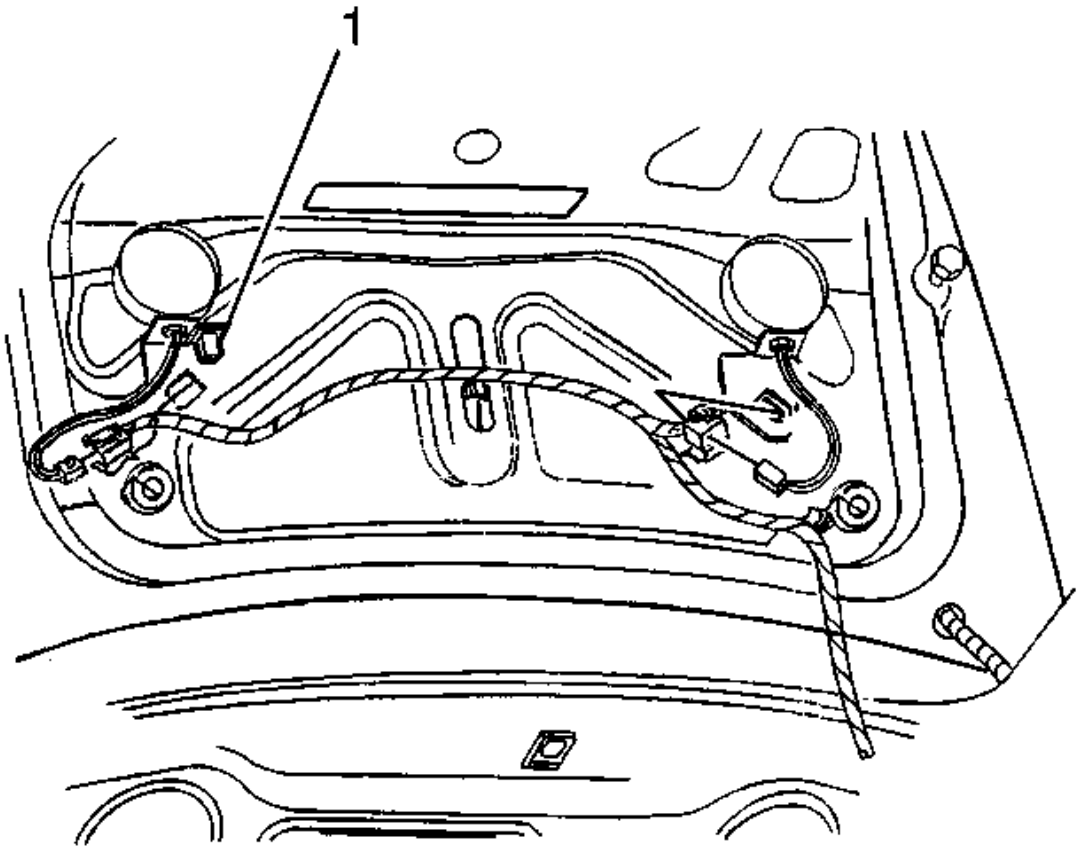


Fig. 45: Rear Compartment Lid Lamps & Flasher Fuse
Courtesy of GENERAL MOTORS COMPANY

2. Install the flasher fuse (1) if required.
3. Connect the electrical connector to the flasher fuse (1).
4. Connect the electrical connectors to the rear compartment lid lamp(s).
5. Close the rear compartment.

REAR COMPARTMENT LID LAMP LENS AND BULB REPLACEMENT (IMPALA LIMITED RPO T53)

Removal Procedure

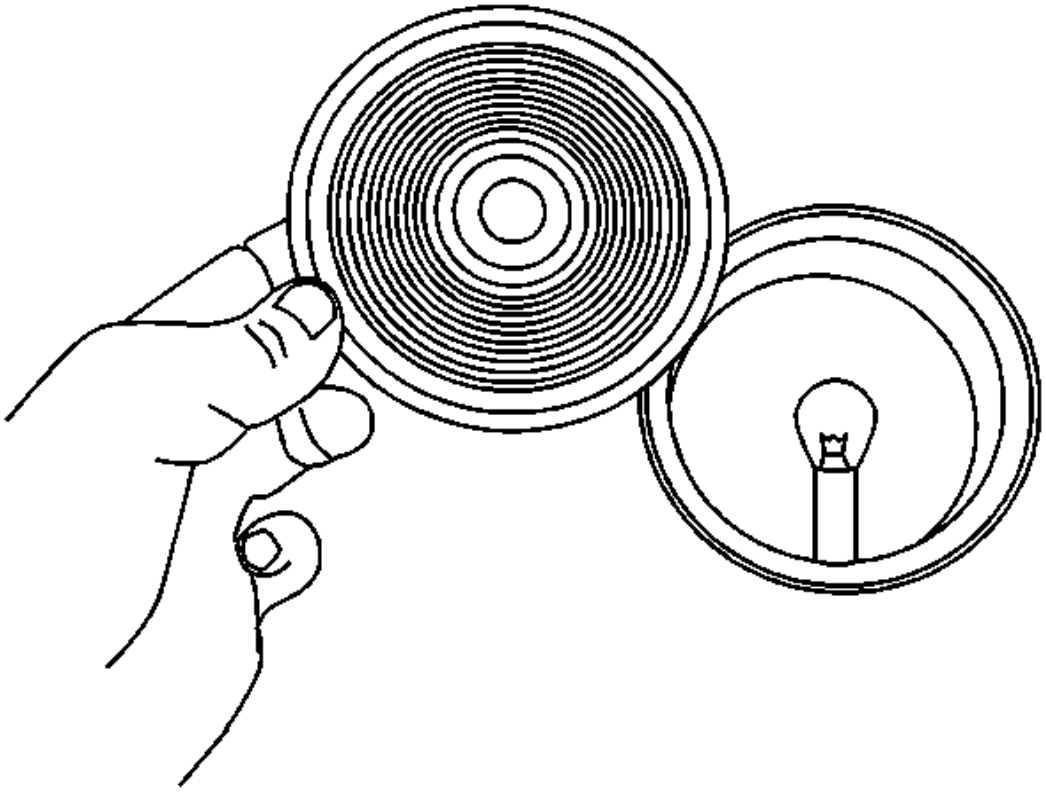


Fig. 46: Rear Compartment Lid Lamp Lens (Impala Limited RPO T53)
Courtesy of GENERAL MOTORS COMPANY

1. Open the rear compartment.
2. Remove the lens from the rear compartment lid lamp.

   Inserted a small coin under the rear compartment lid lamp lens and then twist the coin.

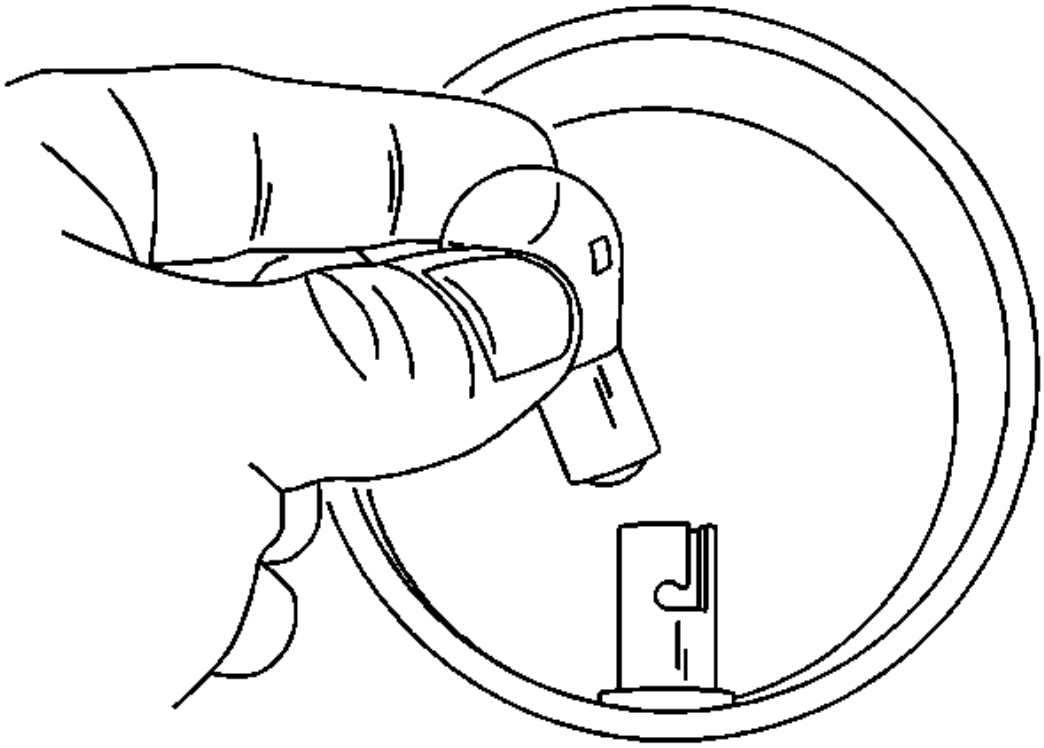


Fig. 47: Lid Lamp Bulb (Impala Limited RPO T53)
Courtesy of GENERAL MOTORS COMPANY

3. Remove the bulb from the rear compartment lid lamp socket.

Installation Procedure

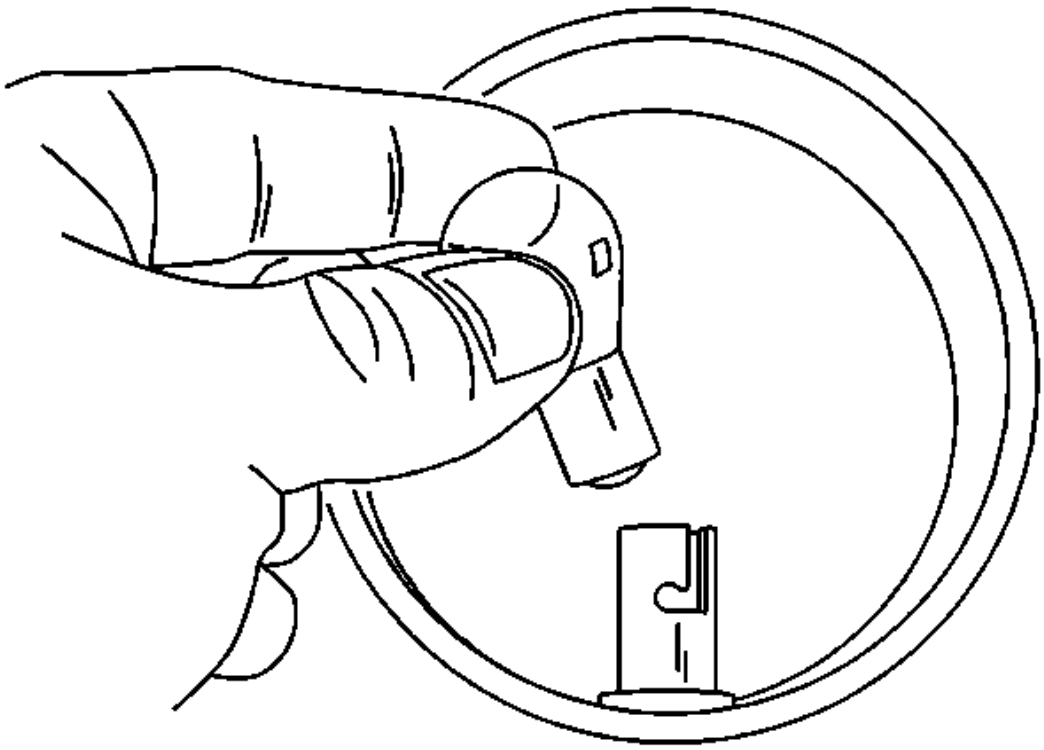


Fig. 48: Lid Lamp Bulb (Impala Limited RPO T53)
Courtesy of GENERAL MOTORS COMPANY

1. Install the bulb to the rear compartment lid lamp socket.

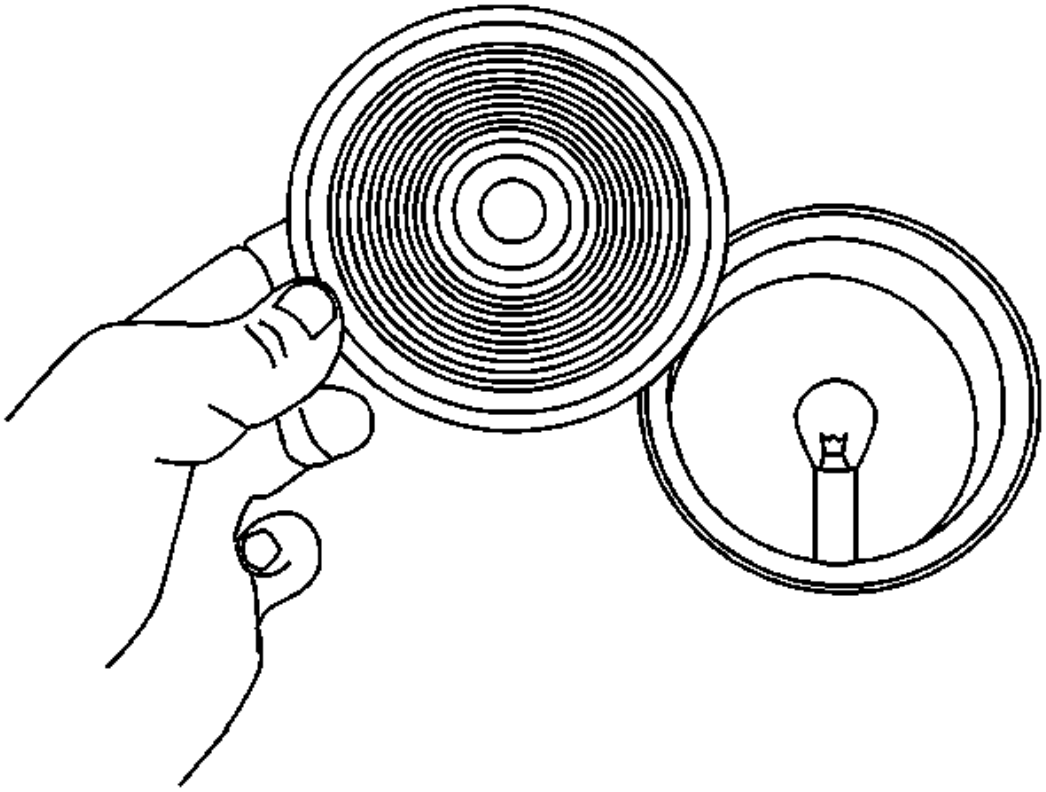


Fig. 49: Rear Compartment Lid Lamp Lens (Impala Limited RPO T53)
Courtesy of GENERAL MOTORS COMPANY

2. Install the lens to the rear compartment lid lamp, pressing into place until fully seated.
3. Close the rear compartment.

EMERGENCY VEHICLE REAR LAMP REPLACEMENT (IMPALA LIMITED RPO 6J6)

Removal Procedure

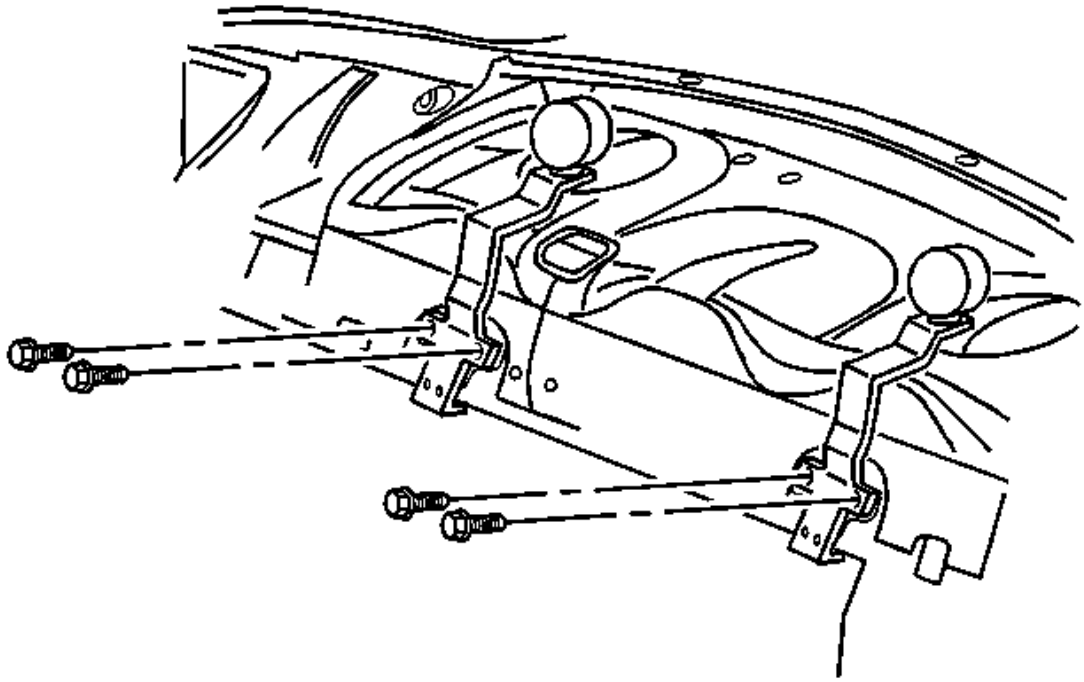


Fig. 50: Window Panel Lamp Bracket(s) (Impala Limited RPO 6J6)
Courtesy of GENERAL MOTORS COMPANY

1. Remove the rear seat back. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)** .
2. Remove the bolts from the rear window panel lamp bracket(s).

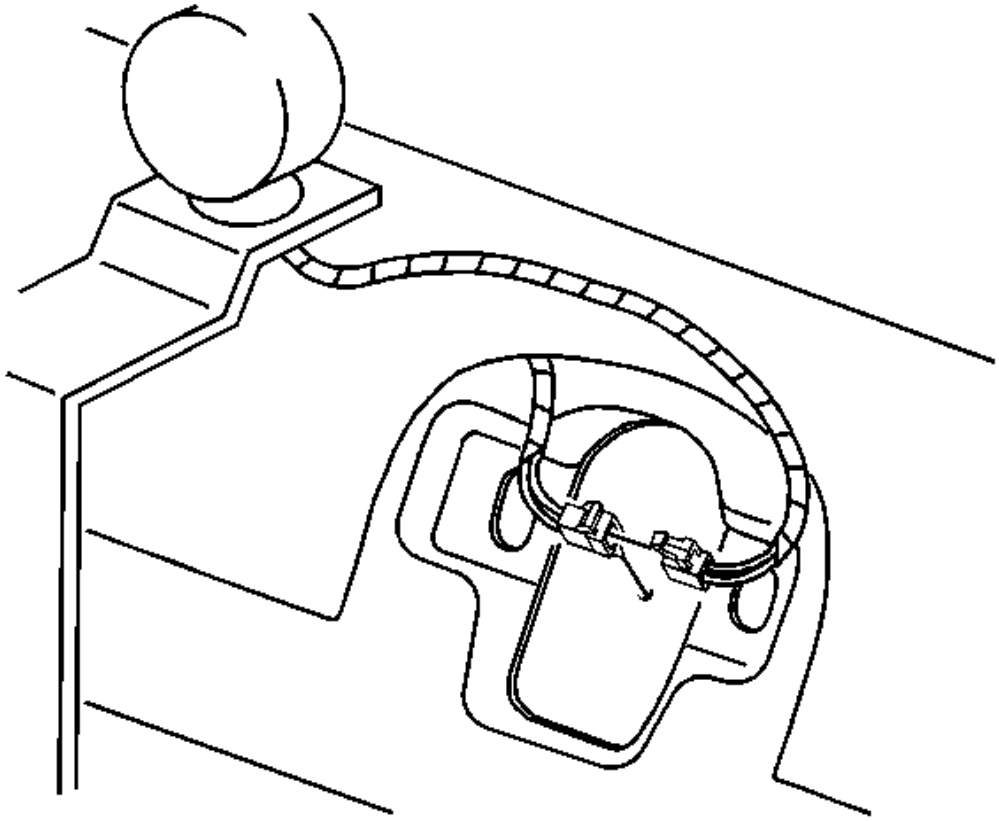


Fig. 51: Window Panel Lamp Electrical Connectors (Impala Limited RPO 6J6)
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the electrical connector(s).
4. Remove the rear window panel lamp(s) from the rear window panel.

Installation Procedure

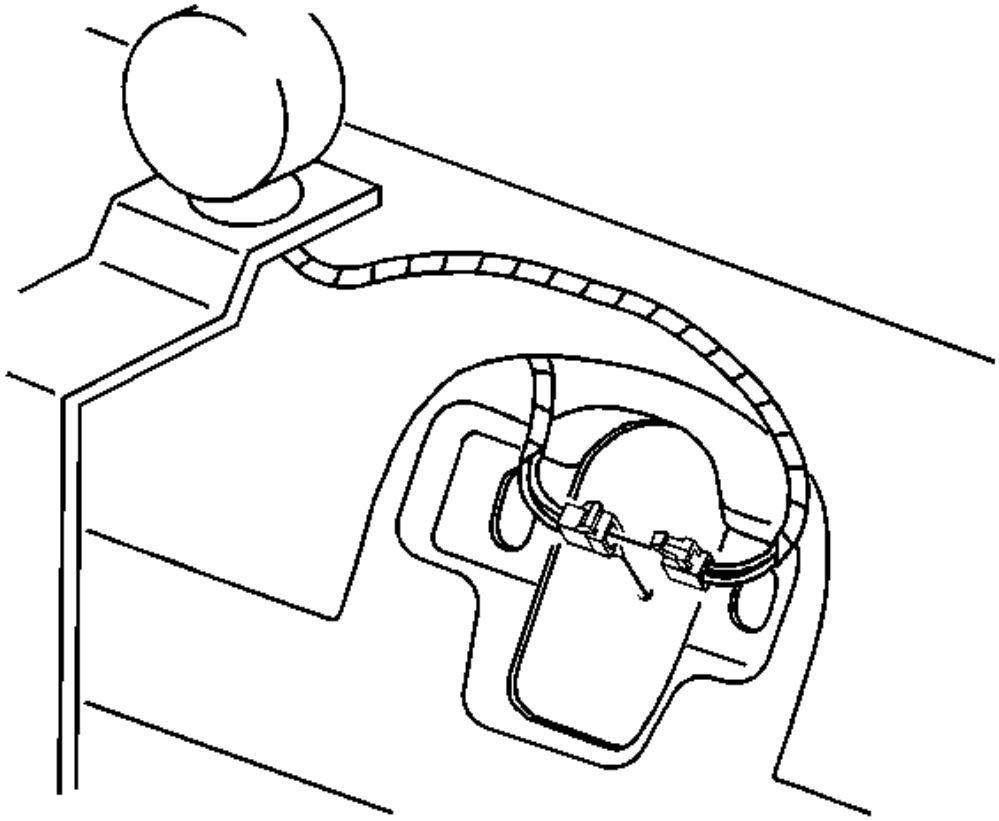


Fig. 52: Window Panel Lamp Electrical Connectors (Impala Limited RPO 6J6)
Courtesy of GENERAL MOTORS COMPANY

1. Connect the electrical connector.

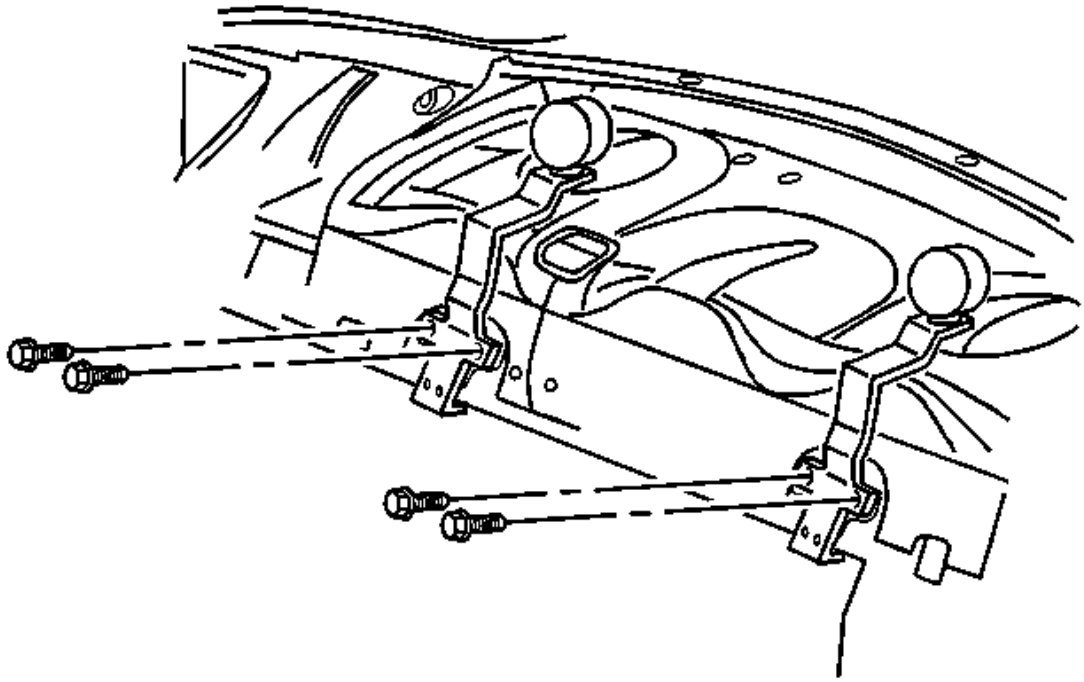


Fig. 53: Window Panel Lamp Bracket(s) (Impala Limited RPO 6J6)
Courtesy of GENERAL MOTORS COMPANY

2. Position the rear window panel lamp bracket(s) to the rear window panel.

CAUTION: Refer to Fastener Caution .

3. Install the bolts to the rear window panel bracket(s).

Tighten

Tighten the window panel bolts to 3 N.m (27 lb in).

4. Install the rear seat back. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)** .

EMERGENCY VEHICLE REAR LAMP LENS AND BULB REPLACEMENT (IMPALA LIMITED RPO 6J6)

Removal Procedure

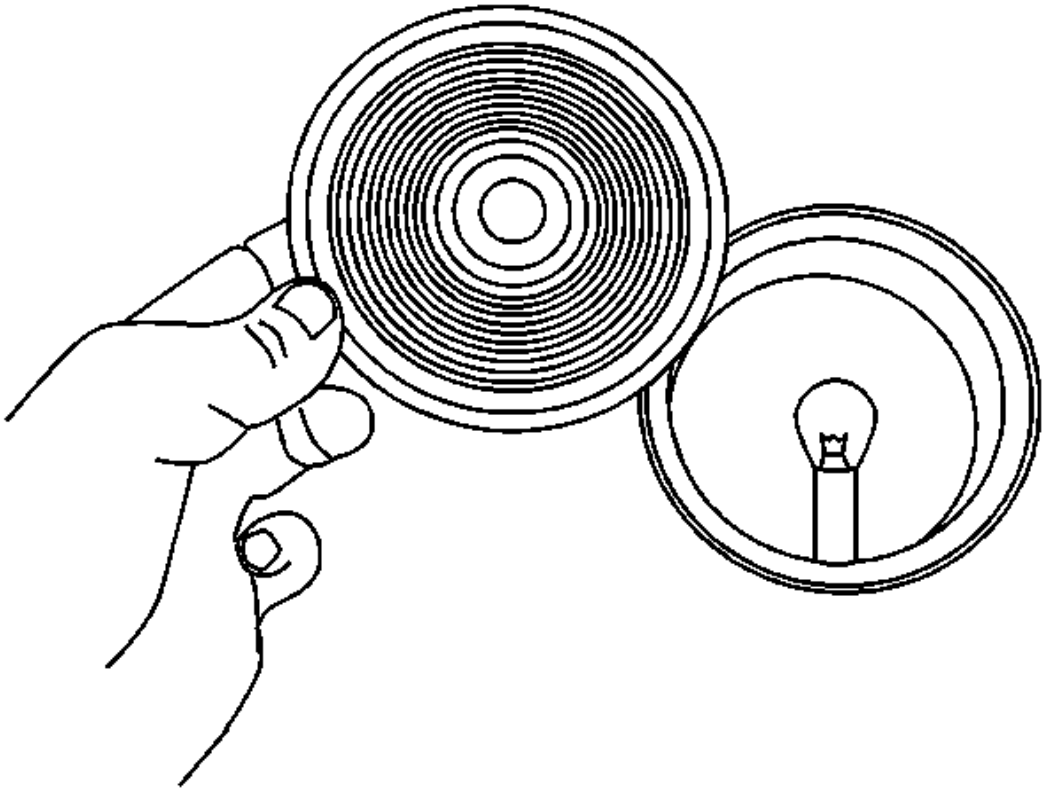


Fig. 54: Rear Compartment Lid Lamp Lens (Impala Limited RPO T53)
Courtesy of GENERAL MOTORS COMPANY

1. Remove the lens from the rear window panel lamp.

   Inserted a small coin under the rear window panel lamp lens and then twist the coin.

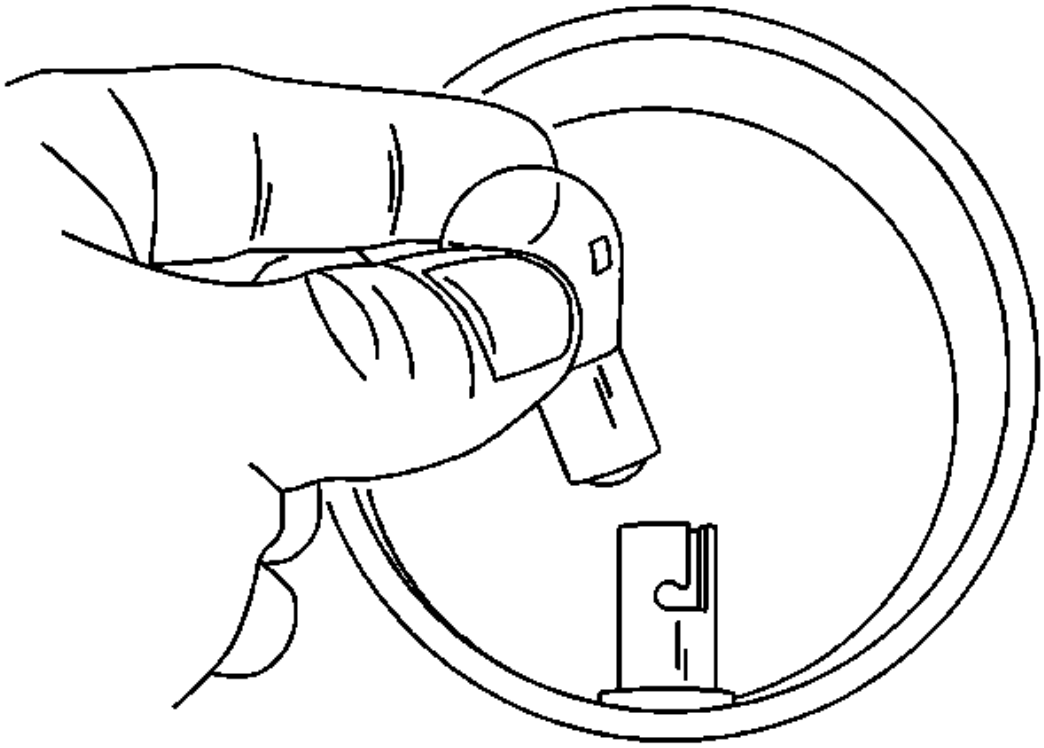


Fig. 55: Lid Lamp Bulb (Impala Limited RPO T53)
Courtesy of GENERAL MOTORS COMPANY

2. Remove the bulb from the rear window panel lamp socket.

Installation Procedure

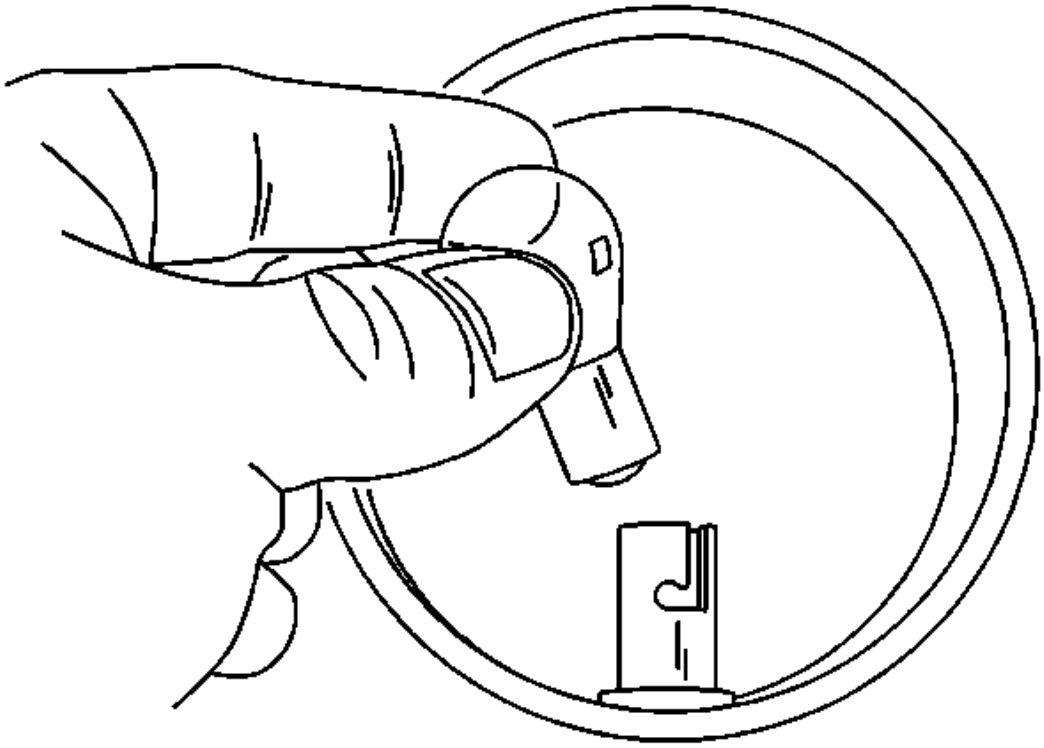


Fig. 56: Lid Lamp Bulb (Impala Limited RPO T53)
Courtesy of GENERAL MOTORS COMPANY

1. Install the bulb to the rear window panel lamp socket.

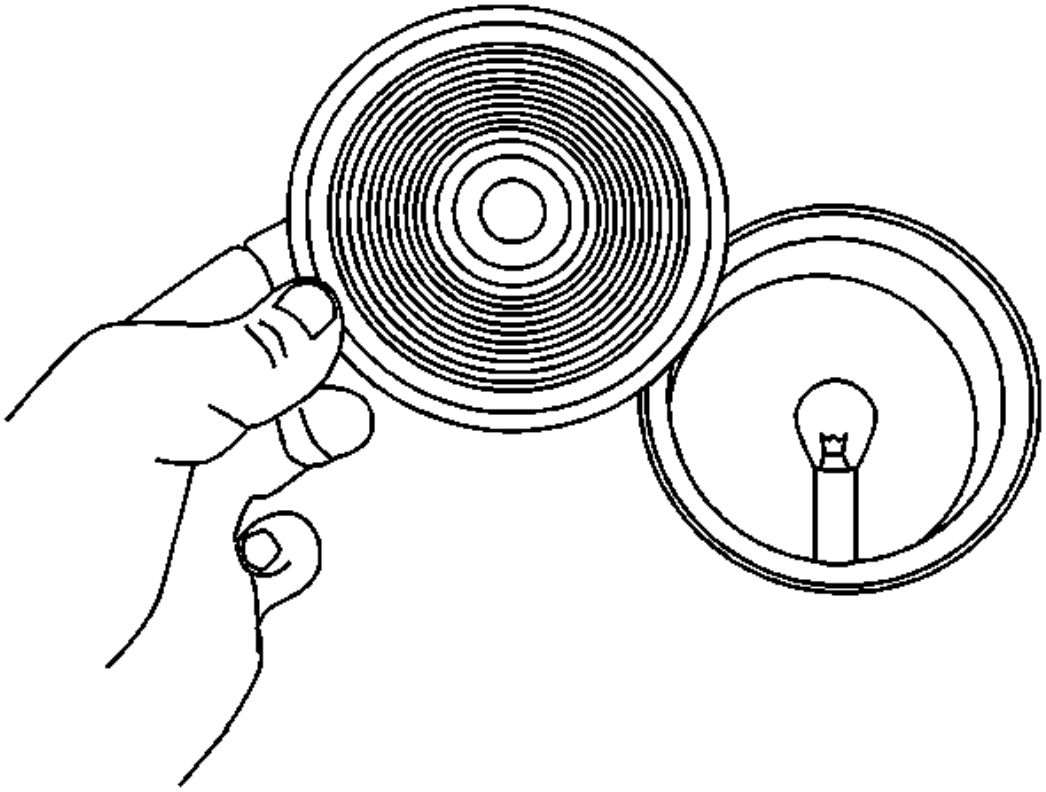


Fig. 57: Rear Compartment Lid Lamp Lens (Impala Limited RPO T53)
Courtesy of GENERAL MOTORS COMPANY

2. Install the lens to the rear window panel lamp, pressing into place until fully seated.

SPOT LAMP REPLACEMENT (IMPALA LIMITED RPO 7X6, 7X7)

Removal Procedure

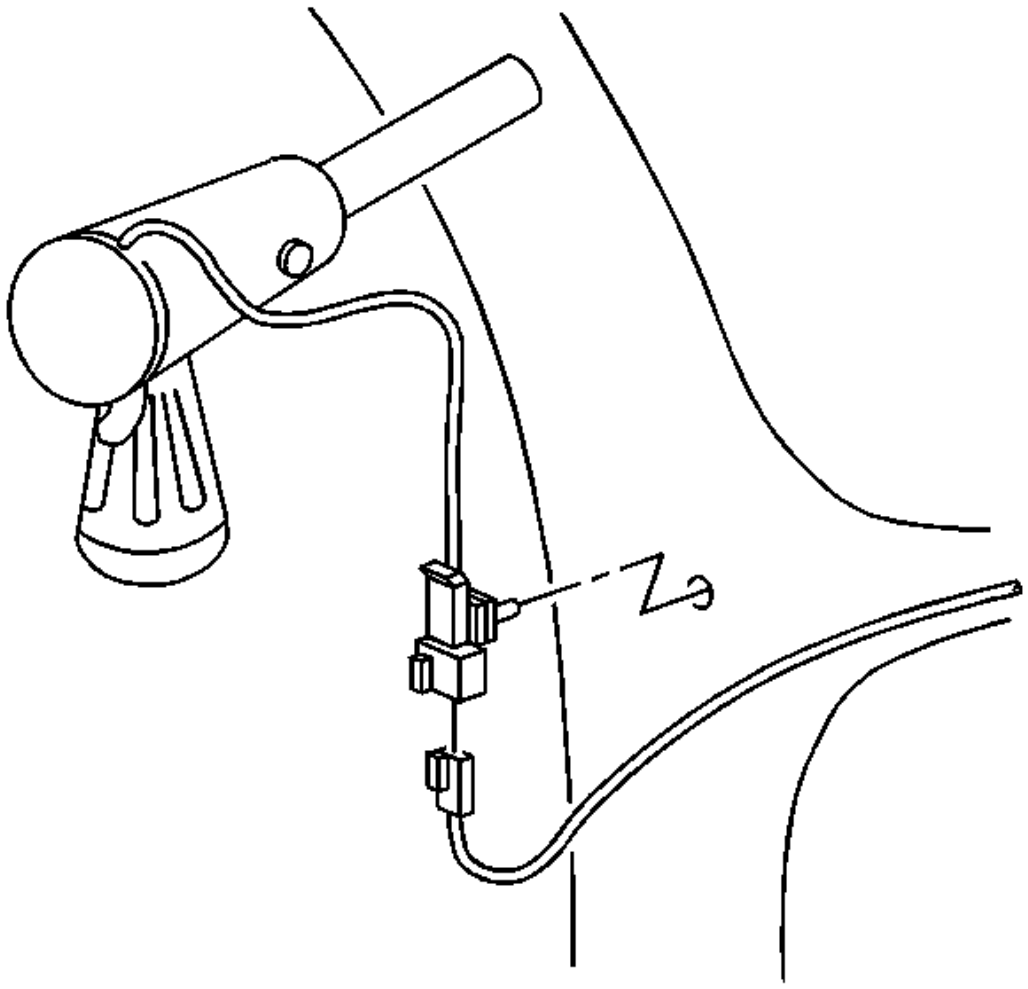


Fig. 58: Spot Lamp Wiring Harness Push-In Retainer & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Remove the spot lamp wiring harness push-in retainer from the windshield garnish molding, using a small flat bladed tool.
2. Disconnect the electrical connector.

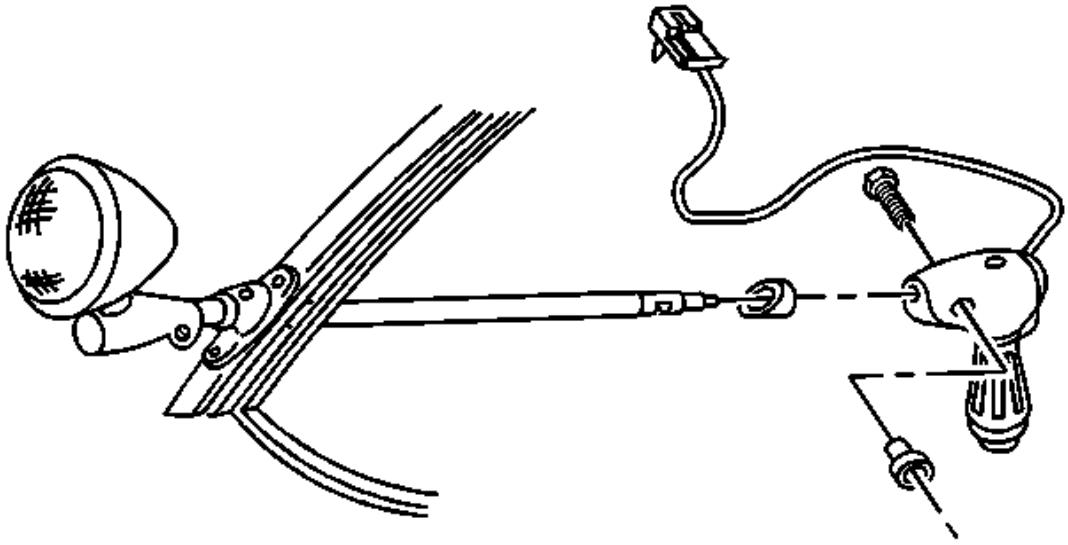


Fig. 59: Spot Lamp & Components
Courtesy of GENERAL MOTORS COMPANY

3. Remove the spot lamp handle wedge key screw from the spot lamp handle.

   Loosen the wedge key screw a few turns then with a light tap with a suitable hammer to the wedge key screw will loosen it from the spot lamp outer tube shaft.

4. Remove the spot lamp handle from the outer tube shaft.
5. Remove the rubber grommet from the outer tube shaft.

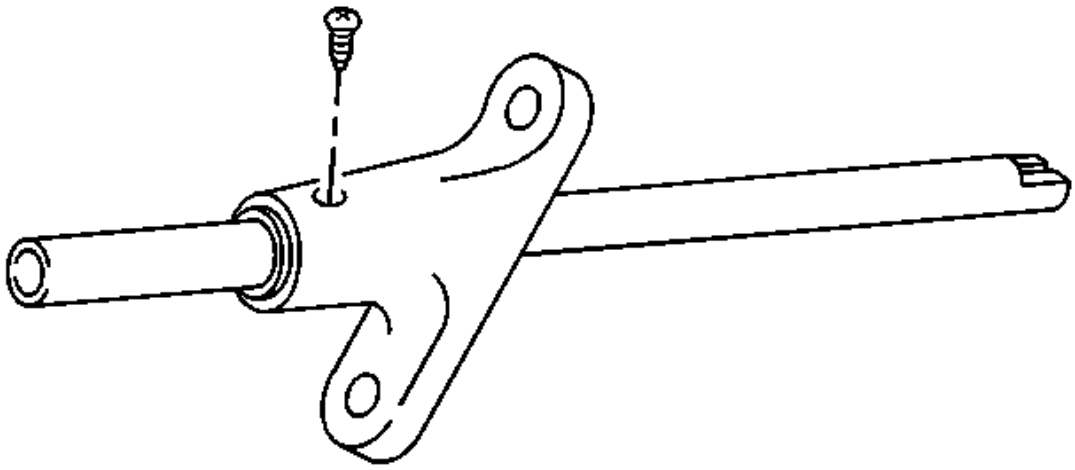


Fig. 60: Spot Lamp Bracket Set Screw
Courtesy of GENERAL MOTORS COMPANY

6. Loosen the spot lamp bracket set screw.

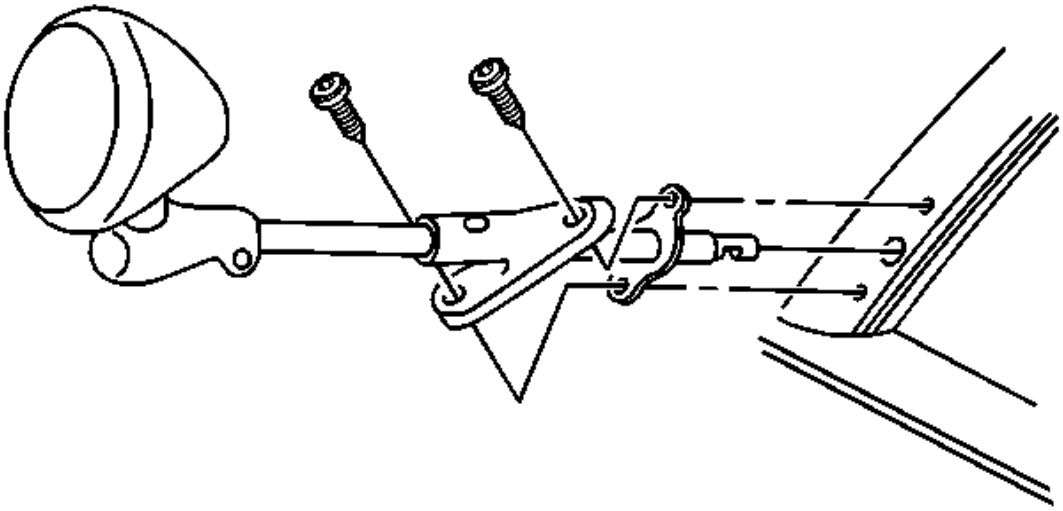


Fig. 61: Spot Lamp Mounting Bracket Screws
Courtesy of GENERAL MOTORS COMPANY

7. Pull the spot lamp with the outer tube shaft out of the spot lamp mounting bracket and set aside.
8. Remove the spot lamp mounting bracket screws.
9. Remove the mounting bracket and the gasket from the windshield pillar.
10. Clean the mounting surface of the windshield pillar.

Installation Procedure

NOTE: **This method of installation will stop the chance of any alignment and binding problems.**

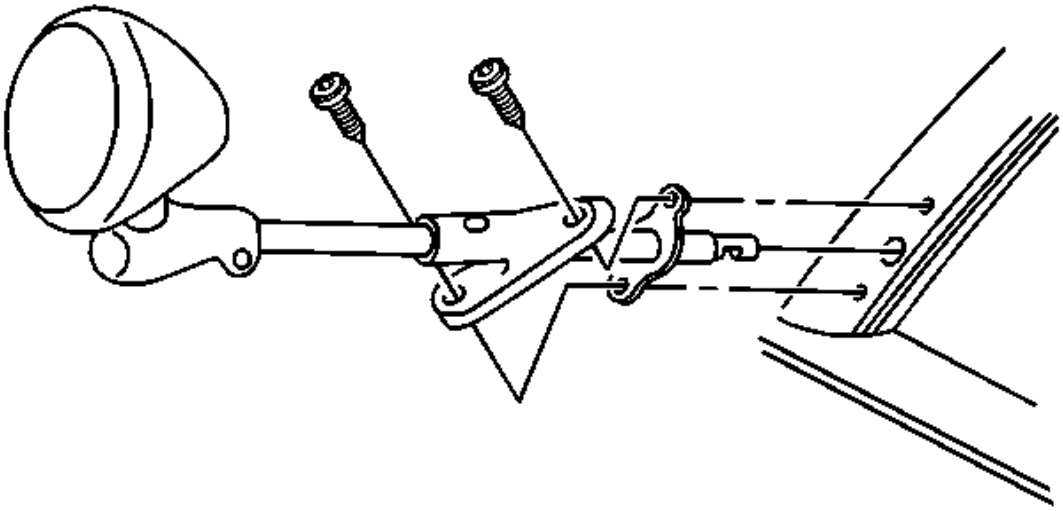


Fig. 62: Spot Lamp Mounting Bracket Screws
Courtesy of GENERAL MOTORS COMPANY

1. Install the mounting bracket and the gasket on to the spot lamp outer tube shaft.
2. Apply a small amount of RTV sealer GM P/N 12345336 or Canadian P/N 12346286 or equivalent to the screw holes on the windshield pillar.
3. Install the mounting bracket , the gasket and the spot lamp outer tube shaft through the windshield pillar.

CAUTION: Refer to Fastener Caution .

4. Install the spot lamp mounting bracket screws.

Tighten

Tighten the spot lamp mounting bracket screws to 3.5 N.m (31 lb in).

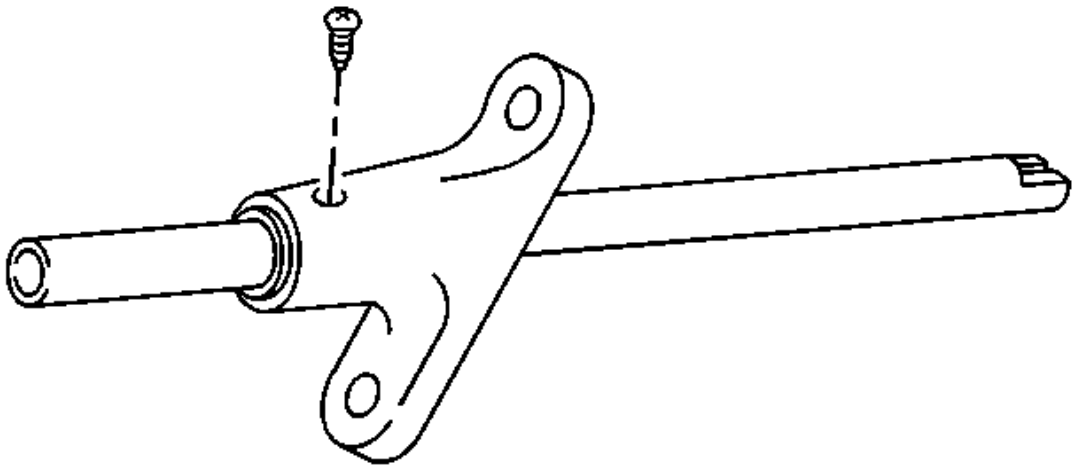


Fig. 63: Spot Lamp Bracket Set Screw
Courtesy of GENERAL MOTORS COMPANY

5. Rotate the spot lamp to the upright position.

   Point the spot lamp forward.

6. Tighten the spot lamp mounting bracket set screw just enough in order to firmly hold the spot lamp in the upright position.

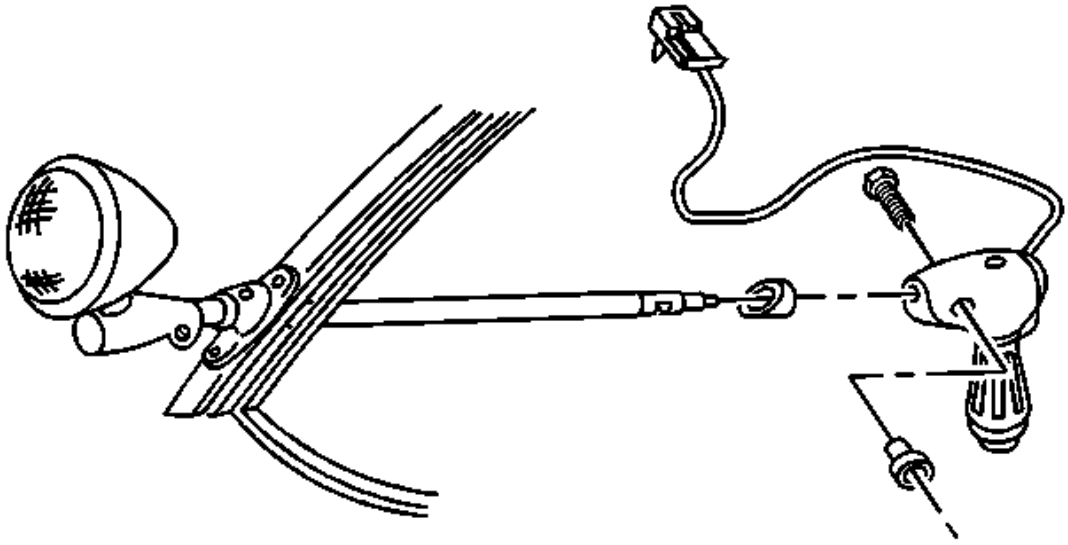


Fig. 64: Spot Lamp & Components
Courtesy of GENERAL MOTORS COMPANY

7. Install the rubber grommet to the outer tube shaft.
8. Install the spot lamp handle onto the outer tube shaft in the vertical down position until the handle bottoms out, and the flat detent on the outer tube shaft is exposed through the wedge key screw hole.
9. Install the spot lamp wedge key screw.

Tighten

Tighten the spot lamp wedge key screw to 7.5 N.m (66 lb in).

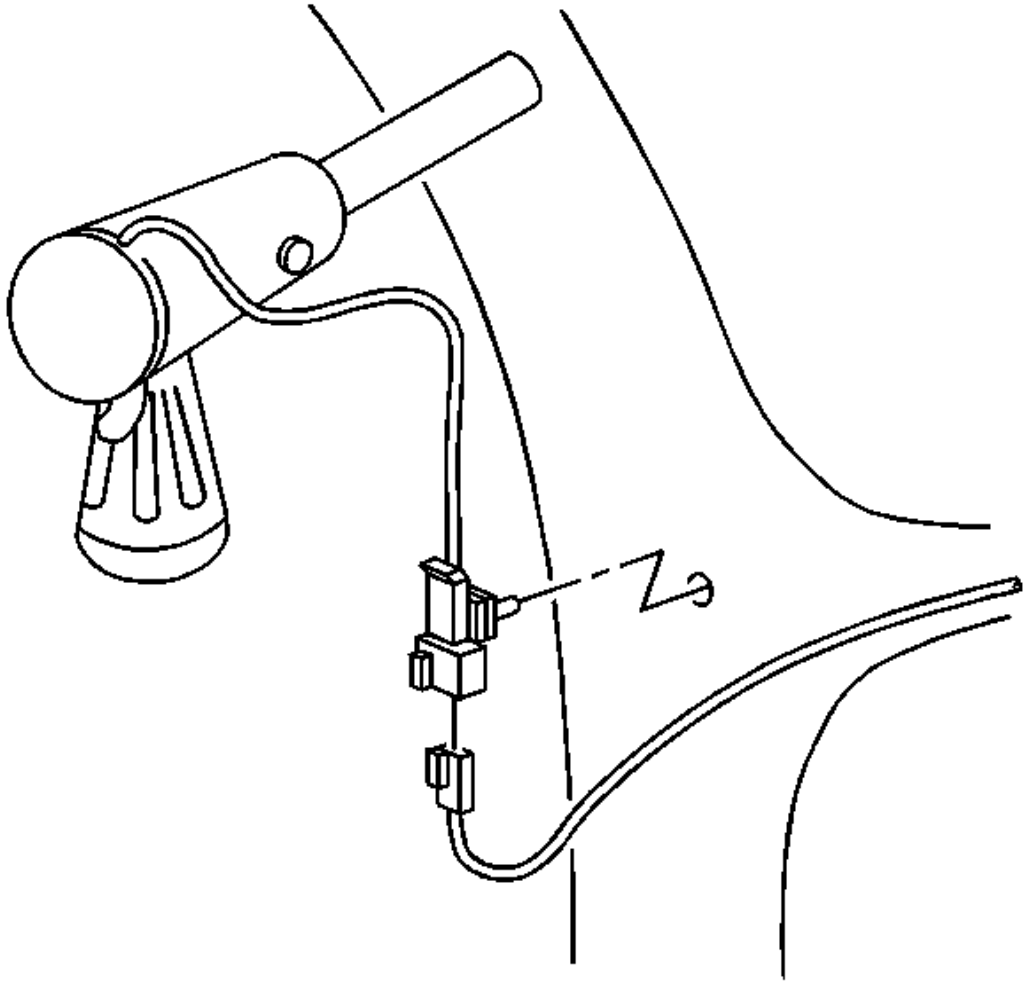


Fig. 65: Spot Lamp Wiring Harness Push-In Retainer & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

10. Connect the electrical connector.
11. Install the spot lamp wiring harness push-in retainer to the windshield garnish molding, pressing in until fully seated.
12. Inspect the spot lamp for proper operation.
    - The handle must rotate the spotlamp approximately 90 degrees about the spot lamp shaft axis from the parked position to the vertical position.
    - The spot lamp head must rotate 360 degrees about its axis.
    - The spot lamp must able to be turned ON/OFF independent of the ignition switch.
13. If spot lamp adjustment is required, refer to **Spot Lamp Travel Adjustment (Impala Limited RPO 7X6, 7X7)**.

SPOT LAMP BULB REPLACEMENT (IMPALA LIMITED RPO 7X6, 7X7)

Removal Procedure

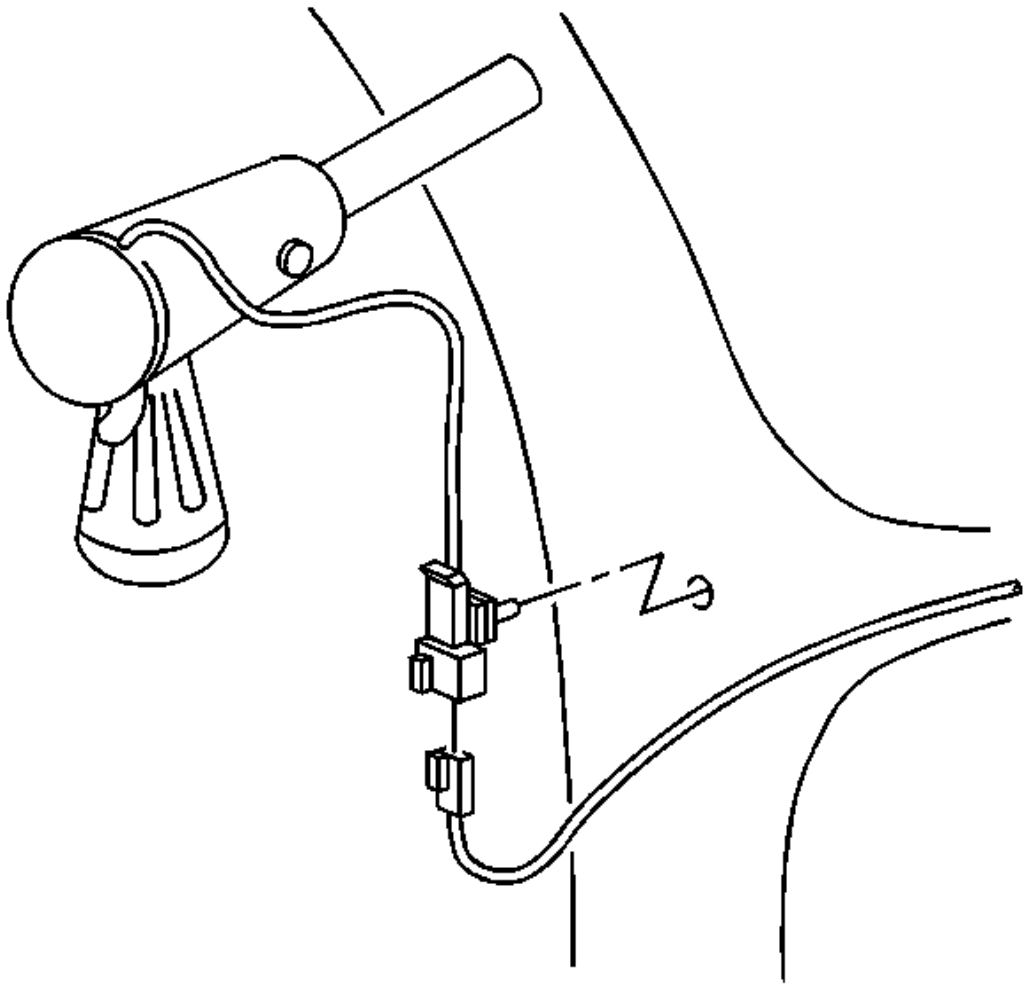


Fig. 66: Spot Lamp Wiring Harness Push-In Retainer & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Remove the spot lamp wiring harness push-in retainer from the windshield garnish molding, using a small flat bladed tool.
2. Disconnect the electrical connector.

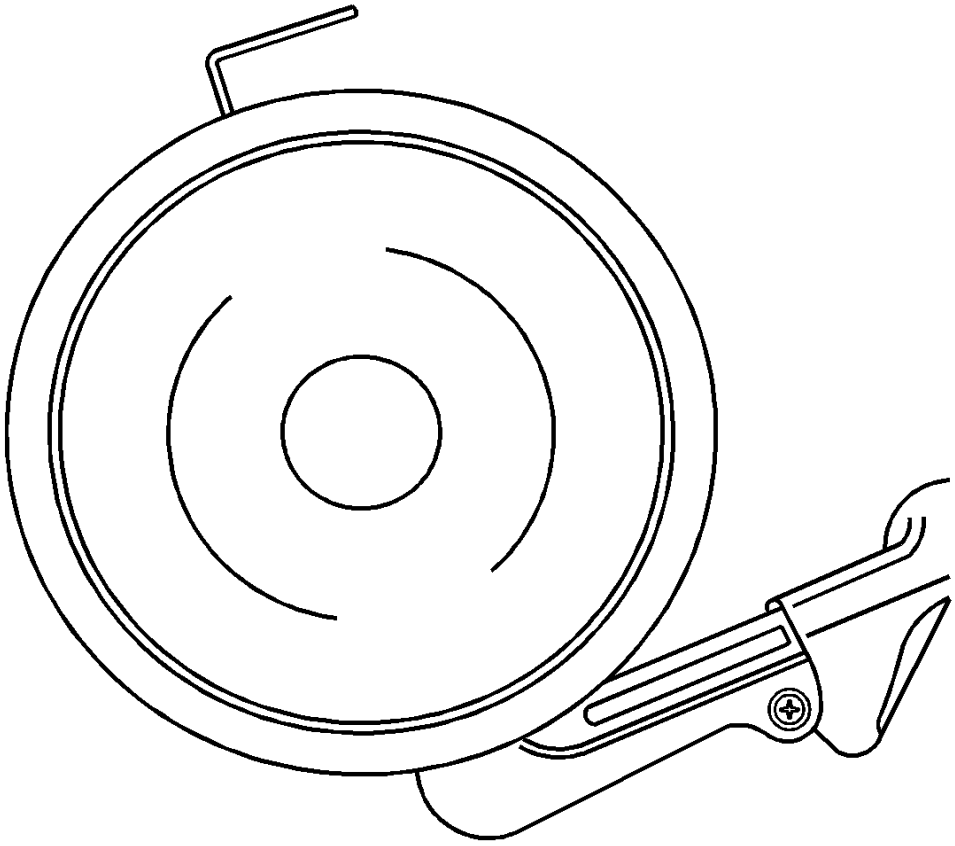


Fig. 67: Locating Spot Lamp Bezel Screw (Impala Limited RPO 7X6, 7X7)
Courtesy of GENERAL MOTORS COMPANY

3. Remove the screw from the spot lamp bezel.

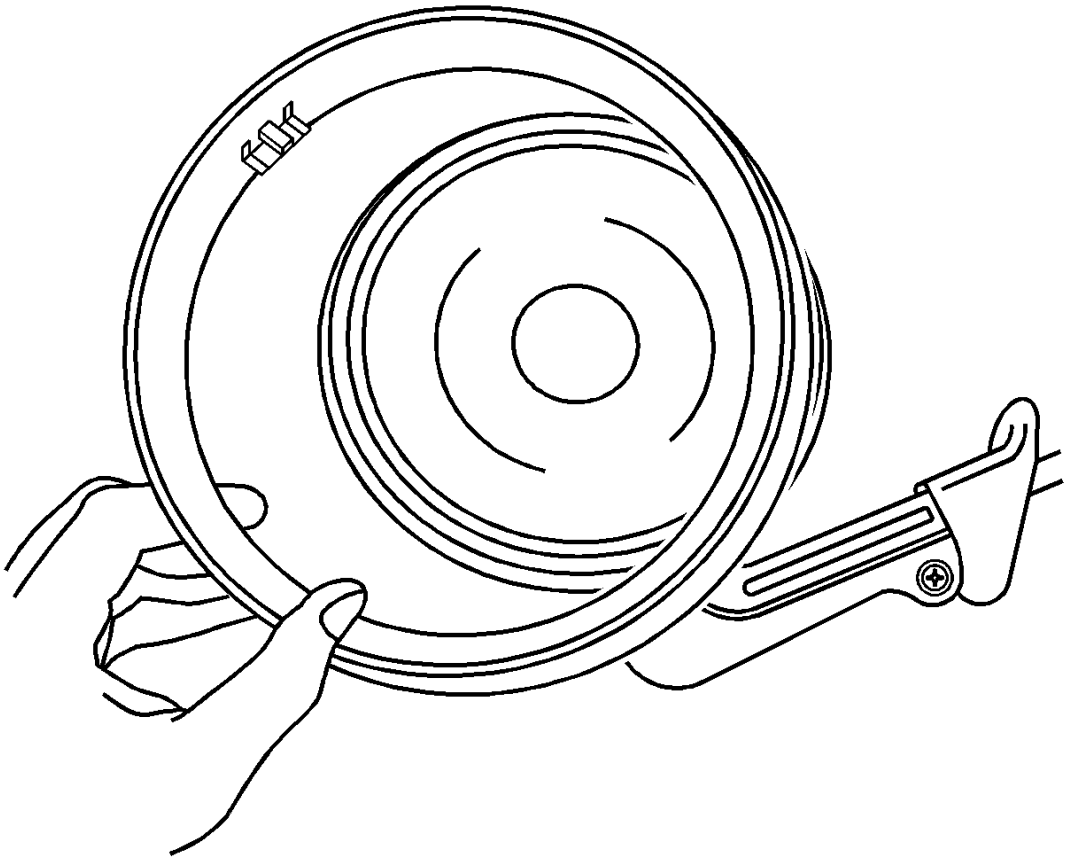


Fig. 68: Spot Lamp Bezel
Courtesy of GENERAL MOTORS COMPANY

4. Remove the spot lamp bezel from the spot lamp.

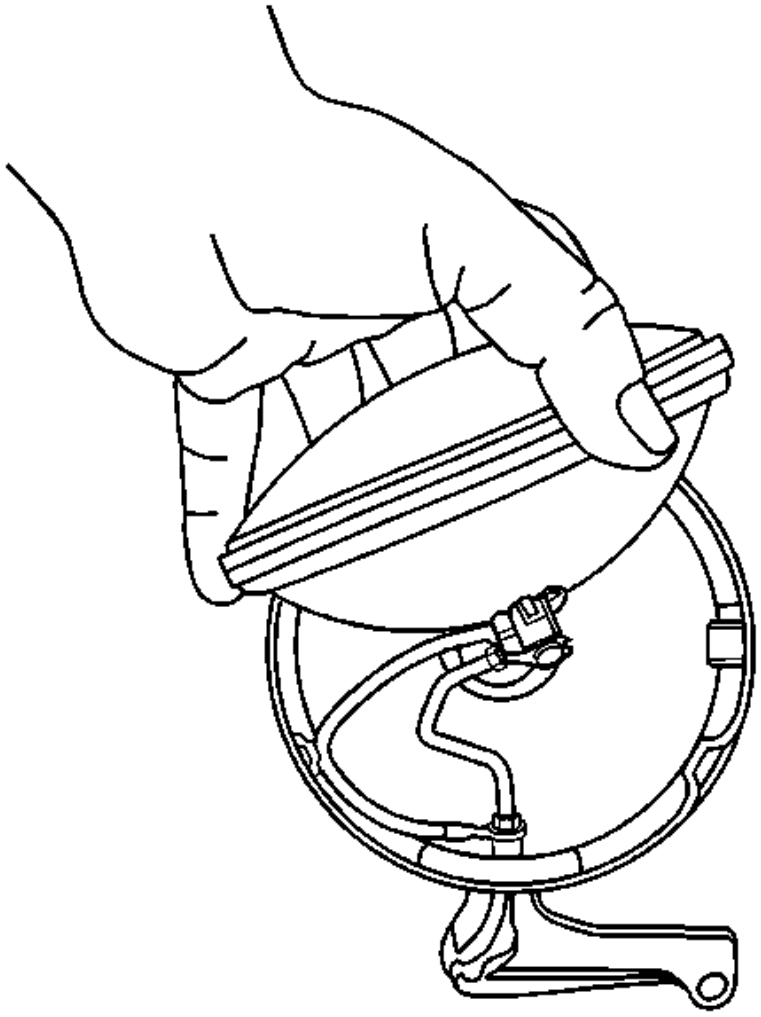


Fig. 69: Spot Lamp (Impala Limited RPO 7X6, 7X7)
Courtesy of GENERAL MOTORS COMPANY

5. Remove the lamp from the spot lamp.

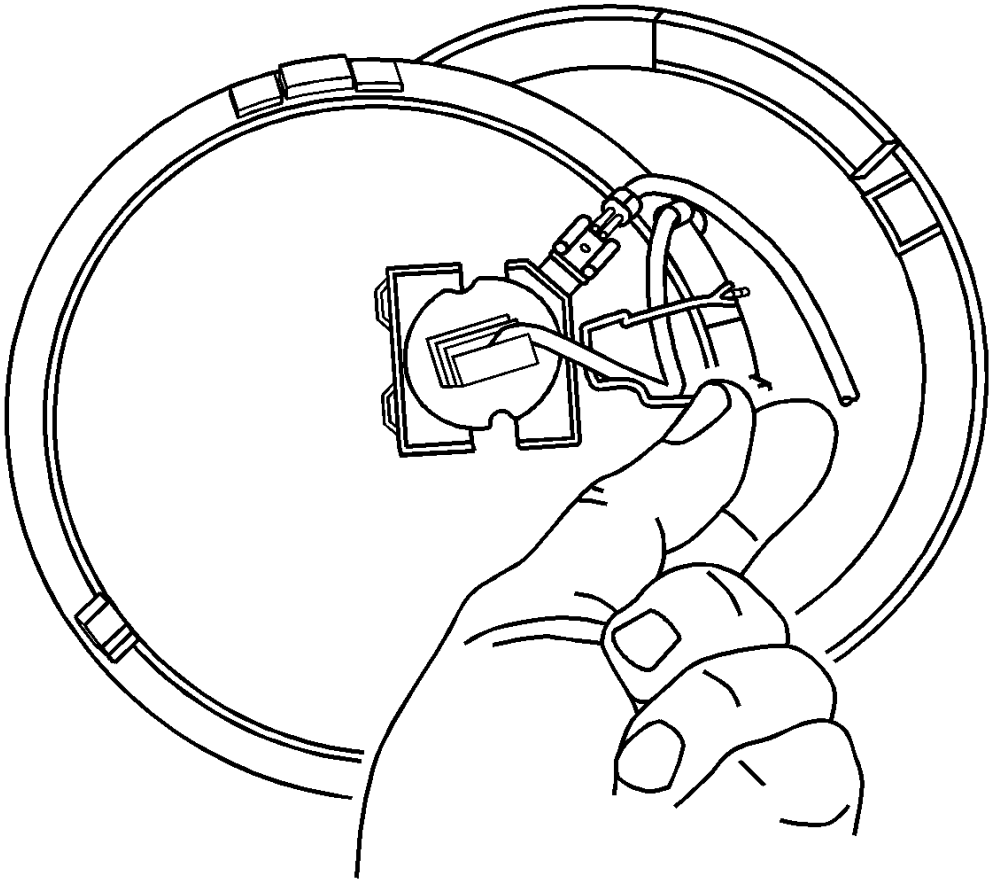


Fig. 70: Spot Lamp Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

6. Remove spot lamp bulb retaining clip.

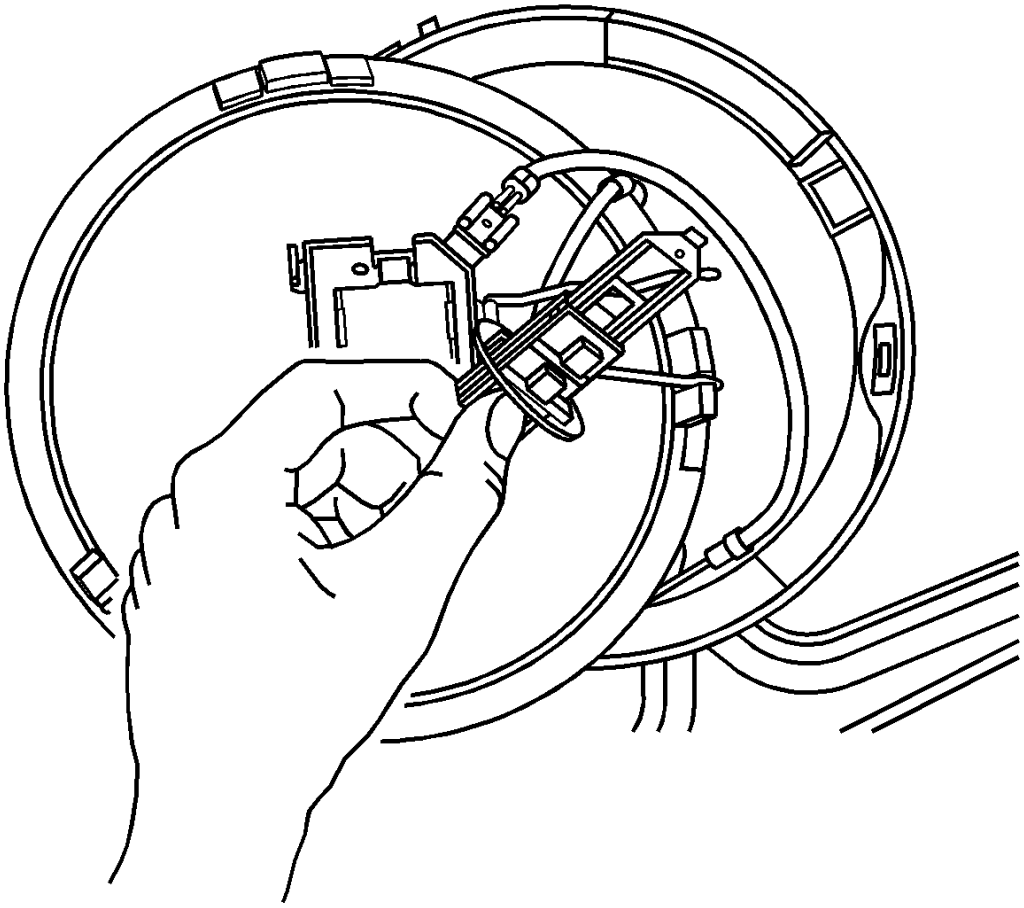


Fig. 71: Spot Lamp Bulb & Spot Lamp
Courtesy of GENERAL MOTORS COMPANY

7. Remove the spot lamp bulb from the spot lamp.

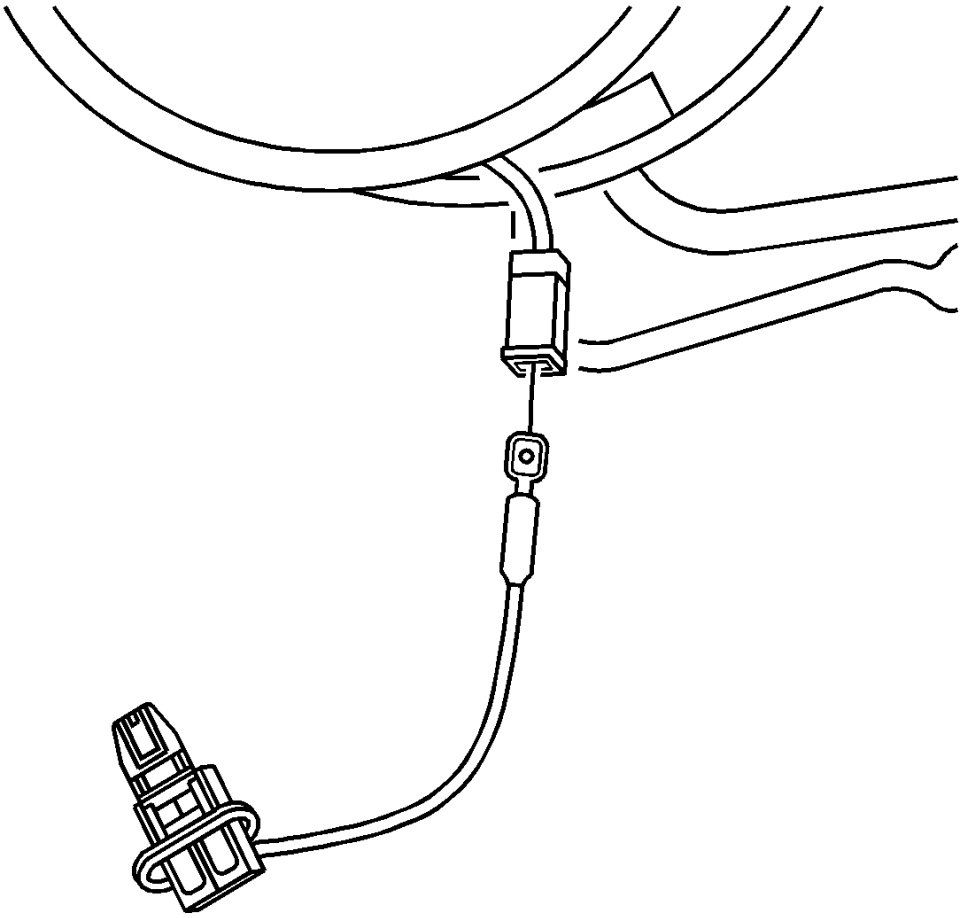


Fig. 72: Spot Lamp Bulb Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the spot lamp bulb electrical connector.

Installation Procedure

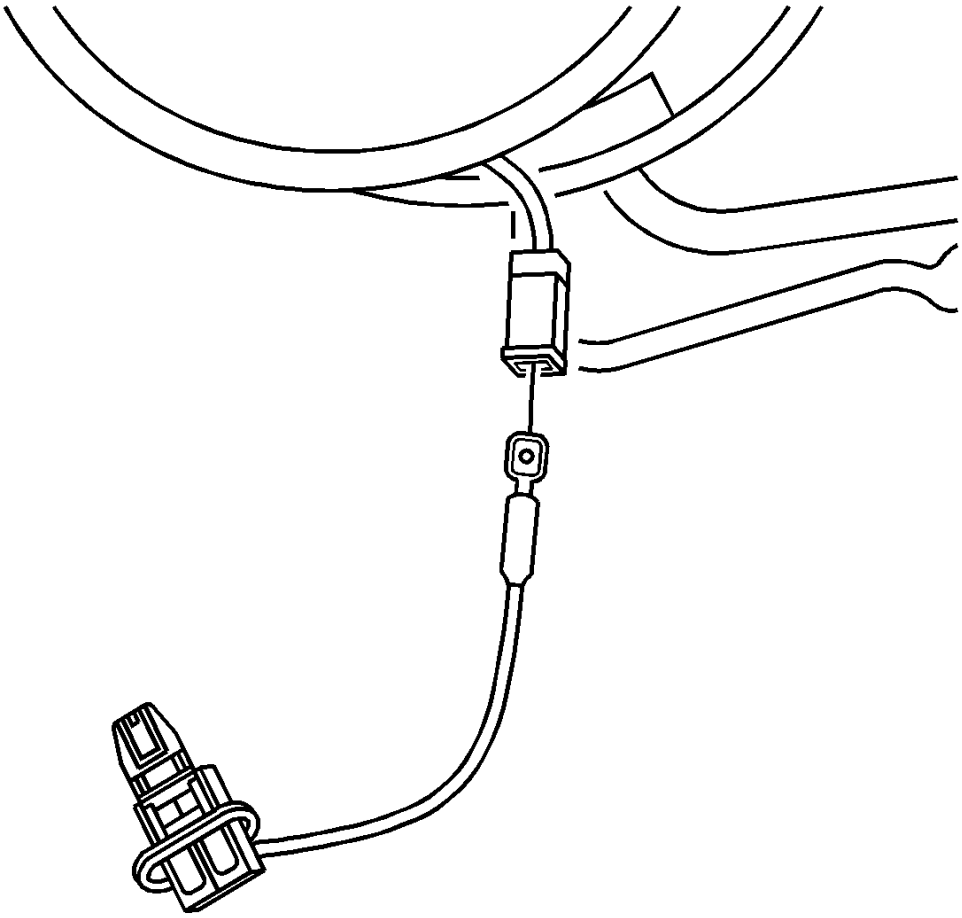


Fig. 73: Spot Lamp Bulb Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

1. Connect the spot lamp bulb electrical connector.

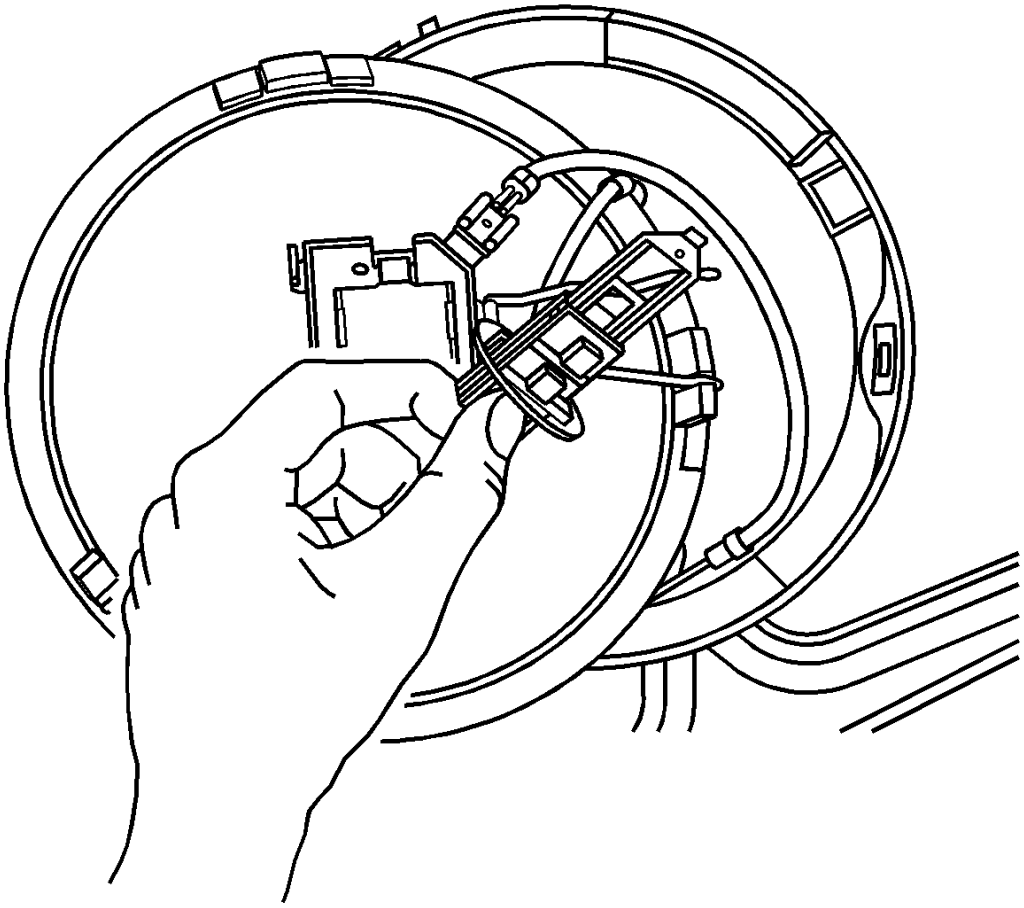


Fig. 74: Spot Lamp Bulb & Spot Lamp
Courtesy of GENERAL MOTORS COMPANY

2. Install the spot lamp bulb to the spot lamp.

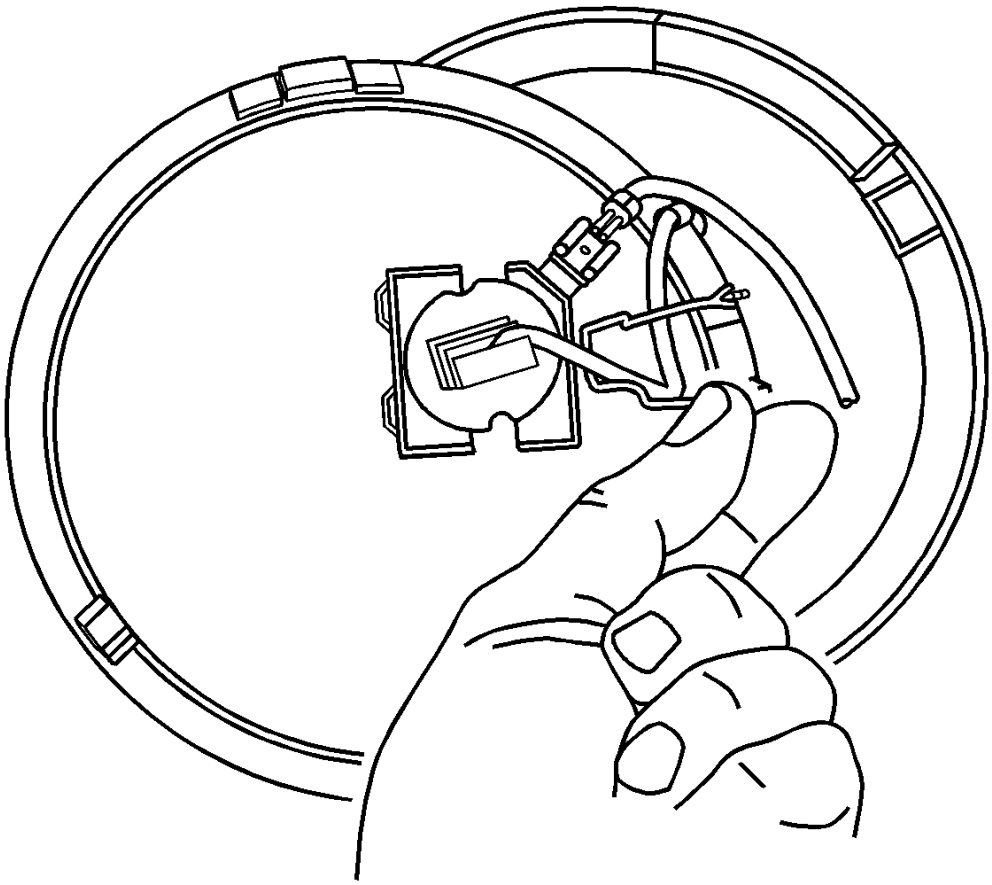


Fig. 75: Spot Lamp Retaining Clip
Courtesy of GENERAL MOTORS COMPANY

3. Install the spot lamp bulb retaining clip.

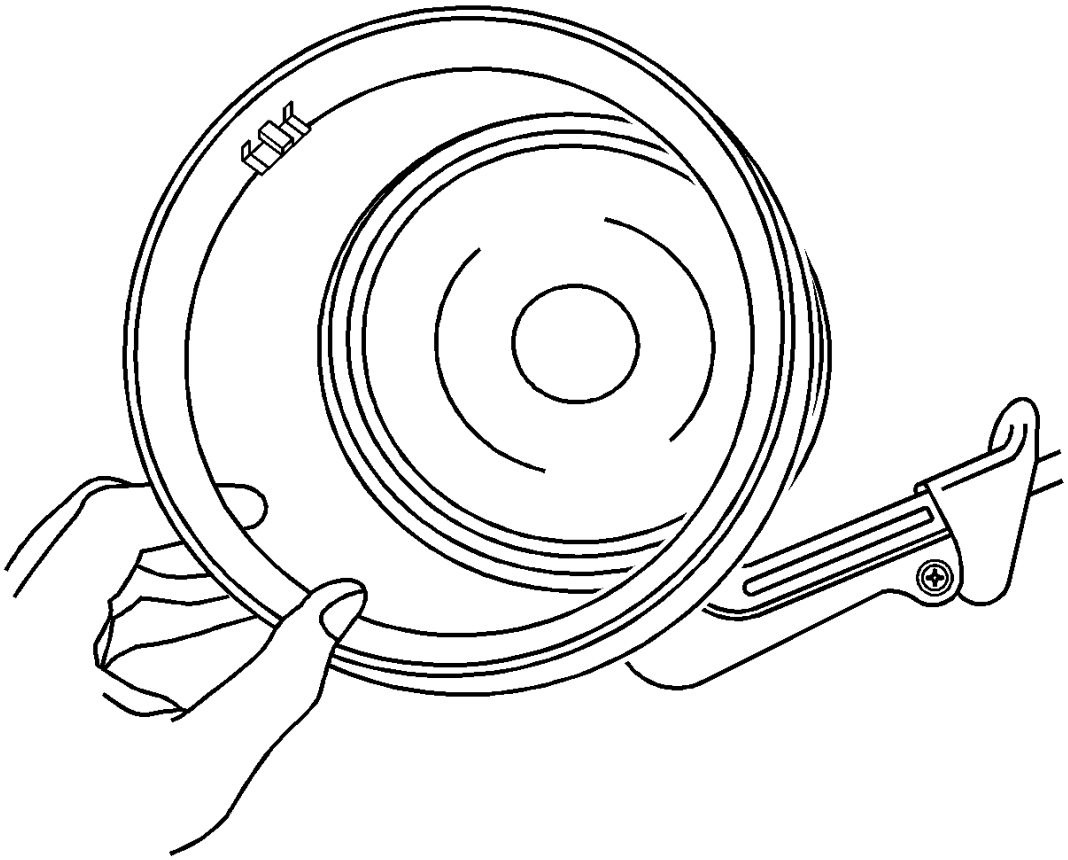


Fig. 76: Spot Lamp Bezel
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The spot lamp assembly must be clocked in the UP position, refer to the emblem on the face of the lamp.**

4. Holding the spot lamp in position, install the spot lamp bezel to the spot lamp.

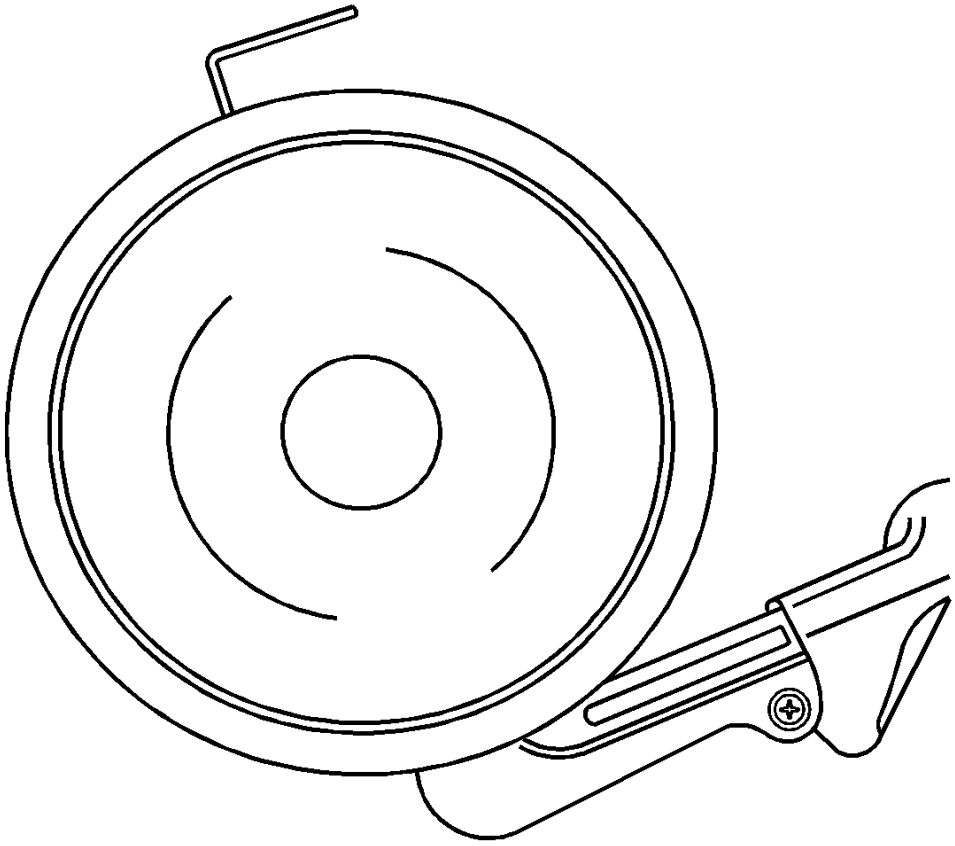


Fig. 77: Locating Spot Lamp Bezel Screw (Impala Limited RPO 7X6, 7X7)
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

5. Install the spot lamp bezel screws.

Tighten

Tighten the spot lamp bezel screws to 2 N.m (18 lb in).

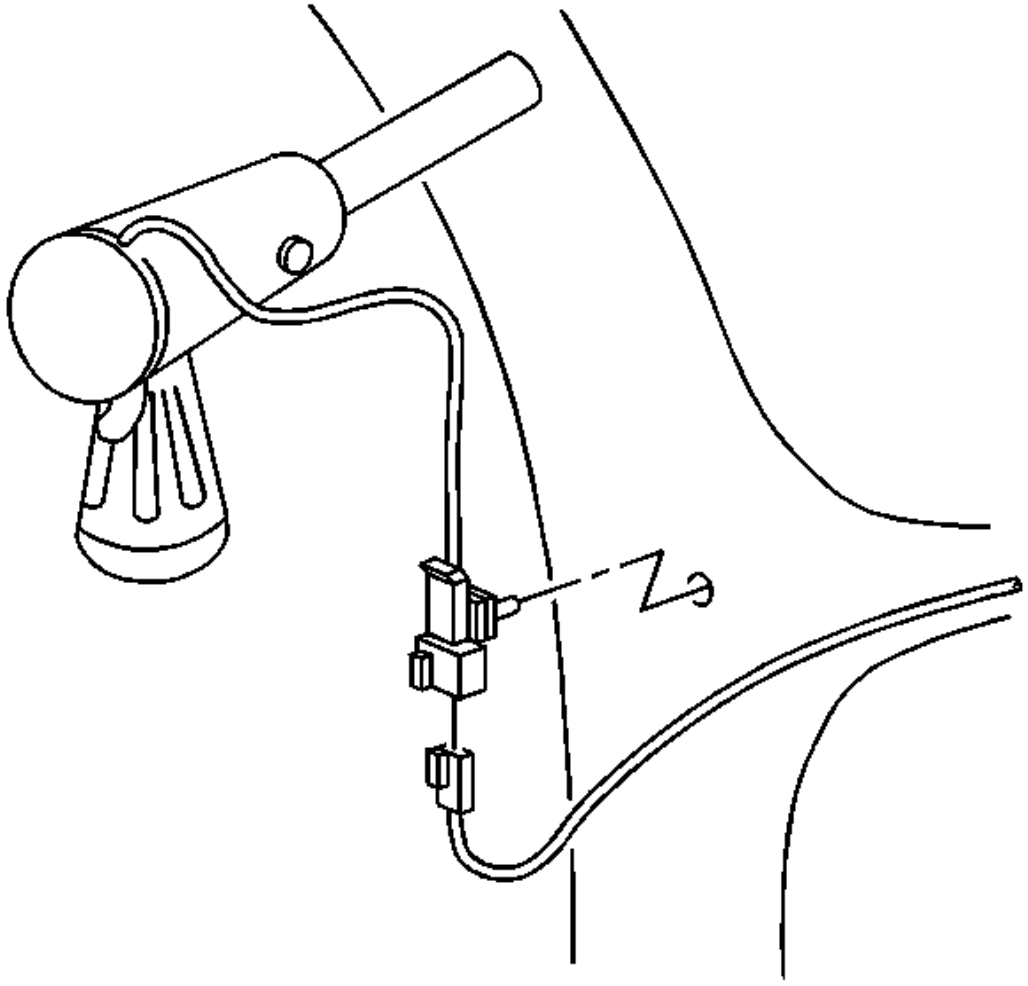


Fig. 78: Spot Lamp Wiring Harness Push-In Retainer & Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

6. Using a small flat-bladed tool, install the spot lamp wiring harness push-in retainer to the windshield garnish molding.
7. Connect the electrical connector.
8. Inspect the spot lamp for proper operation.

SPOT LAMP TRAVEL ADJUSTMENT (IMPALA LIMITED RPO 7X6, 7X7)

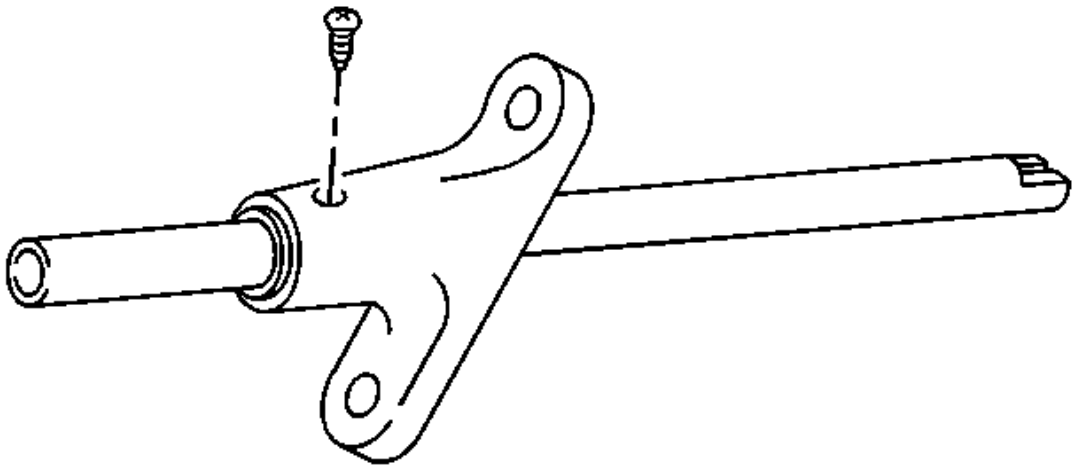


Fig. 79: Spot Lamp Bracket Set Screw
Courtesy of GENERAL MOTORS COMPANY

1. Loosen the spot lamp bracket clamp bolt.
2. Grasp the spot lamp.

   Slowly rotate the spot lamp inboard until the shaft contacts the parkstop position.

3. Rotate the spot lamp slowly outboard to 5 degrees past the vertical position in order for the backstop to be in motion and the outer tube shaft to rotate.
4. Tighten the bracket clamp bolt sufficiently, in order to prevent the outer shaft tube from rotating while the spotlamp is moving between the stop positions.
5. Rotate the spot lamp head inboard to the parkstop position in order to prevent the spot lamp from coming in contact with the body components.
6. Position the parkstop of the shaft in order to rotate the spot lamp on its axis, clearing the nearest body components by 13-0.5 mm (0.50-0.02 in).

CAUTION: Refer to Fastener Caution .

7. Tighten the bracket clamp screw when the parkstop has been set, in order to prevent rotation of the spot lamp shaft.

   Tighten

   Tighten the spot lamp bracket clamp bolt to 6 N.m (53 lb in).

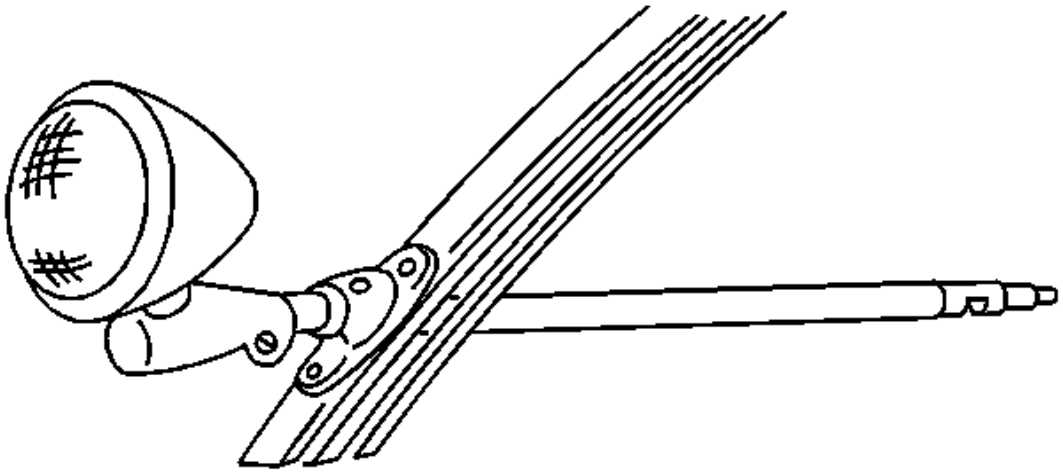


Fig. 80: Stop Lamp (Impala Limited RPO 7X6, 7X7)
Courtesy of GENERAL MOTORS COMPANY

8. Adjust the spot lamp head clamping bolt, in order to easily rotate the spot lamp (120 degrees) in any adjustable position between the parkstop and the backstop positions.

   The total motion of the spot lamp is approximately 90 degrees.

   Tighten

   Tighten the spot lamp head clamping bolt to 2.5 N.m (22 lb in).

REAR COMPARTMENT COURTESY LAMP REPLACEMENT

Removal Procedure

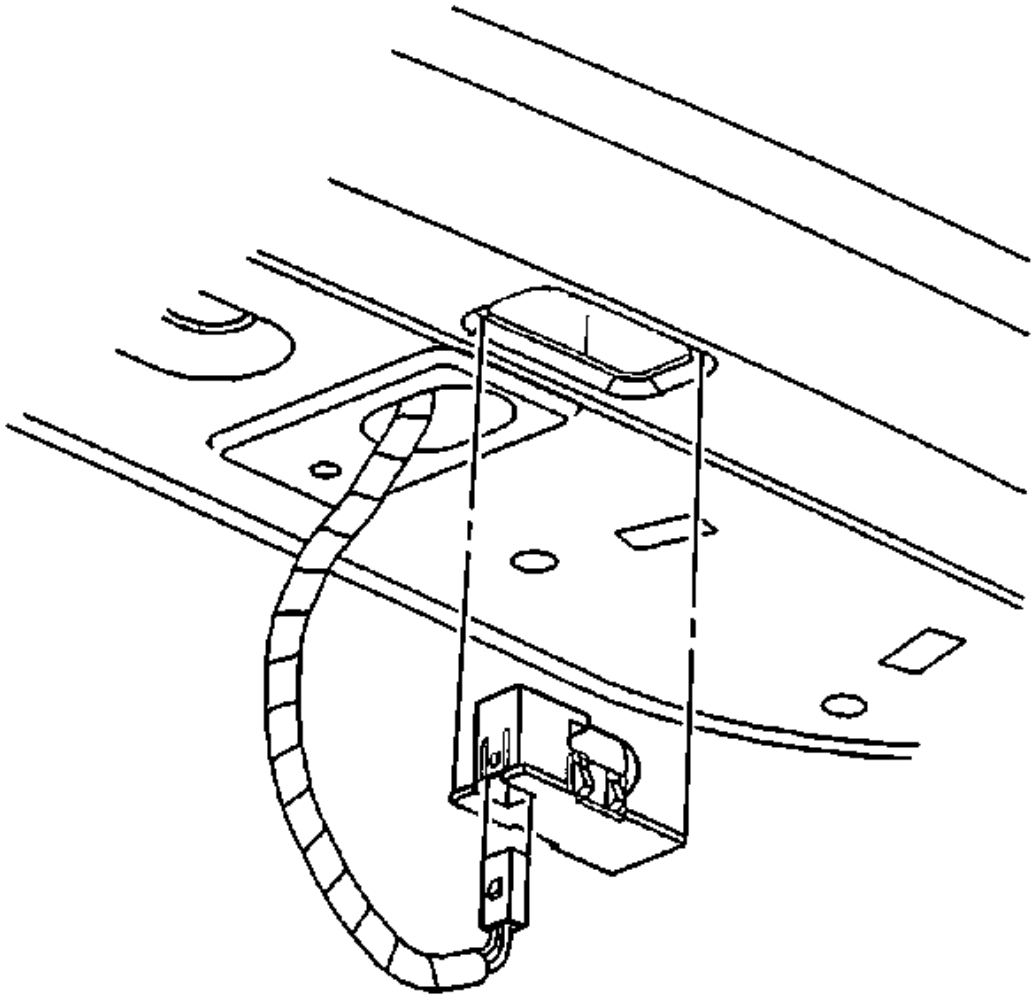


Fig. 81: Rear Compartment Lamp
Courtesy of GENERAL MOTORS COMPANY

1. Open the rear compartment.
2. Remove the rear compartment lamp using a small flat-bladed tool to release the retaining tabs.
3. Remove the bulb from the rear compartment lamp socket.

Installation Procedure

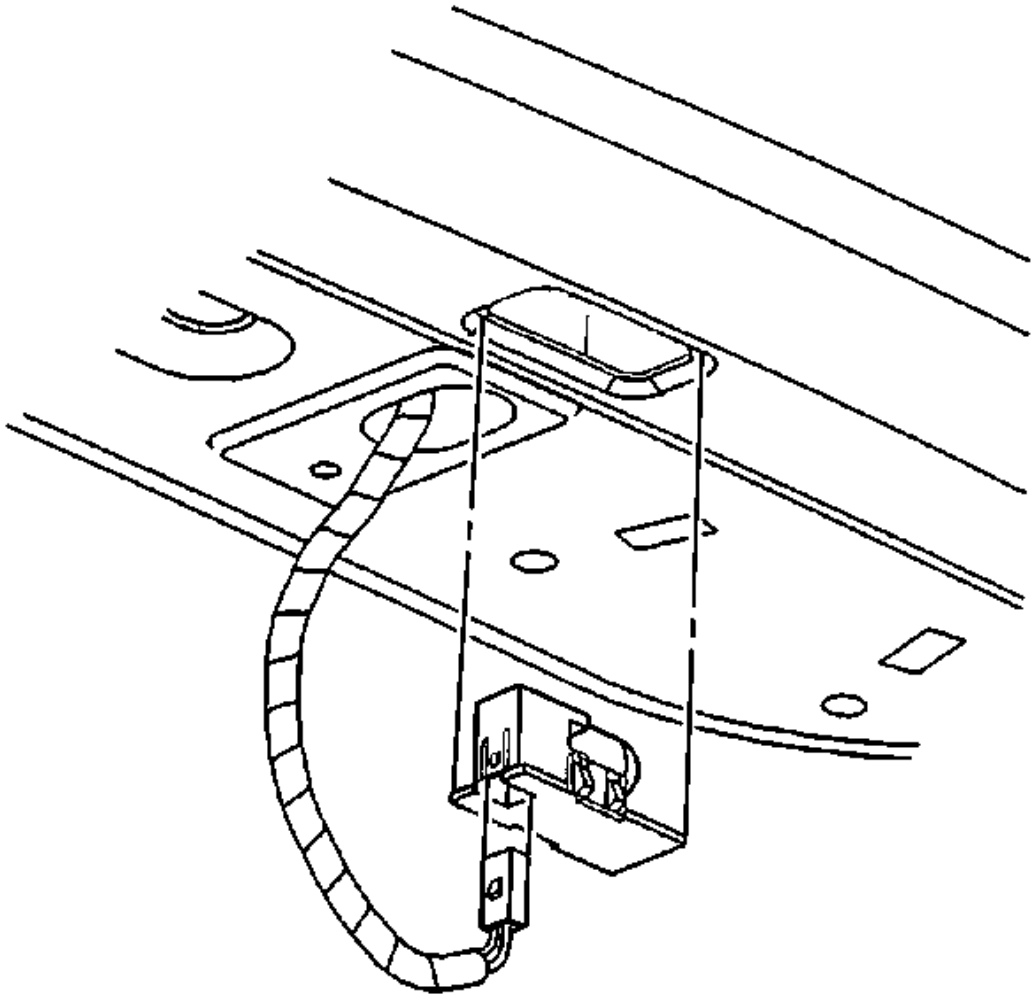


Fig. 82: Rear Compartment Lamp
Courtesy of GENERAL MOTORS COMPANY

1. Install the bulb to the rear compartment lamp socket.
2. Install the rear compartment lamp, pressing into place until full seated.
3. Close the rear compartment.

DESCRIPTION AND OPERATION

EXTERIOR LIGHTING SYSTEMS DESCRIPTION AND OPERATION

Exterior Lamps

The exterior lighting system consists of the following components:

- Headlamp switch
- Turn signal/multifunction switch
- Brake pedal position sensor

- Body control module (BCM)
- Ambient light sensor
- DRL PCB relay
- Low beam PCB relay
- High beam PCB relay
- Park lamp PCB relay
- Fog lamp PCB relay
- Low beam headlamps
- High beam headlamps
- Park lamps
- Tail lamps
- License lamps
- Marker lamps
- Turn signal lamps
- Stop lamps
- Center high mounted stop lamp (CHMSL)
- Backup lamps
- Front fog lamps

Low Beam Headlamp Operation

The low beam headlamps may be turned ON in 3 different ways:

- When the headlamp switch in the HEAD position for normal operations
- When the headlamp switch is in the AUTO position, for automatic lamp control (ALC)
- When the headlamp switch is placed in the AUTO position, with the windshield wipers ON in daylight conditions, after a 6 second delay

Battery voltage is applied at all times to the coil and switch sides of the LOW BEAM PCB Relay located in the underhood fuse block. When the headlamp switch is placed in the HEAD position, ground is applied through headlamps ON switch signal circuit to the body control module (BCM), signaling the headlamps ON request. In response to this signal, the BCM applies ground through the headlamp low beam relay control circuit energizing the low beam relay. With the relay energized, battery voltage is applied through the switch side of the relay, the left and right low beam fuses, and the low beam supply voltage circuits illuminating the low beam headlamps.

High Beam Headlamp Operation

Battery voltage is applied at all times to the coil and switch sides of the HIGH BEAM PCB Relay located in the underhood fuse block. When the headlamp dimmer switch is placed in the high beam position, the headlamp dimmer switch signal circuit to the BCM is pulled low signaling the headlamp high beam request. In response to this signal, the BCM applies ground through the high beam relay control circuit energizing the high beam relay. With the high beam relay energized, battery voltage is applied through the switch side of the relay, the left and right high beam fuses, and the high beam supply voltage circuits illuminating the high beam headlamps. At the same time the BCM sends a serial data message to the instrument panel cluster (IPC) requesting the IPC to

illuminate the high beam indicator.

Flash to Pass (FTP)

When the turn signal/multifunction switch handle is pulled toward the driver, the FTP switch is active and the flash to pass switch signal circuit to the BCM is pulled low signaling the flash to pass request. The BCM then turns ON the high beam headlamps, as described above, until the turn signal/multifunction switch handle is released. If the low beam headlamps were ON during FTP operation, they will remain ON.

Daytime Running Lamps (DRL) and Automatic Lamp Control (ALC)

The low beam headlamps are used for DRL operation at a reduced intensity. The DRLs will operate only while the engine is running and the headlamp switch is in the AUTO position. When the DRLs are ON, no other exterior lamps such as the parking lamps, tail lamps, etc. will be on when the DRL are being used. The instrument panel will not be illuminated either.

DRL operation is determined by the ambient light sensor and controlled by the body control module (BCM). The ambient light sensor is a light-sensitive transistor used to monitor outside lighting conditions. The BCM provides a 5-volt reference signal to the sensor. The sensor will vary this voltage signal between 0.2 and 4.9 volts depending on outside lighting conditions. The BCM monitors the ambient light sensor signal circuit to determine if outside lighting conditions are correct for either DRL or ALC operation. When the BCM determines the conditions are met for DRL operation, it applies ground to the DRL relay control circuit energizing the DRL PCB Relay. With the relay energized, battery voltage is applied through the switch side of the relay, the DRL 1 fuse, a resistor wire to the DRL 2 fuse, both low beam headlamp fuses, and the low beam supply voltage circuits illuminating the headlamps at a reduced intensity. Any function or condition that turns on the headlamps will cancel DRL operation.

When the BCM detects low light conditions, it will turn OFF the daytime running lamps and turn ON the low beam headlamps as described above in Low Beam Headlamp Operation. The BCM will also turn ON the low beam headlamps in daylight conditions when the windshield wipers are turned ON.

Park, Tail, Marker and License Lamps

The park, tail, license, and marker lamps are turned ON when the headlamp switch is placed in either the HEAD or PARK lamp positions, or anytime the automatic light control (ALC) turns the headlamps ON. When the headlamp switch is placed in the park lamp or headlamp positions, ground is applied through the signal circuit to the BCM indicating the park lamp request. In response to this signal, the BCM applies ground through the park lamp relay control circuit energizing the PARK LP PCB Relay. With the relay energized, battery voltage is applied through the switch side of the relay, both park lamp fuses, and the supply voltage circuits illuminating the park, tail marker, and license lamps.

Turn Signal Lamps

The LT T/SIG and RT T/SIG fuses located in the underhood fuse block supplies battery positive voltage to the body control module (BCM) for turn signal and hazard lamp operation. When the turn signal switch is place in either the LEFT or RIGHT position, ground is applied through the turn signal switch signal circuit to the BCM indicating the turn signal request. In response to this signal, the BCM applies a pulsating voltage to the front and rear turn signal lamps supply voltage circuits cycling the lamps ON and OFF. The BCM also sends a message via to the instrument panel cluster (IPC) to cycle the turn signal indicator ON and OFF depending on the position of the turn signal switch.

Hazard Lamps

The hazard flashers may be activated in any power mode. When the hazard switch is placed in the ON position, ground is applied through the hazard switch signal circuit to the body control module (BCM) indicating the hazard lamps ON request. In response to this signal, the BCM applies a pulsating voltage to all front and rear turn signal lamps supply voltage circuits cycling the lamps ON and OFF. The BCM also sends a serial data message to the instrument panel cluster (IPC) to cycle both turn signal indicators ON and OFF.

Stop Lamps

The LT T/SIG and RT T/SIG fuses located in the underhood fuse block are also used by the body control module (BCM) for stop lamp operation.

The brake pedal position sensor is used to sense the action of the driver application of the brake pedal. The body control module (BCM) provides both, a 5-volt reference voltage and low reference to the brake pedal position sensor. The position sensor provides an analog voltage signal back to the BCM that will increase as the brake pedal is applied. When the brake pedal is applied, the BCM will then apply battery voltage to the left and right stop lamp supply voltage circuits and the center high mounted stop lamp (CHMSL) supply voltage circuit illuminating the stop lamps. At the same time the BCM signals the transmission control module (TCM) and the engine control module (ECM) that the brakes are applied.

The stop lamps on this vehicle will not illuminate unless the ignition is in the accessory, run, or crank positions. When the ignition is in the OFF position the stop lamps will not illuminate when the brake pedal is applied.

Backup Lamps

Battery voltage from the CHMSL/BCK-UP fuse is supplied to the body control module (BCM) for backup lamp operation. When the gear selector is placed in to the REVERSE position, the powertrain control module (PCM) sends a serial data message to the BCM indicating that the gear selector is in the reverse position. The BCM then applies battery voltage to the backup lamp supply voltage circuit illuminating the left and right backup lamps. The engine may need to be running for the backup lamps to function.

Front Fog Lamps

Battery voltage is applied at all times to the coil and switch sides of the FOG LAMP PCB Relay located in the underhood fuse block. . When the fog lamp switch is turned ON, ground is applied through the fog lamp switch signal circuit to the body control module (BCM) indicating the fog lamp request. In response to this signal, the BCM applies ground to the fog lamp relay control circuit energizing the FOG LP PCB Relay. With the relay energized, battery voltage is applied through the switch side of the relay, the FOG LAMPS fuse, and the fog lamp supply voltage circuits illuminating the fog lamps. At the same time the BCM sends a message via serial data to the instrument panel cluster (IPC) requesting that the fog lamp indicator be illuminated.

Battery Rundown Protection/Inadvertent Power

The BCM controls the lighting system through circuits that enable the exterior lamp functions of the park lamps, the head lamps, the fog lamps, and the interior lamps. The BCM opens these enabling circuits 10 minutes after the ignition switch is turned OFF with no lamp switch activity. If the ignition switch is turned to any position other than OFF, or if a lamp switch is activated during this time period, the timer resets for another 10 minutes.

INTERIOR LIGHTING SYSTEMS DESCRIPTION AND OPERATION

The interior lighting consist of two groups; lamps that may not be manually dimmed (Interior Lamps) and lamps that may be dimmed (Interior Lamps Dimming).

The first group listed below includes lamps that may not be dimmed

- Left and right I/P courtesy lamps
- Dome lamp (Coupe)
- Dome/reading lamp (Sedan)
- Left and right vanity mirror lamps
- Reading lamp assembly (w/ 9C1, 9C3)
- Inside rearview mirror lamps
- Rear compartment courtesy lamp

Interior Lamps Features

The interior lamps system features the following functions:

- An illuminated entry feature that illuminates the courtesy lamps when entering the vehicle or activating the remote keyless entry system.
- An illuminated exit feature that illuminates the courtesy lamps when the ignition key has been removed from the ignition.
- An inadvertent power feature that supplies voltage to all interior lamps after the ignition is turned OFF. The inadvertent power feature will deactivate all interior lamps after 10 minutes to prevent battery rundown.
- A theater dimming feature that will slowly dim the interior lamps from full brightness to OFF.
- An lamp switch assembly that illuminates the courtesy lamps.
- Individual switches for control of each interior lamp that is not illuminate with the interior lamp switch.

Courtesy Lamps

When the driver door is opened, ground is applied through the door latch door open switch and the left front door open switch signal circuit to the BCM indicting the door open position. Or, when either one of the passenger doors is opened, ground is applied through the door latch door open switch and the passenger door open switch signal circuit to the BCM indicating the door open position. Once a door open signal is received, the BCM will apply battery voltage from the INT LIGHTS fuse through the courtesy lamp supply voltage circuits illuminating the lamps listed below:

- Left and right I/P courtesy lamps
- Dome lamp (Coupe)
- Dome/reading lamp (Sedan)

Courtesy Lamps Manual Operation

The courtesy lamps can be manually turned ON by the IP dimmer switch. When the dimmer switch is placed in the DOME position, ground is applied through the dimmer switch and the courtesy lamp switch ON signal circuit to the BCM indicating the courtesy lamps ON request. In response to this signal, the BCM then applies

battery positive voltage from the INT LIGHTS fuse through the courtesy lamp supply voltage circuits illuminating the courtesy lamps listed above. The courtesy lamps ON operation of the dimmer switch will override any BCM operation of the interior lamps already in progress.

Keyless Entry Interior Illumination

When the remote function actuator transmitter is used to unlock the doors, the BCM receives a door-unlock signal. The BCM must have inputs that indicate that the ignition switch is OFF, the courtesy lamp switch is OFF, and all the doors are closed. The BCM will then illuminate the courtesy lamps and will remain illuminated for approximately 25 seconds after the door is closed. If the door locks are activated to the LOCK position, or if the ignition switch is turned to either the RUN or START position, the BCM will turn OFF the courtesy lamps immediately.

Courtesy/Illuminated Exit

The illuminated exit feature will activate the courtesy lamps when the key IN input of the BCM transitions from an active state to an inactive state (removing the ignition key). When the key is removed from the ignition, the key IN input to the BCM becomes inactive. The BCM will illuminate the courtesy lamps for approximately 25 seconds.

Theater Dimming

The theater dimming feature that will slowly dim the interior lamps from full brightness to OFF. The following actions will over ride the theater dimming feature causing the courtesy lamps to deactivate immediately if no other BCM function commands the courtesy lamps ON:

- A transition from active to inactive of the interior lamps switch, turning OFF the interior lamps switch
- A LOCK command from the remote keyless entry system
- A last door closed locking function, locking and closing all the doors

I/P Compartment Lamp

The BCM supplies battery positive voltage from the INT LTS/PNL DIM fuse through the inadvertent power courtesy lamps circuit to the IP compartment lamp. When the IP compartment is opened, the IP compartment lamp switch closes to ground and the lamp illuminates.

Rear Compartment Lamp

The BCM supplies battery positive voltage from the INT LTS/PNL DIM fuse through the inadvertent power courtesy lamps circuit to the rear compartment lamp. When the rear compartment is opened, the rear compartment lamp switch closes to ground and the lamp illuminates.

Dome/Reading Lamps

The dome/reading lamp is a duel purpose lamp that can be illuminated two different ways. First, the lamp can be turned ON during courtesy lamp operation as described above. Second, the lamps can be turned ON individually for reading lamp operation by the lamp switch. The BCM supplies battery voltage from the INT LTS/PNL DIM fuse through the inadvertent power courtesy lamp circuit to the dome/reading lamp for reading lamp operation only.

Sunshade Vanity Mirror Lamps

The BCM supplies battery voltage from the INT LTS/PNL DIM fuse through the inadvertent power courtesy lamps circuit to the left and right vanity mirror lamps. When the vanity mirror cover on the sunshade is opened, the vanity mirror lamp switch is closed to ground and the lamp illuminates.

Interior Lamps Dimming

The second interior lighting group includes lamps which may be dimmed. This group may use a combination of vacuum fluorescent (VF) illumination, LED illumination and incandescent lamps.

- Headlamp switch
- Instrument panel cluster (IPC)
- Driver window switch
- Driver door lock switch
- Outside rearview mirror switch
- Front passenger window switch
- Front passenger door lock switch
- Radio
- HVAC control module
- Driver information center (DIC) switch
- Steering wheel controls

When the ignition switch is turned to the RUN position, the instrument panel cluster (IPC), radio VF display, and the HVAC control assembly turns ON at maximum brightness. When the headlamp switch is in the PARK or HEADLAMP ON position, all incandescent and LED back lighting turn ON at the dimming level indicated by the instrument panel (I/P) dimmer switch. The dimmer switch is used to increase and decrease the brightness of the interior backlighting components. The BCM supplies a voltage reference through the I/P dimming voltage reference circuit to the interior lamp dimmer switch, which is part of the headlamp switch. When the dimmer switch is placed in a desired brightness position, reference voltage is applied through the dimmer switch rheostat and the I/P lamps dimmer switch signal circuit to the BCM. The BCM interprets this voltage signal, then applies a pulse width modulated (PWM) voltage through the I/P lamps supply voltage circuits and the LED dimming supply circuit to all related interior lamps, illuminating them to the desired level of brightness.

Battery Rundown Protection / Inadvertent Power

The BCM controls the lighting system through circuits that enable the exterior lamp functions of the park lamps, the head lamps, the fog lamps, and the interior lamps. The BCM opens these enabling circuits 10 minutes after the ignition switch is turned OFF with no lamp switch activity. If the ignition switch is turned to any position other than OFF, or if a lamp switch is activated during this time period, the timer resets for another 10 minutes.

Article GUID: A00737175

SPECIFICATIONS

APPROXIMATE FLUID CAPACITIES

The following approximate capacities are given in US English and metric conversions. See **Fluid and Lubricant Recommendations** for more information. All capacities are approximate. When adding, be sure to fill to the approximate level, as recommended in this manual. Recheck fluid level after filling.

Application	Specification	
	Metric	US English
Cooling System		
• 3.6L Engines	9.6 liters	10.1 quarts
• Police Package	10.0 liters	10.6 quarts
Engine Oil With Filter		
• 3.6L Engines	5.7 liters	6.0 quarts
• Police Package	5.7 liters	6.0 quarts
Fuel Tank	66.2 liters	17.5 gallons
6T70 (MH2) Transaxle		
• Valve Body Cover Removal - Approximate Capacity	5.0 - 7.0 liters	5.3 - 7.4 quarts
• Fluid Change - Drain Plug - Approximate Capacity	4.0 - 6.0 liters	4.2 - 6.3 quarts
• Overhaul - Approximate Capacity	7.0 - 9.0 liters	7.4 - 9.5 quarts

FLUID AND LUBRICANT RECOMMENDATIONS

Usage	Fluid/Lubricant
Engine Oil	Use only engine oil licensed to the dexos1 specfication, or equivalent, of the proper SAE viscosity grade. ACDelco dexos1 Synthetic Blend is recommended. Use SAE 5W-30 viscosity grade engine oil. Cold Temperature Operation: In an area of extreme cold, where the temperature falls below -29 Â°C (-20 Â°F), an SAE 0W-30 oil may be used. An oil of this viscosity grade will provide easier cold starting for the engine at extremely low temperatures. When selecting an oil of the appropriate viscosity grade, always select an oil of the correct specification. Refer to Owner's Manual for more information.

Usage	Fluid/Lubricant
Engine Coolant	50/50 mixture of clean, drinkable water and use only DEX-COOL Coolant.
Hydraulic Brake System	DOT 3 Hydraulic Brake Fluid GM P/N 88862806 (Canadian P/N 88862807)
Windshield Washer	Automotive windshield washer fluid that meets regional freeze protection requirements.
Power Steering System	GM Power Steering Fluid GM P/N 89021184 (Canadian P/N 89021186)
Automatic Transmission	DEXRONÂ®-VI Automatic Transmission Fluid
Key Lock Cylinders	Multi-Purpose Lubricant, Superlube GM P/N 12346241 (Canadian P/N 10953474)
Hood Latch Assembly, Secondary Latch, Pivots, Spring Anchor, and Release Pawl	Lubriplate Lubricant Aerosol GM P/N 89021668 (Canadian P/N 89021674) or lubricant meeting requirements of NLGI #2, Category LB or GC-LB
Hood and Hood Hinges	Multi-Purpose Lubricant, Superlube GM P/N 12346241 (Canadian P/N 10953474)
Weatherstrip Conditioning	Weatherstrip Lubricant GM P/N 3634770 (Canadian P/N 10953518) or Dielectric Silicone Grease GM P/N 12345579 (Canadian P/N 10953481)

MAINTENANCE ITEMS

Maintenance Procedure	Link
Approximate Fluid Capacities	**Approximate Fluid Capacities**
Fluid and Lubricant Recommendations	**Fluid and Lubricant Recommendations**
Maintenance Replacement Parts	**Maintenance Replacement Parts**
GM Oil Life System Resetting	**GM Oil Life System Resetting**
Tire Rotation	**Tire Rotation**
Tire Pressure Indicator Sensor Learn	**Tire Pressure Indicator Sensor Learn**
Passenger Compartment Air Filter Replacement	**Passenger Compartment Air Filter Replacement**
Brake Pad Inspection	**Brake Pad Inspection**
Cooling System Draining and Filling	**Cooling System Draining and Filling**
Hydraulic Brake System Bleeding	**Hydraulic Brake System Bleeding (Manual)** **Hydraulic Brake System Bleeding (Pressure)**
Air Cleaner Element Replacement - 3.6L (LFX)	**Air Cleaner Element Replacement** - 3.6L (LFX)
Spark Plug Replacement - 3.6L (LFX)	**Spark Plug Replacement** - 3.6L (LFX)
Drive Belt Replacement - 3.6L (LFX)	**Drive Belt Replacement** - 3.6L (LFX)
Automatic Transmission Fluid Drain and Fill - 6T70 (MH2)	**Transmission Fluid Drain and Fill** - 6T70 (MH2)

MAINTENANCE REPLACEMENT PARTS

Replacement parts identified below by name, part number, or specification can be obtained from your dealer.

Part	GM Part Number	ACDelco Part Number

Part	GM Part Number	ACDelco Part Number
Engine Air Cleaner/Filter	10350737	A2962C
Engine Oil Filter	89017525	PF63
Passenger Compartment Air Filter	15284938	CF132
Spark Plugs	12622561	41-109
Wiper Blades		
• Driver Side - 55.0 cm (21.7 in)	15941731	-
• Passenger Side - 55.0 cm (21.7 in)	15941732	-

MAINTENANCE

MAINTENANCE SCHEDULE (NORTH AMERICAN EMISSIONS)

The Maintenance Schedule information will only be found in the Owner's Manual.

Refer to the Maintenance Schedule subsection of the Owner's Manual, or you may be able to use the Search information function using the words Scheduled Maintenance.

GM OIL LIFE SYSTEM RESETTING

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL SOON message will come on. Change the engine oil as soon as possible within the next 600 miles (1 000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

If the system is ever reset accidentally, change the engine oil at 3,000 miles (5 000 km) since last oil change.

How to Reset the Engine Oil Life System

To reset the Engine Oil Life System, do the following:

1. Display the OIL LIFE REMAINING on the driver information center (DIC).
2. Press and hold the SET/RESET button on the DIC for more than five seconds. The oil life will change to 100 percent.

If the CHANGE ENGINE OIL SOON message comes back on when you start the vehicle the Engine Oil Life System has not reset. Repeat the procedure.

Article GUID: A00737182

REMINDER INDICATOR (RESET PROCEDURES)

GM: Buick / Cadillac / Chevrolet / GMC / Olds / Pontiac - 1980-18

ENGINE OIL REPLACEMENT REMINDER

NOTE: **Most 1981-88 General Motors vehicles do not use a Service Reminder Indicator (SRI).**

NOTE: **To determine the appropriate reset procedure, refer to ENGINE OIL REPLACEMENT REMINDER RESET INDEX. Only vehicles listed in this index have an oil change reminder reset.**

ENGINE OIL REPLACEMENT REMINDER RESET INDEX

Model & Year	Reset Procedure
Alero	
1999-03	Engine Oil Replacement Reminder Reset - Procedure 1
2004	Engine Oil Replacement Reminder Reset - Procedure 3
Acadia	
2007-10	Engine Oil Replacement Reminder Reset - Procedure 16
2011-17	Engine Oil Replacement Reminder Reset - Procedure 6
Allante	
1989-93	Engine Oil Replacement Reminder Reset - Procedure 23
ATS	
2013-17	Engine Oil Replacement Reminder Reset - Procedure 33
Aurora	
1995-99	Engine Oil Replacement Reminder Reset - Procedure 27
2001-03	Engine Oil Replacement Reminder Reset - Procedure 6
Avalanche	
2002-06	Engine Oil Replacement Reminder Reset - Procedure 3
2007-13	Engine Oil Replacement Reminder Reset - Procedure 6
Aveo	
2009-11	Engine Oil Replacement Reminder Reset - Procedure 3
Aztek	
2001-05	Engine Oil Replacement Reminder Reset - Procedure 3
Bravada	
2002-04	Engine Oil Replacement Reminder Reset - Procedure 11
Bonneville	
2003-05	Engine Oil Replacement Reminder Reset - Procedure 6
Brougham	
1992	Engine Oil Replacement Reminder Reset - Procedure 3
Cascada	
2016-17	Engine Oil Replacement Reminder Reset - Procedure 18

Model & Year	Reset Procedure
Camaro	
1998-02	Engine Oil Replacement Reminder Reset - Procedure 1
2010-15	Engine Oil Replacement Reminder Reset - Procedure 18
2016-17	Engine Oil Replacement Reminder Reset - Procedure 33
Canyon	
2004-12	Engine Oil Replacement Reminder Reset - Procedure 10
2015-17	Engine Oil Replacement Reminder Reset - Procedure 18
Caprice	
1994	Engine Oil Replacement Reminder Reset - Procedure 2
1995-96	Engine Oil Replacement Reminder Reset - Procedure 3
2011-17	Engine Oil Replacement Reminder Reset - Procedure 18
Captiva Sport	
2012-15	Engine Oil Replacement Reminder Reset - Procedure 6
Century	
1997-04	Engine Oil Replacement Reminder Reset - Procedure 6
City Express	
2015-17	Engine Oil Replacement Reminder Reset - Procedure 3
Classic	
2005	Engine Oil Replacement Reminder Reset - Procedure 4
Cobalt & G5 Pursuit (Canadian)	
2005-09	Engine Oil Replacement Reminder Reset - Procedure 4
Colorado	
2004-12	Engine Oil Replacement Reminder Reset - Procedure 10
2015-17	Engine Oil Replacement Reminder Reset - Procedure 18
Corvette	
1990-96	Engine Oil Replacement Reminder Reset - Procedure 5
1997-13	Engine Oil Replacement Reminder Reset - Procedure 6
2014-17	Engine Oil Replacement Reminder Reset - Procedure 33
Cruze	
2011-17	Engine Oil Replacement Reminder Reset - Procedure 18
Cruze Limited	
2016	Engine Oil Replacement Reminder Reset - Procedure 18
CT6	
2016-17	Engine Oil Replacement Reminder Reset - Procedure 33
CTS	
2003-04	Engine Oil Replacement Reminder Reset - Procedure 20
2005-08	Engine Oil Replacement Reminder Reset - Procedure 22
2009	Engine Oil Replacement Reminder Reset - Procedure 6
2010-11	Engine Oil Replacement Reminder Reset - Procedure 3 or Engine Oil Replacement Reminder Reset - Procedure 19

Model & Year	Reset Procedure
2012-15	Engine Oil Replacement Reminder Reset - Procedure 6
2016-17	Engine Oil Replacement Reminder Reset - Procedure 33
Cutlass Calais, Cutlass Supreme, Cutlass Ciera, Cutlass Cruiser	
1990-91	Engine Oil Replacement Reminder Reset - Procedure 28
DeVille	
1991-93	Engine Oil Replacement Reminder Reset - Procedure 25
1994-99	Engine Oil Replacement Reminder Reset - Procedure 19
2000-05	Engine Oil Replacement Reminder Reset - Procedure 16
DeVille Concours	
1994-96	Engine Oil Replacement Reminder Reset - Procedure 19
1997-99	Engine Oil Replacement Reminder Reset - Procedure 6
DTS	
2006-11	Engine Oil Replacement Reminder Reset - Procedure 6
Eighty Eight & Ninety Eight	
1990-91	Engine Oil Replacement Reminder Reset - Procedure 28
1992-94	Engine Oil Replacement Reminder Reset - Procedure 29
1995-97	Engine Oil Replacement Reminder Reset - Procedure 30
Eldorado	
1989-91	Engine Oil Replacement Reminder Reset - Procedure 24
1992-93	Engine Oil Replacement Reminder Reset - Procedure 26
1994-97	Engine Oil Replacement Reminder Reset - Procedure 19
1997-02	Engine Oil Replacement Reminder Reset - Procedure 6
ELR	
2014-16	Engine Oil Replacement Reminder Reset - Procedure 33
Enclave	
2008-17	Engine Oil Replacement Reminder Reset - Procedure 16
Encore	
2013-17	Engine Oil Replacement Reminder Reset - Procedure 18
Envision	
2016-17	Engine Oil Replacement Reminder Reset - Procedure 33
Envoy Series	
2002-06	Engine Oil Replacement Reminder Reset - Procedure 6
2007-09	Engine Oil Replacement Reminder Reset - Procedure 4
Equinox	
2005-09	Engine Oil Replacement Reminder Reset - Procedure 3
2011-14	Engine Oil Replacement Reminder Reset - Procedure 6
2015-17	Engine Oil Replacement Reminder Reset - Procedure 34
Escalade Series	
2002-06	Engine Oil Replacement Reminder Reset - Procedure 3
2007-14	Engine Oil Replacement Reminder Reset - Procedure 6
2015-17	Engine Oil Replacement Reminder Reset - Procedure 33

Model & Year	Reset Procedure
Express/ Chevy Express/ Cutaway/ RV	
2003-17	Engine Oil Replacement Reminder Reset - Procedure 3
Firebird	
1998-02	Engine Oil Replacement Reminder Reset - Procedure 6
Fleetwood	
1991-92	Engine Oil Replacement Reminder Reset - Procedure 25
1993-96	Engine Oil Replacement Reminder Reset - Procedure 3
Grand Am	
1999-02	Engine Oil Replacement Reminder Reset - Procedure 2
2003-05	Engine Oil Replacement Reminder Reset - Procedure 3
Grand Prix	
1998-03	Engine Oil Replacement Reminder Reset - Procedure 3
2004-08	Engine Oil Replacement Reminder Reset - Procedure 6
GTO	
2004-06	Engine Oil Replacement Reminder Reset - Procedure 3
G5	
2007-10	Engine Oil Replacement Reminder Reset - Procedure 4
G6	
2005-10	Engine Oil Replacement Reminder Reset - Procedure 32
G8	
2008-09	Engine Oil Replacement Reminder Reset - Procedure 9
HHR	
2006-11	Engine Oil Replacement Reminder Reset - Procedure 4
Impala	
2000-06	Engine Oil Replacement Reminder Reset - Procedure 8
2007-13	Engine Oil Replacement Reminder Reset - Procedure 6
2014-17	Engine Oil Replacement Reminder Reset - Procedure 33
Impala Limited	
2014-16	Engine Oil Replacement Reminder Reset - Procedure 16
Intrigue	
1998-02	Engine Oil Replacement Reminder Reset - Procedure 3
LaCrosse & Allure	
2005-13	Engine Oil Replacement Reminder Reset - Procedure 18
2014-17	Engine Oil Replacement Reminder Reset - Procedure 33
LeSabre	
1994-99	Engine Oil Replacement Reminder Reset - Procedure 12
2000-05	Engine Oil Replacement Reminder Reset - Procedure 14
Lucerne	
2006-10	Engine Oil Replacement Reminder Reset - Procedure 6
2011	Engine Oil Replacement Reminder Reset - Procedure 18
Lumina	

Model & Year	Reset Procedure
1997-01	Engine Oil Replacement Reminder Reset - Procedure 6
Malibu	
2004-07	Engine Oil Replacement Reminder Reset - Procedure 13
2008-12	Engine Oil Replacement Reminder Reset - Procedure 4
2013-17	Engine Oil Replacement Reminder Reset - Procedure 18
Malibu Limited	
2016	Engine Oil Replacement Reminder Reset - Procedure 18
Montana	
2000-05	Engine Oil Replacement Reminder Reset - Procedure 3
Monte Carlo	
1997-99	Engine Oil Replacement Reminder Reset - Procedure 6
2000-06	Engine Oil Replacement Reminder Reset - Procedure 8
2007	Engine Oil Replacement Reminder Reset - Procedure 6
Park Avenue	
1991-94	Engine Oil Replacement Reminder Reset - Procedure 15
1995-96	Engine Oil Replacement Reminder Reset - Procedure 12
1997-05	Engine Oil Replacement Reminder Reset - Procedure 14
Pickup/ C3500/ Cab & Chassis (C/K)	
1996-00	Engine Oil Replacement Reminder Reset - Procedure 3
Rainier	
2004-07	Engine Oil Replacement Reminder Reset - Procedure 17
Regal	
1997-04	Engine Oil Replacement Reminder Reset - Procedure 6
2011-13	Engine Oil Replacement Reminder Reset - Procedure 18
2014-17	Engine Oil Replacement Reminder Reset - Procedure 33
Rendezvous	
2002-07	Engine Oil Replacement Reminder Reset - Procedure 17
Roadmaster	
1994	Engine Oil Replacement Reminder Reset - Procedure 15 or Engine Oil Replacement Reminder Reset - Procedure 2
1995-96	Engine Oil Replacement Reminder Reset - Procedure 3
Savana Series/ Cutaway/ RV	
2003-17	Engine Oil Replacement Reminder Reset - Procedure 3
Seville	
1989-91	Engine Oil Replacement Reminder Reset - Procedure 24
1992-93	Engine Oil Replacement Reminder Reset - Procedure 26
1994-97	Engine Oil Replacement Reminder Reset - Procedure 19
1998-04	Engine Oil Replacement Reminder Reset - Procedure 16
Sierra Series	
1999-06	Engine Oil Replacement Reminder Reset - Procedure 3

Model & Year	Reset Procedure
2007-17	Engine Oil Replacement Reminder Reset - Procedure 6
Silhouette	
2000-01	Engine Oil Replacement Reminder Reset - Procedure 3
2002-04	Engine Oil Replacement Reminder Reset - Procedure 6
Silverado Series	
2001-06	Engine Oil Replacement Reminder Reset - Procedure 3
2007-15	Engine Oil Replacement Reminder Reset - Procedure 6
2016-17	Engine Oil Replacement Reminder Reset - Procedure 33
Solstice	
2006-10	Engine Oil Replacement Reminder Reset - Procedure 4
Sonic	
2012-17	Engine Oil Replacement Reminder Reset - Procedure 18
Spark	
2013-16	Engine Oil Replacement Reminder Reset - Procedure 35
2017	Engine Oil Replacement Reminder Reset - Procedure 18
SRX	
2004	Engine Oil Replacement Reminder Reset - Procedure 20
2005-06	Engine Oil Replacement Reminder Reset - Procedure 22
2007-09	Engine Oil Replacement Reminder Reset - Procedure 6
2010-12	Engine Oil Replacement Reminder Reset - Procedure 18
2013-16	Engine Oil Replacement Reminder Reset - Procedure 33
SS	
2014-17	Engine Oil Replacement Reminder Reset - Procedure 18
SSR	
2004	Engine Oil Replacement Reminder Reset - Procedure 3
2005-06	Engine Oil Replacement Reminder Reset - Procedure 6
STS	
2005-11	Engine Oil Replacement Reminder Reset - Procedure 7
Suburban	
2000-06	Engine Oil Replacement Reminder Reset - Procedure 3
2007-17	Engine Oil Replacement Reminder Reset - Procedure 6
Tahoe	
2000-06	Engine Oil Replacement Reminder Reset - Procedure 3
2007-17	Engine Oil Replacement Reminder Reset - Procedure 6
Terrain	
2011-17	Engine Oil Replacement Reminder Reset - Procedure 34
Toronado	
1989-92	Engine Oil Replacement Reminder Reset - Procedure 31
Torrent	
2006-09	Engine Oil Replacement Reminder Reset - Procedure 3
Trailblazer	

Model & Year	Reset Procedure
2002-09	Engine Oil Replacement Reminder Reset - Procedure 11
Traverse	
2009-17	Engine Oil Replacement Reminder Reset - Procedure 6
Trax	
2015-17	Engine Oil Replacement Reminder Reset - Procedure 18
Uplander, Montana SV6 (Canadian)	
2005-08	Engine Oil Replacement Reminder Reset - Procedure 6
Venture	
2000-04	Engine Oil Replacement Reminder Reset - Procedure 3
2005	Engine Oil Replacement Reminder Reset - Procedure 6
Verano	
2012-17	Engine Oil Replacement Reminder Reset - Procedure 18
Volt	
2011-15	Engine Oil Replacement Reminder Reset - Procedure 21
2016-17	Engine Oil Replacement Reminder Reset - Procedure 33
XLR	
2004	Engine Oil Replacement Reminder Reset - Procedure 6
2005-09	Engine Oil Replacement Reminder Reset - Procedure 19
XT5	
2017	Engine Oil Replacement Reminder Reset - Procedure 33
XTS	
2013-17	Engine Oil Replacement Reminder Reset - Procedure 33
Yukon Series	
2000-06	Engine Oil Replacement Reminder Reset - Procedure 3
2007-17	Engine Oil Replacement Reminder Reset - Procedure 6

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 1

1. The CHANGE OIL (or CHANGE ENGINE OIL) message is displayed when its time to change engine oil, usually between 3000 and 7500 miles since last oil change.
2. To reset the oil life monitor, turn the ignition switch to RUN position, with engine off. Press the TRIP/OIL RESET button on the instrument panel for 12 seconds. The OIL CHANGE light will start to flash to confirm that system is reset (on some models a chime will also sound). Reset is complete when OIL CHANGE light goes out.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 2

Engine oil life monitor calculates engine oil temperature and RPM. It indicates when the engine oil is nearly worn out. A CHANGE OIL light on the instrument cluster is illuminated when it is time to change the engine oil. To reset CHANGE OIL light:

1. Remove IP fuse block cover (cover can be seen when driver's door is open).
2. Turn ignition ON, engine OFF.

3. Press OIL RESET button and hold for 5 seconds.
4. If Oil Life light does not reset, repeat procedure with ignition OFF.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 3

Engine oil life monitor calculates engine oil temperature and RPM. It indicates when the engine oil is nearly worn out. A CHANGE OIL light on the instrument cluster is illuminated when it is time to change the engine oil.

1. To reset oil life monitor and turn off CHANGE OIL light (or message), turn ignition to ON position with engine off.
2. Depress accelerator pedal to wide open throttle 3 times within 5 seconds.
3. Turn ignition to LOCK/OFF
4. If light (or message) does not turn off, turn ignition OFF and repeat procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 4

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL SOON message will come on. Change the engine oil as soon as possible within the next 600 miles (1, 000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

Reset Procedure

1. Turn the ignition key to RUN with the engine OFF.
2. Press the INFO and RESET buttons on the Driver Information Center (DIC) at the same time to enter the personalization menu.
3. Press the INFO button to scroll through the available personalization menu modes until the DIC display shows OIL-LIFE RESET.
4. Press the INFO and RESET buttons at the same time for one second and release.
5. Press and hold the reset button until the DIC display shows ACKNOWLEDGED. This will tell you the system has been reset.
6. Turn the key to LOCK/OFF.

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 5

Engine oil life monitor calculates engine oil temperature and RPM. It indicates when the oil is nearly worn out. A CHANGE OIL light on left side of instrument cluster is illuminated when it is time to change oil. To reset oil

life monitor:

1. Turn ignition on.
2. Depress ENG MET button on trip monitor and release.
3. Within 5 seconds, depress and release ENG MET button again.
4. Within 5 seconds, depress and hold the ENG MET or GAUGES button again. The CHANGE OIL light should flash.
5. Depress and hold the RANGE or GAUGES button until the CHANGE OIL light stops flashing and goes out. When the light goes out, the engine oil life monitor is reset. This should take about 10 seconds.

NOTE: **If the light does not reset, turn ignition off and repeat the procedure.**

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 6

The Driver Information Center (DIC) will display a CHANGE OIL message when an oil change is due. The instrument cluster may also have a CHANGE OIL light. To reset the oil life monitor:

Reset Procedure

1. Turn ignition switch to RUN position, with engine off.
2. Press the TRIP (on some models SELECT or SET/RESET) button, located on the DIC, until the OIL LIFE display appears. Message will display percentage of oil life remaining.

   NOTE: **On models without DIC buttons, use the TRIP/ODOMETER reset stem.**

3. Press and hold SET/RESET button (on some models, the check-symbol button) on DIC for at least 5 seconds. The message will change to indicate that the Oil Life has been reset. On some models, 3 chimes will also sound.
4. Turn ignition off.
5. Turn the key to OFF. If the light or message comes back on when you start your vehicle, the oil life system has not reset. Repeat the procedure.

NOTE: **On some models, if oil life system does not reset, try turning ignition OFF after displaying oil life message. Then press and hold reset button.**

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 7

When the system has calculated that oil life has been diminished, it indicates that an oil change is necessary. A CHANGE ENGINE OIL SOON message in the DIC comes on. Reset the system whenever the engine oil is

changed so that the system can calculate the next engine oil change. To reset the system:

1. Press the up or down arrow to scroll the DIC to show OIL LIFE.
2. Once the XXX% ENGINE OIL LIFE menu item is highlighted, press and hold the RESET button until the percentage shows 100%

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 8

The CHANGE ENGINE OIL message is displayed when its time to change engine oil, usually between 3000 and 7500 miles since last oil change. The oil change interval is not based on mileage, but on engine revolutions and engine operating temperature.

1. There are 2 ways to reset the engine oil life monitor. To reset the engine oil life monitor using the accelerator pedal, go to step 4. To reset the engine oil life monitor using the radio, turn the radio off. Turn ignition to ACC or ON, with the engine off. Press and hold the DISP (on some models, TUNE DISP) button (or knob) on the radio for at least 5 seconds until SETTINGS is displayed.
2. Press the SEEK (on some models, SEEK PTYPE or SEEK PSCAN) up or down arrow to scroll through the main menu. Scroll until OIL LIFE appears on the display. Press the PREV or NEXT button to enter the sub-menu. RESET will be displayed.
3. Press the DISP/TUNE DISP button to reset. A chime will sound to verify the new setting and DONE will be displayed for one second. Once the message indicator has been reset, scroll through the menu until EXIT appears on the display. Press the DISP/TUNE DISP button to exit the program. A chime will sound to verify the exit.
4. To reset the engine oil life monitor using the accelerator pedal, turn ignition on with engine off. Fully depress and release the accelerator pedal slowly 3 times within 5 seconds. If CHANGE ENGINE OIL light flashes, oil life monitor is reset. If the CHANGE ENGINE OIL light comes back on and stays on, oil life monitor has not reset. Repeat reset procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 9

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE message will come on. Change the engine oil as soon as possible within the next 600 miles (1000 km). It is possible that, if driving under the best conditions, the oil life may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

To reset the Engine Oil Life System, do the following:

1. Press and hold the TRIP button on the steering wheel while turning on the ignition. Do not start the engine.
2. The instrument panel cluster will prompt to clear the service code.
3. Release the button.
4. Press and hold ENTER Switch on the left side of the steering wheel for approximately one second.
5. Turn off the ignition.

If the CHANGE ENGINE OIL SOON message comes back on when you start the vehicle, the engine oil life system has not reset. Repeat the procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 10

1. Turn ignition ON, with engine off.
2. Press and release reset stem on instrument panel while OIL LIFE message is displayed.
3. Once the alternating OIL LIFE and RESET messages appear, press and hold stem in until several beeps will sound. This confirms that oil life system has been reset. Turn ignition off or full LOCK position. If CHANGE OIL messages comes back after starting engine, repeat reset procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 11

Reset Procedure

If vehicle is equipped with a Driver Information Center (DIC), reset oil life monitor by pressing the Driver Information Center SELECT button for 5 seconds while ENGINE OIL LIFE is displayed.

Alternate Method

To reset the oil life monitor, turn ignition switch to ON or RUN position with engine off. Depress accelerator pedal slowly to wide open throttle 3 times within 5 seconds. If CHANGE ENG OIL light flashes for 5 seconds, oil life monitor is reset. If the CHANGE ENG OIL light does not flash, oil life monitor has not reset. Repeat this step.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 12

1. CHANGE OIL SOON light will come on when engine oil has broken down enough to require changing. After changing oil, reset oil life display.
2. To reset light, turn ignition on. Open glove box to access oil reset button. Press and hold oil reset button in glove box for at least 5 seconds, but not longer than 60 seconds. The CHANGE OIL SOON light will flash 4 times to indicate light has been reset.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 13

GM Oil Life System calculates when to change your engine oil and filter based on vehicle use. Anytime oil is changed, reset the system so it can calculate when the next oil change is required. If a situation occurs where you change your oil prior to a Change Oil Soon message being turned on, reset the system. After changing the engine oil, reset the system.

1. Display OIL LIFE RESET on the DIC.
2. Press and hold ENTER button for at least one second. An ACKNOWLEDGED display message will appear for 3 seconds or until the next button is pressed. This will tell you the system has been reset.
3. Turn key to OFF.
4. If Change Oil Soon message comes back on when you start your vehicle, engine oil life system has not reset. Repeat the procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 14

1. To display this light, press the GAGE INFO or GAGES button on the Driver Information Center (DIC). When oil life index is less than 10 percent, display will show OIL LIFE INDEX CHANGE OIL. After changing oil, reset system.

2. To reset light, display OIL LIFE INDEX. Hold RESET button for more than 5 seconds. After reset, oil life will change to 100 percent.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 15

1. CHANGE OIL SOON light will come on when engine oil has broken down enough to require changing. After changing oil, reset oil life display.
2. To reset light, locate reset button hole under the dash near passenger door. Use a pencil or similar object to push and hold button (inside hole) for 5 seconds. The CHANGE OIL SOON light will flash 4 times to indicate light has been reset.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 16

Vehicles WITHOUT Driver Information Center (DIC) Buttons

1. Turn the ignition to ON/RUN, with the engine off. The vehicle must be in P (Park) to access this display. Press the trip odometer reset stem until OIL LIFE REMAINING displays.
2. Press and hold the trip odometer reset stem until OIL LIFE REMAINING shows "100%." Three chimes sound and the CHANGE ENGINE OIL SOON message goes off.
3. Turn the key to LOCK/OFF. If the CHANGE ENGINE OIL SOON message comes back on when the vehicle is started, the engine oil life system has not been reset. Repeat the procedure.

Vehicles WITH Driver Information Center (DIC) Buttons

1. Turn the ignition to ON/RUN position, with the engine off.
2. Press the VEHICLE INFORMATION BUTTON (i) until OIL LIFE REMAINING displays.
3. Press and hold the SET/RESET button (check-mark symbol) until "100%" is displayed. Three chimes sound (on some models) and the CHANGE ENGINE OIL SOON message goes off.
4. Turn ignition to LOCK/OFF position. If the CHANGE ENGINE OIL SOON message comes back on when engine is started, repeat reset procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 17

Reset Procedure

1. Turn the ignition to ON, with the engine off.
2. Press the MODE button until the Driver Information Center (DIC) reads OIL LIFE LEFT/HOLD SET TO RESET.
3. Press and hold the SET button until 100% is displayed. You will hear three chimes and the CHANGE ENGINE OIL message will go off. Turn the key to OFF.
4. If the CHANGE ENGINE OIL message comes back on when engine is started, the engine oil life system has not reset. Repeat the procedure.

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.

3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 18

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL message or light will come on. Change the engine oil as soon as possible within the next 600 miles (1 000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

NOTE: **Be careful not to reset the oil life display accidentally at any time other than after the oil is changed. It cannot be reset accurately until the next oil change.**

Vehicles with DIC (& Steering Wheel Controls)

1. Using the DIC controls on the right side of the steering wheel (see **Fig. 1**), display REMAINING OIL LIFE on the driver information center (DIC).
2. Press SEL or SET/CLR (check mark icon on some systems) on the DIC controls and hold down for a few seconds to clear the CHANGE ENGINE OIL SOON message and reset the oil life at 100%.

NOTE: **Be careful not to reset the oil life display accidentally at any time other than after the oil is changed. It cannot be reset accurately until the next oil change.**

NOTE: **If the CHANGE OIL message comes back on when the vehicle is started, the engine oil life system has not been reset. Repeat the procedure.**

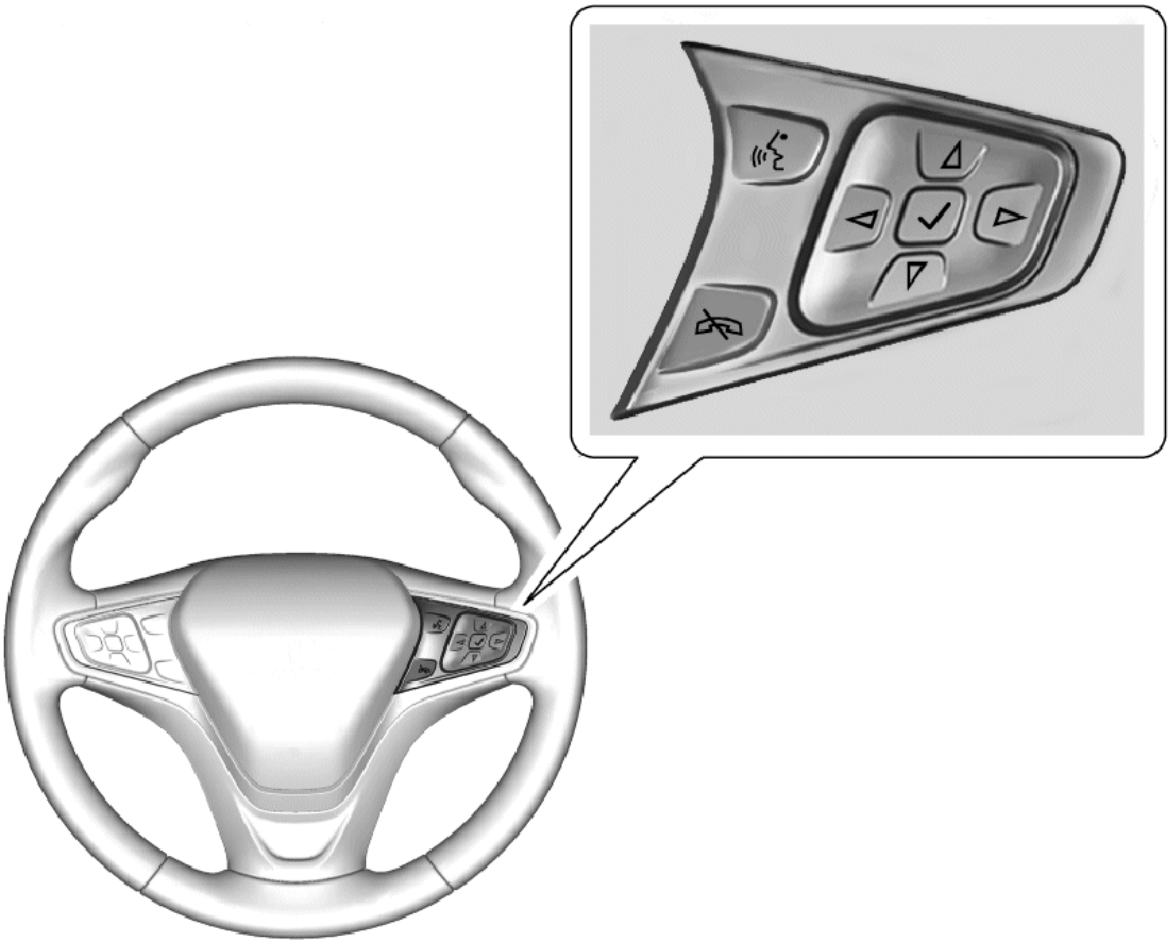


Fig. 1: Identifying DIC Controls (Steering Wheel - Typical)
Courtesy of GENERAL MOTORS COMPANY

Vehicles with DIC (& Turn Signal Lever Controls)

1. Turn the ignition to ON/RUN with the engine off.
2. Press the DIC MENU button on the turn signal lever to enter the Vehicle Information Menu. Use the thumbwheel to scroll through the menu items until you reach REMAINING OIL LIFE. See **Fig. 2**.

   NOTE: On vehicles with an Uplevel DIC, the controls are at the right-hand side of the steering wheel.

3. Press the SET/CLR button (on some models, the check-symbol button) while the oil life display is active. After a few seconds, there will be a single chime (on some models) and the oil life will be reset to 100%
4. Turn the ignition to LOCK/OFF.

The system is reset when the CHANGE OIL message is off and the REMAINING OIL LIFE 100% message is displayed.

NOTE: If the CHANGE OIL message comes back on or Code 82 DIC message comes on when the vehicle is started, the engine oil life system has not been reset. Repeat the procedure.

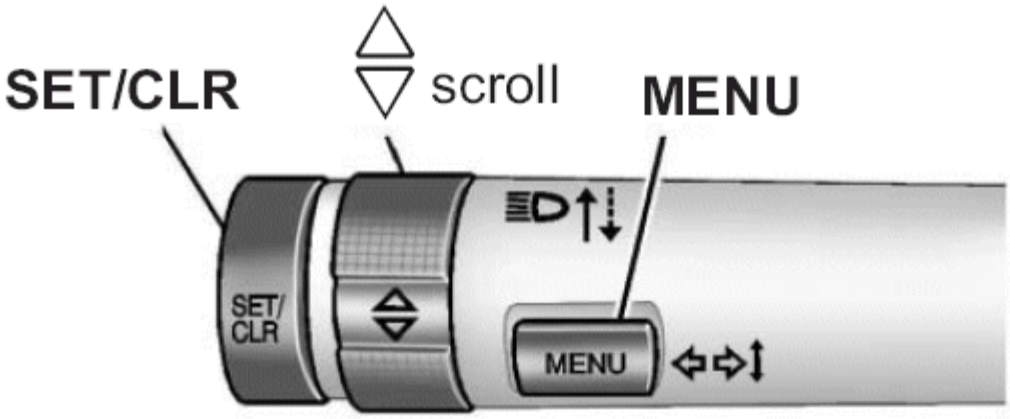


Fig. 2: Identifying DIC Controls (Turn Signal Lever)
Courtesy of GENERAL MOTORS COMPANY

Vehicles without DIC (Some Models)

1. With the engine OFF, turn the ignition key to RUN.
2. Fully press and release the accelerator pedal slowly three times within five seconds.
3. Turn the key to OFF, than start the vehicle.

Reset Using Diagnostic Scan Tool (Some Models)

1. Turn on ignition.
2. Connect scan tool.
3. Select Module Diagnosis.
4. Select Engine Control Module.
5. Select Configuration/Reset function.
6. Select Engine Oil System Reset.
7. Push Enter button to run function.
8. Confirm Executed successfully.
9. Turn ignition of and confirm.
10. Turn ignition on and confirm.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 19

1. The Driver Information Center (DIC) will display remaining oil life as a percentage estimate of the useful life of oil.
2. When remaining oil life is 10 percent or less, the system will display CHANGE OIL SOON. When oil life expires, display will show CHANGE ENGINE OIL. After changing oil, reset oil life display.
3. To reset oil life display, press INFORMATION (or INFORMATION SKIP) button to display OIL LIFE LEFT. Press and hold RESET (or RESET NO) button until 100 OIL LIFE LEFT (0.0 OIL LIFE LEFT on some early models) is displayed.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 20

With Base Audio System

Press up or down arrow on the INFO button located to right of Driver Information Center (DIC) display to access DIC menu. Once 100 percent ENGINE OIL LIFE menu item is highlighted, press and hold the CLR button. Percentage will return to 100 and oil life indicator will be reset. Repeat procedure if the percentage does not return to 100.

With Navigation System

Turn the system on by pressing PWR/VOL knob once. PWR/VOL knob is located to lower left of DIC display. Press INFO button located to left of the display to access Vehicle Information menu. Turn TUNE/SEL knob located to lower right of the display until ENGINE OIL LIFE is highlighted. Press TUNE/SEL knob once to select it. When 100 percent Engine Oil Life is displayed, press multifunction button next to reset prompt in upper right corner of the display. Percentage will return to 100 and the oil life indicator will be reset. Repeat procedure if the percentage does not return to 100.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 21

1. Use the SELECT knob to select OIL LIFE on the DIC menu.
2. Press SELECT to start the OIL LIFE reset procedure.
3. The DIC menu will display "Are you sure that you want to reset?" Use SELECT to choose YES to reset oil life or NO to exit and return to the previous menu.
4. If YES is selected, the DIC menu will display RESET OIL LIFE for a short time and then 100% OIL LIFE will be display when OIL LIFE is successfully reset.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 22

With Base Audio System

1. Press the CLR button located to the right of the driver information center (DIC) display to acknowledge the Change Engine Oil message. This will clear the message from the display and reset it.
2. Press the up or down arrow on the INFO button located to the right of the Driver Information Center (DIC) display to access the DIC menu.
3. Once 100% ENGINE OIL LIFE menu item is highlighted, press and hold the CLR button. The percentage will return to 100 and the oil life indicator will be reset. Repeat the steps if the percentage does not return to 100.
4. Turn OFF the key. If the Change Engine Oil message comes back on when you start the vehicle, the engine oil life system has not reset. Repeat the procedure.

Without DIC

1. With the engine OFF, turn the ignition key to RUN.
2. Fully press and release the accelerator pedal slowly three times within five seconds.
3. Turn the key to OFF, then start the vehicle.

With Navigation System

1. Press the multifunction button, next to the OK prompt in the upper right of the display to acknowledge the Change Engine Oil message. This will clear the message from the display and reset it.

2. Turn the system on by pressing the PWR/VOL knob once. The PWR/VOL knob is located to the lower left of the driver information center (DIC) display.
3. Press the INFO button located to the left of the display to access the Vehicle Information menu.
4. Turn the TUNE/SEL knob located to the lower right of the display until Engine Oil Life is highlighted. Press the knob once to select it.
5. Once the 100% Engine Oil Life is displayed, press the multifunction button next to the Reset prompt in the upper right corner of the display. The percentage will return to 100 and the oil life indicator will be reset. Repeat the steps if the percentage does not return to 100.
6. Turn OFF the key. If the Change Engine Oil message comes back on when you start the vehicle, the engine oil life system has not reset. Repeat the procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 23

1. An OIL LIFE INDEX is one of the displays on Driver Information Center (DIC). It will display remaining oil life as a percentage estimate of the useful life of oil.
2. It will show 100 percent when the system is reset. When the oil life is 0 percent, the display will show CHANGE ENGINE OIL. After changing oil, reset oil life display.
3. To reset service reminder on 1989 models, press RANGE button until OIL LIFE INDEX appears on display. Depress and hold in AVG ECON and RANGE buttons for more than 5 seconds or until 100 is displayed. This will reset remaining oil life to 100 percent.
4. On 1990-93 models, press RANGE button until OIL LIFE INDEX appears on DIC display. Depress and hold in AVG SPEED and RANGE buttons for more than 5 seconds or until 100 is displayed. This will reset remaining oil life to 100 percent.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 24

1. An OIL LIFE INDEX is one of 4 displays on Driver Information Center (DIC). It will display remaining oil life as a percentage estimate of the useful life of oil.
2. Display will show 100 percent when the system is reset. When remaining oil life is 10 percent or less, the system will display CHANGE OIL SOON. When the oil life expires, the display will show CHANGE ENGINE OIL. After changing oil, reset oil life display.
3. To reset oil life display, press ENG DATA button until OIL LIFE INDEX appears on DIC display. Depress and hold in ENG DATA and RANGE buttons until 100 is displayed. This will reset remaining oil life to 100 percent.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 25

1. An OIL LIFE INDEX is one of the displays on Driver Information Center (DIC). It will display remaining oil life as a estimated percentage of the useful life of oil.
2. It will show 100 percent when the system is reset. When the oil life is 0 percent, the display will show CHANGE ENGINE OIL. After performing necessary services, reset service reminder.
3. To reset service reminder, turn ignition to on position. Do not start engine. Depress and hold RANGE and FUEL USED buttons until OIL LIFE INDEX appears on DIC display. Depress and hold RANGE and RESET buttons for 5-60 seconds.
4. When CHANGE OIL SOON light flashes 4 times, remaining oil life index is reset to 100 percent. If CHANGE OIL SOON comes on and stays on for 5 seconds, display did not reset. Repeat step 3.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 26

1. Oil change reminder display on the Driver Information Center (DIC) is similar to 1990-91 models, but reset procedures are different. After changing oil, reset oil life display.
2. To reset, press INFORMATION button to display OIL LIFE INDEX. Press and hold STORE/RECALL button until 100 is displayed. This will reset oil life display to 100 percent.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 27

1. The Driver Information Center (DIC) displays estimated percentage of the remaining useful life of engine oil or transaxle fluid. When remaining oil or fluid life is 0 percent, the display will show CHANGE OIL NOW or CHANGE TRNS FLUID NOW. After changing engine oil or transaxle fluid, reset oil life display.
2. To reset the display, turn ignition on with engine off. Press ENG button to select the OIL LIFE or TRNS FLUID LIFE percentage display. Then, press and hold in RESET for at least 5 seconds.
3. The word RESET will appear. Then, OIL LIFE 100 or TRNS FLUID 100 will be displayed.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 28

1. An oil change reminder displays estimated percentage of the remaining useful life of the oil. When engine is started, a tone will sound and approximate distance to next oil change will be displayed.
2. When remaining oil life is 10 percent or less, the system will calculate distance to next oil change. When the oil life is 0 percent, the display will show CHANGE OIL NOW. After changing oil, reset oil life display.
3. To reset the display, press and hold in OIL button to select the oil life display. Then, press and hold in RESET and OIL buttons for at least 5 seconds. This will reset oil life display to 100 percent.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 29

1. To reset the display, press and release the TEST button.
2. Press and release the OIL button.
3. Press and hold the RESET button for at least 7 seconds. This will reset oil life display to 100 percent.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 30

1. To reset the display, press and release RESET button on Driver Information Center (DIC).
2. Press SEL button (with down arrow) to select OIL.
3. Press SEL button (with left and right arrows) to display oil life.
4. Press and hold RESET button for about 5 seconds.
5. A reset message will display, then oil life will display 100 percent.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 31

With Information Center Display

OIL LIFE INDEX is one of 4 engine data displays used on models with Information Center display. It will display remaining oil life as estimated percentage of the useful life of oil. It will show 100 percent when the

system is reset. After changing oil, reset oil life display.

1. To reset the display, press ENG DATA button (1989-90) or OPTIONS button (1991-92) until oil life index is displayed.
2. Then, press and hold in ENG DATA and GAGE buttons (1989) or RESET/ENTER button (1990-92) for at least 5 seconds. This will reset remaining oil life to 100 percent.

With Visual Information Center

OIL LIFE is one of the displays used on models with a Visual Information Center (VIC). It will display data regarding previous oil change. A bar graph display shows full when oil is changed. Bar graph will go down as vehicle is driven and oil ages. When bar graph reaches CHANGE OIL mark, oil should be changed. After changing oil, reset oil life display.

1. To reset the display, press INFO hard key and then OIL LIFE soft key to display oil life index.
2. Press RESET soft key.
3. A reset confirmation page will appear and ask if oil has been changed. Press YES soft key to reset bar graph, and update last oil change date and mileage information.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 32

When the system has calculated that oil life has been diminished, it will indicate that an oil change is necessary. A CHANGE ENGINE OIL SOON message will come on. Change the engine oil as soon as possible within the next 600 miles (1000 km). It is possible that, if driving under the best conditions, the oil life system may not indicate that an oil change is necessary for over a year. However, the engine oil and filter must be changed at least once a year and at this time the system must be reset.

To reset the Engine Oil Life System, do the following:

1. With the CHANGE OIL SOON message displayed, press any of the three driver information center (DIC) buttons to clear the CHANGE OIL SOON message.
2. Display OIL LIFE RESET on the DIC.
3. Press and hold the ENTER button for at least one second. An ACKNOWLEDGED display message will appear for three seconds or until the next button is pressed. This will tell you the system has reset.
4. Turn the ignition to OFF.

If the CHANGE ENGINE OIL message comes back on when you start the vehicle the Engine Oil Life System has not reset. Repeat the procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 33

This vehicle has a computer system that indicates when to change the engine oil and filter. This is based on a combination of factors which include engine revolutions, engine temperature, and miles driven. Based on driving conditions, the mileage at which an oil change is indicated can vary considerably. For the oil life system to work properly, the system must be reset every time the oil is changed. To reset the system:

Reset Procedure

1. Using the DIC controls on the right side of the steering wheel, display REMAINING OIL LIFE on the

driver information center (DIC).

2. Press SEL (check mark icon on some systems) on the DIC controls and hold down for a few seconds to clear the CHANGE ENGINE OIL SOON message and reset the oil life at 100%.

NOTE: **Be careful not to reset the oil life display accidentally at any time other than after the oil is changed. It cannot be reset accurately until the next oil change.**

Alternate Method (Some Models)

1. Turn the ignition key to RUN with the engine off.
2. Fully press the release the accelerator pedal 3 times within 5 seconds. Several beeps sound. This confirms the oil life system has been reset.
3. If the CHANGE/OIL message comes back on when you start the engine, the engine oil life system has not been reset. Repeat the procedure.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 34

Vehicles with Driver Information Center (DIC)

1. Turn the ignition to ON/RUN with the engine off.
2. Press the DIC MENU button on the center console to enter the Vehicle Information Menu.
3. Press either the up or down arrows to view REMAINING OIL LIFE.
4. Press the SET/CLR button until 100% is displayed.
5. Turn the ignition to LOCK/OFF.

The system is reset when the CHANGE ENGINE OIL SOON message goes off.

NOTE: **If the CHANGE OIL message comes back on when the vehicle is started, the engine oil life system has not been reset. Repeat the procedure.**

Alternate Method

1. With the engine OFF, turn the ignition key to RUN.
2. Fully press and release the accelerator pedal slowly three times within five seconds.
3. Turn the key to OFF, than start the vehicle.

ENGINE OIL REPLACEMENT REMINDER RESET - PROCEDURE 35

Reset the system whenever the engine oil is changed so that the system can calculate the next engine oil change. Always reset the engine oil life to 100% after every oil change. It will not reset itself. Use the DIC controls at the right side of the instrument cluster to reset the system.

1. Display remaining oil life (oil can w/ %) on the DIC
2. Press and hold SET/CLR on the DIC for more than five seconds. The oil life will change to 100%.

If the OIL CHANGE DIC message comes back on when the vehicle is started, the engine oil life system has not reset. Repeat the procedure.

EMISSIONS MAINTENANCE REMINDER (REMINDER FLAG)

NOTE: **To determine the appropriate reset procedure, refer to EMISSIONS MAINTENANCE REMINDER RESET. Only vehicles listed in this index have an Oxygen Sensor Reminder Flag reset.**

EMISSIONS MAINTENANCE REMINDER RESET INDEX

Model & Year	Reset Procedure
Some Models	
1980	Emissions Maintenance Reminder Reset - Procedure 1

EMISSIONS MAINTENANCE REMINDER RESET- PROCEDURE 1

1. Every 30, 000 miles, a reminder flag appears in speedometer face, indicating service of oxygen sensor is necessary. See **Fig. 3**. Inspect and service oxygen sensor as necessary and reset flag.
2. To reset flag, remove instrument panel trim plate. Remove instrument cluster lens. Using pointed tool, apply light downward pressure on notches of flag until it is reset. An alignment mark will appear in left center of odometer window when flag is fully reset.

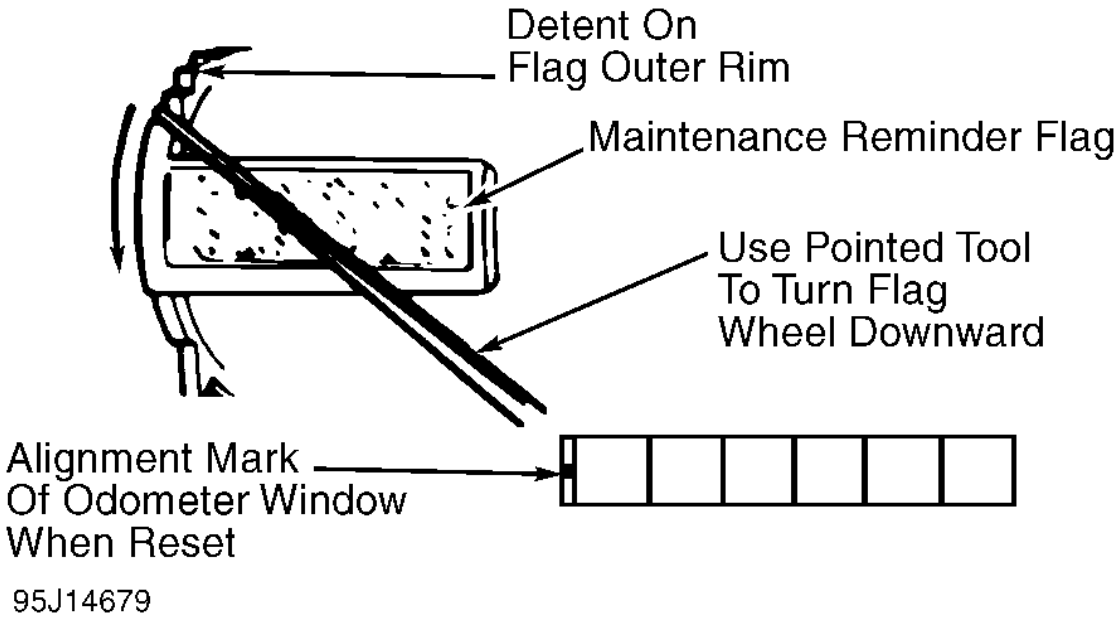


Fig. 3: Resetting Reminder Flag
Courtesy of GENERAL MOTORS CORP.

EMISSIONS MAINTENANCE REMINDER (WARNING LIGHT)

NOTE: **To determine the appropriate reset procedure, refer to EMISSIONS MAINTENANCE REMINDER RESET INDEX. Only vehicles listed in this index have an oxygen sensor warning light reset.**

EMISSIONS MAINTENANCE REMINDER RESET INDEX

Model & Year	Reset Procedure
Sprint	
1985-86	Emissions Maintenance Reminder Reset - Procedure 1

EMISSIONS MAINTENANCE REMINDER RESET - PROCEDURE 1

At 30, 000 mile intervals, a SENSOR light in dash will start flashing, indicating oxygen sensor needs replacement. To reset mileage counter (after sensor replacement), locate SENSOR light cancel switch on right side of fuse box. Return cancel switch to OFF position. Start engine to ensure light remains off.

EMISSIONS MAINTENANCE REMINDER (CHECK ENGINE LIGHT)

NOTE: **To determine the appropriate reset procedure, refer to EMISSIONS MAINTENANCE REMINDER RESET INDEX. Only vehicles listed in this index have a check engine light reset.**

EMISSIONS MAINTENANCE REMINDER RESET INDEX

Model & Year	Reset Procedure
Geo Tracker	
1989-94	Emissions Maintenance Reminder Reset - Procedure 1

EMISSIONS MAINTENANCE REMINDER RESET - PROCEDURE 1

Federal Emissions

1. CHECK ENGINE light functions as a service reminder indicator and emission system service. CHECK ENGINE light will come on each 50, 000 miles (PCV and EGR), each 80, 000 miles (oxygen sensor) and each 100, 000 miles (charcoal canister) to indicate needed emission system service.
2. After servicing and/or replacing components, reset CHECK ENGINE light by sliding cancel switch to its opposite position. See **CHECK ENGINE LIGHT RESET SWITCH LOCATION (GEO TRACKER)**for switch location.

CHECK ENGINE LIGHT RESET SWITCH LOCATION (GEO TRACKER)

Application	Location
1989-91	Behind Access Panel, Directly Below Steering Column
1992-94	(1) Behind Instrument Panel, Next To Left Speaker
(1) See **Fig. 4**.	

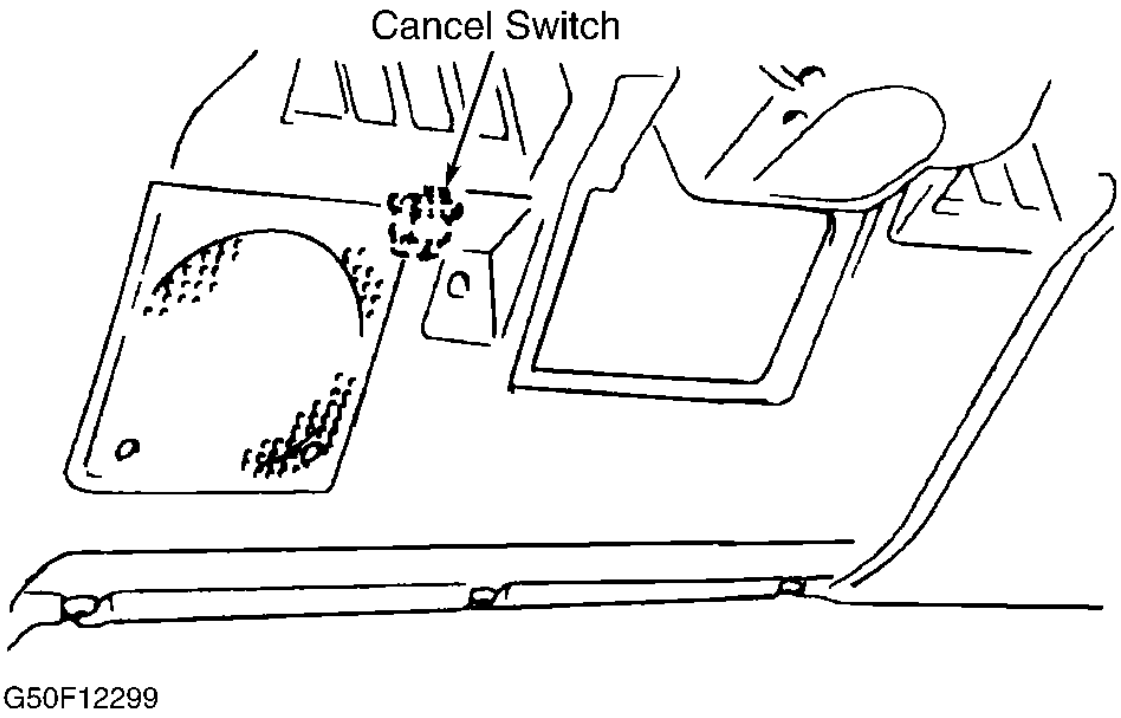


Fig. 4: Check Engine Light Reset Switch Location (1992-94 Geo Tracker - Federal Emissions)
Courtesy of GENERAL MOTORS CORP.

California Emissions

CHECK ENGINE light indicates when it is necessary to have emission system serviced, regardless of mileage. CHECK ENGINE light comes on briefly when starting as a bulb check. If light does not come on or stays on constantly, repair as necessary.

FUEL FILTER REPLACEMENT REMINDER

NOTE: To determine the appropriate reset procedure, refer to Fuel Filter Life Reset Index. Only vehicles listed in this index have a fuel filter life reset.

FUEL FILTER REPLACEMENT REMINDER RESET INDEX

Application	Reset Procedure
Some Models	Fuel Filter Replacement Reminder Reset - Procedure 1

FUEL FILTER REPLACEMENT REMINDER RESET - PROCEDURE 1

NOTE: This procedure does not apply to all models. Manufacturer does not specify which vehicles are equipped with a Fuel Filter Replacement Reminder.

NOTE: ALWAYS reset the FUEL FILTER LIFE system (if equipped) after a fuel filter change.

"FUEL FILTER LIFE" message will appear when a reset is performed either by using the steering wheel controls or performing manual reset procedure.

1. On vehicles with steering wheel controls, press and hold the select button for 5 seconds while the FUEL FILTER LIFE message is displayed. This message will appear on the Driver Information Center (DIC) for 10 seconds.
2. On vehicles without steering wheel controls, go to next step.
3. Without pressing the pedals, turn the ignition key to the ON position, engine off. Wait 5 seconds.
4. Completely depress the brake and accelerator pedals simultaneously and hold for 10 seconds. The system is now reset. Turn ignition key OFF.
5. On all vehicles, the next time engine is started, the message will no longer be displayed.

MAINTENANCE SERVICE REMINDER

NOTE: **To determine the appropriate reset procedure, refer to MAINTENANCE SERVICE REMINDER RESET INDEX. Only vehicles listed in this index have a Service Reminder reset.**

MAINTENANCE SERVICE REMINDER RESET INDEX

Model & Year	Reset Procedure
6000 STE	
1987-89	Maintenance Service Reminder Reset - Procedure 1
Bonneville	
1988-91	Maintenance Service Reminder Reset - Procedure 1
Caprice	
2011	Maintenance Service Reminder Reset - Procedure 2

MAINTENANCE SERVICE REMINDER RESET - PROCEDURE 1

The SERVICE REMINDER message light is used on models with a Driver Information Center (DIC). After performing necessary services, reset service reminder light.

1. To reset service reminder, push DIC button until desired service item is displayed.
2. Press and hold down the DIC button. With button pressed, the distance display will decrease in increments of 500 miles.
3. Release button when desired distance is displayed on the DIC.

MAINTENANCE SERVICE REMINDER RESET - PROCEDURE 2

The displayed service reminder is reset using a scan tool or by the following procedure:

1. Turn the ignition to the OFF position.
2. Press and hold the TRIP button.
3. Turn the ignition to the ON position.
4. Release the TRIP button.

5. Once in the Service Reset screen, press and hold the ENTER switch for 3-5 seconds. A confirmation beep will sound upon reset.
6. Turn the ignition to the OFF position.

NOTE: **If the service reminder comes back on when you start the vehicle, the Service Reminder Display has not reset. Repeat the procedure.**

TIMING BELT REPLACEMENT REMINDER

NOTE: **To determine the appropriate reset procedure, refer to TIMING BELT REPLACEMENT REMINDER INDEX. Only the vehicles listed in this index have a Timing Belt Replacement Reminder Reset.**

CHANGE TIMING BELT MESSAGE INDEX

Model & Year	Reset Procedure
Chevrolet Cruze - 1.8L LUW and LWE Engines (2011-16)	Timing Belt Replacement Reminder Reset - Procedure 1
Chevrolet Sonic - 1.8L LUW and LWE Engines (2012-16)	Timing Belt Replacement Reminder Reset - Procedure 1

TIMING BELT REPLACEMENT REMINDER RESET - PROCEDURE 1

NOTE: **Applies to 1.8L LUW and LWE engines.**

Description

On LUW and LWE engines, the Instrument Cluster monitors the odometer mileage to determine when a timing belt (if equipped) replacement may be necessary. After the vehicle has accumulated approximately 100, 000 miles (160, 000 kilometers), the Instrument Cluster may display the CHANGE TIMING BELT message.

Message Reset

After the engine timing belt has been replaced, reset the CHANGE TIMING BELT message by locating and removing the fuses that supply power to the Instrument Cluster, for two minutes.

- **2011-16 Cruze** : Fuse #21 (F21DA) Underhood (**Fig. 5**)
- **2012-16 Sonic** : Fuse #F26 (F26DA) Under Dash (lower-left of dash - **Fig. 6**)

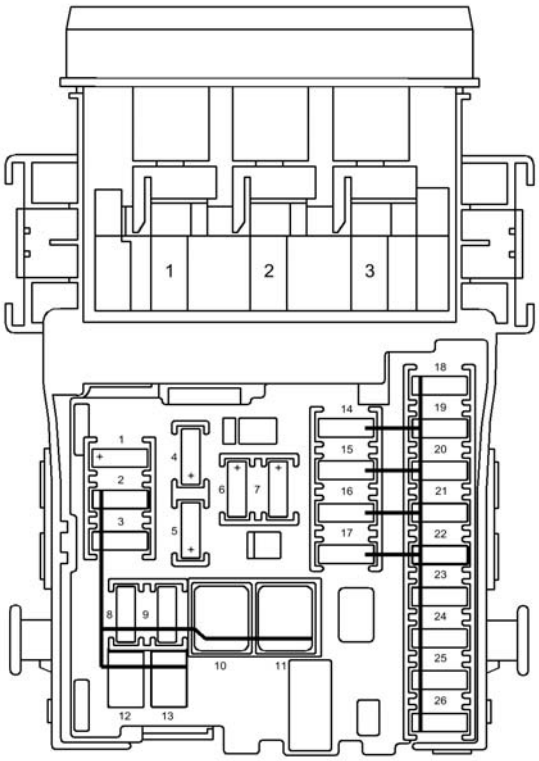


Fig. 5: Underhood Fuses (Cruze)
Courtesy of GENERAL MOTORS CORP.

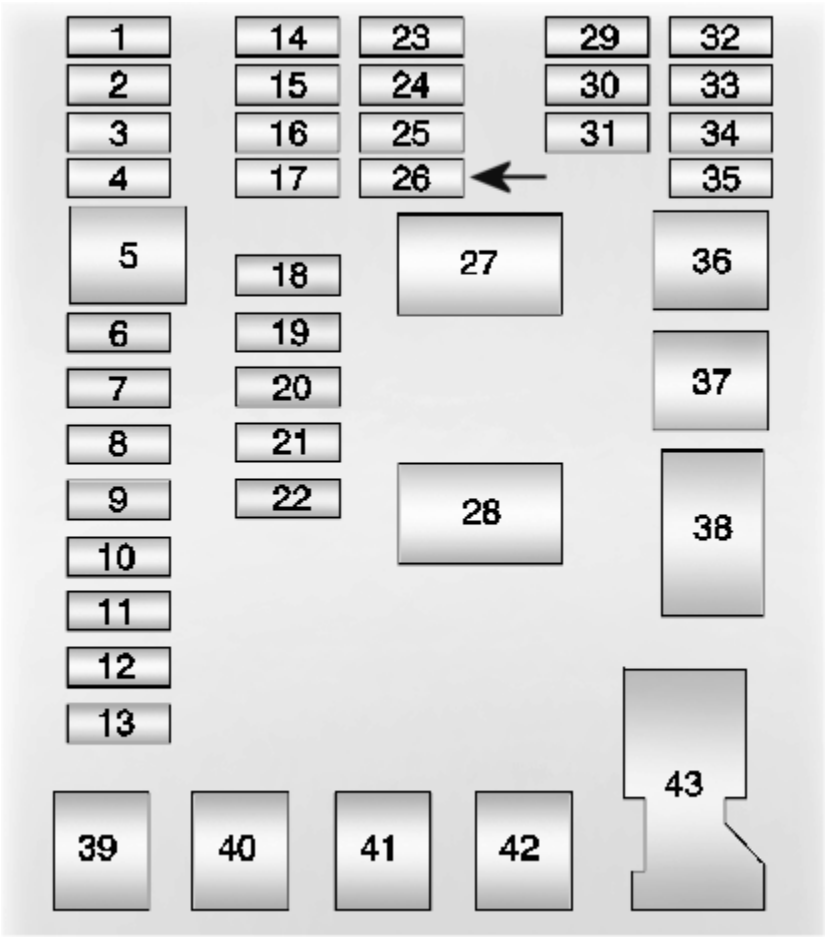


Fig. 6: Instrument Panel Fuses (Sonic)
Courtesy of GENERAL MOTORS CORP.

TRANSMISSION FLUID REPLACEMENT REMINDER

NOTE: **To determine the appropriate reset procedure, refer to TRANSMISSION FLUID REPLACEMENT REMINDER RESET INDEX. Only the vehicles listed in this index have a CHANGE TRANS FLUID MESSAGE reset.**

TRANSMISSION FLUID REPLACEMENT REMINDER RESET INDEX

Model & Year	Reset Procedure
Aurora	
1995-99	Transmission Fluid Replacement Reminder Reset - Procedure 4
Concours	
1994-98	Transmission Fluid Replacement Reminder Reset - Procedure 1
1999	Transmission Fluid Replacement Reminder Reset - Procedure 2
CTS	
2003	Transmission Fluid Replacement Reminder Reset - Procedure 3
2004	Transmission Fluid Replacement Reminder Reset - Procedure 2
DeVille	
1992-97	Transmission Fluid Replacement Reminder Reset - Procedure 1
1998-04	Transmission Fluid Replacement Reminder Reset - Procedure 2
Eldorado	
1992-98	Transmission Fluid Replacement Reminder Reset - Procedure 1
1999-00	Transmission Fluid Replacement Reminder Reset - Procedure 2
2001-02	Transmission Fluid Replacement Reminder Reset - Procedure 1
Seville	
1992-97	Transmission Fluid Replacement Reminder Reset - Procedure 1
1998-04	Transmission Fluid Replacement Reminder Reset - Procedure 2
SRX	
2004	Transmission Fluid Replacement Reminder Reset - Procedure 2

TRANSMISSION FLUID REPLACEMENT REMINDER RESET - PROCEDURE 1

The CHANGE TRANS FLUID message will appear on the Driver Information Center (DIC) when trans fluid change is due. Change fluid in both the oil pan and side cover.

1. To reset display, turn ignition ON with engine OFF.
2. On the climate control panel, press and hold OFF and REAR DEFOG buttons until TRANS FLUID RESET message appears in DIC (about 5-20 seconds).

TRANSMISSION FLUID REPLACEMENT REMINDER RESET - PROCEDURE 2

The CHANGE TRANS FLUID message will appear on the Driver Information Center (DIC) when trans fluid change is due. Percentage of transaxle fluid life remaining may be checked at any time by pressing INFO button

several times until TRANS FLUID LIFE message appears.

1. To reset display, turn ignition key ON with engine OFF.
2. Press the INFO button until TRANS FLUID LIFE message appears.
3. Press and hold INFO RESET button until display shows 100 percent TRANS FLUID LIFE. Transaxle fluid life index is now reset.

TRANSMISSION FLUID REPLACEMENT REMINDER RESET - PROCEDURE 3

NOTE: **The CHANGE TRANS FLUID message will appear on the Driver Information Center (DIC) when trans fluid change is due.**

Resetting With Base Audio System

Press CLR button located to the right of the DIC display to acknowledge the CHANGE TRANS FLUID message. This will clear the message from the display and reset it. To reset transmission fluid life indicator, press up or down arrow on INFO button located to the right of the DIC display to access the DIC menu. Once percentage TRANS FLUID LIFE menu item is highlighted, press and hold CLR button. Percentage will return to 100, and transmission fluid life indicator will be reset. Repeat if percentage does not return to 100.

Resetting With Navigation System

Press multifunction button located to the right of the DIC display, next to the OK prompt to acknowledge the CHANGE TRANS FLUID message. This will clear the message form the display and reset it. To reset transmission fluid life indicator, turn system on by pressing PWR/VOL knob once. PWR/VOL knob is located to the lower left of the DIC display. Press INFO button located to the left of the DIC display to access the VEHICLE INFO menu. Turn TUNE/SEL knob located to the lower right of the DIC display until TRANS FLUID LIFE is highlighted. Press knob once to select it. Once percentage TRANS FLUID LIFE is displayed, press multifunction button next to the RESET prompt in the upper right corner of the display. Percentage will return to 100, and transmission fluid life indicator will be reset. Repeat if percentage does not return to 100.

TRANSMISSION FLUID REPLACEMENT REMINDER RESET - PROCEDURE 4

1. The Driver Information Center (DIC) displays estimated percentage of the remaining useful life of transaxle fluid. When remaining fluid life is 0 percent, the display will show CHANGE TRNS FLUID NOW. After changing transaxle fluid, reset oil life display.
2. To reset the display, turn ignition on with engine off. Press ENG button to select the TRNS FLUID LIFE percentage display. Then, press and hold in RESET for at least 5 seconds.
3. The word RESET will appear. Then, TRNS FLUID 100 will be displayed.

TIRE PRESSURE MONITOR SYSTEM REMINDER

NOTE: **To determine the appropriate reset procedure, refer to TPMS REMINDER RESET INDEX. Only vehicles listed in this index have a TPMS Reminder Reset.**

TPMS REMINDER RESET INDEX

Model	Application	Procedure
Buick		

Model	Application	Procedure
Allure	2007	TPMS Reminder Reset - Procedure 1
Â	2008-09	TPMS Reminder Reset - Procedure 2
Cascada	2016-18	TPMS Reminder Reset - Procedure 25
Century	1999-05	(1) TPMS Reminder Reset - Procedure 21
Enclave	2008-12	TPMS Reminder Reset - Procedure 2
Â	2013-18	TPMS Reminder Reset - Procedure 9
Encore	2013-18	TPMS Reminder Reset - Procedure 25
Envision	2016-18	TPMS Reminder Reset - Procedure 26
LaCrosse	2006-09	TPMS Reminder Reset - Procedure 2
Â	2010-12	TPMS Reminder Reset - Procedure 11
Â	2013-18	TPMS Reminder Reset - Procedure 26
LaSabre	2002-05	(1) TPMS Reminder Reset - Procedure 20
Lucerne	2006	(1) TPMS Reminder Reset - Procedure 22
Â	2007-11	TPMS Reminder Reset - Procedure 2
Park Avenue	1998-05	(1) TPMS Reminder Reset - Procedure 20
Rainier	2006-07	TPMS Reminder Reset - Procedure 1
Regal	1999-04	(1) TPMS Reminder Reset - Procedure 21
Â	2011-12	TPMS Reminder Reset - Procedure 11
Â	2013-18	TPMS Reminder Reset - Procedure 26
Rendezvous	2003-07	(1) TPMS Reminder Reset - Procedure 24
Verano	2012	TPMS Reminder Reset - Procedure 11
Â	2013-17	TPMS Reminder Reset - Procedure 25
Cadillac		
ATS	2013-18	TPMS Reminder Reset - Procedure 11
CT6	2016-18	TPMS Reminder Reset - Procedure 11
CTS	2004-12	With RPO UH3: TPMS Reminder Reset - Procedure 9 W/O RPO UH3: TPMS Reminder Reset - Procedure 10
Â	2013-14	TPMS Reminder Reset - Procedure 9
Â	2015-18	TPMS Reminder Reset - Procedure 11
Deville	2001-05	TPMS Reminder Reset - Procedure 4
DTS	2006-11	TPMS Reminder Reset - Procedure 2
ELR	2014-16	TPMS Reminder Reset - Procedure 11
Escalade Series	2004-06	TPMS Reminder Reset - Procedure 1
Â	2008-12	TPMS Reminder Reset - Procedure 2
Â	2013-14	TPMS Reminder Reset - Procedure 9
Â	2015-18	TPMS Reminder Reset - Procedure 11
Seville	2001-04	TPMS Reminder Reset - Procedure 4
SRX	2008-11	TPMS Reminder Reset - Procedure 2

Model	Application	Procedure
Â	2012-16	TPMS Reminder Reset - Procedure 11
STS	2005-11	TPMS Reminder Reset - Procedure 3
XLR	2008	TPMS Reminder Reset - Procedure 2
XT5	2017-18	TPMS Reminder Reset - Procedure 11
XTS	2013-18	TPMS Reminder Reset - Procedure 11
Chevrolet		
Avalanche	2004-07	TPMS Reminder Reset - Procedure 1
Â	2008-11	TPMS Reminder Reset - Procedure 2
Â	2012	TPMS Reminder Reset - Procedure 3
Â	2013	TPMS Reminder Reset - Procedure 9
Aveo	2008-11	(2) TPMS Reminder Reset - Procedure 7
Bolt EV	2017	TPMS Reminder Reset - Procedure 28
Camaro	2010-11	TPMS Reminder Reset - Procedure 2
Â	2012	TPMS Reminder Reset - Procedure 11
Â	2013-15	TPMS Reminder Reset - Procedure 25
Â	2016-18	TPMS Reminder Reset - Procedure 11
Caprice	2011-13	TPMS Reminder Reset - Procedure 31
Â	2014-17	TPMS Reminder Reset - Procedure 25
Captiva Sport	2012-15	TPMS Reminder Reset - Procedure 2
City Express	2015-18	TPMS Reminder Reset - Procedure 32
Cobalt	2008-10	TPMS Reminder Reset - Procedure 3
Colorado	2006-12	TPMS Reminder Reset - Procedure 1
Â	2015-18	Base DIC TPMS Reminder Reset - Procedure 25 Uplevel DIC TPMS Reminder Reset - Procedure 11
Corvette	1987-96	(1) TPMS Reminder Reset - Procedure 20
Â	1997-04	TPMS Reminder Reset - Procedure 6
Â	2005-06	TPMS Reminder Reset - Procedure 3
Â	2007-13	TPMS Reminder Reset - Procedure 9
Â	2014-18	TPMS Reminder Reset - Procedure 8
Cruze	2011-12	TPMS Reminder Reset - Procedure 11
Â	2013-18	Base DIC TPMS Reminder Reset - Procedure 25 Uplevel DIC TPMS Reminder Reset - Procedure 11
Cruze Limited	2016	TPMS Reminder Reset - Procedure 25
Equinox	2007	TPMS Reminder Reset - Procedure 5
Â	2008-11	TPMS Reminder Reset - Procedure 2
Â	2012	TPMS Reminder Reset - Procedure 11
Â	2013-14	TPMS Reminder Reset - Procedure 25

Model	Application	Procedure
Â	2015-18	TPMS Reminder Reset - Procedure 33
Express Van	2008-12	TPMS Reminder Reset - Procedure 2
Â	2013-18	TPMS Reminder Reset - Procedure 27
HHR	2008-11	TPMS Reminder Reset - Procedure 3
Impala	2000-02	(1) TPMS Reminder Reset - Procedure 13
Â	2003-05	(1) TPMS Reminder Reset - Procedure 14
Â	2006-07	TPMS Reminder Reset - Procedure 5
Â	2008-12	TPMS Reminder Reset - Procedure 2
Â	2013	TPMS Reminder Reset - Procedure 9
Â	2014-18	TPMS Reminder Reset - Procedure 28
Impala Limited	2014-16	TPMS Reminder Reset - Procedure 9
Malibu / Classic	2008-11	TPMS Reminder Reset - Procedure 3
Â	2012	TPMS Reminder Reset - Procedure 2
Â	2013-14	TPMS Reminder Reset - Procedure 25
Â	2015-18	TPMS Reminder Reset - Procedure 28
Malibu Limited	2016	TPMS Reminder Reset - Procedure 25
Monte Carlo	2000-02	(1) TPMS Reminder Reset - Procedure 13
Â	2003-05	(1) TPMS Reminder Reset - Procedure 14
Â	2006-07	TPMS Reminder Reset - Procedure 5
Orlando (Canada)	2012	TPMS Reminder Reset - Procedure 11
Silverado Series	2006-07	TPMS Reminder Reset - Procedure 1
Â	2008-11	TPMS Reminder Reset - Procedure 2
Â	2012	TPMS Reminder Reset - Procedure 3
Â	2013	TPMS Reminder Reset - Procedure 27
Â	2014-18	TPMS Reminder Reset - Procedure 26
Sonic	2012	TPMS Reminder Reset - Procedure 11
Â	2013-18	TPMS Reminder Reset - Procedure 25
Spark	2013-15	TPMS Reminder Reset - Procedure 29
Â	2016-18	TPMS Reminder Reset - Procedure 25
Spark EV	2014-16	TPMS Reminder Reset - Procedure 30
SS	2014-17	TPMS Reminder Reset - Procedure 25
Suburban	2004-07	TPMS Reminder Reset - Procedure 1
Â	2008-11	TPMS Reminder Reset - Procedure 2
Â	2012	TPMS Reminder Reset - Procedure 3
Â	2013-14	TPMS Reminder Reset - Procedure 9
Â	2015-18	TPMS Reminder Reset - Procedure 26
Tahoe	2004-07	TPMS Reminder Reset - Procedure 1
Â	2008-11	TPMS Reminder Reset - Procedure 2
Â	2012	TPMS Reminder Reset - Procedure 3
Â	2013-14	TPMS Reminder Reset - Procedure 9

Model	Application	Procedure
Â	2015-18	TPMS Reminder Reset - Procedure 26
TrailBlazer	2006-07	TPMS Reminder Reset - Procedure 1
Traverse	2009-12	TPMS Reminder Reset - Procedure 2
Â	2013-18	TPMS Reminder Reset - Procedure 9
Trax	2015-18	TPMS Reminder Reset - Procedure 25
Uplander	2008	TPMS Reminder Reset - Procedure 3
Volt	2011-12	TPMS Reminder Reset - Procedure 11
Â	2013-15	TPMS Reminder Reset - Procedure 30
Â	2016-18	TPMS Reminder Reset - Procedure 11
GMC		
Acadia	2007-11	TPMS Reminder Reset - Procedure 3
Â	2012	TPMS Reminder Reset - Procedure 2
Â	2013-16	TPMS Reminder Reset - Procedure 9
Â	2017-18	TPMS Reminder Reset - Procedure 11
Acadia Limited	2017	TPMS Reminder Reset - Procedure 9
Canyon	2006-12	TPMS Reminder Reset - Procedure 1
Â	2015-18	TPMS Reminder Reset - Procedure 34
Envoy	2006-09	TPMS Reminder Reset - Procedure 1
Savana Series	2008-12	TPMS Reminder Reset - Procedure 2
Â	2013-18	TPMS Reminder Reset - Procedure 27
Sierra Series	2006-07	TPMS Reminder Reset - Procedure 1
Â	2008-11	TPMS Reminder Reset - Procedure 2
Â	2012	TPMS Reminder Reset - Procedure 3
Â	2013	TPMS Reminder Reset - Procedure 9
Â	2014-18	TPMS Reminder Reset - Procedure 26
Terrain	2010-11	TPMS Reminder Reset - Procedure 2
Â	2012-18	TPMS Reminder Reset - Procedure 12
Yukon Series	2004-07	TPMS Reminder Reset - Procedure 1
Â	2008-11	TPMS Reminder Reset - Procedure 2
Â	2012	TPMS Reminder Reset - Procedure 3
Â	2013-14	TPMS Reminder Reset - Procedure 9
Â	2015-18	TPMS Reminder Reset - Procedure 26
Oldsmobile		
Alero	1999-00	(1) TPMS Reminder Reset - Procedure 16
Aurora	2001-03	(1) TPMS Reminder Reset - Procedure 17
Pontiac		
Aztek	2003-05	(1) TPMS Reminder Reset - Procedure 23
Bonneville	2000-05	(1) TPMS Reminder Reset - Procedure 15
G3	2009	TPMS Reminder Reset - Procedure 2
G5	2008-10	TPMS Reminder Reset - Procedure 2

Model	Application	Procedure
G6	2008-10	TPMS Reminder Reset - Procedure 2
G8	2008-09	TPMS Reminder Reset - Procedure 2
Grand Am	1999-05	(1) TPMS Reminder Reset - Procedure 18
Grand Prix	2008	TPMS Reminder Reset - Procedure 2
Solstice	2008-10	TPMS Reminder Reset - Procedure 2
Torrent	2008-09	TPMS Reminder Reset - Procedure 2
Wave	2008	TPMS Reminder Reset - Procedure 2
Vibe	2005-10	(1) TPMS Reminder Reset - Procedure 19

(1) This is an Indirect TPM System. A tire sensor activation tool is not required for this procedure.

(2) A tire sensor activation tool cannot be used for this procedure.

TPMS REMINDER RESET - PROCEDURE 1

NOTE: **When the wheels have been rotated, or a tire pressure sensor or EGM/LGM has been replaced, retrain tire pressure sensors.**

NOTE: **The DIC will display the "SERVICE TIRE MONITOR" message if one or more of the tire pressure sensors has malfunctioned or if all of the sensors have not been programmed successfully. If, after the relearn procedure, the warning indicators are still on, there is a problem in the TPM system.**

NOTE: **If this procedure is performed following replacement and reprogramming of the Liftgate Module (LGM), DIC may display a low tire pressure fault and all tire pressures read 0 psi. If this problem occurs, see appropriate manufacturer service information.**

NOTE: **The TPM system will cancel the learn mode if more than 2 minutes have passed and no sensors have been learned, or if the system has been in learn mode for more than 5 minutes. If the learn mode is canceled before any sensor has been learned, the EGM/LGM will remember all current sensor IDs and their locations. As soon as the first sensor ID code is learned, all other IDs are erased from the EGM/LGM's memory. On models that display the individual tire pressure on DIC, updated tire pressures will not be displayed until EGM/LGM receives 2 more valid transmissions from each sensor.**

NOTE: **Before proceeding with the steps below, ensure that no other sensor learn procedure is being performed simultaneously, or that tire pressures are not being adjusted on a TPM equipped vehicle within close proximity.**

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF. Apply parking brake.

NOTE: **If Learn Mode cannot be enabled, TPM system is not enabled in EGM/LGM. See appropriate manufacturer service information.**

3. To enable Learn Mode, turn headlight switch from OFF to parking lamps 4 times within 4 seconds. A double horn chirp will sound and the low tire pressure indicator will begin to flash to indicate the learn mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, turn ignition switch to OFF position to exit Learn Mode.
7. Test drive the vehicle above 25 mph for at least 2 minutes before viewing tire pressures on DIC.

TPMS REMINDER RESET - PROCEDURE 2

NOTE: **If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be retrained.**

NOTE: **When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.**

NOTE: **Under the following conditions, the TPM system may not function properly:**

- **If one or more of the tire pressure sensors are missing or inoperable.**
- **A compact spare tire is used.**

NOTE: **If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be retrained.**

NOTE: **The relearn procedure must be completed within 15 minutes from when the vehicle is stationary after being driven at 20 mph (32 km/h), or greater, for 10 seconds.**

NOTE: **The learn mode will cancel if the ignition is cycled to OFF or if more than 2 minutes has elapsed for any sensor that has not been learned. If the learn mode is cancelled before the first sensor is learned, the original sensor IDs will be maintained. If the learn mode is canceled after the first sensor is learned, the following will occur:**

- **All stored sensor IDs will be invalidated in the RCDLR memory.**
- **If equipped, the DIC will display dashes instead of tire pressures.**
- **DTC C0775 will be set.**

These conditions will now require the learn procedure to be repeated for the system to function properly.

IMPORTANT: Ensure that no other learn procedure is being performed simultaneously or that tire pressures are not being adjusted on another TPM equipped vehicle within close proximity. Stray signals from other TPM equipped vehicles just driving by can be inadvertently learned. If any random horn chirps are heard from the vehicle while performing the learn procedure, most likely a stray sensor has been learned and the procedure will need to be cancelled and repeated. Under these circumstances, performing the TPM Learn Procedure away from other vehicles would be highly recommended. In the event a particular sensor activation does not cause the horn to chirp, it may be necessary to rotate the wheel valve stem to a different position due to the sensor signal is being blocked by another component.

1. Turn ignition switch to ACC position. Apply parking brake.
2. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
3. To enable Learn Mode:
   - On vehicles equipped with keyless entry, simultaneously press the keyless entry transmitters lock and unlock buttons until a double horn chirp sounds indicating the Learn Mode has been enabled. On vehicles with DIC, a TIRE LEARN message may be displayed. The left front turn signal will also be illuminated.
   - On vehicles not equipped with keyless entry, press and release the driver information center (DIC) INFO button until the TIRE LEARN message appears on the DIC display. Press and hold the SET/RESET button until a double horn chirp sounds indicating the Learn Mode has been enabled. The left front turn signal will also be illuminated.
4. Ignition ON.
5. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
6. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
7. After left rear sensor has been learned, turn ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 3

NOTE: **If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.**

NOTE: **When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.**

NOTE: **In vehicles without the "UH3" option, each turn signal will illuminate one at a time indicating which location is to be learn.**

NOTE: **The TPM system will cancel the learn mode if more then 2 minutes have passed and no sensors have been learned, or if the ignition switch is turn to the OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.**

NOTE: **Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.**

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition switch to ACC position. Apply parking brake.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the Learn Mode has been enabled.

   NOTE: **The left front turn signal will also illuminate to indicate the learn mode has been enabled.**

4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 4

NOTE: **If the wheels have been rotated, or tire pressure sensor or Remote Control Door Lock Receiver (RCDLR) is replaced, the TPM system needs to relearn tire pressure sensor IDs.**

NOTE: **When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on, there is a problem in the TPM system. See appropriate manufacturer service information.**

NOTE: **The TPM system will cancel Learn Mode if ignition is turned off, if more than 1 or 2 minutes has passed and no sensors have been learned, vehicle battery voltage is less than 8 volts, all 4 sensors have been learned, or if the RCDLR has been in Learn Mode for more than 5 minutes. If Learn Mode is cancelled before any IDs are learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory.**

NOTE: **Before proceeding with the registration procedure, ensure that no other sensor**

learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF.

NOTE: **If the TPM Learn Mode cannot be enabled, ensure the TPM option is enabled in the RCDLR. See appropriate manufacturer service information.**

3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a horn chirp sounds, indicating Learn Mode has been enabled.

NOTE: **If a horn chirp does not sound after 15 seconds, remove, then re-apply TPM sensor relearn magnet.**

4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After the horn chirp sounds, proceed to the next 3 sensors in the following order: right front, right rear, then left rear.
6. After the left rear sensor ID is learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn the ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 5

NOTE: **If the wheels have been rotated, or tire pressure sensor or Remote Control Door Lock Receiver (RCDLR) is replaced, the TPM system needs to relearn tire pressure sensor IDs.**

NOTE: **When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on, there is a problem in the TPM system. See appropriate manufacturer service information.**

NOTE: **The TPM system will cancel Learn Mode if ignition is turned off, if more than 1 or 2 minutes has passed and no sensors have been learned, vehicle battery voltage is less than 8 volts, all 4 sensors have been learned, or if the RCDLR has been in Learn Mode for more than 5 minutes. If Learn Mode is cancelled before any IDs are learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory.**

NOTE: **Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.**

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF.

3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a horn chirp sounds, indicating Learn Mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After the horn chirp sounds, proceed to the next 3 sensors in the following order: right front, right rear, then left rear.
6. After the left rear sensor ID is learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn the ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 6

NOTE: **If the wheels have been rotated, or tire pressure sensor or Remote Control Door Lock Receiver (RCDLR) is replaced, the TPM system needs to relearn tire pressure sensor IDs.**

NOTE: **When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on, there is a problem in the TPM system. See appropriate manufacturer service information.**

NOTE: **The TPM system will cancel Learn Mode if ignition is turned off, if more than 1 or 2 minutes has passed and no sensors have been learned, vehicle battery voltage is less than 8 volts, all 4 sensors have been learned, or if the RCDLR has been in Learn Mode for more than 5 minutes. If Learn Mode is cancelled before any IDs are learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory.**

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition ON with engine OFF.
3. Press RESET button on DIC in order to clear any warning messages.
4. Press and release OPTIONS button until display is blank.
5. Press and hold RESET button for 3 seconds.

NOTE: **If the DIC does not display "TIRE TRAINING" message, ensure TPM option is enabled in the RCDLR. See appropriate manufacturer service information.**

6. Press and release OPTIONS button until "TIRE TRAINING" is displayed.
7. Press and release RESET button. The DIC should display "LEARN L FRONT TIRE", verifying Learn Mode has been enabled.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After the horn chirp sounds, proceed to the next 3 sensors in the following order: right front, right rear, then left rear.
10. Turn the ignition switch to OFF position to exit the learn mode.

TPMS REMINDER RESET - PROCEDURE 7

NOTE: **An OEM scan tool or Pressure Increase/Decrease Method is used to perform this procedure.**

NOTE: **Before proceeding with this process, ensure that no other learn procedure is being performed simultaneously or that tire pressures are not being adjusted on another TPM equipped vehicle within close proximity. Stray signals from other TPM equipped vehicles just driving by can be inadvertently learned. If any random horn chirps are heard from the vehicle while performing the learn procedure, most likely a stray sensor has been learned and the procedure will need to be cancelled and repeated. Under these circumstances, performing the TPM Learn Procedure away from other vehicles would be highly recommended. In the event a particular sensor activation does not cause the horn to chirp, it may be necessary to rotate the wheel valve stem to a different position due to the sensor signal is being blocked by another component.**

1. Ignition ON with engine OFF, apply the parking brake.
2. Using a scan tool, initiate the TPM Learn Mode.
3. Perform the procedure by following the menu selections. A double horn chirp will sound and the IPC tire pressure monitor indicator warning lamp icon will flash indicating Learn Mode is enabled.
4. Starting with the left front tire, active the sensors by one of the following methods:
   - Hold the antenna of the scan tool, aimed upward, against the tire sidewall close to the wheel rim at the valve stem location. Press and release the activate button and wait for a horn chirp. Once the horn chirp has sounded, the sensor information is learned.
   - Increase/decrease the tire pressure for 8-10 seconds then wait for a horn chirp. The horn chirp may occur before or up to 30 seconds after the 8-10 second pressure increase/decrease time period has been reached. Once the horn chirp has sounded, the sensor information has been learned.
5. After the horn chirp has sounded, repeat step 4 for the remaining 3 sensors in the following order: Right front, Right rear, Left rear.
6. After the left rear sensor is learned, a double horn chirp will sound indicating all sensor IDs have been learned and the tire pressure module will exit the Learn mode turning OFF the IPC tire pressure monitor warning indicator lamp icon.
7. Ignition OFF, adjust all tires to the recommended pressures. Refer to the tire placard label.

TPMS REMINDER RESET - PROCEDURE 8

Automatic Sensor Learn Process

Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the tires or replacing one or more of the TPMS sensors. When a tire is installed, the vehicle must be stationary for about 20 minutes before the system recalculates. The following relearn process takes up to 10 minutes, driving at a minimum speed of 12 mph (19 km/h). A dash (-) or pressure value will display in the DIC. A warning message displays in the DIC if a problem occurs during the relearn process.

TPMS REMINDER RESET - PROCEDURE 9

NOTE: **For Cadillac CTS with RPO UH3, use this procedure. For CTS without RPO UH3, see Procedure 10.**

NOTE: **If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.**

NOTE: **When the tire pressure warning light illuminates and warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.**

NOTE: **The TPM system will cancel the learn mode if more then 2 minutes have passed and no sensors have been learned, or if the ignition switch is turn to the OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.**

NOTE: **Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.**

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition switch to RUN position. Apply parking brake.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the Learn Mode has been enabled. On some models, a TIRE LEARNING ACTIVE message may also be displayed on the DIC screen.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 10

NOTE: **For Cadillac CTS without RPO UH3, use this procedure. For CTS with RPO UH3, see Procedure 9.**

NOTE: **If a tire pressure sensor or the Remote Control Door Lock Receiver (RCDLR) is replaced, or if wheels have been rotated, tire pressure sensor must be relearned.**

NOTE: **When the tire pressure warning light illuminates and warning message appears**

on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning indicators are still on or display shows dashes instead of a value, there is a problem in the TPM system. See appropriate manufacturer service information.

NOTE: **The TPM system will cancel the learn mode if more then 2 minutes have passed and no sensors have been learned, or if the ignition switch is turn to the OFF position. If the learn mode is canceled before the first ID is learned, the RCDLR will remember all previously stored IDs and their locations. As soon as the first sensor ID is learned, all other IDs are erased from the RCDLR's memory. If the learn mode is canceled after the first ID is learned, the RCDLR will store the IDs as invalid and the DIC will display dashes instead of tire pressures.**

NOTE: **Before proceeding with the registration procedure, ensure that no other sensor learn procedure is being performed simultaneously, or that no tire pressures are being adjusted on another TPM equipped vehicle within close proximity.**

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Depending on ignition type:
   - With standard ignition switch, place the switch in the RUN position.
   - With electronic keyless ignition, place the switch in the ACC position.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a double horn chirp sounds, indicating the Learn Mode has been enabled.
4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 11

NOTE: **This procedure is for vehicles with an Uplevel DIC.**

When a low tire pressure condition is detected, the TPMS illuminates the low tire pressure warning light on the instrument cluster. A message to check the pressure in a specific tire displays in the Driver Information Center (DIC). The low tire pressure warning light and the DIC warning message come on at each ignition cycle until the tires are inflated to the correct inflation pressure. Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the vehicle's tires or replacing one or more of the TPMS sensors. The TPMS sensor matching process should also be performed after replacing a spare tire with a road tire containing the TPMS sensor. The malfunction light and the DIC message should go off at the next ignition cycle. The sensors are matched to the tire/wheel positions, using a TPMS relearn tool.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Place the vehicle power mode in ON/RUN/START.

4. Make sure the Tire Pressure info display option is turned on. The info displays on the DIC can be turned on and off through the Settings menu.
5. Use the five-way DIC control on the right side of the steering wheel to scroll to the Tire Pressure screen under the DIC info page.
6. Press and hold the SEL button located in the center of the five-way DIC control. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen
7. Start with the driver side front tire. Place a tire sensor activation tool against the tire sidewall, near the valve stem. Then press the button to activate the TPMS sensor. A horn chirp confirms that the sensor identification code has been matched to this tire and wheel position.
8. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
9. After left rear sensor has been learned, the horn sounds two times to indicate the sensor identification code has been matched to the driver side rear tire, and the TPMS sensor matching process is no longer active. The TIRE LEARNING ACTIVE message on the DIC display screen goes off.
10. Press STOP to turn the ignition off.

TPMS REMINDER RESET - PROCEDURE 12

If refilling a low tire, no specific reset procedure is required. All warnings are extinguished once the TPMS receives a signal that all tires are properly inflated.

Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the tires or replacing one or more of the TPMS sensors. The TPMS sensor matching process should also be performed after replacing a spare tire with a road tire containing the TPMS sensor. The malfunction light and the DIC message should go off at the next ignition cycle. The sensors are matched to the tire/ wheel positions, using a TPMS relearn tool.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine off.
4. Use the MENU button (center console) to select the Vehicle Information Menu in the Driver Information Center (DIC). Use the arrow keys to scroll to the Tire Pressure screen
5. Press the SET/CLR button to begin the sensor matching process. A message requesting acceptance of the process should display.
6. Press the SET/CLR button again to confirm the selection. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
7. Start with the driver side front tire. Place a tire sensor activation tool against the tire sidewall, near the valve stem. Then press the button to activate the TPMS sensor. A horn chirp confirms that the sensor identification code has been matched to this tire and wheel position.
8. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
9. After left rear sensor has been learned, the horn sounds two times to indicate the sensor identification code has been matched to the driver side rear tire, and the TPMS sensor matching process is no longer active. The TIRE LEARNING ACTIVE message on the DIC display screen goes off.

10. Turn the ignition to LOCK/OFF.

TPMS REMINDER RESET - PROCEDURE 13

LOW TIRE PRESSURE light comes on if air pressure in one tire drops to 12 psi (kPa) less than the other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, if air pressure is adjusted or when vehicle battery is disconnected. Light will stay on until ignition is turned off or RESET button is pressed. Check and adjust air pressure in all 4 tires before resetting system.

1. There are 2 ways to reset the tire inflation monitor. To reset the tire inflation monitor using the exterior or interior lamp controls, go to step 4. To reset tire inflation monitor using the radio, turn the radio off. Turn ignition to ACC or ON, with the engine OFF. Press and hold the TUNE DISP button on the radio for at least 5 seconds until settings is displayed.
2. To scroll through the main menu:
   - On Impala, press the SEEK PTYPE up or down arrow.
   - On Monte Carlo, press the SEEK PSCAN up or down arrow.

   On all models, scroll until TIRE MON appears on the display. Press the 1 PREV or 2 NEXT button to enter the sub-menu. RESET will be displayed.
3. Press the TUNE DISP button to reset. A chime will sound to verify the new setting and DONE will be displayed for one second. Once the message has been reset, scroll through the menu until EXIT appears on the display. Press the TUNE DISP button to exit the program. A chime will sound to verify the exit.
4. Reset the tire inflation monitor:
   - On Impala, using the interior lighting controls, turn the switch from OFF to ON position 3 times with ignition switch in ON position.
   - On Monte Carlo, using the exterior lighting controls, turn the switch from OFF to parking lamps 3 times with ignition switch in ON position.

TPMS REMINDER RESET - PROCEDURE 14

NOTE: **There are 3 different ways to reset the Tire Pressure Monitor (TPM) system. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the 3 speed ranges to complete the calibration process.**

Using Exterior Lamp Switch

1. Adjust all tire pressures to the recommended kPa/psi.
2. Turn ignition ON with engine OFF.
3. Cycle the exterior lamp switch from OFF to parking lamps 3 times within 5 seconds.
4. Use the scan tool in order to clear the TPM DTC.

Using RDS Radio, If Equipped

1. Adjust all tire pressures to the recommended kPa/psi.
2. Turn the ignition to ACC or ON, with the engine OFF.
3. Turn the radio OFF.
4. Press and hold the DISP button until SETTINGS is displayed.

5. Press the SEEK up or down arrows until TIRE MON is displayed.
6. Press the PREV or NEXT button to enter the sub-menu. RESET will be displayed.
7. Press the DISP button, A chime will sound and DONE will be displayed.
8. Scroll until EXIT is displayed.
9. Press the DISP button to exit the TPM reset mode. A chime will sound to verify exit.
10. Use the scan tool in order to clear the TPM DTC.

Using Scan Tool

1. Adjust all tire pressures to the recommended kPa/psi.
2. Install the scan tool.
3. Turn ignition ON with engine OFF.
4. With the scan tool select Special Functions.
5. Select TIM Reset.
6. Press the Reset soft key.
7. Use the scan tool in order to clear the TPM DTC.

TPMS REMINDER RESET - PROCEDURE 15

CHECK TIRE PRESSURE or TIRE PRESS message will come on if air pressure in one tire is lower than the other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, or if air pressure is adjusted. Message will stay on until system is recalibrated. Check and adjust air pressure in all 4 tires before recalibrating system.

NOTE: **If vehicle is equipped with Systems Monitor, go to step 2.**

1. To recalibrate vehicle equipped with Driver Information Center (DIC), turn ignition ON with engine OFF. Using the MODE and SELECT button on DIC, change display until TIRE PRESSURE appears. Press and hold RESET button for 5 seconds. TIRE PRESSURE RESET should now appear on display. If TIRE PRESSURE RESET does not appear on display after 5 seconds, repair system as necessary. Using a scan tool, clear TPM DTC.
2. To recalibrate vehicle equipped with Systems Monitor, turn ignition ON with engine OFF. Press and hold TIRE PRESS RESET button for 5 seconds. TIRE PRESS light on the Systems Monitor should begin to flash. Release the TIRE PRESS RESET button. TIRE PRESS light should go out and system is now reset. If TIRE PRESS light does not begin to flash after 5 seconds, repair system as necessary. Using a scan tool, clear TPM DTC.

TPMS REMINDER RESET - PROCEDURE 16

CHECK TIRE PRESSURE light comes on if air pressure in one tire drops to 12 psi (kPa) less than the other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, or if air pressure is adjusted. Light will stay on until ignition is turned off or RESET button is pressed. Check and adjust air pressure in all 4 tires before resetting system.

1. To reset tire inflation monitor, turn ignition ON with engine OFF. Press and release the RESET button. RESET button is located inside of driver's side instrument panel fuse block (left end of instrument panel). The CHANGE OIL indicator light will begin to flash.

2. Press and release the RESET button again. The CHANGE OIL indicator light will turn off, and the CHECK TIRE PRESSURE indicator light will begin to flash. While the CHECK TIRE PRESSURE indicator light is flashing, press and hold the RESET button until the chime sounds indicating system is reset. If CHECK TIRE PRESSURE light does not go out, repeat reset procedure. If system still will not reset, repair system as necessary.

TPMS REMINDER RESET - PROCEDURE 17

NOTE: **When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.**

NOTE: **When the low tire pressure warning messages appear, immediately check air pressure of all tires and adjust to the specified pressure. If warning messages are still displayed, there is a malfunction in the TPM system. See appropriate manufacturer service information.**

NOTE: **Under the following conditions, the system may not function properly:**

- **More than one tire is low.**
- **Only one tire is replaced with a new tire during service.**
- **Vehicle is moving faster than 65 mph (105 km/h).**
- **The system is not yet calibrated.**
- **Tire treadwear is uneven.**
- **Compact spare tire is installed.**
- **Tire chains are being used.**
- **Vehicle is being driven on a rough or frozen road.**
- **If ABS warning light is on.**

CAUTION: **DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.**

NOTE: **There are 2 ways to recalibrate the Tire Pressure Monitor (TPM) system:**

- ***Using DIC Reset Button*** **(if no scan tool is available)**
- ***Using Scan Tool*** **(if an OBD-II compatible scan tool is available).**

Using DIC Reset Button

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press SELECT right arrow button until "GAGE" is displayed.

5. Press SELECT down arrow button until "TIRE PRESSURE" is displayed.
6. Press and hold RESET button until "TIRE PRESSURE RESET" is displayed.
7. Release RESET button. DIC should display "TIRE PRESSURE NORMAL".
8. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
    - 15-40 mph (24-64 km/h).
    - 40-70 mph (64-113 km/h).
    - 70-90 mph (113-145 km/h).

NOTE: **The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.**

NOTE: **Learning process does not need to be completed during a single trip.**

Using Scan Tool

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Connect scan tool. Turn ignition ON with engine OFF.
4. Using scan tool, select "SPECIAL FUNCTIONS".
5. Select "TIRE PRESSURE RESET".
6. Press RESET soft key. A "TIRE PRESSURE NORMAL" message should appear on display.
7. If necessary, use scan tool to clear any TPM Diagnostic Trouble Codes (DTCs).
8. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
    - 15-40 mph (24-64 km/h).
    - 40-70 mph (64-113 km/h).
    - 70-90 mph (113-145 km/h).

NOTE: **The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.**

NOTE: **Learning process does not need to be completed during a single trip.**

TPMS REMINDER RESET - PROCEDURE 18

The Tire Pressure Monitor (TPM) system alerts the driver when a large change in the pressure of one tire exists,

while the vehicle is being driven. The TPM system uses the Electronic Brake Control Module (EBCM), ABS wheel speed sensor inputs, class 2 serial data circuit, and the Driver Information Center (DIC) to perform the system functions. The EBCM contains software to calculate relative tire pressure differences. The software requires approximately 30 minutes of straight line driving in 3 different speed ranges to complete the calibration process to have full capability for detecting a tire pressure condition. The speed ranges are 15-40 mph, 40-70 mph and 70-90 mph.

1. LOW TIRE PRESSURE light comes on if air pressure in one tire drops to 12 psi less than the other 3 tires, if tires are rotated, if tire(s) are repaired or replaced, if air pressure is adjusted or if vehicle battery is disconnected. Light will stay on until ignition is turned off or RESET button is pressed. Check and adjust air pressure in all 4 tires before resetting system.
2. To reset tire inflation monitor, turn ignition ON with engine OFF. Press and release the RESET button. RESET button is located inside of driver's side instrument panel fuse block (left end of instrument panel). The CHANGE OIL indicator light will begin to flash.
3. Press and release the RESET button again. The CHANGE OIL indicator light will turn off, and the LOW TIRE PRESSURE indicator light will begin to flash. While the LOW TIRE PRESSURE indicator light is flashing, press and hold the RESET button until the chime sounds indicating system is reset. If the LOW TIRE PRESSURE indicator light does not go out, repeat reset procedure. If system still will not reset, repair system as necessary.

TPMS REMINDER RESET - PROCEDURE 19

NOTE: **After resetting, the tire pressure monitoring (TPM) system requires 60 minutes or more of driving at a speed of 30 km/h (19 mph) or above to complete the calibration process to have full capability for detecting a tire pressure condition.**

1. Adjust all tire pressures to the recommended kPa/psi.
2. Turn ignition ON with engine OFF.
3. Press and hold the tire pressure warning reset switch until the tire pressure warning indicator blinks 3 times at one second intervals.
4. If the tire pressure warning indicator does not blink, repeat the procedure starting at step 2.
5. Drive the vehicle for 60 minutes or more at a speed of 30 km/h (19 mph).
6. Verify the system has initialized. Turn ignition ON with engine OFF and observe the tire pressure warning indicator.
    - System Initialized: light on for 3 seconds.
    - System not initialized: light on for 4 seconds.

TPMS REMINDER RESET - PROCEDURE 20

NOTE: **When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.**

CAUTION: **DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a**

tire pressure is low or high.

NOTE: **When the tire pressure warning message appears on DIC, immediately check air pressure of all tires and adjust to the specified pressure. If warning message is still displayed, there is a malfunction in the TPM system. See appropriate manufacturer service information.**

NOTE: **Under the following conditions, the system may not function properly:**

- **More than one tire is low.**
- **Vehicle is moving faster than 65 mph (105 km/h).**
- **The system is not yet calibrated.**
- **Tire treadwear is uneven.**
- **Compact spare tire is installed.**
- **Tire chains are being used.**
- **Vehicle is being driven on a rough or frozen road.**
- **If ABS warning light is on.**

NOTE: **There are 2 ways to recalibrate the Tire Pressure Monitor (TPM) system:**

- ***Using DIC Reset Button*** **(if no scan tool is available)**
- ***Using Scan Tool*** **(if an OBD-II compatible scan tool is available).**

Using DIC Reset Button

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press and hold appropriate button (located on left side of steering column) until "TIRE PRESSURE" message appears on display:
   - 1997-99 models: Press and hold GAGES button
   - 2000-05 models: Press and hold GAGES INFO button
5. Press and hold RESET button for 5 seconds. After 5 seconds, "TIRE PRESSURE RESET" message should appear on display.
6. Release RESET button. A "TIRE PRESSURE NORMAL" message should appear on display.
7. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
   - 15-40 mph (24-64 km/h).
   - 40-70 mph (64-113 km/h).
   - 70-90 mph (113-145 km/h).

NOTE: **The EBCM learns tire pressure calibration for each speed range**

independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.

NOTE: **Learning process does not need to be completed during a single trip.**

Using Scan Tool

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Connect scan tool. Turn ignition ON with engine OFF.
4. Using scan tool, select SPECIAL FUNCTIONS.
5. Select TIM RESET.
6. Press RESET soft key. A "TIRE PRESSURE NORMAL" message should appear on display.
7. If necessary, use scan tool to clear any TPM Diagnostic Trouble Codes (DTCs).
8. After resetting, the TPM system requires up to 30 minutes of straight line driving in each of the following speed ranges to complete calibration process:
   - 15-40 mph (24-64 km/h).
   - 40-70 mph (64-113 km/h).
   - 70-90 mph (113-145 km/h).

NOTE: **The EBCM learns tire pressure calibration for each speed range independently. In Monitor Mode 1, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Monitor Mode 2, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.**

NOTE: **Learning process does not need to be completed during a single trip.**

TPMS REMINDER RESET - PROCEDURE 21

Using Reset Button (1999-05 Models)

1. Adjust all tire pressures to the recommended Psi (kPa). See vehicle's Loading Information Label for recommended tire pressure. Turn ignition ON with engine OFF.
2. Press and hold the red RESET button located in the passenger side instrument panel fuse block.
3. The LOW TIRE indicator will flash 3 times, then turn off.
4. Use scan tool to clear the TPM DTC.

Using Scan Tool (2003-05 Models)

1. Adjust all tire pressures to the recommended Psi (kPa). See vehicle's Loading Information Label for recommended tire pressure. Turn ignition ON with engine OFF.

2. Install scan tool. Turn ignition ON with engine OFF.
3. With scan tool, select Special Functions.
4. Select TIM Reset.
5. Press Reset soft key.
6. LOW TIRE indicator will flash 3 times, then turn OFF.
7. Clear the TPM DTC.

TPMS REMINDER RESET - PROCEDURE 22

NOTE: **When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.**

CAUTION: **DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.**

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press and hold the MODE button until DIC display reads "LOW TIRE PRESSURE HOLD SET TO RESET".
5. Press and hold SET button chime sounds and "TIRE PRESSURE RESET" is displayed and a chime sounds 3 times.
6. Release SET button and DIC will display "TIRE PRESSURE NORMAL".

NOTE: **If low tire pressure warning message is still set, TPM system has not reset. Repeat procedure. If it does not work after two tries, refer to appropriate service information.**

7. After resetting, the TPM system requires up to 5 miles of driving in each of the following speed ranges to complete the calibration process:
   - 25-40 mph (40-64 km/h).
   - 40-60 mph (65-96 km/h).
   - 60-85 mph (96-136 km/h).

NOTE: **Learning process does not need to be completed during a single trip.**

TPMS REMINDER RESET - PROCEDURE 23

1. Check and adjust air pressure in all 4 tires before resetting system. Refer to tire placard located on the inside edge of the driver's door. Turn ignition ON, with engine OFF.
2. Press the MODE button on the Driver Information System until LOW TIRE PRESSURE HOLD SET TO RESET is displayed.
3. Press and hold the SET button until a chime sounds and TIRE PRESSURE RESET is displayed and a

chime sounds 3 times.

4. Release the SET button and TIRE PRESSURE NORMAL will be displayed.

TPMS REMINDER RESET - PROCEDURE 24

NOTE: **When a spare tire is mounted, a wheel is replaced or rotated, or tire pressure has been adjusted, TPM system will need to be recalibrated.**

CAUTION: **DO NOT recalibrate TPM system until all problems are fixed and tire pressure in all 4 tires has been adjusted. If recalibration is done when tire pressures are incorrect, TPM system will not work properly and may not set an alert when a tire pressure is low or high.**

1. Turn ignition switch to OFF position.
2. Ensure all tire pressures are adjusted to the pressure recommended on tire pressure label.
3. Turn ignition ON with engine OFF.
4. Press and hold the MODE button until DIC display reads "LOW TIRE PRESSURE HOLD SET TO RESET".
5. Press and hold SET button until a chime sounds and "TIRE PRESSURE RESET" is displayed.
6. System will now sound a chime 3 times, and DIC will display "TIRE PRESSURE NORMAL".

   NOTE: **If low tire pressure warning message is still set, TPM system has not reset. Repeat procedure.**

7. After resetting, the TPM system requires up to 5 miles (8 km) of flat, smooth road, straight line driving in each of the 4 speed ranges (about 10-20 minutes in each range) to complete the calibration process:
   - 19-40 mph (31-65 km/h).
   - 40-59 mph (65-95 km/h).
   - 59-74.5 mph (95-120 km/h).
   - 74.5-90 mph (120-145 km/h).

   NOTE: **The EBCM learns tire pressure calibration for each speed range independently. In Calibration Mode, EBCM has only partially learned tire pressure calibration for speed range and has limited detection capability for a tire pressure condition. In Detection Mode, EBCM has fully learned tire pressure calibration for speed range and has full detection capability for a tire pressure condition.**

   NOTE: **Learning process does not need to be completed during a single trip.**

TPMS REMINDER RESET - PROCEDURE 25

NOTE: **This procedure is for vehicles with a Base DIC.**

If refilling a low tire, no specific reset procedure is required. All warnings are extinguished once the TPMS receives a signal that all tires are properly inflated.

Each TPMS sensor identification code needs to be matched to a new tire/wheel position after rotating the vehicle's tires or replacing one or more of the TPMS sensors. The TPMS sensor matching process should also be performed after replacing a spare tire with a road tire containing the TPMS sensor. The malfunction light and the DIC message should go off at the next ignition cycle. The sensors are matched to the tire/wheel positions using a TPMS relearn tool. There are two minutes to match the first tire/wheel position, and five minutes overall to match all four tire/wheel positions. If it takes longer, the matching process stops and must be restarted.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/ RUN with the engine OFF or place the vehicle power mode in ON/ RUN/ START. See **Fig. 7**.
4. Use the MENU button to select the VEHICLE INFORMATION MENU in the Driver Information Center (DIC). See **Fig. 8**.
5. Use the thumbwheel (or up and down arrows) to scroll to the TIRE PRESSURE MENU item screen.
6. Press the SET/CLR button to begin the sensor matching process. A message requesting acceptance of the process should display.
7. Press the SET/CLR button again to confirm the selection. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

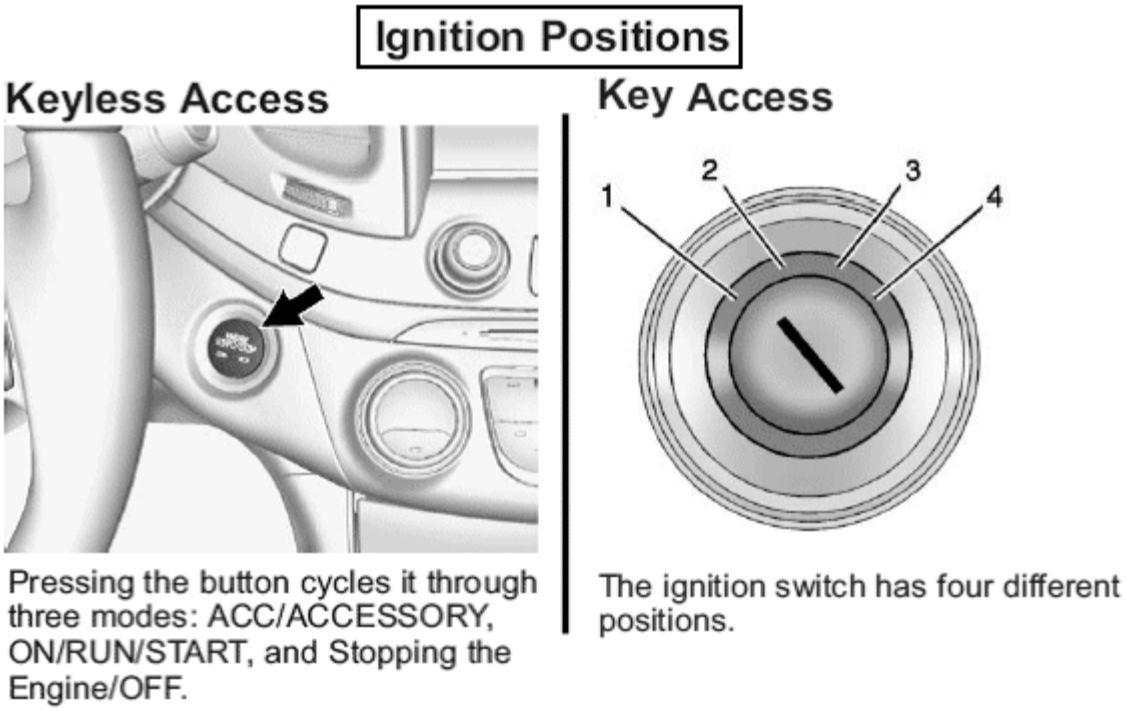


Fig. 7: Ignition Positions (Key & Keyless)
Courtesy of GENERAL MOTORS CORP.

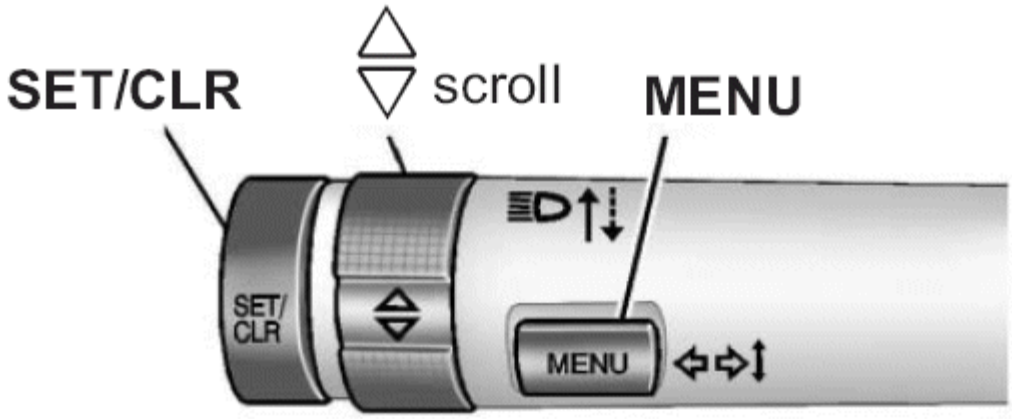


Fig. 8: Identifying DIC Controls (Turn Signal Lever)
Courtesy of GENERAL MOTORS CORP.

TPMS REMINDER RESET - PROCEDURE 26

If refilling a low tire, no specific reset procedure is required. All warnings are extinguished once the TPMS receives a signal that all tires are properly inflated.

Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the tires or replacing one or more of the TPMS sensors. The TPMS sensor matching process should also be performed after replacing a spare tire with a road tire containing the TPMS sensor. The malfunction light and the DIC message should go off at the next ignition cycle. The sensors are matched to the tire/ wheel positions, using a TPMS relearn tool.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine OFF.
4. Up-level Driver Information Center (DIC) Only: Make sure the TIRE PRESSURE INFO page option is turned on. The info pages on the DIC can be turned on and off through the SETTINGS menu.
5. - **Up-Level DIC** : Use the DIC controls (arrow buttons) on the right side of the steering wheel to scroll to the TIRE PRESSURE screen under the DIC info page.
   - **Base-Level DIC** : Use the TRIP ODOMETER RESET stem to scroll to the TIRE PRESSURE screen.
6. - **Up-Level DIC** : Press and hold the SET/RESET button (check-mark symbol) located in the center of the DIC controls.
   - **Base-Level DIC** : Press and hold the TRIP ODOMETER RESET stem for about five seconds. A message asking if the process should begin should appear. Select YES and press the TRIP ODOMETER RESET stem to confirm the selection.
7. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.

9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 27

If refilling a low tire, no specific reset procedure is required. All warnings are extinguished once the TPMS receives a signal that all tires are properly inflated.

Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the tires or replacing one or more of the TPMS sensors. The TPMS sensor matching process should also be performed after replacing a spare tire with a road tire containing the TPMS sensor. The malfunction light and the DIC message should go off at the next ignition cycle. The sensors are matched to the tire/ wheel positions, using a TPMS relearn tool.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn ignition switch to ON/RUN position, with engine OFF.
3. Simultaneously press the keyless entry transmitter's lock and unlock buttons until a horn chirp sounds, indicating Learn Mode has been enabled. The TIRE LEARNING ACTIVE message displays on the DIC screen.

NOTE: **If the vehicle does not have RKE, press the Driver Information Center (DIC) vehicle information button until the PRESS (check mark symbol) TO RELEARN TIRE POSITIONS message displays. The horn sounds twice to signal the receiver is in relearn mode and TIRE LEARNING ACTIVE message displays on the DIC screen. If the vehicle does not have RKE or DIC buttons, press the trip odometer reset stem on the instrument cluster until the PRESS (check mark symbol) TO RELEARN TIRE POSITIONS message displays. The horn sounds twice to signal the receiver is in relearn mode and TIRE LEARNING ACTIVE message displays on the DIC screen.**

4. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
5. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
6. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 28

If refilling a low tire, no specific reset procedure is required. All warnings are extinguished once the TPMS receives a signal that all tires are properly inflated.

TPMS sensors are mounted onto each tire and wheel assembly, excluding the spare tire and wheel assembly. Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the vehicle's tires or replacing one or more of the TPMS sensors. The TPMS

sensor matching process should also be performed after replacing a spare tire with a road tire containing the TPMS sensor. The malfunction light and the DIC message should go off at the next ignition cycle. The sensors are matched to the tire/wheel positions, using a TPMS relearn tool.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/ RUN with the engine OFF or place the vehicle power mode in ON/ RUN/ START. See **Fig. 7**.
4. Make sure the Tire Pressure info page option is turned on. The info pages on the Driver Information Center (DIC) can be turned on and off through the Settings menu.
5. Use the DIC controls on the right side of the steering wheel to scroll to the Tire Pressure screen under the DIC info page.
6. Press and hold the SET/RESET button (check mark symbol) located in the center of the DIC controls.
7. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 29

If refilling a low tire, no specific reset procedure is required. All warnings are extinguished once the TPMS receives a signal that all tires are properly inflated.

TPMS sensors are mounted onto each tire and wheel assembly, excluding the spare tire and wheel assembly. Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the vehicle's tires or replacing one or more of the TPMS sensors. The TPMS sensor matching process should also be performed after replacing a spare tire with a road tire containing the TPMS sensor. The malfunction light and the DIC message should go off at the next ignition cycle. The sensors are matched to the tire/wheel positions, using a TPMS relearn tool.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine OFF.
4. Press the MENU button (right-hand side of instrument cluster) once on the Driver Information Center (DIC).
5. Press the up or down arrow button until the Tire Learn screen is displayed.
6. Press and hold the SET/CLR button to begin the sensor matching process.
7. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.

9. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 30

If refilling a low tire, no specific reset procedure is required. All warnings are extinguished once the TPMS receives a signal that all tires are properly inflated.

TPMS sensors are mounted onto each tire and wheel assembly, excluding the spare tire and wheel assembly. Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the vehicle's tires or replacing one or more of the TPMS sensors. The TPMS sensor matching process should also be performed after replacing a spare tire with a road tire containing the TPMS sensor. The malfunction light and the DIC message should go off at the next ignition cycle. The sensors are matched to the tire/wheel positions, using a TPMS relearn tool.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Put the vehicle in ON/ RUN and place the vehicle in P (Park).
4. If the Driver Information Center (DIC) display is minimized, press the SELECT knob to maximize it. See **Fig. 9**.
5. Use the SELECT knob to scroll to the Tire Pressure display screen.
6. Press and hold the SELECT knob for five seconds to begin the sensor matching process. A message displays confirming to begin the process.
7. Use the SELECT knob to select YES with the highlighted selection, and press the SELECT knob again to confirm the selection.
8. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
9. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
10. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
11. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

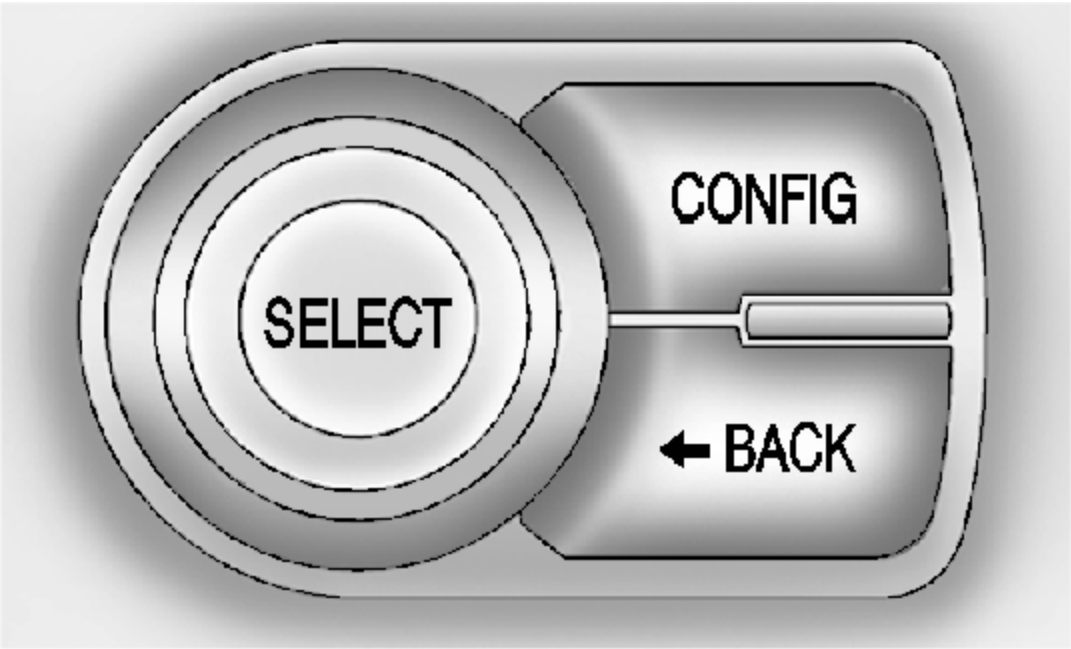


Fig. 9: Identifying DIC Controls (Spark EV)
Courtesy of GENERAL MOTORS CORP.

TPMS REMINDER RESET - PROCEDURE 31

NOTE: **You have two minutes to match the first tire/wheel position, and five minutes overall to match all four tire/wheel positions. If it takes longer, the matching process stops and must be restarted.**

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine off.
4. Enter the learn sequence from the TPM Learn screen, located under the Customization Menu in the instrument panel cluster. Press SRCE button until you see Customize Options and then press ENTER (left pointing arrow). Move the thumbwheel up or down to scroll through the available options. Press ENTER to select an item. To exit the current menu, or go back, use the thumbwheel to select BACK (left arrow) at the top of the screen and then press ENTER.
5. Start with the driver side front tire. The driver side front indicator lamp also comes on to indicate that corner's sensor is ready to be learned. Place a tire sensor activation tool against the tire sidewall, near the valve stem. Then press the button to activate the TPMS sensor. A horn chirp confirms that the sensor identification code has been matched to this tire and wheel position
6. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
7. After the driver side rear TPMS sensor has been learned the horn chirps two times. The driver side rear indicator lamp turns off and the TPMS sensor matching process is done. Turn the ignition switch to LOCK/OFF.

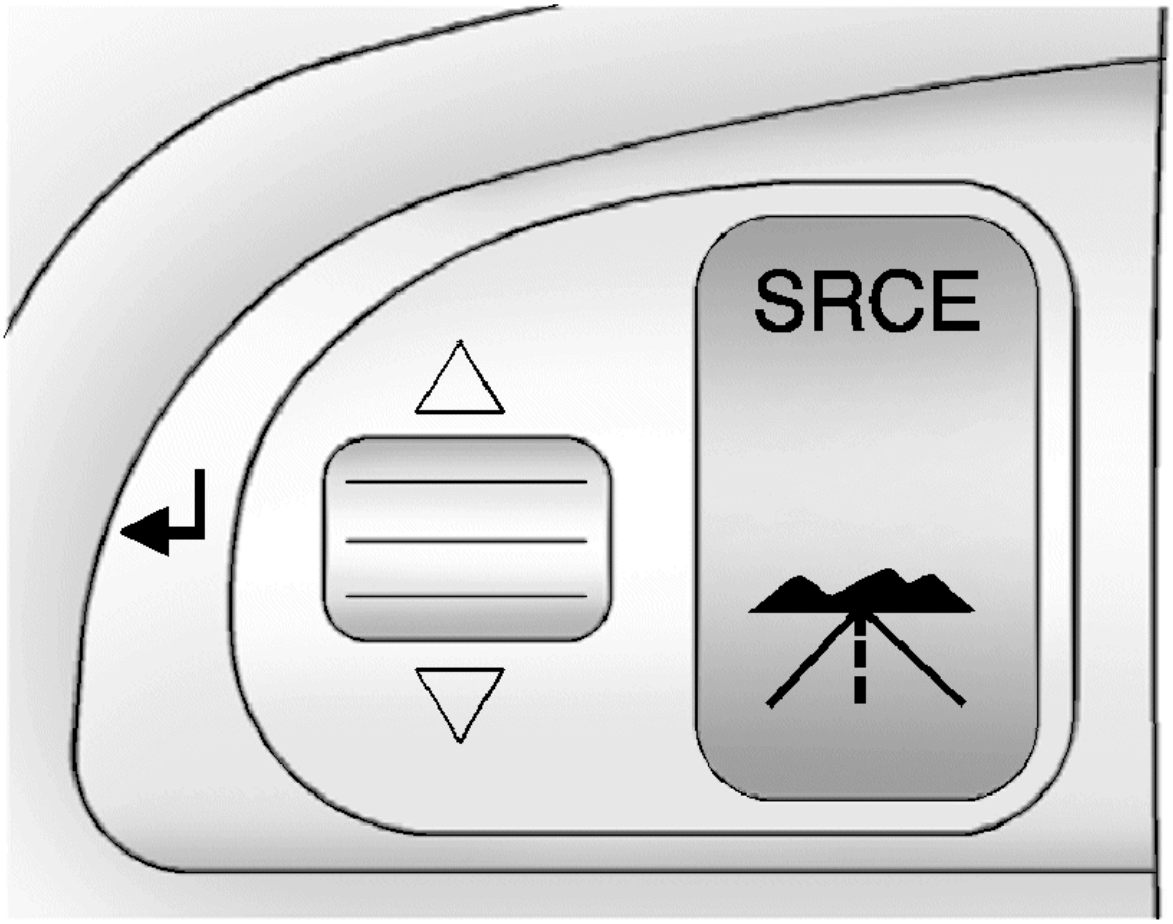


Fig. 10: Identifying DIC Controls
Courtesy of GENERAL MOTORS CORP.

TPMS REMINDER RESET - PROCEDURE 32

NOTE: **An OEM scan tool is used to perform this procedure.**

NOTE: **The sensor learn procedure must be performed after every tire rotation, tire pressure indicator module replacement, or sensor replacement. Make sure the TPM tool battery is sufficient to complete TPM learn process. Do not place the TPM tool directly on the valve stem. The TPM tool should be placed against the tire sidewall near the valve stem. The TPM sensor learn activation procedure may have to be repeated up to 3 times before determining a sensor is malfunctioning. The low tire pressure warning light will start to flash to indicate the learn mode has been enabled. The front and back turn signals will flash twice when a sensor has been learned.**

1. Ignition ON with engine OFF, apply the parking brake.
2. Using a scan tool, initiate the TPM Learn Mode.
3. Starting with the left front tire, active the sensor by holding the antenna of the tire pressure monitor special tool aimed upward against the tire sidewall close to the wheel rim at the valve stem location. Press and release the activate button. Ensure that the transmit indicator on the special tool indicates that the sensor activation signal is being transmitted. Wait for the front and back turn signals to flash twice. If the

front and back turn signals do not flash, repeat the sensor activation sequence with the tool. Once the front and back turn signals have flashed twice, the sensor information is learned.

NOTE: **Follow the sensor order listed here since there is no visual indicator on the vehicle for the sensor learn order.**

4. After the front and back turn signals have flashed twice, repeat step 2 for the remaining 3 sensors in the following order: Right front, Right rear, Left rear.
5. When the left rear sensor has been learned, the front and back turn signals will flash twice, the learn process is complete and the tire pressure indicator module exits the Learn mode.

TPMS REMINDER RESET - PROCEDURE 33

If refilling a low tire, no specific reset procedure is required. All warnings are extinguished once the TPMS receives a signal that all tires are properly inflated.

Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the tires or replacing one or more of the TPMS sensors. The TPMS sensor matching process should also be performed after replacing a spare tire with a road tire containing the TPMS sensor. The malfunction light and the DIC message should go off at the next ignition cycle. The sensors are matched to the tire/ wheel positions, using a TPMS relearn tool.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Set the parking brake.
3. Turn the ignition to ON/RUN with the engine OFF.
4. Press the MENU button (center console) to select the Vehicle Information Menu in the Driver Information Center (DIC).
5. Use the arrow keys to scroll to the Tire Pressure screen.
6. Press the SET/CLR button to begin the sensor matching process. A message should display requesting acceptance of the process.
7. Press the SET/CLR button again to confirm the selection. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
8. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
9. After horn chirp has sounded, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
10. After left rear sensor has been learned, a double horn chirp will sound, indicating all 4 sensor IDs have been learned. Turn ignition switch to OFF position to exit Learn Mode.

TPMS REMINDER RESET - PROCEDURE 34

If refilling a low tire, no specific reset procedure is required. All warnings are extinguished once the TPMS receives a signal that all tires are properly inflated.

Each TPMS sensor has a unique identification code. The identification code needs to be matched to a new tire/wheel position after rotating the tires or replacing one or more of the TPMS sensors. The TPMS sensor matching process should also be performed after replacing a spare tire with a road tire containing the TPMS

sensor. The malfunction light and the DIC message should go off at the next ignition cycle. The sensors are matched to the tire/ wheel positions, using a TPMS relearn tool.

1. Set the tire pressure of all wheels to pressure specified on the tire and loading information label.
2. Turn the ignition to ON/RUN with the engine OFF. Set the parking brake.
3. Up-level Driver Information Center (DIC) Only: Make sure the TIRE PRESSURE INFO page option is turned on. The info pages on the DIC can be turned on and off through the SETTINGS menu.
4. - **Up-Level DIC** : Use the DIC controls (arrow buttons) on the right side of the steering wheel to scroll to the TIRE PRESSURE screen under the DIC info page.
   - **Base-Level DIC** : Use the MENU button to select the Vehicle Information menu in the DIC. Use the thumbwheel to scroll to the Tire Pressure Menu item screen. See **Fig. 8**.
5. - **Up-Level DIC** : Press and hold the SET/RESET button (check-mark symbol) located in the center of the DIC controls.
   - **Base-Level DIC** : Press the SET/CLR button to begin the sensor matching process. A message asking if the process should begin should appear. Press the SET/CLR button again to confirm the selection.
6. The horn sounds twice to signal the receiver is in relearn mode and the TIRE LEARNING ACTIVE message displays on the DIC screen.
7. Starting with left front tire, hold a tire sensor activation tool against the side wall of the tire, within 3 inches of the valve stem. Activate tool until a horn chirp sounds.
8. After horn chirp has sounded and the right turn signal has illuminated, proceed to the next 3 sensors in the following order: right front, right rear and left rear.
9. After left rear sensor has been learned, the horn sounds two times to indicate the sensor identification code has been matched to the driver side rear tire, and the TPMS sensor matching process is no longer active. The TIRE LEARNING ACTIVE message on the DIC display screen goes off.
10. Turn the ignition switch to LOCK/OFF.
11. Set all four tires to the recommended air pressure level as indicated on the Tire and Loading Information label.

Article GUID: A00161620

RESTRAINTS

Seat Belts - Impala

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Child Seat Tether Bracket Screws	24 N.m	18 lb ft
Front Seat Buckle Side Belt Nut	42 N.m	31 lb ft
Guide Loop Bolt	42 N.m	31 lb ft
Rear Seat Center Belt Nuts	42 N.m	31 lb ft
Seat Belt Buckle Anchor Bolt	42 N.m	31 lb ft
Seat Belt Buckle Anchor Nut	42 N.m	31 lb ft
Seat Belt D-Ring Bolt	42 N.m	31 lb ft
Seat Belt Retractor Anchor Plate Nut	42 N.m	31 lb ft
Seat Belt Retractor Bolt	42 N.m	31 lb ft
Shoulder Belt Anchor Plate Bolt	42 N.m	31 lb ft
Shoulder Belt Guide Adjuster Bracket Bolts	42 N.m	31 lb ft

SCHEMATIC WIRING DIAGRAMS

SEAT BELT WIRING SCHEMATICS

Seat Belt

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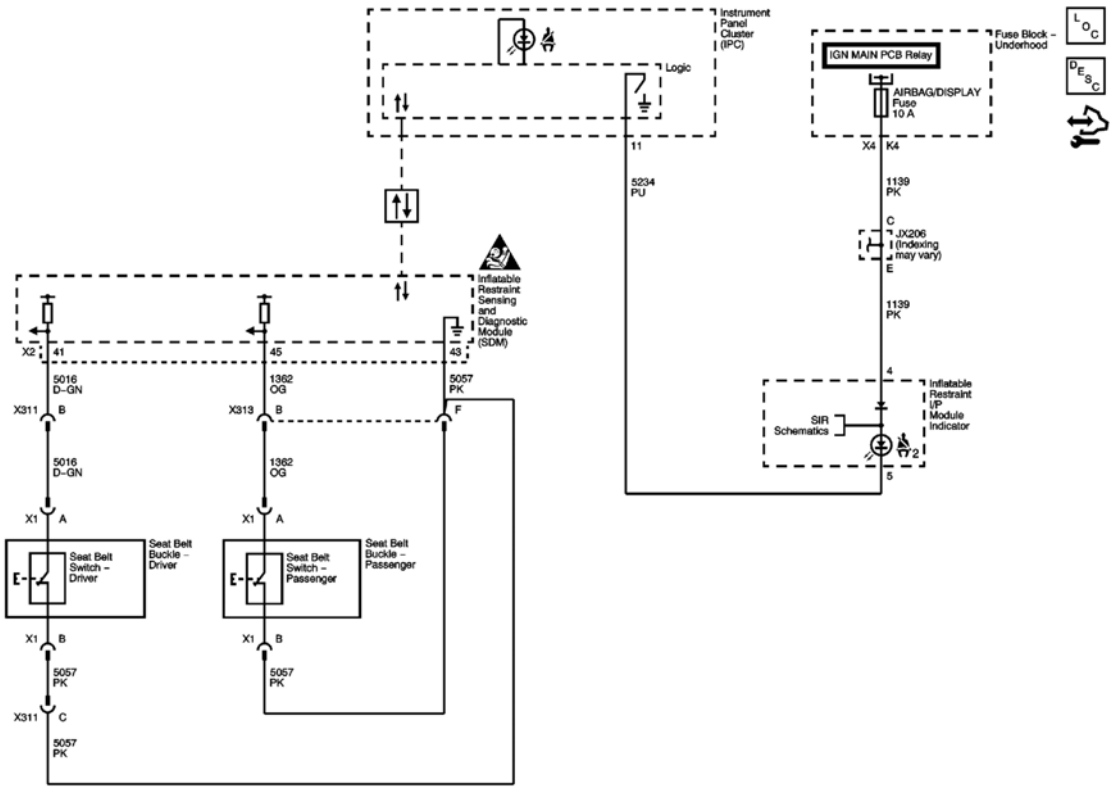

Fig. 1: Seat Belt Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

SEAT BELT SYSTEM OPERATIONAL AND FUNCTIONAL CHECKS

NOTE: **If the vehicle has been in a collision, refer to Repairs and Inspections Required After a Collision for additional information.**

Perform the following inspection from the driver seat:

1. Turn the ignition switch to the ON position. Verify the proper operation of the seat belt reminder lamp with the belt buckled and with the belt unbuckled. Refer to **Seat Belt System Description and Operation**.
2. Inspect the shoulder belt guide in order to ensure that the following conditions are met:
   - The shoulder belt guide swivels freely.
   - The seat belt webbing is seated flatly in the guide slot.
   - The seat belt webbing does not bind.
3. Verify that the seat belt buckle faces inboard and is accessible.
4. Verify that the seat belt retractor units are securely attached.
5. Verify that the seat belt anchor bolts are secure.
6. Fully extend the seat belt webbing. Verify that the seat belt webbing does not have any twists or tears.
7. Allow the seat belt webbing to retract. Verify that the seat belt webbing returns freely and completely

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back into the retractor. If the seat belt webbing will not retract, refer to **Seat Belt Does Not Retract**.

8. Snap the seat belt latch plate into the buckle.
9. Sharply tug on the seat belt latch plate and the buckle. Verify that the seat belt latch plate and the buckle remain locked when tugged.
10. Push the button on the buckle:
    - Verify that the seat belt latch plate releases easily from the buckle.
    - Verify that the button returns to its original position.

Repeat the inspection procedure found in steps 2-10 for the front passenger seat.

Perform the following steps in order to inspect the center seat belts:

1. Verify that the center seat belts are accessible.
2. Verify that the center seat belts have no twists or tears in the webbing.
3. Snap the center seat belt latch plate into the buckle.
4. Sharply tug on the seat belt latch plate and the buckle. Verify that the seat belt latch plate and the buckle remain locked when tugged.
5. Push the button on the buckle:
    - Verify that the seat belt latch plate releases easily from the buckle.
    - Verify that the button returns to its original position.

Repeat the inspection procedure found in steps 2-10 for the rear seats.

Repeat the center seat belt inspection procedure found in steps 1-5 for the rear seat.

For information on removal of the rear seats cushions, refer to **Rear Seat Cushion Removal and Installation (Impala Limited)** .

Emergency Locking Retractors

WARNING: Perform this test in an area clear of other vehicles or obstructions. Do not conduct this test on the open road. A large, empty parking lot is suitable. Failure to observe this precaution may result in damage to the vehicle and possible personal injury.

1. Fasten the seat belts. Use an assistant when the retractor under test is not part of the driver seat belt.
2. Accelerate the vehicle slowly to 16 km/h (10 mph) and apply the brakes firmly.
3. Verify that the seat belt locks when braking firmly.
4. If the belt does not lock, proceed with the following steps:
    1. Remove the seat belt retractor assembly, refer to the appropriate service procedure.
    2. Tilt the seat belt retractor slowly.

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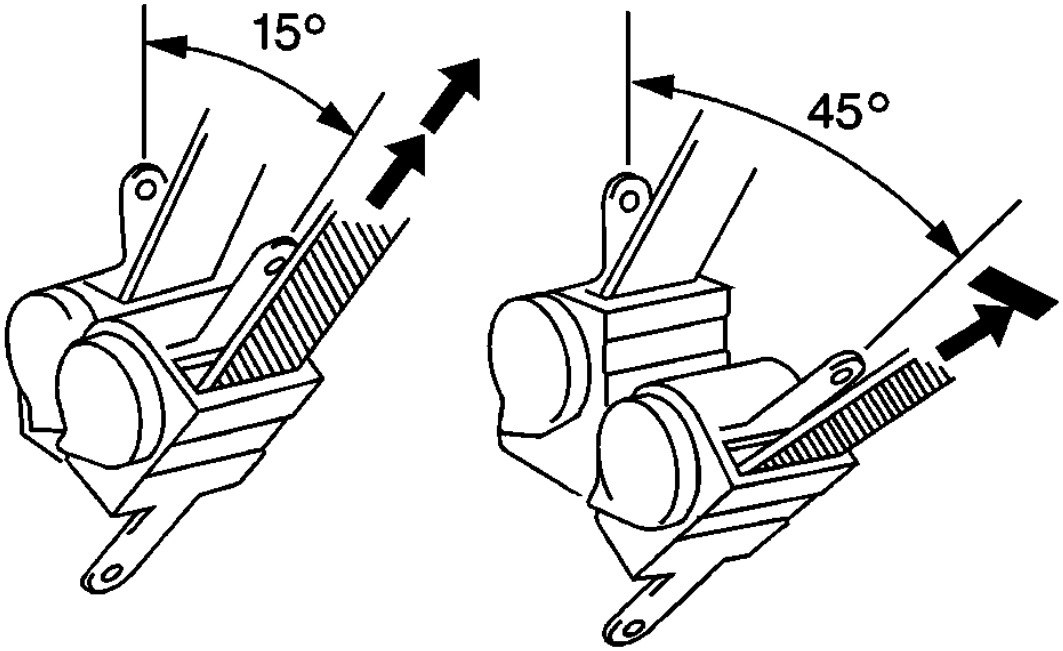

Fig. 2: Checking Seat Belt Retractor Inclination
Courtesy of GENERAL MOTORS COMPANY

3. Ensure that the seat belt webbing can be pulled from the retractor at an inclination of 15 degrees or less and cannot be pulled from the retractor at an inclination of 45 degrees or more.
4. If the seat belt retractor does not operate as described, replace the retractor assembly. Refer to the appropriate service procedure.

SYMPTOMS - SEAT BELTS

IMPORTANT: Review the seat belt system description and operation in order to familiarize yourself with the system and how it functions. Refer to **Seat Belt System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the seat belt system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

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Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

- Refer to **Seat Belt Indicator Malfunction - Driver** in order to diagnose the symptom.
- Refer to **Seat Belt Indicator Malfunction - Passenger** in order to diagnose the symptom.

SEAT BELT DOES NOT RETRACT

1. Grasp the seat belt and pull it out slowly and evenly from the retractor, do that in 15-25mm (5/8-1in) increments, continuing until the seat belts entire length has been pulled out.
2. Release the seat belt, and allow the retractor to slowly retract the full length of the seat belt. The seat belt must retract without any additional help.
3. Additionally, make sure, that the seat belt can be stopped any time while retracting and then resumed while being released again. This must also be possible in all retracting positions.
4. Should problems be observed in step 3, perform the first two steps 2 more times.
5. Should the retractor, after performing these steps, not function freely and properly, it is to be replaced with a new part.

SEAT BELT INDICATOR MALFUNCTION - DRIVER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Seat Belt Switch Signal	1	2	-	-
Low Reference	-	2	-	-

1. Indicator will remain ON with seat belt buckled.
2. Indicator will illuminate only for the bulb test.

Circuit/System Description

The driver seat belt switch is a 2-wire switch wired to the inflatable restraint sensing and diagnostic module (SDM) using a signal circuit and a low reference circuit. When the seat belt is unbuckled the switch is closed, and when the seat belt is buckled the switch is open. The SDM sends the status of the driver seat belt via serial data to the instrument panel cluster (IPC). After receiving the message, the IPC controls the illumination of the driver seat belt indicator.

Reference Information

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Schematic Reference

- **Seat Belt Schematics**
- **SIR Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Seat Belt System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Verification

1. Ignition ON, with a scan tool perform the IPC Display Test and verify the driver seat belt indicator is illuminated for 5 seconds.
   - If the indicator does not illuminate, replace the IPC.
2. Monitor the SDM Driver Seat Belt Switch parameter while connecting and disconnecting the seat belt. The parameter should display Buckled and Unbuckled when changing seat belt states.

Circuit/System Testing

IMPORTANT:

When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- The seat belt switch
- The seat belt switch harness connector
- The SDM
- The SDM harness connector

1. Ignition OFF, disconnect the harness connector at the seat belt switch.
2. Ignition ON, test the resistance between the low reference circuit terminal B and signal circuit terminal A of the switch (buckle side) while connecting and disconnecting the seat belt. The resistance should switch between infinity and less than 2 ohms.
   - If not as specified, replace the seat belt buckle.

3. Ignition OFF, reconnect the harness connector at the seat belt switch.
4. Make sure the seat belt is buckled.
5. Ignition ON, using a scan tool, verify the SDM Driver Seat Belt Switch parameter display is Buckled.
    - If the parameter is Unbuckled, test the seat belt switch signal circuit for a short to ground. If the circuit tests normal replace the SDM.
6. Make sure the seat belt is unbuckled.
7. Install a 3-amp fused jumper wire between the signal circuit terminal A and the low reference circuit terminal B (harness side). Verify the SDM Driver Seat Belt Switch parameter display is Unbuckled.
    - If the parameter is Buckled, test the signal and the low reference circuits for open/high resistance or a short to voltage. If the circuits test normal, replace the SDM.
8. If all circuits test normal, test or replace the seat belt switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the seat belt switch.
2. With the seat belt buckled, test for infinite resistance between the signal circuit terminal A and the low reference terminal B.
    - If not the specified range, replace the seat belt switch.
3. With the seat belt unbuckled, test for less than 2 ohms of resistance between the signal circuit terminal A and the low reference terminal B.
    - If greater than the specified range, replace the seat belt switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Front Seat Belt Buckle Replacement**
- **Control Module References** for SDM or IPC replacement, setup, and programming

SEAT BELT INDICATOR MALFUNCTION - PASSENGER

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Low Reference	-	2	-	-
Passenger Seat Belt Switch Signal	1	2	-	-
Ignition 1 Voltage	3	3	-	-
Passenger Seat Belt Indicator Control	4	5	-	-

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
1. The passenger seat belt indicator will remain ON with seat occupied and the seat belt buckled. 2. The passenger seat belt indicator will not illuminate with the seat occupied and the seat belt disconnected, but will illuminate for the bulb test. 3. No indicator on the inflatable restraint passenger air bag ON/OFF indicator will illuminate at any time. 4. The passenger seat belt indicator will illuminate at all times. 5. The passenger seat belt indicator will never illuminate but the PPS ON/OFF indicator does.				

Circuit/System Description

The seat belt buckle switch is a 2-wire switch wired to the inflatable restraint sensing and diagnostic module (SDM) using a signal circuit and a low reference circuit. When the seat belt is unbuckled the switch is closed, and when the seat belt is buckled the switch is open. When the passenger presence system (PPS) indicates that the seat is occupied, the SDM sends the status of the passenger seat belt via serial data to the instrument panel cluster (IPC). After receiving the message, the IPC controls the illumination of the passenger seat belt indicator by grounding the indicator control circuit. If an occupant is seated in the front passenger seat and the seat belt is unfastened, the SDM will send a message to the IPC to illuminate the fasten seat belt indicator for approximately 72 seconds or until the seat belt is fastened.

Diagnostic Aids

Objects on the passenger seat can cause the passenger seat belt reminder to be commanded on. Depending on the sensing technology used, a conductive object (computers, MP3 players, cell phones, diagnostic scan tool, wires, a hand, etc.) placed on the passenger seat may cause the Passenger Presence Detection Module to command the passenger air bag indicator ON and/or command the passenger seat belt indicator ON. The fasten seat belt chime will also sound.

Reference Information

Schematic Reference

- **Seat Belt Schematics**
- **SIR Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Seat Belt System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**

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- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Circuit/System Verification

1. With no weight in the passenger seat observe the passenger seat belt status indicator. Turn ON the ignition, the indicator should illuminate for 5 seconds.
   - If the indicator is always ON or always OFF, refer to Indicator Circuit Test.
2. Ignition ON, monitor the Passenger Seat Belt Switch parameter while connecting and disconnecting the seat belt. The parameter should display Buckled and Unbuckled when changing seat belt states.
   - If the parameter displays incorrectly, refer to Switch Circuit Test.

Circuit/System Testing

Indicator Circuit Test

1. Ignition OFF, disconnect the harness connector at the passenger air bag ON/OFF indicator.
2. Ignition ON, verify a test lamp illuminates between the ignition circuit terminal 4 and ground.
   - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test or replace the passenger air bag ON/OFF indicator.
3. Connect a test lamp between the control circuit terminal 5 and the ignition circuit terminal 4.

   IMPORTANT: Allow 5 seconds after seat is occupied for test lamp to change states.

4. With the passenger seat occupied the test lamp should turn ON with the seat belt disconnected, and turn OFF with the seat belt connected.
   - If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the IPC.
   - If the test lamp is always OFF, test the control circuit for an open/high resistance. If the circuit tests normal, replace the IPC.
5. If the circuits test normal, replace the passenger air bag ON/OFF indicator.

Switch Circuit Test

IMPORTANT: When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- The passenger seat belt switch
- The passenger seat belt switch harness connector
- The SDM
- The SDM harness connector

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1. Ignition OFF, disconnect the harness connector at the passenger seat belt switch.
2. Test the resistance between the low reference circuit terminal B X1 and signal circuit terminal A X1 of the switch (buckle side) while connecting and disconnecting the seat belt. The resistance should switch between infinity and less than 2 ohms.
    - If not as specified, replace the seat belt buckle.
3. Ignition ON, using a scan tool, verify the Passenger Seat Belt Switch parameter display is Buckled.
    - If the parameter is Unbuckled, test the seat belt switch signal circuit for a short to ground. If the circuit tests normal replace the SDM.
4. Install a 3 A fused jumper wire between the signal circuit terminal A X1 and the low reference circuit terminal B X1 (harness side). Verify the scan tool Passenger Seat Belt Switch parameter display is Unbuckled.
    - If the parameter is Buckled, test the signal and the low reference circuits for open/high resistance. If the circuits test normal, replace the SDM.

Component Testing

1. Ignition OFF, disconnect the harness connector at the seat belt switch.
2. With the seat belt buckled, test for infinite resistance between the signal circuit terminal A X1 and the low reference terminal B X1 (buckle side).
    - If not the specified range, replace the seat belt switch.
3. With the seat belt unbuckled, test for less than 2 ohms between the signal circuit terminal A X1 and the low reference terminal B X1.
    - If greater than the specified range, replace the seat belt switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair

- **Front Seat Belt Buckle Replacement**
- **Instrument Panel Airbag Arming Status Display Replacement**
- **Control Module References** for SDM or IPC replacement, programming and setup

REPAIR INSTRUCTIONS

REPAIRS AND INSPECTIONS REQUIRED AFTER A COLLISION

WARNING: Restraint systems can be damaged in a collision. To help avoid injury and ensure that all parts in need of replacement are replaced:

- **Replace any seat belt system that was in use during the collision serious enough to deploy any automatic restraint device such as air bags and seat belt pretensioners. This not only includes seat belt systems in use by people of adult size, but seat belt systems used to secure child restraints, infant carriers and booster seats, including LATCH system and top tether anchorages.**
- **Replace any seat belt system that has torn, worn, or damaged**

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components. This not only includes adult seat belt systems, but built-in child restraints and LATCH system components, if any.

- **Replace any seat belt system if you observe the words "REPLACE" or "CAUTION", or if a yellow tag is visible. Do not replace a seat belt if only the child seat caution label is visible.**
- **Replace any seat belt system if you are doubtful about its condition. This not only includes adult seat belt systems, but built-in child restraints, LATCH system components, and any restraint system used to secure infant carriers, child restraints, and booster seats.**

Do NOT replace single seat belt system components in vehicles that have been in a collision as described above. Always replace the entire seat belt system with the buckle, guide and retractor assembly, which includes the latch and webbing material.

After a minor collision where no automatic restraint device was deployed, seat belt system replacement may not be necessary, unless some of the parts are torn, worn, or damaged.

SEAT BELT LATCH STOP INSTALLATION

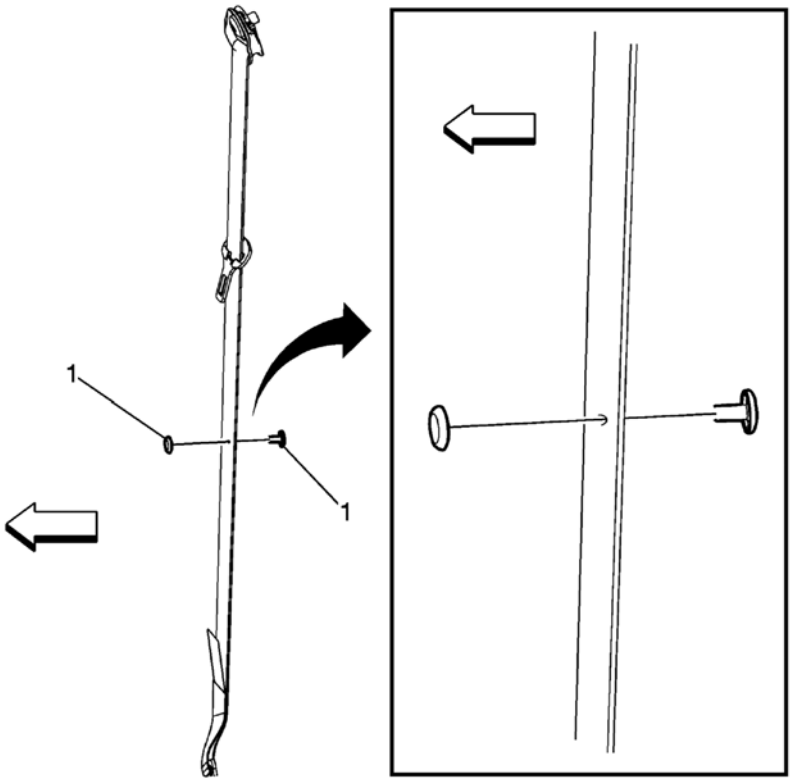

Fig. 3: View Of Seat Belt Latch Stop Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	

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Callout	Component Name
1. Locate the hole in the seat belt webbing where the original seat belt stop button was located. 2. If the original hole in the seat belt webbing is not visible, perform the following: • If either the right or left stop button is missing use the opposing seat belt as a reference. • With the opposing seat belt fully stowed, measure the distance between the seat belt lower anchor and the stop button. • Using the measurement obtained above, measure and mark the location of the missing stop button on the center of the seat belt webbing. 3. Ensure the seat belt latch plate is located above the mark or original hole.	
1	Seat Belt Stop Button **Procedure** 1. Work the male half of the stop button through the hole in the webbing or at the marked location. 2. Align the female half of the stop button with the male half of the stop button. 3. Snap the two halves together. 4. Trim off any access of the male half of the stop button flush with the female half of the stop button. **TIP:** Ensure the male half of the stop button is facing forward in the vehicle in order to ensure the stop button will not snag customers clothing.

FRONT SEAT BELT BUCKLE REPLACEMENT

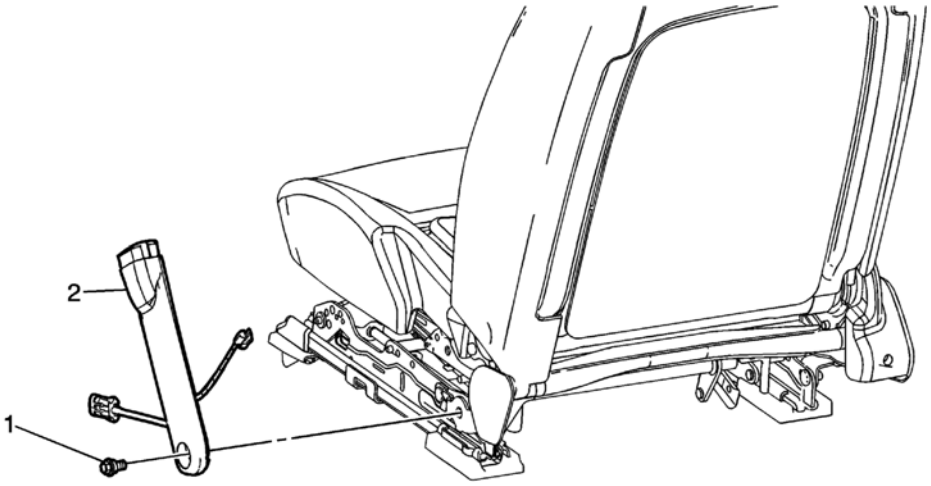

Fig. 4: Front Seat Belt Buckle
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	

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Callout	Component Name
Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)** .	
1	Seat Belt Buckle Bolt **CAUTION:** **Refer to** **Fastener** **Caution** . **TIP:** Disconnect the electrical connector. **Tighten** 42 N.m (31 lb ft)
2	Seat Buckle Assembly Belt

FRONT CENTER SEAT BELT BUCKLE REPLACEMENT

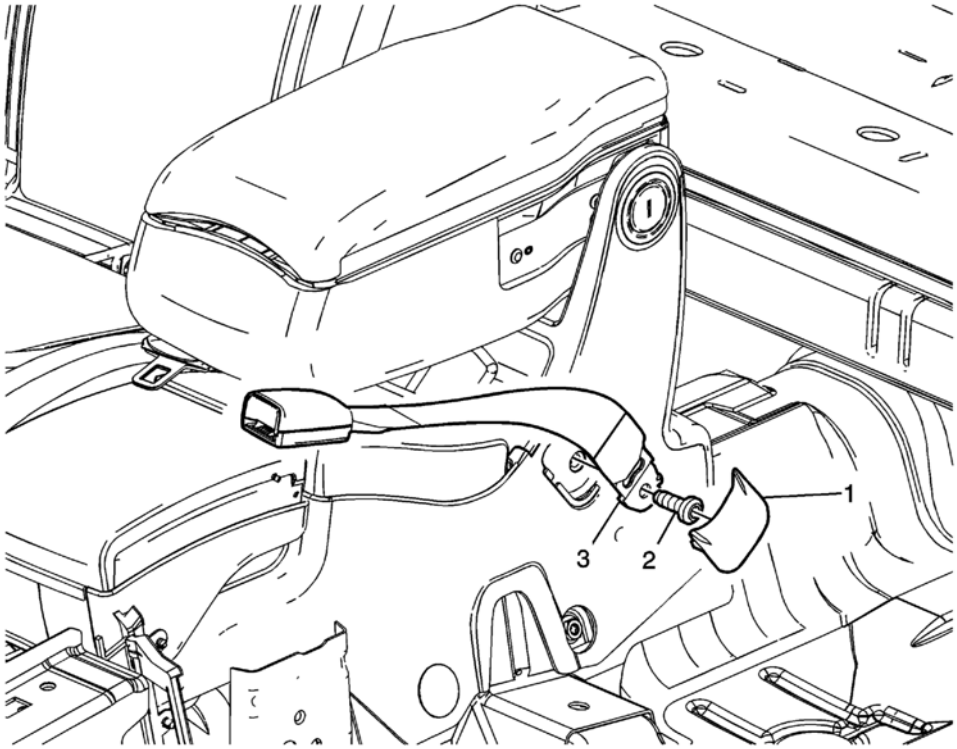

Fig. 5: Center Front Seat Belt Buckle
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Center Front Seat Trim Plate **TIP:** Slide the driver seat to the full forward position and adjust the seat back to the full forward position to allow access.
2	Seat Belt Buckle Center Front Bolt

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Callout	Component Name
	CAUTION: **Refer to** **Fastener** **Caution .** **Tighten** 42 N.m (31 lb ft)
3	Seat Belt Center Front Buckle

REAR SEAT BUCKLE SIDE BELT REPLACEMENT (IMPALA LIMITED WITHOUT AM9)

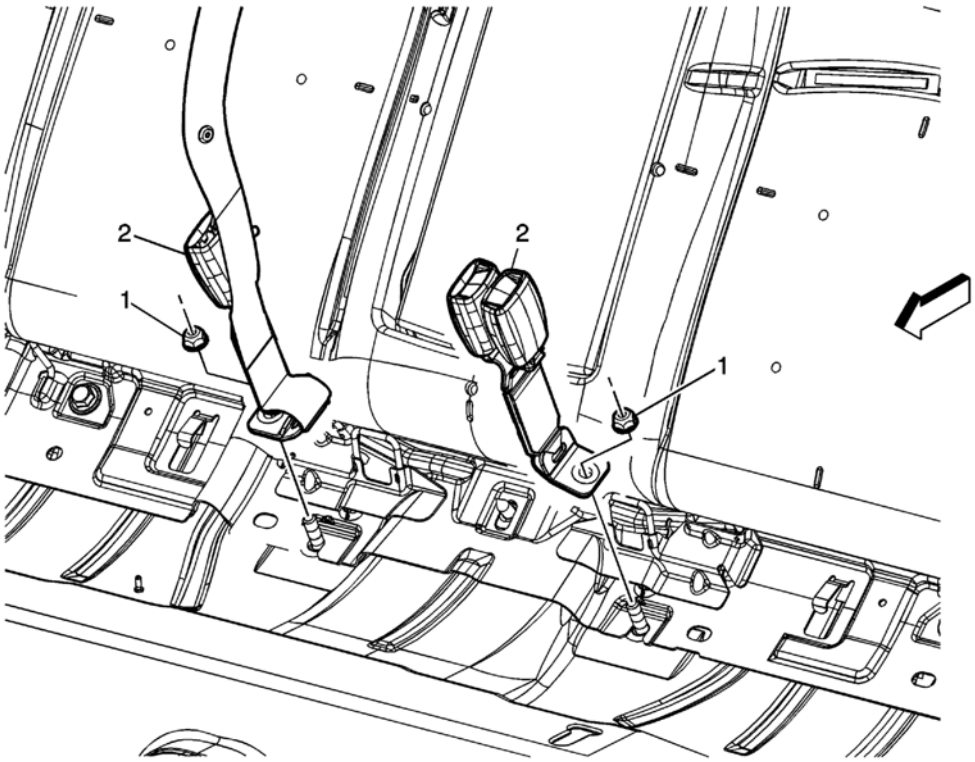

Fig. 6: Rear Seat Belt Buckle Components (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)** .	
1	Seat Belt Buckle Nut **CAUTION:** **Refer to** **Fastener** **Caution .** **Tighten** 42 N.m (31 lb ft)

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Callout	Component Name
2	Seat Buckle Assembly Buckle

REAR SEAT BUCKLE SIDE BELT REPLACEMENT (IMPALA LIMITED WITH AM9)

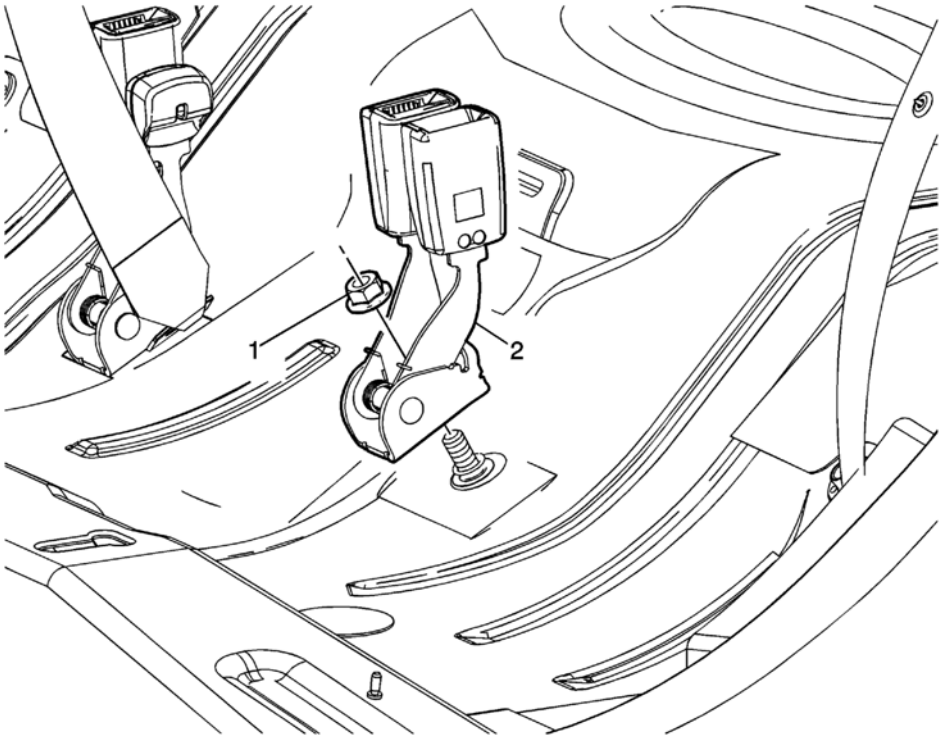

Fig. 7: Rear Seat Belt Buckle (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)** .	
1	Seat Belt Buckle Nut **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 42 N.m (31 lb ft)
2	Seat Buckle Assembly Buckle

FRONT SEAT CENTER LATCH SIDE BELT REPLACEMENT (IMPALA LIMITED)

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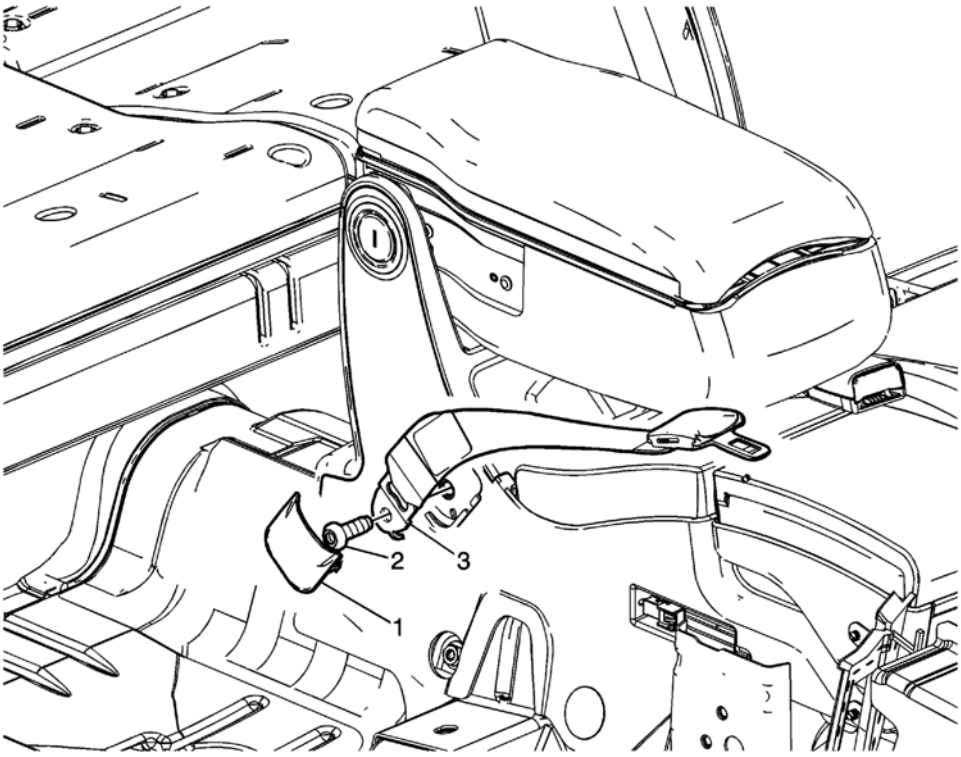

Fig. 8: Center Front Seat Belt (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Center Front Seat Trim Plate **TIP:** Slide the passenger seat to the full forward position and adjust the seat back to the full forward position to allow access.
2	Seat Belt Center Front Bolt **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 42 N.m (31 lb ft)
3	Seat Center Front Belt

FRONT SEAT BELT GUIDE ADJUSTER REPLACEMENT (IMPALA LIMITED)

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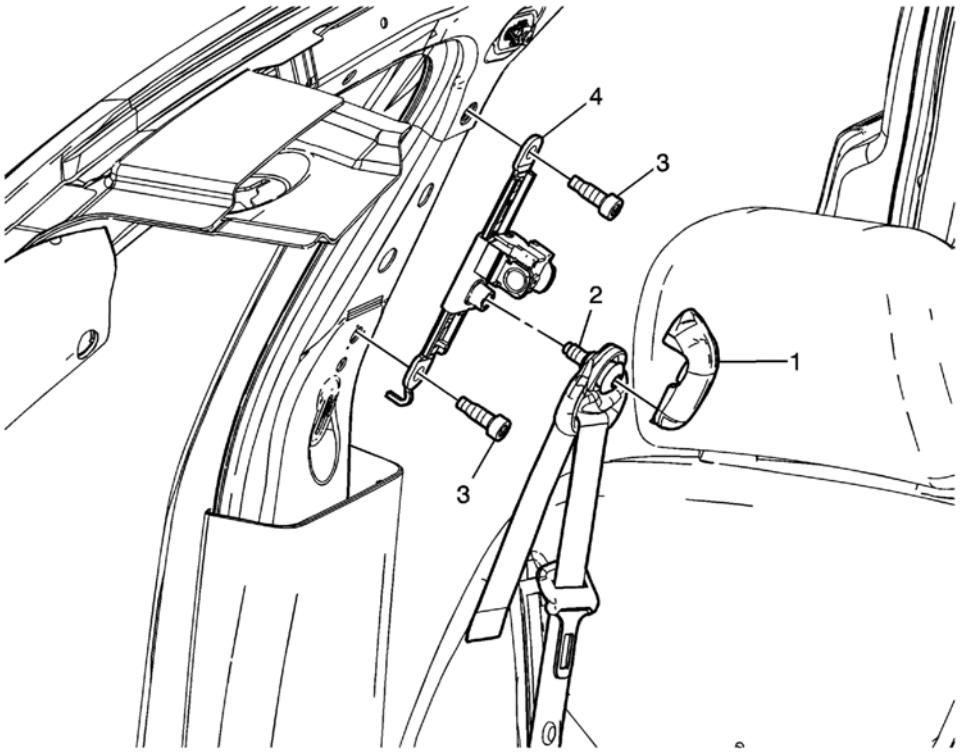

Fig. 9: Front Shoulder Belt Guide Adjuster (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the trim panel, upper center pillar. Refer to **Center Pillar Upper Trim Panel Replacement** .	
1	Shoulder Belt Guide Adjuster Cover
2	Shoulder Belt Guide Bolt **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 42 N.m (31 lb ft)
3	Shoulder Belt Guide Adjuster Assembly Bolt **Tighten** 42 N.m (31 lb ft)
4	Shoulder Belt Guide Adjuster Assembly

REAR SEAT BELT RETRACTOR REPLACEMENT (IMPALA LIMITED)

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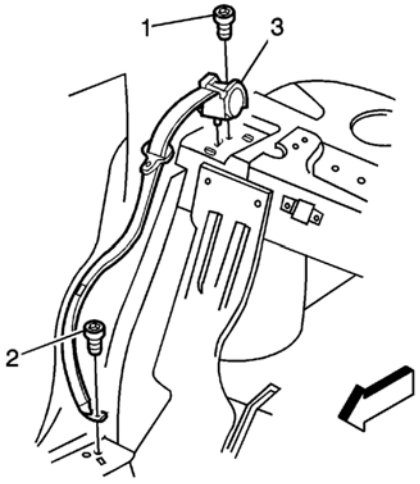

Fig. 10: Rear Seat Belt Retractor (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear window shelf trim panel. Refer to **Rear Window Shelf Trim Panel Replacement** .	
1	Seat Shoulder Belt Retractor Bolt **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 42 N.m (31 lb ft)
2	Seat Shoulder Belt Bolt **Tighten** 42 N.m (31 lb ft)
3	Seat Shoulder Belt Retractor

REAR SEAT CENTER RETRACTOR SIDE BELT REPLACEMENT (IMPALA LIMITED WITH AM9)

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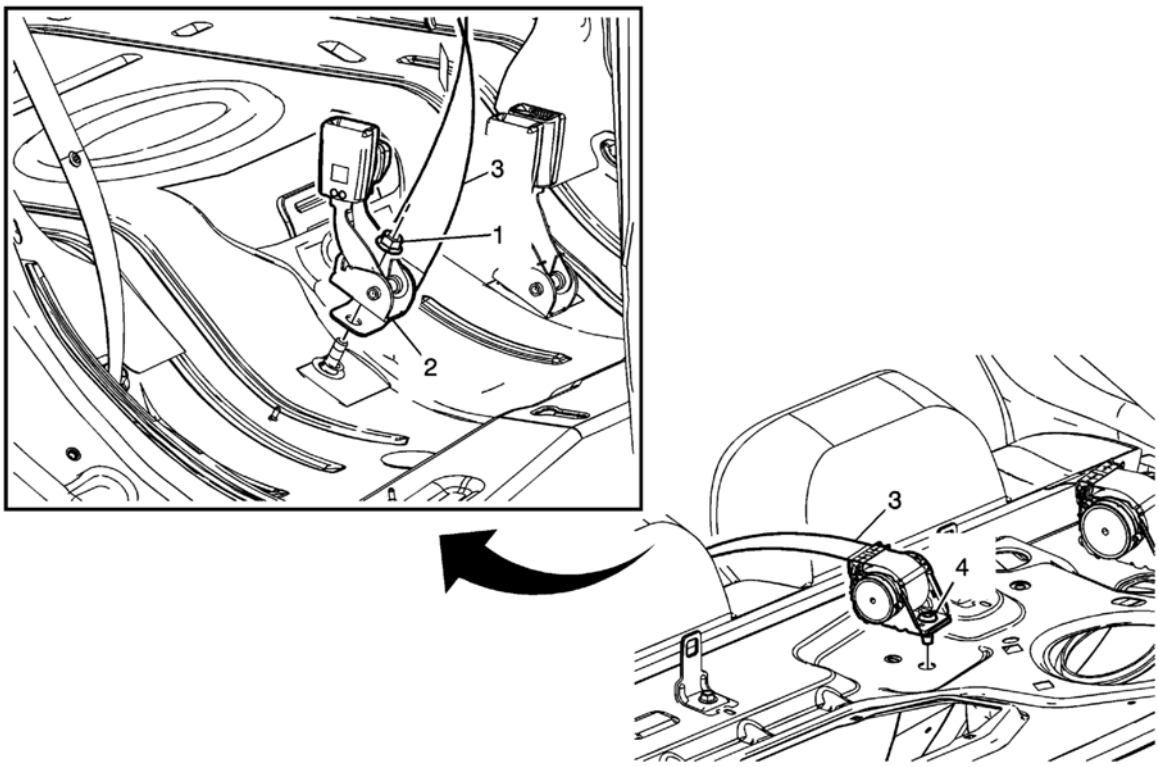

Fig. 11: Center Rear Seat Belt Retractor (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the rear window shelf trim panel. Refer to **Rear Window Shelf Trim Panel Replacement** .	
1	Seat Shoulder Belt Retractor Center Nut **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 42 N.m (31 lb ft)
2	Rear Seat Right Buckle
3	Seat Shoulder Belt Center Retractor
4	Seat Shoulder Belt Retractor Center Bolt **Tighten** 42 N.m (31 lb ft)

REAR SEAT CENTER RETRACTOR SIDE BELT REPLACEMENT (IMPALA LIMITED WITHOUT AM9)

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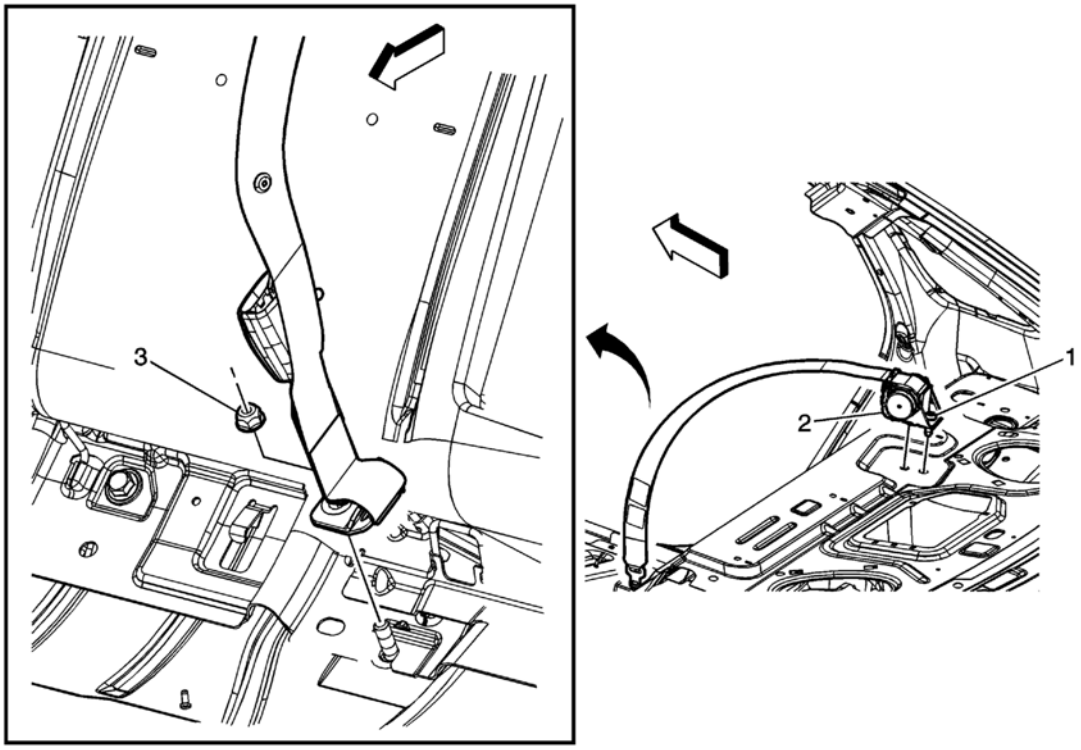

Fig. 12: Center Rear Seat Belt Retractor Components (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the rear seat cushion. Refer to **Rear Seat Cushion Removal and Installation (Impala Limited)** . 2. Remove the rear seat back. Refer to **Rear Seat Back Cushion Removal and Installation (Impala Limited)** . 3. Remove the rear window shelf trim panel. Refer to **Rear Window Shelf Trim Panel Replacement** .	
1	Seat Belt Retractor Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 42 N.m (31 lb ft)
2	Seat Shoulder Belt Anchor Plate Bolt **Tighten** 42 N.m (31 lb ft)

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Callout	Component Name
3	Rear Shoulder Seat Belt Retractor

CHILD RESTRAINT TETHER ANCHOR REPLACEMENT (IMPALA LIMITED)

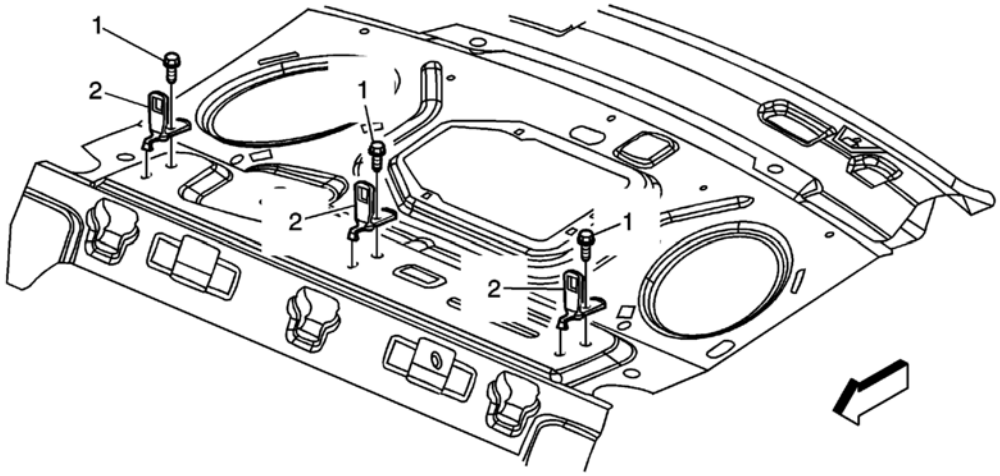

Fig. 13: Child Restraint Tether Anchor (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the trim panel, rear window shelf. Refer to **Rear Window Shelf Trim Panel Replacement** .	
1	Child Seat Restraint System Bracket Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 24 N.m (18 lb ft)
2	Child Seat Restraint System Bracket

DESCRIPTION AND OPERATION

SEAT BELT SYSTEM DESCRIPTION AND OPERATION

Restraint System

NOTE: **If the vehicle has been in a collision, refer to Repairs and Inspections Required After a Collision for additional information.**

Vehicle has front and rear seat belts that are the primary means of occupant restraint. Seat belts help to keep the occupants inside the passenger compartment and to gradually reduce the impact forces during the following

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events:

- Frontal impact type crashes
- Rear impact type crashes
- Side impact type crashes
- Roll-over type crashes

All seat belt retractors have emergency locks. The retractors remain unlocked during normal operation and under normal driving conditions. The retractors remain unlocked during normal conditions in order to allow free movement of the upper body of each occupant. A pendulum locks the seat belt webbing into position. The pendulum causes a locking bar to engage a cog on the spool of the retractor mechanism when any of the following conditions occur:

- A rapid extraction of the seat belt webbing from the retractor
- An abrupt change in vehicle speed
- An abrupt change in vehicle direction
- Operation of the vehicle on a steep upgrade
- Operation of the vehicle on a downgrade

The seat belts have an automatic locking (cinch) feature. The cinch feature is activated when the seat belt webbing is completely extended from the retractor. The cinch feature prevents the webbing from extending beyond the position from which it is allowed to retract. Use of the cinch feature is recommended for securing a child seat. The cinch feature may be cancelled by allowing the webbing to wind back completely into the retractor. After the cinch feature is cancelled, the webbing is unlocked. After the cinch feature is cancelled, the webbing will extend from the retractor. This vehicle is also equipped with a supplemental inflatable restraint (SIR) system. Refer to **Supplemental Inflatable Restraint System Description and Operation** .

Front Seat Belt System

The front seat belt system includes a driver and passenger seat belt pretensioner retractor. For more information on the pretensioner retractor refer to **Supplemental Inflatable Restraint System Description and Operation** . Both front seat belts includes a seat belt switch in the seat buckle which is monitored by the inflatable restraint sensing and diagnostic module (SDM) for control of a reminder lamp and a tone alarm.

NOTE: **The front passenger seat is equipped with a passenger presence system (PPS), which detects an occupant. If the PPS detects an empty front passenger seat, then the passenger fasten safety belt indicator will be disabled.**

- When the driver and passenger seat belts are buckled, and the ignition switch is turned ON, the instrument cluster will illuminate the driver and passenger seat belt indicators for a bulb check for several seconds, then turn OFF.
- When the driver seat belt is not buckled, and the ignition switch is in the ON position, the following events will occur:
  - The tone alarm will operate for 4-8 seconds and then go OFF.
  - The fasten safety belt indicator will turn ON solid for 20 seconds, then flash for 55 seconds before turning OFF. The tone alarm and indicator will immediately turn OFF when the driver seat belt is

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buckled.

- When the passenger seat belt is not buckled with an occupant sitting in the passenger front seat, and the ignition switch is turned ON, the following events will occur after a delay of approximately 25 seconds:
  - The tone alarm will operate for 4-8 seconds and then go OFF.
  - The reminder lamp, which is located within the PPS status indicator for the passenger seat, will be turned ON solid for 20 seconds, then flash for 55 seconds before turning OFF. The tone alarm and indicator will immediately turn OFF when the passenger seat belt is buckled.

Rear Seat Belt System

The Rear Seat Belt System includes the following components:

- The rear seat belt retractor is located at the wheelhouse panel and attached to the floor panel by the rear seat shoulder belt retractor bracket.
- The rear seat belt buckles and the center seat belt are attached to floor panel.

Child Seat Restraint System

WARNING: A child in a rear-facing child restraint can be seriously injured if the right-front passengers air bag inflates. This is because the back of a rear-facing child restraint would be very close to the inflating air bag. NEVER use a rear-facing child restraint in this vehicle. If a forward-facing child restraint is suitable for your child, ALWAYS move the front passenger seat as far back as it will go and then install the child restraint. Be sure the child restraint position does not conflict with any additional requirements provided by the manufacturer. For more information, refer to the vehicle owners manual and the instruction that came with the child restraint.

The child seat may only be used in a forward facing seating location. The child seat should be installed and secured according to the manufacturer's directions. If the child seat has a top strap, the seat will need to be anchored. Passengers should not be allowed to sit at locations where the seat belts are being used to secure the child seat.

All vehicles are equipped with a dual-mode type retractor with emergency and automatic locking features. The automatic locking feature is for restraint of a child seat. The child seat can be secured by pulling the seat belt all the way out to lock it. Then tighten the seat belt around the child seat.

If a child seat is to be used in the second seat position, a special dealer-installed anchor must be used in order to anchor the child seat top strap. This only applies to the seats designed with the top strap provision and for the vehicles sold in Canada. In order to ensure the correct top strap angle, the child seat is only to be used at the seating position for which the top strap anchor is installed.

Fasten Safety Belt Indicators

There are 2 fasten safety belt indicators for this vehicle. The driver fasten safety belt reminder is located on the instrument panel cluster (IPC) and the passenger fasten safety belt reminder is located in the PASSENGER AIR BAG ON/OFF status indicator. The fasten safety belt indicator is only illuminated with the ignition in the RUN position. The IPC illuminates the fasten safety belt indicator under the following condition:

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After a bulb check the SDM controls both indicators by using a serial data communications message to request illumination. If either seat belt is unfastened, (passenger indicator will only illuminate after an approximate 25 second delay, and only if an occupant is seated in the front passenger seat), the SDM will illuminate the appropriate fasten safety belt indicator for 20 seconds of solid illumination and then 55 seconds of flashing illumination before turning OFF or immediately turn OFF when the seat belt is fastened. If the driver seat belt is unfastened within 8 seconds following a key transition to RUN the SDM sends a message requesting 5 chimes to sound. When the enhanced reminder function is enabled the illumination and chime sequence will repeat after approximately 30 seconds and then again after 3 minutes if the seat belt remains unfastened and vehicle speed is greater than 5 mph.

Article GUID: A00737172

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Inflatable Restraint Front End Sensor Fasteners	11 Â± 1.5 N.m	97 Â± 13 lb in
Inflatable Restraint Instrument Panel (I/P) Module Fasteners	10 N.m	89 lb in
Inflatable Restraint Roof Rail Module Fasteners	9 N.m	80 lb in
Inflatable Restraint Sensing and Diagnostic Module (SDM) Fasteners	10 N.m	89 lb in
Inflatable Restraint Side Impact Module Fasteners	5 N.m	45 lb in
Inflatable Restraint Side Impact Sensor (SIS) Fasteners	10 N.m	89 lb in
Seat Shoulder Belt Retractor Pretensioner Anchor Fastener	42 N.m	31 lb ft
Seat Shoulder Belt Retractor Pretensioner Fastener	42 N.m	31 lb ft
Seat Shoulder Belt Retractor Pretensioner Guide Fastener	42 N.m	31 lb ft

SCHEMATIC WIRING DIAGRAMS

SIR WIRING SCHEMATICS

Power, Ground, Serial Data, Sensors, and Indicators

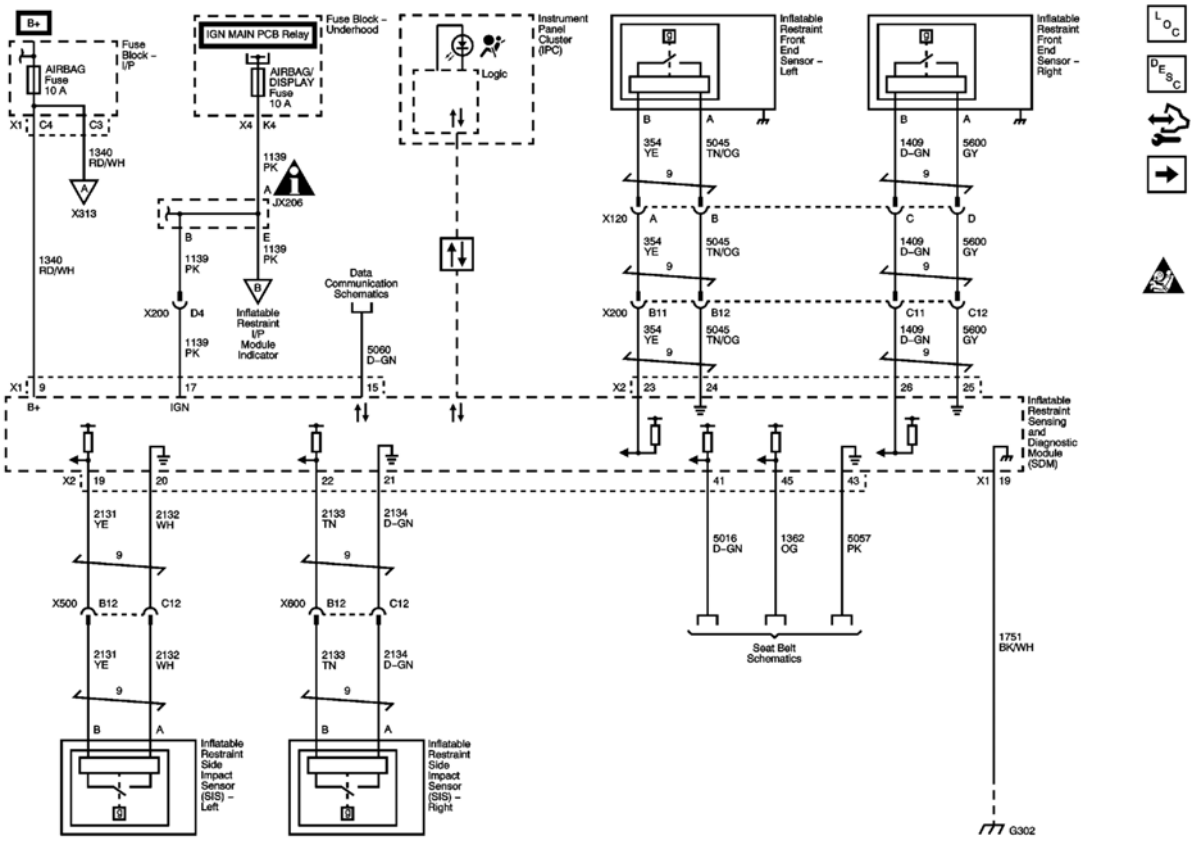


Fig. 1: Power, Ground, Serial Data, Sensors, and Indicators Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Deployment Loops

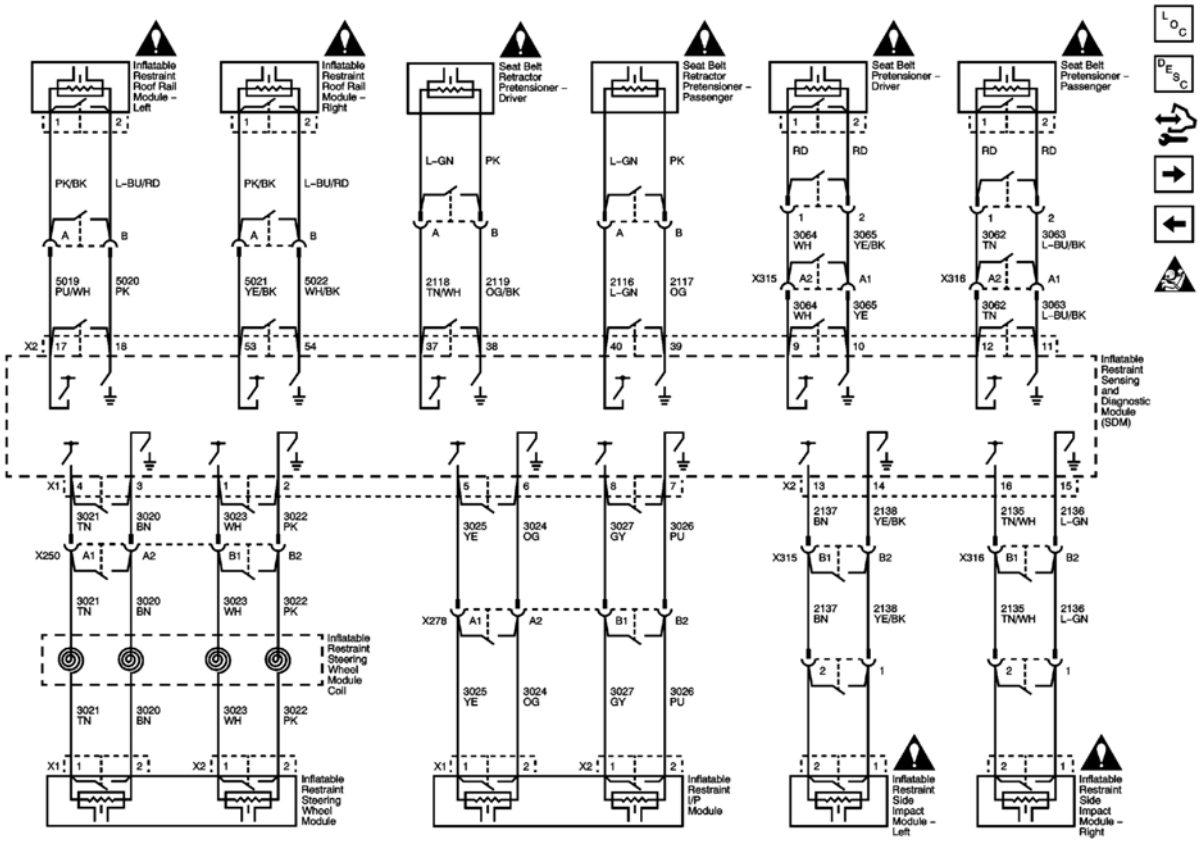


Fig. 2: Deployment Loops Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Passenger Presence System

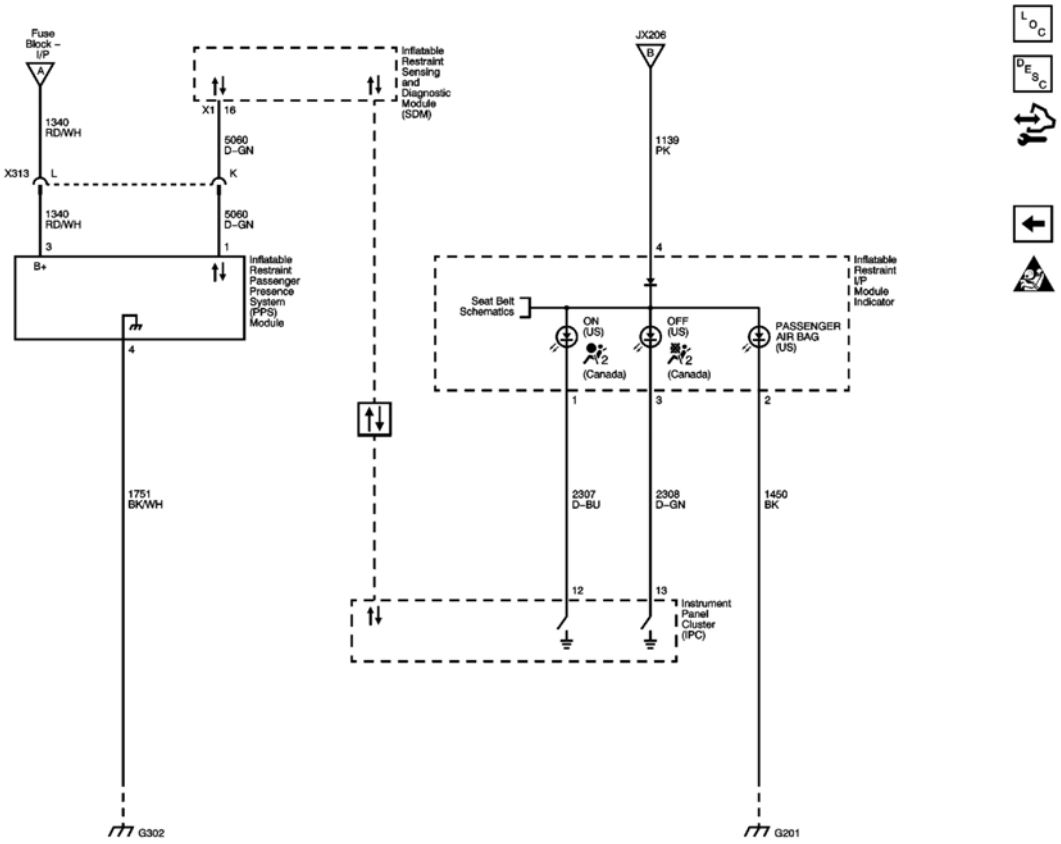


Fig. 3: Passenger Presence System Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B0012 OR B0013: STEERING WHEEL AIR BAG DEPLOYMENT LOOP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

DTC Descriptors

DTC B0012 01

Driver Steering Wheel Air Bag Deployment Loop Stage 1 Short to Battery

DTC B0012 02

Driver Steering Wheel Air Bag Deployment Loop Stage 1 Short to Ground

DTC B0012 08

Driver Steering Wheel Air Bag Deployment Loop Stage Signal Invalid

DTC B0012 0D

Driver Steering Wheel Air Bag Deployment Loop Stage 1 High Resistance

DTC B0012 0E

Driver Steering Wheel Air Bag Deployment Loop Stage 1 Low Resistance

DTC B0013 01

Driver Steering Wheel Air Bag Deployment Loop Stage 2 Short to Battery

DTC B0013 02

Driver Steering Wheel Air Bag Deployment Loop Stage 2 Short to Ground

DTC B0013 08

Driver Steering Wheel Air Bag Deployment Loop Stage Signal Invalid

DTC B0013 0D

Driver Steering Wheel Air Bag Deployment Loop Stage 2 High Resistance

DTC B0013 0E

Driver Steering Wheel Air Bag Deployment Loop Stage 2 Low Resistance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Driver Steering Wheel Air Bag Stage 1 High Control	B0012 02, B0012 0E	B0012 0D	B0012 08	B0012 01	-
Driver Steering Wheel Air Bag Stage 1 Low Control	B0012 02, B0012 0E	B0012 0D	B0012 08	B0012 01	-
Driver Steering Wheel Air Bag Stage 2 High Control	B0013 02, B0013 0E	B0013 0D	B0012 08	B0013 01	-
Driver Steering Wheel Air Bag Stage 2 Low Control	B0013 02, B0013 0E	B0013 0D	B0012 08	B0013 01	-

Circuit/System Description

During a frontal crash of sufficient force the Inflatable Restraint Sensing and Diagnostic Module will allow current to flow through the deployment loop in order to deploy the driver Steering Wheel Air Bag. The Inflatable Restraint Sensing and Diagnostic Module performs continuous diagnostic tests on the deployment loops to check for proper circuit continuity and for shorts to ground or voltage. There are 2 shorting bars used

within the driver Steering Wheel Air Bag coil connector which will short together both driver Steering Wheel Air Bag stage 1 high circuit and driver Steering Wheel Air Bag stage 1 low circuit and both driver Steering Wheel Air Bag stage 2 high circuit and driver Steering Wheel Air Bag stage 2 low circuit when the connector is disconnected. This will help to prevent unwanted deployment of the Steering Wheel Air Bag during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0012 01 stage 1 or B0013 01 stage 2

The driver Steering Wheel Air Bag deployment loop is shorted to voltage for 2 seconds.

B0012 02 stage 1 or B0013 02 stage 2

The driver Steering Wheel Air Bag deployment loop is shorted to ground for 2 seconds.

B0012 08 stage 1 or B0013 08 stage 2

The driver Steering Wheel Air Bag deployment loop is invalid during Inflatable Restraint Sensing and Diagnostic Module initialization.

B0012 0D stage 1 or B0013 0D stage 2

The driver Steering Wheel Air Bag deployment loop resistance is greater than 4.4 Ω for 2 seconds.

B0012 0E stage 1 or B0013 0E stage 2

The driver Steering Wheel Air Bag deployment loop resistance is less than 1.7 Ω for 2 seconds.

Action Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the Instrument Cluster to illuminate the AIR BAG indicator.
- The Inflatable Restraint Sensing and Diagnostic Module will store a DTC, however if an event occurs the system will still attempt deployment.

Conditions for Clearing the DTC

- The condition for setting the DTC is no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aid

NOTE: The following diagnostic aids apply for both current and history DTCs.

A worn Steering Wheel Air Bag coil can cause a repeated history DTC to set. To verify this condition, turn the steering wheel 360 degrees in one direction then back 360 degrees in the other direction, multiple times, while viewing the scan tool Deployment Loop Resistance 1 and 2 parameters.

An incorrectly installed connector position assurance (CPA) or incorrectly seated connector can cause a shorting bar to short both control circuits together. Check the connectors and CPAs if a DTC with symptom byte 02 or 0E is set, to ensure the shorting bars are not causing the circuits to be shorted together. Shorting bars are used in the locations listed below:

- Steering Wheel Air Bag assembly
- Steering Wheel Air Bag Coil assembly
- Inline harness connectors
- Harness side of the Inflatable Restraint Sensing and Diagnostic Module connector

Terminal fretting or incorrectly seated connector can cause an open/high resistance condition. Check the circuit terminals for fretting or incorrectly seated connector if a DTC with symptom byte 04 or 0D is set.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38125-580 Terminal Release Tool Kit

Circuit/System Verification

NOTE:

- **Refer to SIR Service Precautions**
- **Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.**
  - **Driver Steering Wheel Air Bag**

- **Driver Steering Wheel Air Bag coil**
- **Inflatable Restraint Sensing and Diagnostic Module**
- **Air bag wiring harness connector**
- **Inflatable Restraint Sensing and Diagnostic Module wiring harness connector**

- **The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.**
- **If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.**

1. Verify the appropriate scan tool Deployment Loop Resistance parameters stay consistently between 2.1 and 4.0 Ω without any spikes or dropouts while turning the steering wheel 360 degrees in one direction then back 360 degrees in the other direction.
   - **If less than 2.1 or greater than 4.0 Ω**

     Refer to Circuit/System Testing.

   - **If there are spikes or dropouts**

     Replace the X85 Steering Wheel Air Bag Coil.

   - **If within 2.1 and 4.0 Ω without any spikes or dropouts**
2. Verify DTC B0012 or B0013 is only set as a history DTC.
   - **If the DTC is set as current**

     Refer to Circuit/System Testing.

   - **If the DTC is set as history**
3. Verify the scan tool Deployment Loop Resistance parameters stay consistently between 2.1 and 4.0 Ω without any drop outs or spikes while moving the harness near each connector listed below.
   - X85 Steering Wheel Air Bag coil
   - F107 Steering Wheel Air Bag
   - Any inline harness connector
   - K36 Inflatable Restraint Sensing and Diagnostic Module
   - **If the reading is erratic while moving the harness, perform the following**
   - Inspect each connector terminal for damage or corrosion and repair as necessary.
   - Apply dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to each connector terminal.
   - Ensure each connector and CPA is correctly seated.
   - **If within 2.1 and 4.0 Ω without any spikes or dropouts**

4. All OK

Circuit/System Testing

1. Ignition OFF. Disconnect the scan tool. Disconnect the appropriate harness connector listed below at the F107 Steering Wheel Air Bag.
    - DTC B0012 connector X1
    - DTC B0013 connector X2
2. At the harness connector, test for greater than 25 Ω between the control circuit terminal 1 and the control circuit terminal 2.
    - **If 25 Ω or less**
    1. Disconnect the X1 harness connector at the Inflatable Restraint Sensing and Diagnostic Module.

        NOTE: **Some connectors may be equipped with shorting bars as a safety component to prevent accidental inflator deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the connector, shorting bar, or terminal when depressing the shorting bar.**

    2. Test for infinite resistance between the two control circuits.
        - If less than infinite resistance, repair the short between the two circuits.
        - If infinite resistance, replace the Inflatable Restraint Sensing and Diagnostic Module.
    - **If greater than 25 Ω**
3. Ignition ON.
4. Test for less than 11 V between the control circuit terminals listed below and ground:
    - Control circuit terminal 1
    - Control circuit terminal 2
    - **If 11 V or greater**
    1. Ignition OFF, disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module, ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
    - **If less than 11 V**
5. Ignition OFF.
6. Test for greater than 25 Ω between the control circuit terminals listed below and ground:
    - Control circuit terminal 1
    - Control circuit terminal 2
    - **If 25 Ω or less**

1. Disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
2. Test for infinite resistance between the control circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If greater than 25 Ω**

7. Ignition OFF, install a 3 A fused jumper wire between the control circuit terminal 1 and the control circuit terminal 2, ignition ON.
8. Verify the scan tool Deployment Loop Resistance parameter is consistently less than 2 Ω while turning the steering wheel 360 degrees in one direction then back 360 degrees in the other direction.
    - **If the reading is erratic while turning the steering wheel**

      Replace the X85 Steering Wheel Air Bag.

    - **If 2 Ω or greater**

    1. Ignition OFF, disconnect the X1 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
    2. Test for less than 2 Ω in the X85 Steering Wheel Air Bag coil and each control circuit end to end.
        - If 2 Ω or greater, replace the coil or repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

    - **If less than 2 Ω**

9. Ignition OFF, disconnect the 3 A fused jumper wire. Connect the harness connector at the F107 Steering Wheel Air Bag, press in the CPA (if equipped) until an audible and/or tactile click is heard.
10. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
11. Verify DTC B0012 is not set.
    - **If DTC B0012 is set**

      Replace the F107 Steering Wheel Air Bag.

    - **If DTC B0012 is not set**

12. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Steering Wheel Airbag Coil Replacement**
- **Airbag Steering Wheel Module Replacement**
- **SIR/SRS Wiring Repairs**
- **Control Module References** for Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B0014, B0021, B0031, OR B0038: SEAT SIDE AIR BAG DEPLOYMENT LOOP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0014 01

Driver Seat Side Air Bag Deployment Loop Short to Battery

DTC B0014 02

Driver Seat Side Air Bag Deployment Loop Short to Ground

DTC B0014 08

Driver Seat Side Air Bag Deployment Loop Signal Invalid

DTC B0014 0D

Driver Seat Side Air Bag Deployment Loop High Resistance

DTC B0014 0E

Driver Seat Side Air Bag Deployment Loop Low Resistance

DTC B0021 01

Passenger Seat Side Air Bag Deployment Loop Short to Battery

DTC B0021 02

Passenger Seat Side Air Bag Deployment Loop Short to Ground

DTC B0021 08

Passenger Seat Side Air Bag Deployment Loop Signal Invalid

DTC B0021 0D

Passenger Seat Side Air Bag Deployment Loop High Resistance

DTC B0021 0E

Passenger Seat Side Air Bag Deployment Loop Low Resistance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Left Front Side Air Bag High Control	B0014 02, B0014 0E	B0014 0D	B0014 08	B0014 01	-

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Left Front Side Air Bag Low Control	B0014 02, B0014 0E	B0014 0D	B0014 08	B0014 01	-
Right Front Side Air Bag High Control	B0021 02, B0021 0E	B0021 0D	, B0021 08	B0021 01	-
Right Front Side Air Bag Low Control	B0021 02, B0021 0E	B0021 0D	B0021 08	B0021 01	-

Circuit/System Description

During a side or frontal crash of sufficient force the Inflatable Restraint Sensing and Diagnostic Module will allow current to flow through the deployment loop in order to deploy an air bag. There are 2 shorting bars used within the connector that will short together the control circuits, when the connector is disconnected. This will help to prevent unwanted deployment of the air bag or retractor pretensioner during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0014 01, B0021 01

The air bag control circuit is shorted to voltage for 2 seconds.

B0014 02, B0021 02

The air bag control circuit is shorted to ground for 2 seconds.

B0014 08, B0021 08

The air bag control circuit is open for 2 seconds.

B0014 0D, B0021 0D

The air bag deployment loop resistance is greater than 4.2 Ω for 2 seconds.

B0014 0E, B0021 0E

The air bag deployment loop resistance is less than 1.4 Ω for 2 seconds.

Action Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the Instrument Cluster to illuminate the AIR BAG indicator.
- The Inflatable Restraint Sensing and Diagnostic Module will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aid

NOTE: The following diagnostic aids apply for both current and history DTCs.

An incorrectly installed connector position assurance (CPA) or incorrectly seated connector can cause a shorting bar to short both control circuits together. Check the connectors and CPAs if a DTC with symptom byte 02 or 0E is set, to ensure the shorting bars are not causing the circuits to be shorted together. Shorting bars are used in the locations listed below:

- Left and right Seat Side Air Bags
- Inline harness connectors
- Harness side of the Inflatable Restraint Sensing and Diagnostic Module connector

Terminal fretting or incorrectly seated connector can cause an open/high resistance condition. Check the circuit terminals for fretting or incorrectly seated connector if a DTC with symptom byte 04 or 0D is set. DTCs of deployment loops which are in the seat can occur because of stress or damage to the harness due to seat movement. Move the seat to the full extent of travel while using the scan tool to observe deployment type loop parameters.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38125-580 Terminal Release Tool Kit

Circuit/System Testing

NOTE:

- **Refer to SIR Service Precautions**
- **Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.**
  - **Seat side air bag**
  - **Inflatable Restraint Sensing and Diagnostic Module**
  - **All wiring harness connectors**
  - **Inflatable Restraint Sensing and Diagnostic Module wiring harness connector**
- **The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.**
- **If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.**

1. Ignition OFF, disconnect the scan tool and then disconnect the appropriate F106 Side Air Bag. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for greater than 25 Ω between the control circuit terminals 1 and 2.
   - **If 25 Ω or less**
   1. Disconnect the harness connector listed below at the K36 Inflatable Restraint Sensing and Diagnostic Module:
      - DTC B0014 - connector X1
      - DTC B0021 - connector X2

      NOTE: **Some connectors may be equipped with shorting bars as a safety component to prevent accidental inflator deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the connector, shorting bar, or terminal when depressing the shorting bar.**

   2. Test for infinite resistance between the two control circuits.
      - If less than infinite resistance, repair the short between the two circuits.
      - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
   - **If greater than 25 Ω**
3. Ignition ON.

4. Test for less than 11 V between the control circuit terminals listed below and ground:
    - F106LF Seat Air Bag - Left Front control circuit terminal 1 X1
    - F106LF Seat Air Bag - Left Front control circuit terminal 2 X1
    - F106RF Seat Air Bag - Right Front control circuit terminal 1 X1
    - F106RF Seat Air Bag - Right Front control circuit terminal 2 X1
    - **If 11 V or greater**

      Repair the short to voltage on the circuit.

    - **If less than 11 V**
5. Ignition OFF.
6. Test for greater than 25 Ω between the control circuit terminals listed below and ground:
    - F106LF Seat Air Bag - Left Front control circuit terminal 1 X1
    - F106LF Seat Air Bag - Left Front control circuit terminal 2 X1
    - F106RF Seat Air Bag - Right Front control circuit terminal 1 X1
    - F106RF Seat Air Bag - Right Front control circuit terminal 2 X1
    - **If 25 Ω or less**

      Repair the short to ground on the circuit.

    - **If greater than 25 Ω**
7. Ignition OFF, disconnect the harness connectors at the Inflatable Restraint Sensing and Diagnostic Module.
8. Test for less than 2 Ω between each harness connector terminal listed below end to end:
    - F106LF Seat Air Bag - Left Front control circuit terminal 1 X1 and K36 Inflatable Restraint Sensing and Diagnostic Module 6 X1
    - F106LF Seat Air Bag - Left Front control circuit terminal 2 X1 and K36 Inflatable Restraint Sensing and Diagnostic Module 5 X1
    - F106RF Seat Air Bag - Right Front control circuit terminal 1 X1 and K36 Inflatable Restraint Sensing and Diagnostic Module 5 X2
    - F106RF Seat Air Bag - Right Front control circuit terminal 2 X1 and K36 Inflatable Restraint Sensing and Diagnostic Module 6 X2
    - **If 2 Ω or greater**

      Repair the open/high resistance in the circuit.

    - **If less than 2 Ω**
9. Ignition OFF, connect all harness connectors, press in the CPA (if equipped) until an audible and/or tactile click is heard.
10. Ignition ON.
11. Clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
12. Verify DTC B0014 or B0021 is not set.
    - **If DTC B0014 or B0021 is set**

Replace the appropriate F106 Side Air Bag.

- **If DTC B0014 or B0021 is not set**

13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Seat Outboard Seat Back Airbag Replacement**
- **Control Module References** for Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B0015, B001A, B001B, OR B0022: SEAT BELT ANCHOR PRETENSIONER DEPLOYMENT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0015 01

Driver Seat Belt Retractor Pretensioner Deployment Loop Short to Battery

DTC B0015 02

Driver Seat Belt Retractor Pretensioner Deployment Loop Short to Ground

DTC B0015 04

Driver Seat Belt Retractor Pretensioner Deployment Loop Open

DTC B0015 0D

Driver Seat Belt Retractor Pretensioner Deployment Loop High Resistance

DTC B0015 0E

Driver Seat Belt Retractor Pretensioner Deployment Loop Low Resistance

DTC B001A 01

Driver Seat Belt Anchor Pretensioner Deployment Loop Short to Battery

DTC B001A 02

Driver Seat Belt Anchor Pretensioner Deployment Loop Short to Ground

DTC B001A 04

Driver Seat Belt Anchor Pretensioner Deployment Loop Open

DTC B001A 0D

Driver Seat Belt Anchor Pretensioner Deployment Loop High Resistance

DTC B001A 0E

Driver Seat Belt Anchor Pretensioner Deployment Loop Low Resistance

DTC B001B 01

Passenger Seat Belt Anchor Pretensioner Deployment Loop Short to Battery

DTC B001B 02

Passenger Seat Belt Anchor Pretensioner Deployment Loop Short to Ground

DTC B001B 04

Passenger Seat Belt Anchor Pretensioner Deployment Loop Open

DTC B001B 0D

Passenger Seat Belt Anchor Pretensioner Deployment Loop High Resistance

DTC B001B 0E

Passenger Seat Belt Anchor Pretensioner Deployment Loop Low Resistance

DTC B0022 01

Passenger Seat Belt Retractor Pretensioner Deployment Loop Short to Battery

DTC B0022 02

Passenger Seat Belt Retractor Pretensioner Deployment Loop Short to Ground

DTC B0022 04

Passenger Seat Belt Retractor Pretensioner Deployment Loop Open Circuit

DTC B0022 0D

Passenger Seat Belt Retractor Pretensioner Deployment Loop High Resistance

DTC B0022 0E

Passenger Seat Belt Retractor Pretensioner Deployment Loop Low Resistance

Diagnostic Fault Information

Circuit	Short to	High	Open	Short to	Signal

	Ground	Resistance		Voltage	Performance
Driver Seat Belt Retractor Pretensioner High Control	B0015 02, B0015 0E	B0015 0D	B0015 04, B0015 0D	B0015 01	-
Driver Seat Belt Retractor Pretensioner Low Control	B0015 02, B0015 0E	B0015 0D	B0015 04, B0015 0D	B0015 01	-
Driver Seat Belt Anchor Pretensioner Low Control	B001A 02, B001A 0E	B001A 0D	B001A 04	B001A 01	-
Driver Seat Belt Anchor Pretensioner High Control	B001A 02, B001A 0E	B001A 0D	B001A 04	B001A 01	-
Passenger Seat Belt Anchor Pretensioner Low Control	B001B 02, B001B 0E	B001B 0D	B001B 04	B001B 01	-
Passenger Seat Belt Anchor Pretensioner High Control	B001B 02, B001B 0E	B001B 0D	B001B 04	B001B 01	-
Passenger Seat Belt Retractor Pretensioner High Control	B0022 02, B0022 0E	B0022 0D	B0022 04, B0022 0D	B0022 01	-
Passenger Seat Belt Retractor Pretensioner Low Control	B0022 02, B0022 0E	B0022 0D	B0022 04, B0022 0D	B0022 01	-

Circuit/System Description

During a side or frontal crash of sufficient force the Inflatable Restraint Sensing and Diagnostic Module (SDM) will allow current to flow through the deployment loop in order to deploy an air bag or pretensioner. There are 2 shorting bars which will short together control circuits, when the connector is disconnected. This will help to prevent unwanted deployment of the air bag or pretensioner during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0015 01, B001A 01, B001B 01, B0022 01

The pretensioner control circuit is shorted to voltage for 2 seconds.

B0015 02, B001A 02, B001B 02, B0022 02

The pretensioner control circuit is shorted to ground for 2 seconds.

B0015 04, B001A 04, B001B 04, B0022 04

The pretensioner control circuit is open for 2 seconds.

B0015 0D, B001A 0D, B001B 0D, B0022 0D

The pretensioner deployment loop resistance is greater than 4.2 Ω for 2 seconds.

B0015 0E, B001A 0E, B001B 0E, B0022 0E

The pretensioner deployment loop resistance is less than 1.4 Ω for 2 seconds.

Action Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the instrument cluster to illuminate the AIR BAG indicator.
- The Inflatable Restraint Sensing and Diagnostic Module will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aid

NOTE: The following diagnostic aids apply for both current and history DTCs.

An incorrectly installed connector position assurance (CPA) or incorrectly seated connector can cause a shorting bar to short both control circuits together. Check the connectors and CPAs if a DTC with symptom byte 02 or 0E is set, to ensure the shorting bars are not causing the circuits to be shorted together. Shorting bars are used in the locations listed below:

- Driver and passenger anchor or retractor pretensioners
- Inline harness connectors
- Harness side of the Inflatable Restraint Sensing and Diagnostic Module connector

Terminal fretting or incorrectly seated connectors can cause an open/high resistance condition. Check the circuit terminals for fretting or incorrectly seated connector if a DTC with symptom byte 04 or 0D is set. DTCs of deployment loops which are in the seat can occur because of stress or damage to the harness due to seat movement. Move the seat to the full extent of travel while using the scan tool to observe deployment type loop parameters.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- Circuit Testing
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs
- Connector Repairs

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38125-580 Terminal Release Tool Kit

Circuit/System Verification

NOTE: **Refer to SIR Service Precautions.**

Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.

- **Seat Belt Retractor Pretensioner**
- **Seat Belt Anchor Pretensioner**
- **Inflatable Restraint Sensing and Diagnostic Module**
- **Seat Belt Retractor Pretensioner wiring harness connector**
- **Seat Belt Anchor Pretensioner wiring harness connector**
- **Inflatable Restraint Sensing and Diagnostic Module wiring harness connector**

NOTE: **The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.**

If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.

1. Verify the appropriate scan tool Deployment Loop Resistance parameters stay consistently between 2.1 and 4.0 Ω without any spikes or dropouts while moving the harness near each connector listed below:
   - F112 Seat Belt Retractor Pretensioner
   - F113 Seat Belt Anchor Pretensioner
   - Any inline harness connector
   - K36 Inflatable Restraint Sensing and Diagnostic Module
   - **If less than 2.1 or greater than 4.0 Ω**

Refer to Circuit/System Testing.

- **If there are spikes or dropouts, perform the following**
- Inspect each connector terminal and harness for damage or corrosion and repair as necessary
- Apply dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087) to each connector terminal
- Insure each connector and CPA is correctly seated.
- **If within 2.1 and 4.0 Ω without any spikes or dropouts**

2. All OK

Circuit/System Testing

1. Ignition OFF. Scan tool disconnected. Disconnect the appropriate harness connector listed below:
   - F112 Seat Belt Retractor Pretensioner
   - F113 Seat Belt Anchor Pretensioner
2. Test for greater than 25 Ω between the control circuit terminals 1 and 2.
   - **If 25 Ω or less**
   1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.

      NOTE: **Some connectors may be equipped with shorting bars as a safety component to prevent accidental deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the connector, shorting bar, or terminal when depressing the shorting bar.**

   2. Test for infinite resistance between the two control circuits.
      - If less than infinite resistance, repair the short between the two circuits.
      - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
   - **If greater than 25 Ω**
3. Ignition ON.
4. Test for less than 11 V between the control circuit terminals listed below and ground:
   - Control circuit terminal 1
   - Control circuit terminal 2
   - **If 11 V or greater**
   1. Ignition OFF. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module. Ignition ON
   2. Test for less than 1 V between the control circuit and ground.
      - If 1 V or greater, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If less than 11 V**

5. Ignition OFF.
6. Test for greater than 25 Ω between the control circuit terminals listed below and ground:
    - Control circuit terminal 1
    - Control circuit terminal 2
    - **If 25 Ω or less**
    1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
    - **If greater than 25 Ω**
7. Install a 3 A fused jumper wire between the control circuit terminals 1 and 2. Ignition ON.
8. Verify the appropriate scan tool Deployment Loop Resistance parameter is less than 2 Ω.
    - **If 2 Ω or greater**
    1. Ignition OFF. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
    2. Test for less than 2 Ω in each control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
    - **If less than 2 Ω**
9. Ignition OFF, connect the harness connector at the F112 Seat Belt Retractor Pretensioner or F113 Seat Belt Anchor Pretensioner, press in the CPA (if equipped) until an audible and/or tactile click is heard.
10. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
11. Verify DTC B0015, B001A, B001B, or B0022 is not set.
    - **If DTC B0015, B001A, B001B, or B0022 is set**

      Replace the appropriate F112 Seat Belt Retractor Pretensioner or F113 Seat Belt Anchor Pretensioner.

    - **If DTC B0015, B001A, B001B, or B0022 is not set**
12. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Front Seat Belt Anchor Plate Tensioner Replacement**
- **Seat Belt Retractor Pretensioner Replacement - Front**
- **SIR/SRS Wiring Repairs**
- **Control Module References** for Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B0016, B0018, B0023, OR B0025: ROOF RAIL AIR BAG DEPLOYMENT LOOP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0016 01

Left Roof Rail Air Bag Deployment Loop Short to Battery

DTC B0016 02

Left Roof Rail Air Bag Deployment Loop Short to Ground

DTC B0016 08

Left Roof Rail Air Bag Deployment Loop Signal Invalid

DTC B0016 0D

Left Roof Rail Air Bag Deployment Loop High Resistance

DTC B0016 0E

Left Roof Rail Air Bag Deployment Loop Low Resistance

DTC B0023 01

Right Roof Rail Air Bag Deployment Loop Short to Battery

DTC B0023 02

Right Roof Rail Air Bag Deployment Loop Short to Ground

DTC B0023 08

Right Roof Rail Air Bag Deployment Loop Signal Invalid

DTC B0023 0D

Right Roof Rail Air Bag Deployment Loop High Resistance

DTC B0023 0E

Right Roof Rail Air Bag Deployment Loop Low Resistance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Left Roof Rail Air Bag High Control	B0016 02, B0016 0E	B0016 0D	B0016 08	B0016 01	-
Left Roof Rail Air Bag Low Control	B0016 02, B0016 0E	B0016 0D	B0016 08	B0016 01	-
Right Roof Rail Air Bag High Control	B0023 02, B0023 0E	B0023 0D	B0023 08	B0023 01	-
Right Roof Rail Air Bag Low Control	B0023 02, B0023 0E	B0023 0D	B0023 08	B0023 01	-

Circuit/System Description

During a side or frontal crash of sufficient force the Inflatable Restraint Sensing and Diagnostic Module will allow current to flow through the deployment loop in order to deploy an air bag or pretensioner. There are 2 shorting bars which will short together control circuits, when the connector is disconnected. This will help to prevent unwanted deployment of the air bag or pretensioner during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0016 01, B0023 01

The air bag control circuit is shorted to voltage for 2 seconds.

B0016 02, B0023 02

The air bag control circuit is shorted to ground for 2 seconds.

B0016 08, B0023 08

The air bag control circuit is open for 2 seconds.

B0016 0D, B0023 0D

The air bag deployment loop resistance is greater than 4.2 Ω for 2 seconds.

B0016 0E, B0023 0E

The air bag deployment loop resistance is less than 1.4 Ω for 2 seconds.

Action Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the instrument cluster to illuminate the AIR BAG indicator.
- The Inflatable Restraint Sensing and Diagnostic Module will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aid

NOTE: The following diagnostic aids apply for both current and history DTCs.

An incorrectly installed connector position assurance (CPA) or incorrectly seated connector can cause a shorting bar to short both control circuits together. Check the connectors and CPAs if a DTC with symptom byte 02 or 0E is set, to ensure the shorting bars are not causing the circuits to be shorted together. Shorting bars are used in the locations listed below:

- Passenger Instrument Panel Air Bag
- Driver and passenger seat side air bags
- Left and right Roof Rail Air Bags
- Driver and passenger seat belt buckle pretensioners
- Inline harness connectors
- Harness side of the Inflatable Restraint Sensing and Diagnostic Module connector

Terminal fretting or incorrectly seated connectors can cause an open/high resistance condition. Check the circuit terminals for fretting or incorrectly seated connector if a DTC with symptom byte 04 or 0D is set. DTCs of deployment loops which are in the seat DTC can occur because of stress or damage to the harness due to seat movement. Move the seat to the full extent of travel while using the scan tool to observe deployment type loop parameters.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38125-580 Terminal Release Tool Kit

Circuit/System Testing

1. Ignition OFF. Scan tool disconnected. It may take up to 2 minutes for all vehicle systems to shut down. Disconnect the appropriate harness connected listed below:
    - DTC B0016 - Roof Rail Air Bag-Left
    - DTC B0023 - Roof Rail Air Bag-Right
2. At the harness connector, test for greater than 25 Ω between the control circuit terminals 1 and 2.
    - **If 25 Ω or less**
    1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.

        NOTE: **Some connectors may be equipped with shorting bars as a safety component to prevent accidental inflator deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the connector, shorting bar, or terminal when depressing the shorting bar.**

    2. Test for infinite resistance between the two control circuits.
        - If less than infinite resistance, repair the short between the two circuits.
        - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
    - **If greater than 25 Ω**
3. Ignition ON.
4. Test for less than 11 V between the control circuit terminals listed below and ground:
    - Control circuit terminal 1
    - Control circuit terminal 2
    - **If 11 V or greater**
    1. Ignition OFF. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module. Ignition ON.
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
    - **If less than 11 V**
5. Ignition OFF.
6. Test for greater than 25 Ω between the control circuit terminals listed below and ground:

- Control circuit terminal 1
- Control circuit terminal 2
- **If 25 Ω or less**

1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
2. Test for infinite resistance between the control circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If greater than 25 Ω**

7. Ignition OFF, disconnect the X2 harness connector at the Inflatable Restraint Sensing and Diagnostic Module.
8. Test for less than 2 Ω between each appropriate harness connector terminal listed below end to end:
    - F105L Roof Rail Air Bag - Left control circuit terminal 1 and K36 Inflatable Restraint Sensing and Diagnostic Module 1 X2
    - F105L Roof Rail Air Bag - Left control circuit terminal 2 and K36 Inflatable Restraint Sensing and Diagnostic Module 2 X2
    - F105R Roof Rail Air Bag - Right control circuit terminal 1 and K36 Inflatable Restraint Sensing and Diagnostic Module 4 X2
    - F105R Roof Rail Air Bag - Right control circuit terminal 2 and K36 Inflatable Restraint Sensing and Diagnostic Module 3 X2
    - **If 2 Ω or greater**

      Repair the open/high resistance in the circuit.

    - **If less than 2 Ω**
9. Ignition OFF, connect all harness connectors, press in the CPA (if equipped) until an audible and/or tactile click is heard.
10. Ignition ON.
11. Clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
12. Verify DTC B0016 or B0023 is not set.
    - **If DTC B0016 or B0023 is set**

      Replace the appropriate F105 Roof Rail Air Bag.

    - **If DTC B0016 or B0023 is not set**
13. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Roof Side Rail Airbag Replacement**
- **SIR/SRS Wiring Repairs**
- **Control Module References** for Inflatable Restraint Sensing and Diagnostic Module replacement,

programming and setup

DTC B0019 OR B0020: INSTRUMENT PANEL AIR BAG DEPLOYMENT LOOP

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0019 01

Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Short to Battery

DTC B0019 02

Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Short to Ground

DTC B0019 08

Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Signal Invalid

DTC B0019 0D

Passenger Instrument Panel Air Bag Deployment Loop Stage 1 High Resistance

DTC B0019 0E

Passenger Instrument Panel Air Bag Deployment Loop Stage 1 Low Resistance

DTC B0020 01

Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Short to Battery

DTC B0020 02

Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Short to Ground

DTC B0020 08

Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Signal Invalid

DTC B0020 0D

Passenger Instrument Panel Air Bag Deployment Loop Stage 2 High Resistance

DTC B0020 0E

Passenger Instrument Panel Air Bag Deployment Loop Stage 2 Low Resistance

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Passenger Instrument Panel Air Bag Stage 1 High Control	B0019 02, B0019 0E	B0019 0D	B0019 08	B0019 01	-
Passenger Instrument Panel Air Bag Stage 1 Low Control	B0019 02, B0019 0E	B0019 0D	B0019 08	B0019 01	-
Passenger Instrument Panel Air Bag Stage 2 High Control	B0020 02, B0020 0E	B0020 0D	B0020 08	B0020 01	-
Passenger Instrument Panel Air Bag Stage 2 Low Control	B0020 02, B0020 0E	B0020 0D	B0020 08	B0020 01	-

Circuit/System Description

During a side or frontal crash of sufficient force the Inflatable Restraint Sensing and Diagnostic Module will allow current to flow through the deployment loop in order to deploy an air bag or pretensioner. There are 2 shorting bars which will short together control circuits, when the connector is disconnected. This will help to prevent unwanted deployment of the air bag or pretensioner during servicing.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

B0019 01, B0020 01

The air bag control circuit is shorted to voltage for 2 seconds.

B0019 02, B0020 02

The air bag control circuit is shorted to ground for 2 seconds.

B0019 08, B0020 08

The air bag control circuit is open for 2 seconds.

B0019 0D, B0020 0D

The air bag deployment loop resistance is greater than 4.2 Ω for 2 seconds.

B0019 0E, B0020 0E

The air bag deployment loop resistance is less than 1.4 Ω for 2 seconds.

Action Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the instrument cluster to illuminate the

AIR BAG indicator.

- The Inflatable Restraint Sensing and Diagnostic Module will store a DTC, however if an event occurs the system will still attempt deployments.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aid

NOTE: The following diagnostic aids apply for both current and history DTCs.

An incorrectly installed connector position assurance (CPA) or incorrectly seated connector can cause a shorting bar to short both control circuits together. Check the connectors and CPAs if a DTC with symptom byte 02 or 0E is set, to ensure the shorting bars are not causing the circuits to be shorted together. Shorting bars are used in the locations listed below:

- Passenger Instrument Panel Air Bag
- Inline harness connectors
- Harness side of the Inflatable Restraint Sensing and Diagnostic Module connector

Terminal fretting or incorrectly seated connectors can cause an open/high resistance condition. Check the circuit terminals for fretting or incorrectly seated connector if a DTC with symptom byte 04 or 0D is set. DTCs of deployment loops which are in the seat can occur because of stress or damage to the harness due to seat movement. Move the seat to the full extent of travel while using the scan tool to observe deployment type loop parameters.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-38125-580 Terminal Release Tool Kit

Circuit/System Testing

NOTE:

- **Refer to SIR Service Precautions.**
- **Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or replacement of the affected component/connector.**
  - **Passenger Instrument Panel Air Bag**
  - **Passenger Instrument Panel Air Bag wiring harness connector**
  - **Inflatable Restraint Sensing and Diagnostic Module**
  - **Inflatable Restraint Sensing and Diagnostic Module wiring harness connector**
- **The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly.**
- **If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.**

1. Ignition OFF. Scan tool disconnected. Disconnect the F105 Passenger Instrument Panel Air Bag inline harness connector X278.
2. At the harness connector, test for greater than 25 Ω between the appropriate control circuit terminals listed below on the K36 Inflatable Restraint Sensing and Diagnostic Module side of the connector:
   - F105 Passenger Instrument Panel Air Bag stage 1 X278 terminal B1 and B2
   - F105 Passenger Instrument Panel Air Bag stage 2 X278 terminal A1 and A2
   - **If 25 Ω or less**
   1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.

      NOTE: **Some connectors may be equipped with shorting bars as a safety component to prevent accidental inflator deployment. When testing on a connector with shorting bars, the shorting bars must be disabled to ensure accurate test results. Insert an appropriate pick from EL-38125-580 and depress the shorting bars above the appropriate terminals. This will lift the shorting bar from the terminal and allow accurate test results. Take care not to damage the**

connector, shorting bar, or terminal when depressing the shorting bar.

2. Test for infinite resistance between the two control circuits.
    - If less than infinite resistance, repair the short between the two circuits.
    - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If greater than 25 Ω**

3. Ignition ON.
4. Test for less than 11 V between the control circuit terminals listed below and ground:
    - X278 control circuit terminal A1
    - X278 control circuit terminal A2
    - X278 control circuit terminal B1
    - X278 control circuit terminal B2

- **If 11 V or greater**

1. Ignition OFF. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module. Ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If less than 11 V**

5. Ignition OFF. Test for greater than 25 Ω between the control circuit terminals listed below and ground:
    - X278 control circuit terminal A1
    - X278 control circuit terminal A2
    - X278 control circuit terminal B1
    - X278 control circuit terminal B2

- **If 25 Ω or less**

1. Disconnect the X2 harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
2. Test for infinite resistance between the control circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If greater than 25 Ω**

6. Ignition OFF. Connect the inline harness connector X278. Disconnect the appropriate F105 Passenger Instrument Panel Air Bag harness connector.
7. Ignition ON.
8. Test for less than 11 V between the control circuit terminals listed below and ground:
    - F105 Passenger Instrument Panel Air Bag control circuit terminal 1 X1
    - F105 Passenger Instrument Panel Air Bag control circuit terminal 2 X1
    - F105 Passenger Instrument Panel Air Bag control circuit terminal 1 X2

- F105 Passenger Instrument Panel Air Bag control circuit terminal 2 X2
- **If 11 V or greater**

  Repair the short to voltage on the circuit.

- **If less than 11 V**

9. Ignition OFF.
10. Test for greater than 25 Ω between the control circuit terminals listed below and ground:
    - F105 Passenger Instrument Panel Air Bag control circuit terminal 1 X1
    - F105 Passenger Instrument Panel Air Bag control circuit terminal 2 X1
    - F105 Passenger Instrument Panel Air Bag control circuit terminal 1 X2
    - F105 Passenger Instrument Panel Air Bag control circuit terminal 2 X2
    - **If 25 Ω or less**

      Repair the short to ground on the circuit.

    - **If greater than 25 Ω**
11. Ignition OFF, disconnect the X1 harness connector at the Inflatable Restraint Sensing and Diagnostic Module.
12. Test for less than 2 Ω between each harness connector terminal listed below end to end:
    - F105 Passenger Instrument Panel Air Bag control circuit - terminal 1 X1 and K36 Inflatable Restraint Sensing and Diagnostic Module 1 X1
    - F105 Passenger Instrument Panel Air Bag control circuit - terminal 2 X1 and K36 Inflatable Restraint Sensing and Diagnostic Module 2 X1
    - F105 Passenger Instrument Panel Air Bag control circuit - terminal 1 X2 and K36 Inflatable Restraint Sensing and Diagnostic Module 4 X1
    - F105 Passenger Instrument Panel Air Bag control circuit - terminal 2 X2 and K36 Inflatable Restraint Sensing and Diagnostic Module 3 X1
    - **If 2 Ω or greater**

      Repair the open/high resistance in the circuit.

    - **If less than 2 Ω**
13. Ignition OFF, connect the harness connector at the F105 Passenger Instrument Panel Air Bag, press in the CPA (if equipped) until an audible and/or tactile click is heard.
14. Ignition OFF, connect all harness connectors, press in the CPA (if equipped) until an audible and/or tactile click is heard.
15. Ignition ON.
16. Clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
17. Verify DTC B0019 or B0020 is not set.
    - **If DTC B0019 or B0020 is set**

      Replace the F105 Passenger Instrument Panel Air Bag.

- **If DTC B0019 or B0020 is not set**

18. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Airbag Instrument Panel Module Replacement (Impala Limited)**
- **SIR/SRS Wiring Repairs**
- **Control Module References** for Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B0052: DEPLOYMENT COMMANDED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using the diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0052 00

Deployment Commanded

DTC B0052 56

Deployment Commanded Too Many Transitions

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) senses vehicle impacts and provides deployment signals to the air bags and anchor and/or retractor pretensioners when warranted. The inflatable restraint sensing and diagnostic module sets DTC B0052 after each command for deployment. DTC B0052 will latch and not clear after 3 commanded deployments by the inflatable restraint sensing and diagnostic module. Therefore the inflatable restraint sensing and diagnostic module has to be replaced.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

- The inflatable restraint sensing and diagnostic module detects a frontal impact of sufficient force to warrant deployment of the frontal air bags.
- The inflatable restraint sensing and diagnostic module detects a side impact or rollover (if equipped) of sufficient force to warrant deployment of a seat air bag and/or roof rail air bag.

Action Taken When the DTC Sets

The inflatable restraint sensing and diagnostic module requests the instrument cluster to illuminate the AIR BAG indicator.

Conditions for Clearing the DTC

- DTC B0052 00 is a DTC that may be cleared with a scan tool without replacing the inflatable restraint sensing and diagnostic module. This DTC will not clear if deployment has been commanded more then two times, and the inflatable restraint sensing and diagnostic module would have to be replaced.
- DTC B0052 56 is a latched DTC. The DTC cannot be cleared with the scan tool. Replacement of the inflatable restraint sensing and diagnostic module is required.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify that DTC B0052 00 is not set.
    - **If DTC B0052 00 is set**

      Clear the DTC. If the DTC will not clear, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

    - **If DTC B0052 00 is not set**
2. Verify that DTC B0052 56 is not set.
    - **If DTC B0052 56 is set**

      Replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If DTC B0052 56 is not set**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for inflatable restraint sensing and diagnostic module replacement, programming and setup

DTC B0055: SIDE AIR BAG DEPLOYMENT COMMANDED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category

DTC Descriptor

DTC B0055 00

Side Air Bag Deployment Commanded

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) contains a sensing device that converts vehicle velocity changes into an electrical signal. The SDM compares this electrical signal to a value stored in memory. When the generated signal exceeds the stored value, the SDM performs additional signal processing and compares the generated signals to values stored in memory. When 2 of the generated signals exceed the stored values, the SDM will cause current to flow through the air bags, deploying the side air bags and causing DTC B0055 to set.

This DTC is set when the SDM has commanded an air bag deployment with no faults present.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

- The SDM detects a frontal impact of sufficient force to warrant deployment of the frontal air bags.
- The SDM detects a side impact of sufficient force to warrant deployment of a side air bag and/or roof rail air bag.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM records crash data.

Conditions for Clearing the DTC

DTC B0055 is a latched code and cannot be cleared.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, Verify that the vehicle does not show any signs of side impact or frontal air bag deployment.
    - **If the vehicle displays any signs of air bag deployment**

      Refer to **Repairs and Inspections Required After a Collision**.

    - **If the vehicle does not show any signs of air bag deployment**
2. Verify DTC B0055 is not set.
    - **If DTC B0055 is set**

      Replace the K36 SDM

    - **If DTC B0055 is not set**
3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for SDM replacement, programming and setup

DTC B0056-B0058: AIR BAG/PRETENSIONER SUPPRESSED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0056 00

Passenger Frontal Air Bag Suppressed

DTC B0057 00

Passenger Side Air Bag Suppressed

DTC B0058 00

Passenger Pretensioner Suppressed

Circuit/System Description

When the ignition is turned ON, the passenger presence system (PPS) and the inflatable restraint sensing and diagnostic module (SDM) performs tests to diagnose critical malfunctions within itself. The PPS is used to monitor the weight of an occupant in the front passenger seat. If the pressure from the occupant's weight is less than a specified value or an empty seat is detected, the PPS module will send a suppress signal to the SDM to disable the passenger instrument panel air bag. When the PPS detects a fault within itself, then the PPS will communicate to the SDM through serial data communications that a PPS fault is present. The SDM will suppress the deployment of the module and then illuminate the AIR BAG indicator.

DTC B0056 sets because the PPS commanded to suppress the passenger instrument panel air bag when the vehicle was involved in a collision and the SDM has commanded an air bag deployment.

DTC B0057 sets because the PPS commanded to suppress the passenger seat side air bag when the vehicle was involved in a collision and the SDM has commanded an air bag deployment.

DTC B0058 sets because the PPS commanded to suppress the passenger seat belt pretensioners when the vehicle was involved in a collision and the SDM has commanded an air bag deployment.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

This DTC sets when the SDM has commanded an air bag deployment while the PPS has determined that the front passenger seat has one the following conditions:

- The pressure from the occupant's weight is less than a specified value. The PPS module sent a suppress signal to the SDM to suppress the passenger instrument panel air bag.

- Empty front passenger seat
- A PPS fault was detected

Action Taken When the DTC Sets

- DTC B0056 and B0058 will only set if there is a child seated or the passenger seat is empty.
- DTC B0052, B0053, or B0055 will set along with this DTC.
- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.

Conditions for Clearing the DTC

Any of the codes will set along with one of the following latched codes: DTC B0052, B0053, or B0055 and cannot be cleared.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition OFF, verify that the vehicle does not show any signs of air bag or pretensioner deployment.
    - If the vehicle displays any signs of deployment, refer to **Repairs and Inspections Required After a Collision**.
2. Verify DTC B0052, B0053, or B0055 is not set.
    - If DTC is set , refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
3. Clear DTCs. Verify DTC B0056, B0057, or B0058 is not set.
    - If DTC is set, replace the SDM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for SDM replacement, setup, and programming

DTC B0074: PASSENGER PRESENCE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0074 00

Passenger Presence Sensor

DTC B0074 0D

Passenger Presence Sensor Circuit Resistance Above Threshold

DTC B0074 0E

Passenger Presence Sensor Circuit Resistance Below Threshold

DTC B0074 0F

Passenger Presence Sensor Circuit Erratic (Wet Seat)

Circuit/System Description

The passenger presence sensor continually monitors itself and if a fault in this circuit occurs, a DTC will set in the passenger presence module. When the inflatable restraint sensing and diagnostic module (SDM) detects this DTC within the passenger presence module, it will notify the customer of the enable/disable status by illuminating the OFF indicator on the PASSENGER AIR BAG ON/OFF indicators. Then the passenger presence module will communicate to the SDM through serial data communications that a PPS fault is present. The SDM will then disable the deployment of the passenger instrument panel air bag and then illuminate the AIR BAG warning indicator.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

- The SDM has received a fault message from the passenger presence module.
- The passenger presence module detects a wet seat fault if DTC B0074 0F is set.

Action Taken When the DTC Sets

- The SDM disables the passenger instrument panel air bag deployment loop.
- The SDM will illuminate the OFF portion of the PASSENGER AIR BAG ON/OFF indicator.
- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aids

- If either the SDM or PPS were replaced verify that the correct part numbers were used for the vehicle application.
- If this DTC is set as either current or history it may have been caused by an electronic device. If an electronic device (Computers, MP3 Players, Cell Phones, Diagnostic Scan Tool, Power Inverter, etc.) was placed on the passenger seat the passenger presence module may command the passenger air bag indicator to turn on and/or command the passenger seat belt indicator to turn on. Make sure there are no objects on the passenger seat and clear the DTCs. If this DTC resets then perform this diagnostic. If the DTC does not reset there is no further work needed on the passenger presence system.
- If this DTC is set as either current or history it may have been caused by an aftermarket seat heater. The aftermarket seat heater may command the passenger air bag indicator to turn on and/or command the passenger seat belt indicator to turn on. Remove the aftermarket seat heater from the passenger seat and clear the DTCs. If this DTC resets then perform this diagnostic. If the DTC does not reset there is no further work needed on the passenger presence system.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

NOTE: **The passenger presence system (PPS) is a calibrated unit. When replacing the assembly all parts in the service kit must remain together. Do not mix any of the old parts with the new parts. PPS comes in as part of a service kit which contains a seat foam, presence sensor and a electronic control unit (ECU) module (if applicable).**

When removing connectors, inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector:

- **Passenger presence module**
- **Passenger presence sensor wiring harness**

1. Verify that no other passenger presence module DTCs are set.
   - If other passenger presence module DTCs are set, investigate those DTCs first.
2. Verify that DTC B0074 0F is not set.
   - If this DTC is set, verify there are no electronic devices on the passenger seat. If not, then verify the seat is dry by removing the trim from the seat bottom frame. IF the seat is wet, allow 24-48 hours dry time with trim completely off. If the DTC is history, do not replace the passenger presence module. Clear the passenger presence module codes.
3. Verify that DTC B0074 00, B0074 0D, or B0074 0E is not set.
   - If any of the DTCs are set then replace the passenger presence module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for passenger presence system replacement, programming and setup

DTC B0081: PASSENGER PRESENCE MODULE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0081 0F

Passenger Presence Module Erratic

DTC B0081 11

Passenger Presence Module Above Threshold (Build Check Failure)

DTC B0081 3A

Passenger Presence Module Incorrect Component Installed

DTC B0081 4B

Passenger Presence Module Calibration Not Learned

DTC B0081 5A

Passenger Presence Module Plausibility Failure

DTC B0081 71

Passenger Presence Module Invalid Serial Data Received

Circuit/System Description

When the ignition is turned ON, the Passenger Presence Module and the Inflatable Restraint Sensing and Diagnostic Module performs tests to diagnose critical malfunctions within itself. When the Inflatable Restraint Sensing and Diagnostic Module has completed the power-up mode, the Inflatable Restraint Sensing and Diagnostic Module will establish communication with the Passenger Presence Module. The Inflatable Restraint Sensing and Diagnostic Module will also request the instrument panel cluster to illuminate both of the PASSENGER AIR BAG ON/OFF indicators. If the Inflatable Restraint Sensing and Diagnostic Module detects that the Passenger Presence Module has set a current DTC, the Inflatable Restraint Sensing and Diagnostic Module will then disable the passenger instrument panel air bag deployment loop, set DTC B0081, and illuminate the AIR BAG indicator.

Conditions for Running the DTC

Ignition voltage is between 9-16 V.

Conditions for Setting the DTC

Any of the following conditions must exist for 5 seconds:

B0081 0F

- The Inflatable Restraint Sensing and Diagnostic Module has received a fault present message from the Passenger Presence Module.
- The Passenger Presence Module is in assembly plant mode and the Inflatable Restraint Sensing and Diagnostic Module is in production mode.

B0081 11

The Passenger Presence Module is above maximum threshold. The Passenger Presence Module failed the preload/build check.

B0081 3A

The Inflatable Restraint Sensing and Diagnostic Module has received a mismatch message indicating the wrong Passenger Presence Module is installed on the vehicle.

B0081 4B

The Passenger Presence Module is not calibrated. Preload/build check test not run.

B0081 5A

The Passenger Presence Module detects a plausibility error.

B0081 71

The Inflatable Restraint Sensing and Diagnostic Module has received invalid or no serial data from the Passenger Presence Module.

Action Taken When the DTC Sets

- The Inflatable Restraint Sensing and Diagnostic Module requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The passenger instrument panel air bag deployment loop will be disabled.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Diagnostic Aids

- If either the Inflatable Restraint Sensing and Diagnostic Module or Passenger Presence Module were replaced verify that the correct part numbers were used for the vehicle application.
- If this DTC is set as either current or history it may have been caused by an electronic device. If an electronic device (Computers, MP3 Players, Cell Phones, Diagnostic Scan Tool, Power Inverter, etc.) was placed on the passenger seat the Passenger Presence Module may command the passenger air bag indicator to turn on and/or command the passenger seat belt indicator to turn on. Make sure there are no objects on the passenger seat and clear the DTCs. If this DTC resets then perform this diagnostic. If the DTC does not reset there is no further work needed on the passenger presence system.
- If this DTC is set as either current or history it may have been caused by an aftermarket seat heater. The aftermarket seat heater may command the passenger air bag indicator to turn on and/or command the passenger seat belt indicator to turn on. Remove the aftermarket seat heater from the passenger seat and clear the DTCs. If this DTC resets then perform this diagnostic. If the DTC does not reset there is no further work needed on the passenger presence system.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, verify no Passenger Presence Module DTCs are set.
   - If any Passenger Presence Module DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Verify that DTC B0081 3A is not set .
   - If DTC B0081 3A is set, verify that the correct Passenger Presence Module is installed. If the incorrect Passenger Presence Module is installed, replace with the correct part number.
3. Verify that DTC B0081 4B is not set.
   - If DTC B0081 4B is set, refer to **Passenger Presence System Preload Test**
4. Verify that DTC B0081 11 is not set.
   - If DTC B0081 11 sets, perform the preload test. If the preload test fails, repeat the test. Refer to **Passenger Presence System Preload Test**.
5. Verify that DTC B1325 is not set.
   - If DTC B1325 is set, refer to **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, P0560, P0562, or P0563**

Circuit/System Testing

NOTE: **When removing connectors, inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected component/connector:**

- **Passenger Presence Module**
- **Inflatable Restraint Sensing and Diagnostic Module**
- **Passenger Presence Module harness connector**
- **Inflatable Restraint Sensing and Diagnostic Module wiring harness connector**

1. Ignition OFF, disconnect the harness connector at the Passenger Presence Module.
2. Ignition OFF, test for less then 10 Ω between the ground circuit terminal 4 and ground.
   - If greater then the specified range, test the ground circuit for an open/high resistance.

3. Ignition ON, verify a test lamp illuminates between the B+ circuit terminal 3 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. Reconnect all Passenger Presence Module components and perform the **Passenger Presence System Preload Test**.
5. Clear all DTCs and operate the vehicle. DTC B0081 should not set.
    - If DTC B0081 sets, replace the Passenger Presence Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **SIR/SRS Wiring Repairs**
- **Control Module References** for passenger presence system and Inflatable Restraint Sensing and Diagnostic Module replacement, programming and setup

DTC B0083-B0088: FRONT/FRONT SIDE IMPACT SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B0083 01

Left Front Impact Sensor Short to Battery

DTC B0083 02

Left Front Impact Sensor Short to Ground

DTC B0083 05

Left Front Impact Sensor Short to Battery or Open

DTC B0083 0F

Left Front Impact Sensor Erratic

DTC B0083 39

Left Front Impact Sensor Internal Electronic Failure

DTC B0083 3A

Left Front Impact Sensor Incorrect Component Installed

DTC B0083 71

Left Front Impact Sensor Invalid Serial Data Received

DTC B0084 01

Right Front Impact Sensor Short to Battery

DTC B0084 02

Right Front Impact Sensor Short to Ground

DTC B0084 05

Right Front Impact Sensor Short to Battery or Open

DTC B0084 0F

Right Front Impact Sensor Erratic

DTC B0084 39

Right Front Impact Sensor Internal Electronic Failure

DTC B0084 3A

Right Front Impact Sensor Incorrect Component Installed

DTC B0084 71

Right Front Impact Sensor Invalid Serial Data Received

DTC B0085 01

Left Front Side Impact Sensor Short to Battery

DTC B0085 02

Left Front Side Impact Sensor Short to Ground

DTC B0085 05

Left Front Side Impact Sensor Short to Battery or Open

DTC B0085 0F

Left Front Side Impact Sensor Erratic

DTC B0085 39

Left Front Side Impact Sensor Internal Electronic Failure

DTC B0085 3A

Left Front Side Impact Sensor Incorrect Component Installed

DTC B0085 71

Left Front Side Impact Sensor Invalid Serial Data Received

DTC B0086 01

Right Front Side Impact Sensor Short to Battery

DTC B0086 02

Right Front Side Impact Sensor Short to Ground

DTC B0086 05

Right Front Side Impact Sensor Short to Battery or Open

DTC B0086 0F

Right Front Side Impact Sensor Erratic

DTC B0086 39

Right Front Side Impact Sensor Internal Electronic Failure

DTC B0086 3A

Right Front Side Impact Sensor Incorrect Component Installed

DTC B0086 71

Right Front Side Impact Sensor Invalid Serial Data Received

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Left Front Impact Sensor High Signal	B0083 02	B0083 0F	B0083 05	B0083 01, B0083 05	B0083 0F
Left Front Impact Sensor Low Reference	B0083 02	B0083 0F	B0083 05	B0083 01, B0083 05	B0083 0F
Right Front Impact Sensor High Signal	B0084 02	B0084 0F	B0084 05	B0084 01, B0084 05	B0084 0F
Right Front Impact Sensor Low Reference	B0084 02	B0084 0F	B0084 05	B0084 01, B0084 05	B0084 0F
Left Front Side Impact Sensor High Signal	B0085 02	B0085 0F	B0085 05	B0085 01, B0085 05	B0085 0F
Left Front Side Impact Low Reference	B0085 02	B0085 0F	B0085 05	B0085 01, B0085 05	B0085 0F

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
Right Front Side Impact Sensor High Signal	B0086 02	B0086 0F	B0086 05	B0086 01, B0086 05	B0086 0F
Right Front Side Impact Low Reference	B0086 02	B0086 0F	B0086 05	B0086 01, B0086 05	B0086 0F

Circuit/System Description

The impact sensor utilizes a bidirectional 2-wire circuit. The impact sensor modulates current on the interface to send ID, state of health, and deployment commands to the inflatable restraint sensing and diagnostic module (SDM). The SDM serves as a power source and a ground for the impact sensor. When the ignition is turned ON and input power from the SDM is first detected, the impact sensor responds by performing internal diagnostics and sending an ID to the SDM. The SDM considers the ID to be valid if the response time is less than 5 seconds. The impact sensor continually communicates status messages to the SDM, which determines if a fault is present in the impact sensor circuit. When a fault is detected, the SDM may reset the impact sensor up to 2 times by removing and reapplying power to it. If the fault is still present, the SDM will set a DTC.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

Any of the following conditions exist for 2.5 seconds:

B0083 01, B0084 01, B0085 01, B0086 01

The impact sensor has been shorted to voltage.

B0083 02, B0084 02, B0085 02, B0086 02

- The impact sensor has been shorted to ground.
- The impact sensor current is greater than 23 mA for greater than 5 milliseconds.

B0083 05 or B0084 05, B0085 05, B0086 05

- The impact sensor has been shorted to voltage.
- The impact sensor circuit is open.
- The SDM has not received a message from the impact sensor for greater than 375 milliseconds.

B0083 0F, B0084 0F, B0085 0F, B0086 0F

The SDM has received erratic messages from the impact sensor.

B0083 39, B0084 39, B0085 39, B0086 39

- The SDM has received a Not OK (NOK) message from the impact sensor.
- The SDM has not received a message.

B0083 3A, B0084 3A, B0085 3A, B0086 3A

- The SDM has received an ID message from the impact sensor, which does not match the ID stored in the SDM memory.
- The SDM has reset the impact sensor twice without detecting the correct ID message.

B0083 71, B0084 71, B0085 71, B0086 71

The SDM has received invalid serial data from the impact sensor.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- SIR is disabled and no deployments are allowed.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE:

- **Refer to SIR Service Precautions.**
- **Inspect all terminals for damage or corrosion when disconnecting connectors. Damage or corrosion in the following requires repair or**

replacement of the affected component/connector.

- **Impact sensor**
- **Inflatable Restraint Sensing and Diagnostic Module**
- **Impact sensor wiring harness connector**
- **Inflatable Restraint Sensing and Diagnostic Module wiring harness connector**

- **The connector and connector position assurance (CPA) may seat independent of each other. Both the connector and CPA should seat with an audible and/or tactile click. The CPA isolates the shorting-bars within the connector allowing the deployment circuit to operate properly. Replace any CPA that is damaged or missing.**
- **If the condition is intermittent or cannot be duplicated, disconnect the connectors and add dielectric grease / lubricant (Nyogel 760G or equivalent, meeting GM specification 9986087). This procedure will correct the high resistance condition due to terminal fretting corrosion.**

1. Verify that DTC B0083-B0088 symptom byte 08, 0F, 3A, or 39 is not set as current.
   - **If DTC B0083-B0088 symptom byte 08, 0F, 3A, or 39 is set as current**

     Replace the appropriate Impact Sensor.

   - **If DTC B0083-B0088 symptom byte 08, 0F, 3A, or 39 is not set as current**
2. Verify that DTC B0083-B0088 symptom byte 02, 05 or 71 is not set as current.
   - **If DTC B0083-B0088 symptom byte 02, 05 or 71 is set as current**

     Refer to Circuit/System Testing.

   - **If DTC B0083-B0088 symptom byte 02, 05 or 71 is not set as current**
3. All OK.

Circuit/System Testing

1. Perform the Circuit/System Verification before proceeding.
2. Ignition OFF, disconnect the harness connector at the appropriate Impact Sensor. It may take up to 2 min for all vehicle systems to power down.
3. Test for less than 10 Ω between the appropriate low reference circuit terminal A and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF, disconnect the appropriate harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
   2. Test for less than 2 Ω in the low reference circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.
   - **If less than 10 Ω**
4. Test for greater than 50k Ω between the appropriate signal circuit terminal B and ground.

- **If 50k Ω or less**

1. Disconnect the appropriate harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
2. Test for infinite resistance between the signal circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If greater than 50k Ω**

5. Ignition ON, test for less than 1 V between the appropriate signal circuit terminal B and ground.
    - **If greater than 1 V**

    1. Disconnect the appropriate harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
    2. Ignition ON, test for less than 1 V between the signal circuit and ground.
        - If greater than 1 V, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

    - **If less than 1 V**

NOTE: **When using the MIN MAX function, autorange on the DMM may not function properly. To ensure accurate test results, turn off autorange and manually set the DMM range to 000.0 V.**

6. Ignition OFF, install a DMM between the appropriatesignal circuit terminal B and ground. Set the DMM to capture DC voltage using the MIN MAX function. Turn off autorange and manually set the DMM range to 000.0 V. Ignition ON.
7. Verify the MAX voltage captured by the DMM is between 4-9V.
    - **If less than 4 V**

    1. Disconnect the appropriate harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the Inflatable Restraint Sensing and Diagnostic Module.

    - **If greater than 9V**

    1. Ignition OFF. Disconnect the appropriate harness connector at the K36 Inflatable Restraint Sensing and Diagnostic Module. Ignition ON.
    2. Test for less than 1 V between the signal circuit terminal B and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

    - **If between 4-9V**

8. Ignition OFF, connect all harness connectors, press in the CPA (if equipped) until an audible and/or tactile

click is heard.

9. Ignition ON, clear DTCs. Operate the vehicle within the Conditions for Running the DTC.
10. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the appropriate Impact Sensor.

    - **If the DTC does not set**
11. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Airbag Front End Sensor Replacement**
- **Airbag Side Impact Sensor Replacement (Impala Limited)**
- **SIR/SRS Wiring Repairs**
- **Control Module References** for SDM replacement, setup, and programming

DTC B1001: SDM OPTION CONFIGURATION ERROR (SDM)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1001 00

SDM Option Configuration Error

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) stores a primary data key, which is a 4-digit number, and a secondary data key, which is a portion of the vehicle identification number (VIN). When the ignition is turned ON, the SDM compares this information to the information stored in the body control module (BCM) over the serial data communication circuit. If there is a mismatch between the information stored in the SDM and BCM, DTC B1001 will set.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

- The 4-digit primary data key stored in the SDM does not match the 4 digits stored in the BCM.
- The VIN stored in the BCM does not match that of the vehicle.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM disables all deployments.

Conditions for Clearing the DTC

- The last 4-digit Primary Data Key in the SDM match the last 4 digits stored in the BCM.
- The VIN that is stored in the SDM matches the VIN stored in the BCM.

Diagnostic Aids

This DTC is an indication that an incorrect SDM is installed in the vehicle, or that the SDM and/or the BCM was replaced without reprogramming the BCM with the new information.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **SIR/SRS Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Testing

NOTE: **When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected.**

- **SDM**
- **SDM wiring harness**

1. Ignition ON, verify the scan tool Secondary Key Status displays Valid.

- If not the specified value, verify the scan tool Received VIN Digits 2-7 match the vehicle VIN , if the VIN does not match, reprogram the BCM. If the VIN matches, reprogram the SDM.

2. Ignition ON, verify the scan tool Primary Key Status displays Valid.
   - If not the specified value, verify the scan tool SDM Primary Key matches the Received Primary Key, if the key does not match, perform the Setup SDM Primary Key in BCM procedure.
3. With a scan tool, verify DTC B1001 is not set as current.
   - If DTC is set as current, replace the SDM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for SDM or BCM replacement, setup, and programming

DTC B1001: OPTION CONFIGURATION ERROR (PPS)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1001 00

Option Configuration Error

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) stores a 4-digit primary key for the inflatable restraint passenger presence system (PPS). The SDM sends the PPS module the primary key. If the PPS module determines that it is the wrong primary key, the PPS module will set DTC B1001 and send the SDM a vehicle mismatch message. The SDM then will set DTC B0081 and illuminate the SIR warning indicator. The PPS module does not use a secondary key.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

The 4-digit primary key stored in the SDM does not match the 4-digit key stored in the PPS module.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The passenger instrument panel air bag deployment is disabled.

Conditions for Clearing the DTC

The 4-digit Primary Key in the SDM and in the PPS module match.

Diagnostic Aids

This DTC is an indication that the PPS module was not set-up correctly, is not the correct part number or that the PPS module is defective.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **SIR/SRS Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

IMPORTANT:

When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected.

- PPS module
- PPS module wiring harness

1. Verify the correct PPS module part number has been installed
   - If the wrong PPS module part number was installed, replace with the correct PPS module.
2. Verify that DTC B1001 is not set as current in the PPS module.
   - If DTC is set as current, perform the PPS Preload procedure. Verify the SDM is sending the correct key. If DTC resets replace the PPS module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for PPS module replacement, setup, and programming

DTC B1019: SDM SYSTEM CONFIGURATION ERROR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B1019 00

SDM System Configuration Error

DTC B1019 3A

SDM System Configuration Error Incorrect Component Installed

Circuit/System Description

The passenger air bag ON/OFF indicators are used to notify the driver when the Passenger Presence System (PPS) has enabled or disabled the passenger instrument panel air bag . When the ignition is turned ON, the ignition voltage is supplied to the passenger air bag ON/OFF indicators and to the PPS module. The instrument panel cluster (IPC) grounds all indicator control circuits to the passenger air bag ON/OFF indicators for illumination. The IPC receives serial data messages from the supplemental inflatable restraints system to illuminate the indicators as necessary.

After the SDM is programmed, the SDM setup procedure is required. During this set up procedure, the SDM will compare the content that was just programmed to the actual components that are installed on the vehicle. If the SDM detects that there are too few or too many components on the system, DTC B1019 00 will set and not allow the setup procedure to complete.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

B1019 00

- The SDM was programmed with the wrong options for the vehicle.
- The wrong components were installed for the content of the vehicle.
- SDM connector may have bent pins or shorting bars causing the SDM to learn deployment loops that are not actually present.

B1019 3A

- The vehicle was configured for passenger presence system (PPS) but the SDM does not detect that all the PPS indicators are present due to loss of power at indicator, or an open indicator control circuit.
- The vehicle is not configured for PPS and the SDM detects that the PPS indicator is present.

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG warning lamp.
- The SDM disables all deployments when B1019 00 DTC is set as current.

Conditions for Clearing the DTC

- The correct SDM must be installed.
- The correct components must be installed.
- The PPS indicator operates as indicated in the **Seat Belt System Description and Operation** , and **Supplemental Inflatable Restraint System Description and Operation**.

Diagnostic Aids

- If the SDM has been replaced, make sure that the correct part number was installed for this vehicle. If after programming the SDM DTC B1019 00 sets as current, check for bent pins or shorting bars at the SDM connector.
- DTC B1019 3A can be set if any of the passenger air bag ON/OFF indicators, including the passenger seat belt buckle indicator are inoperative.

Reference Information

Schematic Reference

- **Seat Belt Schematics**
- **SIR Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Seat Belt System Description and Operation**
- **Supplemental Inflatable Restraint System Description and Operation**

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Connector Repairs**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

B1019 3A

1. With a scan tool, verify DTC B1370 is not set as current in the SDM.
   - If DTC is current refer to **DTC B1370**.
2. If equipped with PPS, verify the appropriate PPS indicator segments illuminate by occupying and unoccupying the passenger seat.
   - If the PPS indicator segments do not illuminate properly, refer to **Seat Belt Indicator Malfunction - Passenger** .

Circuit/System Testing

IMPORTANT:

When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected.

- PPS module
- SDM
- PPS module wiring harness connector
- SDM wiring harness connector

B1019 00

1. Ignition ON, verify the scan tool SDM End Model Part Number is correct for the vehicle.
   - If the part number is incorrect, reprogram the SDM.

IMPORTANT:

- If not equipped with PPS, the scan tool parameter should display Not Present and the PPS indicator should not be present on the vehicle
- If equipped with PPS, the scan tool parameter should display Auto, Manual, or Auto + Man and the PPS indicator should be present on the vehicle

2. Observe the scan tool PPS Options parameter to determine how the vehicle PPS is currently configured in the SDM. Verify the actual vehicle equipment and the current configuration indicated by the scan tool parameter are the same.
   - If the original configuration does not match the actual vehicle equipment, reprogram the SDM with the correct configuration.
3. Ignition OFF, disconnect the harness connectors at the SDM and verify the connector is in good condition and has no bent pins, terminals or shorting bars
   - If damage is found, repair the bent pins, terminals or shorting bars as needed and perform the Setup New SDM procedure.
4. Connect the harness connector at the SDM.
5. Ignition ON, verify the scan tool System Configuration matches the actual components installed on the vehicle.

- If the System Configuration does not match the actual components installed, reprogram the SDM with the correct components.

6. Ignition ON, clear all PPS module and SDM DTCs.
7. Verify DTC B1019 does not set.
    - If DTC sets, replace the SDM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **SIR/SRS Wiring Repairs**
- **Control Module References** for PPS module or SDM replacement, setup, and programming

DTC B101D, B101E, OR B1089: AIR BAG DEPLOYMENT LOOP INVALID

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC B101D

Driver Steering Wheel Air Bag Deployment Loop Invalid Configuration

DTC B101E

Passenger Instrument Panel Air Bag Deployment Loop Invalid Configuration

DTC B1089

Deployment Loops Signals Cross Coupled

Circuit/System Description

When the ignition switch is turned to ON, the sensing and diagnostic module (SDM) will perform a turn - on test to diagnose critical malfunctions within the SDM itself.

Conditions for Running the DTC

- The ignition switch is in the ON position.
- Battery voltage must be between 9-16 V.

Conditions for Setting the DTC

B101D

The configuration of the driver steering wheel air bag deployment loop is invalid.

B101E

The configuration of the passenger instrument panel air bag deployment loop is invalid is invalid.

B1089

A cross-link of the deployment loop circuit has been detected.

Action Taken When the DTC Sets

The SDM will command the Air Bag Warning indicator to illuminate

Conditions for Clearing the DTC

- Installing a compatible air bag switch for that specific make and model vehicle.
- Installing a compatible air bag squib circuit for that specific make and model vehicle.
- Installing a compatible steering wheel air bag or passenger instrument panel air bag for that specific make and model vehicle.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON
2. Replace the appropriate SIR components and clear the DTC, verify the DTC does not reset.
    - **If the DTC resets**

      Replace the K36 Inflatable Restraint Sensing and Diagnostic Module.

- **If the DTC does not reset**

3. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Steering Wheel Airbag Coil Replacement**
- **Airbag Steering Wheel Module Replacement**
- **Airbag Instrument Panel Module Replacement (Impala Limited)**
- **SIR/SRS Wiring Repairs**
- **Control Module References** for SDM replacement, programming and setup

DTC B1370: DEVICE IGNITION 1 CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using the diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B1370 06

Device Ignition 1 Circuit Short to Ground or Open

Circuit/System Description

The inflatable restraint sensing and diagnostic module (SDM) monitors the ignition 1 signal from the ignition switch. When the vehicle ignition switch is placed in the RUN or CRANK position, the switch supplies voltage to the SDM ignition 1 input terminal. If an open or short to ground in this SDM ignition 1 circuit is detected, then DTC B1370 will set.

Conditions for Running the DTC

Ignition voltage is between 9-16 volts.

Conditions for Setting the DTC

The SDM detects a short to ground or an open in the ignition 1 voltage circuit for at least 10 seconds when the ignition switch is in RUN or CRANK .

Action Taken When the DTC Sets

- The SDM requests the instrument panel cluster (IPC) to illuminate the AIR BAG indicator.
- The SDM determines its power mode only from the GMLAN power mode messages and discards the ignition 1 input for the remainder of the ignition cycle.

Conditions for Clearing the DTC

- The condition for setting the DTC no longer exists.
- A history DTC will clear once 100 malfunction-free ignition cycles have occurred.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

IMPORTANT:

When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected.

- SDM
- SDM wiring harness

1. Ignition OFF, remove the AIRBAG/DISPLAY fuse.
2. Ignition ON, with a DMM, test for 9-16 V between the voltage supply side and ground.
   - If not the specified range, refer to **DTC B1370-B1379, B1380-B1389, or B1440-B1443** .
3. Ignition OFF, disconnect the harness connector at the SDM.
4. Ignition OFF, disconnect the X4 harness connector at the Underhood Fuse Block.
5. Ignition OFF, test for less than 1 ohm between the ignition 1 voltage circuit terminal 32 and the underhood fuse block terminal K4 X4.
   - If greater then the specified range, test the circuit for an open/high resistance.
6. Ignition ON, test for less than 1 volt between the ignition 1 voltage circuit terminal 32 and the underhood fuse block K4 X4.

- If greater then the specified value, test the circuit for a short to voltage.

7. If all circuits test normal, replace the SDM.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **SIR/SRS Wiring Repairs**
- **Control Module References** for SDM replacement, setup, and programming

PASSENGER PRESENCE SYSTEM PRELOAD TEST

The passenger presence system consists of an electronic control module, a conductive based sensor mat, wiring harness, and PASSENGER AIR BAG ON/OFF indicators. The sensor mat is made up of several flexible conductive metal strips placed underneath the seat cushion trim. These sensor strips transmit and receive a low level electric field. The weight of the occupant sitting in the front passenger seat is measured as a change in current flow within the sensor mat. If the passenger seat bottom cushion, seat bottom trim, or heater pad has been serviced, reinstalled, or removed for any reason, the procedure below will check for any preloads on the passenger presence system. A service replacement passenger presence module does not require an unlock procedure prior to an initial preload test.

Passenger Presence System Preload System Test

NOTE:

- **Before the passenger presence system can be checked for preloads the front passenger seat must be completely empty of all items. The presence of any items on the front passenger seat will affect the calibration and operation of the passenger presence system. When the preload test is performed, the instrument cluster and dash lights will begin illuminating at varying intensity. This is normal operation during the Passenger Presence Sensor Learn procedure and does not indicate additional system faults.**
- **The Diagnostic System Check - Vehicle must be performed after successfully completing the preload test procedure to ensure the system is functioning properly.**

1. Empty the front passenger seat, this system is susceptible to conductive material.
2. With the scan tool, perform the Passenger Presence Sensor Learn procedure.
3. Using the scan tool, check for DTC B0081 in history. If the Passenger Presence Sensor Learn procedure fails or DTC B0081 is current, confirm that there is no conductive material on the seat. Perform the Passenger Presence Sensor Learn test again. If the test fails again, for heated seats, ensure that the sensor pad is on top of the heater element. Once the test successfully completes, cycle the ignition OFF.
4. Perform the **Diagnostic System Check - Vehicle** after successfully completing the Passenger Presence Sensor Learn procedure to ensure the system is functioning properly.

SYMPTOMS - SIR

IMPORTANT: Complete the following steps before using the symptom tables:

1. Perform **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
    - There are no DTCs set.
    - The inflatable restraint sensing and diagnostic module (SDM) can communicate via the serial data link.
2. Review the SIR system description and operation in order to familiarize yourself with the system functions. Refer to **Supplemental Inflatable Restraint System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the SIR system. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

Airbag Indicator Malfunction (Driver)Airbag Indicator Malfunction (Passenger) in order to diagnose the symptom.

AIRBAG INDICATOR MALFUNCTION (DRIVER)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

When the ignition is turned ON, the instrument panel cluster (IPC) flashes the air bag indicator 7 times for a bulb check. The inflatable restraint sensing and diagnostic module (SDM) performs diagnostic tests on the SIR system during the bulb check. If any malfunction exists the SDM will request the IPC to illuminate the air bag indicator steady, via serial data. If a preexisting malfunction exists, the air bag indicator will illuminate steady immediately after the ignition is turned ON. If the ignition 1 voltage is outside of the normal operating voltage range 9-16 volts, the SDM will command the IPC to illuminate the air bag indicator with no DTCs present, then disables all deployment loops.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for Scan Tool Information

Diagnostic Aids

A DTC B1370 may set if the ignition 1 circuit is outside the 9-16 volts range.

Circuit/System Testing

1. Ignition ON, with a scan tool, verify the Battery Voltage Parameter is 9-16 volts.
    - If not the specified range, refer to **Diagnostic System Check - Vehicle** .
2. Ignition OFF, monitor the IPC, ignition ON. The SIR warning indicator should flash then turn OFF.
    - If the SIR warning indicator continually flashes, program the SDM.
    - If the SIR warning indicator remains on steady, test for DTCs and refer to **Diagnostic Trouble Code (DTC) List - Vehicle** . If no DTC is current, proceed to the next step.
3. With a scan tool, perform the Display Test in Instrument Panel Cluster/Special Functions. The Air Bag indicator should turn ON and OFF as commanded.
    - If the air bag indicator does not illuminate as expected, replace the IPC.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **SIR/SRS Wiring Repairs**
- **Control Module References** for IPC or SDM replacement, setup, and programming

AIRBAG INDICATOR MALFUNCTION (PASSENGER)

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage
Ignition 1 Voltage	1	1*	1	-
Passenger Air Bag OFF Indicator Control	4	2*	2	-
Passenger Air Bag ON Indicator Control	5	3*	3	-
1. No indicators will illuminate. 2. The OFF indicator will not illuminate. 3. The ON indicator will not illuminate. 4. The OFF indictor will illuminate any time the ignition is ON. 5. The ON indictor will illuminate any time the ignition is ON. * High resistance may cause any or all indicators to illuminate less bright than normal.				

Circuit/System Description

The passenger air bag ON/OFF indicators are used to notify the driver when the Passenger Presence System (PPS) has enabled or disabled the passenger instrument panel air bag. When the ignition is turned ON, the ignition voltage is supplied to the passenger air bag ON/OFF indicators and to the passenger presence module. The passenger presence module communicates with the SDM indicating if the passenger seat is occupied or not. The IPC receives serial data messages from the SDM to illuminate the appropriate passenger instrument panel air bag indicator. The instrument panel cluster (IPC) grounds the appropriate indicator control circuit to the passenger air bag ON or OFF indicator for illumination.

Reference Information

Schematic Reference

SIR Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Supplemental Inflatable Restraint System Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **The passenger air bag ON and OFF indicators may not operate as expected if there are supplemental inflatable restraint (SIR) DTCs. Repair all SIR DTC before proceeding with this diagnostic.**

1. Ignition ON, the passenger air bag ON and OFF indicators should both illuminate for approximately 5 seconds for a bulb check.
2. Monitor the parameter Passenger Classification in Passenger Presence System with a scan tool. With the passenger seat unoccupied, the parameter should display Empty Seat. The passenger air bag OFF indicator should illuminate.
3. Have an adult sit in the passenger seat. The passenger air bag indicator should switch from OFF to ON within 5 seconds.

Circuit/System Testing

NOTE: **When removing connectors inspect for damage or corrosion. Damage or corrosion in the following requires repair or replacement of the affected.**

- **Passenger air bag on/off indicator.**
- **Passenger air bag on/off indicator wiring harness.**

1. Ignition OFF, disconnect the harness connector at the inflatable restraint passenger air bag ON/OFF indicator.
2. Ignition ON, verify a test lamp illuminates between the ignition circuit terminal 4 and ground.
   - If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test or replace the inflatable restraint passenger air bag ON/OFF indicator.
3. Connect a test lamp between the ignition circuit terminal 4 and the control circuit terminal 3.
4. With the passenger seat unoccupied, then occupied the test lamp should switch states within 5 seconds.
   - If the test lamp is always on, test the control circuit for a short to ground. If the circuit tests normal replace the IPC.
   - If the test lamp is always off, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal replace the IPC.
5. Connect a test lamp between the ignition circuit terminal 4 and the control circuit terminal 1.
6. With the passenger seat unoccupied, then occupied the test lamp should switch states within 5 seconds.
   - If the test lamp is always on, test the control circuit for a short to ground. If the circuit tests normal replace the IPC.
   - If the test lamp is always off, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal replace the IPC.
7. If all circuits test normal, replace the inflatable restraint passenger air bag ON/OFF indicator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **SIR/SRS Wiring Repairs**
- **Instrument Panel Airbag Arming Status Display Replacement**
- **Control Module References** for instrument panel cluster (IPC) replacement, setup, and programming

SIR DISABLING AND ENABLING

SIR component location affects how a vehicle should be serviced. There are parts of the SIR system installed in various locations around a vehicle. To find the location of the SIR components refer to **Supplemental Inflatable Restraint System Description and Operation**.

There are several reasons for disabling the SIR system, such as repairs to the SIR system or servicing a component near or attached to an SIR component. There are several ways to disable the SIR system depending on what type of service is being performed. The following information covers the proper procedures for disabling/enabling the SIR system.

Condition	Action
If the vehicle was involved in an accident with an air bag deployment.	Disconnect the negative battery cable(s) *. Refer to **Repairs and Inspections Required After a Collision**.
When performing SIR diagnostics.	Follow the appropriate SIR service manual diagnostic procedure(s) *
When moving, removing or replacing an SIR component or a component attached to an SIR component. (Anytime you remove fasteners.)	Disconnect the negative battery cable(s) *
If the vehicle is suspected of having shorted electrical wires.	Disconnect the negative battery cable(s) *
When performing electrical diagnosis on components other than the SIR system.	Remove the SIR/Airbag fuse(s) when indicated by the diagnostic procedure to disable the SIR system
* DTC's may be lost when the negative battery cable is disconnected.	

SIR Service Precautions

WARNING: When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Failure to observe the correct procedure could cause deployment of the SIR components. Serious injury can occur. Failure to observe the correct procedure could also result in unnecessary SIR system repairs.

The Inflatable Restraint Sensing and Diagnostic Module (SDM) maintains a reserved energy supply. The reserved energy supply provides deployment power for the air bags if the Inflatable Restraint Sensing and Diagnostic Module loses battery power during a collision. Deployment power is available for as much as 2 minutes after disconnecting the vehicle power. Waiting 2 minutes before working on the system after disabling the SIR system prevents deployment of the air bags from the reserved energy supply.

General Service Instructions

The following are general service instructions which must be followed in order to properly repair the vehicle and return it to its original integrity:

- Do not expose air bags to temperatures above 85Â°C (185Â°F).
- Verify the correct replacement part number. Do not substitute a component from a different vehicle.
- Use only original GM replacement parts available from your authorized GM dealer. Do not use salvaged parts for repairs to the SIR system.

Discard any of the following components if it has been dropped from a height of 80 cm (31.5 Inches) or greater:

- Inflatable Restraint Sensing and Diagnostic Module (SDM)
- Any air bag
- Driver steering wheel air bag coil
- Any impact sensor
- Seat belt anchor and/or retractor pretensioners
- Passenger presence module and/or occupant sensor

Disabling Procedure - Air Bag Fuse

1. Turn the steering wheel so that the vehicles wheels are pointing straight ahead.
2. Place the ignition in the OFF position.

WARNING: The SDM may have more than one fused power input. To ensure there is no unwanted SIR deployment, personal injury, or unnecessary SIR system repairs, remove all fuses supplying power to the SDM. With all SDM fuses removed and the ignition switch in the ON position, the AIR BAG warning indicator illuminates. This is normal operation, and does not indicate a SIR system malfunction.

3. Locate and remove the fuse(s) supplying power to the Inflatable Restraint Sensing and Diagnostic Module. Refer to **SIR Schematics**, or **Electrical Center Identification Views** .
4. Wait 2 minutes before working on the system.

Enabling Procedure - Air Bag Fuse

1. Place the ignition in the OFF position.
2. Install the fuse(s) supplying power to the Inflatable Restraint Sensing and Diagnostic Module. Refer to **SIR Schematics**, or **Electrical Center Identification Views** .
3. Turn the ignition switch to the ON position. The AIR BAG indicator will illuminate or flash then turn OFF.
4. Perform the Diagnostic System Check - Vehicle if the AIR BAG warning indicator does not operate as described. Refer to **Diagnostic System Check - Vehicle** .

Disabling Procedure - Negative Battery Cable

1. Turn the steering wheel so that the vehicles wheels are pointing straight ahead.

2. Place the ignition in the OFF position.
3. Disconnect the negative battery cable from the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
4. Wait 2 minutes before working on system.

Enabling Procedure - Negative Battery Cable

1. Place the ignition in the OFF position.
2. Connect the negative battery cable to the battery. Refer to **Battery Negative Cable Disconnection and Connection** .
3. Turn the ignition switch to the ON position. The AIR BAG indicator will illuminate or flash then turn OFF.
4. Perform the Diagnostic System Check - Vehicle if the AIR BAG warning indicator does not operate as described. Refer to **Diagnostic System Check - Vehicle** .

REPAIR INSTRUCTIONS

SIR SERVICE PRECAUTIONS

General Service Instructions

WARNING: When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Refer to SIR Disabling and Enabling . Failure to observe the correct procedure could cause deployment of the SIR components, personal injury, or unnecessary SIR system repairs.

WARNING: Do not strike or jolt the inflatable restraint sensing and diagnostic module (SDM). Before applying power to the SDM, make sure that it is securely fastened with the arrow facing toward the front of the vehicle. Failure to observe the correct installation procedure could cause SIR deployment, personal injury, or unnecessary SIR system repairs.

NOTE: The Inflatable Restraint Sensing and Diagnostic Module (SDM) maintains a reserved energy supply. The reserved energy supply provides deployment power for the SIR air bags. Deployment power may be available for up to 2 minutes after disconnecting the vehicle power. Disabling the SIR system prevents deployment of the SIR air bags from the reserved energy supply.

NOTE: The following are general service instructions which must be followed in order to properly repair the vehicle and return it to its original integrity:

- Do not expose air bags to temperatures above 85 Â°C (185 Â°F)
- Verify the correct replacement part number. Do not substitute a component from a different vehicle
- Use only original GM replacement parts available from your authorized GM dealer. Do not use salvaged parts for repairs to the SIR system

NOTE: Discard any of the following components if it has been dropped from a height of

80 cm (31.49 in) or greater:

- Inflatable Restraint Sensing and Diagnostic Module
- Passenger instrument panel air bag
- Driver steering wheel air bag
- Driver steering wheel air bag coil
- Roof rail air bags
- Front and /or side impact sensors
- Seat belt achor and/or retractor pretensioners
- Front seat side air bag
- Knee air bag

AIRBAG FRONT END SENSOR REPLACEMENT

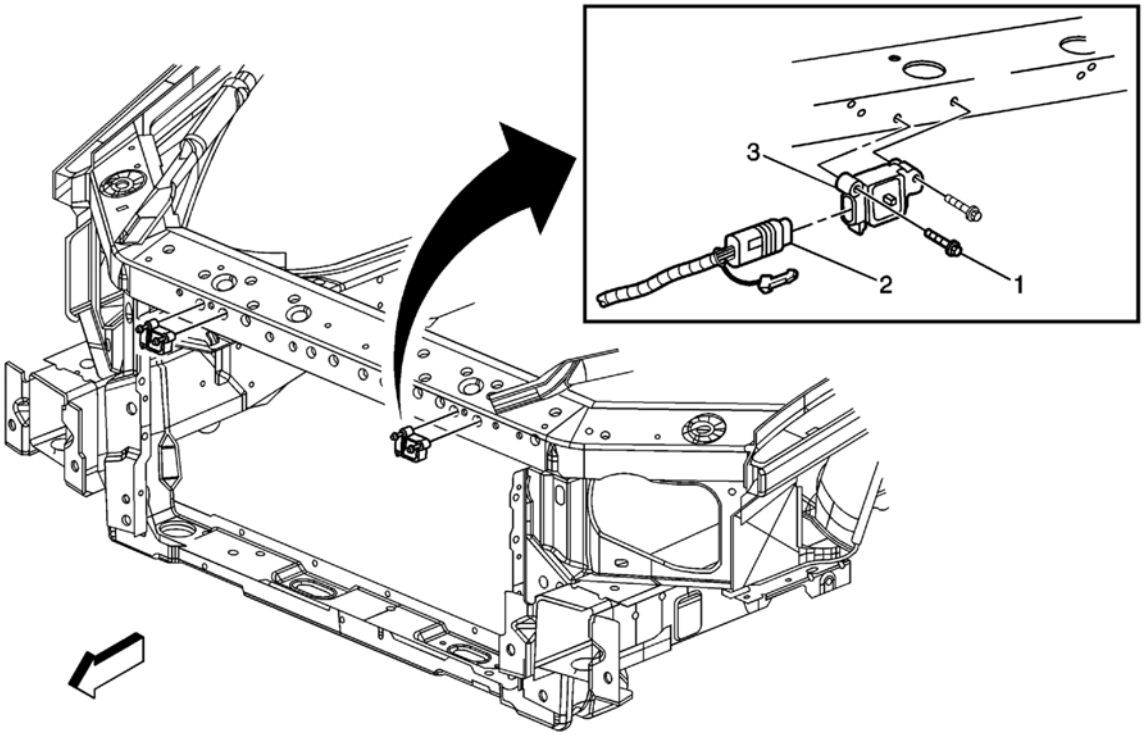


Fig. 4: Identifying Inflatable Restraint Front End Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to SIR Warning .** **Preliminary Procedures** 1. Disable the supplemental inflatable restraint (SIR) system. Refer to **SIR Disabling and Enabling**.	

Callout	Component Name
2. Remove the upper air baffle and deflector. Refer to **Radiator Air Upper Baffle and Deflector Replacement** . 3. Remove both headlamps. Refer to **Headlamp Replacement** . 4. Remove the fascia grille support bolts, 8 total. DO NOT remove the bumper fascia. Refer to **Front Bumper Fascia Energy Absorber Replacement** . 5. Remove the retainers from fascia to grille support, 4 total. 6. Pull the grille support forward to gain clearance to the sensors.	
1	Inflatable Front End Sensor Mounting Bolts (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 11 N.m (97 lb in)
2	Connector Position Assurance (CPA) Connector
3	Inflatable Front End Sensor

AIRBAG SIDE IMPACT SENSOR REPLACEMENT (IMPALA LIMITED)

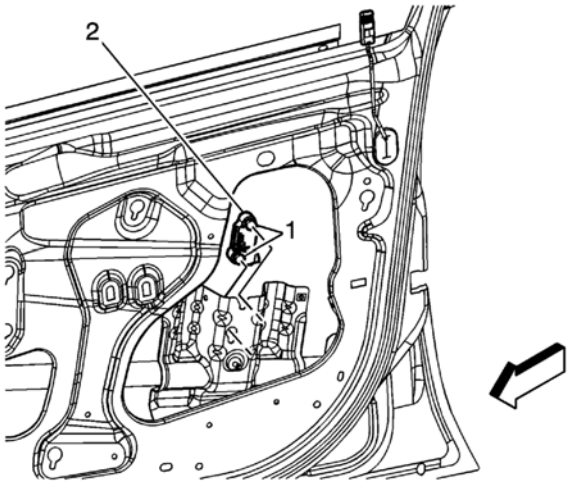


Fig. 5: Inflatable Restraint Side Impact Sensor (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Do not strike or jolt the inflatable**	

Callout	Component Name
restraint side impact sensor (SIS). Before applying power to the SIS make sure that it is securely fastened. Failure to observe the correct installation procedures could cause SIR deployment, personal injury, or unnecessary SIR system repairs. **WARNING:** **Refer to SIR Warning .** **Preliminary Procedure** 1. Disable the SIR system. Refer to **SIR Disabling and Enabling**. 2. Remove the front door panel. Refer to **Front Side Door Trim Panel Replacement** .	
1	Inflatable Restraint Side Impact Sensor Assembly Bolt/Screw (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **TIP:** Loosen the fasteners and slide the sensor out of the keyhole slots. **Tighten** 10 N.m (89 lb in)
2	Inflatable Restraint Side Impact Sensor Assembly

AIRBAG SENSING AND DIAGNOSTIC MODULE REPLACEMENT

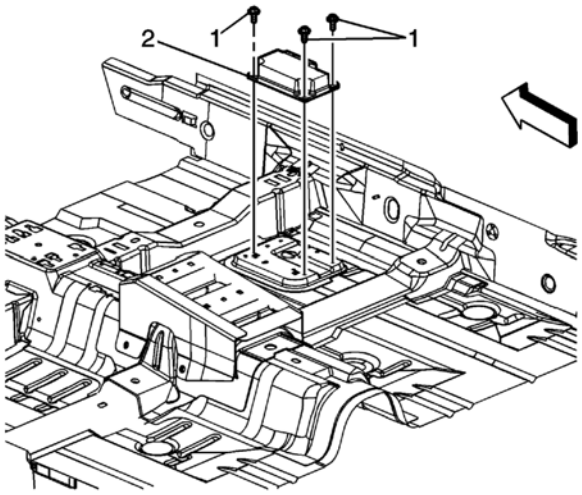


Fig. 6: Inflatable Restraint Sensing And Diagnostic Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Do not strike or jolt the inflatable restraint sensing and diagnostic module (SDM). Before applying power to the SDM, make sure that it is securely fastened with the arrow facing toward the front of the vehicle. Failure to observe the correct installation procedure could cause SIR deployment, personal**	

Callout	Component Name
injury, or unnecessary SIR system repairs. **WARNING:** **Refer to SIR Warning .** **Preliminary Procedure** 1. Disable the supplemental inflatable restraint (SIR) system. Refer to **SIR Disabling and Enabling**. 2. Remove the right front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)** . 3. Pull the carpeting back in order to access the sensing and diagnostic module (SDM). Refer to **Floor Panel Carpet Replacement (Impala Limited)** . 4. Program the inflatable restraint SDM after replacement. Refer to **Control Module References** .	
1	Inflatable Restraint Sensing and Diagnostic Module Bolt/Screw (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (88 lb in)
2	Inflatable Restraint Sensing and Diagnostic Module Assembly

AIRBAG STEERING WHEEL MODULE REPLACEMENT

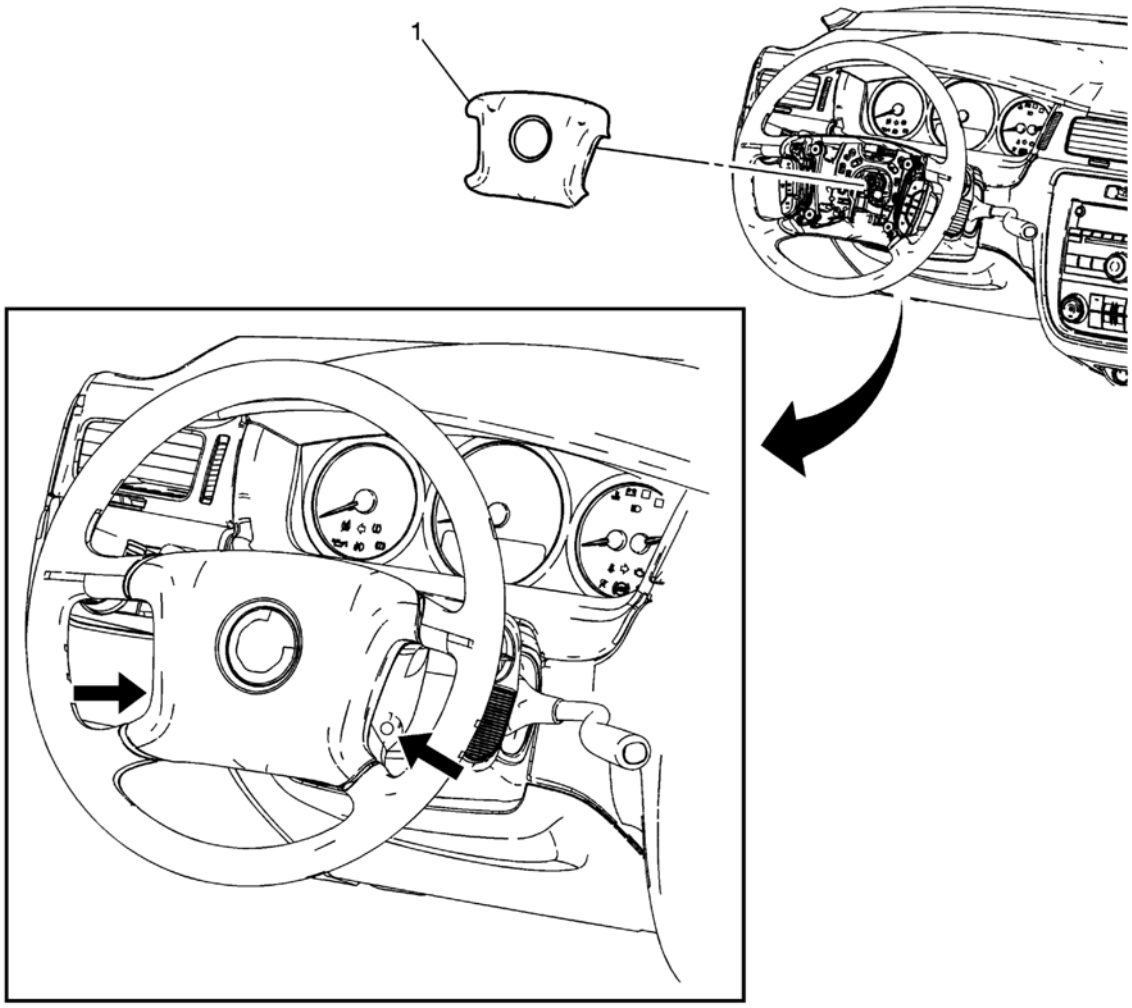


Fig. 7: Inflatable Restraint Steering Wheel Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: Refer to SIR Warning .	
WARNING: Refer to SIR Inflator Module Handling and Storage Warning .	
Preliminary Procedure Disable the supplemental inflatable restraint (SIR) system. Refer to SIR Disabling and Enabling.	

Callout	Component Name
1	Inflatable Restraint Steering Wheel Module Assembly **WARNING:** **After installation of the steering wheel airbag module to the steering wheel, slightly pull the module outward. If there is no give on the airbag module then it is secured correctly. If the airbag module is not fully attached personal injury could result.** **Procedure** Insert a small blunt-ended tool through the access openings, on the left and right of the steering wheel, push on the blunt-ended tool to release the steering wheel inflator from the steering wheel.

STEERING WHEEL AIRBAG COIL REPLACEMENT

Special Tools

J 42640 Steering Column Anti Rotation Pin

Removal Procedure

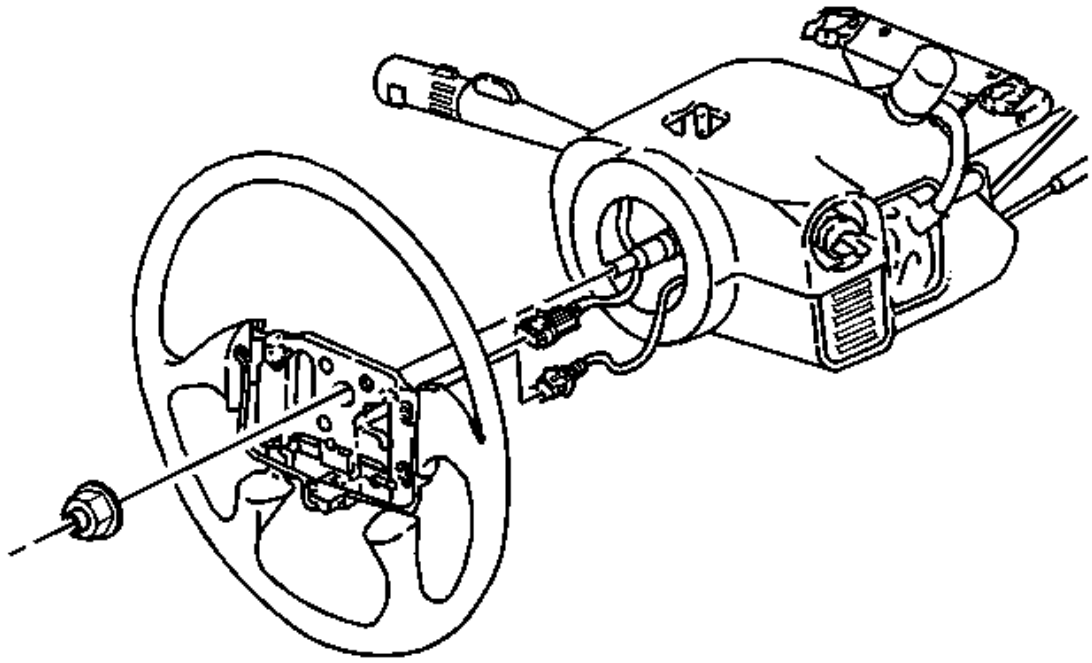


Fig. 8: Steering Wheel, Shaft & Nut
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to SIR Warning .

1. Disable the SIR System. Refer to **SIR Disabling and Enabling**.

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may

cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has became un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

2. Verify the following before removing the SIR coil:
   - The wheels on the vehicle are straight ahead.
   - That **J 42640** Steering Column Anti Rotation Pin is installed or the ignition switch is in the LOCK position.
3. Remove the steering wheel from the steering shaft. Refer to **Steering Wheel Replacement** .

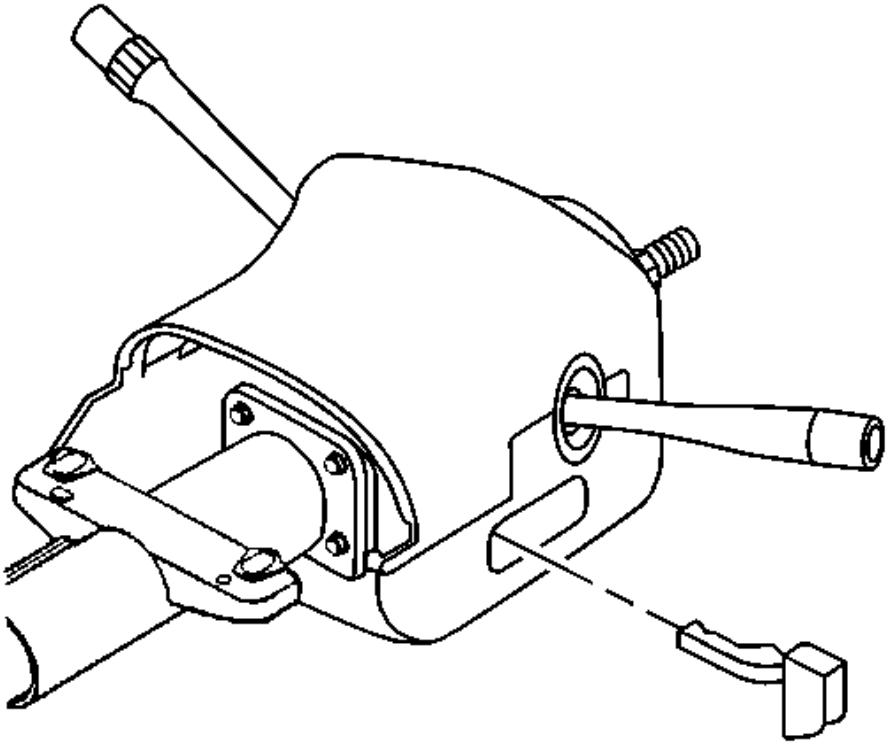


Fig. 9: Removing/Installing Tilt Lever
Courtesy of GENERAL MOTORS COMPANY

4. On vehicles with a tilt column, pull the tilt lever straight out from the steering column.

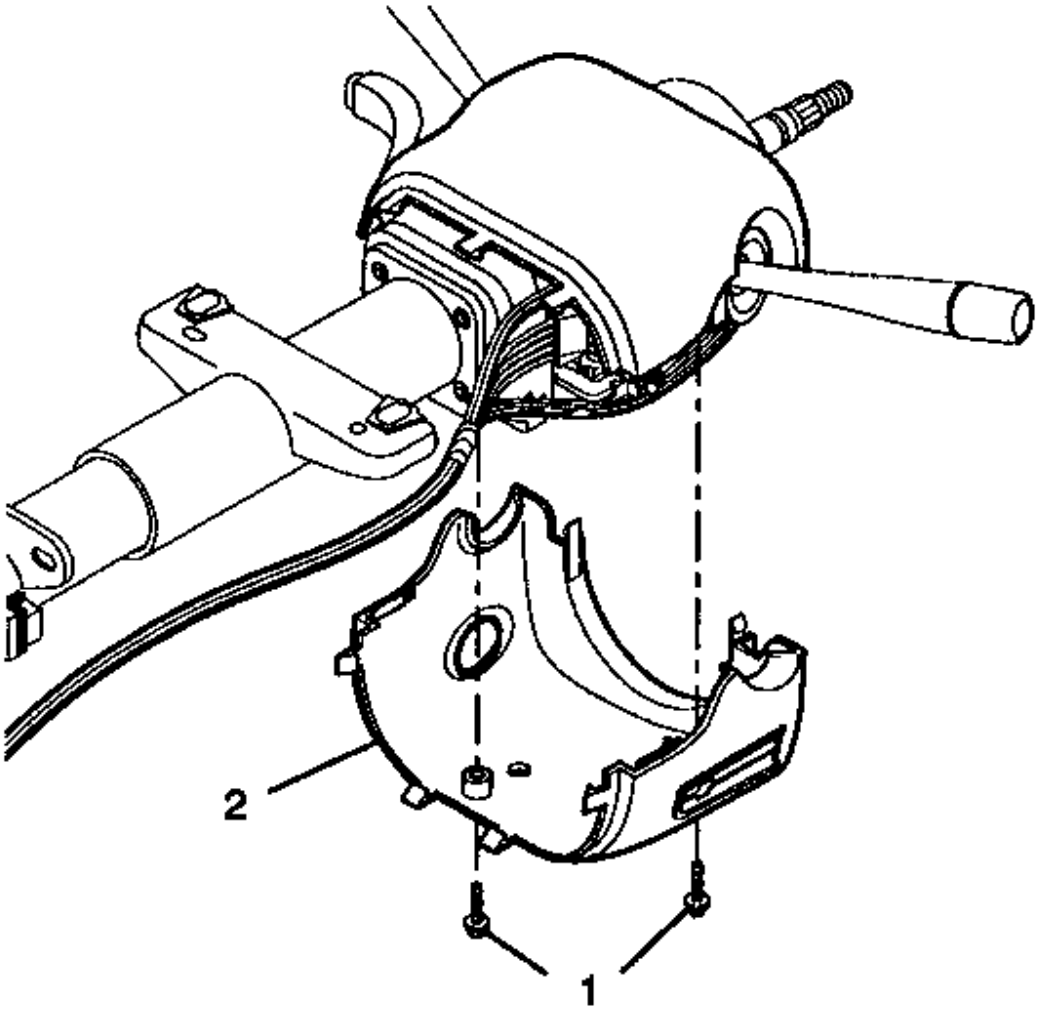


Fig. 10: Identifying Lower Trim Cover
Courtesy of GENERAL MOTORS COMPANY

5. Remove 2 TORXÂ® head screws (1) from the lower trim cover (2).
6. Remove the lower trim cover (2).

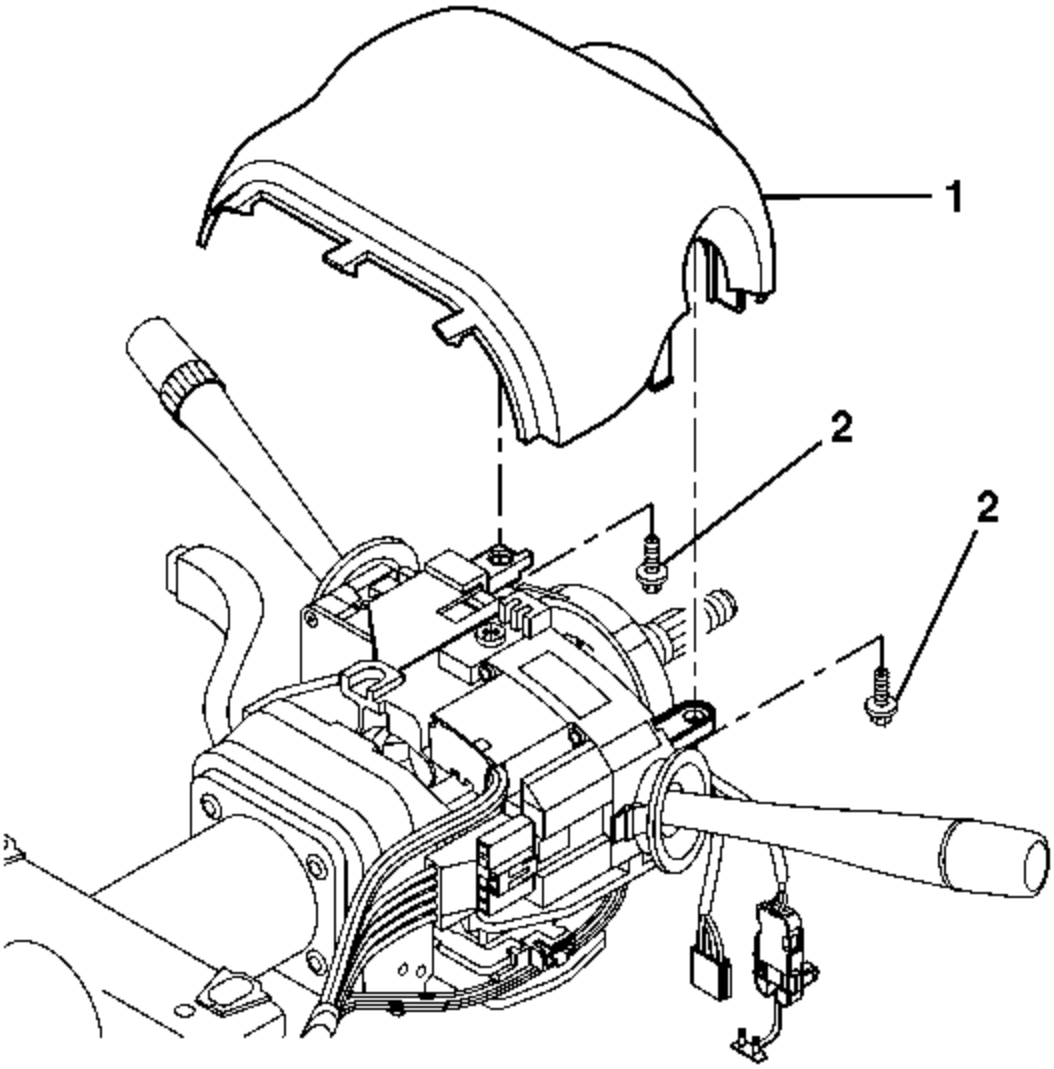


Fig. 11: Identifying Upper Trim Cover
Courtesy of GENERAL MOTORS COMPANY

7. Remove 2 TORXÂ® head screws (2) from the upper trim cover (1).
8. Remove the upper trim cover (1).

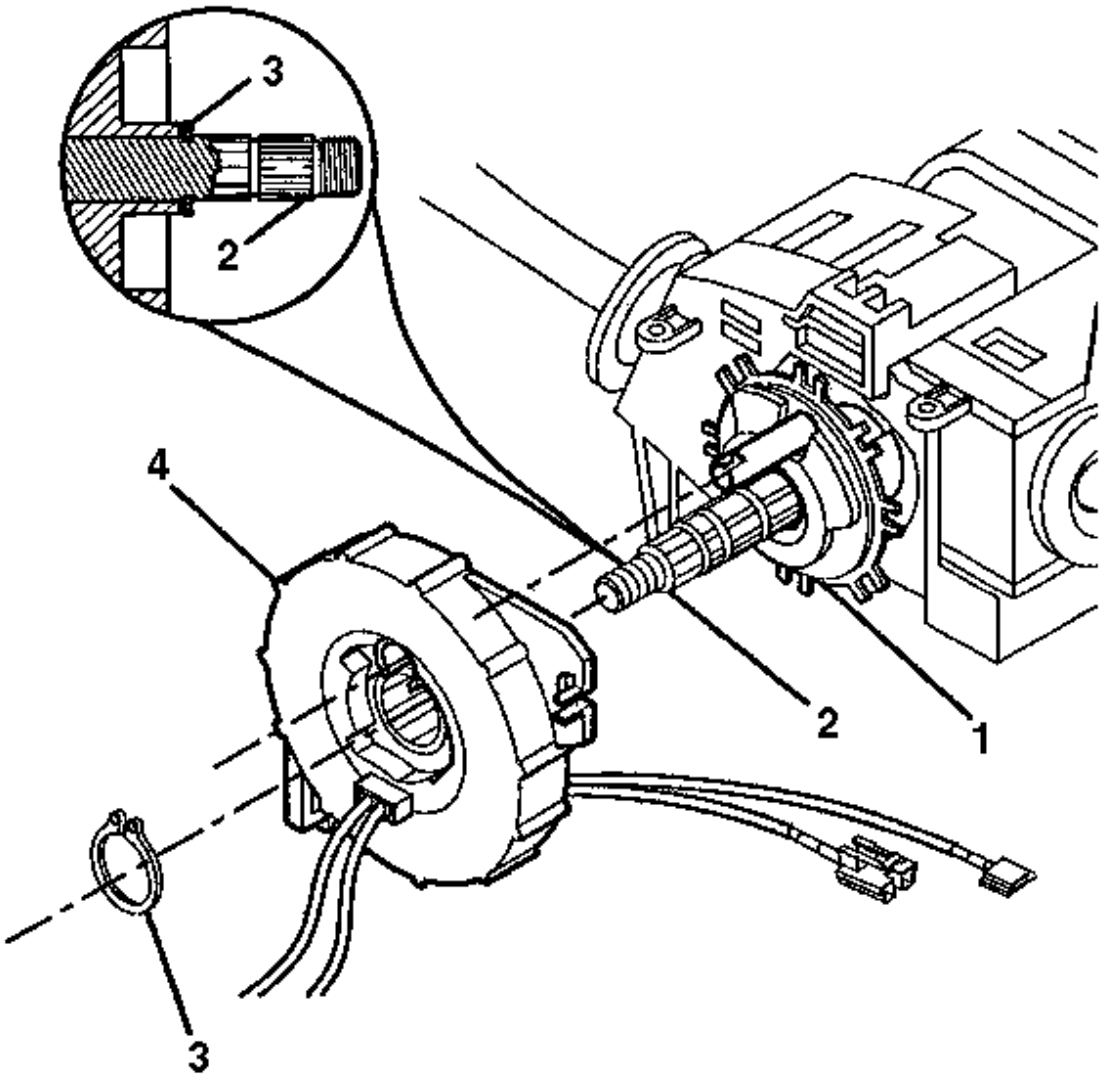


Fig. 12: Identifying SIR Coil, Steering Shaft Assembly & Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

9. Remove the wire harness straps from the steering wheel column wire harness.
10. Remove the retaining ring (3).
11. Remove the SIR coil (4) from the steering shaft.
12. If replacing, discard the SIR coil.

Installation Procedure

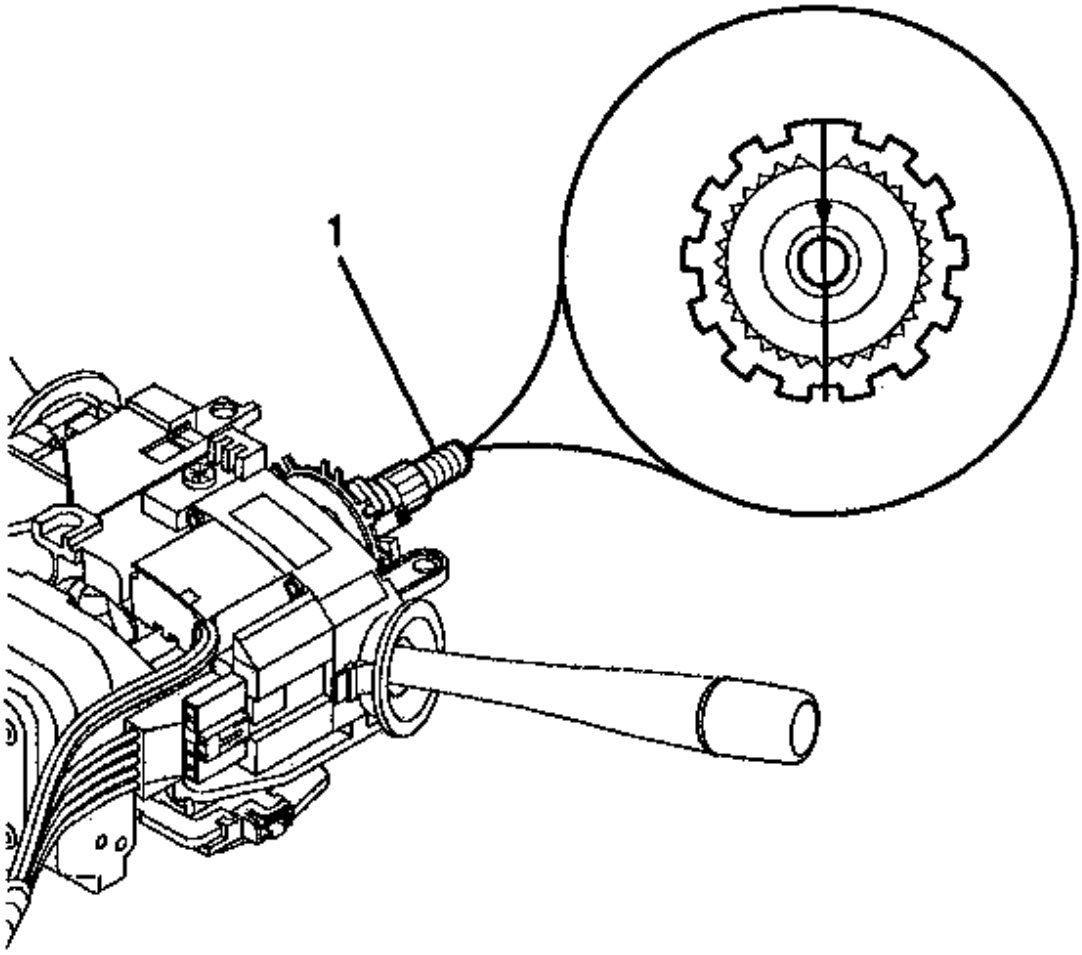


Fig. 13: View Of Block Tooth Of Steering Shaft Assembly In 12 O'clock Position
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **The new SIR coil assembly will be centered. Improper alignment of the SIR coil assembly may damage the unit, causing an inflatable restraint malfunction.**

CAUTION: **With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:**

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may

cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has became un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. Verify the following:
   - The wheels on the vehicle are straight ahead.
   - That **J 42640** Steering Column Anti Rotation Pin is installed or the ignition switch is in the LOCK position.

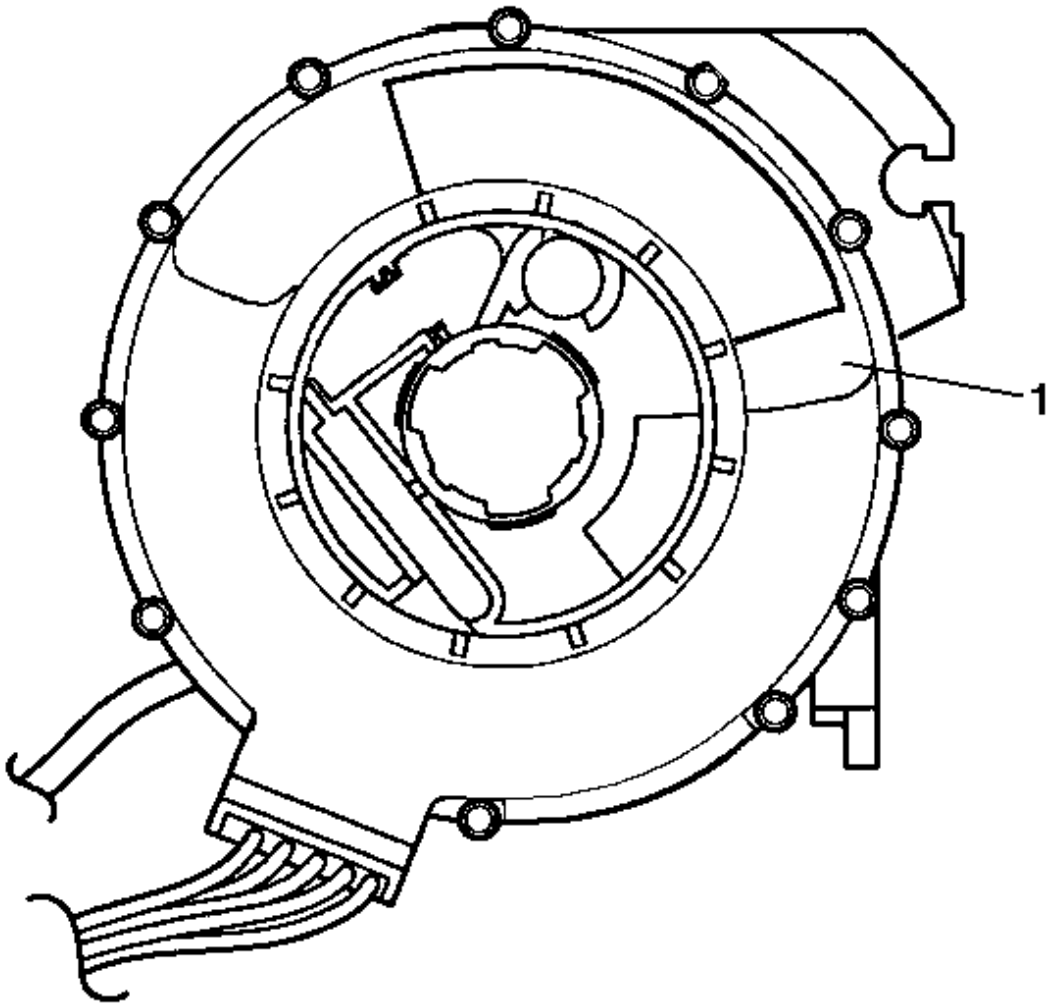


Fig. 14: View Of SIR Coil
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not remove the centering tab from the new SIR coil until the installation is complete. If the SIR coil does not come with a centering tab, you must center the SIR coil.**

2. If reusing the existing coil it MUST be centered, refer to **Airbag Steering Wheel Module Coil Centering**.

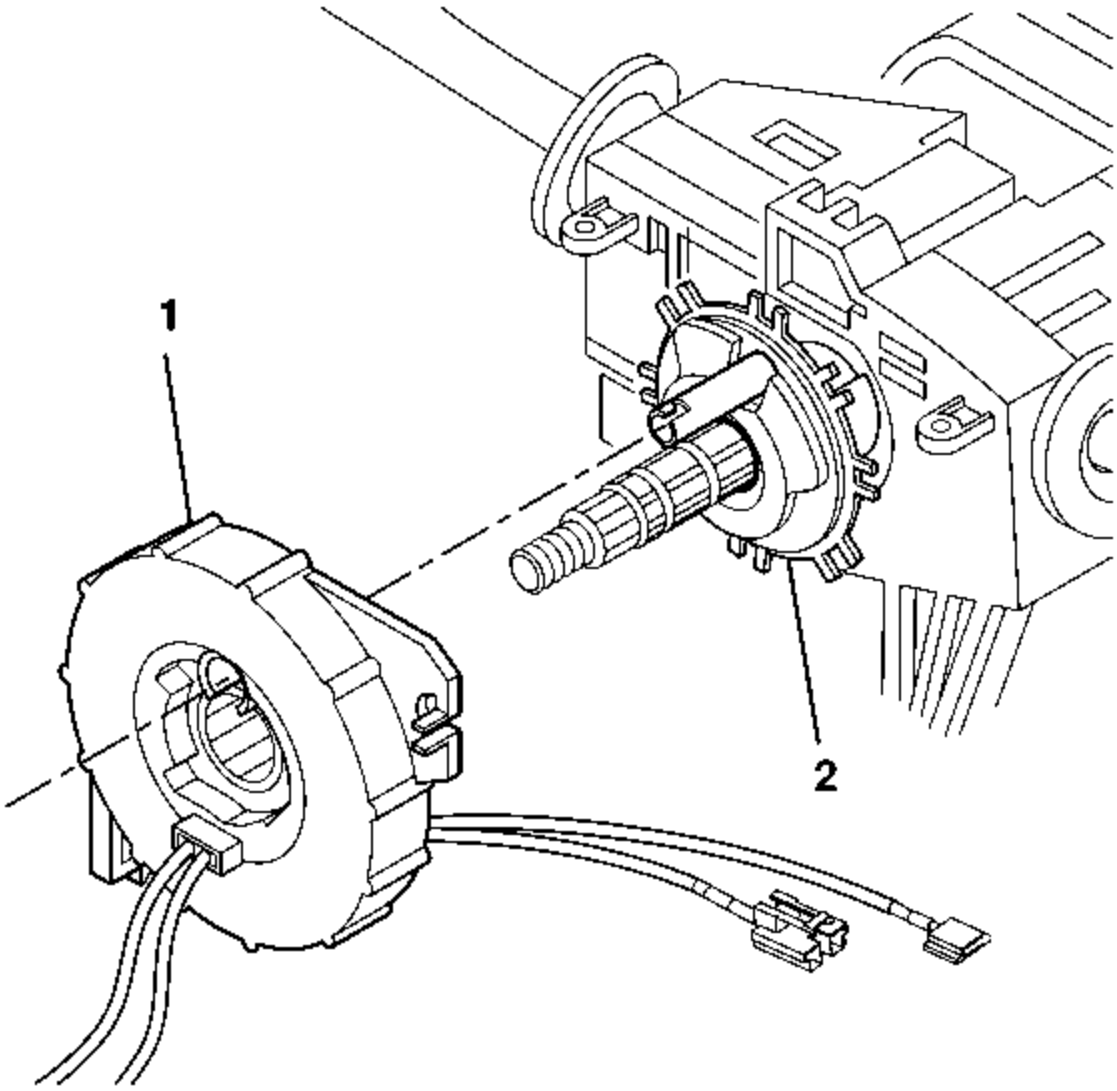


Fig. 15: Aligning SIR Coil Assembly With Horn Tower
Courtesy of GENERAL MOTORS COMPANY

3. Align the SIR coil assembly (1) with the horn tower on the turn signal cancel cam assembly (2).

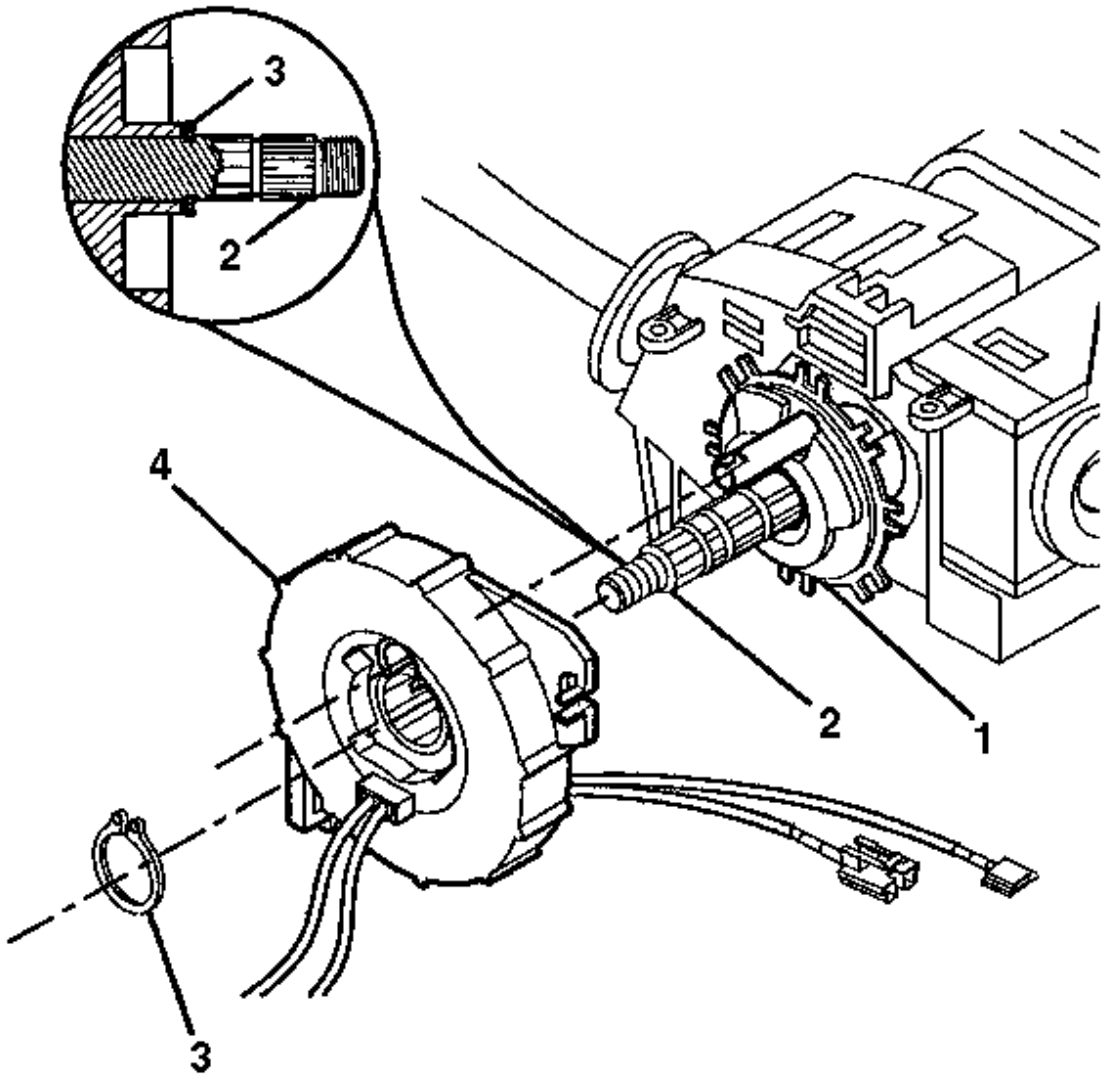


Fig. 16: Identifying SIR Coil, Steering Shaft Assembly & Retaining Ring
Courtesy of GENERAL MOTORS COMPANY

4. Slide the SIR coil (4) onto the steering shaft assembly (2).
5. Firmly seat the retaining ring (3) into the groove on the steering shaft assembly (2).
6. Remove and discard the centering tab from the new SIR coil (4).

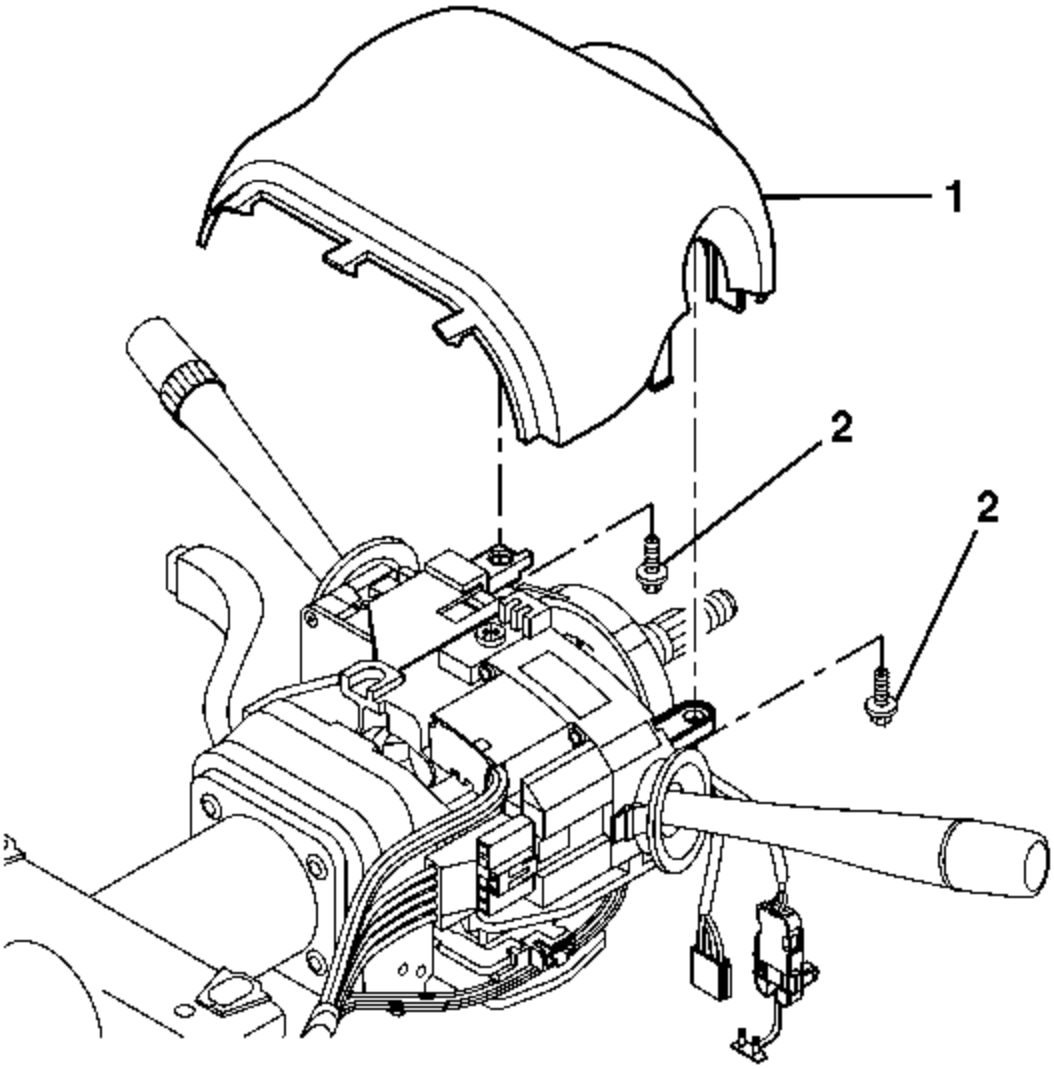


Fig. 17: Identifying Upper Trim Cover
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. Install the upper trim cover (1) and secure by using 2 TORXÂ® head screws (2).

Tighten

Tighten the screws to 1.5 N.m (13 lb in).

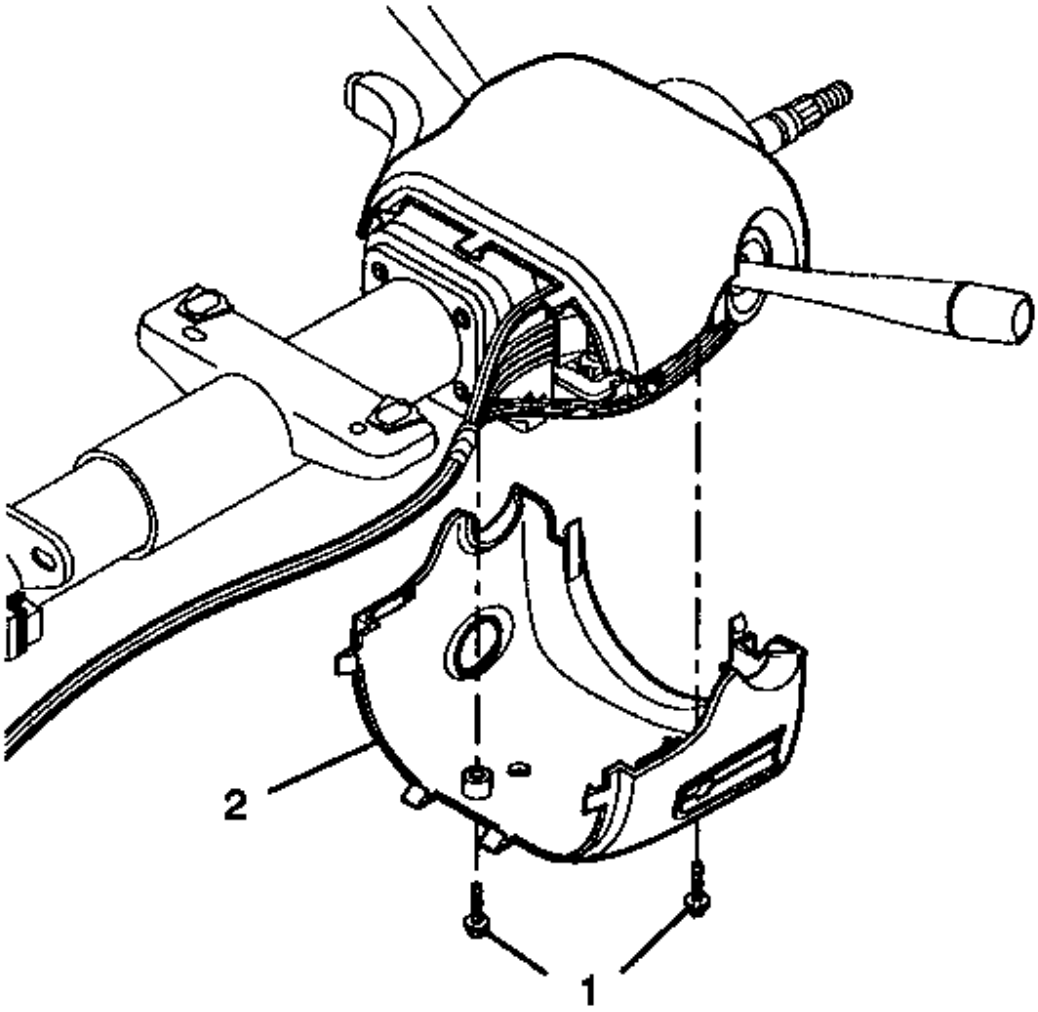


Fig. 18: Identifying Lower Trim Cover
Courtesy of GENERAL MOTORS COMPANY

8. Install the lower trim cover (2) and secure by using 2 TORXÂ® head screws (1).

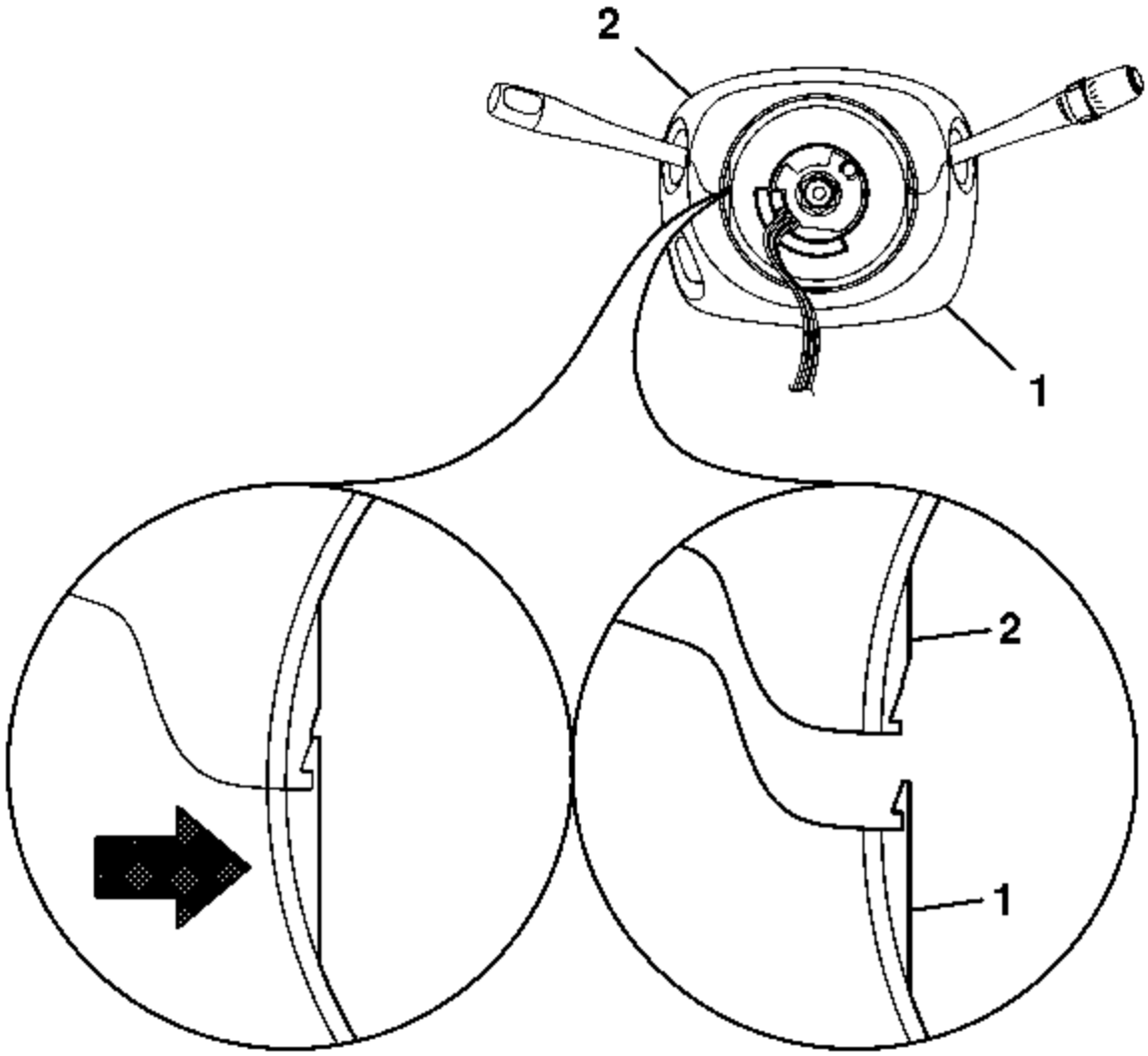


Fig. 19: Upper & Lower Trim Cover Tabs
Courtesy of GENERAL MOTORS COMPANY

9. Verify that the tabs on the lower trim cover (1) engage with the tabs on the upper trim cover (2). Snap the tabs together.

Tighten

Tighten the screws to 1.5 N.m (13 lb in).

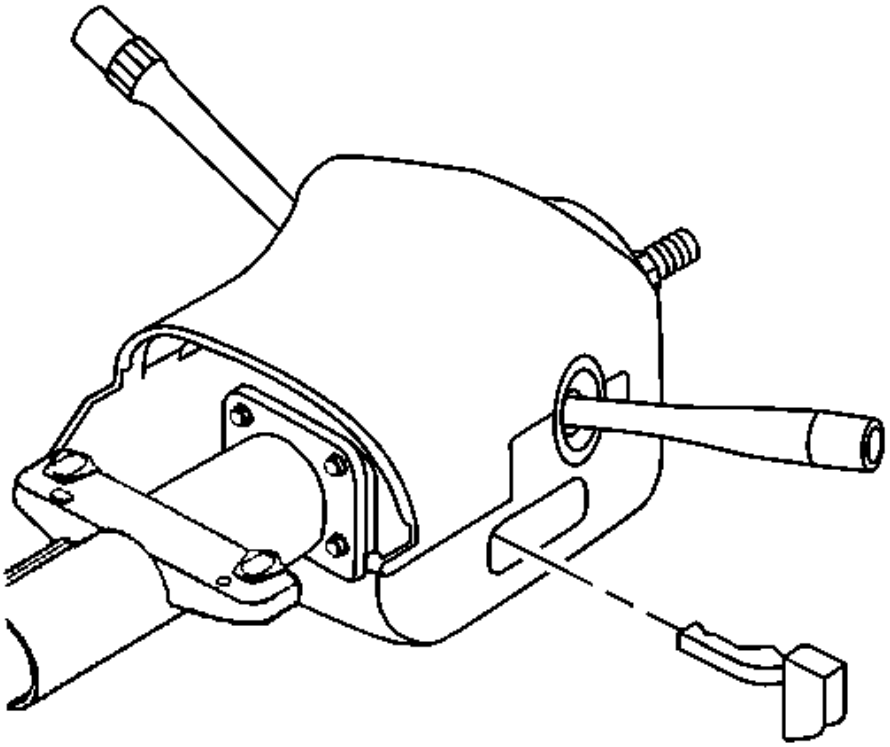


Fig. 20: Removing/Installing Tilt Lever
Courtesy of GENERAL MOTORS COMPANY

10. On vehicles with a tilt column, align the tilt lever into the steering column.
11. Slide the tilt lever handle into the steering column until the handle locks into position.

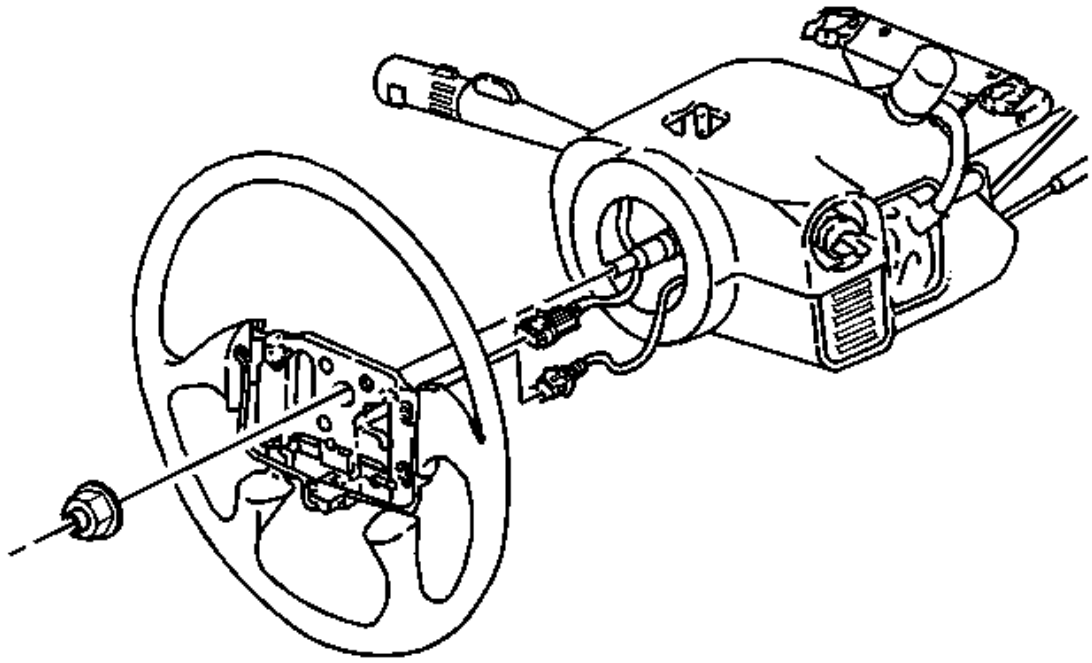


Fig. 21: Steering Wheel, Shaft & Nut
Courtesy of GENERAL MOTORS COMPANY

12. Install the steering wheel onto the steering shaft. Refer to **Steering Wheel Replacement** .
13. Enable the SIR system. Refer to **SIR Disabling and Enabling**.

AIRBAG STEERING WHEEL MODULE COIL CENTERING

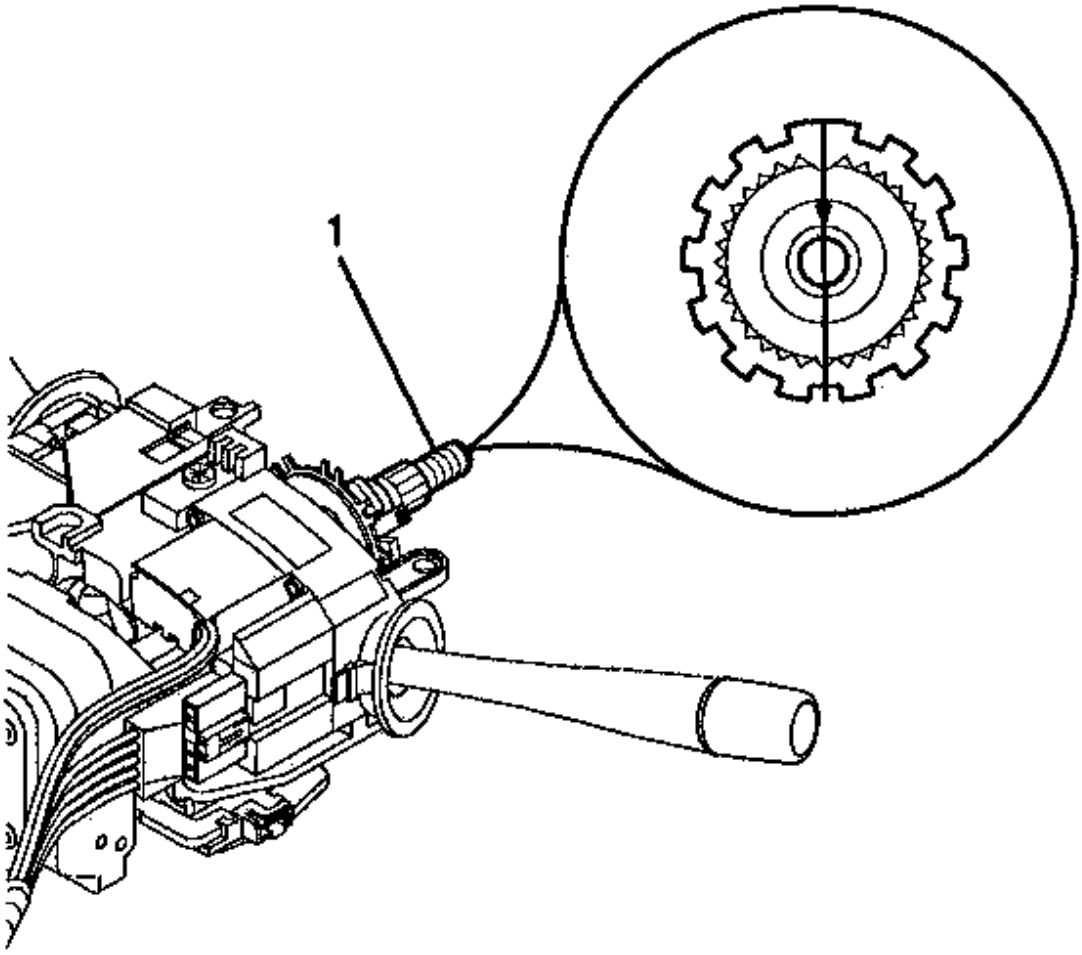


Fig. 22: View Of Block Tooth Of Steering Shaft Assembly In 12 O'clock Position
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **The new SIR coil assembly will be centered. Improper alignment of the SIR coil assembly may damage the unit, causing an inflatable restraint malfunction.**

NOTE: **If double wire harness strap is installed onto the wire harness assembly and column, you must reuse the holder for the wire straps during installation.**

Remove the wire harness strap(s) where necessary.

1. Verify the following conditions before centering the SIR coil:
    - The wheels on the vehicle are straight ahead.
    - The block tooth (1) of the steering shaft assembly is in the 12 o'clock position.
    - The ignition switch is in the LOCK position.

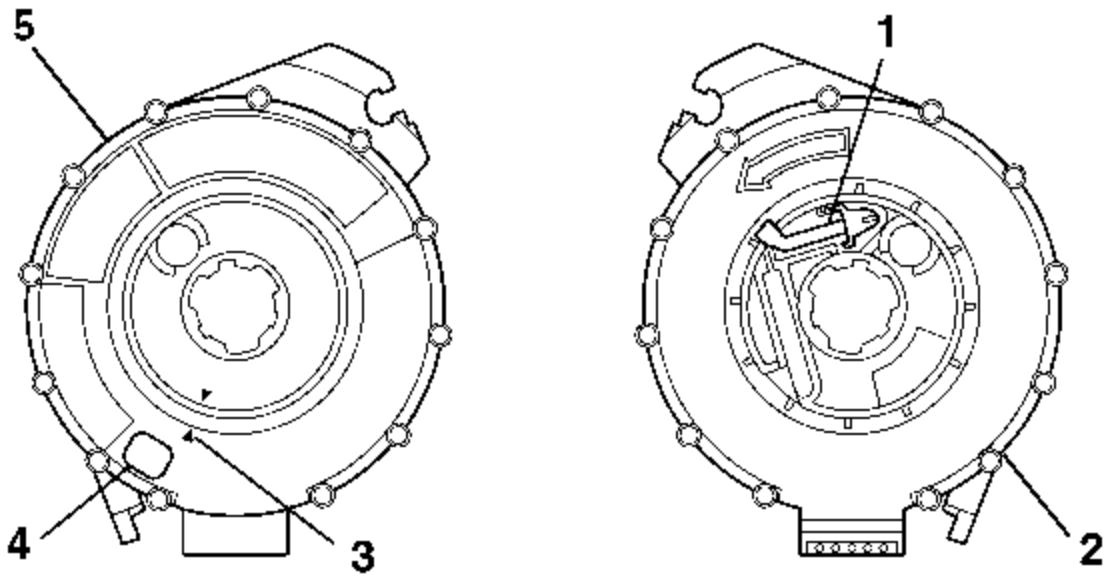


Fig. 23: Centering SIR Coil (With Centering Window & Spring Service Lock)
Courtesy of GENERAL MOTORS COMPANY

2. If the front (5) of the SIR coil has a centering window (4), and the back side (2) includes a spring service lock (1), perform the following steps:
    1. Hold the SIR coil with the face up.
    2. While depressing the spring service lock, rotate the coil hub clockwise until the coil ribbon stops.
    3. Rotate the coil hub slowly, counterclockwise, until the centering window appears yellow and both arrows (3) line up.
    4. Release spring service lock between the locking tab. The SIR coil is now centered.
    5. Align the centered SIR coil with the horn tower and slide onto the steering shaft assembly.

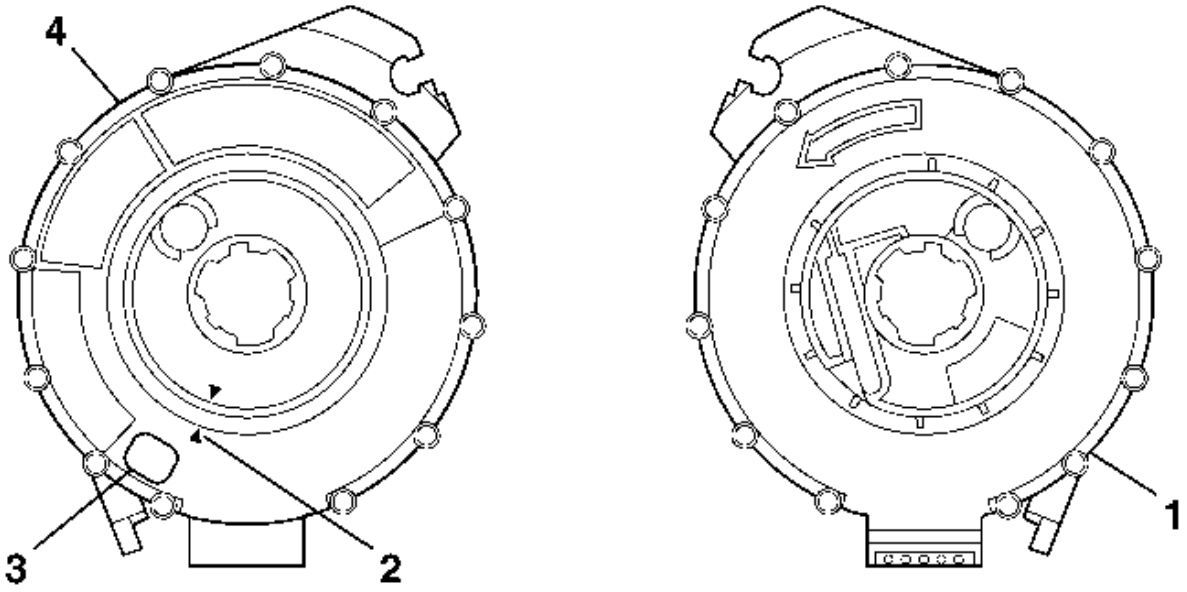


Fig. 24: Centering SIR Coil (With Centering Window, Without Spring Service Lock)
Courtesy of GENERAL MOTORS COMPANY

3. If the front (4) of the SIR coil has a centering window (3), and the back side (1) includes NO spring service lock, perform the following steps:
    1. Hold the SIR coil with the face up.
    2. Rotate the coil hub clockwise until the coil ribbon stops.
    3. Rotate the coil hub slowly, counterclockwise until the centering window appears yellow and both arrows (2) line up. This is the CENTER position.
    4. While holding the coil hub in the CENTER position, align the SIR coil with the horn tower and slide onto the steering shaft assembly.

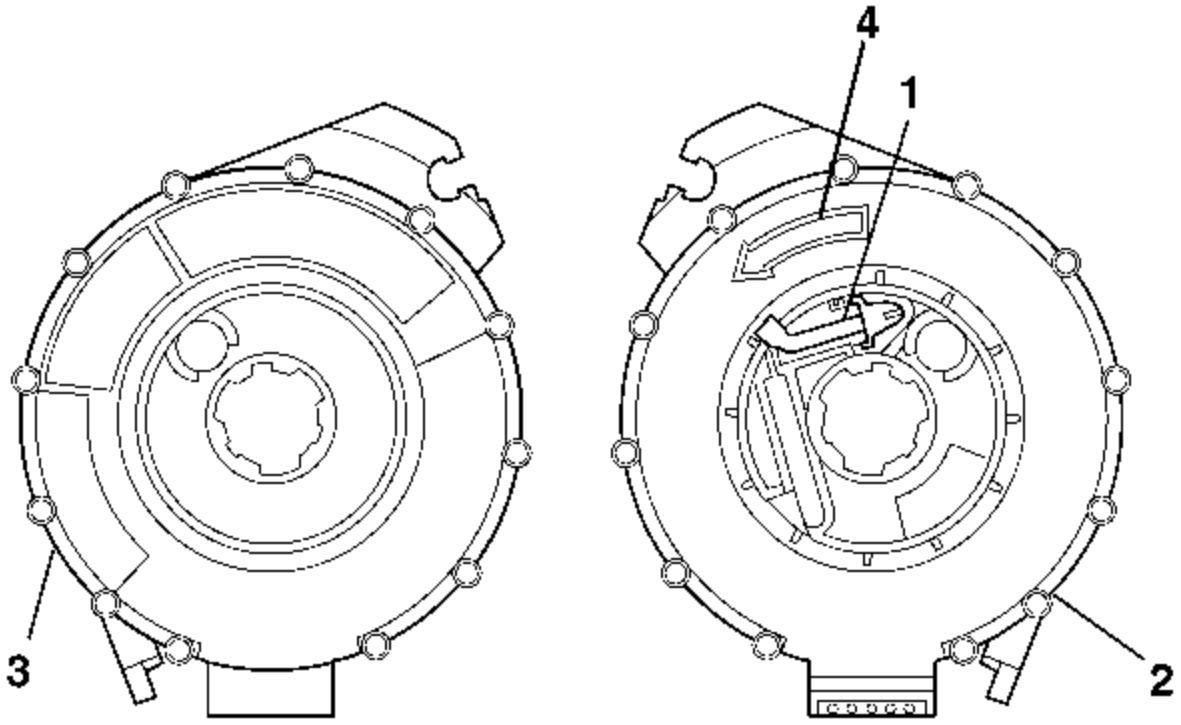


Fig. 25: Centering SIR Coil (No Centering Window, But Back Side Includes A Spring Service Lock)
Courtesy of GENERAL MOTORS COMPANY

4. If the front side (3) of the SIR coil has NO centering window, but the back side (2) includes a spring service lock (1), perform the following steps:
    1. Hold the SIR coil with the back side up.
    2. While depressing the spring service lock, rotate the coil hub in the direction of the arrow (4) until the coil ribbon stops.
    3. Still pressing the spring service lock, rotate the coil hub in the opposite direction 2 1/2 revolutions.
    4. Release the spring service lock between locking tabs. The SIR coil is now centered.
    5. Align the centered SIR coil with the horn tower and slide onto the steering shaft assembly.

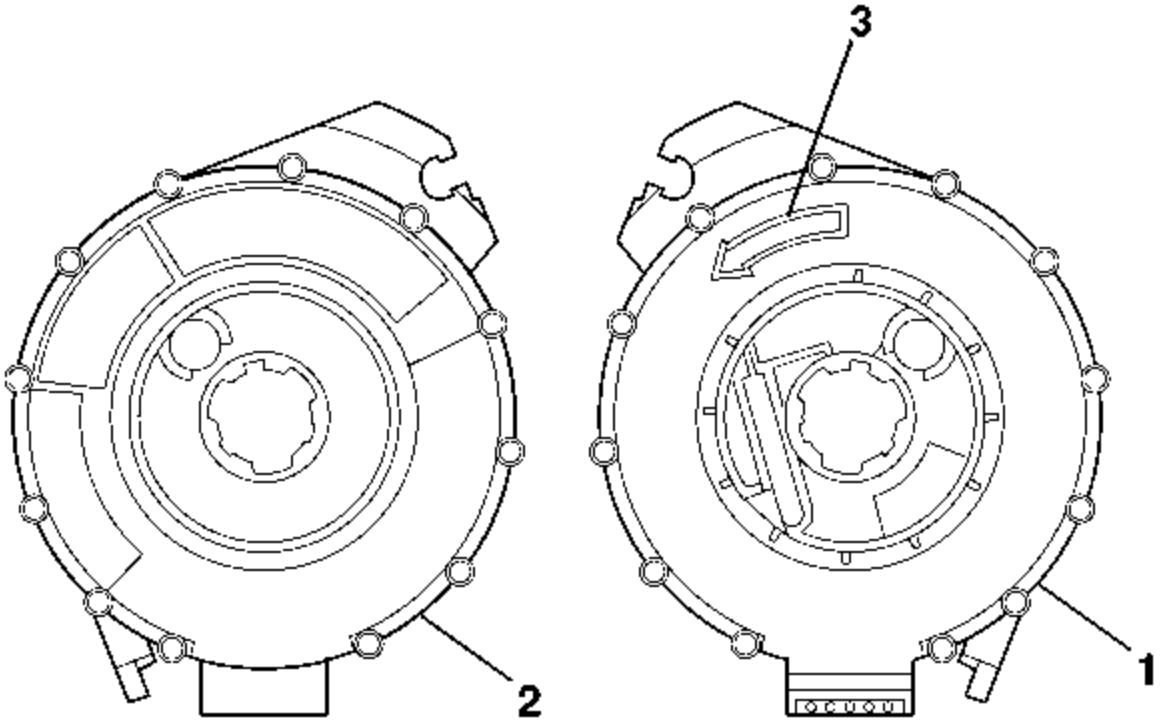


Fig. 26: Centering SIR Coil (Without Centering Window, Without Spring Service Lock)
Courtesy of GENERAL MOTORS COMPANY

5. If the front side (2) of the SIR coil has NO centering window, and the back side (1) includes NO spring service lock, perform the following steps:
    1. Hold the SIR coil with the face up.
    2. Rotate the coil hub in the direction of the arrow until the coil ribbon stops.
    3. Rotate the coil hub, slowly, counterclockwise, for 2 1/2 revolutions. This is the CENTER position.
    4. While maintaining the coil hub in the CENTER position, align the centered SIR coil with the horn tower and slide onto the steering shaft assembly.
6. If double wire harness strap is installed onto the wire harness assembly and column, you must route the wires up against the steering column. One wire harness strap will surround one lead from the coil to the steering column. The other wire harness strap will surround all leads to the steering column.

AIRBAG INSTRUMENT PANEL MODULE REPLACEMENT (IMPALA LIMITED)

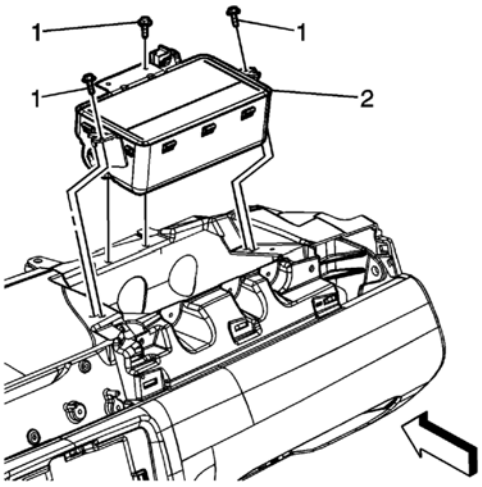


Fig. 27: Inflatable Restraint Instrument Panel Module (Impala Limited)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to SIR Warning .** **WARNING:** **Refer to SIR Inflator Module Handling and Storage Warning .** **Preliminary Procedures** 1. Disable the SIR. Refer to **SIR Disabling and Enabling**. 2. Remove the instrument panel (I/P) upper trim panel. Refer to **Instrument Panel Upper Trim Pad Replacement** .	
1	Inflatable Restraint I/P Module Bolts (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 10 N.m (89 lb in)
2	Inflatable Restraint I/P Module Assembly

INFLATABLE RESTRAINT PASSENGER PRESENCE SYSTEM REPLACEMENT - FRONT

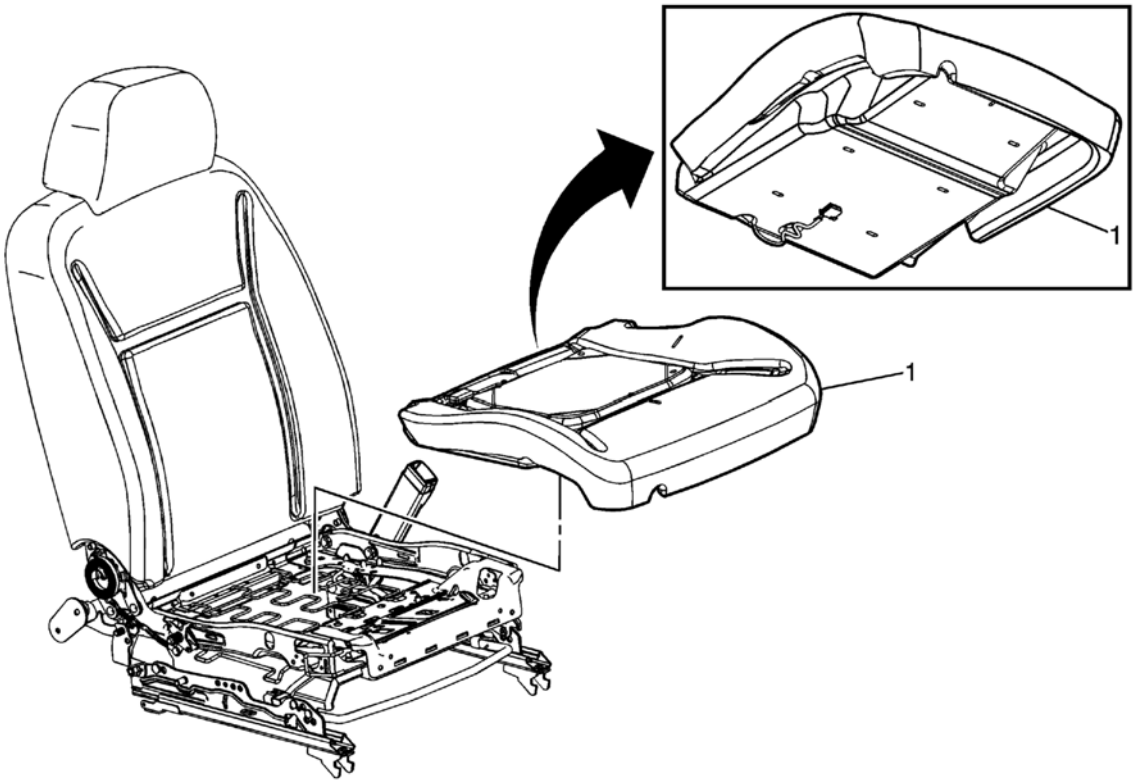


Fig. 28: Identifying Inflatable Restraint Passenger Presence System
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)** . 2. Remove the seat cushion cover. Refer to **Front Seat Cushion Cover and Pad Replacement (Impala Limited)** .	
1	Inflatable Restraint Front Passenger Presence System Assembly **WARNING:** **Replace the passenger presence system as a complete assembly to prevent possible injury to the occupant. All the**

Callout	Component Name
	components in the service kit are assembled and calibrated as a unit. Using only some of the components in the service kit will cause the passenger presence system to operate improperly. **WARNING:** **To avoid personal injury, perform a preload test on the passenger presence system whenever you remove or replace the seat cushion trim. Failure to do so may cause the system to malfunction.** **Procedures** 1. Passenger Presence System Preload Test the inflatable restraint passenger presence system whenever the seat cushion or any component of the passenger presence system is removed. Refer to **Passenger Presence System Preload Test**

Callout	Component Name
	2. Program the inflatable restraint passenger presence system after replacement. Refer to **Control Module References** . • The passenger presence system is an integral part of the pad on the passenger seat cushion. • The seat cushion heater is attached directly to the pad, then the sensor goes on top of the heater (if equipped). • The sensor, module and seat cushion pad must be replaced as a unit. • Note the routing of the wiring harness and connector location for installation.

FRONT SEAT OUTBOARD SEAT BACK AIRBAG REPLACEMENT

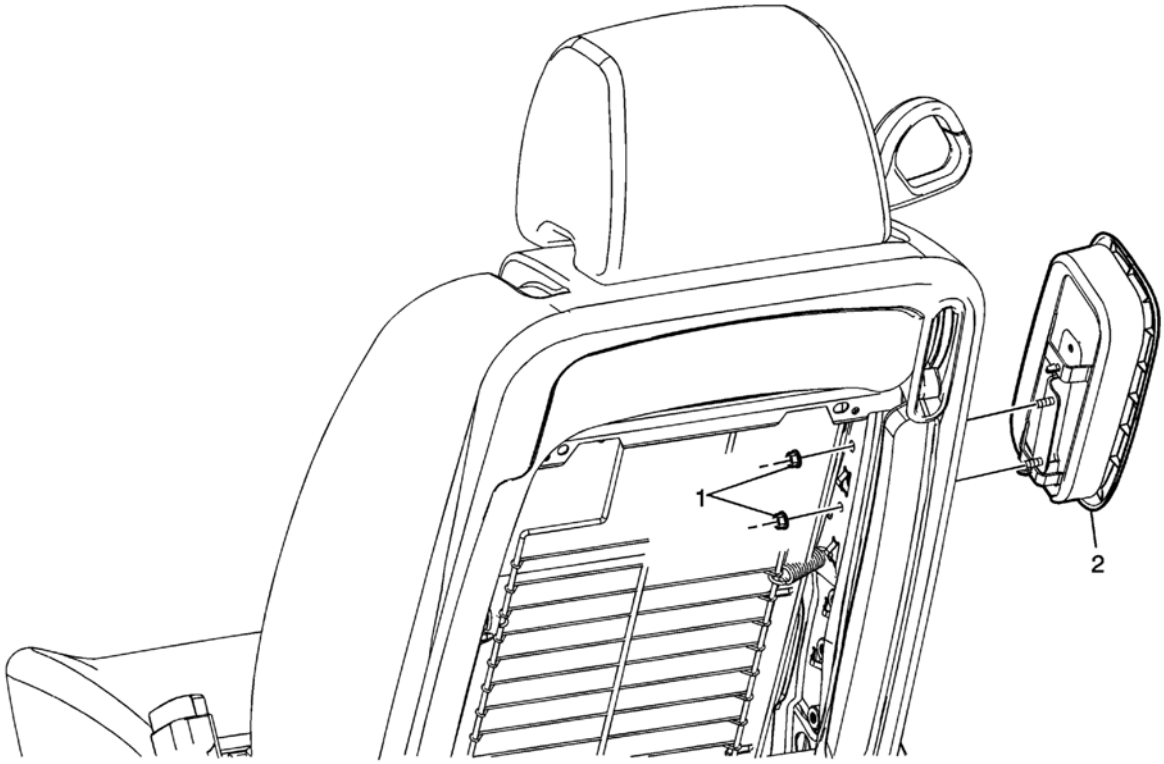


Fig. 29: Inflatable Restraint Side Impact Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Following the deployment of a side impact air bag, inspect the following parts for**	

Callout	Component Name
damage. Replace these parts if necessary: • **The seat cushion frame** • **The seat recliner, if equipped** • **The seat adjuster** • **The seat back frame** **Failure to do so may cause future personal injury.** **WARNING:** **Do not strike or jolt the inflatable restraint side impact sensor (SIS). Before applying power to the SIS make sure that it is securely fastened. Failure to observe the correct installation procedures could cause SIR deployment, personal**	

Callout	Component Name
injury, or unnecessary SIR system repairs. **Preliminary Procedure** 1. Disable the SIR system. Refer to **SIR Disabling and Enabling**. 2. Remove the front seat. Refer to **Front Seat Removal and Installation - Bucket (Impala Limited)** . 3. Remove the front seat back cushion finish panel. Refer to **Front Seat Back Cushion Finish Panel Replacement (Impala Limited)** .	
1	Inflatable Restraint Front Seat Side Module Nut (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 3.5 N.m (31 lb in)
2	Inflatable Restraint Front Seat Side Module **Procedure** 1. Remove the connector position assurance (CPA) from the module electrical connector. 2. Disconnect the electrical connector. 3. Refer to **Inflatable Restraint Module Handling and Scrapping**.

INSTRUMENT PANEL AIRBAG ARMING STATUS DISPLAY REPLACEMENT

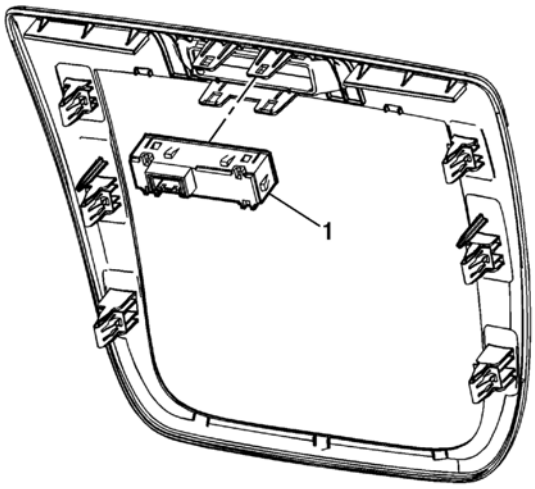


Fig. 30: Inflatable Restraint IP Module Indicator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Fastener Tightening Specifications: Refer to **Fastener Specifications**. Preliminary Procedure Remove the instrument panel accessory trim panel. Refer to **Instrument Panel Accessory Trim Plate Replacement** .	
1	Indicator Assembly, Inflatable Restraint Instrument Panel Module

ROOF SIDE RAIL AIRBAG REPLACEMENT

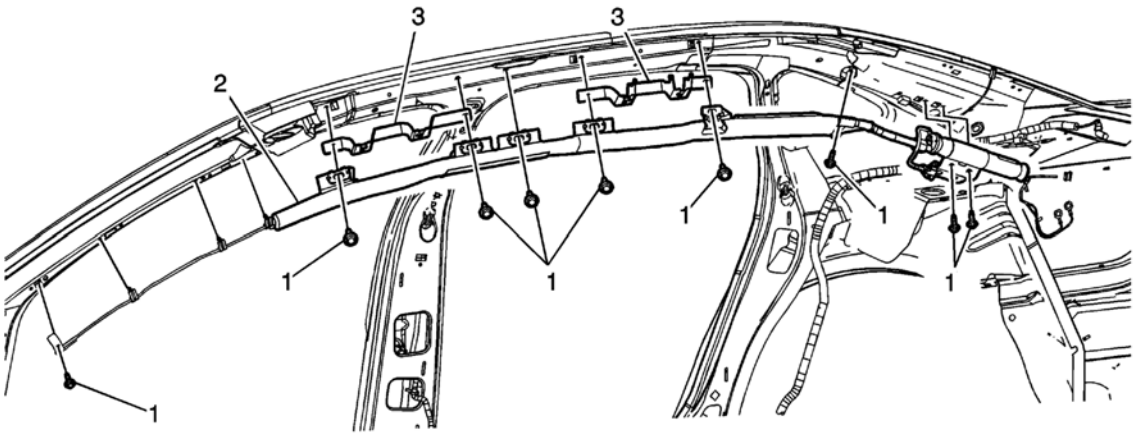


Fig. 31: Inflatable Restraint Roof Rail Module
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **In order to prevent SIR deployment,**	

Callout	Component Name
personal injury, or unnecessary SIR system repairs, do not strike the door or the door pillar in the area of the side impact sensor (SIS). Turn OFF the ignition and remove the key when performing service in the area of the SIS. **WARNING: When installing the roof rail airbag, do not twist or turn the airbag 360 degrees. Securing the roof rail airbag with an airbag twisted or turned 360 degrees may cause the airbag not to deploy correctly and could cause personal injury.** **WARNING:**	

Callout	Component Name
Refer to SIR Warning . **WARNING:** **Refer to SIR Inflator Module Handling and Storage Warning .** **Preliminary Procedures** 1. Disable the SIR system. Refer to **SIR Disabling and Enabling**. 2. Remove the windshield pillar garnish molding. Refer to **Windshield Pillar Garnish Molding Replacement** . 3. Remove the center pillar trim. Refer to **Center Pillar Upper Trim Panel Replacement** . 4. Remove the rear quarter upper trim panel. Refer to **Quarter Upper Trim Panel Replacement** . 5. Remove the assist handles. Refer to **Assist Handle Replacement** . 6. Lower the side of the headliner. Refer to **Headlining Trim Panel Replacement** .	
1	Inflatable Restraint Roof Side Rail Bolt **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Inflatable Restraint Roof Side Rail Module Assembly
3	Assist Handle Bracket Assembly

FRONT SEAT BELT ANCHOR PLATE TENSIONER REPLACEMENT

Removal Procedure

WARNING: **Refer to SIR Warning .**

WARNING: **In order to prevent accidental deployment and the risk of personal injury, do not dispose of an undeployed inflatable restraint seat belt pretensioner as normal shop waste. Undeployed seat belt pretensioners contain substances that could cause severe illness or personal injury if their sealed containers are damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed seat belt**

pretensioner. Failure to observe the following disposal methods may be a violation of appropriate country, regional or local laws.

WARNING: When carrying an undeployed inflatable restraint seat belt pretensioner:

- **Do not carry the seat belt pretensioner by the wires or connector.**
- **Carry the seat belt pretensioner by the piston tube, keeping hands and fingers away from the cable.**
- **Make sure the open end of the seat belt pretensioner piston tube points away from you and other people.**
- **Do not cover the seat belt pretensioner piston tube opening with your hand.**

Failure to observe these guidelines may result in personal injury.

1. Move the front seat all the way forward.
2. Disable the SIR. Refer to **SIR Disabling and Enabling**.
3. Remove the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement** .

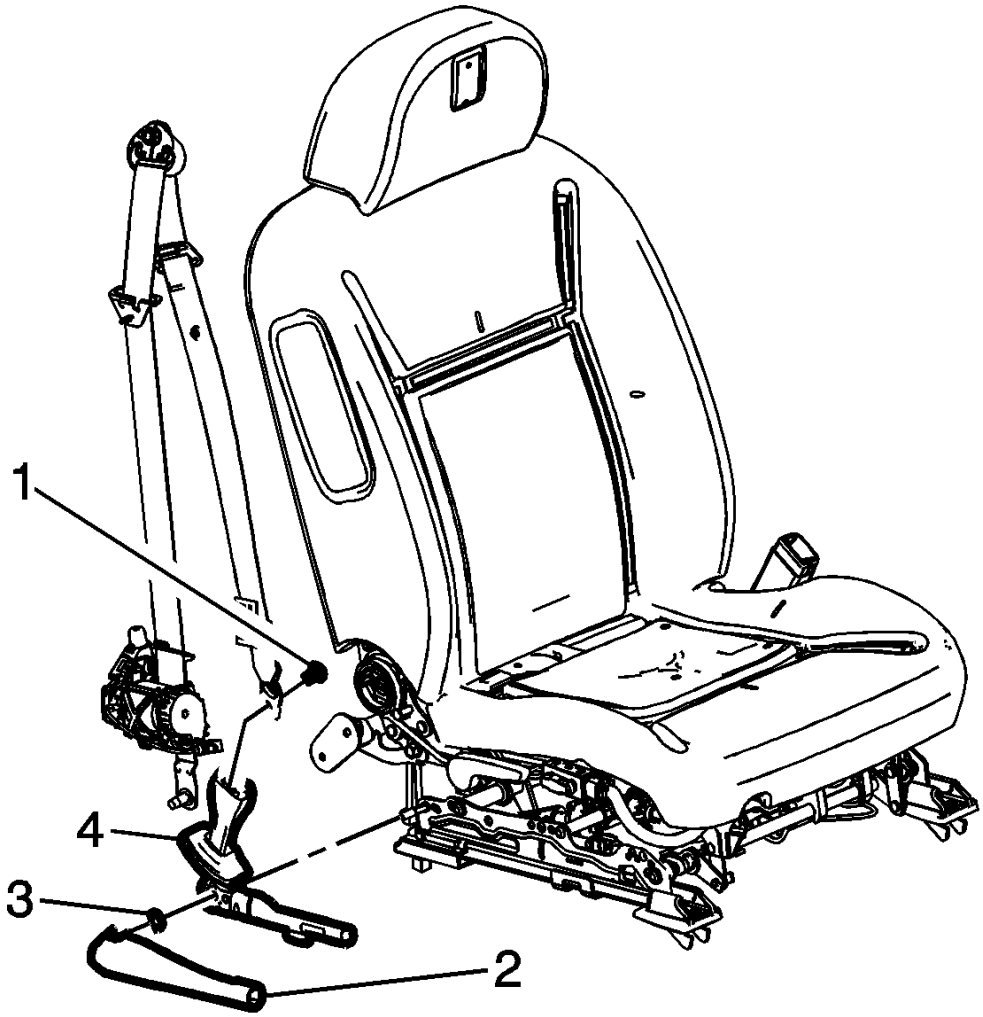


Fig. 32: Identifying Seat Belt Retractor Pretensioner
Courtesy of GENERAL MOTORS COMPANY

4. Unsnap the upper sleeve from the linkage cover and slide down.
5. Remove the linkage screw. Then push the screw through the hole using the small access hole on the opposite side of the linkage cover bolt/screw (1).
6. If the screw does not come out, the cover halves can be separated with a flat-head screwdriver to access and hold the nut.
7. Pull the anchor linkage plate from the linkage cover.
8. Remove the tensioner cover (2).
9. Remove the seat belt tensioner assembly nut (3).

NOTE: **The tensioner is on the opposite side of the seat belt buckle.**

10. Remove the seat belt (anchor side) tensioner assembly (4).

Installation Procedure

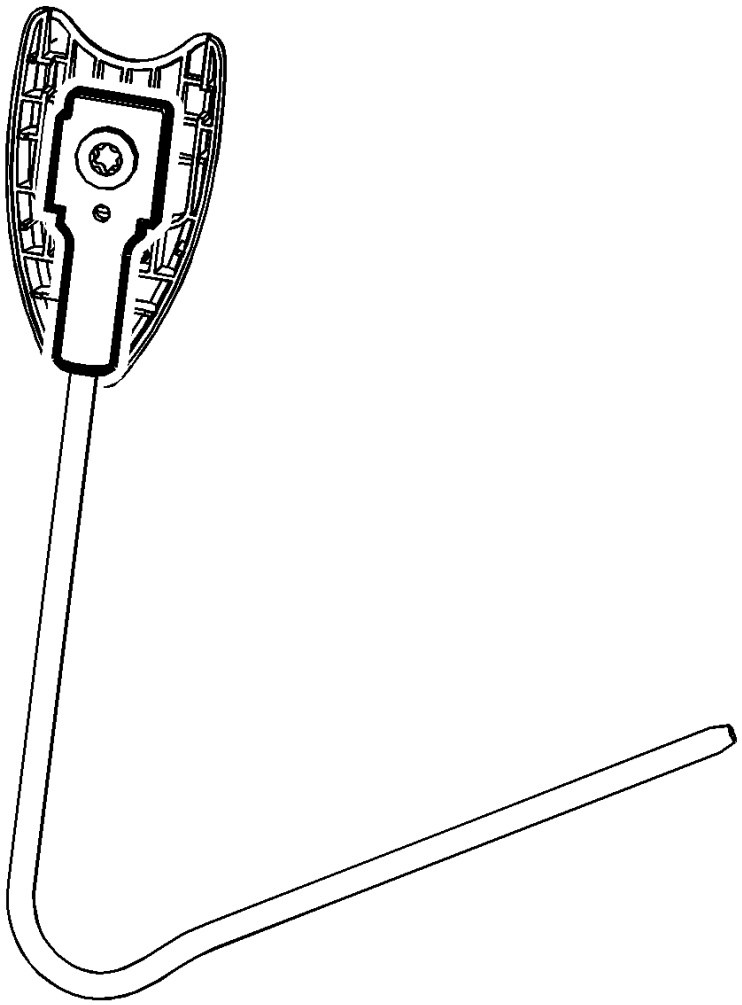


Fig. 33: Seat Belt Anchor Plate Tensioner (First Design)

Courtesy of GENERAL MOTORS COMPANY

NOTE: **First Design**

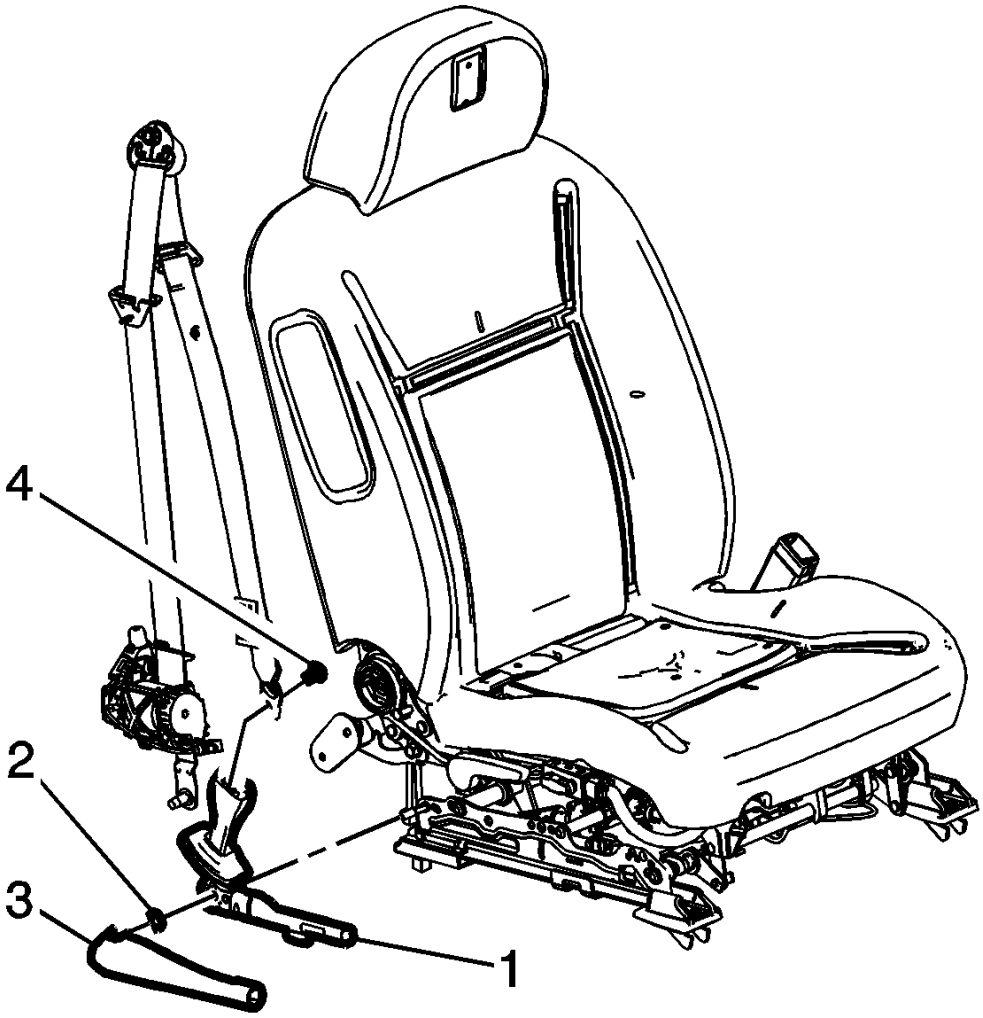


Fig. 34: Seat Belt (Anchor Side) Tensioner Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the seat belt (anchor side) tensioner assembly (1).

CAUTION: **Refer to Fastener Caution .**

2. Install the seat belt tensioner assembly nut (2) and tighten to 42 N.m (31 lb ft).
3. Install the tensioner cover (3).
4. Install the anchor linkage plate with the seat belt webbing label facing the occupant. Ensure there is no twist in webbing from the D ring to the anchor linkage plate.
5. Push the anchor linkage plate into linkage cover past the white stamped markings.
6. Install the anchor linkage plate bolt/screw (4) and tighten to 6 N.m (53 lb in).
7. Pull linkage sleeve upwards, and snap into place.

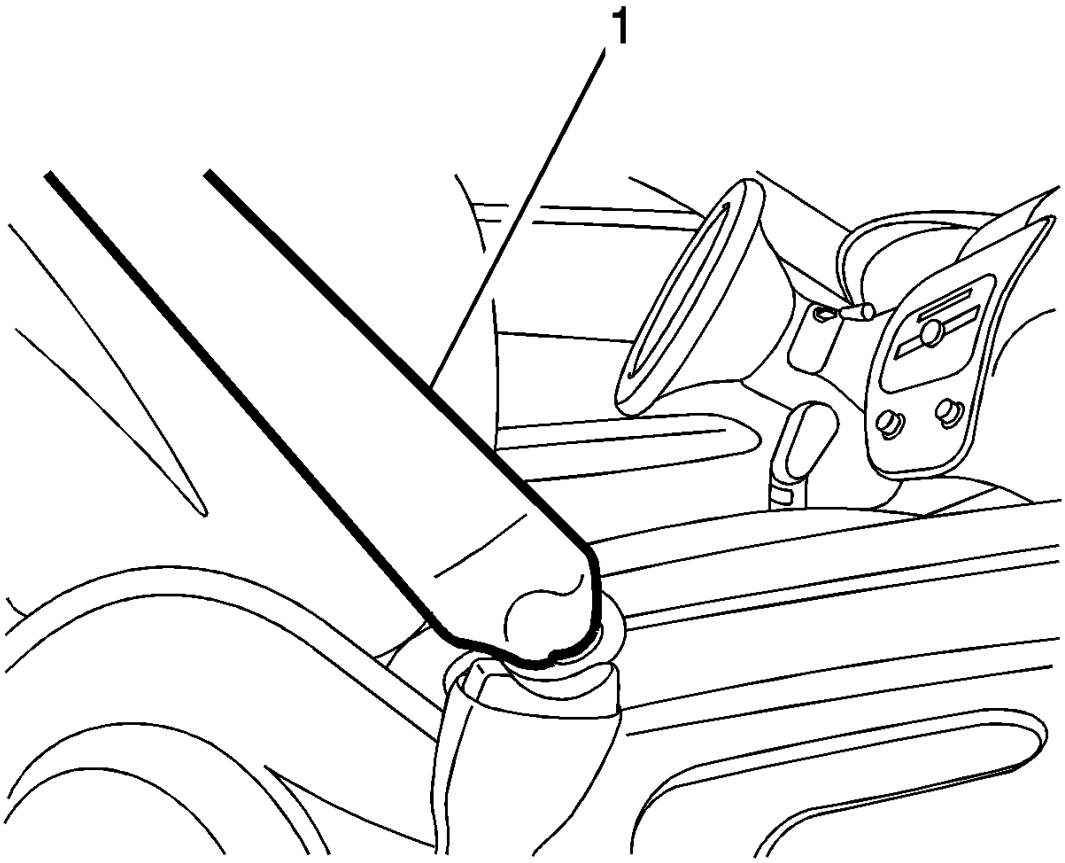


Fig. 35: Seat Belt Webbing
Courtesy of GENERAL MOTORS COMPANY

8. Check for label facing inward toward occupant and no twisting in the seat belt webbing (1).

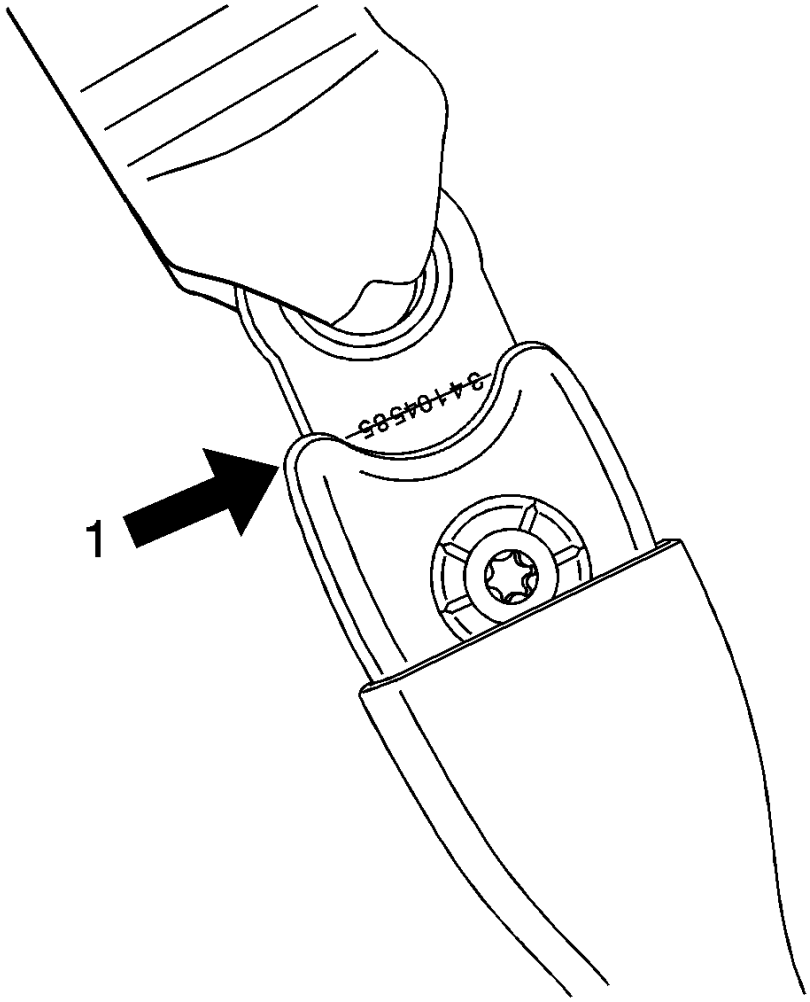


Fig. 36: Anchor Linkage Plate Cover
Courtesy of GENERAL MOTORS COMPANY

9. Check that NO white line and stamping numbers are visible above the anchor linkage plate cover (1).

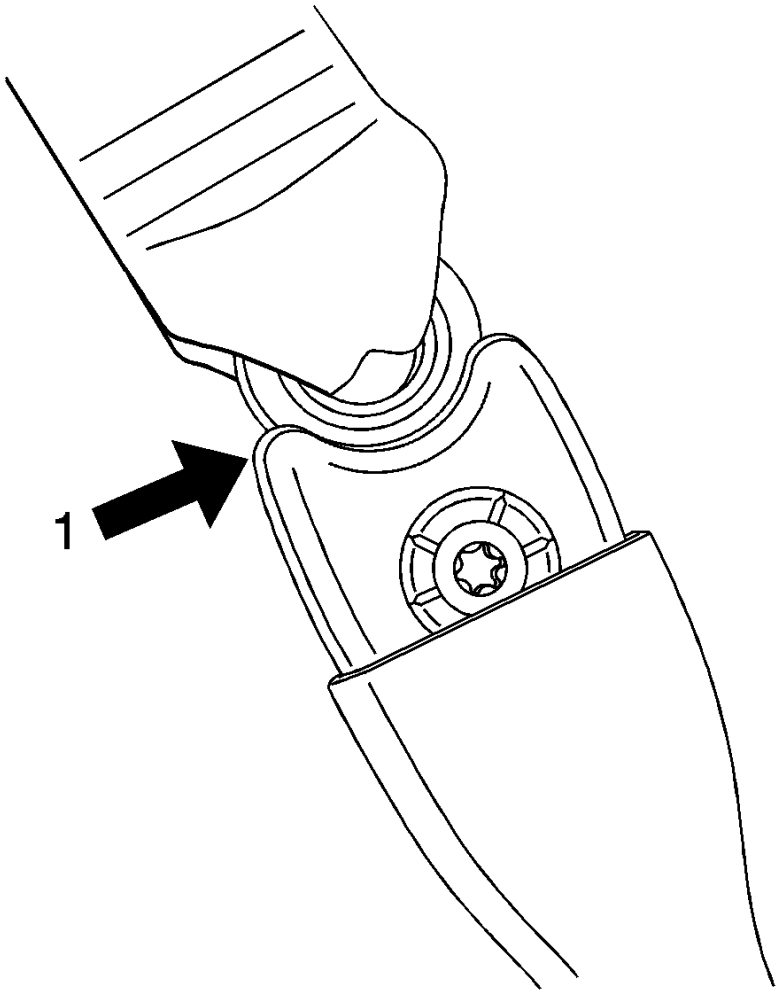


Fig. 37: Anchor Linkage Plate Cover
Courtesy of GENERAL MOTORS COMPANY

10. This illustration shows proper installation of anchor linkage plate cover (1).
11. Install the seat cushion outer trim panel. Refer to **Seat Cushion Outer Trim Panel Replacement** .
12. Enable the SIR. Refer to **SIR Disabling and Enabling**.

Installation Procedure

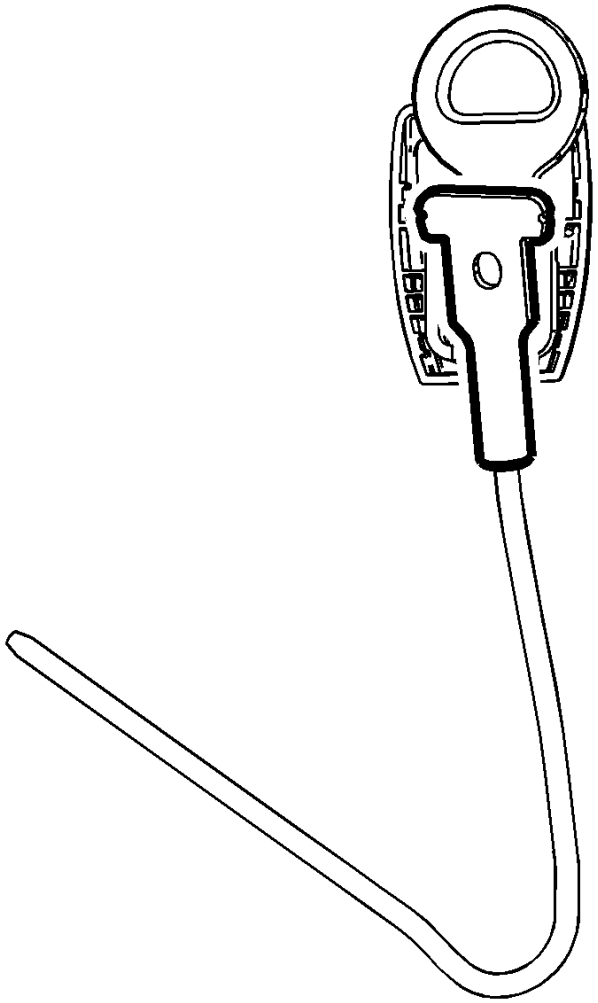


Fig. 38: Seat Belt Anchor Plate Tensioner (Second Design)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Second Design**

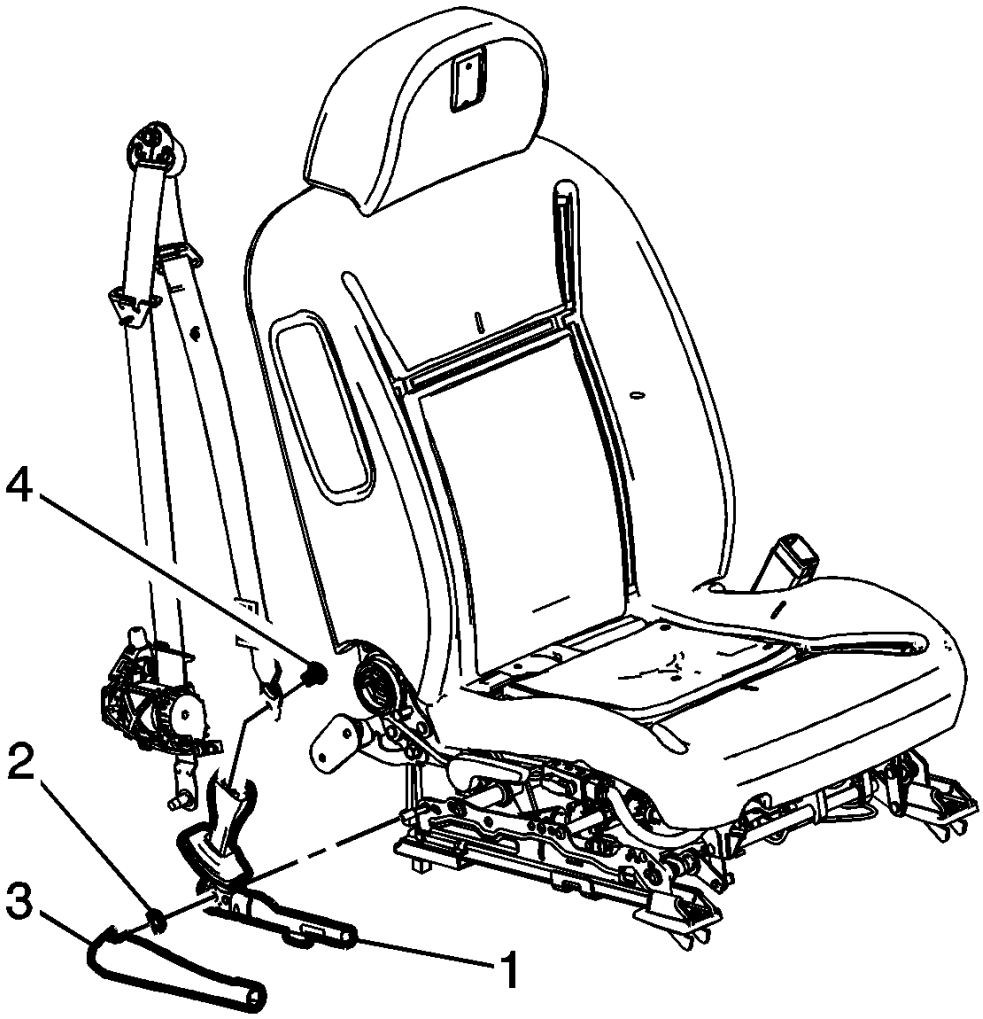


Fig. 39: Seat Belt (Anchor Side) Tensioner Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the seat belt (anchor side) tensioner assembly (1).

CAUTION: Refer to Fastener Caution .

2. Install the seat belt tensioner assembly nut (2) and tighten to 42 N.m (31 lb ft).
3. Install the tensioner cover (3).
4. Install the anchor linkage plate with the seat belt webbing label facing the occupant. Ensure there is no twist in webbing from the D ring to the anchor linkage plate.
5. Remove the inner cover and interlock the anchor linkage plate with seat belt webbing and tighten to 6 N.m (53 lb in).

SEAT BELT RETRACTOR PRETENSIONER REPLACEMENT - FRONT

Removal Procedure

WARNING: Refer to SIR Warning .

WARNING: **In order to prevent accidental deployment and the risk of personal injury, do not dispose of an undeployed inflatable restraint seat belt pretensioner as normal shop waste. Undeployed seat belt pretensioners contain substances that could cause severe illness or personal injury if their sealed containers are damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed seat belt pretensioner. Failure to observe the following disposal methods may be a violation of appropriate country, regional or local laws.**

WARNING: **When carrying an undeployed inflatable restraint seat belt pretensioner:**

- **Do not carry the seat belt pretensioner by the wires or connector.**
- **Carry the seat belt pretensioner by the piston tube, keeping hands and fingers away from the cable.**
- **Make sure the open end of the seat belt pretensioner piston tube points away from you and other people.**
- **Do not cover the seat belt pretensioner piston tube opening with your hand.**

Failure to observe these guidelines may result in personal injury.

1. Move the front seat all the way forward.
2. Disable the SIR. Refer to **SIR Disabling and Enabling**.
3. Remove the lower center pillar trim. Refer to **Center Pillar Lower Trim Panel Replacement** .

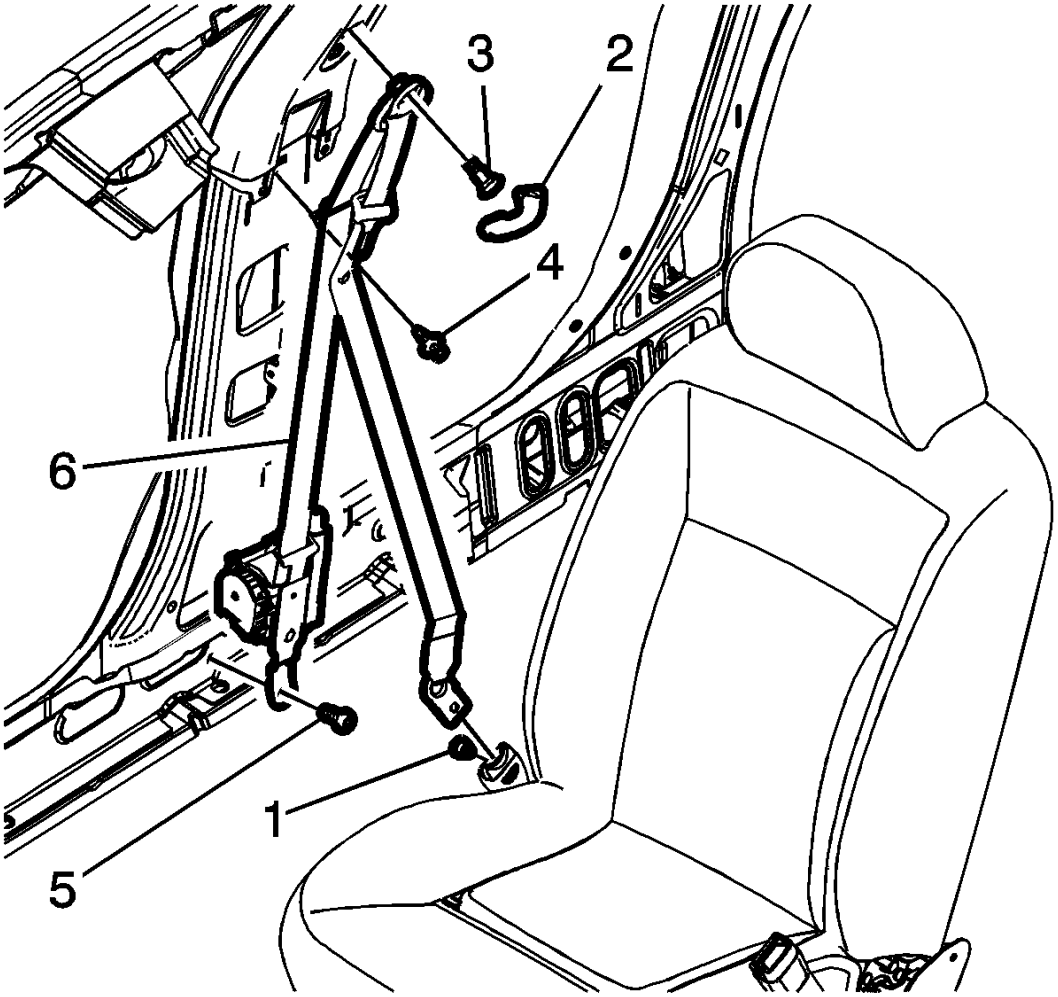


Fig. 40: Seat Belt Retractor Pretensioner - Front
Courtesy of GENERAL MOTORS COMPANY

4. Unsnap the upper sleeve from the linkage cover and slide down.
5. Remove the linkage screw then push the screw through the hole using the small access hole on the opposite side of the linkage cover (1).
6. Pull the anchor linkage plate from the linkage cover.
7. Remove the seat shoulder belt guide adjustable cover (2).
8. Remove the upper seat shoulder belt retractor bolt (3).
9. Remove the seat shoulder belt anchor pushpin retainer (4).
10. Remove the lower seat shoulder belt retractor bolt (5).
11. Remove the seat shoulder belt retractor (6).

Installation Procedure

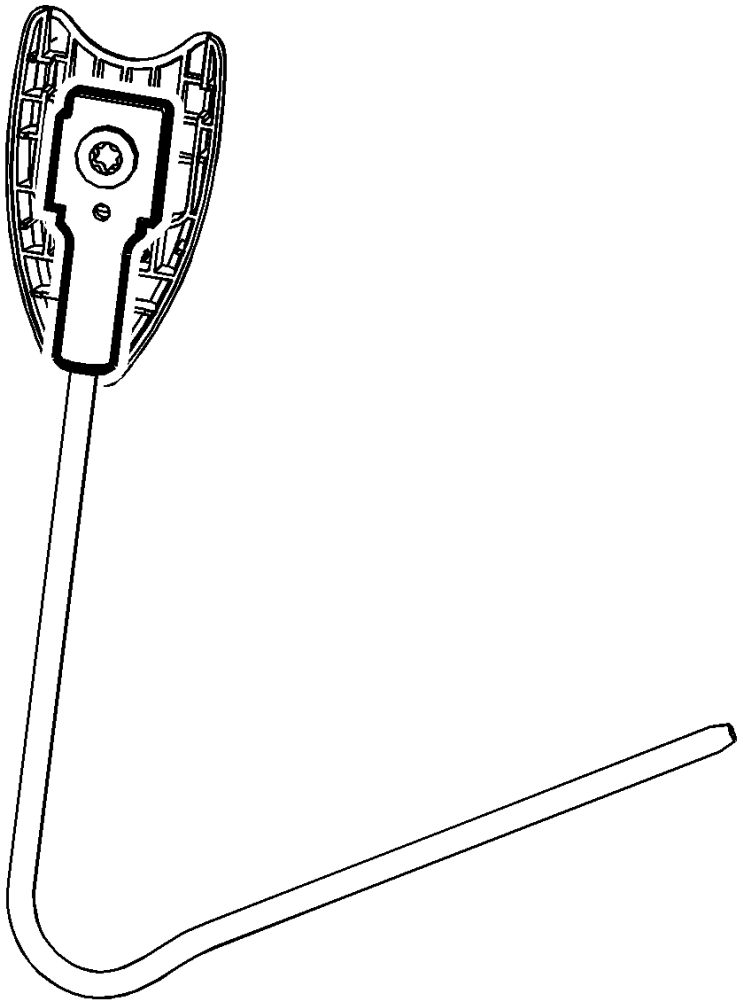


Fig. 41: Seat Belt Anchor Plate Tensioner (First Design)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **First Design**

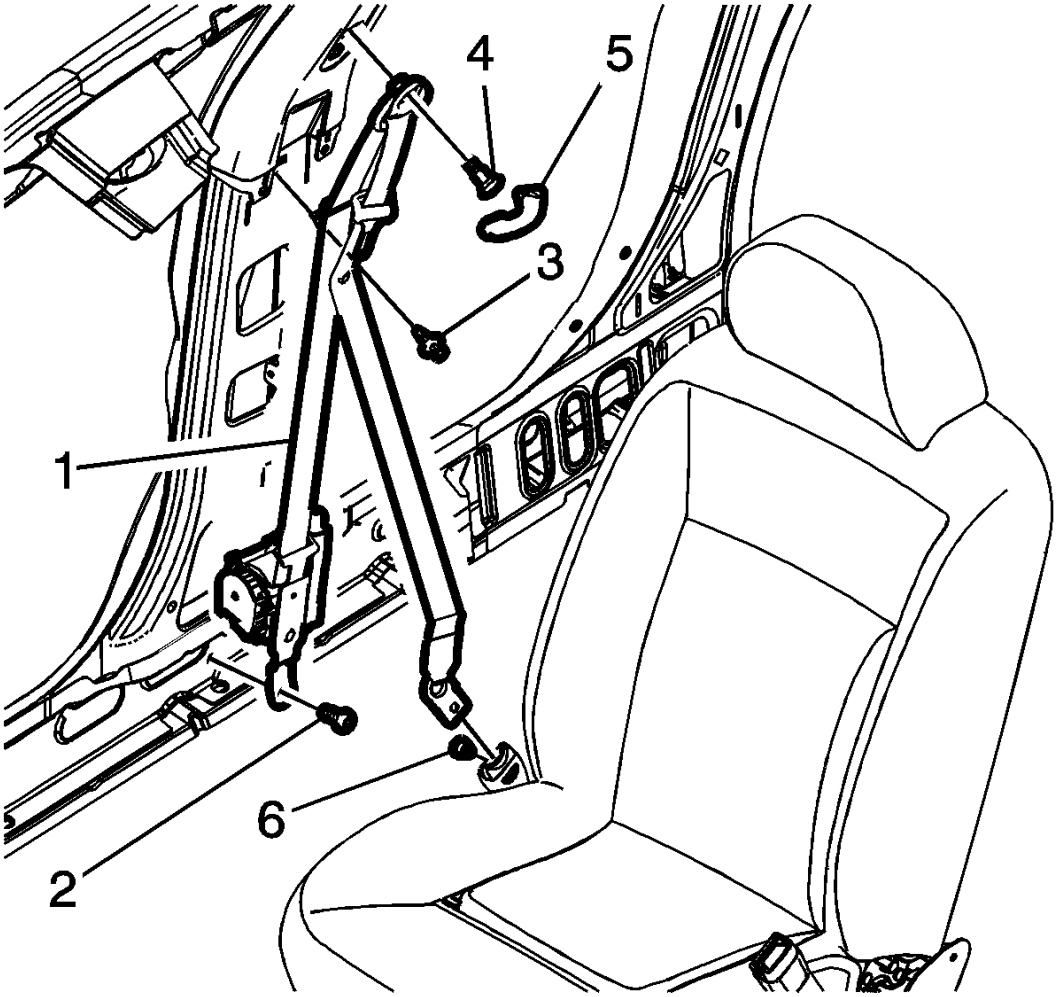


Fig. 42: Seat Shoulder Belt Retractor
Courtesy of GENERAL MOTORS COMPANY

1. Install the seat shoulder belt retractor (1).

CAUTION: Refer to Fastener Caution .

2. Install the lower seat shoulder belt retractor bolt (2) and tighten to 68 N.m (50 lb ft).
3. Install the seat shoulder belt anchor pushpin retainer (3).
4. Install the upper seat shoulder belt retractor bolt (4) and tighten to 42 N.m (31 lb ft)
5. Install the seat shoulder belt guide adjustable cover (5).
6. Install the anchor linkage plate with the seat belt webbing label facing the occupant. Ensure there is no twist in webbing from the D ring to the anchor linkage plate.
7. Push the anchor linkage plate into linkage cover past the white stamped markings.
8. Install the anchor linkage plate bolt/screw (6) and tighten to 6 N.m (53 lb in).

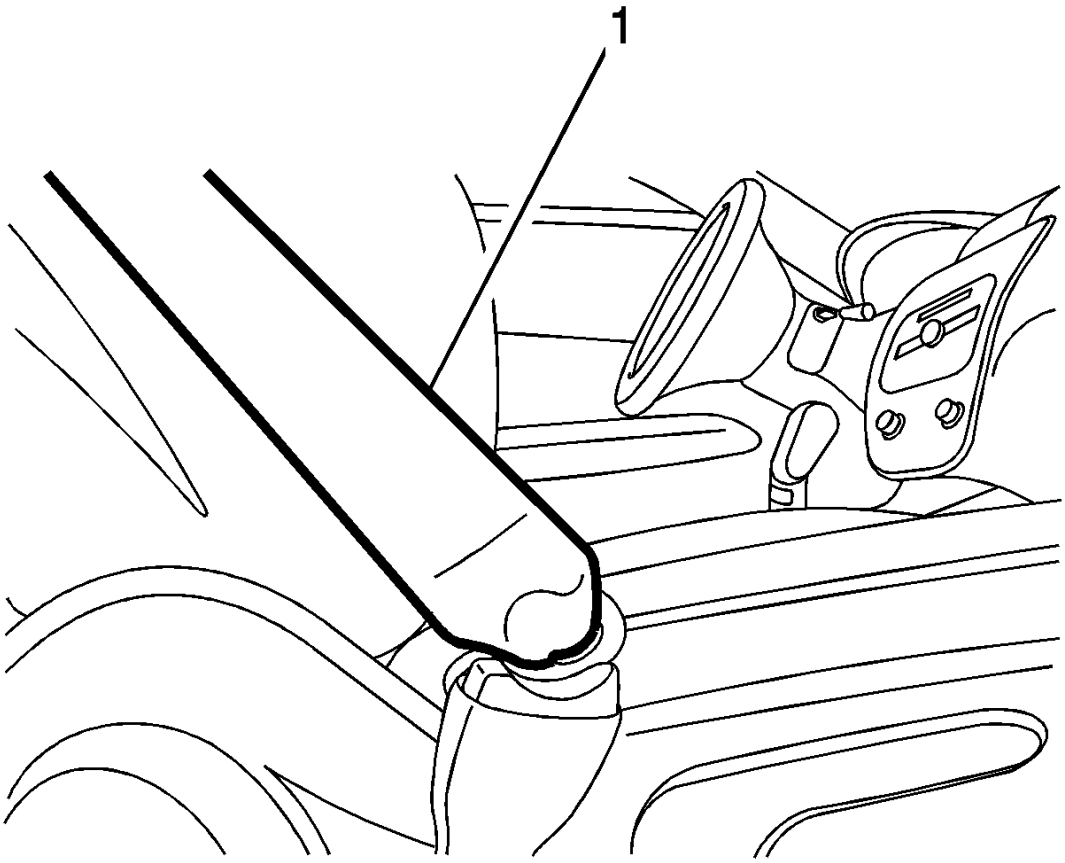


Fig. 43: Seat Belt Webbing
Courtesy of GENERAL MOTORS COMPANY

9. Check for label facing inward toward occupant and no twisting in the seat belt webbing (1).

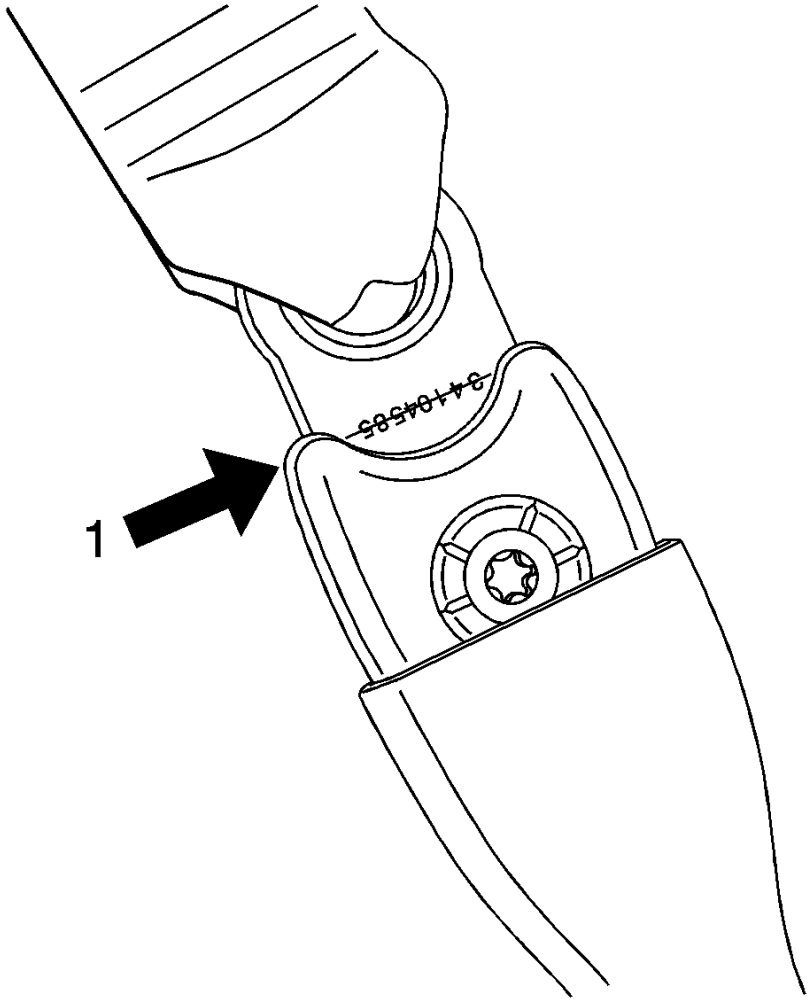


Fig. 44: Anchor Linkage Plate Cover
Courtesy of GENERAL MOTORS COMPANY

10. Check that NO white line and stamping numbers are visible above the anchor linkage plate cover (1).

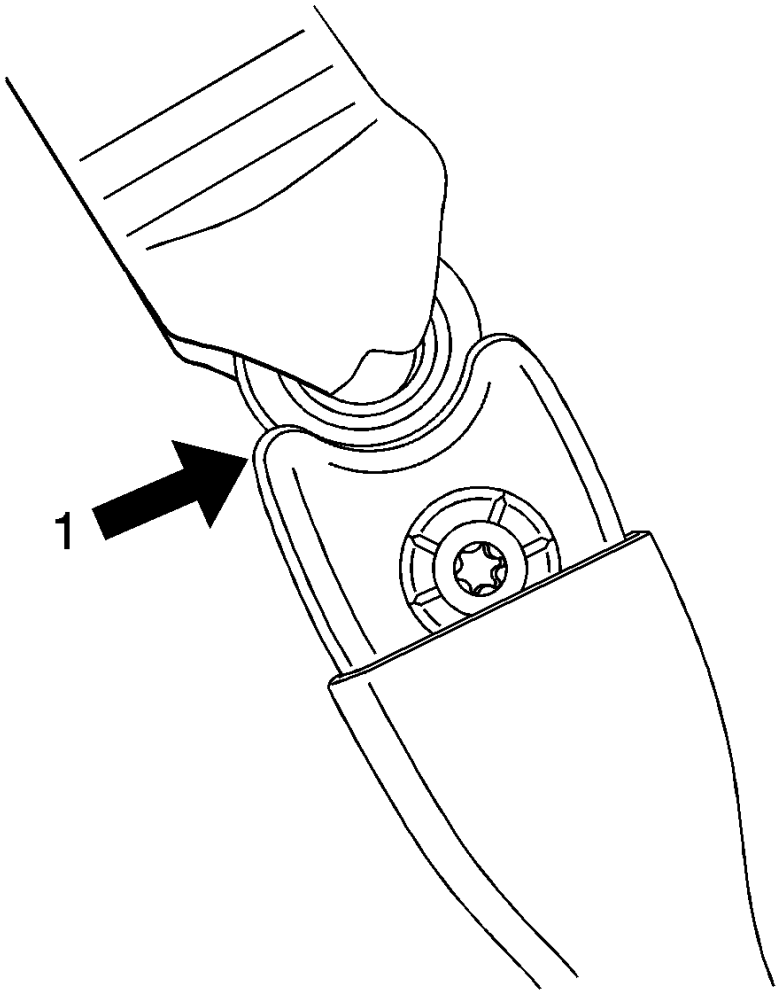


Fig. 45: Anchor Linkage Plate Cover
Courtesy of GENERAL MOTORS COMPANY

11. This illustration shows proper installation of anchor linkage plate cover (1).
12. Install the lower center pillar trim. Refer to **Center Pillar Lower Trim Panel Replacement** .
13. Enable the SIR. Refer to **SIR Disabling and Enabling**.

Installation Procedure

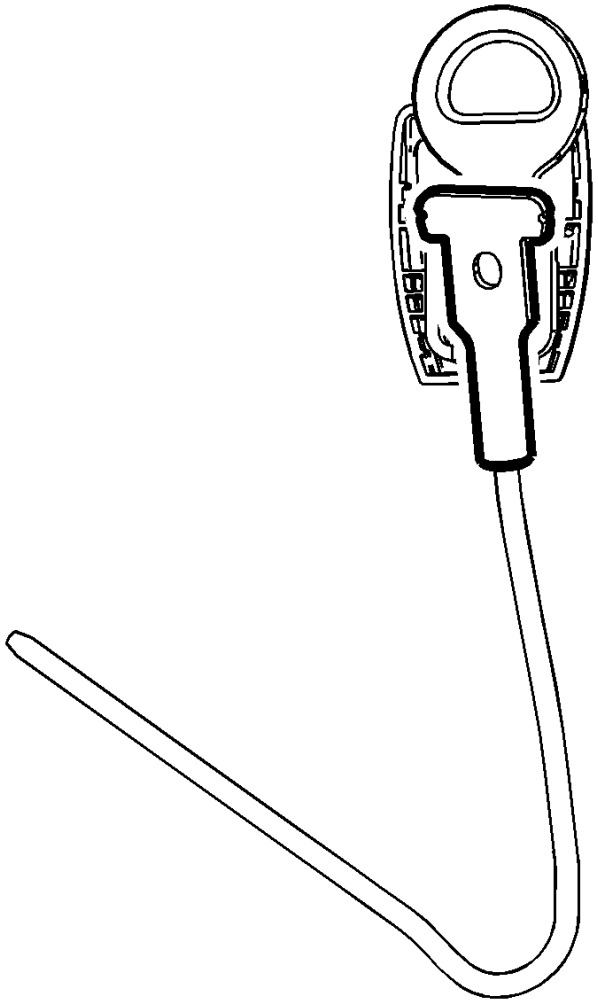


Fig. 46: Seat Belt Anchor Plate Tensioner (Second Design)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Second Design**

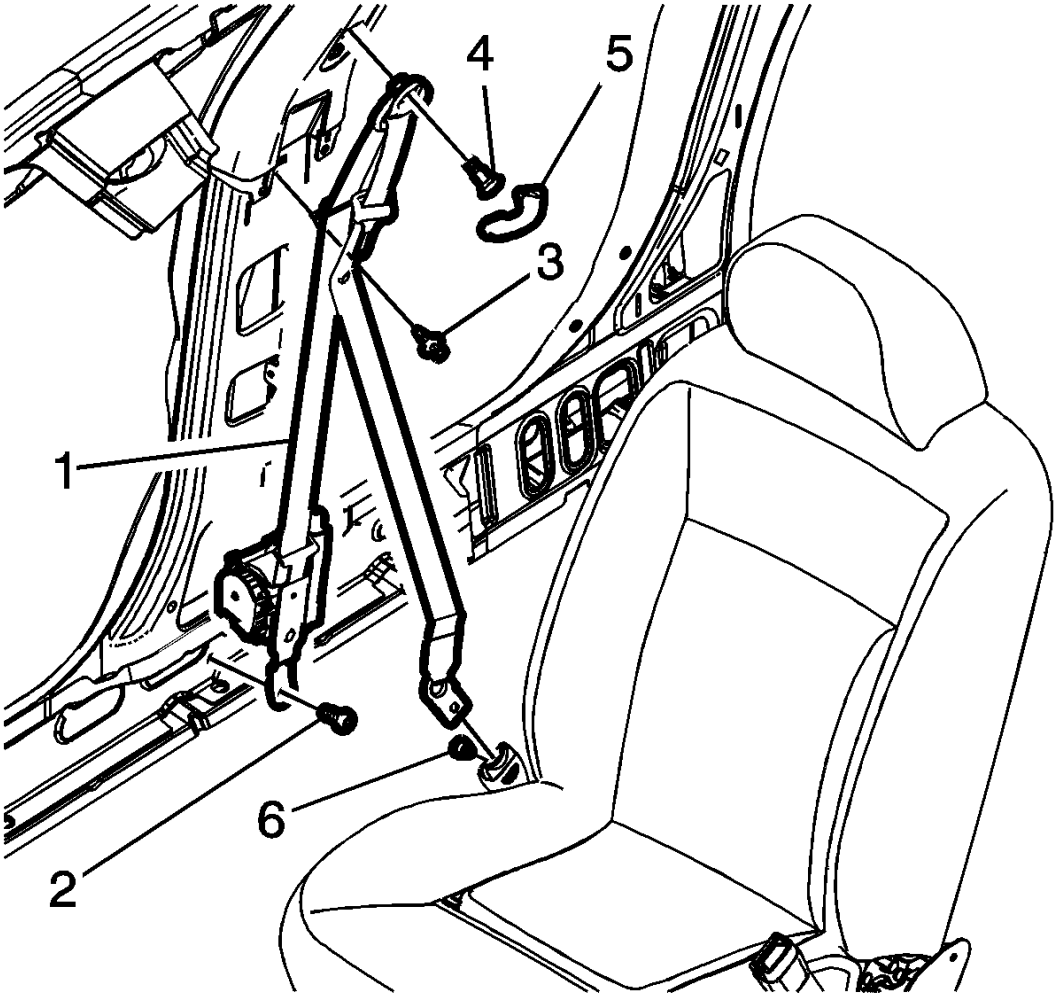


Fig. 47: Seat Shoulder Belt Retractor
Courtesy of GENERAL MOTORS COMPANY

1. Install the seat shoulder belt retractor (1).

CAUTION: Refer to Fastener Caution .

2. Install the lower seat shoulder belt retractor bolt (2) and tighten to 68 N.m (50 lb ft).
3. Install the seat shoulder belt anchor pushpin retainer (3).
4. Install the upper seat shoulder belt retractor bolt (4) and tighten to 42 N.m (31 lb ft)
5. Install the seat shoulder belt guide adjustable cover (5).
6. Install the anchor linkage plate with the seat belt webbing label facing the occupant. Ensure there is no twist in webbing from the D ring to the anchor linkage plate.
7. Remove the inner cover and interlock the anchor linkage plate with seat belt webbing and tighten to 6 N.m (53 lb in).

REPAIRS AND INSPECTIONS REQUIRED AFTER A COLLISION

Accident With or Without Air Bag Deployment - Component Inspections

WARNING: Proper operation of the Supplemental Inflatable Restraint (SIR) sensing system requires that any repairs to the vehicle structure return the vehicle structure to the original production configuration. Not properly repairing the vehicle structure could cause non-deployment of the air bag(s) in a frontal collision or deployment of the air bag(s) for conditions less severe than intended.

After any collision, inspect the following components as indicated. If you detect any damage, replace the component. If you detect any damage to the mounting points or mounting hardware, repair the component or replace the hardware as needed.

- The steering column-Inspect the steering column for bending, twisting, buckling or any type of damage.
- The instrument panel knee bolsters and mounting points-Inspect the knee bolsters for bending, twisting, buckling, or any other type of damage.
- The instrument panel brackets, braces, etc.-Inspect for bending, twisting, buckling, or any other type of damage.
- The seat belts-Perform the seat belt operational and functional checks. Refer to **Repairs and Inspections Required After a Collision** .
- The instrument panel cross car beam-Inspect for bending, twisting, buckling, or any other type of damage.
- The instrument panel mounting points and brackets-Inspect for bending, twisting, buckling, or any other type of damage.
- The seats and seat mounting points-Inspect for bending, twisting, buckling, or any other type of damage.
- The roof and headliner mounting points.
- The brake pedal --Inspect the brake pedal for bending, twisting, buckling or any type of damage.

Accident With Frontal Air Bag Deployment - Component Replacement and Inspections

After a collision involving air bag deployment, replace the following components.

- Driver Steering Wheel Air Bag
- Passenger instrument panel air bag, if deployed
- Inflatable Restraint Sensing and Diagnostic Module (SDM), if the Inflatable Restraint Sensing and Diagnostic Module has set DTC B0052 and will not clear
- Front and/or Side Impact Sensors
- Driver/Passenger Seat Side Air Bag, if deployed
- Seat back cover if Side Seat Air Bag is deployed
- Driver/Passenger Seat Belt Anchor and/or Retractor Pretensioners

Perform additional inspections on the following components.

- Steering wheel air bag coil and the coil wiring pigtail-Inspect for melting, scorching, or other damage due to excessive heat.
- Mounting points or mounting hardware for the passenger instrument panel air bag, steering wheel air bag, Inflatable Restraint Sensing and Diagnostic Module, seat side air bag (if deployed) and seat belt anchor and/or retractor pretensioners-Inspect for any damage and repair or replace each component as needed.

Accident With Side Seat Air Bag Deployment - Component Replacement and Inspections

After a collision involving driver/passenger side seat air bag deployment, replace the following components.

- Left/right side impact sensors on the side of the impact.
- Left/right roof rail air bag on the side of the impact.
- Inflatable Restraint Sensing and Diagnostic Module (SDM), if the Inflatable Restraint Sensing and Diagnostic Module has set DTC B0052 and will not clear.
- Inflatable Restraint Seat Belt Anchor and/or Retractor Pretensioner.
- Driver or passenger seat back cushion cover replacement.

WARNING: Do not repair or replace the seat stitching or seams in the seat back trim cover with an internal mounted seat side airbag module. Replace the complete seat back trim cover from the OEM. Non-OEM seat stitching may cause improper airbag deployment which could result in personal injury.

Perform additional inspections on the following components.

- Mounting points or mounting hardware for the side impact sensors, and driver/passenger side seat air bags on the side of impact-Inspect for any damage and repair or replace each component as needed.
- Mounting points, mounting hardware, headliner and trim pieces for the left/right roof rail air bag on the side of impact-Inspect for any damage and repair or replace each component as needed.
- Mounting points or mounting hardware for the Inflatable Restraint Sensing and Diagnostic Module and seat belt anchor and/or retractor pretensioners-Inspect for any damage and repair or replace each component as needed.
- The seat cushion frame
- The seat recliner and cover, if equipped
- The seat adjuster
- The seat back frame
- Door trim assembly
- Impacted seat cushion side covers and switches

Accident With Seat Belt Pretensioner Deployment Only - Component Replacement and Inspections

After a collision involving driver/passenger Seat Belt Retractor or Anchor Pretensioner deployment, replace the following components.

- Driver and Passenger Inflatable restraint seat belt anchor pretensioner and/or retractor pretensioner
- Inflatable Restraint Sensing and Diagnostic Module (SDM), if the Inflatable Restraint Sensing and Diagnostic Module has set DTC B0052 and will not clear

Perform additional inspections for any damage and repair or replace each component as needed on the following components.

- Mounting points or mounting hardware for the Inflatable Restraint Sensing and Diagnostic Module
- Mounting points or mounting hardware for the Seat Belt Anchor Pretensioners

- Mounting points or mounting hardware for the Seat Belt Retractor Pretensioners

Impact Sensor Replacement Guidelines

The impact sensor replacement policy requires replacing sensors in the area of the accident damage. The area of accident damage is defined as the portion of the vehicle which is crushed, bent, or damaged due to a collision. An example of this would be a moderate collision where the front of the vehicle impacts a object. If the vehicle has an impact sensor mounted forward of the radiator, it must be replaced.

- Replace the impact sensor whether or not the air bags have deployed.
- Replace the impact sensor even if it appears to be undamaged.

Impact sensor damage which is not visible, such as slight bending of the mounting bracket or cuts in the wire insulation, can cause improper operation of the SIR system. Do not try to determine whether the impact sensor is undamaged, replace the impact sensor. Also, if you follow a diagnostic trouble code (DTC) procedure and a malfunctioning impact sensor is indicated, replace the impact sensor.

INFLATABLE RESTRAINT MODULE HANDLING AND SCRAPPING

Special Tools

- **EL-38826** SIR Deployment Harness
- **EL-39401-B** SIR Deployment Fixture

For equivalent regional tools, refer to **Special Tools**.

Live and Undeployed Air Bag

WARNING: Refer to SIR Inflator Module Handling and Storage Warning .

Take special care when handling or storing an undeployed air bag. An air bag deployment produces a rapid generation of gas. This may cause the air bag, or an object in front of the air bag, to project through the air in the event of an unlikely deployment.

Dual Stage Air Bags

Dual stage air bags have two deployment stages. If stage 1 was used to deploy a dual stage air bag, stage 2 may still be active. Therefore, a deployed dual stage air bag must be treated as an active air bag. If disposal of a dual stage air bag is required, both deployment loops must be energized to deploy the air bag.

Scrapping Procedure

During the course of a vehicle's useful life, certain situations may arise which will require the disposal of a live and undeployed air bag. Do NOT dispose a live and undeployed air bag through normal disposal channels until the air bag has been deployed.

Do not deploy the air bag in the following situations:

- After replacement of an air bag under warranty-the air bag may need to be returned undeployed to the manufacturer.
- If the vehicle is the subject of a product liability claim, related to the SIR system and is subject to a

preliminary investigation - do NOT alter the SIR system in any manner.

- If the vehicle is involved in a campaign affecting the air bags - follow the instructions in the campaign service bulletin for proper SIR handling procedures.

Deployment Procedures

NOTE: **Some countries, states or localities may not allow service deployment of air bags without special permission or training. Local laws regarding deploying and scrapping of air bags/devices with pyrotechnics must be followed.**

You can deploy the air bag either inside or outside of the vehicle. The method used depends upon the final disposition of the vehicle. Review the following procedures in order to determine which will work best in a given situation:

Deployment Outside Vehicle - Steering Wheel Air Bag, Instrument Panel Air Bag, and Roof Rail Air Bag

Deploy the air bag outside of the vehicle when the vehicle will be returned to service. Situations that require deployment outside of the vehicle include the following:

- Using the SIR diagnostics, you determine that the air bag is malfunctioning.
- The air bag is cosmetically damaged, scratched, or ripped.
- The air bag pigtail is damaged.
- The air bag connector is damaged.
- The air bag connector terminals are damaged.

Deployment and disposal of a malfunctioning air bag is subject to any required retention period.

WARNING: **Refer to SIR Inflator Module Disposal Warning .**

1. Turn OFF the ignition.

   WARNING: **Refer to SIR Inflator Module Handling and Storage Warning .**

2. Remove the air bag.

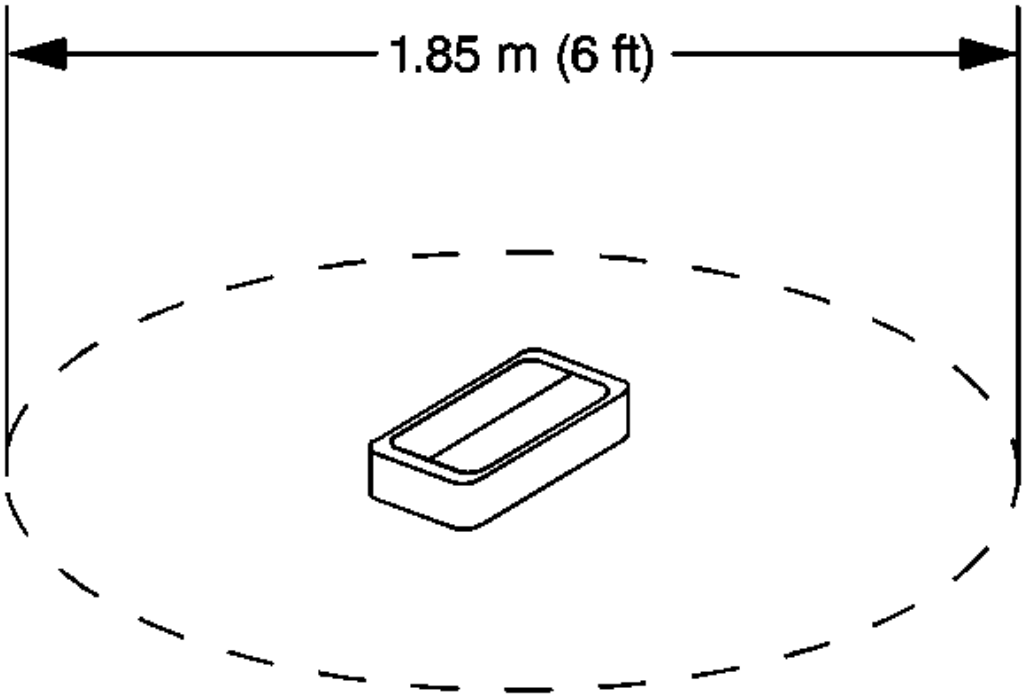


Fig. 48: Identifying Clearance For Deployment Of Inflator Module
Courtesy of GENERAL MOTORS COMPANY

3. Clear a space on the ground about 1.85 m (6 ft) in diameter for deployment of the air bag or deployment fixture. If possible, use a paved, outdoor location free of activity. Otherwise, use a space free of activity on the shop floor. Ensure you have sufficient ventilation.
4. Clear the area of loose or flammable objects.

NOTE: **Dual stage deployments are only used in steering wheel and instrument panel air bags. If stage 1 was used to deploy a dual stage air bag, stage 2 may still be active. If disposal of a dual stage air bag is required, both deployment loops must be energized to deploy the air bag.**

5. If you are deploying a steering wheel air bag, place the air bag in the center of the space with the vinyl trim cover facing up and away from the surface.

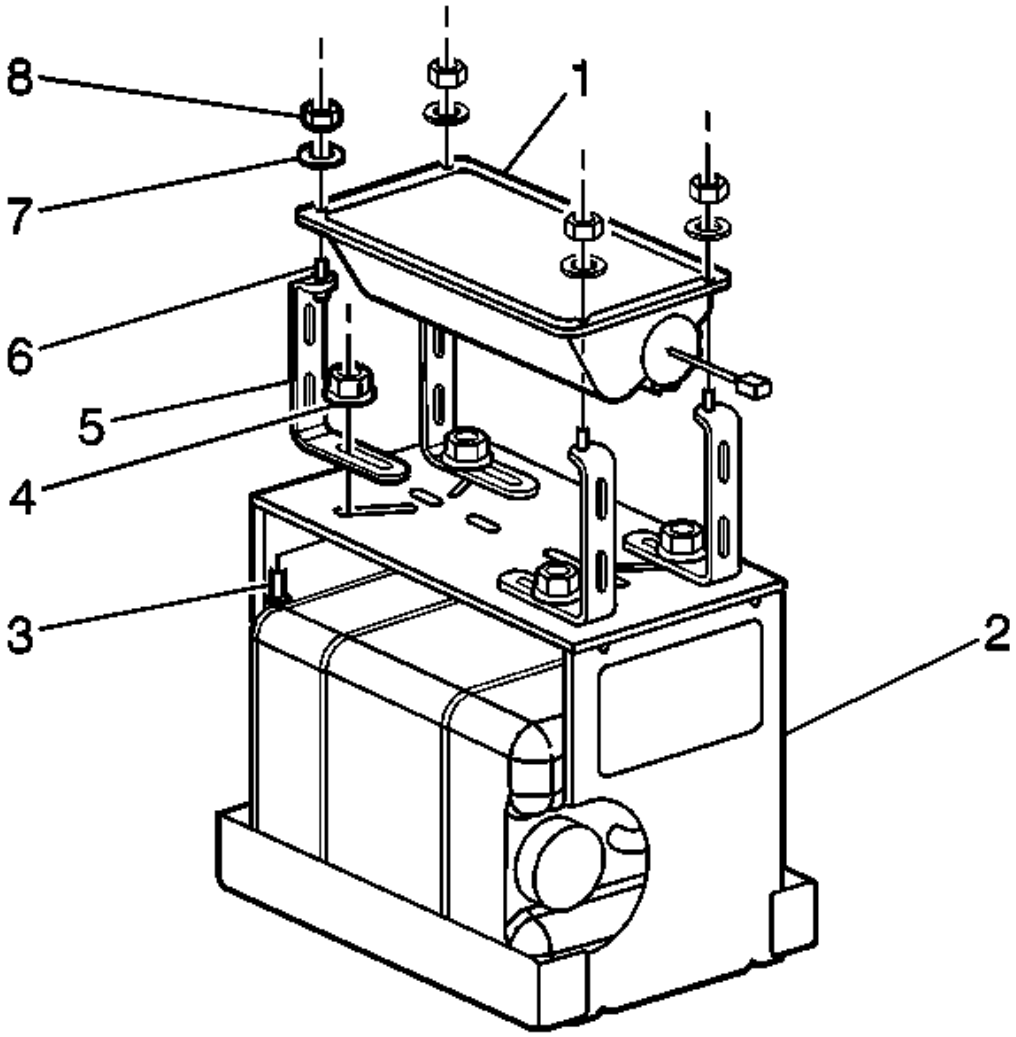


Fig. 49: Identifying I/P Module Components
Courtesy of GENERAL MOTORS COMPANY

6. When deploying an instrument panel air bag, perform the following instructions:
    1. Place the **EL-39401-B** fixture in the center of the cleared area.
    2. Fill the deployment fixture with water or sand.
    3. Using the proper nuts and bolts, mount the instrument panel air bag (1) to the deployment fixture (2), with the vinyl trim facing up.
    4. Securely tighten all fasteners that hold the instrument panel air bag (1) to the deployment fixture (2).

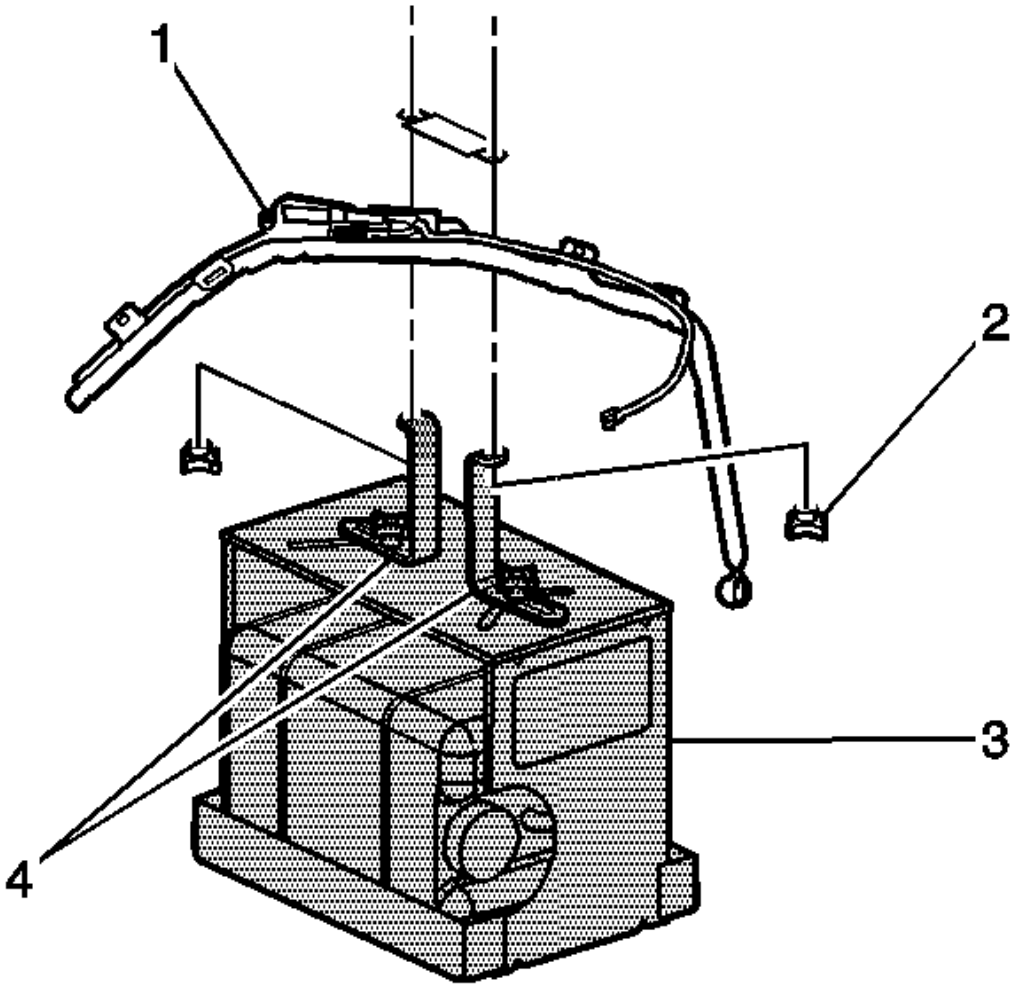


Fig. 50: Identifying Fasteners Holding Side Impact Module To Deployment Fixture
Courtesy of GENERAL MOTORS COMPANY

7. When deploying a roof rail air bag, perform the following instructions:
    1. Place the **EL-39401-B** fixture (3) in the center of the cleared area.
    2. Fill the deployment fixture with water or sand to provide sufficient stabilization of fixture during deployment.
    3. Adjust and secure the fixture arms (4) to the deployment fixture (3), using the proper nuts and bolts.
    4. Attach the roof rail air bag in the deployment fixture and securely tighten all fasteners.

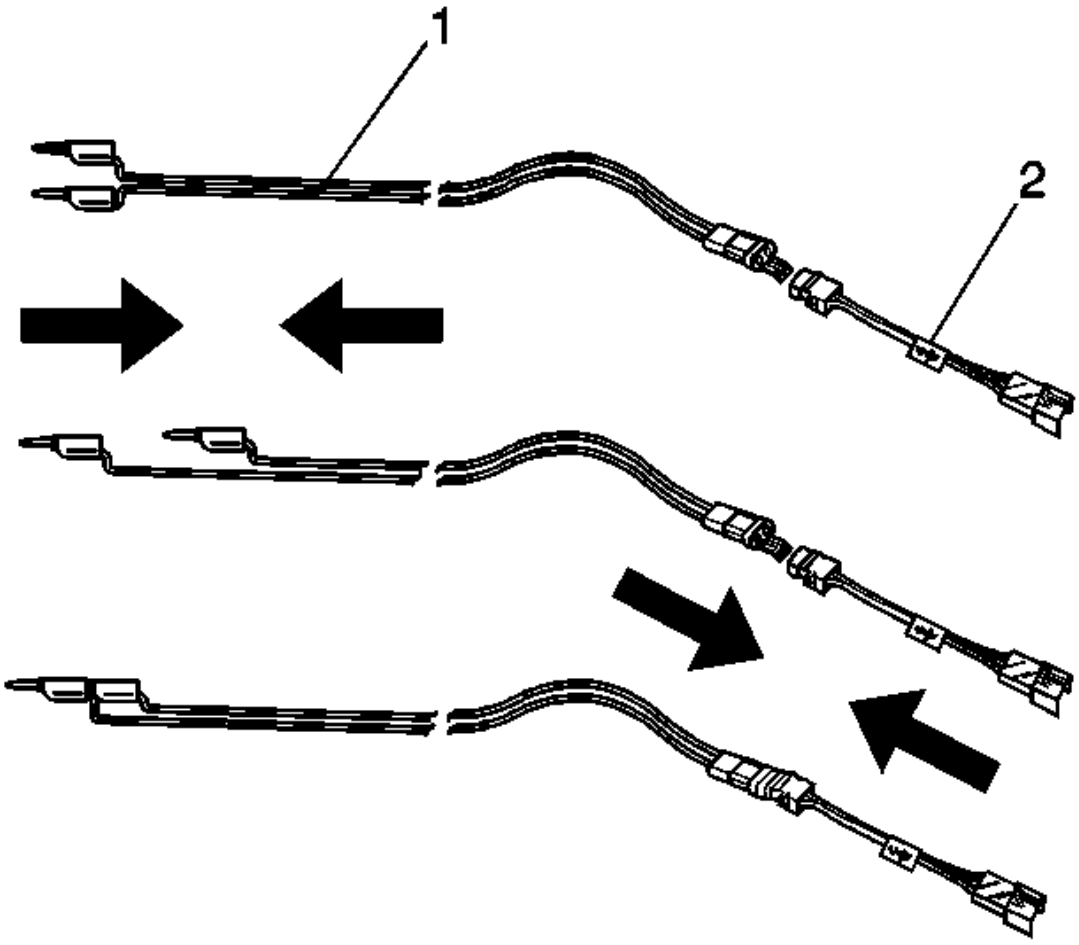


Fig. 51: Identifying SIR Deployment Harness & Adapter
Courtesy of GENERAL MOTORS COMPANY

8. Inspect the **EL-38826** harness and the appropriate pigtail adapter (2) for damage. Replace as needed.
9. Short the 2 SIR deployment harness leads (1) together using one banana plug seated into the other.
10. Connect the appropriate pigtail adapter (2) to the SIR deployment harness (1).

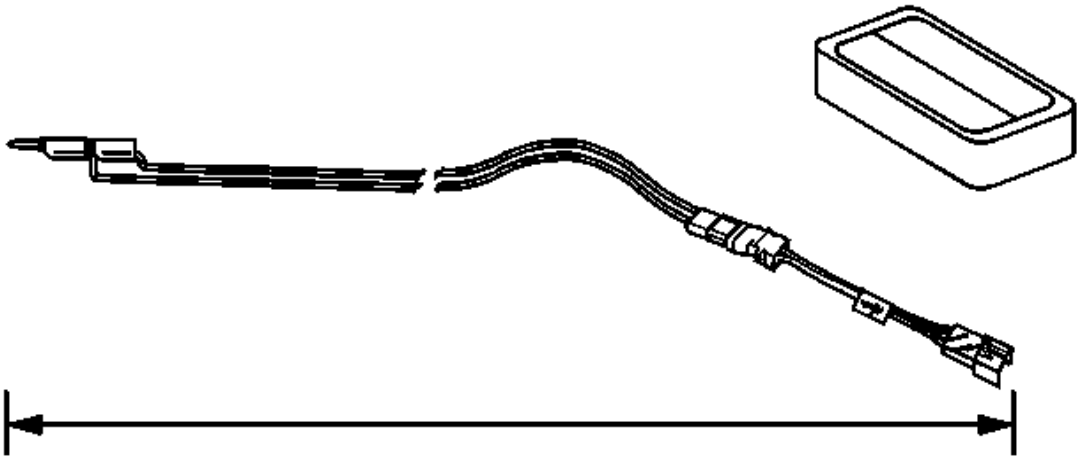


Fig. 52: Extending SIR Deployment Harness & Adapter
Courtesy of GENERAL MOTORS COMPANY

11. Extend the SIR deployment harness and adapter to the full length from the deployment fixture or area.

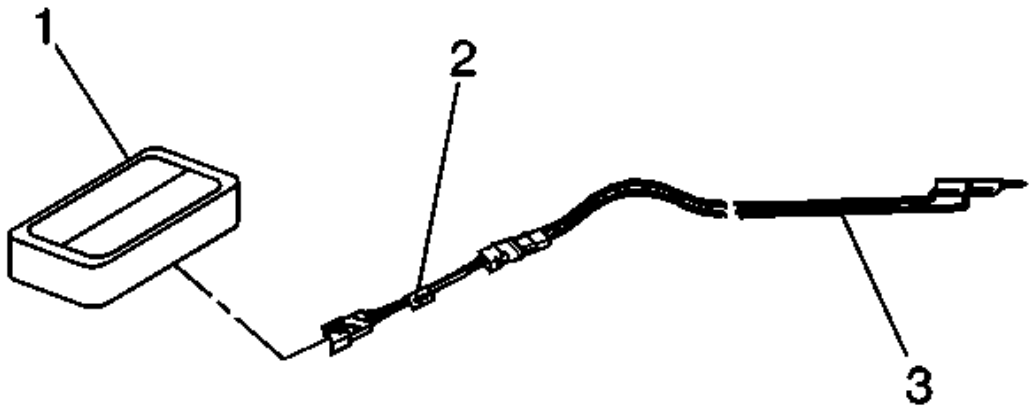


Fig. 53: Identifying Inflator Module, SIR Deployment Harness & Adapter
Courtesy of GENERAL MOTORS COMPANY

NOTE: **On a dual stage air bag, both connectors must be attached to the deployment harness adapter. This will ensure that both stage 1 and stage 2 of the deployment loops are energized, regardless of the deployment state.**

12. Connect the air bag (1) to the adapter (2) on the SIR deployment harness (3).

NOTE:

- **The rapid expansion of gas involved with deploying an air bag is very loud. Notify all the people in the immediate area that you intend to deploy the air bag.**
- **When the air bag deploys, the deployment fixture may jump about 30 cm (1 ft) vertically. This is a normal reaction of the air bag due to the force of the rapid expansion of gas inside the air bag.**
- **If you are deploying a dual stage air bag with stage 1 already deployed, the fixture may not move and the noise may have been**

reduced.

13. Clear the area of people.

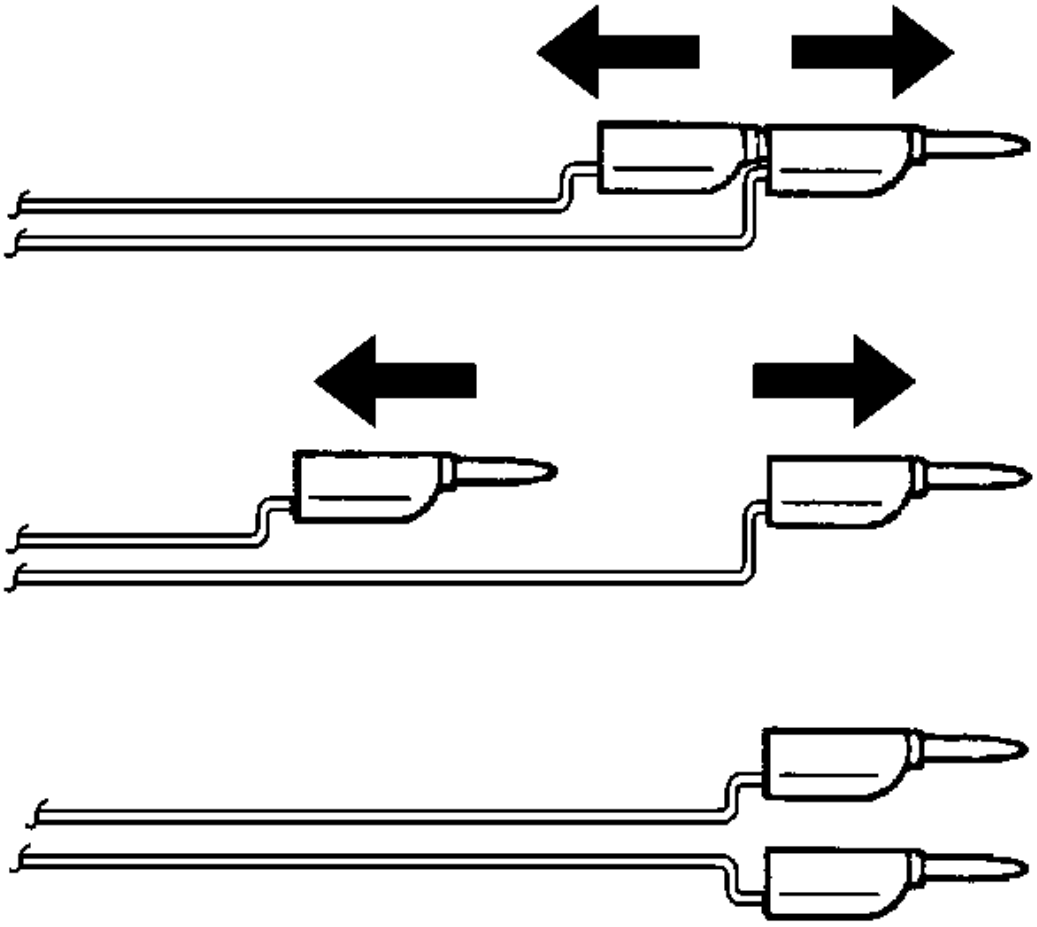


Fig. 54: Separating Banana Plugs
Courtesy of GENERAL MOTORS COMPANY

14. Separate the 2 banana plugs on the SIR deployment harness that were shorted together earlier in the procedure.

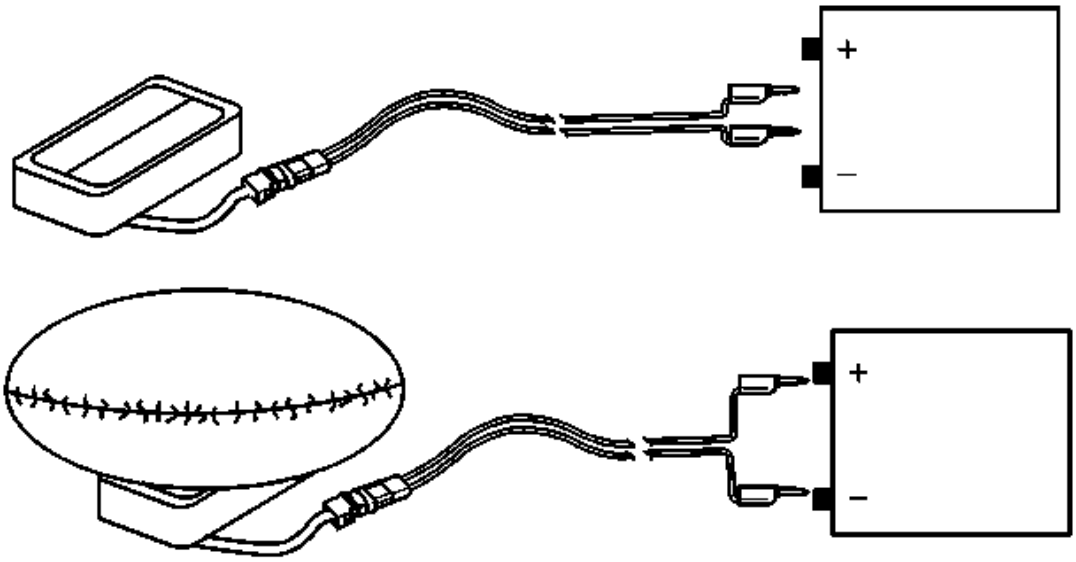


Fig. 55: Identifying SIR Deployment Harness Wires To Power Source
Courtesy of GENERAL MOTORS COMPANY

15. Place a 12 V minimum/2A minimum power source, such as a vehicle battery, near the shorted end of the harness.
16. Connect the SIR deployment harness wires to the power source. Deployment of the air bag will occur when contact is made.

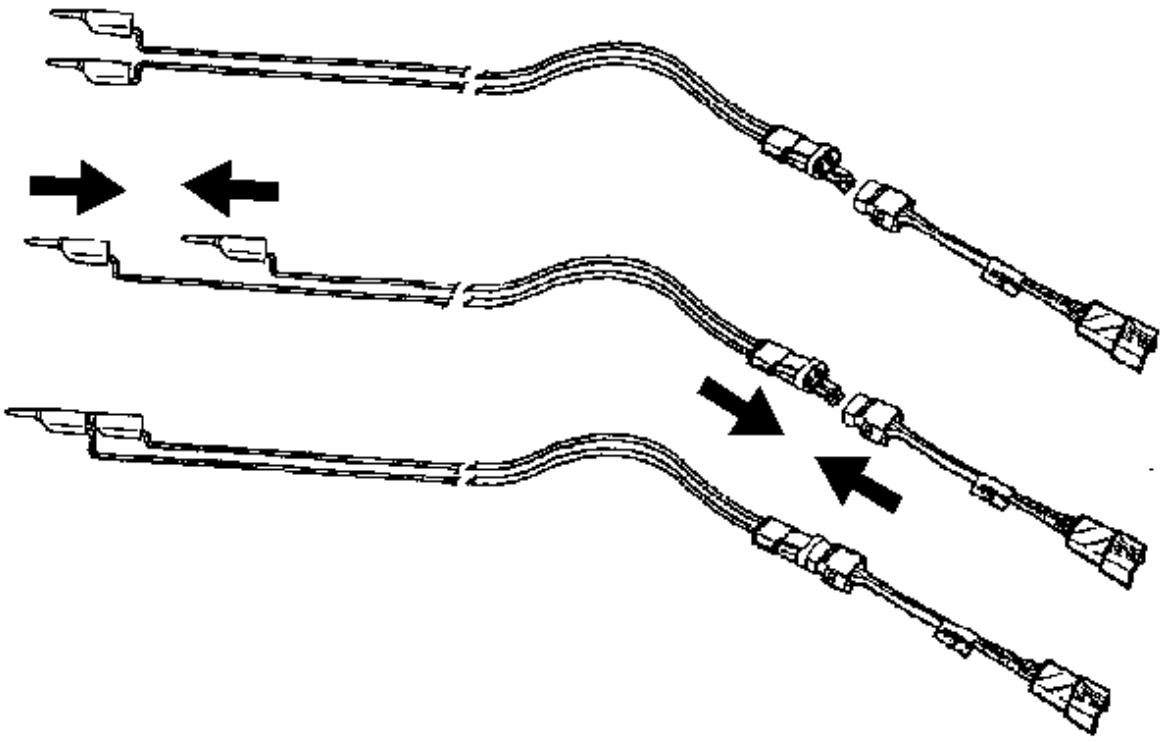


Fig. 56: View Of Deployment Harness Leads
Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the SIR deployment harness from the power source after the air bag deploys.
18. If the air bag did not deploy, disconnect the adapter and discontinue the procedure and contact the Technical Assistance Group.

    If deployment was successful, proceed to the following steps.

WARNING: Refer to SIR Deployed Inflator Modules Are Hot Warning .

19. Seat one banana plug into the other in order to short the deployment harness leads.
20. Put on a pair of shop gloves.
21. Disconnect the pigtail adapter from the air bag as soon as possible.
22. Inspect the pigtail adapter and the SIR deployment harness. Replace as needed.
23. Dispose of the deployed air bag through normal refuse channels.

24. Wash your hands with a mild soap.

Deployment Inside Vehicle - Vehicle Scrapping Procedure

Deploy the air bags inside of the vehicle when destroying the vehicle or when salvaging the vehicle for parts. This includes, but is not limited to, the following situations:

- The vehicle has completed all useful life.
- Irrepairable damage occurred to the vehicle in a non-deployment type accident.
- Irrepairable damage occurred to the vehicle during a theft.
- The vehicle is being salvaged for parts to be used on a vehicle with a different VIN, as opposed to rebuilding as the same VIN.

WARNING: Refer to SIR Inflatable Module Deployment Outside Vehicle Warning .

1. Lower the driver and passenger windows.
2. Turn the ignition switch to the OFF position and remove the ignition key.
3. Check that all air bags which will be deployed are mounted securely.
4. Remove all loose objects from the front seats.

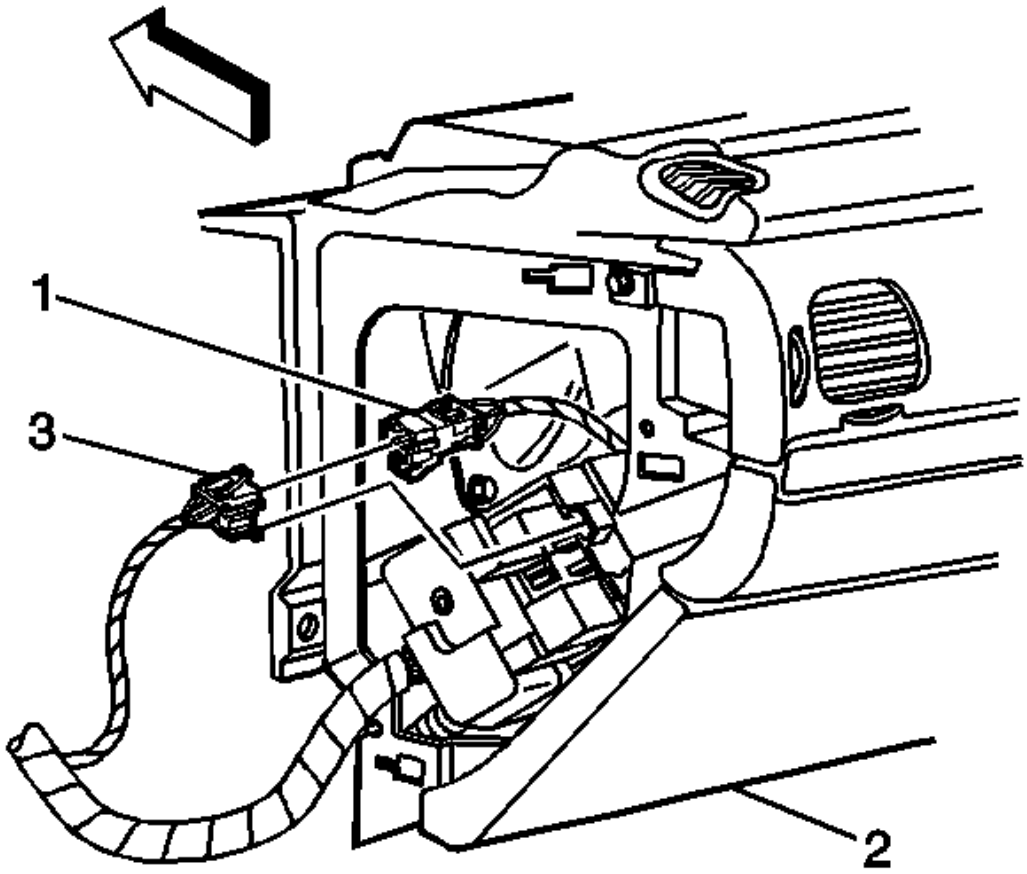


Fig. 57: Identifying I/P Module Connector To Vehicle Harness Connector (LH Side I/P)
Courtesy of GENERAL MOTORS COMPANY

WARNING: A deployed dual stage inflator module will look the same whether one or both stages were used. Always assume a deployed dual stage inflator module has an active stage 2. Improper handling or servicing can activate the inflator module and cause personal injury.

5. Disconnect the steering wheel air bag yellow connector (1) from vehicle harness yellow connector (3).

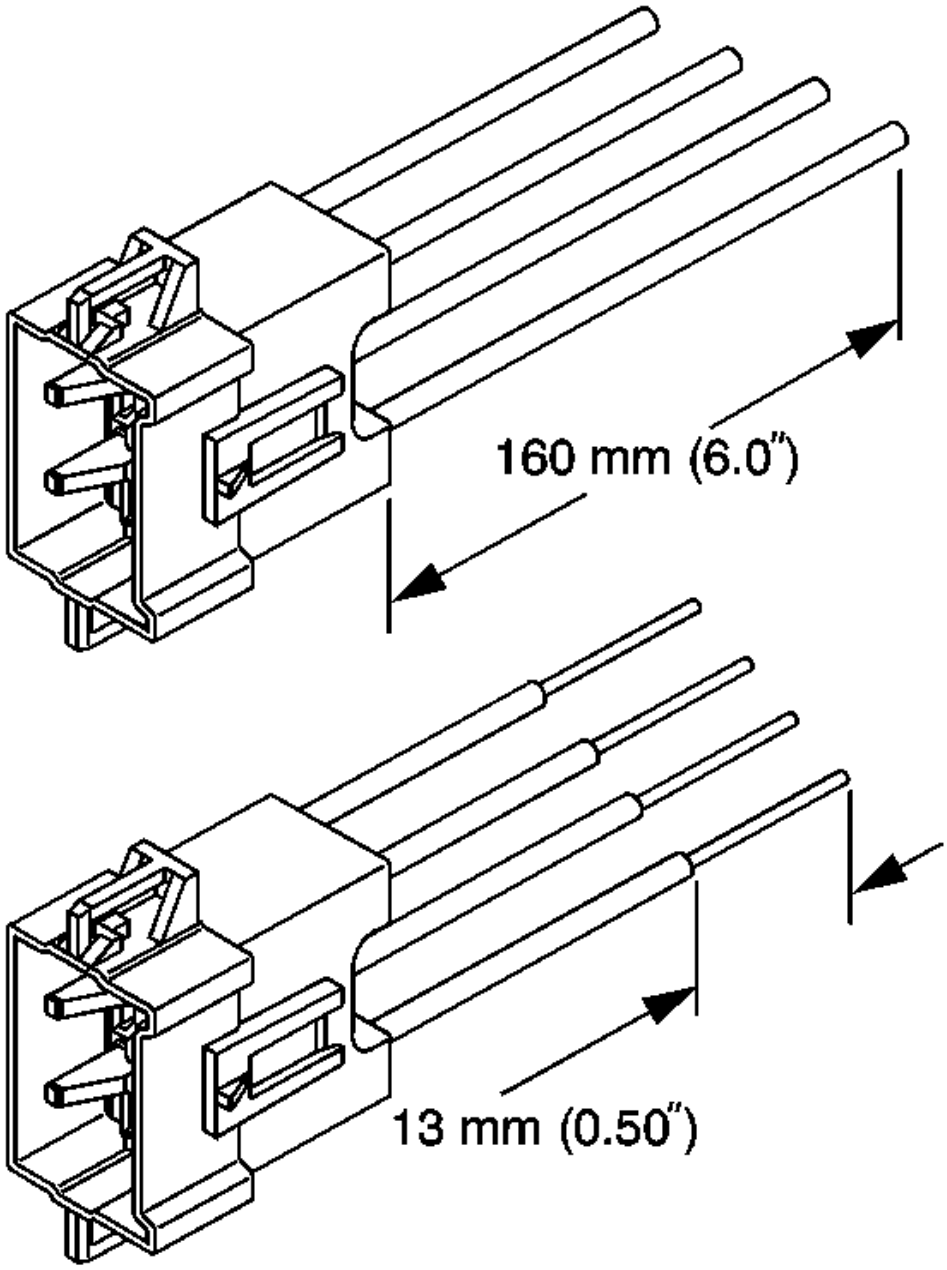


Fig. 58: Stripping SIR Wires
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the vehicle is equipped with dual stage air bags the steering wheel air bag and instrument panel air bag will each have 4 wires. Refer to COMPONENT CONNECTOR END VIEWS - INDEX for determining high and low circuits.**

6. Cut the yellow harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
7. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.

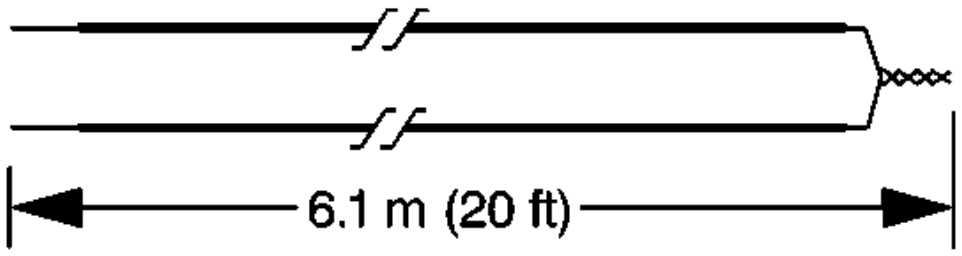


Fig. 59: Fabricating 20 Ft. Deployment Harness
Courtesy of GENERAL MOTORS COMPANY

8. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gauge) or thicker multi-strand wire. Use these wires to fabricate the driver deployment harness.
9. Strip 13 mm (0.5 in) of insulation from both ends of the wires.
10. Twist together one end from each of the wires in order to short the wires. Deployment wires shall remain shorted, and not connected to a power source until you are ready to deploy the air bag.

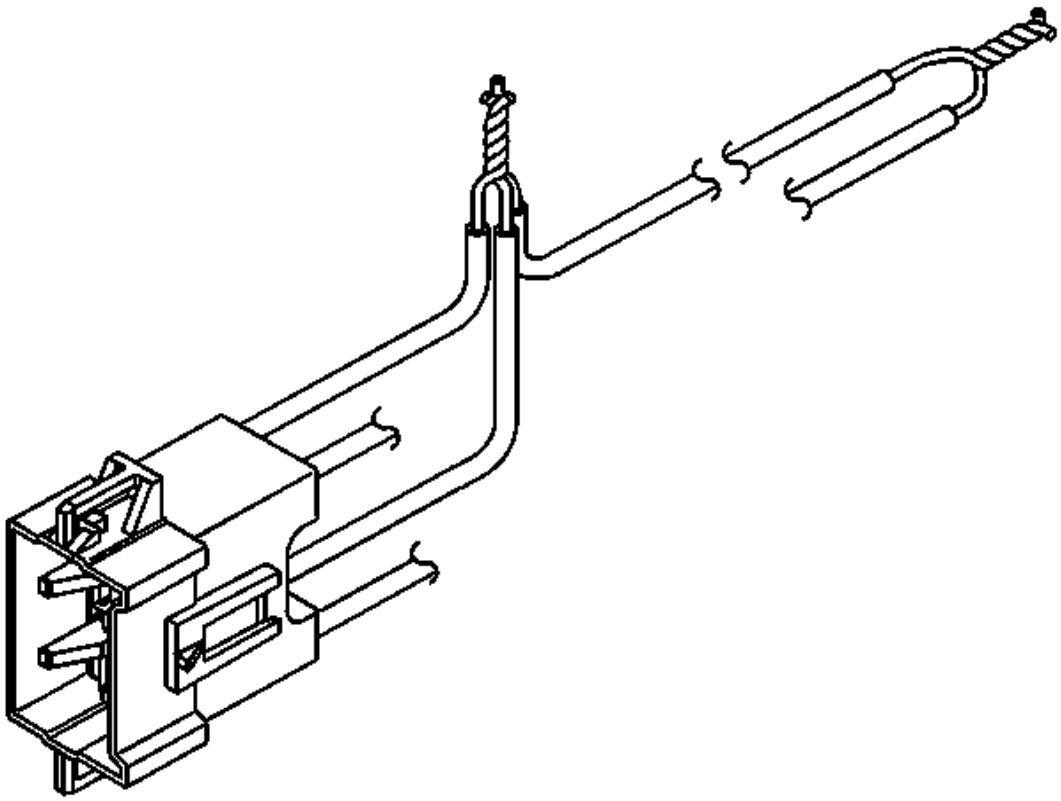


Fig. 60: Twisting Connector Wire Leads (High Circuits) To Deployment Harness Wire
Courtesy of GENERAL MOTORS COMPANY

11. Twist together the 2 connector wire leads from the high circuits from both stages of the steering wheel air bag, to one set of deployment wires. Refer to **COMPONENT CONNECTOR END VIEWS - INDEX** in order to determine the correct circuits.
12. Inspect that the 3-wire connection is secure.
13. Secure and insulate the 3-wire connection to the deployment harness using electrical tape.

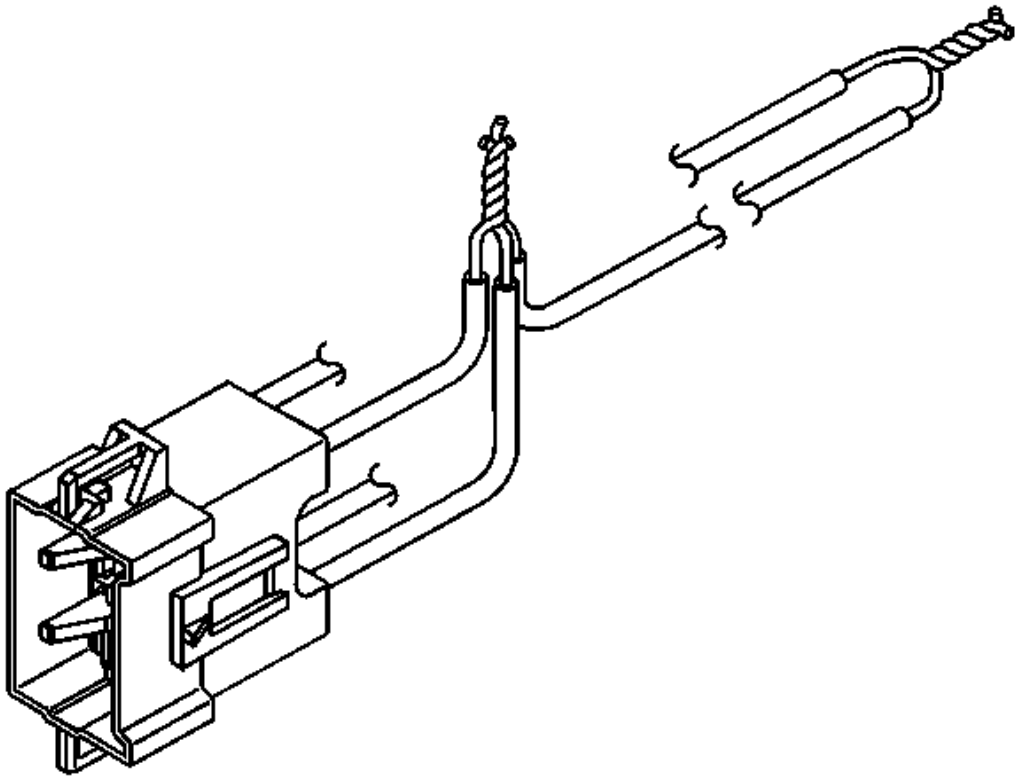


Fig. 61: Twisting Connector Wire Leads (Low Circuits) To Deployment Harness Wire
Courtesy of GENERAL MOTORS COMPANY

14. Twist together the 2 connector wire leads from the low circuits from both stages of the steering wheel air bag, to one set of deployment wires. Refer to **COMPONENT CONNECTOR END VIEWS - INDEX** in order to determine the correct circuits.
15. Inspect that the 3-wire connection is secure.
16. Secure and insulate the 3-wire connection to the deployment harness using electrical tape.
17. Connect the deployment harness to the connector on the steering wheel air bag.
18. Route the deployment harness out of the driver side of the vehicle.
19. Disconnect the yellow left roof rail harness connector from the vehicle harness connector.
20. Cut the harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
21. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.
22. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gauge) or thicker multi-strand wire. These wires will be used to fabricate the roof rail air bag deployment harness.
23. Strip 13 mm (0.5 in) of insulation from both ends of the wires.
24. Twist together one end from each of the wires in order to short the wires.

25. Twist together one connector wire lead to one deployment wire.
26. Secure and insulate the connection using electrical tape.
27. Twist together and tape the remaining connector wire lead to the remaining deployment wire.
28. Connect the deployment harness to the yellow connector of the roof rail air bag.
29. Route the deployment harness out of the driver side of the vehicle.

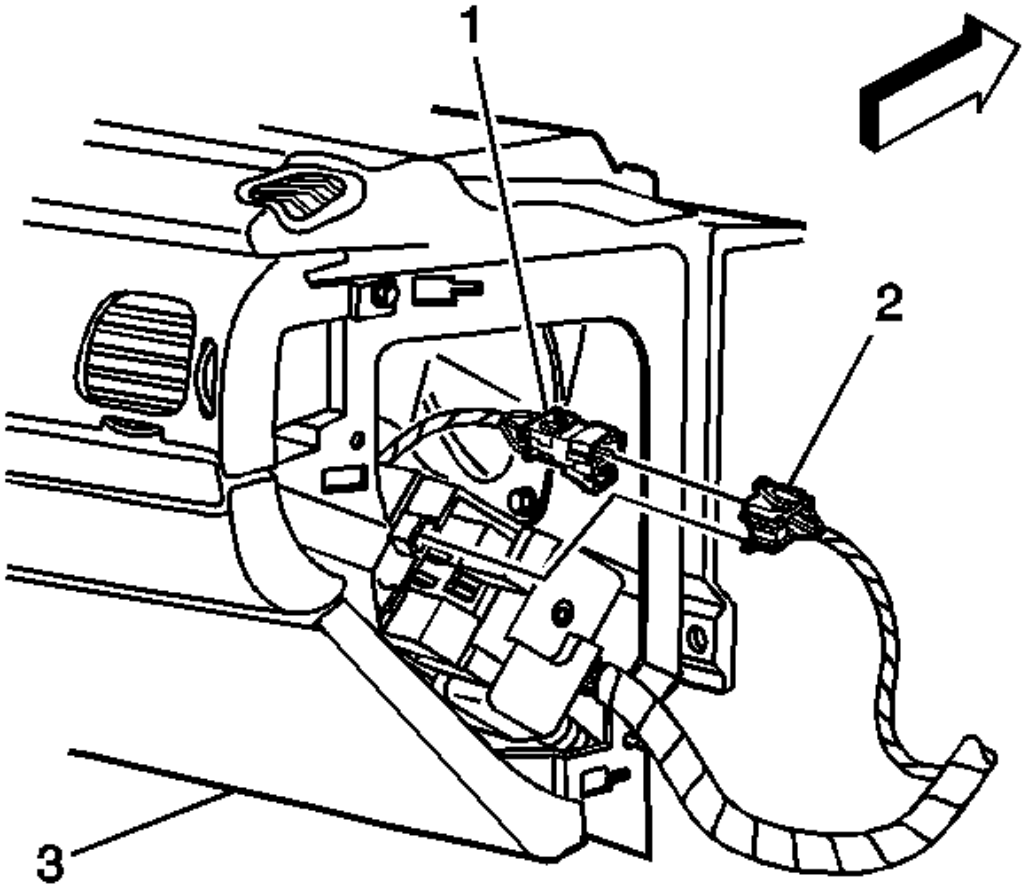


Fig. 62: Identifying I/P Module Connector To Vehicle Harness Connector
Courtesy of GENERAL MOTORS COMPANY

30. Disconnect the instrument panel air bag yellow harness connector (1) from the vehicle harness connector (2).

NOTE: **If the vehicle is equipped with dual stage air bags the steering wheel air bag and instrument panel air bag will each have 4 wires. Refer to COMPONENT CONNECTOR END VIEWS - INDEX for determining high and low circuits.**

31. Cut the yellow harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
32. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.

33. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gauge) or thicker multi-strand wire. These wires will be used to fabricate the passenger deployment harness.
34. Strip 13 mm (0.5 in) of insulation from both ends of the wires.
35. Twist together one end from each of the wires in order to short the wires.
36. Twist together the 2 connector wire leads from the high circuits from both stages of the instrument panel air bag to one set of deployment wires. Refer to **COMPONENT CONNECTOR END VIEWS - INDEX** in order to determine the correct circuits.
37. Inspect that the 3-wire connection is secure.
38. Secure and insulate the 3-wire connection to the deployment harness using electrical tape.
39. Twist together the 2 connector wire leads from the low circuits from both stages of the instrument panel air bag to one set of deployment wires. Refer to **COMPONENT CONNECTOR END VIEWS - INDEX** in order to determine the correct circuits.
40. Inspect that the 3-wire connection is secure.
41. Secure and insulate the 3-wire connection to the deployment harness using electrical tape.
42. Connect the deployment harness to the instrument panel air bag in-line connector.
43. Route the deployment harness out of the passenger side of the vehicle.
44. Disconnect the yellow harness connector to the right roof rail air bag from the vehicle harness connector.
45. Cut the harness connector out of the vehicle, leaving at least 16 cm (6 in) of wire at the connector.
46. Strip 13 mm (0.5 in) of insulation from each of the connector wire leads.
47. Cut two 6.1 m (20 ft) deployment wires from a 0.8 mm (18 gauge) or thicker multi-strand wire. These wires will be used to fabricate the roof rail air bag deployment harness.
48. Strip 13 mm (0.5 in) of insulation from both ends of the wires.
49. Twist together one end from each of the wires in order to short the wires.
50. Twist together one connector wire lead to one deployment wire.
51. Secure and insulate the connection using electrical tape.
52. Twist together and tape the remaining connector wire lead to the remaining deployment wire.
53. Connect the deployment harness to the roof rail air bag yellow connector.
54. Route the deployment harness out of the passenger side of the vehicle.
55. Completely cover the windshield and the front door window openings with a drop cloth.
56. Stretch to the full length all of the deployment harness wires on the right side of the vehicle.
57. Deploy each deployment loop one at a time.
58. Place a power source, 12 V minimum/2A minimum, such as a vehicle battery, near the shorted end of the harnesses.
59. Separate one set of wires and touch the wire ends to the power source in order to deploy the selected air bag.
60. Disconnect the deployment harness from the power source and twist the wire ends together.
61. Continue the same process with the remaining deployment harnesses.
62. Disconnect all harnesses from the vehicle.
63. Discard the harnesses.
64. Scrap the vehicle in the same manner as a non-SIR equipped vehicle.

65. If one or all of the air bags did not deploy, remove the undeployed air bags from the vehicle.

PRETENSIONER HANDLING AND SCRAPPING

Scrapping Procedure

During the course of a vehicles useful life, certain situations may arise which will necessitate the disposal of a live (undeployed) pretensioner. The following information covers the proper procedures for the disposing of a live (undeployed) pretensioner. Deploy the pretensioner before disposal. Do not dispose of a live (undeployed) pretensioner through normal disposal channels until the pretensioner has been deployed. The following information covers the proper procedures for the disposing of a live (undeployed) pretensioner.

- After replacement of a pretensioner under warranty. The pretensioner may need to be returned undeployed to the original manufacturer of pretensioner.
- If the vehicle is the subject of a Product Liability report related to the SIR system and is subject to a Preliminary Investigation (GM-1241). Do not alter the SIR system in any manner.
- If the vehicle is involved in a campaign affecting the pretensioners. Follow the instructions in the Campaign Service Bulletin for proper SIR handling procedures.

Deployment Procedures

NOTE: **Some countries, states or localities may not allow service deployment of air bags without special permission or training. Local laws regarding deploying and scrapping of air bags/devices with pyrotechnics must be followed.**

The pretensioner can be deployed inside or outside of the vehicle. The method used depends upon the final disposition of the vehicle. Review the following procedures in order to determine which will work best in a given situation.

Deployment Inside the Vehicle

Refer to **Inflatable Restraint Module Handling and Scrapping** for deploying the pretensioner inside vehicle under Vehicle Scrapping Procedure.

Deployment Outside Vehicle for Seat Belt Pretensioners

Deploy the seat belt pretensioners outside of the vehicle when the vehicle will be returned to service. Situations that require deployment outside of the vehicle include the following:

- Using the SIR diagnostics, you determine that the seat belt pretensioner is malfunctioning.
- The pretensioner pigtail (if equipped) is damaged.
- The pretensioner connector is damaged.
- The pretensioner connector terminal is damaged.

Deployment and disposal of a malfunctioning seat belt pretensioner is subject to any required retention period.

WARNING: **In order to prevent accidental deployment of the pretensioner which could cause personal injury, do not dispose of an undeployed pretensioner as normal shop waste. The undeployed pretensioner contains substances that could**

cause severe illness or personal injury if the sealed container is damaged during disposal. Use the following deployment procedures to safely dispose of an undeployed pretensioner. Failure to dispose of a pretensioner as instructed may be a violation of federal, state, or local laws.

WARNING: When you are deploying a pretensioner for disposal, perform the deployment procedures in the order listed. Failure to follow the procedures in the order listed may result in personal injury.

Special Tools

- **EL-39401-B** SIR Deployment Fixture
- **EL-38826** SIR Deployment Harness

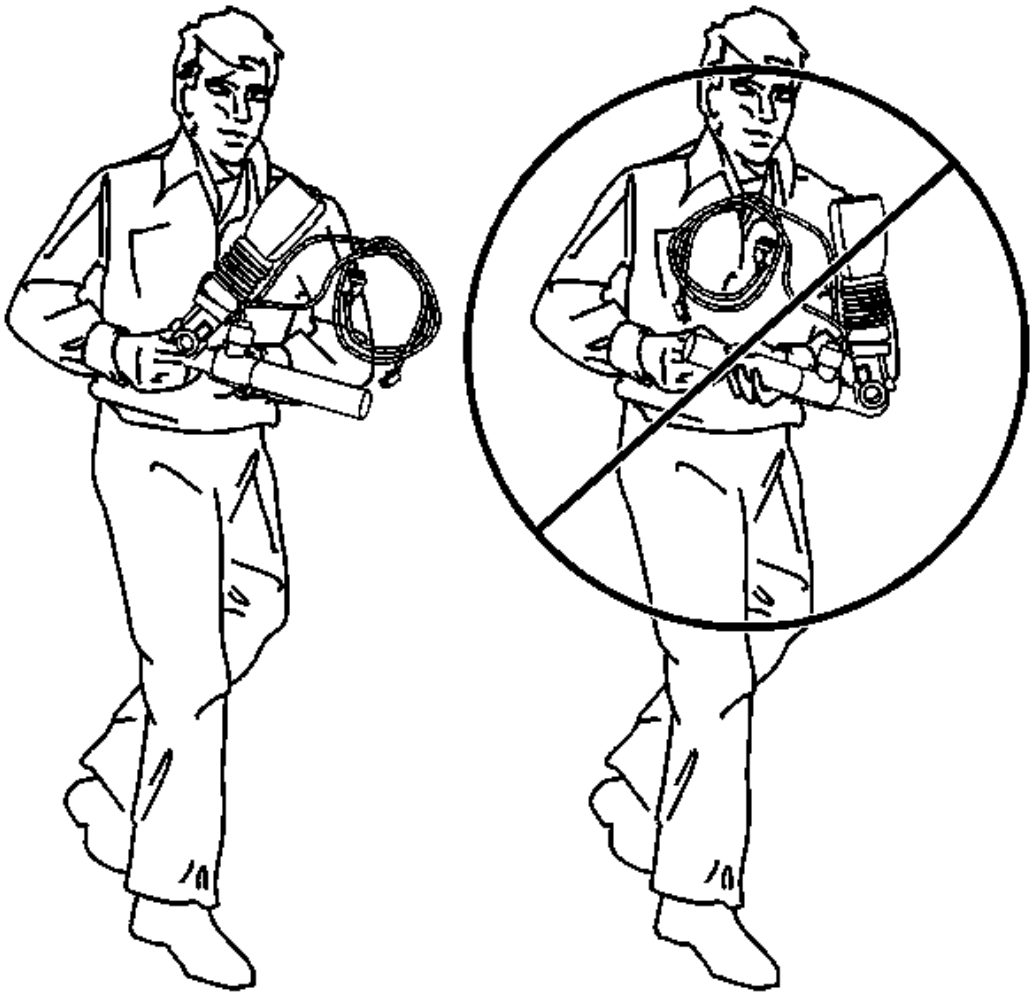


Fig. 63: Proper Pretensioner Carrying
Courtesy of GENERAL MOTORS COMPANY

1. Turn the ignition switch to the OFF position.
2. Remove the ignition key.

3. Put on safety glasses.
4. Remove the seat belt pretensioner from the vehicle.
5. When carrying a pretensioner to the deployment area keep the open end of pretensioner pointed away from the body.

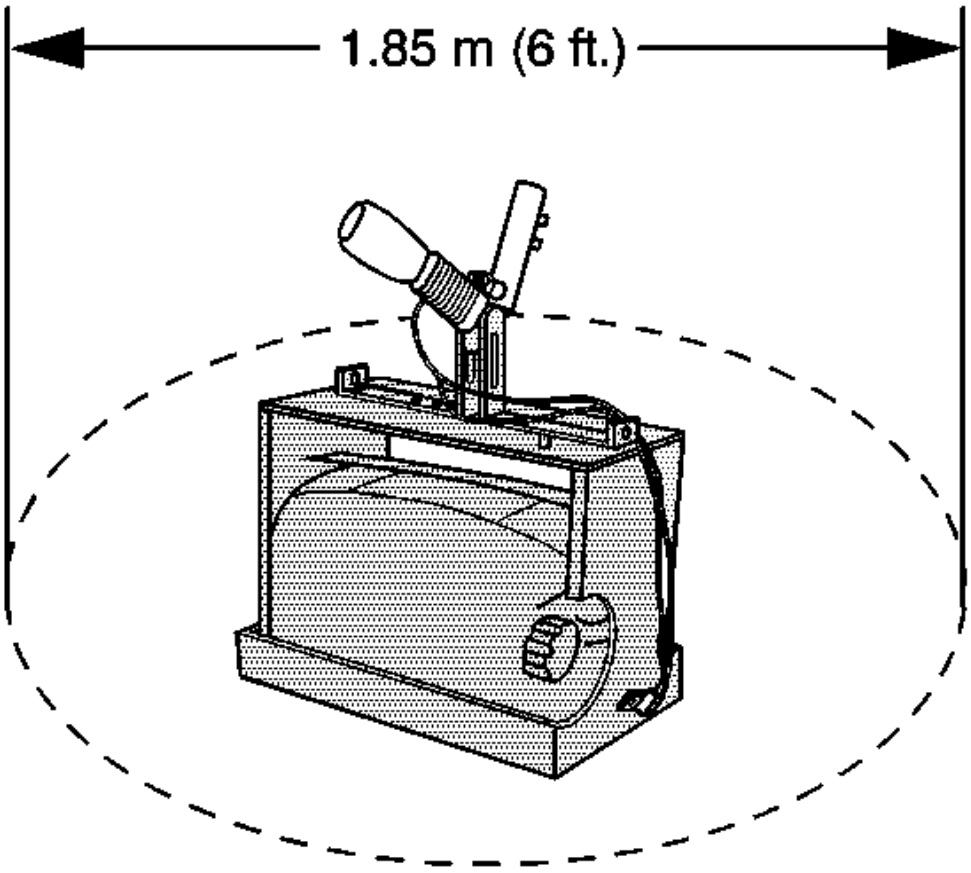


Fig. 64: Pretensioner Deployment Area
Courtesy of GENERAL MOTORS COMPANY

6. Clear a space on the ground about 1.85 M (6 ft) in diameter for deployment of the pretensioner. If possible, use a paved, outdoor location free of activity. Otherwise, use a space free of activity on the shop floor. Make sure you have sufficient ventilation.
7. Make sure no loose or flammable objects are in the area.
8. Place the **EL-39401-B** SIR deployment fixture in the center of the cleared area.
9. Fill the fixture plastic reservoir with water or sand.

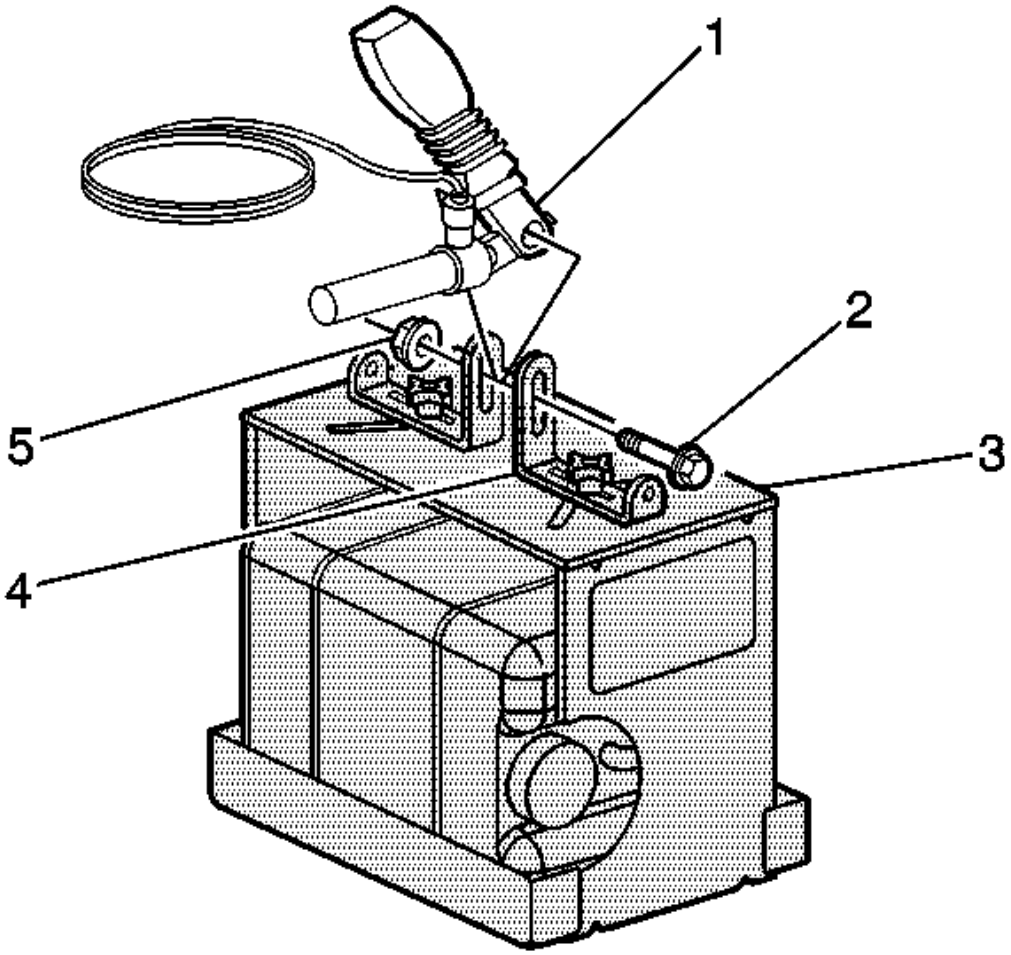


Fig. 65: Mounting Pretensioner In SIR Deployment Fixture
Courtesy of GENERAL MOTORS COMPANY

10. Mount the pretensioner (1) in the SIR deployment fixture (3) with the open end facing up using the following mounting method.
    1. Adjust and secure the EL-39401-B arms (4) to the deployment fixture (3).
    2. To mount, use the proper size bolt (2) and nut (5) with washers in order to secure the pretensioner (1) to the deployment fixture brackets (4).
    3. Securely tighten all fasteners prior to deployment.

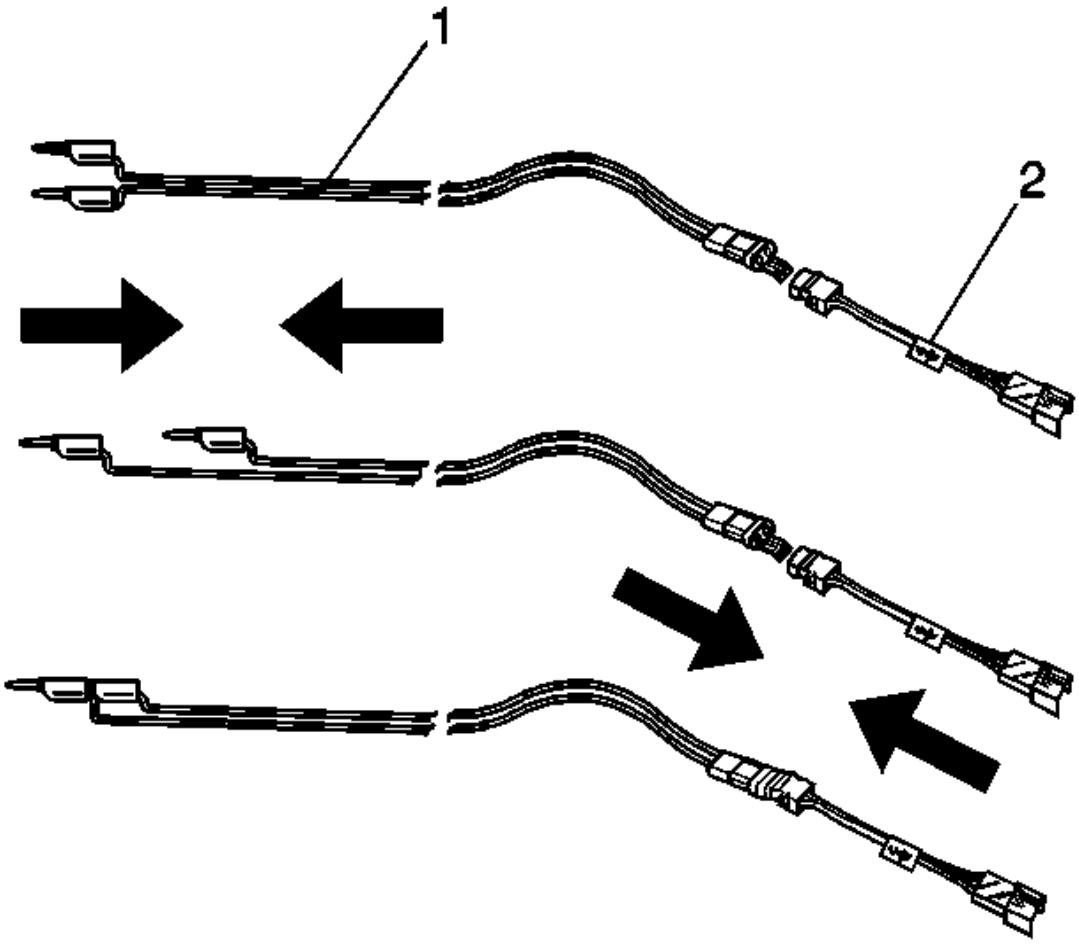


Fig. 66: Identifying SIR Deployment Harness & Adapter
Courtesy of GENERAL MOTORS COMPANY

11. Inspect the **EL-38826** SIR deployment harness and the appropriate pigtail adapter for damage. Replace as needed.
12. Short the 2 SIR deployment harness (1) leads together using one banana plug seated into the other.
13. Connect the appropriate pigtail adapter (2) to the SIR deployment harness (1).

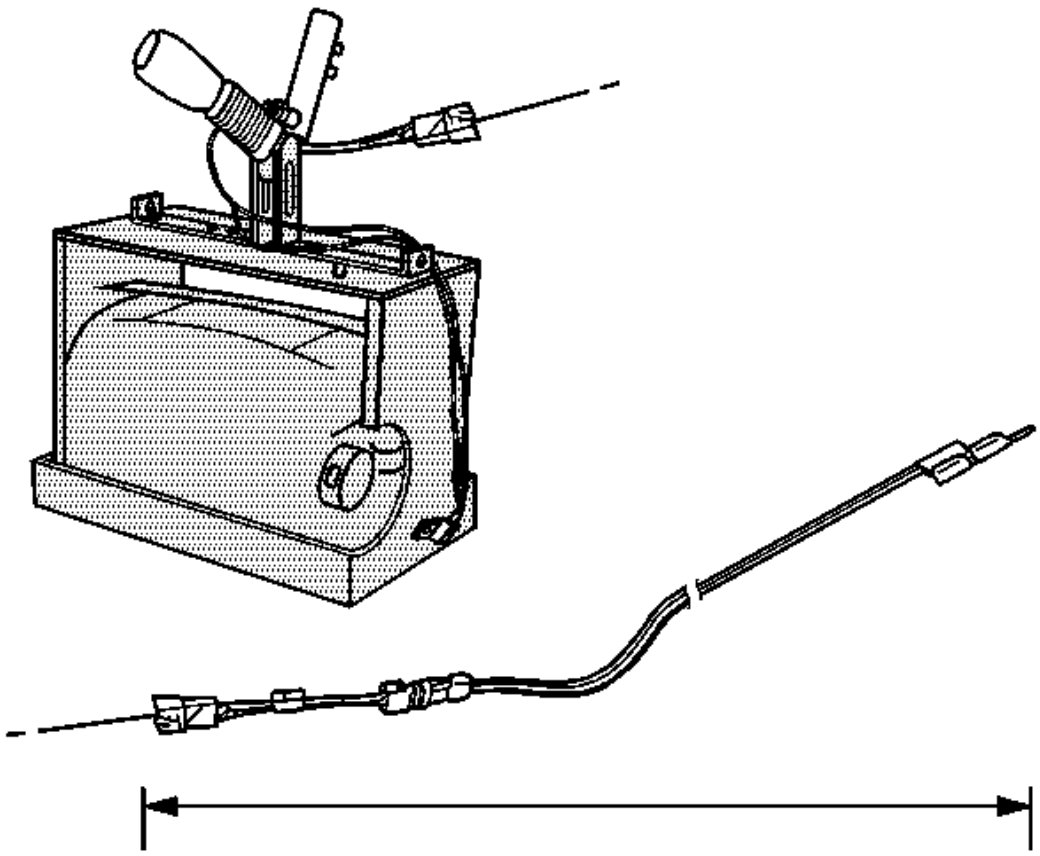


Fig. 67: Extending SIR Deployment Harness & Adapter
Courtesy of GENERAL MOTORS COMPANY

14. Extend the SIR deployment harness and adapter to full length from the deployment fixture.

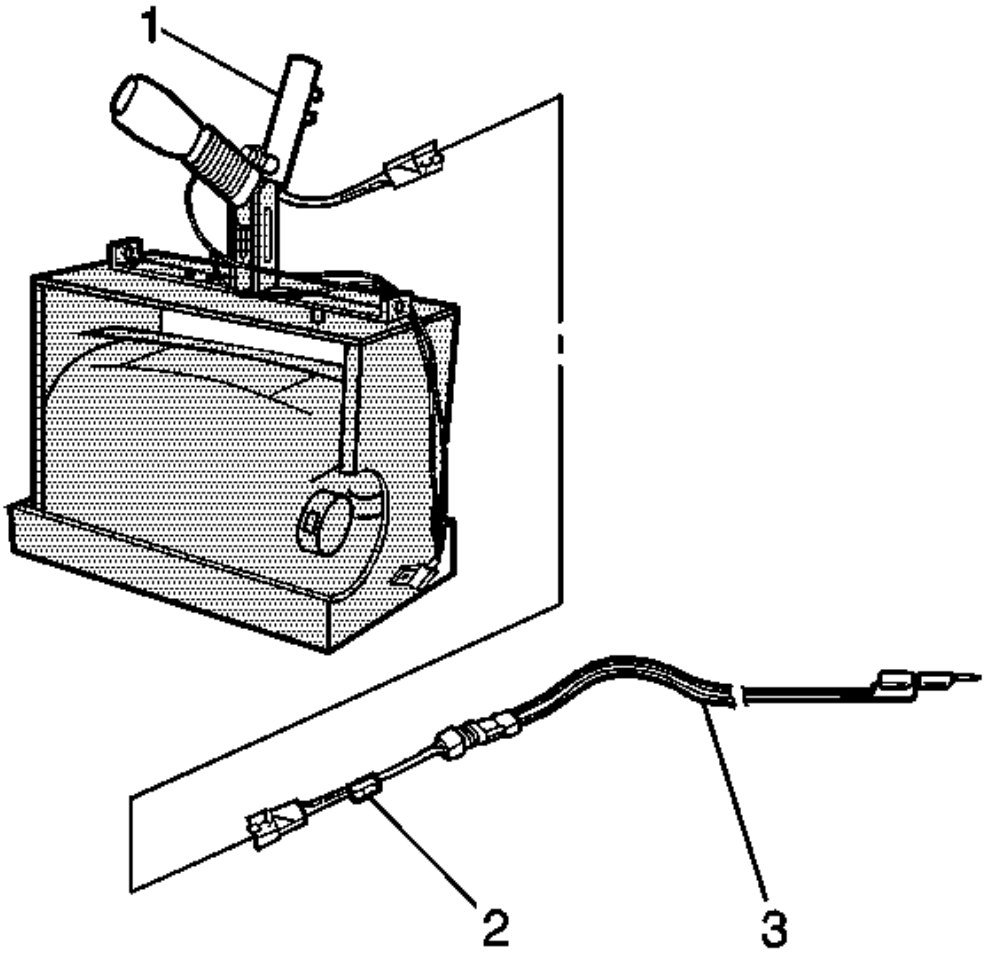


Fig. 68: Connecting Pretensioner To Adapter
Courtesy of GENERAL MOTORS COMPANY

15. Connect the pretensioner (1) to the adapter (2) on the deployment harness (3).

NOTE: **The rapid gas expansion involved with deploying a pretensioner is very loud. Notify all the people in the immediate area that you intend to deploy the seat belt pretensioner.**

16. Clear the area of people.

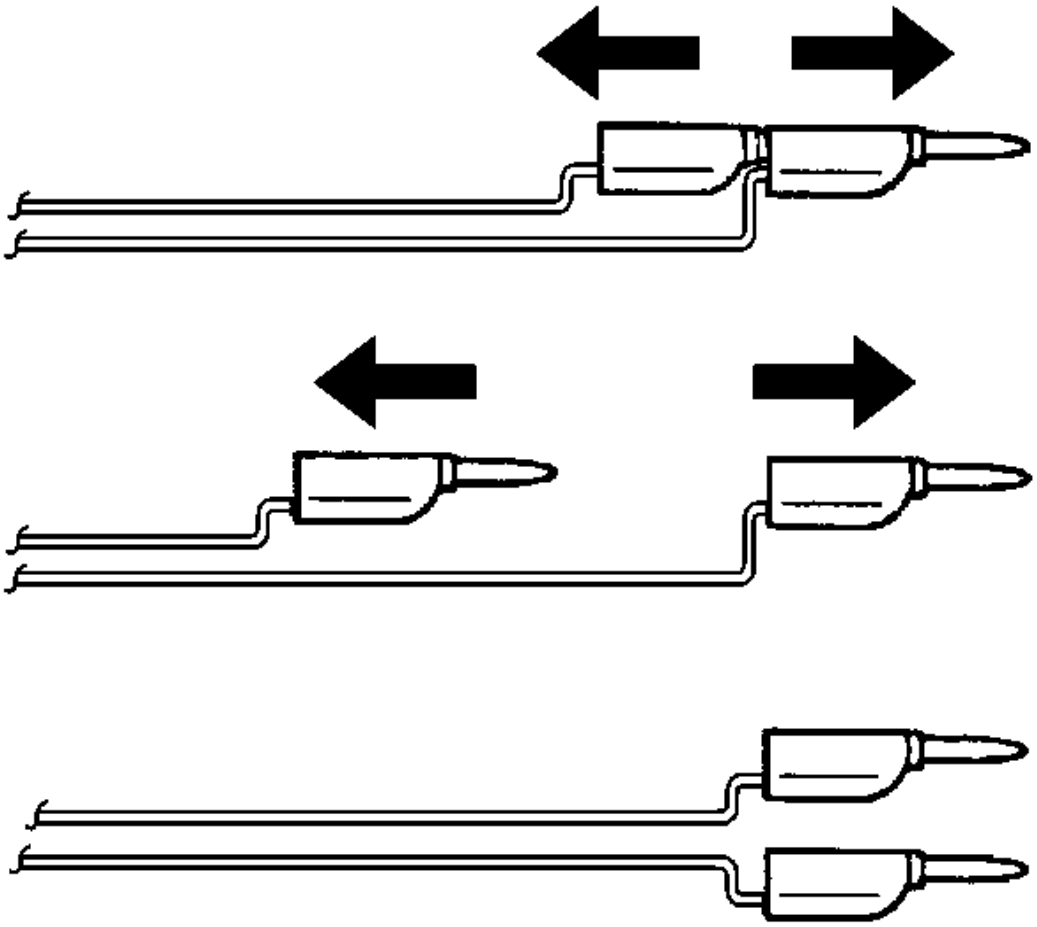


Fig. 69: Separating Banana Plugs
Courtesy of GENERAL MOTORS COMPANY

WARNING: When you are deploying a pretensioner for disposal, perform the deployment procedures in the order listed. Failure to follow the procedures in the order listed may result in personal injury.

17. Separate the 2 banana plugs on the SIR deployment harness.

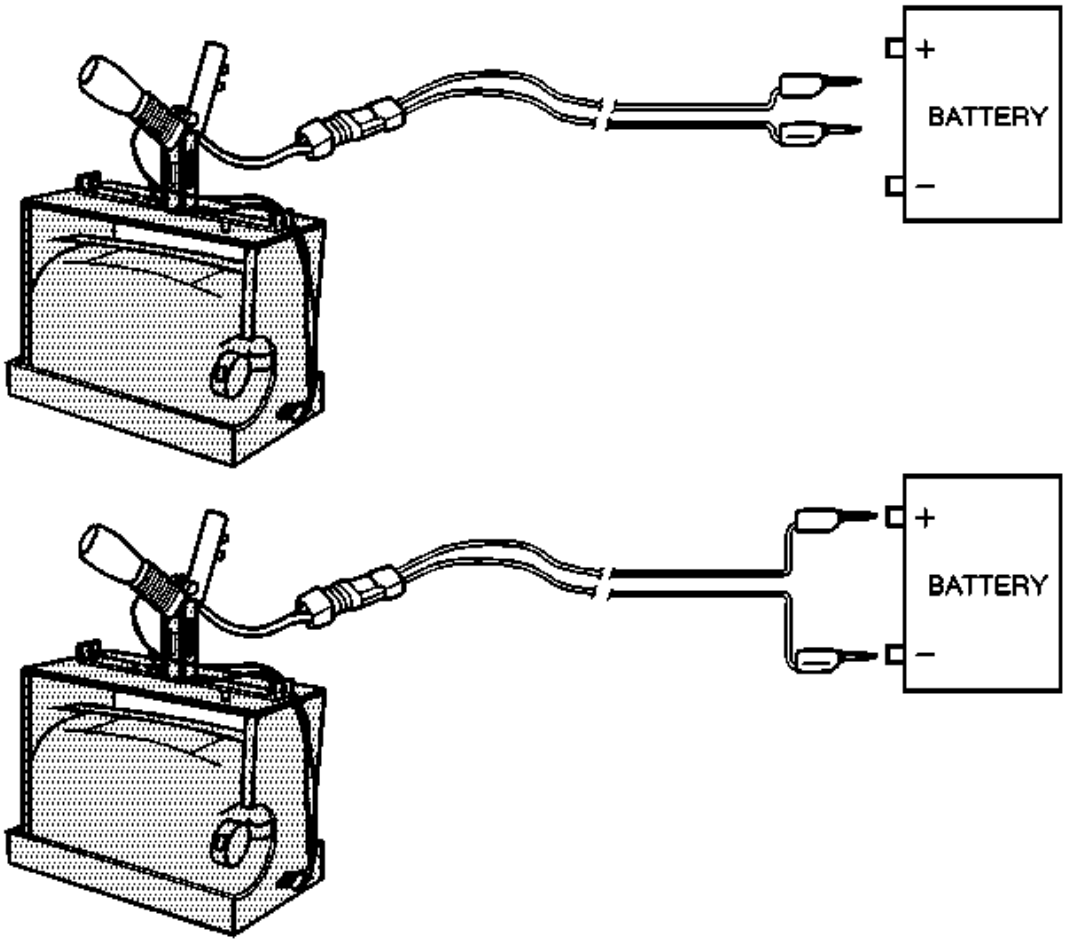


Fig. 70: Deploying Pretensioner
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When the seat belt pretensioner deploys, the deployment fixture may jump about 30 cm (1 ft) vertically. This is a normal reaction of the seat belt pretensioner due to the force of the rapid expansion of gas inside the pretensioner.**

18. Place a 12 V minimum/2 A minimum power source (i.e., vehicle battery) near the shorted end of the harness.
19. Connect the SIR deployment harness wires to the power source. Pretensioner deployment will occur when contact is made.
20. Disconnect the SIR deployment harness from the power source after the pretensioner deploys.

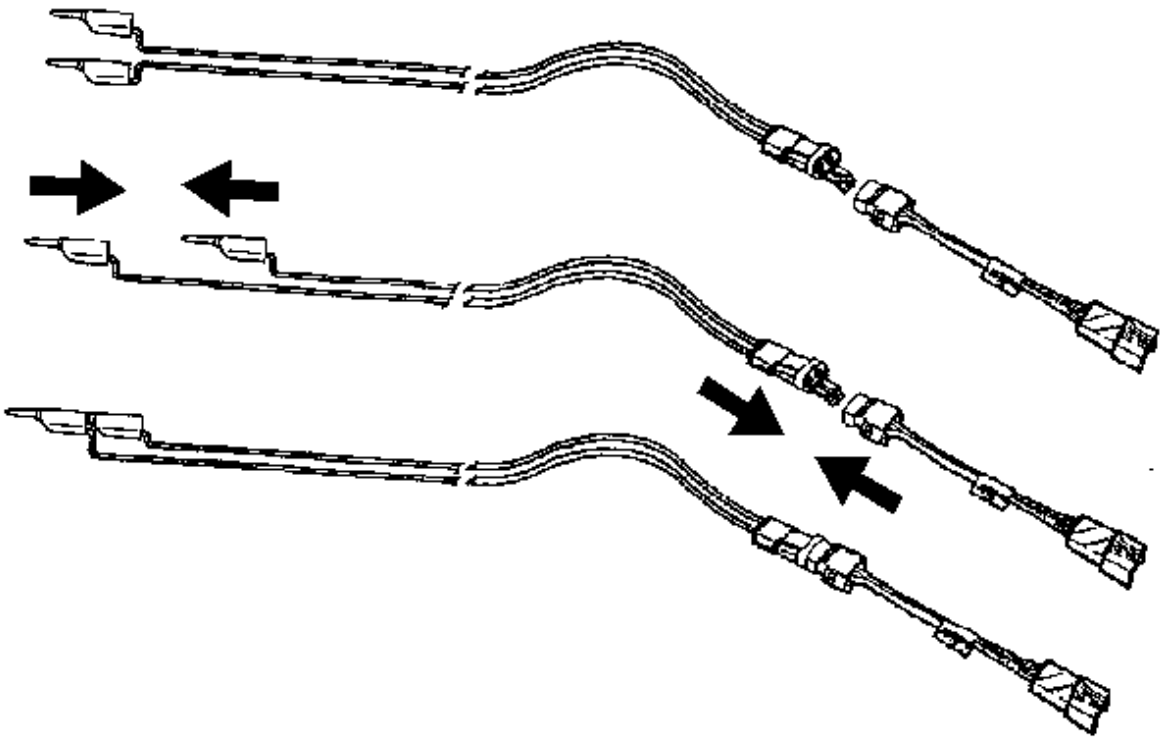


Fig. 71: View Of Deployment Harness Leads
Courtesy of GENERAL MOTORS COMPANY

21. Seat one banana plug into the other in order to short the deployment harness leads.
22. If the pretensioner did not deploy, disconnect the adapter and discontinue the procedure. Contact the Technical Assistance Group. Otherwise, proceed to the following steps.
23. Put on a pair of shop gloves.
24. Disconnect the pigtail adapter from the pretensioner as soon as possible.
25. Inspect the pigtail adapter and the SIR deployment harness. Replace as needed.
26. Dispose of the deployed pretensioner through normal refuse channels.
27. Wash hands with a mild soap.

DESCRIPTION AND OPERATION

SUPPLEMENTAL INFLATABLE RESTRAINT SYSTEM DESCRIPTION AND OPERATION

SIR System Overview

The supplemental inflatable restraint (SIR) system supplements the protection offered by the seat belts. The SIR system contains an inflatable restraint sensing and diagnostic module (SDM), air bags, seat belt pretensioners (retractor), and impact sensors. The SDM determines the severity of a collision with the assistance of impact sensors located at strategic points on the vehicle. When the SDM detects a collision, the SDM will process the information provided by the sensors to further support air bag or pretensioner deployment. The SDM will deploy the air bags and pretensioners if it detects a collision of sufficient force. If the force of the impact is not sufficient to warrant air bag deployment, the SDM may still deploy the seat belt pretensioners. The SDM contains a sensing device that converts vehicle velocity changes to an electrical signal. The SDM compares these signals to values stored in memory. If the signals exceed a stored value, the SDM will determine the severity of the impact and either cause current to flow through the frontal deployment loops deploying the frontal air bags and pretensioners, or it will deploy the pretensioners only. The SDM continuously monitors the deployment loops for malfunctions and illuminates the SIR system AIR BAG indicator if a fault is detected. The SDM performs continuous diagnostic monitoring of the SIR system electrical components. Upon detection of a circuit malfunction, the SDM will set a DTC and inform the driver by illuminating the SIR system AIR BAG indicator. The steering column and knee bolsters are designed to absorb energy and compress during frontal collisions in order to limit leg movement and decrease the chance of injury to the driver and passenger.

SIR System AIR BAG Indicator

The SIR system AIR BAG indicator, located in the instrument cluster, is used to notify the driver of SIR system malfunctions and to verify that the inflatable restraint sensing and diagnostic module (SDM) is communicating with the instrument cluster. When the ignition is turned ON, the SDM is supplied with ignition positive voltage. The instrument cluster will momentarily turn on the SIR system AIR BAG indicator. While the indicator is on, the SDM conducts tests on all SIR system components and circuits. If no malfunctions are detected the SDM will communicate with the instrument cluster through the serial data circuit and command the SIR system AIR BAG indicator OFF. The SDM provides continuous monitoring of the air bag circuits by conducting a sequence of checks. If a malfunction is detected the SDM will store a diagnostic trouble code (DTC) and command the instrument cluster to illuminate the SIR system AIR BAG indicator via serial data. The presence of a SIR system malfunction could result in non-deployment of the air bags or deployment in conditions less severe than intended. The SIR system AIR BAG indicator will remain ON until the malfunction has been repaired.

Inflatable Restraint Sensing and Diagnostic Module (SDM)

The inflatable restraint sensing and diagnostic module (SDM) is a microprocessor and the control center for the supplemental inflatable restraint (SIR) system. The SDM contains internal sensors along with external impact sensors, mounted at strategic locations on the vehicle. In the event of a collision, the SDM compares the signals from the internal and external impact sensors to a value stored in memory. When the generated signals exceed the stored value, the SDM will cause current to flow through the appropriate deployment loops to deploy the air bags. The SDM records the SIR system status when a deployment occurs and illuminates the SIR system AIR BAG indicator located in the instrument cluster. The SDM performs continuous diagnostic monitoring of the SIR system electrical components and circuitry when the ignition is turned ON. If the SDM detects a malfunction, a DTC will be stored and the SDM will request the instrument cluster to illuminate the SIR system AIR BAG indicator, notifying the driver that a malfunction exists. In the event that ignition positive voltage is lost during a collision, the SDM maintains a 23-volt loop reserve for deployment of the air bags. It is important when disabling the SIR system for servicing or rescue operations to allow the 23-volt loop reserve to dissipate, which could take up to 2 min.

Air Bags

This vehicle contains 6 air bags. The 6 air bags are located in the driver steering wheel (dual air bags), passenger instrument panel (passenger side) (dual air bags), driver seat side (B-pillar), passenger seat side (B-pillar), left roof rail, and right roof rail. To view the locations of the air bags refer to **Master Electrical Component List** . Air bags contain a housing, inflatable air bag, two initiating devices (if dual air bags), canister of gas generating material and, in some cases, stored compressed gas. The deployment loops supply current to deploy the air bags. The steering wheel and passenger instrument panel air bags have two stages of deployment, which varies the amount of restraint to the occupant according to the collision severity. For moderate frontal collisions the air bags deploy at less than full deployment which consists of stage 1 of the air bag. For more severe frontal collisions a full deployment is initiated which consists of stage 1 and stage 2 of the air bag. The current passing through the air bags ignite the material in the canister producing a rapid generation of gas and is some cases, the release of compressed gas. The gas produced from this reaction rapidly inflates the air bag. Once the air bag is inflated it quickly deflates through the air bag vent holes and/or the bag fabric. A shorting bar (if equipped) is located in the connector.

Seat Belt Pretensioners (Anchor and Retractor)

The seat belt pretensioners (driver and passenger) consist of a housing, seat belt retractor (located in the B-pillar), seat belt anchor (located on the outboard side of the seat), seat belt webbing, an initiator, and a canister of gas generating materials. To view the locations of the seat belt pretentioners refer to **Master Electrical Component List** . The initiator is part of the seat belt pretensioner deployment loop. When the vehicle is involved in a collision of sufficient force, the SDM causes current to flow through the seat belt deployment loops to the initiator. Current passing through the initiator ignites the material in the canister producing a rapid generation of gas. The gas produced from this reaction deploys the seat belt pretensioners which removes all of the slack in the seat belts. Depending on the severity of the collision, the seat belt pretensioners may deploy without the front air bags deploying, or they will deploy immediately before the front air bags deploy. A shorting bar (if equipped) is located in the connector.

Impact Sensors

This vehicle contains 4 impact sensors. The 4 impact sensors are located in the front of the vehicle (2, left and right), and 2 in the front doors (left and right). To view the locations of the impact sensors refer to **Master Electrical Component List** . The impact sensors contain a sensing device which monitors vehicle acceleration and velocity changes to detect side collisions that are severe enough to warrant air bag deployment. The impact sensors are not part of the deployment loop, but instead provide input to the SDM. The SDM contains a microprocessor that performs calculations using the measured accelerations and compares these calculations to a value stored in memory. When the generated calculations exceed the stored value, the SDM will cause current to flow through the deployment loops deploying the appropriate air bags.

Passenger Presence Detection System and Passenger Air Bag Indicator

NOTE: **The Passenger Presence System (PPS) and the seat bottom foam cushion is a calibrated unit and cannot be service separately. After repairing or replacing the PPS, the system must be checked for preload in order to function properly.**

The PPS is used to monitor the pressure profile of an occupant on the front outboard passenger seat and communicate the status to the sensing and diagnostic module (SDM) whether to enable or suppress the deployment of the instrument panel (I/P) module. The PPS consists of an electronic control module and sensor mat assembly attached to the bottom seat cushion, wiring harness, and PASSENGER AIR BAG ON/OFF

indicators. The PPS measures the weight of the occupant sitting in the front passenger seat as a pressure change. If the pressure from the occupant's weight is less than a specified value, the PPS module will send a suppress signal to the SDM to disable the I/P module. If the pressure from the occupant's weight is higher than a specified value, the PPS module will send an enable signal to the SDM to enable the I/P module. The PPS module will notify the customer of the enable/disable status by turning ON one of the PASSENGER AIR BAG ON/OFF indicators. The PPS monitors itself for faults and will set diagnostic trouble codes (DTCs) if a fault is detected. The PPS will also notify the SDM of a fault. The SDM will respond by requesting the instrument panel cluster (IPC) to turn the SIR system AIR BAG indicator ON.

Seat Belt Indicators

The seat belt indicators are controlled through the inflatable restraint sensing and diagnostic module (SDM). For further information on seat belt indicators refer to **Seat Belt System Description and Operation** .

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

Illustration	Tool Number/ Description
	EL 38826 J 38826 SIR Deployment Harness

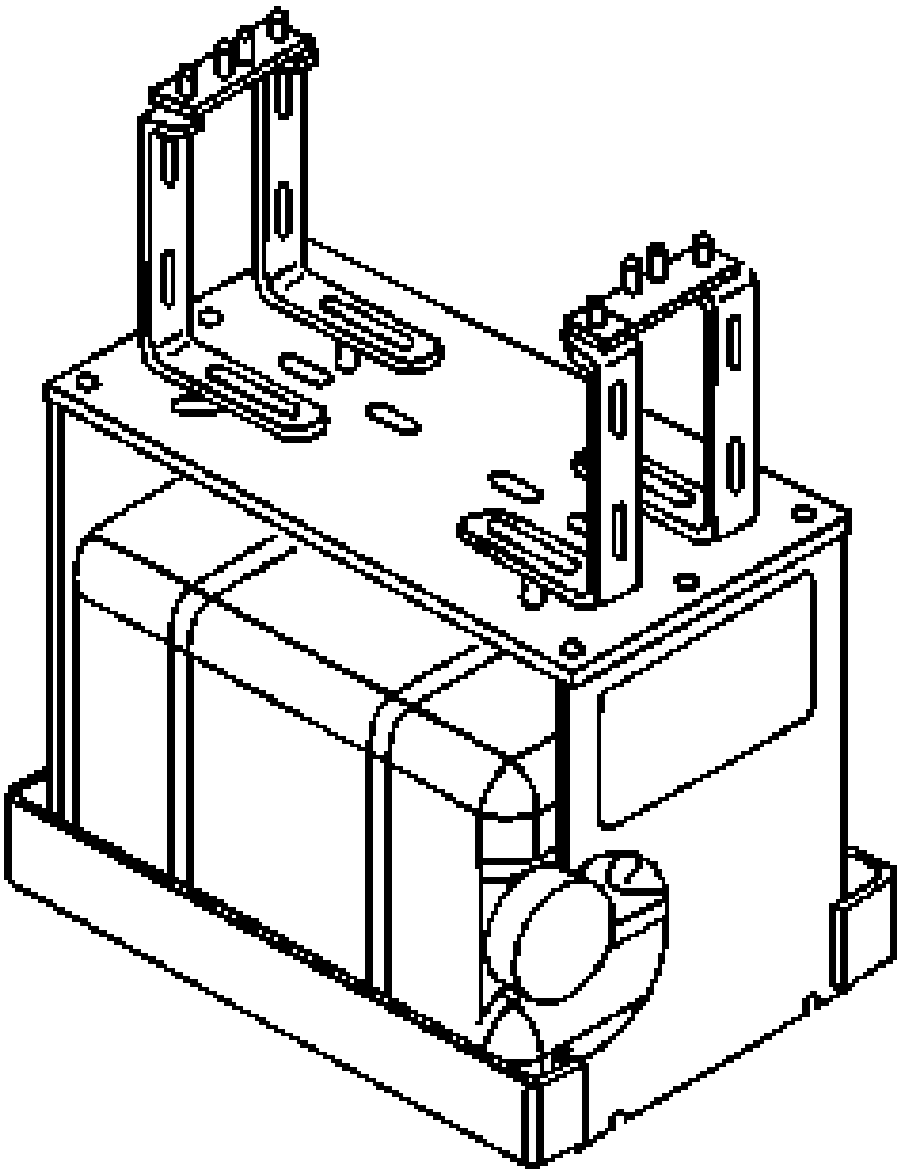
Illustration	Tool Number/ Description
	EL 39401-B J 39401-B SIR Deployment Fixture

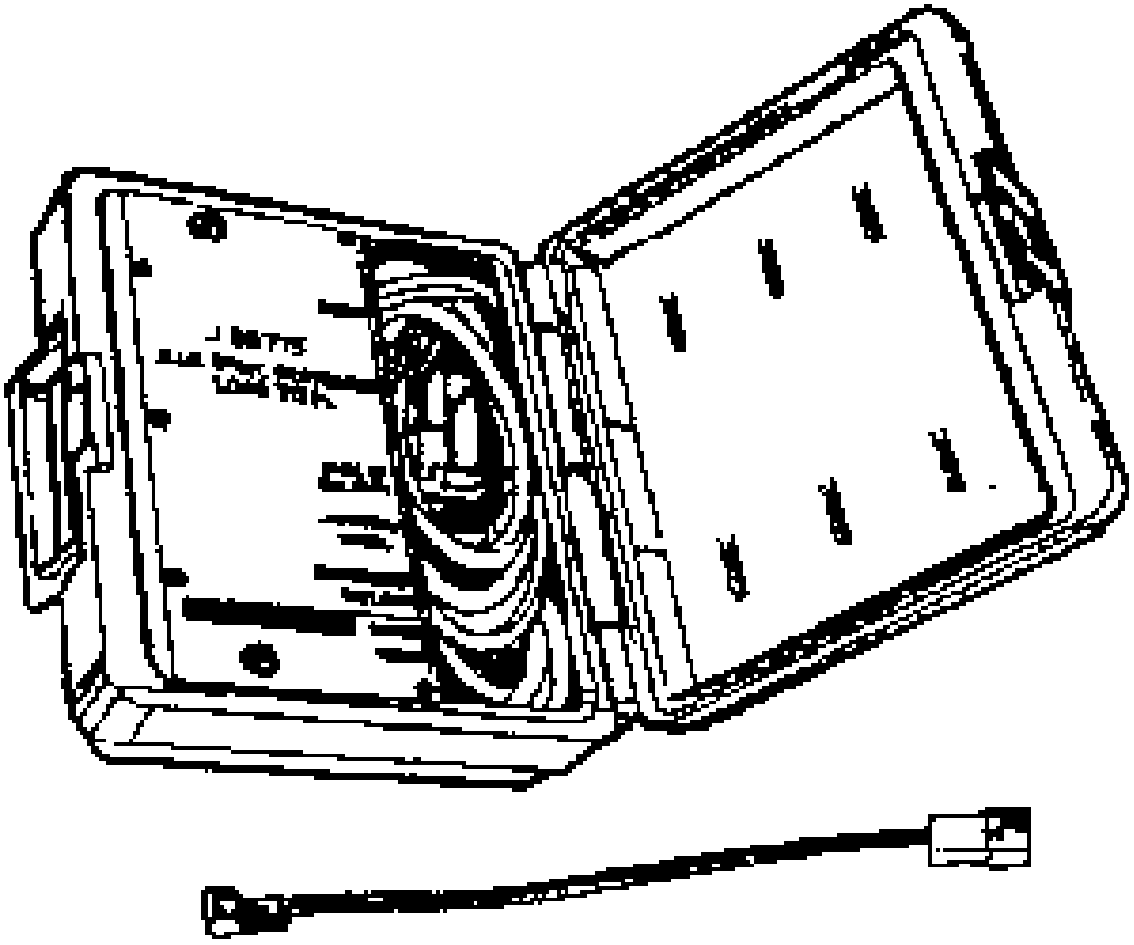
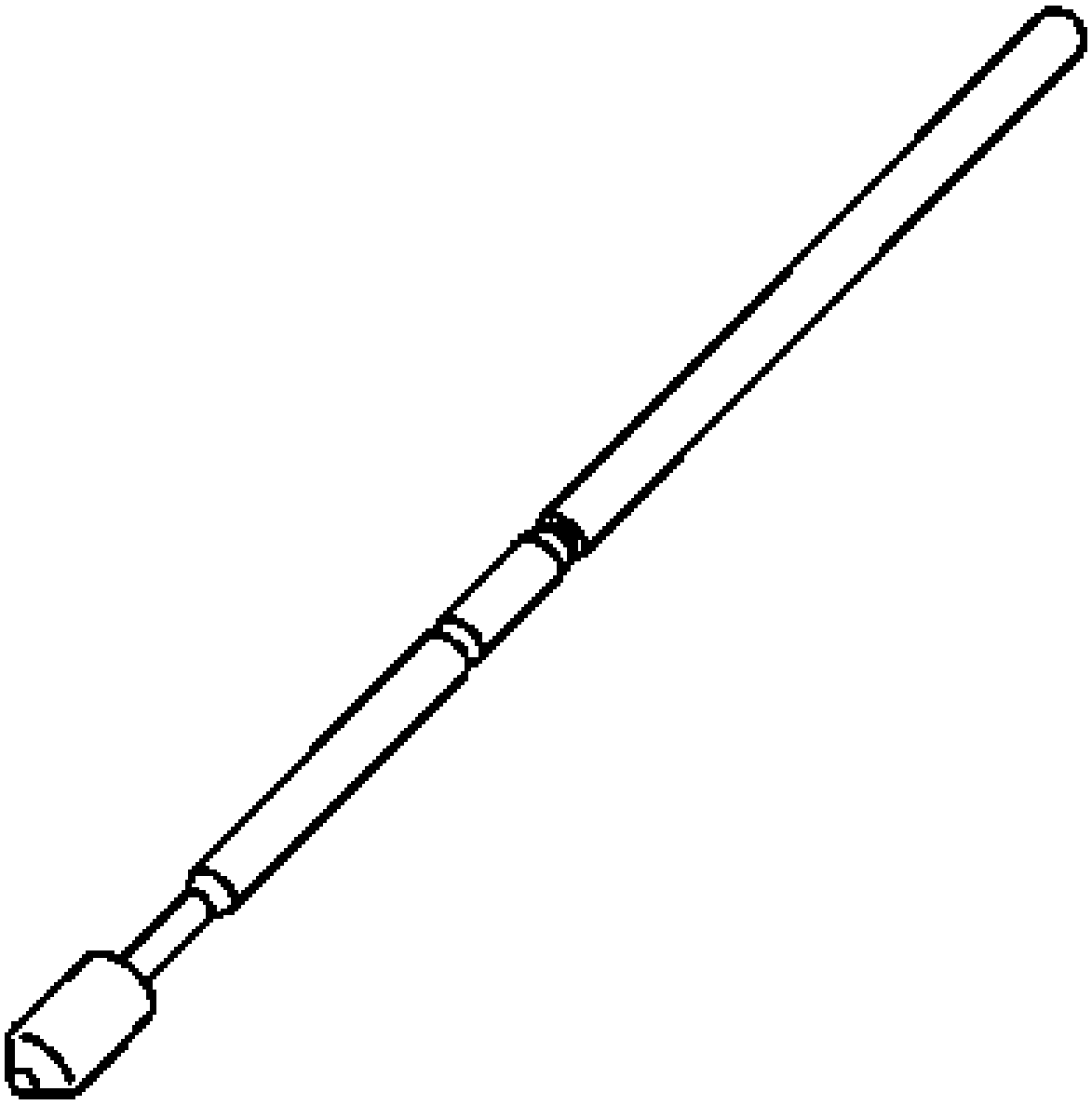
Illustration	Tool Number/ Description
	J 38715-A Driver or Passenger Load Tool Brazil - Use Local Equivalent

Illustration	Tool Number/ Description
	CH 42640 Steering Column Anti-rotation Pin Brazil - Use Local Equivalent

Article GUID: A00737167

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Power Steering Fluid Cooler Bolt	8 N.m	71 lb in
Power Steering Fluid Cooling Pipe Fitting	34 N.m	25 lb ft
Power Steering Fluid Reservoir Bolt	6 N.m	53 lb in
Power Steering Gear Inlet Hose Bracket Bolt	7 N.m	62 lb in
Power Steering Gear Inlet Hose Fitting	34 N.m	25 lb ft
Power Steering Gear Pipe Fitting	34 N.m	25 lb ft
Power Steering Pump Bolt	22 N.m	16 lb ft
Steering Gear Bolt	90 N.m	66 lb ft
Steering Gear Heat Shield Bolt	9 N.m	80 lb in
Steering Linkage Inner Tie Rod	100 N.m	74 lb ft
Steering Linkage Outer Tie Rod Nut		
• First Pass	30 N.m	22 lb ft
• Final Pass	120 degrees	

POWER STEERING PUMP SPECIFICATIONS

Vehicle	Engine Code	Engine Size	High Flow		Pressure Relief	
			LPM	GPM	kPa	PSI
Impala	LFX	3.6L	7.4/8.9	2/2.4	10687/11376	1550/1650

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	US English
Power Steering System	0.91 L	1.92 pt

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - POWER STEERING SYSTEM

IMPORTANT: Review the system description and operation in order to familiarize yourself with the system functions. Refer to **Power Steering System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the power steering system.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for leaking power steering components. If necessary, refer to **Power Steering Fluid Leaks**.
- Verify the power steering fluid level per operating specification. Refer to **Checking and Adding Power Steering Fluid**.
- Inspect the power steering fluid for the following indications of contamination:
  - Milky fluid - water
  - Brown fluid - burnt
  - Debris in fluid - plastic or dirt
- If necessary, flush the power steering system. Refer to **Power Steering System Flushing**.

Symptoms List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Power Steering Fluid Leaks**
- **Rattle, Clunk, Pop or Shudder Noise from the Power Steering System**
- **Whine or Growl Noise from the Power Steering System**
- **Steering Effort Hard or Too Easy in One or Both Directions**

POWER STEERING SYSTEM TEST

Rack and Pinion System

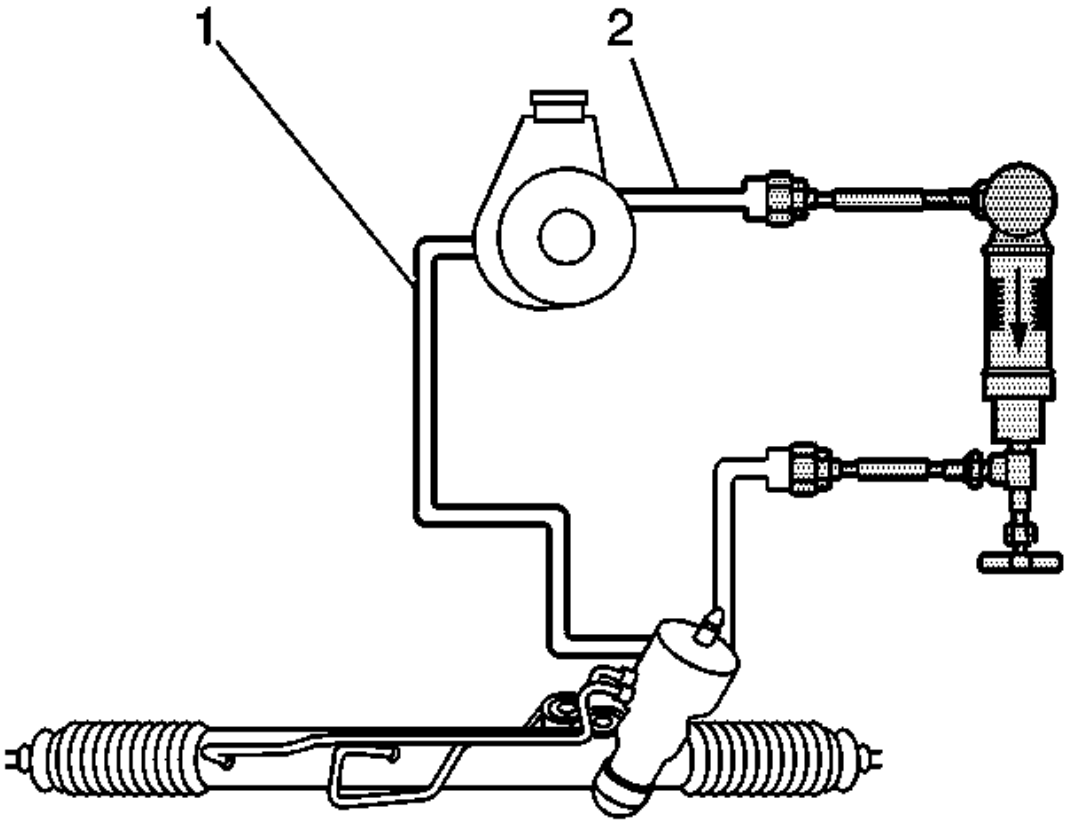


Fig. 1: Testing Rack and Pinion System Pressures
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Power Steering Return Hose
2	Power Steering Pressure Hose

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5

This step tests the system for restrictions.

7

This step tests the following components for the following conditions:

- The pump for internal leaks
- The power steering pipes for kinks

8

This step tests the ability of the pump to regulate flow at maximum pressure.

10

This step tests the ability of the pump to regulate flow under normal operating conditions.

12

This step tests the internal components of the pump and the gear.

Step	Action	Value(s)	Yes	No
DEFINITION: The Power Steering System Test Procedure will perform the following functions: • Test the operation of the hydraulic power steering system. • Test the operation of the power steering pump and power steering gear. • Identify restrictions in the system.				
1	Inspect the power steering fluid for the following indications of contamination: • Milky fluid - water • Brown fluid - burnt • Debris in fluid - plastic or dirt Is the fluid free of contamination?	-	Go to **Step 3**	Go to **Step 2**
2	Flush the power steering system. Refer to **Power Steering System Flushing**. Did you complete the procedure?	-	Go to **Step 3**	-
3	**NOTE:** **In order to accurately diagnose the system, the malfunction must be present during the test procedure.** Attempt to duplicate the condition.Is the condition present?	-	Go to **Step 4**	System OK
4	1. Turn the ignition switch to the OFF position.	-	Go to **Step 5**	-

Step	Action	Value(s)	Yes	No
	2. Place a drain pan under the vehicle in order to catch any power steering fluid. 3. Disconnect the power steering pressure pipe/hose from the power steering pump or the power steering gear as necessary. 4. Install the **J-44721** Power Steering System Analyzer. 5. Fill the power steering system. Refer to **Checking and Adding Power Steering Fluid**. Did you complete the installation?			
5	1. Fully open the **J-44721** Power Steering System Analyzer valve. 2. Start the engine. **CAUTION:** **Do not hold the steering wheel in the full turn position longer than 5 seconds, as damage to the steering pump may result.** 3. Turn the steering wheel and BRIEFLY hold the steering wheel against the steering stop in order to release any trapped air from the system. 4. Inspect and ensure that all of the power steering pipe/hose connections are not leaking. 5. Making sure the steering wheel is OFF the steering stop, observe the pressure reading. Is the pressure reading greater than the specified value?	1379 kPa (200 psi)	Go to **Step 6**	Go to **Step 7**

Step	Action	Value(s)	Yes	No
6	**NOTE:** **A restriction may be present in the power steering system. Turn OFF the engine IMMEDIATELY.** Locate and repair the restriction.Did you complete the repair?	-	Go to **Step 15**	-
7	1. Allow the engine to run until the engine reaches full operating temperature. 2. Record the pressure reading and flow reading. 3. Partially close the **J-44721** Power Steering System Analyzer valve until the system pressure reaches the specified value, then record the FLOW reading. 4. Subtract second flow reading from the first flow reading. Is the flow DECREASE greater than 3.8 L (1 gal) per minute?	4827 kPa (700 psi)	Go to **Step 11**	Go to **Step 8**
8	**NOTE:** **Do not leave the valve closed for more than 5 seconds, or internal pump damage could accrue.** Fully close then open the **J-44721** Power Steering System Analyzer valve 3 times. Record all of the high pressure readings. Refer to **Power Steering Pump Specifications** for power steering system pressure relief specifications.Are the 3 high pressure readings within specifications?	-	Go to **Step 9**	Go to **Step 13**

Step	Action	Value(s)	Yes	No
9	Are the three high pressure readings within 245 kPa (50 psi) of each other?	-	Go to **Step 10**	Go to **Step 13**
10	1. Increase the engine speed to approximately 1,500 RPM. 2. Record the flow reading. Refer to **Power Steering Pump Specifications** for power steering system pressure specifications. Is the actual flow reading within specifications?	-	Go to **Step 11**	Go to **Step 13**
11	Is the difference between the actual flow reading and the maximum flow specification more than 3.8 L (1 gal) per minute?	-	Go to **Step 13**	Go to **Step 12**
12	Turn the steering wheel from steering stop to steering stop and record the FLOW readings at each stop. Is the flow LOWER than 3.8 L (1 gal) per minute?	-	Go to **Step 15**	Go to **Step 14**
13	Replace the power steering pump. Refer to **Power Steering Pump Replacement**. Did you complete the replacement?	-	Go to **Step 15**	-
14	The power steering gear is leaking across the piston or bypassing the valve circuit. Replace the power steering gear. Refer to **Steering Gear Replacement**. Did you complete the replacement?	-	Go to **Step 15**	-
15	Test the power steering system for the original condition. Does the original condition still exist?	-	Go to **Step 5**	Go to **Step 16**
16	1. Disconnect and remove the **J-44721** Power Steering System Analyzer from the vehicle. 2. Connect the vehicle power steering pipes/hoses. 3. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**. Did you complete the procedure?	-	System OK	-

POWER STEERING FLUID LEAKS

Special Tools

GE-28431-6 Fluorescent Dye

For equivalent regional tools, refer to **Special Tools**.

NOTE:

- **If fluid is found on a manual steering gear or on an electronic power steering gear, do not replace steering gear. Vehicles equipped with these systems do not use hydraulic power steering fluid. The fluid may be assembly fluid or another system fluid.**
- **Clean the components and identify the sources of the leaks before attempting to repair or replace any power steering components. Clearly mark all locations of leaks with paint, marker, or equivalent for warranty identification and engineering root cause analysis.**

Some customers may comment on a fluid LEAK or NOISY power steering pump. Upon inspection, the technician may find power steering fluid leaking from the hydraulic power steering system. Use the following inspection procedure in order to diagnose the source of the leak and take appropriate action to correct the condition.

1. Inspect the fluid level in the power steering fluid reservoir. Refer to **Checking and Adding Power Steering Fluid**. If the fluid level is NOT low, a careful analysis of the condition is necessary to confirm that the type of fluid is actually power steering fluid.
2. Visually inspect the power steering system and components where the fluid has accumulated.

CAUTION: **Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.**

3. Use a clean towel or a rag in order to completely clean off all residual fluid from the power steering components.
4. Add 30 cc (1 oz) of **GE-28431-6** dye to the power steering fluid.
5. Start the vehicle and warm the steering system by turning to the left steering stop and to the right steering stop 10 times with the weight of the vehicle on the front tires.
6. Turn vehicle engine OFF.
7. Shine a black light on the area where the residual fluid accumulated. Identify the sources of the leaks.
8. Mark all locations of leaks with paint, marker, or equivalent.
9. Repair or replace all affected components.

RATTLE, CLUNK, POP OR SHUDDER NOISE FROM THE POWER STEERING SYSTEM

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Power Steering System**
2	Verify that a rattle, clunk or shudder noise is present. Is a rattle, clunk or shudder noise present?	Go to **Step 3**	System OK
3	Inspect the power steering hoses for proper routing and clearance. Is the routing or clearance of the power steering hoses	Go to **Step 11**	Go to **Step 4**

Step	Action	Yes	No
	incorrect?		
4	Inspect the engine drive belt for cracking or excessive wear. Refer to **Drive Belt Falls Off and Excessive Wear Diagnosis** . Is the drive belt cracked or excessively worn?	Go to **Step 12**	Go to **Step 5**
5	Inspect the power steering pump pulley for damage. Is the power steering pump pulley damaged?	Go to **Step 13**	Go to **Step 6**
6	Inspect the power steering pump for the proper installation. Refer to **Power Steering Pump Replacement**. Is the power steering pump installation incorrect?	Go to **Step 14**	Go to **Step 7**
7	Inspect the power steering gear for the proper installation. Refer to **Steering Gear Replacement**. Is the power steering gear installation incorrect?	Go to **Step 15**	Go to **Step 8**
8	Inspect for looseness in the inner tie rods or in the outer tie rods. Refer to **Steering Linkage Inner Tie Rod Inspection**, and to **Steering Linkage Outer Tie Rod Inspection**. Are the inner tie rods or the outer tie rods loose?	Go to **Step 16**	Go to **Step 9**
9	Inspect the front frame mounts and the front suspension. Refer to **Noise Diagnosis - Front Suspension** . Are the front frame mounts worn or is the front suspension worn?	Go to **Step 17**	Go to **Step 10**
10	Inspect the intermediate shaft. Is the intermediate shaft worn?	Go to **Step 18**	Go to **Step 3**
11	Adjust or replace the hoses. Refer to the appropriate procedures: • **Power Steering Fluid Cooling Pipe Replacement** • **Power Steering Fluid Cooler Replacement** • **Power Steering Fluid Reservoir Hose Replacement** • **Power Steering Gear Inlet Pipe/Hose Replacement** Did you complete the repair?	Go to **Step 19**	-
12	Replace the drive belt. Refer to **Drive Belt Replacement** . Did you complete the repair?	Go to **Step 19**	-
13	Replace the power steering pump pulley. Refer to **Power Steering Pump Pulley Replacement**.	Go to **Step 19**	-

Step	Action	Yes	No
	Did you complete the repair?		
14	Install the power steering pump correctly. Refer to **Power Steering Pump Replacement**. Did you complete the repair?	Go to **Step 19**	-
15	Install the power steering gear correctly. Refer to **Steering Gear Replacement**. Did you complete the repair?	Go to **Step 19**	-
16	Replace either the worn inner tie rod or the worn outer tie rod. Refer to **Steering Linkage Inner Tie Rod Replacement**, or to **Steering Linkage Outer Tie Rod Replacement**. Did you complete the repair?	Go to **Step 19**	-
17	Replace the worn front frame mount or the worn front suspension components. Did you complete the repair?	Go to **Step 19**	-
18	Replace the intermediate shaft. Refer to **Intermediate Steering Shaft Replacement** . Did you complete the repair?	Go to **Step 19**	-
19	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

WHINE OR GROWL NOISE FROM THE POWER STEERING SYSTEM

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Power Steering System**
2	Verify that a whine or growl noise is present. Is a whine or growl noise present?	Go to **Step 3**	System OK
3	Inspect the power steering fluid for the following indications of contamination: • Milky fluid - water • Brown Fluid - burnt • Debris in fluid - plastic or dirt Is the fluid free of contamination?	Go to **Step 4**	Go to **Step 9**
4	Inspect the power steering fluid temperature and level. Refer to **Checking and Adding Power Steering Fluid**. Is the fluid level between the MIN mark and the MAX mark?	Go to **Step 5**	Go to **Step 10**

Step	Action	Yes	No
5	1. Bleed the power steering system. Refer to **Power Steering System Bleeding**. 2. Verify that a whine or growl noise is present. Is a whine or growl noise present?	Go to **Step 6**	System OK
6	Using the **J-39570** Chassis Ear , inspect the steering gear for a whine or growl noise. Is the noise present at the steering gear?	Go to **Step 11**	Go to **Step 7**
7	Using the **J-39570** Chassis Ear , inspect the power steering pump for a whine or growl noise. Is the noise present at the power steering pump?	Go to **Step 12**	Go to **Step 8**
8	Using the **J-39570** Chassis Ear , inspect the power steering hoses for a whine or growl noise. Is the noise present at the power steering hoses?	Go to **Step 13**	Go to **Step 1**
9	Flush the power steering system. Refer to **Power Steering System Flushing**. Did you complete the procedure?	Go to **Step 14**	-
10	Inspect the power steering system for leaks. Repair or replace all affected components. Refer to **Power Steering Fluid Leaks**. Did you complete the inspection and repairs?	Go to **Step 14**	-
11	Replace the steering gear. Refer to **Steering Gear Replacement**. Did you complete the repair?	Go to **Step 14**	-
12	Replace the power steering pump. Refer to **Power Steering Pump Replacement**. Did you complete the repair?	Go to **Step 14**	-
13	Adjust the routing of the power steering hoses. Did you complete the repair?	Go to **Step 14**	-
14	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

POOR RETURN OF STEERING WHEEL

Step	Action	Yes	No
DEFINITION: After completing a turn, extra steering input is required for the steering wheel to return to center.			
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Power Steering System**
2	Verify that poor return of the steering wheel is present. Does the system operate normally?	System OK	Go to **Step 3**

Step	Action	Yes	No
3	1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Lubricate the tie rod ends and ball joints, if applicable. 3. Inspect the suspension system for worn or damaged components. 4. Repair as necessary. Did you find and correct the condition?	Go to **Step 12**	Go to **Step 4**
4	1. Rotate the steering wheel ONE revolution in both directions. 2. Rotate the steering wheel back to the original position. Was the steering wheel abnormally difficult to rotate in either direction?	Go to **Step 5**	Go to **Step 10**
5	**NOTE:** **Position the wheels straight ahead. Do NOT rotate the steering wheel more than one complete revolution from center.** 1. Disconnect the intermediate shaft from the steering column. 2. Note the position of the steering wheel and rotate the steering wheel ONE revolution in both directions. 3. Rotate the steering wheel back to the original position. Was the steering wheel abnormally difficult to rotate in either direction?	Go to **Step 11**	Go to **Step 6**
6	Inspect the intermediate shaft for stiff or loose joints. Repair or replace as necessary. Did you find and complete the repair?	Go to **Step 12**	Go to **Step 7**
7	1. Remove the front tire and wheel assemblies. Refer to **Tire and Wheel Removal and**	Go to **Step 12**	Go to **Step 8**

Step	Action	Yes	No
	Installation . 2. Disconnect both outer tie rod ends from the steering knuckles. 3. Use your hands in order to move the tie rod end studs. 4. If abnormally difficult to move, replace the tie rod end. If equipped with recirculating ball steering, ensure that idler and pitman arm joints are not to stiff. Repair as necessary. Did you find and complete the repair?		
8	1. Use your hands to rotate the steering knuckle inboard and outboard in order to inspect for a binding strut bearings, ball joints, or axle. 2. Repair or replace any abnormally stiff or loose components. Did you find and complete the repair?	Go to **Step 12**	Go to **Step 9**
9	Inspect for binding in the steering gear. If a binding is present, repair or replace the steering gear. Did you find and complete the repair?	Go to **Step 12**	Go to **Step 10**
10	Inspect the wheel alignment and adjust as necessary. Refer to **Wheel Alignment Measurement** . Did you find and complete the repair?	Go to **Step 12**	-
11	Inspect the steering column for a binding. If a binding is present, repair or replace the steering column as necessary. Did you find and complete the repair?	Go to **Step 12**	-
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	-

STEERING EFFORT HARD OR TOO EASY IN ONE OR BOTH DIRECTIONS

Step	Action	Yes	No
1	Did you review the Power Steering System Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Power Steering System**
2	Verify that the steering effort is hard or too easy in one or both directions. Does the system operate normally?	System OK	Go to **Step 3**

Step	Action	Yes	No
3	1. Bleed the power steering system. Refer to **Power Steering System Bleeding**. 2. Perform the power steering test procedure. Refer to **Power Steering System Test**. Did you complete the procedure?	Go to **Step 4**	-
4	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

REPAIR INSTRUCTIONS

STEERING LINKAGE INNER TIE ROD INSPECTION

Special Tools

J-8001 Dial Indicator Set

For equivalent regional tools, refer to **Special Tools**.

NOTE: **This inspection procedure does not supersede local government required inspections that have more stringent requirements.**

1. Turn the ignition key to the ON position with the engine OFF.
2. With the aid of an assistant, turn the steering wheel to the full stop position and hold the steering wheel in that position until the test is complete. The tie rod being tested should be inside the steering gear housing seated against the steering stop.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. If there is not a good location for the **J-8001** Dial Indicator pointer at the steering gear housing, install a large worm gear hose clamp to the steering gear housing over the larger steering gear boot clamp and align the clamp so that the screw can be a location for the **J-8001** Dial Indicator pointer.

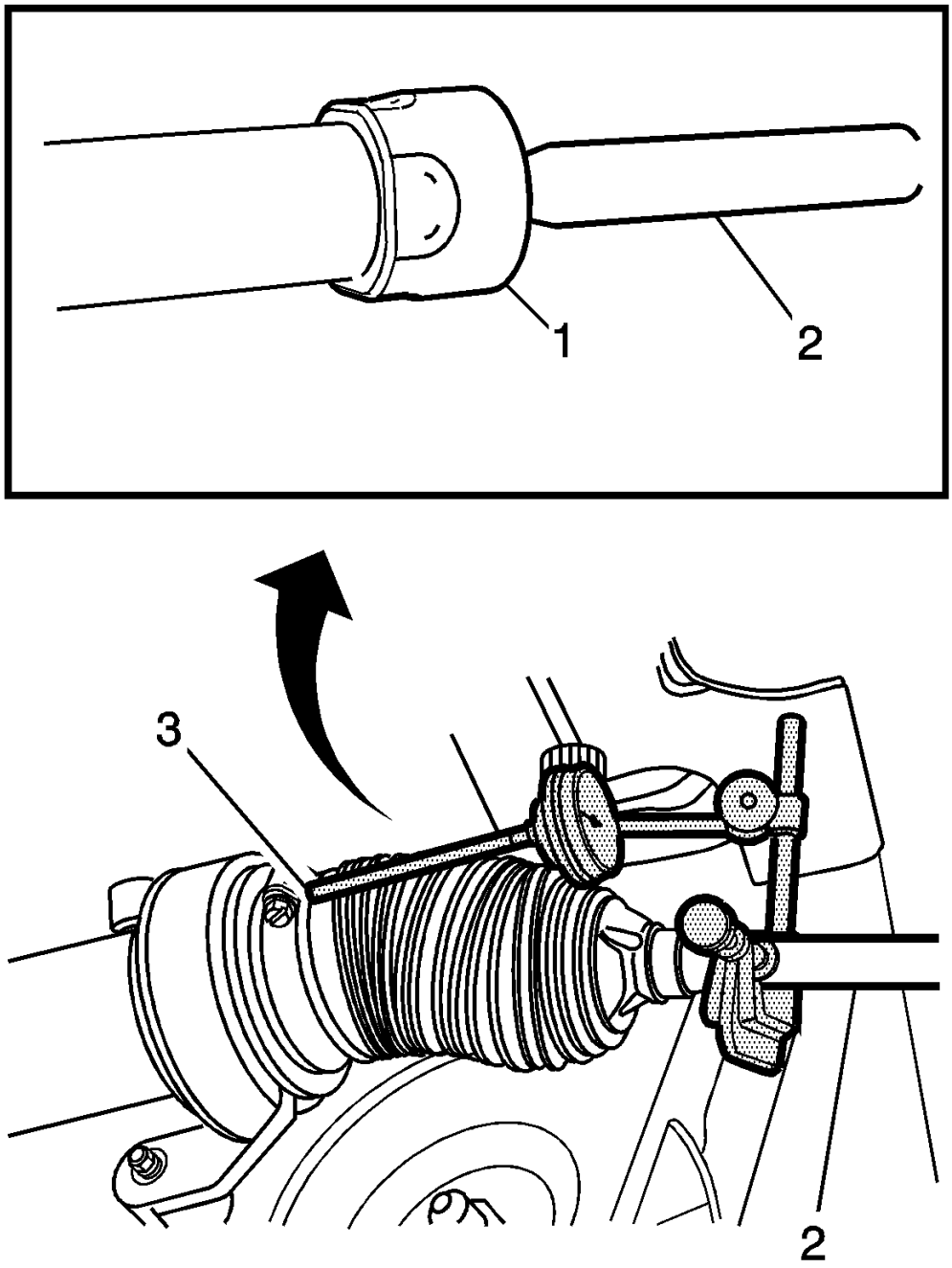


Fig. 2: Measuring Lash Between Inner Tie Rod & Steering Gear Housing
Courtesy of GENERAL MOTORS COMPANY

5. Install the **J-8001** Dial Indicator between the inner tie rod (2) and the steering gear housing or the worm gear clamp in such a way as to measure the lash between the inner tie rod and the steering gear housing.

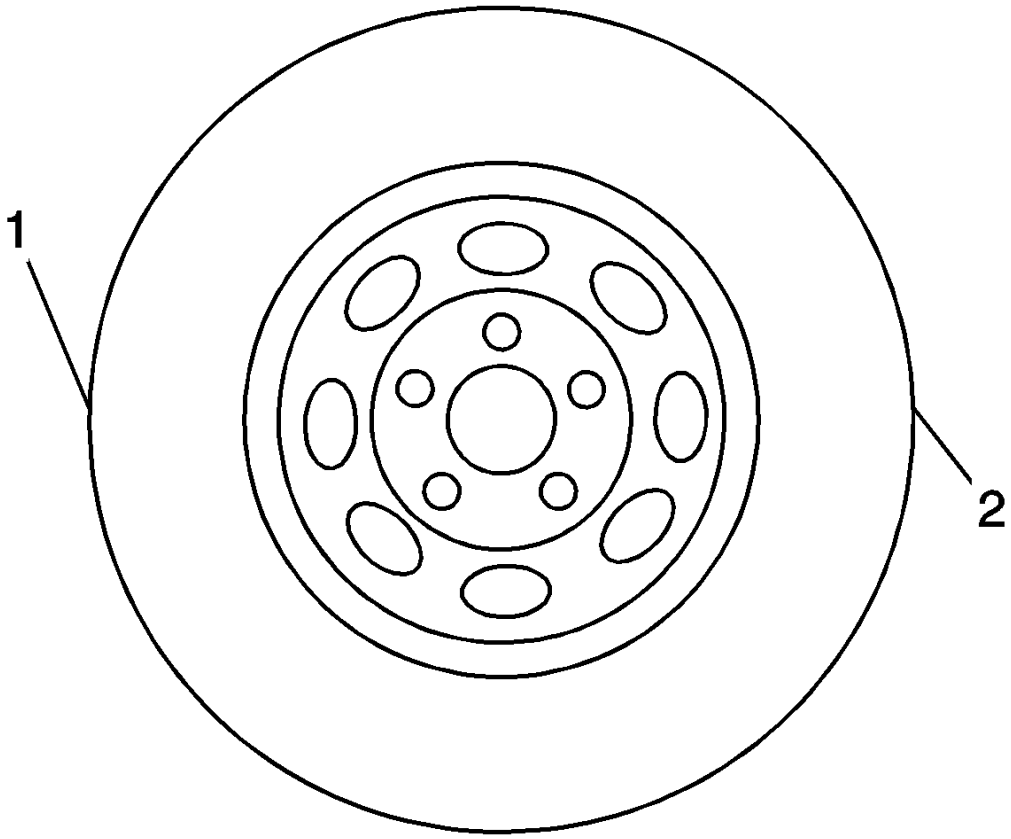


Fig. 3: Identifying Tire Grasping Positions
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Only move the tire enough to feel any lash between the inner tie rod and the inner tie rod housing without moving the steering gear rack.**

6. Grasping the tire at the 3 o'clock (2) and 9 o'clock (1) positions, gently push in on one side of the tire in order to remove any lash.
7. Zero the **J-8001** Dial Indicator.
8. On the same side of the tire previously pushed in, gently pull out and measure the lash.
9. Record the measurement seen on the **J-8001** Dial Indicator.
10. If the measured value exceeds 0.5 mm (0.02 in), replace the steering gear. Refer to **Steering Gear Replacement**.
11. Repeat the procedure for the other side.

STEERING LINKAGE OUTER TIE ROD INSPECTION

Special Tools

J-8001 Dial Indicator Set

For equivalent regional tools, refer to **Special Tools**.

NOTE: **This inspection procedure does not supersede local government required inspections that have more stringent requirements.**

1. Inspect the outer tie rod end seal. If the outer tie rod end seal is torn, replace the outer tie rod end. Refer to **Steering Linkage Outer Tie Rod Replacement**.
2. Raise the side of the vehicle being inspected with a floor jack while maintaining contact between the opposite wheel and the shop floor. Support the lower control arm with a floor jack stand as far outboard as possible and remove the floor jack. Refer to **Lifting and Jacking the Vehicle** .

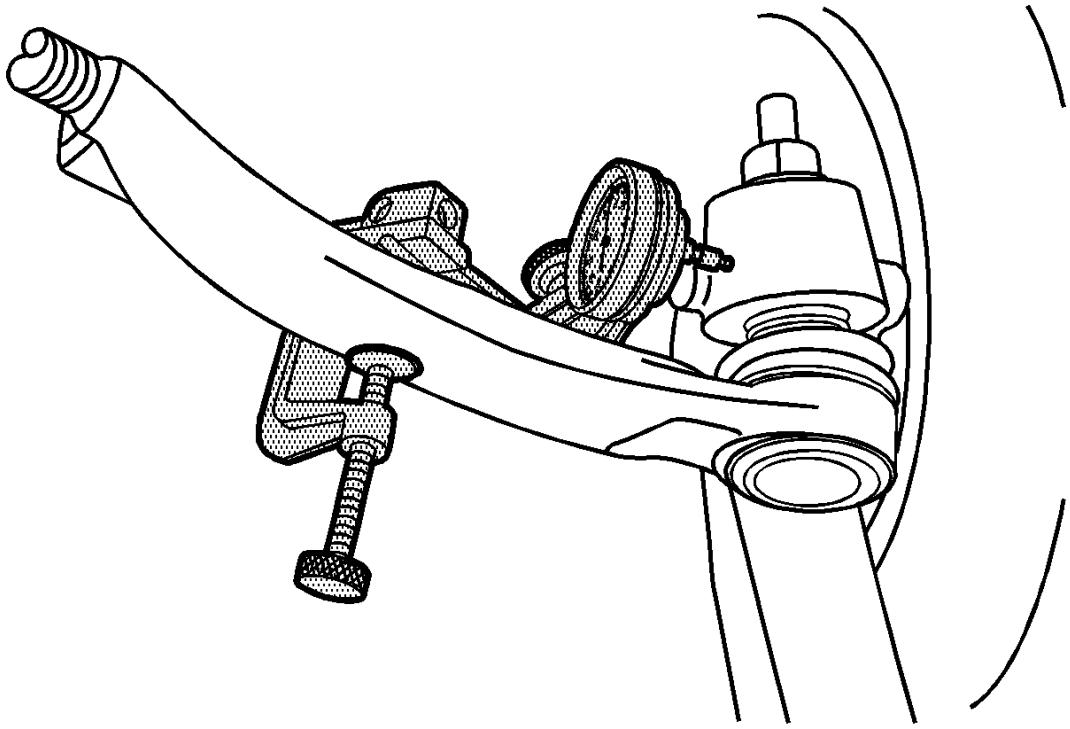


Fig. 4: Measuring Outer Tie Rod Lash
Courtesy of GENERAL MOTORS COMPANY

3. Install the **J-8001** Dial Indicator between the outer tie rod end and the steering knuckle as shown in the graphic. Note that the tire and wheel assembly is shown removed only for clarification of the **J-8001** Dial Indicator position.

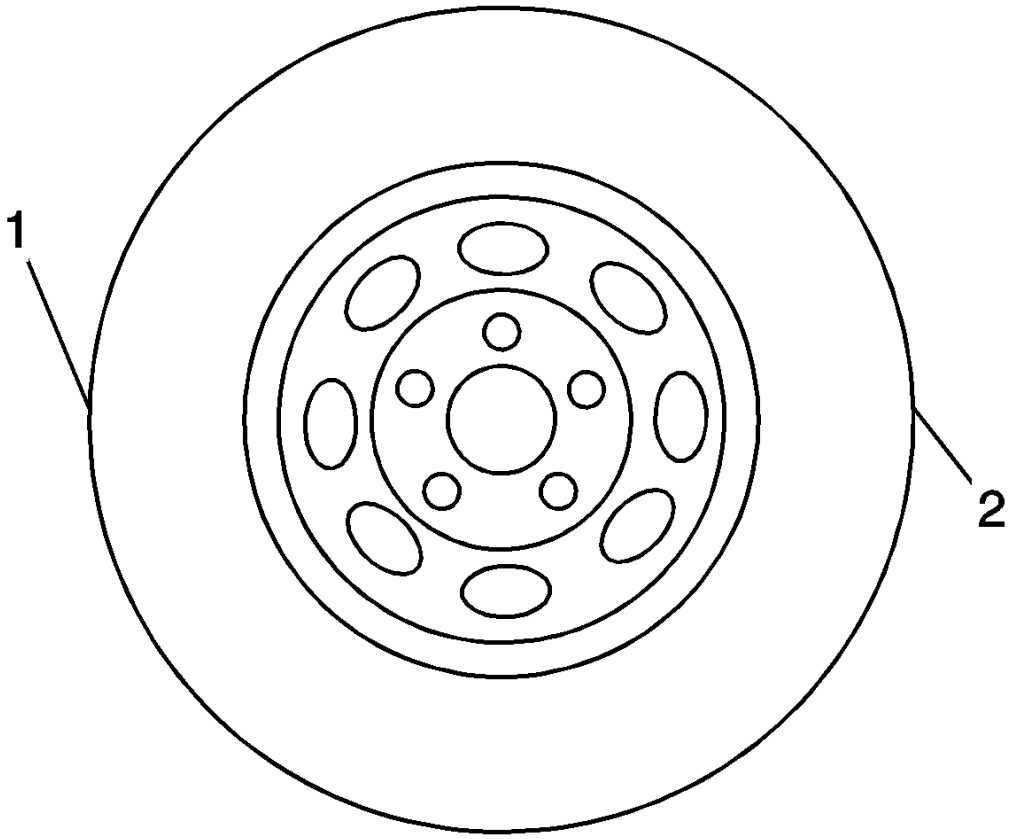


Fig. 5: Identifying Tire Grasping Positions
Courtesy of GENERAL MOTORS COMPANY

4. Grasping the tire at the 3 o'clock (2) and 9 o'clock (1) positions, gently push in on one side of the tire to remove any lash.
5. Zero the **J-8001** Dial Indicator.
6. On the same side of the tire previously pushed inwards, gently pull outwards and measure the lash.
7. Record the measurement seen on the **J-8001** Dial Indicator.
8. If the measured value exceeds 0.5 mm (0.02 in) then replace the outer tie rod. Refer to **Steering Linkage Outer Tie Rod Replacement**.
9. Repeat the procedure for the other side.

POWER STEERING SYSTEM BLEEDING

Special Tools

- **CH-43485** Power Steering Bleeder Adapter
- **GE-23738-A** Vacuum Pump

For equivalent regional tools, refer to **Special Tools**.

NOTE:

- **If you service the power steering system, you will not be able to obtain an accurate fluid level reading unless you bleed the air from the power steering system.**
- **Hoses touching the frame, body or engine may cause system noise. Ensure the hoses do not touch any other part of the vehicle.**
- **Loose connections may not leak, but could allow air into the steering system. Ensure all hose connections are tight.**
- **Maintain the power steering fluid level throughout the bleeding procedure.**
- **Use clean, new power steering fluid only. Refer to Fluid and Lubricant Recommendations .**
- **Introducing too much air into the power steering system will increase the amount of time required to bleed the system.**
- **DO NOT start the engine until instructed to do so.**
- **DO NOT use a hoist. Keep the rear tires on the ground.**

1. Apply the park brake.
2. Using a floor jack and jack stands, raise the front of the vehicle until the center of the front wheels are approximately 61 cm (24 in)off the ground. Refer to **Lifting and Jacking the Vehicle** .
3. Fill the power steering fluid reservoir with fluid to the bottom of the filler neck. Leave the cap off.
4. Place towels around the power steering fluid reservoir neck in order to catch any fluid flowing out of the reservoir.

NOTE: **The fluid level will rise and fall as you turn the steering wheel and you bleed air from the system. This step may take several minutes.**

5. With the key in the ON position and with the ENGINE OFF, turn the steering wheel from stop to stop until the fluid level stabilizes and there are fewer bubbles in the reservoir.
6. Ensure the fluid level is at the bottom of the filler neck.
7. Connect the **CH-43485** adapter to the **GE-23738-A** pump clear hose.
8. Hold the **CH-43485** adapter on the top of the reservoir filler neck.
9. Apply a vacuum of 68 kPa (20 in Hg, 10 psi).
10. Set the **GE-23738-A** pump down. The vacuum will hold the **CH-43485** adapter in place.

NOTE: **The vacuum gauge needle will fluctuate while the steering wheel is moving. This step may take several minutes.**

11. Maintain a vacuum of 68 kPa (20 in Hg, 10 psi)while turning the steering wheel from stop to stop. Hold the steering wheel at each steering stop until there are fewer bubbles in the **GE-23738-A** pump clear hose.
12. With the steering wheel in the straight ahead position, maintain a vacuum of 68 kPa (20 in Hg, 10 psi)for 5 minutes.
13. Inspect the condition of the fluid in the **GE-23738-A** pump clear hose. If any bubbles are in the fluid,

repeat steps 11 and 12.

14. Lower the vehicle.
15. Relieve the vacuum in the **GE-23738-A** pump.
16. Remove the **CH-43485** adapter from the reservoir filler neck.
17. Ensure the power steering fluid level is at the MAX mark on the capstick fluid level indicator.
18. With the reservoir cap off, start the engine. Slowly rotate the steering wheel from stop to stop 10 times. Hold the steering wheel at each stop for 2 seconds.
19. Verify the steering system does not shudder while turning the steering wheel. If the steering system exhibits a shudder condition, repeat steps 1 through 18.
20. Turn the engine OFF.
21. Ensure the power steering fluid level is at the MAX mark on the capstick fluid level indicator. Install the cap to the reservoir. Refer to **Checking and Adding Power Steering Fluid**.
22. Test drive the vehicle.

CHECKING AND ADDING POWER STEERING FLUID

CAUTION: **When adding fluid or making a complete fluid change, always use the proper power steering fluid. Failure to use the proper fluid will cause hose and seal damage and fluid leaks.**

1. Clean the area surrounding the reservoir cap.
2. Remove the reservoir cap.
3. Inspect the power steering pump fluid level at regular intervals. Use the appropriate procedure below.

   Add fluid when required. Refer to **Fluid and Lubricant Recommendations** .

   Fluid Is Hot

   1. Run the engine until the fluid reaches about 80Â°C (170Â°F).
   2. Turn the engine OFF.
   3. Remove the reservoir cap.
   4. Inspect the fluid level on the capstick.
   5. Ensure that the fluid level is at the HOT/FULL/MAX mark on the capstick.
4. If the fluid level is low, add power steering fluid to the proper level.
5. Install the reservoir cap.
6. When checking the fluid level after servicing the steering system, bleed the air from the system. Refer to **Power Steering System Bleeding**.

POWER STEERING SYSTEM FLUSHING

NOTE: **Do not reuse any drained power steering fluid regardless of appearance or condition.**

1. Raise the vehicle until the front wheels are off the ground. Refer to **Lifting and Jacking the Vehicle** .

2. Place a large drain pan under the vehicle in order to collect the draining fluid.
3. Remove the fluid return hose at the power steering fluid reservoir or the pump inlet connection, as applicable.
4. Plug the reservoir return hose inlet connection on the power steering fluid reservoir or the pump, as applicable.

NOTE: **This step may require 4 L (4 qt) of power steering fluid until the draining fluid appears clear.**

5. Have an assistant maintain the minimum fluid level in the reservoir using clean, new power steering fluid. Refer to **Checking and Adding Power Steering Fluid**.
6. With the key in the ON position and with the engine OFF, turn the steering wheel fully to the left and to the right. Continue until the fluid from the return hose runs clear.
7. Remove the plug and install the fluid return hose to the power steering fluid reservoir or the pump inlet connection, as applicable.
8. Bleed the power steering system. Refer to **Power Steering System Bleeding**.
9. Inspect the power steering fluid for the following indications of contamination:
    - Milky fluid - water
    - Brown fluid - burnt
    - Plastic debris or dirt chunks
10. If the fluid is contaminated, repeat steps 3-9.
11. Remove the drain pan.
12. Lower the vehicle.

POWER STEERING FLUID RESERVOIR REPLACEMENT

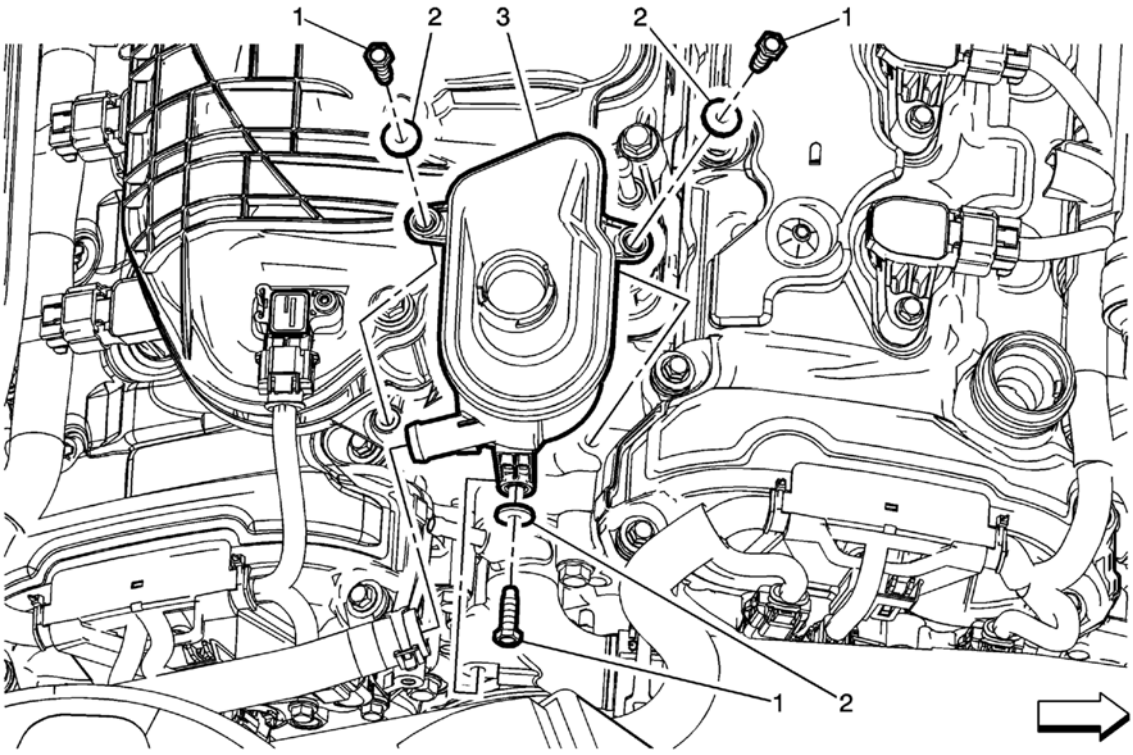


Fig. 6: Power Steering Fluid Reservoir Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Place drain pans under the vehicle. 2. Remove the intake manifold cover. Refer to **Intake Manifold Cover Replacement** . 3. Remove as much power steering fluid from the power steering fluid reservoir as possible. 4. Position the surge tank inlet hose away from the power steering fluid reservoir. Refer to **Radiator Surge Tank Inlet Hose Replacement** . 5. Disconnect the power steering fluid reservoir hose from the power steering fluid reservoir.	
1	Power Steering Fluid Reservoir Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 6 N.m (53 lb in)
2	Power Steering Fluid Reservoir Washer (Qty: 3)

Callout	Component Name
3	Power Steering Fluid Reservoir **Procedure** 1. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**. 2. Clean any excess power steering fluid from the vehicle. 3. Remove the drain pans.

POWER STEERING PUMP PULLEY REPLACEMENT

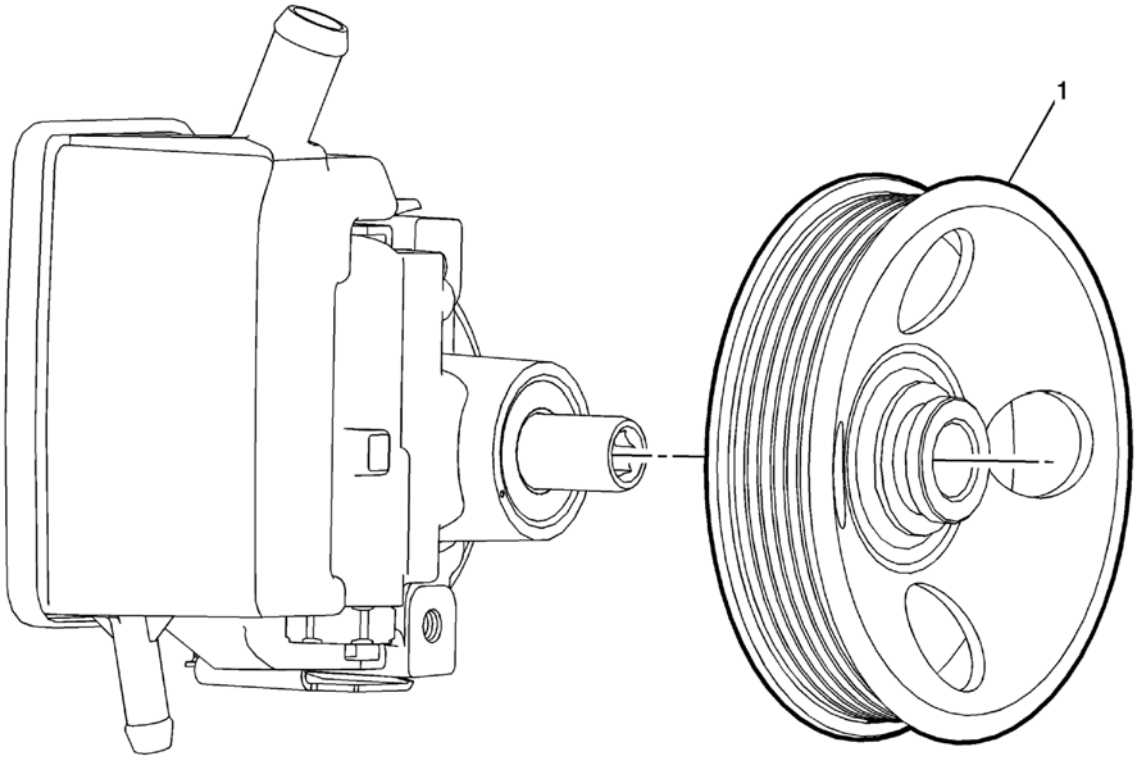


Fig. 7: Power Steering Pump Pulley Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the power steering pump. Refer to **Power Steering Pump Replacement**.	
1	Power Steering Pump Pulley **Procedure** 1. Use the **J-25034-C** Remover in order to remove the power steering pump pulley. 2. Use the **J-25033-C** Installer in order to install the power steering pump pulley. 3. Ensure the axial tolerance of the power steering pump pulley on the shaft is within 0.25 mm (0.010 in).

Callout	Component Name
	Special Tools • **J-25033-C** Pulley Installer • **J-25034-C** Pulley Remover For equivalent regional tools, refer to **Special Tools**.

POWER STEERING PUMP REPLACEMENT

Removal Procedure

1. Place drain pans under the vehicle.
2. Remove as much power steering fluid from the reservoir as possible.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the right front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
5. Disconnect the drive belt from the power steering pump pulley only. Refer to **Drive Belt Replacement** .
6. Disconnect the power steering gear inlet hose from the power steering pump. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.

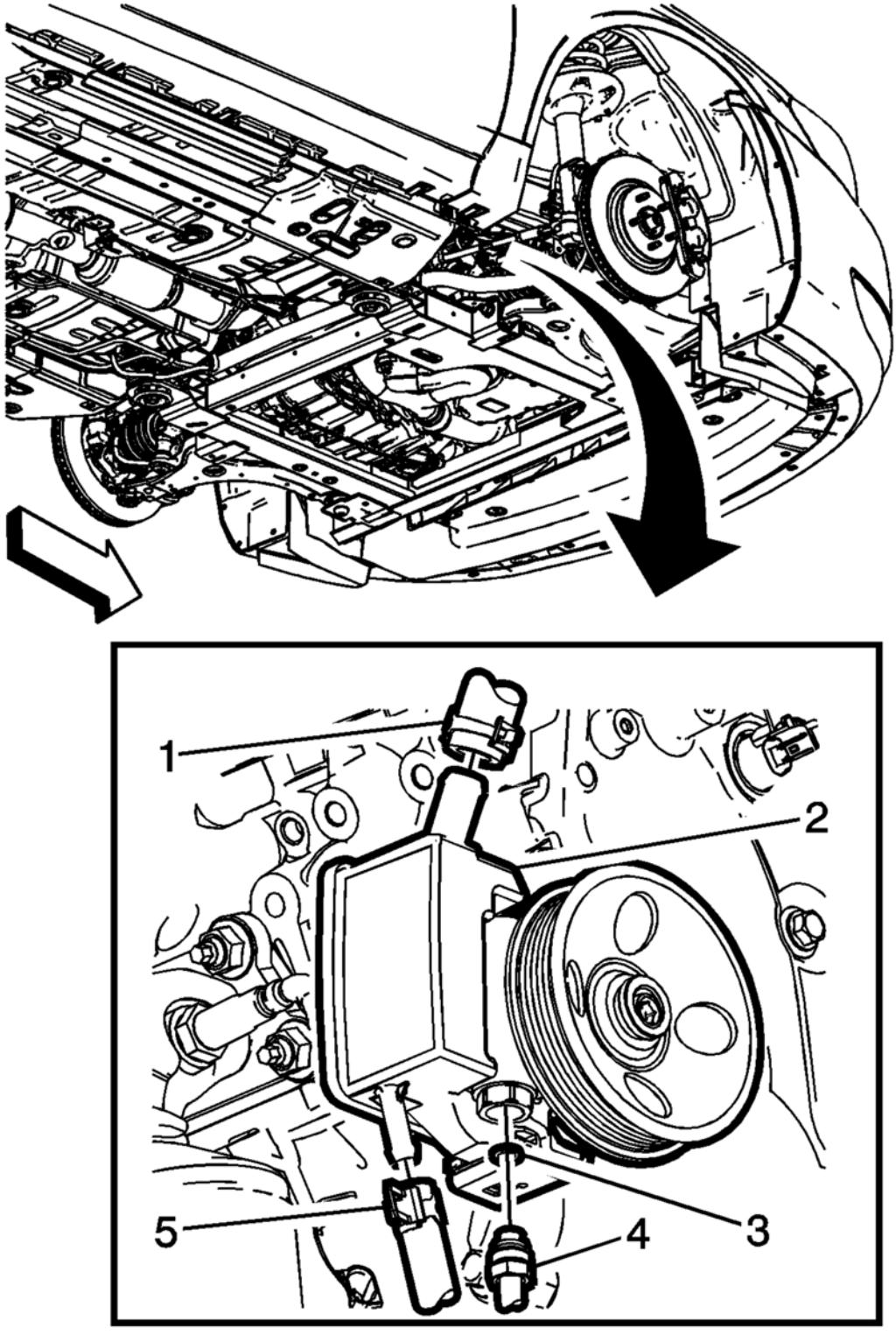


Fig. 8: Power Steering Pump Components
Courtesy of GENERAL MOTORS COMPANY

7. Remove the steering gear inlet hose O-ring seal (3).

   Discard the seal.

8. Disconnect the power steering fluid cooling pipe (5) from the power steering pump (2).
9. Disconnect the power steering fluid reservoir hose (1) from the power steering pump.

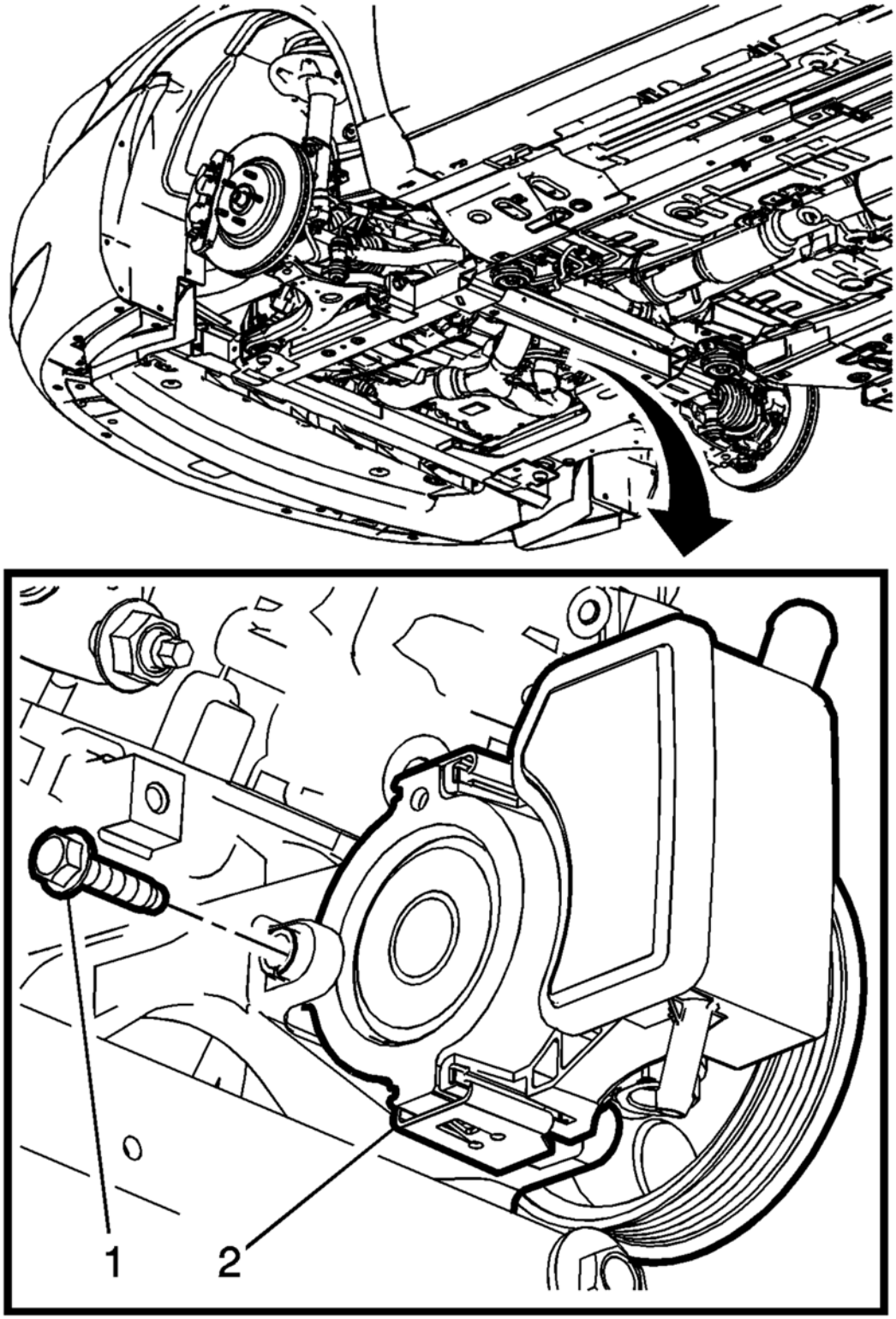


Fig. 9: Power Steering Pump And Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Remove the bolt (1) from the left side of the power steering pump (2).

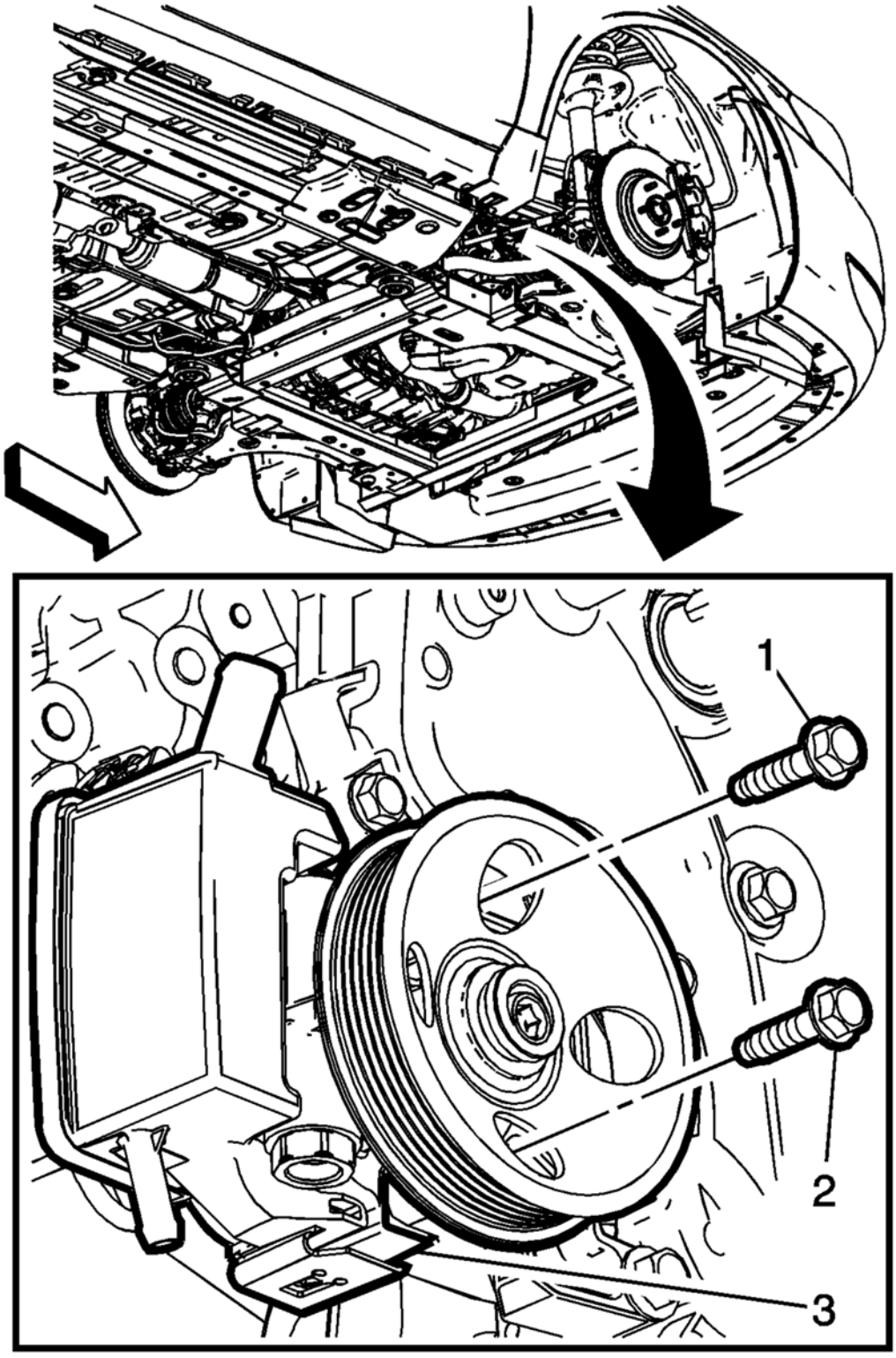


Fig. 10: Power Steering Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The right side power steering pump bolts go through the holes in the right side of the bracket and fasten to the holes in the pump.**

11. Remove the 2 bolts (1, 2) from the right side of the power steering pump (3).

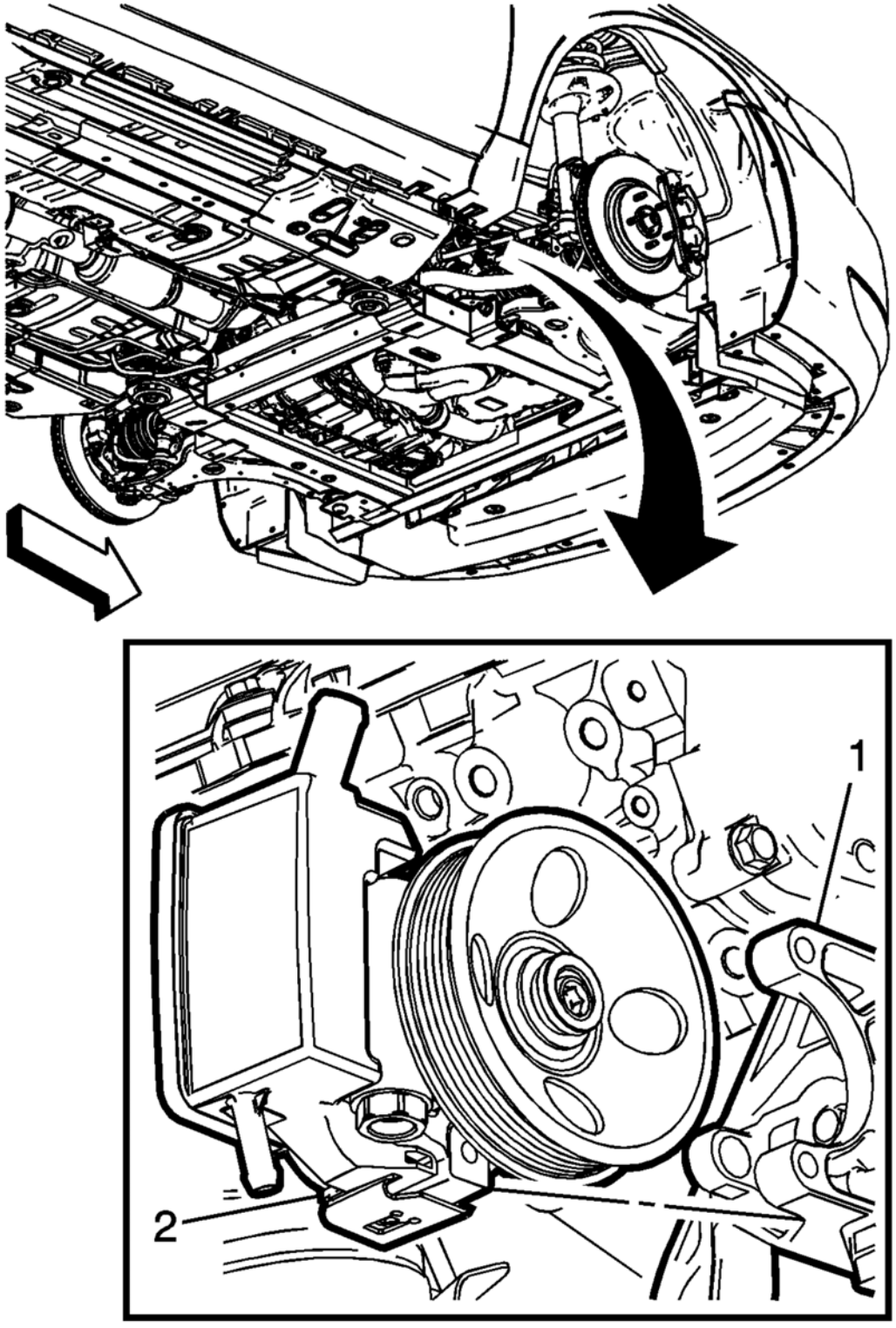


Fig. 11: Power Steering Pump
Courtesy of GENERAL MOTORS COMPANY

12. Remove the power steering pump (2) through the right wheel opening.
13. Transfer components as necessary.

Installation Procedure

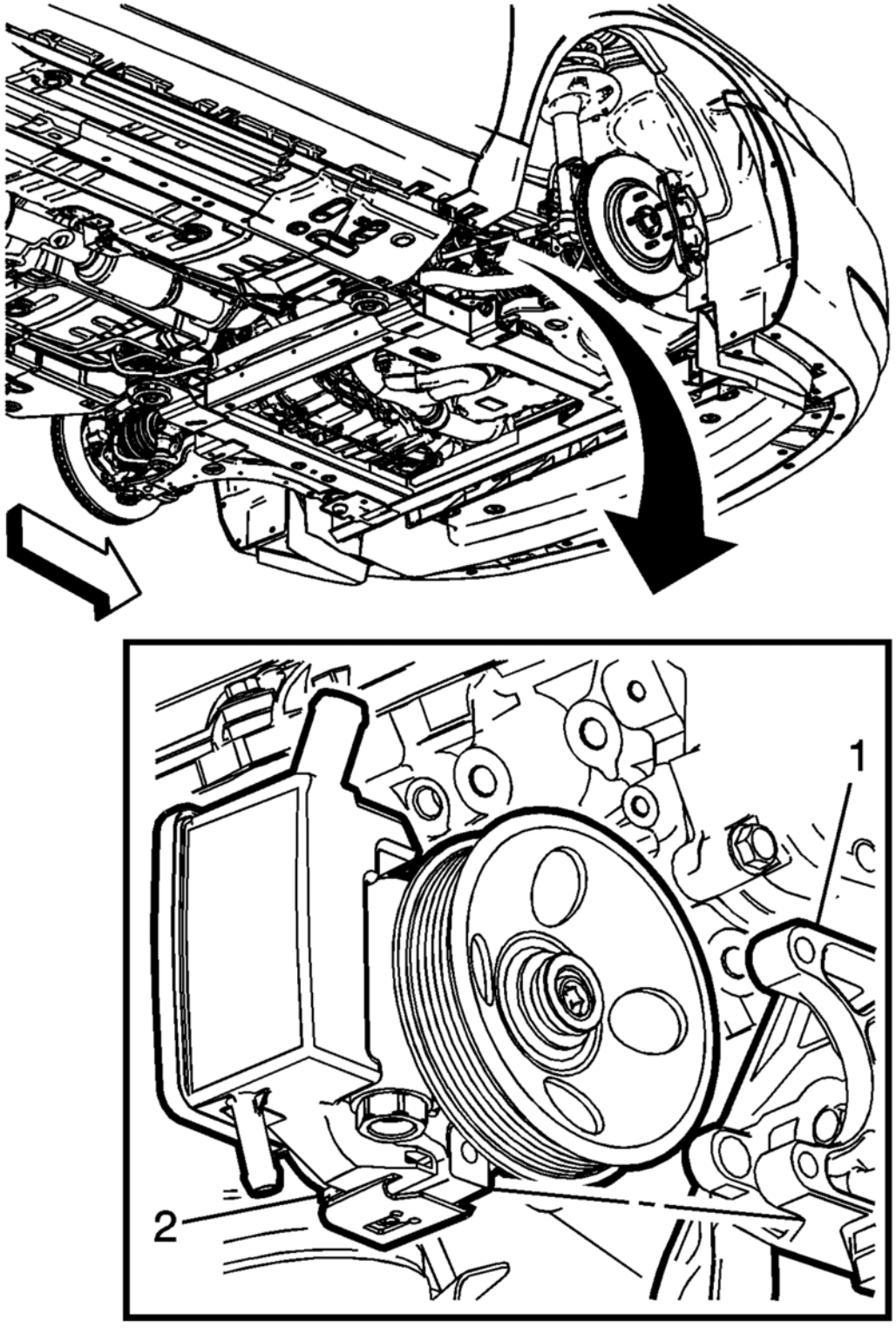


Fig. 12: Power Steering Pump
Courtesy of GENERAL MOTORS COMPANY

1. Position the power steering pump (2) in the vehicle through the right wheel opening.
2. Align the bolt holes in the power steering pump with the bolt holes in the bracket (1).

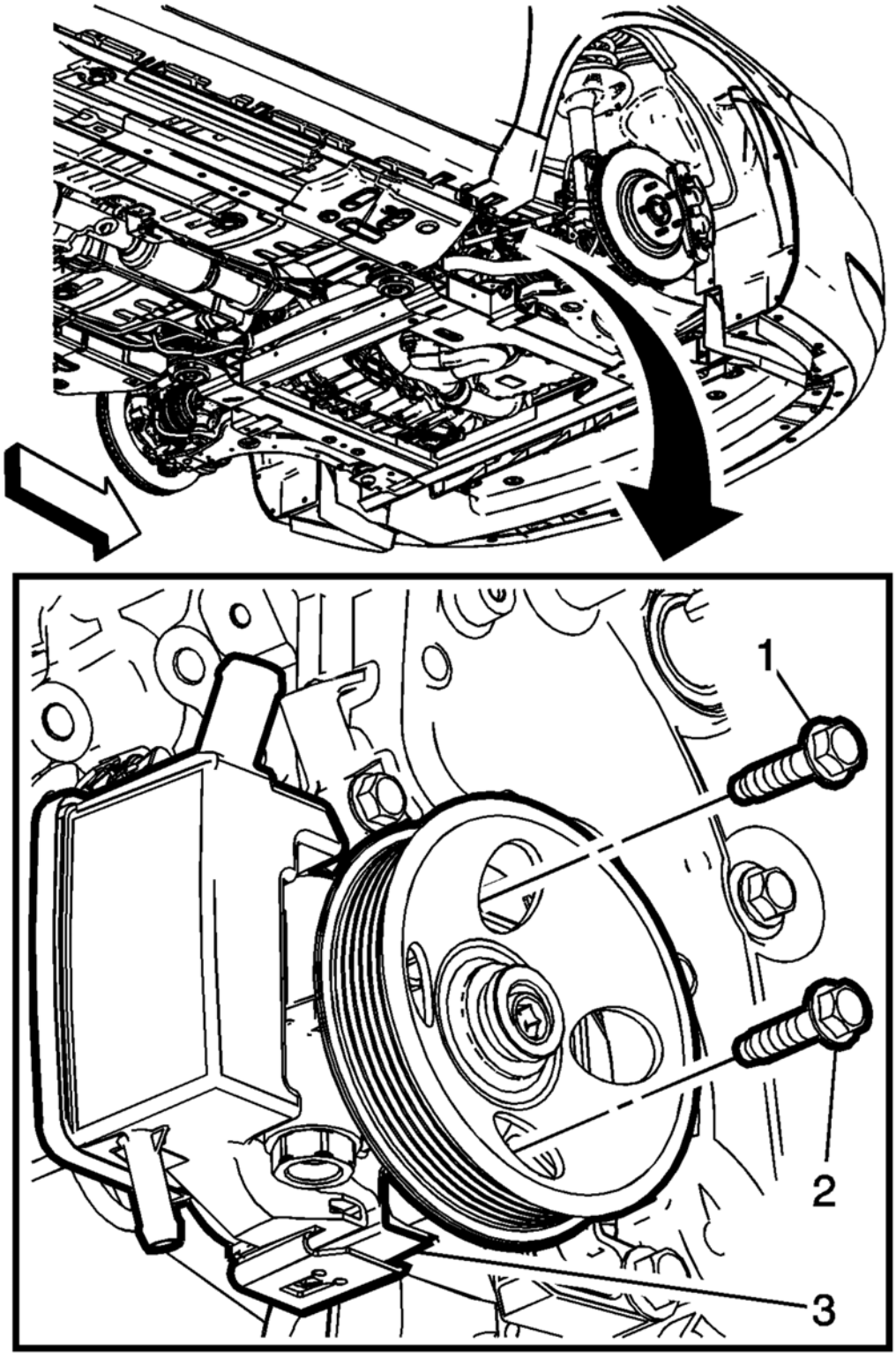


Fig. 13: Power Steering Pump And Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the 2 bolts (1, 2) to the right side of the power steering pump (3) and tighten to 22 N.m (16 lb ft).

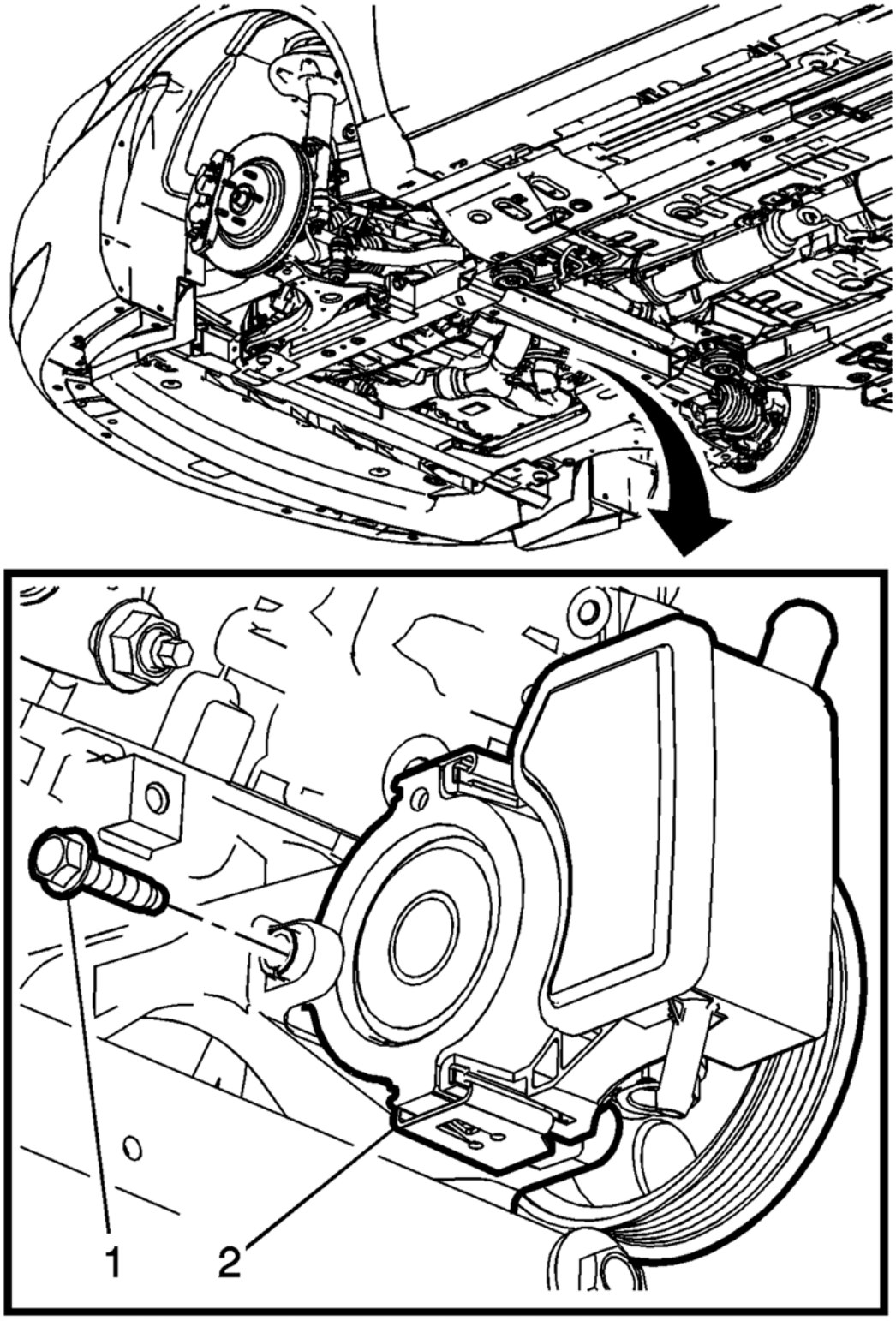


Fig. 14: Power Steering Pump And Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the bolt (1) to the left side of the power steering pump (2) and tighten to 22 N.m (16 lb ft).

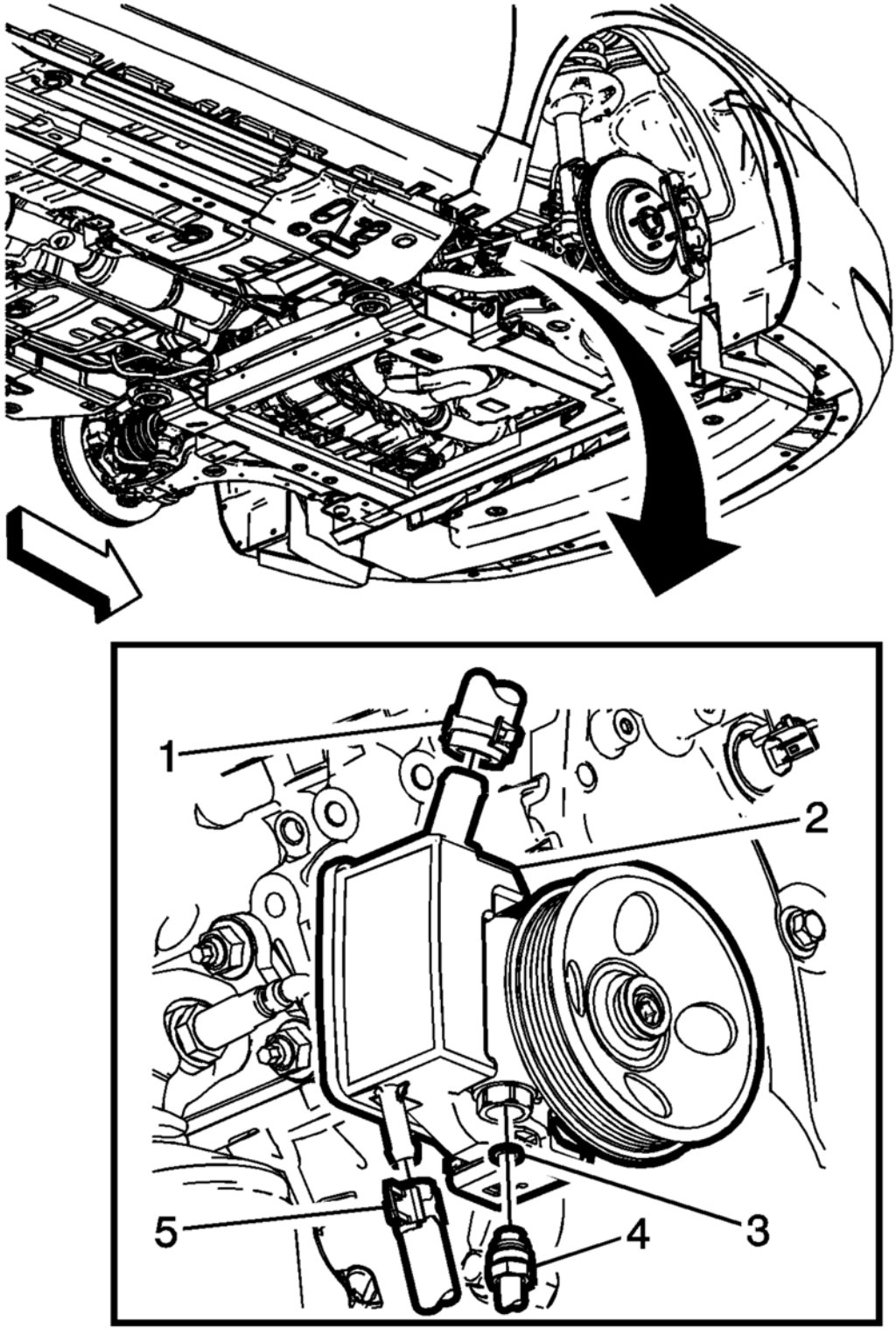


Fig. 15: Power Steering Pump Components
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Installing Hoses without Twists or Bends Caution .

5. Connect the power steering fluid reservoir hose (1) to the power steering pump (2).
6. Connect the power steering fluid cooling pipe (5) to the power steering pump.

7. Install a NEW power steering gear inlet hose O-ring seal (3).
8. Connect the power steering gear inlet hose to the steering gear. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
9. Connect the drive belt to the power steering pump pulley. Refer to **Drive Belt Replacement** .
10. Install the right front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
11. Lower the vehicle.
12. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
13. Clean any excess power steering fluid from the vehicle.
14. Remove the drain pans.

POWER STEERING FLUID RESERVOIR REPLACEMENT - OFF VEHICLE

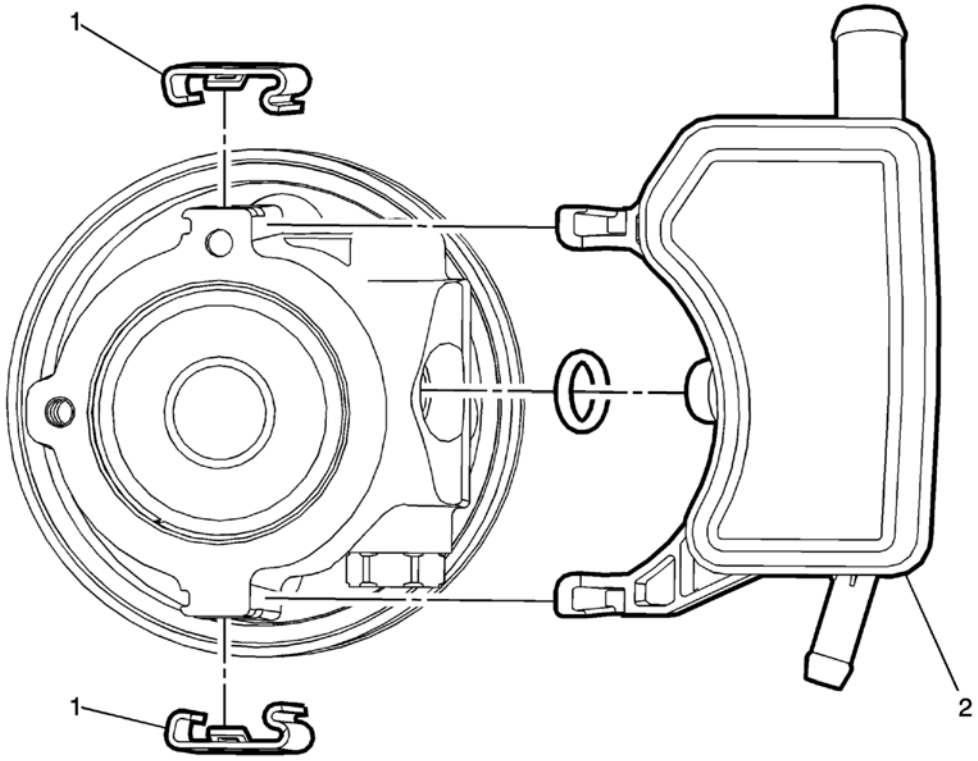


Fig. 16: Power Steering Fluid Reservoir & Clips
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the power steering pump and the lower reservoir as an assembly. Refer to **Power Steering Pump Replacement**.	
1	Power Steering Fluid Reservoir Clip (Qty: 2)
2	Power Steering Fluid Reservoir **Procedure** Install a NEW power steering pump seal.

STEERING LINKAGE OUTER TIE ROD REPLACEMENT

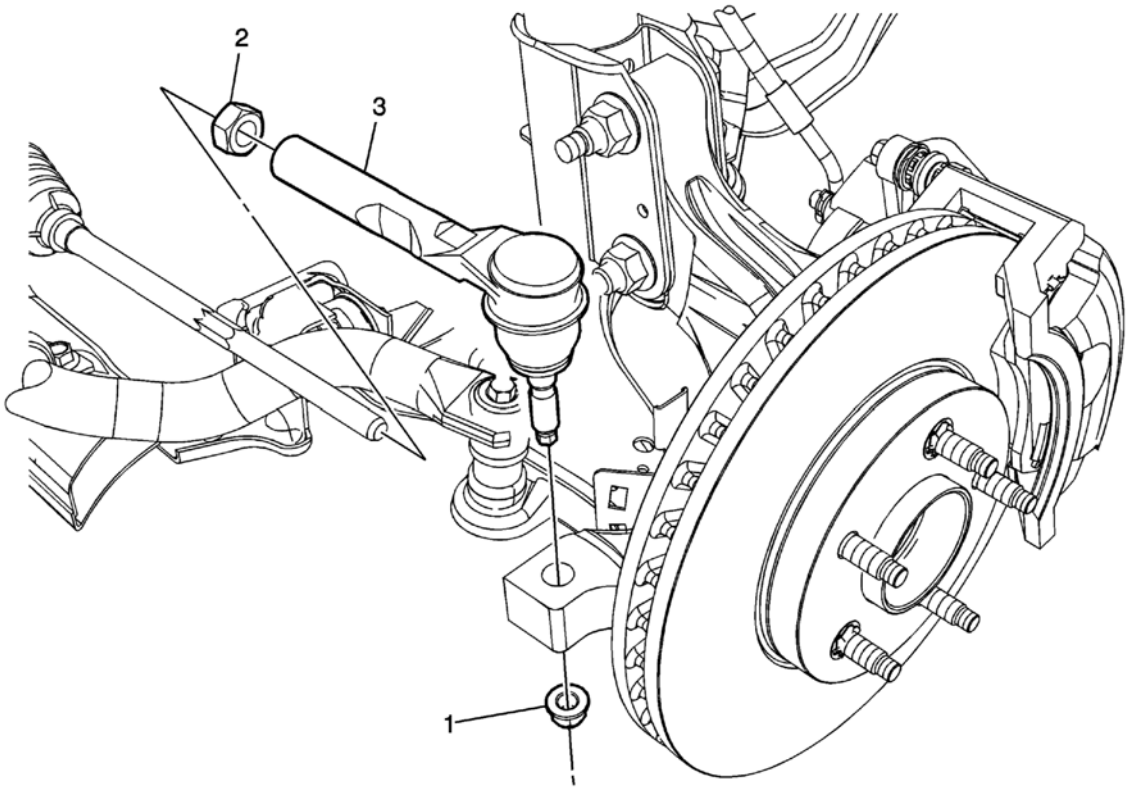


Fig. 17: View Of Rack and Pinion Outer Tie Rod End
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the front tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .	
1	Steering Linkage Outer Tie Rod Nut **CAUTION:** **Refer to Fastener Caution .** **CAUTION:** **This vehicle is equipped with torque-to-yield or single use fasteners. Install a NEW torque-to-yield or**

Callout	Component Name
	single use fastener when installing this component. Failure to replace the torque-to-yield or single use fastener could cause damage to the vehicle or component. **Procedure** 1. Remove the steering linkage outer tie rod nut. Discard the nut. 2. Install a NEW steering linkage outer tie rod nut. Ensure that 2 1/2 to 4 1/2 threads are visible past the nylon washer. **Tighten** 1. 30 N.m (22 lb ft) 2. 120 degrees
2	Steering Linkage Inner Tie Rod Nut **Procedure** 1. Use paint in order to place match marks on the steering linkage inner tie rod nut and on the steering linkage inner tie rod. 2. During installation, align the match marks. 3. Do not tighten the nut during installation. Tighten the nut after adjusting the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .
3	Steering Linkage Outer Tie Rod **CAUTION:**

Callout	Component Name
	Do not free the ball stud by using a pickle fork or a wedge-type tool. Damage to the seal or bushing may result. **Procedure** 1. Use the **J-24319-B** puller in order to disconnect the steering linkage outer tie rod from the steering knuckle. 2. After the installation is complete, measure and adjust the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** . **Special Tools** **J-24319-B** Steering Linkage and Tie Rod Puller For equivalent regional tools, refer to **Special Tools**.

STEERING GEAR BOOT REPLACEMENT

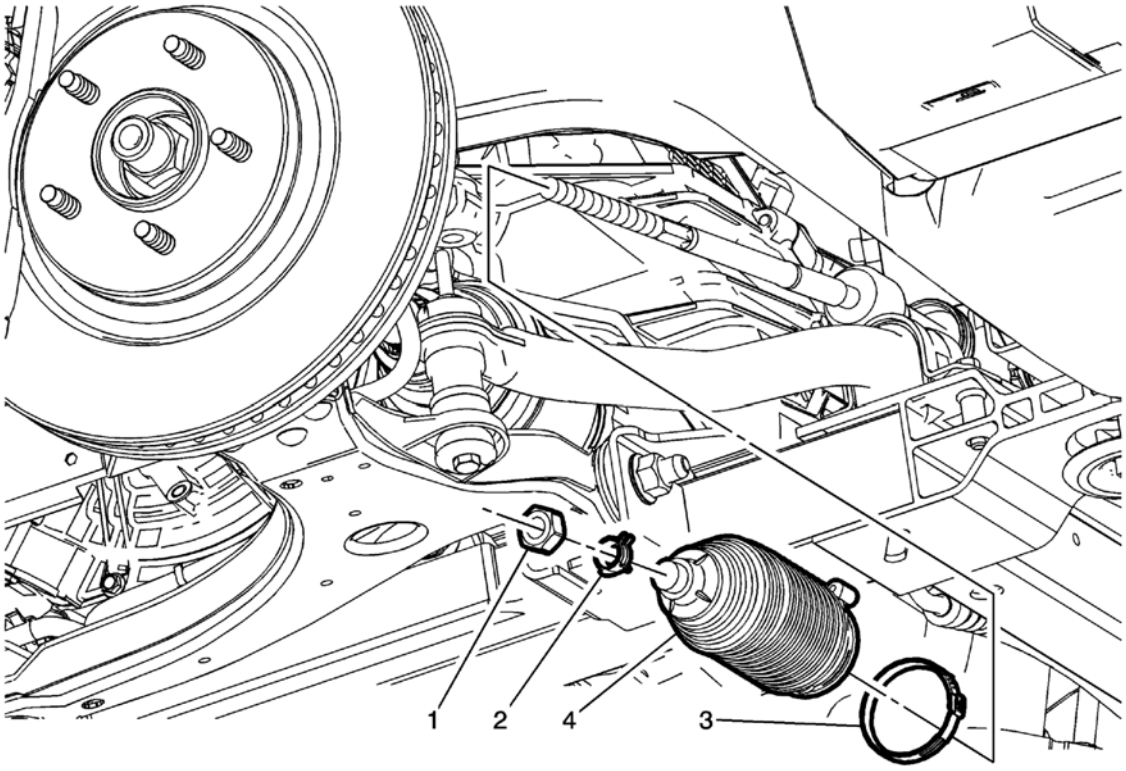


Fig. 18: Steering Gear Boot Components

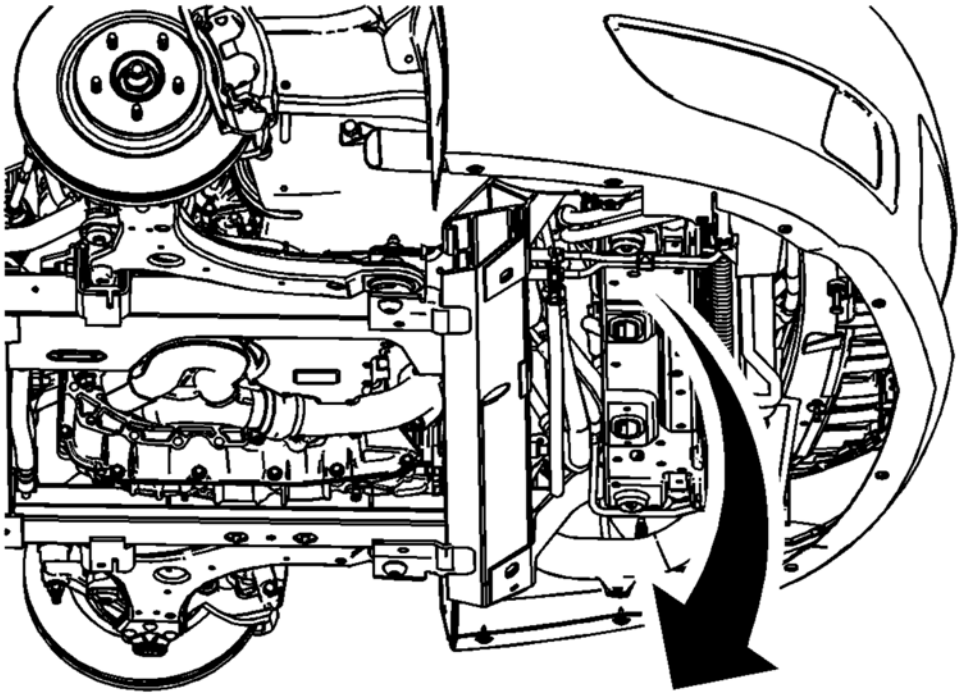
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the steering linkage outer tie rod. Refer to **Steering Linkage Outer Tie Rod Replacement**.	
1	Steering Linkage Inner Tie Rod Nut **Procedure** 1. Use paint in order to place match marks on the steering linkage inner tie rod nut and on the steering linkage inner tie rod. 2. During installation, align the match marks. 3. Do not tighten the nut during installation. Tighten the nut after adjusting the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment**
2	Steering Gear Boot Outer Clamp
3	Steering Gear Boot Inner Clamp **Procedure** 1. Cut the old steering gear boot inner clamp. Discard the clamp. 2. Use the **J-22610** pliers in order to crimp the new steering gear inner boot clamp. **Special Tools** **J-22610** Keystone Clamp Pliers For equivalent regional tools, refer to **Special Tools**.
4	Steering Gear Boot **Procedure** 1. After removing the boot, inspect the inner tie rod for evidence of corrosion or contamination. If none is evident, continue with the repair. If corrosion or contamination is evident, replace the steering gear. Refer to **Steering Gear Replacement**. 2. Ensure the new steering gear boot is seated in the assembly groove of the steering gear.

POWER STEERING FLUID COOLING PIPE REPLACEMENT

Removal Procedure

1. Place drain pans under the vehicle.
2. Remove as much power steering fluid from the reservoir as possible.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
5. Remove the right side engine splash shield. Refer to **Engine Splash Shield Replacement (Right)** .



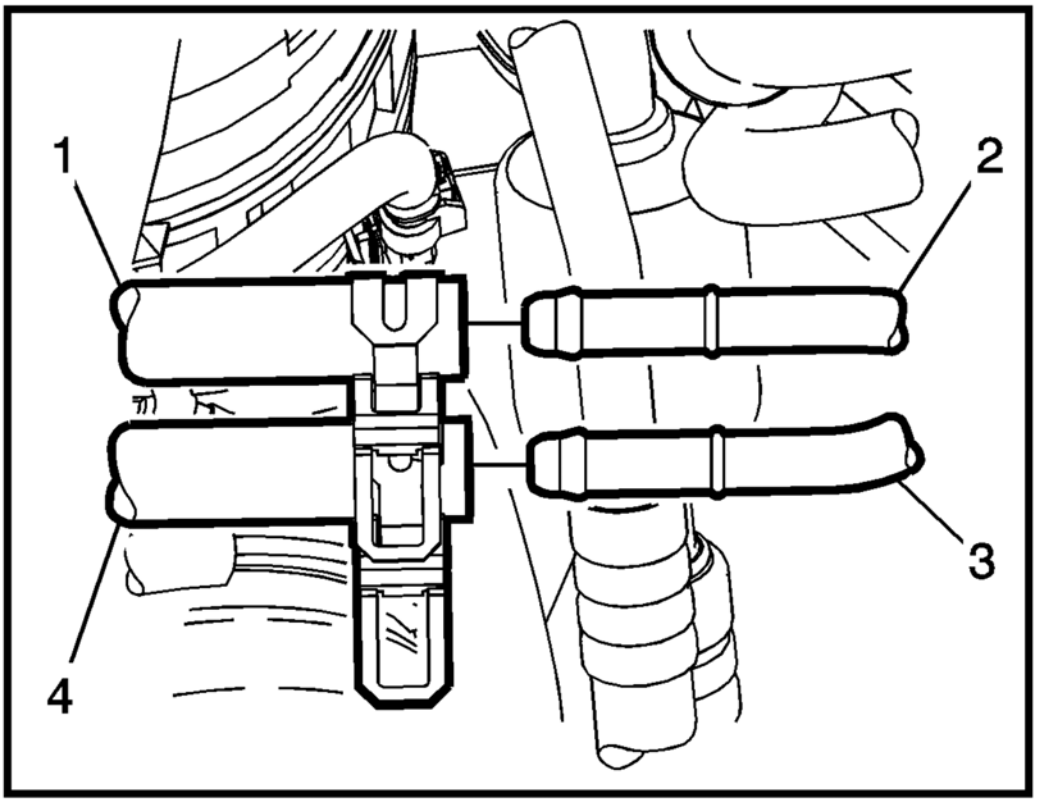


Fig. 19: Power Steering Fluid Cooler And Pipe
Courtesy of GENERAL MOTORS COMPANY

6. Loosen the 2 hose clamps and disconnect the power steering fluid cooling pipe (1, 4) from the power steering fluid cooler (2, 3).
7. On the right side of the frame, disconnect the wire harness retainers and position the wire harness out of the way in order to access the power steering fluid cooling pipe.

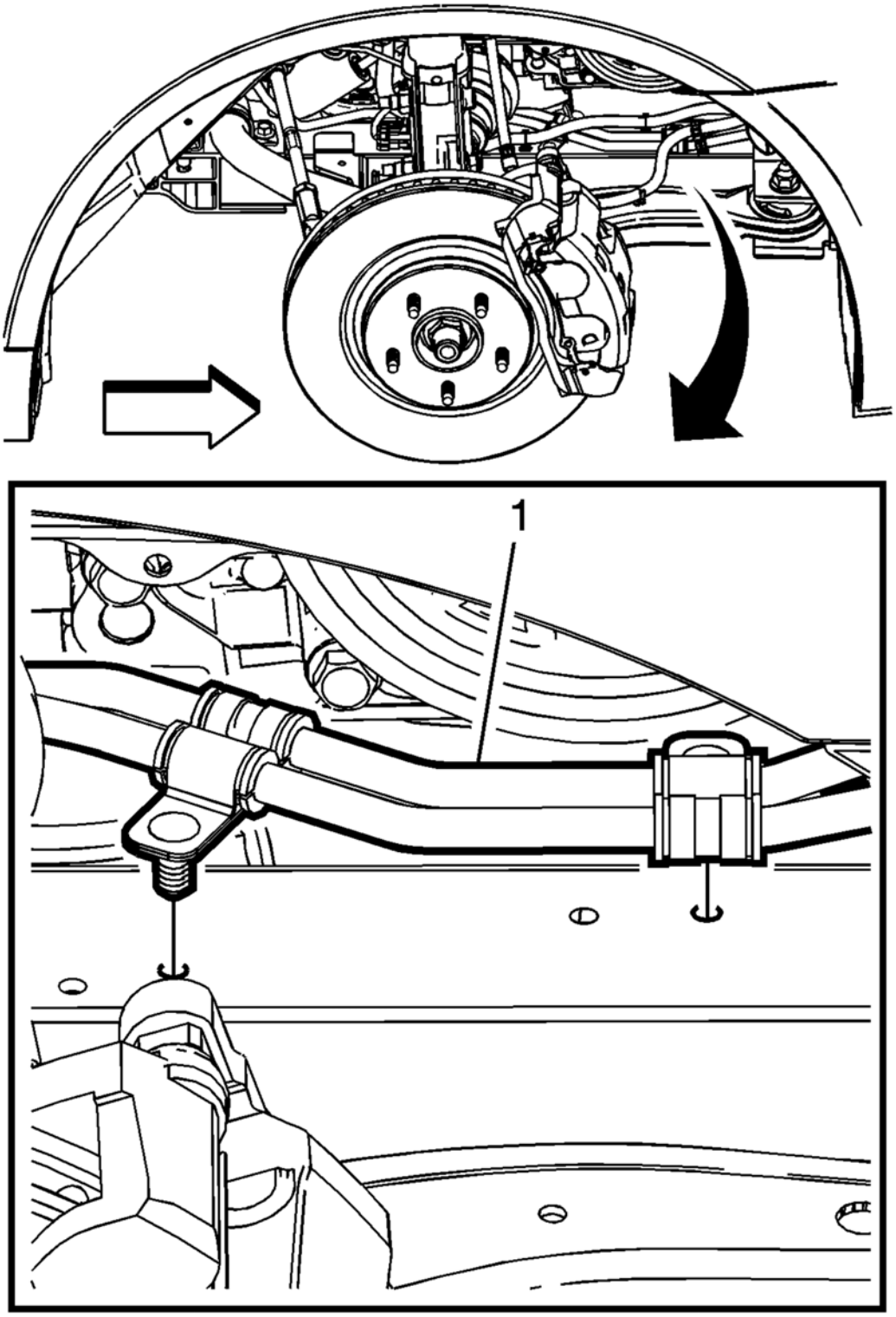
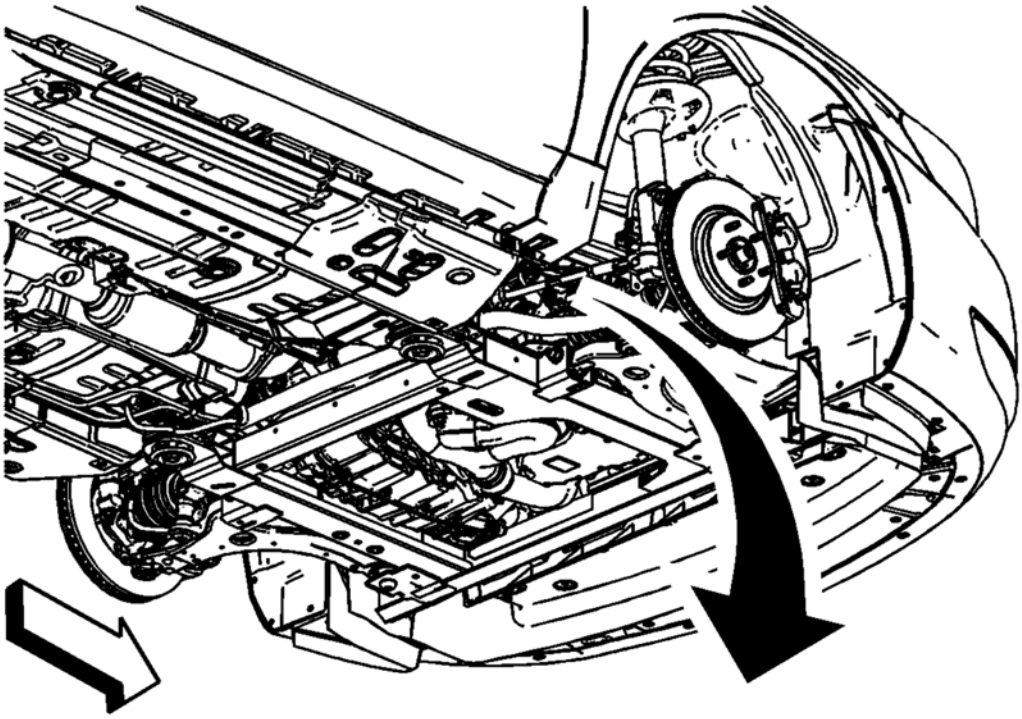


Fig. 20: Power Steering Fluid Cooling Pipe
Courtesy of GENERAL MOTORS COMPANY

8. On the right side of the frame, disconnect the 2 retainers and the power steering fluid cooling pipe (1) from the frame.



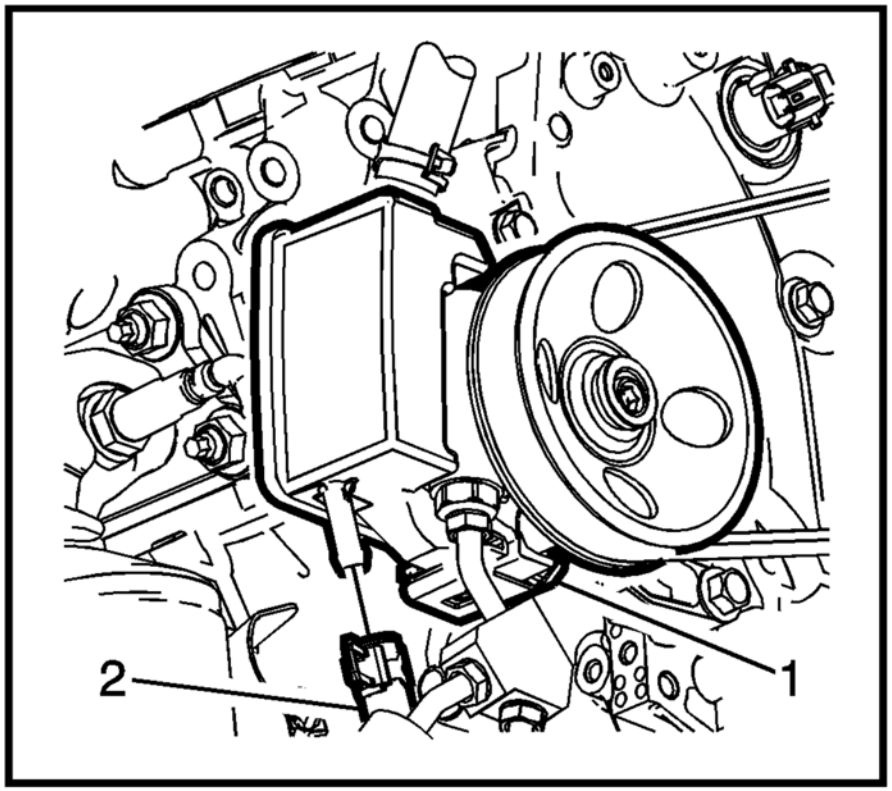


Fig. 21: Power Steering Pump And Power Steering Fluid Cooling Pipe

Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the power steering fluid cooling pipe (2) from the lower power steering fluid reservoir, which is on the power steering pump (1).
10. Disconnect the power steering gear inlet hose from the steering gear. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
11. Position the power steering gear inlet hose out of the way in order to access the power steering fluid cooling pipe on the steering gear.

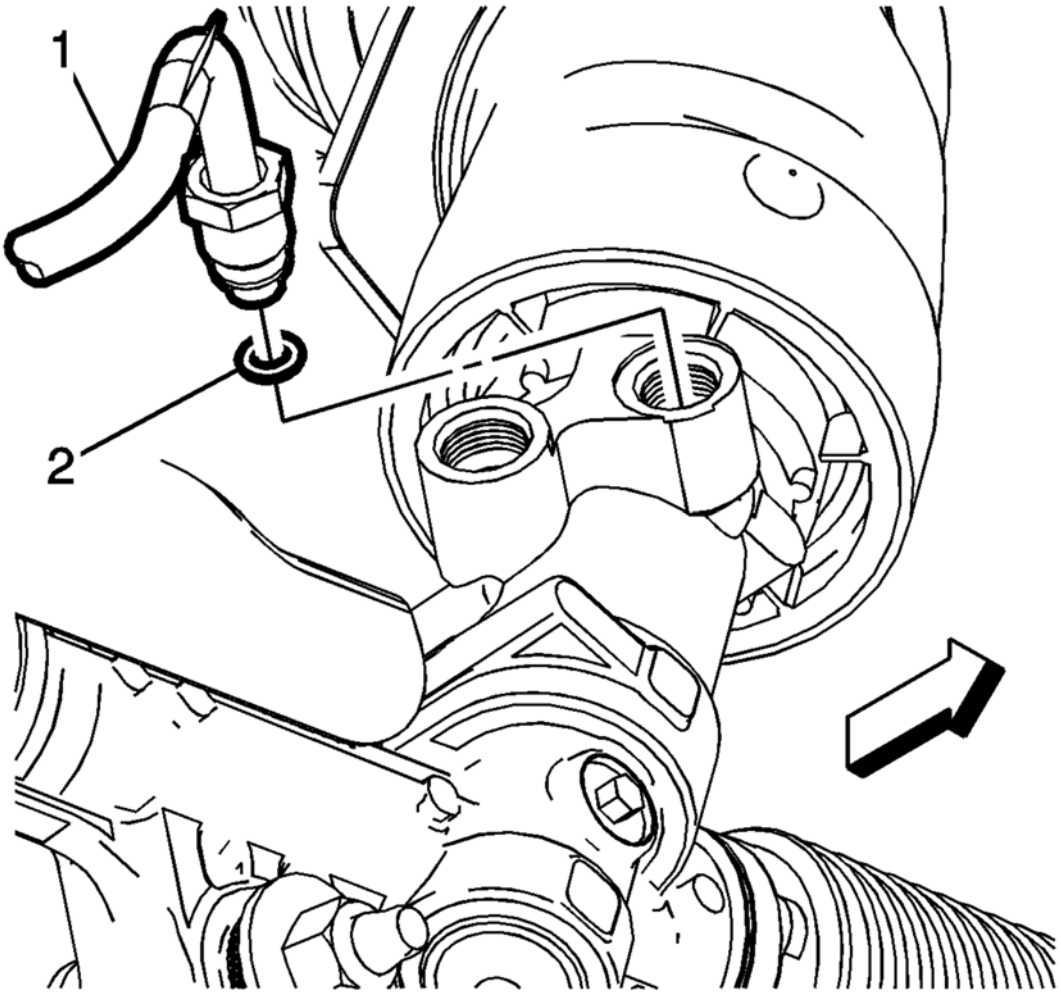


Fig. 22: Power Steering Fluid Cooling Pipe And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

12. Disconnect the power steering fluid cooling pipe (1) from the steering gear.
13. Remove the power steering fluid cooling pipe O-ring seal (2).

    Discard the seal.

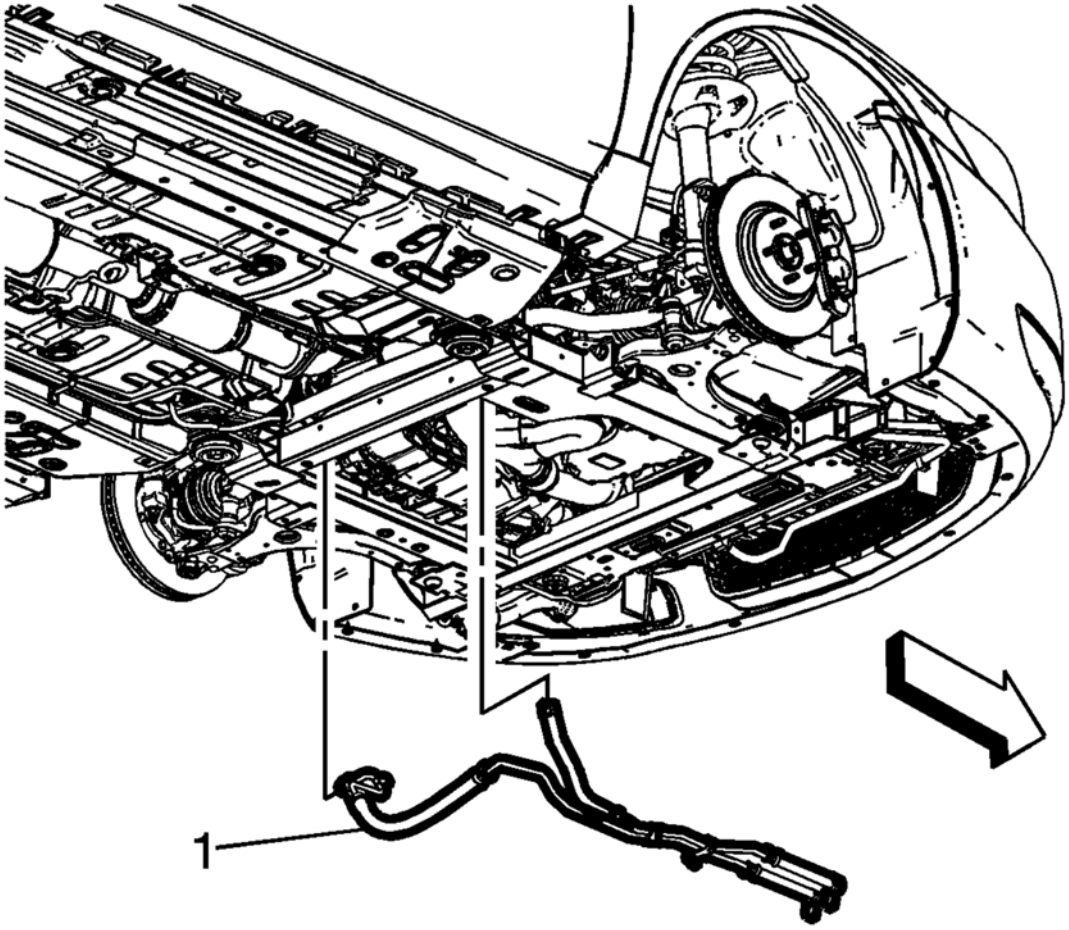


Fig. 23: Power Steering Fluid Cooling Pipe
Courtesy of GENERAL MOTORS COMPANY

14. Remove the power steering fluid cooling pipe (1) from the vehicle.

Installation Procedure

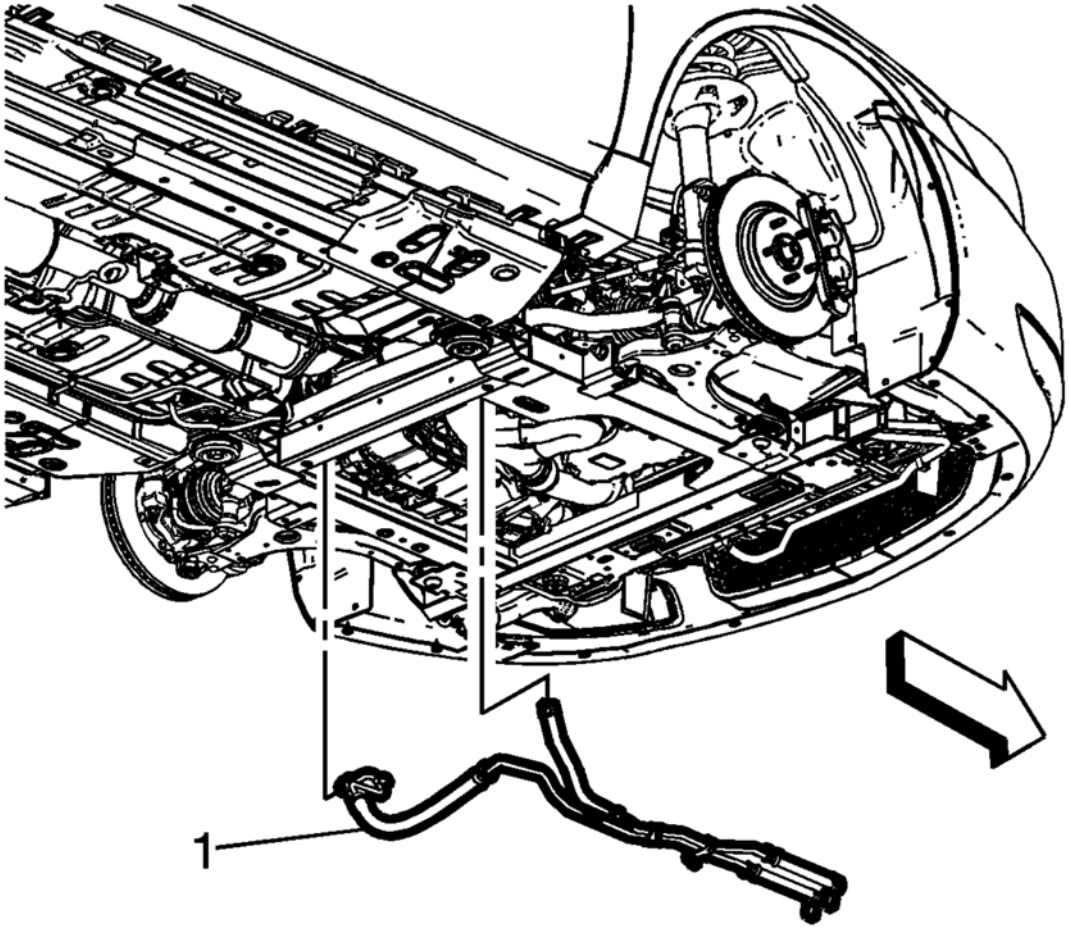


Fig. 24: Power Steering Fluid Cooling Pipe
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Installing Hoses without Twists or Bends Caution .

1. Position the power steering fluid cooling pipe (1) in the vehicle.

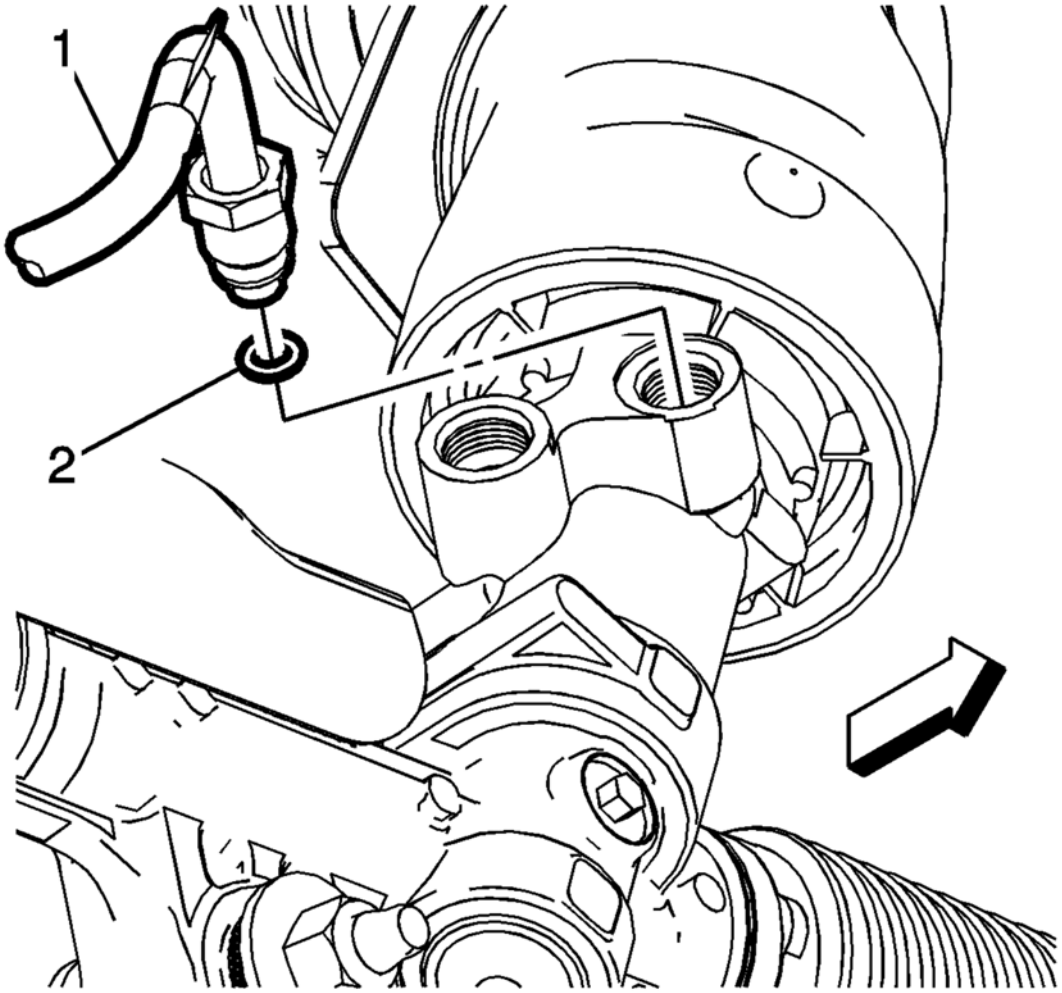


Fig. 25: Power Steering Fluid Cooling Pipe And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW power steering fluid cooling pipe O-ring seal (2).

CAUTION: Refer to Fastener Caution .

3. Connect the power steering fluid cooling pipe (1) to the steering gear. Tighten the fitting to 34 N.m (25 lb ft).
4. Connect the power steering gear inlet hose to the steering gear. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.

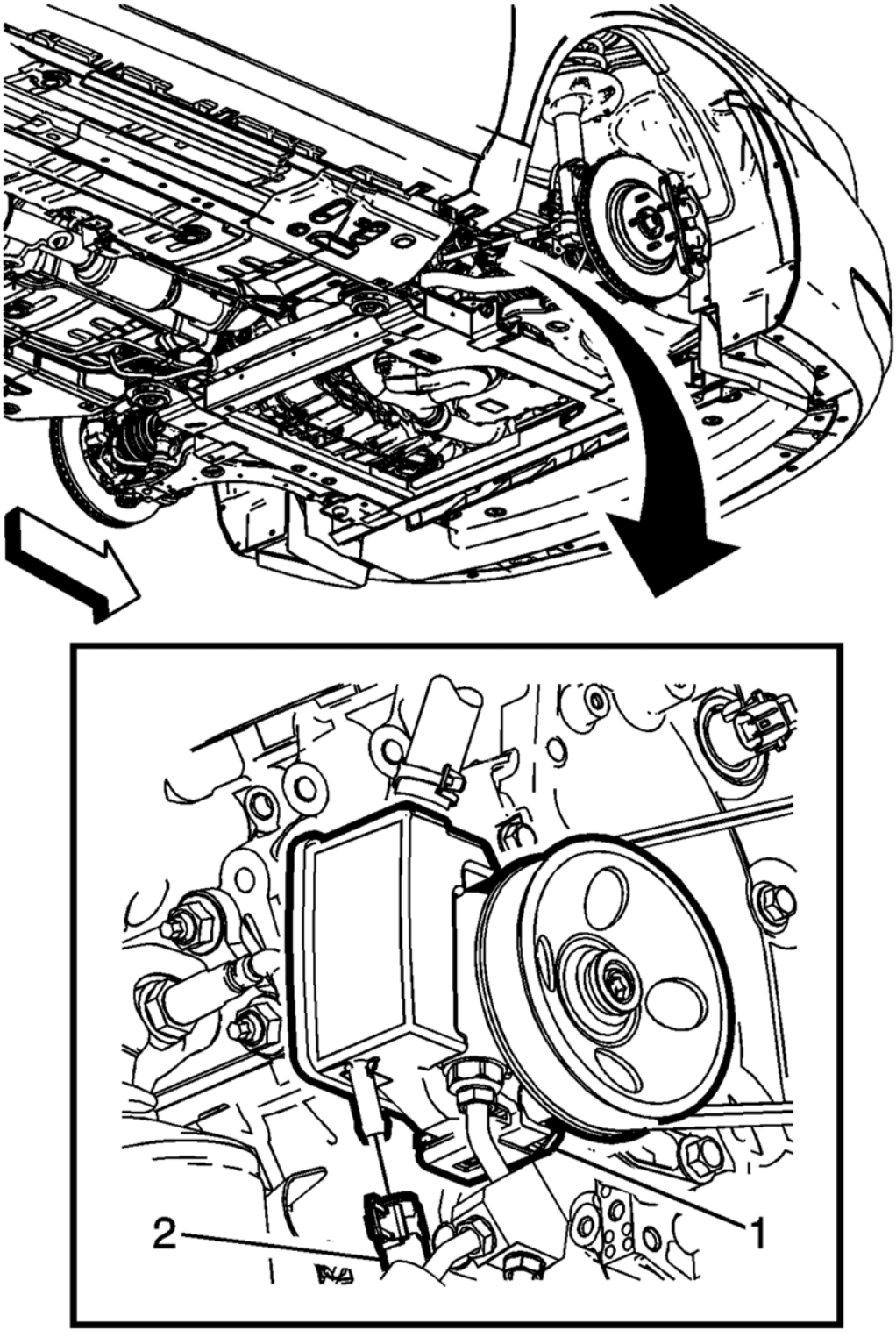


Fig. 26: Power Steering Pump And Power Steering Fluid Cooling Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Connect the power steering fluid cooling pipe (2) to the lower power steering fluid reservoir, which is on the power steering pump (1). Secure the pipe with the hose clamp.

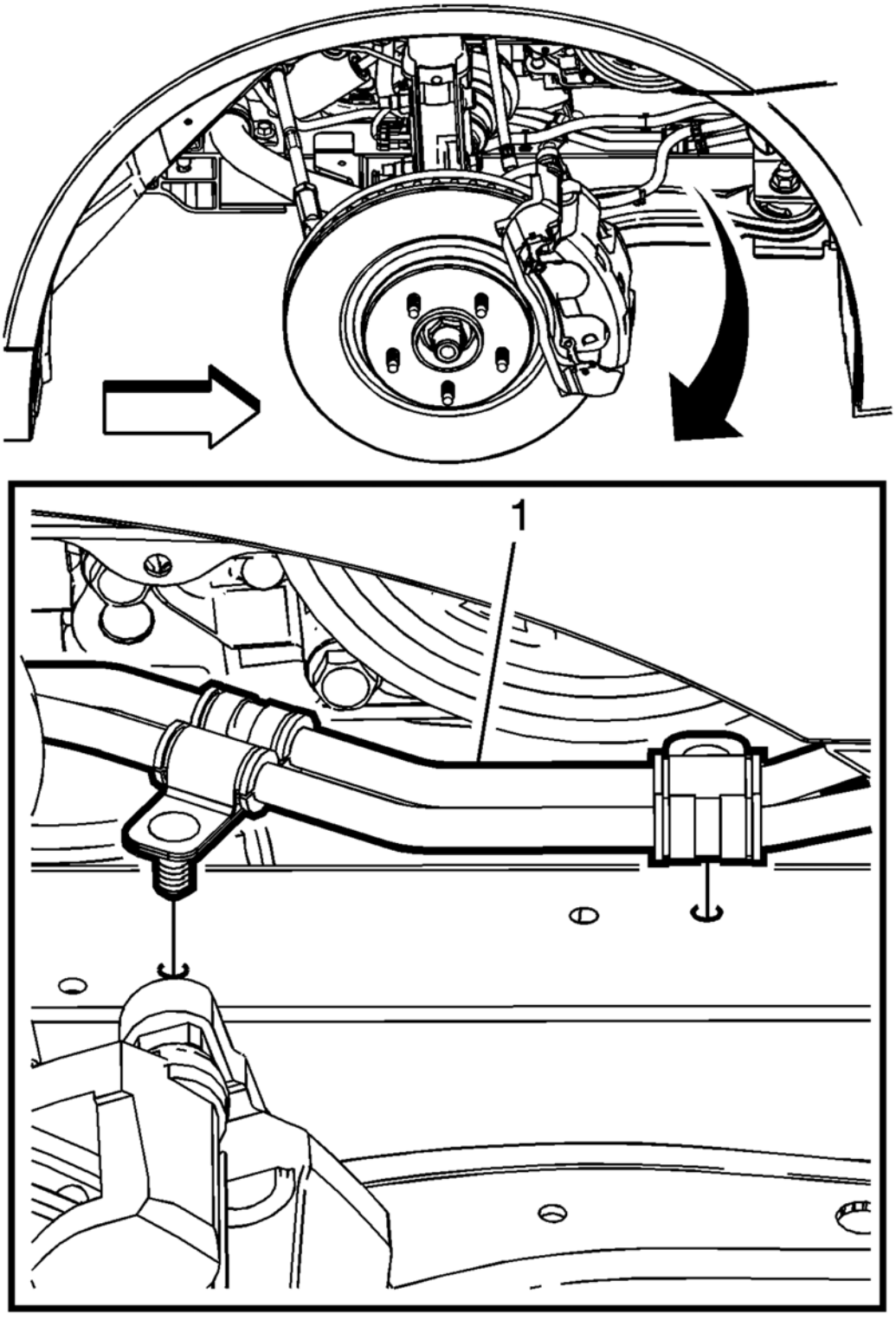


Fig. 27: Power Steering Fluid Cooling Pipe
Courtesy of GENERAL MOTORS COMPANY

6. On the right side of the frame, connect the 2 retainers and the power steering fluid cooling pipe (1) to the frame.
7. On the right side of the frame, connect the wire harness retainers.

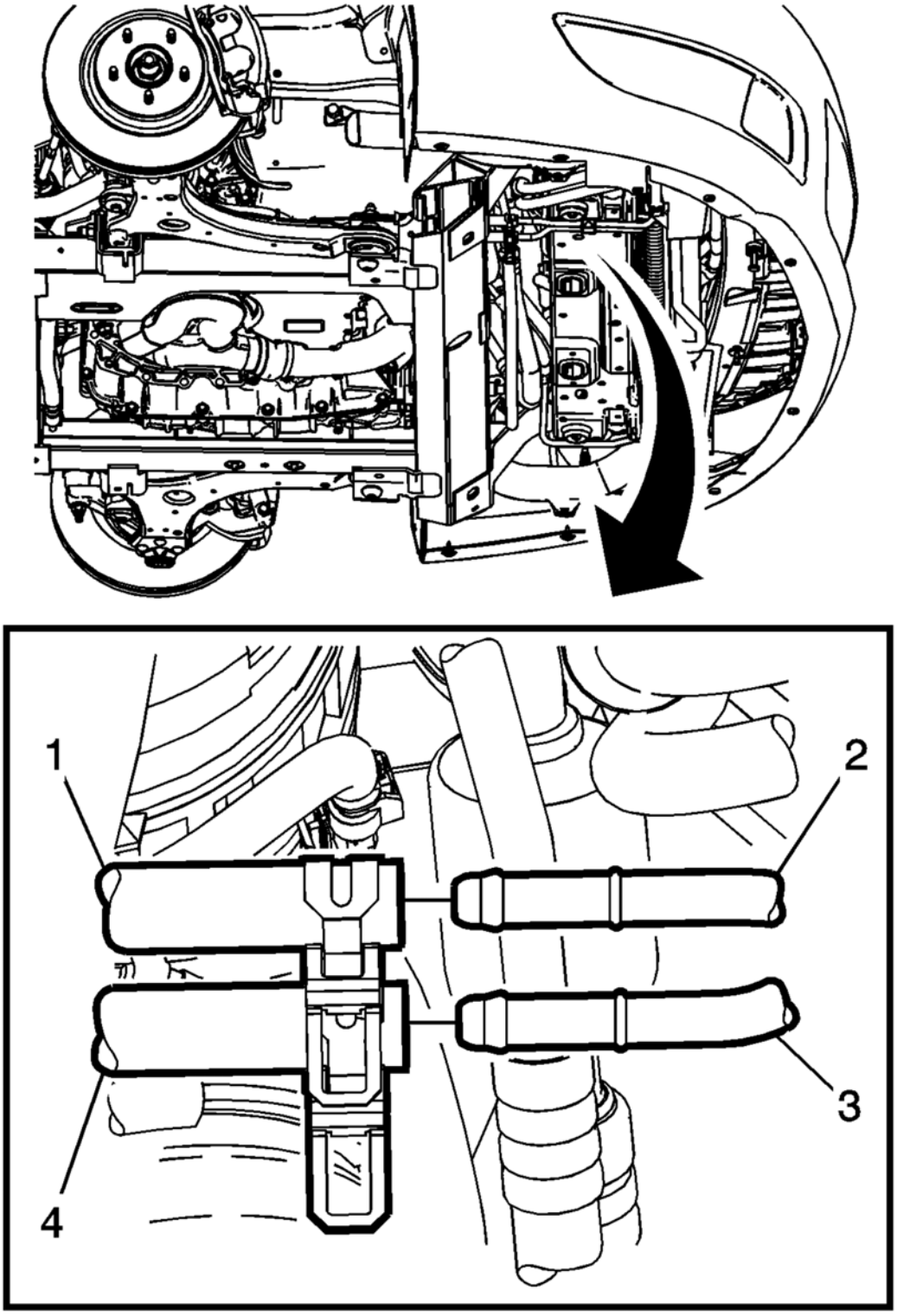


Fig. 28: Power Steering Fluid Cooler And Pipe
Courtesy of GENERAL MOTORS COMPANY

8. Connect the power steering fluid cooling pipe (1, 4) to the power steering fluid cooler (2, 3). Secure the pipe with the 2 hose clamps.
9. Install the right side engine splash shield. Refer to **Engine Splash Shield Replacement (Right)** .

10. Install the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
11. Lower the vehicle.
12. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
13. Clean any excess power steering fluid from the vehicle.
14. Remove the drain pans.

POWER STEERING FLUID COOLER REPLACEMENT

Removal Procedure

1. Place drain pans under the vehicle.
2. Remove as much power steering fluid from the reservoir as possible.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .

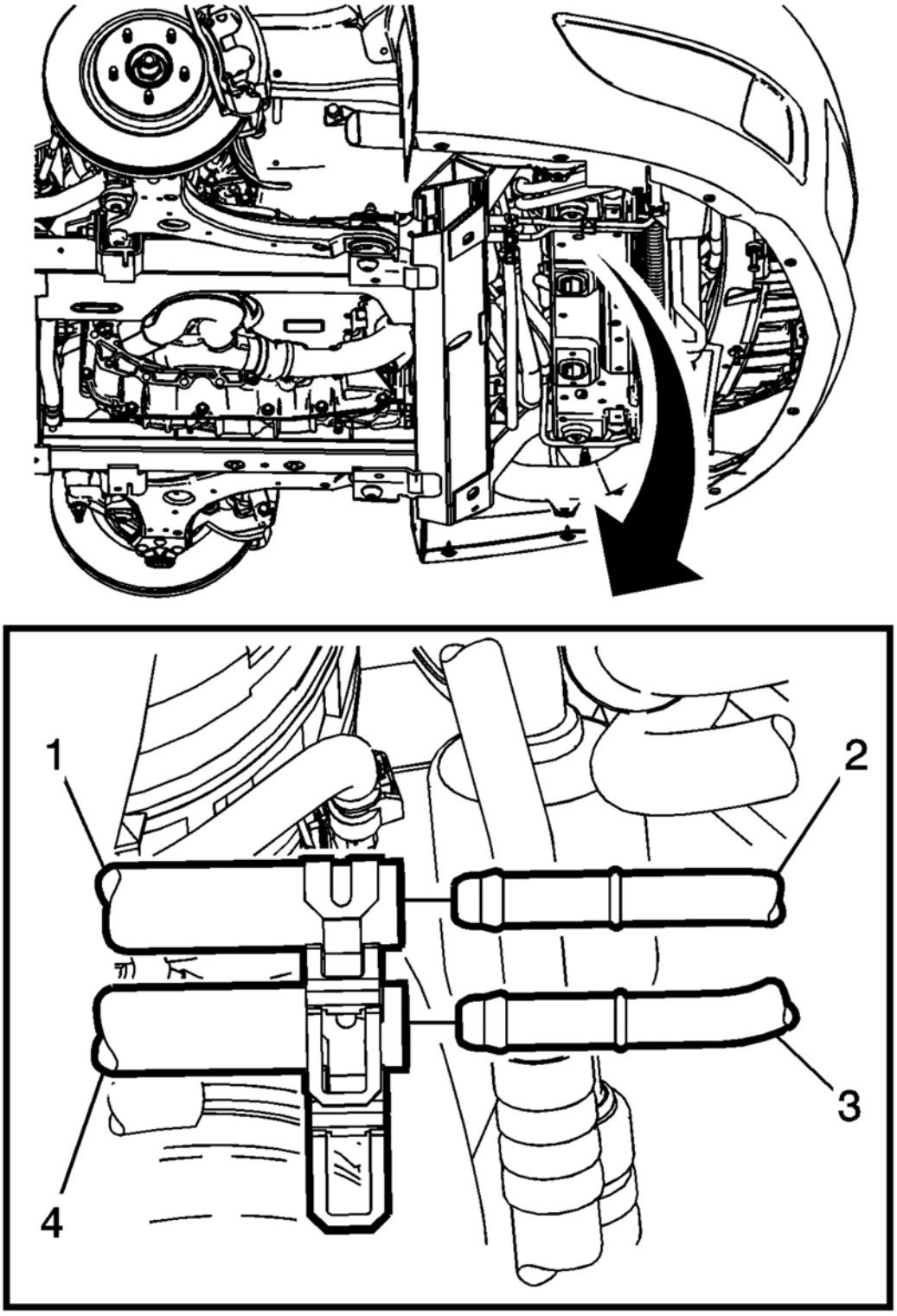


Fig. 29: Power Steering Fluid Cooler And Pipe
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the 2 hose clamps and disconnect the power steering fluid cooling pipe (1, 4) from the power steering fluid cooler (2, 3).

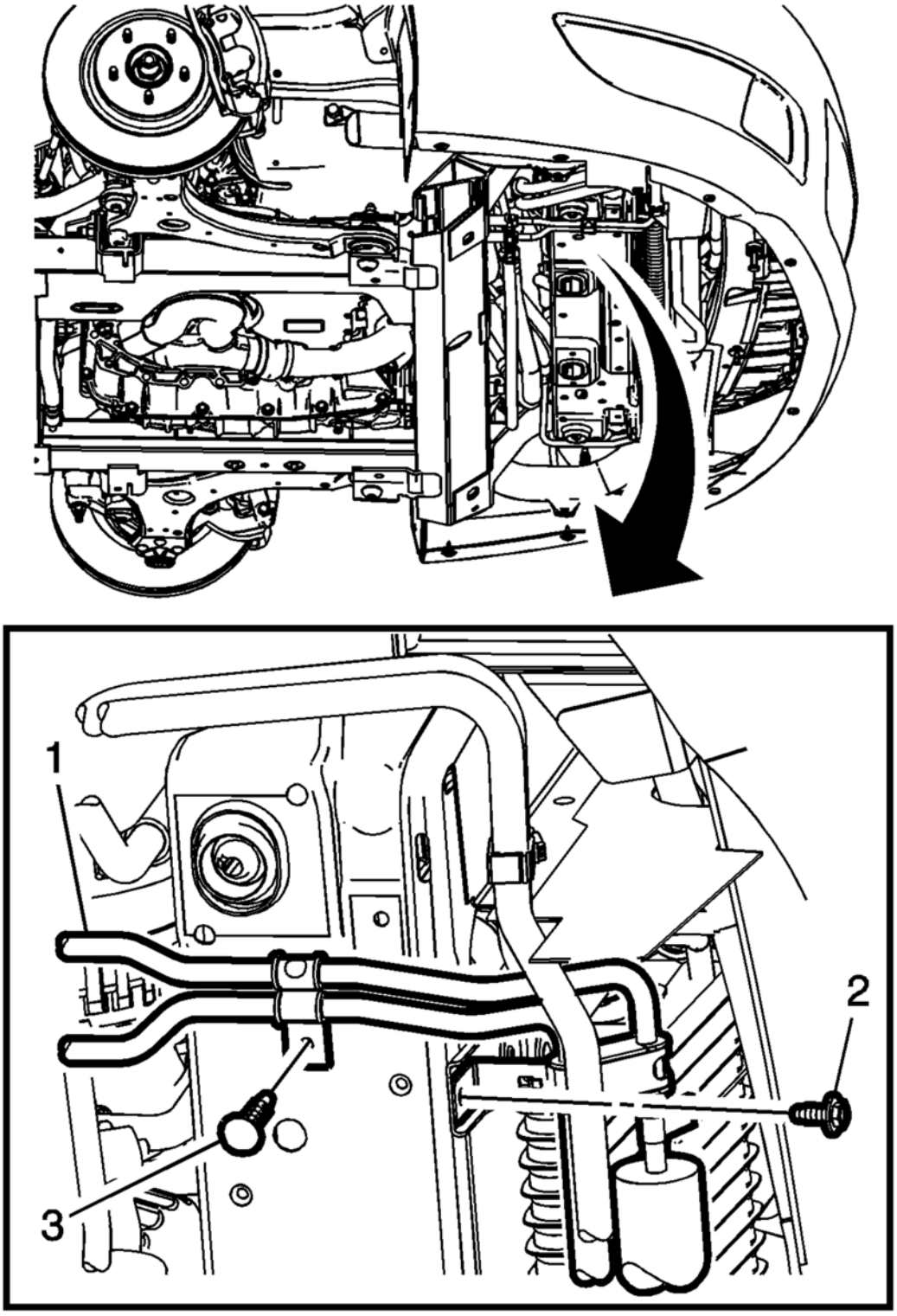


Fig. 30: Power Steering Fluid Cooler, Retainer And Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove the bolt (2) from the power steering fluid cooler (1).
7. Disconnect the retainer (3) and the power steering fluid cooler from the front end lower tie bar.

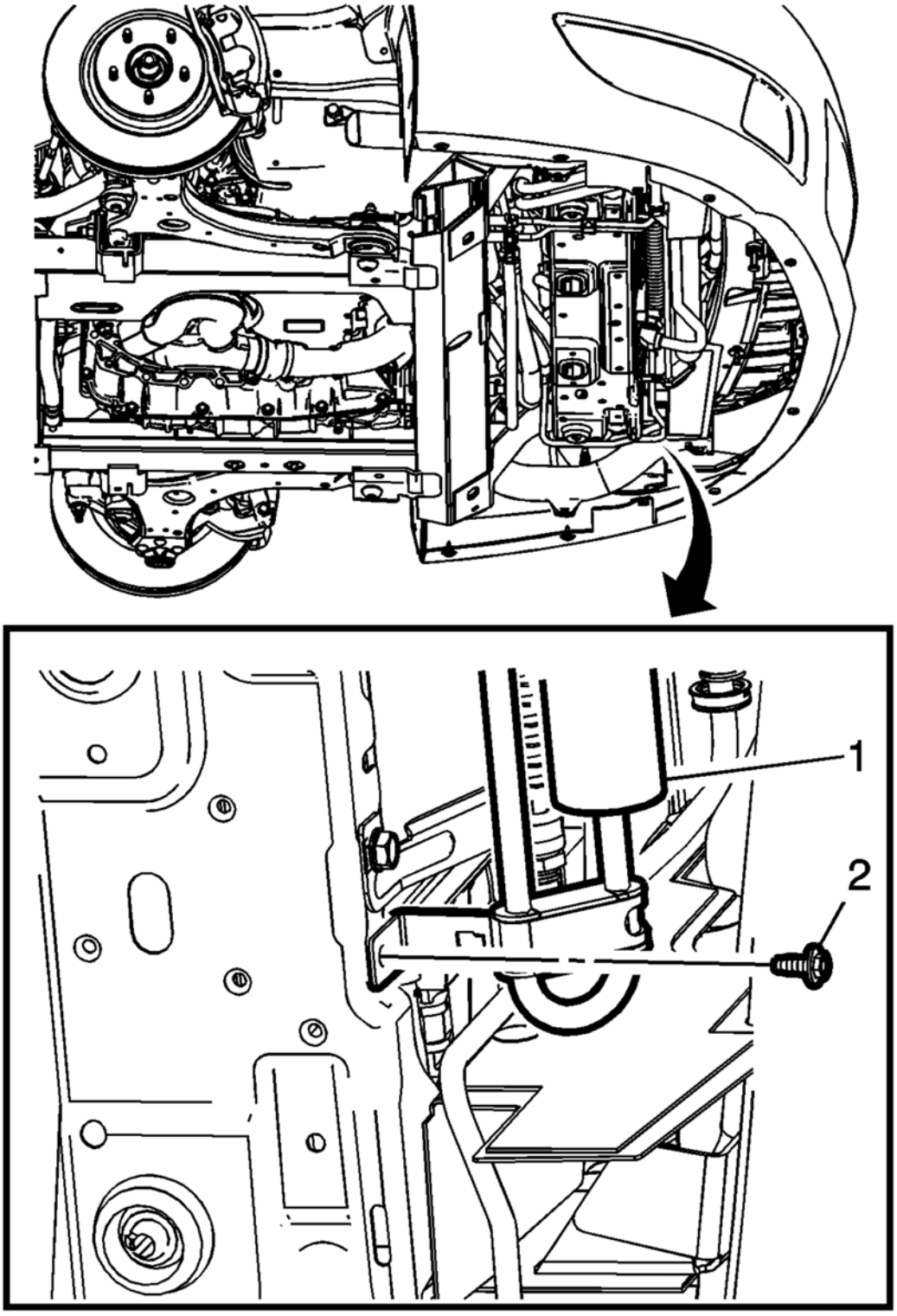


Fig. 31: Power Steering Fluid Cooler And Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove the bolt (2) from the power steering fluid cooler (1).

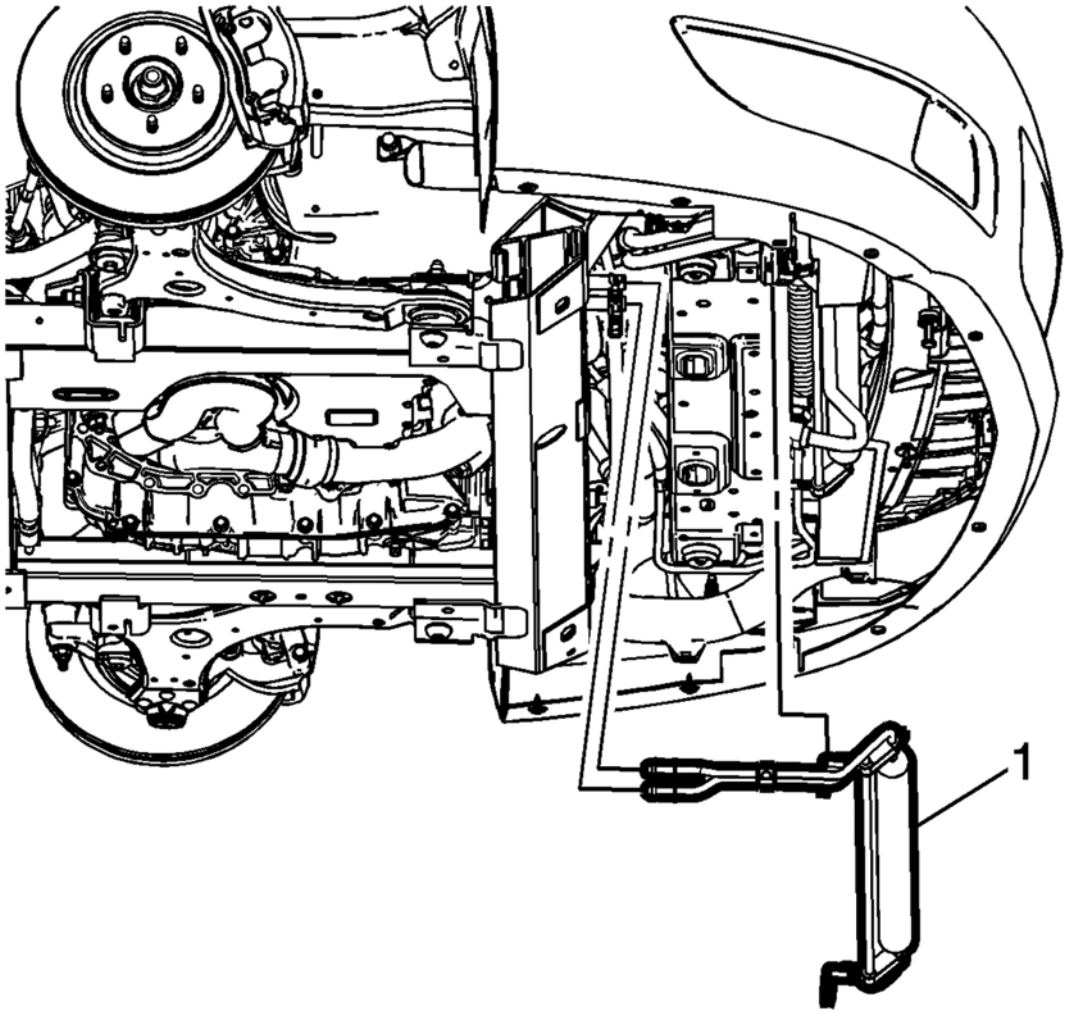


Fig. 32: Power Steering Fluid Cooler
Courtesy of GENERAL MOTORS COMPANY

9. Remove the power steering fluid cooler (1) from the vehicle.

Installation Procedure

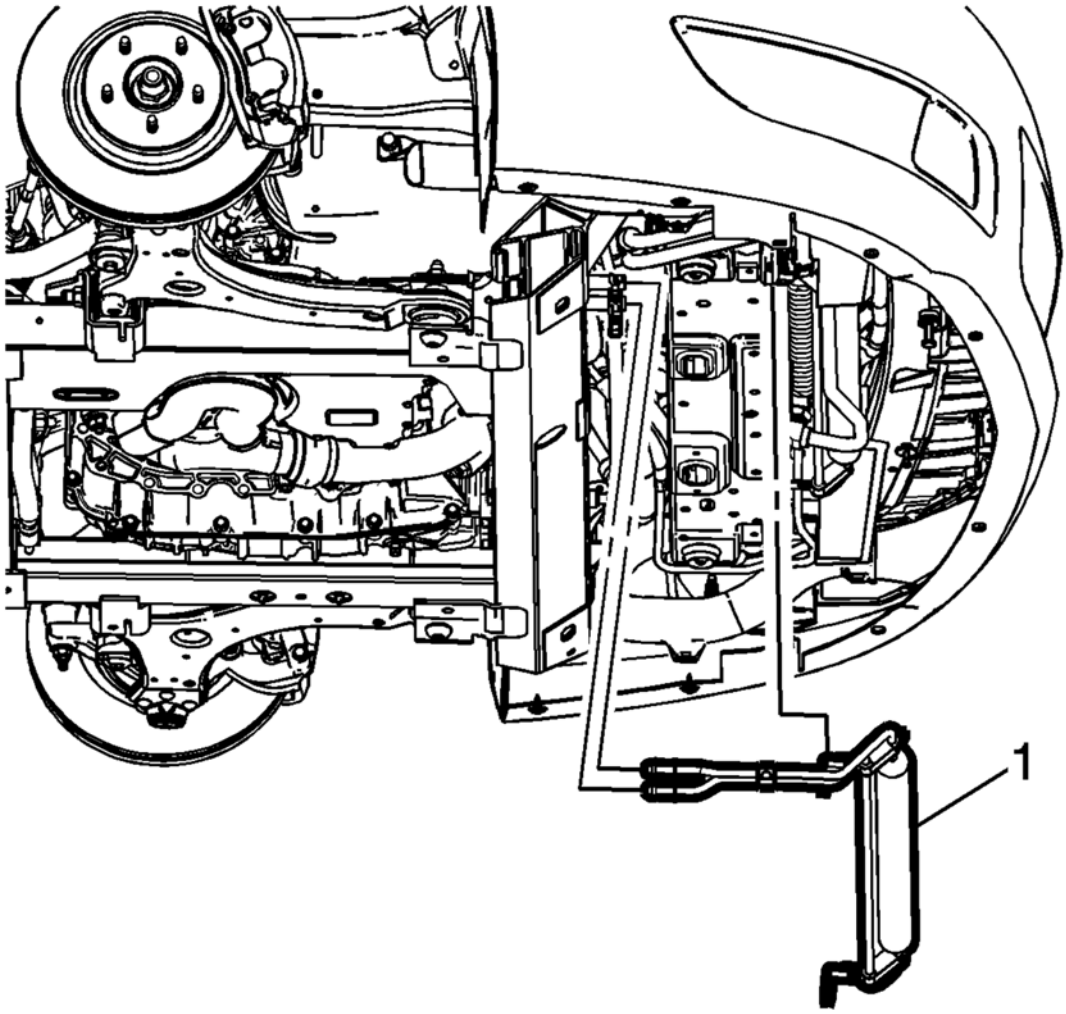


Fig. 33: Power Steering Fluid Cooler
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Installing Hoses without Twists or Bends Caution .

1. Position the power steering fluid cooler (1) in the vehicle.

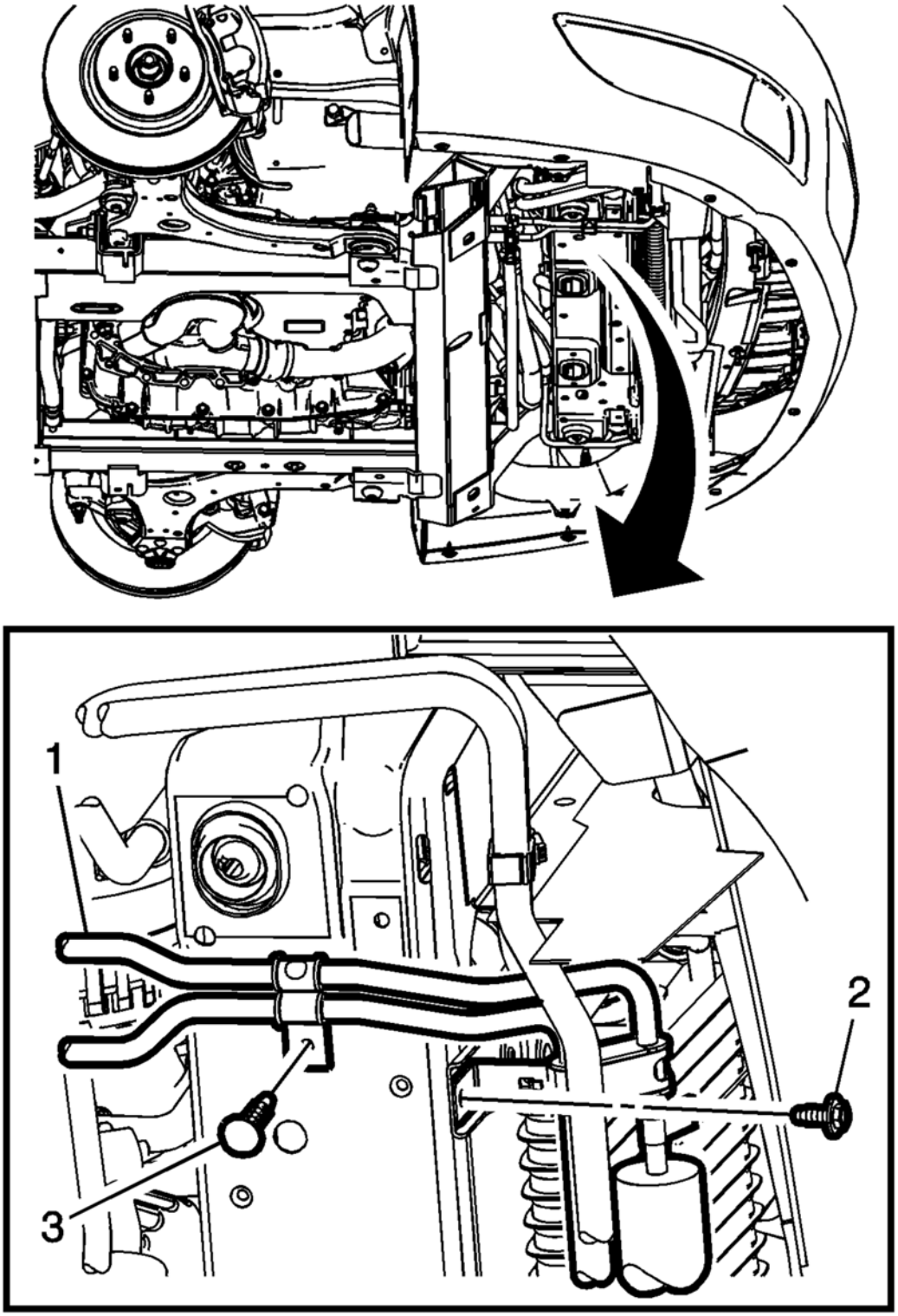


Fig. 34: Power Steering Fluid Cooler, Retainer And Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Connect the retainer (3) and the power steering fluid cooler (1) to the front end lower tie bar.

CAUTION: Refer to Fastener Caution .

3. Install the bolt (2) to the power steering fluid cooler and tighten to 8 N.m (71 lb in).

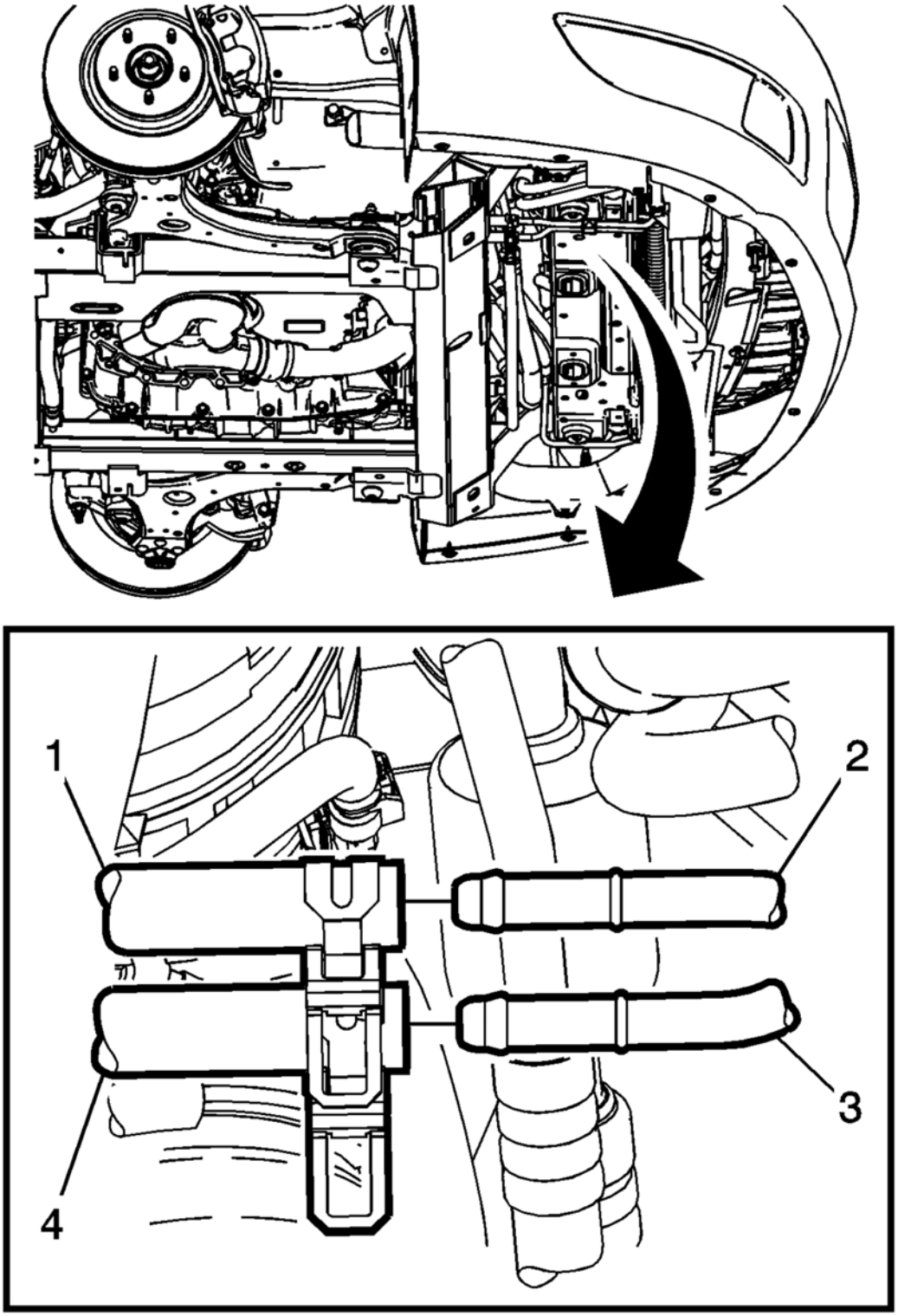


Fig. 35: Power Steering Fluid Cooler And Pipe
Courtesy of GENERAL MOTORS COMPANY

4. Connect the power steering fluid cooling pipe (1, 4) to the power steering fluid cooler (2, 3). Secure the pipe with the 2 hose clamps.

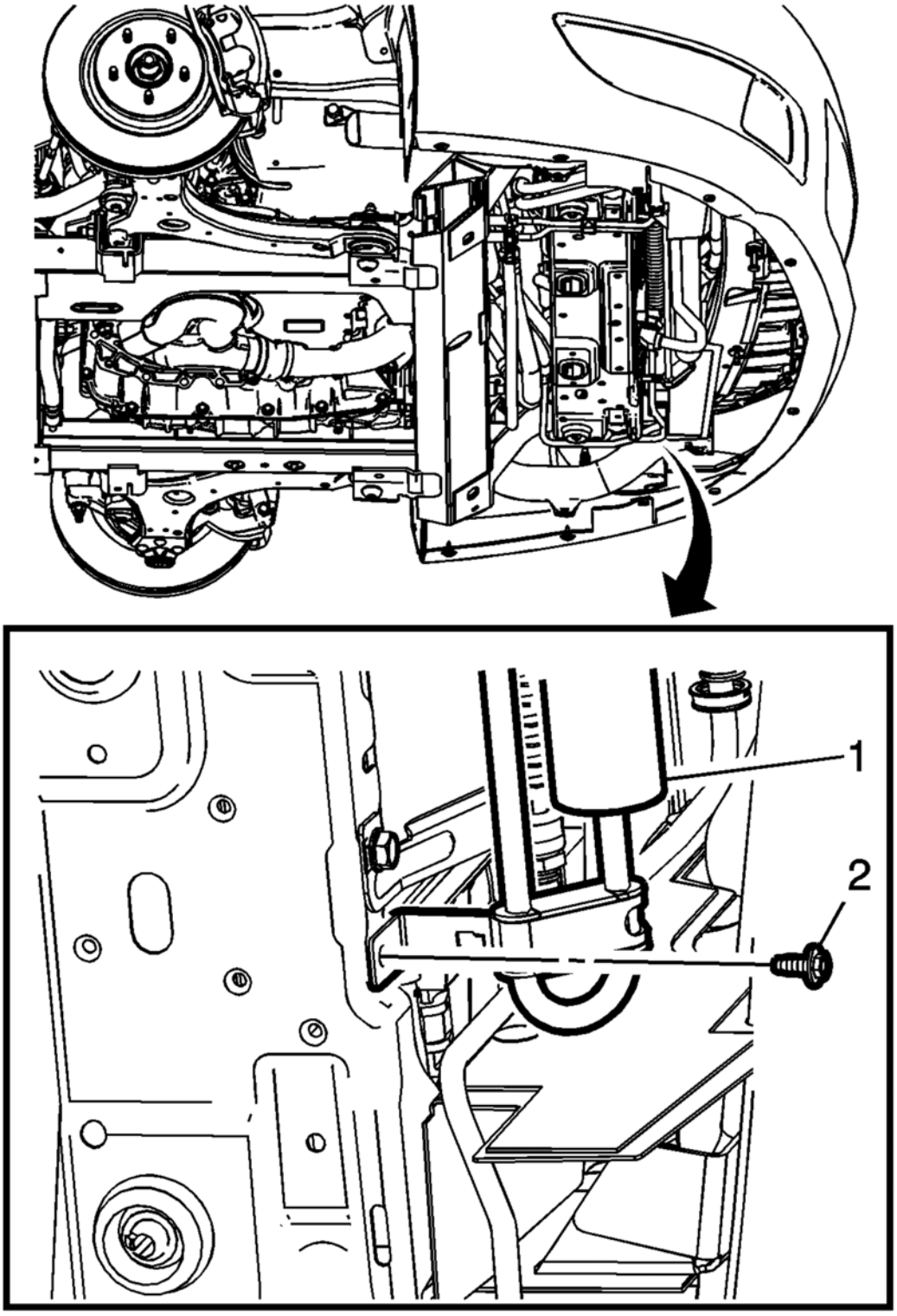


Fig. 36: Power Steering Fluid Cooler And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Install the bolt (2) to the power steering fluid cooler (1) and tighten to 8 N.m (71 lb in).
6. Install the radiator air lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .

7. Lower the vehicle.
8. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
9. Clean any excess power steering fluid from the vehicle.
10. Remove the drain pans.

POWER STEERING FLUID RESERVOIR HOSE REPLACEMENT

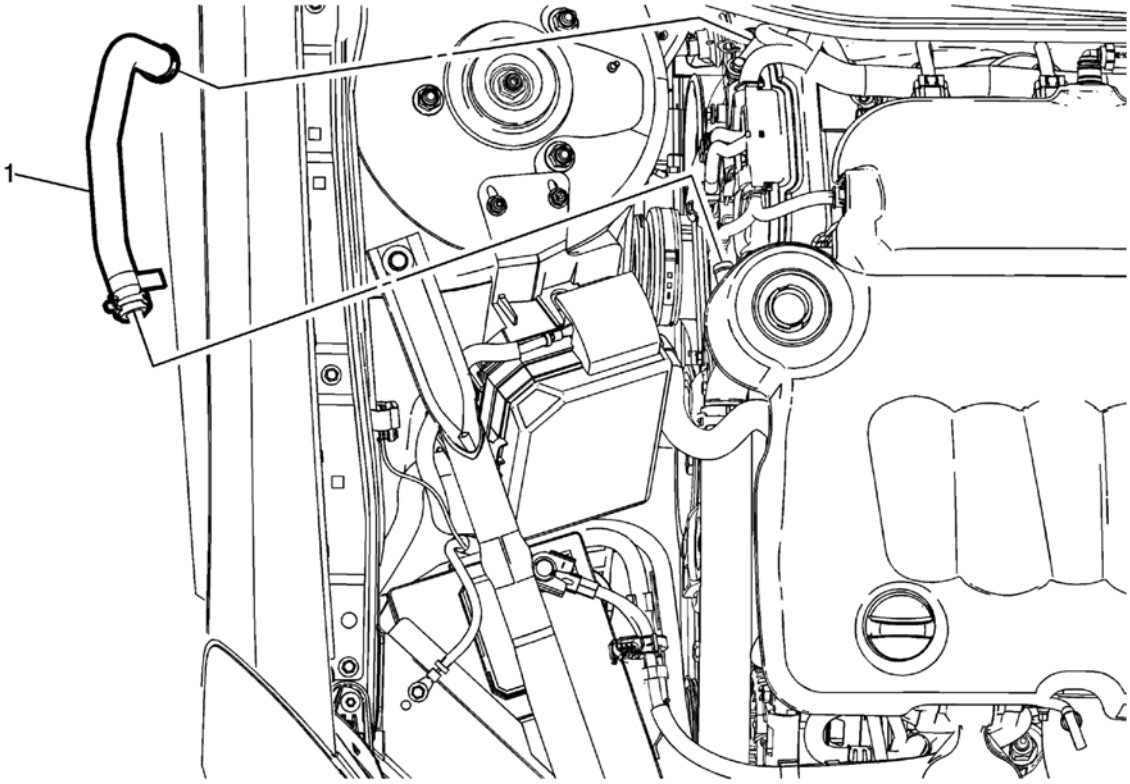


Fig. 37: Power Steering Fluid Reservoir Hose
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Place drain pans under the vehicle. 2. Remove as much power steering fluid from the upper power steering fluid reservoir as possible.	
1	Power Steering Fluid Reservoir Hose **CAUTION:** **Refer to Installing Hoses without Twists or Bends Caution .**

Callout	Component Name
	Procedure 1. Loosen the hose clamp and disconnect the power steering fluid reservoir hose from the upper power steering fluid reservoir. 2. Loosen the hose clamp and disconnect the power steering fluid reservoir hose from the lower power steering fluid reservoir which is part of the power steering pump. 3. After the installation is complete, fill and bleed the power steering system. Refer to **Power Steering System Bleeding**. 4. Clean any excess power steering fluid from the vehicle. 5. Remove the drain pans.

POWER STEERING GEAR INLET PIPE/HOSE REPLACEMENT

Removal Procedure

1. Place drain pans under the vehicle.
2. Remove as much power steering fluid from the reservoir as possible.
3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
4. Remove the front tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .

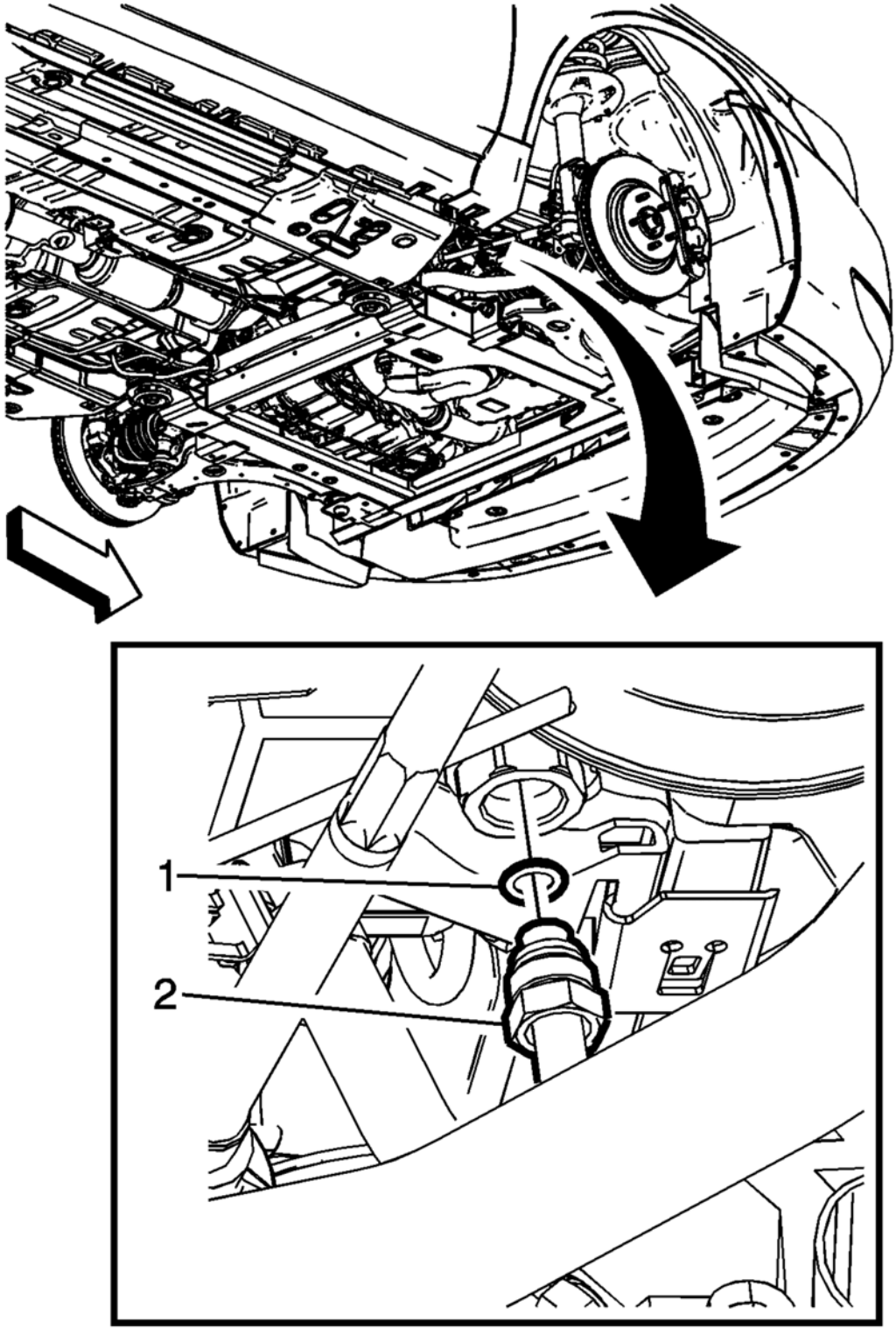


Fig. 38: Power Steering Gear Inlet Hose And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect the power steering gear inlet hose (2) from the power steering pump.
6. Remove the power steering gear inlet hose O-ring seal (1).

   Discard the seal.

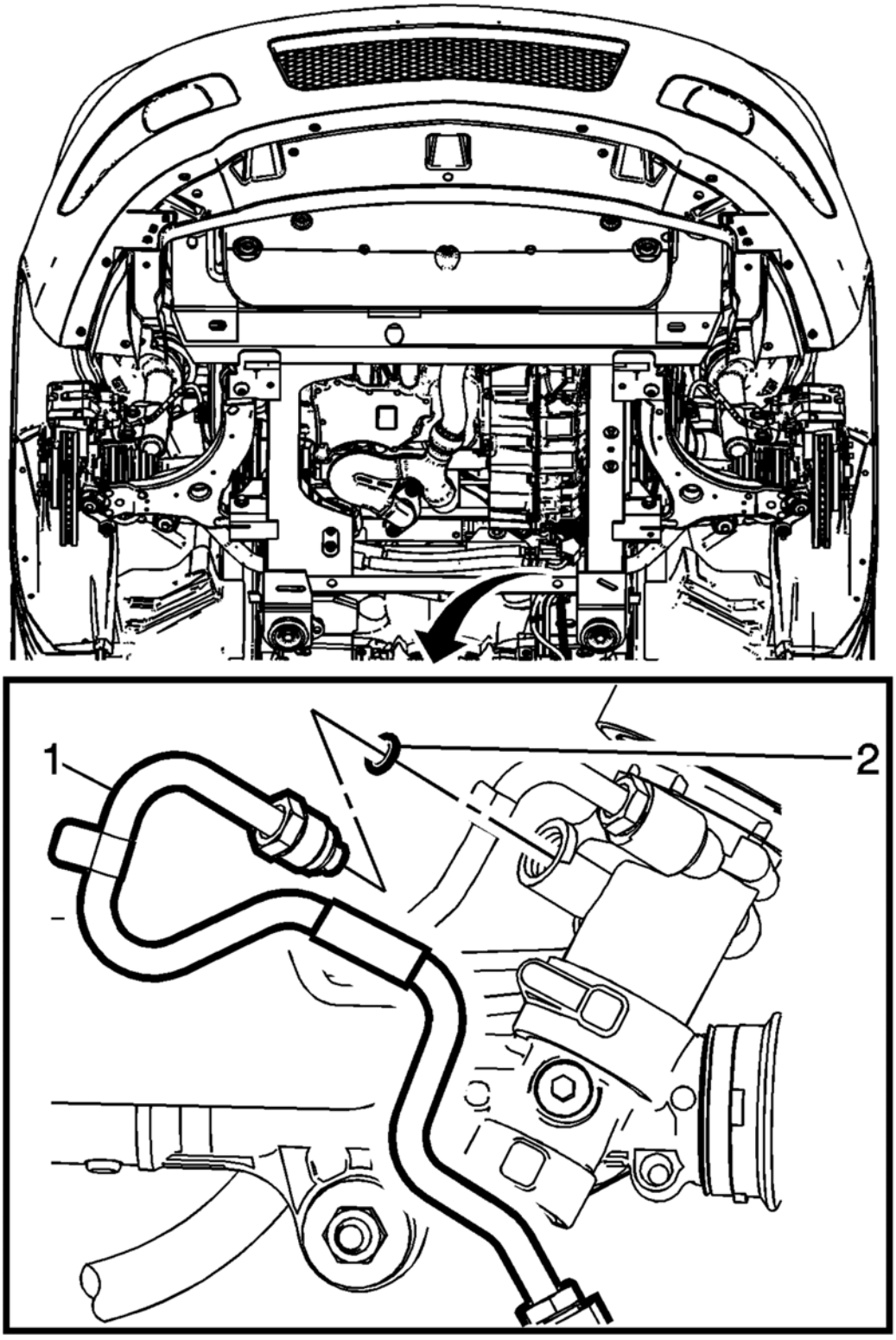


Fig. 39: Power Steering Gear Inlet Hose And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

7. Disconnect the power steering gear inlet hose (1) from the steering gear.
8. Remove the power steering gear inlet hose O-ring seal (2).

   Discard the seal.

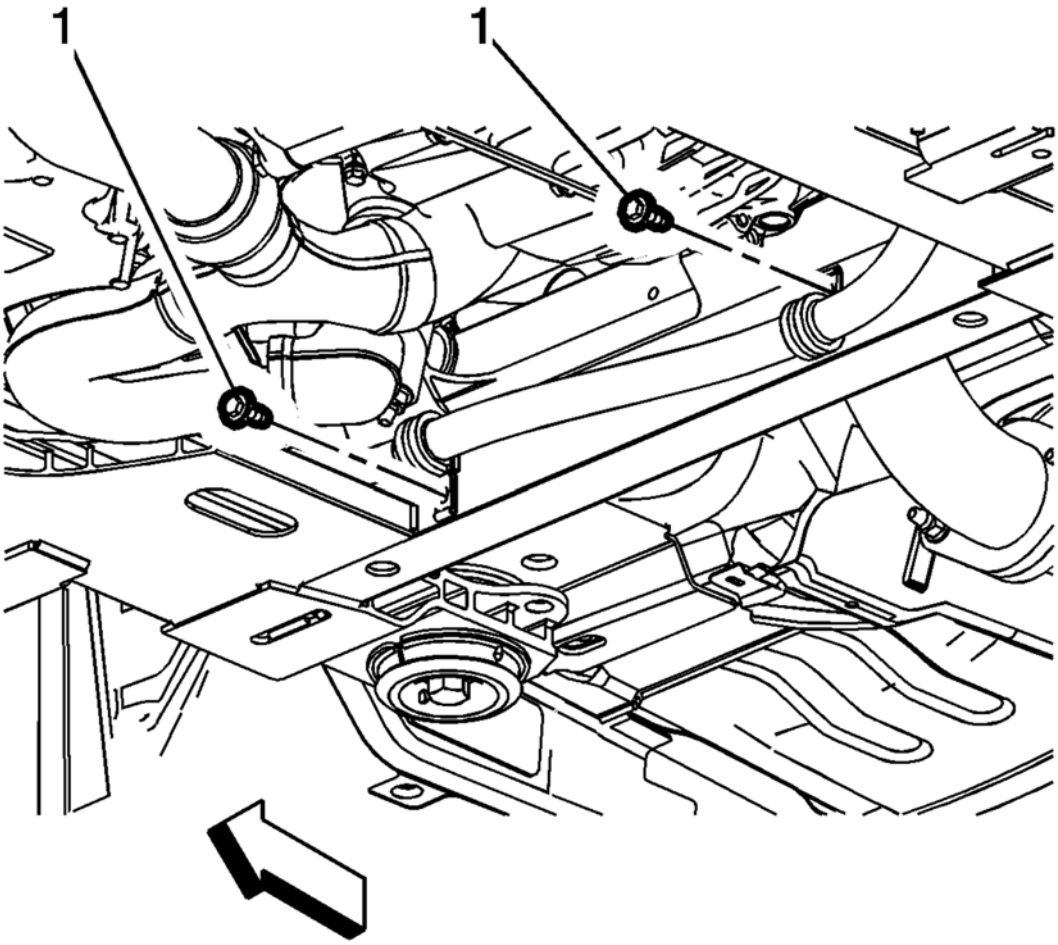


Fig. 40: Power Steering Gear Inlet Hose Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the power steering gear inlet hose bracket bolts (1).

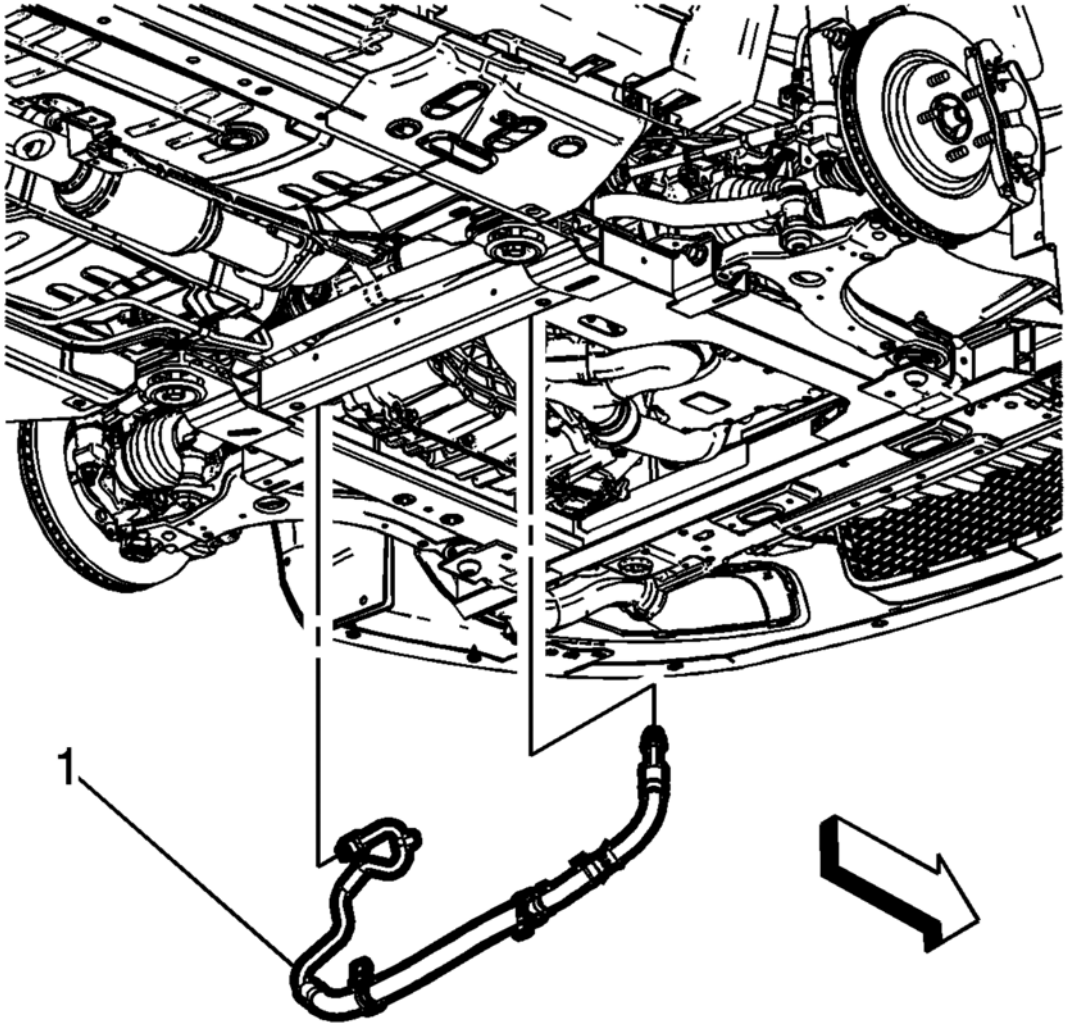


Fig. 41: Power Steering Gear Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

10. Remove the power steering gear inlet hose (1) from the vehicle.

Installation Procedure

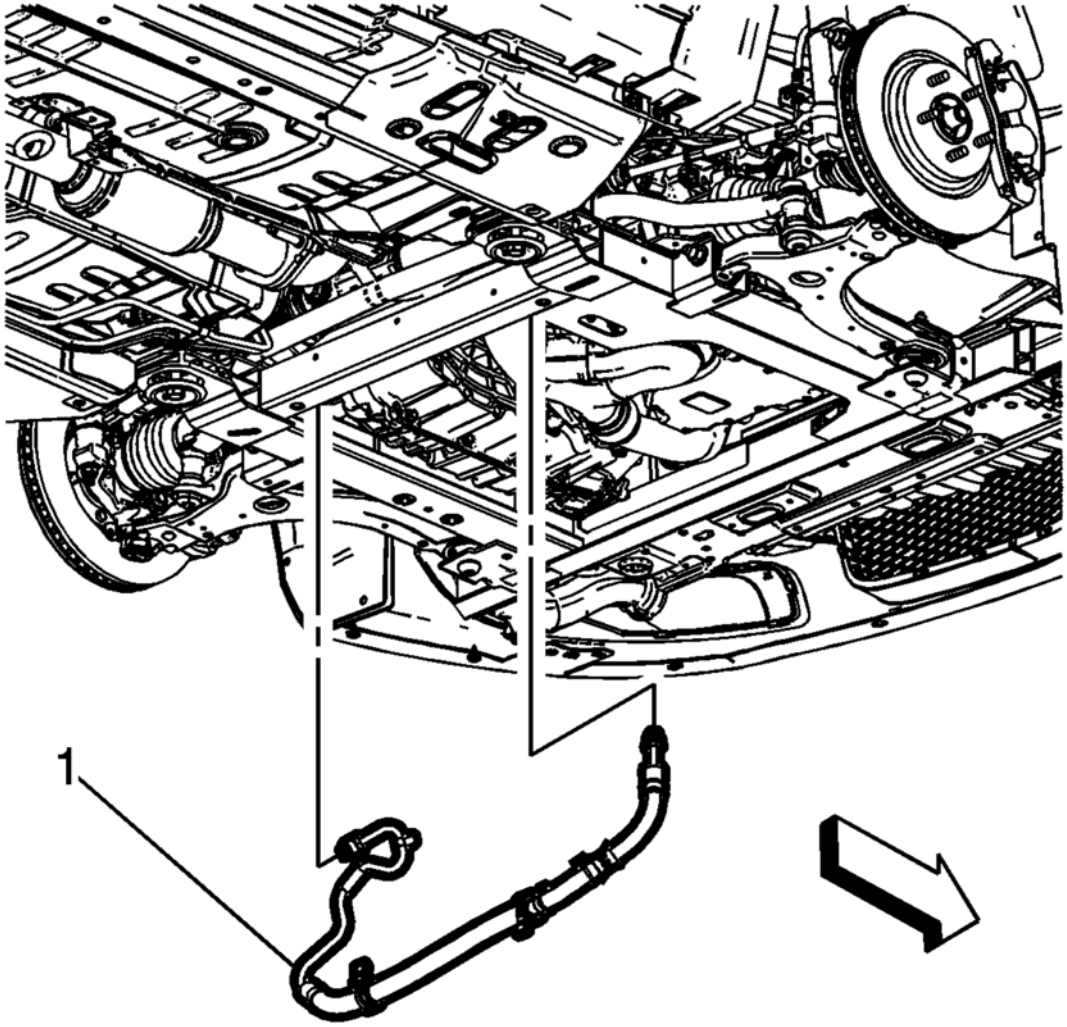


Fig. 42: Power Steering Gear Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Installing Hoses without Twists or Bends Caution .

1. Position the power steering gear inlet hose (1) in the vehicle.

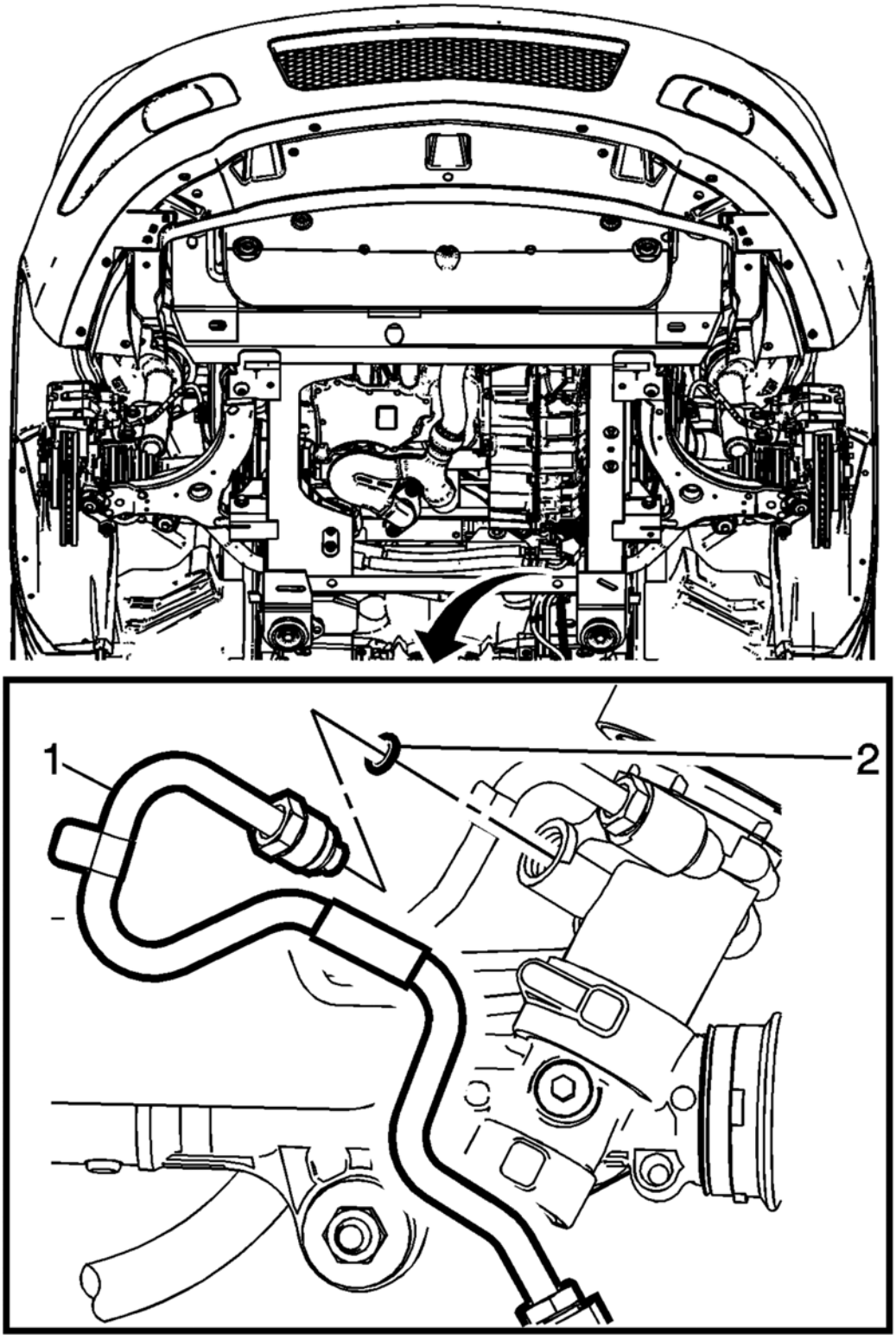


Fig. 43: Power Steering Gear Inlet Hose And O-Ring Seal
Courtesy of GENERAL MOTORS COMPANY

2. Install a NEW power steering gear inlet hose O-ring seal (2).

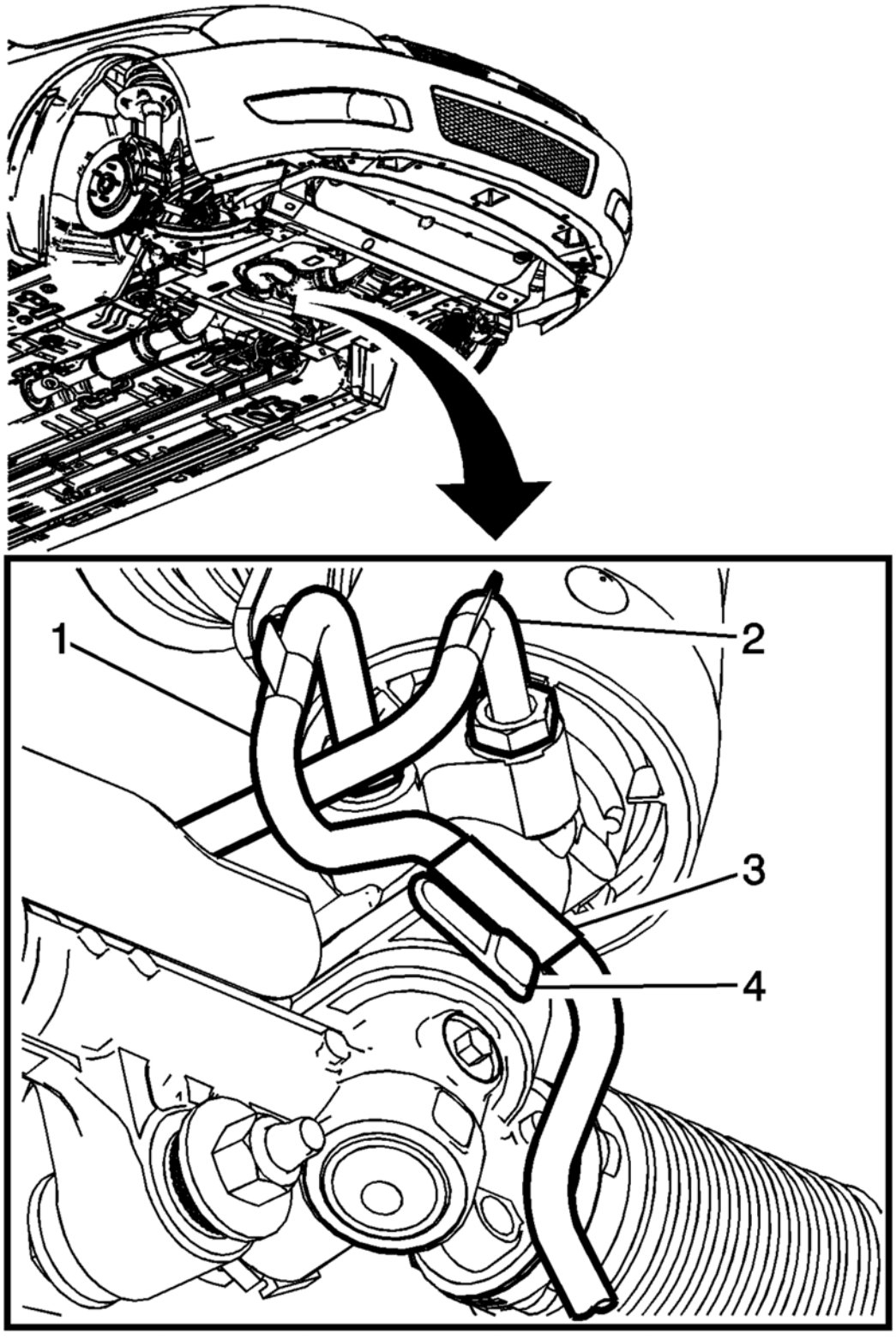


Fig. 44: Power Steering Gear Inlet Hose, Steering Gear Housing Casting And Rubber Isolation Tube

Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **The position of the rubber isolation tube (3) against the steering gear**

housing casting (4) is critical to the performance of the power steering gear inlet hose (1).

3. Connect the power steering gear inlet hose to the steering gear. Position the rubber isolation tube against the steering gear housing casting. Tighten the fitting to 34 N.m (25 lb ft).

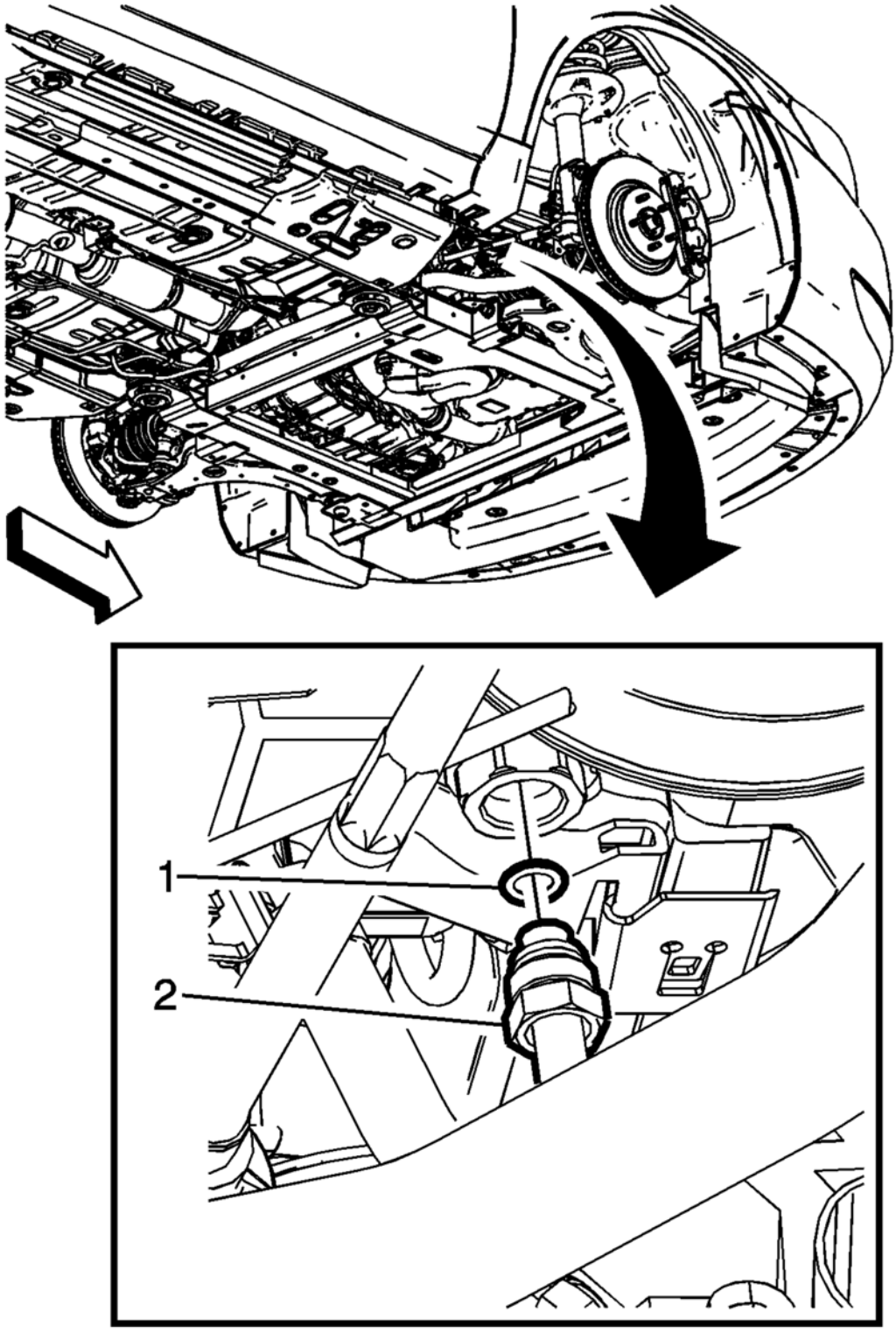


Fig. 45: Power Steering Gear Inlet Hose And O-Ring Seal

Courtesy of GENERAL MOTORS COMPANY

4. Install a NEW power steering gear inlet hose O-ring seal (1).
5. Connect the power steering gear inlet hose (2) to the power steering pump and tighten the fitting to 34 N.m (25 lb ft).

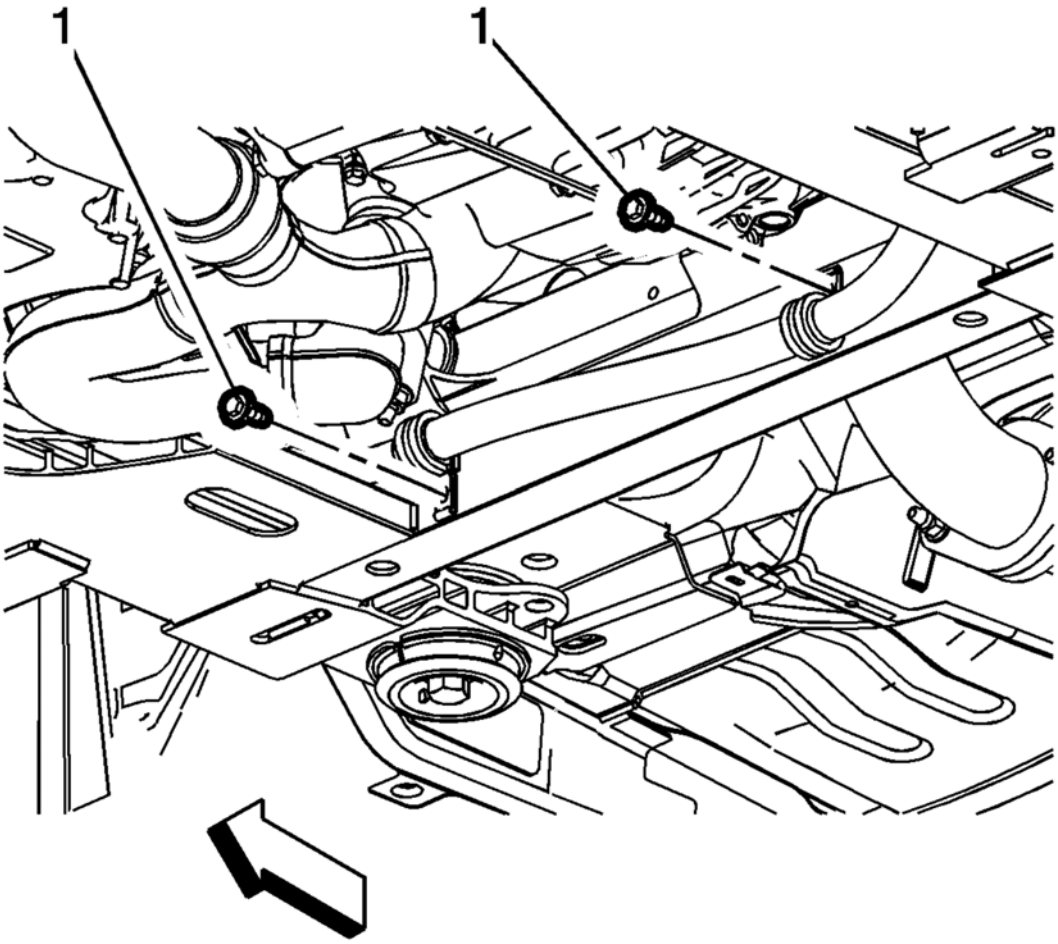


Fig. 46: Power Steering Gear Inlet Hose Bracket Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Install the power steering gear inlet hose bracket bolts (1) and tighten to 7 N.m (62 lb in).
7. Install the front tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
8. Lower the vehicle.
9. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
10. Clean any excess power steering fluid from the vehicle.
11. Remove the drain pans.

STEERING GEAR PIPE AND SEAL REPLACEMENT

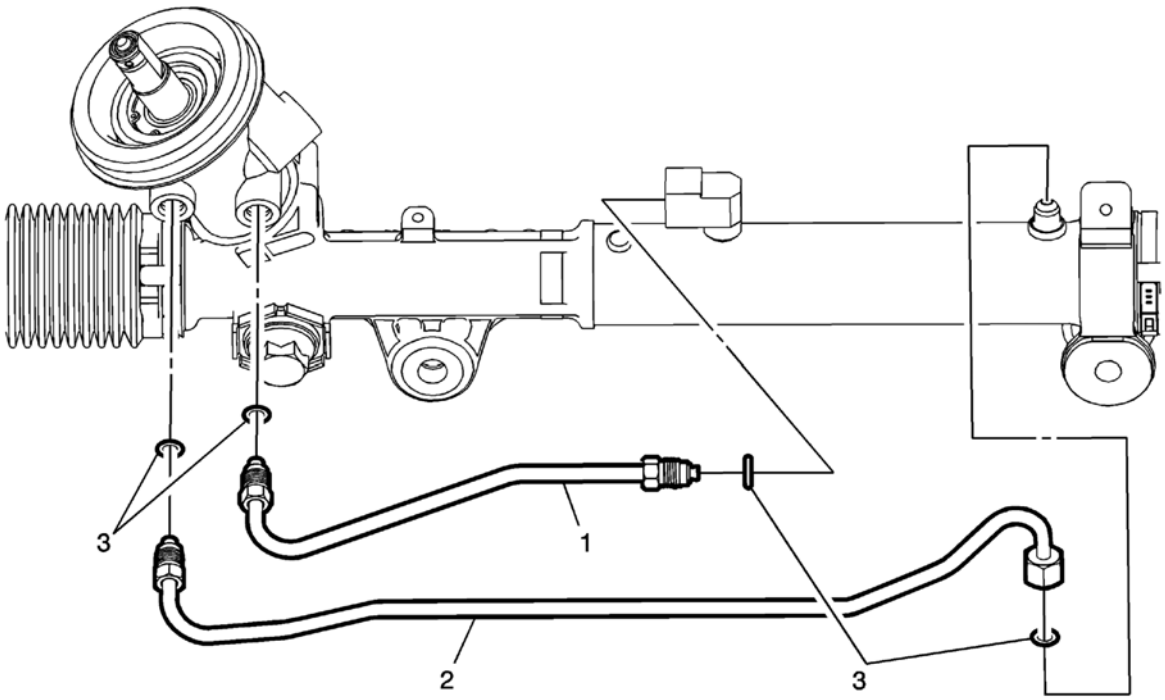


Fig. 47: Steering Gear Pipe And Seal
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the steering gear. Refer to **Steering Gear Replacement**.	
1	Steering Gear Pipe **CAUTION:** **Refer to Fastener Caution .** **Tighten** 34 N.m (25 lb ft)
2	Steering Gear Pipe **Tighten** 34 N.m (25 lb ft)
3	Steering Gear Pipe Seal (Qty: 4) **Procedure**

Callout	Component Name
	1. Remove the steering gear pipe seals. Discard the seals. 2. Install NEW steering gear pipe seals.

STEERING GEAR HEAT SHIELD REPLACEMENT

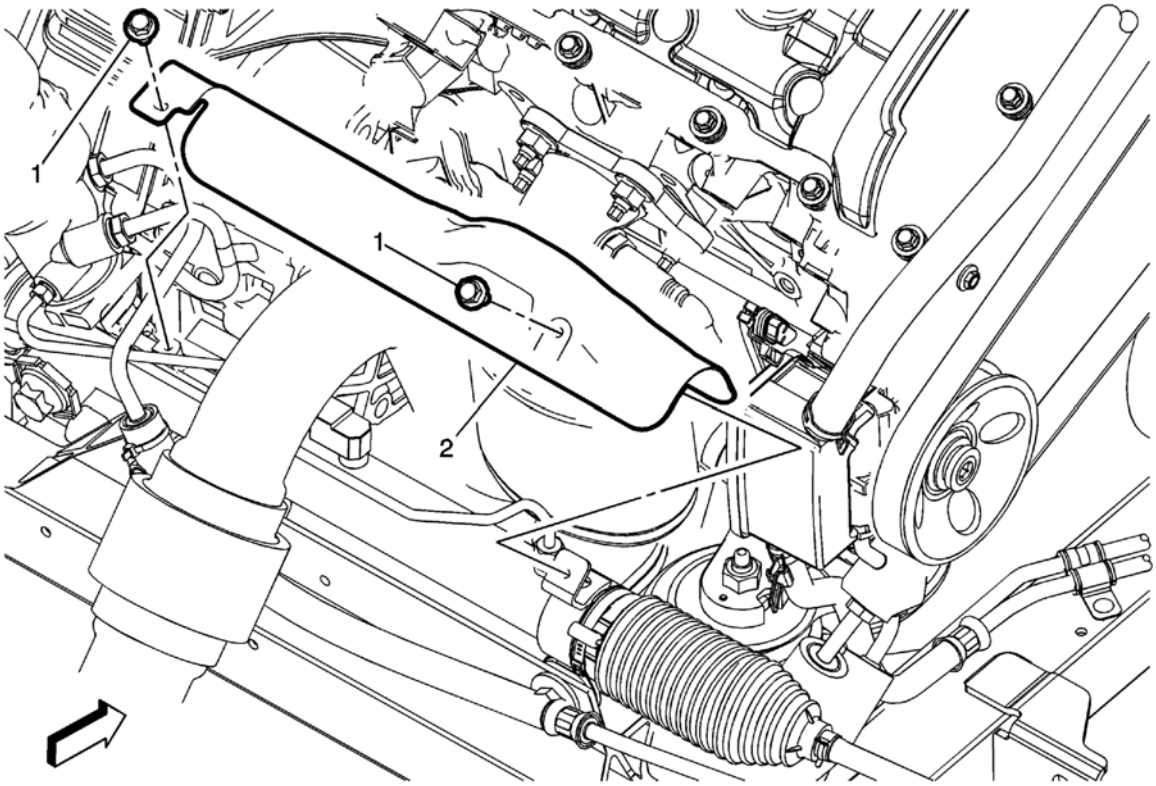


Fig. 48: Steering Gear Heat Shield
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
CAUTION: **Do not lower the rear of the frame too far as damage to the engine components nearest to the cowl may result.** **Preliminary Procedures**	

Callout	Component Name
1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Lower the rear of the frame in order to access the steering gear heat shield bolts. Refer to **Frame Replacement** .	
1	Steering Gear Heat Shield Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 9 N.m (80 lb in)
2	Steering Gear Heat Shield

STEERING GEAR REPLACEMENT

Special Tools

J-42640 Steering Column Anti-rotation Pin

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

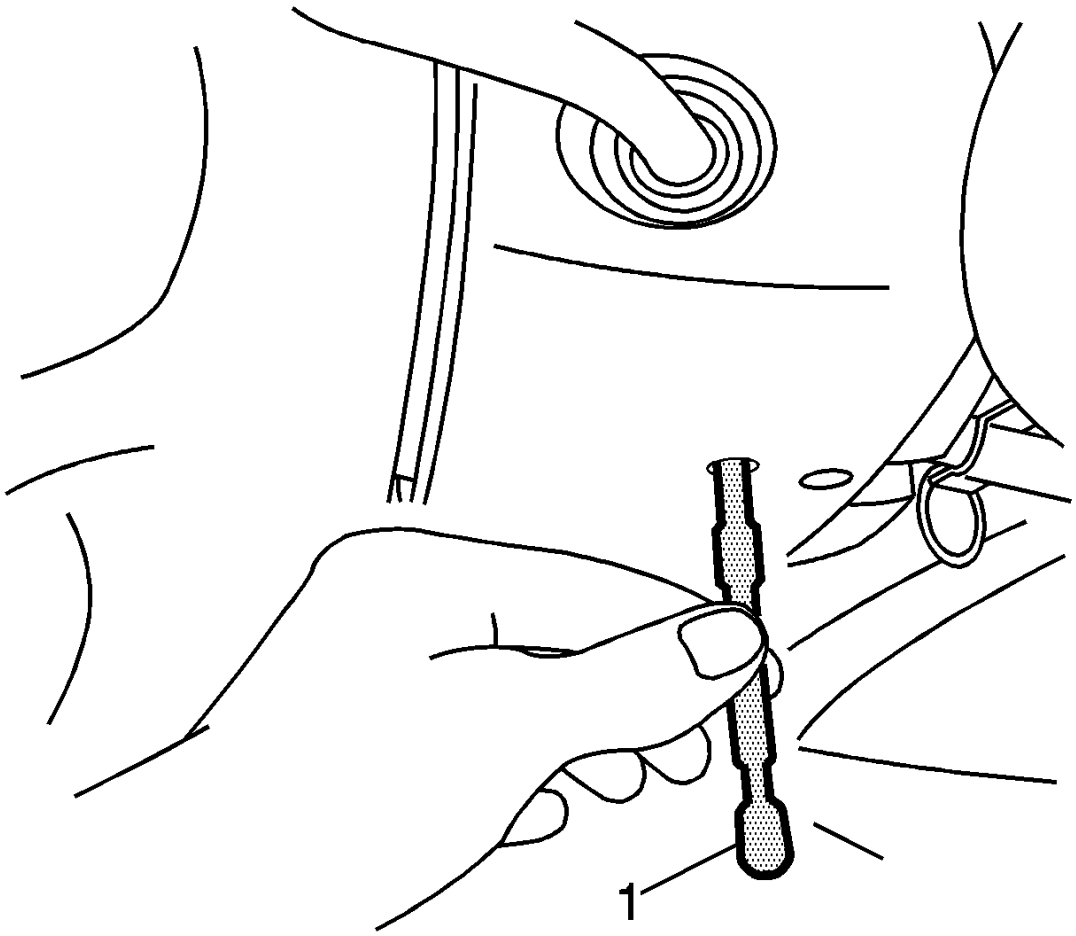


Fig. 49: Locking/Unlocking Steering Column
Courtesy of GENERAL MOTORS COMPANY

CAUTION: With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. Insert the **J-42640** pin into the steering column access hole in order to lock the steering column.

2. Place drain pans under the vehicle.
3. Remove as much power steering fluid from the reservoir as possible.
4. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
5. Remove the front tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
6. Disconnect the intermediate steering shaft from the steering gear pinion shaft. Refer to **Intermediate Steering Shaft Replacement** .
7. Disconnect both of the outer tie rods from the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
8. Remove the rear engine mount. Refer to **Engine Rear Mount Replacement** .

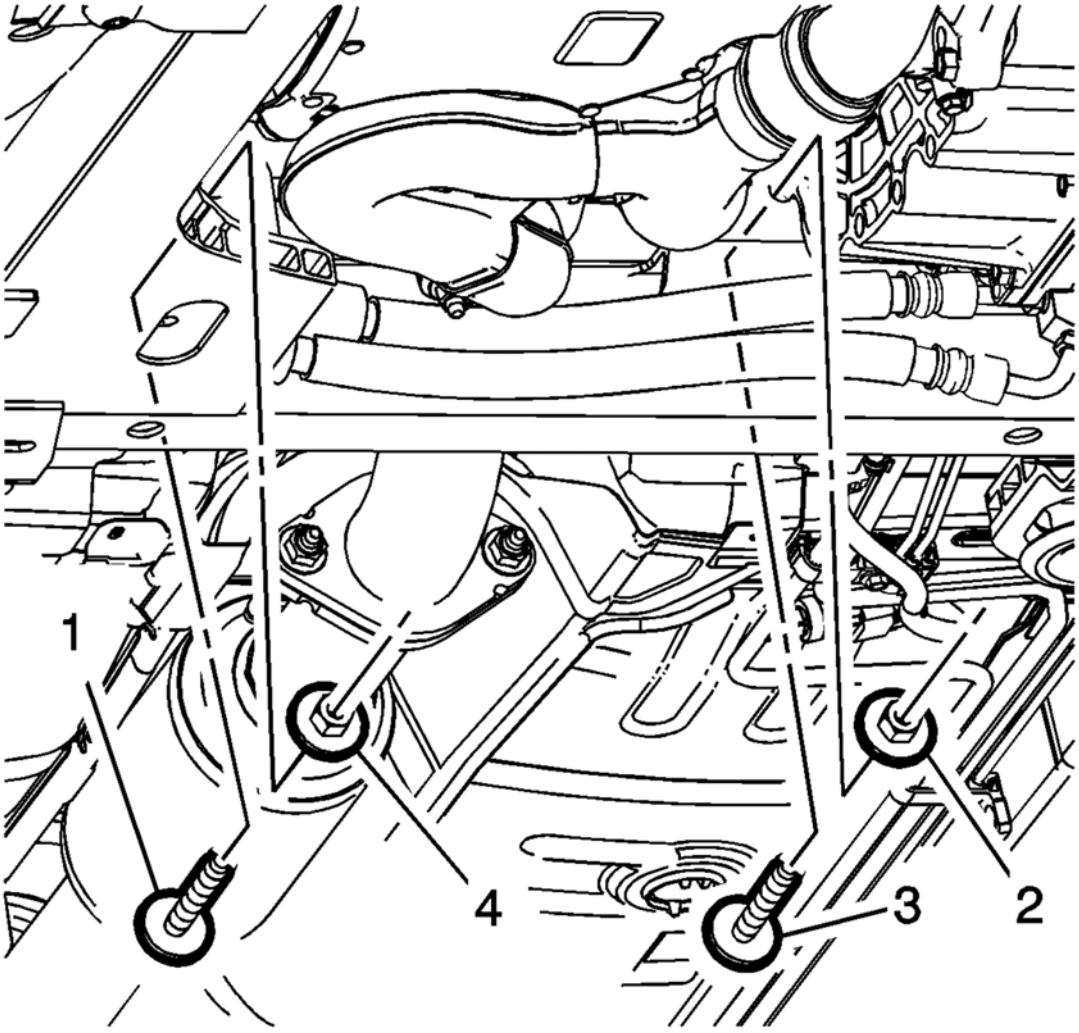


Fig. 50: Steering Gear Bolts And Nuts
Courtesy of GENERAL MOTORS COMPANY

9. Remove the 2 steering gear bolts (1, 3) and the 2 nuts (2, 4).

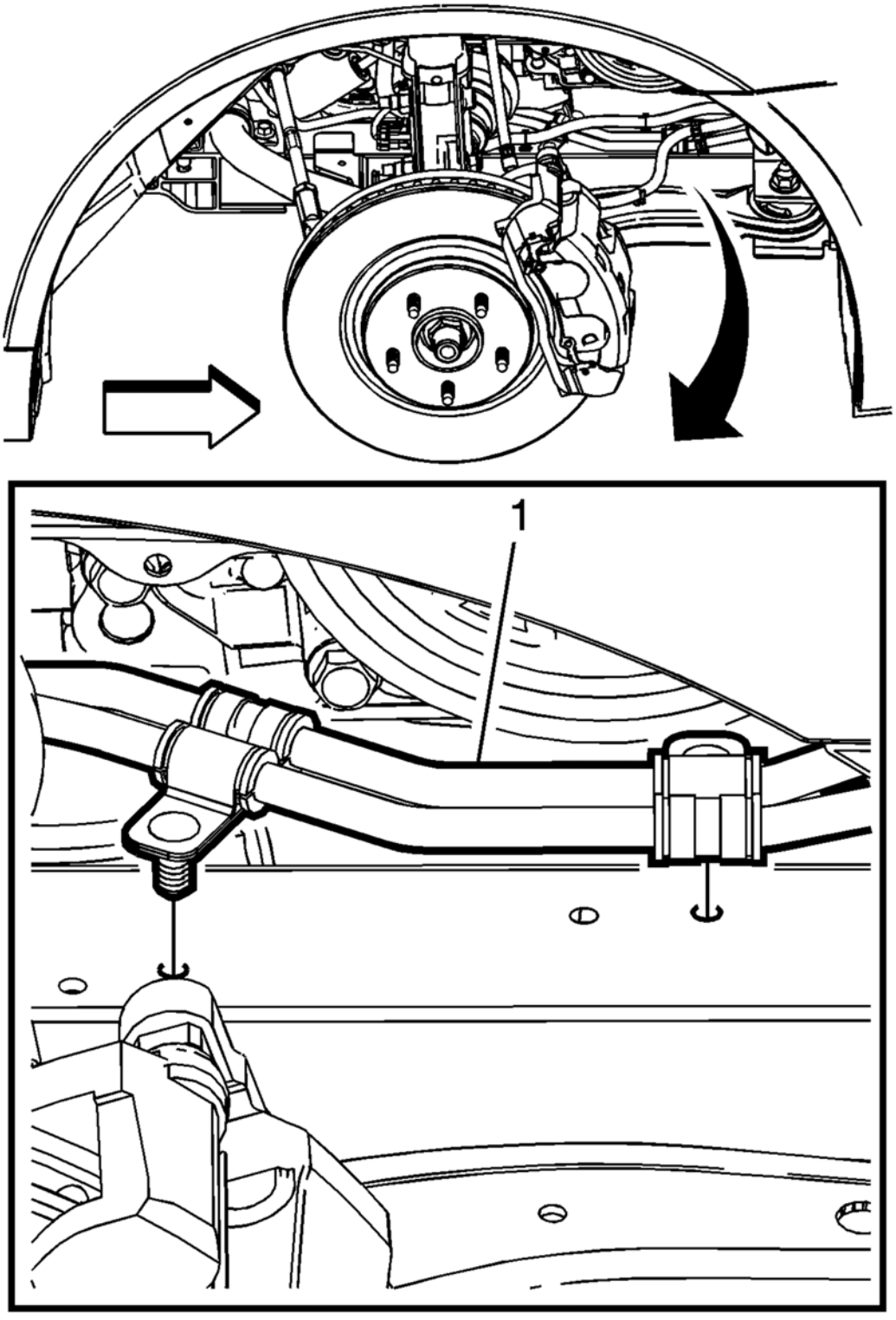


Fig. 51: Power Steering Fluid Cooling Pipe
Courtesy of GENERAL MOTORS COMPANY

10. On the right side of the frame, disconnect the 2 retainers and the power steering fluid cooling pipe (1) from the frame.

CAUTION: Do not lower the rear of the frame too far as damage to the engine

components nearest to the cowl may result.

11. Lower the rear of the frame in order to access the steering gear. Refer to **Frame Replacement** .
12. Disconnect the power steering gear inlet hose from the steering gear. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
13. Remove the steering gear inlet hose O-ring seal.

    Discard the seal.

14. Disconnect the power steering fluid cooling pipe from the steering gear. Refer to **Power Steering Fluid Cooling Pipe Replacement**.
15. Remove the power steering fluid cooling pipe O-ring seal.

    Discard the seal.

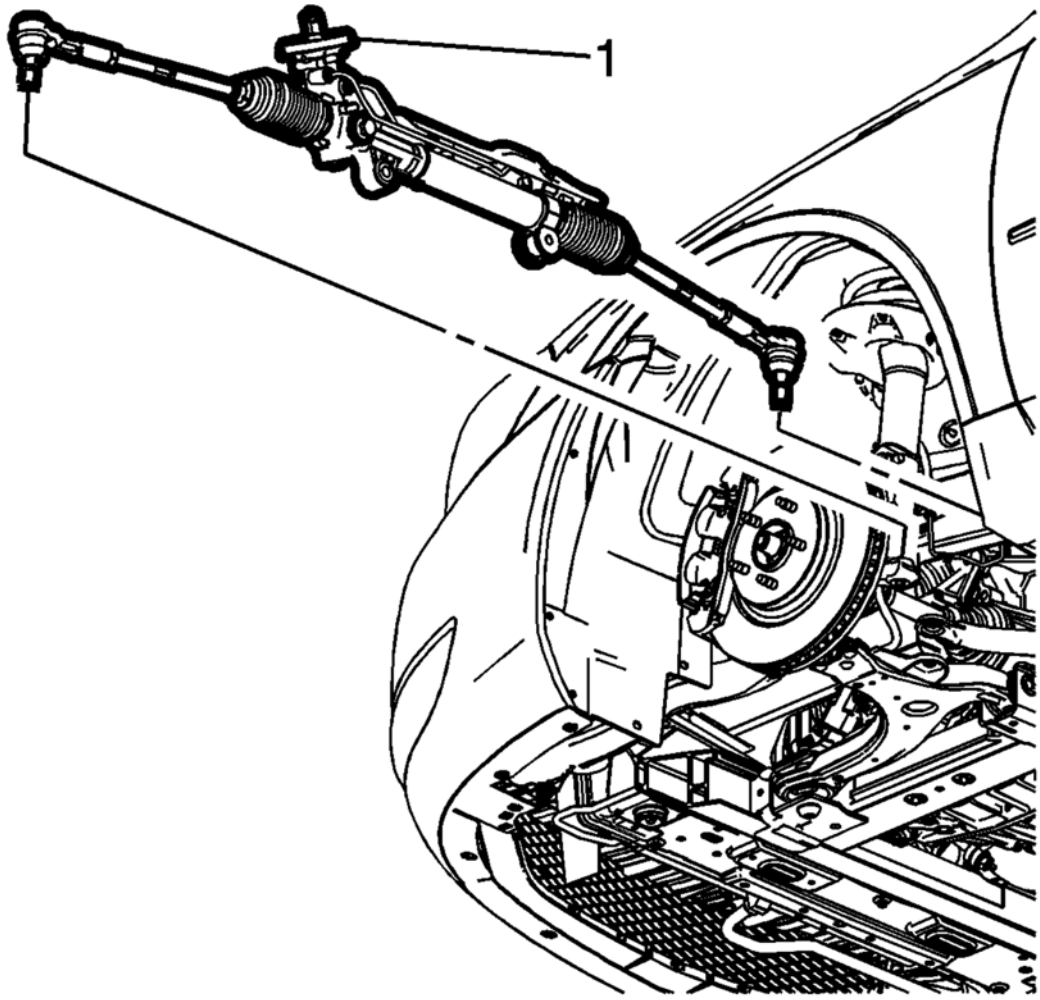


Fig. 52: Steering Gear
Courtesy of GENERAL MOTORS COMPANY

16. Remove the steering gear (1) through the left wheel opening.
17. Transfer components as necessary.

Installation Procedure

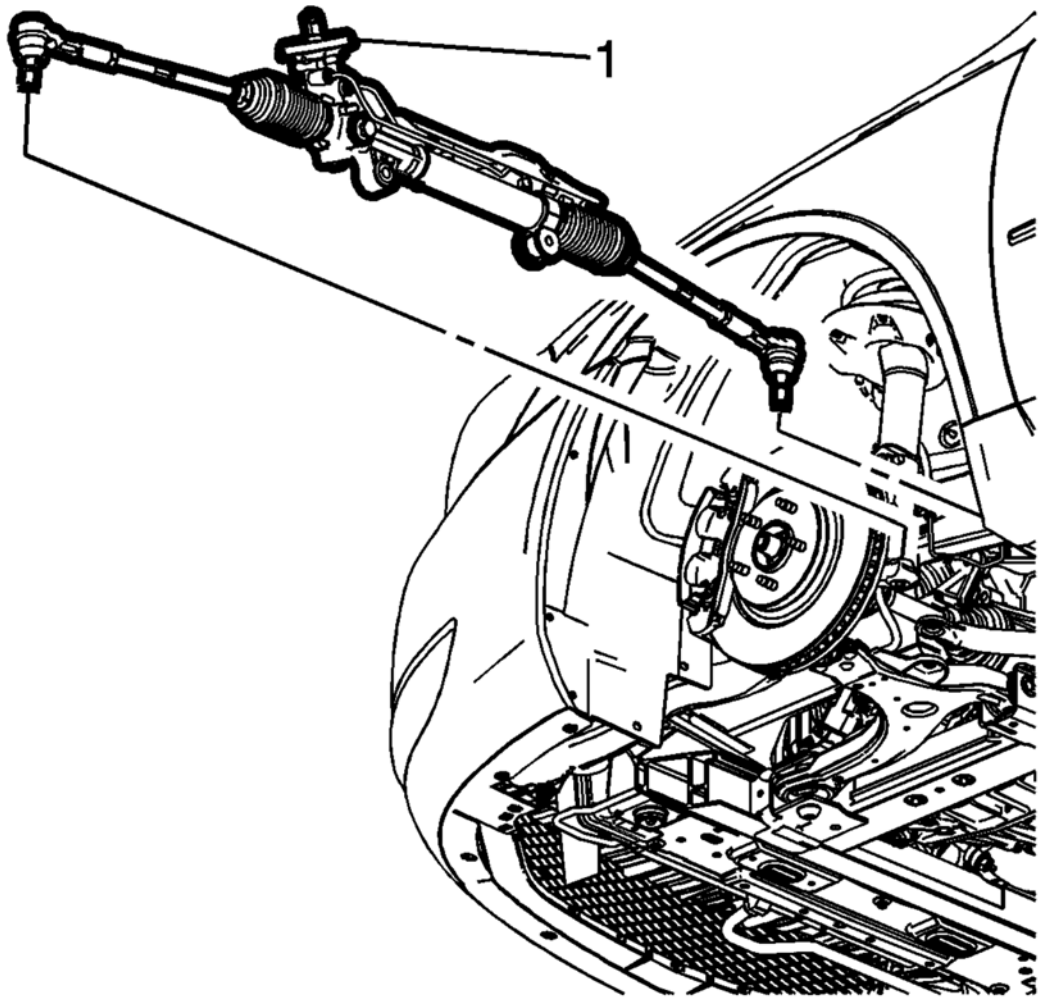


Fig. 53: Steering Gear
Courtesy of GENERAL MOTORS COMPANY

1. Position the steering gear (1) in the vehicle through the left wheel opening.
2. Install a NEW power steering fluid cooling pipe O-ring seal.

CAUTION: Refer to Installing Hoses without Twists or Bends Caution .

3. Connect the power steering fluid cooling pipe to the steering gear. Refer to **Power Steering Fluid Cooling Pipe Replacement**.
4. Install a NEW power steering gear inlet hose O-ring seal.
5. Connect the power steering gear inlet hose to the steering gear. Refer to **Power Steering Gear Inlet Pipe/Hose Replacement**.
6. Install the frame. Refer to **Frame Replacement** .

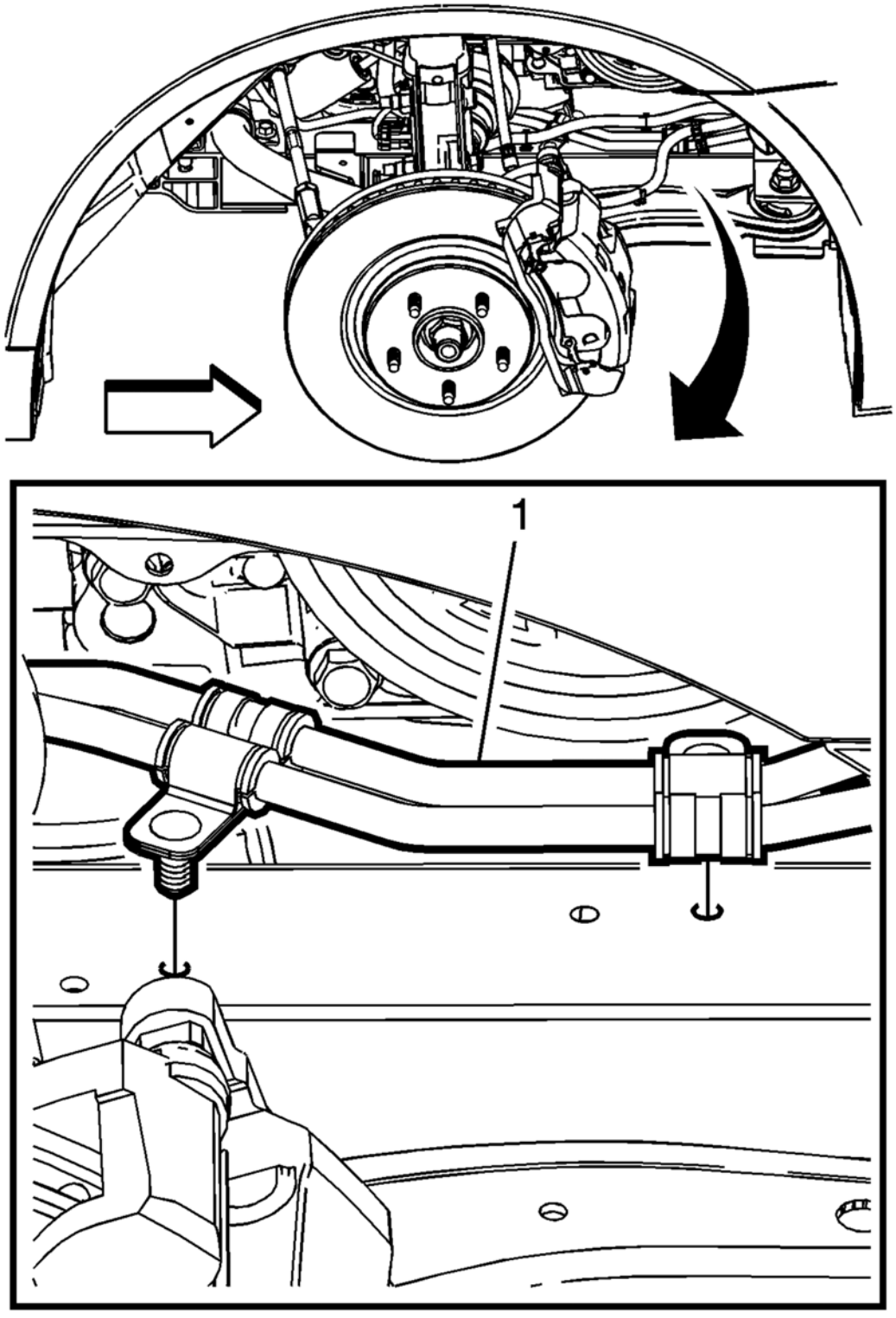


Fig. 54: Power Steering Fluid Cooling Pipe
Courtesy of GENERAL MOTORS COMPANY

7. On the right side of the frame, connect the 2 retainers and the power steering fluid cooling pipe (1) to the frame.

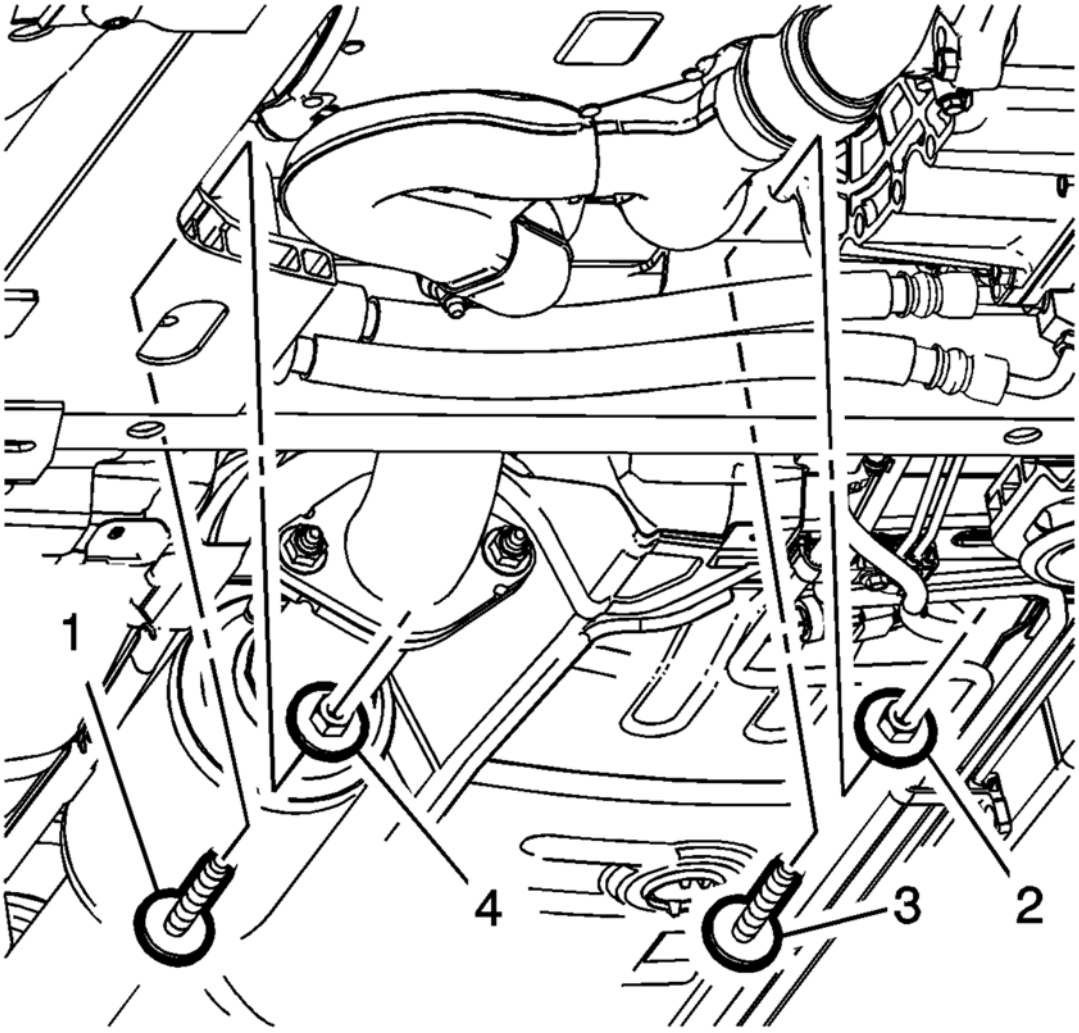


Fig. 55: Steering Gear Bolts And Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

8. Install the 2 steering gear bolts (1, 3) and the 2 nuts (2, 4). Hold the nuts and tighten the steering gear bolts to 90 N.m (66 lb ft).
9. Install the rear engine mount. Refer to **Engine Rear Mount Replacement** .
10. Connect both of the outer tie rods to the steering knuckles. Refer to **Steering Linkage Outer Tie Rod Replacement**.
11. Connect the intermediate steering shaft to the steering gear pinion shaft. Refer to **Intermediate Steering Shaft Replacement** .
12. Install the front tire and wheel assemblies. Refer to **Tire and Wheel Removal and Installation** .
13. Lower the vehicle.

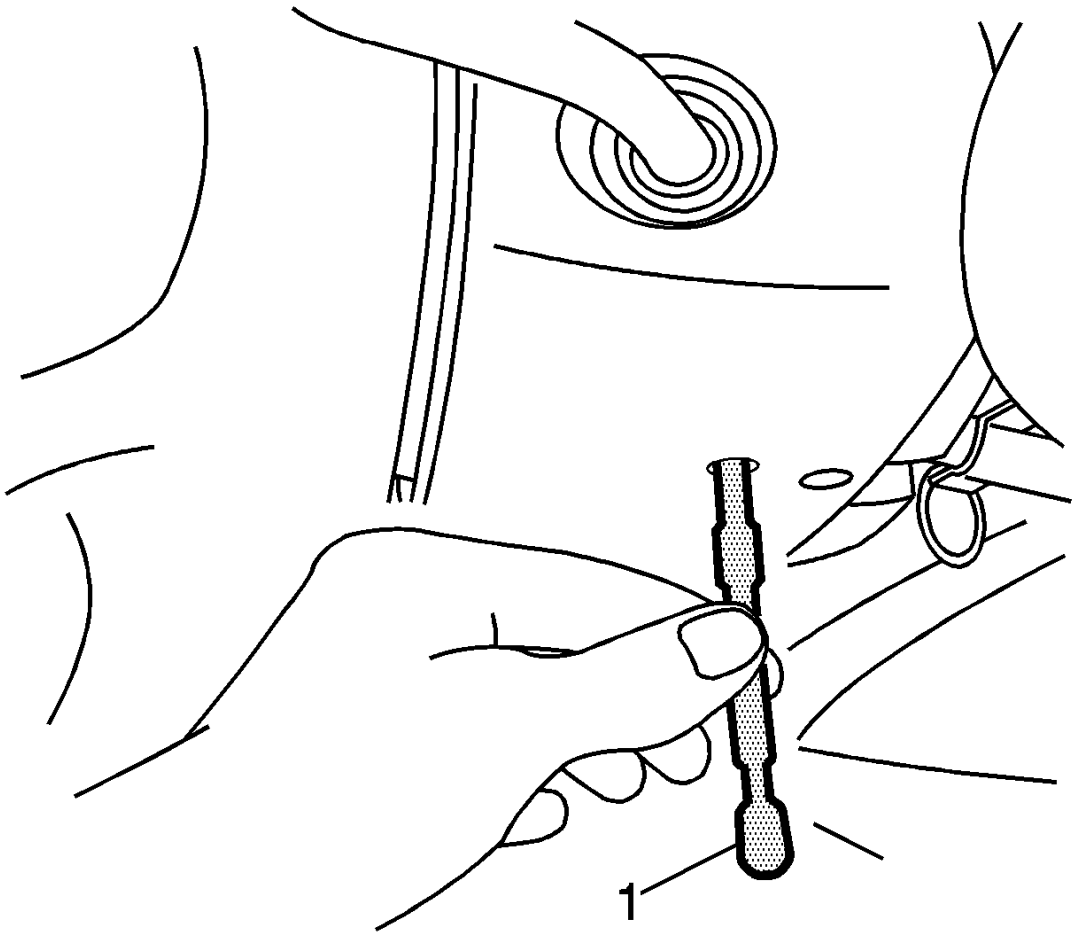


Fig. 56: Locking/Unlocking Steering Column
Courtesy of GENERAL MOTORS COMPANY

14. Remove the **J-42640** pin from the steering column.
15. Fill and bleed the power steering system. Refer to **Power Steering System Bleeding**.
16. Clean any excess power steering fluid from the vehicle.
17. Remove the drain pans.
18. Measure and adjust the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment** .

STEERING LINKAGE INNER TIE ROD REPLACEMENT

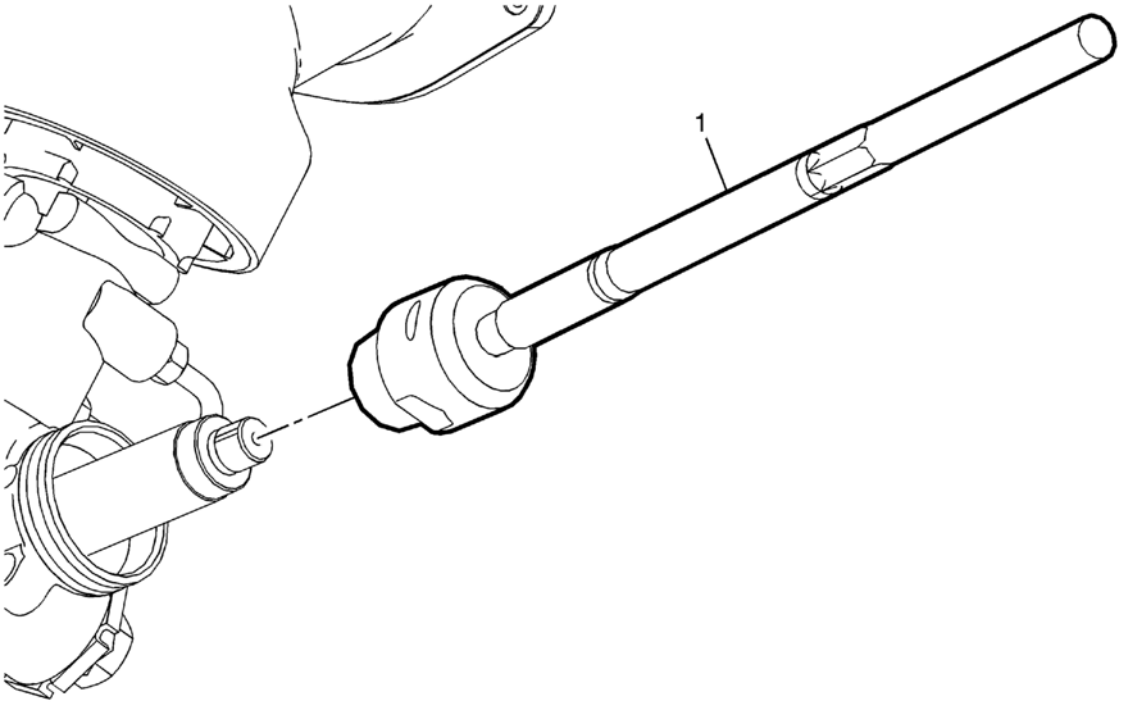


Fig. 57: Steering Linkage Inner Tie Rod
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the steering gear boot. Refer to **Steering Gear Boot Replacement**.	
1	Steering Linkage Inner Tie Rod **CAUTION:** **Do not change the steering gear preload adjustment before moving the inner tie rod from the steering gear. Changing the steering gear preload**

Callout	Component Name
	adjustment before moving the inner tie rod could result in damage to the pinion and the steering gear. **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Place a wrench on the flats of the steering linkage inner tie rod housing. 2. Rotate the steering linkage inner tie rod housing counterclockwise in order to remove the steering linkage inner tie rod from the rack. 3. Rotate the steering linkage inner tie rod housing clockwise in order to install the steering linkage inner tie rod to the rack. **Tighten** 100 N.m (74 lb ft)

DESCRIPTION AND OPERATION

POWER STEERING SYSTEM DESCRIPTION AND OPERATION

The hydraulic power steering pump is a constant displacement vane-type pump that provides hydraulic pressure and flow for the power steering gear. The hydraulic power steering pump is either belt-driven or direct cam-driven.

The power steering fluid reservoir holds the power steering fluid. The power steering fluid reservoir may be integral with the power steering pump or remotely located. The vehicle may have a combination of a power steering fluid reservoir integral with the power steering pump and a remotely located power steering fluid reservoir. The following locations are typical locations for the remote reservoir:

- Mounted to the front of the dash panel
- Mounted to the inner fender
- Mounted to a bracket on the engine

The 2 basic types of power steering gears are listed below:

- A recirculating ball system
- A rack and pinion system

In the recirculating ball system, a worm gear converts steering wheel movement to movement of a sector shaft. A pitman arm attached to the bottom of the sector shaft actually moves one tie rod. An intermediate rod moves the other tie rod.

In the rack and pinion system, the rack and the pinion are the 2 components that convert steering wheel rotation to lateral movement. The steering shaft is attached to the pinion in the steering gear. The pinion rotates with the steering wheel. Gear teeth on the pinion mesh with the gear teeth on the rack. The rotating pinion moves the rack from side to side. The lateral action of the rack pushes and pulls the tie rods in order to change the direction of the vehicle's front wheels.

The power steering pressure hose connects the power steering pump union fitting to the power steering gear and allows pressurized power steering fluid to flow from the pump to the gear.

The power steering return hose returns fluid from the power steering gear back to the power steering fluid reservoir. The power steering return hose may contain an integral fin-type or line-type power steering fluid cooler.

In a typical power steering system, a pump generates hydraulic pressure, causing fluid to flow, via the pressure hose, to the steering gear valve assembly. The steering gear valve assembly regulates the incoming fluid to the right and left chambers in order to assist in right and left turns.

Turning the steering wheel activates the valve assembly, which applies greater fluid pressure and flow to 1 side of the steering gear piston, and lower pressure and flow to the other side of the piston. The pressure assists the movement of the gear piston. Tie rods transfer this force to the front wheels, which turn the vehicle right or left.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

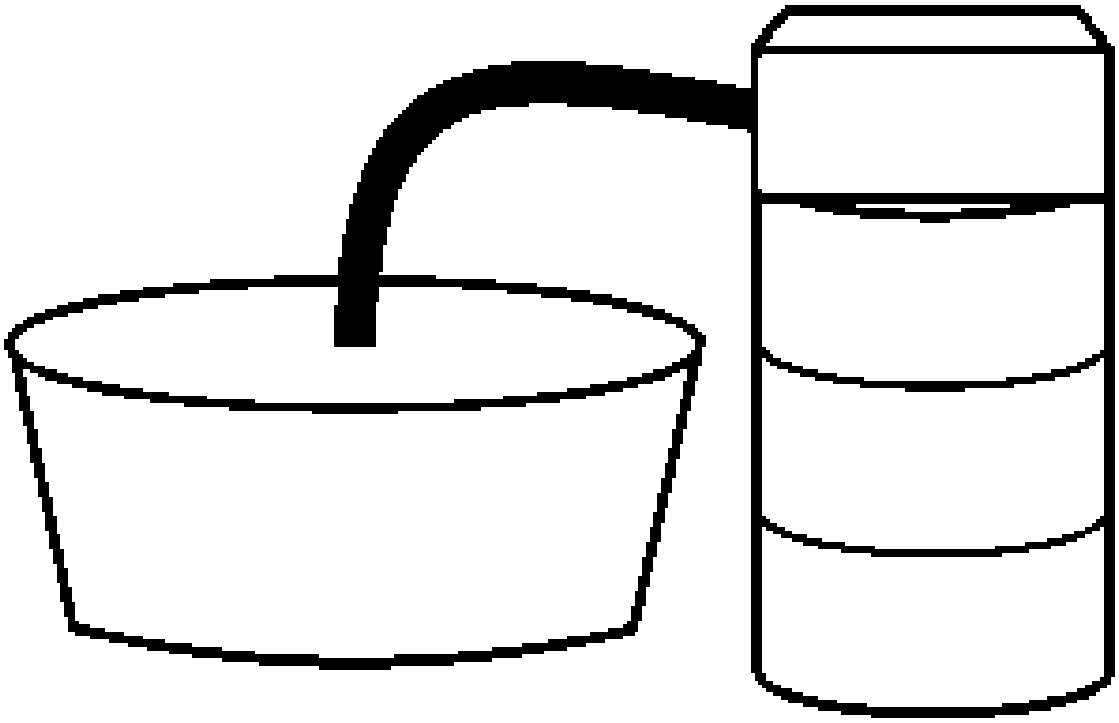
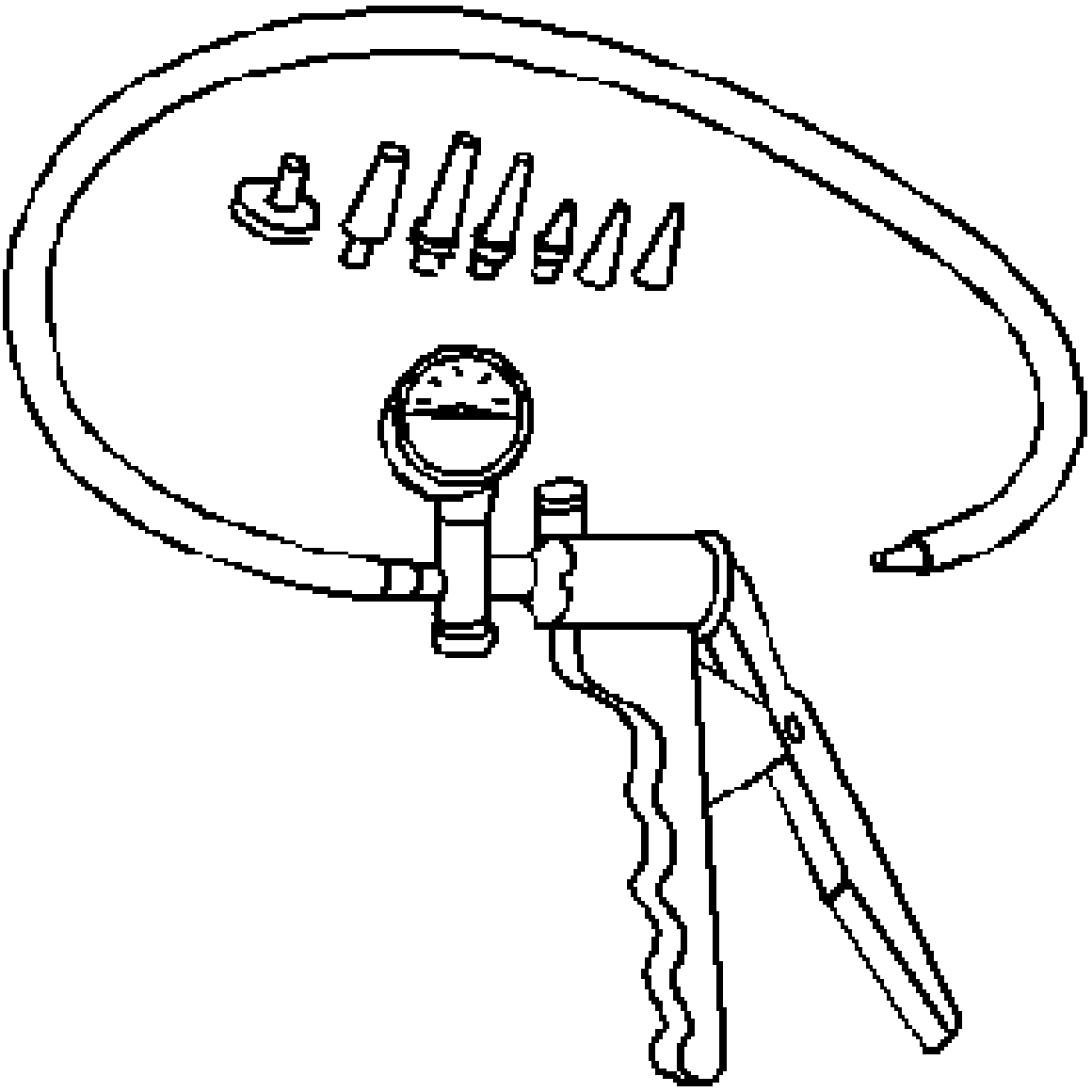
Illustration	Tool Number/ Description
	CH-43485 J-43485 Power Steering Bleeder Adapter

Illustration	Tool Number/ Description
	GE-23738-A J-23738-A J-35555 MKM-667 SA9180NE 30 14 883 Vacuum Pump

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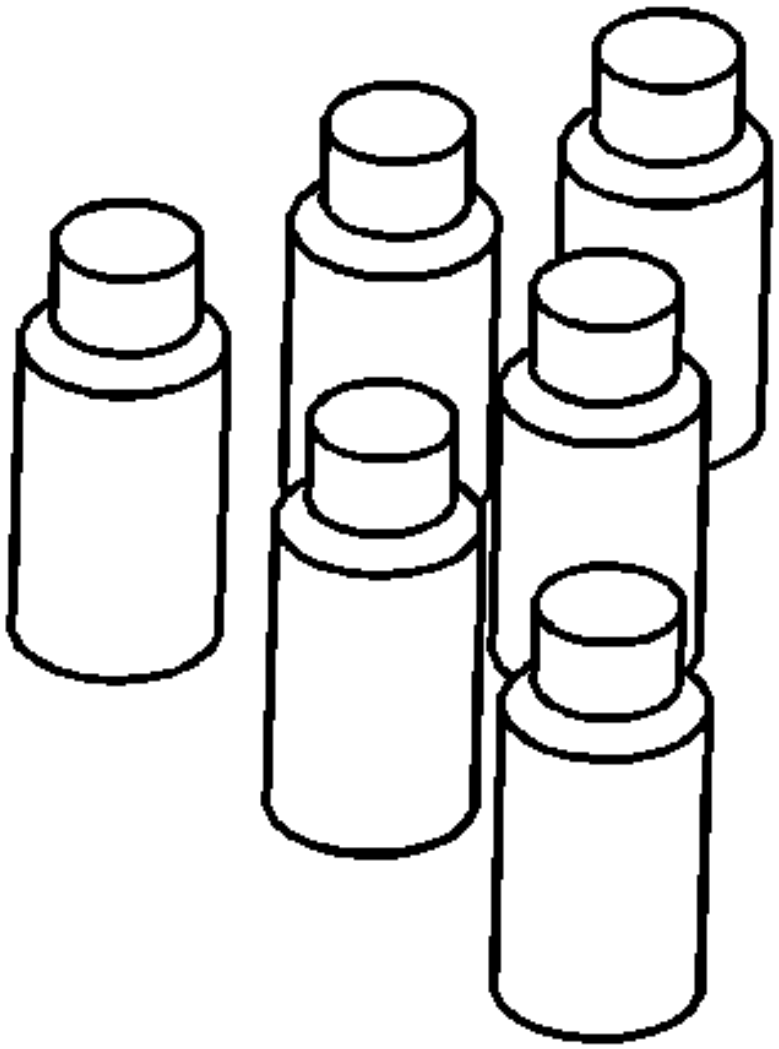	GE-28431-6 J-28431-6 Fluorescent Dye

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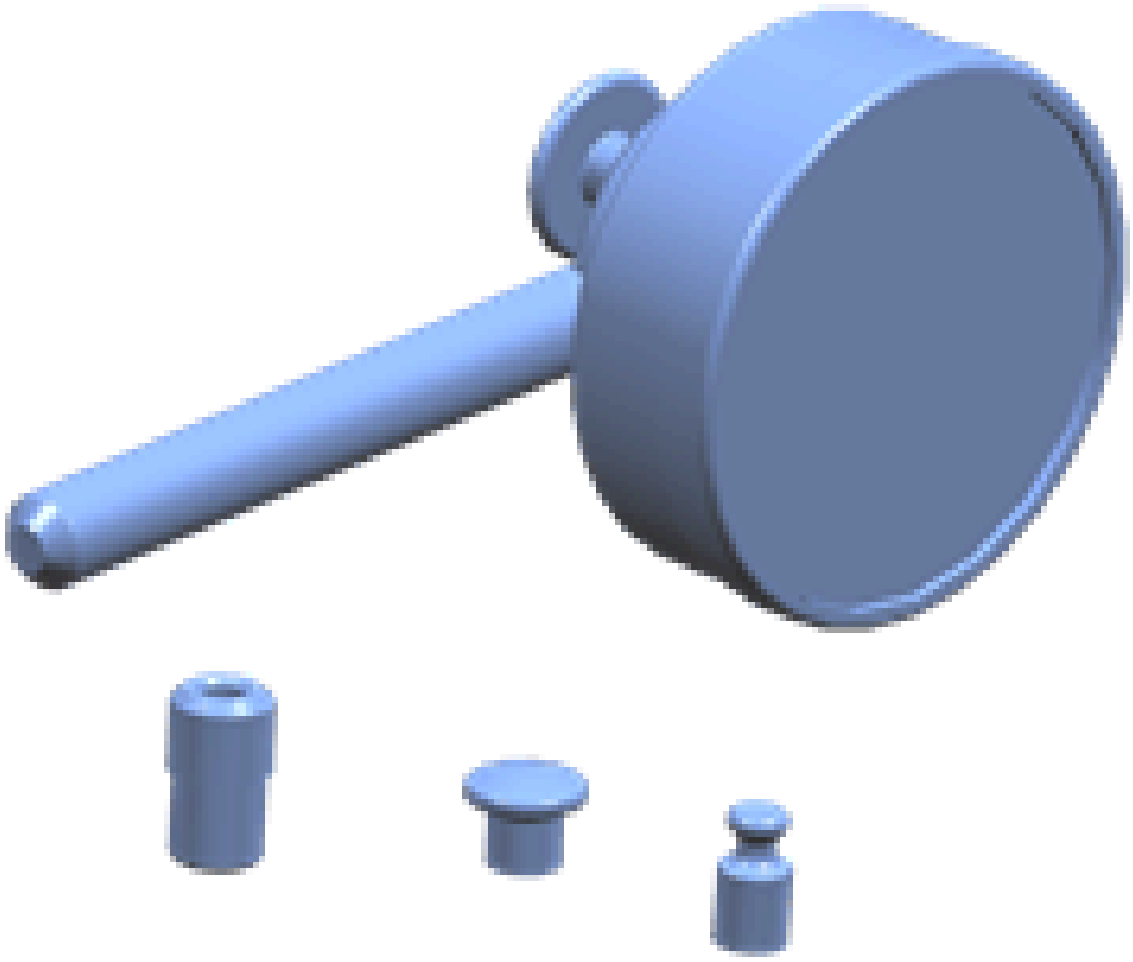
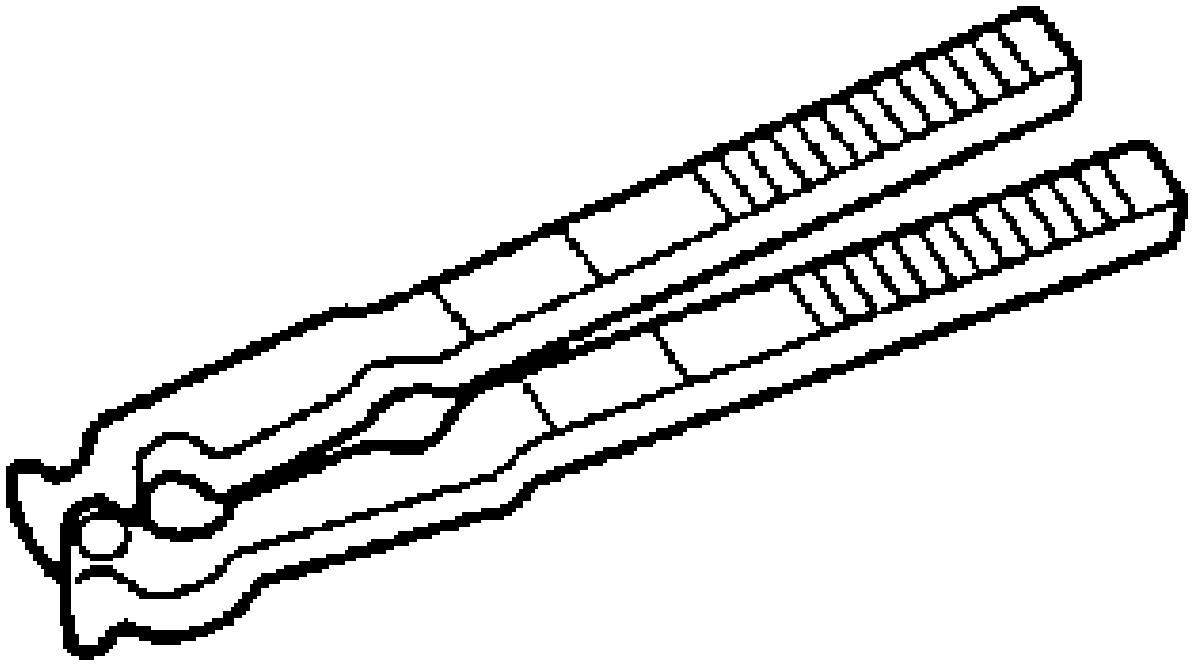
	J-8001 GE-8001 Dial Indicator Set

Illustration	Tool Number/ Description
	J-22610 CH-22610 KM-J-22610 SA9164C Keystone Clamp Pliers

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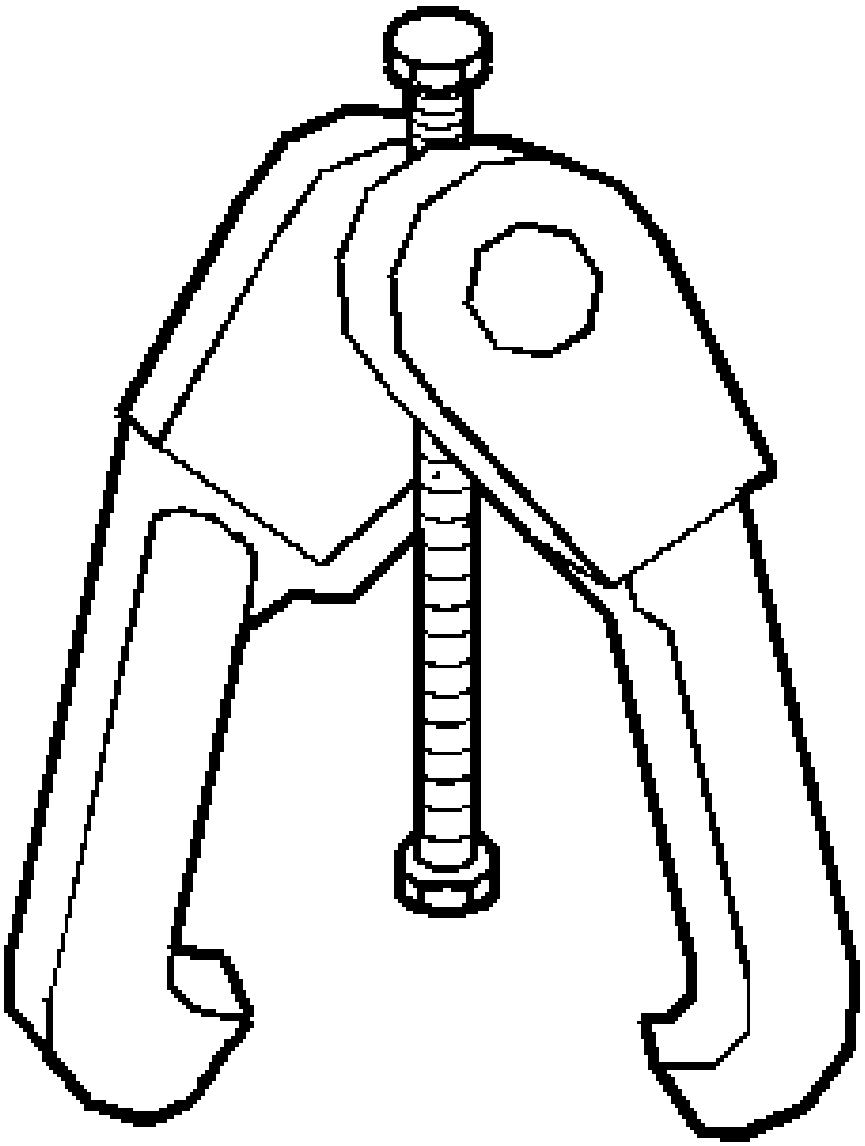
	J-24319-B CH-24319-B SA91100C 7503 Steering Linkage and Tie Rod Puller

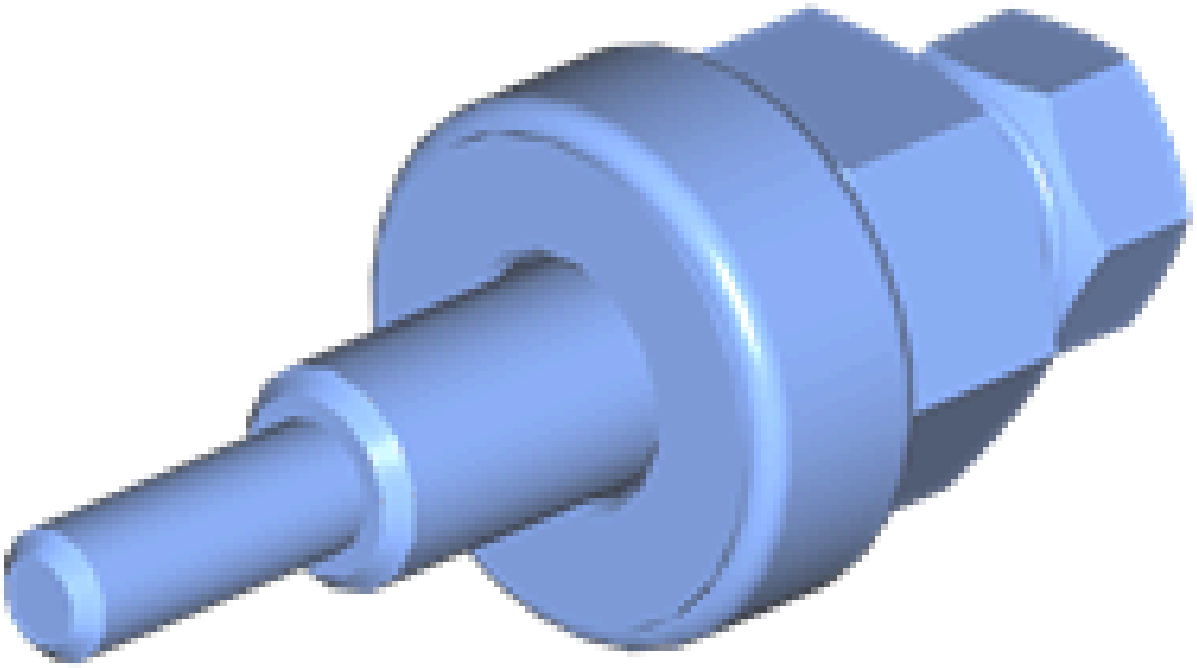
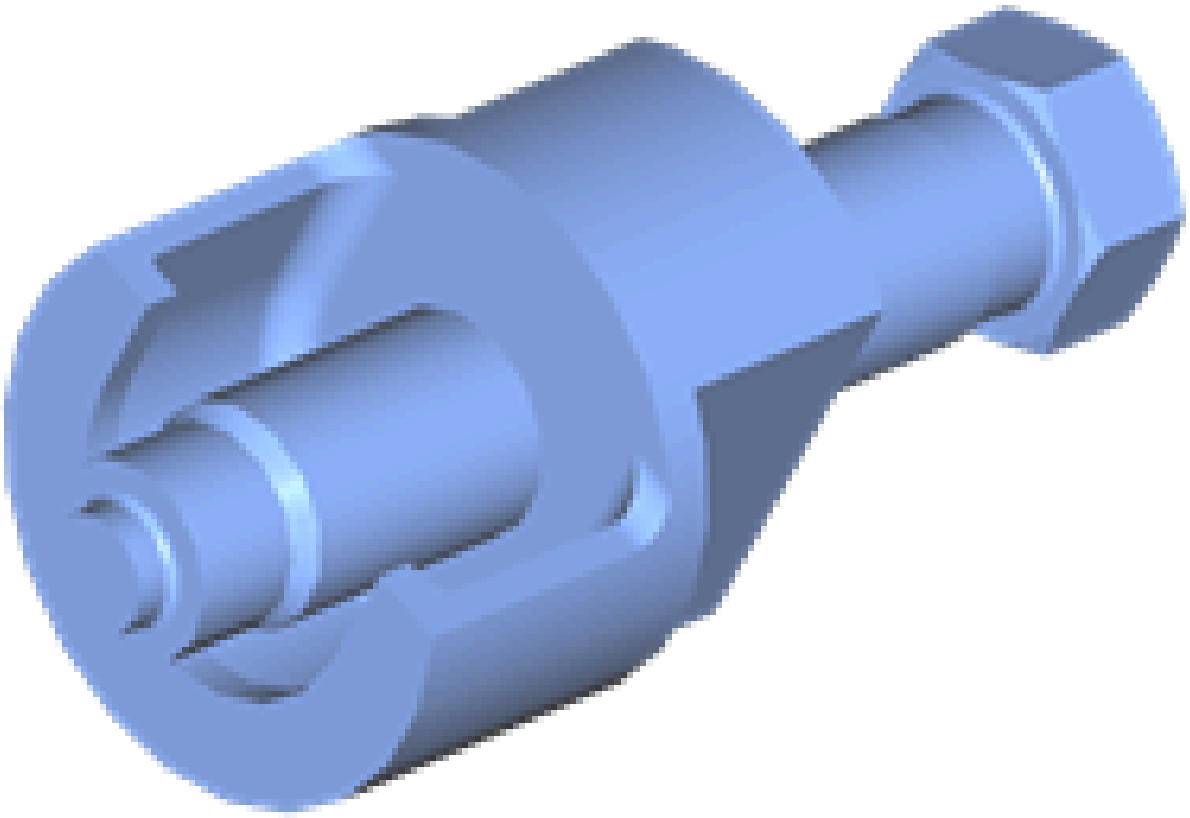
Illustration	Tool Number/ Description
	J-25033-C CH-25033-C KM-25033-C 8996415 Pulley Installer

Illustration	Tool Number/ Description
	J-25034-C CH-25034-C KM-25034-C Pulley Remover

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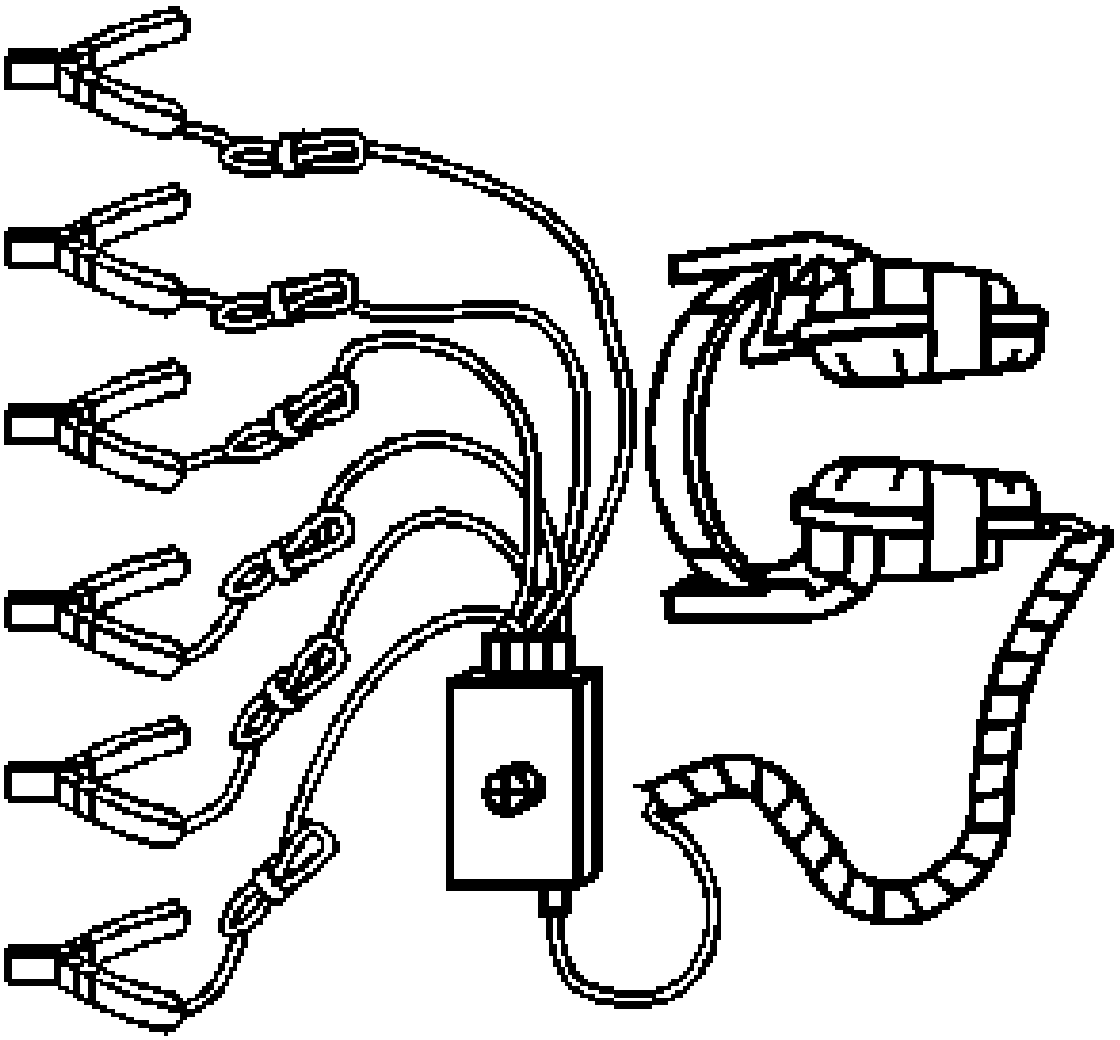
	J-39570 CH-39570 Chassis Ear

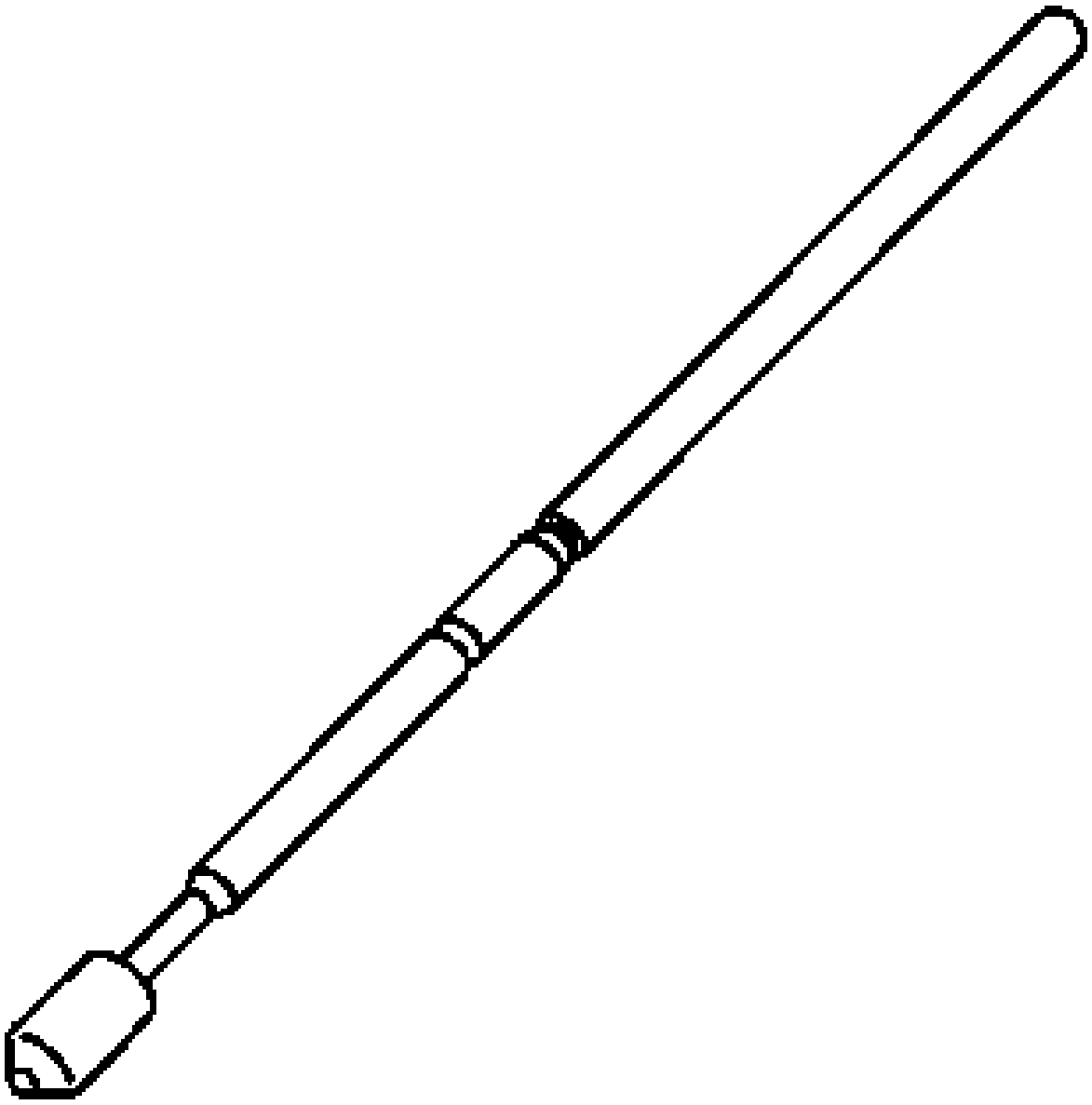
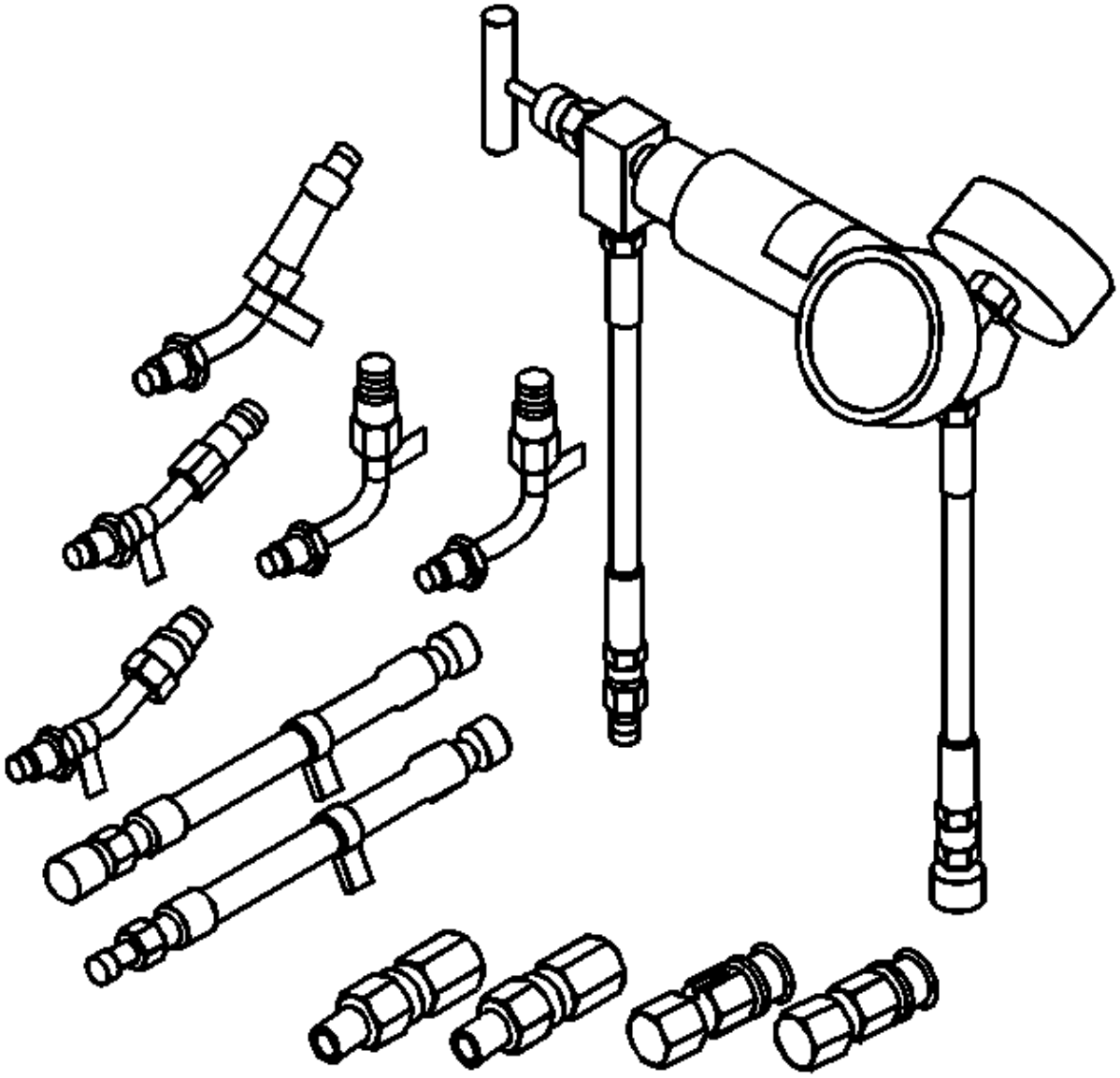
Illustration	Tool Number/ Description
	J-42640 CH-42640 Steering Column Anti-rotation Pin

Illustration	Tool Number/ Description
	J-44721 CH-44721 Power Steering Analyzer

Article GUID: A00737197

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Intermediate Steering Shaft Bolt	62 N.m	46 lb ft
Intermediate Steering Shaft Lower Bolt	48 N.m	35 lb ft
Intermediate Steering Shaft Seal Bolt	3 N.m	27 lb in
Linear Shift Assembly Bolt	10 N.m	89 lb in
Shift Lever Bolt	20 N.m	15 lb ft
Steering Column Bolt	25 N.m	18 lb ft
Steering Column Nut	25 N.m	18 lb ft
Steering Column Support Bolt	17 N.m	13 lb ft
Steering Column Trim Bolt	3 N.m	27 lb in
Steering Wheel Nut	41 N.m	30 lb ft
Turn Signal Multifunction Switch Bolt	1 N.m	11 lb in

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Centering Sphere	Lubricant	12345718	10953516
Pivot Pin	Lubricant	12346293	992723
Turn Signal Cancel Cam	Lubricant	12377900	10953529

COMPONENT LOCATOR

STEERING COLUMN DISASSEMBLED VIEW (COLUMN SHIFT)

Tilt Steering Column, Column Shift

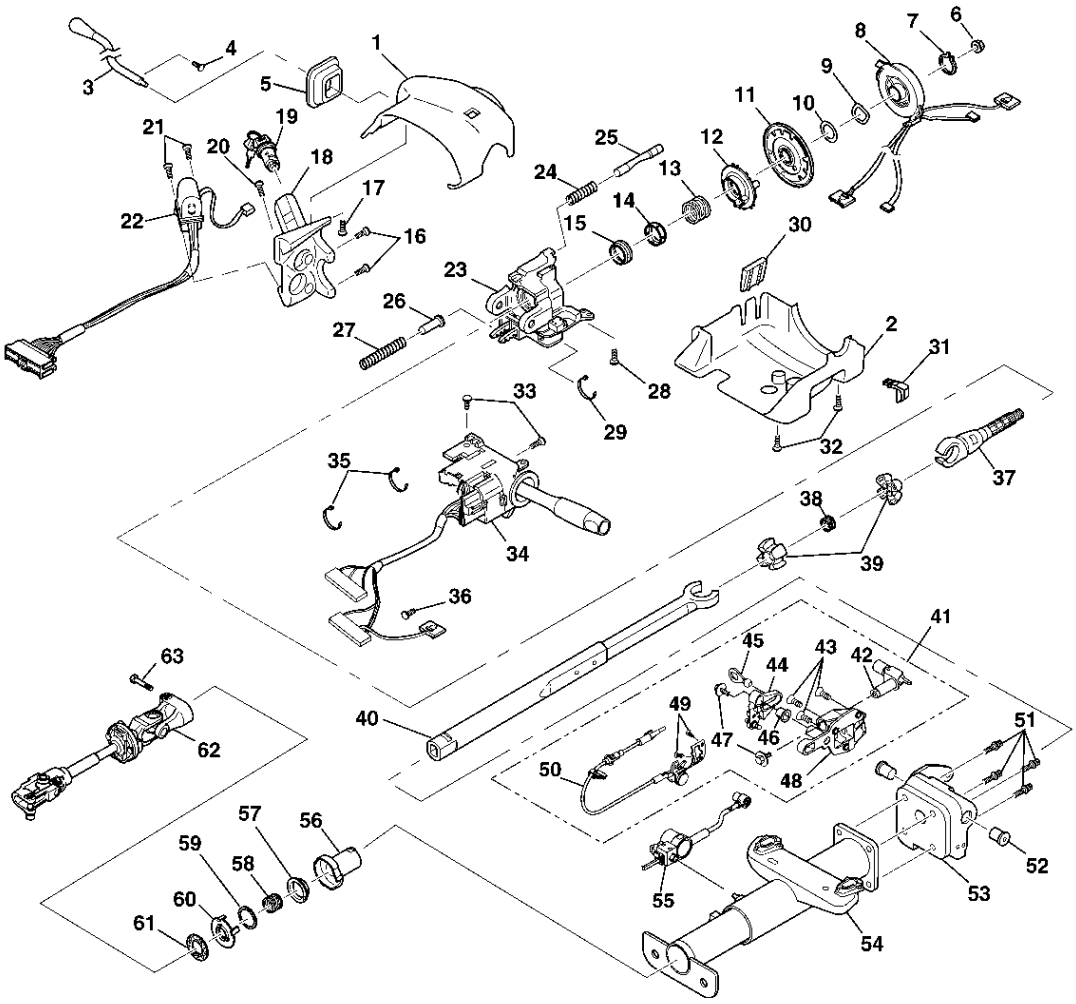


Fig. 1: Tilt Steering Column Disassembled View, Column Shift
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Upper Trim Cover
2	Lower Trim Cover
3	Shift Lever Assembly
4	Shift Lever Screw
5	Shift Lever Seal
6	Flanged Prevailing Torque Nut
7	Retaining Ring
8	SIR Coil
9	Wave Washer
10	Bearing Retainer
11	Shaft Lock Shield Assembly
12	Turn Signal Cancel Cam Assembly
13	Upper Bearing Spring
14	Upper Bearing Inner Race Seat

Callout	Component Name
15	Inner Race
16	Pan Head Tapping Screws
17	TORXÂ® Head Screw
18	Ignition Lock Cylinder Case Assembly
19	Steering Column Lock Cylinder Set
20	Pan Head Tapping Screw
21	Tapping Screws
22	Ignition Switch Assembly
23	Steering Column Tilt Head Housing Assembly
24	Lock Bolt Spring
25	Lock Bolt Assembly
26	Spring Guide
27	Tilt Spring
28	TORXÂ® Head Screw
29	Wire Harness Strap
30	Trim Cover Protector
31	Tilt Knob
32	TORXÂ® Head Screws
33	Pan Head Tapping Screws
34	Turn Signal and Multifunction Switch Assembly
35	Wire Harness Straps
36	Position Assurance Connector
37	Race and Upper Shaft Assembly
38	Joint Preload Spring
39	Centering Sphere
40	Lower Steering Shaft Assembly
41	Linear Shift Assembly
42	Shift Lever Clevis
43	Flat Head 6-Lobed Soc Tap Screws
44	Cable Shift Cam Assembly
45	Ball and Actuator Assembly
46	Cam Bushing
47	Hexagon Flange Head Bolts
48	Gear Shift Lever Assembly Support Bracket
49	Oval Head 6-Lobed Soc Tap Screws
50	Park Lock Cable System
51	TORXÂ® Head Screws
52	Pivot Pins
53	Steering Column Support Assembly
54	Steering Column Jacket Assembly
55	Automatic Transmission Shift Lock Control

Callout	Component Name
56	Adapter and Bearing Assembly
57	Lower Bearing Seat
58	Lower Bearing Spring
59	Lower Spring Retainer
60	Retainer
61	Steering Shaft Seal
62	Intermediate Steering Shaft Assembly
63	Pinch Bolt

STEERING COLUMN DISASSEMBLED VIEW (FLOOR SHIFT)

Tilt Steering Column, Floor Shift

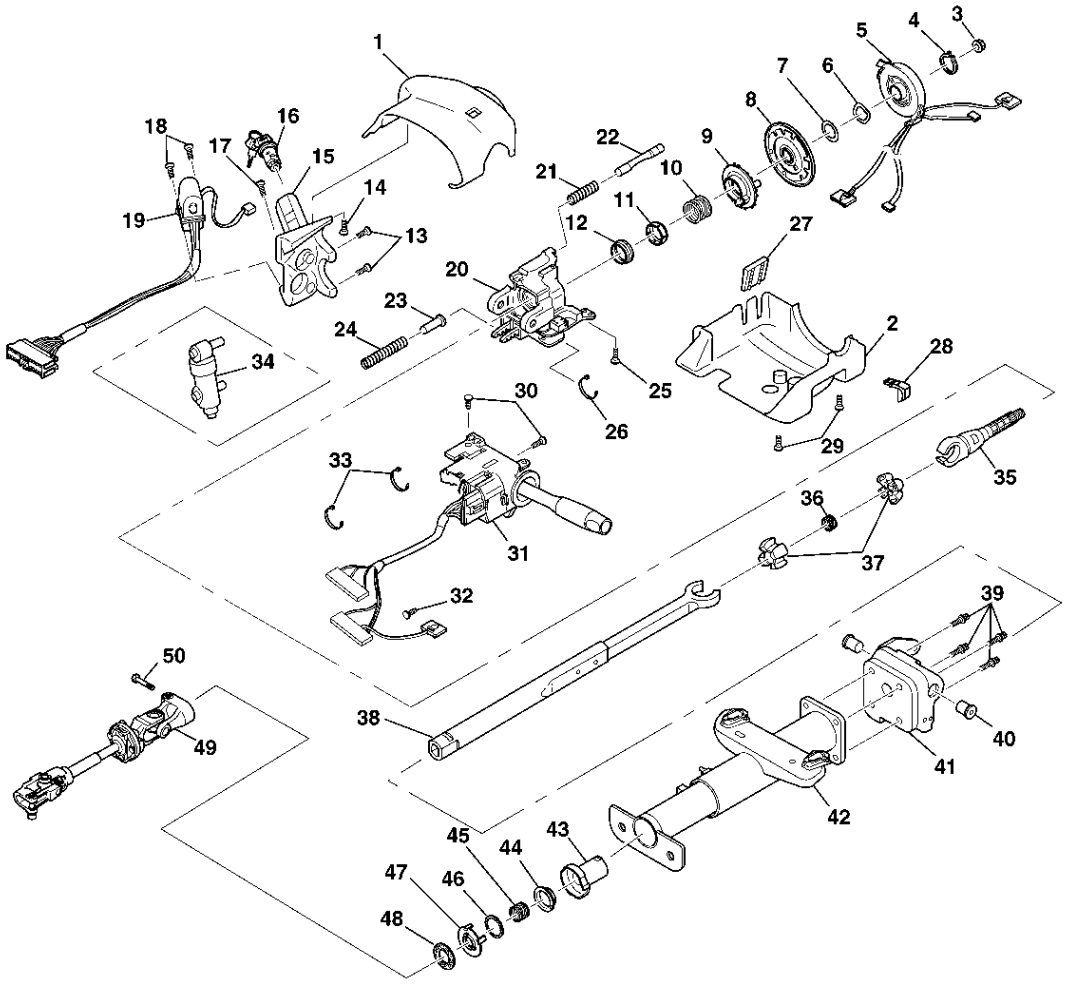


Fig. 2: Tilt Steering Column Disassembled View, Floor Shift
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Upper Trim Cover

Callout	Component Name
2	Lower Trim Cover
3	Flanged Prevailing Torque Nut
4	Retaining Ring
5	SIR Coil
6	Wave Washer
7	Bearing Retainer
8	Shaft Lock Shield Assembly
9	Turn Signal Cancel Cam Assembly
10	Upper Bearing Spring
11	Upper Bearing Inner Race Seat
12	Inner Race
13	Pan Head Tapping Screws
14	TORXÂ® Head Screw
15	Ignition Lock Cylinder Case Assembly
16	Steering Column Lock Cylinder Set
17	Pan Head Tapping Screw
18	Tapping Screws
19	Ignition Switch Assembly
20	Steering Column Tilt Head Assembly
21	Lock Bolt Spring
22	Lock Bolt Assembly
23	Spring Guide
24	Tilt Spring
25	TORXÂ® Head Screw
26	Wire Harness Strap
27	Trim Cover Protector
28	Tilt Knob
29	Pan Head Tapping Screws
30	Pan Head Tapping Screws
31	Turn Signal and Multifunction Switch Assembly
32	Position Assurance Connector
33	Wire Harness Straps
34	Steering Wheel Theft Deterrent Park Lock
35	Race and Upper Shaft Assembly
36	Joint Preload Spring
37	Centering Sphere
38	Lower Shaft Assembly
39	TORXÂ® Head Screws
40	Pivot Pins
41	Steering Column Support Assembly
42	Steering Column Jacket Assembly

Callout	Component Name
43	Adapter and Bearing Assembly
44	Lower Bearing Seat
45	Lower Bearing Spring
46	Lower Spring Retainer
47	Retainer
48	Steering Shaft Seal
49	Intermediate Steering Shaft Assembly
50	Pinch Bolt

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - STEERING WHEEL AND COLUMN

Review the system description and operation in order to familiarize yourself with the system functions. Refer to **Steering Wheel and Column Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the steering wheel and column.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Symptoms List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Noise in Steering Column**
- **Looseness in Steering Column**
- **Steering Column Tilt Function Inoperative**
- **Ignition Can/Cannot Be Turned Off with Transmission in Any Gear**

STEERING COLUMN TILT FUNCTION INOPERATIVE

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Steering Wheel and Column**
2	Verify that the steering column tilt function is inoperative. Does the steering column tilt function operate normally?	System OK	Go to **Step 3**

Step	Action	Yes	No
3	If equipped, verify that the following components are not seized or corroded: • Tilt pivot pins • Tilt head lock shoes Are the components seized or corroded?	Go to **Step 7**	Go to **Step 4**
4	Inspect the tilt pivot pins for binding. Are the tilt pivot pins binding?	Go to **Step 8**	Go to **Step 5**
5	Inspect for a weak or broken steering column tilt spring. Is the steering column tilt spring weak or broken?	Go to **Step 9**	Go to **Step 6**
6	Inspect the steering column wiring harness routing for tightness. Was the steering column wiring harness routed correctly?	Go to **Step 11**	Go to **Step 10**
7	Replace the steering column. Refer to **Steering Column Replacement**. Did you complete the repair?	Go to **Step 11**	-
8	If serviceable, replace the pivot pins. If not serviceable replace the steering column. Refer to **Steering Column Replacement**. Did you complete the repair?	Go to **Step 11**	-
9	If serviceable, replace the tilt spring. Did you complete the repair?	Go to **Step 11**	-
10	Route the steering column wiring harness to the correct location. Did you correctly route the wiring harness?	Go to **Step 11**	-
11	Operate the steering column tilt function in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

NOISE IN STEERING COLUMN

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Steering Wheel and Column**
2	Verify that noise is present in the steering column during operation. Is noise present in the steering column during operation?	Go to **Step 3**	System OK

Step	Action	Yes	No
3	Inspect the steering column mounting features for the following conditions: • The steering column mounting fasteners are loose. • The steering column mounting features are sheared. Are the steering column mounting features loose or sheared?	Go to **Step 10**	Go to **Step 4**
4	Inspect the SIR/SRS coil for noise. Is the SIR/SRS coil noisy?	Go to **Step 11**	Go to **Step 5**
5	If equipped, inspect the lock plate retaining ring for correct installation. Is the lock plate retaining ring installed incorrectly?	Go to **Step 12**	Go to **Step 6**
6	Inspect the steering column upper and lower bearings for the following conditions: • Damage • Lubrication • Wear • Proper seating Are the bearings in need of repair or replacement?	Go to **Step 13**	Go to **Step 7**
7	Does the steering column tilt joint need to be lubricated?	Go to **Step 14**	Go to **Step 8**
8	**NOTE:** **Inspect the intermediate steering shaft for noise while driving the vehicle, turning the steering wheel, and applying the brakes.** Inspect the intermediate steering shaft for noise.Is the intermediate steering shaft noisy?	Go to **Step 15**	Go to **Step 9**

Step	Action	Yes	No
9	**NOTE:** **For vehicles equipped with a telescoping steering column, perform this step. If not equipped, go to next step.** Inspect the steering column for noise while telescoping the column.Is the steering column noisy while telescoping?	Go to **Step 16**	Go to **Step 17**
10	**NOTE:** **If the steering column mounting features are damaged or sheared, replace the steering column. Refer to Steering Column Replacement.** Tighten the steering column mounting fasteners to specification. Refer to **Fastener Specifications**.Did you complete the repair?	Go to **Step 17**	-
11	Replace the SIR/SRS coil. Refer to **Steering Wheel Airbag Coil Replacement** . Did you complete the repair?	Go to **Step 17**	-
12	Install the lock plate retaining ring correctly. Did you complete the repair?	Go to **Step 17**	-
13	**NOTE:** **If the steering column upper and/or lower bearings are**	Go to **Step 17**	-

Step	Action	Yes	No
	not serviceable, replace the steering column. Refer to Steering Column Replacement. Replace the steering column upper and/or lower bearings, if serviceable.Did you complete the replacement?		
14	Lubricate the steering column tilt joint. Did you complete the repair?	Go to **Step 17**	-
15	Replace the appropriate intermediate steering shaft component. Did you complete the repair?	Go to **Step 17**	-
16	Redistribute or add lubricant to the steering column lower jacket with the column telescoped to its end of outward travel. Did you complete the repair?	Go to **Step 17**	-
17	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

LOOSENESS IN STEERING COLUMN

Step	Action	Yes	No
1	Did you review the Steering Wheel and Column Description and Operation and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Steering Wheel and Column**
2	Verify that the steering column is loose. Is the steering column loose?	Go to **Step 3**	System OK
3	Inspect the steering column mounting features for the following conditions. • The steering column mounting fasteners are loose. • The steering column mounting features are sheared. Are the steering column mounting features loose or sheared?	Go to **Step 5**	Go to **Step 4**
4	Inspect the upper and/or lower bearings for looseness. Are any of the bearings worn or loose?	Go to **Step 6**	Go to **Step 7**

Step	Action	Yes	No
5	**NOTE:** **If the steering column mounting features are damaged or sheared, replace the steering column. Refer to Steering Column Replacement.** Tighten the steering column mounting fasteners to specification. Refer to **Fastener Specifications**.Did you complete the repair?	Go to **Step 7**	-
6	**NOTE:** **If the steering column upper and/or lower bearings are not serviceable, replace the steering column. Refer to Steering Column Replacement.** Replace the upper and/or lower bearings, if serviceable.Did you complete the repair?	Go to **Step 7**	-
7	Operate the steering column in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

REPAIR INSTRUCTIONS

INTERMEDIATE STEERING SHAFT SEAL REPLACEMENT

Special Tools

J-42640 Steering Column Anti-rotation Pin

Removal Procedure

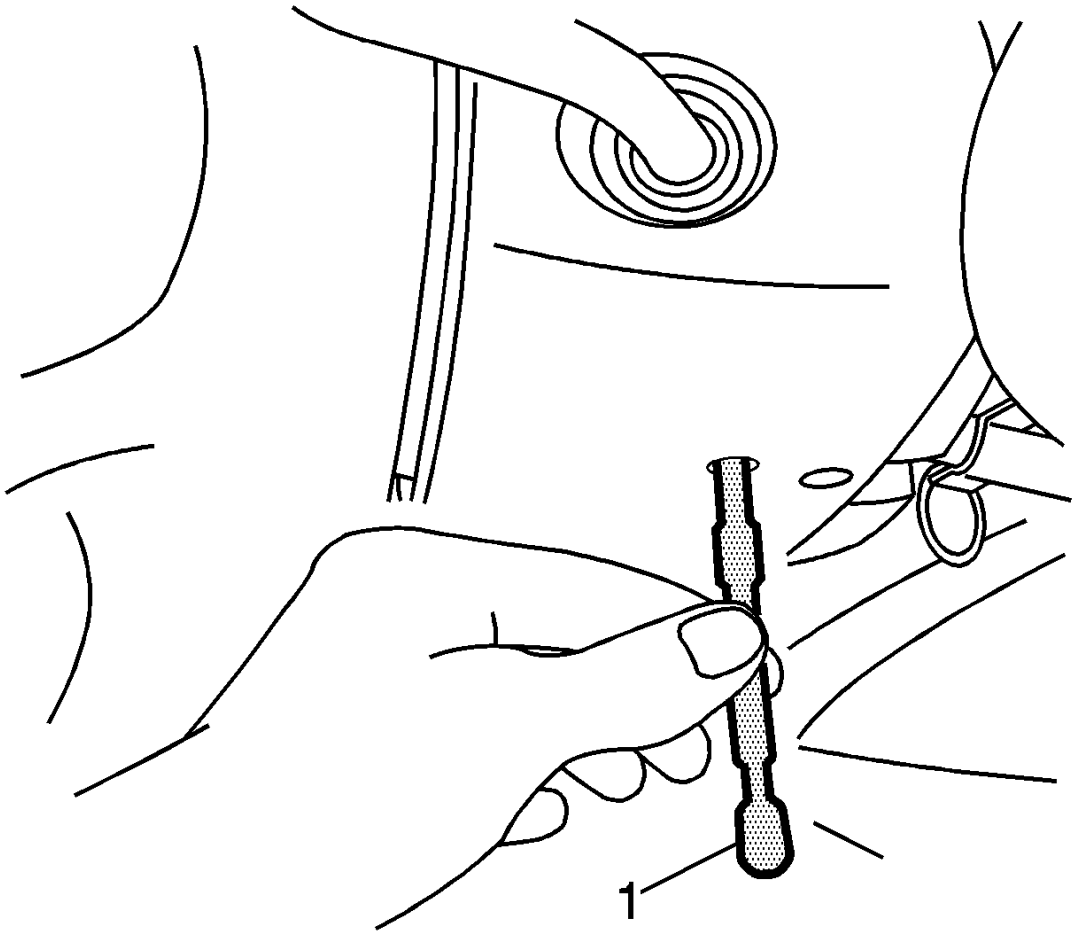


Fig. 3: Locking/Unlocking Steering Column
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:**

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible

damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. Insert the **J-42640** pin into the steering column access hole in order to lock the steering column.
2. Separate the intermediate steering shaft seal from the steering column.
3. Disconnect the intermediate steering shaft from the steering column. Refer to **Intermediate Steering Shaft Replacement**.
4. Push the intermediate steering shaft down in order to collapse the intermediate steering shaft.

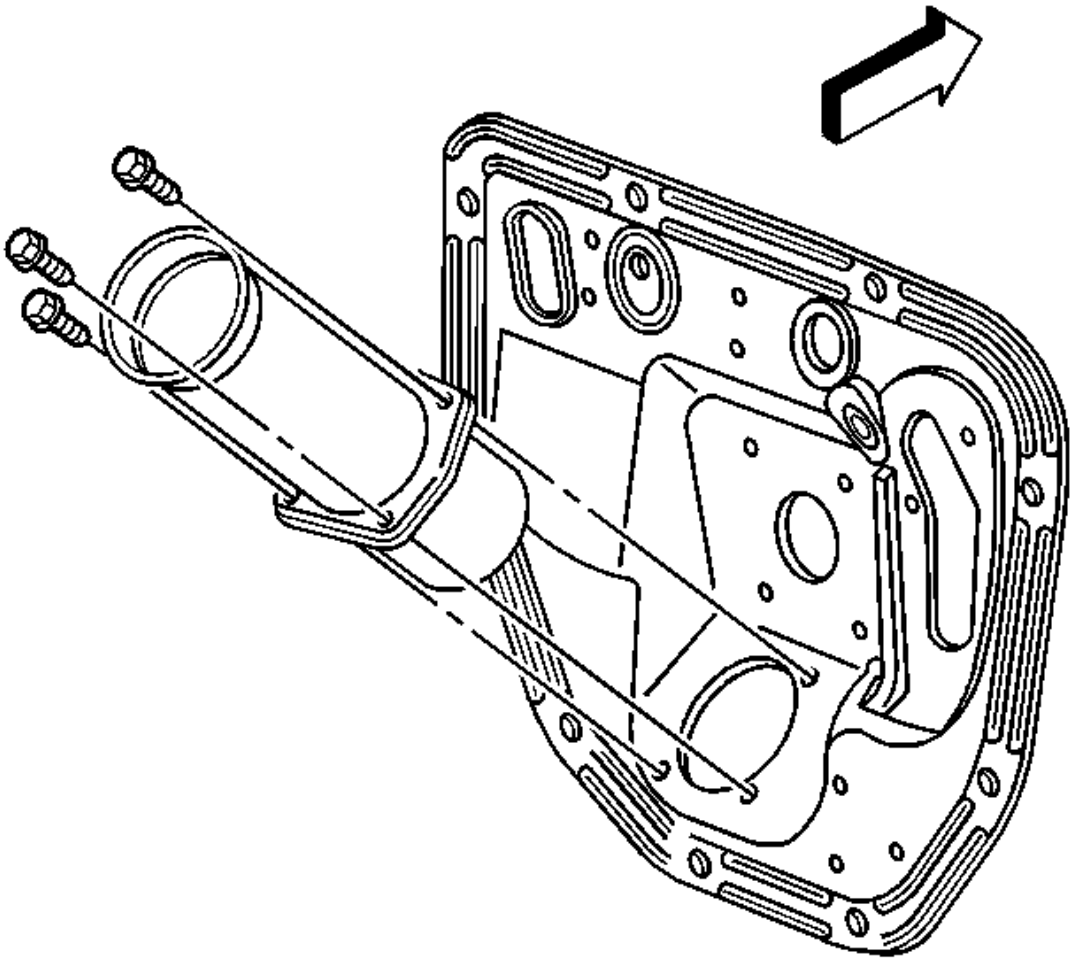


Fig. 4: Locating Intermediate Shaft Seal Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the intermediate steering shaft seal bolts.
6. Separate the intermediate steering shaft seal from the steering gear.
7. Remove the intermediate steering shaft seal from the vehicle.

Installation Procedure

1. Position the intermediate steering shaft seal in the vehicle.
2. Position the intermediate steering shaft lower seal on the intermediate shaft and on the steering gear.
3. Position the intermediate steering shaft upper seal over the lower seal and on the dash panel.
4. Connect the intermediate steering shaft to the steering column. Refer to **Intermediate Steering Shaft Replacement**.
5. Install the intermediate steering shaft seal to the steering column.

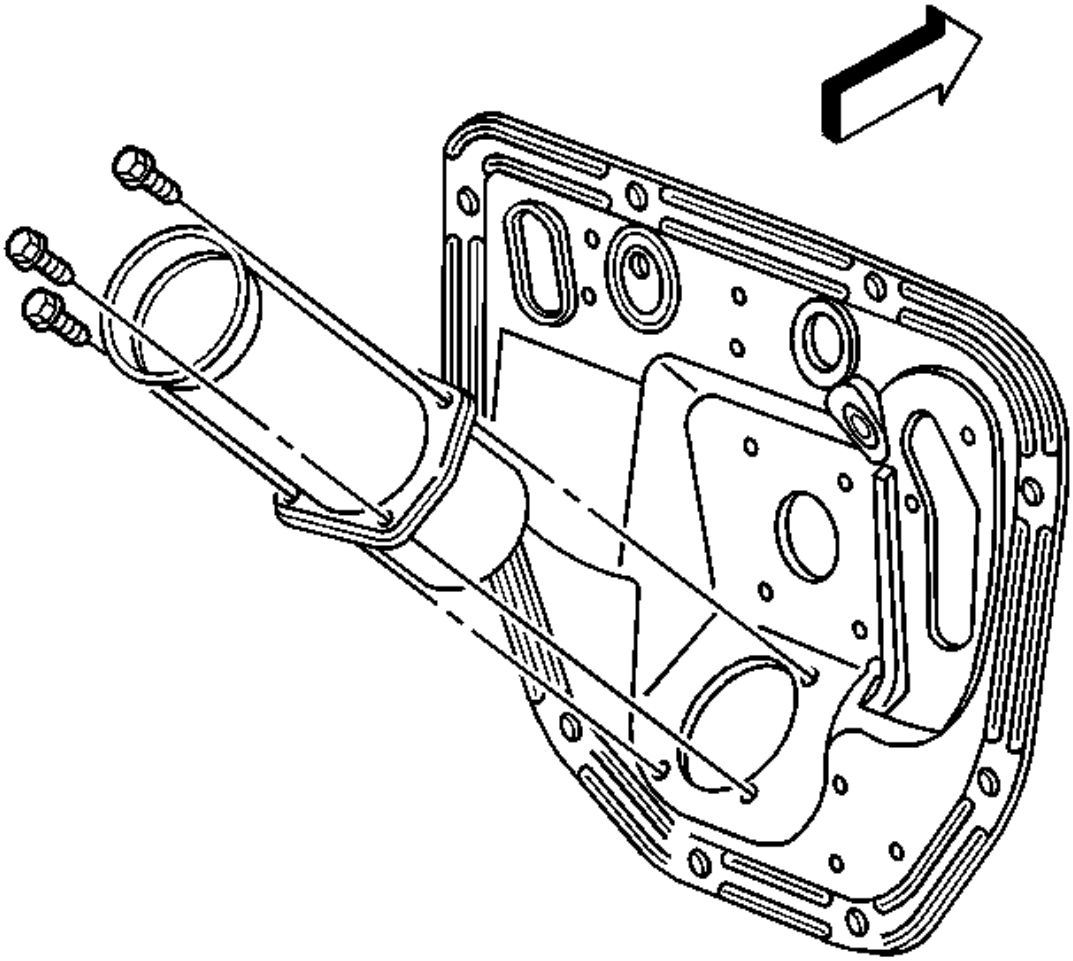


Fig. 5: Locating Intermediate Shaft Seal Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

6. Install the intermediate steering shaft seal bolts and tighten to 3 N.m (27 lb in).
7. Remove the **J-42640** pin.

INTERMEDIATE STEERING SHAFT REPLACEMENT

Special Tools

J 42640 Steering Column Anti-rotation Pin

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

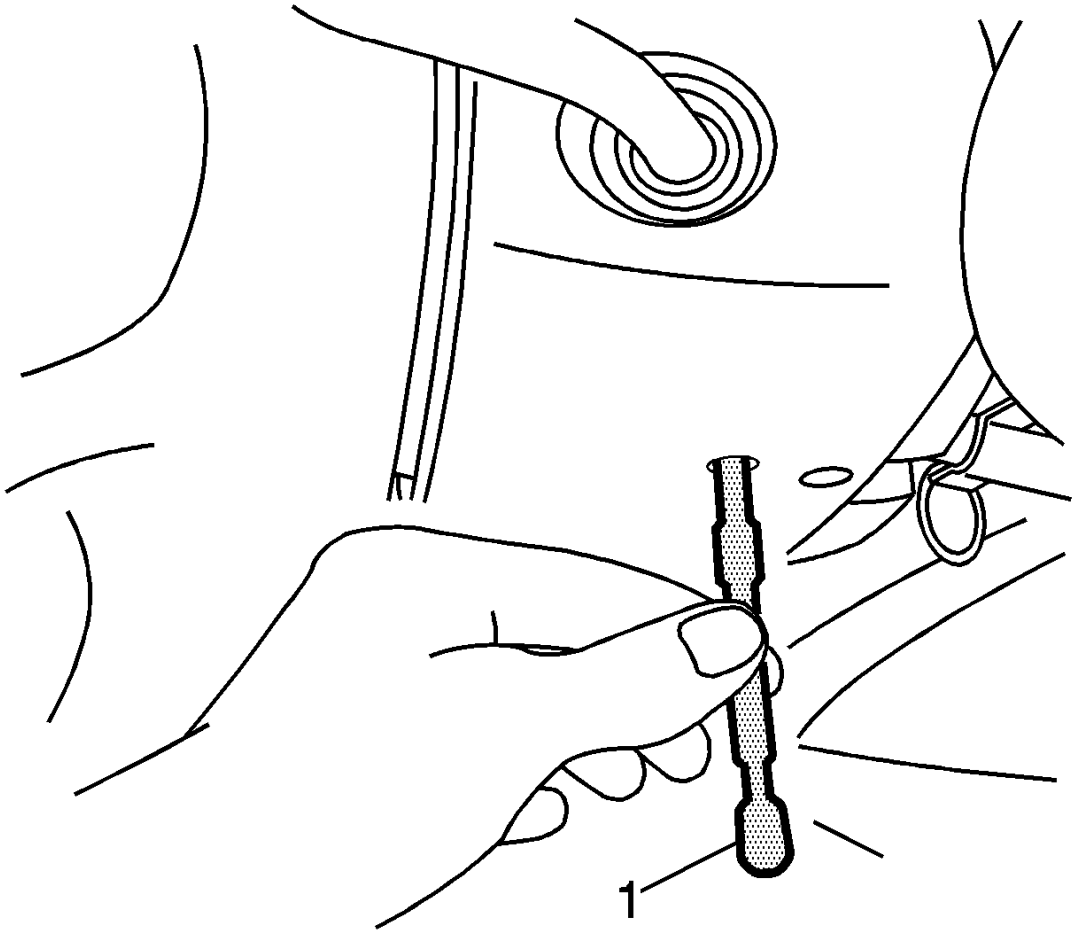


Fig. 6: Locking/Unlocking Steering Column
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation. Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components:**

- **The steering column**
- **The intermediate shaft(s)**
- **The steering gear**

After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may

cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has became un-centered, refer to your specific SIR coil's centering procedure to re-center SIR Coil.

1. Insert the **J-42640** pin into the steering column access hole in order to lock the steering column.
2. Remove the front left tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

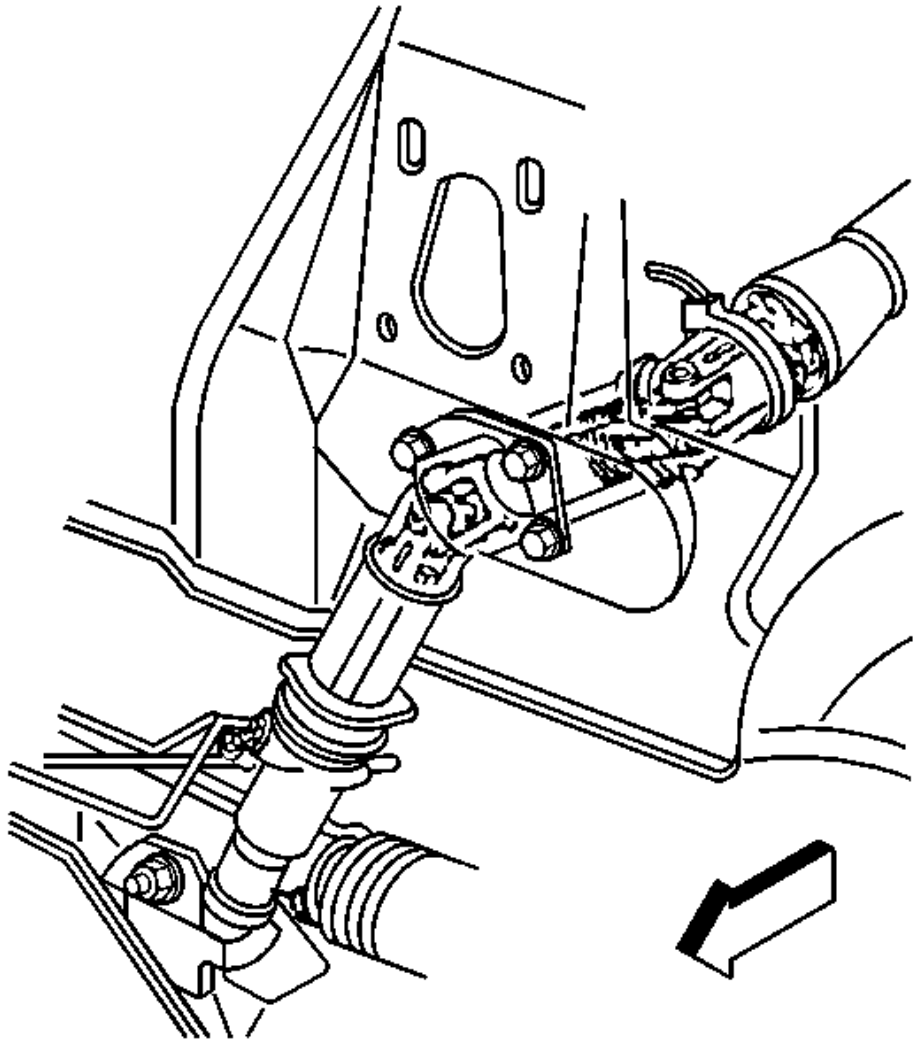


Fig. 7: Providing Access To Intermediate Steering Shaft Lower Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Move the intermediate steering shaft seal at the steering gear in order to provide access to the intermediate steering shaft lower bolt.
4. Use paint in order to place match marks on the intermediate shaft and on the steering gear.

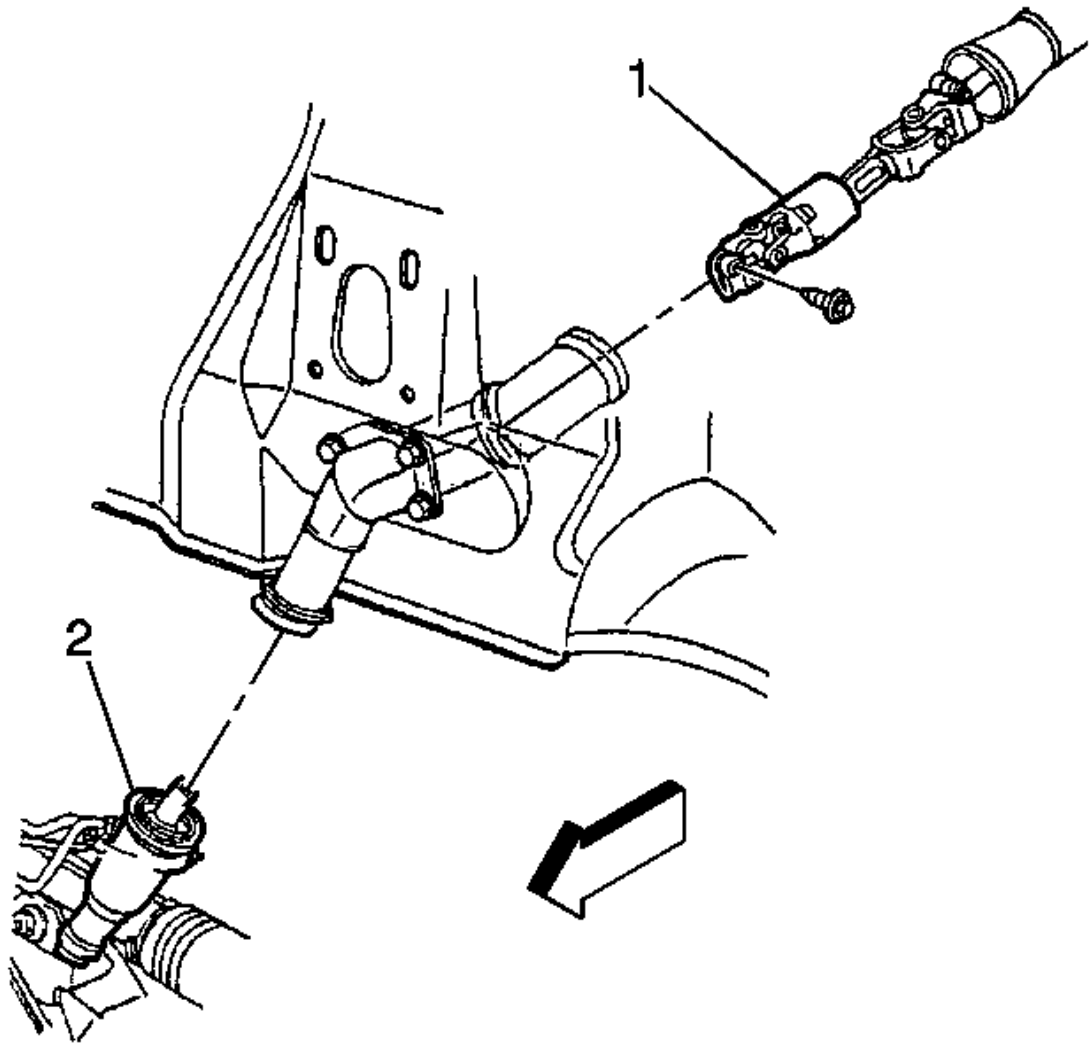


Fig. 8: View Of Intermediate Steering Shaft To Power Steering Gear Stub Shaft
Courtesy of GENERAL MOTORS COMPANY

5. Remove the intermediate steering shaft lower pinch bolt from the steering gear (2).
6. Separate the intermediate steering shaft (1) from the steering gear (2).
7. Remove the left instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .

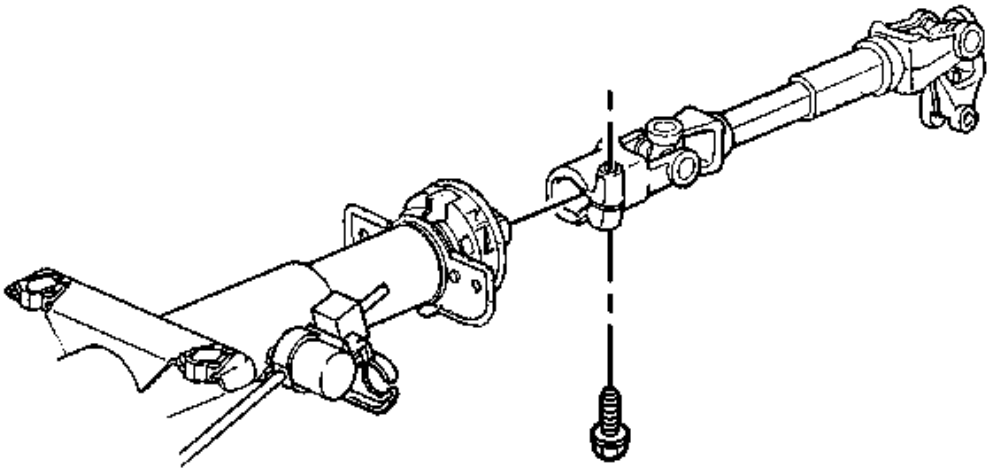


Fig. 9: View Of Upper Pinch Bolt Of Intermediate Steering Shaft
Courtesy of GENERAL MOTORS COMPANY

8. Reposition the intermediate steering shaft seal in order to gain access to the intermediate steering shaft bolt at the steering column.
9. Use paint in order to place match marks on the intermediate shaft and on the steering column.
10. Remove the intermediate steering shaft bolt and nut at the steering column.
11. Disconnect the intermediate steering shaft from the steering column.
12. Remove the intermediate steering shaft from the vehicle.

Installation Procedure

1. If you are installing a NEW intermediate shaft, copy the match marks from the old intermediate shaft to the new intermediate shaft.

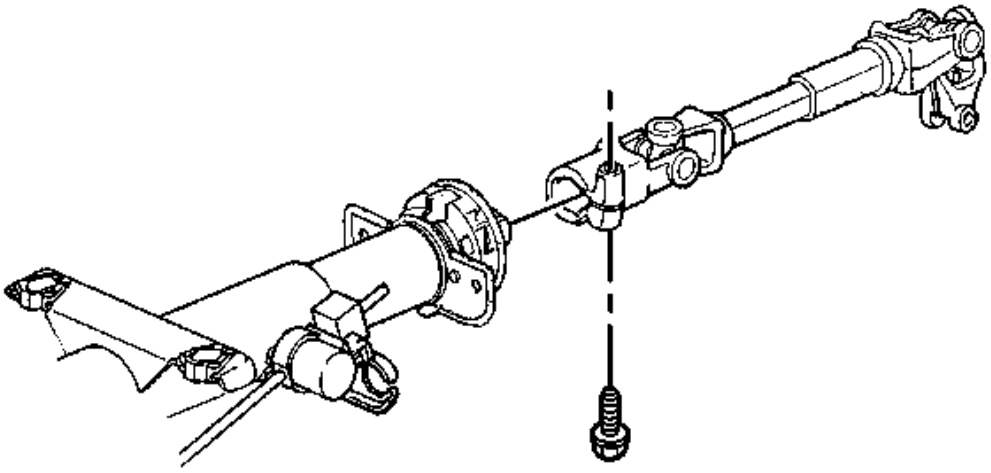


Fig. 10: View Of Upper Pinch Bolt Of Intermediate Steering Shaft
Courtesy of GENERAL MOTORS COMPANY

2. Position the intermediate steering shaft in the vehicle.
3. Align the match marks and connect the intermediate shaft to the steering column.

CAUTION: Refer to Fastener Caution .

4. Install the intermediate steering shaft bolt at the steering column and tighten to 62 N.m (46 lb ft).
5. Position the intermediate steering shaft seal onto the steering column.
6. Install the left instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** .

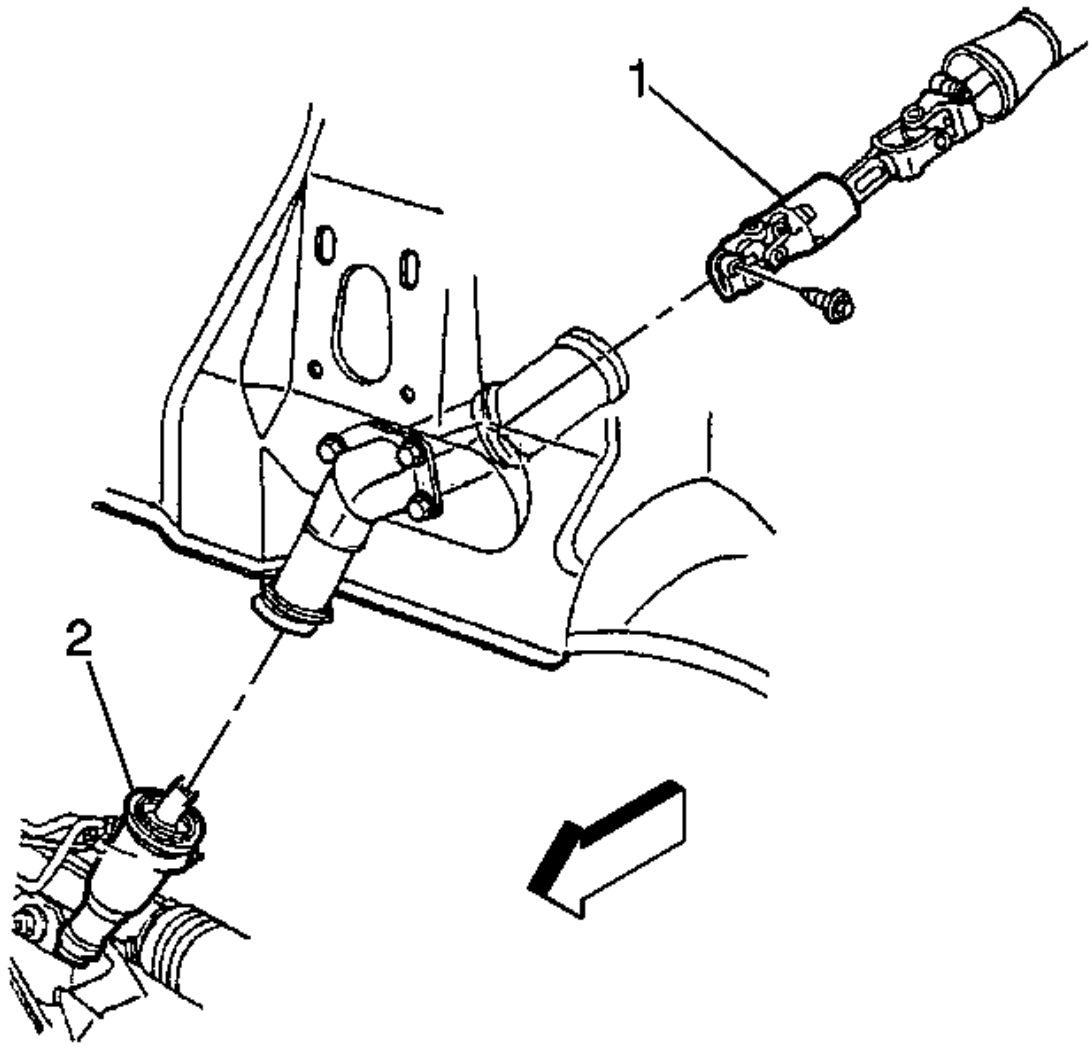


Fig. 11: View Of Intermediate Steering Shaft To Power Steering Gear Stub Shaft
Courtesy of GENERAL MOTORS COMPANY

7. Align the match marks and connect the intermediate steering shaft (1) to the power steering gear stub shaft (2).
8. Install the intermediate steering shaft lower bolt at the steering gear and tighten to 48 N.m (35 lb ft).

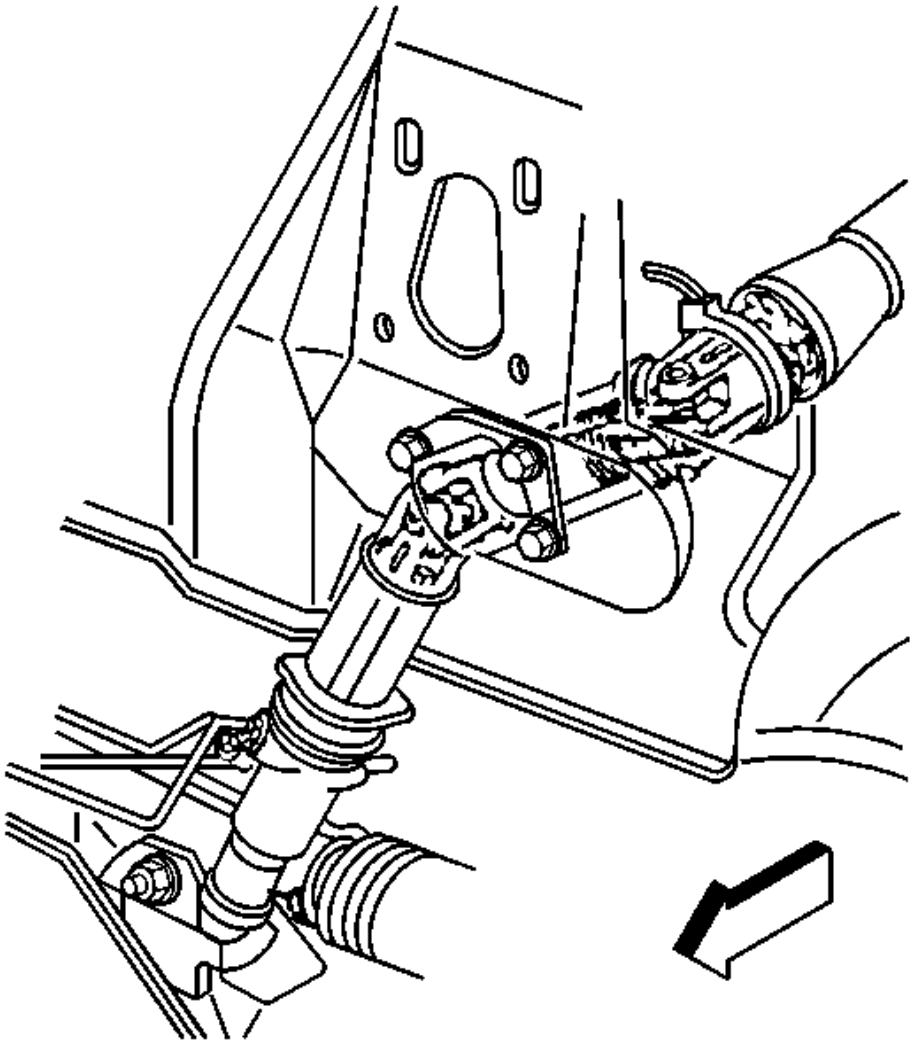


Fig. 12: Providing Access To Intermediate Steering Shaft Lower Pinch Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Position the intermediate steering shaft seal onto the steering gear.
10. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
11. Remove the **J 42640** pin.

STEERING COLUMN ACCIDENT DAMAGE INSPECTION

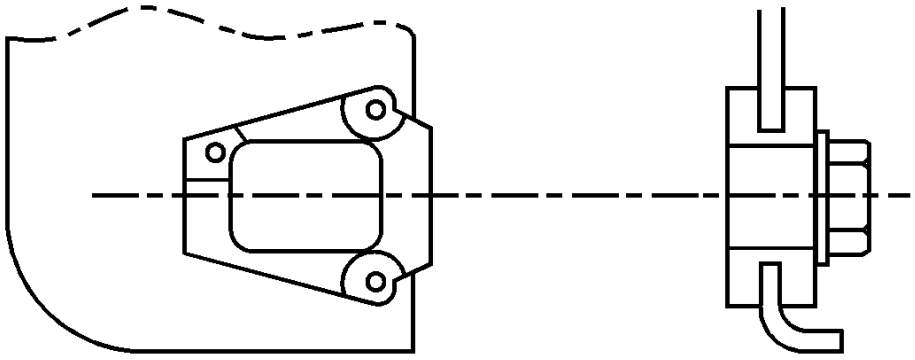


Fig. 13: Inspecting Capsules On Steering Column Bracket Assembly
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Vehicles involved in accidents that result in any of the following kinds of damage or situations, may also have a damaged or misaligned steering column:

- **Frame damage**
- **Major body damage**
- **Sheet metal damage**
- **If the steering column has been impacted**
- **If the supplemental inflatable restraints system was deployed**

- Inspect the capsules on the steering column bracket assembly. All capsules must be securely seated in the bracket slots and inspected for any loose conditions when pushed or pulled by hand.
- Observe how the bracket is attached to the jacket assembly.
  - If the capsules are not securely seated and the bracket is bolted to the jacket assembly, replace only the bracket.

- If the capsules are not securely seated and the bracket is welded to the jacket assembly, replace only the jacket assembly.

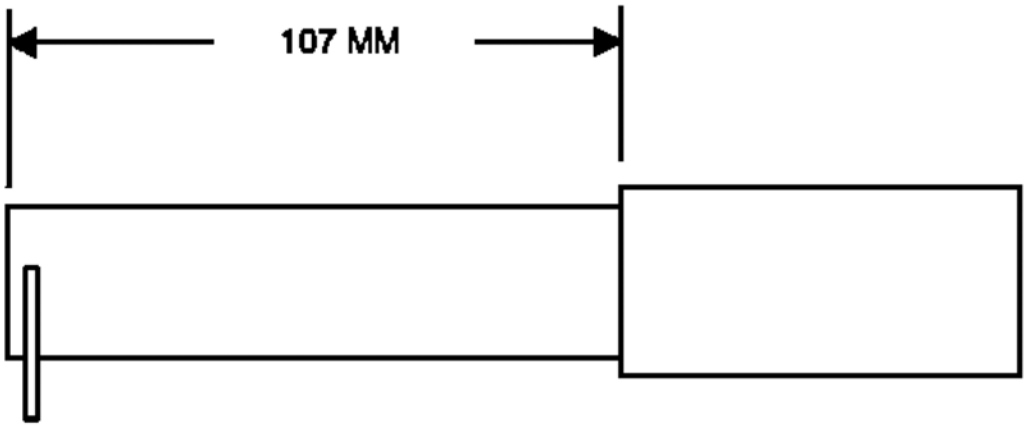


Fig. 14: Measuring Distance From Lower Edge Of Upper Jacket To A Defined Point On Lower Jacket
Courtesy of GENERAL MOTORS COMPANY

- Inspect for jacket assembly collapse by measuring the distance from the lower edge of the upper jacket to a defined point on the lower jacket. Replace the jacket assembly if the measured dimensions are not within specifications.

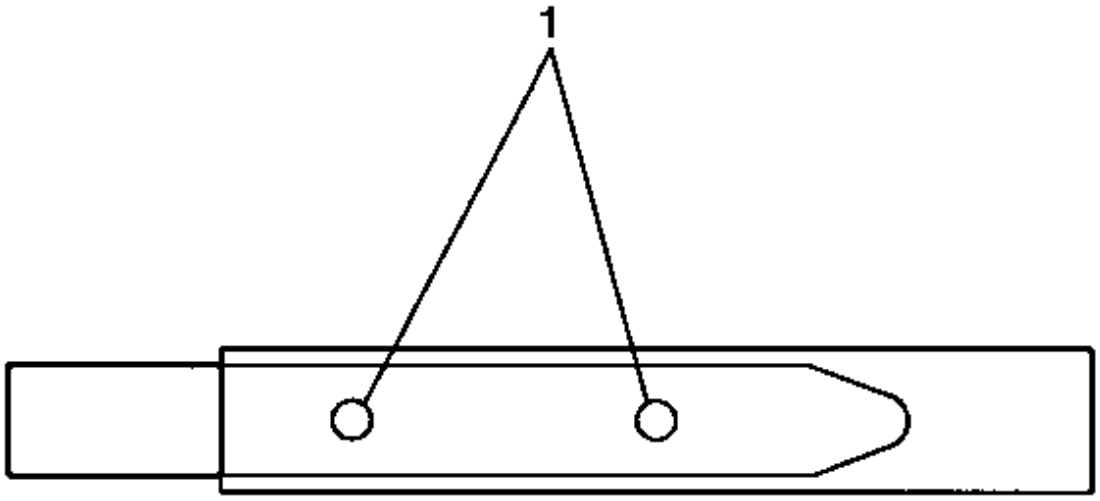


Fig. 15: Inspecting Steering Shaft For Sheared Injected Plastic
Courtesy of GENERAL MOTORS COMPANY

- Visually inspect the steering shaft for sheared injected plastic (1). If the steering shaft shows sheared plastic (1), replace the steering shaft.
- Any frame damage that could cause a bent steering shaft must have the steering shaft runout checked. Using a dial indicator at the lower end of the steering shaft, rotate the steering wheel. The runout must not exceed 1.60 mm (0.06 in).

STEERING COLUMN TRIM COVER REPLACEMENT

Removal Procedure

1. Remove the steering wheel. Refer to **Steering Wheel Replacement**.
2. Remove the steering column opening filler. Refer to **Steering Column Opening Filler Replacement** .

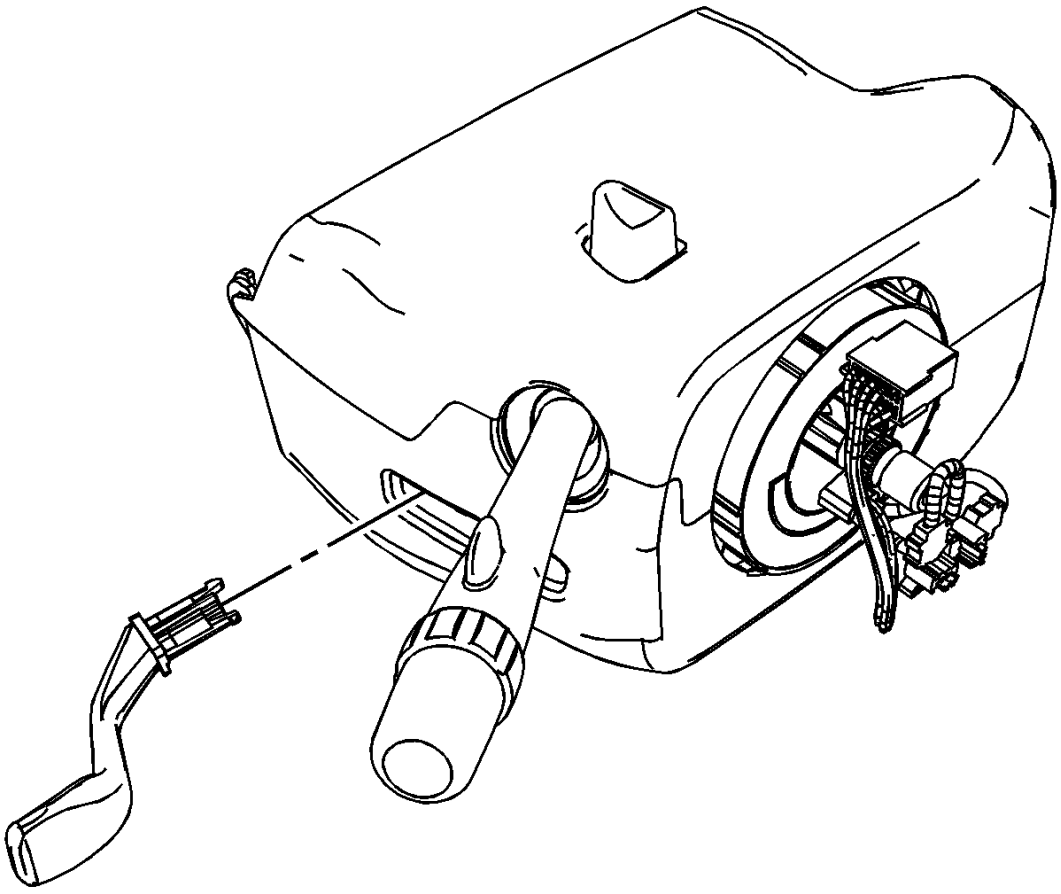


Fig. 16: View Of Tilt Lever
Courtesy of GENERAL MOTORS COMPANY

3. Remove the tilt lever.

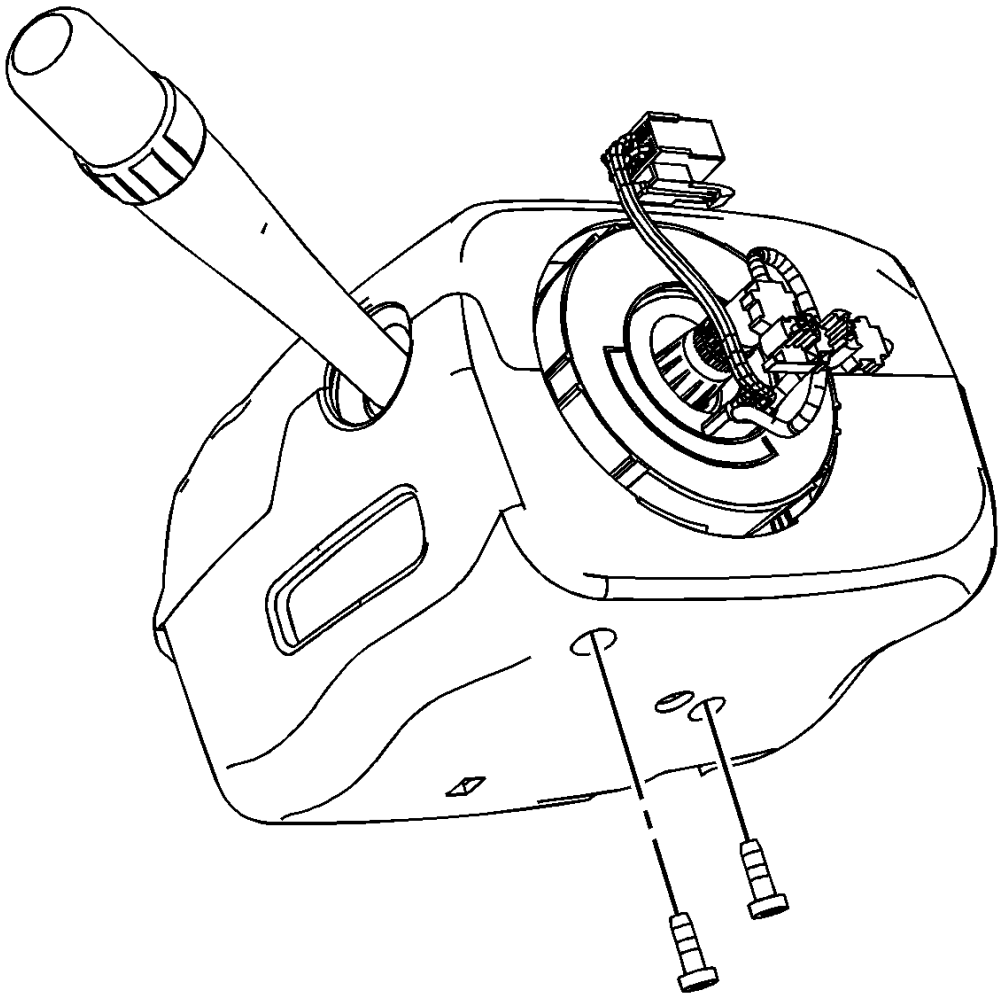


Fig. 17: View Of Lower Steering Column Trim Cover & Retaining Screws
Courtesy of GENERAL MOTORS COMPANY

4. Remove the steering column trim cover bolts.

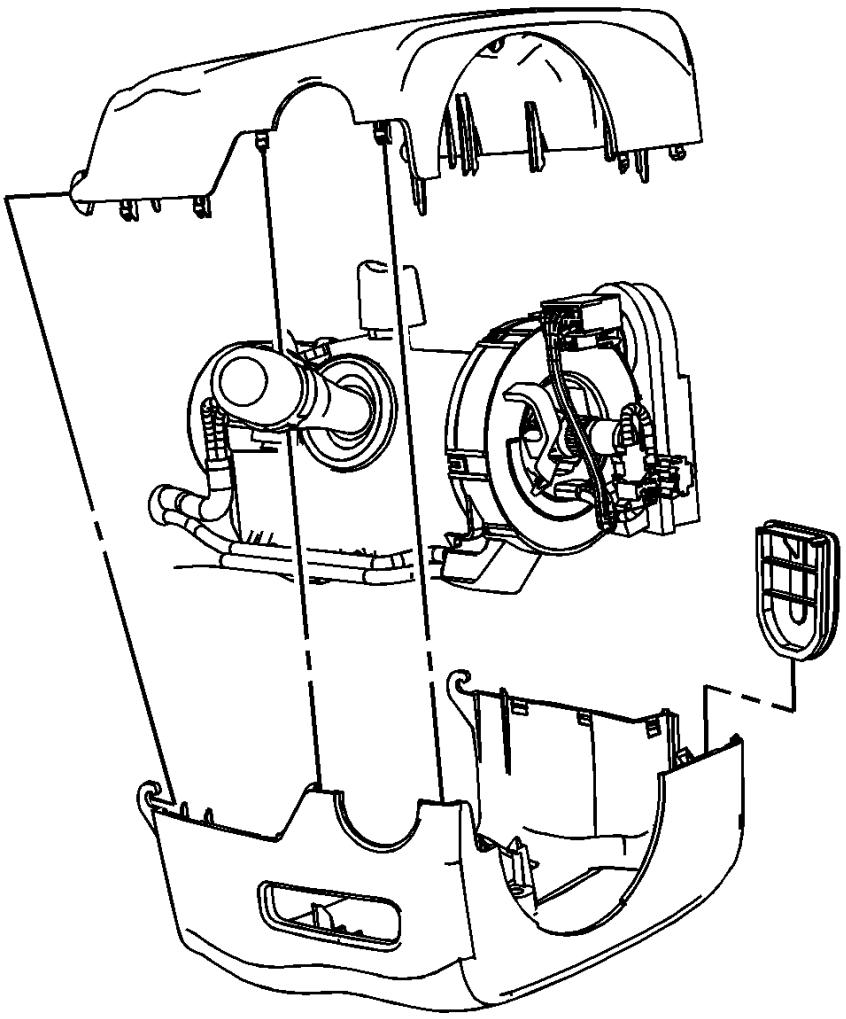


Fig. 18: View Of Upper & Lower Steering Column Cover & Steering Column
Courtesy of GENERAL MOTORS COMPANY

5. Separate the upper steering column trim cover from the lower steering column trim cover and remove them from the vehicle.

Installation Procedure

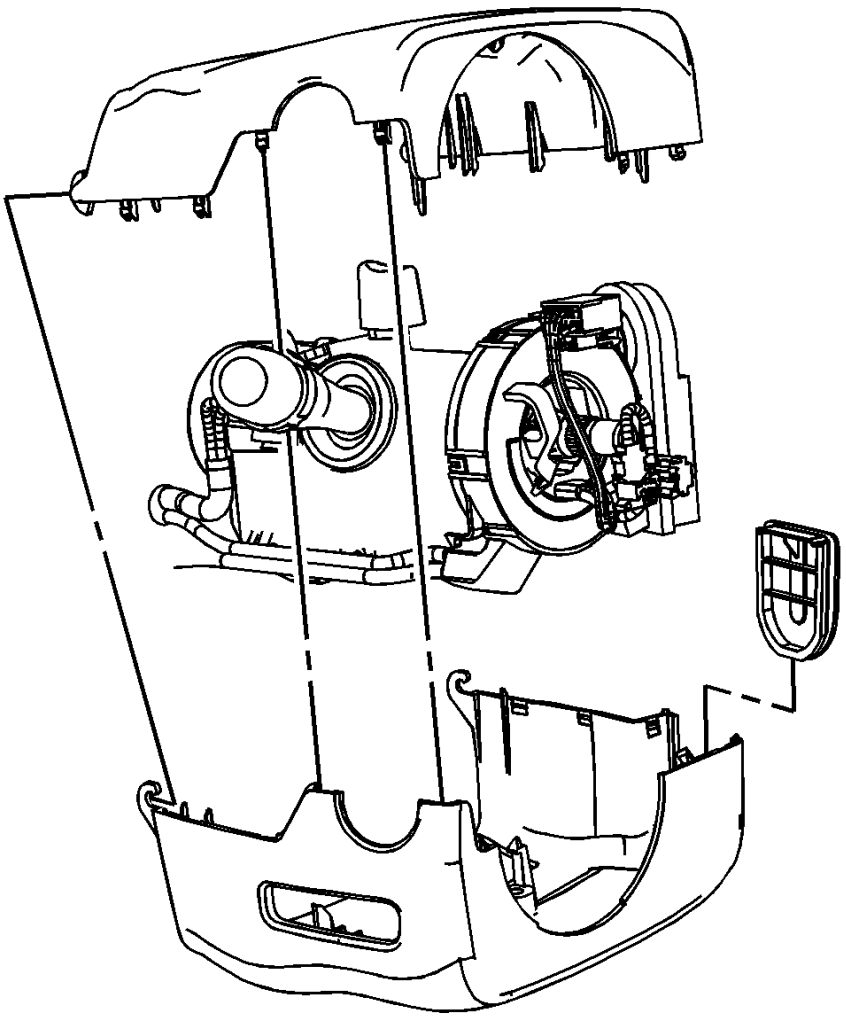


Fig. 19: View Of Upper & Lower Steering Column Cover & Steering Column
Courtesy of GENERAL MOTORS COMPANY

1. Position the upper steering column trim cover and the lower steering column trim cover together on the steering column.

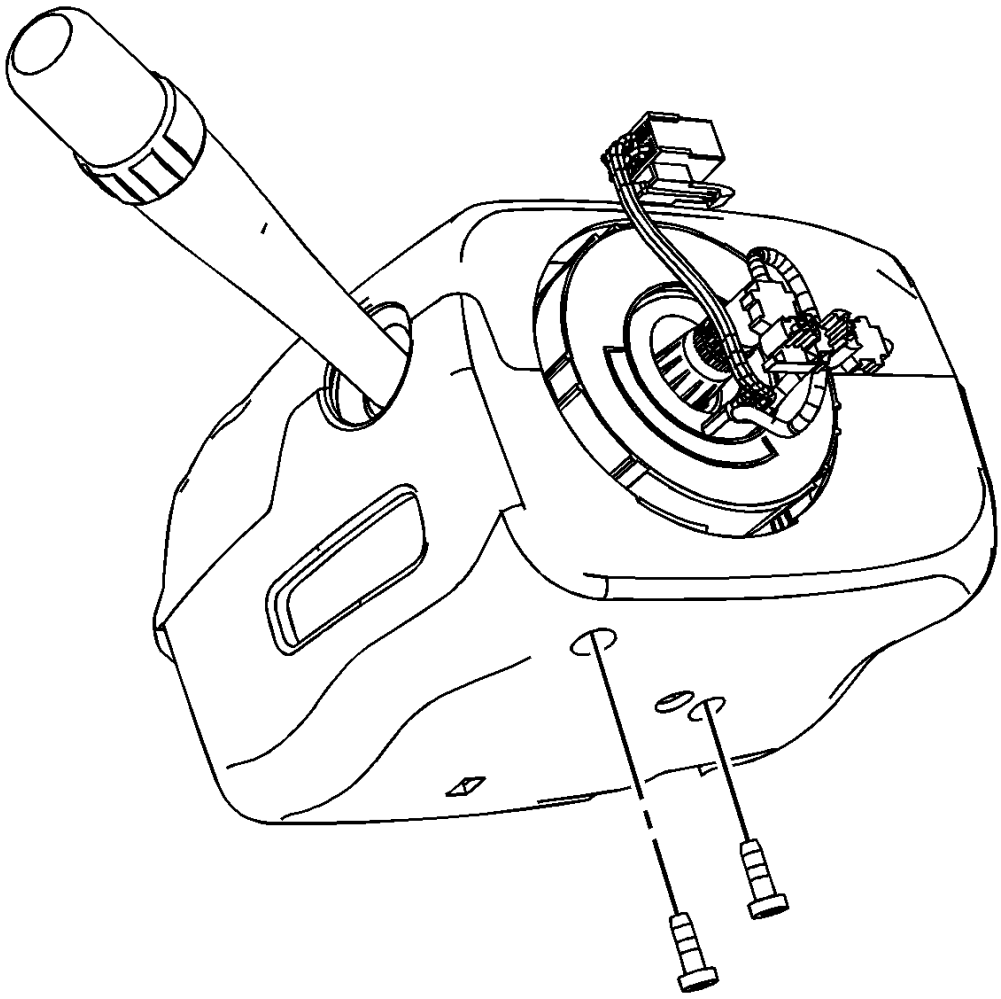


Fig. 20: View Of Lower Steering Column Trim Cover & Retaining Screws
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the steering column trim cover bolts and tighten to 3 N.m (27 lb in).

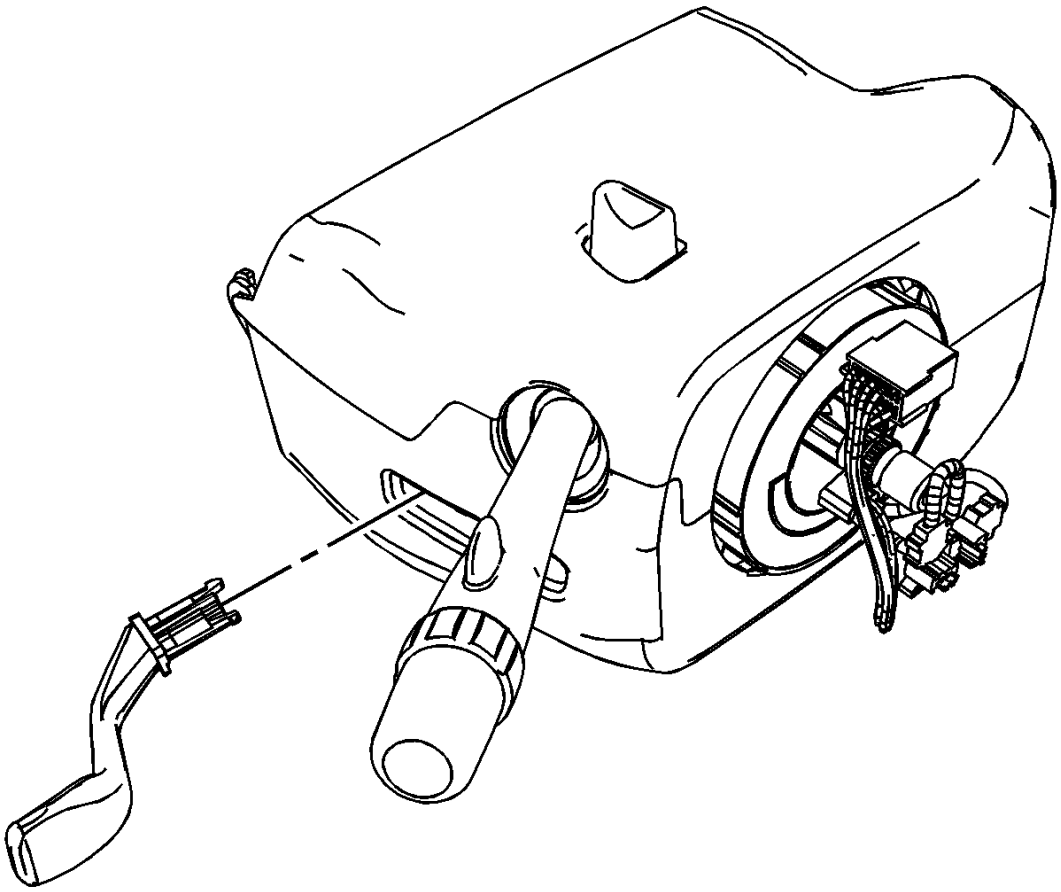


Fig. 21: View Of Tilt Lever
Courtesy of GENERAL MOTORS COMPANY

3. Install the tilt lever.
4. Install the steering column opening filler. Refer to **Steering Column Opening Filler Replacement** .
5. Install the steering wheel. Refer to **Steering Wheel Replacement**.

TURN SIGNAL CANCEL CAM AND STEERING SHAFT UPPER BEARING SPRING REPLACEMENT

Special Tools

- **J 23653-SIR** Steering Column Lock Plate Compressor
- **J 42137** Steering Column Lock Plate Compressor Adapter

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the inflatable restraint steering wheel module coil. Refer to **Steering Wheel Airbag Coil**

Replacement .

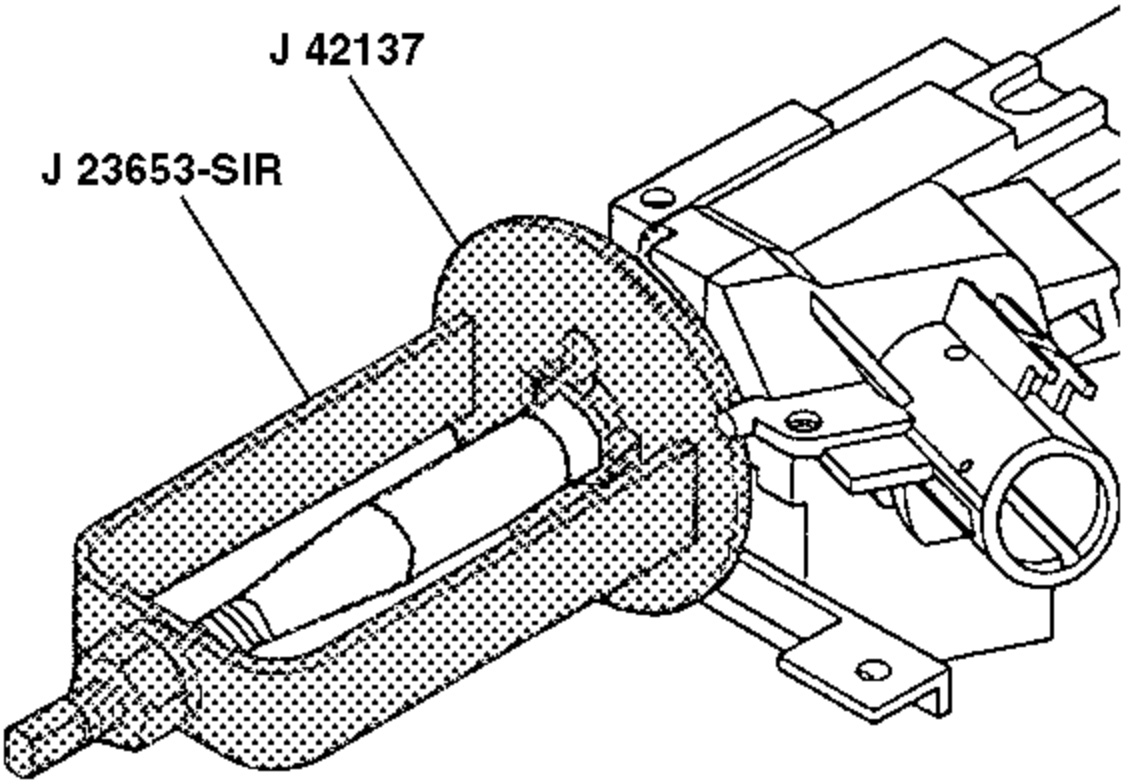


Fig. 22: Compressing Cam Orientation Plate
Courtesy of GENERAL MOTORS COMPANY

2. Remove the steering shaft lock plate retaining ring using the **J 23653-SIR** compressor and the **J 42137** adapter and dispose of it.

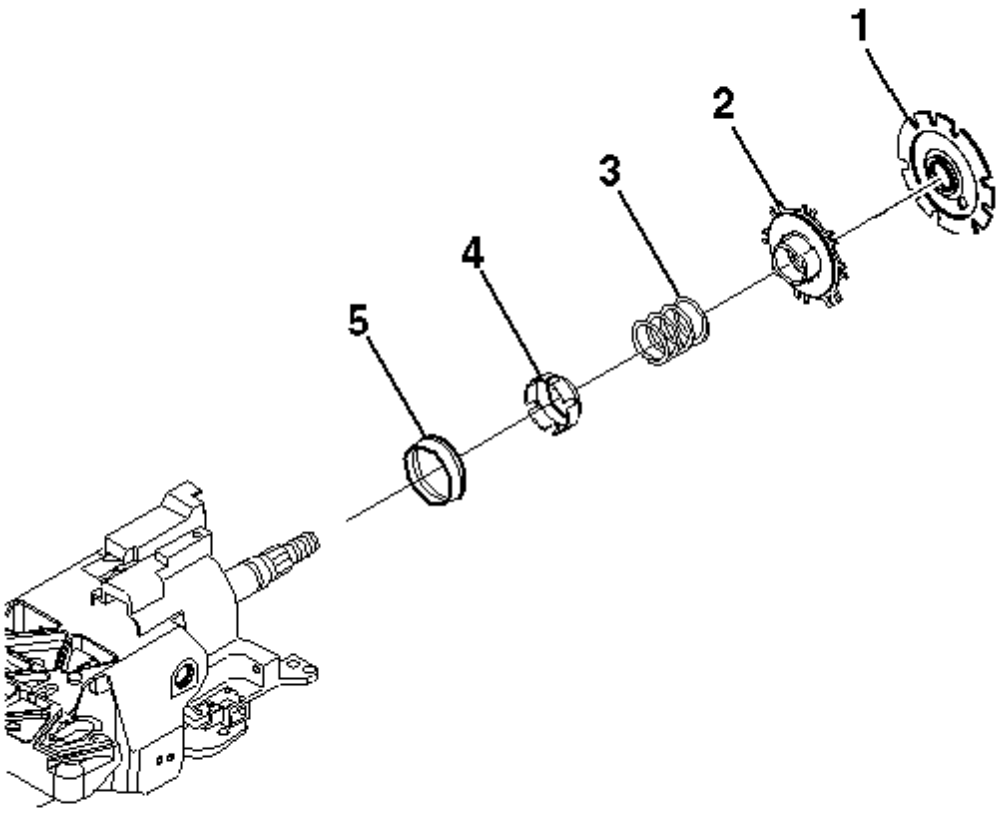


Fig. 23: View of Shaft Lock Shield Assembly, Turn Signal Cancel Cam Assembly, Upper Bearing Spring, Bearing Inner Race Seat and Inner Race
Courtesy of GENERAL MOTORS COMPANY

3. Remove the turn signal cancel cam plate (1).
4. Remove the turn signal cancel cam (2).
5. Remove the steering shaft upper bearing spring (3).
6. Remove the steering shaft upper bearing race seat (4).
7. Remove the steering shaft upper bearing (5).

Installation Procedure

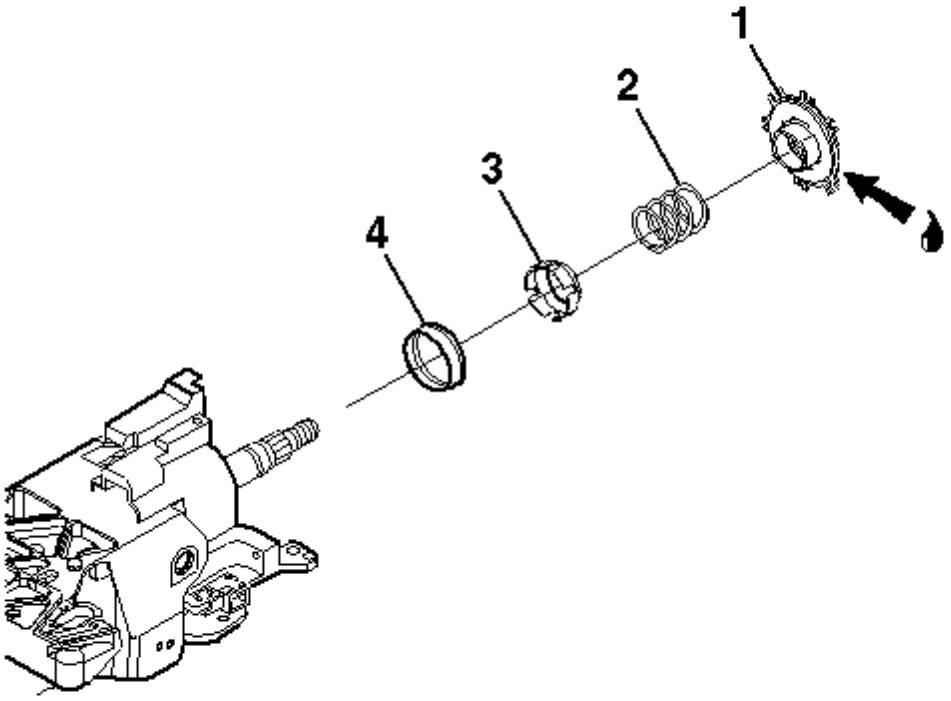


Fig. 24: View of Inner Race, Upper Bearing Inner Race Seat, Upper Bearing Spring, and Turn Signal Cancel Cam Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the steering shaft upper bearing (4).
2. Install the steering shaft upper bearing race seat (3).
3. Install the steering shaft upper bearing spring (2).
4. Apply lubricant to the turn signal cancel cam (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended lubricant.
5. Install the turn signal cancel cam (1).

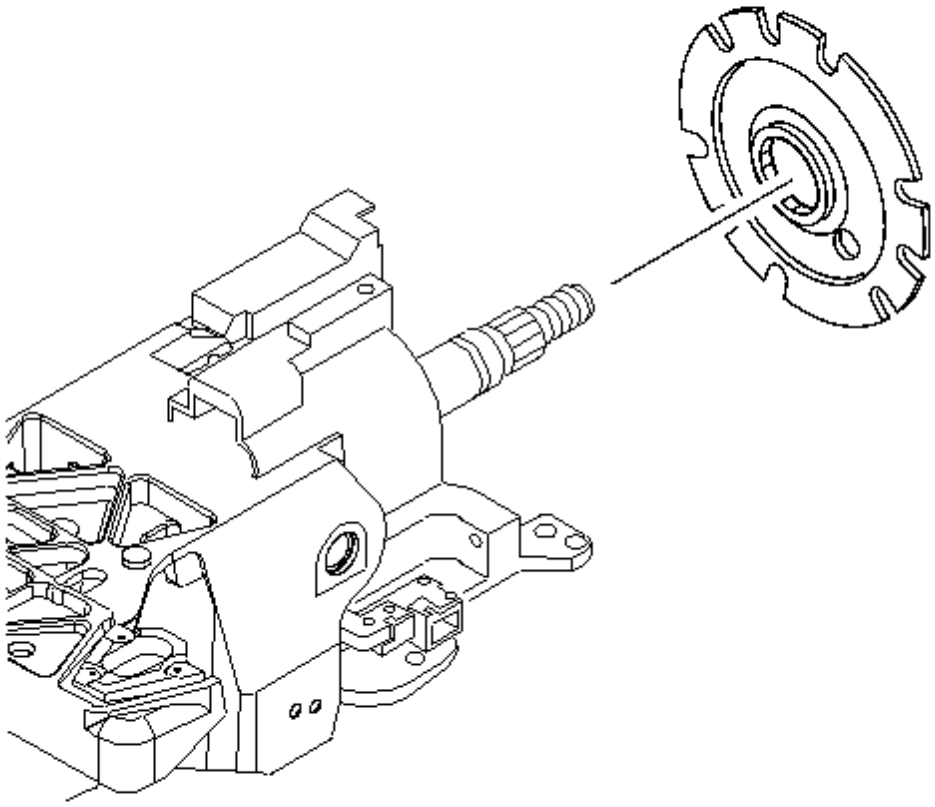


Fig. 25: View of Shaft Lock Shield Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Install the turn signal cancel cam plate.

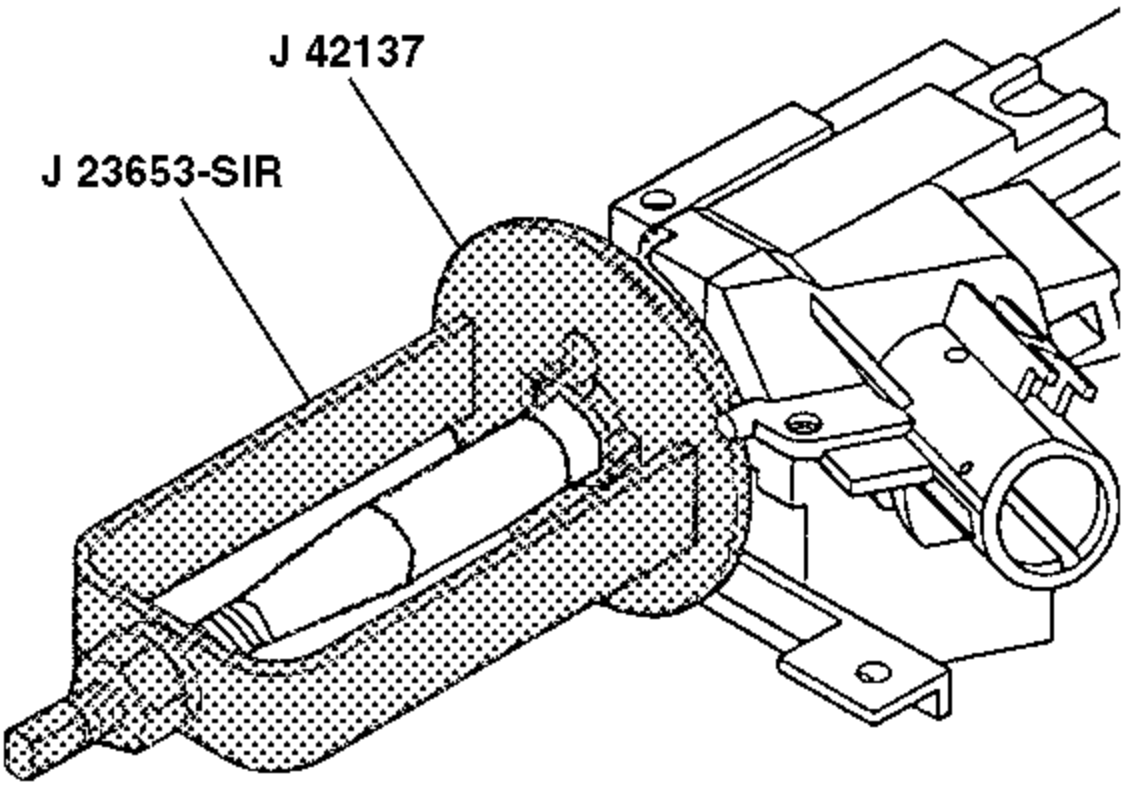


Fig. 26: Compressing Cam Orientation Plate
Courtesy of GENERAL MOTORS COMPANY

7. Install the new steering shaft lock plate retaining ring using the **J 23653-SIR** compressor and the **J 42137** adapter.

TURN SIGNAL MULTIFUNCTION SWITCH REPLACEMENT

Removal Procedure

1. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

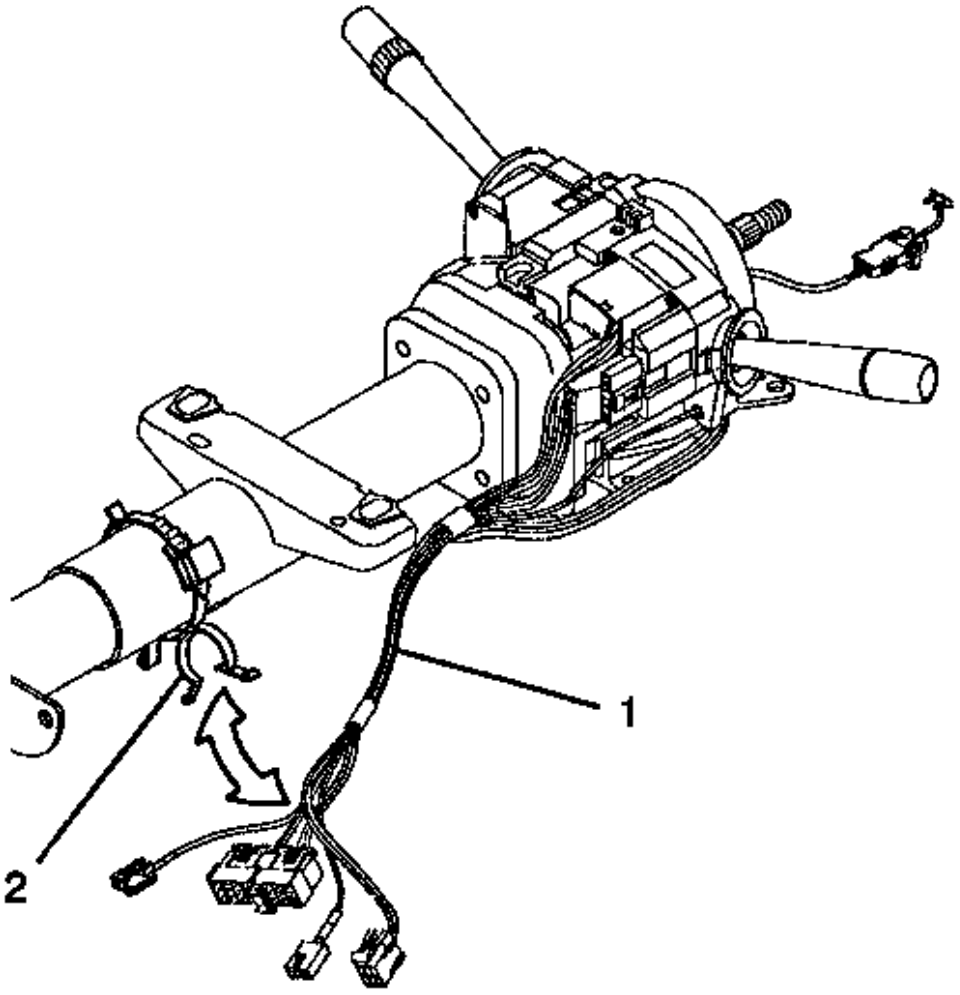


Fig. 27: View Of Steering Column Wire Harness Assembly & Wire Harness Strap
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The abrasion sleeve located on the steering column wire harness assembly must be reinstalled. Make note of what connector is coming out of the abrasion sleeve for installation purposes.**

2. Remove the wire harness assembly (1) from the wire harness strap (2).
3. Disconnect the turn signal multifunction switch connector from the inflatable restraint steering wheel module coil connector.

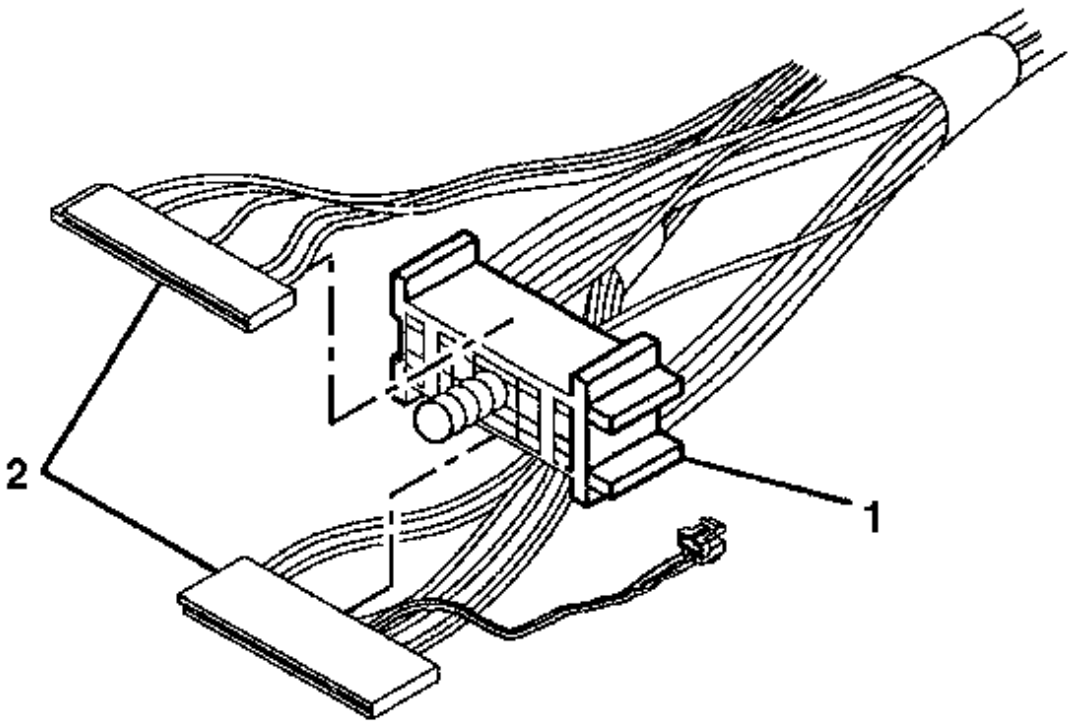


Fig. 28: Turn Signal & Multifunction Switch Assembly Connectors
Courtesy of GENERAL MOTORS COMPANY

4. Slide the 2 connectors (2) of the turn signal multifunction switch assembly out of the bulkhead connector (1).

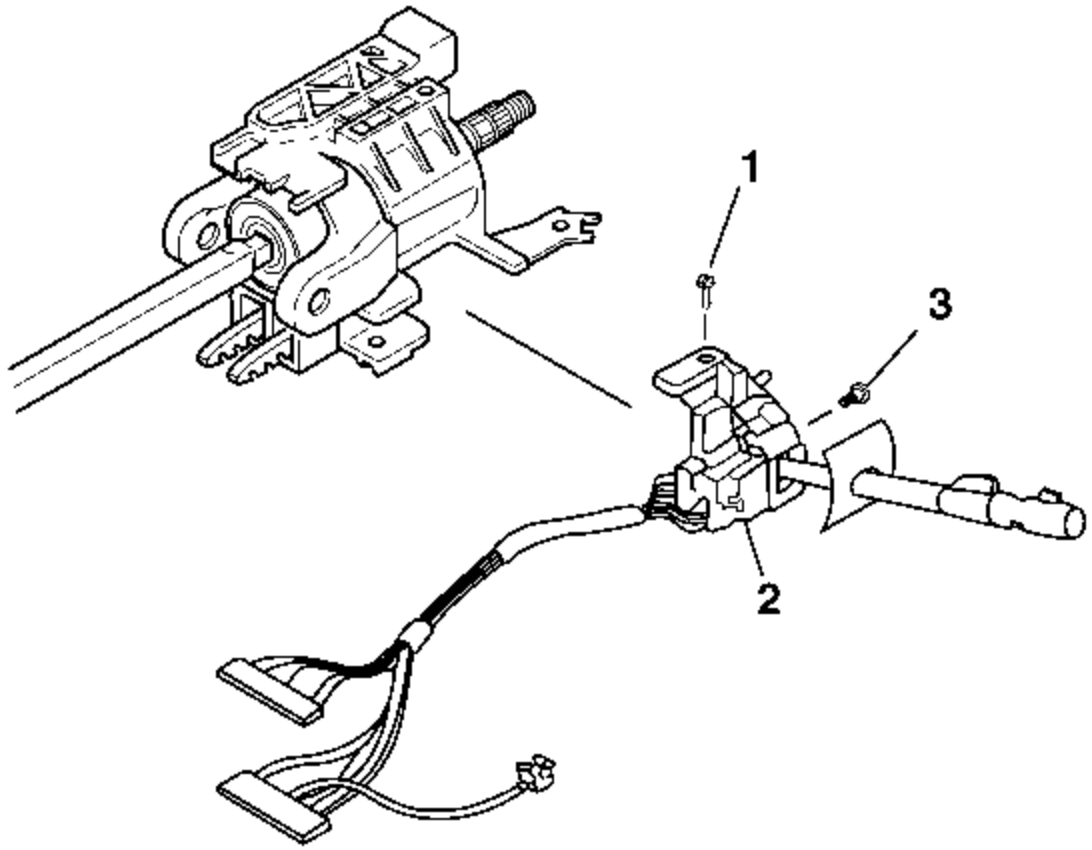


Fig. 29: View Of Turn Signal & Multifunction Switch Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Remove the turn signal multifunction switch bolts (1) and (3) from the turn signal multifunction switch (2).
6. Remove the turn signal multifunction switch (2) from the steering column tilt head assembly.

Installation Procedure

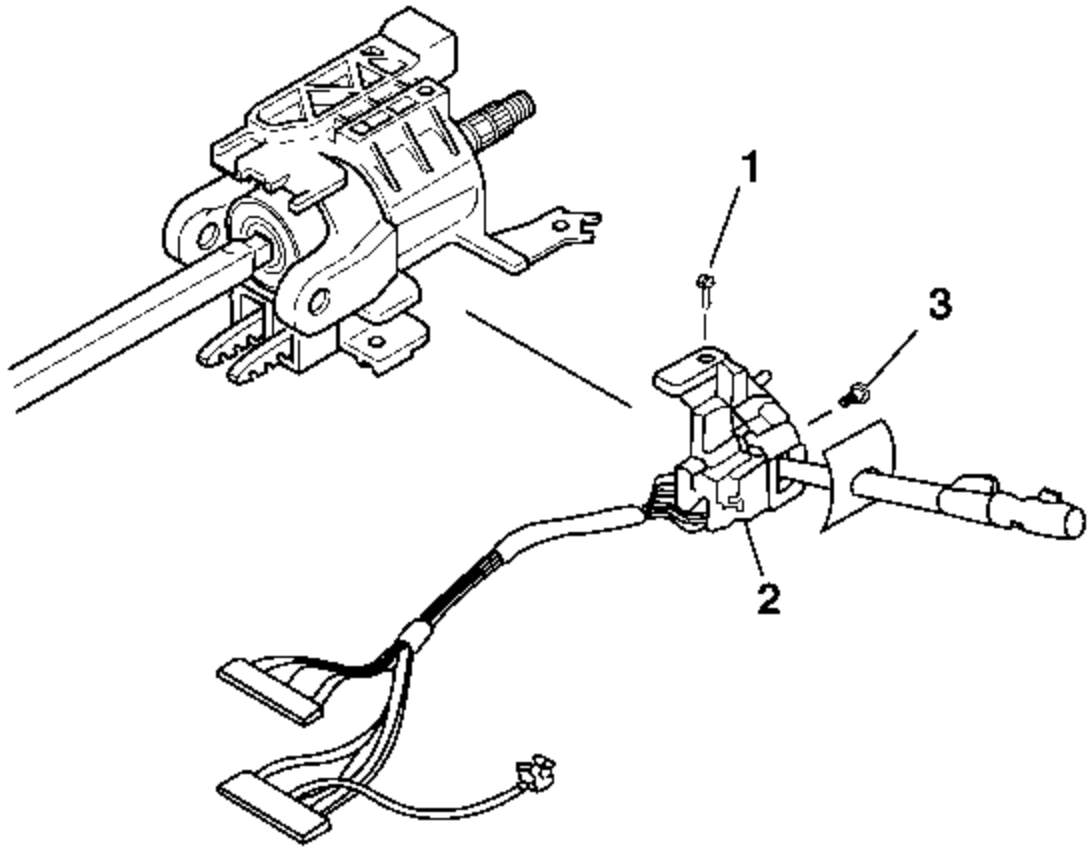


Fig. 30: View Of Turn Signal & Multifunction Switch Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Position the turn signal multifunction switch (2) onto the steering column tilt head assembly.

CAUTION: **Refer to Fastener Caution .**

NOTE: **Be sure that the electrical contact of the turn signal and multifunction switch assembly (2) rests on the turn signal cancel cam assembly.**

2. Install the turn signal multifunction switch bolts (1) and (3) into the turn signal multifunction (2) and tighten to 1 N.m (11 lb in).

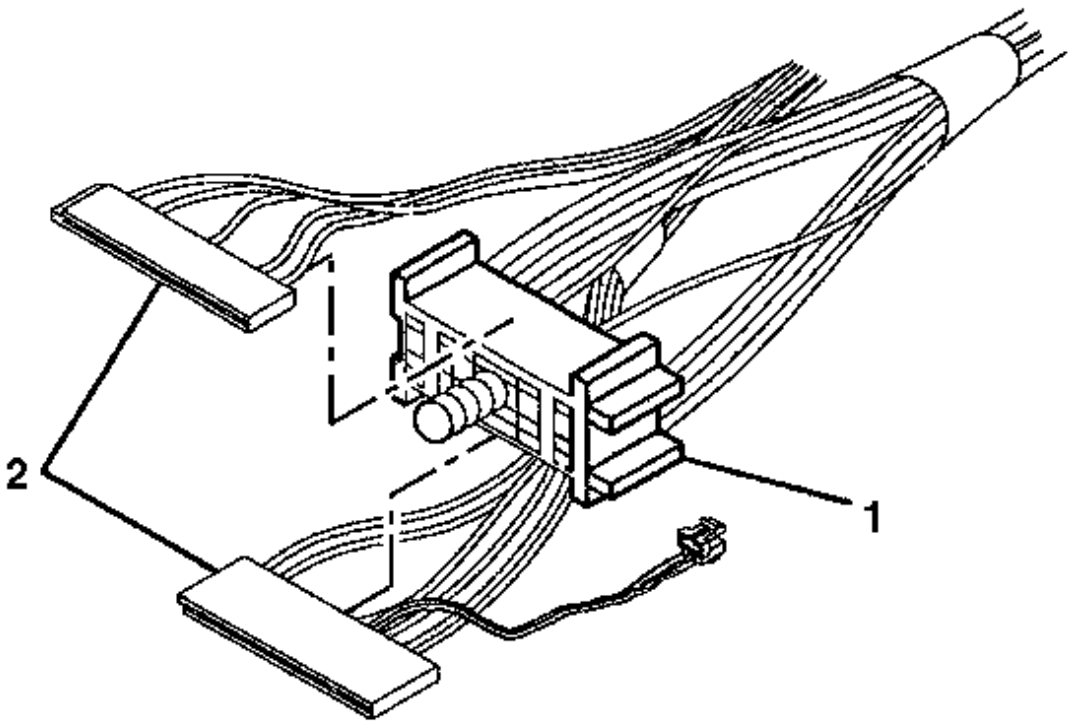


Fig. 31: Turn Signal & Multifunction Switch Assembly Connectors
Courtesy of GENERAL MOTORS COMPANY

3. Slide the 2 connectors (2) of the turn signal multifunction switch assembly into the bulkhead connector (1).

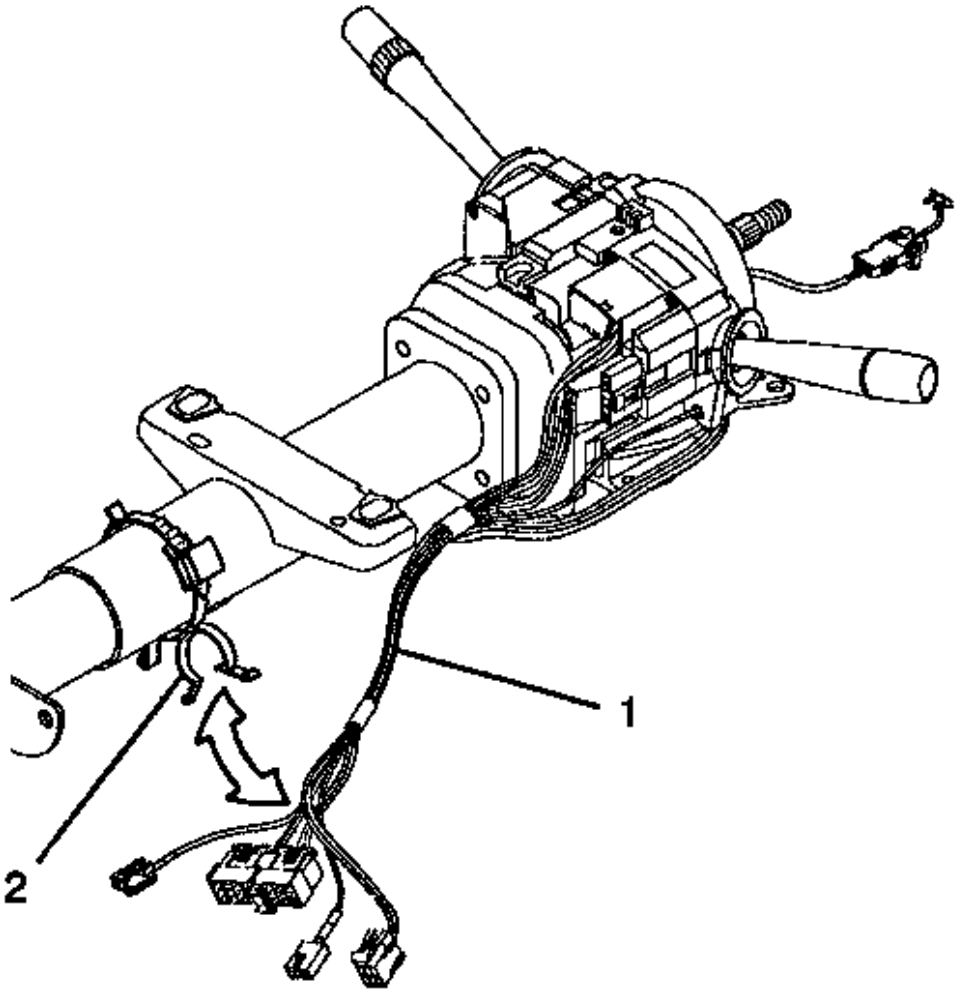


Fig. 32: View Of Steering Column Wire Harness Assembly & Wire Harness Strap
Courtesy of GENERAL MOTORS COMPANY

4. Connect the turn signal multifunction switch connector to the inflatable restraint steering wheel module coil connector.

NOTE: **The abrasion sleeve must be installed back onto the steering column wire harness assembly. The ignition lock cylinder case wires and connector must be hanging out of the middle of the abrasion sleeve.**

5. Install the wire harness assembly (1) to the wire harness strap (2).
6. Install the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

TURN SIGNAL SWITCH HOUSING REPLACEMENT

Removal Procedure

1. Remove the turn signal cancel cam and steering shaft upper bearing spring. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement**.
2. Remove the turn signal multifunction switch. Refer to **Turn Signal Multifunction Switch Replacement**.

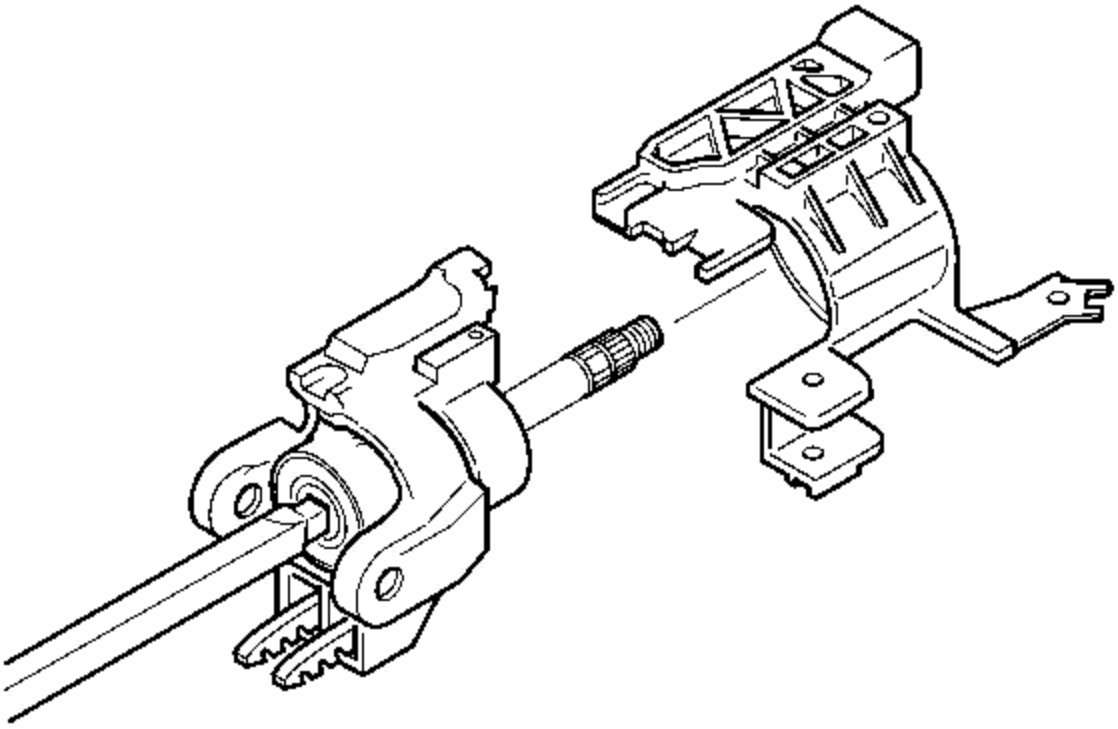


Fig. 33: View Of Turn Signal Switch Housing & Steering Column Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Slide the turn signal switch housing off of the steering column.

Installation Procedure

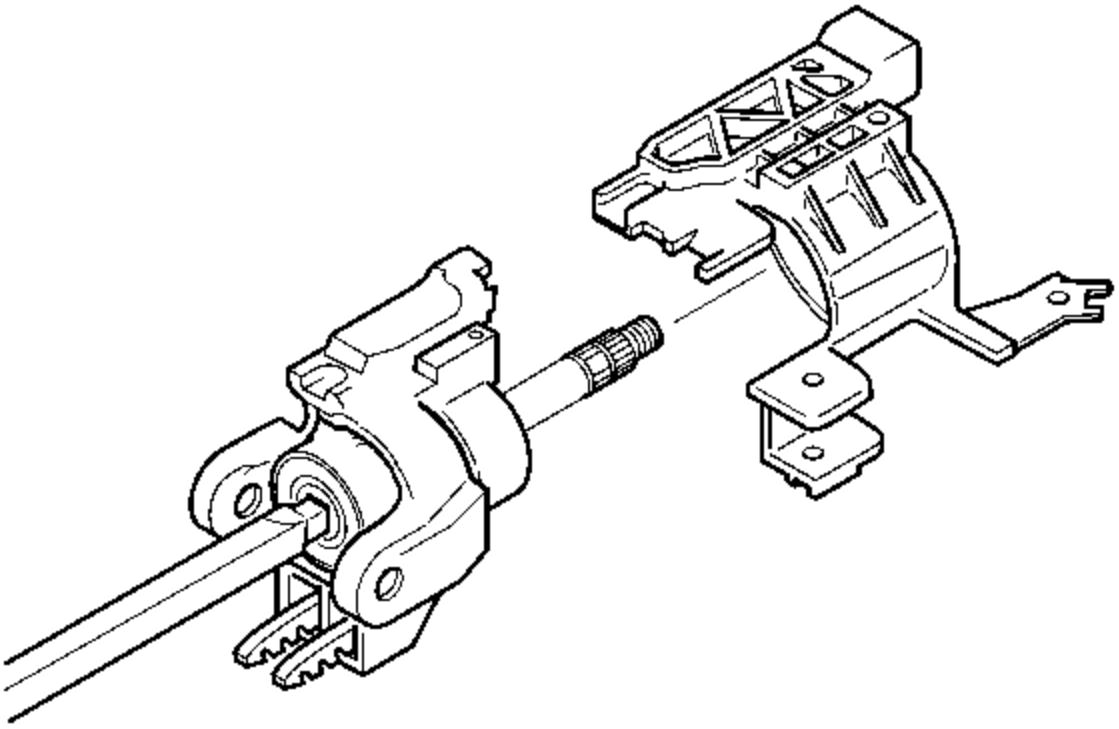


Fig. 34: View Of Turn Signal Switch Housing & Steering Column Shaft Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The turn signal switch housing must be pressed firmly against the steering column to seat it properly.**

1. Slide the turn signal switch housing onto the steering column.
2. Install the turn signal multifunction switch. Refer to **Turn Signal Multifunction Switch Replacement**.
3. Install the turn signal cancel cam and steering shaft upper bearing spring. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement**.

SHIFT LEVER REPLACEMENT

Removal Procedure

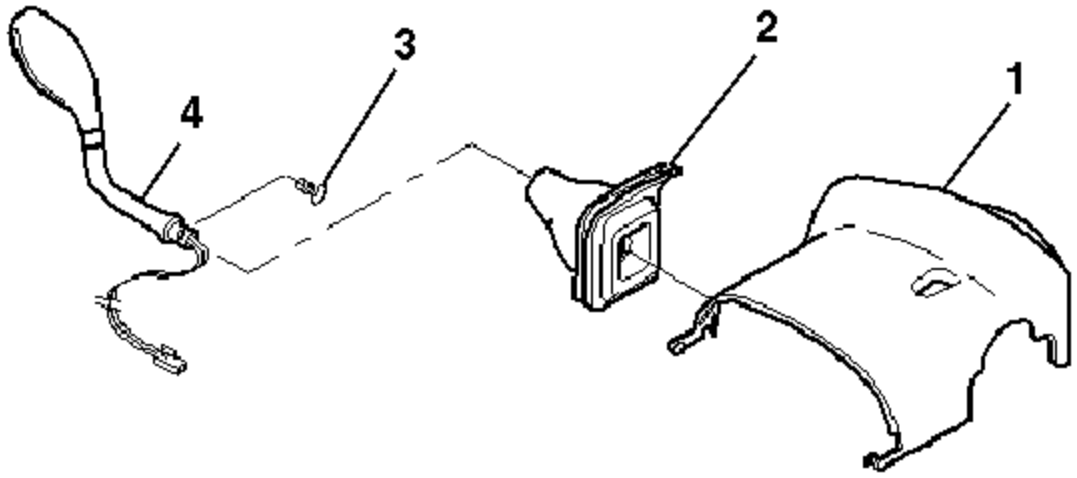


Fig. 35: View Of Shift Lever, Seal (Boot), Screw & Upper Trim Cover
Courtesy of GENERAL MOTORS COMPANY

1. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.
2. Disconnect the shift lever electrical connector at the base of the steering column.
3. Remove the shift lever screw (3) from the shift lever (4).
4. Disengage the shift lever (4) from the linear shift assembly.
5. Transfer the shift lever seal (2) if needed.

Installation Procedure

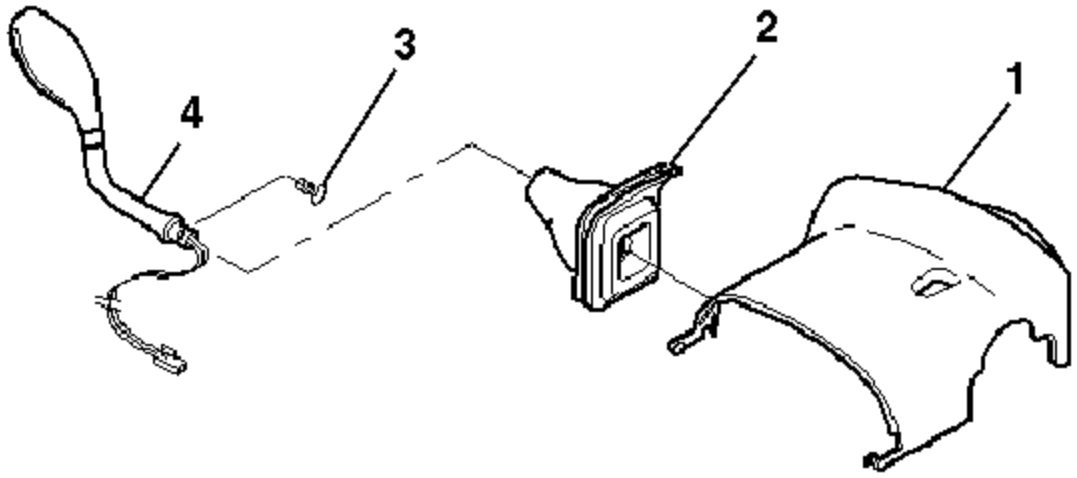


Fig. 36: View Of Shift Lever, Seal (Boot), Screw & Upper Trim Cover
Courtesy of GENERAL MOTORS COMPANY

1. Engage the shift lever (4) to the linear shift assembly.

CAUTION: Refer to Fastener Caution .

2. Install the shift lever screw (3) to the shift lever (4) and tighten it to 20 N.m (15 lb ft).
3. Connect the shift lever electrical connector at the base of the steering column.
4. Install the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

LINEAR SHIFT ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.
2. Remove the shift lever. Refer to **Shift Lever Replacement**.

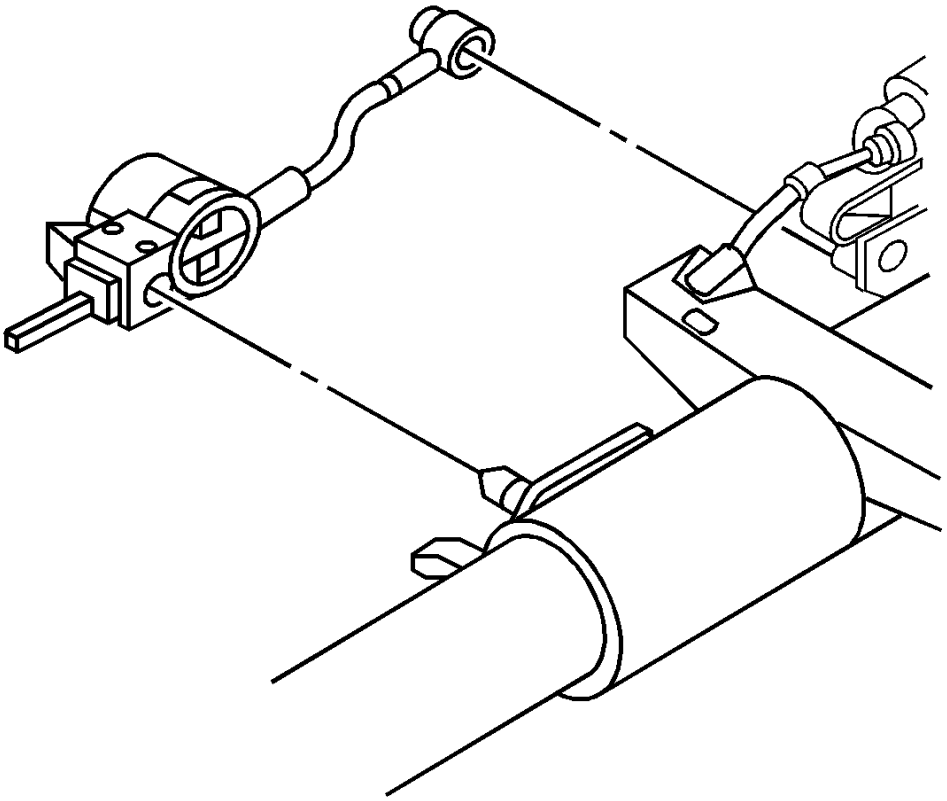


Fig. 37: View Of Automatic Transmission Shift Lock Control Actuator
Courtesy of GENERAL MOTORS COMPANY

3. With a screwdriver, carefully pry the automatic transmission shift lock control away from the steering column jacket.
4. Place the ignition lock cylinder in the OFF-LOCK position.

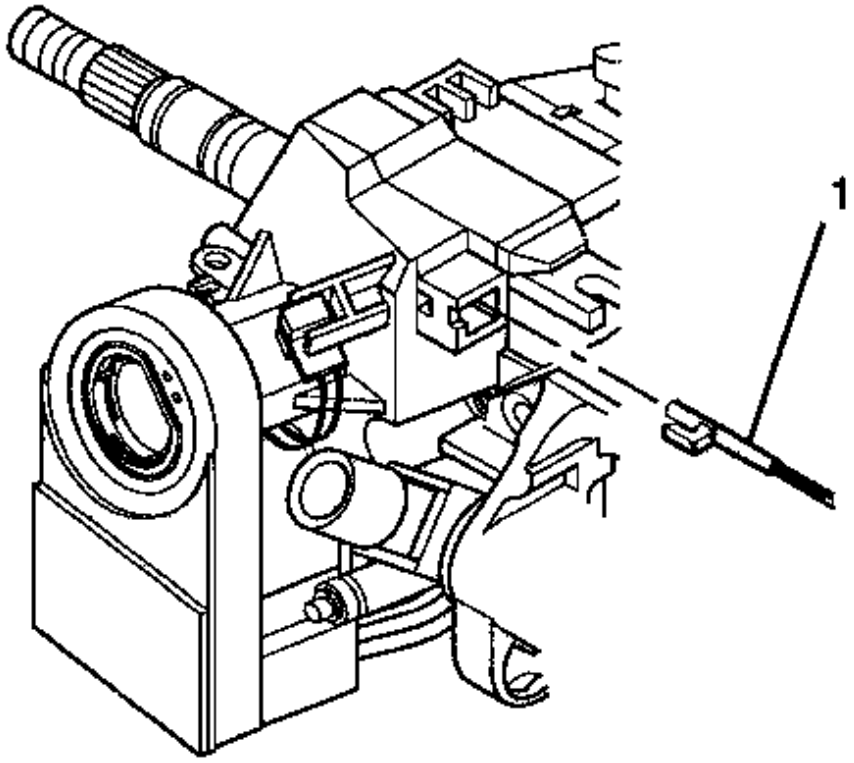


Fig. 38: Identifying Park Lock Cable At Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT remove the tape on the park lock cable. If the tape is removed from the park lock cable, you MUST order a new linear shift assembly.**

5. Insert a small screwdriver into the slot on the ignition lock cylinder case and push against the locking tab to remove the park lock cable (1).

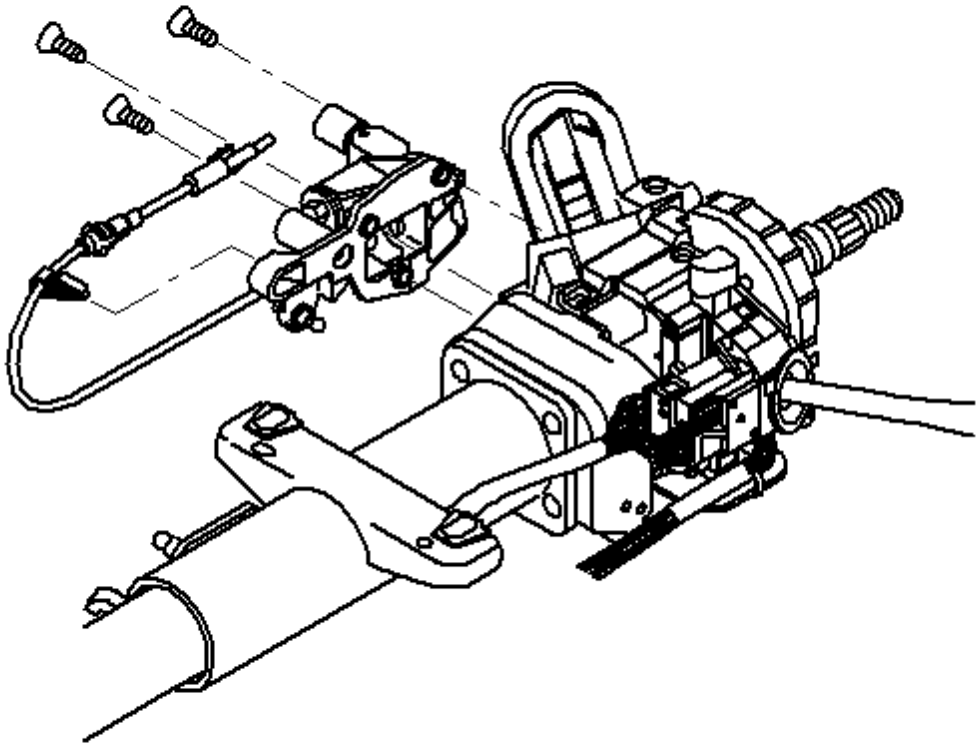


Fig. 39: Flat-Head 6-Lobed Socket Tap Screws & Linear Shift Assembly
Courtesy of GENERAL MOTORS COMPANY

NOTE: **It may be necessary to move the linear shift assembly out of park to access the lower linear shift assembly bolt.**

6. Remove the linear shift assembly bolts.
7. Remove the linear shift assembly.

Installation Procedure

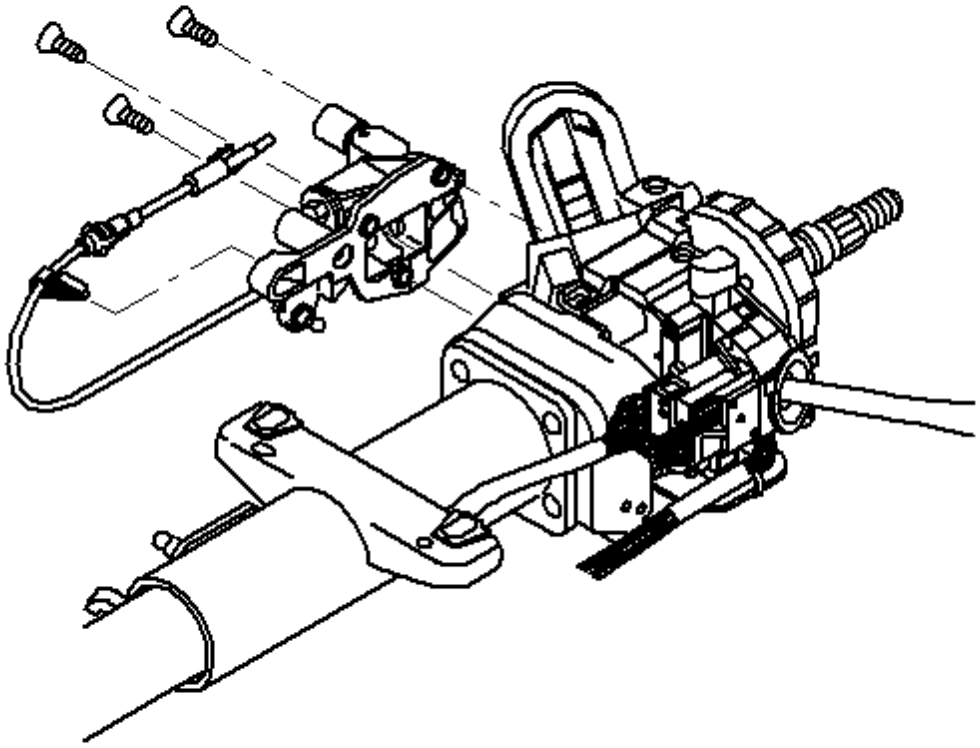


Fig. 40: Flat-Head 6-Lobed Socket Tap Screws & Linear Shift Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Position the linear shift assembly to the steering column.

CAUTION: **Refer to Fastener Caution .**

NOTE: **Start all linear shift assembly bolts by hand before finalizing any torques.**

2. Install the linear shift assembly bolts and tighten to 10 N.m (89 lb in).

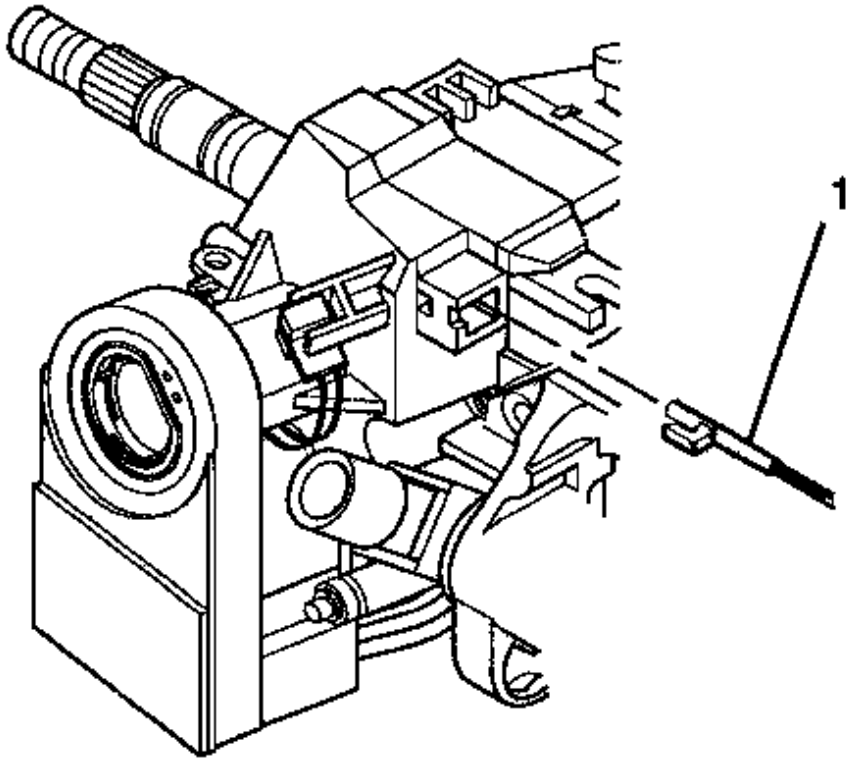


Fig. 41: Identifying Park Lock Cable At Ignition Lock Cylinder
Courtesy of GENERAL MOTORS COMPANY

3. Connect the park lock cable (1) to the ignition lock cylinder case.
    - The ignition lock cylinder should be in the OFF-LOCK position.
    - The locking tab at the end of the park lock cable (1) must be installed into the ignition lock cylinder case completely.

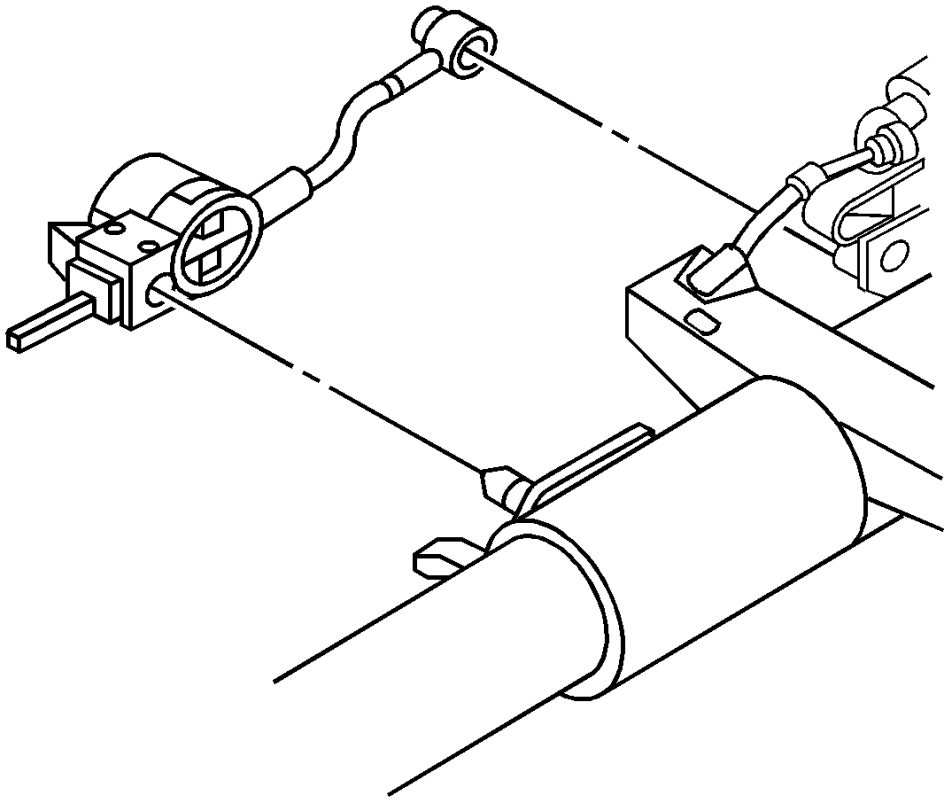


Fig. 42: View Of Automatic Transmission Shift Lock Control Actuator
Courtesy of GENERAL MOTORS COMPANY

4. Install the automatic transmission shift lock control.
5. Install the shift lever and put the column in the NEUTRAL position. Refer to **Shift Lever Replacement**.

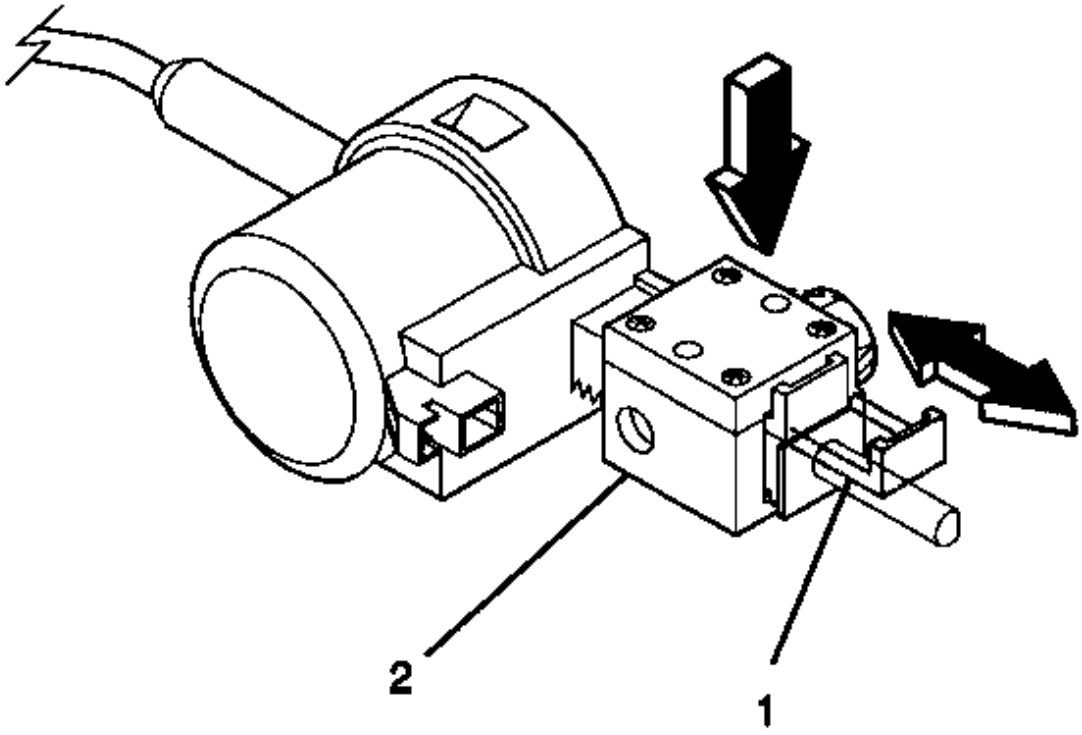


Fig. 43: Adjusting Automatic Transmission Shift Lock Control Actuator
Courtesy of GENERAL MOTORS COMPANY

6. Adjust the automatic transmission shift lock control.
    1. Pull the tab (1) out on the block side (2) of the automatic transmission shift lock control.
    2. Press on the adjuster block (2) to compress the internal adjuster spring to disengage the adjuster teeth. Slide the adjuster block as far away from the solenoid as possible.
    3. Lock in place by pushing the tab (1) back in.
7. Inspect the automatic transmission shift lock control.
    1. The automatic transmission shift lock control must lock the shift lever when it is put into the PARK position.
    2. When the column is installed in the vehicle you will not be able to move the shift lever out of the PARK position without pressing on the brake pedal. The solenoid will be energized.
    3. Readjust if needed.
8. Install the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

STEERING COLUMN TILT WHEEL RELEASE LEVER REPLACEMENT

Removal Procedure

1. Disable the supplemental inflatable restraint (SIR) system. Refer to **SIR Disabling and Enabling** .

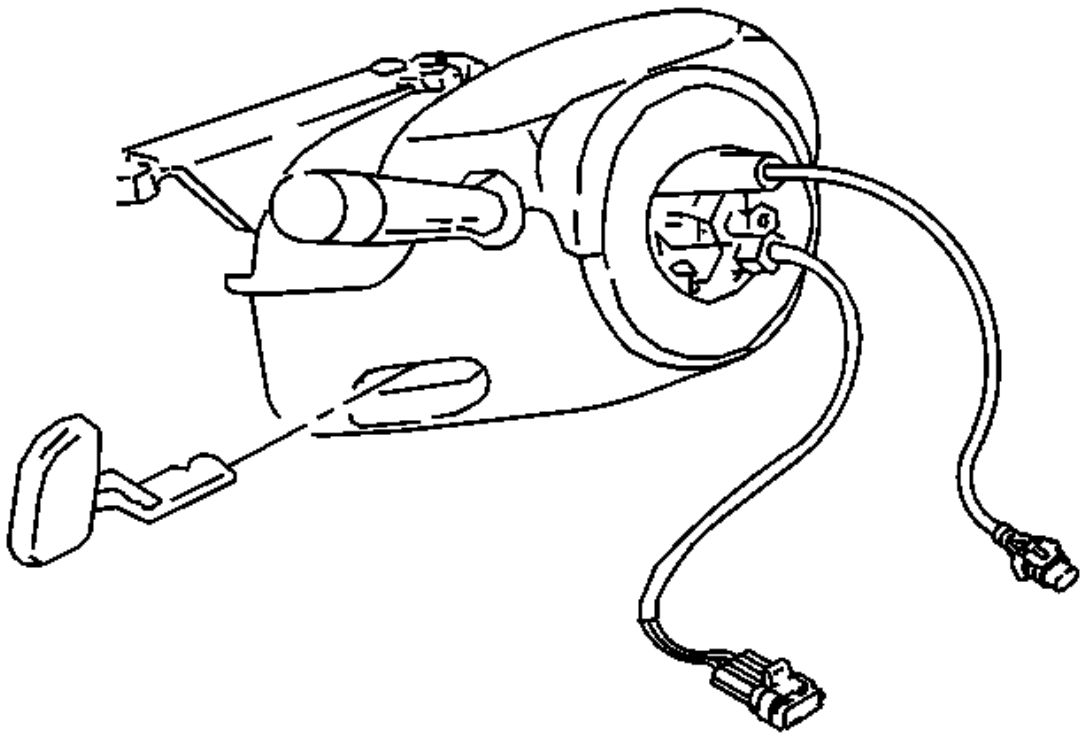


Fig. 44: Identifying Tilt Lever
Courtesy of GENERAL MOTORS COMPANY

2. Pull the tilt lever out from the steering column.

Installation Procedure

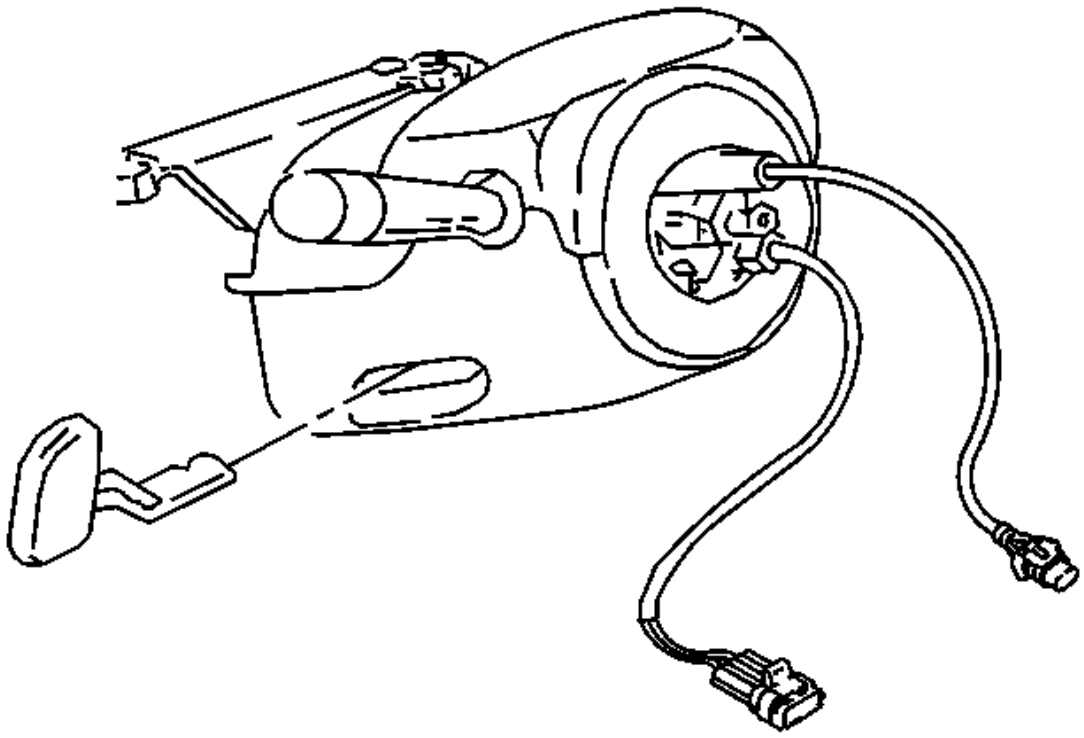


Fig. 45: Identifying Tilt Lever
Courtesy of GENERAL MOTORS COMPANY

1. Push the tilt lever into the steering column.
2. Enable the SIR system. Refer to **SIR Disabling and Enabling** .

STEERING WHEEL REPLACEMENT

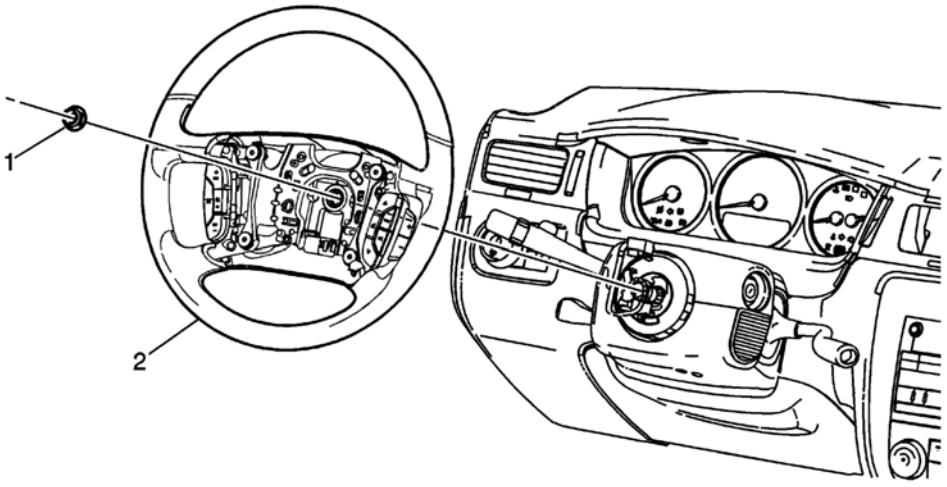


Fig. 46: Steering Wheel
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the inflatable restraint steering wheel module. Refer to **Airbag Steering Wheel Module Replacement** .	
1	Steering Wheel Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten** 41 N.m (30 lb ft)
2	Steering Wheel **Procedure** 1. Disconnect any electrical connectors as needed. 2. Use the **J 1859-A** puller and the **J 42578** legs to remove the steering wheel. **Special Tools** • **J 1859-A** Steering Wheel Puller • **J 42578** Steering Wheel Puller Legs For regional tools, refer to **Special Tools**.

STEERING WHEEL THEFT DETERRENT LOCK REPLACEMENT

Removal Procedure

1. Remove the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement** .

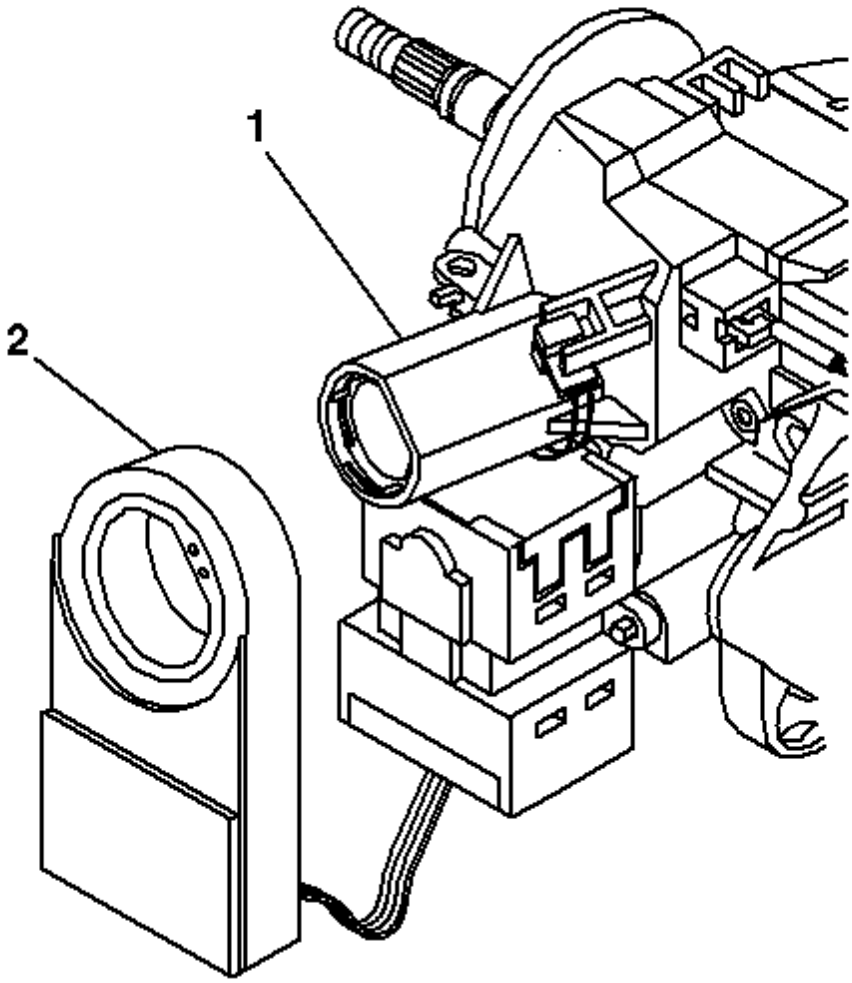


Fig. 47: Locating Theft Deterrent Module & Ignition Lock Cylinder Case Assembly
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the electrical connector from the steering wheel theft deterrent lock.
3. If necessary, disconnect the electrical connector from the ignition lock cylinder case (1).
4. Remove the steering wheel theft deterrent lock (2) from ignition lock cylinder case (1).

Installation Procedure

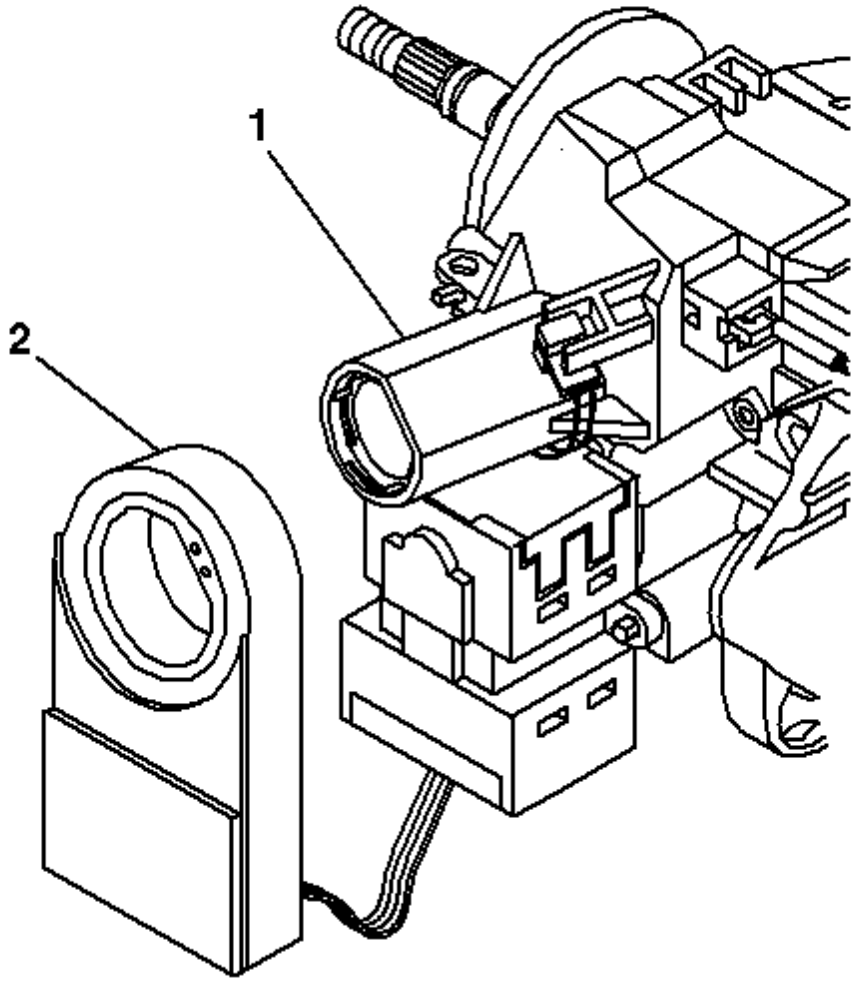


Fig. 48: Locating Theft Deterrent Module & Ignition Lock Cylinder Case Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the steering wheel theft deterrent lock (2) to ignition lock cylinder case (1).
2. Connect the electrical connector to the steering wheel theft deterrent lock.
3. If necessary, connect the electrical connector to the ignition lock cylinder case (1).
4. Install the ignition lock cylinder. Refer to **Ignition Lock Cylinder Replacement** .

STEERING COLUMN TILT SPRING REPLACEMENT

Removal Procedure

1. Remove the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

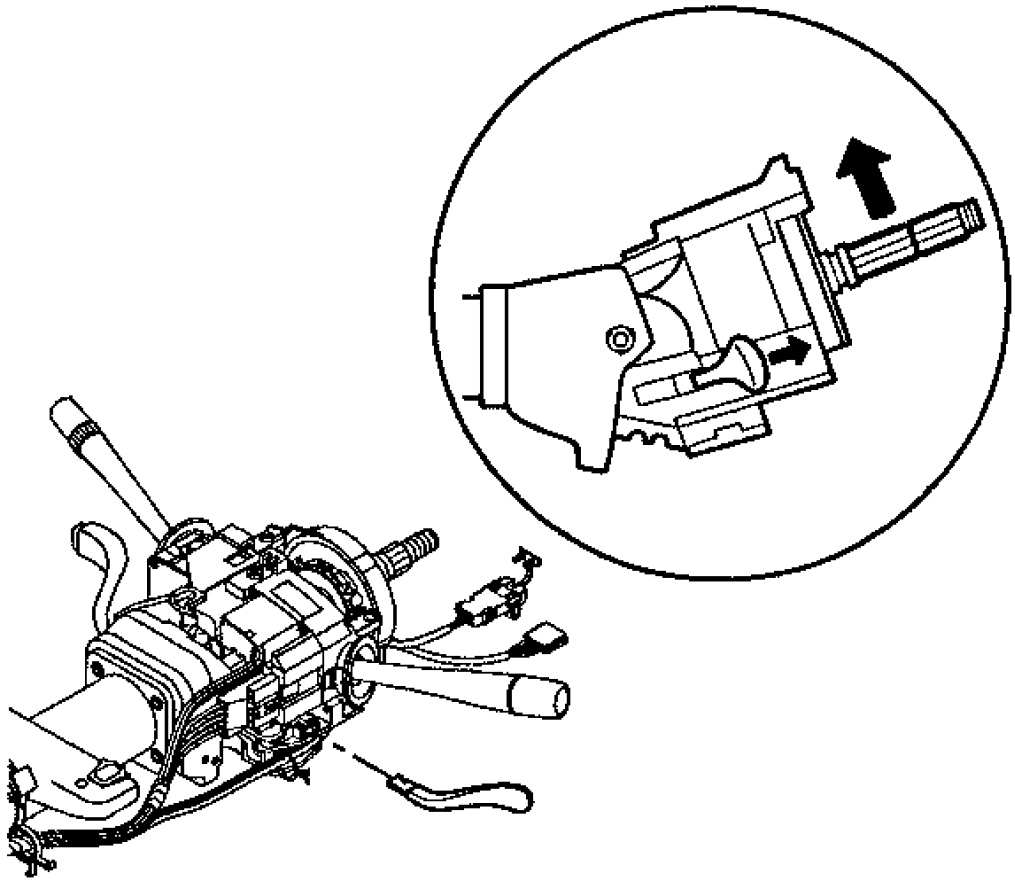


Fig. 49: Tilting Column To Up Position
Courtesy of GENERAL MOTORS COMPANY

2. Install the tilt lever onto the steering column tilt head assembly.
3. Use the tilt lever to tilt the column to the UP position.

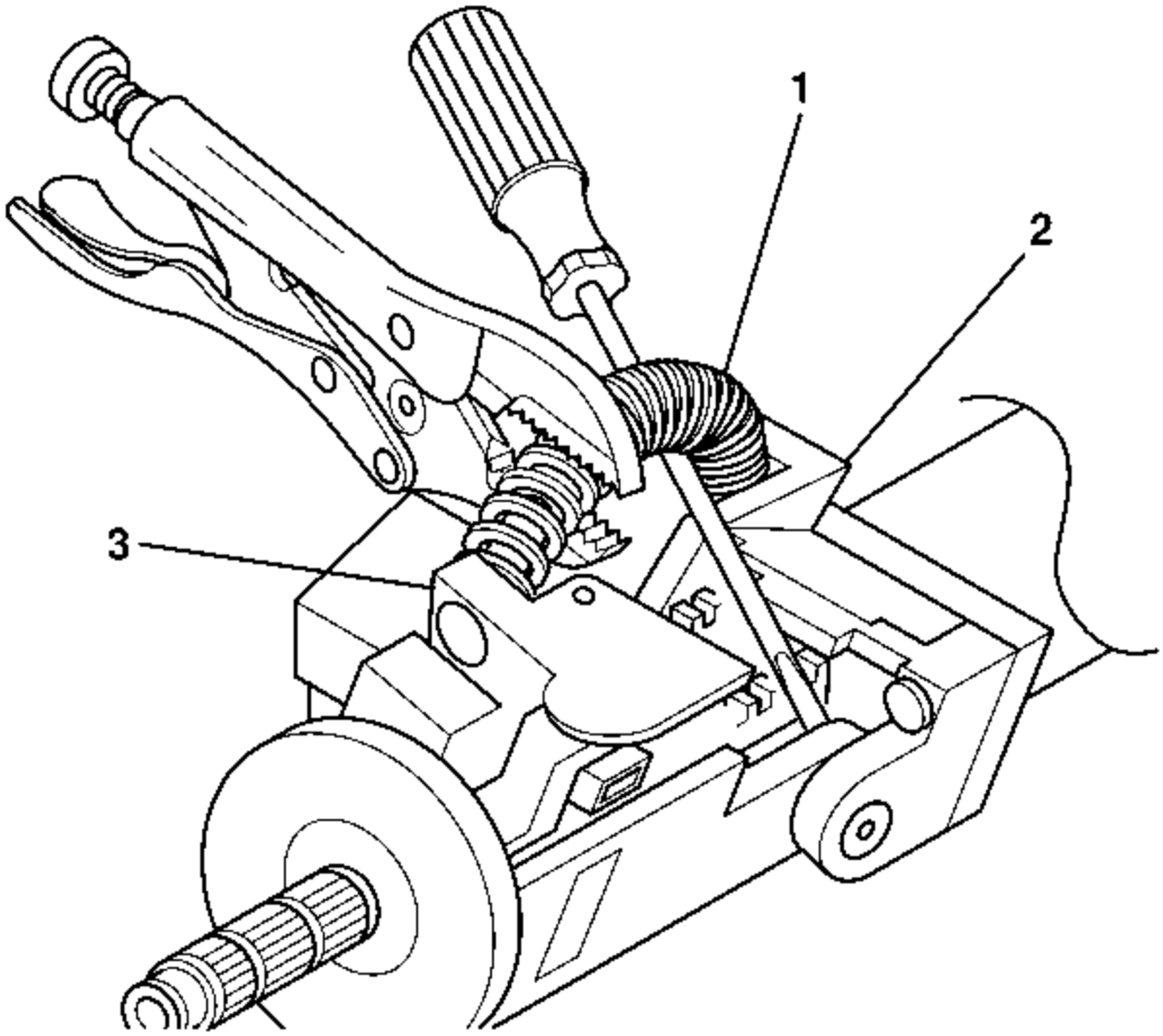


Fig. 50: View Of Tilt Spring And Steering Column Support Assembly
Courtesy of GENERAL MOTORS COMPANY

WARNING: The tilt spring and the spring guide are under pressure. The tilt spring and the spring guide may become a projectile. Secure the spring with locking pliers during removal. Secure the spring with locking pliers during installation. Bodily injury may result during removal and installation of the tilt spring and the spring guide. Always use caution during removal and installation of the tilt spring and the spring guide.

4. Remove the steering column tilt spring (1) from the steering column support assembly (2) and from the steering column tilt head assembly (3) by using the following procedure:
    1. Pry up the steering column tilt spring (1) until a bulge occurs and most of the tension is removed.
    2. Secure the steering column tilt spring (1) with locking pliers.
    3. Continue prying up the steering column tilt spring (1) until it disengages from the post on the steering column support assembly (2) and from the steering column tilt head assembly (3).

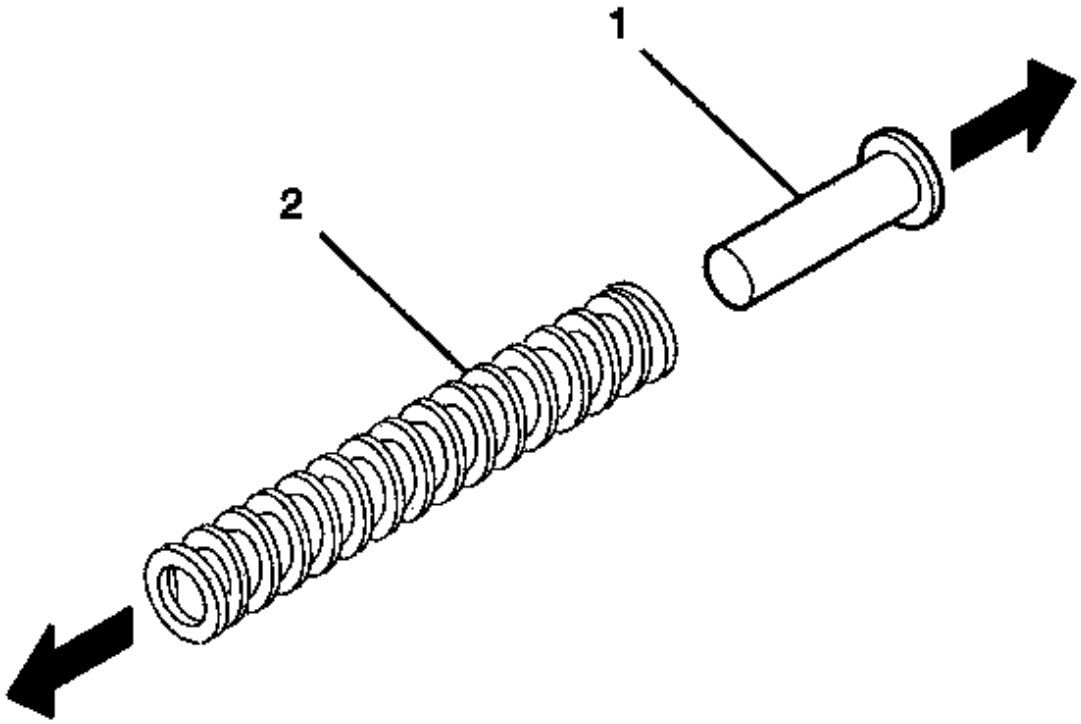


Fig. 51: Identifying Spring Guide Components
Courtesy of GENERAL MOTORS COMPANY

5. Remove the steering column tilt spring guide (1) from the steering column tilt spring (2).

Installation Procedure

1. Tilt the steering column to the UP position.

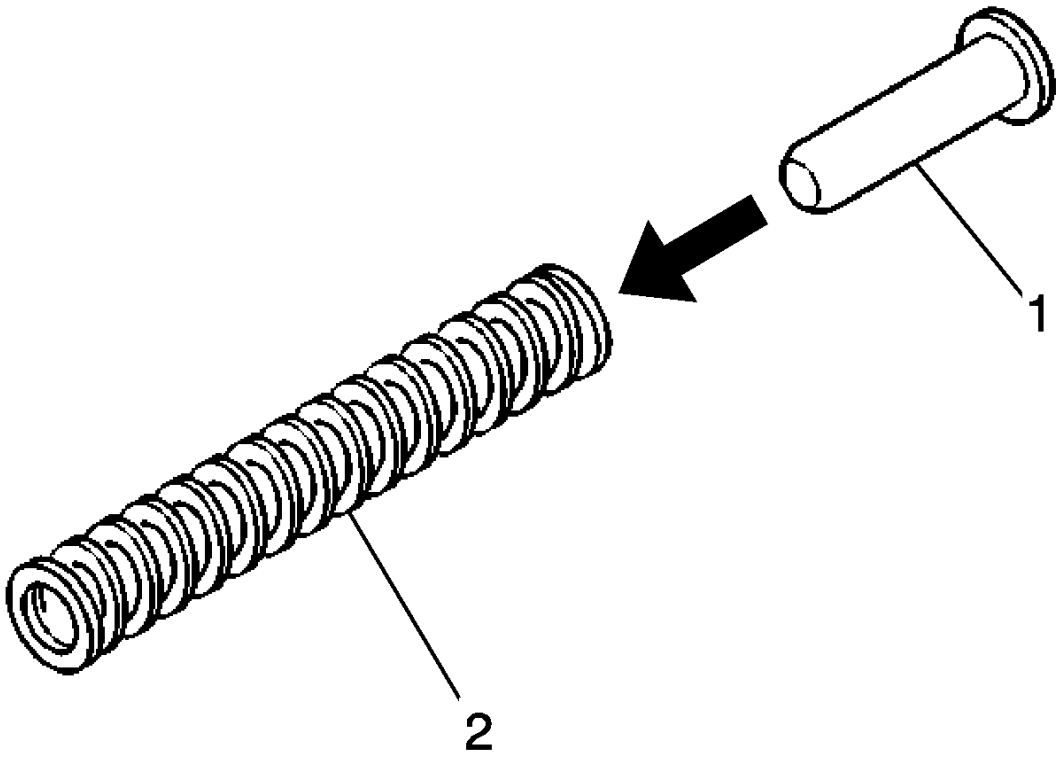


Fig. 52: Spring Guide & Tilt Spring
Courtesy of GENERAL MOTORS COMPANY

2. Install the steering column spring guide (1) into the steering column tilt spring (2).

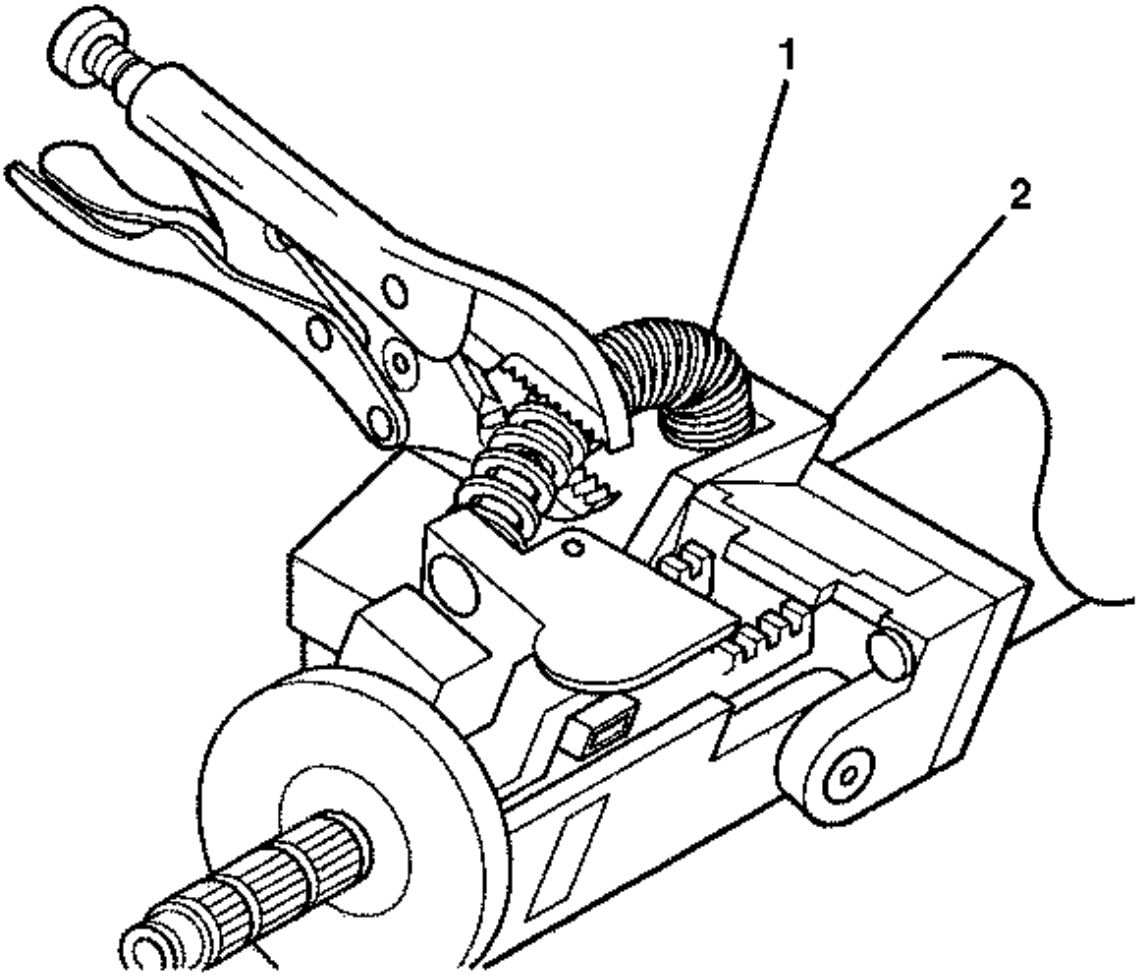


Fig. 53: Identifying Tilt Spring And Steering Column Support Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Install the steering column tilt spring (1) onto the steering column support assembly (2) and onto the steering column tilt head assembly by using the following procedure:
    1. Install the steering column tilt spring (1) onto the steering column tilt head assembly.
    2. Install the steering column tilt spring (1) onto the post on the steering column support assembly (2).
4. Install the steering column trim covers. Refer to **Steering Column Trim Cover Replacement**.

STEERING COLUMN TILT HEAD REPLACEMENT

Special Tools

J 21854-01 Pivot Pin Remover

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Remove the turn signal cancel cam and steering shaft upper bearing spring. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement**.

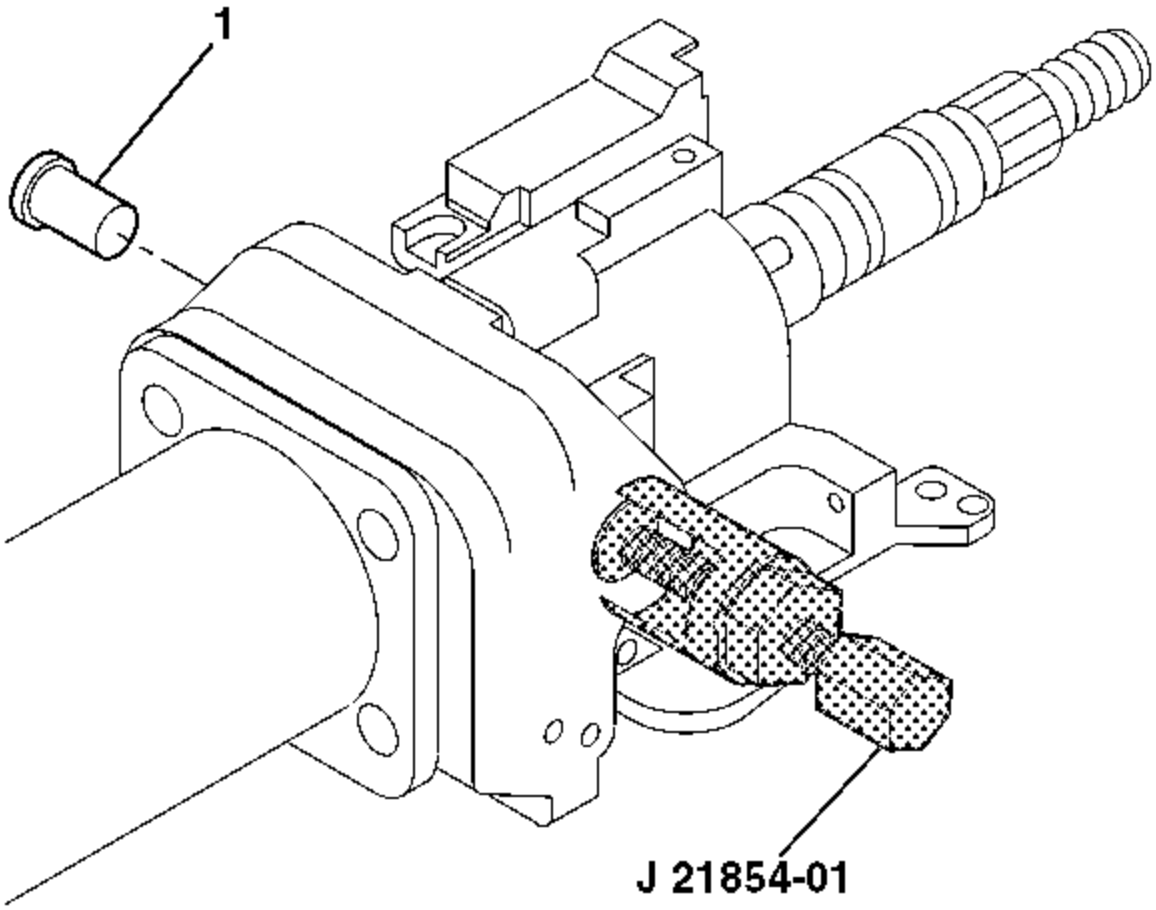


Fig. 54: Pivot Pins And Special Tool
Courtesy of GENERAL MOTORS COMPANY

2. Use the **J 21854-01** remover to remove the pivot pins (1).

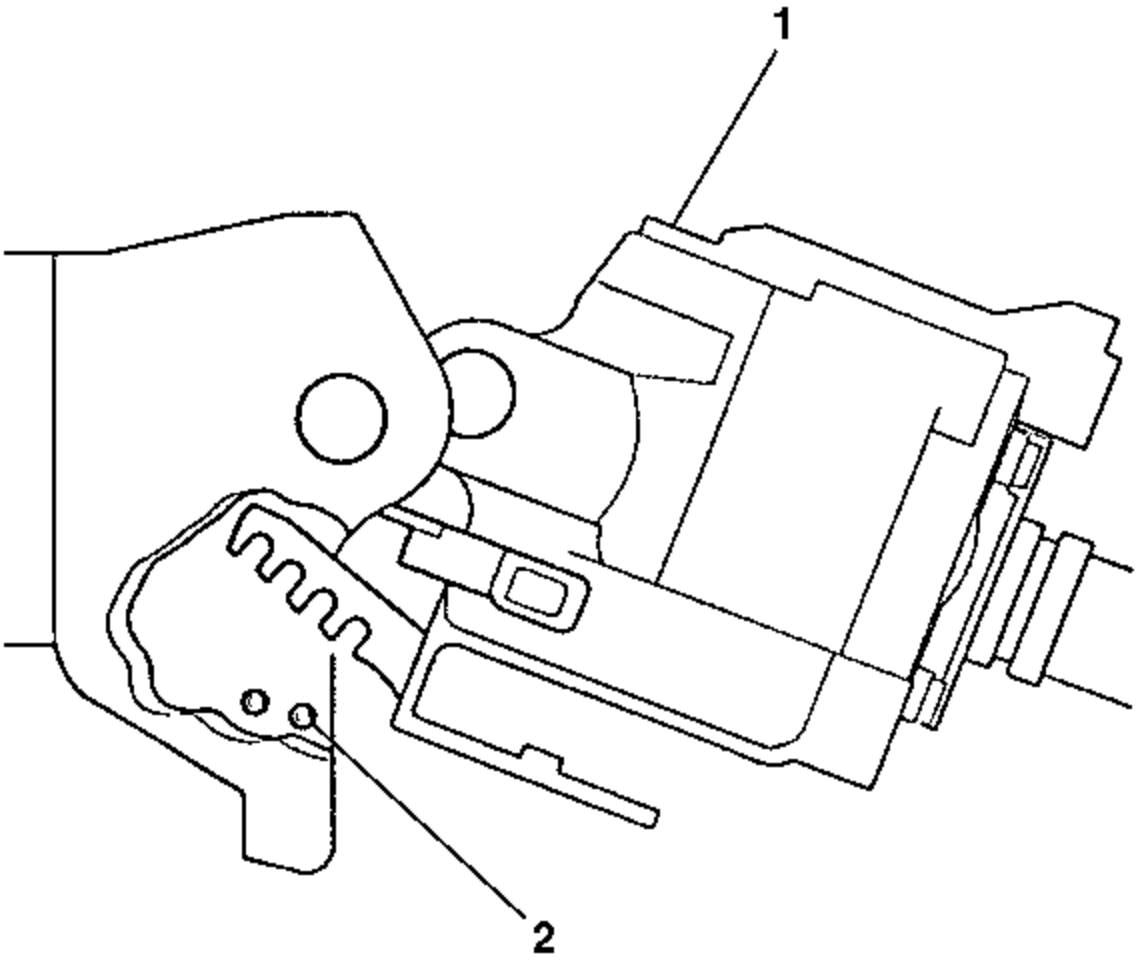


Fig. 55: Disengaging Steering Wheel Lock Shoes From Dowel Pins
Courtesy of GENERAL MOTORS COMPANY

3. Pull the tilt arm in order to disengage the steering wheel lock shoes from the dowel pins (2) in the steering column support assembly.

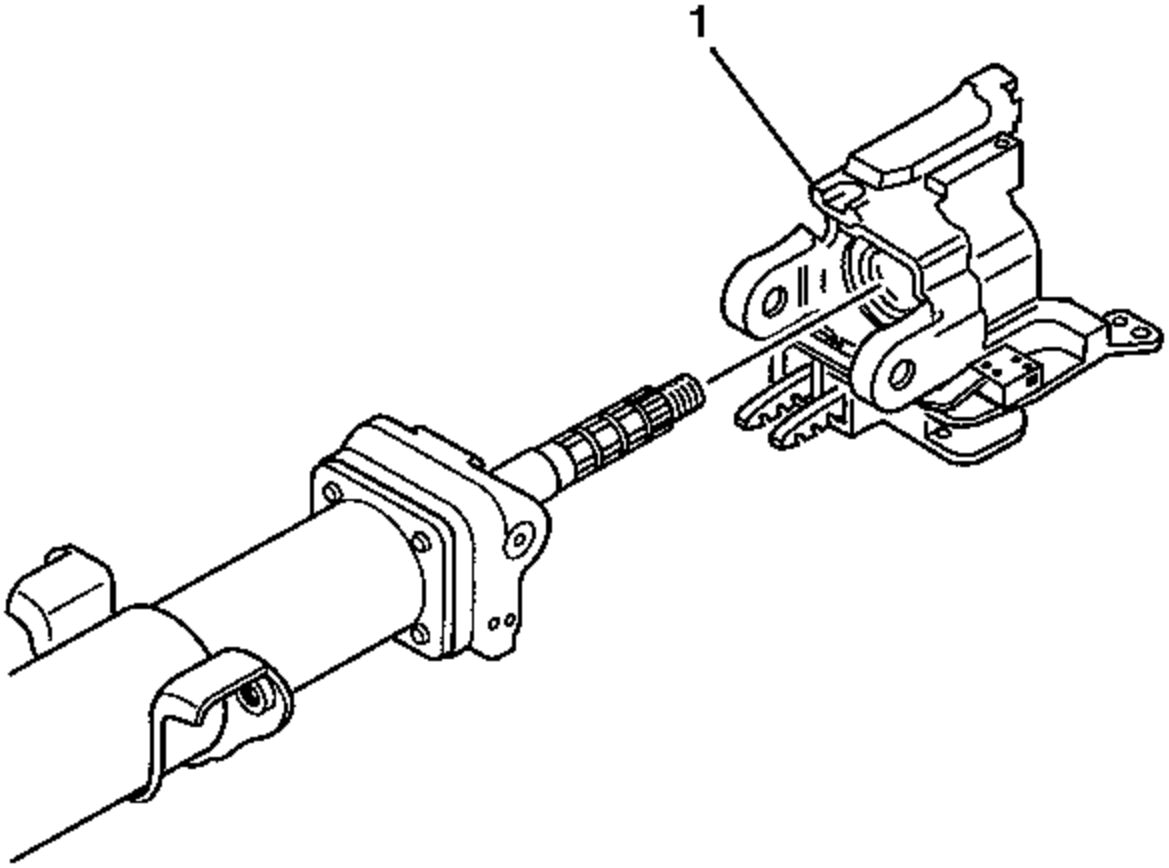


Fig. 56: View Of Steering Column Housing And Bearing Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Remove the steering column tilt head (1).

Installation Procedure

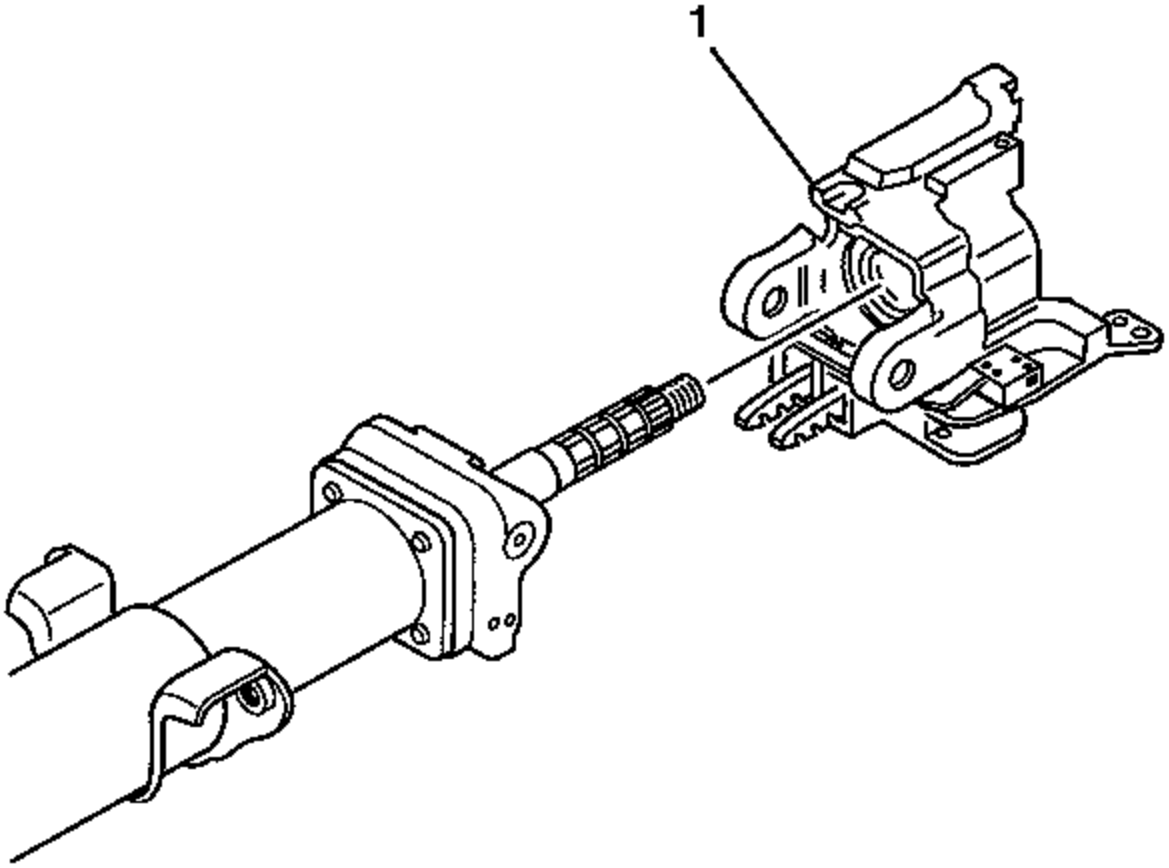


Fig. 57: View Of Steering Column Housing And Bearing Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Position the steering column tilt head (1) on to the steering column.

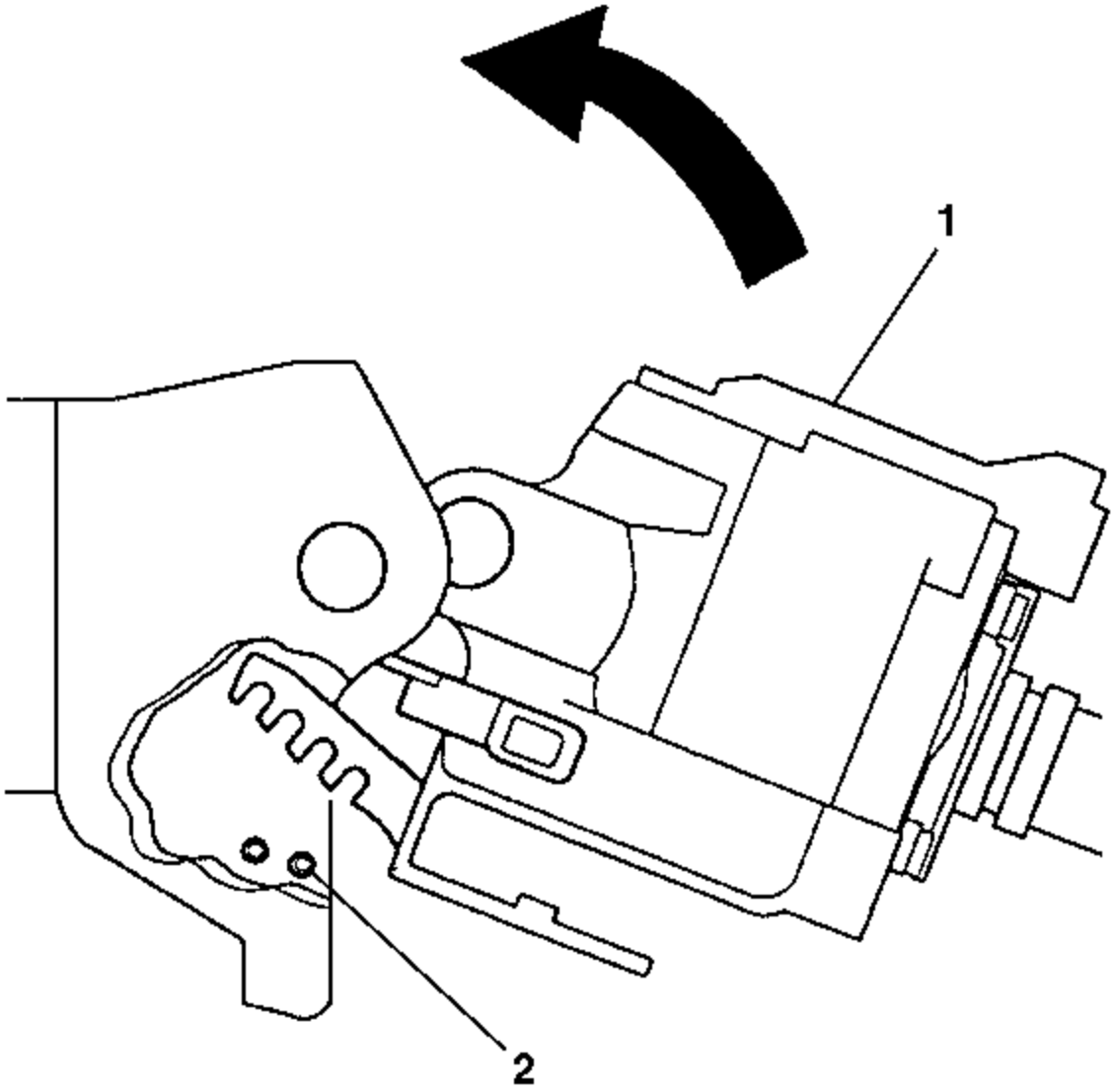


Fig. 58: Locking Shoes To Dowel Pins
Courtesy of GENERAL MOTORS COMPANY

2. Using the tilt lever position, lock the shoes to the dowel pins (2).
3. Rotate the steering column tilt head (1) in order to align the holes for the pivot pins.

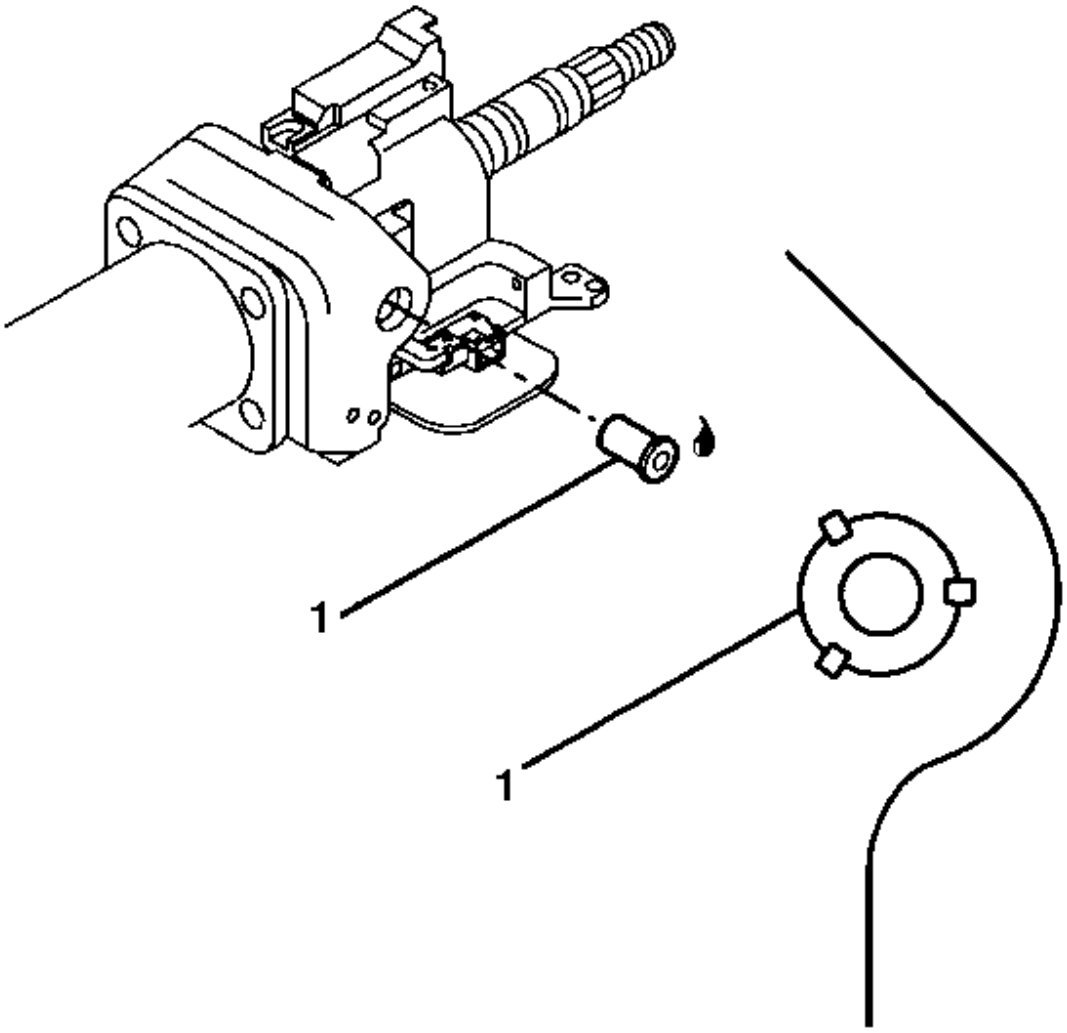


Fig. 59: View Of Pivot Pins At Steering Column Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Install the 2 pivot pins by performing the following steps:
    1. Lubricate the pivot pins (1). Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended lubricant.
    2. Press the pivot pins (1) until the pins are firmly seated.
    3. Stake the pivot pins at three new locations (1).
5. Install the turn signal cancel cam and steering shaft upper bearing spring. Refer to **Turn Signal Cancel Cam and Steering Shaft Upper Bearing Spring Replacement**.

STEERING COLUMN REPLACEMENT

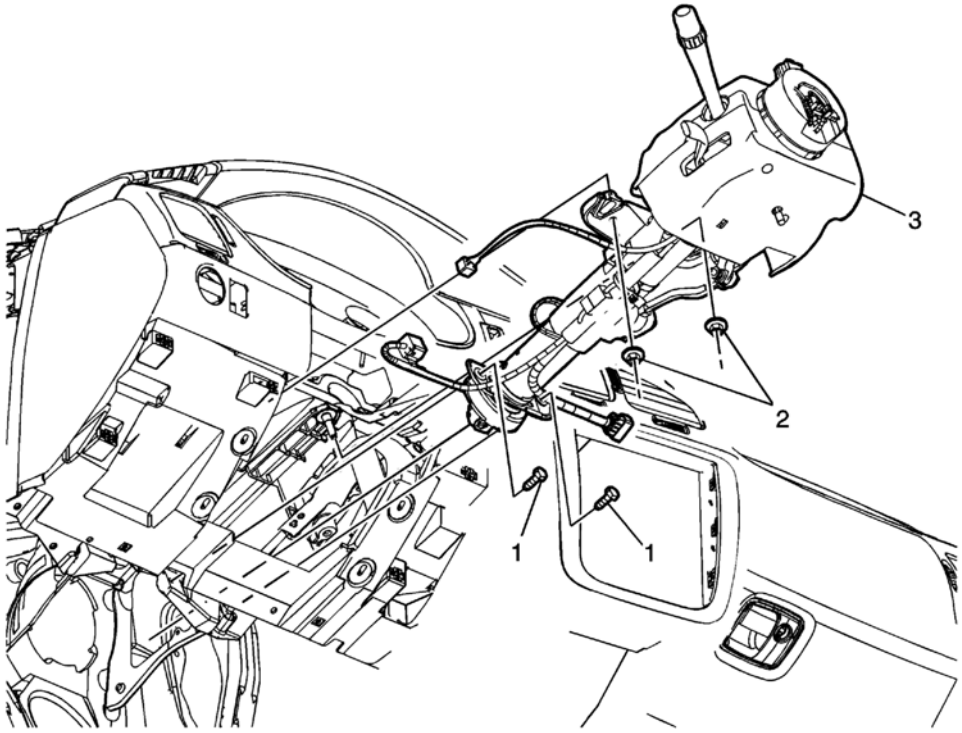


Fig. 60: Steering Column
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Refer to SIR Warning .** **WARNING:** **Refer to Battery Disconnect Warning .** **CAUTION:** **With wheels of the vehicle facing straight ahead, secure the steering wheel utilizing steering column anti-rotation pin, steering column lock, or a strap to prevent rotation.**	

Callout	Component Name
Locking of the steering column will prevent damage and a possible malfunction of the SIR system. The steering wheel must be secured in position before disconnecting the following components: • **The steering column** • **The intermediate shaft(s)** • **The steering gear** **After disconnecting these components, do not rotate the steering wheel or move the front tires and wheels. Failure to follow this procedure may cause the SIR coil assembly to become un-centered and cause possible damage to the SIR coil. If you think the SIR coil has become un-centered, refer to your specific SIR coil's centering procedure to re-**	

Callout	Component Name
center SIR Coil. **Preliminary Procedures** 1. Insert the **J-42640** pin into the steering column access hole in order to lock the steering column. 2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection** . 3. Disable the SIR system. Refer to **SIR Disabling and Enabling** . 4. Remove the steering wheel. Refer to **Steering Wheel Replacement**. 5. Remove the left closeout/insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Left Side** . 6. Remove the steering column filler panel. Refer to **Steering Column Opening Filler Replacement** . 7. Remove the knee bolster reinforcement. Refer to **Driver Knee Bolster Reinforcement Replacement** . 8. Remove the intermediate shaft from the bottom of the steering column. Refer to **Intermediate Steering Shaft Replacement**. 9. Perform passkey relearn after the ignition lock cylinder has been replaced. Refer to **Control Module References** . **Special Tools J 42640** Steering Column Anti-rotation Pin	
1	Steering Column Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
2	Steering Column Nut (Qty: 2) **Procedure** Once all steering column bolts and nuts are started, torque the steering column bolts first. **Tighten** 25 N.m (18 lb ft)
3	Steering Column **Procedure** 1. Disconnect any electrical connectors as needed. 2. Transfer any parts as needed.

STEERING SHAFT LOWER BEARING REPLACEMENT

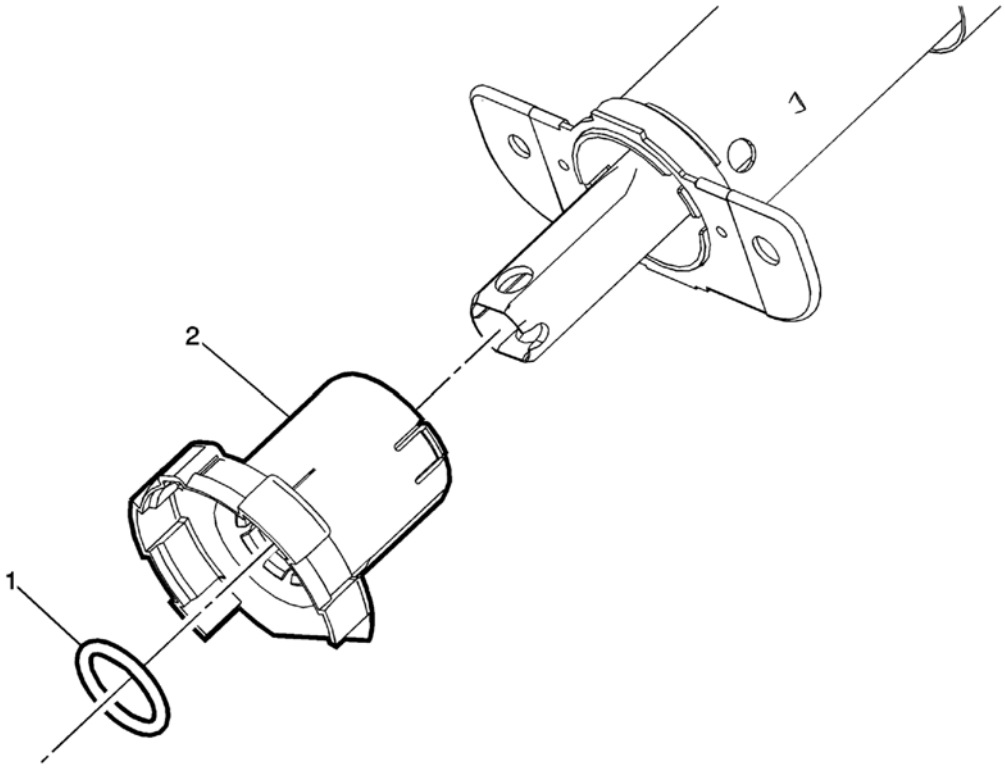


Fig. 61: Steering Shaft Lower Bearing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the steering angle sensor. Refer to **Steering Angle Sensor Replacement** .	
1	Steering Shaft Lower Bearing Retaining Ring **CAUTION:** **Refer to Fastener Caution .** **Procedure** Remove and discard the old retaining ring. Do NOT reuse the retaining ring, replace with NEW only.
2	Steering Shaft Lower Bearing

DESCRIPTION AND OPERATION

STEERING WHEEL AND COLUMN DESCRIPTION AND OPERATION

The steering wheel and column has 4 primary functions:

- Heated Steering Wheel

- Vehicle steering
- Vehicle security
- Driver convenience
- Driver safety

Heated Steering Wheel

The heated steering wheel control module controls the heated steering wheel and the heated steering wheel ON indicator based on an input from the heated steering wheel switch. When the heated steering wheel switch is pressed, the switch signal circuit is pulled to ground. This indicates to the heating steering wheel control module that steering wheel heat is requested. When the request is seen, the heated steering wheel control module supplies ground to the indicator lamp and supplies voltage to the heating elements, which are internal to the steering wheel. The heated steering wheel temperature is monitored through an internal temperature sensor. When the steering wheel reaches operating temperature the module will cycle the voltage on and off to maintain the operating temperature.

Vehicle Steering

The steering wheel is the first link between the driver and the vehicle. The steering wheel is fastened to a steering shaft within the column. At the lower end of the column, the intermediate shaft connects the column to the steering gear.

Vehicle Security, Found on Some Vehicle Models

Theft deterrent components are mounted and designed into the steering column. The following components allow the column to be locked in order to minimize theft:

- The ignition switch-location varies
- The steering column lock-content varies
- The ignition cylinder-location varies
- The theft deterrent module-location varies

Driver Convenience

The steering wheel and column may also have driver controls attached for convenience and comfort. The following controls may be mounted on or near the steering wheel or column.

- The turn signal switch
- The hazard switch
- The headlamp dimmer switch
- The wiper/washer switch
- The horn pad/cruise control switch
- The redundant radio/entertainment system controls
- The manual/power tilt or tilt/telescoping functions
- The power pedal adjustment control switch
- The navigation/OnStarÂ® features

- The HVAC controls

Driver Safety

The steering wheel and column has safety features to protect the driver. The following components may be mounted on or near the steering column:

Energy-Absorbing Steering Column

The energy-absorbing steering column compresses in the event of a front-end collision, which reduces the chance of injury to the driver. The energy-absorbing feature, collapsible steering shaft, and break away mounting features help reduce the injury in the event of an accident. In addition to these features, the following driver safety features may be on the steering column. To inspect the steering column for damage, refer to **Steering Column Accident Damage Inspection**.

Electronic Park Lock (EPL)/Ignition Lock Cylinder Control Actuator

If the vehicle is equipped with automatic transmission and a floor mounted console gear shift, it has an ignition lock cylinder control actuator system in the steering column. The ignition lock cylinder control actuator purpose is to prevent the ignition key from being turned to the OFF position when the transmission is in any position other than PARK and the vehicle may still be moving. The column ignition lock system consists of an ignition lock cylinder control actuator, and a park position switch that is located in the automatic transmission shift lock control switch. The ignition lock cylinder control actuator contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

Linear Shift Assembly

If the vehicle is equipped with a column mounted gear shift, it has a linear shift assembly on the steering column. The linear shift assembly has a cable that runs from the linear shift assembly to the ignition lock cylinder case. The purpose of this cable is to prevent the ignition key from being turned to the OFF position when the transmission is in gear and the vehicle may still be moving. The linear shift assembly cable contains a pin that is spring loaded to mechanically prevent the ignition key cylinder from being turned to the lock position when the vehicle transmission is not in the PARK position. If vehicle power is lost, and/or the transmission is not in the PARK position the operator will not be able to turn the ignition key to the lock position and will not be able to remove the ignition key from the column.

SIR Coil and Module

For additional information on the operation of the SIR coil and module, refer to **Supplemental Inflatable Restraint System Description and Operation** .

Automatic Transmission Shift Lock Actuator

The automatic transmission shift lock control system is a safety device that prevents an inadvertent shift out of PARK when the engine is running. The driver must press the brake pedal before moving the shift lever out of the PARK position. The system consists of the following components: the automatic transmission shift lock control solenoid, the automatic transmission shift lock control switch, the body

control module (BCM), the powertrain control module (PCM)/engine control module (ECM). With the ignition in the ON position, voltage is supplied to automatic transmission shift lock control switch. Voltage flows through the normally closed contacts of the automatic transmission shift lock control switch to the automatic transmission shift lock control solenoid. When the BCM receives a class 2 message from the PCM/ECM indicating the transmission is in the park position the BCM then grounds the automatic transmission shift lock solenoid control circuit . This energizes the automatic transmission shift lock control solenoid causing the transmission shift lever to be physically locked in the PARK position. When the brake pedal is pressed the contacts in the automatic transmission shift lock control switch open, de-energizing the automatic transmission shift lock control solenoid. This allows the shift lever to be move out of the PARK position.

Steering Wheel Angle Sensor or Steering Wheel Position Sensor

The steering wheel position sensor is located somewhere along the steering shaft assembly. The sensor measures the position of the steering wheel and the speed at which it is rotated. A signal representing this measurement is provided to the vehicle stability enhancement system (VSES) module. The VSES module uses this signal, along with several others representing different vehicle conditions, to monitor the driving behavior of the vehicle and ensure that it stays in control. If the VSES module determines that the vehicle is out of control it provides signals to the powertrain control module (PCM) and the ABS module. These output signals are used to modulate the transmission torque and brake pressure of each of the vehicles wheels in order to regain control of the vehicle.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

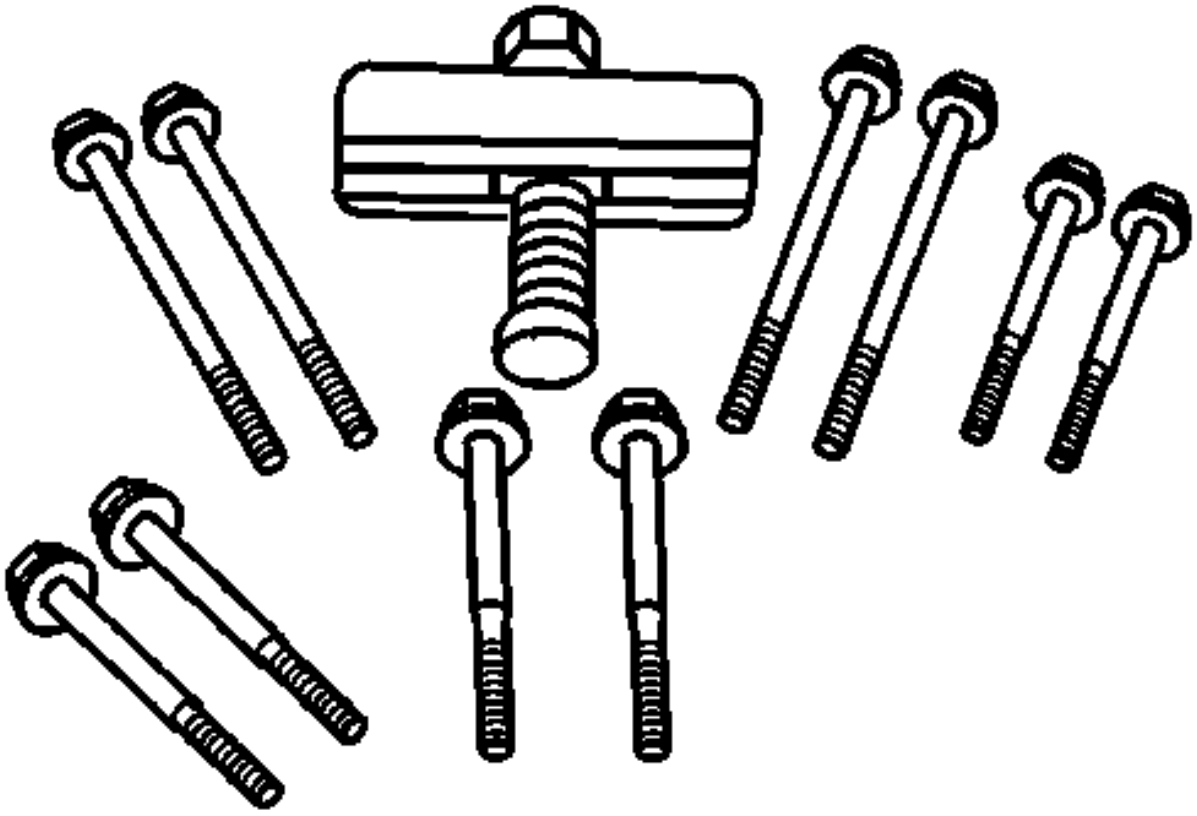
Illustration	Tool Number/ Description
	J-1859-A Countergear and Steering Wheel Puller

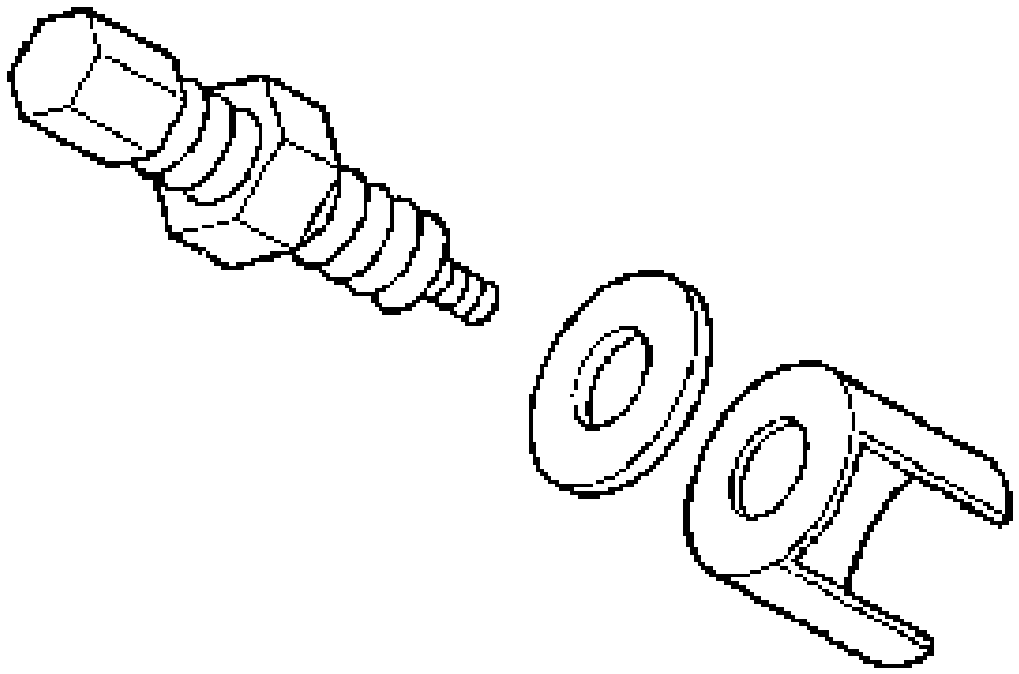
Illustration	Tool Number/ Description
	J-21854-01 Pivot Pin Remover

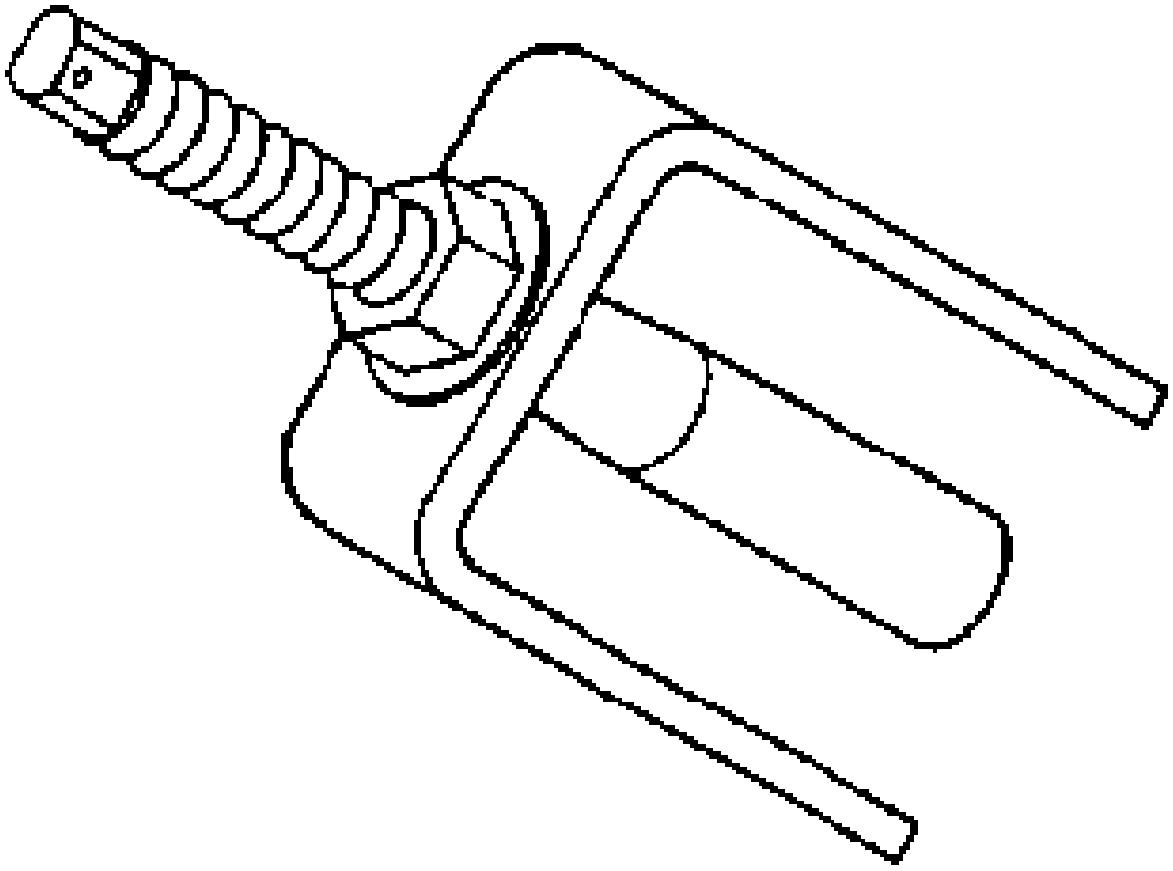
Illustration	Tool Number/ Description
	J-23653-SIR Steering Column Lock Plate Compressor

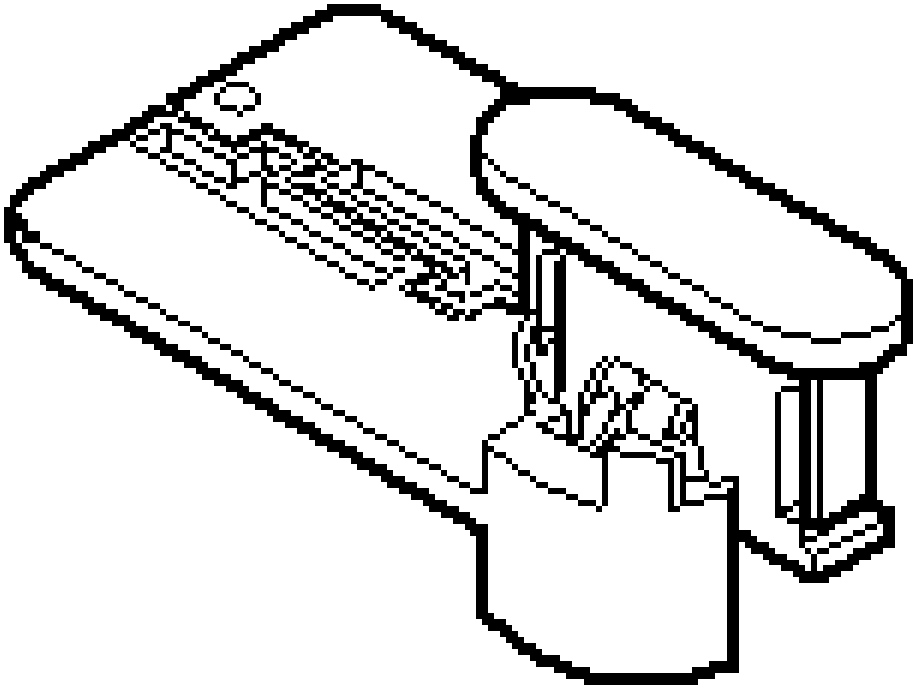
Illustration	Tool Number/ Description
	J-41688 Centering Sphere Installer - Tilt Steering Wheel

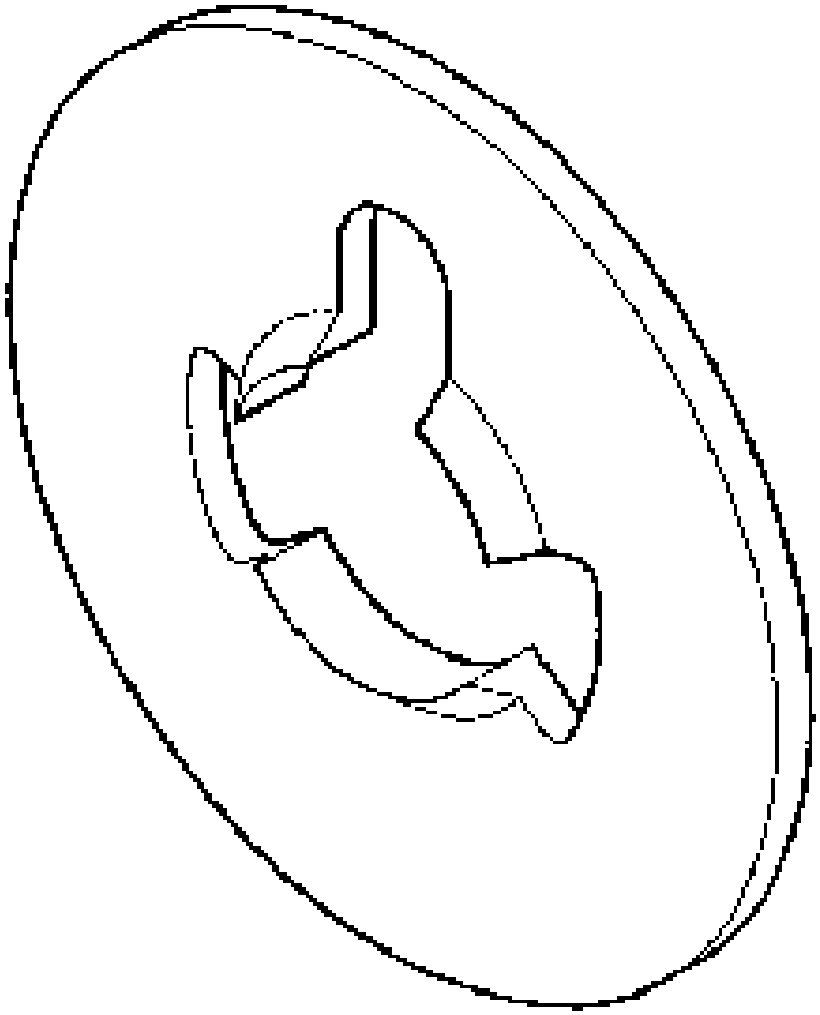
Illustration	Tool Number/ Description
	J-42137 Cam Orientation Plate Adapter

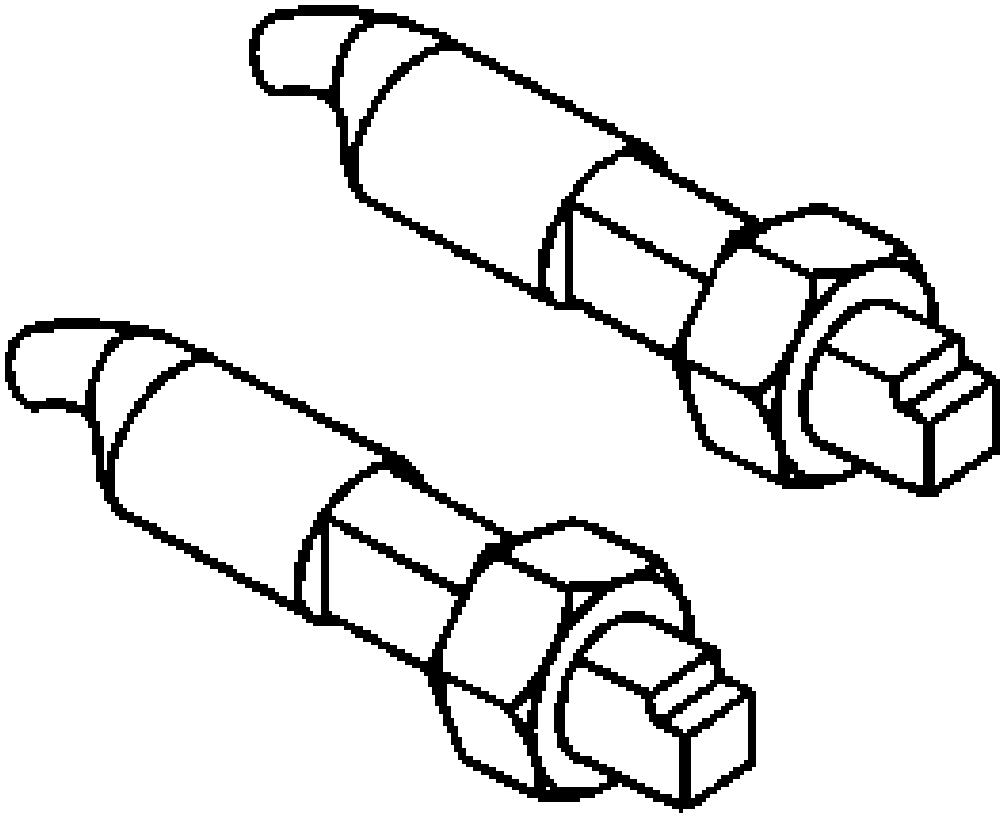
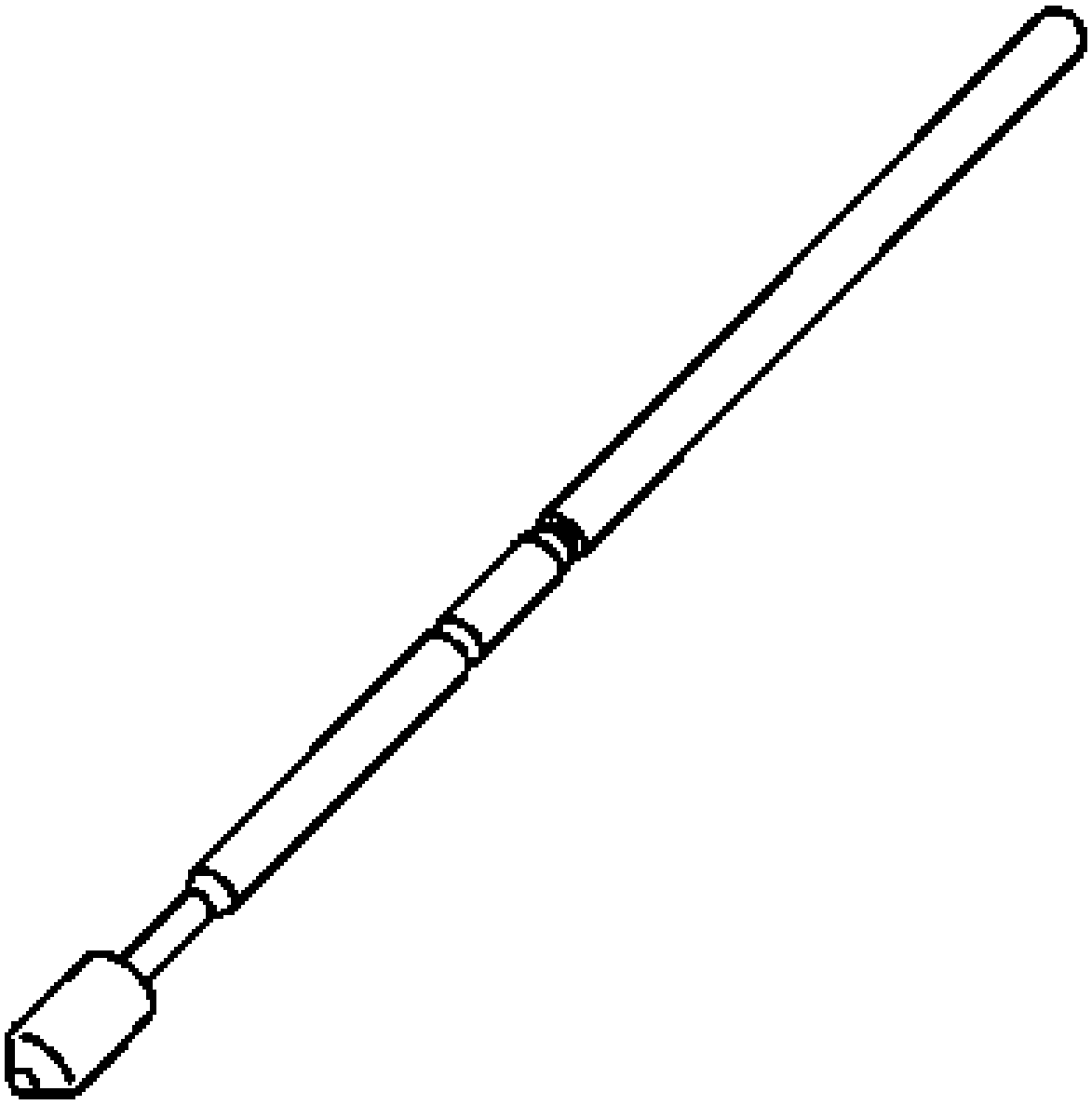
Illustration	Tool Number/ Description
	J-42578 Steering Wheel Puller Legs

Illustration	Tool Number/ Description
	J-42640 Steering Column Anti-Rotation Pin

Article GUID: A00737186

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
[1] Front Lower Control Arm Ball Stud to Steering Knuckle Nut	20 N.m + 120 degrees	15 lb ft + 120 degrees
Front Lower Control Ball Stud to Control Arm Nuts	68 N.m	50 lb ft
Front Lower Control Arm Mounting Nuts	125 N.m	92 lb ft
Front Stabilizer Shaft Bracket Bolt	42 N.m	31 lb ft
Front Stabilizer Shaft Link Nut	23 N.m	17 lb ft
Front Suspension Strut Mount to Body Nut	33 N.m	24 lb ft
Front Suspension Strut Rod to Strut Mount Nut	70 N.m	52 lb ft
Front Suspension Strut to Steering Knuckle Bolts	130 N.m	96 lb ft
Front Wheel Bearing/Hub Bolts	130 N.m	96 lb ft
Powertrain Cradle to Body Bolts (Front)	145 N.m	107 lb ft
Powertrain Cradle to Body Bolts (Rear)	160 N.m	118 lb ft
[1] Tighten the nut to 20 N.m(15 lb ft) plus 2 nut flats (120Â°) to align the cotter pin hole with the front lower control arm ball stud. Turn the nut clockwise. DO NOT loosen the nut in order to align the cotter pin hole. Minimum torque is 55 N.m (41 lb ft).		

REPAIR INSTRUCTIONS

STABILIZER SHAFT REPLACEMENT

Removal Procedure

WARNING: Failure to disconnect intermediate shaft from rack and pinion stub shaft can result in damage to steering gear and/or intermediate shaft. This damage can cause loss of steering control which could result in personal injury.

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the left tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the pinch bolt from the lower intermediate steering shaft. Refer to **Intermediate Steering Shaft Replacement** .
4. Loosen all insulator clamp attaching bolts.
5. Place a jackstand under the center of the rear frame crossmember.
6. Remove the rear frame-to-body bolts.
7. Lower the rear of the frame just enough to gain access to the stabilizer shaft.

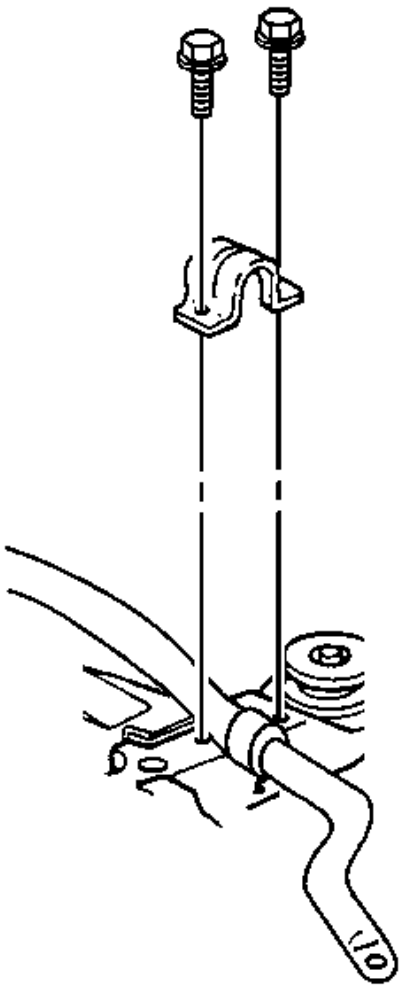


Fig. 1: View Of Insulator Brackets
Courtesy of GENERAL MOTORS COMPANY

8. Remove the insulator clamp bolts and the clamps from the frame.

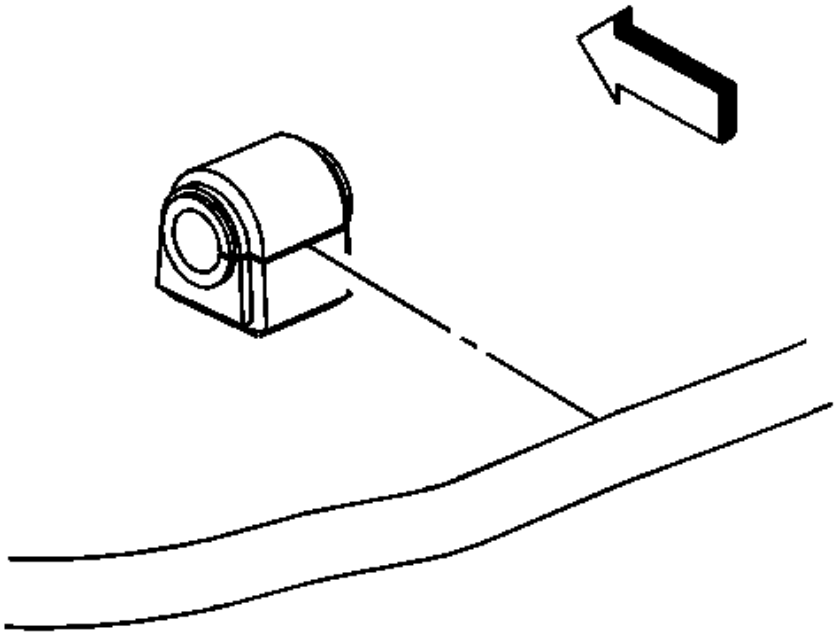


Fig. 2: View Of Insulator For Stabilizer Bar
Courtesy of GENERAL MOTORS COMPANY

9. Remove the insulators from the stabilizer bar.

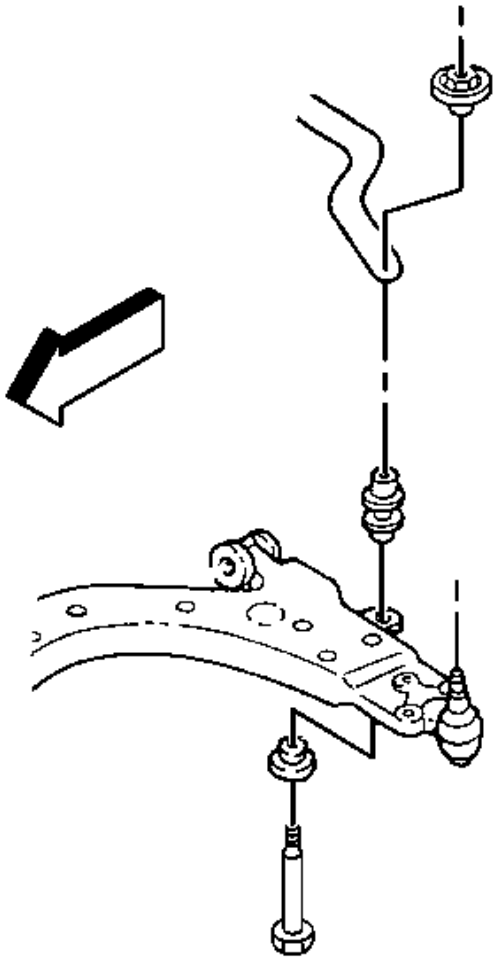


Fig. 3: View Of Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

10. Remove the stabilizer bar links from the control arms. Refer to **Stabilizer Shaft Link Replacement**.
11. Pull the stabilizer shaft rearward.
12. Swing the stabilizer shaft down to remove the stabilizer shaft from the left side of the vehicle.

Installation Procedure

WARNING: When installing the intermediate shaft make sure that the shaft is seated prior to pinch bolt installation. If the pinch bolt is inserted into the coupling before shaft installation, the two mating shafts may disengage. Disengagement of the two mating shafts will cause loss of steering control which could result in personal injury.

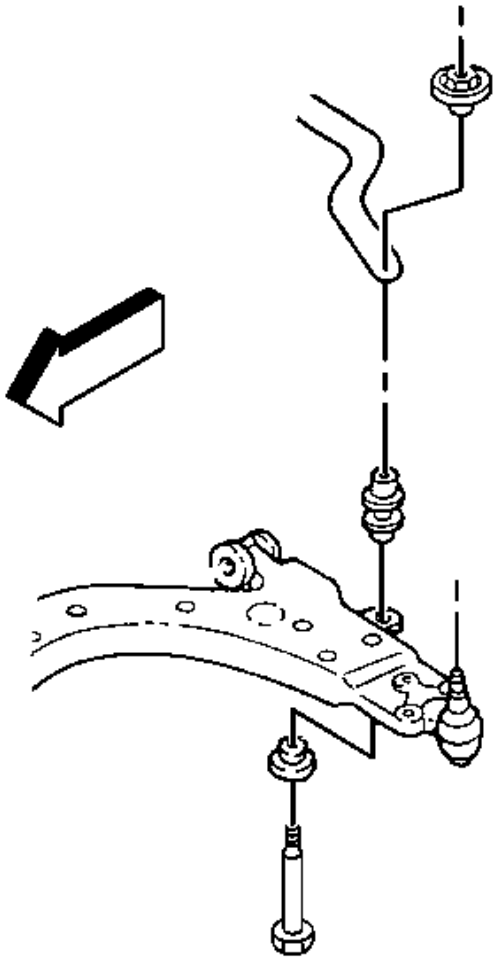


Fig. 4: View Of Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

1. Insert the stabilizer shaft to the left side of the vehicle.

NOTE: **DO NOT tighten the stabilizer link nut at this time. The weight of the vehicle must be supported by the control arms such that you can obtain the vehicle design trim heights before tightening the link nut.**

2. Loosely install the stabilizer shaft link at the control arm.

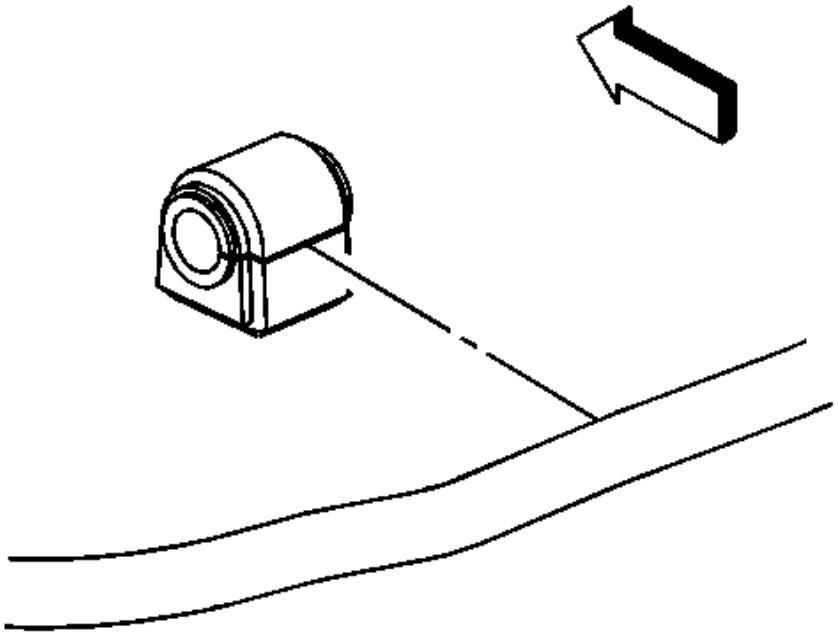


Fig. 5: View Of Insulator For Stabilizer Bar
Courtesy of GENERAL MOTORS COMPANY

3. Install the insulators on to the stabilizer bar.

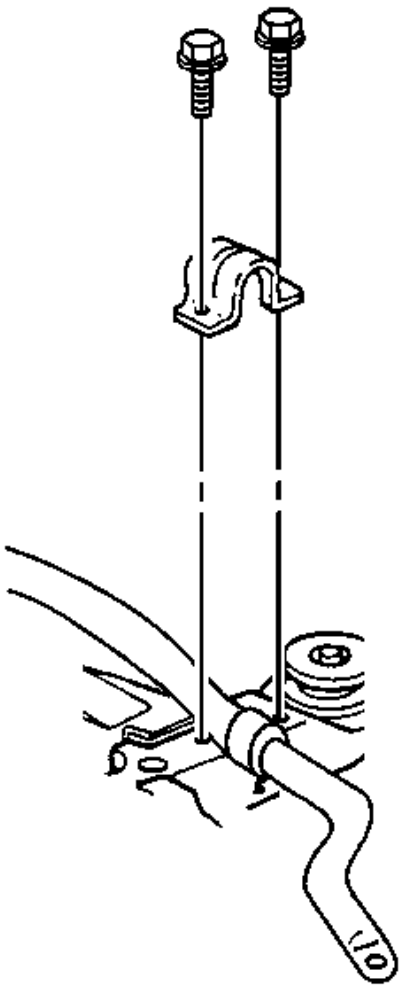


Fig. 6: View Of Insulator Brackets
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Connect the insulator clamps to the frame.

Tighten

Tighten the stabilizer shaft bracket bolt to 42 N.m (31 lb ft).

5. Raise the frame into position while you guide the steering shaft onto the gear.
6. Install the rear frame-to-body attaching bolts.

Tighten

Tighten the frame to body attaching bolts to 160 N.m (118 lb ft).

7. Remove the jackstand.

8. Install the pinch bolt and tighten. Refer to **Intermediate Steering Shaft Replacement** .
9. Install the left tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
10. Lower the vehicle.
11. Support the weight of the vehicle by the control arms.
12. Tighten the stabilizer link nut.

Tighten

Tighten the stabilizer shaft link nut to 23 N.m (17 lb ft).

STABILIZER SHAFT LINK REPLACEMENT

Removal Procedure

1. Raise the vehicle and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

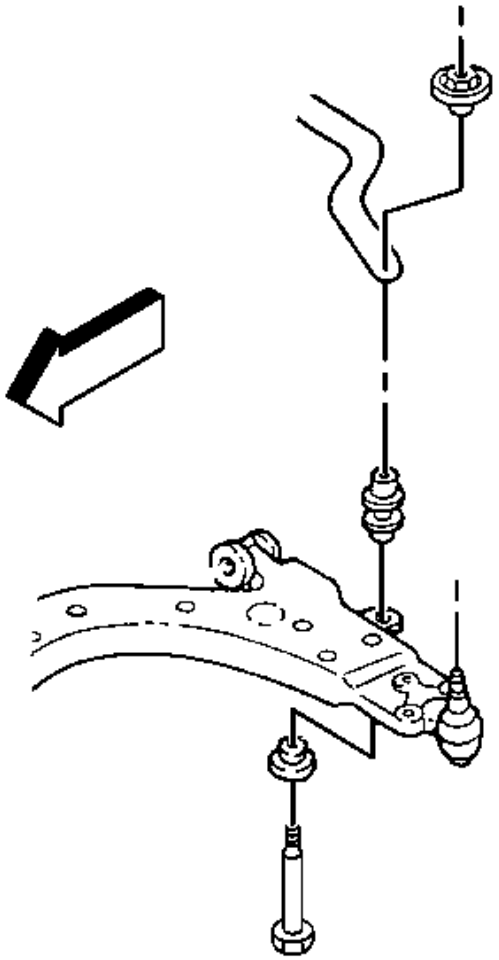


Fig. 7: View Of Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

3. Remove the stabilizer shaft link bolt and nut.
4. Remove the stabilizer shaft link from the vehicle.

Installation Procedure

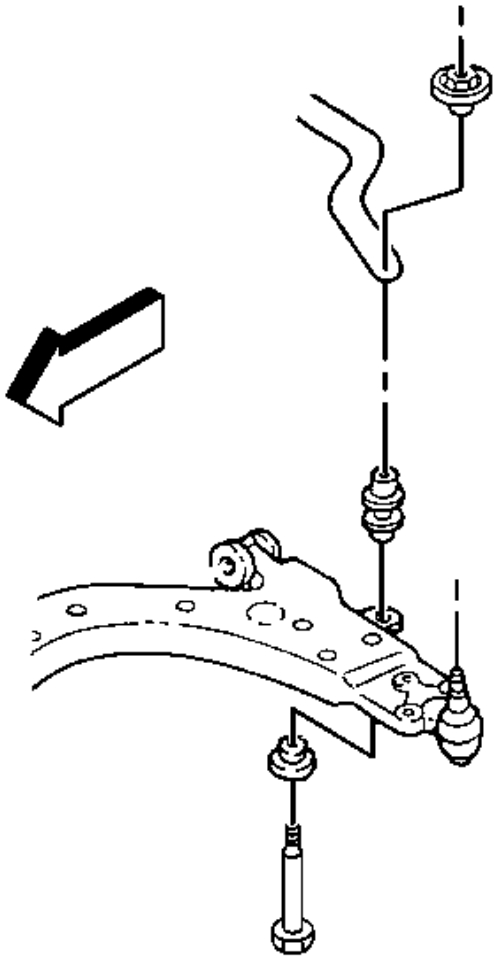


Fig. 8: View Of Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

1. Install the stabilizer link into the vehicle.

CAUTION: Refer to Fastener Caution .

2. Install the stabilizer shaft link bolt and nut.

Tighten

Tighten the stabilizer shaft link nut to 23 N.m (17 lb ft).

3. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
4. Lower the vehicle.

STABILIZER SHAFT INSULATOR REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

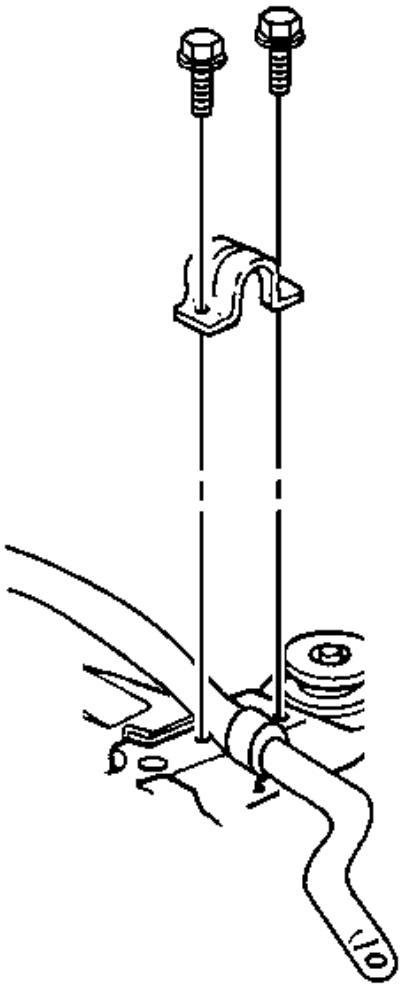


Fig. 9: View Of Insulator Brackets
Courtesy of GENERAL MOTORS COMPANY

2. Remove the left and right side stabilizer shaft insulator bracket bolts.
3. Remove the left and right side stabilizer shaft insulator brackets.

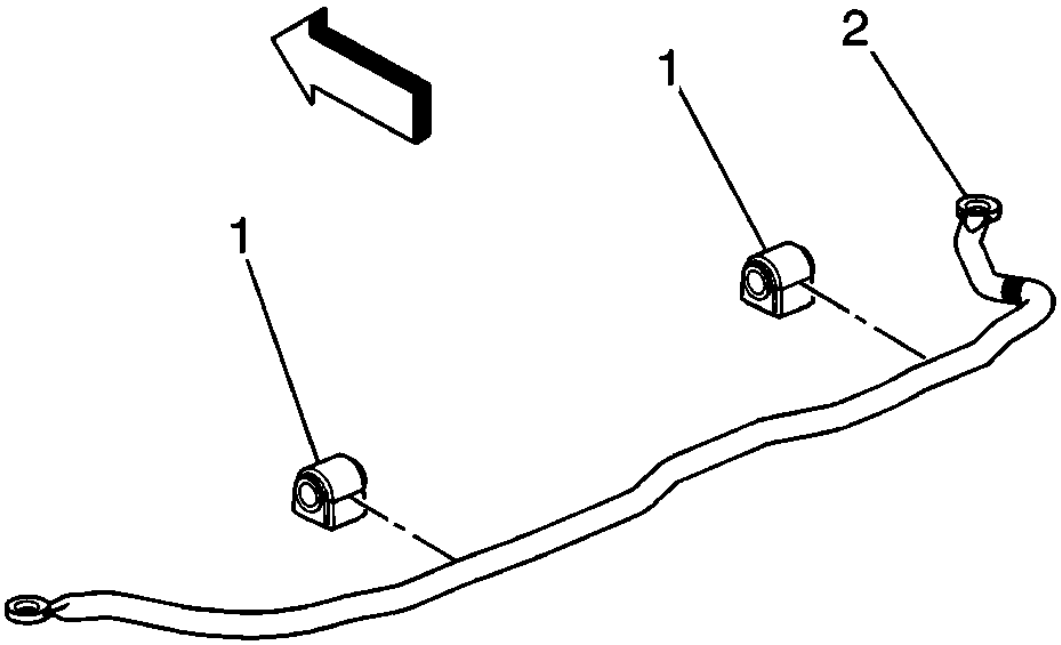


Fig. 10: Stabilizer Shaft Insulators
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left and right side stabilizer shaft insulators (1) from the stabilizer shaft (2).

Installation Procedure

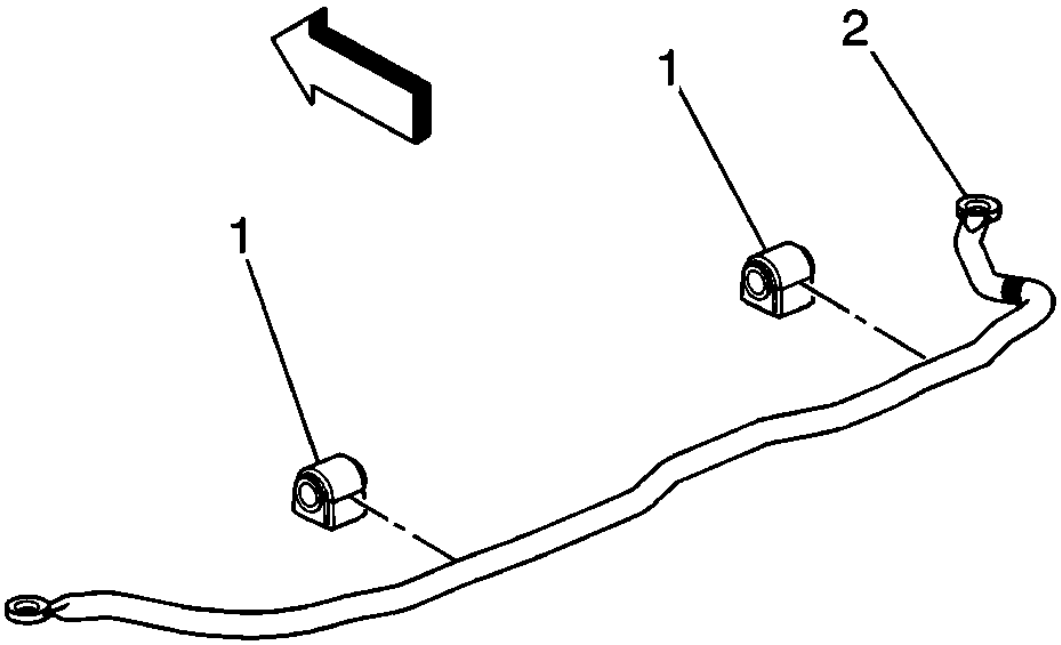


Fig. 11: Stabilizer Shaft Insulators
Courtesy of GENERAL MOTORS COMPANY

1. Install the left and right side stabilizer shaft insulators (1) to the stabilizer shaft (2).

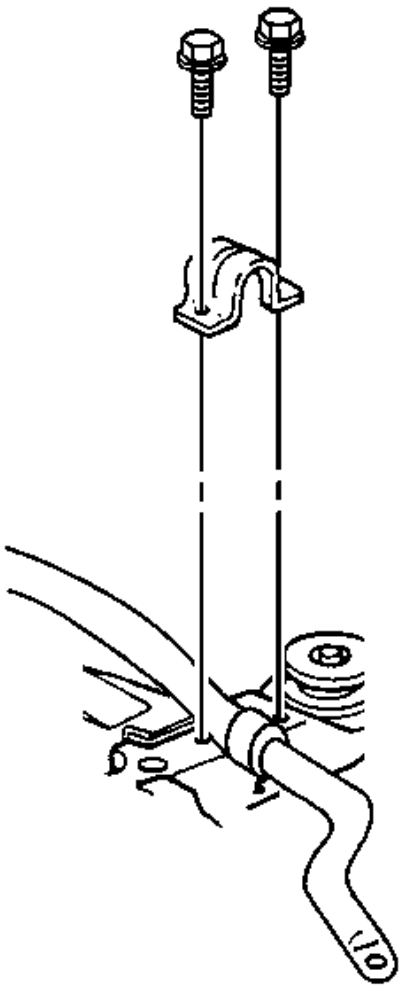


Fig. 12: View Of Insulator Brackets
Courtesy of GENERAL MOTORS COMPANY

2. Install the left and right side stabilizer shaft insulator brackets.

CAUTION: **Refer to Fastener Caution .**

3. Install the left and right side stabilizer shaft insulator bracket bolts.

Tighten

Tighten the stabilizer shaft insulator bracket bolts to 42 N.m (31 lb ft).

4. Lower the vehicle.

LOWER CONTROL ARM BALL JOINT REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

2. Remove the tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the lower control arm. Refer to **Lower Control Arm Replacement**.
4. Secure the lower control arm in a suitable vise.

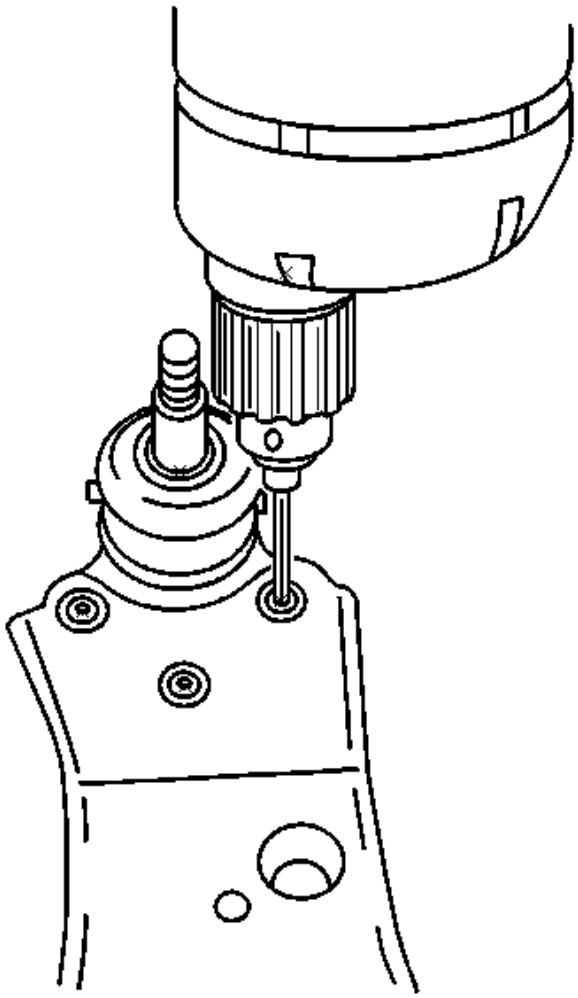


Fig. 13: Drilling Out Lower Ball Joint Rivet Heads
Courtesy of GENERAL MOTORS COMPANY

5. Using the appropriate size drill, drill out the rivet heads from the lower control arm.

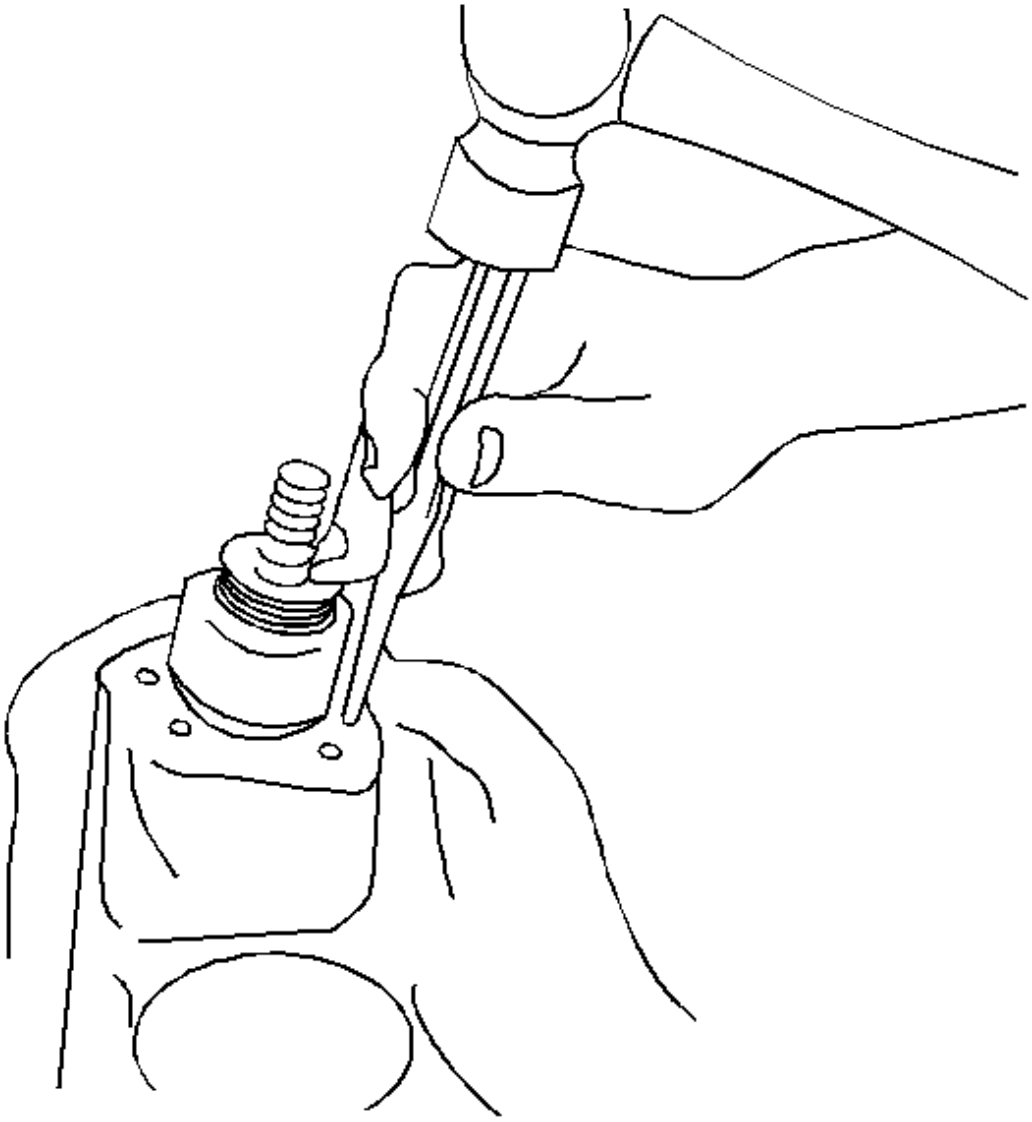


Fig. 14: Using Hammer & Drift To Remove Lower Ball Joint Rivets
Courtesy of GENERAL MOTORS COMPANY

6. Using a hammer and a drift punch, remove the remaining rivets from the control arm.

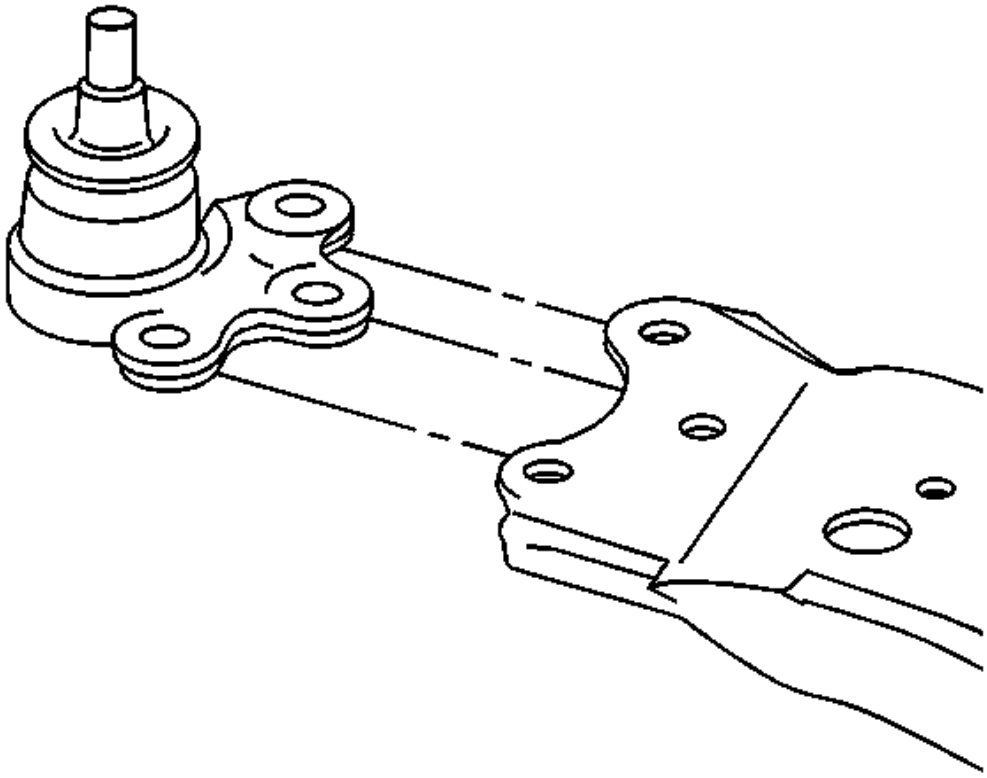


Fig. 15: Lower Ball Joint
Courtesy of GENERAL MOTORS COMPANY

7. Remove the ball joint from the lower control arm.

Installation Procedure

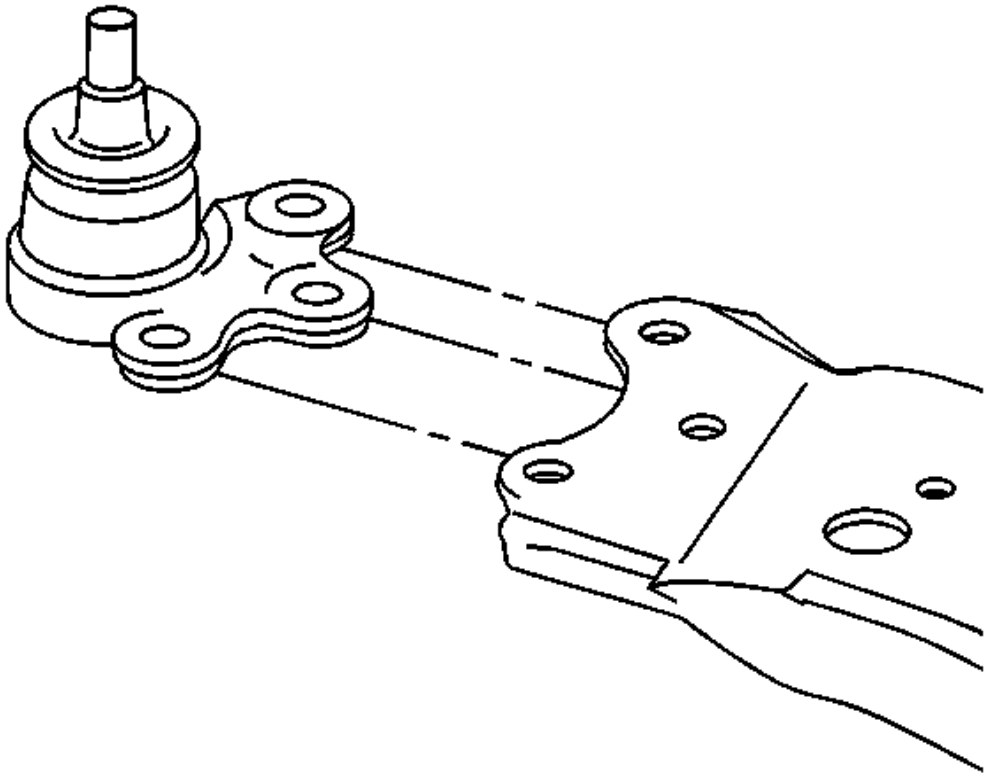


Fig. 16: Lower Ball Joint
Courtesy of GENERAL MOTORS COMPANY

1. Position the new ball joint in the lower control arm.

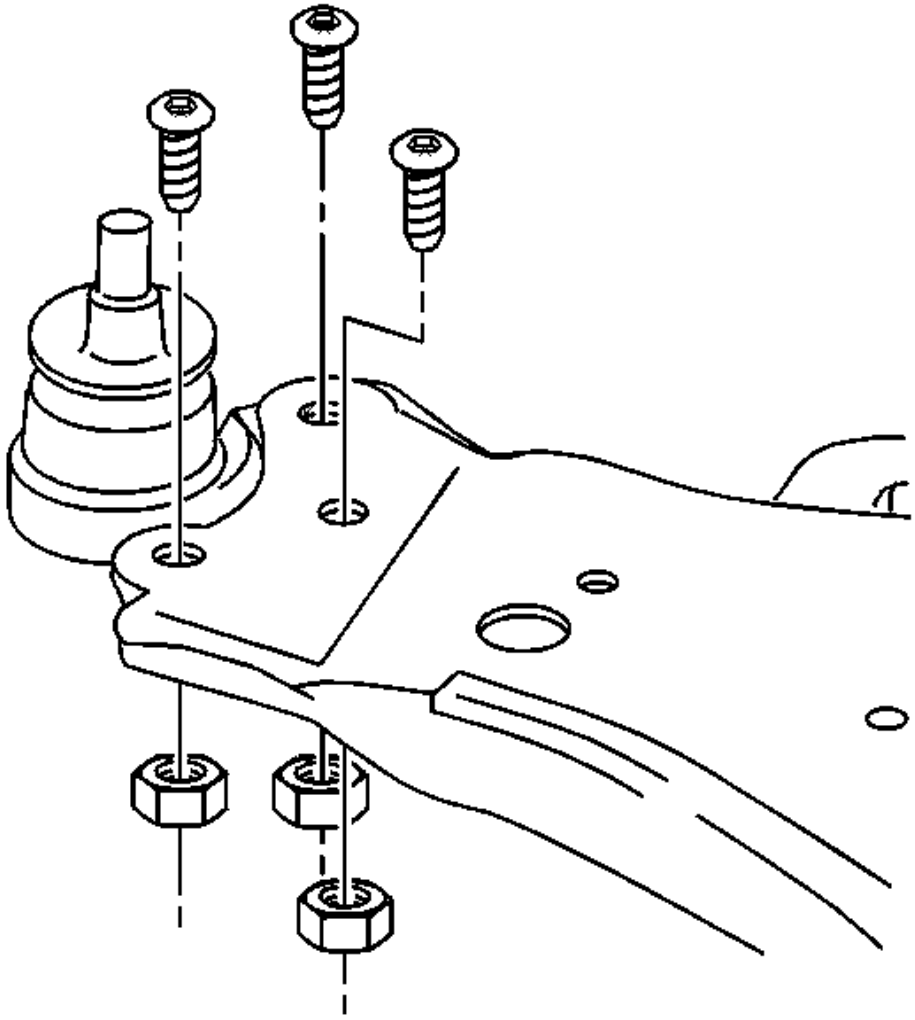


Fig. 17: Identifying Ball Joint Retaining Nuts
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Install the NEW ball joint bolts facing downward.**

2. Install the NEW ball joint bolts.

CAUTION: **Refer to Fastener Caution .**

3. Install the NEW ball joint retaining nuts.

Tighten

Tighten the ball joint nuts to 68 N.m (50 lb ft).

4. Install the lower control arm. Refer to **Lower Control Arm Replacement**.
5. Install the tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
6. Remove the support and lower the vehicle. Refer to **Lifting and Jacking the Vehicle**

FRONT WHEEL BEARING AND HUB REPLACEMENT

Special Tools

J 42129 Wheel Hub Remover

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .

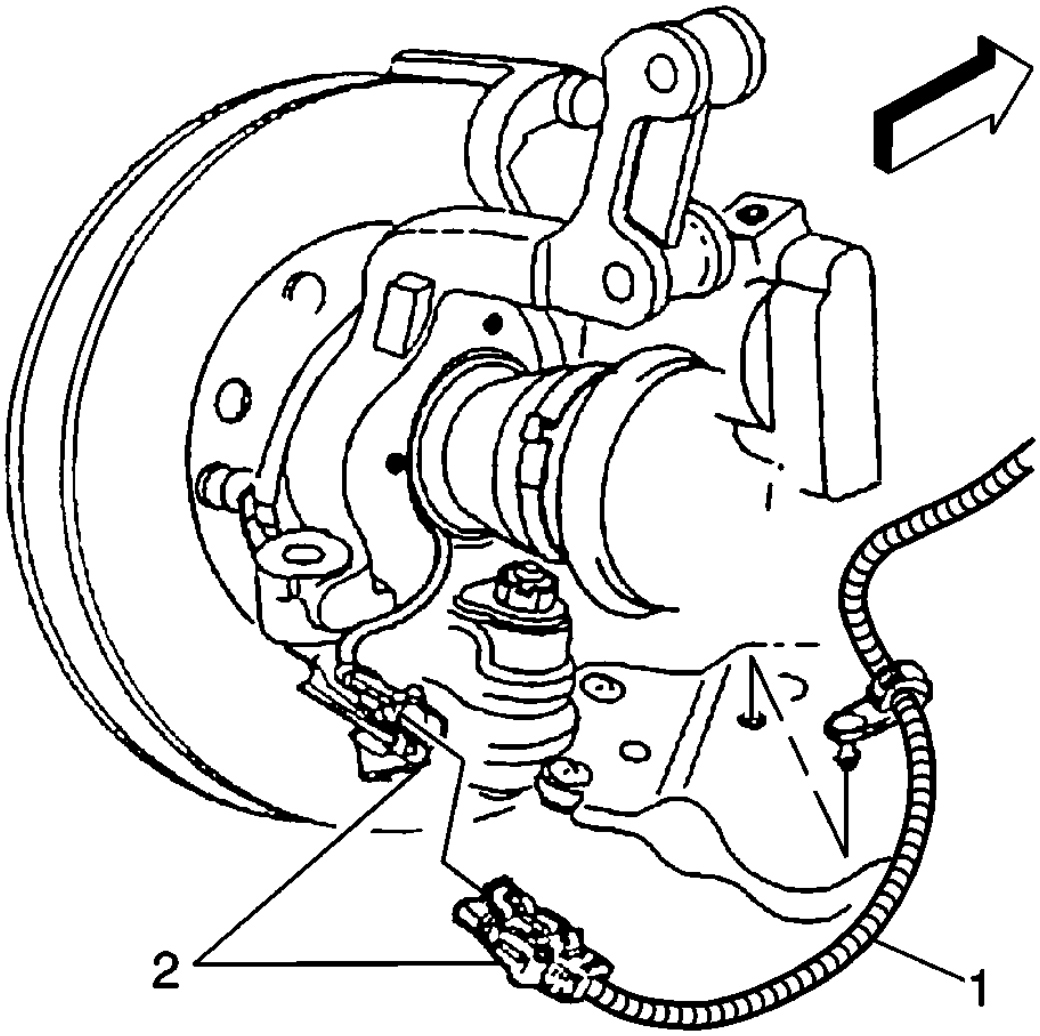


Fig. 18: View Of Wheel Speed Sensor, Connector And Harness
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the wheel speed sensor electrical connector (2), if equipped.

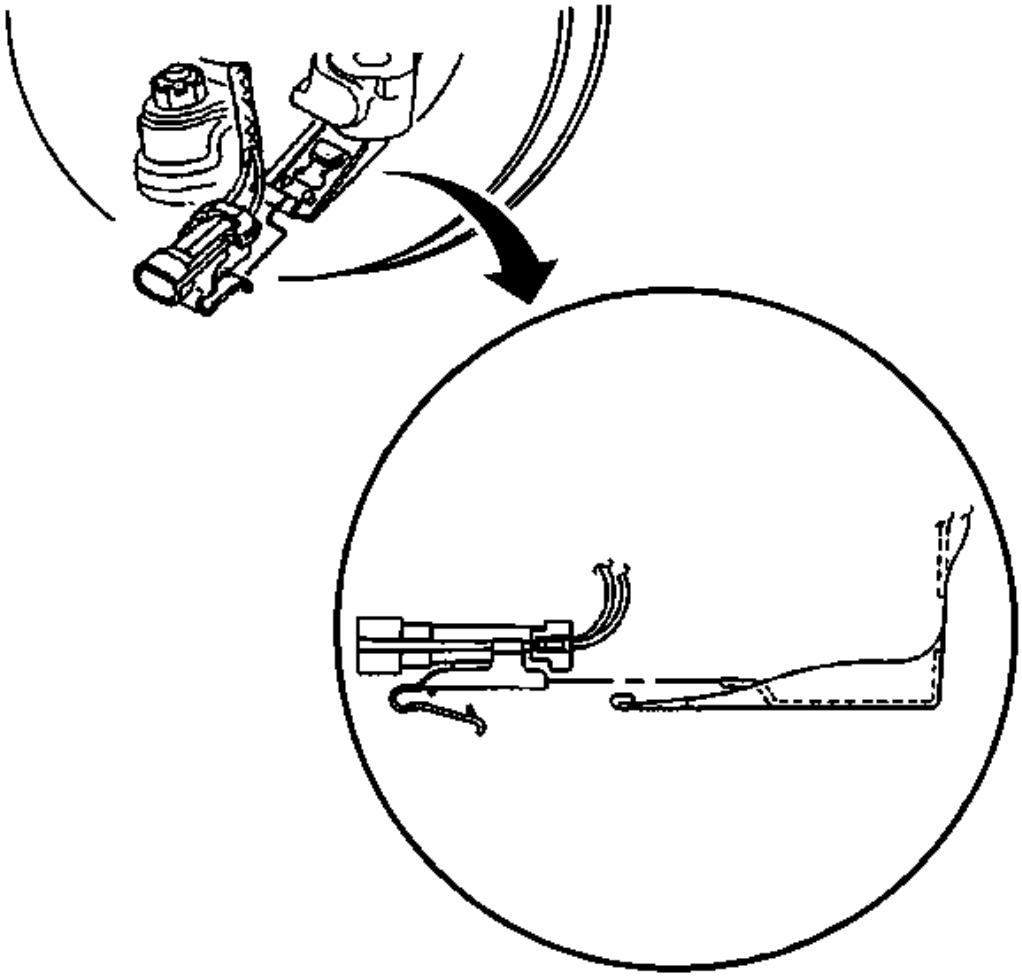


Fig. 19: View Of Wheel Speed Sensor Electrical Connector & Bracket
Courtesy of GENERAL MOTORS COMPANY

4. Remove the wheel speed sensor electrical connector from the bracket, if equipped.
5. Remove the front wheel drive shaft nut. Refer to **Wheel Drive Shaft Replacement (Left Side)** **Wheel Drive Shaft Replacement (Right Side)** .
6. Remove the brake rotor. Refer to **Front Brake Rotor Replacement** .

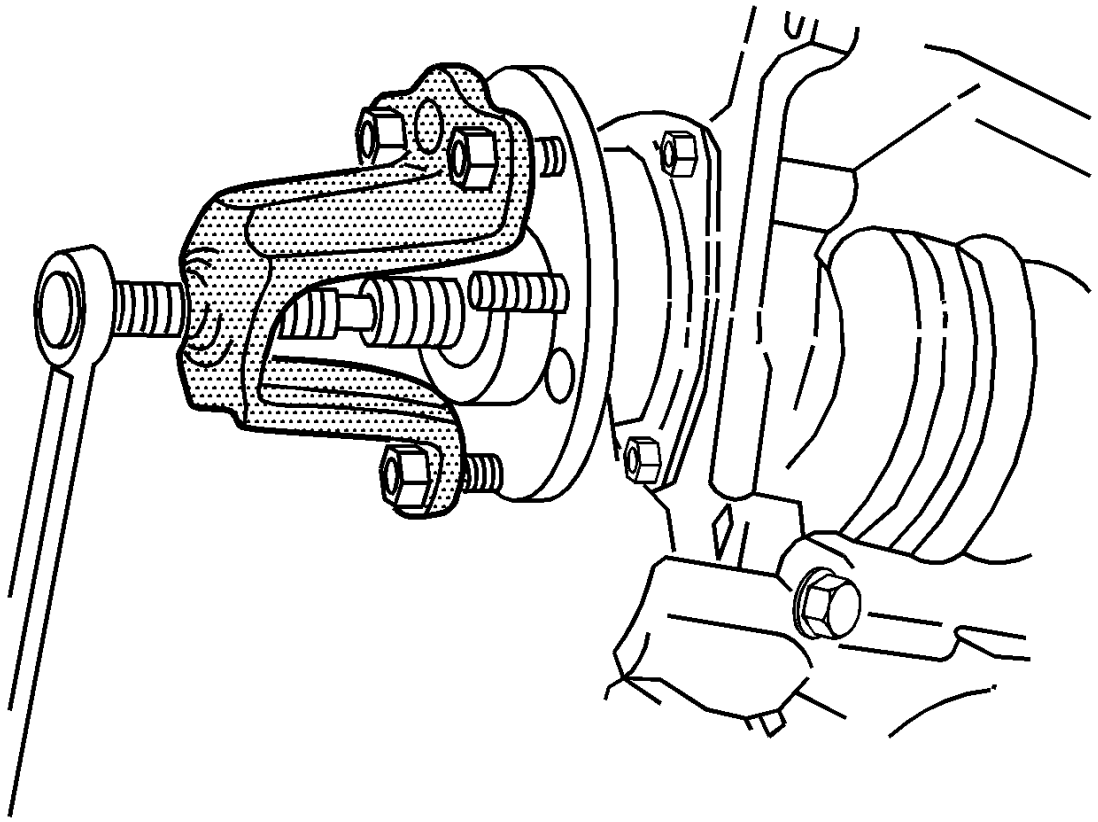


Fig. 20: Pushing Wheel Drive Shaft Out Of Wheel Bearing/Hub
Courtesy of GENERAL MOTORS COMPANY

7. Use 3 wheel nuts in order to attach the **J 42129** wheel hub remover to the wheel bearing/hub.
8. Use the **J 42129** wheel hub remover in order to push the wheel drive shaft out of the wheel bearing/hub.

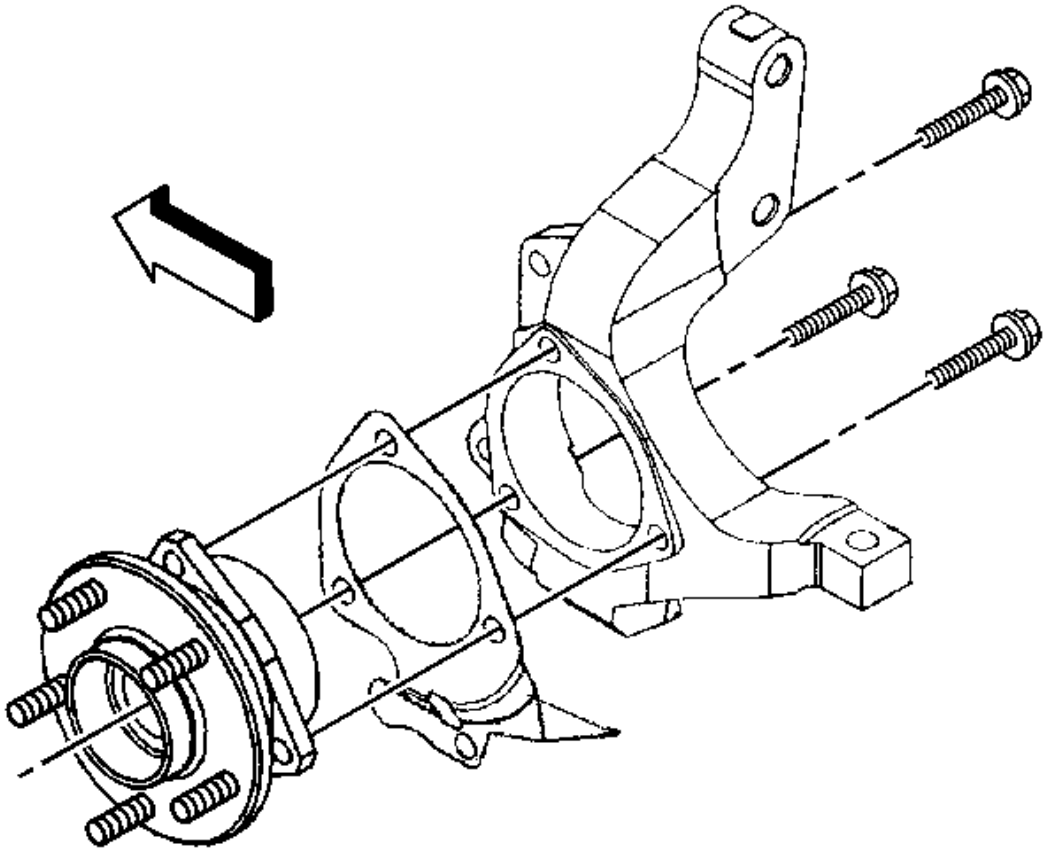


Fig. 21: View Of Wheel Bearing/Hub & Splash Shield
Courtesy of GENERAL MOTORS COMPANY

9. Remove and DISCARD the wheel bearing/hub bolts. Remove the **J 42129** wheel hub remover from the hub.

NOTE: **Ensure that the wheel drive shaft outer seal/boot is not damaged.**

10. Remove the wheel bearing/hub and splash shield-noting the position of the shield for re-installation.

Installation Procedure

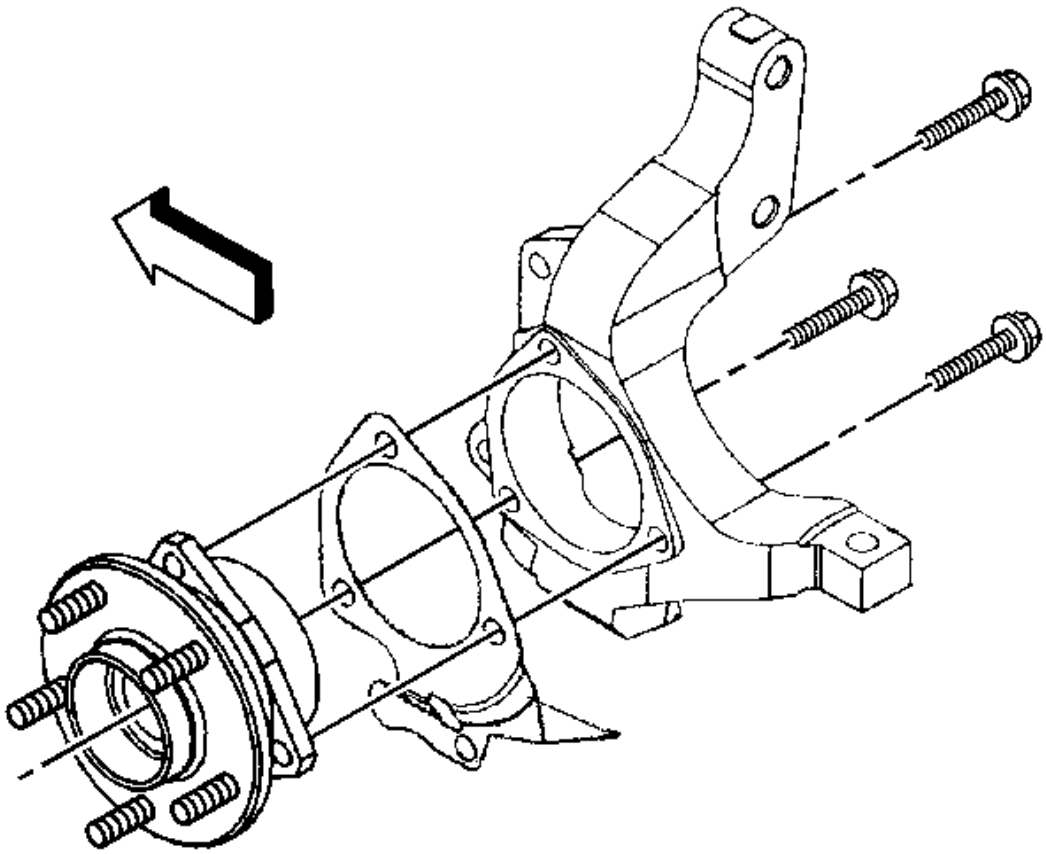


Fig. 22: View Of Wheel Bearing/Hub & Splash Shield
Courtesy of GENERAL MOTORS COMPANY

1. Install the wheel bearing/hub with the splash shield as noted during removal.

WARNING: **These fasteners MUST be replaced with new fasteners anytime they become loose or are removed. Failure to replace these fasteners after they become loose or are removed may cause loss of vehicle control and personal injury.**

CAUTION: **Refer to Fastener Caution .**

2. Install NEW wheel bearing/hub bolts.

Tighten

Tighten the NEW wheel bearing/hub bolts to 130 N.m (96 lb ft).

3. Install the brake rotor and caliper. Refer to **Front Brake Rotor Replacement** .

4. Install the front wheel drive shaft nut. Refer to **Wheel Drive Shaft Replacement (Left Side)** **Wheel Drive Shaft Replacement (Right Side)** .

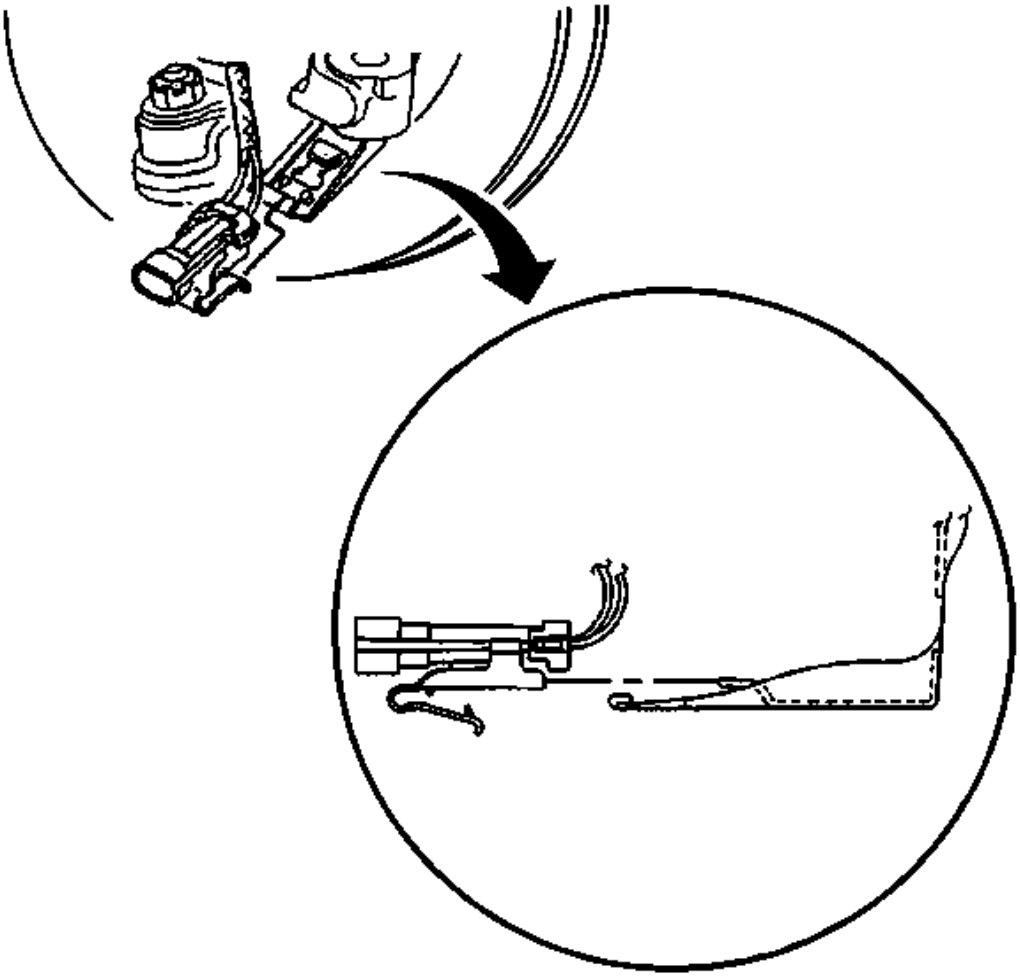


Fig. 23: View Of Wheel Speed Sensor Electrical Connector & Bracket
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the connector clip engages the bracket properly.**

5. Install the wheel speed sensor electrical connector to the bracket, if equipped.

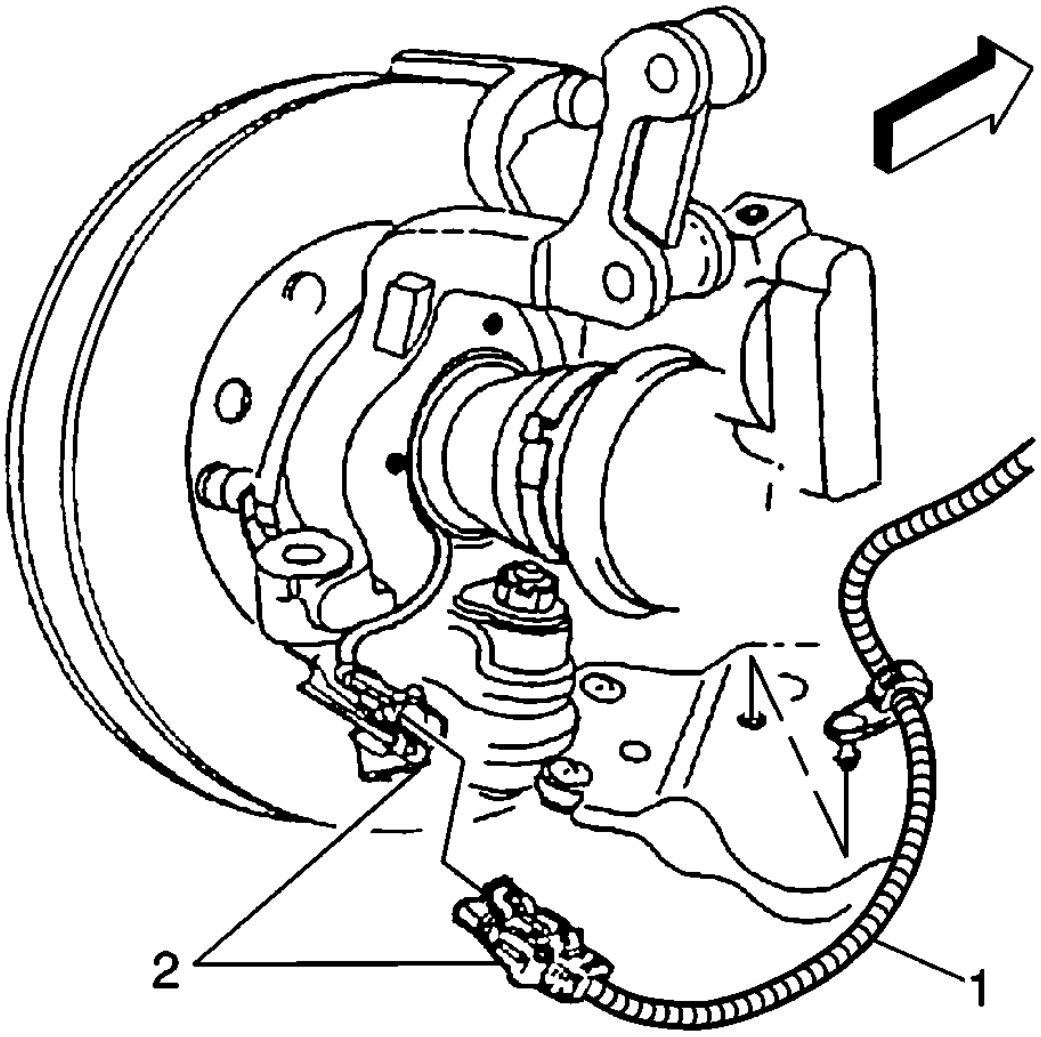


Fig. 24: View Of Wheel Speed Sensor, Connector And Harness
Courtesy of GENERAL MOTORS COMPANY

6. Connect the wheel speed sensor electrical connector (2), if equipped.
7. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
8. Lower the vehicle.

STEERING KNUCKLE REPLACEMENT

Removal Procedure

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the bearing/hub assembly. Refer to **Front Wheel Bearing and Hub Replacement**.
3. Remove the front lower control arm ball stud. Refer to **Lower Control Arm Replacement**.
4. Remove the outer tie rod end from the steering knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .

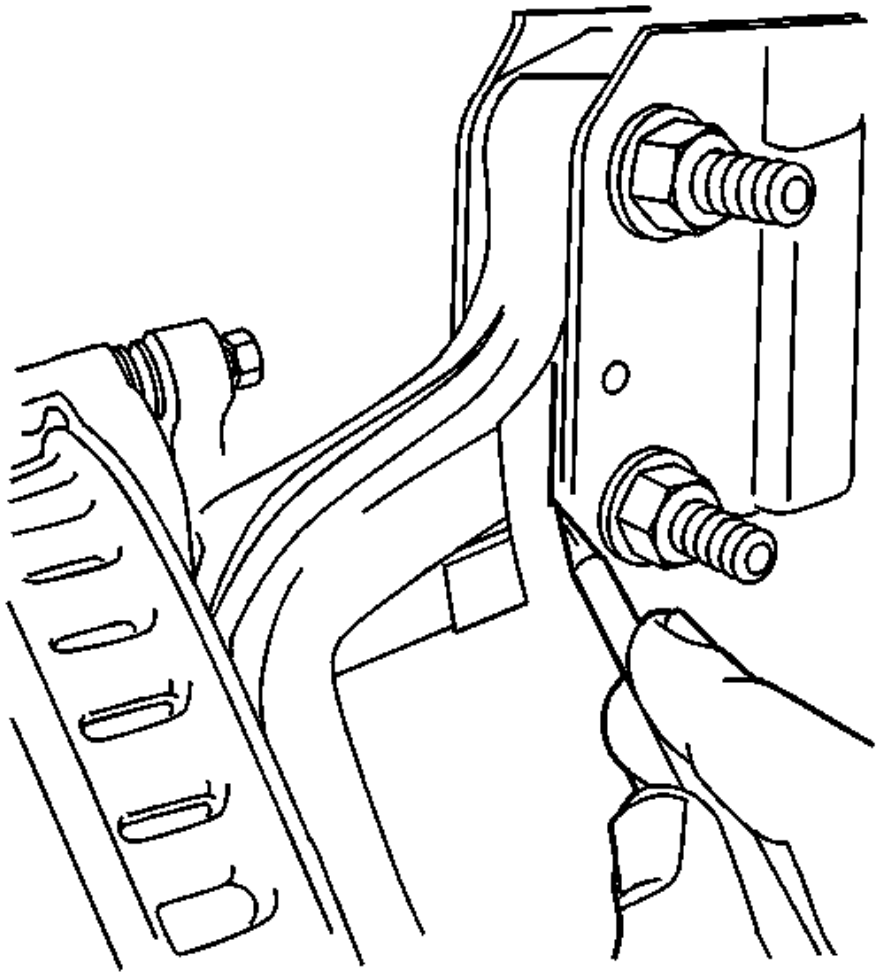


Fig. 25: Scribing Strut To Knuckle
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If removing the knuckle to service other suspension or steering components, perform the following step.**

5. Scribe the strut to the knuckle.

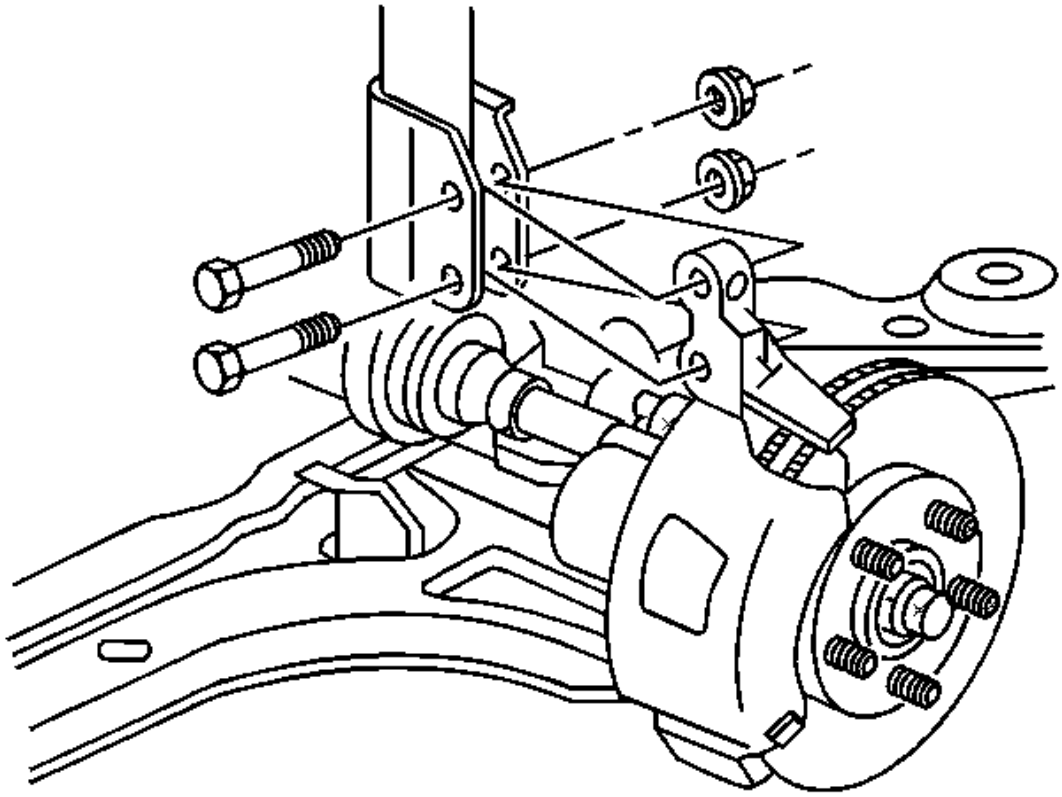


Fig. 26: View Of Steering Knuckle To Strut Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the bolts and nuts attaching the strut to the knuckle.
7. Remove the knuckle from the vehicle.

Installation Procedure

1. Install the knuckle to the vehicle.

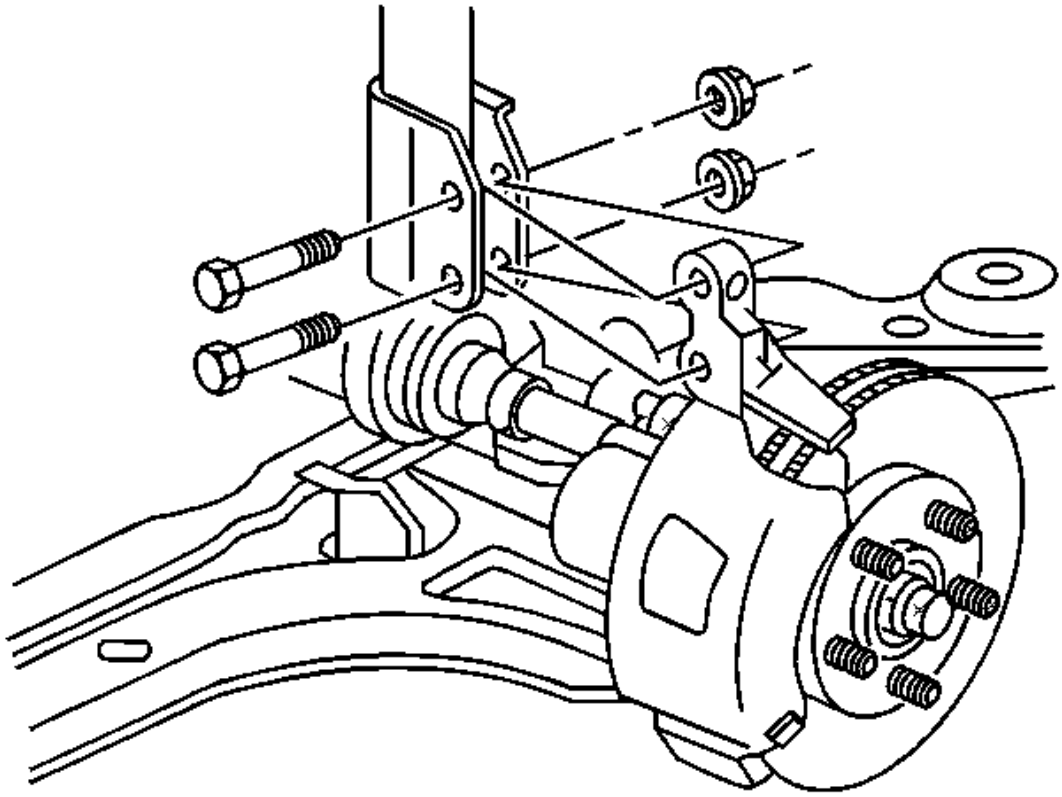


Fig. 27: View Of Steering Knuckle To Strut Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the bolts and nuts attaching the strut to the knuckle.

   Tighten

   Tighten the strut to knuckle bolts to 130 N.m (96 lb ft).

3. Install the outer tie rod to the steering knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .
4. Connect the front lower control arm ball stud to the knuckle. Refer to **Lower Control Arm Replacement**.
5. Install the front wheel drive shaft bearing. Refer to **Front Wheel Bearing and Hub Replacement**.
6. Lower the vehicle.
7. Inspect the front wheel alignment and adjust, if necessary. Refer to **Wheel Alignment Measurement** .

LOWER CONTROL ARM REPLACEMENT

Special Tools

J 41820 Ball Joint/Stud Separator

Removal Procedure

CAUTION: Use only the recommended tools for separating the ball joint from the knuckle. Do NOT hammer or pry the ball joint from the knuckle. Failure to use the recommended tools may cause damage to the ball joint and seal.

NOTE: Use the ignition key in order to unlock the steering column.

1. Turn the steering wheel in order to move the front of the applicable wheel to the outboard most position.

NOTE: Use ONLY a frame-contact type vehicle lift or a floor jack at the recommended lift points. Do NOT use a suspension-contact type vehicle lift. Do NOT lift the vehicle by the lower control arms.

2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .

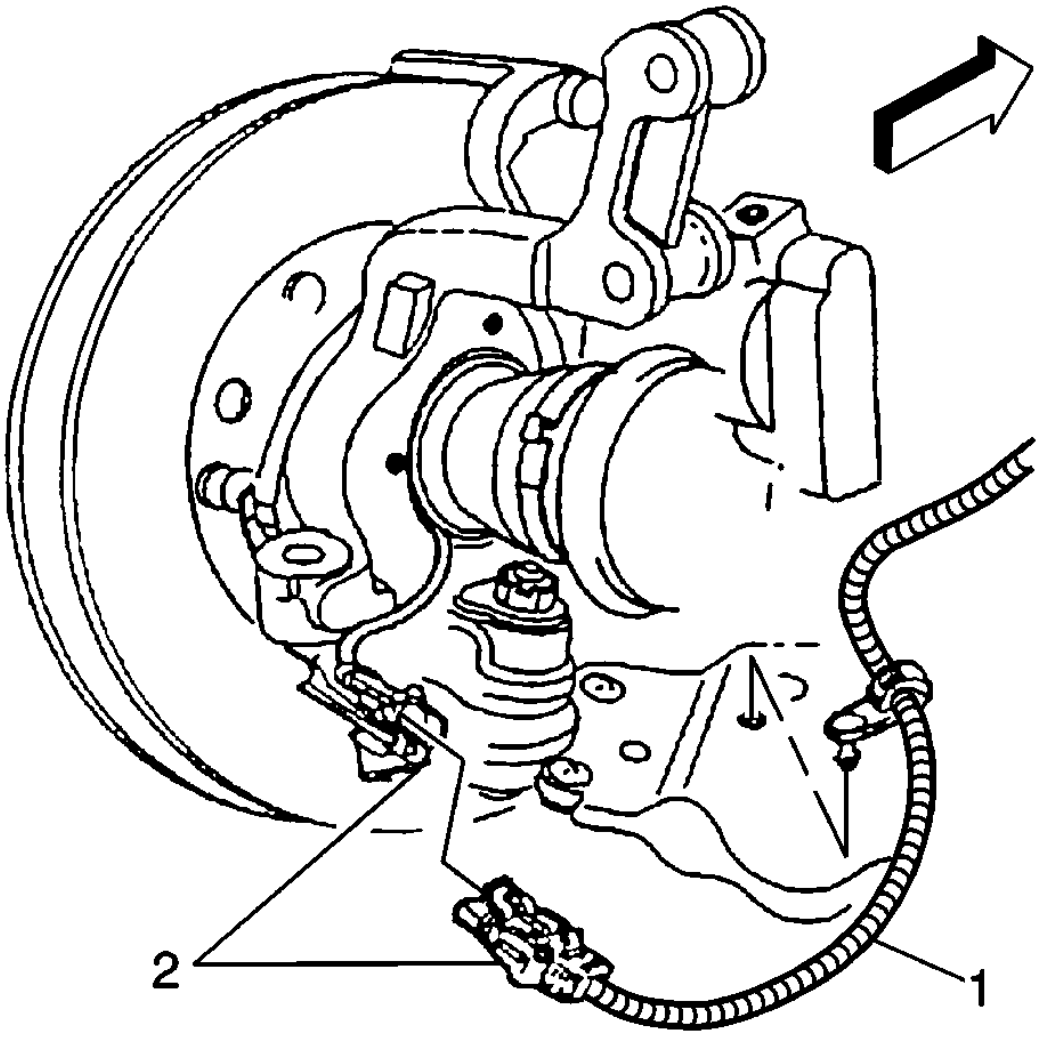


Fig. 28: View Of Wheel Speed Sensor, Connector And Harness
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the ABS wheel speed sensor connector (2), if equipped.
5. Disconnect the ABS wheel speed sensor jumper harness from the harness retainer clips, if equipped.
6. Remove the stabilizer shaft link. Refer to **Stabilizer Shaft Link Replacement**.

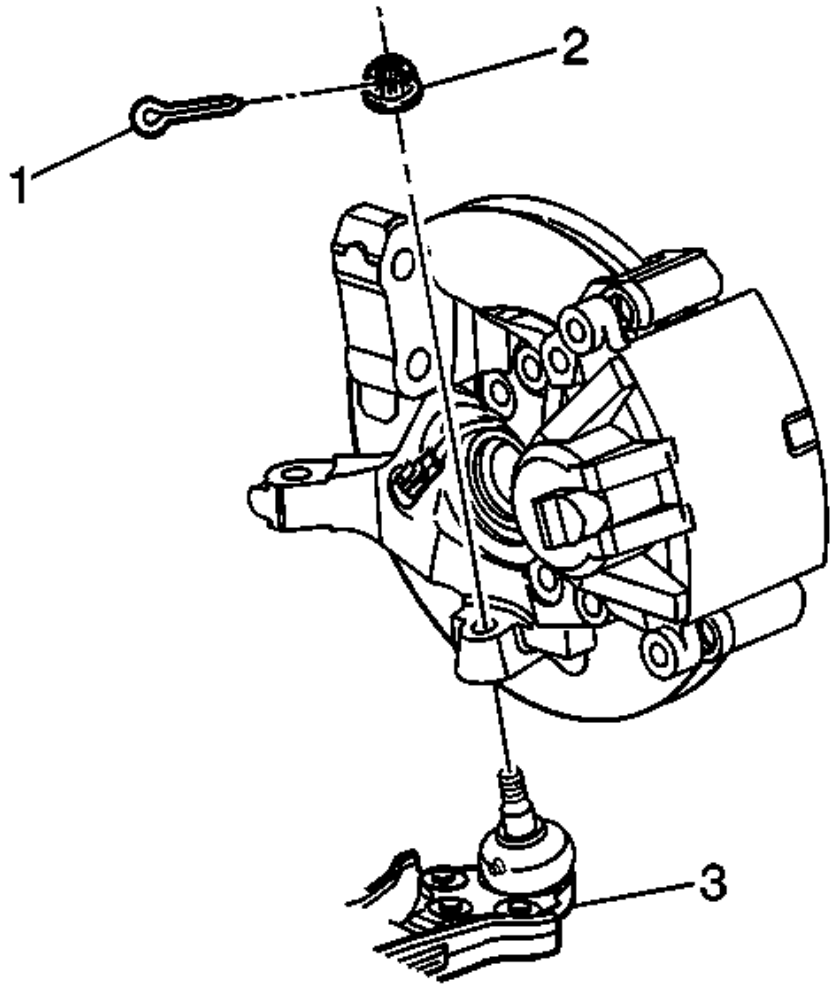


Fig. 29: Identifying Ball Stud Cotter Pin
Courtesy of GENERAL MOTORS COMPANY

7. Remove the cotter pin (1) from the ball stud (3).
8. Loosen the ball stud nut (2).

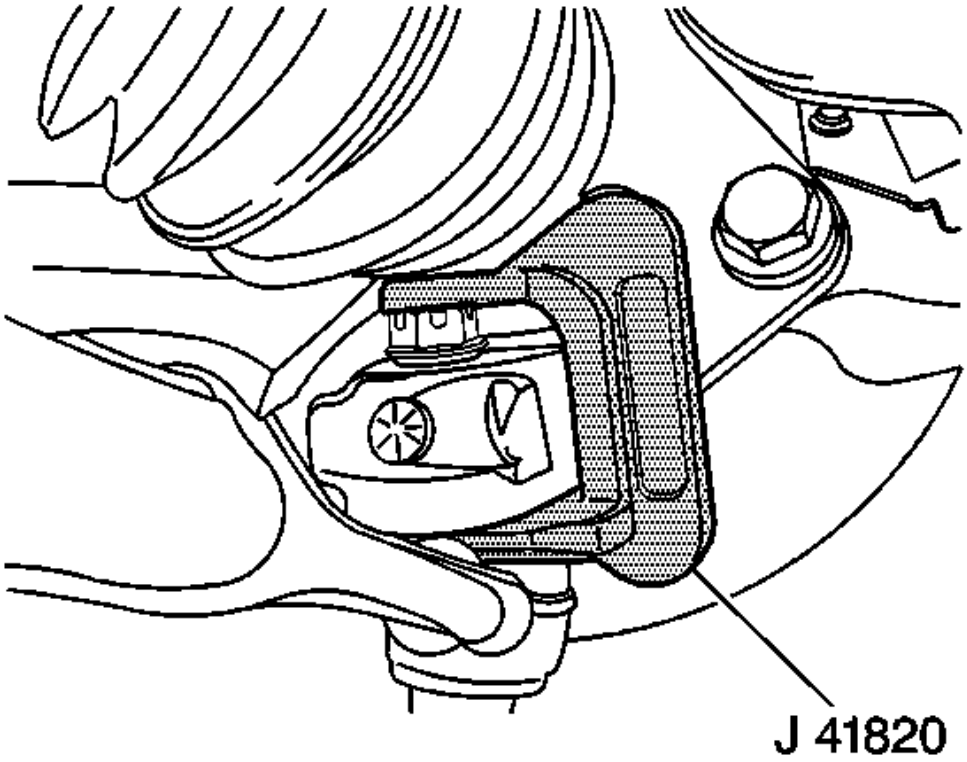


Fig. 30: Separating Ball Stud From Steering Knuckle
Courtesy of GENERAL MOTORS COMPANY

9. Install the **J 41820** ball joint/stud separator over the ball stud and lower control arm, as shown.
10. Rotate the ball stud nut counterclockwise in order to separate the ball stud from the steering knuckle.
11. Remove the **J 41820** ball joint/stud separator.
12. Remove the ball stud nut.

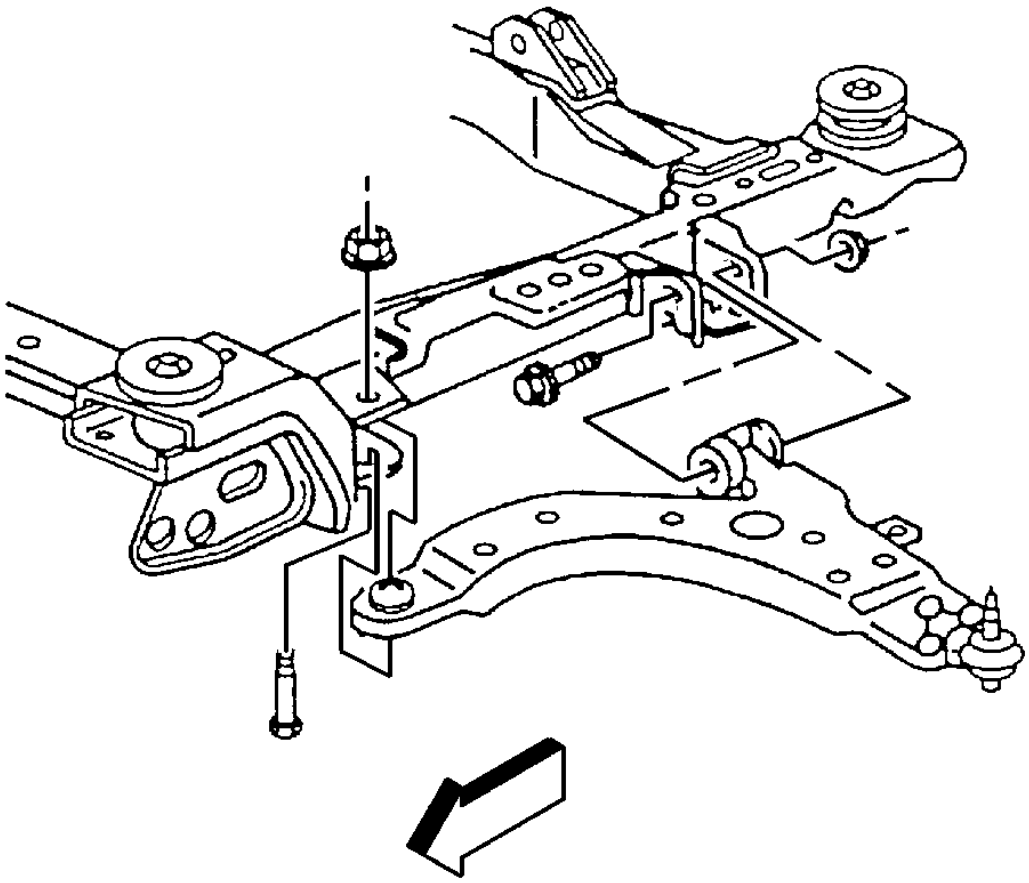


Fig. 31: View Of Lower Control Arm
Courtesy of GENERAL MOTORS COMPANY

13. Remove the lower control arm bolts and nuts.
14. Remove the lower control arm.

Installation Procedure

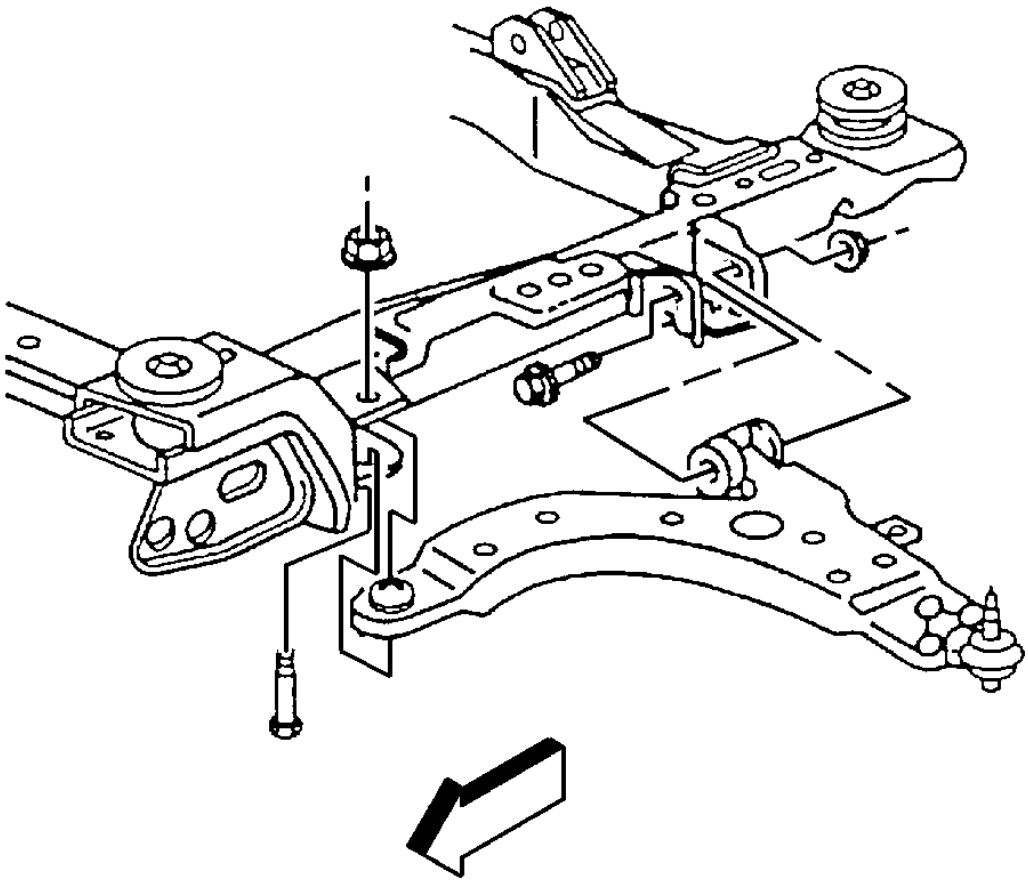


Fig. 32: View Of Lower Control Arm
Courtesy of GENERAL MOTORS COMPANY

1. Install the lower control arm.
2. Install the control arm bolts and nuts. Do not tighten at this time.

NOTE: **Align the ball stud cotter pin hole parallel to the knuckle in order to ease the cotter pin installation.**

3. Install the ball stud to the knuckle.

CAUTION: **Refer to Fastener Caution .**

NOTE: **Verify the nut is torqued to a minimum of 55 N.m.**

4. Install the ball stud castle nut.

Tighten

Tighten the ball stud castle nut to 20 N.m + 120 degrees (15 lb ft + 120 degrees).

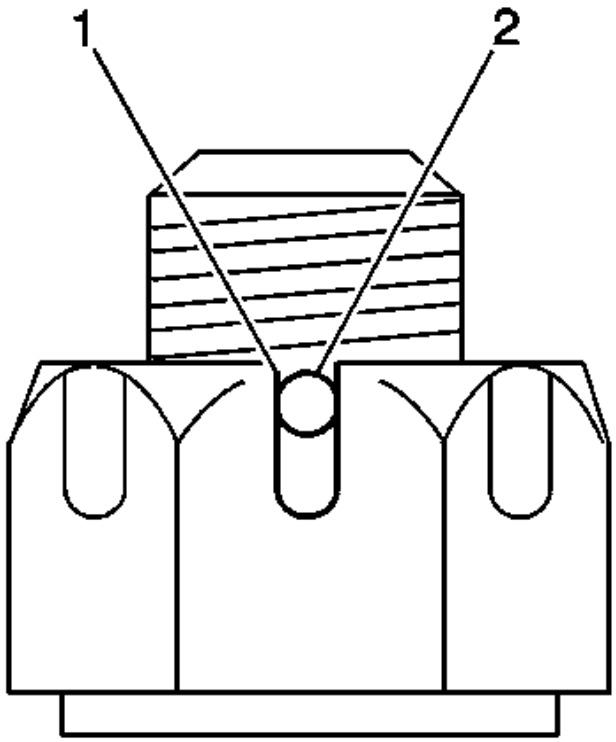


Fig. 33: Aligning Ball Stud Castle Nut Slot To The Ball Stud Cotter Pin Hole
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do NOT loosen the ball stud nut in order to align the ball stud nut slots to the ball stud cotter pin hole.**

5. If necessary, tighten the ball stud castle nut in order to align the ball stud castle nut slot (1) to the ball stud cotter pin hole (2), as shown.

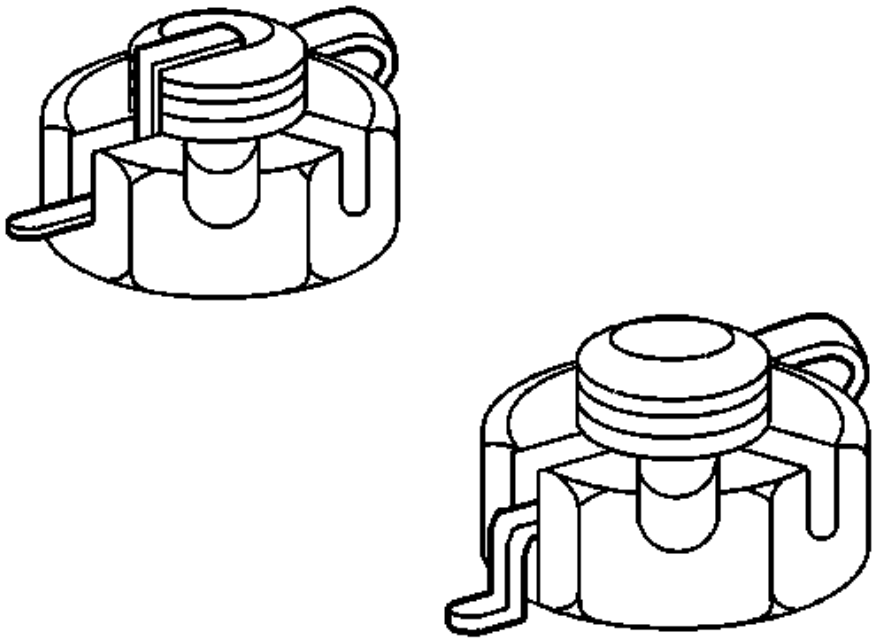


Fig. 34: Securing Cotter Pin In Ball Joint Castle Nut
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the cotter pin ends do NOT contact the ABS wheel speed sensor, the ABS sensor connector, or the drive axle.**

6. Install a NEW cotter pin and bend the ends as shown in either example.
7. Install the stabilizer shaft link. Refer to **Stabilizer Shaft Link Replacement**.
8. Install the ABS wheel speed sensor jumper harness to the harness retainer clips, if equipped.

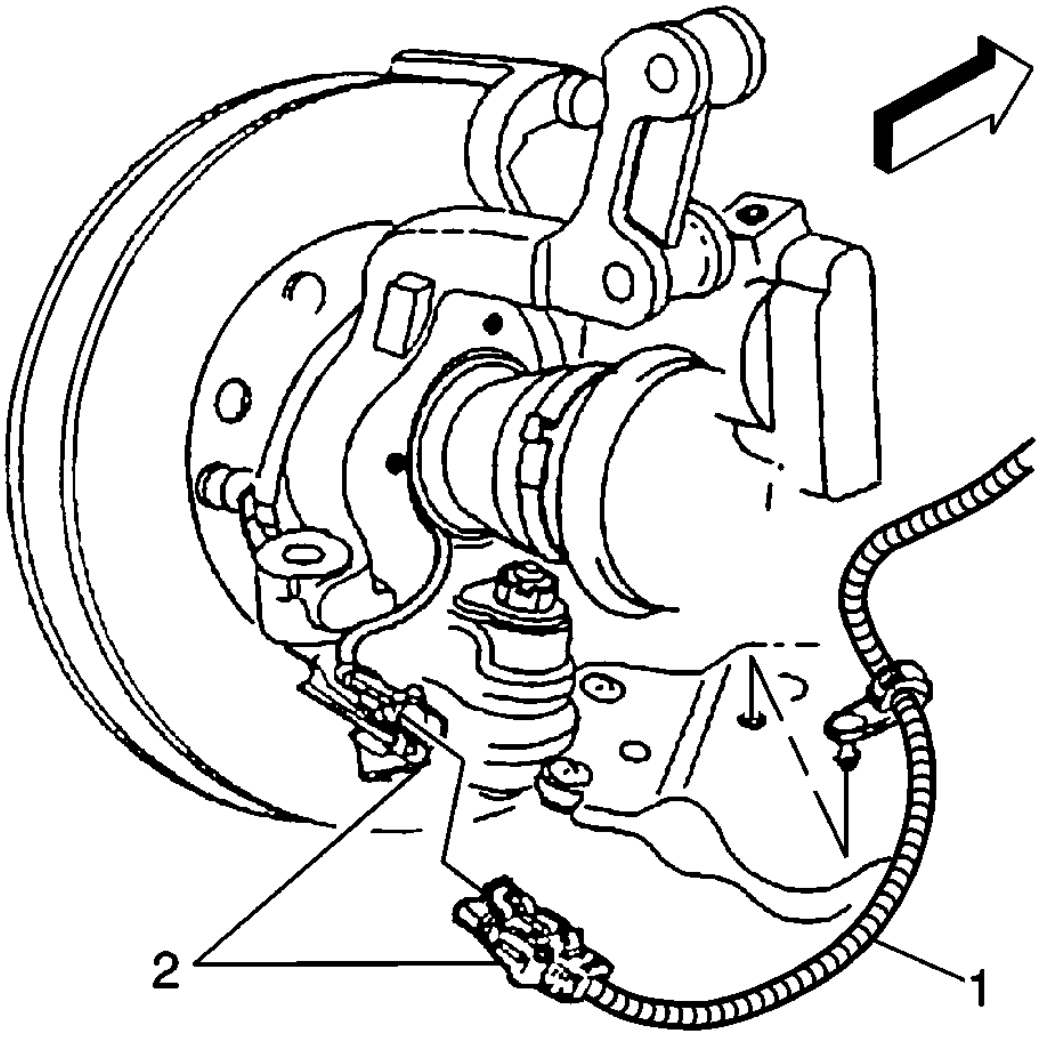


Fig. 35: View Of Wheel Speed Sensor, Connector And Harness
Courtesy of GENERAL MOTORS COMPANY

9. Install the ABS wheel speed sensor connector (2), if equipped.

NOTE: **This is a prevailing torque type fastener. This fastener may be reused ONLY if:**

- **The fastener and its counterpart are clean and free from rust.**
- **The fastener develops 3 N.m (27 lb in) of torque against its counterpart prior to the fastener seating.**

If the fastener does not meet these criteria, REPLACE the fastener.

10. Install the lower control arm nuts.

Tighten

Tighten the lower control arm nuts to 125 N.m (92 lb ft).

11. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
12. Lower the vehicle.

FRONT LOWER CONTROL ARM BUSHING REPLACEMENT (VERTICAL)

Tools Required

- **J 21474-01** Control Arm Bushing Set
- **J 21474-2** Bushing Installer Remover
- **J 21474-4** Nut
- **J 21474-13** Control Arm Bushing Installer
- **J 21474-27** 1/2 Inch Puller Bolt Thrust Bearing
- **J 23444-A** High Pressure Lubricant
- **J 34126** Driven Sprocket Support Bearing Installer
- **J 35379** Front Knuckle Support

Removal Procedure

1. Remove the lower control arm. Refer to **Lower Control Arm Replacement**.
2. Secure the lower control arm in a vice.

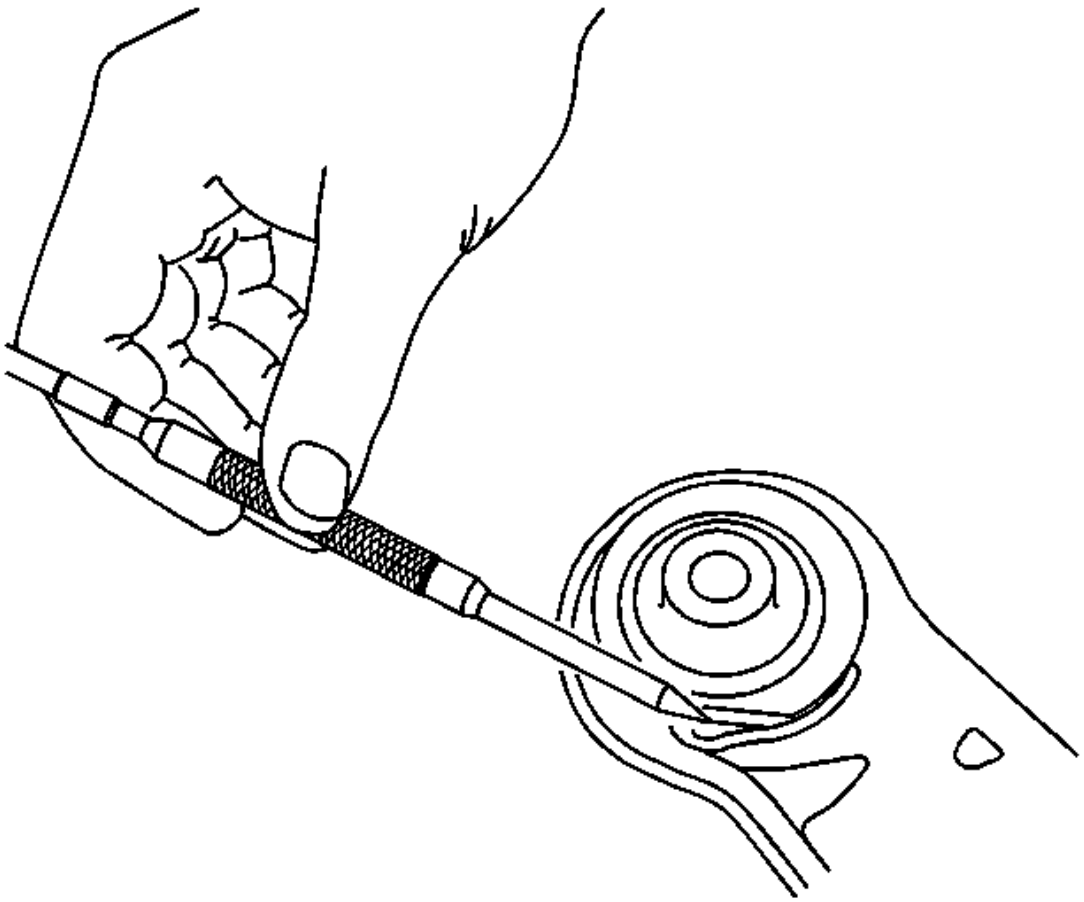


Fig. 36: Scribing Orientation Of Control Arm Bushing On Lower Control Arm
Courtesy of GENERAL MOTORS COMPANY

3. Mark the lower control arm along the flat edge of the bushing flange.

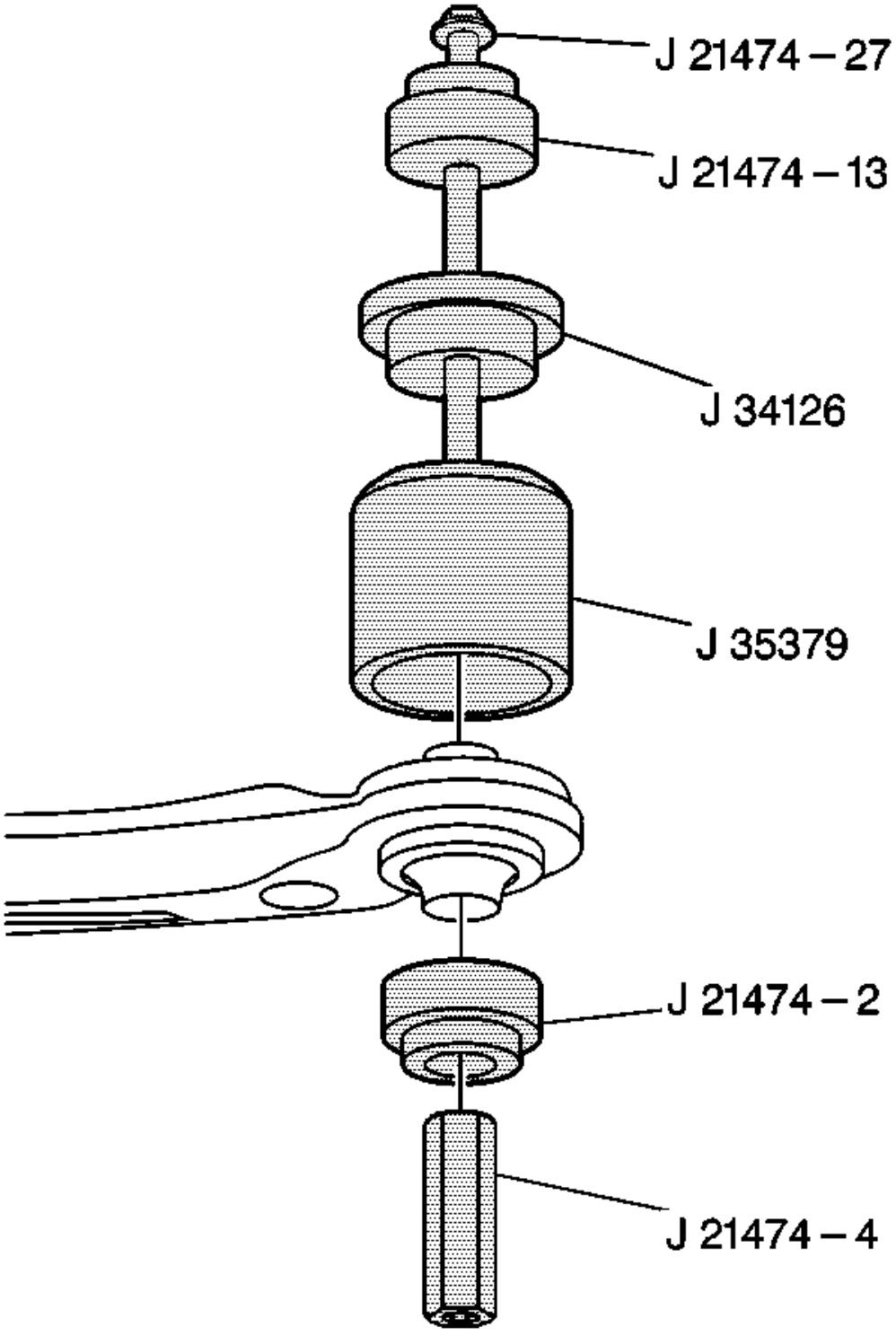


Fig. 37: Bushing Removal/Installation Tools
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Apply **J 23444-A** high pressure lubricant or equivalent to the threads of **J 21474-27** 1/2 inch puller bolt thrust bearing.

4. Assemble the following bushing removal tools as shown:

1. **J 21474-27** 1/2 inch puller bolt thrust bearing
2. **J 21474-13** control arm bushing installer
3. **J 34126** driven sprocket support bearing installer
4. **J 35379** front knuckle support
5. **J 21474-2** bushing installer remover
6. **J 21474-4** nut

5. Tighten **J 21474-4** nut.
6. Disassemble the bushing removal tools.

Installation Procedure

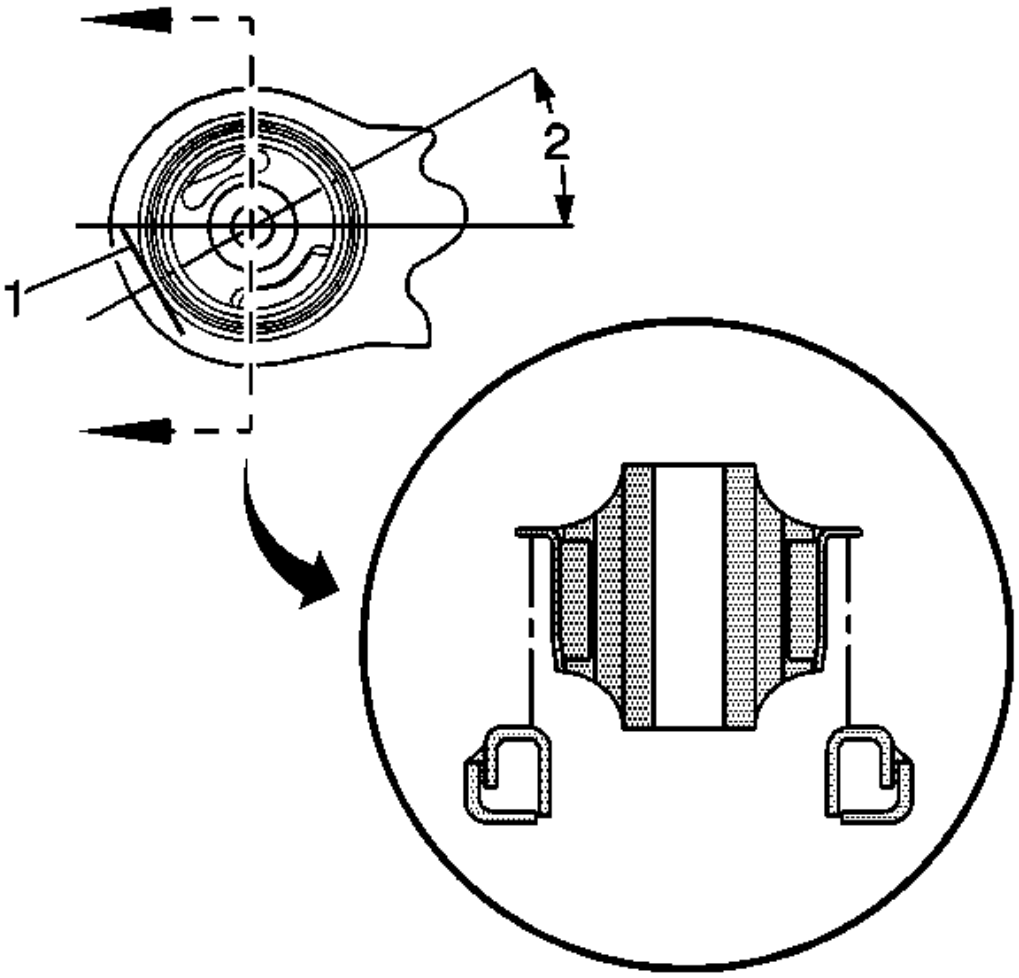


Fig. 38: Aligning Flat Edge Of Bushing Flange To Mark In Control Arm
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: You MUST install the lower control arm vertical bushing in the same position in order to maintain the original vehicle ride, handling, and road feel.

1. Align the flat edge of the bushing flange to the mark in the control arm (1). Ensure that the flat edge of the bushing flange is 30 degrees (2) from the centerline of the lower control arm. Ensure that the thin slot in the bushing is facing outboard.
2. Insert the bushing into the control arm.

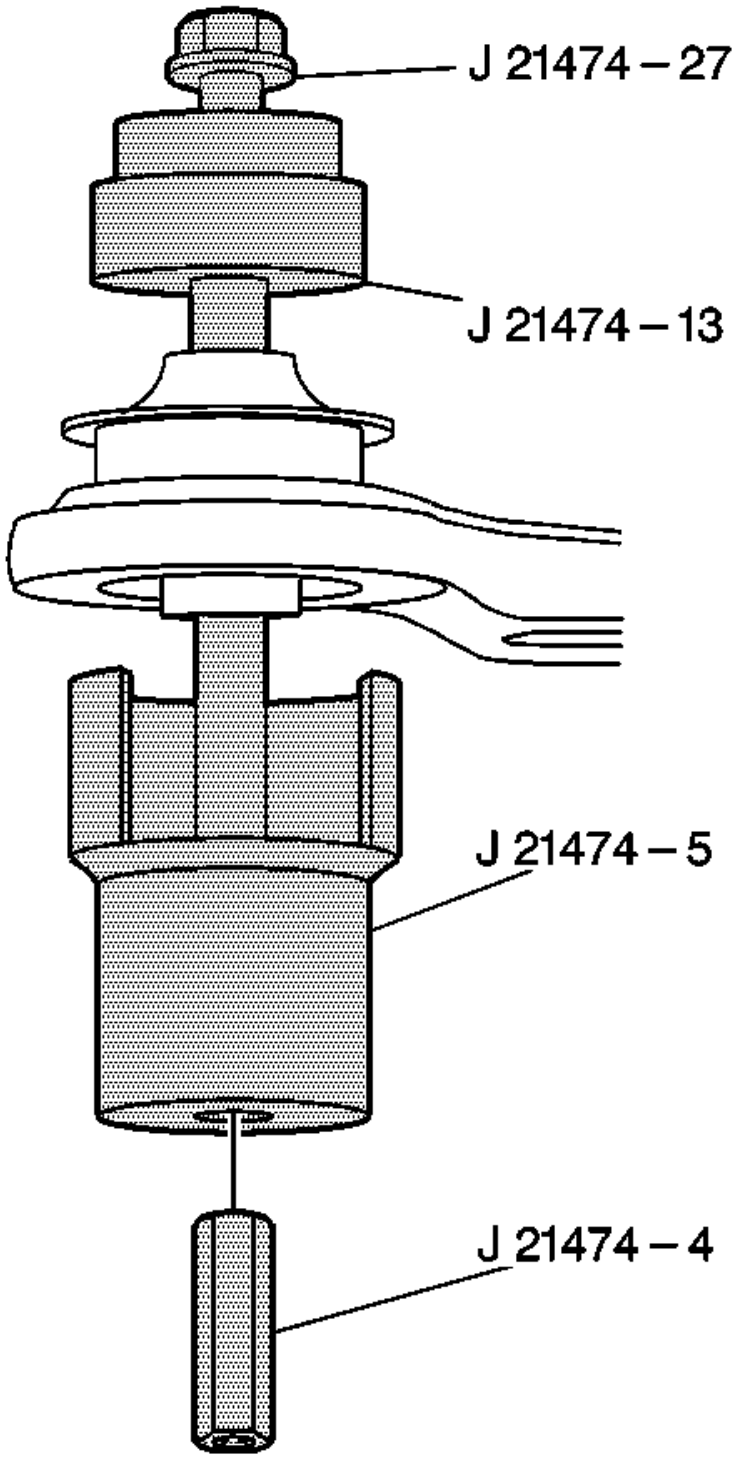


Fig. 39: Illustrating Proper Installation Of Bushing Tools
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Apply **J 23444-A** high pressure lubricant or equivalent to the threads of **J 21474-27** 1/2 inch puller bolt thrust bearing.

3. Assemble the following bushing installation tools as shown:
    1. **J 21474-27** 1/2 inch puller bolt thrust bearing
    2. **J 21474-13** control arm bushing installer
    3. **J 21474-5** control arm bushing receiver
    4. **J 21474-4** nut
4. Tighten **J 21474-4** nut.
5. Disassemble the bushing installation tools.
6. Install the lower control arm. Refer to **Lower Control Arm Replacement**.

FRONT LOWER CONTROL ARM BUSHING REPLACEMENT (HORIZONTAL)

Tools Required

- **J 21474-01** Control Arm Bushing Service Set
- **J 21474-5** Control Arm Bushing Receiver

Removal Procedure

1. Remove the lower control arm. Refer to **Lower Control Arm Replacement**.
2. Secure the lower control arm in a vise.

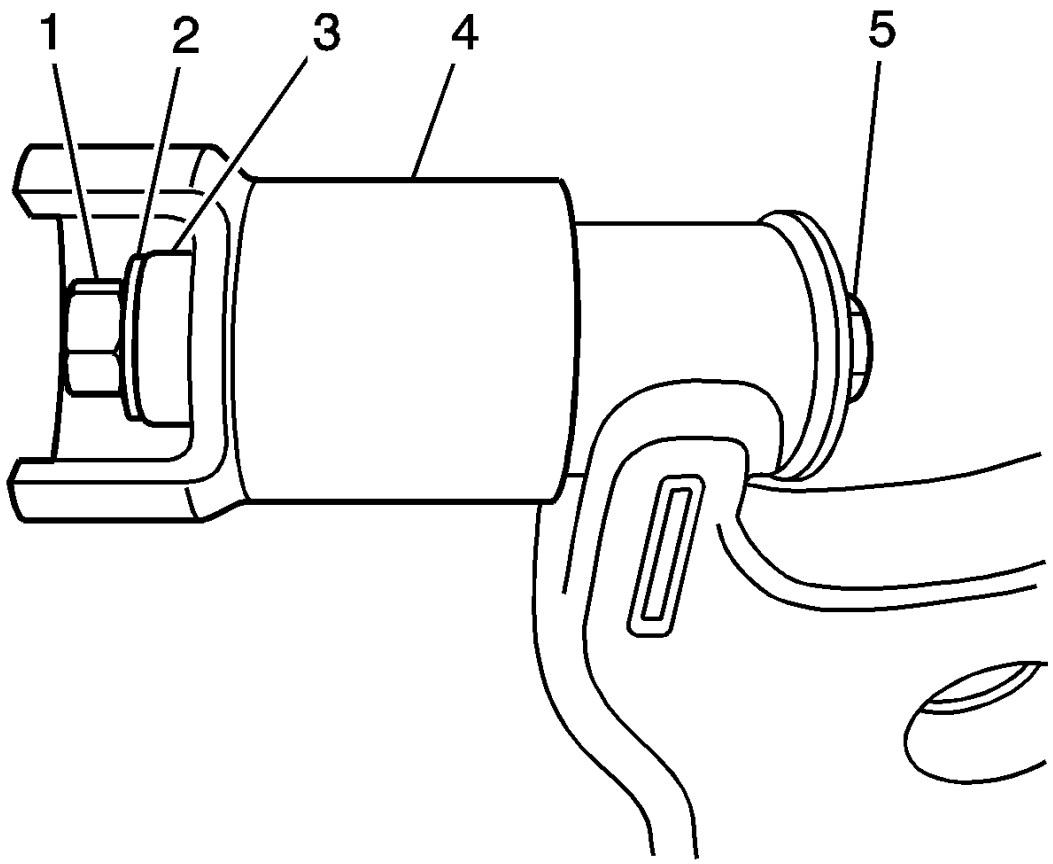


Fig. 40: Assembling Bushing Removal Tools
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Use a 1/2 x 20 in standard thread nut with the puller bolt.

3. Assemble the bushing removal tools as indicated:
    1. The nut (1)
    2. The **J 21474-01** control arm bushing service set washer (2)
    3. The **J 21474-01** control arm bushing service set bearing (3)
    4. The **J 21474-5** control arm bushing receiver (4)
    5. The **J 21474-01** control arm bushing service set puller bolt (5)
4. Tighten the puller bolt (5) until the bushing is removed.
5. Disassemble the **J 21474-01** control arm bushing service set and **J 21474-5** control arm bushing receiver.

Installation Procedure

1. Lubricate the bushing with liquid hand soap or equivalent.

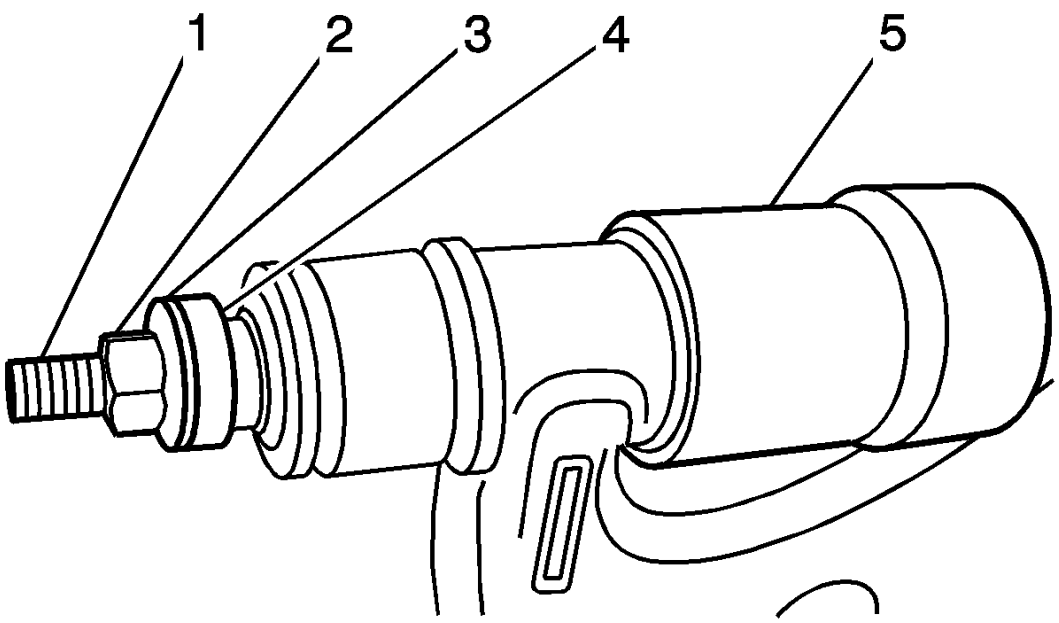


Fig. 41: Assembling Bushing Installation Tools
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Use a 1/2 x 20 in standard thread nut with the puller bolt.

2. Assemble the following bushing installation tools as indicated :
    1. The nut (1)
    2. The **J 21474-01** control arm bushing service set washer (2)
    3. The **J 21474-01** control arm bushing service set bearing (3)
    4. The **J 21474-5** control arm bushing receiver (4)
    5. The **J 21474-01** control arm bushing service set puller bolt (5)
3. Tighten the puller bolt (5) until the bushing is installed into the control arm.
4. Disassemble the **J 21474-01** control arm bushing service set and **J 21474-5** control arm bushing receiver.
5. Remove the control arm from the vice.
6. Install the lower control arm. Refer to **Lower Control Arm Replacement**.

WHEEL STUD REPLACEMENT

Tools Required

J 6627-A Tie Rod Puller

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Without disconnecting the hydraulic brake hose, remove and support the brake caliper and bracket as an assembly.
4. Remove the brake rotor. Refer to **Front Brake Rotor Replacement** .

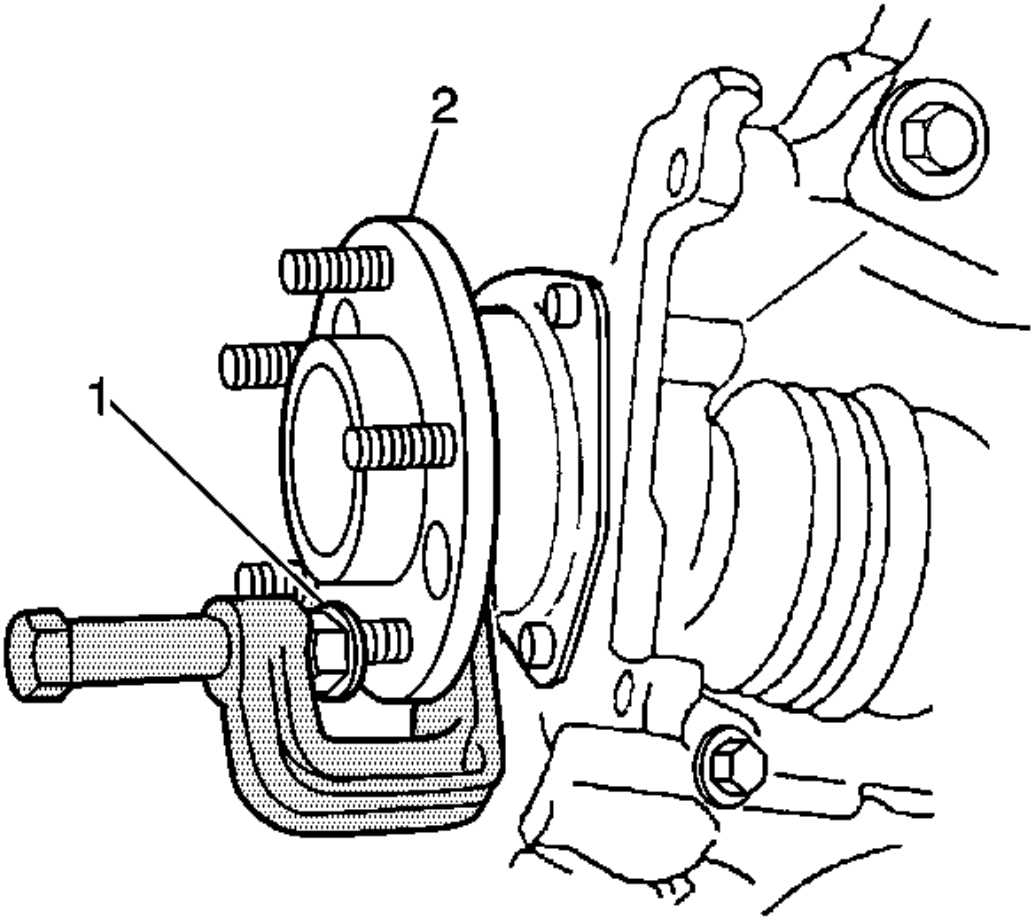


Fig. 42: Extracting Stud From Hub
Courtesy of GENERAL MOTORS COMPANY

5. Rotate the bearing hub to a position where the least amount of interference between the stud and the steering knuckle exists.
6. Using the **J 6627-A** tie rod puller , release the wheel stud (1) from the bearing hub (2) and discard the stud.

IMPORTANT: Some models may require additional clearance for stud removal.

7. If necessary, loosen the wheel bearing/hub assembly retaining bolts enough to walk the bearing away slightly from the knuckle. Refer to **Front Wheel Bearing and Hub Replacement**.

Installation Procedure

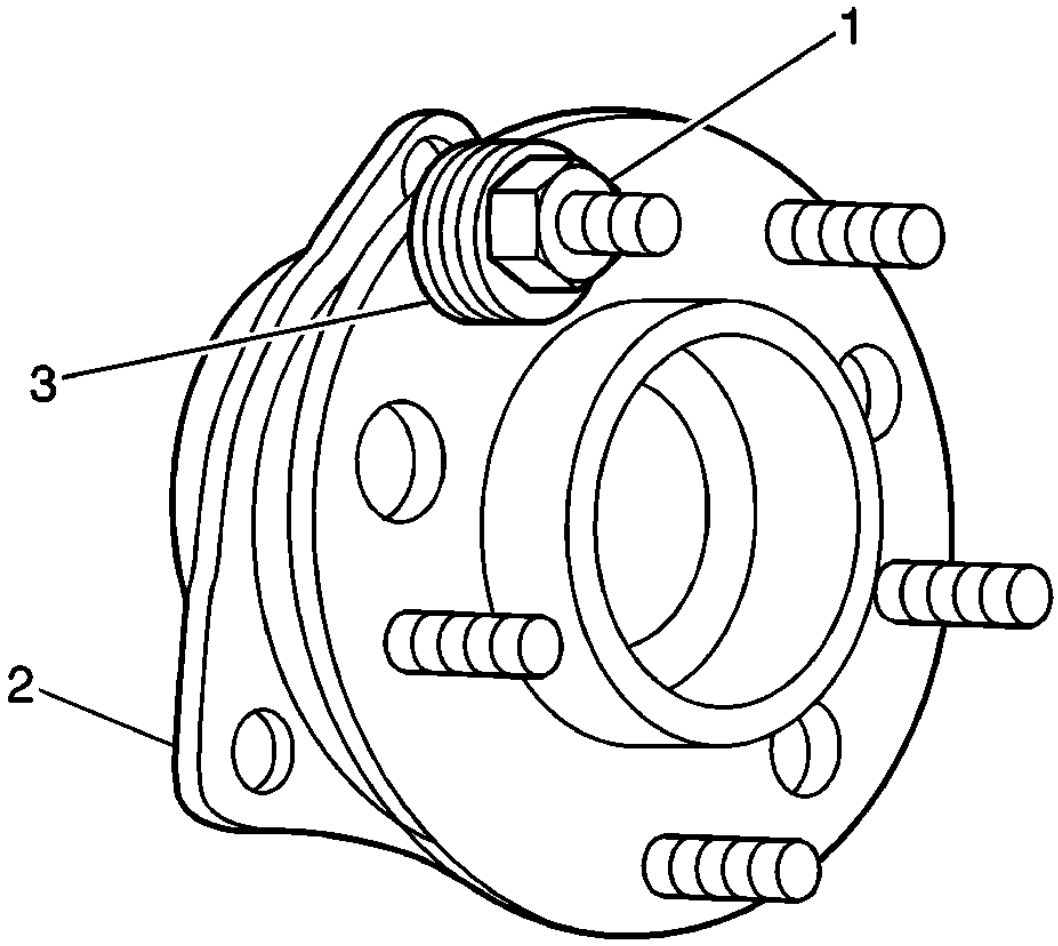


Fig. 43: Installing Wheel Stud
Courtesy of GENERAL MOTORS COMPANY

1. Install the NEW stud in the bearing hub.
2. Tighten the wheel bearing/hub assembly bolts, if loosened during removal. Refer to **Front Wheel Bearing and Hub Replacement**.
3. Add enough washers (3) in order to draw the stud into the hub (2).
4. Install the wheel nut (1) with the flat side against the washers (3).

IMPORTANT: Fully seat the wheel stud against the hub flange (2).

5. Tighten the wheel nut (1) until the head of the wheel stud is fully seated against the back of the bearing

hub flange.

6. Remove the wheel nut (1) and the washers (3).
7. Install the brake rotor, and the brake caliper and bracket as an assembly. Refer to **Front Brake Rotor Replacement** .
8. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
9. Lower the vehicle.

STRUT ASSEMBLY REMOVAL AND INSTALLATION

Removal Procedure

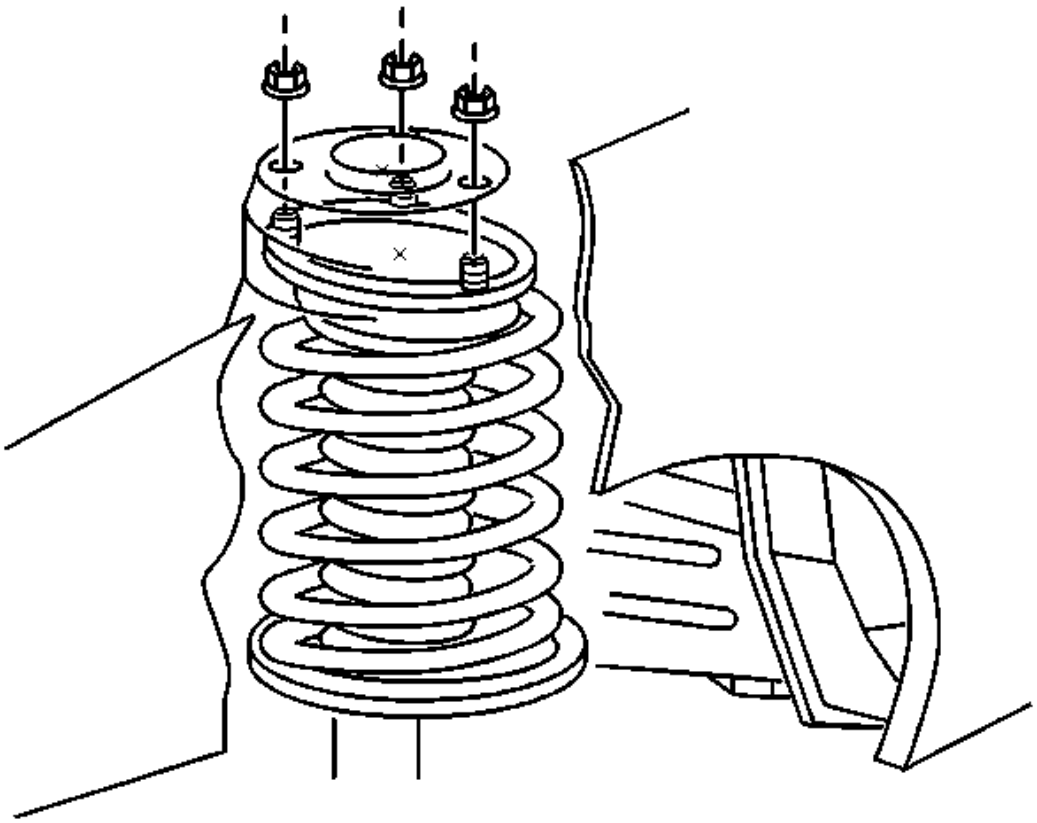


Fig. 44: Identifying Upper Strut Mounting Nuts
Courtesy of GENERAL MOTORS COMPANY

1. Remove the strut upper nuts.

NOTE: **Lift the vehicle using ONLY a frame-contact vehicle lift. Do NOT lift the vehicle using a suspension-contact vehicle lift.**

2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .

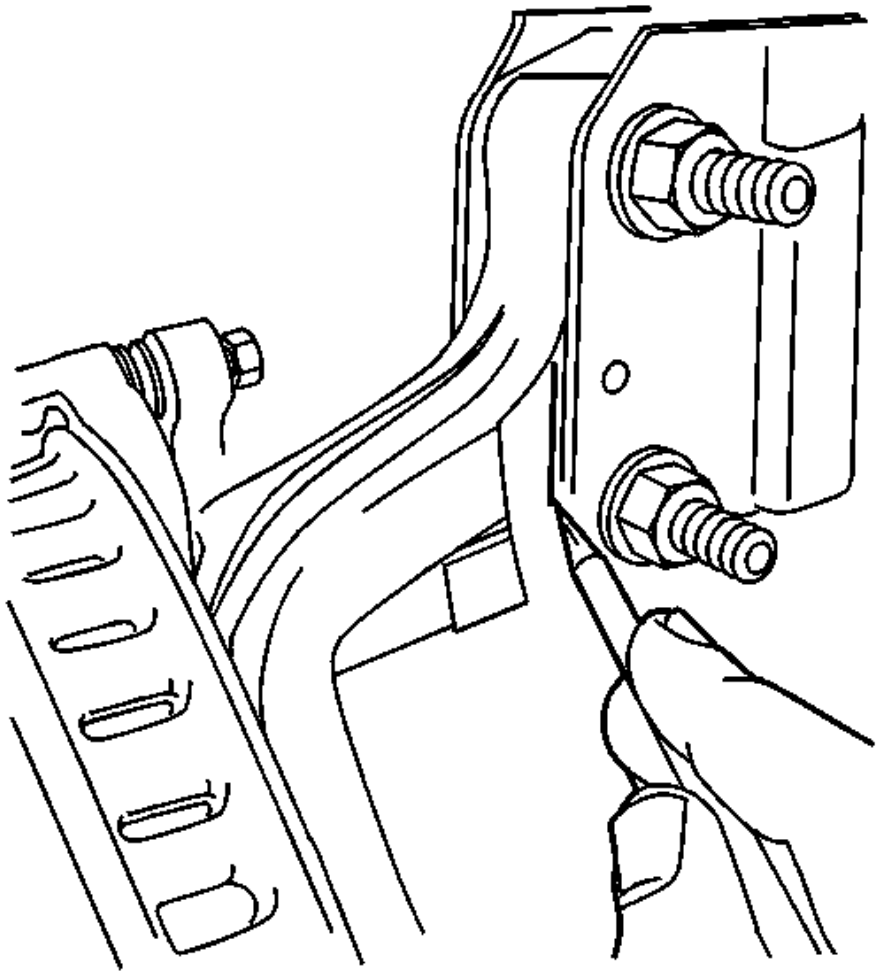


Fig. 45: Scribing Strut To Knuckle
Courtesy of GENERAL MOTORS COMPANY

4. Scribe the strut to the knuckle.

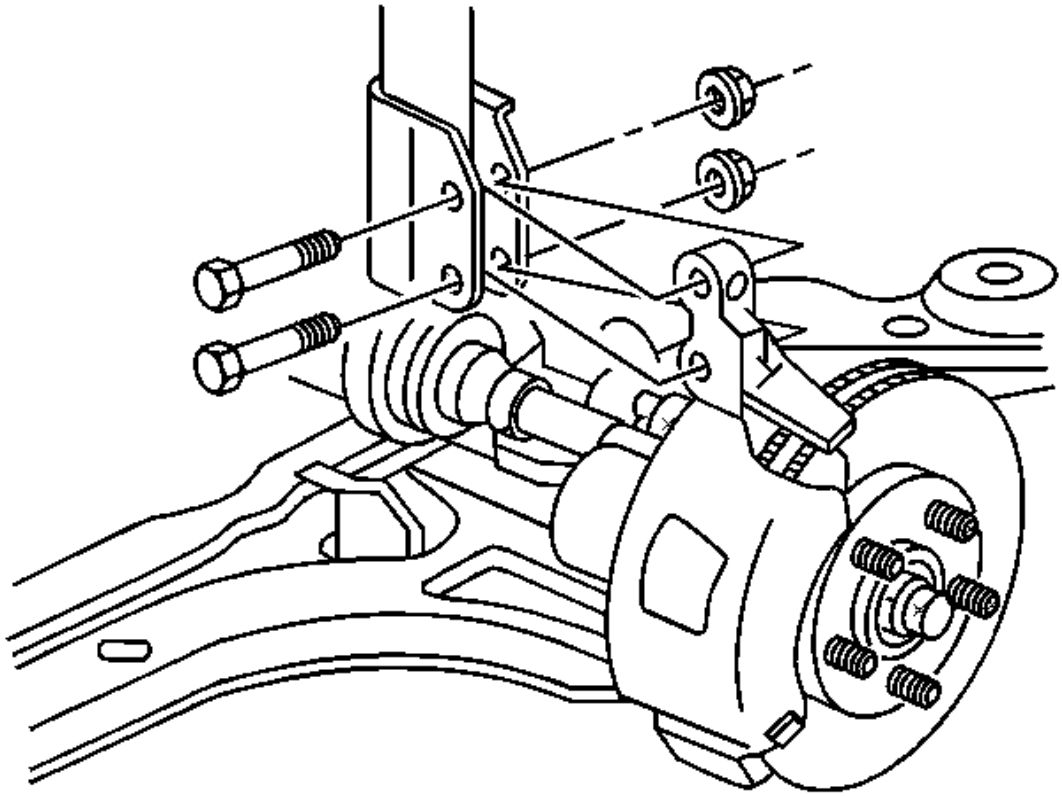


Fig. 46: View Of Steering Knuckle To Strut Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the strut lower bolts and nuts.
6. Remove the strut.

Installation Procedure

1. Install the strut.

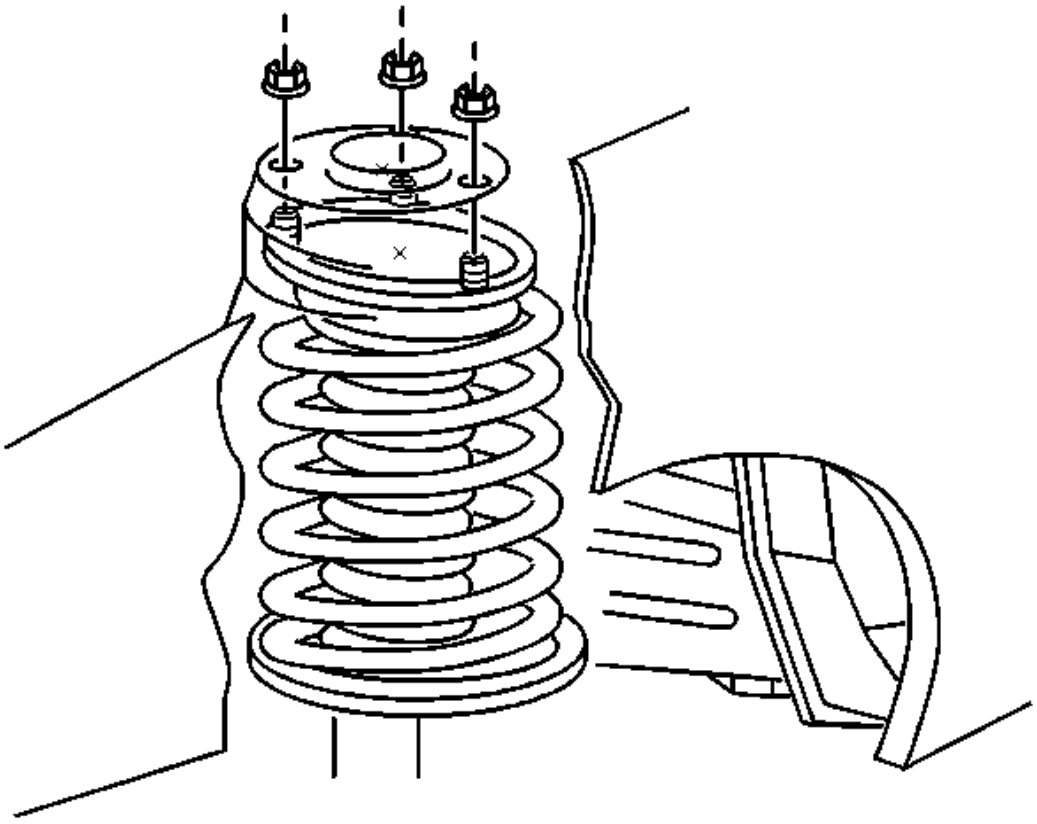


Fig. 47: Identifying Upper Strut Mounting Nuts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the strut upper nuts.

Tighten

Tighten the strut upper nuts to 33 N.m (24 lb ft).

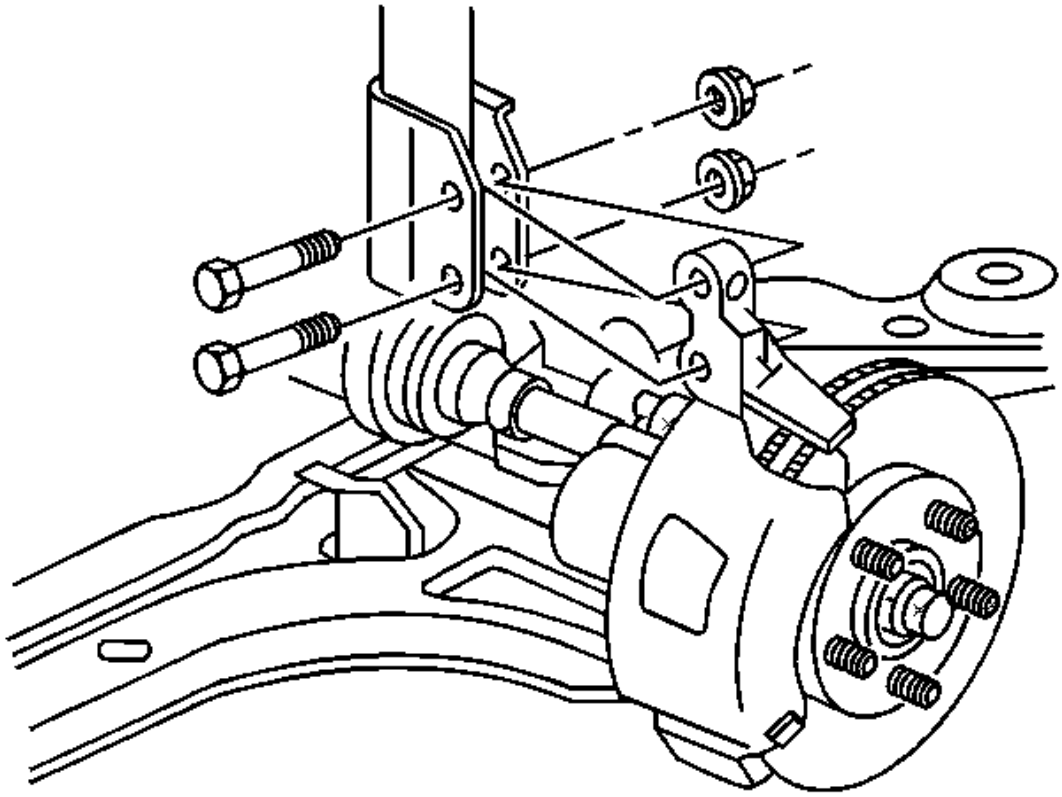


Fig. 48: View Of Steering Knuckle To Strut Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the strut lower bolts and nuts.

NOTE: **This is a prevailing torque type fastener. This fastener may be reused ONLY if:**

- **The fastener and its counterpart are clean and free from rust.**
- **The fastener develops 3 N.m (27 lb in) of torque/drag against its counterpart prior to the fastener seating.**

If the fastener does not meet these criteria, REPLACE the fastener.

4. Align the strut to the mark on the knuckle.

Tighten

Tighten the strut lower nuts to 130 N.m (96 lb ft).

5. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
6. Lower the vehicle.
7. Align the front wheels. Refer to **Wheel Alignment Measurement** .

SUSPENSION SHOCK/STRUT DISPOSAL

WARNING: Use the proper eye protection when drilling to prevent metal chips from causing physical injury.

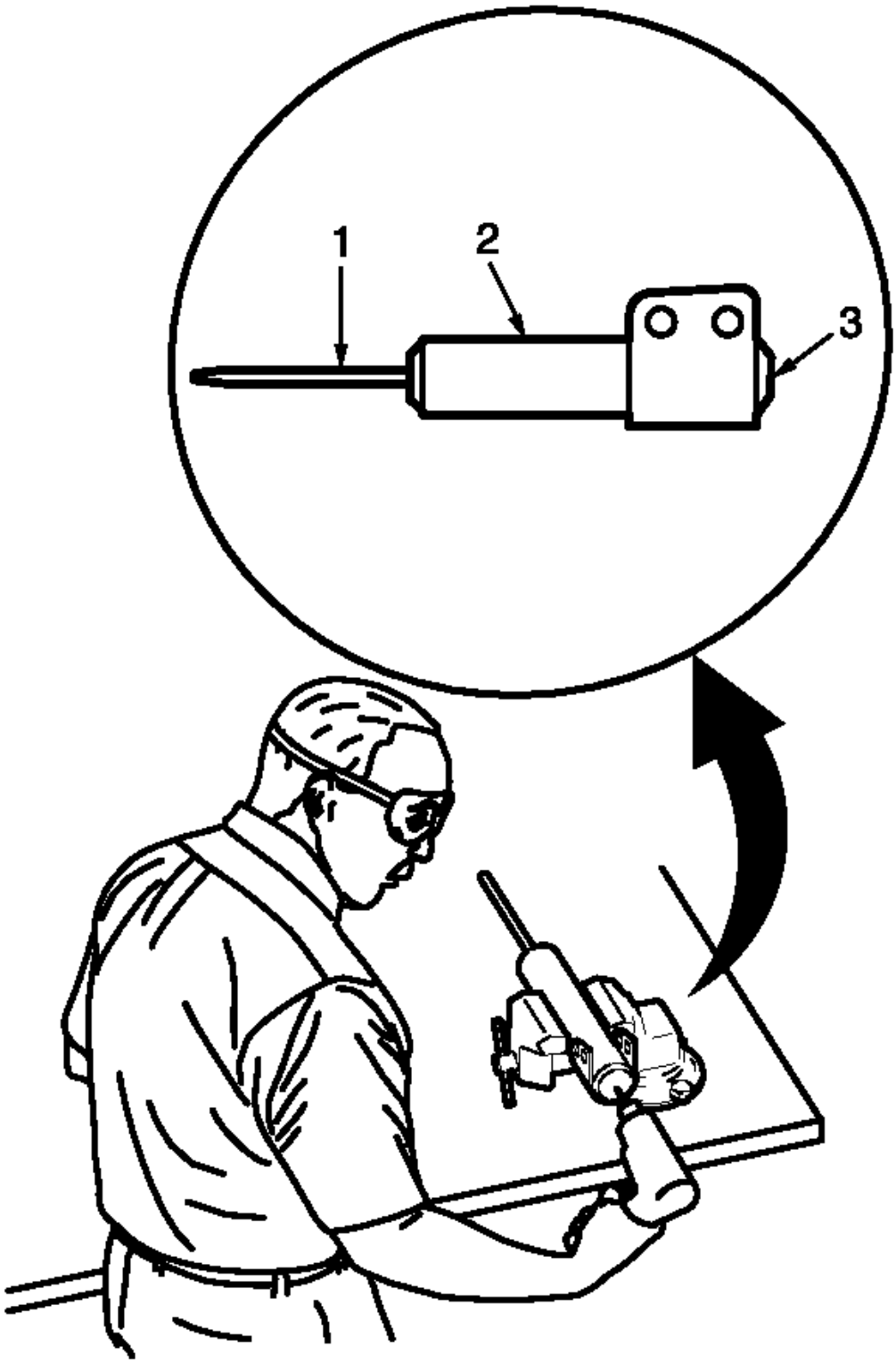


Fig. 49: Drilling Hole In Strut At Center Of End Cap
Courtesy of GENERAL MOTORS COMPANY

1. Clamp the strut in a vise horizontally with the rod (1) completely extended.
2. Drill a hole in the strut at the center of the end cap (3) using a 5 mm (3/16 in) drill bit. Gas or a gas/oil mixture will exhaust when the drill bit penetrates the strut. Use shop towels in order to contain the escaping oil.

3. Remove the strut from the vise.
4. Hold the strut over a drain pan vertically with the hole down.
5. Move the rod (1) in and out of the tube (2) to completely drain the oil from the strut.

STRUT, STRUT COMPONENT, OR SPRING REPLACEMENT

Special Tools

- **J 42991** Strut Rod Nut Socket
- **J 45400** Strut Spring Compressor

Disassembly Procedure

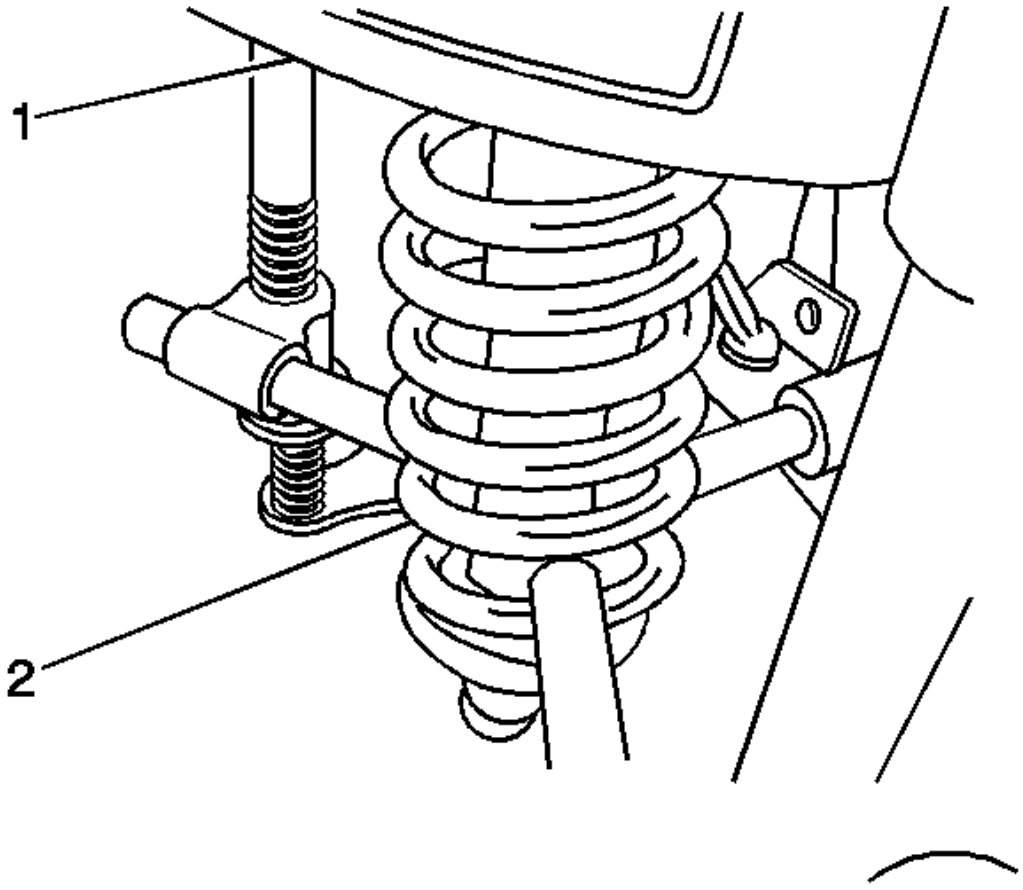


Fig. 50: Compressing/Releasing Lower Part Of Shock Spring
Courtesy of GENERAL MOTORS COMPANY

1. Remove the strut from the vehicle. Refer to **Strut Assembly Removal and Installation**.
2. Install the strut (2) in the **J 45400** strut spring compressor (1).

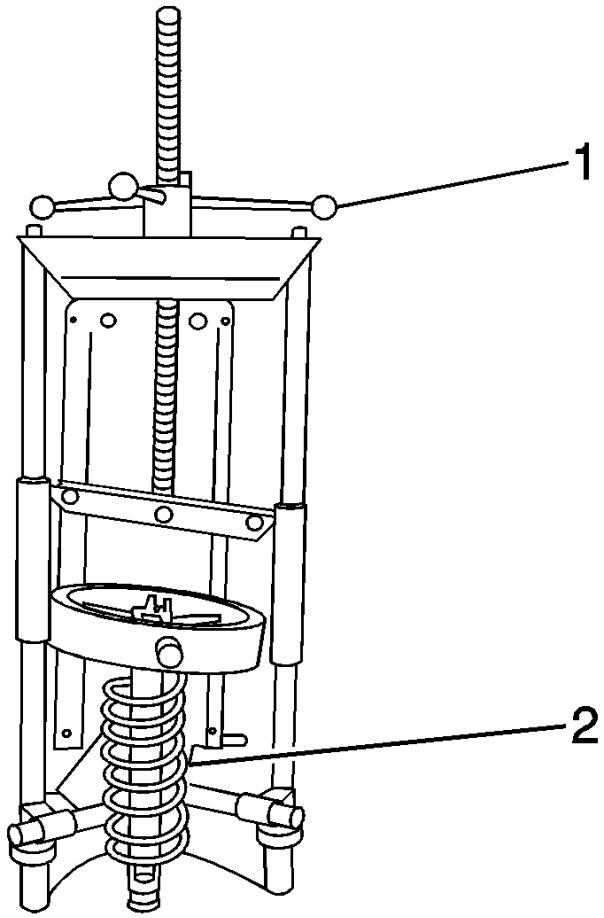


Fig. 51: View Of Compressor Forcing Screw & Coil Spring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The spring is compressed when the strut moves freely.**

3. Turn the spring compressor forcing screw (1) until the coil spring (2) is compressed.

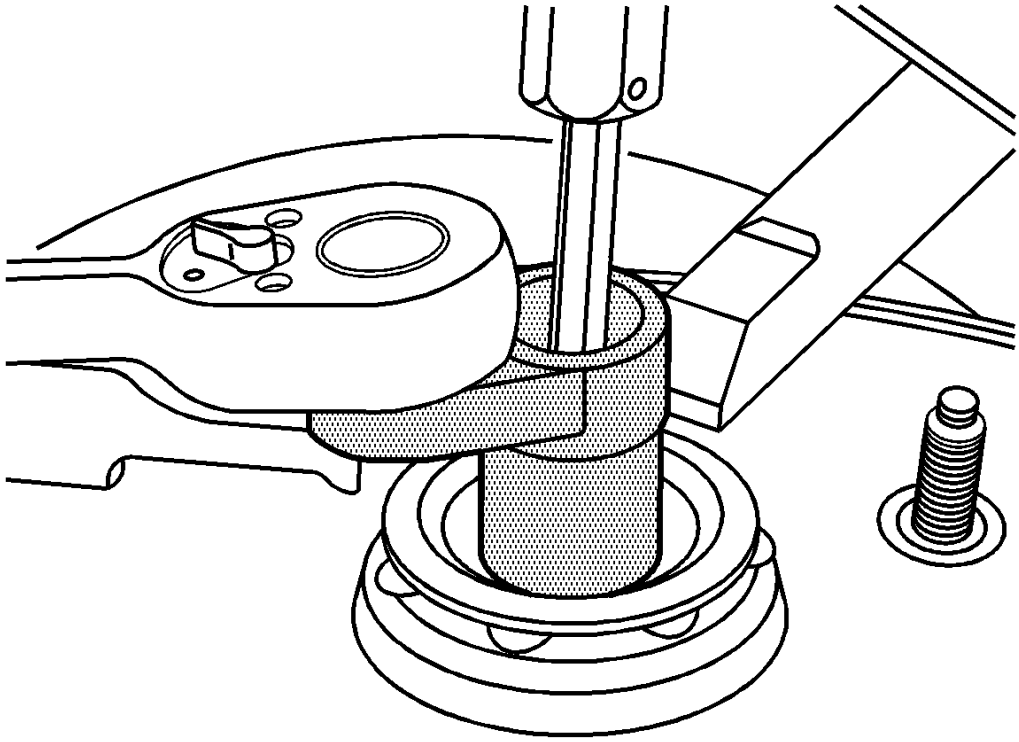


Fig. 52: View Of Special Tools & Strut Shaft
Courtesy of GENERAL MOTORS COMPANY

4. Use a 45 TORXÂ® socket in order to hold the strut shaft. Remove the upper strut mount nut by turning with **J 42991** strut rod nut socket.
5. Remove the strut from the **J 45400** strut spring compressor.

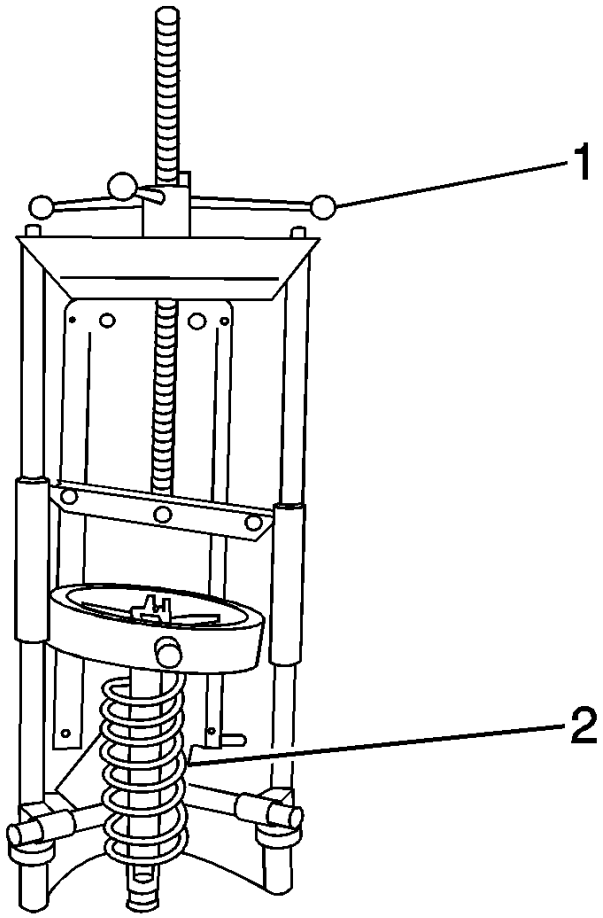


Fig. 53: View Of Compressor Forcing Screw & Coil Spring
Courtesy of GENERAL MOTORS COMPANY

6. Loosen the compressor forcing screw (1) until the upper strut mount and coil spring (2) may be removed.
7. Remove the upper strut mount and the coil spring from the **J 45400** strut spring compressor.

Assembly Procedure

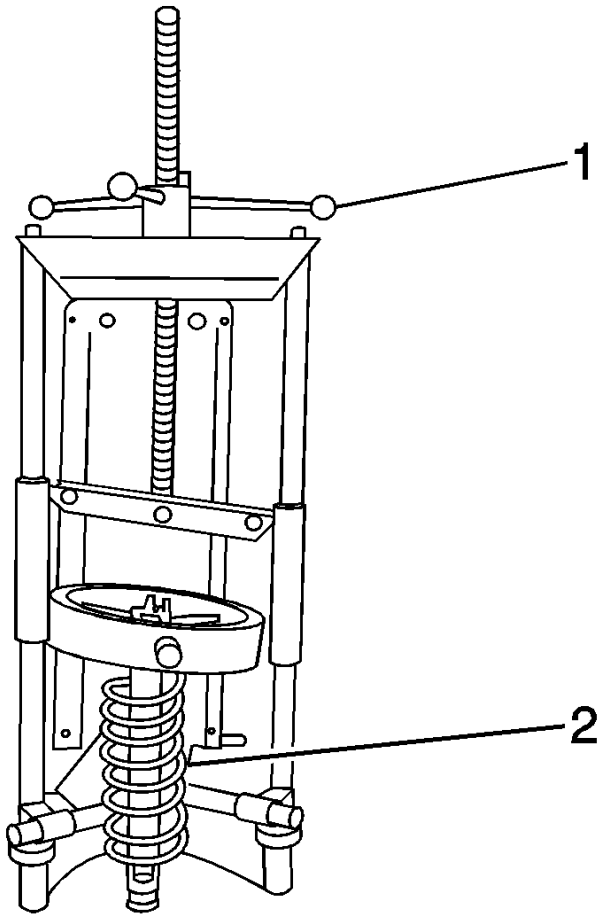


Fig. 54: View Of Compressor Forcing Screw & Coil Spring
Courtesy of GENERAL MOTORS COMPANY

1. Install the coil spring and upper strut mount to the **J 45400** strut spring compressor.
2. Turn the spring compressor forcing screw (1) until the coil spring is compressed.
3. Install the strut to the coil spring and upper strut mount.

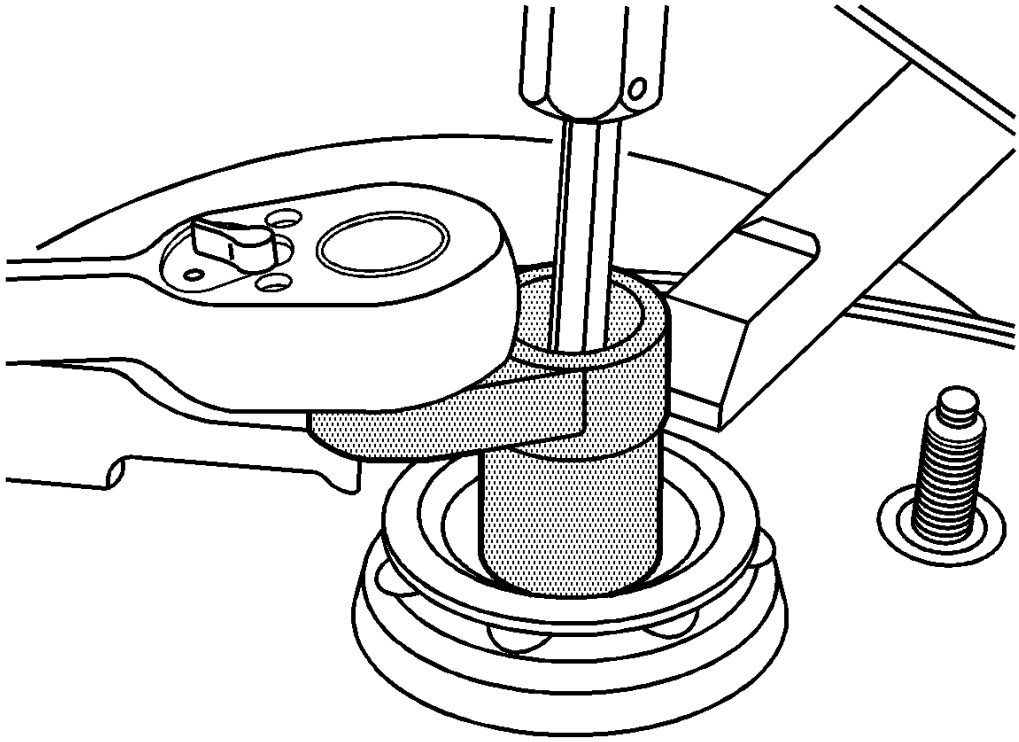


Fig. 55: View Of Special Tools & Strut Shaft
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the strut retaining nut.

   Using the **J 42991** strut rod nut socket and a 45 TORXÂ® socket, install the strut mount nut.

   Tighten

   Tighten the strut mount nut to 70 N.m (52 lb ft).

5. Remove the strut from the **J 45400** strut spring compressor.
6. Install the strut to the vehicle. Refer to **Strut Assembly Removal and Installation**.

DESCRIPTION AND OPERATION

FRONT SUSPENSION DESCRIPTION AND OPERATION

The front suspension has 2 primary purposes:

- Isolate the driver from irregularities in the road surface.
- Define the ride and handling characteristics of the vehicle.

The front suspension absorbs the impact of the tires travelling over irregular road surfaces and dissipates this energy throughout the suspension system. This process isolates the vehicle occupants from the road surface. The rate at which the suspension dissipates the energy and the amount of energy that is absorbed is how the suspension defines the vehicles ride characteristics. Ride characteristics are designed into the suspension system and are not adjustable. The ride characteristics are mentioned in this description in order to aid in the understanding of the functions of the suspension system. The suspension system must allow for the vertical movement of the tire and wheel assembly as the vehicle travels over irregular road surfaces while maintaining the tire's horizontal relationship to the road.

This requires that the steering knuckle be suspended between a lower control arm and a strut assembly. The lower control arm attaches from the steering knuckle at the outermost point of the control arm. The attachment is through a ball and socket type joint. The innermost end of the control arm attached at 2 points to the vehicle frame through semi-rigid bushings. The upper portion of the steering knuckle is attached to a strut assembly. The strut assembly then connects to the vehicle body by way of an upper bearing. The steering knuckle is allowed to travel up and down independent of the vehicle body structure and frame.

This up and down motion of the steering knuckle as the vehicle travels over bumps is absorbed predominantly by the coil spring. This spring is retained under tension over the strut assembly. A strut is used in conjunction with this system in order to dampen out the oscillations of the coil spring. A strut is a basic hydraulic cylinder. The strut is filled with oil and has a moveable shaft that connects to a piston inside the strut. Valves inside the shock absorber offer resistance to oil flow and consequently inhibit rapid movement of the piston and shaft. Each end of the shock absorber is connected in such a fashion to utilize this recoil action of a spring alone. Each end of the strut is designed as the connection point of the suspension system to the vehicle and acts as the coil spring seat. This allows the strut to utilize the dampening action to reduce the recoil of a spring alone. The lower control arm is allowed to pivot at the vehicle frame in a vertical fashion. The ball joint allows the steering knuckle to maintain the perpendicular relationship to the road surface.

Front suspensions systems utilize a stabilizer shaft. The stabilizer bar connects between the left and right lower control arm assemblies through the stabilizer link and stabilizer shaft insulators. This bar controls the amount of independent movement of the suspension when the vehicle turns. Limiting the independent movement defines the vehicles handling characteristics on turns.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

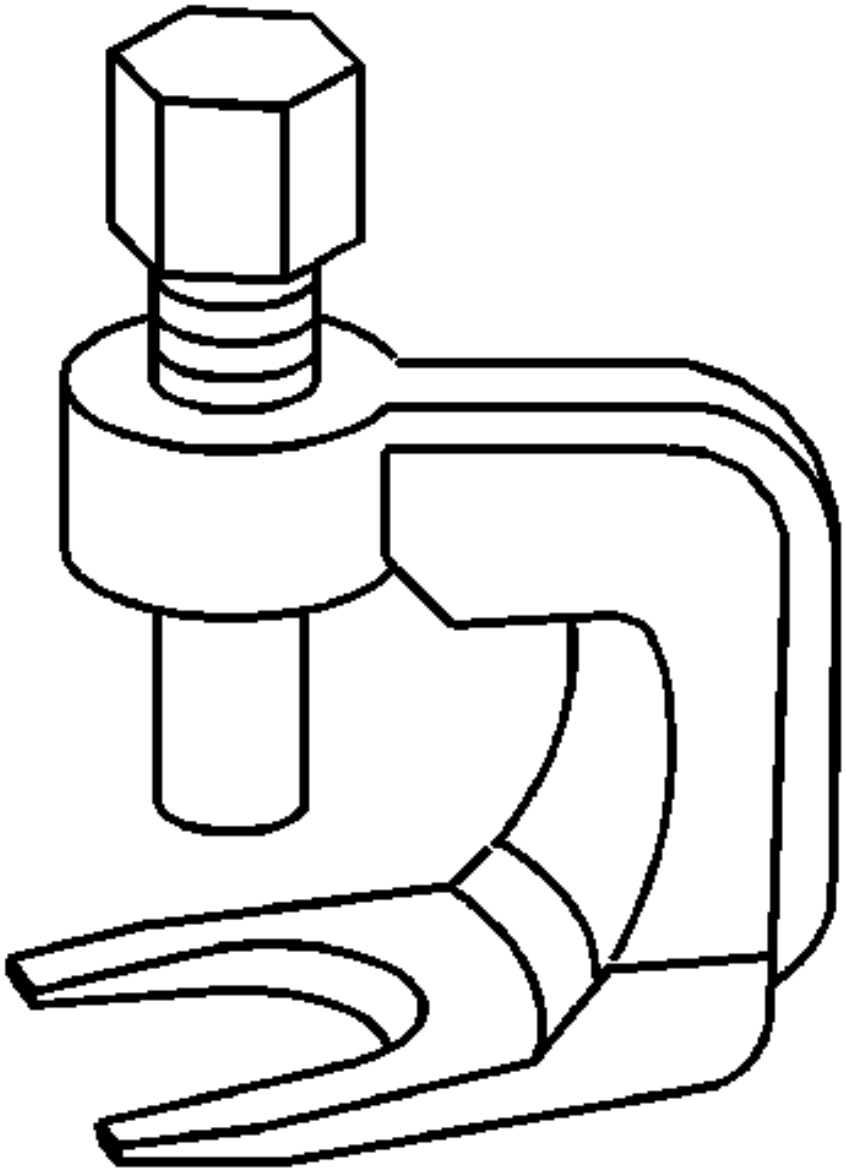
Illustration	Tool Number/ Description
	J 6627-A Tie Rod Puller

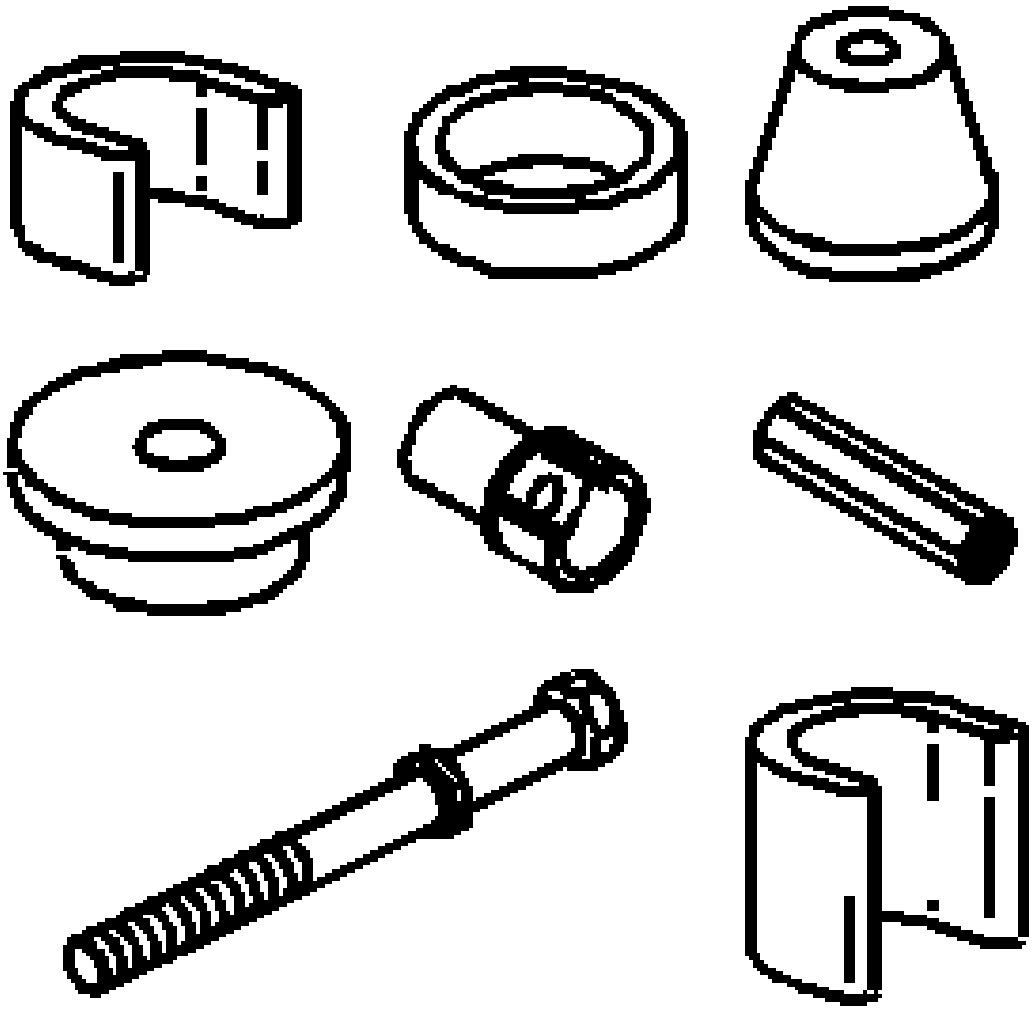
Illustration	Tool Number/ Description
	J 21474-01 Control Arm Bushing Set

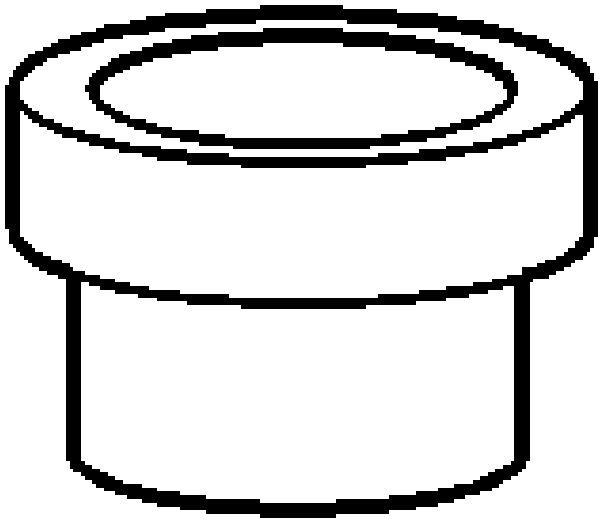
Illustration	Tool Number/ Description
	J 21474-2 Bushing Installer Remover

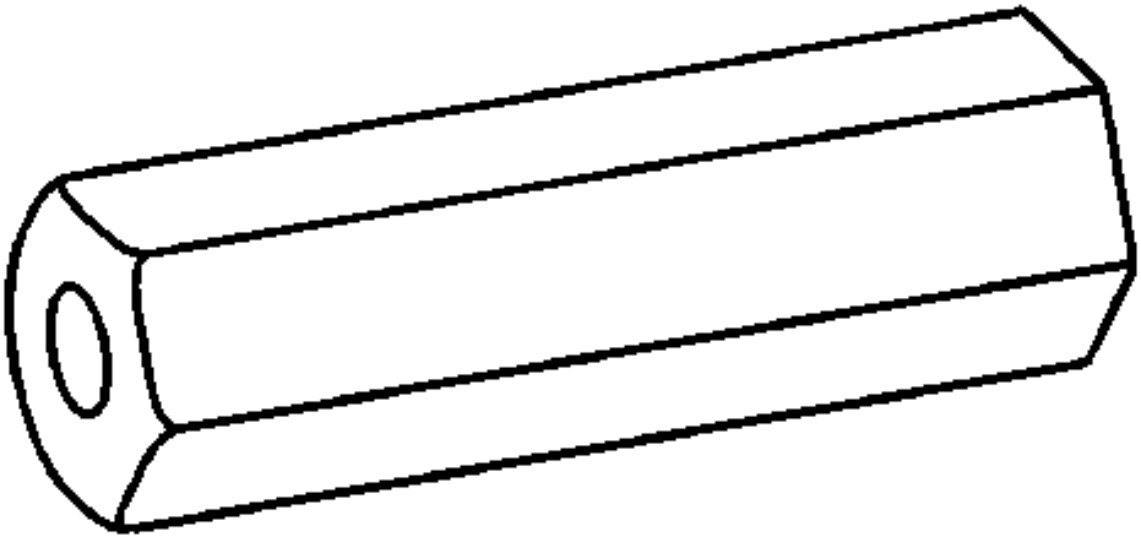
Illustration	Tool Number/ Description
	J 21474-4 1/2 Inch Nut

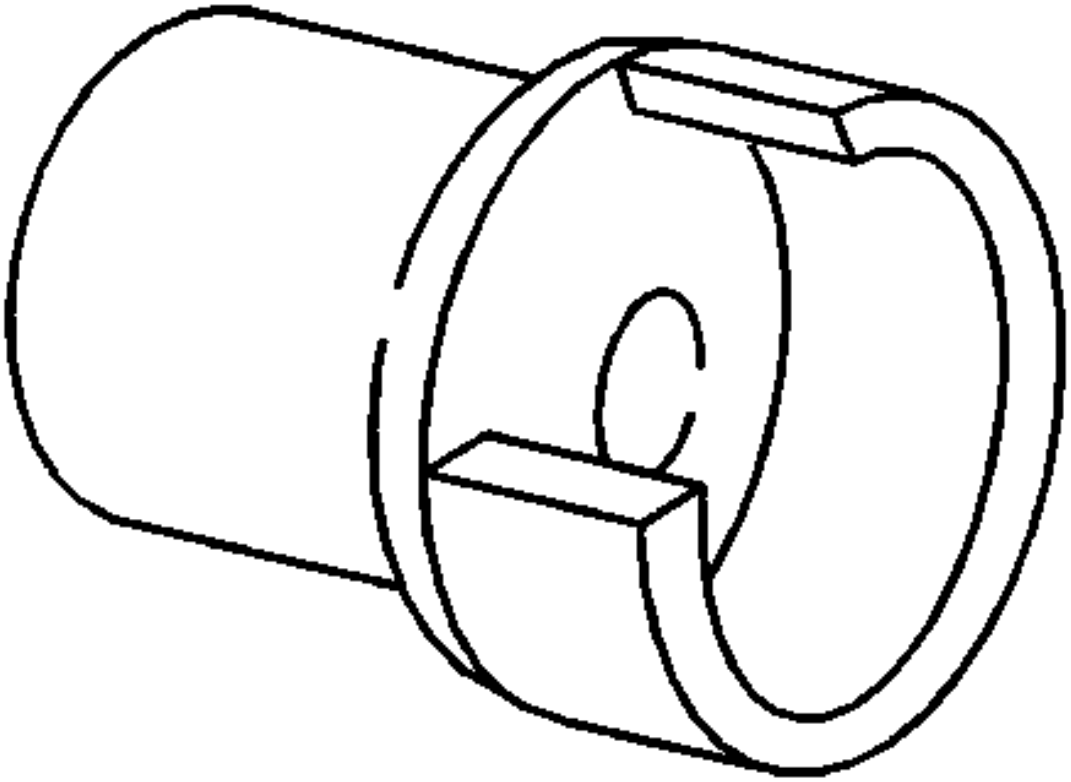
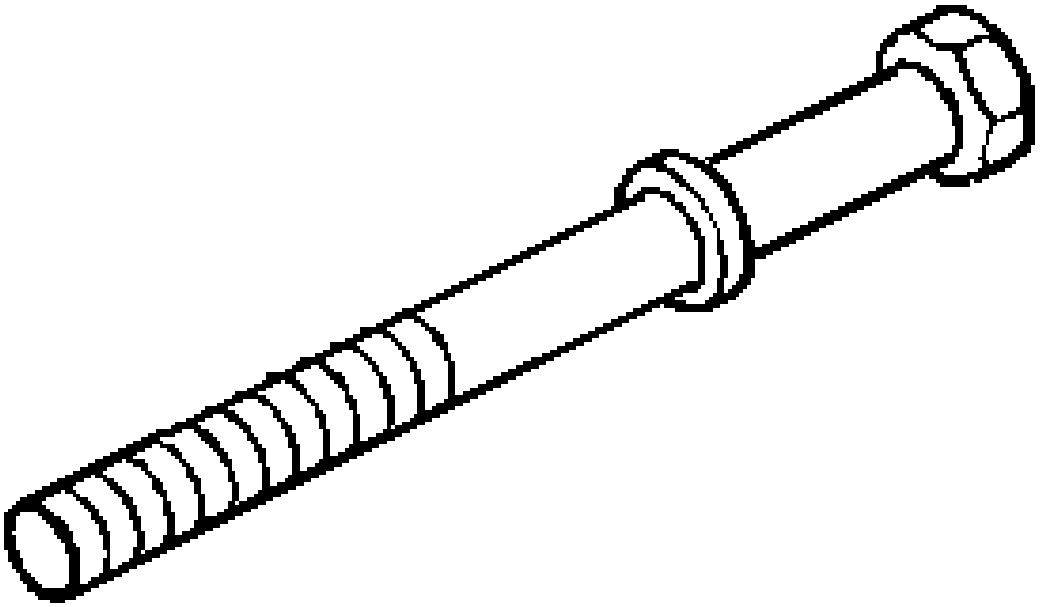
Illustration	Tool Number/ Description
	J 21474-5 Control Arm Bushing Receiver

Illustration	Tool Number/ Description
	J 21474-27 1/2 Inch Puller Bolt Thrust Bearing

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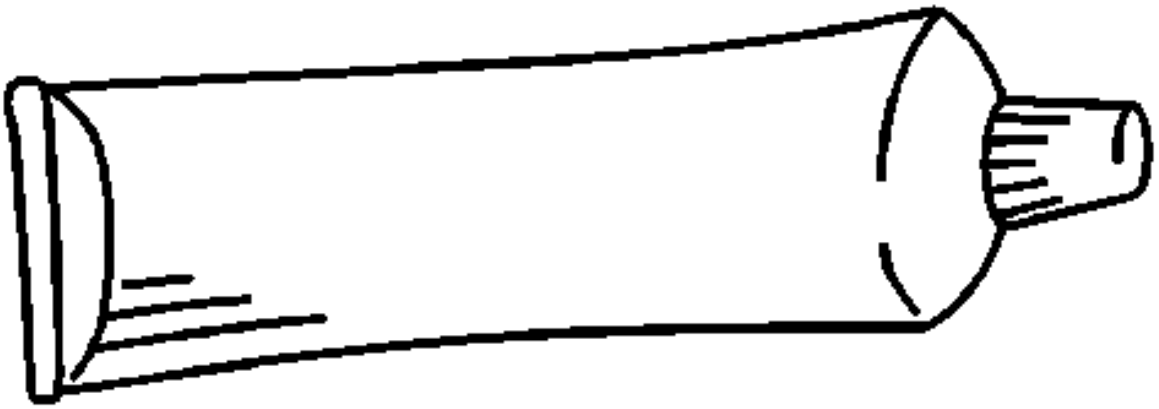
	J 23444-A Extreme Press Lubricant - 1/4-Ounce Tube

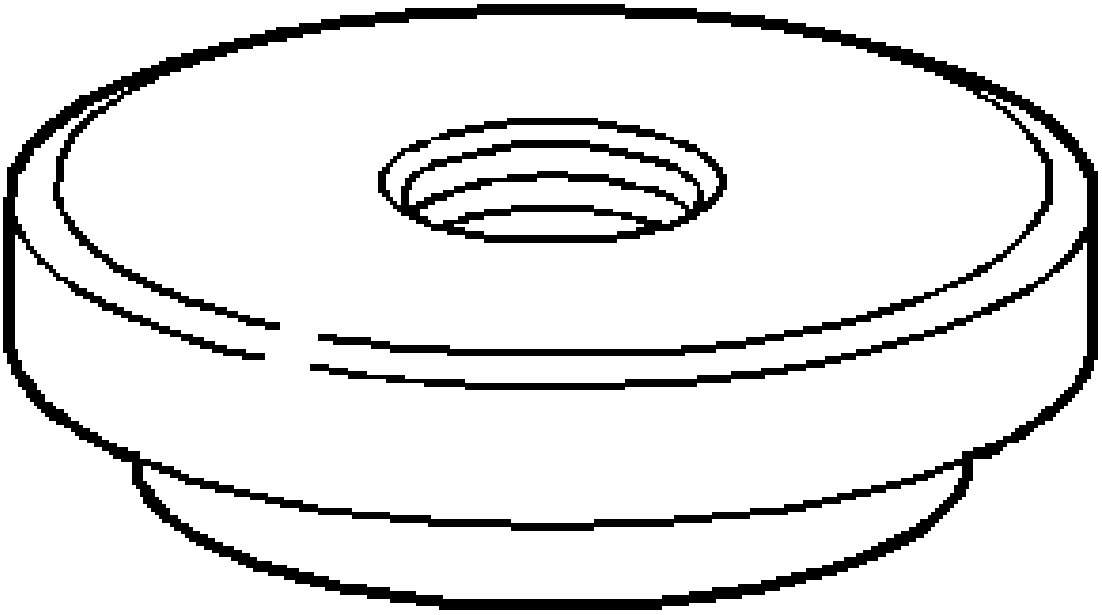
Illustration	Tool Number/ Description
	J 34126 Sprocket Bearing Remover

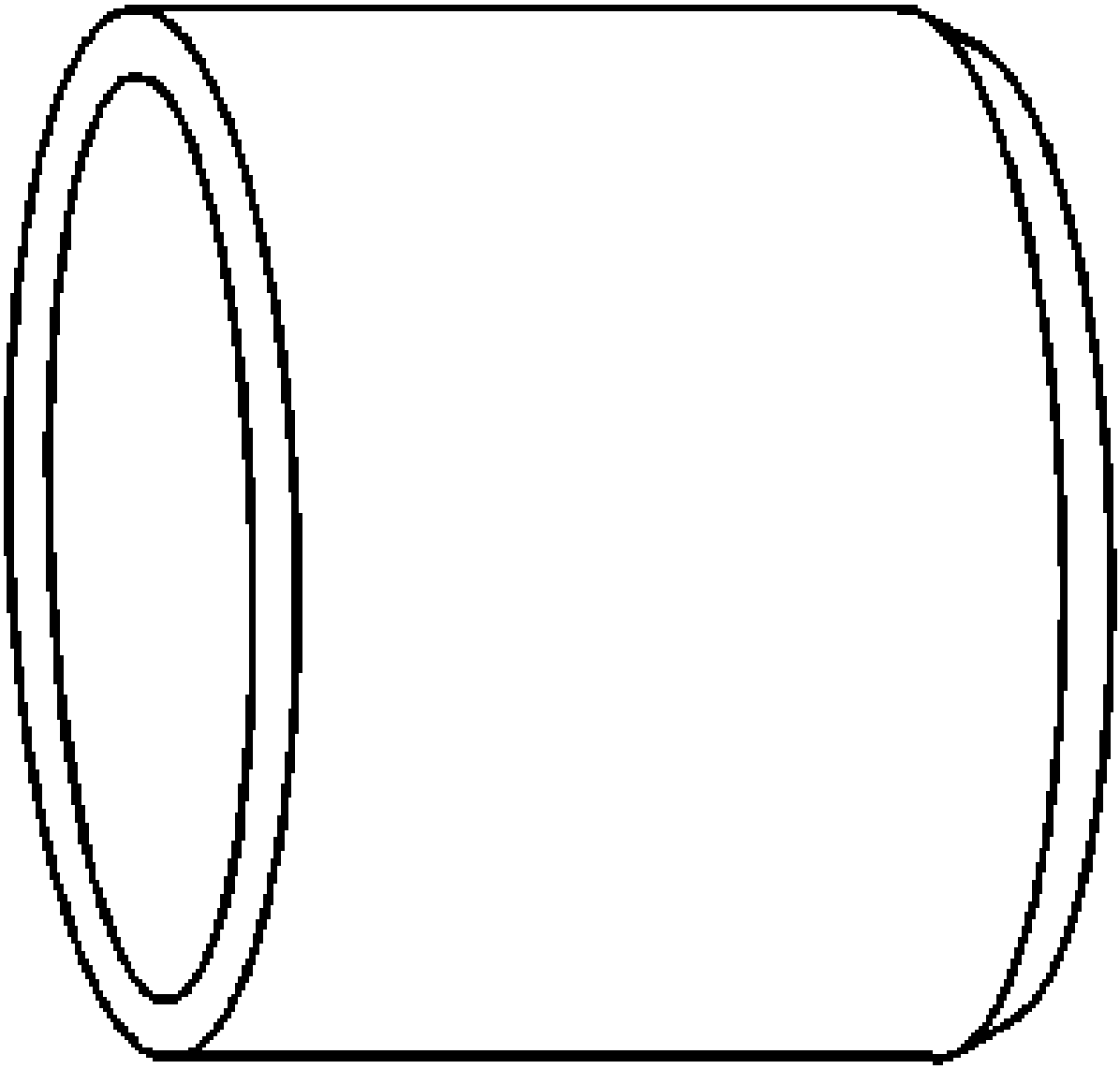
Illustration	Tool Number/ Description
	J 35379 Front Knuckle Support

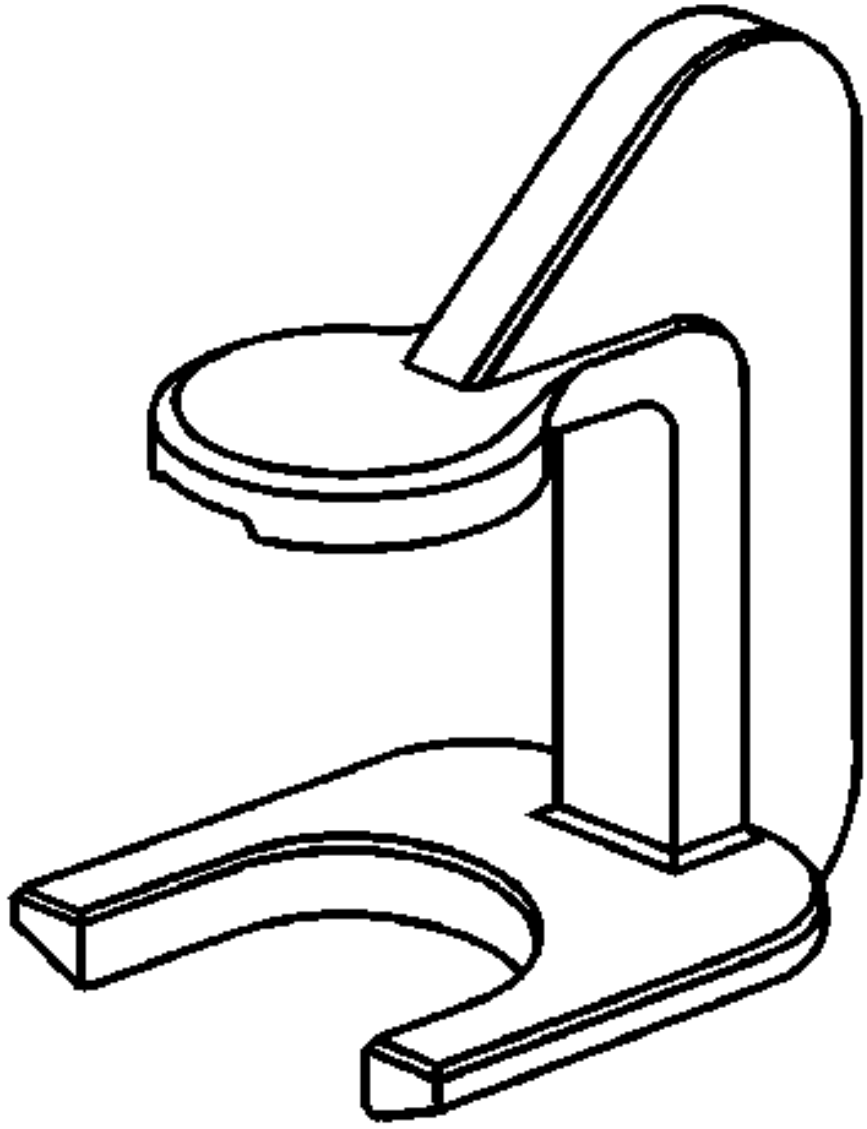
Illustration	Tool Number/ Description
	J 41820 Ball Joint Separator

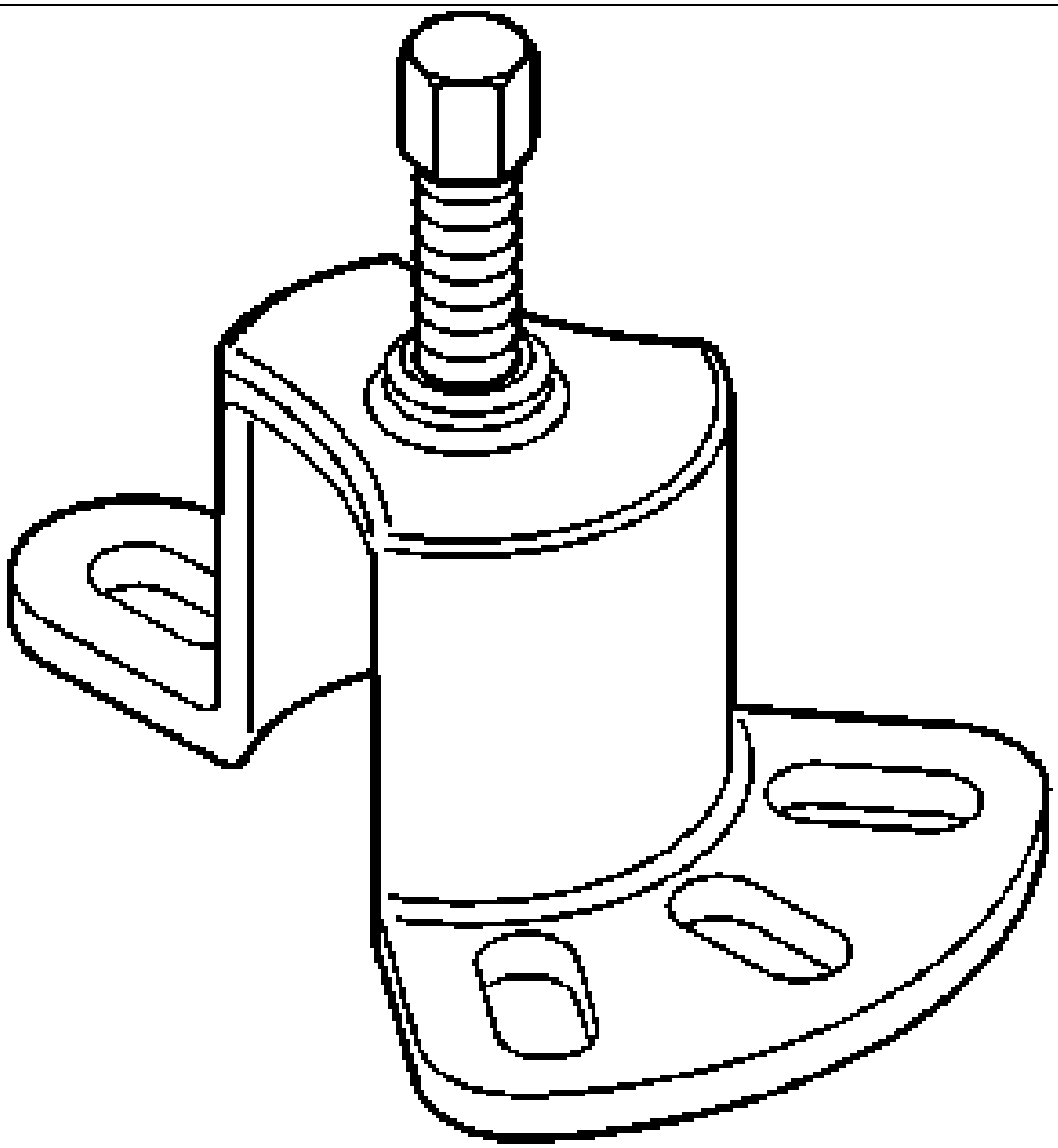
Illustration	Tool Number/ Description
	J 42129 Wheel Hub Remover

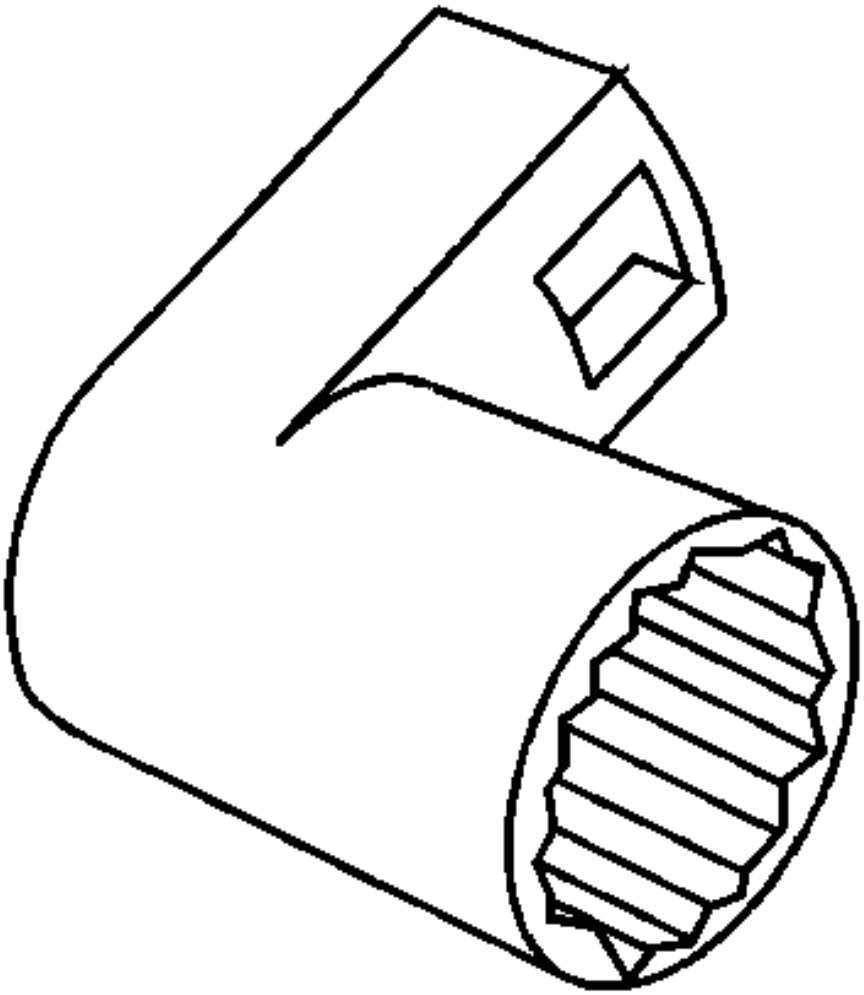
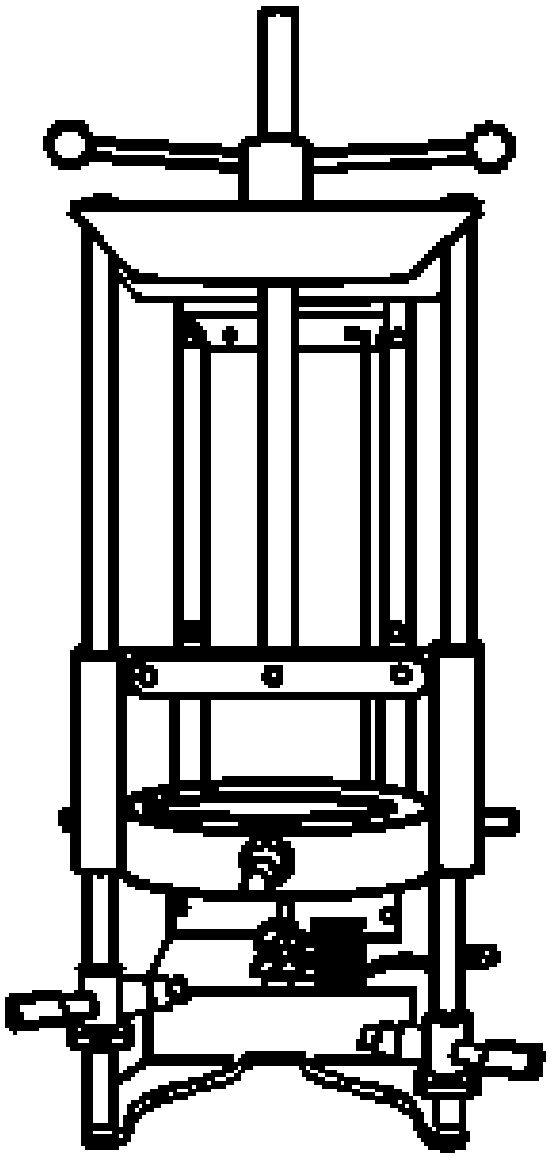
Illustration	Tool Number/ Description
	J 42991 Strut Rod Nut Socket

Illustration	Tool Number/ Description
	J 45400 Strut Spring Compressor

Article GUID: A00737183

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Brake Hose Bracket Bolt	10 N.m	89 lb in
Rear Strut Mount to Body Nuts	45 N.m	33 lb ft
Rear Strut Rod to Strut Mount Nut	75 N.m	55 lb in
Rear Strut to Knuckle Nuts	120 N.m	89 lb ft
Rear Suspension Support Mounting Bolts	110 N.m	81 lb ft
Rear Wheel Hub/Bearing to Knuckle Bolts	75 N.m	55 lb ft
Spindle Rods to Knuckle Nuts	150 N.m	111 lb ft
Spindle Rod to Rear Support Bolts	135 N.m	100 lb ft
Stabilizer Shaft Bracket Nuts	48 N.m	35 lb ft
Stabilizer Shaft Link Nuts (Lower)	50 N.m	37 lb ft
Stabilizer Shaft Link Nuts (Upper)	52 N.m	38 lb ft
Trailing Arm to Body Bracket Bolt	105 N.m	77 lb ft
Trailing Arm Bracket to Body Bolts	52 N.m	38 lb ft
Trailing Arm to Knuckle Bolt	240 N.m	177 lb ft

REPAIR INSTRUCTIONS

REAR WHEEL BEARING AND HUB REPLACEMENT

Removal Procedure

NOTE: **The wheel bearing in the rear wheel hub is integrated into one unit. The hub is non-serviceable. If the hub and/or bearing is damaged, replace the complete hub and bearing assembly.**

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the brake rotor. Refer to **Rear Brake Rotor Replacement** .

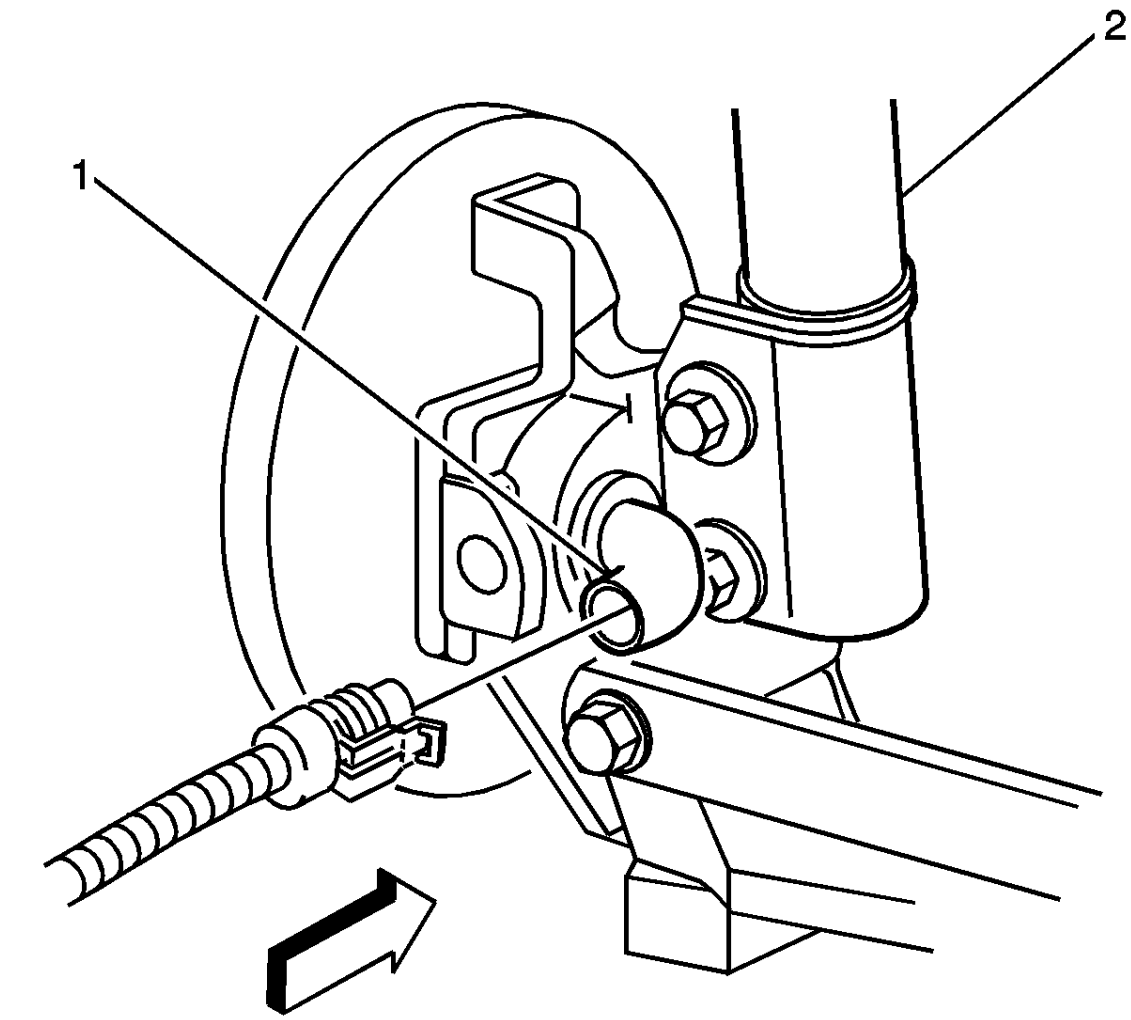


Fig. 1: Rear Wheel Speed Sensors Component View
Courtesy of GENERAL MOTORS COMPANY

4. Remove the ABS electrical connector from the wheel speed sensor (1), if equipped.
5. Remove the park brake cable from the park brake actuator. Refer to **Parking Brake Rear Cable Replacement (Z7U)** .
6. Remove the mounting bolts from the rear bearing/hub.

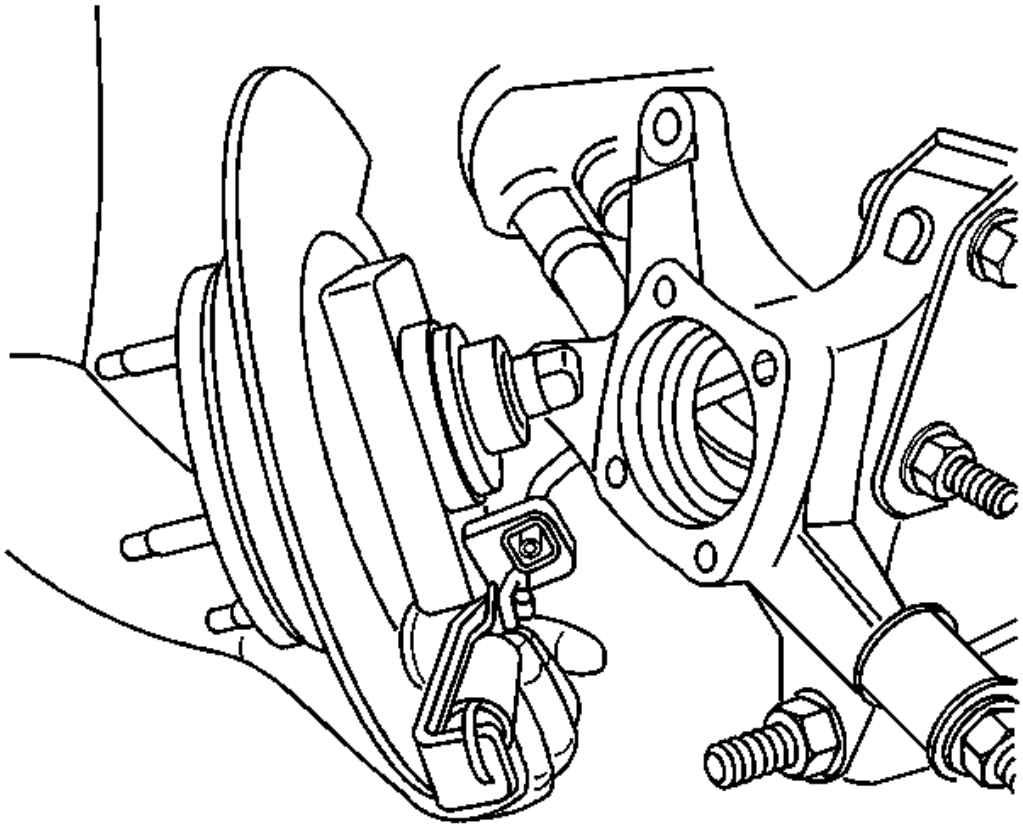


Fig. 2: Park Brake Actuator
Courtesy of GENERAL MOTORS COMPANY

7. Remove the wheel bearing/hub and park brake assembly from the knuckle.
8. Remove the park brake actuator from the rear wheel bearing/hub. Refer to **Parking Brake Rear Cable Replacement (Z7U)** .

Installation Procedure

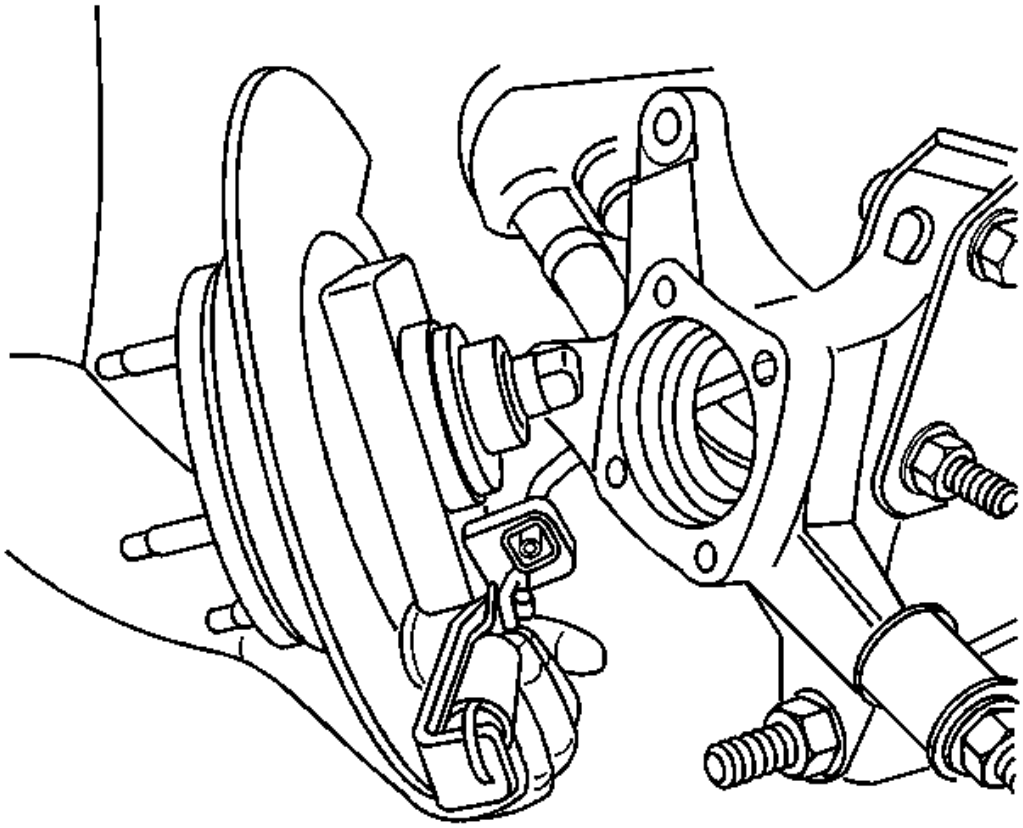


Fig. 3: Park Brake Actuator
Courtesy of GENERAL MOTORS COMPANY

1. Install the park brake actuator to the rear wheel bearing/hub. Refer to **Parking Brake Rear Cable Replacement (Z7U)** .
2. Install the wheel bearing/hub and park brake assembly to the knuckle.

CAUTION: Refer to Fastener Caution .

3. Install the wheel bearing/hub-to-knuckle bolts.

Tighten

Tighten the bolts to 75 N.m (55 lb ft).

4. Install the park brake cable to the park brake actuator. Refer to **Parking Brake Rear Cable Replacement (Z7U)** .

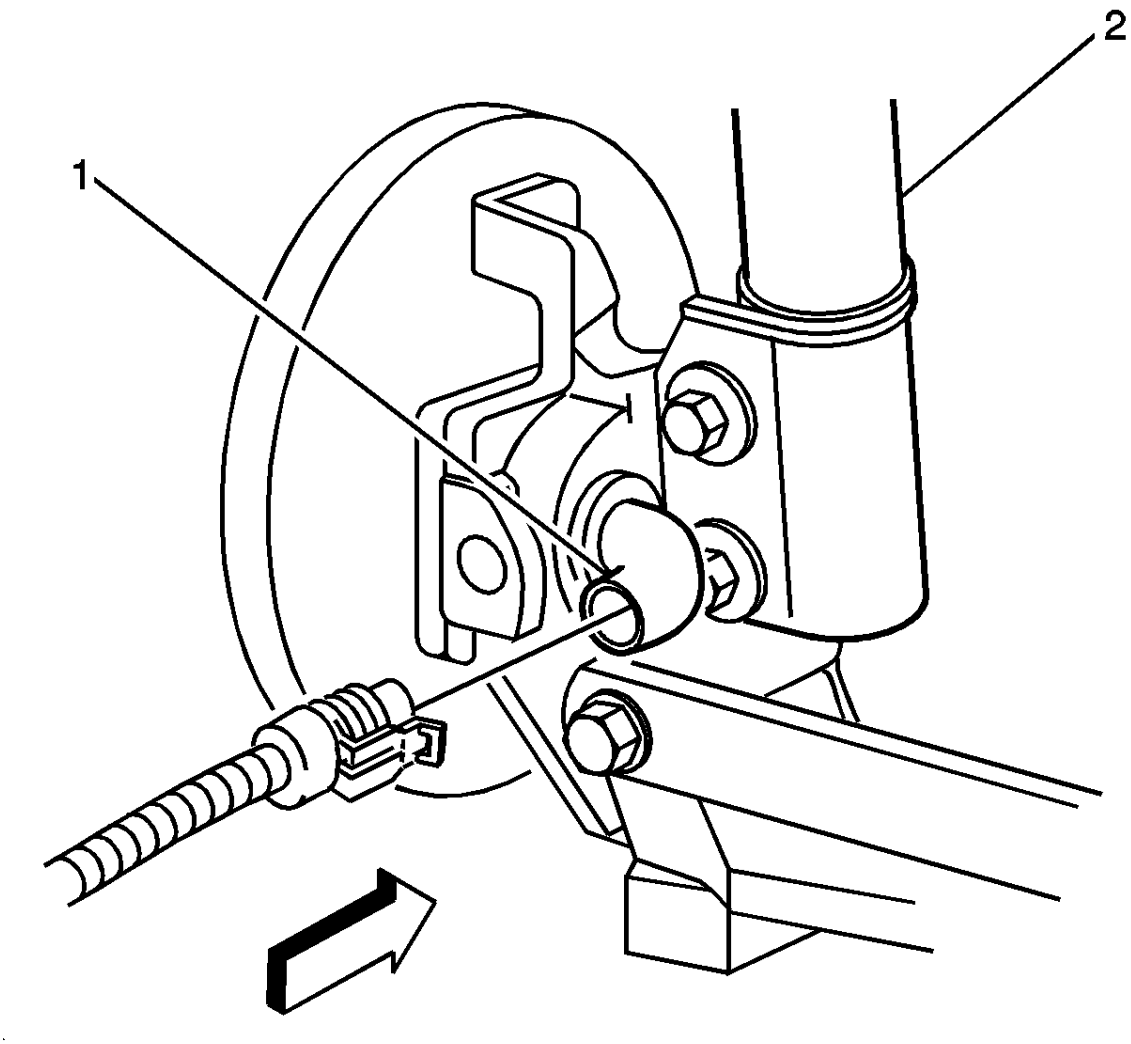


Fig. 4: Rear Wheel Speed Sensors Component View
Courtesy of GENERAL MOTORS COMPANY

5. Install the ABS electrical connector to the wheel speed sensor (1), if equipped.
6. Install the brake rotor. Refer to **Rear Brake Rotor Replacement** .
7. Install the tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
8. Lower the vehicle.

SUPPORT REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the rear tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the exhaust pipe. Refer to **Exhaust Muffler Replacement** .
4. Disconnect the brake lines from the rear suspension support. Refer to **Rear Brake Hose Replacement** .
5. Disconnect the parking brake cables and tensioner from the suspension support. Refer to **Parking Brake Rear Cable Replacement (Z7U)** .
6. Remove the stabilizer shaft from the rear suspension support. Refer to **Stabilizer Shaft Replacement**.

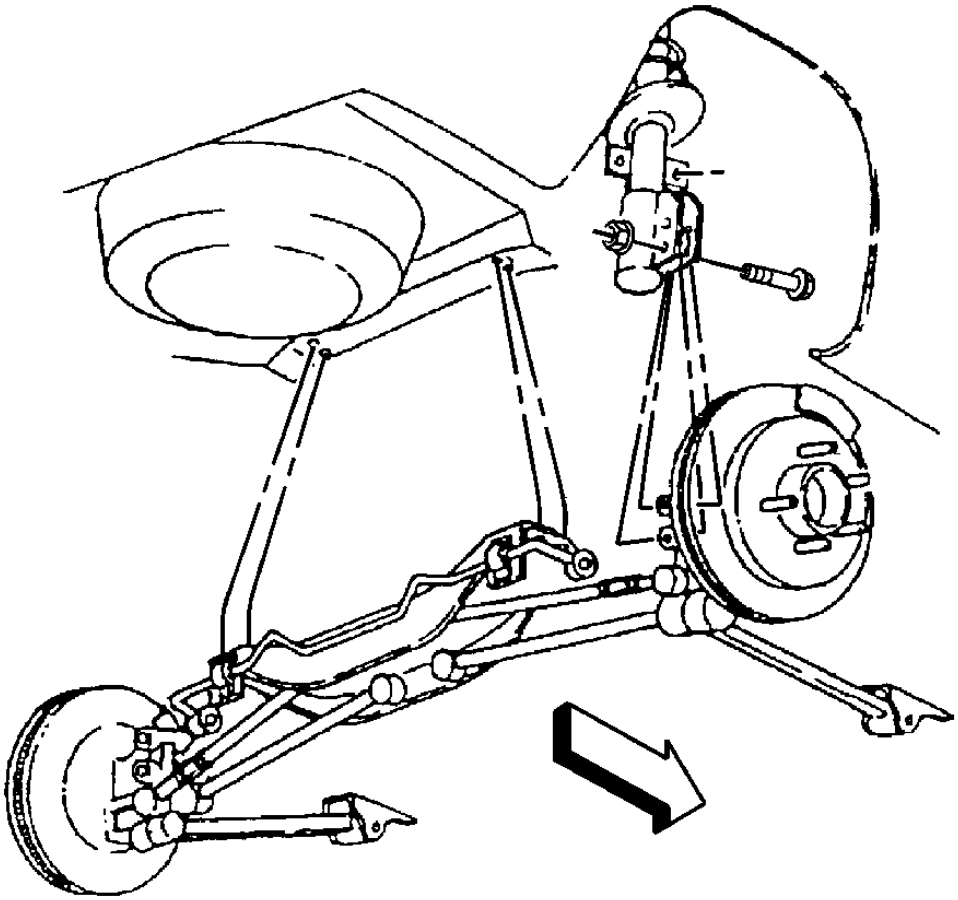


Fig. 5: Rear Suspension Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Support the rear suspension support with jack stands before removing the mounting bolts.**

7. Remove the rear suspension support mounting bolts.
8. Remove the rear wheel spindle rods bolts from the knuckle.
9. Lower the rear suspension support in order to gain access to the rear wheel spindle rod bolts.
10. Remove the rear wheel spindle rods bolts from the rear suspension support.
11. Remove the rear suspension support.

Installation Procedure

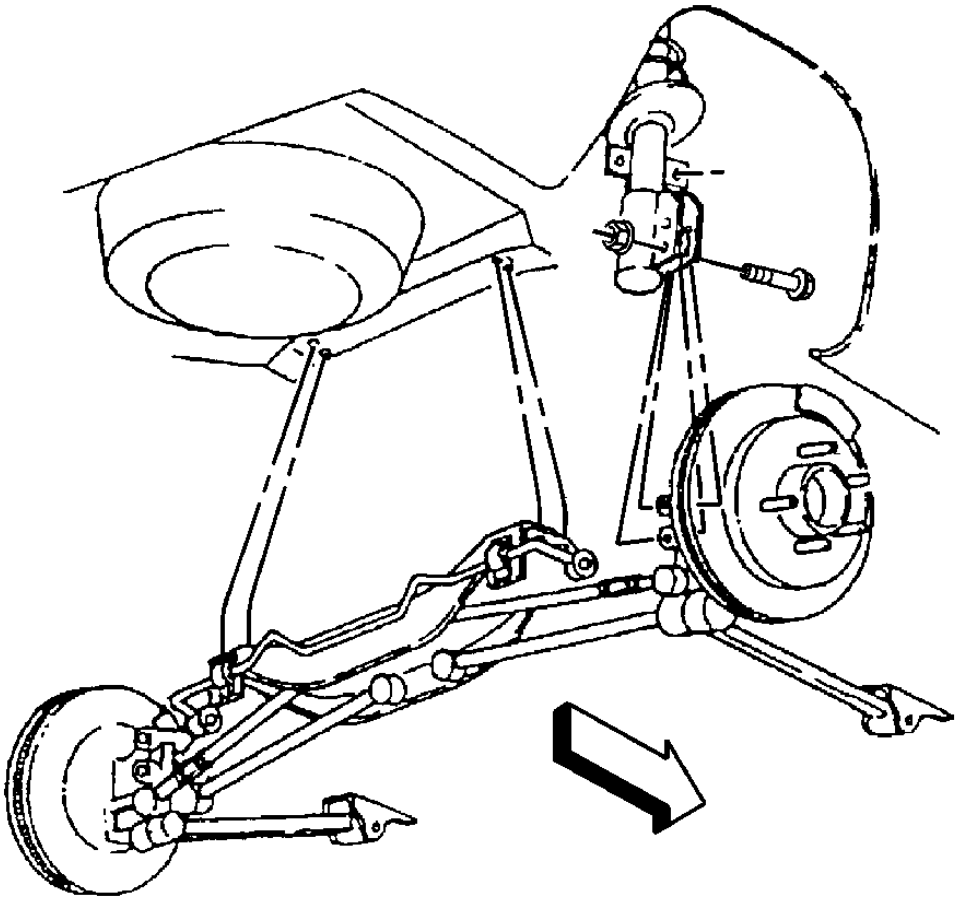


Fig. 6: Rear Suspension Components
Courtesy of GENERAL MOTORS COMPANY

1. Position the rear suspension support in place.

CAUTION: **Refer to Fastener Caution .**

2. Install the rear wheel spindle rod-to-rear suspension support bolts and nuts.

Tighten

Tighten the nuts to 135 N.m (100 lb ft).

3. Install the rear suspension support mounting bolts.

Tighten

Tighten the bolts to 110 N.m (81 lb ft).

4. Position the rear wheel spindle rod to the knuckle.
5. Install the retaining bolts and nuts to the knuckle.

Tighten

Tighten the nut to 150 N.m (111 lb ft).

6. Install the stabilizer shaft to the rear suspension support. Refer to **Stabilizer Shaft Replacement**.
7. Connect the brake lines to the rear suspension support. Refer to **Rear Brake Hose Replacement** .
8. Install the parking brake cables and the tensioner. Refer to **Parking Brake Rear Cable Replacement (Z7U)** .
9. Install the exhaust pipe. Refer to **Exhaust Muffler Replacement** .
10. Install the tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
11. Lower the vehicle.
12. Adjust the rear wheel alignment. Refer to **Wheel Alignment Measurement** .

KNUCKLE REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

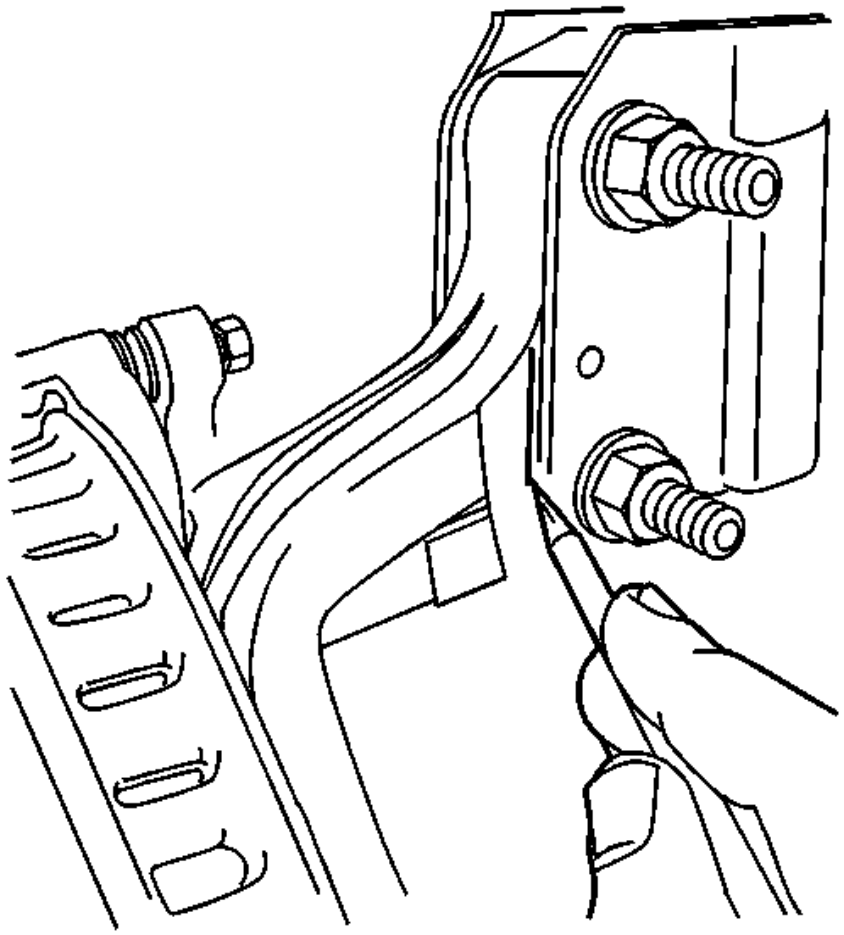


Fig. 7: Scribing Strut To Knuckle

Courtesy of GENERAL MOTORS COMPANY

NOTE: **If removing the knuckle to service other suspension components, perform the following step.**

3. Scribe the strut to the knuckle.
4. Remove the bearing/hub assembly. Refer to **Rear Wheel Bearing and Hub Replacement**.
5. Remove the rear wheel spindle rods from the knuckle. Refer to **Rear Wheel Spindle Rod Replacement**.

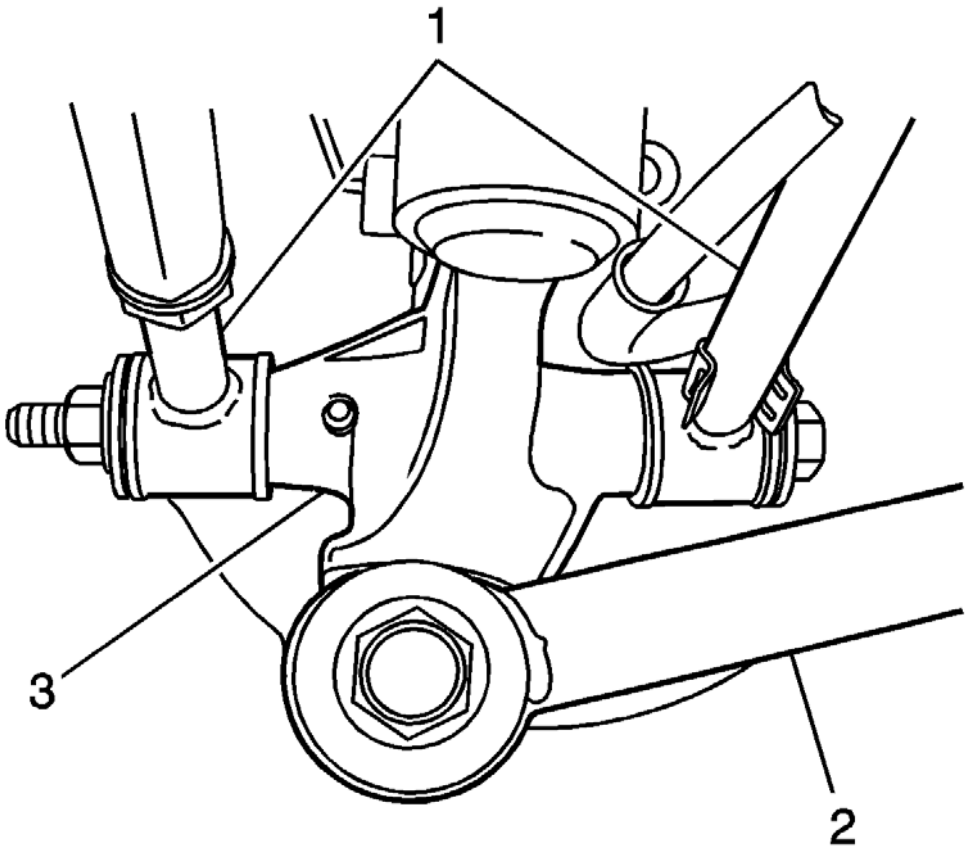


Fig. 8: View Of Trailing Arm & Knuckle
Courtesy of GENERAL MOTORS COMPANY

6. Remove the trailing arm (2) from the knuckle (3). Refer to **Trailing Arm Replacement**.

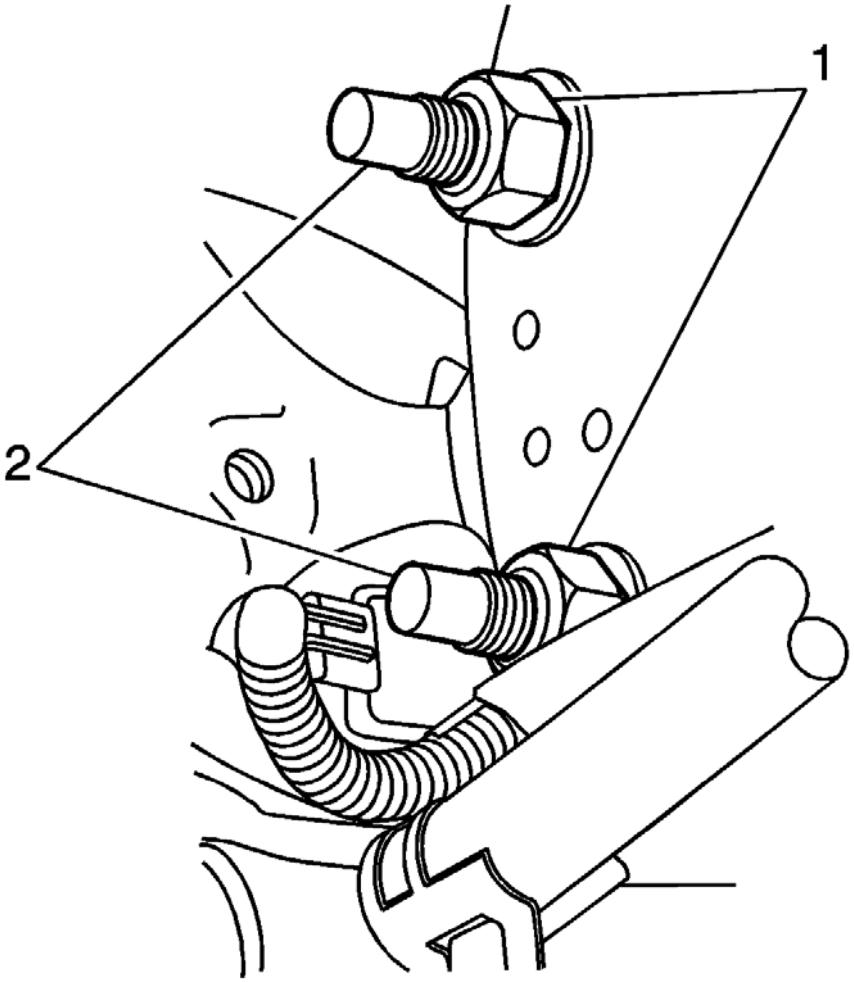


Fig. 9: Rear Strut To Knuckle
Courtesy of GENERAL MOTORS COMPANY

7. Remove the rear strut to knuckle bolts (2) and the nuts (1). Refer to **Strut Assembly Removal and Installation**.
8. Remove the knuckle from the vehicle.

Installation Procedure

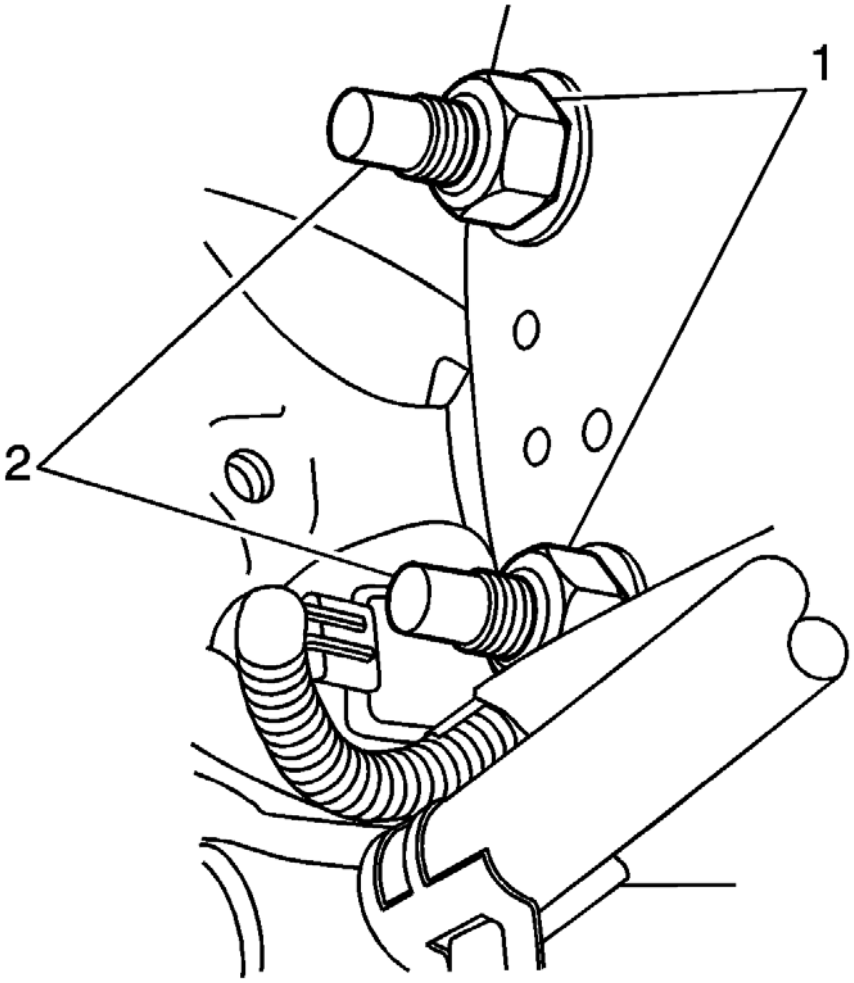


Fig. 10: Rear Strut To Knuckle
Courtesy of GENERAL MOTORS COMPANY

1. Install the knuckle to the vehicle.

NOTE: **If reinstalling the original knuckle, align the rear strut with the scribe marks on the knuckle.**

2. Hand start the strut to knuckle bolts (2) and nuts (1). Do not tighten the nuts at this time.

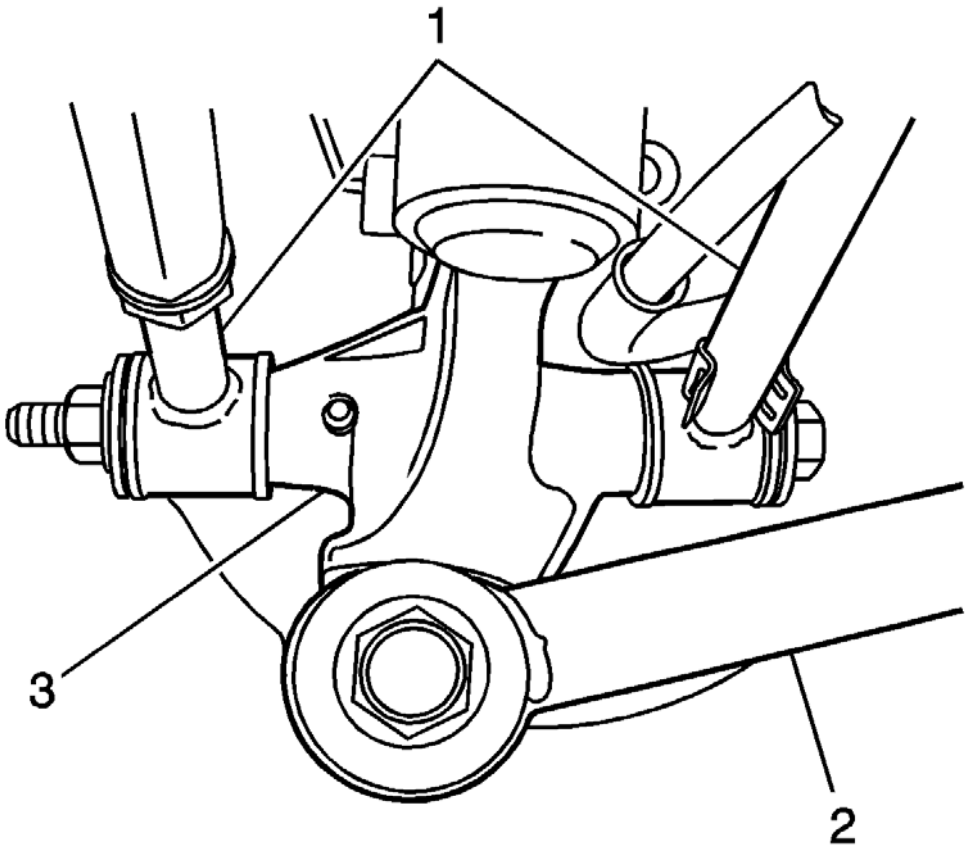


Fig. 11: View Of Trailing Arm & Knuckle
Courtesy of GENERAL MOTORS COMPANY

3. Connect the rear suspension trailing arm (2) to the knuckle (3). Refer to **Trailing Arm Replacement**.

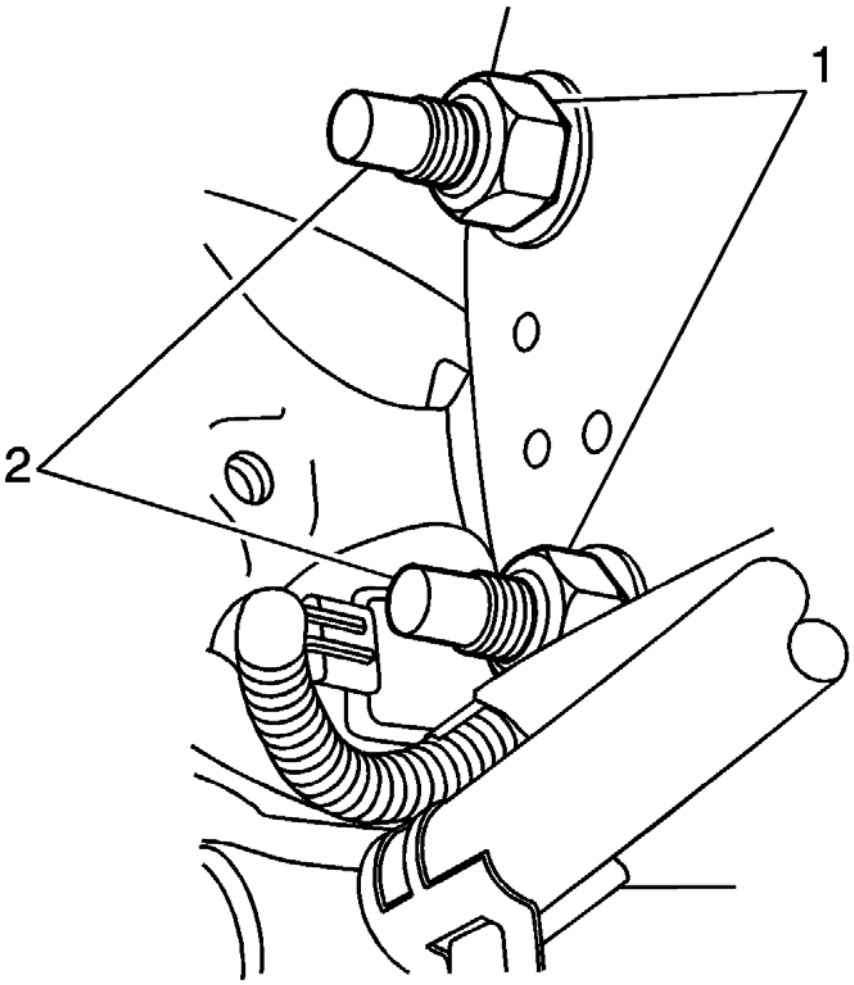


Fig. 12: Rear Strut To Knuckle
Courtesy of GENERAL MOTORS COMPANY

4. Connect the rear wheel spindle rods to the knuckle. Refer to **Rear Wheel Spindle Rod Replacement**.
5. Install the bearing/hub assembly. Refer to **Rear Wheel Bearing and Hub Replacement**.

CAUTION: Refer to Fastener Caution .

6. Tighten the strut to knuckle bolts (2) and nuts (1).

Tighten

Tighten bolts to 120 N.m (89 lb ft).

7. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
8. Remove the support and lower the vehicle.
9. Inspect the rear wheel alignment, adjust if necessary. Refer to **Wheel Alignment Measurement** .

STABILIZER SHAFT REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

2. Remove the tires and wheels. Refer to **Tire and Wheel Removal and Installation** .

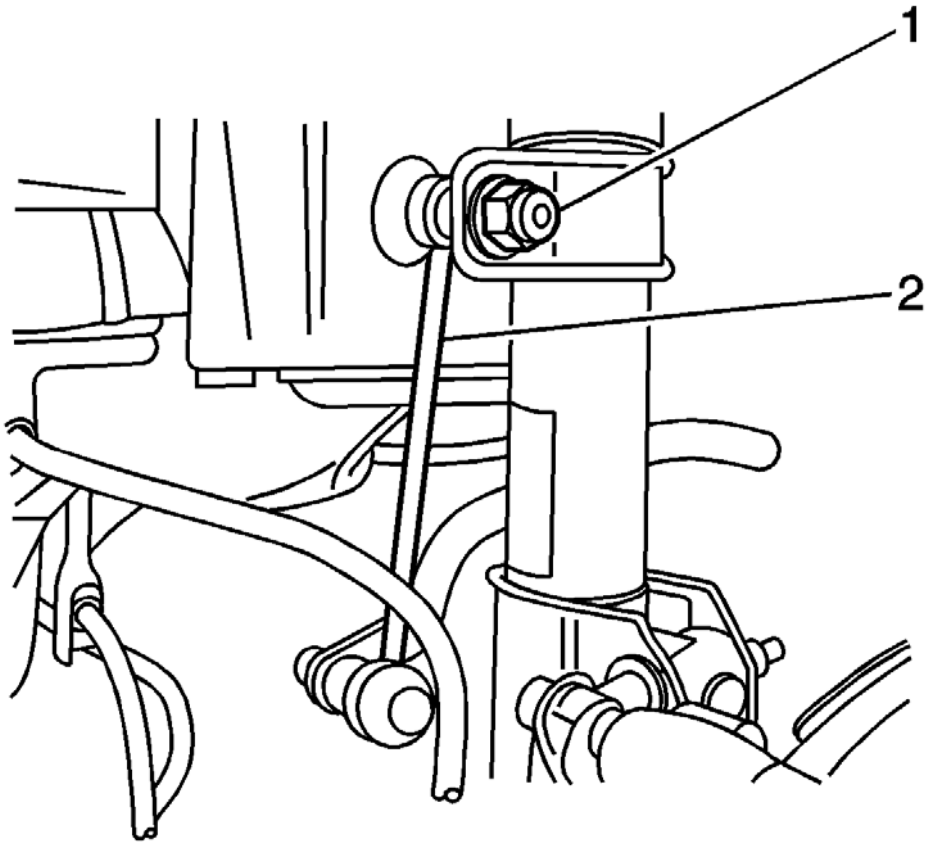


Fig. 13: View Of Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

3. Remove the left and right stabilizer shaft link nuts from the stabilizer shaft links (1).

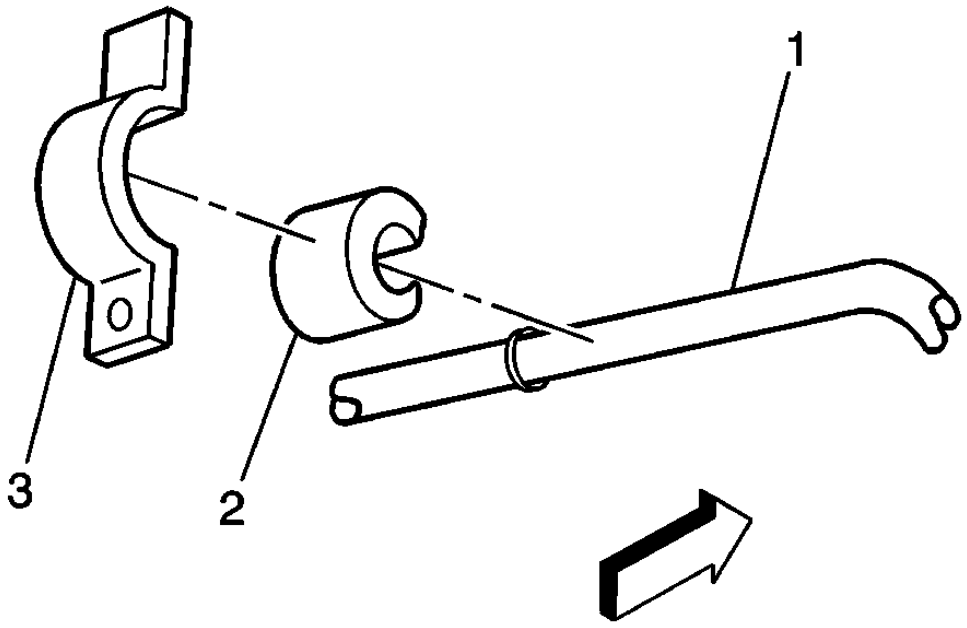


Fig. 14: Stabilizer Shaft, Insulator, & Insulator Bracket
Courtesy of GENERAL MOTORS COMPANY

4. Remove the insulator brackets (3) and the bolts from the stabilizer shaft (1).

NOTE: **If the stabilizer bar has broken, inspect the rear coil springs for witness marks indicating contact. If there is noticeable contact or paint removed , replace the coil spring.**

5. Remove the stabilizer shaft (1) from the rear suspension support.

Installation Procedure

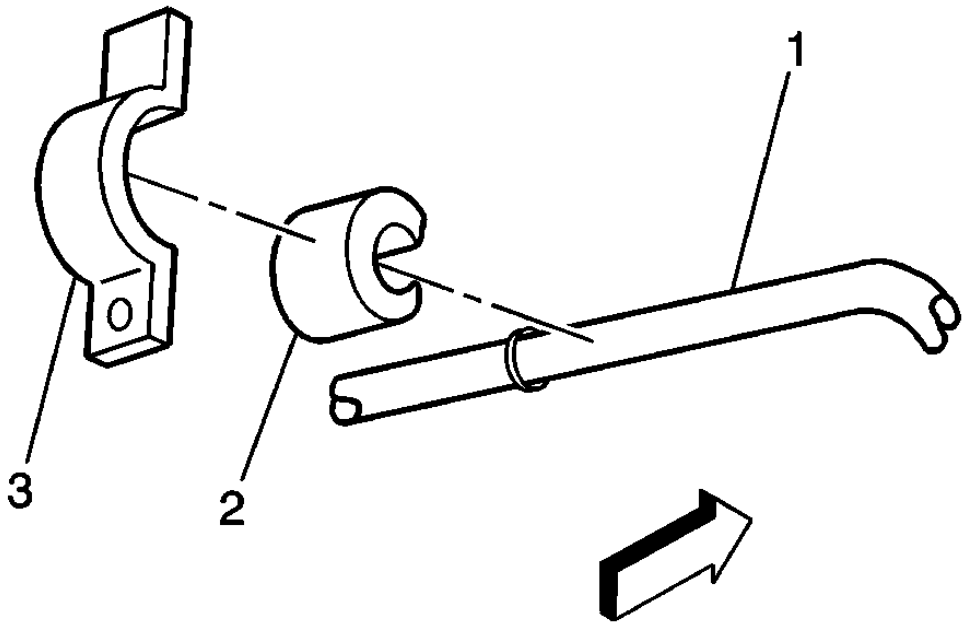


Fig. 15: Stabilizer Shaft, Insulator, & Insulator Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Install the stabilizer shaft (1) to the rear suspension support.
2. Install the stabilizer shaft insulator brackets (3) and hand tighten the bolts. Do not tighten the bolts at this time.

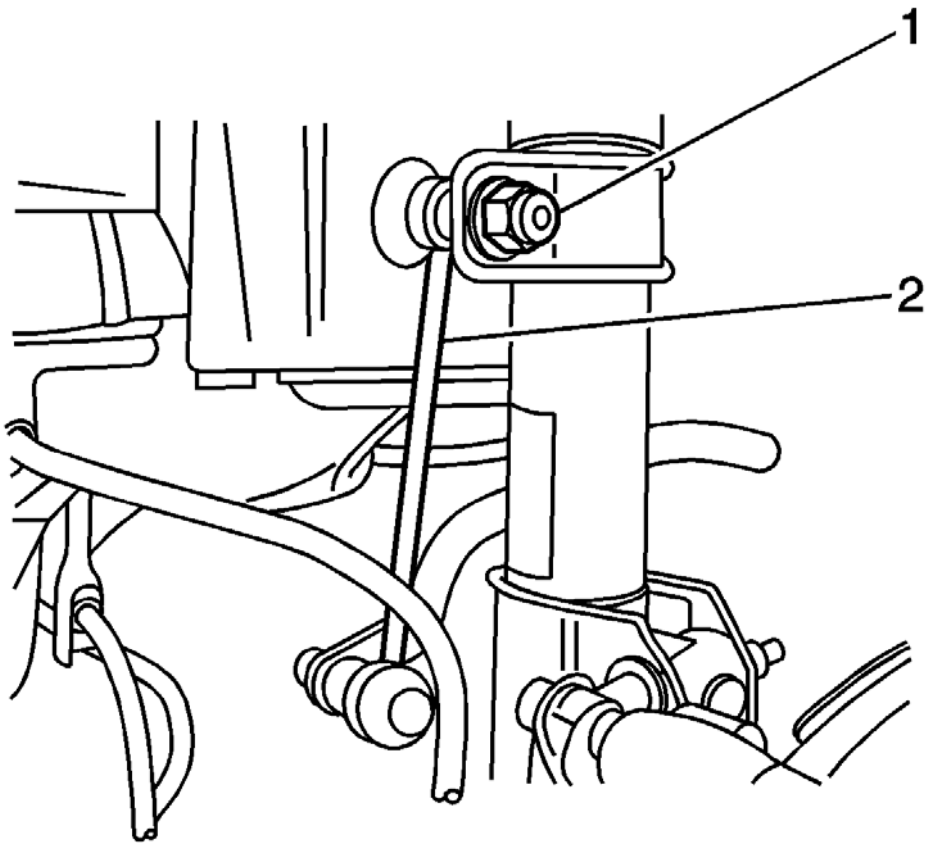


Fig. 16: View Of Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Install the right and left stabilizer shaft link nuts to the stabilizer shaft links (1).

   Tighten

   - Tighten the stabilizer shaft link nuts to 52 N.m (38 lb ft).
   - Tighten the stabilizer shaft insulator bracket nuts to 48 N.m (35 lb ft).
4. Install the tires and wheels. Refer to **Tire and Wheel Removal and Installation** .
5. Lower the vehicle.

STABILIZER SHAFT INSULATOR REPLACEMENT

Removal Procedure

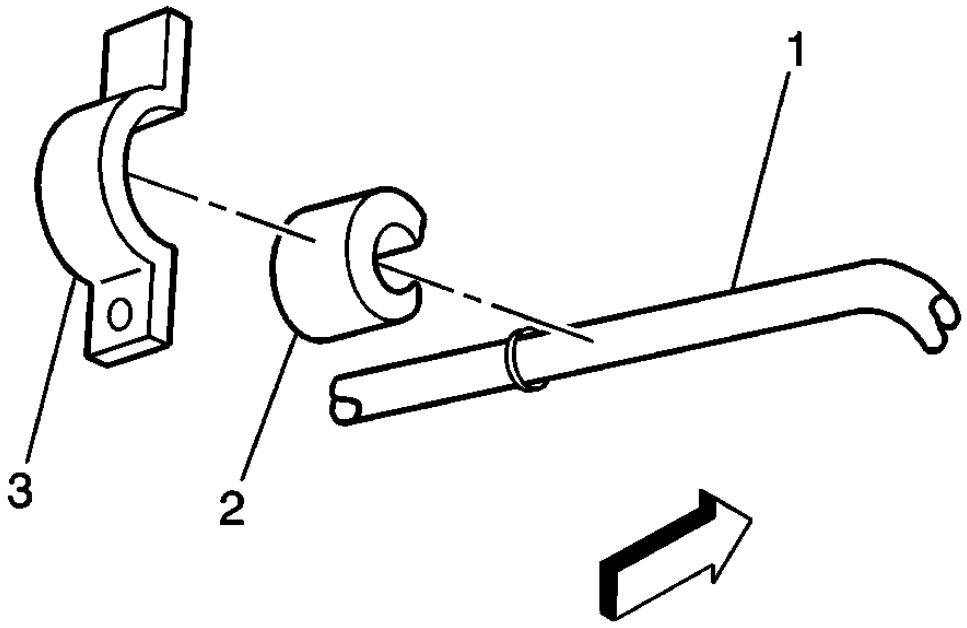


Fig. 17: Stabilizer Shaft, Insulator, & Insulator Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the bolt from the stabilizer shaft insulator bracket (3).
3. Remove the stabilizer shaft insulator bracket.
4. Remove the stabilizer shaft insulator (2) from the stabilizer shaft.

Installation Procedure

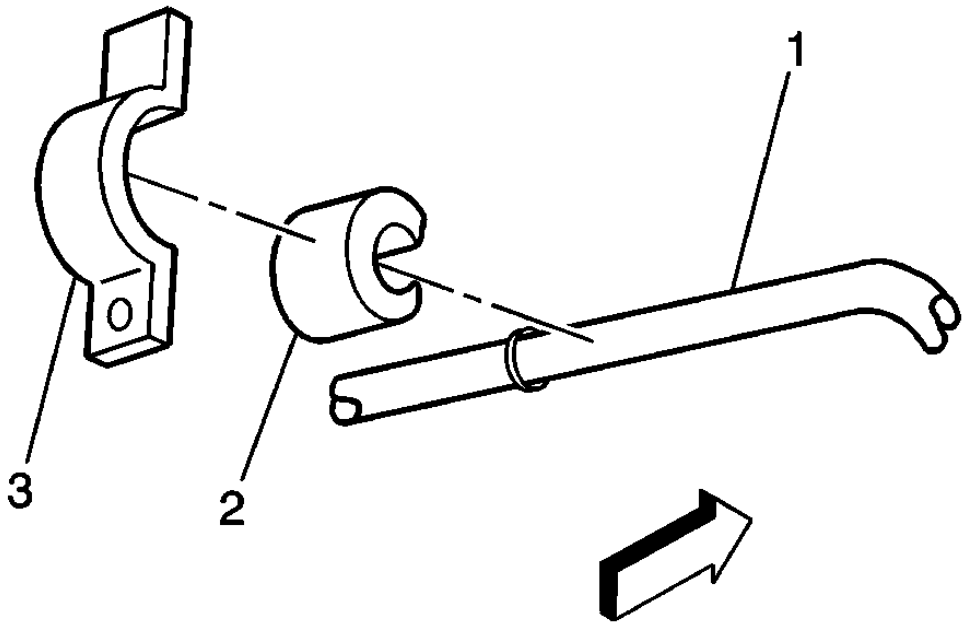


Fig. 18: Stabilizer Shaft, Insulator, & Insulator Bracket
Courtesy of GENERAL MOTORS COMPANY

1. Install the stabilizer shaft insulator (2) to the stabilizer shaft.
2. Install the stabilizer shaft insulator bracket (3).

CAUTION: Refer to Fastener Caution .

3. Install the stabilizer shaft bracket nuts.

Tighten

Tighten the bolts to 48 N.m (35 lb ft).

4. Lower the vehicle.

STABILIZER SHAFT LINK REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

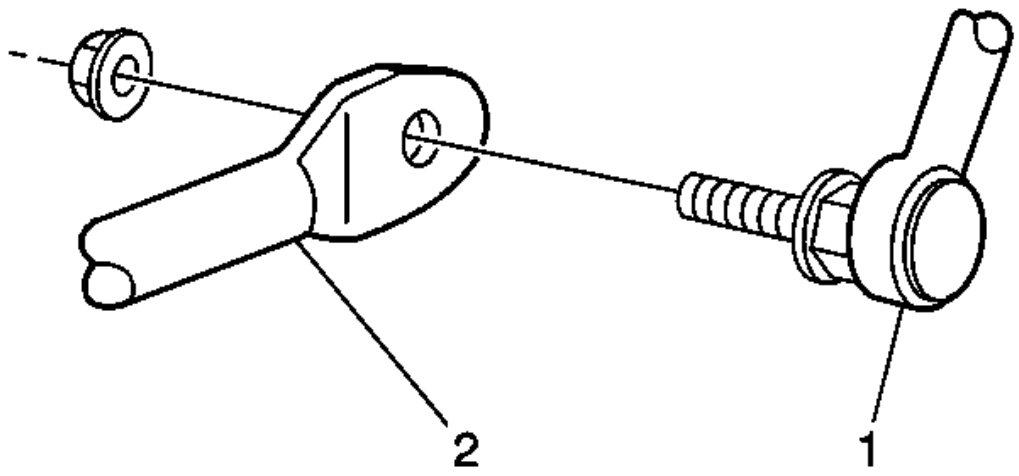


Fig. 19: View Of Stabilizer Shaft And Link
Courtesy of GENERAL MOTORS COMPANY

2. Remove the stabilizer shaft link nut from the stabilizer shaft link (1) and the stabilizer shaft (2).

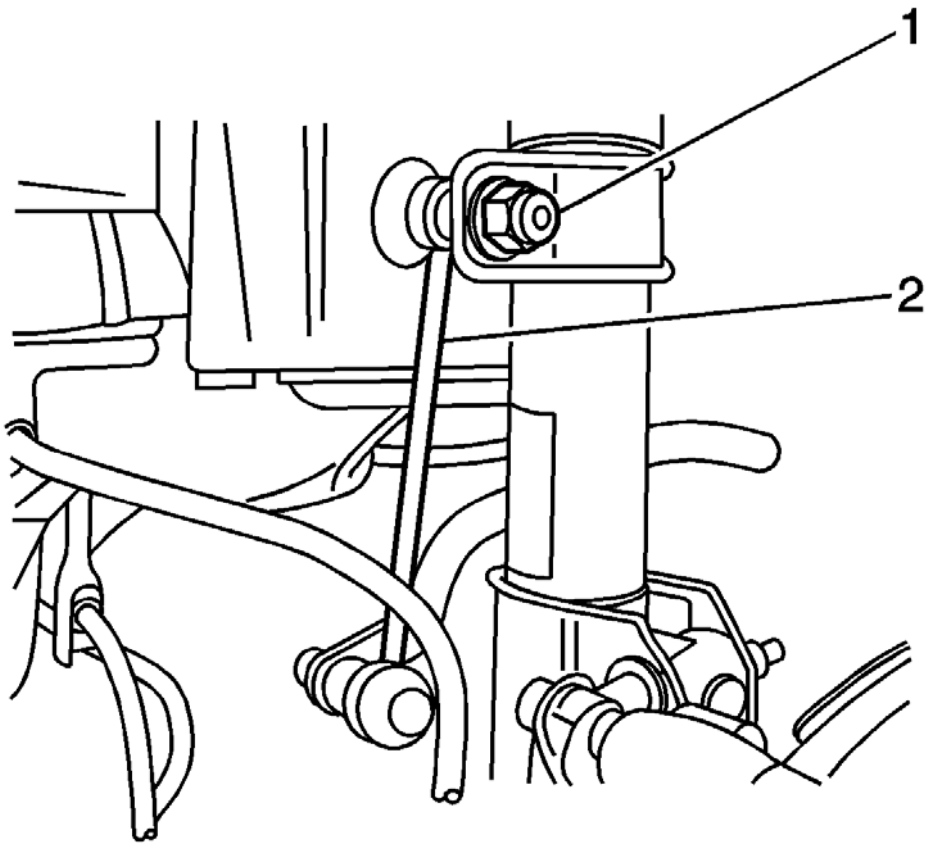


Fig. 20: View Of Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

3. Remove the stabilizer shaft link nut from the stabilizer shaft link (1) and the strut.
4. Remove the stabilizer shaft link (1) from the vehicle.

Installation Procedure

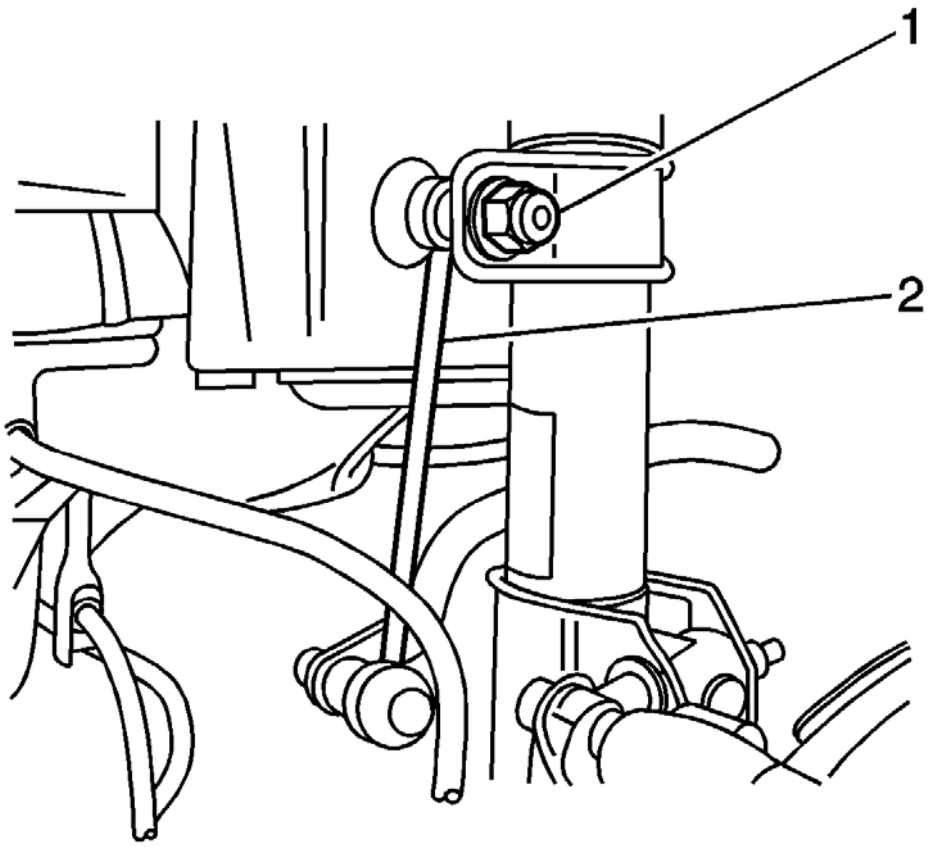


Fig. 21: View Of Stabilizer Shaft Link
Courtesy of GENERAL MOTORS COMPANY

1. Install the stabilizer shaft link (1) to the vehicle.
2. Connect the stabilizer shaft link (1) to the stabilizer shaft (2).

CAUTION: Refer to Fastener Caution .

3. Install the lower stabilizer shaft link nut to the stabilizer shaft link (1) and the stabilizer shaft (2).

Tighten

Tighten the nut to 50 N.m (37 lb ft).

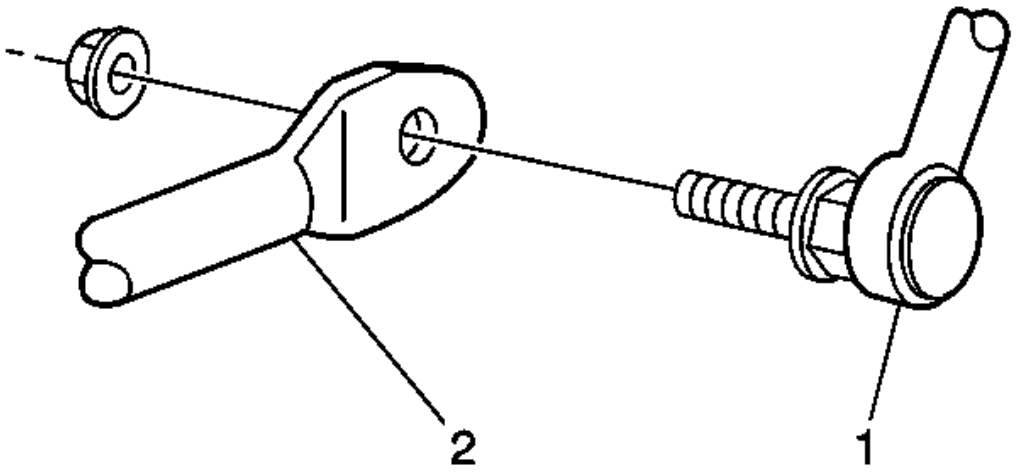


Fig. 22: View Of Stabilizer Shaft And Link
Courtesy of GENERAL MOTORS COMPANY

4. Connect the stabilizer shaft link (1) to the strut.
5. Install the upper stabilizer shaft link nut to the stabilizer shaft link (1) and the strut.

   Tighten

   Tighten the nut to 52 N.m (38 lb ft).

6. Lower the vehicle.

TRAILING ARM REPLACEMENT

Removal Procedure

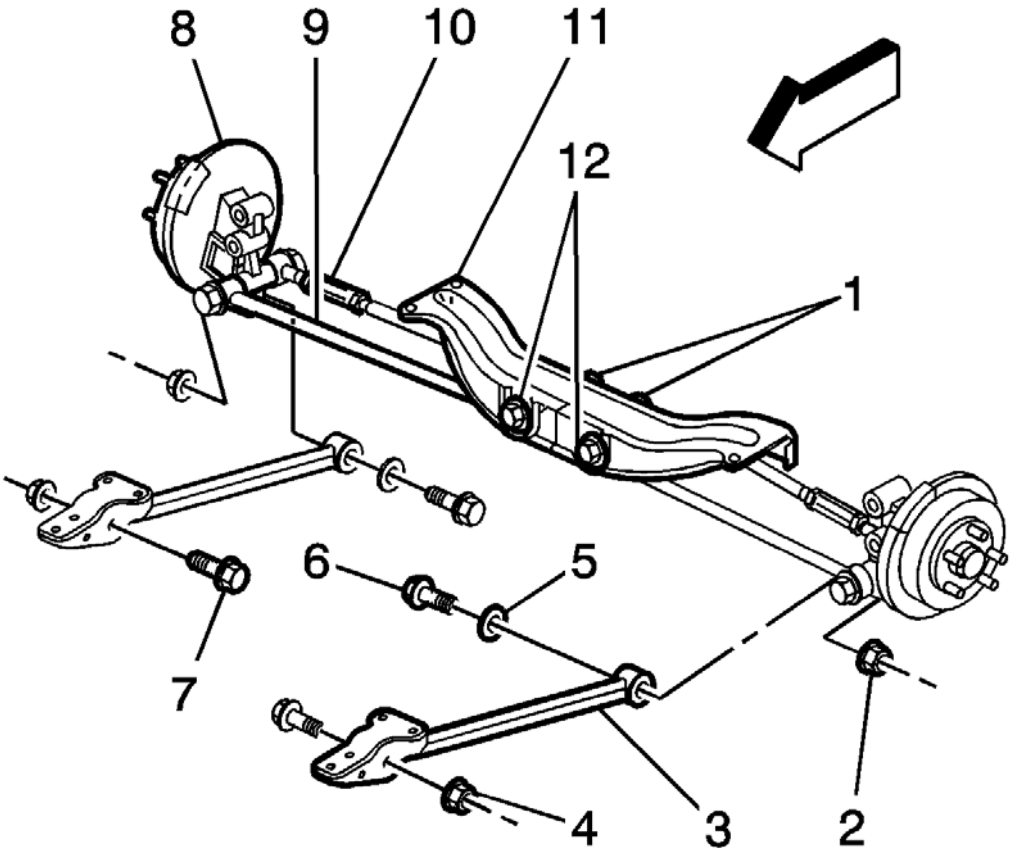


Fig. 23: Rear Suspension
Courtesy of GENERAL MOTORS COMPANY

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the bolt (6) and nut (2) from the trailing arm (3) and the knuckle (8).
3. Remove the nut (4) and bolt (7) from the trailing arm (3) and the trailing arm bracket.
4. Remove the trailing arm (3) from the vehicle.

Installation Procedure

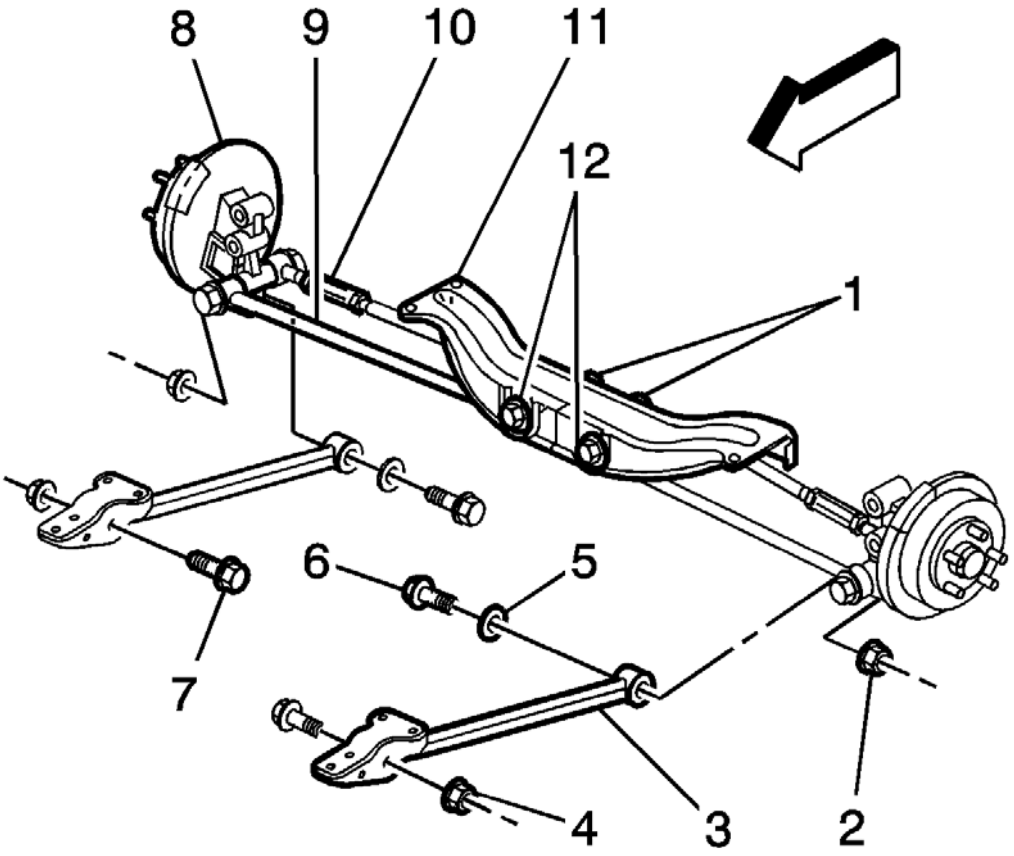


Fig. 24: Rear Suspension
Courtesy of GENERAL MOTORS COMPANY

1. Install the trailing arm (3) to the trailing arm bracket.

CAUTION: Refer to Fastener Caution .

2. Install the bolt (7) and nut (4) to the trailing arm (3) and the trailing arm bracket.

Tighten

Tighten the bolt and nut to 105 N.m (77 lb ft).

3. Install the trailing arm (3) to the knuckle (8).
4. Install the bolt (6) and nut (2) to the trailing arm (3) and the knuckle (8).

Tighten

Tighten the nut to 240 N.m (177 lb ft).

5. Lower the vehicle.

REAR WHEEL SPINDLE ROD REPLACEMENT

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .

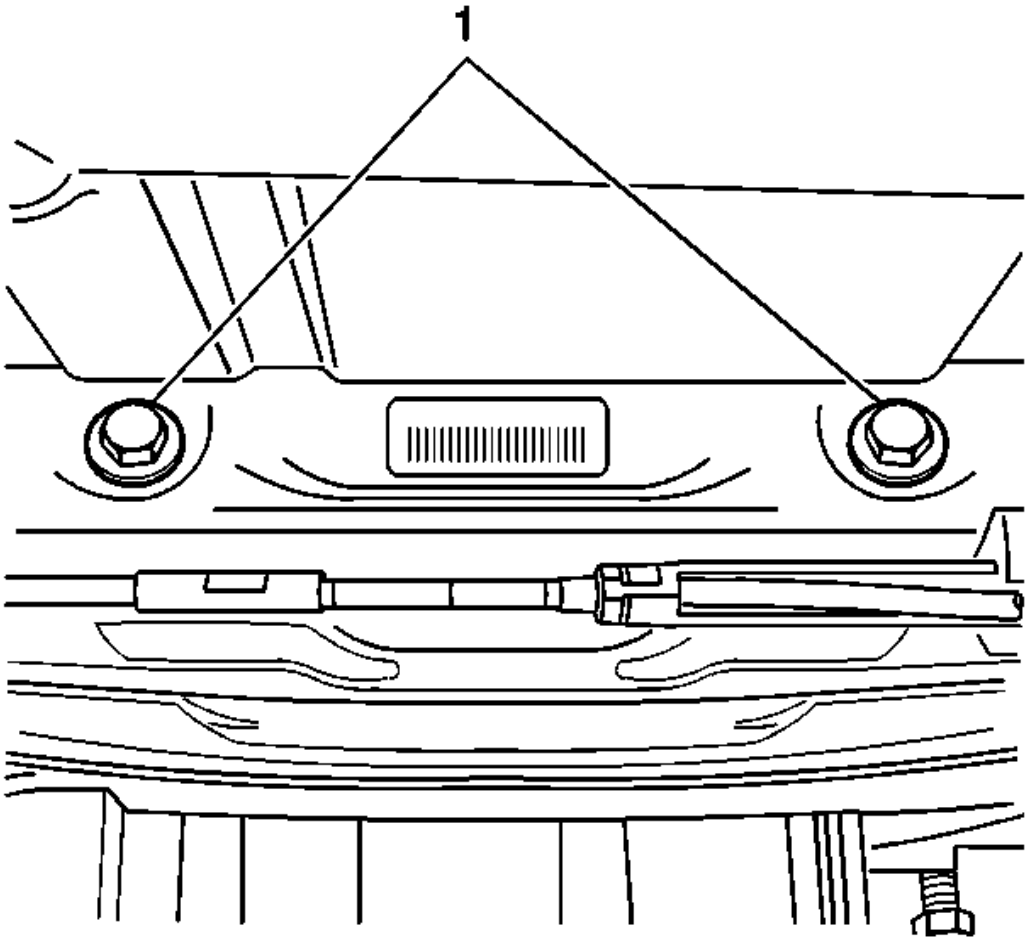


Fig. 25: View Of Spindle Rod And Rear Suspension Support Bolt
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Use a transmission jack or suitable hoist stands to prop the rear suspension support.**

3. Lower the rear suspension support to gain clearance to the spindle rod to knuckle bolt. Refer to **Support Replacement**.
4. Remove the bolt (1) and nut from the spindle rod and the rear suspension support.

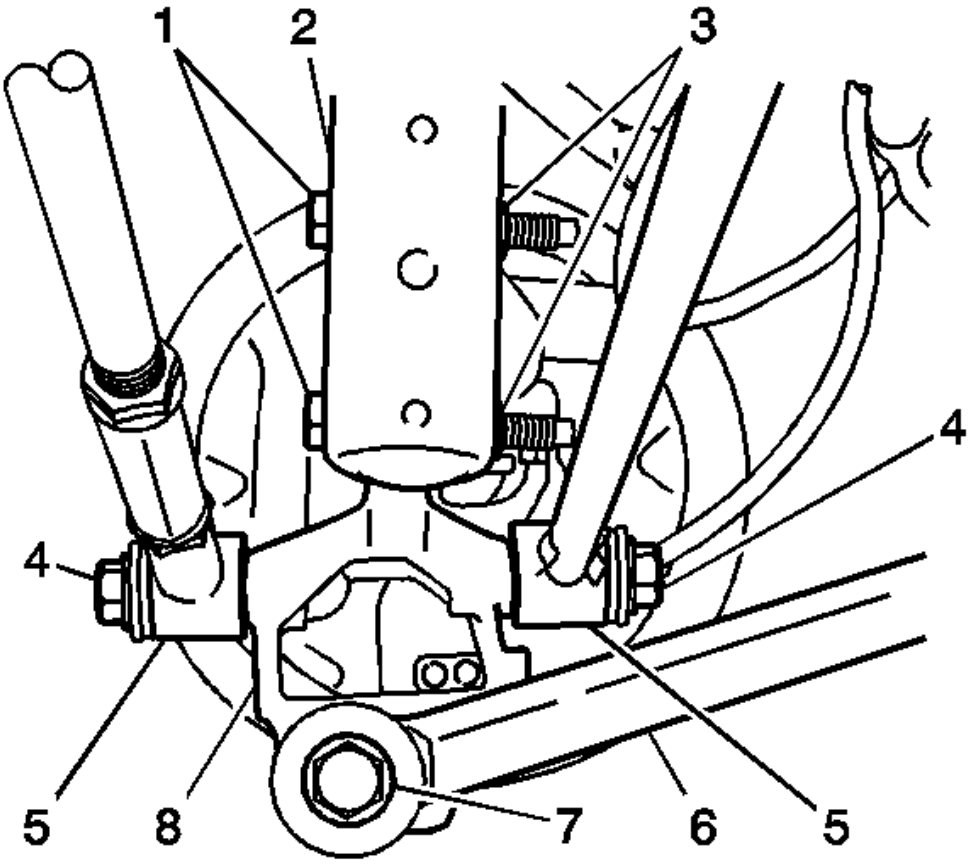


Fig. 26: View Of Spindle Rod, Knuckle, And Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the spindle rod to knuckle bolt (4) and nut.
6. Push the spindle rod to knuckle bolt (4) forward enough to provide clearance for the spindle rod (5) removal.
7. Remove the spindle rod (5) from the vehicle.

Installation Procedure

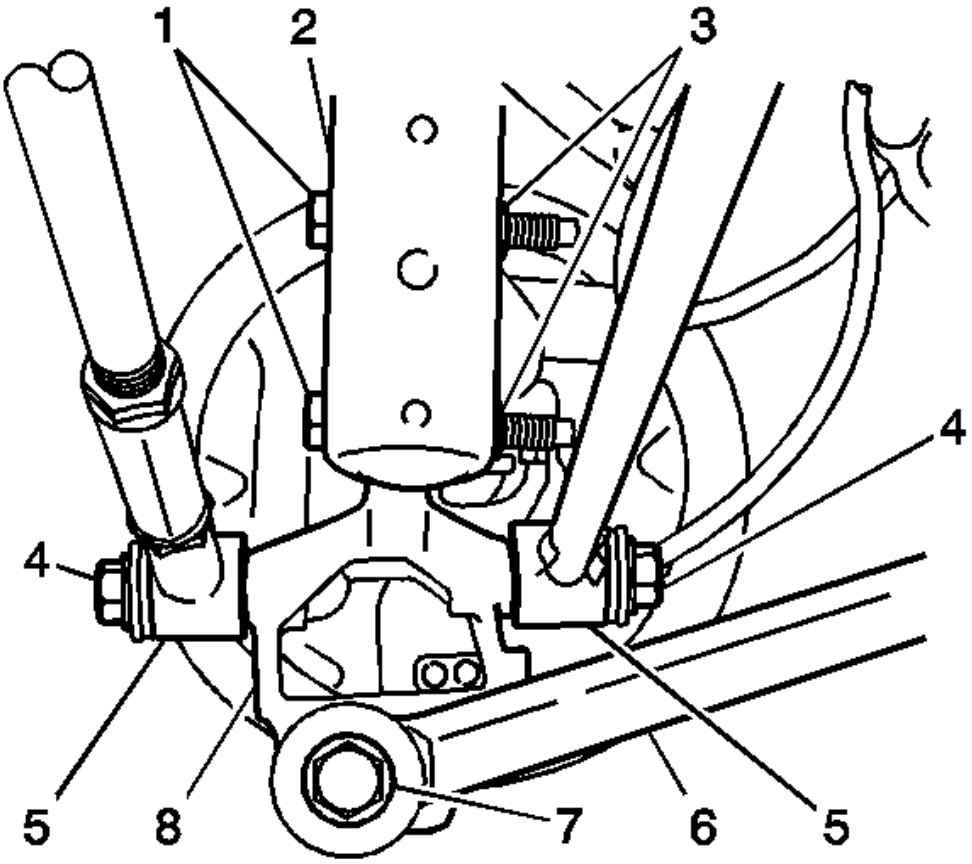


Fig. 27: View Of Spindle Rod, Knuckle, And Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install the spindle rod (5) to the vehicle.
2. Install the spindle rod (5) to the knuckle (8).

CAUTION: Refer to Fastener Caution .

3. Install the spindle rod to knuckle bolt (4) and nut.

Tighten

Tighten the nut to 150 N.m (110 lb ft).

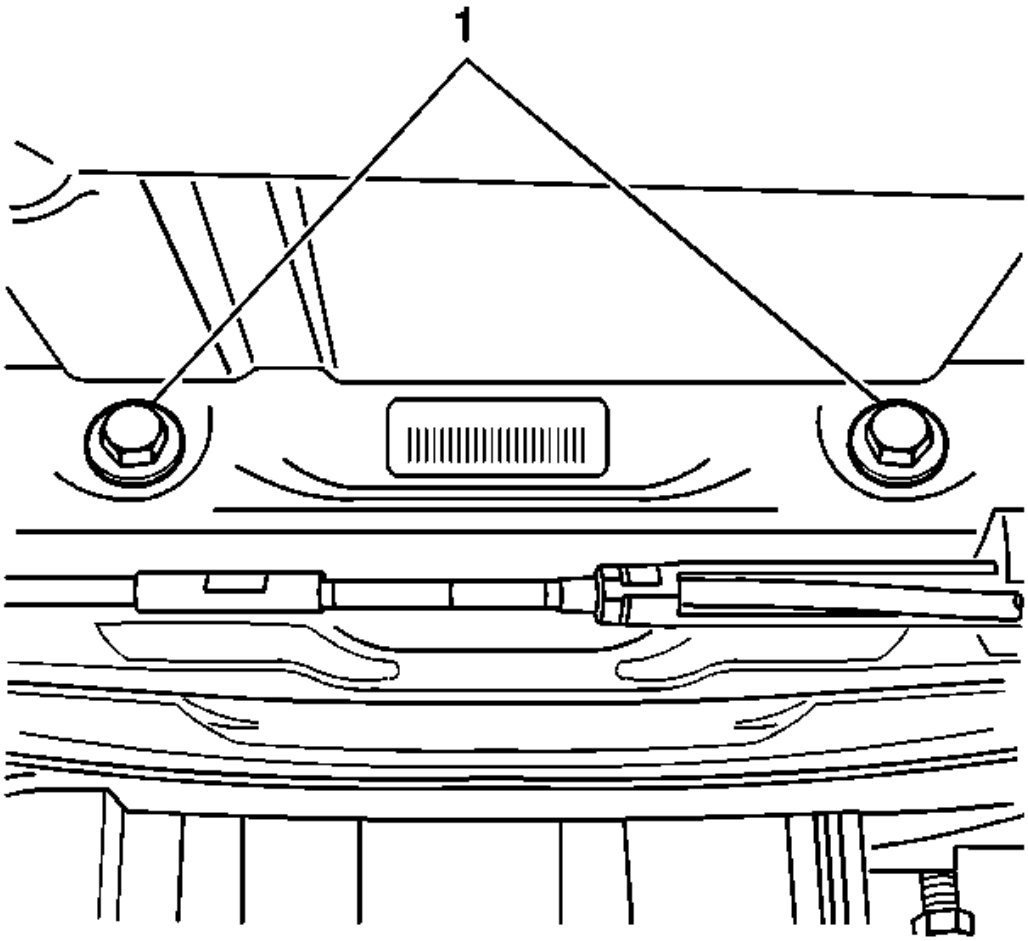


Fig. 28: View Of Spindle Rod And Rear Suspension Support Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install the spindle rod to the rear suspension support.
5. Install the bolt (1) and nut to the rear suspension support.

Tighten

Tighten the bolt to 135 N.m (100 lb ft).

6. Install the rear suspension support. Refer to **Support Replacement**.
7. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
8. Lower the vehicle.
9. Adjust the wheel toe angle. Refer to **Wheel Alignment Specifications** .

STRUT ASSEMBLY REMOVAL AND INSTALLATION

Removal Procedure

CAUTION: Care should be taken to avoid chipping or scratching the coating when handling the suspension coil spring. Damage to the coating can cause premature failure.

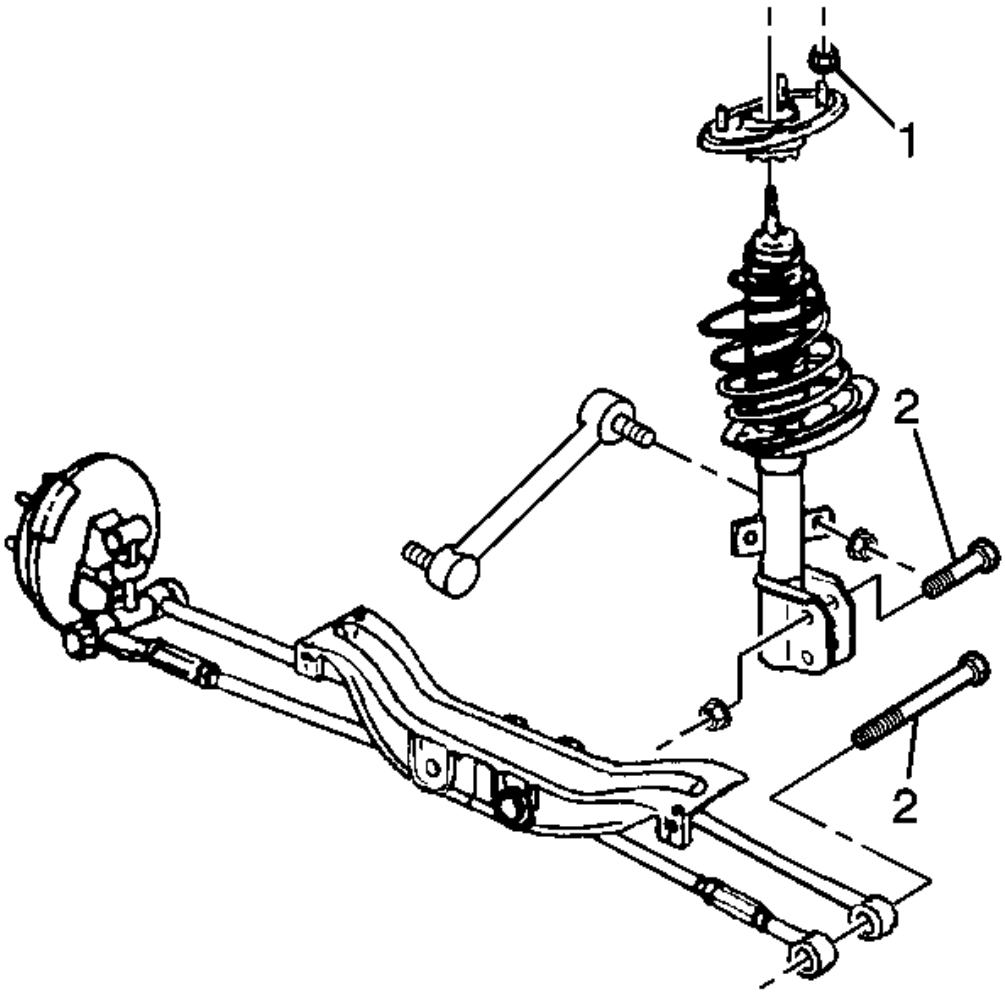


Fig. 29: View Of Strut-To-Body Mount Nuts And Brake Hose Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Remove the strut-to-body mount nuts (1).
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
4. Remove the stabilizer shaft link from the strut. Refer to **Stabilizer Shaft Link Replacement**.
5. Remove the bolt (2) from the brake hose bracket and the strut assembly.

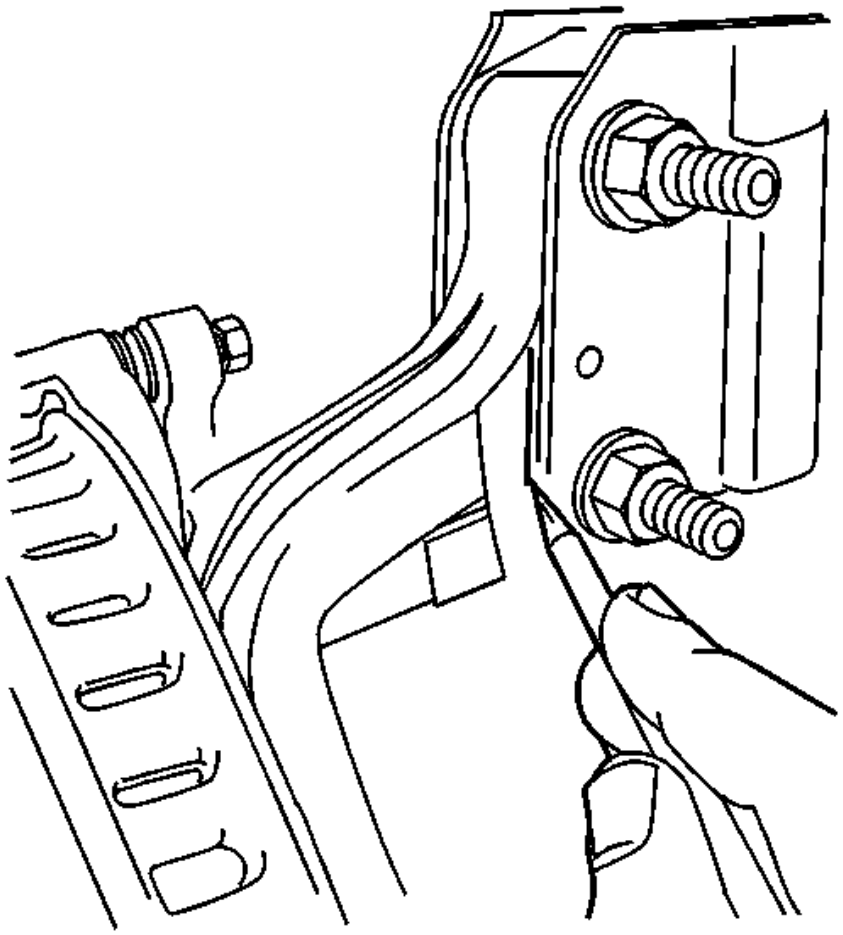


Fig. 30: Scribing Strut To Knuckle
Courtesy of GENERAL MOTORS COMPANY

6. Scribe the strut to the knuckle.

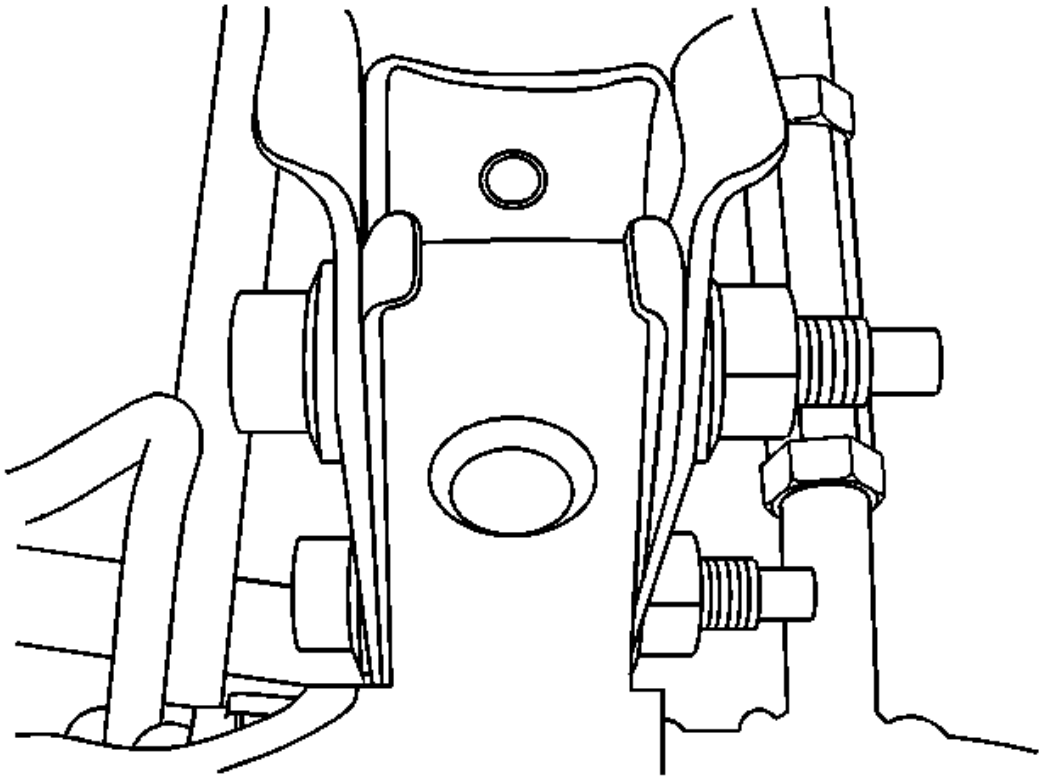


Fig. 31: View Of Strut
Courtesy of GENERAL MOTORS COMPANY

CAUTION: The knuckle must be retained after the strut-to-knuckle bolts have been removed. Failure to observe this may cause ball joint and/or wheel drive shaft damage.

7. Remove the strut to knuckle bolts.
8. Remove the strut from the vehicle.

Installation Procedure

CAUTION: Care should be taken to avoid chipping or scratching the coating when handling the suspension coil spring. Damage to the coating can cause premature failure.

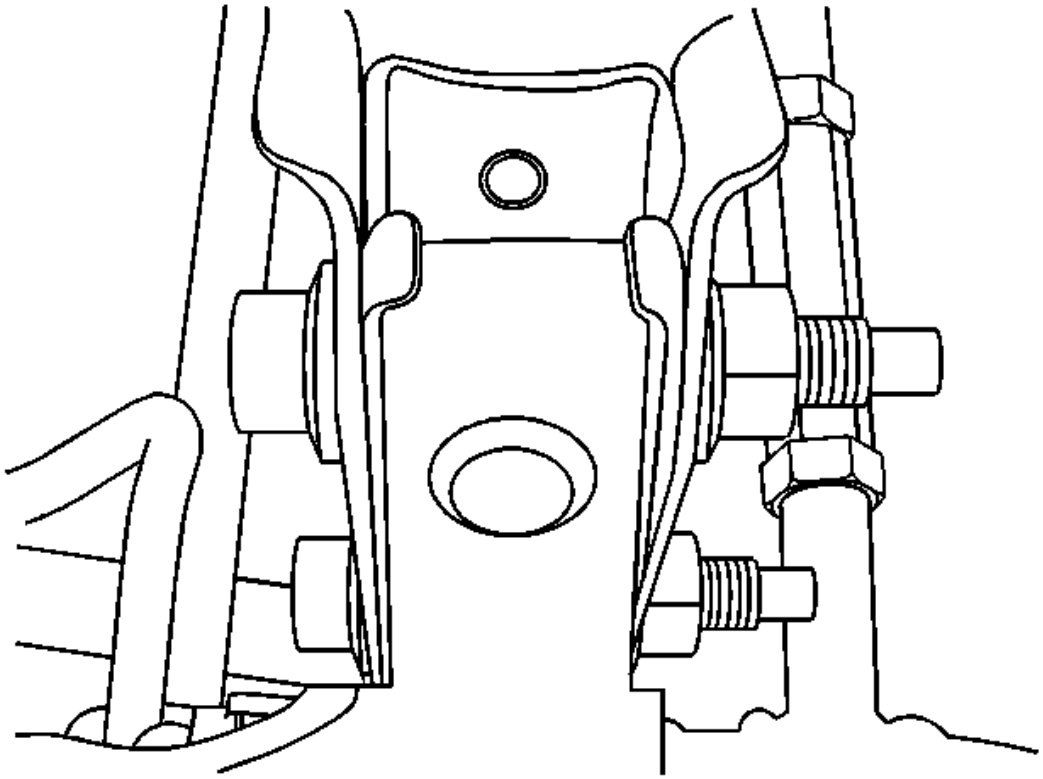


Fig. 32: View Of Strut
Courtesy of GENERAL MOTORS COMPANY

1. Install the strut into place.

CAUTION: Refer to Fastener Caution .

2. Install the strut to knuckle bolts.

Tighten

Tighten the strut to knuckle bolts and nuts to 120 N.m (89 lb ft).

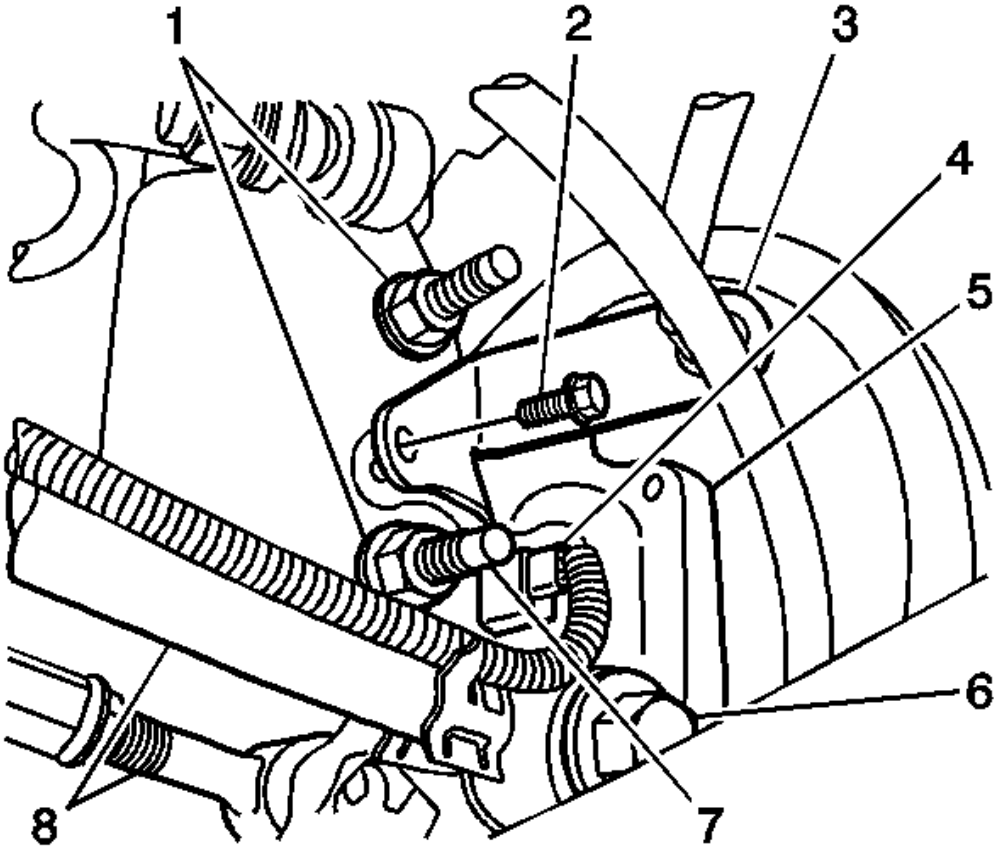


Fig. 33: View Of Brake Hose Bracket And Bolt And Strut Assembly
Courtesy of GENERAL MOTORS COMPANY

3. Install the bolt (2) to the brake hose bracket (3) and the strut assembly.

   Tighten

   Tighten the bolt to 10 N.m (89 lb in).

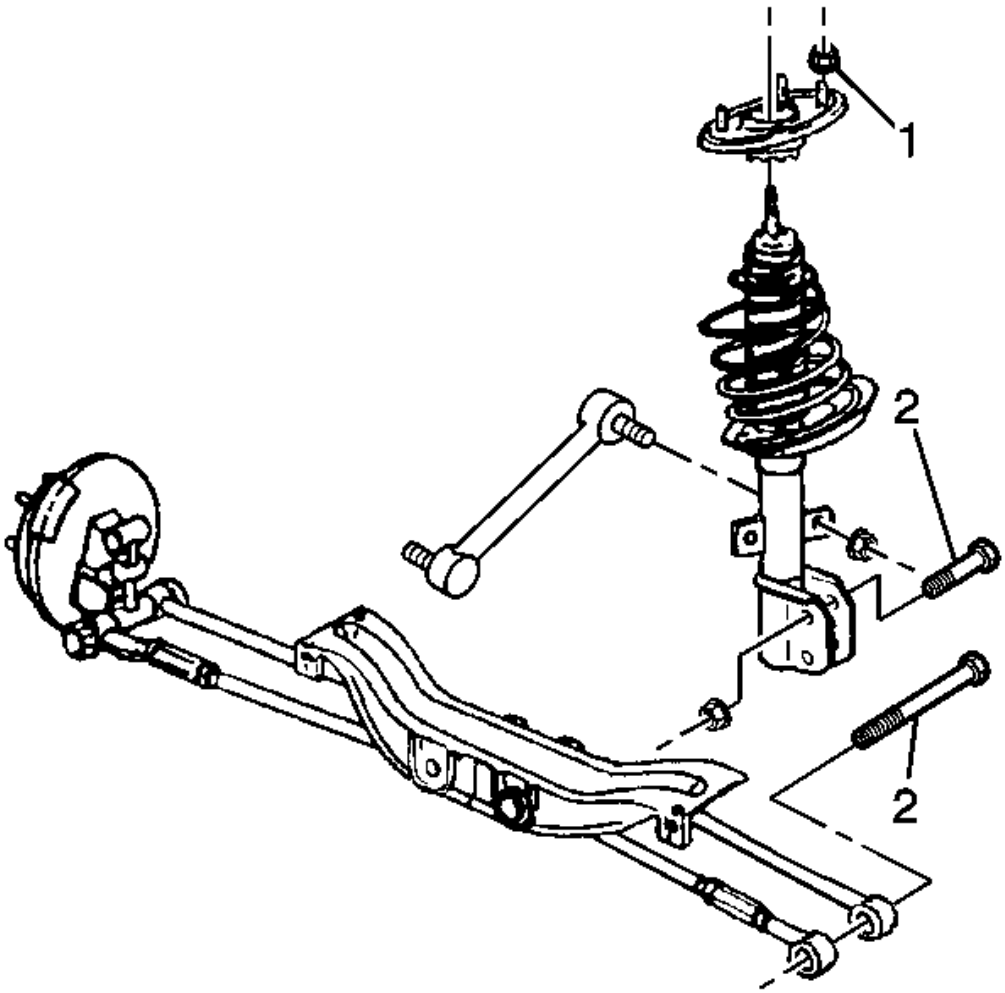


Fig. 34: View Of Strut-To-Body Mount Nuts And Brake Hose Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Connect the stabilizer shaft link to the strut. Refer to **Stabilizer Shaft Link Replacement**.
5. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation** .
6. Install strut to body mount nuts (1).

   Tighten

   Tighten the strut to body mount nuts to 45 N.m (33 lb ft).

7. Lower the vehicle.
8. Adjust the rear wheel alignment. Refer to **Wheel Alignment Specifications** .

SUSPENSION SHOCK/STRUT DISPOSAL

WARNING: Gas charged shock absorbers contain high pressure gas. Do not remove the snap ring from inside the top of the tube. If the snap ring is removed, the contents of the shock absorber will come out with extreme force which may result in personal injury.

WARNING: To prevent personal injury, wear safety glasses when centerpunching and drilling the shock absorber. Use care not to puncture the shock absorber tube with the centerpunch.

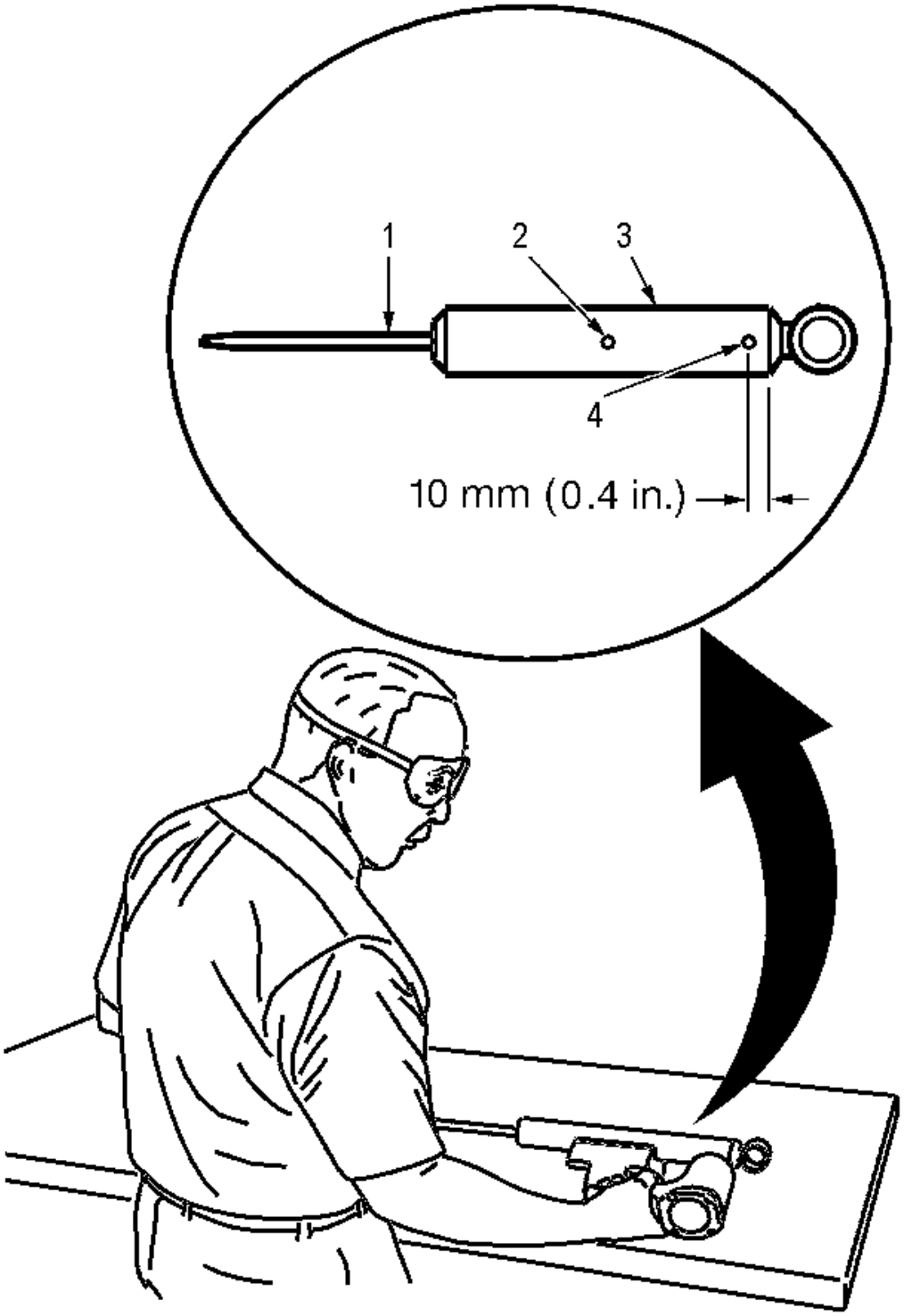


Fig. 35: Drilling Hole In Shock Absorber At Centerpunched Locations
Courtesy of GENERAL MOTORS COMPANY

1. Make an indentation 10 mm (0.4 in) from the bottom (4) of the tube (3) using a centerpunch.
2. Clamp the shock absorber in a vise horizontally with the shock absorber rod (1) completely extended.

3. Drill a hole in the shock absorber at the centerpunch (4) using a 5 mm (3/16 in) drill bit. Gas or a gas/oil mixture will exhaust when the drill bit penetrates the shock absorber. Use shop towels in order to contain the escaping oil.
4. Make an indentation in the middle (2) of the tube (3) with a centerpunch.
5. Drill a second hole in the shock absorber at the centerpunch (2) using a 5 mm (3/16 in) drill bit. Oil will exhaust when the drill bit penetrates the shock absorber. Use shop towels in order to contain the escaping oil.
6. Remove the shock absorber from the vise. Hold the shock absorber over a drain pan horizontally with the holes down. Move the rod (1) in and out of the tube (3) to completely drain the oil from the shock absorber.

STRUT, STRUT COMPONENT, OR SPRING REPLACEMENT

Special Tools

- **J 42991** Strut Rod Nut Socket
- **J 45400** Strut Spring Compressor

Disassembly Procedure

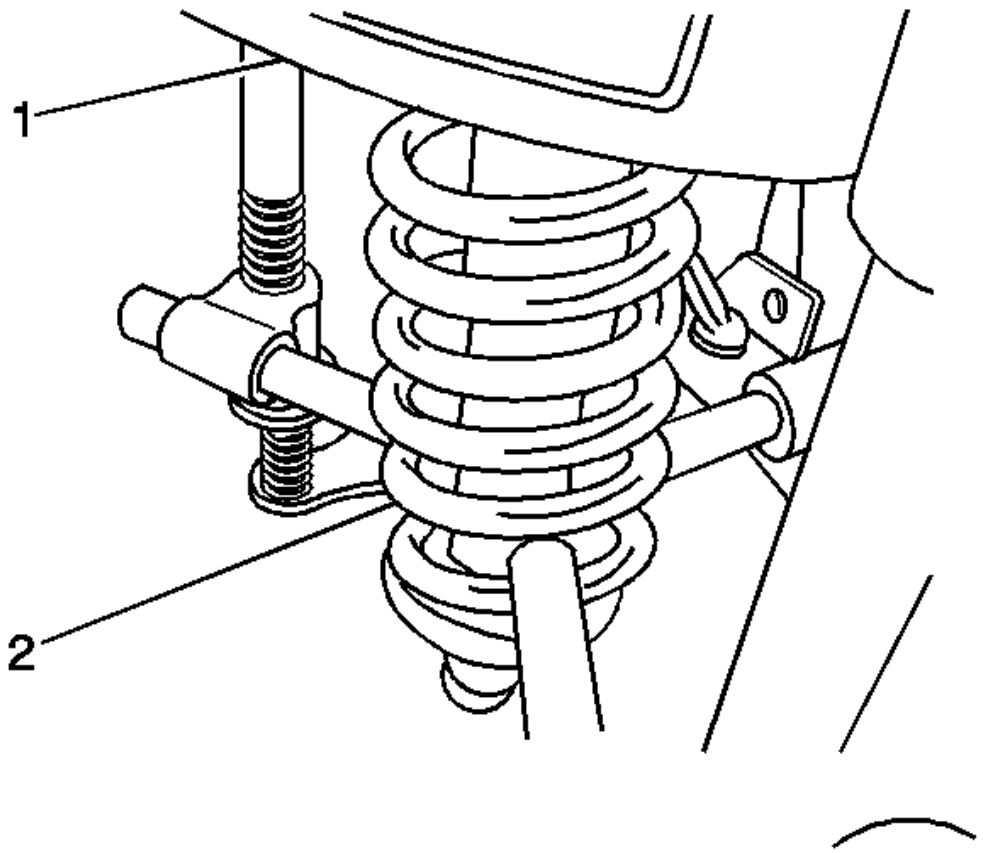


Fig. 36: Compressing/Releasing Lower Part Of Shock Spring
Courtesy of GENERAL MOTORS COMPANY

1. Remove the strut from the vehicle. Refer to **Strut Assembly Removal and Installation**.

2. Install the strut (2) in the **J 45400** Strut Spring Compressor (1).

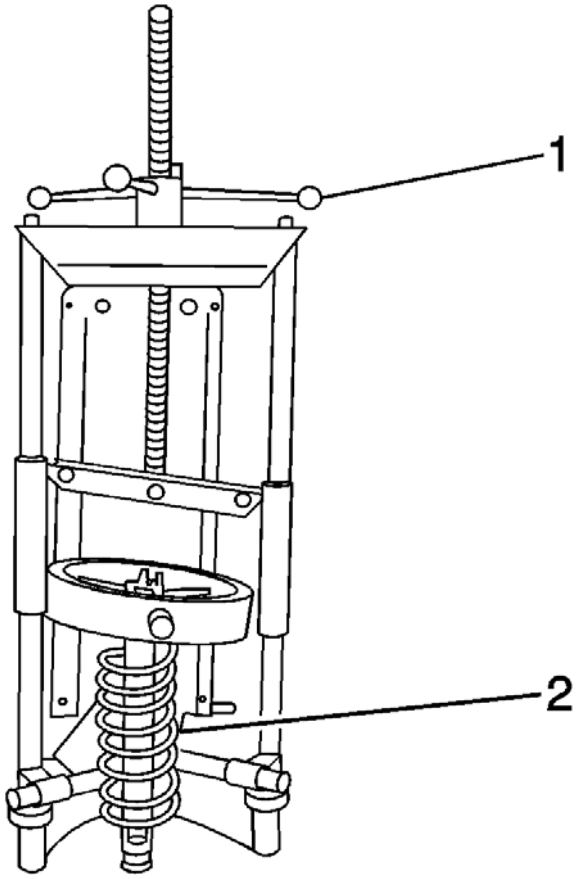


Fig. 37: View Of Compressor Forcing Screw & Coil Spring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The spring is compressed when the strut moves freely.**

3. Turn the spring compressor forcing screw (1) until the coil spring (2) is compressed.

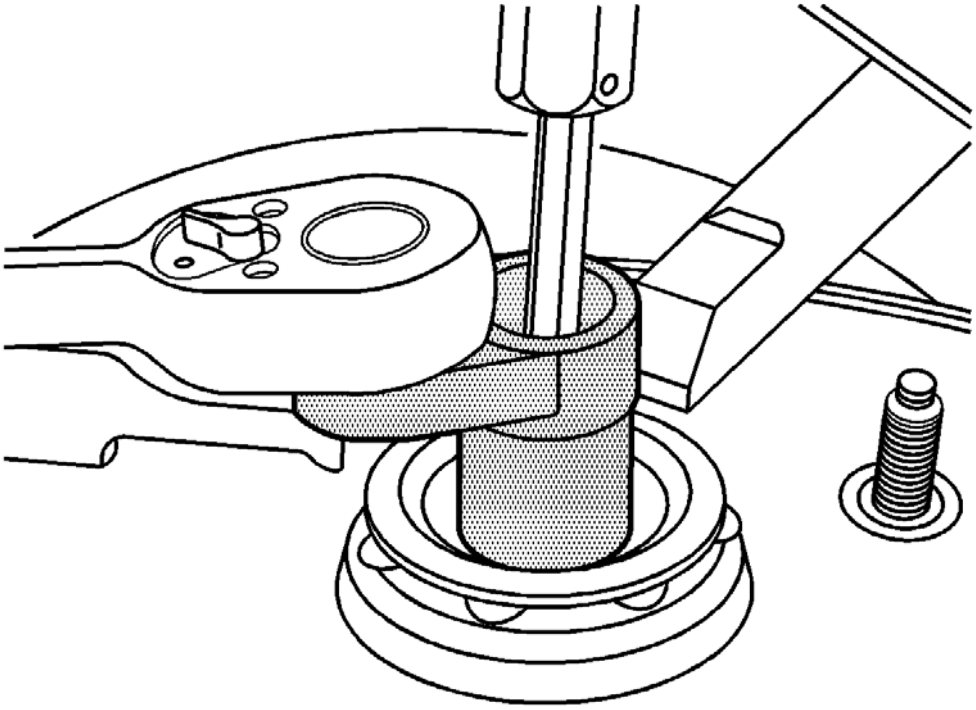


Fig. 38: View Of Special Tools & Strut Shaft
Courtesy of GENERAL MOTORS COMPANY

4. Use a 45 TORXÂ® socket in order to hold the strut shaft. Remove the upper strut mount nut by turning with **J 42991** Strut Rod Nut Socket.
5. Remove the strut from the **J 45400** Strut Spring Compressor.

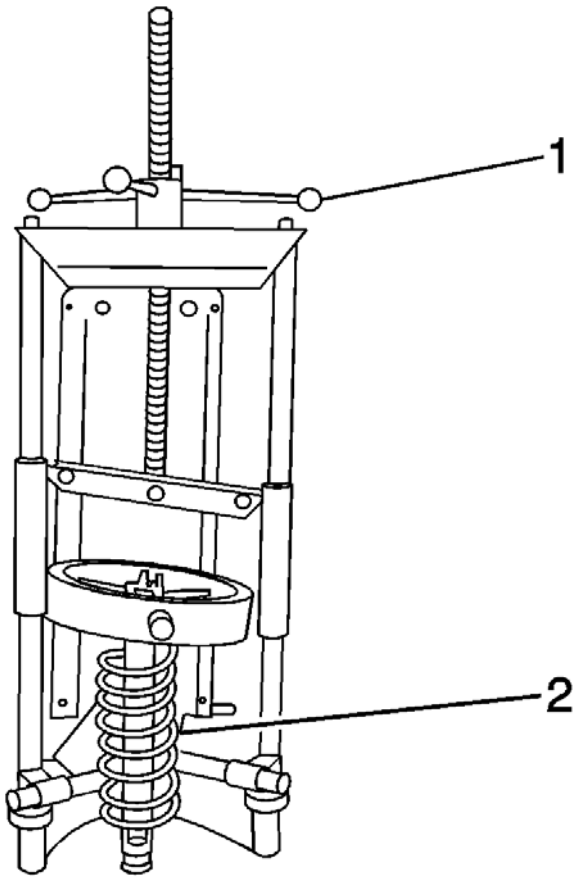


Fig. 39: View Of Compressor Forcing Screw & Coil Spring
Courtesy of GENERAL MOTORS COMPANY

6. Loosen the compressor forcing screw (1) until the upper strut mount and coil spring (2) may be removed.
7. Remove the upper strut mount and the coil spring from the **J 45400** Strut Spring Compressor.

Assembly Procedure

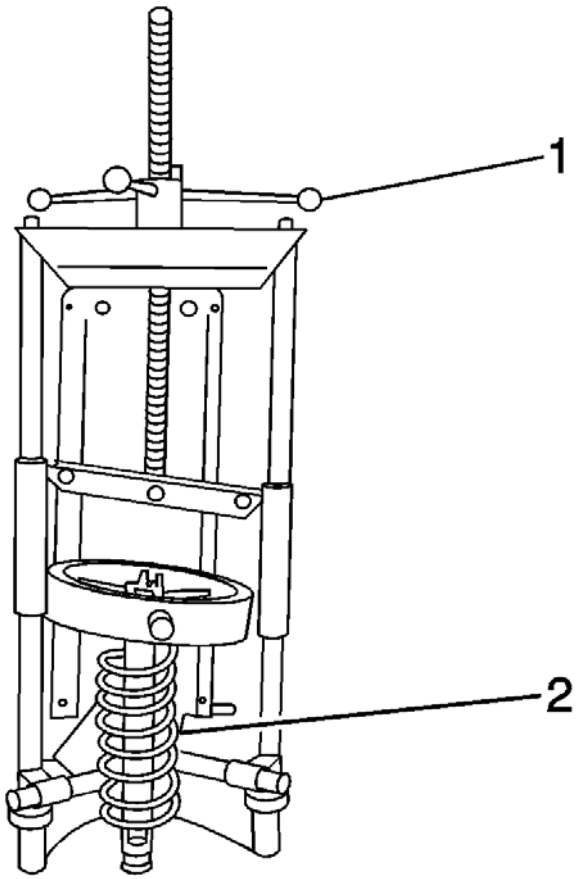


Fig. 40: View Of Compressor Forcing Screw & Coil Spring
Courtesy of GENERAL MOTORS COMPANY

1. Install the coil spring and upper strut mount to the **J 45400** Strut Spring Compressor.
2. Turn the spring compressor forcing screw (1) until the coil spring is compressed.
3. Install the strut to the coil spring and upper strut mount.

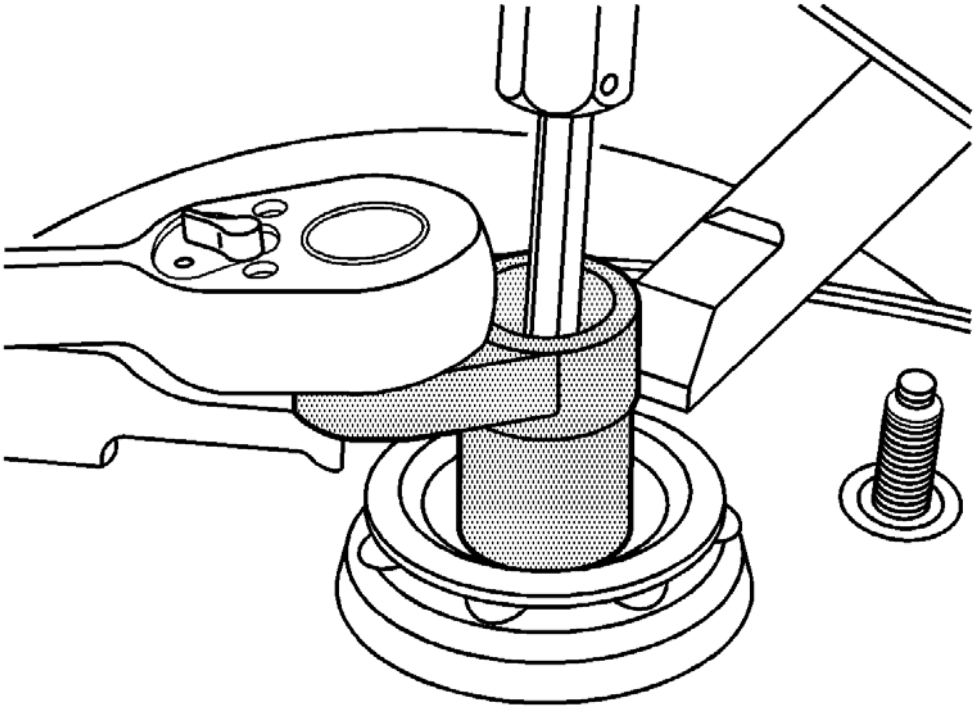


Fig. 41: View Of Special Tools & Strut Shaft
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the strut rod to mount nut.

   Using the **J 42991** Strut Rod Nut Socket and a 45 TORXÂ® socket, tighten the strut mount nut.

   Tighten

   Tighten the strut mount nut to 75 N.m (55 lb ft).

5. Remove the strut from the **J 45400** Strut Spring Compressor.
6. Install the strut to the vehicle. Refer to **Strut Assembly Removal and Installation**.

WHEEL STUD REPLACEMENT

Special Tools

J 6627-A Tie Rod Puller

For regional equivalent tools, refer to **Special Tools**.

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Remove the rear wheel bearing/hub assembly. Refer to **Rear Wheel Bearing and Hub Replacement**.

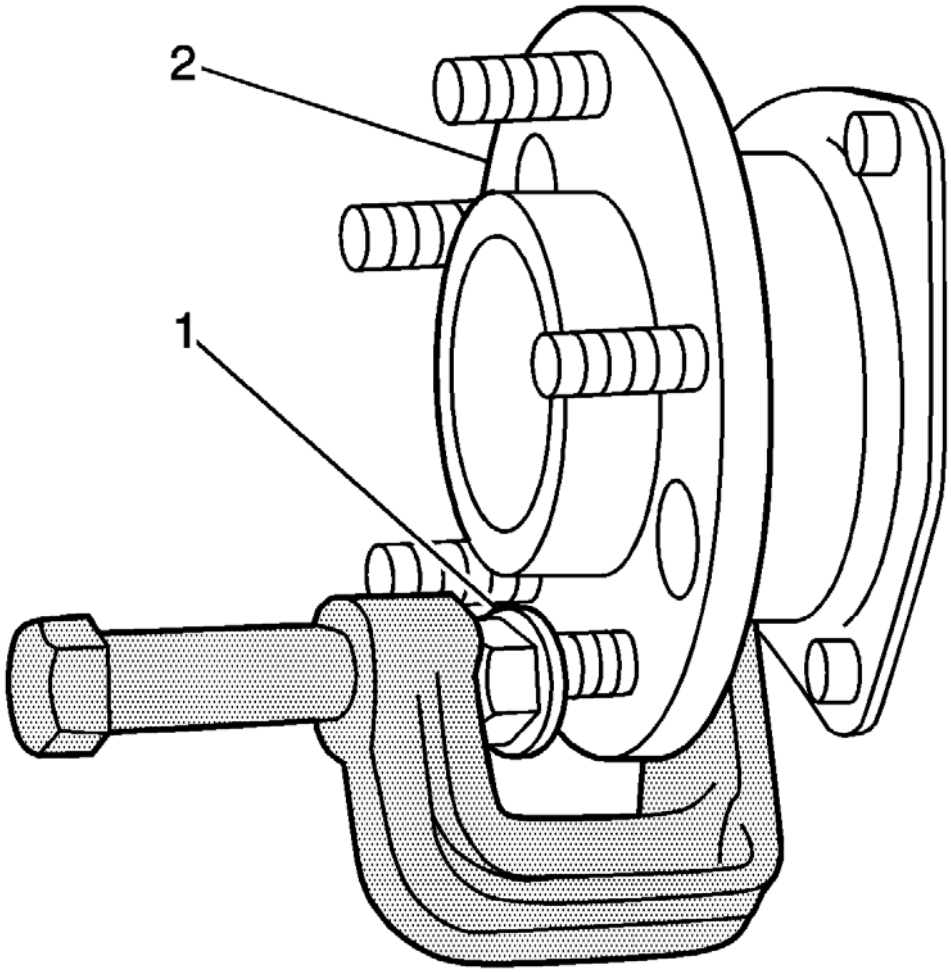


Fig. 42: View Of Stud And Hub
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Insert the wheel bearing/hub in a suitable holding devise.**

4. Using the **J 6627-A** puller (1), remove the wheel stud from the wheel bearing/hub (2).

Installation Procedure

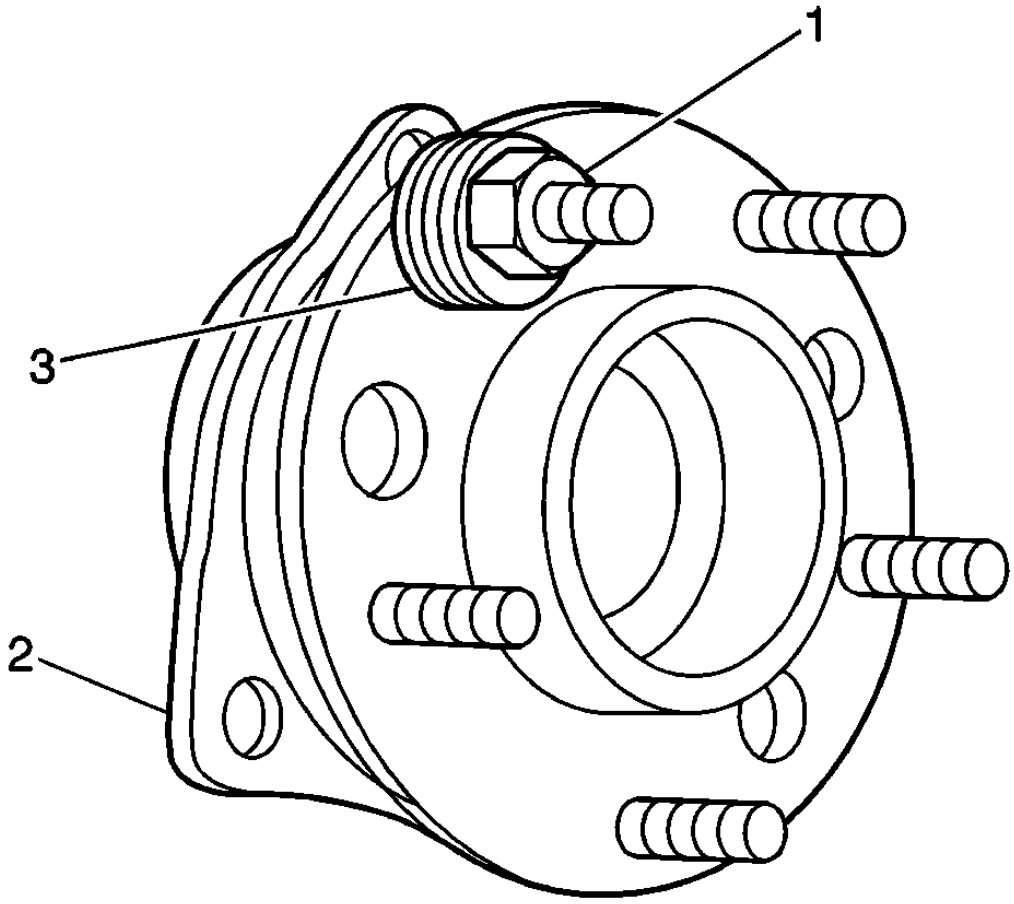


Fig. 43: Installing Wheel Stud
Courtesy of GENERAL MOTORS COMPANY

1. Install a replacement stud in the wheel hub.
2. Add enough washers (3) in order to draw the stud into the hub (2).
3. Install the wheel nut (1) with the flat side against the washers (3).

NOTE: **Fully seat the wheel stud against the hub flange (2).**

4. Tighten the wheel nut (1) until the wheel stud is fully seated against the hub flange.
5. Remove the wheel nut (1) and the washers (3).
6. Install the rear wheel bearing/hub assembly. Refer to **Rear Wheel Bearing and Hub Replacement**.
7. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
8. Lower the vehicle.

DESCRIPTION AND OPERATION

REAR SUSPENSION DESCRIPTION AND OPERATION

The rear suspension utilizes coil springs over struts and light weight aluminum knuckles. Each wheel is mounted to a

tri-link independent suspension system. The 3 links are identified as the inverted U-channel trailing arm and the tubular front and rear rods.

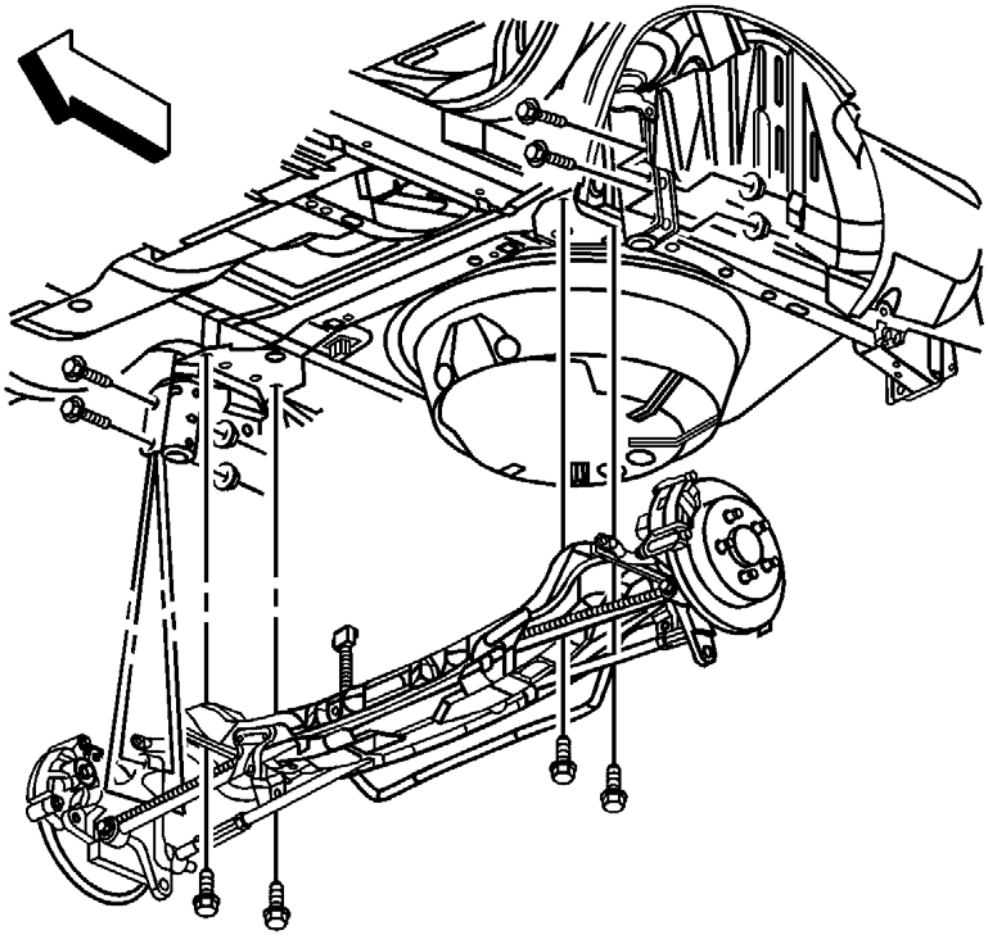


Fig. 44: View Of Rear Suspension
Courtesy of GENERAL MOTORS COMPANY

Parallel links allow the rear wheels to deflect upward when the rear wheels hit a road hazard, without moving the toe angle in a positive direction. An advantage of this suspension system is the reduction of unsprung and overall weight. Handling is improved with the independent action of each rear wheel. The rods control the lateral wheel deflection.

Several techniques are employed to achieve this independent wheel movement. The tri-link design may be compared to a right angle. The wheel is located at the right angle formed by the rods and the trailing arm. The ends of the tri-links hinge in order to provide vertical wheel travel. The solid links force the wheel to travel through a controlled arc whose fore-aft position is determined by the trailing arm, and whose lateral position is determined by the rods.

Aside from maintaining geometric wheel location, each portion of the suspension has additional functions. The knuckle supports the brake caliper. All brake torque and braking forces are transmitted through the tri-links and the strut. The final duty of the rods is to maintain the camber angle of the wheel throughout the wheel's travel, and to allow for setting the toe. The overall result of this rear suspension geometry is to maintain the rear wheels in a near vertical position at all times.

The stabilizer shaft attaches to the stabilizer bar drop link and extends rearward, where the stabilizer connects to the rear suspension support by 2 rubber bushings and mounting brackets.

A non-serviceable unit hub and bearing bolts to the knuckle. This hub and bearing is a sealed, maintenance-free unit.

Check the suspension system periodically for the following conditions:

- Shock absorbency
- Bushing durability
- Tightness of attaching bolts
- Visible damage
- Misalignment
- Excessive wear

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description

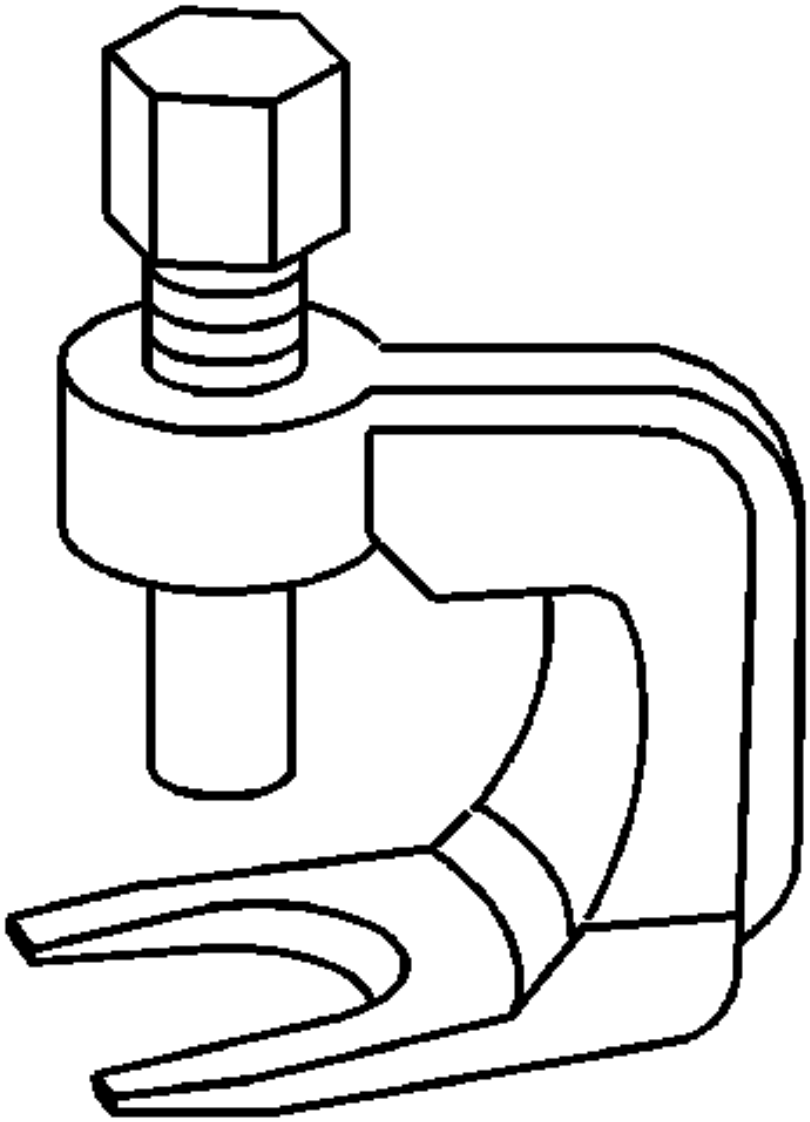
Illustration	Tool Number/Description
	J 6627-A Tie Rod Puller

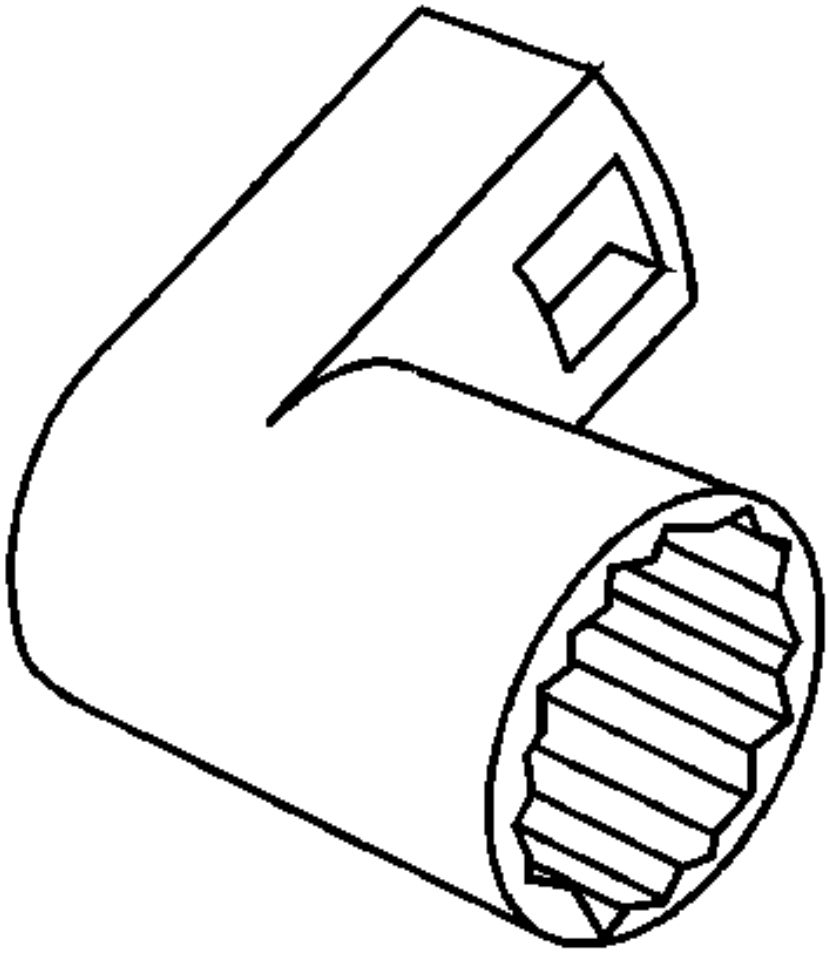
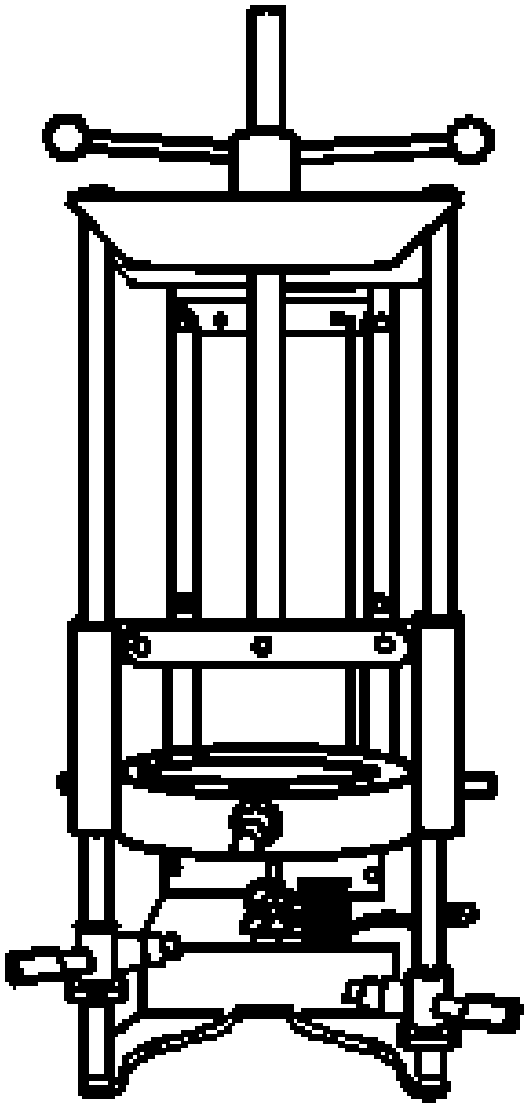
Illustration	Tool Number/Description
	J 42991 Strut Rod Nut Socket

Illustration	Tool Number/Description
	J 45400 Strut Spring Compressor

Article GUID: A00737184

SPECIFICATIONS

TRIM HEIGHT SPECIFICATIONS

RPO	Service Preferred	Cross Tolerance
Z. Trim Height		
• 7B3, QPP & 9C1	63 mm (2.48 in) Â± 10 mm (Â± 0.4 in)	0 Â± 10 mm (Â± 0.4 in)
• 7B3, QPP & 9C3	54 mm (2.12 in) Â± 10 mm (Â± 0.4 in)	0 Â± 10 mm (Â± 0.4 in)
• FE1 & QPX	48 mm (1.89 in) Â± 10 mm (Â± 0.4 in)	0 Â± 10 mm (Â± 0.4 in)
• FE2 & QVS	48 mm (1.89 in) Â± 10 mm (Â± 0.4 in)	0 Â± 10 mm (Â± 0.4 in)
• FE3 & QDG	48 mm (1.89 in) Â± 10 mm (Â± 0.4 in)	0 Â± 10 mm (Â± 0.4 in)
D Trim Height		
• 7B3, QPP & 9C1	277 mm (10.91 in) Â± 10 mm (Â± 0.4 in)	0 Â± 10 mm (Â± 0.4 in)
• 7B3, QPP & 9C3	277 mm (10.91 in) Â± 10 mm (Â± 0.4 in)	0 Â± 10 mm (Â± 0.4 in)
• FE1 & QPX	279 mm (10.98 in) Â± 10 mm (Â± 0.4 in)	0 Â± 10 mm (Â± 0.4 in)
• FE2 & QVS	279 mm (10.98 in) Â± 10 mm (Â± 0.4 in)	0 Â± 10 mm (Â± 0.4 in)
• FE3 & QDG	268 mm (10.55 in) Â± 10 mm (Â± 0.4 in)	0 Â± 10 mm (Â± 0.4 in)
P Trim Height		
• 7B3, QPP & 9C1	753 mm (29.65 in) Â± 12 mm (Â± 0.5 in)	0 Â± 12 mm (Â± 0.5 in)
• 7B3, QPP & 9C3	742 mm (29.21 in) Â± 12 mm (Â± 0.5 in)	0 Â± 12 mm (Â± 0.5 in)
• FE1 & QPX	734 mm (28.90 in) Â± 12 mm (Â± 0.5 in)	0 Â± 12 mm (Â± 0.5 in)
• FE2 & QVS	736 mm (28.97 in) Â± 12 mm (Â± 0.5 in)	0 Â± 12 mm (Â± 0.5 in)
• FE3 & QDG	744 mm (29.29 in) Â± 12 mm (Â± 0.5 in)	0 Â± 12 mm (Â± 0.5 in)
R Trim Height		
• 7B3, QPP & 9C1	733 mm (28.86 in) Â± 12 mm (Â± 0.5 in)	0 Â± 12 mm (Â± 0.5 in)

RPO	Service Preferred	Cross Tolerance
• 7B3, QPP & 9C3	733 mm (28.86 in) Â± 12 mm (Â± 0.5 in)	0 Â± 12 mm (Â± 0.5 in)
• FE1 & QPX	732 mm (28.82 in) Â± 12 mm (Â± 0.5 in)	0 Â± 12 mm (Â± 0.5 in)
• FE2 & QVS	735 mm (28.94 in) Â± 12 mm (Â± 0.5 in)	0 Â± 12 mm (Â± 0.5 in)
• FE3 & QDG	730 mm (28.74 in) Â± 12 mm (Â± 0.5 in)	0 Â± 12 mm (Â± 0.5 in)

DIAGNOSTIC INFORMATION AND PROCEDURES

SYMPTOMS - SUSPENSION GENERAL DIAGNOSIS

IMPORTANT: The following steps must be completed before using the symptom tables.

1. Determine whether the vehicle is equipped with an electrically assisted or active suspension system. Perform electrical diagnosis prior to beginning mechanical diagnosis.
2. Review the system description and operation in order to familiarize yourself with the system functions. Refer to the appropriate description and operation:
   - **Front Suspension Description and Operation**
   - **Rear Suspension Description and Operation**
   - **General Description**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of any of the Suspension subsystems.
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.
- Inspect for proper tire size and inflation pressure. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Ride Diagnosis**
- **Vehicle Leads/Pulls**
- **Body Leans or Sways in Corners**
- **Suspension Bottoms**
- **Torque Steer**
- **Memory Steer**
- **Noise Diagnosis - Front Suspension**
- **Noise Diagnosis - Rear Suspension**
- **Suspension Strut and Shock Absorber Testing - On Vehicle**
- **Wheel Bearings Diagnosis**

- **Radial Tire Lead/Pull Correction**

RIDE DIAGNOSIS

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Suspension General Diagnosis**
2	IMPORTANT: Verify the vehicle suspension package RPO. Verify that the ride is too soft or too hard.Does the vehicle ride normally?	System OK	Go to **Step 3**
3	Check the tire inflation and adjust to specifications. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** . Did you adjust the tire pressure?	Go to **Step 6**	Go to **Step 4**
4	Inspect the vehicle trim height. Refer to **Trim Height Inspection**. Did you find and correct the condition?	Go to **Step 6**	Go to **Step 5**
5	Inspect the following suspension components for wear or damage: • Shock Absorbers-Refer to **Suspension Strut and Shock Absorber Testing - On Vehicle**. • Springs Did you find and correct the condition?	Go to **Step 6**	-
6	Drive the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

VEHICLE LEADS/PULLS

Step	Action	Yes	No
DEFINITION: At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle straight path.			
1	Did you review the General Description and perform the visual/physical inspections?	Go to **Step 2**	Go to **Symptoms - Suspension General Diagnosis**
2	Road test the vehicle in order to verify the complaint. Does the vehicle operate normally?	System OK	Go to **Step 3**
3	Inspect the tire/wheel assemblies for: • Correct tire pressure-Refer to the tire placard. • Correct tire size-Refer to the tire placard. • Abnormal tire wear or damage	Go to **Step 9**	Go to **Step 4**

Step	Action	Yes	No
	Did you find and correct the condition?		
4	Perform the **Radial Tire Lead/Pull Correction** . Did you find and correct the condition?	Go to **Step 9**	Go to **Step 5**
5	Inspect and correct/adjust the suspension and steering systems for: • Vehicle trim height-Refer to **Trim Height Inspection**. • Excessively worn, loose, or damaged components Did you find and correct the condition?	Go to **Step 9**	Go to **Step 6**
6	Inspect the brake system for brake drag. With the vehicle suspended on a hoist, brake drag can be identified by rotating each wheel several times and observing whether more force is needed to rotate the left wheel or the right wheel. Refer to **Brakes Drag** . Did you find and correct the condition?	Go to **Step 9**	Go to **Step 7**
7	Inspect the wheel alignment and adjust as necessary. Refer to **Wheel Alignment Measurement** . Did you correct the condition?	Go to **Step 9**	Go to **Step 8**
8	Inspect the steering gear for unequal effort. The vehicle must be suspended on a hoist, the engine running, and the transmission in park or neutral. Grasp the tire assembly and manually simulate a turn from the left of center and the right of center observing whether more force is needed to turn to the left or to the right. If this condition exists, replace the steering gear. Did you correct the condition?	System OK	Go to **Step 3**
9	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

BODY LEANS OR SWAYS IN CORNERS

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Suspension General Diagnosis**
2	Verify the vehicle leans or sways in corners. Does the vehicle operate normally?	System OK	Go to **Step 3**
3	Inspect the following components for wear or damage: • Rear Coil Springs • Front Coil Springs	Go to **Step 5**	Go to **Step 4**

Step	Action	Yes	No
	Are the components worn or damaged?		
4	1. Inspect the stabilizer shaft link for wear or damage. 2. Repair as necessary. Did you find and correct the condition?	Go to **Step 6**	Go to **Step 2**
5	Replace the springs as necessary. Did you complete the repair?	Go to **Step 6**	-
6	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

SUSPENSION BOTTOMS

Step	Action	Yes	No
DEFINITION: A loud bang or thump that can usually be felt and/or heard when the vehicle is driven over bumps. This condition is commonly noticed when the vehicle trim height is too low.			
1	Did you review the General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Suspension General Diagnosis**
2	Verify that the suspension bottoms. Does the vehicle operate normally?	System OK	Go to **Step 3**
3	Inspect for vehicle overloading and correct the overloading condition as necessary. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** for specifications. Did you find and correct the condition?	Go to **Step 6**	Go to **Step 4**
4	Inspect the following components: • Inspect the shock absorbers. Refer to **Suspension Strut and Shock Absorber Testing - On Vehicle**. • Inspect for damaged coil springs, torsion bar or leaf springs and replace as necessary. Did you find and correct the condition?	Go to **Step 6**	Go to **Step 5**
5	Inspect the vehicle trim height. Refer to **Trim Height Inspection**. Did you complete the trim height inspection procedure?	Go to **Step 6**	-
6	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

TORQUE STEER

Step	Action	Yes	No
DEFINITION: On a dry, smooth, flat road, the vehicle has a left or right steering force only during acceleration.			

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Suspension General Diagnosis**
2	1. Drive the vehicle on a straight, smooth, flat road. 2. Press the accelerator and determine if any additional steering input is required to maintain a straight ahead direction. 3. Repeat this test with the vehicle traveling in the opposite direction in order to eliminate crosswind effects. Lead/pull caused by unlevel roads and crosswinds are considered normal. Does the vehicle exhibit torque steer when the accelerator is pressed?	Go to **Step 3**	System OK
3	1. Drive the vehicle on a straight, smooth, flat road at 64-97 km/h (40-60 mph). 2. Remove your foot from the accelerator. 3. Shift the transmission into NEUTRAL in order to allow the vehicle to coast. 4. Is any additional steering input required to maintain a straight ahead direction. 5. Repeat this test with the vehicle traveling in the opposite direction in order to eliminate crosswind effects. Lead/pull caused by unlevel roads and crosswinds are considered normal. Does the vehicle direction change when the steering wheel is momentarily released?	Go to **Vehicle Leads/Pulls**	Go to **Step 4**
4	Inspect the front suspension and powertrain mounts for worn or damaged components and repair as necessary. Did you find and correct the condition?	Go to **Step 6**	Go to **Step 5**
5	Inspect the vehicle trim height. Refer to **Trim Height Inspection**. Did you find and correct the condition?	Go to **Step 6**	-
6	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	-

MEMORY STEER

Step	Action	Yes	No
DEFINITION: A lead or pull in the direction the driver previously turned the vehicle. Additionally, after turning in the opposite direction, the vehicle will want to lead or pull in that direction.			
1	Did you review the General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Suspension General Diagnosis**

Step	Action	Yes	No
2	Verify that memory steer is present. Does the system operate normally?	System OK	Go to **Step 3**
3	1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Lubricate the tie rod ends and the ball joints if applicable. 3. Inspect the suspension system for worn or damaged components. 4. Repair as necessary. Did you find and correct the condition?	Go to **Step 7**	Go to **Step 4**
4	Inspect for binding strut bearings. 1. Disconnect the strut from the steering knuckle. 2. If the strut is abnormally difficult to rotate, repair or replace the upper bearing mount. Did you find and complete the repair?	Go to **Step 7**	Go to **Step 5**
5	Inspect for binding in the lower ball joints. If joint is binding, replace the joint. Did you find and complete the repair?	Go to **Step 7**	Go to **Step 6**
6	Inspect the wheel alignment and adjust as necessary. Refer to **Wheel Alignment Measurement** . Did you complete the wheel alignment?	Go to **Step 7**	-
7	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	-

NOISE DIAGNOSIS - FRONT SUSPENSION

Step	Action	Yes	No
DEFINITION: Any noise emitted from the front of the vehicle that is induced by VEHICLE SPEED or DRIVING TERRAIN as related to the front suspension.			
1	Did you review the General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Suspension General Diagnosis**
2	Attempt to duplicate the condition. Road test the vehicle. Did you duplicate the condition?	Go to **Step 3**	System OK
3	Is the noise reactive to vehicle load or speed?	Go to **Step 4**	Go to **Step 7**
4	Inspect the tires for the following condition: • Proper tire Inflation and adjust as necessary. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** . • Unusual tire wear. Refer to **Vibration Analysis - Tire and Wheel** .	Go to **Step 14**	Go to **Step 5**

Step	Action	Yes	No
	• Inspect the wheel nuts for looseness and tighten as necessary. Refer to **Fastener Specifications** . Did you find and correct the condition?		
5	Inspect the front wheel bearings. Refer to **Wheel Bearings Diagnosis**. Did you find and correct the condition?	Go to **Step 14**	Go to **Step 6**
6	Inspect for transaxle noise. Refer to **Symptoms - Automatic Transmission** . Did you find and correct the condition?	Go to **Step 14**	Go to **Step 7**
7	Bounce the front of the vehicle in order to duplicate the noise. Did you duplicate the noise?	Go to **Step 8**	Go to **Step 9**
8	1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Inspect the front suspension components for looseness. Refer to **Fastener Specifications** . 3. Inspect the front suspension components for damage and repair as necessary. Did you find and correct the condition?	Go to **Step 14**	Go to **Step 9**
9	1. Install the **J 39570** Chassis Ear or equivalent. 2. Bounce the front of the vehicle, using the **J 39570** Chassis Ear or equivalent, in order to locate the source of the noise. If necessary road test the vehicle. 3. Repair or replace any damaged components as necessary. Did you find and correct the condition?	Go to **Step 14**	Go to **Step 10**
10	Inspect the ball joints and steering components for the following conditions. • Lack of lubrication where applicable. • Looseness in the steering linkage. • Looseness in the tie rods. Refer to **Steering Linkage Outer Tie Rod Replacement** , or **Steering Linkage Inner Tie Rod Replacement** . Did you find and correct the condition?	Go to **Step 14**	Go to **Step 11**
11	Inspect for damaged shock absorbers. Refer to **Suspension Strut and Shock Absorber Testing - On Vehicle**. Did you find and correct the condition?	Go to **Step 14**	Go to **Step 12**

Step	Action	Yes	No
12	Inspect the front stabilizer shaft and stabilizer shaft links for damage and repair as necessary. Refer to **Stabilizer Shaft Replacement** , or **Stabilizer Shaft Link Replacement** . Did you find and correct the condition?	Go to **Step 14**	Go to **Step 13**
13	Inspect for control arm damage and repair as necessary. Refer to **Lower Control Arm Replacement** . Did you find and correct the condition?	Go to **Step 14**	-
14	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

NOISE DIAGNOSIS - REAR SUSPENSION

Step	Action	Yes	No
DEFINITION: Any noise emitted from the rear of the vehicle that is induced by VEHICLE SPEED or DRIVING TERRAIN as related to the rear suspension.			
1	Did you review the General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Suspension General Diagnosis**
2	Attempt to duplicate the condition. Road test the vehicle. Did you duplicate the condition?	Go to **Step 3**	System OK
3	Is the noise reactive to vehicle load or speed?	Go to **Step 4**	Go to **Step 6**
4	Perform the following Inspections: • Inspect and adjust the tire Inflation. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** . • Inspect for unusual tire wear. Refer to **Vibration Analysis - Tire and Wheel** . • Inspect the wheel nuts for looseness. Refer to **Fastener Specifications** . Did you find and correct the condition?	Go to **Step 10**	Go to **Step 5**
5	Inspect the rear wheel bearings. Refer to **Wheel Bearings Diagnosis**. Did you find and correct the condition?	Go to **Step 10**	Go to **Step 6**
6	Bounce the rear of the vehicle in order to duplicate the noise. Did you duplicate the noise?	Go to **Step 7**	Go to **Step 9**

Step	Action	Yes	No
7	1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Inspect the rear suspension components for looseness. Refer to **Fastener Specifications** . 3. Inspect the rear suspension components for damage and repair as necessary. Did you find and correct the condition?	Go to **Step 10**	Go to **Step 8**
8	Inspect the rear shock absorber. Refer to **Suspension Strut and Shock Absorber Testing - On Vehicle**. Did you find and correct the condition?	Go to **Step 10**	Go to **Step 9**
9	1. Install the **J 39570** Chassis Ear Chassis Ear or equivalent. 2. Bounce the rear of the vehicle, using the **J 39570** Chassis Ear or equivalent, in order to locate the source of the noise. If necessary, road test the vehicle. 3. Repair or replace any defective component as necessary. Did you find and correct the condition?	Go to **Step 10**	System OK
10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

LOWER CONTROL ARM BALL JOINT INSPECTION

Special Tools

J 8001 Dial Indicator Set

NOTE:

- **The vehicle must rest on a level surface**
- **The vehicle must be stable. DO NOT rock the vehicle on the floor.**

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Clean and inspect the ball joint seal for cuts or tears. If the ball joint seal is damaged, replace the ball joint or lower control arm as applicable for this vehicle.

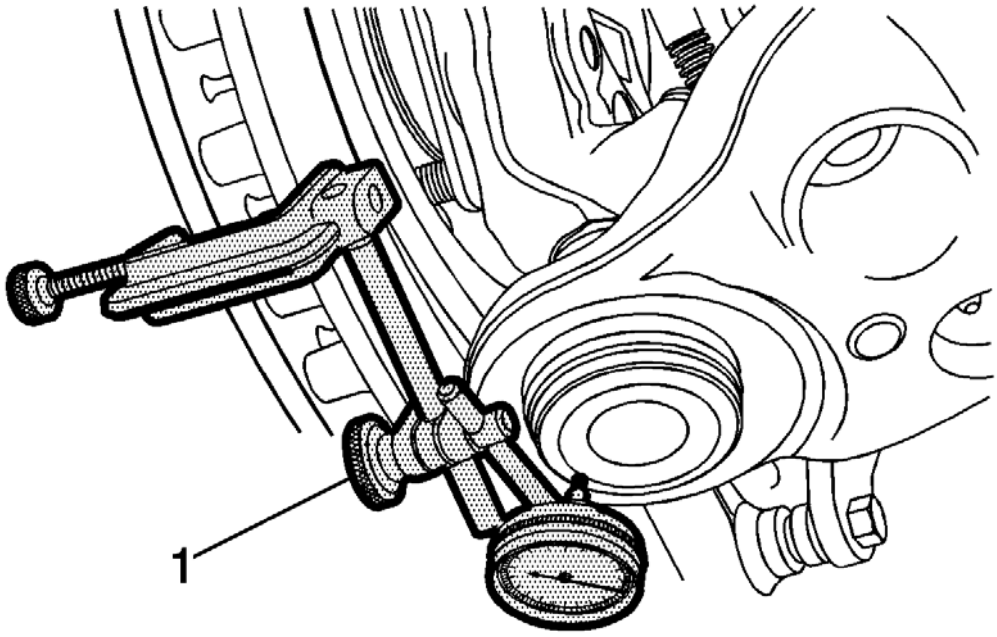


Fig. 1: Measuring Vertical Lash In Ball Joint
Courtesy of GENERAL MOTORS COMPANY

3. Install the **J 8001** dial indicator , to measure the vertical lash of the ball joint.

CAUTION: Do not pry in such a way that the ball joint seal is contacted. Damage to the seal may result.

4. Gently lift or pry between the knuckle and the lower control arm to induce ball joint movement, record the measurement
5. If dial indicator is reading more than 0.5 mm (0.02 in), replace the ball joint or lower control arm as applicable for this vehicle.

SUSPENSION STRUT AND SHOCK ABSORBER TESTING - ON VEHICLE

Step	Action	Yes	No
1	Did you review the General Description and perform the necessary inspections?	Go to **Step 2**	Go to **Symptoms - Suspension General Diagnosis**
2	Verify that the customer's concern is present. Does the vehicle operate normally?	System OK	Go to **Step 3**

Step	Action	Yes	No
3	IMPORTANT: A light film of oil on the top portion of the shock reservoir is normal. Inspect each strut or shock absorber for external fluid leakage.Is a strut or shock absorber leaking?	Go to **Step 5**	Go to **Step 4**
4	1. Use your hands in order to lift up and push down each corner of the vehicle 3 times. 2. Remove your hands from the vehicle. 3. Locate a shock or strut that exceeds 2 cycles. Did you locate shock or strut that exceeds 2 cycles?	Go to **Step 5**	Go to **Step 6**
5	IMPORTANT: Inspect the vehicle trim height in order to correct any possible causes of shock/strut failures. Refer to **Trim Height Inspection**. Replace the strut or shock absorber. Refer to **Strut, Strut Component, or Spring Replacement** , for the front suspension or **Strut Assembly Removal and Installation** for the rear suspension.Did you complete the repair?	Go to **Step 6**	-
6	Operate the vehicle in order to verify the repair. Did you correct the condition?	System OK	Go to **Step 3**

WHEEL BEARINGS DIAGNOSIS

Step	Action	Values	Yes	No
1	Did you review the General Description and perform the necessary inspections?	-	Go to **Step 2**	Go to **Symptoms - Suspension General Diagnosis**
2	1. Install the **J 39570** Chassis Ear Chassis Ear. IMPORTANT: A noise heard during left turns is a good indicator of a noisy right wheel bearing. A noise heard during right turns is a good indicator of a noisy left wheel bearing. 2. Road test the vehicle to verify the location of the noise. Drive the vehicle on a smooth road at a moderate speed range. While driving, turn the wheel to the left and the right to apply loads to each wheel corner. Is the noise present at the wheel bearing?	48-72 km/h (30-45 mph)	Go to **Step 7**	Go to **Step 3**

Step	Action	Values	Yes	No
3	1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation** . 3. Ensure the wheel drive shaft nut is properly tightened. Refer to **Fastener Specifications** . Are the nuts fastened to the correct specified value?	-	Go to **Step 4**	Go to **Step 8**
4	IMPORTANT: Support the vehicle by the lower control arms or the rear axle to prevent movement during wheel bearing/hub inspection. 1. Mount and secure the **J 8001** Dial Indicator to the steering knuckle. 2. Firmly push the hub flange towards the vehicle. 3. Ensure that the dial indicator contacts the vertical surface of the hub as close as possible to the center of the flange. 4. Firmly pull the hub flange away from the vehicle in order to inspect the total travel indicator by the dial indicator. Is the measurement greater then the specified value?	0.127 mm (0.005 in)	Go to **Step 7**	Go to **Step 5**
5	Inspect for tire or wheel damage. Refer to **Tire and Wheel Assembly Runout Measurement - On-Vehicle** . Did you find and correct the condition?	Â	Go to **Step 9**	Go to **Step 6**
6	Inspect the front and/or rear suspension. Refer to **Noise Diagnosis - Front Suspension**, or **Noise Diagnosis - Rear Suspension**. Did you find and correct the condition?	-	Go to **Step 9**	Go to **Step 2**
7	Replace the wheel bearing. Refer to **Front Wheel Bearing and Hub Replacement** , or **Rear Wheel Bearing and Hub Replacement** . Did you complete the repair?	-	Go to **Step 9**	-
8	Remove the old wheel drive shaft nut and install a NEW wheel drive shaft nut. Tighten to the specified value. Refer to **Fastener Specifications** . Did you complete the repair?	-	Go to **Step 9**	-

Step	Action	Values	Yes	No
9	Road test the vehicle to verify the repair. Does the vehicle operate normally?	-	System OK	Go to **Step 3**

TRIM HEIGHT INSPECTION

Trim Height Measurements

Trim height is a predetermined measurement relating to vehicle ride height. Incorrect trim heights can cause bottoming out over bumps, damage to the suspension components, and symptoms similar to wheel alignment problems. Check the trim heights when diagnosing suspension concerns and before checking the wheel alignment.

Perform the following before measuring the trim heights:

1. Set the tire pressures to the pressure shown on the certification label. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .
2. Check the fuel level. Add additional weight if necessary to simulate a full tank.
3. Make sure the rear compartment is empty except for the spare tire.
4. Make sure the vehicle is on a level surface, such as an alignment rack.
5. Close the doors.
6. Close the hood.
7. All dimensions are measured vertical to the ground. Trim heights should be within 13 mm (0.5 in) to be considered correct.

Z Height Measurement

The Z height dimension measurement determines the proper ride height for the front end of the vehicle. There is no adjustment procedure. Repair may require replacement of suspension components.

1. Lift the front bumper of the vehicle up about 38 mm (1.5 in).
2. Gently remove your hands. Let the vehicle settle.
3. Repeat this operation for a total of 3 times.

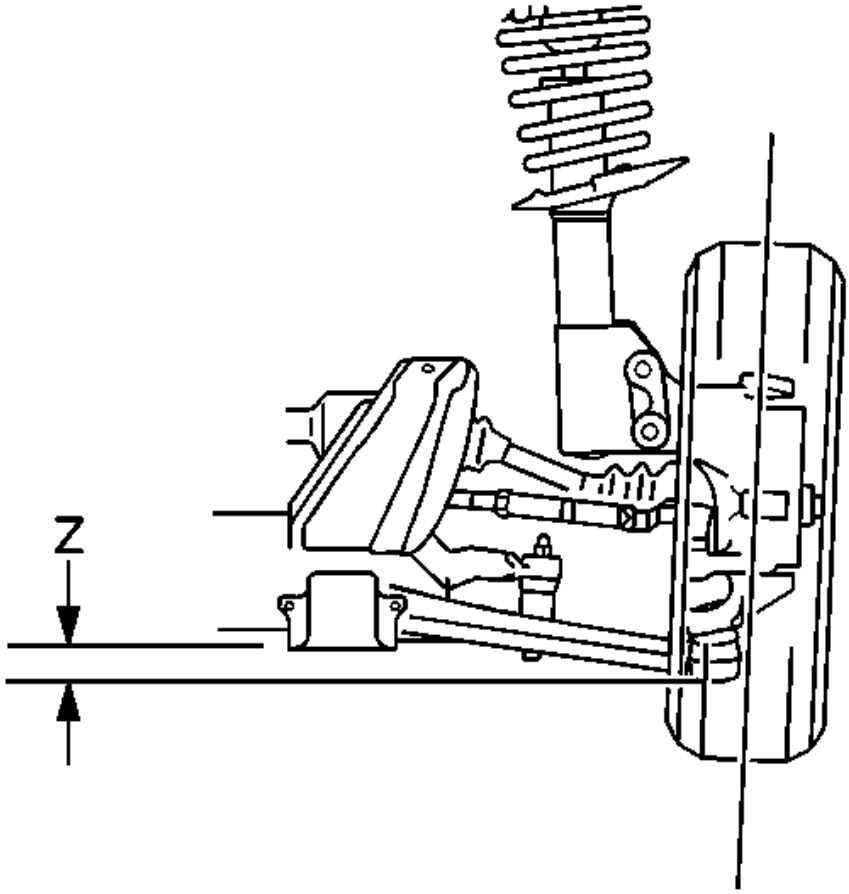


Fig. 2: Measuring "Z" Height Dimension
Courtesy of GENERAL MOTORS COMPANY

4. Measure from the pivot bolt center line down to the lower corner of the lower ball joint in order to obtain the Z height measurement.
5. Push the front bumper of the vehicle down about 38 mm (1.5 in).
6. Gently remove your hands.
7. Allow the vehicle to settle into position.
8. Repeat the jouncing operation 2 more times for a total of 3 times.
9. Measure the Z dimension.
10. The true Z height dimension number is the average of the high and the low measurements. Refer to **Trim Height Specifications**.

D Height Measurement

The D height dimension measurement determines the proper rear end ride height. There is no adjustment procedure. Repair may require replacement of suspension components.

1. With the vehicle on a flat surface, lift upward on the rear bumper 38 mm (1.5 in).
2. Gently remove your hands.

Allow the vehicle to settle into position.

3. Repeat the jouncing operation 2 more times for a total of 3 times.

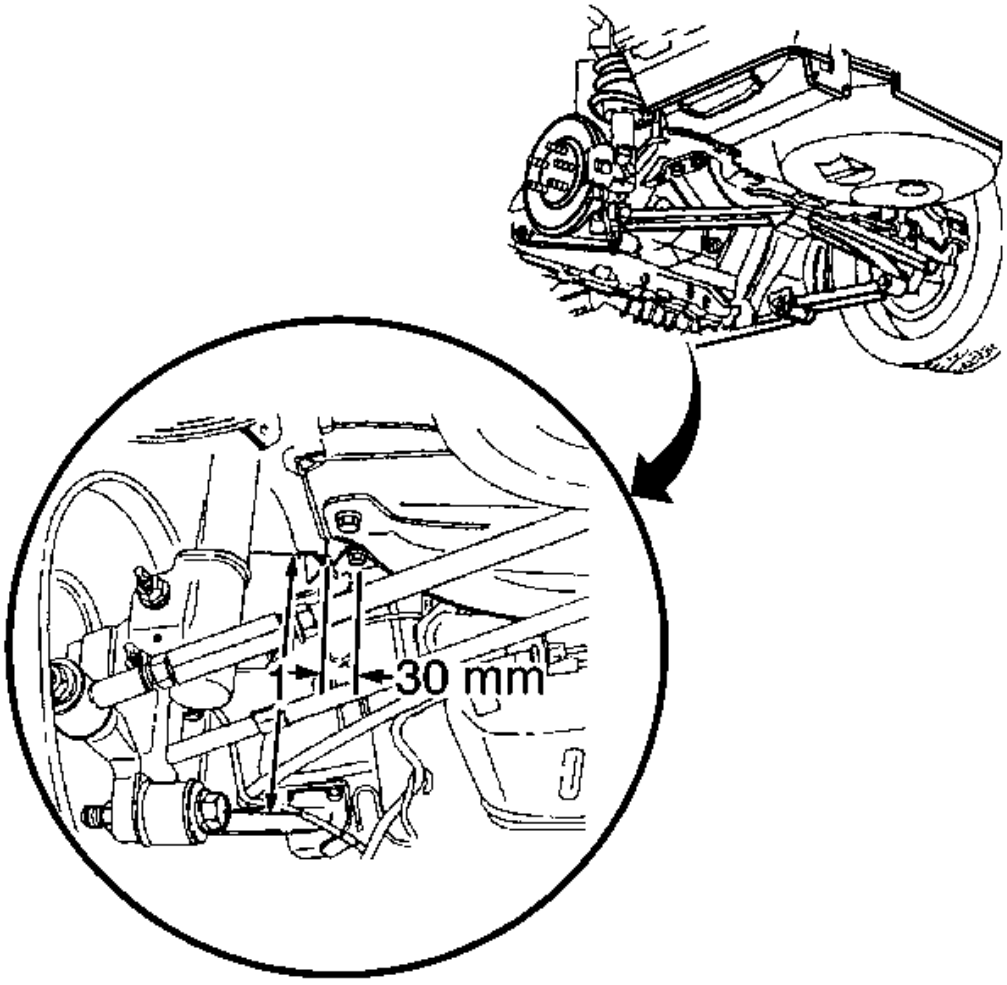


Fig. 3: Measuring D Height Dimension
Courtesy of GENERAL MOTORS COMPANY

4. The D height is measured from a point 30 mm (1.1 in) outboard of the rear brake hose bracket bolt centerline to the bolt centerline of the trailing arm to the knuckle attachment.
5. Push the rear bumper downward to 38 mm (1.5 in).
6. Gently remove your hands.

Allow the vehicle to settle into position.

7. Repeat the jouncing operation 2 more times for a total of 3 times.
8. Measure the D height dimension.
9. The true D height dimension number is the average of the high and the low measurements. Refer to **Trim Height Specifications**.
10. If these measurements are out of specifications, inspect for the following conditions:
    - Improper weight distribution

- Collision damage
- Worn or damaged suspension components

Measuring the P and R Dimension

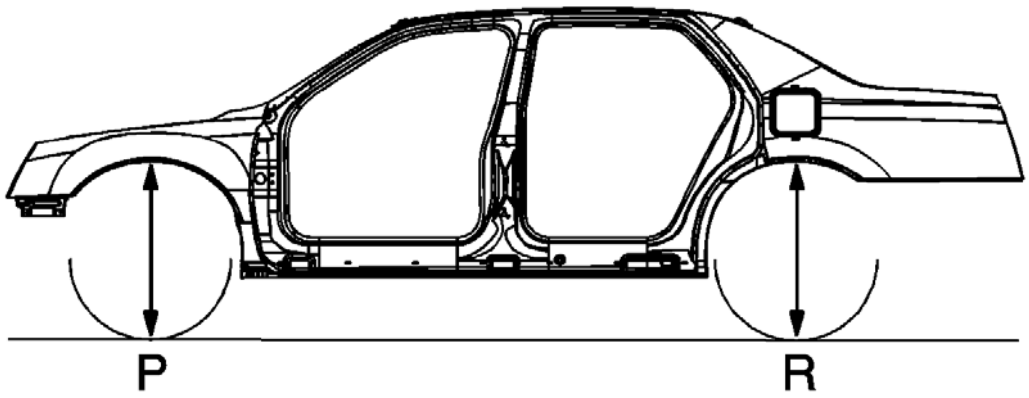


Fig. 4: Locating P And R Dimension Measurement Areas
Courtesy of GENERAL MOTORS COMPANY

Use the following procedure to check the P and R dimensions.

1. Use your hands to lift the front bumper approximately 38 mm (1.59 in).
2. Remove your hands and allow the vehicle to lower.
3. Use your hands to jounce the front of the vehicle downward approximately 38 mm (1.59 in).
4. Remove your hands and allow the vehicle to rise.
5. The dimension (P) for the left and right side of the vehicle is measured from the bottom lip of the wheel opening to the ground measured at the center line of the front wheel.
6. Compare the measurement to the specification table. Refer to **Trim Height Specifications**.
7. If the measurement is outside of the specified range, replace the front springs. Refer to **Strut, Strut Component, or Spring Replacement** .
8. Use your hands to lift the rear bumper approximately 38 mm (1.59 in).
9. Remove your hands and allow the vehicle to lower.

10. Use your hands to jounce the rear of the vehicle downward approximately 38 mm (1.59 in).
11. The dimension (R) for the left and right side of the vehicle is measured from the bottom lip of the wheel opening to the ground measured at the center line of the rear wheel.
12. Compare the measurement to the specification table. Refer to **Trim Height Specifications**.
13. If the measurement is outside of the specified range, replace the rear springs. Refer to **Strut, Strut Component, or Spring Replacement** .

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

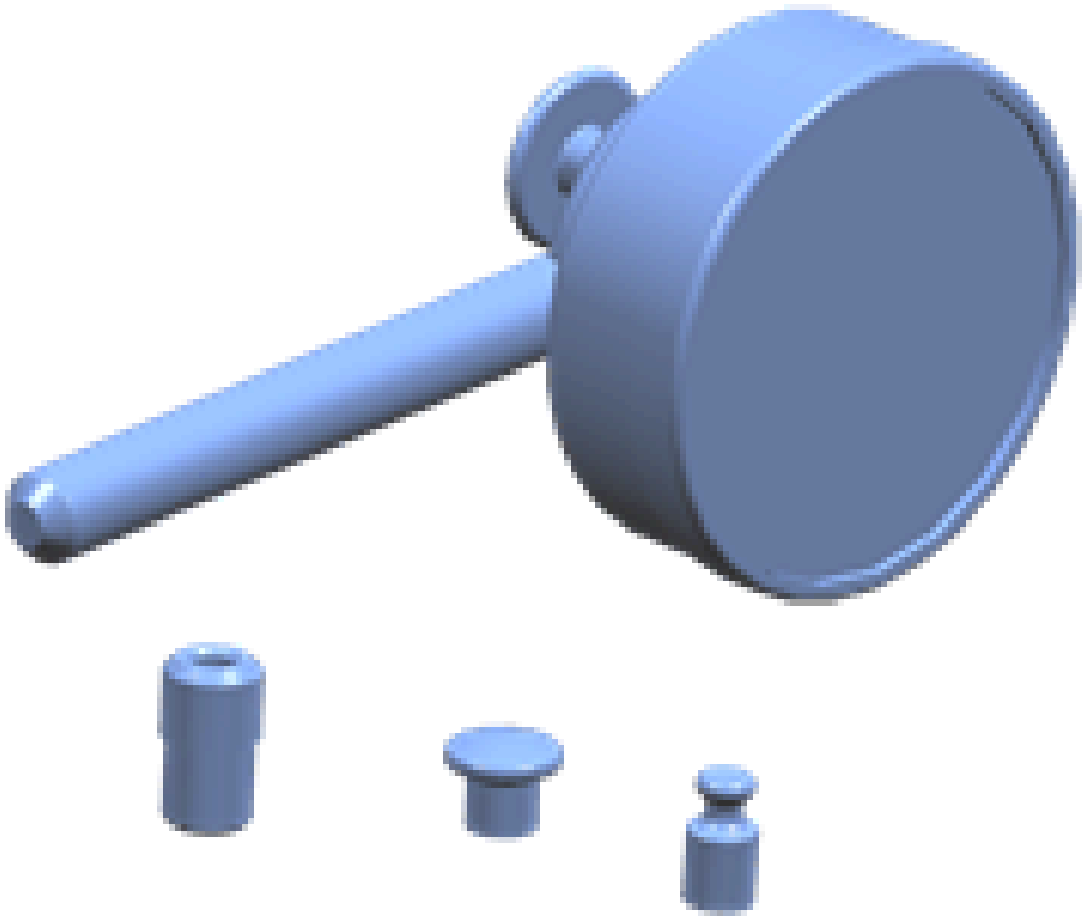
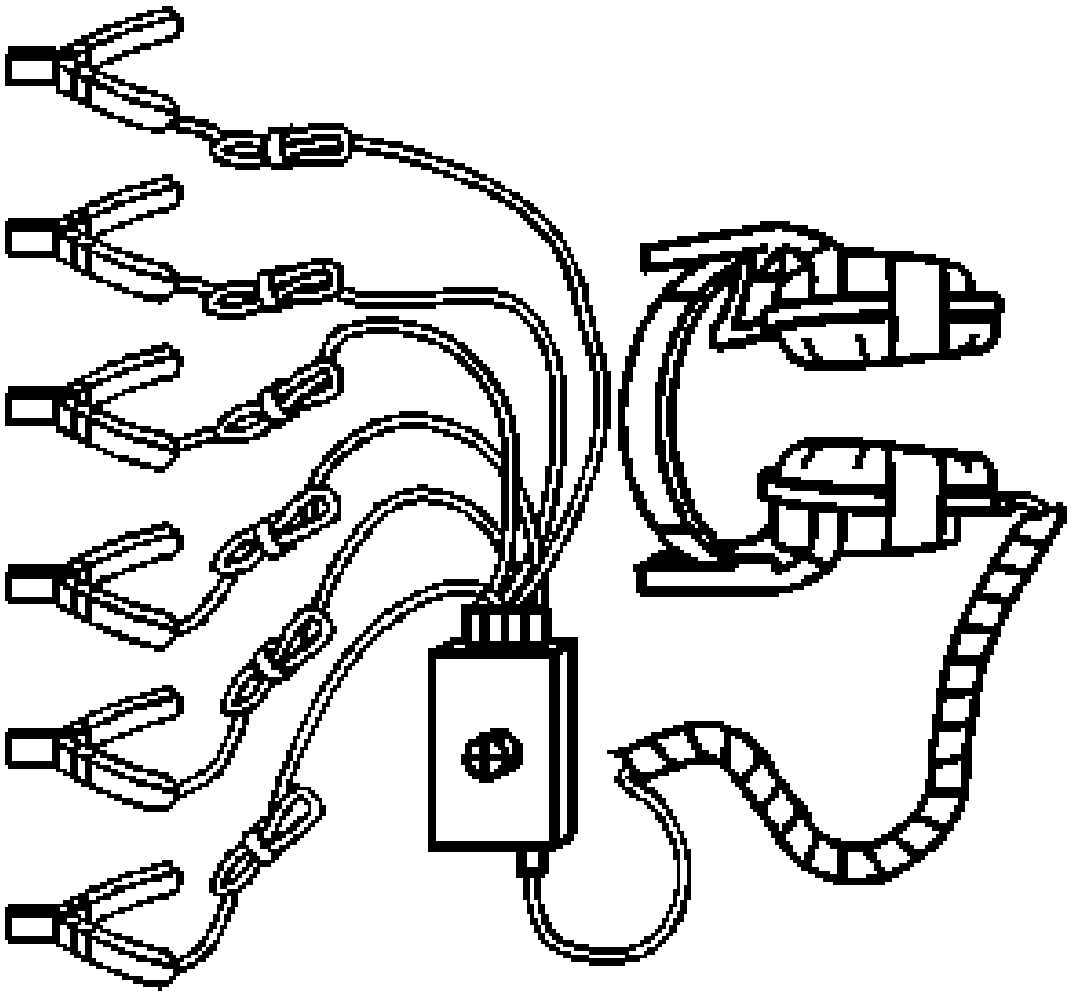
Illustration	Tool Number/Description
	J 8001 Dial Indicator

Illustration	Tool Number/Description
	J 39570 Chassis Ear

Article GUID: A00737220

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Tire Pressure Sensor Nut	7 N.m	62 lb in

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC C0569: SYSTEM CONFIGURATION ERROR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0569 00

System Configuration Error

Circuit/System Description

If the tire type and pressure selection information is not entered with the scan tool during the remote control door lock receiver (RCDLR) setup, the tire pressure monitor indicator icon on the instrument panel cluster (IPC) will flash for 1 minute and then remain illuminated after the ignition switch is cycled ON and the IPC bulb check is complete. If equipped, the driver information center (DIC) will also display a service tire monitor type message. Under these circumstances, DTC C0569 will be set and the tire type and pressure information will need to be entered for the system to function correctly.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The RCDLR has not undergone the programming procedure.

Action Taken When the DTC Sets

- The tire pressure monitor indicator icon on the instrument panel cluster (IPC) flashes for 1 minute and then remains illuminated after the ignition switch is cycled ON and the IPC bulb check is complete.
- If equipped, the driver information center (DIC) displays the suspect tire pressure as dashes.
- If equipped, the DIC displays a service tire monitor type message.

Conditions for Clearing the DTC

A current DTC will clear when the RCDLR has undergone the tire type and pressure selection setup procedure and 1 ignition cycle has occurred.

Diagnostic Aids

A newly replaced RCDLR will set DTC C0569 after programming on its initial ignition ON cycle if the module setup information has not been entered. The Tire Type and Tire Pressure Selection setup must be performed with the scan tool.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that the DTC C0569 is not set.

- If the DTC is set, perform the RCDLR tire type and pressure selection setup with the scan tool and cycle the ignition. If the DTC resets, replace the RCDLR.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for RCDLR replacement, setup, and programming

DTC C0750, C0755, C0760, OR C0765: LOW TIRE PRESSURE SENSOR SIGNAL

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC C0750 00

Left Front Low Tire Pressure Sensor

DTC C0750 08

Left Front Low Tire Pressure Sensor Signal Invalid

DTC C0755 00

Right Front Low Tire Pressure Sensor

DTC C0755 08

Right Front Low Tire Pressure Sensor Signal Invalid

DTC C0760 00

Left Rear Low Tire Pressure Sensor

DTC C0760 08

Left Rear Low Tire Pressure Sensor Signal Invalid

DTC C0765 00

Right Rear Low Tire Pressure Sensor

DTC C0765 08

Right Rear Low Tire Pressure Sensor Signal Invalid

Circuit/System Description

The tire pressure monitor (TPM) system has a radio frequency (RF) transmitting pressure sensor in each wheel/tire assembly. As vehicle speed increases, centrifugal force closes the sensors internal roll switch, which puts the sensor into Rolling mode. The remote control door lock receiver (RCDLR) receives and translates the data contained in the tire pressure sensor RF transmissions into sensor presence, sensor mode, and tire pressure. Once vehicle speed is greater than 40 km/h (25 mph), the RCDLR waits for the sensors to go into rolling mode. If one or more sensors do not go into rolling mode, or do not transmit at all, the RCDLR will set DTC C0750, C0755, C0760, or C0765 respectively.

Conditions for Running the DTC

Vehicle speed is greater than 40 km/h (25 mph).

Conditions for Setting the DTC

- A sensor does not transmit for 18 minutes.
- A sensor low battery condition.

Action Taken When the DTC Sets

- The tire pressure monitor indicator icon on the instrument panel cluster (IPC) flashes for 1 minute and then remains illuminated after the ignition switch is cycled ON and the IPC bulb check is complete.
- If equipped, the driver information center (DIC) displays the suspect tire pressure as dashes.
- If equipped, the DIC displays a service tire monitor type message.

Conditions for Clearing the DTC

- A current DTC will clear when the malfunction is no longer present and 1 ignition cycle occurs.
- The RCDLR automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

Diagnostic Aids

- Some aftermarket wheel valve stem holes are located further from the wheel rim than original equipment wheels. When using the TPM special tool to activate a sensor, ensure the tool antenna is no further than 15 cm (6 in) from the sensor and is aiming upward.
- Aftermarket wheel valve stem locations can cause a sensor to not function correctly.
- A sensor may have been damaged due to a previous wheel/tire service or flat tire event.
- The use of other than GM approved tire sealants can obstruct the sensor pressure sensing port and cause inaccurate tire pressure readings. If this condition is verified, remove the sealer from the tire and replace the sensor. Refer to **Tire Pressure Indicator Sensor Replacement**.
- Occasionally sensor transmissions are not received by the RCDLR due to vehicle level RF interference from items such as but not limited to aftermarket ignition systems, DVD players, CB radios, or metallic type window tinting.
- The sensor activation procedure may have to be repeated up to 3 times before determining a sensor is malfunctioning. In the event a particular sensor's information is displayed on the special tool upon activation but the horn does not chirp, it may be necessary to rotate the wheel valve stem to a different position due to the RF signal is being blocked by another component.
- Occasionally sensors can become mislocated due to previous tire rotations where the sensor learn procedure was not performed or stray sensor transmissions have been received from other vehicles . Always learn the sensors to ensure the DTC set is for that actual physical corner of the vehicle. Refer to **Tire Pressure Indicator Sensor Learn**.
- A sensor low battery condition will set a sensor DTC but will not illuminate the low tire pressure indicator or display a message on the DIC, if equipped. The sensor battery condition can be verified in the scan tool RCDLR data list. If a sensor low battery condition is indicated on the scan tool, the sensor will need to be replaced. Refer to **Tire Pressure Indicator Sensor Replacement**.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-46079/J-46079 Tire Pressure Monitor Diagnostic Tool

Circuit/System Verification

1. Using the **EL-46079/J-46079** tool , activate each tire pressure sensor and record each sensors transmission data and physical location. Verify **EL-46079/J-46079** tool displays the 8-digit ID number, accurate tire pressure Â±27.6 kPa (4 psi), Learn Mode, and at least a 1/4 graph signal strength displayed.

- If any of the parameters listed above are not displayed, replace the suspect tire pressure sensor.

2. With the scan tool, verify tire pressure sensors ID and locations displayed on the scan tool match the IDs and locations recorded from the special tool.
   - If the IDs and locations do not match, perform the **Tire Pressure Indicator Sensor Learn**.
3. Enable the TPM learn mode. Use the **EL-46079/J-46079** tool in simulate mode to learn 4 simulated sensor transmissions into the RCDLR. Verify that all 4 simulated sensor locations, IDs, and tire pressures displayed on the TPM special tool match the corresponding scan tool parameters displayed.
   - If the scan tool does not match, replace the RCDLR.
4. Test drive the vehicle above 40 km/h (25 mph) for greater than 2 minutes. With the scan tool, observe the suspect Pressure Sensor Mode data parameter. Verify the sensor mode changes to Rolling.
   - If the Pressure Sensor Mode does not change, replace the suspect tire pressure sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Tire Pressure Indicator Sensor Replacement**
- **Tire Pressure Indicator Sensor Learn**
- **Control Module References** for RCDLR replacement, programming, and setup

DTC C0775: LOW TIRE PRESSURE SYSTEM SENSORS NOT LEARNED

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0775

Low Tire Pressure System Sensors Not Learned

Circuit/System Description

If the tire pressure sensor learn procedure has not been performed, the tire pressure monitor indicator icon on the instrument panel cluster (IPC) will flash for 1 minute and then remain illuminated after the ignition switch is cycled ON and the IPC bulb check is complete. If equipped, the driver information center (DIC) will also display a service tire monitor type message. Under these circumstances, DTC C0775 will be set and the tire pressure sensor learn procedure will need to be performed for the system to function correctly.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The remote control door lock receiver (RCDLR) has not undergone the tire pressure sensor learn procedure.

Action Taken When the DTC Sets

- The tire pressure monitor indicator icon on the instrument panel cluster (IPC) will flash for 1 minute and then remain illuminated after the ignition switch is cycled ON and the IPC bulb check is complete.
- If equipped, the driver information center (DIC) displays a service tire monitor type warning message.

Conditions for Clearing the DTC

A current DTC will clear when the RCDLR has undergone the tire pressure sensor learn procedure and 1 ignition cycle has occurred.

Diagnostic Aids

A newly replaced RCDLR will set DTC C0775 on its initial ignition ON cycle. The tire pressure sensor learn procedure must be performed.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Verify that the DTC C0775 is not set.

- If the DTC is set, perform the tire pressure sensor learn procedure. Cycle the ignition. If the DTC resets, replace the RCDLR.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Tire Pressure Indicator Sensor Learn**
- **Control Module References** for RCDLR replacement, setup, and programming

SYMPTOMS - TIRE PRESSURE MONITORING

1. Perform the **Diagnostic System Check - Vehicle** , before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Tire Pressure**

Monitor Description and Operation.

Visual/Physical Inspection

- Inspect if tires are inflated per placard values.
- Inspect for aftermarket devices which could affect the operation of the Tire Pressure Monitoring (TPM) System. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to **Low Tire Pressure Indicator Malfunction** in order to diagnose the symptom.

LOW TIRE PRESSURE INDICATOR MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Circuit/System Description

The remote control door lock receiver (RCDLR) receives a radio frequency (RF) transmission from each tire pressure sensor. Each sensor has its own unique identification (ID) code, which it transmits as part of each RF message, that must be learned into the RCDLR memory. Once all 4 IDs have been learned and vehicle speed is greater than 40 km/h (25 mph), the RCDLR continuously compares IDs in received transmission to its learned IDs to determine if all 4 sensors are present. If the RCDLR detects a low tire pressure condition or a malfunction in the system, it will send a serial data message to the instrument panel cluster (IPC) requesting the appropriate tire pressure monitor indicator illumination and also to display the appropriate data message on the driver information center (DIC), if equipped.

Diagnostic Aids

- If unsure about the condition, cycle the ignition and observe the tire pressure monitor indicator icon. If the tire pressure monitor indicator icon is continuously illuminated after the IPC bulb check is completed, a low tire pressure condition is present. Check the tires for damage or leaks and inflate to the tire placard specifications. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** , . If the tire pressure monitor indicator icon flashes for 1 minute after the IPC bulb check is completed and then remains illuminated, a tire pressure monitor system DTC is set. Perform the **Diagnostic System Check - Vehicle** to proceed with the proper diagnosis.
- Temperature can greatly effect tire pressures. Low tire pressure on a cold morning may cause the tire pressure monitor indicator icon to turn ON. The air pressure in the tire increases as the ambient temperature rises or as the tire warms up while the vehicle is driven. The pressure may increase enough to exceed the predetermined low pressure threshold which will turn OFF the tire pressure monitor indicator icon .
- Some aftermarket wheel valve stem holes are located further from the wheel rim than original equipment

wheels. When using the TPM special tool to activate a sensor, ensure the tool antenna is no further than 15 cm (6 in) from the sensor and is aiming upward.

- Aftermarket wheel value stem locations can cause a sensor to not function correctly.
- A sensor may have been damaged due to a previous wheel/tire service or flat tire event.
- The use of other than GM approved tire sealants can obstruct the sensor pressure sensing port and cause inaccurate tire pressure readings. If this condition is verified, remove the sealer from the tire and replace the sensor. Refer to **Tire Pressure Indicator Sensor Replacement**.
- Occasionally sensor transmissions are not received by the RCDLR due to vehicle level RF interference from items such as but not limited to aftermarket ignition systems, DVD players, CB radios, or metallic type window tinting.
- The sensor activation procedure may have to be repeated up to 3 times before determining a sensor is malfunctioning. In the event a particular sensor's information is displayed on the special tool upon activation but the horn does not chirp, it may be necessary to rotate the wheel valve stem to a different position due to the RF signal is being blocked by another component.
- Occasionally sensors can become mislocated due to previous tire rotations where the sensor learn procedure was not performed or stray sensor transmissions have been received from other vehicles. Always learn the sensors to ensure the DTC set is for that actual physical corner of the vehicle. Refer to **Tire Pressure Indicator Sensor Learn**.

Reference Information

Description and Operation

Tire Pressure Monitor Description and Operation

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Special Tools

J 46079 Tire Pressure Monitor Diagnostic Tool

Circuit/System Verification

NOTE: **Low tire pressure in one or more tires is indicated by a continuously illuminated tire pressure monitor indicator icon after the IPC bulb check is completed. If equipped with a DIC, a check tire pressure type message will also be displayed. It is not necessary to perform the Learn procedure for a low tire condition.**

When a TPM DTC is set, the tire pressure monitor indicator icon will flash for 1 minute after the IPC bulb check is completed and then remains illuminated. If equipped with a DIC, a service tire monitor type message will also be displayed.

1. Verify all tires are inflated to the proper pressure Â±10%. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** .
    - If not within the specified range, adjust all tire pressures to specification and drive the vehicle over 40 km/h (25 mph) for greater than 2 minutes. Verify the tire pressure monitor indicator icon is OFF.
2. Using the **J 46079** tire pressure monitor diagnostic tool , activate each B2 Tire Pressure Sensor and record each sensor tire pressure reading. Check the tire pressures with a known accurate hand held tire pressure gauge. Verify that the pressure readings from the special tool do not differ more than 27.6 kPa (4 psi) from the actual tire pressure readings.
    - If not within the specified range, replace the appropriate B2 Tire Pressure Sensor.
3. Using a scan tool, enable the TPM learn mode. Use the **J 46079** tire pressure monitor diagnostic tool in simulate mode to learn 4 simulated sensor transmissions into the RCDLR. Observe tire pressures in the scan tool data display. Verify the simulated tire pressures do not differ more than +/-27.6 kPa (4 psi) of the scan tool reading.
    - If not within the specified range, replace the RCDLR.
4. Using a scan tool, perform the instrument panel special functions Lamp Test. Command the instrument panel warning lamps ON and OFF. Verify the tire pressure monitor indicator icon turns ON and OFF.
    - If the tire pressure monitor icon does not turn ON and OFF, replace the IPC.
5. Ignition ON, use the scan tool to setup the Tire Type/Pressure Selection in the RCDLR Module Setup menu. Refer to the **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** . Drive the vehicle over 40 km/h (25 mph) for greater than 2 minutes. Verify the tire pressure monitor indicator icon is OFF.
    - If the tire pressure monitor indicator icon is ON, replace the RCDLR.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Tire Pressure Indicator Sensor Replacement**
- **Tire Pressure Indicator Sensor Learn**
- **Control Module References** for IPC or RCDLR replacement, setup, and programming

REPAIR INSTRUCTIONS

TIRE PRESSURE INDICATOR SENSOR REPLACEMENT

Removal Procedure

1. Raise the vehicle on a suitable support. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire/wheel assembly from the vehicle. Refer to **Tire and Wheel Removal and Installation** .
3. Dismount the tire from the rim. Refer to **Tire Dismounting and Mounting** .

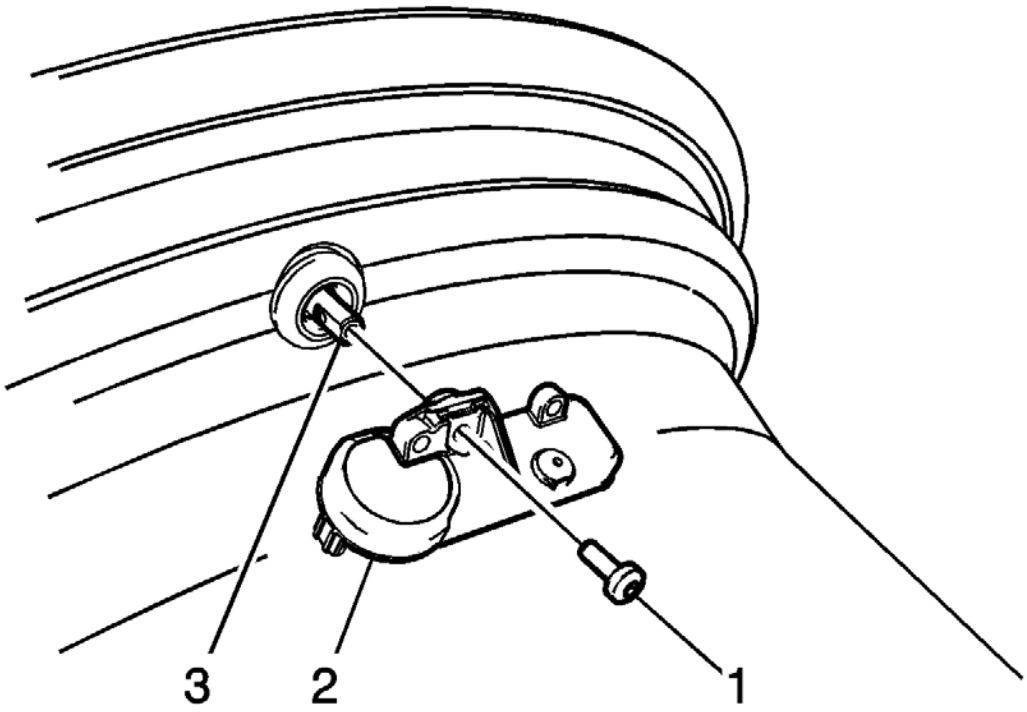


Fig. 1: View Of Tire Pressure Indicator Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: **When servicing the tire pressure sensor always use a new SchraderÂ® tire pressure monitor (TPM) and a new TORX screw during installation.**

4. Remove the TORX screw (1) from the tire pressure sensor (2) and pull it straight off the tire pressure valve stem (3).

CAUTION: **Do not scratch or damage the clear coating on aluminum wheels with the tire changing equipment. Scratching the clear coating could cause the aluminum wheel to corrode and the clear coating to peel from the wheel.**

5. Remove the tire pressure valve stem by pulling it through the rim.

Installation Procedure

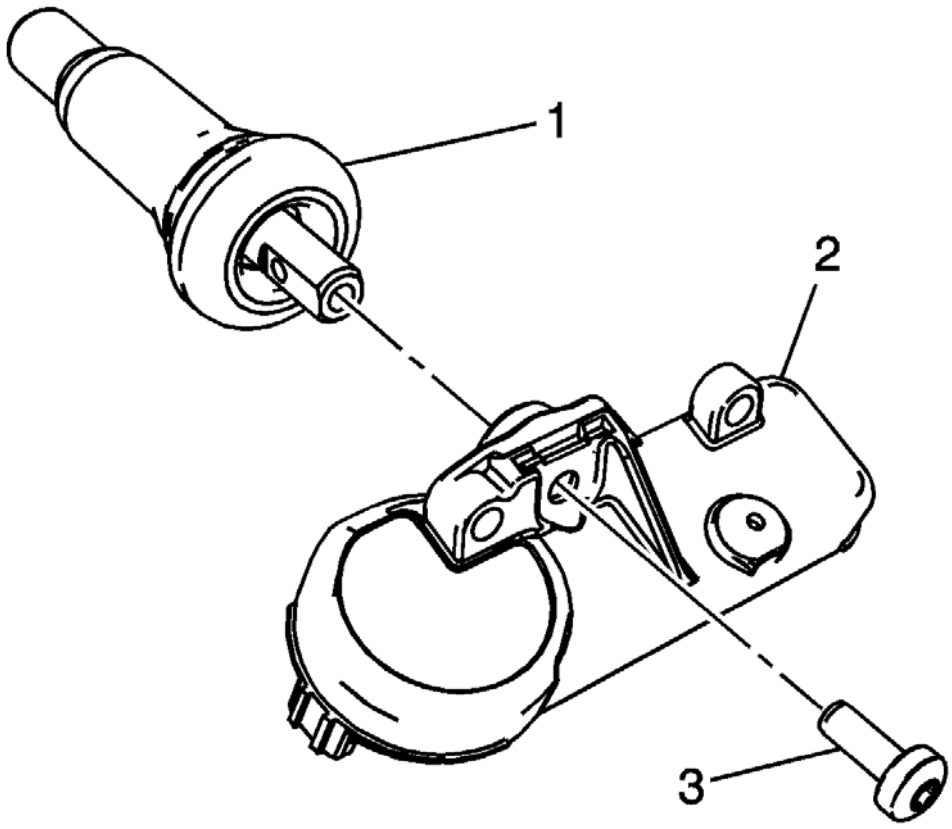


Fig. 2: View Of Tire Pressure Indicator Sensor
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE:

- **Ensure the flat of the valve, lines up with the flats of the snap in the enclosure.**
- **TPM valves and TORX screws are one-time use only.**

1. Assemble the tire pressure sensor (2) to the valve stem and install the new TORX screw (3) and tighten to 1.3 N.m (11.5 lb in).

NOTE: **Use and approved tire mounting lubricant. DO NOT use silicon or corrosive base compounds to lubricate the tire bead and the wheel rim. A corrosive type compound can cause tire or rim deterioration.**

2. Apply tire soap to the rubber portion of the valve stem (1).

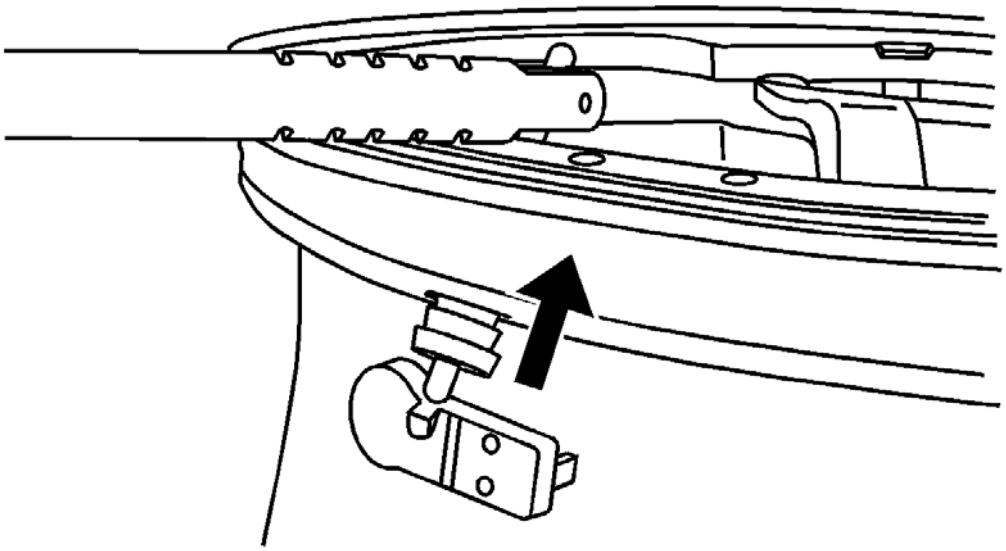


Fig. 3: View Of Tire Valve Stem Mounting Tool
Courtesy of GENERAL MOTORS COMPANY

3. Using a tire valve stem mounting tool, pull the valve stem through in a direction parallel to the valve hole on the rim.

NOTE: **Snap Fit TPM sensors are still shipped in the OFF mode. However, the TPM no longer needs to be spun to remove it from the OFF mode. The sensor will exit its OFF state when the tire is inflated. The technician can then program the vehicle as normal.**

4. Mount the tire to the rim. Refer to **Tire Dismounting and Mounting** .
5. Install the tire/wheel assembly on the vehicle. Refer to **Tire and Wheel Removal and Installation** .
6. Lower the vehicle.
7. Learn the tire pressure sensors. Refer to **Tire Pressure Indicator Sensor Learn**.

TIRE PRESSURE INDICATOR SENSOR LEARN

Special Tools

- **EL-46079** Tire Pressure Monitor Diagnostic Tool

or

- **EL-50448** Tire Pressure Monitor Sensor Activation Tool

For equivalent regional tools, refer to **Special Tools**.

Learn Mode Description

The tire pressure monitor (TPM) system uses the instrument panel cluster (IPC), body control module (BCM), remote control door lock receiver (RCDLR), keyless entry transmitter, 4 radio frequency transmitting pressure sensors, and the serial data circuit to perform the TPM learn mode functions. The sensor learn procedure must be performed after every tire rotation, RCDLR replacement, or sensor replacement. Once the learn mode has been enabled, each of the sensors unique identification codes can be learned into the RCDLR memory. When a sensor ID has been learned, the RCDLR sends a serial data message to the BCM to sound a horn chirp. This verifies the sensor has transmitted its ID and the RCDLR has received and learned it. The RCDLR must learn the sensor IDs in the proper sequence to determine correct sensor location. The first learned ID is assigned to the left front location, the second to right front, the third to right rear and the fourth to left rear. The turn signals will individually illuminate indicating which location is to be learned in the proper sequence.

Sensor Functions Using EL-46079, EL-50448, or Equivalent

Each sensor has an internal low frequency coil. When the TPM special tool is used in activate mode, it produces a low frequency transmission that activates the sensor. The sensor responds to a low frequency activation by transmitting in learn mode. When the RCDLR receives a learn mode transmission while in TPM learn mode, it will assign that sensors ID to the location on the vehicle relative to the order in which it was learned.

Learn Mode Cancellation

The learn mode will cancel if the ignition is cycled to OFF or if more than 2 minutes has elapsed for any sensor that has not been learned. If the learn mode is cancelled before the first sensor is learned, the original sensor IDs will be maintained. If the learn mode is canceled after the first sensor is learned, the following will occur:

- All stored sensor IDs will be invalidated in the RCDLR memory.
- If equipped, the DIC will display dashes instead of tire pressures.
- DTC C0775 will be set.

These conditions will now require the learn procedure to be repeated for the system to function properly.

TPM Learn Procedure

NOTE: **In the event a particular sensor's information is displayed on the special tool upon activation but the horn does not chirp, it may be necessary to rotate the wheel valve stem to a different position due to the sensor signal is being blocked by another component.**

TPM Learn Enable Methods

1. Ignition ON, initiate the TPM Learn Mode using one of the following procedures:
    - Using a scan tool, initiate the TPM Learn Mode. A double horn chirp will sound indicating the Learn Mode has been enabled. The left front turn signal will also be illuminated.
    - On vehicles equipped with keyless entry, simultaneously press the keyless entry transmitters lock and unlock buttons until a double horn chirp sounds indicating the Learn Mode has been enabled. The left

front turn signal will also be illuminated.

- On vehicles not equipped with keyless entry, press and release the driver information center (DIC) INFO button until the TIRE LEARN message appears on the DIC display. Press and hold the SET/RESET button until a double horn chirp sounds indicating the Learn Mode has been enabled. The left front turn signal will also be illuminated.

2. Starting with the left front tire, active the sensor by holding the antenna of the TPM special tool aimed upward against the tire sidewall close to the wheel rim at the valve stem location. Press and release the Activate button. Ensure that the transmit indicator on the special tool indicates that the sensor activation signal is being transmitted. Wait for a horn chirp. If the horn does not chirp, repeat the sensor activation sequence with the tool. Once the horn chirp has sounded, the sensor information is learned and the turn signal in the next location to be learned will illuminate.
3. After the horn chirp has sounded and the right front turn signal is illuminated, repeat step 2 for the remaining 3 sensors in the following order:
    1. Right front
    2. Right rear
    3. Left rear
4. When the left rear sensor has been learned and a double horn chirp has sounded, the learn process is complete and the RCDLR exits the learn mode.

DESCRIPTION AND OPERATION

TIRE PRESSURE MONITOR DESCRIPTION AND OPERATION

The tire pressure monitor (TPM) system warns the driver when a significant loss, or gain of tire pressure occurs in any of the 4 tires and allows the driver to display the individual tire pressures and their locations on the driver information center (DIC).

The system uses the body control module (BCM), driver information center (DIC), instrument panel cluster (IPC), remote control door lock receiver (RCDLR), a radio frequency (RF) transmitting pressure sensor in each wheel/tire assembly, and the serial data circuit to perform the system functions. Each sensor has an internal power supply with a 10 year service life.

When the vehicle is stationary, the sensors internal accelerometer is inactive, which puts the sensors into a stationary state. In this state the sensors sample tire pressure once every 30 seconds and do not transmit at all if the tire pressure does not change. As vehicle speed increases, centrifugal force activates the sensors internal accelerometer causing the sensors to go into rolling mode. In this mode, the sensors sample tire pressure once every 30 seconds and transmit in rolling mode once every 60 seconds. The RCDLR receives and translates the data contained in each sensors RF transmission into sensor presence, sensor mode, and tire pressure. The RCDLR sends the tire pressure and tire location data to the DIC via the serial data circuit where they are displayed.

The sensors continuously compare their last pressure sample to their current pressure sample and will transmit in re-measure mode if a 8.3 kPa (1.2 psi) change in tire pressure has been detected in either a stationary or rolling state. When the TPM system detects a significant loss, or gain of tire pressure, the tire pressure monitor indicator icon is illuminated on the IPC and if equipped, a check tire pressure type message is displayed on the DIC. Both the indicator icon and DIC message can be cleared by adjusting the tire pressures to the recommended kPa/psi and driving the vehicle above 40 km/h (25 mph) for at least 2 minutes.

If power is disconnected from the RCDLR or if the vehicle battery is disconnected each TPM sensor ID is retained but all of the tire pressure information is lost. Under these circumstances the RCDLR cannot assume that the tire

pressures were maintained over an unknown period of time. If equipped, the DIC will display all dashes and the scan tool will indicate a default tire pressure value of 1020 kPa (148 psi) for each tire. Driving the vehicle above 40 km/h (25 mph) for at least 2 minutes will activate the sensors causing the DIC to display the current tire pressures. The Tire Pressure Monitor Diagnostic Tool special tool or the pressure increase/decrease method may also be used to activate the sensors as well.

The RCDLR has the ability to detect malfunctions within the TPM system. In the event a DTC is set, the tire pressure monitor indicator icon on the IPC will flash for 1 minute and then remain illuminated after the ignition is turned ON and the IPC bulb check has been completed. Any malfunction detected will cause the DIC to display a service tire monitor system type message. For more information on other functions of the RCDLR, refer to **Keyless Entry System Description and Operation** .

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

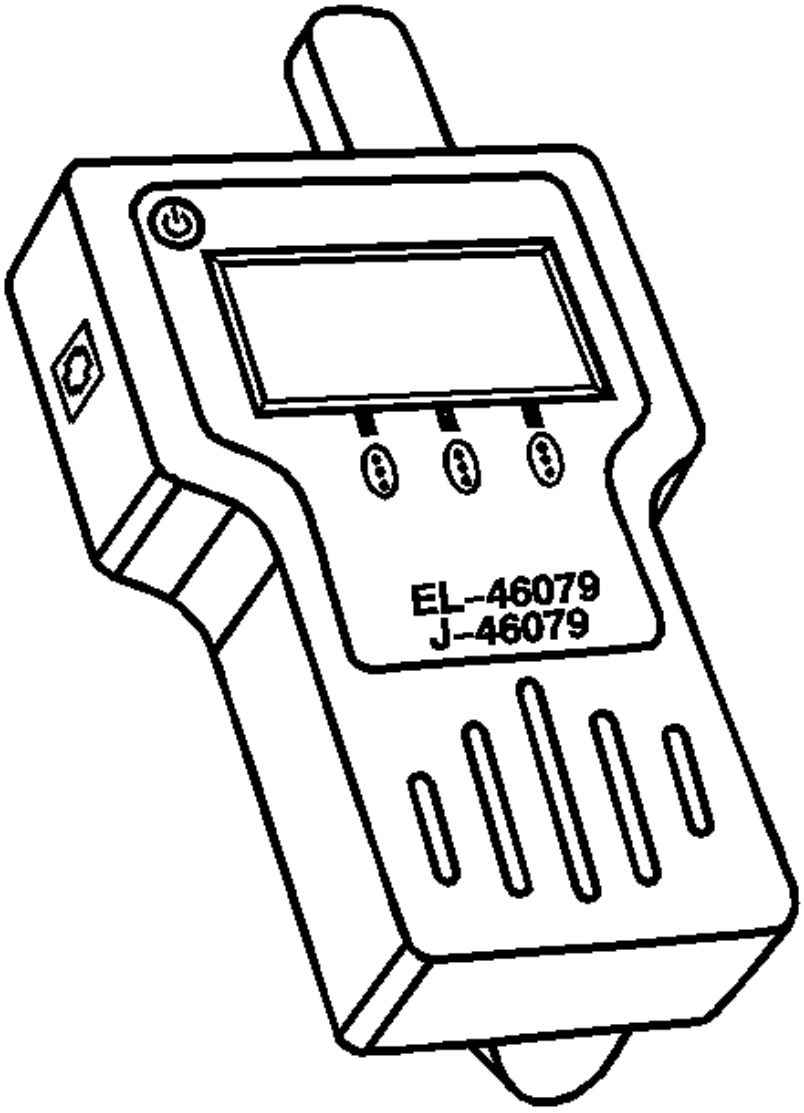
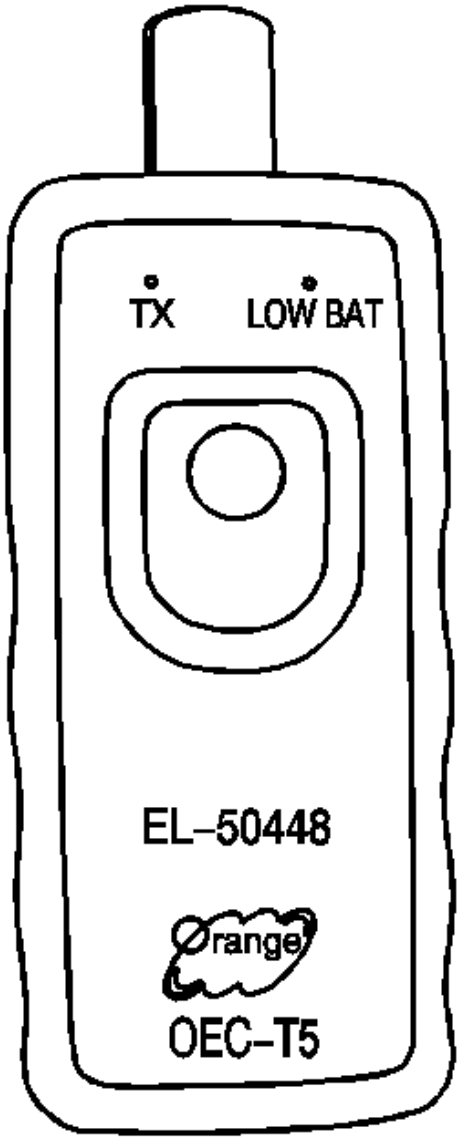
Illustration	Tool Number/Description
	EL 46079 Tire Pressure Monitor Diagnostic Tool

Illustration	Tool Number/Description
	EL 50448 Tire Pressure Monitor Sensor Activation Tool

Article GUID: A00737174

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Wheel Nut Torque	150 N.m	111 lb ft

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	Canadian Part Number
Aluminum Wheel	Adhesive/Sealant	12378478	88900041
Aluminum Wheel	3MÂ® General Purpose Cleaner	08984	-
Wheel	Mounting Lubricant	12345884	88863415
Wheel to Hub	Lubricant	1051344	993037

DIAGNOSTIC INFORMATION AND PROCEDURES

TIRE DIAGNOSIS - IRREGULAR OR PREMATURE WEAR

Tire Wear

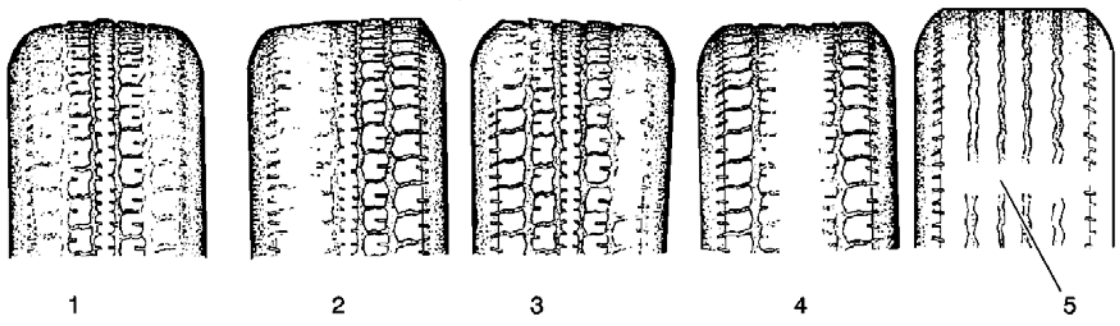


Fig. 1: Identifying Types Of Tire Wear
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Under-Inflation, Hard Cornering, Lack of Regular Rotation

Callout	Component Name
2	Incorrect Wheel Alignment, Hard Cornering, Lack of Regular Rotation
3	Incorrect Wheel Alignment
4	Over-Inflation, Heavy Acceleration, Lack of Regular Rotation
5	Normal Wear to the Wear Indicator

Inspection Procedure

1. Inspect the front tire wear.
2. Inspect the rear tire wear.
3. Rotate the tires if any of the following conditions exist:
    - The amount of time or mileage since the last tire rotation matches the maintenance schedule.
    - The outer tread blocks are worn more than the middle tread blocks (1).
    - The outer tread blocks are worn more than the inner tread blocks (2).
    - The middle tread blocks are worn more than the outer tread blocks (4).
4. Measure the wheel alignment if any of the following conditions exist:
    - The tread blocks have feathered edges (3).
    - The outer tread blocks are worn more than the inner tread blocks (2).
    - The inner tread blocks are worn more than the outer tread blocks (2).
5. Inspect the struts or the shock absorbers if the tire tread exhibits a cupped appearance (3).

TIRE DIAGNOSIS - WADDLE COMPLAINT

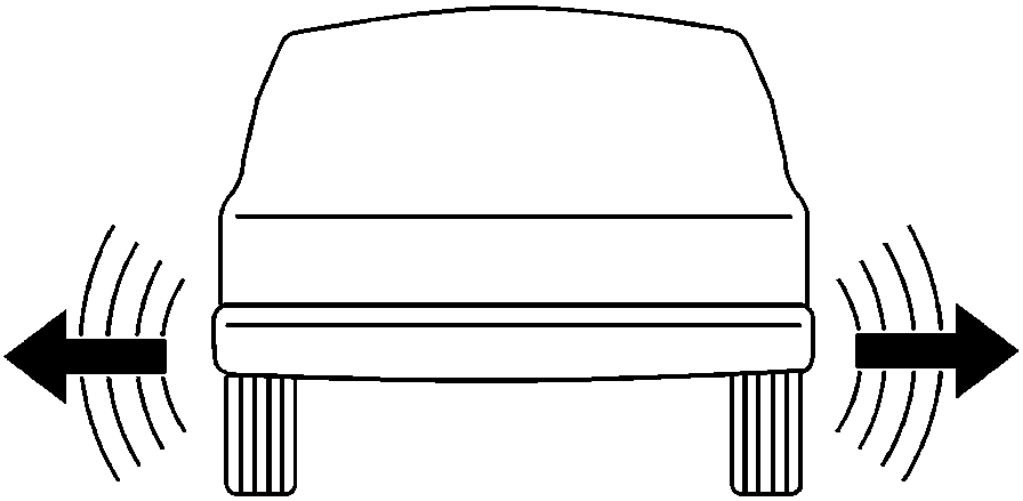


Fig. 2: Identifying Tire Wobble/Waddle
Courtesy of GENERAL MOTORS COMPANY

Tire waddle is a side to side movement at the front of the vehicle and/or the rear of the vehicle. Tire waddle can be caused by the following conditions:

- A steel belt not being straight within the tire
- Excessive lateral runout of the tire
- Excessive lateral runout of the wheel

The tire waddle is most noticeable at a low speed of about 8-48 km/h (5-30 mph). Tire waddle may appear as ride roughness at 80-113 km/h (50-70 mph). Tire waddle may appear as a vibration at 80-113 km/h (50-70 mph).

Inspection Procedure

1. Raise and support the vehicle with safety stands. Refer to **Lifting and Jacking the Vehicle** .

WARNING: Wear gloves when inspecting the tires in order to prevent personal injury

from steel belts sticking through the tire.

2. Perform the following preliminary inspection:
    1. Mark the tire with a crayon in order to note the start and the stop position.
    2. Rotate each tire and wheel by hand.
    3. Inspect the tire for bulges or bent wheels. Replace as necessary.
3. Use tire substitution in order to identify the faulty tire. Perform the following steps for a tire substitution check:
    1. Use a comparable tire in order to replace each tire, one at a time.
    2. Test drive the vehicle.
    3. If the problem is tire or wheel related, you will eliminate the problem when you remove the faulty tire from the vehicle.

WHEEL MOUNTING SURFACE CHECK

Replace any wheels that are bent or dented, or have excessive lateral or radial runout. Wheels with runout greater than specified may cause objectionable vibrations.

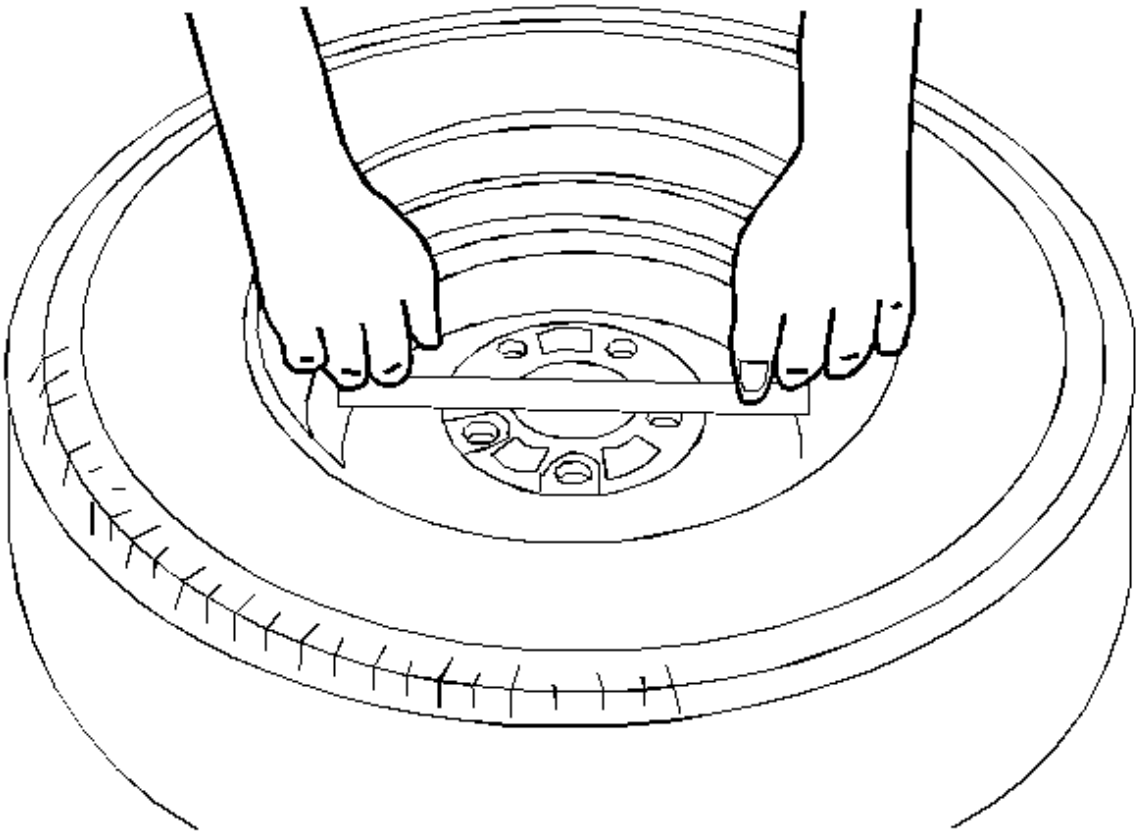


Fig. 3: Checking Wheel Mounting Surface
Courtesy of GENERAL MOTORS COMPANY

1. Use a straight edge 203-229 mm (8-9 in) long. Place the straight edge on the wheel inboard mounting surface. Try to rock the straightedge up and down within the mounting surface.

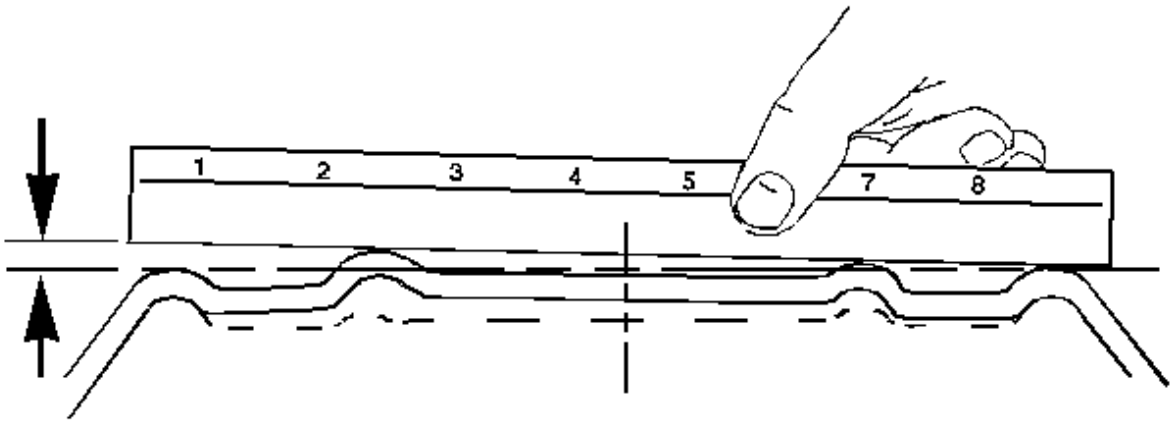


Fig. 4: Inspecting Wheel Inboard Mounting Surface
Courtesy of GENERAL MOTORS COMPANY

2. Repeat this procedure on at least 3-4 different positions on the inboard mounting surface.
    - The outer ring of the mounting surface normally is raised above everything inside the mounting surface.
    - The mounting surface will be raised above the outer ring if the wheel mounting surface has been bent on a tire changer.
    - If you can rock the straight edge, the mounting surface is bent and you must replace the wheel.

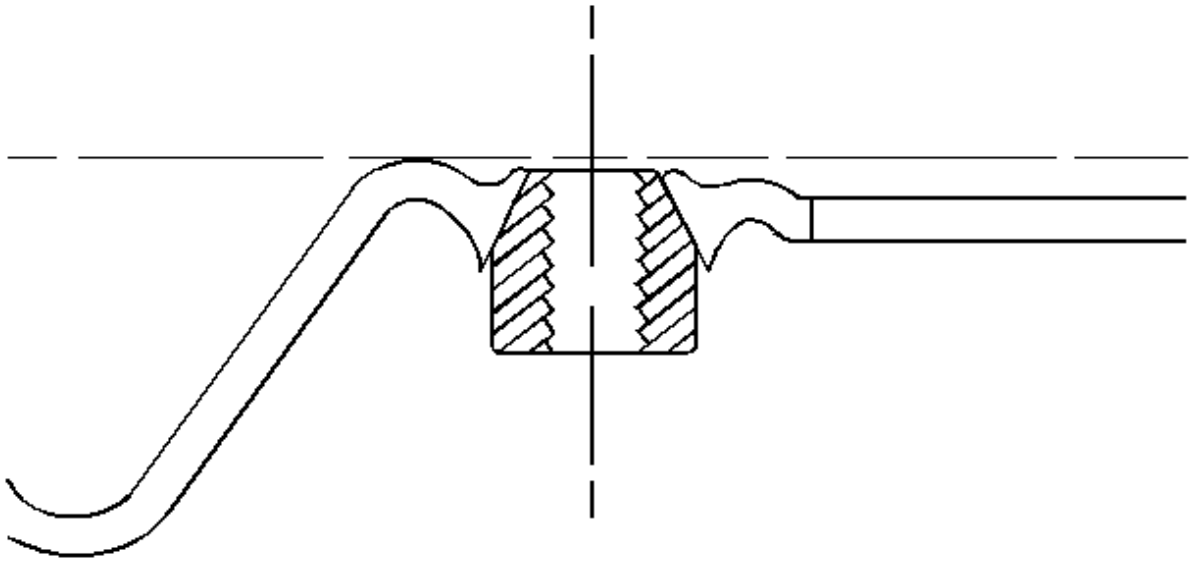


Fig. 5: Inspecting Mounting Wheel/Nut Holes For Damage Caused From Over-Torquing The Wheel/Nuts
Courtesy of GENERAL MOTORS COMPANY

3. Inspect the mounting wheel/nut holes for damage caused from over-torquing the wheel/nuts. Inspect for collapsed wheel/nut bosses. Inspect for cracked wheel bosses.

CAUTION: The use of non-GM original equipment wheels may cause:

- **Damage to the wheel bearing, the wheel fasteners and the wheel**
- **Tire damage caused by the modified clearance to the adjacent vehicle components**
- **Adverse vehicle steering stability caused by the modified scrub radius**
- **Damage to the vehicle caused by the modified ground clearance**
- **Speedometer and odometer inaccuracy**

NOTE:

- **Replacement wheels must be equivalent to the original equipment wheels in the following ways:**
  - **The load capacity**
  - **The wheel diameter**
  - **The rim width**
  - **The wheel offset**
  - **The mounting configuration**
- **A wheel of the incorrect size or type may affect the following conditions:**
  - **Wheel and hub-bearing life**
  - **Brake cooling**
  - **Speedometer/odometer calibration**
  - **Vehicle ground clearance**
  - **Tire clearance to the body and the chassis**

4. Replace the wheel if the wheel is bent.
5. Replace the wheel if the wheel/nut boss area is cracked.

Identify steel wheels with a 2 or 3-letter code stamped into the rim near the valve stem. Aluminum wheels have the code, the part number, and the manufacturer identification cast into the back side of the wheel.

RADIAL TIRE LEAD/PULL CORRECTION

Lead/Pull Correction Table

Step	Action	Yes	No
DEFINITION: Lead/pull is the deviation of the vehicle from a straight path on a level road with no pressure on the steering wheel. Lead is usually caused by the following conditions: • Poor tire construction • Uneven brake assemblies • Improper tire and wheel alignment In the front tires (rear tires will not cause lead) Tire construction can be a cause of lead in a vehicle. An example of this is placement of the belt. Off center belts on radial tires can cause the tire to develop a side force while rolling straight down the road, and the tire will tend to roll like a cone. Use the lead/pull correction table in order to verify that improper tire and wheel alignment is not mistaken for tire lead.			
1	Inspect and repair/replace the tire/wheel assemblies for the following conditions: • Correct tire pressure • Excessive/uneven tire wear • Correct tire size	Go to **Step 2**	-

Step	Action	Yes	No
	• Excessive radial/lateral wheel runout • Out of balance Is the action complete?		
2	Inspect and repair the front and rear suspensions for the following conditions: • Damage • Excessive wear • Loose components • Excessive wheel bearing play Is the action complete?	Go to **Step 3**	-
3	Inspect and repair the power steering gear and pump for the following conditions: • Damage • Excessive wear Is the action complete?	Go to **Step 4**	-
4	1. Cross-switch the front tire/wheel assemblies. 2. Road test the vehicle. Does the vehicle still lead/pull?	Go to **Step 5**	System OK
5	Does the vehicle lead/pull in the opposite direction?	Go to **Step 6**	Go to **Braking Action Uneven - Pulls to One Side**
6	1. Cross-switch the left front tire/wheel assembly with the left rear tire/wheel assembly. 2. Road test the vehicle. Does the vehicle still lead/pull?	Go to **Step 7**	Go to **Step 8**
7	1. Cross-switch the right front tire/wheel assembly with the right rear tire/wheel assembly. 2. Road test the vehicle. Does the vehicle still lead/pull?	Go to **Braking Action Uneven - Pulls to One Side**	Go to **Step 9**
8	Replace the left rear tire. Is the repair complete?	System OK	-
9	Replace the right rear tire. Is the repair complete?	System OK	-

REPAIR INSTRUCTIONS

ALUMINUM WHEEL POROSITY REPAIR

1. Remove the tire and wheel. Refer to **Tire and Wheel Removal and Installation**.
2. Inflate the tire to the manufactures specified pressure as stated on the tire.
3. Submerge the tire/wheel into a water bath in order to locate the leak.
4. Inscribe a mark on the wheel in order to indicate the leak areas.
5. Inscribe a mark on the tire at the valve stem in order to indicate the orientation of the tire to the wheel.
6. Remove the tire from the wheel. Refer to **Tire Dismounting and Mounting**.

   IMPORTANT: Do not damage the exterior surface of the wheel.

7. Use number 80 grit sandpaper to scuff the inside of the rim surface at the leak area.
8. Use general purpose cleaner such as 3MÂ®, P/N 08984 or equivalent, to clean the leak area.
9. Apply 3 mm (0.12 in) thick layer of adhesive/sealant, GM P/N 12378478 (Canadian P/N 88900041) or equivalent, to the leak area.
10. Allow for the adhesive/sealant to dry.
11. Align the inscribed mark on the tire with the valve stem on the wheel.
12. Install the tire to the wheel. Refer to **Tire Dismounting and Mounting**.
13. Pressurize the tire to 276 kPa (40 psi).
14. Submerge the tire/wheel into a water bath in order ensure the leak is sealed.
15. Inflate the tire to the specified pressure as stated on the tire placard.
16. Balance the tire and wheel. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle** .
17. Install the tire and wheel. Refer to **Tire and Wheel Removal and Installation**.

ALUMINUM WHEEL REFINISHING

Finish Damage Evaluation Procedure

NOTE:

- **If the wheels are chrome-plated, do not re-plate or refinish the wheels.**
- **If the wheels are polished aluminum, do not refinish the wheels in the dealer environment. Utilize a refinisher that meets manufacturer guidelines.**

1. Inspect the wheels for damage from uncoated wheel balance weights or from automatic car wash facilities.
2. Inspect the wheels for the following conditions:
   - Corrosion
   - Scrapes
   - Gouges
3. Verify the damage is not deeper than what sanding can remove.

4. Inspect the wheels for cracks. If a wheel has cracks, discard the wheel.
5. Inspect the wheels for bent rim flanges. If a rim flange is bent, discard the wheel.

Refinishing Procedure

WARNING: **To avoid serious personal injury when applying any two part component paint system, follow the specific precautions provided by the paint manufacturer. Failure to follow these precautions may cause lung irritation and allergic respiratory reaction.**

1. Remove the tire and wheel assembly from the vehicle. Refer to **Tire and Wheel Removal and Installation**.
2. Remove the balance weights from the wheel.
3. Remove the tire from the wheel. Refer to **Tire Dismounting and Mounting**.
4. Use a suitable cleaner in order to remove the following contaminants from the wheel:
   - Lubricants
   - Wax
   - Dirt

NOTE:
- **Do not re-machine the wheel.**
- **Do not use chemicals in order to strip the paint from the wheel.**

5. Use plastic media blasting in order to remove the paint from the wheel.
6. If the wheel had a machined aluminum finish, spin the wheel and use sand paper in order to restore the circular machined appearance.

NOTE: **The wheel mounting surface and the wheel nut contact surface must remain free of paint.**

7. Mask the wheel mounting surface and the wheel nut contact surface.
8. Follow the paint manufacturer's instructions for painting the wheel.
9. Unmask the wheel.
10. Install a new valve stem.

NOTE: **Use new coated balance weights in order to balance the wheel.**

11. Install the tire to the wheel. Refer to **Tire Dismounting and Mounting**.
12. Use a suitable cleaner in order to remove the following contaminants from the wheel mounting surface:
    - Corrosion
    - Overspray
    - Dirt
13. Install the tire and wheel assembly to the vehicle. Refer to **Tire and Wheel Removal and Installation**.

TIRE AND WHEEL REMOVAL AND INSTALLATION

Special Tools

- **CH-41013** Rotor Resurfacing Kit
- **CH-42450-A** Wheel Hub Resurfacing Kit

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the wheel center cap, if equipped.

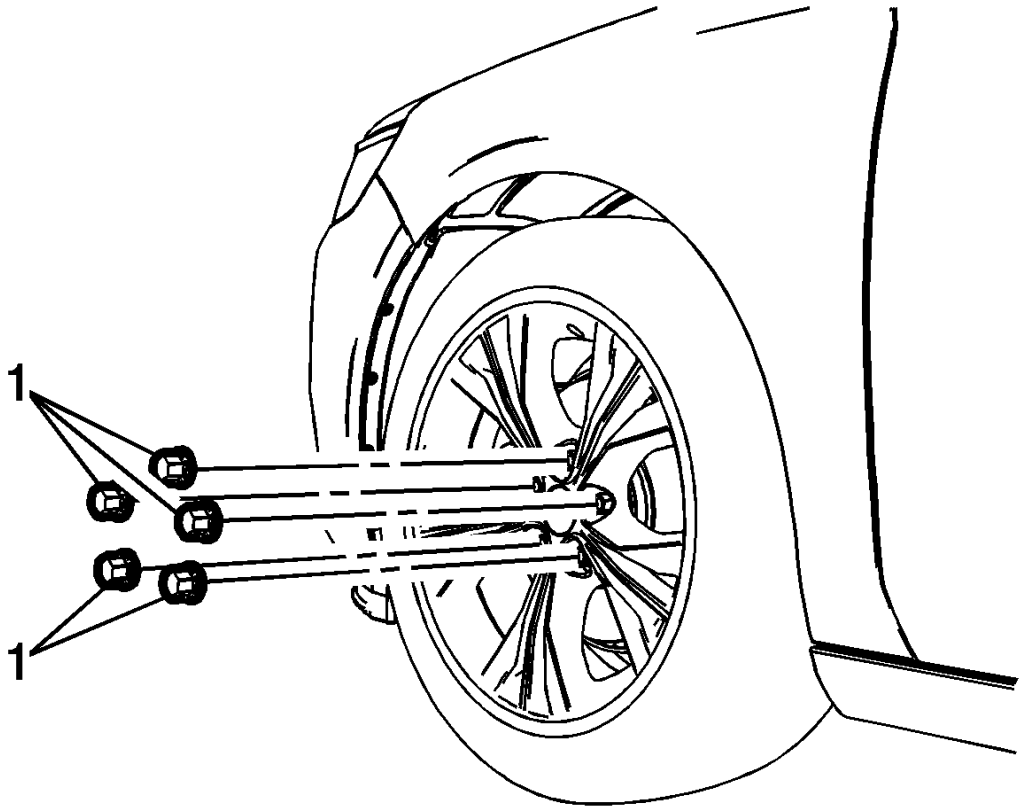


Fig. 6: Wheel Nut Caps
Courtesy of GENERAL MOTORS COMPANY

3. Remove the wheel nut caps (1), if equipped.

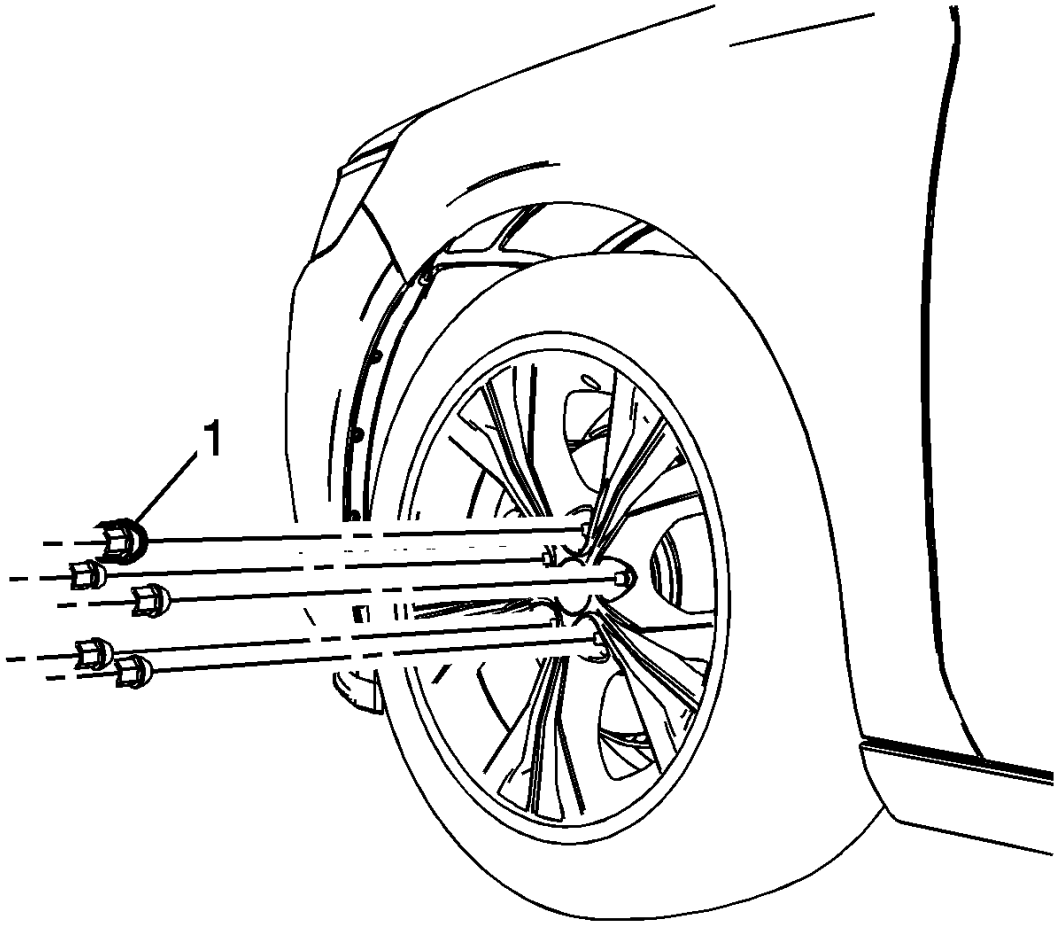


Fig. 7: Wheel Nuts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the wheel nuts (1).

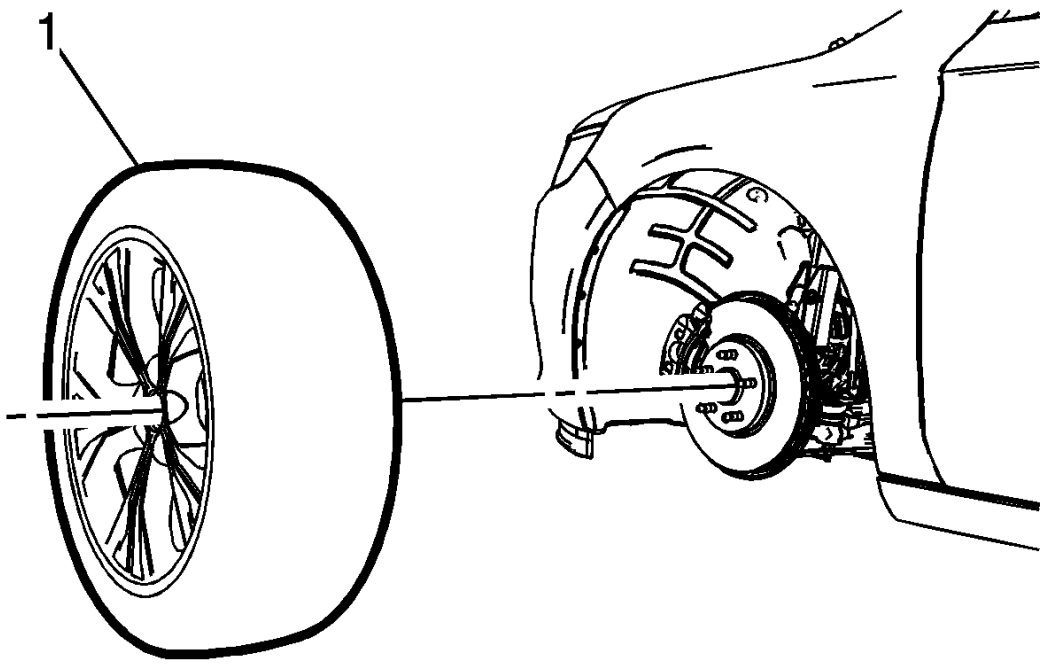


Fig. 8: Tire & Wheel Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Remove the tire and wheel assembly (1).

WARNING: If penetrating oil gets on the vertical surfaces between the wheel and the rotor or drum it could cause the wheel to work loose as the vehicle is driven, resulting in loss of control and an injury accident.

CAUTION: Removing the wheel may be difficult because of foreign materials or a tight fit between the wheel and the hub/rotor. Slightly tap the tire side wall with a rubber mallet in order to remove the wheel. Failure to follow these instructions may result in damage to the wheel.

CAUTION: Never use heat to loosen a tight wheel bolt or nut. This can shorten the life of wheel and damage wheel bearings.

6. If the tire and wheel assembly is difficult to remove or cannot be removed, perform the following steps:
   - Hand install the wheel nuts.
   - Loosen the wheel nuts 2 complete turns.

- Lower the vehicle.
- Rock the vehicle from side to side.
- Repeat the procedure if necessary.

7. When the tire and wheel assembly loosens, raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
8. Remove the wheel nuts.
9. Remove the tire and wheel assembly.

Installation Procedure

WARNING: **Before installing the wheels, remove any buildup of corrosion on the wheel mounting surface and brake drum or disc mounting surface. Installing wheels with poor metal-to-metal contact at the mounting surfaces can cause wheel nuts to loosen. This can cause a wheel to come off when the vehicle is moving, causing loss of control and possibly personal injury.**

NOTE: **Do not use power grinding tools to clean the brake rotor or drum to wheel mating surfaces.**

1. Using a wire brush or wire wheel, clean the wheel to brake rotor or drum mating surface.
2. Using the **CH-41013** Rotor Resurfacing Kit , clean the rotor or drum to wheel contact area.
3. Using the **CH-42450-A** Wheel Hub Resurfacing Kit , clean the surfaces around the wheel studs.
4. Clean the threads of the wheel studs.
5. If the threads of the wheel stud are damaged, replace the wheel stud. Refer to **Wheel Stud Replacement** , or **Wheel Stud Replacement** .
6. After cleaning all of the wheel and brake rotor or drum contact areas, use brake cleaner or denatured alcohol to remove any dirt and debris from the wheel nuts and the brake rotor or drum.
7. Inspect and clean the contact areas of the wheel. Refer to **Wheel Mounting Surface Check**.

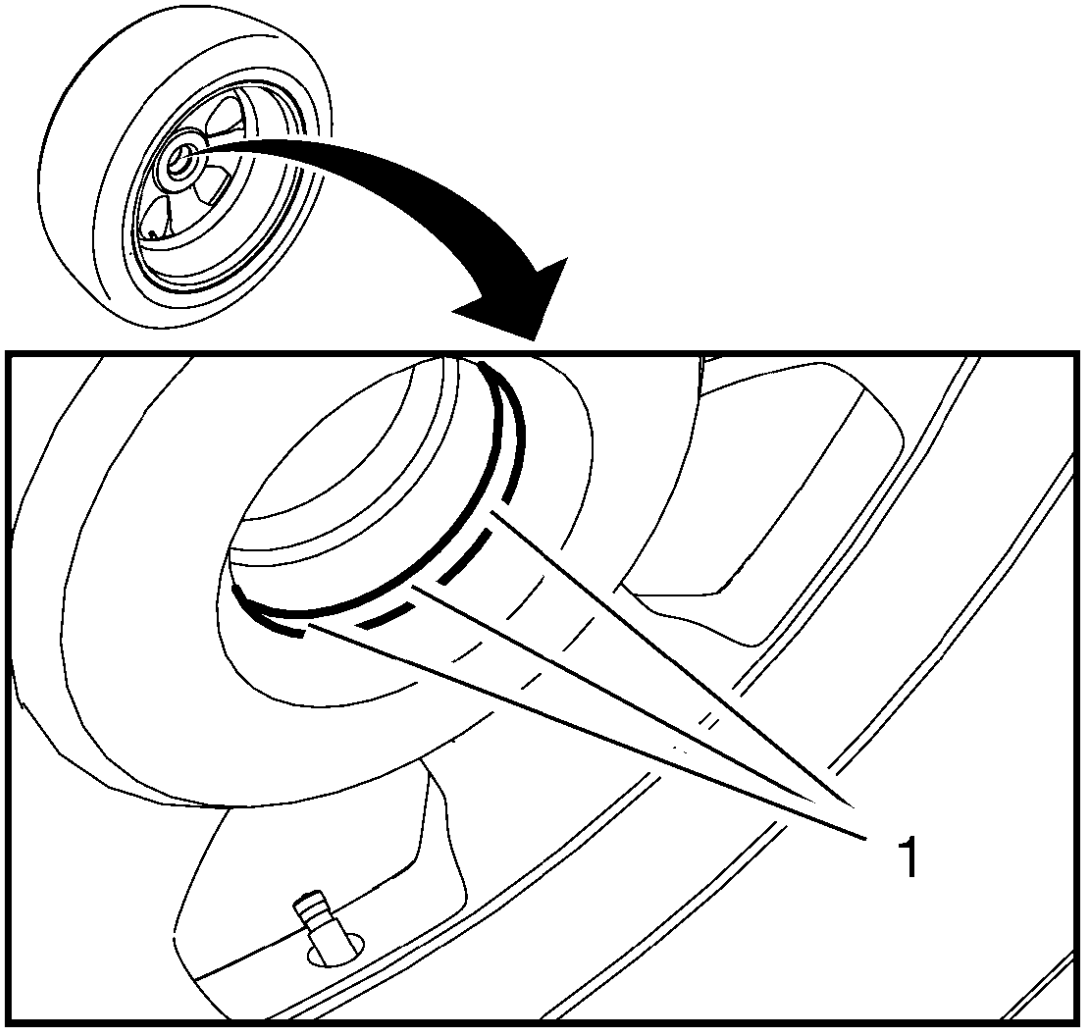


Fig. 9: Rim Inner Center Seat
Courtesy of GENERAL MOTORS COMPANY

8. Apply a small amount of lubricant to the inner diameter of the wheel hub pilot hole (1) where it contacts the wheel hub flange. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

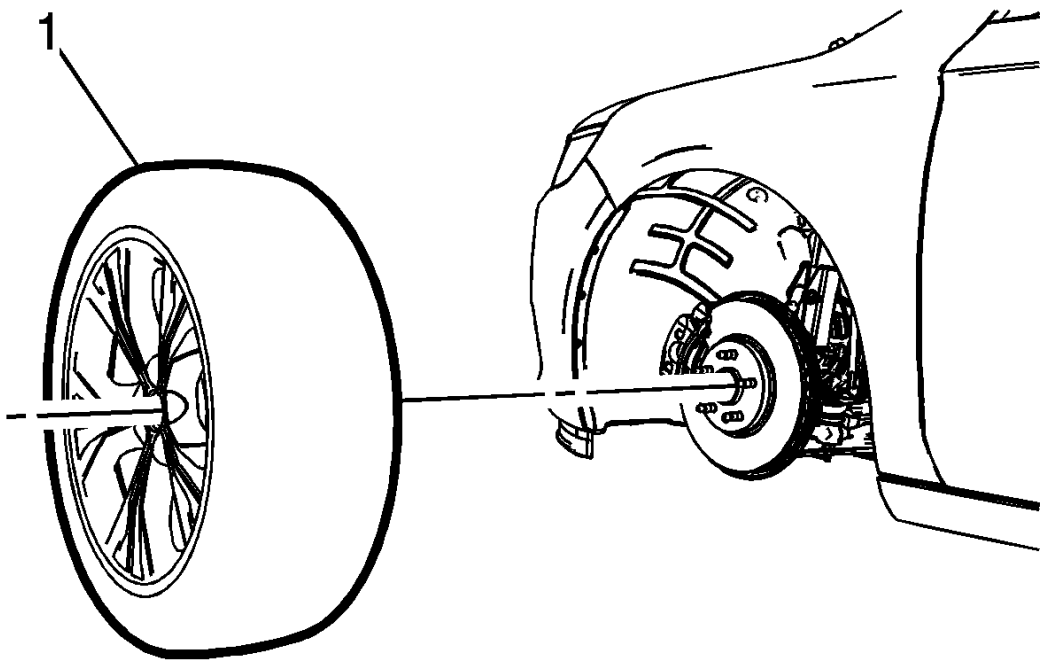


Fig. 10: Tire & Wheel Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Install the tire and wheel assembly (1).

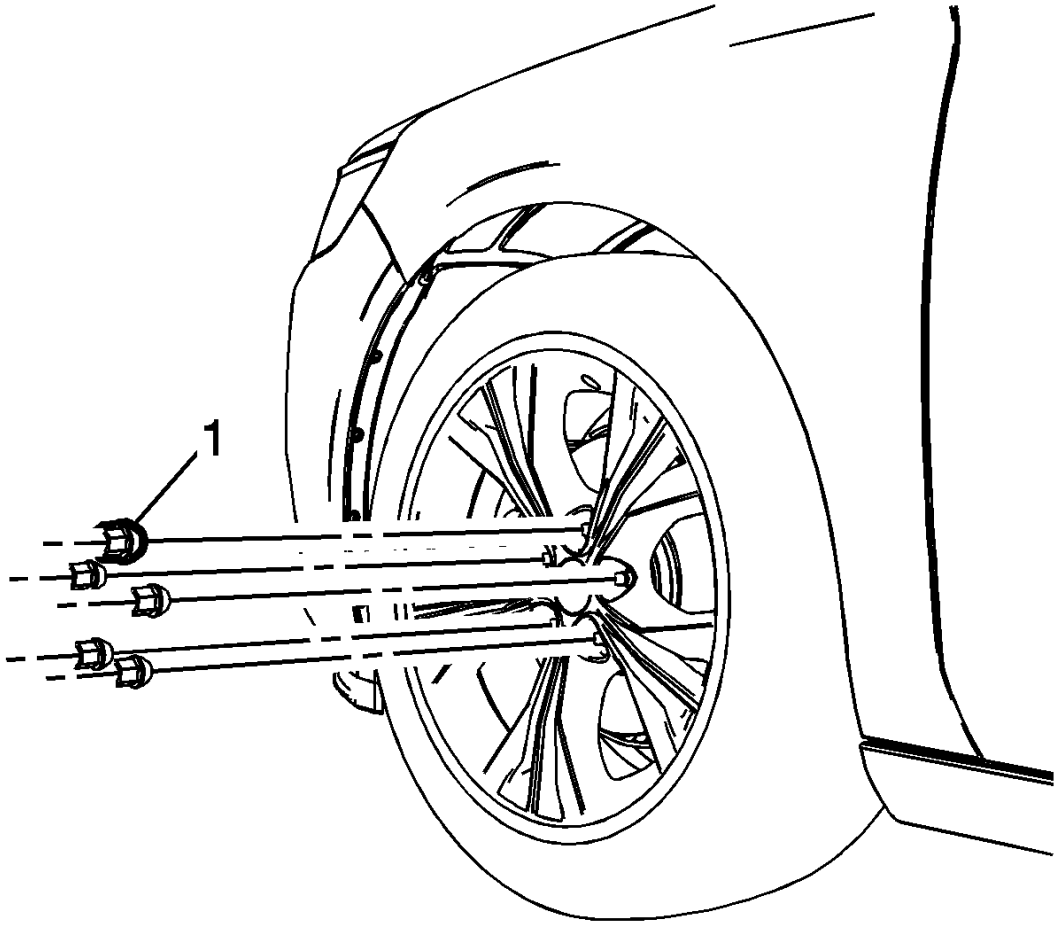


Fig. 11: Wheel Nuts
Courtesy of GENERAL MOTORS COMPANY

WARNING: Never grease or lubricate wheel nuts, studs and mounting surfaces. Wheel nuts, studs, and mounting surfaces must be clean and dry. Tightening the lubricated parts can cause damage to the wheel studs. This can cause a wheel to come off when the vehicle is moving, causing loss of control and possibly personal injury.

10. Hand install the wheel nuts (1).

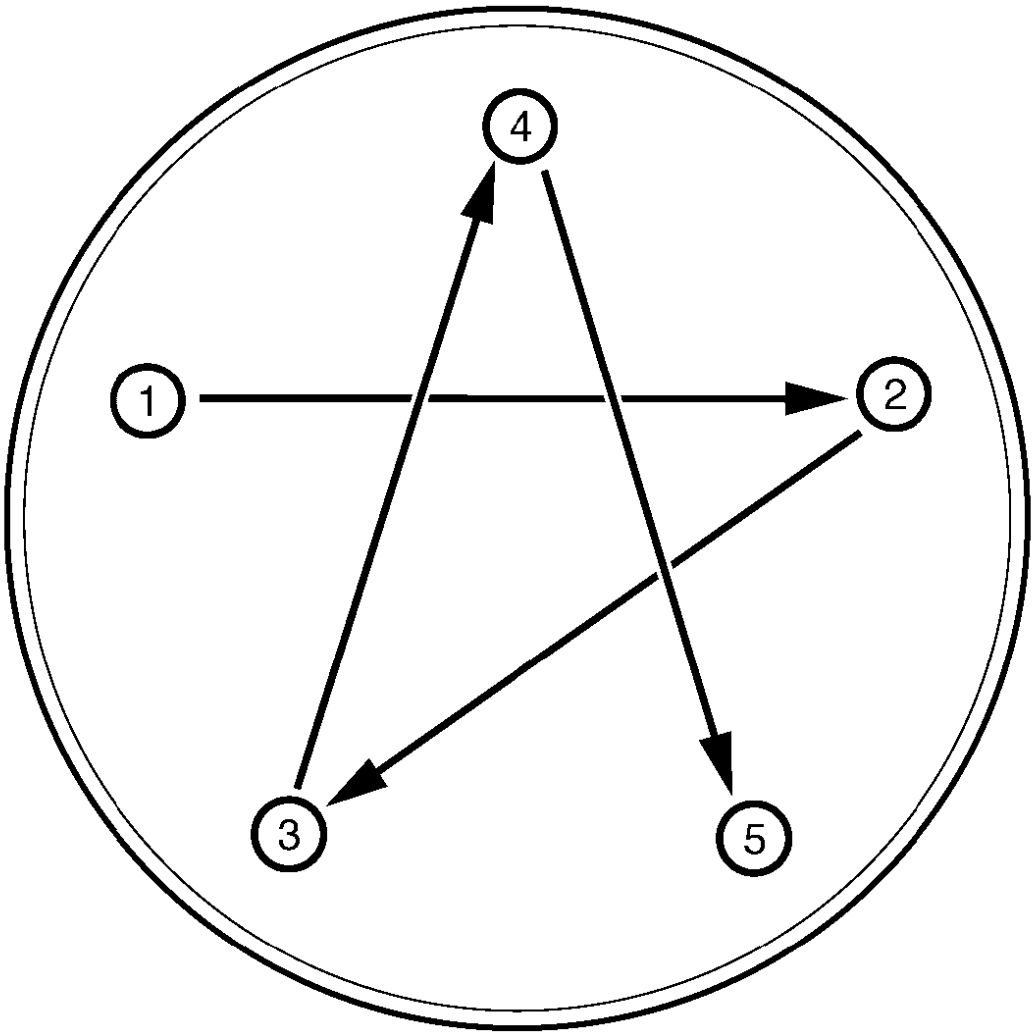


Fig. 12: Wheel Nut Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Improperly tightened wheel bolts or nuts can lead to brake pulsation and rotor damage. In order to avoid expensive brake repairs, evenly tighten the wheel bolts or nuts to the proper torque specification.**

CAUTION: **Refer to Fastener Caution .**

11. Using a torque wrench and the appropriate socket, alternately and evenly tighten the wheel nuts in the sequence illustrated.
    - If equipped with aluminum wheels, tighten the wheel nuts to 126 N.m (93 lb ft).
    - If equipped with steel wheels, tighten the wheel nuts to 140 N.m (103 lb ft).

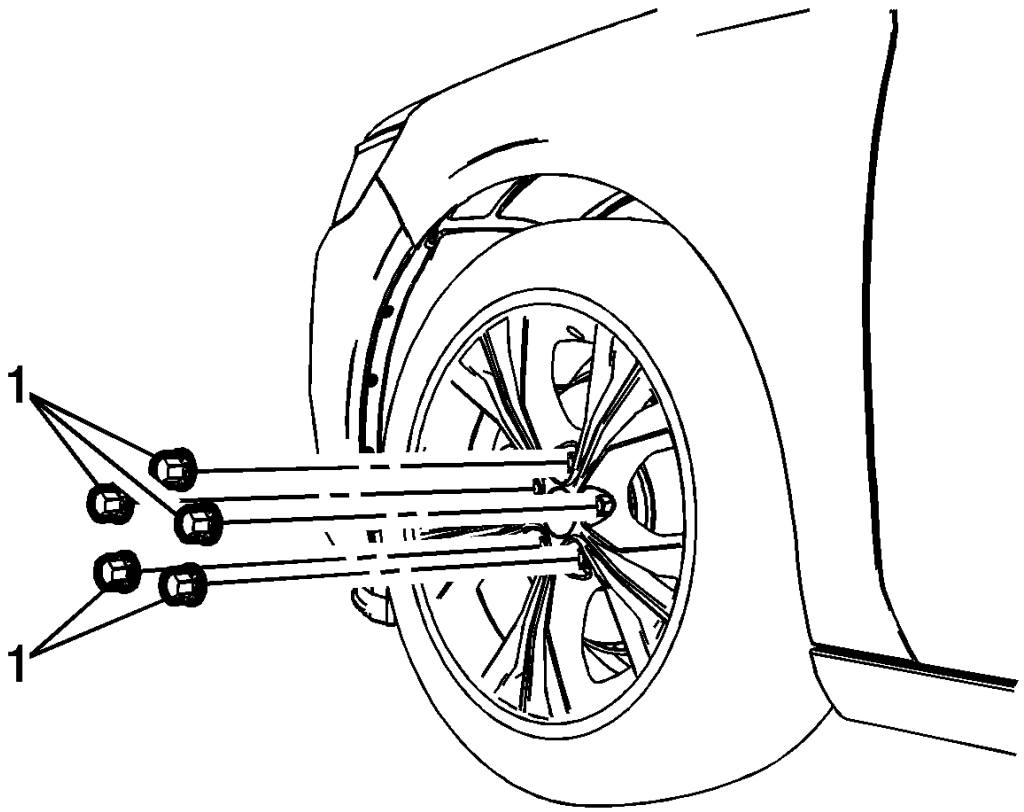


Fig. 13: Wheel Nut Caps
Courtesy of GENERAL MOTORS COMPANY

12. Install the wheel nut caps (1), if equipped.
13. Install the wheel center cap, if equipped.

TIRE REPAIR

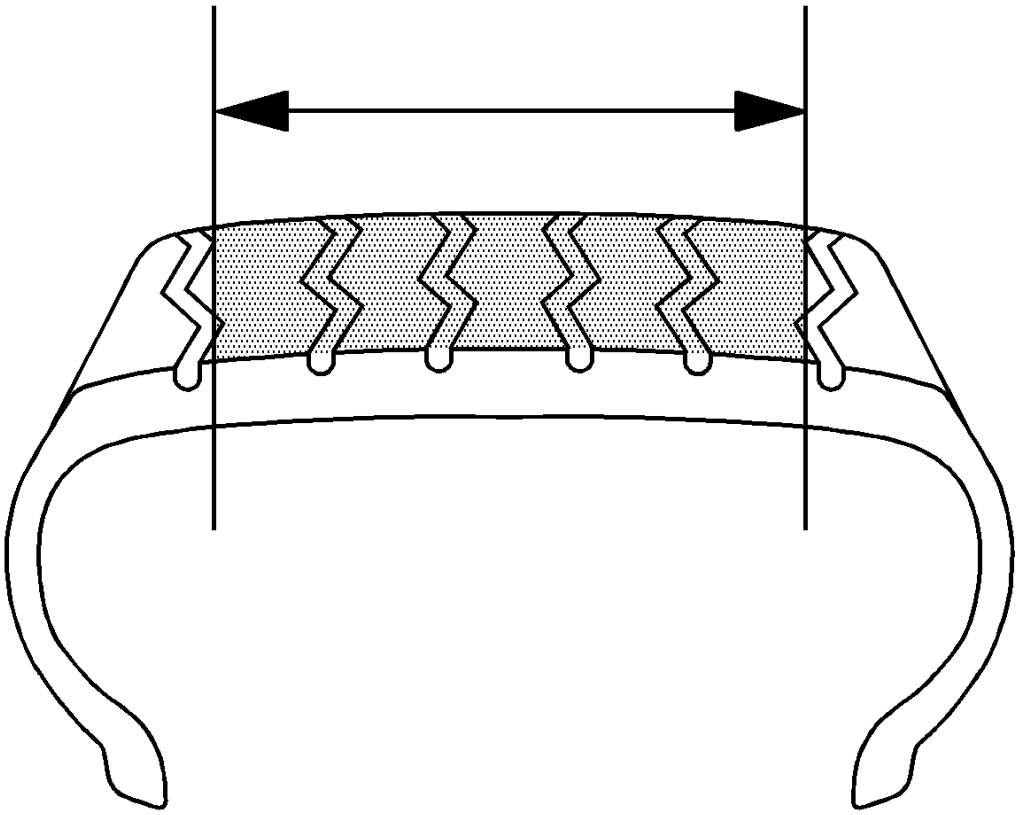


Fig. 14: Identifying Repairable Area On A Radial Tire
Courtesy of GENERAL MOTORS COMPANY

WARNING:

- **Tire changing can be dangerous and should be done by trained professionals using proper tools and procedures. Always read and understand any manufacturer's warnings contained in their customers literature or molded into the tire sidewall.**
- **Serious eye and ear injury may result from not wearing adequate eye and ear protection while repairing tires.**
- **NEVER inflate beyond 275 kPa (40 pounds) pressure to seat beads.**
- **NEVER stand, lean or reach over the assembly during inflation.**

Repairable area on a radial tire.

NOTE:

- **NEVER repair tires worn to the tread indicators 1.59 mm (2/32 in) remaining depth.**
- **NEVER repair tires with a tread puncture larger than 6.35 mm (1/4 in).**
- **NEVER substitute an inner tube for a permissible or non-permissible**

repair.

- **NEVER perform an outside-in tire repair (plug only, on the wheel).**
- **Every tire must be removed from the wheel for proper inspection and repair.**
- **Regardless of the type of repair used, the repair must seal the inner liner and fill the injury.**
- **Consult with repair material supplier/manufacturer for repair unit application procedures and repair tools/repair material recommendations.**

Three basic steps for tire puncture repair:

1. Remove the tire from the wheel for inspection and repair.
2. Fill the injury (puncture) to keep moisture out.
3. Seal the inner liner with a repair unit to prevent air loss.

External Inspection

1. Prior to demounting, inspect the tire surface, the valve and the wheel for the source of the leak by using a water and soap solution. Mark the injured area and totally deflate the tire by removing the valve core.
2. Demount the tire from the wheel and place the tire on a well-lighted spreader.

Internal Inspection

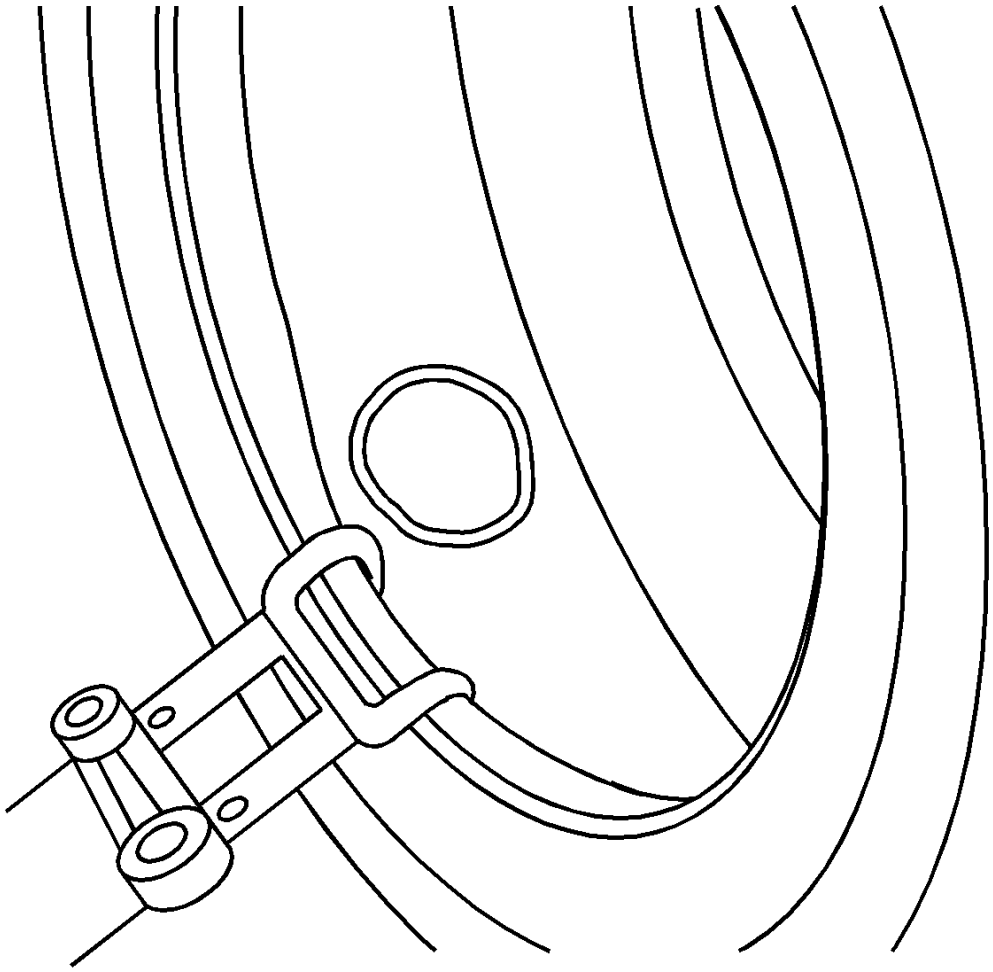


Fig. 15: Marking Tire Puncture Location
Courtesy of GENERAL MOTORS COMPANY

1. Spread the beads and mark the puncture with a tire crayon.
2. Inspect the inner tire for any signs of internal damage.
3. Remove the puncturing object, noting the direction of the penetration.
4. Probe the injury with a blunt awl in order to determine the extent and direction of the injury.
5. Remove any loose foreign material from the injury.
6. Punctures exceeding 6.35 mm (1/4 in) should not be repaired.

Cleaning

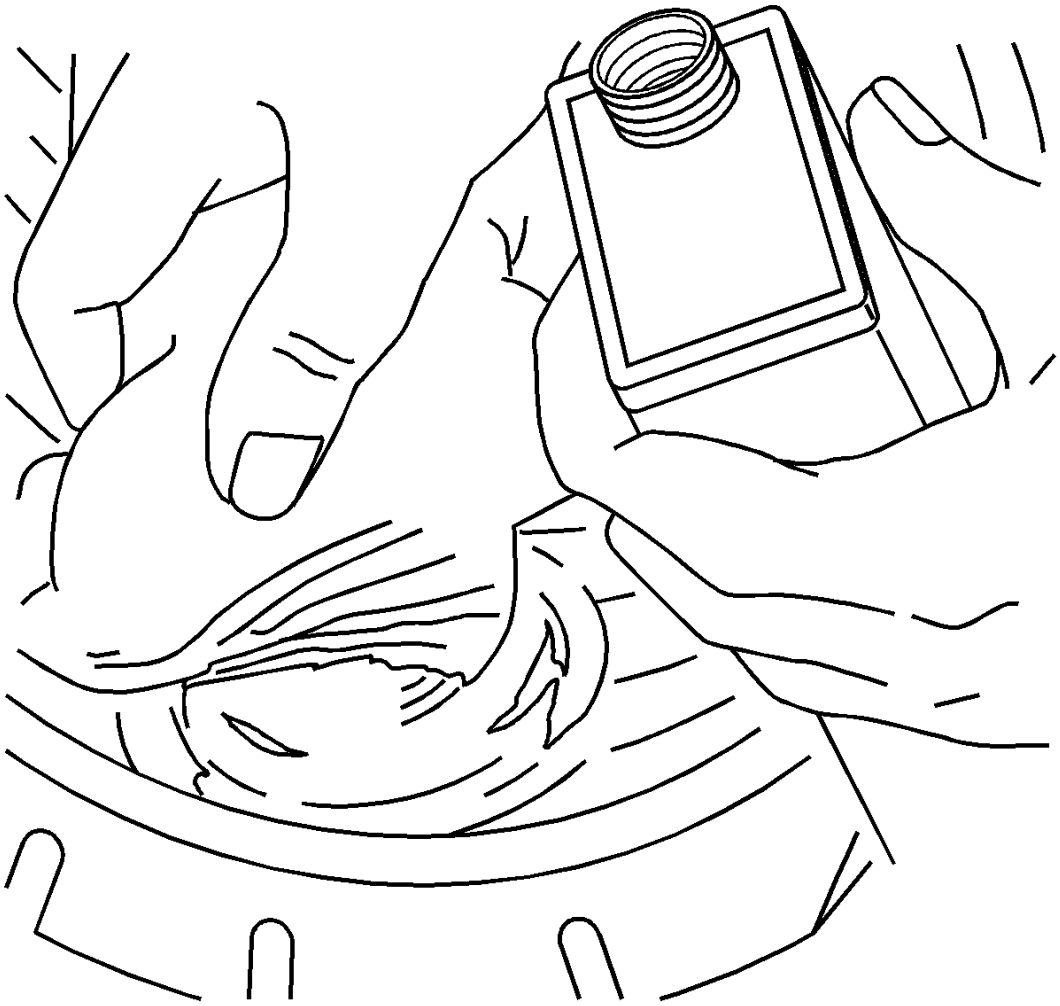


Fig. 16: Cleaning Repair Area
Courtesy of GENERAL MOTORS COMPANY

1. Clean the area around the puncture thoroughly with a proper liner cleaner, clean cloth and a scraper. This step serves to remove dirt and mold lubricants to insure proper adhesion and non-contamination of the buffing tool.
2. Refer to information on the product or manufacturer's Material Safety Data Sheet and follow guidelines for handling and disposal.

Clean the Injury Channel

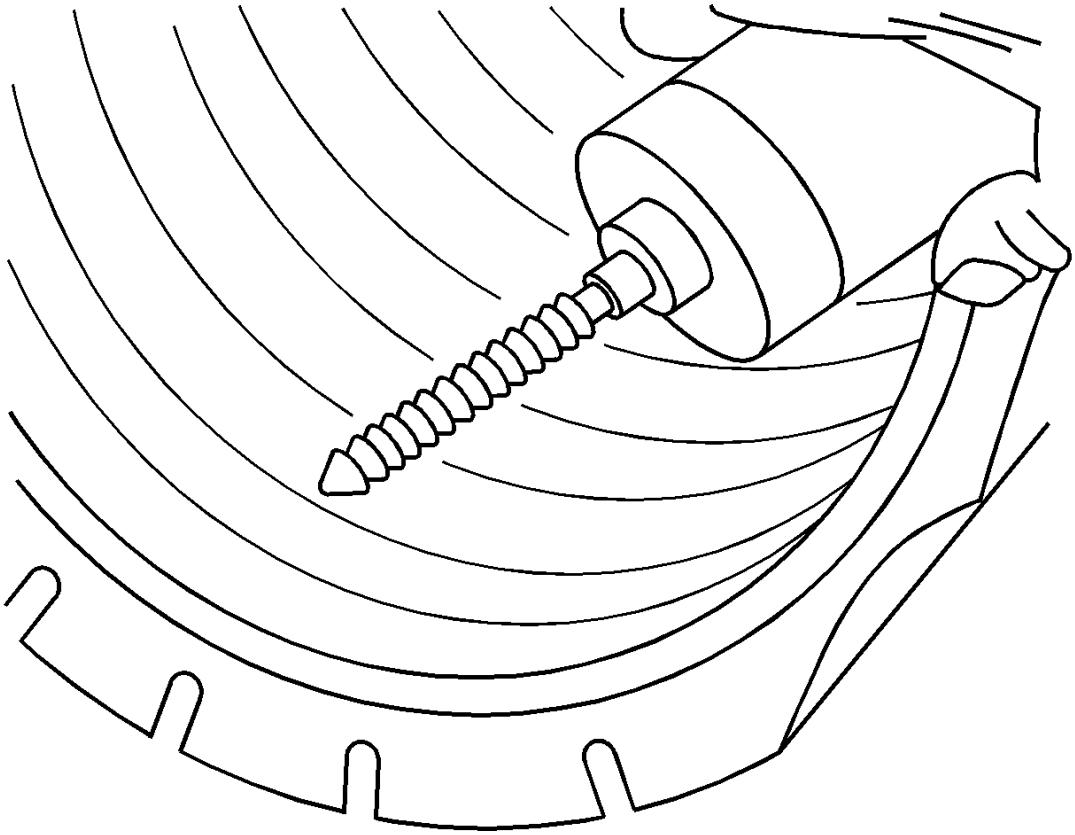


Fig. 17: Reaming Puncture Channel
Courtesy of GENERAL MOTORS COMPANY

1. Use a proper hand reamer, carbide cutter or drill bit to ream the puncture channel from the inside of the tire in order to clean the injury.
2. Remove steel wires protruding above the liner surface to prevent damage to the repair unit.
3. Consult your repair material supplier for recommended reaming tool(s).

Fill the Injury

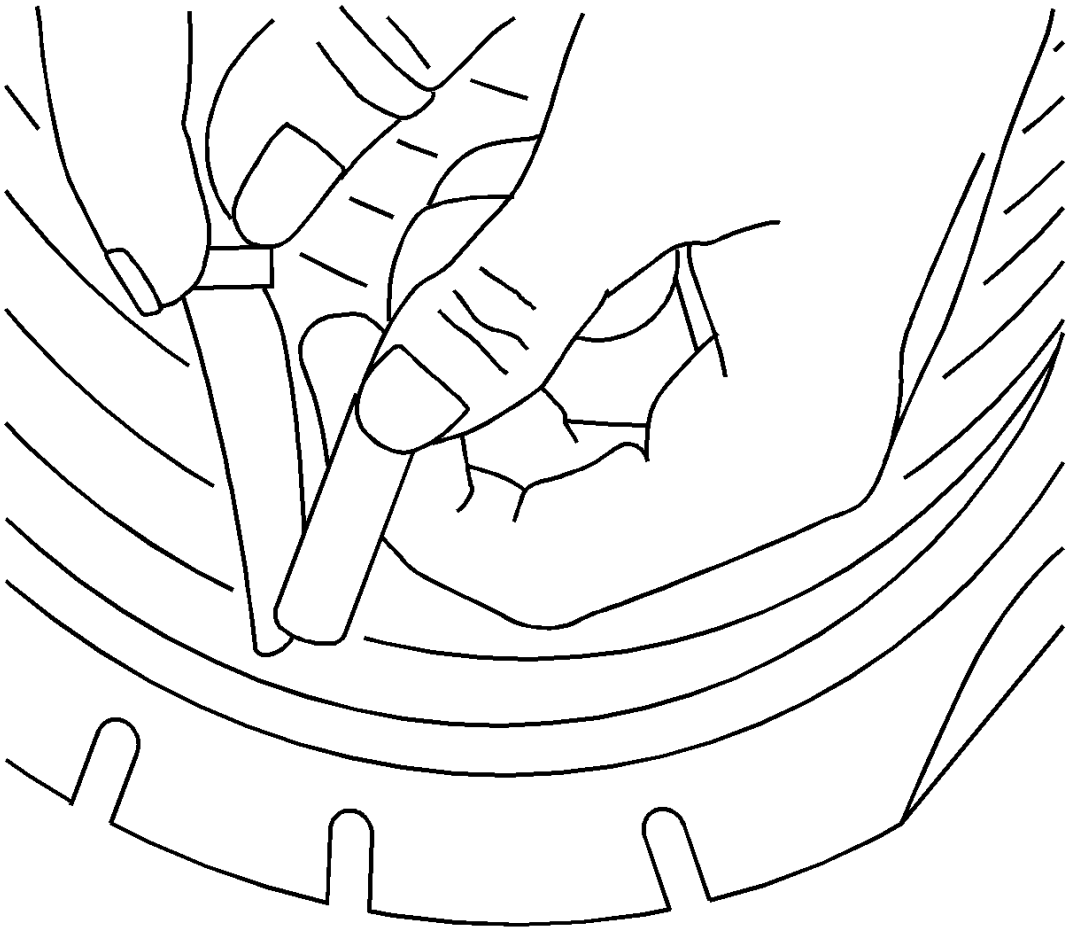


Fig. 18: Filling Injury Location
Courtesy of GENERAL MOTORS COMPANY

1. It is necessary to fill the injury channel to provide back up for the repair unit and to prevent moisture from entering the tire fabric and steel wires.
2. For combination repair/plug units skip this step. Cement the injured channel and fill the injury from the inside of the tire with the repair plug per repair material manufacturer recommendations. Without stretching the plug, cut the plug off just above the inside tire surface.
3. Consult your repair material supplier for proper repair material selection.

Repair Unit Selection

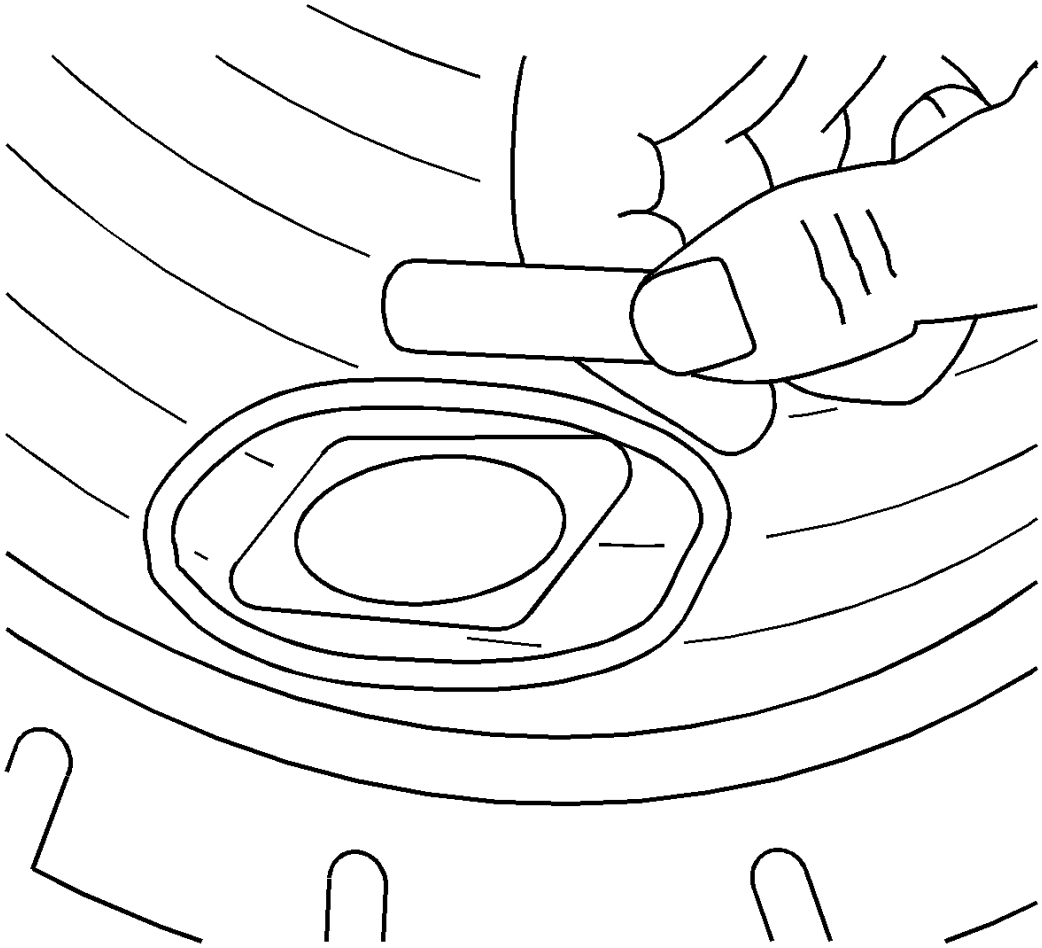


Fig. 19: Outlining Tire Injury Area
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not install the repair unit in this step.**

1. Center the repair unit over the injury as a reference and outline an area larger than the unit so that buffing will not remove the crayon marks.
2. Remove the repair unit.
3. DO NOT overlap previous or multiple repair units.
4. Consult your repair material supplier for proper repair unit selection.

Buffing

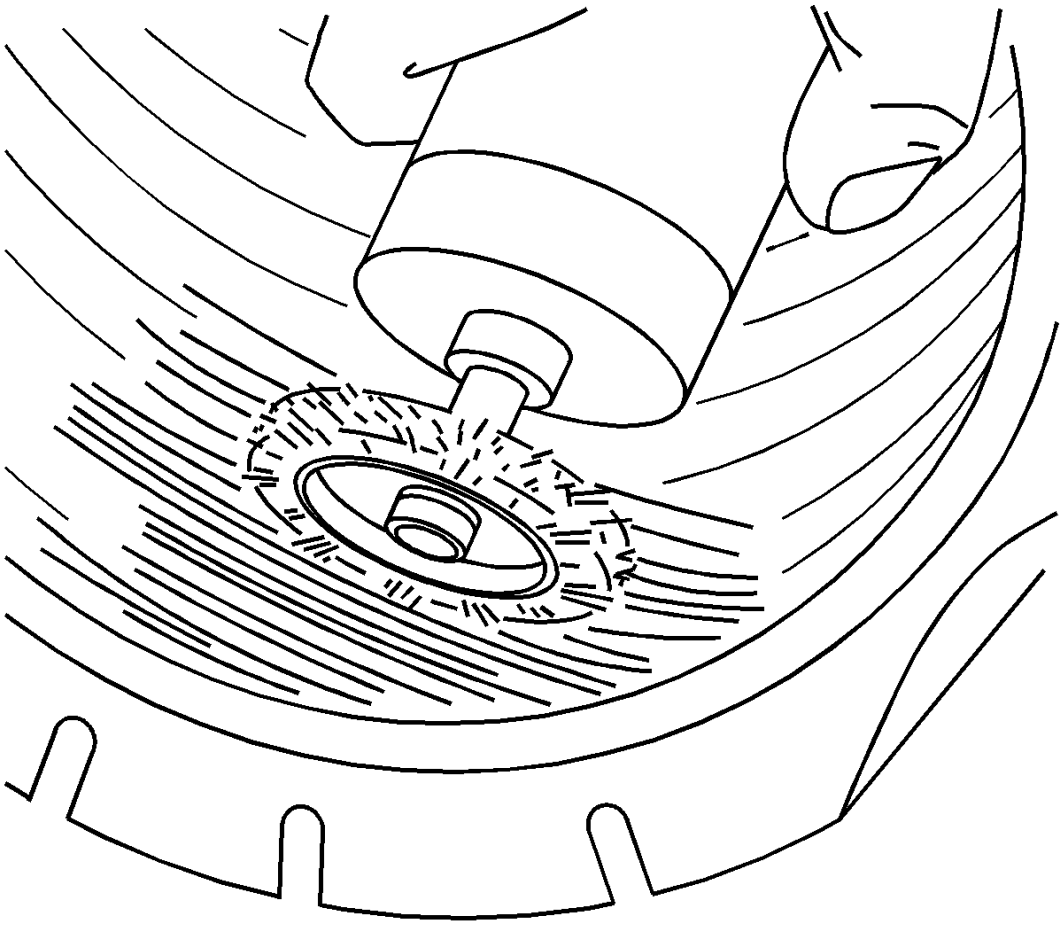


Fig. 20: Buffing Within Marked Area
Courtesy of GENERAL MOTORS COMPANY

1. To prevent contamination and preserve the outline, buff within the marked area thoroughly and evenly with a low speed buffing tool using a fine wire brush or gritted rasp.
2. Buff to a smooth velvet surface (RMA number 1 or number 2 buffed texture).
3. Use caution not to gouge the inner liner or expose casing fabric.
4. Remove any buffing dust with a vacuum cleaner.
5. Consult your repair material supplier for a proper buffing tool.

Cementing

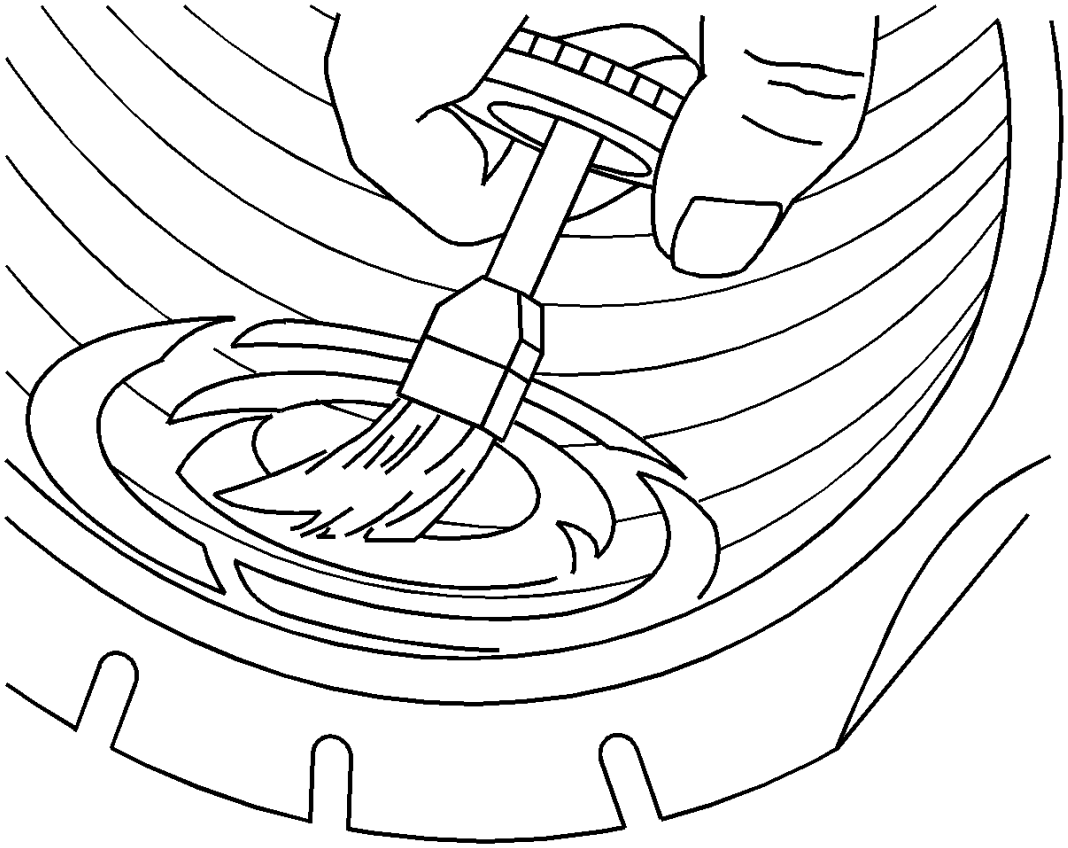


Fig. 21: Applying Chemical Cement
Courtesy of GENERAL MOTORS COMPANY

Apply chemical cement according to the repair material manufacturers procedures.

Repair Unit Application

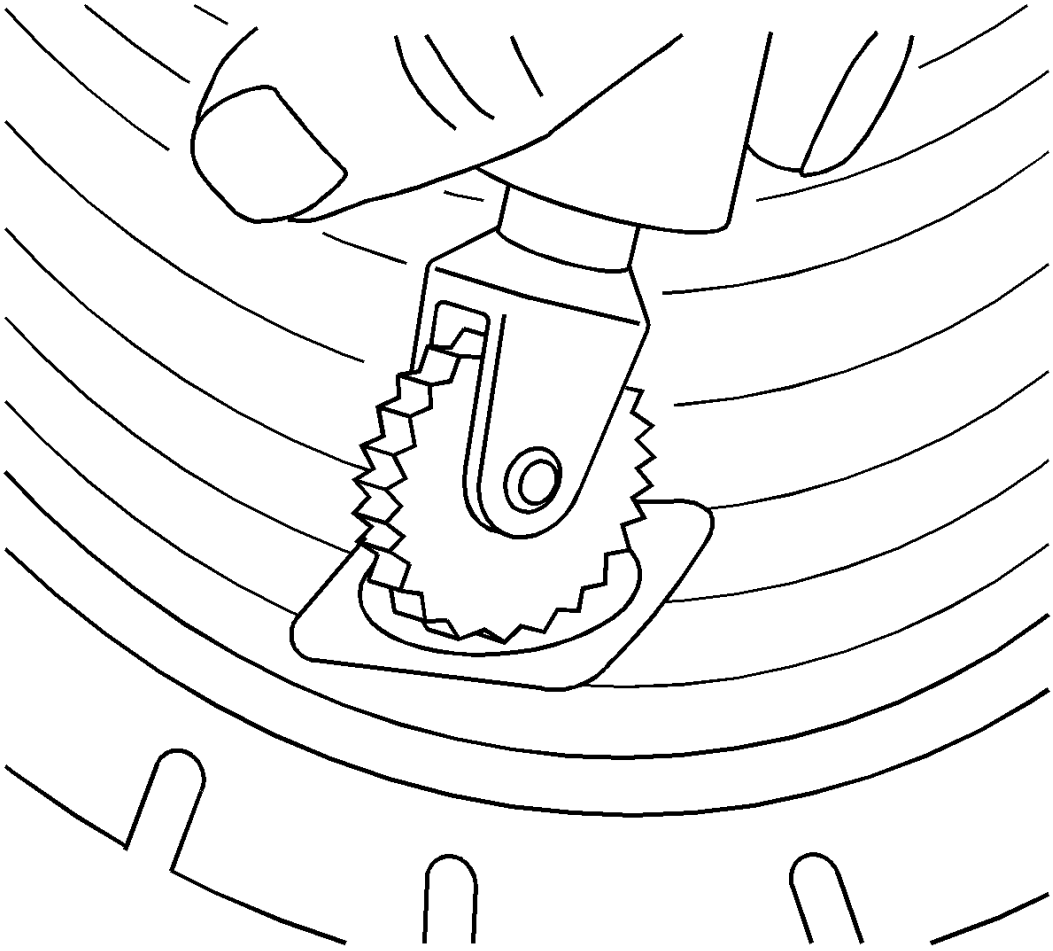


Fig. 22: Installing Repair Unit
Courtesy of GENERAL MOTORS COMPANY

The tire must be in the relaxed position when the repair unit is installed. Do not spread the beads excessively.

Two-Piece Plug and Repair Units

1. If applicable, install the repair unit so that the alignment is correct.
2. Center the repair unit over the injury and stitch down thoroughly with the stitching tool, working from the center out.

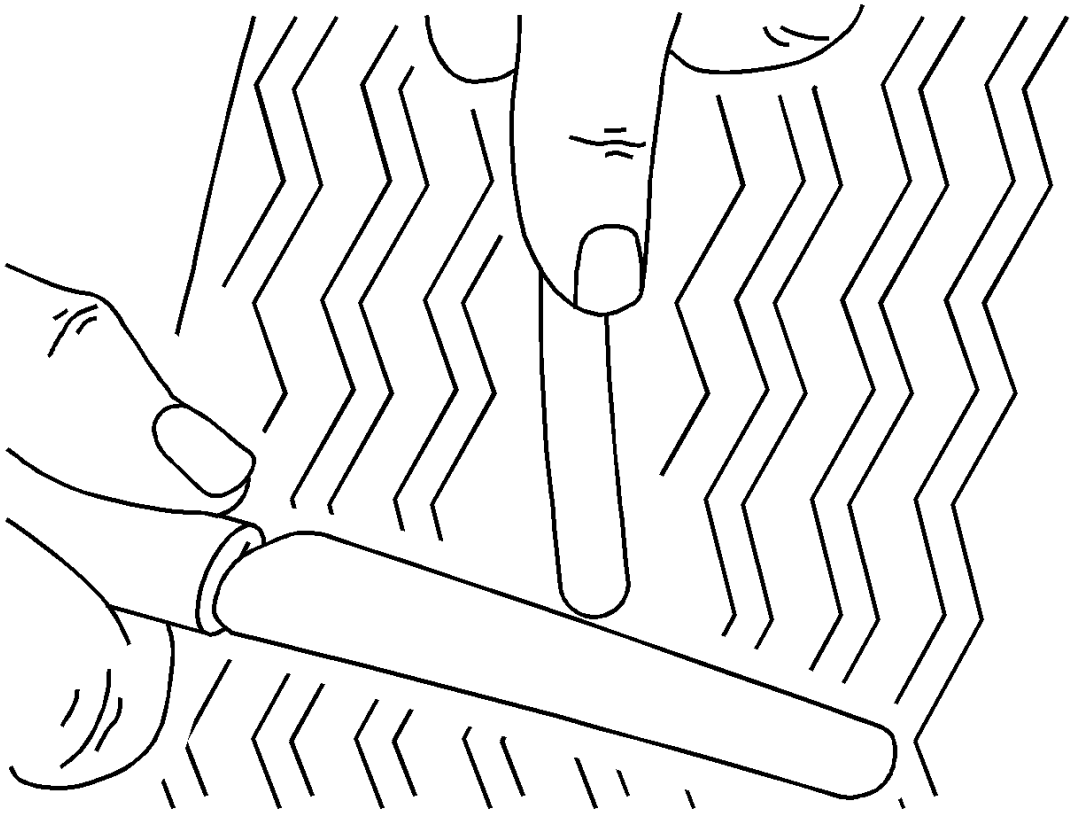


Fig. 23: Cutting Plug Material
Courtesy of GENERAL MOTORS COMPANY

3. Being careful not to stretch the plug material, cut the plug flush with the outer tread.

Combination Repair/Plug Units

1. Pull the plug through the injury until the repair just reaches the liner. Stitch down thoroughly.
2. Follow the repair material manufacturer's recommendations for further installation instructions.

   Consult your repair material supplier for the proper stitching tool.

Safety Cage

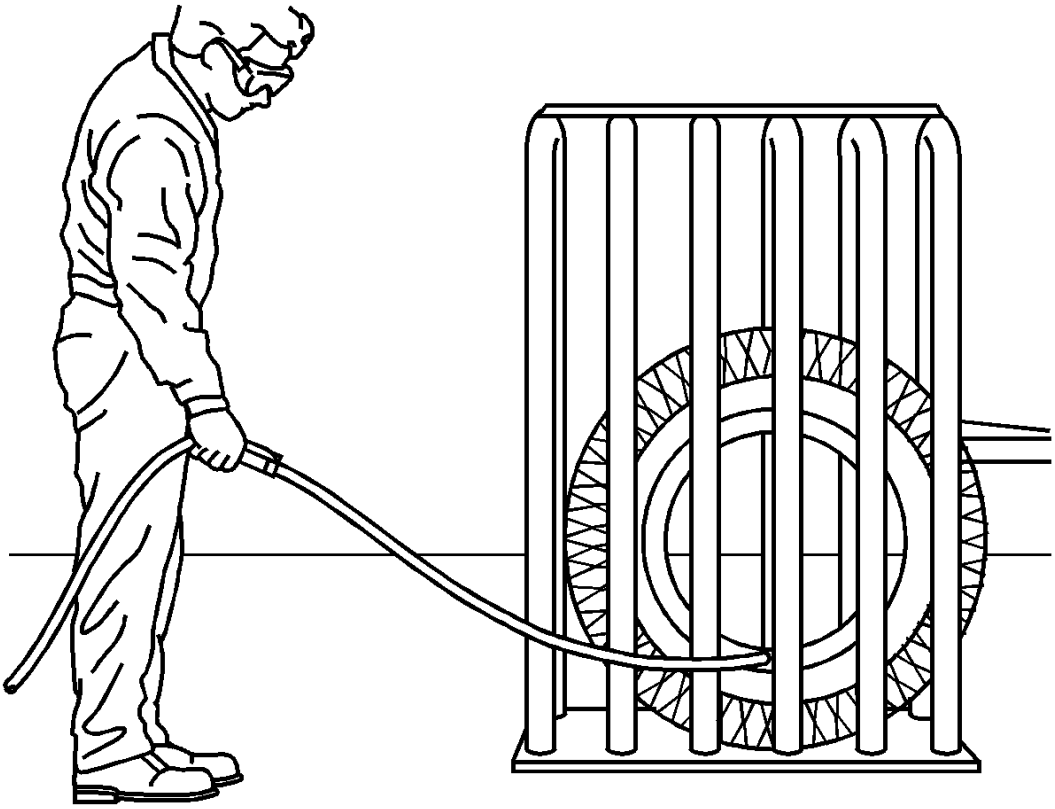


Fig. 24: Identifying Safety Cage
Courtesy of GENERAL MOTORS COMPANY

Some run flat tires may require more than 275 kPa (40 psi) to seat the bead. In such a case, a tire safety cage must be used. Consult the tire manufacturer for its individual repair policy.

Final Inspection

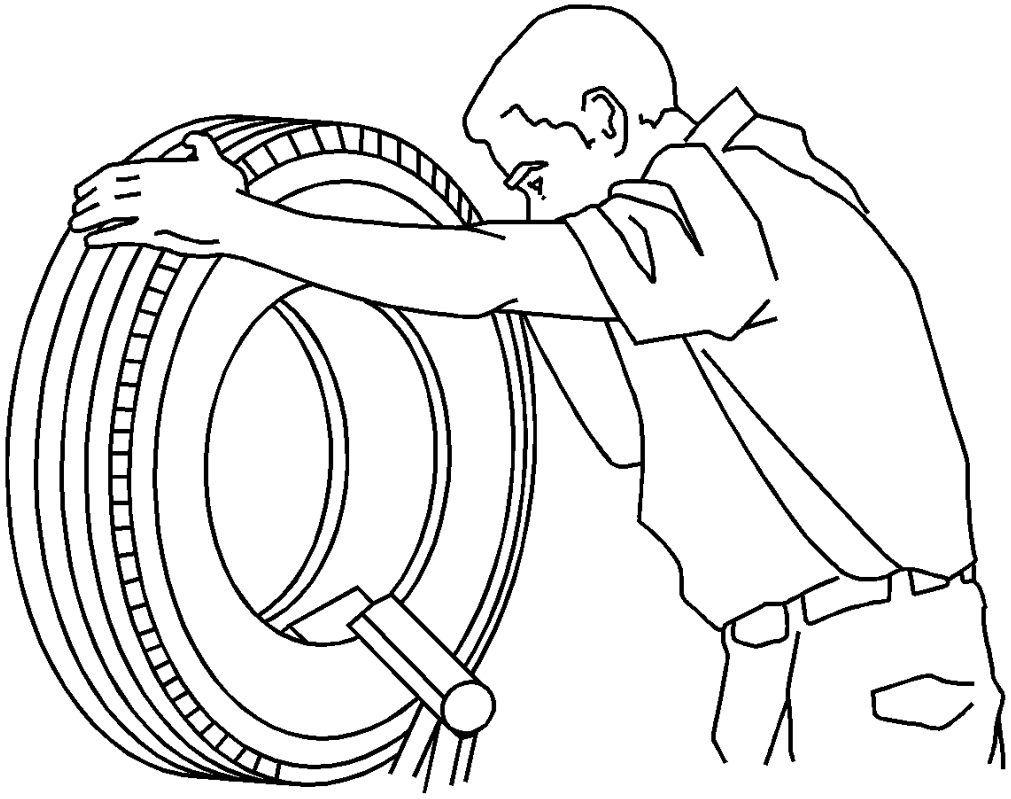


Fig. 25: Performing Final Inspection
Courtesy of GENERAL MOTORS COMPANY

1. After remounting and inflating the tire, check both beads, the repair and the valve with a water and soap solution in order to detect leaks.
2. If the tire continues to lose air, the tire must be demounted and reinspected.
3. Balance the tire and wheel assembly. Refer to **Tire and Wheel Assembly Balancing - Off Vehicle** .

For additional tire puncture repair information, contact:

Rubber Manufacturers Association (RMA)

1400 K Street, N.W., Suite 900

Washington

DC

20005-2403

Telephone: 202-682-4800

E-mail: info@rma.org

Website: www.rma.org

TIRE DISMOUNTING AND MOUNTING

CAUTION: Use a tire changing machine in order to dismount tires. Do not use hand tools or tire irons alone in order to remove the tire from the wheel. Damage to the tire beads or the wheel rim could result.

CAUTION: Do not scratch or damage the clear coating on aluminum wheels with the tire changing equipment. Scratching the clear coating could cause the aluminum wheel to corrode and the clear coating to peel from the wheel.

CAUTION: Damage to either the tire bead or the wheel mounting holes can result from the use of improper wheel attachment or tire mounting procedures. It takes up to 70 seconds for all of the air to completely exhaust from a large tire. Failure to follow the proper procedures could cause the tire changer to put enough force on the tire to bend the wheel at the mounting surface. Such damage may result in vibration and/or shimmy, and under severe usage lead to wheel cracking.

1. Remove the valve core from the valve stem.
2. Deflate the tire completely.

NOTE: Rim-clamp European-type tire changers are recommended.

3. Use the tire changer in order to remove the tire from the wheel. Follow steps 4-7 to remove the tire from the wheel.

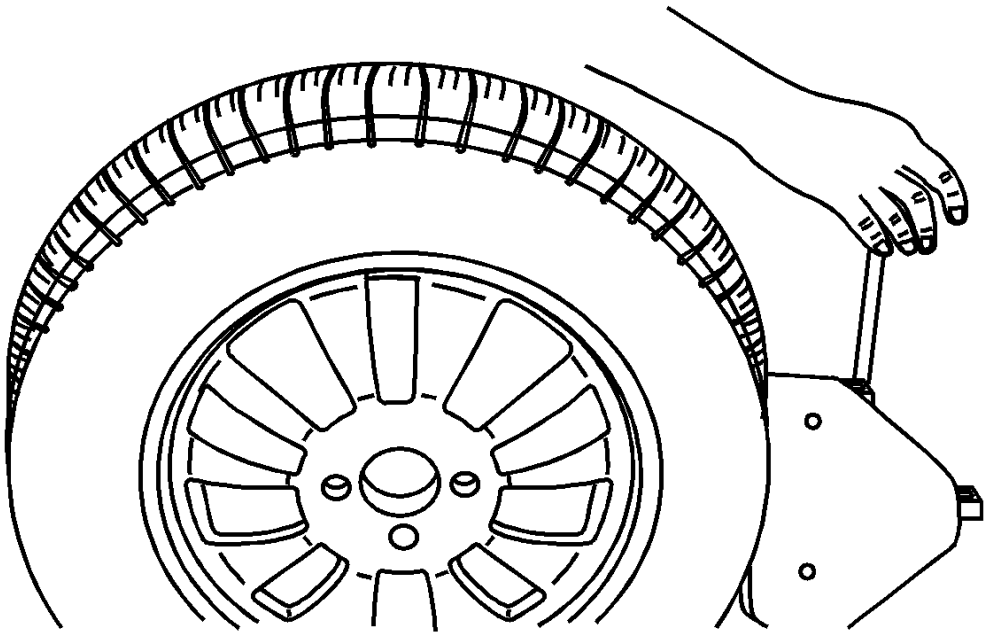


Fig. 26: Using Tire Changer to Remove Tire
Courtesy of GENERAL MOTORS COMPANY

4. When separating the tire bead from the wheel, position the bead breaking fixture 90, 180 and 270 degrees from the valve stem.

CAUTION: Failure to position valve stem in proper position while dismounting and mounting the tire may result in the TPM sensor to become damaged.

5. Position the wheel and tire so the valve stem is at the 7 o'clock position relative to the head. Apply tire bead lubricant to the pry bar to prevent damage to the tire bead. The tire iron or pry bar can be inserted when prying the outer tire bead up and over the mounting/dismounting head.

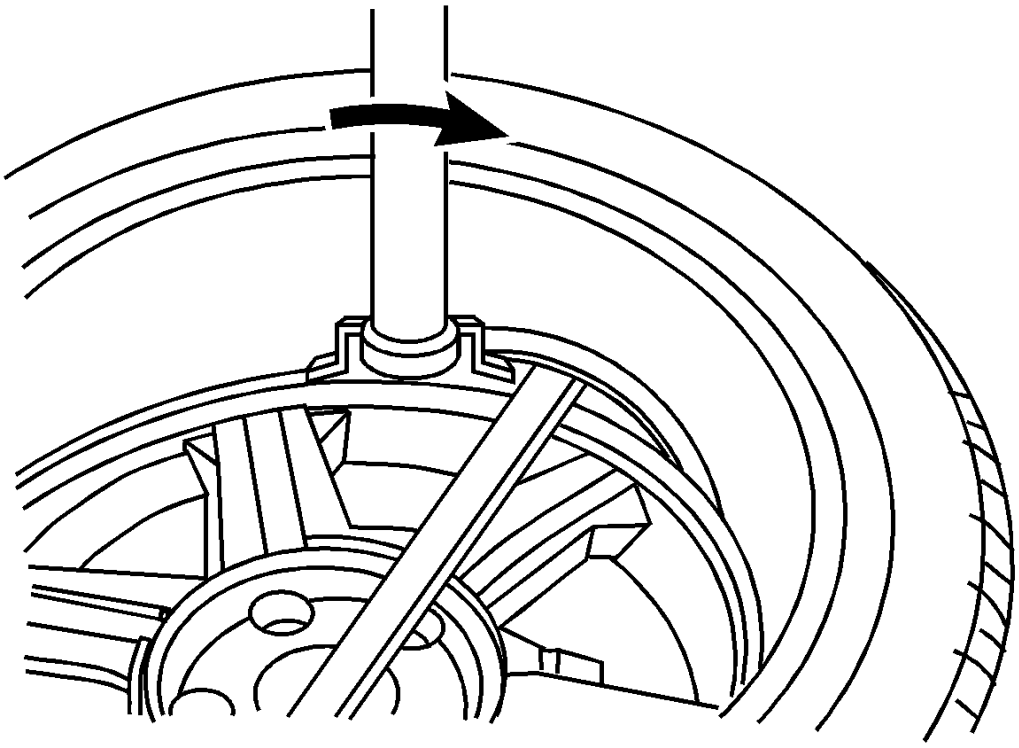


Fig. 27: Separating Tire Bead from Wheel
Courtesy of GENERAL MOTORS COMPANY

6. Position the wheel and tire so the valve stem is again at the 7 o'clock position relative to the head. The tire iron or pry bar can be inserted when prying the inner tire bead up and over the mounting/dismounting head.
7. Remove all residual liquid sealant from the inside of the tire and wheel surfaces. If any tire sealant is noted upon tire dismounting on vehicles equipped with TPM, replace the tire pressure sensor. Refer to **Tire Pressure Indicator Sensor Replacement** .
8. Use medium coarseness steel wool in order to remove any rubber, light rust or corrosion from the wheel bead seats.

CAUTION: When mounting the tires, use an approved tire mounting lubricant. DO NOT use silicon or corrosive base compounds to lubricate the tire bead and the wheel rim. A silicon base compound can cause the tire to slip on the rim. A corrosive type compound can cause tire or rim deterioration.

9. Apply mounting lubricant to the tire bead and the wheel rim. Refer to **Adhesives, Fluids, Lubricants, and Sealers**.

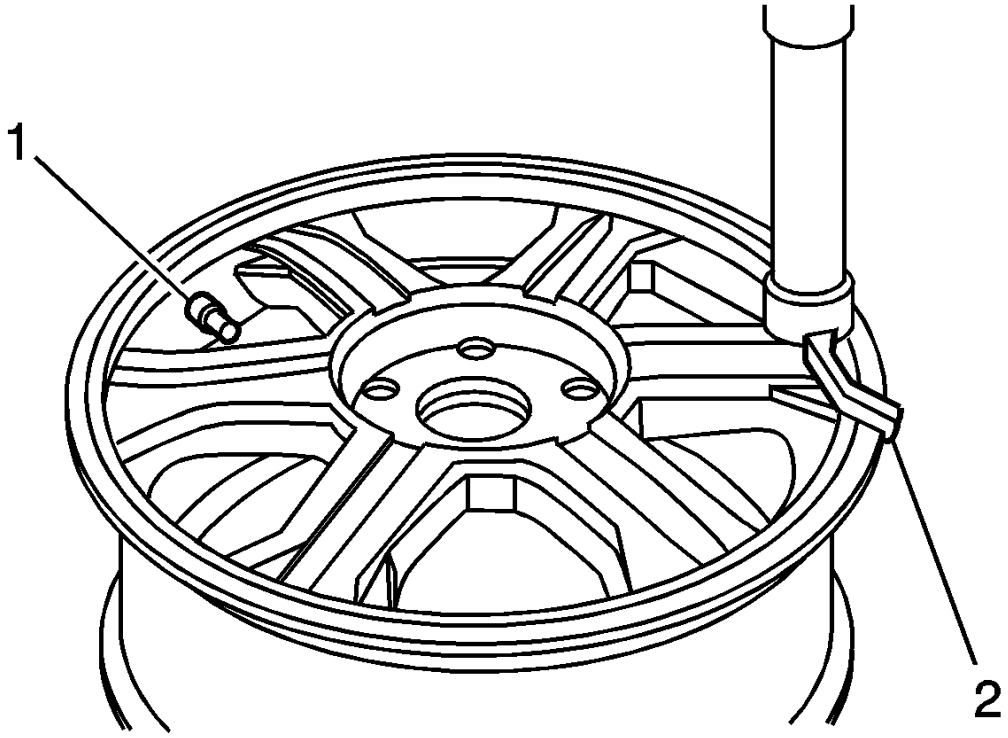


Fig. 28: Position Rim So Valve Stem Is At 7 O'clock Position Relative To Head
Courtesy of GENERAL MOTORS COMPANY

10. Position the rim so the valve stem (1) is at the 7 o'clock position relative to the head (2). This will protect the sensor when the bottom bead seats.

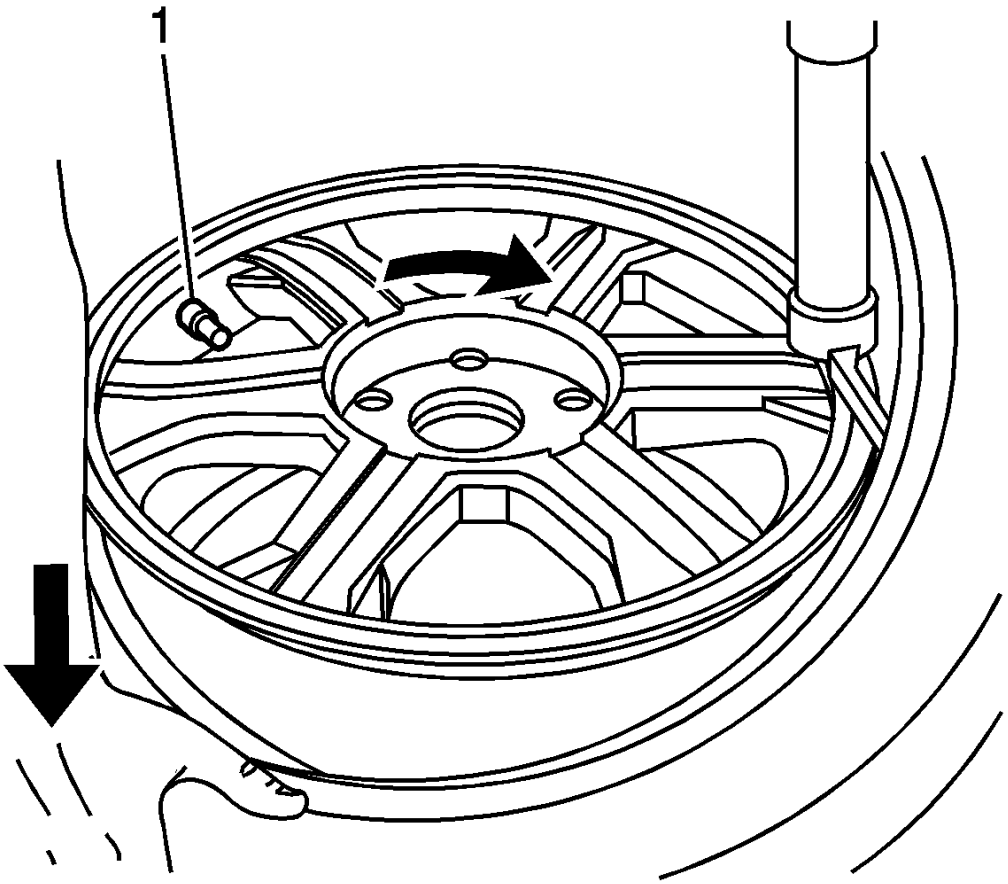


Fig. 29: Ensure Valve Stem Is At 7 O'clock Position
Courtesy of GENERAL MOTORS COMPANY

11. Using the tire machine, rotate the tire/wheel assembly clockwise when transferring the tire bead to the inside of the wheel rim. Ensure that the valve stem (1) is at the 7 o'clock position.

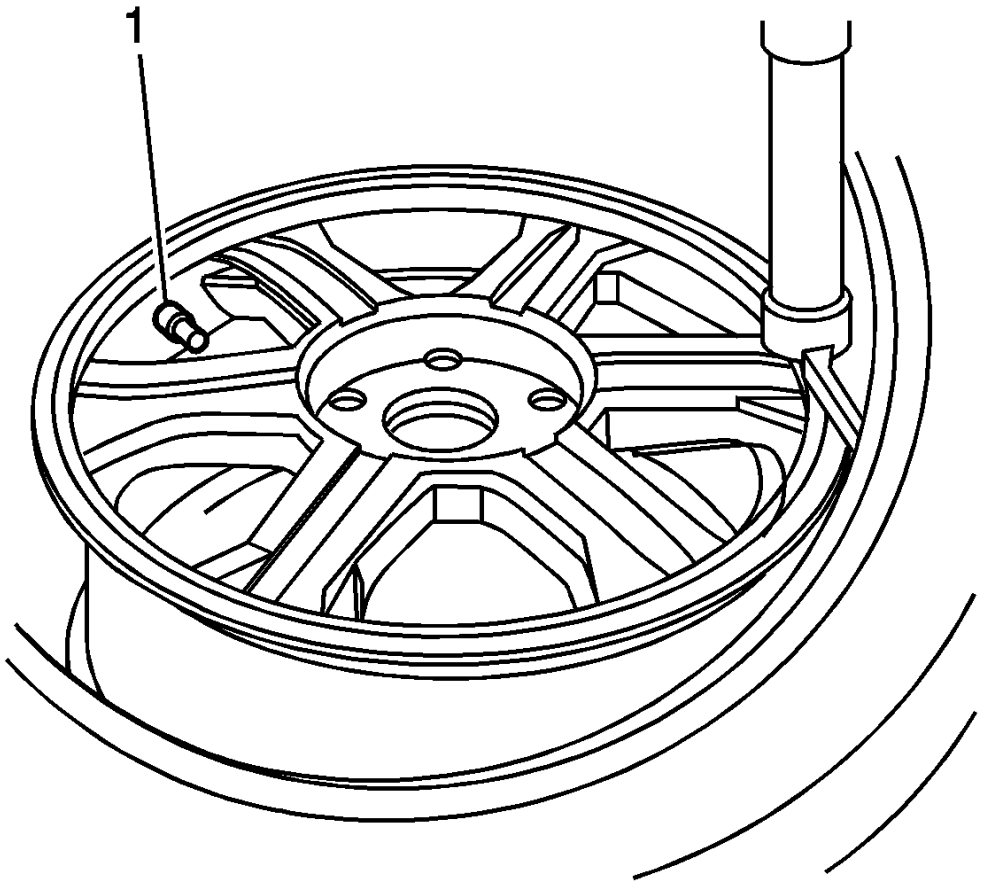


Fig. 30: Reposition Wheel And Tire So Valve Stem Is At 7 O'clock Position Relative To Head
Courtesy of GENERAL MOTORS COMPANY

12. After the bottom bead is on the wheel, reposition the wheel and tire so that the valve stem (1) is at the 7 o'clock position relative to the head. This will protect the sensor while mounting the tire bead to the outside of the wheel.

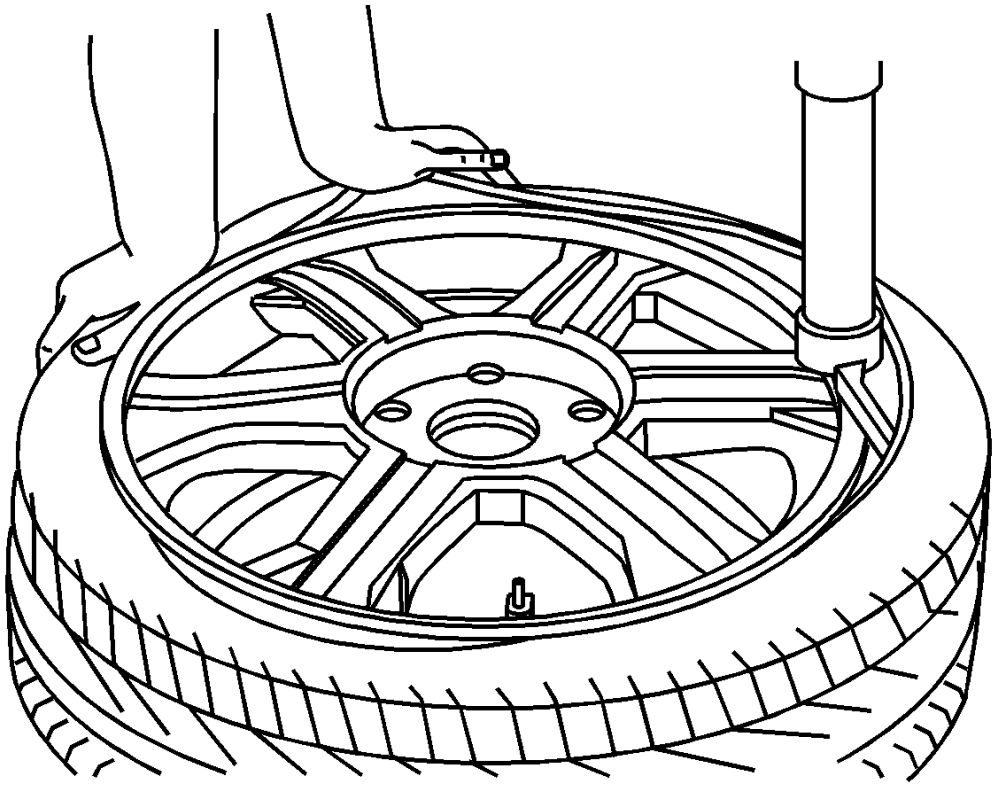


Fig. 31: Using Tire Changer
Courtesy of GENERAL MOTORS COMPANY

13. Use the tire changer in order to install the tire to the wheel.

WARNING: To avoid serious personal injury, do not stand over tire when inflating. The bead may break when the bead snaps over the safety hump. Do not exceed 275 kPa (40 psi) pressure when inflating any tire if beads are not seated. If 275 kPa (40 psi) pressure will not seat the beads, deflate, relubricate the beads and reinflate. Overinflation may cause the bead to break and cause serious personal injury.

14. Inflate the tire until it passes the bead humps. Be sure that the valve core is not installed at this time.
15. Install the valve core to the valve core stem.
16. Inflate the tire to the proper air pressure.
17. Ensure that the locating rings are visible on both sides of the tire in order to verify that the tire bead is fully seated on the wheel.

TIRE ROTATION

Rotate the tires and wheels at frequent intervals to equalize wear. Refer to tire rotation in Maintenance and Lubrication. In addition to scheduled rotation, rotate the tire and wheel whenever uneven tire wear is noticed.

Radial tires tend to wear faster in the shoulder area, particularly in front positions. Radial tires in non-drive locations may develop an irregular wear pattern that may increase tire noise. This makes regular rotation especially necessary.

Refer to **Tire and Wheel Removal and Installation** for tire removal.

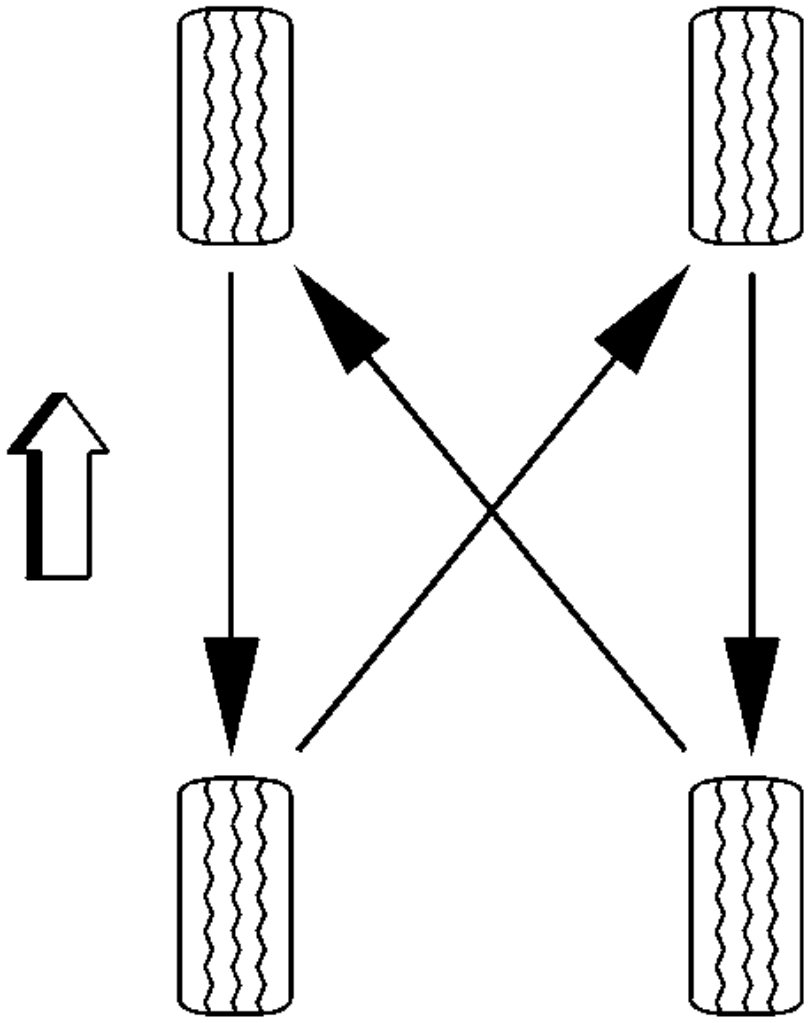


Fig. 32: Identifying Tire Rotation Pattern
Courtesy of GENERAL MOTORS COMPANY

Always use a 4-wheel rotation. After rotation, check the wheel nuts for specified torque. Then, set the tire pressure.

DESCRIPTION AND OPERATION

ALL SEASONS TIRES DESCRIPTION

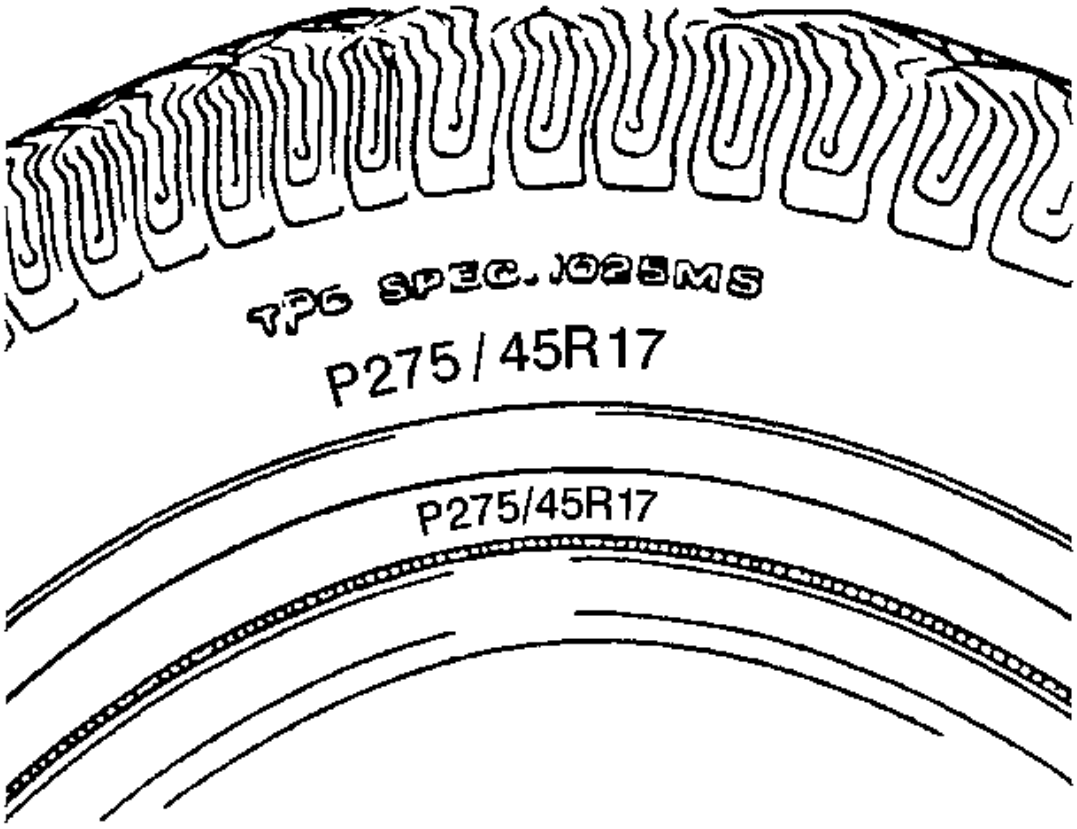


Fig. 33: Identifying All Seasons Tire Marking
Courtesy of GENERAL MOTORS COMPANY

Most GM vehicles are equipped with steel belted all-season radial tires as standard equipment. These tires qualify as snow tires, with a higher than average rating for snow traction than the non-all season radial tires previously used. Other performance areas, such as wet traction, rolling resistance, tread life, and air retention, are also improved. This is done by improvements in both tread design and tread compounds. These tires are identified by an M + S molded in the tire side wall after the tire size. The suffix MS is also molded in the tire side wall after the TPC specification number.

The optional handling tires used on some vehicles now also have the MS marking after the tire size and the TPC specification number.

GENERAL DESCRIPTION

The factory installed tires are designed to operate satisfactorily with loads up to and including the full rated load capacity when these tires are inflated to the recommended pressures.

The following factors have an important influence on tire life:

- Correct tire pressures
- Correct wheel alignment
- Proper driving techniques
- Tire rotation

The following factors increase tire wear:

- Heavy cornering
- Excessively rapid acceleration
- Heavy braking

METRIC WHEEL NUTS AND BOLTS DESCRIPTION

Metric wheel/nuts and bolts are identified in the following way:

- The wheel/nut has the word Metric stamped on the face.
- The letter M is stamped on the end of the wheel bolt.

The thread sizes of metric wheel/nuts and the bolts are indicated by the following example: M12 x 1.5.

- M = Metric
- 12 = Diameter in millimeters
- 1.5 = Millimeters gap per thread

P-METRIC SIZED TIRES DESCRIPTION

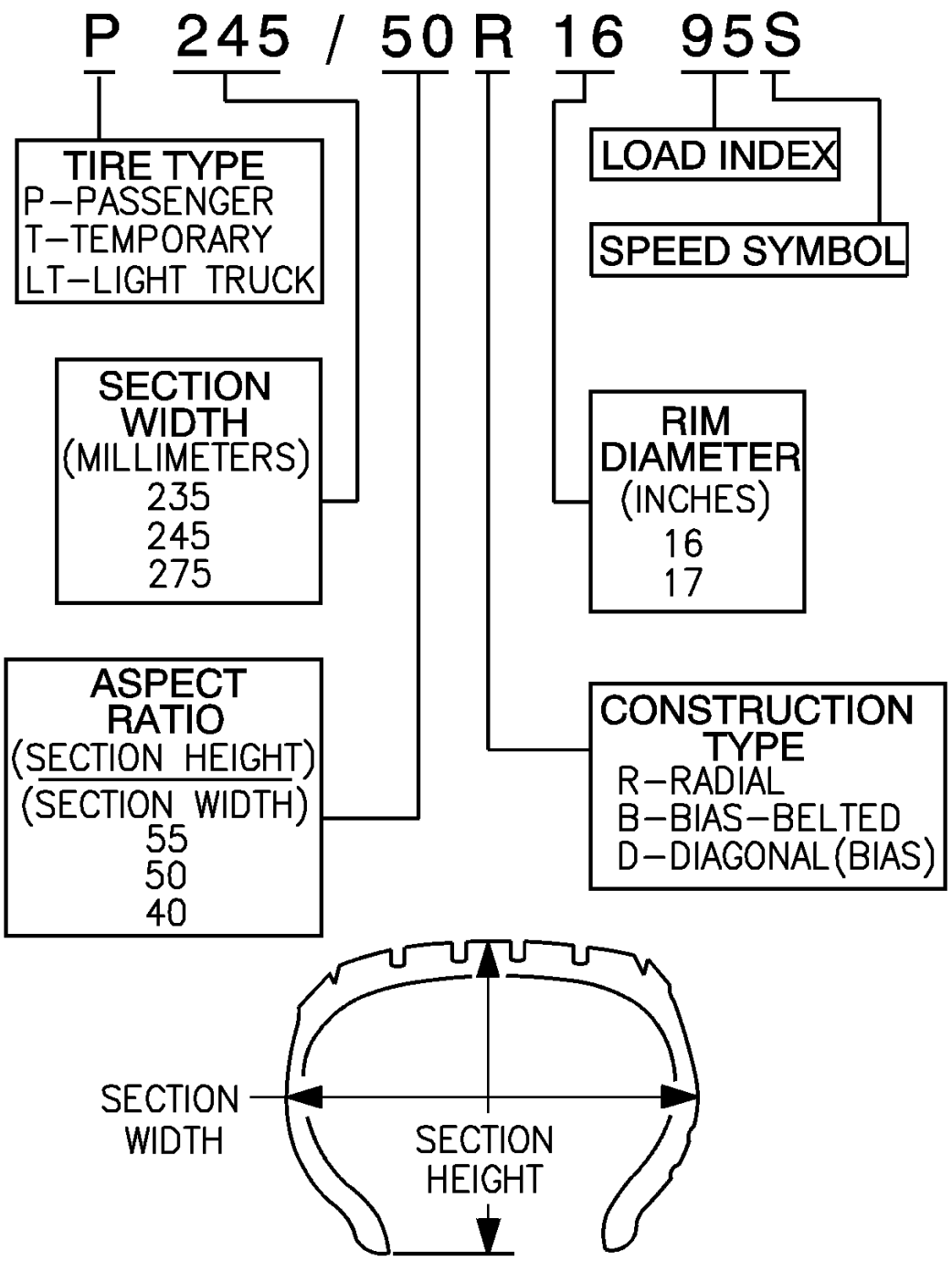


Fig. 34: Identifying P-Metric Sized Tire Marking
Courtesy of GENERAL MOTORS COMPANY

Replacement tires should be of the same tire performance criteria (TPC) specification number. This will ensure the same size, the same load range, and the same construction as those originally installed on the vehicle.

REPLACEMENT WHEELS DESCRIPTION

Replace the wheel if any of the following conditions exist:

- The wheel exhibits excessive runout.
- The wheel is bent.
- The wheel is cracked.
- The wheel is severely rusted.
- The wheel is severely corroded.

NOTE: **Air leaks caused by porosity on aluminum wheels are repairable.**

WARNING: **If you are replacing the wheel(s), the wheel stud(s), the wheel nut(s) or the wheel bolt(s), install only new GM original equipment parts. Installation of used parts or non-GM original equipment parts may cause the wheel to loosen, loss of tire air pressure, poor vehicle handling and loss of vehicle control resulting in personal injury.**

- The wheel leaks air.

CAUTION: **The use of non-GM original equipment wheels may cause:**

- **Damage to the wheel bearing, the wheel fasteners and the wheel**
- **Tire damage caused by the modified clearance to the adjacent vehicle components**
- **Adverse vehicle steering stability caused by the modified scrub radius**
- **Damage to the vehicle caused by the modified ground clearance**
- **Speedometer and odometer inaccuracy**

Replace the wheel, the wheel studs and the wheel/nuts, or the wheel bolts if applicable, if any of the following conditions exist:

- The wheel has elongated bolt holes.
- The wheel/nuts, or bolts if applicable, loosen repeatedly.

Steel wheel identification is stamped into the wheel near the valve stem.

Aluminum wheel identification is cast into the inboard side of the wheel.

STEEL WHEEL REPAIR DESCRIPTION

CAUTION: **Do not heat wheels in an attempt to soften them for straightening or repair damage from striking curbs, etc. Do not weld wheels. The alloy used in these wheels is heat-treated and uncontrolled heating from welding affects the properties of the material.**

CAUTION: **The use of tubes in tubeless tires is not a recommended repair due to the fact that speed ratings are greatly reduced.**

You can repair porosity in aluminum wheels. If leaks are found in a steel wheel, replace the wheel with a wheel of original equipment quality.

TIRE CHAIN USAGE DESCRIPTION

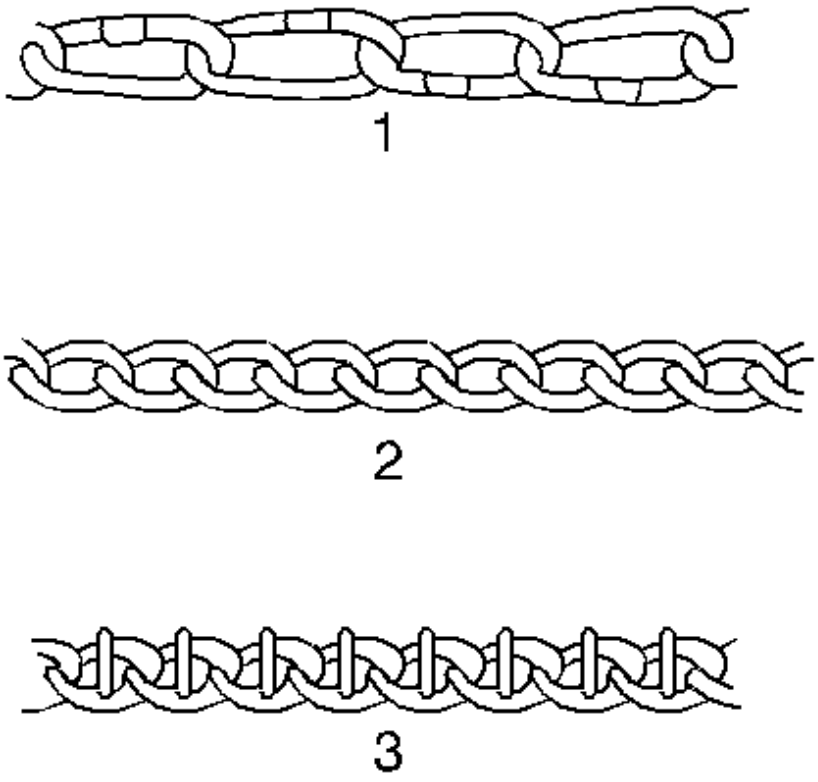


Fig. 35: Identifying Types Of Tire Chains
Courtesy of GENERAL MOTORS COMPANY

When you use tire chains, most current vehicles require the following chain types:

- SAE Class S or 1100 Series, Type PL tire chains (1)
- SAE Class U or 1200 Series, Type P tire chains (2)
- 1800 Series Lug Reinforced tire chains (3)

These chains are specially designed in order to limit the fly-off effect that occurs when the wheel rotates.

Manufacturers of tire chains have a specific chain size for each tire size. These ensure a proper fit when the

chains are installed. Purchase the correct chains for the tires on which the chains will be used. Do not use rubber adjusters to take up slack in chains that are loose due to incorrect size. Always follow the chain manufacturer's installation instructions.

The use of chains may adversely affect handling. When using chains, remember the following information:

- Ensure that the vehicle is designed for chain clearance.
- Adjust the speed to road conditions.
- Avoid sharp turns.
- Avoid locked-wheel braking in order to prevent chain damage to the vehicle.
- Install the chains as tightly as possible on the drive tires. Tighten the chains again after driving 0.4-0.8 km (0.25-0.5 mi). Do not use chains on the non-drive tires. These chains may contact and damage the vehicle. If you use chains on the non-drive tires, ensure that there is enough clearance.
- Do not exceed 70 km/h (45 mph). Do not exceed the chain manufacturer's speed limit, if lower.
- Drive in a restrained manner. Avoid large bumps, potholes, severe turns, and other maneuvers that cause the tires to bounce up and down.
- Follow any other instructions from the chain manufacturer that do not disagree with the above.

TIRE INFLATION DESCRIPTION

When you inflate the tires to the recommended inflation pressures, the factory-installed wheels and tires are designed in order to handle loads to the tire's rated load capacity. Incorrect tire pressures, or under-inflated tires, can cause the following conditions:

- Vehicle handling concerns
- Poor fuel economy
- Shortened tire life
- Tire overloading

Inspect the tire pressure when the following conditions apply:

- The vehicle has been sitting at least 3 hours.
- The vehicle has not been driven for more than 1.6 km (1 mi).
- The tires are cool.

Inspect the tires monthly or before any extended trip. Adjust the tire pressure to the specifications on the tire label. Install the valve caps or the extensions on the valves. The caps or the extensions keep out dust and water.

The kilopascal (kPa) is the metric term for pressure. The tire pressure may be printed in both kilopascal (kPa) and psi. One psi equals 6.9 kPa.

Inflation Pressure Conversion (Kilopascals to PSI)

kPa	psi	kPa	psi
140	20	215	31
145	21	220	32
155	22	230	33

kPa	psi	kPa	psi
160	23	235	34
165	24	240	35
170	25	250	36
180	26	275	40
185	27	310	45
190	28	345	50
200	29	380	55
205	30	415	60
Conversion: 6.9 kPa = 1 psi			

Tires with a higher than recommended pressure can cause the following conditions:

- A hard ride
- Tire bruising
- Rapid tread wear at the center of the tire

Tires with a lower than recommended pressure can cause the following conditions:

- A tire squeal on turns
- Hard steering
- Rapid wear and uneven wear on the edge of the tread
- Tire rim bruises and tire rim rupture
- Tire cord breakage
- High tire temperatures
- Reduced vehicle handling
- High fuel consumption
- Soft riding

Unequal pressure on the same axle can cause the following conditions:

- Uneven braking
- Steering lead
- Reduced vehicle handling

Refer to the Tire Placard for specific tire and wheel applications and tire pressures.

TREAD WEAR INDICATORS DESCRIPTION

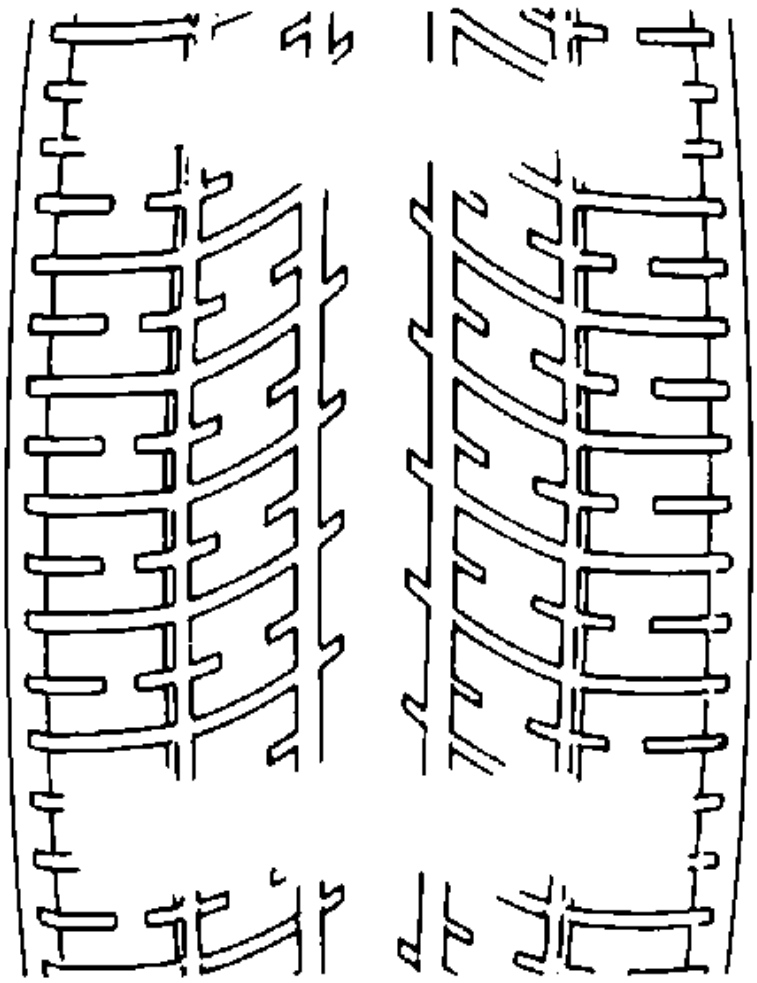


Fig. 36: View Of Tread Wear Indicators
Courtesy of GENERAL MOTORS COMPANY

The original equipment tires have tread wear indicators that show when you should replace the tires.

The location of these indicators are at 60 degree intervals around the outer diameter of the tire. The indicators appear as a 6 mm (0.25 in) wide band when the tire tread depth becomes 1.6 mm (2/32 in).

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

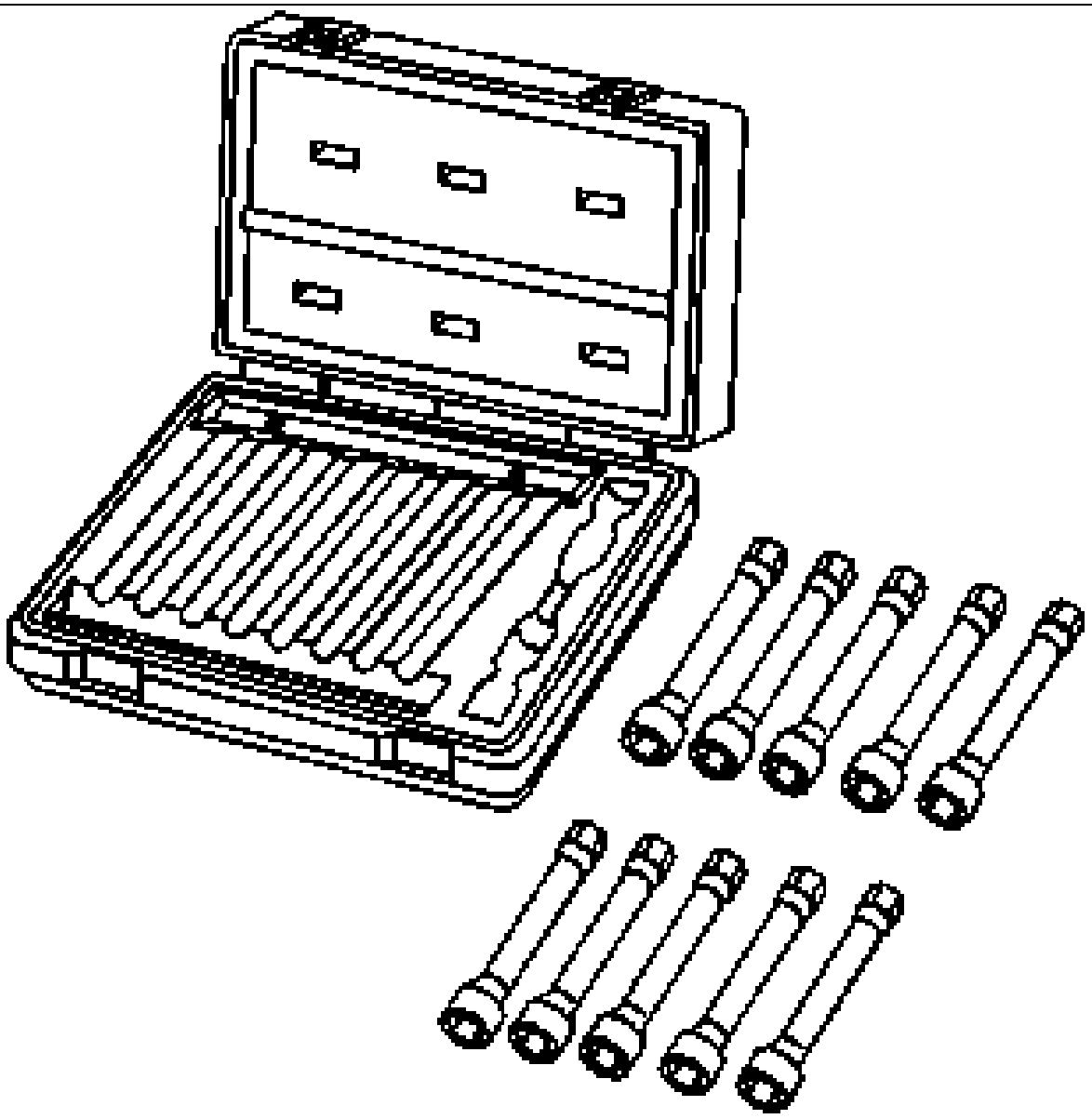
Illustration	Tool Number/ Description
	J 39544-KIT Complete Torque Socket Set-10 Pieces

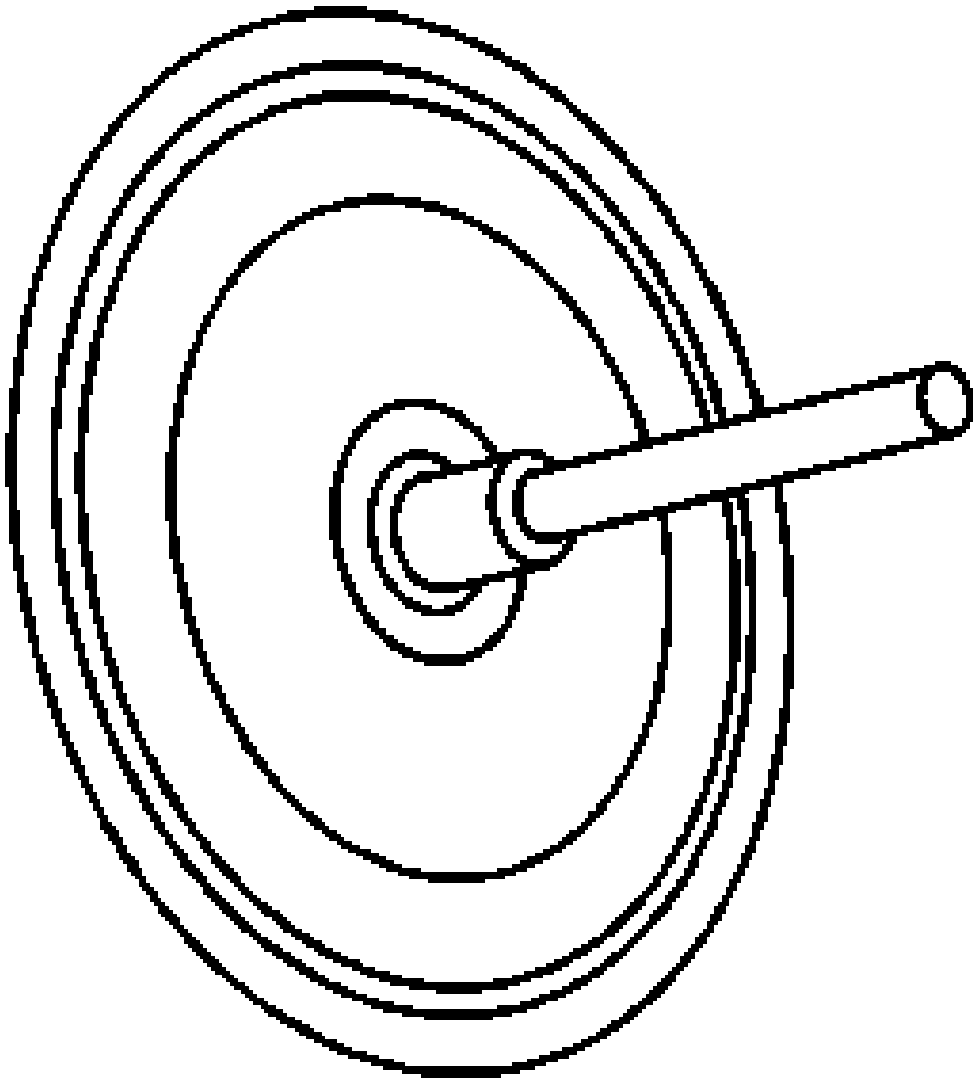
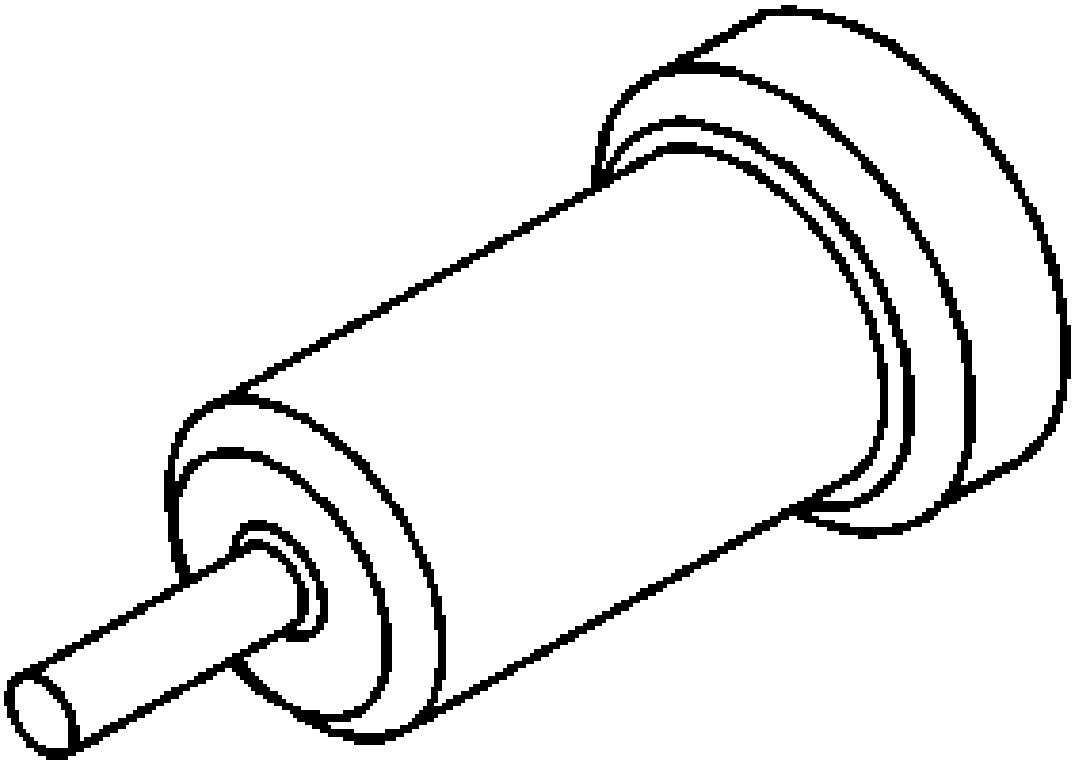
Illustration	Tool Number/ Description
	J 41013 Rotor Resurfacing Kit

Illustration	Tool Number/ Description
	J 42450-A Wheel Hub Resurfacing Kit

Article GUID: A00737185

WHEEL ALIGNMENT SPECIFICATIONS

CAMARO

CAMARO FE2, ROA with WRS Tire Size - Front and Rear P245/50ZR19

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	5.15	5.9	6.65
Right Front Caster (Â°)	5.15	5.9	6.65
Left Front Camber (Â°)	-0.95	-0.2	0.55
Right Front Camber (Â°)	-0.95	-0.2	0.55
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.15	-0.4	0.35
Right Rear Camber (Â°)	-1.15	-0.4	0.35
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAMARO FE2, ROA without WRS Tire Size - Front and Rear P245/50ZR19

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	5.15	5.9	6.65
Right Front Caster (Â°)	5.15	5.9	6.65
Left Front Camber (Â°)	-0.95	-0.2	0.55
Right Front Camber (Â°)	-0.95	-0.2	0.55
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.5	-0.75	0
Right Rear Camber (Â°)	-1.5	-0.75	0
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0

Measurement	Minimum	Preferred	Maximum
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAMARO FE2, ROB with WRS Tire Size - Front and Rear P245/55R18

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	5.15	5.9	6.65
Right Front Caster (Â°)	5.15	5.9	6.65
Left Front Camber (Â°)	-0.95	-0.2	0.55
Right Front Camber (Â°)	-0.95	-0.2	0.55
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.15	-0.4	0.35
Right Rear Camber (Â°)	-1.15	-0.4	0.35
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAMARO FE2, ROB without WRS Tire Size - Front and Rear P245/55R18

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	5.15	5.9	6.65
Right Front Caster (Â°)	5.15	5.9	6.65
Left Front Camber (Â°)	-0.95	-0.2	0.55
Right Front Camber (Â°)	-0.95	-0.2	0.55
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.5	-0.75	0

Measurement	Minimum	Preferred	Maximum
Right Rear Camber (Â°)	-1.5	-0.75	0
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAMARO FE2, ROC with WRS Tire Size - Front and Rear P245/45ZR20 and P275/40ZR20

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	5.15	5.9	6.65
Right Front Caster (Â°)	5.15	5.9	6.65
Left Front Camber (Â°)	-0.95	-0.2	0.55
Right Front Camber (Â°)	-0.95	-0.2	0.55
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.15	-0.4	0.35
Right Rear Camber (Â°)	-1.15	-0.4	0.35
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAMARO FE2, ROC without WRS Tire Size - Front and Rear P245/45ZR20 and P275/40ZR20

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	5.15	5.9	6.65
Right Front Caster (Â°)	5.15	5.9	6.65
Left Front Camber (Â°)	-0.95	-0.2	0.55
Right Front Camber (Â°)	-0.95	-0.2	0.55
Front Toe (Â°)	0	0.2	0.4

Measurement	Minimum	Preferred	Maximum
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.5	-0.75	0
Right Rear Camber (Â°)	-1.5	-0.75	0
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAMARO FE3 / FE4, ROC Tire Size - Front and Rear P245/45ZR20 and P275/40ZR20

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	5.15	5.9	6.65
Right Front Caster (Â°)	5.15	5.9	6.65
Left Front Camber (Â°)	-1.55	-0.8	-0.05
Right Front Camber (Â°)	-1.55	-0.8	-0.05
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.15	-0.4	0.35
Right Rear Camber (Â°)	-1.15	-0.4	0.35
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAMARO FE4, RKC Tire Size - Front and Rear P285/35ZR20

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	5.15	5.9	6.65
Right Front Caster (Â°)	5.15	5.9	6.65

Measurement	Minimum	Preferred	Maximum
Left Front Camber (Â°)	-1.55	-0.8	-0.05
Right Front Camber (Â°)	-1.55	-0.8	-0.05
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.15	-0.4	0.35
Right Rear Camber (Â°)	-1.15	-0.4	0.35
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAMARO FE5, RPG Tire Size - Front and Rear P285/35ZR20 and P305/35ZR20

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	4.85	5.6	6.35
Right Front Caster (Â°)	4.85	5.6	6.35
Left Front Camber (Â°)	-1.75	-1	-0.25
Right Front Camber (Â°)	-1.75	-1	-0.25
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.25	-0.5	0.25
Right Rear Camber (Â°)	-1.25	-0.5	0.25
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAMARO FE6, RKC Tire Size - Front and Rear P285/35ZR20

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	4.85	5.6	6.35
Right Front Caster (Â°)	4.85	5.6	6.35
Left Front Camber (Â°)	-1.75	-1	-0.25
Right Front Camber (Â°)	-1.75	-1	-0.25
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.5	-0.75	0
Right Rear Camber (Â°)	-1.5	-0.75	0
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAMARO FEA Z28 Performance Suspension

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	4.85	5.6	6.35
Right Front Caster (Â°)	4.85	5.6	6.35
Left Front Camber (Â°)	-1.75	-1	-0.25
Right Front Camber (Â°)	-1.75	-1	-0.25
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.75	-1	-0.25
Right Rear Camber (Â°)	-1.75	-1	-0.25
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAPRICE

CAPRICE PPV

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	4.75	6	7.25
Right Front Caster (Â°)	4.75	6	7.25
Left Front Camber (Â°)	-0.43	-0.1	0.23
Right Front Camber (Â°)	-0.43	-0.1	0.23
Front Toe (Â°)	0	0.17	0.34
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-0.95	-0.5	-0.05
Right Rear Camber (Â°)	-0.95	-0.5	-0.05
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.2	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAPTIVA

CAPTIVA All Models except Sport

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.43	2.18	2.93
Right Front Caster (Â°)	1.43	2.18	2.93
Left Front Camber (Â°)	-1.35	-0.6	0.15
Right Front Camber (Â°)	-1.35	-0.6	0.15
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.1	-0.35	0.4
Right Rear Camber (Â°)	-1.1	-0.35	0.4
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.2	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAPTIVA Sport RPO LEA ZLF26 AWD

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.4	3.2
Right Front Caster (Â°)	1.6	2.4	3.2
Left Front Camber (Â°)	-1.6	-0.8	0
Right Front Camber (Â°)	-1.6	-0.8	0
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.2	-0.4	0.4
Right Rear Camber (Â°)	-1.2	-0.4	0.4
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAPTIVA Sport RPO LEA ZLF26 FWD

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.4	3.2
Right Front Caster (Â°)	1.6	2.4	3.2
Left Front Camber (Â°)	-1.6	-0.8	0
Right Front Camber (Â°)	-1.6	-0.8	0
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.2	-0.4	0.4
Right Rear Camber (Â°)	-1.2	-0.4	0.4
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAPTIVA Sport RPO LFW and F46 ZLF26 AWD

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.7	3.5
Right Front Caster (Â°)	1.9	2.7	3.5
Left Front Camber (Â°)	-1.4	-0.6	0.2
Right Front Camber (Â°)	-1.4	-0.6	0.2
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.2	-0.4	0.4
Right Rear Camber (Â°)	-1.2	-0.4	0.4
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAPTIVA Sport RPO LFW and F46 ZLF26 FWD

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.7	3.5
Right Front Caster (Â°)	1.9	2.7	3.5
Left Front Camber (Â°)	-1.4	-0.6	0.2
Right Front Camber (Â°)	-1.4	-0.6	0.2
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.2	-0.4	0.4
Right Rear Camber (Â°)	-1.2	-0.4	0.4

Measurement	Minimum	Preferred	Maximum
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAPTIVA Sport RPO LFW ZLF26 AWD

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.4	3.2
Right Front Caster (Â°)	1.6	2.4	3.2
Left Front Camber (Â°)	-1.5	-0.7	0.1
Right Front Camber (Â°)	-1.5	-0.7	0.1
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.2	-0.4	0.4
Right Rear Camber (Â°)	-1.2	-0.4	0.4
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CAPTIVA Sport RPO LFW ZLF26 FWD

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.4	3.2
Right Front Caster (Â°)	1.6	2.4	3.2
Left Front Camber (Â°)	-1.5	-0.7	0.1
Right Front Camber (Â°)	-1.5	-0.7	0.1
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.2	-0.4	0.4
Right Rear Camber (Â°)	-1.2	-0.4	0.4
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CITY EXPRESS

CITY EXPRESS RRG , RRJ P185/60 R15

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.42	4.17	4.92
Right Front Caster (Â°)	3.42	4.17	4.92
Left Front Camber (Â°)	-1.08	-0.33	0.42
Right Front Camber (Â°)	-1.08	-0.33	0.42
Front Toe (Â°)	0.02	0.1	0.18
Left SAI (Â°)	11.17	11.92	12.67
Right SAI (Â°)	11.17	11.92	12.67
Left Rear Camber (Â°)	-2	-1.5	-1
Right Rear Camber (Â°)	-2	-1.5	-1
Rear Toe (Â°)	-0.22	0.28	0.78
Thrust Angle	0	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

COLORADO

COLORADO All Models

Measurement	Minimum	Preferred	Maximum

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.8	2.8	3.8
Right Front Caster (Â°)	1.8	2.8	3.8
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CORVETTE

CORVETTE FE1, FE2, FE3, FE4 Suspension

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	6.8	7.4	8
Right Front Caster (Â°)	6.8	7.4	8
Left Front Camber (Â°)	-0.8	-0.2	0.4
Right Front Camber (Â°)	-1.1	-0.5	0.1
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.1	-0.5	0.1
Right Rear Camber (Â°)	-1.1	-0.5	0.1
Rear Toe (Â°)	-0.2	0	0.2
Thrust Angle	0.2	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CORVETTE FE6, FE7 Suspension

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	6.8	7.4	8
Right Front Caster (Â°)	6.8	7.4	8
Left Front Camber (Â°)	-1.2	-0.6	0
Right Front Camber (Â°)	-1.5	-0.9	-0.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.7	-1.1	-0.5
Right Rear Camber (Â°)	-1.7	-1.1	-0.5
Rear Toe (Â°)	-0.2	0	0.2
Thrust Angle	0.2	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CRUZE

CRUZE 4-Door Notchback 69 and 5-Door Hatchback 68 Chassis Protection Kit, Engine Compartment (XL4)

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.7	4.45	5.2
Right Front Caster (Â°)	3.7	4.45	5.2
Left Front Camber (Â°)	-1.05	-0.3	0.45
Right Front Camber (Â°)	-1.05	-0.3	0.45
Front Toe (Â°)	-0.13	0.07	0.27
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.9	-1.4	-0.9
Right Rear Camber (Â°)	-1.9	-1.4	-0.9
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.3	17.73	18.48
Left Toe Out, Inward (Â°)	19.23	17.73	18.48

Measurement	Minimum	Preferred	Maximum
Right Toe Out, Inward (Â°)	19.23	20	20
Left Toe Out, Outward (Â°)	20	20	20
Right Toe Out, Outward (Â°)	20	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CRUZE 4-Door Notchback 69 and 5-Door Hatchback 68 Standard

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.9	4.65	5.4
Right Front Caster (Â°)	3.9	4.65	5.4
Left Front Camber (Â°)	-1.1	-0.35	0.4
Right Front Camber (Â°)	-1.1	-0.35	0.4
Front Toe (Â°)	-0.12	0.08	0.28
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.95	-1.45	-0.95
Right Rear Camber (Â°)	-1.95	-1.45	-0.95
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.3	17.73	18.48
Left Toe Out, Inward (Â°)	19.23	17.73	18.48
Right Toe Out, Inward (Â°)	19.23	20	20
Left Toe Out, Outward (Â°)	20	20	20
Right Toe Out, Outward (Â°)	20	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CRUZE except XJ2 and IK9 RPO codes QOI P225/45R18

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.25	-0.5	0.25
Right Front Camber (Â°)	-1.25	-0.5	0.25
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-2.2	-1.45	-0.7
Right Rear Camber (Â°)	-2.2	-1.45	-0.7

Measurement	Minimum	Preferred	Maximum
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CRUZE except XJ2 and IK9 RPO codes QYF P225/50R17

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.25	-0.5	0.25
Right Front Camber (Â°)	-1.25	-0.5	0.25
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-2.2	-1.45	-0.7
Right Rear Camber (Â°)	-2.2	-1.45	-0.7
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CRUZE except XJ2 and IK9 RPO codes QYW P215/60R16

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.25	-0.5	0.25
Right Front Camber (Â°)	-1.25	-0.5	0.25
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-2.2	-1.45	-0.7
Right Rear Camber (Â°)	-2.2	-1.45	-0.7
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CRUZE IK9 RPO Restriction QOI P225/45R18

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.35	-0.6	0.15
Right Front Camber (Â°)	-1.35	-0.6	0.15
Front Toe (Â°)	-0.12	0.08	0.28
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-2.2	-1.45	-0.7
Right Rear Camber (Â°)	-2.2	-1.45	-0.7
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CRUZE IK9 RPO Restriction QYF P225/50R17

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.35	-0.6	0.15

Measurement	Minimum	Preferred	Maximum
Right Front Camber (Â°)	-1.35	-0.6	0.15
Front Toe (Â°)	-0.12	0.08	0.28
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-2.2	-1.45	-0.7
Right Rear Camber (Â°)	-2.2	-1.45	-0.7
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CRUZE IK9 RPO Restriction QYW P215/60R16

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.35	-0.6	0.15
Right Front Camber (Â°)	-1.35	-0.6	0.15
Front Toe (Â°)	-0.12	0.08	0.28
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-2.2	-1.45	-0.7
Right Rear Camber (Â°)	-2.2	-1.45	-0.7
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CRUZE XJ2 RPO Restriction QOI P225/45R18

Measurement	Minimum	Preferred	Maximum

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.3	-0.55	0.2
Right Front Camber (Â°)	-1.3	-0.55	0.2
Front Toe (Â°)	-0.12	0.08	0.28
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-2.2	-1.45	-0.7
Right Rear Camber (Â°)	-2.2	-1.45	-0.7
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

CRUZE XJ2 RPO Restriction QYF P225/50R17

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.3	-0.55	0.2
Right Front Camber (Â°)	-1.3	-0.55	0.2
Front Toe (Â°)	-0.12	0.08	0.28
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-2.2	-1.45	-0.7
Right Rear Camber (Â°)	-2.2	-1.45	-0.7
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

EQUINOX

EQUINOX All Models

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	2.7	3.3
Right Front Caster (Â°)	2.1	2.7	3.3
Left Front Camber (Â°)	-1.3	-0.5	0.3
Right Front Camber (Â°)	-1.3	-0.5	0.3
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.2	-0.4	0.4
Right Rear Camber (Â°)	-1.2	-0.4	0.4
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

EXPRESS

EXPRESS G20 HD/G30/G40

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.3	4.3	5.3
Right Front Caster (Â°)	3.7	4.7	5.7
Left Front Camber (Â°)	-0.35	0.25	0.85
Right Front Camber (Â°)	-0.35	0.25	0.85
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

IMPALA

IMPALA All RPOs

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3	3.8	4.6
Right Front Caster (Â°)	3	3.8	4.6
Left Front Camber (Â°)	-1.2	-0.4	0.4
Right Front Camber (Â°)	-1.2	-0.4	0.4
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.6	-0.8	0
Right Rear Camber (Â°)	-1.6	-0.8	0
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

IMPALA Limited 9C1 & 9C3

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.2	3	3.8
Right Front Caster (Â°)	2.2	3	3.8
Left Front Camber (Â°)	-1.4	-0.6	0.2
Right Front Camber (Â°)	-1.4	-0.6	0.2
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.5	-0.7	0.1
Right Rear Camber (Â°)	-1.5	-0.7	0.1
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0

Measurement	Minimum	Preferred	Maximum
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

IMPALA Limited FE1, FE2 (LS, LT)

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	2.9	3.7
Right Front Caster (Â°)	2.1	2.9	3.7
Left Front Camber (Â°)	-1.6	-0.8	0
Right Front Camber (Â°)	-1.6	-0.8	0
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.4	-0.6	0.2
Right Rear Camber (Â°)	-1.4	-0.6	0.2
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

IMPALA Limited FE3 (LTZ)

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.3	3.1	3.9
Right Front Caster (Â°)	2.3	3.1	3.9
Left Front Camber (Â°)	-1.5	-0.7	0.1
Right Front Camber (Â°)	-1.5	-0.7	0.1
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.7	-0.9	-0.1

Measurement	Minimum	Preferred	Maximum
Right Rear Camber (Â°)	-1.7	-0.9	-0.1
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

MALIBU

MALIBU RPO 1ZH69, 1ZK69 P225/50R18

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.1	3.9	4.7
Right Front Caster (Â°)	3.1	3.9	4.7
Left Front Camber (Â°)	-1.2	-0.4	0.4
Right Front Camber (Â°)	-1.2	-0.4	0.4
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.6	-0.8	0
Right Rear Camber (Â°)	-1.6	-0.8	0
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

MALIBU RPO QGK P235/50R18

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.1	3.9	4.7
Right Front Caster (Â°)	3.1	3.9	4.7
Left Front Camber (Â°)	-1.2	-0.4	0.4
Right Front Camber (Â°)	-1.2	-0.4	0.4

Measurement	Minimum	Preferred	Maximum
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.6	-0.8	0
Right Rear Camber (Â°)	-1.6	-0.8	0
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

MALIBU RPO QPE P205/60R16

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.1	3.9	4.7
Right Front Caster (Â°)	3.1	3.9	4.7
Left Front Camber (Â°)	-1.2	-0.4	0.4
Right Front Camber (Â°)	-1.2	-0.4	0.4
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.6	-0.8	0
Right Rear Camber (Â°)	-1.6	-0.8	0
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

MALIBU RPO RA8 P215/60R16

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.1	3.9	4.7

Measurement	Minimum	Preferred	Maximum
Right Front Caster (Â°)	3.1	3.9	4.7
Left Front Camber (Â°)	-1.2	-0.4	0.4
Right Front Camber (Â°)	-1.2	-0.4	0.4
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.6	-0.8	0
Right Rear Camber (Â°)	-1.6	-0.8	0
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

MALIBU RPO RA9 P225/55R17

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.1	3.9	4.7
Right Front Caster (Â°)	3.1	3.9	4.7
Left Front Camber (Â°)	-1.2	-0.4	0.4
Right Front Camber (Â°)	-1.2	-0.4	0.4
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.6	-0.8	0
Right Rear Camber (Â°)	-1.6	-0.8	0
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

MALIBU RPO RP2 P245/40R19

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.1	3.9	4.7
Right Front Caster (Â°)	3.1	3.9	4.7
Left Front Camber (Â°)	-1.2	-0.4	0.4
Right Front Camber (Â°)	-1.2	-0.4	0.4
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.6	-0.8	0
Right Rear Camber (Â°)	-1.6	-0.8	0
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO

SILVERADO (1500 Crew Cab) Regular Box (6' 6") With QHX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.8	2.8	3.8
Right Front Caster (Â°)	2.1	3.1	4.1
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Crew Cab) Regular Box (6' 6") With QNM,RC3,RC5.RKX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	1.9	2.9	3.9
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Crew Cab) Regular Box (6' 6") With QSS and R5A, QSS and R4Y

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.2	3.2	4.2
Right Front Caster (Â°)	1.8	2.8	3.8
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Crew Cab) Regular Box (6' 6") With QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.5	3.5	4.5
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Crew Cab) Regular Box (6' 6") With RBW,RBX,RHH,QBL,RC7 RBZ&R5C,RBZ&R4Z

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2	3	4
Right Front Caster (Â°)	2	3	4
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Crew Cab) Short Box (5' 8") With QHX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	2	3	4
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Crew Cab) Short Box (5' 8") With QNM,RC3,RC5.RKX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2	3	4
Right Front Caster (Â°)	1.8	2.8	3.8
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Crew Cab) Short Box (5' 8") With QSS and R5A, QSS and R4Y

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	1.7	2.7	3.7
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Crew Cab) Short Box (5' 8") With QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.4	3.4	4.4
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7

Measurement	Minimum	Preferred	Maximum
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Crew Cab) Short Box (5' 8") With RBZ &R5C, RBZ &R4Z, RBW, RBX, RHH, QBL, RC7

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9
Right Front Caster (Â°)	1.9	2.9	3.9
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Extended Cab) Regular Box (6' 6") With QHX

Measurement	Minimum	Preferred	Maximum

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.8	2.8	3.8
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Extended Cab) Regular Box (6' 6") With QNM,RC3,RC5.RKX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.8	2.8	3.8
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Extended Cab) Regular Box (6' 6") With QSS and R5A, QSS and R4Y

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Extended Cab) Regular Box (6' 6") With QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.2	3.2	4.2
Right Front Caster (Â°)	1.2	2.2	3.2
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Extended Cab) Regular Box (6' 6") With RBZ &R5C, RBZ &R4Z, QBL, RBX, RBW, RHH, RC7

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	1.7	2.7	3.7
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Regular Cab) Long Box (8' 0") With QBL,RBX,RBW,RHH,RC7

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Regular Cab) Long Box (8' 0") With QHX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.7	2.7	3.7
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Regular Cab) Long Box (8' 0") With QSS and R5A, QSS and R4Y

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.8	2.8	3.8
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0

Measurement	Minimum	Preferred	Maximum
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Regular Cab) Long Box (8' 0") With QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	1.1	2.1	3.1
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Regular Cab) Long Box (8' 0") With RBZ &R5C, RBZ &R4Z, QNM, RC3,RC5,RKX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Regular Cab) Regular Box (6' 6") With QBL,RBX,RBW,RHH,RC7

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Regular Cab) Regular Box (6' 6") With QHX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.2	2.2	3.2
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7

Measurement	Minimum	Preferred	Maximum
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Regular Cab) Regular Box (6' 6") With QSS and R5A, QSS and R4Y

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.2	2.2	3.2
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Regular Cab) Regular Box (6' 6") With QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9

Measurement	Minimum	Preferred	Maximum
Right Front Caster (Â°)	0.9	1.9	2.9
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (1500 Regular Cab) Regular Box (6' 6") With RBZ &R5C, RBZ &R4Z, QNM, RC3,RC5,RKX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.3	2.3	3.3
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 2500 Long Box (8' 0") SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 2500 Long Box (8' 0") SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 2500 Regular Box (6' 6") SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 2500 Regular Box (6' 6") SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.8	2.8	3.8
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 3500 Cab Chassis All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 3500 Long Box (8' 0") (Box Delete) DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 3500 Long Box (8' 0") (Box Delete) SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 3500 Long Box (8' 0") DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.7	2.7	3.7
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3

Measurement	Minimum	Preferred	Maximum
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 3500 Long Box (8' 0") SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	1.7	2.7	3.7
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Diesel) Denali CK 3500 Regular Box (6' 6") SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6

Measurement	Minimum	Preferred	Maximum
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 2500 Long Box (8' 0") SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.8	2.8	3.8
Right Front Caster (Â°)	1.8	2.8	3.8
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 2500 Long Box (8' 0") SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 2500 Regular Box (6' 6") SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.8	2.8	3.8
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 2500 Regular Box (6'6") SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	1.7	2.7	3.7
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 3500 Cab Chassis All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	1.8	2.8	3.8
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0

Measurement	Minimum	Preferred	Maximum
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 3500 Long Box (8' 0") (Box Delete) SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	1.7	2.7	3.7
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 3500 Long Box (8' 0") DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9
Right Front Caster (Â°)	2	3	4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 3500 Long Box (8' 0") SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2	3	4
Right Front Caster (Â°)	2	3	4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Crew Cab - Gas) Denali CK 3500 Regular Box (6' 6") SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9
Right Front Caster (Â°)	1.9	2.9	3.9
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3

Measurement	Minimum	Preferred	Maximum
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.2	2.2	3.2
Right Front Caster (Â°)	1.1	2.1	3.1
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6

Measurement	Minimum	Preferred	Maximum
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 2500 Long Box (8' 0") SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 2500 Long Box (8' 0") SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 2500 Regular Box (6' 6") (Box Delete) SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 2500 Regular Box (6' 6") (Box Delete) SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.2	2.2	3.2
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 2500 Regular Box (6' 6") SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 2500 Regular Box (6' 6") SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 3500 Long Box (8' 0") (Box Delete) DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 3500 Long Box (8' 0") (Box Delete) SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.3	2.3	3.3
Right Front Caster (Â°)	1.1	2.1	3.1
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 3500 Long Box (8' 0") DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3

Measurement	Minimum	Preferred	Maximum
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Diesel) Denali CK 3500 Long Box (8' 0") SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5

Measurement	Minimum	Preferred	Maximum
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 2500 Long Box (8' 0") (Box Off) SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 2500 Long Box (8' 0") SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 2500 Long Box (8' 0") SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 2500 Regular Box (6' 6") (Box Delete) SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 2500 Regular Box (6' 6") (Box Delete) SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.2	2.2	3.2
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 2500 Regular Box (6' 6") SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 2500 Regular Box (6' 6") SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0

Measurement	Minimum	Preferred	Maximum
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 3500 Long Box (8' 0") (Box Delete) DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.7	2.7	3.7
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 3500 Long Box (8' 0") (Box Delete) SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 3500 Long Box (8' 0") DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.8	2.8	3.8
Right Front Caster (Â°)	1.7	2.7	3.7
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Extended Cab - Gas) Denali CK 3500 Long Box (8' 0") SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9
Right Front Caster (Â°)	1.8	2.8	3.8
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3

Measurement	Minimum	Preferred	Maximum
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Diesel) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1	2	3
Right Front Caster (Â°)	0.9	1.9	2.9
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Diesel) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW w/QXT

Measurement	Minimum	Preferred	Maximum

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.1	2.1	3.1
Right Front Caster (Â°)	0.8	1.8	2.8
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Diesel) Denali CK 2500 Long Box (8' 0") SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Diesel) Denali CK 2500 Long Box (8' 0") SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.2	2.2	3.2
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Diesel) Denali CK 3500 Cab Chassis Wheel Base 137.5in (3492.5mm) DRW

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Diesel) Denali CK 3500 Cab Chassis Wheel Base 153.7 in (3904.4mm) DRW

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.3	2.3	3.3
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Diesel) Denali CK 3500 Long Box (8' 0") (Box Delete) DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Diesel) Denali CK 3500 Long Box (8' 0") (Box Delete) SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.3	2.3	3.3
Right Front Caster (Â°)	1.1	2.1	3.1
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Diesel) Denali CK 3500 Long Box (8' 0") DRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.8	2.8	3.8
Right Front Caster (Â°)	1.8	2.8	3.8
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Diesel) Denali CK 3500 Long Box (8' 0") SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Gas) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1	2	3
Right Front Caster (Â°)	0.9	1.9	2.9
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3

Measurement	Minimum	Preferred	Maximum
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Gas) Denali CK 2500 Long Box (8' 0") (Box Delete) SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.1	2.1	3.1
Right Front Caster (Â°)	0.8	1.8	2.8
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Gas) Denali CK 2500 Long Box (8' 0") SRW W/O QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4

Measurement	Minimum	Preferred	Maximum
Right Front Caster (Â°)	1.3	2.3	3.3
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Gas) Denali CK 2500 Long Box (8' 0") SRW w/QXT

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.5	2.5	3.5
Right Front Caster (Â°)	1.2	2.2	3.2
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Gas) Denali CK 3500 Cab Chassis Wheel Base 137.5in (3492.5mm) DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.4	2.4	3.4
Right Front Caster (Â°)	1.4	2.4	3.4
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Gas) Denali CK 3500 Cab Chassis Wheel Base 153.7 in (3904.4mm) DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.7	2.7	3.7
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Gas) Denali CK 3500 Long Box (8' 0") (Box Delete) DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.6	2.6	3.6
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Gas) Denali CK 3500 Long Box (8' 0") (Box Delete) SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.3	2.3	3.3
Right Front Caster (Â°)	1.1	2.1	3.1
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Gas) Denali CK 3500 Long Box (8' 0") DRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.8	2.8	3.8
Right Front Caster (Â°)	1.8	2.8	3.8
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SILVERADO (2500 and 3500 Regular Cab - Gas) Denali CK 3500 Long Box (8' 0") SRW All

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.6	2.6	3.6
Right Front Caster (Â°)	1.5	2.5	3.5
Left Front Camber (Â°)	-0.3	0.5	1.3
Right Front Camber (Â°)	-0.3	0.5	1.3
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SONIC

SONIC ECO Suspension

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.8	4.55	5.3
Right Front Caster (Â°)	3.8	4.55	5.3
Left Front Camber (Â°)	-1.7	-0.95	-0.2
Right Front Camber (Â°)	-1.7	-0.95	-0.2
Front Toe (Â°)	-0.16	0.04	0.24
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.5	-1	-0.5
Right Rear Camber (Â°)	-1.5	-1	-0.5
Rear Toe (Â°)	-0.09	0.41	0.91
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SONIC FE1 Suspension

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.65	4.4	5.15
Right Front Caster (Â°)	3.65	4.4	5.15
Left Front Camber (Â°)	-1.55	-0.8	-0.05
Right Front Camber (Â°)	-1.55	-0.8	-0.05
Front Toe (Â°)	-0.1	0.1	0.3

Measurement	Minimum	Preferred	Maximum
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.5	-1	-0.5
Right Rear Camber (Â°)	-1.5	-1	-0.5
Rear Toe (Â°)	-0.1	0.4	0.9
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SONIC FE3 Suspension

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.8	4.55	5.3
Right Front Caster (Â°)	3.8	4.55	5.3
Left Front Camber (Â°)	-1.7	-0.95	-0.2
Right Front Camber (Â°)	-1.7	-0.95	-0.2
Front Toe (Â°)	-0.16	0.04	0.24
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.5	-1	-0.5
Right Rear Camber (Â°)	-1.5	-1	-0.5
Rear Toe (Â°)	-0.09	0.41	0.91
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SONIC FE4 Suspension

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.6	4.35	5.1
Right Front Caster (Â°)	3.6	4.35	5.1

Measurement	Minimum	Preferred	Maximum
Left Front Camber (Â°)	-1.45	-0.7	0.05
Right Front Camber (Â°)	-1.45	-0.7	0.05
Front Toe (Â°)	-0.07	0.13	0.33
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.5	-1	-0.5
Right Rear Camber (Â°)	-1.5	-1	-0.5
Rear Toe (Â°)	-0.12	0.38	0.88
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SPARK

SPARK Classic

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.8	3.8	4.8
Right Front Caster (Â°)	2.8	3.8	4.8
Left Front Camber (Â°)	-0.25	0.5	1.25
Right Front Camber (Â°)	-0.25	0.5	1.25
Front Toe (Â°)	0	0.17	0.34
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-2	-1.5	-1
Right Rear Camber (Â°)	-2	-1.5	-1
Rear Toe (Â°)	-0.08	0.25	0.58
Thrust Angle	0	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SPARK EV

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.9	3.65	4.4
Right Front Caster (Â°)	2.9	3.65	4.4
Left Front Camber (Â°)	-1.17	-0.42	0.33
Right Front Camber (Â°)	-1.17	-0.42	0.33
Front Toe (Â°)	-0.16	0.04	0.24
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.5	-1	-0.5
Right Rear Camber (Â°)	-1.5	-1	-0.5
Rear Toe (Â°)	-0.3	0.05	0.4
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SPARK M300 Diesel

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.69	3.44	4.19
Right Front Caster (Â°)	2.69	3.44	4.19
Left Front Camber (Â°)	-0.7	0.05	0.8
Right Front Camber (Â°)	-0.7	0.05	0.8
Front Toe (Â°)	-0.04	0.16	0.36
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.95	-1.45	-0.95
Right Rear Camber (Â°)	-1.95	-1.45	-0.95
Rear Toe (Â°)	-0.19	0.16	0.51
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Max Turn, Outward (Â°)	0	-	-

SPARK M300 F

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.9	3.65	4.4
Right Front Caster (Â°)	2.9	3.65	4.4
Left Front Camber (Â°)	-1.17	-0.42	0.33
Right Front Camber (Â°)	-1.17	-0.42	0.33
Front Toe (Â°)	-0.16	0.04	0.24
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.95	-1.45	-0.95
Right Rear Camber (Â°)	-1.95	-1.45	-0.95
Rear Toe (Â°)	-0.05	0.3	0.65
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SPARK M300 Gasoline

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.8	3.55	4.3
Right Front Caster (Â°)	2.8	3.55	4.3
Left Front Camber (Â°)	-0.95	-0.2	0.55
Right Front Camber (Â°)	-0.95	-0.2	0.55
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.95	-1.45	-0.95
Right Rear Camber (Â°)	-1.95	-1.45	-0.95
Rear Toe (Â°)	-0.11	0.24	0.59
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SS

SS FE3 Suspension All Models

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	4.75	6	7.25
Right Front Caster (Â°)	4.75	6	7.25
Left Front Camber (Â°)	-0.63	-0.3	0.03
Right Front Camber (Â°)	-0.63	-0.3	0.03
Front Toe (Â°)	0	0.17	0.34
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.15	-0.7	-0.25
Right Rear Camber (Â°)	-1.15	-0.7	-0.25
Rear Toe (Â°)	0	0.2	0.4
Thrust Angle	0.2	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SUBURBAN

SUBURBAN C/K 1500 w/ 17" Tires With RC3,QBL,RBZ and R5C,RBZ and R4Y,QAR

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	2.1	3.1	4.1
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SUBURBAN C/K 1500 w/ 18" Tires With RBX, RBW, QXO

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	2.1	3.1	4.1
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SUBURBAN C/K 1500 w/ 18" Tires With RKX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.2	3.2	4.2
Right Front Caster (Â°)	2	3	4
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SUBURBAN C/K 1500 w/ 20" Tires With QHX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9
Right Front Caster (Â°)	2.2	3.2	4.2
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SUBURBAN C/K 1500 w/ 20" Tires With QSS and R5A

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.2	3.2	4.2
Right Front Caster (Â°)	1.9	2.9	3.9
Left Front Camber (Â°)	-0.9	-0.1	0.7

Measurement	Minimum	Preferred	Maximum
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SUBURBAN C/K 1500 w/ 20" Tires With RC7, QSS and R5C

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	2.1	3.1	4.1
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

SUBURBAN C/K 1500 w/ 22" Tires With QST

Measurement	Minimum	Preferred	Maximum

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	2.1	3.1	4.1
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TAHOE

TAHOE C/K 1500 w/ 17" Tires With RC3,QBL,RBZ and R5C,RBZ and R4Y,QAR

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	2.1	3.1	4.1
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TAHOE C/K 1500 w/ 18" Tires With RBX, RBW, QXO

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	2.1	3.1	4.1
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TAHOE C/K 1500 w/ 18" Tires With RKX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.2	3.2	4.2
Right Front Caster (Â°)	2	3	4
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TAHOE C/K 1500 w/ 20" Tires With QHX

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	1.9	2.9	3.9
Right Front Caster (Â°)	2.2	3.2	4.2
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TAHOE C/K 1500 w/ 20" Tires With QSS and R5A

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.2	3.2	4.2
Right Front Caster (Â°)	1.9	2.9	3.9
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0

Measurement	Minimum	Preferred	Maximum
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TAHOE C/K 1500 w/ 20" Tires With RC7, QSS and R5C

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	2.1	3.1	4.1
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TAHOE C/K 1500 w/ 22" Tires With QST

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	2.1	3.1	4.1
Right Front Caster (Â°)	2.1	3.1	4.1
Left Front Camber (Â°)	-0.9	-0.1	0.7
Right Front Camber (Â°)	-0.9	-0.1	0.7
Front Toe (Â°)	-0.1	0.1	0.3
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Right Rear Camber (Â°)	0	0	0
Rear Toe (Â°)	0	0	0
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TRAVERSE

TRAVERSE All Models except QPR

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.9	4.7	5.5
Right Front Caster (Â°)	3.9	4.7	5.5
Left Front Camber (Â°)	-1.7	-0.9	-0.1
Right Front Camber (Â°)	-1.7	-0.9	-0.1
Front Toe (Â°)	-0.2	0	0.2
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.7	-0.9	-0.1
Right Rear Camber (Â°)	-1.7	-0.9	-0.1
Rear Toe (Â°)	-0.1	0.1	0.3
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TRAVERSE All Models With QPR

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.9	4.7	5.5
Right Front Caster (Â°)	3.9	4.7	5.5
Left Front Camber (Â°)	-1.7	-0.9	-0.1
Right Front Camber (Â°)	-1.7	-0.9	-0.1

Measurement	Minimum	Preferred	Maximum
Front Toe (Â°)	-0.2	0	0.2
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.7	-0.9	-0.1
Right Rear Camber (Â°)	-1.7	-0.9	-0.1
Rear Toe (Â°)	-0.2	0	0.2
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TRAX

TRAX LS/LT/LTZ (AWD) P 205/70R16 (Canada)

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.35	-0.6	0.15
Right Front Camber (Â°)	-1.35	-0.6	0.15
Front Toe (Â°)	-0.04	0.16	0.36
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.75	-1	-0.25
Right Rear Camber (Â°)	-1.75	-1	-0.25
Rear Toe (Â°)	-0.2	0.2	0.6
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TRAX LS/LT/LTZ (AWD) P 215/55R18 (Canada)

Measurement	Minimum	Preferred	Maximum

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.35	-0.6	0.15
Right Front Camber (Â°)	-1.35	-0.6	0.15
Front Toe (Â°)	-0.04	0.16	0.36
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.75	-1	-0.25
Right Rear Camber (Â°)	-1.75	-1	-0.25
Rear Toe (Â°)	-0.2	0.2	0.6
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TRAX LS/LT/LTZ (FWD) P 205/70R16 (Canada)

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.35	-0.6	0.15
Right Front Camber (Â°)	-1.35	-0.6	0.15
Front Toe (Â°)	-0.04	0.16	0.36
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.75	-1	-0.25
Right Rear Camber (Â°)	-1.75	-1	-0.25
Rear Toe (Â°)	-0.2	0.2	0.6
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

TRAX LS/LT/LTZ (FWD) P 215/55R18 (Canada)

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.75	4.5	5.25
Right Front Caster (Â°)	3.75	4.5	5.25
Left Front Camber (Â°)	-1.35	-0.6	0.15
Right Front Camber (Â°)	-1.35	-0.6	0.15
Front Toe (Â°)	-0.04	0.16	0.36
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-1.75	-1	-0.25
Right Rear Camber (Â°)	-1.75	-1	-0.25
Rear Toe (Â°)	-0.2	0.2	0.6
Thrust Angle	0.3	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

VOLT

VOLT All Models

Measurement	Minimum	Preferred	Maximum
Left Front Caster (Â°)	3.6	4.4	5.2
Right Front Caster (Â°)	3.6	4.4	5.2
Left Front Camber (Â°)	-1.2	-0.4	0.4
Right Front Camber (Â°)	-1.2	-0.4	0.4
Front Toe (Â°)	0	0.2	0.4
Left SAI (Â°)	0	0	0
Right SAI (Â°)	0	0	0
Left Rear Camber (Â°)	-2.2	-1.4	-0.6
Right Rear Camber (Â°)	-2.2	-1.4	-0.6
Rear Toe (Â°)	-0.25	0.15	0.55
Thrust Angle	0.4	0	0
Left Toe Out, Inward (Â°)	0	0	0
Right Toe Out, Inward (Â°)	0	0	0
Left Toe Out, Outward (Â°)	0	0	0
Right Toe Out, Outward (Â°)	0	0	0
Left Max Turn, Inward (Â°)	0	0	0
Right Max Turn, Inward (Â°)	0	0	0

Measurement	Minimum	Preferred	Maximum
Left Max Turn, Outward (Â°)	0	0	0
Right Max Turn, Outward (Â°)	0	-	-

Article GUID: A00565576

Suspension

Wheel Alignment - Impala

SPECIFICATIONS

WHEEL ALIGNMENT SPECIFICATIONS

Alignment Condition: Full tank of fuel, no passengers and placed on flat level surface.

RPO Restriction	Wheels	Caster Â± 0.8Â°		Cross Caster Â± 0.8Â°	Camber Â± 0.8Â°		Cross Camber Â± 0.8Â°	Total Toe Â± 0.2Â°	Steering Wheel Angle Â± 3.5Â°	Thrust Angle Â± 0.3Â°
		Left	Right	(Left - Right)	Left	Right	(Left - Right)	(Left + Right)		(Left - Right)/2
FE1, FE2 (LS, LT)	Front	2.9Â°	2.9Â°	0.0Â°	-0.8Â°	-0.8Â°	0.0Â°	0.1Â°	0.0Â°	-
	Rear	-	-	-	-0.6Â°	-0.6Â°	-	0.1Â°	-	0.0Â°
FE3 (LTZ)	Front	3.1Â°	3.1Â°	0.0Â°	-0.7Â°	-0.7Â°	0.0Â°	0.1Â°	0.0Â°	-
	Rear	-	-	-	-0.9Â°	-0.9Â°	-	0.1Â°	-	0.0Â°
9C1 & 9C3	Front	3.0Â°	3.0Â°	0.0Â°	-0.6Â°	-0.6Â°	0.0Â°	0.1Â°	0.0Â°	-
	Rear	-	-	-	-0.7Â°	-0.7Â°	-	0.1Â°	-	0.0Â°

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Front Strut to Knuckle Bolts	130 N.m	96 lb ft
Front Tie Rod End Jam Nut	70 N.m	52 lb ft
Rear Spindle Rod Jam Nut	70 N.m	52 lb ft
Rear Strut to Knuckle Nuts	120 N.m	89 lb ft

REPAIR INSTRUCTIONS

WHEEL ALIGNMENT MEASUREMENT

Steering and vibration complaints are not always the result of improper alignment. One possible cause is wheel and tire imbalance. Another possibility is tire lead due to worn or improperly manufactured tires. Lead/pull is defined as follows: At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle's straight path. Lead is the vehicle deviation from a straight path on a level road without pressure on the steering wheel. Refer to **Radial Tire Lead/Pull Correction** in order to determine if the vehicle has a tire lead problem.

Before performing any adjustment affecting wheel alignment, perform the following inspections in order to ensure correct alignment readings:

- Inspect for visible damage to the suspension components and replace as necessary.
- Inspect the tires for the proper inflation and irregular tire wear. Refer to **Vehicle Certification, Tire Placard, Anti-Theft, and Service Parts ID Label** , and **Tire Diagnosis - Irregular or Premature Wear** .
- Inspect the runout of the wheels and the tires. Refer to **Tire and Wheel Runout Specifications** .
- Inspect the wheel bearings for backlash and excessive play. Refer to **Wheel Bearings Diagnosis** .
- Inspect the ball joints for looseness or wear.
- Inspect the tie rod ends for looseness or wear.
- Inspect the control arms and stabilizer shaft for looseness or wear.
- Inspect the steering gear for looseness at the frame. Refer to **Fastener Specifications** .
- Inspect the struts/shock absorbers for wear, leaks, and any noticeable noises. Refer to **Suspension Strut and Shock Absorber Testing - On Vehicle** .
- Inspect the vehicle trim height. Refer to **Trim Height Inspection** .
- Inspect the steering wheel for excessive drag or poor return due to stiff or rusted linkage or suspension components.
- Inspect the fuel level. The fuel tank should be full or the vehicle should have a compensating load added.

Give consideration to excess loads, such as tool boxes, sample cases, etc. If normally carried in the vehicle, these items should remain in the vehicle during alignment adjustments. Give consideration also to the condition of the equipment being used for the alignment. Follow the equipment manufacturer's instructions.

Satisfactory vehicle operation may occur over a wide range of alignment settings. However, if the setting exceeds the service allowable specifications, correct the alignment to the service preferred specifications. Refer to **Wheel Alignment Specifications**.

Perform the following steps in order to measure the front and rear alignment angles:

1. Install the alignment equipment according to the manufacturer's instructions.
2. Jounce the front and the rear bumpers 3 times prior to checking the wheel alignment.
3. Measure the alignment angles and record the readings.

NOTE:

- **Record the "Before" and "After" alignment measurements.**
- **When performing adjustments to vehicles requiring a 4-wheel alignment, set the rear toe adjustment first in order to obtain proper front alignment angles.**

4. Adjust alignment angles to vehicle specification, if necessary. Refer to **Wheel Alignment Specifications**.

FRONT CAMBER ADJUSTMENT

Adjustment Procedure

1. Before performing any adjustment affecting the wheel alignment, refer to **Wheel Alignment Measurement**.
2. Loosen the strut to the knuckle bolts. Refer to **Strut Assembly Removal and Installation** .

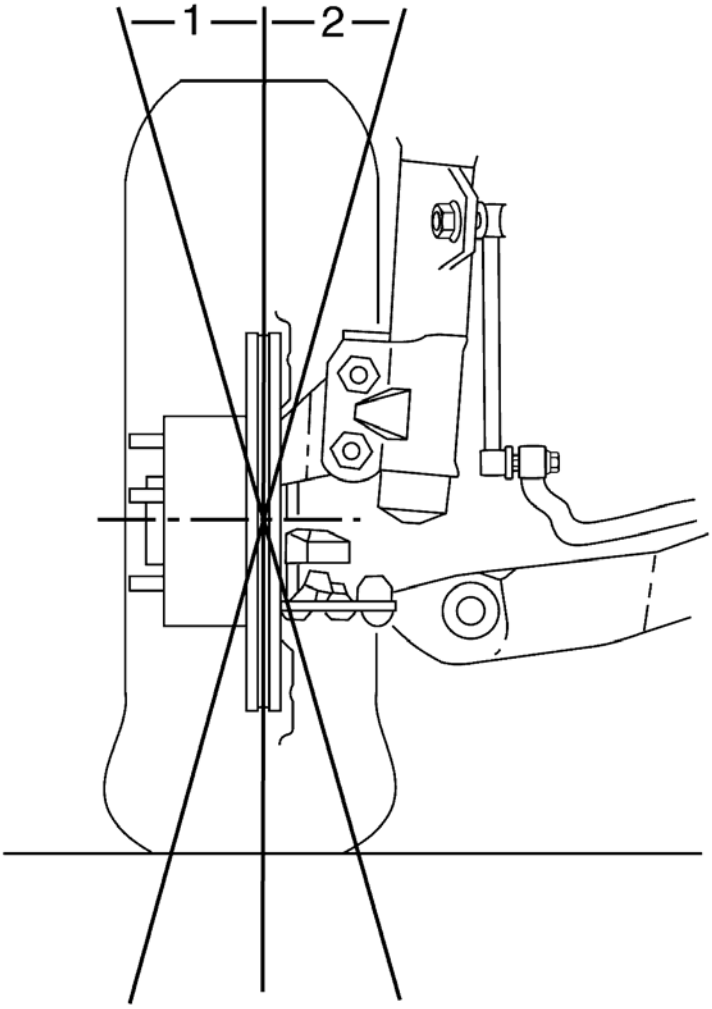


Fig. 1: View Of Positive Or Negative Camber
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

3. Determine the actual camber, Positive (1) or Negative (2).

NOTE: For accurate readings, do not push or pull on the tire and wheel assembly during the alignment.

4. Adjust the front camber to specifications, refer to **Wheel Alignment Measurement**.

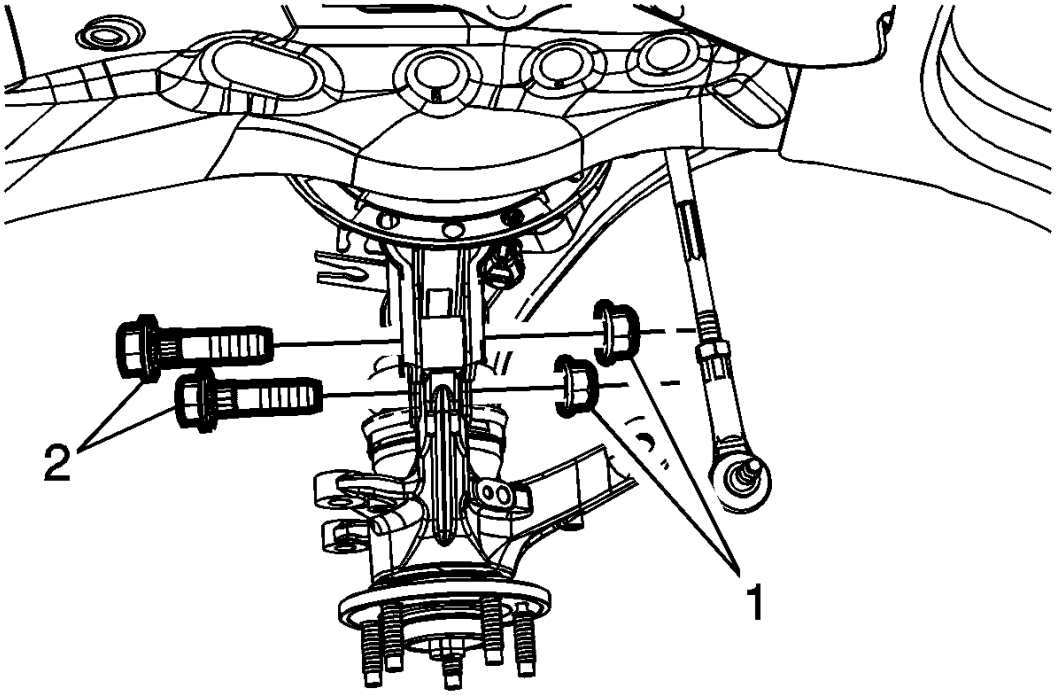


Fig. 2: Front Strut Components
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the strut-to-knuckle nuts (1) to:
   - First Pass: 80 N.m (59 lb ft)
   - Final Pass: plus 180 degrees

NOTE: **After adjusting the front camber, it is necessary to adjust the front toe.**

6. Adjust the front toe. Refer to **Wheel Alignment - Steering Wheel Angle and/or Front Toe Adjustment**.

WHEEL ALIGNMENT - STEERING WHEEL ANGLE AND/OR FRONT TOE ADJUSTMENT

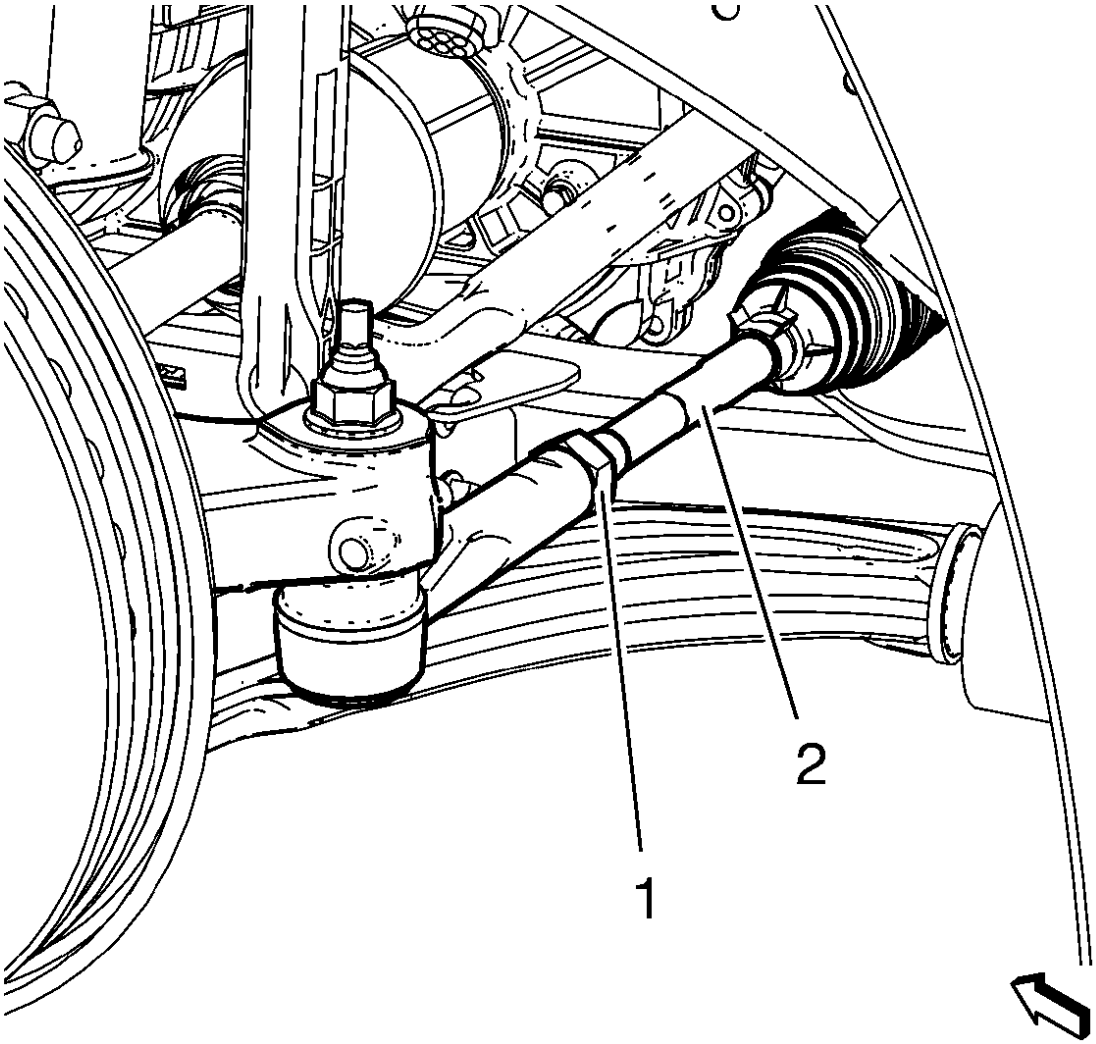


Fig. 3: Inner Tie Rod And Jam Nut
Courtesy of GENERAL MOTORS COMPANY

1. Ensure that the steering wheel is set in a straight ahead position.
2. Loosen the tie rod jam nut (1).
3. Adjust the toe to specification by turning the inner tie rod (2). Refer to **Wheel Alignment Specifications**.

CAUTION: Refer to Fastener Caution .

4. Tighten the tie rod jam nut (1) to 60 N.m (44 lb ft).
5. The steering angle sensor must be recentered, the steering stops must be relearned. Refer to **Steering Angle Sensor Centering** .

REAR TOE ADJUSTMENT

NOTE: Adjust the rear toe on each rear wheel separately.

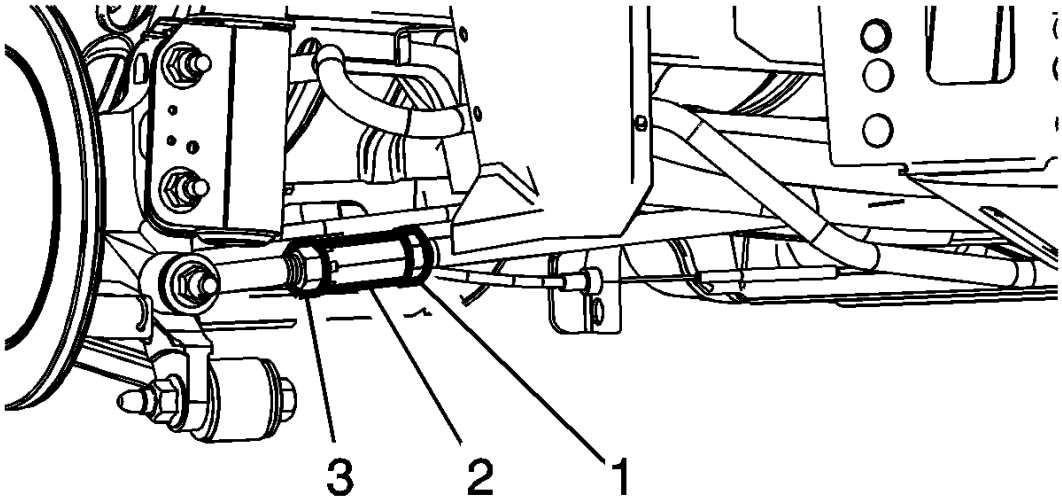


Fig. 4: Rear Suspension Adjust Link, Nuts And Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Loosen the rear suspension adjust link nuts (1) and (3).
2. Adjust the toe by rotating the rear suspension adjust link (2) until the proper specification as been reached. Refer to **Wheel Alignment Specifications**.

CAUTION: Refer to Fastener Caution .

3. Using a backup wrench to hold the rear suspension adjust link (2), tighten the rear suspension adjust link nuts (1) and (3) to 75 N.m (55 lb ft).
4. Recheck the toe setting.
5. If necessary, readjust the toe specifications.

DESCRIPTION AND OPERATION

CAMBER DESCRIPTION

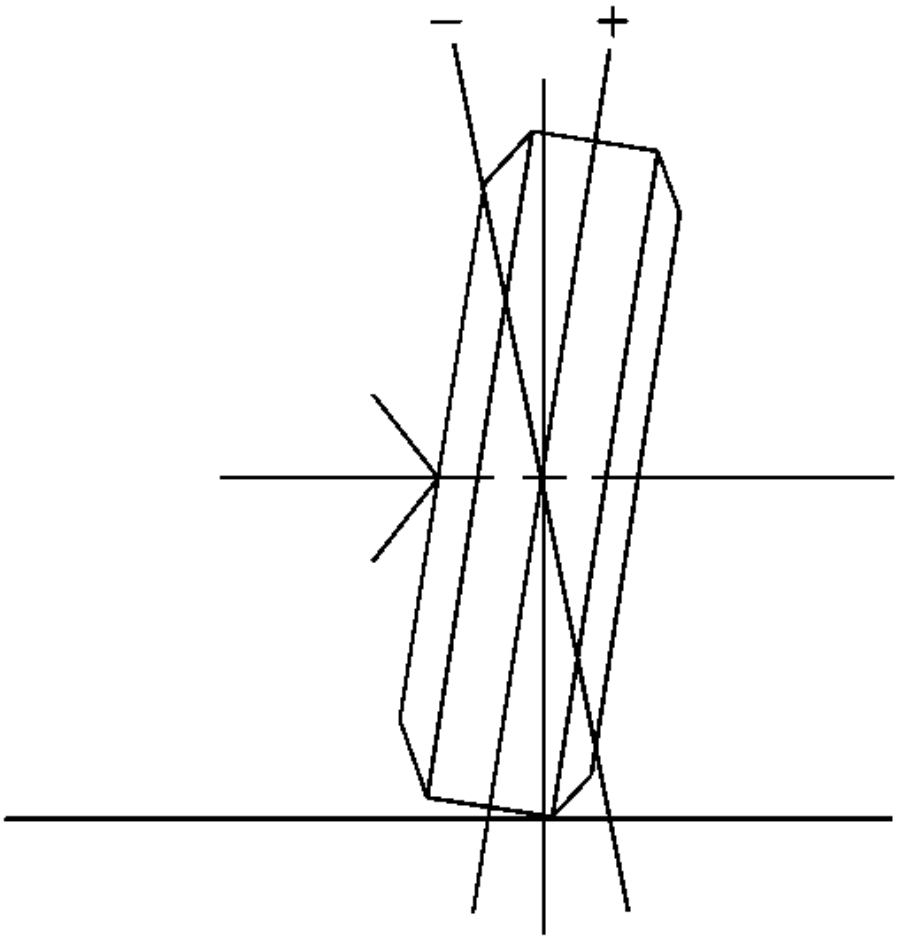


Fig. 5: Illustrating Camber Angle
Courtesy of GENERAL MOTORS COMPANY

Camber is the tilting of the wheels from the vertical when viewed from the front of the vehicle. When the wheels tilt outward at the top, the camber is positive (+). When the wheel tilts inward at the top, the camber is negative (-). The amount of tilt is measured in degrees from the vertical. Camber settings influence the directional control and the tire wear.

Too much positive camber will result in premature wear on the outside of the tire and cause excessive wear on the suspension parts.

Too much negative camber will result in premature wear on the inside of the tire and cause excessive wear on the suspension parts.

Unequal side-to-side camber of 1 degree or more will cause the vehicle to pull or lead to the side with the most positive camber.

Cross Camber is the difference between the left camber value and the right camber value.

Cross Camber = L camber - R camber

CASTER DESCRIPTION

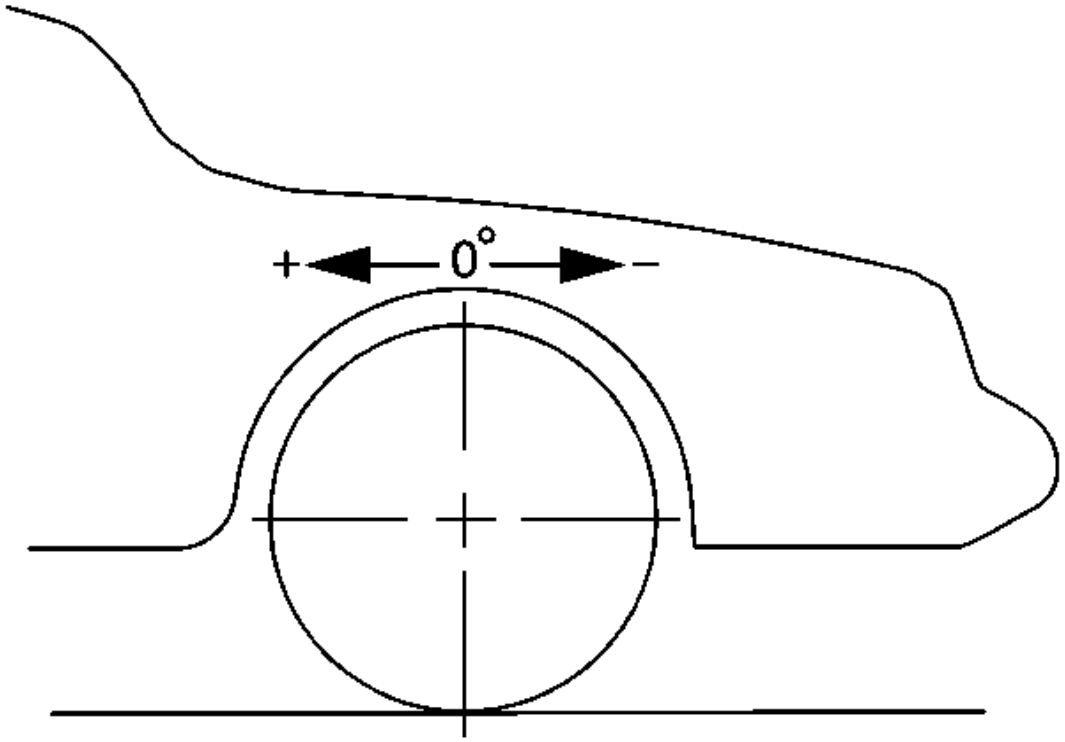


Fig. 6: Illustrating Caster Angle
Courtesy of GENERAL MOTORS COMPANY

Caster is the tilting of the uppermost point of the steering axis either forward or backward, when viewed from the side of the vehicle. A backward tilt is positive (+) and a forward tilt is negative (-). Caster influences directional control of the steering but does not affect the tire wear . Caster is affected by the vehicle height, therefore it is important to keep the body at its designed height. Overloading the vehicle or a weak or sagging rear spring will affect caster. When the rear of the vehicle is lower than its designated trim height, the front suspension moves to a more positive caster. If the rear of the vehicle is higher than its designated trim height, the front suspension moves to a less positive caster.

With too little positive caster, steering may be touchy at high speed and wheel returnability may be diminished when coming out of a turn. If one wheel has more positive caster than the other, that wheel will pull toward the center of the vehicle. This condition will cause the vehicle to pull or lead to the side with the least amount of positive caster.

Cross Caster is the difference between the left caster value and the right caster value.

Cross caster = L caster - R caster

LEAD/PULL DESCRIPTION

At a constant highway speed on a typical straight road, lead/pull is the amount of effort required at the steering wheel to maintain the vehicle's straight path.

IMPORTANT: Vehicles will tend to lead/pull in the direction of the road slope as part of normal operation.

Lead/pull is usually caused by the following factors:

- Road slope
- Variability in tire construction
- Wheel alignment (front cross caster and camber)
- Unbalanced steering gear
- Electronic Power Steering (EPS) steering position and torque sensors not calibrated correctly, if equipped.

MEMORY STEER DESCRIPTION

Memory steer is when the vehicle wants to lead or pull in the direction the driver previously turned the vehicle. Additionally, after turning in the opposite direction, the vehicle will want to lead or pull in that direction.

SCRUB RADIUS DESCRIPTION

Ideally, the scrub radius is as small as possible. Normally, the SAI angle and the centerline of the tire and the wheel intersect below the road surface, causing a positive scrub radius. With struts, the SAI angle is much larger than the long arm/short arm type of suspension. This allows the SAI angle to intersect the camber angle above the road surface, forming a negative scrub radius. The smaller the scrub radius, the better the directional stability. Installing aftermarket wheels that have additional offset will dramatically increase the scrub radius. The newly installed wheels may cause the centerline of the tires to move further away from the spindle. This will increase the scrub radius.

A large amount of scrub radius can cause severe shimmy after hitting a bump. Four-wheel drive vehicles with large tires use a steering damper to compensate for an increased scrub radius. Scrub radius is not directly measurable by the conventional methods. Scrub radius is projected geometrically by engineers during the design phase of the suspension.

SETBACK DESCRIPTION

Setback applies to both the front and the rear wheels. Setback is the amount that one wheel may be aligned behind the other wheel. Setback may be the result of a road hazard or a collision. The first clue is a caster difference from side-to-side of more than 1 degree.

THRUST ANGLES DESCRIPTION

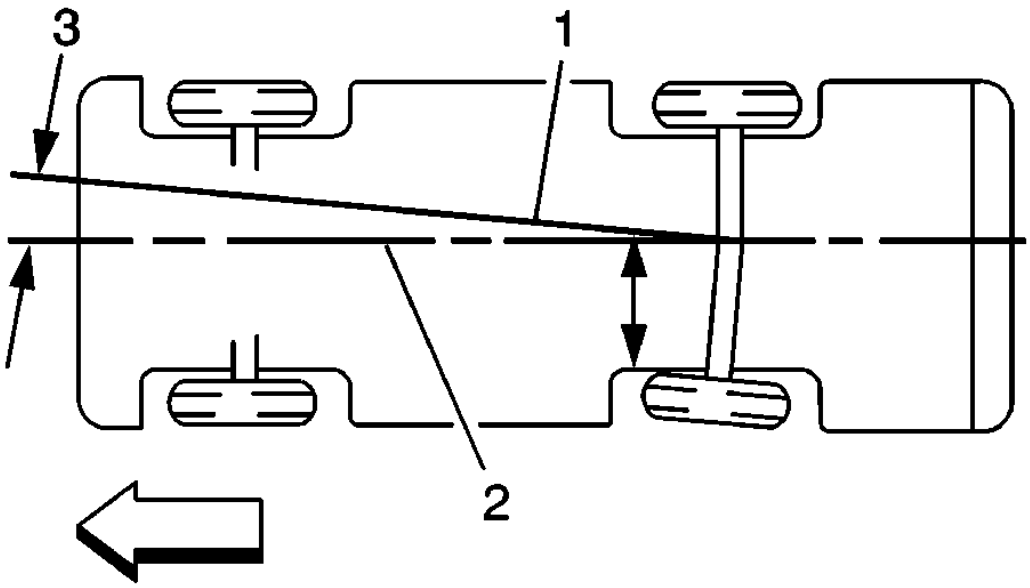


Fig. 7: Illustrating Thrust Angles
Courtesy of GENERAL MOTORS COMPANY

The front wheels aim or steer the vehicle. The rear wheels control tracking. This tracking action relates to the thrust angle (3). The thrust angle is the path that the rear wheels take. Ideally, the thrust angle is geometrically aligned with the body centerline (2).

In the illustration, toe-in is shown on the left rear wheel, moving the thrust line (1) off center. The resulting deviation from the centerline is the thrust angle.

If the thrust angle is not set properly the vehicle may "dog track", the steering wheel may not be centered or it could be perceived as a bent axle. Thrust angle can be checked during a wheel alignment.

Positive thrust angle means the thrust line is pointing to the right hand side (RHS) of the vehicle.

Negative thrust angle means the thrust line is pointing to the left hand side (LHS) of the vehicle.

If the thrust angle is out of specification, moving the axle to body relationship will change the thrust angle reading.

If the vehicle is out in the Positive (+) direction-moving the RHS forward and/or LHS rearward will move the thrust angle towards zero degrees.

If the vehicle is out in the Negative (-) direction-moving the RHS rearward and/or LHS forward will move the thrust angle towards zero degrees.

TOE DESCRIPTION

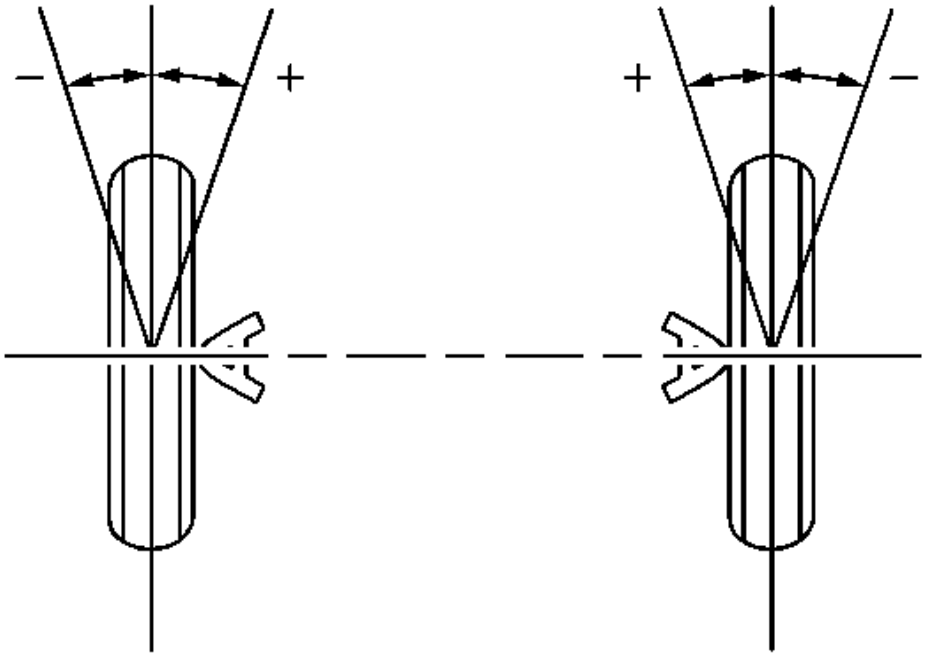


Fig. 8: Illustrating Toe Angle
Courtesy of GENERAL MOTORS COMPANY

Toe is a measurement of how much the front and/or rear wheels are turned in or out from a straight-ahead position. When the wheels are turned in, toe is positive (+). When the wheels are turned out, toe is negative (-). The actual amount of toe is normally only a fraction of a degree. The purpose of toe is to ensure that the wheels roll parallel.

Toe also offsets the small deflections of the wheel support system that occur when the vehicle is rolling forward. In other words, with the vehicle standing still and the wheels set with toe-in, the wheels tend to roll parallel on the road when the vehicle is moving.

Improper toe adjustment will cause premature tire wear and cause steering instability.

TORQUE STEER DESCRIPTION

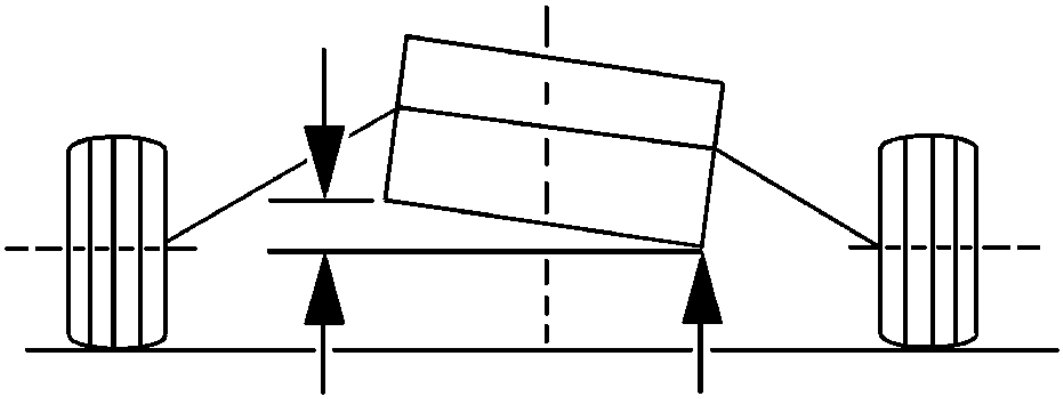


Fig. 9: Identifying Torque Steer
Courtesy of GENERAL MOTORS COMPANY

A vehicle pulls or leads in one direction during hard acceleration. A vehicle pulls or leads in the other direction during deceleration.

The following factors may cause torque steer to be more apparent on a particular vehicle:

- A slightly smaller diameter tire on the right front increases a right torque lead. Inspect the front tires for differences in the brand, the construction, or the size. If the tires appear to be similar, change the front tires from side-to-side and retest the vehicle. Tire and wheel assemblies have the most significant effect on torque steer correction.
- A large difference in the right and left front tire pressure
- Left-to-right differences in the front view axle angle may cause significant steering pull in a vehicle. The pull will be to the side with the most downward sloping axle from the differential to the wheels. Axles

typically slope downward from the differential. The slope of the transaxle pan to level ground may be used as an indication of bias axle angles. The side with the higher transaxle pan, shown on the left side of the illustration, has the most downward sloping axle angle.

WANDER DESCRIPTION

Wander is the undesired drifting or deviation of a vehicle to either side from a straight path with hand pressure on the steering wheel. Wander is a symptom of the vehicle's sensitivity to external disturbances, such as road crown and crosswind, and accentuated by poor on-center steering feel.

Article GUID: A00737241

COMPONENT LOCATOR

DISASSEMBLED VIEWS

Case and Associated Parts

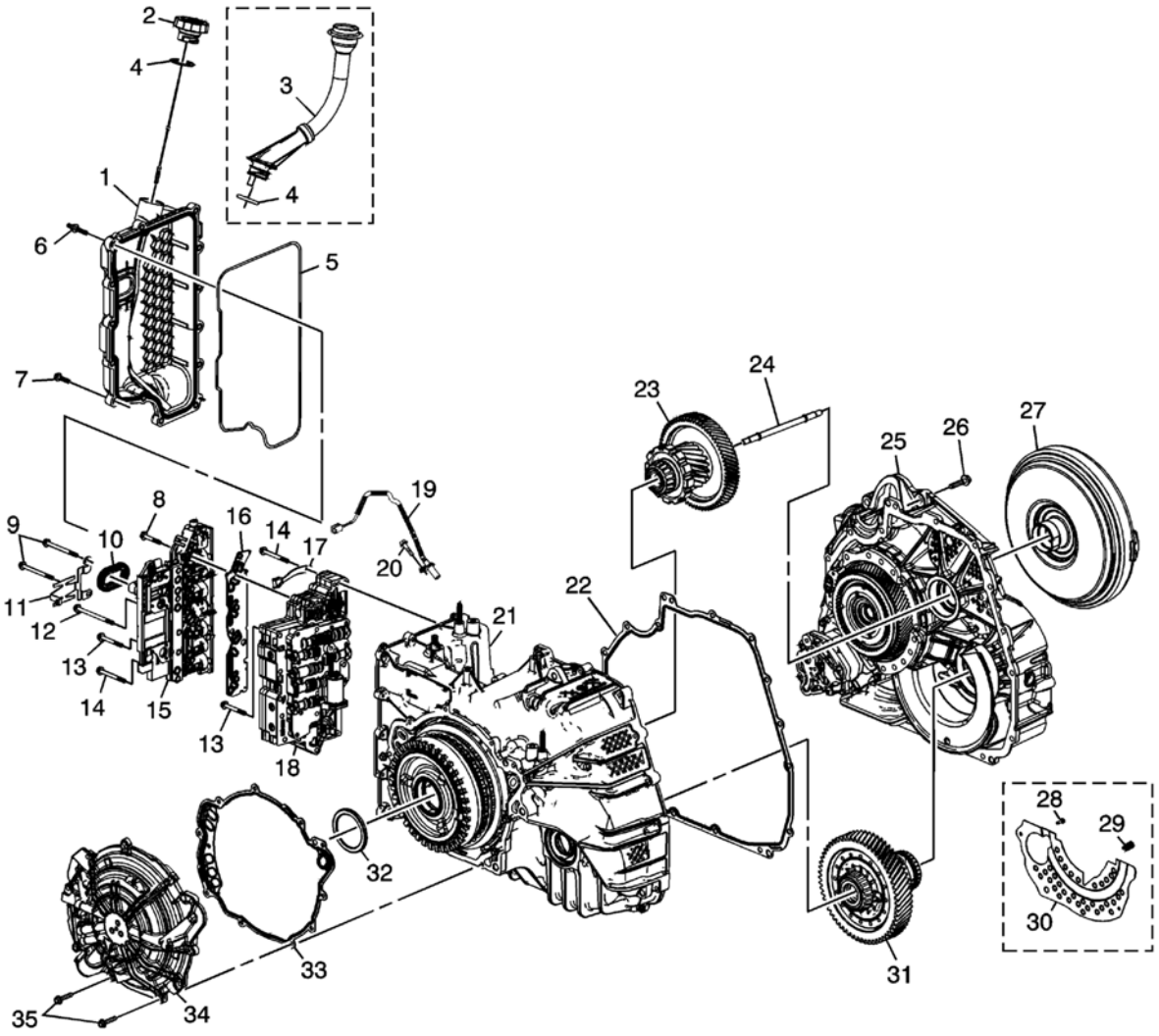


Fig. 1: Identifying Case & Associated Parts
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Control Valve Body Cover Assembly
2	Transmission Fluid Level Indicator Assembly
3	Fluid Level Indicator Tube - Model Dependent
4	Fluid Level Indicator Tube Seal - Model Dependent
5	Control Valve Body Cover Assembly Gasket

Callout	Component Name
6	Control Valve Body Cover Stud
7	Control Valve Body Cover Bolt
8	Control Valve Body Bolt
9	Control Valve Body Bolt
10	Control Valve Body Cover Wiring Connector Hole Seal
11	Control Solenoid Valve Spring
12	Control Valve Body Bolt
13	Control Valve Body Bolt
14	Control Valve Body Bolt
15	Control Solenoid (w/Body and TCM) Valve Assembly
16	Control Solenoid (w/Body and TCM) Filter Plate Assembly
17	Manual Shaft Detent Assembly
18	Control Valve Body Assembly
19	A/Trans Output Speed Sensor Assembly
20	A/Trans Output Speed Sensor Bolt
21	A/Trans Case Assembly
22	Torque Converter Housing Outer Seal
23	Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly
24	Front Differential Drive Pinion Gear Lube Tube
25	Torque Converter and Support and A/Trans Fluid Pump Housing Assembly
26	Torque Converter and Differential Housing Bolt
27	Torque Converter Assembly
28	Dust Cover Push Pin - Model Dependent
29	Dust Cover Bolt - Model Dependent
30	Dust Cover - Model Dependent
31	Front Differential Carrier Assembly
32	Input Shaft Thrust Bearing Assembly
33	A/Trans Case Cover Gasket
34	A/Trans Case Cover Assembly
35	A/Trans Case Cover Assembly Bolt

Transmission Case Assembly

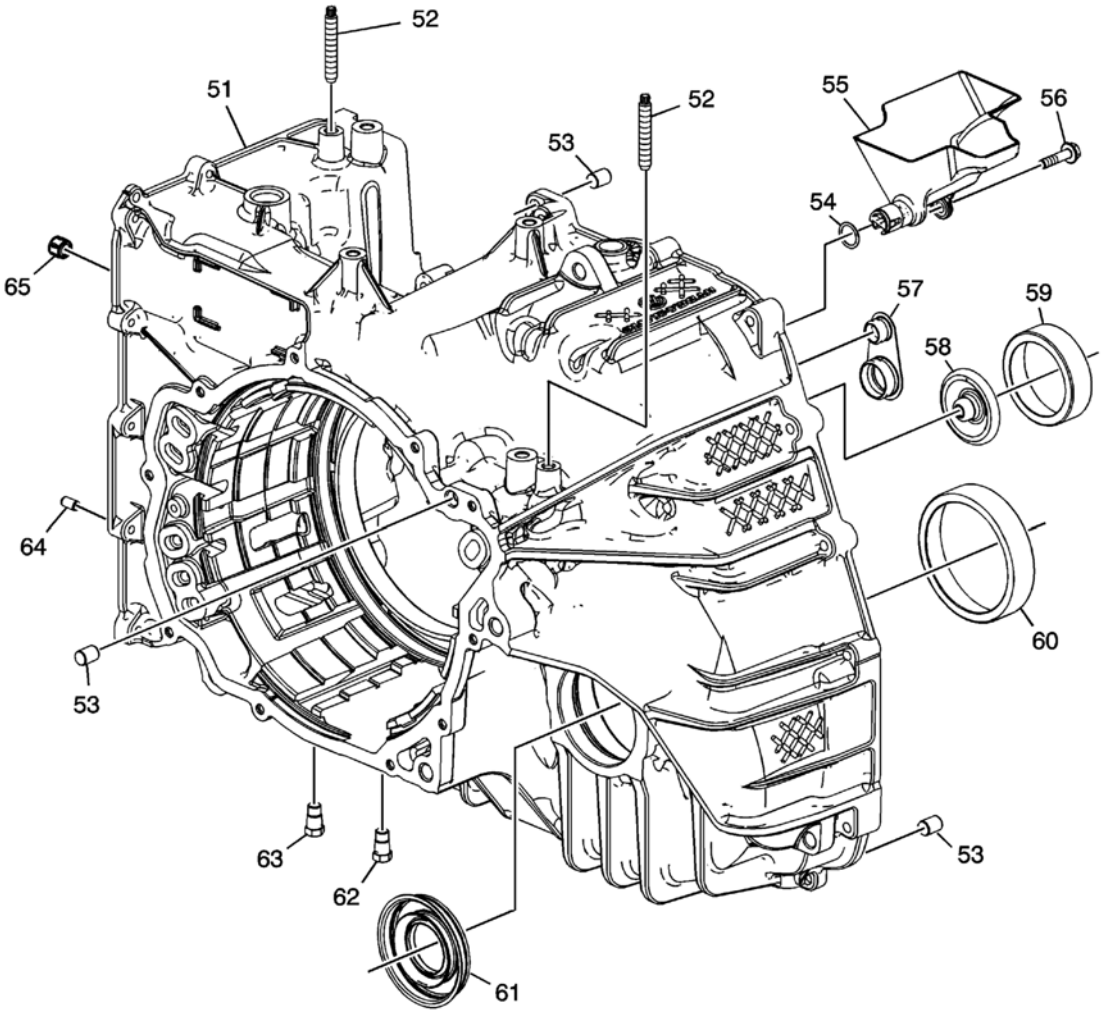


Fig. 2: Identifying Transmission Case Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
51	A/Trans Case Assembly
52	Transmission Fluid Cooler Pipe Stud
53	Transmission Case Cover Locator Pin
54	A/Trans Fluid Trough O-Ring Seal
55	A/Trans Fluid Trough Assembly
56	A/Trans Fluid Trough Bolt
57	A/Trans Pump Fluid Outlet Seal Assembly
58	Front Differential Drive Pinion Gear Lube Dam
59	Front Differential Drive Pinion Gear Bearing Cup
60	Front Differential Carrier Bearing Cup
61	Front Wheel Drive Shaft Oil Seal Assembly
62	A/Trans Fluid Press Test Hole Plug
63	A/Trans Fluid Level Hole Plug
64	Control Valve Body Locator Pin

Callout	Component Name
65	1-2-3-4 Clutch Fluid Passage Seal

Torque Converter, Support and Fluid Pump Housing Assembly

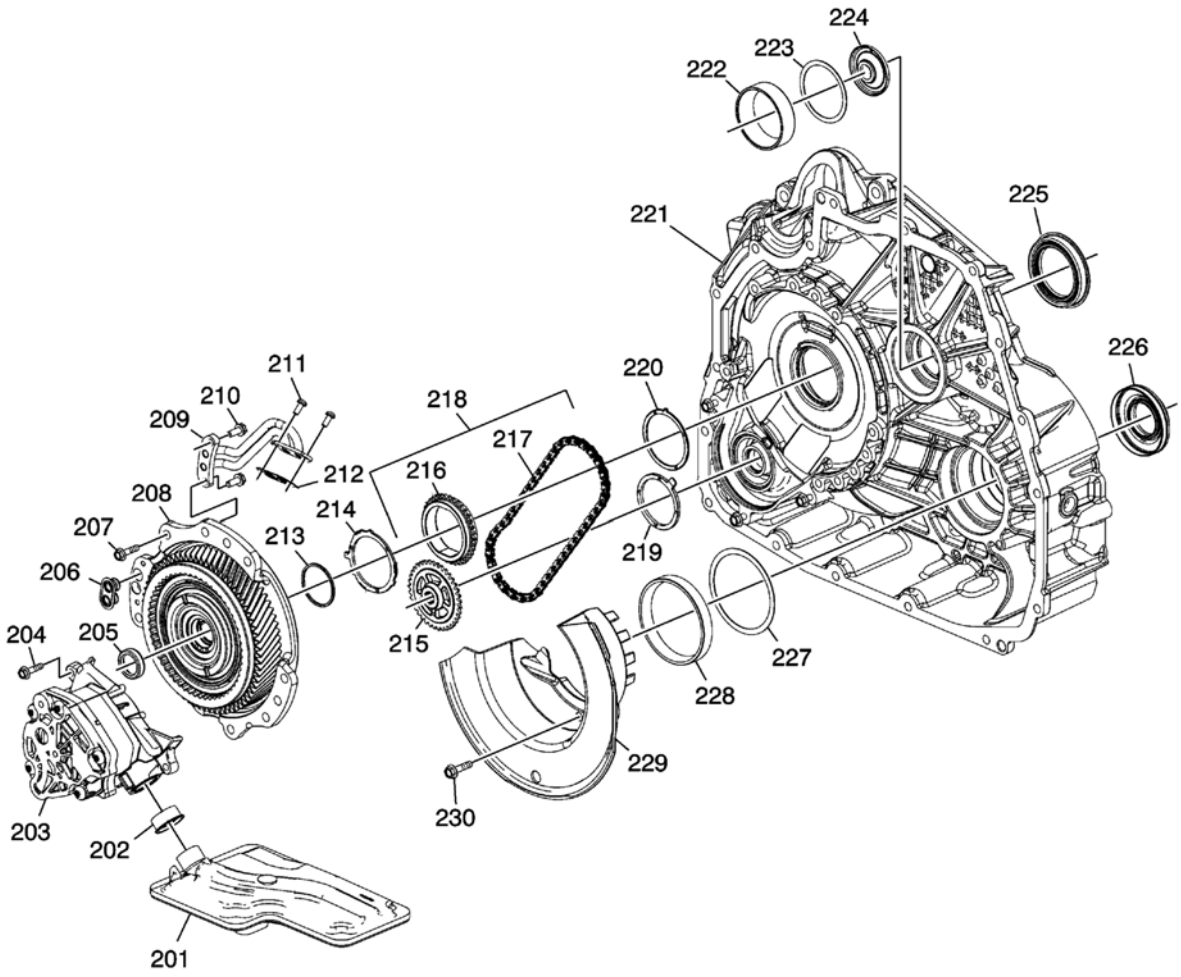


Fig. 3: Identifying Torque Converter, Support & Fluid Pump Housing Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
201	A/Trans Fluid Filter Assembly
202	Filter Neck Seal
203	A/Trans Fluid Pump Assembly
204	A/Trans Fluid Pump Bolt
205	Front Differential Transfer Drive Gear Support Seal Assembly
206	Front Differential Transfer Drive Gear Support Torque Converter Fluid Seal Assembly
207	Front Differential Transfer Drive Gear Support Bolt
208	Front Differential Transfer Drive Gear Support Assembly
209	Front Differential Transfer Drive Gear Fluid Passage Tube Assembly

Callout	Component Name
210	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt
211	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt
212	Front Differential Transfer Drive Gear Support Fluid Passage Tube Gasket
213	Front Differential Transfer Drive Gear Support Seal
214	Drive Sprocket Thrust Washer
215	Oil Pump Drive Link Driven Sprocket
216	Oil Pump Drive Link Drive Sprocket
217	Drive Link
218	Drive Link Assembly
219	Drive Sprocket Thrust Washer
220	Drive Sprocket Thrust Washer
221	Torque Converter and Differential Housing Assembly
222	Front Differential Drive Pinion Gear Bearing Cup
223	Front Differential Drive Pinion Gear Bearing Thrust Washer
224	Front Differential Drive Pinion Gear Lube Dam
225	Torque Converter Fluid Seal Assembly
226	Front Wheel Drive Shaft Oil Seal Assembly
227	Front Differential Bearing Thrust Washer
228	Front Differential Carrier Bearing Cup
229	Front Differential Carrier Baffle
230	Front Differential Carrier Baffle Bolt

Control Valve Body Assembly

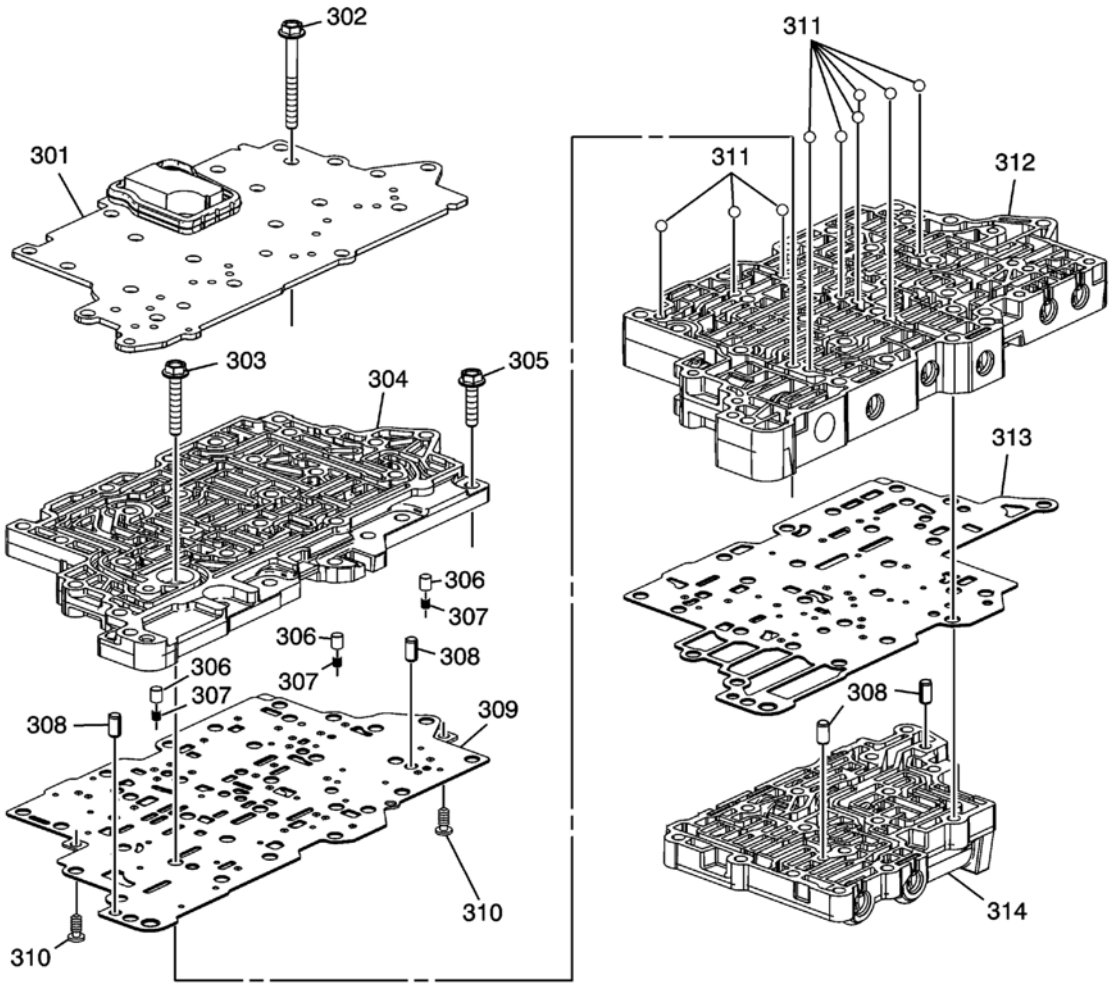


Fig. 4: Control Valve Body Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
301	Control Valve Channel Upper Plate Assembly
302	Control Valve Body Bolt
303	Control Valve Body Bolt
304	Control Valve Channel Plate
305	Control Valve Body Bolt
306	Actuator Feed Accumulator Piston
307	Actuator Feed Accumulator Spring
308	Control Valve Body Locator Pin
309	Control Valve Upper Body Spacer Plate Assembly
310	Control Valve Body Spacer Plate Retainer
311	Control Valve Body Ball Check Valve
312	Control Valve Upper Body Assembly
313	Control Valve Lower Body Spacer Plate Assembly
314	Control Valve Lower Body

Upper Valve Body Assembly

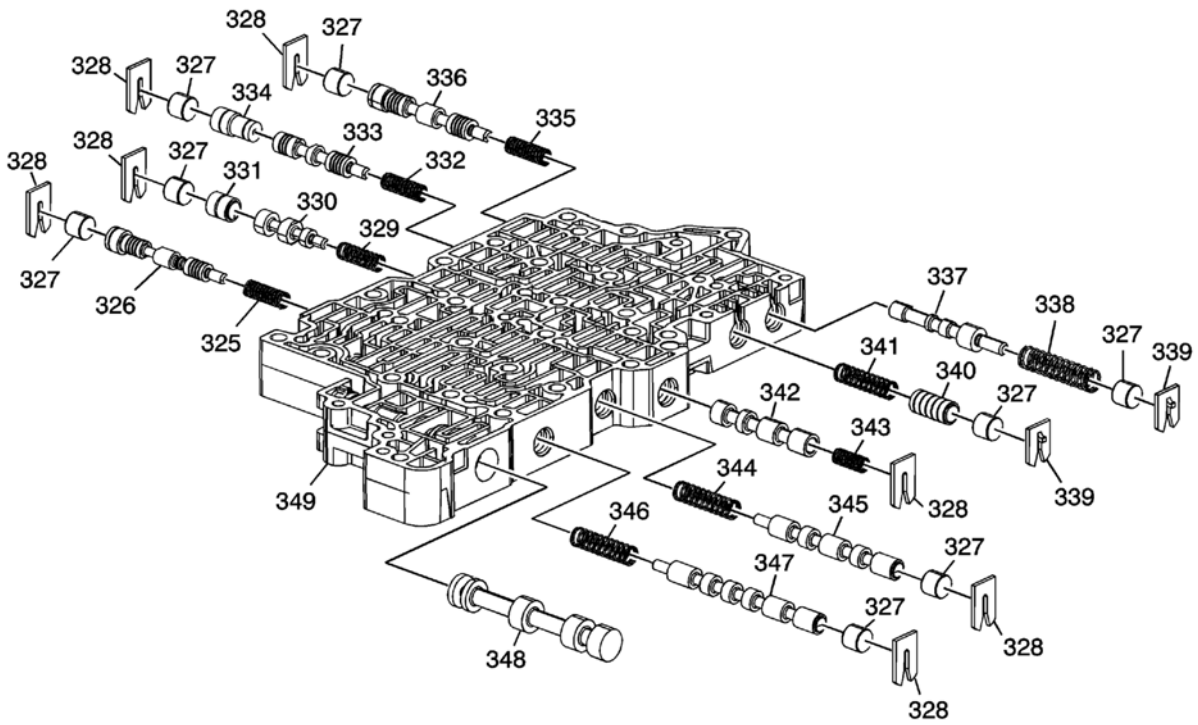


Fig. 5: Identifying Upper Valve Body Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
325	Low and Reverse and 4-5-6 Clutch Regulator Valve Spring
326	Low and Reverse and 4-5-6 Clutch Regulator Valve
327	Pressure Regulator Valve Bore Plug
328	Torque Converter Clutch Valve Spring Retainer
329	Torque Converter Clutch Regulator Apply Valve Spring
330	Torque Converter Clutch Regulator Apply Valve
331	Torque Converter Clutch Regulator Apply Shuttle Valve
332	2-6 Clutch Regulator Valve Spring
333	2-6 Clutch Regulator Valve
334	2-6 Clutch Regulator Valve Gain Valve
335	3-5-Reverse Clutch Regulator Valve Spring
336	3-5-Reverse Clutch Regulator Valve
337	Pressure Regulator Valve
338	Pressure Regulator Valve Spring
339	Pressure Regulator Valve Bore Plug Retainer
340	Isolator Valve
341	Isolator Valve Spring
342	Torque Converter Clutch Control Valve
343	Torque Converter Clutch Control Valve Spring

Callout	Component Name
344	Clutch Select Solenoid Valve #3 Spring
345	Clutch Select Solenoid #3 Valve
346	Clutch Select Solenoid Valve #2 Spring
347	Clutch Select Solenoid #2 Valve
348	Manual Valve
349	Control Valve Upper Body

Lower Valve Body Assembly

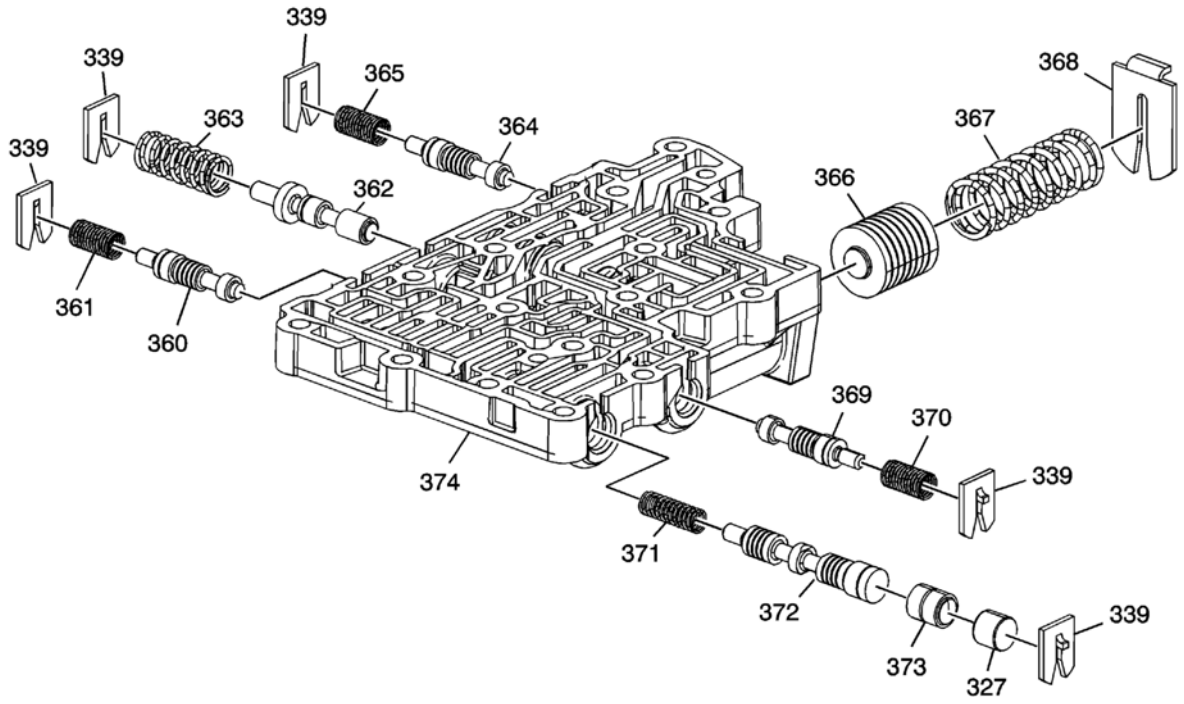


Fig. 6: Identifying Lower Valve Body Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
327	1-2-3-4 Clutch Regulator Valve Bore Plug
339	Actuator Feed Limit Valve Spring Retainer
360	4-5-6 Clutch Boost Valve
361	4-5-6 Clutch Boost Valve Spring
362	Actuator Feed Limit Valve
363	Actuator Feed Limit Valve Spring
364	3-5-Reverse Clutch Boost Valve
365	3-5-Reverse Clutch Boost Valve Spring
366	4-5-6 Clutch Accumulator Piston
367	4-5-6 Clutch Accumulator Piston Spring
368	4-5-6 Clutch Accumulator Piston Retainer

Callout	Component Name
369	1-2-3-4 Clutch Boost Valve
370	1-2-3-4 Clutch Boost Valve Spring
371	1-2-3-4 Clutch Regulator Valve Spring
372	1-2-3-4 Clutch Regulator Valve
373	Default Override 1-2-3-4 Clutch Valve
374	Control Valve Lower Body

A/Trans Case Cover, 2-6 and Low Reverse Pistons

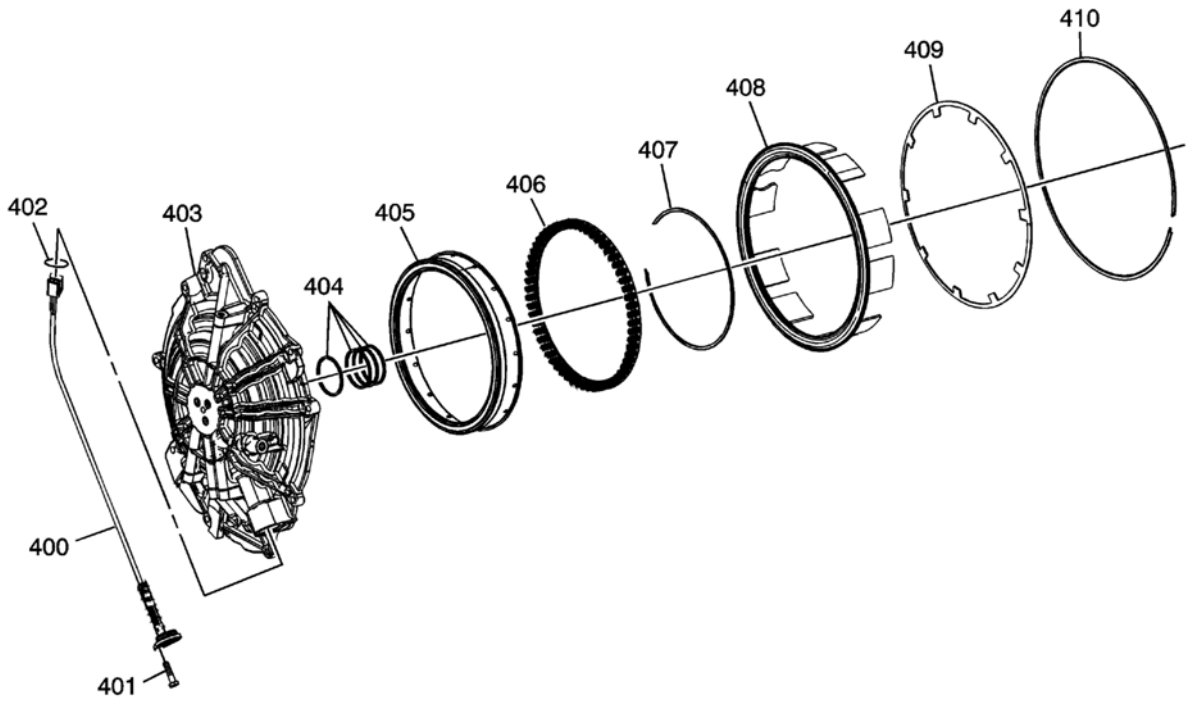


Fig. 7: Identifying A/T Case Cover, 2-6 & Low Reverse Pistons & Retainer Rings
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
400	A/Trans Input Speed Sensor Assembly
401	A/Trans Input Speed Sensor Bolt
402	ISS O-Ring Seal
403	A/Trans Case Cover Assembly
404	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring
405	2-6 Clutch Piston
406	2-6 Clutch Spring Assembly
407	2-6 Clutch Spring Retainer Ring
408	Low and Reverse Clutch Piston Assembly
409	Low and Reverse Clutch Spring
410	Low and Reverse Clutch Spring Retainer Ring

3-5 Reverse Clutch Assembly

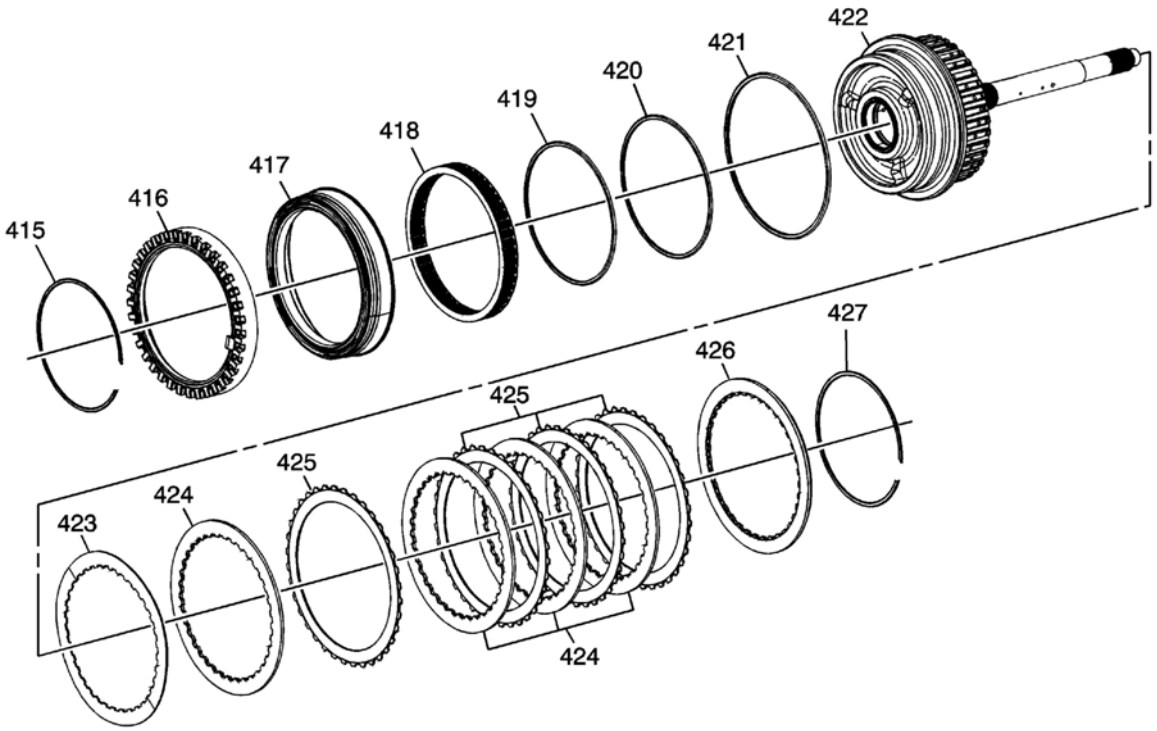


Fig. 8: Identifying 3-5 Reverse Clutch Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
415	A/Trans Input Shaft Speed Sensor Reluctor Ring Retainer Ring
416	A/Trans Input Shaft Speed Sensor Reluctor Wheel
417	3-5-Reverse Clutch Piston
418	3-5-Reverse Clutch Spring
419	3-5-Reverse Clutch Piston Inner Seal
420	3-5-Reverse Clutch Piston Inner Seal
421	3-5-Reverse Clutch Piston Dam Seal
422	3-5-Reverse and 4-5-6 Clutch Housing Assembly
423	3-5-Reverse Clutch (Waved) Plate
424	3-5-Reverse Clutch Plate
425	3-5-Reverse Clutch (w/Friction Material) Plate Assembly
426	3-5-Reverse Clutch Backing Plate
427	3-5-Reverse Clutch Backing Plate Retainer Ring

4-5-6 Clutch Assembly

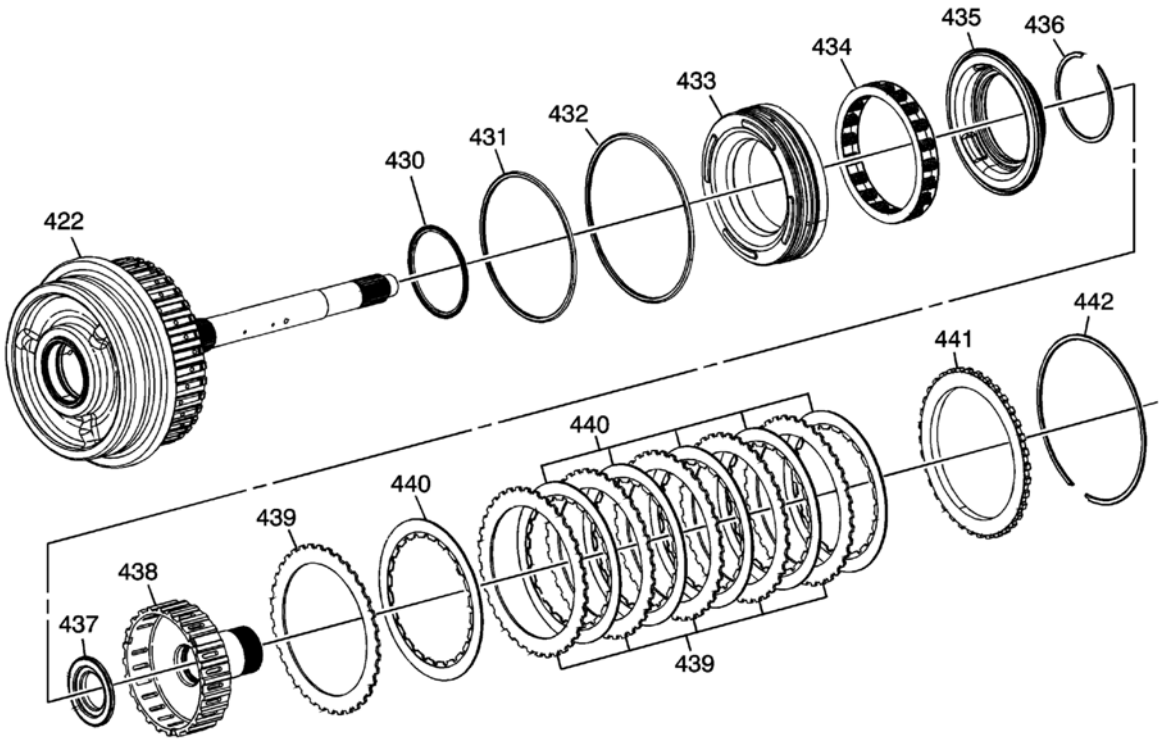


Fig. 9: Identifying 4-5-6 Clutch Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
422	3-5-Reverse and 4-5-6 Clutch Housing Assembly
430	4-5-6 Clutch Piston Inner Seal
431	4-5-6 Clutch Piston Outer Seal
432	4-5-6 Clutch Piston Outer Seal
433	4-5-6 Clutch Piston
434	4-5-6 Clutch Spring
435	4-5-6 Clutch Piston Fluid Dam
436	4-5-6 Clutch Dam Retainer Ring
437	4-5-6 Clutch Hub Thrust Bearing Assembly
438	Reaction Carrier Hub Assembly
439	4-5-6 Clutch Plate
440	4-5-6 Clutch (w/Friction Material) Plate Assembly
441	4-5-6 Clutch Backing Plate
442	4-5-6 Clutch Backing Plate Retainer Ring

2-6, Low and Reverse and 1-2-3-4 Clutch Plate Assemblies

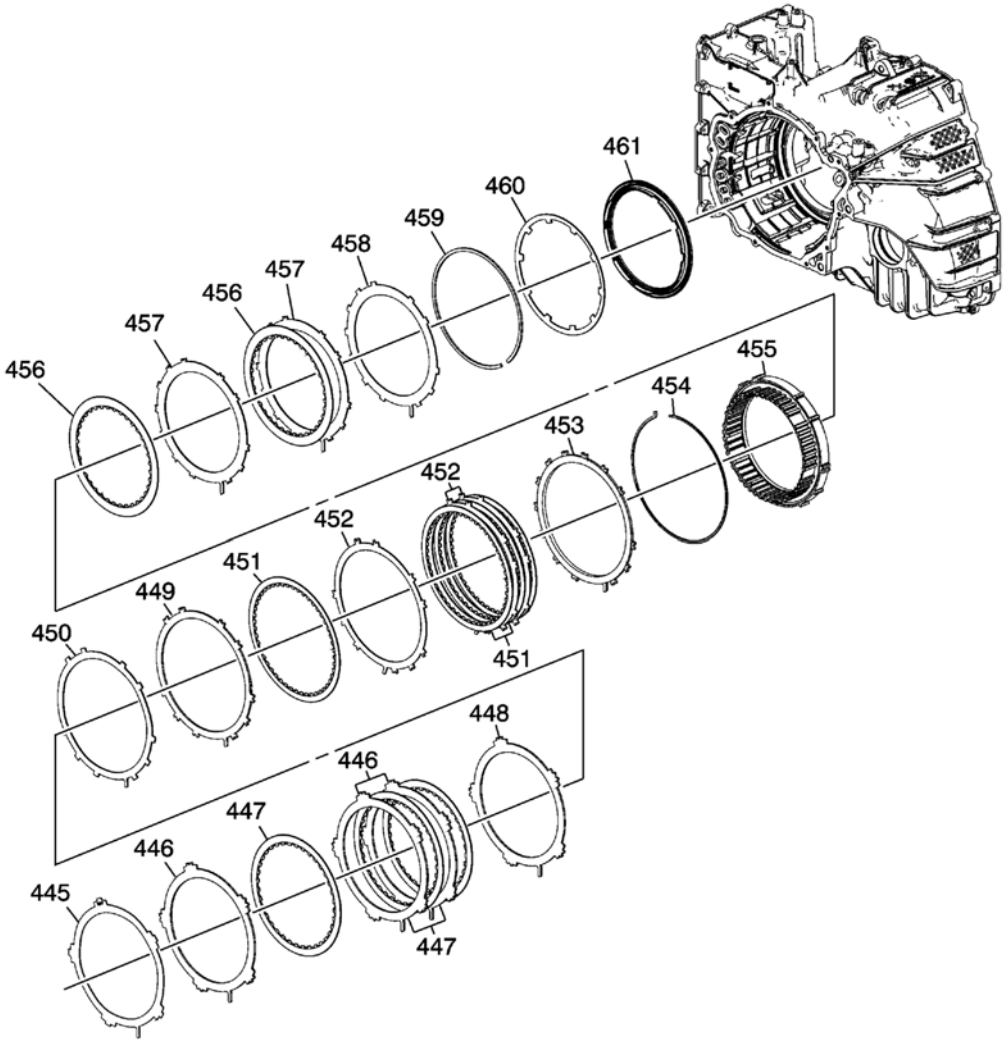


Fig. 10: Identifying 2-6, Low & Reverse & 1-2-3-4 Clutch Plate Assemblies
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
445	2-6 Clutch Cushion Spring
446	2-6 Clutch Plate
447	2-6 Clutch (w/Friction Material) Plate Assembly
448	2-6 Clutch Backing Plate
449	Low and Reverse Clutch Apply Plate
450	Low and Reverse Clutch Cushion (Waved) Spring
451	Low and Reverse Clutch (w/Friction Material) Plate Assembly
452	Low and Reverse Clutch Plate
453	Low and Reverse Clutch Backing Plate
454	Low and Reverse Clutch Retainer Ring
455	Low and Reverse Clutch Assembly (OWC)
456	1-2-3-4 Clutch (w/Friction Material) Plate Assembly
457	1-2-3-4 Clutch Plate
458	1-2-3-4 Clutch (Waved) Plate

Callout	Component Name
459	1-2-3-4 Clutch Spring Retainer Ring
460	1-2-3-4 Clutch Spring
461	1-2-3-4 Clutch Piston
449	Low and Reverse Clutch Apply Plate

Input, Output and Reaction Gearsets

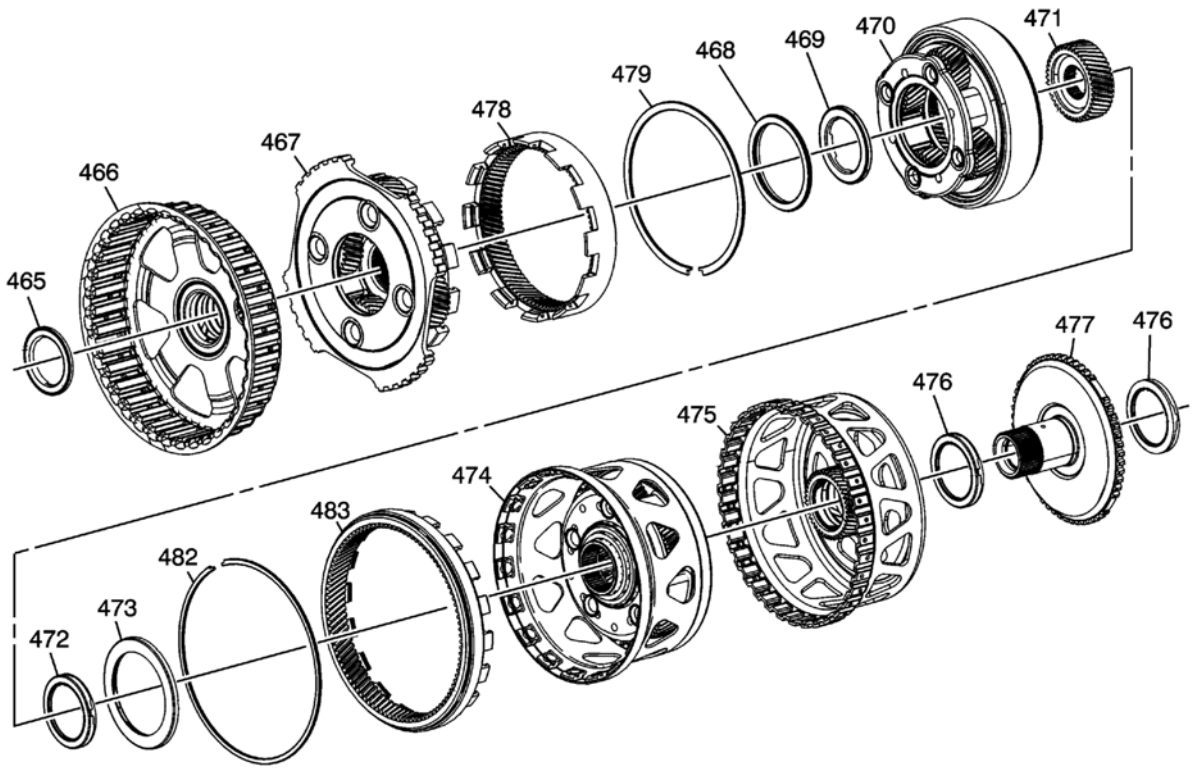


Fig. 11: Identifying Input, Output & Reaction Gearsets
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
465	2-6 Clutch Hub Thrust Bearing
466	Reaction Sun Gear Assembly
467	Reaction Carrier Assembly
468	Input Carrier Thrust Bearing Assembly
469	Input Sun Gear Thrust Bearing Assembly
470	Input Carrier Assembly
471	Input Sun Gear
472	Output Carrier Thrust Bearing Assembly
473	Output Carrier Thrust Bearing Assembly
474	Output Carrier Assembly
475	Output Sun Gear Assembly
476	Front Differential Transfer Drive Gear Input Hub Bearing Assembly
477	Output Carrier Transfer Drive Gear Hub Assembly

Callout	Component Name
478	Input Internal Gear
479	Input Internal Gear Retaining Ring
482	Reaction Internal Gear Retaining Ring
483	Reaction Carrier Internal Gear

Front Differential Transfer Drive Gear Assembly

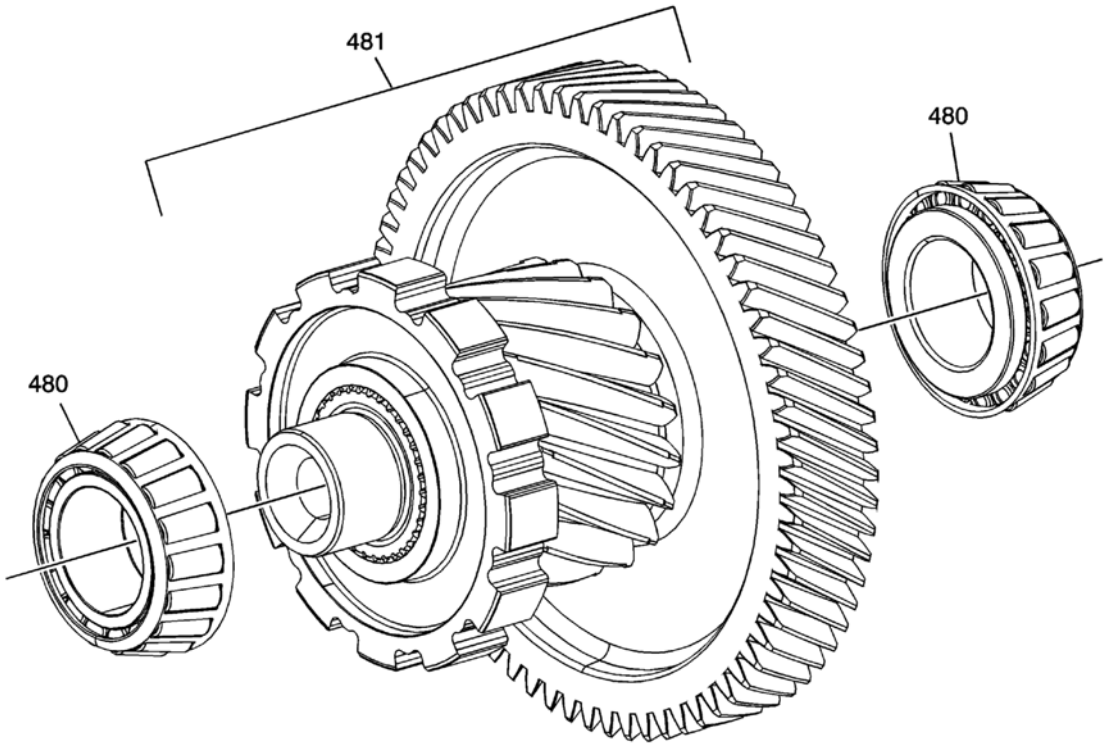


Fig. 12: Identifying Front Differential Transfer Drive Gear Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
480	Front Differential Drive Pinion Gear Bearing Assembly
481	Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly

Front Differential Carrier Assembly

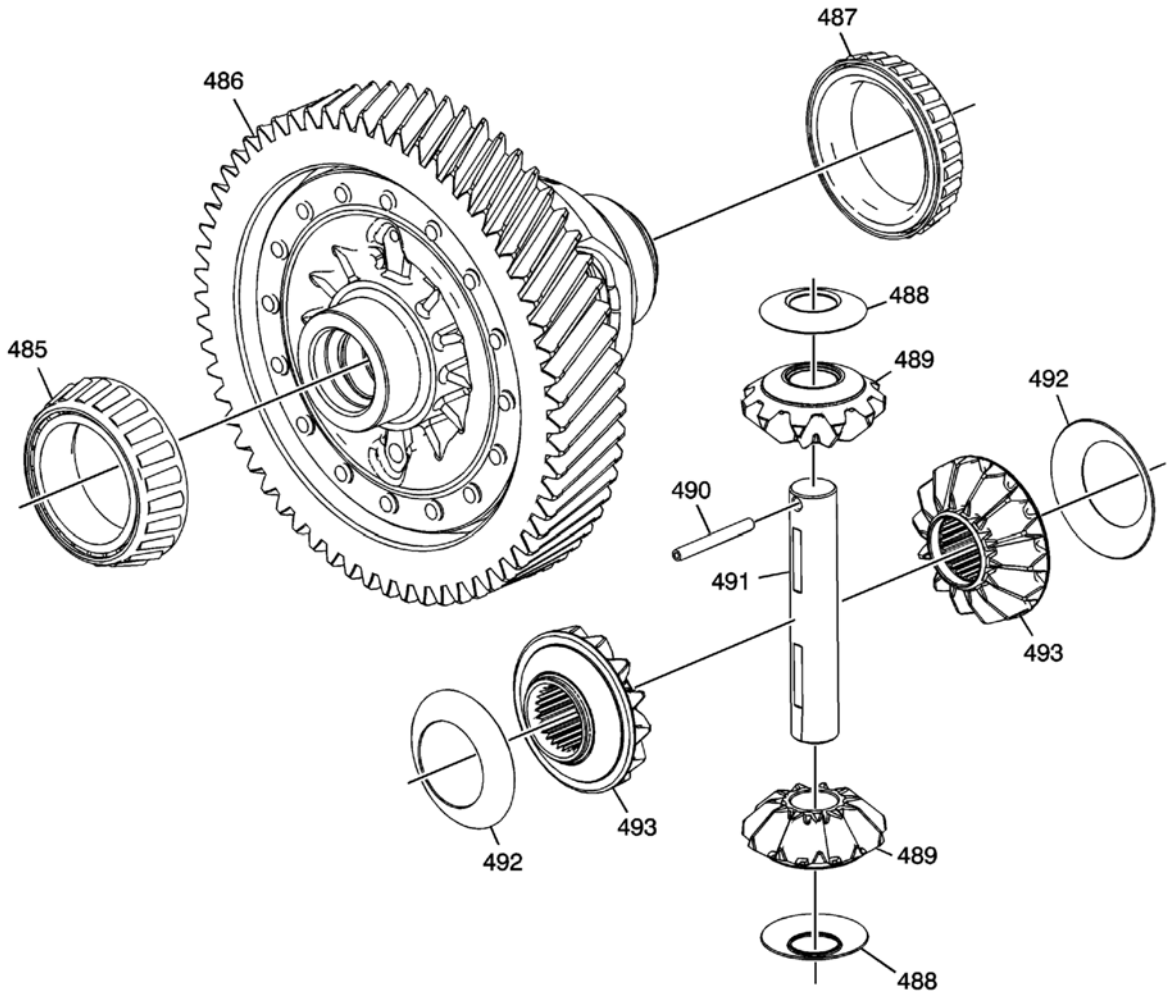


Fig. 13: Identifying Front Differential Carrier Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
485	Front Differential Carrier Bearing Assembly
486	Front Differential Carrier Assembly
487	Front Differential Carrier Bearing Assembly
488	Front Differential Carrier Thrust Washer
489	Front Differential Pinion Gear
490	Front Differential Pinion Gear Shaft Retainer
491	Front Differential Pinion Gear Shaft
492	Front Differential Side Gear Thrust Washer
493	Front Differential Side Gear

Park System Components

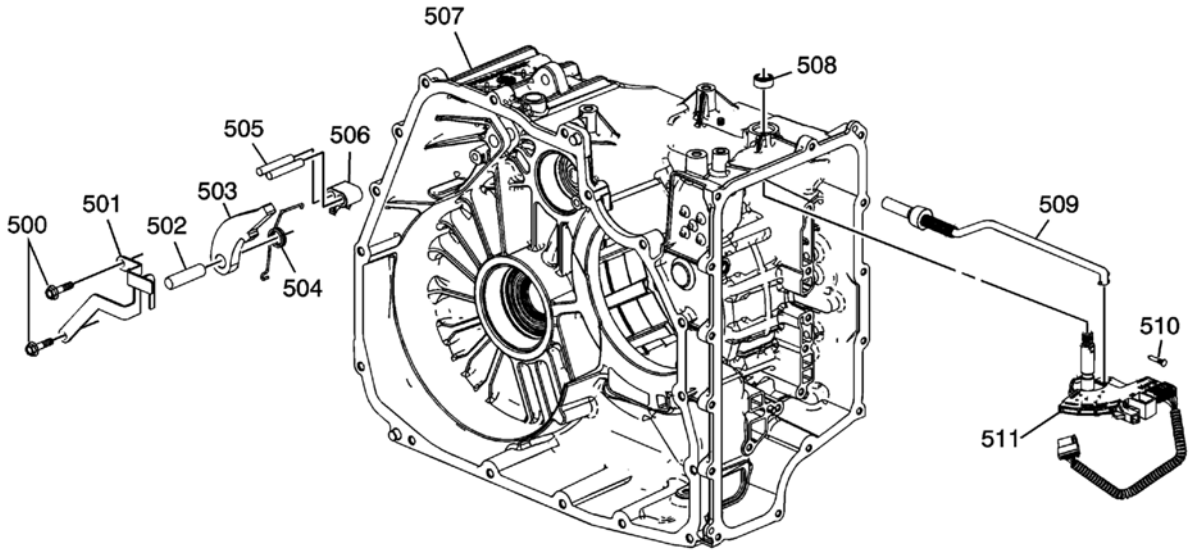


Fig. 14: Identifying Park System Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
500	Park Pawl Actuator Bracket Bolt
501	Park Pawl Actuator Bracket
502	Park Pawl Shaft
503	Park Pawl
504	Park Pawl Spring
505	Park Pawl Actuator Guide Pin
506	Park Pawl Actuator Guide
507	A/Trans Case Assembly
508	Manual Shift Shaft Seal
509	Park Pawl Actuator Assembly
510	Manual Shift Shaft Pin
511	Manual Shift Detent (w/Shaft Position Switch) Lever Assembly

COMPONENT LOCATION

Component Locations

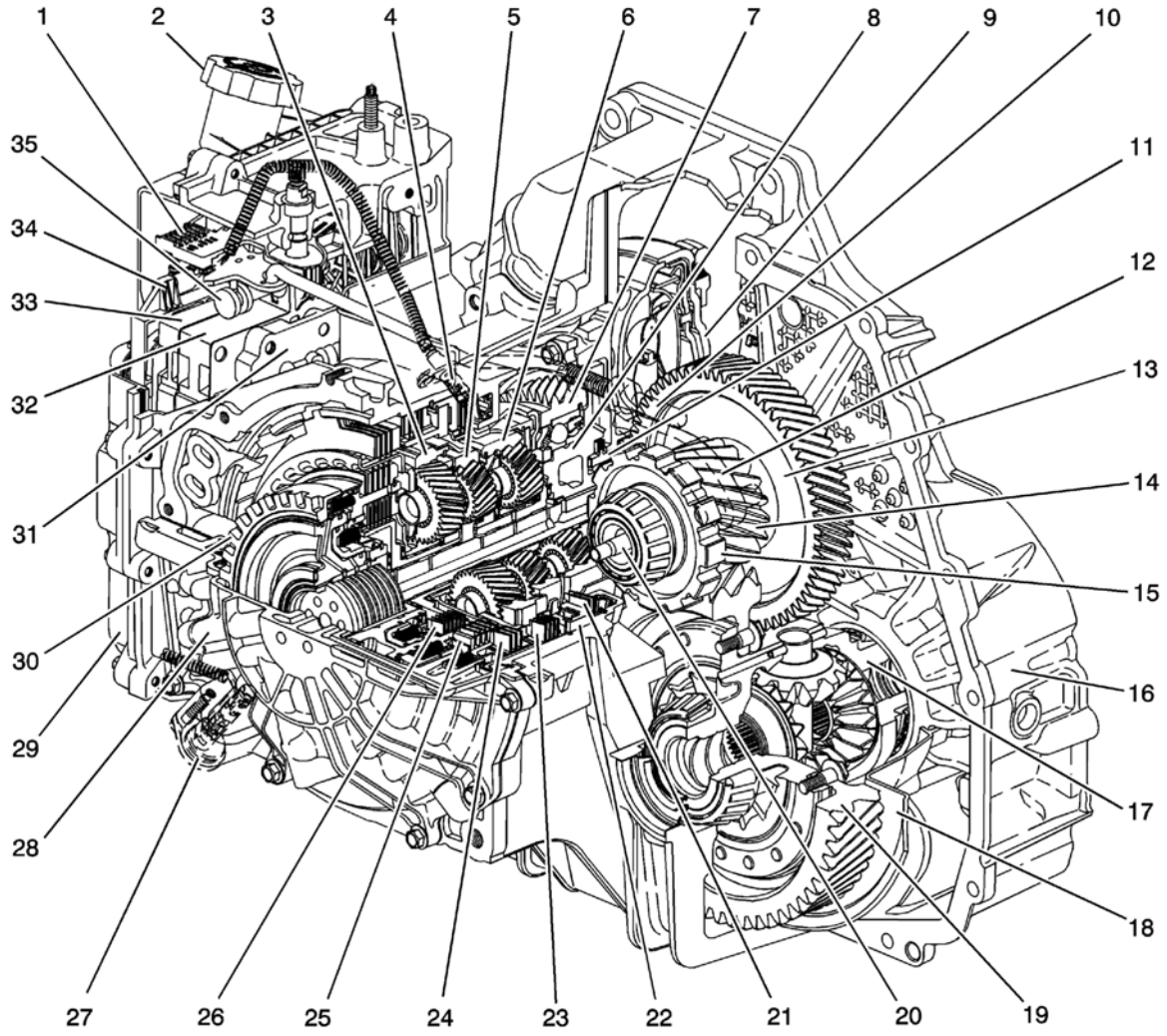


Fig. 15: Identifying A/T Component Locations
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Manual Shift Detent Lever Assembly (w/Shaft Position Switch)
2	Trans Fluid Level Indicator
3	Reaction Carrier Assembly
4	Output Speed Sensor
5	Input Carrier Assembly
6	Output Carrier Assembly
7	Front Differential Transfer Drive Gear
8	Front Differential Transfer Drive Gear Support Assembly
9	Torque Converter Assembly
10	Park Pawl Actuator Assembly
11	Fluid Pump Drive Link Assembly
12	Park Pawl
13	Front Differential Transfer Driven Gear
14	Front Differential Drive Pinion Gear

Callout	Component Name
15	Park Gear
16	Torque Converter and Support and Fluid Pump Housing Assembly
17	Front Differential Carrier Assembly
18	Front Differential Carrier Baffle
19	Front Differential Ring Gear
20	Front Differential Drive Pinion Gear Lube Tube
21	1-2-3-4 Clutch Assembly
22	Low and Reverse Clutch Assembly (OWC)
23	Low and Reverse Clutch
24	2-6 Clutch Assembly
25	3-5-Reverse Clutch Assembly
26	4-5-6 Clutch Assembly
27	Input Speed Sensor
28	Case Cover Assembly
29	Control Valve Body Cover
30	Input Shaft Speed Sensor Reluctor Wheel
31	Control Valve Lower Body Assembly
32	Control Valve Upper Body Assembly
33	Control Valve Channel Plate Assembly
34	Control Solenoid Valve Assembly (w/Body and TCM)
35	Manual Valve

BUSHING, BEARING, AND WASHER LOCATIONS

Bushing and Bearing Locations

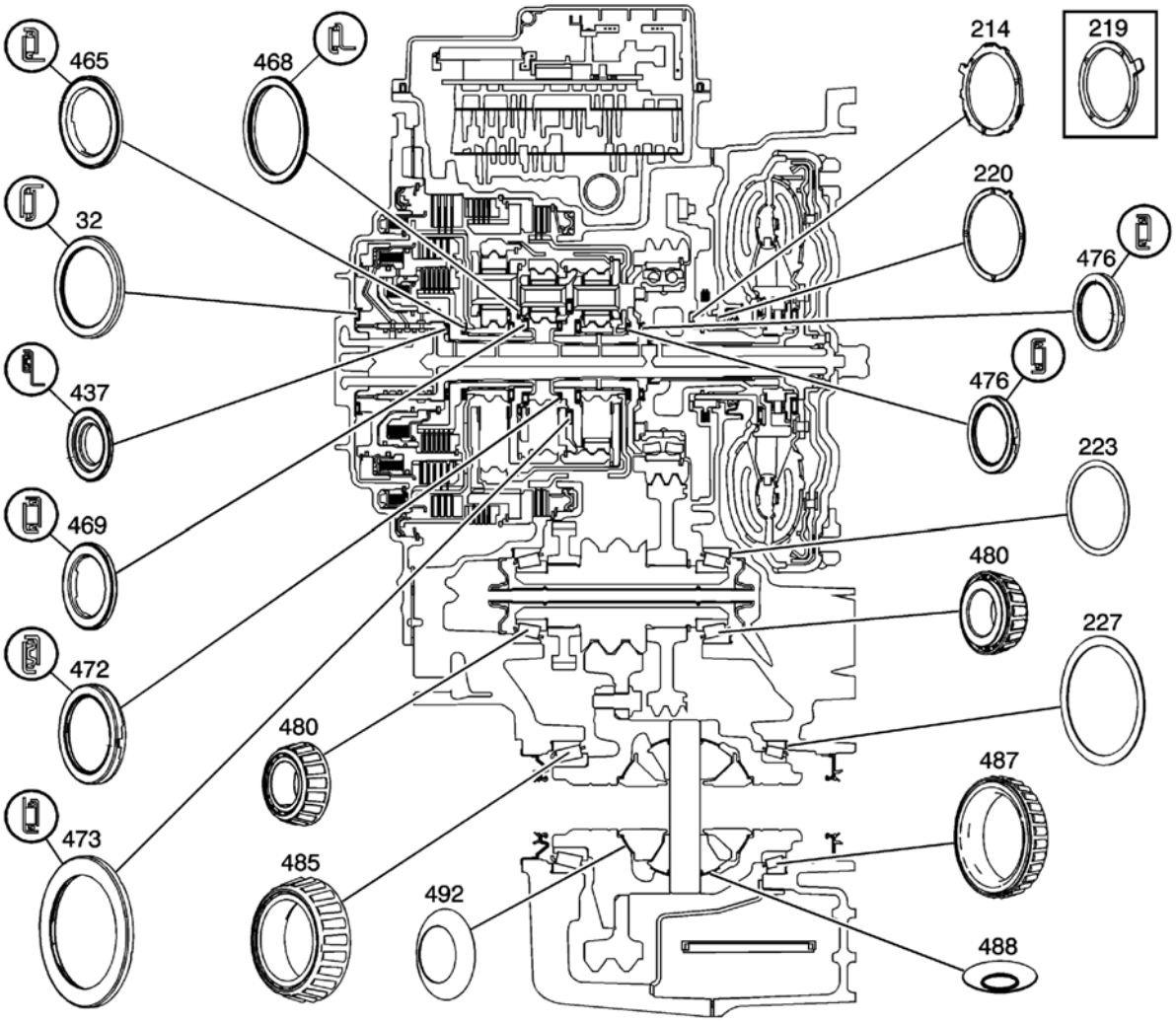


Fig. 16: Identifying Bushing & Bearing Locations
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
32	Input Shaft Thrust Bearing Assembly
214	Drive Sprocket Thrust Washer
219	Drive Sprocket Thrust Washer
220	Drive Sprocket Thrust Washer
223	Front Differential Drive Pinion Gear Bearing Thrust Washer
227	Front Differential Bearing Thrust Washer
437	4-5-6 Clutch Hub Thrust Bearing Assembly
465	2-6 Clutch Hub Thrust Bearing
468	Input Carrier Thrust Bearing Assembly
469	Input Sun Gear Thrust Bearing Assembly
472	Output Carrier Thrust Bearing Assembly
473	Output Carrier Thrust Bearing Assembly
476	Front Differential Transfer Drive Gear Input Hub Bearing Assembly
480	Front Differential Drive Pinion Gear Bearing Assembly

Callout	Component Name
485	Front Differential Carrier Bearing Assembly
487	Front Differential Carrier Bearing Assembly
488	Front Differential Carrier Thrust Washer
492	Front Differential Side Gear Thrust Washer

SEAL LOCATIONS

Seal Locations #1

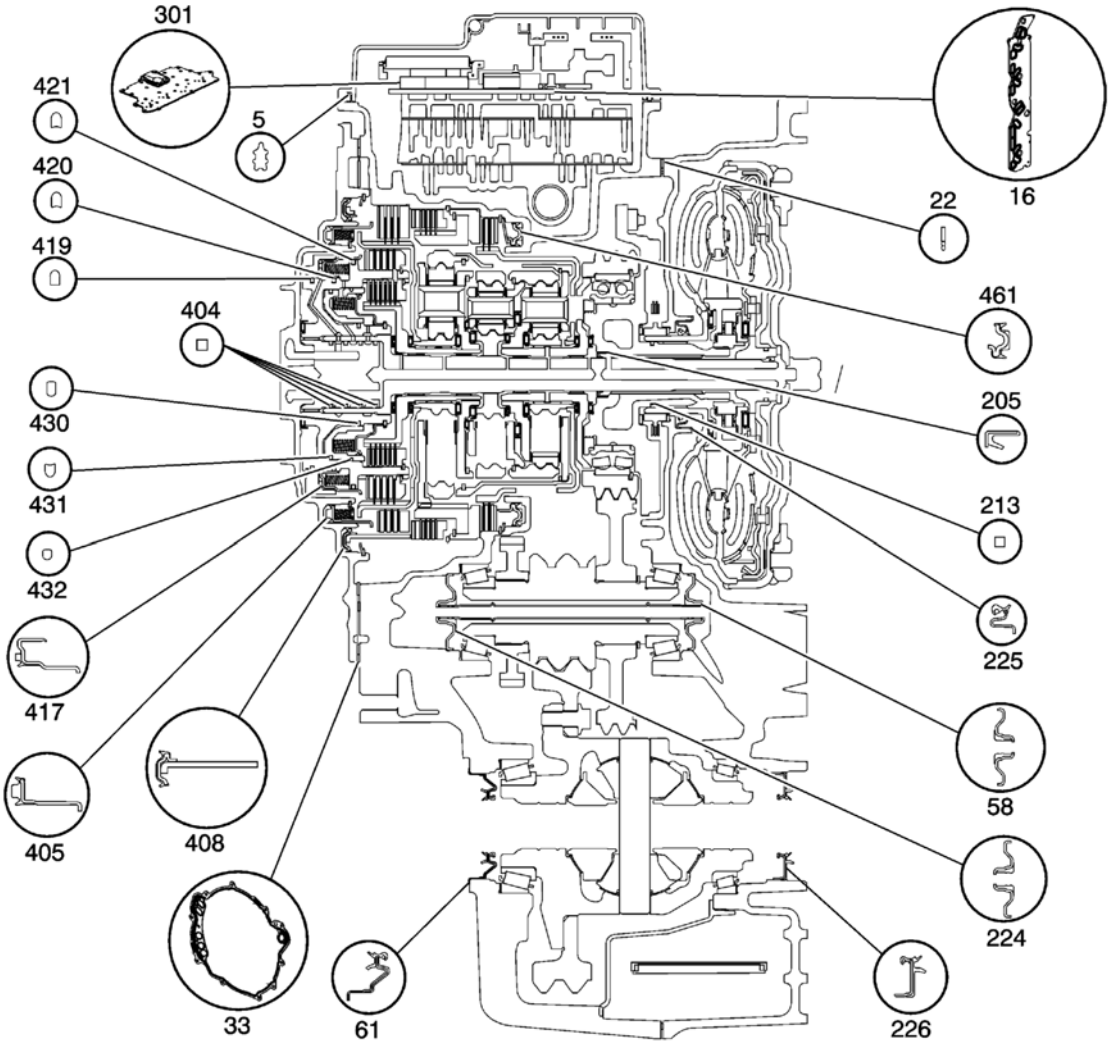


Fig. 17: Seal Locations (1 Of 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
5	Control Valve Body Cover Assembly Gasket
16	Control Solenoid (w/Body and TCM) Filter Plate Assembly
22	Torque Converter Housing Outer Seal
33	A/Trans Case Cover Gasket
58	Front Differential Drive Pinion Gear Lube Dam

Callout	Component Name
61	Front Wheel Drive Shaft Oil Seal Assembly
205	Front Differential Transfer Drive Gear Support Seal Assembly
213	Front Differential Transfer Drive Gear Support Seal
224	Front Differential Drive Pinion Gear Lube Dam
225	Torque Converter Fluid Seal Assembly
226	Front Wheel Drive Shaft Oil Seal Assembly
404	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring
405	2-6 Clutch Piston
408	Low and Reverse Clutch Piston Assembly
417	3-5-Reverse Clutch Piston
419	3-5-Reverse Clutch Piston Inner Seal
420	3-5-Reverse Clutch Piston Inner Seal
421	3-5-Reverse Clutch Piston Dam Seal
430	4-5-6 Clutch Piston Inner Seal
431	4-5-6 Clutch Piston Outer Seal
432	4-5-6 Clutch Piston Outer Seal
461	1-2-3-4 Clutch Piston

Seal Locations #2

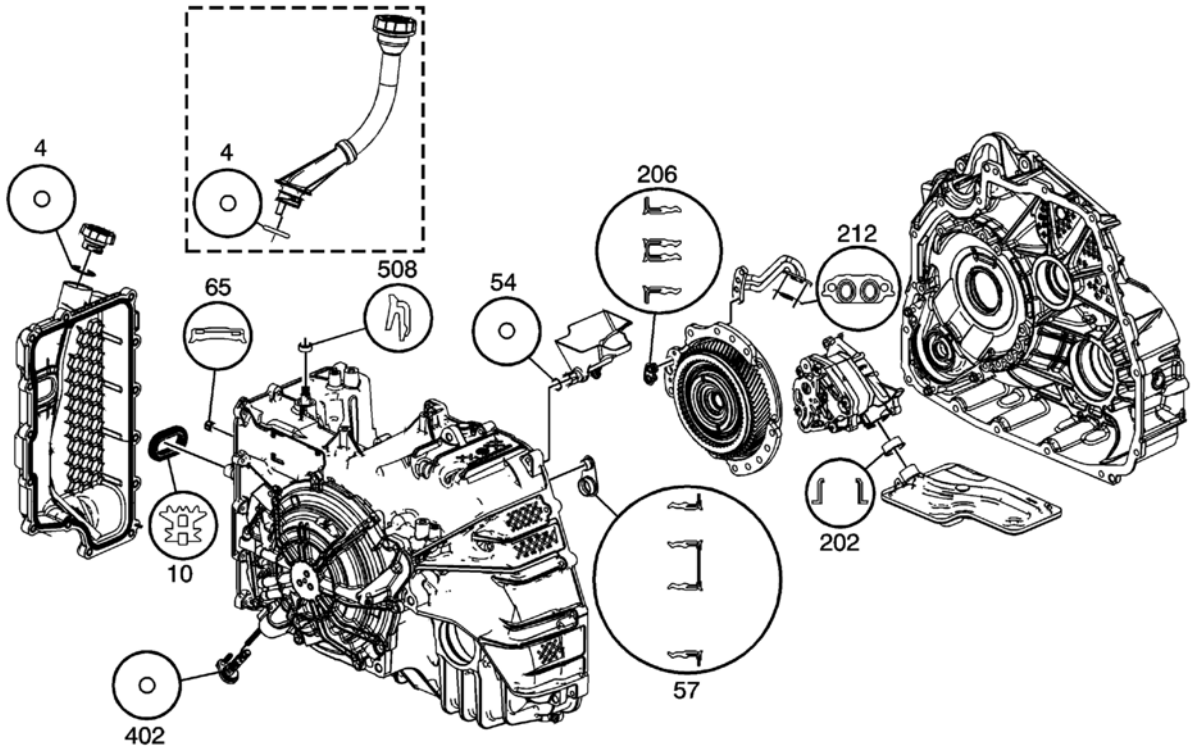


Fig. 18: Identifying Seal Locations (2 Of 2)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name

Callout	Component Name
4	Fluid Level Indicator Tube Seal - Model Dependent
10	Control Valve Body Cover Wiring Connector Hole Seal
54	A/Trans Fluid Trough O-Ring Seal
57	A/Trans Pump Fluid Outlet Seal Assembly
65	1-2-3-4 Clutch Fluid Passage Seal
202	Filter Neck Seal
206	Front Differential Transfer Drive Gear Support Torque Converter Fluid Seal Assembly
212	Front Differential Transfer Drive Gear Support Fluid Passage Tube Gasket
402	ISS O-Ring Seal
508	Manual Shift Shaft Seal

BALL CHECK VALVE LOCATIONS

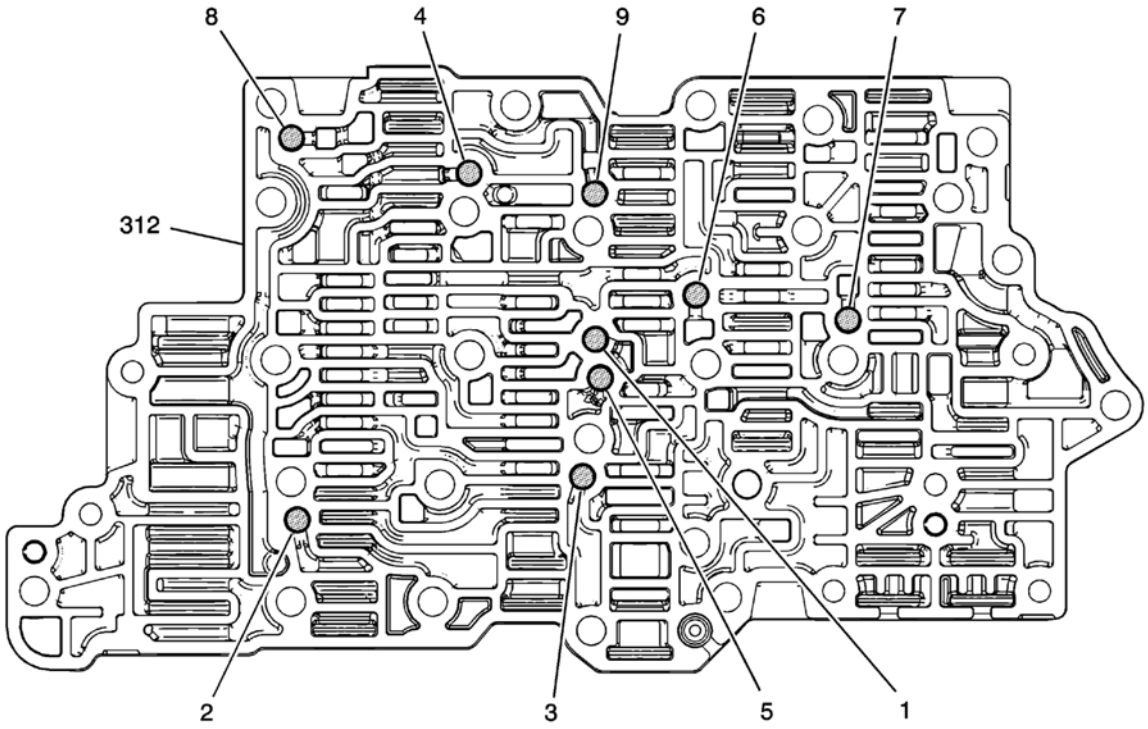


Fig. 19: Identifying Ball Check Valve Locations
Courtesy of GENERAL MOTORS COMPANY

I.D.	Input Oil	Input Oil	Output Oil
1	Drive 1-6	DRV B	26/1234 CL Feed
2	Solenoid 1	Reverse	CSV2 Enable
3	Solenoid 2	456	CSV3 Enable
4	PS4	456	CSV2 Latch
5	Drive 1-6	35 Rev FD	35 Rev Supply
6	2-6/1234	-	1234 Clutch Feed

I.D.	Input Oil	Input Oil	Output Oil
7	35R Supply	-	35R Clutch Feed
8	Low/Rev Supply	-	Low/Rev Clutch Feed
9	456 Clutch Supply	-	456 Clutch Feed

Article GUID: A00737252

Automatic Transmission - 6T70 (MH2) - Description and Operation - Impala

DESCRIPTION AND OPERATION

DEFINITIONS AND ABBREVIATIONS

Throttle Positions

Engine Braking

A condition where the engine is used to slow the vehicle by manually downshifting during a zero throttle coastdown.

Full Throttle Downshift

A quick apply of the accelerator pedal to its full travel, forcing a downshift.

Heavy Throttle

Approximately 3/4 of accelerator pedal travel, 75 percent throttle position.

Light Throttle

Approximately 1/4 of accelerator pedal travel, 25 percent throttle position.

Medium Throttle

Approximately 1/2 of accelerator pedal travel, 50 percent throttle position.

Minimum Throttle

The least amount of throttle opening required for an upshift.

Wide Open Throttle (WOT)

Full travel of the accelerator pedal, 100 percent throttle position.

Zero Throttle Coastdown

A full release of the accelerator pedal while the vehicle is in motion and in drive range.

Shift Condition Definitions

Bump

A sudden and forceful apply of a clutch or a band.

Chuggle

A bucking or jerking. This condition may be most noticeable when the converter clutch is engaged. It is

similar to the feel of towing a trailer.

Delayed

A condition where a shift is expected but does not occur for a period of time. This could be described as a clutch or band engagement that does not occur as quickly as expected during a part throttle or wide open throttle apply of the accelerator, or during manual downshifting to a lower range. This term is also defined as LATE or EXTENDED.

Double Bump - Double Feel

Two sudden and forceful applies of a clutch or a band.

Early

A condition where the shift occurs before the car has reached proper speed. This condition tends to labor the engine after the upshift.

End Bump

A firmer feel at the end of a shift than at the start of the shift. This is also defined as END FEEL or SLIP BUMP.

Firm

A noticeably quick apply of a clutch or band that is considered normal with a medium to heavy throttle. This apply should not be confused with HARSH or ROUGH.

Flare

A quick increase in engine RPM along with a momentary loss of torque. This most generally occurs during a shift. This condition is also defined as SLIPPING.

Harsh - Rough

A more noticeable apply of a clutch or band than FIRM. This condition is considered undesirable at any throttle position.

Hunting

A repeating quick series of upshifts and downshifts that causes a noticeable change in engine RPM, such as a 4-3-4 shift pattern. This condition is also defined as BUSYNESS.

Initial Feel

A distinctly firmer feel at the start of a shift than at the finish of the shift.

Late

A shift that occurs when the engine RPM is higher than normal for a given amount of throttle.

Shudder

A repeating jerking condition similar to CHUGGLE but more severe and rapid. This condition may be most noticeable during certain ranges of vehicle speed.

Slipping

A noticeable increase in engine RPM without a vehicle speed increase. A slip usually occurs during or after initial clutch or band apply.

Soft

A slow, almost unnoticeable clutch or band apply with very little shift feel.

Surge

A repeating engine related condition of acceleration and deceleration that is less intense than CHUGGLE.

Tie-Up

A condition where two opposing clutch and/or bands are attempting to apply at the same time causing the engine to labor with a noticeable loss of engine RPM.

Noise Conditions

Drive Link Noise

A whine or growl that increases or fades with vehicle speed, and is most noticeable under a light throttle acceleration. It may also be noticeable in PARK or NEUTRAL operating ranges with the vehicle stationary.

Final Drive Noise

A hum related to vehicle speed which is most noticeable under a light throttle acceleration.

Planetary Gear Noise

A whine related to vehicle speed, which is most noticeable in FIRST gear, SECOND gear, FOURTH gear or REVERSE. The condition may become less noticeable, or go away, after an upshift.

Pump Noise

A high pitched whine that increases in intensity with engine RPM. This condition may also be noticeable in all operating ranges with the vehicle stationary or moving.

Torque Converter Noise

A whine usually noticed when a vehicle is stopped, and the transmission is in DRIVE or REVERSE. The noise will increase with engine RPM.

Driver Shift Control

Driver shift control (DSC) allows the driver to change gears similar to a manual transmission. Refer to the vehicle owner's manual for specific DSC operating instructions.

Transmission Abbreviations

A/C

Air Conditioning

AC

Alternating Current

AT

Automatic Transmission

CCDIC

Climate Control Driver Information Center

DC

Direct Current

DIC

Driver Information Center

DLC

Data Link Connector

DMM

Digital Multimeter

DSC

Driver Shift Control

DTC

Diagnostic Trouble Code

EBTCM

Electronic Brake/Traction Control Module

ECCC

Electronically-Controlled Capacity Clutch

ECT

Engine Coolant Temperature

EMI

Electromagnetic Interference

IAT

Intake Air Temperature

IGN

Ignition

IMS

Internal Mode Switch

ISS

Input Speed Sensor

MAP

Manifold Absolute Pressure

MIL

Malfunction Indicator Lamp

NC

Normally Closed

NO

Normally Open

OBD

On Board Diagnostic

OSS

Output Speed Sensor

PC

Pressure Control

PCM

Powertrain Control Module

PCS

Pressure Control Solenoid

PS

Pressure Switch

PWM

Pulse Width Modulation

RPM

Revolutions Per Minute

SS

Shift Solenoid

STL

Service Transmission Lamp

TAP

Transmission Adaptive Pressure

TCC

Torque Converter Clutch

TFP

Transmission Fluid Pressure

TFT

Transmission Fluid Temperature

TP

Throttle Position

VSS

Vehicle Speed Sensor

WOT

Wide Open Throttle

TRANSMISSION IDENTIFICATION INFORMATION

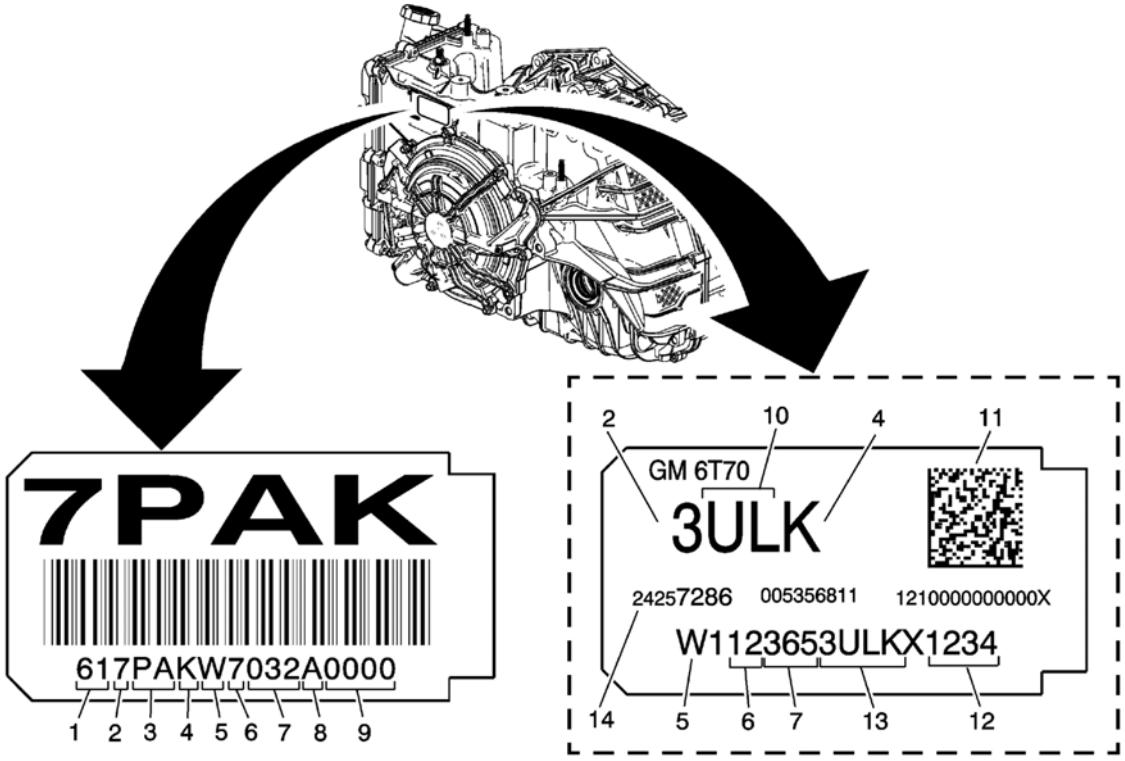


Fig. 1: Transmission Identification Label
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Code for Automatic Transmission
2	Model Year
3	Model for Transmission
4	Transmission Family
5	Source Code for Plant
6	Calendar Year
7	Julian Date
8	Shift/Line (A/B)
9	Numeric sequence starting at 0001 @ 12:01 AM each day
10	Model Code
11	Machine Readable Matrix
12	Sequential Serial Number
13	Broadcast Code
14	Transmission Assembly Number

Source Code for Plant

- 4 - Ramos Arizpe, Mexico
- J - Windsor, Ontario
- S - Strasbourg, France
- W - Warren, Michigan

- Y - Toledo, Ohio
- R - Boryeong, Korea
- M - N.man Tai, Shan Dong, China
- P - San Luis Potosi, Mexico
- S - Silao, Mexico

TRANSMISSION GENERAL DESCRIPTION

The Hydra-matic 6T70/75 is a fully automatic, 6-speed, front-wheel drive, electronic-controlled transmission. It consists primarily of a 4-element torque converter, a compound planetary gear set, friction and mechanical clutch assemblies, and a hydraulic pressurization and control system. There are 2 variants of the transmission, based on torque capacity. Architecture is common between the variants, and component differences are primarily related to size.

The 4-element torque converter contains a pump, a turbine, a pressure plate splined to the turbine, and a stator assembly. The torque converter acts as a fluid coupling to smoothly transmit power from the engine to the transmission. It also hydraulically provides additional torque multiplication when required. The pressure plate, when applied, provides a mechanical direct drive coupling of the engine to the transmission.

The planetary gear sets provide the 6 forward gear ratios and reverse. Changing gear ratios is fully automatic and is accomplished through the use of a transmission control module (TCM) located inside the transmission. The TCM receives and monitors various electronic sensor inputs and uses this information to shift the transmission at the optimum time.

The TCM commands shift solenoids and variable bleed pressure control solenoids to control shift timing and feel. The TCM also controls the apply and release of the torque converter clutch which allows the engine to deliver the maximum fuel efficiency without sacrificing vehicle performance. All the solenoids, including the TCM, are packaged into a self-contained control solenoid valve assembly.

The hydraulic system primarily consists of a vane-type pump, 2 control valve body assemblies, transfer drive gear support assembly and case. The pump maintains the working pressures needed to stroke the clutch pistons that apply or release the friction components. These friction components, when applied or released, support the automatic shifting qualities of the transmission.

The friction components used in this transmission consist of 5 multiple disc clutches. The multiple disc clutches combine with one way clutch to deliver 7 different gear ratios, 6 forward and one reverse, through the gear sets. The gear sets then transfer torque through the transfer drive gear, transfer driven gear and differential assembly.

The transmission may be operated in any of the following gear ranges:

PARK (P)

This position locks the front wheels and prevents the vehicle from rolling either forward or backward. PARK is the best position to use when starting the vehicle. Because the transmission utilizes a shift lock control system, it is necessary to fully depress the brake pedal before shifting out of PARK. For safety reasons, use the parking brake in addition to the PARK position.

REVERSE (R)

This position allows the vehicle to be operated in a rearward direction.

NEUTRAL (N)

This position allows the engine to be started and operated while driving the vehicle. If necessary, you may select this position in order to restart the engine with the vehicle moving. This position should also be used when towing the vehicle.

DRIVE (D)

Drive range should be used for all normal driving conditions for maximum efficiency and fuel economy. Drive range allows the transmission to operate in each of the 6 forward gear ratios. Downshifts to a lower gear, or higher gear ratio, are available for safe passing by depressing the accelerator or by manually selecting a lower gear in the manual mode range.

Driver Shift Control (DSC) or Electronic Range Selection (ERS)

This position (M-Manual / L-Low) allows the driver to utilize the DSC/ERS system. When the shift selector lever is moved to this position, the driver may select upshifts or downshifts by using the paddle switches located on the steering wheel/shifter. An upshift is requested by pushing either + button. Refer to the vehicle owner's manual for more specific DSC/ERS information.

TRANSMISSION COMPONENT AND SYSTEM DESCRIPTION

The mechanical components of the 6T70/75 are as follows:

- A torque converter with an electronically controlled capacity clutch (ECCC)
- Off axis chain driven vane-type fluid pump assembly
- Input sun gear and carrier assembly
- 4-5-6 and 3-5 reverse clutch assembly with turbine shaft
- Low and reverse clutch (one way clutch) assembly
- Control valve body assembly
- Front differential transfer drive gear support assembly
- Front differential transfer drive gear assembly
- Front differential carrier assembly
- Case cover assembly

The electrical components of the 6T70/75 are as follows:

- Output speed sensor assembly
- Input speed sensor assembly
- Manual shift shaft with internal mode switch
- Control solenoid valve assembly, which contains the following components:
  - Transmission control module (TCM)
  - 5 variable bleed line pressure control (PC) solenoids
  - Transmission fluid pressure (TFP) switch assembly

- Torque converter clutch (TCC) pressure control solenoid
- 2 shift solenoids
- Transmission fluid temperature sensor

For more information, refer to **Electronic Component Description**.

TRANSMISSION ADAPTIVE FUNCTIONS

The 6T70/75 transmission utilizes a line pressure control system during upshifts to compensate for the normal wear of transmission components. As the apply components within the transmission wear or change over time, shift time (the time required to apply a clutch) increase or decreases. In order to compensate for these changes, the transmission control module (TCM) adjusts the pressure commands to the various PC solenoids, to maintain the originally calibrated shift timing. The automatic adjusting process is referred to as "adaptive learning" and it is used to ensure consistent shift feel plus increase transmission durability. The TCM monitors the A/T input speed sensor (ISS) and the A/T output speed sensor (OSS) during commanded shifts to determine if a shift is occurring too fast (harsh) or too slow (soft) and adjusts the corresponding pressure control (PC) solenoid signal to maintain the set shift feel.

The purpose of the adapt function is to automatically compensate the shift quality for the various vehicle shift control systems. The adapt function is a continuous process that will help to maintain optimal shift quality throughout the life of the vehicle.

TRANSMISSION INDICATORS AND MESSAGES

The following transmission-related indicators and messages may be displayed on the Instrument Panel Cluster (IPC). For a complete listing and description of all vehicle indicators and messages, refer to **Indicator/Warning Message Description and Operation** .

"TRANSMISSION HOT IDLE ENGINE"

This message is displayed when the TCM detects a transmission fluid temperature (TFT) equal to or greater than 132Â°C (270Â°F) for 5 seconds.

"SERVICE TRANSMISSION"

This message displays when there is a problem with the transmission.

ELECTRONIC COMPONENT DESCRIPTION

Control Solenoid (W/Body and TCM) Valve Assembly

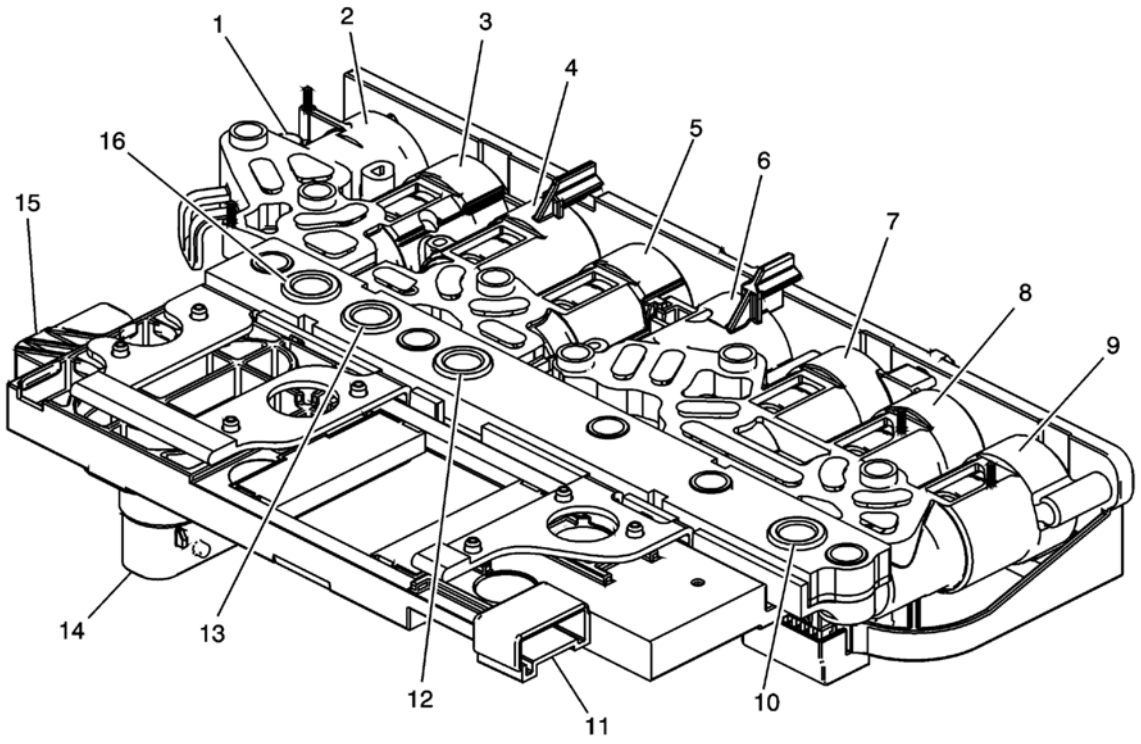


Fig. 2: Identifying Control Solenoid (W/Body & TCM) Valve Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Control Solenoid Valve Assembly X3 (ISS)
2	Shift Solenoid 1
3	Pressure Control Solenoid 3 (R1/456)
4	Pressure Control Solenoid 5 (1234)
5	Torque Converter Clutch (TCC) Pressure Control Solenoid
6	Shift Solenoid 2
7	Pressure Control Solenoid 2 (35R)
8	Pressure Control Solenoid 4 (26)
9	Line Pressure Control Solenoid
10	Transmission Fluid Pressure (TFP) Switch 5 (35R)
11	Control Solenoid Valve Assembly X2 (IMS)
12	Transmission Fluid Pressure (TFP) Switch 3 (26)
13	Transmission Fluid Pressure (TFP) Switch 4 (456/R1)
14	Control Solenoid Valve Assembly X1
15	Control Solenoid Valve Assembly X4 (OSS)
16	Transmission Fluid Pressure (TFP) Switch 5 (35R)

The control solenoid (w/body and TCM) valve assembly contains the following components:

- Transmission control module (TCM)
- Clutch pressure control solenoids (Clutch PC Sol)

- Shift solenoids (SS)
- Line pressure control solenoid (Line PC Sol)
- Torque converter clutch pressure control solenoid (TCC PC Sol)
- Transmission fluid temperature sensor (TFT Sensor)
- TCM temperature sensor
- Power-up temperature sensor
- Transmission fluid pressure switches (TFP Sw)

These components are not serviced separately. The control solenoid (w/body and TCM) valve assembly utilizes a lead-frame system to connect these components electrically to the TCM. No wires are used for these components. The control solenoid (w/body and TCM) valve assembly bolts directly to the lower and upper valve body assemblies inside the transmission. The control solenoid (w/body and TCM) valve assembly connects to the engine harness 20-way connector.

Manual Shift Detent Lever with Shaft Position Switch Assembly (IMS)

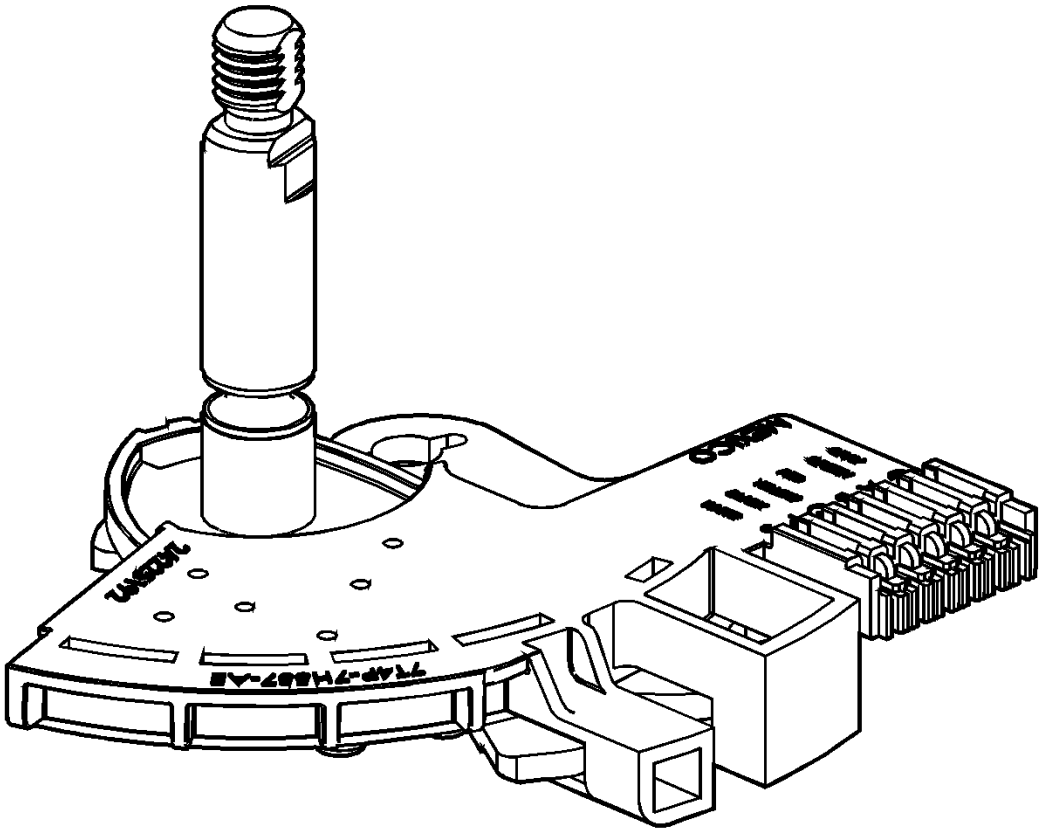


Fig. 3: Identifying Manual Shift Detent Lever with Shaft Position Switch
Courtesy of GENERAL MOTORS COMPANY

The transmission shaft position switch assembly is a sliding contact switch attached to the manual shaft detent lever assembly inside the transmission case. The five inputs to the TCM from the transmission manual shift shaft switch assembly indicate the transmission gear selector lever position. This information is used for engine controls as well as determining the transmission shift patterns. The state of each input is available for display on the scan tool. The five input parameters represented are Signal A, Signal B, Signal C, Signal P (Parity) and Signal N (P/N Start). The transmission shaft position switch assembly is connected to the Control Solenoid (W/Body and TCM) Valve Assembly via the Control Solenoid Valve Assembly X2 (IMS) connector.

Input Speed Sensor (ISS)

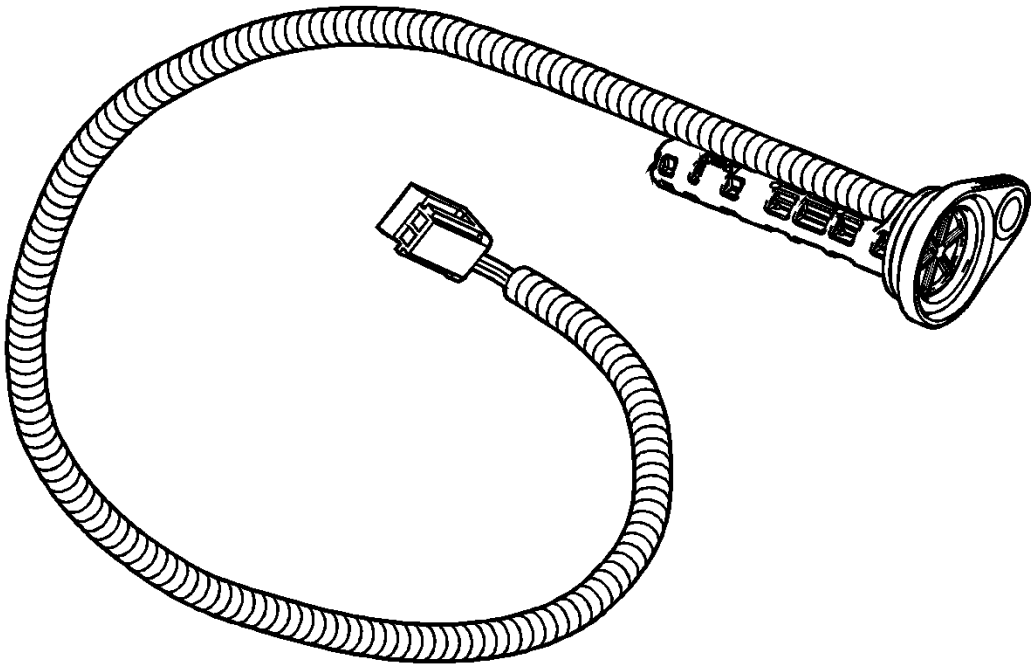


Fig. 4: Identifying Input Speed Sensor (ISS)
Courtesy of GENERAL MOTORS COMPANY

The input speed sensor (ISS) is a hall-effect type sensor. The ISS mounts to the transmission case cover assembly and connects to the control solenoid (w/body and TCM) valve assembly through a wire harness and connector. The sensor faces the 3-5-R clutch piston housing machined teeth surface. The sensor receives 8.3-9.3 volts on the ISS/OSS Supply Voltage circuit from the TCM. As the 3-5-R/4-5-6 clutch piston housing rotates, the sensor produces a signal frequency based on the machined surface of the 3-5-R/4-5-6 clutch piston housing. This signal is transmitted through the ISS signal circuit to the control solenoid (w/body and TCM) valve assembly. The TCM uses the ISS signal to determine line pressure, transmission shift patterns, torque converter

clutch (TCC) slip speed and gear ratio. The input speed sensor (ISS) is connected to the Control Solenoid (W/Body and TCM) Valve Assembly via the Control Solenoid Valve Assembly X3 (ISS) connector.

Output Speed Sensor (OSS)

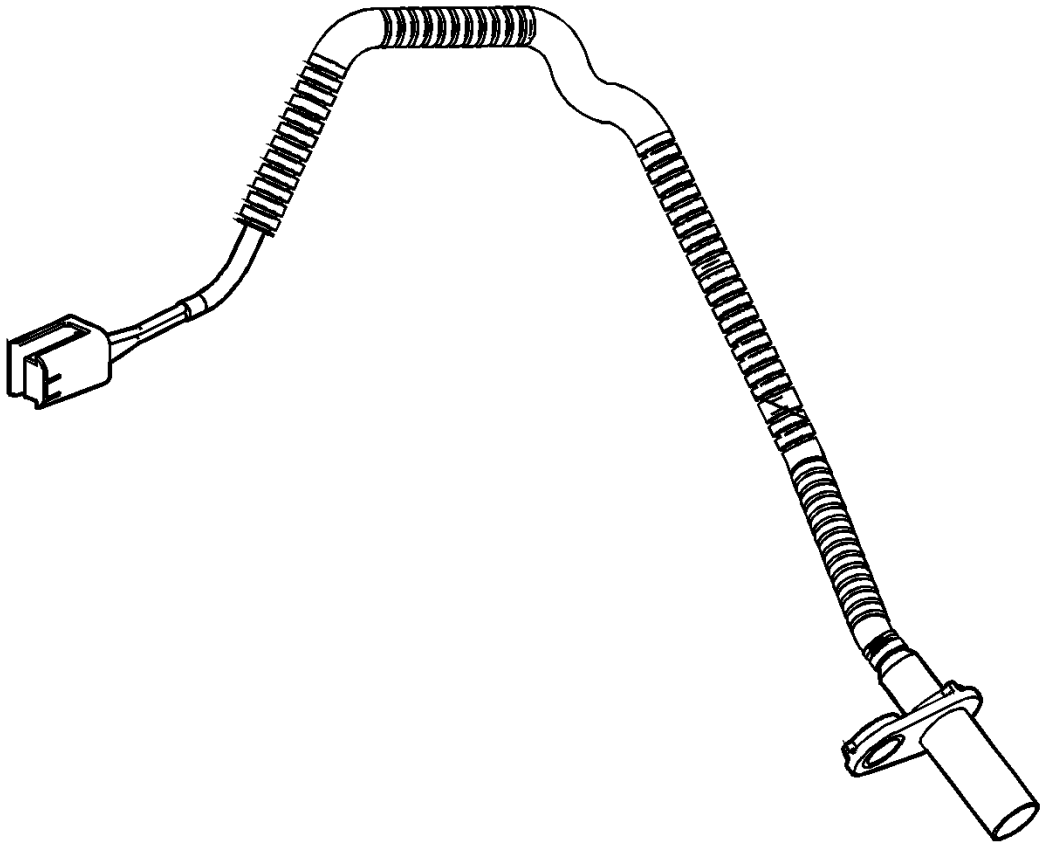


Fig. 5: Identifying Output Speed Sensor (OSS)
Courtesy of GENERAL MOTORS COMPANY

The output speed sensor (OSS) is a hall-effect type sensor. The OSS mounts to the transmission case below the control valve body assembly and connects to the control solenoid (w/body and TCM) valve assembly through a wire harness and connector. The sensor faces the Park gear machined teeth surface. The sensor receives 8.3-9.3 volts on the ISS/OSS supply voltage circuit from the TCM. As the front differential transfer drive gear assembly rotates, the sensor produces a signal frequency based on the machined surface of the Park gear. This signal is transmitted through the OSS signal circuit to the TCM. The TCM uses the OSS signal to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio. The output speed sensor (OSS) is connected to the Control Solenoid (W/Body and TCM) Valve Assembly via the Control Solenoid Valve Assembly X4 (OSS) connector.

AUTOMATIC TRANSMISSION INLINE 20-WAY CONNECTOR DESCRIPTION

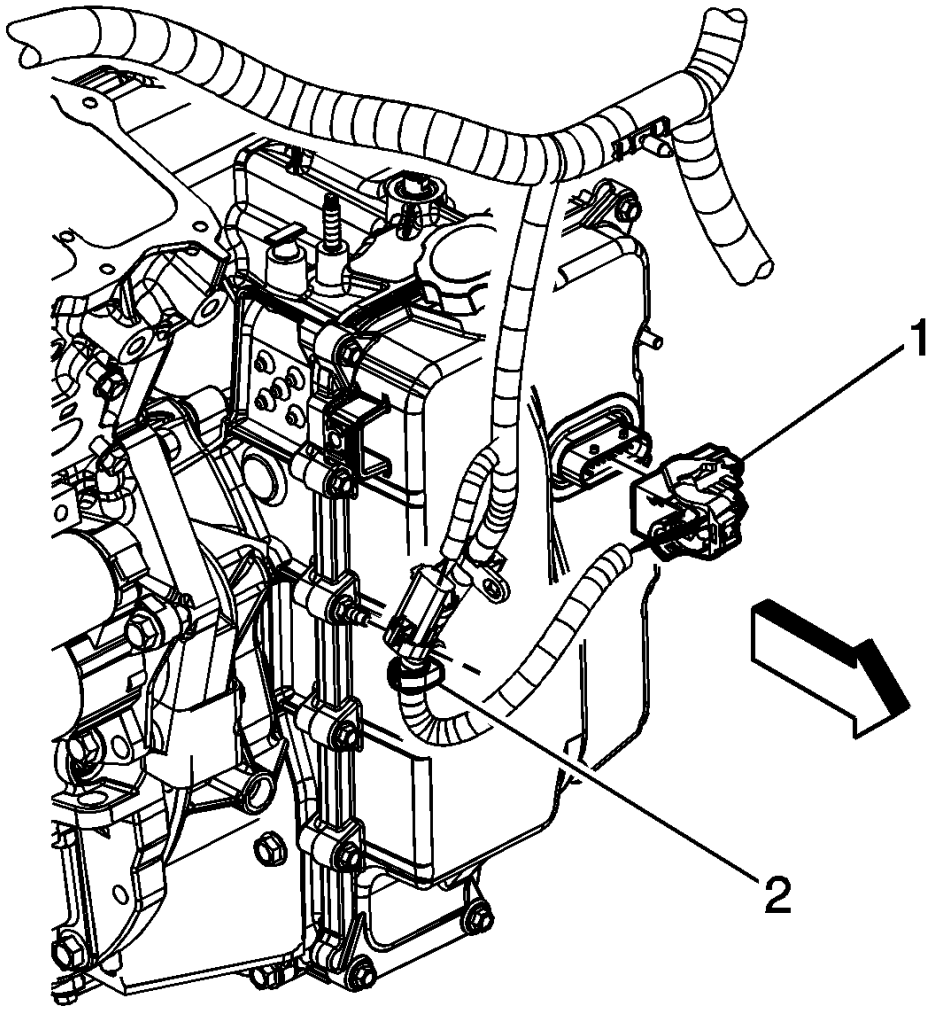


Fig. 6: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

The transmission electrical connector is an important part of the transmission operating system. Any interference with the electrical connection can cause the transmission to set diagnostic trouble codes or affect proper operation. The following items can affect the electrical connection:

- Bent pins in the connector from rough handling during connection and disconnection
- Wires backing away from the pins or coming uncrimped, in the external wiring harness
- Dirt contamination entering the connector when disconnected
- Transmission fluid leaking into the connector, wicking up into the external wiring harness and degrading the wire insulation
- Moisture intrusion in the connector
- Low pin retention in the external connector from excessive connection and disconnection of the wiring connector assembly
- Pin corrosion from contamination
- Damaged connector assembly

Remember the following points:

- Limit twisting or wiggling the connector during removal. Bent pins can occur.
- Do not pry the connector off with a screwdriver or other tool.
- Whenever the transmission external wiring connector is disconnected from the internal harness and the engine is operating, DTCs will set. Clear these DTCs after reconnecting the external connector.

CRUISE GRADE BRAKING DESCRIPTION

Purpose

- Cruise grade braking assists when driving on a downhill grade.
- It maintains vehicle speed by automatically implementing a shift schedule that uses the engine and the transmission to slow the vehicle.

Activation

- This feature is internal to the vehicle's software/calibration and requires no customer action to activate.
- Cruise grade braking is not available in Range Selection Mode.

Function

- Automatic downshifting to assist in speed control will activate when vehicle speed has increased from the set point by a certain amount. Multiple downshift may be commanded depending on the amount of deviation of vehicle speed to the set speed. As vehicle speed slows and approaches the original set speed, upshifts will be commanded to return to a normal operating condition.
- At some speeds and on some downhill grades, the transmission may not be able to command a gear low enough to slow the vehicle to the set point without overspeeding the engine.
- In this case the transmission will command all available downshifts, but if further engine braking is desired, the driver must press the brake pedal to slow the vehicle enough so additional downshift(s) can be commanded.
- Pressing the brake pedal has the normal effect of cancelling cruise control operation and in this case a transition to Normal - Powertrain Braking is completed.
- As always, if cruise control operation was cancelled through usage of the brake pedal, it must be reinitiated by tapping either the Set or Resume Cruise switches.

PARK - ENGINE RUNNING

When the gear selector lever is in the Park (P) position, fluid is drawn into the pump through the transmission fluid filter assembly. Line pressure is then directed to the following valves:

Fluid Pressure Directed in Preparation for a Shift

Manual Valve

Mechanically controlled by the gear selector lever, the manual valve is in the Park (P) position and prevents line pressure from the pressure regulator valve from entering the reverse and drive circuits.

R1/456 Pressure Control (PC) Solenoid 3

The R1/456 pressure control solenoid (PCS) is energized (HIGH) allowing actuator feed limit fluid to enter the

PCS R1/456 CL fluid circuit. PCS R1/456 CL fluid is then routed through orifice #22 to the 4-5-6 clutch boost valve and through orifice #21 to the R1/ 456 clutch regulator valve.

R1/456 Clutch Regulator Valve

PCS R1/456 CL fluid at the R1/4-5-6 clutch regulator valve moves the valve against R1/4-5-6 clutch regulator spring force and R1/FDBK fluid. This allows line pressure to pass through the valve and enter the R1/456CL FD circuit. R1/456CL FD is then routed to clutch select valve 2.

Shift Solenoid 1

Shift solenoid 1 is energized (ON) allowing actuator feed limit fluid to enter the solenoid 1 circuit. Solenoid 1 fluid is routed to the #2 ball check valve and through orifice #10 to the torque converter clutch (TCC) regulator valve and shuttle valve (SHTL).

TCC Regulator Valve and Shuttle Valve

Solenoid 1 fluid is routed to the TCC regulator valve and shuttle valve and moves the valve against TCC regulator valve spring force.

#2 Ball Check Valve

Solenoid 1 fluid seats the #2 ball check valve against the reverse fluid passage and fluid is forced through orifice #15 into the CSV2 enable fluid circuit.

Clutch Select Valve 2

CSV2 enable fluid is routed to the clutch select valve 2 and moves the valve against clutch select valve 2 spring force. This allows R1/456 CL FD fluid to pass through the valve and enter the R1 supply circuit. R1 Supply fluid is then routed into the R1 fluid circuit and, through orifice #18. R1 fluid is then routed to the low & reverse clutch assembly in preparation for a shift into low or reverse gear.

Shift Solenoid 2

Shift solenoid 2 is energized (ON) allowing actuator feed limit fluid to enter the solenoid 2 fluid circuit and is then routed to the #3 ball check valve and through orifice #13 to the clutch select valve #3.

3-5 Reverse Clutch Regulator Valve

Actuator feed limit fluid is routed through the valve and into the PS2 fluid passage. PS2 fluid is then sent to the normally closed #2 pressure switch and opens the switch.

#3 Ball Check Valve

Solenoid 2 fluid seats the #3 ball check valve against 456 CL fluid passage and fluid is forced through orifice #13 into the CSV3 enable fluid circuit. CSV3 enable fluid is then routed to the clutch select valve 3.

Clutch Select Valve #3

CSV3 enable fluid moves the clutch select valve 3 against clutch select valve 3 spring force.

Compensator Blow Off

Line pressure is routed through orifice #17 to the compensator feed circuit. Compensator feed fluid enters the compensator blow off circuit and fills the 4-5-6 dam piston area.

Park- Engine Running

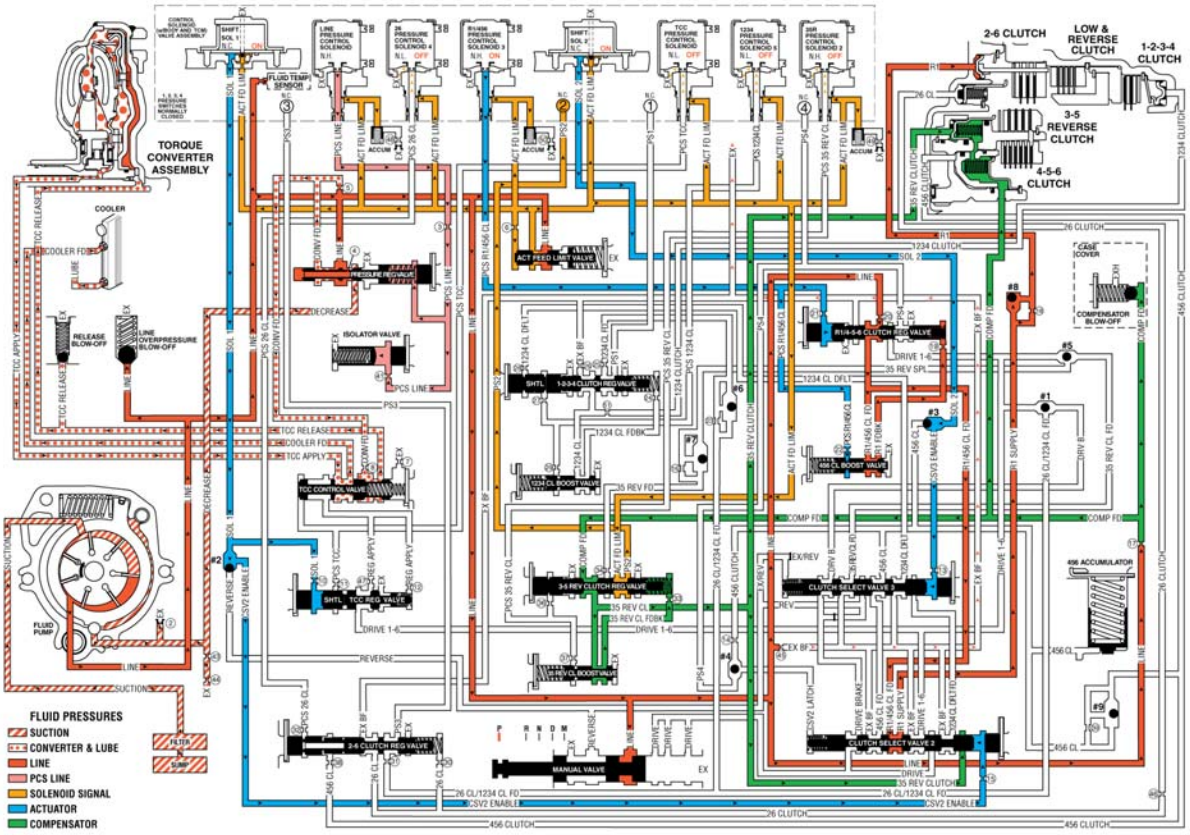


Fig. 7: Identifying Fluid Flow - Park - Engine Running
Courtesy of GENERAL MOTORS COMPANY

REVERSE

When the gear selector lever is moved to the Reverse (R) position (from the Park position) the normally high 35R pressure control solenoid 2 is commanded ON and the following changes occur in the transmission's hydraulic and electrical systems:

Fluid Pressure Directed in Preparation for a Shift

Manual Valve

With the manual valve in the reverse position, line pressure is directed into the reverse fluid circuit to the #2 ball check valve and clutch select valve 3.

#2 Ball Check Valve

Reverse fluid seats the #2 ball check valve against the solenoid 1 fluid passage and fluid is forced through orifice #15 into the CSV2 enable circuit.

Clutch Select Valve 2

CSV2 enable fluid, present at the valve from Park position, continues to hold the clutch select valve 2 against clutch select valve 2 spring force.

Low & Reverse Clutch Applies

Clutch Select Valve 3

Reverse fluid from the manual valve is routed to clutch select valve 3 to combine with clutch select valve 3 spring force to keep the valve in the off position. This allows reverse fluid to pass through the valve and enter the 3-5 clutch reverse feed circuit. The 3-5 clutch reverse feed fluid from the clutch select valve 3 is also routed to #5 ball check valve.

Low & Reverse Clutch

R1 supply fluid passes through orifice #18 and unseats check ball #8. R1 supply fluid enters the low & reverse clutch piston circuit and moves the piston against the spring force to apply the low & reverse clutch plates.

#5 Ball Check Valve

The 3-5 clutch reverse feed fluid seats #5 ball check valve against the drive 1-6 circuit allowing 3-5 clutch reverse feed fluid to enter the 3-5 reverse supply circuit. The 3-5 reverse supply fluid is then routed to #7 ball check valve and through orifice #16 where is enters the 3-5 reverse feed circuit. The 3-5 reverse feed passes through orifice #34 and then is routed to the 3-5 reverse clutch regulator valve.

3-5 Reverse Clutch Applies

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is energized (HIGH) allowing actuator feed limit fluid to enter the PCS 3-5 reverse clutch circuit. PCS 3-5 reverse clutch fluid is then routed through orifice #36 to the 3-5 reverse clutch regulator valve and through orifice #37 to the 3-5 reverse boost valve.

3-5 Reverse Clutch Regulator Valve

PCS 3-5 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 3-5 reverse clutch feedback fluid. This allows 3-5 reverse feed to pass through the valve and enter the 3-5 reverse clutch circuit. The 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch and the 3-5 reverse boost valve. PS2 fluid from pressure switch 2 exhausts through the valve allowing the switch to close.

3-5 Reverse Boost Valve

PCS 3-5 reverse clutch fluid pressure acts on a differential area moving the 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. The 3-5 reverse clutch fluid passes through the valve and enters the 3-5 reverse clutch feedback circuit. As PCS 3-5 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 3-5 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 3-5 clutch reverse feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch

The 3-5 reverse clutch fluid enters the 3-5R/456 clutch housing to move the piston against spring force and compensator feed fluid to apply the 3-5 reverse clutch plates.

Reverse

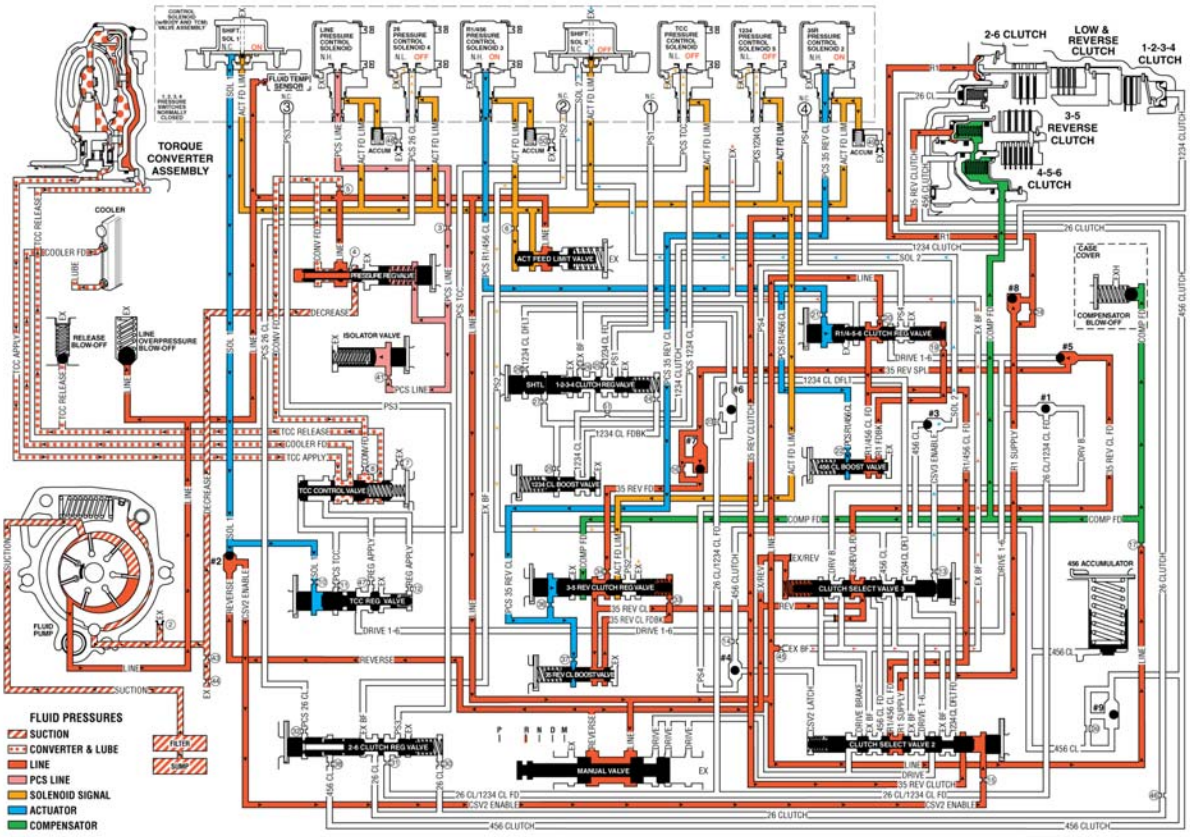


Fig. 8: Identifying Fluid Flow - Reverse
Courtesy of GENERAL MOTORS COMPANY

NEUTRAL - ENGINE RUNNING

When the gear selector is moved to the Neutral (N) position, the hydraulic and electrical system operation is identical to Park (P) range. However, if Neutral is selected after the vehicle was operating in Reverse (R), the normally high 35R pressure control solenoid 2 is commanded OFF and the following changes would occur in the hydraulic system:

3-5 Reverse Clutch Releases

Manual Valve

The manual valve is moved to the Neutral position and blocks line pressure from entering the reverse and drive fluid circuits. The reverse fluid from the #2 ball check valve and clutch select valve 3 is opened to an exhaust passage at the manual valve.

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is commanded OFF allowing PCS 3-5 reverse clutch fluid from the 3-5

reverse clutch boost valve and 3-5 reverse clutch regulator valve to exhaust.

3-5 Reverse Clutch Boost Valve

The 3-5 reverse boost valve spring force moves the valve to allow 3-5 reverse clutch feedback fluid from the 3-5 reverse clutch regulator valve to enter the 3-5 reverse clutch circuit and exhaust.

3-5 Reverse Clutch Regulator Valve

The 3-5 reverse clutch regulator valve spring force moves the valve to allow 3-5 reverse clutch fluid from the 3-5 reverse clutch and clutch select valve 2 to pass through the valve and enter the 35 reverse clutch feed circuit through orifice #16 past check ball #5 to clutch select valve 3 to exhaust back fill circuit to exhaust.

3-5 Reverse Clutch

The 3-5 reverse clutch spring force moves the 3-5 reverse clutch piston to release t h e 3-5 reverse clutch plates and force 3-5 reverse clutch fluid to exhaust from the 3-5/4-5-6 reverse clutch housing. The 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch regulator valve allowing the 3-5 reverse clutch to release.

Clutch Select Valve 3

When reverse fluid exhausts through the manual valve, CSV3 enable fluid moves the valve against clutch select valve 3 spring force. The 3-5 reverse feed fluid is routed into the exhaust back fill circuit and exhausts.

Neutral- Engine Running

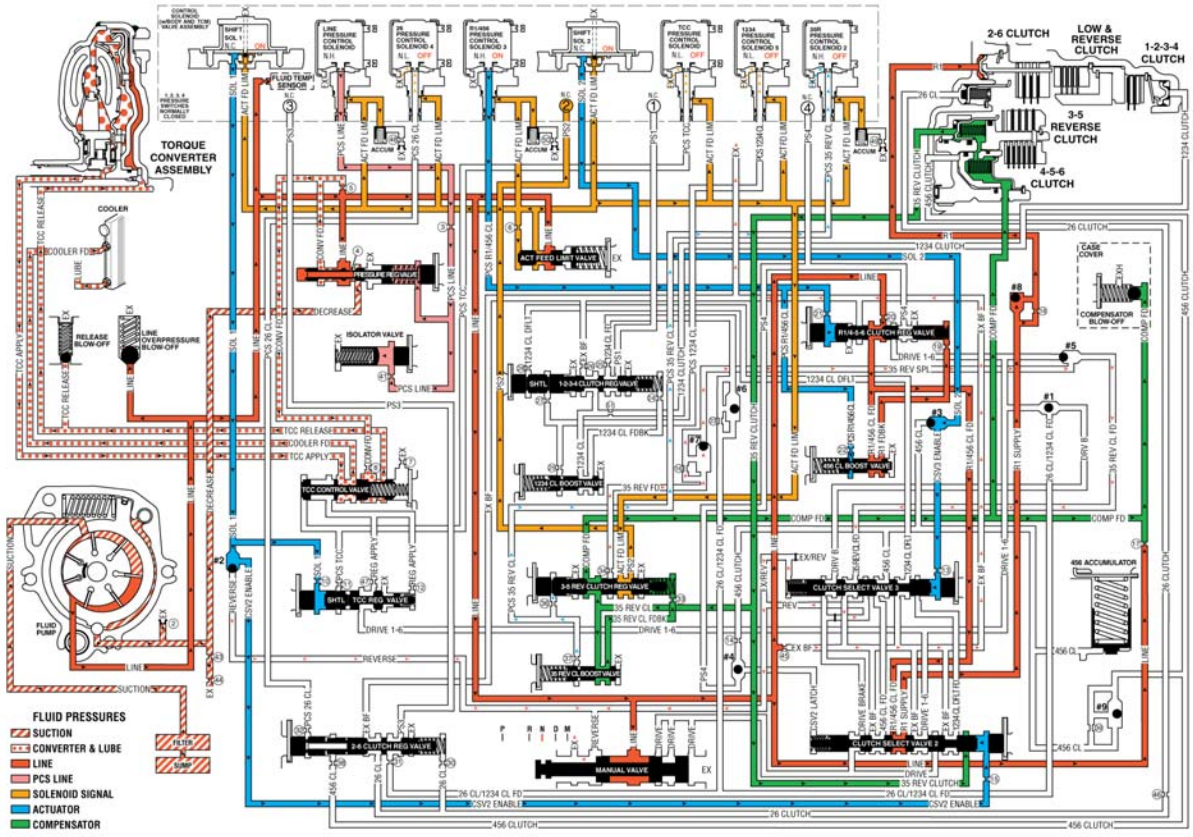


Fig. 9: Identifying Fluid Flow - Neutral - Engine Running
Courtesy of GENERAL MOTORS COMPANY

DRIVE RANGE, FIRST GEAR ENGINE BRAKING

When the gear selector lever is moved to the Drive (D) range from the Neutral (N) position, the transmission will provide engine braking. In this operating range, the normally-low 1234 pressure control solenoid 5 is commanded ON and in the engine braking mode the following changes occur within the hydraulic circuits:

Fluid Pressure is Directed to the 1-2-3-4 Clutch and the Low & Reverse Clutch to Provide Engine Braking

Manual Valve

The manual valve is moved to the Drive (D) position and allows line fluid pressure to enter the drive fluid circuit. Drive fluid is then routed to the clutch select valve 2.

Clutch Select Valve 2

Drive fluid at the clutch select valve 2 passes through the valve and enters the drive brake circuit. Drive brake fluid is then routed to the clutch select valve 3.

Clutch Select Valve 3

Drive brake fluid at the clutch select valve 3 passes through the valve and enters the Drive B fluid circuit. Drive B fluid is then routed to #1 ball check valve.

#1 Ball Check Valve

Drive B fluid seats the #1 ball check valve against drive 1-6 fluid to force drive B fluid into the 26/1234 feed passage. The 26/ 1234 feed fluid is routed through orifice #31 and, to the 2-6 clutch regulator valve. The 26/1234 feed fluid passes through the 2-6 clutch regulator valve and enters the pressure switch 3 (PS3) fluid circuit. PS3 fluid is then routed to the normally closed pressure switch 3 and opens the switch.

#6 Ball Check Valve

26/1234 feed fluid unseats the #6 ball check valve allowing 26/1234 feed fluid to enter the 1234 clutch feed circuit. The 1234 clutch feed fluid is routed through orifice #25 and then to the 1-2-3-4 clutch regulator valve.

1-2-3-4 Clutch Applies

1234 Pressure Control Solenoid 5

The 1234 pressure control solenoid 5 is commanded ON allowing actuator feed limit to enter the PCS 1234 clutch fluid circuit. PCS 1234 clutch fluid is then routed throught orifice #27 to the 1-2-3-4 clutch regulator valve. PCS1234 clutch fluid is also routed through orifice #29 and then to the 1-2-3-4 clutch boost valve.

1-2-3-4 Clutch Regulator Valve

PCS1234 clutch fluid moves the 1-2-3-4 clutch regulator valve against 1-2-3-4 clutch regulator valve spring force to allow 1234 clutch feed fluid to pass through the valve and enter the 1234 clutch fluid circuit. The 1234 clutch fluid is then routed to the 1234 clutch boost valve and the 1-2-3-4 clutch.

1-2-3-4 Clutch Boost Valve

PCS1234 clutch fluid pressure acts on a differential area moving the 1234 clutch boost valve against the 1234

clutch boost valve spring. The 1234 clutch fluid passes through the valve and enters the 1234 clutch feedback circuit. As PCS 1234 clutch fluid pressure is increased to a given value, the 1234 clutch boost valve opens the 1234 clutch feedback circuit to exhaust. This results in the 1234 clutch regulator valve moving to the full feed position sending full 26 CL/1234 CL feed pressure (full line pressure) to the clutch.

1-2-3-4 Clutch

The 1234 clutch fluid enters the 1234 clutch to move the piston against spring force to apply the 1-2-3-4 clutch plates.

Drive Range, First Gear Engine Braking

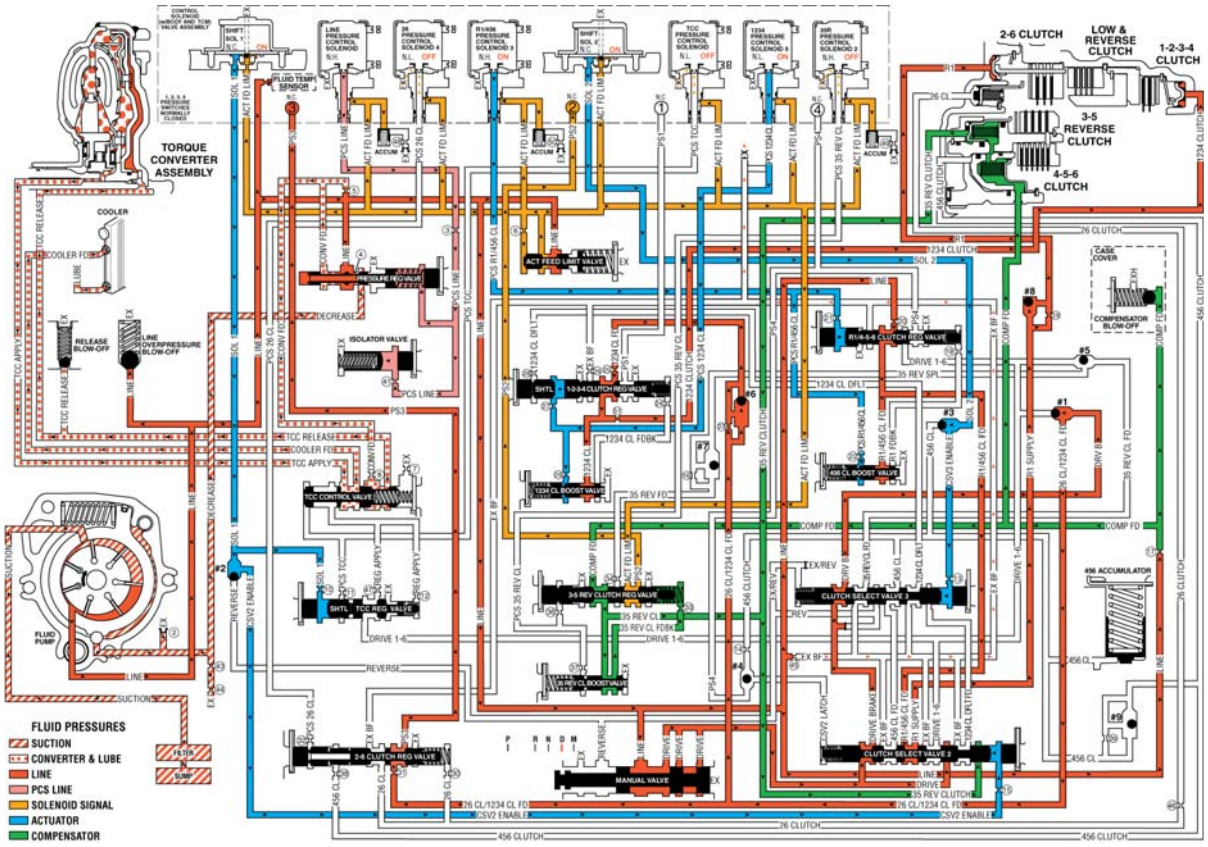


Fig. 10: Identifying Fluid Flow - Drive Range, First Gear Engine Braking
Courtesy of GENERAL MOTORS COMPANY

DRIVE RANGE, FIRST GEAR

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, throttle position sensor and other vehicle sensors to determine the precise moment to deenergize or "turn off" shift solenoid 1 and command OFF the normally-high R1/456 pressure control solenoid 3.

Low & Reverse Clutch Releases

Shift Solenoid 1

When shift solenoid 1 is "turned OFF", CSV2 enable fluid from the clutch select valve 2 passes by the #2 ball check valve and enters the solenoid 1 fluid circuit. Solenoid 1 fluid from the #2 ball check valve and TCC

regulator valve is then routed to the solenoid where it exhausts.

Clutch Select Valve 2

Clutch select valve 2 (CSV2) enable fluid is exhausted from the clutch select valve 2 and clutch select valve 2 spring force moves the valve to the released position. With clutch select valve 2 in the released position, drive fluid from the manual valve passes through the valve and enters the drive 1-6 fluid circuit. Drive 1-6 fluid then feeds the R1/456 and 35 reverse clutch regulator valves and the TCC regulator valve.

R1/456 Pressure Control Solenoid 3

The R1/456 pressure control solenoid 3 is commanded OFF allowing PCS R1/456 fluid from the R1/456 clutch regulator valve and 456 clutch boost valve to exhaust.

R1/456 Clutch Regulator Valve

R1/456 clutch regulator valve spring force moves the valve to exhaust the R1/456 clutch feed circuit and allow drive 1-6 fluid to enter the PS4 fluid circuit. PS4 fluid is then routed to the normally-closed pressure switch 4 and opens the switch. PS4 fluid is also routed to the #4 ball check valve and flows into the CSV2 latch fluid circuit.

#4 Ball Check Valve

PS4 fluid pressure seats the #4 ball check valve against the 456 clutch fluid circuit. PS4 fluid is then directed into the CSV2 latch fluid circuit and routed to the clutch select valve 2. CSV2 latch fluid combines with clutch select valve 2 spring force and holds the valve in this position during all 6 forward gear ranges.

#5 Ball Check Valve

Drive 1-6 fluid pressure seats the #5 ball check valve against the 35 reverse clutch feed fluid passage. Drive 1-6 fluid is then directed into the 35R supply fluid circuit which is routed to the #7 ball check valve and orifice #16.

#7 Ball Check Valve

The 35R supply fluid seats the #7 ball check valve against the 35R feed fluid passage to force 35R supply fluid through orifice #16 before entering the 35R feed circuit. The 35R feed fluid is then routed to the 3-5 reverse clutch regulator valve.

Low and Reverse Clutch

Low and reverse clutch spring force moves the low and reverse clutch piston which forces R1 fluid out. R1 fluid is routed to the clutch select valve 2 where it enters the exhaust backfill circuit. The low and reverse clutch is in the released position.

Drive Range, First Gear

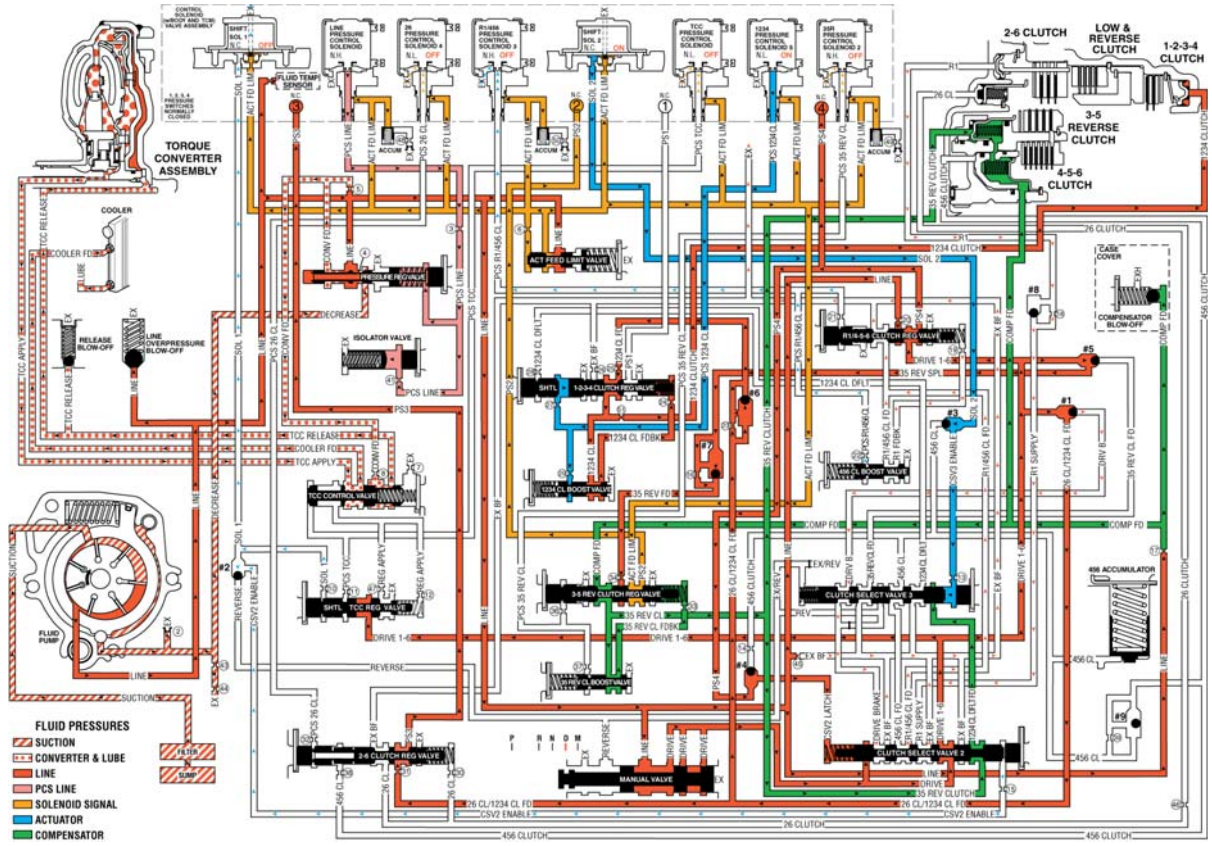


Fig. 11: Identifying Fluid Flow - Drive Range, First Gear
Courtesy of GENERAL MOTORS COMPANY

DRIVE RANGE, THIRD GEAR

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command OFF the normally-low 26 pressure control solenoid 4. At the same time the 35R pressure control solenoid 2 is also commanded ON to regulate 3-5 clutch apply.

3-5 Reverse Clutch Applies

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is commanded ON allowing actuator feed fluid to enter the pressure control solenoid (PCS) 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #36 and then to the 3-5 reverse clutch regulator valve. PCS 35 reverse clutch fluid is also routed through orifice #37 and then to the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Boost Valve

PCS 35 reverse clutch fluid pressure acts on a differential area moving the 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. The 35 reverse clutch fluid passes through the valve and enters the 35 reverse clutch feedback circuit. As PCS 35 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 35 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 35 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 35 reverse clutch feedback fluid. This allows 35 reverse feed to pass through the valve and enter the 35 reverse clutch circuit. The 35 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS2 fluid from the pressure switch 2 exhausts through the valve allowing the switch to close.

3-5 Reverse Clutch

The 35 reverse clutch fluid enters the 3-5 reverse/4-5-6 clutch housing to move the piston against spring force to apply the 3-5 reverse clutch plates.

2-6 Clutch Releases

26 Pressure Control Solenoid 4

The 26 pressure control solenoid 4 is commanded OFF allowing PCS 26 clutch fluid from the 2-6 clutch regulator valve to exhaust. The 26 clutch/1234 clutch feed fluid at the 2-6 clutch regulator valve passes through the valve and enters the PS3 fluid circuit. PS3 fluid is then routed to pressure switch 3 and opens the normally-closed switch.

2-6 Clutch Regulator Valve

The 2-6 clutch regulator valve spring force moves the valve to allow 26 clutch fluid from the 2-6 clutch to pass through the valve and enter the exhaust backfill fluid circuit.

2-6 Clutch

The 2-6 clutch spring force moves the 2-6 clutch piston to release the 2-6 clutch plates and forces 26 clutch fluid to exhaust. The 26 clutch fluid is routed through the 2-6 clutch regulator valve where it enters the exhaust backfill fluid circuit and is exhausted.

Drive Range, Third Gear

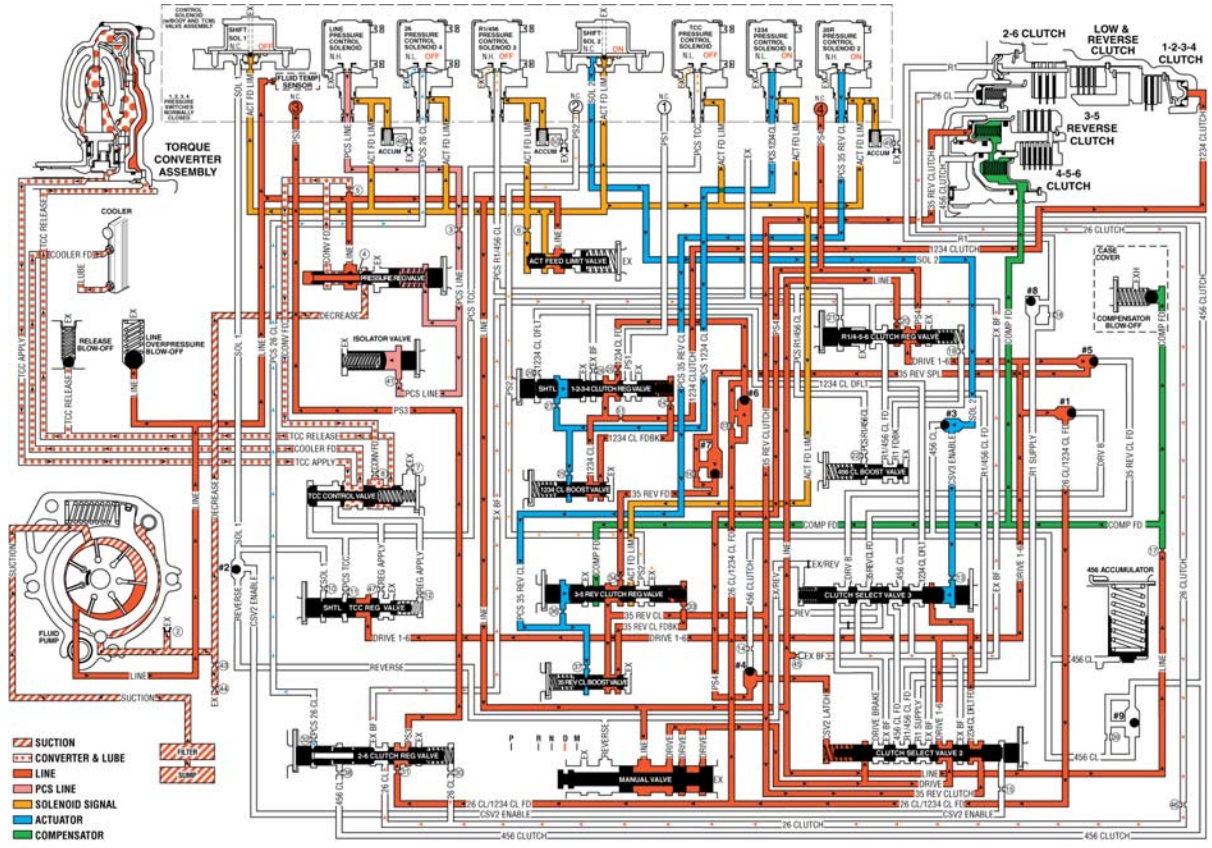


Fig. 12: Identifying Fluid Flow - Drive Range, Third Gear
Courtesy of GENERAL MOTORS COMPANY

DRIVE RANGE, THIRD GEAR DEFAULT

If the transmission is in 1st, 2nd or 3rd gear during a transmission electrical component failure, the transmission will default to 3rd gear. All solenoids will default to their normal state. If the torque converter clutch was applied, it will release. This default action will enable the vehicle to be safely driven to a service center.

1-2-3-4 Clutch Stays Applied

Shift Solenoid 2

Shift solenoid 2 defaults to it's normally-closed state (OFF), and SOL 2 fluid exhausts through the solenoid.

Clutch Select Valve 3

Solenoid 2 fluid pressure no longer holds the clutch select valve 3 open. When the valve moves back to the closed position, it opens the 1234 clutch default fluid circuit, and 1234 default fluid is routed to the 1-2-3-4 clutch regulator valve.

1-2-3-4 Clutch Regulator Valve

With the absence of PCS 1234 clutch fluid, due to the default state of the 1234 pressure control solenoid 5, the 1-2-3-4 regulator valve would close from spring force. However, the 1234 clutch default fluid enters behind the 1-2-3-4 regulator shuttle valve and keeps the valve in the open position.

1-2-3-4 Clutch

With the 1-2-3-4 clutch regulator valve still held in the open position, the 1-2-3-4 clutch will stay applied.

3-5 Reverse Clutch Applied or Applies

35R Pressure Control Solenoid 2

The normal state for the 35R pressure control solenoid 2 is ON, therefore PSC 35 reverse clutch fluid will still be routed to the 3-5 reverse clutch regulator valve and the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Regulator Valve

PCS 3-5 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 3-5 reverse clutch feedback fluid. This allows 3-5 reverse feed to pass through the valve and enter the 3-5 reverse clutch circuit. 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS2 fluid from the pressure switch 2 exhausts through the valve, allowing the switch to close.

3-5 Reverse Clutch Boost Valve

PCS 3-5 reverse clutch fluid pressure acts on a differential area moving the 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. The 3-5 reverse clutch fluid passes through the valve and enters the 3-5 reverse clutch feedback circuit. As PCS 3-5 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 3-5 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 3-5 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch

The 3-5 reverse clutch fluid enters the 3-5 reverse/456 clutch housing to move the piston against spring force to apply the 3-5 reverse clutch plates.

Drive Range, Third Gear Default

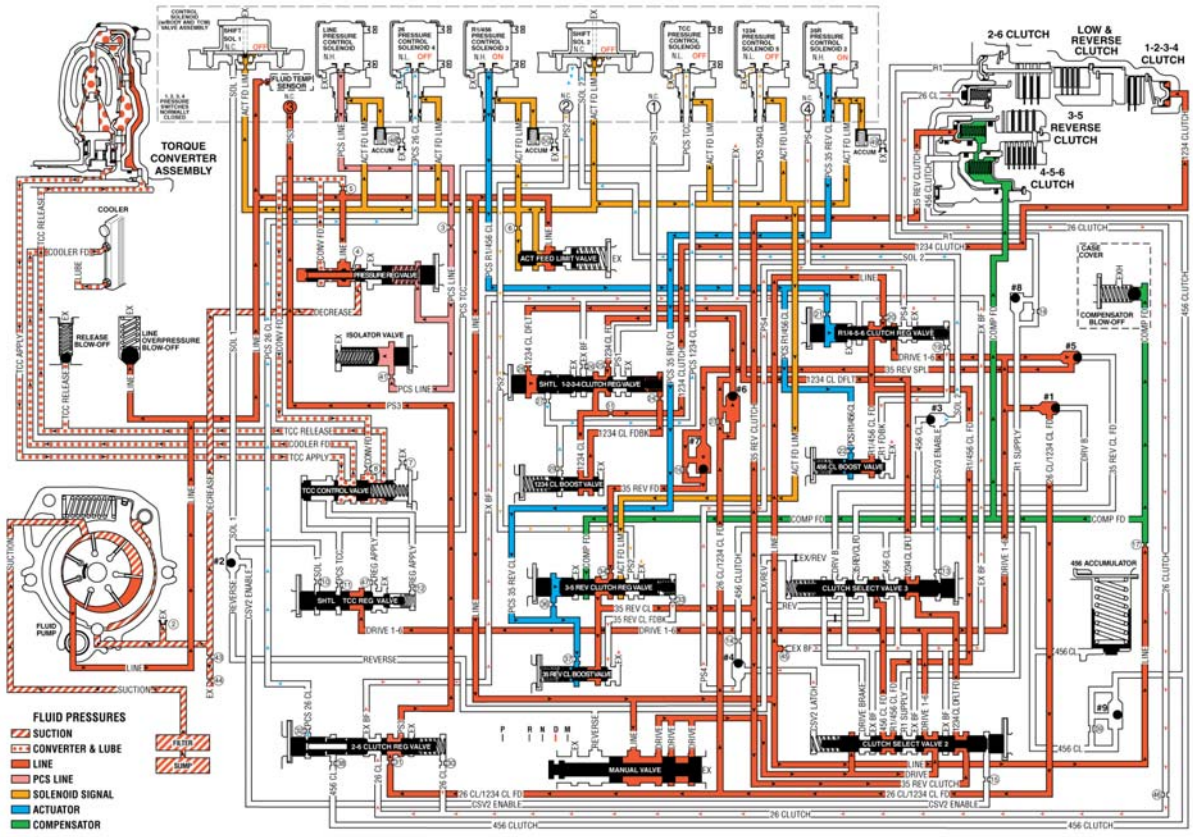


Fig. 13: Identifying Fluid Flow - Drive Range, Third Gear Default
Courtesy of GENERAL MOTORS COMPANY

DRIVE RANGE - FOURTH GEAR

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command OFF the normally-high 35R pressure control solenoid 2. At the same time the normally-low R1/456 pressure control solenoid 3 is commanded ON to regulate 4-5-6 clutch apply.

4-5-6 Clutch Applies

R1/456 Pressure Control Solenoid 3

The R1/456 pressure control solenoid 3 (PCS) is commanded ON allowing actuator feed fluid to enter the PCS R1/456 clutch fluid circuit. PCS R1/456 clutch fluid is routed through orifice #21 to the R1/456 clutch regulator valve and, through orifice #22 to the R1/456 clutch boost valve.

R1/456 Clutch Regulator Valve

PCS R1/456 clutch fluid moves the R1/456 clutch regulator valve against R1/456 clutch regulator valve spring force to allow line fluid to pass through the valve an enter the R1/456 clutch feed circuit. R1/456 clutch feed is then routed to the 4-5-6 clutch boost valve and clutch select valve 2.

4-5-6 Clutch Boost Valve

PCS R1/456 clutch fluid pressure acts on a differential area moving the R1/456 clutch boost valve against the

R1/456 clutch boost valve spring. R1/456 clutch fluid passes through the valve and enters the R1/456 clutch feedback circuit. As PCS R1/456 clutch fluid pressure is increased to a given value, the R1/456 clutch boost valve opens the R1/456 clutch feedback circuit to exhaust. This results in the R1/456 clutch regulator valve moving to the full feed position, sending full line pressure to the clutch.

Clutch Select Valve 2

R1/456 clutch feed fluid passes through the clutch select valve 2 and enters the 456 clutch feed circuit. The 456 clutch feed fluid is routed to the clutch select valve 3 where it passes through the valve and enters the 456 clutch fluid circuit. The 456 clutch fluid is routed to the 4-5-6 clutch, the 4-5-6 accumulator, #9 ball check valve and to the #4 ball check valve. The 456 clutch fluid seats the #9 ball check valve and routes fluid through orifice #39. The 456 clutch fluid passes through orifice #14, seats #4 ball check valve against the PS4 fluid circuit and routes fluid to the CSV2 latch circuit.

4-5-6 Clutch

The 456 clutch fluid enters the 4-5-6 clutch housing to move the piston against spring force, combined with force from the compensator to apply the 4-5-6 clutch plates.

3-5 Reverse Clutch Releases

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is commanded OFF, allowing PCS 35 reverse clutch fluid from the 3-5 reverse clutch boost valve and the 3-5 reverse clutch regulator valve to exhaust through the solenoid.

3-5 Reverse Clutch Boost Valve

The 3-5 reverse boost valve spring force moves the valve to allow 35 reverse clutch feedback fluid from the 3-5 reverse clutch regulator valve to enter the 35 reverse clutch fluid circuit and exhaust.

#9 Ball Check Valve

The 456 clutch fluid pressure seats #9 ball check valve to force fluid through orifice #39 and applies the 456 clutch.

3-5 Reverse Clutch Regulator Valve

The 3-5 reverse clutch regulator valve spring force moves the valve to allow 35 reverse clutch fluid from the 3-5 reverse clutch to pass through the valve and enter the exhaust backfill fluid circuit. The 35 reverse clutch fluid then enters the exhaust backfill fluid circuit and is routed through orifice #30 to the exhaust backfill pressure relief valve where excess pressure is exhausted.

3-5 Reverse Clutch

The 3-5 reverse clutch spring force combined with force from the compensator move the 3-5 reverse clutch piston to release the 3-5 clutch plates and forces 35 reverse clutch fluid to exhaust from 3-5 reverse/456 clutch housing. The 35 reverse clutch fluid is then routed to the 3-5 reverse clutch regulator valve and exhausted.

#4 Ball Check Valve

The 456 clutch fluid pressure passes through orifice #14 to seat #4 ball check valve against PS4 fluid passage. The 456 clutch fluid is then directed into the CSV2 latch circuit.

456 Accumulator

The 456 clutch fluid enters the 456 accumulator to move the piston against spring force to cushion the 456 clutch piston apply.

Drive Range, Fourth Gear

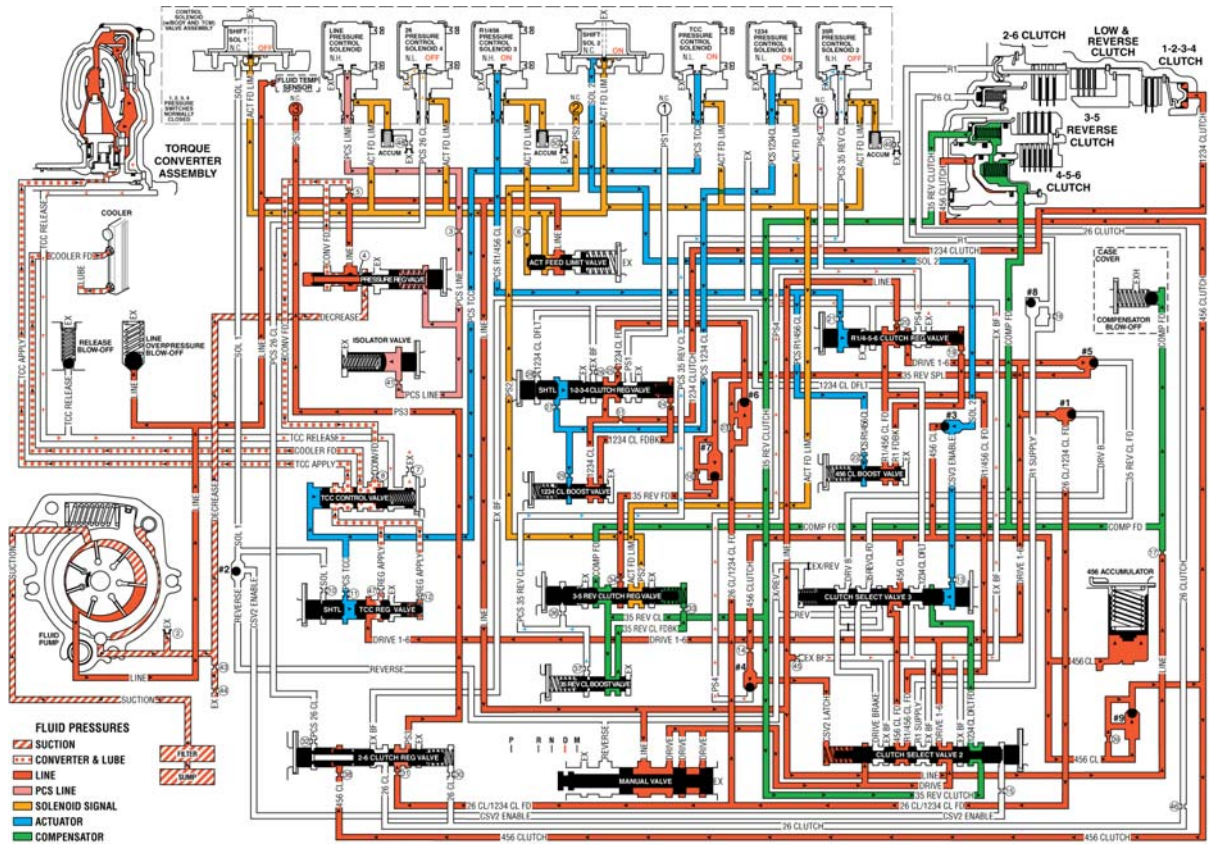


Fig. 14: Identifying Fluid Flow - Drive Range, Fourth Gear
Courtesy of GENERAL MOTORS COMPANY

DRIVE RANGE, FIFTH GEAR

As the vehicle speed increases, the transmission control module (TCM) receives input signals from the automatic transmission input and output speed sensors, the throttle position sensor and other vehicle sensors to determine the precise moment to command ON the normally-high 35R pressure control solenoid 2. At the same time the normally-low 1234 pressure control solenoid 5 is commanded OFF.

3-5 Reverse Clutch Applies

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 is commanded ON, allowing actuator feed fluid to enter the PCS 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #36 and then to the 3-5 reverse clutch regulator valve. PCS 35 reverse clutch fluid is also routed through orifice #37 and then to the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Boost Valve

PCS 35 reverse clutch fluid pressure acts on a differential area moving the PCS 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. The 35 reverse clutch fluid passes through the valve and enters the 35 reverse clutch feedback circuit. As PCS 35 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 35 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 35 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch Regulator Valve

PCS 35 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 35 reverse clutch feedback fluid. This allows 35 reverse feed to pass through the valve and enter the 35 reverse clutch circuit. The 35 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS2 fluid from the pressure switch 2 exhausts through the valve allowing the switch to close.

Clutch Select Valve 2

The 35 reverse clutch fluid passes through the clutch select valve 2 and enters the 1234 clutch default feed fluid circuit. The 1234 clutch default feed fluid is then routed to the clutch select valve 3.

3-5 Reverse Clutch

The 35 reverse clutch fluid enters the 3-5 reverse/456 clutch housing to move the piston against spring force combined with force from the compensator to apply the 3-5 reverse clutch plates.

1-2-3-4 Clutch Releases

1234 Pressure Control Solenoid 5

The 1234 pressure control solenoid 5 is commanded OFF, allowing PCS 1234 clutch fluid from the 1-2-3-4 clutch regulator valve and 1-2-3-4 clutch boost valve to exhaust.

1-2-3-4 Clutch Regulator Valve

The 1-2-3-4 clutch regulator valve spring force moves the valve to allow 1234 clutch feed fluid from the 1-2-3-4 clutch to pass through the valve and enter the exhaust backfill fluid circuit. The 1234 clutch fluid the enters the exhaust backfill fluid circuit and is routed through orifice #26 where excess pressure is exhausted. Also, 1234 clutch regulator valve spring force moves the valve to allow 1234 clutch feed fluid to pass through the valve and enter the PS1 fluid circuit. PS1 fluid is then routed to pressure switch 1 and opens the normally-closed switch.

1-2-3-4 Clutch Boost Valve

The 1-2-3-4 clutch boost valve spring force moves the valve to allow 1234 clutch feedback fluid from the 1-2-3-4 clutch regulator valve to enter the 1234 clutch circuit and exhaust.

1-2-3-4 Clutch

The 1-2-3-4 clutch spring force moves the 1-2-3-4 clutch piston to release the clutch plates and force 1234

clutch fluid from the 1-2-3-4 clutch. The 1234 clutch fluid is routed through the 1-2-3-4 clutch regulator valve where it enters the exhaust backfill fluid circuit.

Drive Range, Fifth Gear

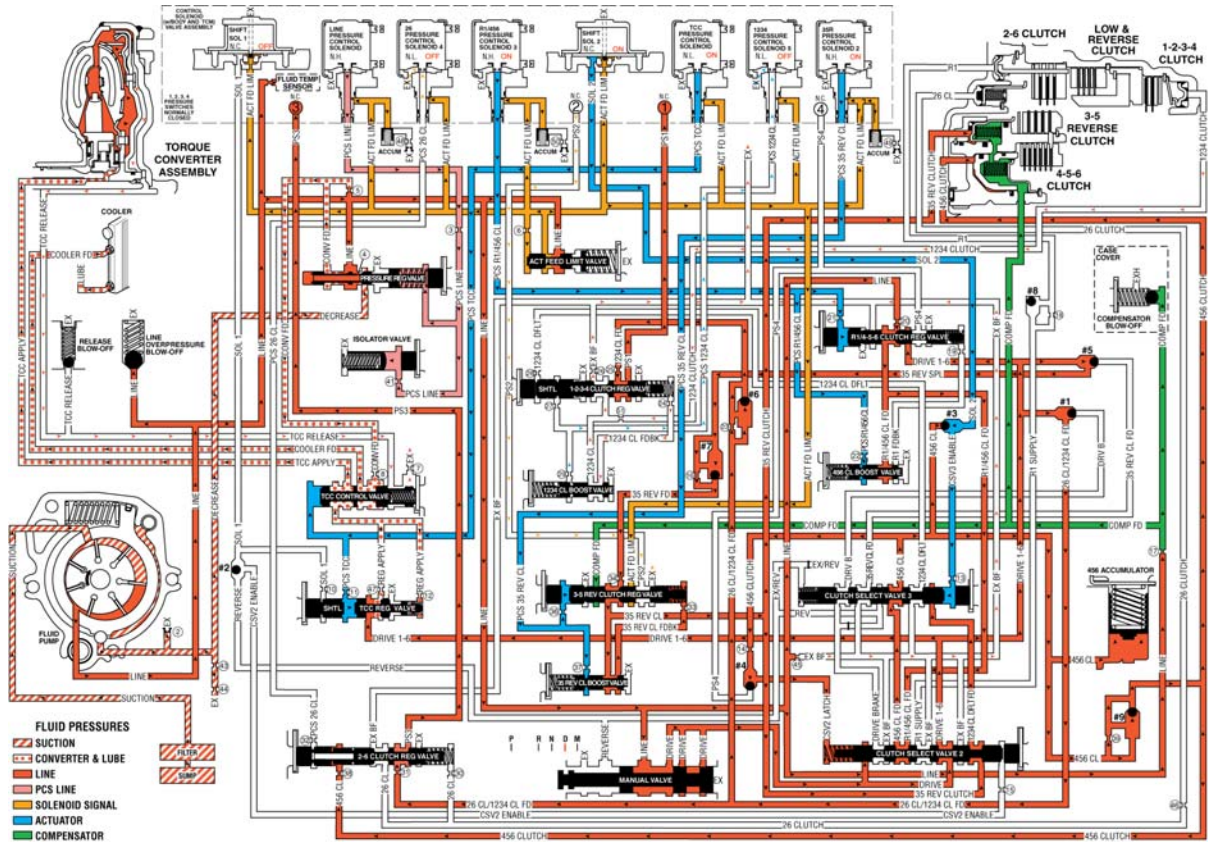


Fig. 15: Identifying Fluid Flow - Drive Range, Fifth Gear
Courtesy of GENERAL MOTORS COMPANY

DRIVE RANGE, FIFTH GEAR DEFAULT

If the transmission is in 4th, 5th or 6th gear during a transmission electrical component failure, the transmission will default to 5th gear. All solenoids will default to their normal state. If the torque converter clutch was applied, it will release. The transmission will stay in 5th gear default range until the ignition has been turned off or transmission shifted to reverse. When the vehicle is restarted, and shifted back into drive, the transmission will then operate in the 3rd gear default range. This default action will enable the vehicle to be safely driven to a service center.

3-5 Reverse Clutch Applies

35R Pressure Control Solenoid 2

The 35R pressure control solenoid 2 defaults to ON, allowing actuator feed fluid to enter the pressure control solenoid (PCS) 35 reverse clutch fluid circuit. PCS 35 reverse clutch fluid is routed through orifice #36 and then to the 3-5 reverse clutch regulator valve. PCS 35 reverse clutch fluid is also routed through orifice #37 and then to the 3-5 reverse clutch boost valve.

3-5 Reverse Clutch Boost Valve

PCS 3-5 reverse clutch fluid pressure acts on a differential area moving the PCS 3-5 reverse clutch boost valve against the 3-5 reverse clutch boost valve spring. The 3-5 reverse clutch fluid passes through the valve and enters the 3-5 reverse clutch feedback circuit. As PCS 3-5 reverse clutch fluid pressure is increased to a given value, the 3-5 reverse clutch boost valve opens the 3-5 reverse clutch feedback circuit to exhaust. This results in the 3-5 reverse clutch regulator valve moving to the full feed position sending full 3-5 reverse clutch feed pressure (full line pressure) to the clutch.

3-5 Reverse Clutch Regulator Valve

PCS 3-5 reverse clutch fluid moves the 3-5 reverse clutch regulator valve against 3-5 reverse clutch regulator valve spring force and 3-5 reverse clutch feedback fluid. This allows 3-5 reverse feed to pass through the valve and enter the 3-5 reverse clutch circuit. The 3-5 reverse clutch fluid is then routed to the 3-5 reverse clutch, the 3-5 reverse boost valve and the clutch select valve 2. When the 3-5 reverse clutch regulator valve is in this position, PS2 fluid from the pressure switch 2 exhausts through the valve, allowing the switch to close.

3-5 Reverse Clutch

The 3-5 reverse clutch fluid enters the 3-5 reverse/456 clutch housing to move the piston against spring force to apply the 3-5 reverse clutch plates.

Clutch Select Valve 3

Once the clutch select valve 3 is moved to the ON position in 4th gear, it will remain in this position throughout the 5th gear default range, until the ignition has been turned OFF. When the ignition is OFF, fluid will exhaust from the valve, thus when the vehicle is restarted, the transmission will then be in the 3rd gear default range.

1-2-3-4 Clutch Releases or 2-6 Clutch Releases

1234 Pressure Control Solenoid 5

If the transmission was in 4th gear when an electrical condition commands a protection mode, the 1234 pressure control solenoid 5 defaults to the OFF position, allowing PCS 1234 clutch fluid from the 1-2-3-4 clutch, the 1-2-3-4 clutch regulator valve and 1- 2-3-4 clutch boost valve to exhaust.

2-6 26 Pressure Control Solenoid 4

If the transmission was in 6th gear when an electrical condition commands a protection mode, the 26 pressure control solenoid 4 defaults to the OFF position, allowing PCS 26 clutch fluid from the 2-6 clutch regulator valve, and the 2-6 clutch to exhaust.

Torque Converter Clutch Releases

TCC Pressure Control Solenoid

The torque converter clutch (TCC) pressure control solenoid will default to it's normal state, OFF. PCS TCC fluid will exhaust from the TCC control valve, and spring force will shuttle the valve to the off position. TCC apply fluid will then be routed to the cooler, and TCC release fluid will be routed to the torque converter for complete TCC release.

1234 Clutch Regulator Valve

The 1234 clutch regulator valve spring force moves the valve to allow 1234 clutch feed fluid to enter the PS1 fluid circuit which opens PS1 switch. The 1234 clutch fluid passes through orifice #51 to the 1234 clutch regulator valve, through orifice #26 and enters the exhaust backfill circuit.

Drive Range, Fifth Gear Default

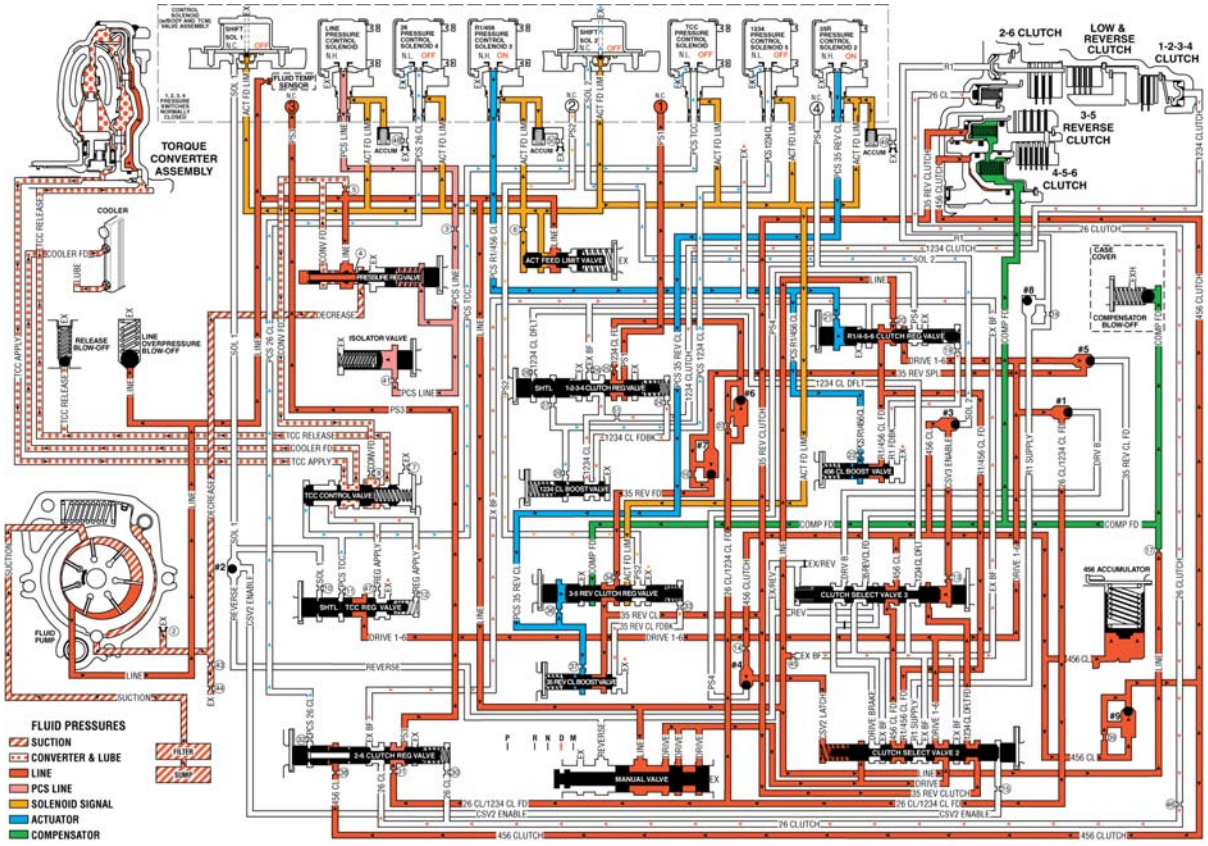


Fig. 16: Identifying Fluid Flow - Drive Range, Fifth Gear Default
Courtesy of GENERAL MOTORS COMPANY

Article GUID: A00737247

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P0601-P0604 OR P062F: CONTROL MODULE MEMORY

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: **DTCs P0601, P0602, P0603, P0604 or P062F could set in other control modules. Verify the DTCs are set in the transmission control module (TCM).**

DTC P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P062F

Control Module Long Term Memory Performance

Circuit/System Description

This is an internal fault detection of the control solenoid valve assembly. This fault is handled inside the control solenoid valve assembly and no external circuits are involved.

Conditions for Running the DTC

Ignition voltage is between 8.6 volts and 18.0 volts.

Conditions for Setting the DTC

P0601

Read only memory (ROM) test has failed 5 or greater times.

P0602

TCM has not been programmed and is unable to detect the start program.

P0603

TCM has detected a memory checksum error.

P0604

TCM has detected a random access memory (RAM) test error 5 or greater times.

P062F

TCM has detected a non-volatile memory error during power-down.

Action Taken When the DTC Sets

P0601, P0603, P0604, or P062F

- DTCs P0601, P0603, P0604, and P062F are Type A DTCs.
- TCM limits the transmission to Reverse and 5th gear operation.
- TCM commands maximum line pressure.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM freezes transmission adaptive functions.
- TCM commands the high side driver OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

P0602

- DTC P0602 is a Type C DTC.
- TCM limits the transmission to Reverse and 5th gear operation.
- TCM commands maximum line pressure.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM freezes transmission adaptive functions.
- TCM commands the high side driver OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

P0601, P0603, P0604, or P062F

DTCs P0601, P0603, P0604, and P062F are Type A DTCs.

P0602

DTC P0602 is a Type C DTC.

Reference Information

Description and Operation

Electronic Component Description for control solenoid valve assembly

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

CAUTION: Before programming a control module, the following must be observed, or control module damage may occur:

- **The TIS terminal, MDI, and/or scan tool must have the latest software.**
- **The vehicle battery must be fully charged. The battery voltage should be between 12-14 volts.**
- **The TIS terminal, MDI, and/or scan tool connections must be secure.**
- **A battery charger must NOT be connected to the battery when programming a control module.**

1. Ignition OFF for 1 minute.
2. Ignition ON.
3. Verify with a scan tool, that DTC P0602 is not set.
   - **If DTC P0602 is set**
   - Program the K71 transmission control module. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Programming and Setup** , . If the DTC resets, replace the Q8 control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
   - **If DTC P0602 is not set**
4. Verify with a scan tool that DTC P0601, P0603, P0604, or P062F is not set.
   - **If DTC P0601, P0603, P0604, or P062F is set**

     Replace the Q8 control solenoid valve assembly.

   - **If DTC P0601, P0603, P0604 or P062F is not set**
5. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the

Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, refer to **Testing for Intermittent Conditions and Poor Connections** .

Repair Instructions

NOTE: Perform the Reset Transmission Adapts any time a transmission related component is serviced.

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control solenoid valve assembly replacement, setup, and programming

DTC P0634: CONTROL MODULE OVERTEMPERATURE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0634

Control Module Overtemperature

Circuit/System Description

The transmission control module (TCM) temperature sensor is located inside of the control solenoid valve assembly which has no serviceable components. The TCM monitors the TCM temperature sensor for over temperature protection.

Conditions for Running the DTC

- Ignition voltage is 8.6-32 V.
- TCM temperature is between 0-170Â°C (32-338Â°F) for 0.25 s.

Conditions for Setting the DTC

Condition 1

TCM detects an internal temperature condition of 146Â°C (295Â°F) or greater for 5 s.

Condition 2

Ignition voltage is 18 V or greater and the TCM detects an internal temperature of 50Â°C (122Â°F) or greater for 2 s.

Action Taken When the DTC Sets

- P0634 is a Type A DTC.

- TCM limits the transmission to Reverse and 3rd or 5th gear operation.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM commands maximum line pressure.
- TCM shuts down.

Conditions for Clearing the DTC

P0634 is a Type A DTC.

Diagnostic Aids

During a road test, the TCM temperature should steadily increase to a normal operating temperature, and then stabilize.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Engine Coolant Temperature parameter was less than 125Â° C (257Â° F) when DTC set by reviewing the scan tool Freeze Frame/Failure Records.
    - **If 125Â° C (257Â° F) or greater**

      Refer to **Engine Overheating** .

    - **If less than 125Â° C (257Â° F)**
3. Verify transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
    - **If the transmission fluid level and condition is not correct**

      Repair as necessary.

    - **If the transmission fluid level and condition is correct**
4. Clear the DTCs from the TCM with a scan tool.
5. Operate the vehicle until normal engine temperature is reached.
6. Verify the scan tool Transmission Fluid Temperature parameter is less than 140Â° C (284Â° F).
    - **If 140Â° C (284Â° F) or greater**
    1. Ignition OFF.
    2. Verify the conditions listed below do not exist:
        - Obstructions to the airflow to the radiator or transmission
        - Radiator damage
        - Transmission cooler damage
        - Transmission cooler pipe kinked or damaged
    - If conditions exist, repair or replace as necessary.
    - If conditions do not exist, refer to **Transmission Fluid Cooler Flushing and Flow Test** .
    - **If less than 140Â° C (284Â° F)**
7. Verify the DTC does not set.
    - **If DTC sets**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If DTC does not set**
8. Operate the vehicle within the conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Record data.
9. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If the DTC does not set**
10. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Transmission Fluid Auxiliary Cooler Replacement**
- **Transmission Fluid Auxiliary Cooler Inlet Hose Replacement**
- **Transmission Fluid Cooler Hose/Pipe Quick-Connect Fitting Disconnection and Connection**
- **Fluid Cooler Inlet Hose Replacement**
- **Fluid Cooler Outlet Hose Replacement**
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup

DTC P0658 OR P0659: ACTUATOR HIGH CONTROL CIRCUIT GROUP 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0658

Actuator High Control Circuit Group 1 Low Voltage

DTC P0659

Actuator High Control Circuit Group 1 High Voltage

Circuit/System Description

The transmission control module (TCM) high side driver 1 is located inside of the control solenoid valve assembly, which has no serviceable components. The high side driver 1 provides power to the pressure control solenoids and shift solenoids.

Conditions for Running the DTC

P0658

- DTC P0658 is not set.
- High side driver 1 is enabled.

P0659

- DTC P0659 is not set.
- Ignition transitions from OFF to ON

Conditions for Setting the DTC

P0658

TCM detects an internal open or short to ground in the high side driver 1 circuit for 1 s.

P0659

TCM detects an internal short to voltage on the high side driver 1 for 1 s.

Action Taken When the DTC Sets

P0658

- DTC P0658 is a Type A DTC.
- TCM turns the high side driver OFF.
- TCM turns OFF all solenoids.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM commands the torque converter clutch (TCC) OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse and 5th gear operation.
- TCM requests a reduced torque value based on input speed.

P0659

DTC P0659 is a Type C DTC.

Conditions for Clearing the DTC

- DTC P0658 is a Type A DTC.
- DTC P0659 is a Type C DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool High Side Driver 1 parameter displays ON.
    - **If ON is not displayed**

      Refer to Circuit/System Testing.

    - **If ON is displayed**
3. Engine Running, and transmission in Park.
4. Verify the scan tool parameters listed below do not display Malfunction:
    - High Side Driver 1 Circuit Low Voltage Test Status
    - High Side Driver 1 Circuit Open Test Status
    - High Side Driver 1 Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **If Malfunction is not displayed**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**
   - **If contaminated**

     Repair as necessary

   - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If the resistance is not within range**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT 47825-20** adapter harness between the vehicle wire harness electrical connector and the Q8 Control Solenoid Valve Assembly electrical connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
   - High Side Driver 1 Circuit Low Voltage Test Status
   - High Side Driver 1 Circuit Open Test Status
   - High Side Driver 1 Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P0667, P0668, OR P0669: CONTROL MODULE TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0667

Control Module Temperature Sensor Performance

DTC P0668

Control Module Temperature Sensor Circuit Low Voltage

DTC P0669

Control Module Temperature Sensor Circuit High Voltage

Circuit/System Description

The transmission control module (TCM) temperature sensor is located inside of the control solenoid valve assembly, which has no serviceable components. The TCM temperature sensor provides the temperature of the TCM. This temperature reading is used in various shifting and diagnostic routines in the TCM software. This fault is handled inside the TCM and no external circuits are involved.

Conditions for Running the DTC

P0667

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0658, P0668, P0669, P06AD, P06AE, P0712, P0713, P0716, P0717, P0722, P0723, P0962, P0963, P0966, P0967, P0970, P0971, P215C, P2720, P2721, P2729, or P2730 is not set.
- Brake torque is not active.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.
- Engine torque signal is valid.
- Accelerator pedal position signal is valid.

P0668

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.

P0669

- DTC P0716, P0717, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM .
- Ignition voltage is between 8.6-32 V.

Conditions for Setting the DTC

P0667

- TCM detects a 20-50Â°C (36-90Â°F) or greater difference between the transmission fluid temperature and TCM substrate temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- TCM detects an 8-10Â°C (14-18Â°F) or greater difference between the TCM power up temperature and TCM substrate temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- Above conditions have to be met for 5 min within a 6 min period.

P0668

TCM temperature is -249Â°C (-416Â°F) or less for 1 min.

P0669

TCM temperature is 249Â°C (480Â°F) or greater for 1 min.

Action Taken When the DTC Sets

- DTCs P0667, P0668, and P0669 are Type B DTCs.
- TCM defaults the TCM substrate temperature to a calculated temperature based on the TCM power up temperature.

Conditions for Clearing the DTC

DTCs P0667, P0668, and P0669 are Type B DTCs.

Diagnostic Aids

The TCM temperature sensor is located inside of the control solenoid valve assembly and its output should resemble that of the transmission fluid temperature sensor output. During a road test, the TCM temperature should steadily increase to a normal operating temperature, and then stabilize.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**

- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool TCM Temperature parameter is between -249 and +249Â°C (-416 and +480Â°F).
   - **If not between -249 and +249Â°C (-416 and +480Â°F)**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If between -249 and +249Â°C (-416 and +480Â°F)**
3. Verify the scan tool TCM Temperature parameter increases greater than 2Â°C (3.5Â°F) after operating the vehicle at 64 km/h (40 mph) for 10 min.
   - **If the temperature does not increase greater than 2Â°C (3.5Â°F)**

     Replace the Q8 Control Solenoid Valve Assembly

   - **If the temperature increases greater than 2Â°C (3.5Â°F)**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Replace the Q8 Control Solenoid Valve Assembly

   - **If the DTC does not set**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.

- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P06AC-P06AE: CONTROL MODULE POWER UP TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P06AC

Control Module Power Up Temperature Sensor Performance

DTC P06AD

Control Module Power Up Temperature Sensor Circuit Low Voltage

DTC P06AE

Control Module Power Up Temperature Sensor Circuit High Voltage

Circuit/System Description

The transmission control module (TCM) power up temperature sensor is located inside of the control solenoid valve assembly, which has no serviceable components. The TCM power up temperature sensor provides the temperature of the TCM when the TCM power is ON. This temperature reading is used in various shifting and diagnostic routines and also to protect the control solenoid valve assembly and TCM. This fault is handled inside the TCM and no external circuits are involved.

Conditions for Running the DTC

P06AC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0658, P0668, P0669, P06AD, P06AE, P0712, P0713, P0716, P0717, P0722, P0723, P0962, P0963, P0966, P0967, P0970, P0971, P215C, P2720, P2721, P2729, or P2730 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.
- Brake torque is not active.
- Engine torque signal is valid.
- Accelerator pedal position signal is valid.

P06AD

- DTC P0716, P0717, P0722, or P0723 is not set.

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.

P06AE

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is between 8.6-32 V.

Conditions for Setting the DTC

P06AC

- TCM detects a 20-50Â° C (36-90Â°F) or greater difference between the transmission fluid temperature and TCM power up temperature, which depends on the average of transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- TCM detects an 8-10Â° C (14-18Â°F) or greater difference between the TCM substrate temperature and TCM power up temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- Above conditions have to be met for 5 min. within a 6 min. period.

P06AD

TCM power up temperature is -59Â°C (-74Â°F) or less for 1 min.

P06AE

TCM power up temperature is 164Â°C (327Â°F) or greater for 1 min.

Action Taken When the DTC Sets

- DTC P06AC, P06AD, P06AE are Type B DTCs.
- TCM defaults the TCM power up temperature to a calculated temperature based on the TCM substrate temperature.

Conditions for Clearing the DTC

DTC P06AC, P06AD, P06AE are Type B DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Transmission General Description**

- **Transmission Component and System Description**
- **Electronic Component Description** for control solenoid valve assembly

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, clear the DTCs with a scan tool.
2. Operate the vehicle at 64 km/h (40 mph) for 10 min.
3. Verify DTC P06AC, P06AD, or P06AE is not set.
    - **If any of the DTCs are set**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If none of the DTCs are set.**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If the DTC does not set**
6. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P0711-P0713: TRANSMISSION FLUID TEMPERATURE SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0711

Transmission Fluid Temperature Sensor Performance

DTC P0712

Transmission Fluid Temperature Sensor Circuit Low Voltage

DTC P0713

Transmission Fluid Temperature Sensor Circuit High Voltage

Circuit/System Description

The transmission fluid temperature sensor is located inside of the transmission control module (TCM) assembly which has no serviceable components. The transmission fluid temperature sensor provides transmission fluid temperature to the TCM. This fault is handled inside the TCM and no external circuits are involved.

Conditions for Running the DTC

P0711

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0658, P0668, P0669, P06AD, P06AE, P0712, P0713, P0716, P0717, P0722, P0723, P0962, P0963, P0966, P0967, P0970, P0971, P215C, P2720, P2721, P2729, or P2730 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.
- Brake torque is not active.
- Engine torque signal is valid.
- Throttle position signal is valid.

P0712 and P0713

- DTC P0716, P0717, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.

Conditions for Setting the DTC

P0711

- TCM detects a 20-50Â° C (36-90Â° F) or greater difference between the transmission fluid temperature

and the TCM substrate temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.

- TCM detects a 20-50Â° C (36-90Â° F) or greater difference between the transmission fluid temperature and the TCM power up temperature, which depends on the average of the transmission fluid temperature, TCM substrate temperature, and TCM power up temperature.
- Above conditions have to be met for 5 min within a 6 min period.

P0712

Transmission fluid temperature is -74Â°C (-101Â°F) or lower for 1 min.

P0713

Transmission fluid temperature is 174Â°C (345Â°F) or greater for 1 min.

Action Taken When the DTC Sets

- DTCs P0711, P0712, and P0713 are Type B DTCs.
- TCM defaults to a calculated transmission fluid temperature based on the TCM Temperature.

Conditions for Clearing the DTC

DTCs P0711, P0712, and P0713 are Type B DTCs.

Diagnostic Aids

The TCM temperature sensor is located inside of the control solenoid valve assembly and its output should resemble that of the transmission fluid temperature sensor's output. During a road test, the transmission fluid temperature should steadily increase to a normal operating temperature, and then stabilize.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine idling at the normal operating temperature.
2. Verify the scan tool Transmission Fluid Temperature parameter is between -74 and +174Â° C (-101 and +345Â° F).
   - **If not between -74 and +174Â° C (-101 and +345Â° F)**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If between -74 and +174Â° C (-101 and +345Â° F)**
3. Verify the scan tool Transmission Fluid Temperature parameter increases greater than 2Â° C (3.5Â° F) after operating the vehicle at 64 km/h (40 mph) for 10 min.
   - **If the temperature does not increase greater than 2Â° C (3.6Â° F)**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If the temperature increases greater than 2Â° C (3.6Â° F)**
4. Verify the scan tool Transmission Fluid Temperature and the TCM Temperature parameters are within 20Â° C (36Â° F).
   - **If the temperatures are not within 20Â° C (36Â° F)**
     1. Ignition OFF, remove the control valve body cover. Refer to **Control Valve Body Cover Replacement** .
     2. Verify the heat sink on the control valve channel upper plate and the control solenoid valve spring are in place and undamaged.
        - If the heat sink on the control valve channel upper plate or the control solenoid valve spring are damaged, replace as necessary
        - If the heat sink on the control valve channel upper plate and the control solenoid valve spring are in place and undamaged, replace the Q8 Control Solenoid Valve Assembly
   - **If the temperatures are within 20Â° C (36Â° F)**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

Replace the Q8 Control Solenoid Valve Assembly.

- **If the DTC does not set**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Valve Lower Body and Upper Body Replacement** for control valve channel upper plate assembly and control solenoid valve spring replacement.
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P0716 OR P0717: INPUT SPEED SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0716

Input Speed Sensor Performance

DTC P0717

Input Speed Sensor Circuit No Signal

Diagnostic Fault Information

Circuit	Short to Ground	Open	Short to Voltage	Signal Performance
8.6 V Reference	P0716, P0717	P0716, P0717	-	P0716
Signal	P0716, P0717	P0716, P0717	P0716, P0717	P0716

Typical Scan Tool Data

Transmission ISS

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, normal operating temperature, transmission in PARK **Parameter Normal Range:** 450-7000 RPM			
8.6 V Reference	0 RPM	0 RPM	-
Signal	0 RPM	0 RPM	0 RPM

ISS/OSS Supply Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** OK			
8.6 V Reference	Out of Range	OK	Out of Range
Signal	OK	OK	OK

Circuit/System Description

The input shaft speed (ISS) sensor is a hall-effect type sensor. The ISS sensor mounts to the inside of the automatic transmission case assembly and connects to the control solenoid valve assembly through a 2-wire harness and connector. The sensor faces the reluctor wheel which is attached to the 4-5-6 clutch and 3-5-R clutch housing. The sensor receives 8.3-9.3 volts on the ISS supply voltage circuit from the transmission control module (TCM). As the 4-5-6 clutch and 3-5-R clutch housing rotates, the sensor produces a signal frequency based on the teeth of the reluctor wheel. This signal is transmitted through the ISS sensor signal circuit to the TCM. The TCM uses the ISS sensor signal to determine line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed, and gear ratio.

Conditions for Running the DTC

P0716

- DTC P0101, P0102, P0103, P0121, P0122, P0123, P0717, P0752, P0973, or P0974 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.
- Engine torque signal is valid.
- Throttle position signal is valid.
- Vehicle speed is 10 km/h (6 mph) or greater.

P0717

- DTC P0101, P0102, P0103, P0722, or P0723 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.
- Vehicle speed is 16 km/h (10 mph) or greater.
- Engine torque is 50 N.m (37 lb ft) or greater.
- Engine torque signal is valid.

Conditions for Setting the DTC

P0716

TCM detects the transmission input shaft speed signal dropped greater than 1350 RPM for 1 s.

P0717 - Condition 1

TCM detects the transmission input shaft speed signal is less than 33 RPM for 5 s.

P0717 - Condition 2

The TCM detects that P0722 set and the Transmission input speed is less than 1000 RPM for 5 s.

Action Taken When the DTC Sets

- DTCs P0716 and P0717 are Type A DTCs.
- TCM freezes transmission adaptive functions.
- TCM commands the high side driver OFF.
- TCM commands TCC OFF.
- TCM commands maximum line pressure.
- TCM disables neutral idle.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- Torque management is enabled.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.

Conditions for Clearing the DTC

DTCs P0716 and P0717 are Type A DTCs.

Diagnostic Aids

If the scan tool ISS/OSS supply voltage parameter is out of range, the fault could also be caused by the transmission output shaft speed sensor.

Damage or misalignment of the 4-5-6 clutch and 3-5-R clutch housing reluctor machined teeth surface may cause a speed sensor malfunction.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ISS/OSS Supply Voltage parameter displays OK.
   - **IF OK is not displayed**

     Refer to Circuit/System Testing.

   - **If OK is displayed**
3. Engine idling, transmission in Park, parking brake applied, and drive wheels chocked.
4. Verify the scan tool Transmission ISS parameter changes or does not drop out while varying the engine speed.
   - **If the Transmission ISS does not vary with engine speed or drops out**

     Refer to Circuit/System Testing.

   - **If the Transmission ISS varies with engine speed and does not drop out**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the control valve body cover.
2. Connect the vehicle wire harness electrical connector to the Q8 Control Solenoid Valve Assembly electrical connector.
3. Disconnect the B14C Transmission Input Shaft Speed Sensor wiring harness connector from the Q8

Control Solenoid Valve Assembly.

4. Ignition ON.
5. Test for 8.3-9.3 V between the ISS sensor supply voltage circuit terminal A at the Q8 Control Solenoid Valve Assembly, and ground at the transmission case.
    - **If not between 8.3-9.3 V**
    1. Ignition OFF, disconnect the B14A Transmission Output Shaft Speed Sensor wiring harness connector from the Q8 Control Solenoid Valve Assembly. Ignition ON.
    2. Test for 8.3-9.3 V between the OSS sensor supply voltage circuit terminal A X3 at the Q8 Control Solenoid Valve Assembly, and ground at the transmission case.
        - If not between 8.3-9.3 V, replace the Q8 Control Solenoid Valve Assembly.
        - If between 8.3-9.3 V, replace the B14A Transmission Output Shaft Speed Sensor.
    - **If between 8.3-9.3 V**
6. Verify the scan tool Transmission ISS parameter is between 495-505 RPM when performing the input shaft speed test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Input Shaft Speed/Output Shaft Speed Input Test**.
    - **If not between 495-505 RPM**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If between 495-505 RPM**
7. Verify there is no damage to the reluctor, which is attached to the 4-5-6 clutch and 3-5-R clutch housing assembly, or misalignment between the B14C Transmission Input Shaft Speed Sensor and reluctor.
    - **If the reluctor is damaged or misaligned**

      Repair or replace as necessary.

    - **If the reluctor is not damaged or misaligned**
8. Replace the B14C Transmission Input Shaft Speed Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Input Speed Sensor Replacement**
- **Output Speed Sensor Replacement**
- **Control Valve Body Cover Replacement**
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P0722 OR P0723: OUTPUT SPEED SENSOR

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0722

Output Speed Sensor Circuit No Signal

DTC P0723

Output Speed Sensor Circuit Intermittent

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
8.6 V Referene	P0722, P0723	P0722, P0723	-	P0723
Signal	P0722, P0723	P0722, P0723	P0722, P0723	P0723

Typical Scan Tool Data

Transmission OSS

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 0-7,000 RPM			
8.6 V Reference	0 RPM	0 RPM	0-7000 RPM
Signal	0 RPM	0 RPM	0 RPM

ISS/OSS Supply Voltage

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Key ON, Engine OFF or Engine running, normal operating temperature **Parameter Normal Range:** OK			
8.6 V	Out of Range	OK	Out of Range
Signal	OK	OK	OK

Circuit/System Description

The automatic transmission output shaft speed (OSS) sensor is a hall-effect type sensor. The sensor faces the front differential transfer drive gear. The sensor receives 8.3-9.3 volts on the OSS sensor supply voltage circuit from the transmission control module (TCM). As the output shaft rotates, the sensor produces a signal frequency based on the machined surface of the output shaft. This signal is transmitted through the OSS sensor signal circuit to the TCM. The TCM uses the OSS sensor signal to calculate output shaft speed to determine commanded line pressure, transmission shift patterns, torque converter clutch (TCC) slip speed and gear ratio.

Conditions for Running the DTC

P0722

- DTC P0101, P0102, P0103, P0121, P0122, P0123, P0716, P0717, or P0723 is not set.
- Selected range is not PARK or NEUTRAL.
- Transmission input speed is 1,000 RPM or greater.
- Engine speed is 3,200 RPM or greater.
- Throttle position is 5 % or greater.
- Throttle position signal is valid.
- Engine torque is 35 N.m (26 lb ft) or greater.
- Engine torque signal is valid.
- Transmission fluid temperature is -40Â°C (-40Â°F) or greater.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.

P0723

- DTC P0101, P0102, P0103, P0121, P0122, P0123, P0973, P0974, P0976, or P0977 is not set.
- Greater than 5 s since last transmission upshift or downshift.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.

Conditions for Setting the DTC

P0722

Transmission output speed is 35 RPM or less for 4.0 s.

P0723

- Transmission output speed is 105 RPM or greater for 0.2 s.
- TCM detects the transmission output shaft speed dropped greater than 650 RPM for 1.5 s.

Action Taken When the DTC Sets

- DTCs P0722 and P0723 are Type A DTCs.
- TCM freezes transmission adaptive functions.
- TCM turns the high side driver OFF.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.

Conditions for Clearing the DTC

DTCs P0722 and P0723 are Type A DTCs.

Diagnostic Aids

- Damage or misalignment of the front differential transfer drive gear teeth surface or metallic debris on the face of the sensor may cause a speed sensor malfunction.
- Proper torque of the OSS mounting bolt is critical to proper OSS operation.
- If the scan tool ISS/OSS Supply Voltage indicates out of range, the fault could also be caused by the transmission input shaft speed sensor.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool ISS/OSS Supply Voltage parameter displays OK.
    - **If OK is not displayed**

      Refer to Circuit/System Testing.

    - **If OK is displayed**
3. Verify the scan tool Transmission OSS parameter changes with vehicle speed or does not drop out while

operating the vehicle at 16-32 km/h (10-20 mph).

- **If the Transmission OSS does not vary with vehicle speed or drops out**

  Refer to Circuit/System Testing.

- **If the Transmission OSS varies with vehicle speed and does not drop out**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the control valve body cover.
2. Connect the vehicle wire harness electrical connector to the Q8 Control Solenoid Valve Assembly electrical connector.
3. Disconnect the B14A Transmission Output Shaft Speed Sensor wiring harness connector from the Q8 Control Solenoid Valve Assembly.
4. Ignition ON.
5. Test for 8.3-9.3 V between the OSS sensor supply voltage circuit terminal A at the Q8 Control Solenoid Valve Assembly, and ground at the transmission case.
   - **If not between 8.3-9.3 V**
   1. Ignition OFF, disconnect the B14C Transmission Input Shaft Speed Sensor wiring harness connector from the Q8 Control Solenoid Valve Assembly. Ignition ON.
   2. Test for 8.3-9.3 V between the OSS sensor supply voltage circuit terminal A X4 electrical connector at the Q8 Control Solenoid Valve Assembly, and ground at the transmission case.
      - If not between 8.3-9.3 V, replace the Q8 Control Solenoid Valve Assembly.
      - If between 8.3-9.3 V, replace the B14C Transmission Input Shaft Speed Sensor.
   - **If between 8.3-9.3 V**
6. Verify the scan tool Transmission OSS parameter is between 256-266 RPM when performing the output shaft speed test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Input Shaft Speed/Output Shaft Speed Input Test**.
   - **If not between 256-266 RPM**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If between 256-266 RPM**
7. Verify there is no damage to the front differential transfer drive gear teeth surface or misalignment with

the B14A Transmission Output Shaft Speed Sensor.

- **If the front differential transfer drive gear is damaged or is misaligned**

  Repair or replace as necessary.

- **If the front differential transfer drive gear is not damaged or misaligned.**

8. Replace the B14A Transmission Output Shaft Speed Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Valve Body Cover Replacement** .
- **Output Speed Sensor Replacement**
- **Input Speed Sensor Replacement**
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup

DTC P0741 OR P0742: TORQUE CONVERTER CLUTCH (TCC) SYSTEM STUCK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: **The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.**

DTC P0741

Torque Converter Clutch (TCC) System Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0742

Torque Converter Clutch (TCC) System Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

The torque converter clutch (TCC) pressure control solenoid is part of the control solenoid valve assembly which has no serviceable components. The TCC pressure control solenoid is a normally low pressure control solenoid. The TCC pressure control solenoid regulates transmission fluid to the TCC regulator valve in the lower valve body and the TCC control valve in the pump cover. When vehicle operating conditions are appropriate to apply the converter clutch, the transmission control module (TCM) will increase current flow to the TCC pressure control solenoid, thereby increasing pressure directed to the TCC control valve. The increase in fluid pressure moves the TCC control valve to the apply position, and moves the TCC regulator apply valve

to the regulating position. The TCC regulator valve regulates TCC apply fluid pressure proportional to TCC solenoid pressure. When the TCC is fully applied, the engine is coupled directly to the transmission. TCC release is accomplished by the TCM decreasing current flow to the TCC PC solenoid. This results in decreasing the apply pressure which allows the TCC control valve to move to the release position. The TCM calculates torque converter slip speed based on the speed signal from the input shaft speed sensor and the engine speed provided by the engine control module.

Conditions for Running the DTC

P0741

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, P0742, P2763, or P2764 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is greater than 8.5 V.
- Transmission fluid temperature is between -6.7 to +130Â°C (20-266Â°F).
- Throttle position is 8.5 % or greater.
- Engine torque is 50 N.m (36 lb ft) or greater.
- Engine torque signal is valid.
- Throttle position signal is valid.
- TCM detects the transmission gear ratios listed below for the commanded gear when TCC is commanded ON:
    - 2nd gear ratio is between 2.67-3.07.
    - 3rd gear ratio is between 1.71-1.97.
    - 4th gear ratio is between 1.32-1.51.
    - 5th gear is between 0.93-1.07.
    - 6th gear is between 0.69-0.79.

P0742

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, P0741, P2763, or P2764 is not set.
- Commanded range is 2nd gear or higher.
- Ignition voltage is 8.5 V or greater.
- Transmission fluid temperature is between 18-130Â°C (64-266Â°F).
- Throttle position is 5 % or greater.
- Engine torque is 80 N.m (59 lb ft) or greater.
- Engine speed is 400-7,500 RPM for 5 s.
- Vehicle speed is 1 km/h (0.6 mph) or greater.
- Engine speed is 500 RPM or greater
- Engine torque signal is valid.

- Throttle position signal is valid.
- TCC is commanded OFF.

Conditions for Setting the DTC

P0741

- TCC Pressure command is 800 kPa (116 psi) or greater for 2 s.
- TCM detects TCC slip of 50 RPM or greater for 5 s.
- The above conditions must occur 3 times.

P0742

TCM detects the TCC slip between -50 and +13 RPM for 2.5 s when the TCC is commanded OFF. This condition must occur 6 times.

Action Taken When the DTC Sets

P0741

- DTC P0741 is a Type B DTC.
- TCM inhibits 6th gear.
- TCM commands TCC OFF.
- TCM forces hot mode shift pattern.

P0742

- DTC P0742 is a Type A DTC.
- TCM freezes transmission adaptive functions.
- TCM forces hot mode shift pattern.
- TCM commands the TCC ON.

Conditions for Clearing the DTC

P0741

DTC P0741 is a Type B DTC.

P0742

DTC P0742 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **If other DTCs are set, diagnose those DTCs first.**

1. Engine idling, transmission in the Park, parking brake applied, and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
   - **If the transmission fluid level and condition is not correct**

     Repair as necessary.

   - **If the transmission fluid level and condition is correct**
3. Ignition ON, clear the TCM DTCs with a scan tool.
4. Verify DTC P0741 or P0742 does not set while performing a road test. Refer to **Road Test**.
   - **If DTC P0741 or P0742 sets**

     Refer to Circuit/System Testing.

   - **If DTC P0741 or P0742 did not set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

7. All OK.

Circuit/System Testing

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure** .
   - **If the pressures are not within range**

     Refer to **Fluid Pressure High or Low**.

   - **If the pressures are within range**
3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.
   - **If the pressure does not change**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If the pressure changes**
5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

P0741 - Upper Valve Body

Release exhaust port/orifice plugged or blocked.

P0741 or P0742 - Upper Valve Body

Torque converter clutch regulator valve stuck/sticking - debris, binding, damaged valve, or scored bore.

P0741 - Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

P0741 - Torque Converter

- Torque converter clutch delamination or material worn off.
- Converter bolts too long damaging the clutch apply surface.
- Damaged seal.

P0741 - Support

Damaged seal.

P0741 or P0742 - Transmission Case Cover

- Pressure release blow-off not seating/sealing.
- Damaged spring.

P0741 - Turbine Shaft

O-ring seal cut or damaged

P0741 or P0742 Q8 Control Solenoid Valve Assembly

- Torque converter clutch pressure control solenoid stuck OFF or leaking.
- Torque converter clutch pressure control solenoid stuck ON.
- Control signal fluid supply leak due to valve body filter plate assembly cracked, or damaged gasket seal.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Torque Converter Removal**
- **Torque Converter and Differential Housing, Front Differential Transfer Drive Gear, and Front Differential Carrier Removal** , and **Torque Converter and Differential Housing Installation**
- **Torque Converter Installation**
- **Control Valve Lower Body and Upper Body Replacement**
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P0751 OR P0752: SHIFT SOLENOID VALVE 1 PERFORMANCE - STUCK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

NOTE: **The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.**

DTC P0751

Shift Solenoid Valve 1 Performance - Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0752

Shift Solenoid Valve 1 Performance - Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Shift solenoid valve 1 is part of the control solenoid valve assembly, which has no serviceable components. The solenoid operates by the transmission control module (TCM) turning the low side driver ON or OFF. When the shift solenoid valve 1 is commanded OFF, the plunger forces the metering ball against the actuator feed limit seat, blocking the flow and any existing pressure is exhausted through the exhaust port. When the shift solenoid valve 1 is commanded ON, the internal plunger moves, allowing the metering valve to move away from the actuator feed limit seat and against the exhaust seat, creating signal fluid pressure. The signal fluid pressure acts against the clutch select valve 2 to overcome the valve spring force, moving the valve to the apply position. Fluid pressure from the R1/4-5-6 regulator valve flows through clutch select valve 2 and is directed to either the low and reverse clutch or the 4-5-6 clutch, depending on the position of clutch select valve 2.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is greater than 8.5 V.
- Engine speed is 400-7,500 RPM for 5 s.
- Throttle position signal is valid.
- Engine torque signal is valid.
- High side driver is enabled.
- Output shaft speed is 36 RPM or greater, or the throttle position is 0.5 % or greater.
- Transmission fluid temperature is -6.6Â°C (20Â°F) or greater.

Conditions for Setting the DTC

P0751

- Commanded gear is 1st.
- TCM detects gear ratio 1.34-1.48.
- Gear slip is 400 RPM or greater for 2 s.
- Above conditions have to occur 8 times.

P0752

- Commanded gear is 3rd
- Transmission has achieved 1st or 2nd.
- Gear slip is 400 RPM or greater for 3 s.
- TCM commands 4th gear if above conditions exist and detects a gear ratio of 4.26-4.71 for 3 s.
- The conditions listed above have to occur 5 times.

Action Taken When the DTC Sets

P0751

- DTC P0751 is a Type B DTC.
- TCM inhibits 1st gear.

- TCM inhibits neutral idle.

P0752

- DTC P0752 is a Type A DTC.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM commands second gear if output speed is less than 1,350 RPM, or neutral if output speed is 1,350 RPM or greater.
- TCM inhibits neutral idle.

Conditions for Clearing the DTC

- DTC P0751 is a Type B DTC.
- DTC P0752 is a Type A DTC.

Diagnostic Aids

Before performing a road test, configure and setup the scan tool for snapshot mode. This allows you to display, monitor, and verify multiple transmission data parameters at one time, after the road test.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**
- **Drive Range, First Gear**
- **Drive Range, Third Gear**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **If other DTCs are set, diagnose those DTCs first.**

1. Engine idling at the normal operating temperature, gear selector in the Park position, parking brake applied, and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
   - **If the transmission fluid level and condition is not correct**

     Repair as necessary

   - **If the transmission fluid level and condition is correct**
3. From a stop, accelerate to 72 km/h (45 mph) with the scan tool Calculated Throttle Position greater than 15 %. Perform this test 8 times.
4. Verify DTC P0751 or P0752 did not set.
   - **If DTC P0751 or P0752 set**

     Refer to Circuit/System Testing.

   - **If DTC P0751 or P0752 did not set**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
7. All OK.

Circuit/System Testing

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure** .
   - **If the pressures are not within range**

Refer to **Fluid Pressure High or Low** .

- **If the pressures are within range**

3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.
   - **If the pressure does not change**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If the pressure changes**
5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

P0751 - Upper Control Valve Body

- Clutch select valve 2 bore plug undersized causing a leak - plug should be a valve fit in the bore.
- Check ball #2 - missing, damaged or malformed, or damage to the seat causing leakage.

P0751 or P0752 - Upper Control Valve Body

Clutch select valve 2 stuck from debris, sediment, binding, or a scored bore.

P0751 or P0752 - Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

P0751 - Lower Control Valve Body

- Shift solenoid 1 - not pressurizing, stuck OFF or leaking.
- Shift solenoid 1 - not exhausting, stuck ON.

P0751 or P0752 - Q8 Control Solenoid Valve Assembly

- Shift solenoid valve 1 stuck OFF or leaking.
- Shift solenoid valve 1 stuck ON.
- Valve body filter plate assembly cracked, blocked, or damaged gasket seal.
- Pressure control solenoid valve 3 stuck ON, stuck OFF, or leaking. Low and Reverse, and 4-5-6 regulator valve stuck or sticking from debris, sediment, binding or scored bore.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0756: SHIFT SOLENOID VALVE 2 PERFORMANCE - STUCK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

NOTE: **The DTC listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.**

DTC P0756

Shift Solenoid Valve 2 Performance - Stuck Off - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

Shift solenoid valve 2 is part of the control solenoid valve assembly, which has no serviceable components. Shift solenoid valve 2 is a normally closed solenoid valve and controls fluid to the clutch select valve 3. The transmission control module (TCM) operates the solenoid by turning the low side driver ON or OFF. When the shift solenoid valve 2 is commanded OFF, the plunger forces the metering ball against the actuator feed limit seat, blocking the flow and any existing pressure is exhausted through the exhaust port. When shift solenoid valve 2 is commanded ON, the internal plunger moves and allows the metering ball to move away from the feed seat and against the exhaust seat, creating signal fluid pressure. The signal fluid acts against the clutch select valve 3 to overcome the valve spring force, moving it to the apply position. Shift solenoid valve 2 is commanded OFF in Reverse, and commanded ON in Park, Neutral, Drive 1 Engine Braking, and Drive 1-6 gear ranges.

Conditions for Running the DTC

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- High side driver is enabled.
- Ignition voltage is greater than 8.5 V.
- Throttle position signal is valid.
- Transmission fluid temperature is -6.6Â°C (20Â°F) or greater.
- Output shaft speed is 36 RPM or greater, or the throttle position is 0.5 percent or greater

Conditions for Setting the DTC

- Commanded Gear is 1st locked.
- Gearbox Slip is 400 RPM or greater for 3 s.
- If above conditions exist, the TCM commands second gear. If the gear ratio is between 2.72-3.01 for 1 s, the counter will increment. DTC will set after 3 occurrences.

Action Taken When the DTC Sets

- DTC P0756 is a Type A DTC.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM commands second gear if output speed is less than 1,350 RPM, or neutral if output speed is 1,350 RPM or greater.

Conditions for Clearing the DTC

DTC P0756 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**
- **Drive Range, First Gear Engine Braking**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

NOTE: **If other DTCs are set, diagnose those DTCs first.**

1. Engine idling, transmission in Park, with parking brake applied and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check**.
    - **If the transmission fluid level and condition is not correct**

      Repair as necessary.

    - **If the transmission fluid level and condition is correct**
3. Ignition ON, clear the TCM DTCs with a scan tool.
4. Engine running, brakes applied, transmission gear shift selector in Reverse. Shift to Drive and accelerate to 56 km/h (35 mph) with the scan tool Calculated Throttle Position greater than 15 %. Perform this test 5 consecutive times.
5. Verify DTC P0756 did not set.
    - **If DTC P0756 sets**

      Refer to Circuit/System Testing.

    - **If DTC P0756 did not set**
6. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
7. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
8. All OK.

Circuit/System Testing

1. Engine idling at the normal operating temperature.
2. Verify the transmission line pressures are within the specified range. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure** .
    - **If the pressures are not within range**

      Refer to **Fluid Pressure High or Low**.

    - **If the pressures are within range**
3. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
4. Verify the pressure changes for all solenoids when performing the solenoid test. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**.
    - **If the pressure does not change**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If the pressure changes**

5. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

Upper Control Valve Body

- Clutch select valve 3 stuck from debris, sediment, binding or scored bore
- Clutch select valve 3 bore plug undersized causing a leak - plug should be a valve fit in the bore.
- Check ball #3 - missing, damaged or malformed, or damage to the seat causing leakage.
- Check ball #1 - missing, damaged or malformed, or damage to the seat causing leakage.

Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

Mechanical Diode

Broken or not capable of holding torque.

Pump Assembly

Fluid pump vanes or fluid pump rotor broken

Pump Seal

Seal is torn or cut, causing a small leak that is overcome with enough speed and pump capacity.

Q8 Control Solenoid Valve Assembly

- Shift solenoid 2 not pressurizing - stuck OFF or leaking.
- Valve body filter plate assembly cracked, blocked, or damaged gasket seal.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Valve Upper Body Assembly Cleaning and Inspection**
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0776 OR P0777: PRESSURE CONTROL SOLENOID VALVE 2 STUCK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: **The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to**

identify the cause.

DTC P0776

Pressure Control Solenoid Valve 2 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0777

Pressure Control Solenoid Valve 2 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

The clutch pressure control (PC) solenoid 2 is part of the control solenoid valve assembly, which has no serviceable components. The PC solenoid 2 regulates transmission fluid pressure to the 3-5-Reverse clutch regulator valve which controls pressure to the 3-5-Reverse clutch. The transmission control module (TCM) calculates gear ratio based on the RPM signals from the input speed sensor (ISS) and the output speed sensor (OSS). The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

P0776

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 8.5 volts or greater.
- Engine speed is 400 RPM or greater for 5.0 seconds.
- Transmission fluid temperature (TFT) is -7Â°C (19Â°F) or greater.
- Transmission output speed is 36 RPM or greater, or the throttle position is 0.5 percent or greater.
- Throttle position signal is valid.
- High side driver is enabled.

P0777

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 8.5 volts or greater.
- Engine speed is 400 RPM or greater for 5.0 seconds.
- TFT is -7Â°C (19Â°F) or greater.
- Engine torque is 20 N.m (15 lb ft) or greater.
- Transmission output speed is 36 RPM or greater, or the throttle position is 0.5 percent or greater.
- Throttle position signal is valid.
- High side driver is enabled.

Conditions for Setting the DTC

P0776

TCM has detected an incorrect gear ratio or neutral condition when the 3-5-Reverse clutch is commanded ON. This condition must occur 3 times.

P0777

TCM has detected an incorrect gear ratio change when the 3-5-Reverse clutch is commanded OFF during a shift or when 3rd gear ratio is detected in 1st gear. This condition must occur 3 times.

Action Taken When the DTC Sets

P0776

- DTC P0776 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM freezes transmission adaptive functions.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse, 2nd, and 4th gear operation.
- TCM inhibits auto grade braking.

P0777

- DTC P0777 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM freezes transmission adaptive functions.
- TCM limits the transmission to 3rd gear and Reverse operation.
- TCM inhibits auto grade braking.

Conditions for Clearing the DIC/DTC

DTCs P0776 and P0777 are Type A DTCs.

Diagnostic Aids

Before performing a road test, configure and setup the scan tool for snapshot mode. This will allow you to display, monitor, and verify multiple transmission data parameters at one time, after the road test.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- COMPONENT CONNECTOR END VIEWS - INDEX
- Inline Harness Connector End Views

Description and Operation

Transmission General Description

Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: **Refer to Parking Brake and Drive Wheels Warning .**

NOTE: **If other DTCs are set, diagnose those DTCs first.**

1. Engine idling in Park, parking brake applied, and drive wheels chocked.
2. Verify correct transmission fluid level and condition. Refer to Transmission Fluid Level and Condition Check.
   - **If the transmission fluid level and condition is not the correct**

     Repair as necessary.

   - **If the transmission fluid level and condition is correct**
3. Verify with a scan tool the Transmission Fluid Pressure Switch 1 parameter values are correct for the Park, Reverse, and Neutral gear select lever positions. Refer to Transmission Fluid Pressure Switch Logic .
   - **If not the correct values for Transmission Fluid Pressure Switch 1**

     Refer to Circuit/System Testing below.

   - **If Transmission Fluid Pressure Switch 1 values are correct**
4. Gear select lever in Drive range. Verify the Transmission Fluid Pressure Switch 1 parameter states are correct for all forward ranges when commanded with a scan tool. Refer to Transmission Fluid Pressure Switch Logic .
   - **If not the correct values for Transmission Fluid Pressure Switch 1**

Refer to Circuit/System Testing below.

- **If Transmission Fluid Pressure Switch 1 values are correct**

5. Ignition ON, clear the TCM DTCs.
6. Perform the **Road Test**. Verify the transmission operation performs as indicated in the road test instructions and DTC P0776 or P0777 did not set.
   - **If DTC P0776 or P0777 sets**

     Refer to Circuit/System Testing below.

   - **If DTC P0776 or P0777 did not set**
7. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Verify the transmission line pressures are within the ranges specified in the Line PC Solenoid Valve Pressure table. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure** .
   - **If line pressures are not within the specified ranges**

     Refer to **Fluid Pressure High or Low**

   - **If line pressures are within the specified ranges**
2. Ignition OFF, remove the Q8 control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
3. Perform the **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**. A pressure change should occur for each solenoid valve.
   - **If a pressure change does not occur for each solenoid**

     Replace the Q8 control solenoid valve assembly

   - **If a pressure change occurs for each solenoid**
4. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

DTC P0776 or P0777 - Upper Control Valve Body Assembly

3-5-R regulator valve stuck/sticking - debris, binding, damaged valve, or scored bore.

DTC P0776 or P0777 - Lower Control Valve Body Assembly

- Actuator feed limit circuit supply fluid to solenoid restricted from debris, a stuck limit valve or sediment blockage.

- 3-5-R clutch boost valve - binding or scored bore - can cause harsh shifts.

DTC P0776 or P0777 - Q8 Control Solenoid Valve Assembly

- Clutch pressure control solenoid 2 stuck ON or stuck OFF.
- Control solenoid valve filter plate assembly, blocked or damaged gasket seal.

DTC P0776 - Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

DTC P0776 or P0777 - Transmission Fluid Pump

- Fluid pump housing vanes/rotor/slide damaged/scored.
- Transmission pump fluid outlet seal assembly damaged/leaking.

DTC P0776 - Transmission Cooling/Lubrication

- Oil filter or filter seal loose, plugged, or damaged.
- Restriction/leak in oil to air cooler/radiator.
- Restricted/leaking/kinked/damaged transmission oil cooler lines.
- Restriction/leak in transmission fluid pump assembly.

DTC P0776 - Torque Converter Assembly

Torque converter overstressed due to high temperature, fluid boiled out.

DTC P0776 - 4-5-6 and 3-5-R Clutch Housing Assembly

- 3-5-R clutch backing plate retaining ring not seated or wave plate broken.
- 3-5-R piston seal torn, cut, or rolled.
- 4-5-6 and 3-5-R clutch housing assembly inner/outer seal damaged or dam pressure too high.

DTC P0776 or P0777 - Automatic Transmission Case Cover

Blow off regulator ball stuck.

DTC P0776 or P0777 - Input Shaft Support

3-5-R and 4-5-6 clutch fluid seal rings damaged, worn, or leaking.

Repair Instructions

NOTE:

- **Perform the Reset Transmission Adapts following all transmission related repairs.**
- **Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection.**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Valve Lower Body and Upper Body Replacement**
- **Low and Reverse Clutch and 1-2-3-4 Clutch Plate Removal**
- **Control Module References** for control solenoid valve assembly replacement, setup, and programming

DTC P0796 OR P0797: PRESSURE CONTROL SOLENOID VALVE 3 STUCK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: **The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.**

DTC P0796

Pressure Control Solenoid Valve 3 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P0797

Pressure Control Solenoid Valve 3 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

The clutch pressure control (PC) solenoid 3 is part of the control solenoid valve assembly, which has no serviceable components. The PC solenoid 3 regulates transmission fluid pressure (TFP) to the R1/4-5-6 clutch regulator valve which controls pressure to the low and reverse clutch and the 4-5-6 clutch. The transmission control module (TCM) calculates gear ratio based on the RPM signals from the input speed sensor (ISS) and the output speed sensor (OSS). The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

P0796

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 8.6 volts or greater.
- Engine speed is 400 RPM or greater for 5.0 seconds.
- Output speed is 36 RPM or greater, or the throttle position is 0.5 percent or greater.
- Throttle position signal is valid.
- High side driver is enabled.

- Transmission fluid temperature (TFT) is -7Â°C (19Â°F) or greater.

P0797

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 8.6 volts or greater.
- Engine speed is 400 RPM or greater for 5.0 seconds.
- Output speed is 36 RPM or greater, or the throttle position is 0.5 percent or greater.
- Throttle position signal is valid.
- High side driver is enabled.
- TFT is -7Â°C (19Â°F) or greater.
- Engine torque is 20 N.m (15 lb ft) or greater when 1st gear is commanded.

Conditions for Setting the DTC

P0796

The TCM has detected an incorrect gear ratio or neutral condition when the low and reverse clutch or the 4-5-6 clutch is commanded ON. This condition must occur 3 times.

P0797

The TCM has detected an incorrect gear ratio change when the low and reverse clutch or the 4-5-6 clutch is commanded OFF during a shift or when 4th ratio is detected in 1st gear. This condition must occur 3 times.

Action Taken When the DTC Sets

P0796

- DTC P0796 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse, 1st, and 3rd gear operation.
- TCM inhibits auto grade braking.

P0797

- DTC P0797 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

- TCM limits the transmission to Reverse and 4th gear operation.
- TCM inhibits neutral idle.
- TCM requests a reduced engine torque based on input speed.

Conditions for Clearing the DIC/DTC

DTCs P0796 and P0797 are Type A DTCs.

Reference Information

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

Transmission General Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Engine idling in Park, with parking brake applied and drive wheels chocked.
2. Verify correct transmission fluid level and condition. Refer to **Transmission Fluid Level and Condition Check**.
3. Verify with a scan tool the Transmission Fluid Pressure Switch 5 parameter values are correct for the Park, Reverse, and Neutral range gear select lever positions. Refer to **Transmission Fluid Pressure Switch Logic** .
   - **If not the correct values for TFP switch 5**

     Refer to Circuit/System Testing below.

- **If TFP switch 5 values are correct**

4. Gear select lever in Drive range. Verify the Transmission Fluid Pressure Switch 5 parameter states are correct for all forward ranges when commanded with a scan tool. Refer to **Transmission Fluid Pressure Switch Logic** .
    - **If not the correct values for TFP switch 5**

      Refer to Circuit/System Testing below.

    - **If TFP switch 5 values are correct**
5. Ignition ON, clear the TCM DTCs.
6. Perform the **Road Test**. Verify the transmission operation performs as indicated in the road test instructions and DTC P0796 or P0797 did not set.
    - **If DTC P0796 or P0797 sets**

      Refer to Circuit/System Testing below.

    - **If DTC P0796 or P0797 did not set**
7. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Verify the transmission line pressures are within the ranges specified in the Line PC Solenoid Valve Pressure table. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure**
    - **If line pressures are not within the specified ranges**

      Refer to **Fluid Pressure High or Low**

    - **If line pressures are within the specified ranges**
2. Ignition OFF, remove the Q8 control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
3. Perform the **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**. Test all solenoids on the Q8 control solenoid valve assembly. A pressure change should occur for each solenoid valve.
    - **If a pressure change does not occur for each solenoid**

      Replace the Q8 control solenoid valve assembly.

    - **If a pressure change occurs for each solenoid**
4. Verify the mechanical conditions listed below do not exist. Repair or replace as necessary.

P0796 or P0797 - Control Valve Upper Body Assembly

4-5-6 regulator valve stuck/sticking from debris, binding, damaged valve, or scored bore.

P0796 - Channel Plate and Spacer Plate

Channel Plate and spacer plate oil channels or orifices blocked by debris.

P0796 - Lower Control Valve Body Assembly

- Actuator feed limit circuit supply fluid to solenoid restricted or not available from debris, stuck limit valve, or sediment blockage.
- 4-5-6 clutch boost valve binding or a scored bore which can also cause harsh shifts.
- 4-5-6 clutch accumulator piston leaking, cracked, or broken.

P0796 or P0797 - Input Shaft Support

Input shaft support 3-5-R and 4-5-6 clutch fluid seal rings damaged, worn, or leaking.

P0796 or P0797 - Q8 Control Solenoid Valve Assembly

- Clutch pressure control solenoid valve 3 stuck ON or stuck OFF.
- Control solenoid filter plate assembly cracked, blocked, or damaged gasket seal.

P0796 - 4-5-6 Clutch Housing Assembly

- 4-5-6 clutch piston assembly damaged or leaking.
- 4-5-6 clutch inner/outer seal damaged.
- Dam pressure too high

P0796 - Automatic Transmission Case Cover

Blow off regulator ball stuck.

P0796 - Transmission Cooling/Lubrication

- Restriction/leak in oil to air cooler/radiator.
- Restricted/leaking/kinked/damaged transmission oil cooler lines.
- Restriction/leak in transmission fluid pump assembly.

P0796 - Torque Converter Assembly

Fluid pump or torque converter overstressed due to high temperature of fluid boiled out.

P0796 - 4-5-6 Reaction Carrier Hub Assembly

4-5-6 reaction carrier hub/shaft - broken hub weld.

P0796 - Automatic Transmission Fluid Filter Assembly

Oil filter or filter seal loose or damaged

P0796 - Automatic Transmission Fluid Pump

Pump fluid outlet seal assembly damaged/leaking.

Repair Instructions

NOTE:

- **Perform the Reset Transmission Adapts following all transmission related repairs.**
- **Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection.**

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- Control Valve Lower Body and Upper Body Replacement
- Low and Reverse Clutch and 1-2-3-4 Clutch Plate Removal , and 3-5-Reverse and 4-5-6 Clutch Housing Disassemble
- Control Module References for control solenoid valve assembly replacement, setup, and programming

DTC P0815, P0816, OR P0826: UPSHIFT/DOWNSHIFT SWITCH

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0815

Upshift Switch Circuit

DTC P0816

Downshift Switch Circuit

DTC P0826

Up and Down Shift Switch Circuit

Diagnostic Fault Information

Driver Shift Request

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Tap Upshift Switch	P0826	P0826	P0815	-
Tap Downshift Switch	P0826	P0826	P0816	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Up and Down Shift Switch	P0826	P0826	P0826	-

Circuit/System Description

When the shift lever is placed in manual mode (M), electronic range select (ERS), which allows for the selection of the range of gears available, is activated. The ERS allows the vehicle operator to increase the highest range by pressing the plus (+) button or decrease the highest range by pressing the minus (-) button. The body control module (BCM) provides ignition voltage and a signal circuit to the resistor network embedded in the cruise control and tap shift switch assembly. When a plus or minus button is pressed, a corresponding voltage drop occurs across the resistor network. This voltage drop is monitored by the BCM. The BCM sends the request to the transmission control module (TCM) to increase or decrease the available gear ranges.

Conditions for Running the DTC

P0815 or P0816

- DTC P0815, P0816, P0826, P1761, P182E, P1876, P1877, or P1915 is not set.
- Time since the range change is greater than 1 second.
- Engine speed is 400 RPM or greater for 5 seconds.
- Ignition voltage is 8.6 volts or greater.

P0826

- Engine speed is greater than 400 RPM for at least 5 seconds.
- Ignition voltage is 8.6 volts or greater.
- DTC P0826 or 1761 is not set.

Conditions for Setting the DTC

P0815 - Condition 1

TCM detects an upshift request for 1 second in PARK or neutral.

P0815 - Condition 2

TCM detects an upshift request for 10 minutes in any forward range.

P0816 - Condition 1

TCM detects a downshift request for 1 second in PARK or neutral.

P0816 - Condition 2

TCM detects a downshift request for 10 minutes in any forward range.

P0826

TCM detects an invalid voltage on the Tap Up/Down signal circuit for 1 minute.

Action Taken When the DTC Sets

- DTCs P0815, P0816, and P0826 are Type C DTCs.
- TCM disables TAP shift operation.

Conditions for Clearing the DTC

DTCs P0815, P0816, and P0826 are Type C DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

Transmission General Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Ignition ON, engine OFF, transmission shift lever in Park, parking brake ON.
2. Verify with a scan tool no internal mode switch (IMS) DTCs set.
   - **If IMS DTCs were set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **If IMS DTCs were not set**

3. Transmission shift lever in manual mode (M).
4. Verify the scan the scan tool Driver Shift Request parameter displays None. Press and release the Tap Up (+) switch, and the Tap Down (-) switch. Verify the Driver Shift Request parameter changes from None to Upshift when the Tap Up switch is pressed, and from None to Downshift when the Tap Down switch is pressed.
    - **If parameter does not display the correct values**

      Refer to Circuit/System testing below.

    - **If parameter displays the correct values**
5. Operate the vehicle within the conditions for running the DTC to verify the DTC does not set. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Ignition OFF, parking brake ON, disconnect the S70L Steering Wheel Control Switch - Left connector, ignition ON.
2. Verify that a test lamp illuminates between the ignition circuit terminal 1 and ground.
    - **If the test lamp does not illuminate**
    1. Ignition OFF, remove the harness connector from the K9 Body Control Module.
    2. Test for infinite resistance between the S70L Steering Wheel Control Switch - Left harness connector ignition circuit terminal 1 and ground.
        - If less than infinite resistance, repair the short to ground in the circuit
        - If infinite resistance
    3. Test for less than 5 Ω in the ignition circuit end to end.
        - If 5 Ω or greater, repair the open/high resistance in the circuit
        - If less than 5 Ω, replace the K9 body control module.
    - **If the test lamp illuminates**
3. Ignition OFF.
4. Test for 6.5-7.1 k ohms between the steering wheel control switch - left connector terminals 1 and 5. Verify the resistance changes to 1.7-2.1 k ohms when the Tap Up button is pressed and 3.8-4.2 k ohms when the Tap Down button is pressed.
    - **If not the correct values**

      Replace the S70L Steering Wheel Control Switch - Left.

    - **If values are correct**
5. Remove the harness connector at the K9 Body Control Module.

6. Test for infinite resistance between the S70L Steering Wheel Control Switch - Left harness connector signal circuit terminal 5 and ground.
    - **If less than infinite resistance**

      Repair the short to ground in the circuit

    - **If infinite resistance**
7. Test for less than 5 Ω in the signal circuit end to end.
    - **If 5 Ω or greater**

      Repair the open/high resistance in the circuit.

    - **If less than 5 Ω**
8. Replace the K9 Body Control Module.

Repair Instructions

NOTE:

- **Perform the Reset Transmission Adapts following all transmission related repairs.**
- **Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection.**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for BCM or control solenoid valve assembly replacement, setup and programming
- **Steering Wheel Control Switch Assembly Replacement**

DTC P0842 OR P0843: TRANSMISSION FLUID PRESSURE SWITCH 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0842

Transmission Fluid Pressure Switch 1 Circuit Low Voltage

DTC P0843

Transmission Fluid Pressure Switch 1 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Transmission Fluid Pressure Switch 1 Signal	P0842	P0843	P0843	-
Transmission Fluid Pressure Switch 3 Signal	P0872	P0873	P0873	-
Transmission Fluid Pressure Switch 4 Signal	P0877	P0878	P0878	-
Transmission Fluid Pressure Switch 5 Signal	P0989	P0990	P0990	-

Typical Scan Tool Data

Transmission Fluid Pressure Switch 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 1 Signal	Low	High	High

Transmission Fluid Pressure Switch 3

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 3 Signal	Low	High	High

Transmission Fluid Pressure Switch 4

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 4 Signal	Low	High	High

Transmission Fluid Pressure Switch 5

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 5 Signal	Low	High	High

Circuit/System Description

The transmission fluid pressure (TFP) switch 1 is part of the control solenoid valve assembly, which has no serviceable components. The transmission control module (TCM) supplies a signal circuit to the TFP Switch 1. The TFP Switch 1 has an internal case ground. TFP Switch 1 is normally closed or LOW. When oil pressure is present at the TFP Switch 1, the switch is open or HIGH. The normally high clutch pressure control (PC) solenoid 2 controls pressure to the 3-5 reverse clutch regulator valve. The TCM monitors the TFP switch 1 to determine the position of the 3-5 reverse clutch regulator valve. When the 3-5 reverse clutch is commanded OFF, pressure is present on the TFP switch 1. When the 3-5 reverse clutch is commanded ON, the 3-5 reverse clutch regulator valve moves and pressure to the TFP switch 1 is exhausted through the 3-5 reverse clutch regulator valve.

Conditions for Running the DTC

P0842 or P0843

- DTC P0711, P0712, P0713, P0716, P0717, P0722, P0723, P0742, P0751, P0756, P0757, P0973, P0974, P0976, P0977, P1915, or P182E is not set.
- High side driver is enabled.
- Engine speed is 400 RPM or greater for 5.0 seconds.
- Engine speed is 550 RPM or greater.
- Ignition voltage is 8.6 volts or greater.
- Transmission fluid temperature (TFT) is between -7 to +120Â°C (19-248Â°F).

Conditions for Setting the DTC

P0842

The TCM detects that the TFP switch 1 signal voltage remains LOW after the 3-5-Reverse clutch transitions from a HIGH pressure state to a LOW pressure state. The TCM counts each incident. The DTC sets when 25 counts are accumulated.

P0843

The TCM detects that the TFP switch 1 signal voltage remains HIGH after the 3-5-Reverse clutch transitions from a LOW pressure state to a HIGH pressure state. The TCM counts each incident. The DTC sets when 35 counts are accumulated.

Action Taken When the DTC Sets

- DTCs P0842 and P0843 are Type C DTCs.
- TCM freezes transmission adaptive functions for the 3-5-Reverse clutch.

Conditions for Clearing the DTC

DTCs P0842 and P0843 are Type C DTCs.

Diagnostic Aids

A TFP switch may malfunction due to normal debris in the transmission fluid causing a TFP Switch DTC to intermittently set. This type of failure should not be immediately noticeable to a customer, as the switch outputs are used for shift adaptives and do not cause transmission symptoms unless the switch malfunctions

continuously for an extended period of time.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Electronic Component Description** for control solenoid valve assembly

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Engine idling in Park with parking brake applied, and drive wheels chocked.
2. Verify with a scan tool the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameter states are correct for the Park, Reverse, and Neutral gear select lever positions. Refer to **Transmission Fluid Pressure Switch Logic** .
    - **If any parameter value is not correct for a given gear range**

Refer to Circuit/System Testing below.

- **If the parameter values are correct for all gear ranges**

3. Verify the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameter states are correct for each forward range with the gear select lever in Drive, using the scan tool to command all forward ranges. Refer to **Transmission Fluid Pressure Switch Logic** .
   - **If any parameter value is not correct for a given gear range**

     Refer to Circuit/System Testing below.

   - **If the parameter values are correct for all gear ranges**
4. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF. Remove the Q8 control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
2. Place the Q8 control solenoid valve assembly on a clean work surface near the transmission assembly.
3. Connect the **DT-47825-20** harness between the vehicle wire harness X1 20-way transmission electrical connector, and the Q8 control solenoid valve assembly electrical connector.
4. Ignition ON, verify with a scan tool that the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameters change states when gently pushing on each TFP switch with the eraser end of a pencil.
   - **If any TFP Switch parameter does not change states**

     Replace the Q8 control solenoid valve assembly.

   - **If all TFP Switch parameters change states**
5. Inspect the channel plate, spacer plate, and filter plate for debris and blocked orifices.

Repair Instructions

NOTE:

- **Perform the Reset Transmission Adapts following all transmission related repairs.**
- **Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection.**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control solenoid valve assembly replacement, setup, or programming

DTC P0851: PARK/NEUTRAL POSITION SWITCH

Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.
- Diagnostic Procedure Instructions provides an overview of each diagnostic category.

DTC Descriptors

DTC P0851

Park/Neutral Position Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P0851	-	-	-
Ground	-	-	-	-

Typical Scan Tool Data

Park/Neutral Position Switch

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 Volts = In-Gear, 0 Volts = Park/Neutral			
Signal	Park/Neutral	In-Gear	In-Gear
Ground	-	In-Gear	-

Circuit/System Description

The transmission manual shift shaft switch assembly, also known as the transmission internal mode switch, is a sliding contact switch attached to the manual shift shaft inside the transmission case. The park/neutral position switch is integrated into the transmission internal mode switch and connects to the transmission control module (TCM) lead-frame through a short wire harness. The circuit uses the TCM as a pass-through connector only. The park/neutral signal is sent from the park/neutral switch directly to the engine control module (ECM) and is used for engine start enable.

Conditions for Running the DTC

- DTC P182E is not set.
- Ignition voltage is 8-32 V.
- Engine speed is running. Vehicle speed is 10 km/h (6 mph) or greater.
- Throttle position is 8 % or greater.

Conditions for Setting the DTC

ECM detects the park/neutral switch signal equals 0 V for 4 s.

Action Taken When the DTC Sets

- DTC P0851 is a Type C DTC.
- ECM uses the indicated transmission range from the TCM to prevent engine start-up with the transmission in reverse or a forward range.

Conditions for Clearing the DTC

DTC P0851 is a Type C DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Ignition ON.
2. Verify that DTC P182E or P1915 is not set.
   - **If any of the DTCs are set**

     Refer to **DTC P182E or P1915**.

   - **If none of the DTCs are set**
3. Verify the gear shift lever position matches the scan tool TCM Internal Mode Switch parameter while slowly moving the gear shift lever from Park through all ranges.
   - **If the gear shift lever position does not match the Internal Mode Switch parameter**

     Adjust or replace the range selector lever cable as necessary.

   - **If the gear shift lever position matches the Internal Mode Switch parameter**
4. Verify the scan tool engine control module Park/Neutral Position Switch parameter displays Park/Neutral when in Park or Neutral and In-Gear when in Reverse or Drive.
   - **If the Park/Neutral Position Switch parameter is not as specified**

     Refer to Circuit/System Testing.

   - **If the Park/Neutral Position Switch parameter is as specified**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, disconnect the X1 harness connector at the Q8 Control Solenoid Valve Assembly harness connector at the automatic transmission.
2. Install the **DT-47825-20** Adapter Harness to the vehicle harness connector.

NOTE: **All testing in steps 3 through 5 will be performed at the DT-47825-20 Adapter Harness connector.**

3. Test for less than 5 Ω between the ground circuit terminal 18 and ground.
   - **If 5 Ω or greater**
   1. Ignition OFF.

2. Test for less than 2 Ω in the ground circuit end to end.
- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, repair the open/high resistance in the ground connection.
- **If less than 5 Ω**

4. Ignition ON.
5. Test for 11-13 V between signal circuit terminal 20 and ground.
- **If not between 11-13 V**

1. Ignition OFF, remove the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between signal circuit terminal 20 and ground.
- If less than infinite resistance, repair the short to ground in the circuit.
- If infinite resistance.

1. Test for less than 2 Ω in the signal circuit end to end.
- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, replace the K20 Engine Control Module.
- **If between 11-13 V**

6. Ignition OFF, transmission in Park, disconnect the **DT-47825-20** Adapter Harness from the vehicle wire harness.
7. Connect the **DT-47825-20** Adapter Harness to the Q8 Control Solenoid Valve Assembly X1 connector.

NOTE: **The ignition will need to be ON momentarily to shift from Park.**

8. Test for less than 10 Ω between the Park/Neutral signal circuit terminal 20 and ground circuit terminal 18 with the transmission in Park and Neutral.
- **If 10 Ω or greater**

1. Disconnect the **DT-47825-20** Adapter Harness and remove the transmission control valve body cover.
2. Install the **DT-47825-20** Adapter Harness to the Q8 Control Solenoid Valve Assembly X1 connector.
3. Disconnect the B15 Transmission Internal Mode Switch electrical connector from the Q8 Control Solenoid Valve Assembly.
4. Test for less than 10 Ω between Park/Neutral signal circuit terminal 20 and terminal A at the Q8 Control Solenoid Valve Assembly X2 connector.
    - If 10 Ω or greater, replace the Q8 Control Solenoid Valve Assembly.
    - If less than 10 Ω, replace the B15 Transmission Internal Mode Switch.

- **If less than 10 Ω**

9. Test for infinite resistance between the Park/Neutral signal circuit terminal 20 and ground circuit terminal 18 with the transmission in Reverse and Drive.
- **If less than infinite resistance**

1. Disconnect the **DT-47825-20** Adapter Harness and remove the transmission control valve body cover.
2. Install the **DT-47825-20** Adapter Harness to the Q8 Control Solenoid Valve Assembly X1

connector.

3. Disconnect the B15 Transmission Internal Mode Switch electrical connector from the Q8 Control Solenoid Valve Assembly.
4. Test for infinite resistance between the Park/Neutral signal circuit terminal 20 and ground circuit terminal 18.
    - If less than infinite resistance, replace the Q8 Control Solenoid Valve Assembly.
    - If infinite resistance, replace the B15 Transmission Internal Mode Switch.

- **If infinite resistance**

10. Replace the K20 Engine Control Module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement**
- **Range Selector Lever Cable Adjustment**
- **Control Valve Body Cover Replacement**
- **Control Module References** for ECM or control solenoid valve assembly replacement, programming, or setup.

DTC P0872 OR P0873: TRANSMISSION FLUID PRESSURE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0872

Transmission Fluid Pressure Switch 3 Circuit Low Voltage

DTC P0873

Transmission Fluid Pressure Switch 3 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Transmission Fluid Pressure Switch 1 Signal	P0842	P0843	P0843	-
Transmission Fluid Pressure Switch 3 Signal	P0872	P0873	P0873	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Transmission Fluid Pressure Switch 4 Signal	P0877	P0878	P0878	-
Transmission Fluid Pressure Switch 5 Signal	P0989	P0990	P0990	-

Typical Scan Tool Data

Transmission Fluid Pressure Switch 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 1 Signal	Low	High	High

Transmission Fluid Pressure Switch 3

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 3 Signal	Low	High	High

Transmission Fluid Pressure Switch 4

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 4 Signal	Low	High	High

Transmission Fluid Pressure Switch 5

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 5 Signal	Low	High	High

Circuit/System Description

The transmission fluid pressure (TFP) switch 3 is part of the control solenoid valve assembly, which has no serviceable components. The transmission control module (TCM) supplies a signal circuit to the TFP switch 3. The TFP switch 3 has an internal case ground. The TFP switch 3 is normally closed or LOW. When oil pressure is present at the TFP switch 3, the switch is open or HIGH. The normally low clutch pressure control (PC)

solenoid 4 controls pressure to the 2-6 clutch regulator valve. The TCM monitors the TFP switch 3 to determine the position of the 2-6 clutch regulator valve. When the 2-6 clutch is commanded OFF, pressure is present on the TFP switch 3. When the 2-6 clutch is commanded ON, the 2-6 clutch regulator valve moves and pressure to the TFP switch 3 is exhausted through the 2-6 clutch regulator valve.

Conditions for Running the DTC

P0872 or P0873

- DTC P0711, P0712, P0713, P0716, P0717, P0722, P0723, P0742, P0751, P0756, P0757, P0973, P0974, P0976, P0977, P1915, or P182E is not set.
- High side driver is enabled.
- Engine speed is 400 RPM or greater for 5 seconds.
- Engine speed is 550 RPM or greater.
- Ignition voltage is 8.6 volts or greater.
- Transmission fluid temperature (TFT) is -7 to +120Â°C (19-248Â°F).

Conditions for Setting the DTC

P0872

The TCM detects that the TFP switch 3 signal voltage remains LOW after the 2-6 clutch transitions from a HIGH pressure state to a LOW pressure state. The TCM counts each incident. The DTC sets when 18 counts are accumulated.

P0873

The TCM detects that the TFP switch 3 signal voltage remains HIGH after the 2-6 clutch transitions from a LOW pressure state to a HIGH pressure state. The TCM counts each incident. The DTC sets when 20 counts are accumulated.

Action Taken When the DTC Sets

- DTCs P0872 and P0873 are Type C DTCs.
- TCM freezes transmission adaptive functions for the 2-6 clutch.

Conditions for Clearing the DTC

DTCs P0872 and P0873 are Type C DTCs.

Diagnostic Aids

A TFP switch may malfunction due to normal debris in the transmission fluid causing a TFP Switch DTC to intermittently set. This type of failure should not be immediately noticeable to a customer, as the switch outputs are used for shift adaptives and do not cause transmission symptoms unless the switch malfunctions continuously for an extended period of time.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Electronic Component Description** for control solenoid valve assembly

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Engine idling in Park with parking brake applied, and drive wheels chocked.
2. Verify with a scan tool the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameter states are correct for the Park, Reverse, and Neutral gear select lever positions. Refer to **Transmission Fluid Pressure Switch Logic** .
   - **If any parameter value is not correct for a given gear range**

     Refer to Circuit/System Testing below.

   - **If parameter values are correct for all gear ranges**
3. Verify the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameter states are correct for each

forward range with the gear select lever in Drive, using the scan tool to command all forward ranges. Refer to **Transmission Fluid Pressure Switch Logic** .

- **If any parameter value is not correct for a given gear range**

  Refer to Circuit/System Testing below.

- **If parameter values are correct for all gear ranges**

4. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF. Remove the Q8 control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
2. Place the Q8 control solenoid valve assembly on a clean work surface near the transmission assembly.
3. Connect the **DT-47825-20** harness between the vehicle wire harness X1 20-way transmission electrical connector, and the Q8 control solenoid valve assembly electrical connector.
4. Ignition ON, verify with a scan tool that the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameters change states when gently pushing on each TFP switch with the eraser end of a pencil.
   - **If any TFP Switch parameter does not change states**

     Replace the Q8 control solenoid valve assembly.

   - **If all TFP Switch parameters change states**
5. Inspect the channel plate, spacer plate, and filter plate for debris and blocked orifices.

Repair Instructions

NOTE:

- **Perform the Reset Transmission Adapts following all transmission related repairs.**
- **Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection.**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control solenoid valve assembly replacement, setup, or programming

DTC P0877 OR P0878: TRANSMISSION FLUID PRESSURE SWITCH 4

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0877

Transmission Fluid Pressure Switch 4 Circuit Low Voltage

DTC P0878

Transmission Fluid Pressure Switch 4 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Transmission Fluid Pressure Switch 1 Signal	P0842	P0843	P0843	-
Transmission Fluid Pressure Switch 3 Signal	P0872	P0873	P0873	-
Transmission Fluid Pressure Switch 4 Signal	P0877	P0878	P0878	-
Transmission Fluid Pressure Switch 5 Signal	P0989	P0990	P0990	-

Typical Scan Tool Data

Transmission Fluid Pressure Switch 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 1 Signal	Low	High	High

Transmission Fluid Pressure Switch 3

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 3 Signal	Low	High	High

Transmission Fluid Pressure Switch 4

Circuit	Short to Ground	Open/High Resistance	Short to Voltage

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 4 Signal	Low	High	High

Transmission Fluid Pressure Switch 5

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 5 Signal	Low	High	High

Circuit/System Description

The transmission fluid pressure (TFP) switch 4 is part of the control solenoid valve assembly which has no serviceable components. The transmission control module (TCM) supplies a signal circuit to the TFP switch 4. The TFP switch 4 has an internal case ground. TFP switch 4 is normally closed or LOW. When oil pressure is present at the TFP switch 4, the switch is open or HIGH. The normally LOW pressure control solenoid 5 controls pressure to the 1-2-3-4 clutch regulator valve. The TCM monitors the TFP switch 4 to determine the position of the 1-2-3-4 clutch regulator valve. When the 1-2-3-4 clutch is commanded OFF, pressure is present on the TFP switch 4. When the 1-2-3-4 clutch is commanded ON, the 1-2-3-4 clutch regulator valve moves and pressure to the TFP switch 4 is exhausted through the 1-2-3-4 clutch regulator valve.

Conditions for Running the DTC

P0877 or P0878

- DTC P0711, P0712, P0713, P0716, P0717, P0722, P0723, P0742, P0751, P0756, P0757, P0973, P0974, P0976, P0977, P1915, or P182E is not set.
- High side driver is enabled.
- Engine speed is 400 RPM or greater for 5.0 seconds.
- Engine speed is 550 RPM or greater.
- Ignition voltage is 8.6 volts or greater.
- Transmission fluid temperature (TFT) is -7 to +120Â°C (19-248Â°F).

Conditions for Setting the DTC

P0877

The TCM detects that the TFP switch 4 signal voltage remains LOW after the 1-2-3-4 clutch transitions from a HIGH pressure state to a LOW pressure state. The TCM counts each incident. The DTC sets when 5 counts are accumulated.

P0878

The TCM detects that the TFP switch 4 signal voltage remains HIGH after the 1-2-3-4 clutch transitions from a LOW pressure state to a HIGH pressure state. The TCM counts each incident. The DTC sets when 8 counts are accumulated.

Action Taken When the DTC Sets

- DTCs P0877 and P0878 are Type C DTCs.
- TCM freezes transmission adaptive functions for the 1-2-3-4 clutch.

Conditions for Clearing the DTC

DTCs P0877 and P0878 are Type C DTCs.

Diagnostic Aids

A TFP switch may malfunction due to normal debris in the transmission fluid causing a TFP Switch DTC to intermittently set. This type of failure should not be immediately noticeable to a customer, as the switch outputs are used for shift adaptives and do not cause transmission symptoms unless the switch malfunctions continuously for an extended period of time.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Electronic Component Description** for control solenoid valve assembly

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Engine idling in Park with parking brake applied, and drive wheels chocked.
2. Verify with a scan tool the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameter states are correct for the Park, Reverse, and Neutral gear select lever positions. Refer to **Transmission Fluid Pressure Switch Logic** .
   - **If any parameter value is not correct for a given gear range**

     Refer to Circuit/System Testing below.

   - **If the parameter values are correct for all gear ranges**
3. Verify the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameter states are correct for each forward range with the gear select lever in Drive, using the scan tool to command all forward ranges. Refer to **Transmission Fluid Pressure Switch Logic**
   - **If any parameter value is not correct for a given gear range**

     Refer to Circuit/System Testing below.

   - **If the parameter values are correct for all gear ranges**
4. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Ignition OFF. Remove the Q8 control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
2. Place the Q8 control solenoid valve assembly on a clean work surface near the transmission assembly.
3. Connect the **DT-47825-20** harness between the vehicle wire harness X1 20-way transmission electrical connector, and the Q8 control solenoid valve assembly electrical connector.
4. Ignition ON, verify with a scan tool that the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameters change states when gently pushing on each TFP switch with the eraser end of a pencil.

- **If any TFP Switch parameter does not change states**

  Replace the Q8 control solenoid valve assembly.

- **If all TFP Switch parameters change states**

5. Inspect the channel plate, spacer plate, and filter plate for debris and blocked orifices.

Repair Instructions

NOTE:

- **Perform the Reset Transmission Adapts following all transmission related repairs.**
- **Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection.**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control solenoid valve assembly replacement, setup, or programming

DTC P0961-P0963: LINE PRESSURE CONTROL SOLENOID VALVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0961

Line Pressure Control Solenoid Valve Performance

DTC P0962

Line Pressure Control Solenoid Valve Control Circuit Low Voltage

DTC P0963

Line Pressure Control Solenoid Valve Control Circuit High Voltage

Circuit/System Description

The line pressure control solenoid is part of the control solenoid valve assembly which has no serviceable components. The normally high line pressure control solenoid regulates and directs the line pressure control solenoid oil pressure to the pressure regulator valve. Increasing line pressure control solenoid pressure increases transmission line pressure. The transmission control module (TCM) varies the current to the line pressure control solenoid by controlling the amount of time the low side driver is ON and OFF. Decreasing the ON time, decreases the current to the line pressure control solenoid, which increases line pressure control solenoid oil pressure by closing OFF the solenoid exhaust port. Increasing the current to the line pressure control solenoid decreases line pressure control oil pressure by opening the solenoid exhaust port. Line pressure control solenoid

power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P0961

TCM detects an internal electrical malfunction of the line pressure control solenoid where the measured line pressure control solenoid current does not equal the commanded line pressure control solenoid current for 5 s.

P0962

TCM detects a short to ground on the line pressure control solenoid control circuit for 2 s.

P0963

TCM detects an open or a short to voltage on the line pressure control solenoid control circuit for 5 s.

Action Taken When the DTC Sets

P0961 or P0963

- DTCs P0961 and P0963 are Type B DTCs.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.

P0962

- DTC P0962 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.
- TCM inhibits the torque converter clutch (TCC).
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM turns the high side driver OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM enables torque management.

Conditions for Clearing the DTC

- DTCs P0961 and P0963 are Type B DTCs.
- DTC P0962 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Engine running, transmission in Park. Move the gear shift lever into each gear position and back into Park position.
2. Verify the scan tool parameters listed below do not display Malfunction:
    - Line Pressure Control Solenoid Valve Performance Test Status
    - Line Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
    - Line Pressure Control Solenoid Valve Control Circuit High Voltage Test Status

- **If Malfunction is displayed**

  Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
5. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If contaminated**

     Repair as necessary.

   - **If not contaminated**
3. Verify the resistance of each solenoid is within the specified range for listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If the resistance is not within range**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
   - Line Pressure Control Solenoid Valve Performance Test Status
   - Line Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
   - Line Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If Malfunction is not displayed**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0965-P0967: PRESSURE CONTROL SOLENOID VALVE 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0965

Pressure Control Solenoid Valve 2 Performance

DTC P0966

Pressure Control Solenoid Valve 2 Control Circuit Low Voltage

DTC P0967

Pressure Control Solenoid Valve 2 Control Circuit High Voltage

Circuit/System Description

Pressure control solenoid 2 is part of the control solenoid valve assembly which has no serviceable components. The normally high pressure control solenoid 2 regulates and directs oil pressure to the 3-5 reverse clutch regulator valve. Increasing pressure to the 3-5 reverse clutch regulator valve increases pressure to the 3-5 reverse clutch. The transmission control module (TCM) varies the current to the pressure control solenoid 2 by controlling the amount of time the low side driver is ON and OFF. Decreasing the current to the pressure control solenoid 2 increases pressure control solenoid 2 oil pressure by closing OFF the solenoid exhaust port. Increasing the current to the pressure control solenoid 2 decreases pressure control solenoid 2 oil pressure by opening the solenoid exhaust port. Power to pressure control solenoid 2 is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P0965

TCM detects an internal electrical performance malfunction of the pressure control solenoid 2 control circuit where the measured pressure control solenoid 2 current does not equal the commanded pressure control solenoid 2 current for 5 s.

P0966

TCM detects a short to ground on the pressure control solenoid 2 control circuit for 1 s.

P0967

TCM detects an open or short to voltage on the pressure control solenoid 2 control circuit for 1 s.

Action Taken When the DTC Sets

P0965

- DTC P0965 is a Type C DTC.
- TCM freezes transmission adaptive functions on the 3-5-Reverse clutch.

P0966

- DTC P0966 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM turns the high side driver OFF.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM enables torque management.

P0967

- DTC P0967 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd gear operation.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

- DTC P0965 is a Type C DTC.
- DTCs P0966 and P0967 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3Â°C (5Â°F) rise in TCM temperature, then operate the vehicle in Park for 5 s.
2. Operate the vehicle in Drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
    - Pressure Control Solenoid Valve 2 Performance Test Status
    - Pressure Control Solenoid Valve 2 Control Circuit Low Voltage Test Status
    - Pressure Control Solenoid Valve 2 Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

Refer to Circuit/System Testing.

- **If Malfunction is not displayed**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If contaminated**

     Repair as necessary.

   - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If the resistance is not within range**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
   - Pressure Control Solenoid Valve 2 Performance Test Status
   - Pressure Control Solenoid Valve 2 Control Circuit Low Voltage Test Status
   - Pressure Control Solenoid Valve 2 Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for Control Solenoid Valve Assembly replacement, programming, and setup.

DTC P0969-P0971: PRESSURE CONTROL SOLENOID VALVE 3

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0969

Pressure Control Solenoid Valve 3 Performance

DTC P0970

Pressure Control Solenoid Valve 3 Control Circuit Low Voltage

DTC P0971

Pressure Control Solenoid Valve 3 Control Circuit High Voltage

Circuit/System Description

Pressure control solenoid 3 is part of the control solenoid valve assembly which has no serviceable components. The normally high pressure control solenoid 3 regulates and directs oil pressure to the R1/4-5-6 regulator valve. Increasing pressure control solenoid 3 pressure increases pressure to the low and reverse clutch or 4-5-6 clutch, depending on the position of the clutch select valve 2. The transmission control module (TCM) varies current to pressure control Solenoid 3 by controlling the time the low side driver is ON and OFF. Decreasing the current to pressure control solenoid 3 increases oil pressure by closing off the solenoid exhaust port. Increasing the current to the pressure control solenoid 3 decreases oil pressure by opening the exhaust port. Power is supplied to the pressure control solenoid 3 by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P0969

TCM detects an internal electrical performance malfunction of the clutch pressure control solenoid 3 control circuit where the measured clutch pressure control solenoid 3 currents does not equal the commanded clutch pressure control solenoid 3 current for 5 s.

P0970

TCM detects a short to ground on the clutch pressure control solenoid 3 control circuit for 1 s.

P0971

TCM detects an open or short to voltage on the clutch pressure control solenoid 3 control circuit for 1 s.

Action Taken When the DTC Sets

P0969

- DTC P0969 is a Type C DTC.
- TCM freezes transmission adaptive functions to the low and reverse clutch and 4-5-6 clutch.

P0970 or P0971

- DTCs P0970 and P0971 are Type A DTCs.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.
- TCM inhibits the torque converter clutch (TCC).
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM turns the high side driver OFF.
- TCM enables torque management.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

- DTC P0969 is a Type C DTC.
- DTCs P0970 and P0971 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3Â°C (5Â°F) rise in TCM temperature, then operate the vehicle with transmission in Park for 5 s.
2. Operate the vehicle in Drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
    - Pressure Control Solenoid Valve 3 Performance Test Status
    - Pressure Control Solenoid Valve 3 Control Circuit Low Voltage Test Status
    - Pressure Control Solenoid Valve 3 Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**

6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If contaminated**

     Repair as necessary.

   - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If the resistance is not within range**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
   - Pressure Control Solenoid Valve 3 Performance Test Status
   - Pressure Control Solenoid Valve 3 Control Circuit Low Voltage Test Status
   - Pressure Control Solenoid Valve 3 Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Replace the Q8 Control Solenoid Valve Assembly.

   - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0973 OR P0974: SHIFT SOLENOID VALVE 1

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0973

Shift Solenoid Valve 1 Control Circuit Low Voltage

DTC P0974

Shift Solenoid Valve 1 Control Circuit High Voltage

Circuit/System Description

Shift solenoid 1 is part of the control solenoid valve assembly, which has no serviceable components. Shift Solenoid 1 is a normally closed (NC) ON/OFF solenoid and is controlled by the transmission control module (TCM) through a low side driver. When the shift solenoid 1 is energized (ON), shift solenoid 1 fluid pressure is directed to the clutch select valve 2, which allows the valve to overcome the spring pressure and move to the applied position. Power to the shift solenoid 1 is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P0973

TCM detects a short to ground on the shift solenoid 1 control circuit for 2 s.

P0974

TCM detects an open or a short to power on the shift solenoid 1 control circuit for 2 s.

Action Taken When the DTC Sets

P0973

- DTC P0973 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd gear operation.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM inhibits auto grade braking

P0974

- DTC P0974 is a Type B DTC.
- TCM inhibits 1st gear.

Conditions for Clearing the DTC

- DTC P0973 is a Type A DTC.
- DTC P0974 is a Type B DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3Â°C (5Â°F) rise in TCM temperature, then operate the vehicle in Park for 5 s.
2. Place the gear selector in Reverse for 5 s and then idle the engine with the gear selector in Park for 5 s.
3. Verify the scan tool parameters listed below do not display Malfunction.
    - Shift Solenoid Valve 1 Control Circuit Low Voltage Test Status
    - Shift Solenoid Valve 1 Control Circuit Open Test Status
    - Shift Solenoid Valve 1 Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Refer to Circuit/System Testing.

    - **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
    - **If the DTC sets**

      Refer to Circuit/System Testing.

    - **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
    - **If contaminated**

      Repair as necessary.

    - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
    - **If the resistance is not within range**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:

- Shift Solenoid Valve 1 Control Circuit Low Voltage Test Status
- Shift Solenoid Valve 1 Control Circuit Open Test Status
- Shift Solenoid Valve 1 Control Circuit High Voltage Test Status
- **If Malfunction is displayed**

  Replace the Q8 Control Solenoid Valve Assembly.

- **If Malfunction is not displayed**

7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0976 OR P0977: SHIFT SOLENOID VALVE 2

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0976

Shift Solenoid Valve 2 Control Circuit Low Voltage

DTC P0977

Shift Solenoid Valve 2 Control Circuit High Voltage

Circuit/System Description

Shift solenoid 2 is part of the control solenoid valve assembly, which has no serviceable components. Shift solenoid 2 is a normally closed ON/OFF solenoid and is controlled by the transmission control module (TCM) through a low side driver. When the shift solenoid 2 is energized, fluid pressure is directed to the clutch select valve 3, which allows the valve to overcome the spring pressure and move to the applied position. Power to the shift solenoid 2 is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P0976

TCM detects a short to ground on the shift solenoid 2 control circuit for 2 s.

P0977

TCM detects an open or short to power on the shift solenoid 2 control circuit for 2 s.

Action Taken When the DTC Sets

P0976

- DTC P0976 is a Type C DTC.
- TCM freezes transmission adaptive functions.

P0977

- DTC P0977 is a Type A DTC.
- TCM limits the transmission to Reverse and 3rd gear operation.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function
- TCM inhibits manual shifting of forward gears

Conditions for Clearing the DTC

- DTC P0976 is a Type C DTC.
- DTC P0977 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in 3rd gear long enough to ensure at least a 3Â°C (5Â°F) rise in TCM temperature.
2. Place the gear selector in Reverse for 5 s and then idle the engine with the gear selector in Park for 5 s.
3. Verify the scan tool parameters listed below do not display Malfunction:
   - Shift Solenoid Valve 2 Control Circuit Low Voltage Test Status
   - Shift Solenoid Valve 2 Control Circuit Open Test Status
   - Shift Solenoid Valve 2 Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.

2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
    - **If contaminated**

      Repair as necessary.

    - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
    - **If the resistance is not within range**

      Replace the Q8 Control Solenoid valve Assembly.

    - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector, and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
    - Shift Solenoid Valve 2 Control Circuit Low Voltage Test Status
    - Shift Solenoid Valve 2 Control Circuit Open Test Status
    - Shift Solenoid Valve 2 Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P0989 OR P0990: TRANSMISSION FLUID PRESSURE SWITCH 5

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0989

Transmission Fluid Pressure Switch 5 Circuit Low Voltage

DTC P0990

Transmission Fluid Pressure Switch 5 Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
TFP Switch 1 Signal	P0842	P0843	P0843	-
TFP Switch 3 Signal	P0872	P0873	P0873	-
TFP Switch 4 Signal	P0877	P0878	P0878	-
TFP Switch 5 Signal	P0989	P0990	P0990	-

Typical Scan Tool Data

Transmission Fluid Pressure Switch 1

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 1 Signal	Low	High	High

Transmission Fluid Pressure Switch 3

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 3 Signal	Low	High	High

Transmission Fluid Pressure Switch 4

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 4 Signal	Low	High	High

Transmission Fluid Pressure Switch 5

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Engine running, normal operating temperature **Parameter Normal Range:** 12 volts = High, 0 volts = Low			
Transmission Fluid Pressure Switch 5 Signal	Low	High	High

Circuit/System Description

The transmission fluid pressure (TFP) switch 5 is part of the control solenoid valve assembly, which has no serviceable components. The transmission control module (TCM) supplies a signal circuit to the TFP switch 5. The TFP switch 5 has an internal case ground. TFP switch 5 is normally closed or LOW. When oil pressure is present at the TFP switch 5, the switch is open or HIGH. The normally high pressure control (PC) solenoid 3 controls pressure to the R1/4-5-6 clutch regular valve. The TCM monitors the TFP switch 5 signal circuit to determine the position of the R1/4-5-6 clutch regulator valve. When the low and reverse clutch and 4-5-6 clutch are commanded OFF, pressure is present on the TFP switch 5. When the low and reverse clutch or the 4-5-6 clutch is commanded ON, the R1/4-5-6 clutch regulator valve moves and pressure to the TFP switch 5 is exhausted through the R1/4-5-6 clutch regulator valve.

Conditions for Running the DTC

DTC P0989 or P0990

- DTC P0711, P0712, P0713, P0716, P0717, P0722, P0723, P0742, P0751, P0756, P0757, P0973, P0974, P0976, P0977, P182E, or P1915 is not set.
- Engine speed is 400 RPM or greater for 5 seconds.
- Engine speed is 550 RPM or greater.
- Ignition voltage is 8.6 volts or greater.
- Transmission fluid temperature (TFT) is -7 to +120Â°C (19-248Â°F).
- High side driver (HSD) is enabled.
- Gear Selector is in a forward range.

Conditions for Setting the DTC

P0989

The TCM detects that the TFP switch 5 signal voltage remains LOW after the low and reverse clutch or the 4-5-6 clutch transitions from a HIGH pressure state to a LOW pressure state. The TCM counts each incident. The DTC sets when 18 counts are accumulated.

P0990

The TCM detects that the TFP switch 5 signal voltage remains HIGH after the low and reverse clutch or the 4-5-6 clutch transitions from a LOW pressure state to a HIGH pressure state. The TCM counts each incident. The DTC sets when 15 counts are accumulated.

Action Taken When the DTC Sets

- DTCs P0989 and P0990 are Type C DTCs.
- TCM freezes transmission adaptive functions for the reverse and low clutch and the 4-5-6 clutch.

Conditions for Clearing the DTC

DTCs P0989 and P0990 are Type C DTCs.

Diagnostic Aids

A TFP switch may malfunction due to normal debris in the transmission fluid causing a TFP Switch DTC to intermittently set. This type of failure should not be immediately noticeable to a customer, as the switch outputs are used for shift adaptives and do not cause transmission symptoms unless the switch malfunctions continuously for an extended period of time.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Description and Operation

- **Transmission General Description**
- **Electronic Component Description** for control solenoid valve assembly

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Engine idling in Park with parking brake applied, and drive wheels chocked.
2. Verify with a scan tool the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameter states are correct for the Park, Reverse, and Neutral gear select lever positions. Refer to **Transmission Fluid Pressure Switch Logic** .
   - **If any parameter value is not correct for a given gear range**

     Refer to Circuit/System Testing below.

   - **If the parameter values are correct for all gear ranges**
3. Verify the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameter states are correct for each forward range with the gear select lever in Drive, using the scan tool to command all forward ranges. Refer to **Transmission Fluid Pressure Switch Logic**
   - **If any parameter value is not correct for a given gear range**

Refer to Circuit/System Testing below.

- **If the parameter values are correct for all gear ranges**

4. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF. Remove the Q8 control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
2. Place the Q8 control solenoid valve assembly on a clean work surface near the transmission assembly.
3. Connect the **DT-47825-20** harness between the vehicle wire harness X1 20-way transmission electrical connector, and the Q8 control solenoid valve assembly electrical connector.
4. Ignition ON, verify with a scan tool that the Transmission Fluid Pressure Switch 1, Transmission Fluid Pressure Switch 3, Transmission Fluid Pressure Switch 4, and Transmission Fluid Pressure Switch 5 parameters change states when gently pushing on each TFP switch with the eraser end of a pencil.
   - **If any TFP Switch parameter does not change states**

     Replace the Q8 control solenoid valve assembly.

   - **If all TFP Switch parameters change states**
5. Inspect channel plate, spacer plate, and filter plate for debris and blocked orifices.

Repair Instructions

NOTE:

- **Perform the Reset Transmission Adapts following all transmission related repairs.**
- **Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection.**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

Control Module References for control solenoid valve assembly replacement, setup, or programming

DTC P1761: UP AND DOWN SHIFT SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P1761

Up and Down Shift Switch Signal Circuit

Circuit/System Description

A signal circuit is provided by the body control module (BCM) to the resistor network embedded in the plus or minus buttons. When a plus or minus button is pressed, a corresponding voltage drop occurs across the resistor network. This voltage drop is monitored by the BCM. The BCM will send the request to the transmission control module (TCM) to perform the upshift or downshift. The TCM is constantly monitoring the serial data sent from the BCM for the correct number and sequence of counts for Tap Up and Tap Down function.

Conditions for Running the DTC

- The TCM rolling counter diagnostic is enabled.
- The Tap Up and Tap Down message health is received from the BCM.
- The engine speed is 400 RPM or greater for 5 s.

Conditions for Setting the DTC

The TCM detects an error in the rolling count value that does not match with the BCM count, 3 times within 10 s.

Action Taken When the DTC Sets

- DTC P1761 is a Type C DTC.
- The TCM inhibits Tap Up/Down function.
- The TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

DTC P1761 is a Type C DTC.

Reference Information

Schematic Reference

- **Automatic Transmission Controls Schematics**
- **Data Communication Schematics**
- **Body Control System Schematics**

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

Electronic Component Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. DTC P1761 is an informational DTC. Diagnose all other body control module DTCs prior to DTC P1761. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If there are no other body control DTCs, diagnosis is accomplished by looking for an intermittent CAN circuit fault. Refer to **Scan Tool Does Not Communicate with High Speed GMLAN Device** .
3. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, refer to **Testing for Intermittent Conditions and Poor Connections** .

Repair Instructions

- Perform the **Reset Transmission Adapts** following all transmission related repairs
- Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure

DTC P182E OR P1915: INTERNAL MODE SWITCH

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P182E

Internal Mode Switch Indicates Invalid Range

DTC P1915

Internal Mode Switch Does Not Indicate Park/Neutral During Start

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal A	P182E	P1915	P1915	P182E, P1915
Signal B	P1915	P182E	P182E	P182E, P1915
Signal C	P1915	P182E	P182E	P182E, P1915
Signal P	P182E	P1915	P1915	P182E, P1915
Ground	-	P182E	P182E	P182E, P1915

Typical Scan Tool Data

Internal Mode Switch A/B/C/P

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, range selector in Park **Parameter Normal Range:** Low High High Low			
Signal A	Low	High	High
Signal B	Low	High	High
Signal C	Low	High	High
Signal P	Low	High	High

Circuit/System Description

The manual shift detent lever with shaft position switch assembly, or internal mode switch assembly, is a sliding contact switch attached to the manual shift detent lever within the transmission. The 4 inputs to the transmission control module (TCM), from the switch, indicate the position selected by the transmission manual shaft. The input voltage at the TCM is high when the switch is open and low when the switch is closed to ground. The state of each input is displayed on the scan tool as the internal mode switch A/B/C/P parameter. The internal mode switch input parameters represented are transmission range Signal A, Signal B, Signal C, and Signal P.

The park/neutral position switch is integrated into the transmission internal mode switch. The circuit uses the TCM as a pass-through connector only.

The park/neutral signal is sent from the park/neutral switch directly to the engine control module (ECM) and is used for engine start enable.

Conditions for Running the DTC

P182E

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, or P0723 is not set.
- Engine speed is 400-7500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.
- Engine torque signal is valid.

P1915

- DTC P0722, P0723, or P1915 is not set.

- Transmission output shaft speed is 90 RPM or less.
- Ignition voltage was 5 V or greater, and has not dropped below 2 V.

Conditions for Setting the DTC

P182E

Internal mode switch does not indicate a valid Park, Reverse, Neutral or Drive Range gear position for 7 s.

P1915

Internal mode switch does not indicate Park or Neutral during the following sequence:

- Engine speed is 50 RPM or less for 0.25 s or greater.
- Engine speed is 50-480 RPM for 0.07 s or greater.
- Engine speed is 525 RPM or greater and the transmission input speed is 200 RPM or greater for 1.25 s.

Action Taken When the DTC Sets

- DTCs P182E and P1915 are Type A DTCs.
- TCM commands maximum line pressure.
- TCM forces the torque converter clutch (TCC) OFF.
- TCM turns all the solenoids OFF.
- TCM freezes transmission adaptive functions.
- TCM limits the transmission to Reverse and 5th gear operation.
- Torque management is enabled.
- TCM turns the high side driver OFF.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.

Conditions for Clearing the DTC

DTCs P182E and P1915 are Type A DTCs.

Diagnostic Aids

Under certain driving conditions, DTC P182E could set due to an intermittent low voltage fault on the park/neutral signal circuit, before conditions for setting DTC P0851 are met. Reference Information

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**

- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Verify the range selector lever cable is adjusted correctly. Refer to **Range Selector Lever Cable Adjustment** .
    - **If cable adjustment is not correct**

      Repair as necessary.

    - **If cable adjustment is correct**
2. Ignition ON.
3. Verify the scan tool transmission control module Internal Mode Switch A/B/C/P parameter matches the **Transmission Internal Mode Switch Logic** table for each gear shift lever position.
    - **If the parameter does not match**

      Refer to Circuit/System Testing.

    - **If the parameter matches**
4. Verify the scan tool engine control module Park/Neutral Position Switch parameter displays Park/Neutral with the gear shift lever in Park or Neutral and In Gear when in Reverser or Drive.

- **If Park/Neutral or In Gear is not displayed**

  Refer to Circuit/System Testing.

- **If Park/Neutral and In Gear is displayed**

5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE:

- **You must perform Circuit/System Verification first.**

1. Ignition OFF, remove the control valve body cover.
2. Connect the vehicle harness connector to the Q8 Control Solenoid Valve Assembly.
3. Disconnect the B15 Transmission Internal Mode Switch connector at the Q8 Control Solenoid Valve Assembly.
4. Ignition ON.
5. Verify the scan tool transmission control module Internal Mode Switch A/B/C/P parameter displays High High High High.
   - **If High High High High is not displayed**

     Replace the Q8 control solenoid valve assembly.

   - **If High High High High is displayed**
6. Verify the scan tool engine control module Park/Neutral Position Switch parameter displays In Gear.
   - **If In Gear is not displayed**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the neutral start signal circuit and ground at the vehicle harness K20 Engine Control Module connector.
   - If less than infinite resistance, repair the short to ground on the circuit
   - If infinite resistance, replace the K20 Engine Control Module
   - **If In Gear is displayed**
7. Install a 3 A fused jumper wire between the low reference circuit terminal A and each signal circuit listed below one at a time at the Q8 Control Solenoid Valve Assembly.
   - Signal A - terminal E
   - Signal B - terminal D
   - Signal C - terminal C

- Signal P - terminal B

8. Verify the scan tool TCM A/B/C/P displays 1 Low and 3 High when a signal circuit is grounded.
   - **If 1 Low and 3 High is not displayed**

     Replace the Q8 control solenoid valve assembly.

   - **If 1 Low and 3 High is displayed**
9. Connect a 3 A fused jumper wire between park/neutral switch signal circuit terminal F and low reference circuit terminal A at the Q8 Control Solenoid Valve Assembly.
10. Verify the scan tool engine control module Park/Neutral Position Switch parameter displays Park/Neutral.
    - **If Park/Neutral is not displayed**
    1. Ignition OFF, disconnect the connector at the K20 Engine Control Module.
    2. Test for less than 2 Ω in the signal circuit end to end
    - If 2 Ω or greater, repair the open/high resistance in the circuit
    - If less than 2 Ω, replace the K20 Engine Control Module
    - **If Park/Neutral is displayed**
11. Replace the B15 Transmission Internal Mode Switch.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Valve Body Cover Replacement**
- **Control Solenoid Valve and Transmission Control Module Assembly Replacement**
- **Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement**
- **Range Selector Lever Cable Adjustment**
- **Control Module References** for ECM or control solenoid valve assembly replacement, programming, and setup.

DTC P2714 OR P2715: PRESSURE CONTROL SOLENOID VALVE 4 STUCK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: **The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.**

DTC P2714

Pressure Control Solenoid Valve 4 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P2715

Pressure Control Solenoid Valve 4 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

The clutch pressure control (PC) solenoid 4 is part of the control solenoid valve assembly which has no serviceable components. The PC solenoid 4 regulates transmission fluid pressure to the 2-6 clutch regulator valve which controls pressure to the 2-6 clutch. The transmission control module (TCM) calculates gear ratio based on the RPM signals from the input speed sensor (ISS) and the output speed sensor (OSS). The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

P2714

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 8.6 volts or greater.
- Output speed is 36 RPM or greater, or throttle position is 0.5 percent or greater.
- Throttle position signal is valid.
- Engine speed is 400 RPM or greater for 5 seconds.
- Transmission fluid temperature is -7Â°C (19Â°F) or greater.
- High side driver (HSD) is enabled.

P2715

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 8.6 volts or greater.
- HSD is enabled.
- Transmission fluid temperature is -7Â°C (19Â°F) or greater.
- Engine speed is 400 RPM or greater for 5 seconds.
- Transmission output shaft speed is 36 RPM or greater, or the throttle position is 0.5 percent or greater.
- Commanded and attained range is not 1st gear.

Conditions for Setting the DTC

P2714

TCM has detected an incorrect gear ratio or neutral condition when the 2-6 clutch is commanded ON. This condition must occur 3 times.

P2715

TCM has detected an incorrect gear ratio change when the 2-6 clutch is commanded OFF during a shift or, when 2nd gear ratio is detected in 1st gear. This condition must occur 3 times.

Action Taken When the DTC Sets

P2714

- DTC P2714 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM freezes transmission adaptive functions.
- TCM limits the transmission to Reverse and 3rd gear operation.

P2715

- DTC P2715 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM freezes transmission adaptive functions.
- TCM limits the transmission to Reverse and 2nd gear operation.

Conditions for Clearing the DIC/DTC

DTCs P2714 and P2715 are Type A DTCs.

Reference Information

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

Transmission General Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

NOTE: If other DTCs are set, diagnose those DTCs first.

1. Engine idling in Park, with parking brake applied and drive wheels chocked.
2. Verify correct transmission fluid level and condition. Refer to **Transmission Fluid Level and Condition Check**.
3. Verify with a scan tool the Transmission Fluid Pressure Switch 3 parameter values are correct for the Park, Reverse, and Neutral gear selector positions. Refer to **Transmission Fluid Pressure Switch Logic** .
   - **If not the correct values for TFP switch 3**

     Refer to Circuit/System Testing below.

   - **If TFP switch 3 values are correct**
4. Place the gear select lever in Drive range. Verify the Transmission Fluid Pressure Switch 3 parameter states are correct for all forward ranges when commanded with a scan tool. Refer to **Transmission Fluid Pressure Switch Logic** .
   - **If not the correct values for TFP switch 3**

     Refer to Circuit/System Testing below.

   - **If TFP switch 3 values are correct**
5. Ignition ON, clear the TCM DTCs
6. Perform the **Road Test**. Verify the transmission operation performs as indicated in the road test instructions and DTC P2714 or P2715 did not set.
   - **If DTC P2714 or P2715 sets**

     Refer to Circuit/System Testing below.

   - **If DTC P2714 or P2715 did not set**
7. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Circuit/System Testing

NOTE: You must perform the Circuit/System Verification first.

1. Verify the transmission line pressures are within the ranges specified in the Line PC Solenoid Valve

Pressure table. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure** .

- **If line pressures are not within the specified ranges**

  Refer to **Fluid Pressure High or Low**.

- **If line pressures are within the specified ranges**

2. Ignition OFF, remove the Q8 control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
3. Perform the **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**. Test all solenoids on the Q8 control solenoid valve assembly. A pressure change should occur for each solenoid valve.
   - **If a pressure change does not occur for each solenoid**

     Replace the Q8 control solenoid valve assembly.

   - **If a pressure change occurs for each solenoid**
4. Verify the conditions listed below do not exist. Repair or replace as necessary.

P2714 or P2715 Control Valve Upper Body Assembly

2-6 clutch regulator valve stuck/sticking - debris, binding, damaged valve, or scored bore.

P2714 Lower Control Valve Body Assembly

Actuator feed limit circuit supply fluid to solenoid restricted or not available - debris or sediment blockage.

P2714 or P2715 Channel Plate and Spacer Plate

Oil channels or orifices blocked by debris.

P2714 or P2715 Control Solenoid Valve Assembly

- Clutch pressure control solenoid 4 stuck ON or stuck OFF.
- Control signal fluid supply leak - valve body filter plate assembly cracked or damaged gasket seal.
- Clutch pressure control solenoid 2 stuck OFF.

P2714 or P2715 Automatic Transmission Case Cover

- 2-6 clutch return spring retaining ring not seated in groove.
- 2-6 clutch piston assembly seal damaged or leaking.
- 2-6 clutch plates worn or damaged.

P2714 1-2-3-4 Clutch Plate Assembly

- 1-2-3-4 clutch backing plate retaining ring not seated/oriented correctly.
- 1-2-3-4 clutch piston seals damaged or leaking.
- 1-2-3-4 clutch piston cracked or damaged.

P2714 Automatic Transmission Fluid Pump Assembly

- Fluid pump housing/vanes/rotor/slide damaged/scored.
- A/Trans pump fluid outlet seal assembly damaged/leaking.

P2714 Automatic Transmission Fluid Filter Assembly

Oil filter or filter seal loose or damaged.

Repair Instructions

NOTE:

- **Perform the Reset Transmission Adapts following all transmission related repairs.**
- **Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection.**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Valve Lower Body and Upper Body Replacement**
- **Low and Reverse Clutch and 1-2-3-4 Clutch Plate Removal**
- **Control Module References** for control solenoid valve assembly replacement, setup, and programming

DTC P2719-P2721: PRESSURE CONTROL SOLENOID VALVE 4

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2719

Pressure Control Solenoid Valve 4 Performance

DTC P2720

Pressure Control Solenoid Valve 4 Control Circuit Low Voltage

DTC P2721

Pressure Control Solenoid Valve 4 Control Circuit High Voltage

Circuit/System Description

Pressure control solenoid 4 is part of the control solenoid valve assembly which has no serviceable components. The normally low pressure control solenoid 4 regulates and directs oil pressure to the 2-6 clutch regulator valve. Increasing pressure control solenoid 4 pressure increases pressure to the 2-6 clutch. The transmission control

module (TCM) varies current to the pressure control solenoid 4 by controlling the amount of time the low side driver is ON and OFF. Increasing the ON time increases current to the clutch pressure control solenoid 4. Increasing current to pressure control solenoid 4 increases oil pressure by closing off the solenoid exhaust port. Decreasing the current to the pressure control solenoid 4 decreases oil pressure by opening the exhaust port. Pressure control solenoid 4 power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P2719

TCM detects an internal electrical performance malfunction on the clutch pressure control 4 control circuit where the measured pressure control solenoid 4 current does not equal the commanded clutch pressure control solenoid 4 current for 5 s.

P2720

TCM detects a short to ground on the clutch pressure control solenoid 4 control circuit for 1 s.

P2721

TCM detects an open or short to voltage on the clutch pressure control solenoid 4 control circuit for 1 s.

Action Taken When the DTC Sets

P2719

- DTC P2719 is a Type C DTC.
- TCM freezes transmission adaptive functions on the 2-6 clutch.

P2720

- DTC P2720 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM commands 2nd gear if the transmission is in a forward gear and the output speed is less than 1350 RPM, or neutral if the output speed is 1,350 RPM or greater.

P2721

- DTC P2721 is a Type A DTC.

- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse and 3rd gear operation.

Conditions for Clearing the DTC

- DTC P2719 is a Type C DTC.
- DTCs P2720 and P2721 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3Â°C (5Â°F) rise in TCM temperature, then operate the vehicle in Park for 5 s.
2. Operate the vehicle in Drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
   - Pressure Control Solenoid Valve 4 Performance Test Status
   - Pressure Control Solenoid Valve 4 Control Circuit Low Voltage Test Status
   - Pressure Control Solenoid Valve 4 Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing

   - **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If contaminated**

     Repair as necessary.

   - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If the resistance is not within range**

     Replace the Q8 Control Solenoid Valve Assembly

   - **If the resistance is within range.**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector, and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.

6. Verify the scan tool parameters listed below do not display Malfunction:
    - Pressure Control Solenoid Valve 4 Performance Test Status
    - Pressure Control Solenoid Valve 4 Control Circuit Low Voltage Test Status
    - Pressure Control Solenoid Valve 4 Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P2723 OR P2724: PRESSURE CONTROL SOLENOID VALVE 5 STUCK

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

NOTE: **The DTCs listed below set due to a transmission hydraulic/mechanical condition. Perform the Circuit/System Verification and Circuit/System Testing to identify the cause.**

DTC P2723

Pressure Control Solenoid Valve 5 Stuck Off - Transmission Hydraulic/Mechanical Performance

DTC P2724

Pressure Control Solenoid Valve 5 Stuck On - Transmission Hydraulic/Mechanical Performance

Circuit/System Description

The clutch pressure control (PC) solenoid 5 is part of the control solenoid valve assembly which has no serviceable components. The clutch PC solenoid 5 regulates the transmission fluid pressure (TFP) to the 1-2-3-4 clutch regulator valve, which controls pressure to the 1-2-3-4 clutch. The transmission control module (TCM) calculates gear ratio based on the RPM signals from the input speed sensor (ISS) and the output speed sensor (OSS). The TCM compares the expected transmission gear ratio to the calculated gear ratio for each commanded gear.

Conditions for Running the DTC

P2723

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 8.6 volts or greater.
- High side driver (HSD) is enabled.
- Output speed is 36 RPM or greater, or the throttle position is 0.5 percent or greater.
- Throttle position signal is valid.
- Engine speed is 400 RPM or greater for 5 seconds.
- Transmission fluid temperature (TFT) is -7Â°C (19Â°F) or greater.

P2724

- DTC P0101, P0102, P0103, P0106, P0107, P0108, P0171, P0172, P0174, P0175, P0201, P0202, P0203, P0204, P0205, P0206, P0207, P0208, P0300, P0301, P0302, P0303, P0304, P0305, P0306, P0307, P0308, P0401, P042E, P0716, P0717, P0722, P0723, or P182E is not set.
- Ignition voltage is 8.6 volts or greater.
- HSD is enabled.
- TFT is -7Â°C (19Â°F) or greater.
- Output speed is 36 RPM or greater, or the throttle position is 0.5 percent or greater.
- Engine speed is 400 RPM or greater for 5 seconds.

Conditions for Setting the DTC

P2723

TCM has detected an incorrect gear ratio or neutral condition when the 1-2-3-4 clutch is commanded ON. This condition must occur 3 times.

P2724

TCM has detected an incorrect gear ratio change when the 1-2-3-4 clutch is commanded OFF during a shift. This condition must occur 3 times.

Action Taken When the DTC Sets

P2723

- DTC P2723 is a Type A DTC.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- Torque management is enabled.
- TCM limits the transmission to Reverse and fifth gear operation.

P2724

- DTC P2724 is a Type A DTC.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse, first, or third gear operation.

Conditions for Clearing the DIC/DTC

DTCs P2723 and P2724 are Type A DTCs.

Diagnostic Aids

Before performing a road test, configure and setup the scan tool for snapshot mode. This will allow you to display, monitor, and verify multiple transmission data parameters at one time, after the road test.

Reference Information

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

Transmission General Description

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: **Refer to Parking Brake and Drive Wheels Warning .**

NOTE: **If other DTCs are set, diagnose those DTCs first.**

1. Engine idling in Park, with parking brake applied and drive wheels chocked.
2. Verify correct transmission fluid level and condition. Refer to **Transmission Fluid Level and Condition Check**.
3. Verify with a scan tool the Transmission Fluid Pressure Switch 4 parameter values are correct for the Park, Reverse, and Neutral gear selector positions. Refer to **Transmission Fluid Pressure Switch Logic** .
    - **If not the correct values for TFP switch 4**

      Refer to Circuit/System below.

    - **If TFP switch 4 values are correct**
4. Gear select lever in Drive range. Verify the Transmission Fluid Pressure Switch 4 parameter states are correct for all forward ranges when commanded with a scan too. Refer to **Transmission Fluid Pressure Switch Logic** .
    - **If not the correct values for TFP switch 4**

      Refer to Circuit/system below.

    - **If TFP switch 4 values are correct**
5. Ignition ON, clear the DTCs from the TCM
6. Perform the **Road Test**. Verify the transmission operation performs as indicated in the road test instructions and DTC P2723 or P2724 did not set.
    - **If DTC P2723 or P2724 sets**

      Refer to Circuit/System below.

    - **If DTC P2723 or P2724 did not set**
7. After performing the above steps, verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Circuit/System Testing

1. Verify the transmission line pressures are within the ranges specified in the Line PC Solenoid Valve Pressure table. Refer to **Line Pressure Check**, and **Solenoid Valve Pressure** .
    - **If line pressures are not within the specified ranges**

      Refer to **Fluid Pressure High or Low**.

    - **If line pressures are within the specified ranges**
2. Ignition OFF, remove the Q8 control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
3. Perform the **Control Solenoid Valve and Transmission Control Module Assembly Solenoid Performance Test**. Test all solenoids on the Q8 control solenoid valve assembly. A pressure change should occur for each solenoid valve.

- **If a pressure change does not occur for each solenoid**

  Replace the Q8 control solenoid valve assembly.

- **If a pressure change occurs for each solenoid**

4. Verify the conditions listed below do not exist. Repair or replace as necessary.

DTC P2723 Control Valve Upper Body Assembly

Manual shift detent (w/shaft position switch) lever assembly not engaged with manual shaft.

DTC P2723 Control Valve Upper Body Assembly

Clutch select valve 3 stuck OFF from debris, binding, damaged valve, or scored bore.

DTC P2723 or P2724 Lower Control Valve Body Assembly

- Actuator feed limit circuit supply fluid to solenoid restricted or not available from debris or sediment blockage.
- 1-2-3-4 clutch boost valve binding or scored bore which can also cause harsh shifts.
- 1-2-3-4 clutch regulator valve stuck/sticking from debris, binding, damaged valve, or scored bore.

DTC P2723 or P2724 Control Solenoid Valve Assembly

- Clutch pressure control solenoid 5 stuck ON or stuck OFF.
- Clutch pressure control solenoid 2 stuck OFF.
- Control solenoid filter plate assembly blocked, or damaged gasket seal.

DTC P2723 Channel Plate and Spacer Plate

Channel plate and spacer plate oil channels or orifices blocked by debris.

DTC P2723 1-2-3-4 Clutch Assembly

- 1-2-3-4 clutch piston cracked/damaged/leaking.
- 1-2-3-4 clutch backing plate retaining ring not seated/oriented, causing clutch pack/piston over travel.

DTC P2723 Low and Reverse Clutch Assembly

- Low and reverse clutch assembly will not hold torque.
- Low and reverse clutch assembly friction plate support face cracked/damaged.

DTC P2723 Automatic Transmission Case

Transmission case 1-2-3-4 clutch fluid passage seal damaged/leaking.

DTC P2723 Automatic Transmission Fluid Pump

- Fluid pump housing vanes/rotor/slide damaged/scored.
- Fluid pump outlet seal assembly damaged/leaking.

DTC P2723 Torque Converter Assembly

Fluid pump or torque converter overstressed due to high temperatures.

DTC P2723 Automatic Transmission Fluid Filter Assembly

Oil filter or filter seal loose or damaged.

DTC P2723 Reaction Sun Gear Assembly

- Reaction sun gear broke away from shell.
- Input sun gear missing or broken.

Repair Instructions

NOTE:

- **Perform the Reset Transmission Adapts following all transmission related repairs.**
- **Before replacing the TCM, perform the Control Solenoid Valve and Transmission Control Module Assembly Inspection.**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Valve Lower Body and Upper Body Replacement**
- **Low and Reverse Clutch and 1-2-3-4 Clutch Plate Removal**
- **Control Module References** for control solenoid valve assembly replacement, setup, and programming

DTC P2728-P2730: PRESSURE CONTROL SOLENOID VALVE 5

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2728

Pressure Control Solenoid Valve 5 Performance

DTC P2729

Pressure Control Solenoid Valve 5 Control Circuit Low Voltage

DTC P2730

Pressure Control Solenoid Valve 5 Control Circuit High Voltage

Circuit/System Description

Pressure solenoid 5 is part of the control solenoid valve assembly which has no serviceable components. The normally low pressure control solenoid 5 regulates and directs oil pressure to the 1-2-3-4 clutch regulator valve. Increasing pressure control solenoid 5 pressure increases pressure to the 1-2-3-4 clutch. The transmission control module (TCM) varies the current to the pressure control solenoid 5 by controlling the amount of time the low side driver is ON and OFF. Decreasing the current to pressure control solenoid 5 decreases pressure control solenoid 5 oil pressure by opening the solenoid exhaust port. Increasing the current to pressure control solenoid 5 increases pressure control solenoid 5 oil pressure by closing OFF the solenoid exhaust port. Pressure control solenoid 5 power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

Conditions for Setting the DTC

P2728

TCM detects an internal electrical performance malfunction of the pressure control solenoid 5 control circuit where the measured pressure control solenoid 5 current does not equal the commanded pressure control solenoid 5 current for 5 s.

P2729

TCM detects a short to ground on the pressure control solenoid 5 control circuit for 1 s.

P2730

TCM detects an open or short to voltage on the pressure control solenoid 5 control circuit for 1 s.

Action Taken When the DTC Sets

P2728

- DTC P2728 is a Type C DTC.
- TCM freezes transmission adaptive functions on the 1-2-3-4 clutch.

P2729

- DTC P2729 is a Type A DTC.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse, 1st and 3rd gear operation.

P2730

- DTC P2730 is a Type A DTC.
- TCM inhibits the TCC.
- TCM forces the high side driver OFF.
- TCM commands maximum line pressure.
- TCM freezes transmission adaptive functions.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- Torque management in enabled.
- TCM limits the transmission to Reverse and 3rd or 5th gear operation.

Conditions for Clearing the DTC

- DTC P2728 is a Type C DTC.
- DTCs P2729 and P2730 are Type A DTCs.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3Â°C (5Â°F) rise in TCM temperature.
2. Operate the vehicle in Drive range. Allow the transmission to shift through all forward gear ranges.
3. Verify the scan tool parameters listed below do not display Malfunction:
   - Pressure Control Solenoid Valve 5 Performance Test Status
   - Pressure Control Solenoid Valve 5 Control Circuit Low Voltage Test Status
   - Pressure Control Solenoid Valve 5 Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If contaminated**

     Repair as necessary.

   - **If not contaminated**
3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If the resistance is not within range**

     Replace the Q8 Control Solenoid Valve Assembly.

- **If the resistance is within range**

4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector, and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
    - Pressure Control Solenoid Valve 5 Performance Test Status
    - Pressure Control Solenoid Valve 5 Control Circuit High Voltage Test Status
    - Pressure Control Solenoid Valve 5 Control Circuit Low Voltage Test Status
    - **If Malfunction is displayed**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

DTC P2762, P2763, OR P2764: TORQUE CONVERTER CLUTCH (TCC) PRESSURE CONTROL SOLENOID VALVE

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P2762

Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Performance

DTC P2763

Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Control Circuit High Voltage

DTC P2764

Torque Converter Clutch (TCC) Pressure Control Solenoid Valve Control Circuit Low Voltage

Circuit/System Description

The torque converter clutch (TCC) pressure control solenoid is part of the control solenoid valve assembly which has no serviceable components. The normally low TCC pressure control solenoid regulates oil pressure

to the TCC regulator valve and TCC control valve. Increasing TCC pressure control solenoid oil pressure increases oil pressure to the torque converter to apply the clutch. The transmission control module (TCM) varies the current to the TCC pressure control solenoid by controlling the amount of time the low side driver is ON and OFF. Increasing current to the TCC pressure control solenoid increases oil pressure by closing OFF the solenoid exhaust port. Decreasing current to the TCC pressure control solenoid decreases oil pressure by opening up the solenoid exhaust port. TCC pressure control solenoid power is supplied by the TCM through a high side driver. The high side driver protects the circuit and components from excessive current flow. If excessive current flow is detected, the high side driver will turn OFF. When the fault is corrected, the high side driver will reset.

Conditions for Running the DTC

P2762

- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.

P2763 and P2764

- DTC P0658 or P0659 is not set.
- Engine speed is 400-7,500 RPM for 5 s.
- Ignition voltage is 8.6-32 V.
- High side driver is enabled.

Conditions for Setting the DTC

P2762

TCM detects an internal electrical performance malfunction of the TCC pressure control solenoid control circuit where the measured TCC pressure control solenoid current does not equal the commanded TCC pressure control solenoid for 5 s.

P2763

TCM detects an open/high resistance or short to voltage on the TCC pressure control solenoid control circuit for 5 s.

P2764

TCM detects a short to ground on the TCC pressure control solenoid control circuit for 5 s.

Action Taken When the DTC Sets

P2762

DTC P2762 is a Type C DTC.

P2763

- DTC P2763 is a Type B DTC.

- TCM inhibits 6th gear.
- TCM forces TCC OFF.
- TCM commands the hot mode shift pattern.

P2764

- DTC P2764 is a Type A DTC.
- TCM inhibits TCC.
- TCM freezes transmission adaptive functions.
- TCM commands maximum line pressure.
- TCM inhibits Tap Up/Down function.
- TCM inhibits manual shifting of forward gears.
- TCM limits the transmission to Reverse and 5th gear operation.
- Torque management is enabled.
- TCM commands the high side driver OFF.

Conditions for Clearing the DTC

- DTC P2762 is a Type C DTC.
- DTC P2763 is a Type B DTC.
- DTC P2764 is a Type A DTC.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **Inline Harness Connector End Views**

Description and Operation

- **Transmission General Description**
- **Transmission Component and System Description**
- **Electronic Component Description**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

DT-47825-20 Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

Circuit/System Verification

1. Operate the vehicle in second gear long enough to ensure at least a 3Â°C (5Â°F) rise in TCM temperature.
2. Operate the vehicle in Drive range and ensure TCC is commanded ON for 1 min.
3. Verify the scan tool parameters listed below do not display Malfunction:
   - TCC Pressure Control Solenoid Valve Control Circuit Status
   - TCC Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
   - TCC Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification first.**

1. Ignition OFF, remove the Q8 Control Solenoid Valve Assembly.
2. Verify the Q8 Control Solenoid Valve Assembly is not contaminated with any debris and clean as necessary. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
   - **If contaminated**

     Repair as necessary.

- **If not contaminated.**

3. Verify the resistance is within the specified range for each solenoid listed in the **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.
    - **If the resistance is not within range**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If the resistance is within range**
4. Place the Q8 Control Solenoid Valve Assembly on a clean work surface near the transmission assembly.
5. Connect the **DT-47825-20** adapter harness between the vehicle harness connector, and the Q8 Control Solenoid Valve Assembly connector. Ignition ON.
6. Verify the scan tool parameters listed below do not display Malfunction:
    - TCC Pressure Control Solenoid Valve Control Circuit Status
    - TCC Pressure Control Solenoid Valve Control Circuit Low Voltage Test Status
    - TCC Pressure Control Solenoid Valve Control Circuit High Voltage Test Status
    - **If Malfunction is displayed**

      Replace the Q8 Control Solenoid Valve Assembly.

    - **If Malfunction is not displayed**
7. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repairs.

- Perform the **Reset Transmission Adapts** following all transmission repairs.
- **Control Module References** for control solenoid valve assembly replacement, programming, and setup.

SYMPTOMS - AUTOMATIC TRANSMISSION

NOTE: **Use the symptom tables only if the following conditions are met:**

- **Refer to Diagnostic Starting Point - Vehicle .**
- **There are no DTCs set.**
- **The control modules can communicate via the serial data link.**
- **Review the system operation in order to familiarize yourself with the system functions. Refer to Transmission General Description , and Transmission Component and System Description .**

Visual/Physical Inspection

Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- Fluid Diagnosis
  - **Transmission Fluid Level and Condition Check**
  - **Fluid Pressure High or Low**
  - **Automatic Transmission Fluid Leaks**
  - **Fluid Leak Diagnosis**
- Noise and Vibration Diagnosis
  - **Whine/Growl Noise**
  - **Noise and Vibration Analysis**
  - **Torque Converter Diagnosis**
- Range Performance Diagnosis
  - **No Park**
  - **No Drive in All Ranges**
  - **No Reverse Gear**
- Shift Quality Feel Diagnosis
  - **Harsh Garage Shift**
  - **Harsh or Late First, Second, Third, and Fourth Shift**
  - **Harsh First and Reverse Shift**
  - **Harsh or Late Second and Sixth Shift**
  - **Harsh or Late Third, Fifth, and Reverse Shift**
  - **Harsh Fourth, Fifth, and Sixth Shift**
- Shift Pattern
  - **No First and Reverse Gears**
  - **No First, Second, Third, and Fourth Gear**
  - **No Second and Sixth Gear**
  - **No Fourth, Fifth, and Sixth Gear**
  - **No Third, Fifth, and Reverse Gear**
- Torque Converter Diagnosis
  - **Torque Converter Diagnosis**
  - **No Torque Converter Clutch Apply**
  - **No Torque Converter Clutch Release**
- Symptom Not Found or No Symptom Detected
  - **Transmission Fluid Level and Condition Check**
  - **Road Test**

- Line Pressure Check

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY INSPECTION

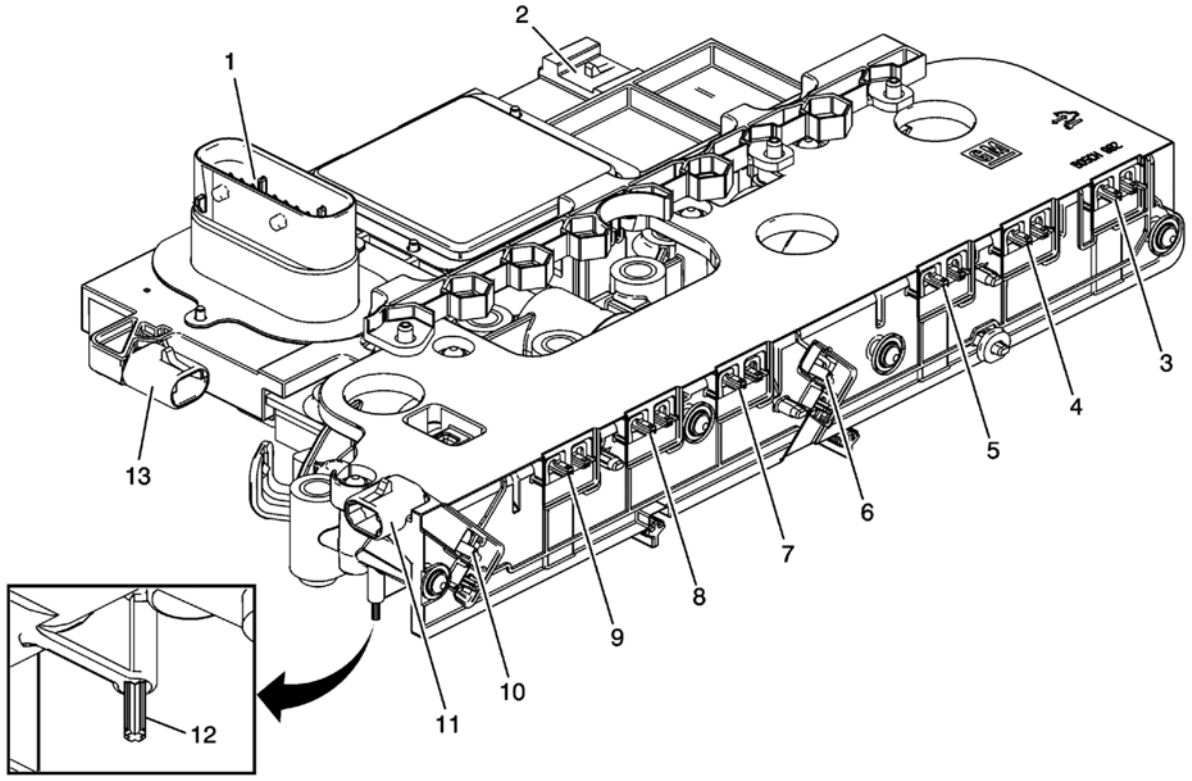


Fig. 1: Identifying Control Solenoid Valve & Transmission Control Module Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Inspect the control solenoid valve assembly connectors and pins (1, 2, 11, 13) for the following conditions:
   - Damage
   - Bent pins
   - Debris
   - Broken retaining tab
   - Contamination
2. Ensure no metallic debris is inside the connectors near the terminal pins.
3. Inspect the control solenoid valve assembly solenoid leads (3) for contamination or metallic debris.
4. Inspect the 4 control solenoid valve assembly filter plate retaining tabs (12) for cracks and ensure proper tension when filter plate is attached.

Solenoid Resistance

Solenoid Name	Illustration Number of Solenoid Lead	Expected Resistance (Ohms)
Line Pressure Control Solenoid	3	4.5-5.2 Ω

Solenoid Name	Illustration Number of Solenoid Lead	Expected Resistance (Ohms)
Pressure Control Solenoid 2 (PCS2)	5	4.5-5.2 Ω
Pressure Control Solenoid 3 (PCS3)	9	4.5-5.2 Ω
Pressure Control Solenoid 4 (PCS4)	4	4.5-5.2 Ω
Pressure Control Solenoid 5 (PCS5)	8	4.5-5.2 Ω
Shift Solenoid 1 (SS1)	10	22-25 Ω
Shift Solenoid 2 (SS2)	6	22-25 Ω
Torque Converter Clutch (TCC) Pressure Control Solenoid	7	4.5-5.2 Ω

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY INPUT SHAFT SPEED/OUTPUT SHAFT SPEED INPUT TEST

Special Tools

- **EL 35616** GM-Approved Terminal Test Kit
- **EL 38522** Variable Signal Generator

For equivalent regional tools, refer to **Special Tools** .

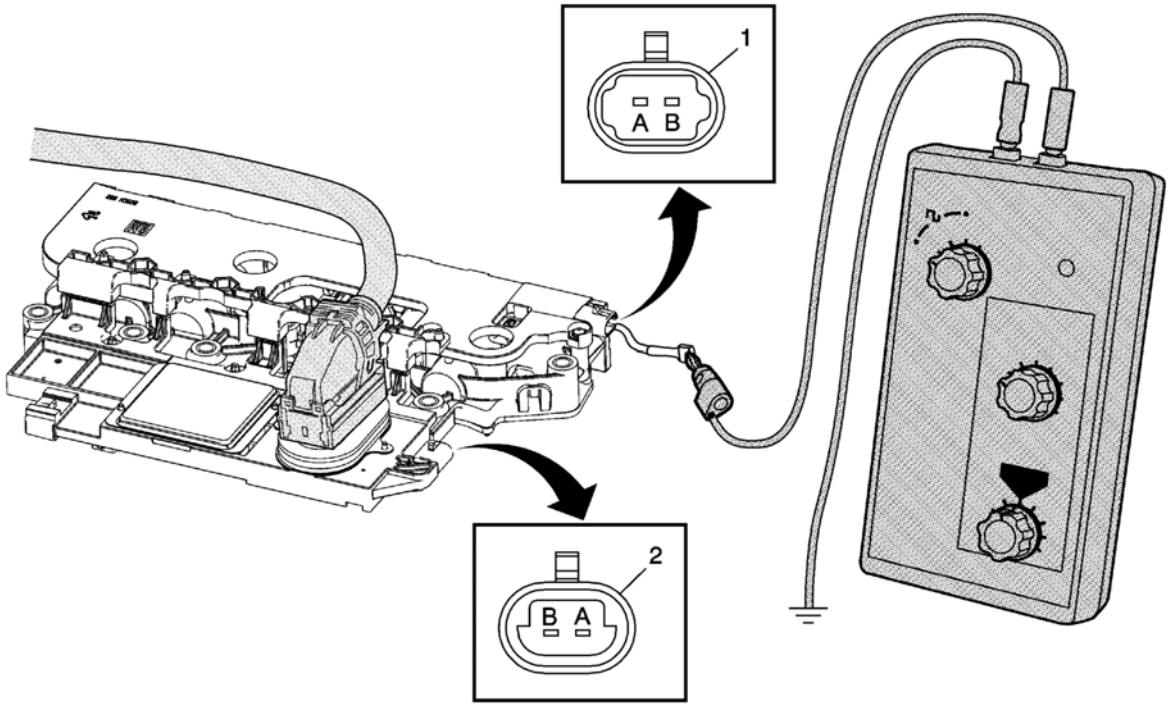


Fig. 2: Identifying Special Tools - J 38522 And J 35616
Courtesy of GENERAL MOTORS COMPANY

The purpose of this test is to provide a simulated input/output speed sensor (ISS/OSS) signal to the control solenoid valve assembly ISS/OSS input circuits.

Transmission Input Speed Sensor

1. Ignition OFF, disconnect the ISS wiring harness connector X3 (1) from the control solenoid valve assembly.
2. Ignition ON, test for 8.3-9.3 volts at terminal A.
    - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
3. Ignition OFF, using the **EL 35616** terminal test kit , connect the **EL38522** variable signal generator red lead to the ISS signal circuit terminal B on the TCM.
4. Connect the black lead from the **EL 38522** variable signal generator to ground.
5. Set the **EL 38522** variable signal generator to 5 volts, the frequency to 300 Hz, and the percent duty cycle to 50 or the normal position.
6. Ignition ON, verify with a scan tool the Transmission ISS parameter is between 495-505 RPM.

- If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .

Transmission Output Speed Sensor

1. Ignition OFF, disconnect the OSS wiring harness connector X4 (2) from the control solenoid valve assembly.
2. Ignition ON, test for 8.3-9.3 volts at terminal A.
    - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .
3. Ignition OFF, using the **EL 35616** terminal test kit , connect the **EL 38522** variable signal generator red lead to the OSS signal circuit terminal B on the TCM.
4. Connect the black lead from the **EL 38522** variable signal generator to ground.
5. Set the **EL 38522** variable signal generator to 5 volts, the frequency to 300 Hz, and the percent duty cycle to 50 or the normal position.
6. Ignition ON, verify with a scan tool the Transmission OSS parameter is between 256-266 RPM.
    - If not within the specified range, replace the control solenoid valve assembly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Replacement** .

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY SOLENOID PERFORMANCE TEST

Special Tools

- **DT-47825-100** Solenoid Test Plate
- **DT-47825-20** Adapter Harness

For equivalent regional tools, refer to **Special Tools** .

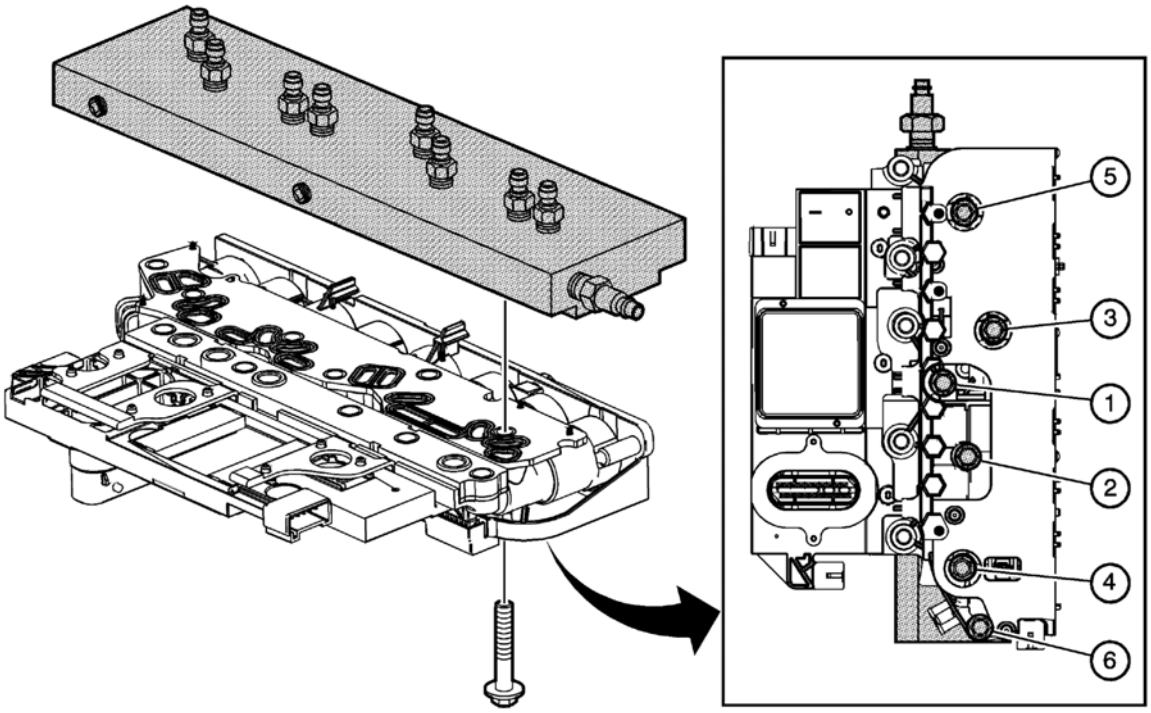


Fig. 3: Identifying Special Tool Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

The purpose of this procedure is to test the functionality of the control solenoid valve assembly solenoids for a gross stuck open or stuck closed condition. The **DT-47825-100** test plate is bolted to the control solenoid valve assembly on the valve body mounting surface. Pressurized air is passed into the aluminum test plate, through the control solenoid valve assembly solenoid passage and back to a pressure gauge on the test plate. The pressure gauge indicates open if air pressure is passed through the solenoid, or closed if the solenoid is unable to pass air through. A scan tool is used to command the solenoids ON and OFF. While watching the pressure gauge, one can determine the valve functionality. The recommended shop air pressure for this test is 90-100 psi.

1. Remove the control solenoid valve assembly from the transmission.
2. Bolt the **DT-47825-100** test plate to the control solenoid valve assembly on the valve body mounting surface. Use the bolts and washers supplied with the tool to attach the test plate. Tighten the bolts to 5 N.m (44 lb in) using a center out alternating torque sequence.
3. Install the pressure gauge to the affected solenoid air port. Reference component to air port table.
4. Connect the shop air pressure line to the **DT-47825-100** test plate test plate air psi inlet port.
5. Connect the **DT-47825-20** harness to the vehicle and control solenoid valve assembly.

CAUTION: Do not energize the solenoids for more than two minutes or the solenoids could be damaged.

6. Ignition ON, with a scan tool command the solenoid in question ON and OFF. Watch the air pressure gauge and look for the change in pressure as you command the valve ON and OFF. The valve should allow air pressure to flow through the valve port to the gauge with a result of pressure reading on the gauge. If the valve is stuck closed, no pressure change will occur. Command the solenoid valve ON and OFF several times to determine the state of the solenoid valve in question. Release the air pressure in the

gauge between pressurization tests.

Control Solenoid Valve Assembly Solenoid Performance Test Plate to Component Identification

Component	Port On Test Plate	Commanded State	
		ON	OFF
PC Solenoid 2, 35R	C	Full pressure to gauge	No pressure to gauge
PC Solenoid 3, R1/456	G	Full pressure to gauge	No pressure to gauge
PC Solenoid 4, 2-6	B	Full pressure to gauge	No pressure to gauge
PC Solenoid 5, 1234	F	Full pressure to gauge	No pressure to gauge
Shift Solenoid 1	H	Full pressure to gauge	No pressure to gauge
Shift Solenoid 2	D	Full pressure to gauge	No pressure to gauge
Line Pressure Control Solenoid	A	Command to highest setting, full pressure to gauge	Command to lowest setting, below 620.5 kPa (90 psi) to gauge
TCC PC Solenoid	E	Full pressure to gauge	No pressure to gauge

NOTE: **With the key ON, engine OFF (KOEO), the transmission control module (TCM) will normally cycle some of the transmission solenoids On and Off to facilitate keeping the ports and solenoids clean and free of debris. This dither function is a normal activity and will cause the valves to cycle open and closed quickly when the TCM is powered up. This can cause the psi gauge to flicker high and low as the valves open and close. This may cause some air to exit the ports where the psi gauge is not connected as those solenoids cycle on and off.**

Drain the TCM of excess transmission fluid before attaching to test plate and use caution when attaching air to test plate air inlet.

RESET TRANSMISSION ADAPTS

The Reset Transmission Adapts is a procedure for automatic transmissions in which the shift pressure learn values of each individual clutch is reset to zero or a base calibrated value, in the transmission control module (TCM).

Once the transmission adapts are set to zero or a calibrated value, the vehicle is then road test under various drive cycle events for the TCM to relearn shift pressure values for the best possible shift feel in all gear ranges.

The Reset Transmission Adapts procedure must be performed when one of the following repairs have been made to the transmission. Failure to perform the procedure after one of the following repairs may result in poor transmission performance, DTCs being set, or customer dissatisfaction.

- Transmission internal service, repair or overhaul
- Valve body repair or replacement
- Control solenoid valve assembly replacement
- Any service/repair in response to a shift quality concern

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustments, programming or setup procedures that are required when a component or

module is removed or replaced.

3. Clear the DTCs.
4. Ignition OFF, all vehicle systems OFF, this may take up to 2 minutes.

NOTE: **Do not cycle or turn the ignition switch OFF until directed to do so below.**

5. Ignition ON, engine running, with a scan tool Reset Transmission Adapts.
6. Perform the **Road Test**.
7. Ignition OFF for 2 minutes.

TRANSMISSION FLUID LEVEL AND CONDITION CHECK

This procedure checks both the transmission fluid level, as well as the condition of the fluid itself.

CAUTION: **Use DexronÂ® VI transmission fluid only. Failure to use the proper fluid may result in transmission internal damage.**

NOTE: **Ensure the transmission has enough fluid in it to safely start the vehicle without damaging the transmission. With the vehicle off there must be at least enough fluid to wet the end of the dipstick bullet. This will ensure that there is enough fluid in the sump to fill the components once the vehicle is started.**

Level Checking Procedure

1. Park the vehicle on a level surface, apply the parking brake and place the shift lever in PARK (P).
2. Start the engine.
3. Depress the brake pedal and move the shift lever through each gear range, pausing for about 3 seconds in each range. Then move the shift lever back to PARK (P).
4. Allow the engine to idle 500-800 rpm for at least 1 minute. Release the brake pedal.
5. Keep the engine running and observe the transmission fluid temperature (TFT) using the Driver Information Center or a scan tool.

NOTE: **If the fluid temperature is below the specified range, perform the following procedure to raise the fluid temperature to the specified range.**

6. If the TFT reading is not within the required temperature ranges, allow the vehicle to cool, or operate the vehicle until the appropriate TFT is reached.

   Drive the vehicle in second gear until the fluid temperature is within the specified range.

NOTE: **Check the transmission fluid level when the TFT is between 180Â°F and 200Â°F (82Â°C and 93Â°C). The fluid level rises as fluid temperature increases, so it is important to ensure the transmission fluid temperature is within range.**

7. Remove the dipstick and wipe it with a clean rag or paper towel.
8. Inspect the fluid color. The fluid should be red or dark brown.

- If the fluid color is very dark or black and has a burnt odor, inspect the fluid for excessive metal particles or other debris. A small amount of "friction" material is a "normal" condition. If large pieces and/or metal particles are noted in the fluid, flush the oil cooler and cooler lines and overhaul the transmission. If there are no signs of transmission internal damage noted, replace the fluid, repair the oil cooler, and flush the cooler lines.
- Fluid that is cloudy or milky or appears to be contaminated with water indicates engine coolant or water contamination. Refer to **Engine Coolant/Water in Transmission**.

9. Install the dipstick and tighten. Wait three seconds and then remove it again.

NOTE: **Always check the fluid level at least twice. Consistent readings are important to maintaining proper fluid level. If inconsistent readings are noted, inspect the transmission vent assembly to ensure it is clean and unclogged.**

NOTE: **It is not necessary to get the fluid level all the way up to the MAX mark. Anywhere within the crosshatch band is acceptable.**

10. Check both sides of the dipstick and read the lower level.
11. Install and remove the dipstick again to verify the reading.
12. If the fluid level is not within the crosshatch band, and the transmission temperature is between 180Â°F and 200Â°F (82Â°C and 93Â°C), add or drain fluid as necessary to bring the level into the crosshatch band. If the fluid level is low, add only enough fluid to bring the level into the crosshatch band.

NOTE: **Do not add more than one pint (0.5L) at a time without rechecking the level. Once the oil is on the dipstick bullet, it will not take much more fluid to raise the fluid level into the crosshatch band. Do not overfill. Also, if the fluid level is low, inspect the transmission for leaks. Refer to Fluid Leak Diagnosis.**

13. If the fluid level is in the acceptable range, install the dipstick.
14. If the fluid was changed, reset the transmission oil life monitor if applicable.

Fluid Condition Inspection

- Inspect the fluid color. The fluid should be red in color. The fluid may also turn brown form normal use, and does not always indicate contamination.

NOTE: **Fluid that is very dark or black and has a burnt odor usually indicates contamination or overheating.**

- If the fluid color is very dark or black and has a burnt odor, inspect the fluid for excessive metal particles or other debris which may indicate transmission damage. Refer to **Road Test** to verify transmission operation. Change the transmission fluid if no other conditions are found.
- Fluid that is cloudy or milky or appears to be contaminated with water indicates engine coolant or water contamination. Refer to **Engine Coolant/Water in Transmission**.

LINE PRESSURE CHECK

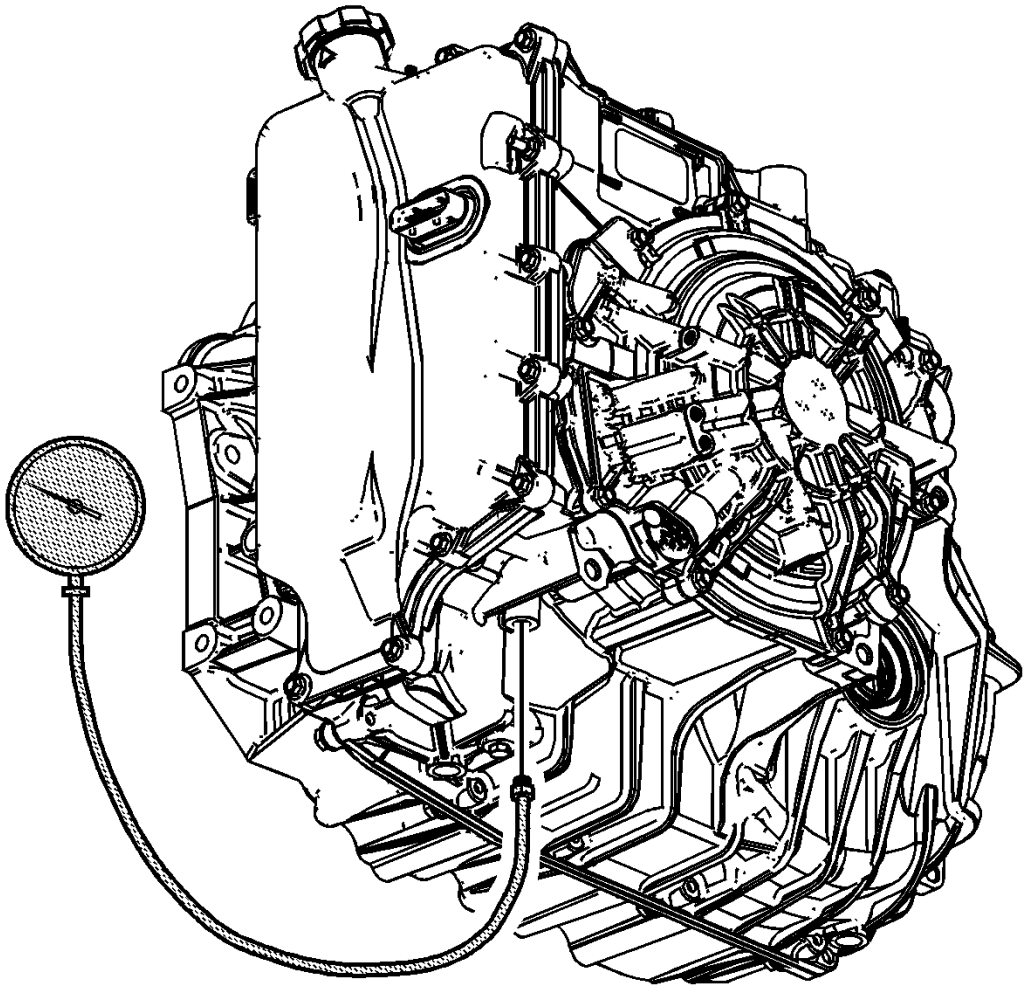


Fig. 4: Identifying Special Tool - J 21867
Courtesy of GENERAL MOTORS COMPANY

Special Tools

DT 21867-A Pressure Gauge

For equivalent regional tools, refer to **Special Tools** .

WARNING: Keep the brakes applied at all times in order to prevent unexpected vehicle motion. Personal injury may result if the vehicle moves unexpectedly.

1. Install a scan tool.
2. Start the engine.
3. Inspect the transmission for the proper fluid level. Refer to **Transmission Fluid Level and Condition Check**.
4. Use the scan tool to inspect for any active or stored diagnostic trouble codes.
5. Inspect the manual linkage at the transmission for proper function.
6. Turn the engine OFF.

7. Remove the line pressure test hole plug.
8. Install the **DT 21867-A** pressure gauge.
9. Access the Scan Tool Transmission Output Controls for the Line PC Solenoid.
10. Start the engine.

NOTE: **In order to achieve accurate line pressure readings, the following procedure must be performed at least 3 times in order to gather uniform pressure readings.**

The scan tool is only able to control the line PC solenoid in PARK and NEUTRAL with engine speeds below 1500 RPM. This protects the clutches from extreme high or low line pressures.

11. Use the scan tool to increase and decrease the Line PC Solenoid in increments of approximately 200 KPa (29 psi). The scan tool commands the increment values automatically.
12. Allow the pressure to stabilize between increments.
13. Compare the pressure readings on the **DT 21867-A** pressure gauge to the actual pressure values in the solenoid valve pressure chart. Refer to **Solenoid Valve Pressure** .
14. If the pressure readings vary greatly, refer to **Fluid Pressure High or Low**.
15. Turn the engine OFF.
16. Remove the **DT 21867-A** pressure gauge.

CAUTION: **Refer to Fastener Caution .**

17. Install the line pressure test hole plug and tighten to 12 N.m (106 lb in).

ROAD TEST

The following test provides a method of evaluating the condition of the automatic transmission. The test is structured so that most driving conditions would be achieved. The test is divided into the following parts:

- Electrical Function Check
- Upshift Control and Torque Converter Clutch (TCC) Apply
- Part Throttle Step-In Downshifts
- Manual Downshifts
- Coasting Downshifts
- Manual Gear Range Selection
  - REVERSE
  - Driver Shift Control

NOTE: **Complete the test in the sequence given. Incomplete testing cannot guarantee an accurate evaluation.**

Before the road test, ensure the following:

- The engine is performing properly.
- Transmission fluid level is correct. Refer to **Transmission Fluid Level and Condition Check**.
- Tire pressure is correct.

During the road test:

- Perform the test only when traffic conditions permit.
- Operate the vehicle in a controlled, safe manner.
- Observe all traffic regulations.
- View the scan tool data while conducting this test.

  Take along qualified help in order to operate the vehicle safely.

- Observe any unusual sounds or smells.

After the road test, check the following:

- Inspect for proper transmission fluid level. Refer to **Transmission Fluid Level and Condition Check**.
- Inspect for any diagnostic trouble codes (DTCs) that may have set during the testing. Refer to the applicable DTC.
- Monitor the scan tool data for any abnormal readings or data.
- Inspect for fluid leaks. Refer to **Fluid Leak Diagnosis**.

Electrical Function Check

Perform this procedure first in order to ensure the electronic transmission components are functioning properly. If these components are not checked, a simple electrical condition could be misdiagnosed.

1. Connect the scan tool.
2. Ensure the gear selector is in PARK and set the parking brake.
3. Start the engine.
4. Verify that the following scan tool data can be obtained and is functioning properly.

   Refer to **Control Module References** for typical data values. Data that is questionable may indicate a concern.

   - Engine Speed
   - Transmission ISS
   - Transmission OSS
   - Vehicle Speed
   - IMS
   - Commanded Gear
   - Gear Ratio
   - Line PC Sol. Pressure Cmd.
   - Brake Switch

- ECT, Engine Data List
- Trans. Fluid Temp.
- TCM Temperature
- Calc. Throttle Position
- Ignition Voltage
- TFP Switch 1
- TFP Switch 3
- TFP Switch 4
- TFP Switch 5
- PC Sol. 2 Pressure Cmd.
- PC Sol. 3 Pressure Cmd.
- PC Sol. 4 Pressure Cmd.
- PC Sol. 5 Pressure Cmd.
- Shift Solenoid 1
- Shift Solenoid 2
- TCC PC Sol. Duty Cycle
- TCC Slip Speed

5. Check the garage shifts.
    1. Apply the brake pedal and ensure the parking brake is set.
    2. Move the gear selector through the following ranges:
        1. PARK to REVERSE
        2. REVERSE to NEUTRAL
        3. NEUTRAL to DRIVE
        4. DRIVE to REVERSE
        5. REVERSE to DRIVE
    3. Pause 2 to 3 seconds in each gear position.
    4. Verify the gear engagements are immediate (less than 2 seconds to complete if trans fluid temperature is above 20Â°C) and not harsh. Note that these shifts may be almost imperceptible in some applications. Using the scan tool to monitor Transmission ISS achieving 0 RPM can be used to check delay in these cases.

NOTE: **Harsh engagement may be caused by any of the following conditions:**

- **High engine idle speed-Compare engine idle speed to desired idle speed.**
- **Incorrect line pressure-Investigate Line PC Sol. Pressure Cmd. kPa (psi), also perform Line Pressure Check.**
- **A default condition caused by certain DTCs that result in maximum line pressure to prevent clutch slippage.**
- **Incomplete adapting or incorrect adapting-Repeat maneuver multiple times to see if shift quality improves. If it does not, refer to the**

service procedures for Harsh Garage Shift, and for Harsh First and Reverse Shift.

NOTE: **Delayed engagement may be caused by any of the following conditions:**

- **Low idle speed-Compare engine idle speed to desired idle speed.**
- **Low fluid level**
- **Incorrect line pressure-Investigate Line PC Sol. Pressure Cmd. kPa (psi), also perform Line Pressure Check.**
- **Cold transmission fluid temperature (TFT)-Use the scan tool to determine TFT.**
- **Selector linkage-Inspect and adjust as necessary.**
- **Incomplete adapting or incorrect adapting-Repeat maneuver multiple times to see if delay improves. If it does not, refer to the service procedures for Harsh First and Reverse Shift.**

6. Monitor transmission range on the scan tool, transmission data list.
    1. Apply the brake pedal and ensure the parking brake is set.
    2. Move the gear selector through all ranges.
    3. Pause 2 to 3 seconds in each range.
    4. Return gear selector to PARK.
    5. Verify that all selector positions match the scan tool display.
7. Check throttle position input.
    1. Apply the brake pedal and ensure the parking brake is set.
    2. Ensure the gear selector is in PARK.
    3. Monitor the scan tool Calc. Throttle Position while increasing and decreasing engine speed with the throttle pedal. The scan tool Calc. Throttle Position percentage should increase and decrease with engine speed.

If any of the above checks do not perform properly, record the result for reference after completion of the road test.

Upshift Control and Torque Converter Clutch (TCC) Apply

The TCM calculates the upshift points based primarily on 2 inputs: throttle position and vehicle speed. When the TCM determines that conditions are met for a shift to occur, the TCM commands the shift by varying current to the appropriate PC solenoids to control oncoming and offgoing clutch pressures.

Perform the following steps:

1. Monitor the following scan tool parameters:
    - Calc. Throttle Position
    - Vehicle Speed
    - Engine Speed

- Transmission ISS
- Transmission OSS
- Commanded Gear
- TCC PC Sol. Pressure Cmd.
- TCC Slip Speed
- TFP Switch 1
- TFP Switch 3
- TFP Switch 4
- TFP Switch 5
- PC Sol. 2 Pressure Cmd.
- PC Sol. 3 Pressure Cmd.
- PC Sol. 4 Pressure Cmd.
- PC Sol. 5 Pressure Cmd.
- Shift Solenoid 1 and 2

2. Place the gear selector in the DRIVE position.
3. Accelerate the vehicle using a steady throttle position between 15 and 20 percent. Hold the throttle steady.
4. As the transmission upshifts, there should be a noticeable shift feel or engine speed change within 1 to 2 seconds of the commanded gear change. The PC solenoid pressure command should change to "YES" for the oncoming clutch and the PC solenoid pressure command should change to "NO" for the offgoing clutch.
5. Note any harsh, soft or delayed shifts or slipping. Note any noise or vibration.
6. The TCC feel may not be noticeable. In many applications the TCC will apply after the 1-2 shift and TCC events will not be easily detected using engine speed.

NOTE: **This transmission is equipped with an electronically controlled capacity clutch (ECCC), which allows operation of the clutch without fully locking to the torque converter cover. The clutch maintains a small amount of slippage, approximately 20 RPM, in 2nd, 3rd, 4th, 5th, and 6th gears, depending on the vehicle application. ECCC was developed to reduce the possibility of noise, vibration or chuggle caused by TCC apply. Full lockup is available at highway speeds on some applications.**

7. Monitor TCC PC solenoid pressure command while driving and check TCC slip speed when the pressure command indicates that the TCC is commanded to apply:

   When the TCC applies, slip speed should be controlled to below 100 RPM when the transmission is not shifting and the throttle is held steady. If the TCC slip exceeds this value for more than 6 seconds after the TCC PC Sol. Pressure Command indicates that the TCC is commanded ON:

   - Check for DTCs.
   - Refer to **Torque Converter Diagnosis**.

Part Throttle Step-In Downshifts

1. Place the gear selector in the DRIVE position.
2. Accelerate the vehicle at light throttle (5-15 percent) until 3rd gear is just achieved.
3. Quickly increase throttle angle until commanded gear indicates that a downshift to 2nd gear is commanded.
4. Verify that the transmission downshifts within 2 seconds of the throttle movement.
5. Repeat steps 2 to 4 at higher speed to achieve 4th gear and then step in to command a 4th gear to 3rd gear downshift.
6. Repeat steps 2 to 4 at higher speed to achieve 5th gear and then step in to command a 5th gear to 4th gear downshift.
7. Repeat steps 2 to 4 at higher speed to achieve 6th gear and then step in to command a 6th gear to 5th gear downshift.
8. Note any harsh, soft or delayed shifts or slipping. Note any noise or vibration.

Manual Downshifts

Manual downshift testing is not required since all vehicles equipped are also equipped with some form of Driver Shift Control (DSC). The TCM will automatically override DSC downshifts to protect the transmission from damage.

Coasting Downshifts

1. Place the gear selector in the DRIVE position.
2. Accelerate the vehicle to 6th gear with the TCC applied.
3. Release the throttle and apply the brakes
4. Verify that the downshifts occur as commanded by monitoring gear ratio, which should change after commanded gear changes.

Manual Gear Range Selection

This application does not utilize manual forward gear ranges.

Reverse

Perform the following test using a 10-15 percent throttle position.

1. With the vehicle stopped, move the gear selector to REVERSE.
2. Slowly accelerate the vehicle.
3. Verify that there is no noticeable slip, noise or vibration.

Driver Shift Control (DSC)

Refer to the owner's manual for specific instructions on the type of DSC available in this application. Utilize the DSC to ensure that the transmission responds appropriately to driver's commands. The TCM will upshift automatically when maximum engine speed is achieved and will protect from any downshift which may cause excessive engine RPM.

TORQUE CONVERTER DIAGNOSIS

Torque Converter Stator

The torque converter stator roller clutch can have 2 different malfunctions.

- The stator assembly freewheels in both directions.
- The stator assembly remains locked up in both directions.

Poor Acceleration at Low Speed - Stator Roller Clutch Freewheels at All Times

If the stator is freewheeling at all times, the vehicle tends to have poor acceleration from a standstill and at speeds below 48-55 km/h (30-34 mph). At speeds above 48-55 km/h (30-34 mph), the vehicle may act normally.

For poor acceleration at low speeds, you should first determine that the exhaust system is not blocked, and the transmission is in First gear when starting out. If the engine freely accelerates to high RPM in NEUTRAL, you can assume that the engine and the exhaust system are normal. Check for poor performance in DRIVE and REVERSE to help determine if the stator is freewheeling at all times.

Poor Acceleration at High Speed - Stator Roller Clutch is Locked Up at All Times

If the stator is locked up at all times, performance is normal when accelerating from a standstill. Engine RPM and vehicle speed are limited or restricted at speeds above 48-55 km/h (30-34 mph). Visual examination of the converter may reveal a blue color from overheating.

Torque Converter Bearing Noise

NOTE: **Do not confuse this noise with pump whine noise, which is usually noticeable in all gear ranges. Pump whine will vary with line pressure.**

Torque converter whine is noticed when the vehicle is stopped and the transmission is in DRIVE or REVERSE. This noise will increase as you increase the engine RPM. The noise will stop when the vehicle is moving or when you apply the torque converter clutch, because there is no slip speed across the bearings.

Perform a stall test to verify that the noise is actually coming from the torque converter:

1. Place your foot on the brake.
2. Put the gear selector in DRIVE.

CAUTION: **You may damage the transmission if you depress the accelerator for more than 6 seconds.**

3. Depress the accelerator to approximately 1,200 RPM for no more than six seconds.

A torque converter noise will increase under this load.

Torque Converter Clutch

The torque converter clutch (TCC) is applied by fluid pressure, which is controlled by a TCC pressure control (PC) solenoid. This solenoid is part of the control solenoid valve assembly, which is located inside the automatic transmission assembly. The solenoid is controlled through a combination of computer controlled switches and sensors. Electronically controlled capacity clutch (ECCC) is controlled slip across the TCC.

Torque Converter Clutch Shudder

The key to diagnosing torque converter clutch (TCC) shudder is to note when it happens and under what conditions. TCC shudder should only occur during the apply, release, or ECCC conditions of the converter clutch. Shudder should never occur after the TCC is fully locked (approximately 0 RPM slip).

If Shudder Occurs During TCC Apply, Release, and ECCC

If the shudder occurs while the TCC is applying, the problem can be within the transmission or the torque converter. Something is causing one of the following conditions to occur:

- The clutch is not engaging completely.
- The clutch is not releasing completely.
- The clutch is releasing and applying rapidly and continuously.

One of the following conditions may be causing the TCC Shudder to occur:

- Leaking turbine shaft/TCC seals
- A restricted release orifice
- A distorted clutch or converter cover due to long flexplate to converter bolts
- Defective friction material on the TCC plate

If Shudder Occurs After TCC has Locked

Engine problems may go unnoticed under light throttle and load, but they become noticeable after the TCC has locked when going up a hill or accelerating.

Refer to **Symptoms - Engine Controls** in order to avoid misdiagnosis of TCC shudder and the unnecessary disassembly of a transmission or the unnecessary replacement of a torque converter.

Torque Converter Vibration Test

NOTE: **The Noise and Vibration Analysis procedure should be performed prior to performing this test.**

Indexing Torque Converter

To determine and correct a torque converter vibration, the following procedure may have to be performed several times to achieve the best possible torque converter to flexplate balance.

1. Remove the torque converter bolts.
2. Rotate the torque converter one bolt position from the original marked position.

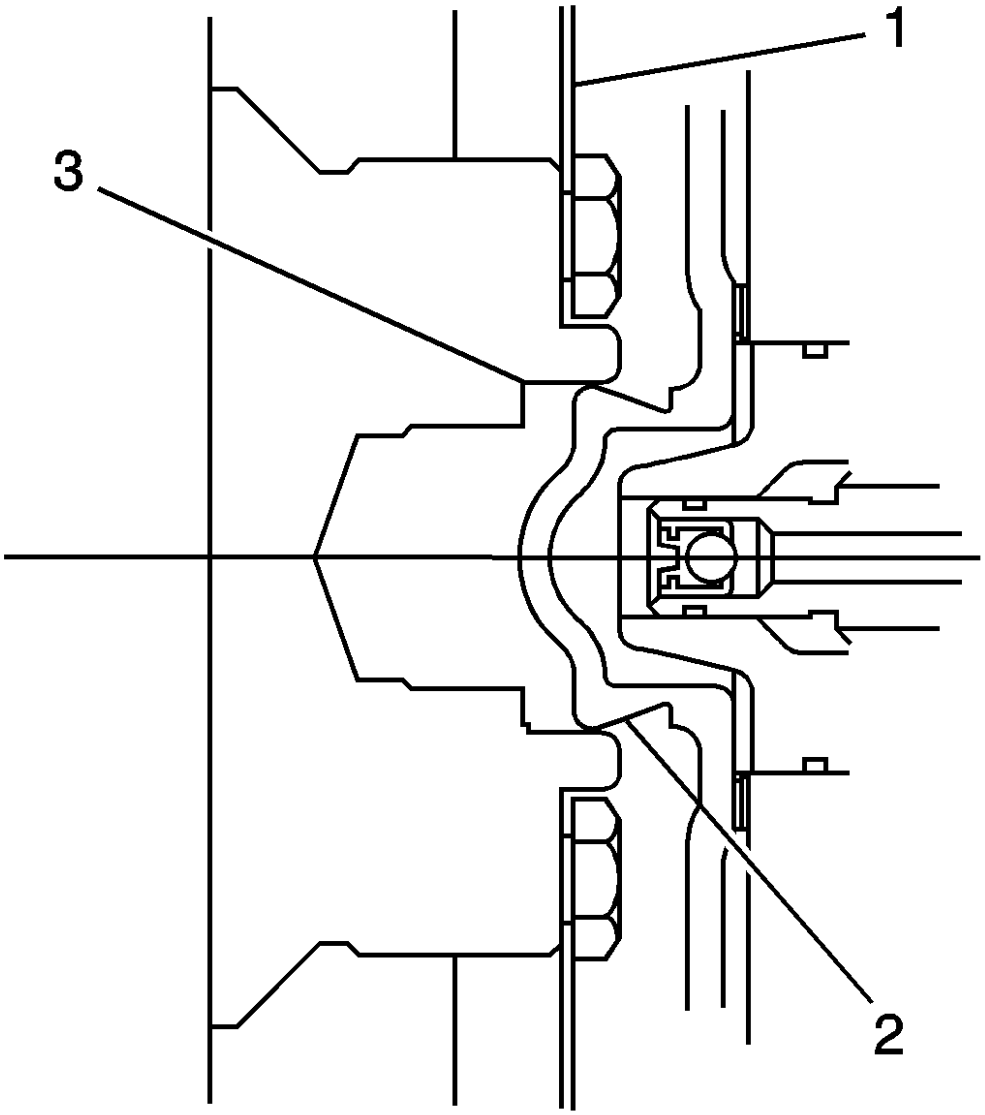


Fig. 5: View Of Torque Converter Hub In Engine Crankshaft
Courtesy of GENERAL MOTORS COMPANY

CAUTION: When installing the torque converter to the flexplate, make sure to use specified bolts. DO NOT use longer bolts. Using longer bolts will result in deformation of the torque converter cover and cause internal damage.

CAUTION: Refer to Fastener Caution .

3. Align the torque converter pilot (2) in the engine crankshaft (3). Install the torque converter to flexplate bolts, and tighten according to **Fastener Specifications (Off Vehicle)** .
4. Lower the vehicle.
5. With the engine at idle speed and the transmission in PARK or NEUTRAL, observe the vibration.

   Repeat this procedure until the best possible balance is obtained.

6. Install the torque converter access cover and bolts (if equipped) and tighten according to **Fastener Specifications (Off Vehicle)** .

Torque Converter Replacement Guide

Condition	Action
• Transmission Fluid Oxidized/Discolored • Clutch Fiber Material	Do not replace the torque converter. Refer to **Transmission Fluid Level and Condition Check**.
Transmission Fluid Contaminated with Metal Particles	**NOTE:** **Do not replace the torque converter for clutch system or gearset component damage. Fine metallic debris or clutch plate material that is suspended in the fluid will not cause damage to the internal torque converter components nor any internal transmission components.**
Harsh Gear Shifts	Do not replace the torque converter. Refer to **Symptoms - Automatic Transmission**.
Noise-Whine	• Refer to **Symptoms - Automatic Transmission**. • Do not replace the torque converter if noise is present in Neutral/Park. Refer to **Symptoms - Engine Mechanical** .
Vibration-Out of Balance	Refer to Torque Converter Vibration Test in this procedure.
No Drive/Slips in Drive	Do not replace the torque converter until completing all engine and transmission diagnostics.

Condition	Action
Idle Surge/Rough Idle	Do not replace the torque converter. Refer to **Symptoms - Engine Controls**
TCC Apply/Release Shudder	Do not replace the torque converter. Refer to Torque Converter Clutch Shudder in this procedure.
TCC Chuggle	Do not replace the torque converter. Refer to **Symptoms - Engine Controls** .
DTC P0741-TCC Stuck OFF/High Slip-Intermittent Only	Do not replace the torque converter. Refer to **DTC P0741 or P0742** diagnostic table.
DTC P0741-TCC Stuck OFF/High Slip	Do not replace the torque converter. Refer to **DTC P0741 or P0742** diagnostic table.
DTC P0742-TCC Stuck ON	Do not replace the torque converter. Refer to **DTC P0741 or P0742** diagnostic table.
Transmission Fluid Contaminated with Sludge/Metal Particles as a result of: • Engine Coolant/Oil • Pump damage • Drive sprocket support damage • Turbine/stator shaft damage • Internal converter damage with no damage found in the transmission	Replace the torque converter.
Poor Acceleration above 48 km/h (30 mph) - Good Launch	Do not replace the torque converter until completing all engine and transmission diagnostics. • Refer to Torque Converter Stator in this procedure. • Refer to **Symptoms - Engine Controls** .
Poor Launch - Good Acceleration above 48 km/h (30 mph)	Do not replace the torque converter until completing all engine and transmission diagnostics. • Refer to Torque Converter Stator in this procedure. • Refer to **Symptoms - Engine Controls** .
Stripped Converter Bolt Holes	• Replace the torque converter. • Inspect flexplate and refer to **Lower Engine Noise, Regardless of Engine Speed** .
Torque Converter Pilot Damaged	Replace the torque converter.

Condition	Action
Torque Converter Hub surface is damaged - scored, raised/transferred metal.	Replace the torque converter.
External Leaks in the weld areas - hub, lug or closure weld.	Replace the torque converter.
Broken/Cracked Flexplate	Replace the torque converter.
Torque Converter Discolored/Overheated	Replace the torque converter.

CLUTCH PLATE DIAGNOSIS

Composition Plates

Dry the plates and inspect the plates for the following conditions:

- Pitting
- Flaking
- Delamination-splitting or separation of bonded clutch material
- Wear
- Glazing
- Cracking
- Charring
- Chips or metal particles embedded in the lining

Replace a composition plate which shows any of these conditions.

Steel Plates

Wipe the plates dry and check the plates for heat discoloration. If the surfaces are smooth, even if color smear is indicated, you can reuse the plate. If the plate is discolored with heat spots or if the surface is scuffed, replace the plate.

Causes of Burned Clutch Plates

The following conditions can result in a burned clutch plate:

- Incorrect usage of clutch or apply plates
- Engine coolant or water in the transmission fluid
- A cracked clutch piston
- Damaged or missing seals
- Low line pressure
- Valve body conditions
    - The valve body face is not flat.
    - Porosity in between channels.
    - The valve train retainers are improperly installed.
    - The checkballs are misplaced.

- The TeflonÂ® seal rings are worn or damaged.

ENGINE COOLANT/WATER IN TRANSMISSION

CAUTION: The antifreeze or water will deteriorate the seals, gaskets and the glue that bonds the clutch material to the pressure plate. Both conditions may cause damage to the transmission.

If antifreeze or water has entered the transmission, perform the following:

1. Disassemble the transmission.
2. Replace all of the rubber type seals. The coolant will attack the seal material which will cause leakage.
3. Replace the composition-faced clutch plate assemblies. The facing material may separate from the steel center portion.
4. Replace all of the nylon parts - washers.
5. Replace the torque converter.
6. Thoroughly clean and rebuild the transmission, using new gaskets and oil filter.
7. Flush the cooler lines after the transmission cooler has been properly repaired or replaced.
8. Inspect the rubber hose portion of the oil cooler lines for damage, if applicable. Refer to **Transmission Fluid Cooler Flushing and Flow Test** .

FLUID LEAK DIAGNOSIS

General Method

1. Verify that the leak is transmission fluid.

   CAUTION: Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.

2. Thoroughly clean the suspected leak area using a rag.

   NOTE: Do not idle vehicle, this will not actuate transmission systems, and do not drive the vehicle on the freeway as this will splatter oil inhibiting leak diagnosis.

3. Operate the vehicle for 15-20 minutes under city driving conditions until normal operating temperatures are reached.
4. Park the vehicle over clean paper or cardboard.
5. Shut OFF the engine.
6. Look for fluid spots on the paper.
7. Make the necessary repairs.

Powder Method

CAUTION: Do not clean using brake cleaner or other reactive solvents as these solvents can damage rubber gaskets, seals and bushings.

1. Thoroughly clean the suspected leak area using a rag.
2. Apply an aerosol type leak tracing powder to the suspected leak area.

NOTE: **Do not idle vehicle, this will not actuate transmission systems, and do not drive the vehicle on the freeway as this will splatter oil inhibiting leak diagnosis.**

3. Operate the vehicle for 15-20 minutes under city driving conditions until normal operating temperatures are reached.
4. Shut OFF the engine.
5. Inspect the suspected leak area.
6. Trace the leak path through the powder in order to find the source of the leak.
7. Make the necessary repairs.

Dye and Black Light Method

A fluid dye and black light kit is available from various tool manufacturers.

1. Follow the manufacturer's instructions in order to determine the amount of dye to use.
2. Operate the vehicle for 24 km (15 mi) or until normal operating temperatures are reached.
3. Detect the leak with the black light.
4. Make the necessary repairs.

Find the Cause of the Leak

Pinpoint the leak and trace the leak back to the source. You must determine the cause of the leak in order to repair the leak properly. For example, if you replace a gasket, but the sealing flange is bent, the new gasket will not repair the leak. You must also repair the bent flange. Before you attempt to repair a leak, check for the following conditions, and make repairs as necessary:

Gaskets

- Fluid level/pressure is too high
- Plugged vent or drain-back holes
- Improperly tightened fasteners
- Dirty or damaged threads
- Warped flanges or sealing surface
- Scratches, burrs, or other damage to the sealing surface
- Damaged or worn gasket
- Cracking or porosity of the component
- Improper sealant used, where applicable
- Incorrect gasket

Seals

- Fluid level/pressure is too high

- Plugged vent or drain-back holes
- Damaged seal bore
- Damaged or worn seal
- Improper installation
- Cracks in component
- Manual shaft or output shaft surface is scratched, nicked, or damaged
- Loose or worn bearing causing excess seal wear

Possible Points of Fluid Leaks

Transmission Case Cover and/or Valve Body Cover

- Incorrectly tightened bolts
- Improperly installed or damaged gasket/seal
- Damaged mounting face
- Incorrect gasket seal

Case Leak

- Damaged input speed sensor seal
- Damaged manual shaft seal
- Loose or damaged oil cooler lines/seals
- Worn or damaged axle shaft oil seal
- Loose line pressure pipe plug or fluid level pipe plug
- Porous casting
- Warped torque converter housing
- Damaged converter housing to case seal

Leak at the Torque Converter End

- Converter leak in the weld area
- Converter seal lip cut. Check the converter hub for damage
- Converter seal bushing moved forward and damaged
- Converter seal garter spring missing from the seal
- Porous casting of the torque converter housing

Leak at the Vent

- Overfilled system
- Water or coolant in the fluid; The fluid will appear milky
- Transmission case porous
- Incorrect fluid level indicator causing an overfilled system
- Plugged vent

Leak Inspection Points

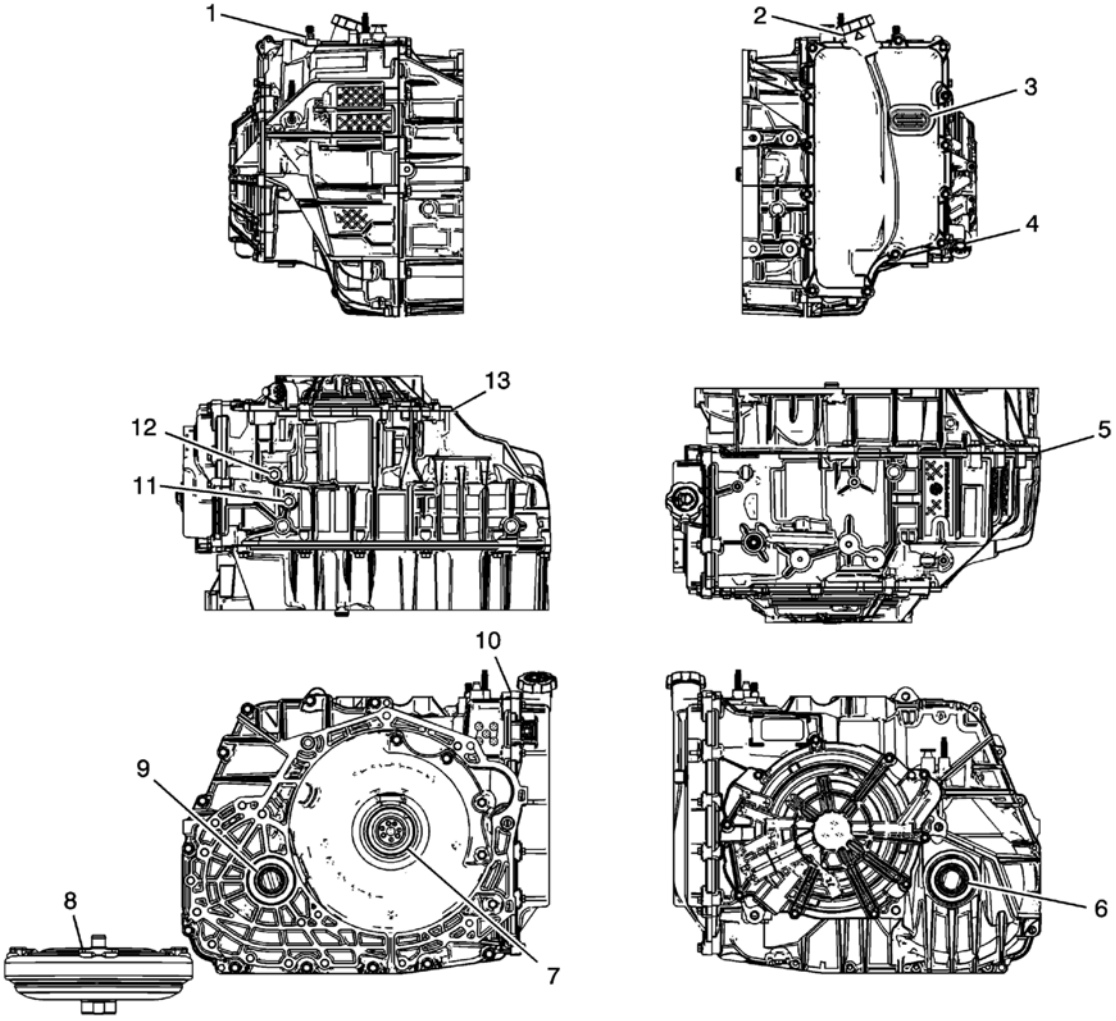


Fig. 6: Identifying Leak Inspection Points
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Manual Shift Shaft Seal
2	Automatic Transmission Vent
3	Control Valve Body Cover Wiring Connector Hole Seal
4	Input Speed Sensor Seal
5	Converter Housing to Case Joint
6	Front Wheel Drive Shaft Oil Seal Assembly - Case
7	Torque Converter Fluid Seal Assembly
8	Torque Converter Assembly
9	Front Wheel Drive Shaft Oil Seal Assembly - Torque Converter Housing
10	Control Valve Body Cover Assembly Gasket
11	Fluid Level Hole Plug
12	Fluid Pressure Hole Plug
13	Case Cover Gasket

CASE POROSITY REPAIR

Some external leaks are caused by case porosity in non-pressurized areas.

1. Thoroughly clean the area to be repaired with a cleaning solvent. Air dry the area.

   WARNING: Epoxy adhesive may cause skin irritations and eye damage. Read and follow all information on the container label as provided by the manufacturer.

2. Using instructions from the manufacturer, mix a sufficient amount of an epoxy to make the repair.
3. Apply the epoxy. A clean, dry soldering acid brush can be used to clean the area and also to apply the epoxy cement. Make certain that the area to be repaired is fully covered.
4. Allow the epoxy cement to cure for three hours before assembling the components.
5. Repeat the fluid leak diagnosis procedures.

BUSHING AND MATING SHAFT INSPECTION

NOTE: Proper bushing and corresponding mating shaft inspection should be performed before replacing the bushing, shaft, and in some cases, the component which houses the bushing. Thoroughly clean and dry the bushing and shaft surfaces before inspecting for damage.

Any of the following bushing conditions require replacement of the bushing and/or housing:

- Discoloration due to heat distress
- Misalignment or displacement of bushing as a result of spinning in housing
- Medium to heavy scoring that can be easily detected with fingernail. Light scoring is a normal condition.
- Debris embedded into the bushing lining material
- Obvious damage, including excessive and uneven wear
- Excessive polishing. Minor polishing of the bushing is an indication of normal wear and does not require replacement.

Any of the following conditions require replacement of the bushing's mating shaft:

- Discoloration due to heat distress
- Rough surface finish that can be easily detected with finger
- Obvious shaft abnormalities, including warping or uneven surfaces
- Obvious damage or cracking

NOISE AND VIBRATION ANALYSIS

A noise or vibration that is noticeable when the vehicle is in motion MAY NOT be the result of the transmission.

If noise or vibration is noticeable in PARK and NEUTRAL with the engine at idle, but is less noticeable as RPM increases, the vibration may be a result of poor engine performance.

- Vibration may also be caused by a small amount of water inside the converter.
- Inspect the engine and transmission mounts for damage and loose bolts.
- Inspect the transmission case mounting holes for the following conditions:
  - Missing bolts, nuts, and studs
  - Stripped threads
  - Cracks
- Inspect the flywheel for the following conditions:
  - Missing or loose bolts
  - Cracks
  - Imbalance
- Inspect the torque converter for the following conditions:
  - Missing or loose bolts or lugs
  - Missing or loose balance weights
  - Imbalance caused by heat distortion or fluid contamination
- If the noise or vibration is noticeable in PARK and NEUTRAL with the engine at idle, but is more noticeable as RPM increases, the vibration may be an engine imbalance or a transmission imbalance. Refer to **Torque Converter Diagnosis**.

WHINE/GROWL NOISE

Checks	Causes
Front Differential Drive Pinion Gear Assembly (23)	• Inspect for worn wheel bearings or axles. • Inspect for proper Taper Roller Bearing Pre-load • Inspect for loose or worn transfer Driven Gear
Differential Assembly (486)	• Inspect for worn wheel bearings or axles. • Inspect for proper Taper Roller Bearing Pre-load • Inspect for worn or damaged Side Gear Thrust Washer (492) or Pinion Gear Thrust Washer (488) • Inspect for loose or worn Side Gear Axle Splines
Input Carrier Assembly (470)	• Inspect for worn or damaged Pinion Gear Thrust Washers and Bushings • Inspect for worn or damaged Pinion Gears, Pins or Needle Bearings • Inspect for loose Hub and Ring Gear
Output Carrier Assembly (474)	• Inspect for worn or damaged Pinion Gear Thrust Washers and Bushings • Inspect for worn or damaged Pinion Gears, Pins or Needle Bearings

Checks	Causes
	• Inspect for loose Hub and Ring Gear
Reaction Carrier Assembly (467)	• Inspect for worn or damaged Pinion Gear Thrust Washers and Bushings • Inspect for worn or damaged Pinion Gears, Pins or Needle Bearings • Inspect for loose hub and Ring Gear
Fluid Pump Assembly (203)	• Inspect for proper fluid level • Inspect for loose or worn Drive Link Assembly (218) • Inspect for worn Driven Sprocket Thrust Washer (214) or Drive Sprocket Thrust Washers (219, 220) • Inspect for leaking Transfer Drive Gear Support Seal (213), Pump Fluid Outlet Seal Assembly (57) or Filter Seal (202) • Inspect for worn or damaged Fluid Pump Shaft Splines
3-5-Reverse Clutch Assembly	• Inspect for inadequate Clutch Plate Clearance • Inspect for loose or worn Clutch Plate Splines (423-425) • Inspect for loose or worn Clutch Spring Retainer (427) • Inspect for loose Speed Sensor Reluctor Wheel (416) or Retainer (415)
4-5-6 Clutch Assembly	• Inspect for inadequate Clutch Plate Clearance • Inspect for loose or worn Clutch Plate Splines (449, 440) • Inspect for loose or worn Clutch Spring Retainer (442) • Inspect for loose or worn 3-5-Reverse/4-5-6 Clutch Housing Bushing
1-2-3-4 Clutch Assembly	• Inspect for inadequate Clutch Plate Clearance • Inspect for loose or worn Clutch Plate Splines (456-458) • Inspect for loose or worn Clutch Spring Retainer (459)
Low and Reverse Clutch Assembly (OWC) (455)	• Inspect for loose or worn Splines (455) • Inspect for loose or worn Retainer (454)
Low and Reverse Clutch	• Inspect for inadequate Clutch Plate Clearance • Inspect for loose or worn Clutch Plate Splines (449-452) • Inspect for loose or worn Clutch Spring Retainer (410)

Checks	Causes
2-6 Clutch Assembly	• Inspect for inadequate Clutch Plate Clearance • Inspect for loose or worn Clutch Plate Splines (445-447) • Inspect for loose or worn Clutch Spring Retainer (407)
Case Assembly (51)	• Inspect for loose or broken Transmission Mount Bolts • Inspect for loose Torque Converter and Differential Housing Bolts (26) • Inspect for loose or broken Fluid Trough Bolts (56)

AUTOMATIC TRANSMISSION FLUID LEAKS

Checks	Causes
Torque Converter (27)	Inspect for damage.
Case Assembly (21)	• Inspect for porosity or damage on the sealing surfaces • Inspect for loose Oil Cooler Line Bolts or damaged Oil Cooler Line Seals • Inspect for damaged Manual Shift Shaft Seal (58) • Inspect for damaged or worn Axle Seal (61) or Axle Seal Slinger on the axle shafts • Inspect for loose Pressure Test Plug (62) and Fluid Level Plug (63)
Torque Converter Housing Assembly (221)	• Inspect for damaged Torque Converter Housing Assembly (25) • Inspect for porosity or damage on the sealing surfaces • Inspect for damaged Torque Converter Housing Seal (22) • Inspect for damaged or worn Torque Converter Fluid Seal (225) • Inspect for loose Torque Converter and Differential Housing Bolts (26) • Inspect for damaged or worn Axle Seal (226) or Axle Seal Slingers on the axle shafts
Case Cover assembly (34)	• Inspect for porosity or damage on the sealing surface • Inspect for damaged Case Cover Gasket (33) • Inpsect for loose Case Cover Assembly Bolts (35) • Inspect for loose Input Speed Sensor (ISS) Bolt (401) • Inspect for damaged Input Speed Sensor (ISS) Seal (402) • Inspect for loose, damaged or leaking Case Cover Assembly bore plugs

SHIFT INDICATOR INDICATES WRONG GEAR SELECTION

Checks	Causes
Shift Cable	• Inspect for damage. • Verify proper attachment to shifter. • Verify cable is locked into shifter bracket. • Verify cable is properly attached to the transmission. • Verify that the cable is locked into the transmission bracket.
Manual Shaft	• Verify shift lever is properly attached to the manual shaft. • Verify manual shaft is not twisted or damaged.
Manual Shift Detent Lever with Shaft Position Switch Assembly, IMS	Verify proper operation. Refer to **Transmission Internal Mode Switch Logic** .

NO PARK

Checks	Causes
Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly (481)	• Inspect for broken or stripped Park Gear splines • Inspect for broken or worn Park Gear
Front Differential Carrier Assembly (486)	Inspect for damaged, broken or loose Front Differential Ring Gear
Output Carrier Transfer Drive Gear Hub Assembly (477)	• Inspect for worn, stripped or broken splines • Inspect for disengaged hub to Transfer Drive Gear
Reaction Carrier Assembly (467)	• Inspect for worn, stripped or broken splines • Inspect for disengaged to the Output Sun Gear (475)
Case Assembly (507)	• Inspect for broken or damaged Case • Inspect for loose or stripped Park Pawl Actuator Bracket Bolts (500) • Inspect for broken or bent Park Pawl Actuator Bracket (501) • Inspect for broken or missing Park Pawl Actuator Guide Pin (505) or Manual Shaft Pin (510) • Inspect for broken, loose or misaligned Park Pawl Guide (506) • Inspect for binding or broken Park Pawl (503) or Actuator Assembly (509)
Manual Shift Detent Lever Assembly (511)	Inspect for broken or disengaged Manual Valve Link Pin

HARSH GARAGE SHIFT

Checks	Causes
Input Carrier Assembly (470)	Inspect for worn or stripped ring gear splines
Case Assembly (51)	• Check the engine for diagnostic codes. If the engine controller signals the transmission that engine torque is inaccurate, the transmission will command high line pressure. • Check line pressure at idle is below 800 kPa. • Inspect for stuck valves in the lower valve body, particularly the boost valves. • Inspect for damaged or fatigued 1-2-3-4 clutch wave plate (458) and low and reverse clutch wave plate (450). • Inspect for stripped or worn splines on 1-2-3-4 clutch plate (456). • Inspect for improperly positioned or plugged low reverse piston (408) air bleed. • Inspect for correct fluid level.
Low and Reverse Clutch Assembly (OWC) (455)	Inspect for stripped or sheared internal and external splines on the low and reverse clutch assembly (455).

NO DRIVE IN ALL RANGES

Checks	Causes
For an explanation of which clutches are applied during the transmission gear ranges, refer to **Range Reference** .	
Case Assembly (51)	• Inspect for cracked or broken Case (51) • Inspect for stripped or sheared splines • Inspect for binding Manual Shift Detent Lever Assembly (511) • Inspect for missing Manual Shift Shaft Pin (510) • Inspect for interference or binding Park Pawl Actuator Assembly (509) • Inspect for disengaged or broken 1-2-3-4 Clutch Piston Spring Retainer (459) • Inspect for loose or damaged case bushing. • Inspect for missing Lube Orifice Plug
Torque Converter (29)	• Inspect for stripped or sheared splines on Turbine Shaft • Inspect for missing Torque Converter to Flywheel bolts.

Checks	Causes
Torque Converter Housing (221)	• Inspect for loose, missing or broken Torque Converter and Differential Housing bolts (26). • Inspect for loose, missing or broken Fluid Pump bolts (204).
35R/456 Housing Assembly (422)	• Inspect for damaged or broken Input Shaft Thrust Bearing Assembly (32) • Inspect for stripped, sheared or loose splines on the Input Shaft to the 3-5 Reverse/4-5-6 Clutch Housing (422)
Oil Pump Assembly (203)	• Inspect for fluid leaks / improper fluid level • Inspect for disengaged, worn, binding or failed Drive Sprocket (216), Driven Sprocket (215) or Drive Link (217) • Inspect for leaking Fluid Outlet Seal Assembly (57) • Inspect for damaged or worn Drive (219, 220) and Driven Sprocket Thrust Washers (214) • Inspect for loose or missing Oil Pump Bolts (204) • Inspect for stripped or sheared splines on the Oil Pump Shaft or Driven Sprocket (215) • Inspect for damaged, clogged or improperly installed Oil Filter Assembly (201) • Inspect for damaged or leaking Oil Filter Neck Seal (202)
Low & Reverse Clutch Assembly (455)	Inspect for stripped or sheared splines to the Reaction Carrier (467)
Input Carrier Assembly (470)	• Inspect for stripped or sheared splines to ring gear • Inspect for improperly installed carrier pinion gear pins • Inspect for damaged or broken Pinion Gears. • Inspect for stripped or sheared splines on the Input Sun Gear (471). • Inspect for damaged or broken Output Internal Gear. • Inspect for broken or disengaged Output Internal Gear Retainer Ring. • Inspect for damaged or broken Input Carrier Thrust Bearing Assembly (468) and Output Carrier Thrust Bearing Assembly (473). • Inspect for damaged or broken Input Carrier Thrust Bearings (469, 472).
Reaction Carrier Assembly (467)	• Inspect for stripped or sheared Reaction Carrier Assembly (467) splines. • Inspect for damaged or broken Input Carrier Thrust Bearings

Checks	Causes
	(468). • Inspect for damaged or broken Pinion Gear teeth. • Inspect for damaged or broken Reaction Internal Gear teeth. • Inpsect for disengaged or broken Reaction Internal Gear retainer ring.
Reaction Sun Gear Assembly (466)	• Inspect for damaged or broken weld at Sun Gear. • Inspect for loose or worn Reaction Sun Gear Assembly bushing.
Output Carrier Assembly (474)	• Inspect for stripped or sheared splines to reaction internal ring gear. • Inspect for damaged or broken Input Sun Gear Thrust Bearings (472). • Inspect for damaged or broken Pinion Gear teeth. • Inspect for damaged or broken Input Carrier Thrust Bearings (473). • Inspect for broken or damaged Output Internal Gear.
Output Sun Gear Assembly (475)	• Inspect for stripped or sheared Output Sun Gear Assembly (475) splines. • Inspect for broken Output Sun Gear Assembly (4755) hub or weld.
Low and Reverse Clutch Assembly (455)	Inspect for disengaged or broken Low and Reverse Clutch Assembly (455).
Differential Carrier Assembly (486)	• Inspect for stripped or sheared splines on Differential Side Gear. • Inspect for stripped or sheared splines Differential Carrier to PTU (AWD only). • Inspect for damaged or broken Pinion Gear teeth. • Inspect for broken, worn or damaged Final Drive Inner and Outer Thrust Washers (492).
Control Solenoid (w/Body and TCM) Valve Assembly	• Check that the Manual Valve (348) is engaged with Manual Shift Detent Lever Assembly (511). • Inspect the Control Solenoid (w/Body and TCM) Valve Assembly (15) and verify that it is functioning properly. Refer to **Control Solenoid Valve and Transmission Control Module Assembly Inspection**.

NO FIRST AND REVERSE GEARS

Checks	Causes
Low and Reverse Clutch Assembly (455)	• Inspect for disengaged or broken low and reverse clutch retainer (454). • Inspect for stripped or sheared splines on low and reverse clutch (455).
Low and Reverse Clutch	• Inspect for stripped or sheared splines on low and reverse clutch plates (449-453). • Inspect for damaged, deformed or improper surface finish on the low and reverse clutch plates (449-453).
Case Cover Assembly (403)	• Inspect for disengaged or broken low and reverse clutch piston spring retainer (410). • Inspect for worn, damaged or debonding low and reverse clutch piston seals (408). • Inspect for broken or deformed low and reverse clutch piston (408). • Inspect for improperly position or too large bleed hole in low and reverse piston (408). • Inspect for porosity or improper finish on the case cover. • Inspect for broken or fatigued low and reverse clutch piston return spring (409).

NO FIRST, SECOND, THIRD, AND FOURTH GEAR

Checks	Causes
1-2-3-4 Clutch Assembly	• Inspect for damaged or worn 1-2-3-4 clutch plates (456-458). • Inspect for damaged or broken 1-2-3-4 clutch piston (461) and piston seals damaged, worn or delaminating. • Inspect for broken or binding 1-2-3-4 clutch piston return spring (460). • Inspect for broken or disengaged 1-2-3-4 clutch piston return spring retainer (459). • Inspect for broken or fatigued 1-2-3-4 clutch wave plate (458).
Output Sun Gear Assembly (457)	Inspect for stripped or sheared splines on the output sun gear shell.
Reaction Carrier Assembly (467)	• Inspect for stripped or sheared splines on the input ring gear. • Inspect for disengaged or broken input ring gear retainer.

Checks	Causes
Output Carrier Assembly (474)	• Low/reverse clutch assembly (OWC) (455) splines sheared or broken. • Inspect for disengaged or broken reaction ring gear retainer.
Case Assembly (51)	Inspect for worn or damaged case splines or retainer ring grooves.

NO SECOND AND SIXTH GEAR

Checks	Causes
2-6 Clutch Assembly	• Inspect for damaged or worn 2-6 clutch plates (445-447). • Inspect for damaged, worn, broken, improper surface finish or sheared splines on the 2-6 clutch backing plate (448).
Reaction Carrier Assembly (467)	• Inspect for stripped or sheared splines on the input ring gear. • Inspect for disengaged or broken input ring gear retainer.
Case Cover Assembly (403)	• Inspect for damaged or broken 2-6 clutch piston (405) and piston seals damaged, worn or delaminating. • Inspect for broken or binding 2-6 clutch piston return spring (406). • Inspect for broken or disengaged 2-6 clutch piston return spring retainer (407). • Inspect for damaged, worn or improper surface finish in the piston bore (403).
Case Assembly (51)	Inspect for stripped or sheared splines (51).

HARSH OR LATE FIRST, SECOND, THIRD, AND FOURTH SHIFT

Checks	Causes
1-2-3-4 Clutch Assembly	• Inspect for damaged or broken 1-2-3-4 clutch piston (461) and piston seals damaged, worn or leaking. • Inspect for fatigued or binding 1-2-3-4 clutch piston return spring (460). • Inspect for improper surface finish on 1-2-3-4 clutch plates (456-458). • Inspect for broken or fatigued 1-2-3-4 clutch waved plate (458).
Case	Inspect for leaking or damaged 1-2-3-4 clutch fluid passage seal (65).

HARSH FIRST AND REVERSE SHIFT

Checks	Causes
Case Cover Assembly (403)	Inspect for plugged or improperly positioned low and reverse piston (408) air bleed.
Low and Reverse Clutch	• Inspect for improper surface finish on low and reverse clutch plates (449-453). • Inspect for damaged or worn low and reverse clutch plates (452). • Inspect for damaged low and reverse clutch backing plate (453). • Inspect for worn splines on backing plate (453). • Inspect for damaged low and reverse clutch piston assembly (408), spring (409), and spring retaining ring (410). • Inspect for fatigued or binding low and reverse clutch piston return spring (409). • Inspect for broken low and reverse clutch wave plate (449).
Lower Valve Body	Inspect for stuck 4-5-6 clutch boost valve.

NO THIRD, FIFTH, AND REVERSE GEAR

Checks	Causes
3-5-Reverse Clutch Assembly	• Inspect for damaged, worn or stripped splines on 3-5-reverse clutch plates (423-426), backing plate (426). • Inspect for sheared or stripped splines on 3-5-rev/4-5-6 housing to turbine shaft (422). • Inspect for damage, improper surface finish, porosity, deformed or unbalanced 3-5-rev/4-5-6 housing (422). • Inspect for damaged, worn, loose or seized hub bushing in the 3-5-rev/4-5-6 housing. • Inspect for broken, porous or improper surface finish or plugged oil passages of the 3-5-rev/4-5-6 housing (422). • Inspect for failure of the Input shaft thrust bearing (32). • Inspect for disengaged or broken 3-5-reverse clutch backing plate retainer (427). • Inspect for disengaged or broken 3-5-reverse backing plate (426). • Inspect for damaged, worn or leaking 3-5-reverse clutch piston seals (419-421). • Inspect for damaged or broken 3-5-rev/4-5-6 clutch housing (422). • Inspect for warped, damaged, improper surface finish or debonding 3-5-reverse clutch piston (417).

Checks	Causes
	• Inspect for broken or fatigued 3-5-reverse clutch spring (418). • Inspect for disengaged or broken speed sensor reluctor retainer (415). • Inspect for broken speed sensor reluctor wheel (416). • Inspect for seized input shaft thrust bearing (32).
Reaction Carrier (467)	• Inspect for broken or disengaged input internal gear retainer. • Inspect for stripped or sheared splines on the input internal gear.
Output Carrier (474)	Inspect for stripped or sheared splines for the reaction internal ring gear.
4-5-6 Clutch Assembly	• Inspect for plugged or missing 4-5-6 piston dam oil feed hole. • Inspect for leaking 4-5-6 piston dam.

HARSH OR LATE SECOND AND SIXTH SHIFT

Checks	Causes
2-6 Clutch Assembly	• Inspect for worn or improper surface finish on the 2-6 Clutch Plates (446, 447) and Backing Plate (448) • Inspect for fatigued 2-6 Clutch Piston Cushion Spring (445)
Case Cover Assembly (403)	• Inspect for damaged or broken 2-6 Clutch Piston (405) and piston seals damaged, worn or delaminating • Inspect for fatigued 2-6 Clutch Piston Return Spring (406)

NO FOURTH, FIFTH, AND SIXTH GEAR

Checks	Causes
4-5-6 Clutch Assembly	• Inspect for damaged or broken 4-5-6 clutch piston (433) and piston seals (430-432). • Inspect for broken or disengaged 4-5-6 backing plate retainer (442). • Inspect for damaged or broken 4-5-6 clutch dam piston (435) and piston seals damaged, worn or delaminating. • Inspect for broken or disengaged 4-5-6 clutch dam retainer (436). • Inspect for sheared or stripped splines on the reaction carrier hub (438). • Inspect for sheared or stripped splines on 3-5-rev/4-5-6

Checks	Causes
	housing to turbine shaft (422). • Inspect for loose, worn or damaged 3-5-rev/4-5-6 housing bushing. • Inspect for broken, porous or improper surface finish or plugged oil passages of the 3-5-rev/4-5-6 housing (422). • Inspect for failure of the input shaft thrust bearing (32). • Inspect for damaged, stripped or sheared splines on 4-5-6 clutch plates (439-441). • Inspect for broken or fatigued 4-5-6 clutch piston return spring (434).

HARSH OR LATE THIRD, FIFTH, AND REVERSE SHIFT

Checks	Causes
3-5-Reverse Clutch Assembly	• Inspect for improper surface finish on 3-5-Reverse Clutch Plates (423-426), Backing Plate (426) • Inspect for plugged or restricted oil passages and air bleed of the 3-5-Rev/4-5-6 Housing (422) • Inspect for damaged, worn or leaking 3-5-Reverse Clutch Piston Seals (419-421) • Inspect for warped 3-5-Rev/4-5-6 Clutch Housing (422) • Inspect for fatigued 3-5-Reverse Clutch Waved Plate (423)

HARSH FOURTH, FIFTH, AND SIXTH SHIFT

Checks	Causes
4-5-6 Clutch Assembly	• Inspect for leaking 4-5-6 clutch piston (433) and piston seals (430-432). • Inspect for plugged or restricted 4-5-6 piston dam air bleed. • Inspect for fatigued 4-5-6 clutch piston spring (434). • Inspect for leaking 4-5-6 clutch dam seals (435). • Inspect for improper surface finish on 4-5-6 clutch plates (439-441). • Inspect for porous, improper surface finish, seal groove damage or plugged or restricted oil passages of the 3-5-rev/4-5-6 housing (422). • Inspect for leaking or damaged 4-5-6 piston dam (435).

NO TORQUE CONVERTER CLUTCH APPLY

Checks	Causes
Torque Converter Assembly (27)	• Inspect for damaged Torque Converter Clutch Seal (inside converter assembly). • Diagnose Torque Converter Assembly for possible internal damage. Refer to **Torque Converter Diagnosis**.
Upper Valve Body Assembly (349)	Inspect for worn, damaged or sticking TCC Regulator Apply (330) and TCC Regulator Apply Shuttle (331) Valves.
Transfer Drive Gear Support Assembly (208)	Inspect for worn or damaged Transfer Drive Gear Support Seal (213).
Torque Converter Housing Assembly (221)	Inspect for leaking or damaged Torque Converter Fluid Seal Assembly (225).

NO TORQUE CONVERTER CLUTCH RELEASE

Checks	Causes
Torque Converter Assembly (27)	Diagnose Torque Converter Assembly for possible internal damage. Refer to **Torque Converter Diagnosis**.
Upper Valve Body Assembly (349)	Inspect for worn, damaged or sticking TCC Regulator Apply (330) and TCC Regulator Apply Shuttle (331) Valves.

HARSH TORQUE CONVERTER CLUTCH APPLY, OR INOPERATIVE OR NO ELECTRONICALLY CONTROLLED CAPACITY CLUTCH CONTROL

Checks	Causes
Torque Converter Assembly (27)	• Inspect for leaking or damaged Torque Converter Clutch Hub Seal. • Diagnose Torque Converter Assembly for possible internal damage. Refer to **Torque Converter Diagnosis**.
Drive Gear Support Assembly (208)	Inspect for leaking Drive Gear Support Seal (213).

NO REVERSE GEAR

Checks	Causes
Low and Reverse Clutch Assembly (455)	• Inspect for disengaged or broken low and reverse clutch retainer (454). • Inspect for stripped or sheared splines on low and reverse clutch (455).
Low and Reverse Clutch	• Inspect for stripped or sheared splines on low and reverse clutch plates (449-453). • Inspect for damaged, deformed or improper surface finish on the low and reverse clutch plates (449-453).

Checks	Causes
3-5-Reverse Clutch Assembly	• Inspect for damaged, worn or stripped splines on 3-5-Reverse Clutch Plates (423-426), Backing Plate (426) • Inspect for sheared or stripped splines on 3-5-Rev/4-5-6 Housing to Turbine Shaft (422) • Inspect for damage, improper surface finish, porosity, deformed or unbalanced 3-5-Rev/4-5-6 Housing (422) • Inspect for damaged, worn, loose or seized hub bushing in the 3-5-Rev/4-5-6 Housing • Inspect for broken, porous or improper surface finish or plugged oil passages of the 3-5-Rev/4-5-6 Housing (422) • Inspect for failure of the Input Shaft Thrust Bearing (32) • Inspect for disengaged or broken 3-5-Reverse Clutch Backing Plate Retainer (427) • Inspect for damaged, worn or leaking 3-5-Reverse Clutch Piston Seals (419-421) • Inspect for damaged or broken 3-5-Rev/4-5-6 Clutch Housing (422) • Inspect for warped, damaged, improper surface finish or debonding 3-5-Reverse Clutch Piston (417) • Inspect for broken or fatiqued 3-5-Reverse Clutch Spring (418) • Inspect for disengaged or broken Speed Sensor Reluctor Retainer (415) • Inspect for broken Speed Sensor Reluctor Wheel (416) • Inspect for seized Input Shaft Thrust Bearing (32)

FLUID PRESSURE HIGH OR LOW

Checks	Causes
Fluid Pump Assembly (203)	• Inspect for loose fluid pump bolts (204). • Inspect for leaking or damaged fluid pump outlet seals (57) and oil filter seal (202). • Inspect for improperly installed or damaged oil filter (201). • Inspect for sticking line pressure blow off valve.
Front Differential Drive Gear Support Assembly (208)	• Inspect for leaking or damaged drive gear support torque converter seal assembly (206) or fluid passage tube gasket (212). • Inspect for leaking or damaged drive gear support fluid passage tube assembly (209).

Checks	Causes
Upper Valve Body Assembly (312)	• Inspect for leaking or damaged upper valve body assembly (309) gasket. • Inspect for worn, sticking or damaged pressure regulator valve (337) or pressure regulator valve spring (338).
Lower Valve Body Assembly (313)	Inspect for leaking or damaged lower valve body assembly (313) gasket.
Control Valve (w/Body and TCM) Valve Assembly (15)	• Inspect for leaking or damaged filter plate assembly seals (16). • Verify VBS operation in not stuck high or low.
Filter Assembly	Inspect for damaged, restricted, or mis-installed fluid filter assembly.
Case Assembly (51)	Inspect for missing lube oil circuit orifice or baffle (229).

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REPAIR INSTRUCTIONS - OFF VEHICLE

LIFT PLATE AND HOLDING FIXTURE INSTALLATION

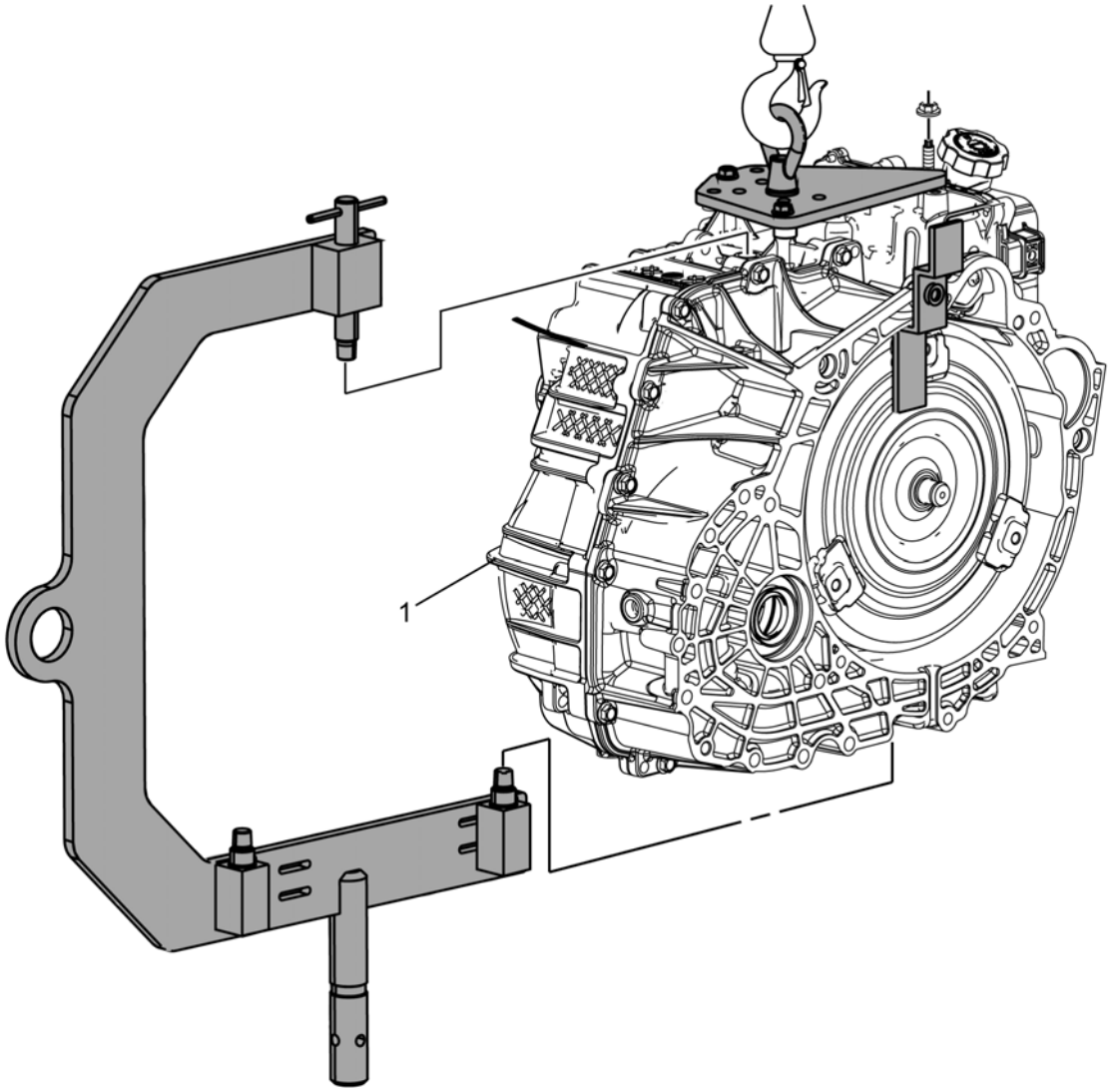


Fig. 1: Identifying Lift Plate & Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	**DT-47811-A** Transmission Lift Plate **WARNING:** **Handle with care, the transmission assembly**

Callout	Component Name
	weighs over 90.7 kg (200 lbs). Bodily injury could occur if not handled properly. **NOTE:** **After Installation of lift plate, raise the transmission with an overhead hoist.** **Tighten** 12 N.m (9 lb ft) **Special Tools** **DT-47811-A** Transmission Lift Plate For equivalent regional tools, refer to **Special Tools** .
2	**DT-46625** Transmission Holding Fixture **CAUTION:** **Refer to Fastener Caution .** **NOTE:** **Adjust mounting block on fixture to match bosses on case, then tighten bolts to:** **Tighten** 13 N.m (10 lb ft) **Special Tools**

Callout	Component Name
	DT-46625 Transmission Holding Fixture For equivalent regional tools, refer to **Special Tools** .

TORQUE CONVERTER REMOVAL

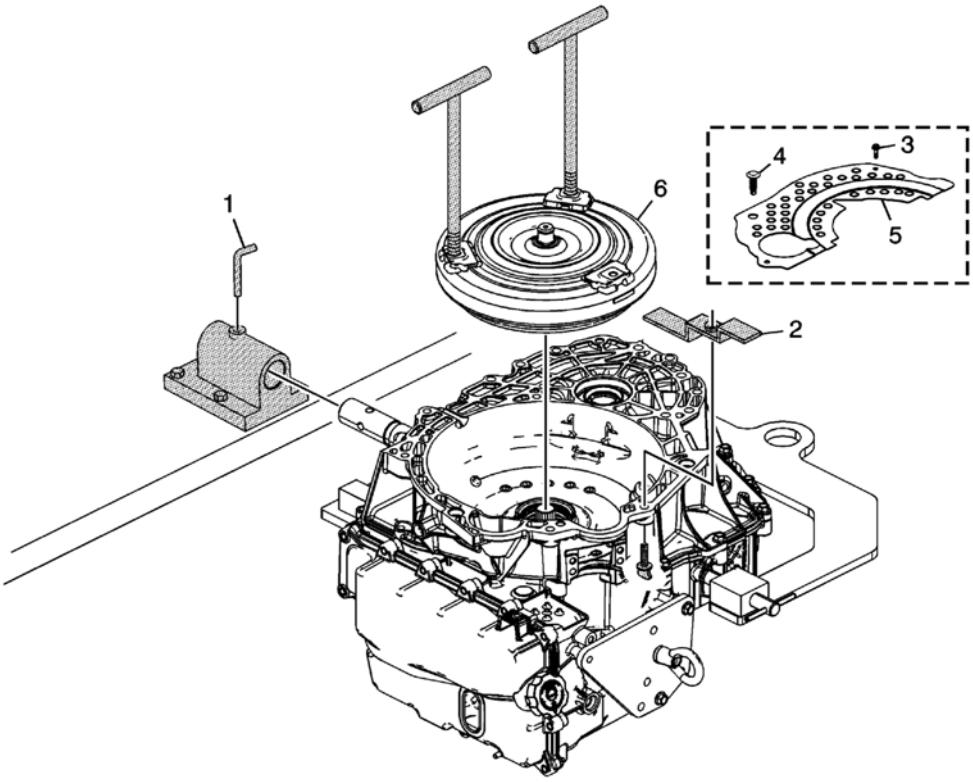


Fig. 2: View Of Torque Converter
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Lock Pin **WARNING:** **Lock pin must be secured into the bench fixture to hold the transmission and prevent bodily injury.** **NOTE:** **Ensure the DT 3289-20 holding**

Callout	Component Name
	fixture is mounted to a bench that is properly supported and will support the weight of the transmission assembly without tipping. **DT-39890 holding fixture adapter adapter and an engine stand can be used as an alternative method for supporting the transmission assembly during repairs.** **Special Tools** • **DT 3289-20** Holding Fixture • **DT-39890** Transmission Holding Fixture Adapter For equivalent regional tools, refer to **Special Tools** .
2	**DT 21366** Converter Holding Strap For equivalent regional tools, refer to **Special Tools** .
3	Dust Cover Bolts M10 x 25, model dependent (Qty: 2)
4	Dust Cover Push Pin, model dependent
5	Dust Cover, model dependent
6	Torque Converter Assembly **CAUTION:** **Only install the lift assist**

Callout	Component Name
	handles until it stops. Do not tighten. Over tightening the lift assist handles can cause damage to the torque converter. **NOTE:** **Failure to raise the torque converter straight up could damage the torque converter clutch lip seal inside the torque converter clutch assembly.** **Special Tools** **DT 46409** Torque Converter Lifting Handles For equivalent regional tools, refer to **Special Tools** .

CONTROL VALVE BODY ASSEMBLY REMOVAL

Control Valve Body Cover Removal

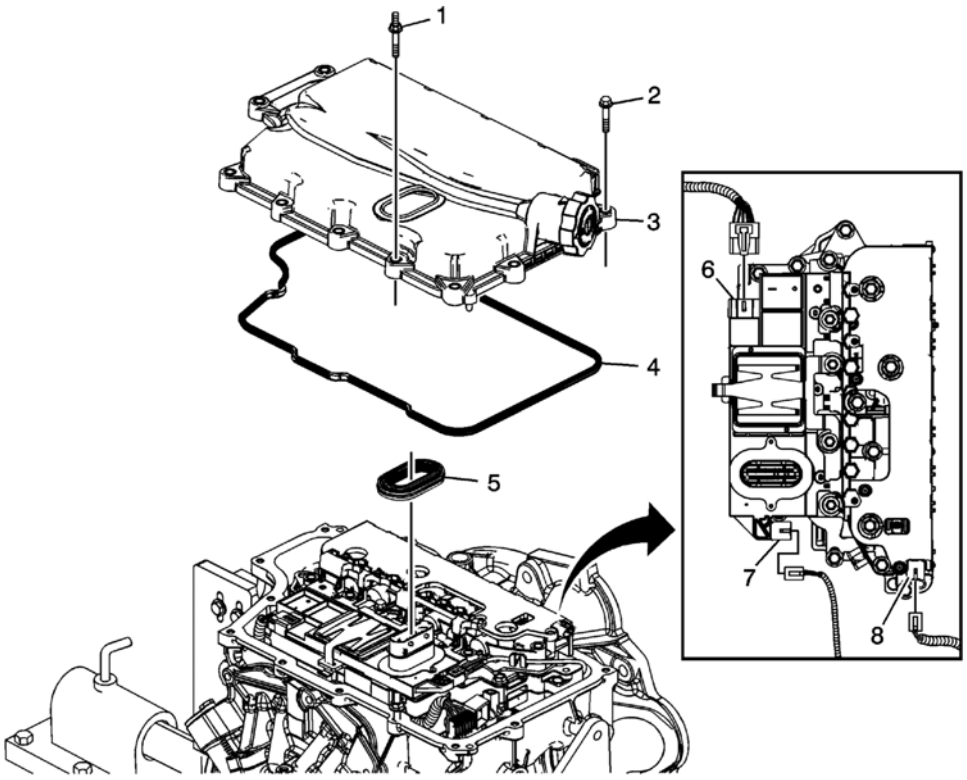


Fig. 3: View Of Control Valve Body Cover
Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Cover Removal

Callout	Component Name
1	Control Valve Body Cover Stud M6 x 30 (Qty: 2)
2	Control Valve Body Cover Bolt M6 x 30 (Qty: 12)
3	Control Valve Body Cover
4	Control Valve Body Cover Gasket **NOTE:** **Do not re-use the valve body cover gasket.**
5	Control Valve Body Cover Wiring Connector Hole Seal **CAUTION:** **Support the control solenoid valve assembly around the connector**

Callout	Component Name
	when removing the seal. Excessive pulling force can damage the internal electrical connections.
6	Shift Position Switch Connector
7	Output Speed Sensor Connector
8	Input Speed Sensor Connector

Control Solenoid (w/Body and TCM) Valve Assembly Removal

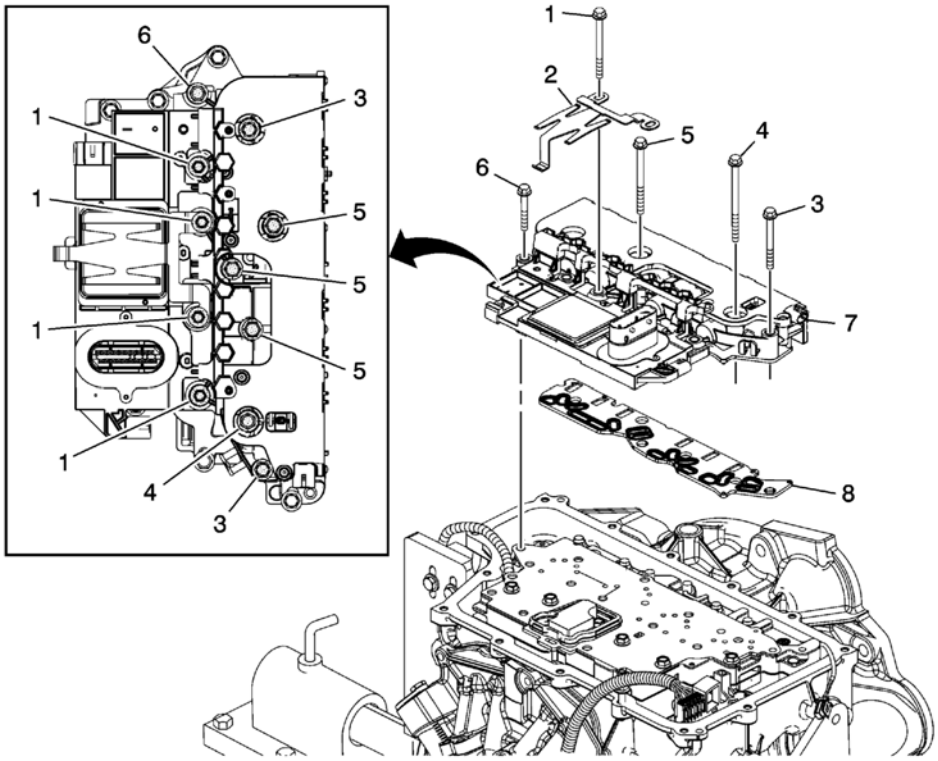


Fig. 4: Control Solenoid (W/ Body and TCM) Valve Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Control Solenoid (w/Body and TCM) Valve Assembly Removal

Callout	Component Name
1	Control Valve Body Bolt M6 x 80 (Qty: 4)
2	Control Solenoid Valve Spring
3	Control Valve Body Bolt M6 x 65 (Qty: 2)
4	Control Valve Body Bolt M6 x 42 (Qty: 1)
5	Control Valve Body Bolt M6 x 95 (Qty: 3)

Callout	Component Name
6	Control Valve Body Bolt M6 x 55 (Qty: 1)
7	Control Solenoid (w/Body and TCM) Valve Assembly
8	Control Solenoid Valve Assembly Filter Plate **CAUTION:** **Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.** **NOTE:** • **Discard the filter plate. It is not reusable.** • **Inspect the pressure switch manifold seals for damage. Replace the control valve assembly as necessary.**

Control Valve Body Assembly and Output Speed Sensor Removal

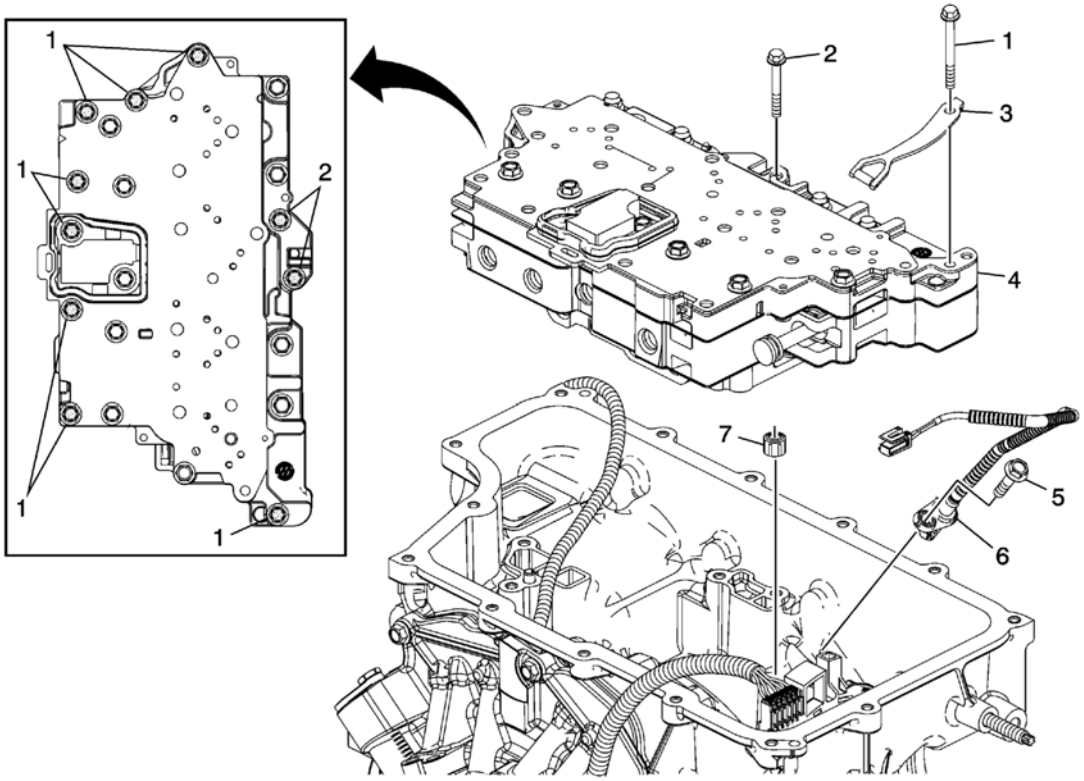


Fig. 5: Control Valve Body Assembly And Output Speed Sensor
Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Assembly and Output Speed Sensor Removal

Callout	Component Name
1	Control Valve Body Bolt M6 x 65 (Qty: 8)
2	Control Valve Body Bolt M6 x 55 (Qty: 2)
3	Manual Shaft Detent Assembly
4	Control Valve Body Assembly
5	A/Trans Output Speed Sensor Bolt M6 x 25
6	A/Trans Output Speed Sensor
7	1-2-3-4 Clutch Fluid Passage Seal **NOTE:** **The seal is not reusable.**

CASE COVER AND 3-5-REVERSE AND 4-5-6 CLUTCH HOUSING REMOVAL

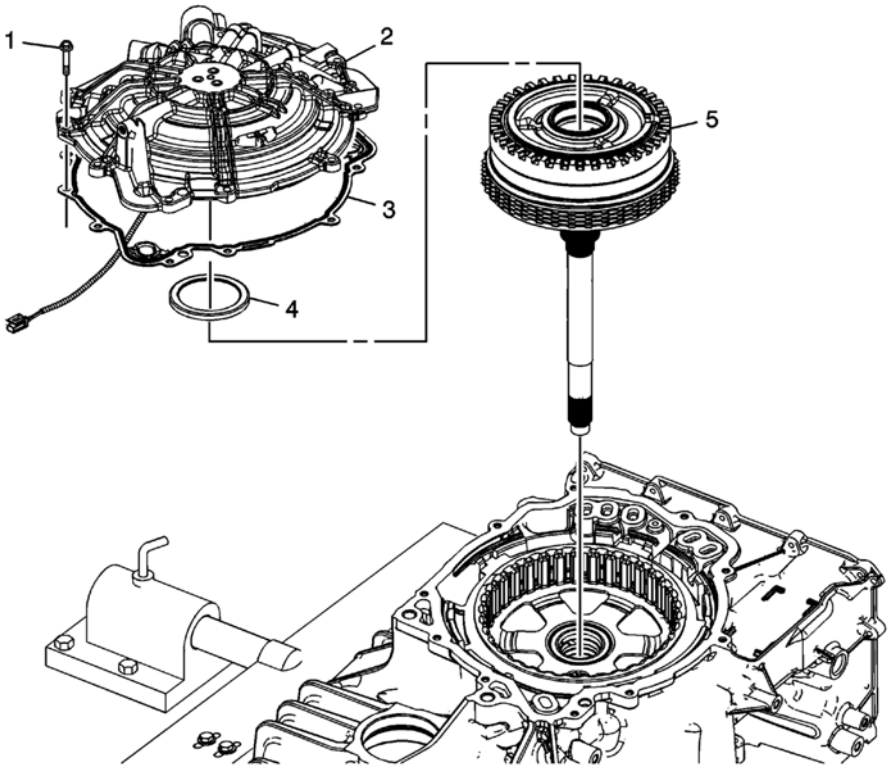


Fig. 6: Identifying Case Cover, 3-5-Reverse & 4-5-6 Clutch Housing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	A/Trans Case Cover Assembly Bolt M6 x 30 (Qty: 10)
2	A/Trans Case Cover Assembly **CAUTION:** **Use care when pulling the input speed sensor wire harness through the case to avoid damaging the harness.**
3	A/Trans Case Cover Gasket **NOTE:** **The gasket is not reusable.**

Callout	Component Name
4	Input Shaft Thrust Bearing Assembly **NOTE:** **The bearing may be stuck to the case cover.**
5	3-5 Rev/4-5-6 Clutch Housing Assembly

REACTION CARRIER HUB AND 2-6 CLUTCH PLATE REMOVAL

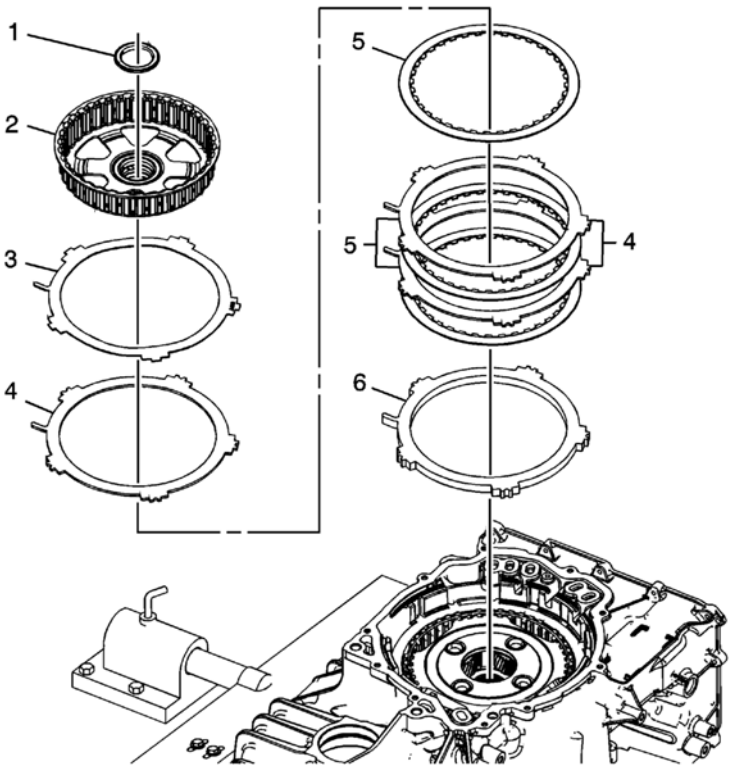


Fig. 7: Identifying Reaction Carrier Hub & 2-6 Clutch Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	2-6 Clutch Hub Thrust Bearing Assembly **NOTE:** **The 2-6 clutch hub thrust bearing assembly may be stuck to the reaction**

Callout	Component Name
	carrier hub assembly.
2	Reaction Sun Gear Assembly
3	2-6 Clutch Cushion Spring
4	2-6 Clutch Plate (Qty: 3)
5	2-6 Clutch (w/Friction Material) Plate Assembly (Qty: 3)
6	2-6 Clutch Backing Plate

INPUT, REACTION, AND OUTPUT CARRIER REMOVAL

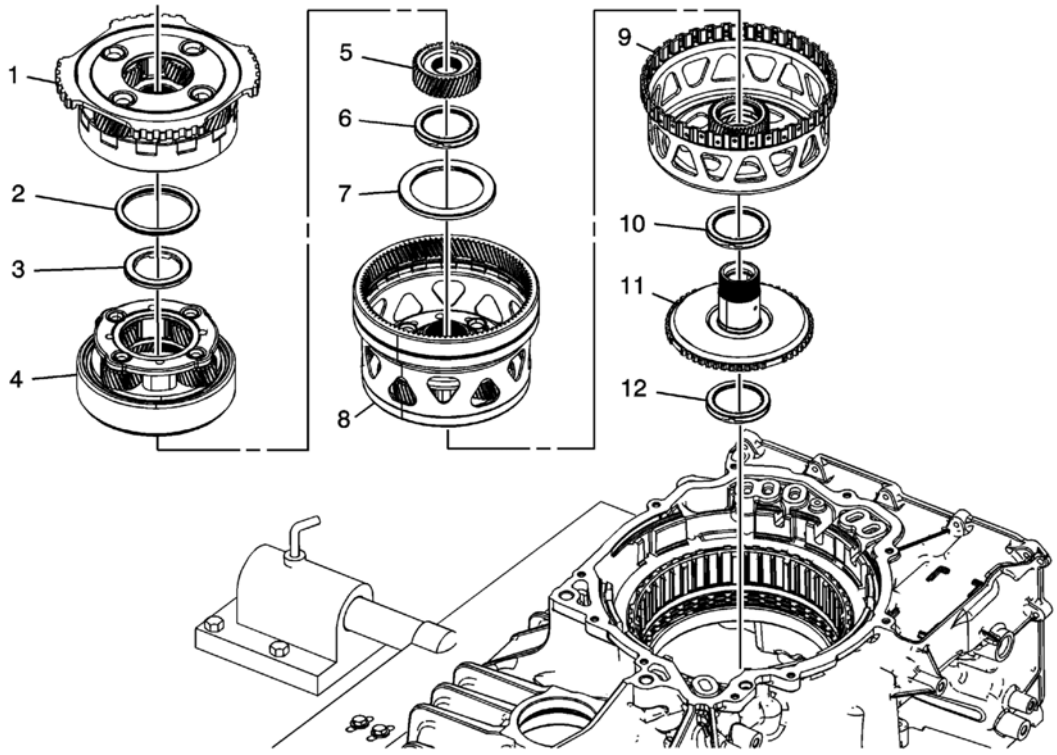


Fig. 8: View Of Input, Reaction & Output Carriers
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Reaction (w/Input Internal Gear) Carrier Assembly
2	Input Carrier Thrust Bearing Assembly
3	Input Sun Gear Thrust Bearing Assembly
4	Input (w/Output Internal Gear) Carrier Assembly
5	Input Sun Gear
6	Output Carrier Thrust Bearing Assembly
7	Output Carrier Thrust Bearing Assembly
8	Output Carrier Assembly
9	Output Sun Gear Assembly
10	Front Differential Transfer Drive Gear Input Hub Bearing Assembly

Callout	Component Name
11	Output Carrier Transfer Drive Gear Hub Assembly
12	Output Carrier Transfer Drive Gear Hub Bearing Assembly **NOTE:** **The bearing may be stuck to the support assembly.**

LOW AND REVERSE CLUTCH PLATE REMOVAL

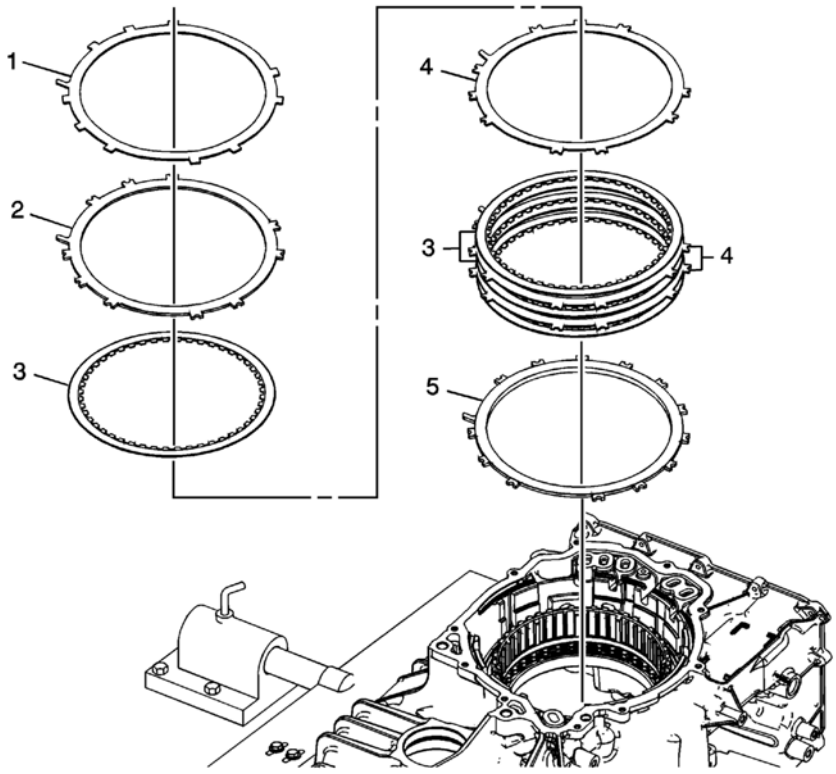


Fig. 9: Identifying Low & Reverse Clutch Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Low and Reverse Clutch Cushion (Waved) Spring
2	Low and Reverse Clutch Apply Plate
3	Low and Reverse Clutch (w/Friction Material) Plate Assembly (Qty: 4)
4	Low and Reverse Clutch Plate (Qty: 3)
5	Low and Reverse Clutch Backing Plate

LOW AND REVERSE CLUTCH AND 1-2-3-4 CLUTCH PLATE REMOVAL

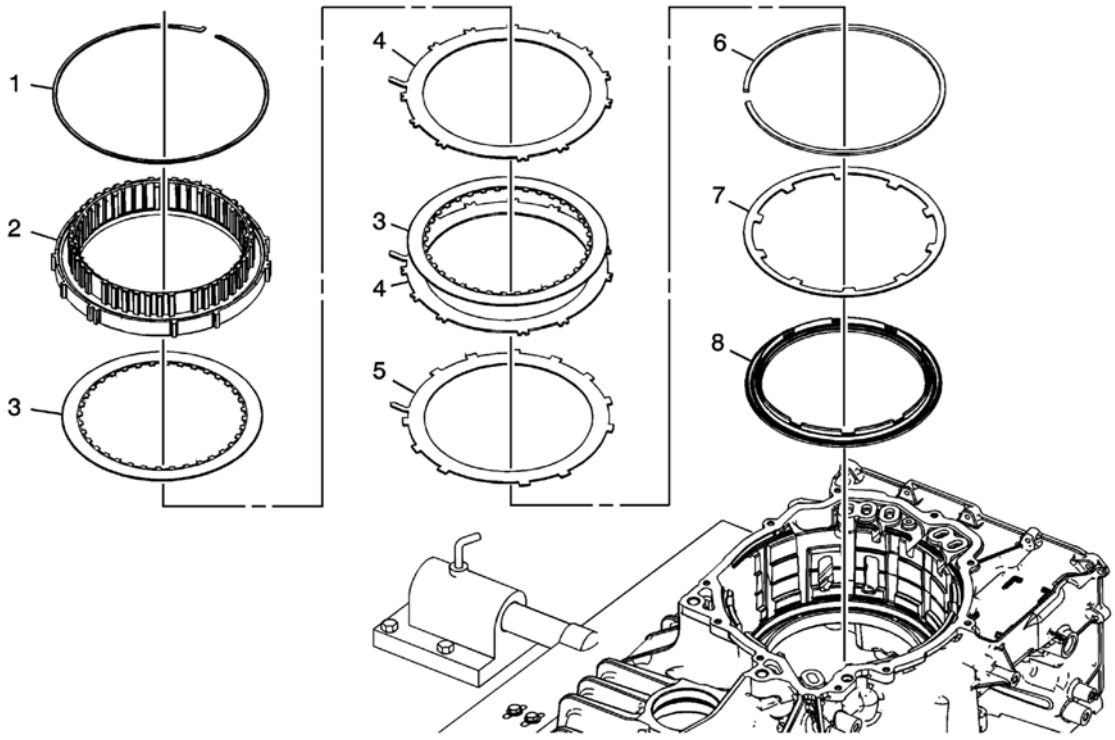


Fig. 10: Identifying Low, Reverse Clutch & 1-2-3-4 Clutch Plates
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Low and Reverse Clutch Retainer Ring
2	Low and Reverse Clutch Assembly
3	1-2-3-4 Clutch (w/Friction Material) Plate Assembly (Qty: 2)
4	1-2-3-4 Clutch Plate (Qty: 2)
5	1-2-3-4 Clutch (Waved) Plate
6	1-2-3-4 Clutch Spring Retainer Ring
7	1-2-3-4 Clutch Spring
8	1-2-3-4 Clutch Piston **NOTE:** • **Use pliers to remove the piston.** • **Inspect the piston seals for damage and/or**

Callout	Component Name
	wear. **The** **piston is** **reusable.**

TORQUE CONVERTER AND DIFFERENTIAL HOUSING, FRONT DIFFERENTIAL TRANSFER DRIVE GEAR, AND FRONT DIFFERENTIAL CARRIER REMOVAL

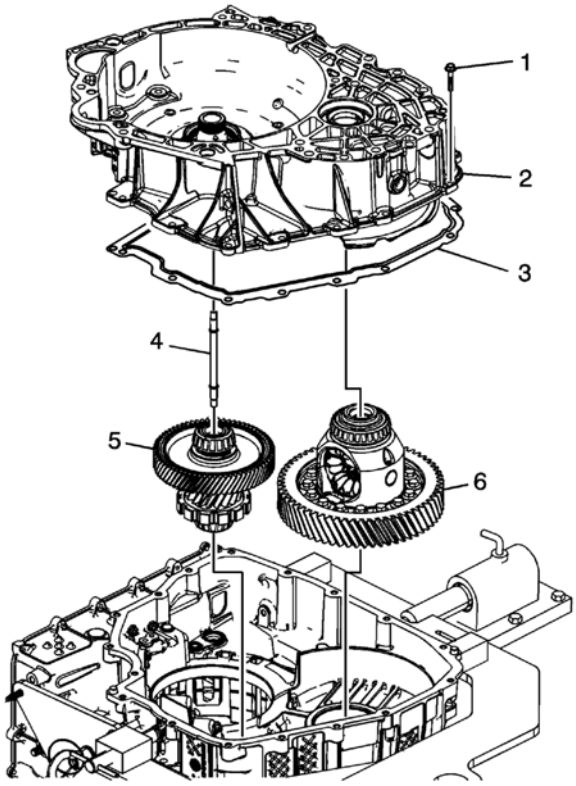


Fig. 11: Identifying Torque Converter, Differential Housing, Front Differential Transfer Drive Gear & Front Differential Carrier
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Torque Converter and Differential Housing Bolt M8 x 35 (Qty: 17)
2	Torque Converter, Support and A/Trans Fluid Pump Housing Assembly
3	Torque Converter Housing Outer Seal **NOTE:** **The seal is not reusable.**
4	Front Differential Drive Pinion Gear Lube Tube
5	Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly
6	Front Differential Carrier Assembly

FLUID TROUGH REMOVAL

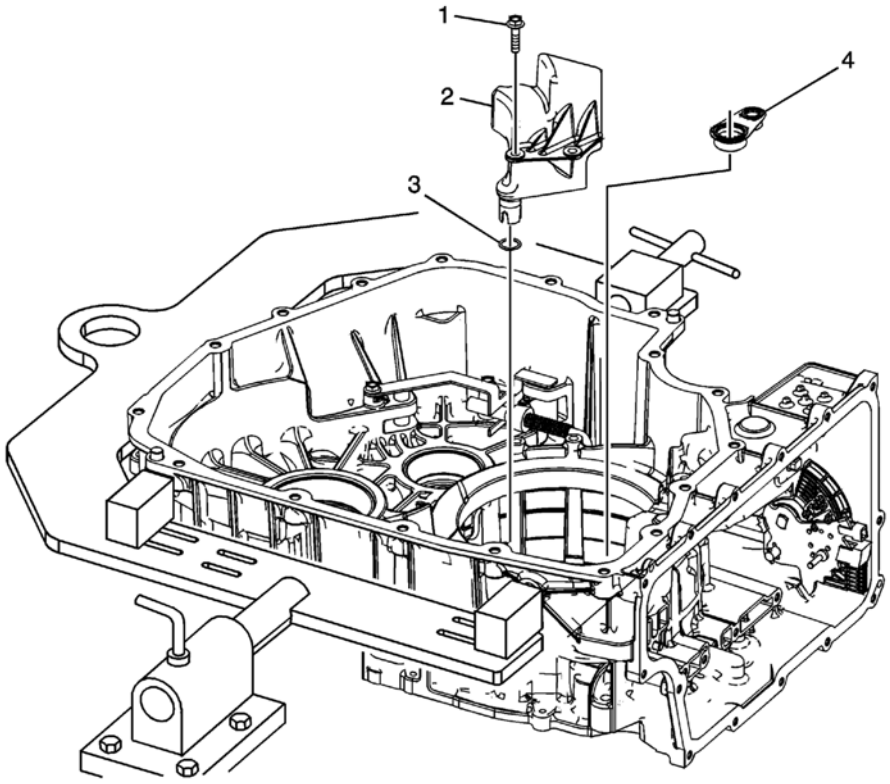


Fig. 12: Identifying Fluid Trough
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	A/Trans Fluid Trough Bolt M6 x 25 (Qty: 1)
2	A/Trans Fluid Trough
3	A/Trans Fluid Trough (O-Ring) Seal
4	A/Trans Fluid Pump Outlet Seal Assembly **NOTE:** **The seal assembly is not reusable.**

MANUAL SHIFT DETENT LEVER WITH SHAFT POSITION SWITCH ASSEMBLY AND PARK PAWL ACTUATOR REMOVAL

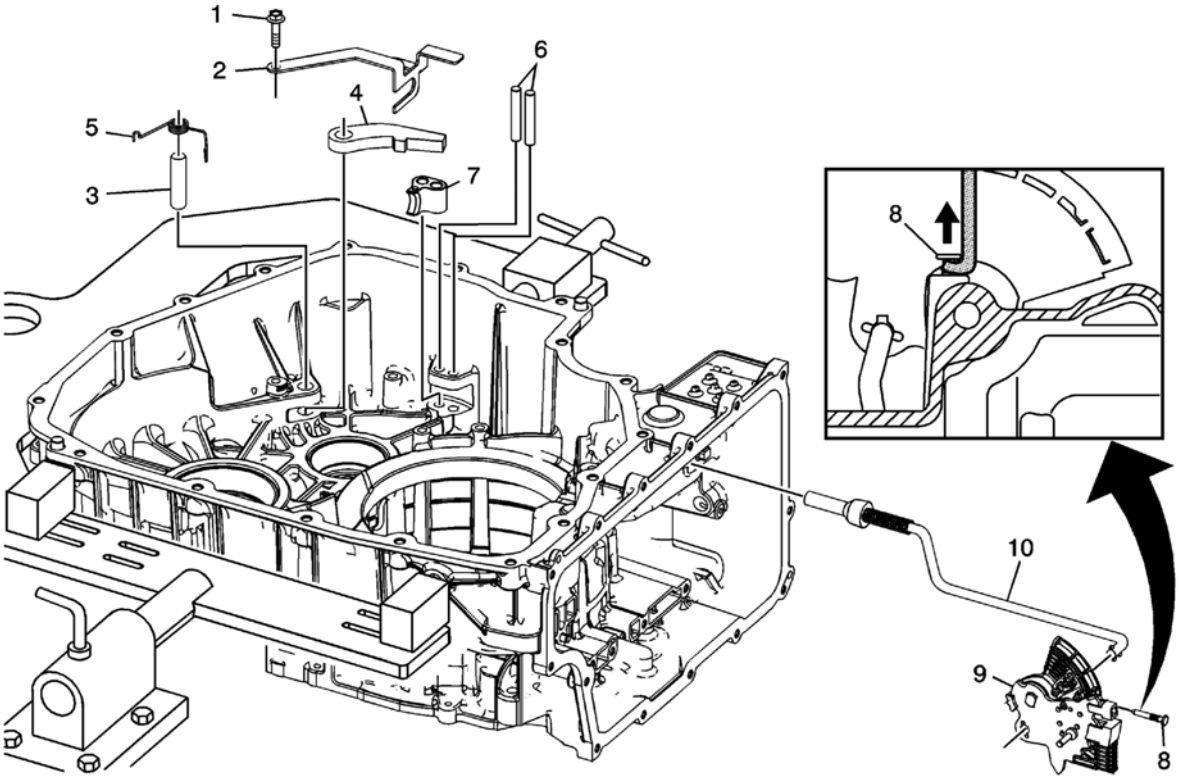


Fig. 13: Identifying Manual Shift Detent Lever With Shaft Position Switch Assembly & Park Pawl Actuator

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Park Pawl Actuator Bracket Bolt M6 x 25 (Qty: 2)
2	Park Pawl Actuator Bracket
3	Park Pawl Shaft
4	Park Pawl
5	Park Pawl Spring
6	Park Pawl Actuator Guide Pin
7	Park Pawl Actuator Guide
8	Manual Shift Detent Lever Pin **NOTE:** • **Use a small nail puller or other suitable tool.** • **Discard the pin. The pin**

Callout	Component Name
	is not reusable. **Special Tools** • **DT 23129** Universal Seal Remover • **GE 6125-1B** Slide Hammer with Adapter For equivalent regional tools, refer to **Special Tools** .
9	Manual Shaft Detent (w/Shift Position Switch) Lever Assembly **NOTE:** **Rotate the assembly counterclockwise so the actuator rod will fit through the case opening.**
10	Park Pawl Actuator Assembly

MANUAL SHIFT SHAFT SEAL REPLACEMENT

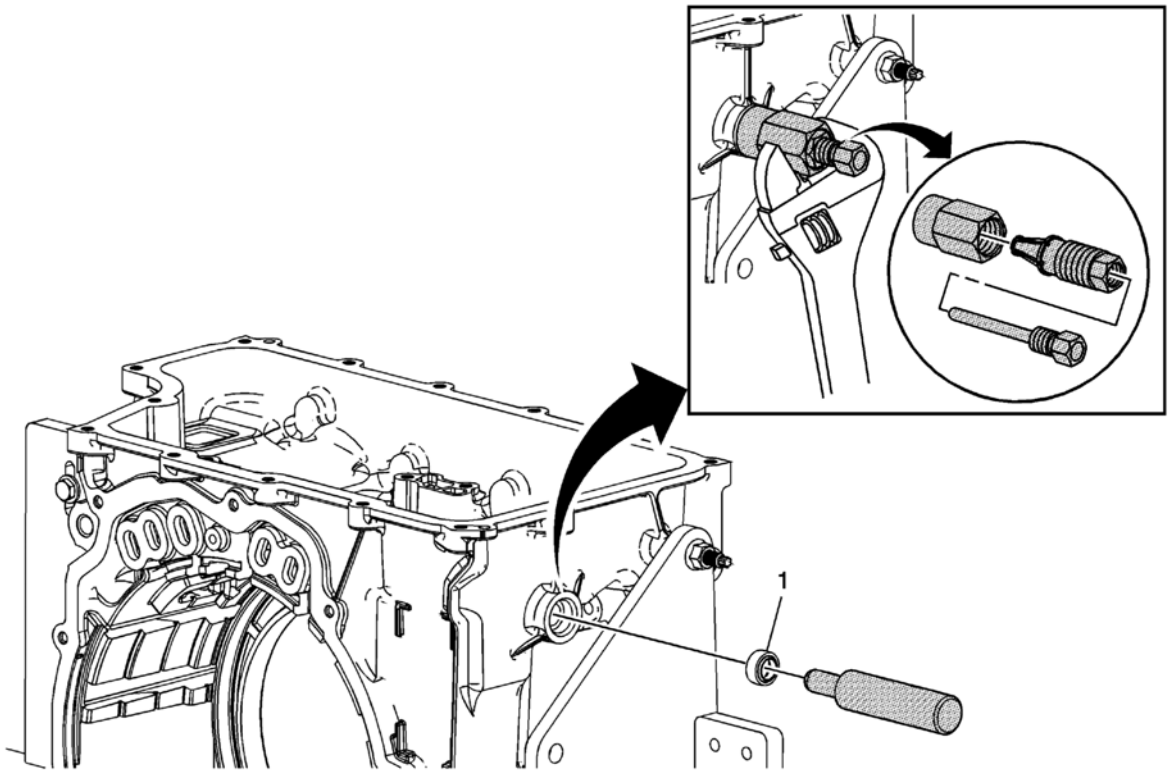


Fig. 14: Identifying Manual Shift Shaft Seal

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Manual Shift Shaft Seal **Special Tools** • **DT 45201** Cooler Line Seal Remover • **DT 46626** Seal Installer For equivalent regional tools, refer to **Special Tools** .

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - CASE SIDE

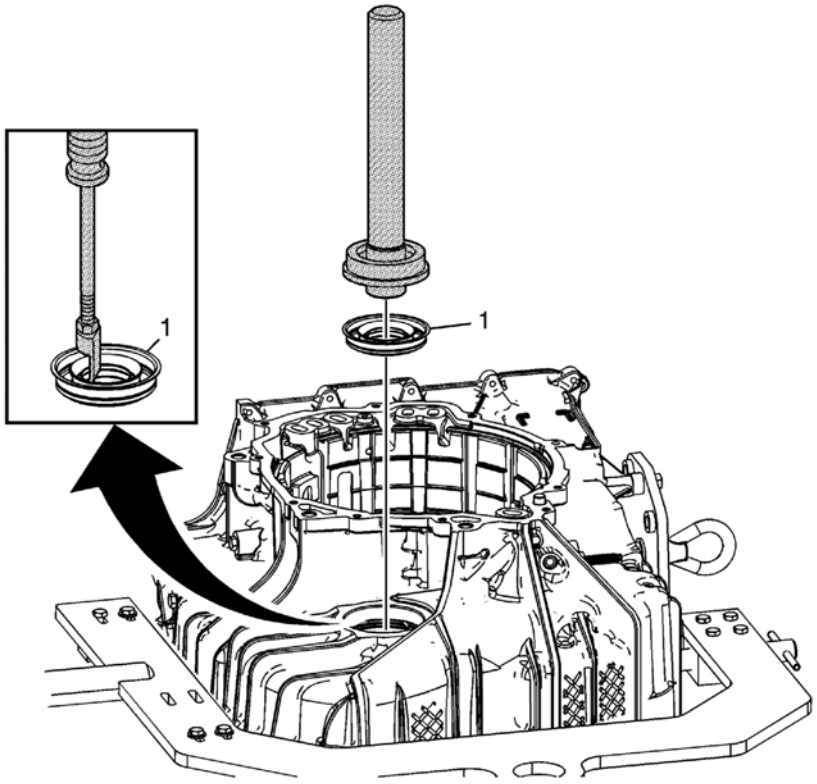


Fig. 15: Identifying Front Wheel Drive Shaft Oil Seal
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Wheel Drive Shaft Oil Seal Assemble **NOTE:** **Use the flat side of J 46629-A seal installer to seat the seal**

Callout	Component Name
	to the case surface. **Special Tools** • **DT 23129** Universal Seal Remover • **DT 46629-A** Seal Installer • **GE 6125-1B** Slide Hammer • **GE 8092** Driver Handle For equivalent regional tools, refer to **Special Tools** .

FRONT DIFFERENTIAL CARRIER BEARING CUP REPLACEMENT - CASE SIDE

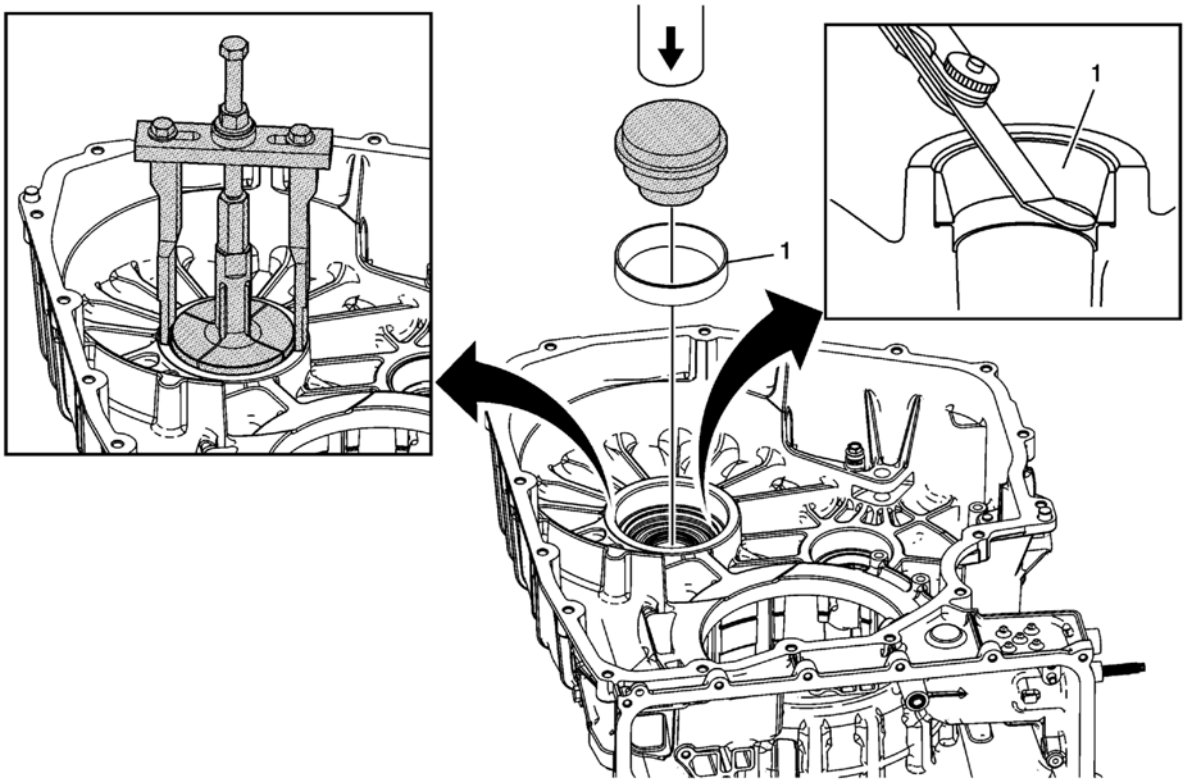


Fig. 16: Identifying Front Differential Carrier Bearing Cup
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Differential Bearing Cup **CAUTION:** **Support the back side of the case**

Callout	Component Name
	before installing the bearing cup. Apply a light coating of transmission fluid to the bore before pressing the cup into position. Install the bearing cup until it stops moving. Applying excessive pressure to the bearing cup once it is seated could cause damage to the case casting. **CAUTION: An unseated or improperly installed bearing cup will result in premature bearing failure. Visually inspect the bearing cup to insure there is"no gap" between the case, thrust washer, and the bearing cup. Use of a**

Callout	Component Name
	feeler gauge may assist in identifying a bearing cup that is not fully seated. **CAUTION:** **Failure to apply the lubricant will cause damage to the bolt and nut threads.** **CAUTION:** **There are first and second design front differential bearing cups. First design bearing cups are manufactured by Timken. Second design bearing cups are manufactured by NSK. Second design bearing cups require DT-45087-A cup installer. If installing second design bearing cups, second design front**

Callout	Component Name
	differential carrier bearings must be used. All four parts must be kept as a set to prevent damage to the transmission. **NOTE:** • **Tighten DT-47927-2 which is part of DT-47927 cup remover until it fits snugly on the bearing cup.** • **Adjust DT 45124 removal bridge so it sits on the torque converter housing surface just beyond the bearing cup opening.** • **Apply the extreme pressure lubricant DT 23444-A**

Callout	Component Name
	extreme press lubricant to the puller bolt threads to prevent damage to the bolt threads during bearing cup removal. • **Hold the puller bridge bolt and turn the nut to remove the bearing cup.** **Special Tools** • **DT 23444-A** Extreme Press Lubricant - 1/4 Ounce Tube • **DT-45087** Bearing Cup Installer • **DT-45087-A** Bearing Cup Installer • **DT 45124** Removal Bridge • **DT-47927** Bearing Cup Remover For equivalent regional tools, refer to **Special Tools** .

FRONT DIFFERENTIAL DRIVE PINION GEAR BEARING CUP AND LUBRICANT DAM REPLACEMENT

Removal

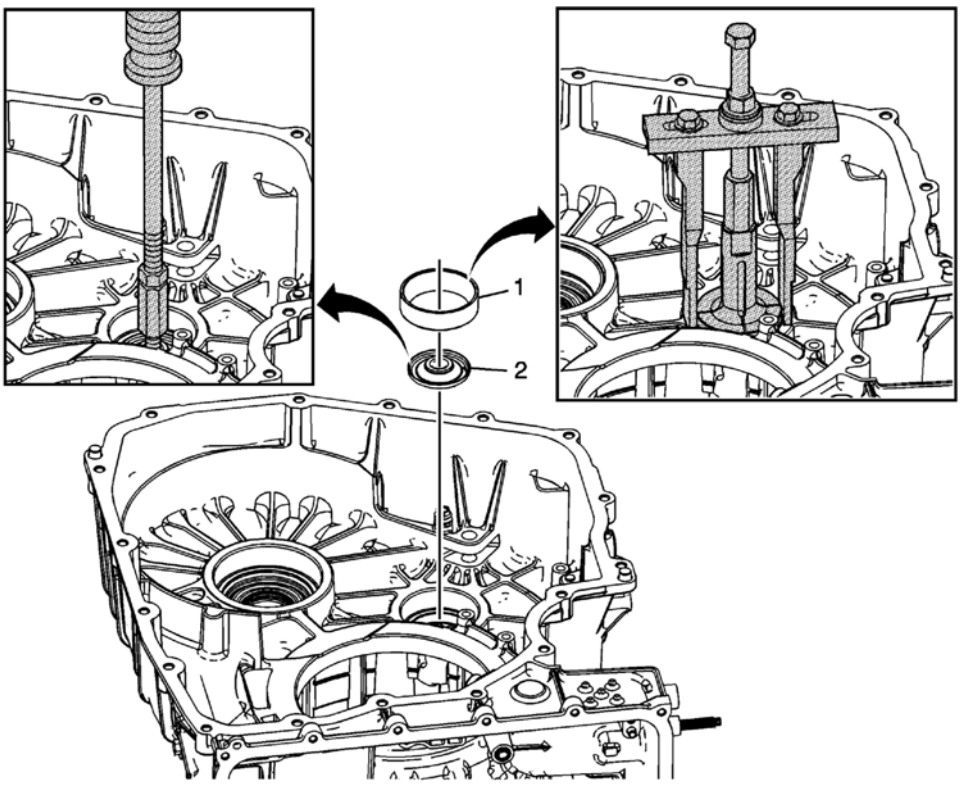


Fig. 17: Identifying Front Differential Drive Pinion Gear Bearing Cup & Lube Dam
Courtesy of GENERAL MOTORS COMPANY

Removal

Callout	Component Name
1	Front Differential Drive Pinion Gear Bearing Cup **CAUTION:** **Failure to apply the lubricant will cause damage to the bolt and nut threads.** **NOTE:** • **Tighten DT-45094 cup remover until it fits snugly on the bearing cup.**

Callout	Component Name
	• Adjust DT 45124 removal bridge so it sits on the case surface just beyond the bearing cup opening. • Apply the extreme pressure lubricant DT 23444-A extreme press lubricant to the puller bolt threads to prevent damage to the bolt threads during bearing cup removal. • Hold the puller bridge nut and turn the bolt to remove the bearing

Callout	Component Name
	cup. **Special Tools** • **DT 23444-A** Extreme Press Lubricant - 1/4 Ounce Tube • **DT-45094** Bearing Cup Remover • **DT 45124** Removal Bridge For equivalent regional tools, refer to **Special Tools** .
2	Front Differential Drive Pinion Gear Lube Dam **Special Tools** • **DT-48055** Lube Dam Removal • **GE 6125-1B** Slide Hammer with Adapter For equivalent regional tools, refer to **Special Tools** .

Installation

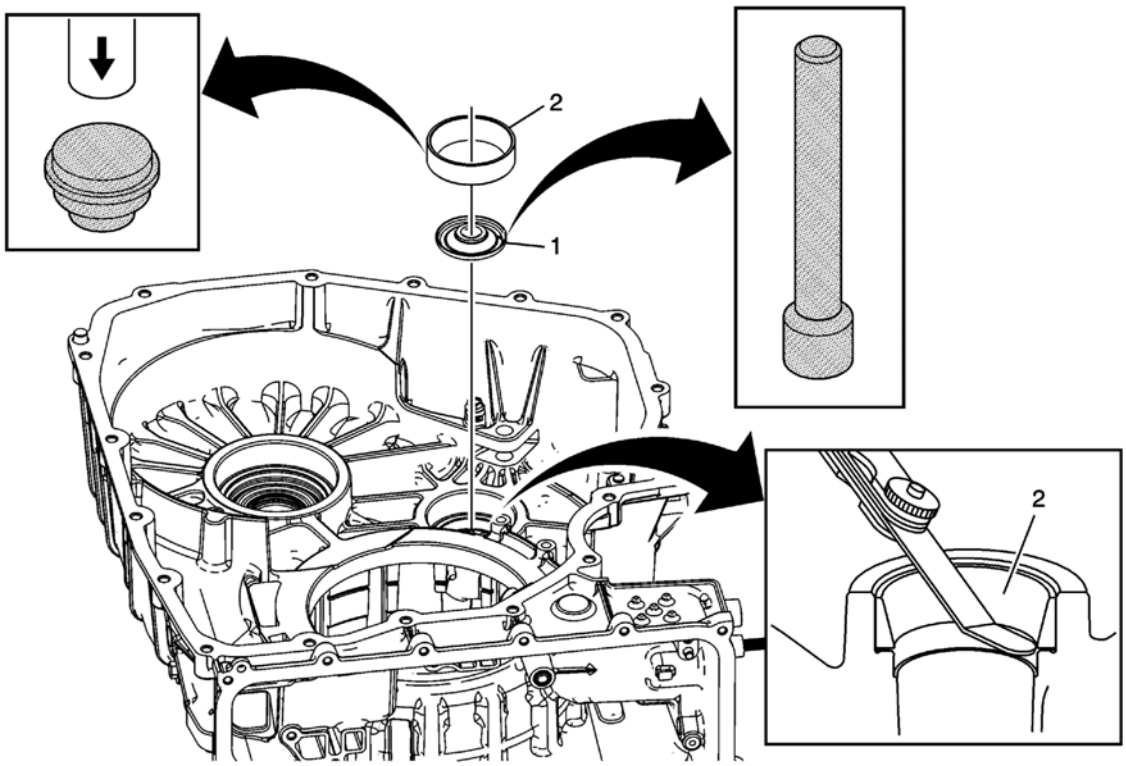


Fig. 18: View Of Front Differential Drive Pinion Gear Bearing Cup & Lube Dam
Courtesy of GENERAL MOTORS COMPANY

Installation

Callout	Component Name
1	Front Differential Drive Pinion Gear Lube Dam **Special Tools** • **DT-46630** Lube Dam Installer • **GE 8092** Driver Handle For equivalent regional tools, refer to **Special Tools** .
2	Front Differential Drive Pinion Gear Bearing Cup **CAUTION:** **Support the back side of the case before installing the bearing cup. Apply a light coating of transmission fluid to the bore before pressing the cup into position. Install the bearing cup until it stops moving. Applying excessive pressure to the bearing cup once it is seated could cause damage to the case casting.** **CAUTION:** **An unseated or improperly installed bearing cup**

Callout	Component Name
	will result in premature bearing failure. Visually inspect the bearing cup to insure there is"no gap" between the case, thrust washer, and the bearing cup. Use of a feeler gauge may assist in identifying a bearing cup that is not fully seated. **Special Tools** **DT-45087** Bearing Cup Installer For equivalent regional tools, refer to **Special Tools** .

TRANSMISSION CASE CLEANING AND INSPECTION

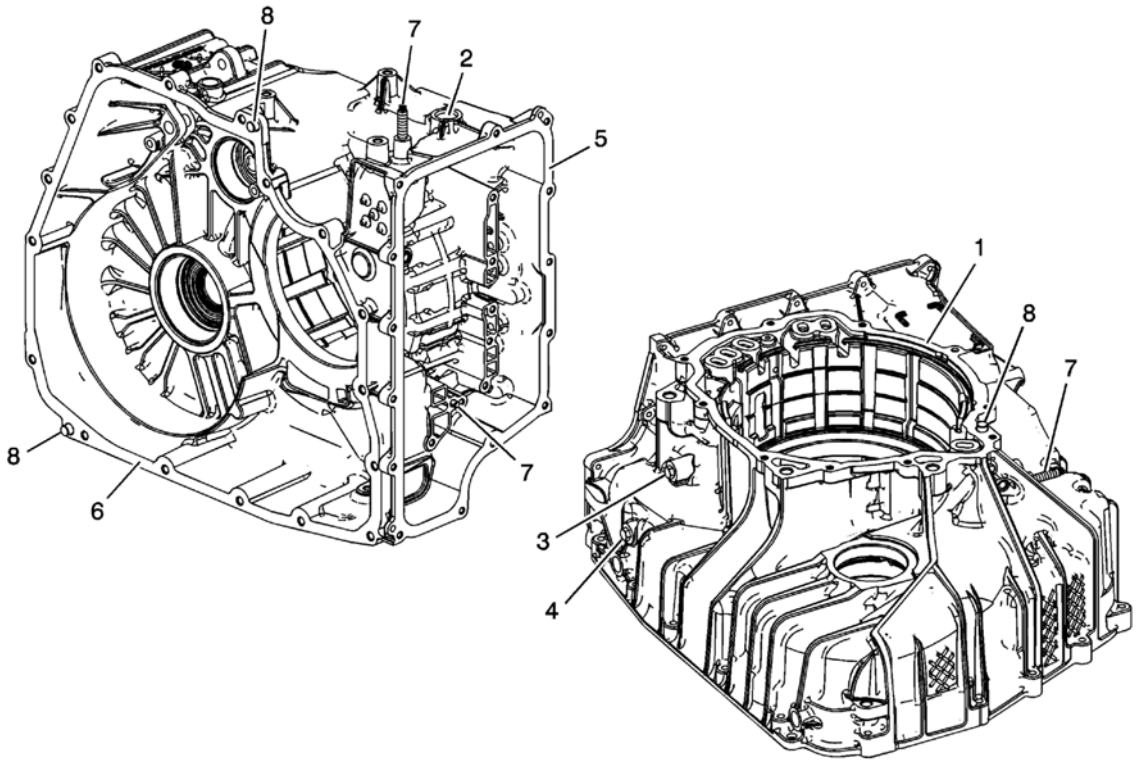


Fig. 19: Identifying Transmission Case Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
CAUTION: **Do not use abrasive pads or bristle devices to clean the sealing surfaces. Abrasive pads produce a fine grit that can effect transmission function. Abrasive pads can also remove enough metal to create oil leaks.**	

Callout	Component Name
CAUTION: **After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.** **CAUTION:** **Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.** **Preliminary Procedures** 1. Thoroughly clean the transmission case assembly, including case threads, with clean solvent. 2. Clean gasket sealing surfaces. Remove all residual gasket material. 3. Inspect all threaded holes. If necessary, repair any thread damage.	
1	Case Cover Sealing Surface
2	Manual Shift Shaft Seal Surface **NOTE:** **Refer to Manual Shift Shaft Seal Replacement.**

Callout	Component Name
3	Fluid Pressure Test Plug
4	Fluid Drain Plug
5	Control Valve Body Cover Sealing Surface
6	Torque Converter Housing Sealing Surface
7	Transmission Fluid Cooler Pipe Stud M8 x 30.5 (Qty: 2) **CAUTION:** **Refer to** **Fastener Caution .** **Tighten** 12 N.m (106 lb in)
8	Transmission Case Cover Locator Pin **Procedure** Inspect the locating pins to be fully seated in case.

MANUAL SHIFT DETENT LEVER WITH SHAFT POSITION SWITCH ASSEMBLY AND PARK PAWL ACTUATOR INSTALLATION

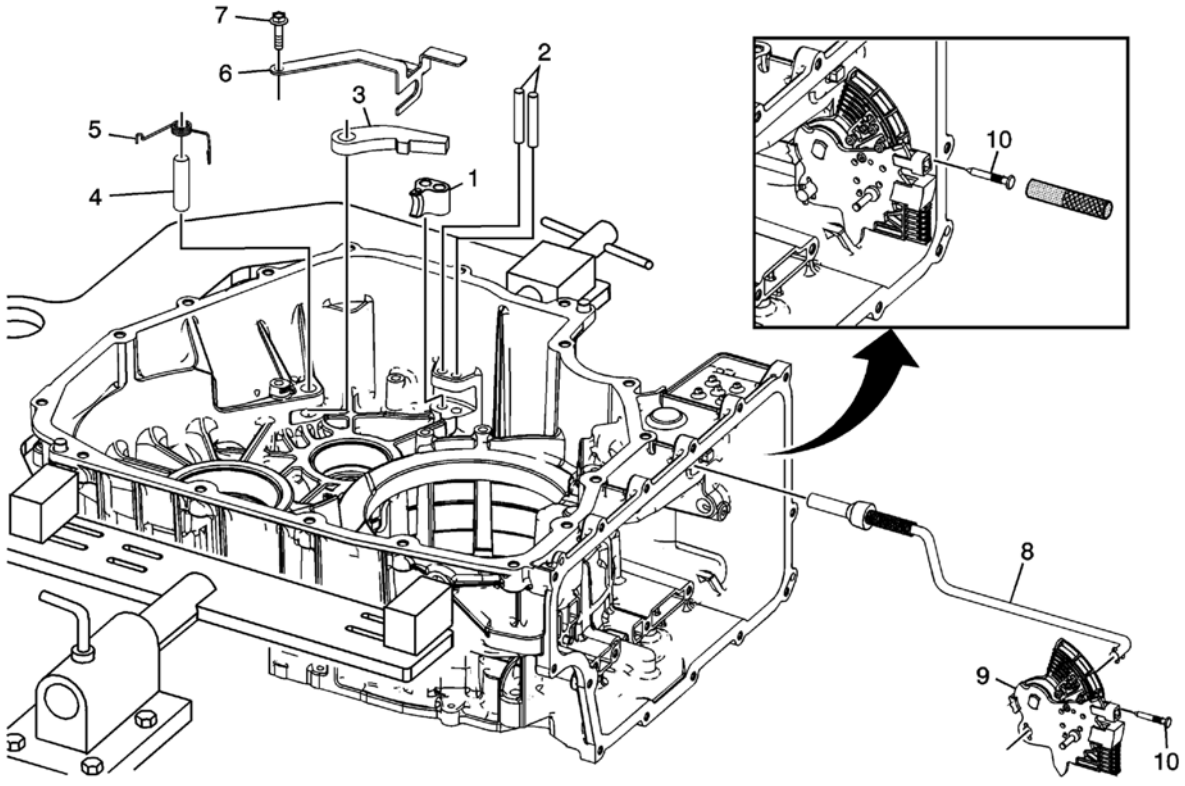


Fig. 20: Identifying Manual Shift Detent Lever With Shaft Position Switch Assembly & Park Pawl Actuator

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Park Pawl Actuator Guide
2	Park Pawl Actuator Guide Pin
3	Park Pawl
4	Park Pawl Shaft
5	Park Pawl Spring
6	Park Pawl Actuator Bracket
7	Park Pawl Actuator Bracket Bolt M6 x 25 (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 12 N.m (106 lb in).
8	Park Pawl Actuator Assembly **NOTE:** **Install the park pawl actuator assembly onto the detent lever assembly.**
9	Manual Shaft Detent (w/Shift Position Switch) Lever Assembly **NOTE:** • **Rotate the assembly clockwise so the actuator rod will fit through the case opening.** • **Lubricate shaft with ATF to prevent damage to the**

Callout	Component Name
	manual shift shaft seal.
10	Manual Shift Shaft Pin **CAUTION:** **Use J 41229 to install the manual shaft pin at the correct height in order to properly secure the manual shaft. If you install the pin too deep, the case bore may crack.** **Procedure** 1. Use a NEW pin to ensure proper engagement to the case. 2. Inspect pin installed height is within 6.5-7.5 mm (0.25-0.30 in). **Special Tools** **DT 41229** Manual Shaft Pin Installer For equivalent regional tools, refer to **Special Tools** .

FLUID TROUGH INSTALLATION

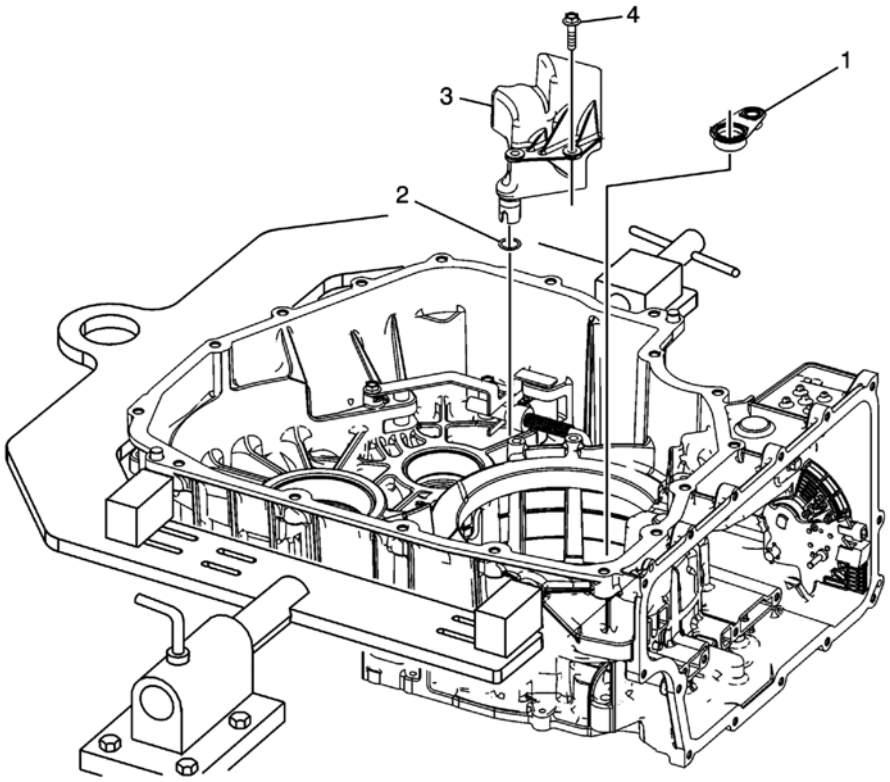


Fig. 21: Identifying Fluid Trough Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	A/Trans Fluid Pump Outlet Seal Assembly
2	A/Trans Fluid Trough (O-ring) Seal
3	A/Trans Fluid Trough
4	A/Trans Fluid Trough Bolt M6 x 25 (Qty: 1) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 12 N.m (106 lb in).

TORQUE CONVERTER AND DIFFERENTIAL HOUSING ASSEMBLY DISASSEMBLE

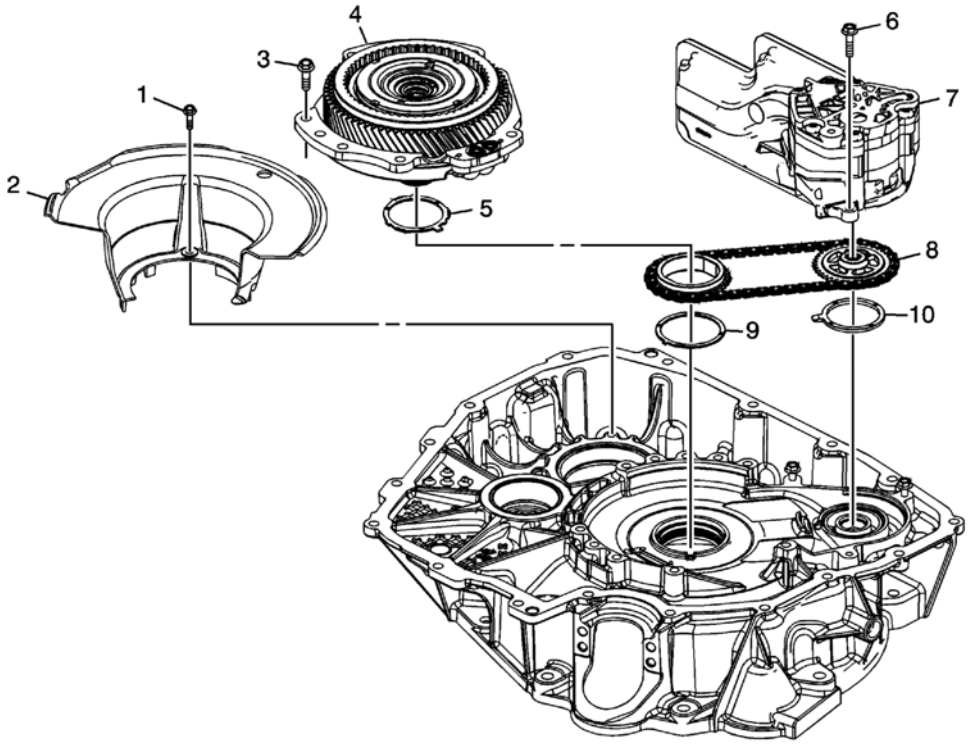


Fig. 22: Identifying Torque Converter & Differential Housing Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Differential Carrier Baffle Bolt M6 x 25
2	Front Differential Carrier Baffle
3	Front Differential Transfer Drive Gear Support Bolt M8 x 25 (Qty: 9)
4	Front Differential Transfer Drive Gear Support Assembly
5	Drive Sprocket Thrust Washer
6	A/Trans Fluid Pump Bolt M6 x 25 (Qty: 3)
7	A/Trans Fluid Pump Assembly
8	Drive Link Assembly **NOTE:** **Link and sprockets will be removed as an assembly.**
9	Drive Sprocket Thrust Washer **NOTE:** **Drive sprocket thrust**

Callout	Component Name
	washer may be stuck to the torque converter housing.
10	Driven Sprocket Thrust Washer

FRONT DIFFERENTIAL CARRIER BEARING CUP AND WASHER REPLACEMENT - TORQUE CONVERTER HOUSING SIDE

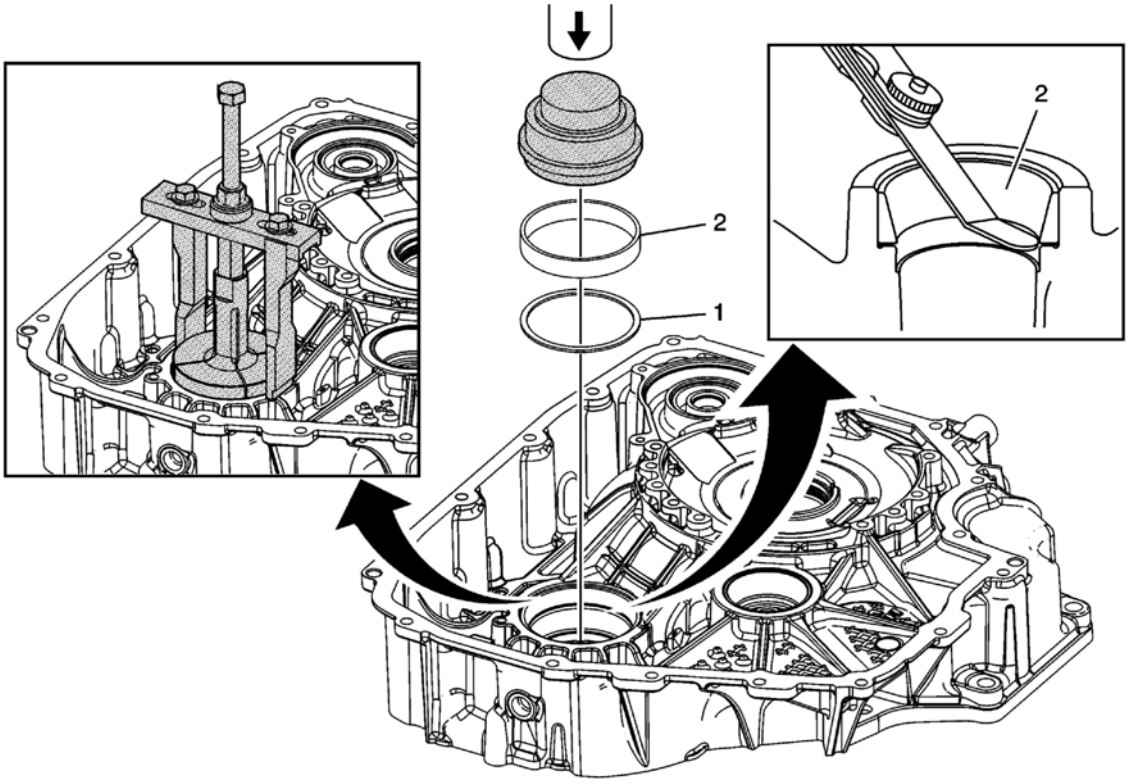


Fig. 23: Identifying Front Differential Carrier Bearing Cup & Washer
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures • Do not install the bearing cup until after the selective washer measurement has been performed. • Install the correct differential bearing washer as determined by the thrust washer measurement procedure. Refer to **Front Differential Drive Pinion Gear Bearing Thrust Washer and Front Differential Bearing Washer Measurement**.	
1	Front Differential Bearing Thrust Washer
2	Front Differential Carrier Bearing Cup **CAUTION:**

Callout	Component Name
	Support the back side of the torque converter housing before installing the bearing cup. Apply a light coating of transmission fluid to the bore before pressing the cup into position. Install the bearing cup until it stops moving. Applying excessive pressure to the bearing cup once it is seated could cause damage to the torque converter housing casting. **CAUTION: An unseated or improperly installed bearing cup will result in premature bearing failure. Visually inspect the bearing cup to insure**

Callout	Component Name
	there is"no gap" between the converter housing, thrust washer, and the bearing cup. Use of a feeler gauge may assist in identifying a bearing cup that is not fully seated. CAUTION: Failure to apply the lubricant will cause damage to the bolt and nut threads. CAUTION: There are first and second design front differential bearing cups. First design bearing cups are manufactured by Timken. Second design bearing cups are manufactured by NSK. Second design bearing cups

Callout	Component Name
	require DT-45087-A cup installer. If installing second design bearing cups, second design front differential carrier bearings must be used. All four parts must be kept as a set to prevent damage to the transmission. **Procedure** 1. Tighten DT 47927-1 which is part of **DT-47927** bearing cup remover until it fits snugly on the bearing cup. 2. Adjust **DT 45124** remover bridge so it sits on the torque converter housing surface just beyond the bearing cup opening. 3. Apply the extreme pressure lubricant supplied with **DT 23444-A** extreme press lubricant to the puller bolt threads to prevent damage to the bolt threads during bearing cup removal. 4. Hold the puller bridge bolt and turn the nut to remove the bearing cup. **Special Tools** • **DT 23444-A** Extreme Press Lubricant - 1/4 Ounce Tube • **DT-45087** Bearing Cup Installer • **DT-45087-A** Bearing Cup Installer • **DT 45124** Remover Bridge • **DT-47927** Bearing Cup Remover For equivalent regional tools, refer to **Special Tools** .

FRONT DIFFERENTIAL DRIVE PINION BEARING CUP, WASHER, AND LUBRICANT DAM REPLACEMENT - TORQUE CONVERTER HOUSING SIDE

Bearing Cup, Washer and Lubricant Dam Removal

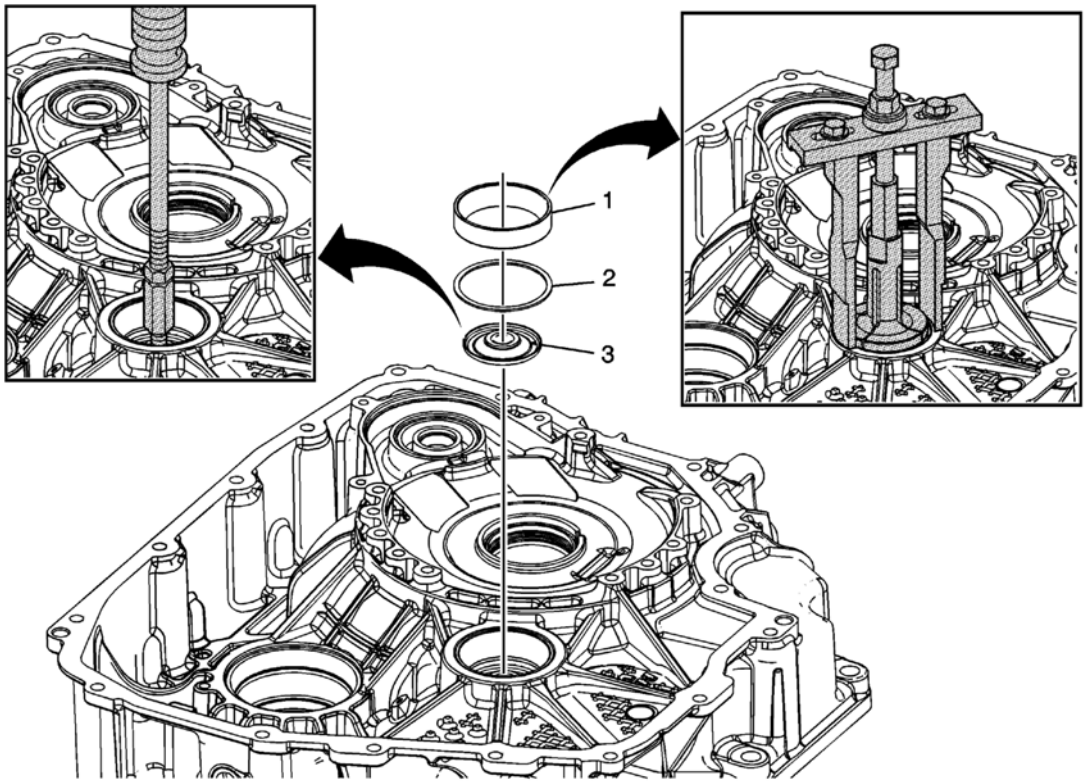


Fig. 24: View Of Front Differential Drive Pinion Bearing Cup, Washer & Lube Dam
Courtesy of GENERAL MOTORS COMPANY

Bearing Cup, Washer and Lubricant Dam Removal

Callout	Component Name
Preliminary Procedure Do not install the bearing cup until after the selective washer measurement has been performed.	
1	Front Differential Drive Pinion Gear Bearing Cup **CAUTION:** **Failure to apply the lubricant will cause damage to the bolt and nut threads.** **Procedure** 1. Tighten **DT-45094** bearing cup remover until it fits snugly on the bearing cup. 2. Adjust **DT 45124** removal bridge so it sits on the torque converter housing surface just beyond the bearing cup opening. 3. Apply the extreme pressure lubricant **DT 23444-A** extreme press lubricant to the puller bolt threads to prevent damage to the bolt threads during bearing cup removal.

Callout	Component Name
	4. Hold the puller bridge bolt and turn the nut to removal the bearing cup. **Special Tools** • **DT 23444-A** Extreme Press Lubricant - 1/4 Ounce Tube • **DT-45087** Transfer Shaft and Differential Bearing Cup Installer • **DT-45094** Bearing Cup Remover • **DT 45124** Removal Bridge • **DT-47927** Bearing Cup Remover For equivalent regional tools, refer to **Special Tools** .
2	Front Differential Drive Pinion Gear Bearing Thrust Washer
3	Front Differential Drive Pinion Gear Lube Dam **Special Tools** • **DT-48055** Lube Dam Remover • **GE 6125-1B** Slide Hammer with Adapter or equivalent For equivalent regional tools, refer to **Special Tools** .

Bearing Cup, Washer and Lubricant Dam Installation

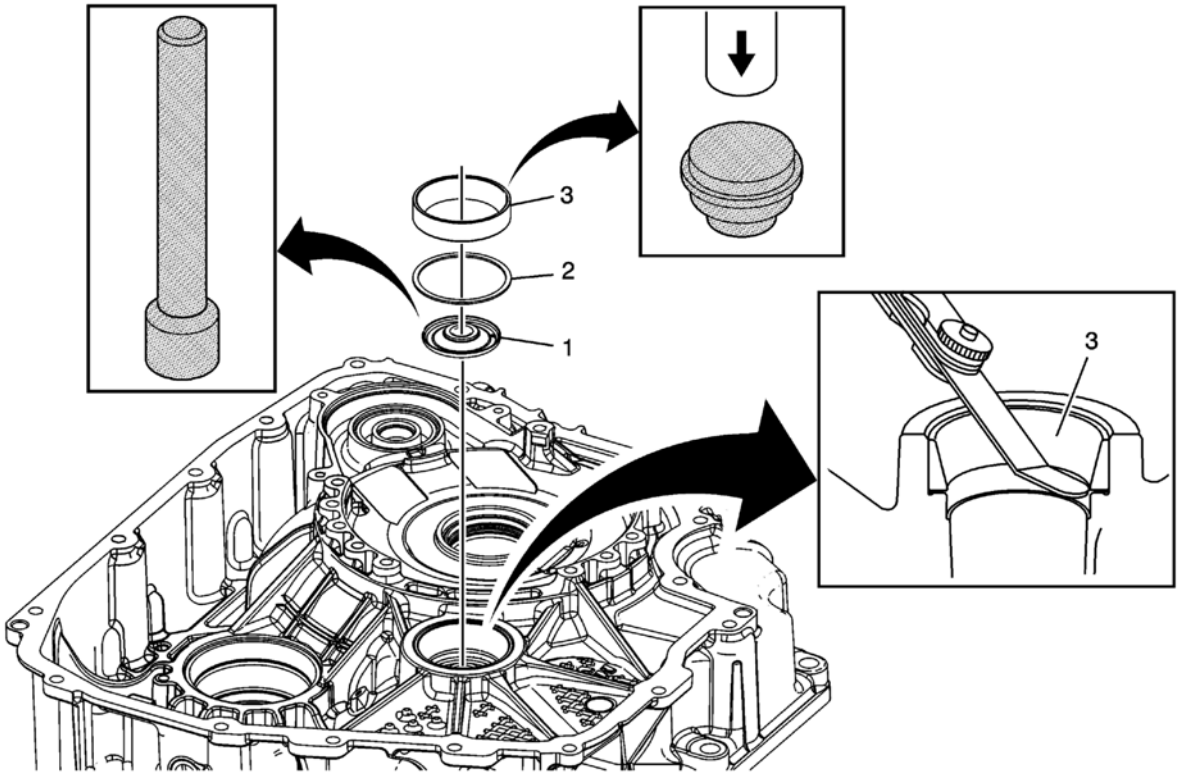


Fig. 25: Identifying Front Differential Drive Pinion Bearing Cup, Washer & Lube Dam

Courtesy of GENERAL MOTORS COMPANY

Bearing Cup, Washer and Lubricant Dam Installation

Callout	Component Name
Preliminary Procedure Do not install the bearing cup until after the selective washer measurement has been performed.	
1	Front Differential Drive Pinion Gear Lube Dam **Special Tools** • **DT-46630** Lube Dam Installer • **GE 8092** Driver Handle For equivalent regional tools, refer to **Special Tools** .
2	Front Differential Drive Pinion Gear Bearing Thrust Washer **NOTE:** **Install the correct drive pinion gear bearing thrust washer as determined by the thrust washer measurement procedure. Refer to Front Differential Drive Pinion Gear Bearing Thrust Washer and Front Differential Bearing Washer Measurement.**
3	Front Differential Drive Pinion Gear Bearing Cup **CAUTION:** **Support the back side of the torque converter housing before**

Callout	Component Name
	installing the bearing cup. Apply a light coating of transmission fluid to the bore before pressing the cup into position. Install the bearing cup until it stops moving. Applying excessive pressure to the bearing cup once it is seated could cause damage to the torque converter housing casting. **CAUTION: An unseated or improperly installed bearing cup will result in premature bearing failure. Visually inspect the bearing cup to insure there is"no gap" between the converter housing, thrust**

Callout	Component Name
	washer, and the bearing cup. Use of a feeler gauge may assist in identifying a bearing cup that is not fully seated. **Special Tools** **DT-45087** Bearing Cup Installer For equivalent regional tools, refer to **Special Tools** .

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - TORQUE CONVERTER HOUSING SIDE

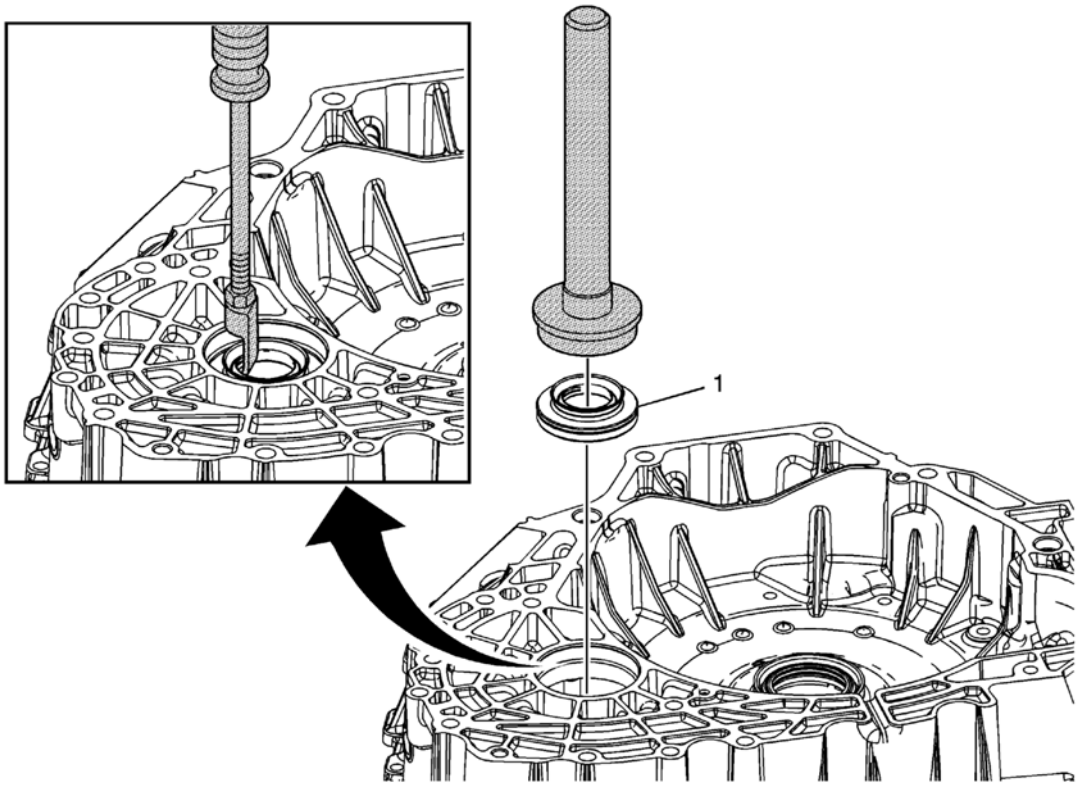


Fig. 26: Identifying Front Wheel Drive Shaft Oil Seal
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Torque Converter - Front Wheel Drive Shaft Oil Seal Assembly **NOTE:**

Callout	Component Name
	Use the open side of DT 46629-A seal installer to avoid seal lip damage and to install the seal to the proper depth. **Special Tools** • **DT 23129** Universal Seal Remover • **DT 46629-A** Seal Installer • **GE 6125-1B** Slide Hammer with Adapter • **GE 8092** Driver Handle For equivalent regional tools, refer to **Special Tools** .

TORQUE CONVERTER HOUSING CLEANING AND INSPECTION

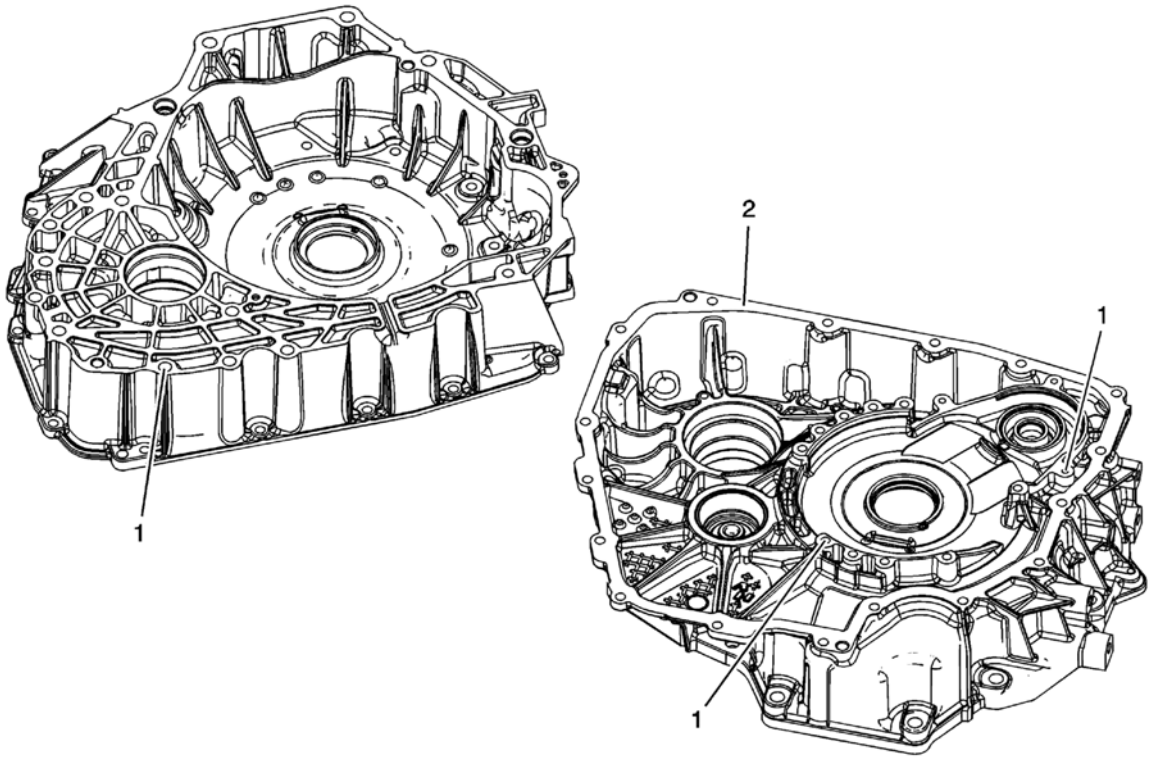


Fig. 27: Identifying Torque Converter Housing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
CAUTION: **After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.** **CAUTION:** **Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.** **CAUTION:** **Do not use abrasive pads or bristle devices to clean the sealing surfaces. Abrasive pads produce a fine grit that can effect transmission**	

Callout	Component Name
function. Abrasive pads can also remove enough metal to create oil leaks. **Preliminary Procedure** Thoroughly clean the torque converter and differential housing, including threads, with clean solvent.	
1	Threaded Holes
2	Gasket Sealing Surfaces

TORQUE CONVERTER FLUID SEAL REPLACEMENT

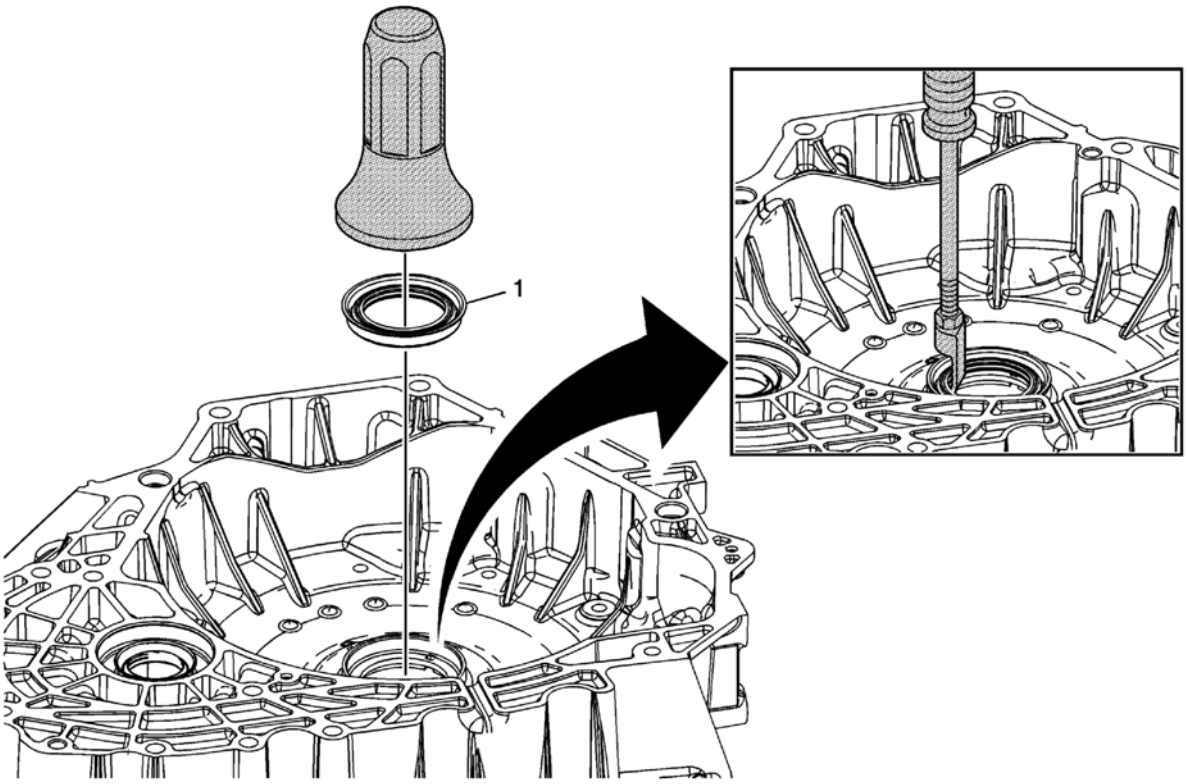


Fig. 28: Identifying Torque Converter Fluid Seal
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Torque Converter Fluid Seal **CAUTION:** **Support the back side of the torque**

Callout	Component Name
	converter housing while installing the seal. Install the seal until it stops moving. Applying excessive pressure to the seal once it is seated could cause damage to the torque converter housing casting. **Special Tools** • **DT 23129** Universal Seal Remover • **DT 49861** Seal Installer • **GE 6125-1B** Slide Hammer with Adapter or equivalent For equivalent regional tools, refer to **Special Tools** .

FRONT DIFFERENTIAL TRANSFER DRIVE GEAR SUPPORT ASSEMBLY DISASSEMBLE

Seal Removal

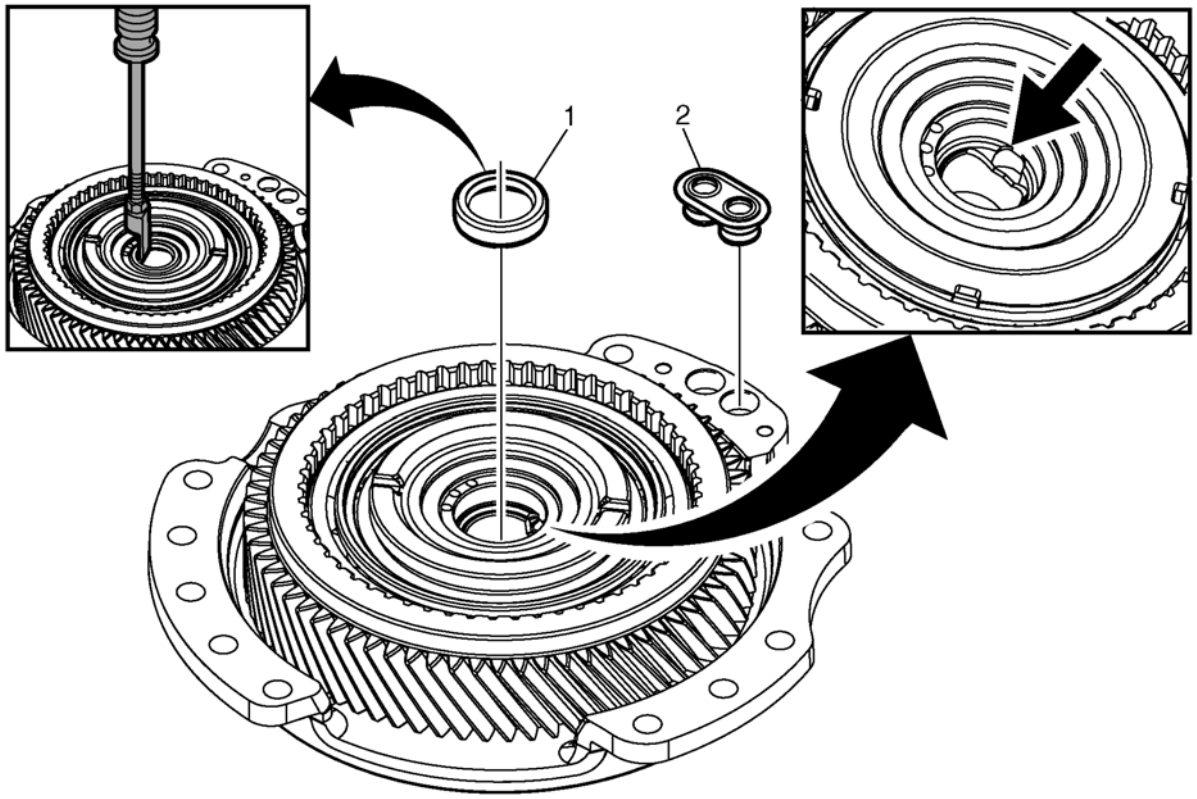


Fig. 29: Identifying Front Differential Transfer Drive Gear Support Seal
Courtesy of GENERAL MOTORS COMPANY

Seal Removal

Callout	Component Name
CAUTION: **Do not remove the transfer drive gear bearing retaining nut. The drive gear and bearing are not serviceable. Removing the retaining nut will damage the support.**	

Preliminary Procedure

- Inspect the support assembly for damage or wear to the splines, bushings, machined surfaces and threaded holes.

Callout	Component Name
• Inspect the transfer drive gear for damage or wear. • Inspect the transfer drive gear bearing assembly for proper operation. • The bearing should roll smoothly and quietly.	
1	Front Differential Transfer Drive Gear Support Seal **Special Tools** • **DT 23129** Universal Seal Remover • **GE 6125-1B** Slide Hammer with Adapter or equivalent For equivalent regional tools, refer to **Special Tools** .
2	Front Differential Transfer Drive Gear Support Torque Converter Fluid Seal Assembly

Fluid Passage Tube Removal

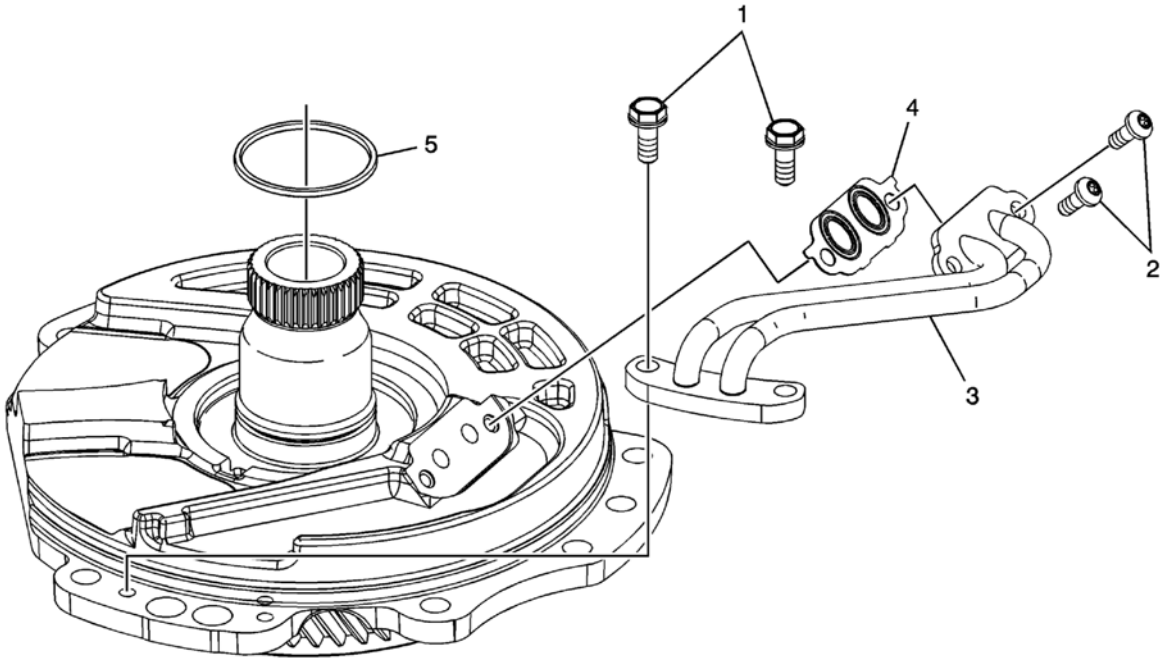


Fig. 30: Identifying Fluid Passage Tube Assembly
Courtesy of GENERAL MOTORS COMPANY

Fluid Passage Tube Removal

Callout	Component Name
CAUTION: **Do not remove the**	

Callout	Component Name
transfer drive gear bearing retaining nut. The drive gear and bearing are not serviceable. Removing the retaining nut will damage the support. **Preliminary Procedures** • Inspect the support assembly for damage or wear to the splines, bushings, machined surfaces and threaded holes. • Inspect the transfer drive gear for damage or wear. • Inspect the transfer drive gear bearing assembly for proper operation. • The bearing should roll smoothly and quietly.	
1	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt M6 x 15 (Qty: 2)
2	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt M5 x 12 (Qty: 2)
3	Fluid Passage Tube Assembly **NOTE:** **Inspect the tubes for damage, wear or cracked welds.**
4	Front Differential Transfer Drive Gear Support Fluid Passage Tube Gasket
5	Front Differential Transfer Drive Gear Support Seal

FRONT DIFFERENTIAL TRANSFER DRIVE GEAR SUPPORT ASSEMBLY ASSEMBLE

Drive Support Seal Installation

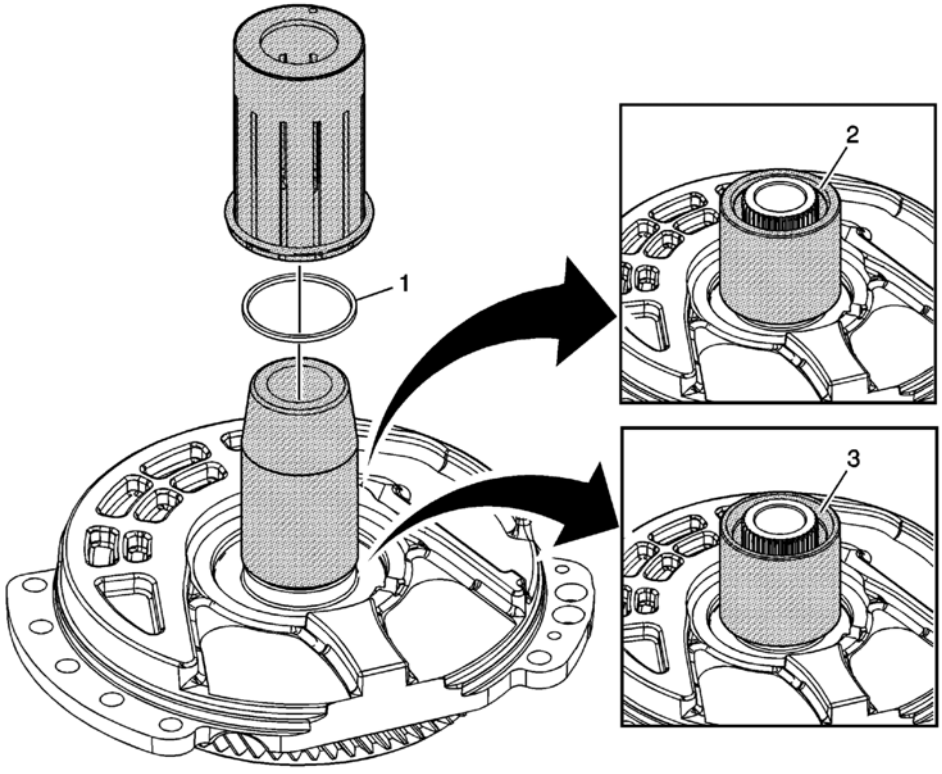


Fig. 31: Identifying Front Differential Transfer Drive Gear Support Seal
Courtesy of GENERAL MOTORS COMPANY

Drive Support Seal Installation

Callout	Component Name
1	Front Differential Transfer Drive Gear Support Seal **NOTE:** **A NEW seal must be installed.** **Special Tools** **DT-46624** Support Seal Installer For equivalent regional tools, refer to **Special Tools** .
2	Small Chamfer Faces Up **CAUTION:** **To avoid damaging the seal, first place DT 46624-1 with the small chamfer end facing up**

Callout	Component Name
	and leave in place for at least 60 seconds.
3	Large Chamfer Faces Up **NOTE:** **Turn DT 46624-1 which is part of DT-46624 seal installer , over with the large chamfer end facing up for 60 seconds to ensure that the seal has been properly sized.**

Fluid Passage Tube Installation

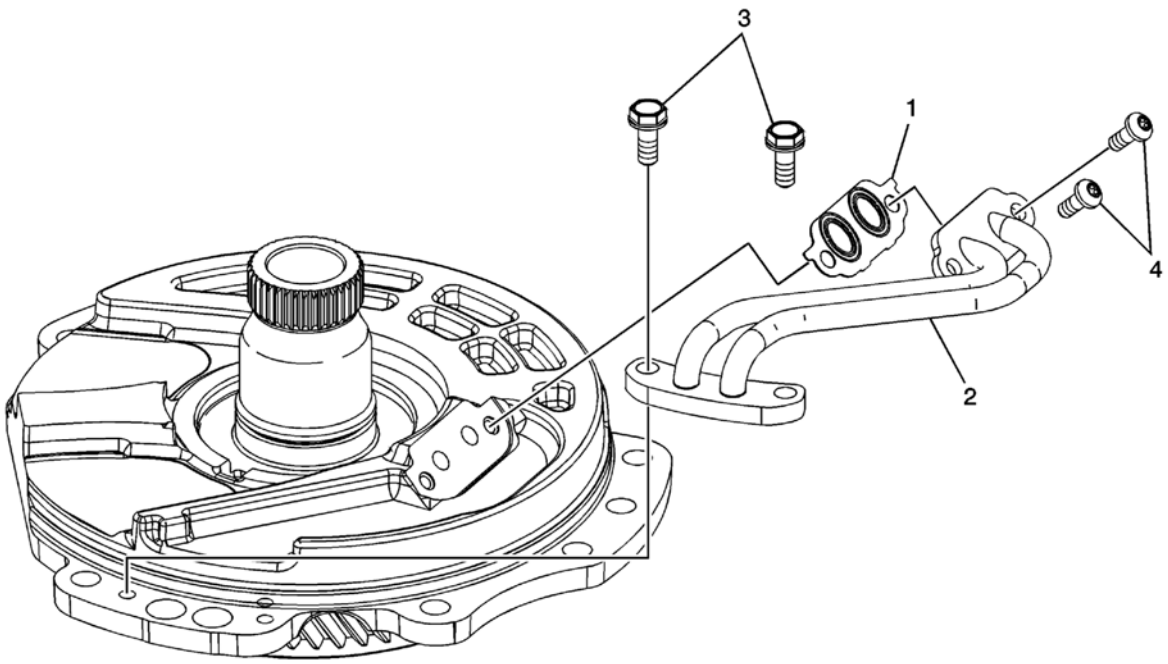


Fig. 32: Identifying Front Differential Transfer Drive Gear Support Fluid Passage Tube

Courtesy of GENERAL MOTORS COMPANY

Fluid Passage Tube Installation

Callout	Component Name
1	Front Differential Transfer Drive Gear Support Fluid Passage Tube Gasket
2	Fluid Passage Tube Assembly
3	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt M6 x 15 (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 12 N.m (106 lb in)
4	Front Differential Transfer Drive Gear Fluid Passage Tube Bolt M5 x 12 (Qty: 2) **Tighten** 7 N.m (62 lb in)

Seal Installation

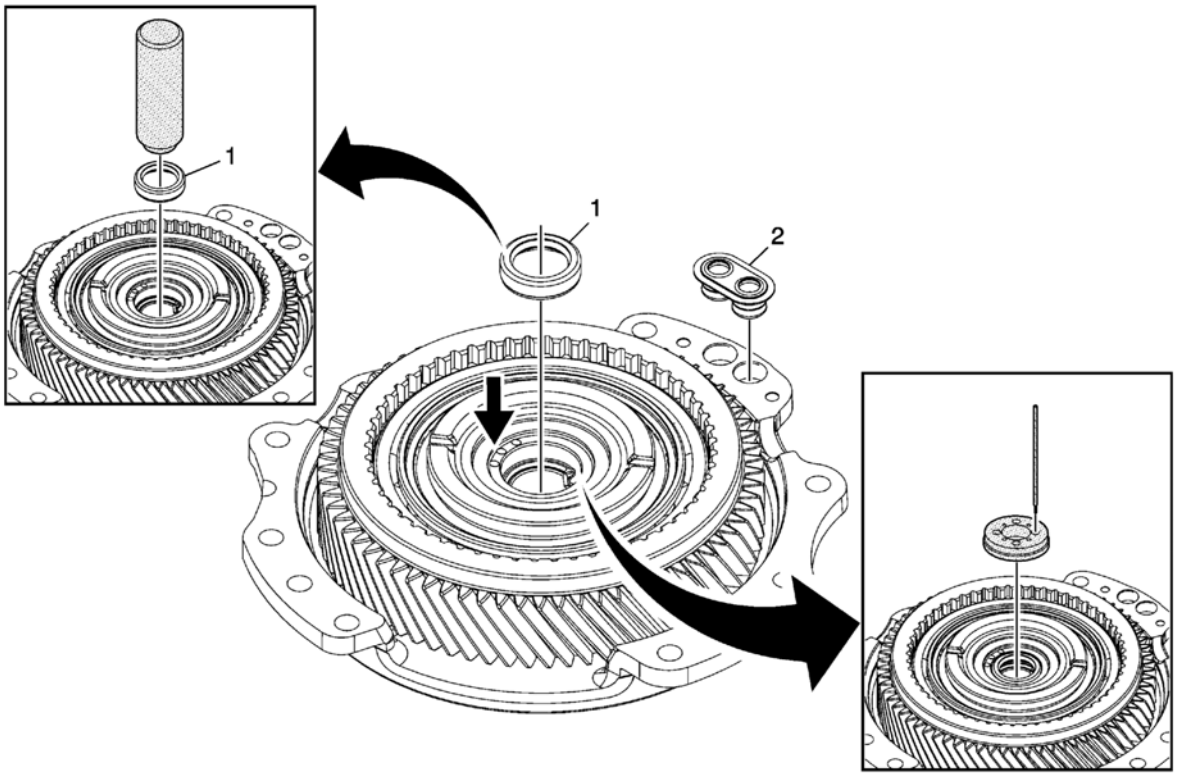


Fig. 33: View Of Front Differential Transfer Drive Gear Support Seal
Courtesy of GENERAL MOTORS COMPANY

Seal Installation

Callout	Component Name

Callout	Component Name
1	Front Differential Transfer Drive Gear Support Seal **CAUTION:** • **Ensure staking does not line up with lubrication holes or the holes may be damaged.** • **Stop driving the seal once it bottoms out to avoid seal damage.** **NOTE:** **The fluid seal assembly must be staked in place using DT-49131 seal staking tool to ensure proper seal retention.** **Special Tools** • **DT-46627-A** Seal Installer • **DT-49131** Seal Staking Tool For equivalent regional tools, refer to **Special Tools** .
2	Front Differential Transfer Drive Gear Support Torque Converter Fluid Seal Assembly

TRANSMISSION FLUID PUMP CLEANING AND INSPECTION

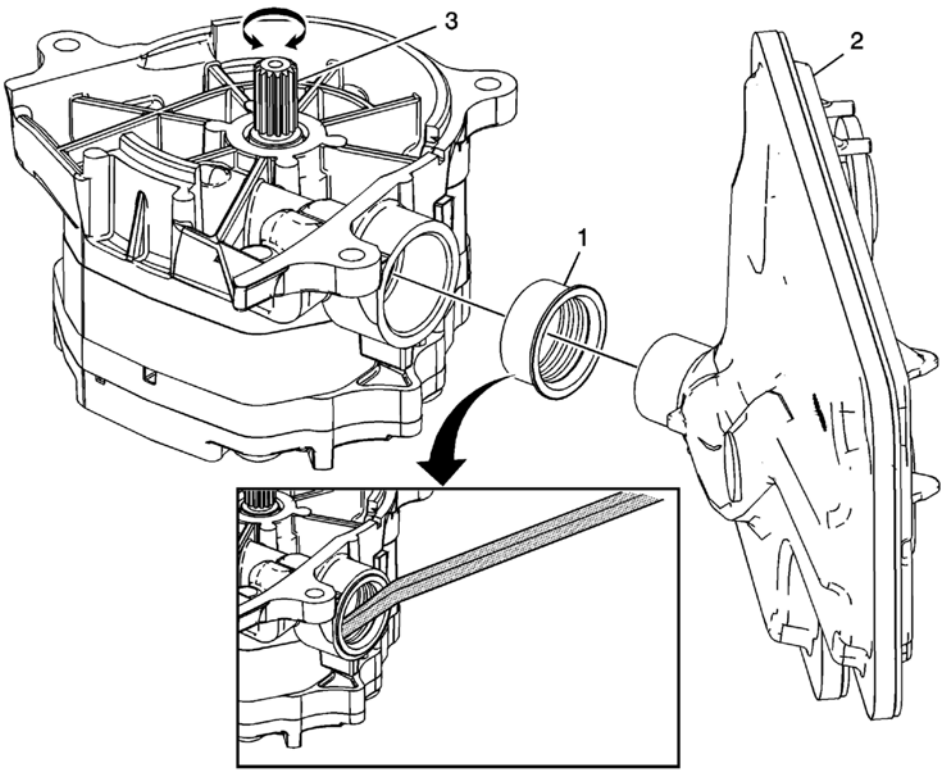


Fig. 34: Identifying Fluid Pump Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
CAUTION: **After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.** **CAUTION:** **Do not reuse cleaning solvents.**	

Callout	Component Name
Previously used solvents may deposit sediment which may damage the component. **Preliminary Procedure** The fluid pump assembly is not serviceable.	
1	Filter Neck Seal **NOTE:** **Install a NEW filter neck seal.** **Special Tools** **28585** Snap ring Remover or equivalent For equivalent regional tools, refer to **Special Tools** .
2	A/Trans Fluid Filter Assembly **NOTE:** **Install a NEW fluid filter assembly.**
3	Fluid Pump Drive Shaft **NOTE:** • **Inspect the fluid pump drive shaft splines for damage or wear.** • **Rotate the fluid pump drive shaft for free**

Callout	Component Name
	operation.

FRONT DIFFERENTIAL DRIVE PINION GEAR BEARING THRUST WASHER AND FRONT DIFFERENTIAL BEARING WASHER MEASUREMENT

Differential Thrust Washer Gauge Installation

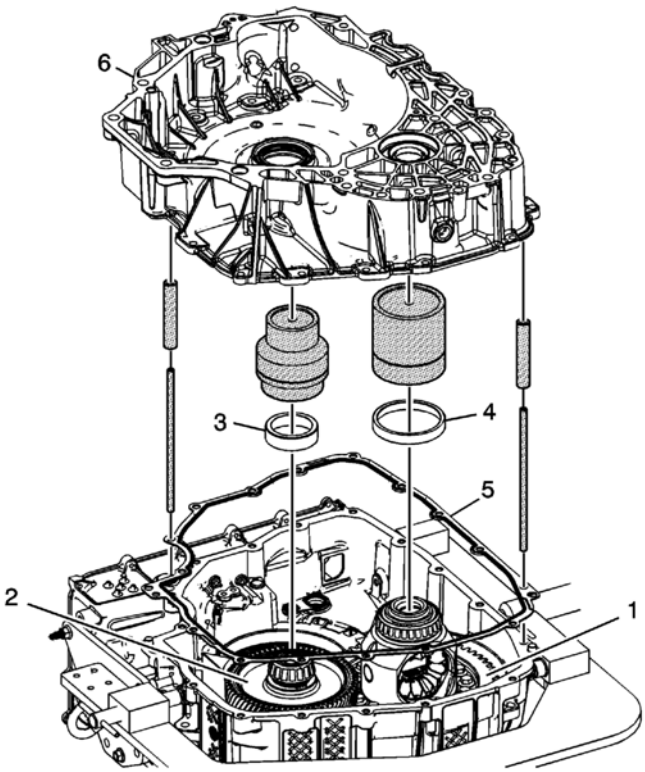


Fig. 35: Identifying Differential Thrust Washer Gage
Courtesy of GENERAL MOTORS COMPANY

Differential Thrust Washer Gauge Installation

Callout	Component Name
1	Front Differential Carrier Assembly **NOTE:** **Install the differential assembly and the pinion gear assembly together to avoid interference with the**

Callout	Component Name
	gears during installation.
2	Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly **NOTE:** **Install the differential assembly and the pinion gear assembly together to avoid interference with the gears during installation.**
3	Front Differential Drive Pinion Gear Bearing Cup **NOTE:** **After placing the bearing cup on the gear, place DT 47800-2 which is part of DT-47800 selection gauge kit , onto the bearing cup.** **Special Tools** **DT-47800** Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to **Special Tools** .
4	Front Differential Carrier Bearing Cup **NOTE:** **After placing the bearing cup on the gear, place DT 47800-1 which is part of DT-47800**

Callout	Component Name
	selection gauge kit , onto the bearing cup. **Special Tools** **DT-47800** Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to **Special Tools** .
5	Torque Converter Housing Outer Seal

Callout	Component Name
6	Torque Converter and Support and A/Trans Fluid Pump Housing Assembly **NOTE:** • **Install 2 DT 47800-6 which is part of DT-47800 selection gauge kit , into a case threaded hole at approximately 180 degrees apart.** • **Some alignment of DT 47800-1 and 2 which is part of DT-47800 selection gauge kit , may be required while lowering the TC housing onto the case.** • **Install DT 47800-3 which is part of DT-47800 selection gauge kit , spacer over DT 47800-6.** **Special Tools** **DT-47800** Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to **Special Tools** .

Torque Sequence

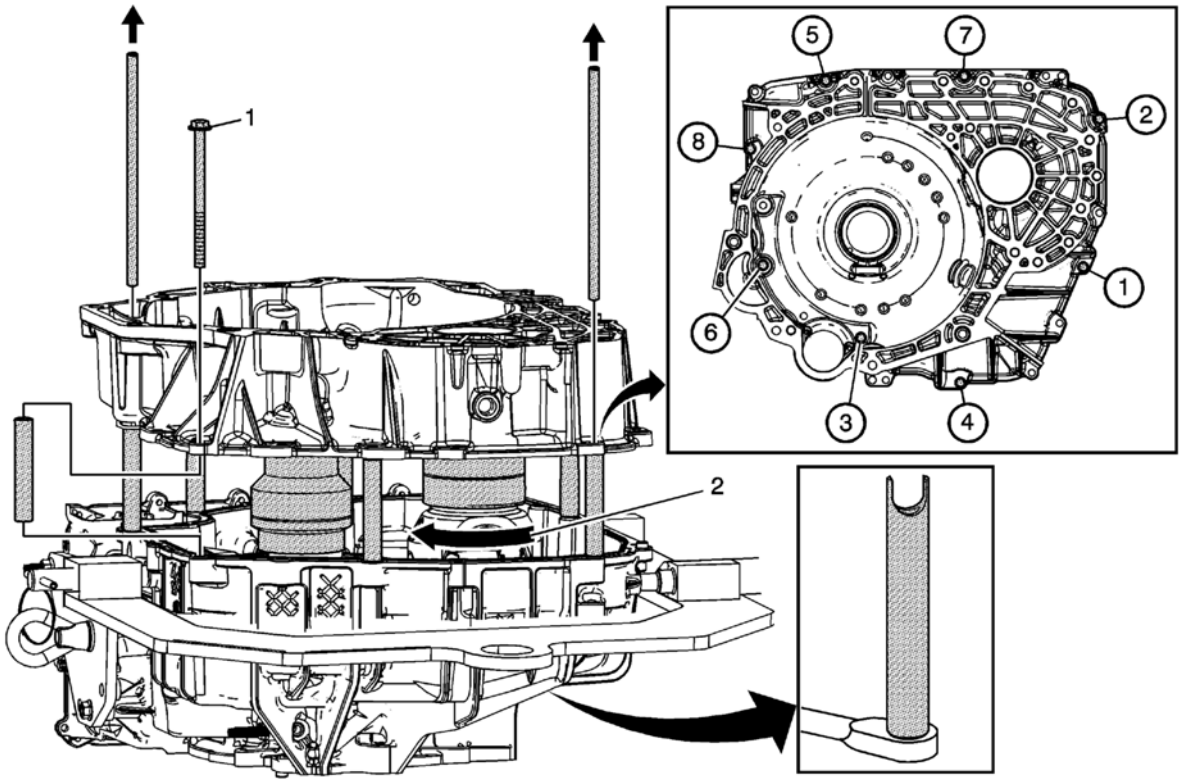


Fig. 36: Identifying Front Differential Carrier Assembly Torque Sequence
Courtesy of GENERAL MOTORS COMPANY

Torque Sequence

Callout	Component Name
1	Spacer Bolt M8 x 127 (Qty: 8) **CAUTION:** **Refer to Fastener Caution .** **Procedure** 1. Install the remaining spacers evenly at every other bolt hole. 2. Remove the DT 47800-6 which is part of **DT-47800** selection gauge kit , guide pins and install spacer bolts in all bolt holes at spacer locations. 3. Tighten the bolts in sequence. **Tighten** 30 N.m (22 lb ft) **Special Tools** **DT-47800** Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to **Special Tools** .

Callout	Component Name
2	Front Differential Carrier Assembly **CAUTION:** **If the bearings are not properly seated into the bearing cups, the washer selection will be inaccurate and the bearing pre-load will be set too low. Low bearing pre-load will cause premature failure of the front differential drive pinion gear.** **Procedure** Rotate the differential assembly 10 revolutions to allow the bearings to seat into the cups. **NOTE:** **Differential rotating tool DT-47793 differential rotating tool can be used to rotate the differential from the case side.** **Special Tools** **DT-47793** Differential Rotating Tool For equivalent regional tools, refer to **Special Tools** .

Differential Thrust Washer Selection

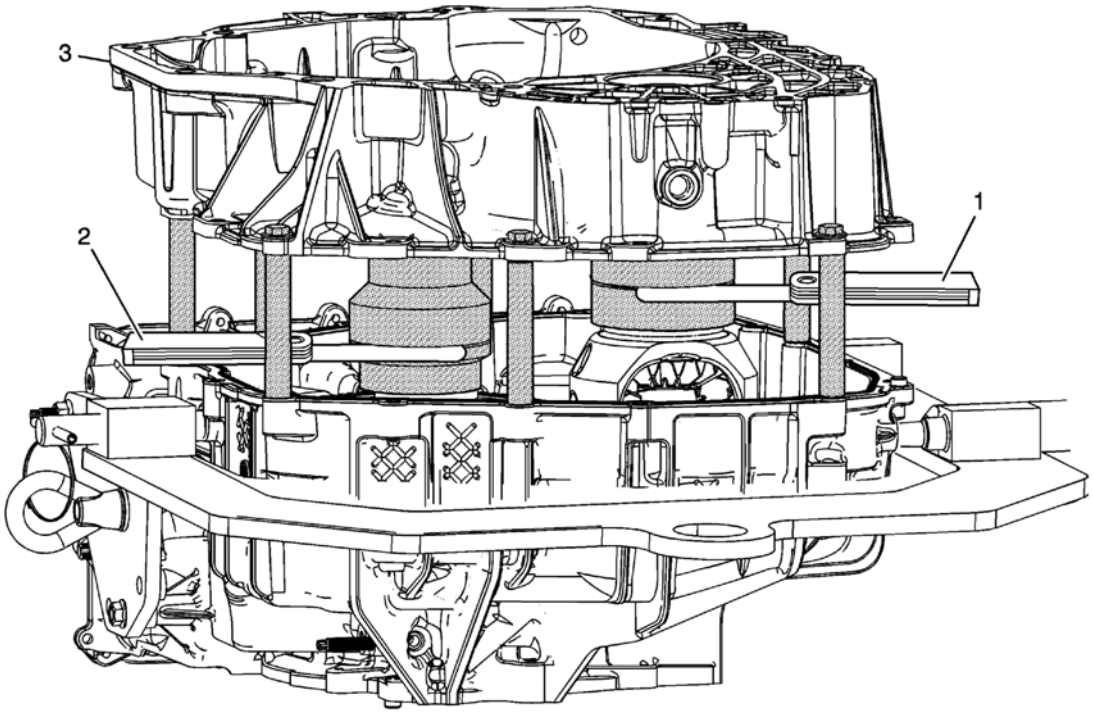


Fig. 37: Identifying Differential Thrust Washer Selection
Courtesy of GENERAL MOTORS COMPANY

Differential Thrust Washer Selection

Callout	Component Name
CAUTION: **Improper thrust washer selection can cause insufficient taper bearing pre-load which will cause premature failure of the front differential drive pinion gear.**	
1	Front Differential Bearing Washer **Procedure** Place DT 47800-7 in the gap in DT 47800-2 which are both part of **DT-47800** selection

Callout	Component Name
	gauge kit , to determine the proper thrust washer. Choose the correct thrust washer. Refer to **Taper Bearing Preload Selective Specifications** . **NOTE:** • **Continue trying different sizes of DT 47800-7 which is part of DT-47800 selection gauge kit , until the gauge will no longer fit into the gap. The correct thrust washer size is equal to the largest blade gauge that fits into the gap.** • **Match the size of the correct DT 47800-7 blade which is part of DT-47800 selection gauge kit , to the color code in the thrust washer specification chart. The washer color coding is on the outside diameter of the washer.** • **The gap in DT 47800-2 which are both part of DT-47800 selection gauge kit may not be even.**

Callout	Component Name
	Hold the top of the gauge and rotate the bottom of the gauge to even out the gap. Take two gap measurements 180 degrees apart. Average the two measurements and select the thrust washer that is closest to the average. • **The washer color coding is on the outside diameter of the washer.** **Special Tools** **DT-47800** Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to **Special Tools** .
2	Front Differential Drive Pinion Gear Bearing Thrust Washer **Procedure** Place DT 47800-7 in the gap in DT 47800-1 which are both part of **DT-47800** selection gauge kit , to determine the proper thrust washer. Choose the correct thrust washer. Refer to **Taper Bearing Preload Selective Specifications** . **NOTE:** • **Continue trying different sizes of DT 47800-7 which is part of DT-47800 selection gauge kit , until the gauge will no longer fit into**

Callout	Component Name
	the gap. The correct thrust washer size is equal to the largest gauge that fits into the gauge. • **Match the size of the correct DT 47800-7 blade which is part of DT-47800 selection gauge kit to the color code in the thrust washer selection chart.** • **The gap in DT 47800-1 which is part of DT-47800 selection gauge kit may not be even. Hold the top of the gauge and rotate the bottom of the gauge to even out the gap. Take two gap measurements 180 degrees apart. Average the two measurements and select the thrust washer that is closest to the average.** • **The washer color coding is on the outside**

Callout	Component Name
	diameter of the washer. **Special Tools** **DT-47800** Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to **Special Tools** .
3	Torque Converter and Support and A/Trans Fluid Pump Housing Assembly **Procedure** 1. Remove DT 47800-3 which are both part of **DT-47800** selection gauge kit , bolts and spacers. 2. Remove the torque converter housing. 3. Remove DT 47800-1 and DT 47800-2 which are both part of **DT-47800** selection gauge kit. 4. Remove the torque converter housing seal. 5. Remove the pinion gear and differential bearing cups. 6. Install the bearing cups and thrust washers into the torque converter housing per the replacement procedures. Refer to **Front Differential Carrier Bearing Cup and Washer Replacement - Torque Converter Housing Side**, and **Front Differential Drive Pinion Bearing Cup, Washer, and Lubricant Dam Replacement - Torque Converter Housing Side**. **NOTE:** **DT 47800-1 and DT 47800-2 which are both part of DT-47800 selection gauge kit , may stick in the torque converter housing. Be careful not to drop the gauges.** **Special Tools** **DT-47800** Thrust Washer Selection Gauge Kit For equivalent regional tools, refer to **Special Tools** .

TORQUE CONVERTER AND DIFFERENTIAL HOUSING ASSEMBLY ASSEMBLE

Pump Assembly Installation

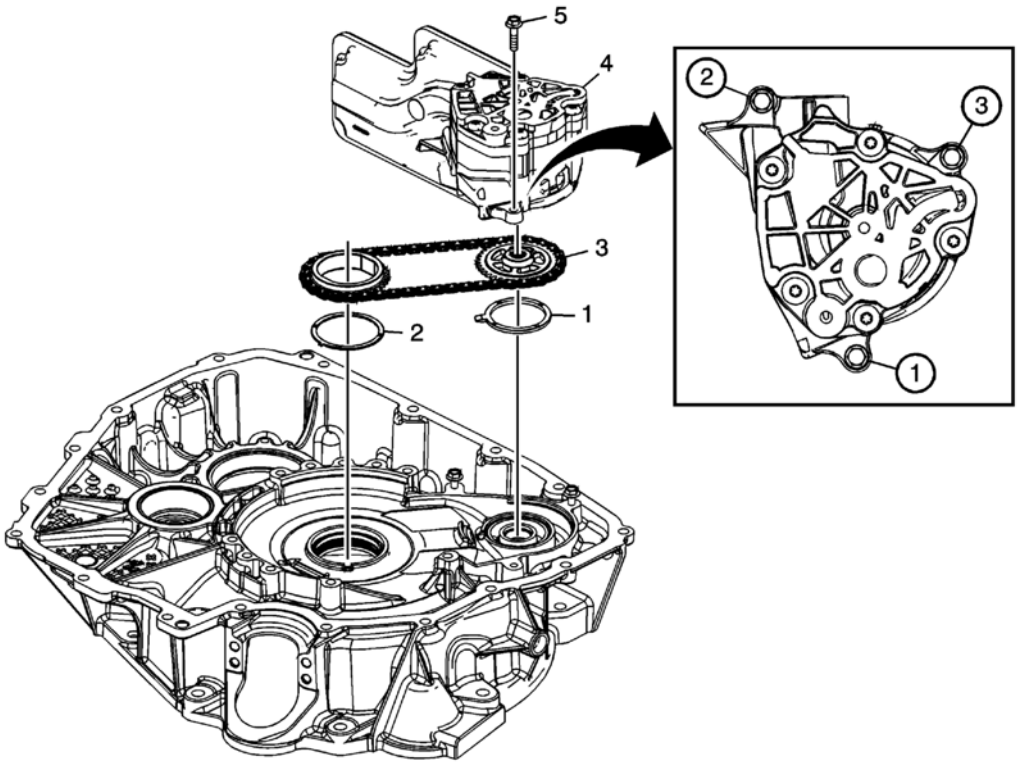


Fig. 38: View Of Pump Assembly
Courtesy of GENERAL MOTORS COMPANY

Pump Assembly Installation

Callout	Component Name
1	Driven Sprocket Thrust Washer
2	Drive Sprocket Thrust Washer
3	Install Drive Link Assembly **NOTE:** **Install as an assembly.**
4	A/Trans Fluid Pump Assembly **NOTE:** **Rotating the drive sprocket and link assembly while installing the oil pump will**

Callout	Component Name
	aid in aligning the driven sprocket and oil pump drive shaft splines.
5	A/Trans Fluid Pump Bolt M6 x 25 (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Procedure:** Tighten in sequence shown. **Tighten** 12 N.m (106 lb in).

Transfer Drive Gear Assembly Installation

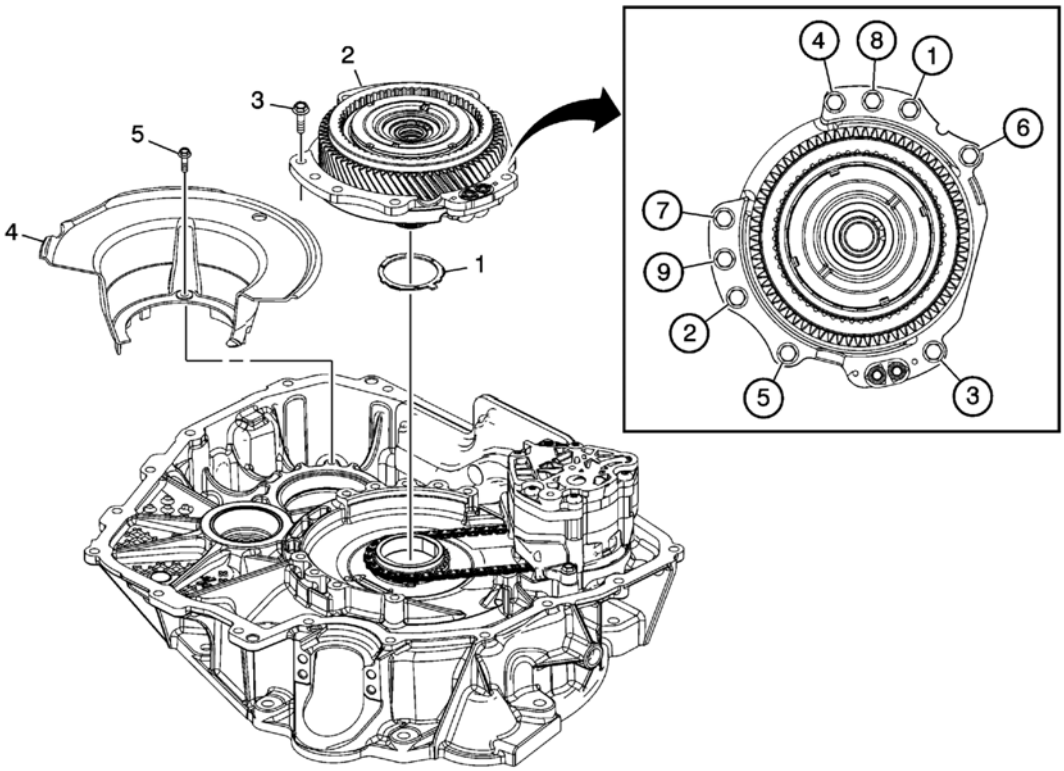


Fig. 39: View of Transfer Drive Gear Assembly
Courtesy of GENERAL MOTORS COMPANY

Transfer Drive Gear Assembly Installation

Callout	Component Name
1	Drive Sprocket Thrust Washer
2	Front Differential Transfer Drive Gear Support Assembly
3	Front Differential Transfer Drive Gear Support Bolt M8 x 25 (Qty: 9) **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten in sequence shown. **Tighten** 10 N.m (89 lb in) plus 50 degrees Â± 4 degrees. **Special Tools:** **EN 45059** Angle Meter For equivalent regional tools, refer to **Special Tools** .
4	Front Differential Carrier Baffle
5	Front Differential Carrier Baffle Bolt M6 x 25 **Tighten** 12 N.m (106 lb in).

FRONT DIFFERENTIAL DRIVE PINION GEAR BEARING REPLACEMENT

Removal

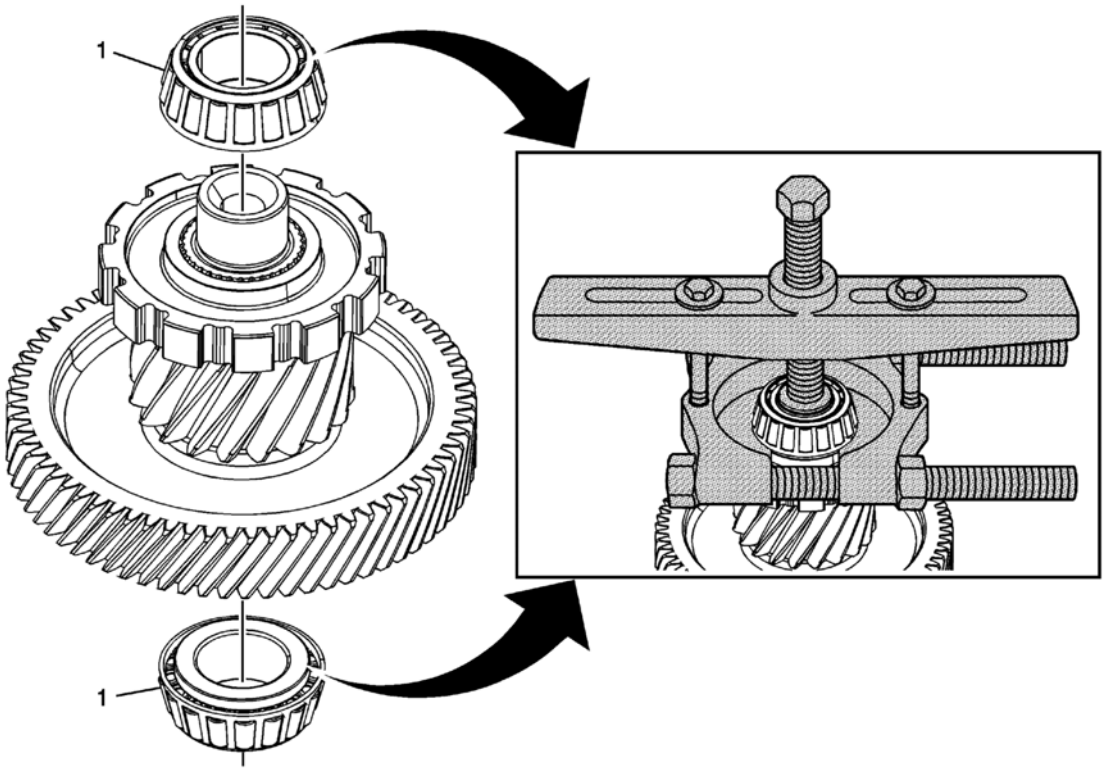


Fig. 40: View Of Front Differential Drive Pinion Gear Bearing
Courtesy of GENERAL MOTORS COMPANY

Removal

Callout	Component Name
1	Front Differential Drive Pinion Gear Bearing **NOTE:** • **When removing the front differential drive pinion gear bearing use DT 41816-2 step plate.** • **Use DT 8433-1 puller bar or equivalent with bolts 2-3/8 x 3 x 24.** **Special Tools** • **DT 8433-1** Puller Bar or equivalent • **DT 22912-B** Split Plate Bearing Remover or equivalent • **DT 41816-2** Step Plate For equivalent regional tools, refer to **Special Tools** .

Installation

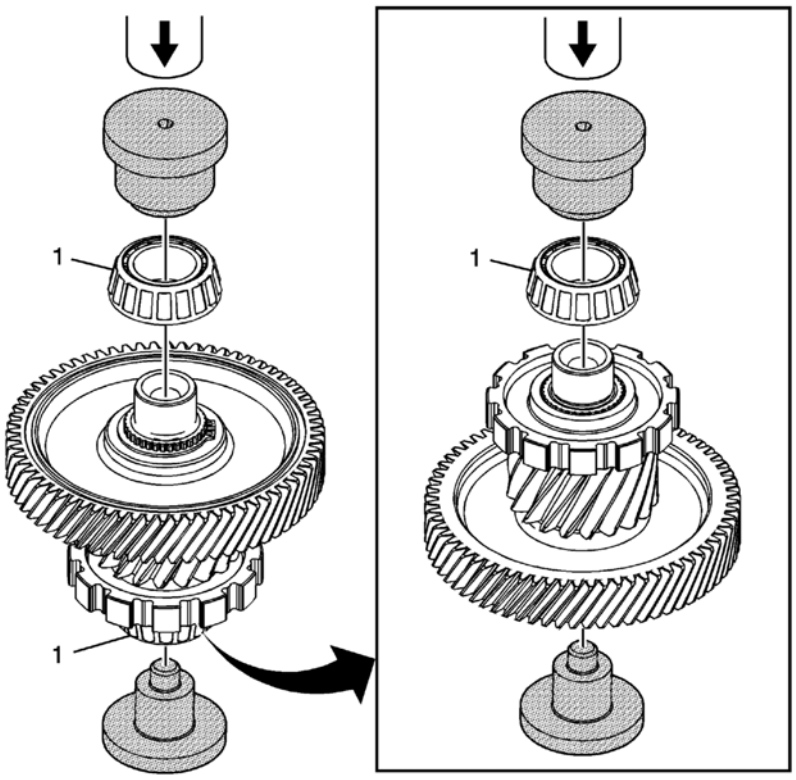


Fig. 41: Identifying Front Differential Drive Pinion Gear Bearing
Courtesy of GENERAL MOTORS COMPANY

Installation

Callout	Component Name
1	Front Differential Drive Pinion Gear Bearing **CAUTION:** **Pressing against the bearing assembly can damage the bearing and cause premature bearing failure.** **Special Tools** **DT-47928** Bearing Installer For equivalent regional tools, refer to **Special Tools** .

FRONT DIFFERENTIAL CARRIER BEARING REPLACEMENT

Removal

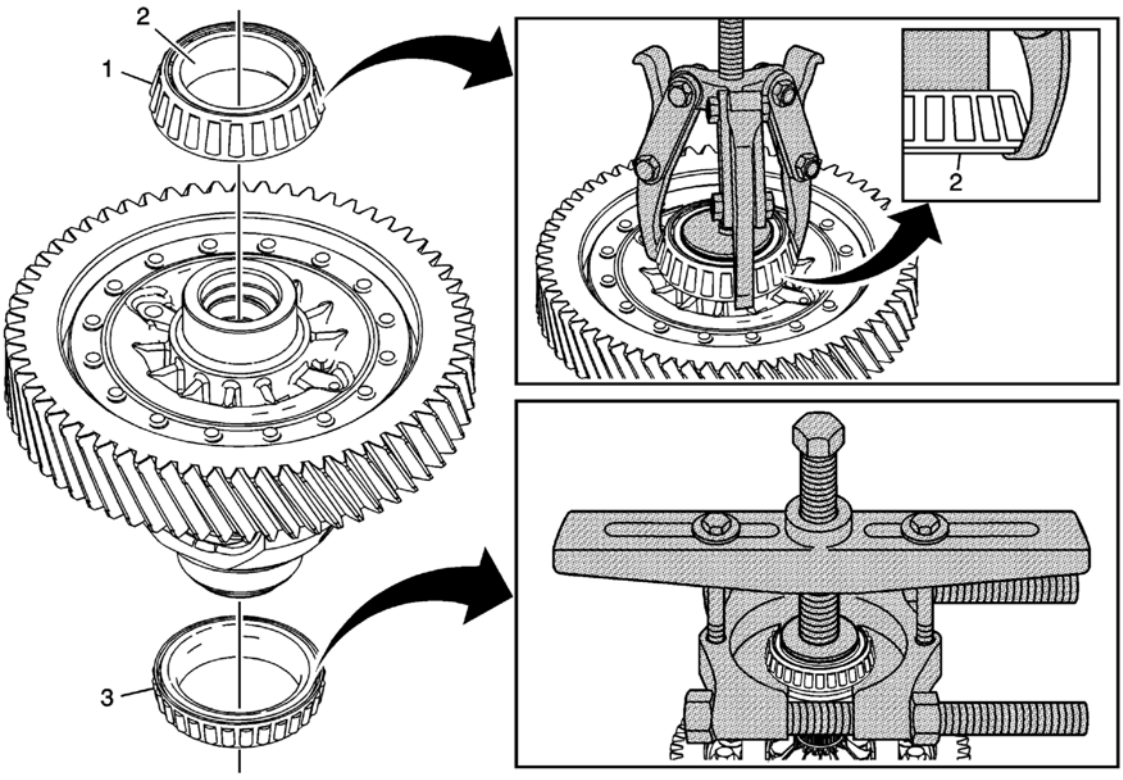


Fig. 42: Identifying Front Differential Carrier Bearing
Courtesy of GENERAL MOTORS COMPANY

Removal

Callout	Component Name
1	Front Differential Carrier Bearing Assembly **Special Tools** • **DT-41816** Three Legged Puller • **DT 41816-2** Step Plate For equivalent regional tools, refer to **Special Tools** .
2	Inner Race **NOTE:** **Ensure all 3 legs of the puller make contact with the inner race of the bearing.**
3	Front Differential Carrier Bearing Assembly **NOTE:**

Callout	Component Name
	• **AWD differential may need longer bolts, 2-3/8 x 5 x 24 thread bolts.** • **When removing the front differential carrier bearing assembly use DT 41816-2 step plate.** **Special Tools** • **DT 8433-1** Puller Bar or equivalent • **DT 22912-B** Split Plate Bearing Remover or equivalent • **DT 41816-2** Step Plate For equivalent regional tools, refer to **Special Tools** .

Installation

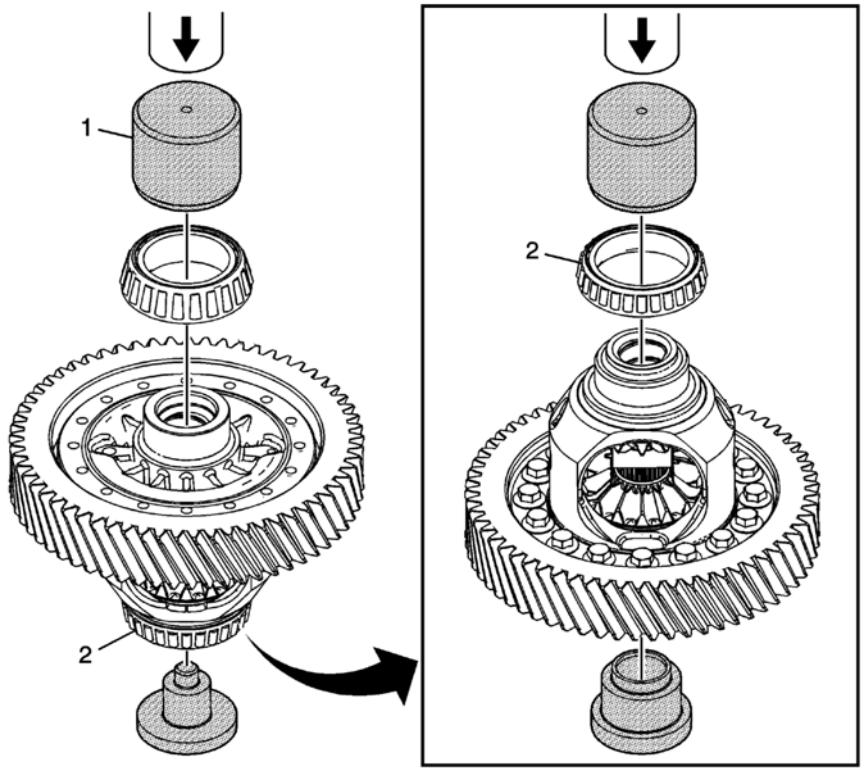


Fig. 43: View Of Front Differential Carrier Bearing
Courtesy of GENERAL MOTORS COMPANY

Installation

Callout	Component Name
1	Front Differential Carrier Bearing Assembly **CAUTION:** **Pressing against the bearing assembly can damage the bearing and cause premature bearing failure.** **CAUTION:** **There are first and second design front differential carrier bearings.**

Callout	Component Name
	First design bearings have twenty eight rollers and are manufactured by Timken. Second design bearings have 30 rollers and are manufactured by NSK. If installing second design bearings, second design front differential carrier bearing cups must be used. All four parts must be kept as a set to prevent damage to the transmission. **Special Tools** **DT-47928** Bearing Installer For equivalent regional tools, refer to **Special Tools** .
2	Front Differential Carrier Bearing Assembly **CAUTION:** **Pressing against the bearing assembly can damage the bearing and cause**

Callout	Component Name
	premature bearing failure. CAUTION: There are first and second design front differential carrier bearings. First design bearings have twenty eight rollers and are manufactured by Timken. Second design bearings have 30 rollers and are manufactured by NSK. If installing second design bearings, second design front differential carrier bearing cups must be used. All four parts must be kept as a set to prevent damage to the transmission. Special Tools

Callout	Component Name
	DT-47928 Bearing Installer For equivalent regional tools, refer to **Special Tools** .

FRONT DIFFERENTIAL CARRIER CLEANING AND INSPECTION

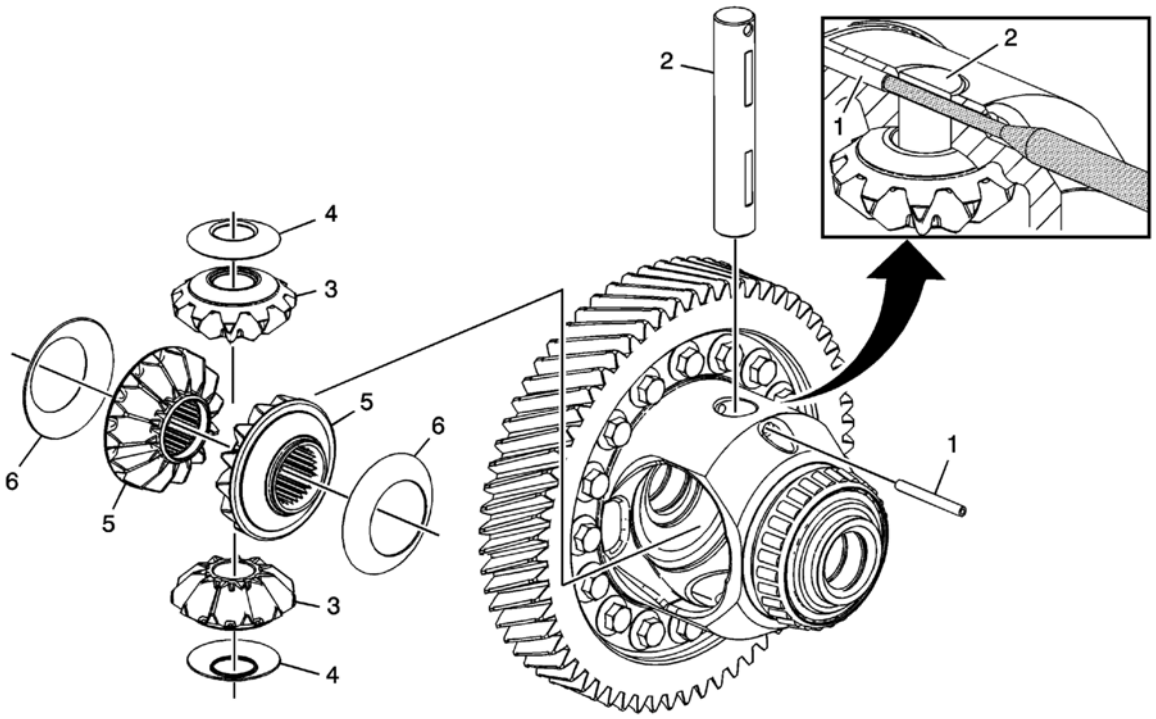


Fig. 44: Identifying Front Differential Carrier Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
CAUTION: **After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component**	

Callout	Component Name
failure. **CAUTION:** **Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.** **CAUTION:** **Keep the thrust washers with gear it was matched to. The thrust washers are selective sizes and it is difficult to identify the proper washer thickness. Improper assembly can cause premature failure of the differential assembly.** **Preliminary Procedure** Clean and inspect the differential assembly, pinion gears and thrust washers for scoring, wear or damage. The differential assembly is only serviced as an assembly.	
1	Front Differential Pinion Gear Shaft Retainer **NOTE:** **Discard and use a new**

Callout	Component Name
	retainer. **Special Tools** 3/16 in (5 mm) 7 in Punch or equivalent For equivalent regional tools, refer to **Special Tools** .
2	Front Differential Pinion Gear Shaft
3	Front Differential Pinion Gears
4	Front Differential Carrier Thrust Washers
5	Front Differential Pinion Side Gears
6	Front Differential Side Gear Thrust Washer

FRONT DIFFERENTIAL DRIVE PINION GEAR AND CARRIER INSTALLATION

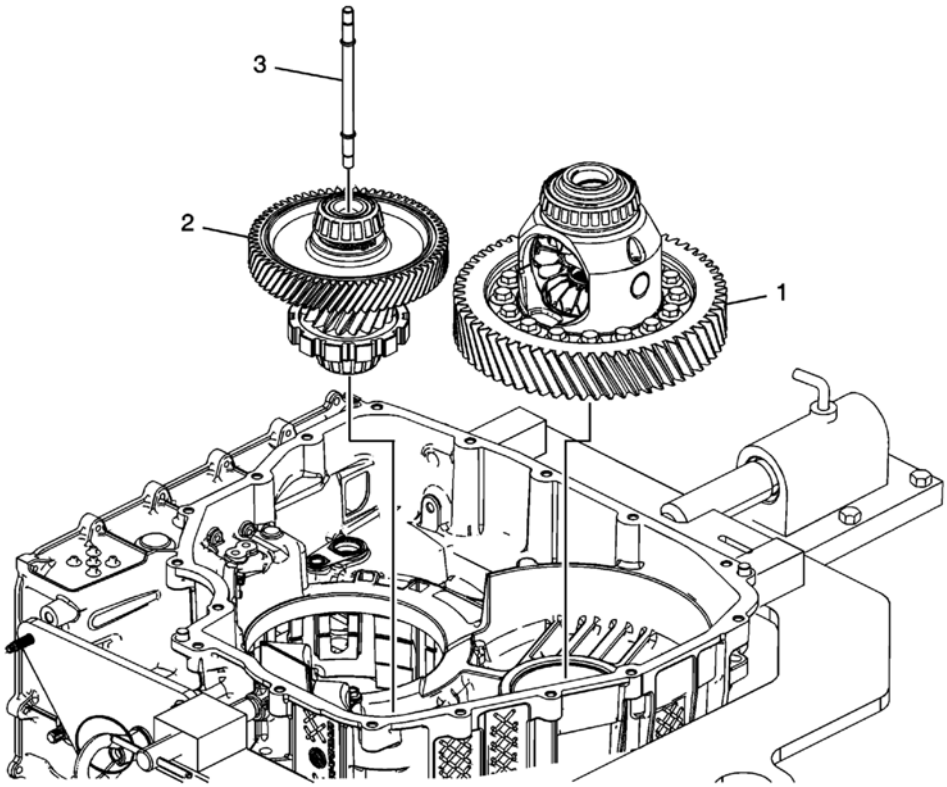


Fig. 45: Identifying Front Differential Carrier Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Differential Carrier Assembly **NOTE:** **Install the differential assembly and the**

Callout	Component Name
	pinion gear assembly together to avoid interference with the gears during installasion.
2	Front Differential Drive Pinion (w/Transfer Gear) Gear Assembly
3	Front Differential Drive Pinion Gear Lube Tube

TORQUE CONVERTER AND DIFFERENTIAL HOUSING INSTALLATION

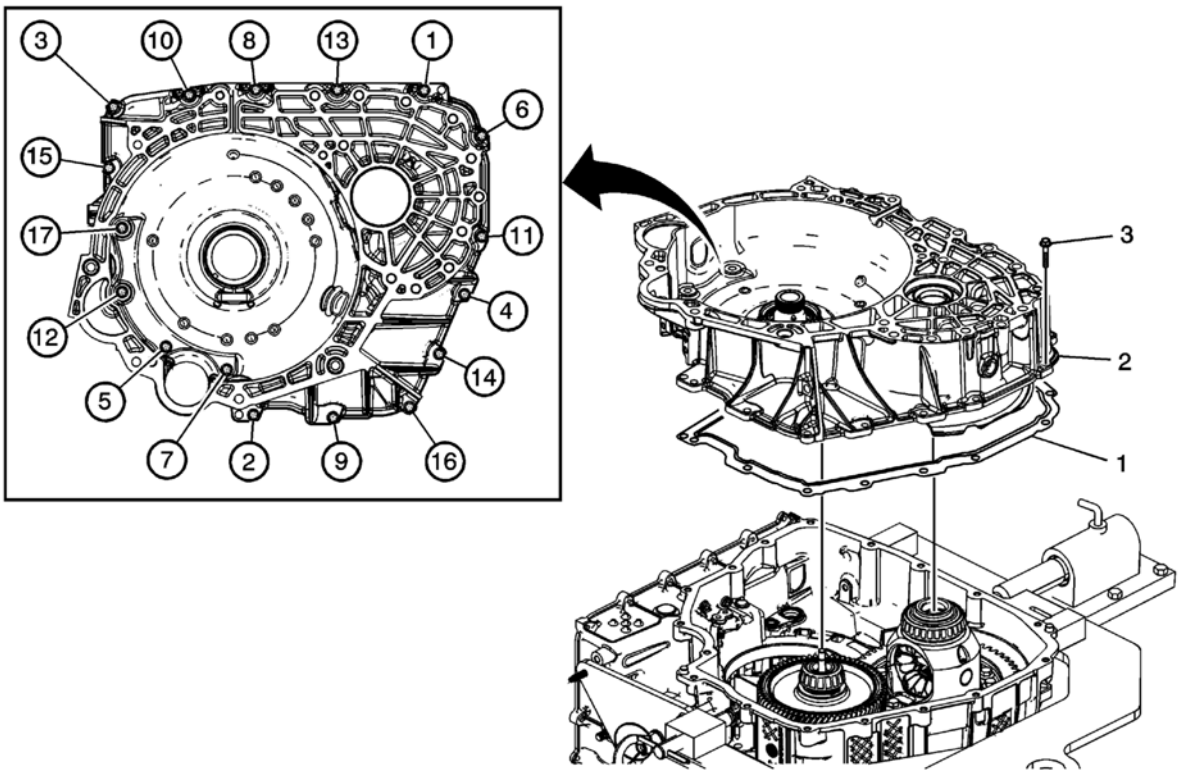


Fig. 46: Identifying Torque Converter & Differential Housing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Torque Converter Housing Outer Seal
2	Torque Converter and Support and A/Trans Fluid Pump Housing Assembly
3	Torque Converter and Differential Housing Bolts M8 x 35 (Qty: 17) **CAUTION:** **Some bolt torques specifications**

Callout	Component Name
	are different. Over tightening the bolts at the 12, 15 and 17 positions in the sequence could cause damage to the case threads. **CAUTION:** **Refer to Fastener Caution .** **Procedure:** Tighten in sequence shown. **Tighten** • Bolts 1-11, 13-14 and 16 to 36 N.m (27 lb ft) • Bolts 12, 15 and 17 to 30 N.m (22 lb ft)

FRONT DIFFERENTIAL CARRIER PRELIMINARY ROTATIONAL TORQUE MEASUREMENT

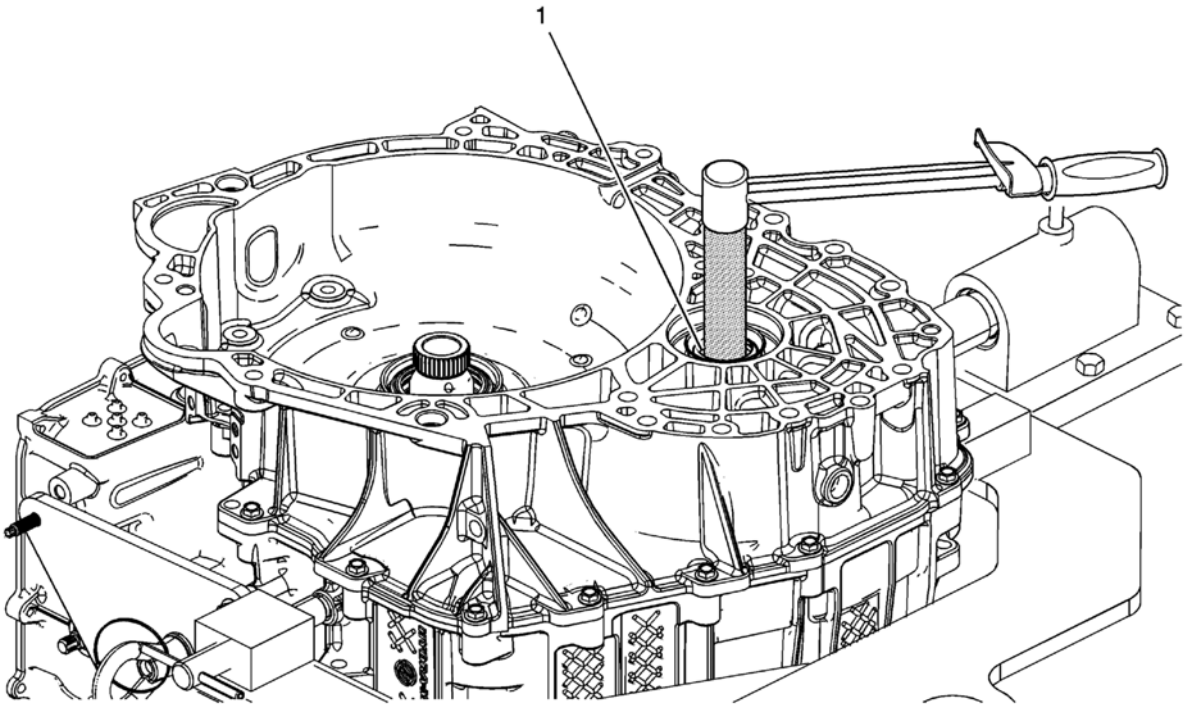


Fig. 47: Front Differential Carrier Preliminary Rotational Torque Measurement Tool
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Differential Carrier Assembly **CAUTION:** **Low bearing pre-load will cause premature failure of the front differential drive pinion gear.** **CAUTION:** **Refer to Fastener Caution .** **NOTE:** • **If the turning torque is not within**

Callout	Component Name
	specifications, the transfer gear assembly and differential bearing thrust washer is incorrect and must be corrected. Refer to Front Differential Drive Pinion Gear Bearing Thrust Washer and Front Differential Bearing Washer Measurement. • **Use a dial or beam torque wrench with DT-47793 differential rotating tool to measure turning torque.** **Tighten** 4-12 N.m (35-106 lb in) **Special Tools** **DT-47793** Differential Rotating Tool For equivalent regional tools, refer to **Special Tools** .

1-2-3-4 CLUTCH PLATE AND LOW AND REVERSE CLUTCH INSTALLATION

Piston and Spring Installation

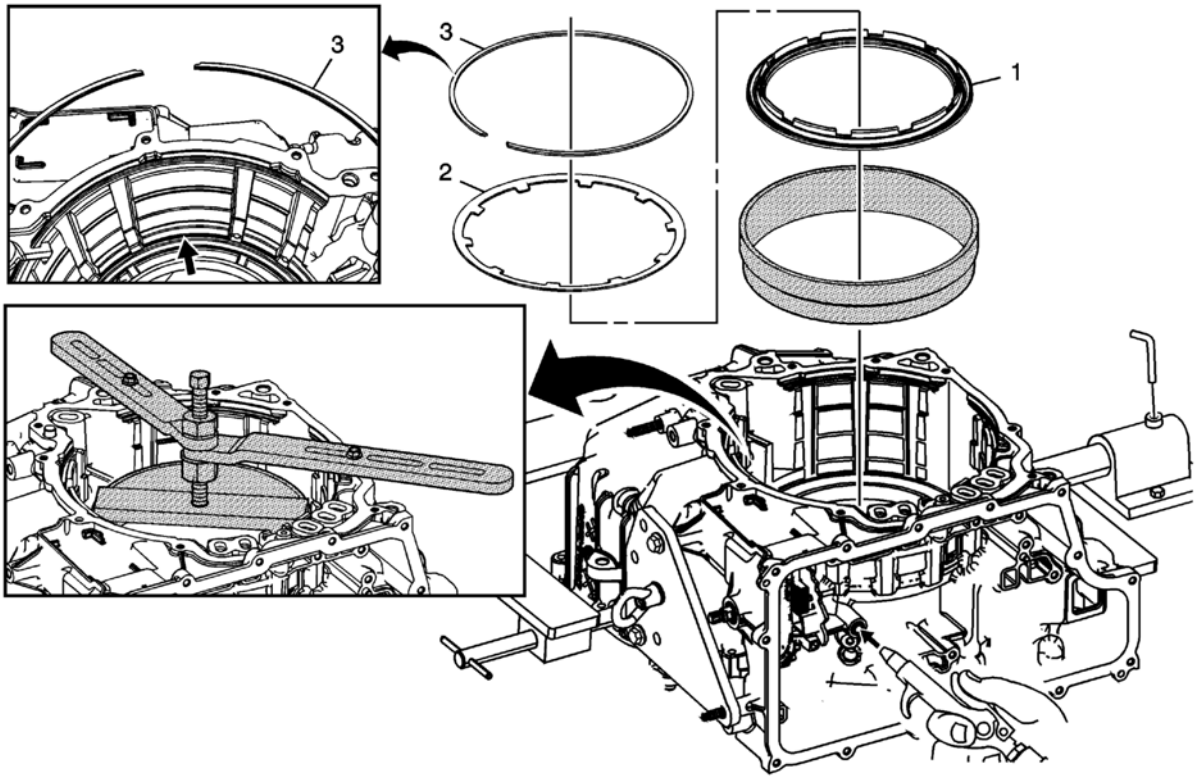


Fig. 48: Identifying 1-2-3-4 Clutch Components
Courtesy of GENERAL MOTORS COMPANY

Piston and Spring Installation

Callout	Component Name

Callout	Component Name
1	1-2-3-4 Clutch Piston **NOTE:** **DT-46623 seal protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of DT-46623 seal protector to ease the installation of the piston.** **Special Tools** **DT-46623** Piston Seal Protector For equivalent regional tools, refer to **Special Tools** .
2	1-2-3-4 Clutch Spring
3	1-2-3-4 Clutch Spring Retainer Ring **CAUTION:** **Refer to Fastener Caution .** **Procedure:** 1. The retainer opening should be supported by a spline tooth of the case. 2. Install **DT-46632** spring compressor and **DT-48056** spring compressor bridge and retain to the case using 2 case cover assembly bolts. 3. Turn the **DT-48056** spring compressor bridge compressor bolt to compress the 1-2-3-4 Clutch Spring until the retaining ring groove is exposed. 4. Push retainer ring into the groove. 5. Remove **DT-48056** spring compressor bridge and **DT-46632** spring compressor. 6. Air check the piston operation by applying air to the 1-2-3-4 clutch feed passage in the

Callout	Component Name
	case. 7. Excessive air leaks indicate damage to the clutch piston seal. **Tighten** 12 N.m (9 lb ft). **Special Tools** • **DT-48056** Spring Compressor Bridge • **DT-46632** Piston Spring Compressor For equivalent regional tools, refer to **Special Tools** .

1-2-3-4 Clutch Plates and Low Reverse Clutch Installation

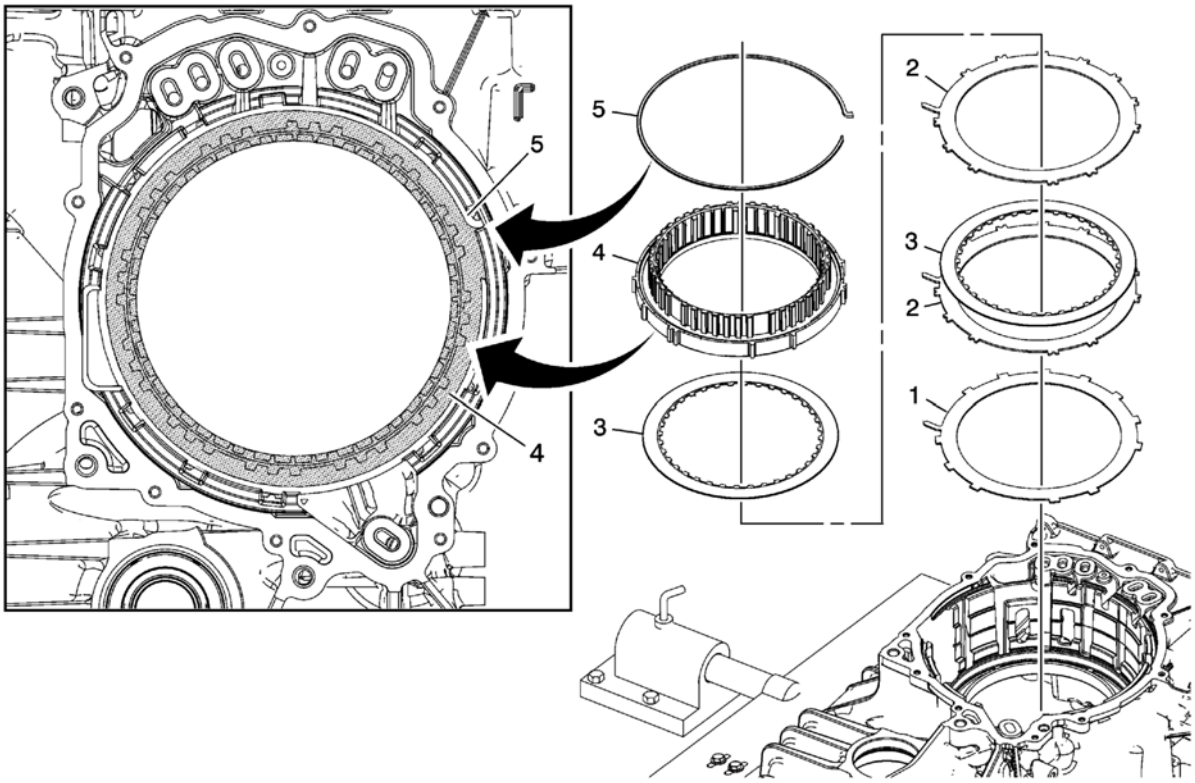


Fig. 49: Identifying 1-2-3-4 Clutch Plates & Low Reverse Clutch Installation Order
Courtesy of GENERAL MOTORS COMPANY

1-2-3-4 Clutch Plates and Low Reverse Clutch Installation

Callout	Component Name
1	1-2-3-4 Clutch (Waved) Plate **NOTE:**

Callout	Component Name
	The tab on the clutch plate faces the bottom of the case.
2	1-2-3-4 Clutch Plate (Qty: 2) **NOTE:** **The tab on the clutch plate faces the bottom of the case.**
3	1-2-3-4 Clutch (w/Friction Material) Plate Assembly (Qty: 2)
4	Low and Reverse Clutch Assembly **NOTE:** **The low and reverse clutch assembly should rotate freely in one direction and lock in the opposite direction. Rotate the clutch assembly and listen/feel for the ratchet of the clutch in it's designed rotational direction.**
5	Low and Reverse Clutch Retaining Ring **NOTE:** **The tab needs to go in groove at about 2**

Callout	Component Name
	o'clock and snap ring opening needs to face 3 o'clock.

Low and Reverse Clutch Plate Installation

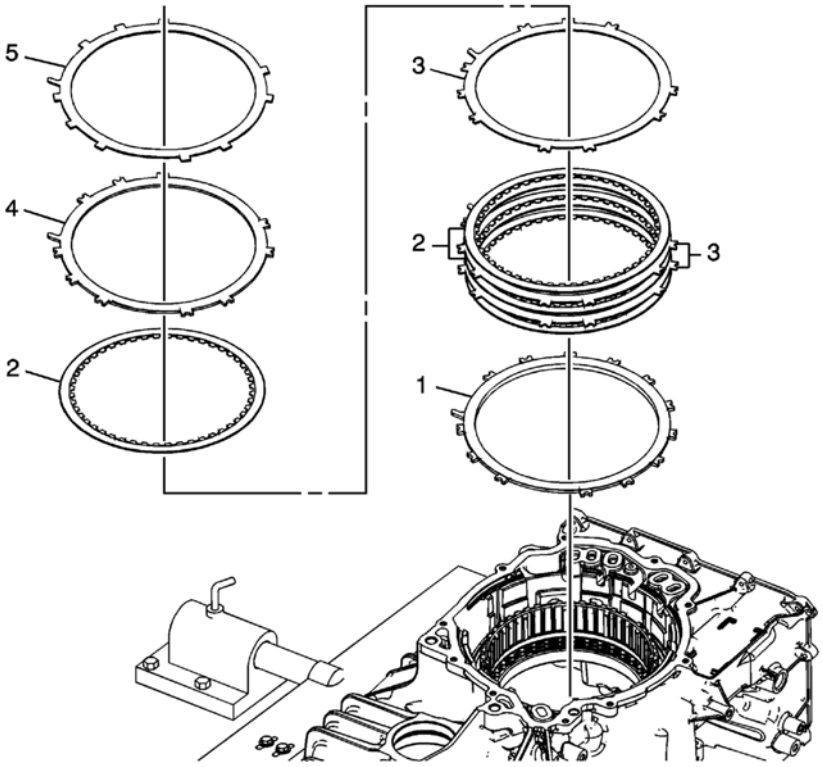


Fig. 50: Identifying Low & Reverse Clutch Plate
Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch Plate Installation

Callout	Component Name
1	Low and Reverse Clutch Backing Plate **NOTE:** **The tab on the clutch plate faces the bottom of the case.**
2	Low and Reverse Clutch (w/Friction Material) Plate Assembly (Qty: 4)
3	Low and Reverse Clutch Plate (Qty: 3)

Callout	Component Name
	NOTE:
4	Low and Reverse Clutch Apply Plate **The tab on the clutch plates faces the bottom of the case.** **NOTE:** **The tab on the clutch plate faces the bottom of the case.**
5	Low and Reverse Clutch Cushion (Waved) Spring **NOTE:** **The tab on the clutch plate faces the bottom of the case.**

REACTION CARRIER CLEANING AND INSPECTION

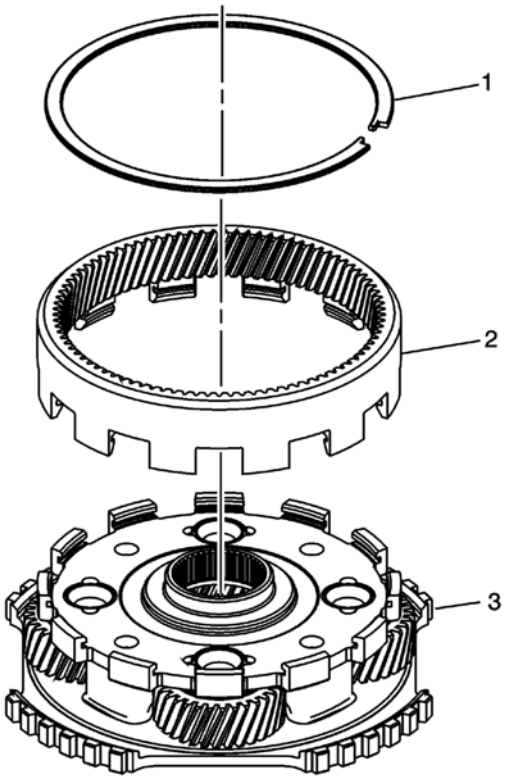


Fig. 51: View Of Reaction Carrier Assembly & Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures	

Callout	Component Name
Clean and Inspect the carrier as an assembly. If wear or damage is found disassemble to replace the affected component.	
1	Input Internal Gear Retaining Ring
2	Input Internal Gear
3	Reaction Carrier Assembly

OUTPUT CARRIER CLEANING AND INSPECTION

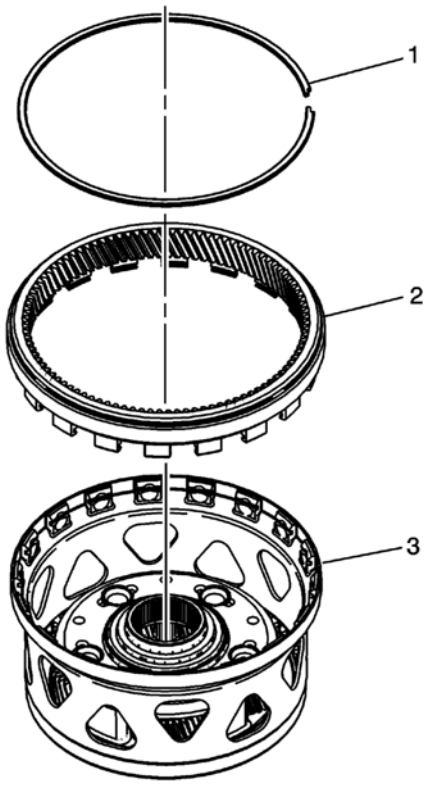


Fig. 52: View Of Output Carrier Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Clean and Inspect the carrier as an assembly. If wear or damage is found disassemble to replace the affected component.	
1	Reaction Internal Gear Retaining Ring
2	Reaction Carrier Internal Gear
3	Output Carrier Assembly

INPUT, REACTION, AND OUTPUT CARRIER INSTALLATION

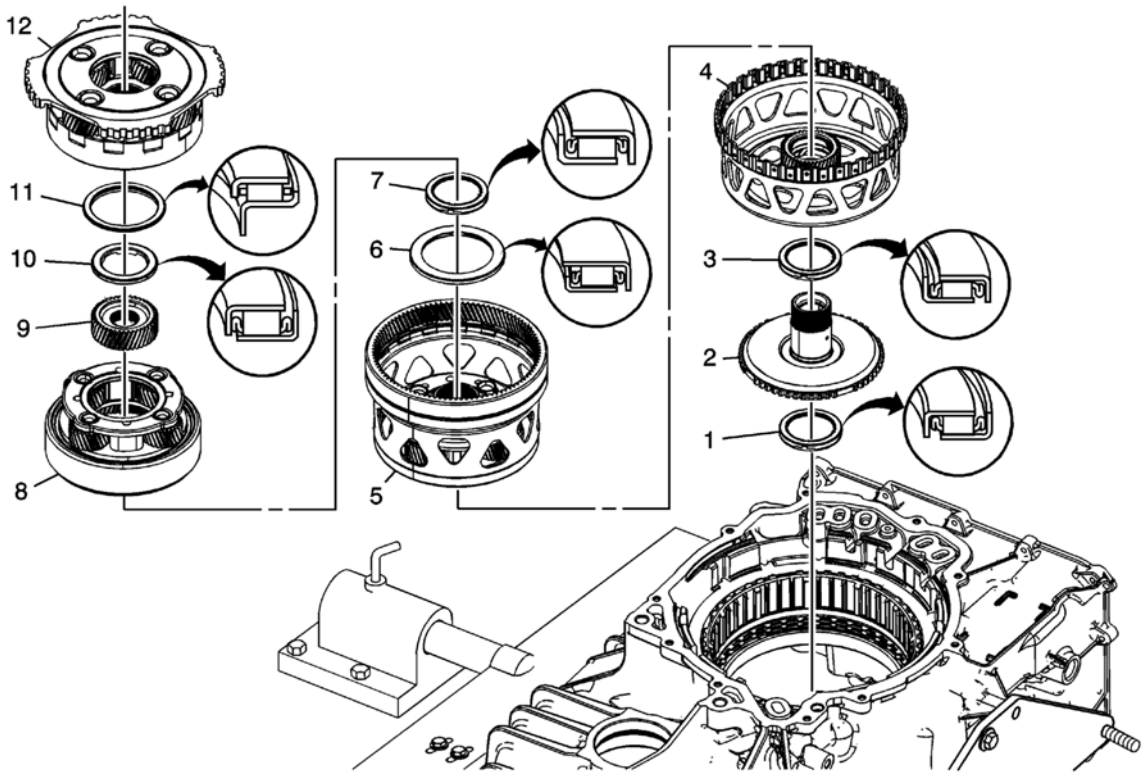


Fig. 53: Identifying Input, Reaction & Output Carrier
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Note location of the orientation lip on bearings. All thrust bearings can only be assembled one way.	
1	Input Shaft Thrust Bearing Assembly
2	Output Carrier Transfer Drive Gear Hub Assembly
3	Front Differential Transfer Drive Gear Input Hub Bearing Assembly
4	Output Sun Gear Assembly
5	Output Carrier Assembly
6	Output Carrier Thrust Bearing Assembly
7	Output Carrier Thrust Bearing Assembly
8	Input (w/Output Internal Gear) Carrier Assembly
9	Input Sun Gear
10	Input Sun Gear Thrust Bearing Assembly
11	Input Carrier Thrust Bearing Assembly
12	Reaction (w/Input Internal Gear) Carrier Assembly

2-6 CLUTCH PLATE INSTALLATION

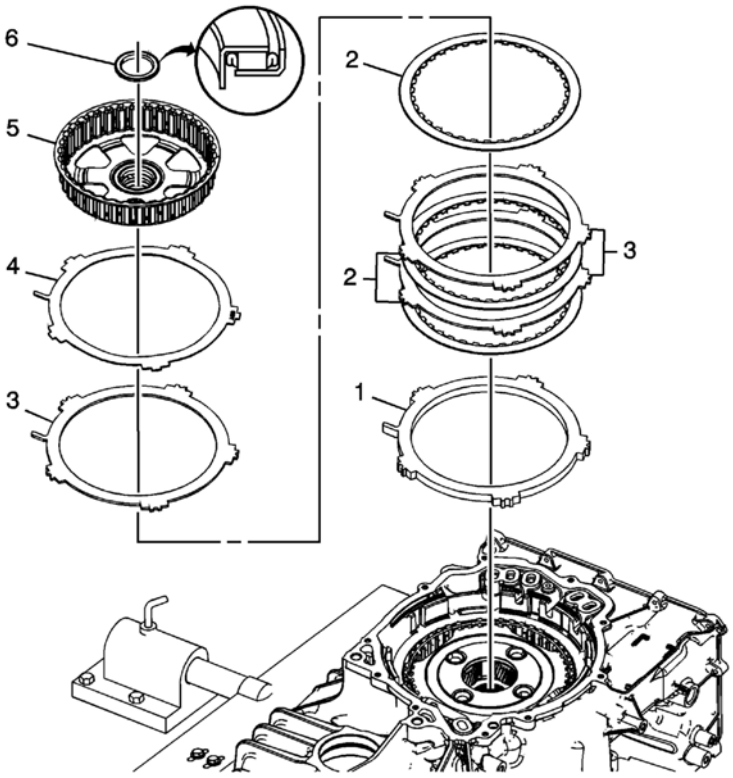


Fig. 54: Identifying 2-6 Clutch Plate
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	2-6 Clutch Backing Plate **NOTE:** **The tab on the clutch plate faces the bottom of the case.**
2	2-6 Clutch (w/Friction Material) Plate Assembly (Qty: 3)
3	2-6 Clutch Plate (Qty: 3) **NOTE:** **The tab on the clutch plate faces the bottom of the case.**
4	2-6 Clutch Cushion Spring
5	Reaction Sun Gear Assembly
6	2-6 Clutch Hub Thrust Bearing Assembly **NOTE:**

Callout	Component Name
	Note location of the orientation lip on bearing. All thrust bearings can only be assembled one way.

3-5-REVERSE AND 4-5-6 CLUTCH HOUSING DISASSEMBLE

Reluctor Wheel and Piston Removal

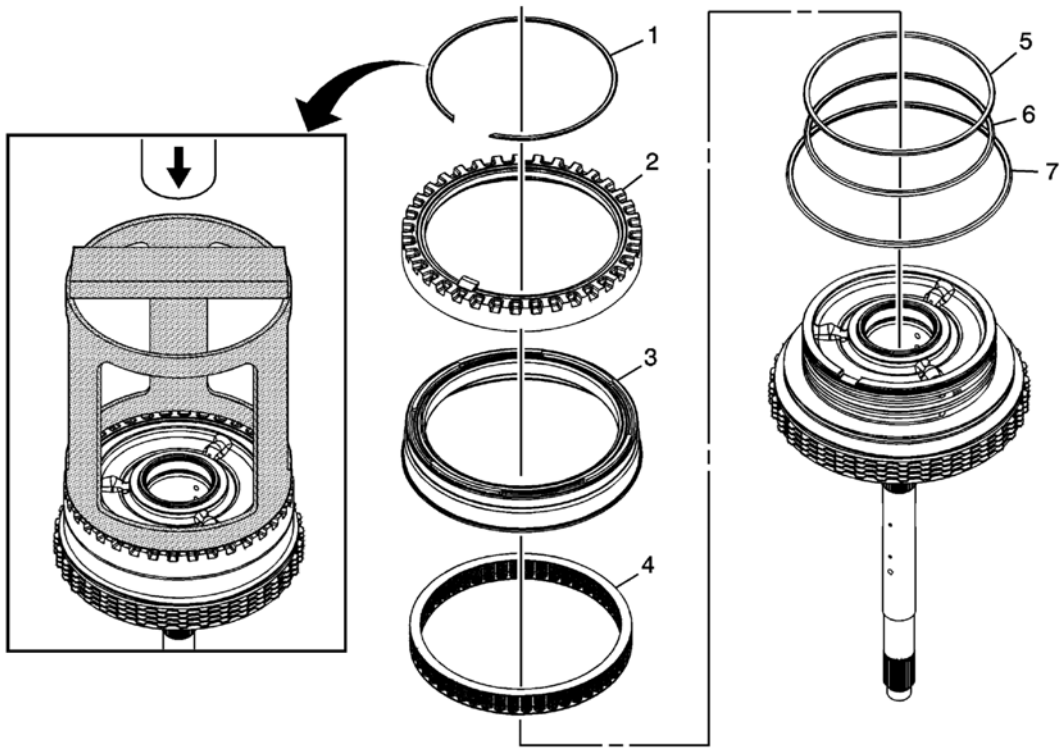


Fig. 55: View Of Input Shaft Speed Sensor Reluctor Wheel Piston & 3-5 Reverse Clutch Piston
Courtesy of GENERAL MOTORS COMPANY

Reluctor Wheel and Piston Removal

Callout	Component Name
1	A/Trans Input Shaft Speed Sensor Reluctor Ring Retaining Ring **CAUTION:** **Compress the reluctor**

Callout	Component Name
	wheel just enough to clear the retainer. Over compressing the reluctor wheel will break the alignment tab and the clutch housing. **Special Tools** **DT-47694** Piston Spring Compressor For equivalent regional tools, refer to **Special Tools** .
2	A/Trans Input Shaft Speed Sensor Reluctor Wheel
3	3-5 Reverse Clutch Piston **NOTE:** **Inspect piston seals for damage and/or wear. Piston is reusable.**
4	3-5 Reverse Clutch Spring Assembly
5	3-5 Reverse Clutch Piston Inner Seal (Orange)
6	3-5 Reverse Clutch Piston Inner Seal (Black)
7	3-5 Reverse Clutch Piston Dam Seal

Clutch Plate Removal

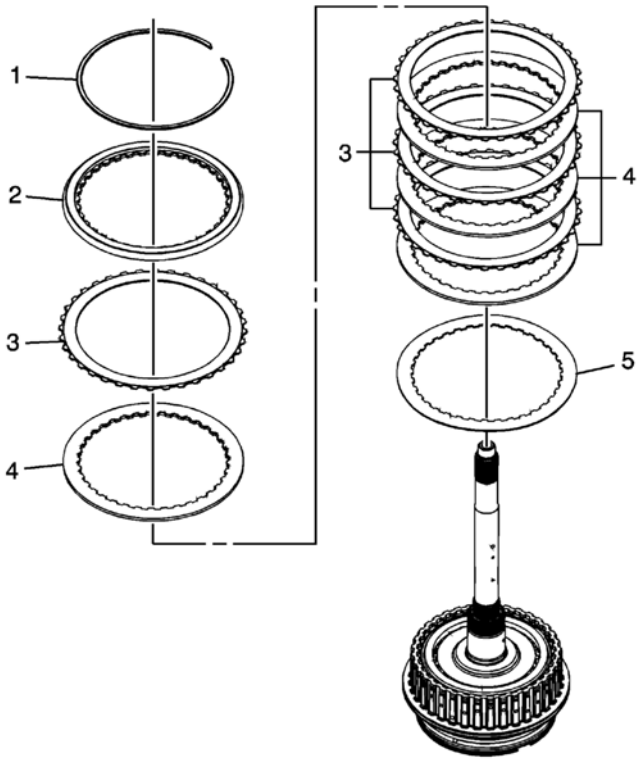


Fig. 56: View Of 3-5 Reverse Clutch Plates
Courtesy of GENERAL MOTORS COMPANY

Clutch Plate Removal

Callout	Component Name
1	3-5 Reverse Clutch Backing Plate Retaining Ring
2	3-5 Reverse Clutch Backing Plate
3	3-5 Reverse Clutch (w/Friction Material) Plate Assembly (Qty: 4)
4	3-5 Reverse Clutch Plate (Qty: 4)
5	3-5 Reverse Clutch (Waved) Plate

4-5-6 Clutch Hub Removal

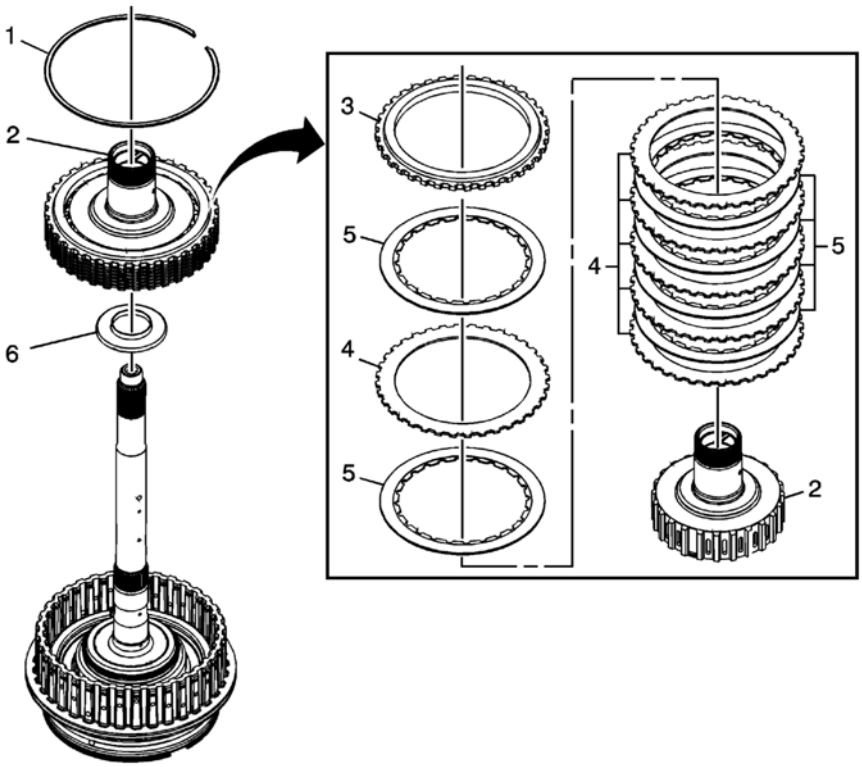


Fig. 57: View Of Reaction Carrier Hub Assembly
Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Hub Removal

Callout	Component Name
1	4-5-6 Backing Plate Retaining Ring **NOTE:** **Gently push down on the backing plate to get enough clearance between the backing plate and retainer.**
2	Reaction Carrier Hub Assembly **NOTE:** **The clutch plates will come out of the housing with the hub assembly.**

Callout	Component Name
3	4-5-6 Clutch Backing Plate
4	4-5-6 Clutch Plate (Qty: 6)
5	4-5-6 Clutch (w/Friction Material) Plate Assembly (Qty: 6)
6	4-5-6 Clutch Hub Thrust Bearing Assembly **NOTE:** **The bearing may stick to the reaction carrier hub.**

4-5-6 Clutch Piston Removal

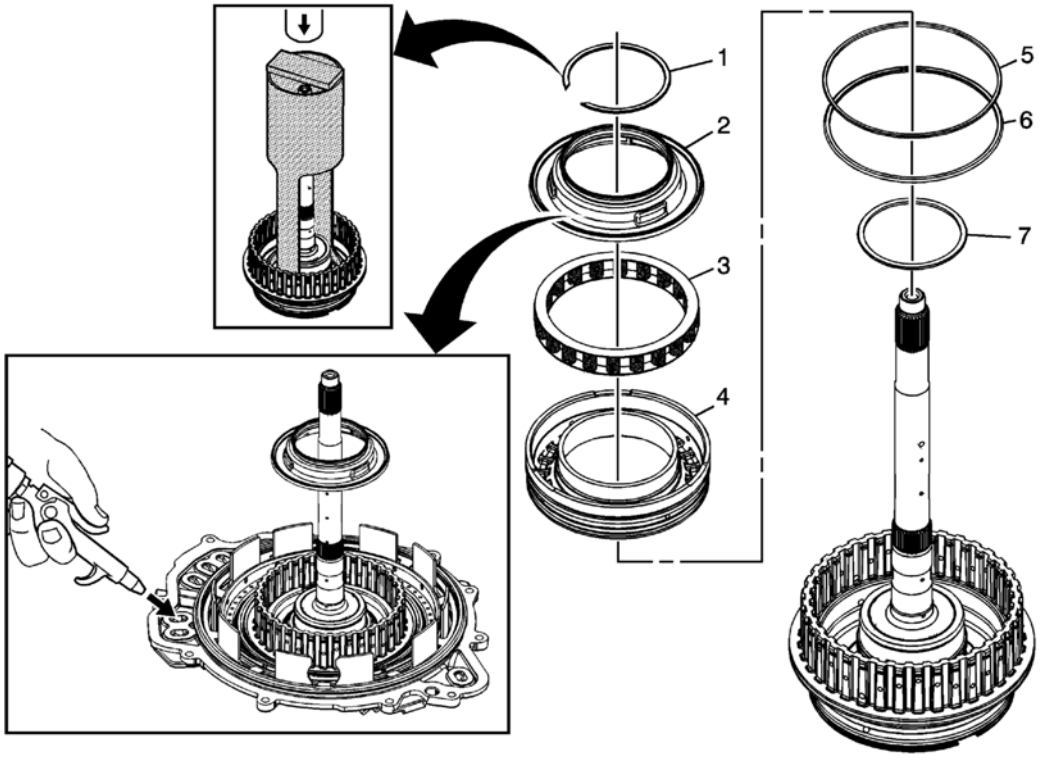


Fig. 58: Identifying 4-5-6 Clutch Piston
Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Piston Removal

Callout	Component Name
1	4-5-6 Clutch Dam Retaining Ring **Special Tools** • **DT-47693** Dam Protector • **GE 8059** Snap Ring Pliers-Parallel Jaw or equivalent

Callout	Component Name
	For equivalent regional tools, refer to **Special Tools** .
2	4-5-6 Clutch Piston Fluid Dam **Procedure:** 1. Place the 3-5-R and 4-5-6 clutch housing onto the case cover assembly. 2. Apply shop air to the 4-5-6 clutch feed hole using a rubber tipped air gun to dislodge the dam piston and the 4-5-6 clutch piston from the clutch housing.
3	4-5-6 Clutch Spring Assembly
4	4-5-6 Clutch Piston
5	4-5-6 Clutch Piston Outer Seal (Stepped)
6	4-5-6 Clutch Piston Outer Seal (Rounded)
7	4-5-6 Clutch Piston Inner Seal

3-5-REVERSE AND 4-5-6 CLUTCH HOUSING ASSEMBLE

4-5-6 Clutch Piston Installation

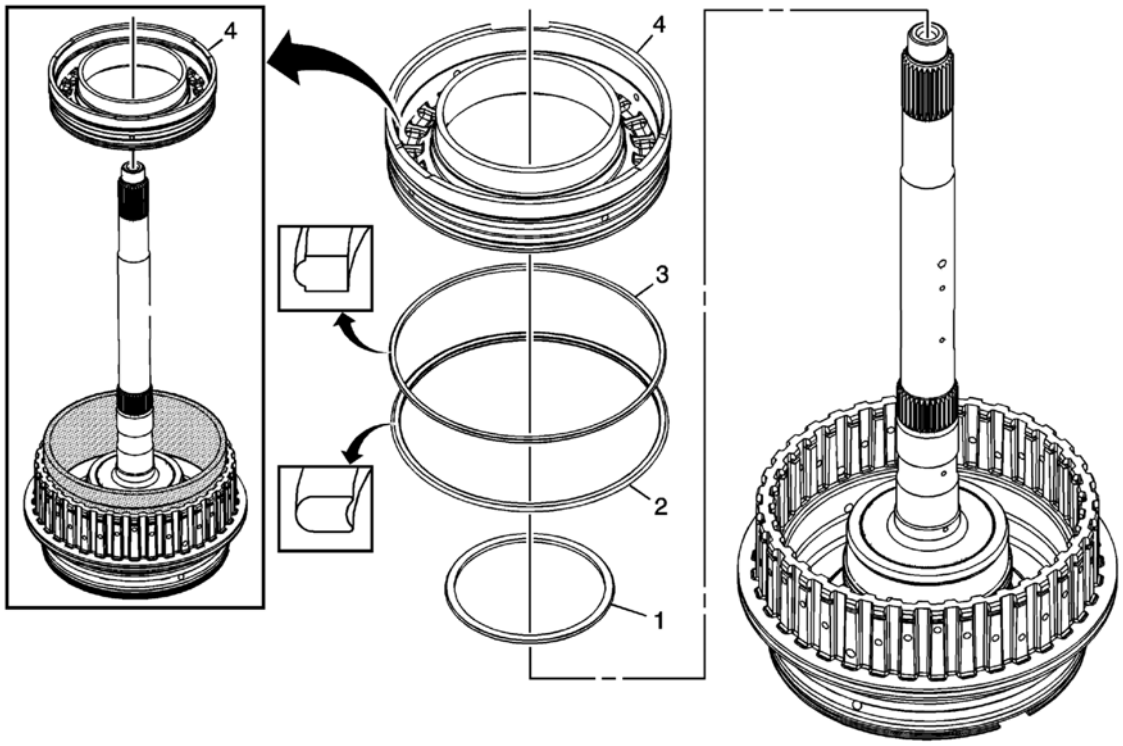


Fig. 59: Identifying 4-5-6 Clutch Piston
Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Piston Installation

Callout	Component Name
1	4-5-6 Clutch Piston Inner Seal
2	4-5-6 Clutch Piston Outer Seal (Rounded)

Callout	Component Name
3	4-5-6 Clutch Piston Outer Seal (Stepped) (Orange)
4	4-5-6 Clutch Piston **NOTE:** **DT-47859 outer seal protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of DT-47859 outer seal protector to ease the installation of the piston.** **Special Tools** **DT-47859** Piston Outer Seal Protector For equivalent regional tools, refer to **Special Tools** .

4-5-6 Clutch Dam Installation

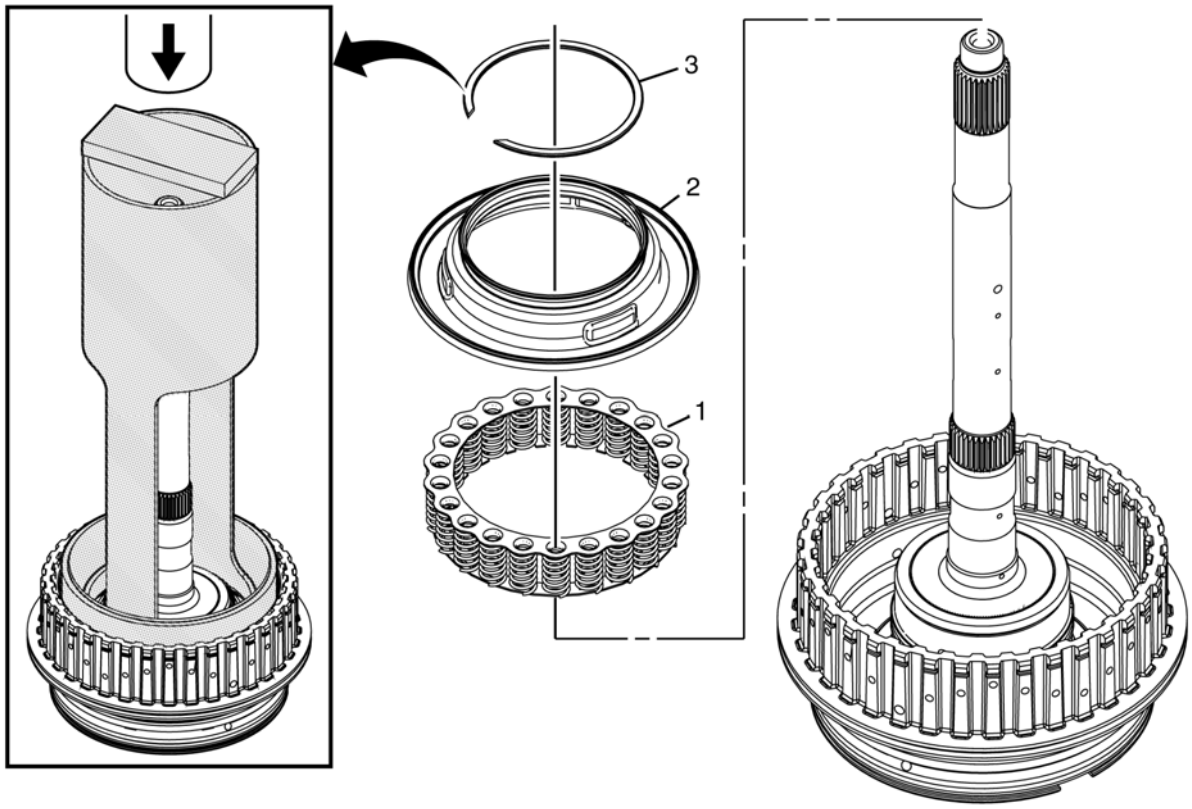


Fig. 60: View Of 4-5-6 Clutch Dam
Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Dam Installation

Callout	Component Name
1	4-5-6 Clutch Spring
2	4-5-6 Clutch Piston Fluid Dam **NOTE:** **DT 47693-1 which is part of DT-47693 dam protector prevents the dam seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of DT 47693-1 which is part of DT-47693**

Callout	Component Name
	dam protector to ease the installation of the dam. **Special Tools** **DT-47693** Dam Protector For equivalent regional tools, refer to **Special Tools** .
3	4-5-6 Clutch Dam Retaining Ring **Special Tools** • DT 47693-2 Clutch Spring Compressor which is part of **DT-47693** Dam Protector • **GE 8059** Snap Ring Pliers-Parallel Jaw or equivalent For equivalent regional tools, refer to **Special Tools** .

4-5-6 Clutch Plates Installation

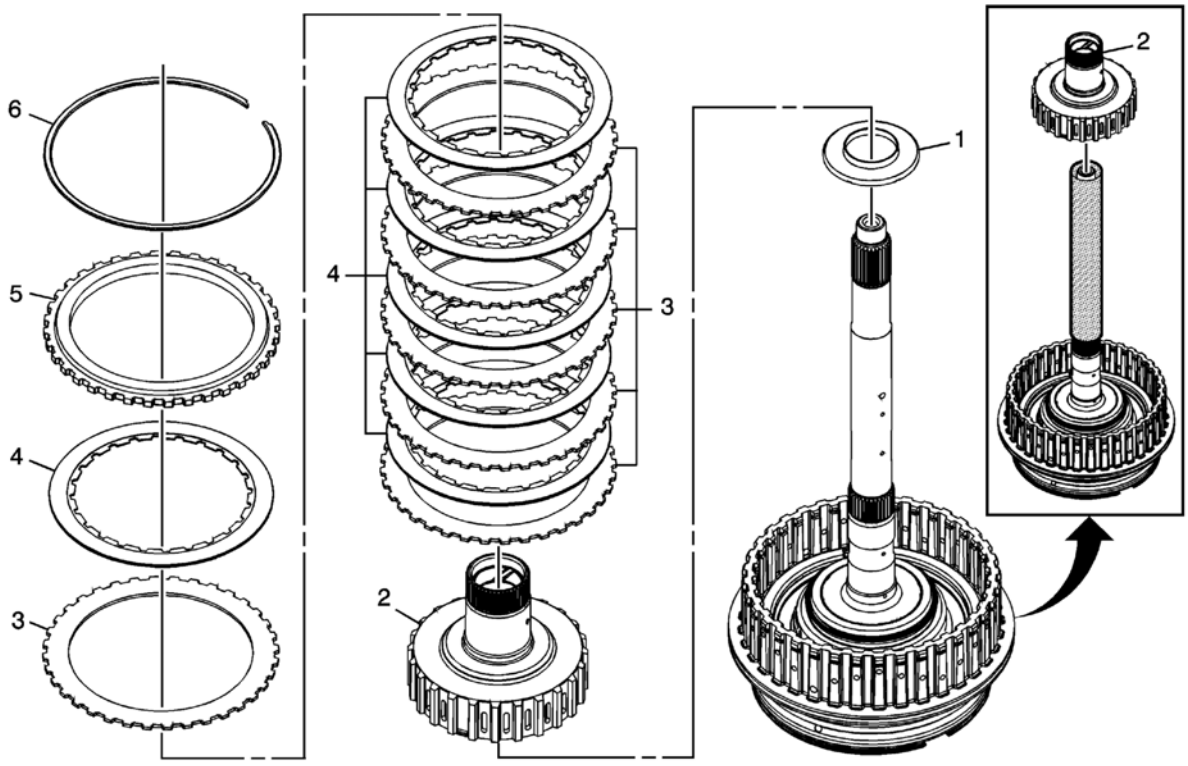


Fig. 61: Locating 4-5-6 Clutch Plates
Courtesy of GENERAL MOTORS COMPANY

4-5-6 Clutch Plates Installation

Callout	Component Name
1	4-5-6 Clutch Hub Thrust Bearing **NOTE:** **Note location of the orientation lip on bearing. All thrust bearings can only be assembled one way.**
2	Reaction Carrier Hub Assembly **CAUTION:** **Failure to use DT 48551 could cause damage to the hub assembly bushings which could cause premature transmission failure.** **Special Tools** **DT-48551** Reaction Hub Bushing Protector For equivalent regional tools, refer to **Special Tools** .
3	4-5-6 Clutch Plate (Qty: 6)
4	4-5-6 Clutch (w/Friction Material) Plate Assembly (Qty: 6)
5	4-5-6 Clutch Backing Plate
6	4-5-6 Clutch Backing Plate Retaining Ring **NOTE:** **Gently push down on the backing plate to get enough**

Callout	Component Name
	clearance between the backing plate and retainer.

3-5 Reverse Clutch Plates Installation

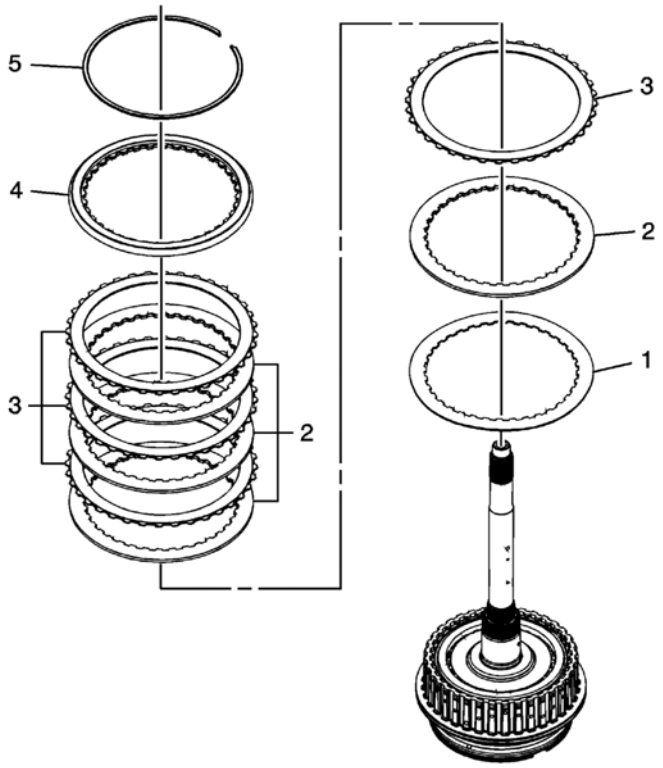


Fig. 62: Identifying 3-5 Reverse Clutch Plates
Courtesy of GENERAL MOTORS COMPANY

3-5 Reverse Clutch Plates Installation

Callout	Component Name
1	3-5 Reverse Clutch (Waved) Plate
2	3-5 Reverse Clutch Plate (Qty: 4)
3	3-5 Reverse Clutch (w/Friction Material) Plate Assembly (Qty: 4)
4	3-5 Reverse Clutch Backing Plate
5	3-5 Reverse Clutch Backing Plate Retaining Ring

Piston and Reluctor Wheel Installation

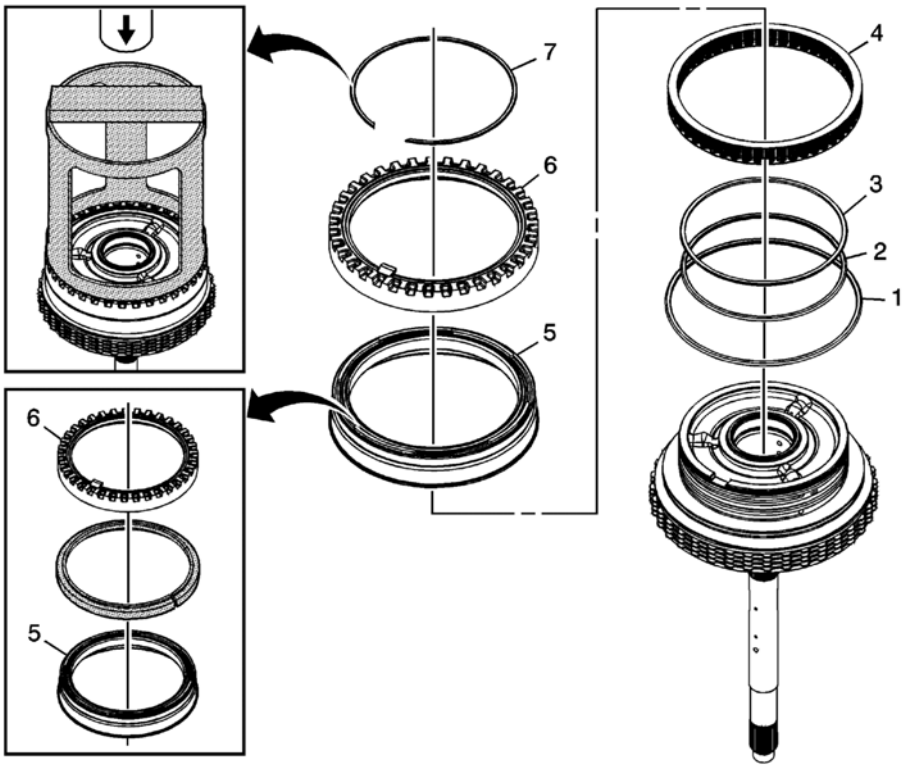


Fig. 63: View Of Piston & Reluctor Wheel
Courtesy of GENERAL MOTORS COMPANY

Piston and Reluctor Wheel Installation

Callout	Component Name
1	3-5 Reverse Clutch Piston Dam Seal
2	3-5 Reverse Clutch Piston Inner Seal (Black) **NOTE:** **Apply a thin coat of ATF to the seal to ease the installation of the piston.**
3	3-5 Reverse Clutch Piston Inner Seal (Orange) **NOTE:** **Apply a thin coat of ATF to the seal to ease the installation of the piston.**

Callout	Component Name
4	3-5 Reverse Clutch Spring Assembly
5	3-5 Reverse Clutch Piston **NOTE:** • **DT-46622 seal protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of DT-46622 seal protector to ease the installation of the piston.** • **Install DT-46622 seal protector onto the speed sensor reluctor wheel. Push the 3-5 Reverse Clutch piston into the reluctor wheel until it stops against J-46622 seal protector. Remove**

Callout	Component Name
	DT-46622 seal protector by separating it at the opening. **Special Tools** **DT-46622** Piston Seal Protector For equivalent regional tools, refer to **Special Tools** .
6	A/Trans Input Shaft Speed Sensor Reluctor Wheel
7	A/Trans Input Shaft Speed Sensor Reluctor Wheel Retaining Ring **CAUTION:** **Compress the reluctor wheel just enough to clear the retainer ring groove. Over compressing the reluctor wheel will break the alignment tab and the clutch housing.** **Special Tools** **DT-47694** Piston Spring Compressor For equivalent regional tools, refer to **Special Tools** .

3-5-R and 4-5-6 Clutch Piston Air Check

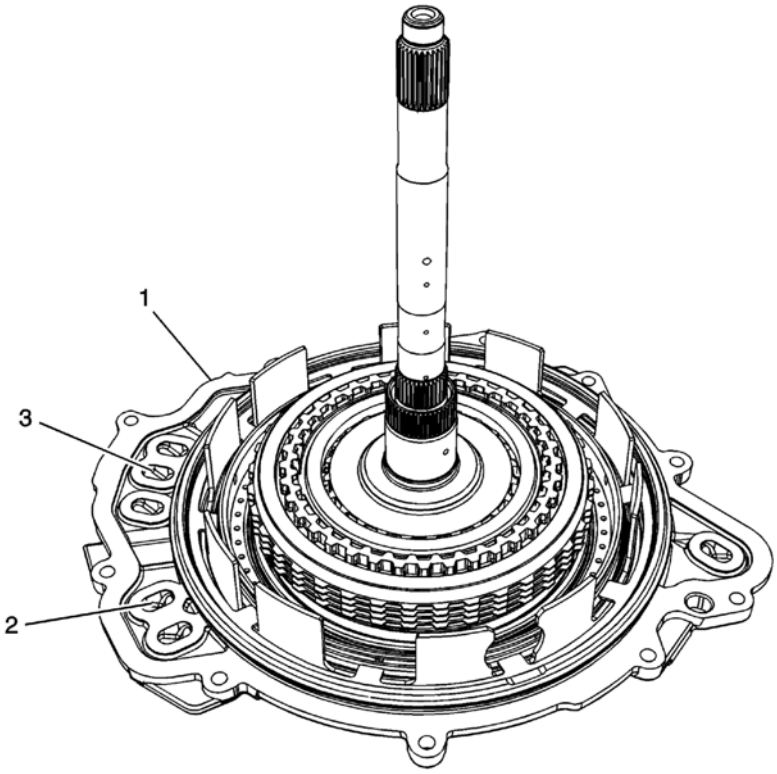


Fig. 64: View of 35R and 4-5-6 Clutch Piston Air Check
Courtesy of GENERAL MOTORS COMPANY

3-5-R and 4-5-6 Clutch Piston Air Check

Callout	Component Name
1	Case Cover Assembly **NOTE:** **The fluid seal rings should be in place and not damaged.**
2	4-5-6 Clutch Feed Fluid Passage **CAUTION:** **Regulate the air pressure to 40 psi maximum. High pressure could cause the piston to over travel and damage**

Callout	Component Name
	the piston seals. **Procedure** 1. Apply shop air to the 4-5-6 clutch feed passage. 2. Observe the 4-5-6 piston movement. **NOTE:** **Minimal piston movement and excessive air leaking could indicate damage to the 4-5-6 piston seals or improper assembly.**
3	3-5 Rev Clutch Feed Fluid Passage **CAUTION:** **Regulate the air pressure to 40 psi maximum. High pressure could cause the piston to over travel and damage the piston seals.** **Procedure** 1. Apply shop air to the 3-5-Rev clutch feed passage. 2. Observe the 3-5-Rev piston movement. **NOTE:** **Minimal piston**

Callout	Component Name
	movement and excessive air leaking could indicate damage to the 3-5-Rev piston seals or improper assembly.

3-5-REVERSE AND 4-5-6 CLUTCH HOUSING INSTALLATION

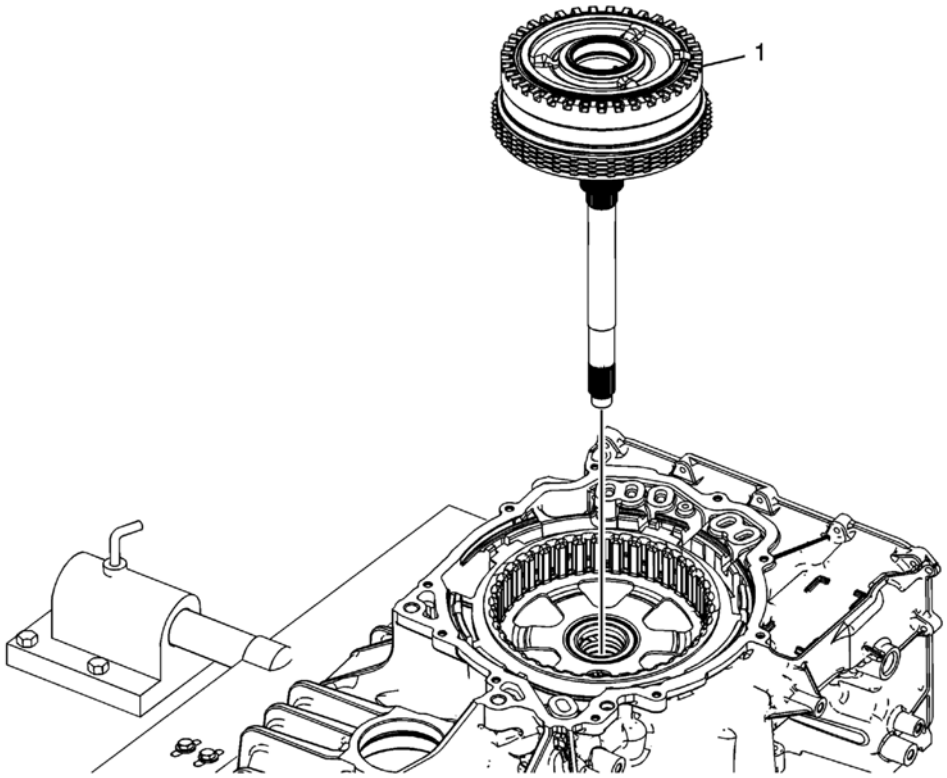


Fig. 65: Identifying 3-5 Reverse & 4-5-6 Clutch Housing
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	3-5 Reverse and 4-5-6 Clutch Assembly **NOTE:** **Rotate the assembly back and forth to align the 3-5**

Callout	Component Name
	reverse clutch plates with the reaction sun gear housing.

CASE COVER ASSEMBLY DISASSEMBLE

ISS Removal

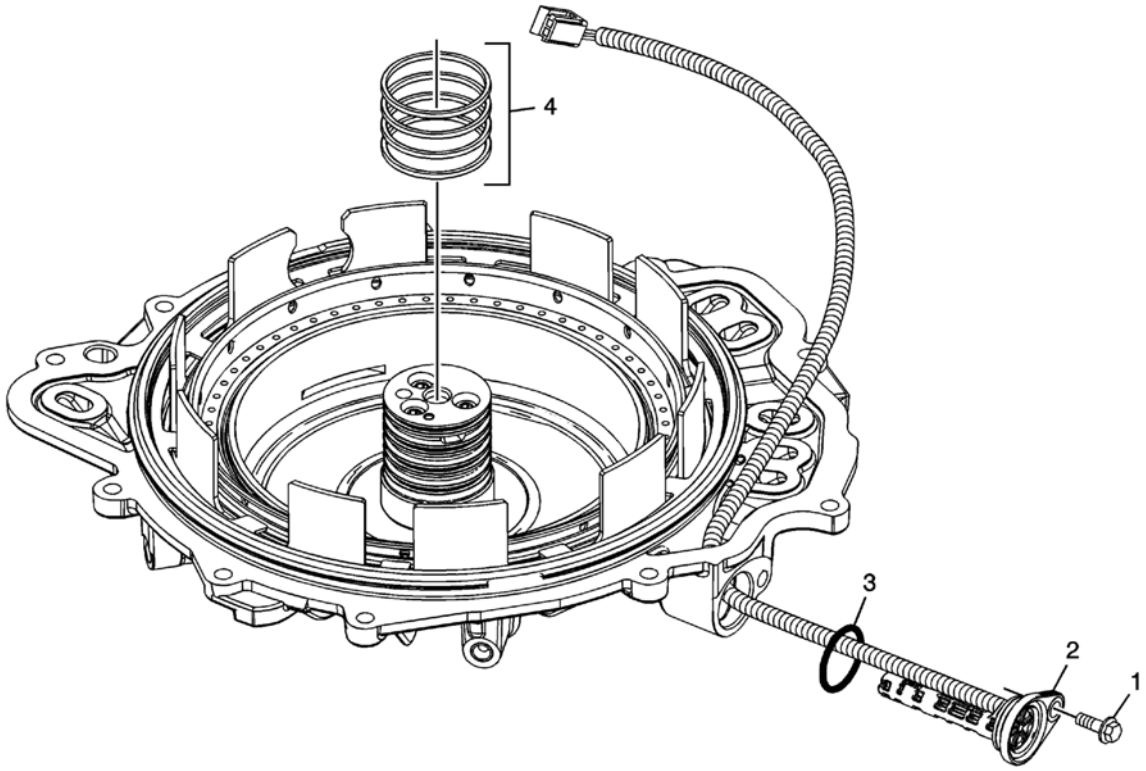


Fig. 66: View Of 3-5 Reverse & 4-5-6 Clutch Fluid Seal Ring
Courtesy of GENERAL MOTORS COMPANY

ISS Removal

Callout	Component Name
1	A/Trans Input Speed Sensor Bolt M6 x 25
2	A/Trans Input Speed Sensor
3	A/Trans Input Speed Sensor Seal **NOTE:** **Discard the seal.**
4	3-5 Reverse and 4-5-6 Clutch Fluid Seal Ring **NOTE:**

Callout	Component Name
	Discard the seals.

Low and Reverse Clutch Piston Removal

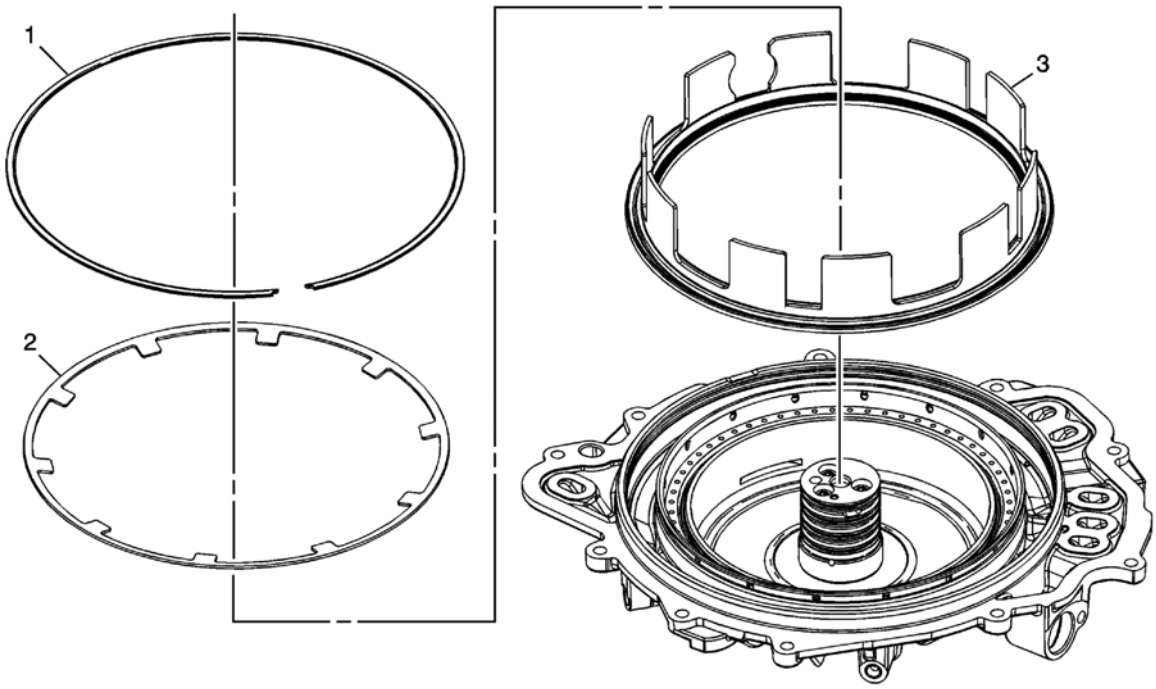


Fig. 67: Identifying Low & Reverse Clutch Piston
Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch Piston Removal

Callout	Component Name
1	Low and Reverse Clutch Spring Retaining Ring
2	Low and Reverse Clutch Spring
3	Low and Reverse Clutch Piston Assembly **NOTE:** **Inspect piston seals for damage and/or wear. Piston is reusable.**

2-6 Clutch Piston Removal

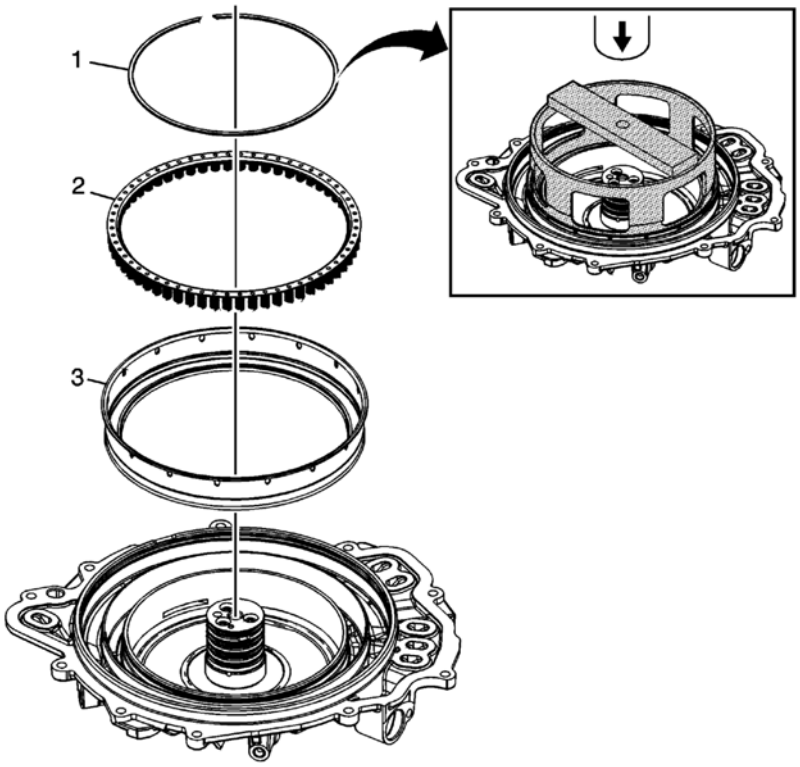


Fig. 68: View Of 2-6 Clutch Piston
Courtesy of GENERAL MOTORS COMPANY

2-6 Clutch Piston Removal

Callout	Component Name
1	2-6 Clutch Spring Retaining Ring **Special Tools** **DT-46632** Spring Compressor For equivalent regional tools, refer to **Special Tools** .
2	2-6 Clutch Spring Assembly
3	2-6 Clutch Piston **NOTE:** **Inspect piston seals for damage and/or wear. Piston is reusable.**

Clean and Inspect

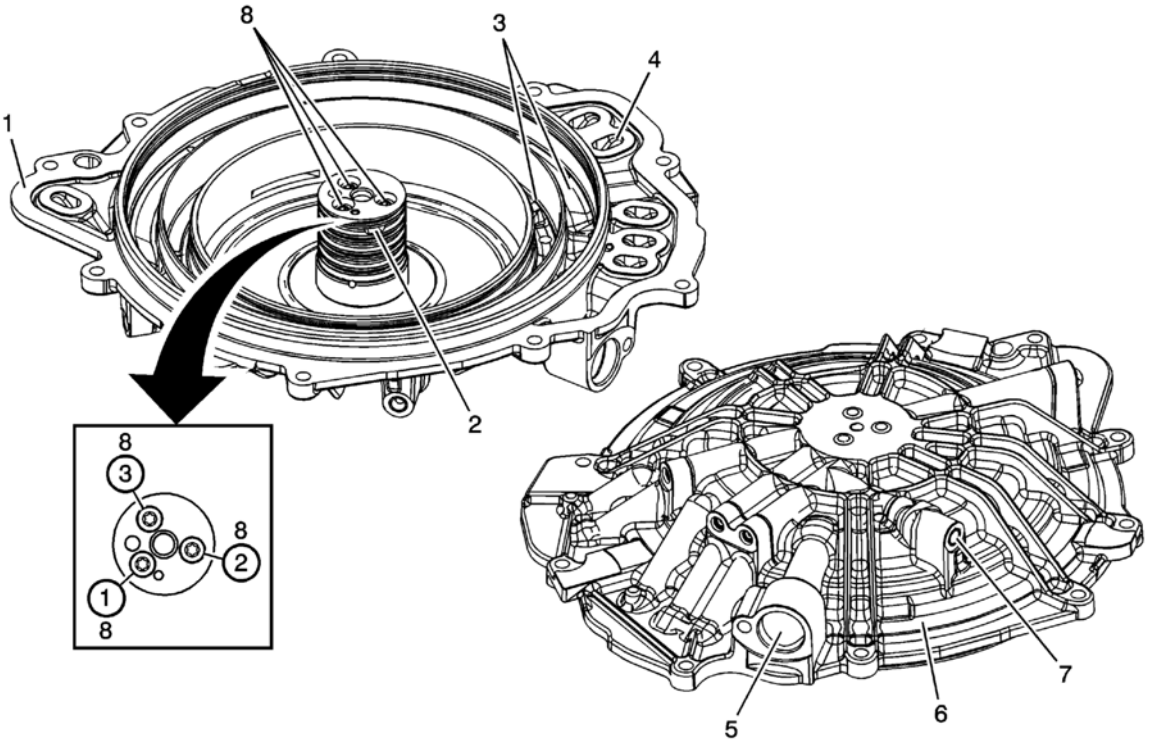


Fig. 69: Identifying Case Cover Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Clean and Inspect

Callout	Component Name
CAUTION: **After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.** **CAUTION:**	

Callout	Component Name
Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component. **Preliminary Procedures** 1. Thoroughly clean the case cover assembly, including threads, with clean solvent. 2. Clean gasket sealing surfaces. Remove all residual gasket material. 3. Inspect all threaded holes. If necessary, repair any thread damage.	
1	Gasket Sealing Surface
2	Fluid Passages
3	Piston Bores
4	Cover to Case Passages
5	A/Trans Input Speed Sensor Assembly Bore
6	Cover Casting
7	Passage Cup Plugs
8	Input Shaft Support Bolts **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tightened bolts in sequence. **Tighten** 12 N.m (106 lb in).

CASE COVER ASSEMBLY ASSEMBLE

Fluid Seal Ring Installation

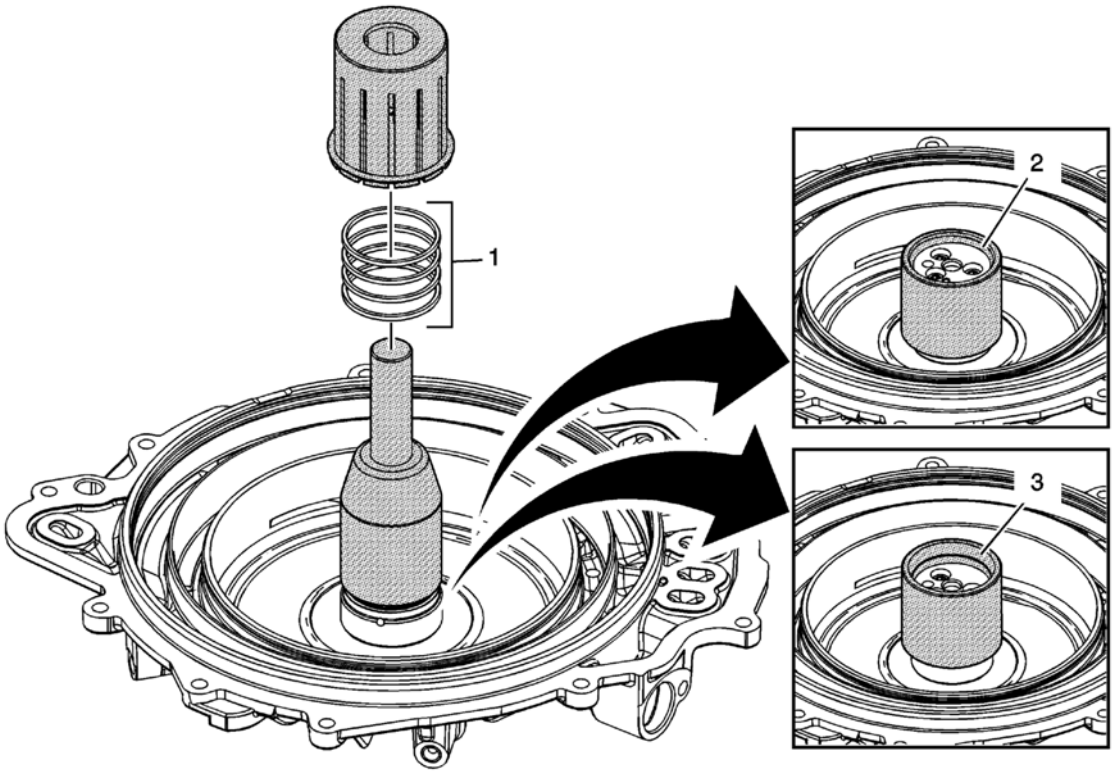


Fig. 70: Identifying Fluid Seal Ring
Courtesy of GENERAL MOTORS COMPANY

Fluid Seal Ring Installation

Callout	Component Name
1	3-5 Reverse and 4-5-6 Clutch Fluid Seal Ring **Procedure** 1. Place DT 46620-3 which is part of **DT-46620** seal installer over the case cover hub and adjust it so that only the bottom seal ring is exposed. 2. Place a NEW fluid seal ring onto DT 46620-3 which is part of **DT-46620** seal installer. 3. Use DT 46620-2 which is part of **DT-46620** seal installer to push the fluid seal ring down over DT 46620-3 which is part of **DT-46620** seal installer into the hub ring groove. 4. Repeat the above steps to install all 4 seal rings, adjusting DT 46620-3 which is part of **DT-46620** seal installer to the appropriate ring groove. **Special Tools** **DT-46620** Seal Installer For equivalent regional tools, refer to **Special Tools** .
2	Small Chamfer Up **CAUTION:**

Callout	Component Name
	Do not force the seal installer down over the seals as this will roll and damage the seals. The large chamfer is designed to fit over the over stretched seal. Use a hand to help shrink the seal if the seal installer is difficult to install over the seal rings. **Procedure** Install DT 46620-1 which is part of **DT-46620** seal installer with the large chamfer end down over the fluid seal rings and leave DT 46620-1 which is part of **DT-46620** seal installer on the seals for at least 60 seconds.
3	Large Chamfer Up **Procedure** 1. Install DT 46620-1 which is part of **DT-46620** seal installer with the small chamfer end facing down for at least 60 seconds. This will properly size the bottom seal ring. 2. Leaving DT 46620-1 which is part of **DT-46620** seal installer on the fluid seal rings for an extended period of time could cause a fluid leak on the initial clutch piston circuit until the seal rings warm up and expand to the proper dimension.

2-6 Clutch Piston Installation

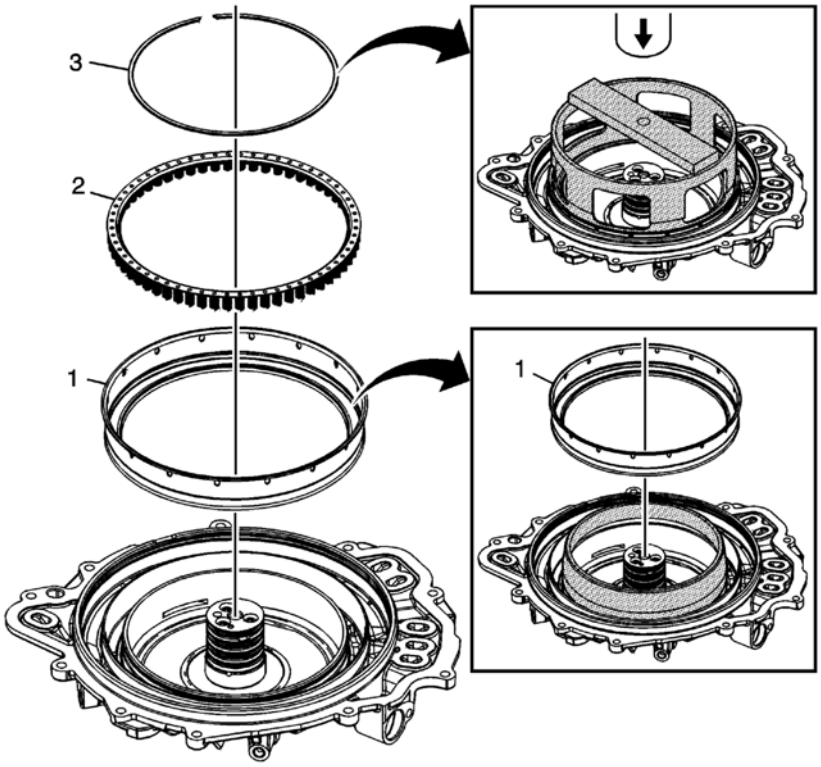


Fig. 71: View Of 2-6 Clutch Piston
Courtesy of GENERAL MOTORS COMPANY

2-6 Clutch Piston Installation

Callout	Component Name
1	2-6 Clutch Piston **Procedure** **DT-46621** seal protector prevents the piston seal lip from damage over the retaining ring groove during installation. Apply a thin coat of ATF to the O.D. of **DT-46621** seal protector to ease the installation of the piston. **Special Tools** **DT-46621** Seal Protector For equivalent regional tools, refer to **Special Tools** .
2	2-6 Clutch Spring Assembly
3	2-6 Clutch Spring Assembly **Procedure** 1. Install the retaining ring with the opening positioned to the top of the case cover. 2. Place the retainer ring inside **DT-46632** spring compressor prior to placing **DT-46632** spring compressor onto the spring. **Special Tools** **DT-46632** Spring Compressor For equivalent regional tools, refer to **Special Tools** .

Low and Reverse Clutch Piston Installation

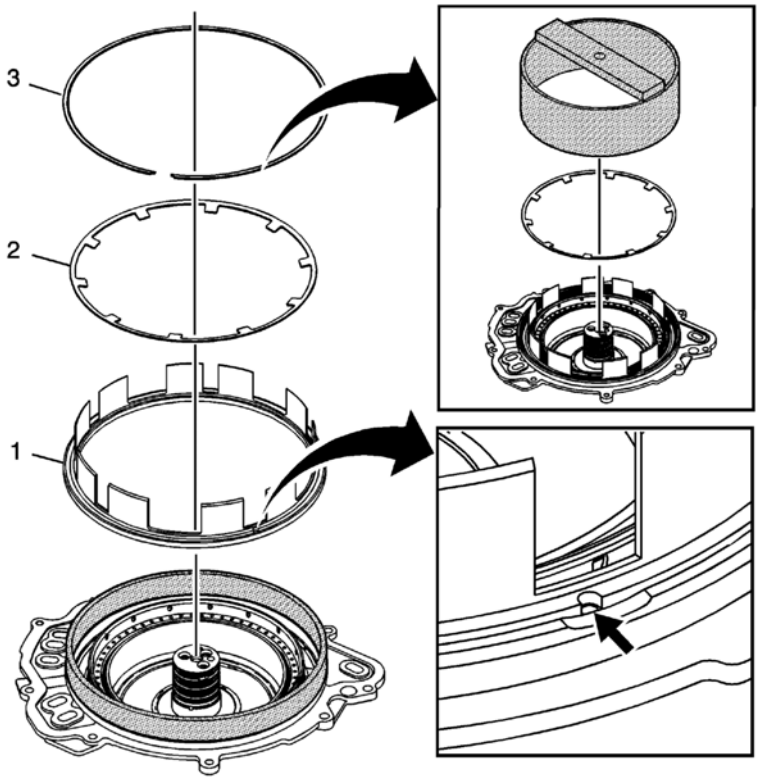


Fig. 72: Identifying Low & Reverse Clutch Piston
Courtesy of GENERAL MOTORS COMPANY

Low and Reverse Clutch Piston Installation

Callout	Component Name
1	Low and Reverse Clutch Piston Assembly **Procedure** 1. Install the L/R piston with the air bleed positioned at the alignment feature on the cover, using **DT-46628-1** seal protector. This will orient the piston fingers with the openings in the case. 2. **DT-46628-1** seal protector prevents the piston seal lip from damage during installation. Apply a thin coat of ATF to the I.D. of **DT-46628-1** seal protector to ease the installation of the piston. **Special Tools** **DT-46628-1** Piston Seal Protector For equivalent regional tools, refer to **Special Tools** .
2	Low and Reverse Clutch Spring
3	Low and Reverse Clutch Spring Retaining Ring **NOTE:**

Callout	Component Name
	Do not align the retainer opening with other retaining ring openings. **Special Tools** **DT-46628-2** Spring Compressor For equivalent regional tools, refer to **Special Tools** .

2-6 and Low-Reverse Piston Function Inspection

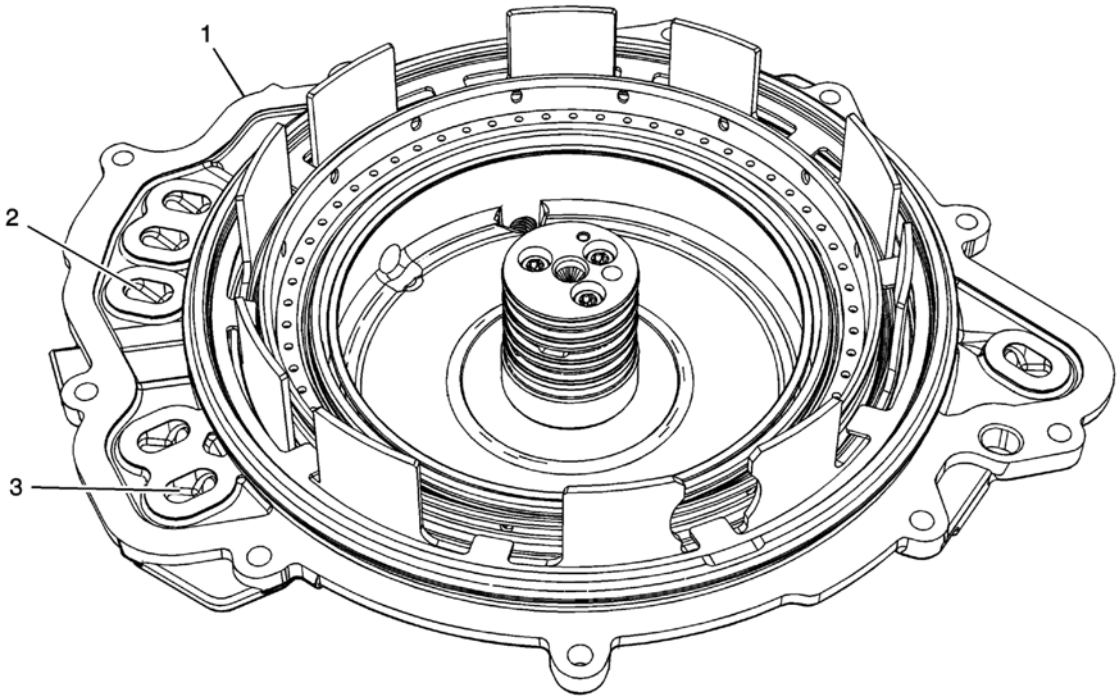


Fig. 73: 2-6 and Low-Reverse Piston Function Inspection
Courtesy of GENERAL MOTORS COMPANY

2-6 and Low-Reverse Piston Function Inspection

Callout	Component Name
1	Case Cover Assembly **NOTE:** **The fluid seal rings should be in**

Callout	Component Name
	place and not damaged.
2	2-6 Clutch Feed Passage **CAUTION:** **Regulate the air pressure to 40 psi maximum. High pressure could cause the piston to over travel and damage the piston seals.** **Procedure** Apply shop air to the 2-6 clutch feed. Observe the 2-6 piston movement. **NOTE:** **Minimal piston movement and excessive air leaking could indicate damage to the 2-6 piston seals or improper assembly.**
3	Low and Reverse Clutch Feed Passage **CAUTION:** **Regulate the air pressure to 40 psi maximum. High pressure**

Callout	Component Name
	could cause the piston to over travel and damage the piston seals. **Procedure** Apply shop air to the Low and Reverse clutch feed. Observe the Low and Reverse piston movement. **NOTE:** **Minimal piston movement and excessive air leaking could indicate damage to the Low and Reverse piston seals or improper assembly.**

Input Speed Sensor Installation

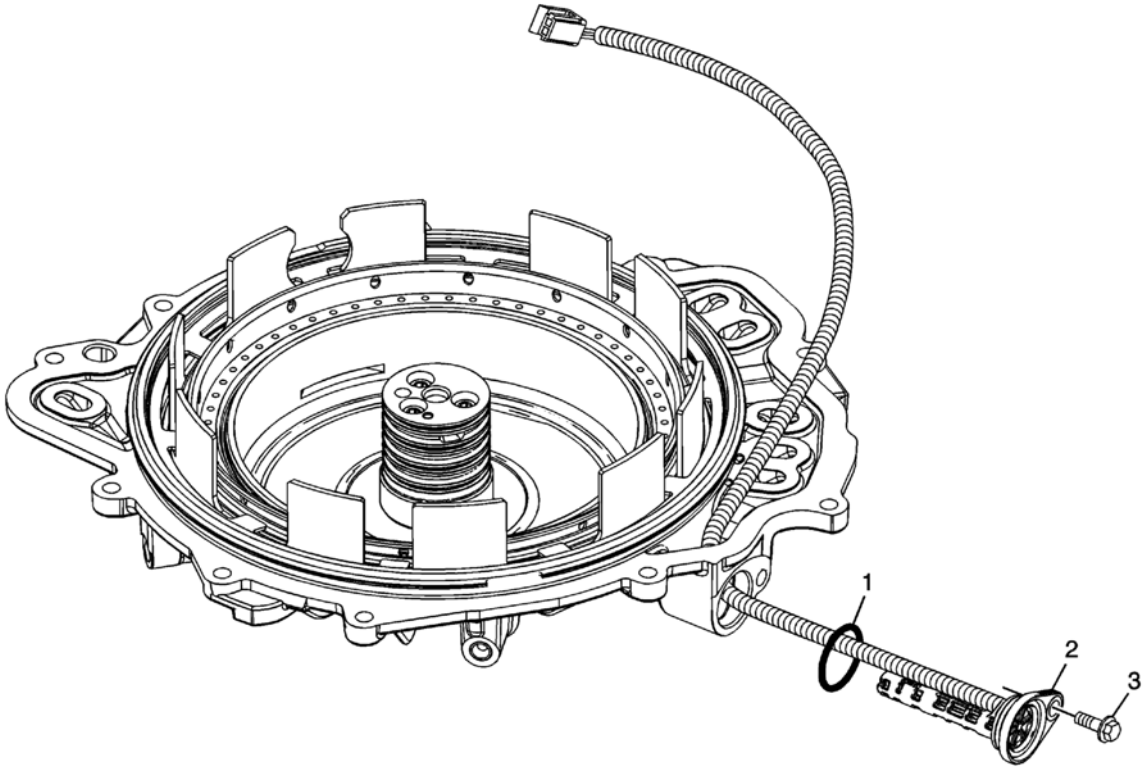


Fig. 74: View Of Input Speed Sensor
Courtesy of GENERAL MOTORS COMPANY

Input Speed Sensor Installation

Callout	Component Name
1	Input Speed Sensor Seal
2	A/Trans Input Speed Sensor Assembly
3	A/Trans Input Speed Sensor Bolt M6 x 25 **CAUTION:** **Refer to Fastener Caution .** **Procedure** Apply threadlocker or equivalent to the input speed sensor bolt. Refer to **Adhesives, Fluids, Lubricants, and Sealers** . **NOTE:** **The seal is coated with a dry lubricant. If the coating is missing, lubricate the**

Callout	Component Name
	seal with automatic transmission fluid prior to installation. **Tighten** 9 N.m (7 lb ft)

CASE COVER ASSEMBLY INSTALLATION

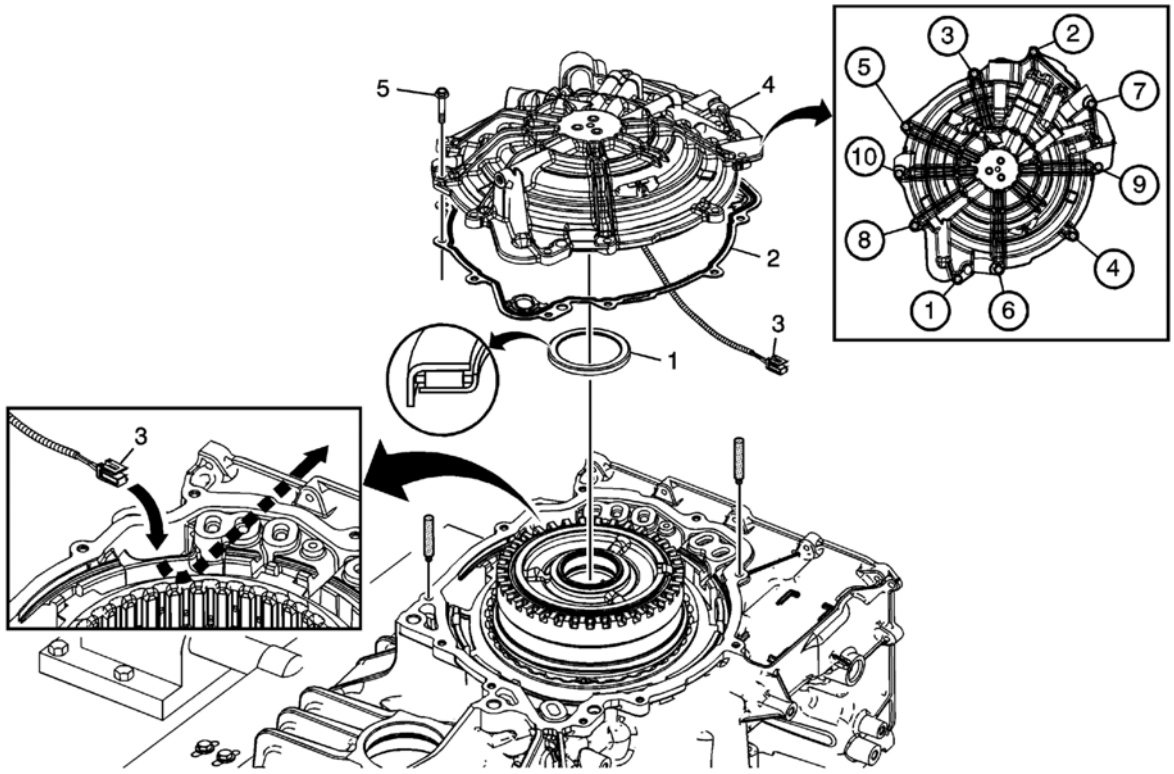


Fig. 75: Identifying Case Cover Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Input Shaft Thrust Bearing **NOTE:** **Note location of the orientation lip on bearing. All thrust**

Callout	Component Name
	bearings can only be assembled one way.
2	A/Trans Case Cover Gasket
3	Input Speed Sensor Wire Harness **NOTE:** **Route the input speed sensor wire harness through the case passage.**
4	A/Trans Case Cover Assembly **Procedure** 1. Use guide pins to install the case cover assembly to prevent damage to the input shaft thrust bearing. 2. Pull the input speed sensor wire harness through the case passage while lowering the cover assembly onto the case. **Special Tools** **39068** Guide Pins For equivalent regional tools, refer to **Special Tools** .
5	A/Trans Case Cover Assembly Bolt M6 x 30 (Qty: 10) **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten in sequence shown. **Tighten** 12 N.m (106 lb in)

FRONT DIFFERENTIAL CARRIER FINAL ROTATIONAL TORQUE MEASUREMENT

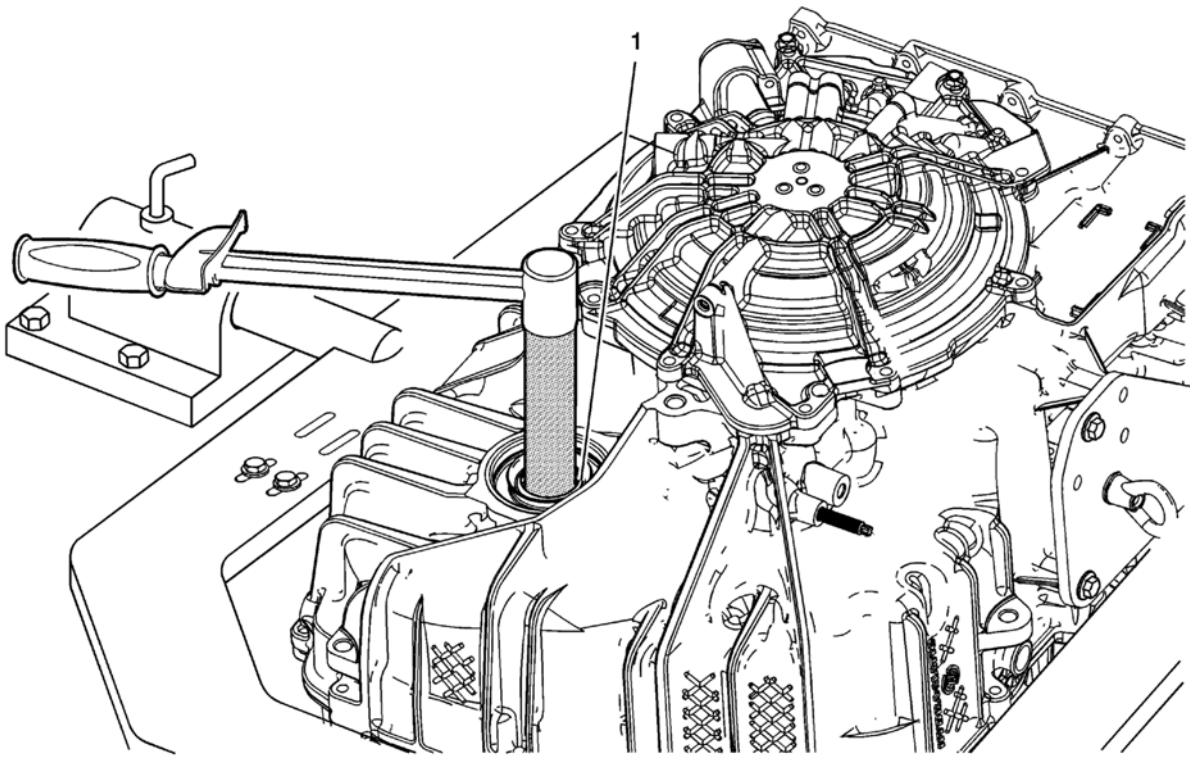


Fig. 76: Front Differential Carrier Final Rotational Torque Measurement
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Front Differential Carrier Assembly **CAUTION:** **Low bearing pre-load will cause premature failure of the front differential drive pinion gear.** **CAUTION:** **Refer to Fastener Caution .** **NOTE:** • **If the turning torque is not within**

Callout	Component Name
	specifications, the transfer gear assembly and differential bearing thrust washer is incorrect and must be corrected. Refer to Front Differential Drive Pinion Gear Bearing Thrust Washer and Front Differential Bearing Washer Measurement. • **Use a dial or beam torque wrench with DT-47793 differential rotating tool to measure turning torque.** **Tighten** 14-22 N.m (10-16 lb ft) **Special Tools** **DT-47793** Differential Rotating Tool For equivalent regional tools, refer to **Special Tools** .

CONTROL VALVE BODY ASSEMBLY DISASSEMBLE

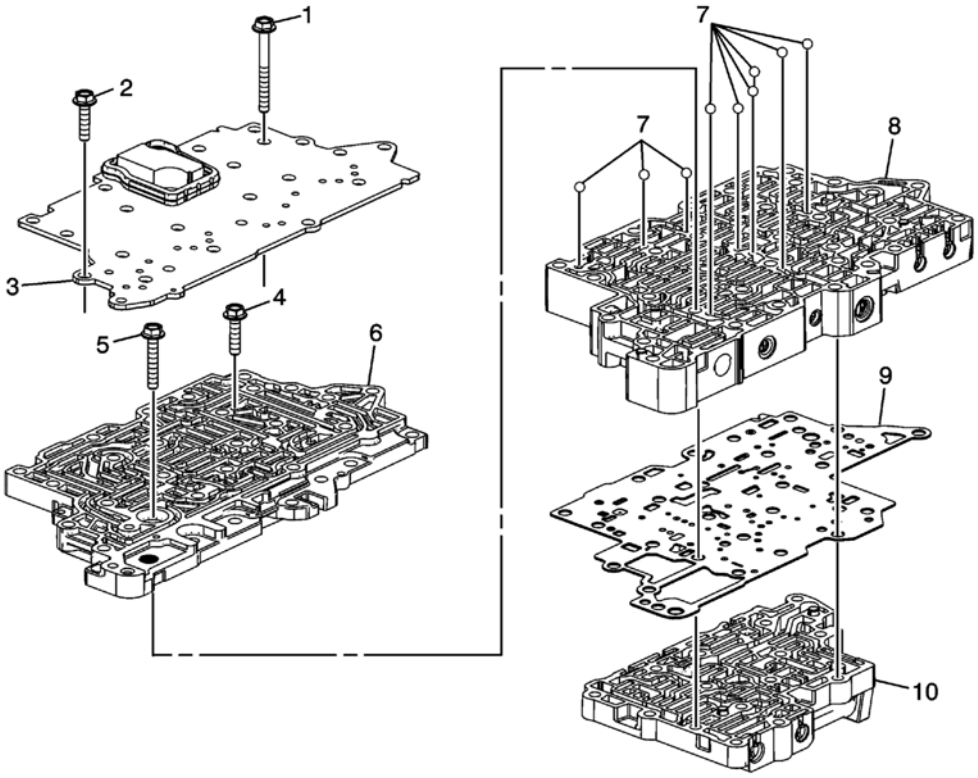


Fig. 77: Control Valve Body Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Control Valve Body Bolt M6 x 65 (Qty: 5)
2	Control Valve Body Bolt M6 x 35 (Qty: 3)
3	Control Valve Channel Upper Plate Assembly **NOTE:** • **Inspect the upper channel plate bolt pass through holes for damage or brinelling. Any damage near the PCS feed hole will cause incorrect pressure switch**

Callout	Component Name
	operation. Replace as necessary. • **The TCU pin gasket is not serviceable. If the gasket is damaged, the control valve channel upper plate assembly must be replaced.**
4	Control Valve Body Bolt M6 x 55 (Qty: 2)
5	Control Valve Body Bolt M6 x 55 (Qty: 1)
6	Control Valve Channel Plate Assembly
7	Control Valve Body Ball Check Valve (Qty: 9)
8	Control Valve Upper Body Assembly
9	Control Valve Lower Body Spacer Plate Assembly **NOTE:** **Discard the spacer plate assembly.**
10	Control Valve Lower Body Assembly

CONTROL VALVE LOWER BODY ASSEMBLY CLEANING AND INSPECTION

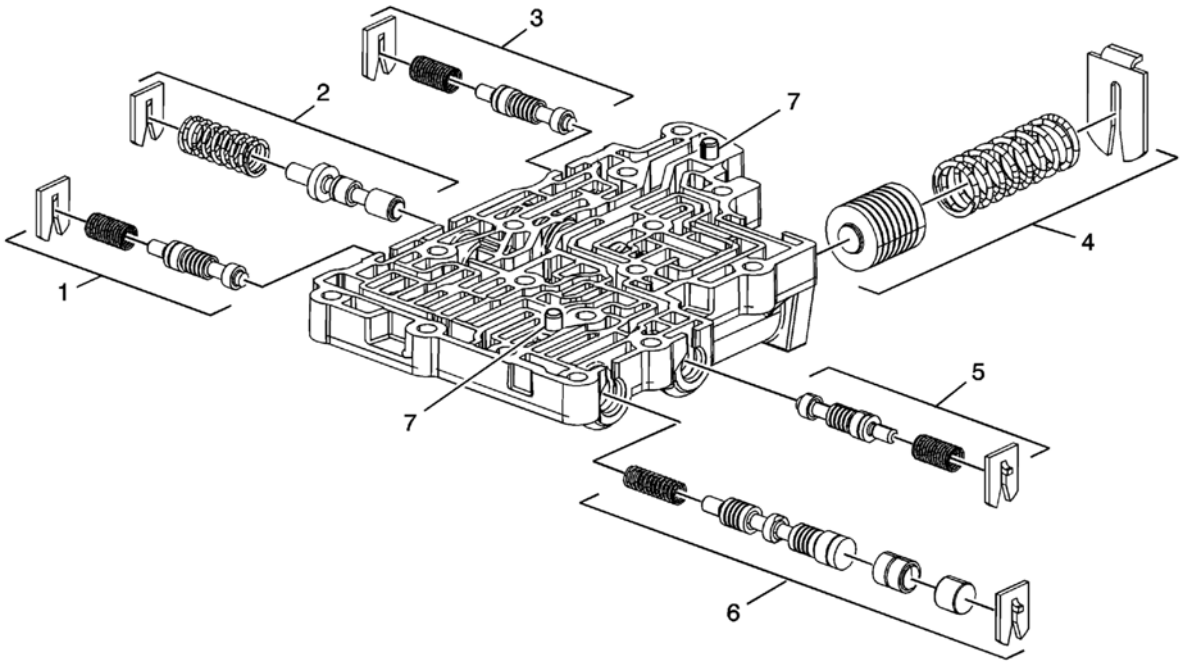


Fig. 78: Identifying Control Valve Lower Body Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result.** **CAUTION:** **After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels**	

Callout	Component Name
in order to dry any transmission components. Lint from the towels can cause component failure. **CAUTION:** **Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.** **Preliminary Procedure** Clean and inspect all valve components and the valve body. The control valve lower body is replaceable only as an assembly.	
1	3-5 Reverse Clutch Boost Valve Train
2	Accumulator Feed Limit Valve Train
3	4-5-6 Clutch Boost Valve Train
4	4-5-6 Clutch Accumulator Piston Assembly
5	1-2-3-4 Clutch Boost Valve Train
6	1-2-3-4 Clutch Regulator Valve Train
7	Control Valve Body Locating Pins (Qty: 2) **NOTE:** **Inspect Valve Body locating pins for proper installed height of 4.25 mm (0.17 in).**

CONTROL VALVE UPPER BODY ASSEMBLY CLEANING AND INSPECTION

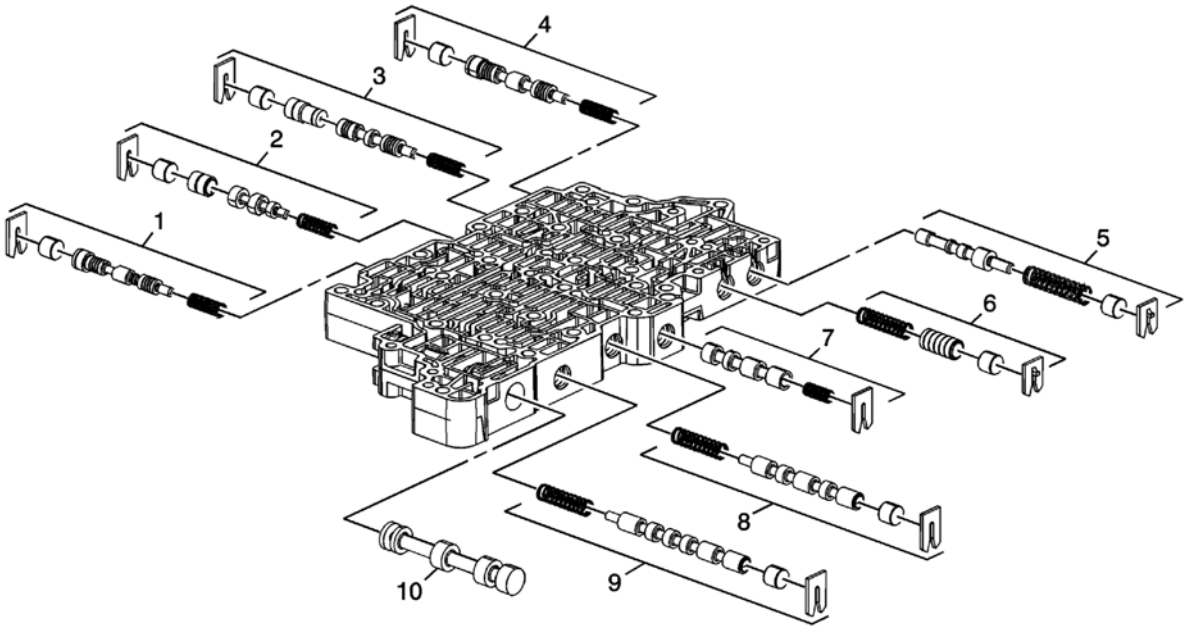


Fig. 79: Identifying Control Valve Upper Body Assembly Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
WARNING: **Valve springs can be tightly compressed. Use care when removing retainers and plugs. Personal injury could result.** **CAUTION:** **After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels**	

Callout	Component Name
in order to dry any transmission components. Lint from the towels can cause component failure. **CAUTION:** **Do not reuse cleaning solvents. Previously used solvents may deposit sediment which may damage the component.** **Preliminary Procedure** Clean and inspect all valve components and the valve body. The control valve upper body is replaceable only as an assembly.	
1	1st Reverse and 4-5-6 Clutch Regulator Valve Train
2	TCC Regulator Apply Valve Train
3	2-6 Clutch Regulator Valve Train
4	3-5 Reverse Clutch Regulator Valve Train
5	Pressure Regulator Valve Train
6	Isolator Valve Train
7	TCC Control Valve Train
8	Clutch Select Solenoid #3 Valve Train
9	Clutch Select Solenoid #2 Valve Train
10	Manual Valve

CONTROL VALVE CHANNEL PLATE CLEANING AND INSPECTION

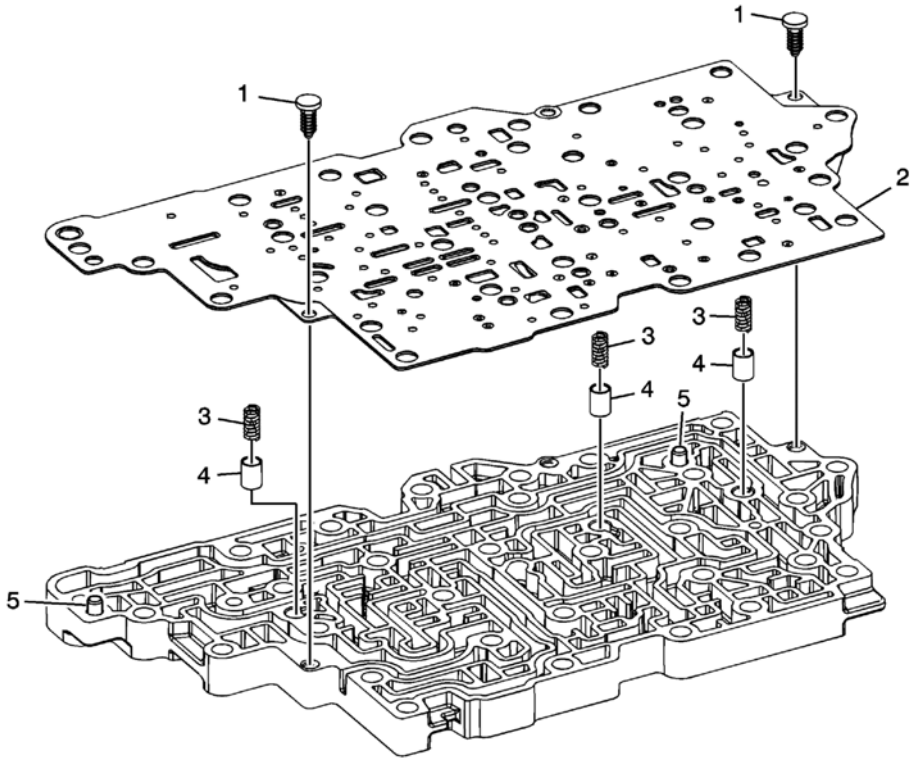


Fig. 80: Identifying Control Valve Channel Plate Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
CAUTION: **After cleaning the transmission components, allow to air dry. Do not use cloth or paper towels in order to dry any transmission components. Lint from the towels can cause component failure.** **CAUTION:** **Do not reuse cleaning solvents.**	

Callout	Component Name
Previously used solvents may deposit sediment which may damage the component.	
1	Control Valve Body Spacer Plate Retainer (Qty: 2)
2	Control Valve Upper Body Spacer Plate Assembly
3	Actuator Feed Accumulator Spring (Qty: 3)
4	Actuator Feed Accumulator Piston (Qty: 3)
5	Control Valve Body Locating Pin (Qty: 2) **NOTE:** **Inspect locating pins for proper installed height of 4.25 mm (0.17 in).**

CONTROL VALVE BODY ASSEMBLY ASSEMBLE

Lower and Upper Body Assemble

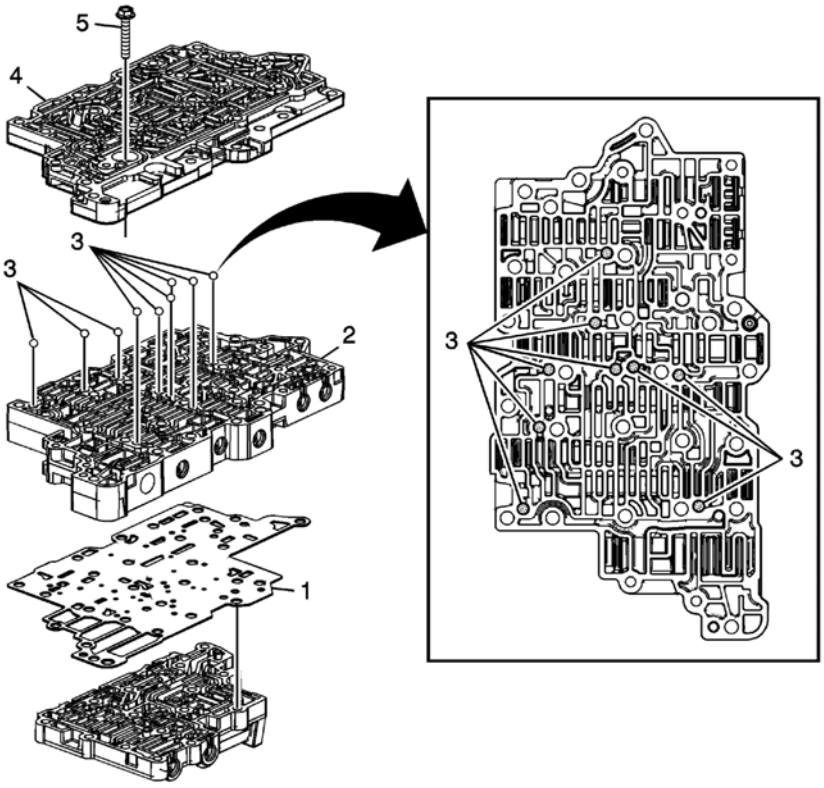


Fig. 81: Identifying Control Valve Body & Bolt
Courtesy of GENERAL MOTORS COMPANY

Lower and Upper Body Assemble

Callout	Component Name
1	Control Valve Lower Body Spacer Plate Assembly **CAUTION:** **Do not use the old spacer plate. Install a NEW spacer plate. Reusing an old spacer plate may cause internal transmission leaks and transmission damage.** **NOTE:** **Inspect the upper channel plate bolt through holes for damage or brinelling. Any damage around the PCS switch feed holes could cause leakage around the PCS switch seals. Replace as necessary.**
2	Control Valve Upper Body Assembly
3	Control Valve Body Ball Check Valve (Qty: 9) **CAUTION:**

Callout	Component Name
	Do not use any type of grease or other material to hold the check ball valves in place during assembly. Grease will cause the valves to not operate properly, resulting in damage to the transmission.
4	Control Valve Channel Plate Assembly
5	Control Valve Body Bolt 6 x 55 (Qty: 1) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 12 N.m (9 lb ft)

Channel Plate and Upper Channel Plate Assemble

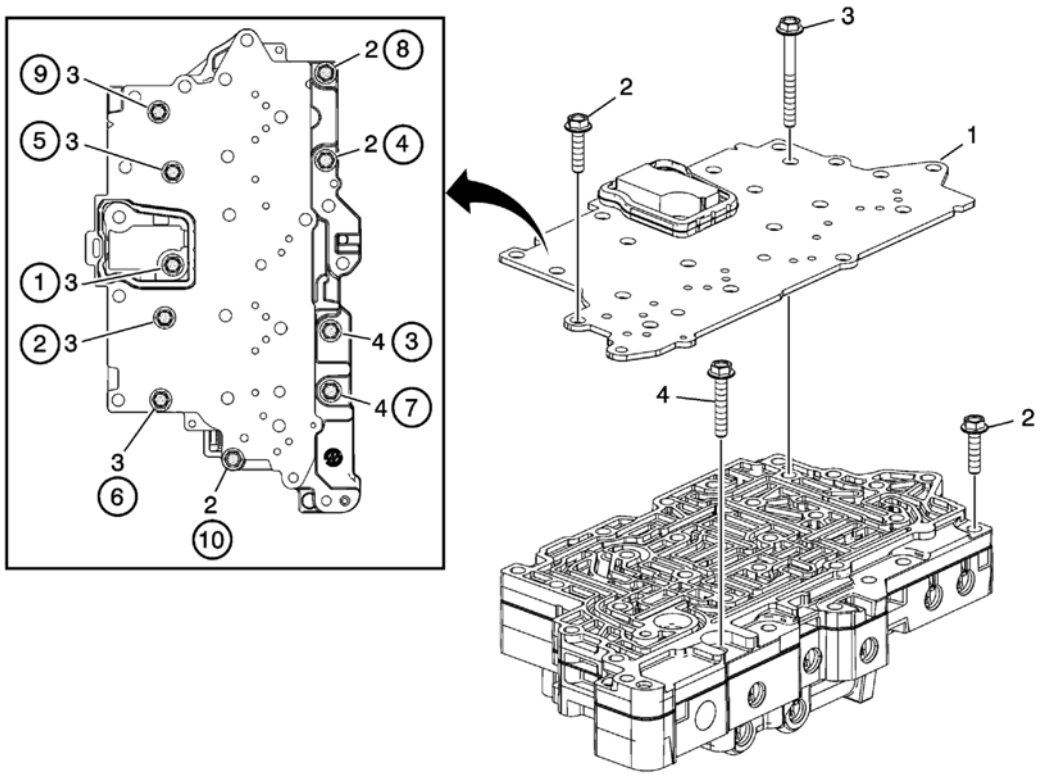


Fig. 82: Channel Plate And Upper Channel Plate
Courtesy of GENERAL MOTORS COMPANY

Channel Plate and Upper Channel Plate Assemble

Callout	Component Name
1	Control Valve Channel Upper Plate Assembly **NOTE:** • **Inspect the upper channel plate bolt pass through holes for damage or burnelling. Any damage near the PCS feed holes could cause leaking around the PCS switch seal.**

Callout	Component Name
	Replace as necessary. • **The TCU pin gasket is not serviceable. If the gasket is damaged, the control valve channel upper plate assembly must be replaced.**
2	Control Valve Body Bolt M6 x 35 (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Procedure** Hand tighten for alignment, then tighten in sequence, after all bolts are installed. **Tighten** 12 N.m (9 lb ft)
3	Control Valve Body Bolt M6 x 65 (Qty: 5) **Procedure** Tighten in sequence. **Tighten** 12 N.m (9 lb ft)
4	Control Valve Body Bolt M6 x 55 (Qty: 2) **Procedure** Tighten in sequence. **Tighten** 12 N.m (9 lb ft)

CONTROL VALVE BODY ASSEMBLY INSTALLATION

Output Speed Sensor and Valve Body Installation

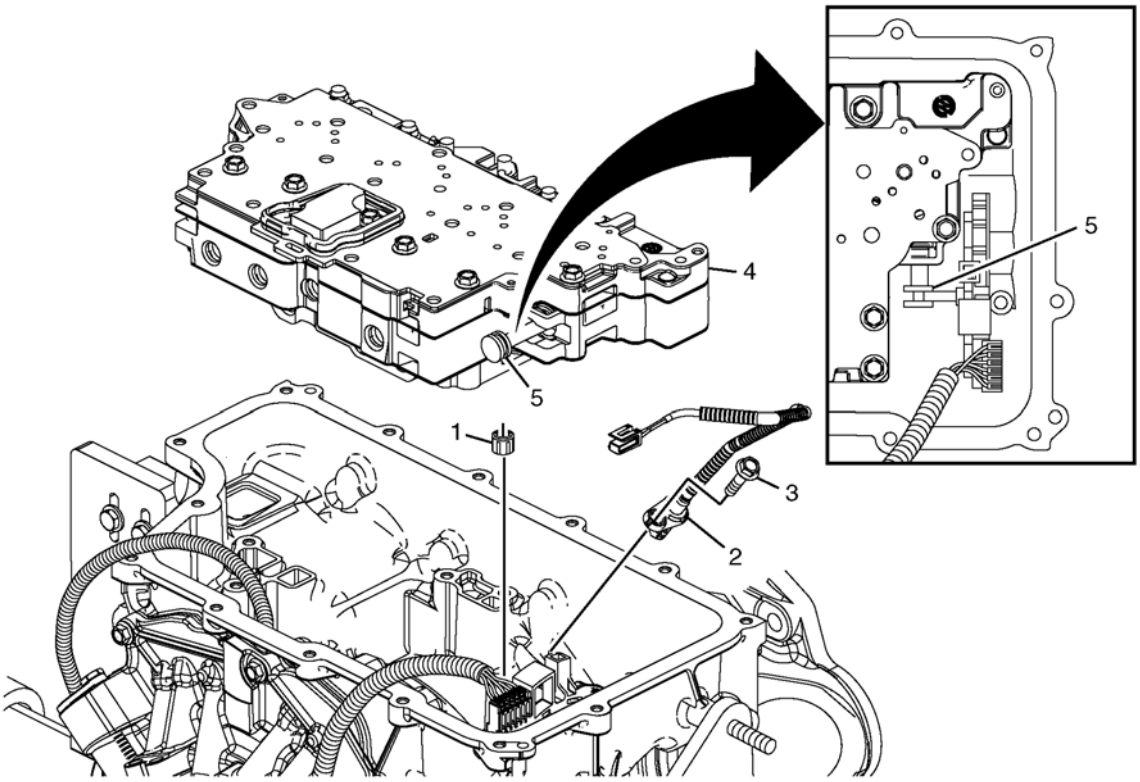


Fig. 83: Output Speed Sensor And Control Valve Body Assembly
Courtesy of GENERAL MOTORS COMPANY

Output Speed Sensor and Valve Body Installation

Callout	Component Name
1	1-2-3-4 Clutch Fluid Passage Seal
2	A/Trans Output Speed Sensor Assembly
3	A/Trans Output Speed Sensor Assembly Bolt M6 x 25 **CAUTION:** **Refer to Fastener Caution .** **Tighten** 12 N.m (9 lb ft)
4	Control Valve Body Assembly
5	Manual Valve **NOTE:** • **Align the manual valve to the detent**

Callout	Component Name
	lever assembly. • **Removing the manual shaft assembly pin will aid in aligning the manual valve to the detent lever. Install the manual shaft pin after the valve body assembly is installed using DT 41229 pin installer , if it was not installed previously. Refer to Manual Shift Detent Lever with Shaft Position Switch Assembly and Park Pawl Actuator Removal.** **Special Tools** **DT 41229** Manual Shaft Pin Installer For equivalent regional tools, refer to **Special Tools** .

Control Valve Body Bolts Installation

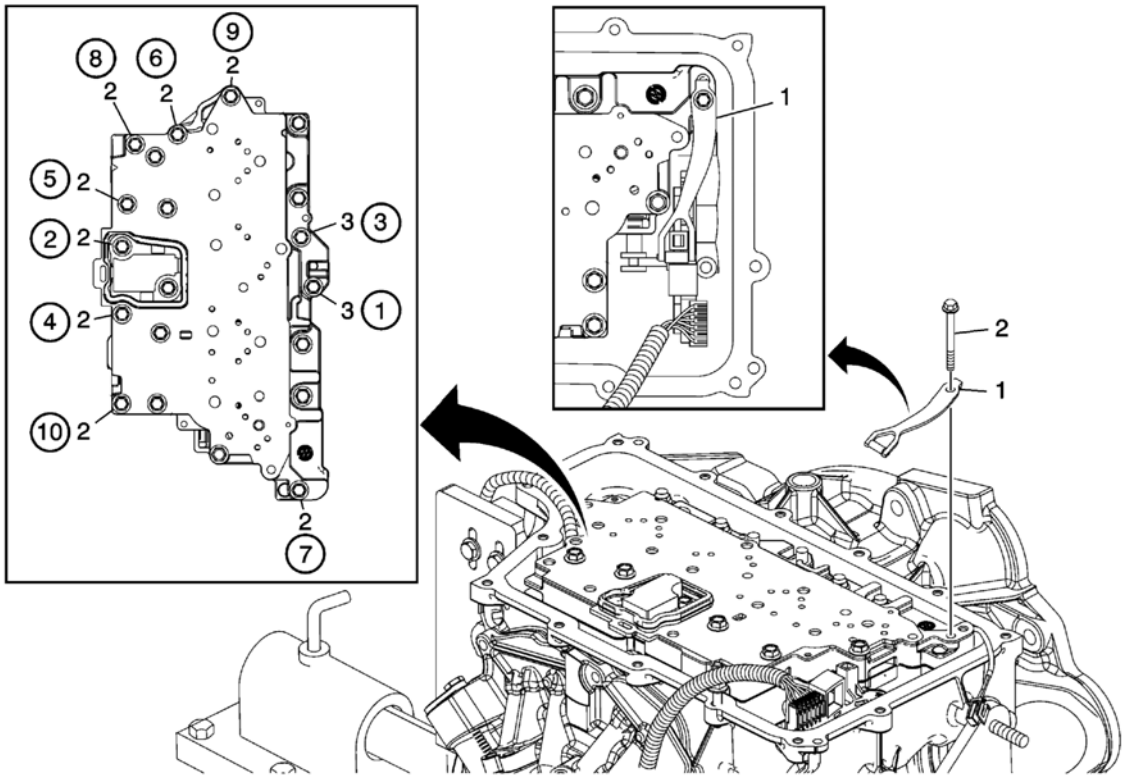


Fig. 84: Control Valve Body Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Bolts Installation

Callout	Component Name
1	Manual Shaft Detent Assembly **NOTE:** **Ensure proper alignment of the detent assembly to the detent lever assembly with position switch while tightening the bolt. The detent assembly can move and hit the valve body**

Callout	Component Name
	assembly that could cause improper engagement with the detent lever assembly.
2	Control Valve Body Bolt M6 x 65 (Qty: 8) **CAUTION:** **Refer to Fastener Caution .** **Procedure** Tighten in sequence. **Tighten** 12 N.m (9 lb ft).
3	Control Valve Body Bolt M6 x 55 (Qty: 2) **Procedure** Tighten in sequence. **Tighten** 12 N.m (9 lb ft).

Filter Plate Installation

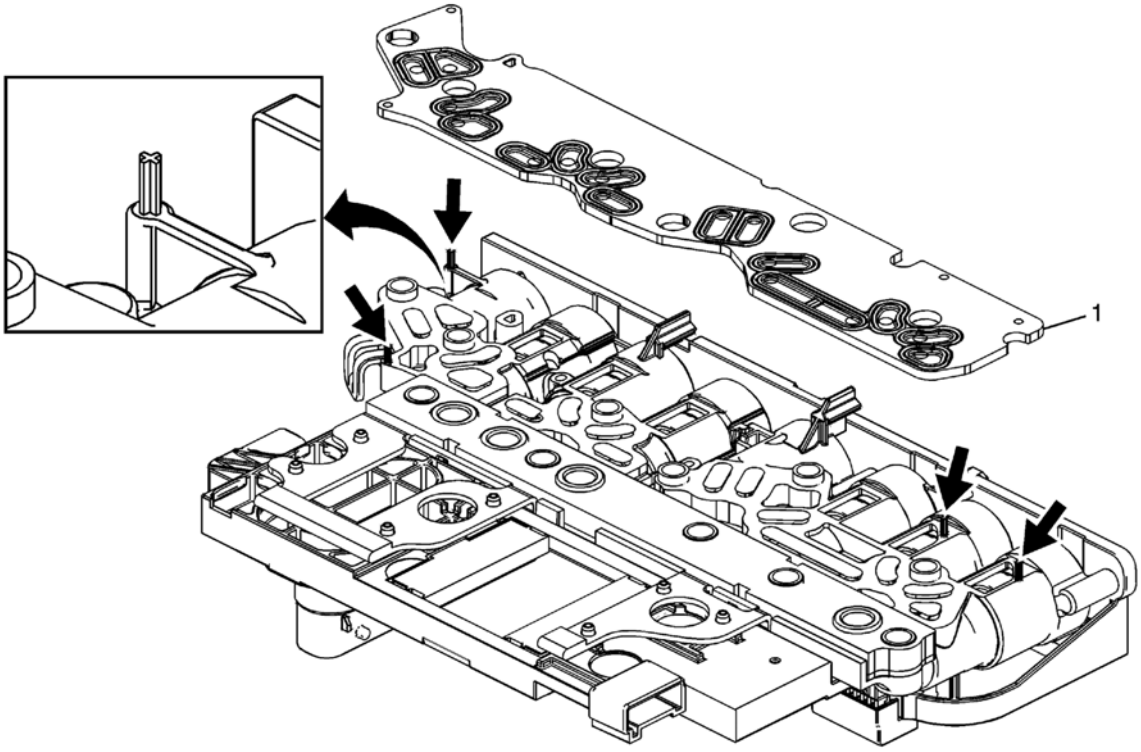


Fig. 85: View Of Filter Plate
Courtesy of GENERAL MOTORS COMPANY

Filter Plate Installation

Callout	Component Name
1	Control Solenoid Valve Assembly Filter Plate **CAUTION:** **Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.**

Callout	Component Name
	NOTE: **Install a NEW filter plate to prevent fluid leaks past the oil seals.**

Control Solenoid (w/Body and TCM) Valve Assembly Installation

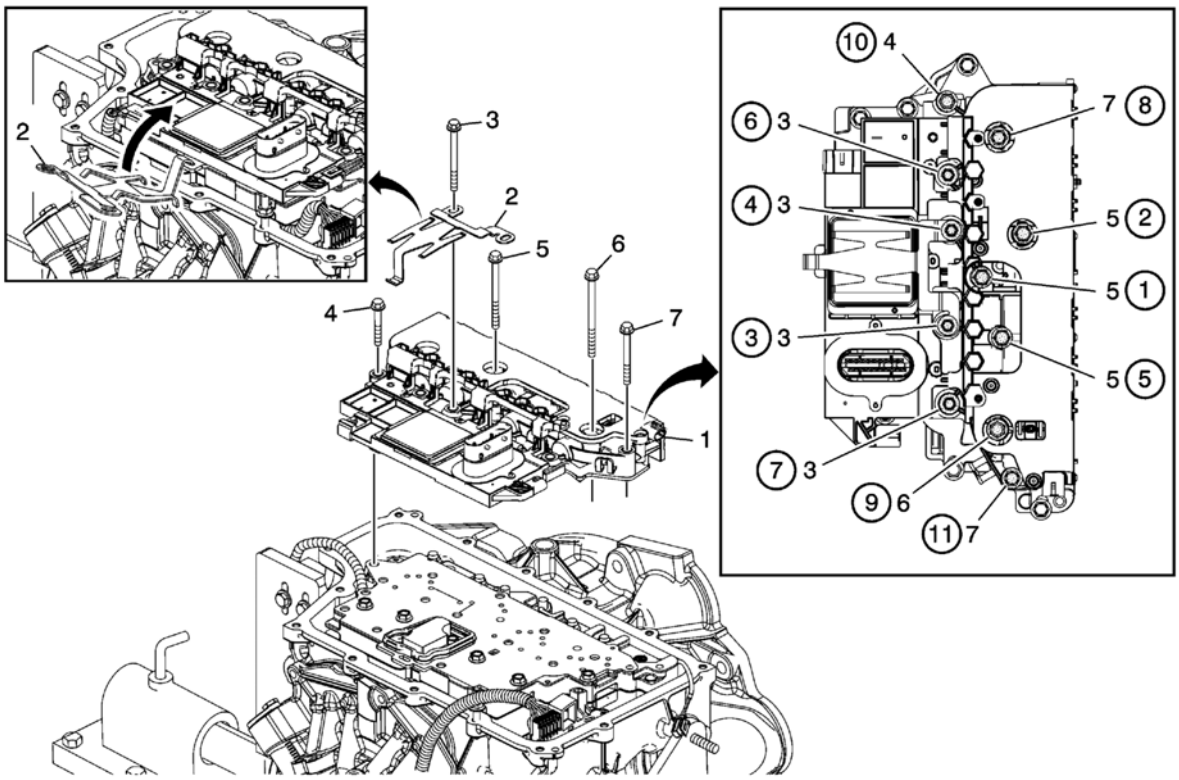


Fig. 86: Control Solenoid (w/Body and TCM) Valve Assembly
Courtesy of GENERAL MOTORS COMPANY

Control Solenoid (w/Body and TCM) Valve Assembly Installation

Callout	Component Name
	CAUTION: **Refer to Fastener Caution .** **Preliminary Procedure** Install all bolts before tightening, then tighten in sequence to 12 N.m (9 lb ft).
1	Control Solenoid (w/Body and TCM) Valve Assembly **CAUTION:**

Callout	Component Name
	Do not drop the control solenoid with body and transmission control module (TCM) valve assembly. Internal damage can occur if the control solenoid with body and TCM valve assembly is dropped. DO NOT reuse the control solenoid with body and TCM valve assembly if it is dropped.
2	Control Solenoid Valve Spring **NOTE:** • **If the control solenoid spring is missing or improperly installed, the TCM may overheat causing the TCM to shut down. The transmission will default to 3rd or 5th gear.**

Callout	Component Name
	• **Insert tab of spring into slot on spacer plate, then rotate into position.**
3	Control Valve Body Bolt M6 x 80 (Qty: 4)
4	Control Valve Body Bolt M6 x 55 (Qty: 1)
5	Control Valve Body Bolt M6 x 95 (Qty: 3)
6	Control Valve Body Bolt M6 x 42 (Qty: 1)
7	Control Valve Body Bolt M6 x 65 (Qty: 2)

Wire Routing and Connector Locations

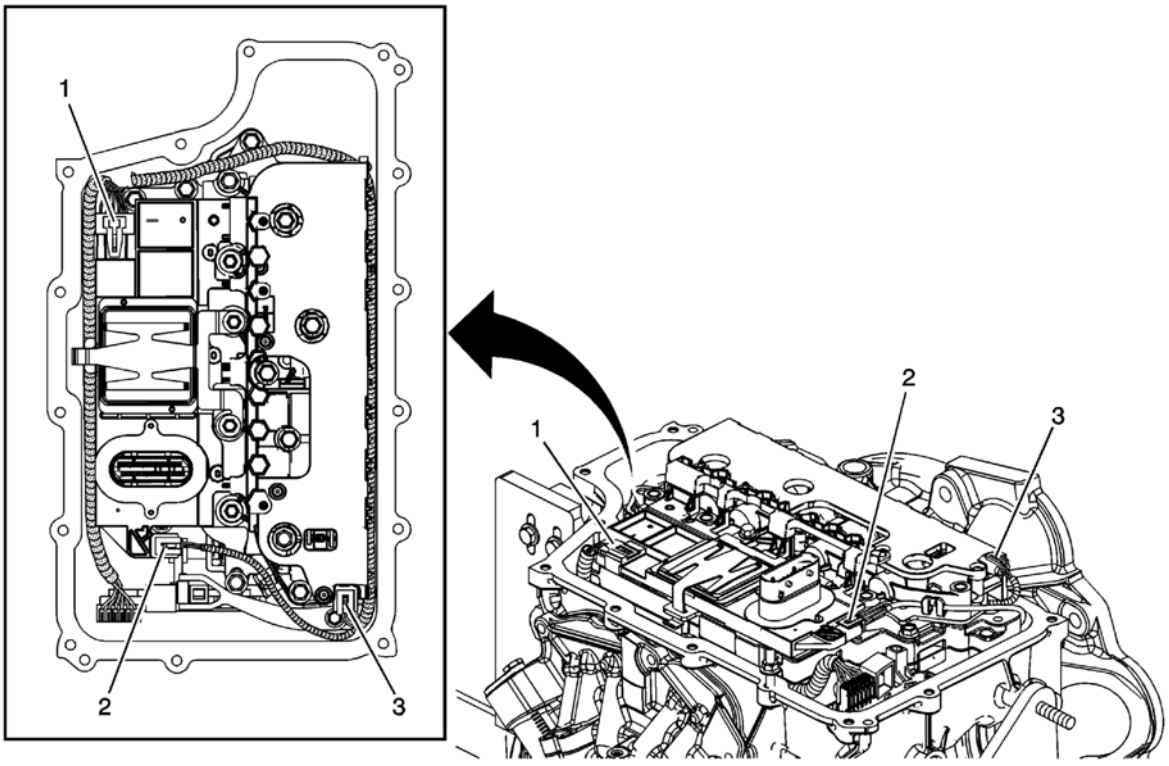


Fig. 87: Identifying Wire Routing & Connector Locations
Courtesy of GENERAL MOTORS COMPANY

Wire Routing and Connector Locations

Callout	Component Name
Preliminary Procedure Route all wires as shown.	
1	Shift Position Switch Connector
2	Output Speed Sensor Connector

Callout	Component Name
3	Input Speed Sensor Connector

Control Valve Body Cover Installation

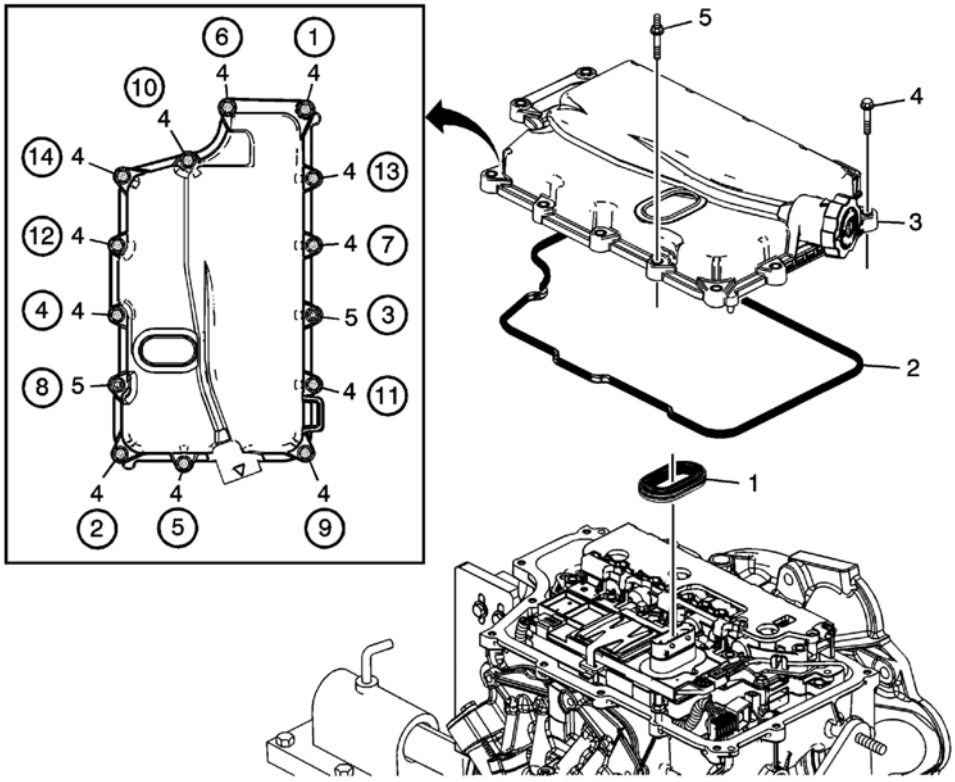


Fig. 88: Identifying Control Valve Body Cover Wiring Connector Hole Seal & Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Cover Installation

Callout	Component Name
1	Control Valve Body Cover Wiring Connector Hole Seal **NOTE:** **Holes in the seal must face down.**
2	Control Valve Body Cover Assembly Gasket
3	Control Valve Body Cover Assembly
4	Control Valve Body Cover Bolt M6 x 30 (Qty: 12) **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	Procedure Tighten in sequence. **Tighten** 12 N.m (9 lb ft).
5	Control Valve Body Cover Stud M6 x 30 (Qty: 2) **Procedure** Tighten in sequence. **Tighten** 12 N.m (9 lb ft).

TORQUE CONVERTER INSTALLATION

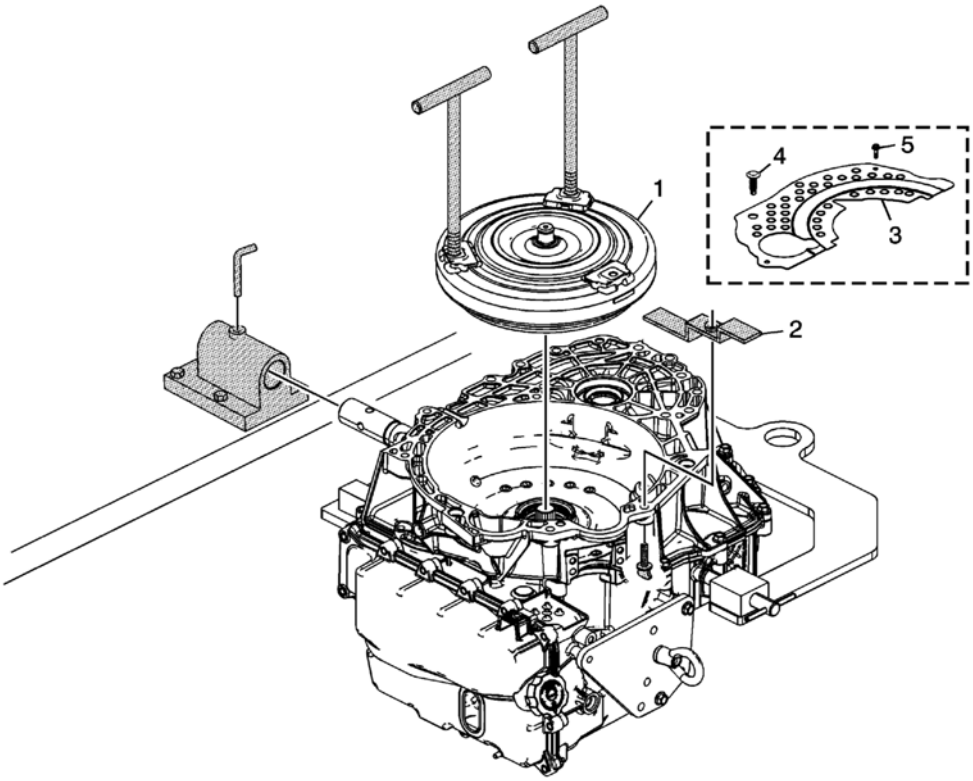


Fig. 89: View Of Torque Converter
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Torque Converter Assembly **CAUTION:** **Lower the torque converter straight down. Failure to lower the**

Callout	Component Name
	torque converter straight down could damage the torque converter clutch lip seal inside the torque converter clutch assembly. **Special Tools** **DT 46409** Torque Converter Lifting Handles For equivalent regional tools, refer to **Special Tools** .
2	**DT 21366** Converter Holding Strap **WARNING:** **The torque converter must be held to the torque converter housing by a retaining device such as shipping brackets. Without the retaining device, the torque converter may slide forward, disengaging the oil pump, or may fall completely out of the transmission causing personal injury and/or**

Callout	Component Name
	property damage.
3	Dust Cover - Model Dependant
4	Dust Cover Push Pin - Model Dependant (Qty: 2)
5	Dust Cover Bolt - Model Dependant **CAUTION:** **Refer to Fastener Caution .** **Tighten** 75 N.m (37 lb ft)

LIFT PLATE AND HOLDING FIXTURE REMOVAL

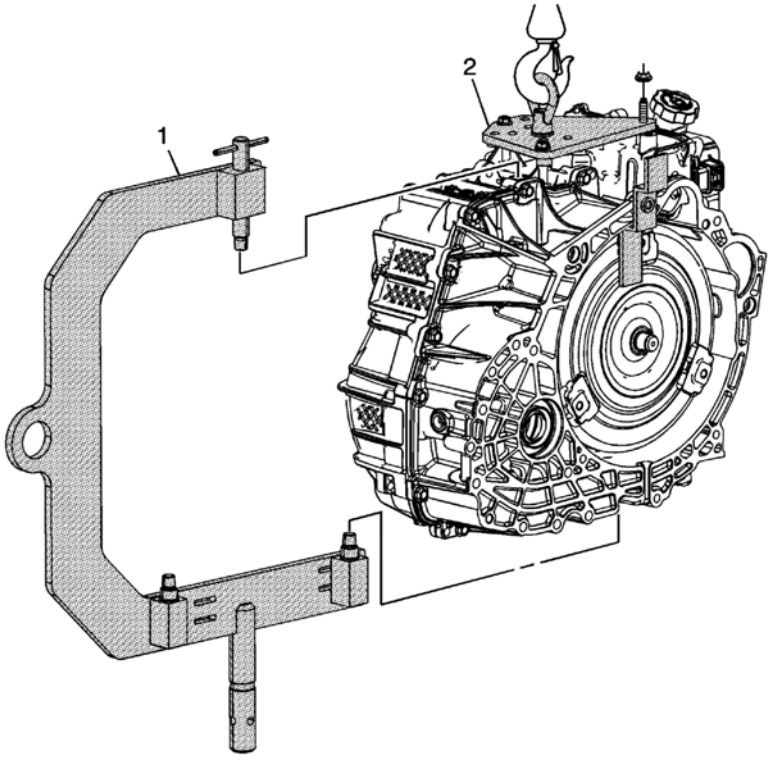


Fig. 90: Identifying Lift Plate & Holding Fixture
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	**DT 46625** Transmission Holding Fixture **NOTE:**

Callout	Component Name
	Raise the transmission in order to remove the holding fixture. For equivalent regional tools, refer to **Special Tools** .
2	**DT-47811-A** Lift Plate **NOTE:** **Lower the transmission assembly onto the transmission jack in order to remove the lift plate.** For equivalent regional tools, refer to **Special Tools** .

Article GUID: A00737250

REPAIR INSTRUCTIONS - ON VEHICLE

MANUAL SHIFT DETENT LEVER WITH SHAFT POSITION SWITCH ASSEMBLY REPLACEMENT

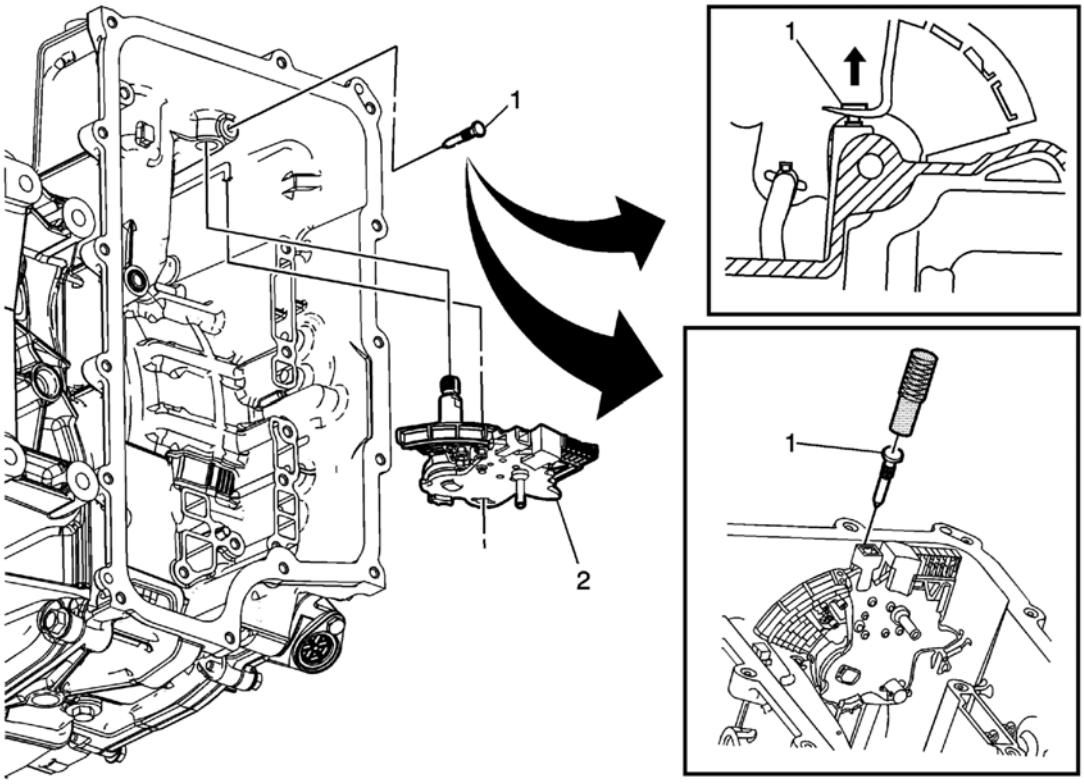


Fig. 1: Identifying Manual Shift Detent Lever & Shaft Position Switch Assembly
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the transmission range selector lever. Refer to **Automatic Transmission Range Selector Lever Replacement**. 2. Remove the lower control valve body. Refer to **Control Valve Lower Body and Upper Body Replacement**.	
1	Manual Shaft Detent Lever Pin **CAUTION:** **Use J 41229 to install the manual shaft**

Callout	Component Name
	pin at the correct height in order to properly secure the manual shaft. If you install the pin too deep, the case bore may crack. • Use a small nail puller to remove the pin. Discard the pin, it is not reusable. • Use **DT-41229** Manual Shaft Pin Installer to install the pin. Inspect that the pin installed height is within 6.5 mm-7.5 mm (0.25 in-0.30 in). **Special Tools** **DT 41229** Manual Shaft Pin Installer
2	Manual Shaft Detent Lever Assembly (With Shift Position Switch) **Procedure** • Removal: Partly lower the manual shaft detent lever assembly (w/shift position switch) in order to rotate the detent lever and disconnect the park actuator rod. Then fully remove the manual shaft detent lever assembly from the transmission case. • Installation: Partly install the manual shaft detent lever assembly (w/shift position switch). Rotate the detent lever and connect the park actuator rod. Then fully install the manual shaft detent lever assembly in the transmission case. • Lubricate the manual shaft with automatic transmission fluid (ATF) to prevent damage to the manual shift shaft seal. **TIP:** Do not pull the park actuator rod end out beyond the machined oil passage surface in the case. A no park condition will exist if the park pawl actuator assembly is pulled out of the transmission too far and the actuator rod disengages from the park pawl. The transmission assembly will require disassembly to re-install the actuator rod over the park pawl.

TRANSMISSION CONTROL LEVER KNOB REPLACEMENT

Removal Procedure

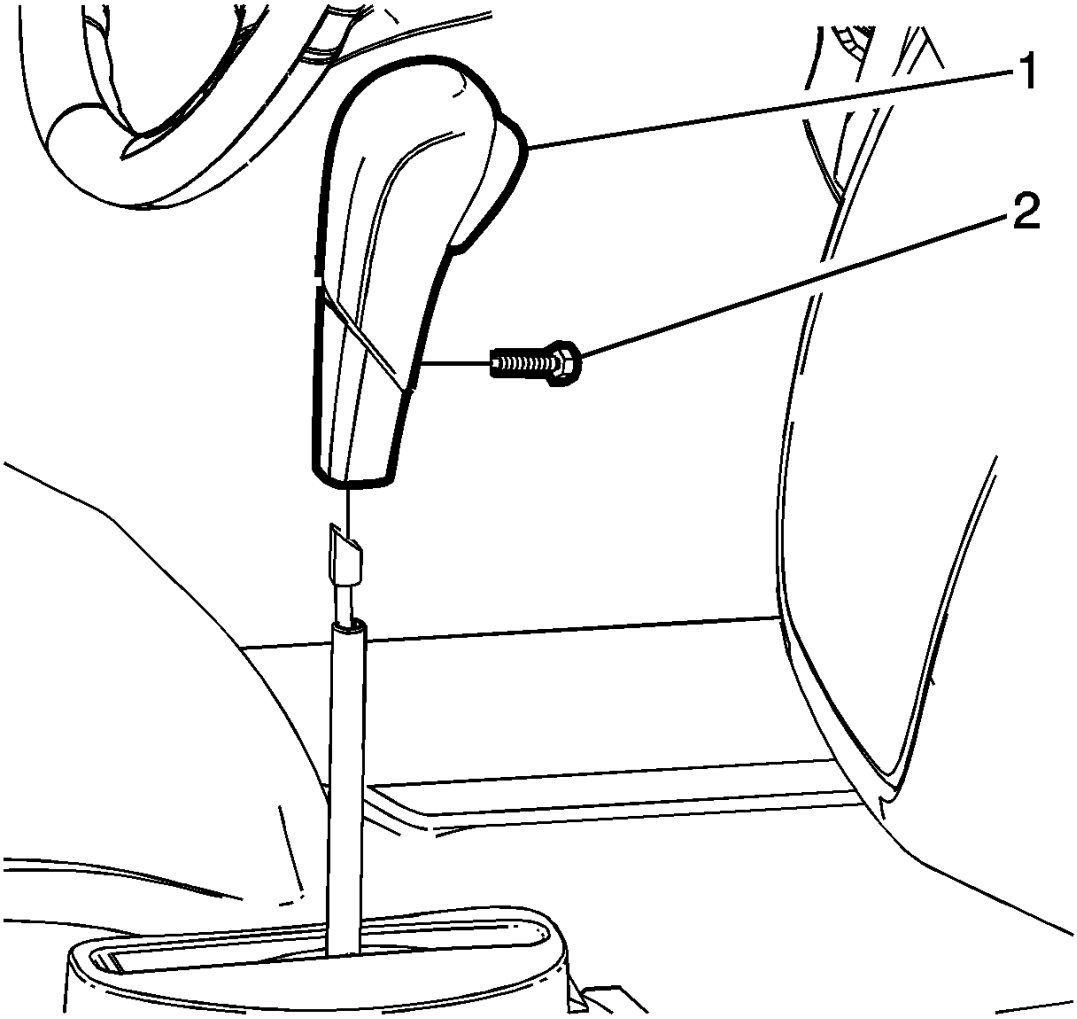


Fig. 2: Shift Knob And Retaining Screw
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Place the shift control in NEUTRAL before attempting to remove the shift knob screw.**

1. Remove the shift knob retaining screw (2).
2. Remove the shift knob (1) from the shift control lever.

Installation Procedure

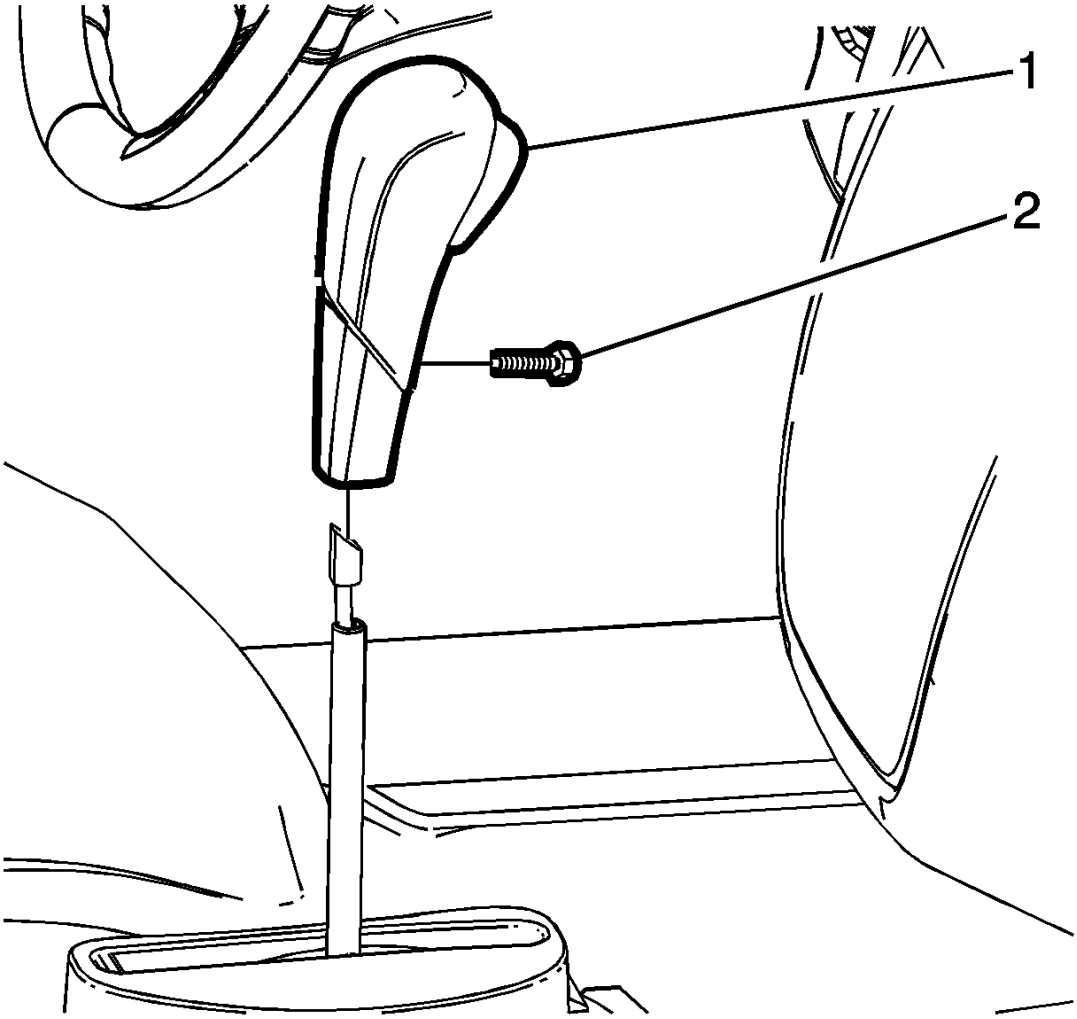


Fig. 3: Shift Knob And Retaining Screw
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Place the shift control in NEUTRAL before attempting to install the shift knob screw.**

1. Install the shift knob (1) to the shift control lever.

CAUTION: **Refer to Fastener Caution .**

2. Install the shift knob retaining screw (2) and tighten to 9 N.m (80 lb in).

TRANSMISSION CONTROL REPLACEMENT

Removal Procedure

1. Remove the console trim plate . Refer to **Front Floor Console Replacement** .
2. Remove the console wiring harness.

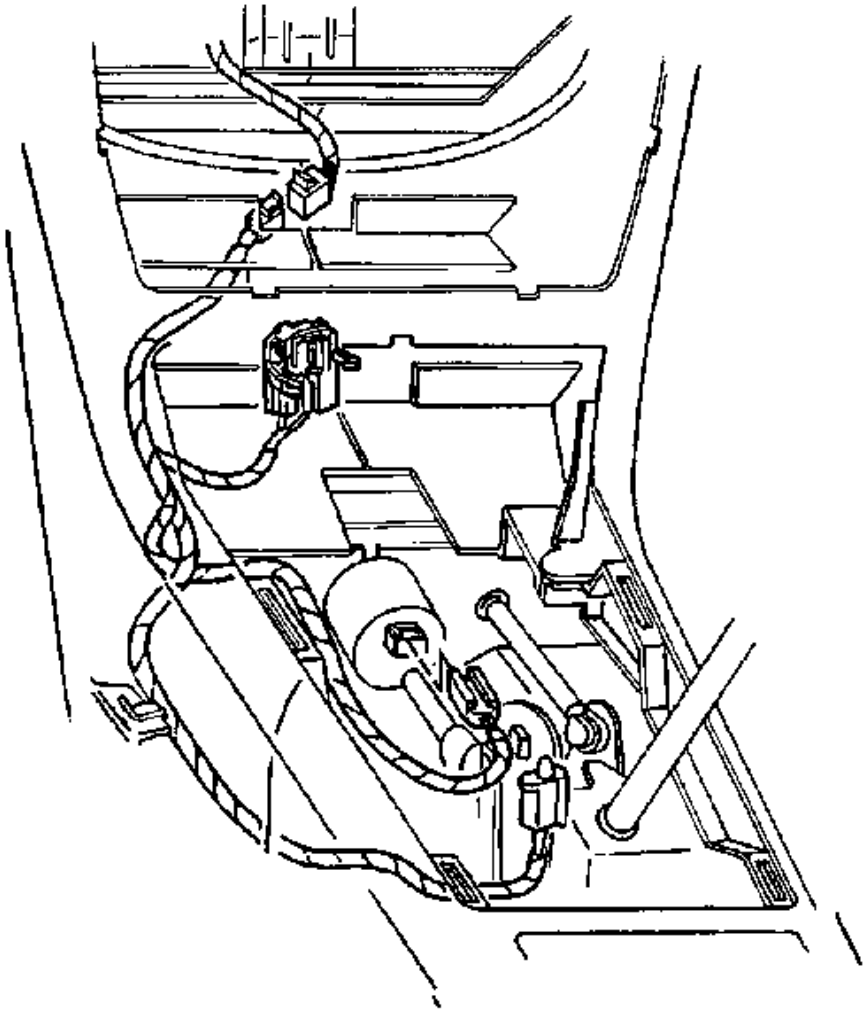


Fig. 4: Removing Console Shift Control Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

3. Remove the console shift control wiring harness.
4. Remove the automatic transaxle range selector cable. Refer to **Range Selector Lever Cable Replacement (Column Shift)Range Selector Lever Cable Replacement (Floor Shift)**.
5. Disconnect the light bulb and the retainer from the shiftier.

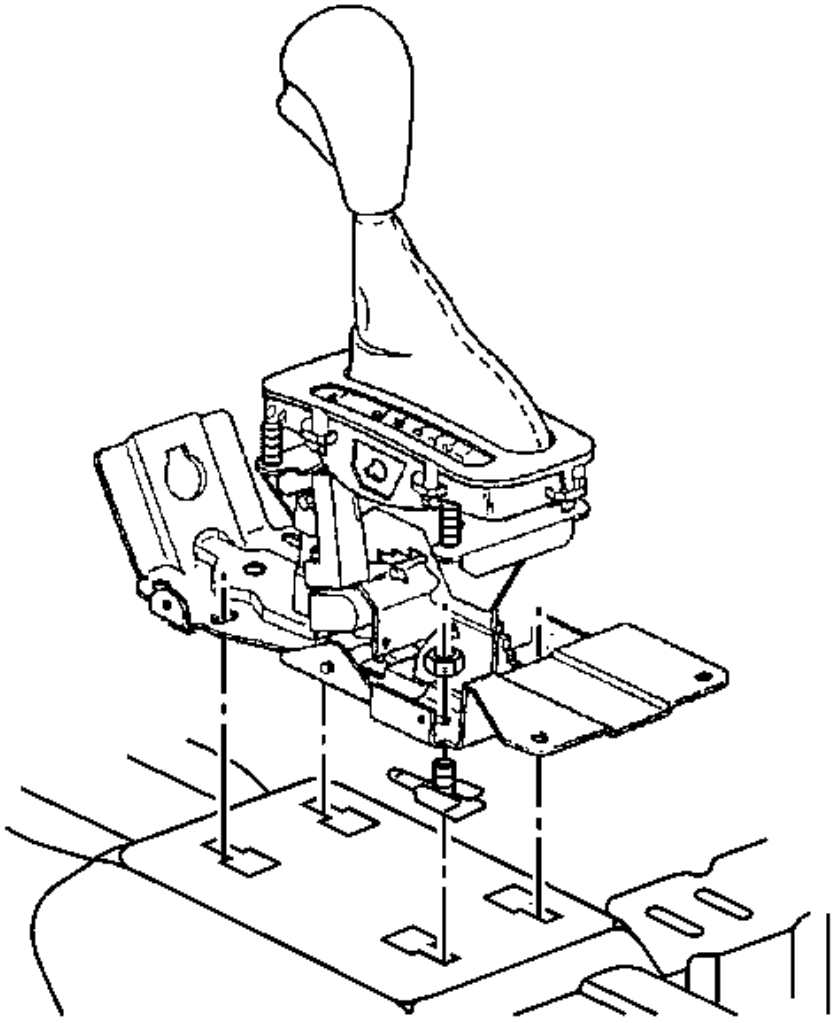


Fig. 5: Console Shift Control Assembly
Courtesy of GENERAL MOTORS COMPANY

6. Remove the console shift control retaining nuts.
7. Remove the console shift control assembly from the vehicle.

Installation Procedure

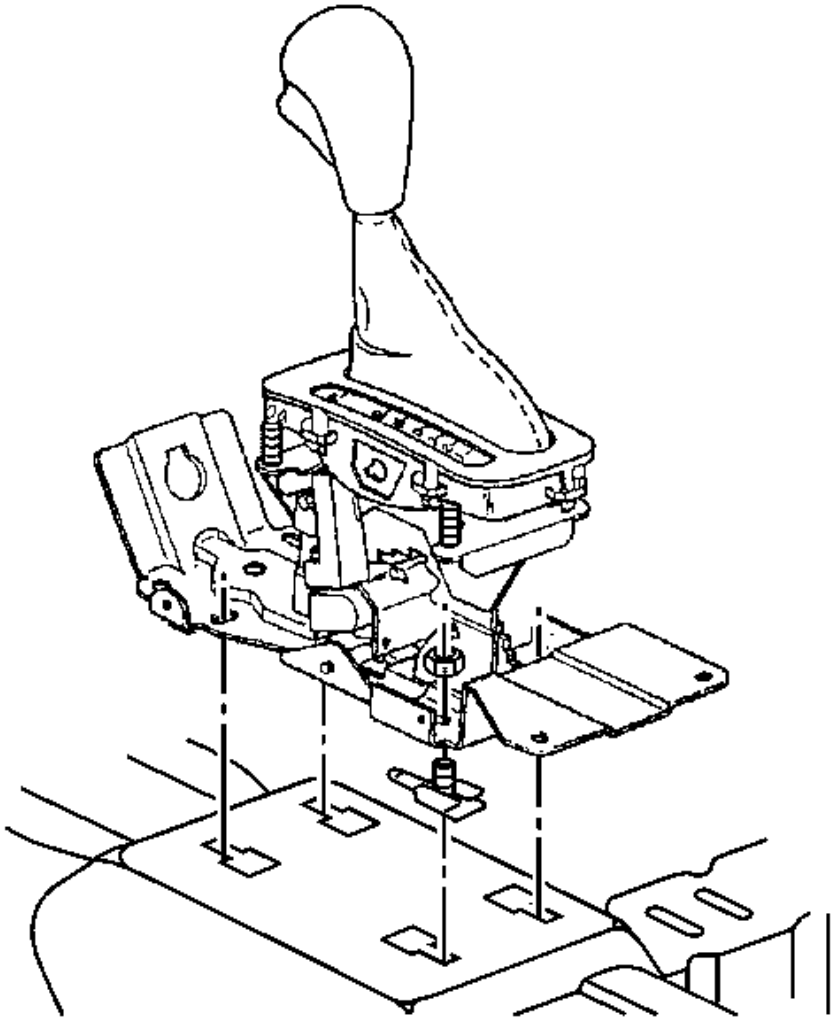


Fig. 6: Console Shift Control Assembly
Courtesy of GENERAL MOTORS COMPANY

1. Install the console shift control into the vehicle.

CAUTION: **Refer to Fastener Caution .**

2. Install the console shift control retaining nuts and tighten to 20 N.m (15 lb ft).
3. Install the automatic transaxle range selector cable. Refer to **Range Selector Lever Cable Replacement (Column Shift)Range Selector Lever Cable Replacement (Floor Shift)**.

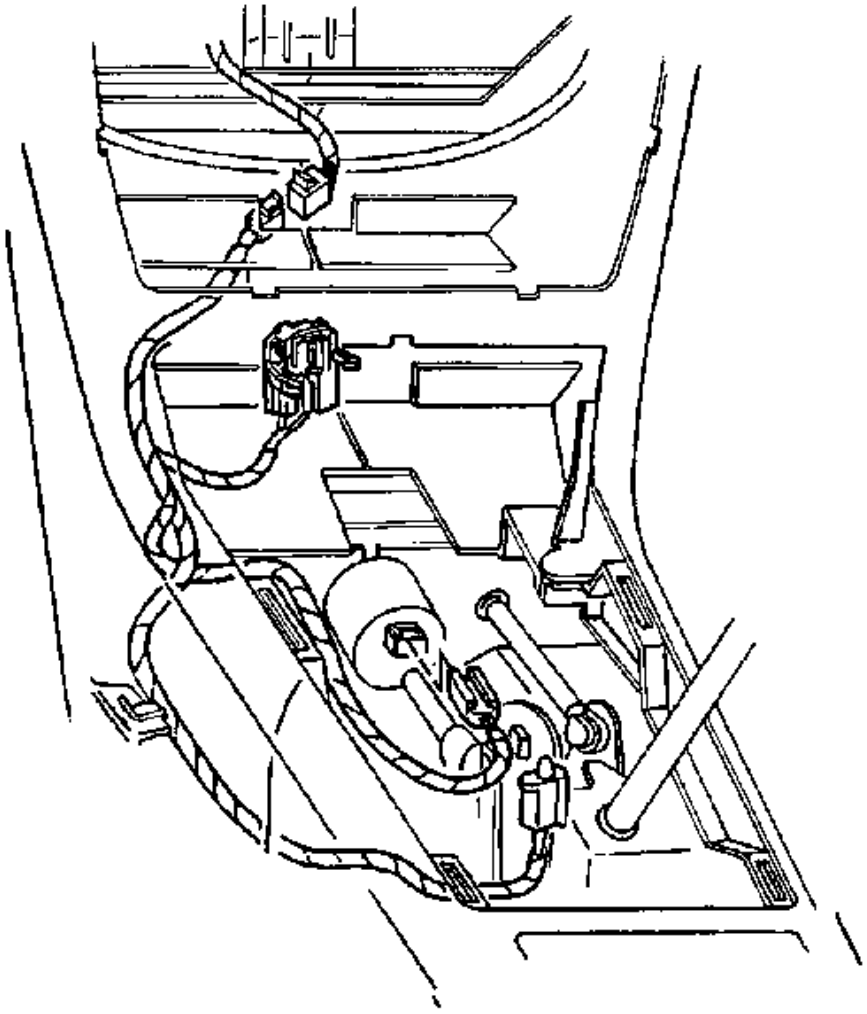


Fig. 7: Removing Console Shift Control Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

4. Install the console shift control wiring harness.
5. Install the console wiring harness.
6. Install the console trim plate. Refer to **Front Floor Console Replacement** .

TRANSMISSION CONTROL CLEANING AND INSPECTION

NOTE: **Do not use any solvent based cleaning products. These products will destroy the materials and/or components in the shift control assembly. Only use Leather, Vinyl, and Plastic Cleaner GM P/N 88861401 (Canadian P/N 88861409) or equivalent.**

1. Remove the necessary trim panels to access the shift control internal components. Refer to the appropriate interior trim procedures.
2. Protect the floor carpet panels on both sides of the console base with absorbent towels to prevent staining from the liquid cleaner.

3. Clean all external shift control components including the shifter handle, bezel and the moving shift lever closeout panel.

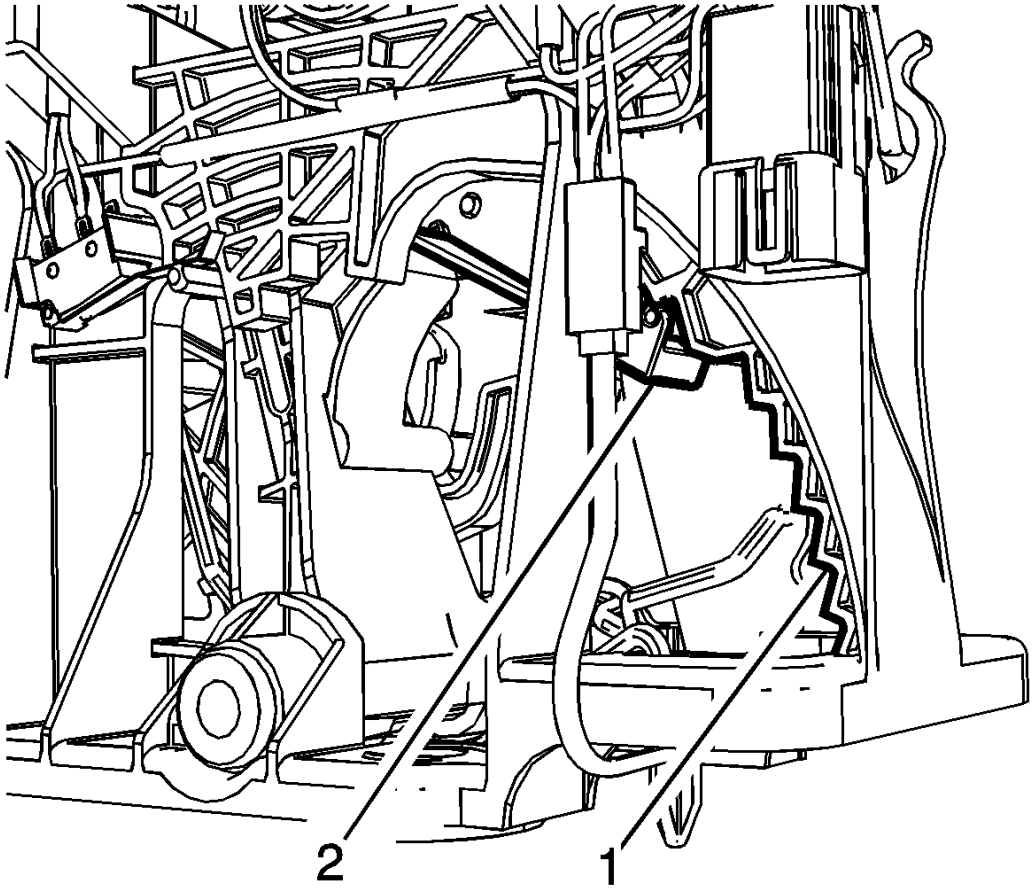


Fig. 8: Stepped Selector Section And Detent Spring
Courtesy of GENERAL MOTORS COMPANY

4. Locate the stepped selector section (1) and detent spring (2) within the shifter assembly.

NOTE: **Do not spray the cleaner directly at any of the electrical components.**

NOTE: **It may be necessary to move the shifter from park in order to completely clean all surfaces of stepped selector or detent spring.**

5. Clean all surfaces of the stepped selector section and detent spring within the shifter assembly that are sticking or binding. Use a small brush to completely clean the working surfaces of the stepped selector and detent spring to remove any foreign material.
6. After thoroughly cleaning the components, wipe off the remaining cleaner with an absorbent towel.
7. Use of low pressure compressed air may be used to assist in drying the components and surrounding area. Using care not to spread the cleaner onto other interior components.

8. Verify the operation of the mechanical and electrical components after cleaning.
9. Install the interior trim panels. Refer to the appropriate interior trim procedures.
10. Thoroughly inspect the shift control, console area and carpet for left over cleaner. Remove excess cleaner, if necessary.

AUTOMATIC TRANSMISSION RANGE SELECTOR LEVER REPLACEMENT

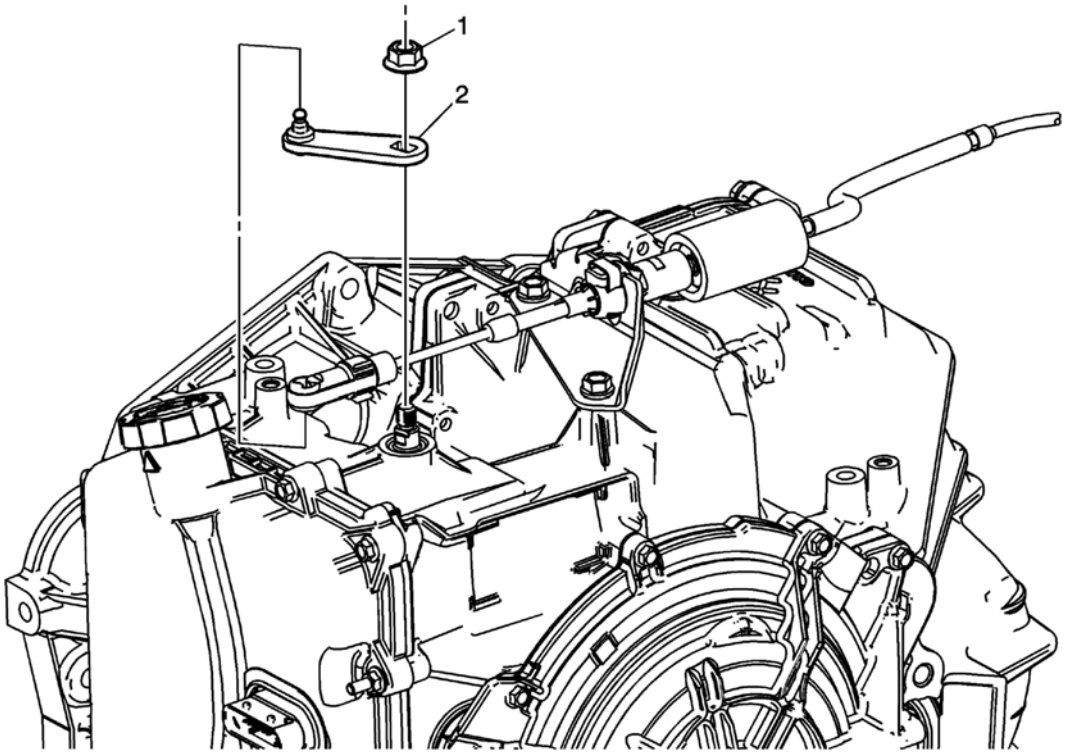


Fig. 9: Identifying A/T Range Selector Lever Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Set the park brake and chock the wheels. 2. Disconnect the range selector cable from the range selector lever.	
1	Transmission Range Selector Lever Nut **WARNING:** **Hold the transmission range selector lever while removing or installing the**

Callout	Component Name
	lever retaining nut. Failure to hold the lever can cause damage to the transmission internal park system components which could allow the vehicle to roll when placed in the park position. **CAUTION:** **Refer to Fastener Caution .** **Tighten** 20 N.m (15 lb ft)
2	Transmission Range Selector Lever

RANGE SELECTOR LEVER CABLE REPLACEMENT (COLUMN SHIFT)

Removal Procedure

1. Set the park brake and chock the wheels.
2. Remove the driver knee bolster reinforcement. Refer to **Driver Knee Bolster Reinforcement Replacement** .

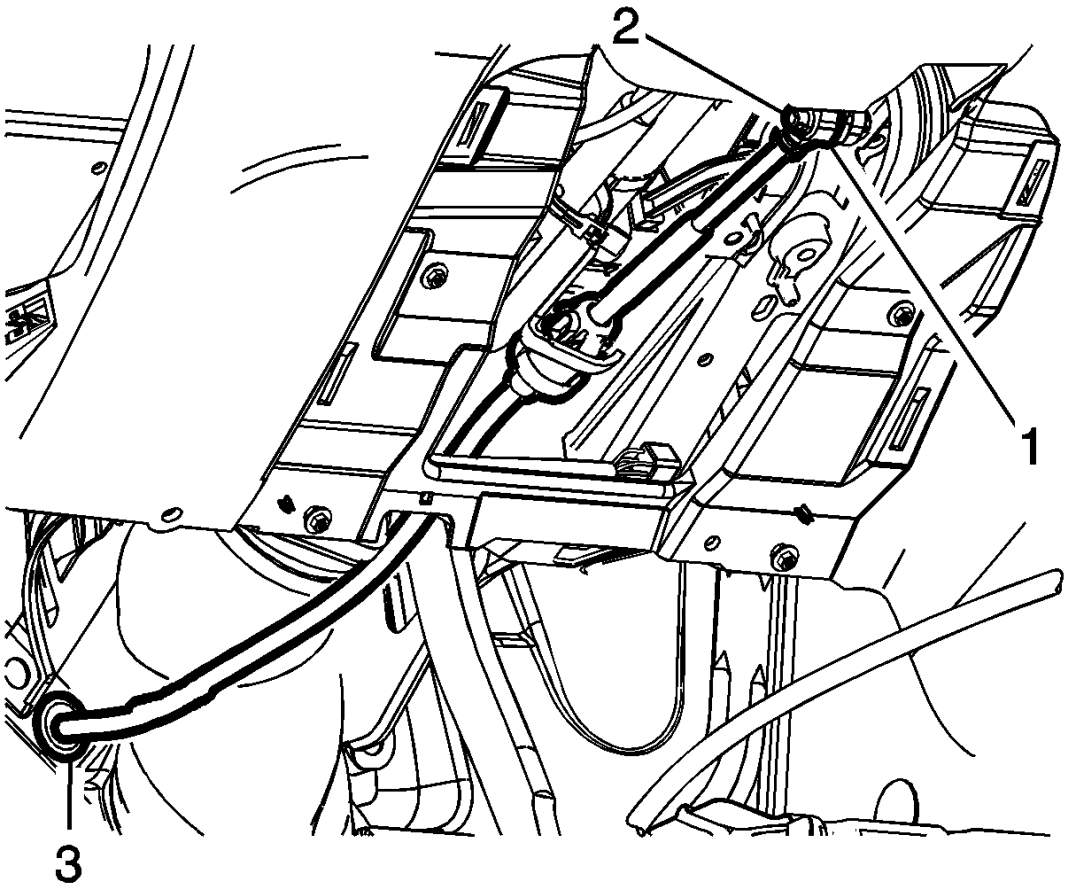


Fig. 10: Transmission Range Selector Lever Cable Terminal And Transmission Manual Shift Lever Pin

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect the transmission range selector lever cable terminal (1) from the transmission manual shift lever pin (2).

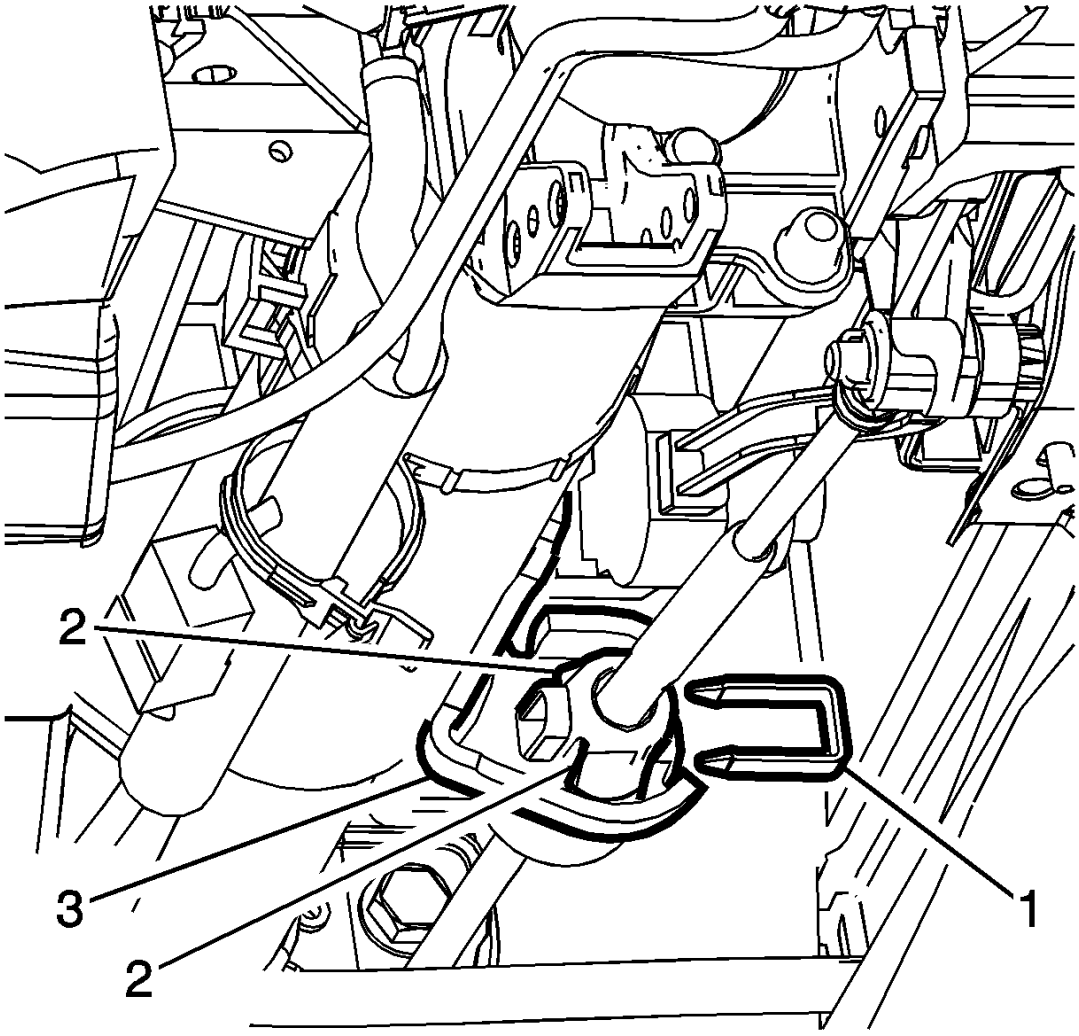


Fig. 11: Cable Interface Retainer, Steering Column Bracket And Range Selector Lever Cable Retaining Tabs
Courtesy of GENERAL MOTORS COMPANY

4. Remove the cable interface retainer (1) from the shift cable.
5. Press the range selector lever cable retaining tabs (2) inward.
6. Remove the range selector lever cable from the steering column bracket (3).
7. Remove the air cleaner assembly from the vehicle. Refer to **Air Cleaner Assembly Replacement** .

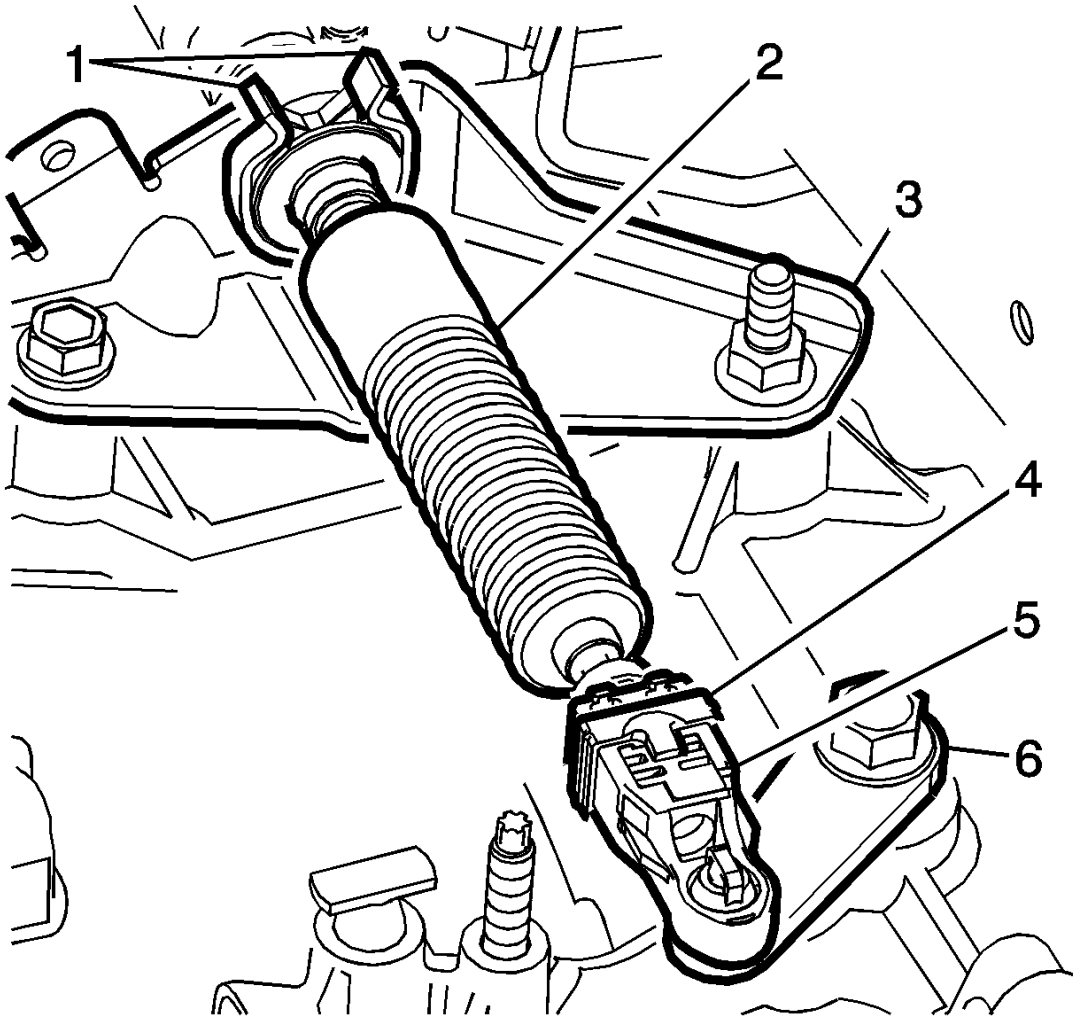


Fig. 12: Transmission Shifter Cable
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the range selector lever cable (2) from the transmission selector lever (6).
9. Press the locking tabs (1) inward in order to release the range selector lever cable (2) from the cable bracket (3).

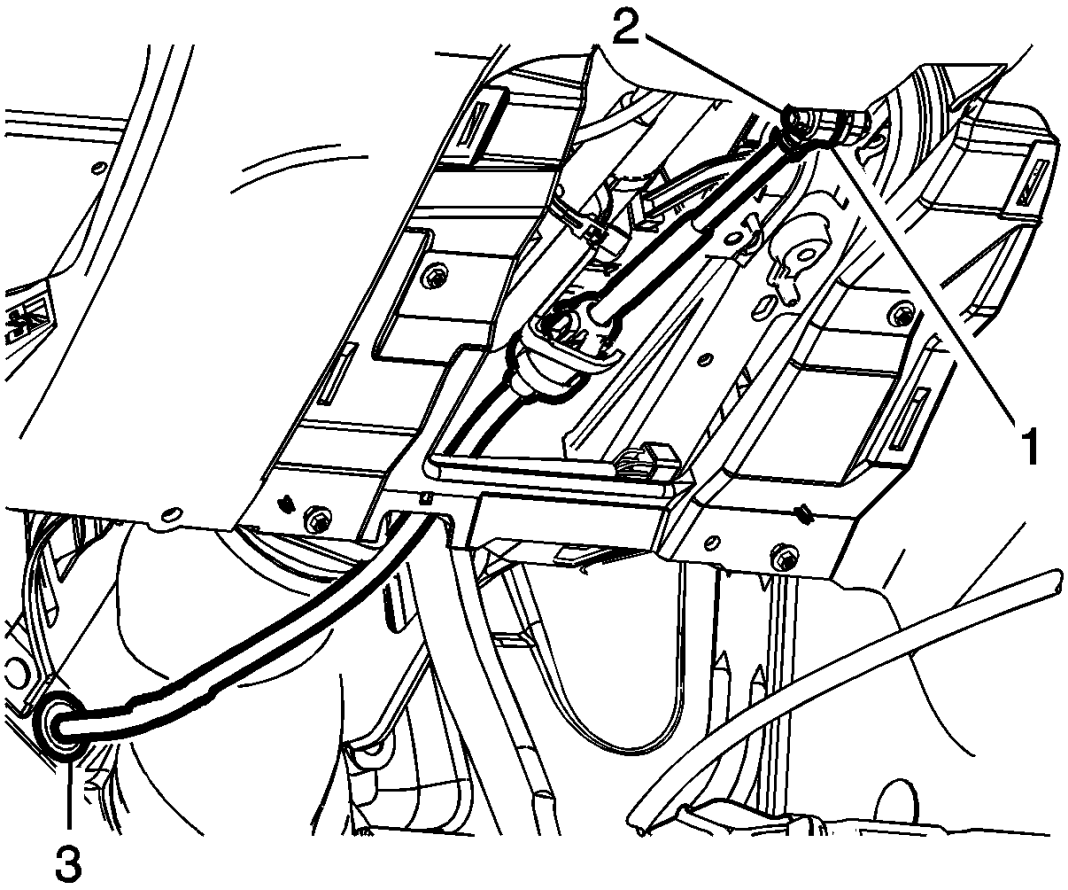


Fig. 13: Transmission Range Selector Lever Cable Terminal And Transmission Manual Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

10. Disengage the transmission range selector lever cable grommet (3) from the cowl panel.
11. Remove the transmission range selector lever cable from the vehicle.

Installation Procedure

1. Install the transmission range selector lever cable to the vehicle.

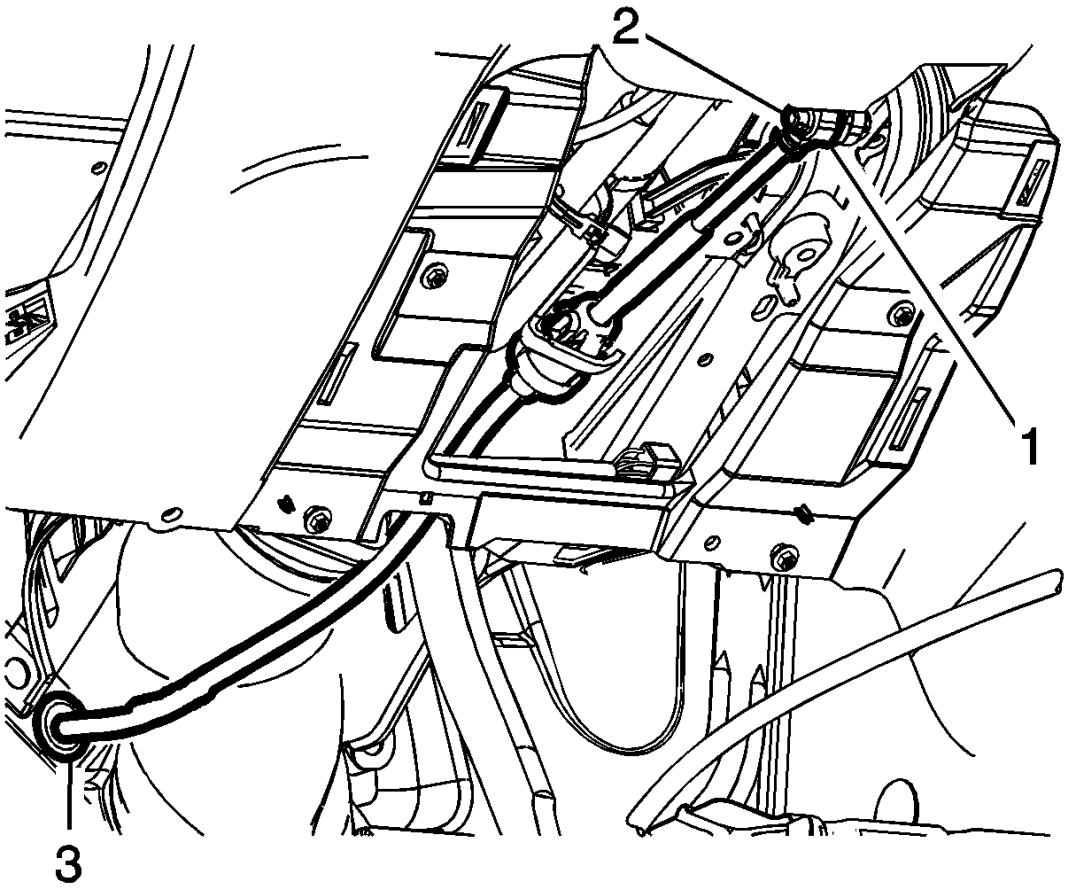


Fig. 14: Transmission Range Selector Lever Cable Terminal And Transmission Manual Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

2. Install the transmission range selector lever cable grommet (3) to the cowl panel.

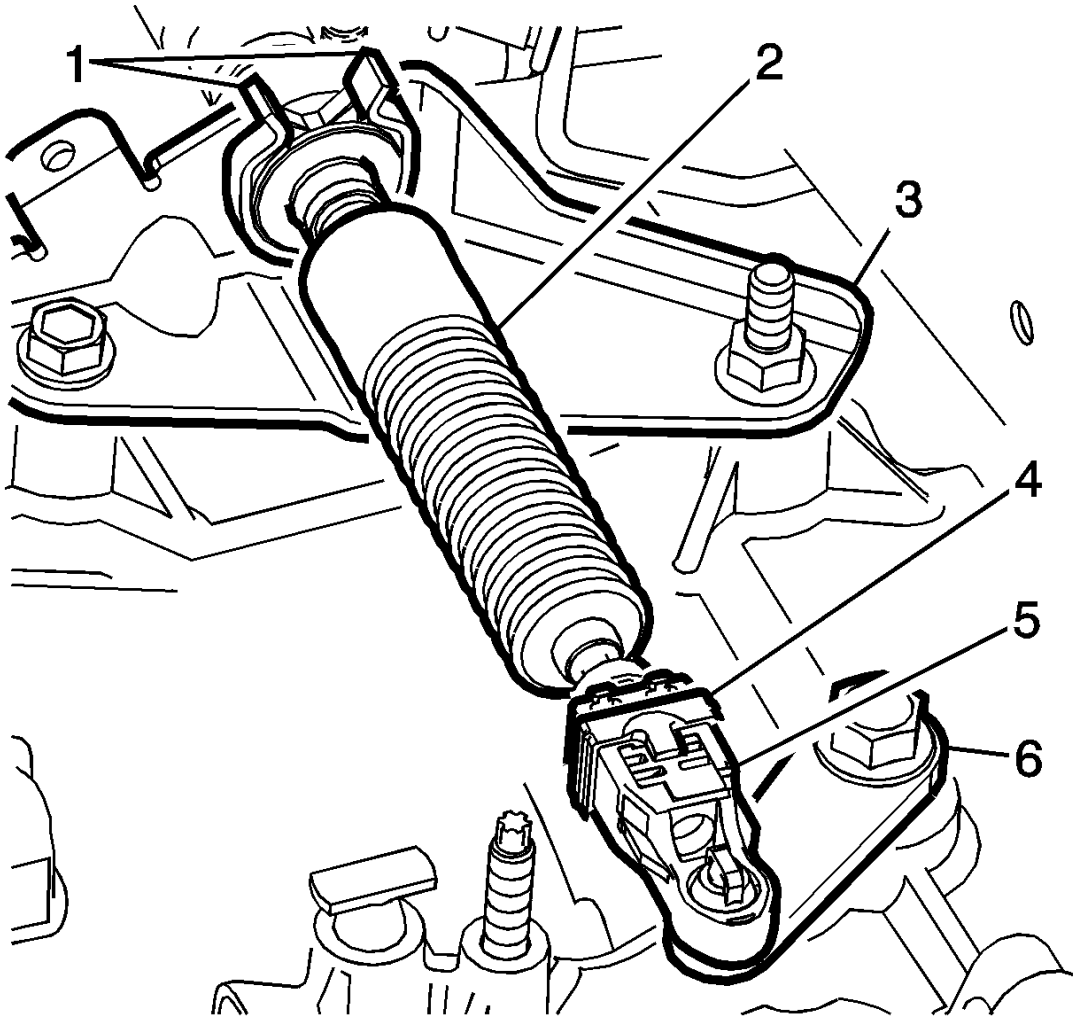


Fig. 15: Transmission Shifter Cable
Courtesy of GENERAL MOTORS COMPANY

3. Connect the range selector lever cable (2) to the transmission selector lever (6).

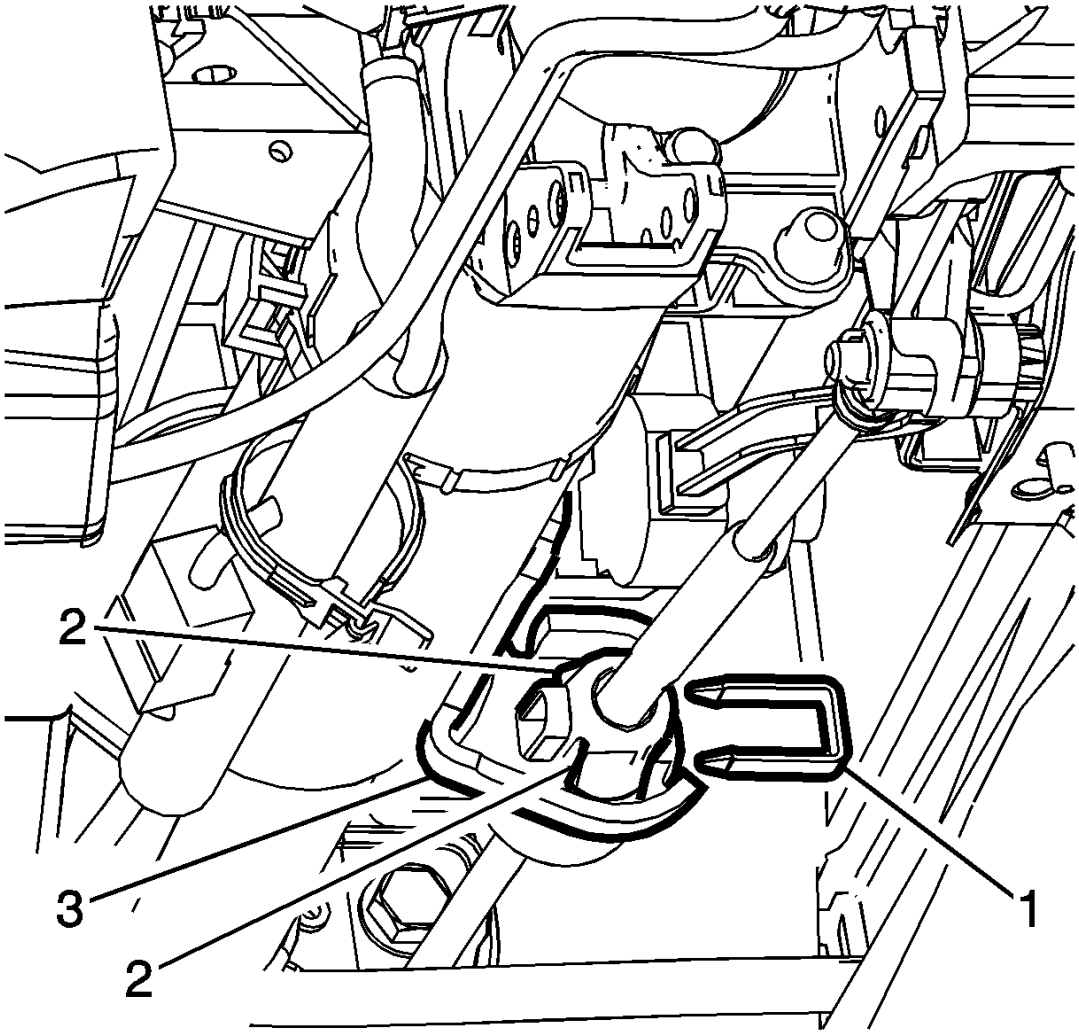


Fig. 16: Cable Interface Retainer, Steering Column Bracket And Range Selector Lever Cable Retaining Tabs
Courtesy of GENERAL MOTORS COMPANY

4. Press the locking tabs (1) inward, then insert the range selector lever cable (2) into the cable bracket (3).
5. Install the range selector lever cable into the steering column bracket (3).
6. Install the cable interface retainer (1) into the range selector lever cable.

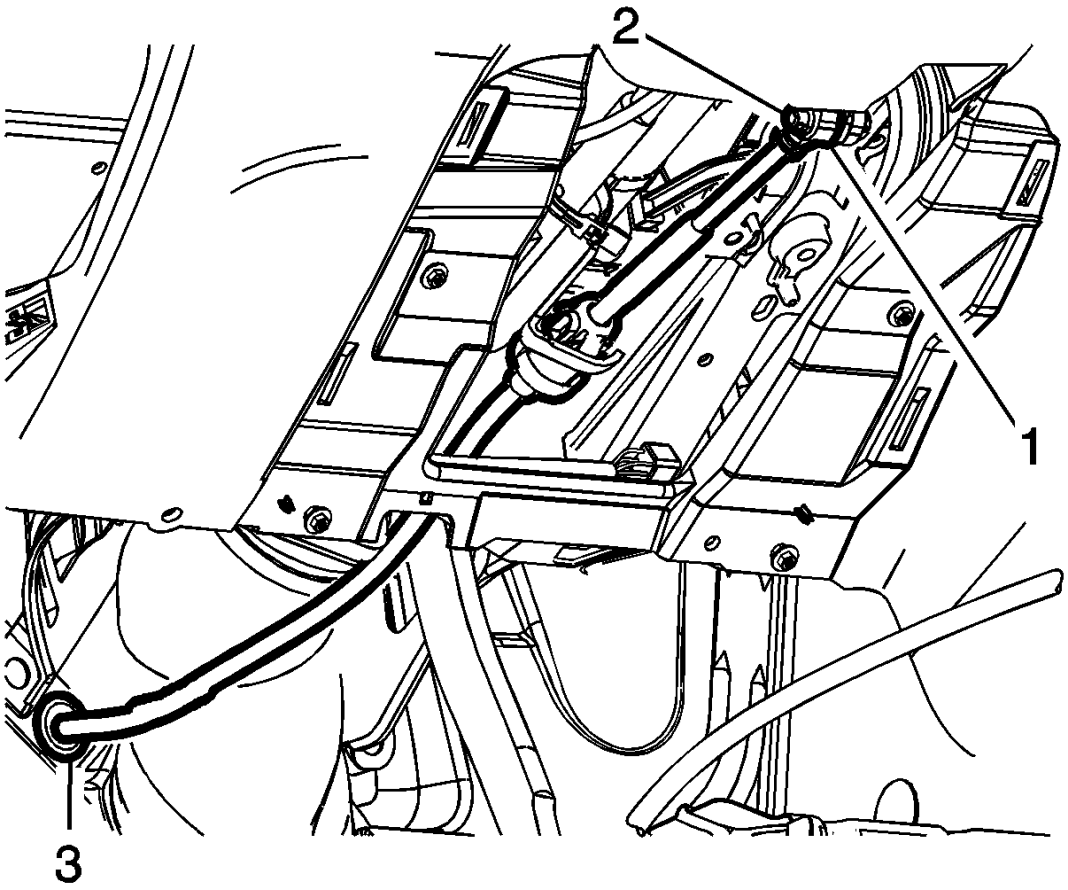


Fig. 17: Transmission Range Selector Lever Cable Terminal And Transmission Manual Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

7. Connect the transmission range selector lever cable terminal (1) to the transmission manual shift lever pin (2).
8. Install the driver knee bolster reinforcement. Refer to **Driver Knee Bolster Reinforcement Replacement** .
9. Adjust the range selector lever cable. Refer to **Range Selector Lever Cable Adjustment**.
10. Install the air cleaner assembly in the vehicle. Refer to **Air Cleaner Assembly Replacement** .

RANGE SELECTOR LEVER CABLE REPLACEMENT (FLOOR SHIFT)

Removal Procedure

WARNING: Refer to Automatic Transmission Range Selector Cable Warning .

1. Remove the air cleaner assembly from the vehicle. Refer to **Air Cleaner Assembly Replacement** .

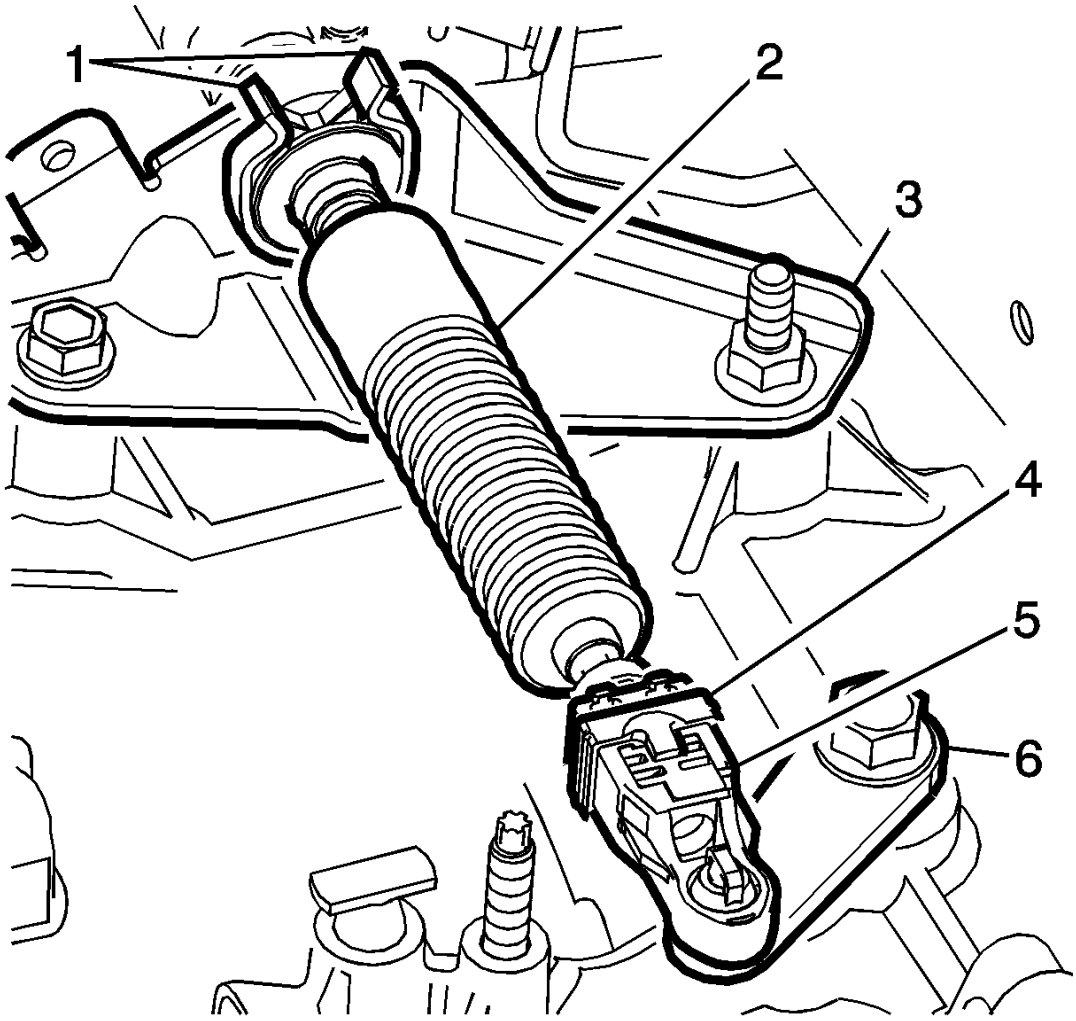


Fig. 18: Transmission Shifter Cable
Courtesy of GENERAL MOTORS COMPANY

2. Remove the automatic transaxle range selector cable (2) from the automatic transaxle range selector lever (6).
3. Press the locking tabs (1) inward in order to release the range selector lever cable (2) from the cable bracket (3).
4. Remove the automatic transaxle range selector cable (2) from the automatic transaxle range selector cable bracket (3).
5. Remove the front floor console. Refer to **Front Floor Console Replacement** .
6. Pull the carpet back to expose the automatic transaxle range selector cable. Refer to **Floor Panel Carpet Replacement (Impala)** .

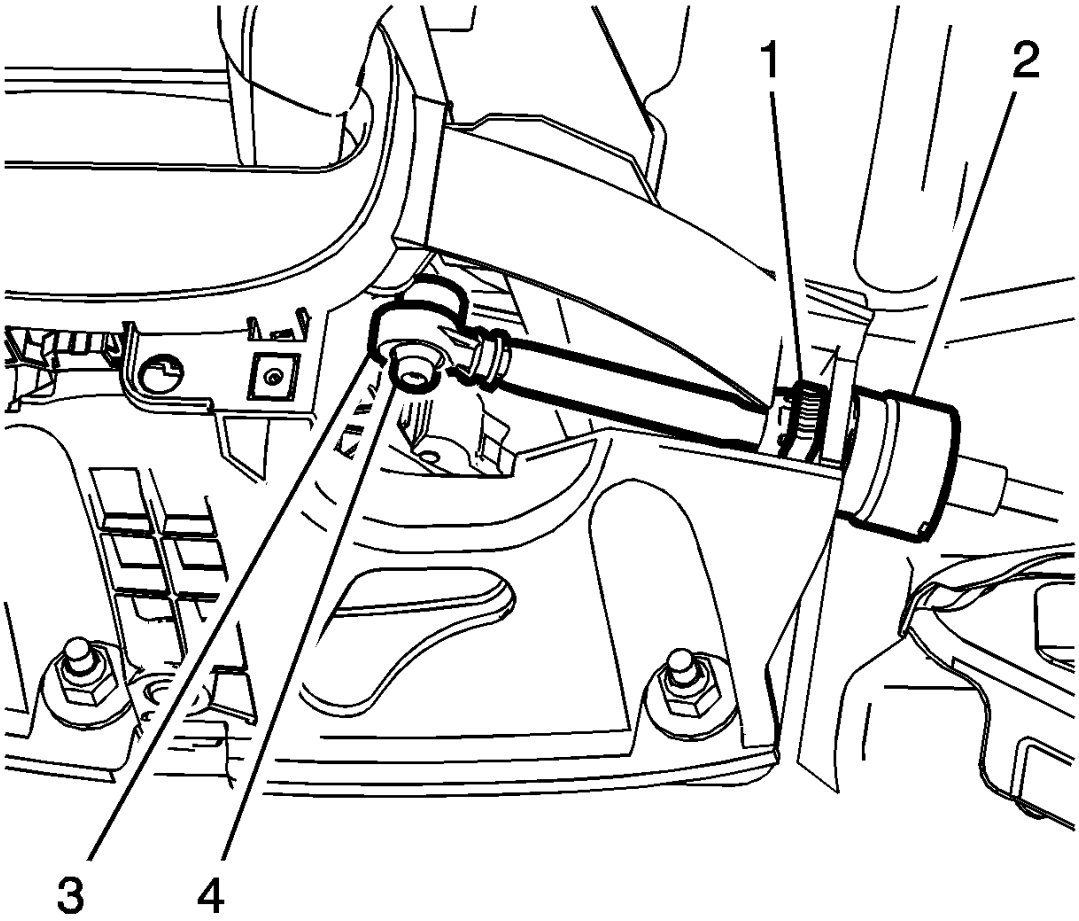


Fig. 19: Automatic Transaxle Range Selector Cable, Retainer, Terminal And Transmission Control Shift Lever Pin

Courtesy of GENERAL MOTORS COMPANY

7. Remove the automatic transaxle range selector cable retainer (1) from the Transmission control assembly.
8. Disconnect the cable terminal (3) from the transmission control shift lever pin (4).
9. Remove the automatic transaxle range selector cable (2) from the console shift control.
10. Install a piece of mechanics wire to the end of the automatic transmission range selector cable.

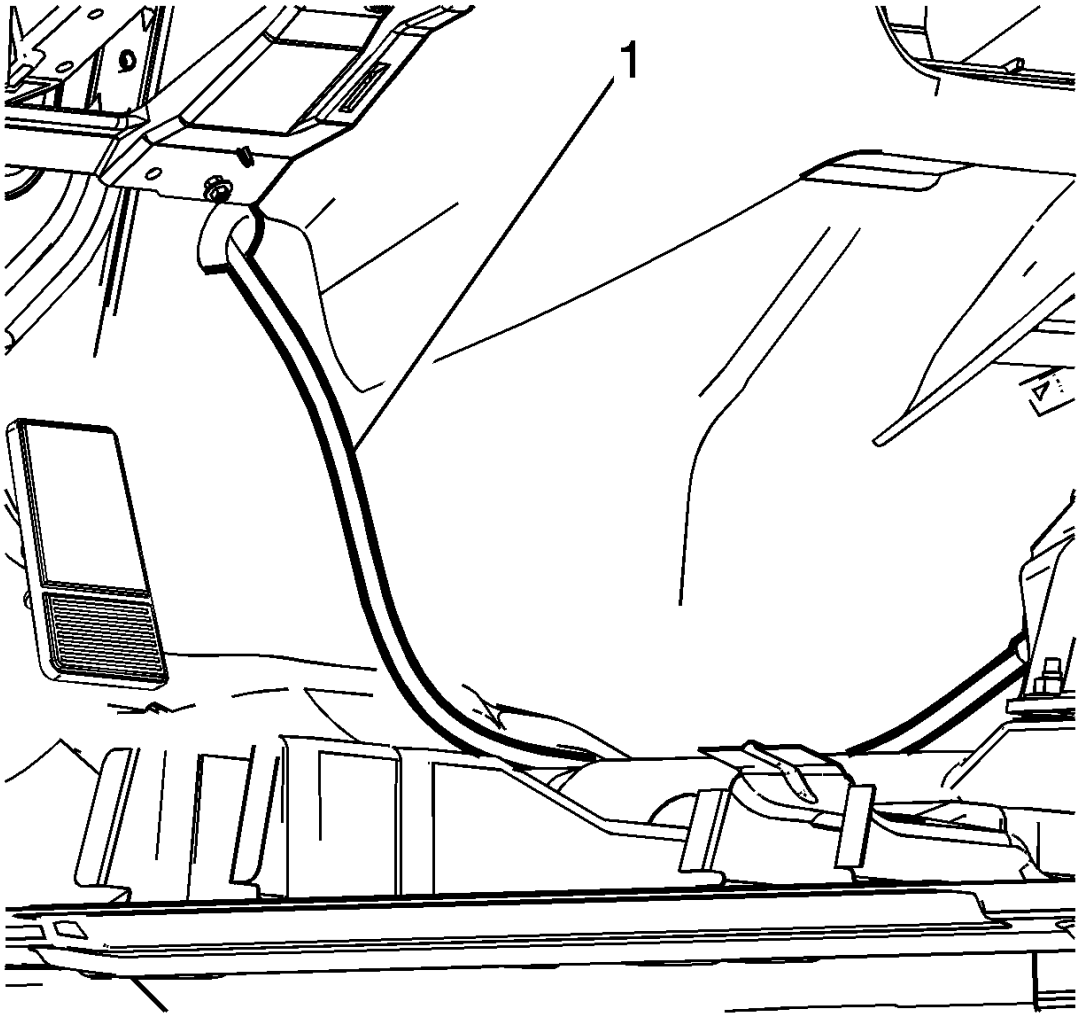


Fig. 20: Automatic Transmission Range Selector Cable And Grommet
Courtesy of GENERAL MOTORS COMPANY

11. Remove the automatic transmission range selector cable and grommet (1) through the hole in the cowl.

Installation Procedure

WARNING: Refer to Automatic Transmission Range Selector Cable Warning .

1. Install the automatic transmission range selector cable through the hole in the cowl.

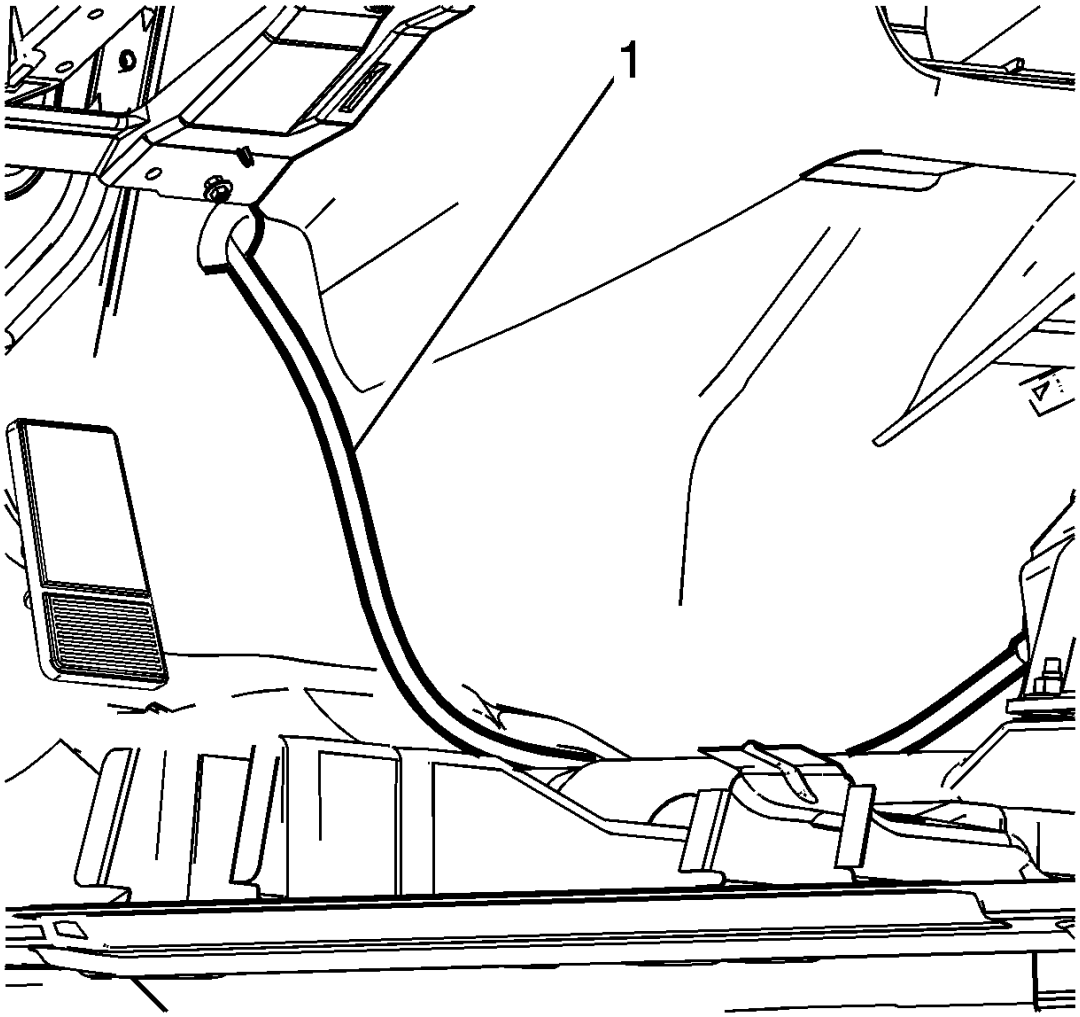


Fig. 21: Automatic Transmission Range Selector Cable And Grommet
Courtesy of GENERAL MOTORS COMPANY

2. Seat the grommet (1) in the cowl.
3. Remove the mechanics wire from the end of the automatic transmission range selector cable.

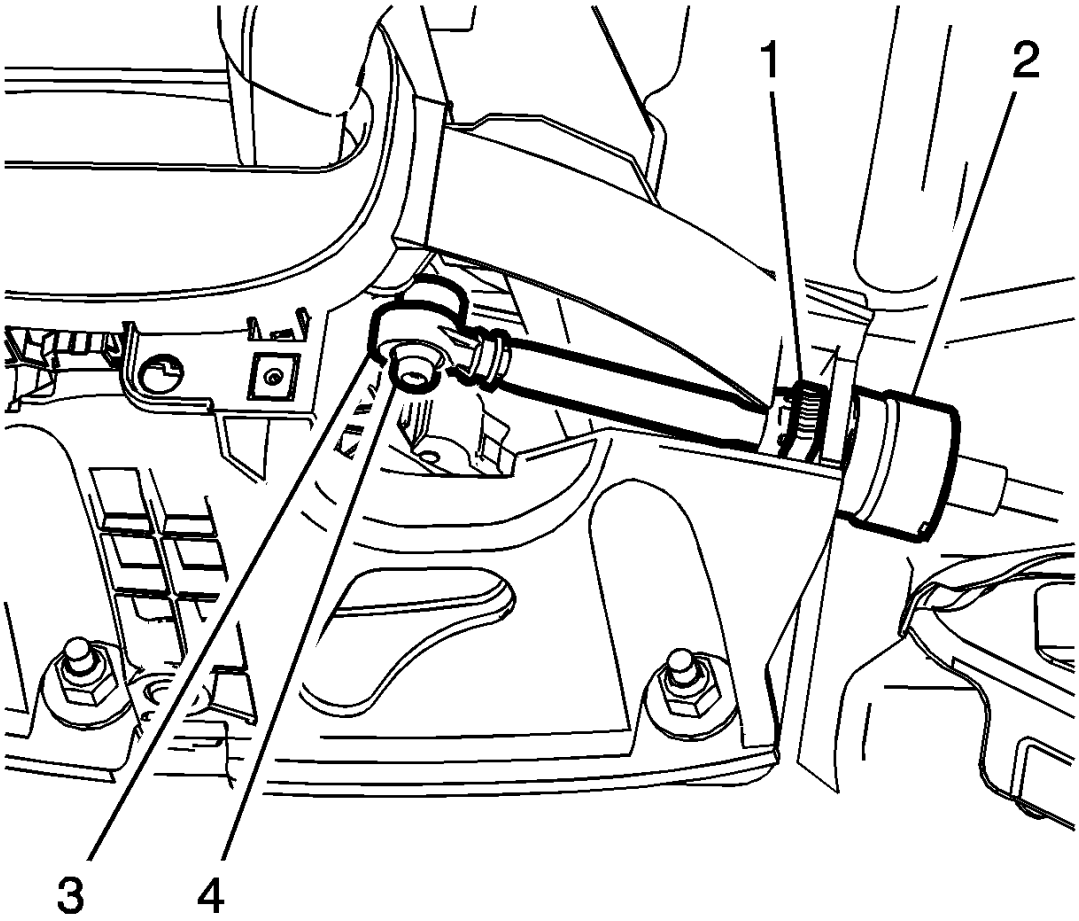


Fig. 22: Automatic Transaxle Range Selector Cable, Retainer, Terminal And Transmission Control Shift Lever Pin
Courtesy of GENERAL MOTORS COMPANY

4. install the automatic transaxle range selector cable (2) to the transmission control assembly.
5. Install the automatic transaxle range selector cable terminal (3) to the transmission control shift lever pin (4).
6. Install the automatic transaxle range selector cable retainer (1) to the console shift control.
7. Install the carpet into position. Refer to **Floor Panel Carpet Replacement (Impala)** .
8. Install the front floor console. Refer to **Front Floor Console Replacement** .
9. Properly route and position the automatic transmission range selector cable in the engine compartment.

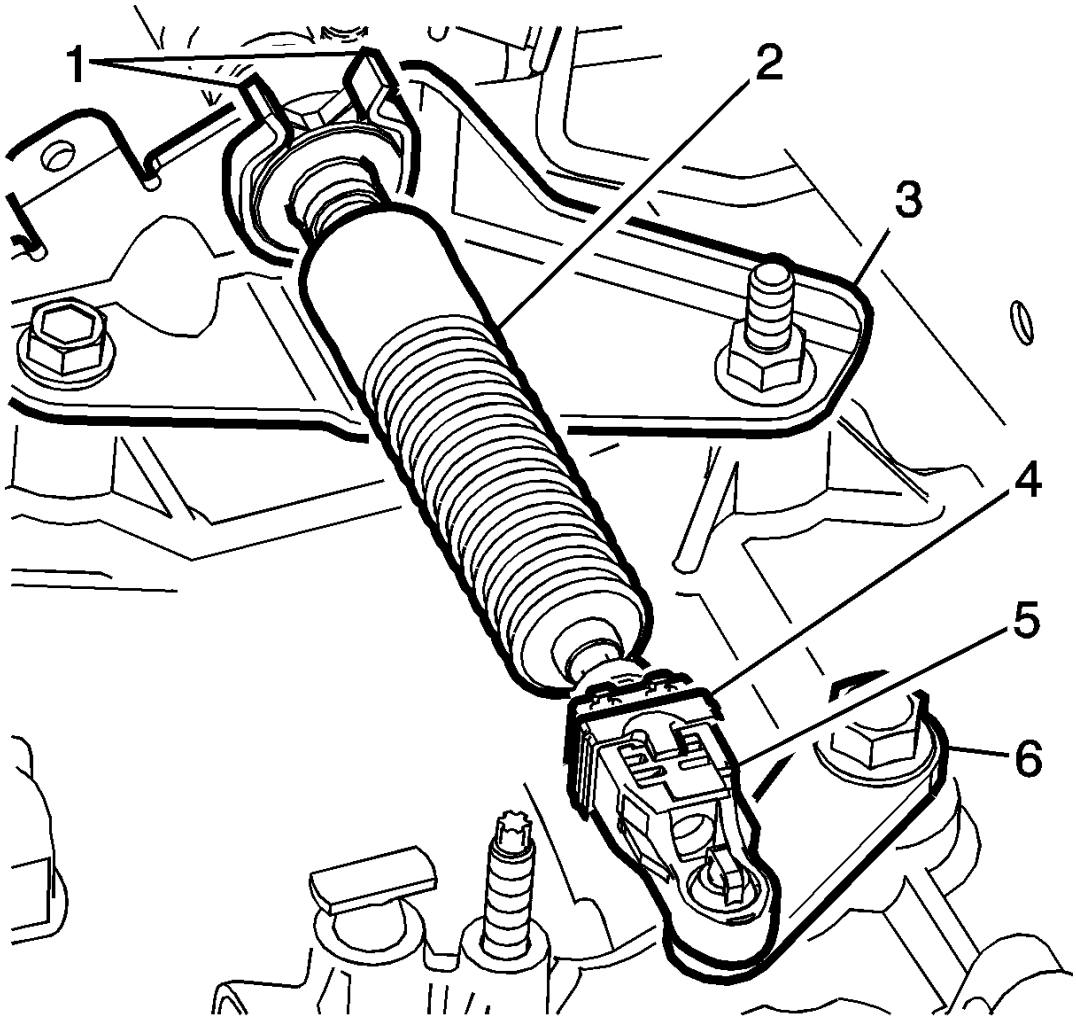


Fig. 23: Transmission Shifter Cable
Courtesy of GENERAL MOTORS COMPANY

10. Install the automatic transaxle range selector cable (2) to the automatic transaxle range selector cable bracket (3).
11. Install the automatic transaxle range selector cable (2) to the automatic transaxle range selector lever (6).
12. Adjust the automatic transaxle range selector cable. Refer to **Range Selector Lever Cable Adjustment**.
13. Install the air cleaner assembly in the vehicle. Refer to **Air Cleaner Assembly Replacement** .

RANGE SELECTOR LEVER CABLE ADJUSTMENT

1. Remove the air cleaner assembly from the vehicle. Refer to **Air Cleaner Assembly Replacement** .

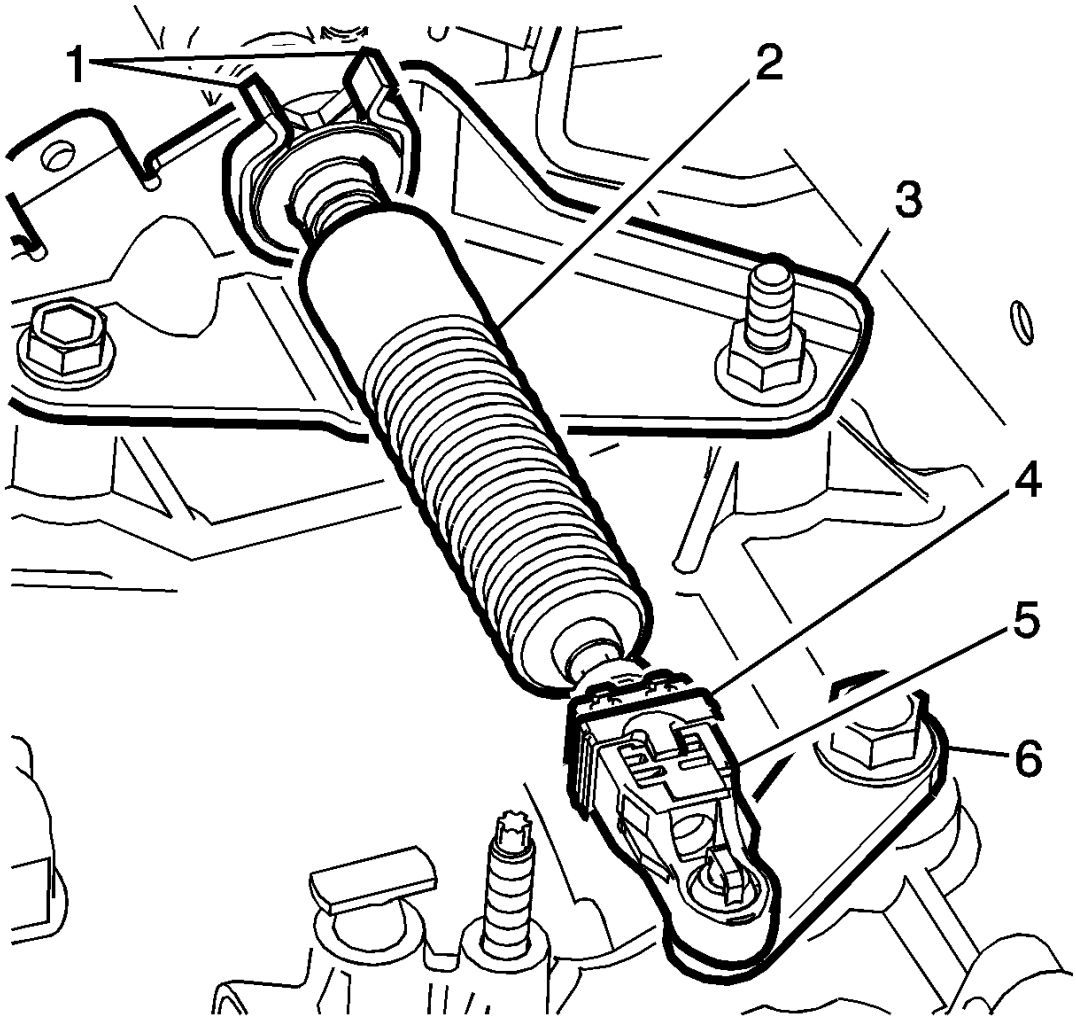


Fig. 24: Transmission Shifter Cable
Courtesy of GENERAL MOTORS COMPANY

2. Pull the secondary adjuster lock (4) rearward.
3. Using a flat bladed tool, push the primary adjuster lock (5) upward.
4. Ensure that the shift lever and the transmission control are in the Park position.
5. Press the primary adjuster lock (5) downward in order to lock the range selector lever cable.
6. Push the secondary adjuster lock (4) forward to lock in the primary adjuster lock.
7. Verify the proper operation of the transmission.
8. Install the air cleaner assembly in the vehicle. Refer to **Air Cleaner Assembly Replacement** .

RANGE SELECTOR LEVER CABLE BRACKET REPLACEMENT

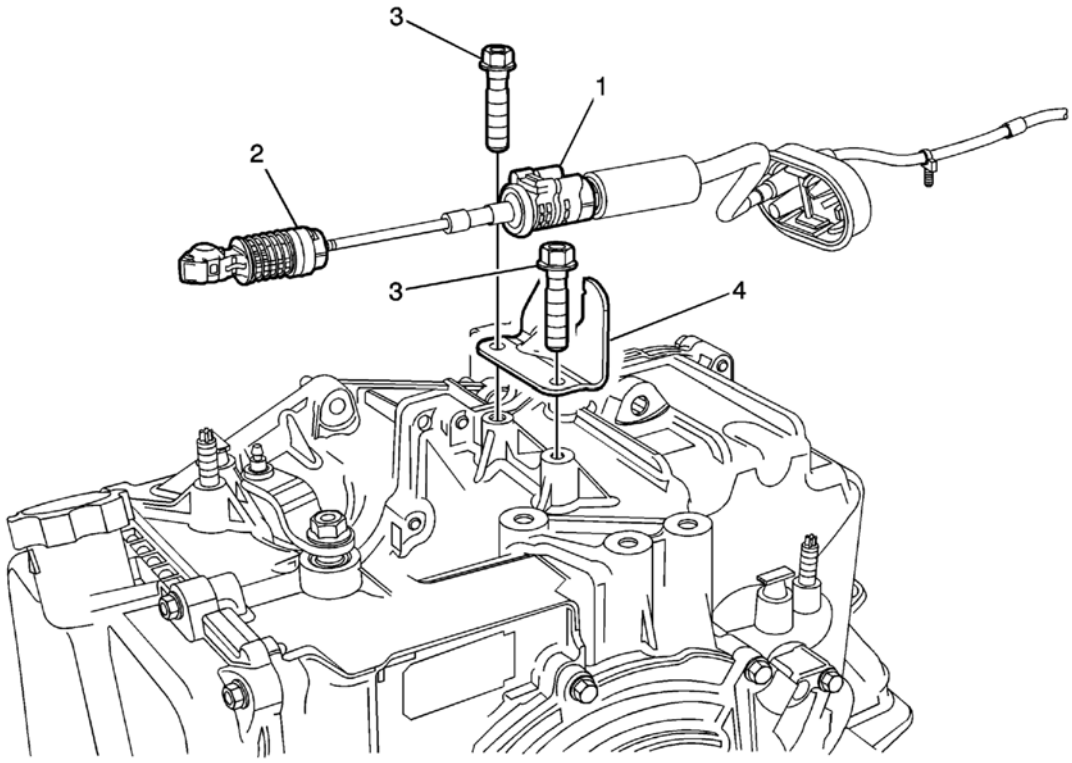


Fig. 25: Range Selector Lever Cable Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Set the park brake and chock the wheels. 2. Remove the battery tray. Refer to **Battery Tray Replacement** .	
1	Transmission Range Selector Lever Cable Retaining Lock
2	Transmission Range Selector Lever Cable
3	Transmission Range Selector Lever Cable Bracket Bolt (Qty: 2) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 25 N.m (18 lb ft)
4	Transmission Range Selector Lever Cable Bracket **Procedure** Adjust the cable. Refer to **Range Selector Lever Cable Adjustment**.

TRANSMISSION FLUID DRAIN AND FILL

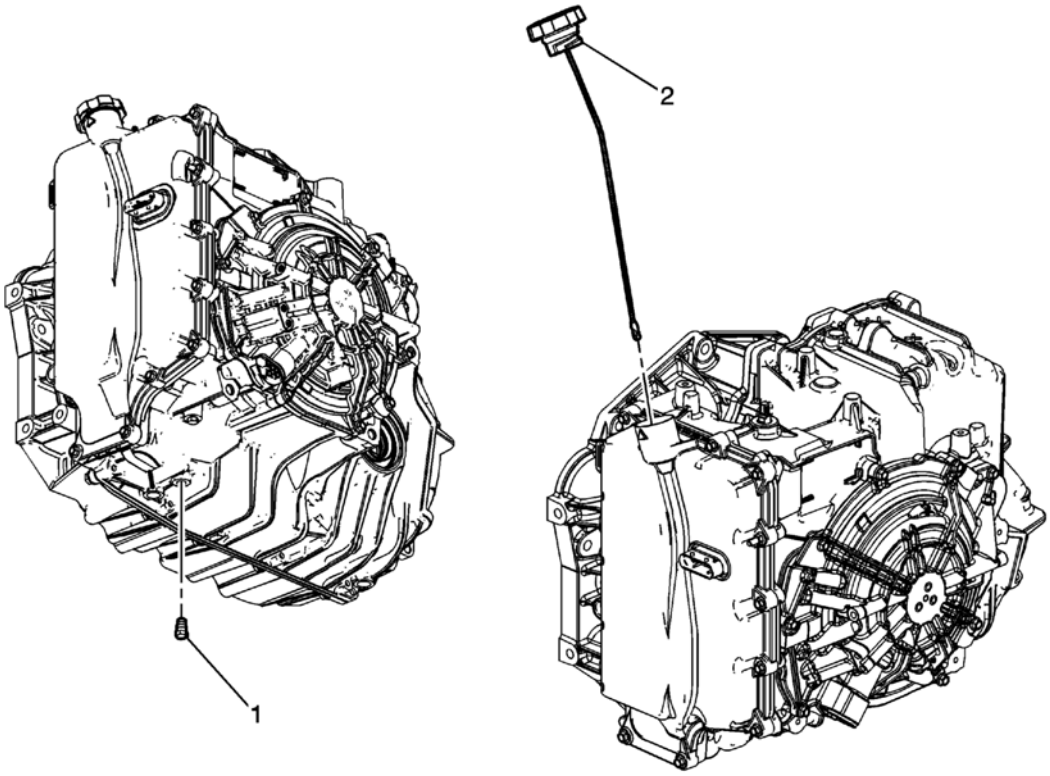


Fig. 26: Identifying Fluid Level Indicator & Drain Plug
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Fluid Drain Plug **CAUTION:** **Refer to Fastener Caution .** **TIP:** Place a drain pan capable of containing more than 5 quarts of fluid under the transmission before removing the plug to drain the fluid. **Tighten** 12 N.m (106 lb in)
2	Fluid Level Indicator • Transmission will require approximately 5 quarts of fluid. • Fill the transmission with fluid. Refer to **Transmission Fluid Level and Condition Check** .

AUTOMATIC TRANSMISSION FLUID PRESSURE TEST HOLE PLUG REPLACEMENT

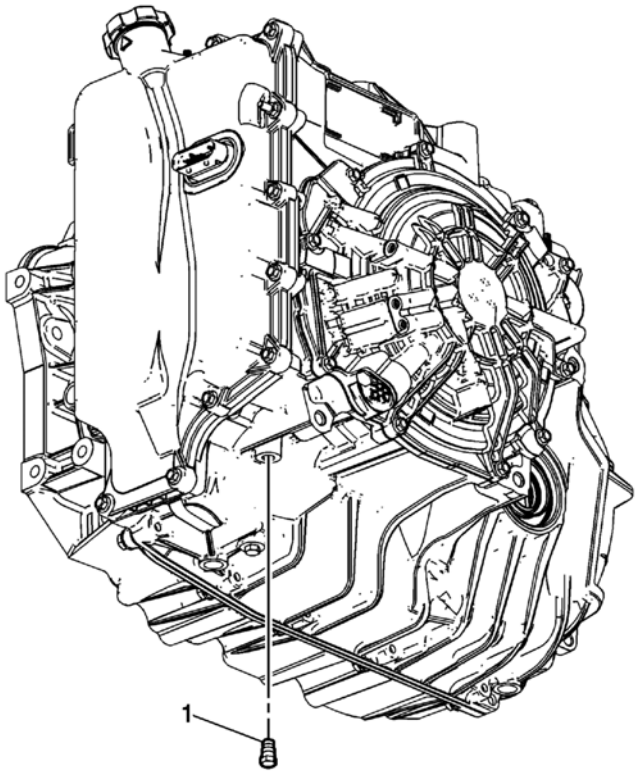


Fig. 27: Identifying Automatic Transmission Fluid Pressure Test Hole Plug
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Fluid Pressure Test Plug **CAUTION:** **Refer to** **Fastener** **Caution** **.** **Tighten** 12 N.m (106 lb in)

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - LEFT SIDE

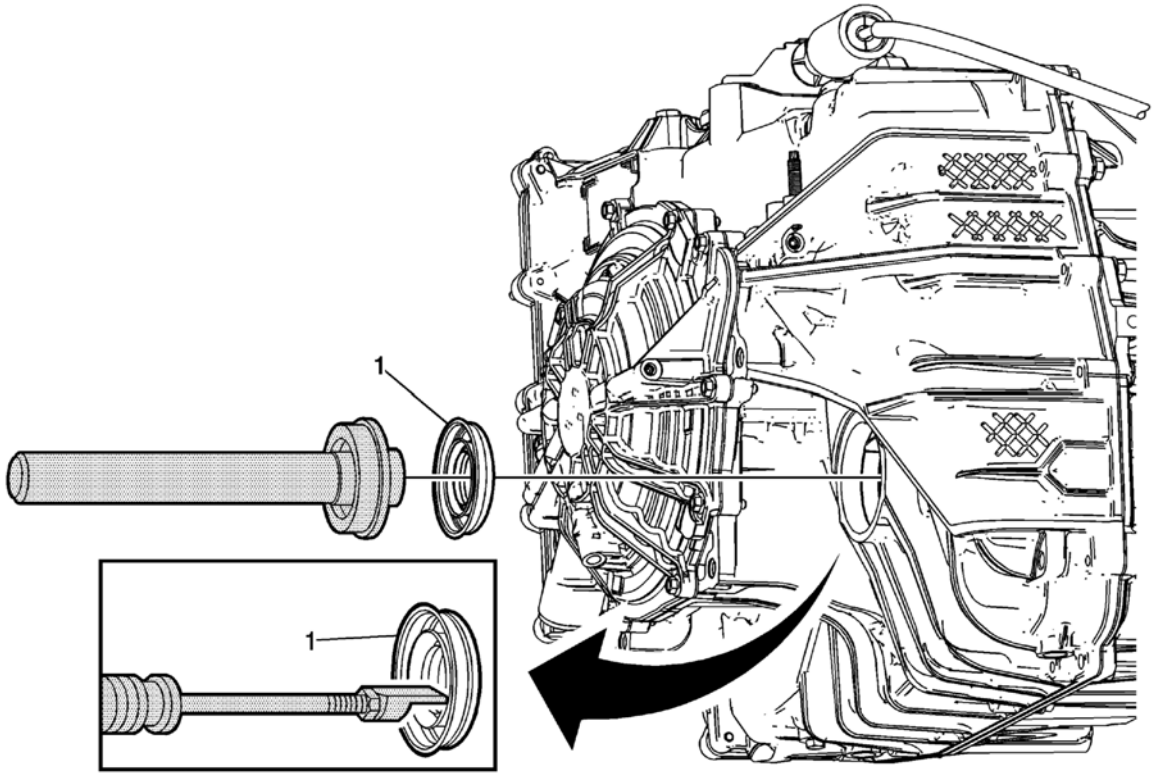


Fig. 28: View Of Front Wheel Drive Shaft Oil Seal - Left Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the left wheel drive shaft. Refer to **Wheel Drive Shaft Replacement (Left Side)** **Wheel Drive Shaft Replacement (Right Side)** .	
1	Left Front Wheel Drive Shaft Oil Seal • For seal removal use **GE-6125-1B** hammer with **DT-23129** remover. • For seal installation use **DT-8092** handle with **J-46629-A** installer. **Special Tools** • **GE-6125-1B** Slide Hammer • **DT-23129** Universal Seal Remover • **DT-8092** Driver Handle • **J-46629-A** Axle Seal Installer

FRONT WHEEL DRIVE SHAFT SEAL REPLACEMENT - RIGHT SIDE

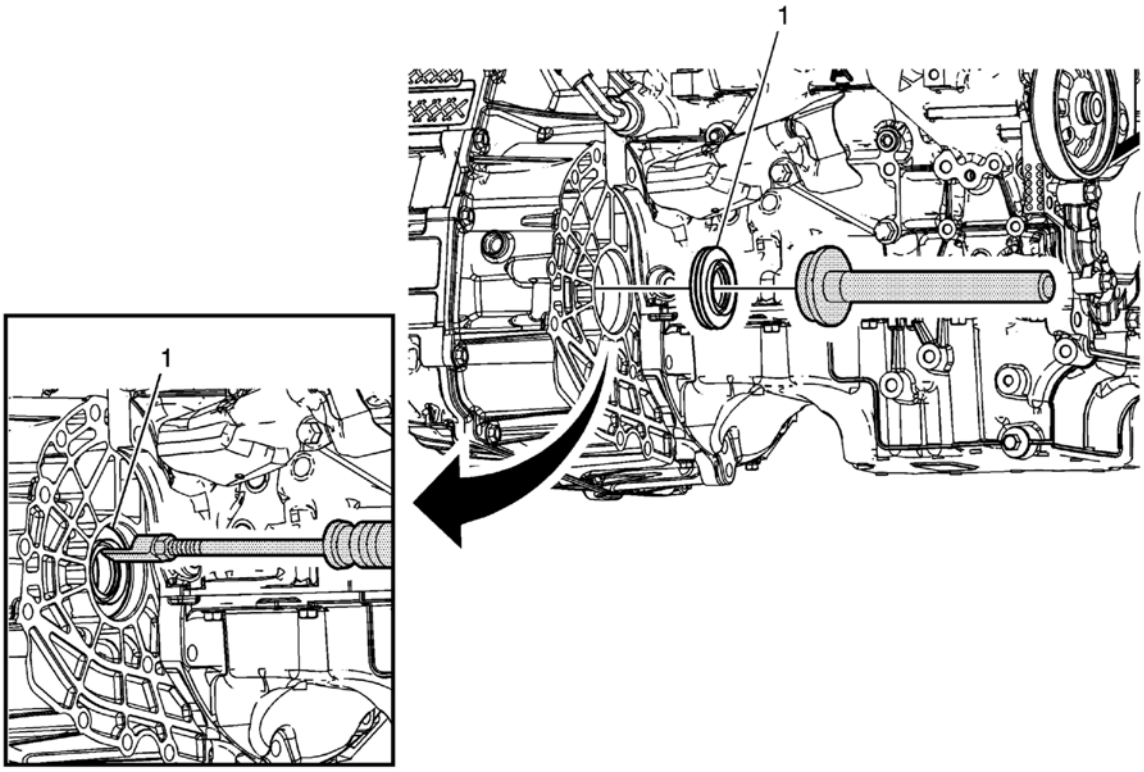


Fig. 29: Identifying Front Wheel Drive Shaft Oil Seal - Right Side
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Front wheel drive models, remove the intermediate drive shaft. Refer to **Front Wheel Drive Intermediate Shaft Replacement** .	
1	Right Front Wheel Drive Shaft Oil Seal • For seal removal use **GE-6125-1B** hammer with **DT-23129** remover Universal Seal Remover. • For seal installation use **DT-8092** handle with **DT-46629-A** installer. **Special Tools** • **GE-6125-1B** Slide Hammer • **DT-8092** Driver Handle • **DT-23129** Universal Seal Remover • **DT-46629-A** Axle Seal Installer For equivalent regional tools, refer to **Special Tools** .

MANUAL SHIFT SHAFT AND SEAL REPLACEMENT

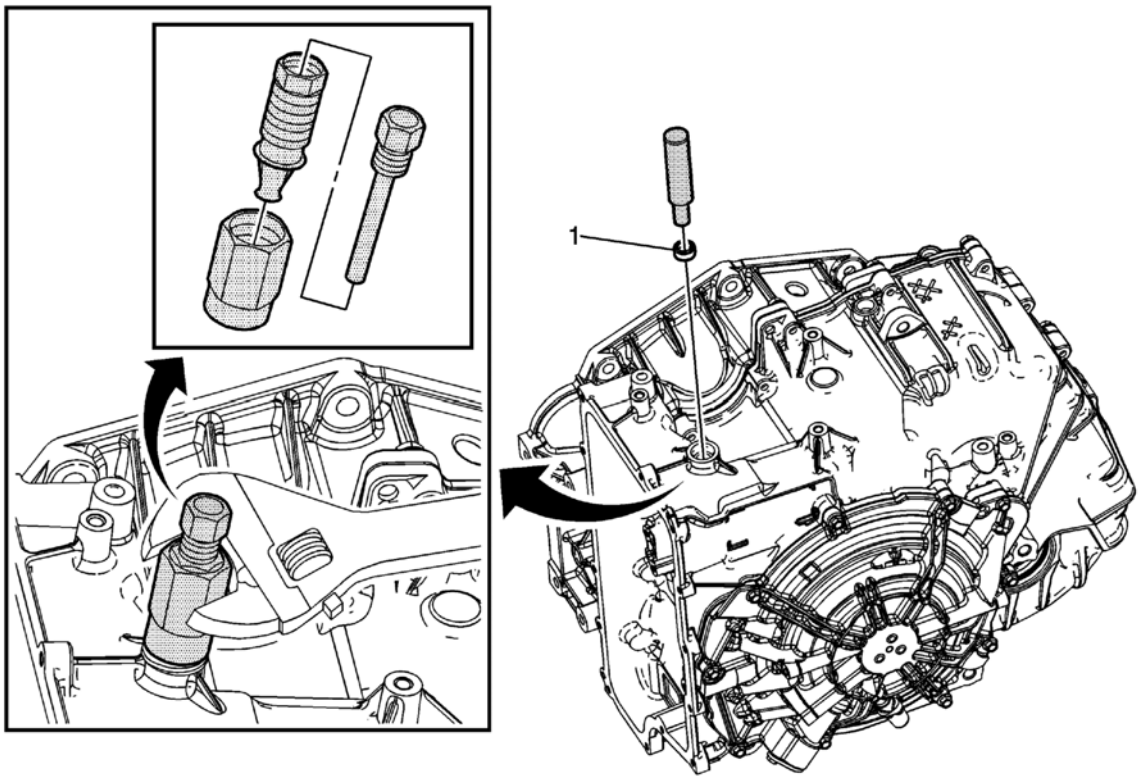


Fig. 30: Identifying Manual Shift Shaft & Seal
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the battery tray. Refer to **Battery Tray Replacement** . 2. Remove the manual shaft and position switch assembly. Refer to **Manual Shift Detent Lever with Shaft Position Switch Assembly Replacement**.	
1	Manual Shift Shaft Seal • For seal removal use **DT-45201** Manual Shaft Seal Remover. • For seal installation use **DT-46626** Manual Shift Shaft Seal Installer. • Lubricate the manual shaft with automatic transmission fluid (ATF) to prevent damage to the manual shift shaft seal. **Special Tools** • **DT-45201** Manual Shaft Seal Remover • **DT-46626** Manual Shift Shaft Seal Installer

CONTROL VALVE BODY COVER REPLACEMENT

Removal Procedure

1. Remove the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
2. Drain the transmission. Refer to **Transmission Fluid Drain and Fill**.

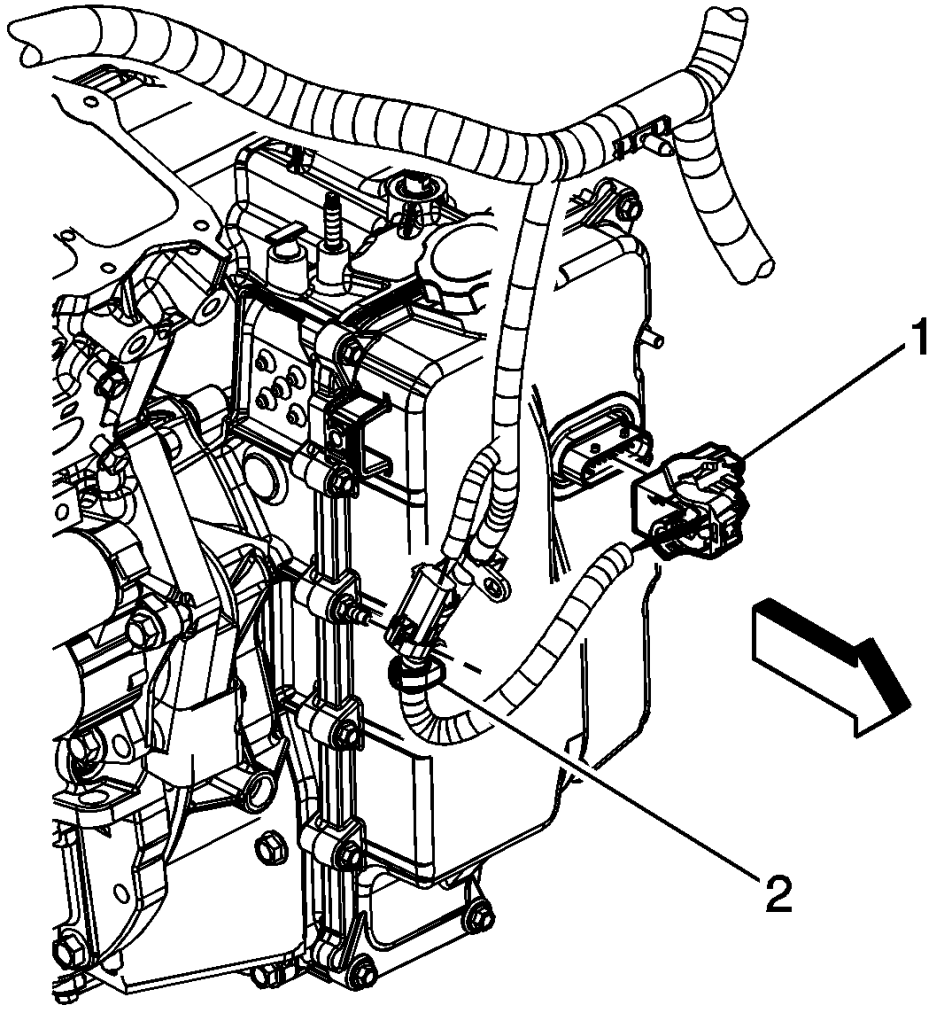


Fig. 31: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Remove the wire harness retainer (2) from the control valve body cover stud.
4. Disconnect the control valve body transmission control module (TCM) electrical connector (1).

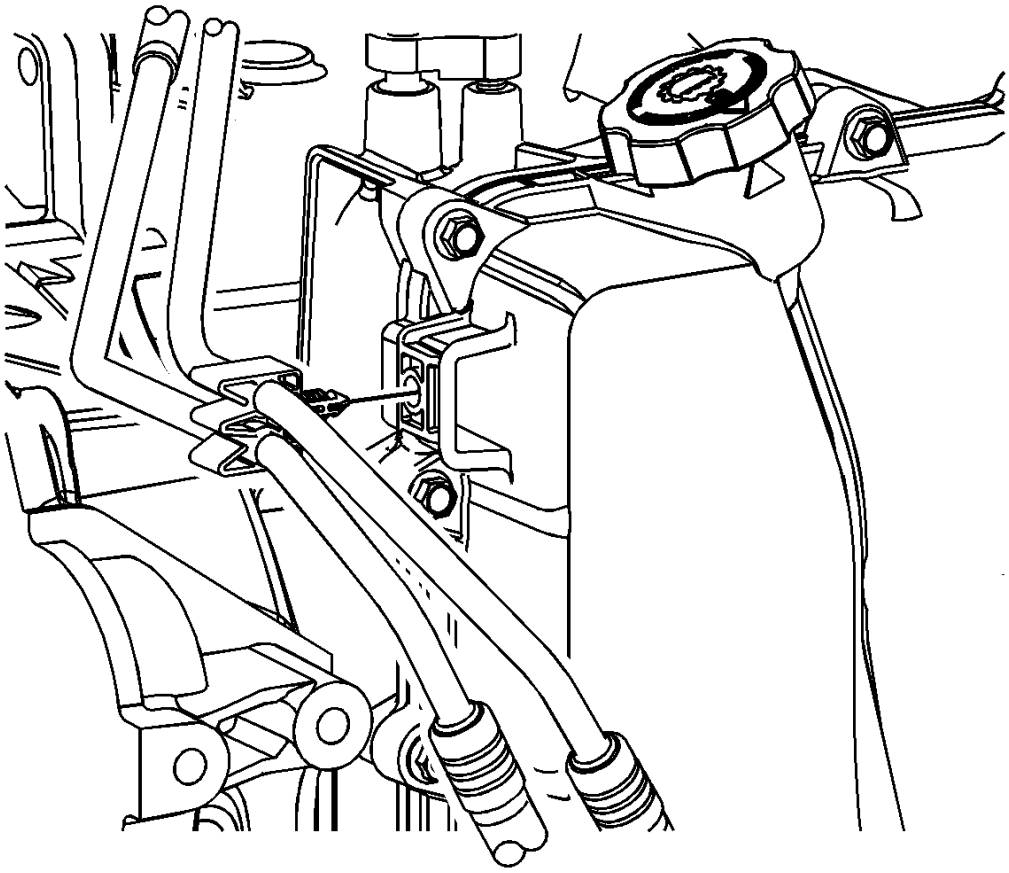


Fig. 32: Identifying Oil Cooler Inlet And Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

5. Remove the oil cooler inlet and outlet hoses from the retainer on the control valve body cover.

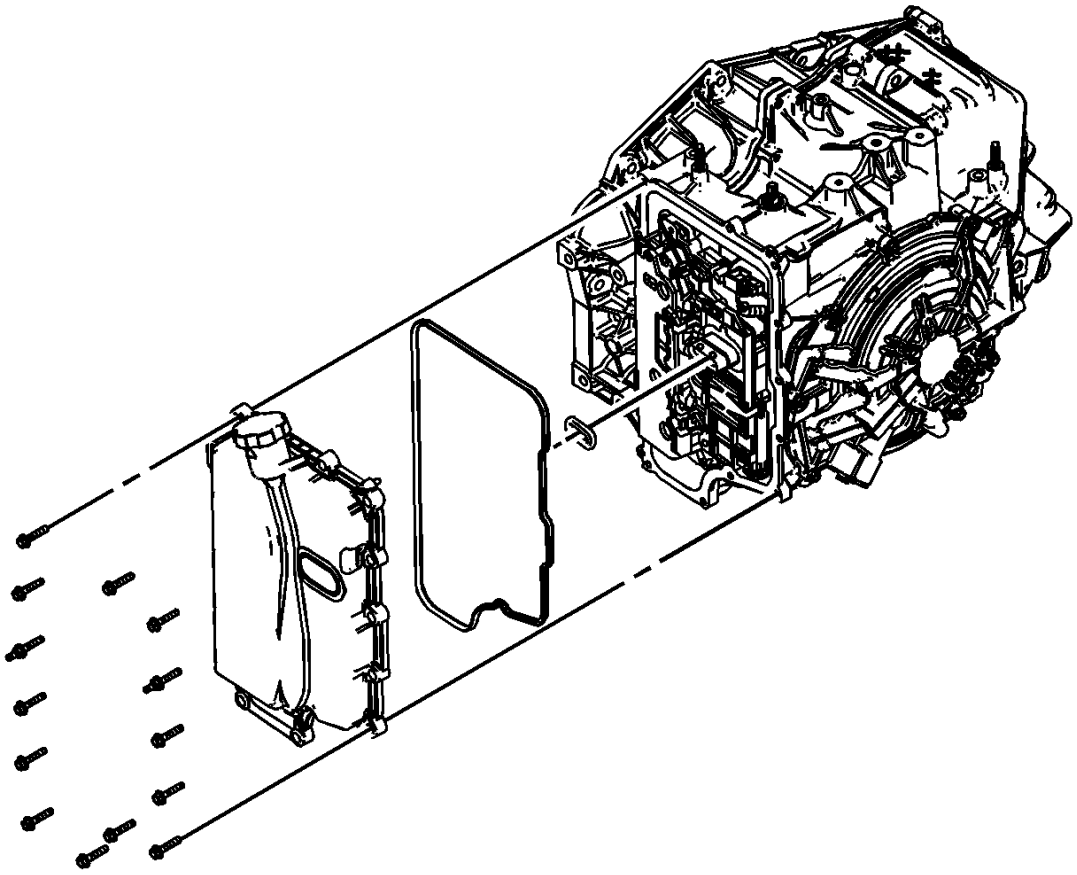


Fig. 33: Identifying Control Valve Body Cover Studs & Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the 2 control valve body cover studs M6 x 30.
7. Remove the 9 lower control valve body cover bolts M6 x 30.
8. Lower the vehicle.
9. Disconnect the transmission wire harness retainer from the bracket on top of the transmission.
10. Remove the top 3 control valve body cover bolts M6 x 30.
11. Remove the control valve body cover.
12. Remove the control valve body cover gasket.
13. Remove the control valve body cover wiring connector hole seal.
14. Remove all traces of the old gasket material. Clean the transmission case and control valve body cover gasket surfaces.

Installation Procedure

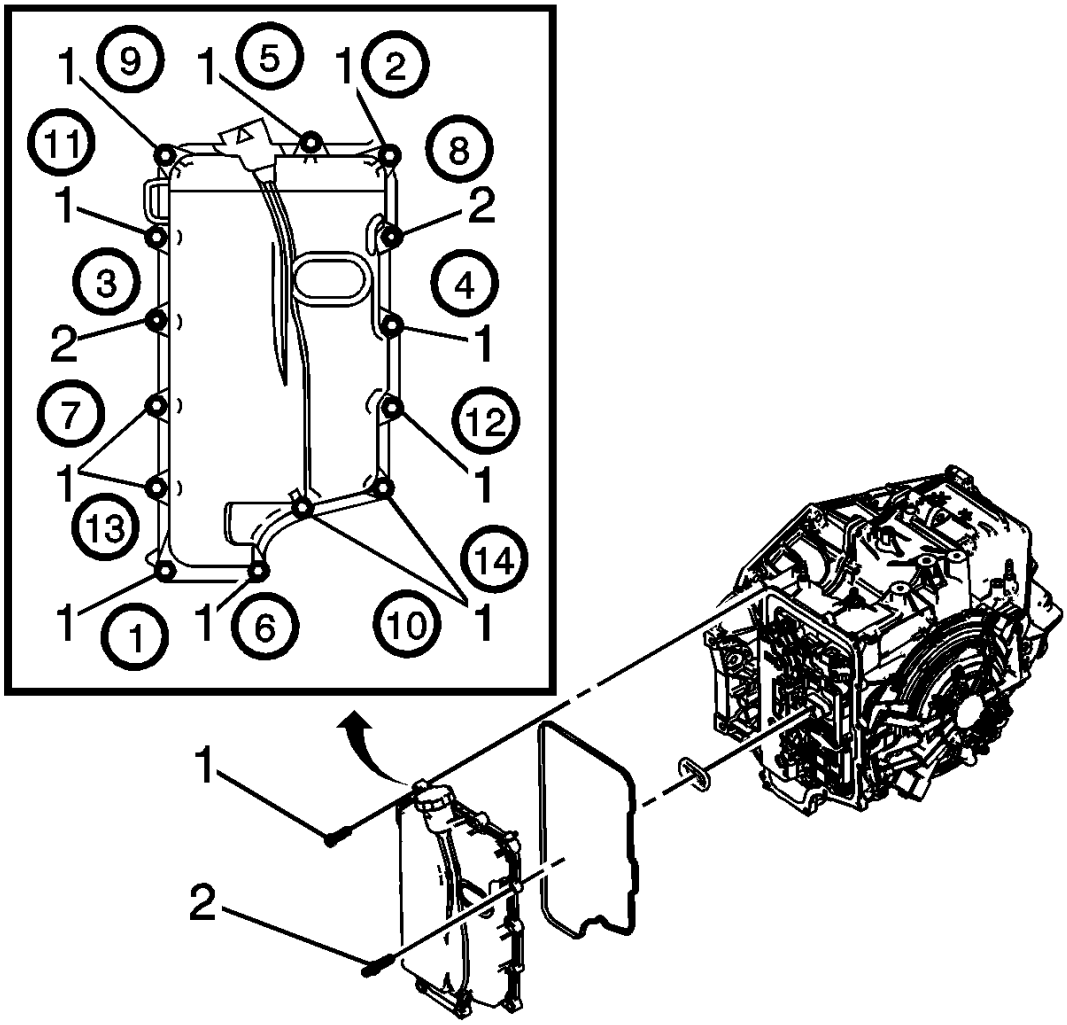


Fig. 34: Identifying Control Valve Body Cover Bolts Torque Sequence
Courtesy of GENERAL MOTORS COMPANY

1. Install the control valve body cover wiring connector hole seal.
2. Install the control valve body cover gasket to the control valve body cover.
3. Install the control valve body cover.

CAUTION: Refer to Fastener Caution .

4. Install the top 3 control valve body cover bolts (1) M6 x 30.
5. Connect the transmission wire harness retainer to the bracket on top of the transmission.
6. Raise the vehicle.
7. Install the 9 lower control valve body cover bolts (1) M6 x 30.
8. Install the 2 control valve body cover studs (2) M6 x 30.
9. Tighten the 12 bolts and 2 studs in sequence to 12 N.m (106 lb in).

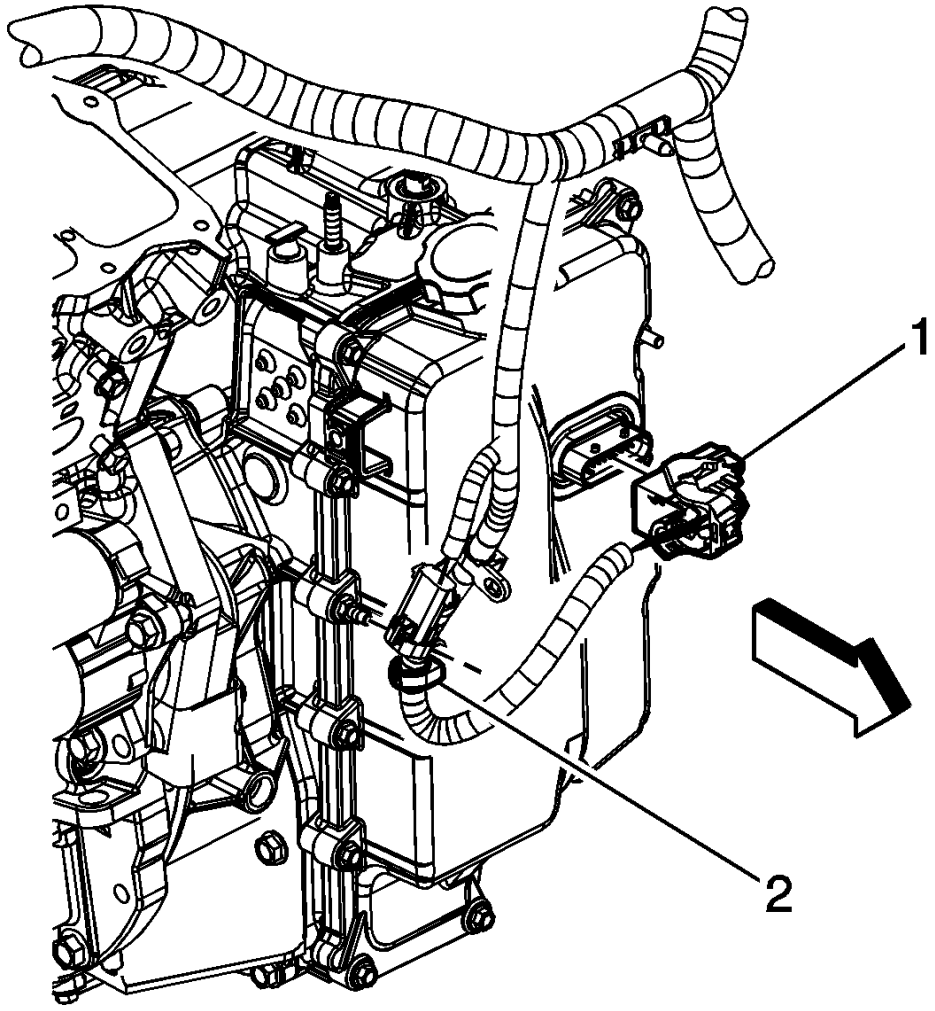


Fig. 35: Identifying Wire Harness Retainer & TCM Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

10. Connect the control valve body TCM electrical connector (1).

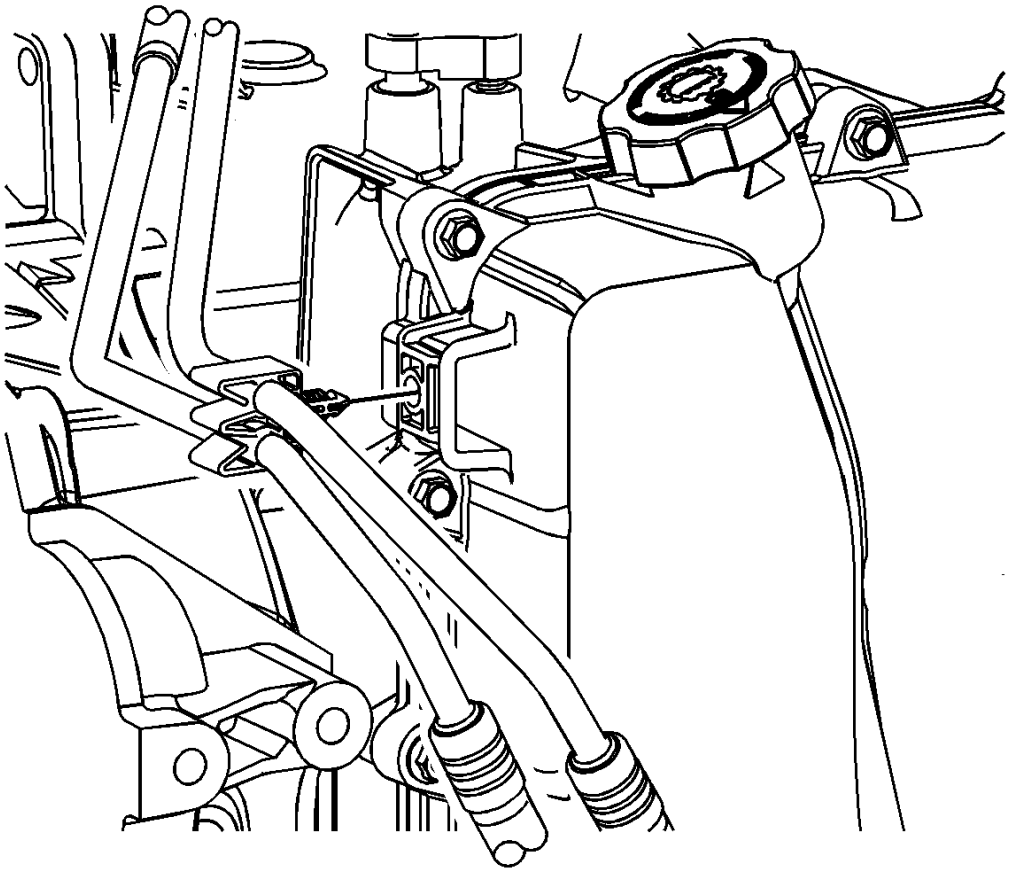


Fig. 36: Identifying Oil Cooler Inlet And Outlet Hoses
Courtesy of GENERAL MOTORS COMPANY

11. Install the oil cooler inlet and outlet hoses to the retainer on the control valve body cover.
12. Install the wire harness retainer to the control valve body cover stud.
13. Tighten the nut to 12 N.m (106 lb in).
14. Fill the transmission. Refer to **Transmission Fluid Drain and Fill**.
15. Install the air cleaner assembly. Refer to **Air Cleaner Assembly Replacement** .
16. Check for leaks.

CONTROL SOLENOID VALVE AND TRANSMISSION CONTROL MODULE ASSEMBLY REPLACEMENT

Removal Procedure

1. Remove the control valve body cover. Refer to **Control Valve Body Cover Replacement**.

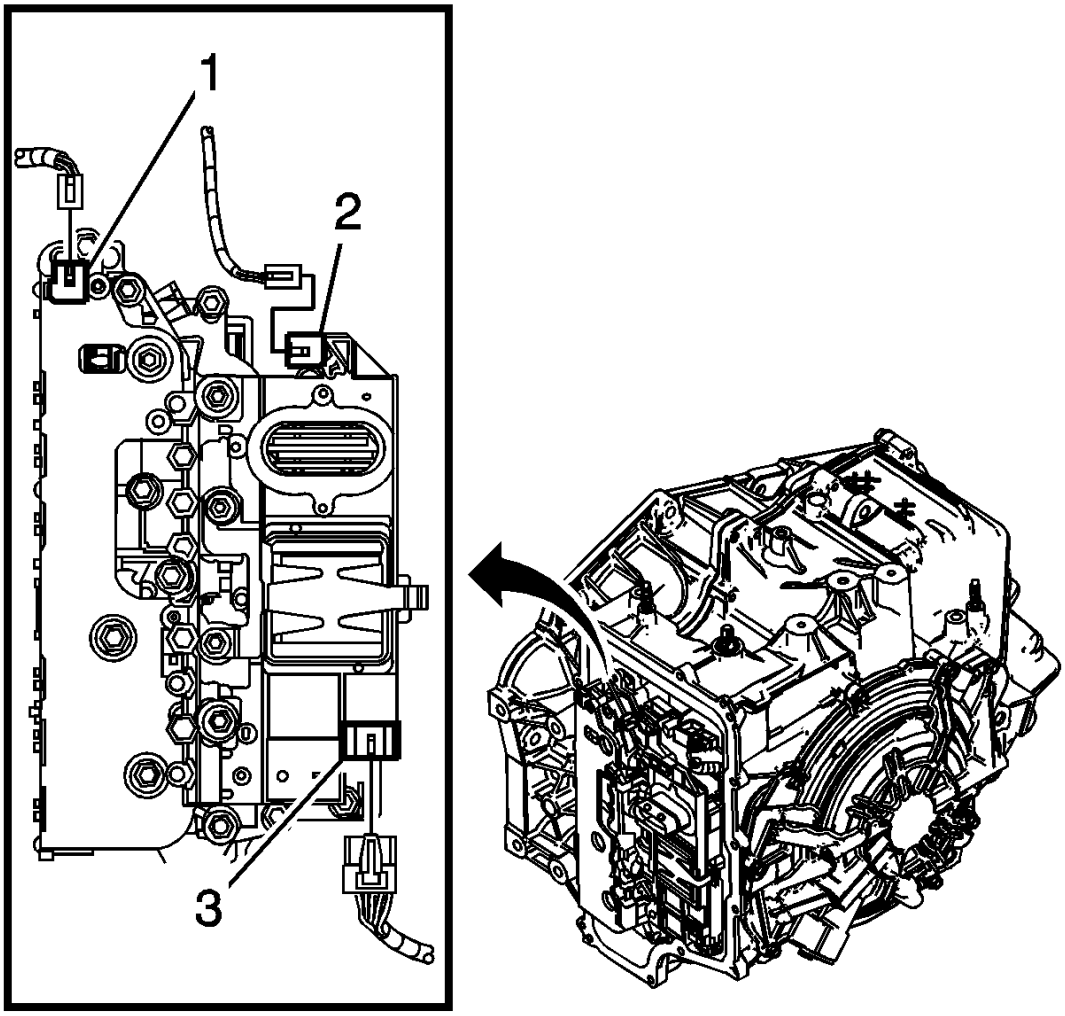


Fig. 37: Identifying Input Speed Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the input speed sensor electrical connector (1).
3. Disconnect the output speed sensor electrical connector (2).
4. Disconnect the shift position switch electrical connector (3).

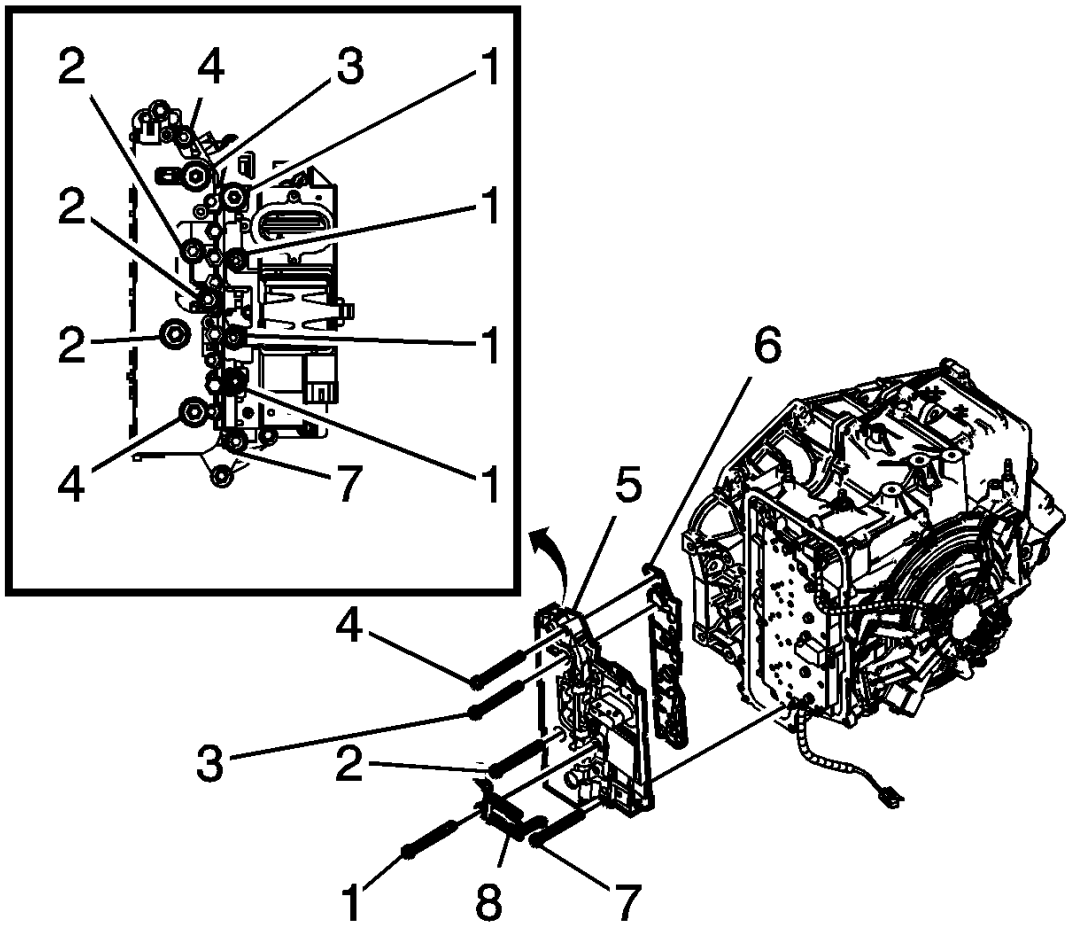


Fig. 38: Identifying Control Valve Body Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 4 control valve body bolts (1) M6 x 80.
6. Position the control solenoid valve spring (8) to the side. Spring will be released with the removal of the control valve body assembly.
7. Remove the 2 control valve body bolts (4) M6 x 65.
8. Remove the control valve body bolt (3) M6 x 42.
9. Remove the 3 control valve body bolts (2) M6 x 95.
10. Remove the control valve body bolt (7) M6 x 55.
11. Remove the control solenoid valve body and transmission control module (TCM) assembly (5).

CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.

12. Remove the control solenoid valve assembly filter plate (6).

- Discard the filler plate. It is not reusable.
- Inspect the pressure switch manifold seals for damage or contamination. Replace the control solenoid valve assembly as necessary.
- Inspect the upper channel plate bolt holes for damage, peening or burnelling. Any damage around the bolt holes near the pressure control switch (PCS) feed holes could cause leakage around the PCS seals. Replace the upper channel plate as necessary.

Installation Procedure

CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.

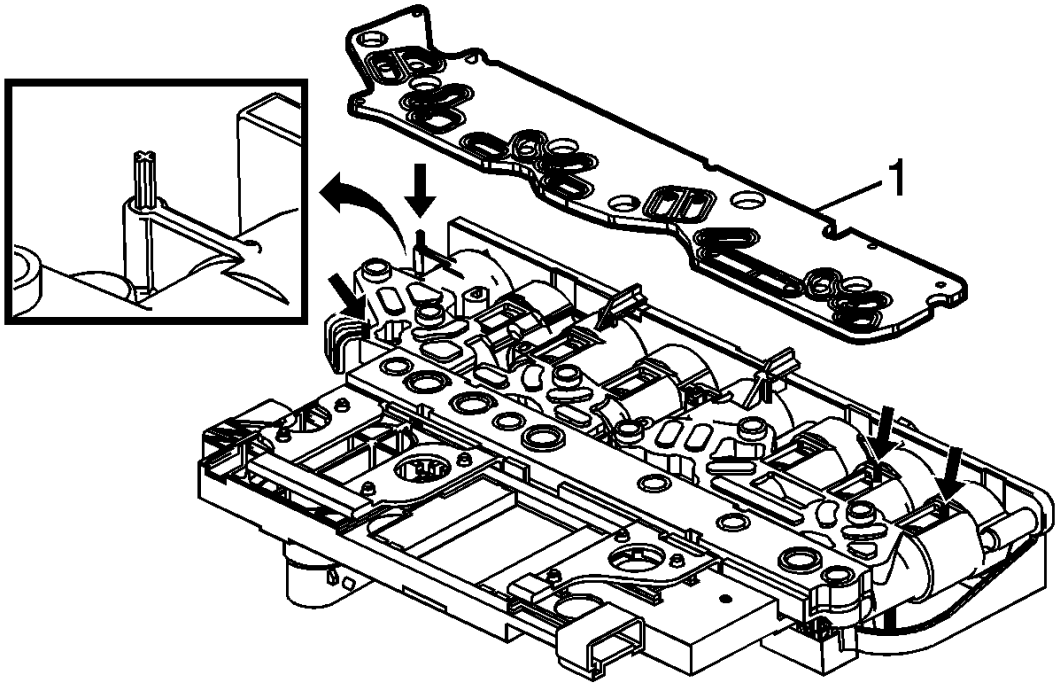


Fig. 39: Identifying Control Solenoid Valve Assembly Filter Plate
Courtesy of GENERAL MOTORS COMPANY

1. Install a NEW control solenoid valve assembly filter plate (1).

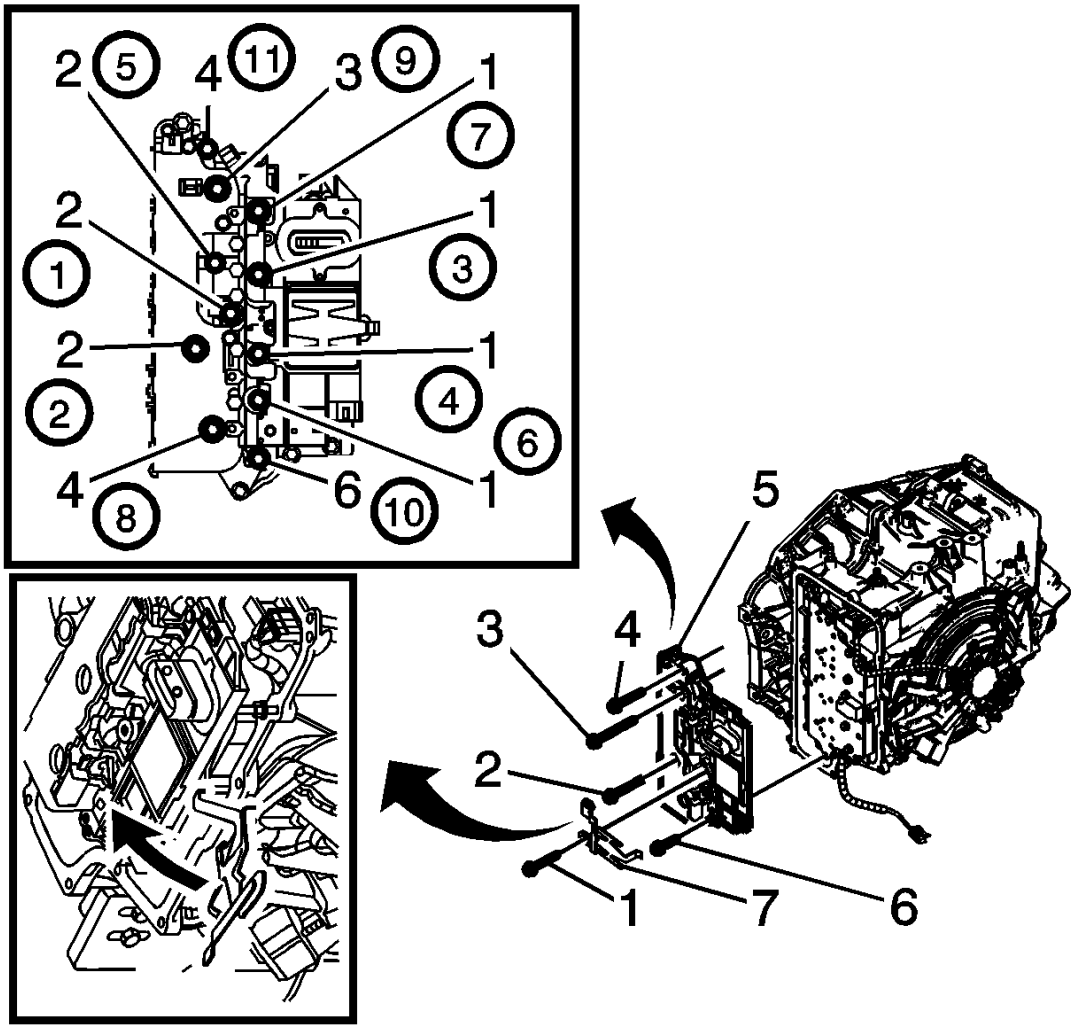


Fig. 40: Identifying Control Valve Body Bolts Torque Sequence
Courtesy of GENERAL MOTORS COMPANY

2. Install the control solenoid valve body and TCM assembly (5).
3. Rotate the control solenoid valve spring (7) into position.

CAUTION: Refer to Fastener Caution .

NOTE: Install all bolts before tightening, then tighten in specified sequence.

4. Install the 4 control valve body bolts (1) M6 x 80.
5. Install the control valve body bolt (6) M6 x 55.
6. Install the 3 control valve body bolts (2) M6 x 95.
7. Install the control valve body bolt (3) M6 x 42.
8. Install the 2 control valve body bolts (4) M6 x 65 and tighten to 12 N.m (106 lb in).

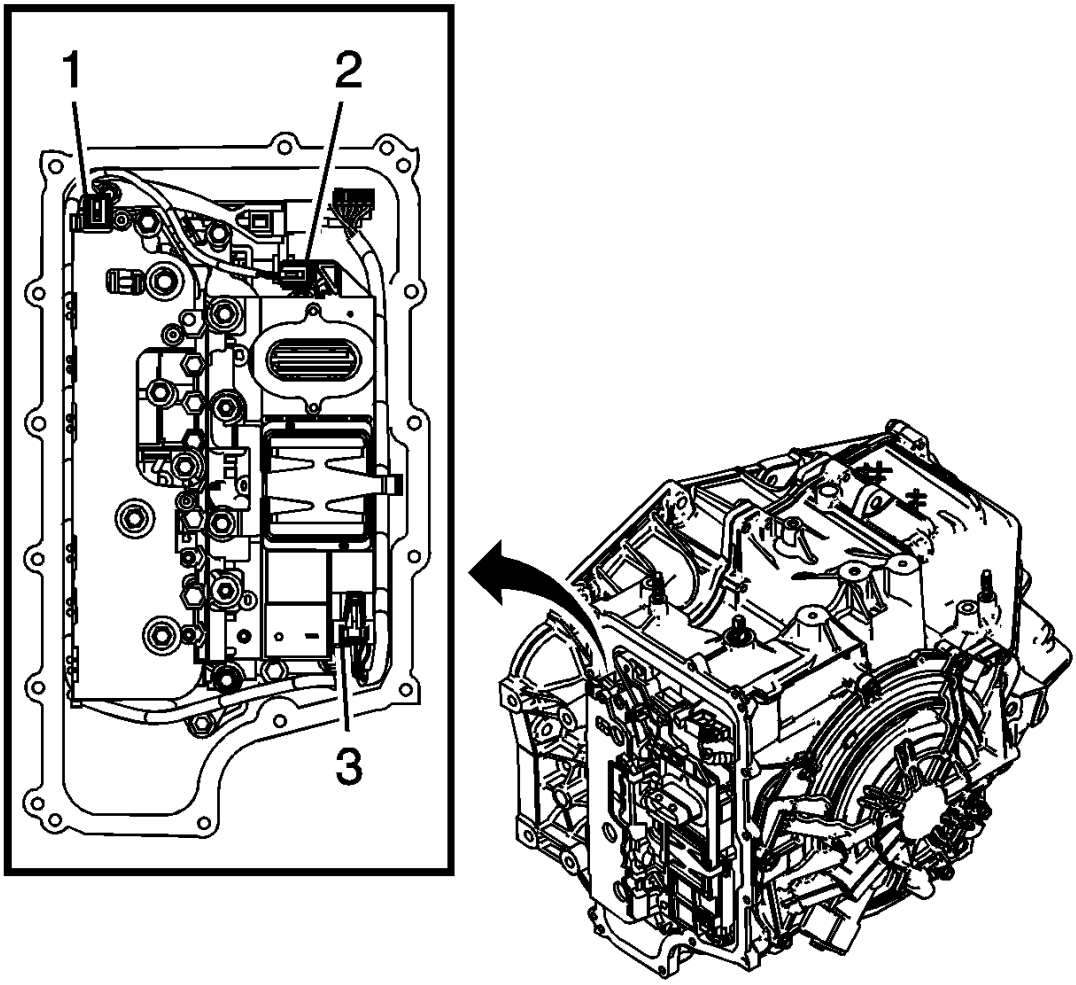


Fig. 41: Identifying Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

9. Connect the input speed sensor electrical connector (1).
10. Connect the output speed sensor electrical connector (2).
11. Connect the shift position switch electrical connector (3).
12. Install the control valve body cover. Refer to **Control Valve Body Cover Replacement**.
13. If a NEW TCM has been installed into the vehicle, the NEW module needs to be reprogrammed. Refer to **Service Programming System (SPS)** .

NOTE: **The Reset Transmission Adapts procedure must be performed when one of the following repairs have been made to the vehicle. Failure to perform the procedure after one of the following repairs may result in poor transmission performance, as well as transmission DTCs being set:**

- **Transmission internal service/overhaul**
- **Valve body repair or replacement**
- **Control solenoid valve assembly replacement**

- **TCM software/calibration update**
- **Any service in response to a shift quality concern**

14. Perform the Reset Transmission Adapts. Refer to **Reset Transmission Adapts** .

CONTROL VALVE LOWER BODY AND UPPER BODY REPLACEMENT

Removal Procedure

1. Remove the control valve body cover. Refer to **Control Valve Body Cover Replacement**.

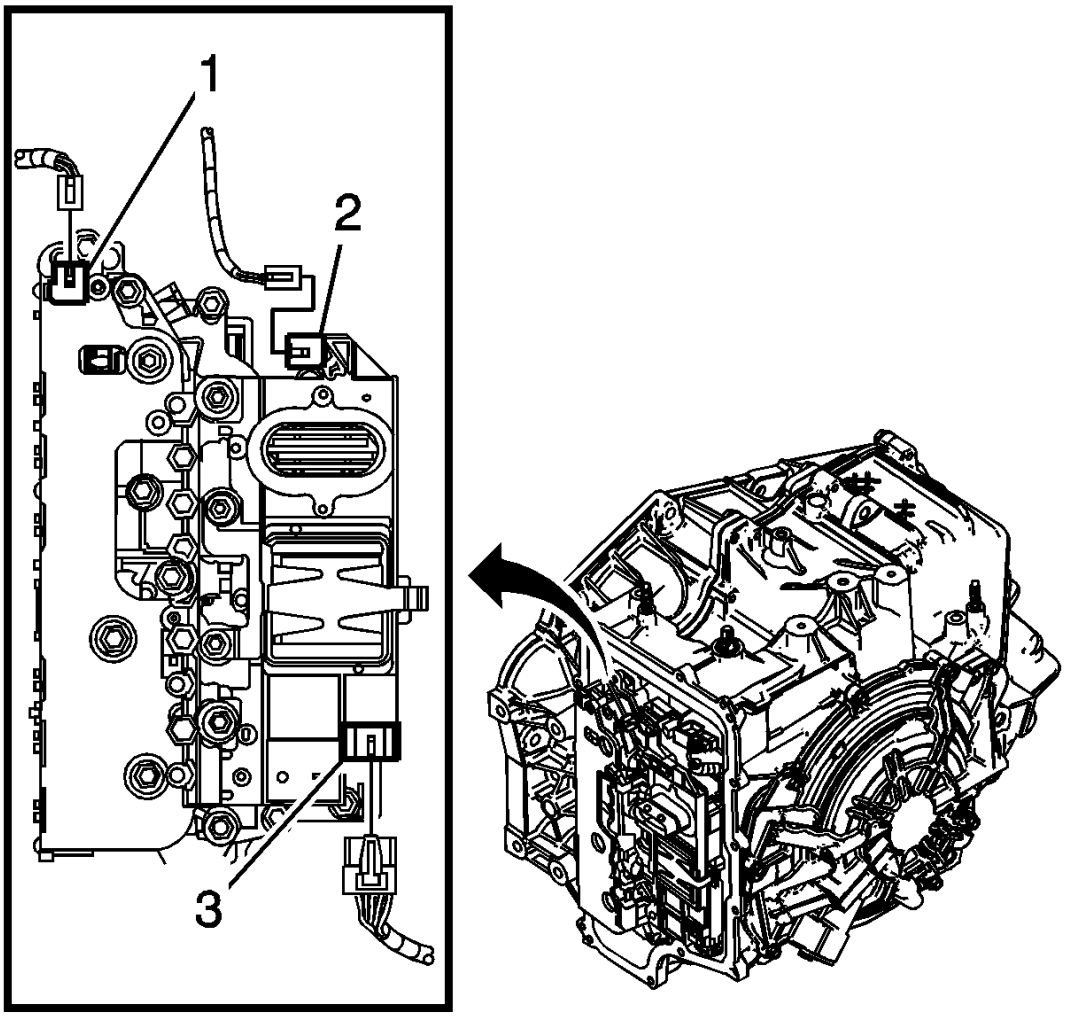


Fig. 42: Identifying Input Speed Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the input speed sensor electrical connector (1).
3. Disconnect the output speed sensor electrical connector (2).
4. Disconnect the shift position switch electrical connector (3).

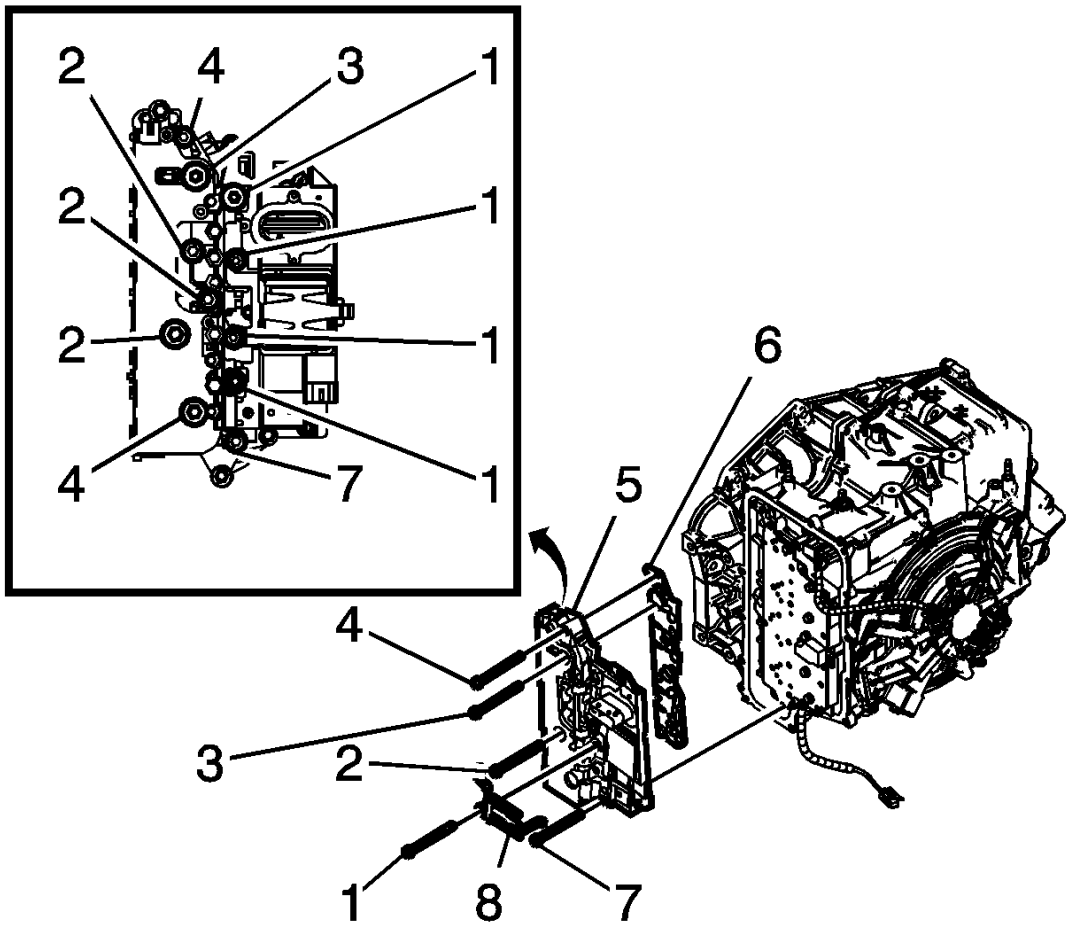


Fig. 43: Identifying Control Valve Body Bolts
Courtesy of GENERAL MOTORS COMPANY

5. Remove the 4 control valve body bolts (1) M6 x 80.
6. Position the control solenoid valve spring (8) to the side. Spring will be released with removal of lower control valve body.
7. Remove the 2 control valve body bolts (4) M6 x 65.
8. Remove the control valve body bolt (3) M6 x 42.
9. Remove the 3 control valve body bolts (2) M6 x 95.
10. Remove the control valve body bolt (7) M6 x 55.
11. Remove the control solenoid valve body and transmission control module (TCM) assembly (5).

CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.

12. Remove the control solenoid valve body assembly filter plate (6).

- Discard the filler plate. It is not reusable.
- Inspect the pressure switch manifold seals for damage or contamination. Replace the control solenoid valve assembly as necessary.
- Inspect the upper channel plate bolt holes for damage, peening or burnelling. Any damage around the bolt holes near the PCS switch feed holes could cause leakage around the PCS switch seals. Replace the upper channel plate as necessary.

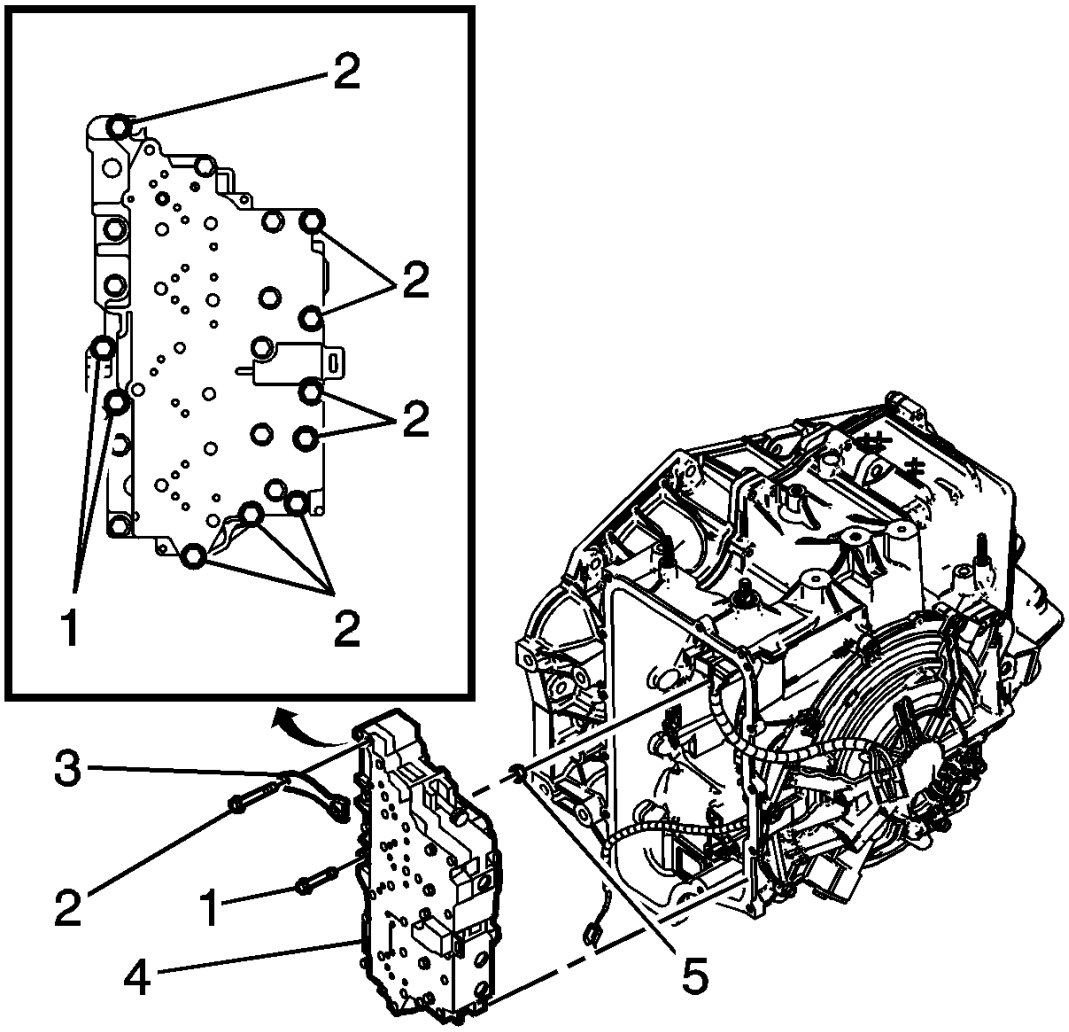


Fig. 44: Identifying Control Valve Body Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the 8 control valve body bolts (2) M6 x 65.
14. Remove the 2 control valve body bolts (1) M6 x 55.
15. Remove the manual shaft detent assembly (3).
16. Remove the control valve body assembly (4).
17. The control solenoid valve spring can now be fully removed from the lower control valve body assembly.

NOTE: **The clutch fluid passage seal is not reusable.**

18. Remove the 1-2-3-4 clutch fluid passage seal (5).

19. Transfer parts as needed. Refer to **Control Valve Body Assembly Disassemble** , and **Control Valve Body Assembly Assemble** .

Installation Procedure

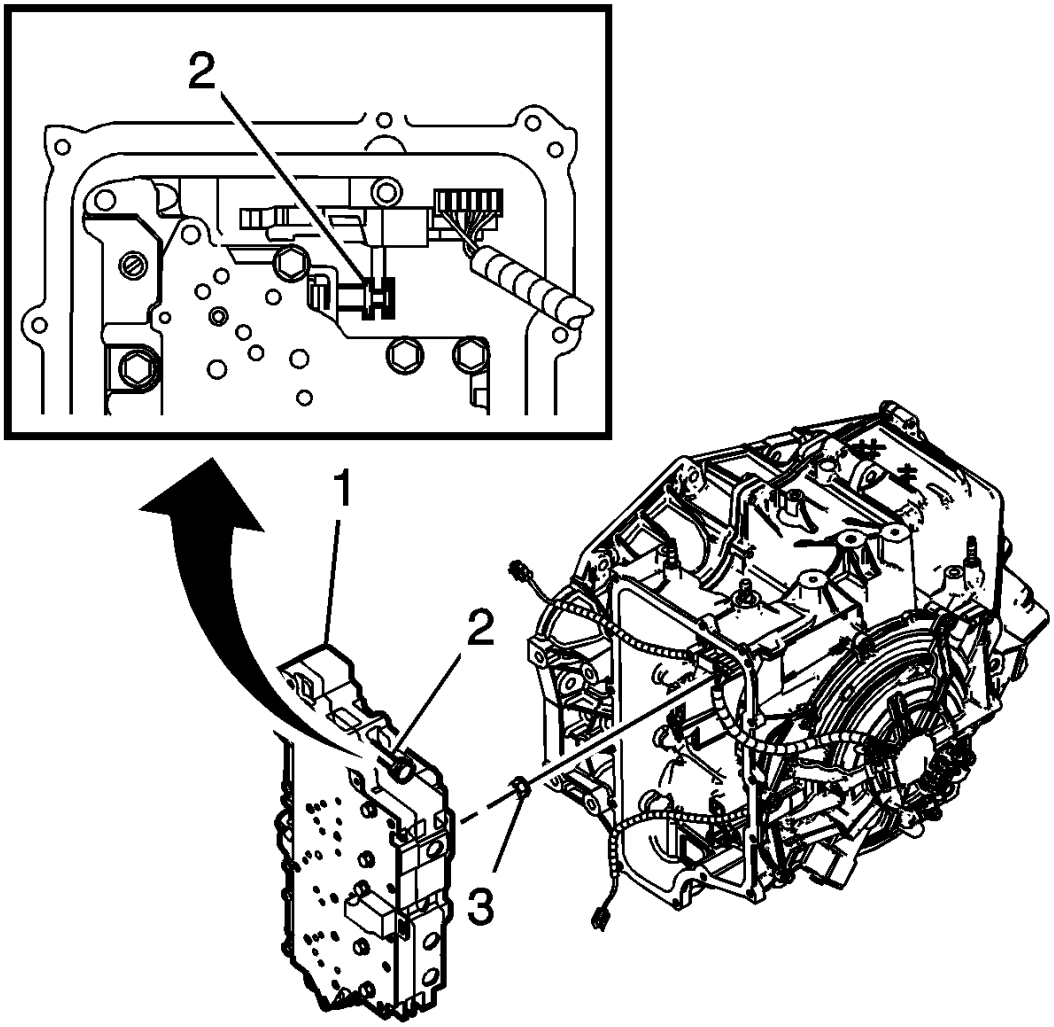


Fig. 45: Identifying Control Valve Body Components
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The clutch fluid passage seal is not reusable.**

1. Install a NEW 1-2-3-4 clutch fluid passage seal (3).

NOTE: **Ensure the control solenoid valve spring is attached to the lower control valve body assembly.**

NOTE: **Align the manual valve (2) to the detent lever assembly while installing the lower control valve body assembly.**

2. Install the control valve body assembly (1).

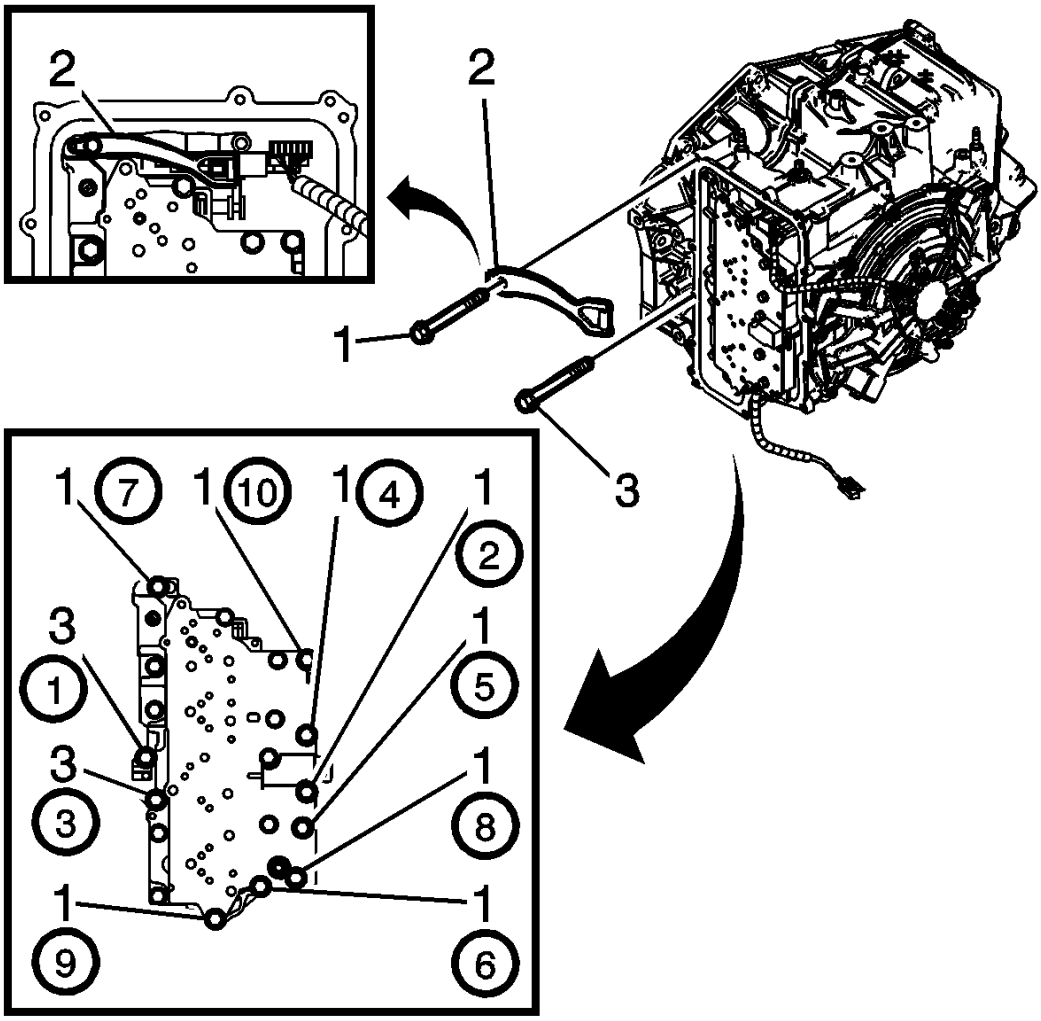


Fig. 46: Identifying Control Valve Body Bolts Torque Sequence
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure proper alignment of the detent assembly to the detent lever assembly with position switch while tightening the bolt. The detent assembly can move and hit the valve body assembly that could cause improper engagement with the detent lever assembly.**

3. Install the manual shaft detent assembly (2).

CAUTION: **Refer to Fastener Caution .**

NOTE: **Install all bolts before tightening, then tighten in specified sequence.**

4. Install the 8 control valve body bolts (1) M6 x 65 and tighten to 12 N.m (106 lb in).
5. Install the 2 control valve body bolts (3) M6 x 55 and tighten to 12 N.m (106 lb in).

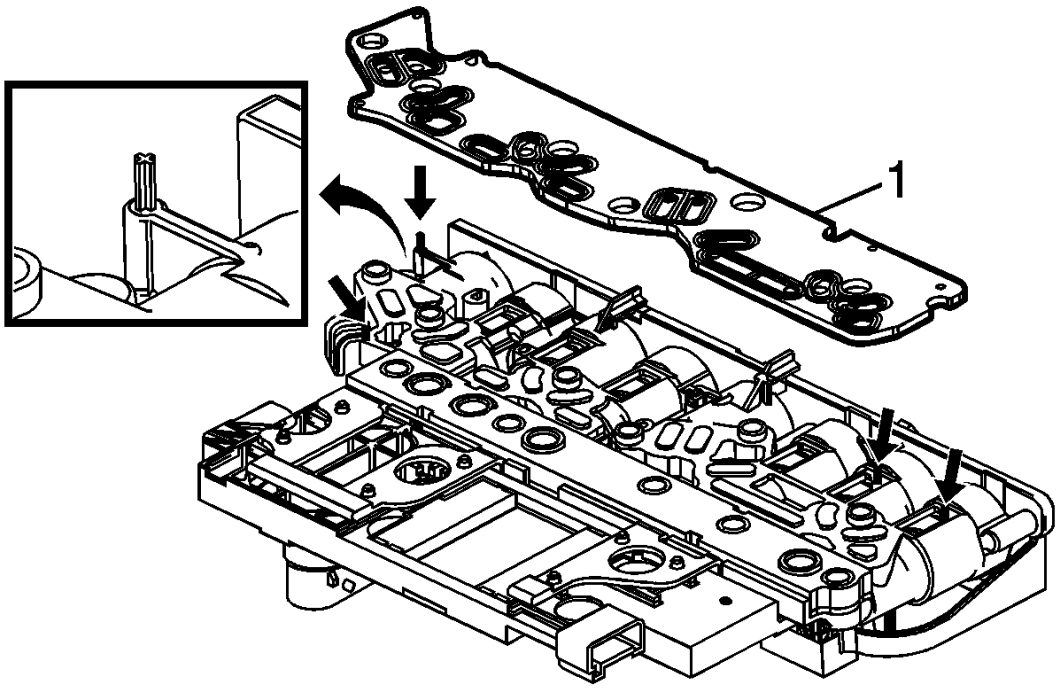


Fig. 47: Identifying Control Solenoid Valve Assembly Filter Plate
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Use care when removing or installing the filter plate assembly. A broken or missing retaining tab may not adequately secure the filter plate to the control solenoid valve assembly, resulting in possible damage or contamination.

6. Install a NEW control solenoid valve assembly filter plate (1).

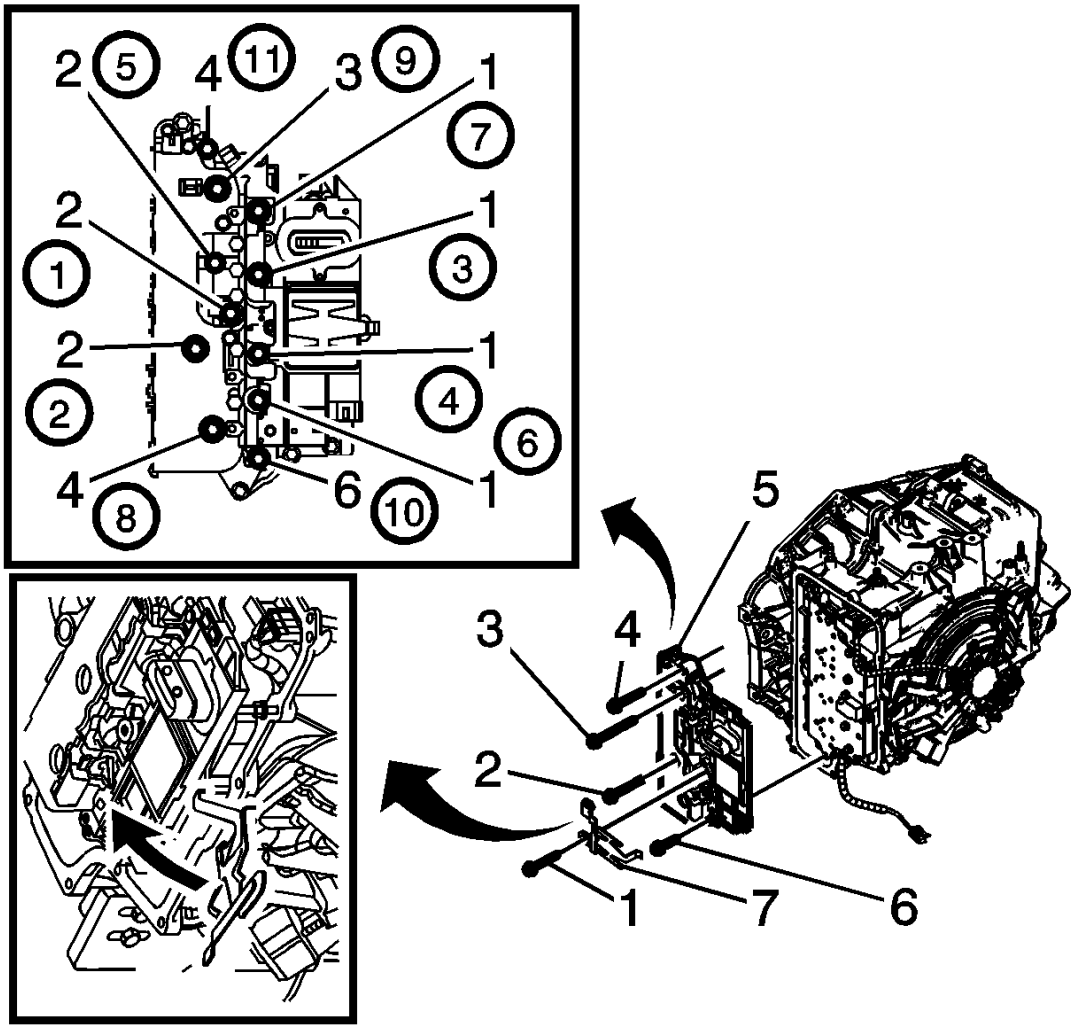


Fig. 48: Identifying Control Valve Body Bolts Torque Sequence
Courtesy of GENERAL MOTORS COMPANY

7. Install the control solenoid valve body and TCM assembly (5).
8. Rotate the control solenoid valve spring (7) into position.

NOTE: **Install all bolts before tightening, then tighten in specified sequence.**

9. Install the 4 control valve body bolts (1) M6 x 80.
10. Install the control valve body bolt (6) M6 x 55.
11. Install the 3 control valve body bolts (2) M6 x 95.
12. Install the control valve body bolt (3) M6 x 42.
13. Install the 2 control valve body bolts (4) M6 x 65.

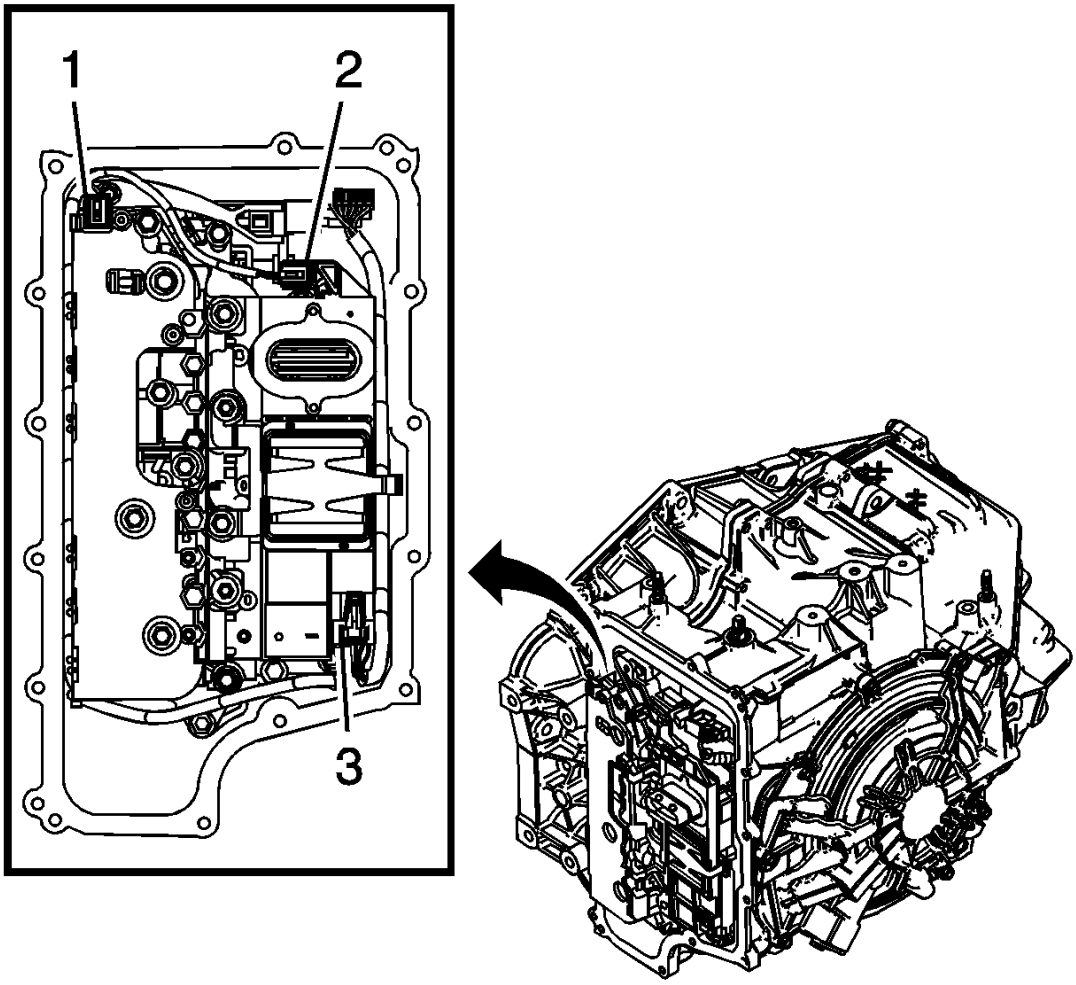


Fig. 49: Identifying Electrical Connectors
Courtesy of GENERAL MOTORS COMPANY

14. Connect the input speed sensor electrical connector (1).
15. Connect the output speed sensor electrical connector (2).
16. Connect the shift position switch electrical connector (3).
17. Install the control valve body cover. Refer to **Control Valve Body Cover Replacement**.
18. For transmission control module programming and setup. Refer to **Control Module References** .

NOTE: **After an internal transmission repair or internal part replacement the Reset Transmission Adapts procedure should be performed.**

19. Perform the Reset Transmission Adapts. Refer to **Reset Transmission Adapts** .

TORQUE CONVERTER REPLACEMENT

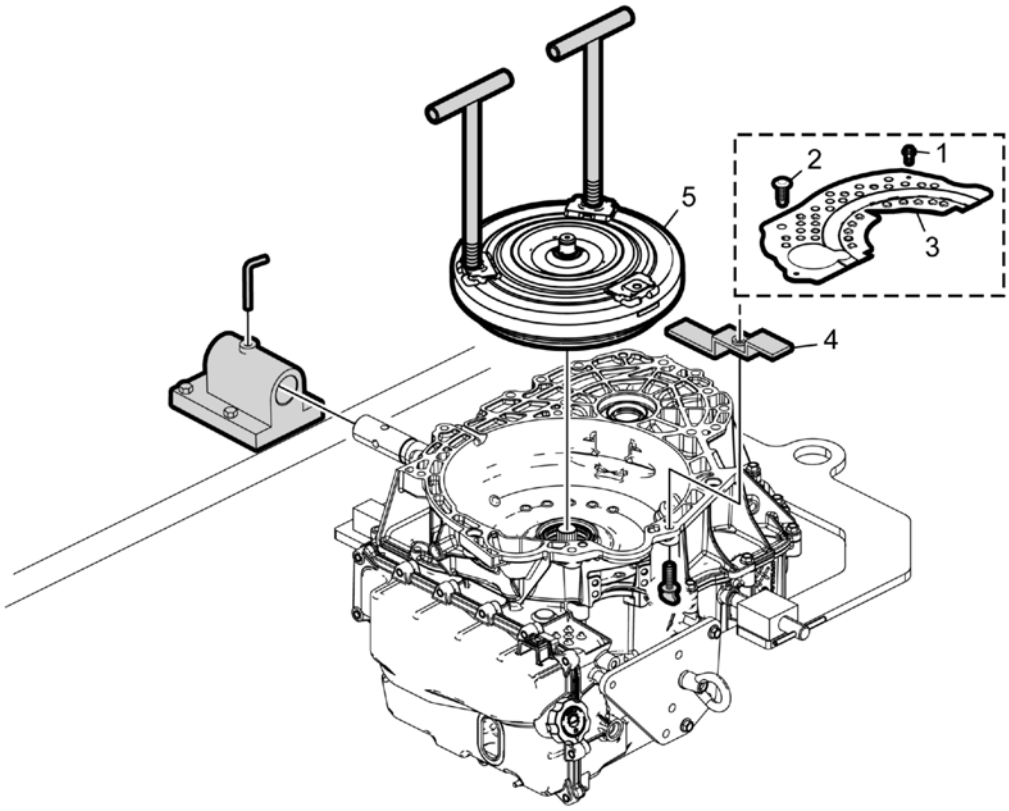


Fig. 50: Torque Converter & Mounting Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the transmission. Refer to **Transmission Replacement**. 2. Position the transmission assembly so the torque converter is facing up.	
1	Dust Cover Bolt M10 x 25, Model Dependent (Qty: 2)
2	Dust Cover Push Pin, Model Dependent
3	Dust Cover, Model Dependent
4	Converter Holding Strap **WARNING:** **The torque converter must be held to the torque converter housing by a retaining device such as shipping brackets. Without the**

Callout	Component Name
	retaining device, the torque converter may slide forward, disengaging the oil pump, or may fall completely out of the transmission causing personal injury and/or property damage. **Special Tools** **DT-21366** Converter Holding Strap For equivalent regional tools, refer to **Special Tools** .
5	Torque Converter Assembly **CAUTION:** **Only install the lift assist handles until it stops. Do not tighten. Over tightening the lift assist handles can cause damage to the torque converter.** **CAUTION:** **Lower the torque converter straight down. Failure to lower the**

Callout	Component Name
	torque converter straight down could damage the torque converter clutch lip seal inside the torque converter clutch assembly. **CAUTION:** **Failure to raise the torque dampener assembly straight up could damage the torque dampener clutch lip seal inside the torque dampener clutch assembly.** **Special Tools** **DT-46409** Torque Converter Lifting Handles For equivalent regional tools, refer to **Special Tools** .

TORQUE CONVERTER FLUID SEAL REPLACEMENT

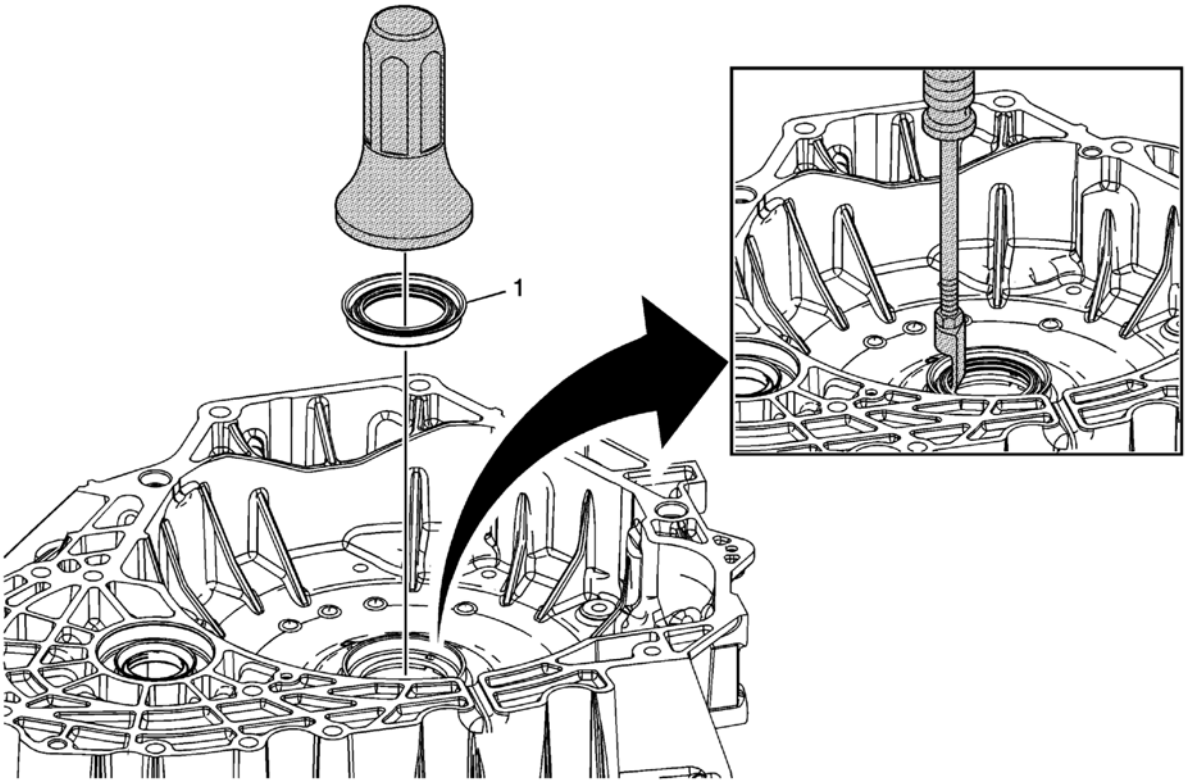


Fig. 51: Identifying Torque Converter Fluid Seal
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the transmission torque converter. Refer to **Torque Converter Replacement**.	
1	Torque Converter Fluid Seal **CAUTION:** **Support the back side of the torque converter housing while installing the seal. Install the seal until it stops moving. Applying excessive pressure to the seal once it is seated could cause**

Callout	Component Name
	damage to the torque converter housing casting. **Special Tools<!--Title-->** • **DT 23129** Universal Seal Remover • **DT 49861** Seal Installer • **GE 6125-1B** Slide Hammer with Adapter or equivalent For equivalent regional tools, refer to **Special Tools** .

OUTPUT SPEED SENSOR REPLACEMENT

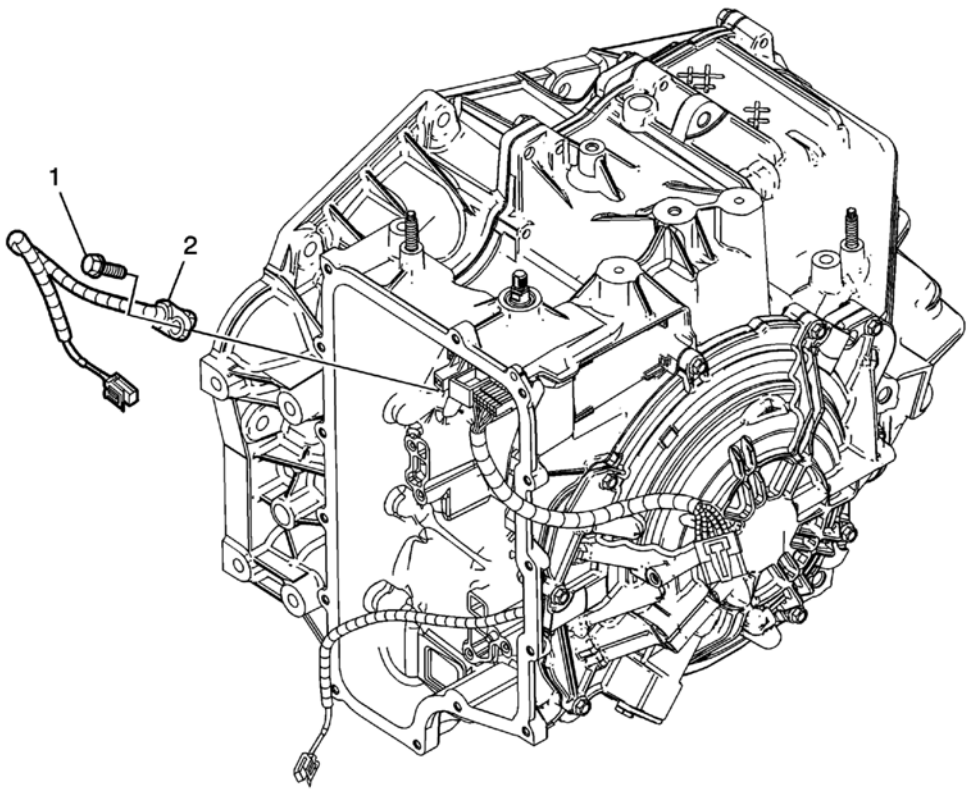


Fig. 52: View Of Output Speed Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the control valve lower body and upper body. Refer to **Control Valve Lower Body and**	

Callout	Component Name
	Upper Body Replacement.
1	Output Speed Sensor Bolt M6 x 25 **CAUTION:** **Refer to Fastener Caution .** **Tighten** 12 N.m (106 lb in)
2	Output Speed Sensor **Procedure** Perform the service programming system procedure. Refer to **Service Programming System (SPS)** . **NOTE:** **After an internal transmission repair or internal part replacement the service programming system procedure should be performed.**

INPUT SPEED SENSOR REPLACEMENT

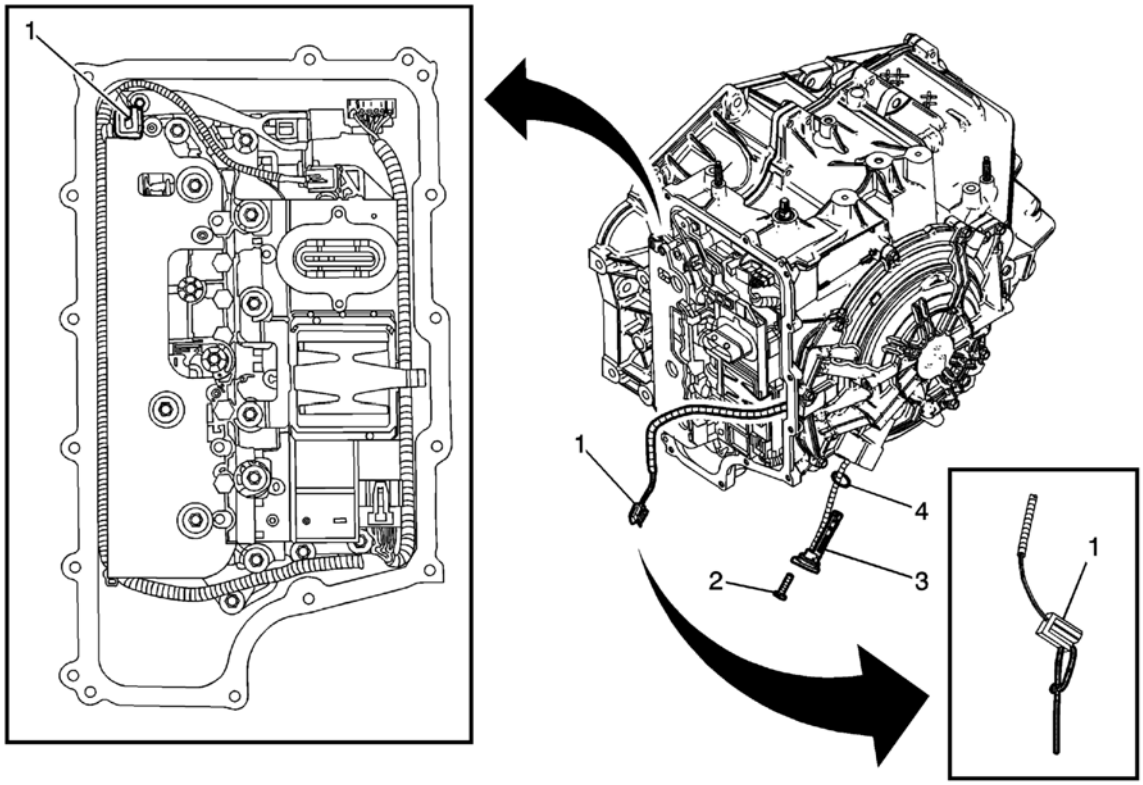


Fig. 53: View Of Input Speed Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** 2. Drain the transmission, refill when repair is completed. Refer to **Transmission Fluid Drain and Fill** 3. Remove the control valve body cover. Refer to **Control Valve Body Cover Replacement**. 4. Perform the service programming system procedure. Refer to **Service Programming System (SPS)** .	
1	Input Speed Sensor (ISS) Wire Harness **Procedure** Attach the **DT-47734** Speed Sensor Harness Tether to the ISS electrical connector locking tab before removal of old ISS to assist in installation of the new ISS. **Special Tools** **DT-47734** Speed Sensor Harness Tether.
2	Input Speed Sensor Bolt M6 x 25 **CAUTION:** **Refer to Fastener Caution .**

Callout	Component Name
	Procedure Apply threadlocker to the input speed sensor bolt. Refer to **Adhesives, Fluids, Lubricants, and Sealers** for the recommended threadlock material. **Tighten** 9 N.m (80 lb in)
3	Input Speed Sensor **TIP:** After an internal transmission repair or internal part replacement the service programming system procedure should be performed.
4	Input Speed Sensor Seal

TRANSMISSION MOUNT REPLACEMENT - LEFT SIDE

Removal Procedure

1. Install the engine support fixture. Refer to **Engine Support Fixture** .
2. Lower the frame enough to gain clearance for mount removal. Refer to **Frame Replacement** .
3. Install a transmission jack and support the transaxle.

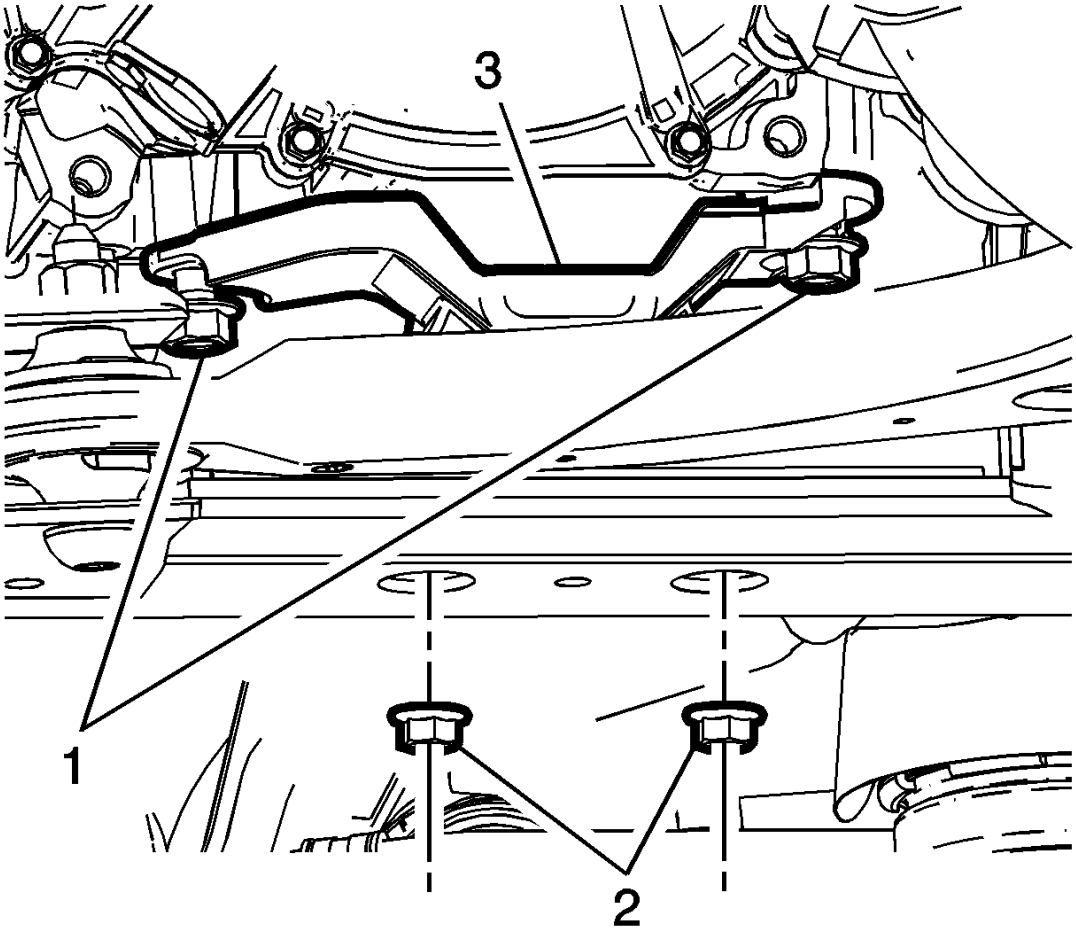


Fig. 54: Left Transmission Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

4. Remove the left transmission mount bolts (1) from the transmission.
5. Remove the left transmission mount from the vehicle.

Installation Procedure

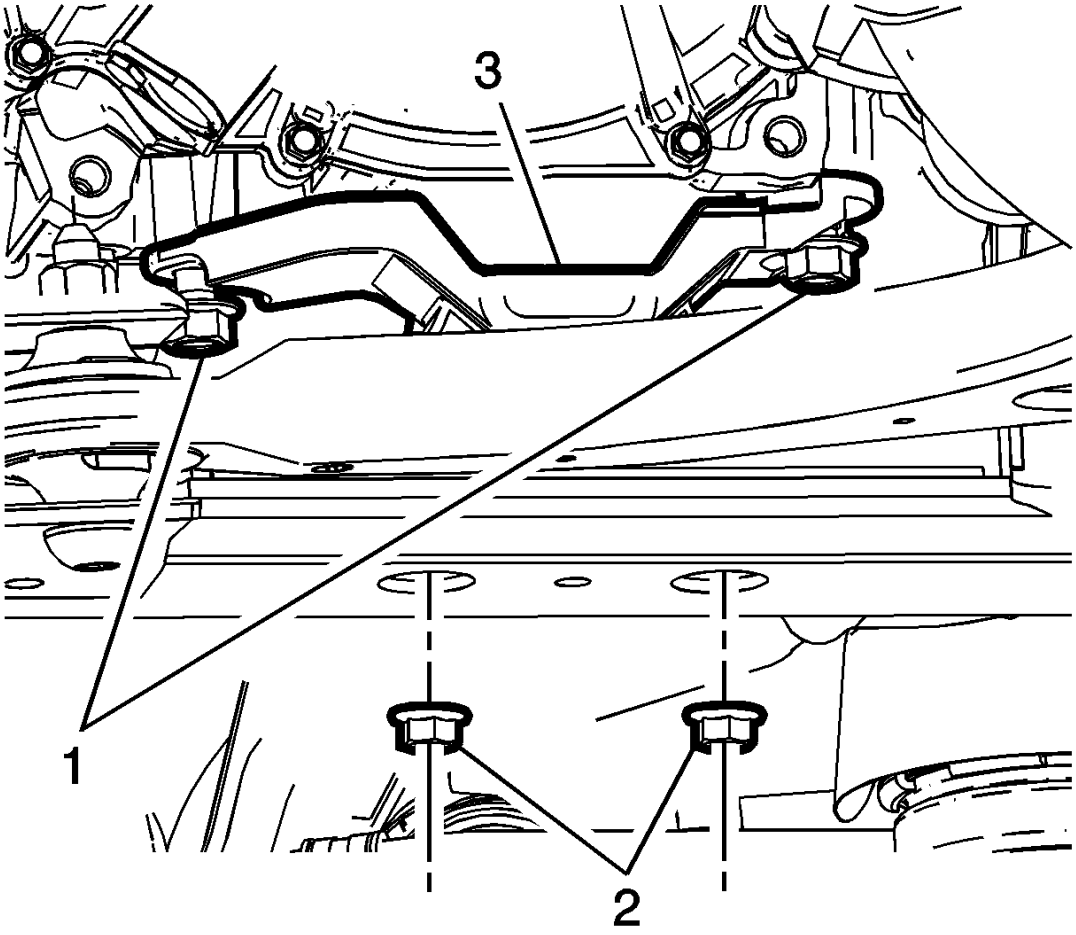


Fig. 55: Left Transmission Mount Bolts
Courtesy of GENERAL MOTORS COMPANY

1. Position the left transmission mount in the vehicle.

CAUTION: Refer to Fastener Caution .

2. Install the left transmission mount to transmission bolts (1) and tighten to 90 N.m (66 lb ft).
3. Install the frame. Refer to **Frame Replacement** .
4. Adjust the position of the transmission mount with an appropriate tool.
5. Install the left transmission mount to frame nuts (1) and tighten to 52 N.m (38 lb ft).
6. Remove the transmission jack.

7. Remove the engine support fixture.

TRANSMISSION REPLACEMENT

Removal Procedure

1. Drain the transmission fluid. Refer to **Transmission Fluid Drain and Fill**.

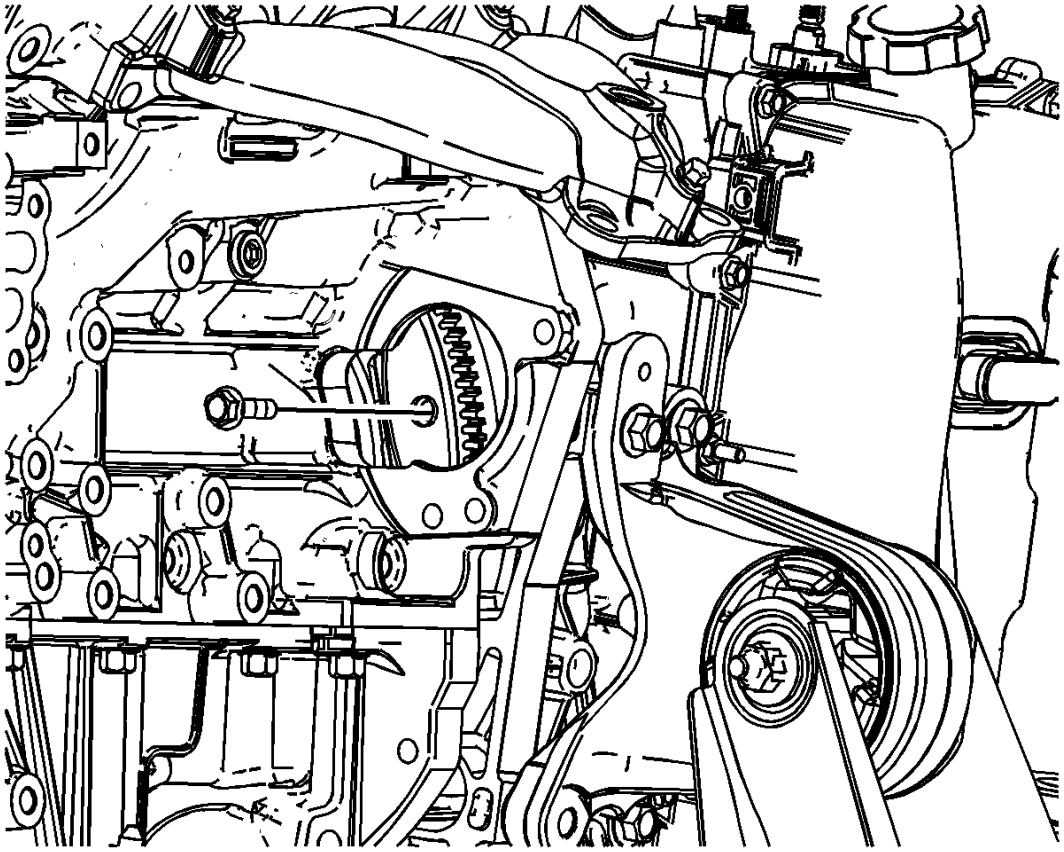


Fig. 56: Identifying Starter
Courtesy of GENERAL MOTORS COMPANY

2. Remove the starter. Refer to **Starter Replacement** .
3. Mark the relationship of the flywheel to the torque converter for reassembly.
4. Remove the four torque converter to flywheel bolts.
5. Remove the left transmission mount to frame nuts.

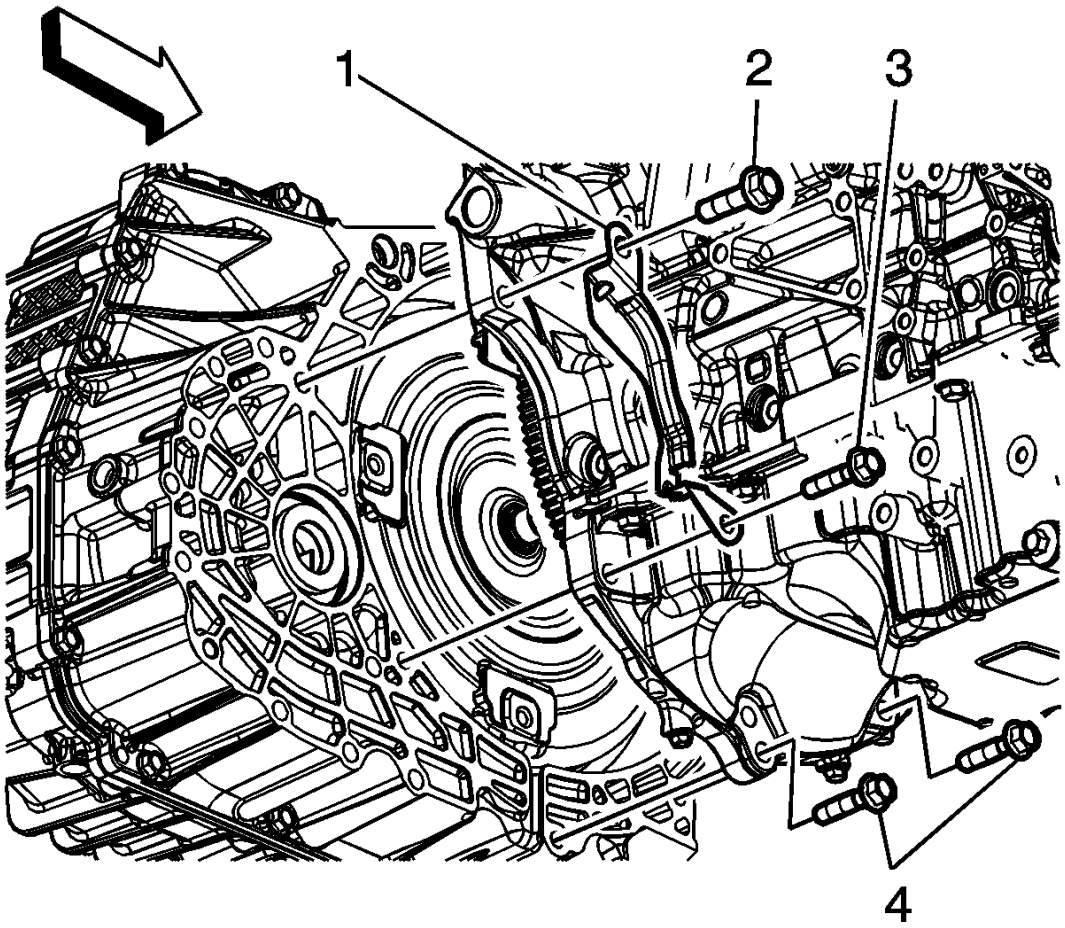


Fig. 57: Identifying Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the lower transmission fasteners (4).
7. Remove the engine, transmission and frame from the vehicle. Refer to **Engine Replacement** .

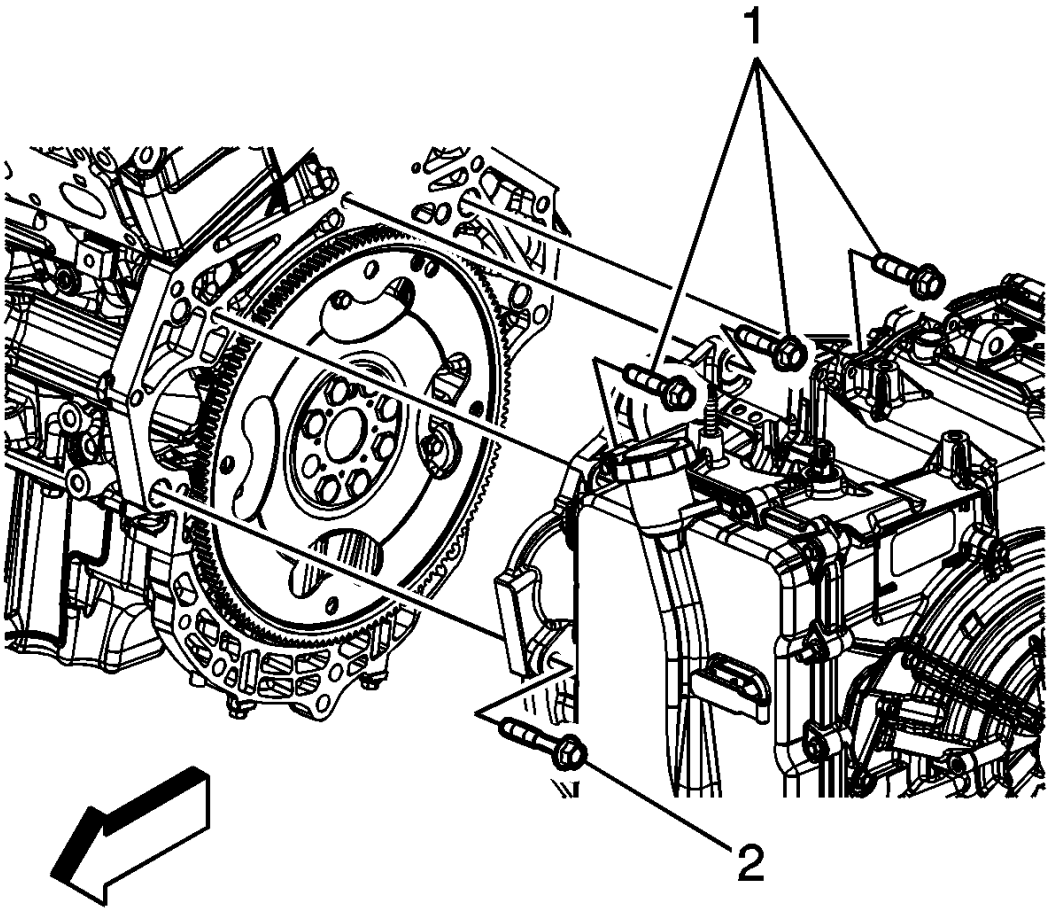


Fig. 58: Identifying Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Remove the upper transmission to engine fasteners (1) and (2).

NOTE: **Ensure the torque converter remains securely in place on the transmission input shaft while separating and removing the transmission.**

9. Using a suitable lifting device, separate the transmission from the engine.
10. Flush and flow test the transmission oil cooler and lines. Refer to **Transmission Fluid Cooler Flushing and Flow Test** .

Installation Procedure

1. Position the transmission the engine assembly.

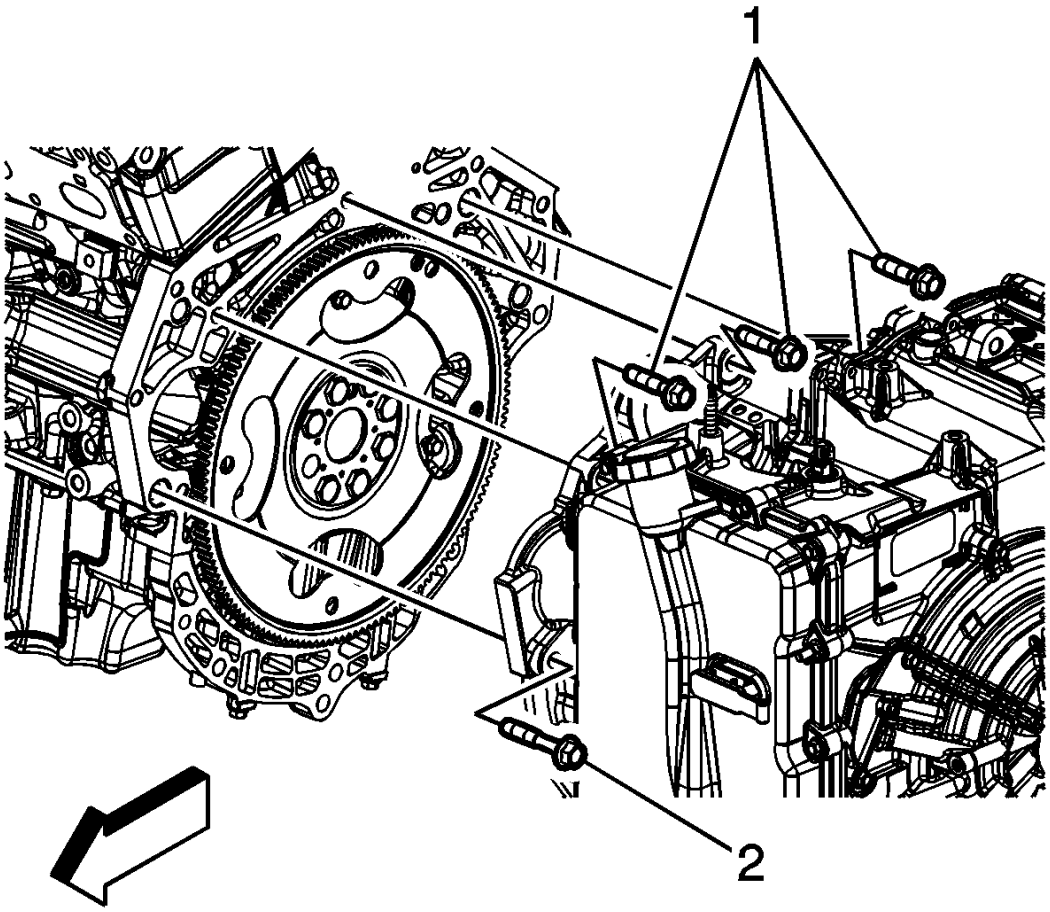


Fig. 59: Identifying Upper Transmission To Engine Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the upper transmission to engine bolt (1, 2) and tighten to 75 (55 lb ft).

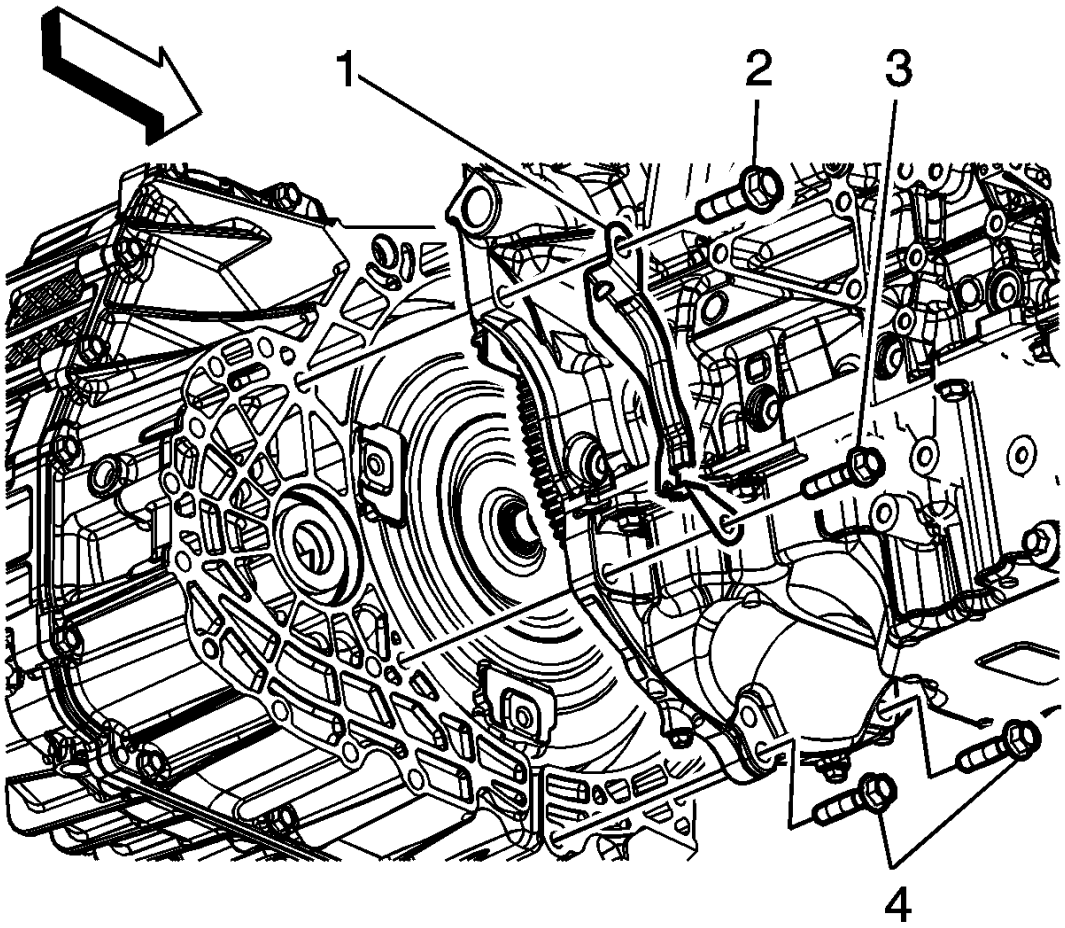


Fig. 60: Identifying Transmission Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Install the lower transmission fasteners (4) and tighten to 75 (55 lb ft).

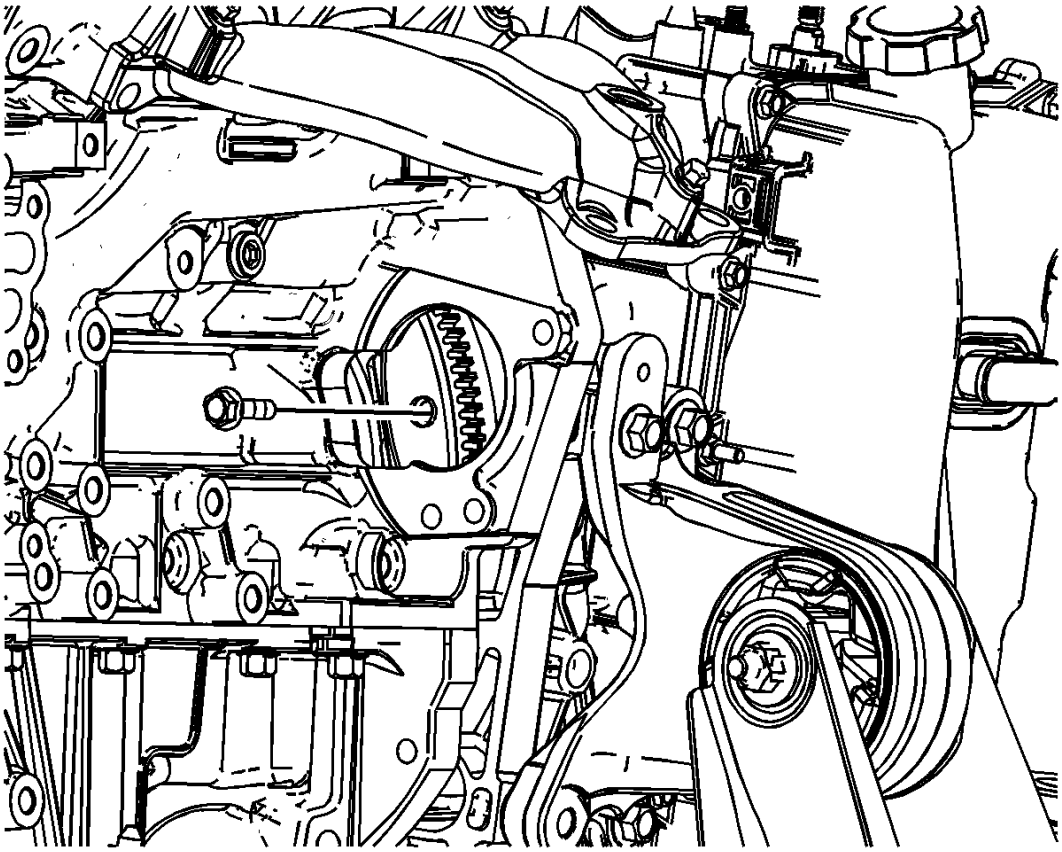


Fig. 61: Identifying Starter
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If reusing the torque converter bolts, clean the threads and apply threadlocker to the threads prior to installation. Refer to Adhesives, Fluids, Lubricants, and Sealers for the recommended threadlock material.**

4. Install the torque converter to flywheel bolts and tighten to 62 (46 lb ft).
5. Install the starter. Refer to **Starter Replacement** .
6. Install the engine, transmission and frame. Refer to **Engine Replacement** .
7. Install the left transmission mount to frame nuts (1) and tighten to 66 (38 lb ft).
8. Adjust the automatic transmission range selector lever cable. Refer to **Range Selector Lever Cable Adjustment**.
9. Fill the transmission with fluid. Refer to **Transmission Fluid Drain and Fill**.
10. If a NEW TCM has been installed into the vehicle, the NEW module needs to be reprogrammed. Refer to **Service Programming System (SPS)** .

NOTE: **The Reset Transmission Adapts procedure must be performed when one**

of the following repairs have been made to the vehicle. Failure to perform the procedure after one of the following repairs may result in poor transmission performance, as well as transmission DTCs being set:

- **Transmission internal service/overhaul**
- **Valve body repair or replacement**
- **Control solenoid valve assembly replacement**
- **TCM software/calibration update**
- **Any service in response to a shift quality concern**

11. Perform the Reset Transmission Adapts. Refer to **Reset Transmission Adapts** .
12. Road test the vehicle.

Article GUID: A00737244

SCHEMATIC WIRING DIAGRAMS

AUTOMATIC TRANSMISSION CONTROLS WIRING SCHEMATICS

Module Power, Ground, Data Communication, and MIL

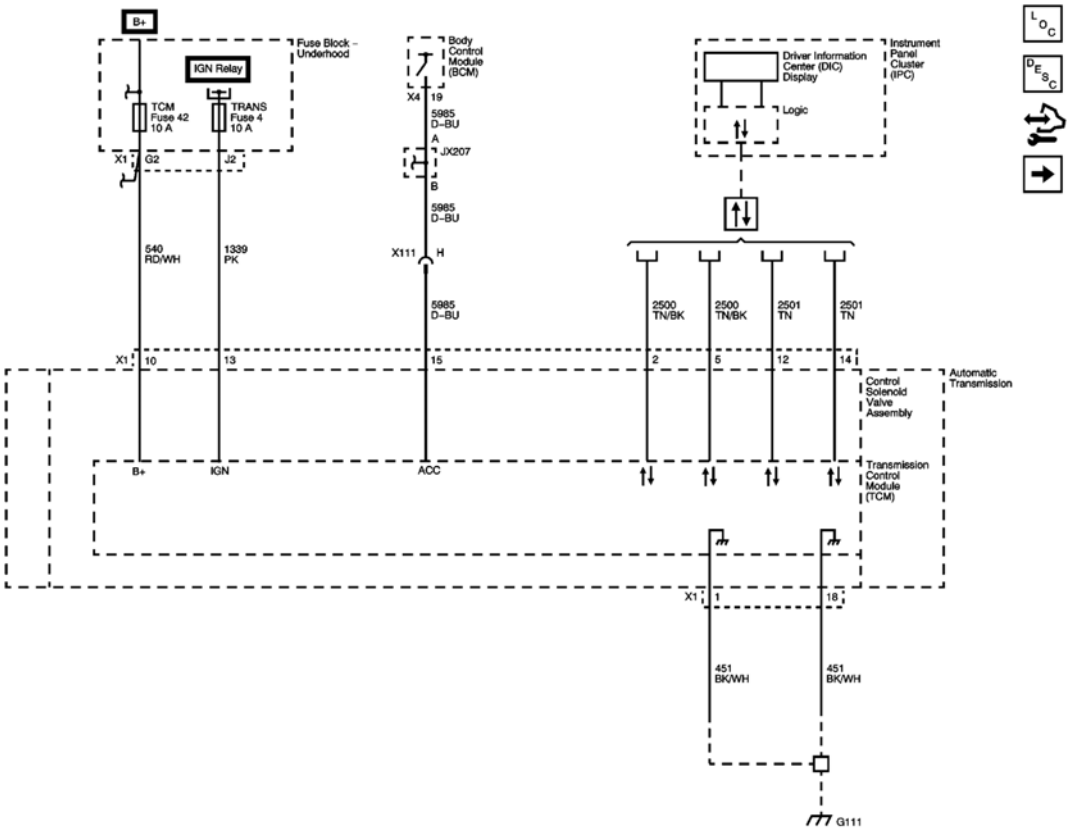


Fig. 1: Module Power, Ground, Data Communication, and MIL Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

ISS, OSS, and TFP Sensors, and TFT Switch

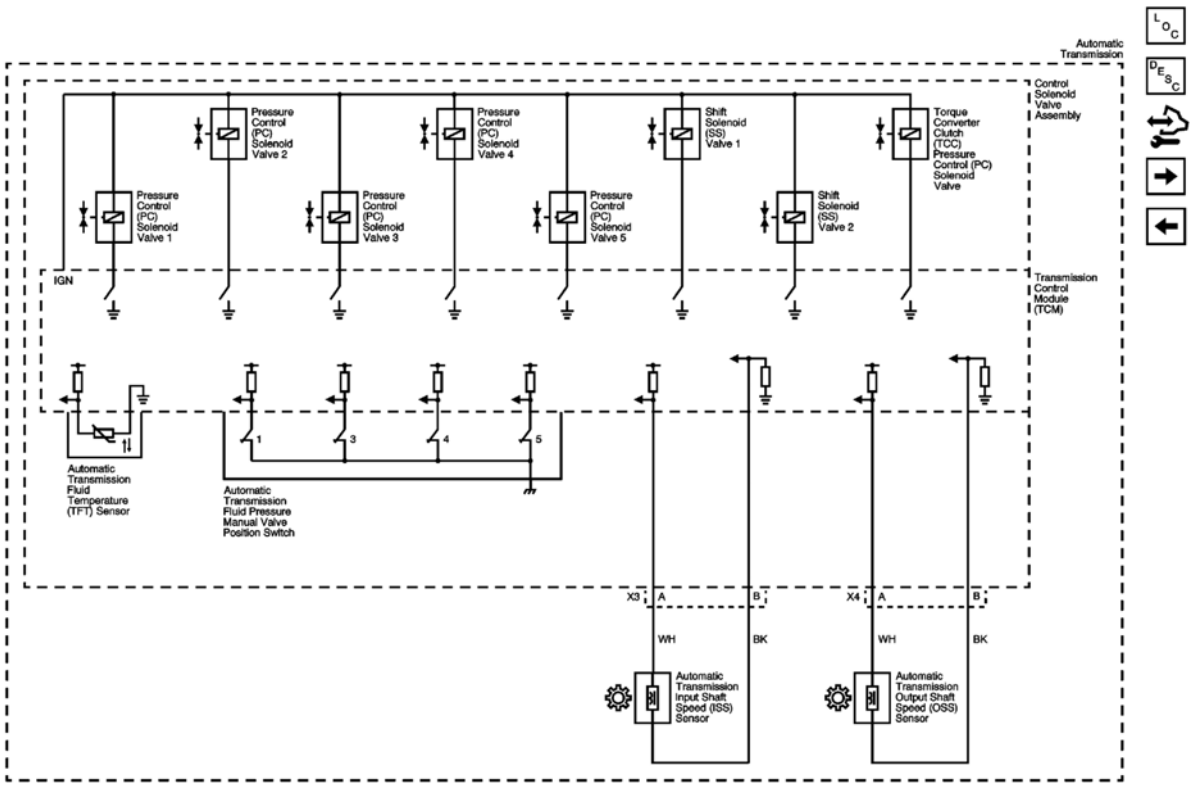


Fig. 2: ISS, OSS, and TFP Sensors, and TFT Switch Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Tap Up, Tap Down, and Internal Mode Switch

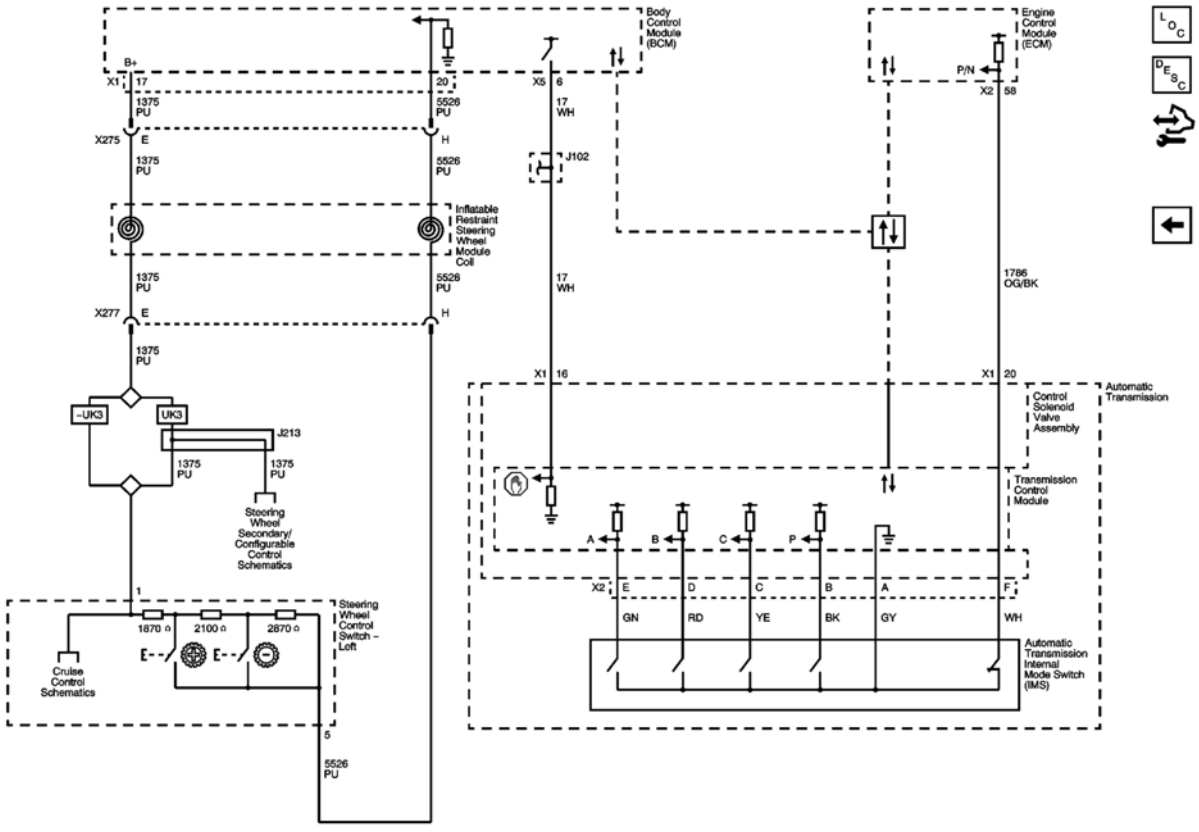
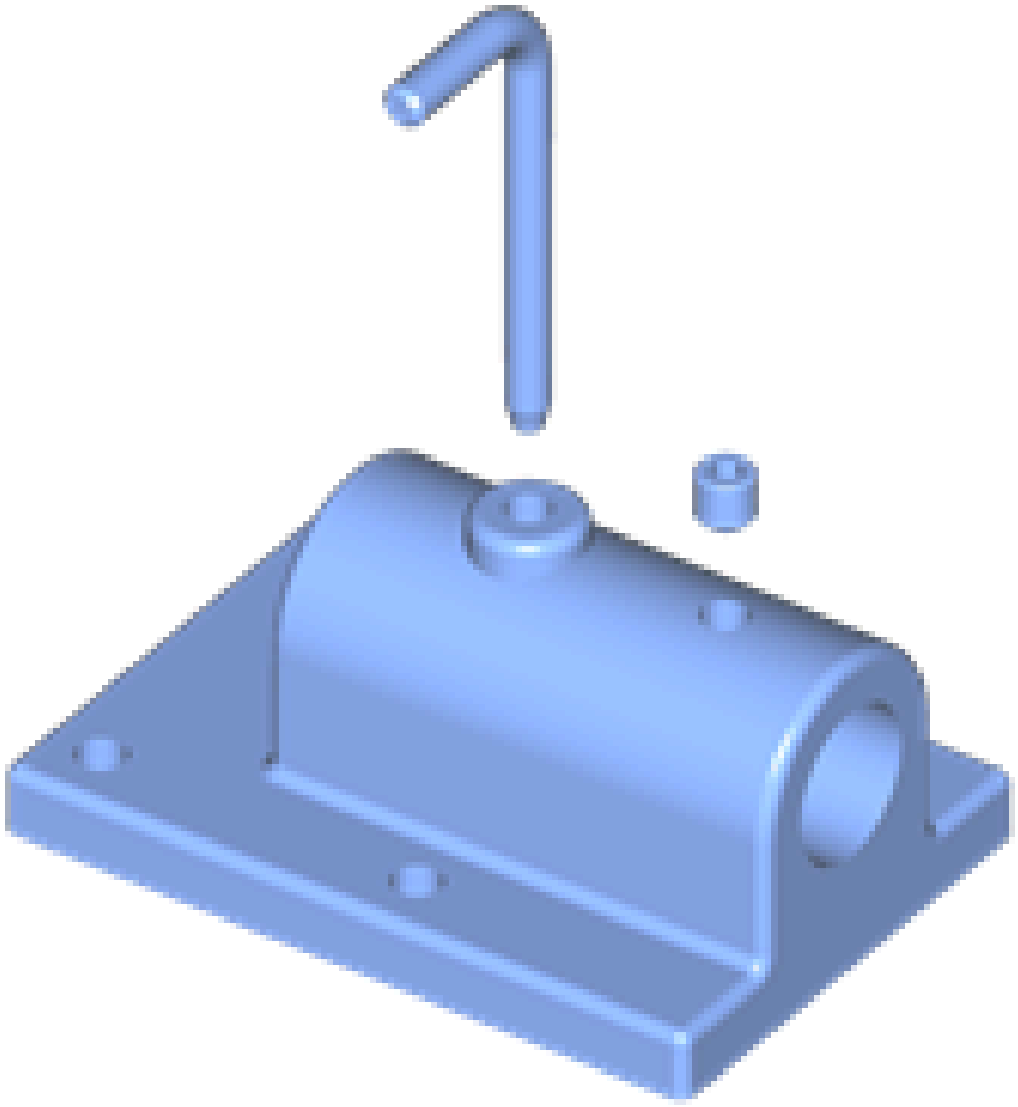


Fig. 3: Tap Up, Tap Down, and Internal Mode Switch Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Article GUID: A00737248

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description
	DT 3289-20 J 3289-20 KM-113-2-A Holding Fixture

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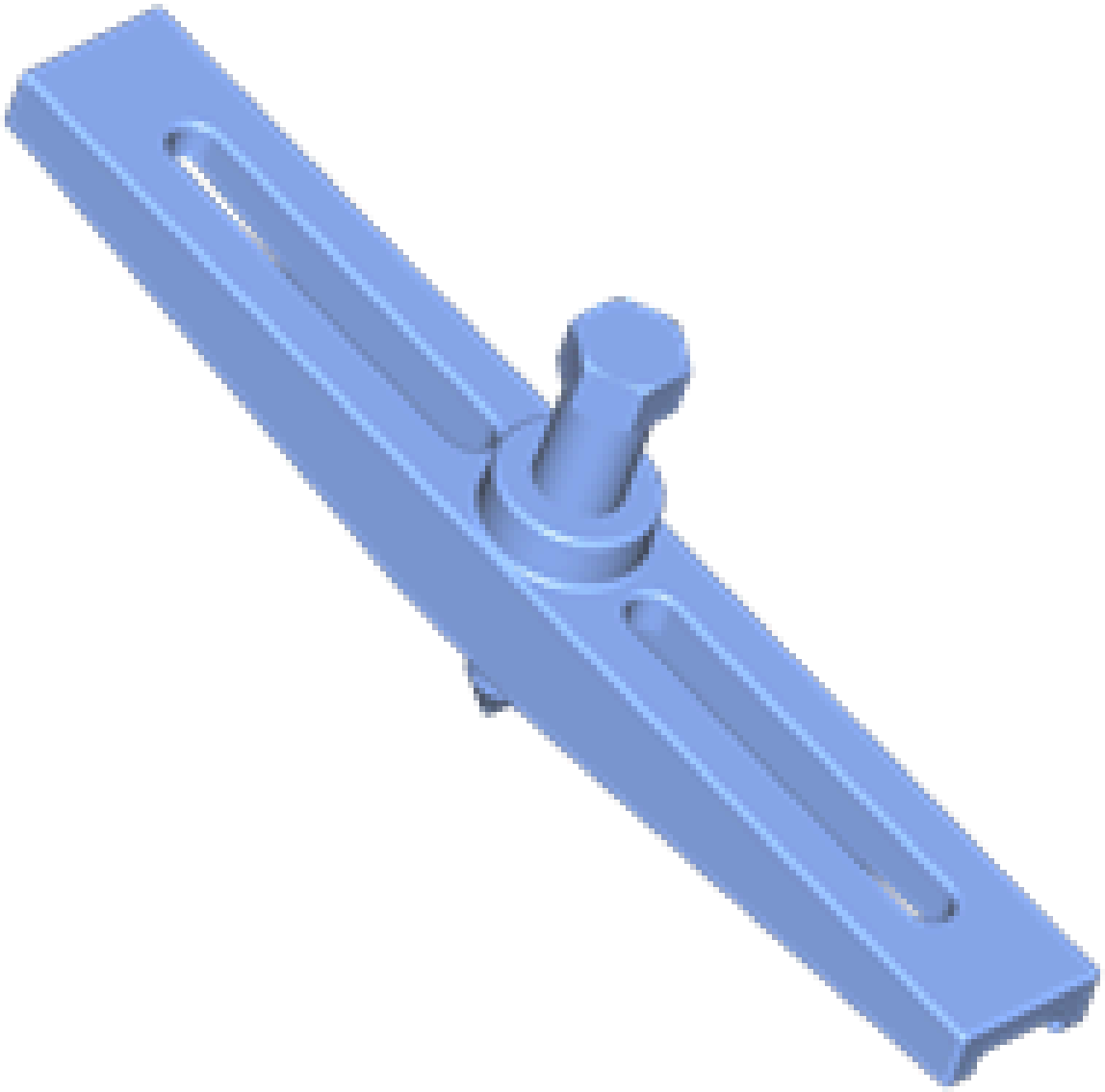	DT 8433-1 J 8433-1 Puller Bar

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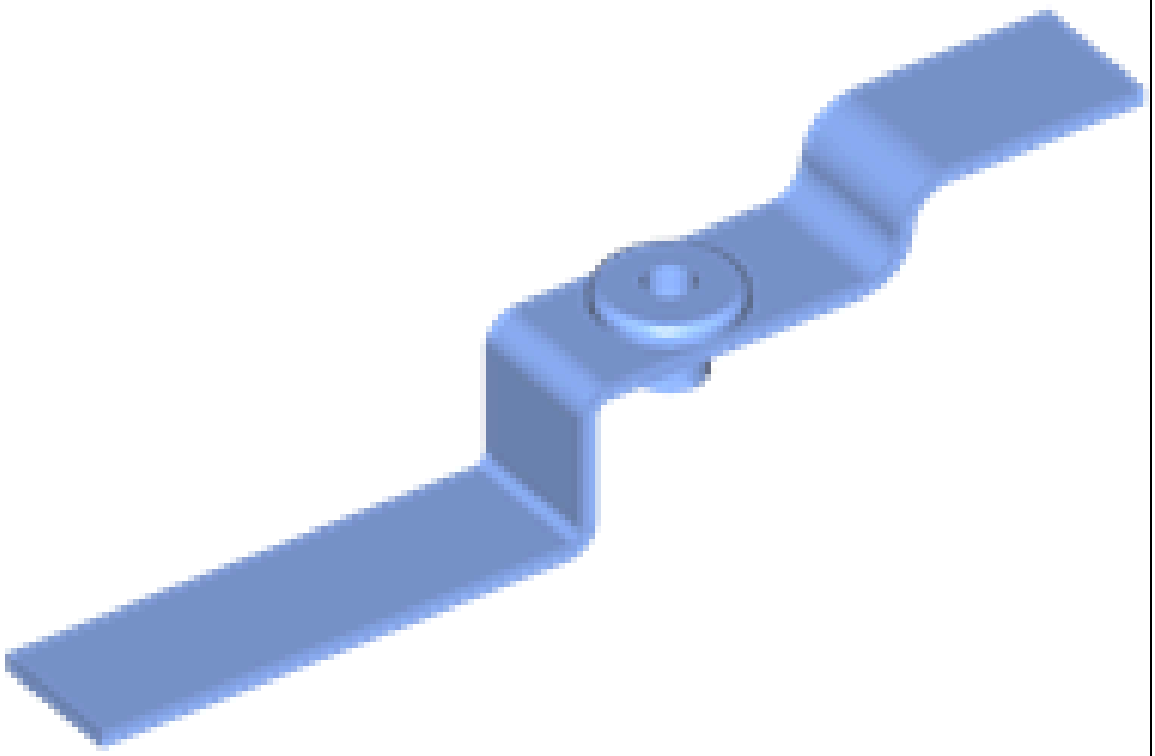	DT 21366 J 21366 Converter Holding Strap

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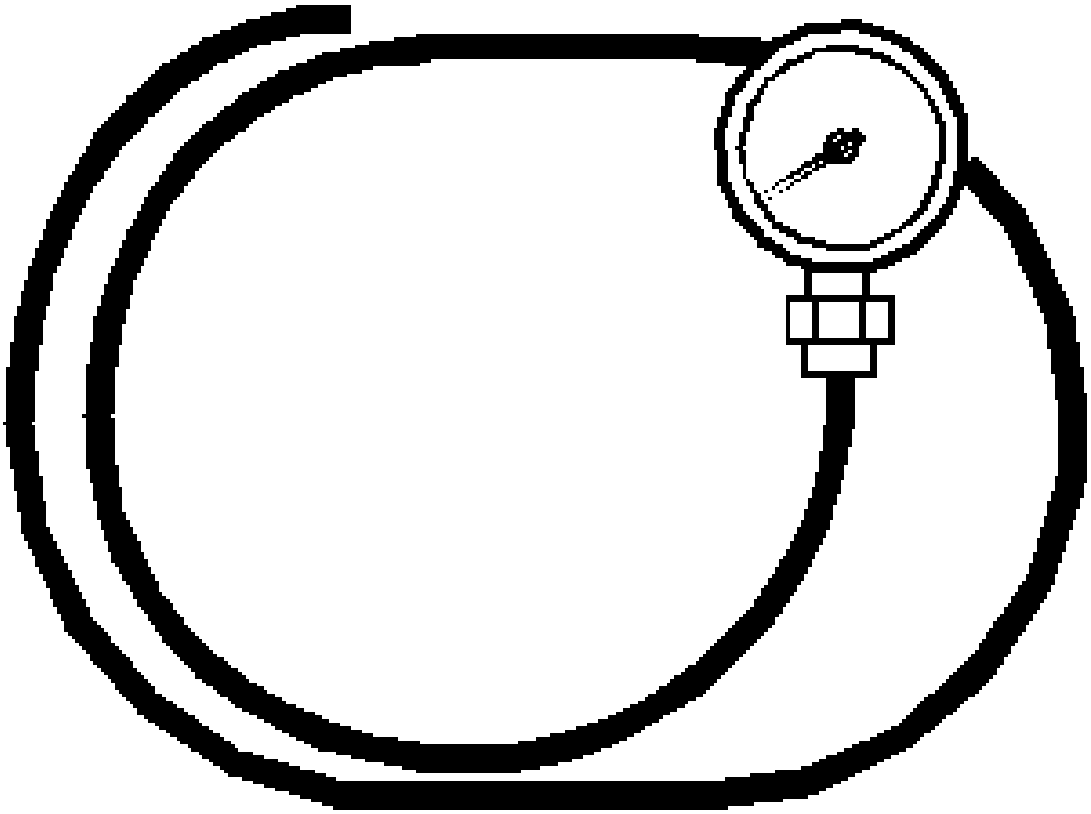	DT 21867-A J 21867-A Pressure Gauge

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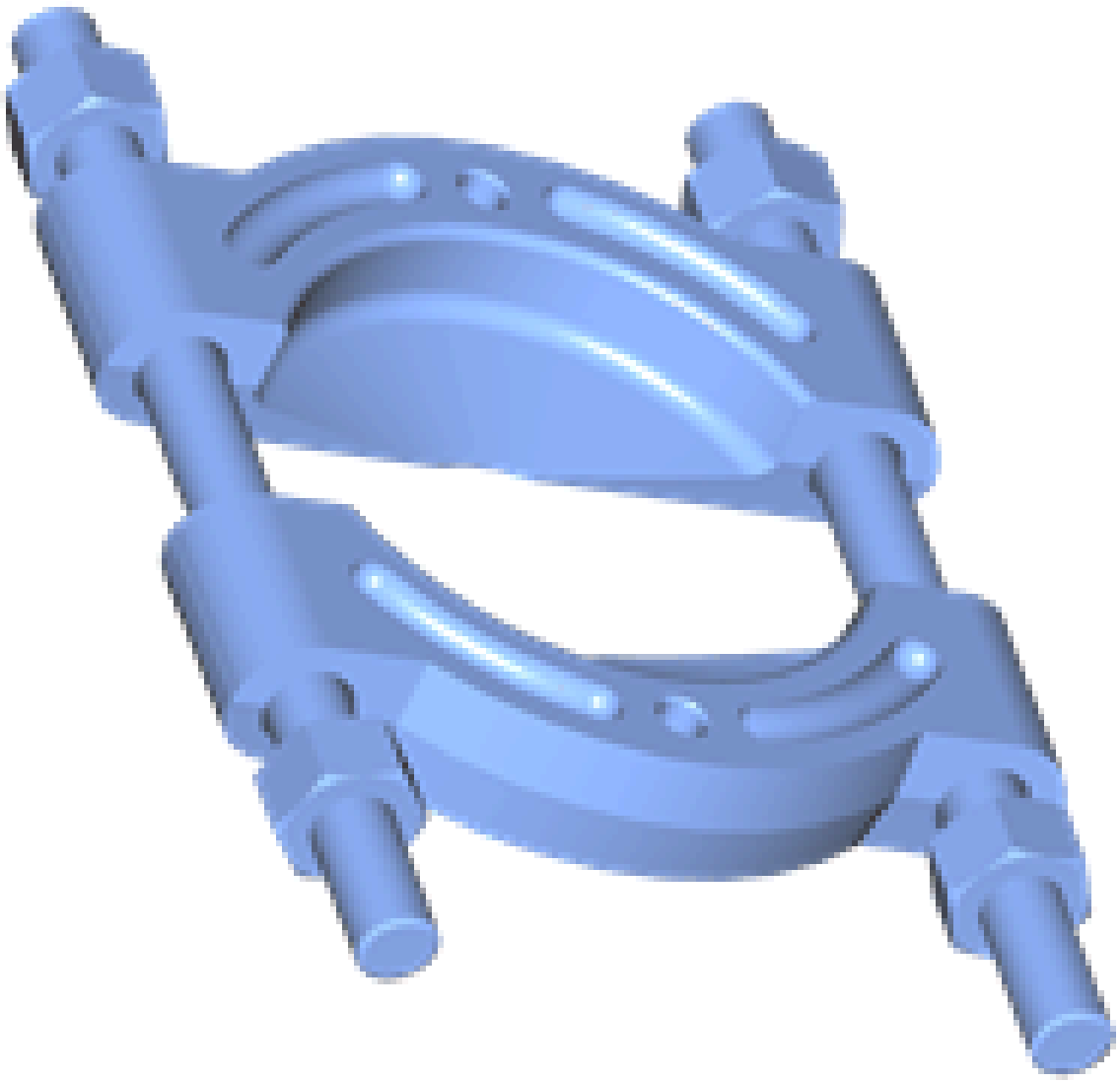	DT 22912-B J 22912-B Split Plate Bearing Remover

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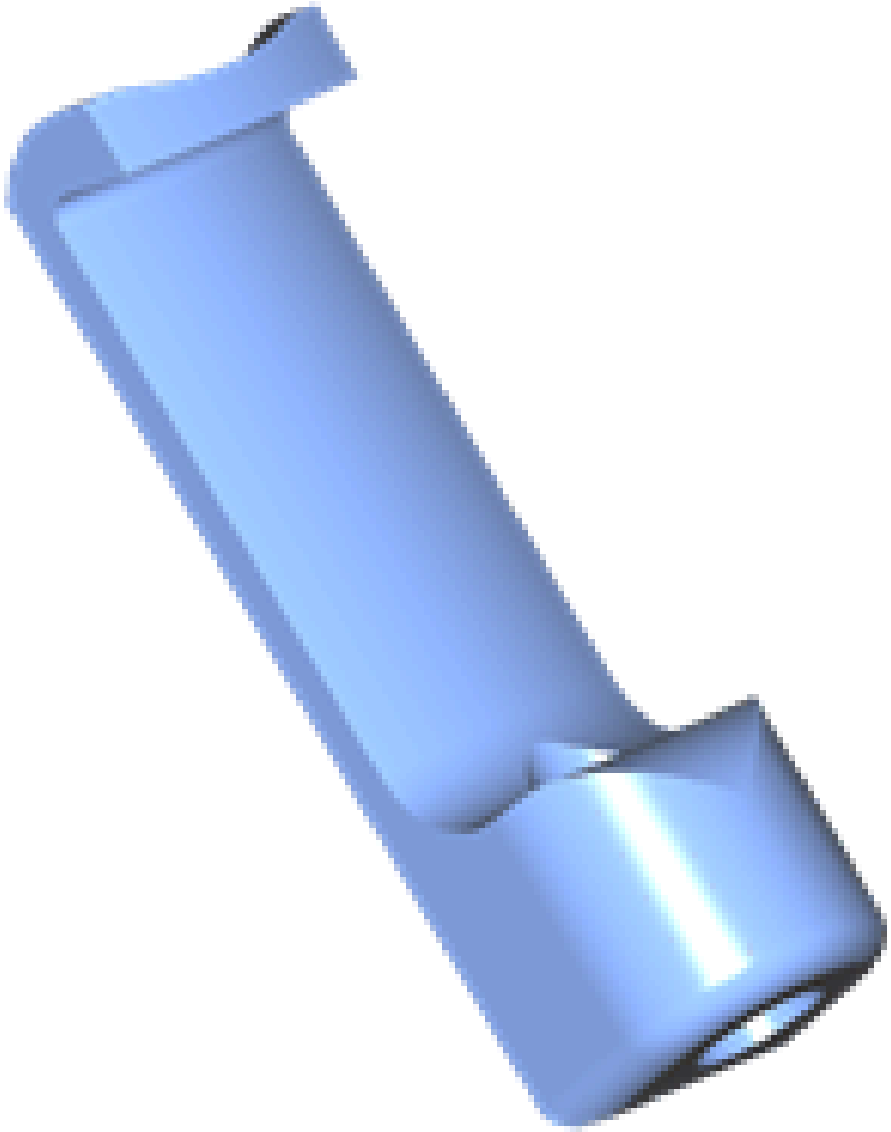	DT 23129 J 23129 KM-586 Universal Seal Remover

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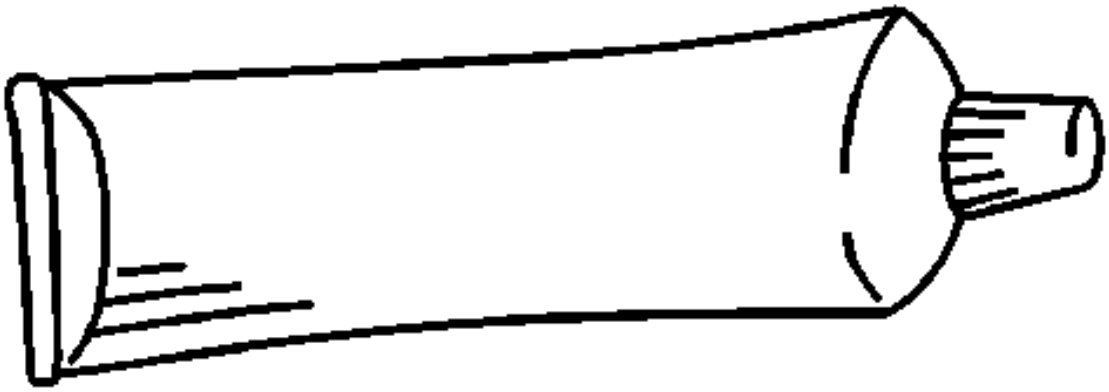	DT 23444-A J 23444-A Extreme Press Lubricant-1/4 Ounce Tube

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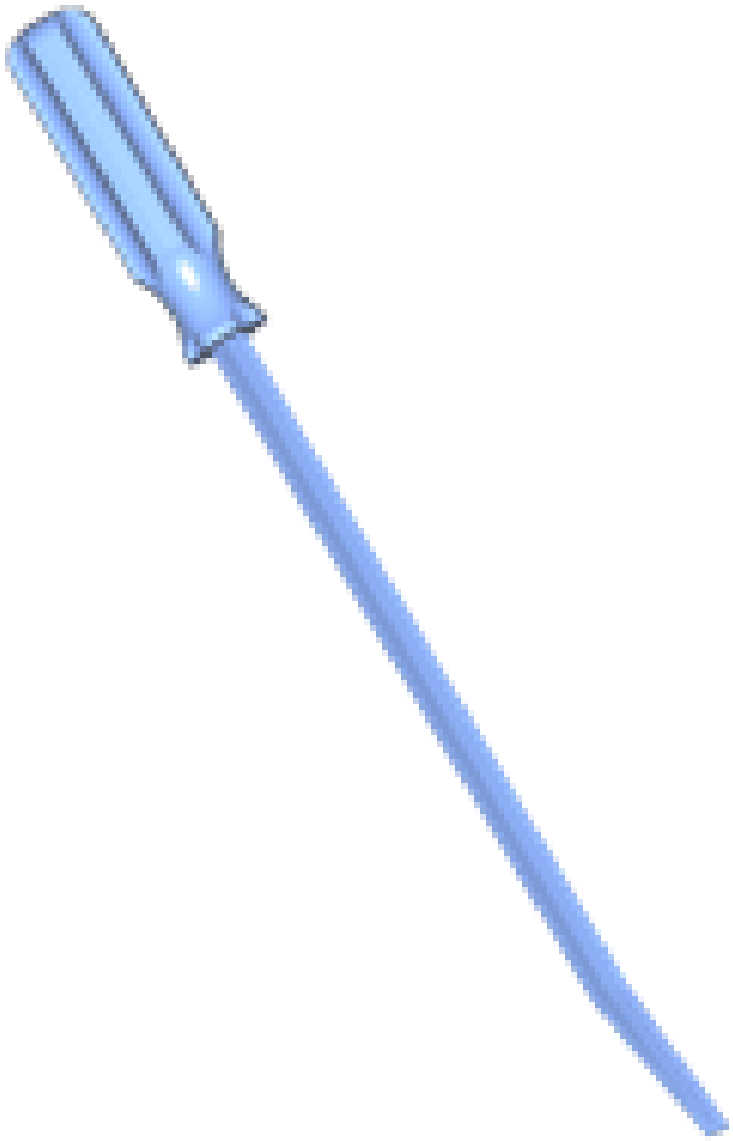	DT 28585 J 28585 Snap Ring Remover

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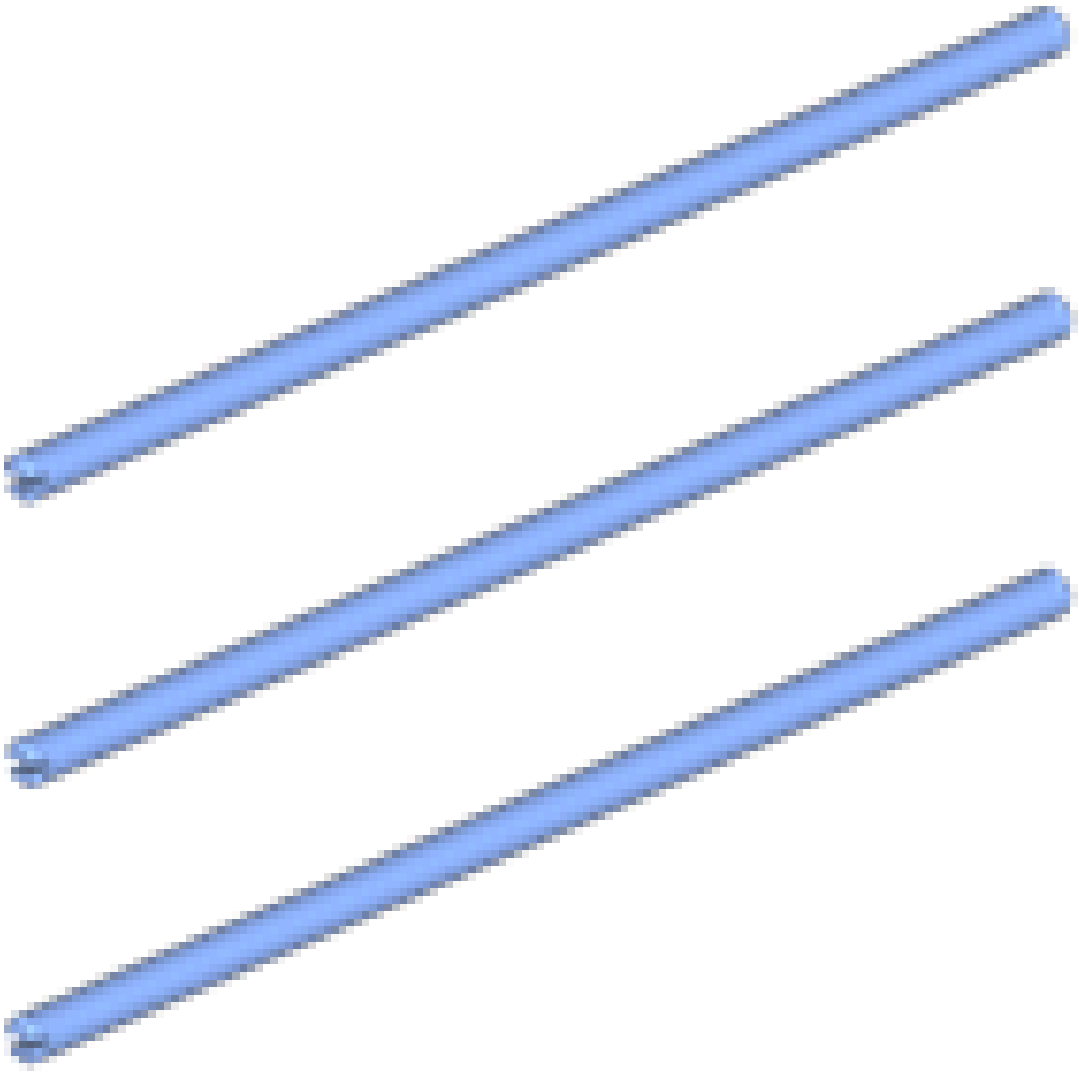	DT 39068 J 39068 Valve Body Guide Pins (3)

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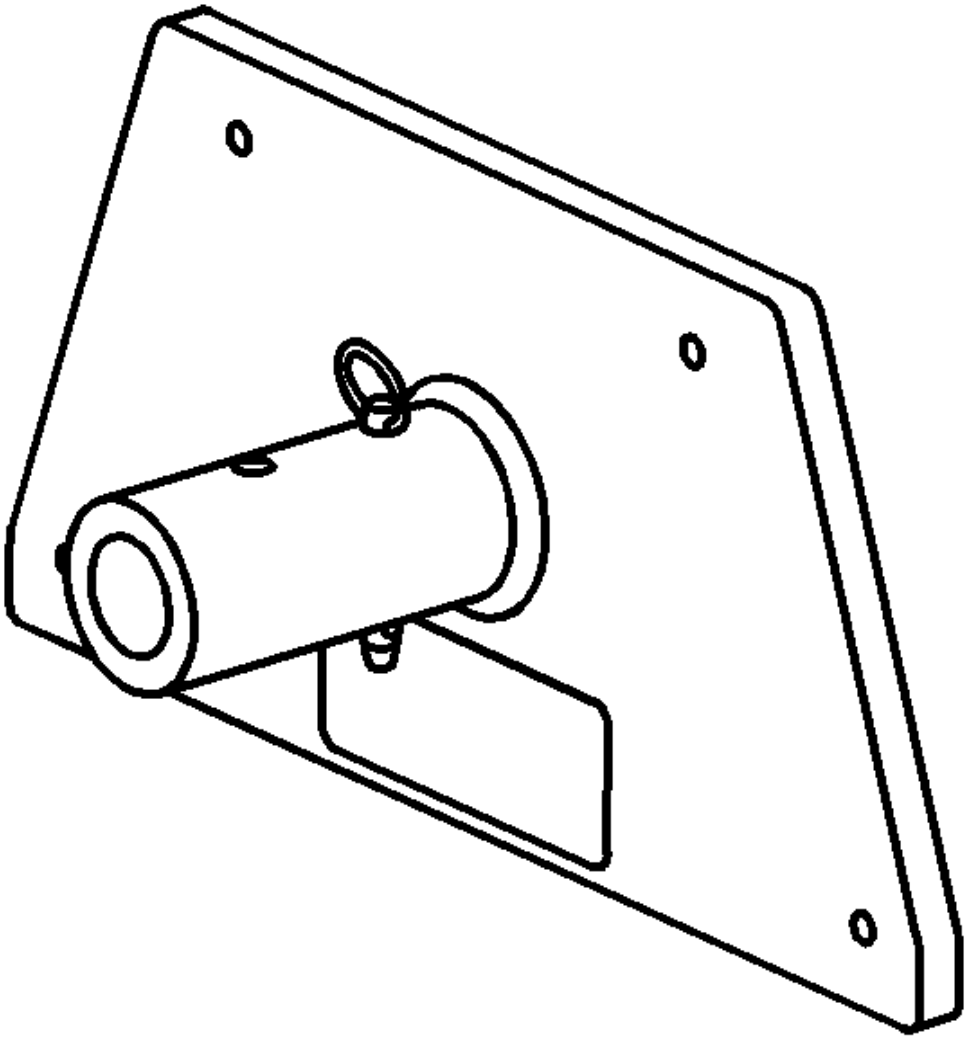	DT 39890 J 39890 Holding Fixture Adapter

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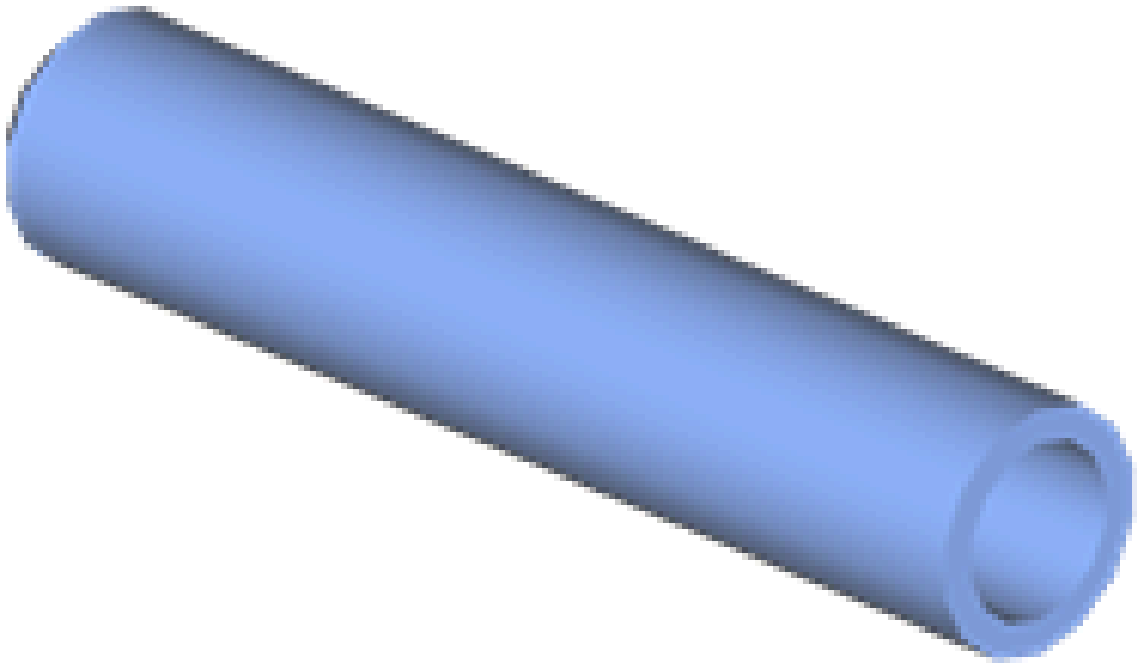	DT 41229 J 41229 Manual Shaft Pin Installer

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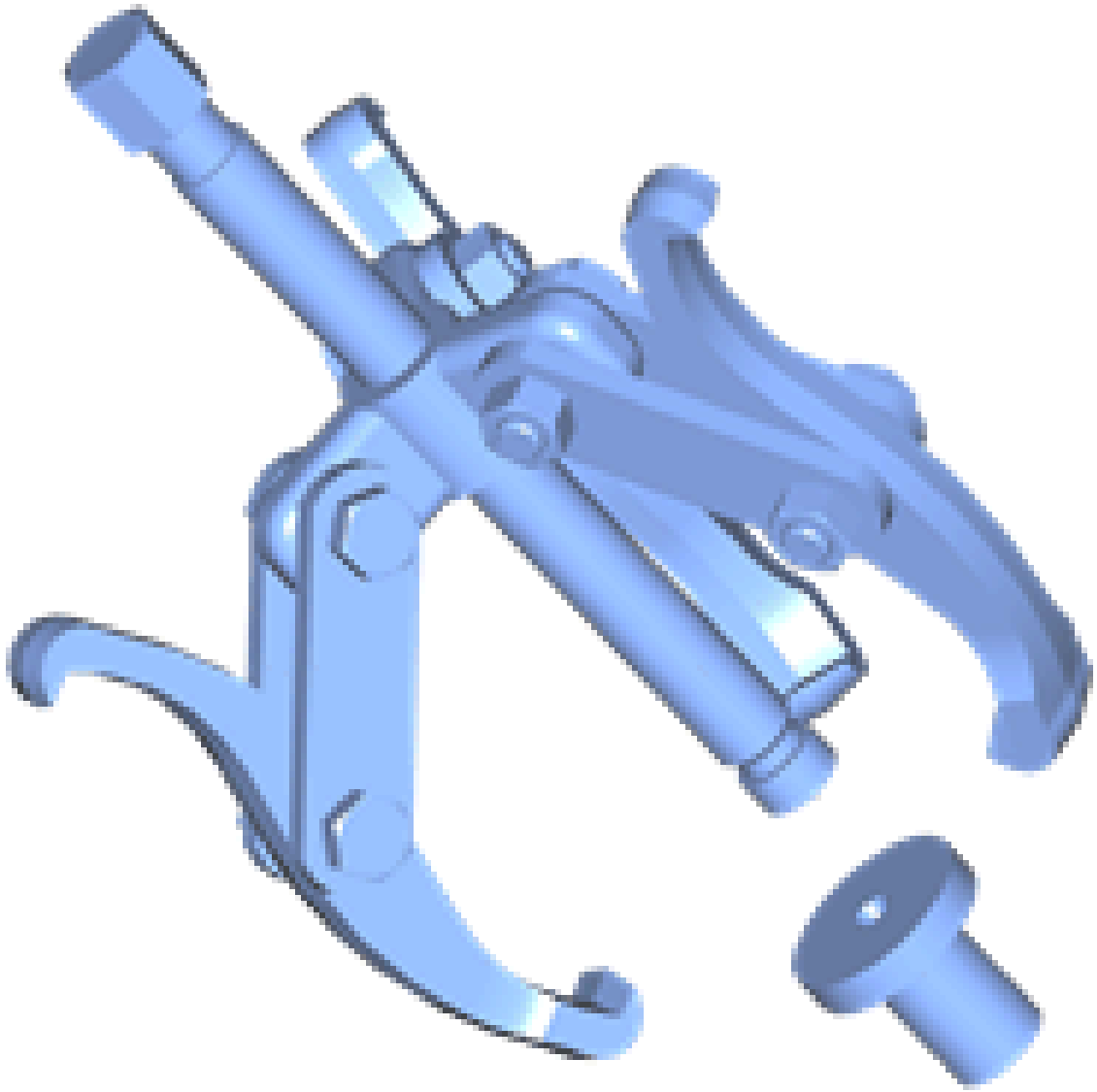	DT 41816 J 41816 Three Legged Puller

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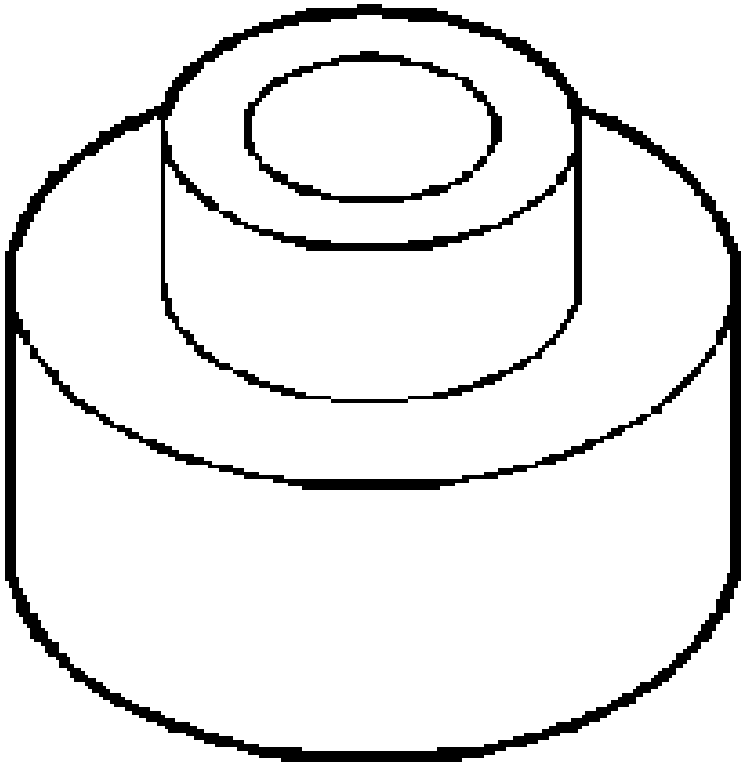	DT 41816-2 J 41816-2 Crankshaft End Protector

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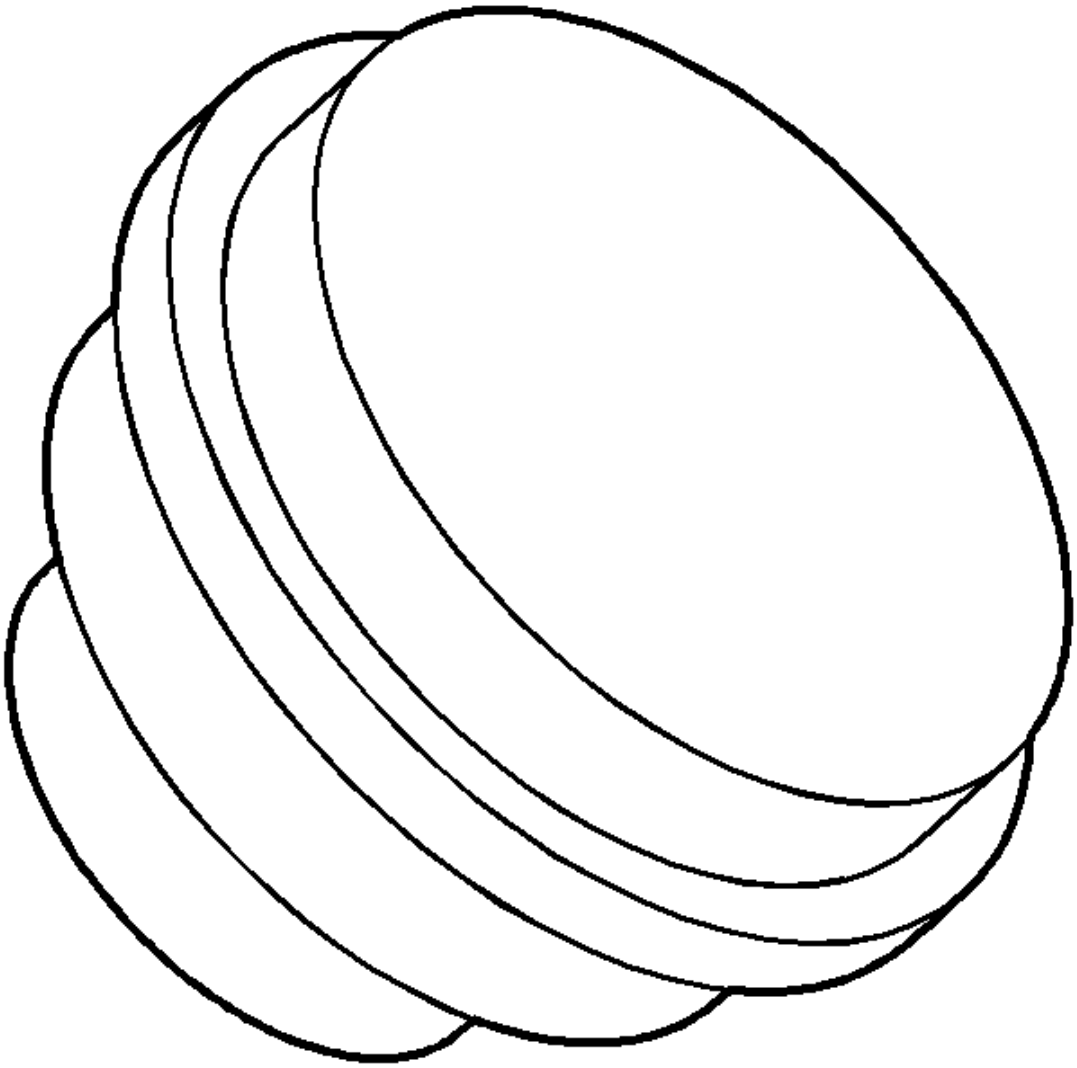	DT 45087 J 45087 Bearing Cup Installer

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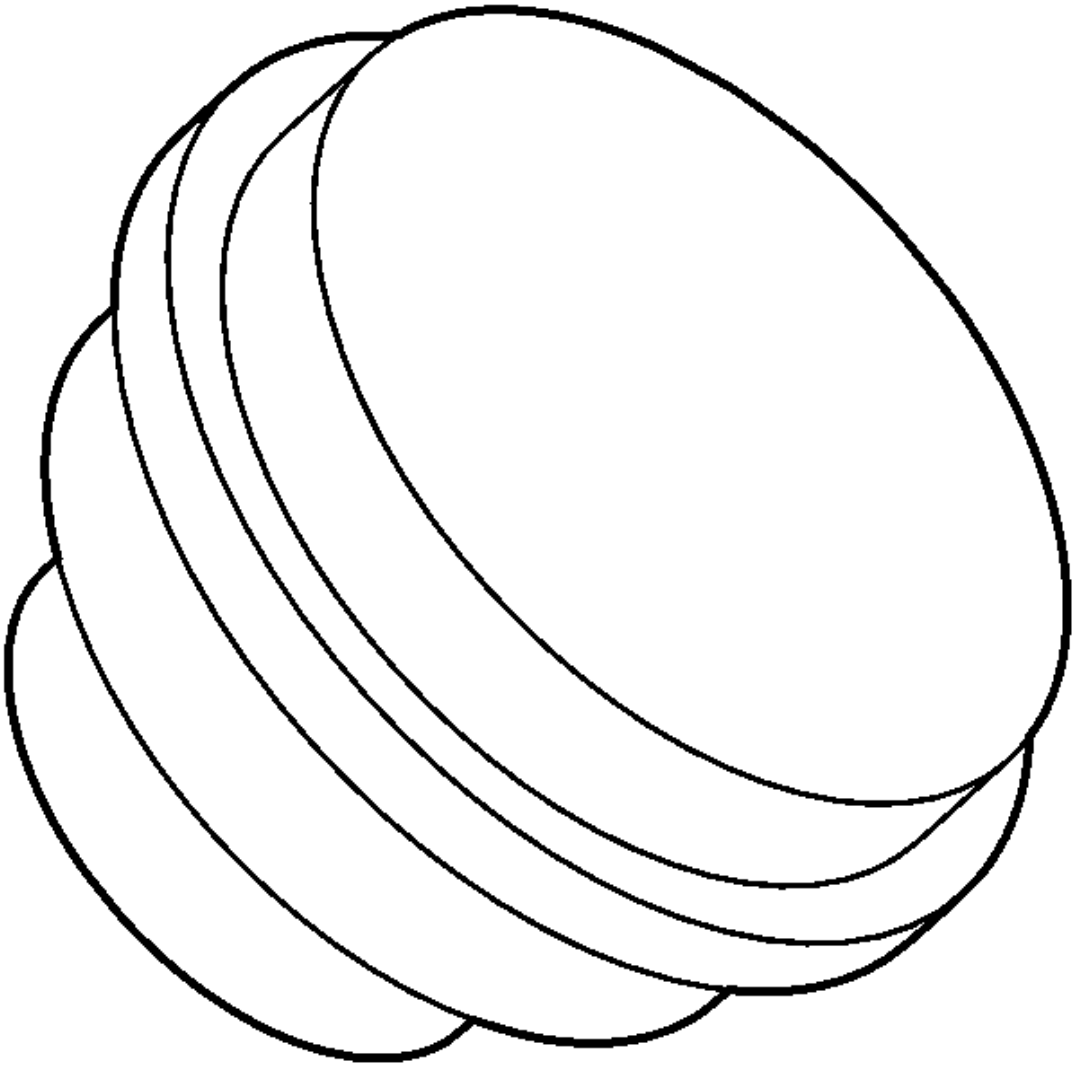	DT 45087-A Bearing Cup Installer

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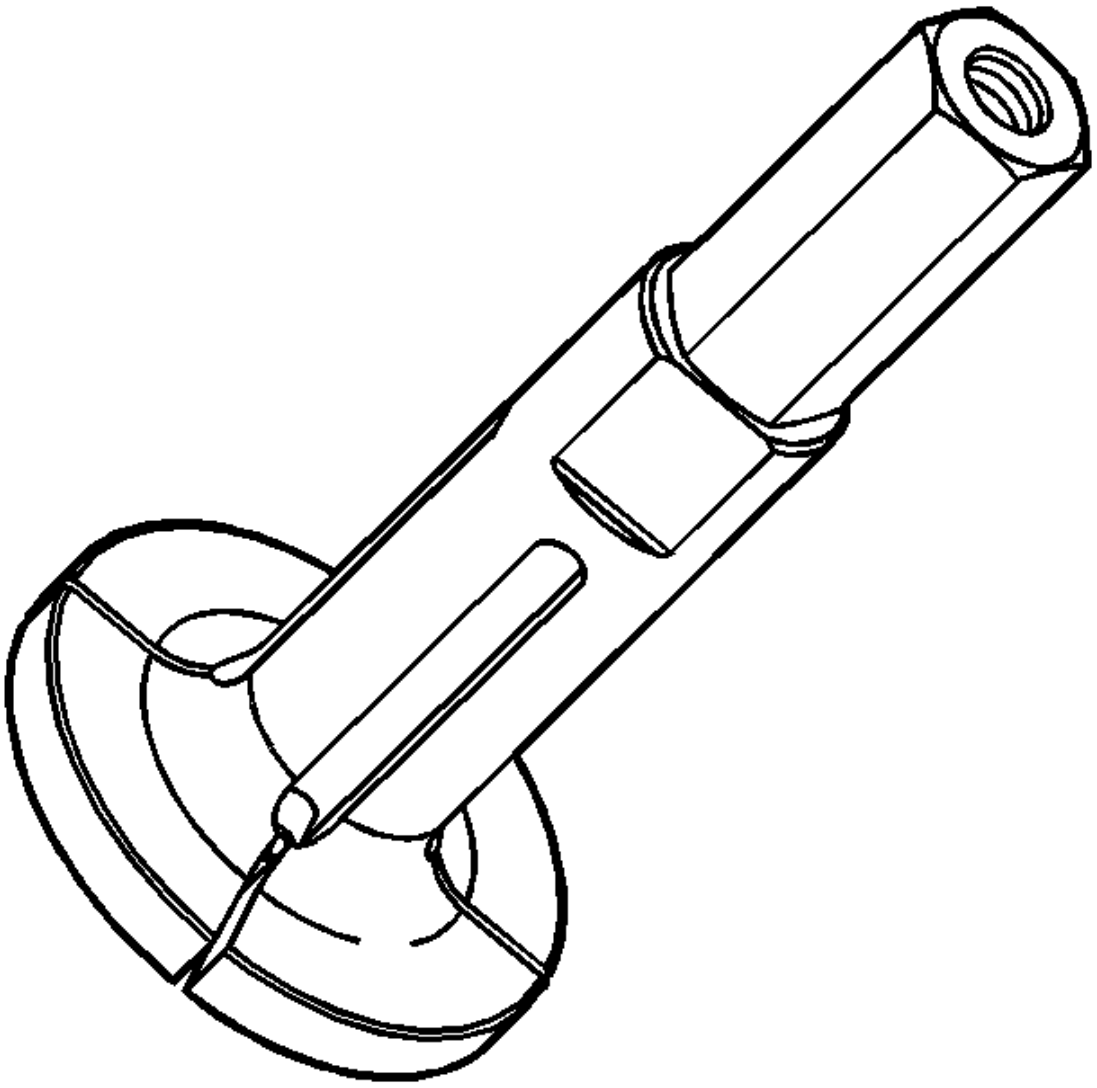	DT 45094 J 45094 Bearing Cup Remover

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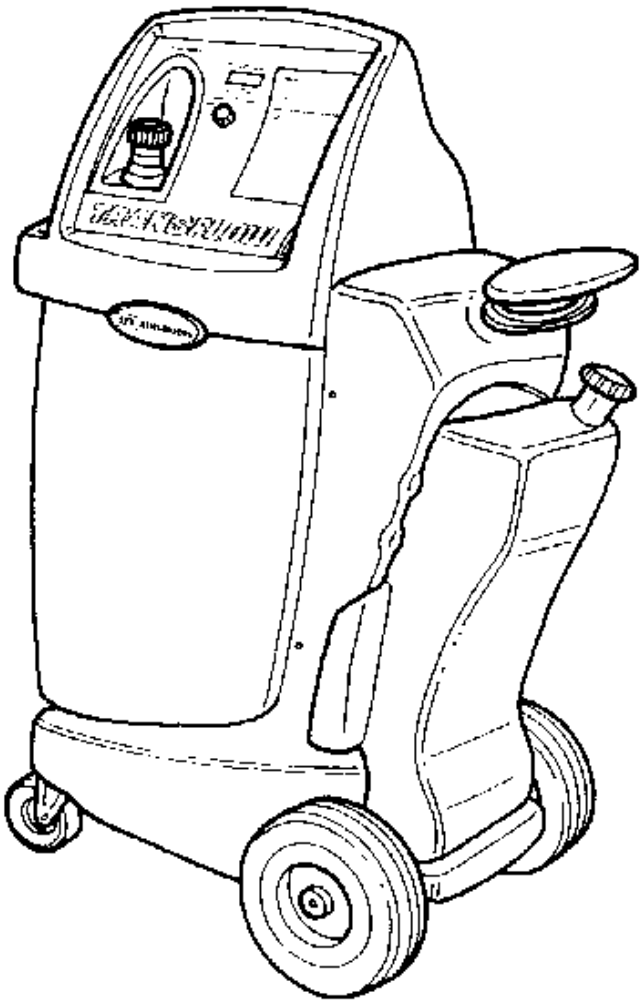	DT 45096 J 45096 Transmission Oil Cooling System Flush and Flow Test Tool

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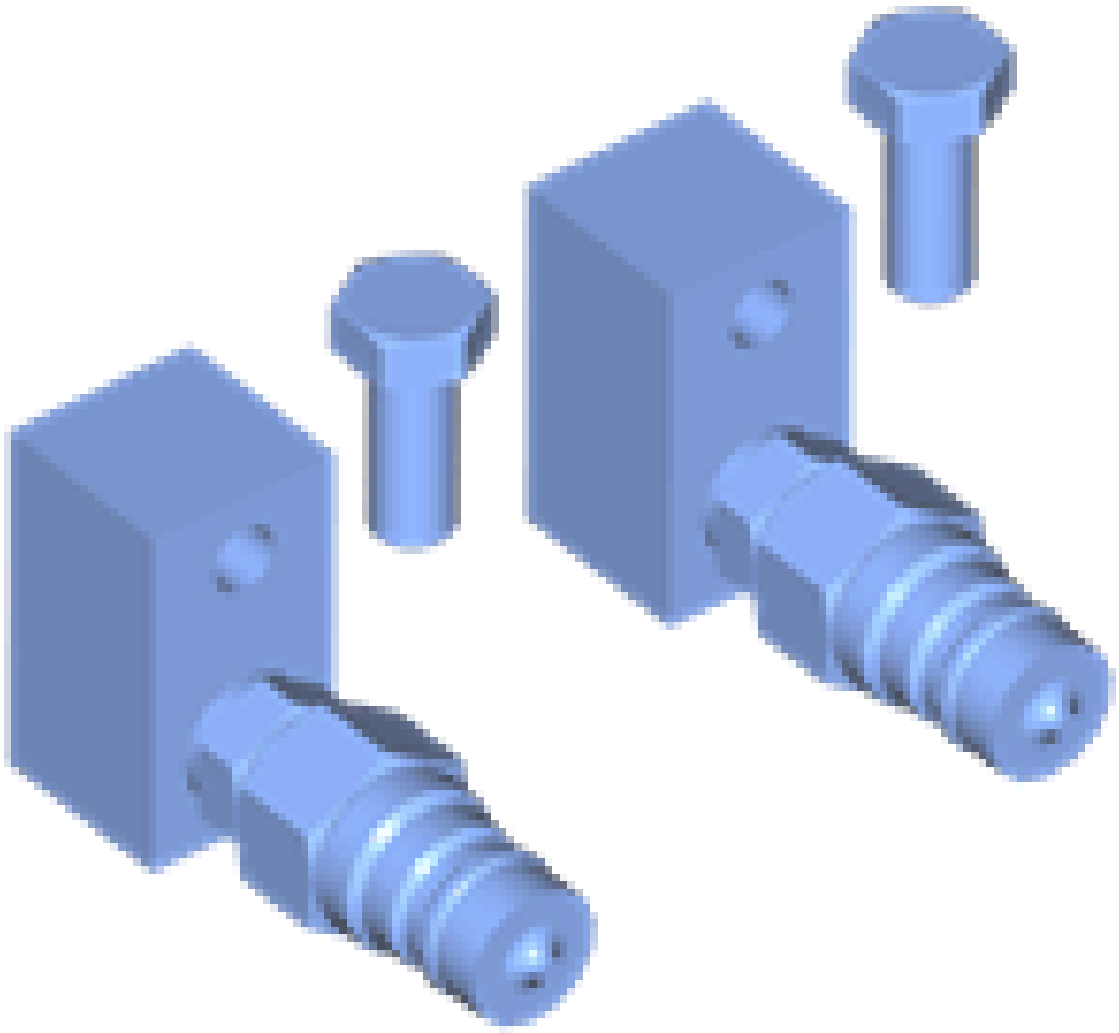	DT 45096-50 J 45096-50 Transmission Cooler Flush Adapter

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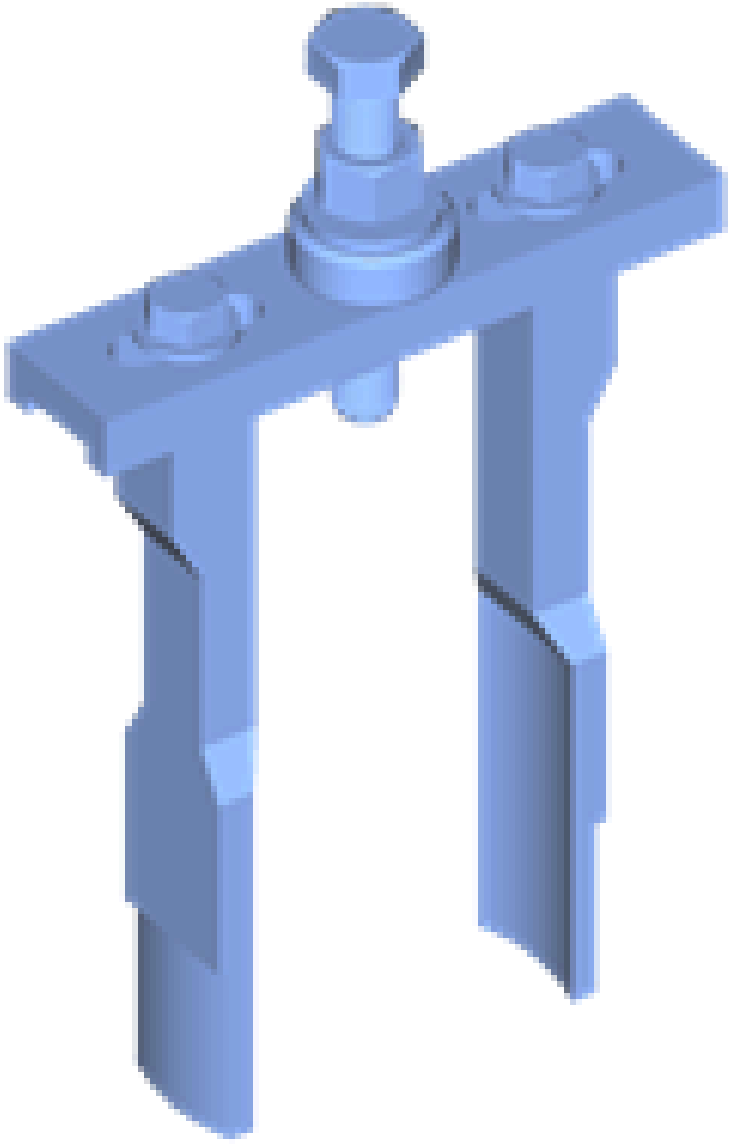	DT 45124 J 45124 Removal Bridge

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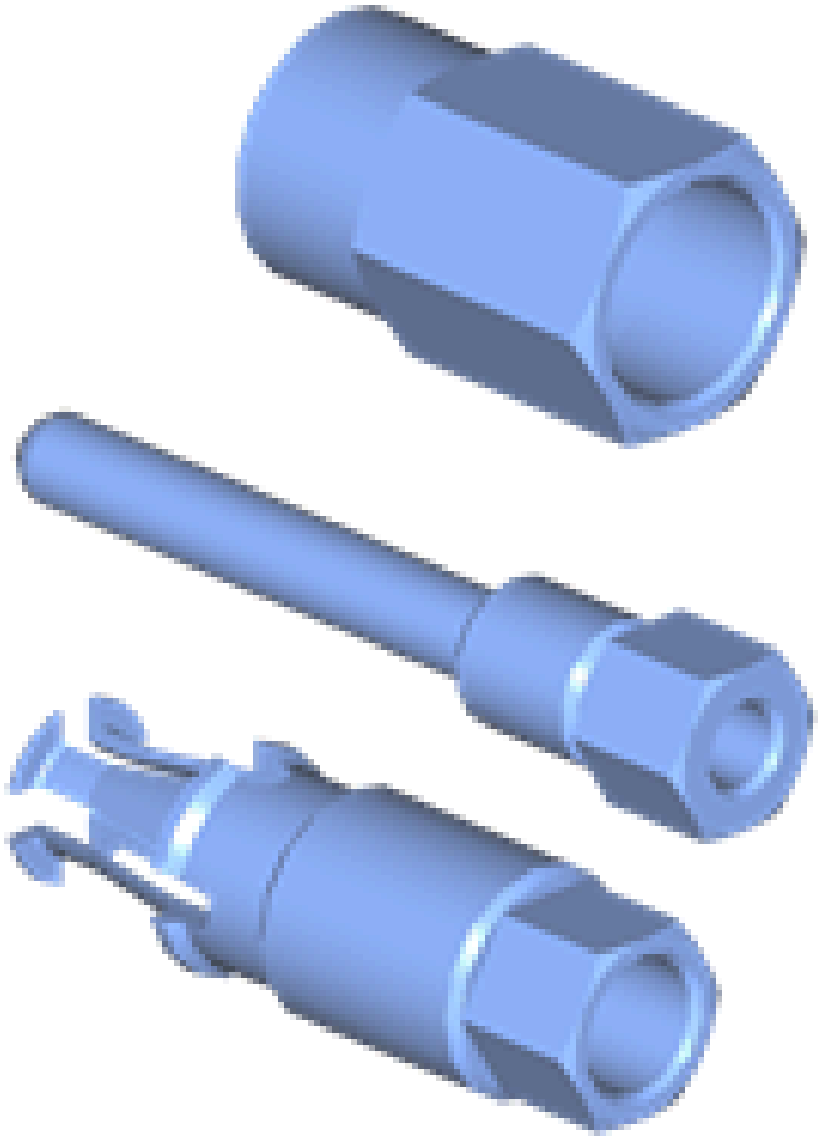	DT 45201 DT 48203 J 45201 Cooler Line Seal Remover

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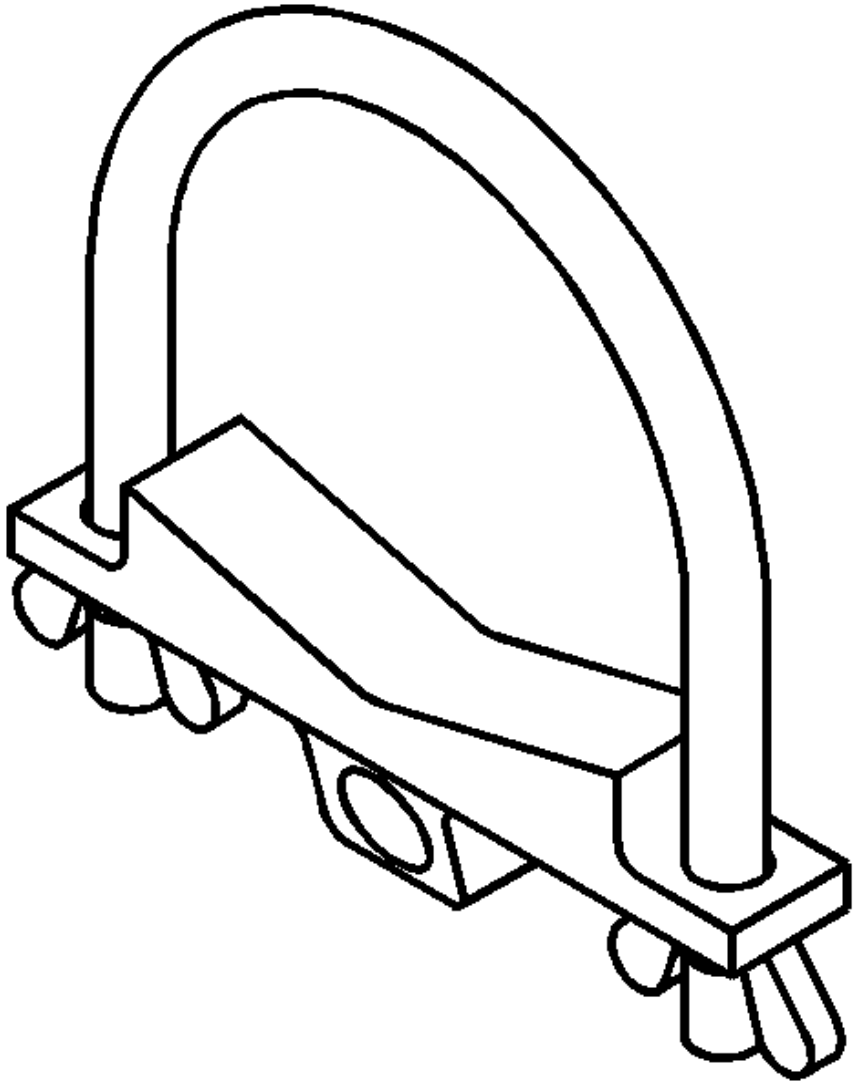	DT 45341 J 45341 Rear Wheel Drive Shaft Removal Tool

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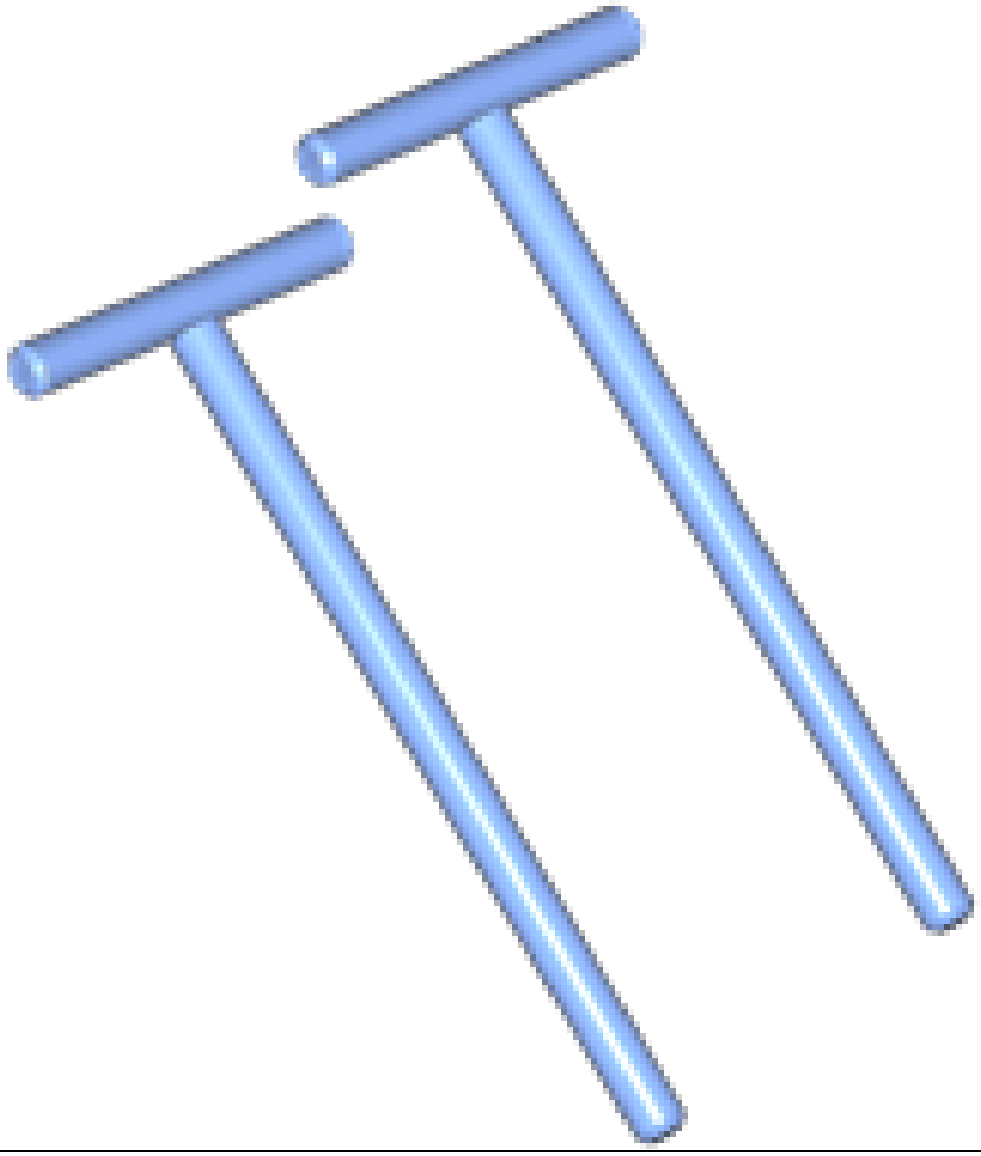	DT 46409 J 46409 KM-922 Torque Converter Lifting Handles

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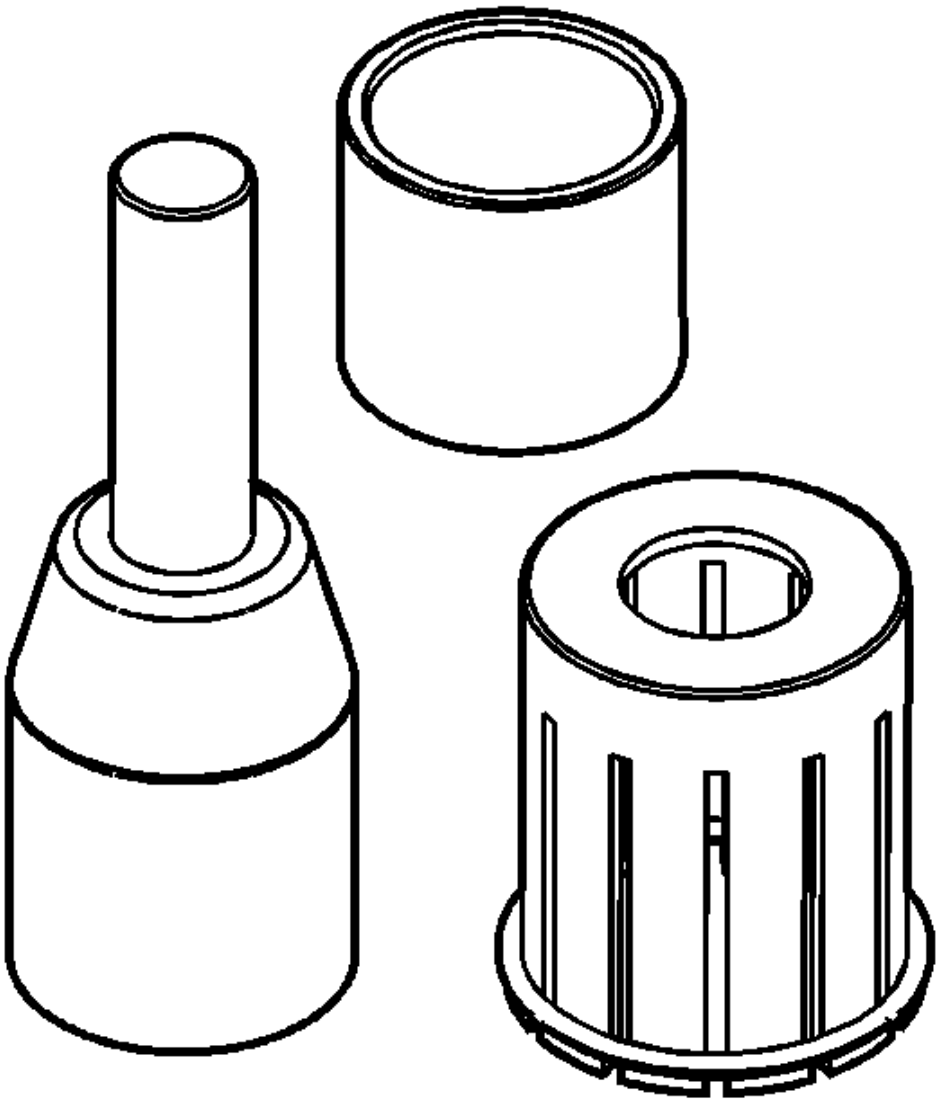	DT 46620 J 46620 Seal Installer

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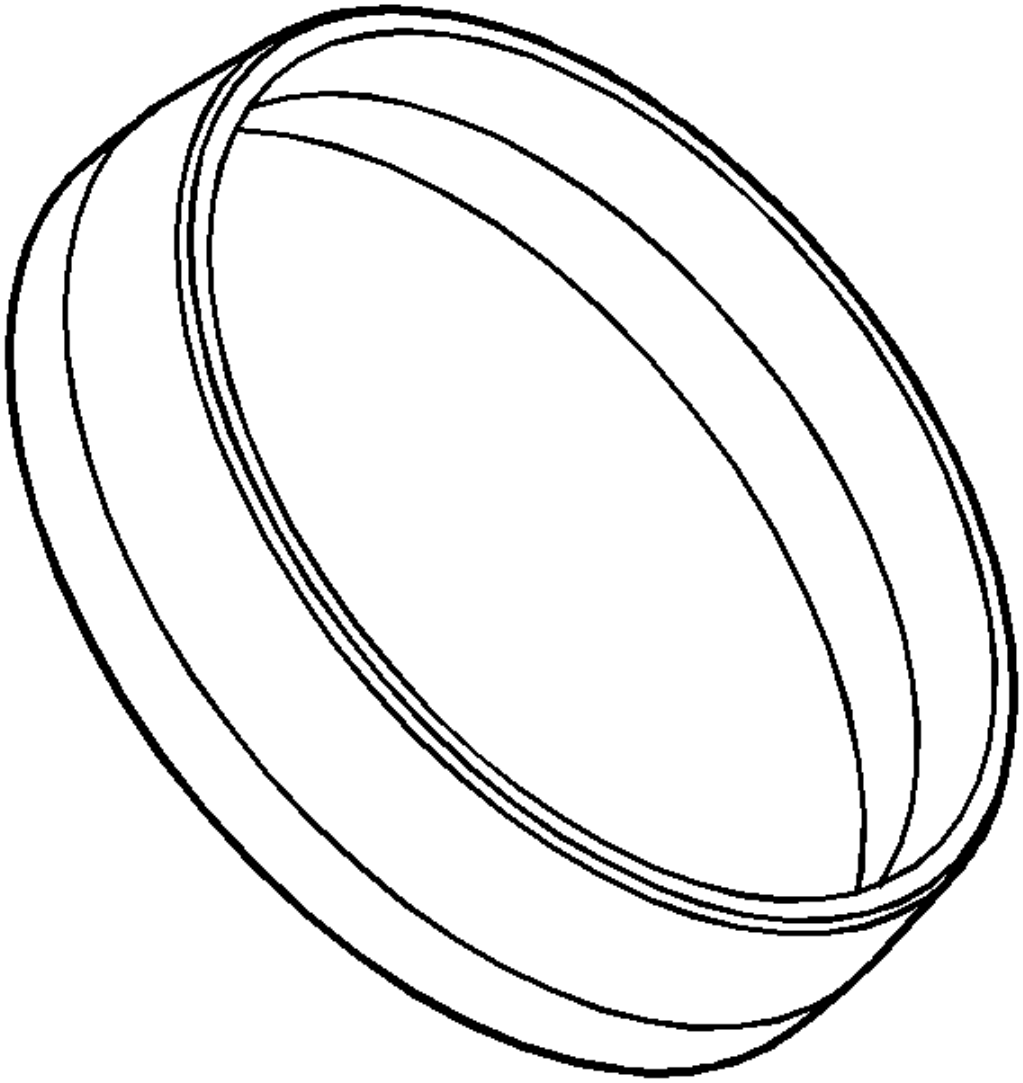	DT 46621 J 46621 Piston Seal Protector

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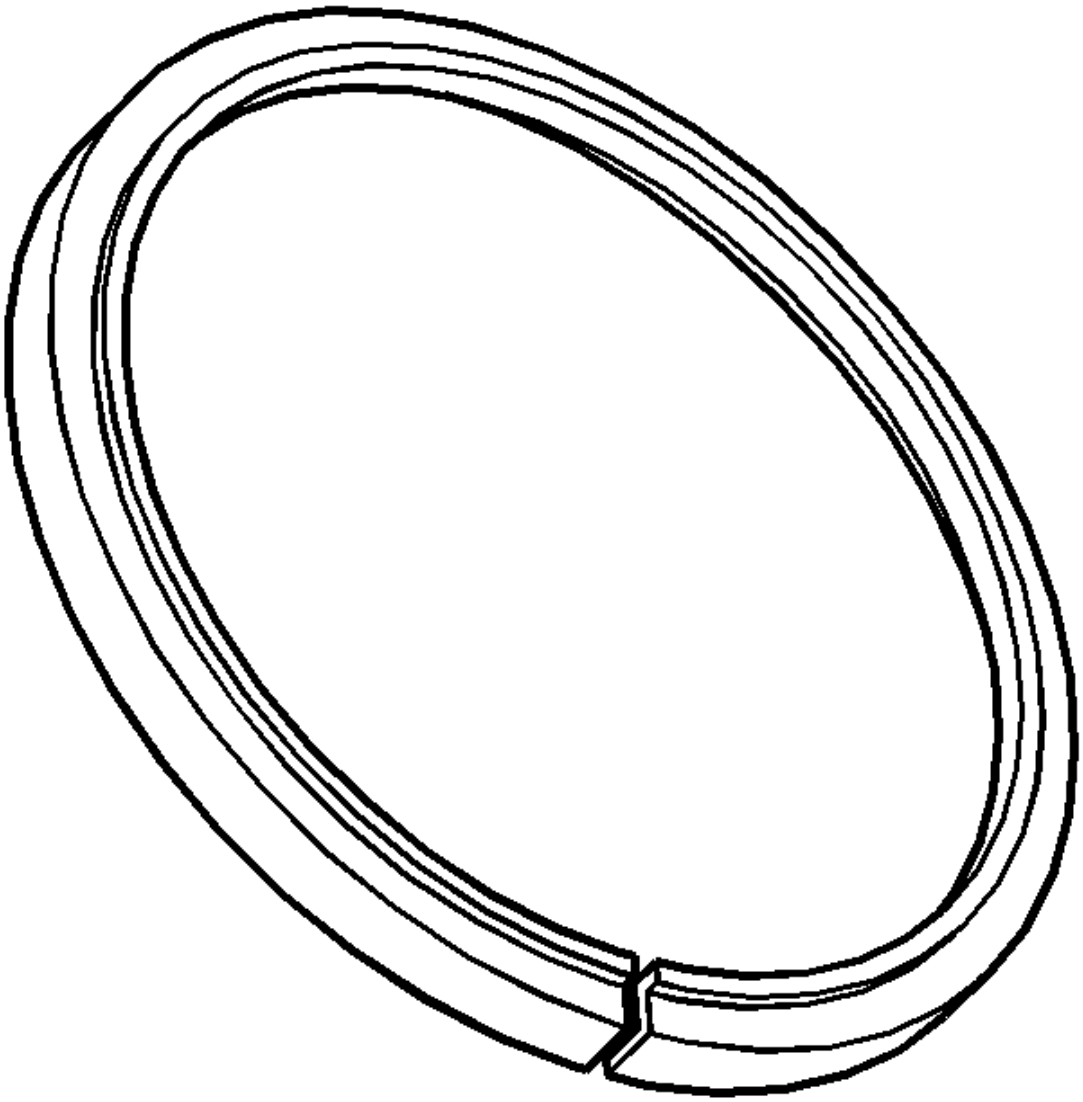	DT 46622 J 46622 Piston Seal Protector

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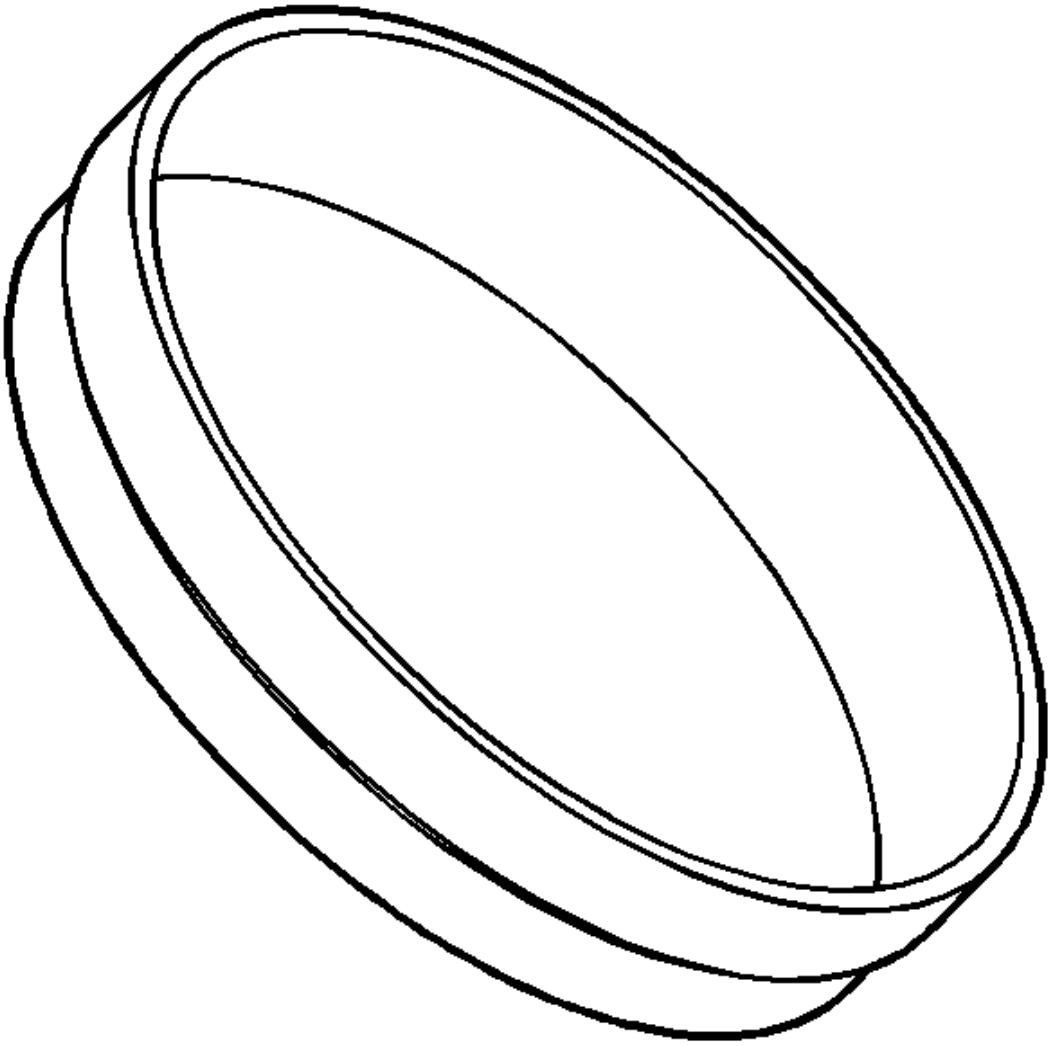	DT 46623 J 46623 Piston Seal Protector

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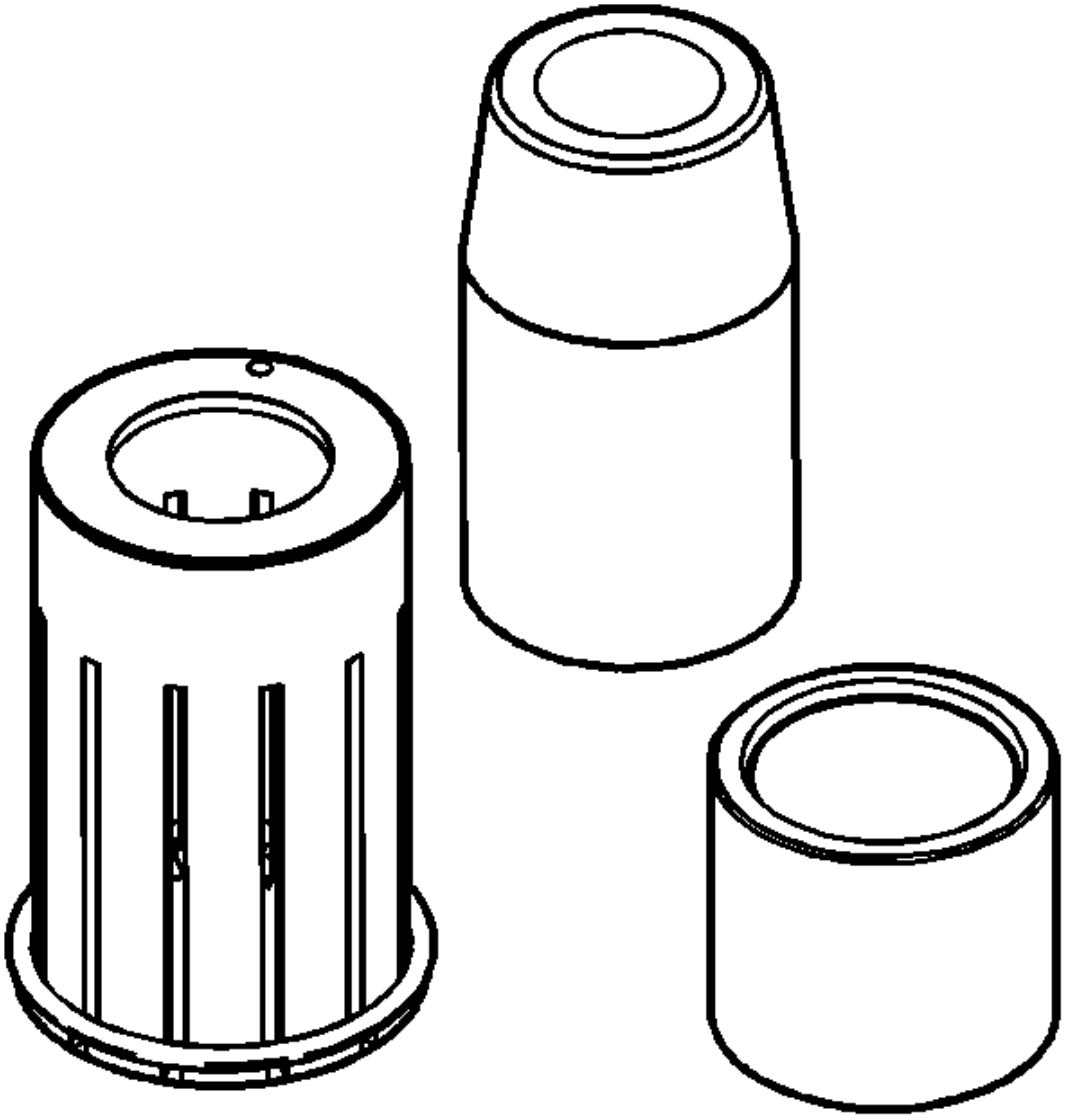	DT 46624 J 46624 Seal Installer

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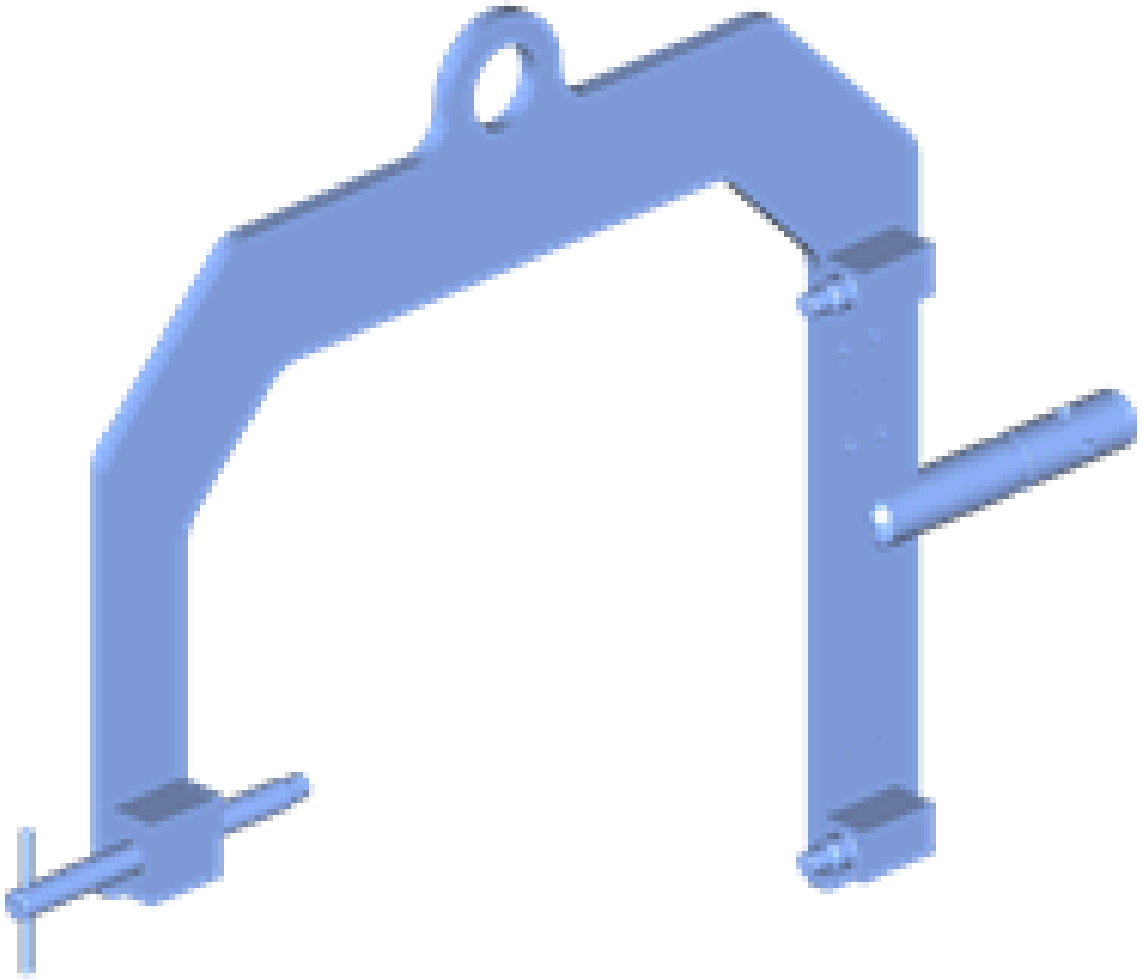	DT 46625 J 46625 Transmission Holding Fixture

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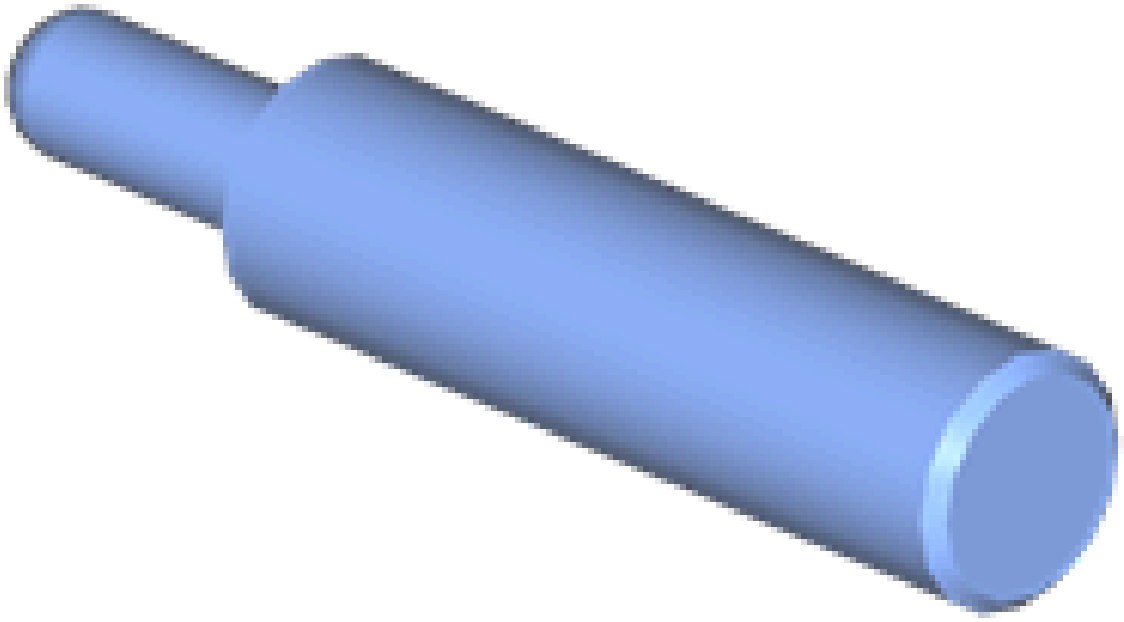	DT 46626 J 46626 Seal Installer

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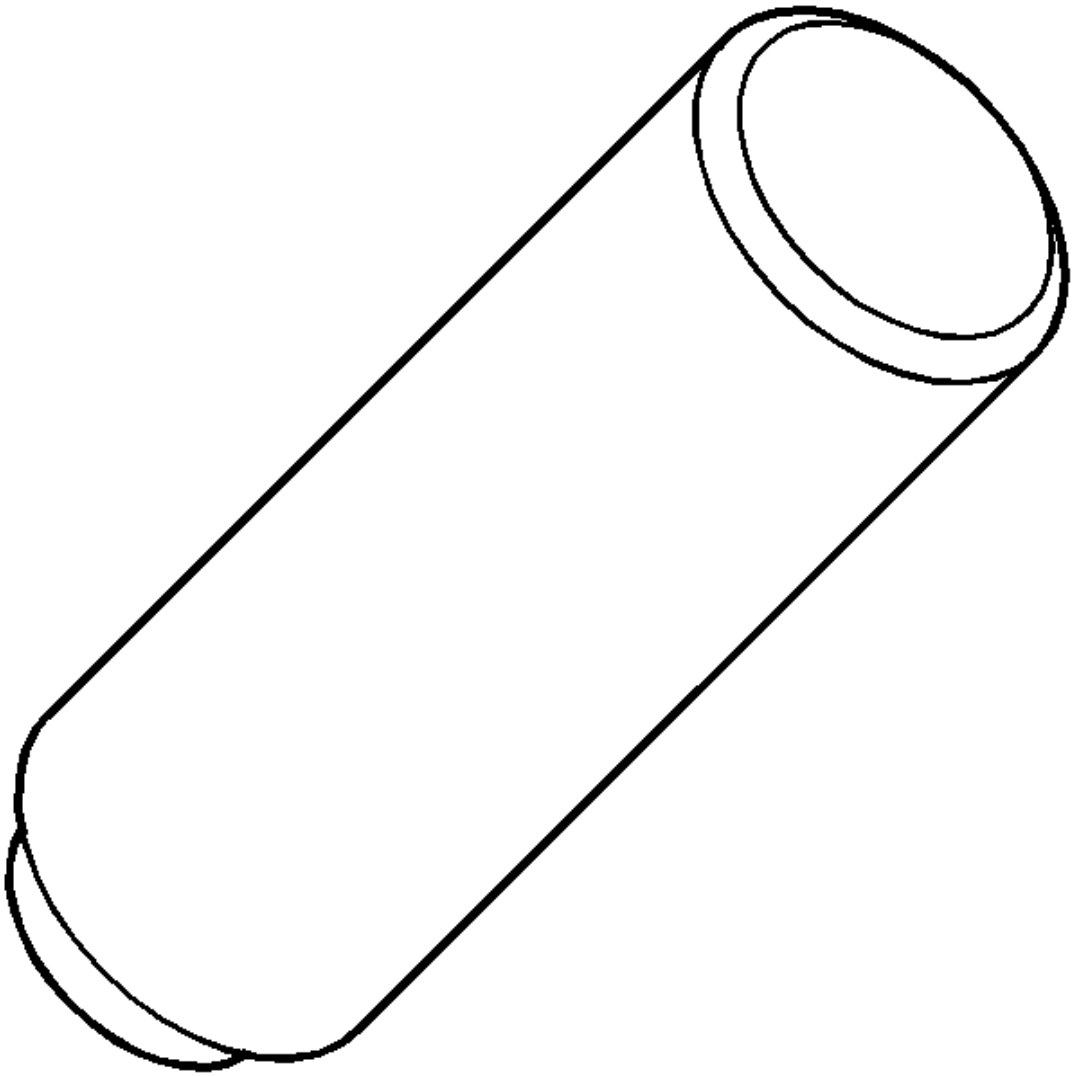	DT 46627-A J 46627-A Seal Installer

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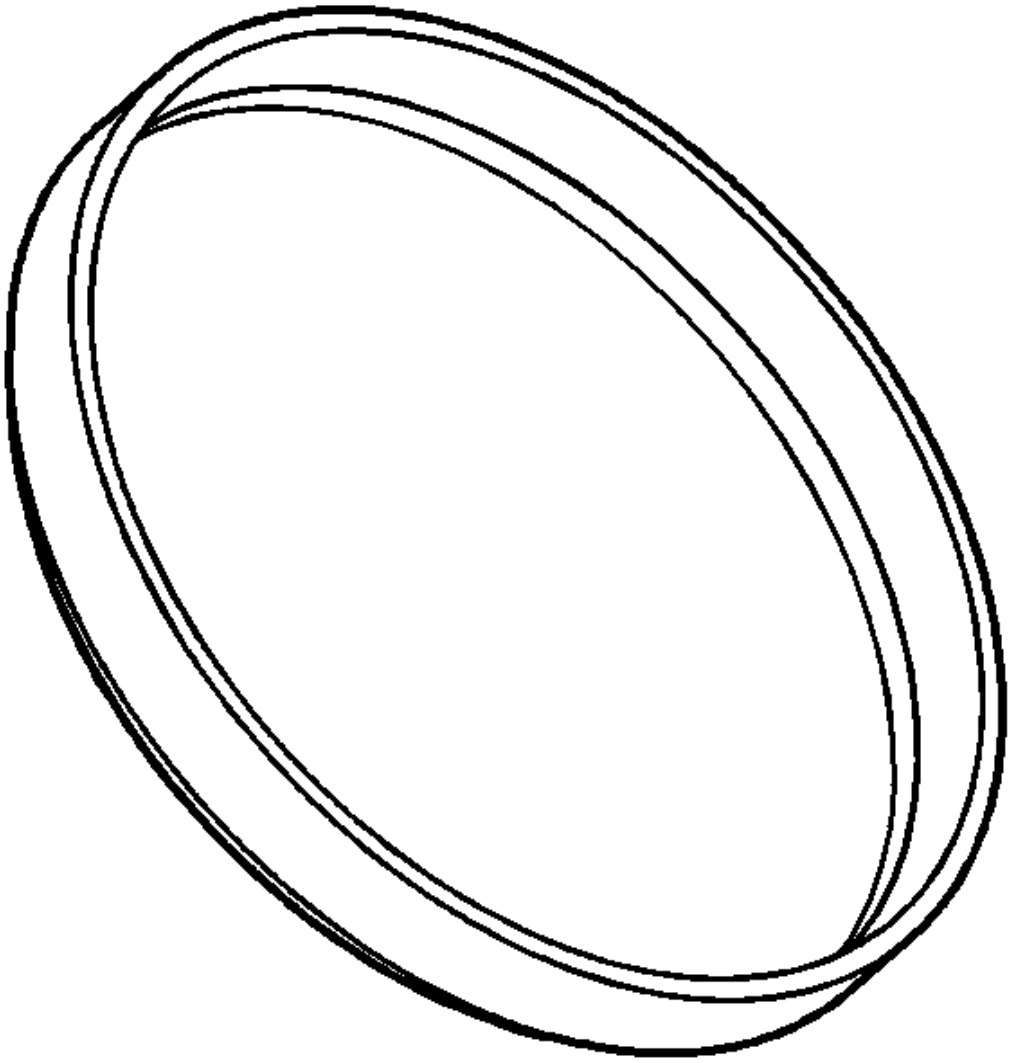	DT 46628-1 J 46628-1 Piston Seal Protector

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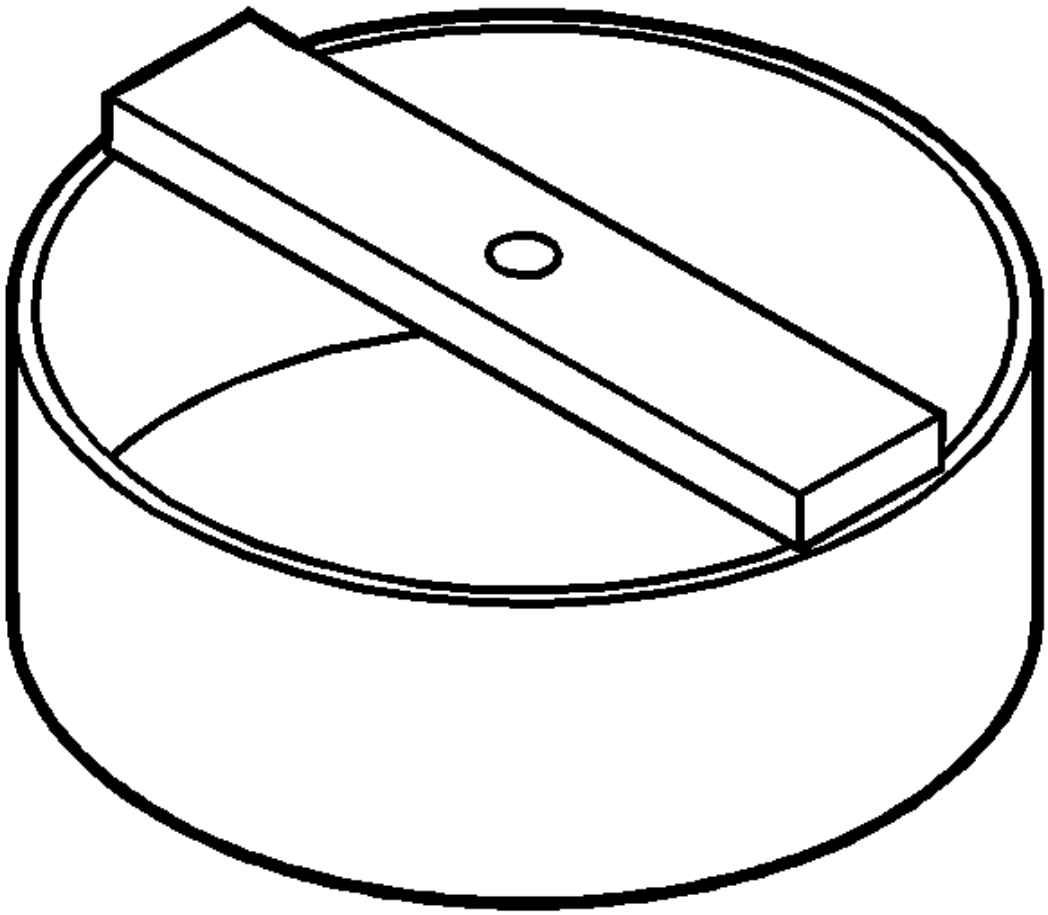	DT 46628-2 J 46628-2 Spring Compressor

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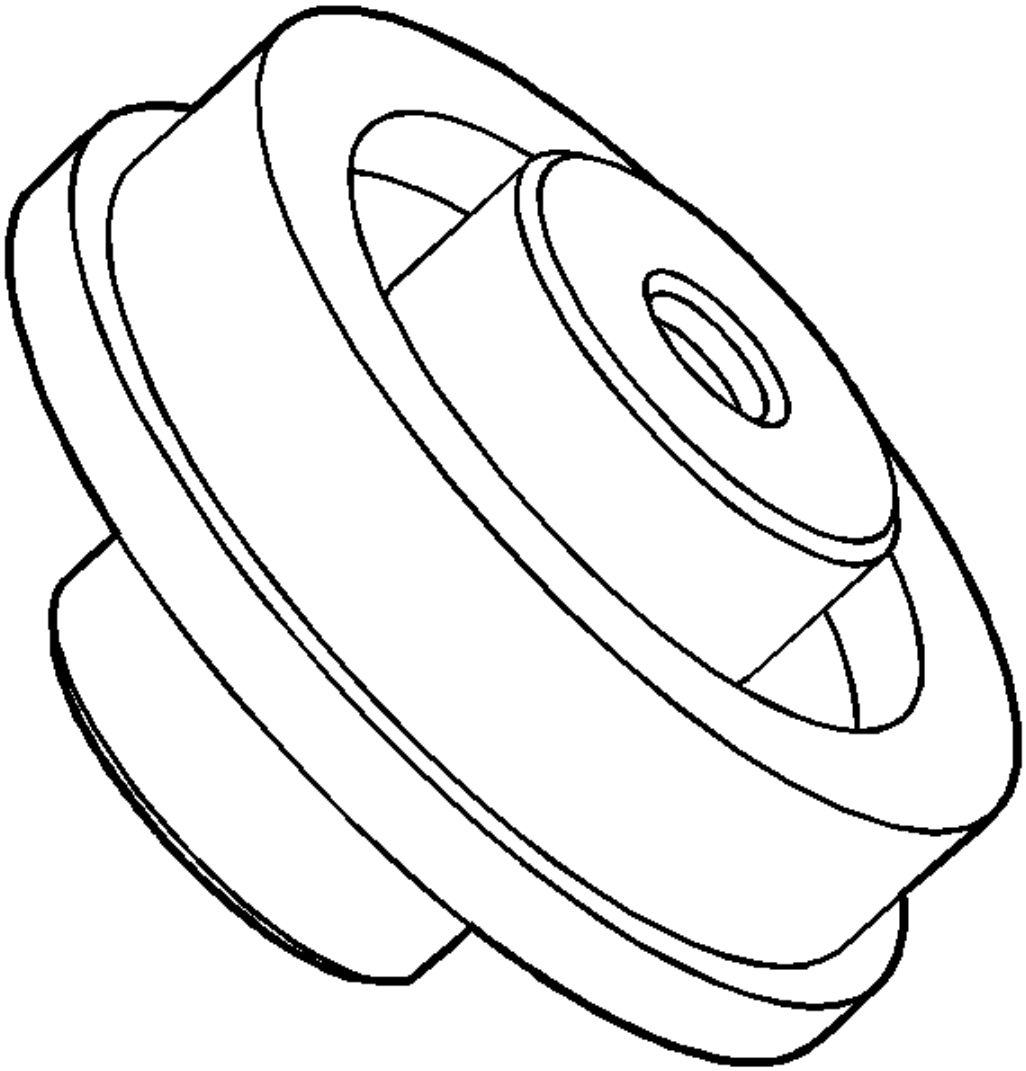	DT 46629-A J 46629-A Seal Installer

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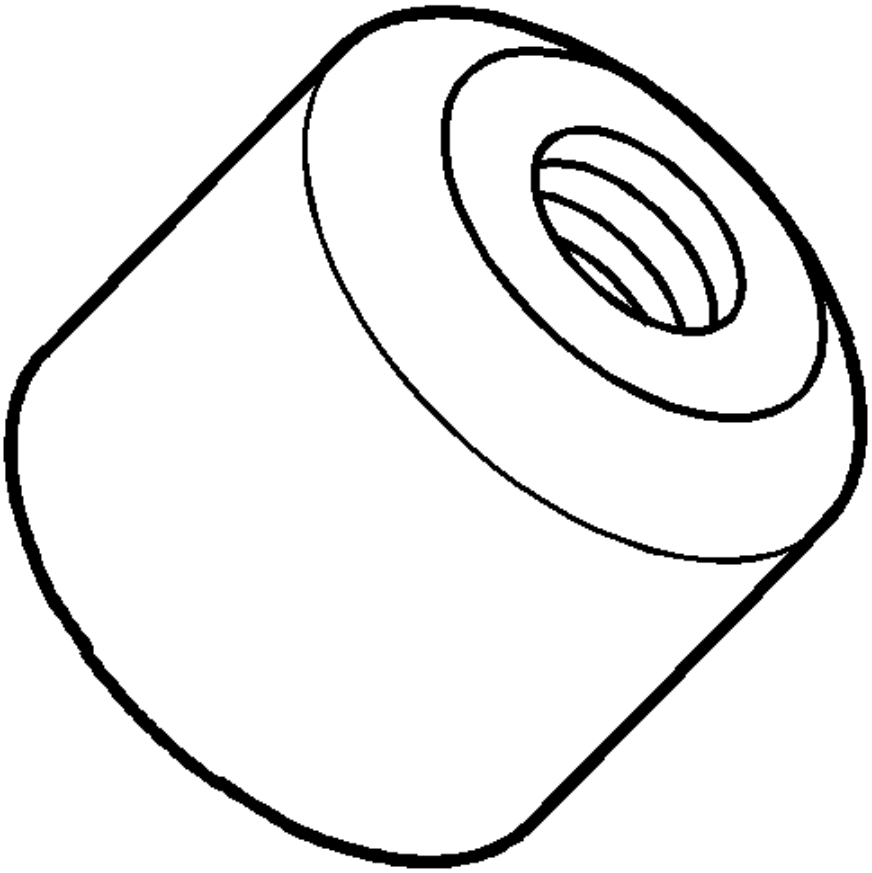	DT 46630 J 46630 Lube Dam Installer

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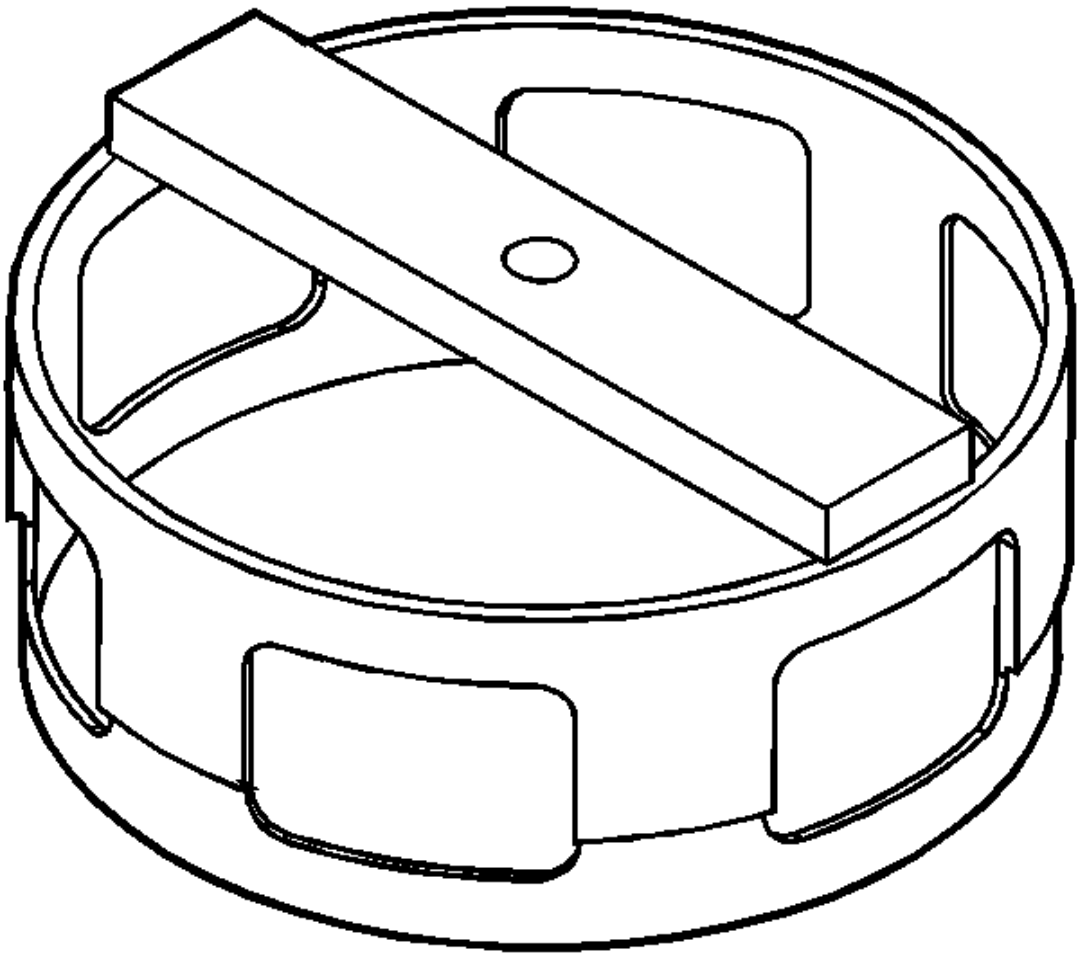	DT 46632 J 46632 Spring Compressor

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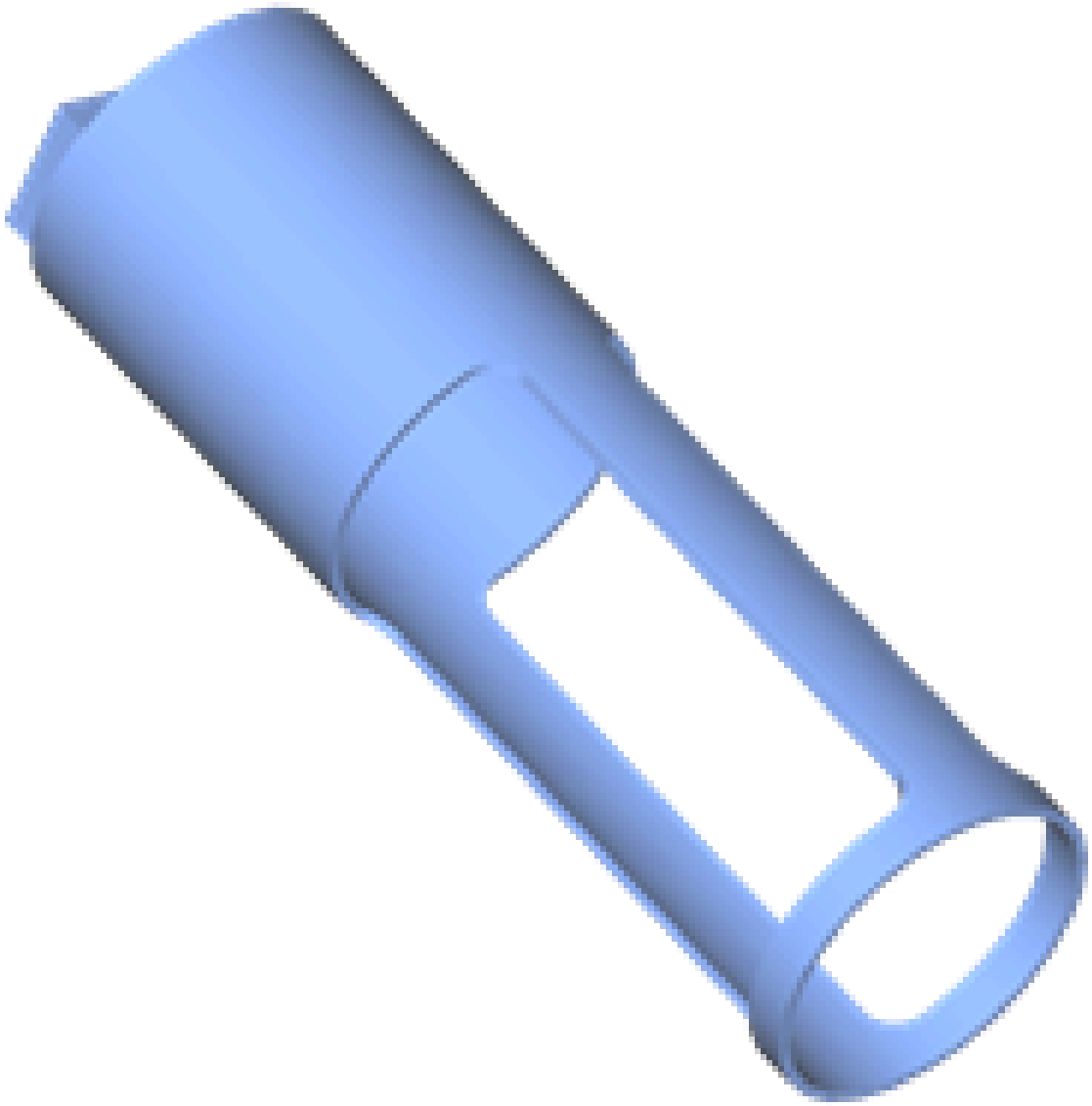	DT 47693 Dam Protector

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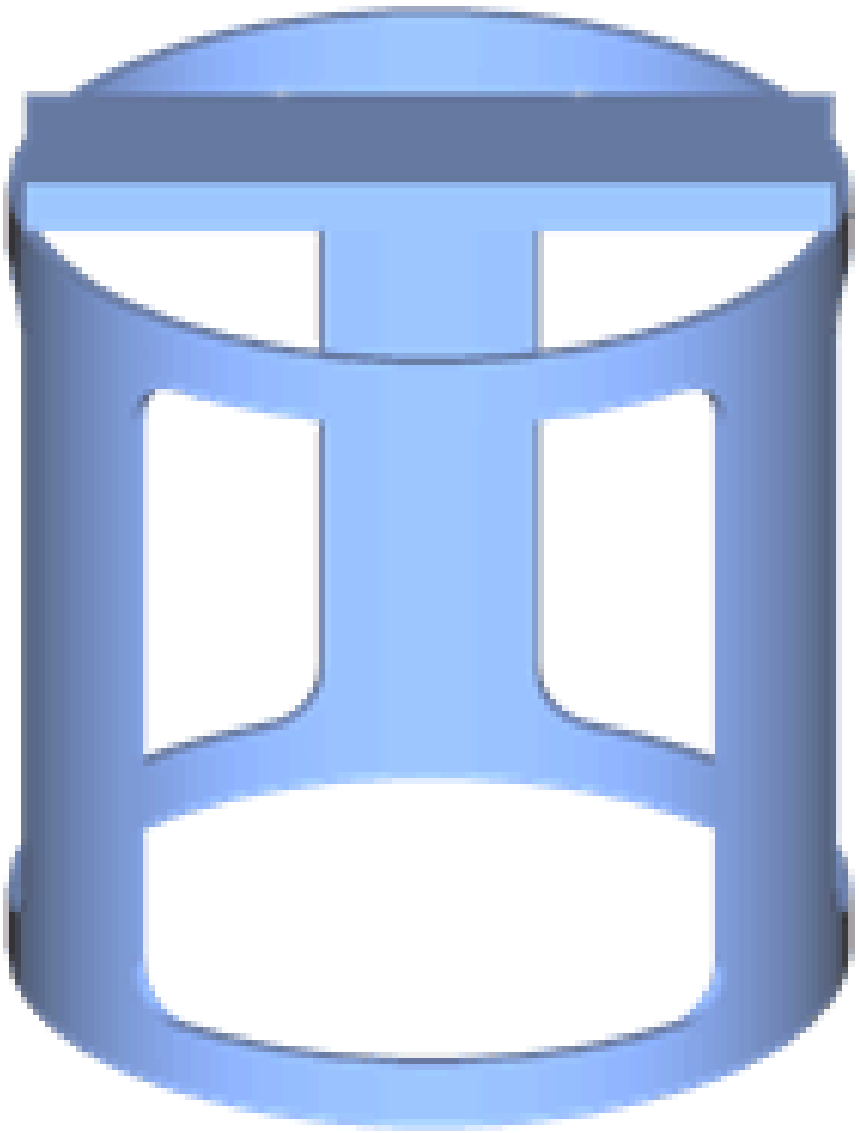	DT 47694 Piston Spring Compressor

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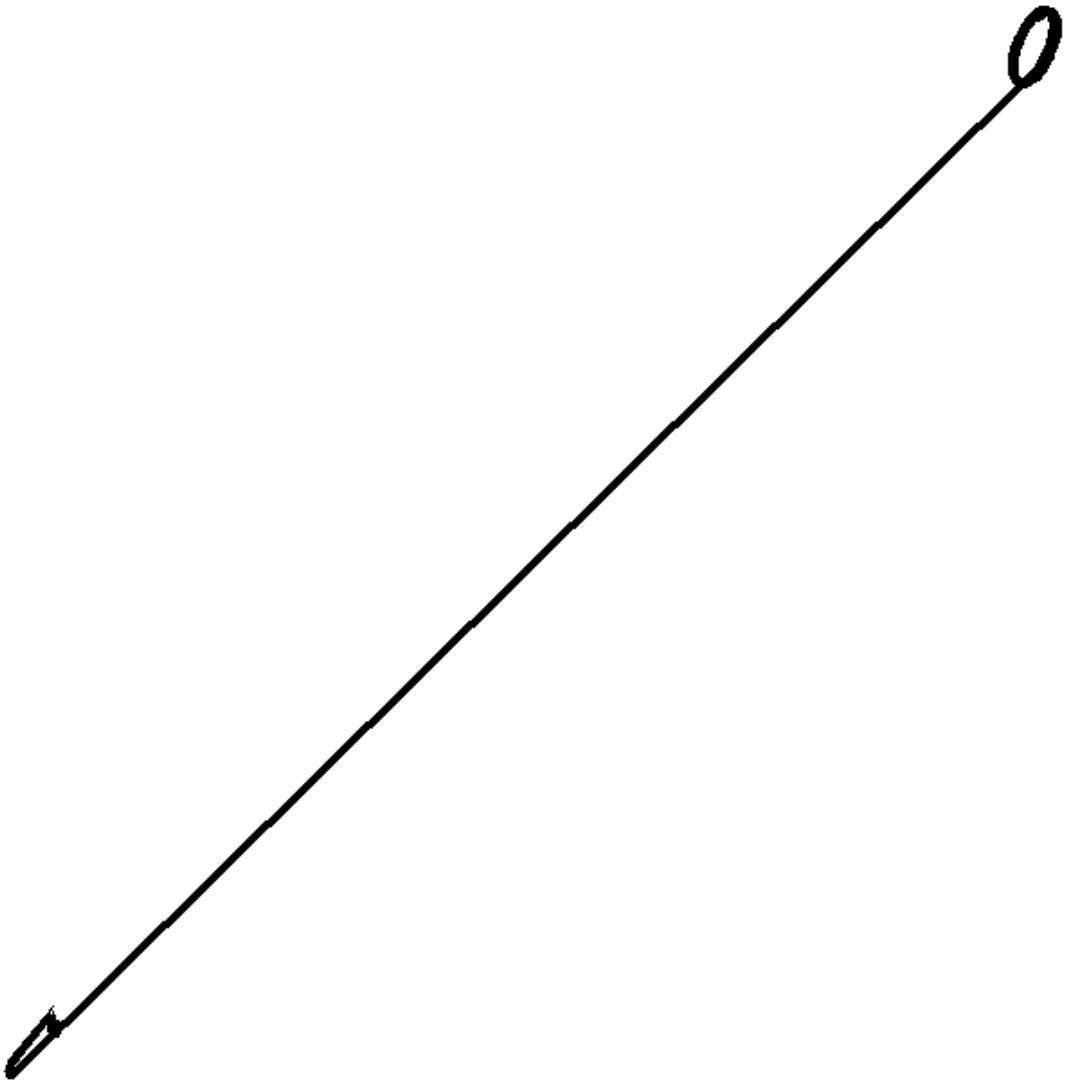	DT 47734 Speed Sensor Harness Tether

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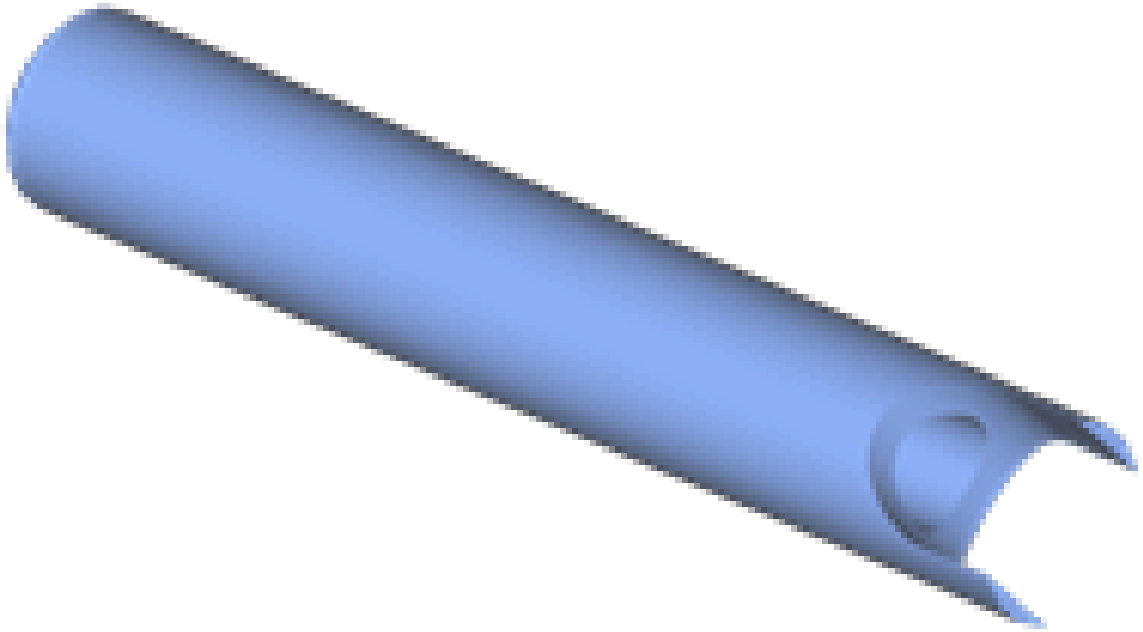	DT 47793 Differential Rotating Tool

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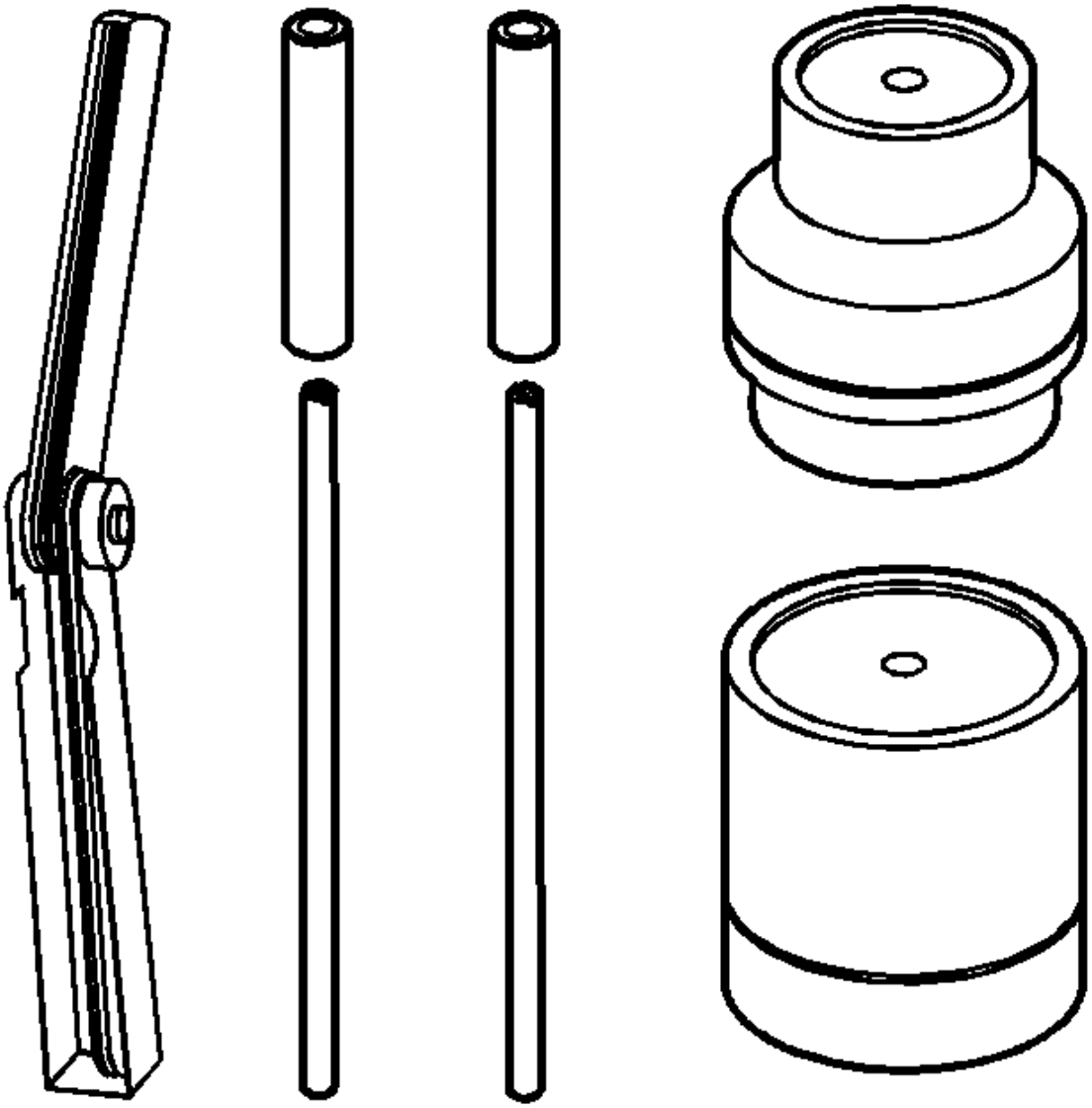
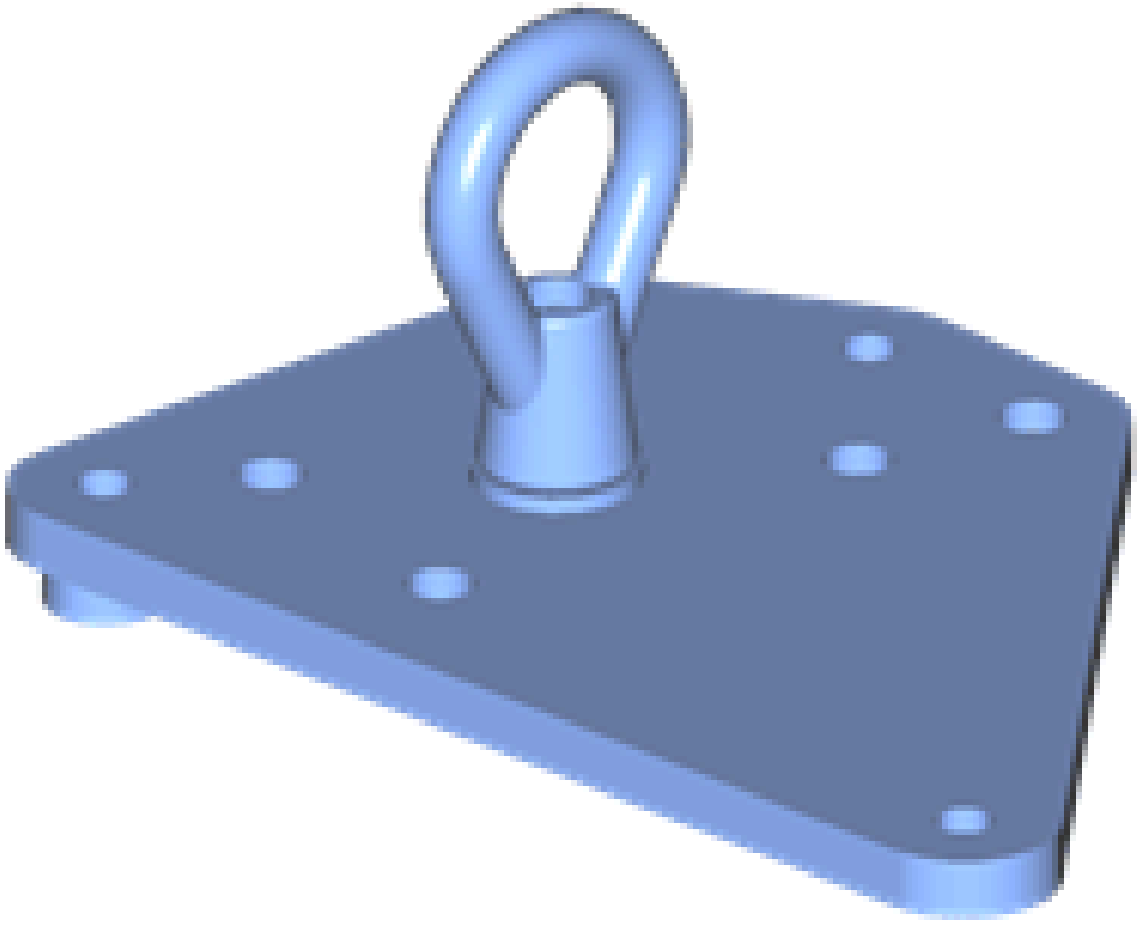
	DT 47800 Shim Selection Gauge

Illustration	Tool Number/Description
	DT 47811-A Lift Plate

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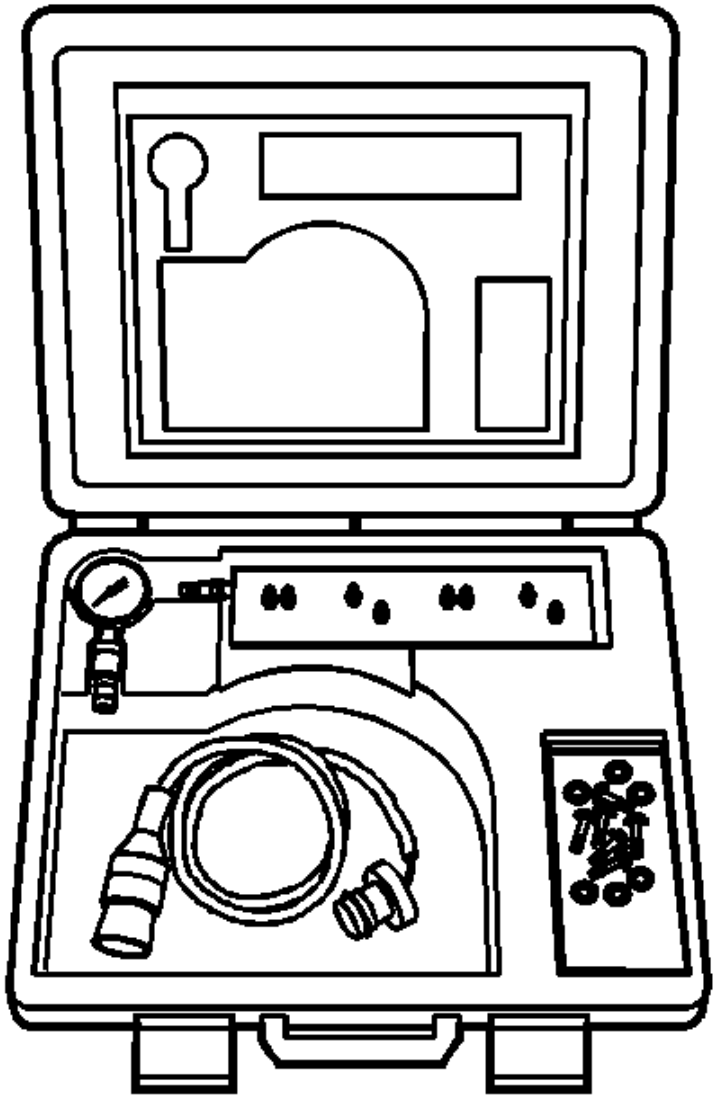	DT 47825 Control Solenoid Test Plate

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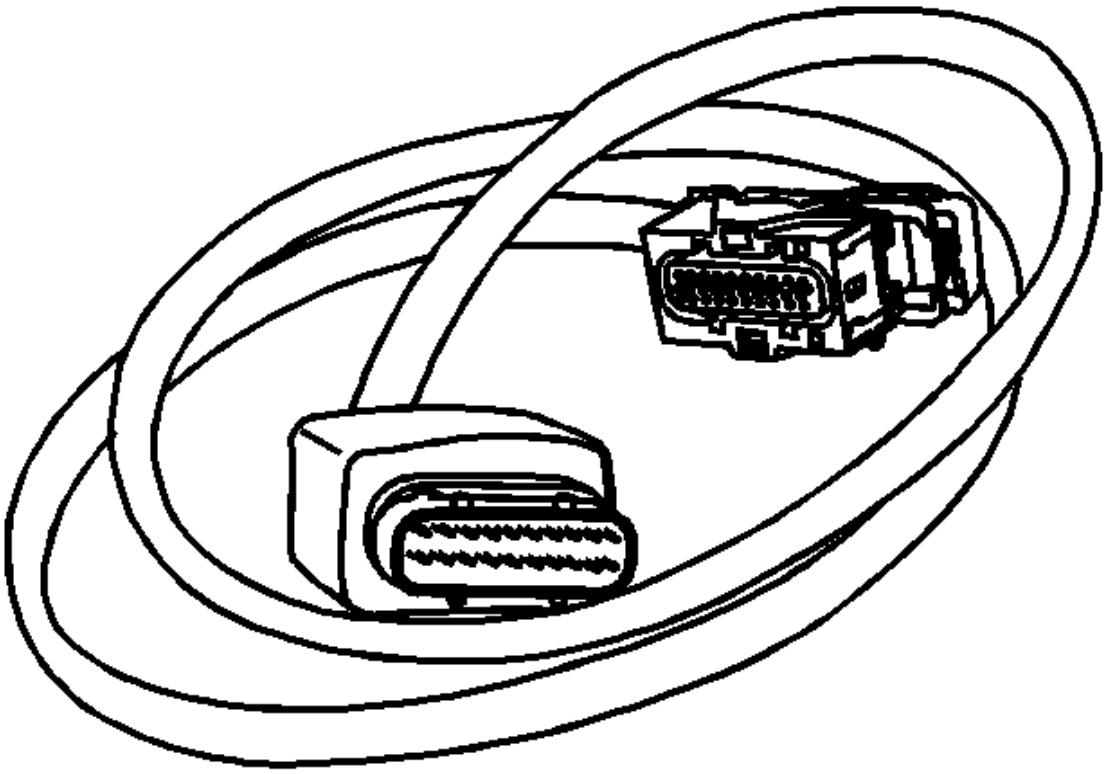	DT 47825-20 Adapter Harness

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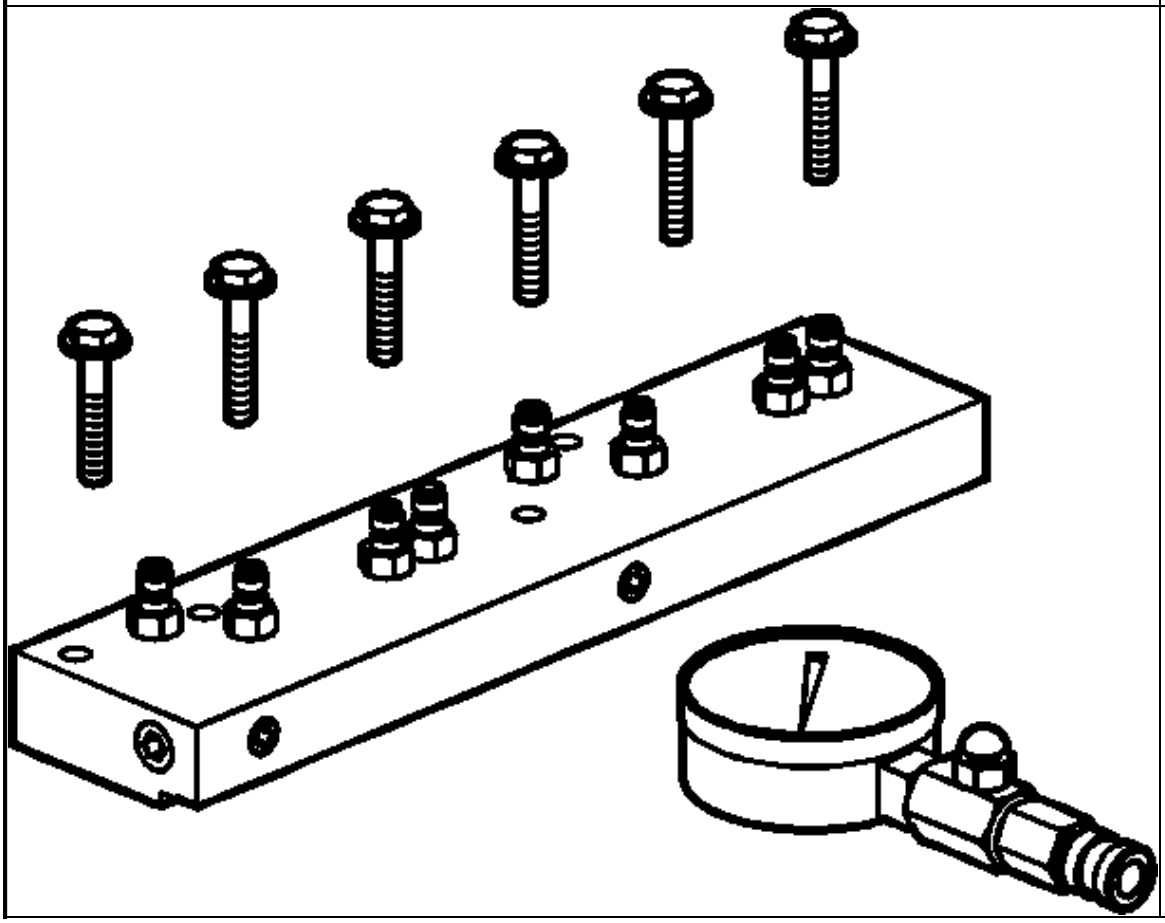	DT 47825-100 Solenoid Test Plate

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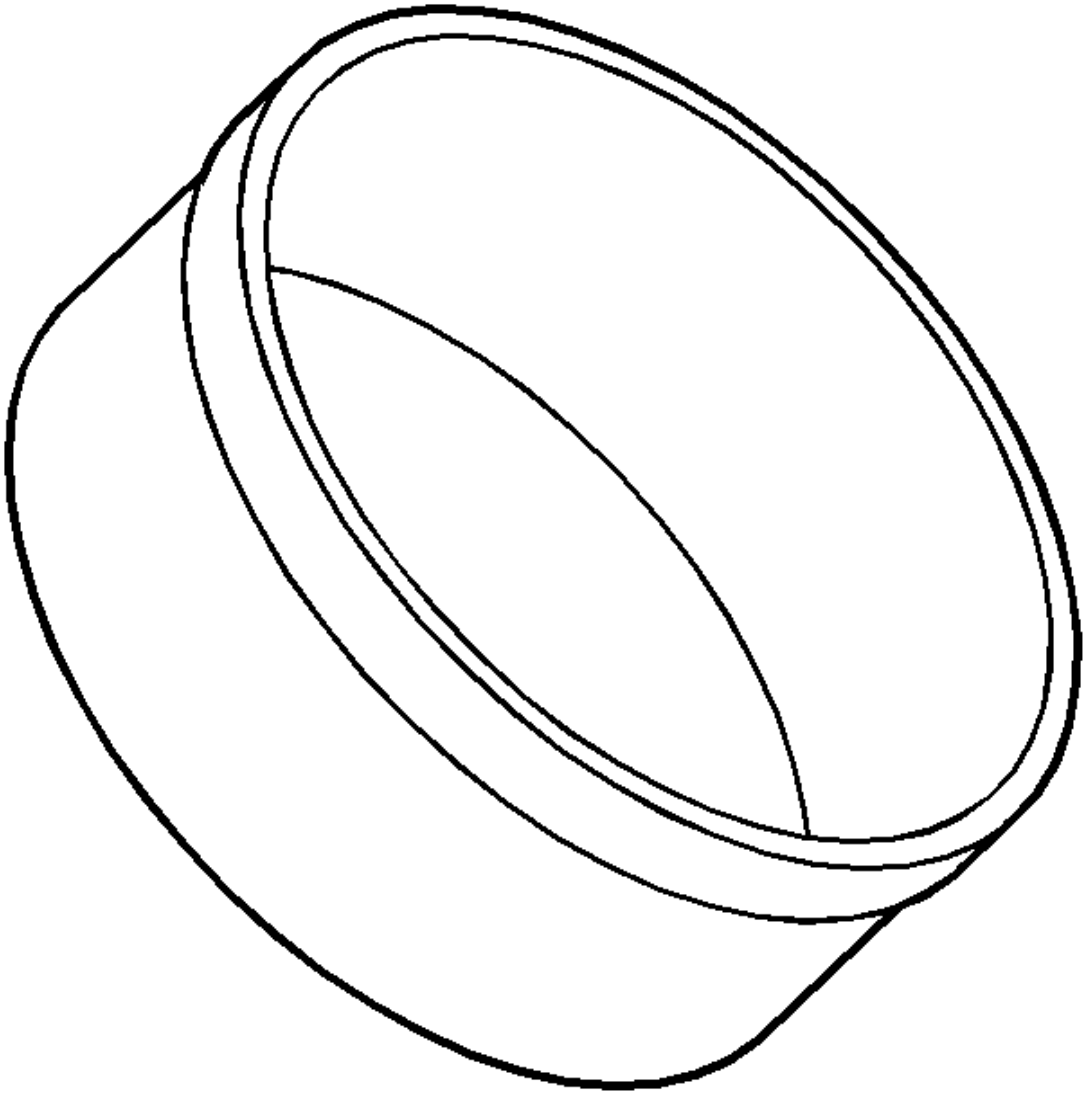	DT 47859 Piston Outer Seal Protector

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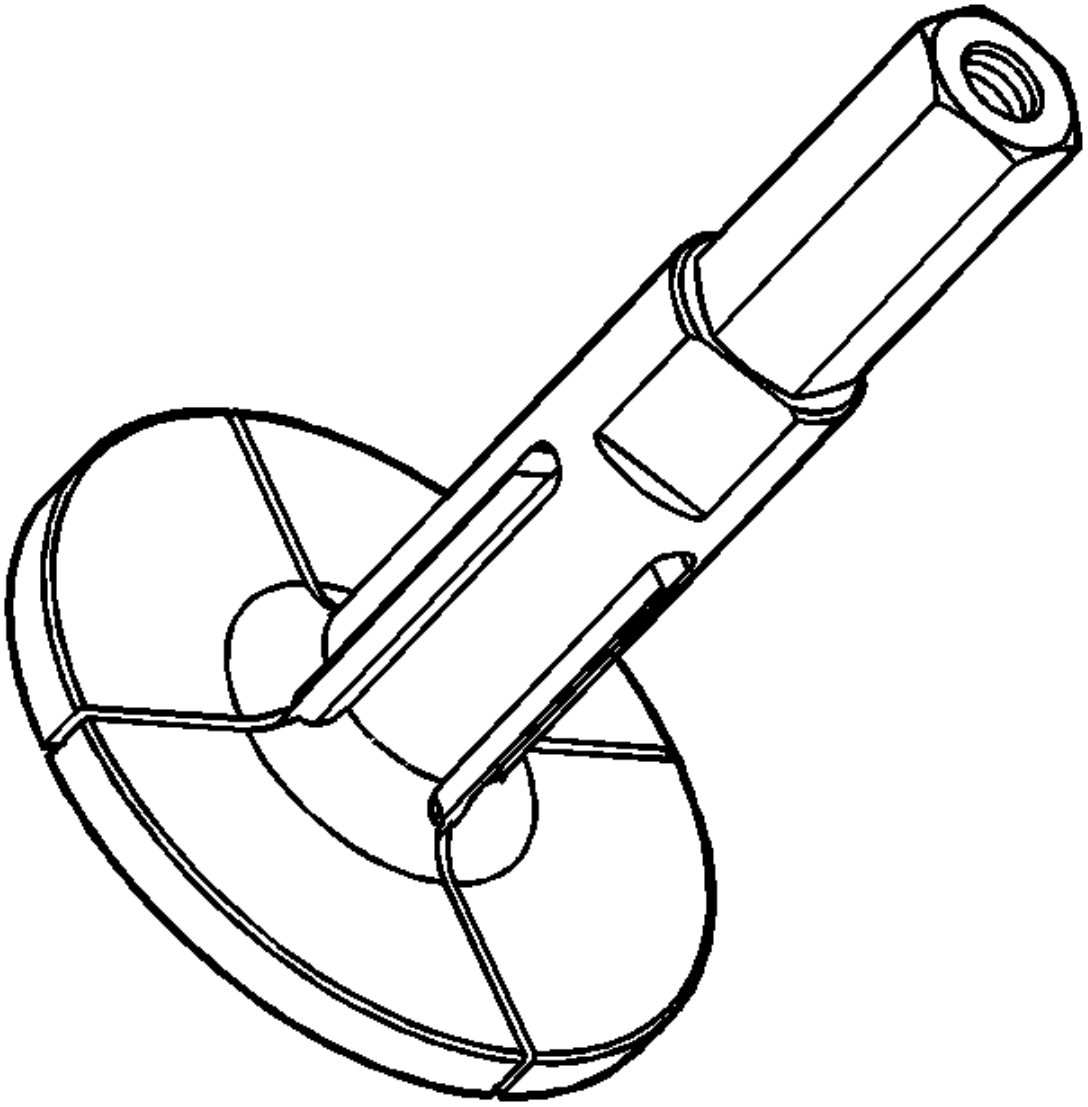	DT 47927 Bearing Cup Remover

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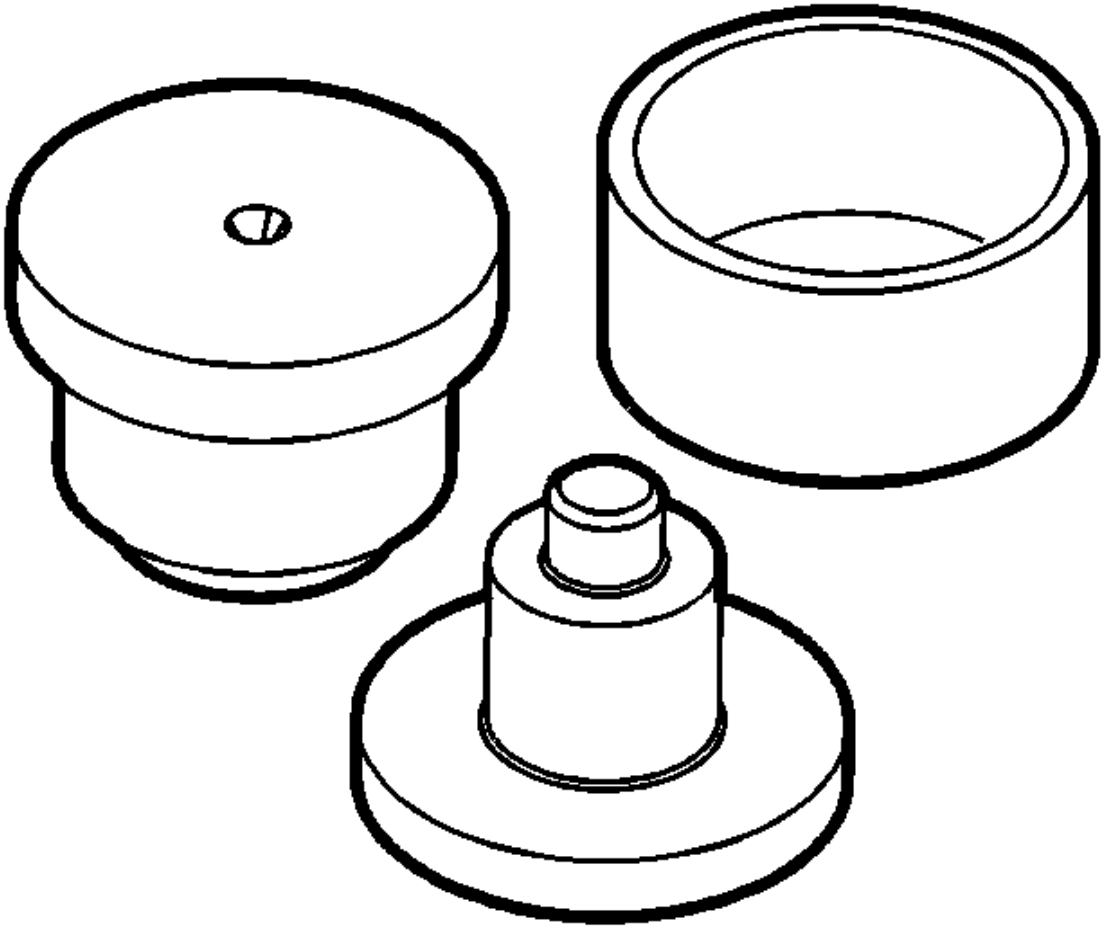
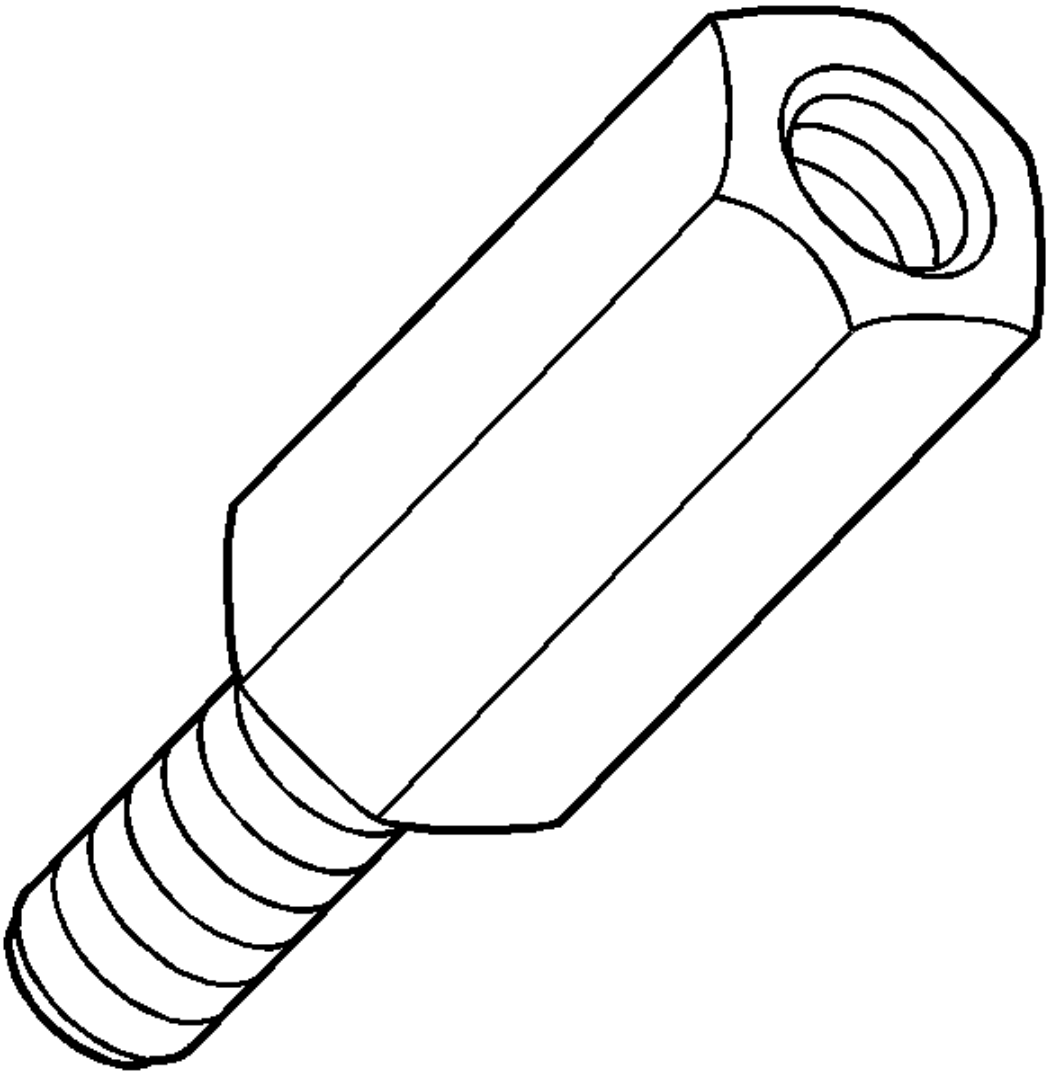
	DT 47928 Bearing Installer

Illustration	Tool Number/Description
	DT 48055 Lube Dam Remover

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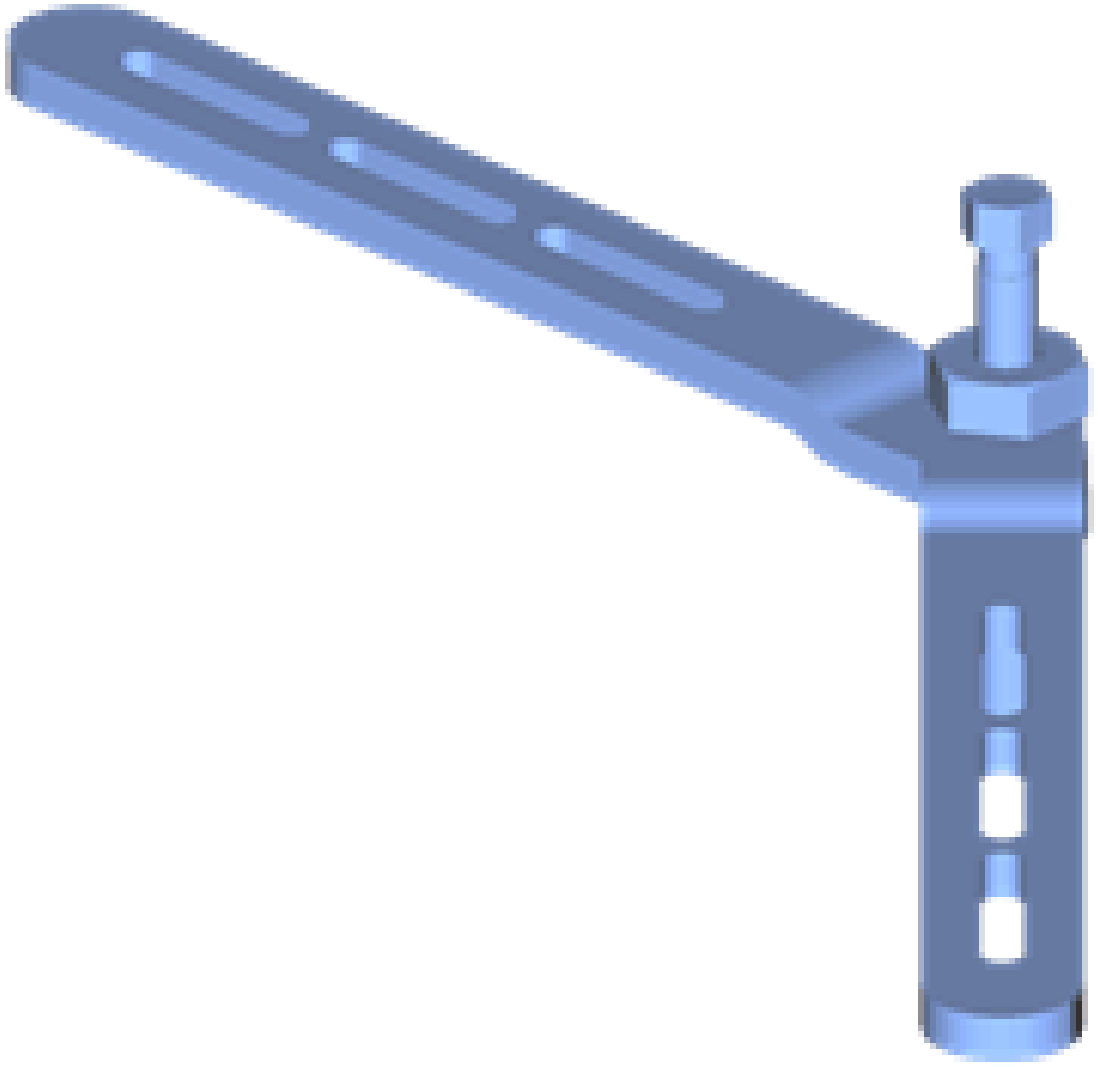
	DT 48056 Spring Compressor Bridge

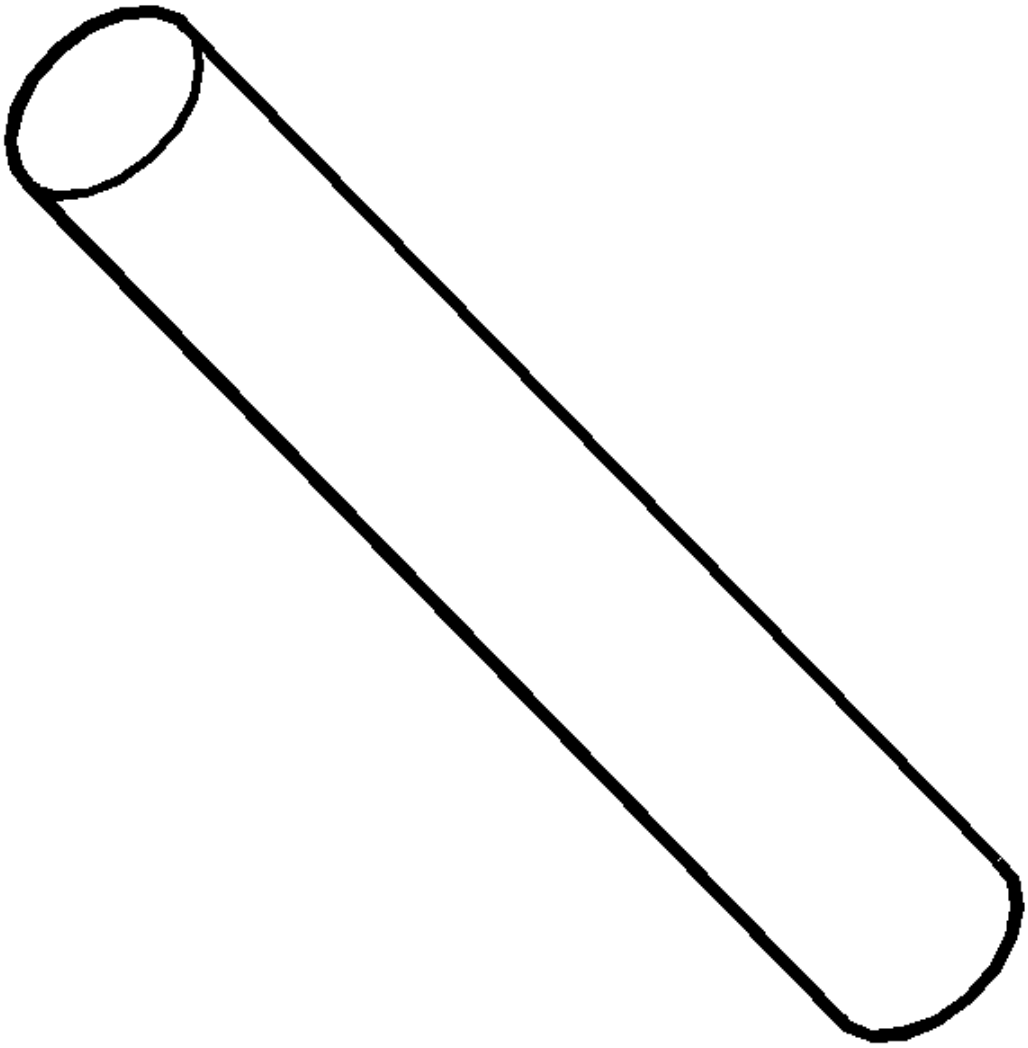
Illustration	Tool Number/Description
	DT 48551 Reaction Hub Bushing Protector

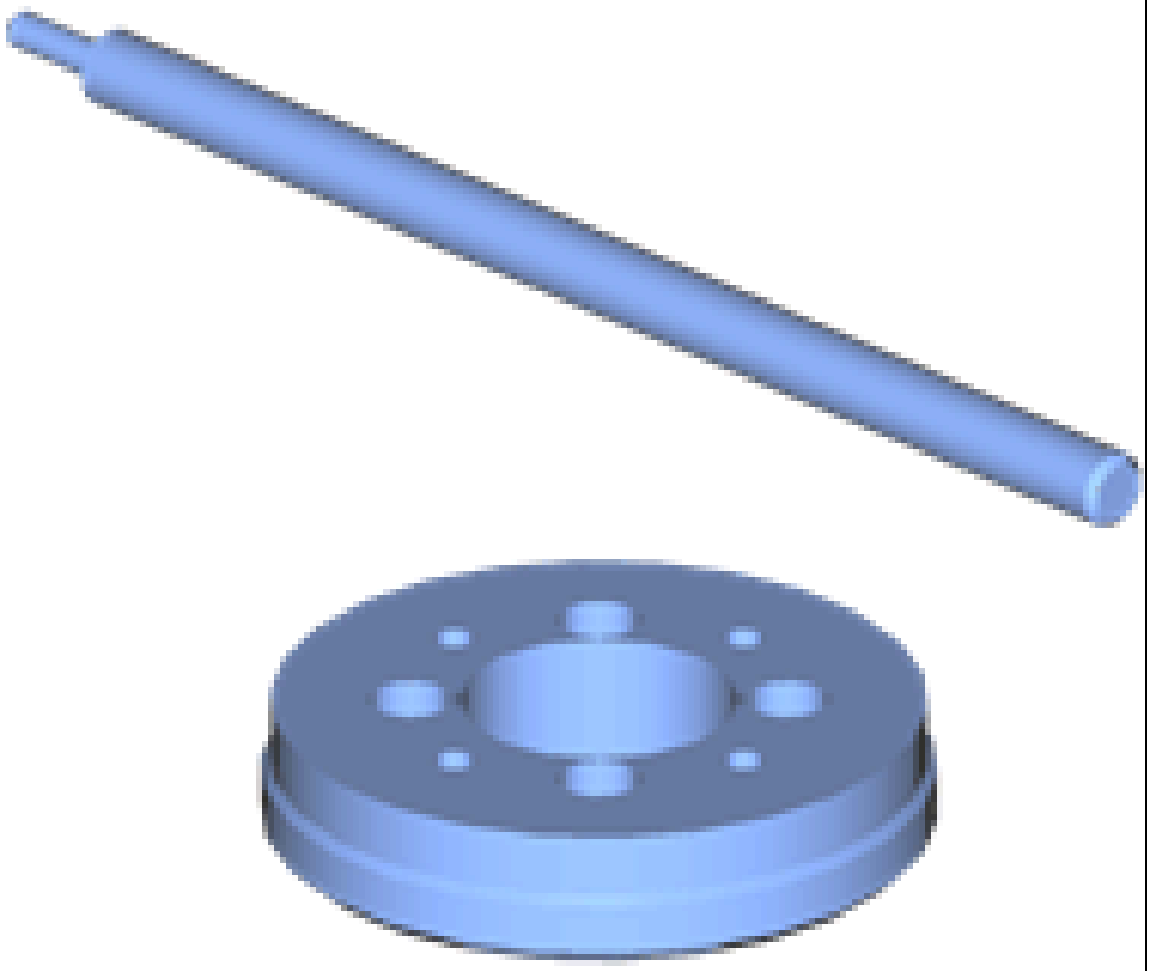
Illustration	Tool Number/Description
	DT 49131 Seal Staking Tool

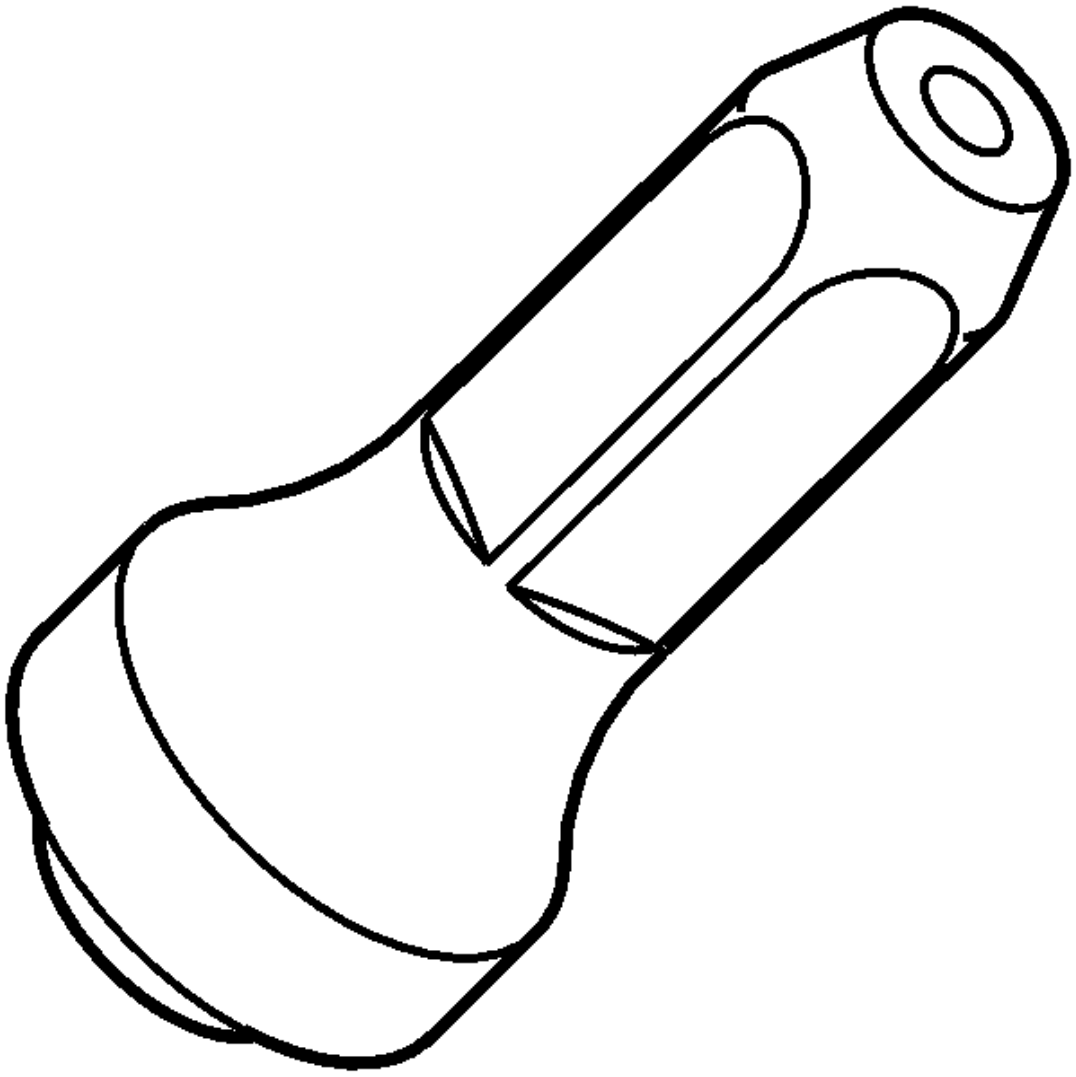
Illustration	Tool Number/Description
	DT 49861 Seal Installer

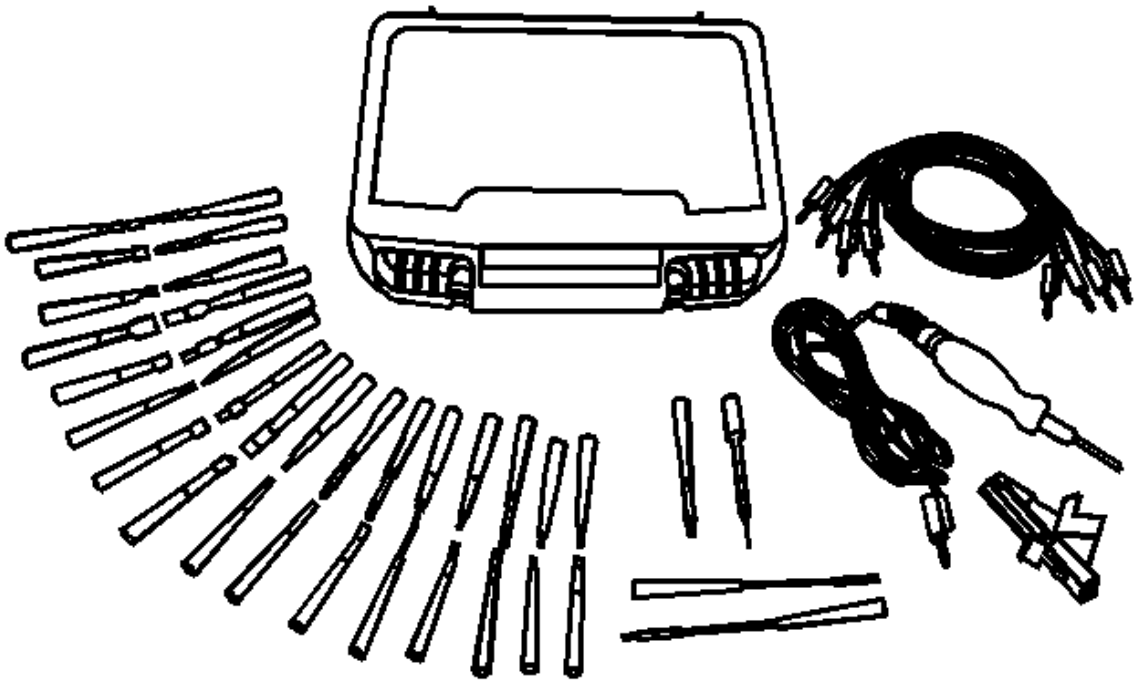
Illustration	Tool Number/Description
	EL 35616 J 35616 GM-Approved Terminal Test Kit

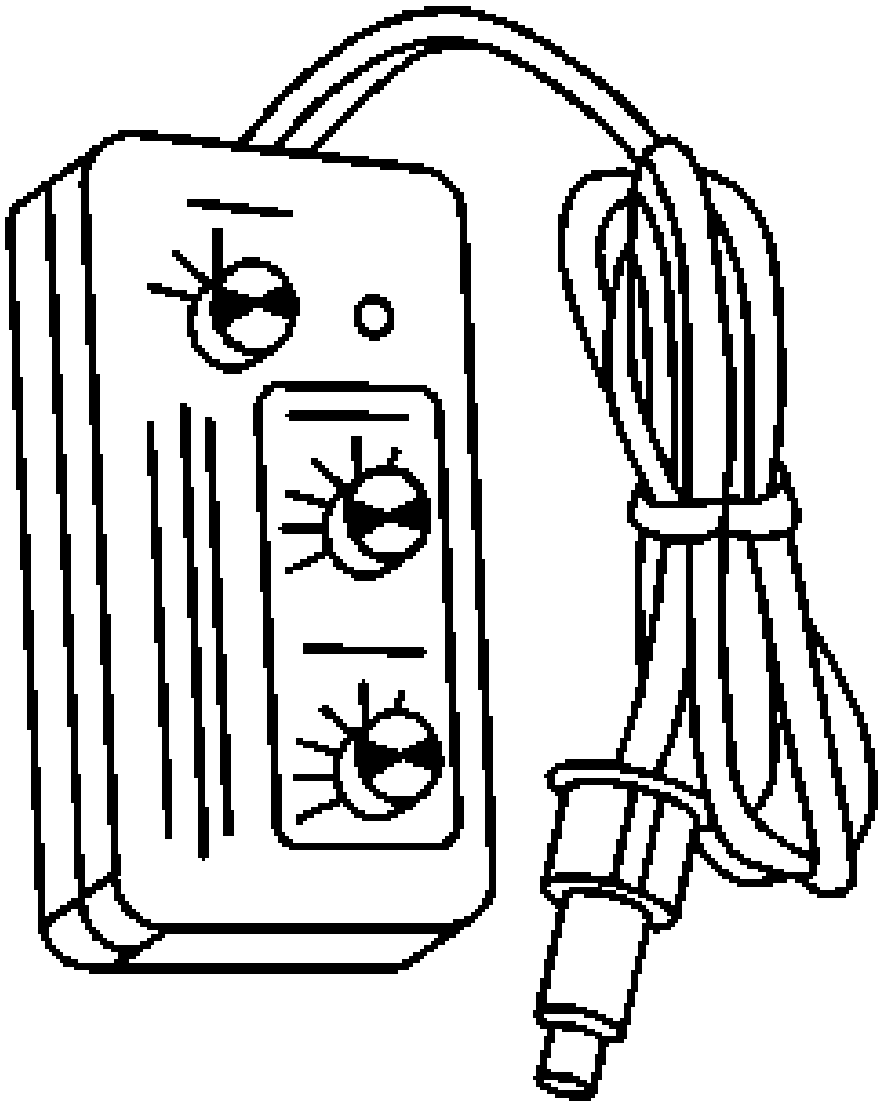
Illustration	Tool Number/Description
	EL 38522 J 38522 Variable Signal Generator

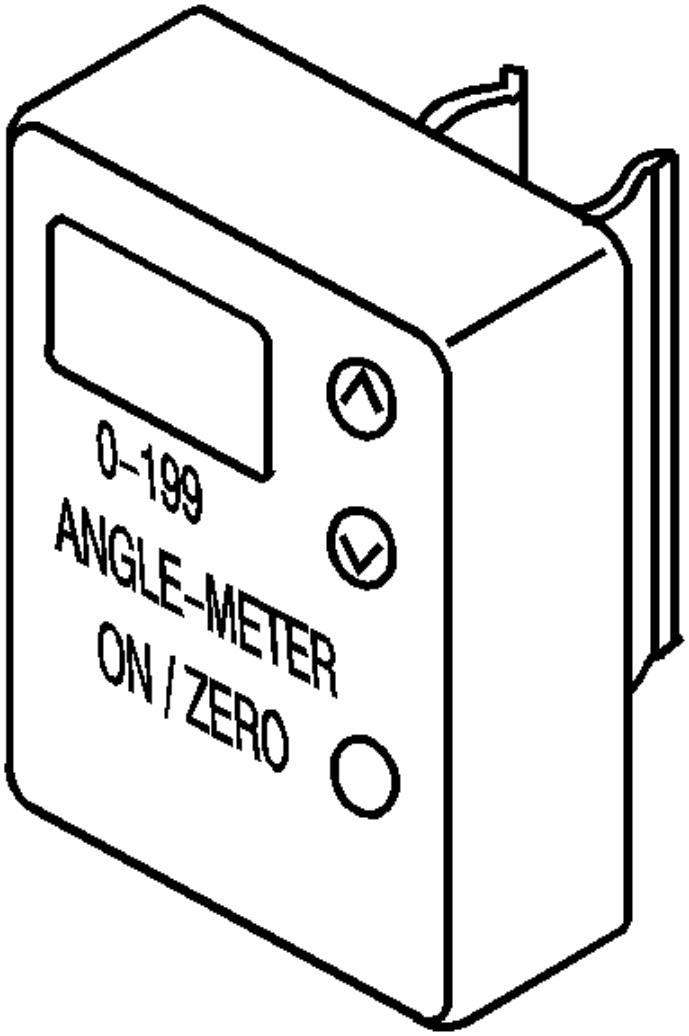
Illustration	Tool Number/Description
	EN 45059 J 45059 Angle Meter

Illustration	Tool Number/Description
	GE 6125-1B J 6125-1B J 6125-B KM-J-7004 Slide Hammer with Adapter

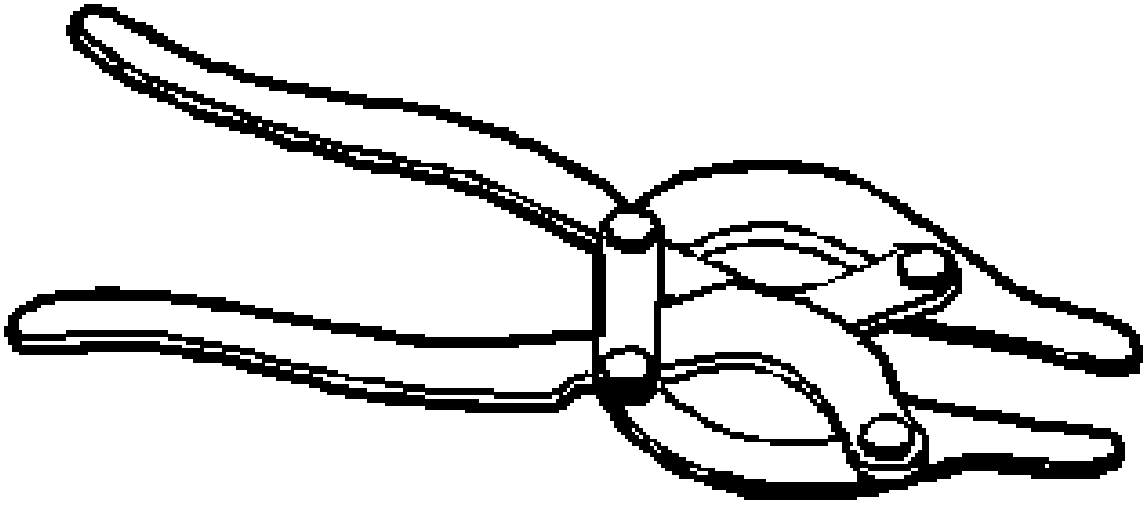
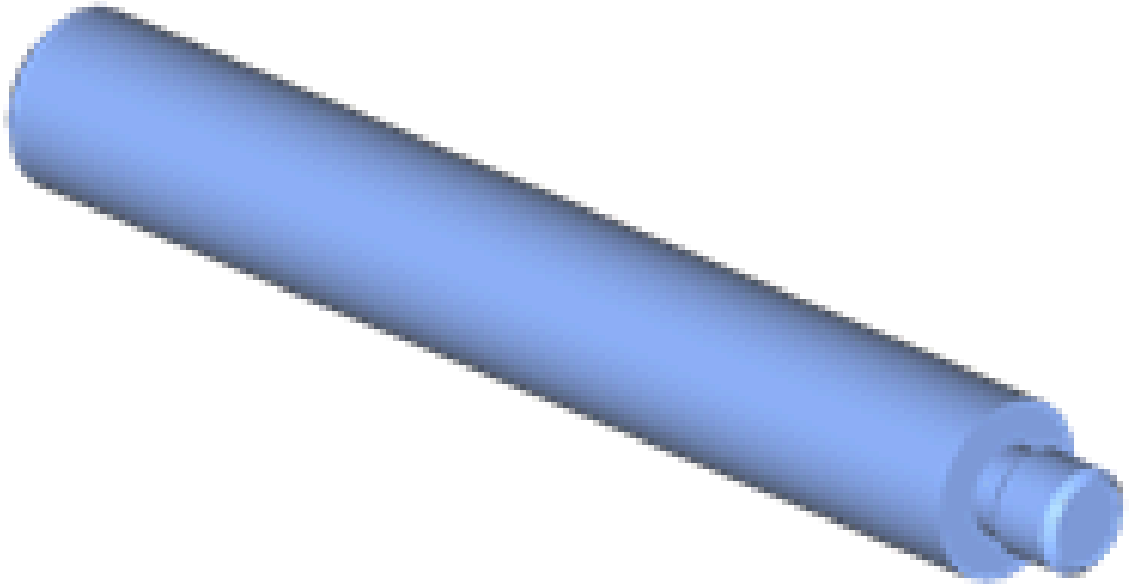
Illustration	Tool Number/Description
	GE 8059 J 8059 KM-396 Snap Ring Plier- Parallel Jaw

Illustration	Tool Number/Description
	GE 8092 J 8092 KM-J-8092 Driver Handle

Article GUID: A00737249

SPECIFICATIONS

FASTENER SPECIFICATIONS (OFF VEHICLE)

Application	*Ref No.	Quantity	Size	Specification	
				Metric	English
A/Trans Case Cover Bolt	18	10	M6x1.0x30	12 N.m	106 lb in
A/Trans Fluid Pump Bolt	1	3	M6x1.0x25	12 N.m	106 lb in
A/Trans Fluid Trough Bolt	11	1	M6x1.0x25	12 N.m	106 lb in
Control Valve Body Assembly (Complete) Bolt	19, 21	3	M6x1.0x55	12 N.m	106 lb in
Control Valve Body Assembly (Complete) Bolt	20	3	M6x1.0x35	12 N.m	106 lb in
Control Valve Body Assembly (Complete) Bolt	22	5	M6x1.0x65	12 N.m	106 lb in
Control Valve Body to Case	23	2	M6x1.0x55	12 N.m	106 lb in
Control Valve Body to Case Bolt	24	8	M6x1.0x65	12 N.m	106 lb in
Control Valve Assembly (w/TCM and Body) to Case Bolt	25	1	M6x1.0x42	12 N.m	106 lb in
Control Valve Assembly (w/TCM and Body) to Case Bolt	26	1	M6x1.0x55	12 N.m	106 lb in
Control Valve Assembly (w/TCM and Body) to Case Bolt	27	2	M6x1.0x65	12 N.m	106 lb in
Control Valve Assembly (w/TCM and Body) to Case Bolt	28	4	M6x1.0x80	12 N.m	106 lb in
Control Valve Assembly (w/TCM and Body) to Case Bolt	29	3	M6x1.0x95	12 N.m	106 lb in
Control Valve Body Cover Bolt	30	12	M6x1.0x30	12 N.m	106 lb in
Control Valve Body Cover Stud	31	2	M6x1.0x30	12 N.m	106 lb in
Fluid Pressure Test Hole Plug	12	1	1/8"-27 NPTF	12 N.m	106 lb in
Fluid Level Hole Plug	13	1	1/8"-27 NPTF	12 N.m	106 lb in

Application	*Ref No.	Quantity	Size	Specification	
				Metric	English
Front Differential Carrier Baffle Bolt	6	1	M6x1.0x25	12 N.m	106 lb in
Front Differential Transfer Drive Gear Support Bolt					
• First Pass	5	9	M8x1.25x25	10 N.m	89 lb in
• Final Pass	5	9	M8x1.25x25	50 degrees	
Input Shaft Support Bolt (Torx)	N/A	3	M6x1.0x50	12 N.m	106 lb in
Input Speed Sensor Bolt	17	1	M6x1.0x25	9 N.m	80 lb in
Output Speed Sensor Bolt	14	1	M6x1.0x25	12 N.m	106 lb in
Park Pawl Actuator Bracket Bolt	10	2	M6x1.0x25	12 N.m	106 lb in
Support Fluid Passage Tube (Torx) Bolt	2	2	M5x0.8x12	7 N.m	62 lb in
Support Fluid Passage Tube Bolt	3	2	M6x1.0x15	12 N.m	106 lb in
Torque Converter and Differential Housing Bolt	8	14	M8x1.25x35	36 N.m	27 lb ft
Torque Converter and Differential Housing Bolt	9	3	M8x1.25x35	30 N.m	22 lb ft
Transmission Cooler Pipe (External Torx) Stud	15	2	M8x1.25x30.5	12 N.m	106 lb in
*Reference number refers to the component callout number in Disassembled Views					

APPROXIMATE FLUID CAPACITIES

Application	Specification	
	Metric	English
6T70/6T75/6T80		
Valve Body Cover Removal - Approximate Capacity	5.0-7.0 liters	5.3-7.4 quarts
Fluid Change - Drain Plug - Approximate Capacity	4.0-6.0 liters	4.2- 6.3 quarts
Overhaul - Approximate Capacity	7.0-9.0 liters	7.4-9.5 quarts

TRANSMISSION GENERAL SPECIFICATIONS

Name	6T70/6T75/6T80
RPO Codes	6T70-MH2, M7W (2WD), MH4, M7U (4WD) 6T75-MY9, M7V (2WD), MH6, M7X (4WD), 6T80-MHM (2WD)
Production Location	Warren Michigan (USA), Ramos, Mexico
Transaxle Drive	Front Wheel Drive, All Wheel Drive

Name	6T70/6T75/6T80
Reverse Gear Ratio	2.88
1st Gear Ratio	4.484
2nd Gear Ratio	2.872
3rd Gear Ratio	1.842
4th Gear Ratio	1.414
5th Gear Ratio	1.000
6th Gear Ratio	0.742
Effective Final Drive Gear Ratio	2.77/3.16/3.39
Torque Converter Size- Diameter of Torque Converter Turbine	246 mm
Pressure Taps	Line Pressure
Transaxle Fluid Type	DEXRON VIÂ®
Transaxle Fluid Capacity	9.0 L/9.5 qts Quarts
Transaxle Type: 6	Six Forward Gears
Transaxle Type: T	Transverse Mount
Transaxle Type: 70/75/80	Product Series
Position Quadrant	P, R, N, D, * *(Refer to the applicable owner's manual)
Case Material	Die Cast Aluminum
Transaxle Net Weight	104 kg
Maximum Trailer Towing Capacity	N/A
Maximum Gross Vehicle Weight (GVW)	4,000 lbs

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	
		United States	Canada
Automatic Transmission Fluid	DEXRONÂ®VI	88861037	19264717
Input Speed Sensor	Threadlock	12345382	10953489
Torque Converter Bolts	Threadlock	12345382	10953489

TAPER BEARING PRELOAD SELECTIVE SPECIFICATIONS

Front Differential Drive Pinion Gear and Differential Thrust Washer Selection Chart

Thrust Washer O.D. Color Code	Washer Thickness	
	Metric	English
Brown	0.494 mm	0.020 in
Purple	0.545 mm	0.022 in
Black	0.596 mm	0.024 in
Pink	0.647 mm	0.026 in
Dark Blue	0.698 mm	0.028 in
Light Green	0.749 mm	0.030 in
Plain	0.800 mm	0.032 in

Thrust Washer O.D. Color Code	Washer Thickness	
	Metric	English
White	0.851 mm	0.034 in
Light Blue	0.902 mm	0.036 in
Orange	0.953 mm	0.038 in
White/Black	1.004 mm	0.040 in
White/Orange	1.055 mm	0.042 in
White/Light Green	1.106 mm	0.044 in

RANGE REFERENCE

Range	Park	Reverse	Neutral	Drive						
				1st Braking	1st	2nd	3rd	4th	5th	6th
1-2-3-4 Clutch	-	-	-	Applied	Applied	Applied	Applied	Applied	-	-
3-5 Reverse Clutch	-	Applied	-	-	-	-	Applied	-	Applied	-
4-5-6 Clutch	-	-	-	-	-	-	-	Applied	Applied	Applied
2-6 Clutch	-	-	-	-	-	Applied	-	-	-	Applied
Low and Reverse Clutch	Applied*	Applied	Applied*	Applied	-	-	-	-	-	-
Low Clutch Assembly (OWC)	-	-	-	Holding	Holding	-	-	-	-	-
* = Applied with NO load										

SHIFT SOLENOID VALVE STATE AND GEAR RATIO

Gear	Shift SOL 1	Shift SOL 2	1-2-3-4 CL PC SOL 5 N.L.	2-6 CL PC SOL 4 N.L.	3-5 REV CL PC SOL 2 N.H.	LOW REV 4-5-6 CL PC SOL 3 N.H.	Gear Ratio
Park	ON	ON	OFF	OFF	OFF	ON	-
Reverse	ON	OFF	OFF	OFF	ON	ON	2.88
Neutral	ON	ON	OFF	OFF	OFF	ON	-
1st Braking	ON	ON	ON	OFF	OFF	ON	4.484
1st	OFF	ON	ON	OFF	OFF	OFF	4.484
2nd	OFF	ON	ON	ON	OFF	OFF	2.872
3rd	OFF	ON	ON	OFF	ON	OFF	1.842

Gear	Shift SOL 1	Shift SOL 2	1-2-3-4 CL PC SOL 5 N.L.	2-6 CL PC SOL 4 N.L.	3-5 REV CL PC SOL 2 N.H.	LOW REV 4-5-6 CL PC SOL 3 N.H.	Gear Ratio
4th	OFF	ON	ON	OFF	OFF	ON	1.414
5th	OFF	ON	OFF	OFF	ON	ON	1.000
6th	OFF	ON	OFF	ON	OFF	ON	0.742
Effective Final Drive Ratio - 6T70/75/80 - 2.77/3.16/3.39 For shift solenoids 1 and 2, "ON" = Solenoid Energized (Pressurized) "OFF" = Solenoid De-energized (No Pressure). For pressure control solenoids, "ON" = Pressurized, "OFF" = No Pressure							

SHIFT SPEED

Shift @ TP	km/h	mph	OSS (RPM)
1-2 @ 12.5	18	11.2	400
2-3 @ 12.5	34	21.1	755
3-4 @ 12.5	46	28.6	1021
4-5 @ 12.5	60	37.3	1332
5-6 @ 12.5	74	46.0	1643
6-5 @ 12.5	69	42.9	1532
5-4 @ 12.5	69	42.9	1532
4-3 @ 12.5	43	26.7	955
3-2 @ 12.5	16	9.9	355
2-1 @ 12.5	16	9.9	355
1-2 @ 25	36	22.4	799
2-3 @ 25	59	36.7	1310
3-4 @ 25	78	48.5	1732
4-5 @ 25	94	58.4	2087
5-6 @ 25	150	93.2	3331
6-5 @ 25	69	42.9	1532
5-4 @ 25	52	32.3	1155
4-3 @ 25	43	26.7	955
3-2 @ 25	16	9.9	355
2-1 @ 25	16	9.9	355

NOTE: **Shift speed points are affected by many different vehicle and transmission operating conditions. The table above represents shift speed points calibrated at specific throttle angles during normal operating conditions and a temperature range between 0-130Â°C (32-266Â°F). These shift speed points are also based on an effective final drive ratio of 2.77, and assume a production-intent tire size. The table below illustrates a number of different variables that influence these shift speed points. Based on a given operating condition, these**

variables may override the normal shift speed points. To assist in monitoring the different variables, the respective scan tool data parameter is also listed.

Shift Speed Variables

Scan Tool Parameter	Shift Speed Variables
Calc. Throttle Position	Calc. Throttle Position (TP) is one of the most important inputs in the transmission shift pattern logic. A very low TP angle will impact the shift pattern by causing upshifts. A very high TP angle will impact the shift pattern by causing downshifts.
Commanded Gear	Based on numerous inputs, the transmission control module (TCM) selects the optimum gear. Once the TCM commands a gear, the pressure control solenoids are activated to hydraulically control engagement of the proper clutch.
Cruise	When cruise control is activated, the shift pattern is altered to reduce excessive shifting.
ECT	Shift speed points may be offset to enhance engine coolant temperature (ECT) warm-up. Also, operating the vehicle at higher engine speeds will reduce the time to warm the ECT and the TFT.
Engine Speed	To protect against an over speed condition, engine speed is monitored. If the engine speed becomes too high, an upshift will occur.
Engine Torque	Engine torque is used to predict vehicle operating conditions, in order to determine the optimum gear and provide for a smoother ride.
IMS	The internal mode switch (IMS) indicates the position of the transmission manual valve. The operator controls this valve by moving the gear range selector. Therefore, the possible gears may be limited by this valve position.
TCC PC Sol. Duty Cycle	The torque converter clutch (TCC) pressure control (PC) solenoid duty cycle indicates when the TCC has been engaged.
TCC Slip Speed	The TCC Slip Speed indicates the difference between engine speed and transmission input speed. The TCC is locked when slip speed is at or near zero, and may be controlling slip when at lower slip speeds.
TFP Switch 1, 3, 4 or 5	The transmission fluid pressure (TFP) switch is used to indicate if fluid pressure to a specific clutch has been applied or released.
Trans. Fluid Temp.	A lower TFT will extend shift speeds, a higher TFT, or hot mode condition, will invoke shorter shift speeds in order to establish a shift pattern required to cool the TFT.
Transmission Hot Mode	If the TFT becomes too hot, a hot mode shift pattern is used. The hot mode shift pattern will invoke lower shift speed points to establish a shift pattern necessary to cool the TFT.
Transmission OSS	The transmission output speed sensor (OSS) is one of the most important inputs into the transmission shift pattern logic. A very low transmission output speed will impact the shift pattern by causing downshifts. A very high transmission output speed will impact the shift pattern by causing upshifts.

TRANSMISSION FLUID PRESSURE SWITCH LOGIC

Gear	TFP Switch States			
	TFP SW1	*TFP SW3	TFP SW4	TFP SW5
Park	High	Low	Low	Low
Reverse	Low	Low	Low	Low
Neutral	High	Low	Low	Low
Drive 1st - Engine Braking	High	High	Low	Low
Drive 1st	High	High	Low	High
Drive 2nd	High	Low	Low	High
Drive 3rd	Low	High	Low	High
Drive 4th	High	High	Low	Low
Drive 5th	Low	High	High	Low
Drive 6th	High	Low	High	Low

High = 12 V (Switch Open or Pressurized)
Low = 0 V (Switch Closed or No Pressure)
Note: All TFP switches are normally closed (NC)
*TFP switch 2 does not exist

TRANSMISSION INTERNAL MODE SWITCH LOGIC

Gear Selector Position	Signal A	Signal B	Signal C	Signal P
Park	LOW	HI	HI	LOW
Park/Reverse	LOW	LOW	HI	LOW
Reverse	LOW	LOW	HI	HI
Reverse/Neutral	HI	LOW	HI	HI
Neutral	HI	LOW	HI	LOW
Neutral/Drive 6	HI	LOW	LOW	LOW
Drive 6	HI	LOW	LOW	HI
Drive 6/Drive 4	LOW	LOW	LOW	HI
Drive 4	LOW	LOW	LOW	LOW
Drive 4/Drive 3	LOW	HI	LOW	LOW
Drive 3	LOW	HI	LOW	HI
Drive 3/Drive 2	HI	HI	LOW	HI
Drive 2	HI	HI	LOW	LOW
Open	HI	HI	HI	HI
Invalid	HI	HI	HI	LOW
Invalid	LOW	HI	HI	HI

HI = Ignition voltage
LOW = 0 volts

SOLENOID VALVE PRESSURE

Line PC Solenoid Valve Pressure

Requested Pressure (kPa)	Actual Pressure	
	Metric	English

Requested Pressure (kPa)	Actual Pressure	
	Metric	English
0	345-900 kPa	50-130 psi
200	690-900 kPa	100-130 psi
400	1100-1310 kPa	160-190 psi
600	1520-1725 kPa	220-250 psi
800	1860-2070 kPa	270-300 psi
1000	1860-2070 kPa	270-300 psi

TRANSMISSION PARTS KIT SPECIFICATIONS

Clutch Plate Pack 24240100

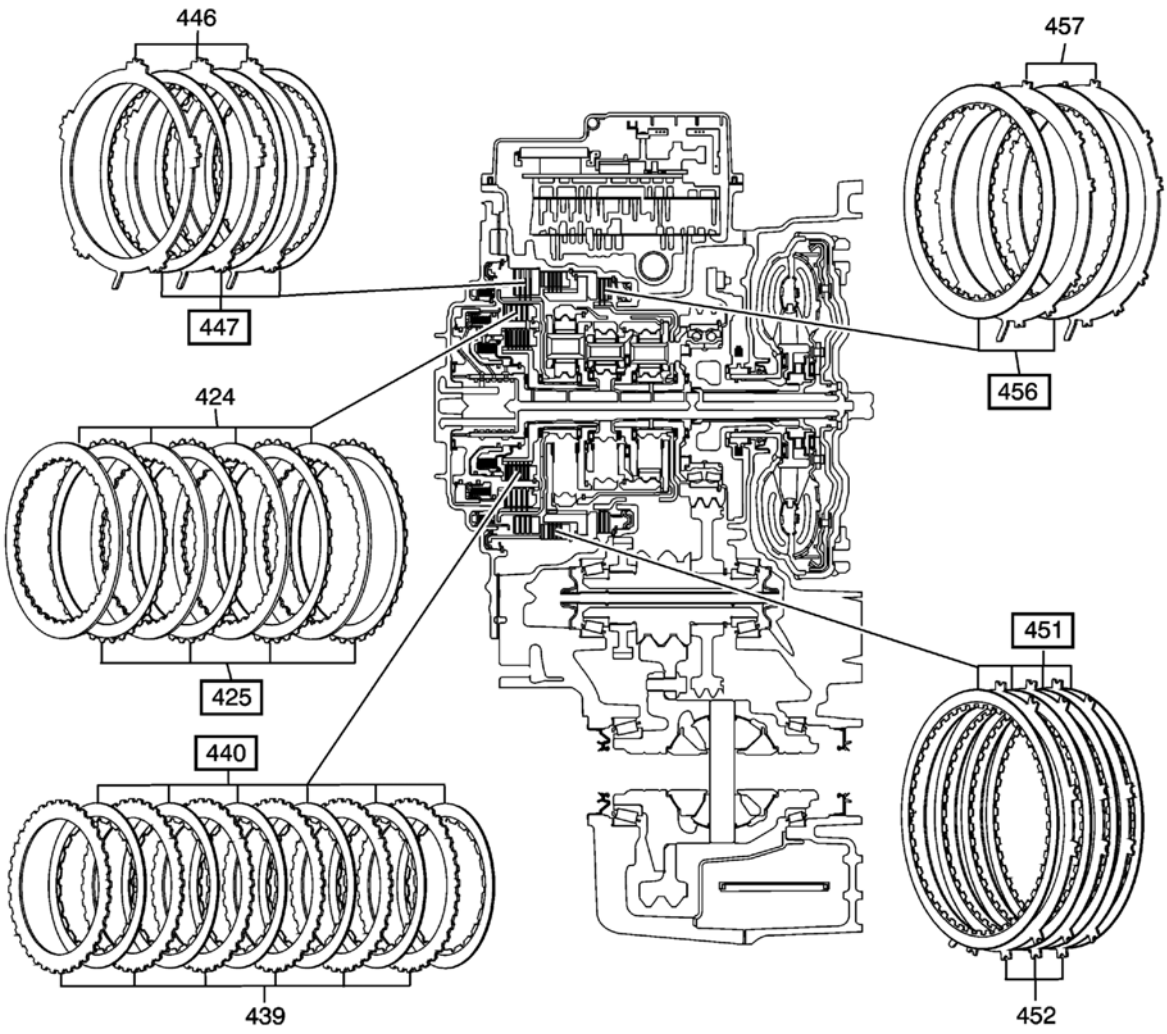


Fig. 1: Clutch Plate Pack
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.**

Clutch Plate Pack 24240100

Callout	Quantity	Component Name
425	4	3-5-Reverse Clutch (w/Friction Material) Plate Assembly
440	6	4-5-6 Clutch (w/Friction Material) Plate Assembly
447	3	2-6 Clutch (w/Friction Material) Plate Assembly
451	4	Low and Reverse Clutch (w/Friction Material) Plate Assembly
456	2	1-2-3-4 Clutch (w/Friction Material) Plate Assembly

Front Wheel Drive Shaft Seal Kit 19258265

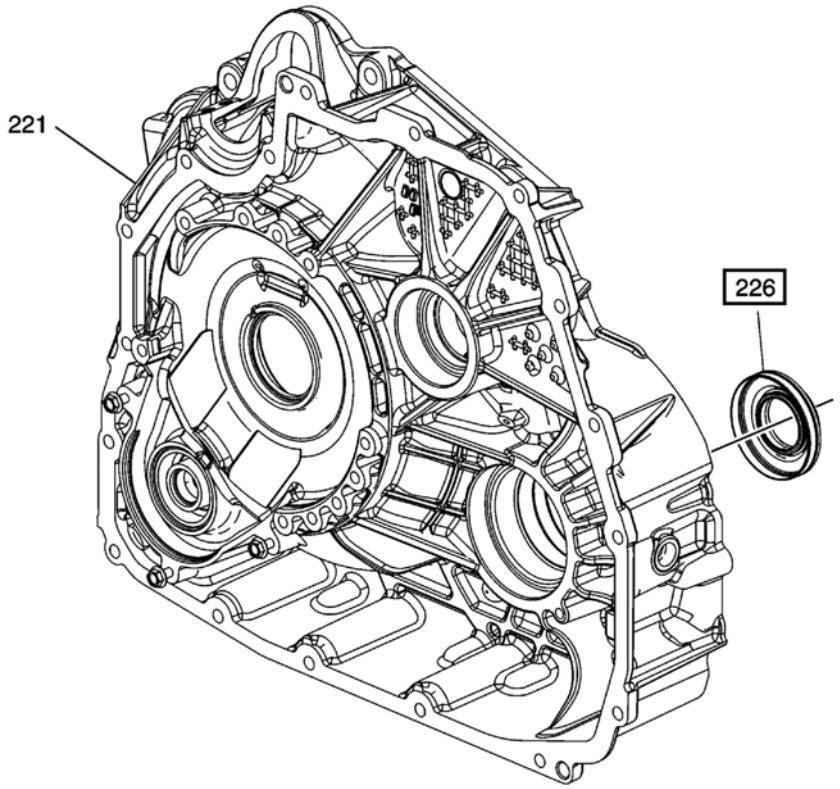


**Fig. 2: **
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.**

Front Wheel Drive Shaft Seal Kit 19258265

Callout	Quantity	Component Name
226	1	Front Wheel Drive Shaft Oil (RHS)Seal Assembly
X	1	Seal Protector (Not Shown)

Front Wheel Drive Shaft Seal Kit 19258266

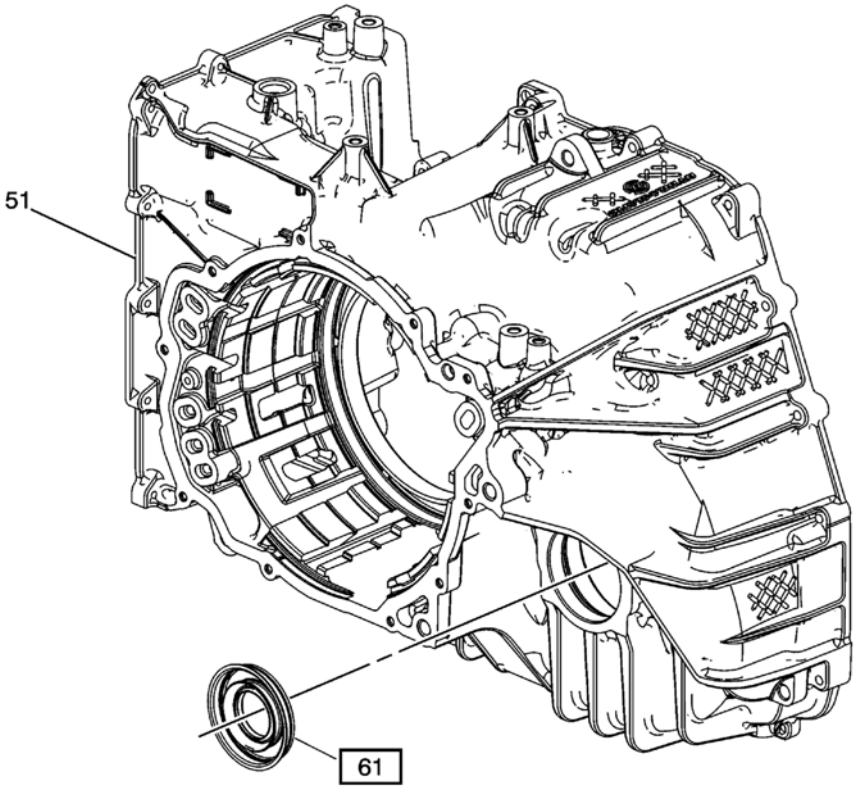


Fig. 3: Front Wheel Drive Shaft Seal Kit
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.**

Front Wheel Drive Shaft Seal Kit 19258266

Callout	Quantity	Component Name
61	1	Front Wheel Drive Shaft Oil Seal Assembly
X	1	Seal Protector (Not Shown)

Control Valve Body Kit 24248118

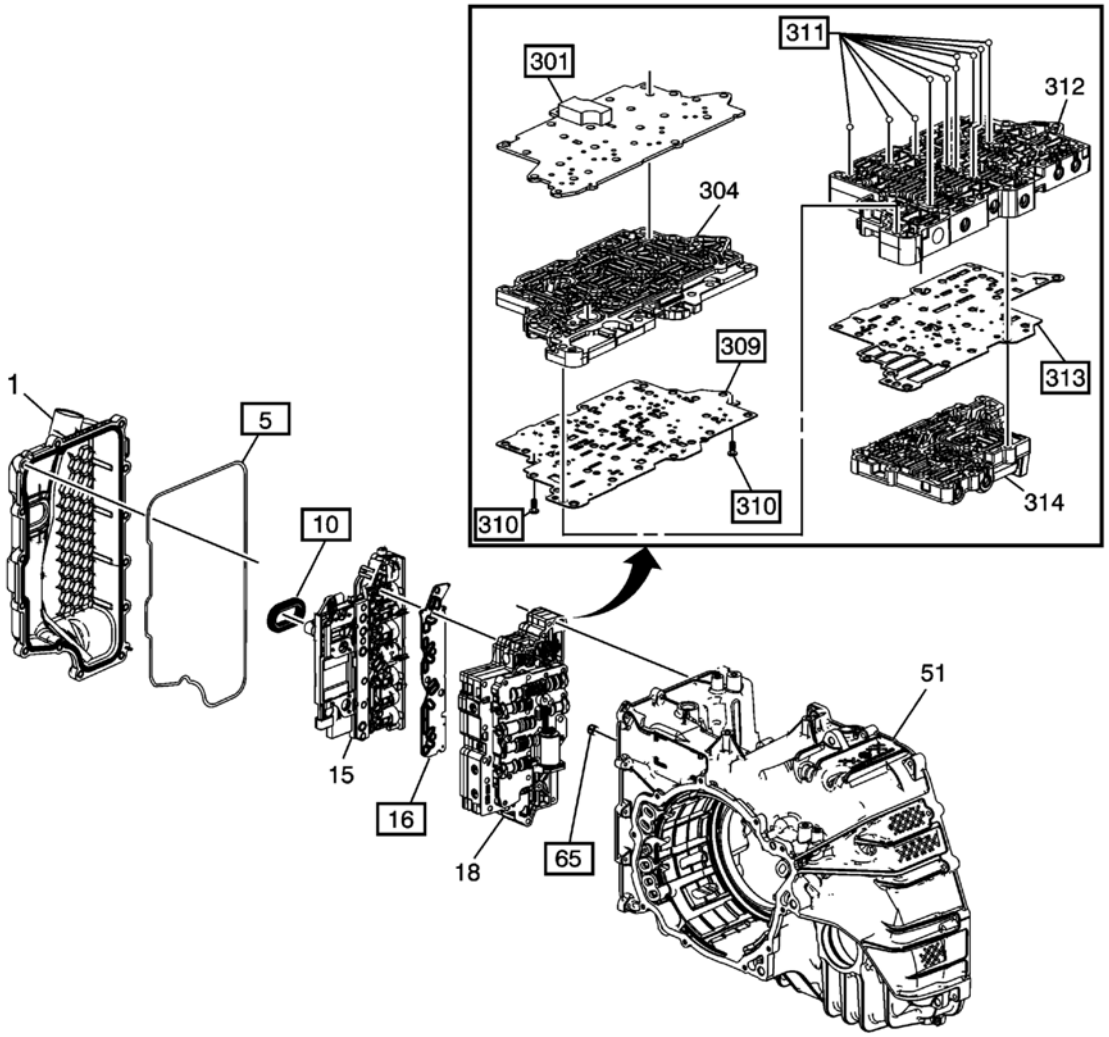


Fig. 4: Control Valve Body Kit
Courtesy of GENERAL MOTORS COMPANY

Control Valve Body Kit 24248118

Callout	Quantity	Component Name
5	1	Control Valve Body Cover Assembly Gasket
10	1	Control Valve Body Cover Wiring Connector Hole Seal
16	1	Control Solenoid (w/Body and TCM) Filter Plate Assembly
65	1	1-2-3-4 Clutch Fluid Passage Seal
301	1	Control Valve Channel Upper Plate Assembly
309	1	Control Valve Upper Body Spacer Plate Assembly
310	2	Control Valve Upper Body Spacer Plate Retainer
311	10	Control Valve Body Ball Check Valve
313	1	Control Valve Lower Body Spacer Plate Assembly

A/Trans Service Seal Kit (1 of 2) 24253594

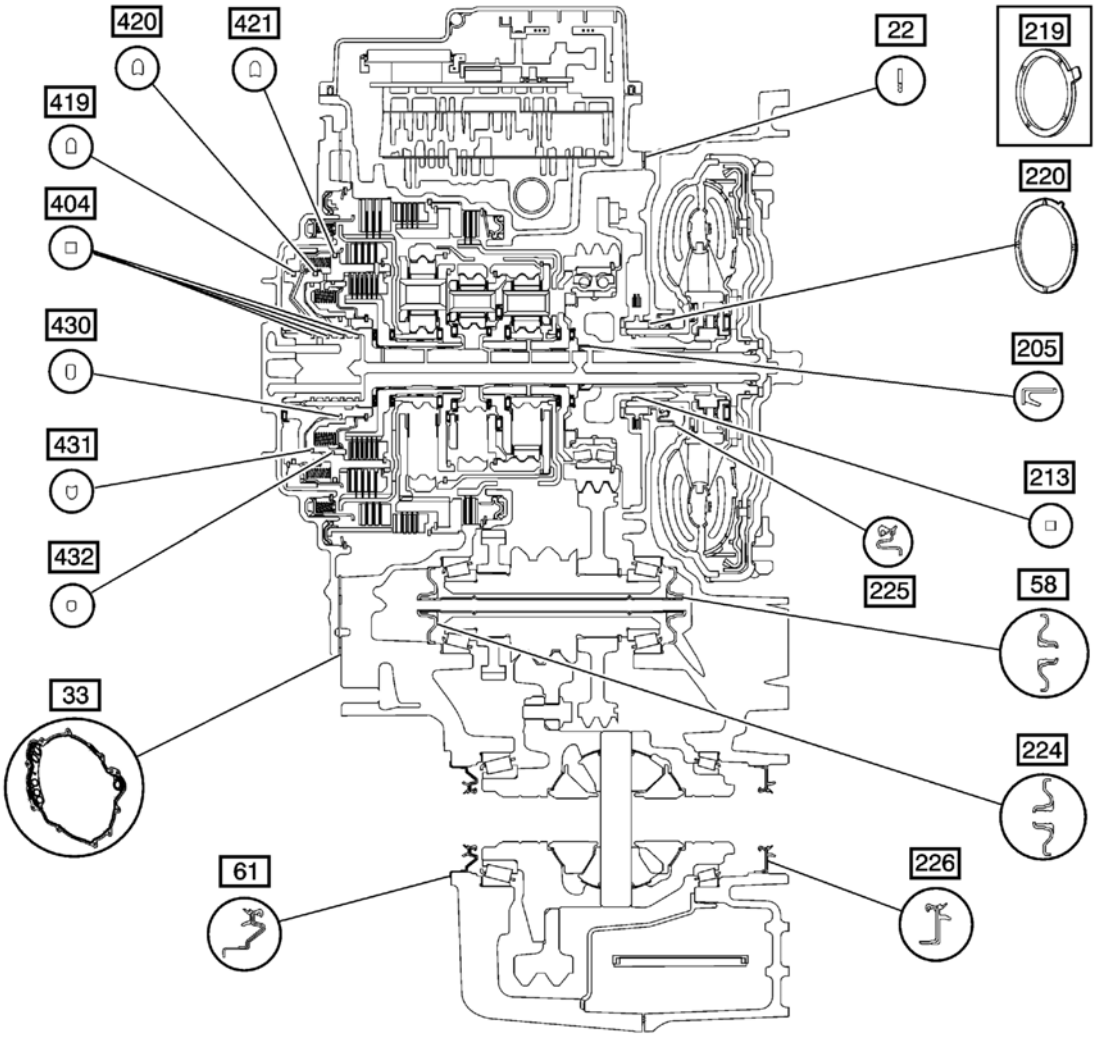


Fig. 5: Automatic Transmission Service Seal Kit (1 Of 2)
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.**

A/Trans Service Seal Kit (1 of 2) 24253594

Callout	Quantity	Component Name
22	1	Torque Converter Housing Outer Seal
33	1	A/Trans Case Cover Gasket
58	1	Front Differential Drive Pinion Gear Lube Dam
61	1	Front Wheel Drive Shaft Oil Seal Assembly
205	1	Front Differential Transfer Drive Gear Support Seal Assembly
213	1	Front Differential Transfer Drive Gear Support Seal
219	1	Drive Sprocket Thrust Washer
220	1	Drive Sprocket Thrust Washer
224	1	Front Differential Drive Pinion Gear Lube Dam
225	1	Torque Converter Fluid Seal Assembly
226	1	Front Wheel Drive Shaft Oil Seal Assembly

Callout	Quantity	Component Name
404	4	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring
419	1	3-5-Reverse Clutch Piston Inner Seal
420	1	3-5-Reverse Clutch Piston Inner Seal
421	1	3-5-Reverse Clutch Piston Dam Seal
430	1	4-5-6 Clutch Piston Inner Seal
431	1	4-5-6 Clutch Piston Outer Seal
432	1	4-5-6 Clutch Piston Outer Seal
X	2	Trans Fluid Cooler Pipe Washer (Not Shown)
X	1	Axle Seal Protector (Not Shown)

A/Trans Service Seal Kit (2 of 2) 24253594

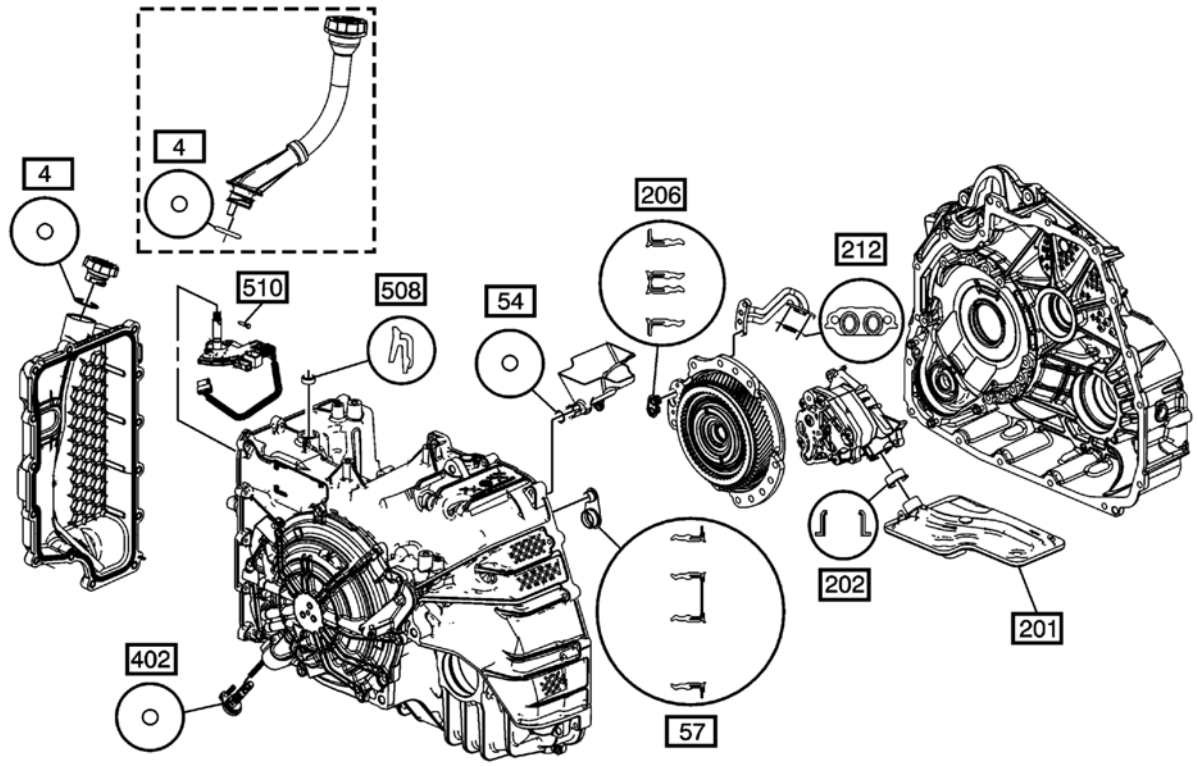


Fig. 6: Automatic Transmission Service Seal Kit (2 Of 2)
Courtesy of GENERAL MOTORS COMPANY

A/Trans Service Seal Kit (2 of 2) 24253594

Callout	Quantity	Component Name
4	1	Fluid Level Indicator Tube Seal - Model Dependent
54	1	A/Trans Fluid Trough O-Ring Seal
57	1	A/Trans Pump Fluid Outlet Seal Assembly
201	1	A/Trans Fluid Filter Assembly
202	1	Filter Neck Seal
206	1	Front Differential Transfer Drive Gear Support Torque Converter Fluid Seal Assembly

Callout	Quantity	Component Name
212	1	Front Differential Transfer Drive Gear Support Fluid Passage Tube Gasket
402	1	ISS O-Ring Seal
508	1	Manual Shift Shaft Seal
510	1	Manual Shift Shaft Pin

A/Trans Service Seal Kit 24256112

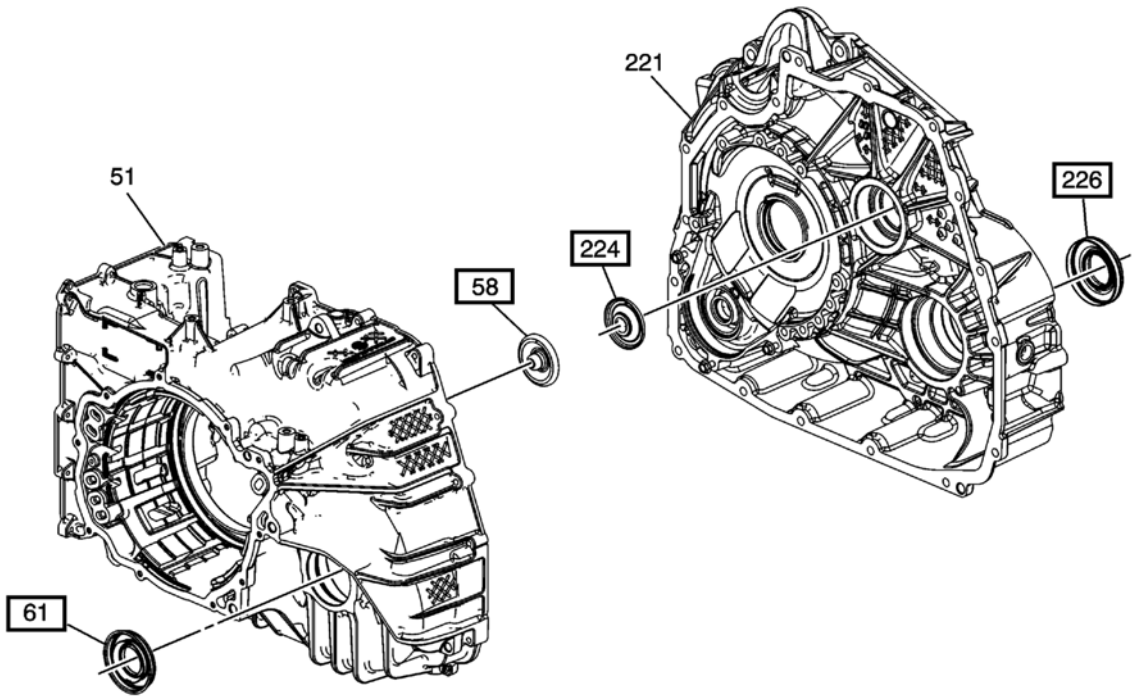


Fig. 7: Automatic Transmission Service Seal Kit
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.**

A/Trans Service Seal Kit 24256112

Callout	Quantity	Component Name
58	1	Front Differential Drive Pinion Gear Lube Dam
61	1	Front Wheel Drive Shaft Oil Seal Assembly
224	1	Front Differential Drive Pinion Gear Lube Dam
226	1	Front Wheel Drive Shaft Oil (RHS) Seal Assembly

Control Valve Body Kit 24256111

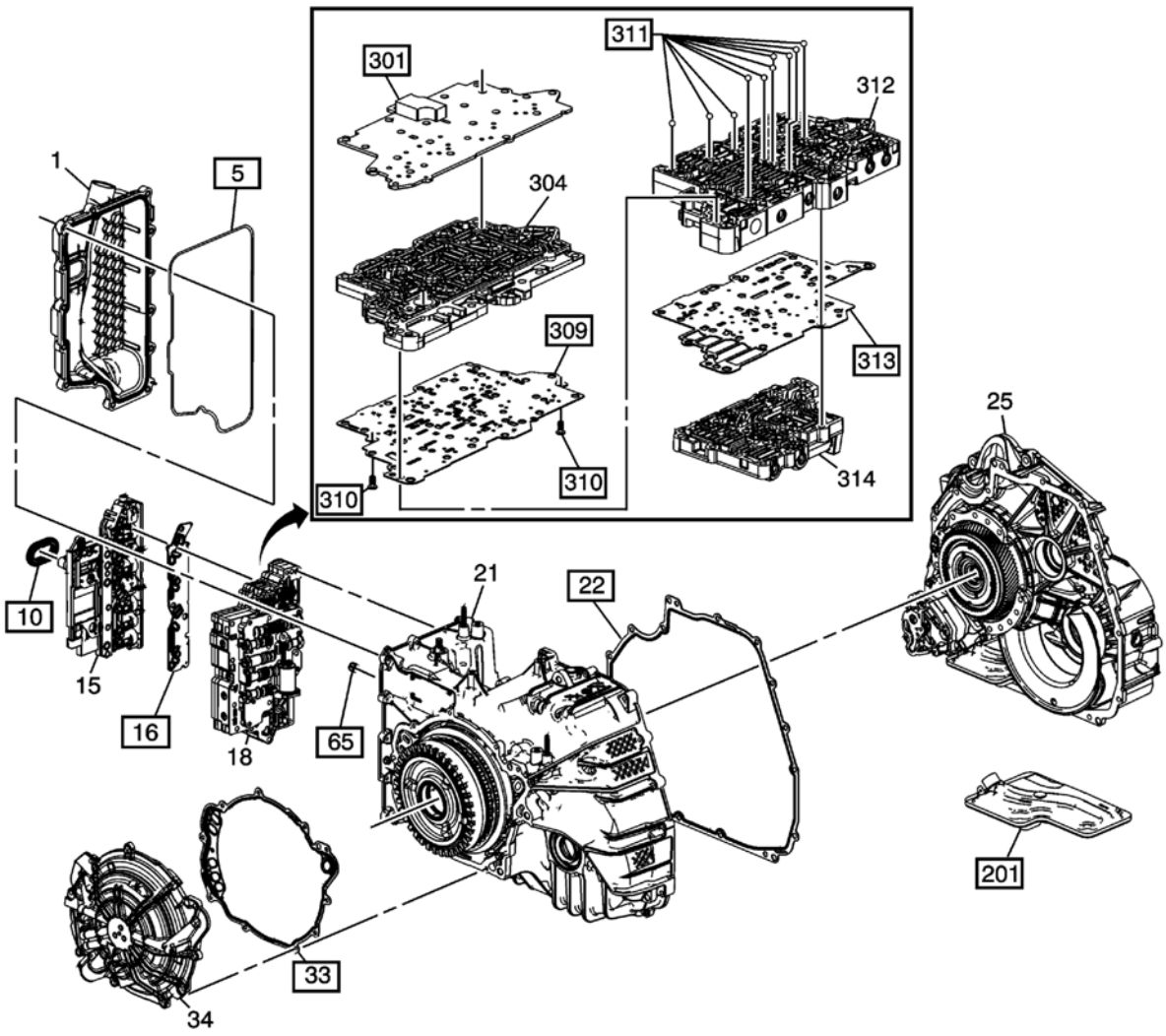


Fig. 8: Control Valve Body Kit 24256111
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.**

Control Valve Body Kit 24256111

Callout	Quantity	Component Name
5	1	Control Valve Body Cover Assembly Gasket
10	1	Control Valve Body Cover Wiring Connector Hole Seal
16	1	Control Solenoid (w/Body and TCM) Filter Plate Assembly
22	1	Torque Converter Housing Outer Seal
33	1	A/Trans Case Cover Gasket
65	1	1-2-3-4 Clutch Fluid Passage Seal
201	1	A/Trans Fluid Filter Assembly
301	1	Control Valve Channel Upper Plate Assembly
309	1	Control Valve Upper Body Spacer Plate Assembly
310	2	Control Valve Upper Body Spacer Plate Retainer
311	10	Control Valve Body Ball Check Valve

Callout	Quantity	Component Name
313	1	Control Valve Lower Body Spacer Plate Assembly

A/Trans Service Seal Kit 24240103

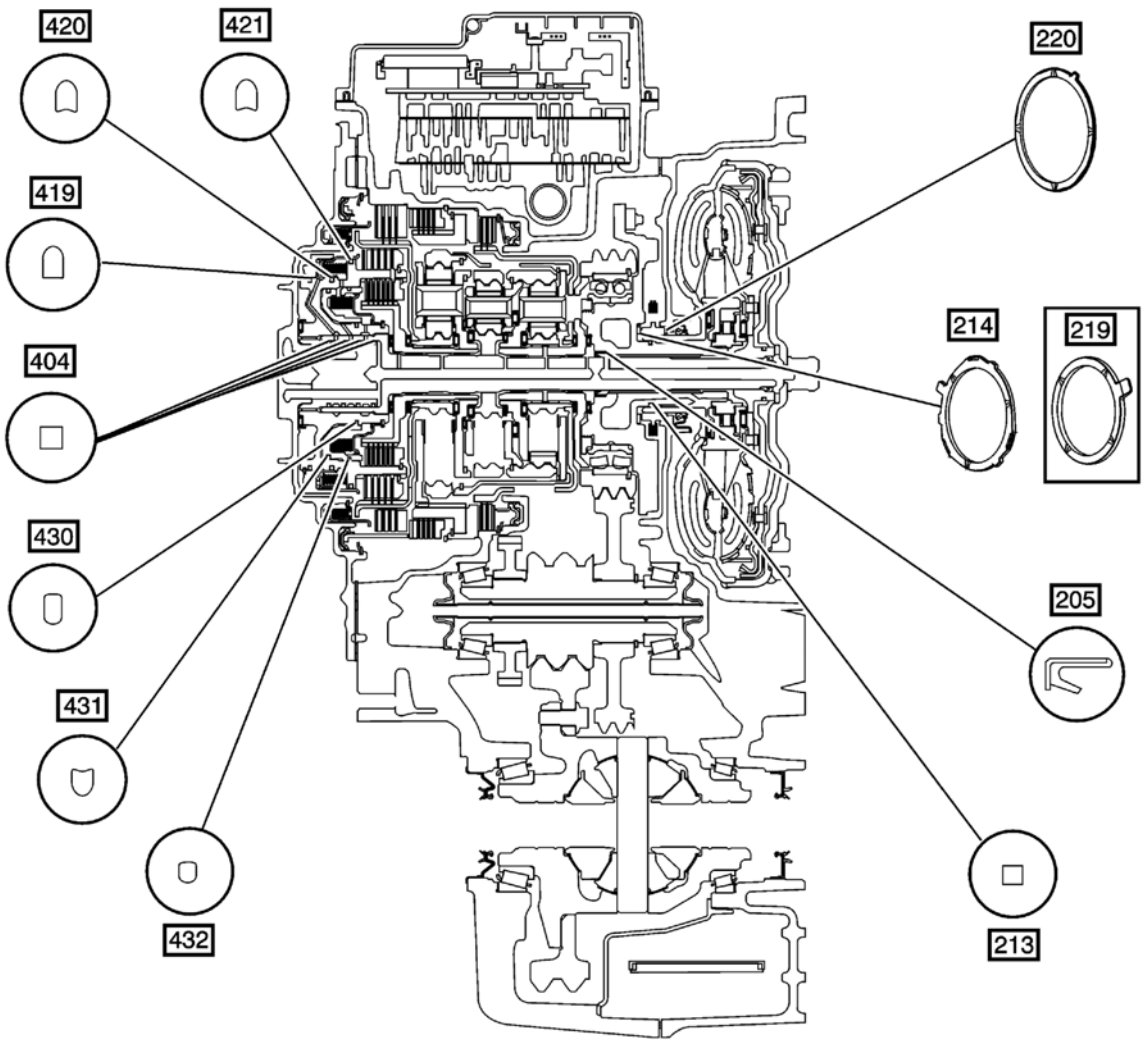


Fig. 9: Automatic Transmission Service Seal Kit
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.**

A/Trans Service Seal Kit 24240103

Callout	Quantity	Component Name
205	1	Front Differential Transfer Drive Gear Support Seal Assembly
213	1	Front Differential Transfer Drive Gear Support Seal
214	1	Drive Sprocket Thrust Washer
219	1	Drive Sprocket Thrust Washer
220	1	Drive Sprocket Thrust Washer
404	4	3-5-Reverse and 4-5-6 Clutch Fluid Seal Ring

Callout	Quantity	Component Name
419	1	3-5-Reverse Clutch Piston Inner Seal
420	1	3-5-Reverse Clutch Piston Inner Seal
421	1	3-5-Reverse Clutch Piston Dam Seal
430	1	4-5-6 Clutch Piston Inner Seal
431	1	4-5-6 Clutch Piston Outer Seal
432	1	4-5-6 Clutch Piston Outer Seal
X	2	Trans Fluid Cooler Pipe Washer (Not Shown)

A/Trans Service Seal Kit 2 24240103

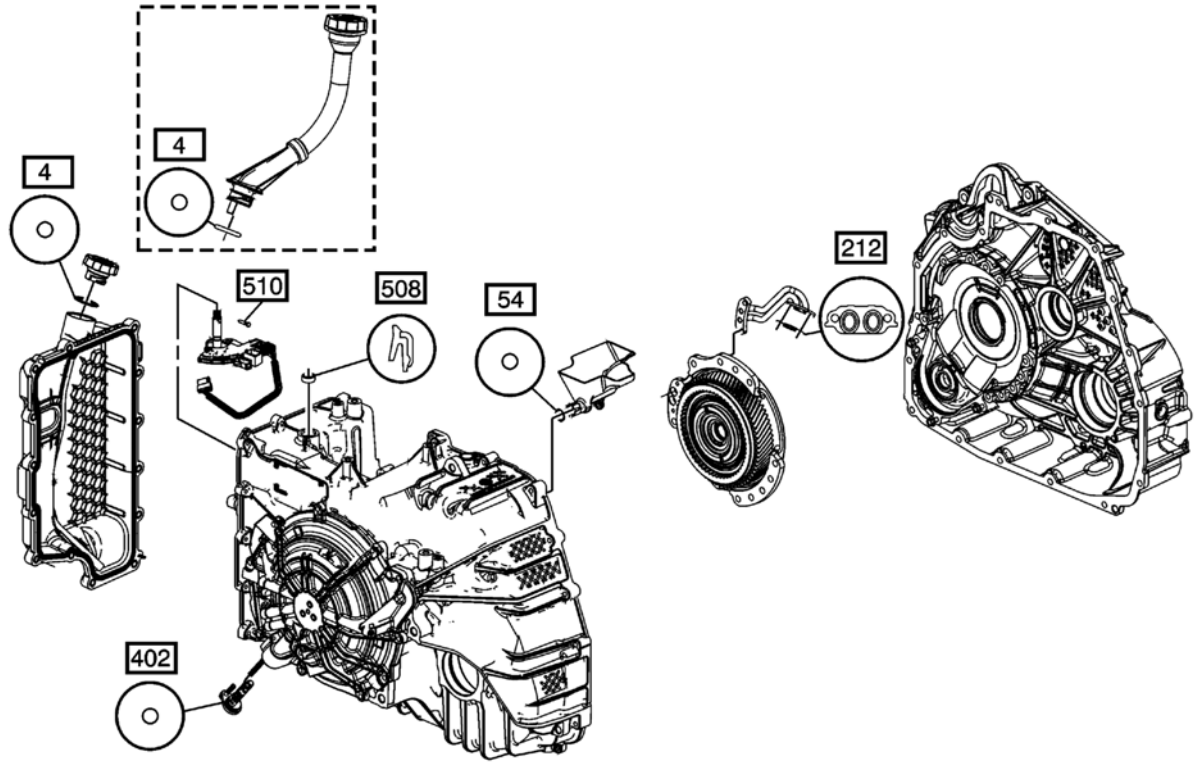


Fig. 10: Automatic Transmission Service Seal Kit
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.**

A/Trans Service Seal Kit 2 24240103

Callout	Quantity	Component Name
4	1	Fluid Level Indicator Tube Seal - Model Dependent
54	1	A/Trans Fluid Trough O-Ring Seal
212	1	Front Differential Transfer Drive Gear Support Fluid Passage Tube Gasket
402	1	ISS O-Ring Seal
508	1	Manual Shift Shaft Seal

Callout	Quantity	Component Name
510	1	Manual Shift Shaft Pin

A/Trans Service Seal Kit 24240106

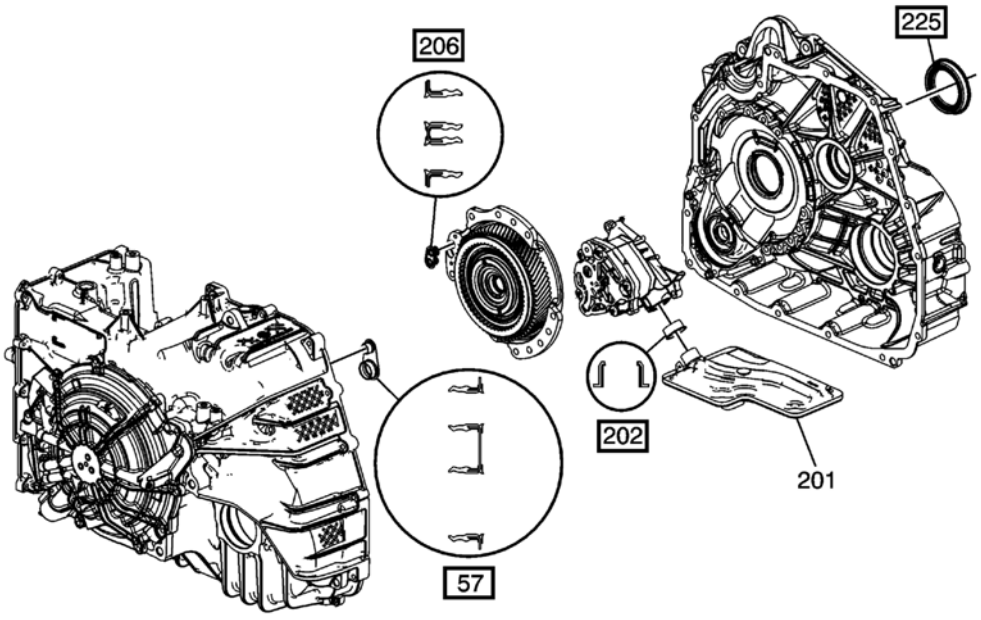


Fig. 11: Automatic Transmission Service Seal Kit
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Callouts with boxes around them indicate part is included in the service kit. Callouts without boxes are shown for relationship purposes only.**

A/Trans Service Seal Kit 24240106

Callout	Quantity	Component Name
57	1	A/Trans Pump Fluid Outlet Seal Assembly
202	1	Filter Neck Seal
206	1	Front Differential Transfer Drive Gear Support Torque Converter Fluid Seal Assembly
225	1	Torque Converter Fluid Seal Assembly
X	1	Front Wheel Drive Shaft Oil Seal Protector (Not Shown)

Article GUID: A00737209

Transmission

Shift Lock Control - Impala

SCHEMATIC WIRING DIAGRAMS

SHIFT LOCK CONTROL WIRING SCHEMATICS

Shift Lock Controls

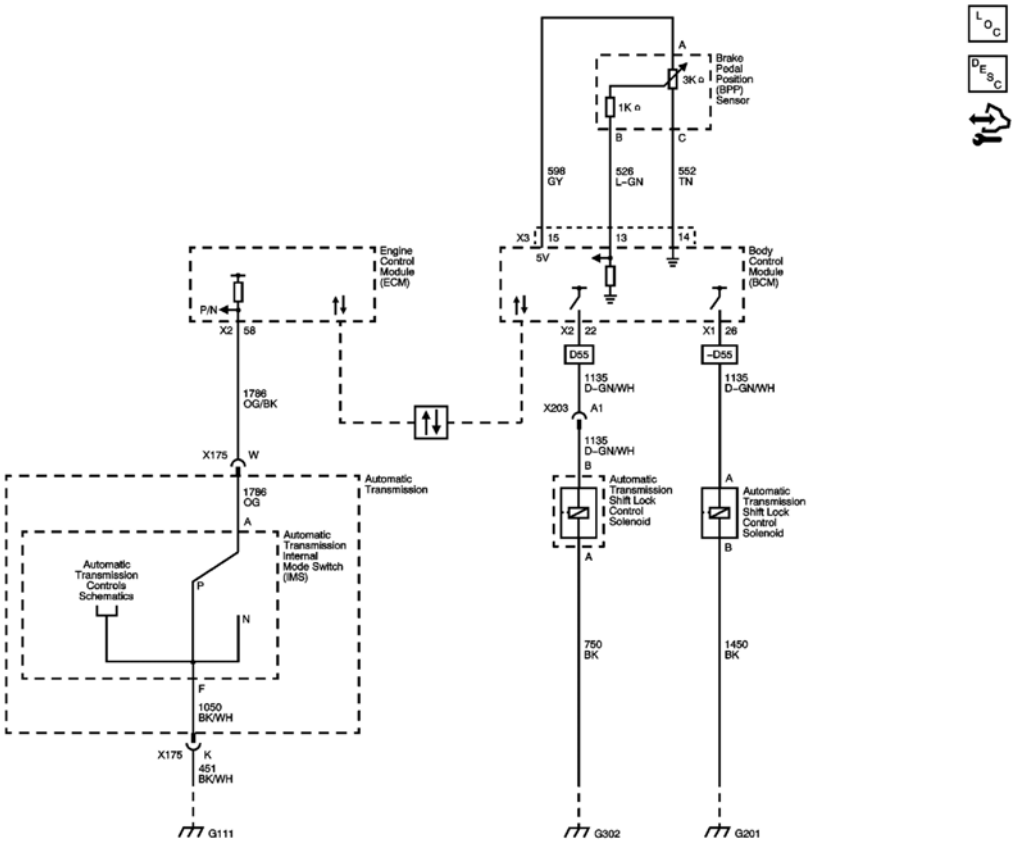


Fig. 1: Shift Lock Controls Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B2705: GEARSHIFT UNLOCK CIRCUIT

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC B2705 02

Gearshift Unlock Circuit Short to Ground

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Shift Lock Control Solenoid Control Circuit	B2705 02	1	-	-
Shift Lock Control Solenoid Ground Circuit	-	1	-	-
1. Unable to move gearshift lever with brake pedal depressed				

Circuit/System Description

The body control module (BCM) controls the automatic transmission shift lock control solenoid by providing a battery positive voltage to the solenoid. The BCM utilizes a smart driver to control the voltage supply circuit to the automatic transmission shift lock control solenoid. The smart driver monitors the voltage and current flow of the control circuit.

Conditions for Running the DTC

- The ignition switch is in the ON position.
- The brake pedal is pressed.
- The transmission is in the PARK position.

Conditions for Setting the DTC

Sets if there is a short to ground in the automatic transmission shift lock control solenoid control circuit.

Action Taken When the DTC Sets

The BCM will not attempt to enable the voltage supply circuit of the automatic transmission shift lock control solenoid until the next key cycle.

Conditions for Clearing the DTC

- A current DTC will clear when the malfunction is no longer present and the ignition switch is cycled.
- All BCM history codes will clear after 100 ignition cycles with no current codes active during the 100 ignition cycles.

Reference Information

Schematic Reference

Shift Lock Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Automatic Transmission Shift Lock Control Description and Operation (Floor Shift)Automatic Transmission Shift Lock Control Description and Operation (Column Shift)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, clear the DTC. Observe the scan tool BCM Brake Applied Output Signal parameter. The parameter should change from ON to OFF when the brake pedal is depressed.
    - If the parameter does not change, refer to **Stop Lamps Malfunction** .
2. Ignition ON, observe the scan tool BCM Shifter Unlock Command parameter. The parameter should change from ON to OFF when the brake pedal is depressed.
    - If the parameter does not change, replace the BCM.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the shift lock control solenoid.
2. Ignition OFF, test for less than 30 Ω between the appropriate connector terminal listed below and ground:
    - Floor shift - terminal A
    - Column shift - terminal B
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Install a test lamp between connector terminal A and terminal B.
4. Ignition ON, command the scan tool BCM Shift Lock Solenoid output control ON and OFF. The test lamp should turn ON and OFF as commanded.
    - If the test lamp is always ON, test the control circuit for short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If the circuit tests normal, test or replace the shift lock control solenoid.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Transmission Control Replacement**
- **Control Module References** for BCM replacement, setup, and programming

SYMPTOMS - AUTOMATIC TRANSMISSION SHIFT LOCK CONTROL

NOTE: **The following steps must be completed before using the symptom tables.**

1. Perform the **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
   - There are no DTCs set.
   - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions. Refer to **Automatic Transmission Shift Lock Control Description and Operation (Floor Shift)Automatic Transmission Shift Lock Control Description and Operation (Column Shift)**.

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the automatic transmission shift lock control. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections**

Symptom List

Refer to a symptom diagnostic procedure in order to diagnose the symptom:

Transmission Control Lever Malfunction

TRANSMISSION CONTROL LEVER MALFUNCTION

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Shift Lock Control Solenoid Control Circuit	B2705 02	1	-	-
Shift Lock Control Solenoid Ground Circuit	-	1	-	-
1. Unable to move gearshift lever with brake pedal depressed				

Circuit/System Description

The body control module (BCM) controls the shift lock solenoid by providing battery voltage to the shift lock control solenoid. The BCM utilizes a smart driver to control the voltage supplied to the shift lock solenoid. The smart driver monitors the voltage and current flow of the control circuit.

Reference Information

Schematic Reference

Shift Lock Control Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Automatic Transmission Shift Lock Control Description and Operation (Floor Shift)Automatic Transmission Shift Lock Control Description and Operation (Column Shift)

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, with the brake pedal applied, observe the scan tool Brake Applied Output Signal parameter. The reading should be ON with the brake pedal depressed.
    - If not the specified parameter, refer to **Stop Lamps Malfunction** .
2. Ignition ON, observe the scan tool BCM shift lock solenoid command parameter. The parameter should change from ON to OFF when the brake pedal is applied and released.
    - If not the specified parameter, replace the BCM.
3. Press the brake pedal, the vehicle operator should be able to move the shifter lever out of the park position.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the shift lock control solenoid.
2. Ignition OFF, test for less than 30 Ω between the appropriate connector terminal listed below and ground:
    - Floor shift - terminal A
    - Column shift - terminal B
    - If greater than the specified range, test the ground circuit for an open/high resistance.

3. Install a test lamp between connector terminal A and terminal B.
4. Ignition ON, command the scan tool BCM Shift Lock Solenoid output control ON and OFF. The test lamp should turn ON and OFF as commanded.
    - If the test lamp is always ON, test the control circuit for short to voltage. If the circuit tests normal, replace the BCM.
    - If the test lamp is always OFF, test the control circuit for short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
5. If the circuit tests normal, test or replace the shift lock control solenoid.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Transmission Control Replacement**
- **Control Module References** for BCM replacement, setup and programming

DESCRIPTION AND OPERATION

AUTOMATIC TRANSMISSION SHIFT LOCK CONTROL DESCRIPTION AND OPERATION (FLOOR SHIFT)

The automatic transmission shift lock control system is a safety device that prevents an inadvertent shift out of PARK when the engine is running. The driver must press the brake pedal before moving the shift lever out of the PARK position. The system consists of the following components:

- The automatic transmission shift lock solenoid (serviced as the automatic transmission shift lock actuator), as well as the body control module (BCM) and the engine control module (ECM). The shift lock solenoid is located within the floor shift control assembly with vehicles equipped with floor shift.
- The body control module (BCM) controls the voltage supply circuit of the shift lock control solenoid. The following conditions must be before the BCM will supply voltage to the shift lock control solenoid.

The BCM controls the voltage to the shift lock control solenoid through the shift lock control solenoid controlled voltage circuit. The following conditions must be met before the BCM will supply voltage to the shift lock solenoid:

- The ignition is in the ON position.
- The engine control module (ECM) sends an input via GMLAN serial data to the BCM indicating the transmission is in the PARK position.
- The BCM determines the brake pedal is applied according the brake pedal position.

Since the shift lock control solenoid is permanently grounded, the BCM supplies voltage to the automatic transmission shift lock control solenoid, mechanically unlocking the shift lever allowing the driver to move the shift lever out of the PARK position as the solenoid energizes. When the brake pedal is not applied, the BCM turns the control voltage output of the shift lock control solenoid OFF, de-energizing the shift lock control solenoid. The de-energized solenoid mechanically locks the shift lever in the PARK position.

During remote start operation, the BCM will de-energize the shift lock control circuit, locking the shift lever in the PARK position.

AUTOMATIC TRANSMISSION SHIFT LOCK CONTROL DESCRIPTION AND OPERATION (COLUMN SHIFT)

The automatic transmission shift lock control system is a safety device that prevents an inadvertent shift out of PARK when the engine is running. The driver must press the brake pedal before moving the shift lever out of the PARK position. The system consists of the following components:

- The automatic transmission shift lock solenoid (serviced as the automatic transmission shift lock actuator), as well as the body control module (BCM) and the engine control module (ECM). The shift lock solenoid is located within the steering column assembly with vehicles equipped with column shift.
- The body control module (BCM) controls the voltage supply circuit of the shift lock control solenoid. The following conditions must be met before the BCM will supply voltage to the shift lock control solenoid.
- The ignition is in the ON position.
- The engine control module (ECM) sends an input via GMLAN serial data to the BCM indicating the transmission is in the PARK position.
- The BCM determines the brake pedal is not applied according the brake pedal position.

Since the shift lock control solenoid is permanently grounded, the BCM supplies voltage to the automatic transmission shift lock control solenoid, mechanically locking the shift lever in the PARK position as the solenoid energizes. When the brake pedal is applied, the BCM turns the control voltage output of the shift lock control solenoid OFF, de-energizing the shift lock control solenoid. The de-energized solenoid releases the mechanical lock allowing the driver to move the shift lever out of the PARK position.

During remote start operation, the BCM will energize the shift lock control circuit, locking the shift lever in the PARK position.

Article GUID: A00737212

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Auxiliary Transaxle Oil Cooler To The Lower Radiator Support Bolt	10 N.m	89 lb in
Auxiliary Transaxle Oil Cooler To The Upper Radiator Support Bolt	25 N.m	18 lb ft
Transaxle Oil Cooler Fitting	38 N.m	28 lb ft

DIAGNOSTIC INFORMATION AND PROCEDURES

TRANSMISSION FLUID COOLER FLUSHING AND FLOW TEST

GM studies indicate that plugged or restricted transmission oil coolers and pipes cause insufficient transmission lubrication and elevated operating temperatures which can lead to premature transmission failure. Many repeat repair cases could have been prevented by following published procedures for transmission oil cooler flushing and flow checking. This procedure includes flow checking and flushing the auxiliary transmission oil cooler, if equipped.

NOTE: **Use the DT-45096 transmission oil cooling system flush and flow test tool or equivalent to flush and flow test the transmission oil cooler and the oil cooler pipes after the transmission is removed for repairs.**

Only use the appropriate GM automatic transmission fluid when doing a repair on a GM transmission.

If the fluid in the **DT-45096** transmission oil cooling system flush and flow test tool is different than what is used in the transmission, use compressed air to blow the residual transmission fluid out of the oil cooler and lines.

Time allowance for performing the cooler flow checking and flushing procedure has been included in the appropriate labor time guide operations since the 1987 model year. The service procedure steps for oil cooler flushing and flow testing are as follows:

Cooler Flow Check and Flushing Steps

1. Machine Set-up
2. Determine Minimum Flow Rate
3. Back Flush
4. Forward Flush
5. Flow Test

6. Code Recording Procedure
7. Clean-up

Special Tools

- **DT-45096** Transmission Oil Cooling System Flush and Flow Test Tool
- **DT-48312** Transmission Cooler Flush Adapter
- Shop air supply with water/oil filters, regulator and pressure gauge - minimum 90 psi
- Eye protection
- Rubber gloves

For equivalent regional tools, refer to **Special Tools** .

Machine Set-up

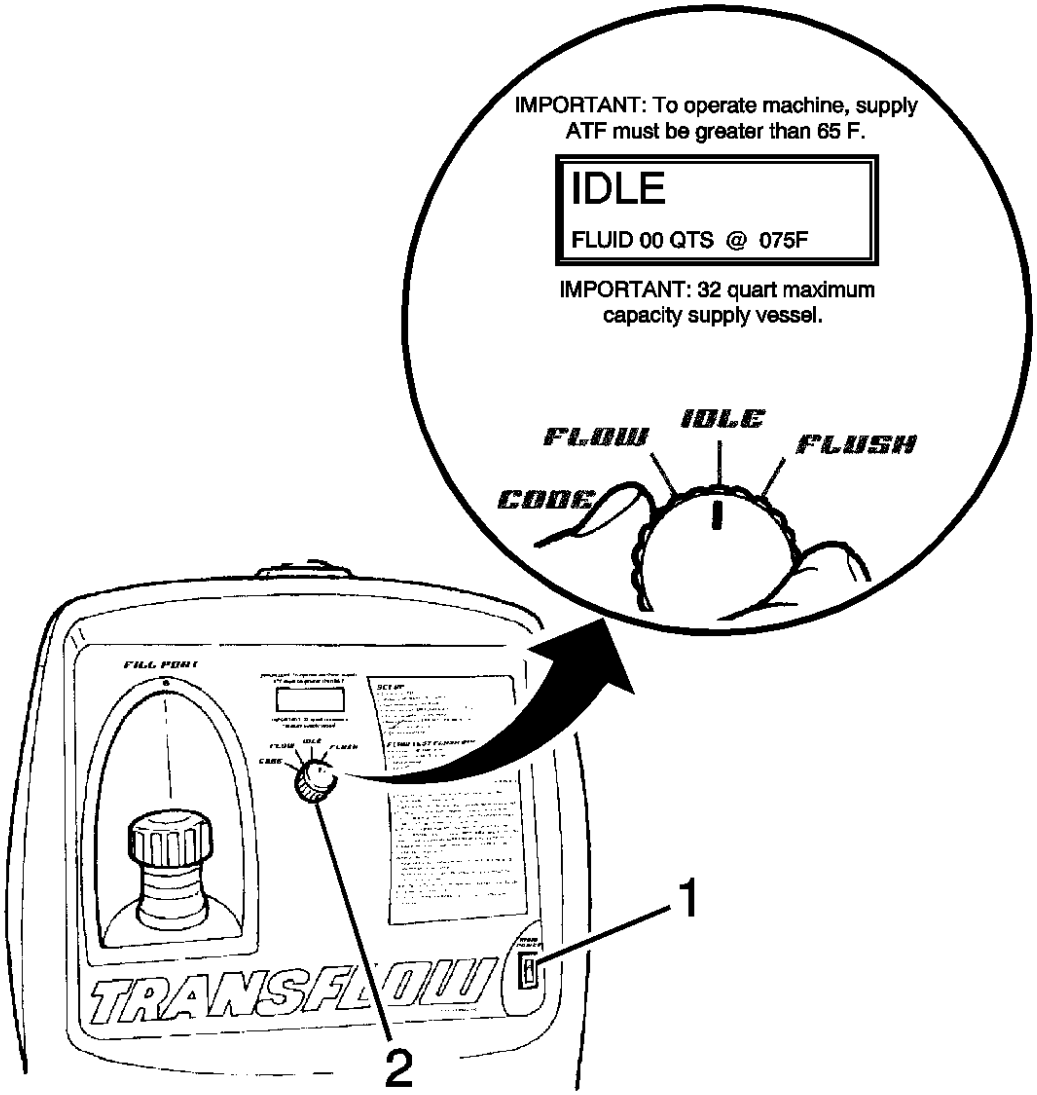


Fig. 1: View Of Main Power Switch & Main Function Switch
Courtesy of GENERAL MOTORS COMPANY

1. Verify that the main power switch (1) is in the OFF position.
2. Place the main function switch (2) in the IDLE position.

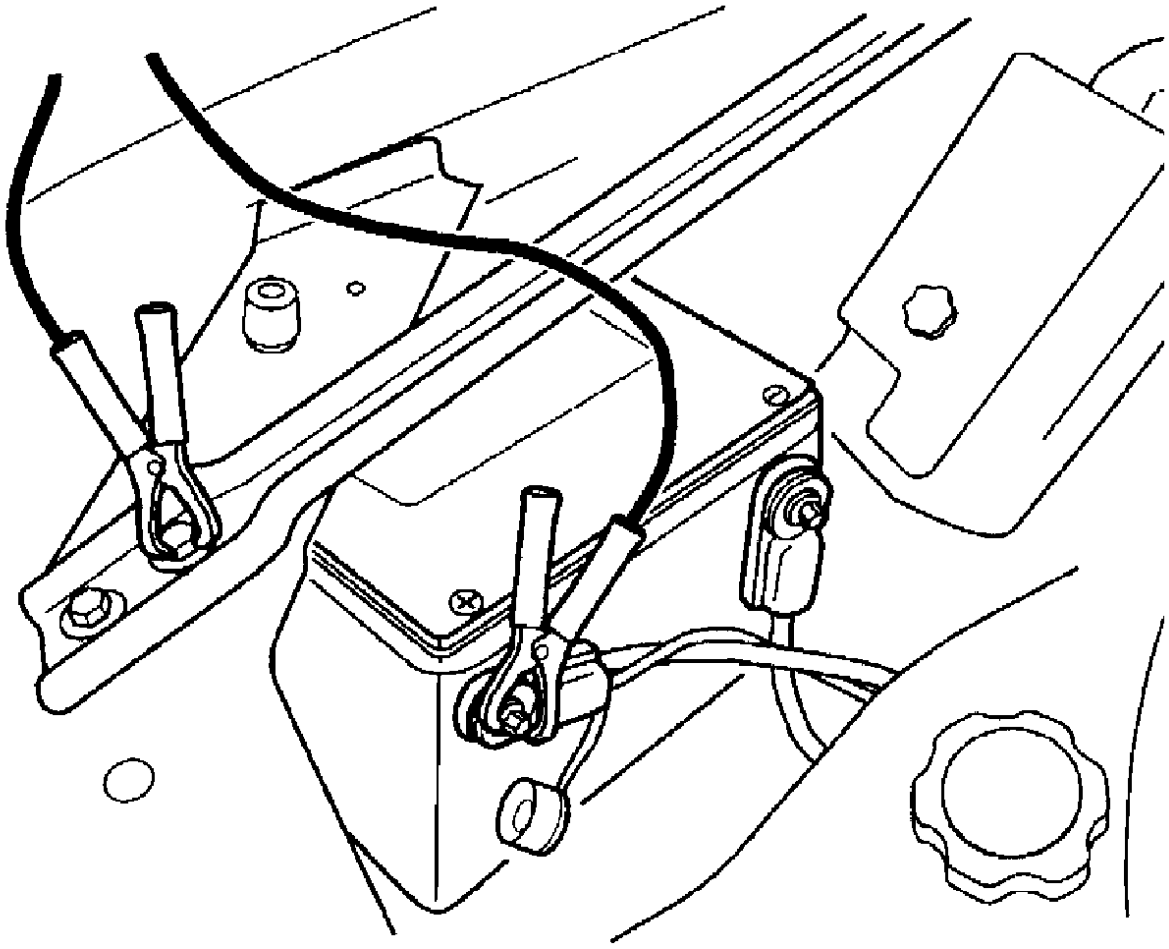


Fig. 2: Connecting To 12V DC Power Source
Courtesy of GENERAL MOTORS COMPANY

3. Connect **DT-45096** flush and flow test tool to the vehicle 12V DC power source by connecting the red battery clip to the positive, +, battery post on the vehicle and connect the negative lead to a known good chassis ground.
4. Turn the main power switch to the ON position.

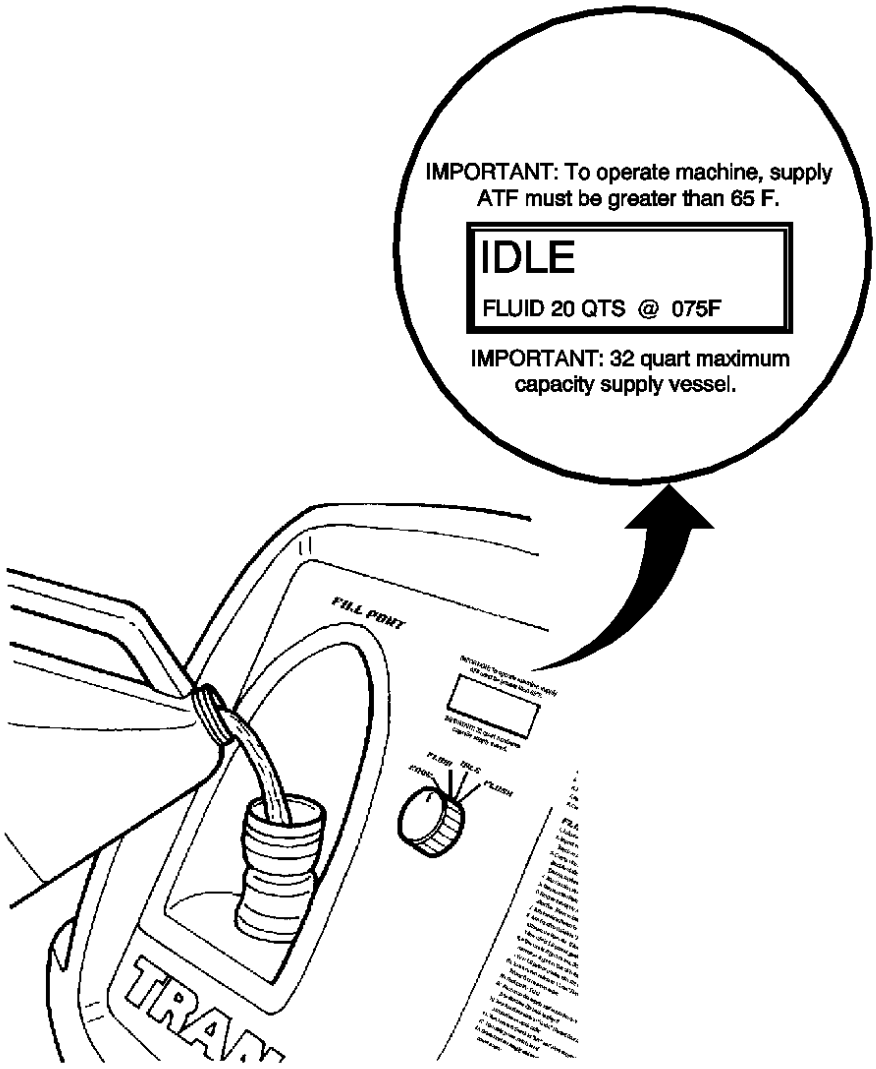


Fig. 3: Filling Supply Tank With Transmission Fluid
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not overfill the supply vessel. Damage to the unit may result. To verify the fluid level, view the LCD screen display while filling the unit, to ensure the fluid level does not exceed 30 L (32 qt).

5. Fill the supply tank with the appropriate GM automatic transmission fluid through the fill port.
6. Reinstall and tighten the fill cap.

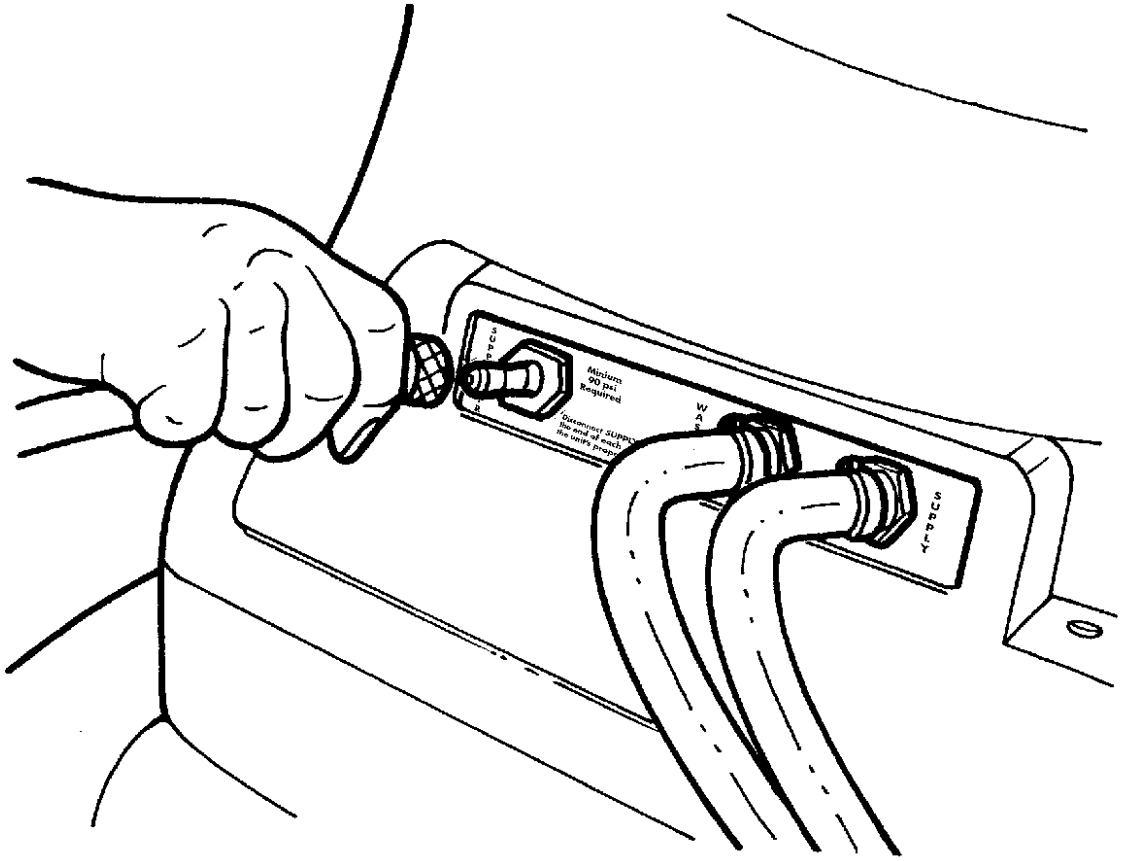


Fig. 4: Applying Shop Air Supply Hose To Quick-Disconnect
Courtesy of GENERAL MOTORS COMPANY

7. Connect a shop air supply hose to the quick-disconnect on the rear panel marked SUPPLY AIR.

Determine Minimum Flow Rate

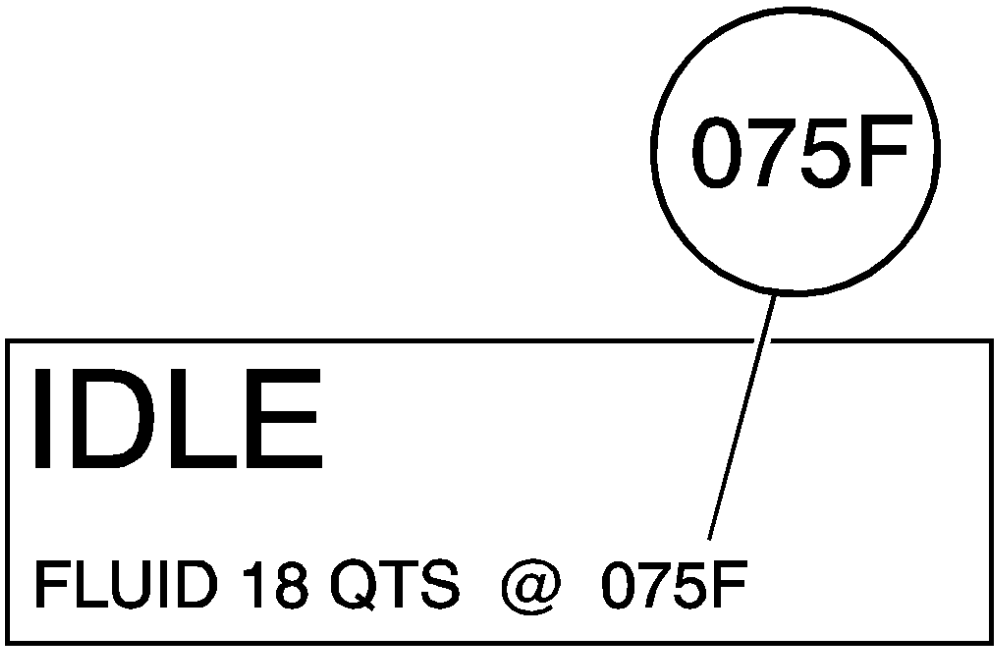


Fig. 5: Identifying Machine Display Of Automatic Transmission Fluid Temperature
Courtesy of GENERAL MOTORS COMPANY

1. From the machine display, identify the temperature of the automatic transmission fluid that is stored in the supply vessel of **DT-45096** flush and flow test tool.

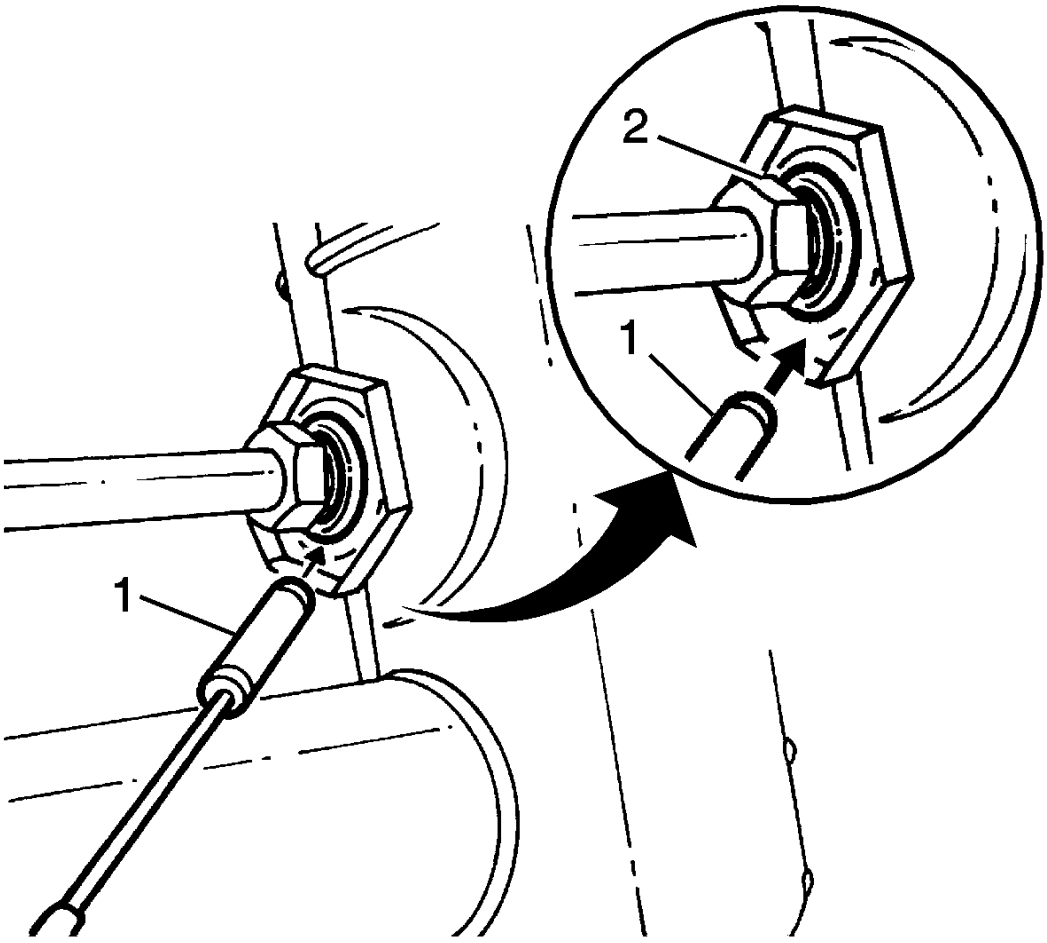


Fig. 6: Identifying Transmission Oil Cooler Metal Composition
Courtesy of GENERAL MOTORS COMPANY

2. Determine whether the transmission oil cooler is steel or aluminum by using a magnet (1) at the cooler flange (2) at the radiator.
3. Refer to the table below. Using the temperature from step 1, locate on either the Steel MINIMUM Flow Rate table or the Aluminum MINIMUM Flow Rate table the minimum flow rate in gallons per minutes (GPM). Record the minimum flow rate in GPMs and the supply fluid temperature for further reference.

   Example

   - Fluid temperature: 75Â°F
   - Cooler type: Steel

   The MINIMUM flow rate for this example would be 0.8 GPM.

4. Inspect transmission oil cooler lines for damage or kinks that could cause restricted oil flow. Repair as needed and refer to the appropriate GM service manual procedures.

Minimum Flow Rate in Gallons Per Minute (gpm)

Temperature Range	Steel	Aluminum
65 - 66Â°F	0.6 gpm	0.5 gpm
67 - 70Â°F	0.7 gpm	0.6 gpm
71 - 75Â°F	0.8 gpm	0.7 gpm
76 - 80Â°F	0.9 gpm	0.8 gpm
81 - 84Â°F	1.0 gpm	0.9 gpm
85 - 89Â°F	1.1 gpm	1.0 gpm
90 - 94Â°F	1.2 gpm	1.1 gpm
95 - 98Â°F	1.3 gpm	1.2 gpm
99 - 103Â°F	1.4 gpm	1.3 gpm
104 - 108Â°F	1.5 gpm	1.4 gpm
109 - 112Â°F	1.6 gpm	1.5 gpm
113 - 117Â°F	1.7 gpm	1.6 gpm
118 - 120Â°F	1.8 gpm	1.7 gpm

Back Flush Procedure

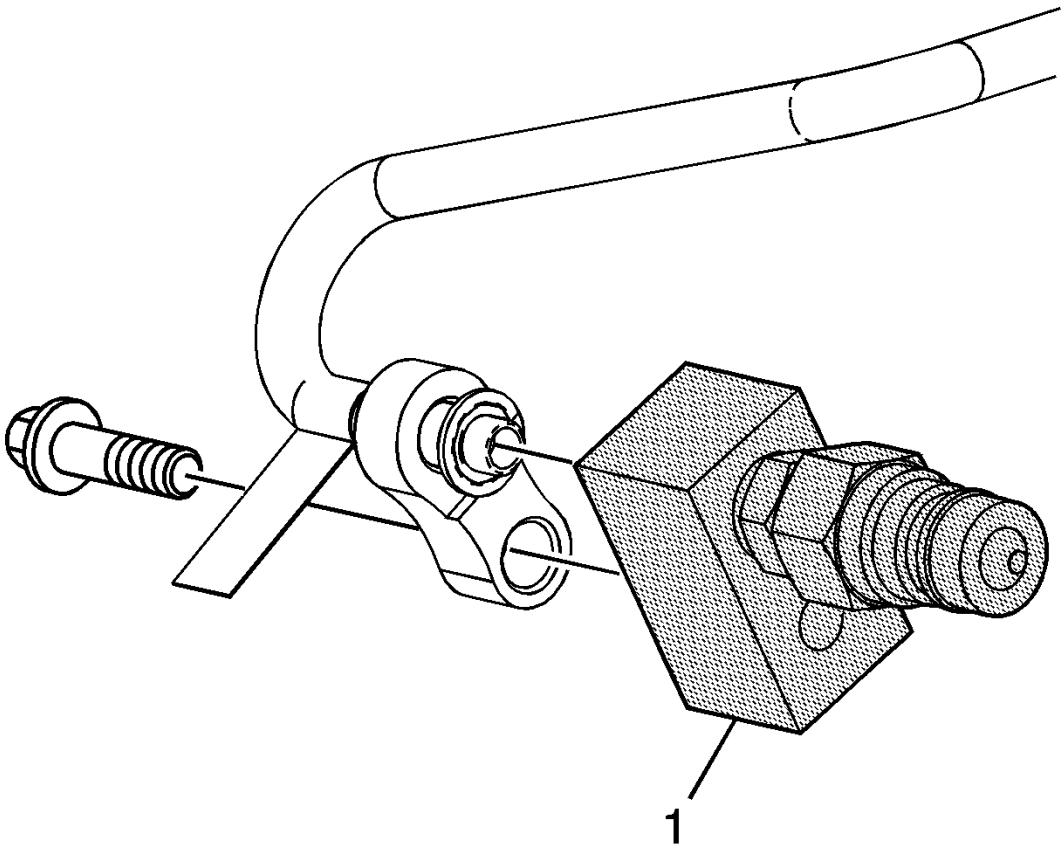


Fig. 7: Cooler Flush Adapter

Courtesy of GENERAL MOTORS COMPANY

1. Connect the **DT-45096-50** cooler flush adapter (1) to the vehicle transmission oil cooler supply and return lines at the transmission.

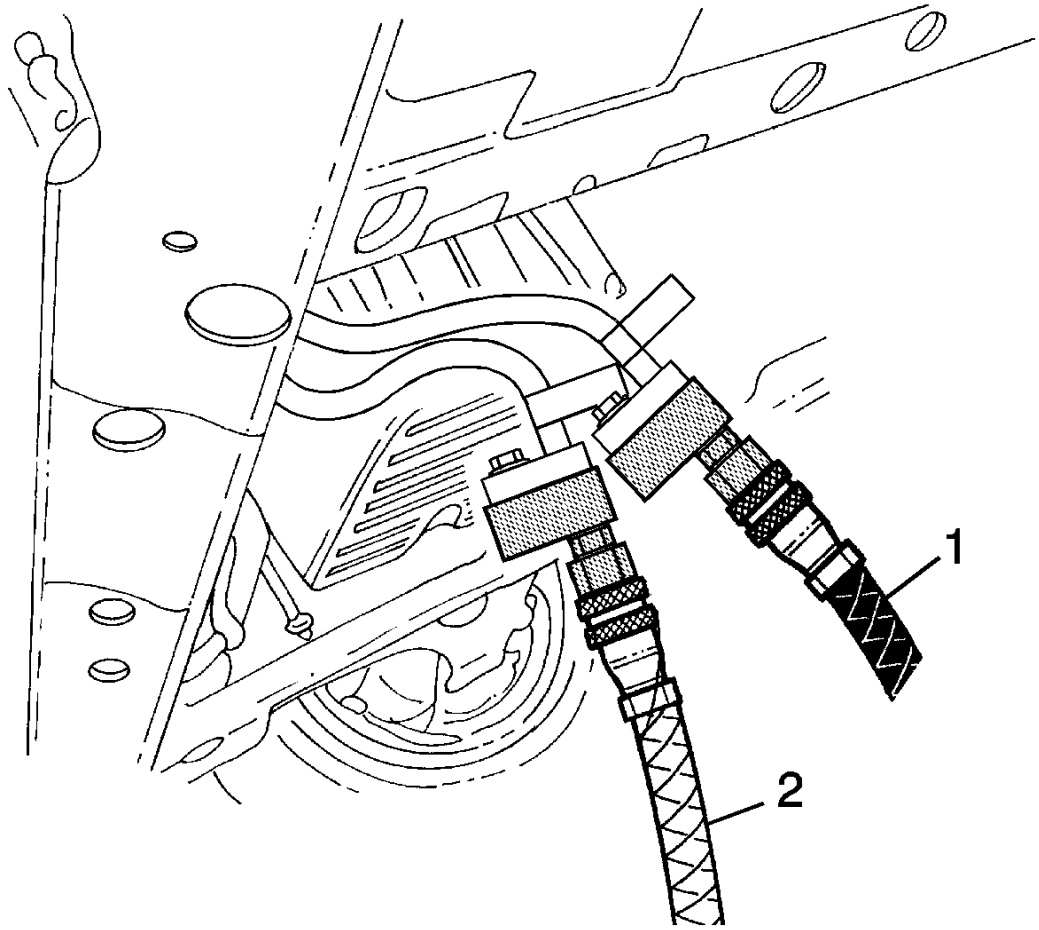


Fig. 8: View Of Black Supply Hose And Clear Waste Hose
Courtesy of GENERAL MOTORS COMPANY

2. Connect the black supply hose (1) to the return line, top connector of the transmission, and the clear waste hose (2) to the feed line, bottom connector of the transmission, to the vehicle cooler lines. This is the reverse flow - backflush direction.

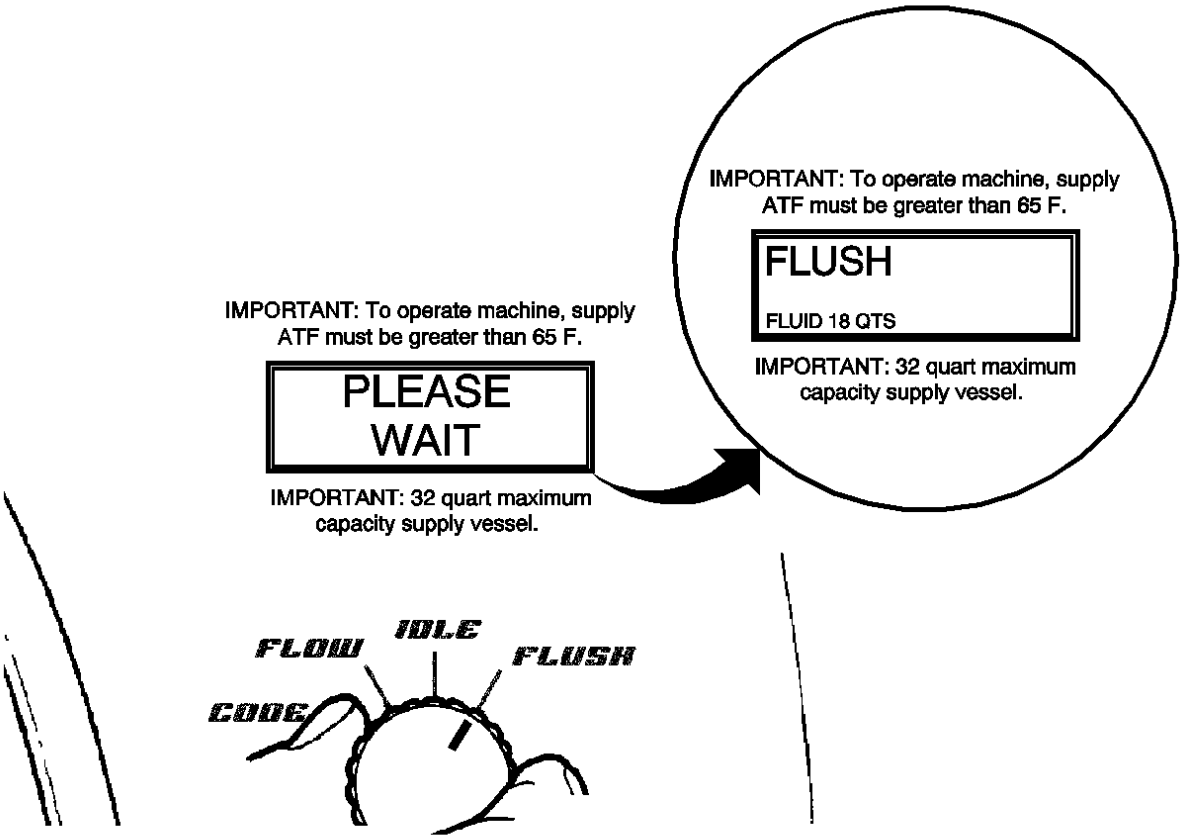


Fig. 9: View Of Main Function Switch FLUSH Position
Courtesy of GENERAL MOTORS COMPANY

3. Turn the main function switch to the FLUSH position. Allow the machine to operate for 30 seconds.

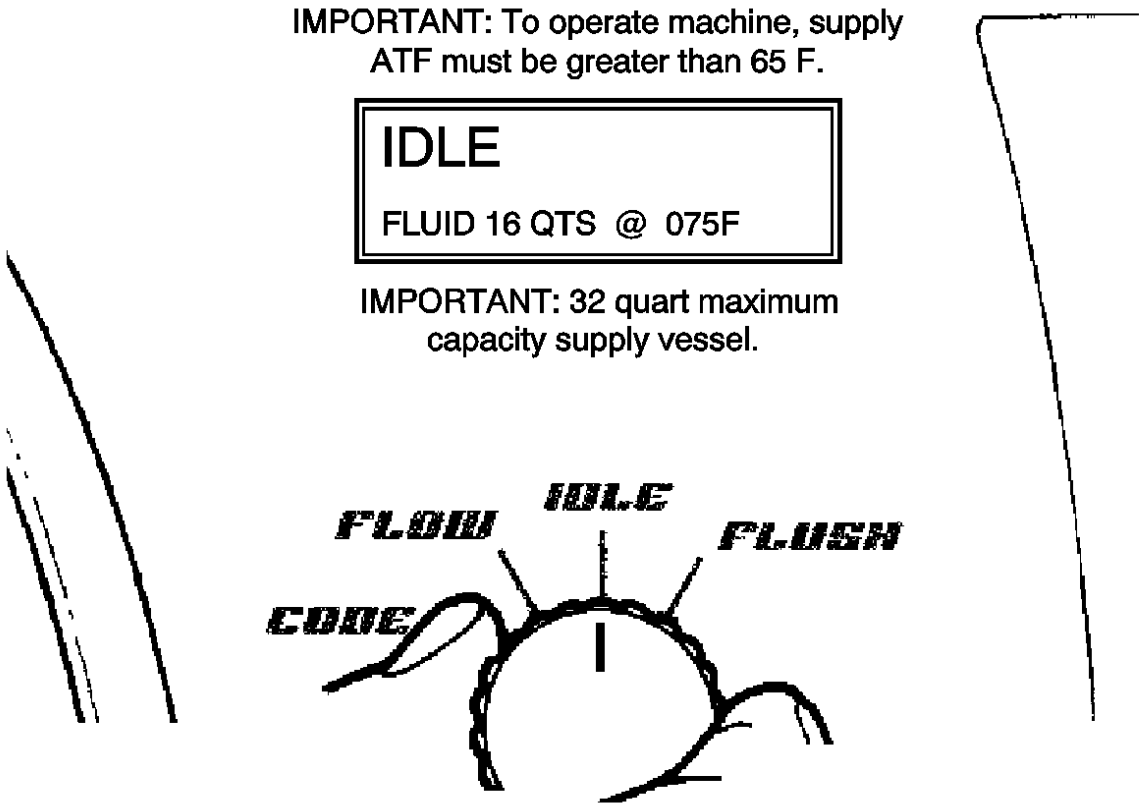


Fig. 10: View Of Main Function Switch IDLE Position
Courtesy of GENERAL MOTORS COMPANY

4. Turn the main function switch to the IDLE position and allow the supply vessel pressure to dissipate.

Forward Flush

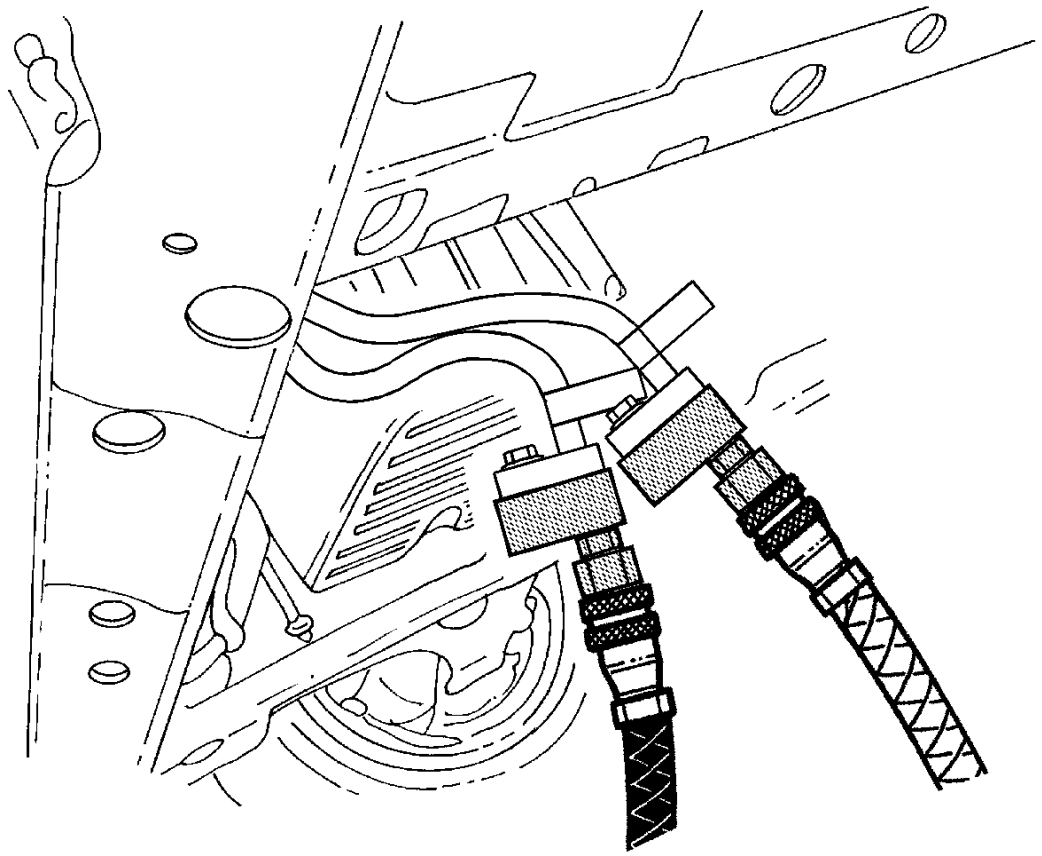


Fig. 11: Identifying Supply And Waste Hoses
Courtesy of GENERAL MOTORS COMPANY

1. Disconnect the supply and waste hoses from the vehicle cooler lines. Reverse the supply and waste hoses to provide a normal flow direction.

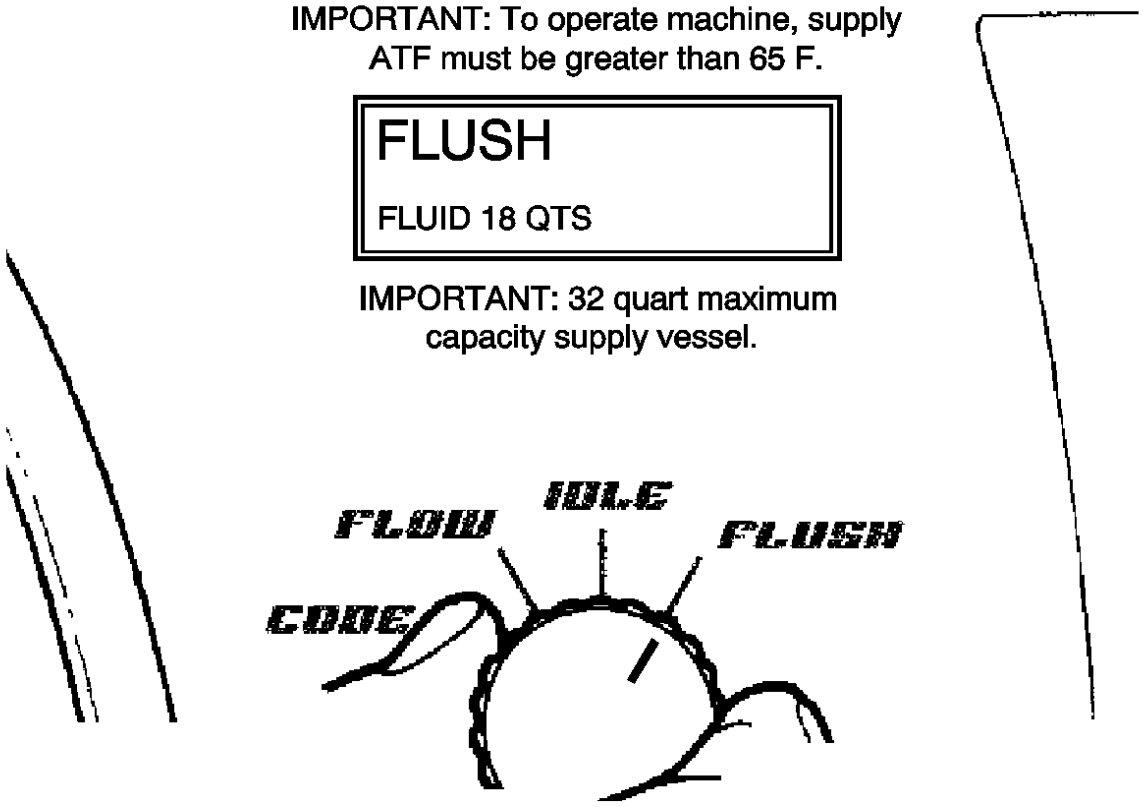


Fig. 12: View Of Main Function Switch FLUSH Position
Courtesy of GENERAL MOTORS COMPANY

2. Turn the main function switch to the FLUSH position and allow machine to operate for 30 seconds.

Flow Test

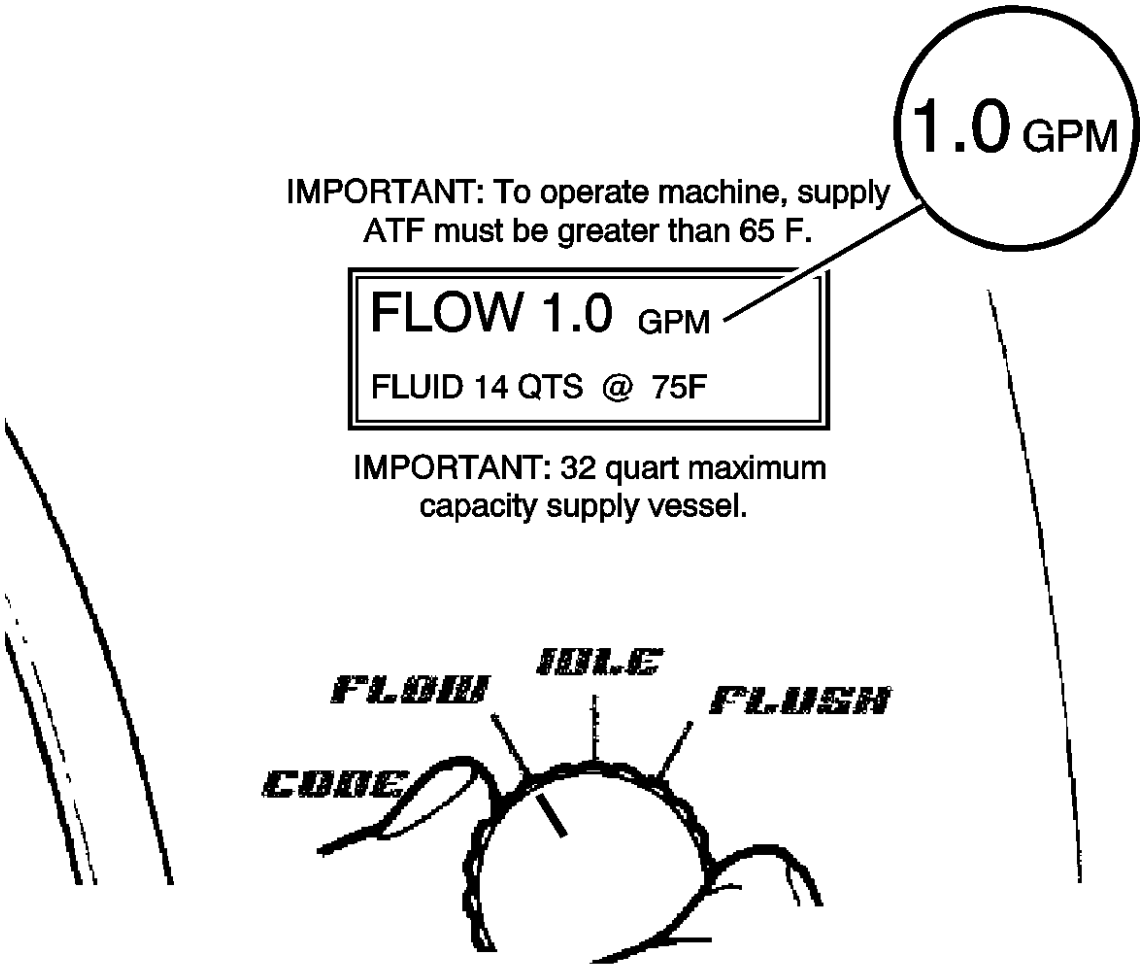


Fig. 13: View Of Main Function Switch FLOW Position
Courtesy of GENERAL MOTORS COMPANY

NOTE: **If the flow rate is less than 0.5 gpm, the LCD displays an error message. Refer to the Troubleshooting section of the operation manual.**

1. Turn the main function switch to the FLOW position and allow the oil to flow for 15 seconds. Observe and note the flow rate; this is the TESTED flow rate.
2. Compare the TESTED flow rate to the MINIMUM flow rate information previously recorded.
    - If the TESTED flow rate is equal to or greater than the MINIMUM flow rate recorded, the oil cooling system is functioning properly. Perform Code Recording Procedure.
    - If the TESTED flow rate is less than the MINIMUM flow rate previously recorded, repeat the back flush and forward flush procedures.
3. If the TESTED flow rate is less than the MINIMUM flow rate after the second test, perform Code Recording Procedure.
    1. Replace the transmission oil cooler.

2. Reconnect supply and waste hoses to the cooler lines in the normal flow direction. Perform Flow Test.
3. Perform Code Recording Procedure.

Code Recording Procedure

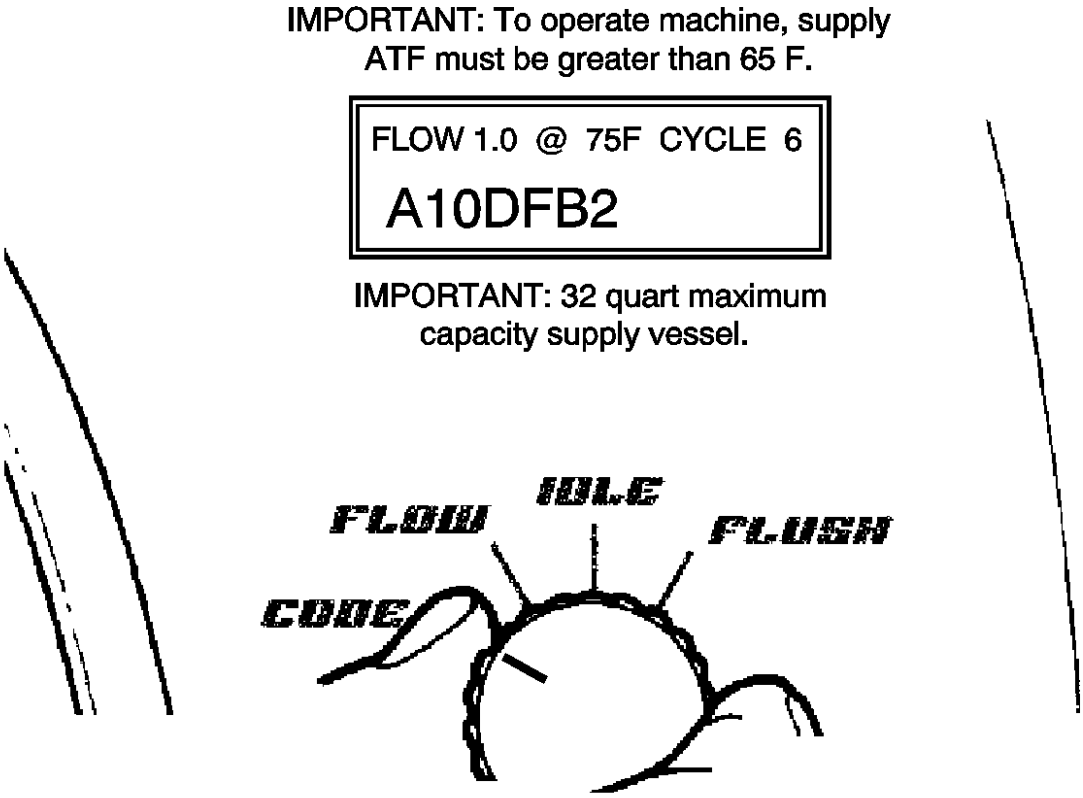


Fig. 14: View Of Main Function Switch CODE Position
Courtesy of GENERAL MOTORS COMPANY

1. Turn the main function switch to the CODE position.

NOTE:

- **If power is interrupted prior to the recording of the seven-character code, the code will be lost and the flow rate test will need to be repeated.**
- **The flow test must run for a minimum of 8-10 seconds and be above 0.5 GPM for a code to be generated.**

2. Record TESTED flow rate, temperature, cycle and seven-character flow code information on repair order.

Clean-up

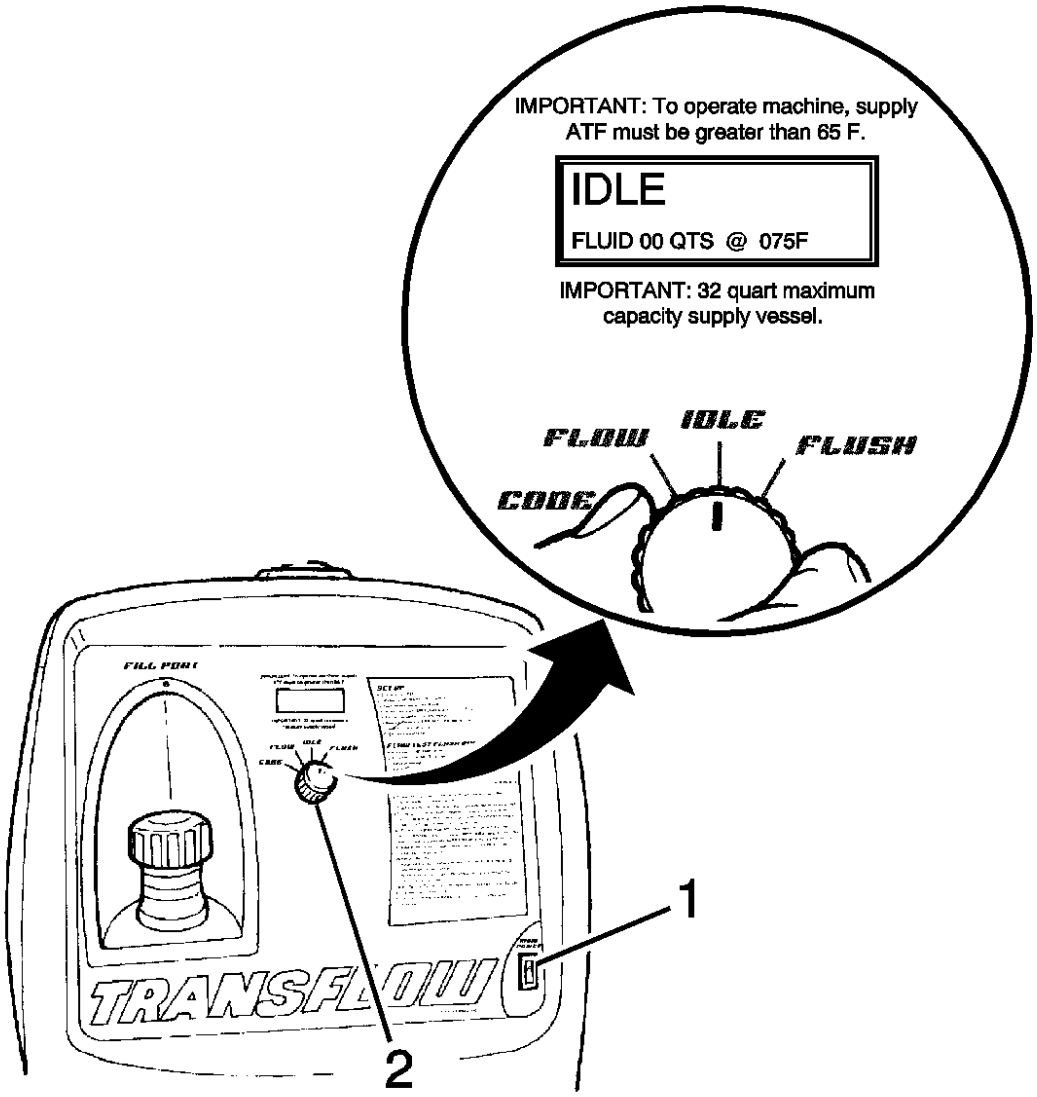


Fig. 15: View Of Main Power Switch & Main Function Switch
Courtesy of GENERAL MOTORS COMPANY

1. Turn the main function switch (2) to the IDLE position and allow the supply vessel pressure to dissipate.
2. Turn the main power switch (1) to the OFF position.

NOTE:

- **A small amount of water may drain from the bottom of the unit when the air supply is disconnected. This is a normal operation of the built-in water separator.**
- **If the fluid in the DT-45096 transmission oil cooling system flush and flow test tool is different than what is used in the transmission, use compressed air to blow the residual transmission fluid out of the oil cooler and lines.**

3. Disconnect the supply and waste hoses and the 12-volt power source from the vehicle.

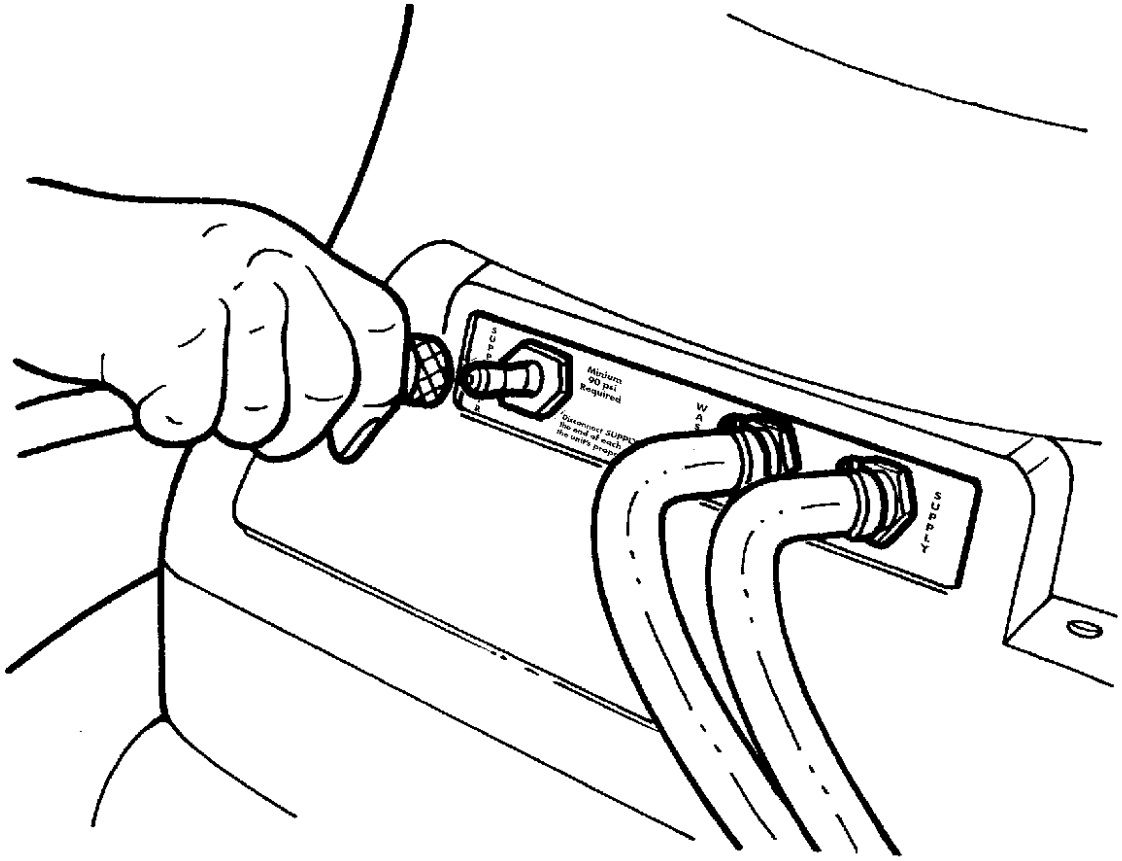


Fig. 16: Applying Shop Air Supply Hose To Quick-Disconnect
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the air supply hose from **DT-45096** flush and flow test tool.
5. Remove the **DT-48312** adapters.
6. Dispose of the waste automatic transmission fluid in accordance with all applicable federal, state, and local requirements.

REPAIR INSTRUCTIONS

TRANSMISSION FLUID AUXILIARY COOLER REPLACEMENT

Removal Procedure

CAUTION: Allow sufficient clearance around the transaxle oil cooler pipes and around the hoses to prevent damage or wear which may cause fluid loss.

1. Remove the upper radiator air baffle. Refer to **Radiator Air Upper Baffle and Deflector Replacement** .
2. Remove the auxiliary transaxle oil cooler bolt from the upper radiator support.
3. Remove the lower radiator air baffle. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .

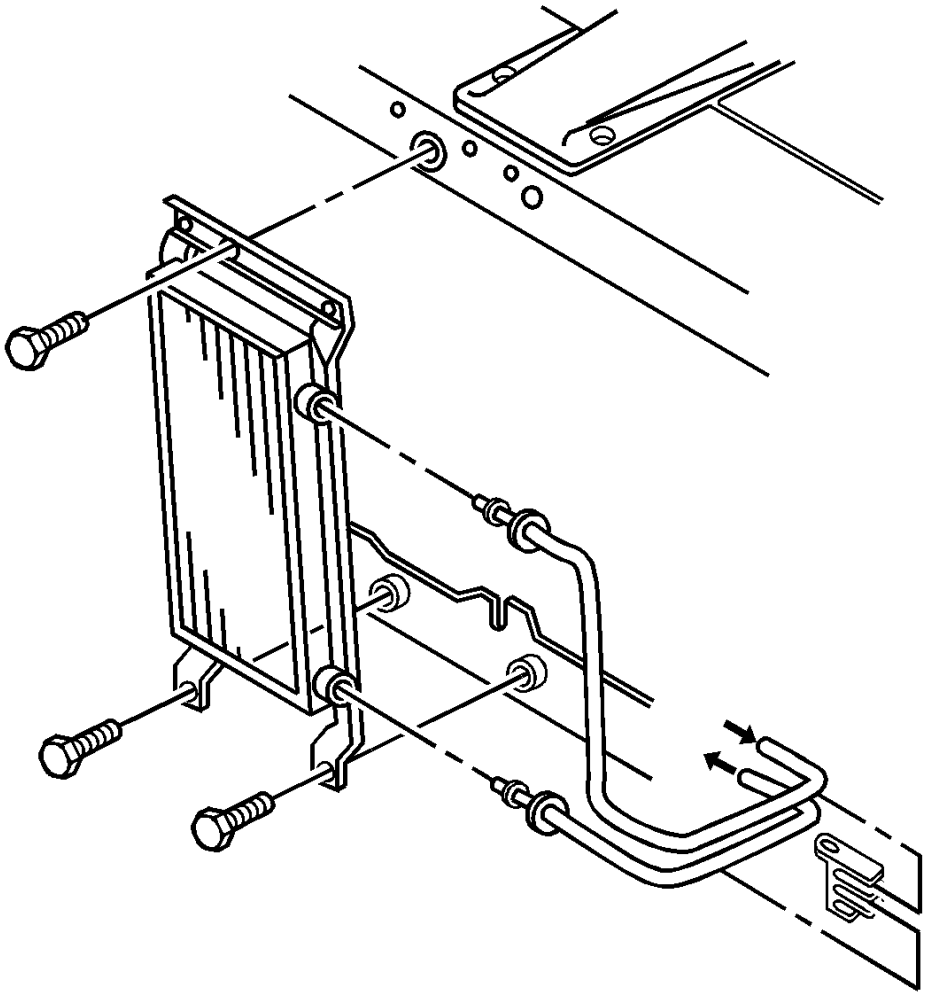


Fig. 17: Auxiliary Transaxle Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

4. Remove the auxiliary transaxle oil cooler bolts from the lower radiator support.
5. Remove the inlet and outlet auxiliary transmission oil cooler lines from the support clips.
6. Lower the auxiliary transaxle oil cooler below the front bumper.
7. Remove the inlet and outlet auxiliary transaxle oil cooler hoses from the auxiliary transaxle oil cooler. Refer to **Fluid Cooler Inlet Hose Replacement**, and **Fluid Cooler Outlet Hose Replacement**.
8. Remove the auxiliary transaxle oil cooler.

Installation Procedure

1. Install the inlet and outlet auxiliary transaxle oil cooler hoses from the auxiliary transaxle oil cooler. Refer to **Fluid Cooler Inlet Hose Replacement**, and **Fluid Cooler Outlet Hose Replacement**

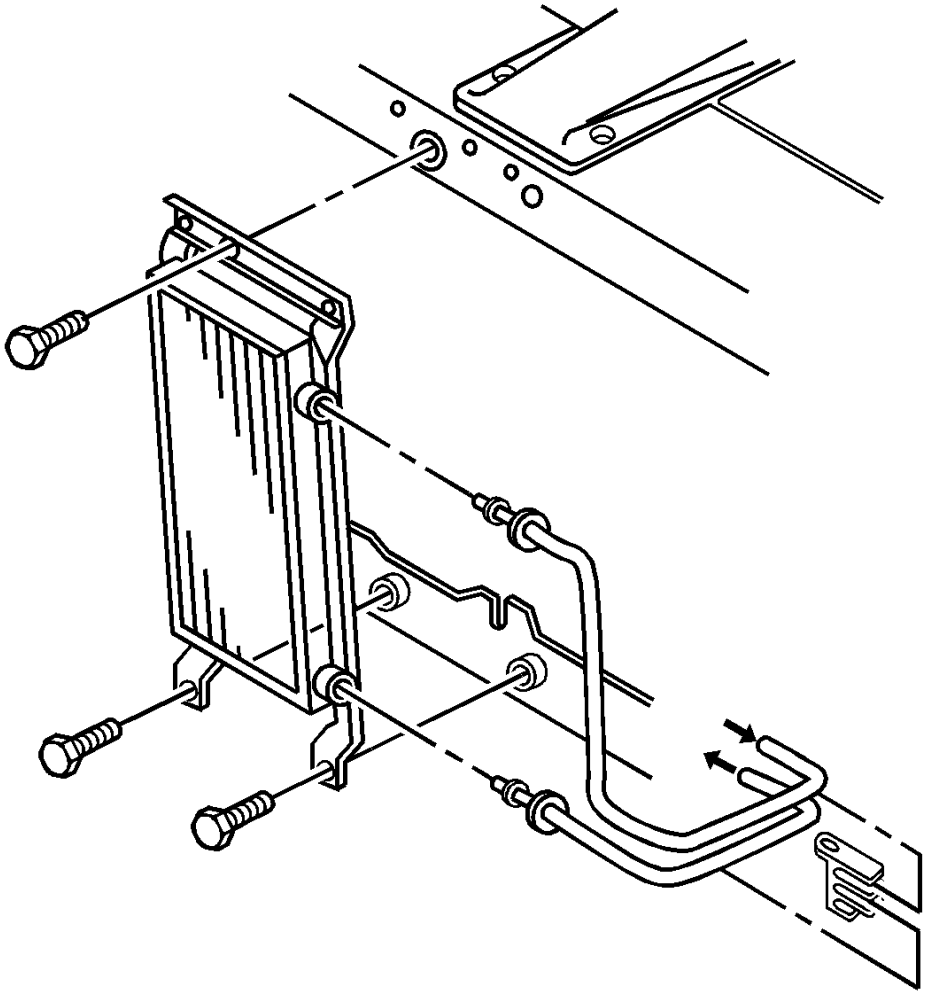


Fig. 18: Auxiliary Transaxle Oil Cooler
Courtesy of GENERAL MOTORS COMPANY

2. Install the auxiliary transaxle oil cooler to the vehicle.
3. Install the inlet and outlet auxiliary transmission oil cooler lines to the support clips.

CAUTION: Refer to Fastener Caution .

4. Install the auxiliary transaxle oil cooler bolts to the lower radiator support.

Tighten

Tighten the bolts to 10 N.m (89 lb in).

5. Install the lower radiator air baffle. Refer to **Radiator Air Lower Baffle and Deflector Replacement** .
6. Install the auxiliary transaxle oil cooler bolt to the upper radiator support.

Tighten

Tighten the bolt to 25 N.m (18 lb ft).

7. Install the upper radiator air baffle. Refer to **Radiator Air Upper Baffle and Deflector Replacement** .
8. Adjust the fluid level.

TRANSMISSION FLUID AUXILIARY COOLER INLET HOSE REPLACEMENT

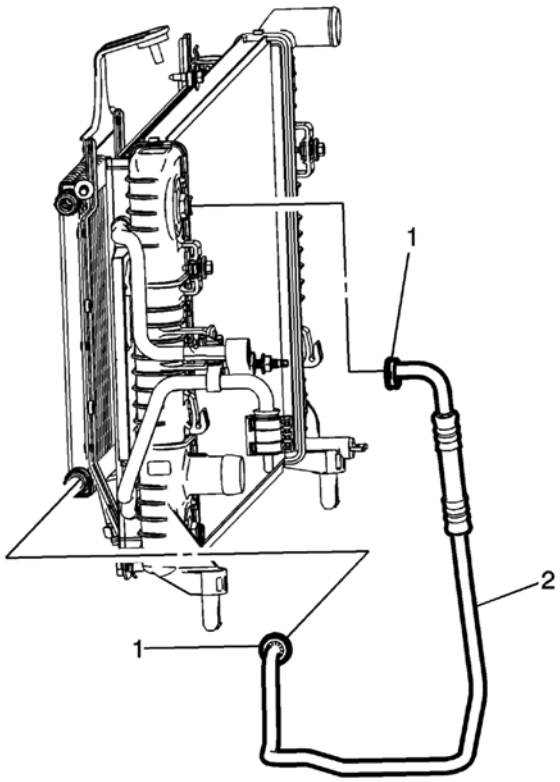


Fig. 19: Transmission Fluid Auxiliary Cooler Inlet Hose
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove Radiator air and lower Baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** . 2. Remove Upper Radiator Air Baffle. Refer to **Radiator Air Upper Baffle and Deflector Replacement** . 3. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Transmission Fluid Cooler Hose/Pipe Quick Disconnection(Qty: 2)
2	Transmission Fluid Auxiliary Cooler Inlet Hose.

TRANSMISSION FLUID COOLER PIPE CONNECTOR REPLACEMENT - RADIATOR

Removal Procedure

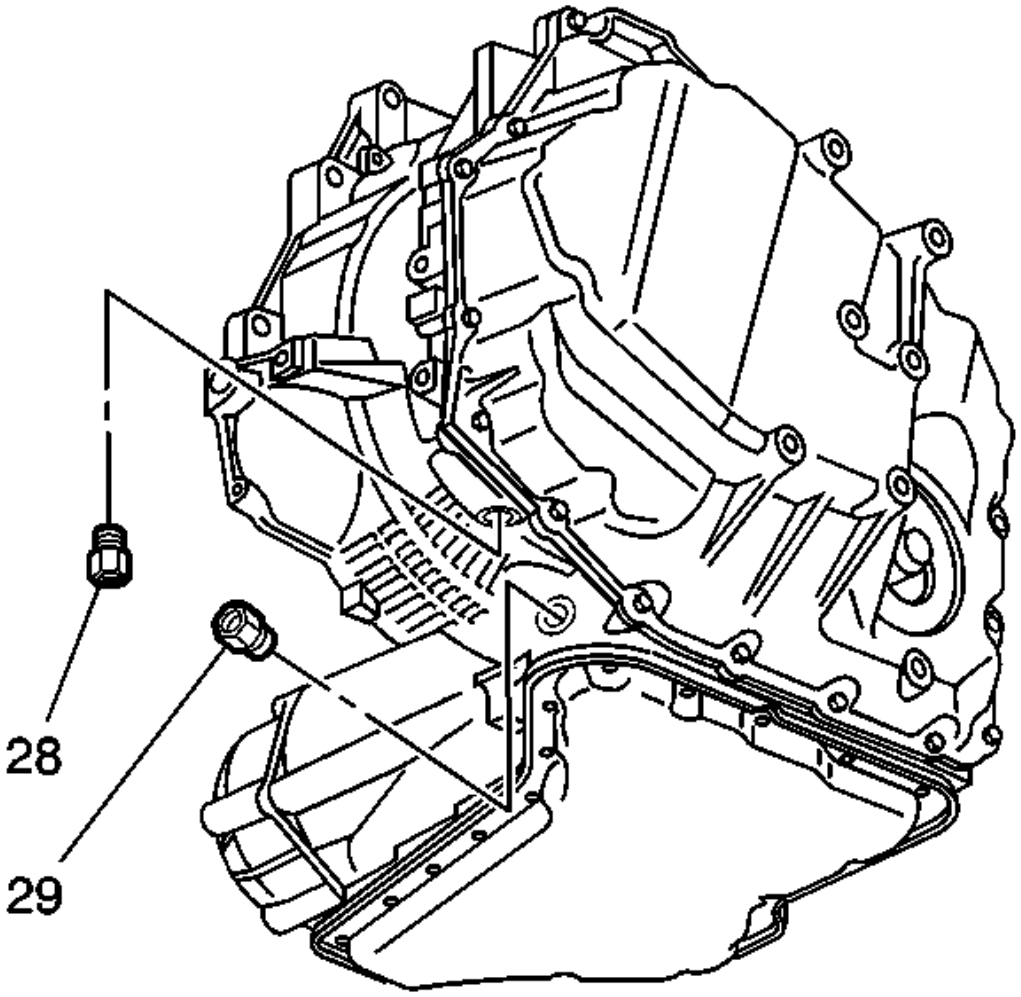


Fig. 20: View Of Transaxle Oil Cooler Fittings
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Allow sufficient clearance around the transaxle oil cooler pipes and around the hoses to prevent damage or wear which may cause fluid loss.

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Position a drain pan under the vehicle.
3. Remove the transaxle oil cooler hoses from the transaxle oil cooler fittings. Refer to **Fluid Cooler Inlet Hose Replacement**, and **Fluid Cooler Outlet Hose Replacement**.
4. Remove the transaxle oil cooler fittings (28, 29) from the transaxle.

Installation Procedure

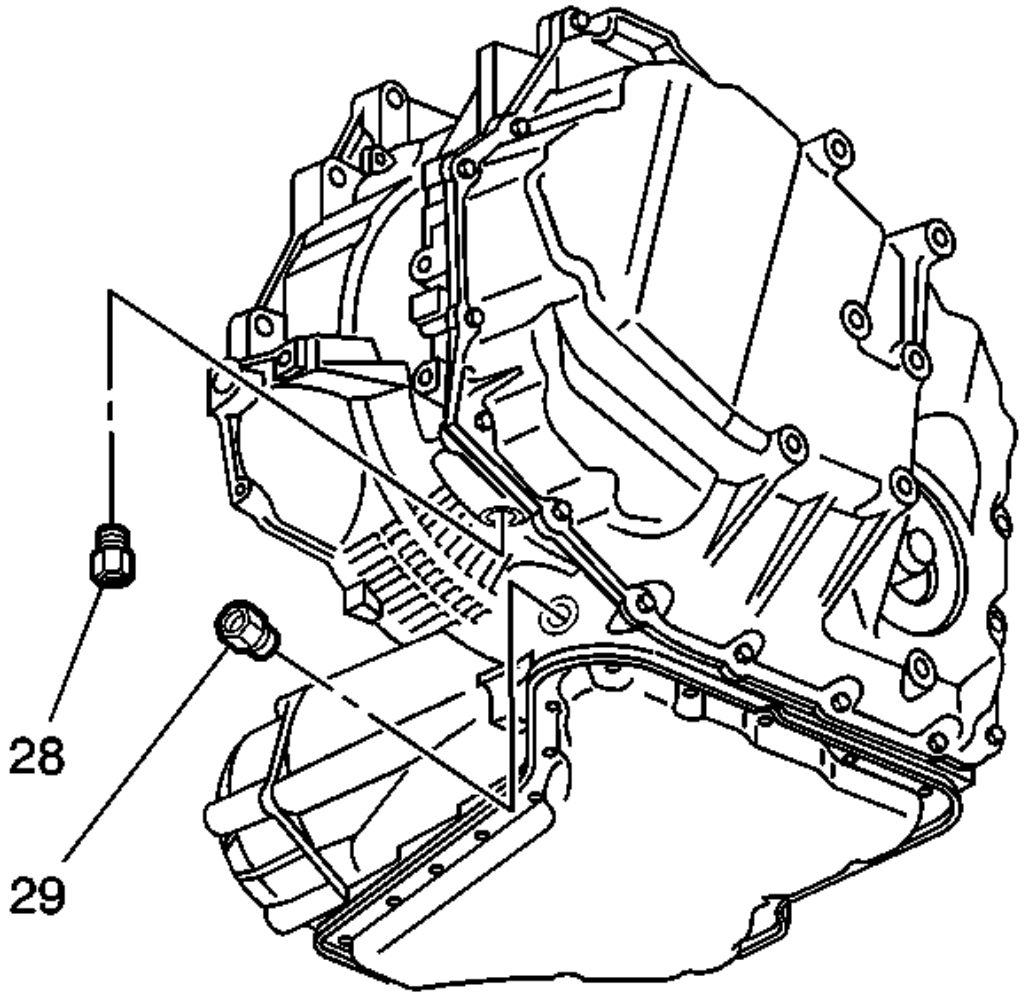


Fig. 21: View Of Transaxle Oil Cooler Fittings
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

NOTE: **The correct thread engagement is critical. Crossthreaded fittings can achieve proper tightness and still leak.**

1. Install the transaxle oil cooler fittings (28, 29) to the transaxle.

   Tighten

   Tighten the fittings to 38 N.m (28 lb ft).

2. Install the transaxle oil cooler hoses from the transaxle oil cooler fittings. Refer to **Fluid Cooler Inlet Hose Replacement**, and **Fluid Cooler Outlet Hose Replacement**.
3. Lower the vehicle.

   CAUTION: **Refer to Transmission Overfill Caution .**

4. Adjust the fluid level.
5. Inspect for fluid leaks. Refer to **Transmission Fluid Level and Condition Check** .
6. Remove the drain pan from under the vehicle.

TRANSMISSION FLUID COOLER HOSE/PIPE QUICK-CONNECT FITTING DISCONNECTION AND CONNECTION

Removal Procedure

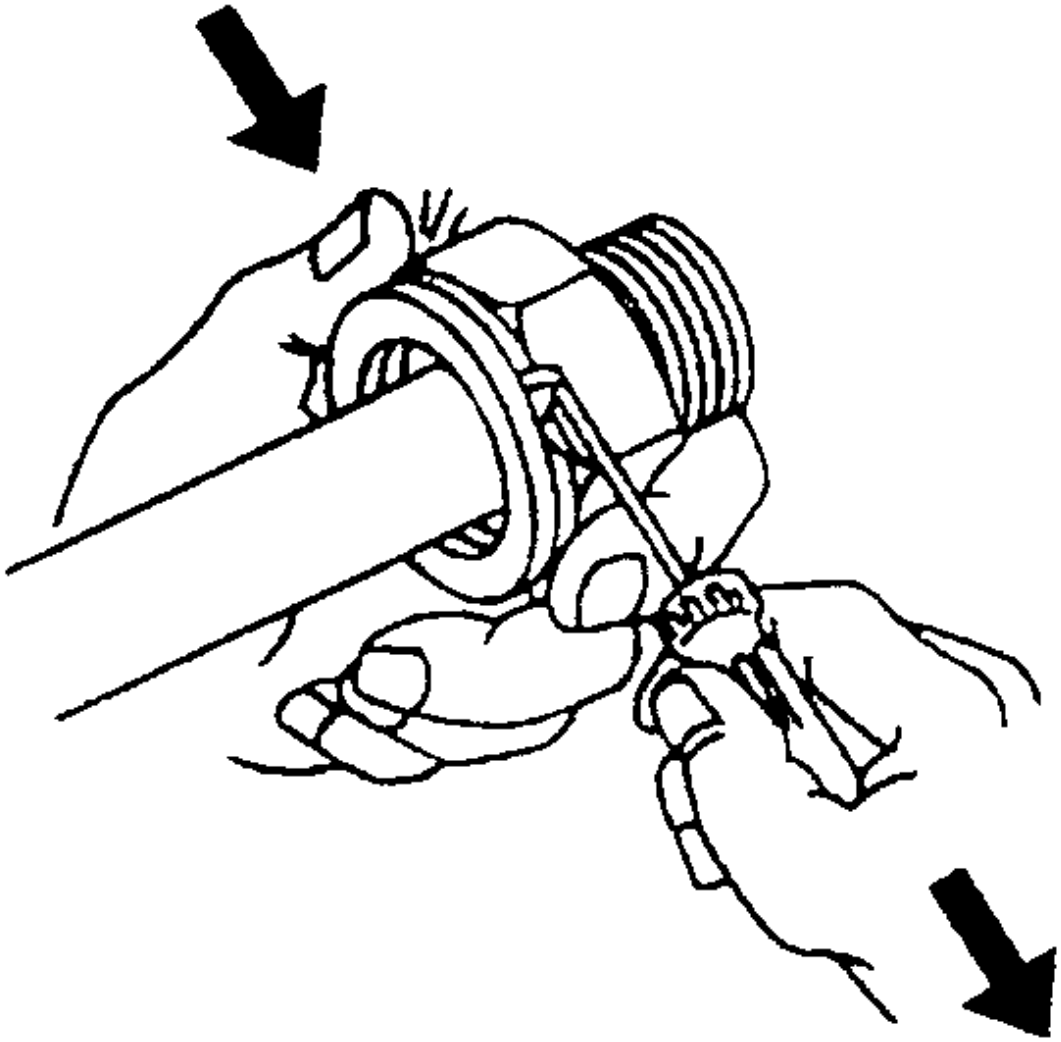


Fig. 22: Retaining Ring For Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Perform the following procedure when removing the retaining rings and cooler lines from the quick connect fittings located on the radiator and/or the transmission.**

1. Pull the plastic cap back from the quick connect fitting and down along the cooler line about 5 cm (2 in).

2. Using a bent-tip screwdriver, pull on one of the open ends of the retaining ring in order to rotate the retaining ring around the quick connect fitting until the retaining ring is out of position and can be completely removed.
3. Remove the retaining ring from the quick connect fitting.
4. Discard the retaining ring.

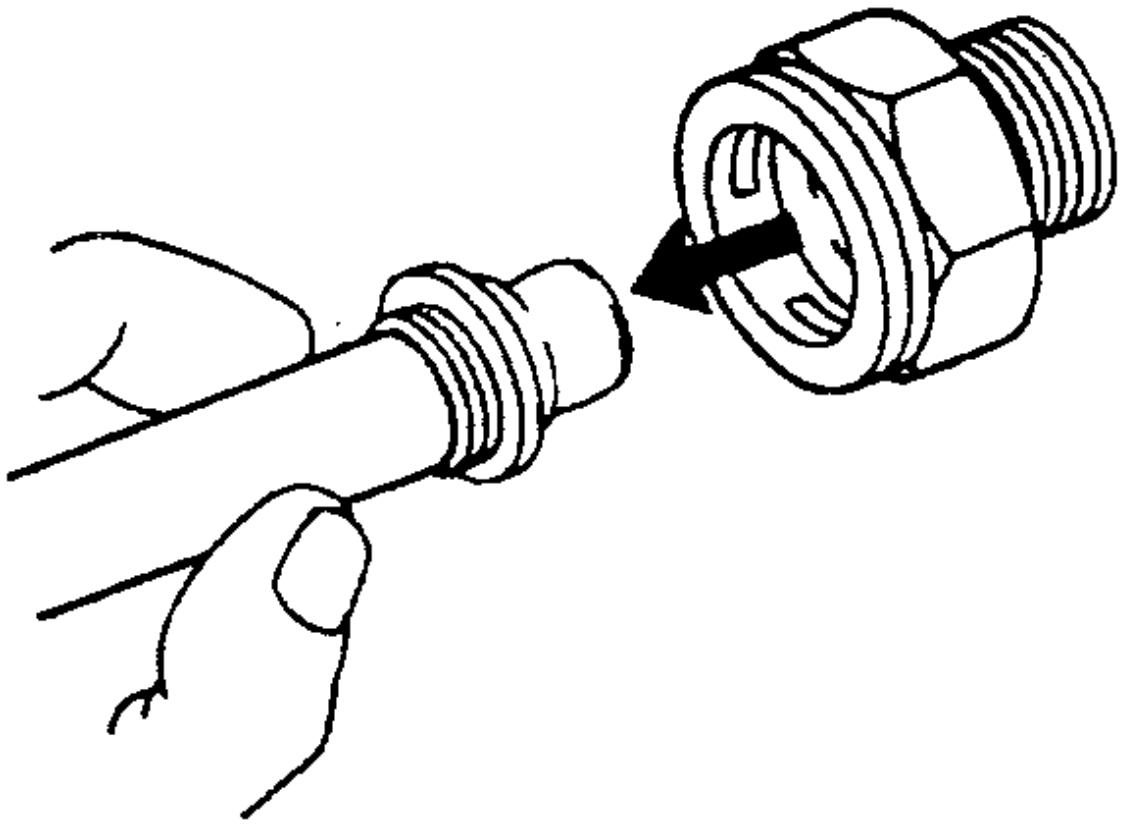


Fig. 23: Cooler Line & Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Pull the cooler line straight out from the quick connect fitting.

Installation Procedure

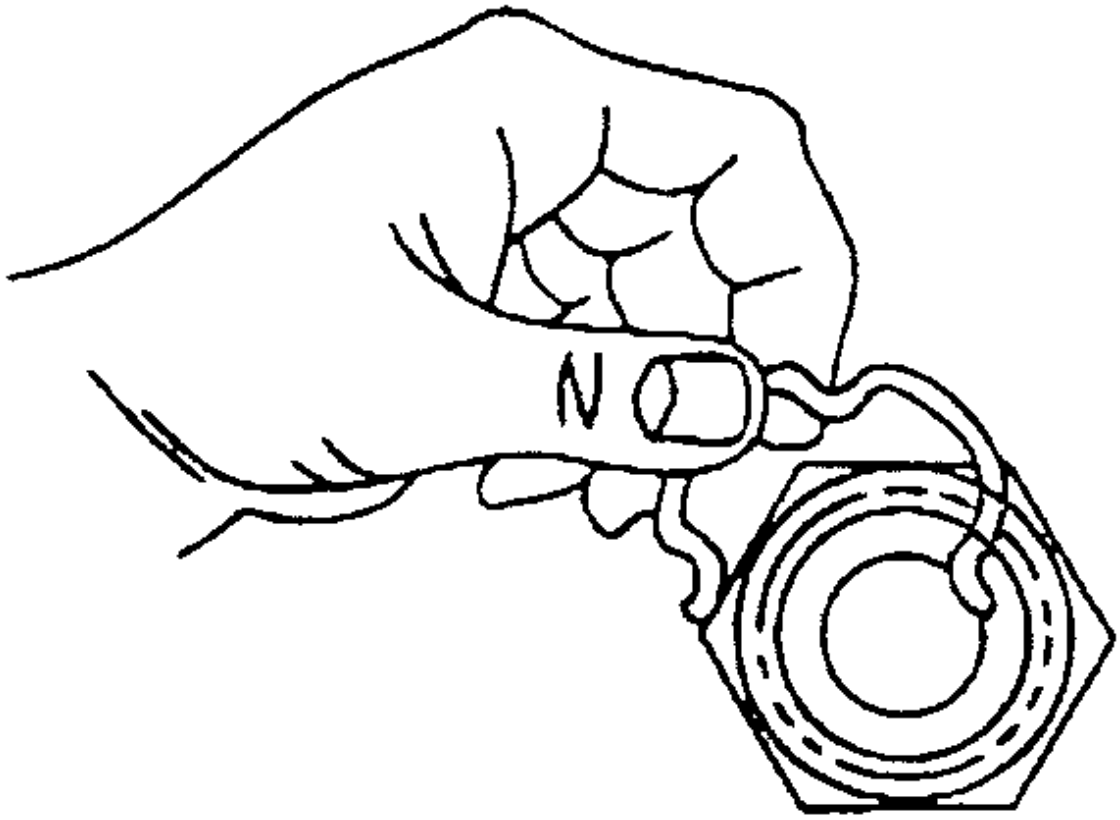


Fig. 24: Hooking Retaining Ring Into Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **Do not reuse any of the existing oil lines or oil line fittings if there is excessive corrosion.**
- **Do not reuse any of the existing retaining rings that were removed from the existing quick connect fittings. Install new retaining rings.**
- **Ensure the following procedures are performed when installing the new retaining rings onto the fittings.**
- **Perform the following procedure when installing the retaining rings and cooler lines to the quick connect fittings located on the radiator and/or the transmission.**

1. Hook one of the open ends of the retaining ring in one of the slots in the quick connect fitting.

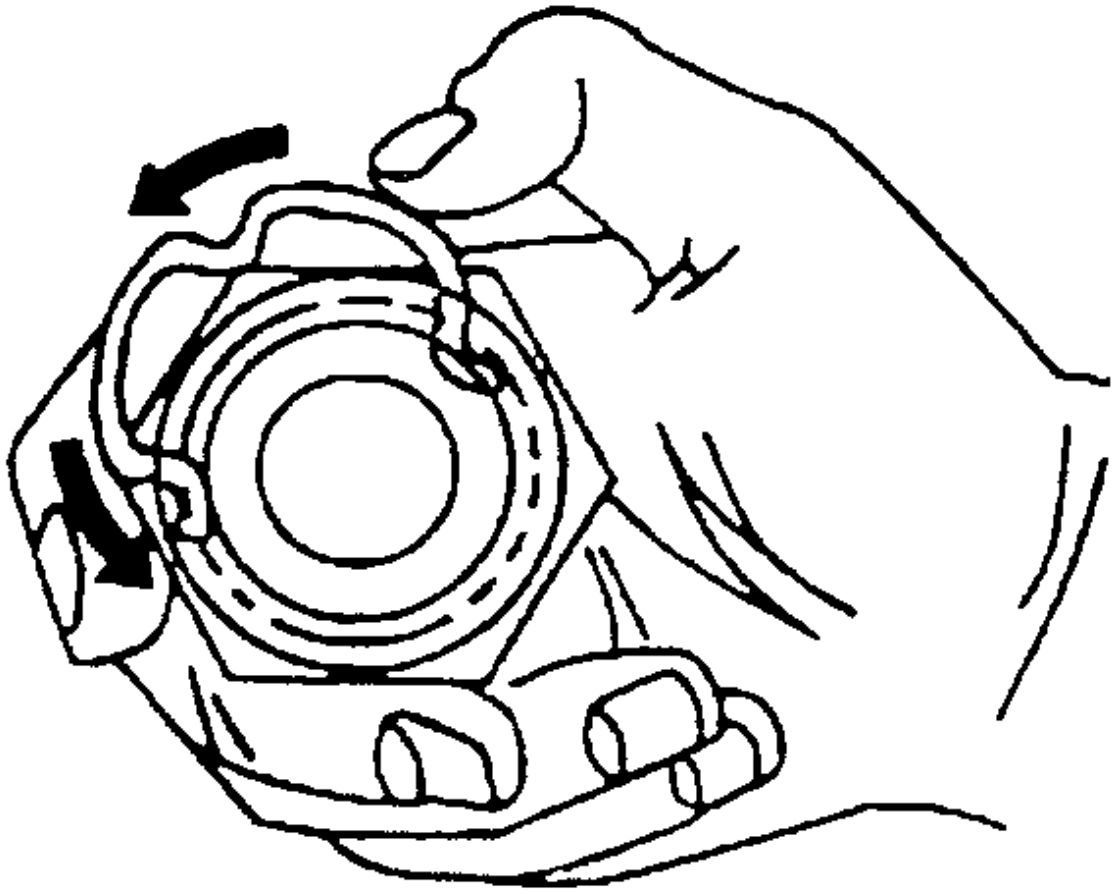


Fig. 25: Rotating Retaining Ring Around Fitting
Courtesy of GENERAL MOTORS COMPANY

2. Rotate the retaining ring around the fitting until the retaining ring is positioned with all 3 ears through the 3 slots on the fitting.

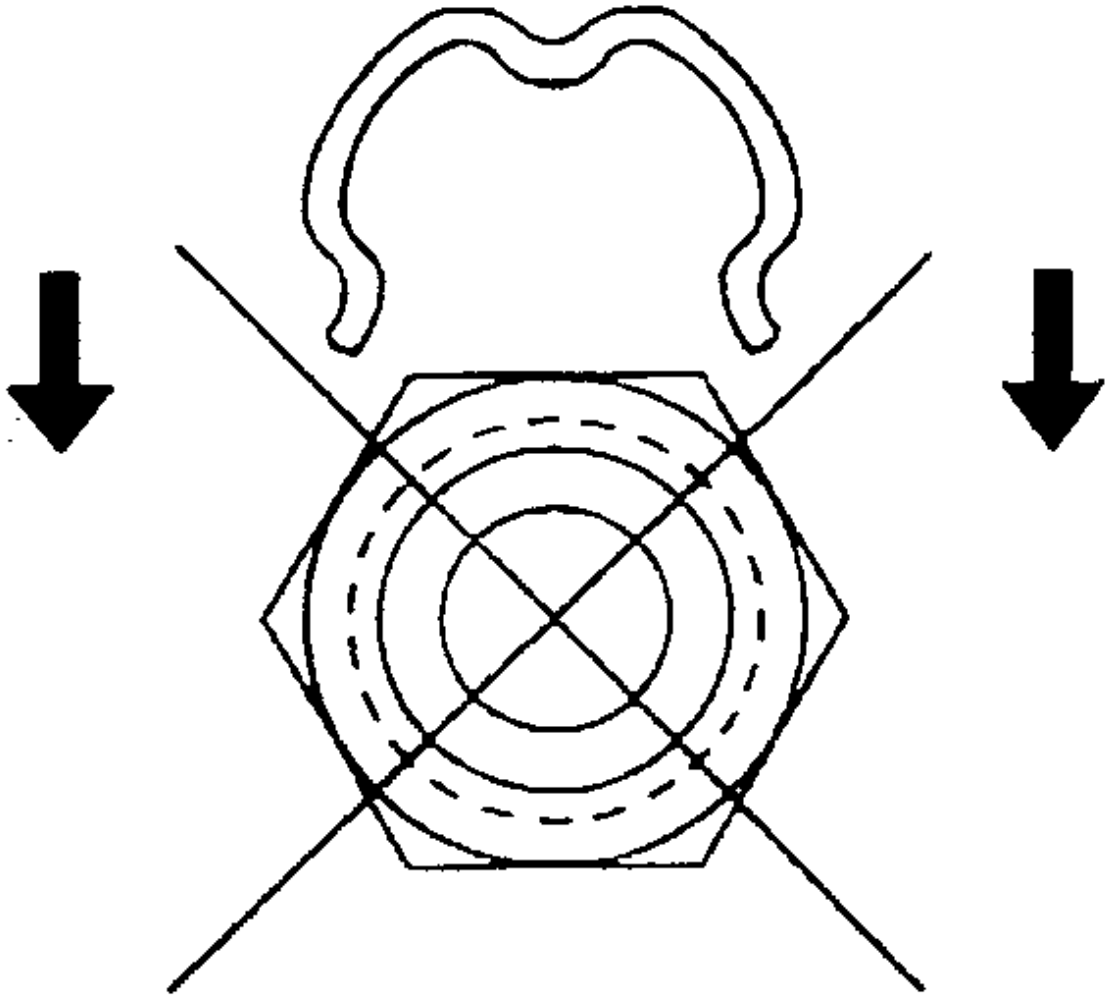


Fig. 26: Identifying Improper Engine Oil Cooler Hose/Pipe Retaining Ring Installation
Courtesy of GENERAL MOTORS COMPANY

3. Do not install the new retaining ring onto the fitting by pushing the retaining ring.

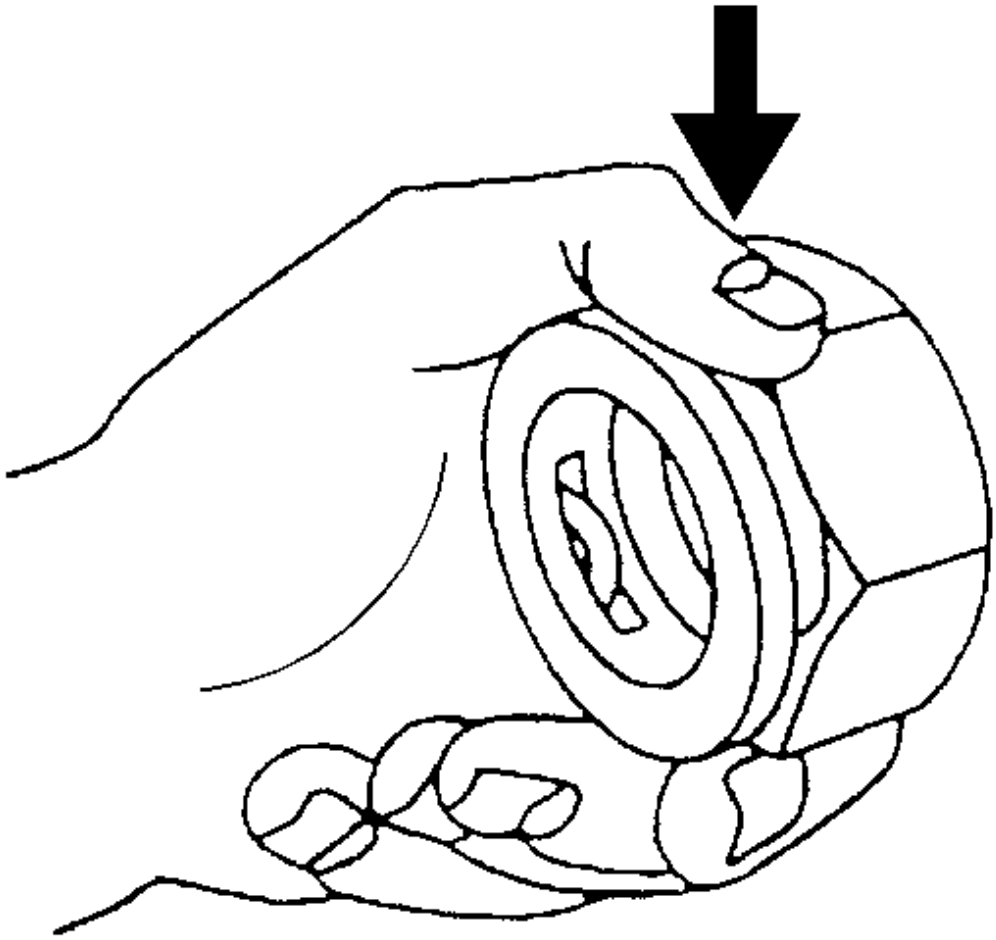


Fig. 27: Ensuring Retaining Ring Is Seated Correctly
Courtesy of GENERAL MOTORS COMPANY

4. Ensure that the 3 retaining ring ears are seen from inside the fitting and that the retaining ring moves freely in the fitting slots.

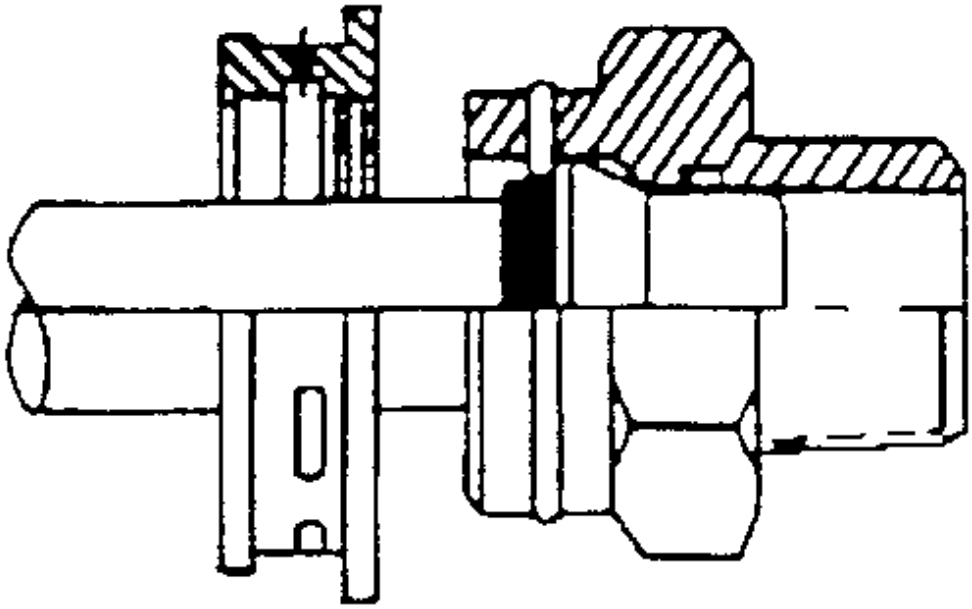


Fig. 28: View Of Cooler Line Quick Connect Fitting
Courtesy of GENERAL MOTORS COMPANY

5. Install the cooler line into the quick connect fitting.
6. Insert the cooler line end into the quick connect fitting until a click is either heard or felt.

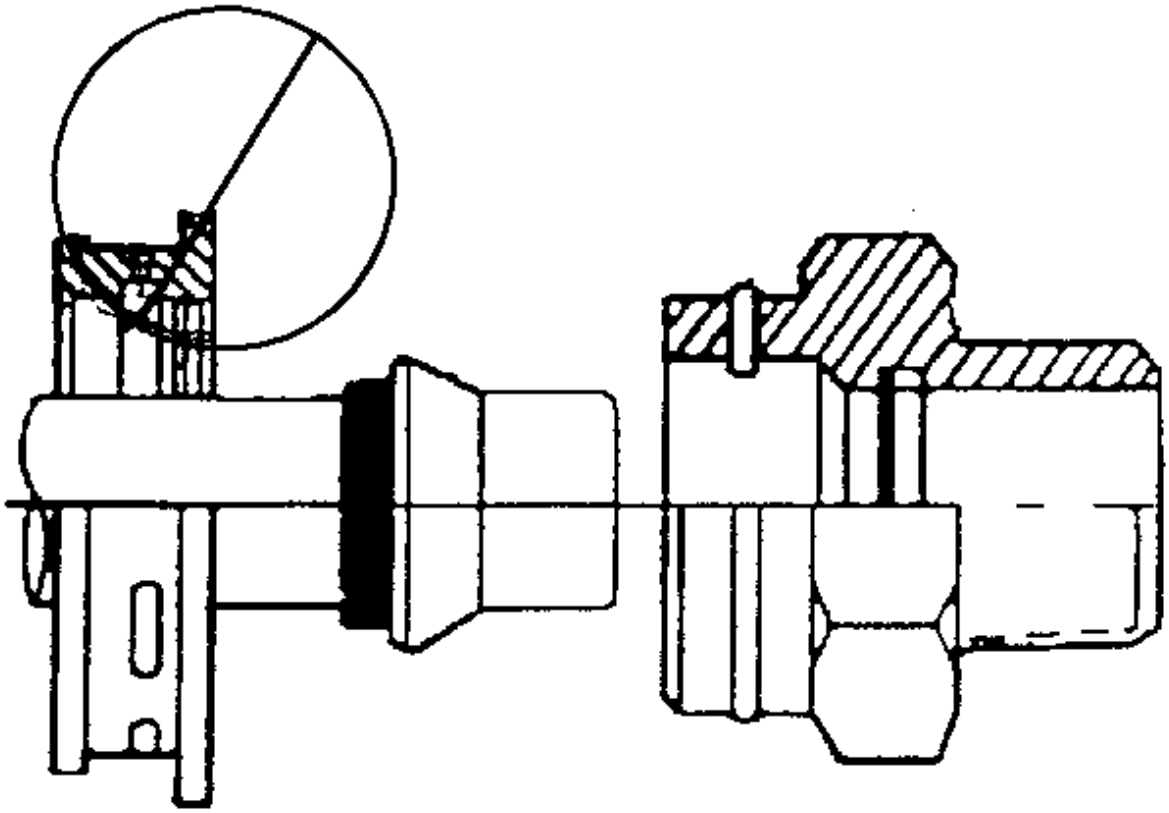


Fig. 29: Do Not Use Plastic Cap On Cooler Line In Order To Install Cooler Line Into The Fitting
Courtesy of GENERAL MOTORS COMPANY

7. Do not use the plastic cap on the cooler line in order to install the cooler line into the fitting.
8. Pull back sharply on the cooler line in order to ensure that the cooler line is fastened into the quick connect fitting.

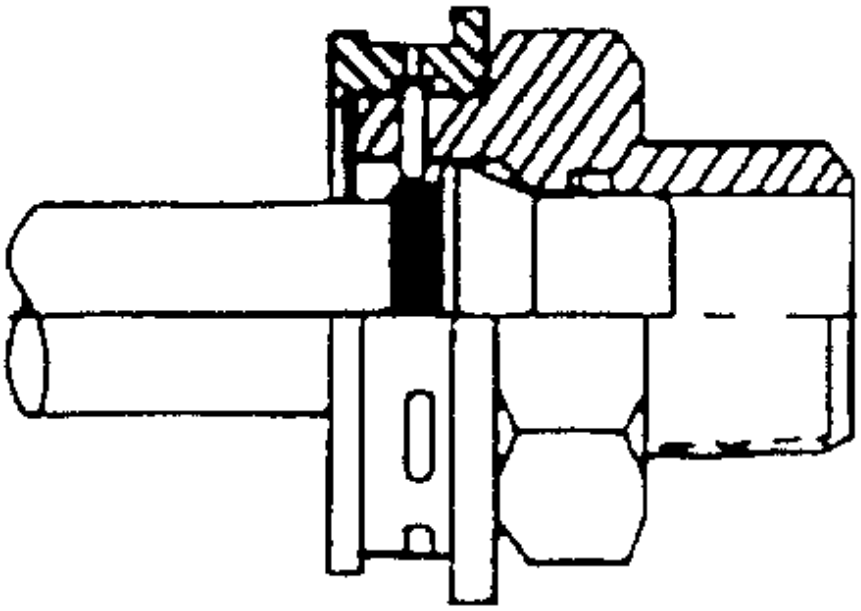


Fig. 30: View Of Cooler Line & Plastic Cap
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Do not manually depress the retaining clip when installing the plastic cap.**

9. Position (snap) the plastic cap onto the fitting. Do not manually depress the retaining ring when installing the plastic cap onto the quick connect fitting.
10. Ensure that the plastic cap is fully seated against the fitting.

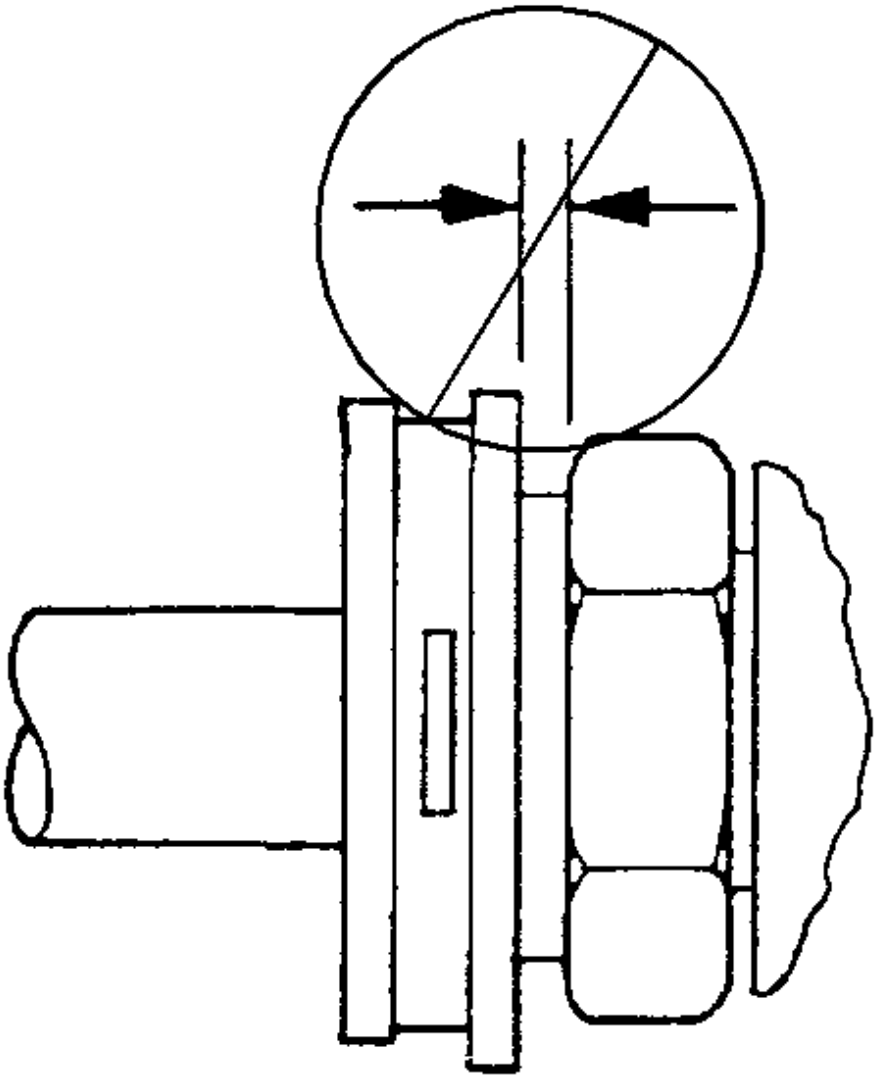


Fig. 31: Checking For Gap Between Cap & Fitting
Courtesy of GENERAL MOTORS COMPANY

11. Ensure that no gap is present between the cap and the fitting.

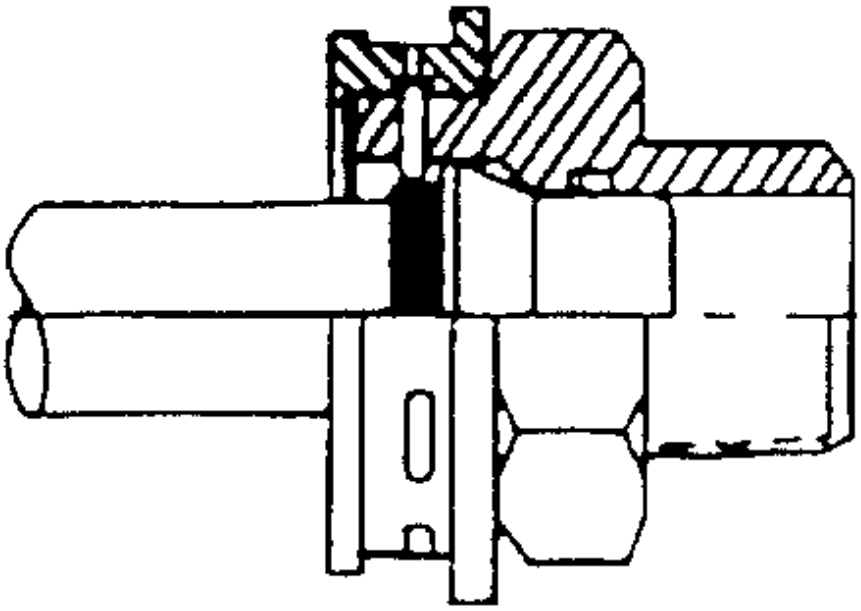


Fig. 32: View Of Cooler Line & Plastic Cap
Courtesy of GENERAL MOTORS COMPANY

12. Ensure that the yellow identification band on the tube is hidden within the quick connect fitting.

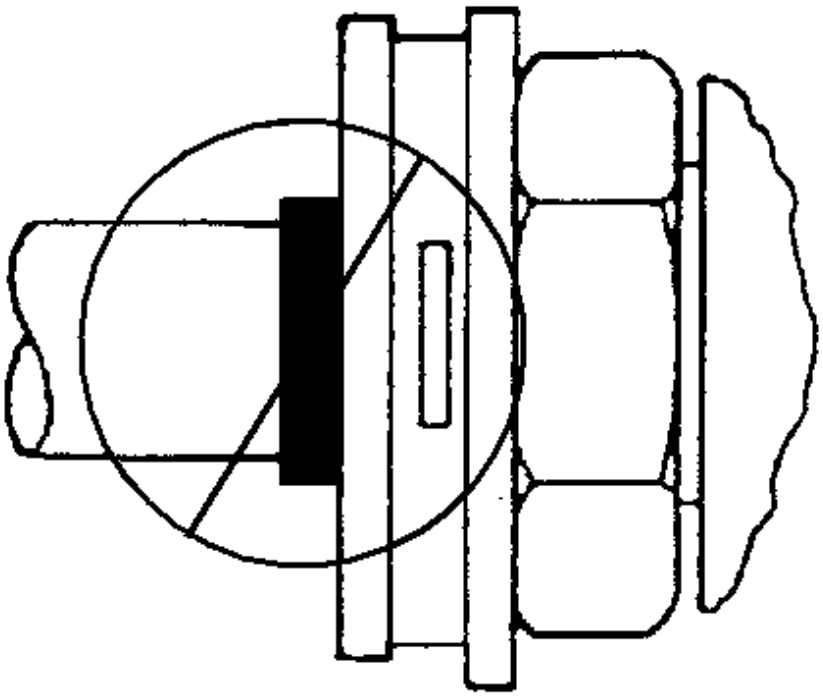


Fig. 33: Identifying Improper Joint Seating
Courtesy of GENERAL MOTORS COMPANY

13. A hidden yellow identification band indicates proper joint seating.
14. Fill the transmission to the proper level with DEXRONÂ® VI transmission fluid. Refer to **Transmission Fluid Level and Condition Check** .

FLUID COOLER INLET HOSE REPLACEMENT

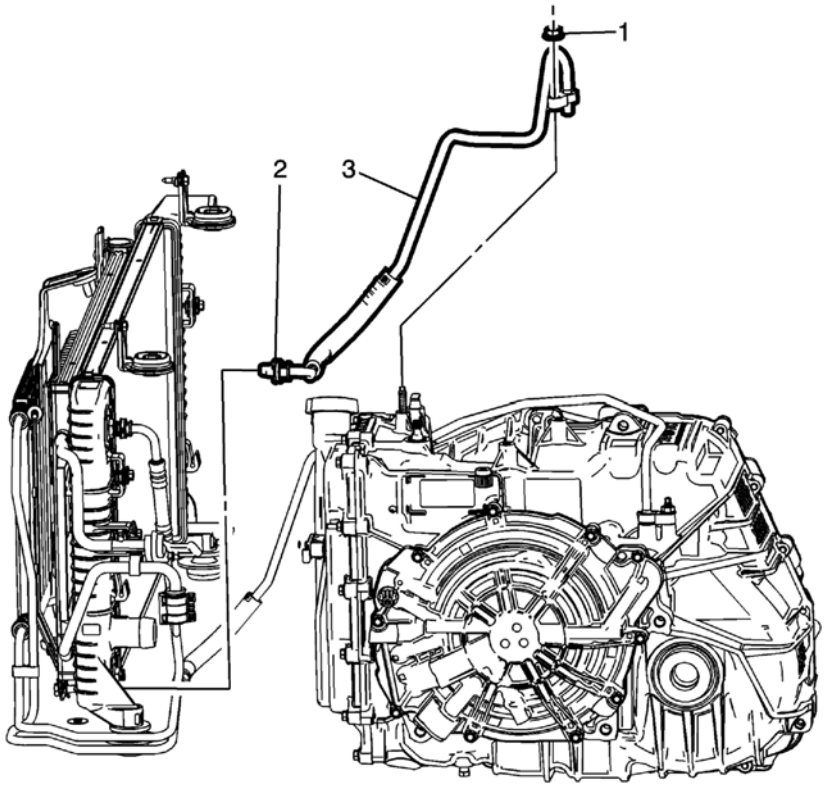


Fig. 34: Fluid Cooler Inlet Hose, Fastener & Quick Connect
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove radiator air and lower baffle and deflector. Refer to **Radiator Air Lower Baffle and Deflector Replacement** . 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Transmission Fluid Cooler Hose/Pipe Fastener (Qty: 1) **CAUTION:** **Refer to Fastener Caution .**
2	Transmission Fluid Cooler Hose/Pipe Quick Disconnection (Qty: 1)
3	Transmission Fluid Cooler Inlet Hose

FLUID COOLER OUTLET HOSE REPLACEMENT

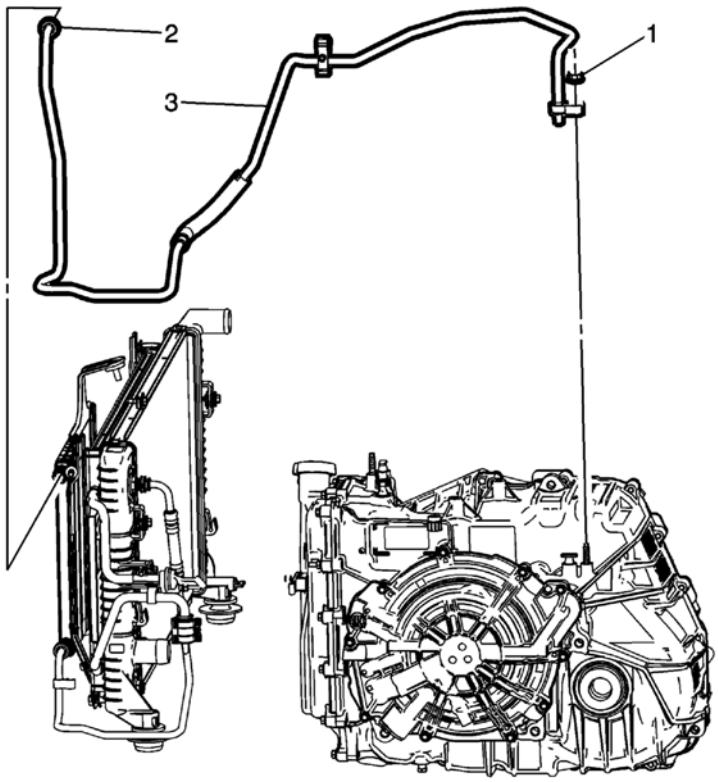


Fig. 35: Fluid Cooler Outlet Hose, Fastener & Quick Connect
Courtesy of GENERAL MOTORS COMPANY

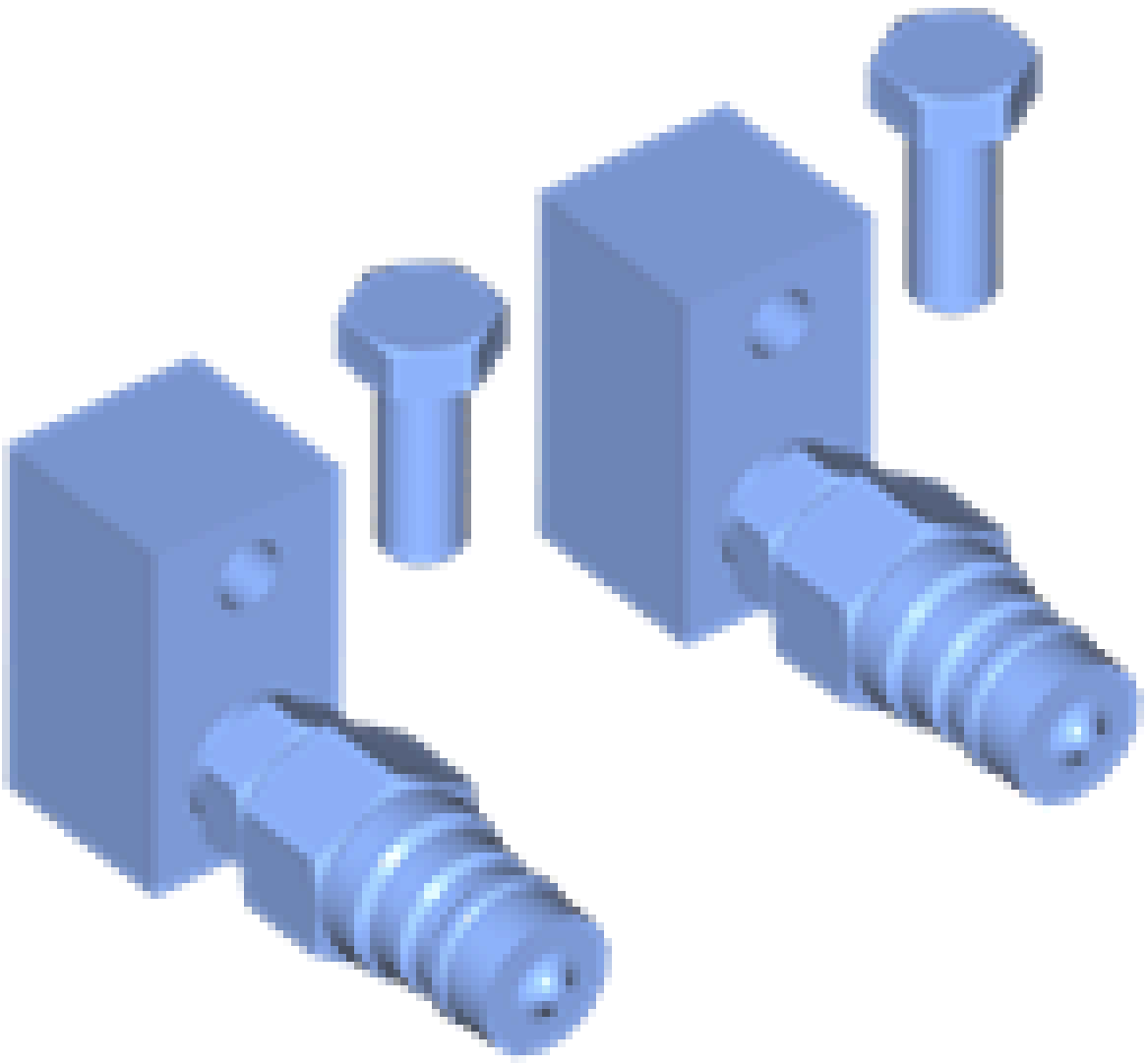
Callout	Component Name
Preliminary Procedures 1. Remove Upper Radiator Air Baffle. Refer to **Radiator Air Upper Baffle and Deflector Replacement** . 2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .	
1	Transmission Fluid Cooler Hose/Pipe Fastener (Qty: 1) **CAUTION:** **Refer to Fastener Caution .**
2	Transmission Fluid Cooler Hose/Pipe Quick Disconnection(Qty: 1)
3	Transmission Fluid Cooler Outlet Hose.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

Illustration	Tool Number/ Description
	DT 45096 J 45096 Transmission Oil Cooling System Flush and Flow Test Tool

Illustration	Tool Number/ Description
	DT 45096-50 J 45096-50 Transmission Cooler Flush Adapter

Article GUID: A00737238

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Front Wheel Drive Shaft Nut	210 N.m	155 lb ft
Drive Axle Eared Clamp	136 N.m	100 lb ft
Drive Axle Seal Clamp	176 N.m	130 lb ft

ADHESIVES, FLUIDS, LUBRICANTS, AND SEALERS

Application	Type of Material	GM Part Number	Canadian Part Number
Wheel Drive Shaft	Grease	1051344	993037

REPAIR INSTRUCTIONS

WHEEL DRIVE SHAFT REPLACEMENT (LEFT SIDE)

Special Tools

- **DT-51504** Seal Protector
- **J-42129** Wheel Hub Remover

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Disconnect the electrical connector for the speed control sensor.

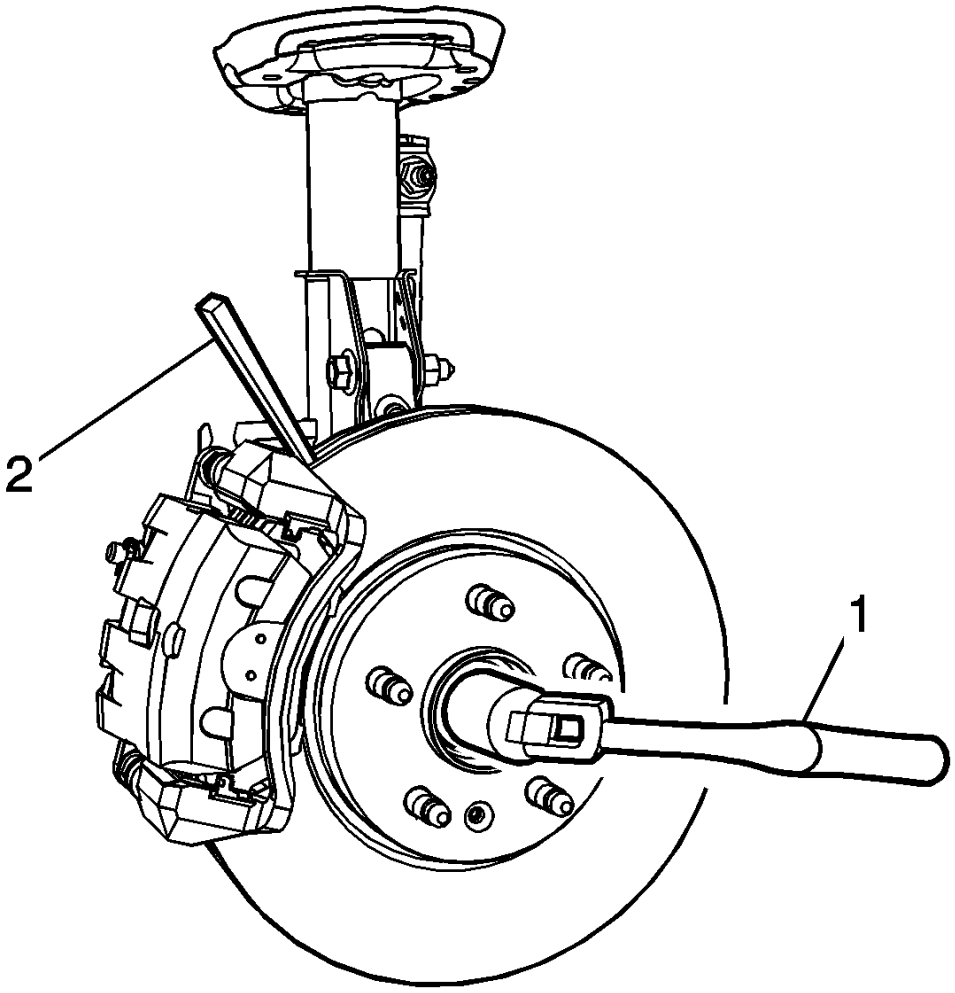


Fig. 1: Holding Brake Rotor With Drift Or Punch
Courtesy of GENERAL MOTORS COMPANY

4. Insert a punch or drift (2) in the cooling fins of the brake rotor.
5. Rotate the brake rotor until the punch or drift (2) is resting against the brake caliper mounting bracket.
6. Using the proper size socket and a breaker bar (1), loosen the wheel drive shaft nut.

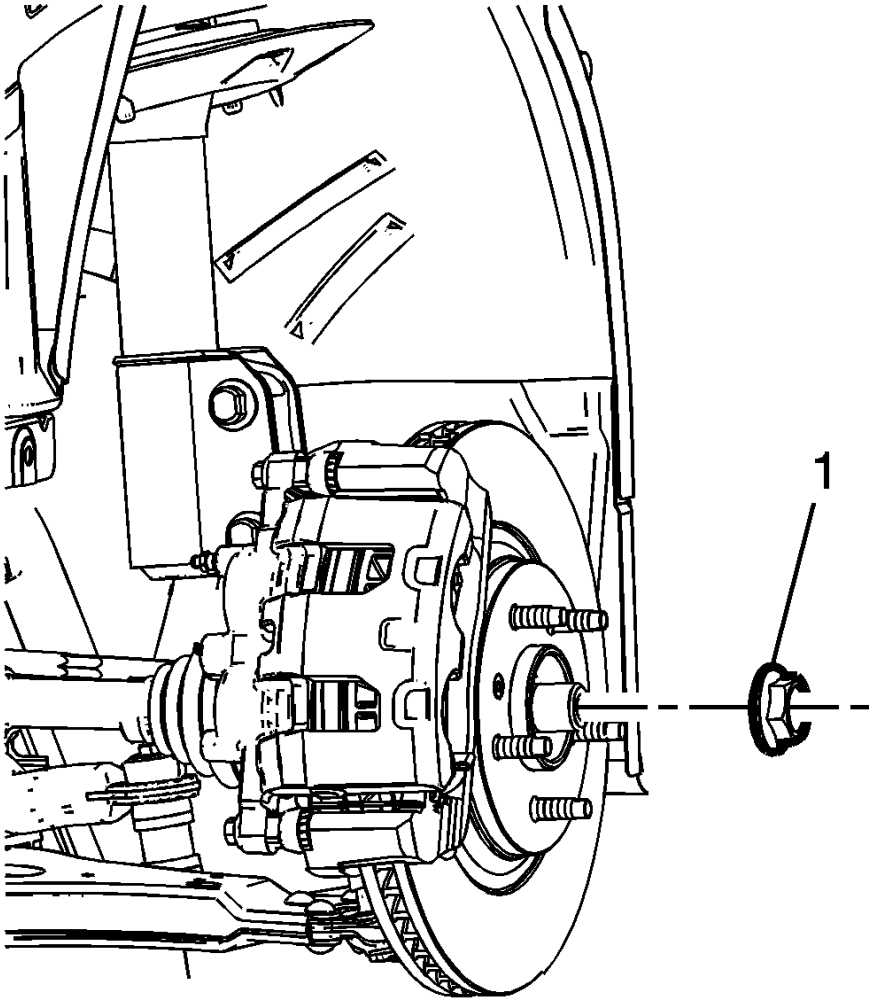


Fig. 2: Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

7. Remove the wheel drive shaft nut (1).
8. Remove the punch or drift from the brake rotor.

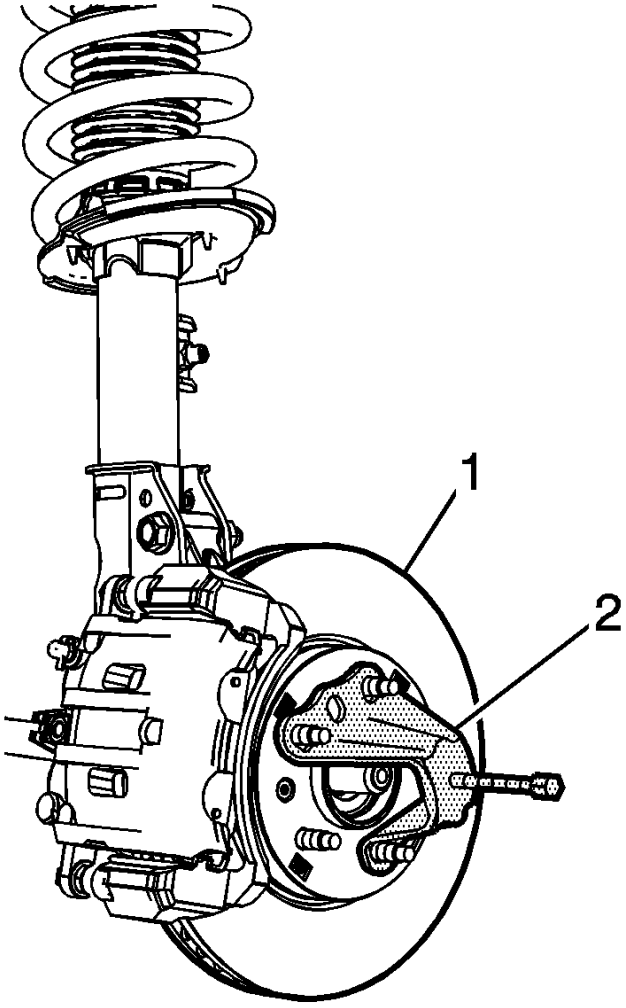


Fig. 3: Separating Wheel Drive Shaft & Steering Knuckle
Courtesy of GENERAL MOTORS COMPANY

9. Using the **J-42129** remover (2), separate the wheel drive shaft from the wheel hub/bearing (1).
10. Remove the **J-42129** remover (2).
11. Remove the outer tie rod end from the steering knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .
12. Remove the stabilizer shaft link from the lower control arm. Refer to **Stabilizer Shaft Link Replacement** .
13. Separate the lower control arm from the steering knuckle. Refer to **Lower Control Arm Replacement** .

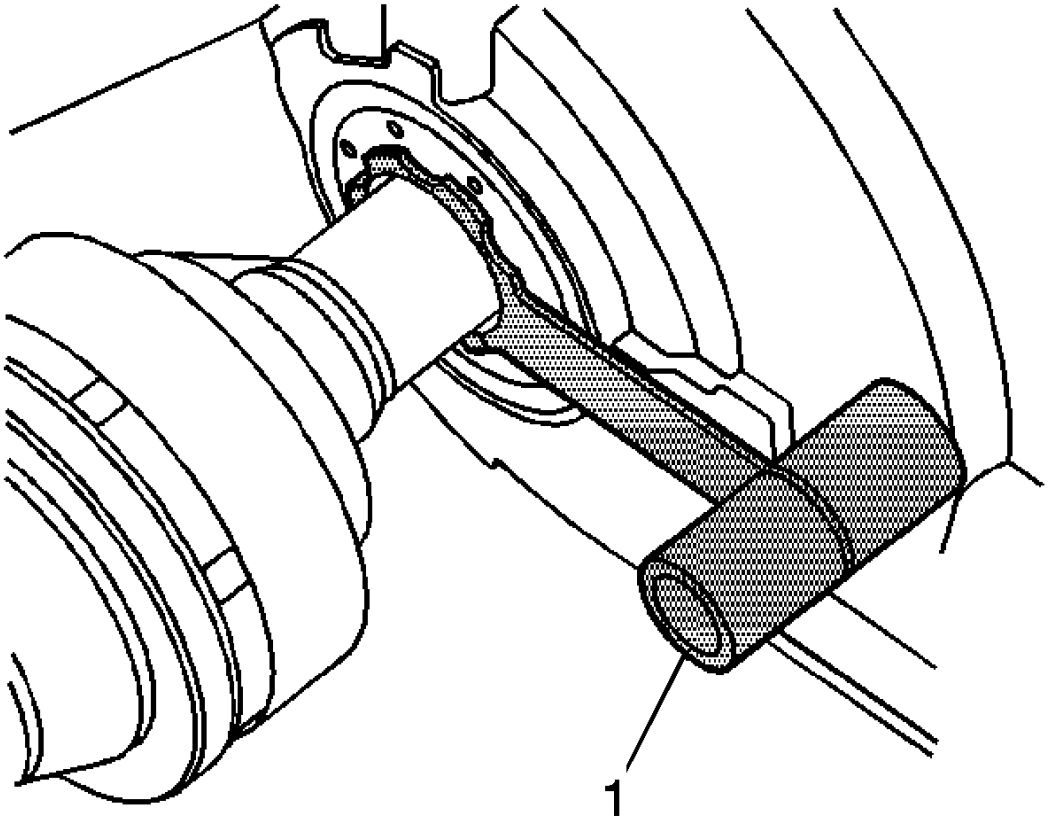


Fig. 4: Differential Output Shaft Seal Protector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: DT-51504 must be installed into the differential output shaft seal prior to removing and installing the wheel drive shaft. Failure to install the DT-51504 as indicated may cause the splines of the wheel drive shaft to damage the differential output seal

14. Install the **DT-51504** protector (1) into the differential.

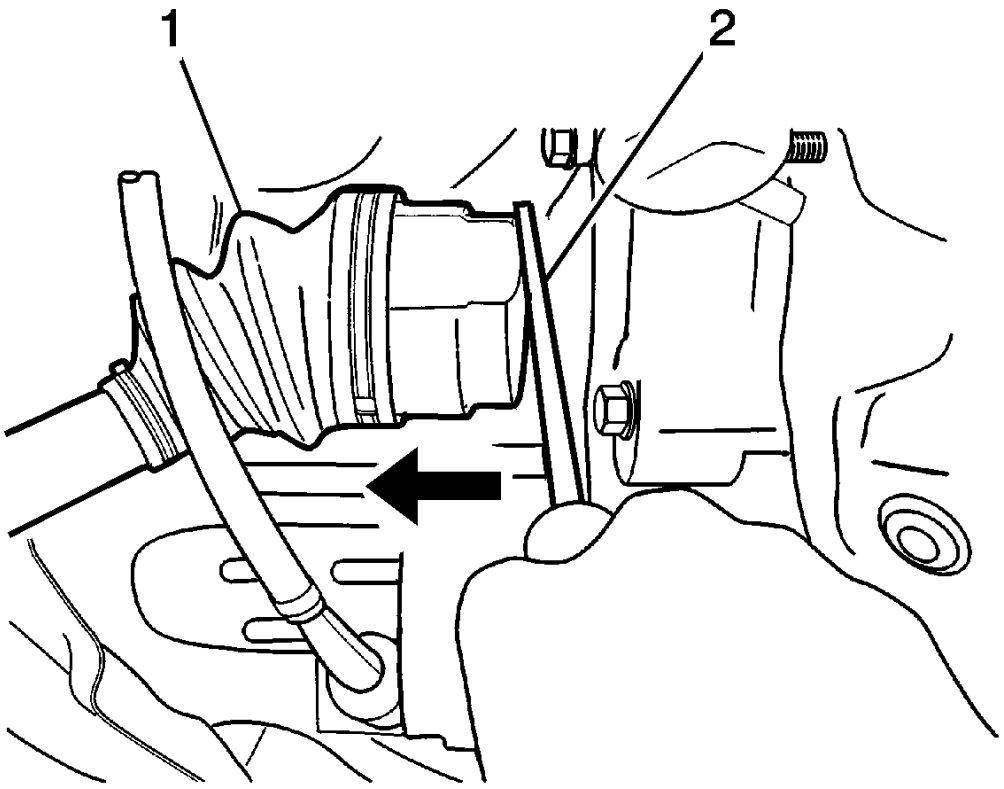


Fig. 5: View Of Wheel Drive Shaft Removal From Differential
Courtesy of GENERAL MOTORS COMPANY

15. Using a large flat-bladed tool (2), remove the wheel drive shaft.

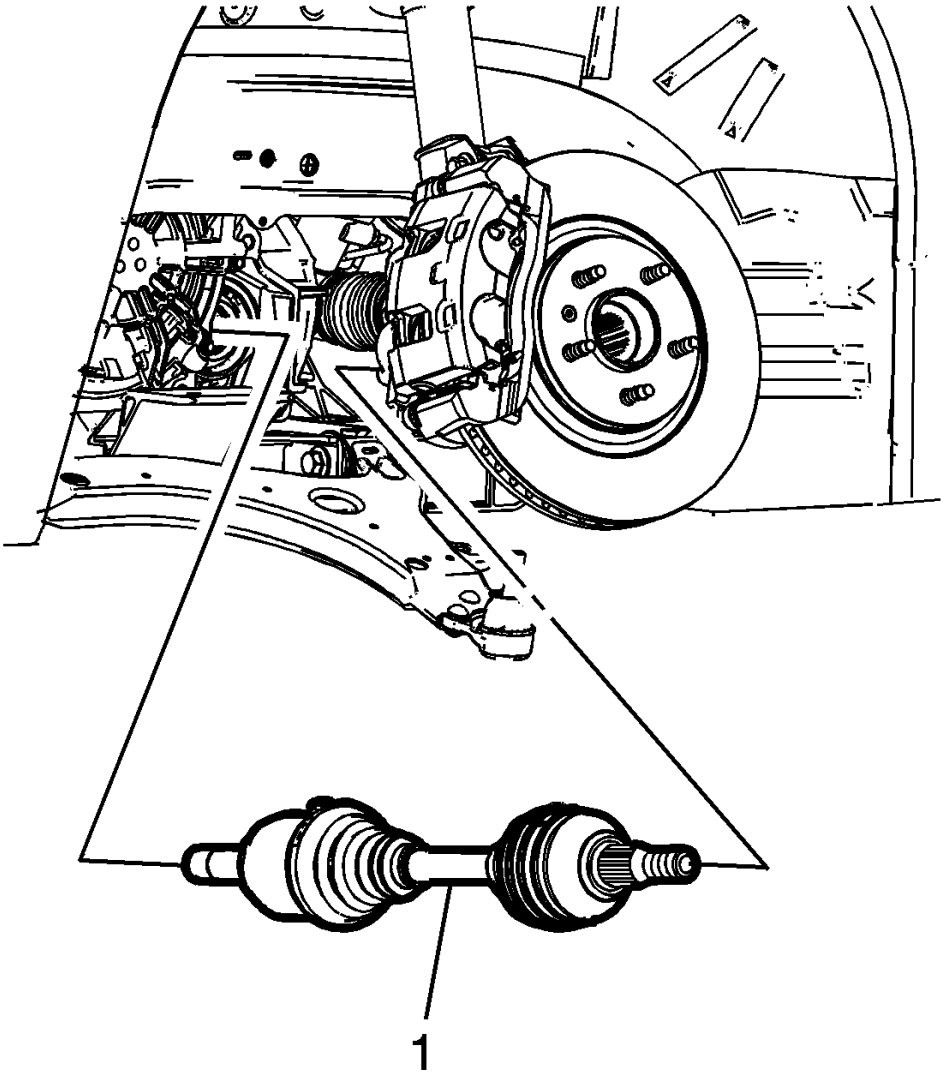


Fig. 6: Left And Right Wheel Drive Shafts
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **It may be necessary to have an assistant hold the knuckle assembly while removing the wheel drive shaft.**
- **If removing the wheel drive shaft to service other suspension or drive**

line components, use care when removing or installing the wheel drive shaft so as not to damage the wheel drive shaft boots.

16. Remove the wheel drive shaft (1) from the vehicle.

Installation Procedure

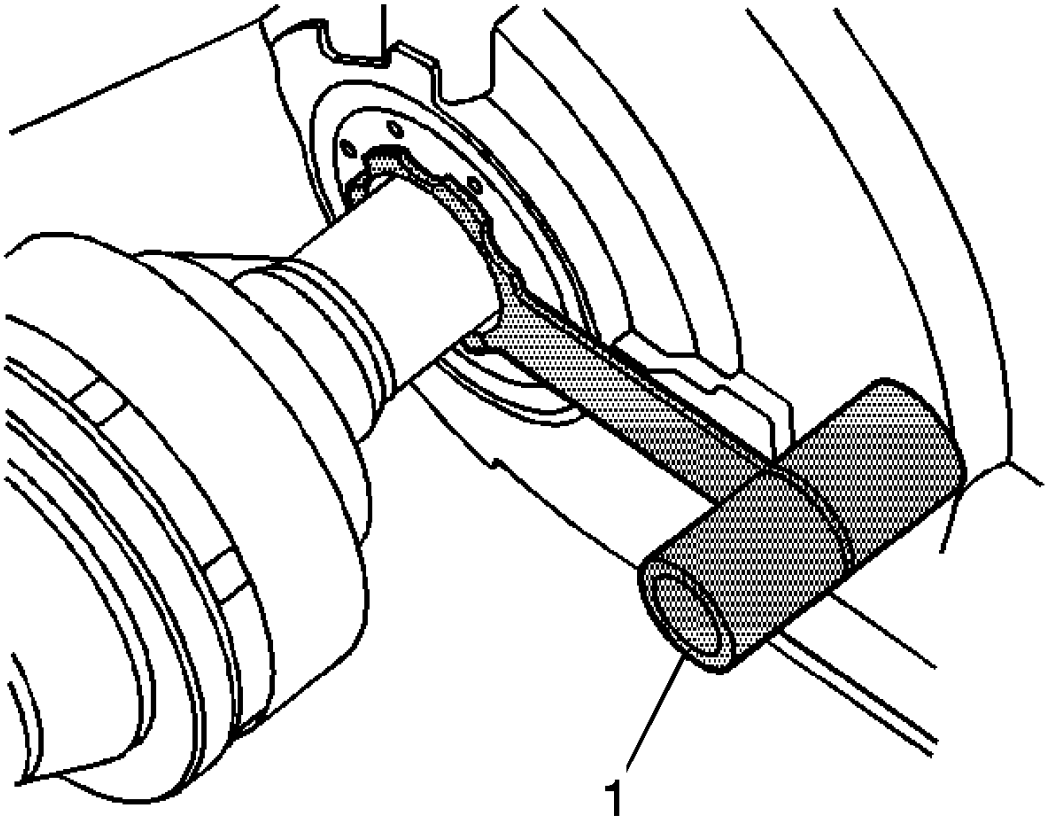


Fig. 7: Differential Output Shaft Seal Protector
Courtesy of GENERAL MOTORS COMPANY

CAUTION: DT-51504 must be installed into the differential output shaft seal prior to removing and installing the wheel drive shaft. Failure to install the DT-51504 as indicated may cause the splines of the wheel drive shaft to damage the differential output seal

1. Install the **DT-51504** protector (1) into the differential.

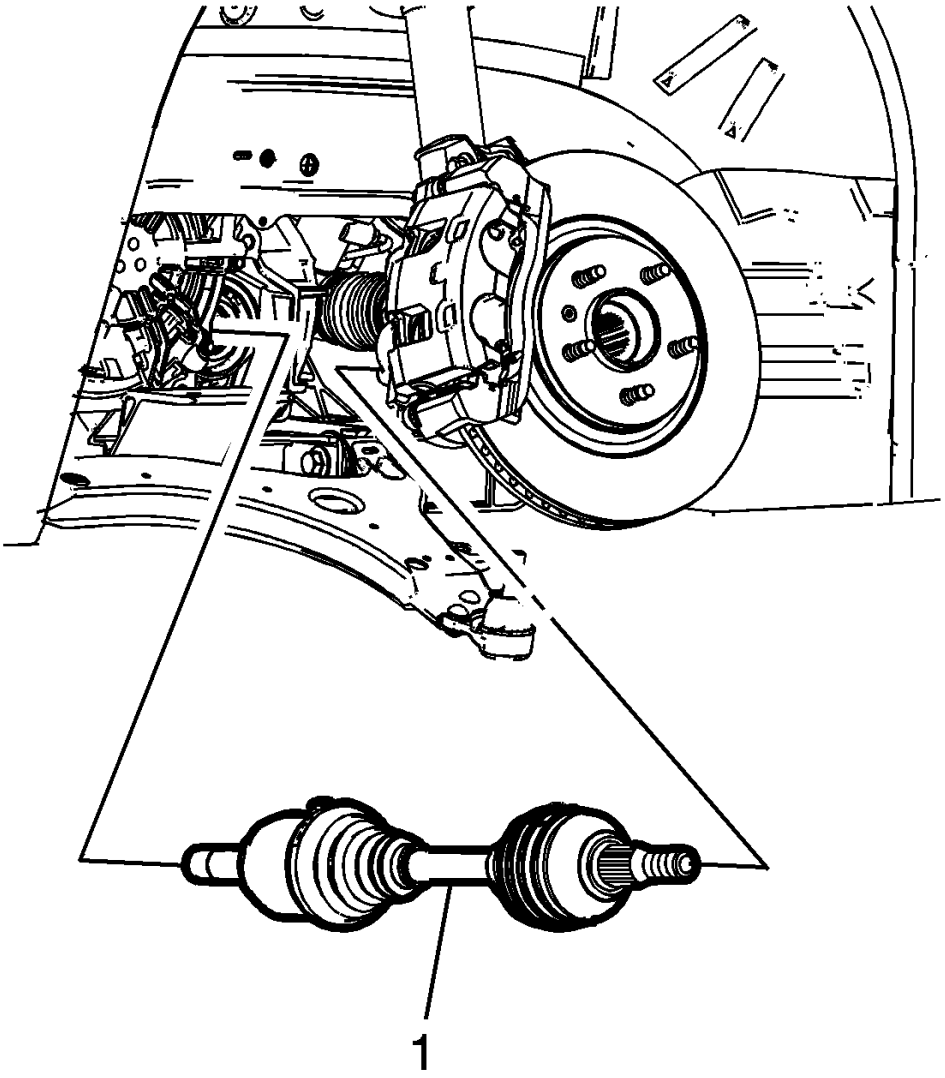


Fig. 8: Left And Right Wheel Drive Shafts
Courtesy of GENERAL MOTORS COMPANY

2. Install the wheel drive shaft (1) into the differential.
3. Remove the **DT-51504** protector (1) from the differential.
4. Install the front wheel drive shaft into the front wheel hub/bearing.

5. Install the lower control arm in the steering knuckle. Refer to **Lower Control Arm Replacement** .
6. Install the stabilizer shaft link in the lower control arm. Refer to **Stabilizer Shaft Link Replacement** .
7. Install the outer tie rod end in the steering knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .

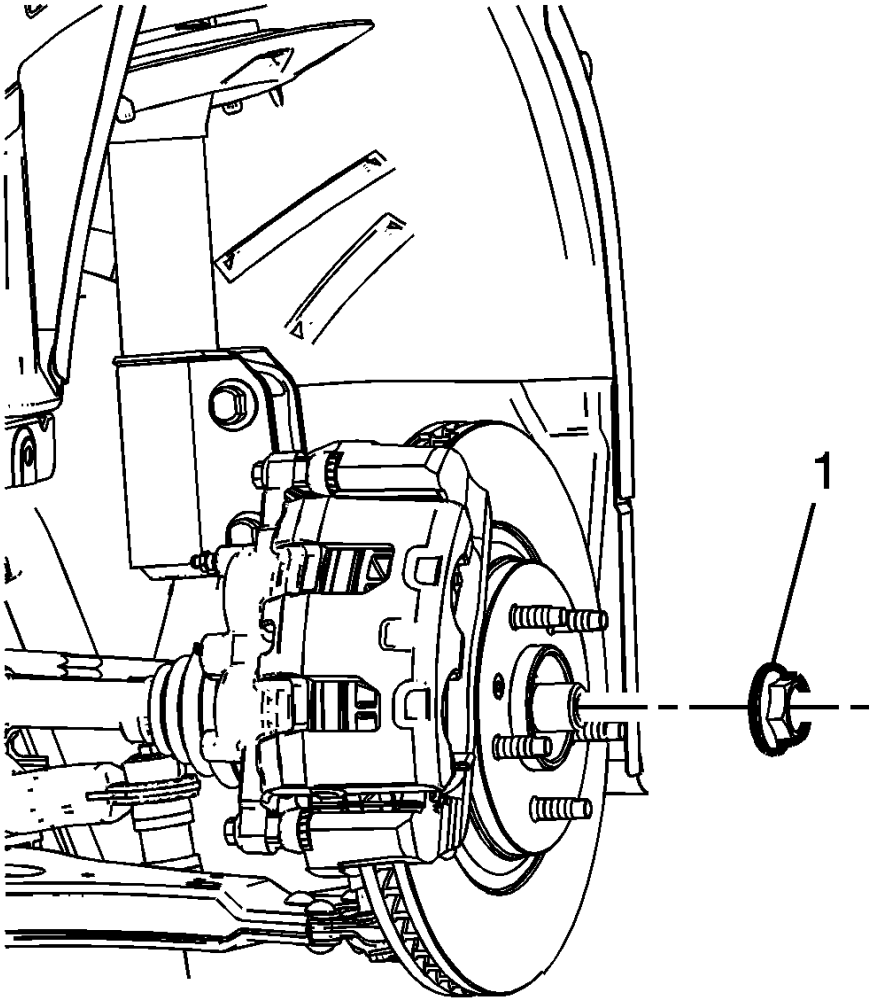


Fig. 9: Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

8. Hand start the NEW wheel drive shaft nut (1).

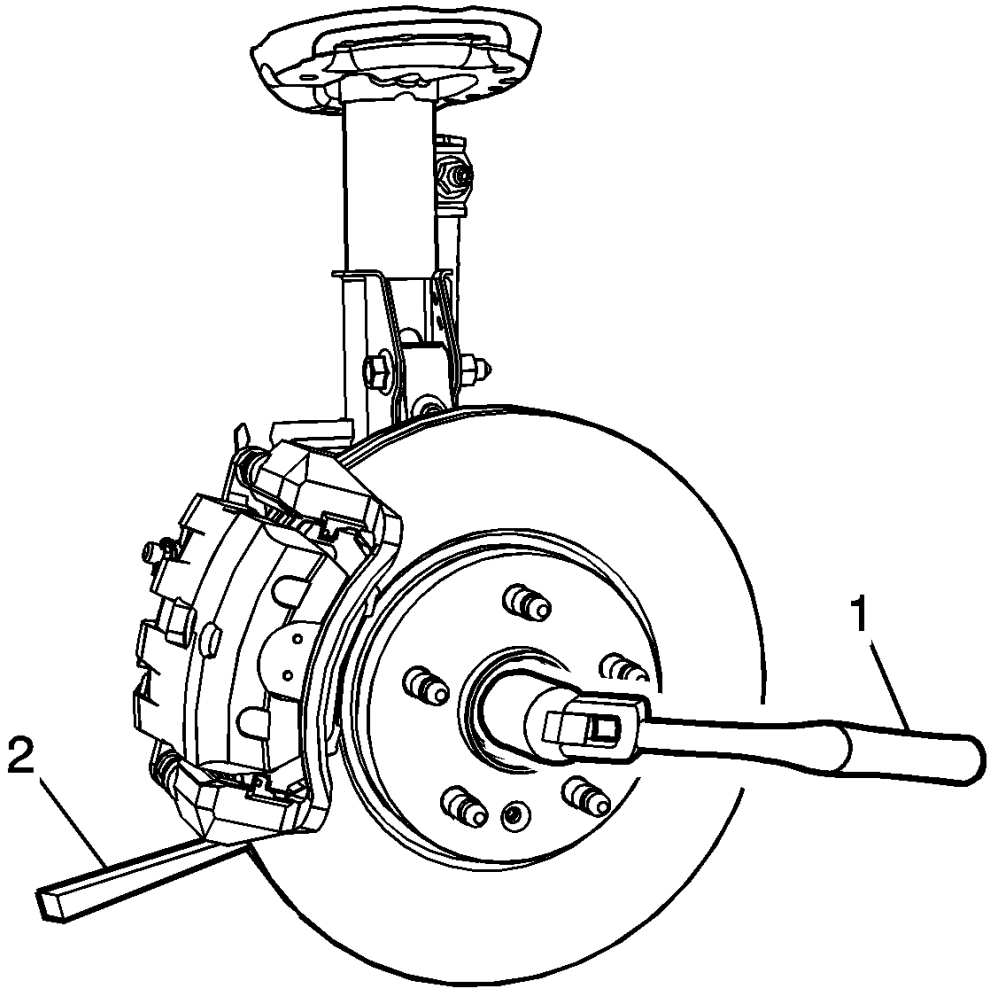


Fig. 10: Holding Brake Rotor From Rotating With Drift Or Punch
Courtesy of GENERAL MOTORS COMPANY

9. Insert a drift or punch (2) in the cooling fins of the brake rotor.
10. Rotate the brake rotor until the drift or punch (2) contacts the brake caliper mounting bracket.

CAUTION: Refer to Fastener Caution .

11. Using a torque wrench (1) and the proper size socket, tighten the wheel drive shaft nut to 210 (155 lb ft).
12. Remove the punch or drift (2) from the brake rotor.
13. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
14. Remove the support and lower the vehicle.

WHEEL DRIVE SHAFT REPLACEMENT (RIGHT SIDE)

Special Tools

J-42129 Wheel Hub Remover

Removal Procedure

1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
2. Remove the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
3. Disconnect the electrical connector for the speed control sensor.

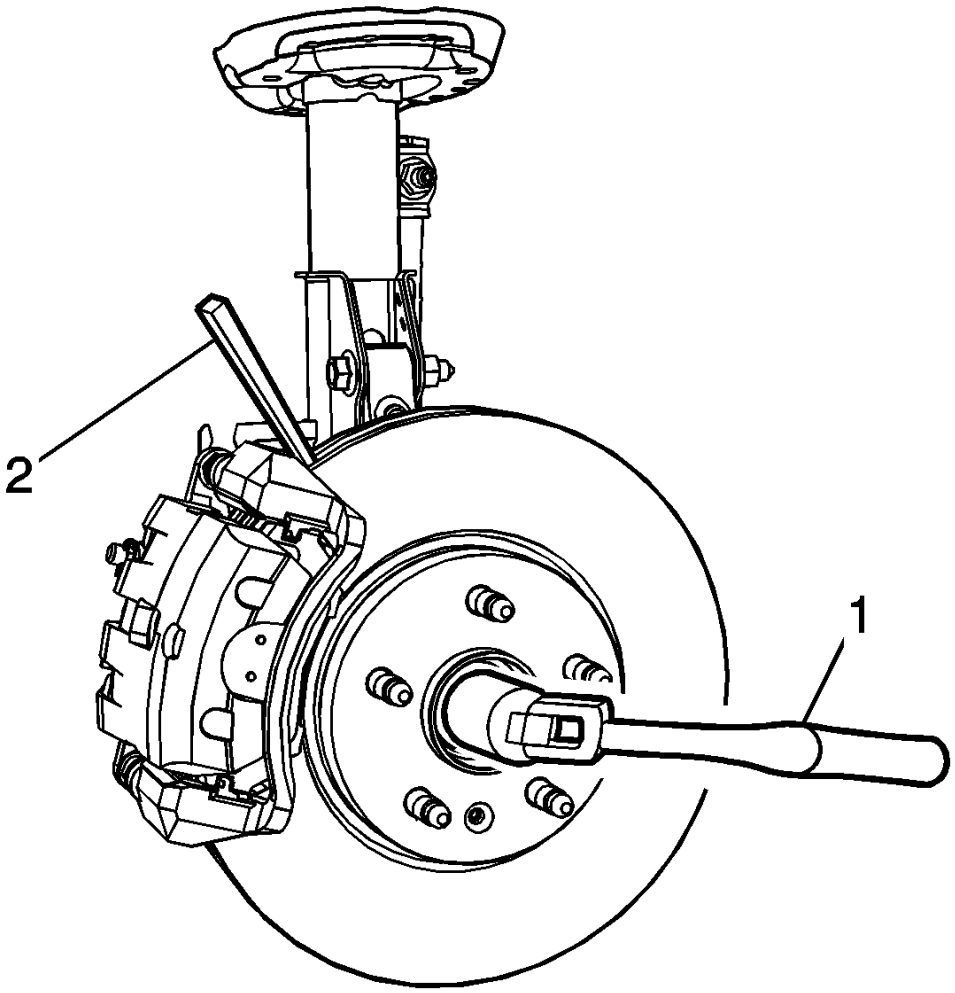


Fig. 11: Holding Brake Rotor With Drift Or Punch
Courtesy of GENERAL MOTORS COMPANY

4. Insert a punch or drift (2) in the cooling fins of the brake rotor.
5. Rotate the brake rotor until the punch or drift (2) is resting against the brake caliper mounting bracket.
6. Using the proper size socket and a breaker bar (1), loosen the wheel drive shaft nut.

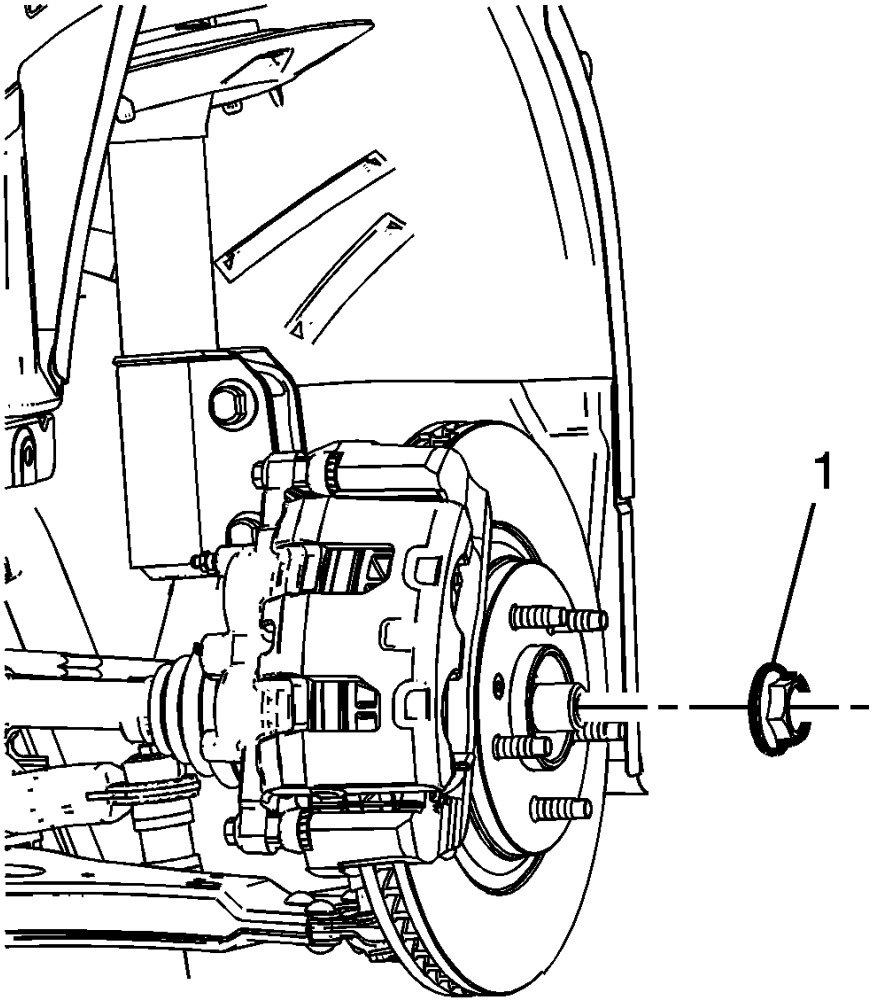


Fig. 12: Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

7. Remove the wheel drive shaft nut (1).
8. Remove the punch or drift from the brake rotor.

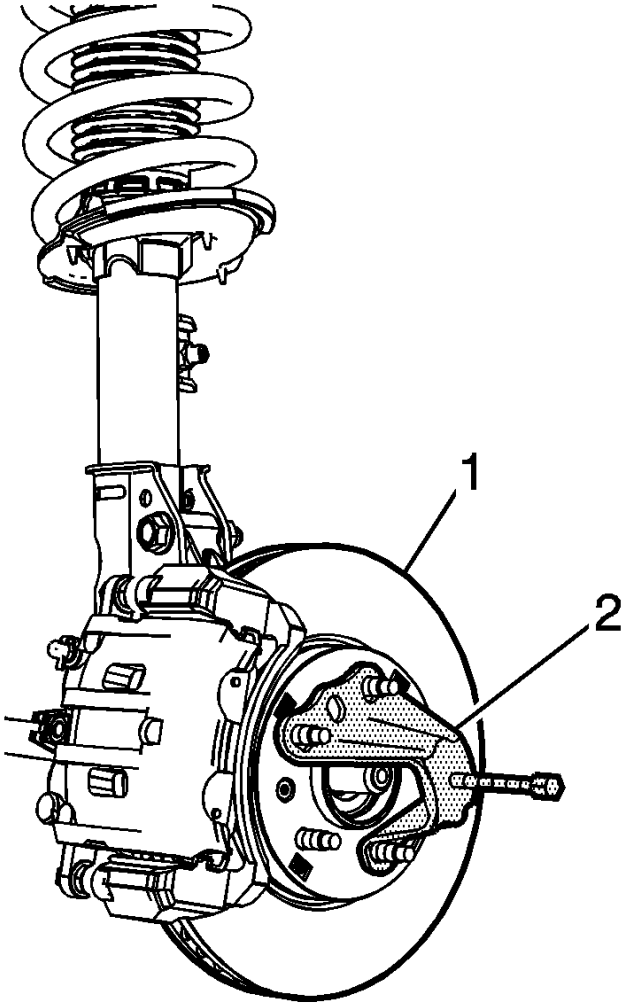


Fig. 13: Separating Wheel Drive Shaft & Steering Knuckle
Courtesy of GENERAL MOTORS COMPANY

9. Using the **J-42129** remover (2), separate the wheel drive shaft from the wheel hub/bearing (1).
10. Remove the **J-42129** remover (2).
11. Remove the outer tie rod end from the steering knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .
12. Remove the stabilizer shaft link from the lower control arm. Refer to **Stabilizer Shaft Link Replacement** .
13. Separate the lower control arm from the steering knuckle. Refer to **Lower Control Arm Replacement** .

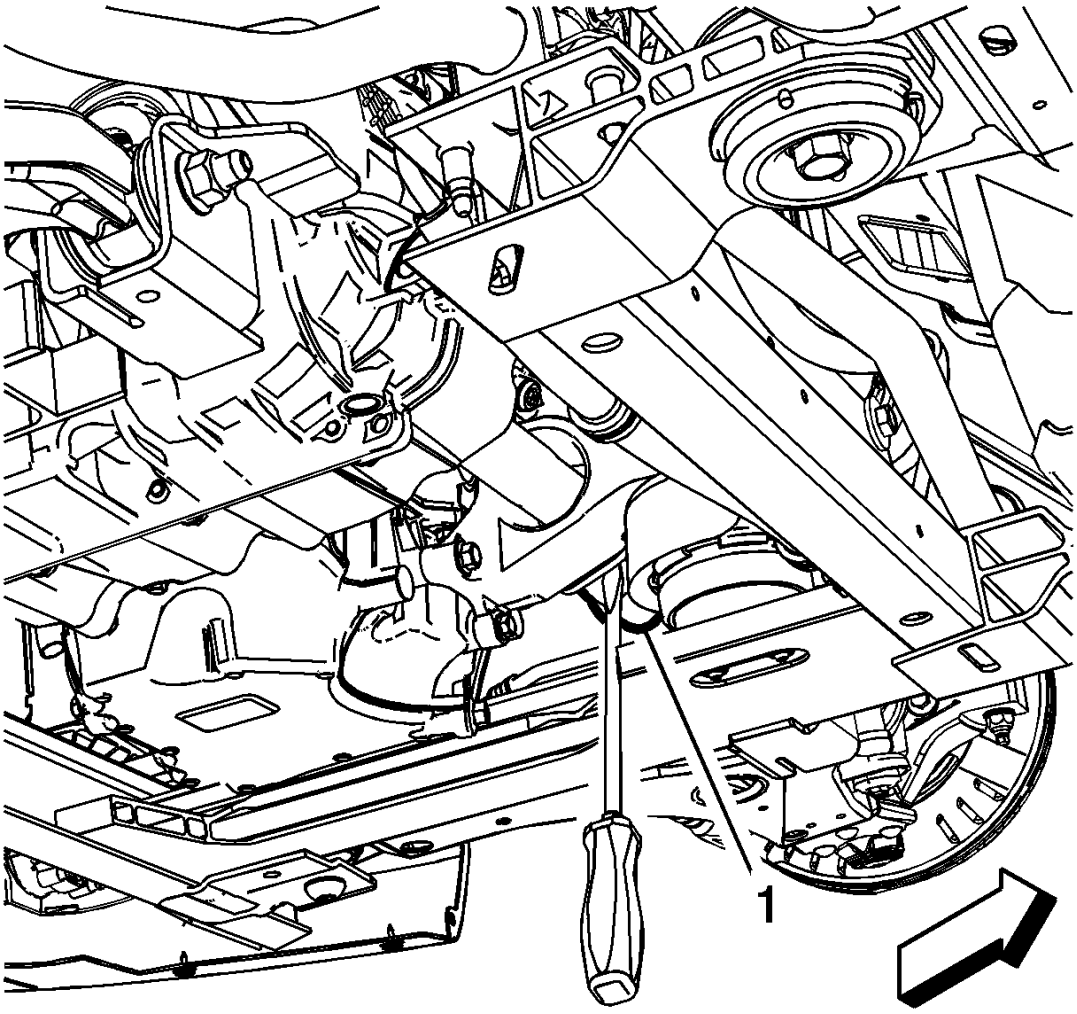


Fig. 14: Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

NOTE:

- **It may be necessary to have an assistant hold the knuckle assembly while removing the wheel drive shaft.**
- **If removing the wheel drive shaft to service other suspension or drive line components, use care when removing or installing the wheel drive shaft so as not to damage the wheel drive shaft boots.**

14. Using an appropriate tool, remove the wheel drive shaft (1) from the intermediate shaft.

Installation Procedure

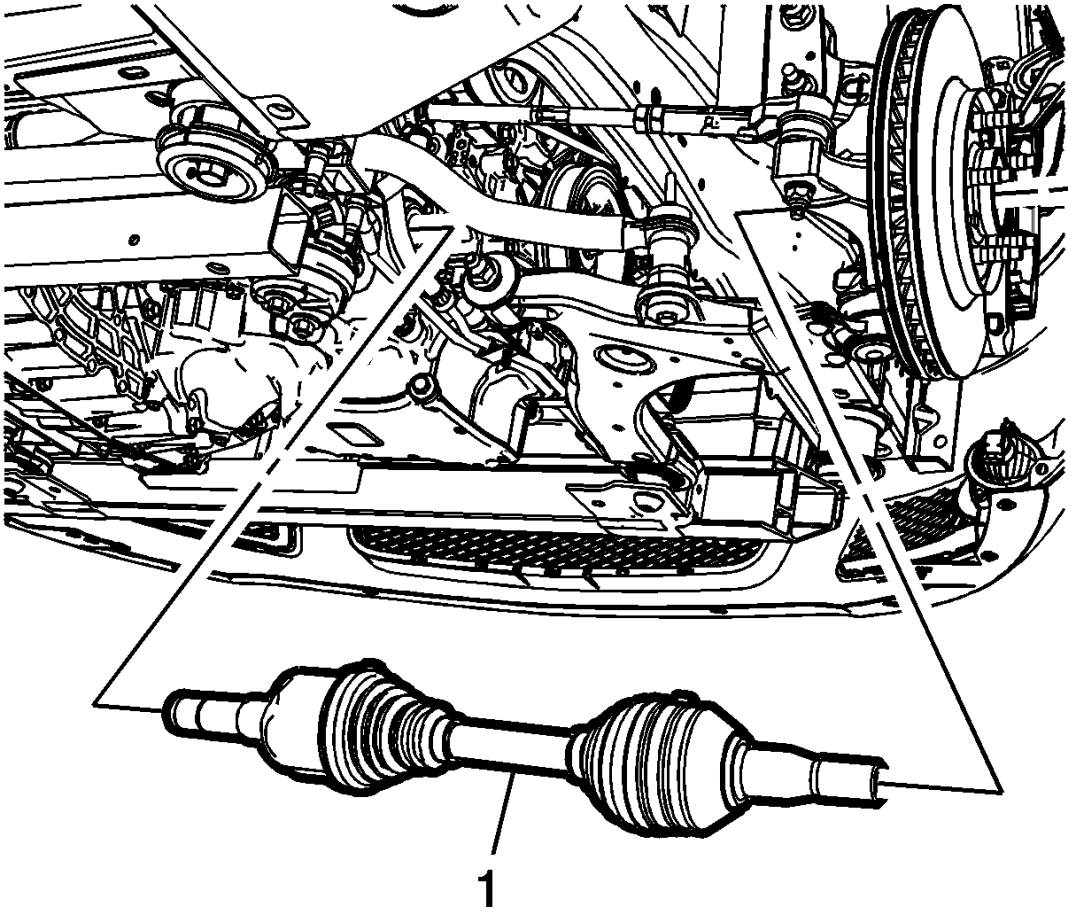


Fig. 15: Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

1. Install the wheel drive shaft (1) into the intermediate shaft.
2. Install the front wheel drive shaft (1) into the front wheel hub/bearing.
3. Install the lower control arm in the steering knuckle. Refer to **Lower Control Arm Replacement** .
4. Install the stabilizer shaft link in the lower control arm. Refer to **Stabilizer Shaft Link Replacement** .
5. Install the outer tie rod end in the steering knuckle. Refer to **Steering Linkage Outer Tie Rod Replacement** .

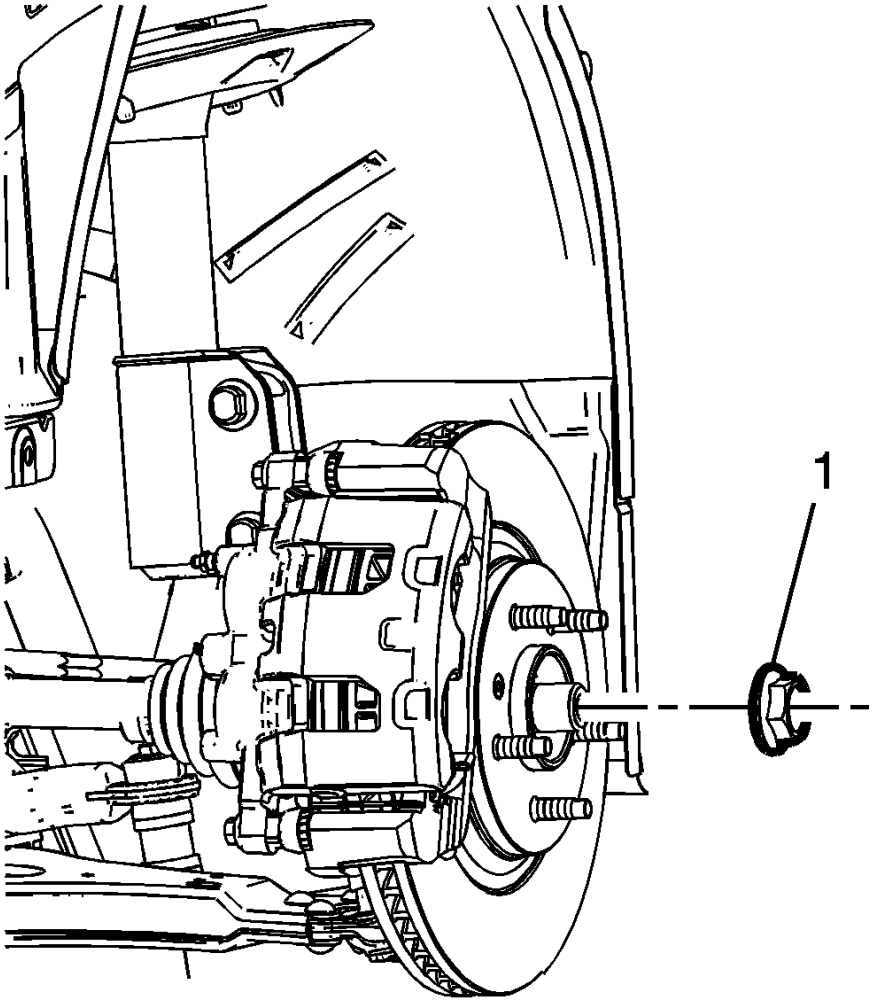


Fig. 16: Wheel Drive Shaft Nut
Courtesy of GENERAL MOTORS COMPANY

6. Hand start the NEW wheel drive shaft nut (1).

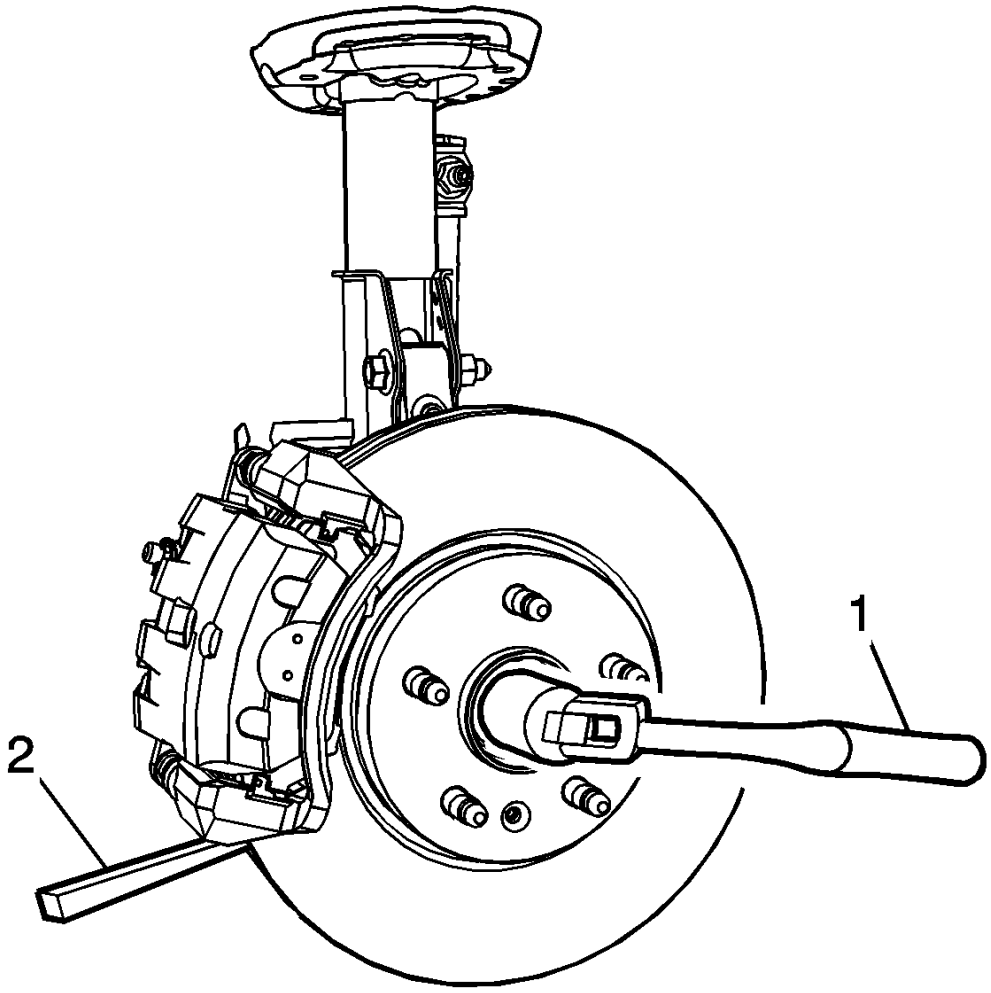


Fig. 17: Holding Brake Rotor From Rotating With Drift Or Punch
Courtesy of GENERAL MOTORS COMPANY

7. Insert a drift or punch (2) in the cooling fins of the brake rotor.
8. Rotate the brake rotor until the drift or punch (2) contacts the brake caliper mounting bracket.

CAUTION: Refer to Fastener Caution .

9. Using a torque wrench (1) and the proper size socket, tighten the wheel drive shaft nut to 210 (155 lb ft).
10. Remove the punch or drift (2) from the brake rotor.
11. Install the tire and wheel assembly. Refer to **Tire and Wheel Removal and Installation** .
12. Remove the support and lower the vehicle.

FRONT WHEEL DRIVE INTERMEDIATE SHAFT REPLACEMENT

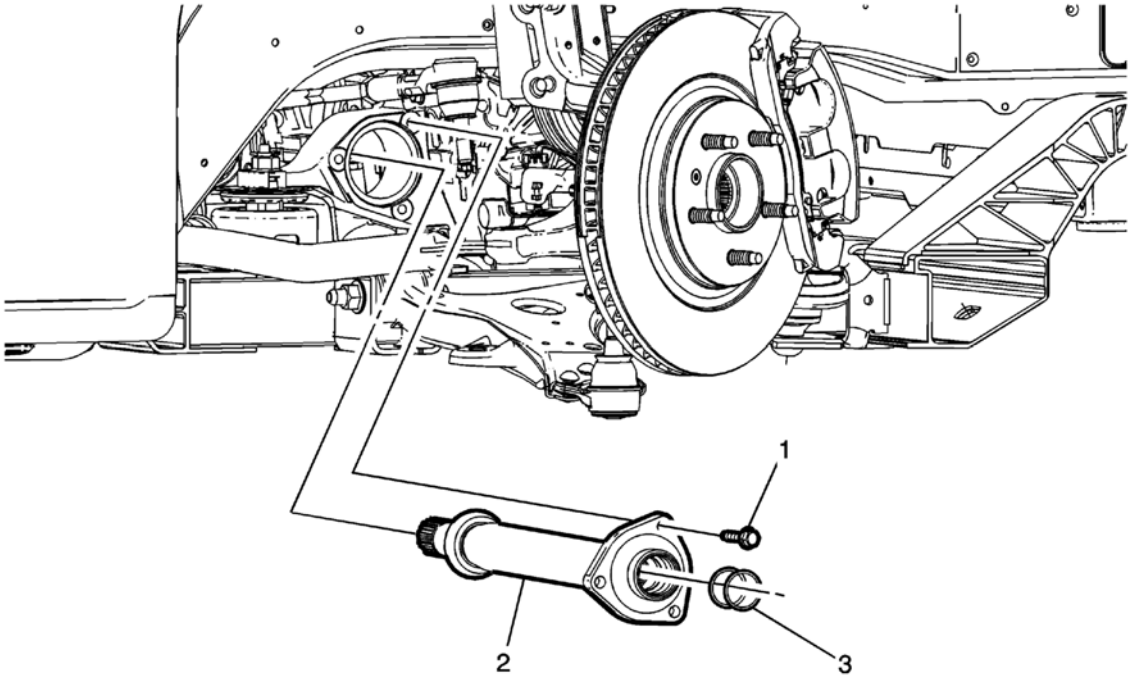


Fig. 18: Front Wheel Drive Intermediate Shaft & Mounting Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** . 2. Remove the wheel drive shaft from the vehicle. Refer to **Wheel Drive Shaft Replacement (Left Side)Wheel Drive Shaft Replacement (Right Side)**.	
1	Front Wheel Drive Intermediate Shaft Bearing Retaining Bolt (Qty: 3) **CAUTION:** **Refer to Fastener Caution .** **Tighten** 22 (16 lb ft).
2	Front Wheel Drive Intermediate Shaft **CAUTION:** **DT-51504 must be installed into**

Callout	Component Name
	the differential output shaft seal prior to removing and installing the wheel drive shaft. Failure to install the DT-51504 as indicated may cause the splines of the wheel drive shaft to damage the differential output seal **Procedure** A small amount of grease must be applied to the wheel drive shaft and/or the internal splines of the wheel drive intermediate shaft. Refer to **Adhesives, Fluids, Lubricants, and Sealers**. **Special Tools** **DT-51504** Seal Protector For regional equivalent tools, refer to **Special Tools**.
3	Front Wheel Drive Intermediate Shaft O-Rings (Qty: 2) **NOTE:** **The front wheel drive intermediate shaft O-rings must be replaced every time the wheel drive shaft have been removed.**

WHEEL DRIVE SHAFT INNER JOINT AND BOOT REPLACEMENT

Special Tools

- **J 35910** Drive Axle Seal Clamp Pliers
- **J 41048** Drive Axle Swage Ring Clamp

Disassemble Procedure

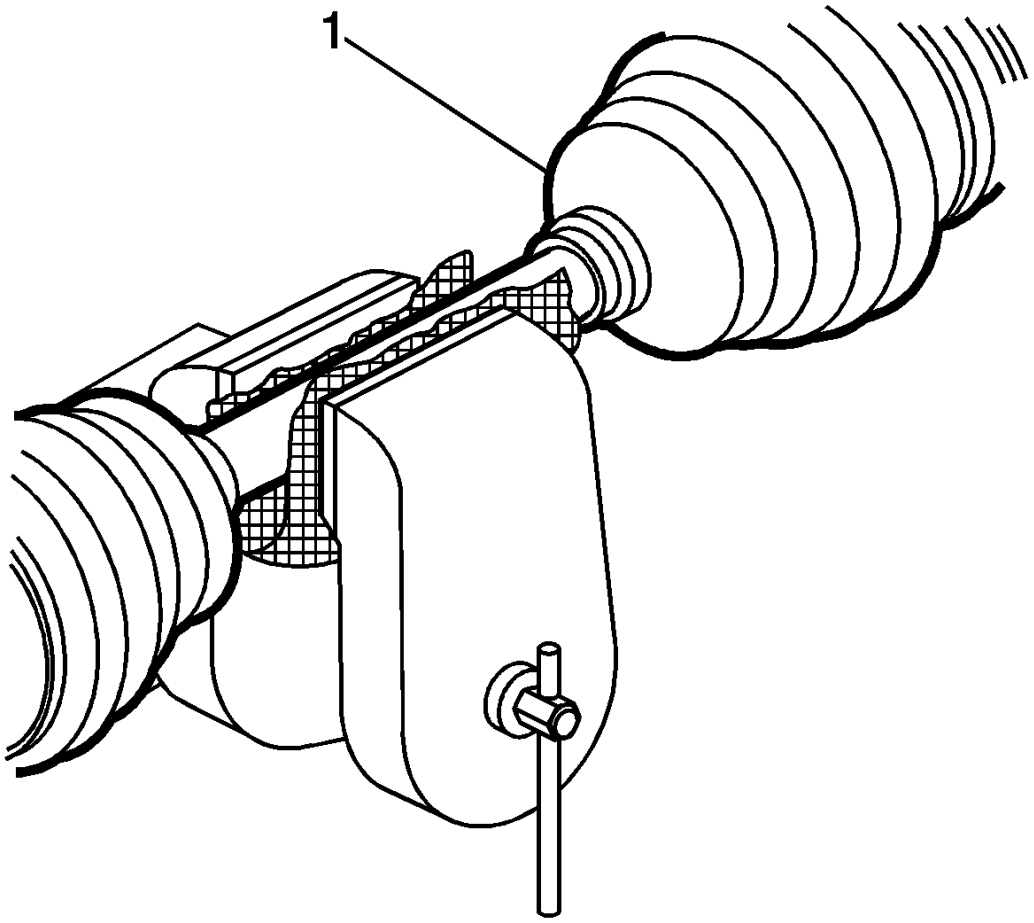


Fig. 19: View Of Front Wheel Drive Shaft Inner Joint
Courtesy of GENERAL MOTORS COMPANY

1. Install the wheel drive shaft in a soft jawed vise.

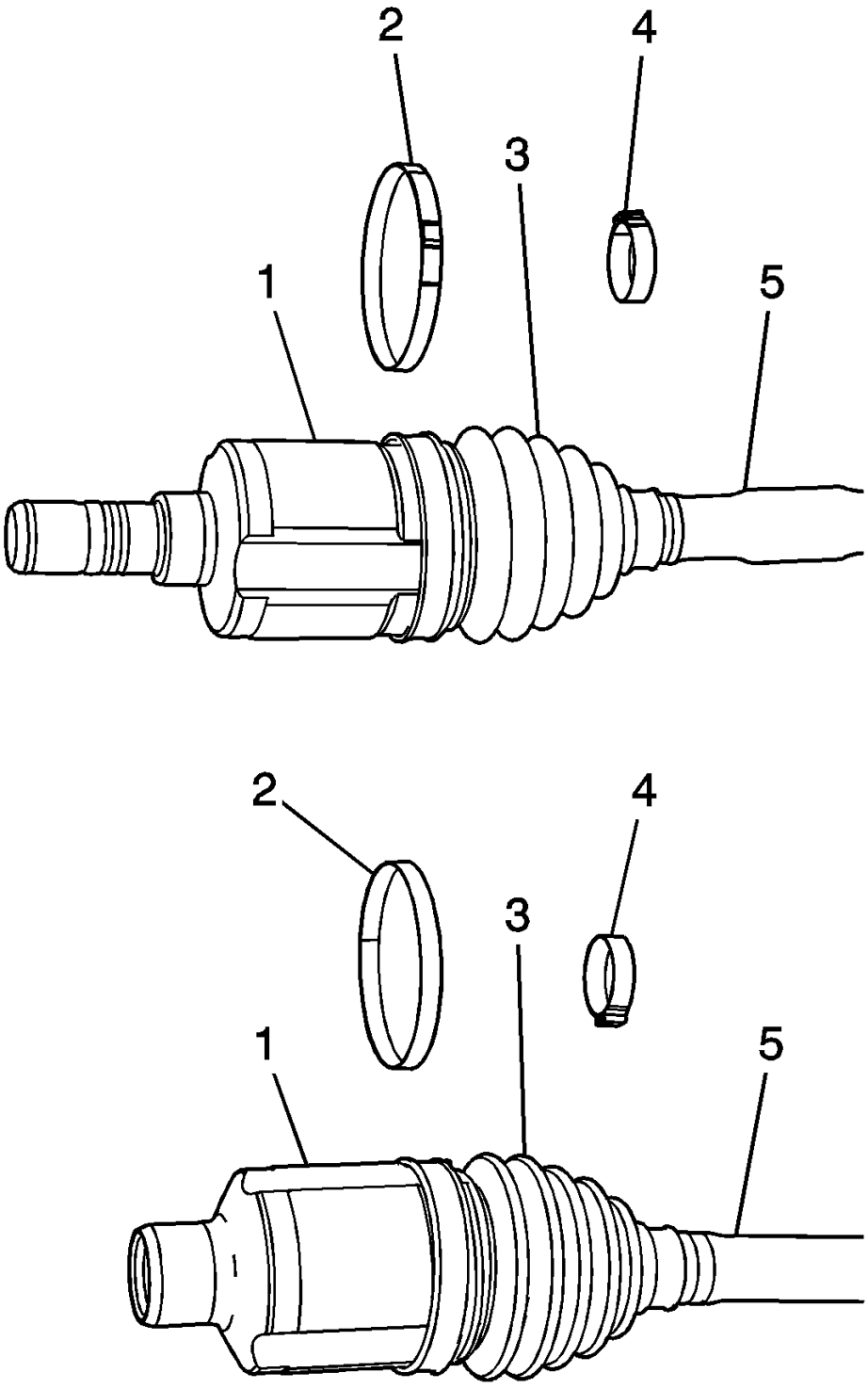


Fig. 20: View Of Wheel Drive Shaft Components
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not cut through the wheel drive shaft inboard or outboard boot during service. Cutting through the boot may damage the sealing surface of the housing and the tripot or the constant velocity joint bushing. Damage to the sealing surface may lead to water and dirt intrusion and premature

wear of the constant velocity joint.

NOTE: **The following service procedure is for those vehicles equipped a swage style boot clamp. For all others, proceed to step 3.**

2. Using the appropriate size side cutter, remove and discard the boot retaining clamps (4) and (2).

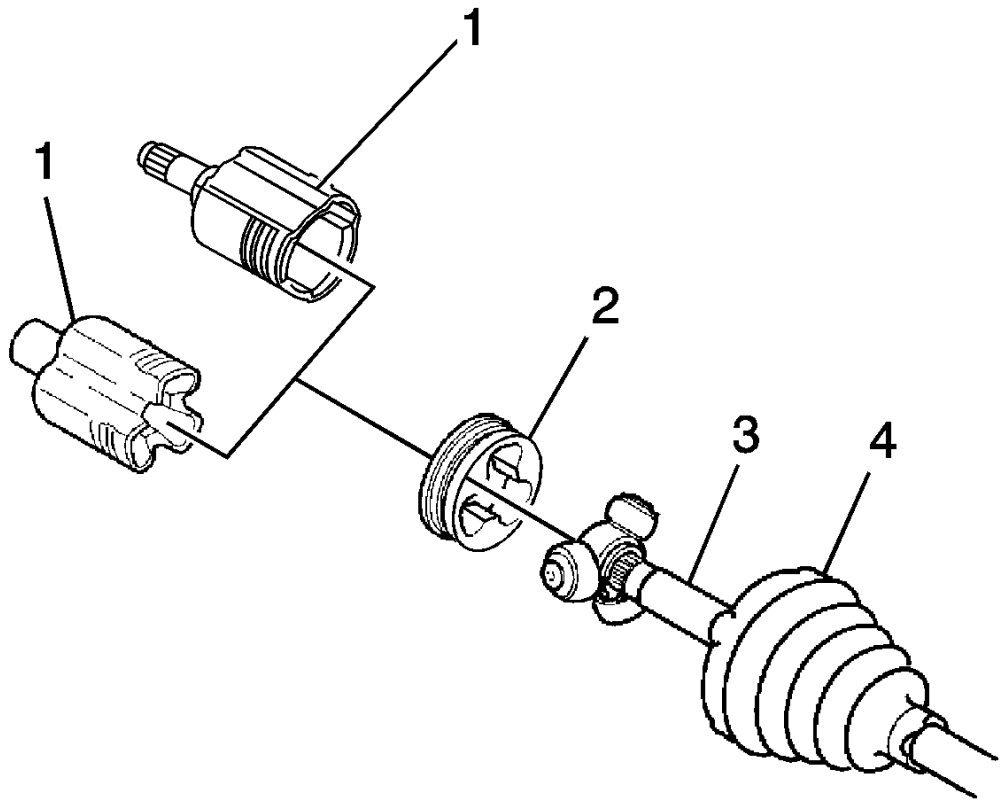


Fig. 21: View Of Tripot Housing, Bushing, Driveshaft And Boot
Courtesy of GENERAL MOTORS COMPANY

3. Remove the boot (4) from the tripod bushing (2).
4. Remove the inner tripod housing (1) and the tripod bushing (2) from the wheel drive shaft (3).

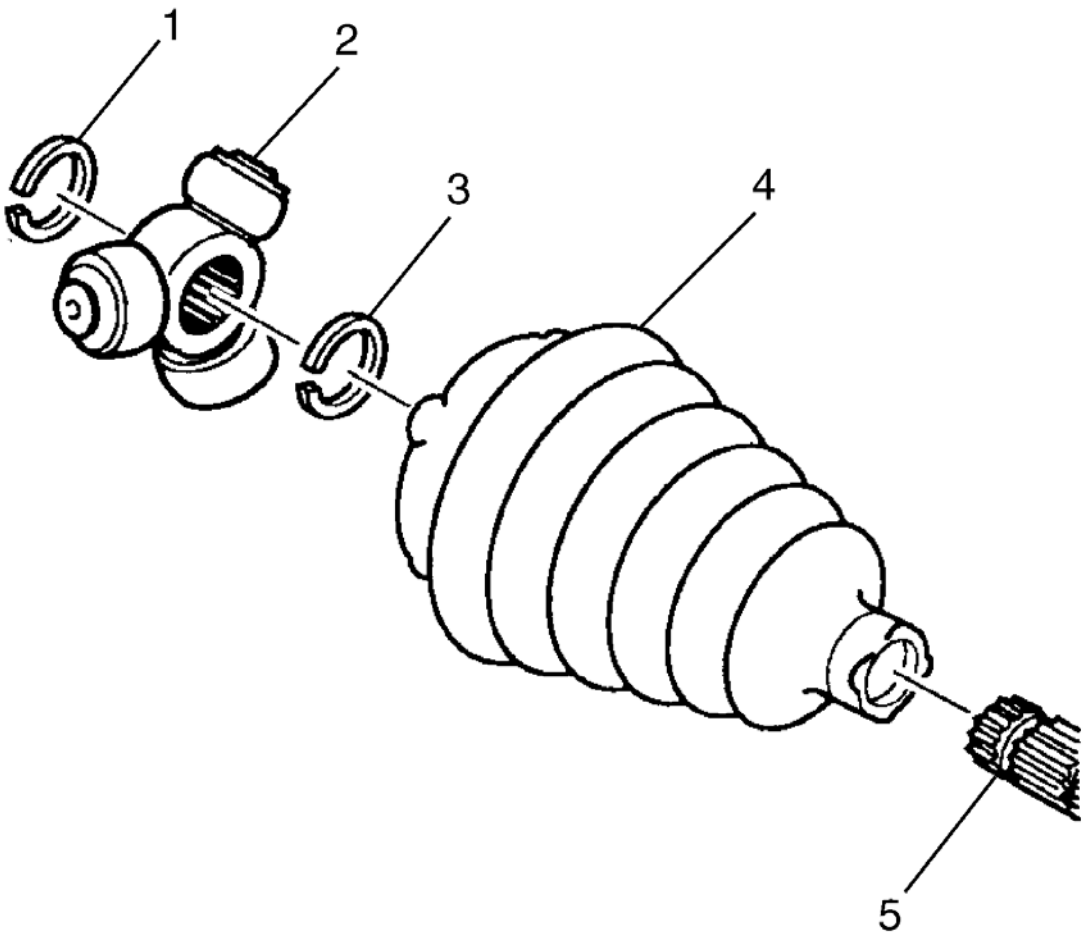


Fig. 22: View Of Spider Assembly, Rings & Tripot Boot
Courtesy of GENERAL MOTORS COMPANY

5. Using the appropriate tool, remove the outer retaining ring (1) from the wheel drive shaft (5).
6. Remove the tripod (2) from the wheel drive shaft (5).

NOTE: **If the tripod has a retaining ring located after it, proceed to step 8. If not, skip step 9 and proceed to step 9.**

7. Using the appropriate tool, remove the inner retaining ring (3) from the wheel drive shaft (5).
8. Remove the boot (4) from the wheel drive shaft (5).
9. Inspect the inner wheel drive shaft joint. Refer to **Wheel Drive Shaft Inner Joint Inspection**.

Assemble Procedure

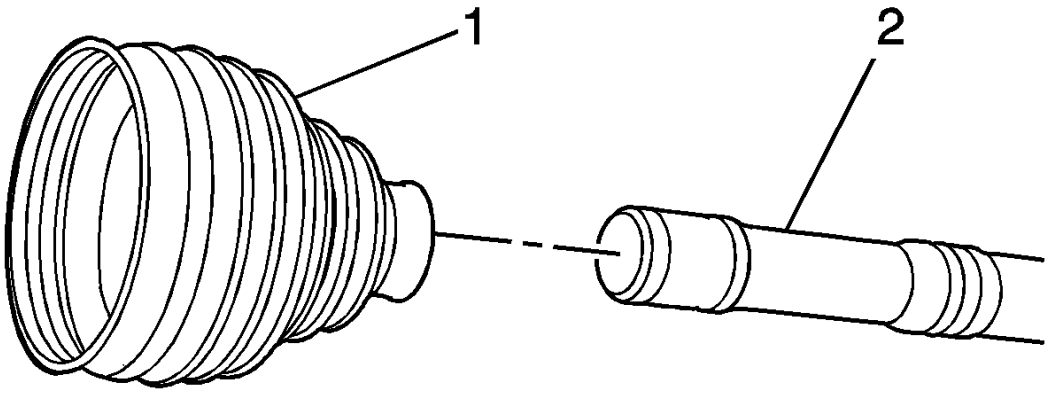


Fig. 23: Identifying Clamp & Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Steps 1-8 are is for those vehicles equipped a swage style boot clamp. For all others, proceed to step 9.**

1. Install the swage clamp and boot (1) on to the wheel drive shaft (2).

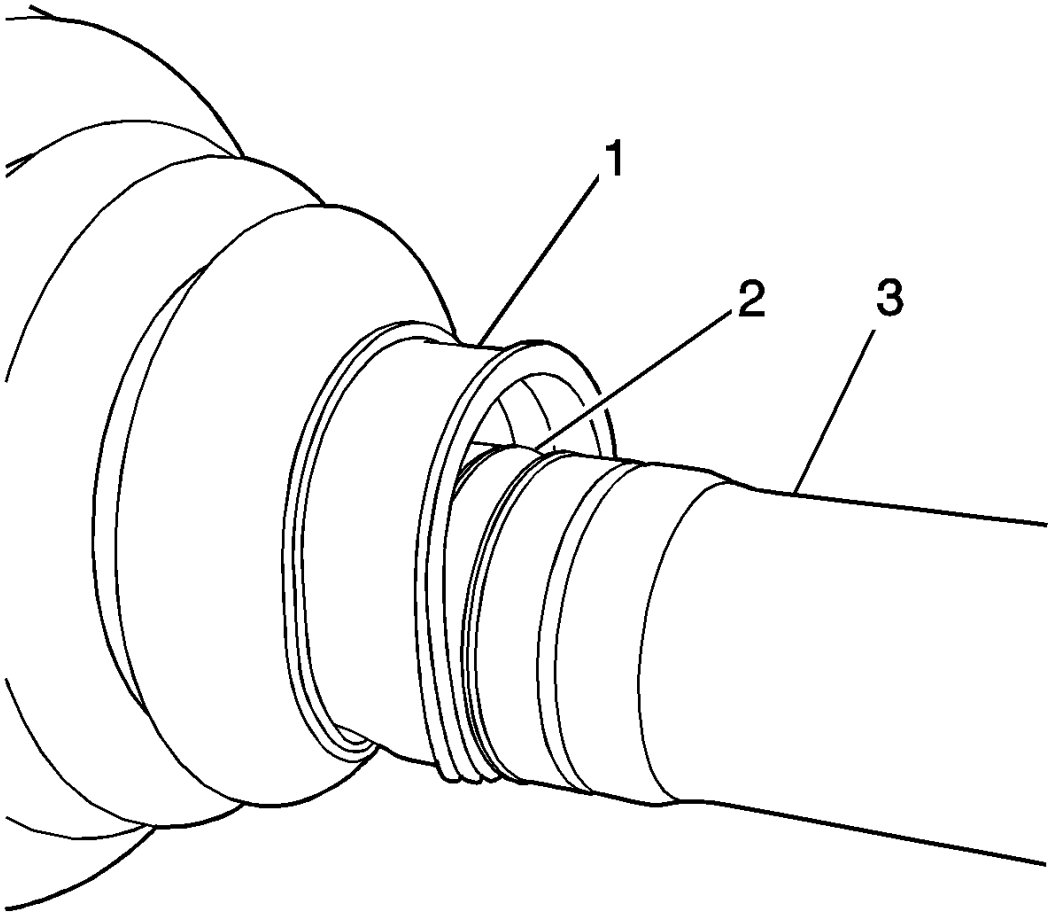


Fig. 24: Identifying Groove In Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

2. Ensure that the boot (1) is properly seated in the groove (2) in the wheel drive shaft (3).

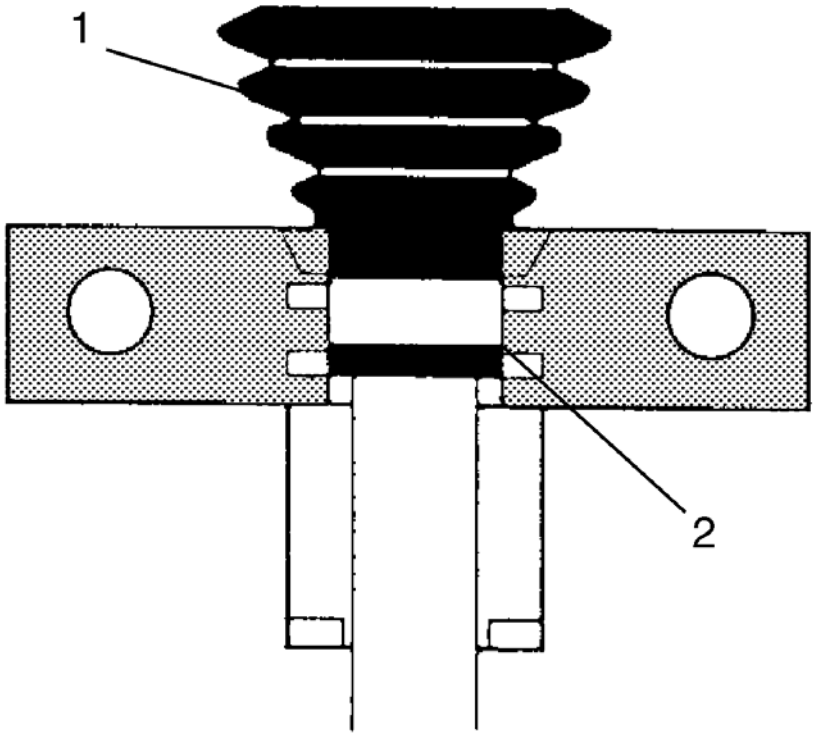


Fig. 25: Identifying Halfshaft Inboard Seal & Swage Ring
Courtesy of GENERAL MOTORS COMPANY

3. Install the **J 41048** drive axle swage ring clamp in a vise.
4. Position the swage clamp (2) so that it is properly seated on the boot (1).
5. Align the boot with the indicator on the bottom die.

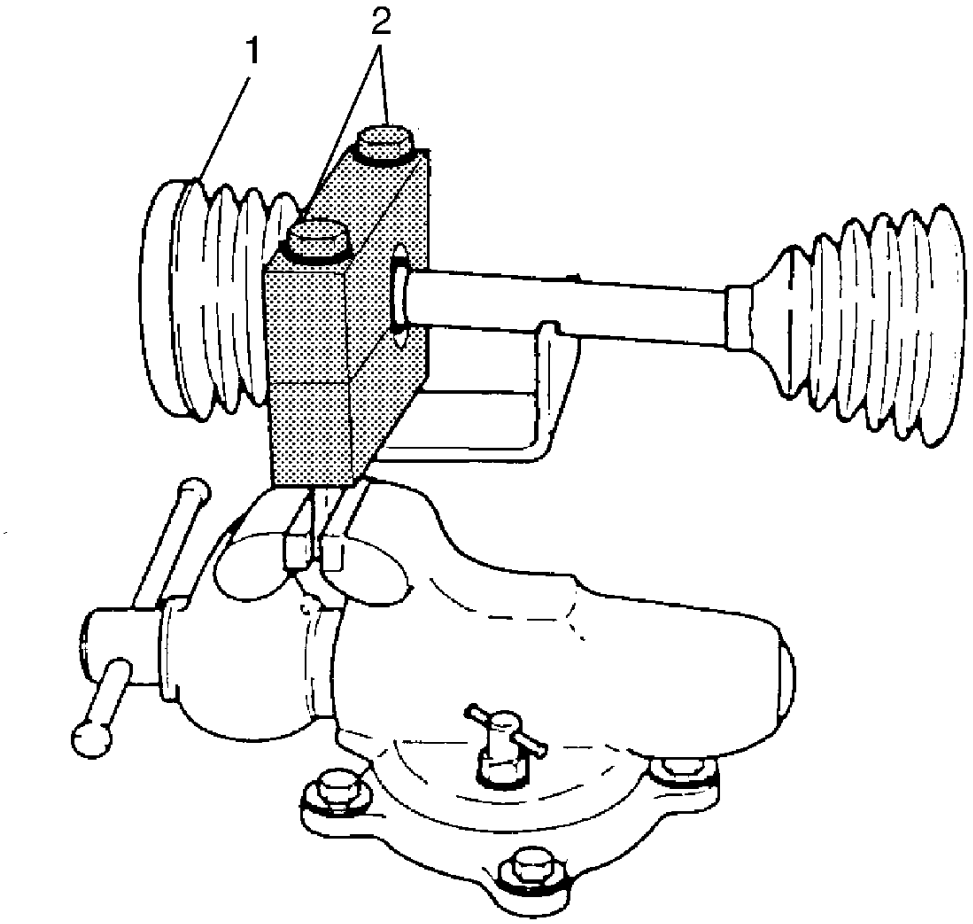


Fig. 26: Swaging Retaining Clamp Ring
Courtesy of GENERAL MOTORS COMPANY

6. Position the upper die and bolts (2) on the wheel drive shaft (1).
7. Hand tighten the bolts (2) until the gap between the upper and lower die are the same.

NOTE: **Before tightening the swage clamp, ensure that the swage clamp is seated properly so that it will not distort or damage the boot.**

8. Tighten the bolts (2) equally one at a time until both of the bolts have bottom out.

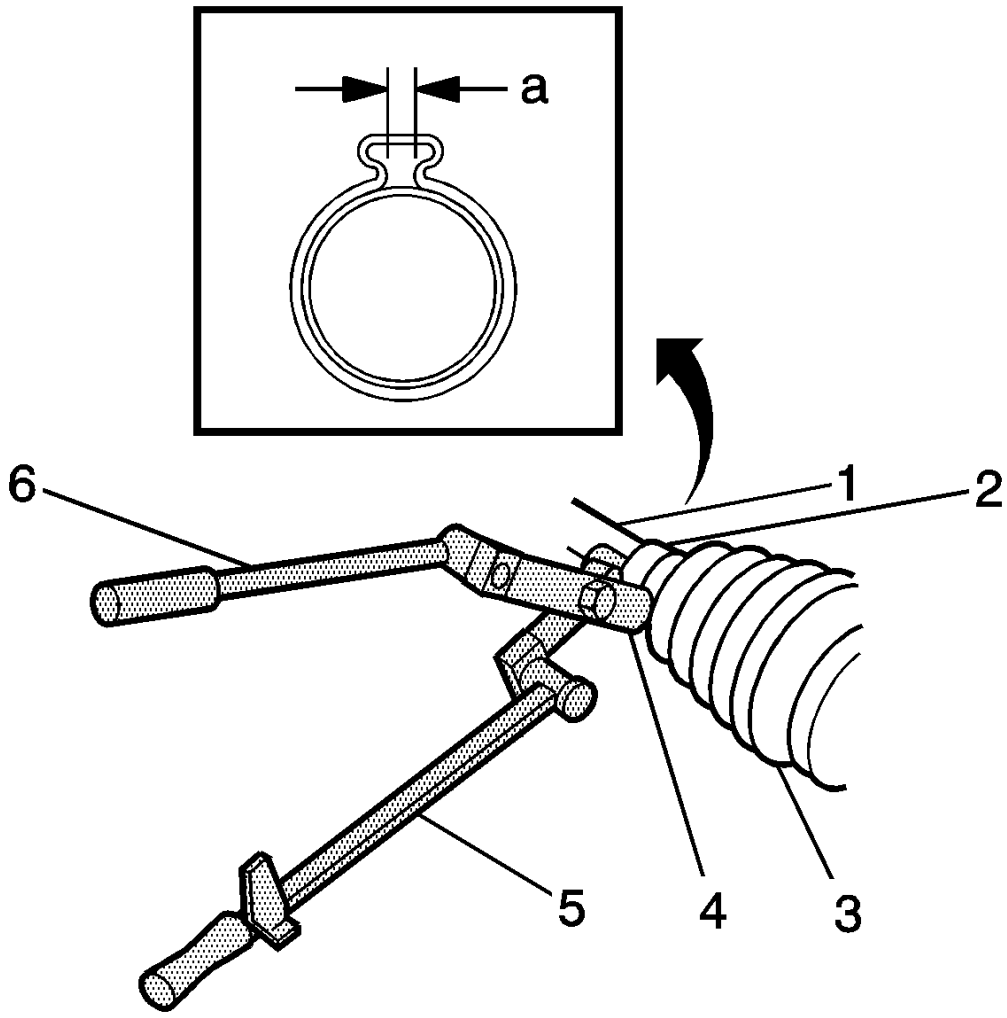


Fig. 27: Drive Axle Seal Clamp Pliers And Drive Shaft Components
Courtesy of GENERAL MOTORS COMPANY

9. Install the boot clamp on the boot.
10. Install the boot (3) and the clamp (2) on the wheel drive shaft (1).
11. Using the **J 35910** drive axle seal clamp pliers (4), torque wrench (5) and the breaker bar (6), tighten the clamp until the gap (a) in the clamp reaches 2.15 mm (0.085 inch).

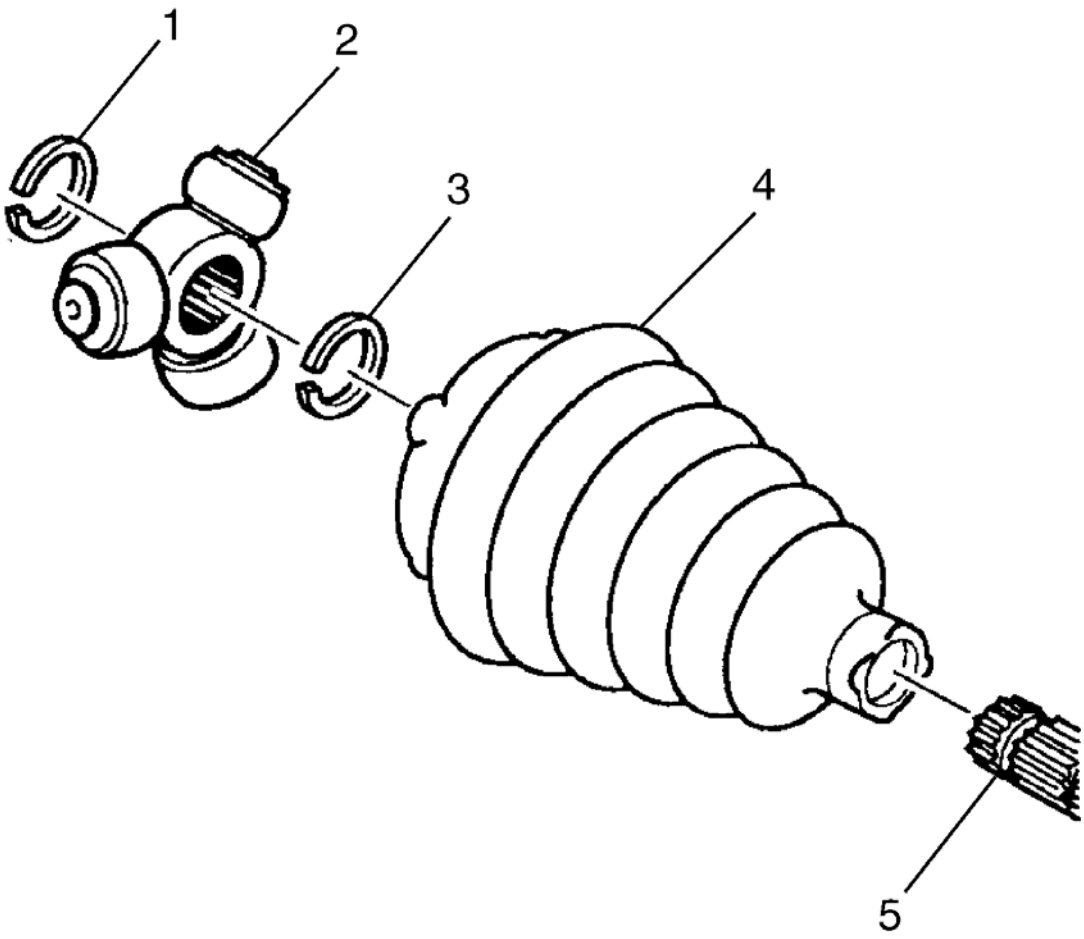


Fig. 28: View Of Spider Assembly, Rings & Tripot Boot
Courtesy of GENERAL MOTORS COMPANY

12. Using the appropriate tool, install the inner retaining ring (3), if equipped.
13. Install the tripod (2) on the wheel drive shaft (5).
14. Using the appropriate tool, install the outer retaining ring (1).

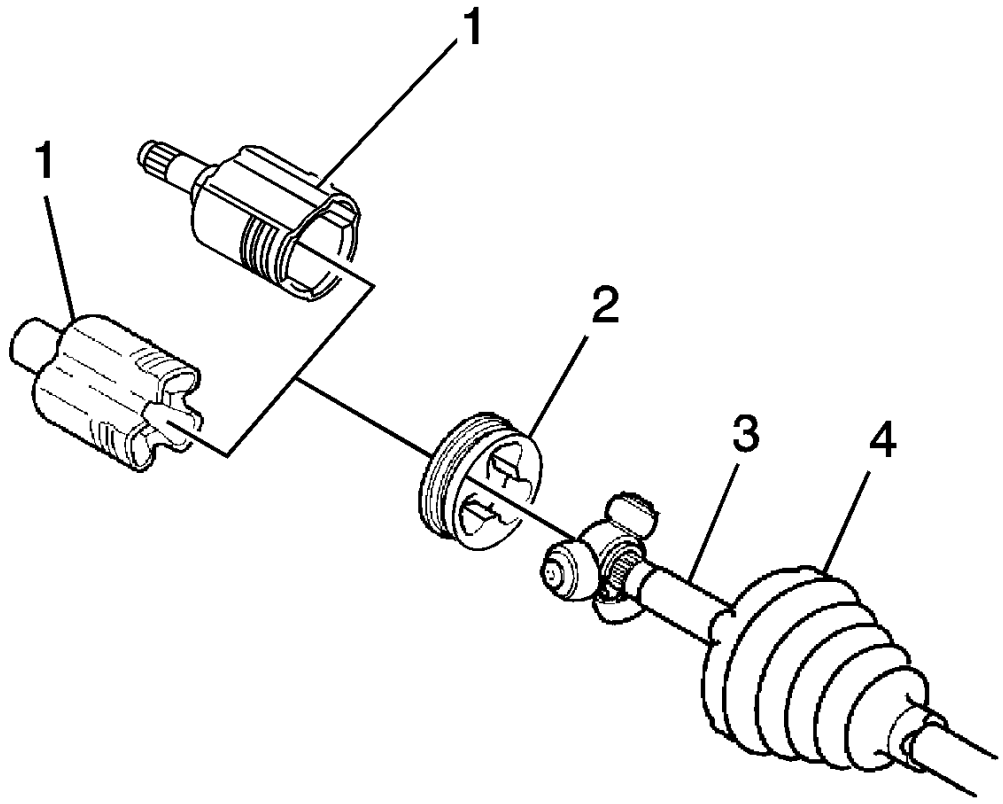


Fig. 29: View Of Tripot Housing, Bushing, Driveshaft And Boot
Courtesy of GENERAL MOTORS COMPANY

15. Install the tripod bushing (2), the tripod housing (1) on to the wheel drive shaft (3).
16. Install the tripod housing (1) on the boot (4).

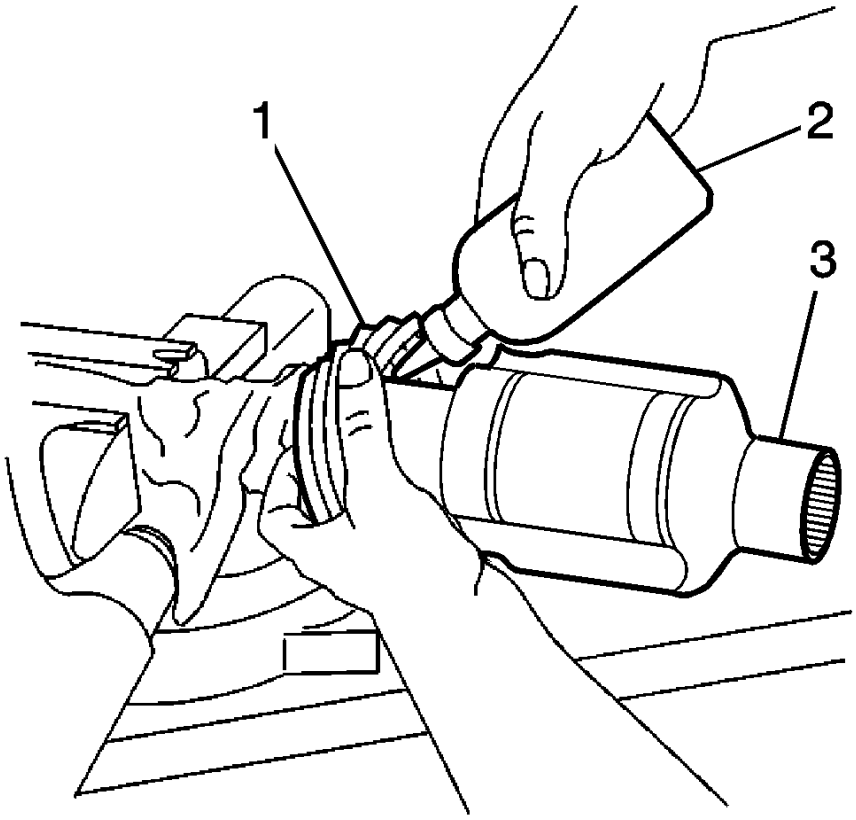


Fig. 30: Applying Lubricant Into Boot and Tripot Housing
Courtesy of GENERAL MOTORS COMPANY

17. Place approximately half the container of grease from the service kit in the boot and the half in the tripod housing.
18. Install the outer boot clamp (3) on the boot (2) and the tripod housing and the bushing (4).

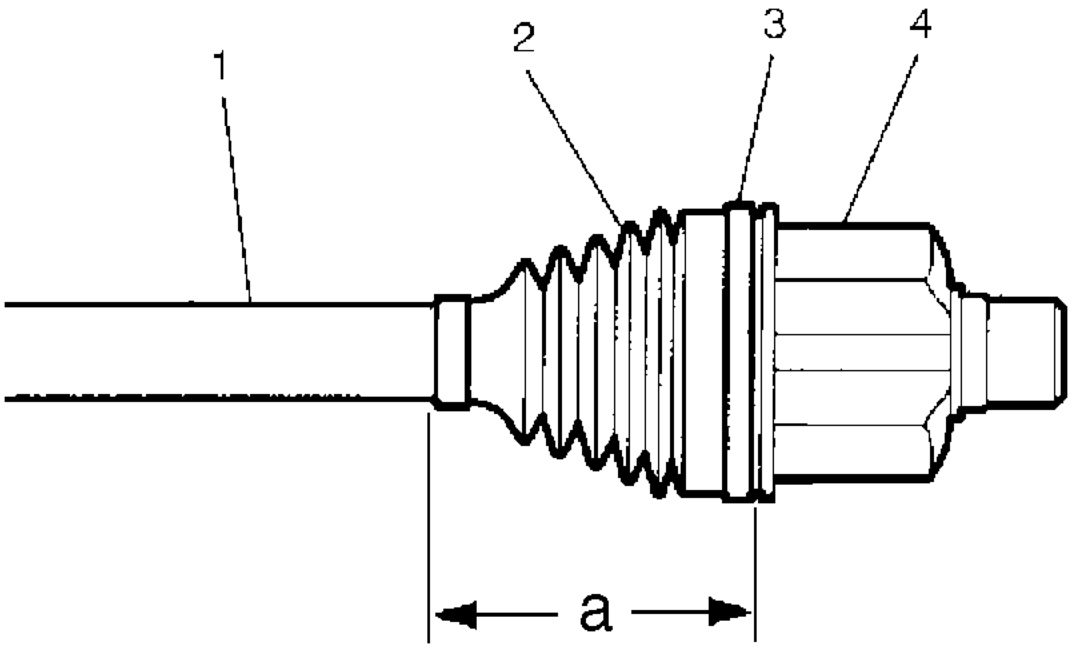


Fig. 31: Identifying Axle Shaft/CV Joint Assembly Components And Installed Boot Measurement Dimension
Courtesy of GENERAL MOTORS COMPANY

19. The measured distance from the rear of the boot to the front of the boot clamp (a) should be 95 mm (3.75 inch).

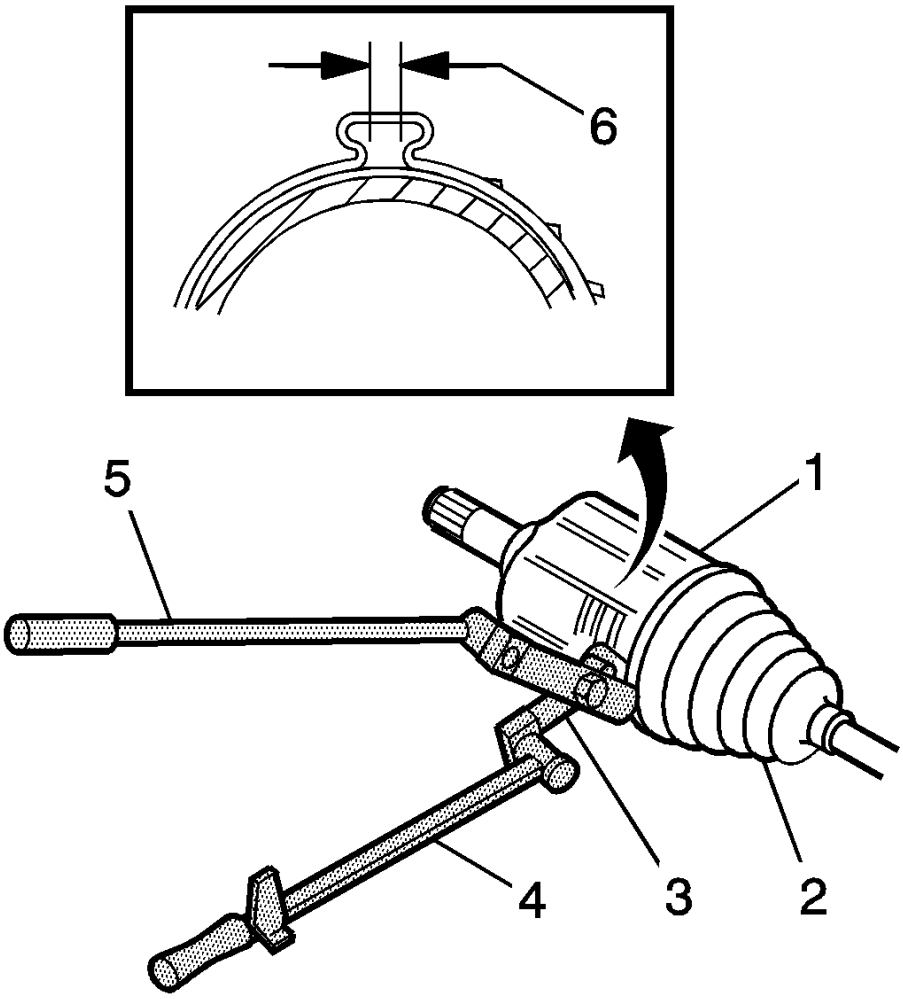


Fig. 32: Measuring Boot Clamp Gap
Courtesy of GENERAL MOTORS COMPANY

20. Using the **J 35910** drive axle seal clamp pliers (3), torque wrench (4), and the breaker bar (5), tighten the clamp (2) to 176 N.m (130 lb ft)..

NOTE: **If the gap dimension is larger than the given specification, continue to tighten the clamp until the specification is reached.**

21. The measured distance of the gap (6) should be 2.60 mm (0.102 inch).
22. Remove the wheel drive shaft from the **J 41048** drive axle swage ring clamp and rotate the tripod housing several times to distribute the grease.

WHEEL DRIVE SHAFT OUTER JOINT AND BOOT REPLACEMENT (WITHOUT WL9)

Special Tools

- **CH 48894** Wheel Drive Shaft Boot Clamp Pliers
- **DT 35910** Drive Axle Seal Clamp Pliers

For equivalent regional tools, refer to **Special Tools**.

NOTE: **The outer Constant Velocity Joint is not serviced separately. If the CV joint is found to have excessive wear or damage, replace the wheel drive shaft as an assembly.**

Disassemble Procedure

1. Remove the wheel drive shaft from the vehicle. Refer to **Wheel Drive Shaft Replacement (Left Side)Wheel Drive Shaft Replacement (Right Side)**

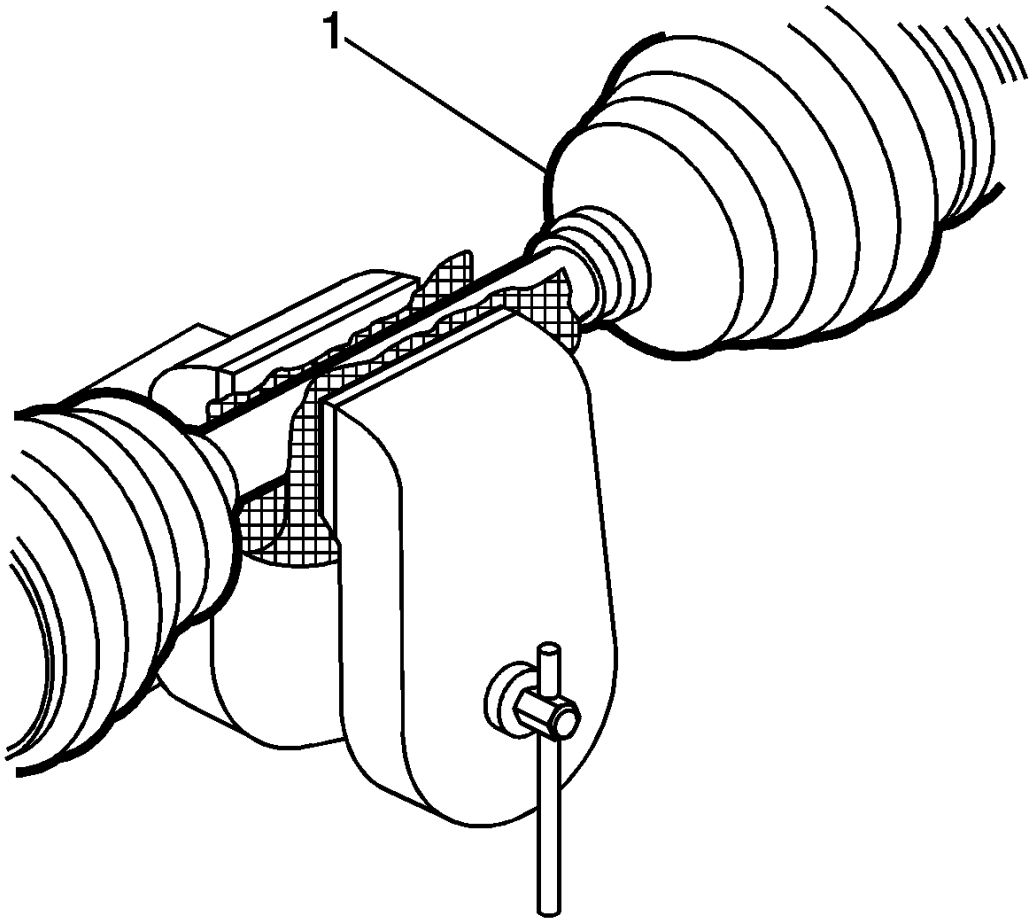


Fig. 33: View Of Front Wheel Drive Shaft Inner Joint
Courtesy of GENERAL MOTORS COMPANY

2. Clamp the drive axle shaft (1) in a soft jawed vice.

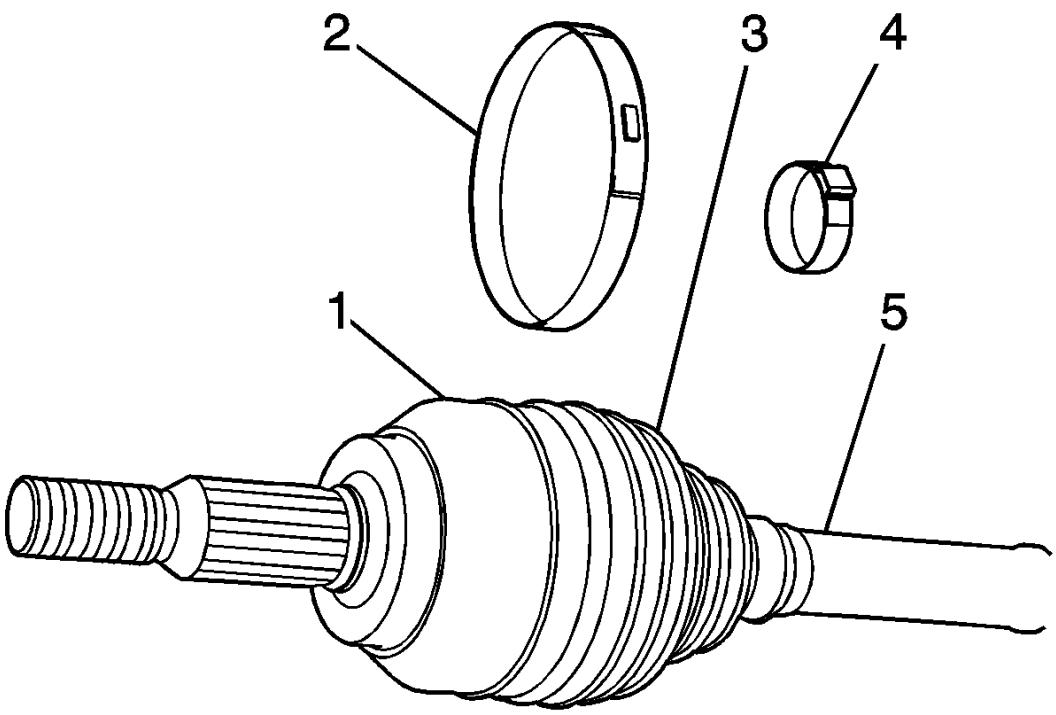


Fig. 34: Identifying Boot Clamps
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not cut through the wheel drive shaft inboard or outboard boot during service. Cutting through the boot may damage the sealing surface of the housing and the tripot or the constant velocity joint bushing. Damage to the sealing surface may lead to water and dirt intrusion and premature wear of the constant velocity joint.

3. Using a flat-bladed tool, remove the boot clamp (2) from the constant velocity (CV) joint (1) and the boot (3).
4. Using a pair of side cutters, remove and discard the boot clamp (4) from the boot (3) and the wheel drive shaft (5). Replace with NEW clamps.

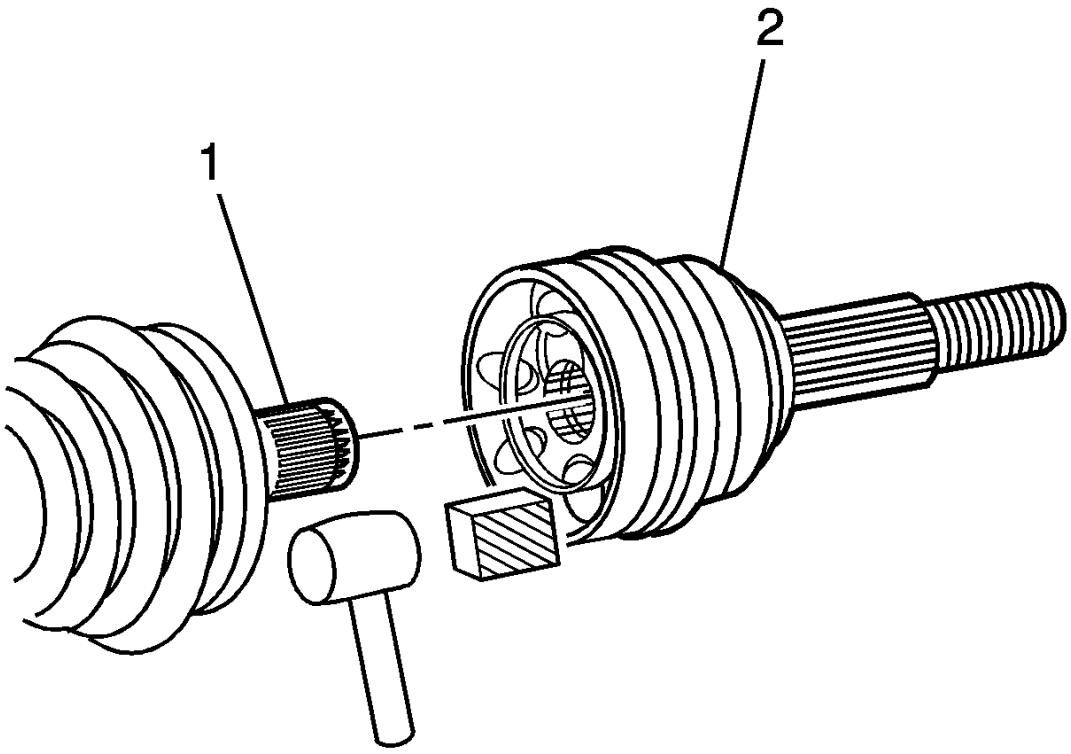


Fig. 35: Separating CV Joint From Axle Shaft
Courtesy of GENERAL MOTORS COMPANY

5. Using a block of wood and a hammer, remove the CV joint (2) from the wheel drive shaft (1).

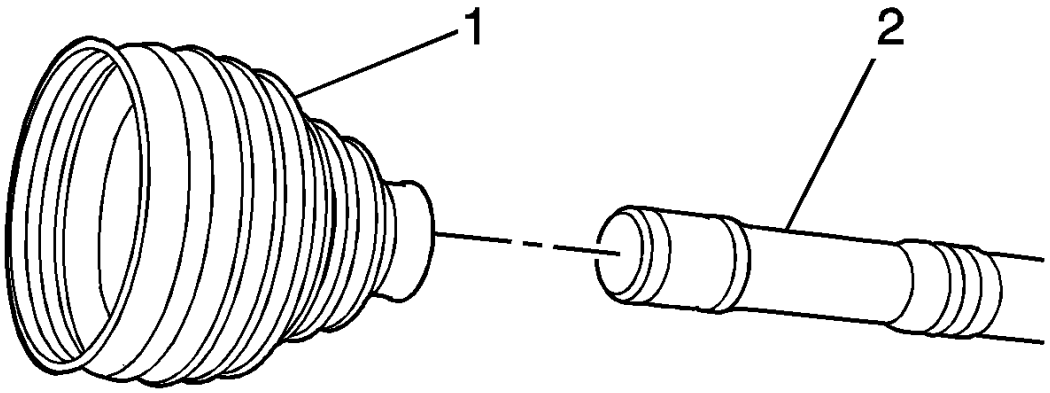


Fig. 36: Identifying Clamp & Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

6. Remove the boot (1) from the wheel drive shaft (2).

Assemble Procedure

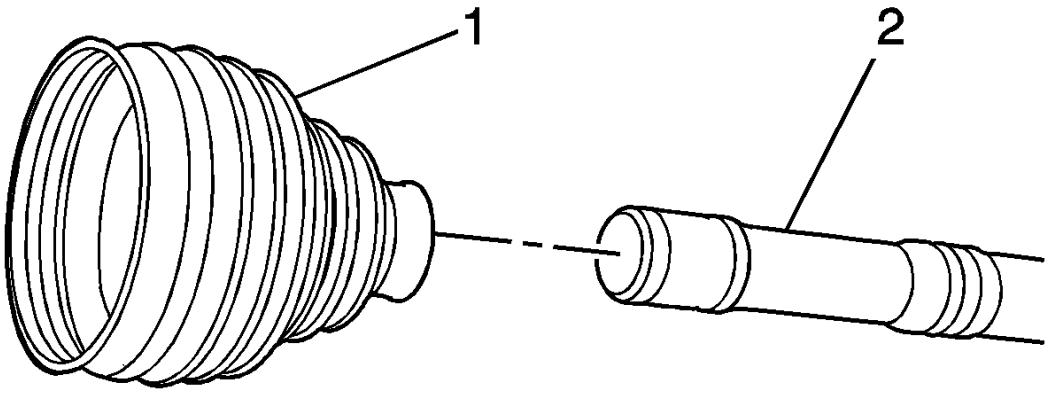


Fig. 37: Identifying Clamp & Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

1. Position the boot (1) on the wheel drive shaft (2).

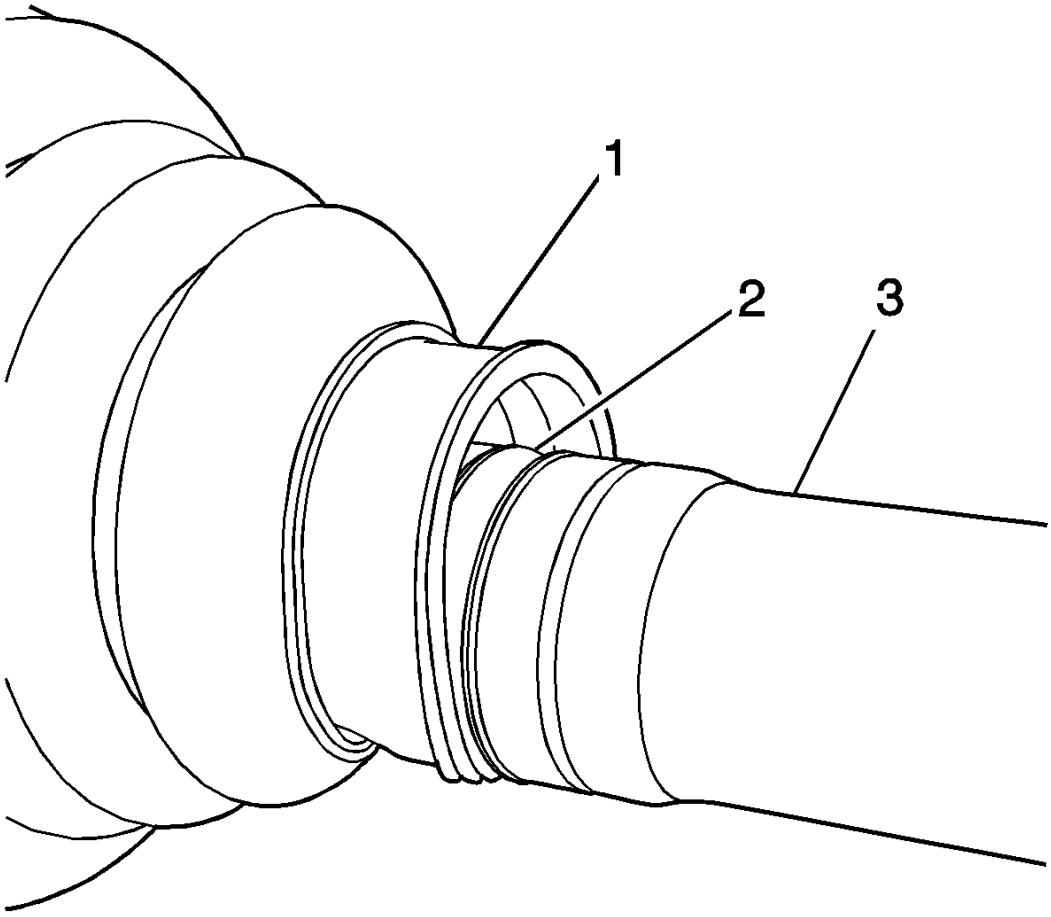


Fig. 38: Identifying Groove In Wheel Drive Shaft
Courtesy of GENERAL MOTORS COMPANY

2. Ensure that the boot (1) is properly seated in the groove (2) in the wheel drive shaft (3).

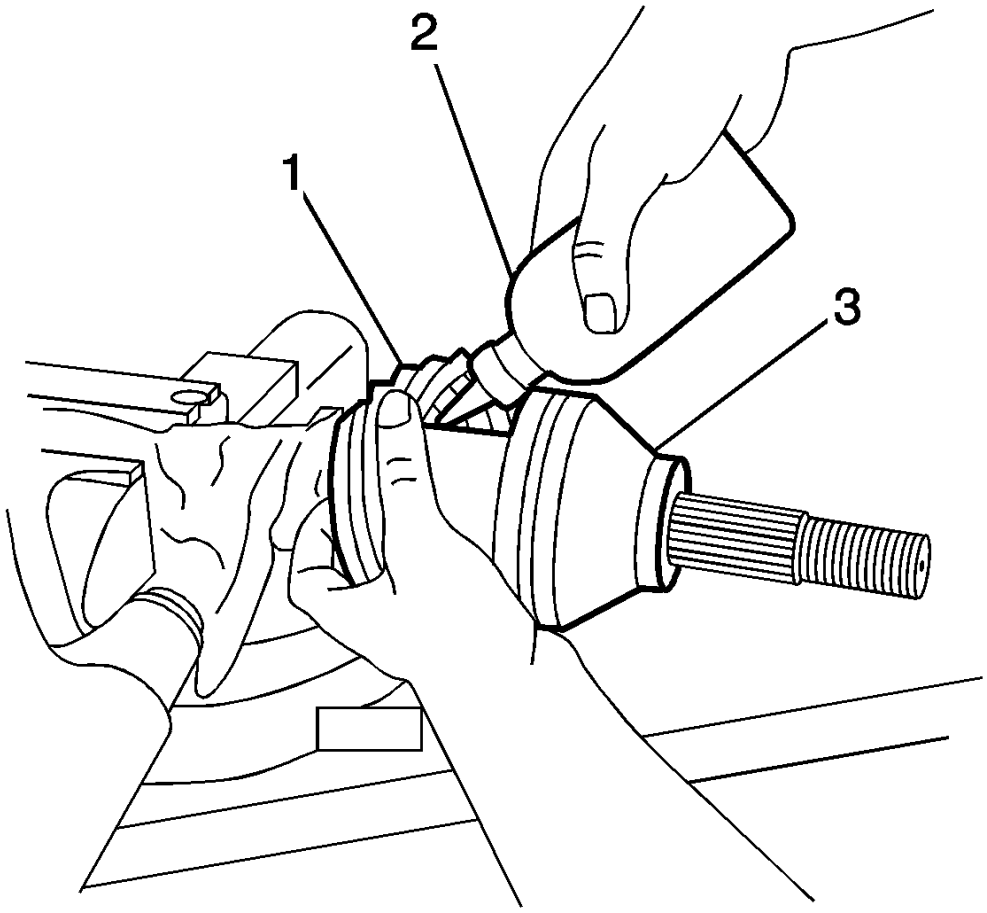


Fig. 39: Lubricating Boot Of Tripot Housing
Courtesy of GENERAL MOTORS COMPANY

3. Place approximately half the lubricant (2) inside the CV joint boot (1) and the other half in the CV joint (3).

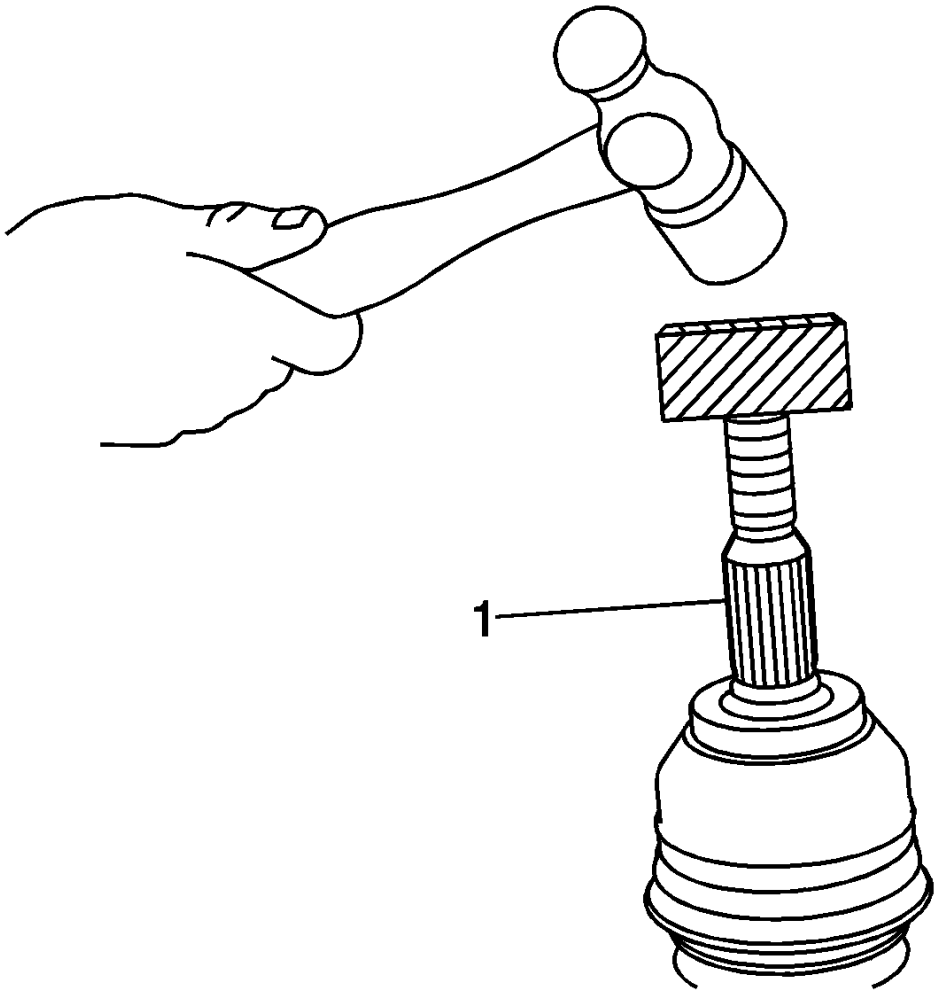


Fig. 40: Installing CV Joint
Courtesy of GENERAL MOTORS COMPANY

4. Using a block of wood and a hammer, install the CV joint on the wheel drive shaft (1).

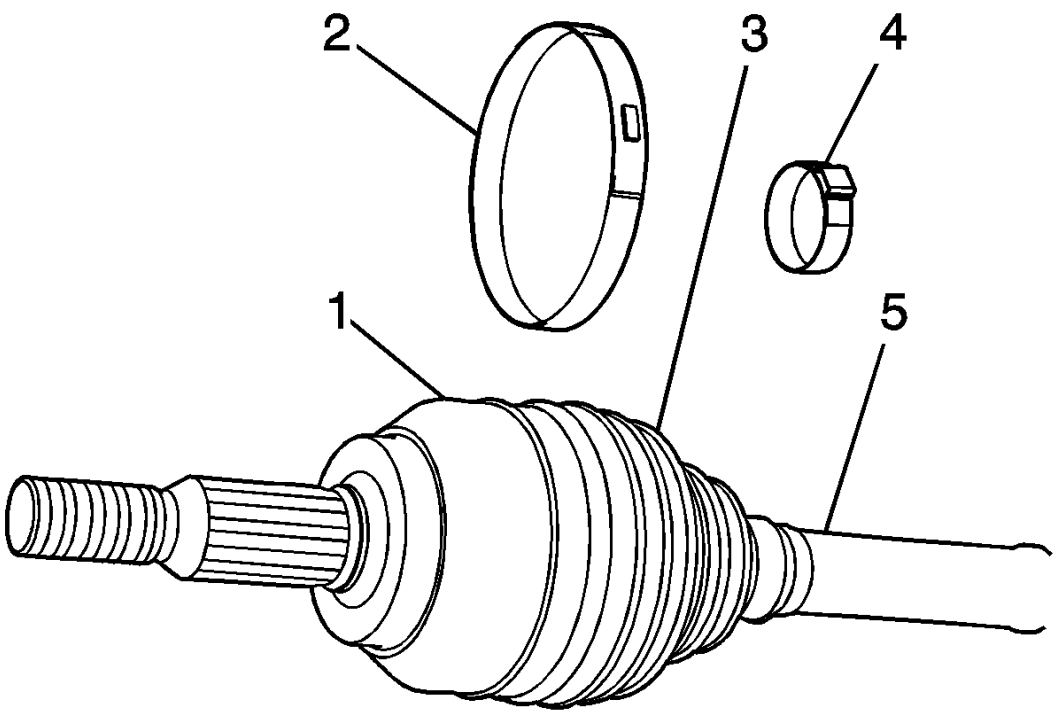


Fig. 41: Identifying Boot Clamps
Courtesy of GENERAL MOTORS COMPANY

5. Install the inboard boot clamp (4) on the boot (3) and the wheel drive shaft (5).
6. Install the outboard boot clamp (2) on the boot (3) and the CV joint housing (1).

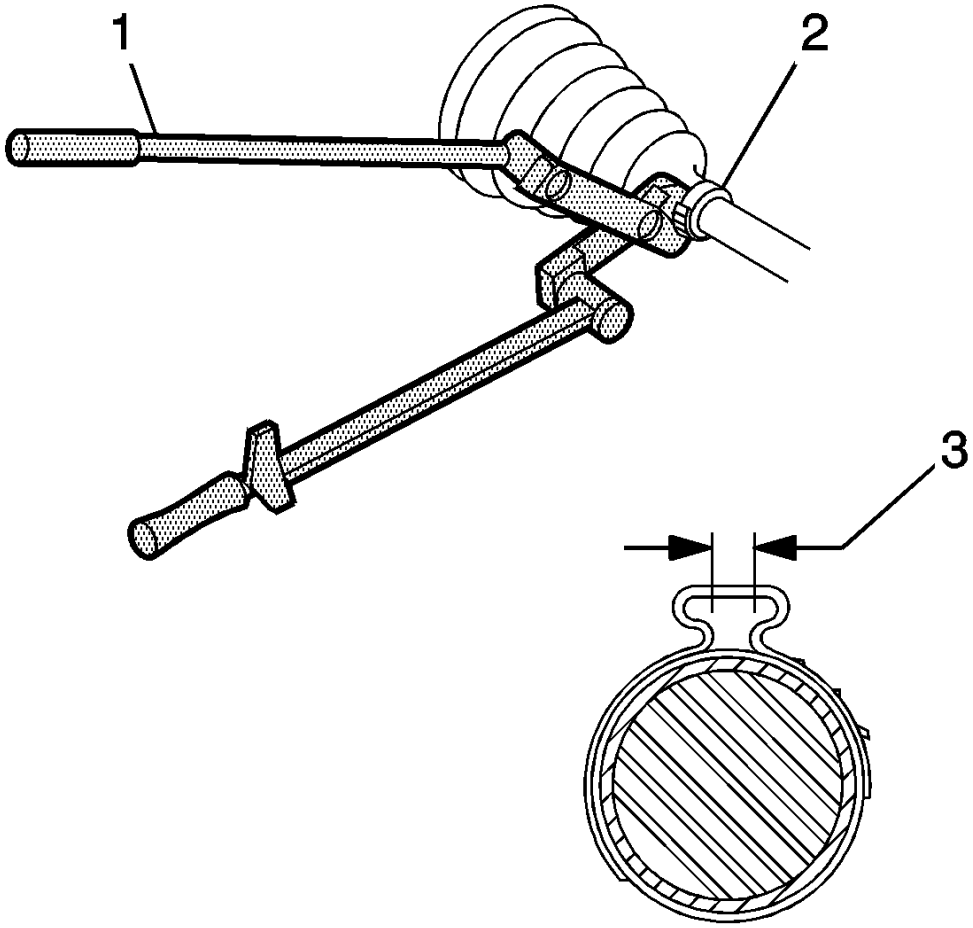


Fig. 42: Identifying Pliers Breaker Bar, Torque Wrench, Ratchet & Gap Measurement
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the boot clamp is properly positioned around the entire circumference of the boot.**

7. Using the **DT 35910** pliers (1), close the clamp (2) until the gap (3) measures 2.15 mm (0.85 in).

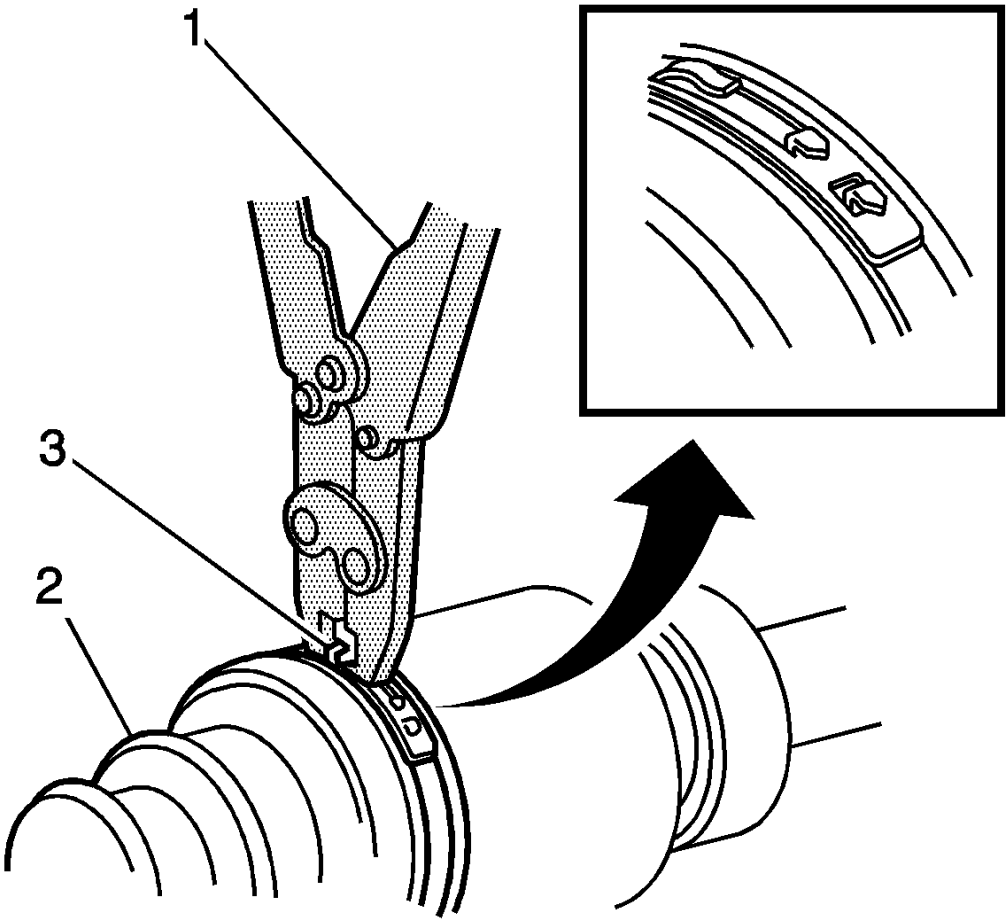


Fig. 43: Latching Large Seal Retaining Clamp
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Ensure that the boot clamp is properly positioned around the entire circumference of the boot.**

8. Using the **CH 48894** pliers (1), close the boot clamp (3).
9. Remove the wheel drive shaft from the bench vise.
10. Move the CV joint in a circular motion 4 to 5 times to distribute the lubricant.
11. Install the wheel drive shaft in the vehicle. Refer to **Wheel Drive Shaft Replacement (Left Side)Wheel Drive Shaft Replacement (Right Side)**.

WHEEL DRIVE SHAFT OUTER JOINT AND BOOT REPLACEMENT (WITH WL9)

Special Tools

- **DT-48267** Drive Axle Swage Ring Clamp
- **J-8059** Snap Ring Pliers
- **J-35910** Drive Axle Seal Clamp Pliers

For equivalent regional tools, refer to **Special Tools**.

Removal Procedure

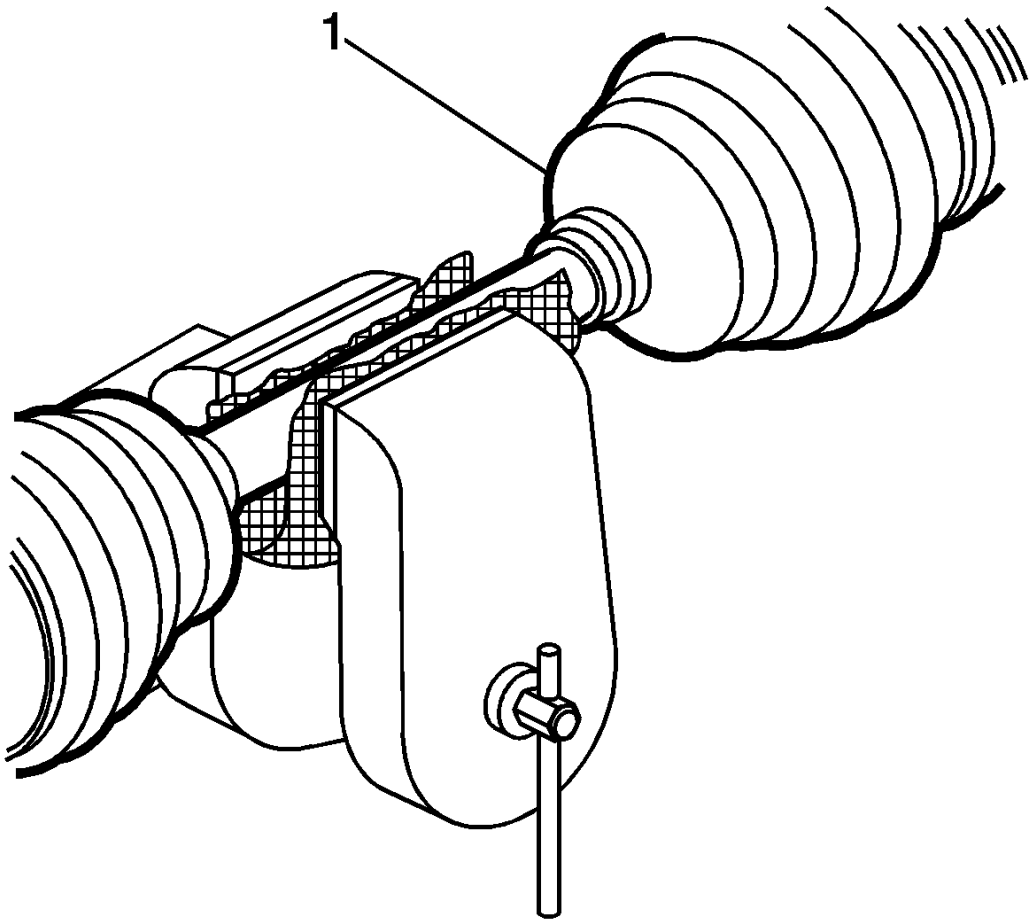


Fig. 44: View Of Front Wheel Drive Shaft Inner Joint
Courtesy of GENERAL MOTORS COMPANY

1. Clamp the wheel drive shaft (1) in a soft jawed vice.

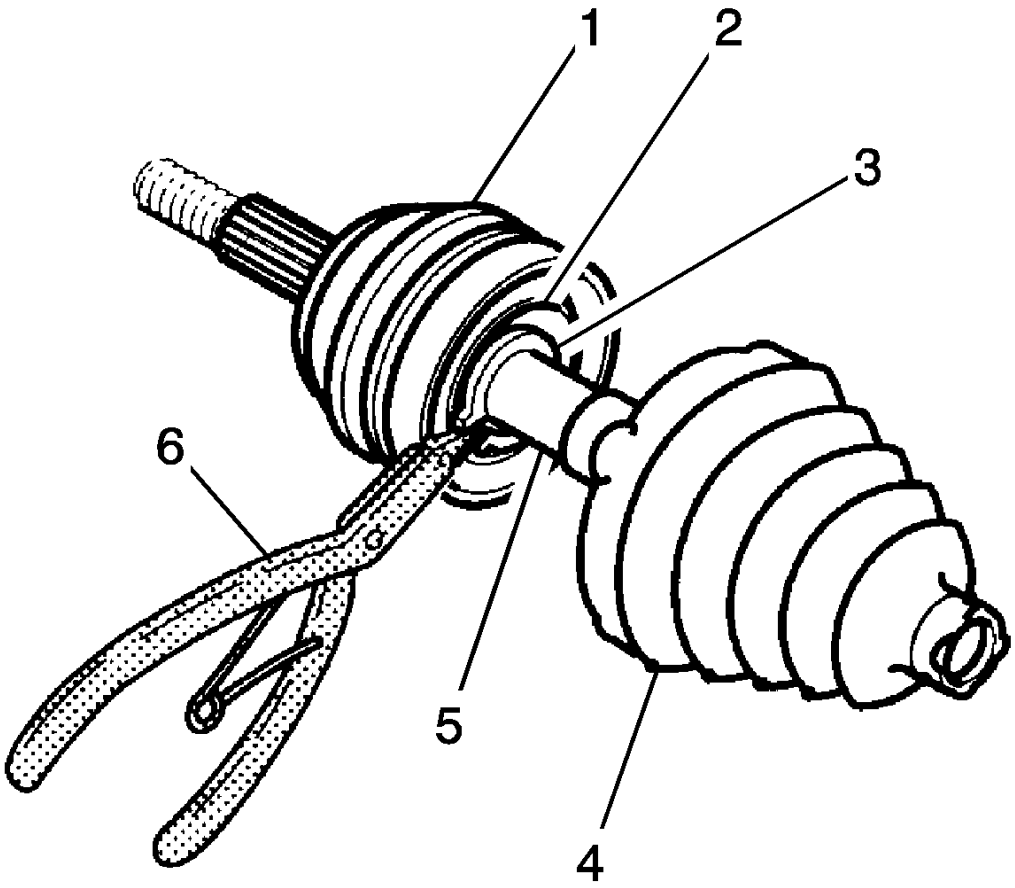


Fig. 45: Identifying CV Joint Components
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Do not cut through the wheel drive shaft inboard or outboard boot during service. Cutting through the boot may damage the sealing surface of the housing and the tripot or the constant velocity joint bushing. Damage to the sealing surface may lead to water and dirt intrusion and premature wear of the constant velocity joint.

2. Remove the large seal retaining clamp from the CV joint with a side cutter. Discard the seal retaining clamp.

   Use a hand grinder to cut through the swage ring in order to remove the swage ring.

3. Remove the small eared clamp with a side cutter. Discard the eared clamp.
4. Separate the wheel drive shaft outboard seal from CV joint outer race (1) at large diameter.
5. Slide the seal (4) away from joint along wheel drive shaft (5).
6. Wipe the grease from the face of the CV joint inner race (3).
7. Spread the ears on the race retaining ring (2) using **J 8059** pliers (6).

8. Remove the CV joint assembly (1) from the wheel drive shaft (5).
9. Remove the wheel drive shaft outboard seal (4) from the wheel drive shaft (5).
10. Discard the old outboard seal (4).

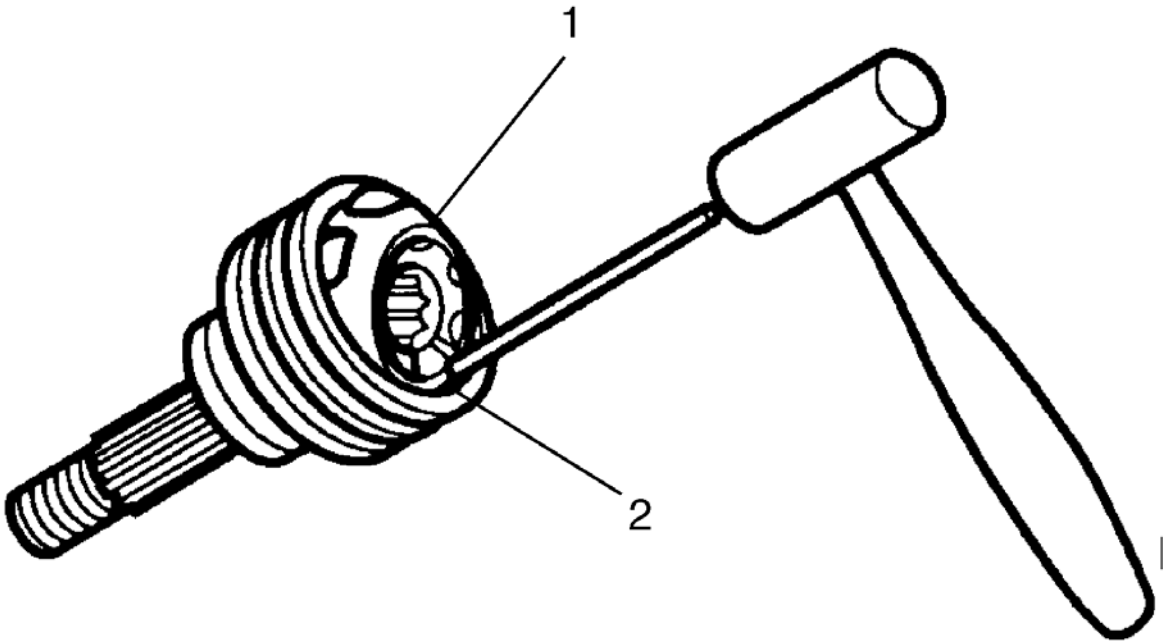


Fig. 46: Tapping Gently On Brass Drift With A Hammer In Order To Tilt Cage
Courtesy of GENERAL MOTORS COMPANY

11. Place a brass drift against the CV joint cage (1).
12. Tap gently on the brass drift with a hammer in order to tilt the cage (1).
13. Remove the first chrome alloy ball (2) when the CV joint cage (1) tilts.
14. Tilt the CV joint cage (1) in the opposite direction to remove the opposing chrome alloy ball (2).
15. Repeat this process to remove all 6 of the balls.

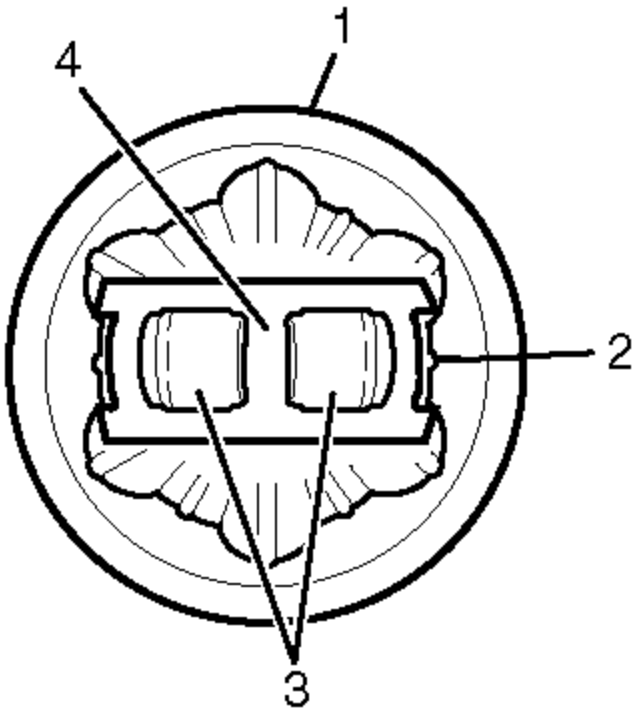


Fig. 47: View Of Outer Race, Inner Race, Cage Window & CV Joint Cage
Courtesy of GENERAL MOTORS COMPANY

16. Pivot the CV joint cage (4) and the inner race 90 degrees to the center line of the outer race (2). At the same time, align the cage windows (3) with the lands of the outer race.
17. Lift out the cage (4) and the inner race.

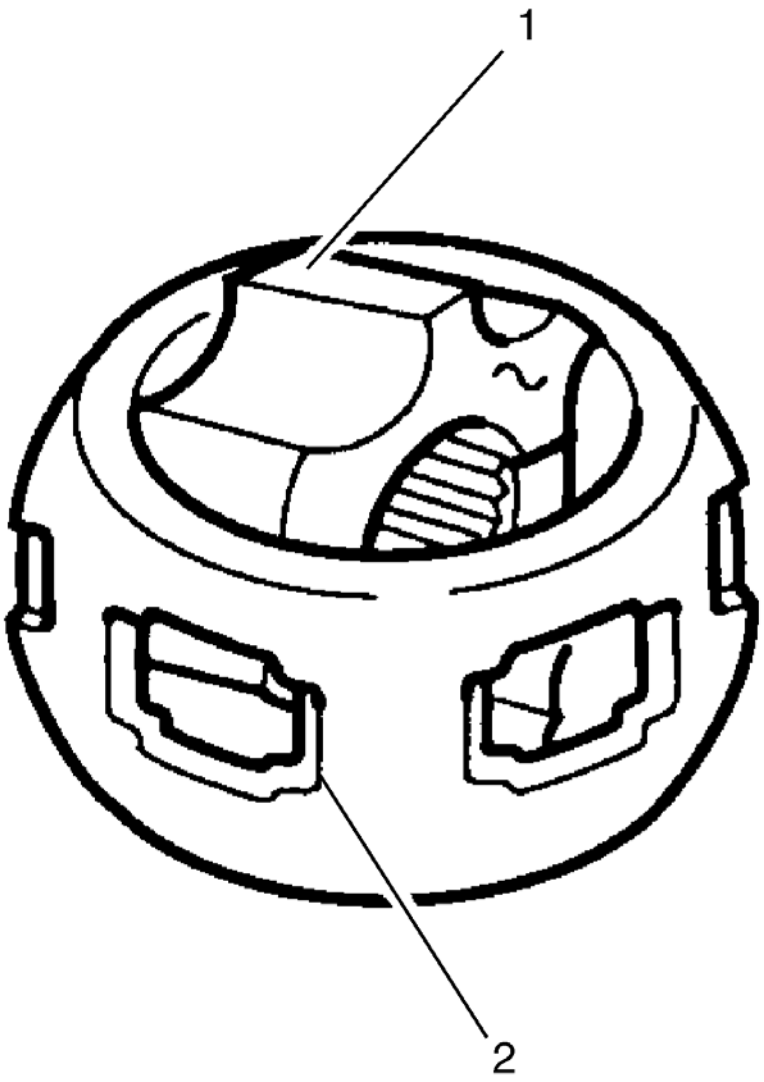


Fig. 48: View Of Inner Race & Cage
Courtesy of GENERAL MOTORS COMPANY

18. Remove the inner race (1) from the cage (2) by rotating the inner race (1) upward.

NOTE: **Remove all traces of old grease and any contaminates**

19. Clean the following items thoroughly with cleaning solvent.
    - The inner and outer race assemblies
    - The CV joint cage
    - The chrome alloy balls
20. Dry all the parts.
21. Check the CV joint assembly for the following items:
    - Unusual wear
    - Cracks

- Damage

22. Replace any damaged parts.
23. Using a wire brush, remove any rust in the seal mounting area (grooves) in the wheel drive shaft.

Installation Procedure

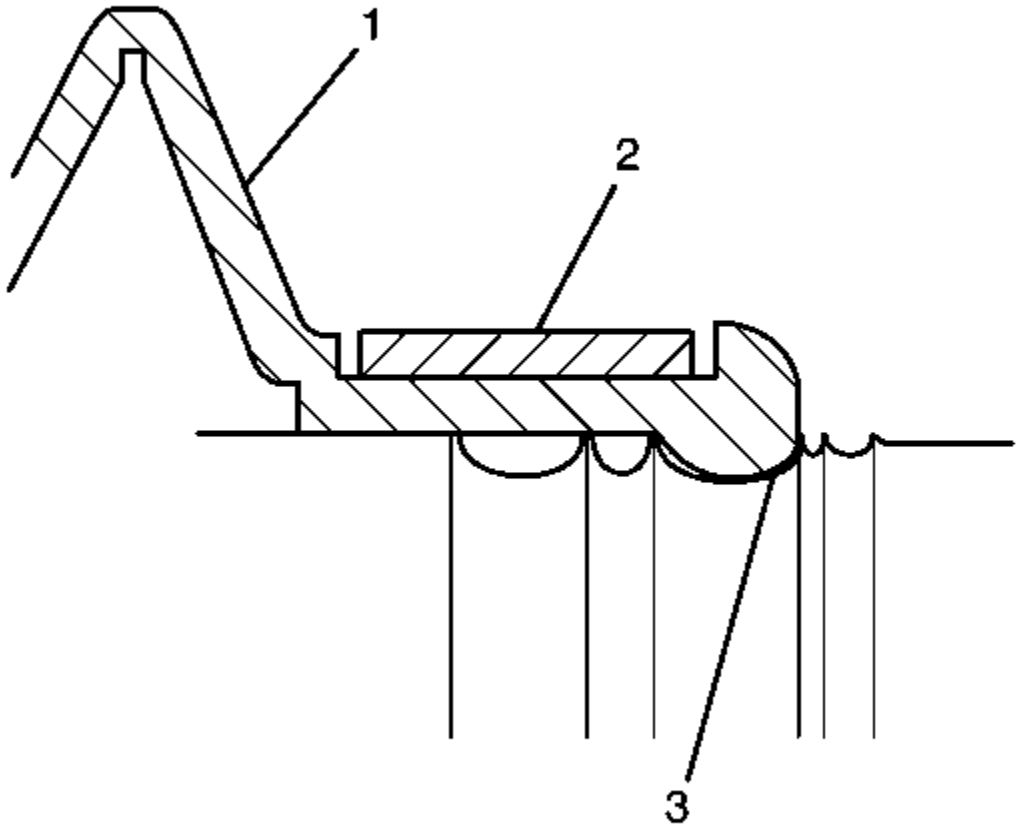


Fig. 49: View Of Outboard Seal, Seal Groove & Eared Clamp
Courtesy of GENERAL MOTORS COMPANY

NOTE: **For eared clamp, place a towel in the vise before inserting the wheel drive shaft.**

1. For eared clamp installation, mount the wheel drive shaft into a vise.

NOTE: **Do not swage or crimp.**

2. Install the new swage ring or eared clamp (2) on the neck of the outboard seal (1).

3. Slide the outboard seal (1) onto the wheel drive shaft and position the neck of the outboard seal (1) in the seal groove on the wheel drive shaft. The largest groove below the sight groove on the wheel drive shaft is the seal groove (3).

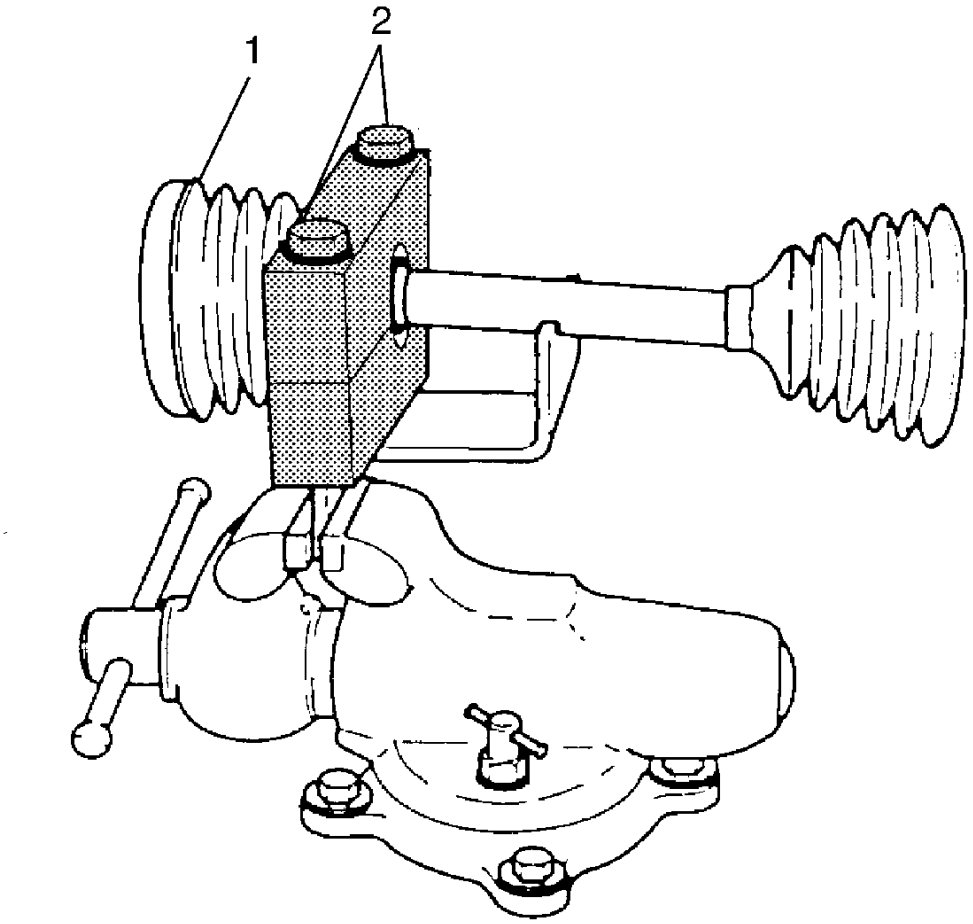


Fig. 50: Swaging Retaining Clamp Ring
Courtesy of GENERAL MOTORS COMPANY

NOTE: **For eared clamp installation, proceed to step 7.**

4. For swage ring installation use **DT-48267** clamp in the following way:
    1. Position the outboard end of the wheel drive shaft assembly (1) in **DT-48267** clamp.
    2. Align the swage ring.
    3. Place the top half of **DT-48267** clamp.

NOTE: **Align the following items during this procedure:**

- **The outboard seal (1)**
- **The wheel drive shaft**
- **The swage ring**

4. Install the bolts (2) and tighten by hand.

NOTE: **Alternate between each bolt until both sides are bottomed.**

5. Using the proper size socket and ratchet wrench, tighten the bolts (2) 180 degrees until bottom.

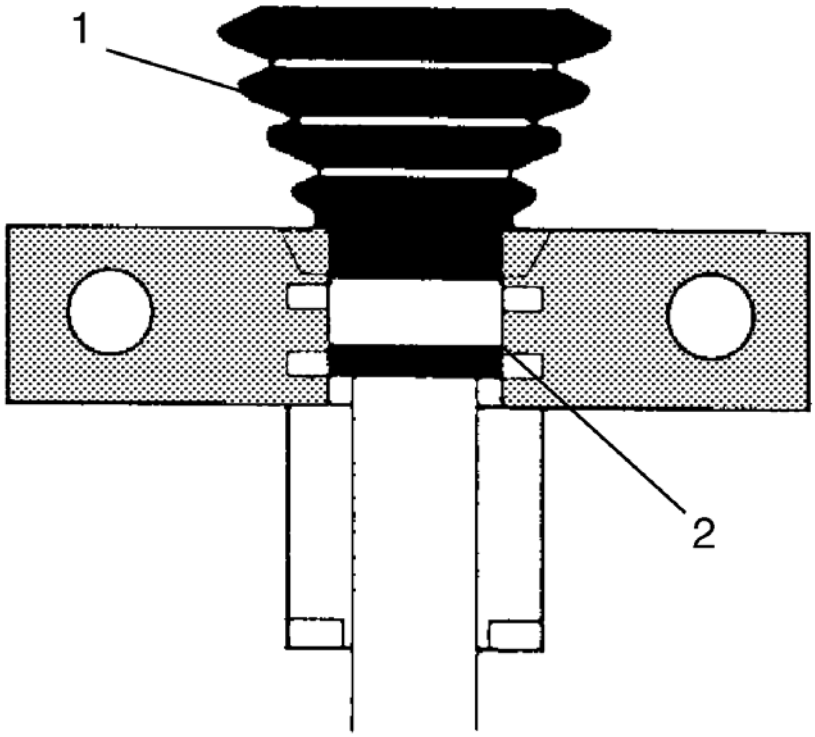


Fig. 51: Identifying Halfshaft Inboard Seal & Swage Ring
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the bolts and separate the dies.
6. Check swaged ring (2) for any lip deformities. If present, place the ring (2) back into the **DT-48267** clamp making sure the ring covers the whole swaging area. If necessary, re-swage the ring.

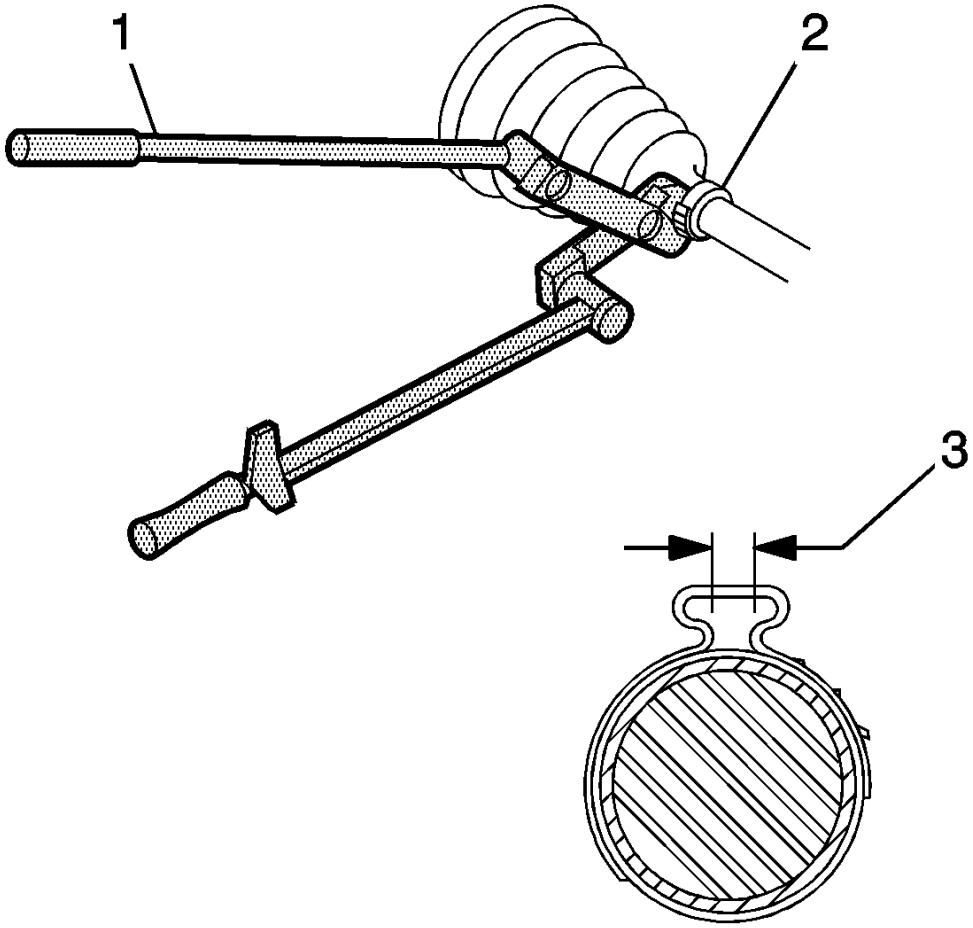


Fig. 52: Identifying Pliers Breaker Bar, Torque Wrench, Ratchet & Gap Measurement
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

7. Crimp the eared clamp (1) using the **J 35910** pliers , a breaker bar, and a torque wrench.

   Tighten

   Tighten the eared clamp to 136 N.m (100 lb ft).

8. Check the gap dimension, continue tightening until the gap dimension is reached.

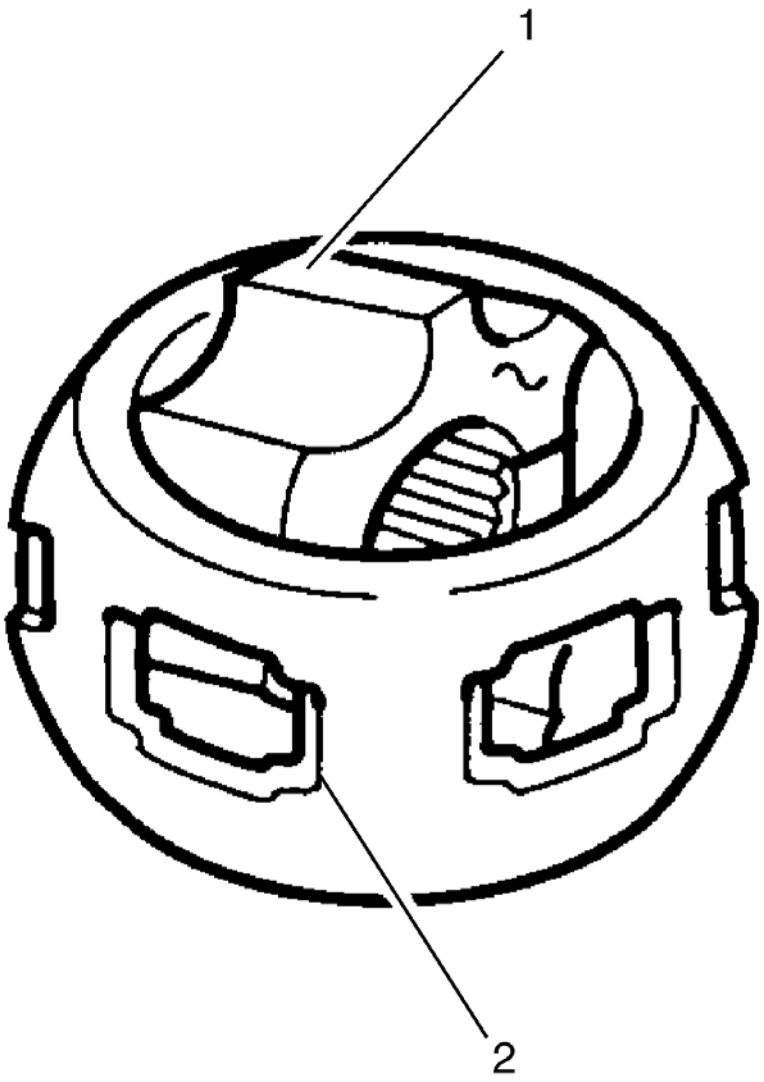


Fig. 53: View Of Inner Race & Cage
Courtesy of GENERAL MOTORS COMPANY

9. Put a light coat of grease from the service kit on the ball grooves of the inner race and the outer race.
10. Hold the inner race 90 degrees to centerline of cage with the lands of the inner race (1) aligned with the windows of the cage (2) and insert the inner race into the cage.

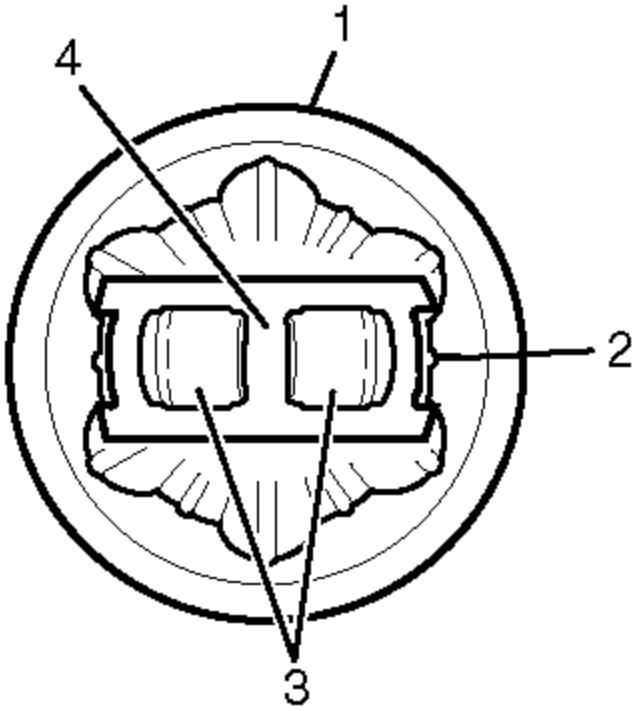


Fig. 54: View Of Outer Race, Inner Race, Cage Window & CV Joint Cage
Courtesy of GENERAL MOTORS COMPANY

11. Hold the cage and the inner race 90 degrees to centerline of the outer race (1) and align the cage windows (3) with the lands of the outer race.

NOTE: **Be sure that the retaining ring side of the inner race faces the wheel drive shaft.**

12. Place the cage and the inner race into the outer race.
13. Insert the first chrome ball then tilt the cage in the opposite direction to insert the opposing ball.
14. Repeat this process until all 6 balls are in place.
15. Place approximately half the grease from the service kit inside the outboard seal and pack the CV joint with the remaining grease.

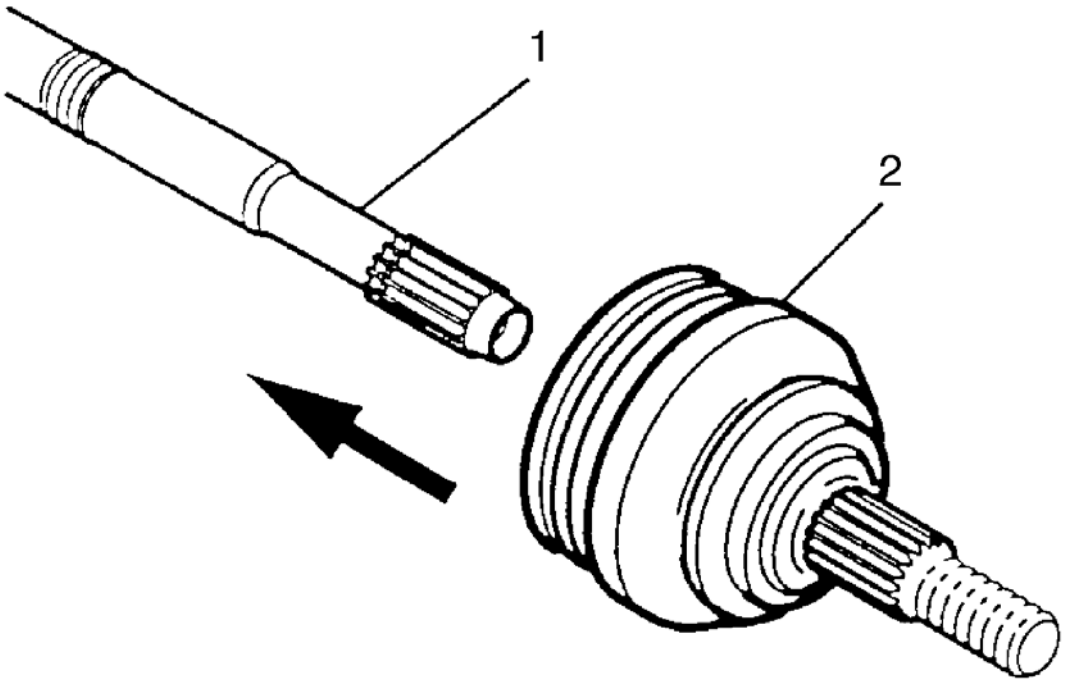


Fig. 55: Pushing CV Joint Onto Halfshaft
Courtesy of GENERAL MOTORS COMPANY

16. Push the CV joint (2) onto the wheel drive shaft (1) until the retaining ring is seated in the groove on the wheel drive shaft (1).

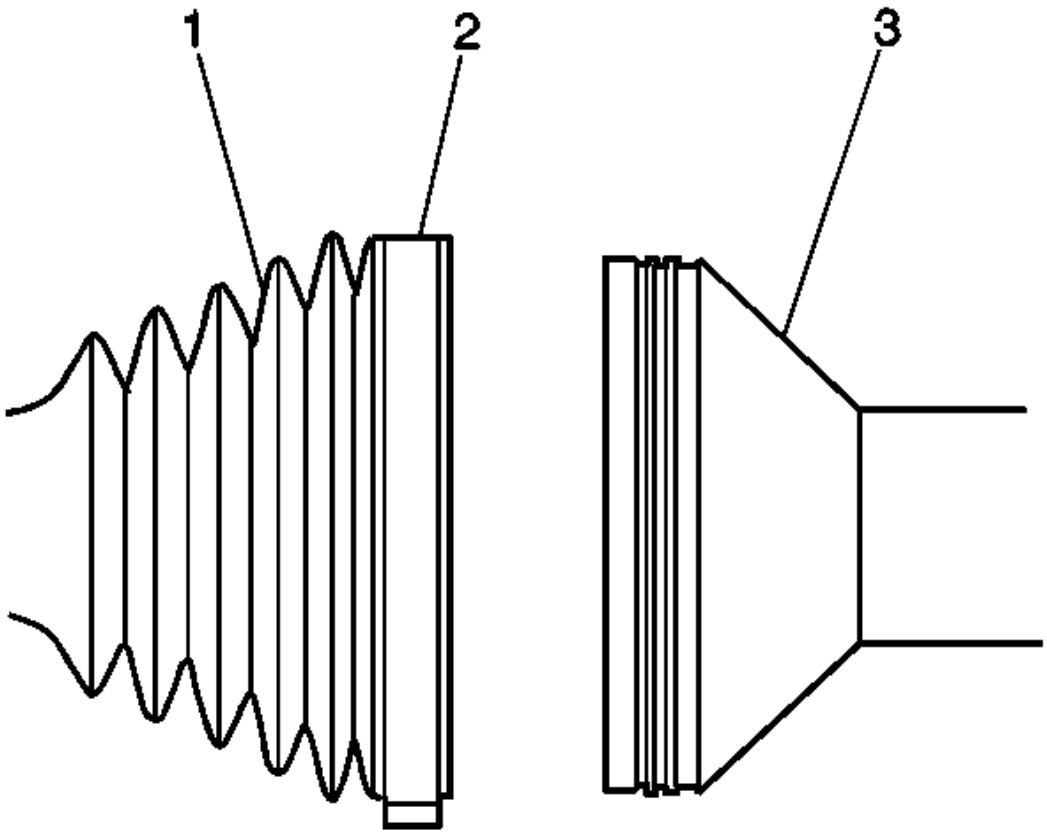


Fig. 56: View Of Boot And Large Seal Retaining Clamp
Courtesy of GENERAL MOTORS COMPANY

NOTE: **The outboard seal (1) must not be dimpled, stretched or out of shape in any way. If the outboard seal (1) is not shaped correctly, equalize the pressure in the outboard seal (1) and shape the seal properly by hand.**

17. Slide large diameter of the outboard seal (1) with the large seal retaining clamp (2) in place over the outside of the CV joint outer race (3) and locate the seal lip in the groove on the CV joint outer race.

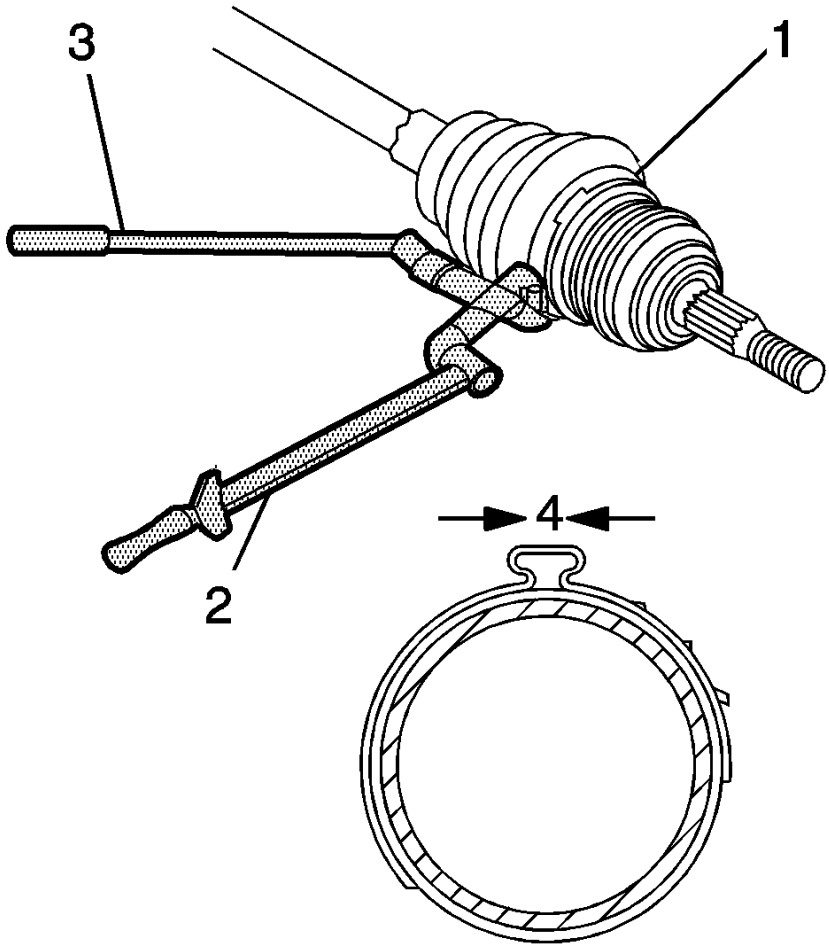


Fig. 57: Crimping Seal Retaining Clamp
Courtesy of GENERAL MOTORS COMPANY

18. Using the **J 35910** pliers (3) and the torque wrench (2), tighten the seal retaining clamp (1) to 176 N.m (130 lb ft).
19. Check the gap dimension (4) on the clamp ear. Continue tightening until the gap dimension is reached. Dimension 1.9 mm (5/64 in).

WHEEL DRIVE SHAFT OUTER JOINT INSPECTION

Special Tools

J 8059 Snap Ring Pliers

Disassembly Procedure

1. Remove the outer constant velocity (CV) joint and boot from the wheel drive shaft. Refer to **Wheel Drive Shaft Replacement (Left Side)Wheel Drive Shaft Replacement (Right Side)**.
2. Remove any grease from the CV joint.

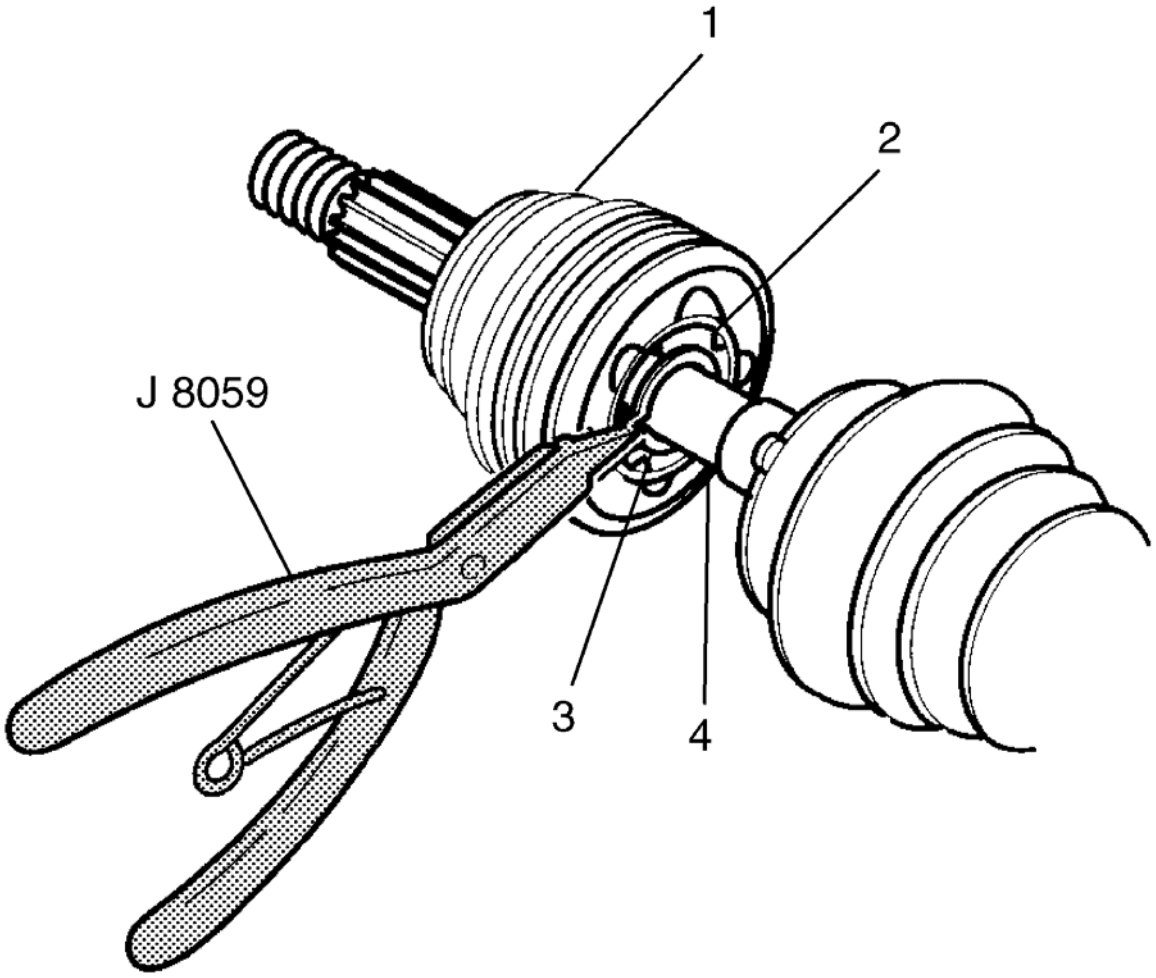


Fig. 58: Snap Ring Pliers
Courtesy of GENERAL MOTORS COMPANY

3. Using the **J 8059** snap ring pliers , remove the retaining ring (3) from the wheel drive shaft (4).

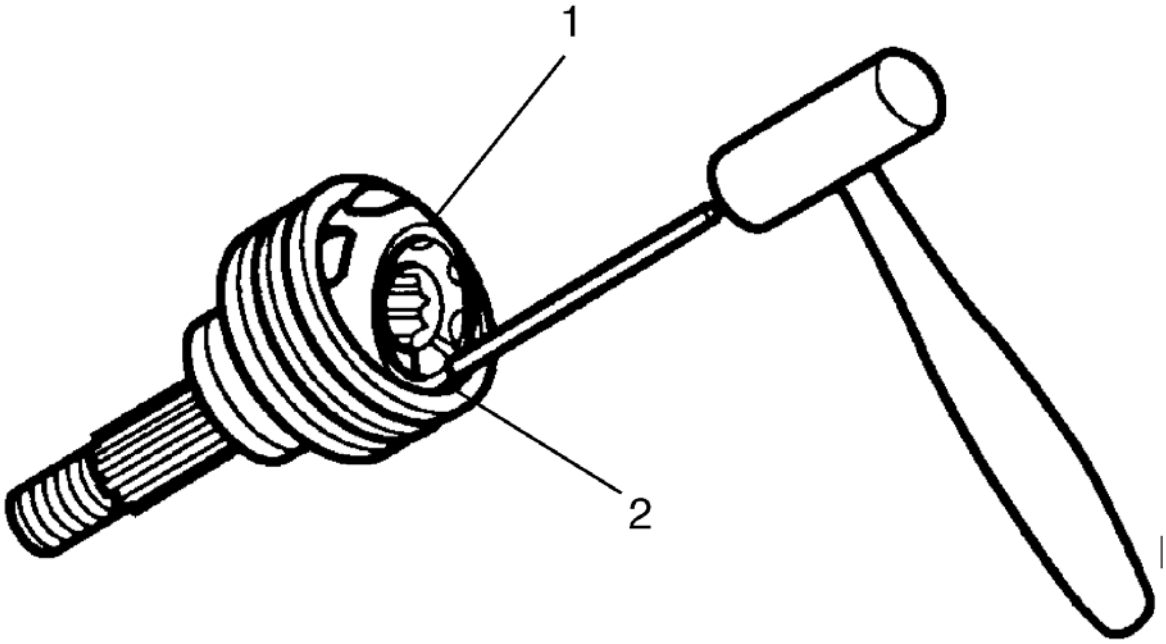


Fig. 59: Tapping Gently On Brass Drift With A Hammer In Order To Tilt Cage
Courtesy of GENERAL MOTORS COMPANY

4. Install the outer CV joint assembly in a vise.

IMPORTANT: The following procedure will have to be repeated until all the ball bearing are removed form the cage.

5. Using a brass drift (1), gentle tap the cage until the ball bearing can be removed from the cage.

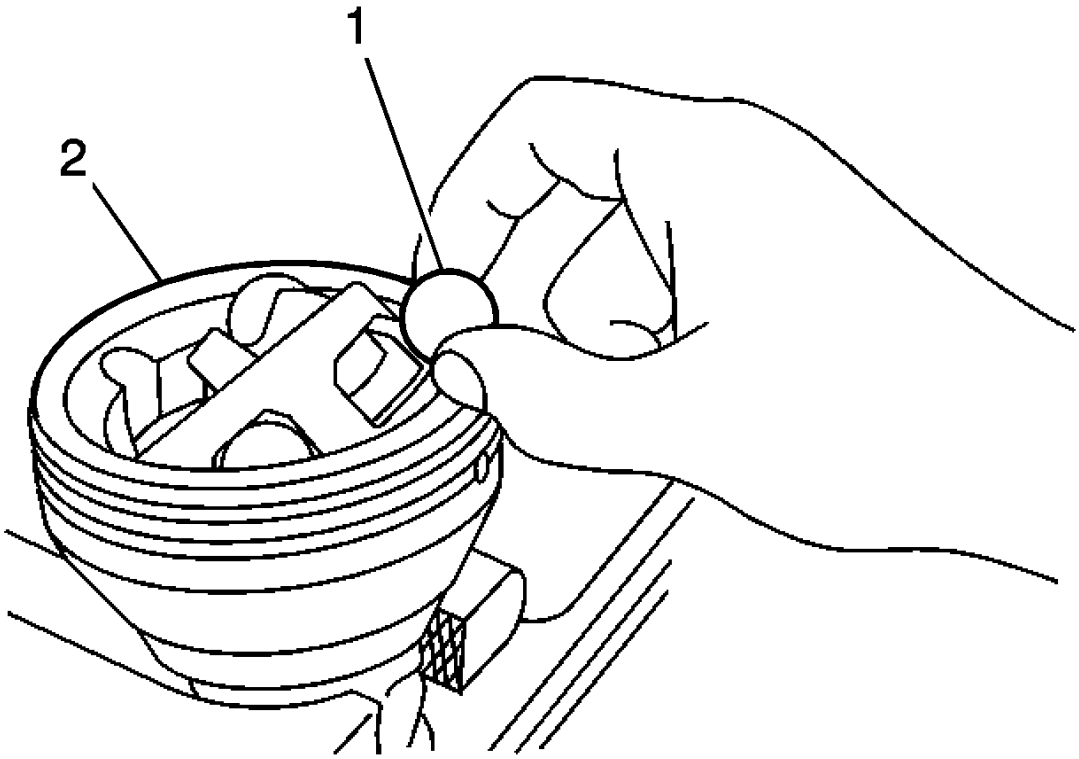


Fig. 60: Removing/Install Ball From Cage & Inner Race
Courtesy of GENERAL MOTORS COMPANY

6. Using a small screwdriver, remove the ball bearings from the CV joint.
7. Position the CV joint housing (2) so they are level.

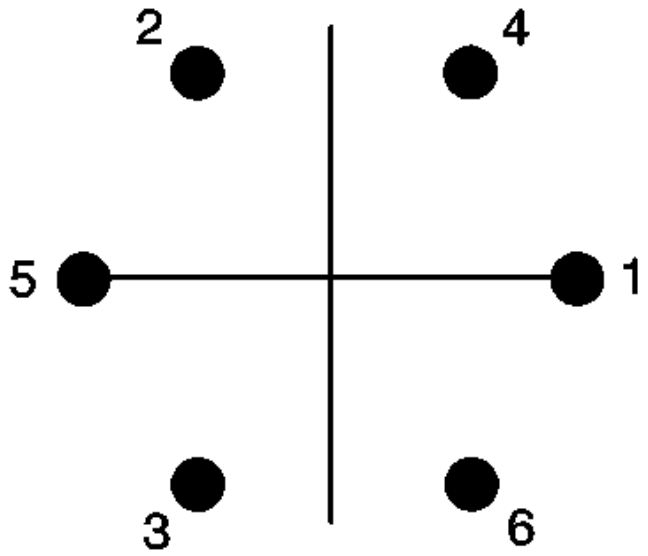


Fig. 61: View Of Ball Removal/Installation Sequence
Courtesy of GENERAL MOTORS COMPANY

8. Remove the ball bearings from the CV joint in sequence.

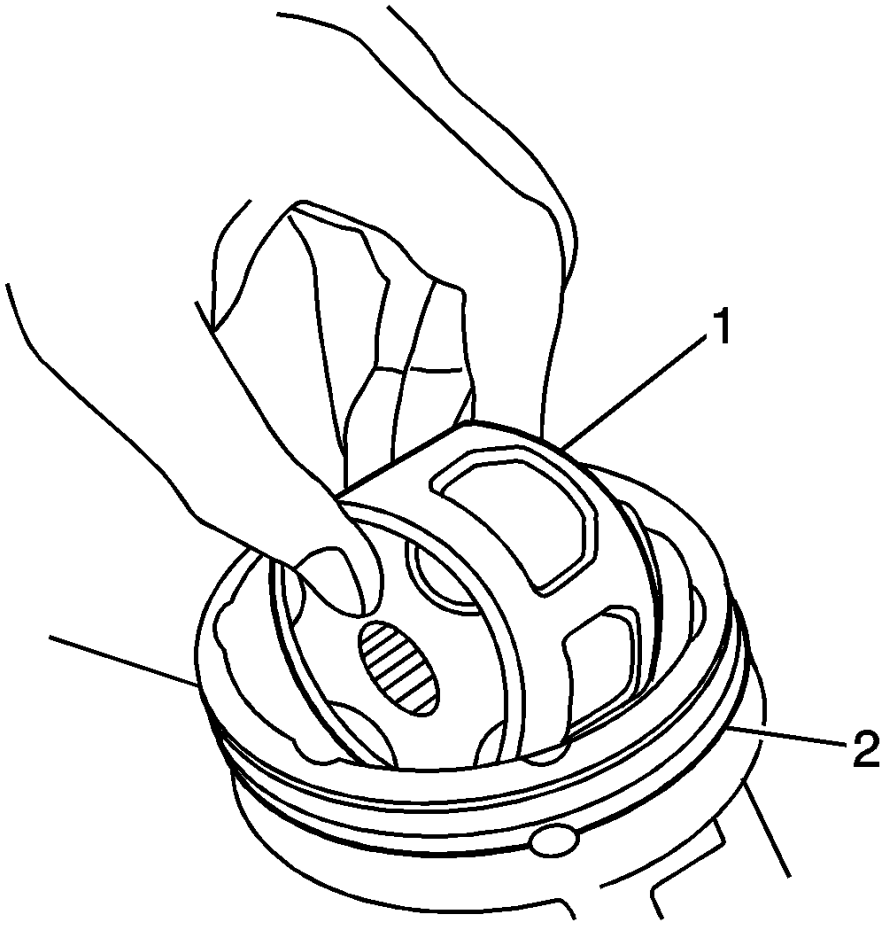


Fig. 62: Positioning Cage & Inner Race 90 Degrees To Centerline Of Outer Race
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: Position the cage so that the larger radius corners of the cage windows are facing up.

9. Position the cage (1) at 90 degrees to the centerline of the outer race.
10. Align the cage windows with the lands of the outer race.
11. Lift and remove the cage and the inner race from the outer race.

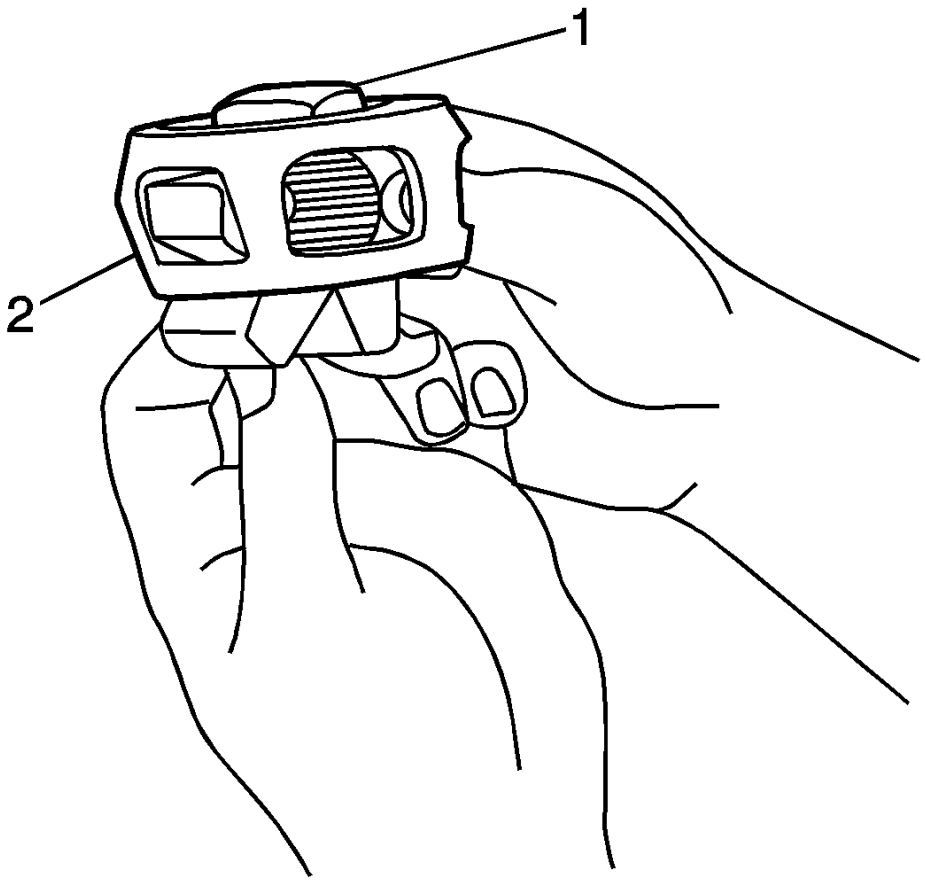


Fig. 63: Positioning Cage So Larger Radius Corners Of Cage Windows Are Up
Courtesy of GENERAL MOTORS COMPANY

12. Position the cage (2) and the inner race (1) so that the larger radius corners of the cage windows are up.
13. Rotate the inner race 90 degrees to the center line of the cage.
14. Align the lands of the inner race with the windows of the cage.
15. Move the inner race land into the cage window.
16. Rotate the inner race down and remove it from the cage.
17. Clean the following items thoroughly with the proper cleaning solvent:
    - The inner race
    - The outer race
    - The cage
    - The ball bearings
    - The exposed end of the wheel drive shaft

IMPORTANT: The internal parts of the CV joint are NOT SERVICED separately. The outer CV joint is serviced as an assembly.

18. If any of the above items are found to have excessive wear or are damaged, replace the outer CV joint as an assembly.

Assembly Procedure

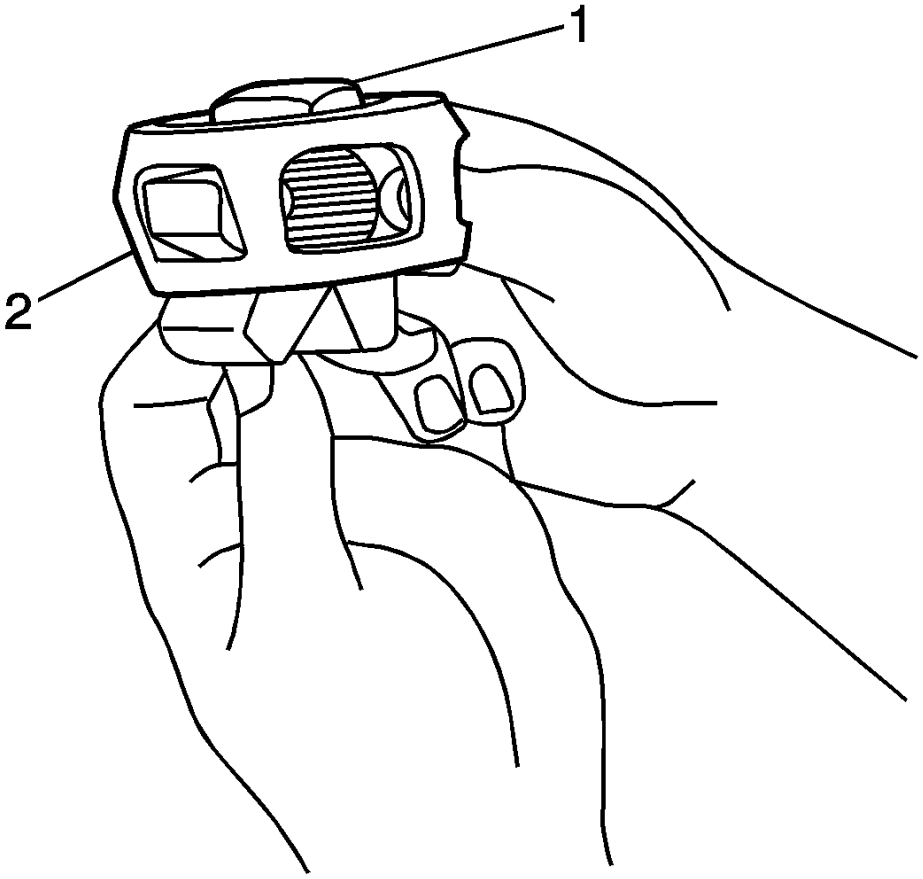


Fig. 64: Positioning Cage So Larger Radius Corners Of Cage Windows Are Up
Courtesy of GENERAL MOTORS COMPANY

1. Position the cage (2) so that the larger radius corners of the cage windows are up.
2. Position the inner race 90 degrees to the centerline of the cage.
3. Insert the inner race through the bottom of the cage.
4. Align the lands of the inner race with the windows of the cage.
5. Move the inner race land into the cage window.
6. Rotate the inner race down and remove it from the cage.
7. Rotate the inner race within the cage so that the grooved surface of the inner race is facing up.
8. Align the inner race ball bearing tracks with the cage windows.

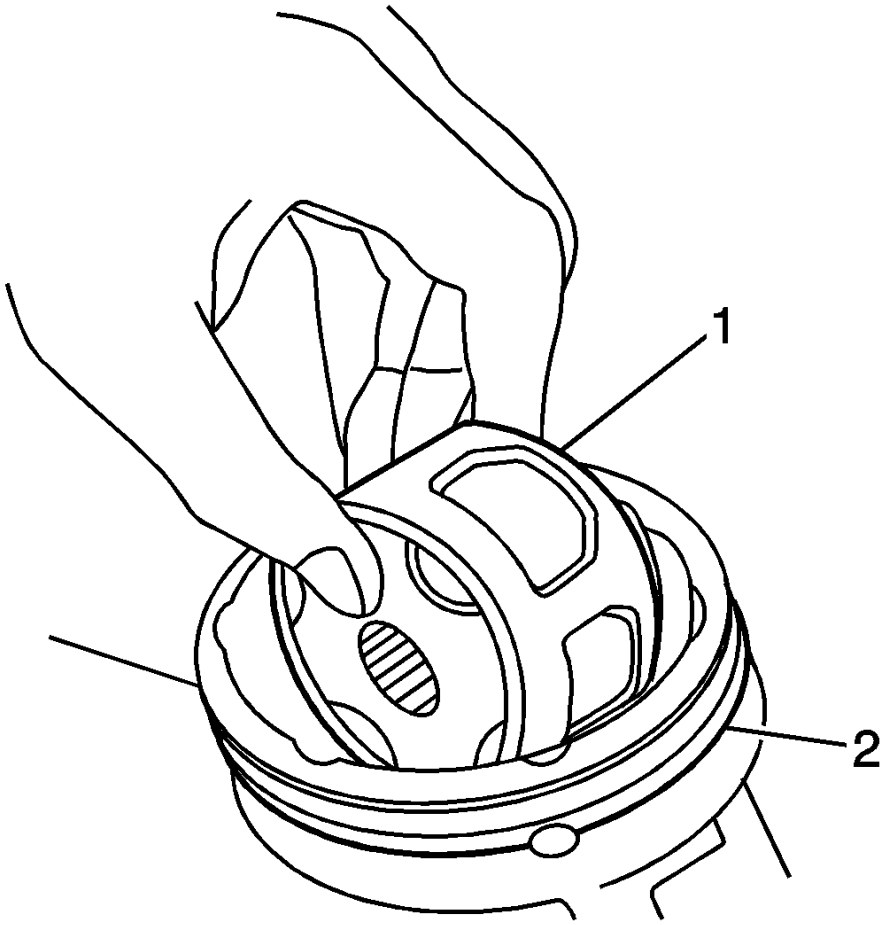


Fig. 65: Positioning Cage & Inner Race 90 Degrees To Centerline Of Outer Race
Courtesy of GENERAL MOTORS COMPANY

9. Wrap a clean shop towel around the CV joint outer race splined shaft.
10. Place the outer race vertically in a bench vise.
11. Position the cage (1) and the inner race at 90 degrees to the centerline of the outer race.
12. With the inner race and the cage assembly in a vertical position, insert the cage and the inner race into the outer race.

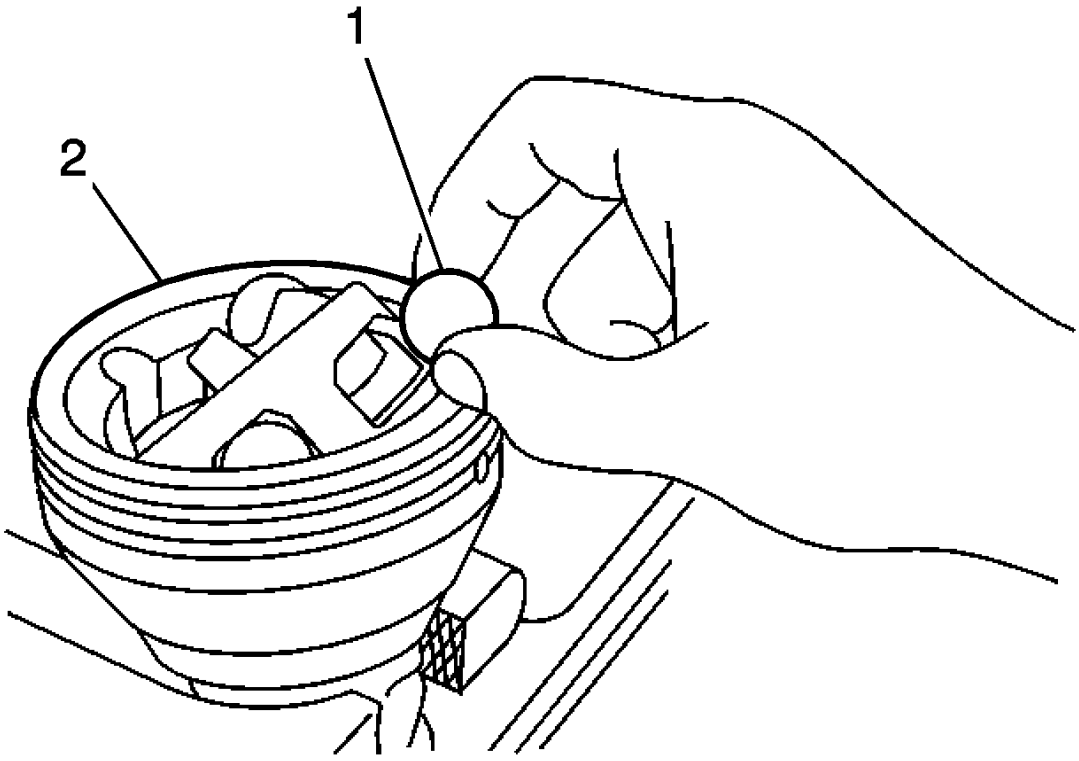


Fig. 66: Removing/Install Ball From Cage & Inner Race
Courtesy of GENERAL MOTORS COMPANY

IMPORTANT: The larger radius corners of the cage windows should be positioned up and the grooved surface of the inner race should be visible.

13. Position the housing (2) and the inner race so that they are level in the vise.
14. Rotate the appropriate components, and align the cage windows and the inner race ball bearing tracks with the outer race ball bearing (1) tracks.
15. Position a cage window and the inner race ball bearing track for the ball bearing installation.

IMPORTANT: When performing the following procedure, the opposing cage window and the inner ball bearing track will be accessible for the ball bearing installation.

16. Press down on the cage following one of the outer race ball bearing tracks.
17. Install the ball bearing through the cage window onto the inner race ball bearing track.

IMPORTANT: The following service procedure will have to be performed after each ball bearing has been installed.

18. After the first ball bearing has been installed, use a brass drift and a hammer and gently tap the cage in order to drive the cage and the inner race down completely in the outer race.

    IMPORTANT: After the ball bearing has been installed, there should be NO GAP between the ball bearing and the inner race.

19. Position the cage and the inner race so that they are level.
20. Using a plastic hammer, lightly tap the ball bearing into place.

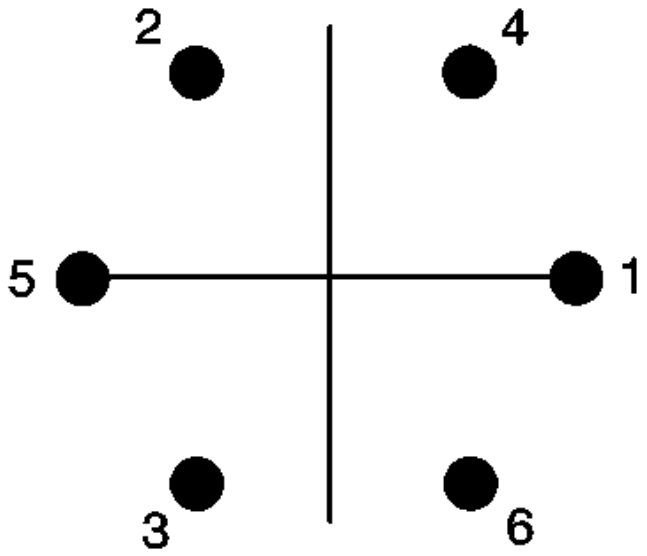


Fig. 67: View Of Ball Removal/Installation Sequence
Courtesy of GENERAL MOTORS COMPANY

21. Install the ball bearings in sequence.
22. Repeat steps 18-20 until all the ball bearings are installed.
23. If any of the internal parts are found to be defective, replace the outer joint. Refer to **Wheel Drive Shaft Outer Joint and Boot Replacement (Without WL9)Wheel Drive Shaft Outer Joint and Boot Replacement (With WL9)**.

WHEEL DRIVE SHAFT INNER JOINT INSPECTION

Inspection Procedure

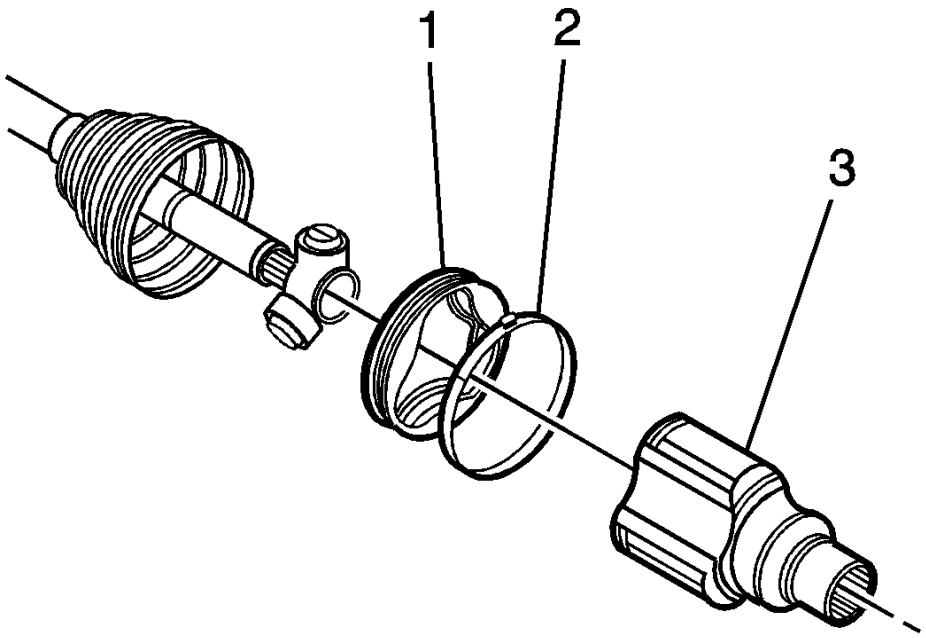


Fig. 68: Identifying Wheel Drive Shaft Inner Joint Inspection Areas
Courtesy of GENERAL MOTORS COMPANY

1. Remove the wheel drive boot clamp (2) from the tripod housing (3).
2. Remove the wheel drive shaft tripod housing (3) from the wheel drive shaft.
3. Remove the wheel drive shaft tripod joint boot bushing (1).
4. Using a suitable cleaner, remove the excess grease from the tripod assembly.
5. Inspect the following items for damage or excessive wear:
    - The wheel drive shaft tripod boot
    - The wheel drive shaft tripod assembly
    - The wheel drive shaft tripod joint housing
    - The wheel drive shaft tripod joint bushing
    - The wheel drive shaft
6. If any of the internal parts are found to be excessively worn or damaged, replace the wheel drive shaft

inner joint and boot. Refer to **Wheel Drive Shaft Inner Joint and Boot Replacement**.

DESCRIPTION AND OPERATION

WHEEL DRIVE SHAFTS DESCRIPTION AND OPERATION

Front wheel drive axles are flexible assemblies.

Front wheel drive axles consist of the following components:

- A front wheel drive shaft tri-pot joint (inner joint)
- A front wheel drive shaft constant velocity joint (outer joint)
- A front wheel drive shaft

  The front wheel drive shaft connects the front wheel drive shaft tri-pot joint and the front wheel drive shaft constant velocity joint.

The front wheel drive shaft tri-pot joint is completely flexible. The front wheel drive shaft tri-pot joint can move in and out.

The front wheel drive shaft constant velocity joint is flexible, but the front wheel drive shaft constant velocity joint cannot move in and out.

Boots (Seals) And Clamps

The front wheel drive shaft constant velocity joint and the front wheel drive shaft tri-pot joint boots (seals) in the front wheel drive axle are made of a thermoplastic material.

The clamps in front wheel drive axle are made of stainless steel.

The boot (seal) provides the following functions:

- Protection of the internal parts of the front wheel drive shaft constant velocity joint and the front wheel drive shaft tri-pot joint.

  The boot (seal) protects the grease from the following sources of damage:

  - Harmful atmospheric conditions (such as extreme temperatures or ozone gas)
  - Foreign material (such as dirt or water)
- Allows angular movement and the axial movement of the front wheel drive shaft tri-pot joint.
- Allows angular movement of the front wheel drive shaft constant velocity joint.

Protect the boots (seals) from sharp tools and from the sharp edges of the surrounding components.

IMPORTANT: Any damage to the boots (seals) or the clamps will result in leakage. Leakage will allow water to leak into the front wheel drive shaft tri-pot joint and the front wheel drive shaft constant velocity joints. Leakage will also allow grease to leak out of the front wheel drive shaft tri-pot joints and the front wheel drive shaft constant velocity joints.

Leakage may cause noisy front wheel drive axle operation and eventual failure of the internal components.

The clamps provide a leak proof connection for the front wheel drive shaft tri-pot joint and the front wheel drive shaft constant velocity joint at the following locations:

- The housing
- The front wheel drive shaft

The thermoplastic material performs well under normal conditions and normal operation. However, the material is not strong enough to withstand the following conditions:

- Abusive handling
- Damage from sharp objects (such as sharp tools or any sharp edges of the surrounding components in the vehicle).

Front Wheel Drive Shaft Tri-pot Joint (Inner Joint)

The front wheel drive shaft tri-pot joint is made with the tri-pot design without an over-extension limitation retainer.

The joint is constructed as follows for vehicles that are equipped with an automatic transmission:

- The left front wheel drive axle has a female spline. The female spline installs over a stub shaft that protrudes from the transaxle.
- The right front wheel drive axle has a male spline. The right front wheel drive axle uses barrel type snap rings in order to interlock with the transaxle gears.

Front Wheel Drive Shaft Constant Velocity Joint (Outer Joint)

The front wheel drive shaft constant velocity joint is made with the Rzeppa joint design.

The shaft end (which mates with the knuckle/hub) has a helical spline. The helical spline ensures a tight, press-type fit.

This design prevents end play between the hub bearing and the front wheel drive axle.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

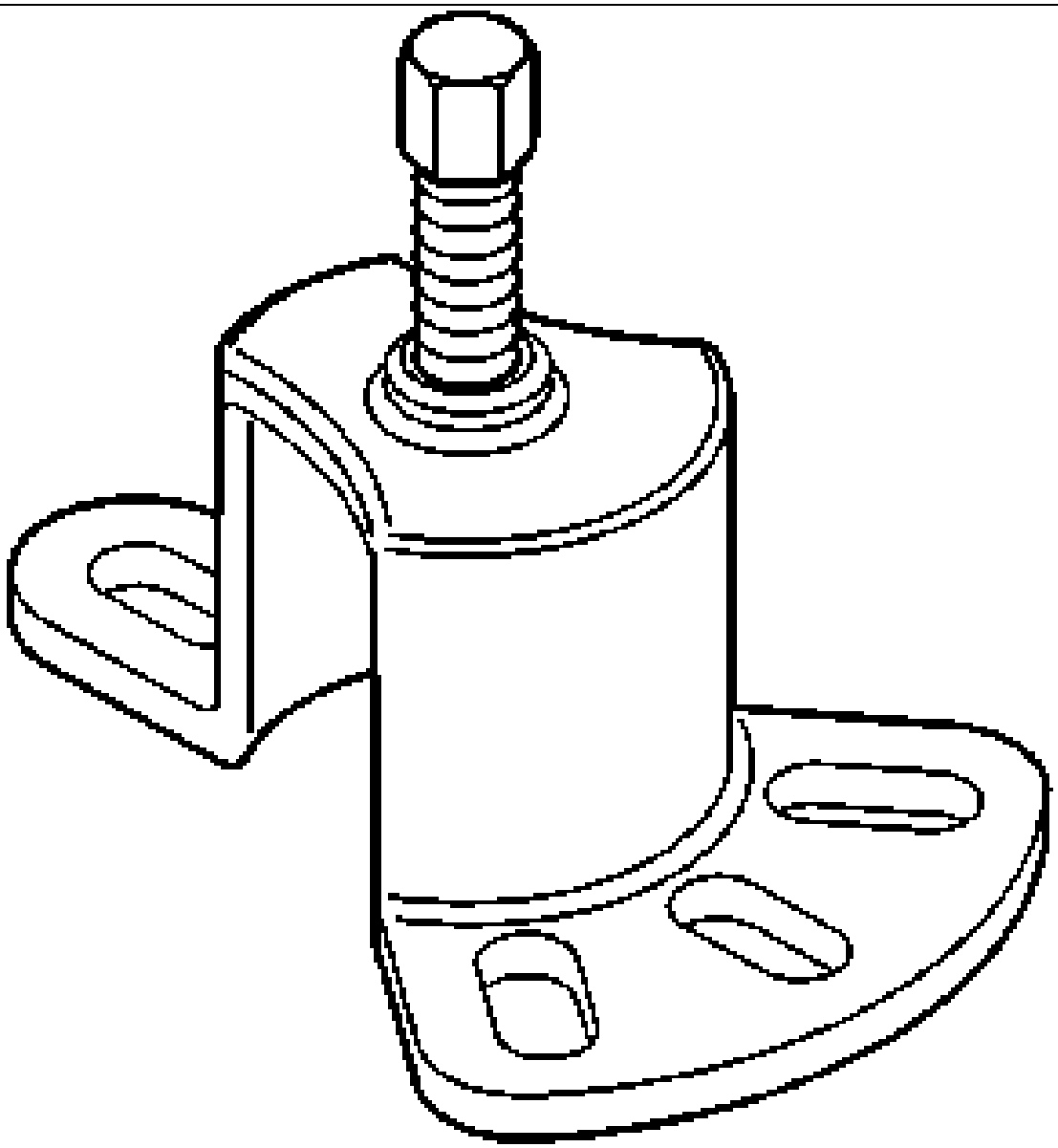
Illustration	Tool Number/ Description
	CH-42129 DT-42129 J-42129 Wheel Hub Remover

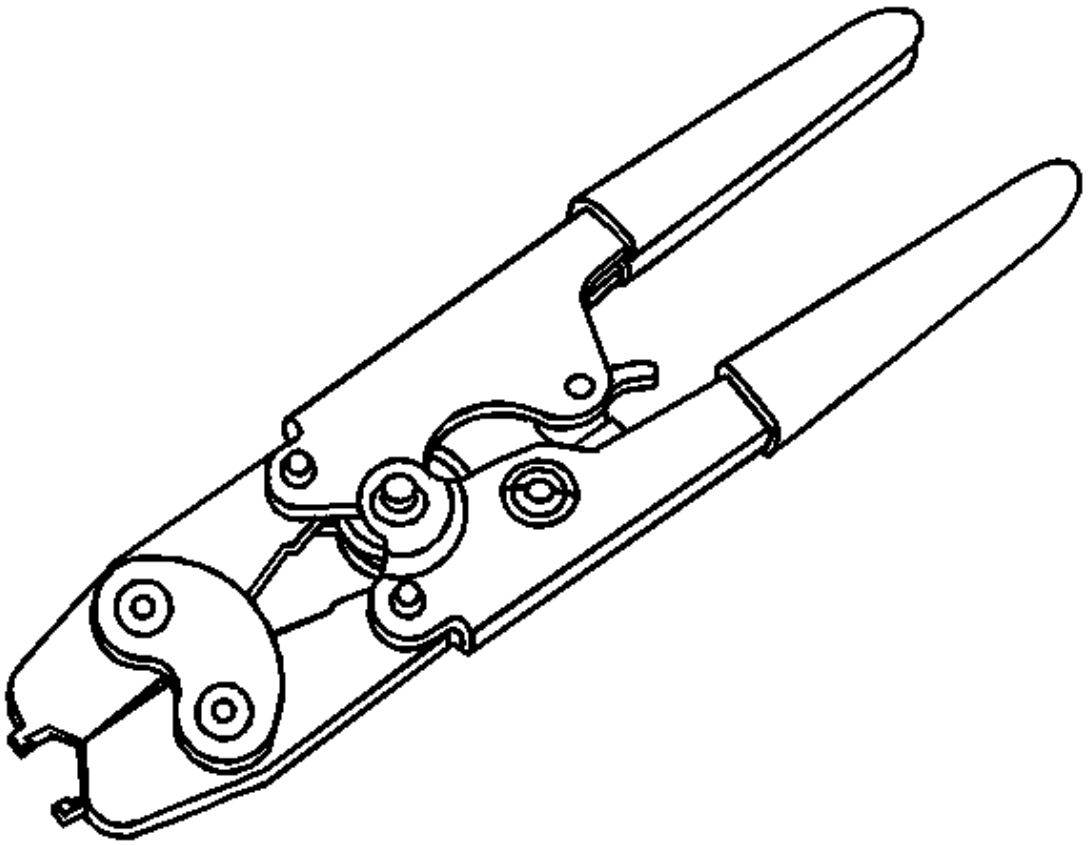
Illustration	Tool Number/ Description
	CH-48894 Wheel Drive Shaft Clamping Pliers

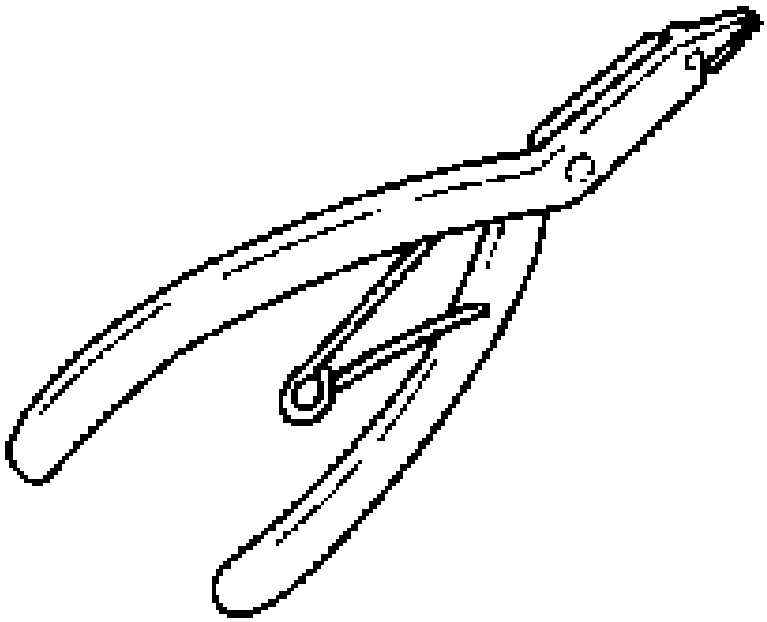
Illustration	Tool Number/ Description
	DT-8059 J-8059 Snap Ring Pliers

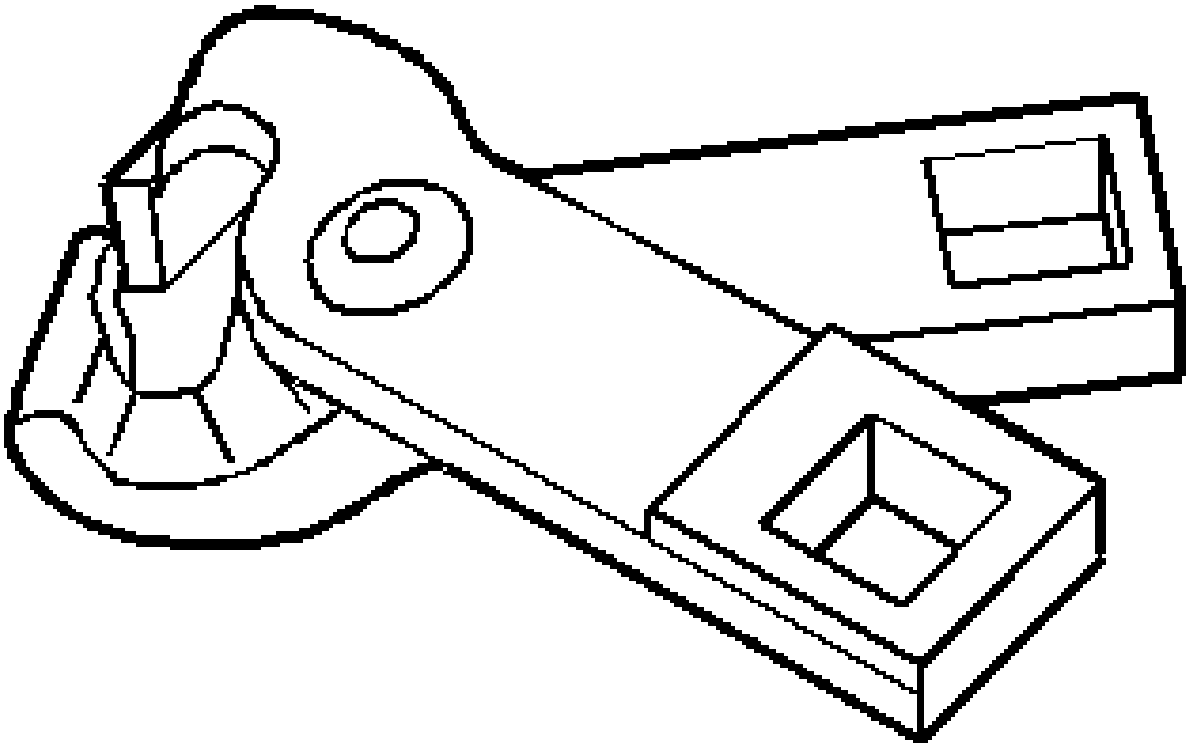
Illustration	Tool Number/ Description
	DT-35910 J-35910 Drive Axle Seal Clamp Pliers

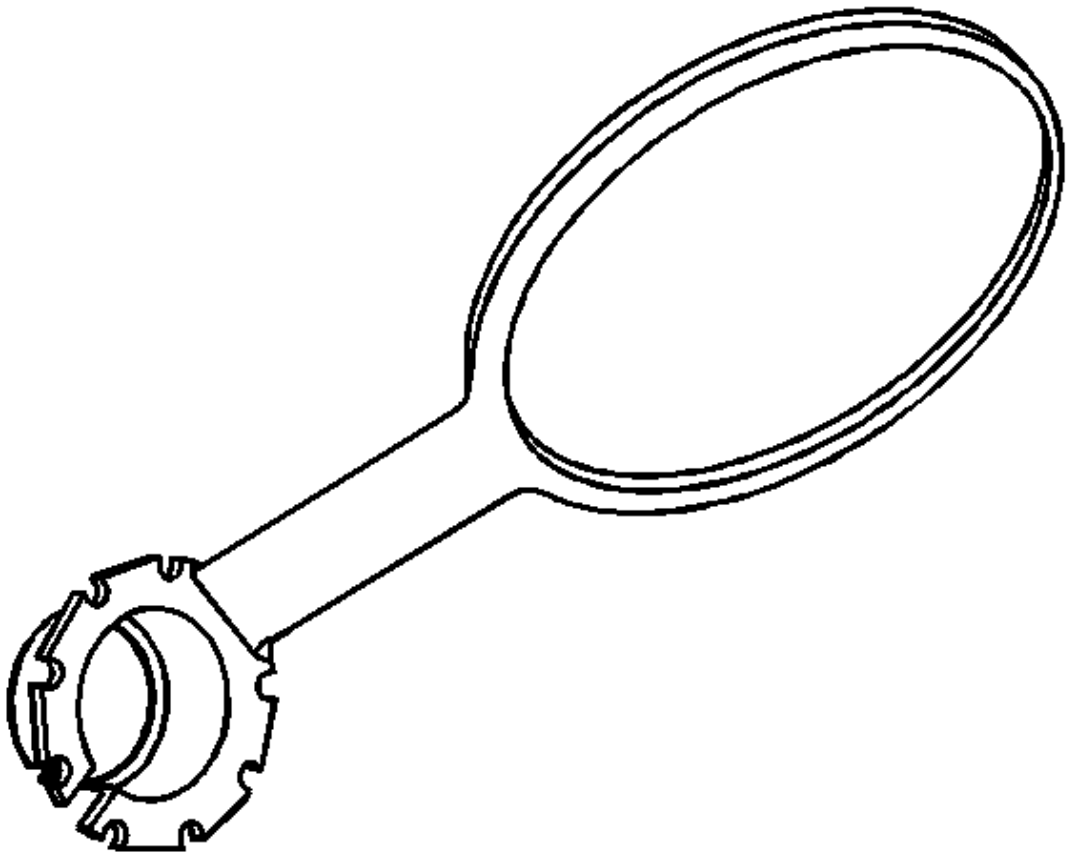
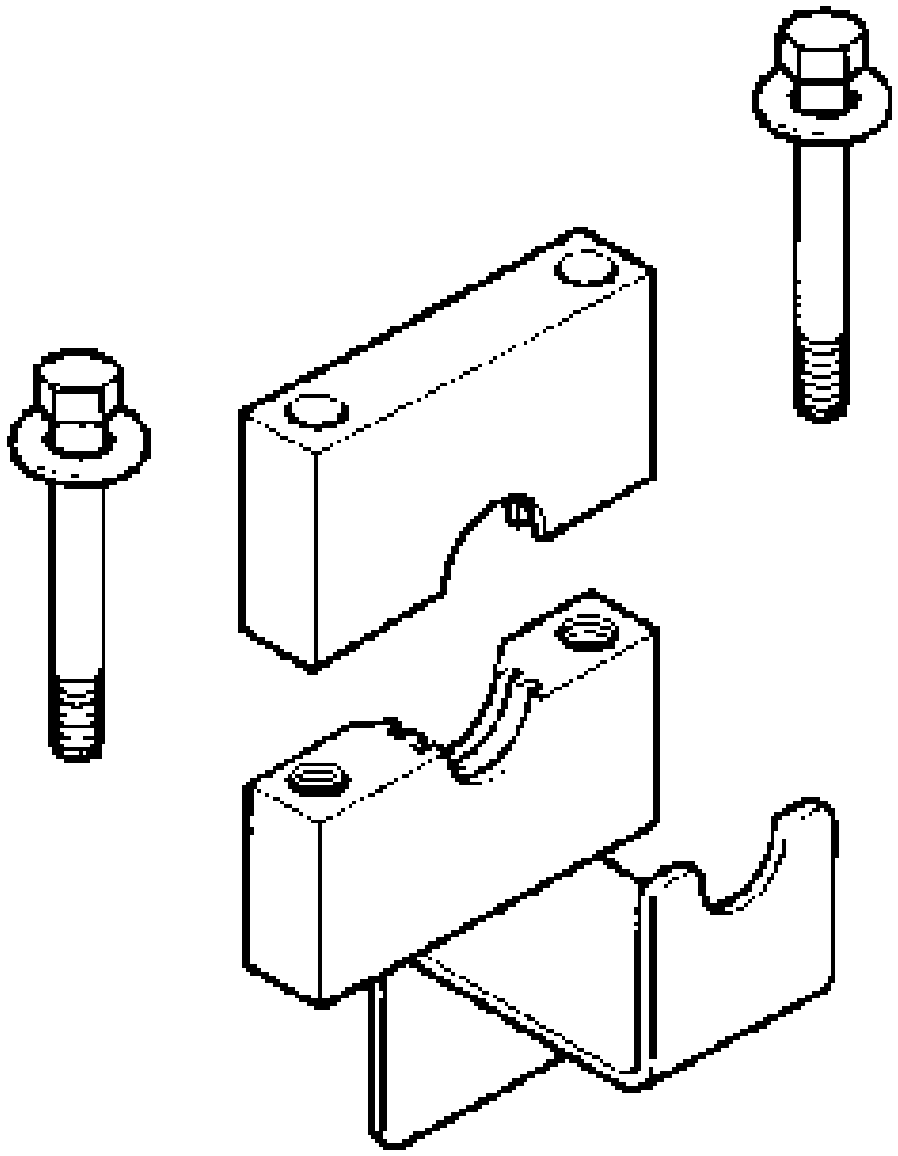
Illustration	Tool Number/ Description
	DT-51504 Seal Protector

Illustration	Tool Number/ Description
	DT-47732 DT-48267 DT-50340 J-41048 Drive Axle Swage Ring Clamp

Article GUID: A00737196

SYSTEM WIRING DIAGRAMS

Chevrolet - Impala

AIR CONDITIONING

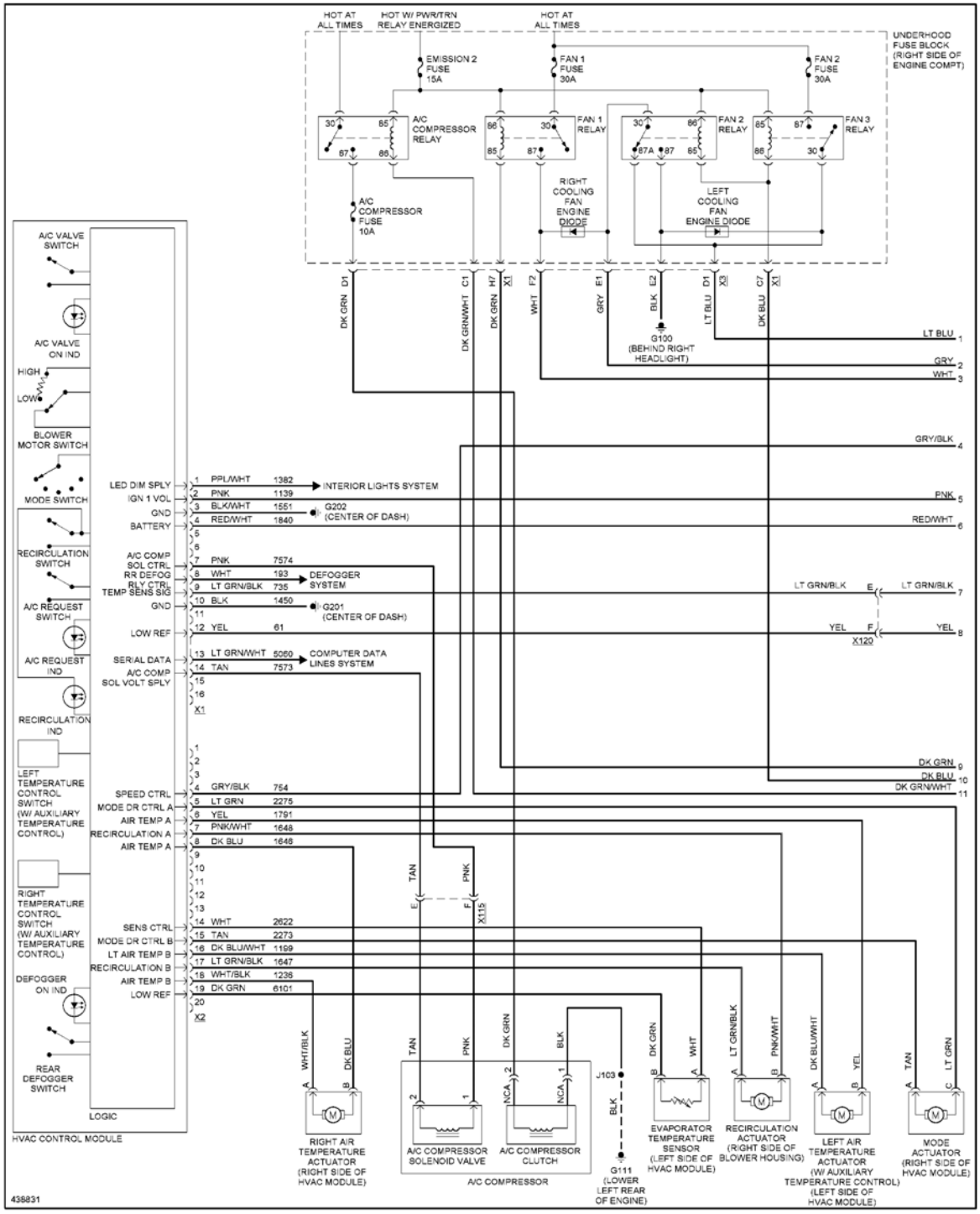


Fig. 1: Manual A/C Circuit (1 of 2)

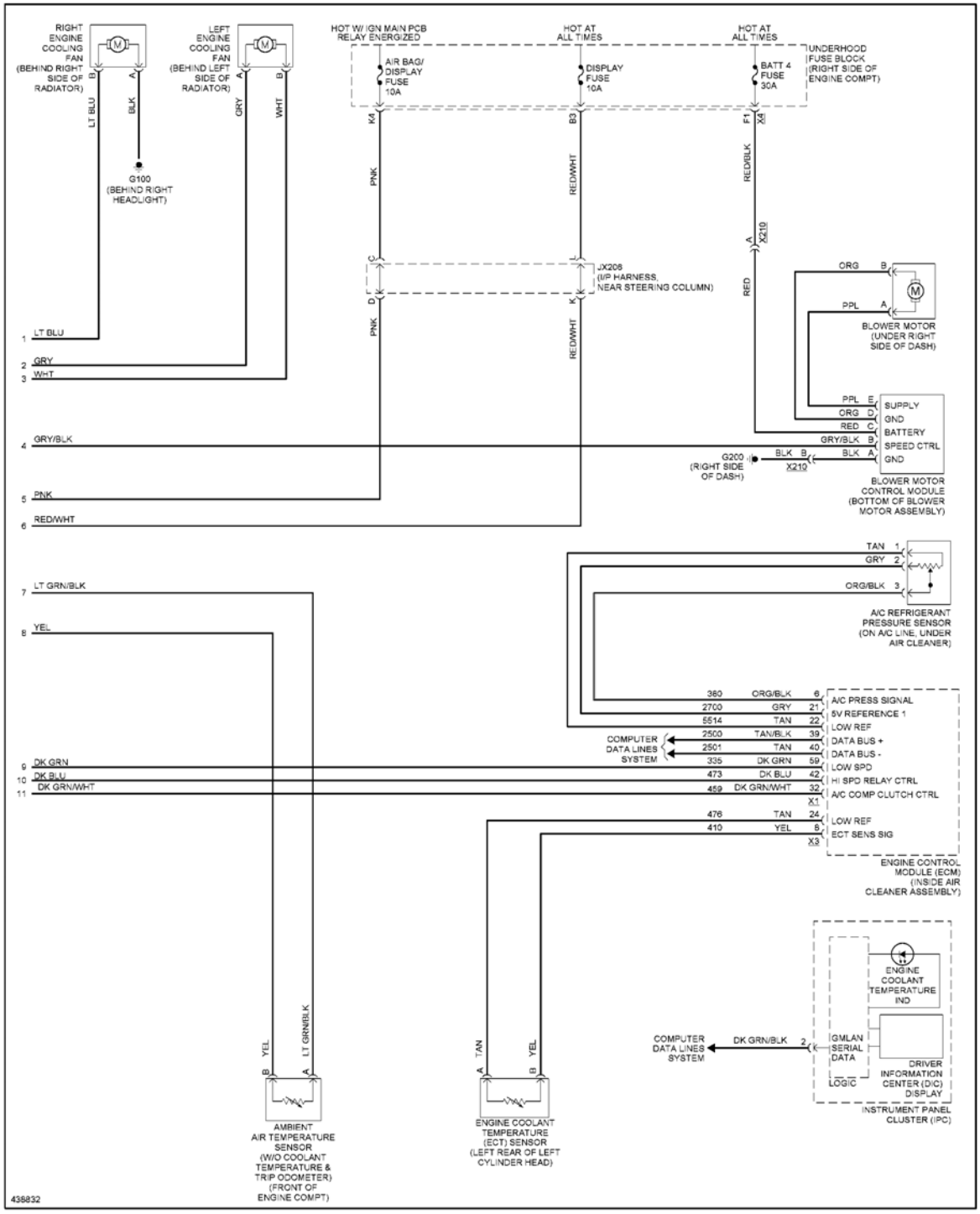


Fig. 2: Manual A/C Circuit (2 of 2)

ANTI-LOCK BRAKES

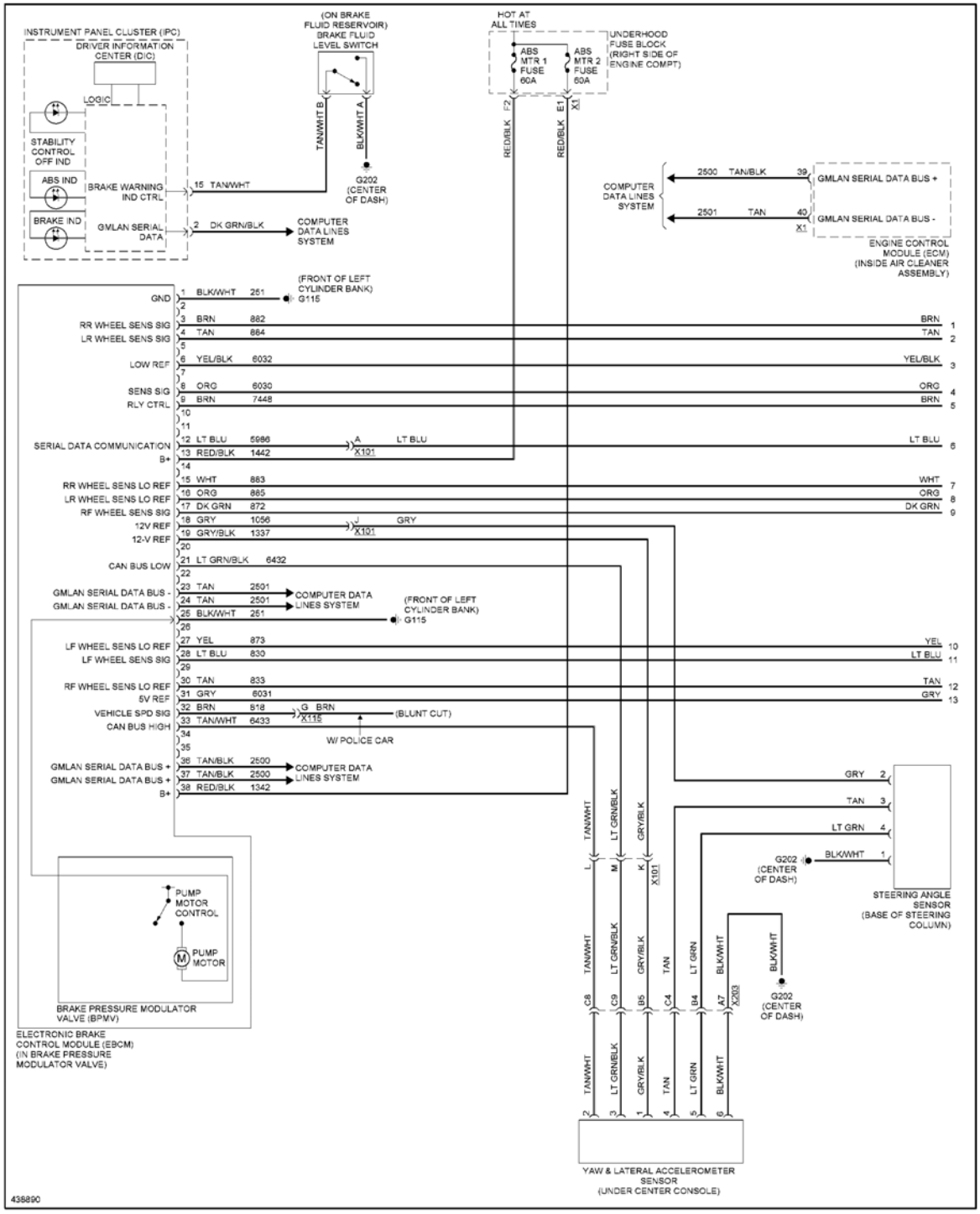


Fig. 3: Anti-lock Brakes Circuit (1 of 2)

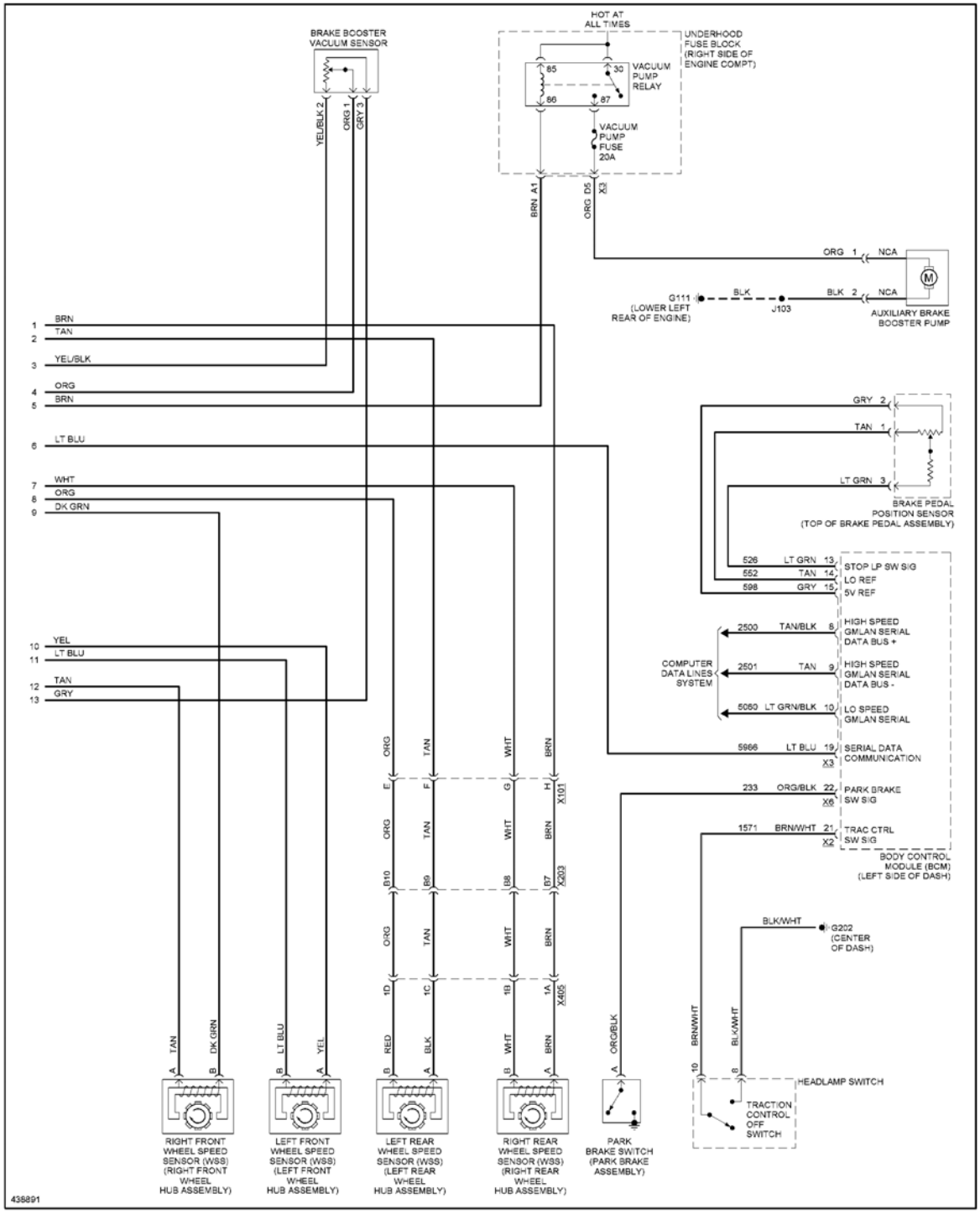


Fig. 4: Anti-lock Brakes Circuit (2 of 2)

ANTI-THEFT

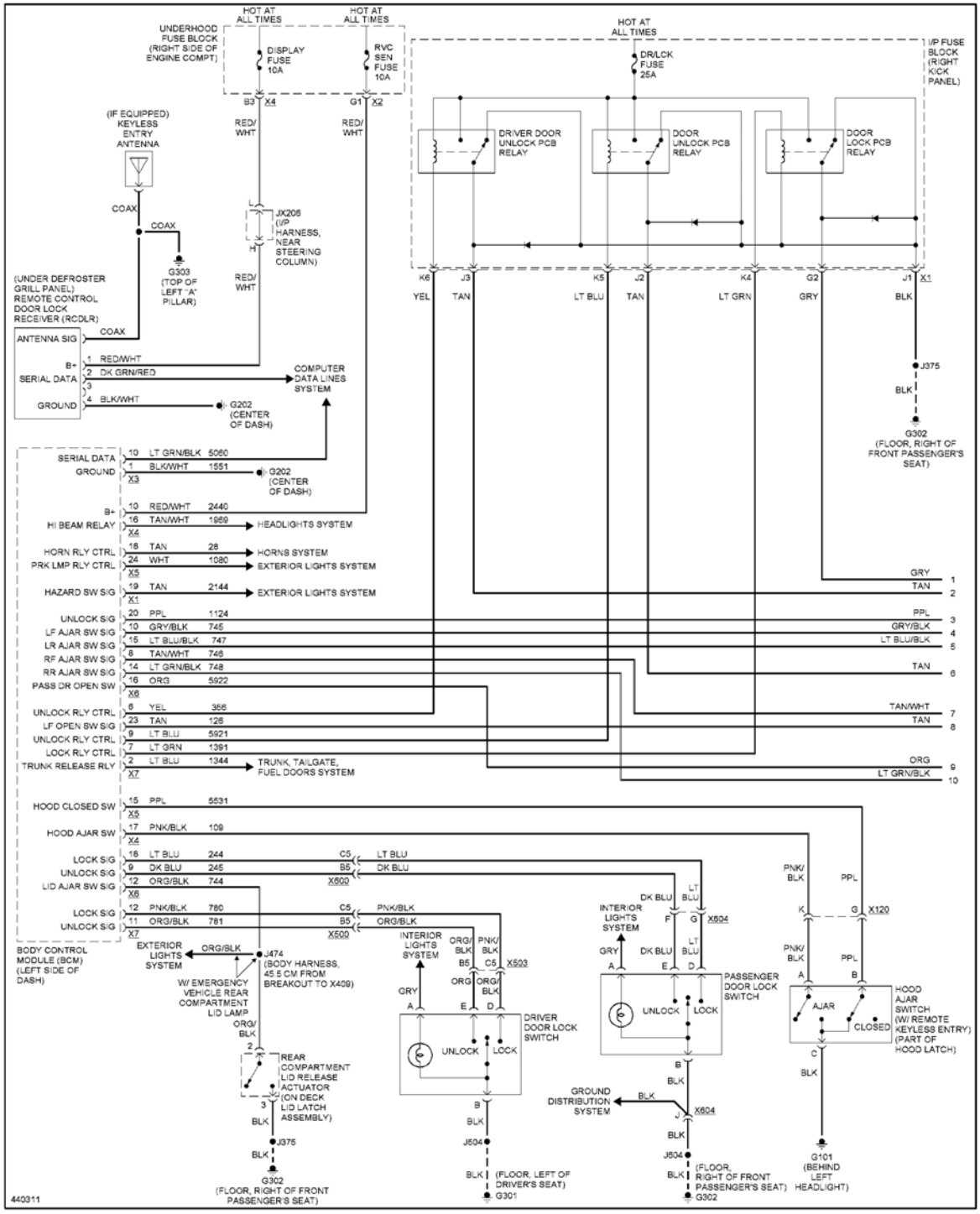


Fig. 5: Forced Entry Circuit (1 of 2)

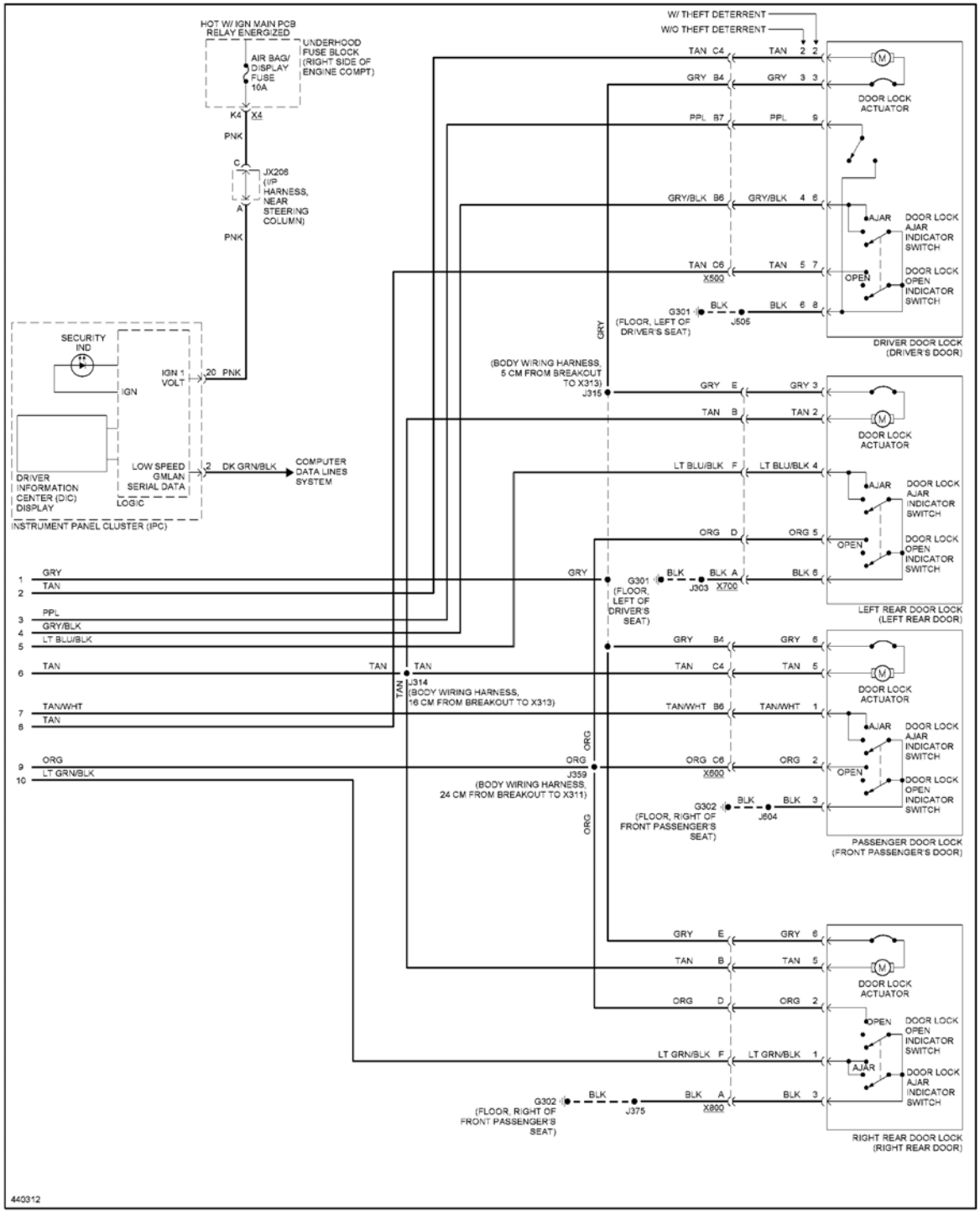


Fig. 6: Forced Entry Circuit (2 of 2)

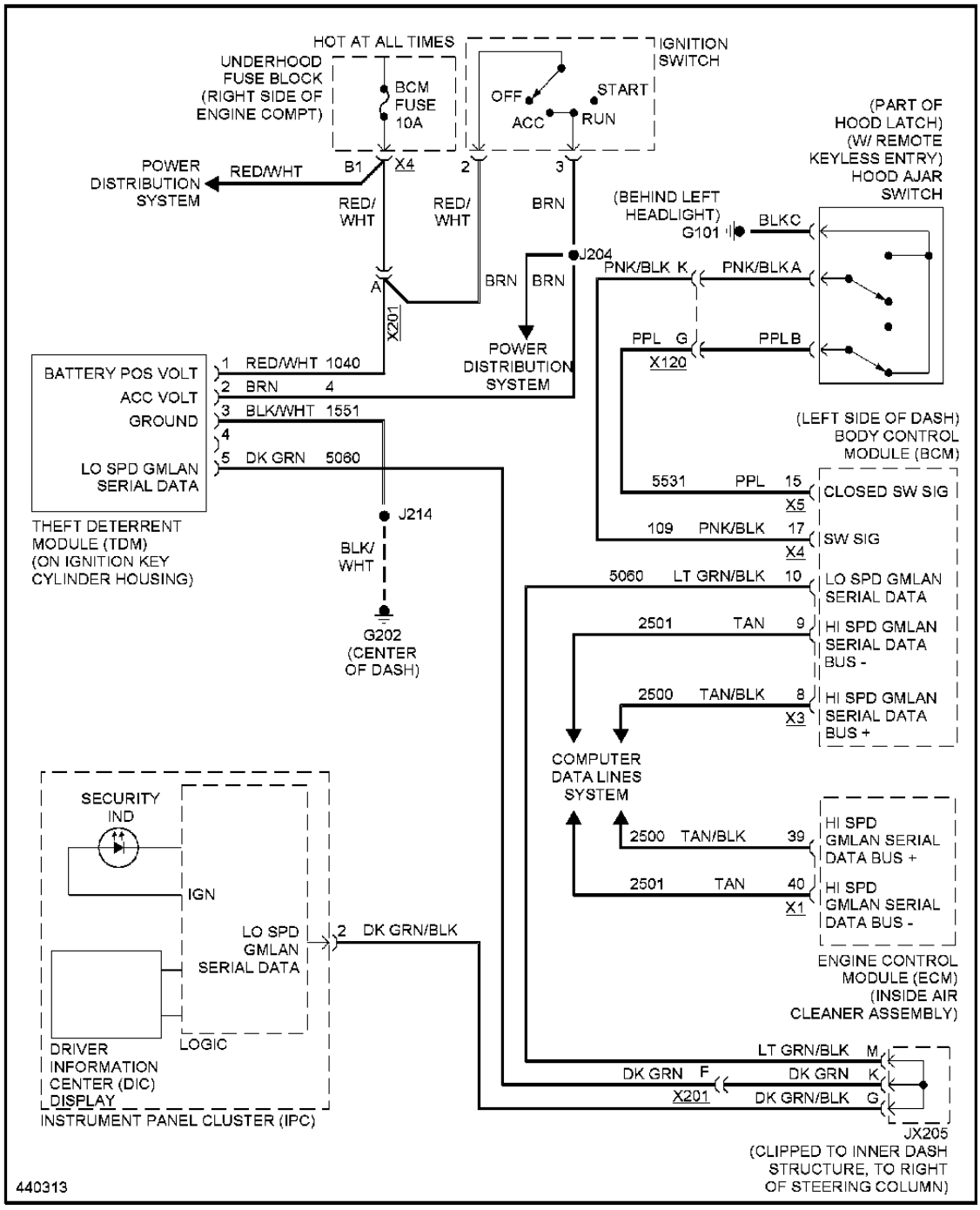


Fig. 7: Pass-Key Circuit

BODY CONTROL MODULES

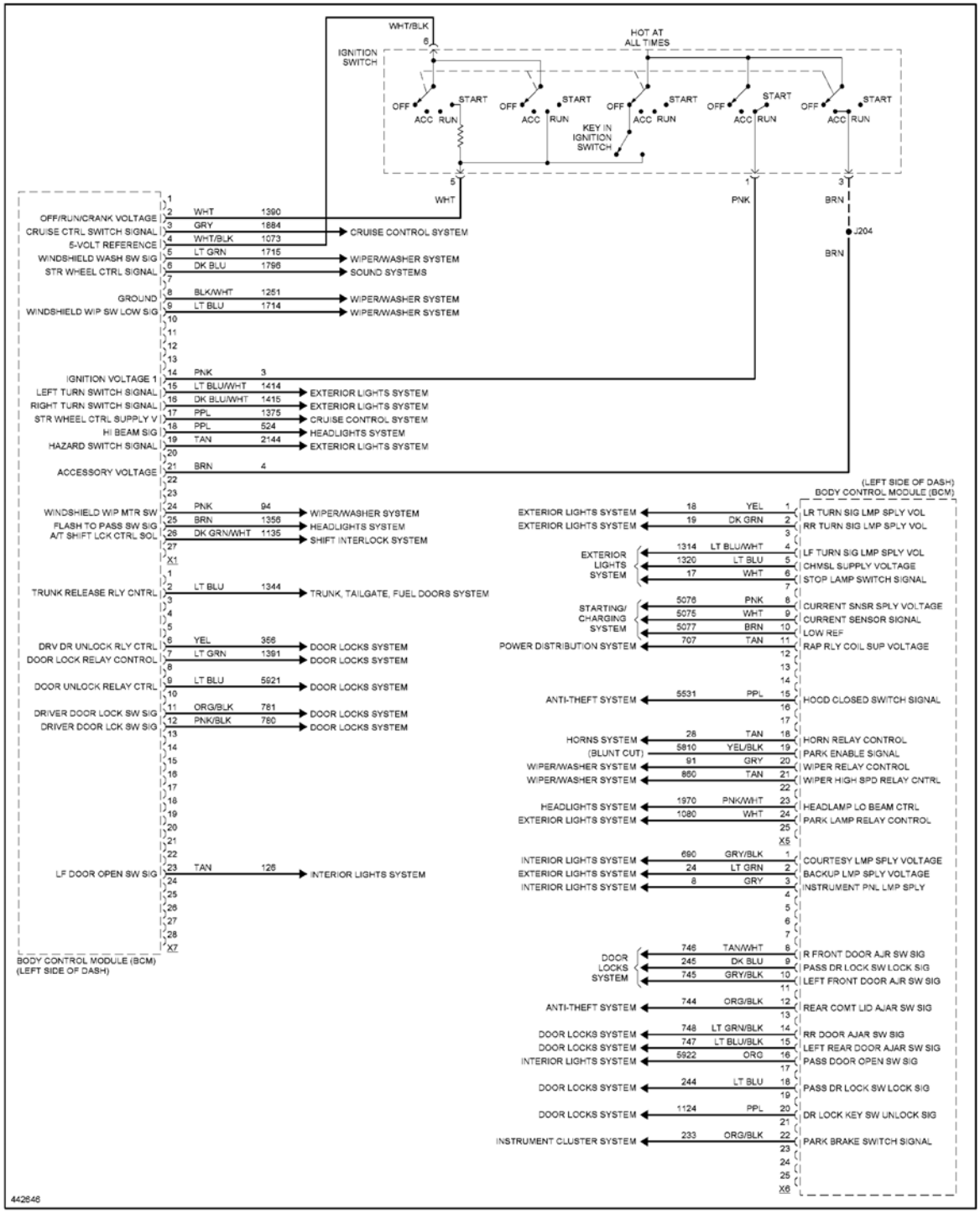


Fig. 8: Body Control Modules Circuit (1 of 2)

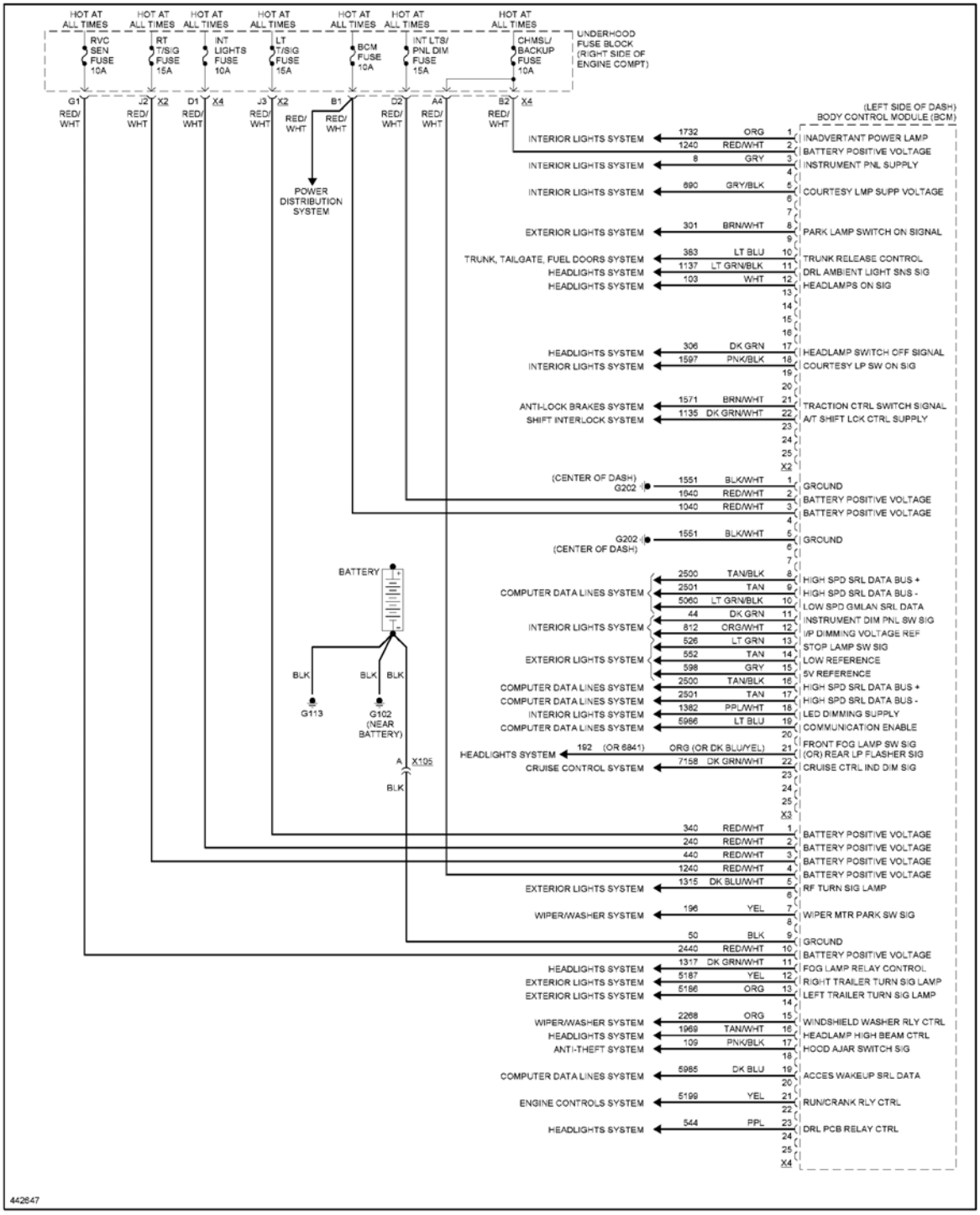


Fig. 9: Body Control Modules Circuit (2 of 2)

COMPUTER DATA LINES

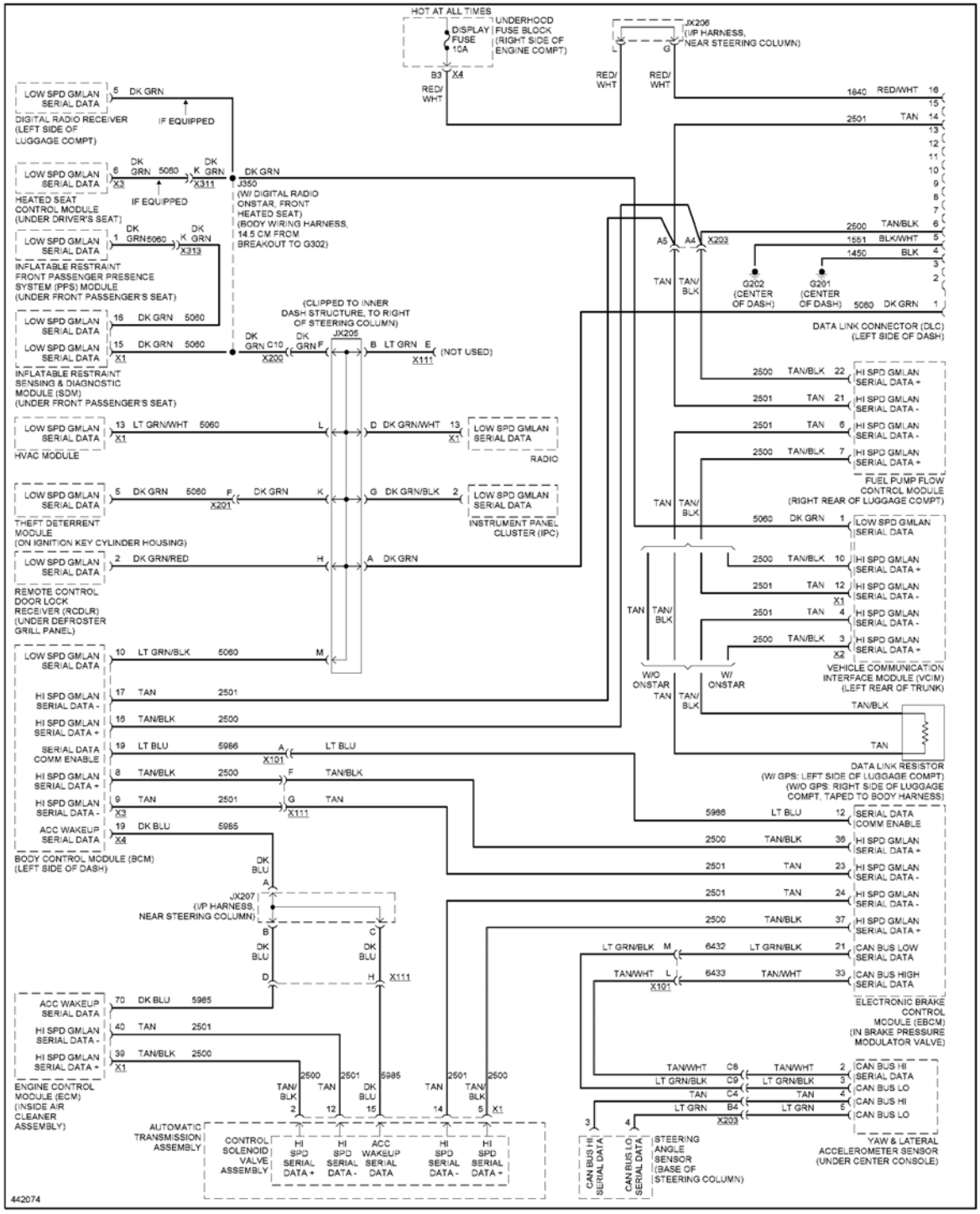


Fig. 10: Computer Data Lines Circuit

COOLING FAN

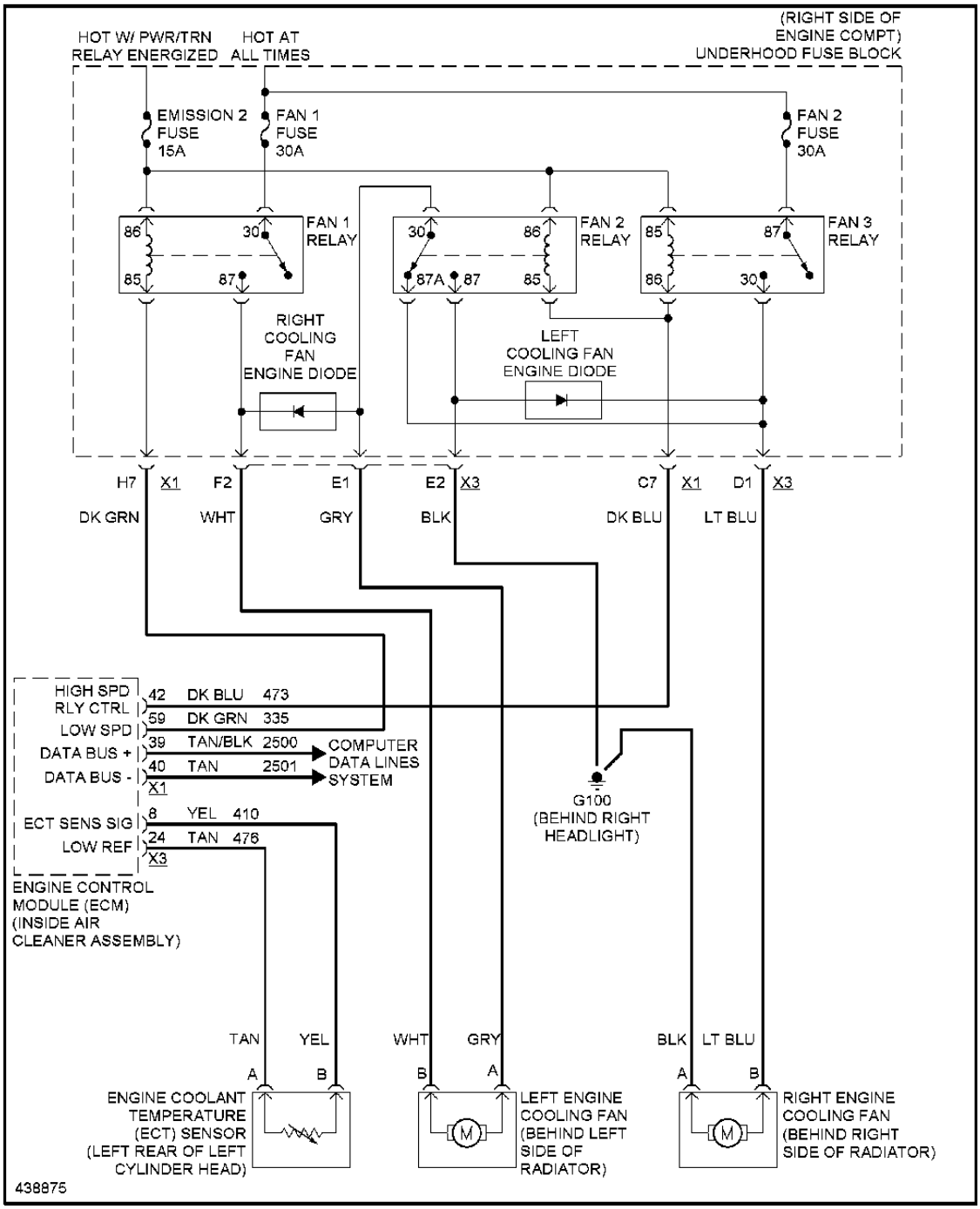


Fig. 11: Cooling Fan Circuit

CRUISE CONTROL

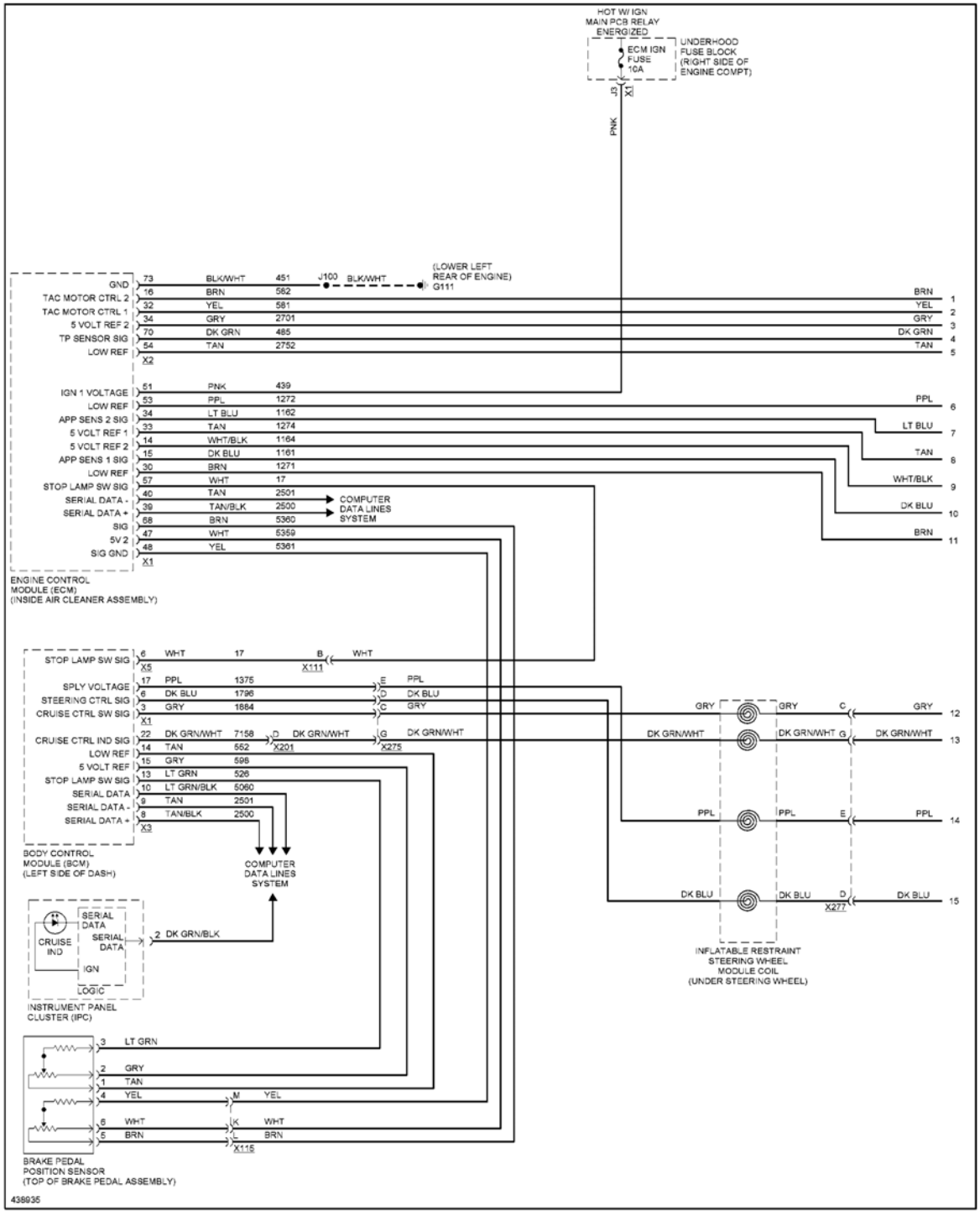


Fig. 12: Cruise Control Circuit (1 of 2)

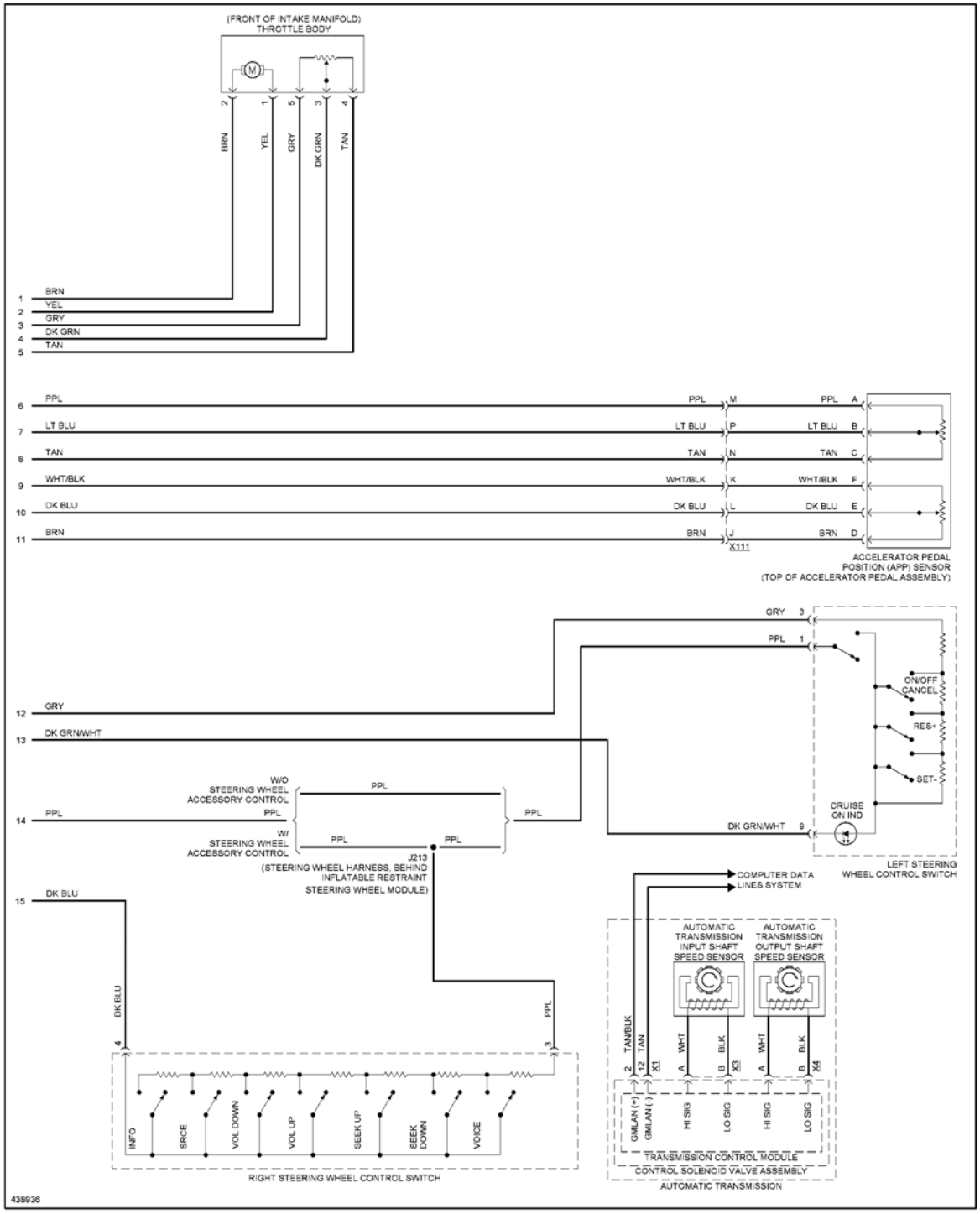


Fig. 13: Cruise Control Circuit (2 of 2)

DEFOGGERS

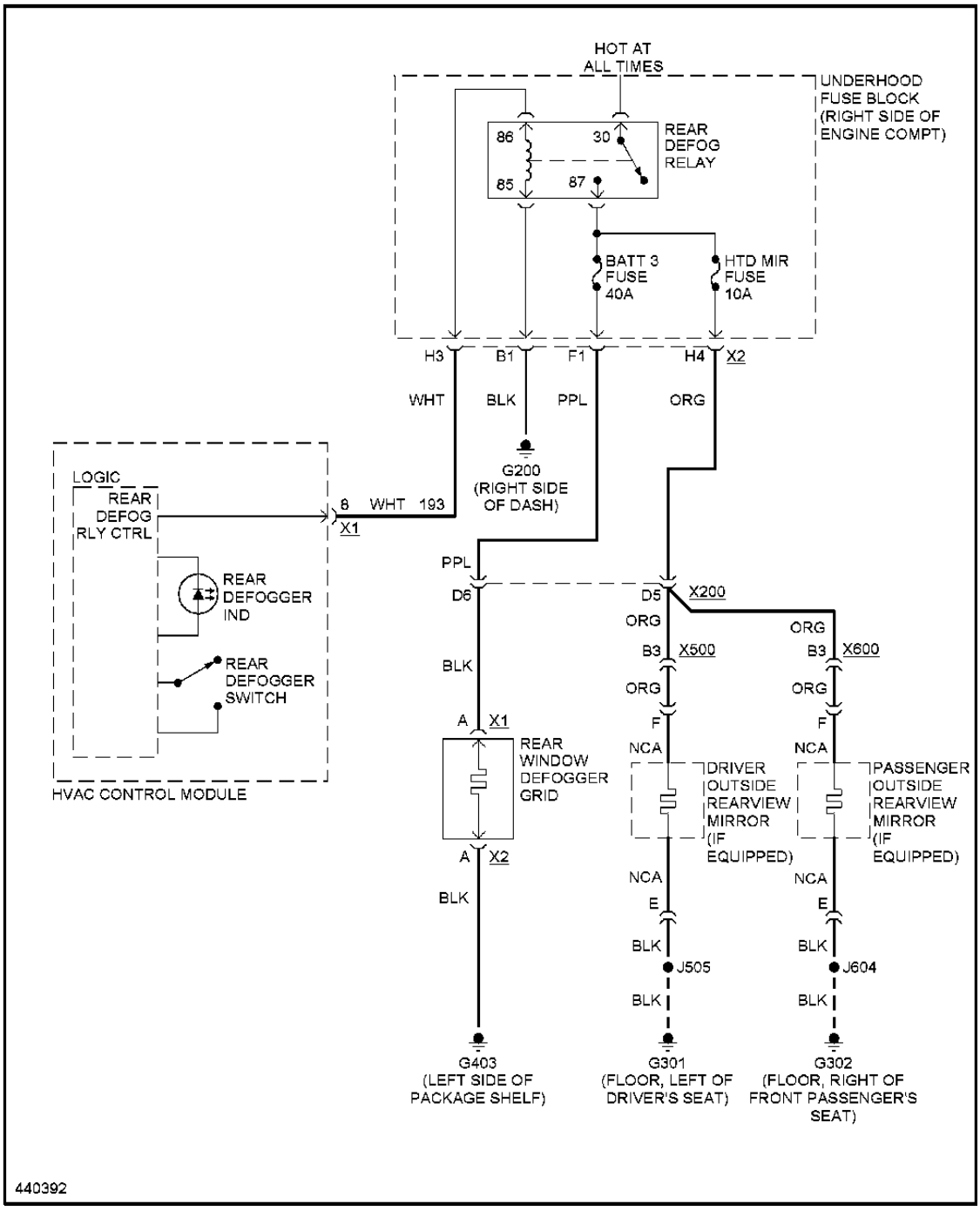


Fig. 14: Defoggers Circuit

ENGINE PERFORMANCE

3.6L VIN 3

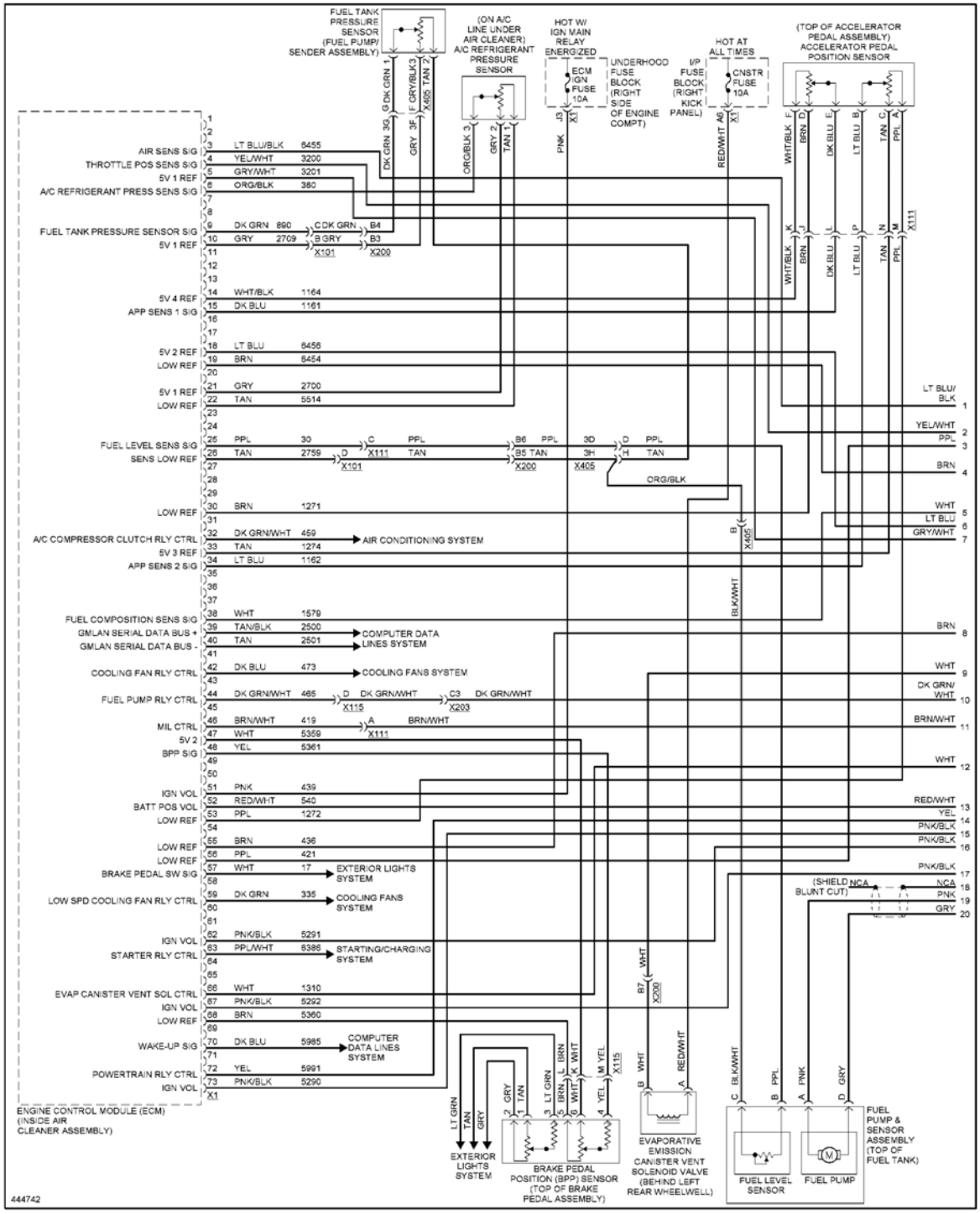


Fig. 15: 3.6L VIN 3, Engine Performance Circuit (1 of 5)

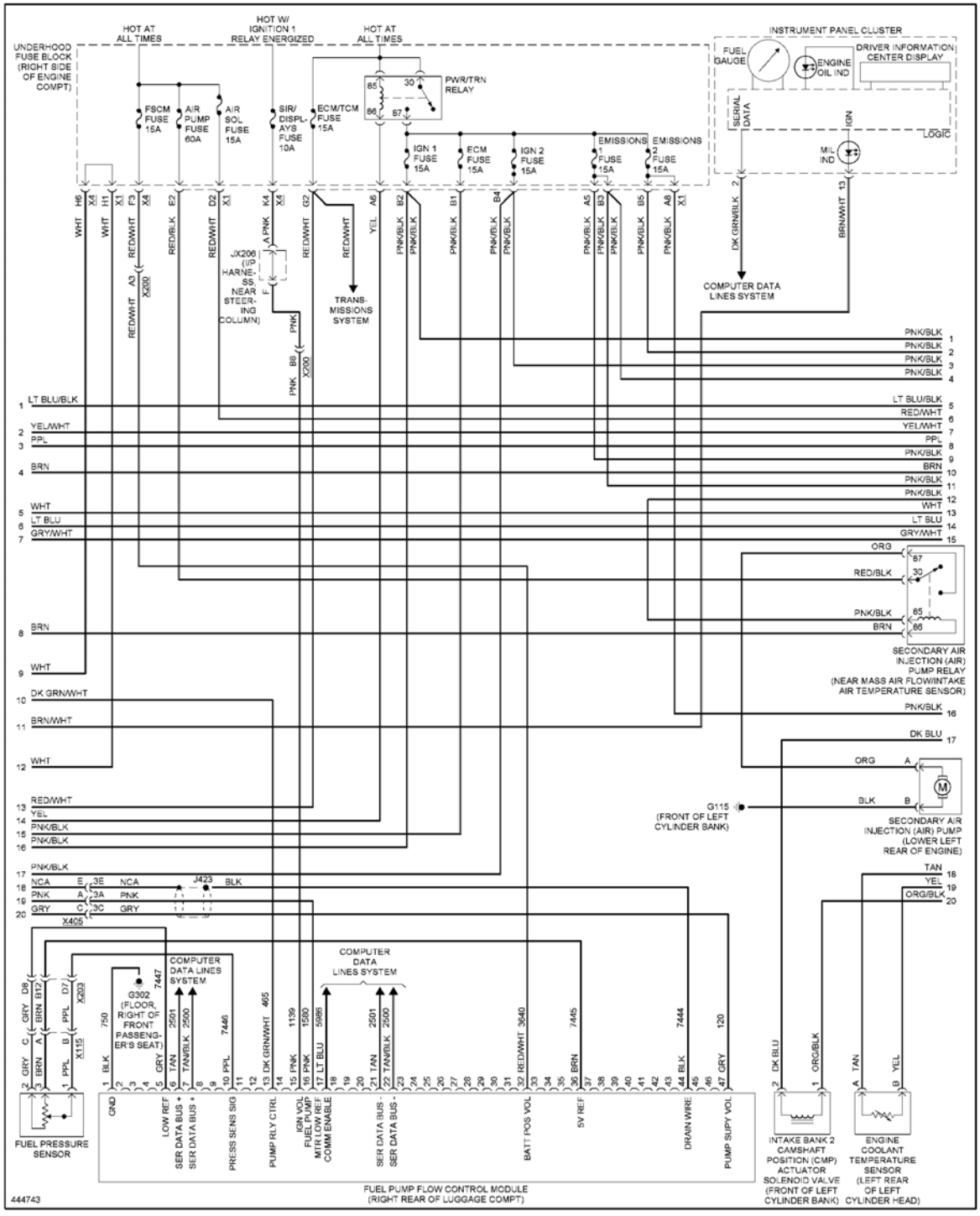


Fig. 16: 3.6L VIN 3, Engine Performance Circuit (2 of 5)

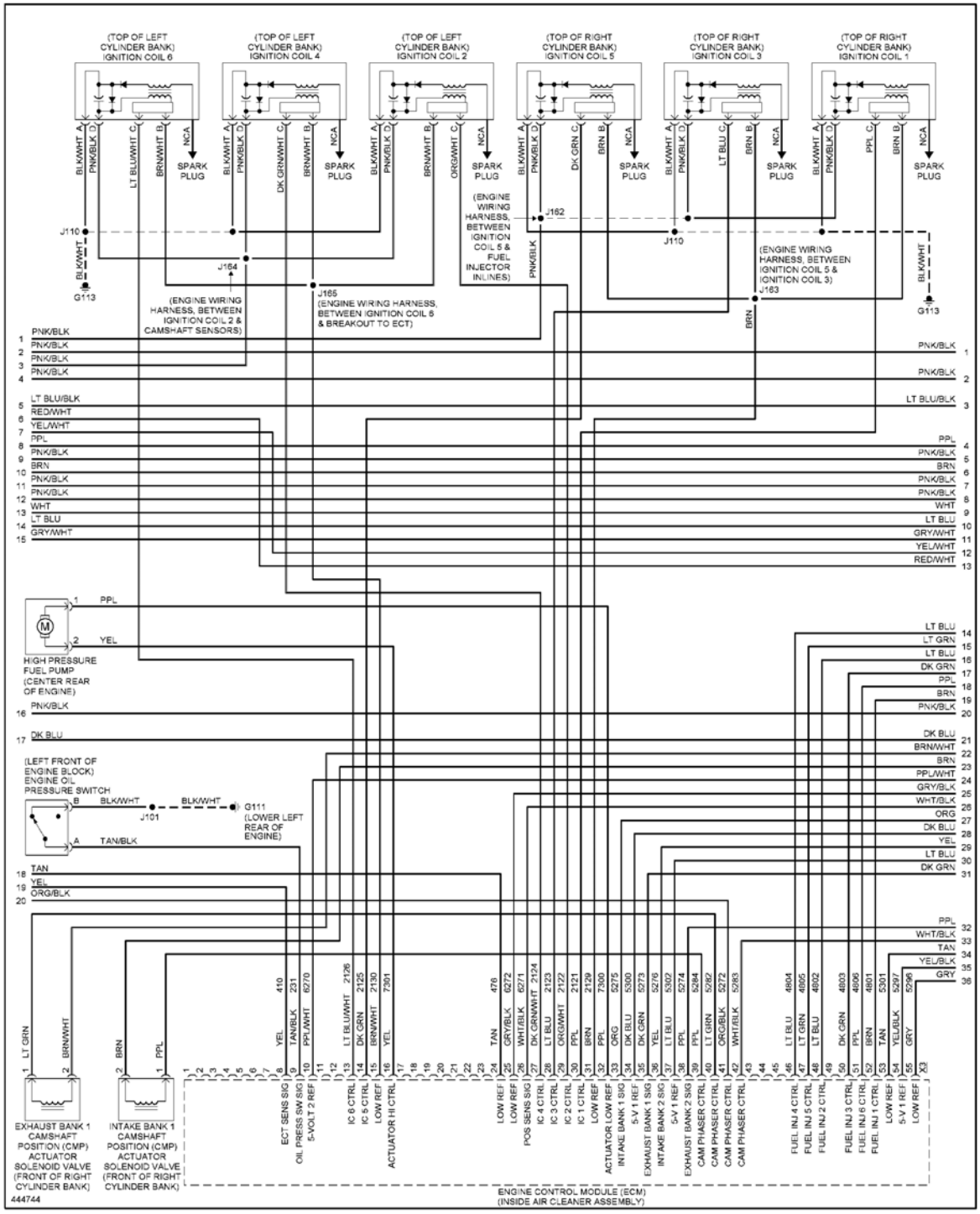


Fig. 17: 3.6L VIN 3, Engine Performance Circuit (3 of 5)

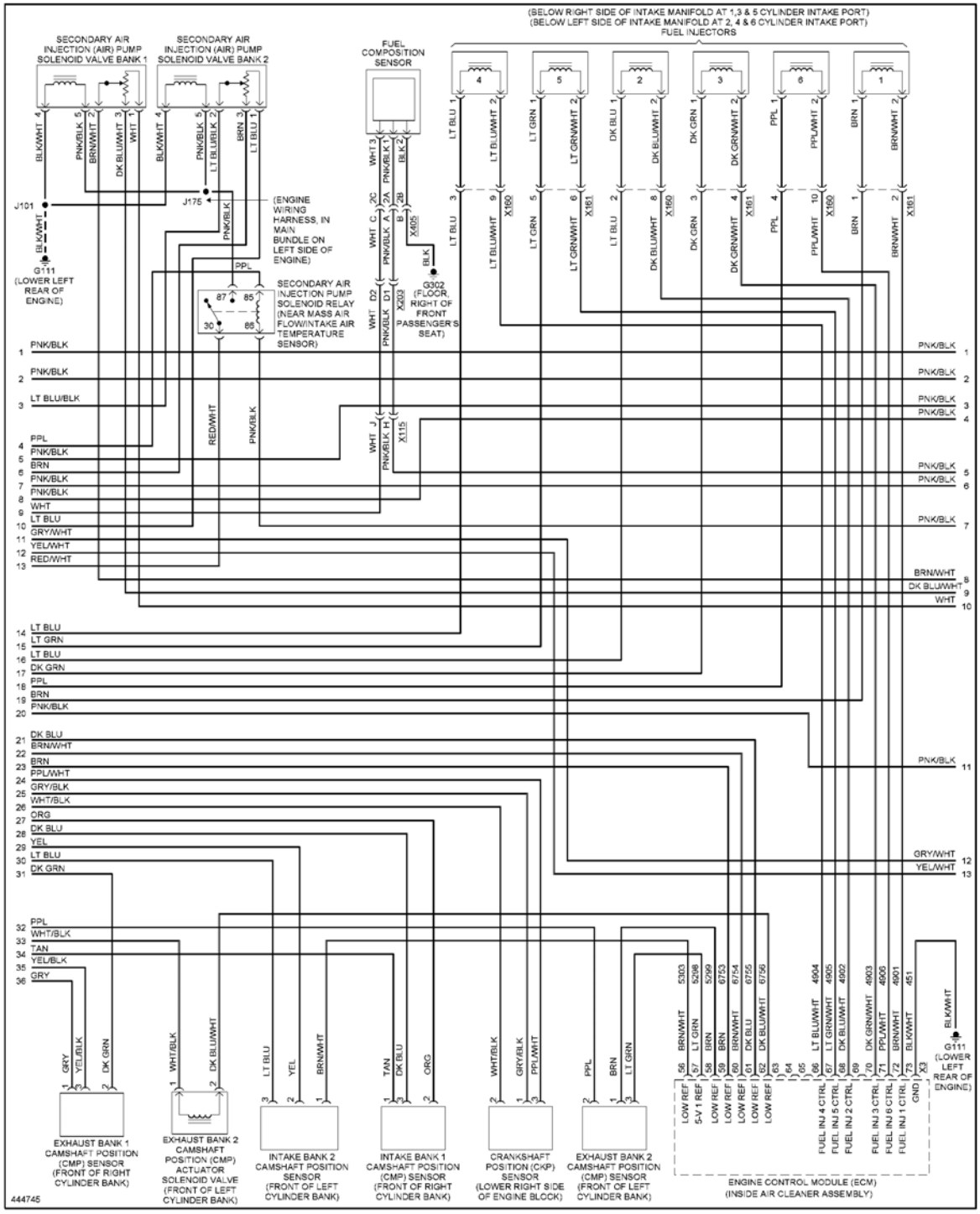


Fig. 18: 3.6L VIN 3, Engine Performance Circuit (4 of 5)

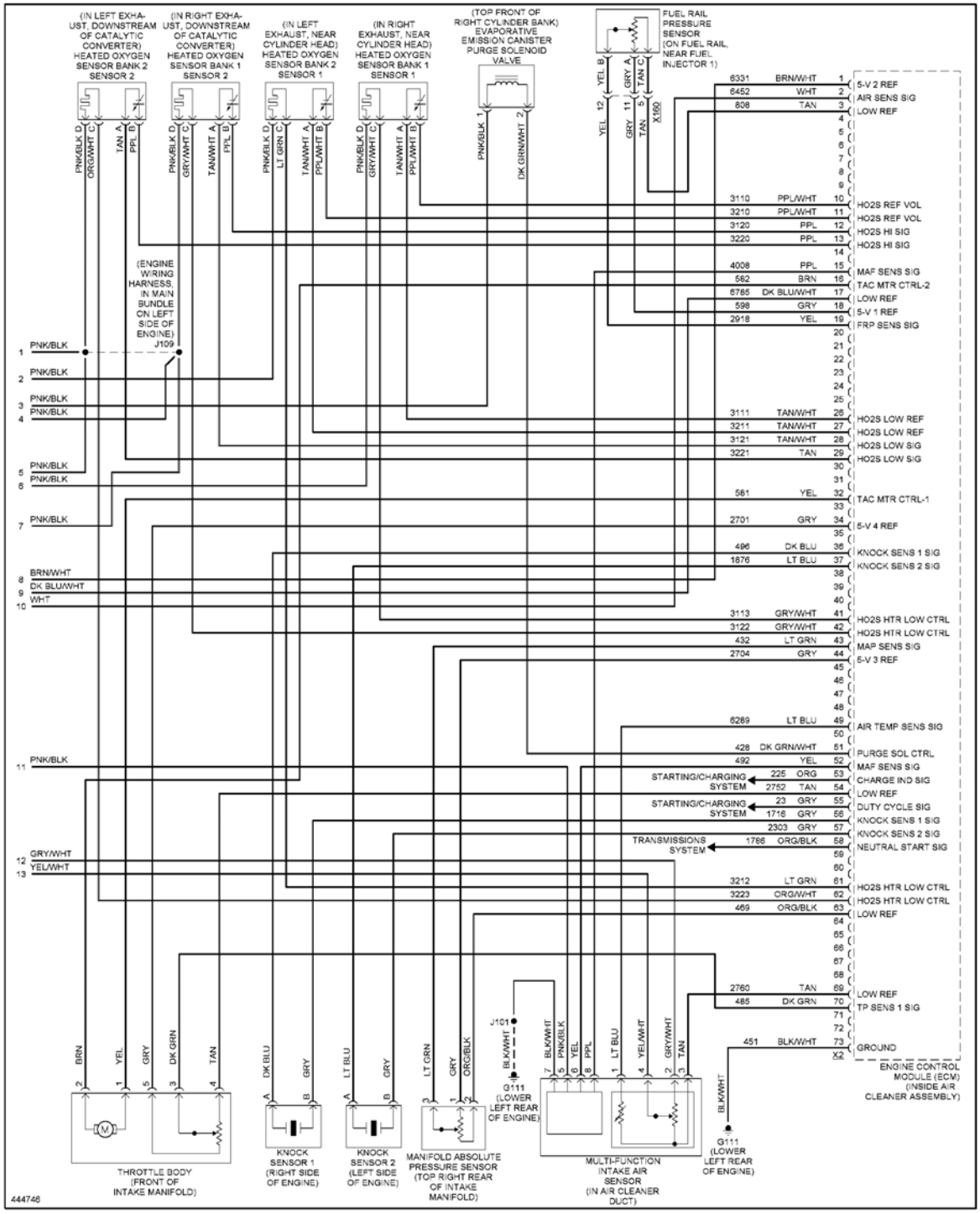


Fig. 19: 3.6L VIN 3, Engine Performance Circuit (5 of 5)

EXTERIOR LIGHTS

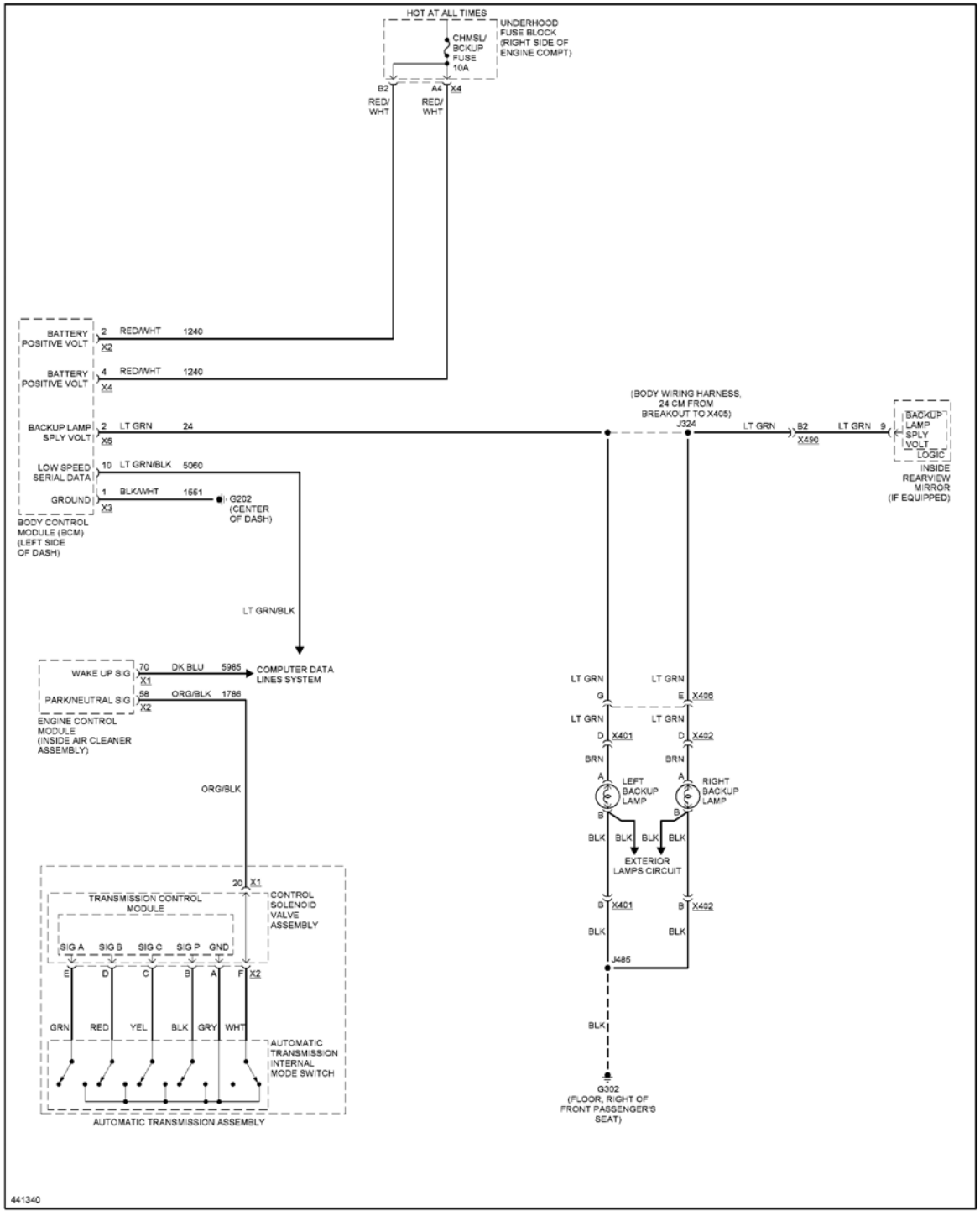


Fig. 20: Backup Lamps Circuit

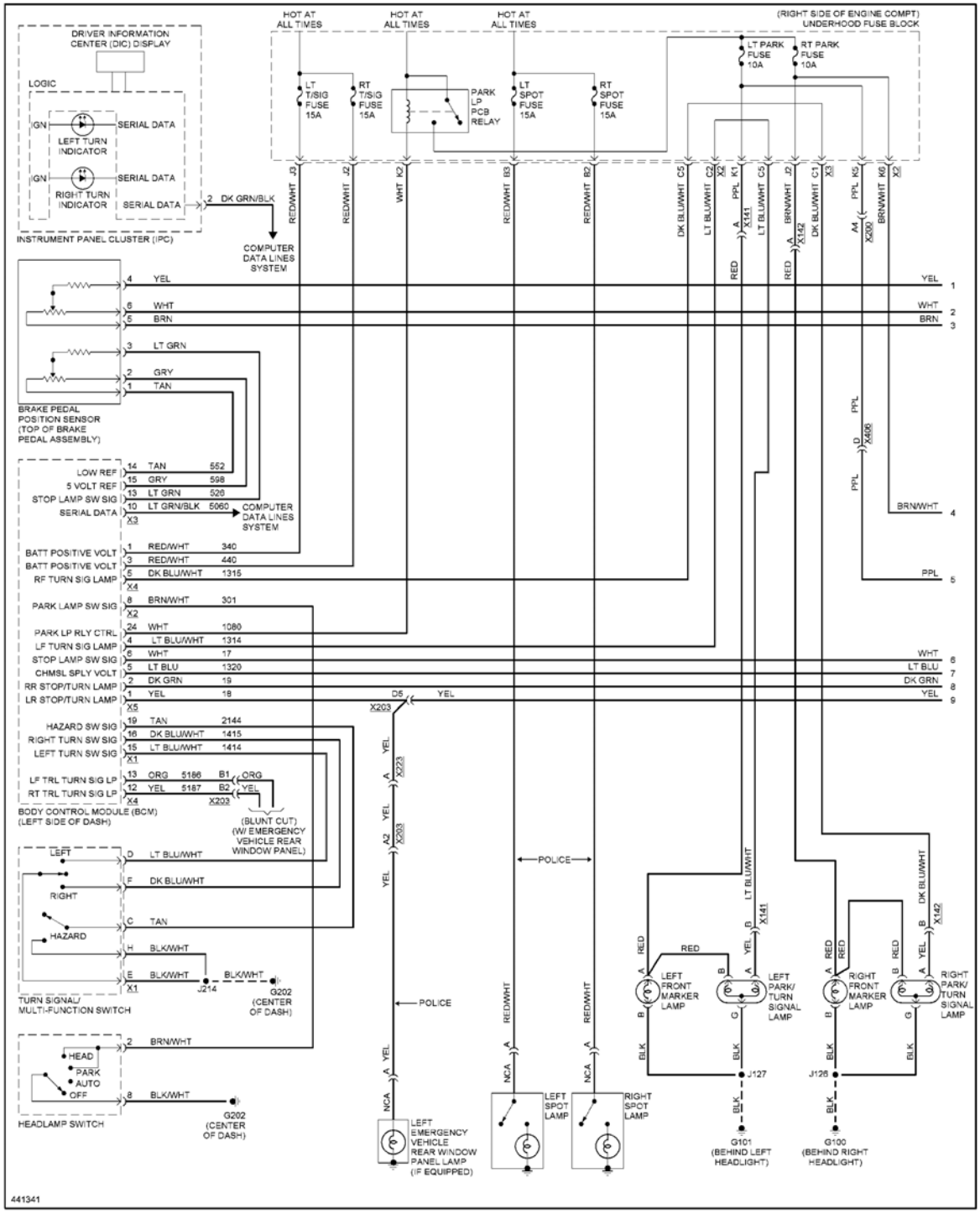


Fig. 21: Exterior Lamps Circuit (1 of 2)

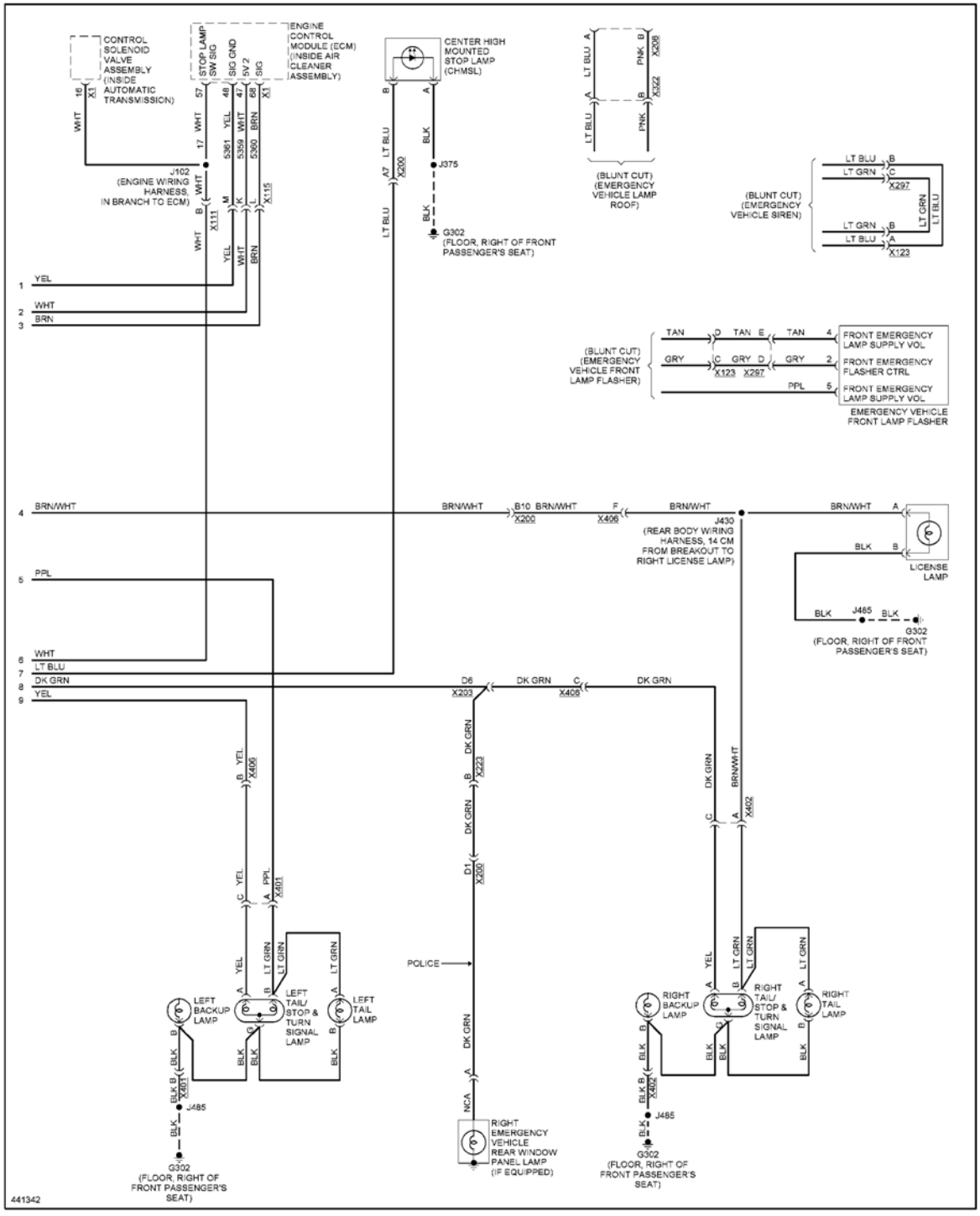


Fig. 22: Exterior Lamps Circuit (2 of 2)

GROUND DISTRIBUTION

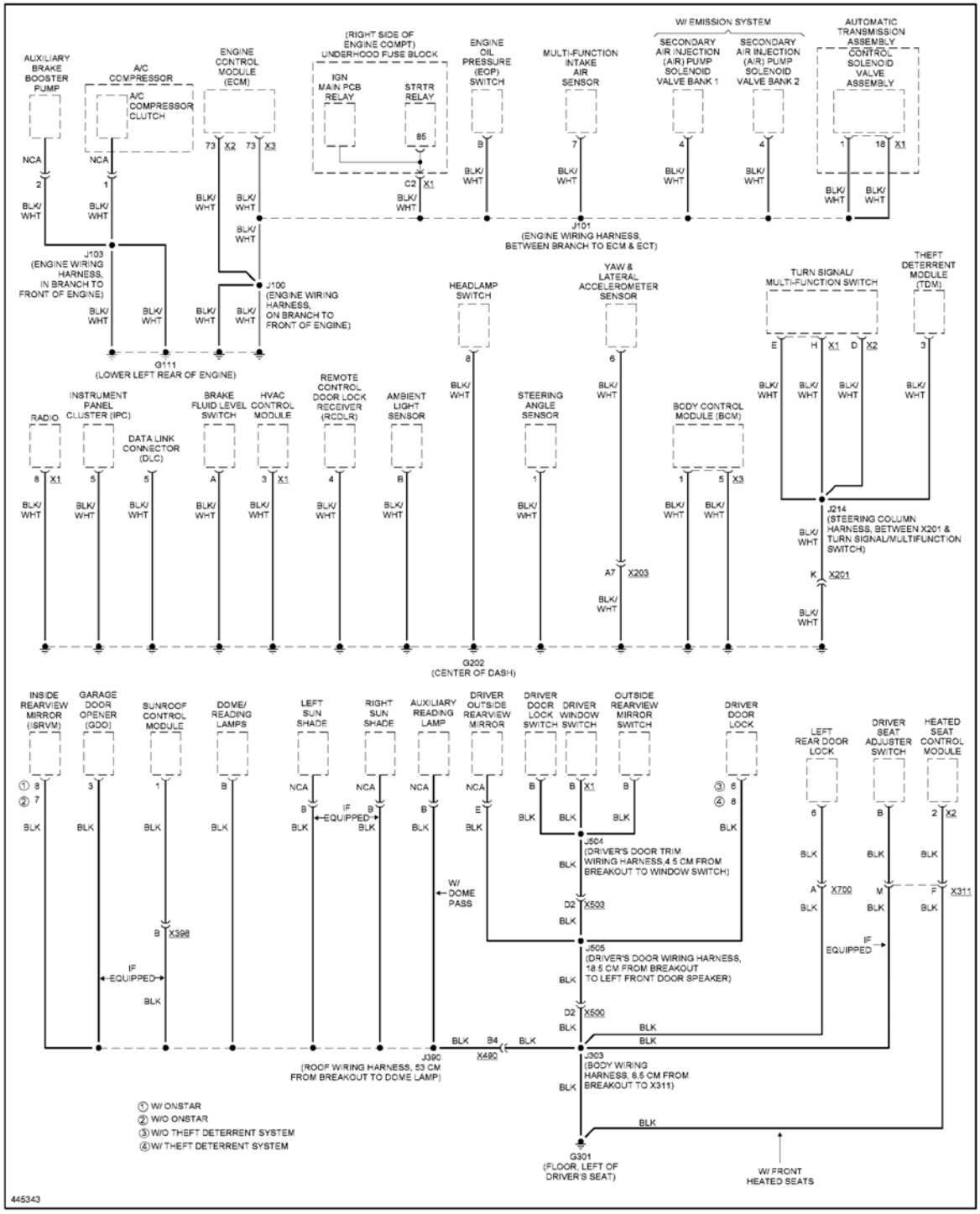


Fig. 23: Ground Distribution Circuit (1 of 3)

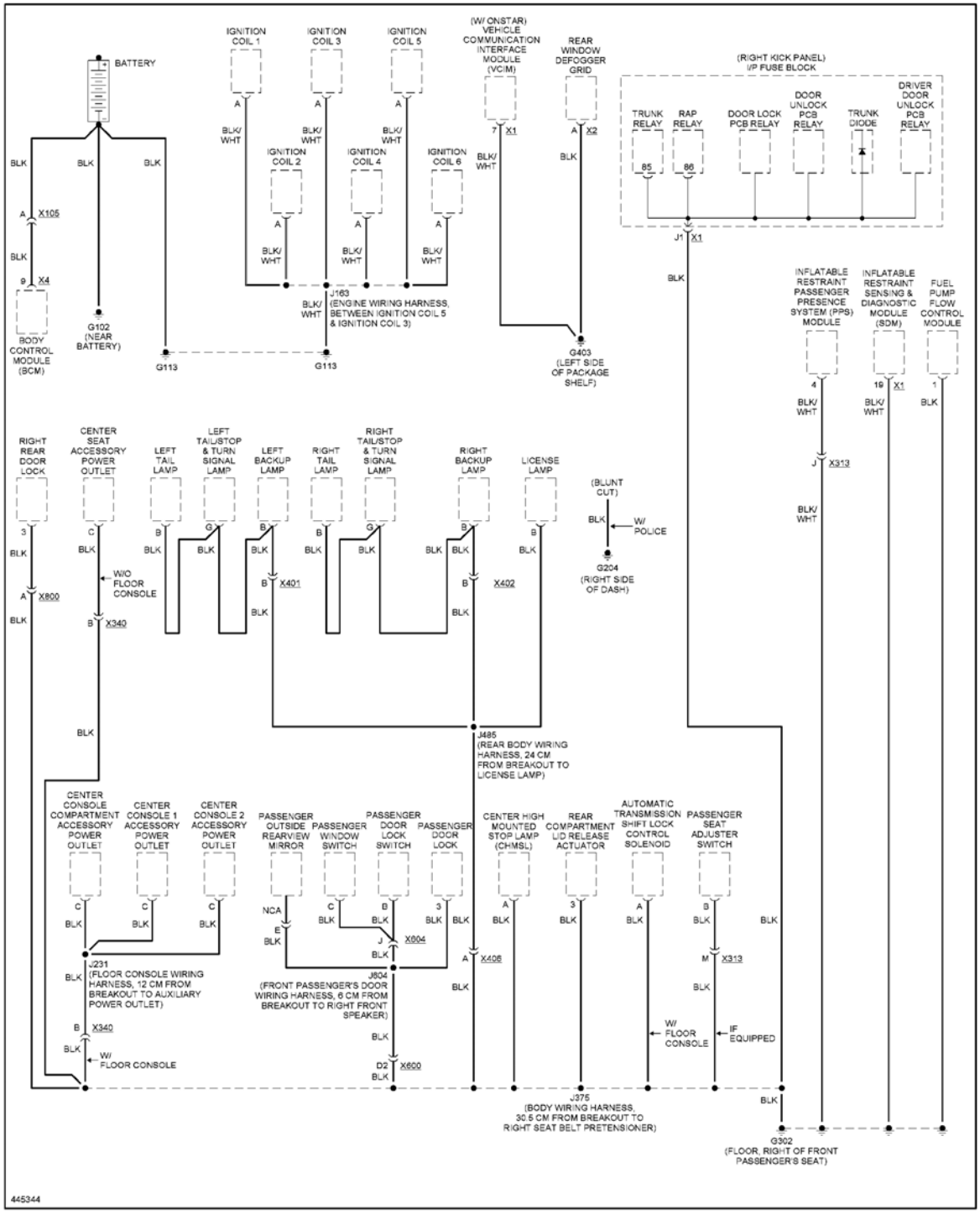


Fig. 24: Ground Distribution Circuit (2 of 3)

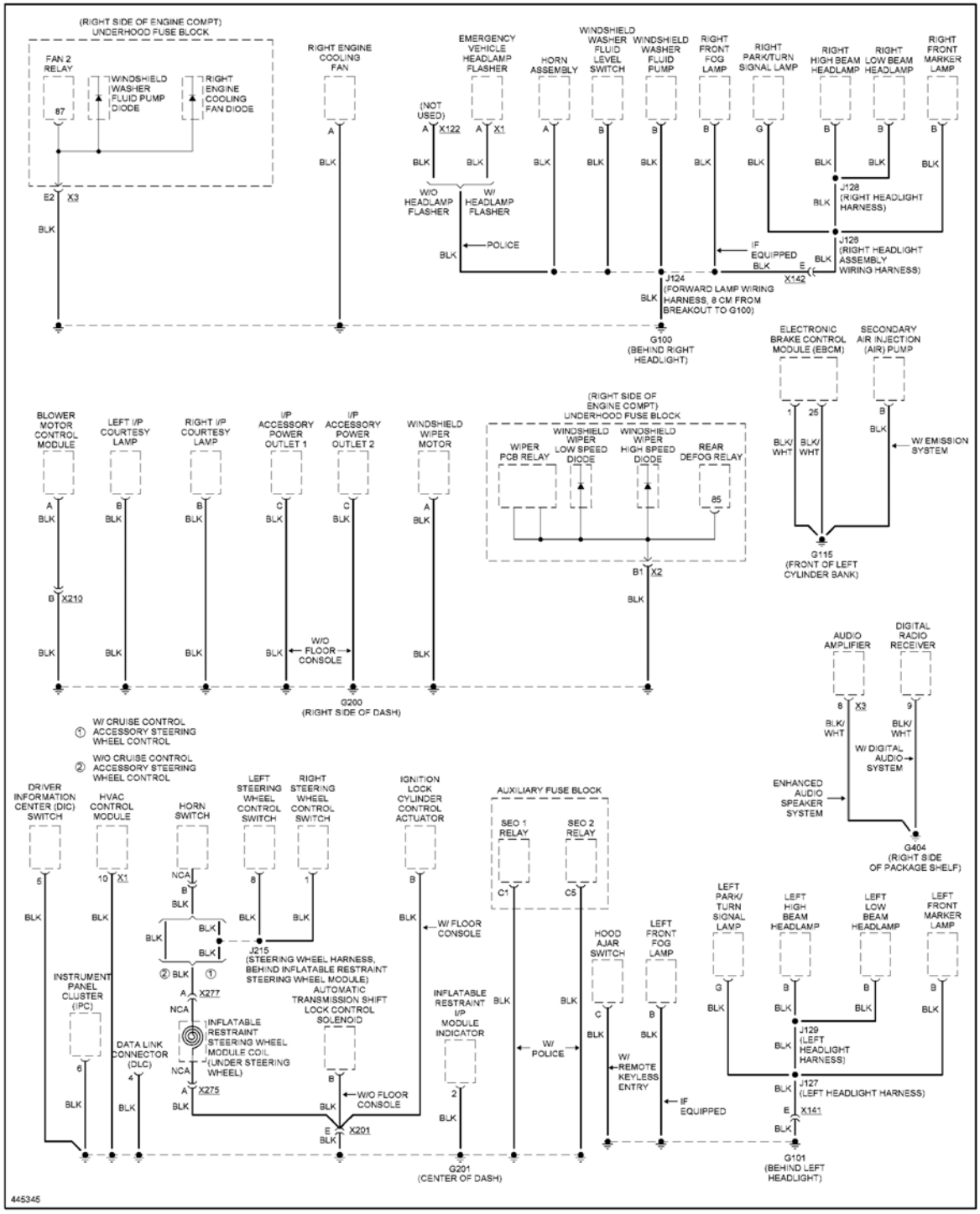


Fig. 25: Ground Distribution Circuit (3 of 3)

HEADLIGHTS

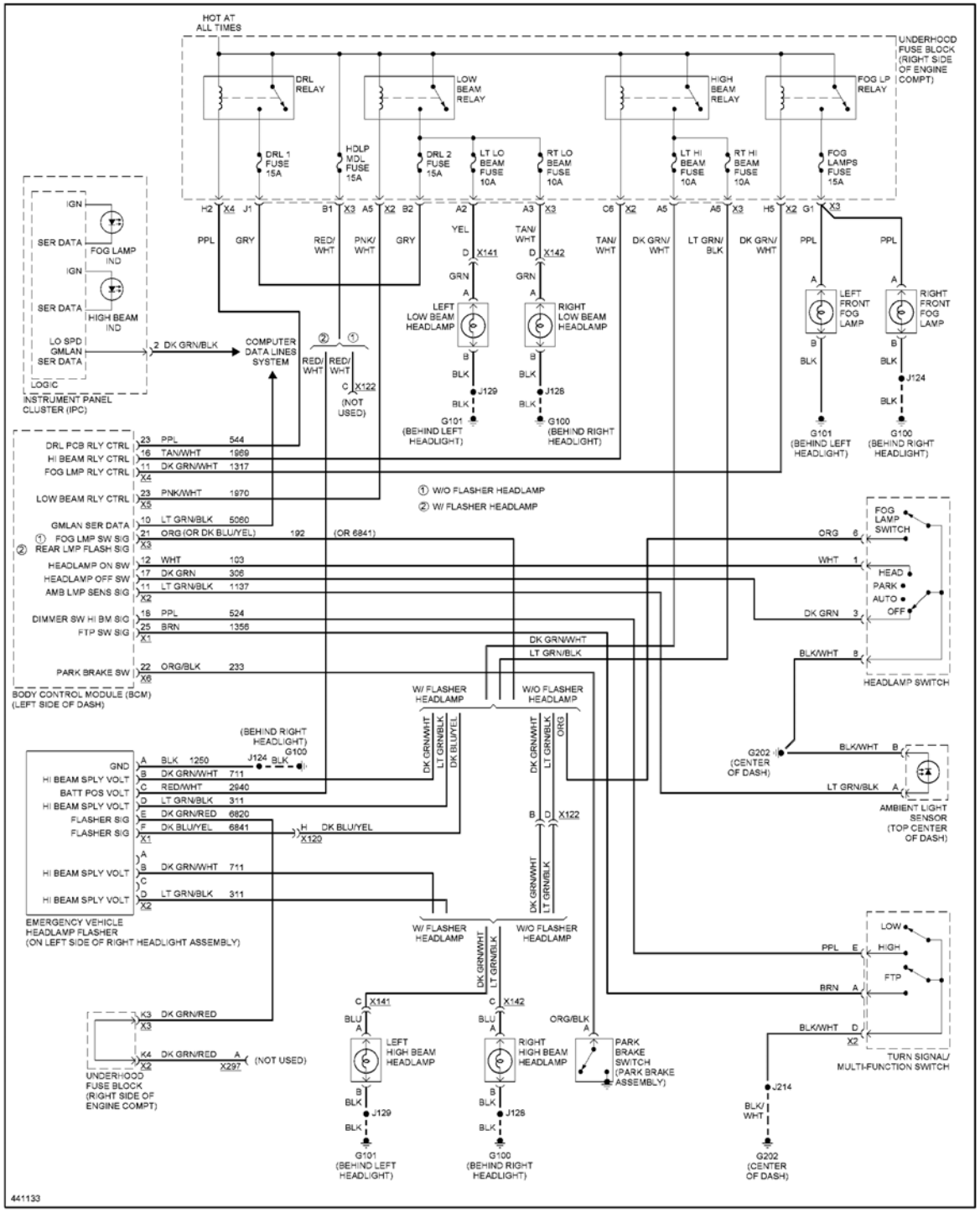


Fig. 26: Headlights Circuit, W/ Police

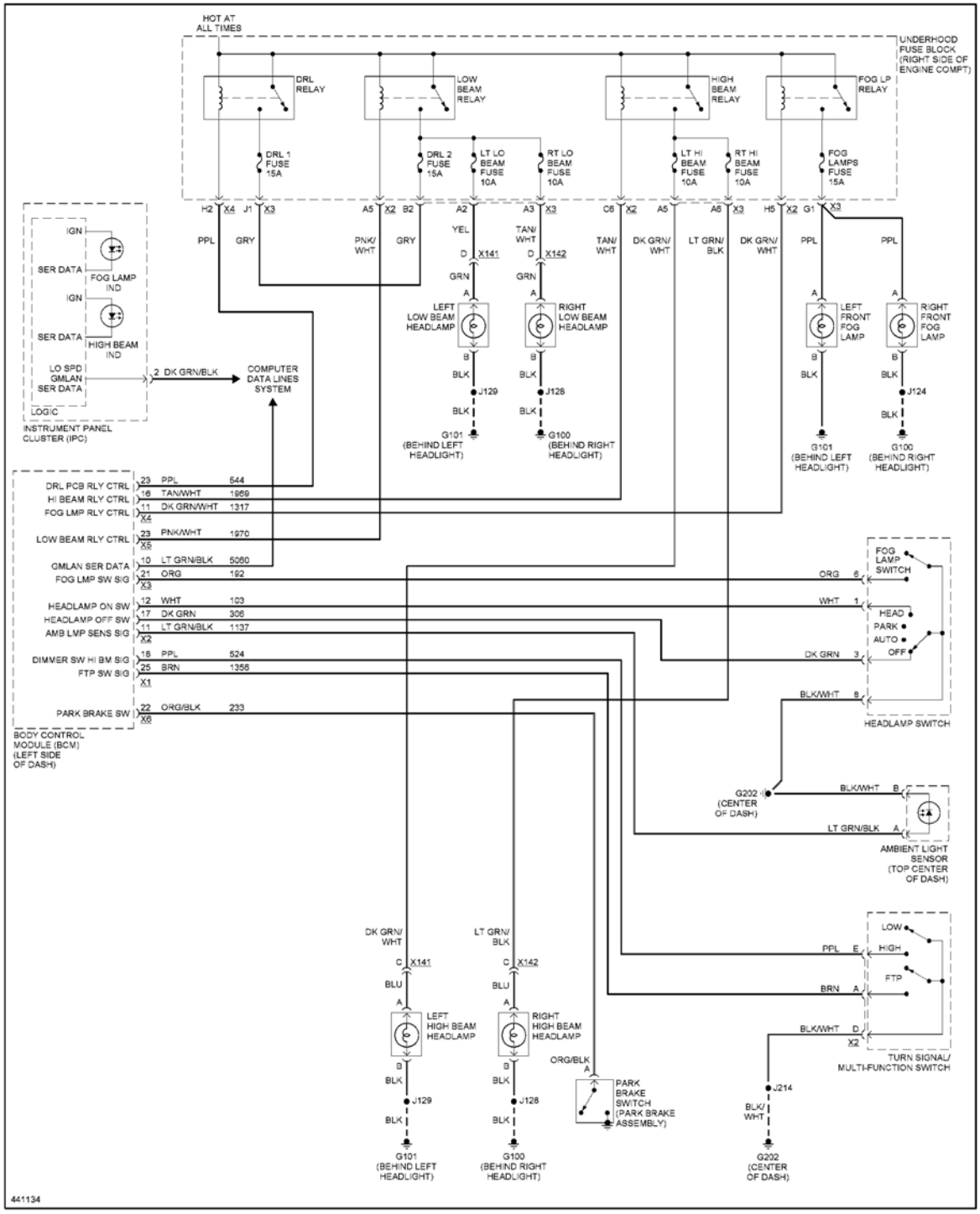


Fig. 27: Headlights Circuit, W/O Police

HORN

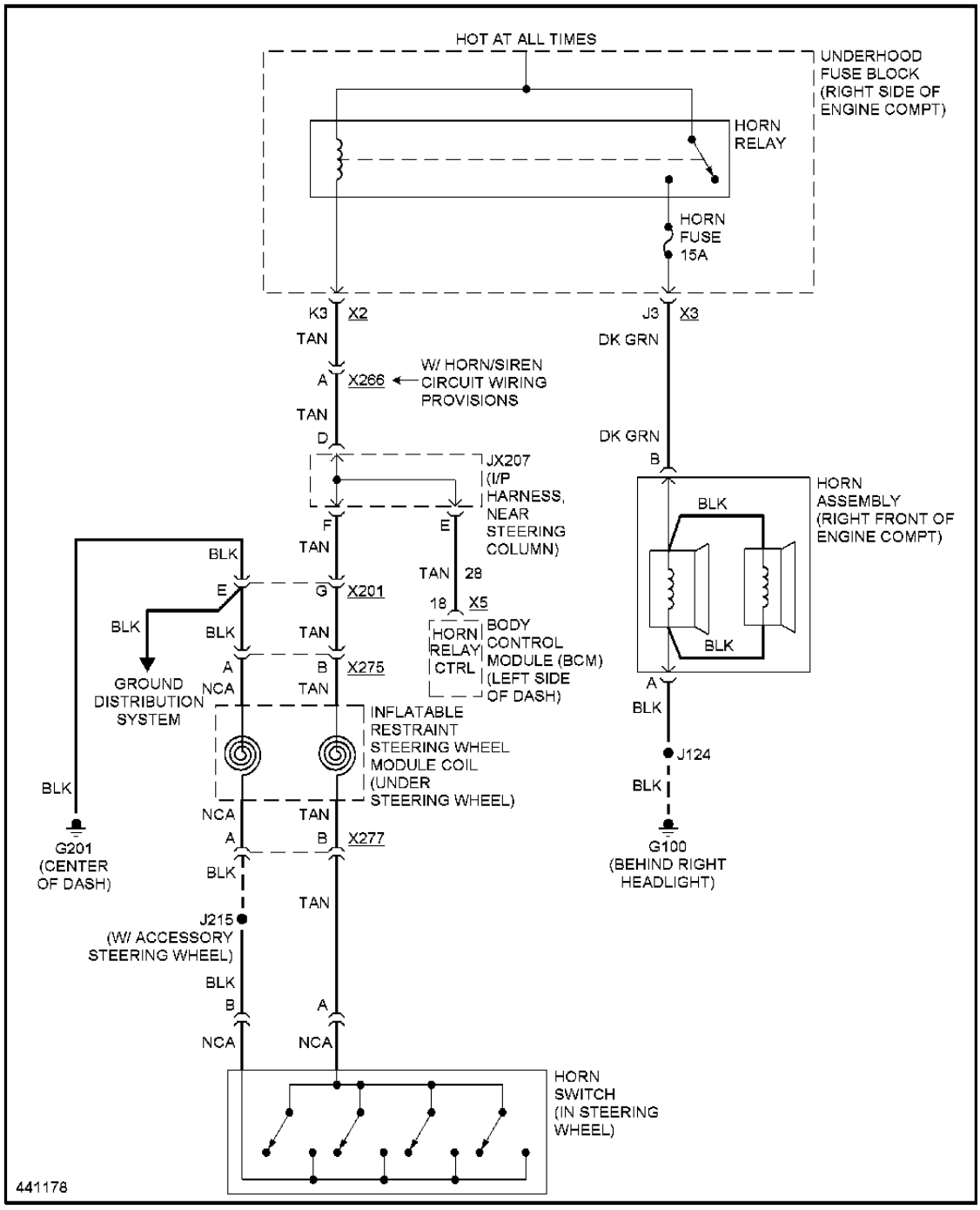


Fig. 28: Horn Circuit

INSTRUMENT CLUSTER

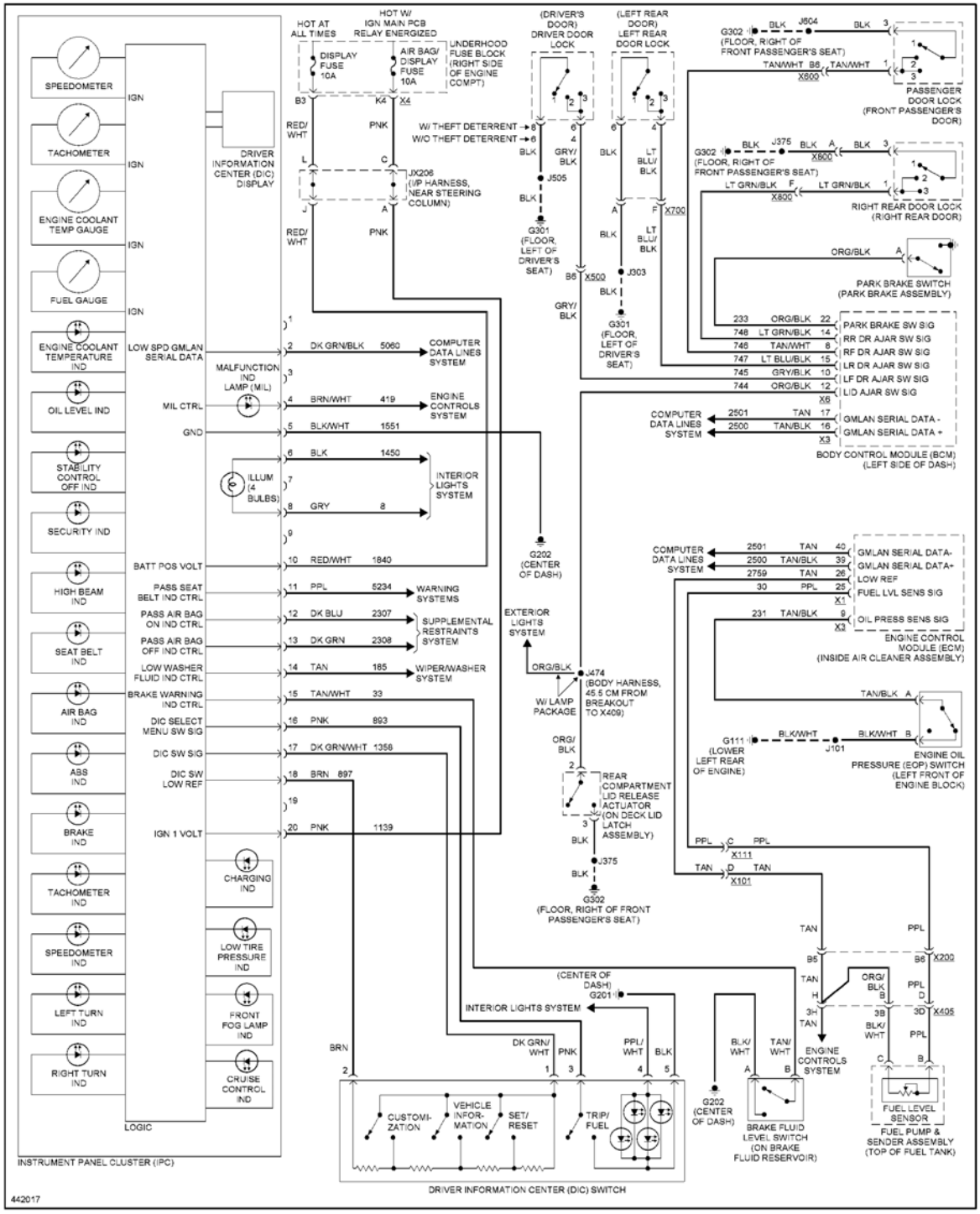


Fig. 29: Instrument Cluster Circuit

INTERIOR LIGHTS

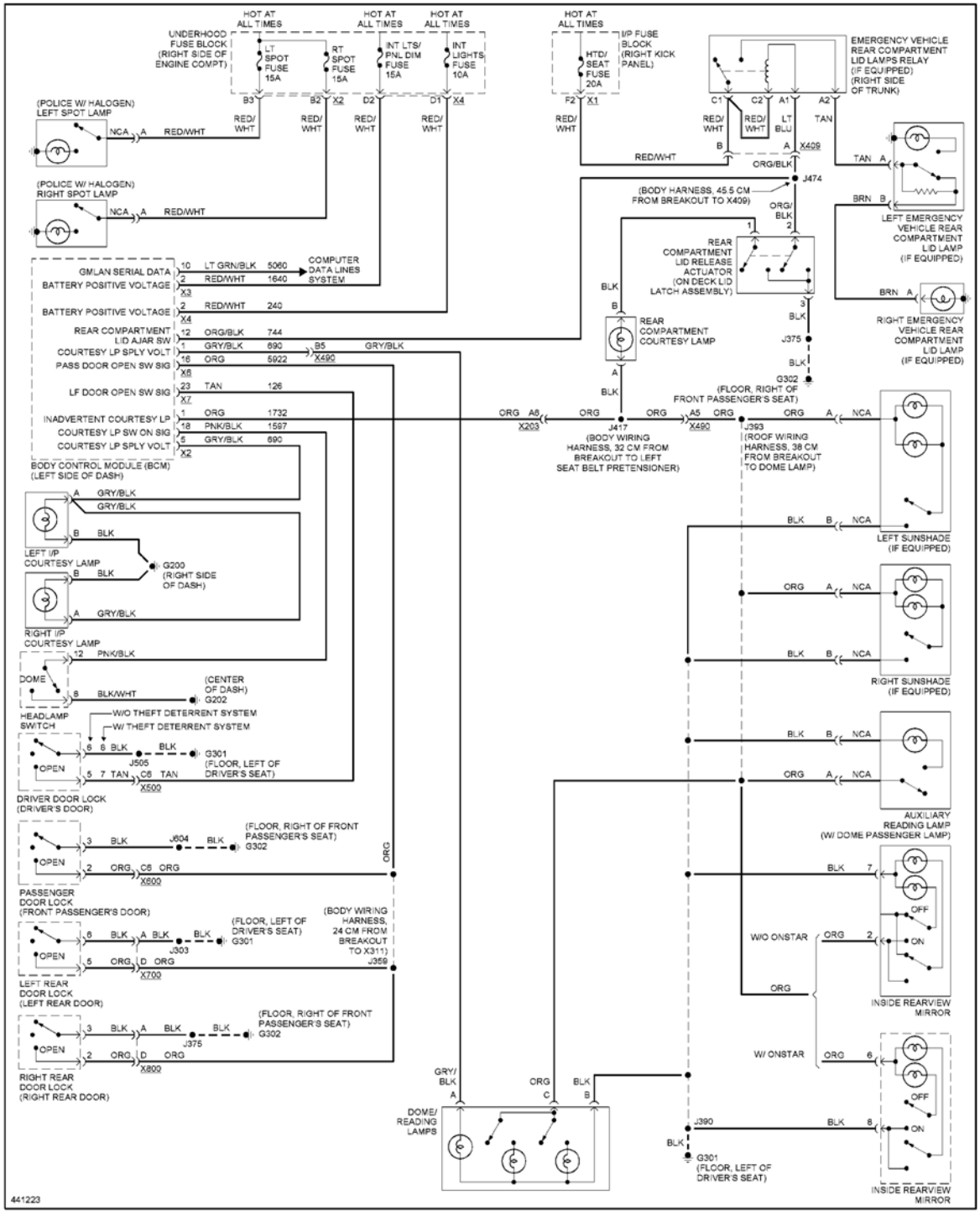


Fig. 30: Courtesy Lamps Circuit

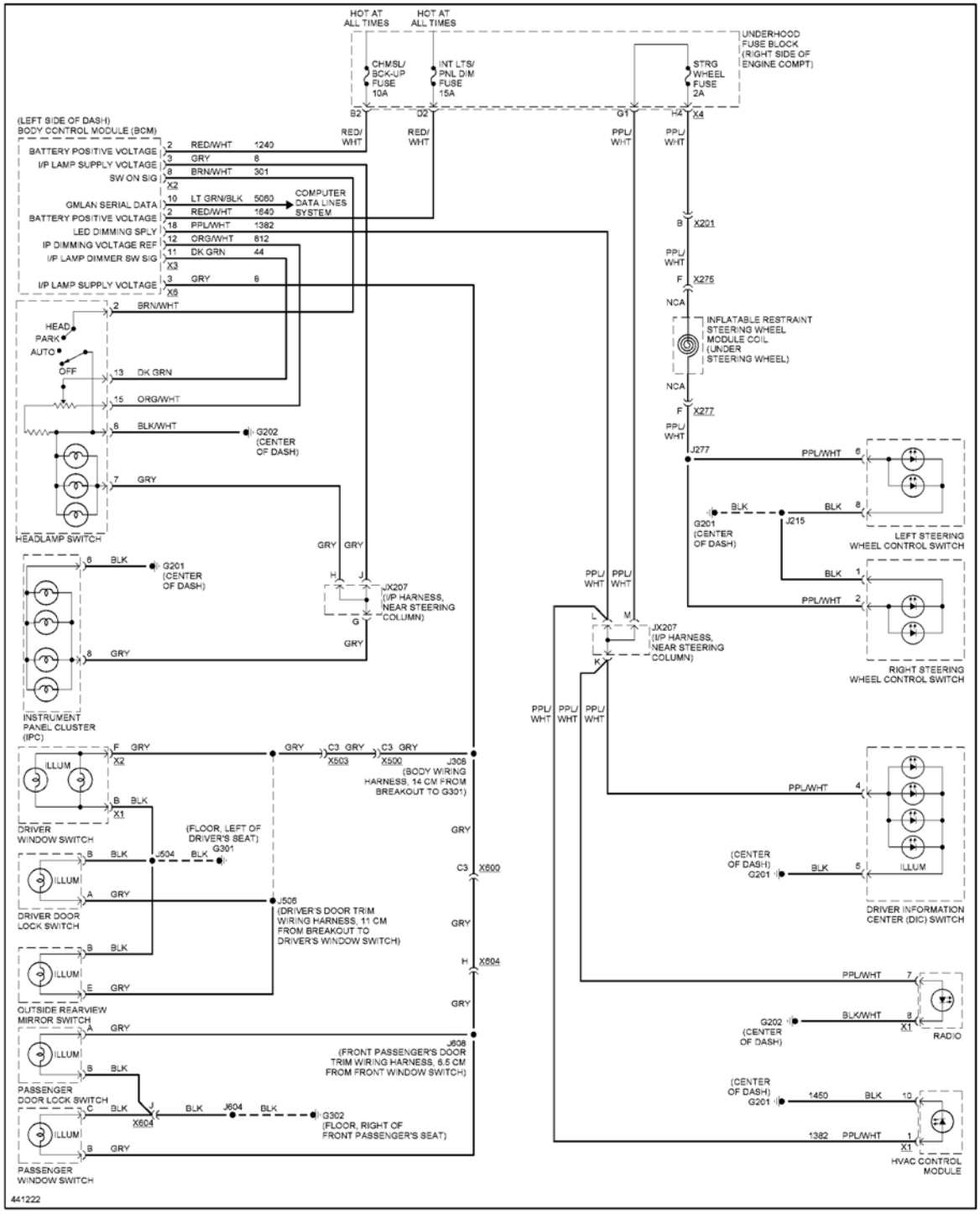


Fig. 31: Instrument Illumination Circuit

NAVIGATION

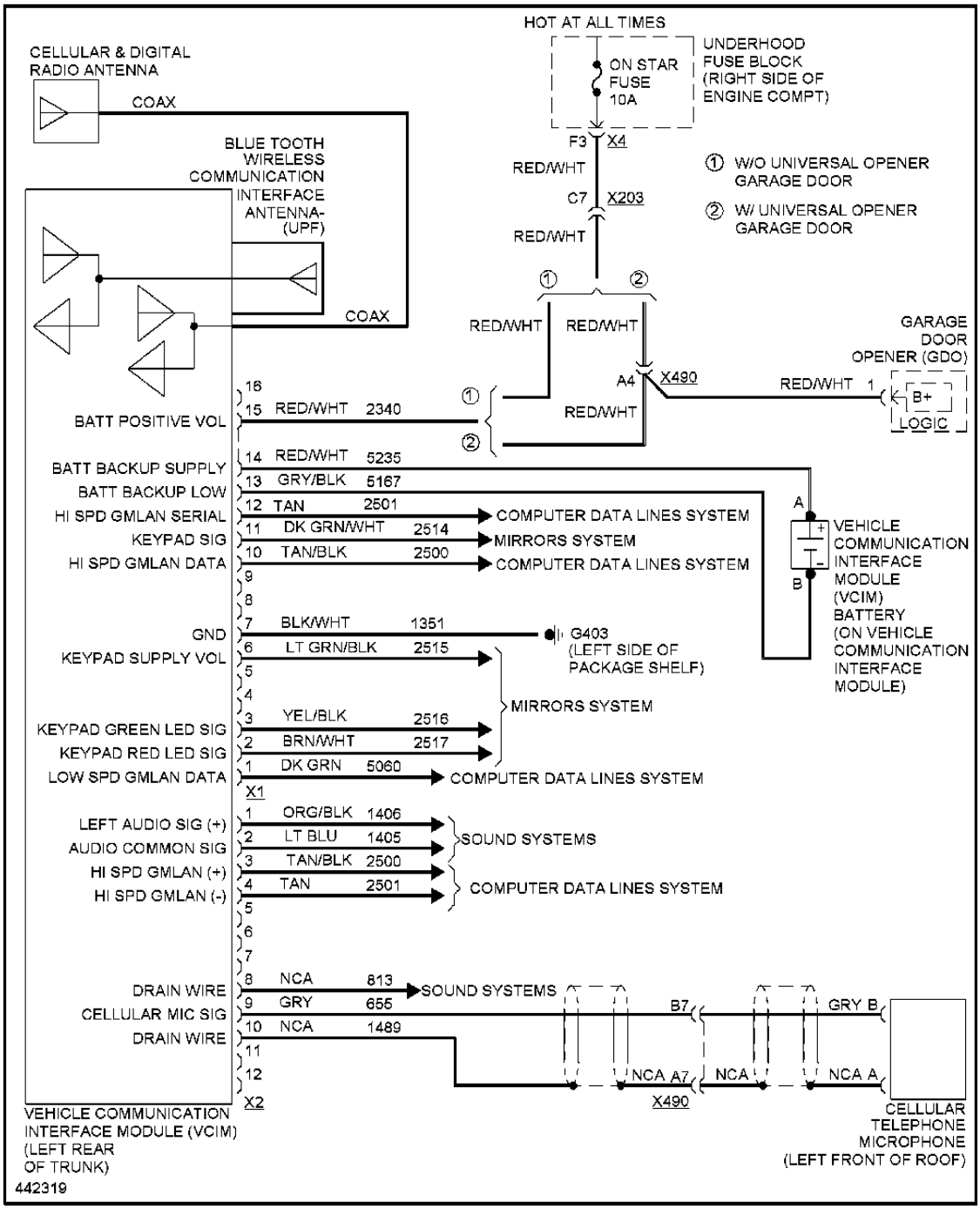


Fig. 32: Navigation Circuit

POWER DISTRIBUTION

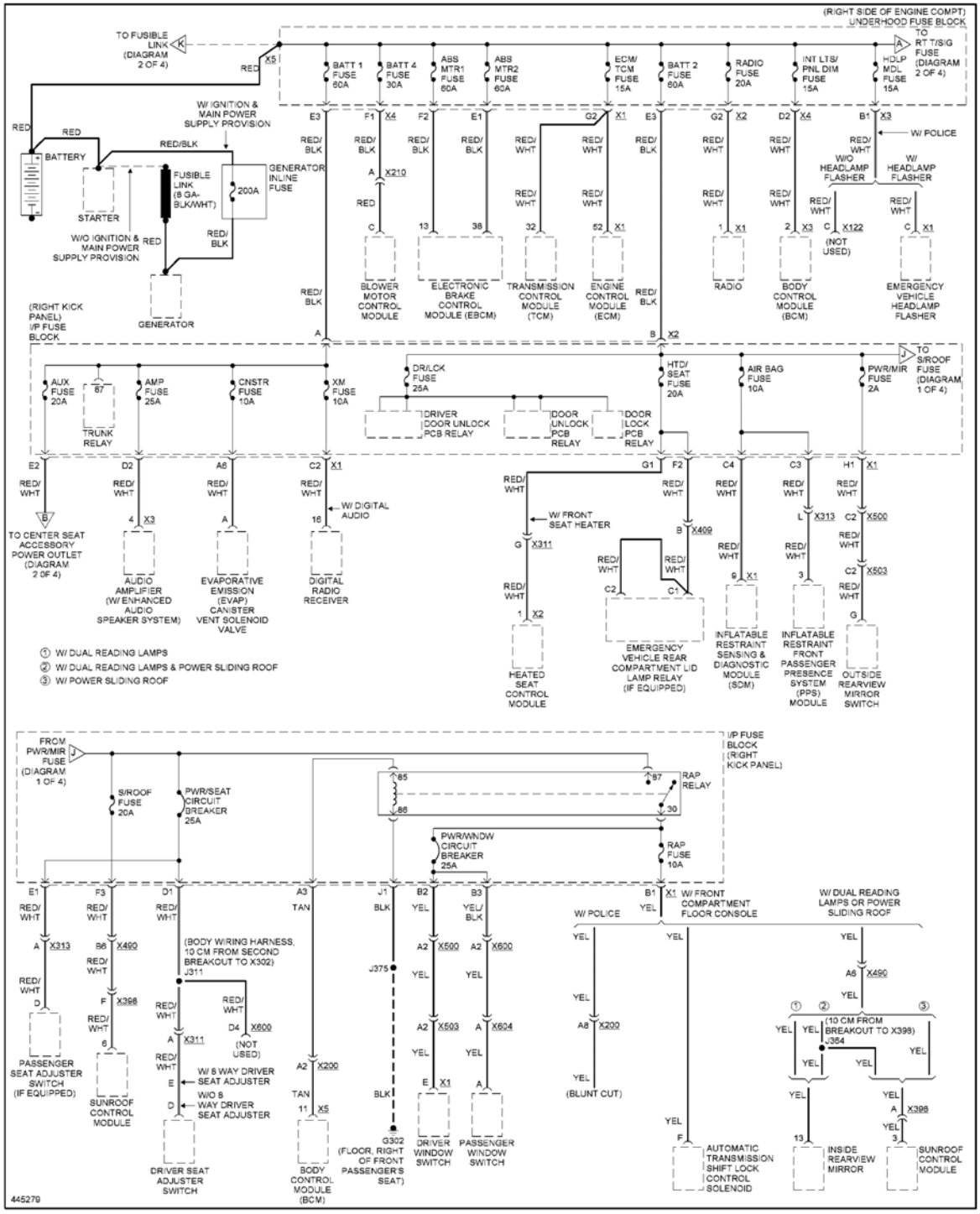


Fig. 33: Power Distribution Circuit (1 of 4)

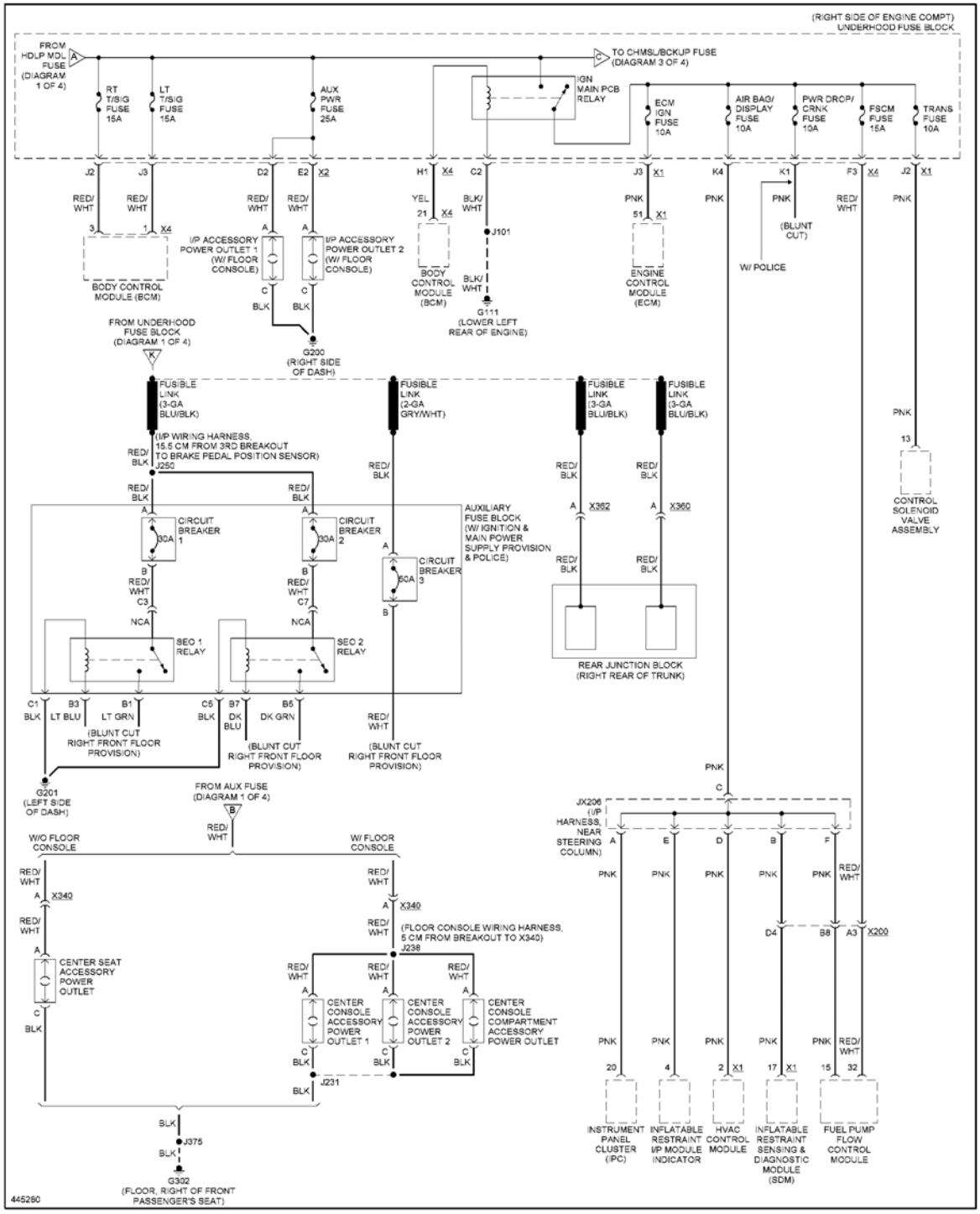


Fig. 34: Power Distribution Circuit (2 of 4)

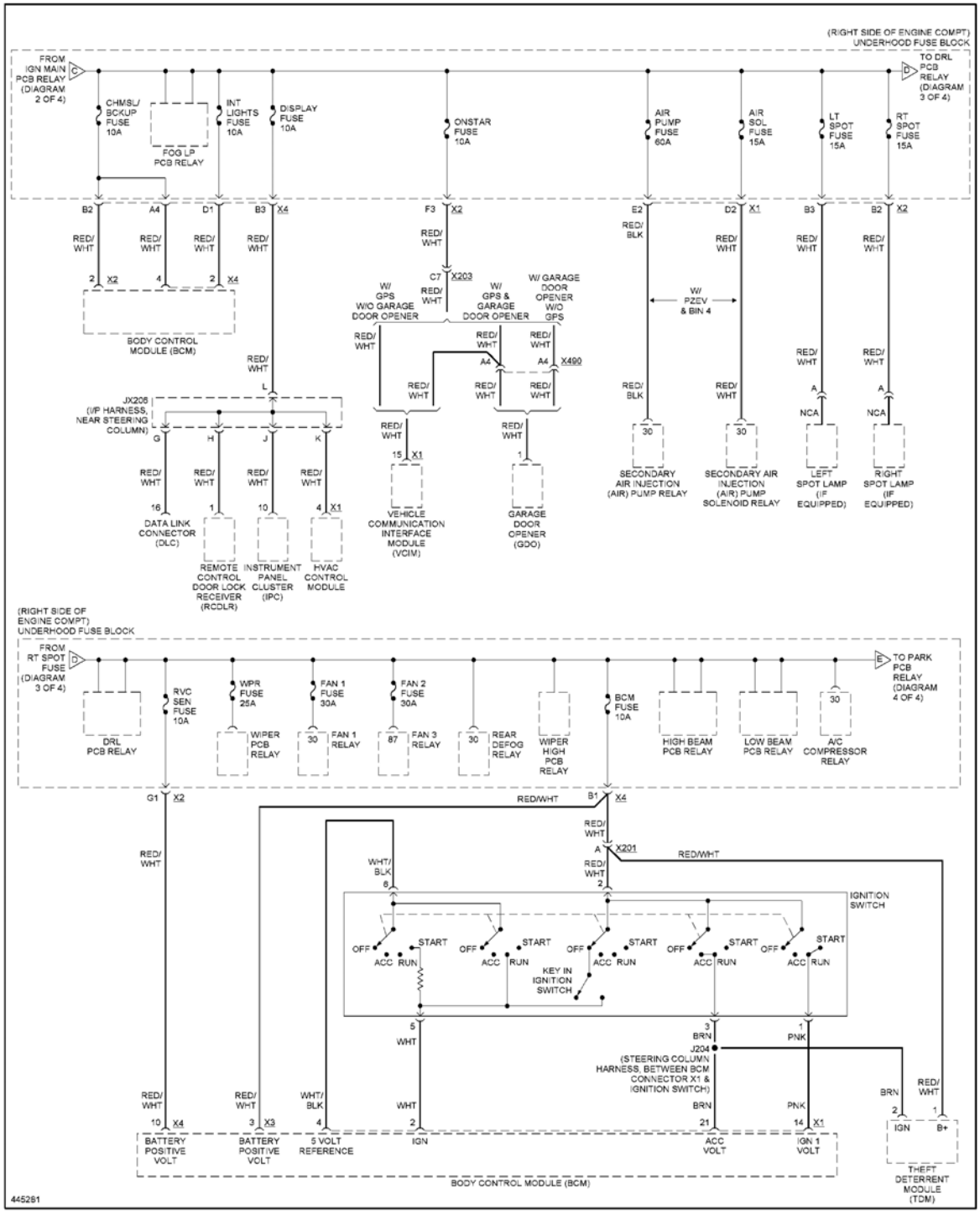


Fig. 35: Power Distribution Circuit (3 of 4)

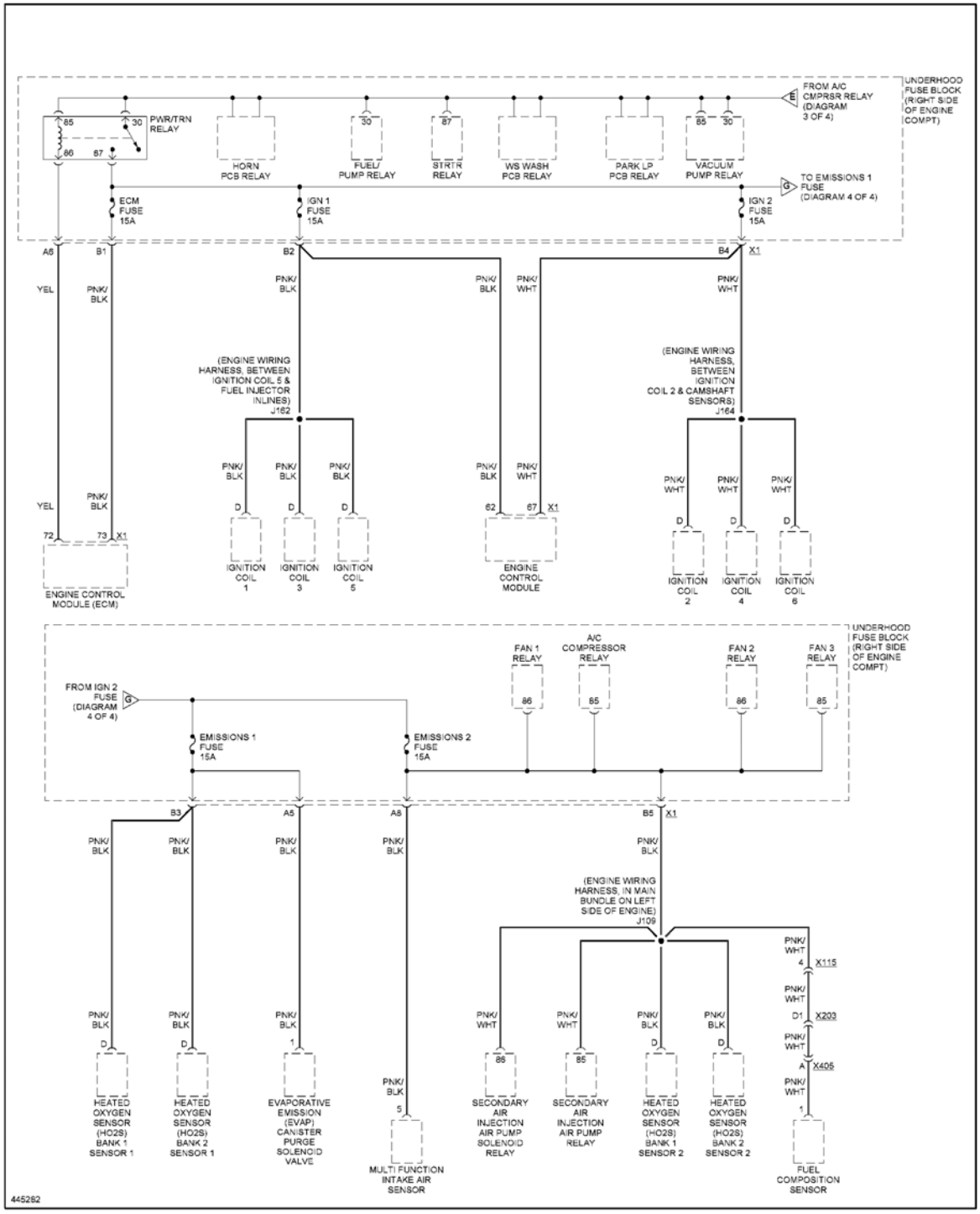


Fig. 36: Power Distribution Circuit (4 of 4)

POWER DOOR LOCKS

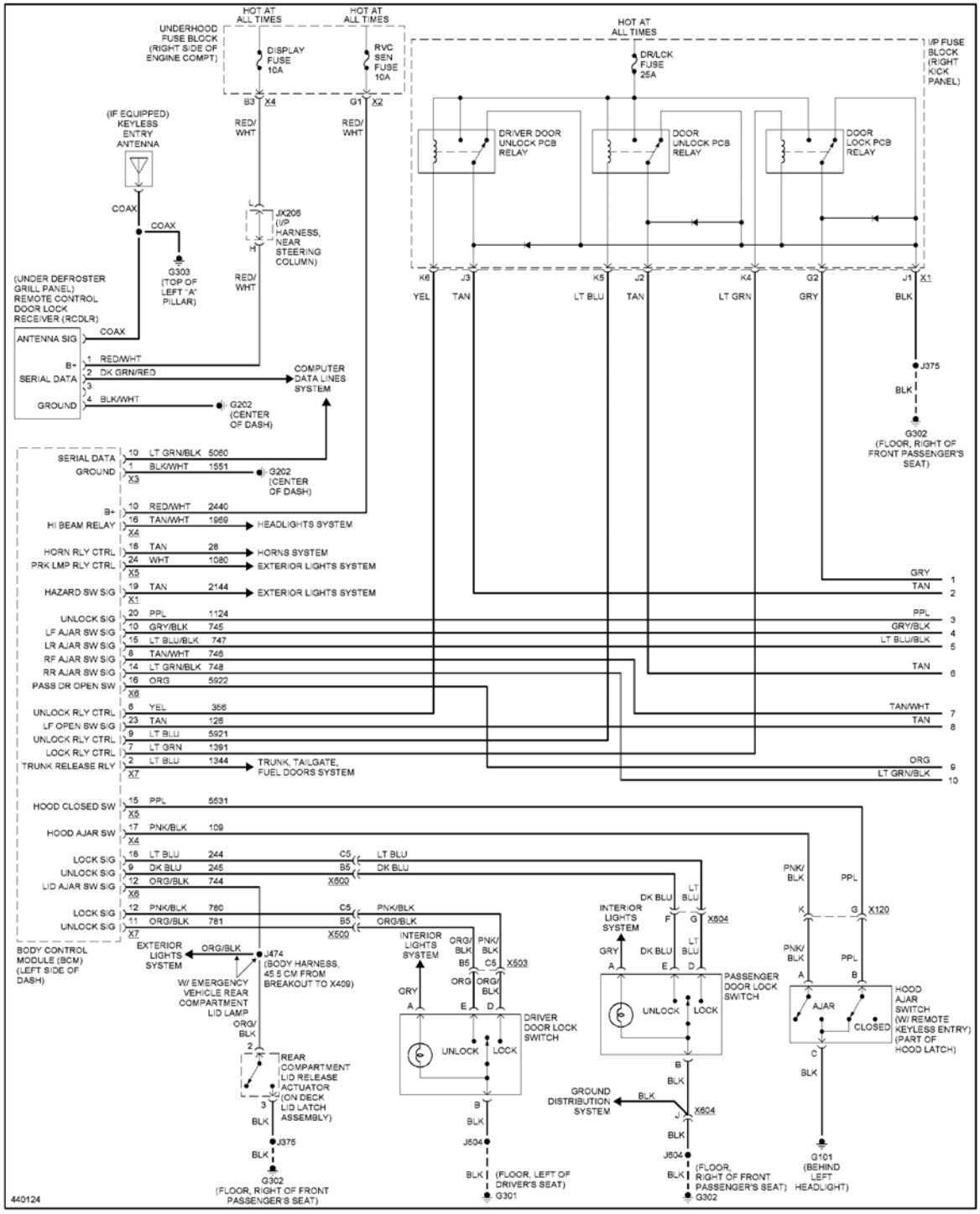


Fig. 37: Power Door Locks Circuit (1 of 2)

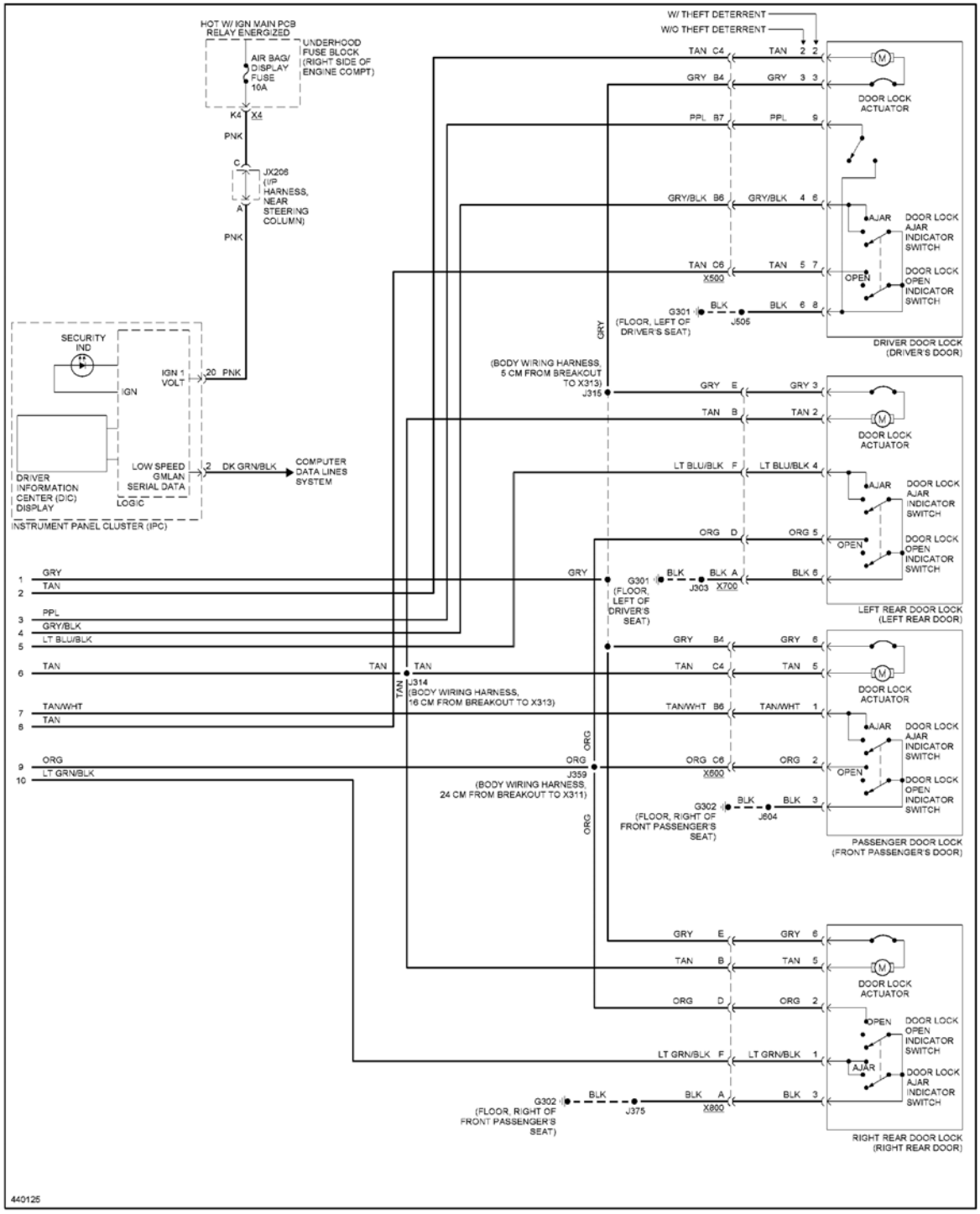


Fig. 38: Power Door Locks Circuit (2 of 2)

POWER MIRRORS

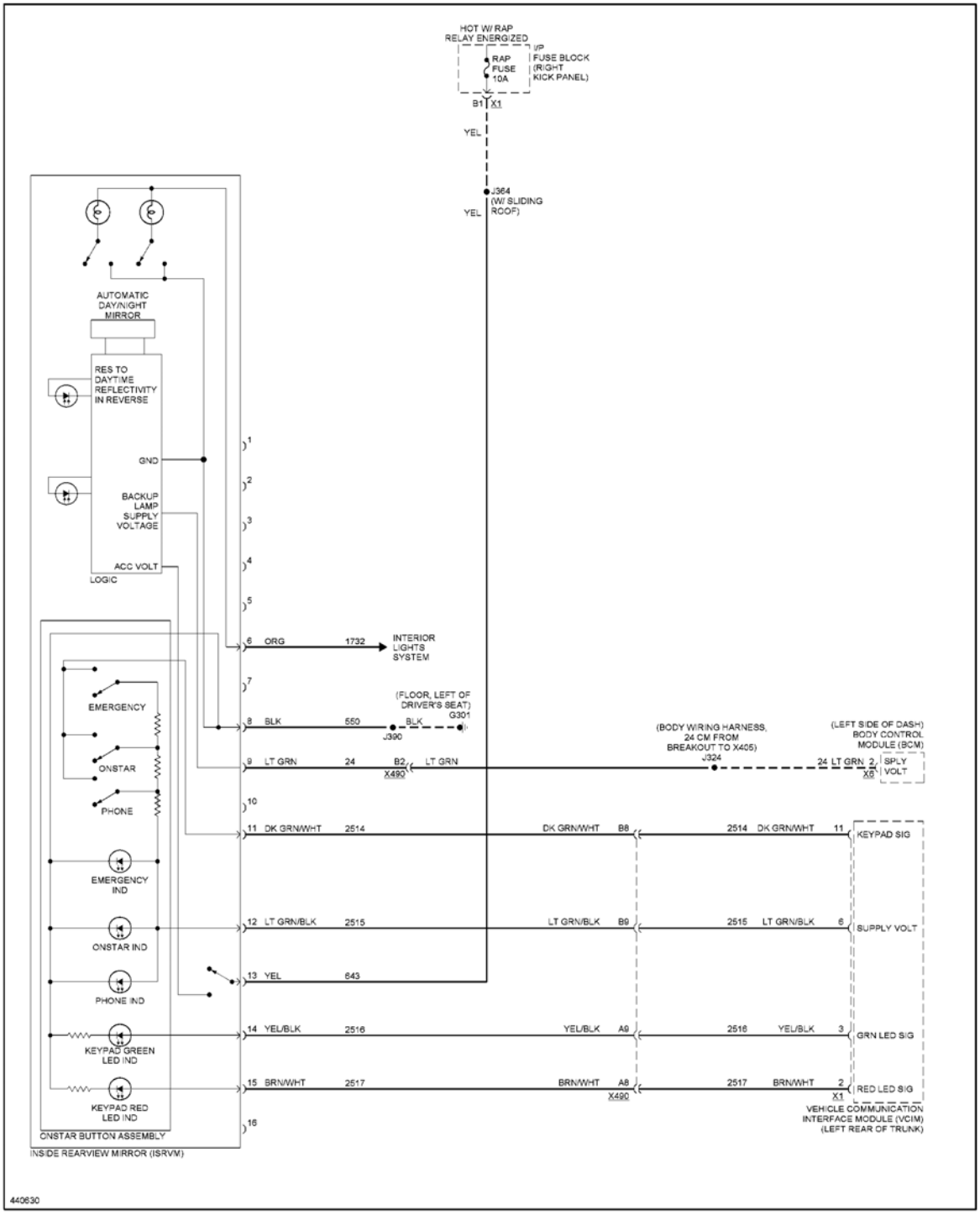


Fig. 39: Electrochromic Mirror Circuit

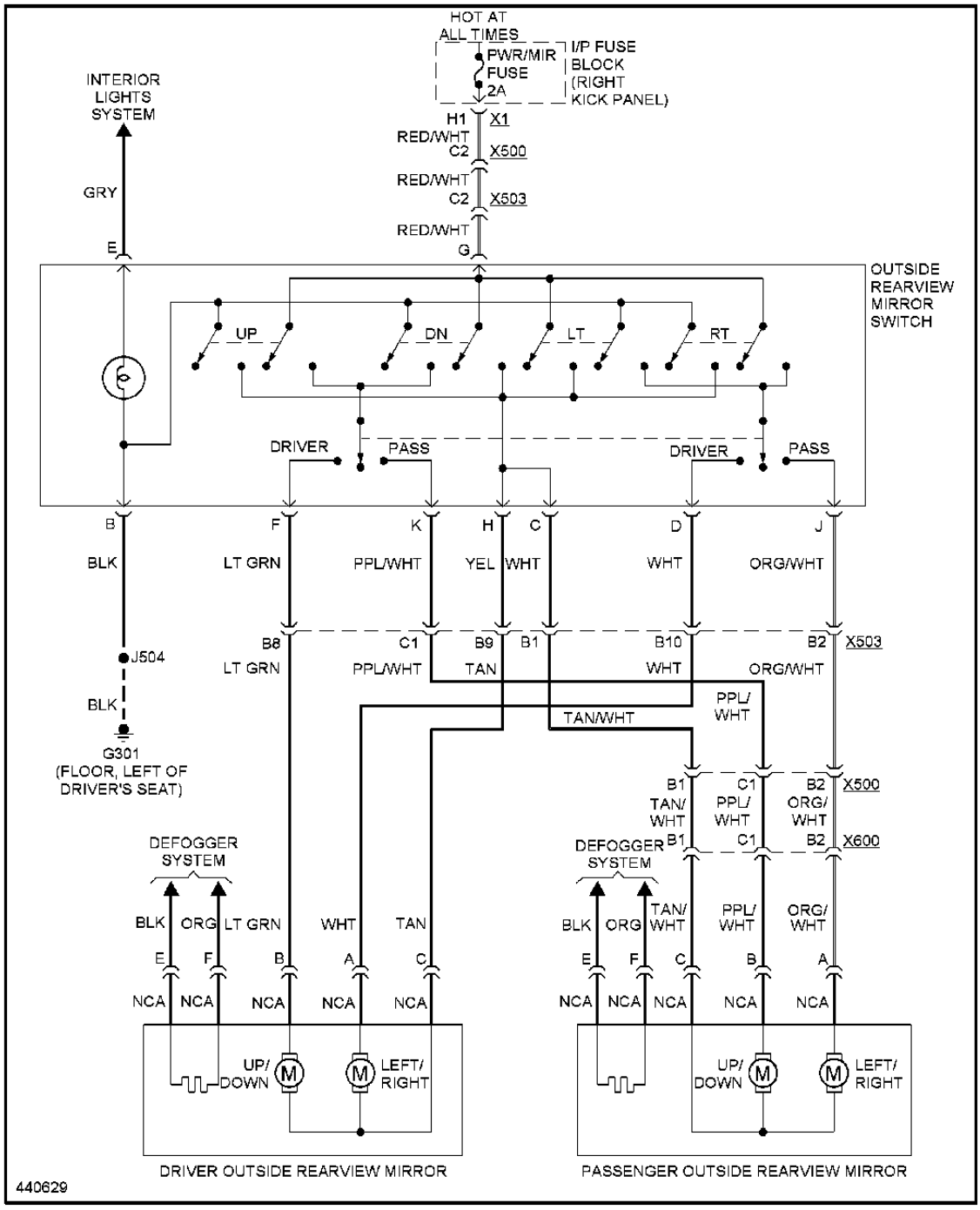


Fig. 40: Power Mirrors Circuit

POWER SEATS

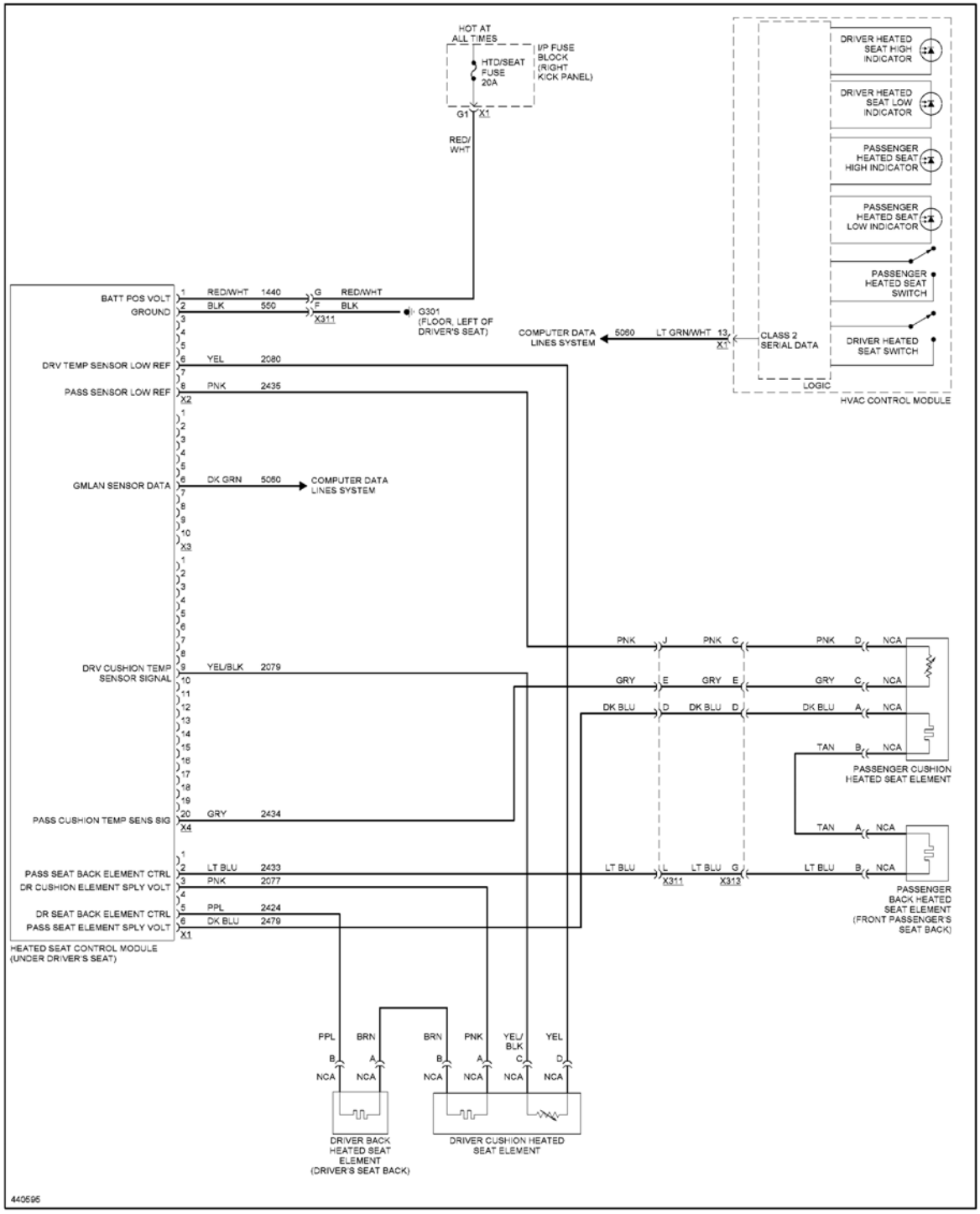


Fig. 41: Heated Seats Circuit

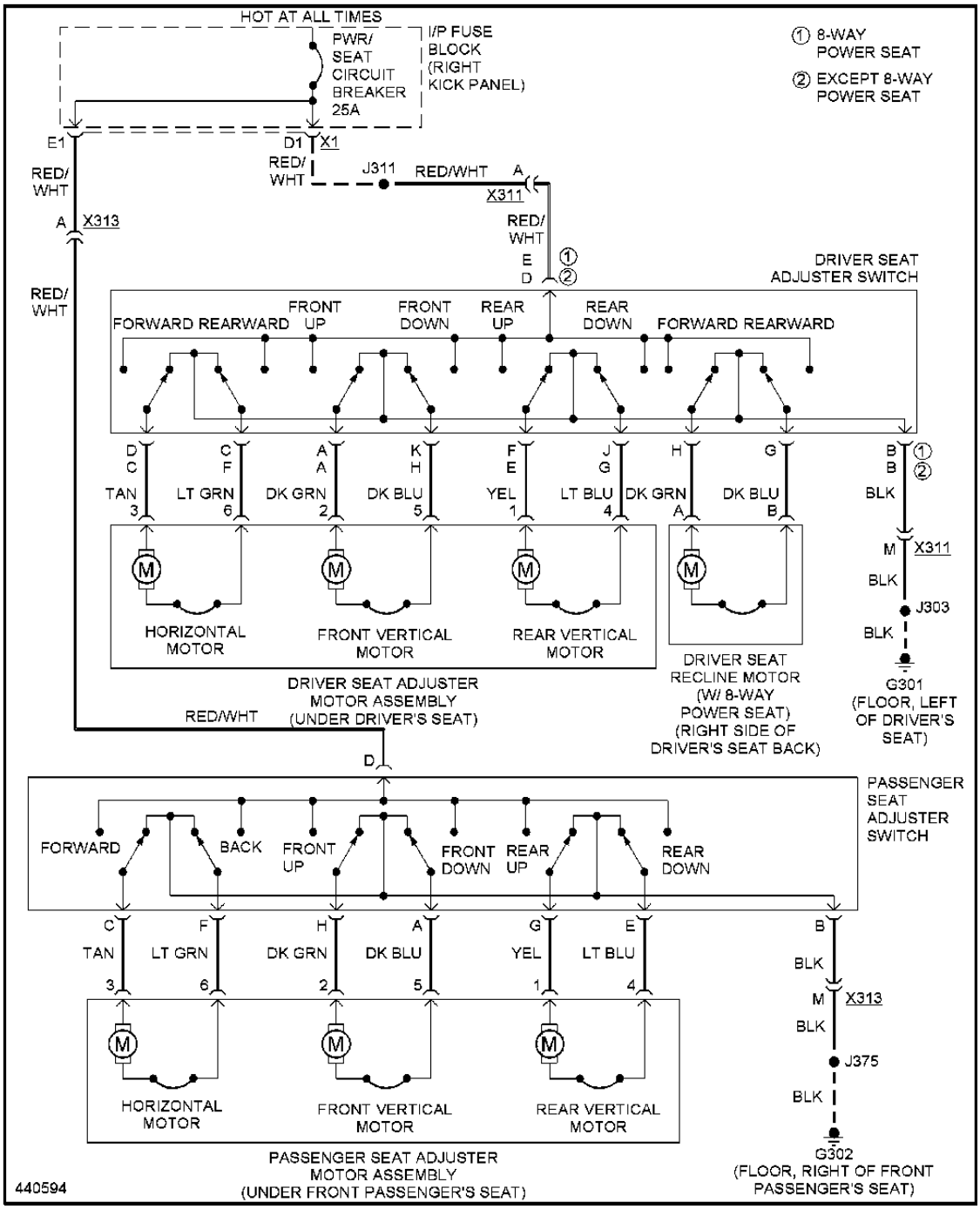


Fig. 42: Power Seat Circuit

POWER TOP/SUNROOF

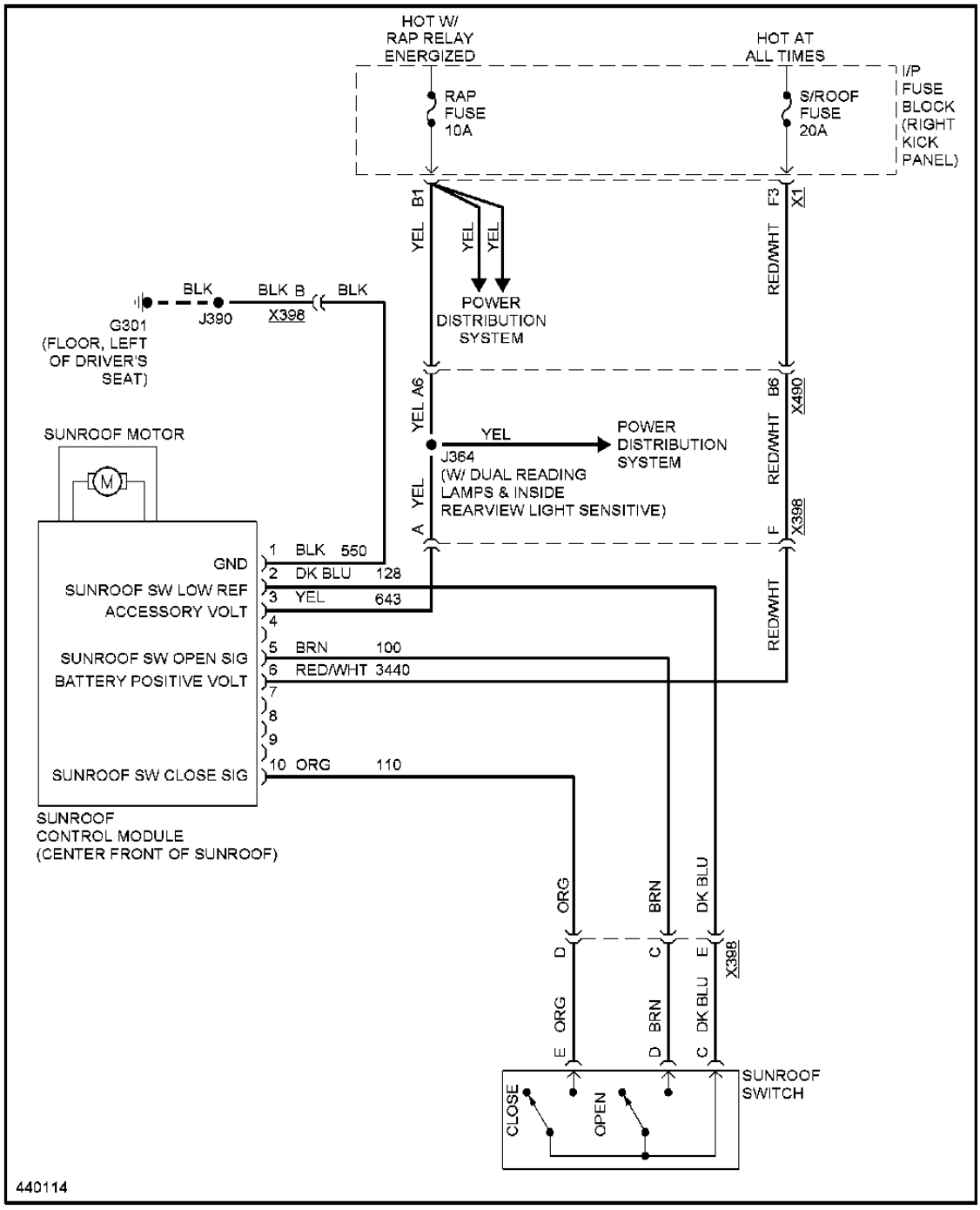


Fig. 43: Power Top/Sunroof Circuit

POWER WINDOWS

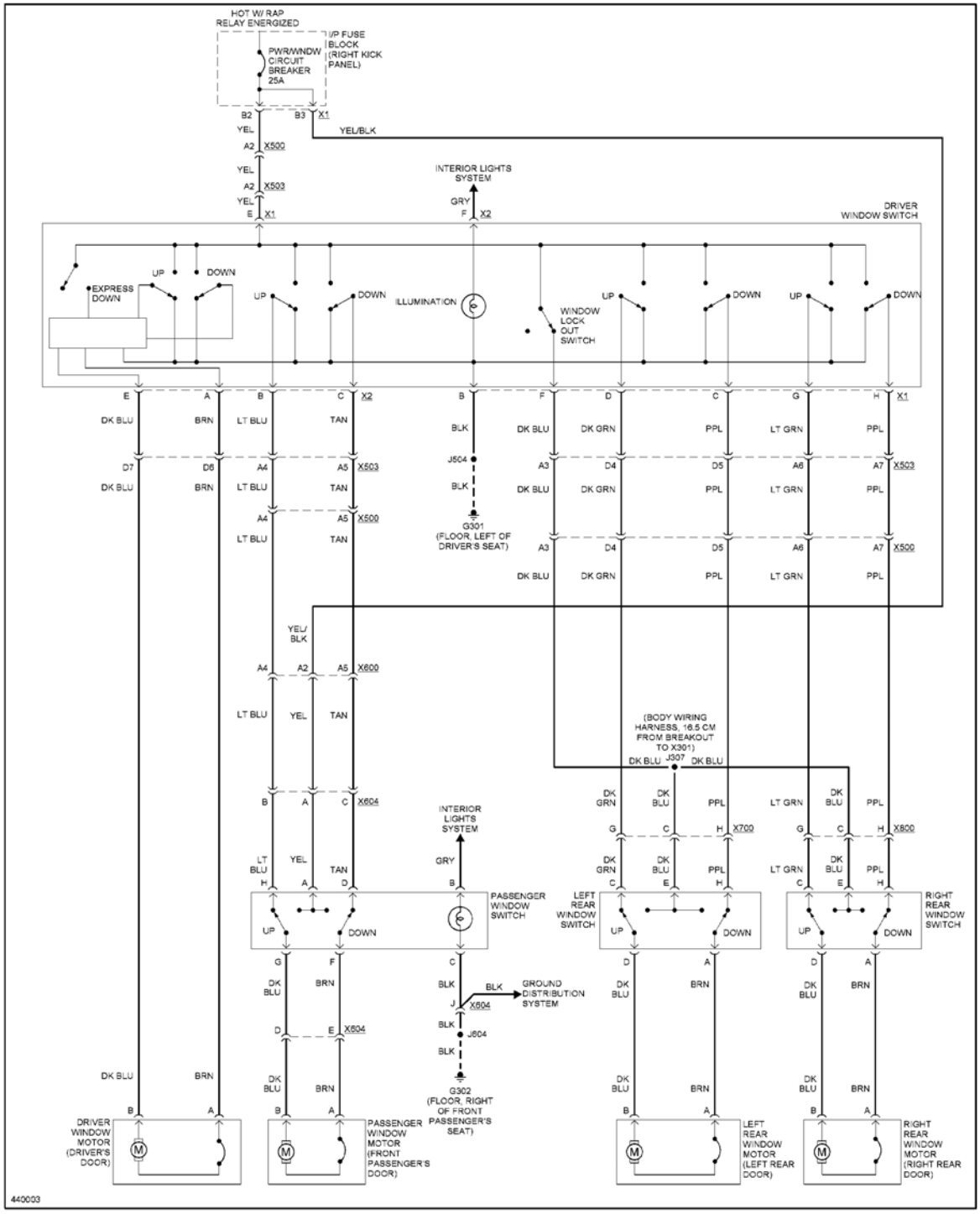


Fig. 44: Power Windows Circuit

RADIO

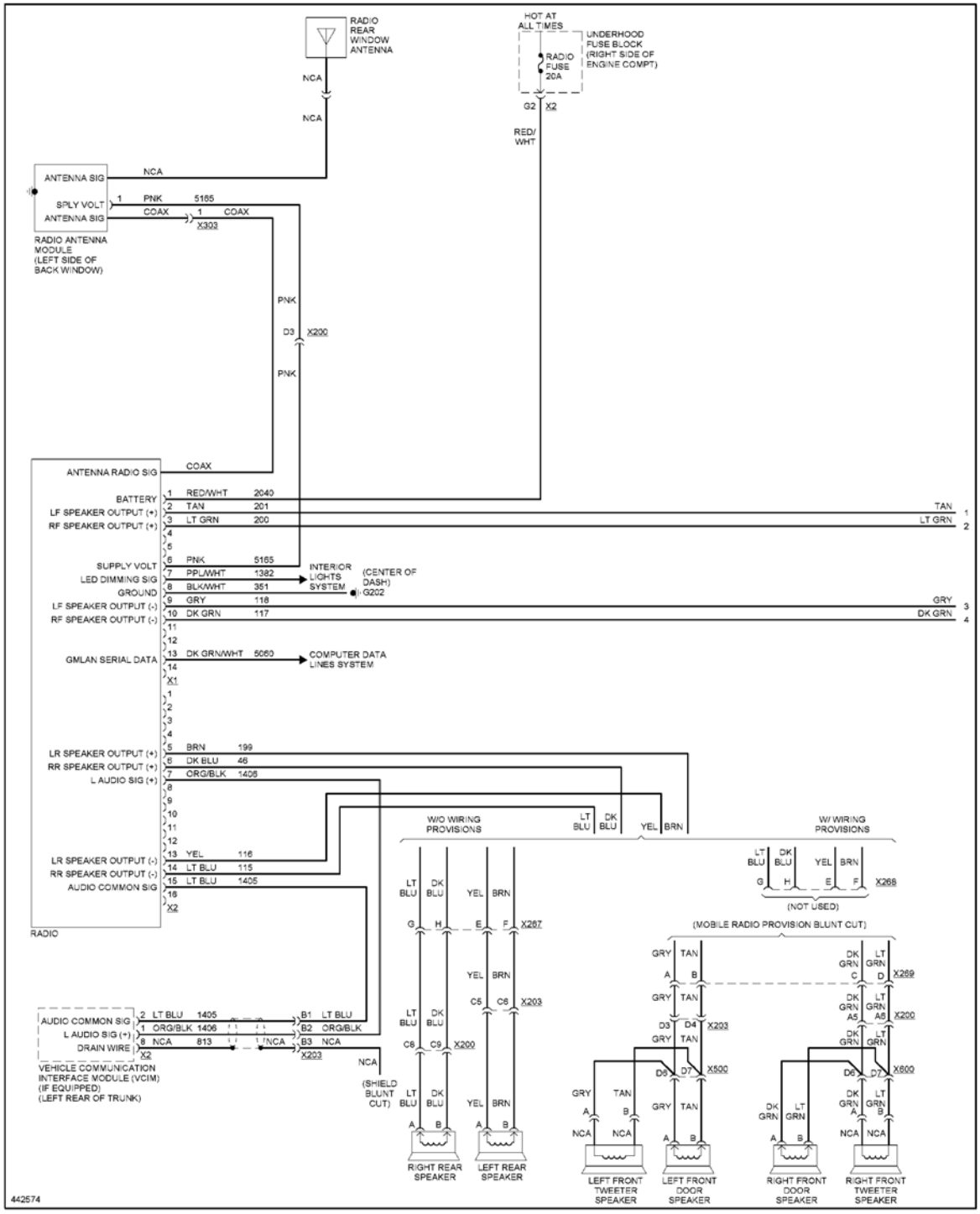


Fig. 45: Radio Circuit, Police Option (1 of 2)

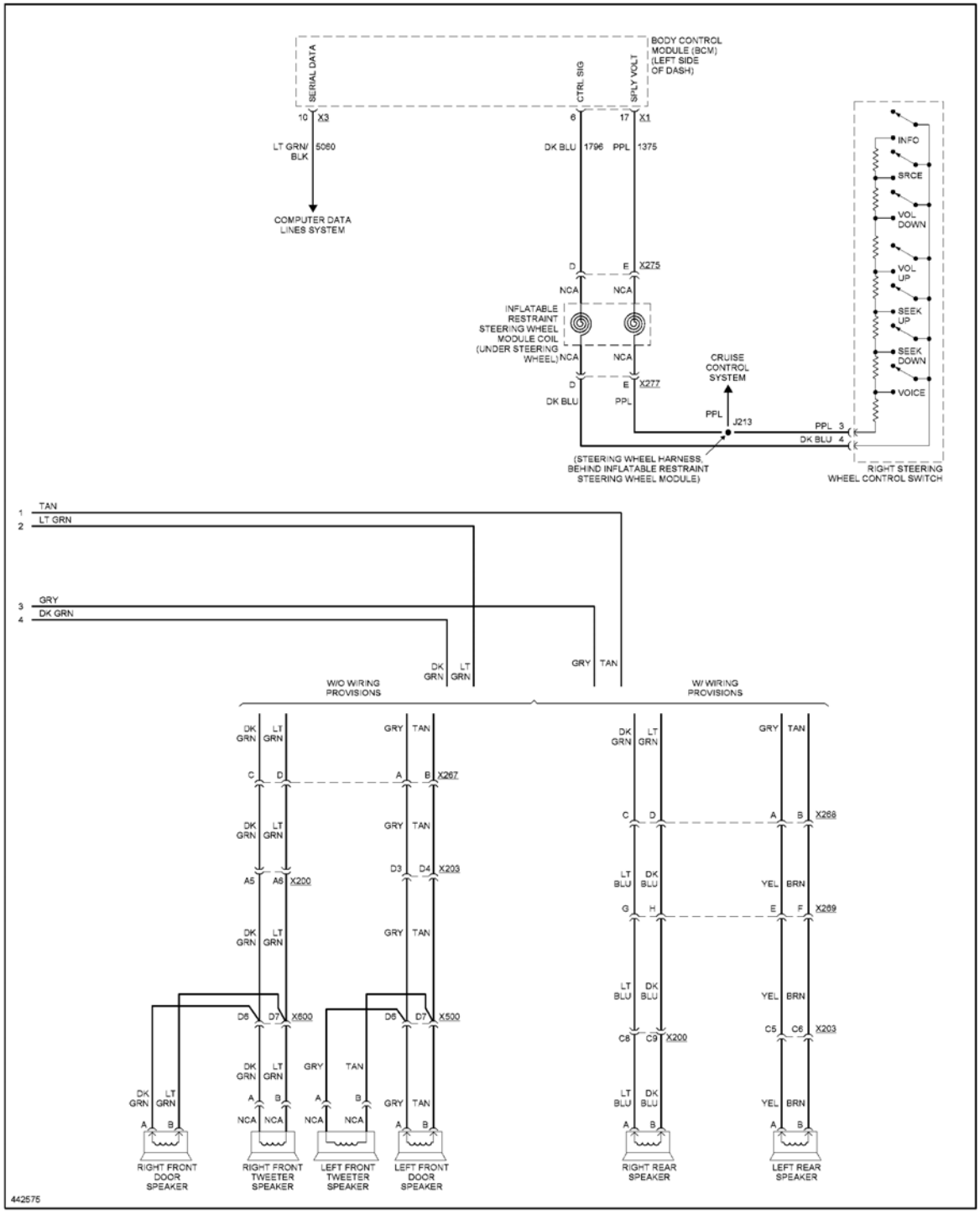


Fig. 46: Radio Circuit, Police Option (2 of 2)

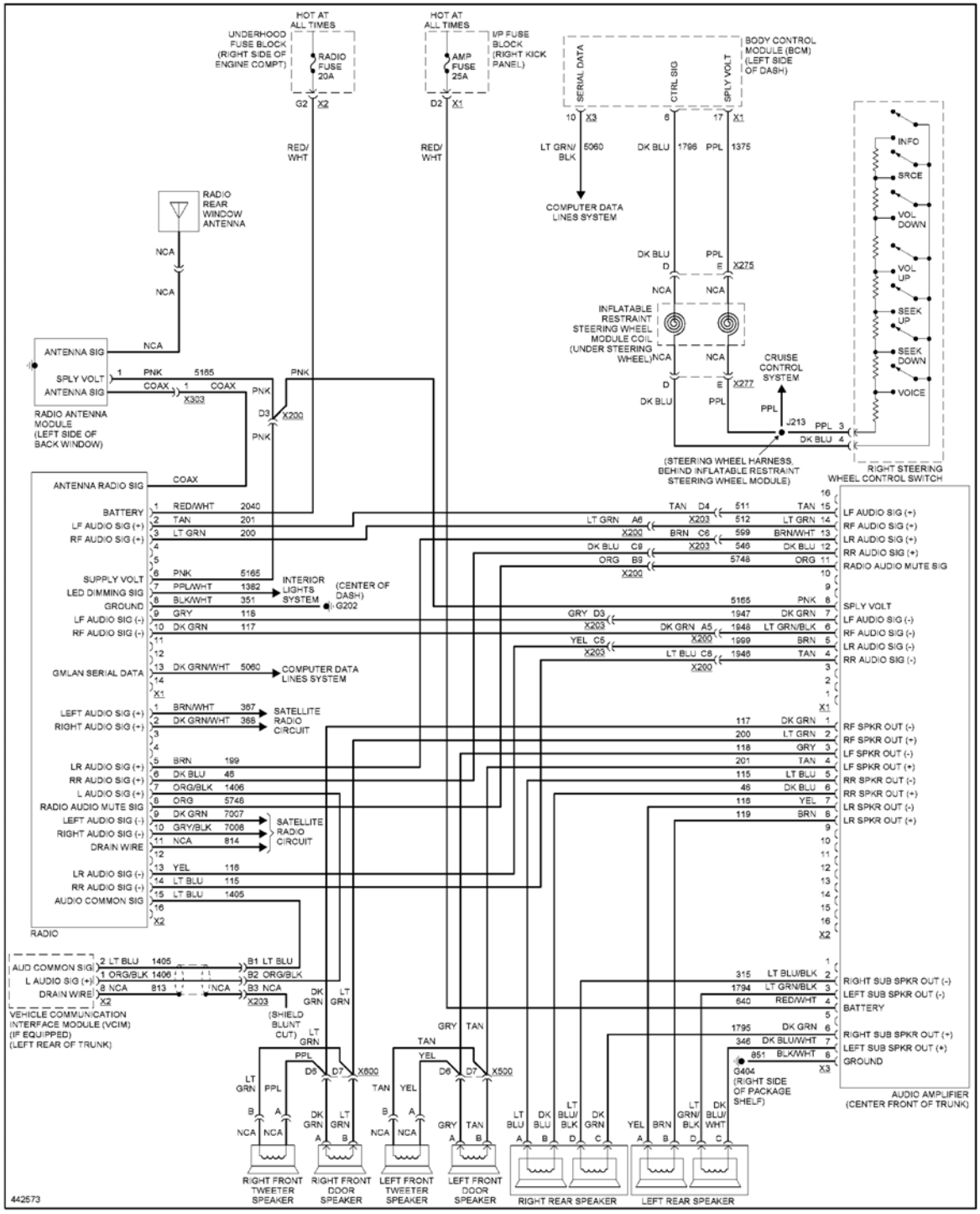


Fig. 47: Radio Circuit, W/ Amplifier

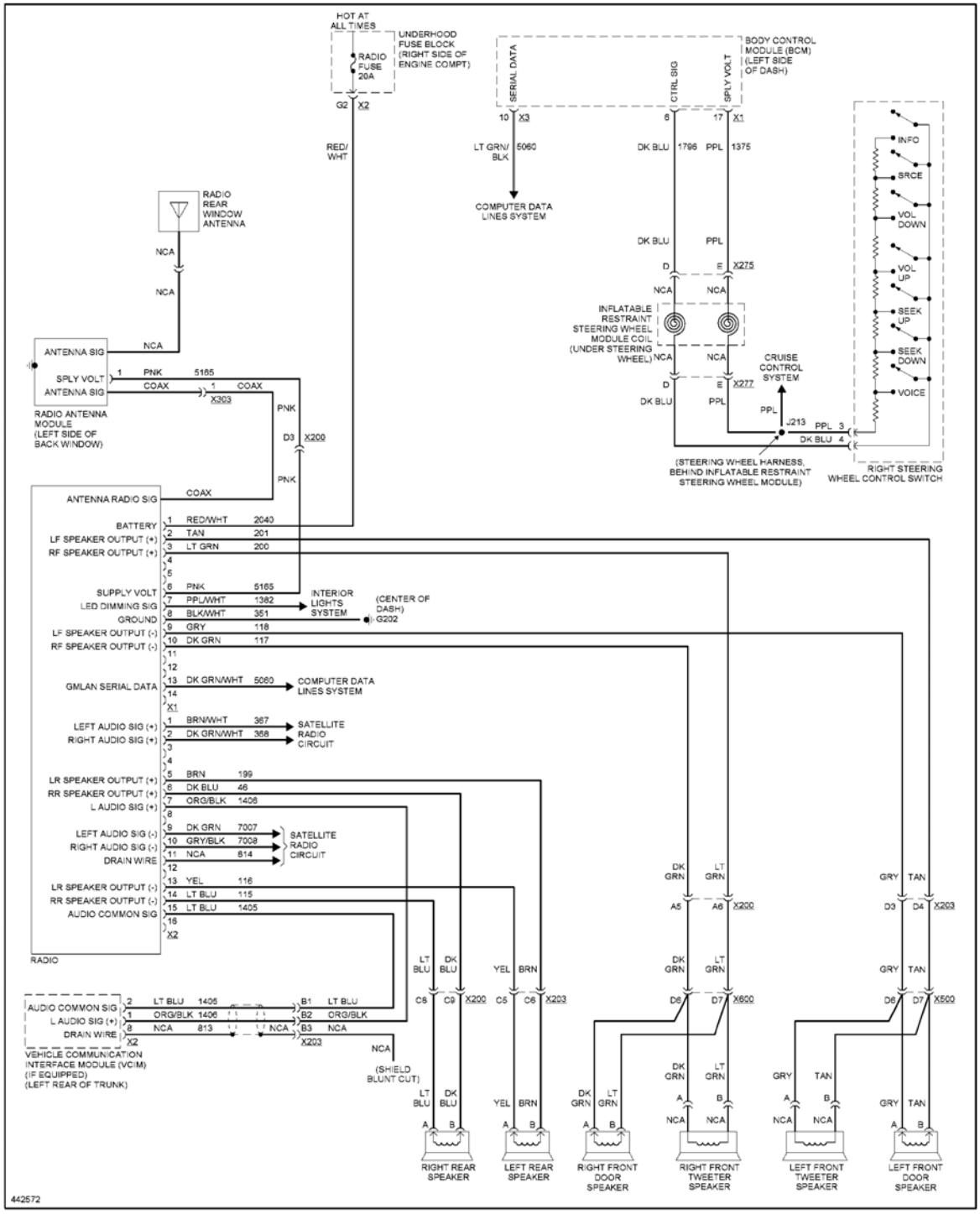


Fig. 48: Radio Circuit, W/O Amplifier

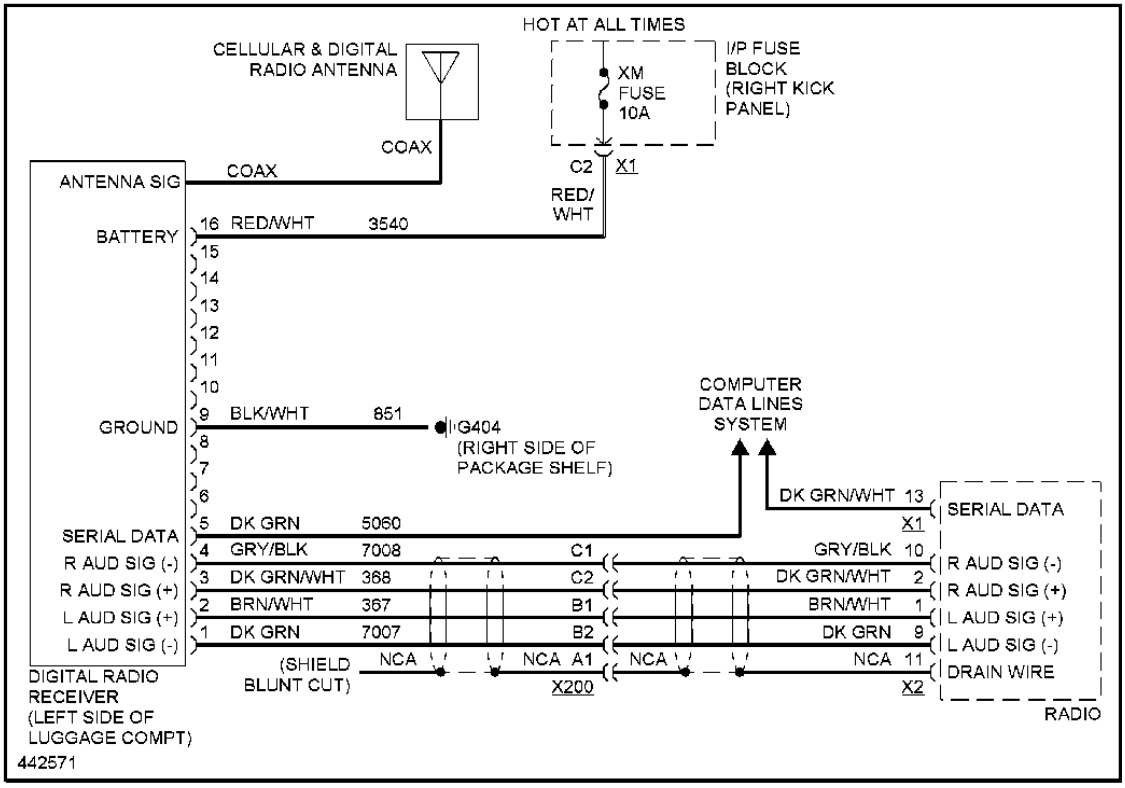


Fig. 49: Satellite Radio Circuit

SHIFT INTERLOCK

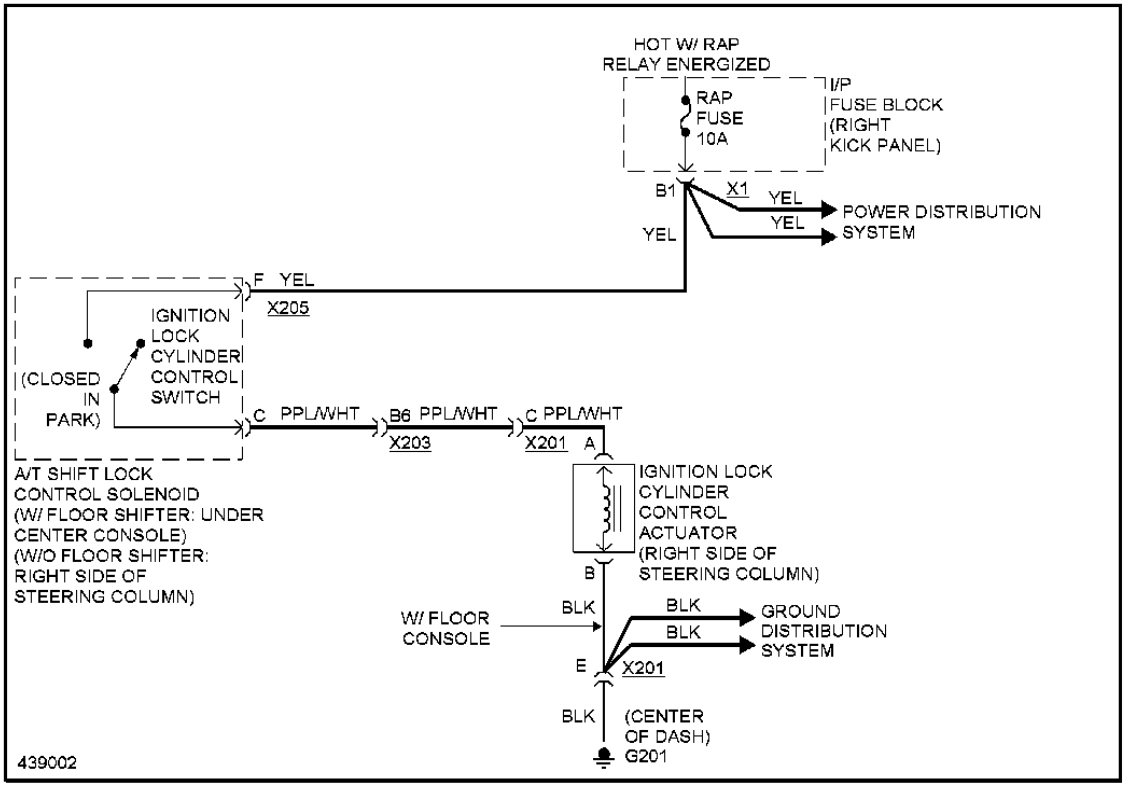


Fig. 50: Ignition Lock Solenoid Circuit

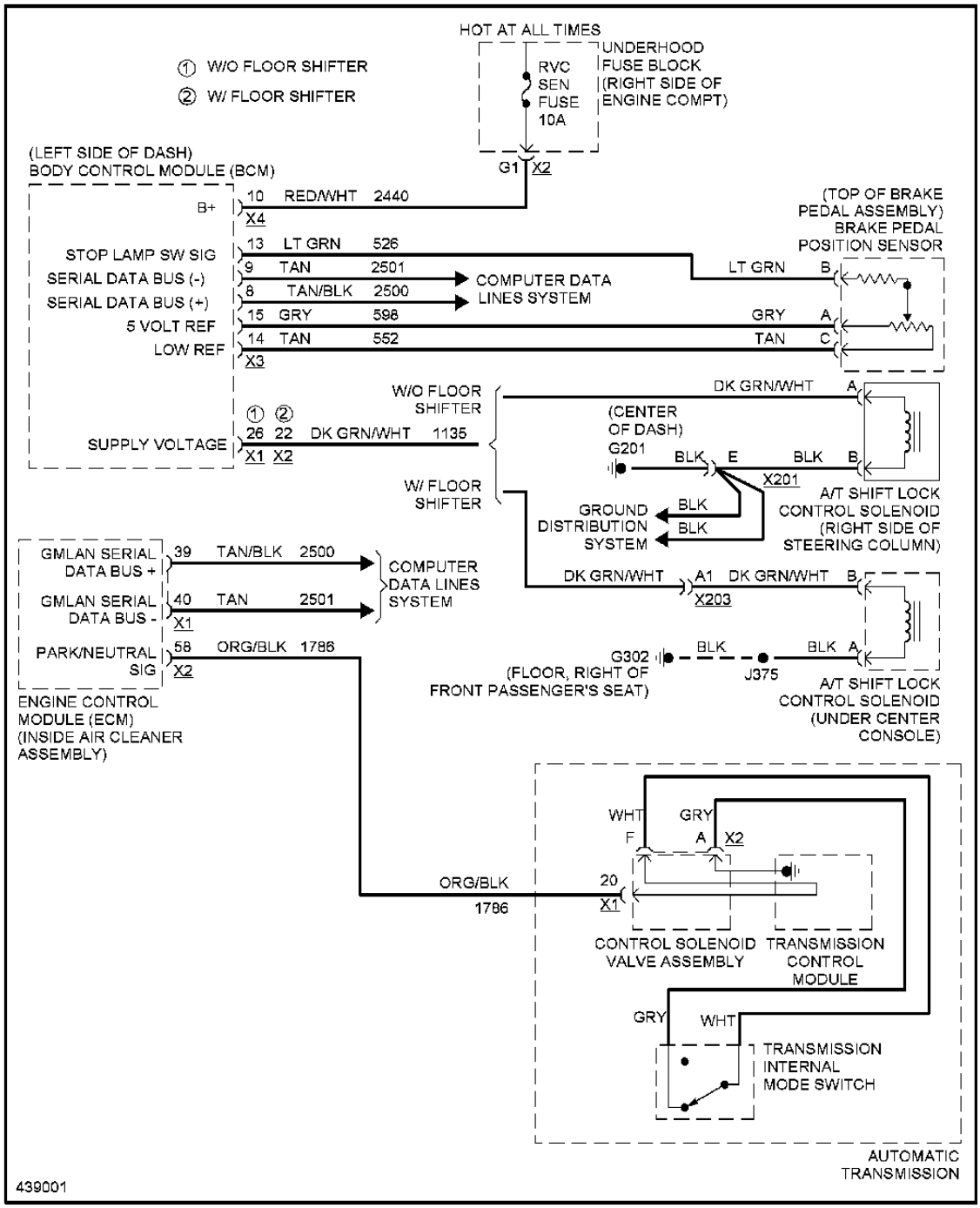


Fig. 51: Shift Interlock Circuit

STARTING/CHARGING

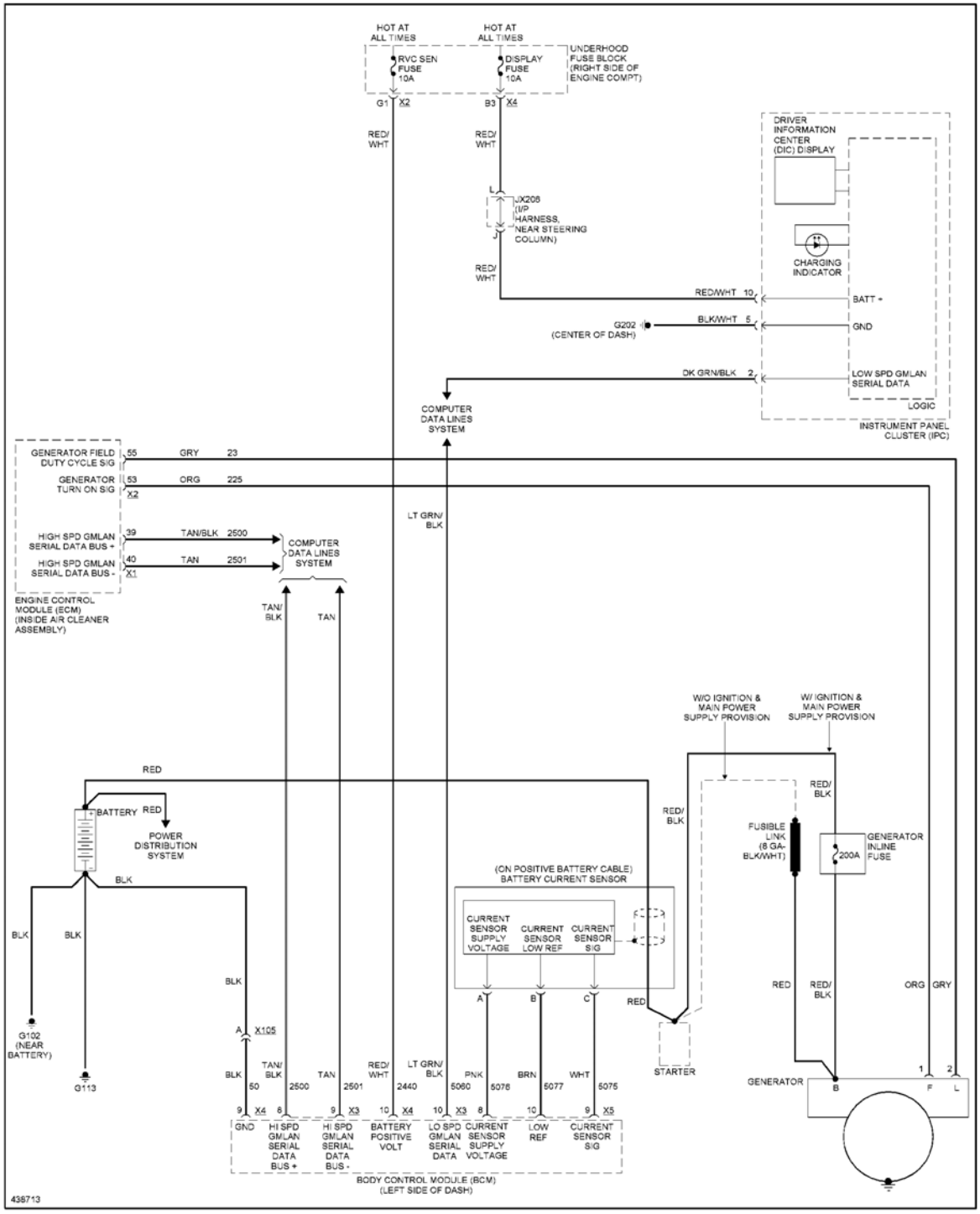


Fig. 52: Charging Circuit

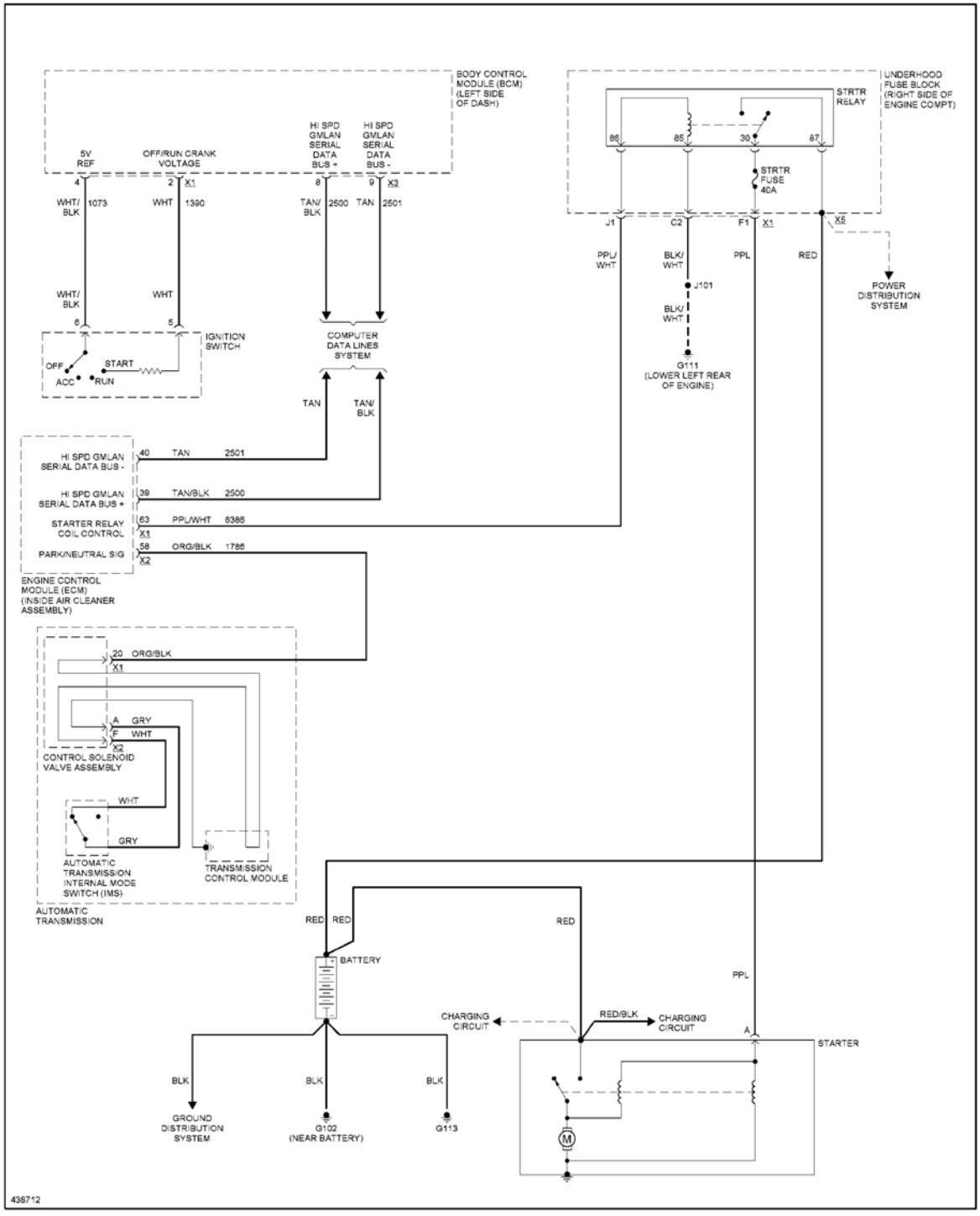


Fig. 53: Starting Circuit

SUPPLEMENTAL RESTRAINTS

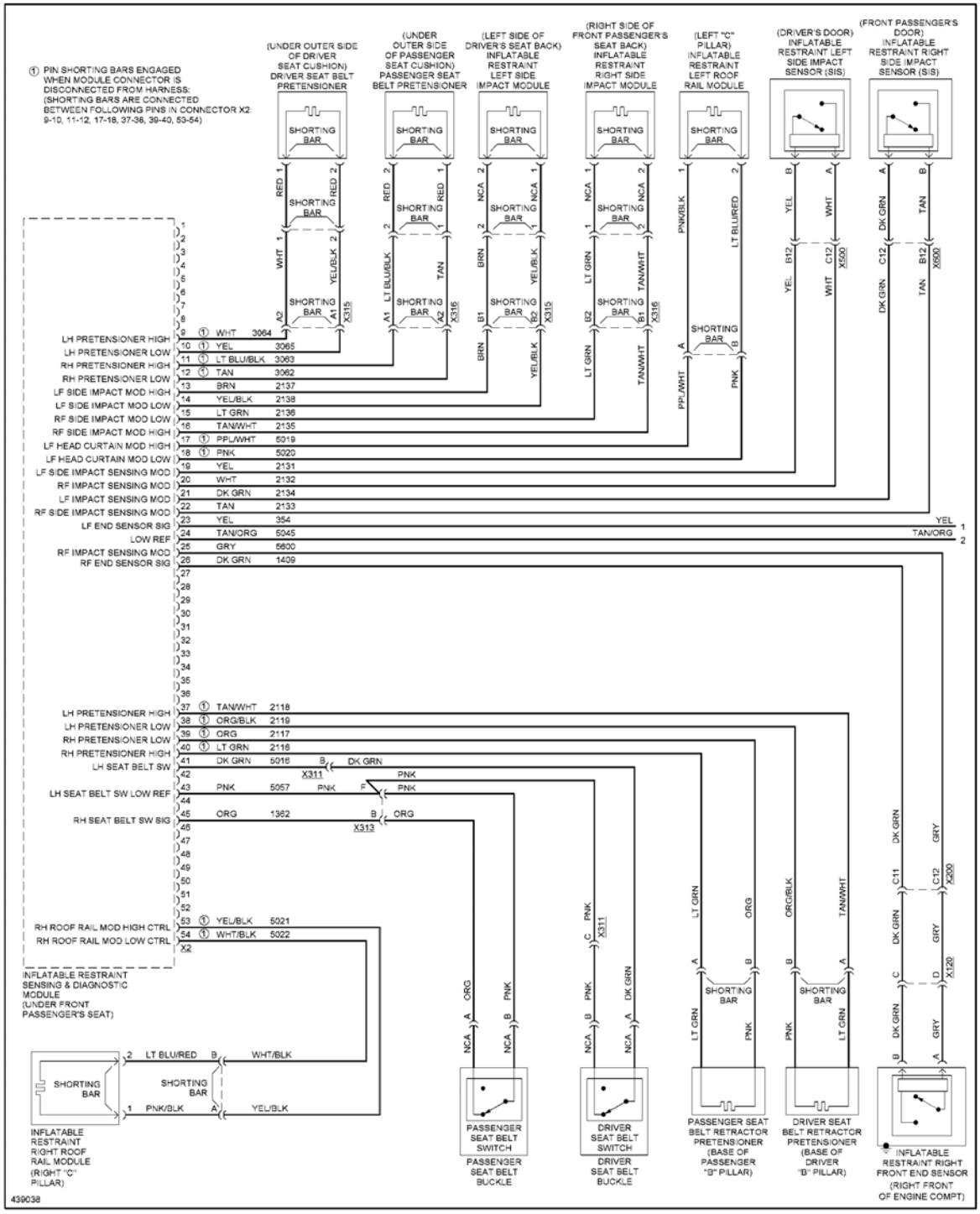


Fig. 54: Supplemental Restraints Circuit (1 of 2)

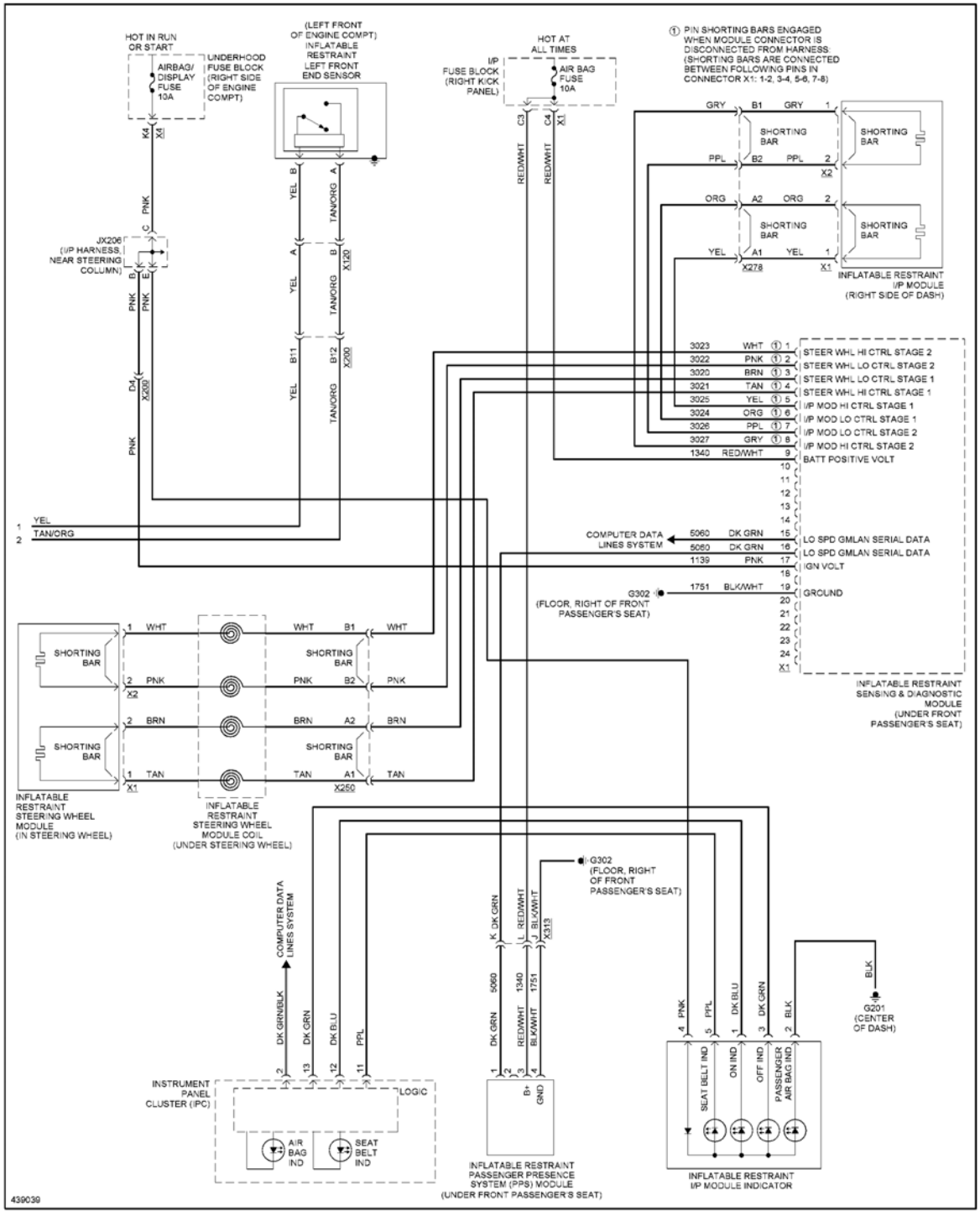


Fig. 55: Supplemental Restraints Circuit (2 of 2)

TRANSMISSION

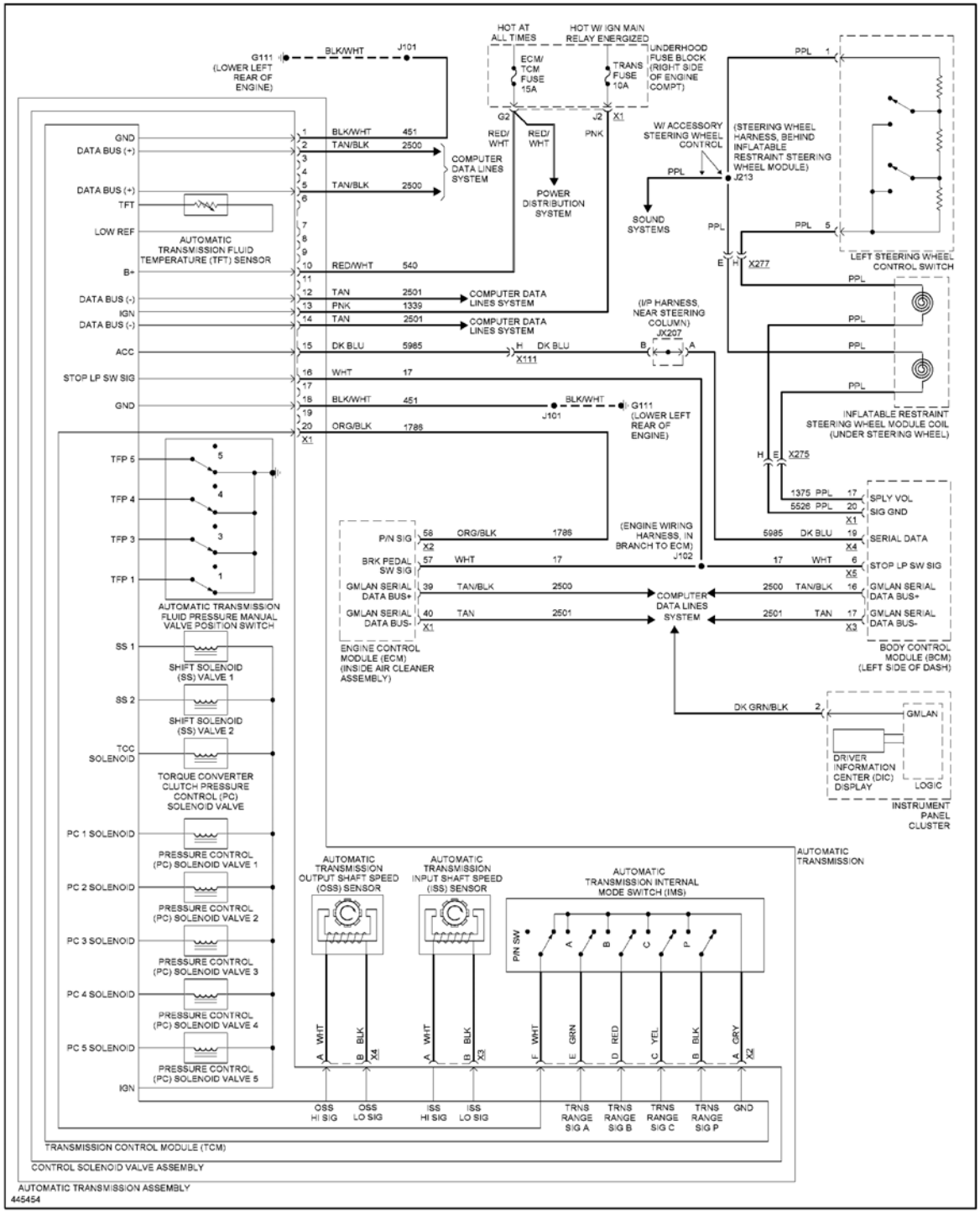


Fig. 56: Transmission Circuit

TRUNK, TAILGATE, FUEL DOOR

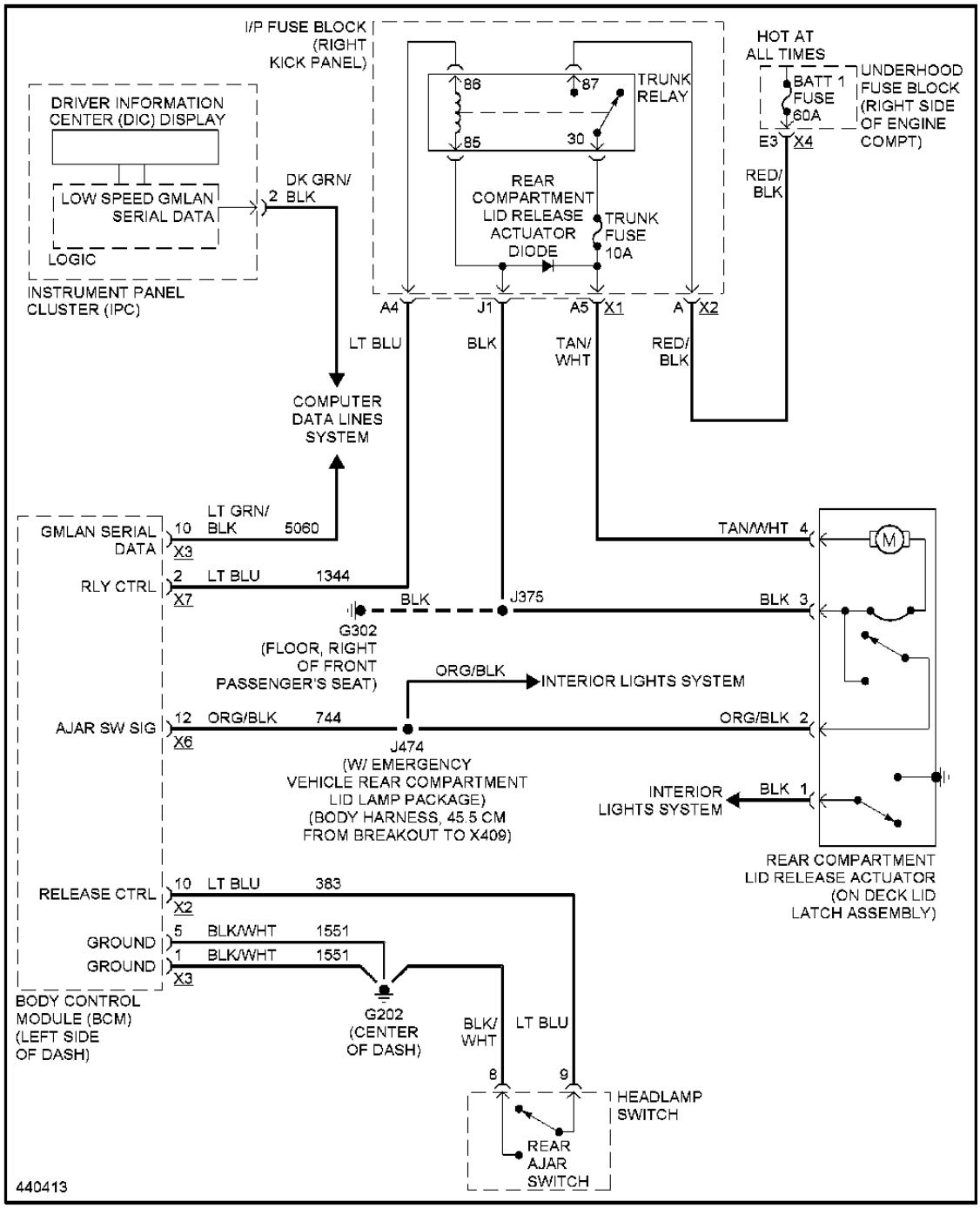


Fig. 57: Trunk Release Circuit

WARNING SYSTEMS

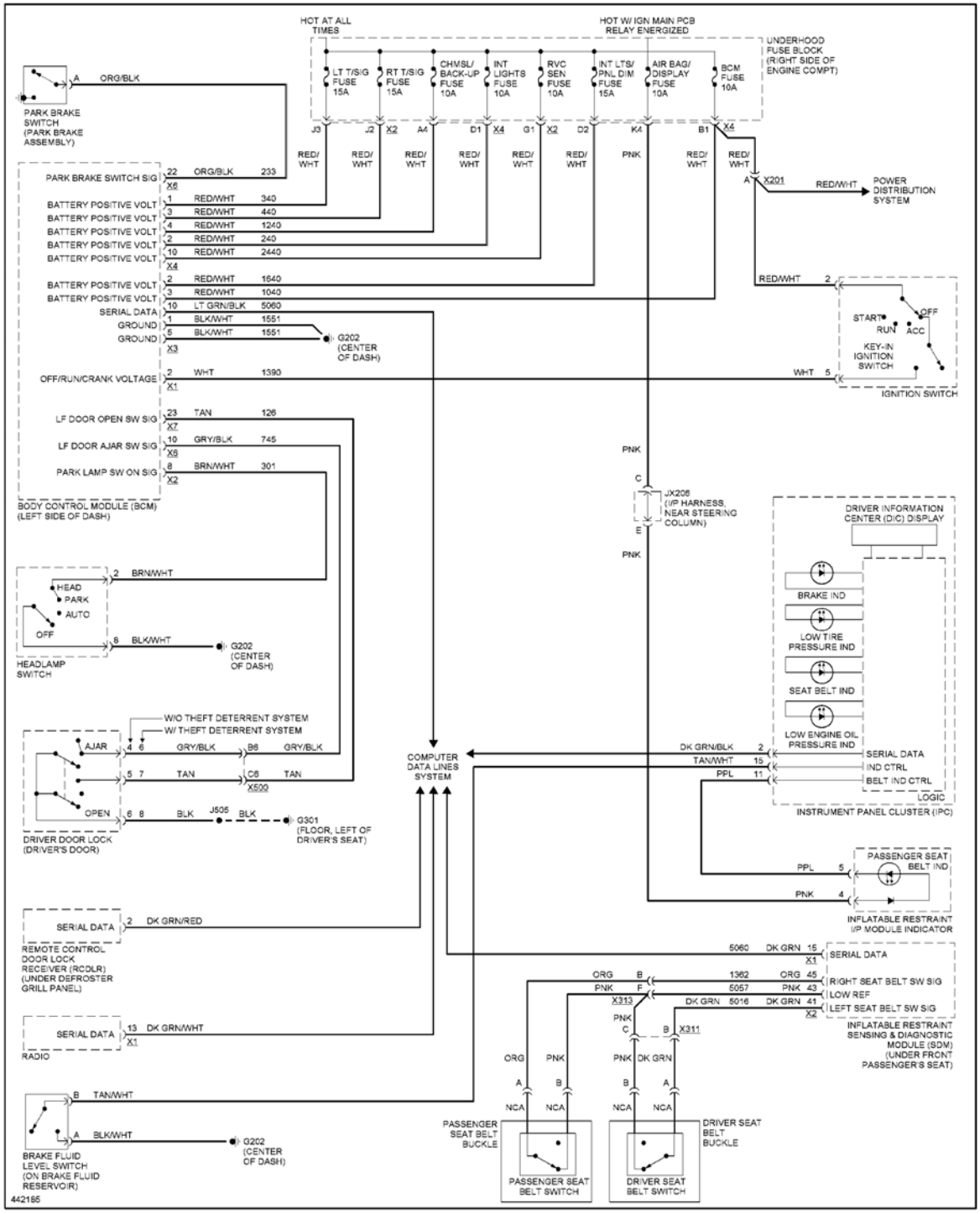


Fig. 58: Warning Systems Circuit

WIPER/WASHER

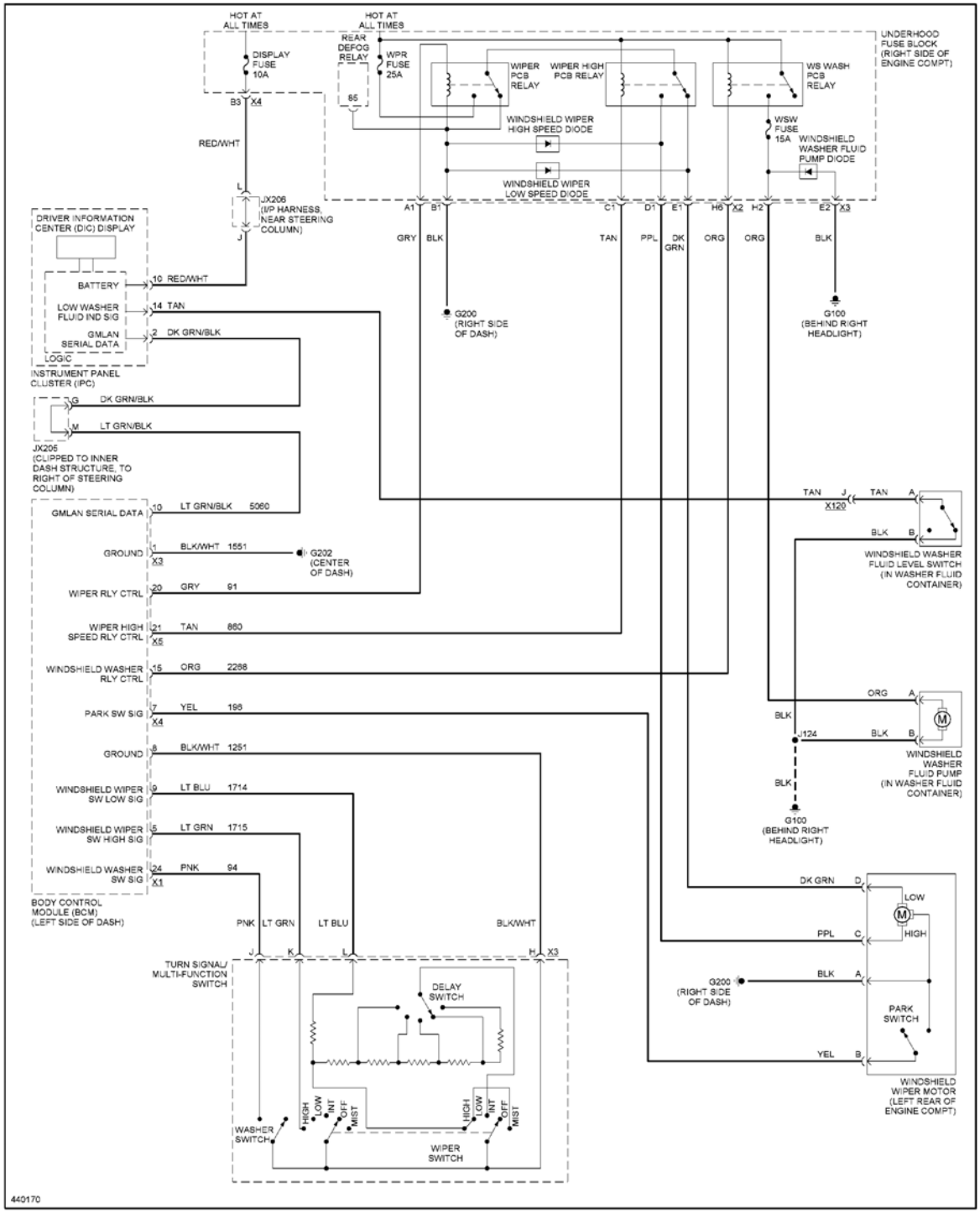


Fig. 59: Wiper/Washer Circuit

Article GUID: A00720430

GENERAL INFORMATION

Using Wiring Diagrams

INTRODUCTION

Obtains wiring diagrams and technical service bulletins, containing wiring diagram changes, from the domestic and import manufacturers. These are checked for accuracy and are all redrawn into a consistent format for easy use. All system wiring diagrams are available in color format and may be viewed and or printed in color or black and white, depending on your program settings and available printer hardware.

In the past, when cars were simpler, diagrams were simpler. All components were connected by wires, and diagrams seldom exceeded 4 pages in length. Today, some wiring diagrams require more than 16 pages. It would be impractical to expect a service technician to trace a wire from page 1 across every page to page 16.

Removing some of the wiring maze reduces eyestrain and time wasted searching across several pages. Today, the majority of diagrams follow a much improved format, which permits space for internal switch details, and component and ground locations.

Components shown with a dashed line instead of a solid line indicate not all circuits are shown in this particular diagram (circuits shown in system diagrams are typically applicable to that system only). The remaining circuits connected to that component will be shown in the appropriate system that they apply to.

Today, the wiring diagram necessary to support a given repair procedure is included within that article or a link is provided to the appropriate SYSTEM WIRING DIAGRAM article. For example, the wiring diagram for a Ford EEC-IV system may be included in ENGINE PERFORMANCE and WIRING DIAGRAMS articles for Ford Motor Co. The wiring diagram for a cruise control system may be included in ACCESSORIES & EQUIPMENT section for the specific vehicle manufacturer, and the wiring diagram for an anti-lock brake system may be included in BRAKES and WIRING DIAGRAMS for the specific manufacturer.

WIRING DIAGRAMS contains all wiring diagrams not included in STARTING & CHARGING SYSTEMS and ACCESSORIES & EQUIPMENT. This includes: Data Link Connectors, Ground Distribution, Power Distribution, Engine Performance, Electric Cooling Fans, Anti-Lock Brakes, Electronic Suspension and Electronic Steering wiring diagrams. The Data Link Connectors wiring diagrams show the circuits by which the various on-board computers exchange information, and the diagnostic connectors used for diagnosis and their location. The Ground Distribution wiring diagrams show all vehicle ground points, their location, and the components common to those ground points. The Power Distribution wiring diagrams show the power feed circuits and the components common to those power feeds.

Wiring diagrams used to support the information in ACCESSORIES & EQUIPMENT are drawn in a "top-down" format. The diagrams are drawn with the power source at the top of the diagram and the ground point at the bottom of the diagram. Component locations are identified on the wiring diagrams. Any wires that do not connect directly to a component are identified on the diagram to indicate where they go.

WIRING DIAGRAM COLOR ABBREVIATIONS

COLOR ABBREVIATIONS

Color	Normal	Optional	Misc. Euro Models

Color	Normal	Optional	Misc. Euro Models
Black	BLK	BK	B
Blue	BLU	BU	U
Brown	BRN	BN	N
Clear	CLR	CR	L
Dark Blue	DK BLU	DK BU	-
Dark Green	DK GRN	DK GN	-
Green	GRN	GN	G
Gray	GRY	GY	S
Light Blue	LT BLU	LT BU	-
Light Green	LT GRN	LT GN	-
Orange	ORG	OG	O
Pink	PNK	PK	K
Purple	PPL	PL	P
Red	RED	RD	R
Tan	TAN	TN	-
Violet	VIO	VI	-
White	WHT	WT	W
Yellow	YEL	YL	Y

WIRING DIAGRAM SYMBOLS

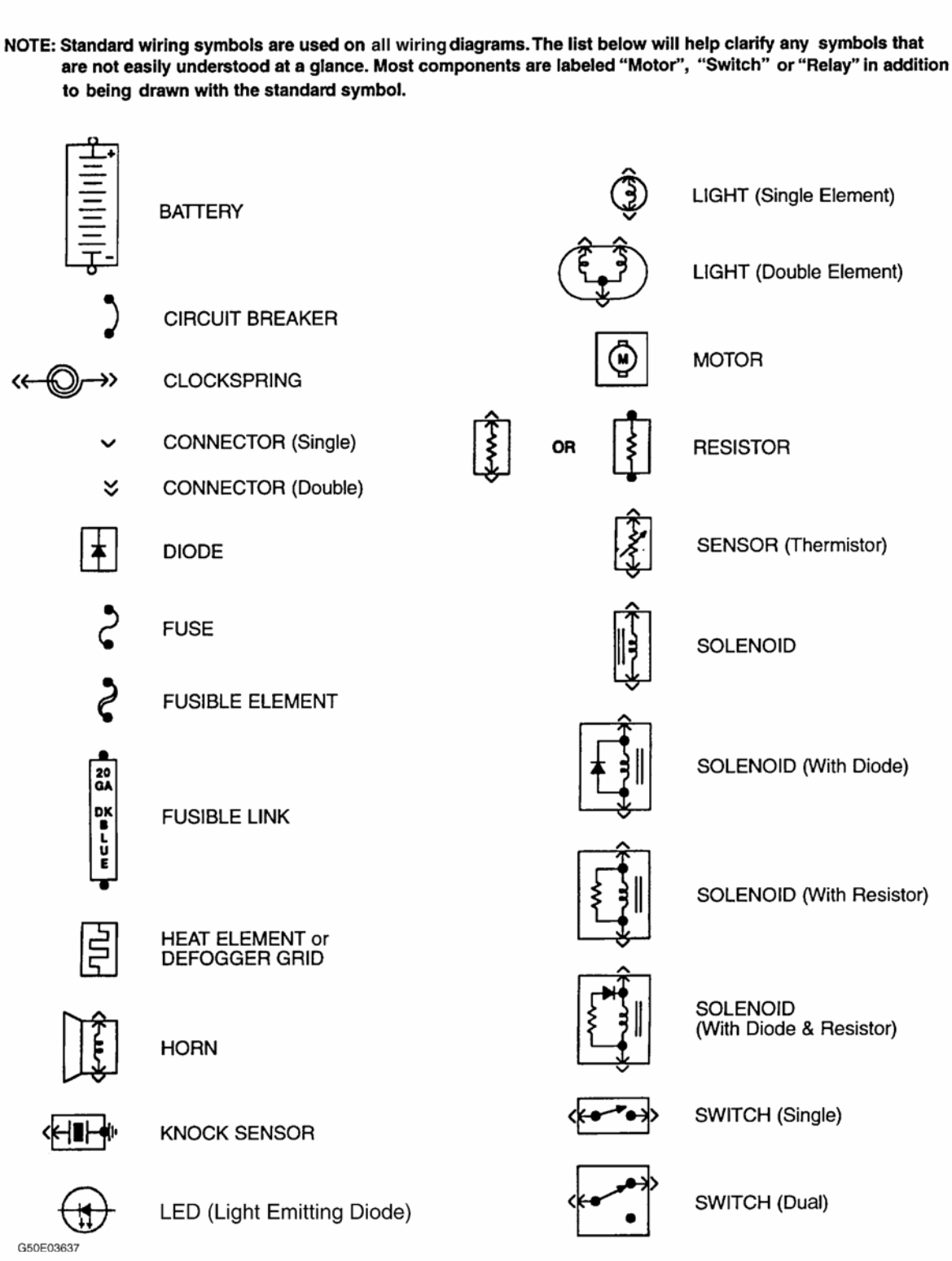
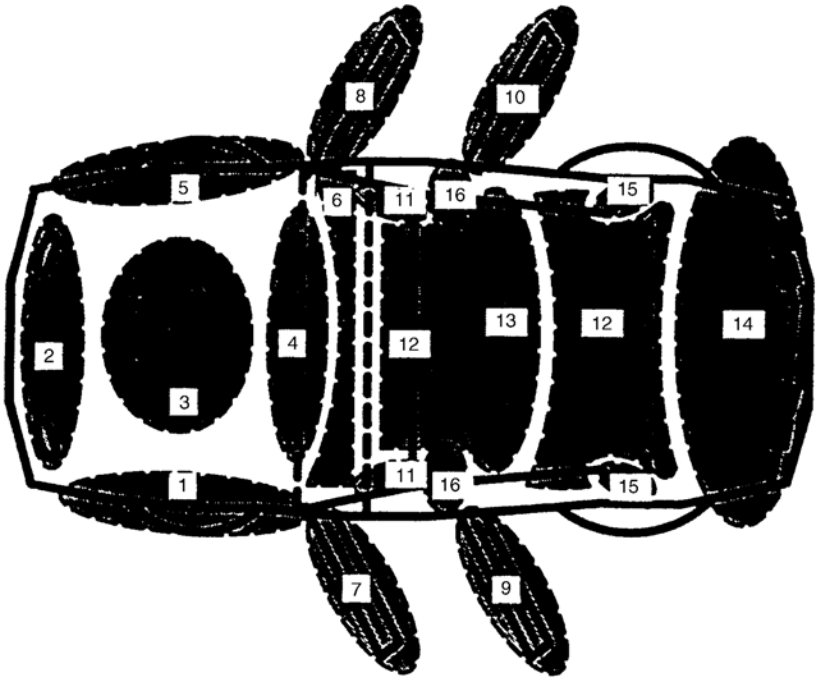


Fig. 1: Identifying Standard Wiring Diagram Symbols

WIRING DIAGRAM GROUND NUMBER LOCATIONS

NOTE: **The following illustration depicts standardized ground numbers and locations to be used in conjunction with wiring diagrams applying to 2001 and prior model years only. See Fig. 2. Wiring diagrams applying to newer**

model years depict manufacturer-specified ground numbers and locations. Do not utilize the illustration with 2002 and newer model year wiring diagrams.



1) Left Fender
- G100 ..... Front Of Fender
- G102 ..... On Shock Tower
- G104 ..... Rear Of Fender

2) Front of Vehicle
- G106 ..... Behind Left Headlight
- G107 ..... Behind Right Headlight
- G108 ..... Left Radiator Support
- G109 ..... Right Radiator Support

3) Engine
- G110 ..... Left Front Of Engine
- G111 ..... Left Front Behind Battery
- G112 ..... Left Side Of Engine
- G114 ..... Left Rear Of Engine
- G115 ..... Rear Of Engine
- G117 ..... Right Rear Of Engine
- G119 ..... Right Front Of Engine
- G120 ..... Right Side Of Engine
- G125 ..... Front Of Engine
- G127 ..... Left Underside Of Hood
- G128 ..... Right Underside Of Hood
- G129 ..... Top Center Of Transaxle

4) Safety Wall
- G116 ..... Left Side Of Safety Wall
- G121 ..... Center Of Safety Wall
- G123 ..... Right Side Of Safety Wall

5) Right Fender
- G101 ..... Front Of Fender
- G103 ..... On Shock Tower
- G105 ..... Rear Of Fender

G00027307

6) Instrument Panel
- G200 ..... Left Kick Panel
- G201 ..... Right Side Of I/P
- G202 ..... Left Side Of I/P
- G203 ..... Right Kick Panel
- G204 ... Left Rear Of Steering Support
- G205 .. Right Rear Of Steering Support
- G206 ..... Center Of I/P
- G207 ..... Top Of Steering Column

7) Left Front Door
- G500 ..... Left Front Door

8) Right Front Door
- G600 ..... Right Front Door

9) Left Rear Door
- G700 ..... Left Rear Door

10) Right Rear Door
- G800 ..... Right Rear Door

11) "A" Pillars
- G900 ..... Left "A" Pillar
- G901 ..... Right "A" Pillar

12) Passenger Compartment
- G300 ..... Below Left Front Seat
- G301 ..... Below Right Front Seat
- G302 ..... Below Center Console
- G303 ..... Below Right Rear Seat
- G304 ..... Below Left Rear Seat
- G306 ..... Below Center Of Rear Seat
- G307 ..... Below Right Rear Window
- G309 ..... Left Front Door Sill
- G310 ..... Behind Right Rear Seat
- G311 ..... Center Of Rear Shelf
- G312 ..... Behind Left Rear Seat

13) Roof
- G902 ..... Left Front Of Roof
- G903 ..... Right Front Of Roof
- G906 ..... Left Rear Of Roof
- G907 ..... Right Rear Of Roof
- G908 ..... Center Front Of Roof
- G909 ..... Center Rear Of Roof

14) Rear Of Vehicle
- G400 ..... Left Front Side Of Trunk
- G401 ..... Right Front Side Of Trunk
- G402 ..... Left Rear Wheelwell
- G403 ..... Right Rear Wheelwell
- G404 ..... Left Rear Side Of Trunk
- G405 ..... Right Rear Side Of Trunk
- G406 ..... Center Rear Of Trunk Lid
- G407 ..... Center Rear Of Trunk
- G408 ..... Center Front Of Trunk
- G409 ..... Rear Of Cargo Bed

15) "C" Pillars
- G904 ..... Left "C" Pillar
- G905 ..... Right "C" Pillar

16) "B" Pillars
- G305 ..... Right "B" Pillar
- G308 ..... Left "B" Pillar

Fig. 2: Ground Numbers & Locations (2001 & Prior Model Years)

WIRING DIAGRAM COMPONENT LOCATIONS

When trying to locate a component in a wiring diagram and you don't know the specific system where it is located, use this handy component locator to find the system wiring diagram in which the component is located.

Then, go to that system and locate the component within the wiring diagram.

For example, if you don't know the specific system in which the ignition switch is located, look up ignition switch in the wiring diagram component location tables and go to the appropriate wiring diagram(s) which contain either full or partial views of the ignition switch. The full view of the ignition switch is located in Power Distribution.

The first listing for the component will be the full or most complete view of the component. Additional listings will be partial views of the component. Not all components are used on all models.

All components will have a partial view in Ground Distribution and Power Distribution. Data Link Connectors show connecting circuits between modules. Alternate names for components may be listed in wiring diagram component locations tables.

WIRING DIAGRAM COMPONENT LOCATIONS

Component	Wiring Diagram
ABS Electronic Control Unit	Anti-Lock Brakes; Data Link Connectors
ABS Hydraulic Unit	Anti-Lock Brakes
Acceleration Sensor	Anti-Lock Brakes
Accessory Delay Relay	Power Windows
A/C Compressor Clutch Relay	Engine Performance
A/C Sensor	Engine Performance
A/C Pressure Switch	Engine Performance
Adaptive Lamp Control Module	Exterior Lights
Air Bag(s)	Air Bag Restraint System
Air Bag Module	Air Bag Restraint System
Air Bag Sensor(s)	Air Bag Restraint System
Air Injection Pump Relay	Engine Performance
Air Temperature Sensor	Overhead Console
Alternator (Generator)	Generators & Regulators
Anti-Theft Control Module	Anti-Theft System; Starters
Autolamp Control Relay	Headlight Systems; Daytime Running Lights
Automatic Shutdown (ASD) Relay	Engine Performance; Generators & Regulators
Autostick Switch	Engine Performance
Auxiliary Battery Relay	Generators & Regulators
Back-Up Lights	Back-Up Lights; Exterior Lights
Barometric (BARO) Pressure Sensor	Engine Performance
Battery	Power Distribution
Battery Temperature Sensor	Engine Performance
Body Control Module	Body Control Computer; Anti-Theft System; Daytime Running Lights; Engine Performance; Headlight Systems; Warning Systems
Boost Control Solenoid	Engine Performance
Boost Sensor	Engine Performance

Component	Wiring Diagram
Brake Fluid Level Switch	Analog Instrument Panels
Brake On/Off (BOO) Switch	Cruise Control Systems; Engine Performance; Shift Interlock Systems
Buzzer Module	Warning Systems
Camshaft Position (CMP) Sensor	Engine Performance
Central Control Module	Anti-Theft System
Clockspring	Air Bag Restraint System; Cruise Control Systems; Steering Column Switches
Clutch Pedal Position Switch	Starters
Clutch Start Switch	Starters
Combination Meter	Analog Instrument Panels
Constant Control Relay Module (CCRM)	Engine Performance; Electric Cooling Fans
Convenience Center	Power Distribution; Illumination/Interior Lights
Convertible Top Motor	Power Convertible Top
Convertible Top Switch	Power Convertible Top
Crankshaft Position (CKP) Sensor	Engine Performance
Cruise Control Module	Cruise Control Systems
Cruise Control Switch	Cruise Control Systems
Condenser Fan Relay(s)	Electric Cooling Fans
Data Link Connector (DLC)	Engine Performance
Daytime Running Lights Module	Daytime Running Lights; Exterior Lights
Defogger Relay	Rear Window Defogger
Diagnostic Energy Reserve Module (DERM)	Air Bag Restraint System
Discriminating Sensor (Air Bag)	Air Bag Restraint System
Distributor	Engine Performance
Door Lock Actuators	Power Door Locks; Remote Keyless Entry
Door Lock Relay(s)	Power Door Locks
Electrochromic Mirror	Power Mirrors
Electronic Level Control (ELC) Height Sensor	Electronic Suspension
Electronic Level Control (ELC) Module	Electronic Suspension
Engine Coolant Temperature (ECT) Sending Unit	Analog Instrument Panels
Engine Coolant Temperature (ECT) Sensor	Engine Performance
Engine Control Module	Engine Performance; Generators & Regulators; Starters
ETACS ECU	Warning Systems; Power Windows; Remote Keyless Entry
Evaporative (EVAP) Emissions Canister	Engine Performance
EVAP Canister Purge Solenoid	Engine Performance
EVAP Canister Vent Solenoid	Engine Performance
Exhaust Gas Recirculation (EGR) Valve	Engine Performance
Fuel Tank Vacuum Sensor	Engine Performance

Component	Wiring Diagram
Fog Lights	Headlight Systems; Daytime Running Lights
Fog Light Relay	Headlight Systems; Daytime Running Lights
Fuel Door Release Solenoid	Power Fuel Door Release
Fuel Gauge Sending Unit	Analog Instrument Panels
Fuel Injectors	Engine Performance
Fuel Pump	Engine Performance
Fuel Pump Relay	Engine Performance; Power Distribution
Fuse/Relay Block	Power Distribution
Fusible Links	Power Distribution; Generators & Regulators; Starters
Generator	Generators & Regulators; Engine Performance; Power Distribution
Generic Electronic Module (GEM)	Body Control Modules; Electronic Suspension
Glow Plug Relay	Engine Performance
Glow Plugs	Engine Performance
Grounds	Ground Distribution
Headlight Door Module	Headlight Doors
Headlight Relay	Headlight Systems; Daytime Running Lights
Headlights	Headlight Systems; Daytime Running Lights
Heated Oxygen Sensor(s) (HO2S)	Engine Performance
Heated Windshield Control Module	Heated Windshields
Height Sensor	Electronic Suspension
Horns	Steering Column Switches
Horn Relay	Steering Column Switches
Idle Air Control (IAC) Motor/Valve	Engine Performance
Ignition Coil(s)	Engine Performance
Ignition Key Lock Cylinder	Anti-Theft System
Ignition Module	Engine Performance
Ignition Switch	Power Distribution; Engine Performance; Generators & Regulators; Starters
Illuminated Entry Module	Illumination/Interior Lights
Illumination Lights	Illumination/Interior Lights
Impact Sensor	Air Bag Restraint System
Inertia Fuel Shutoff Switch	Engine Performance
Inhibit Relay	Starters
Instrument Cluster	Analog Instrument Panels
Intake Air Temperature (IAT) Sensor	Engine Performance
Interior Lights	Illumination/Interior Lights
Interlock Switch	Starters
Junction Block	Power Distribution
Keyless Entry Receiver	Remote Keyless Entry

Component	Wiring Diagram
Key Reminder Switch	Starters
Knock Sensor	Engine Performance
Lamp Control Module	Exterior Lights
License Plate Lamp	Exterior Lights
Lighting Control Module	Lighting Control Modules; Anti-Theft System; Daytime Running Lights; Headlight Systems
Lower Relay	Power Convertible Top
Malfunction Indicator Light (MIL)	Engine Performance; Instrument Panels
Manifold Absolute Pressure (MAP) Sensor	Engine Performance
Mass Airflow (MAF) Sensor	Engine Performance
Mega Fuse	Generators & Regulators
Memory Seat/Mirror Module	Memory Systems
Mirror Defogger	Rear Window Defogger
Moon Roof Motor	Power Moon Roof
Moon Roof Relay	Power Moon Roof
Multi-Function Control Module	Warning Systems
Neutral Safety Switch	Starters
Oil Level Switch	Engine Performance
Oil Pressure Switch/Sending Unit	Analog Instrument Panels; Engine Performance
Overhead Console	Overhead Console
Oxygen Sensor(s) (O2S)	Engine Performance
Parking Brake Switch	Analog Instrument Panels
Park Lights	Exterior Lights
Park/Neutral Position Switch	Starters; Engine Performance; Anti-Theft System; Body Control Module
Perimeter Lighting Control Relay	Exterior Lights
Power Amplifier	Power Antennas
Power Antenna Module	Power Antennas
Power Antenna Motor	Power Antennas
Power Distribution Center	Power Distribution; Generators & Regulators; Starters
Power Door Lock Motors	Power Door Locks
Power Mirror Motors	Power Mirrors; Memory Systems
Power Sliding Door Controller	Power Sliding Side Door
Power Seat Motors	Power Seats; Memory Systems
Power Steering Pressure Switch	Engine Performance
Power Top Motor	Power Convertible Top
Power Top Relay(s)	Power Convertible Top
Powertrain Control Module	Engine Performance; Analog Instrument Panels; Cruise Control Systems; Data Link Connectors; Generators & Regulators; Starters

Component	Wiring Diagram
Power Window Motors	Power Windows
Power Window Relay(s)	Power Windows
Radiator Fan Motor(s)	Electric Cooling Fans
Radiator Fan Relay(s)	Engine Performance; Electric Cooling Fans;
Rainsense Module	Wiper/Washer Systems
Raise Relay	Power Convertible Top
Remote Anti-Theft Personality (RAP) Module	Anti-Theft System; Starters; Warning Systems
Seat Belt Pretensioners	Air Bag Restraint System
Seat Belt Retractor Solenoid	Passive Restraints
Seat Belt Switch	Air Bag Restraint System; Passive Restraints
Shift Interlock Solenoid	Shift Interlock Systems
Shift Lock Actuator	Shift Interlock Systems
Side Marker Lights	Exterior Lights
SIR Coil Assembly (Clockspring)	Air Bag Restraint System
Slip Ring (Clockspring)	Air Bag Restraint System; Steering Column Switches
SRS Control Module	Air Bag Restraint System
Starter Motor	Starters
Starter Interrupt Relay	Starters
Starter Solenoid	Starters
Starter Relay	Starters
Steering Wheel Position Sensor	Anti-Lock Brakes
Stoplights	Exterior Lights
Stoplight Switch	Engine Performance; Cruise Control Systems; Anti-Lock Brakes
Sun Roof ECU	Power Sun Roof
Sun Roof Motor	Power Sun Roof
Sun Roof Position Sensor	Power Sun Roof
Taillights	Exterior Lights
Throttle Position (TP) Sensor	Engine Performance
Torque Converter Clutch Solenoid/Switch	Engine Performance
Traction Control Switch	Anti-Lock Brakes
Trailer Tow Connector	Exterior Lights
Trailer Tow Relay	Exterior Lights
Transmission/Transaxle	Engine Performance
Transmission Control Module (TCM)	Engine Performance; Starters
Transmission Range Sensor	Starters; Back-Up Lights; Engine Performance
Transmission Range Switch	Back-Up Lights; Engine Performance; Anti-Theft System
Turn Signal Flasher	Exterior Lights
Turn Signal Lights	Exterior Lights

Component	Wiring Diagram
Twilight Sentinel Switch	Headlight Systems; Daytime Running Lights
Vapor Canister Leak Detection Pump	Engine Performance
Vehicle Control Module (VCM)	Engine Performance
Vehicle Dynamic Module	Electronic Suspension
Vehicle Speed Control Servo	Cruise Control Systems
Vehicle Speed Sensor	Data Link Connectors; Analog Instrument Panels; Cruise Control Systems; Electronic Suspension
Voltage Regulator	Generators & Regulators
Water-In-Fuel Sensor	Engine Performance; Analog Instrument Panels
Wheel Speed Sensors	Anti-Lock Brakes
Window Timer Module	Power Convertible Top
Windshield Intermittent Wiper Relay	Wiper/Washer Systems
Windshield Washer Motor	Wiper/Washer Systems
Wiper Motor	Wiper/Washer Systems

Article GUID: A00130983

WIRING HARNESS ROUTING DIAGRAMS AND SCHEMATIC WIRING DIAGRAMS

WIRING HARNESS ROUTING VIEWS

Forward Lamp Harness Routing

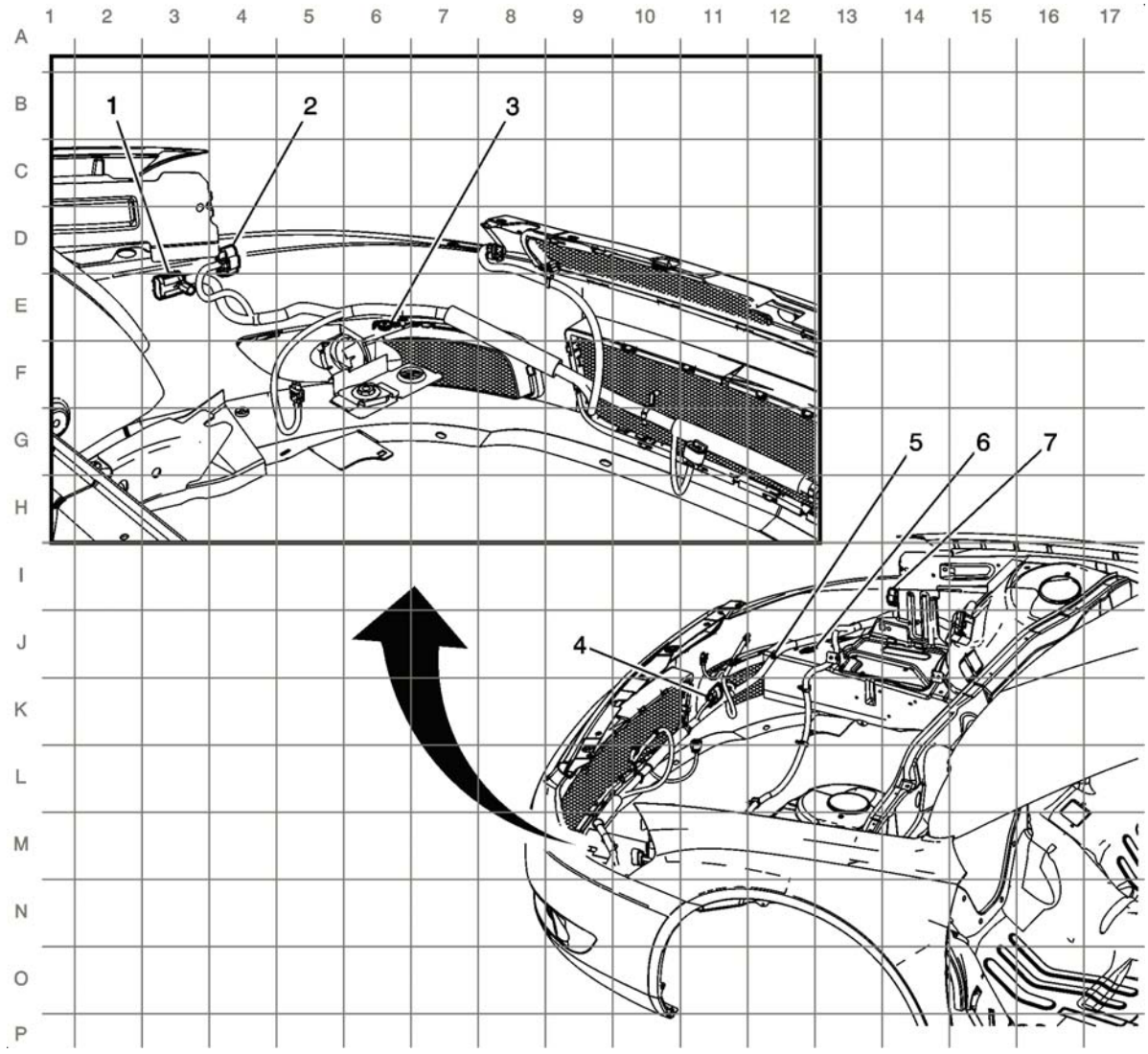


Fig. 1: Forward Lamp Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X120
2	X141
3	G101

Callout	Component Name
4	X122 (9C1 or 9C3 without 6J7)
5	J124
6	G101
7	X142

Engine Harness Routing - Right Front

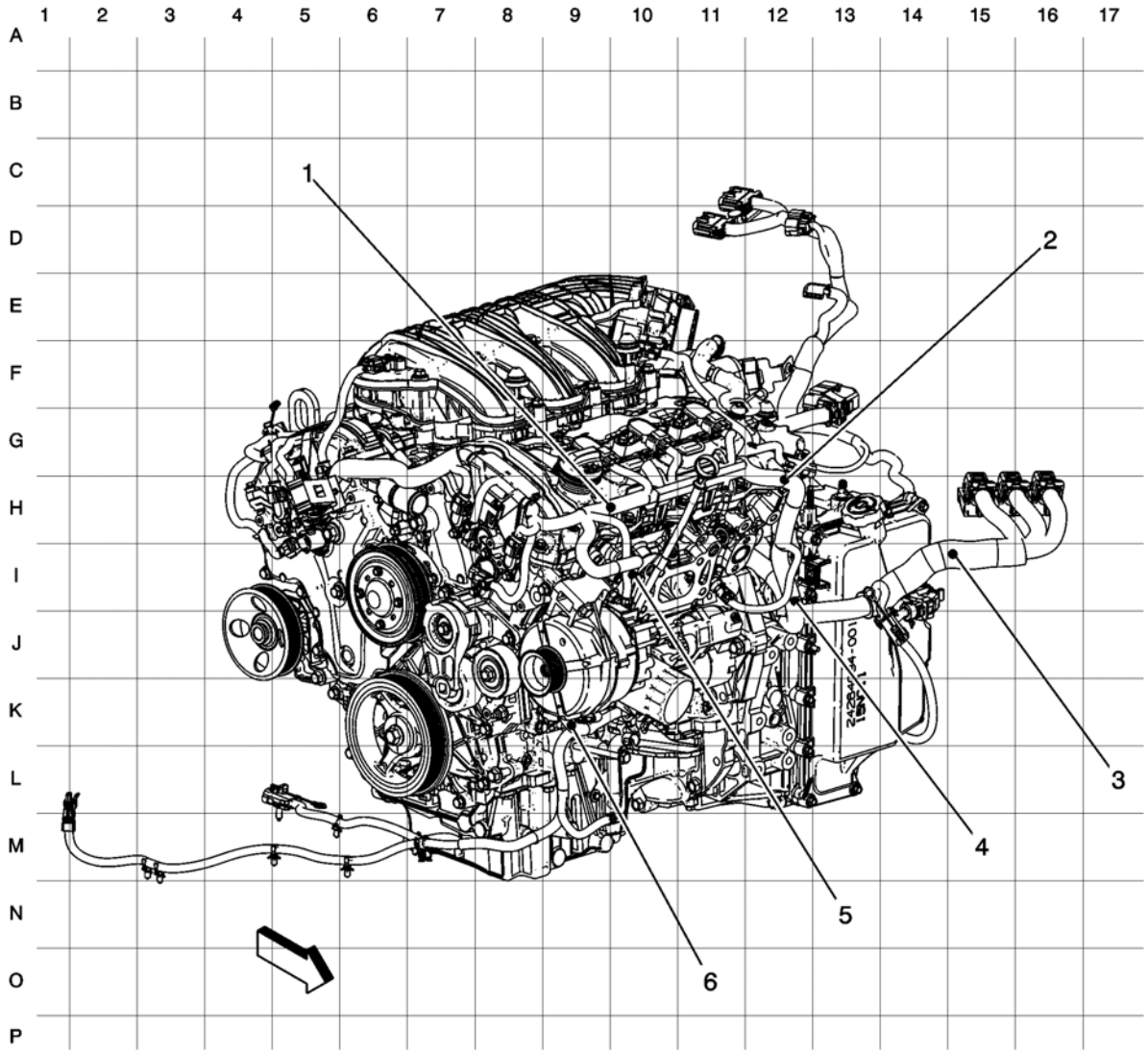


Fig. 2: Engine Harness Routing Diagram -- Right Front
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	J164
2	J165
3	J102
4	J101
5	J100
6	J103

Engine Harness Routing - Left Rear

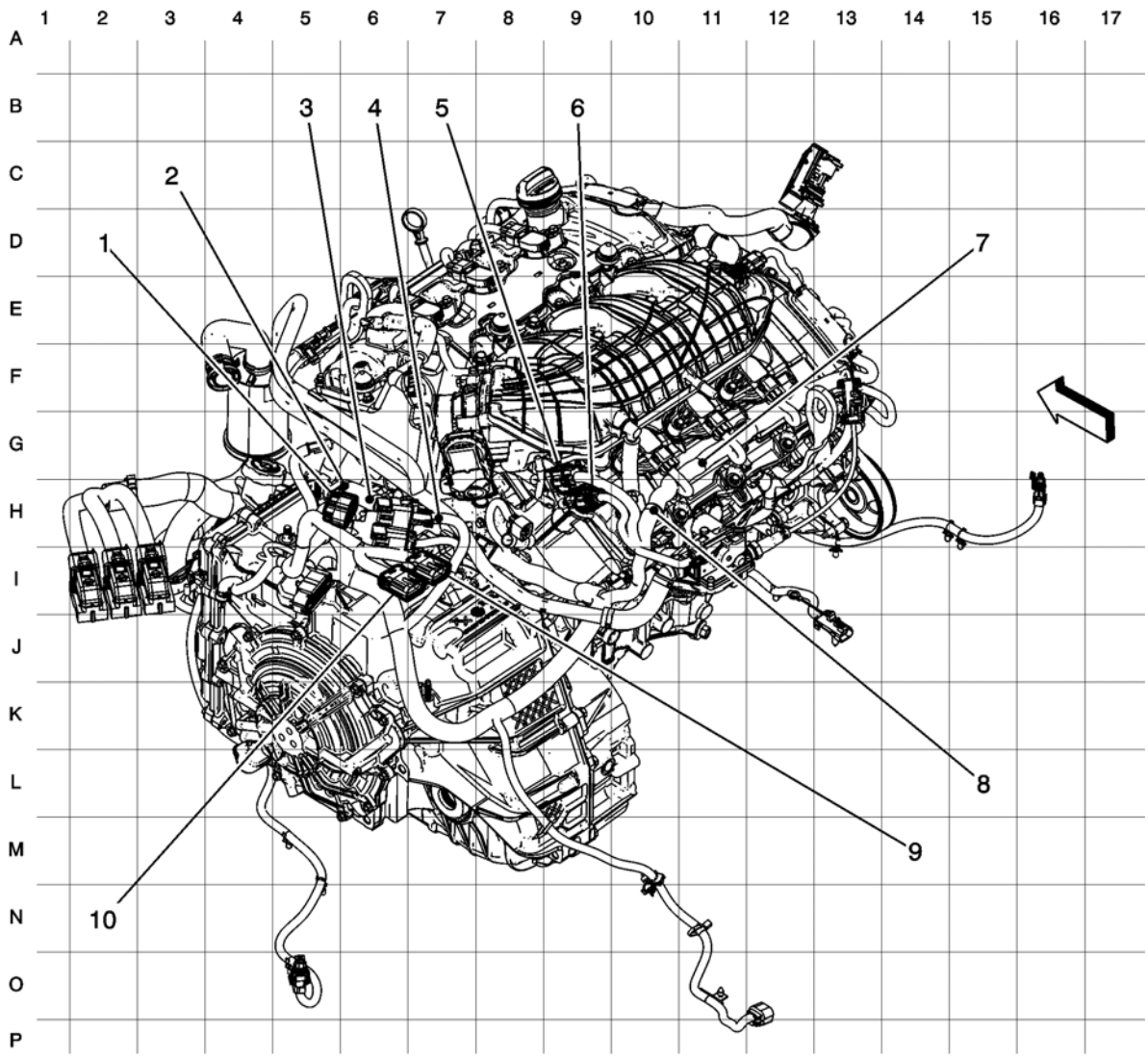


Fig. 3: Engine Harness Routing Diagram -- Left Rear
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X115
2	J110
3	J175
4	J109
5	X160
6	X161
7	J163
8	J162
9	X111
10	X101

Battery Cable Harness Routing (Typical)

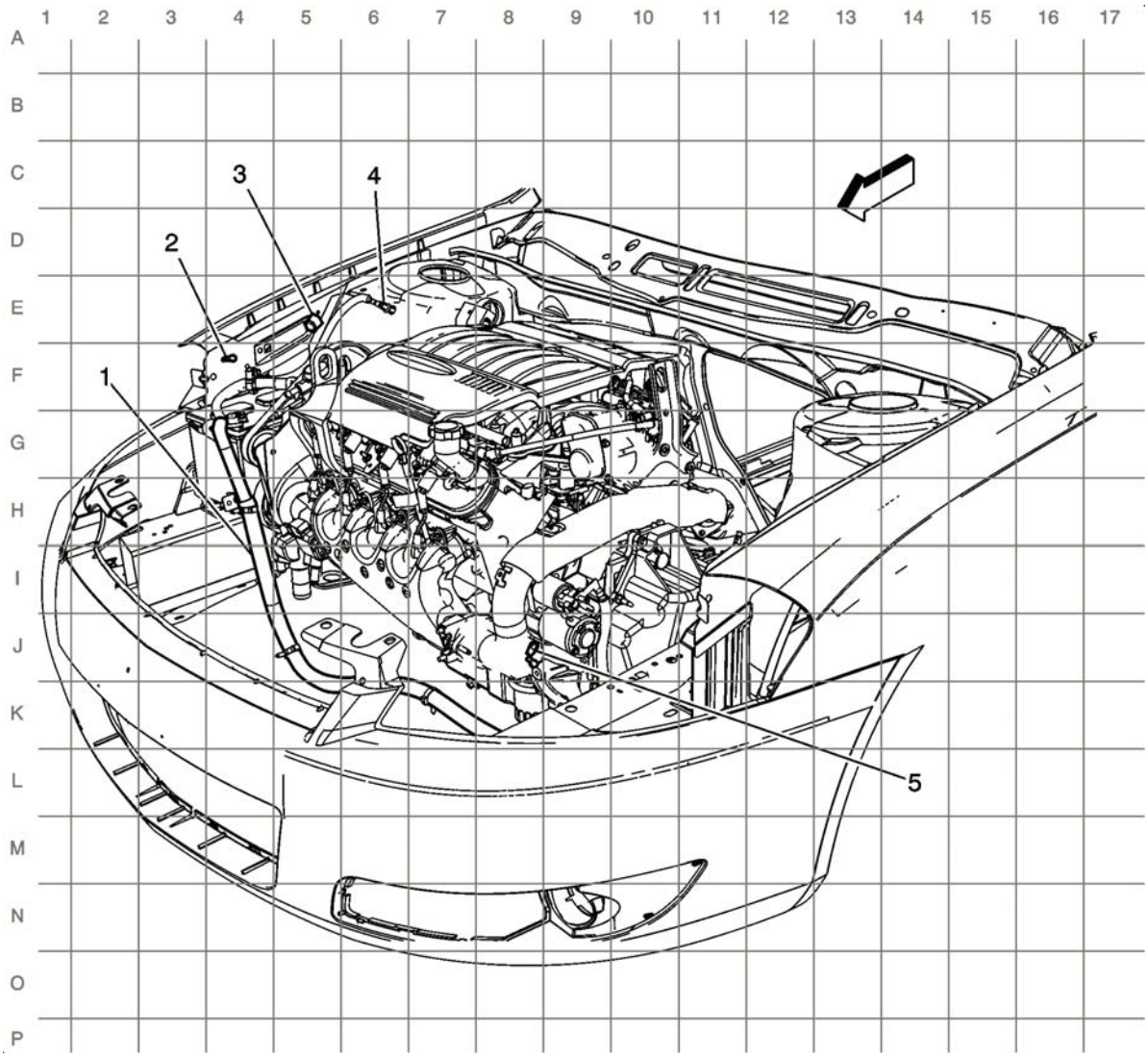


Fig. 4: Battery Cables (Typical)
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Battery Cables
2	G102
3	X105
4	Positive Voltage Stud
5	G111

HVAC Module Harness Routing

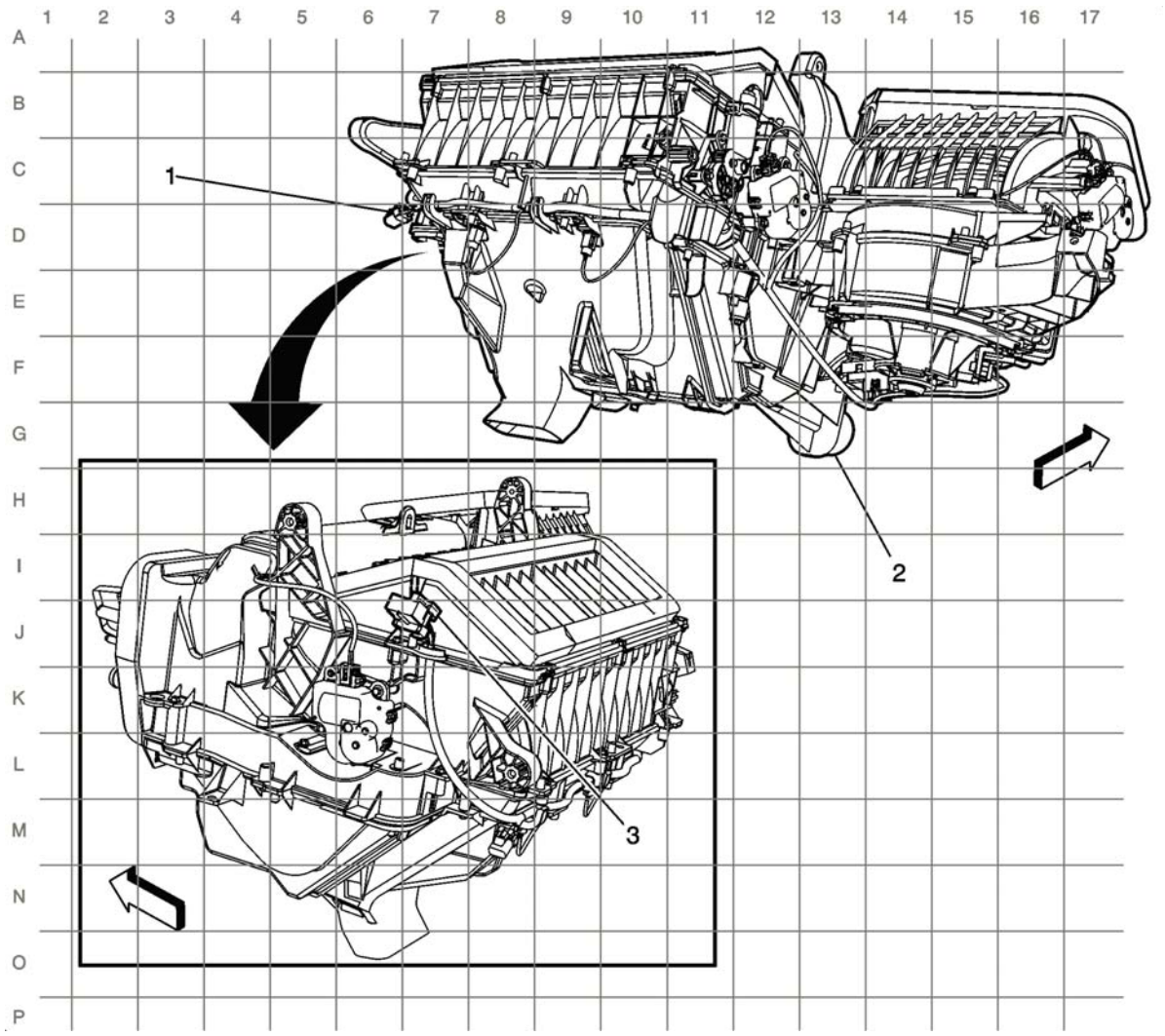


Fig. 5: HVAC Module Wiring
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X210
2	HVAC Module
3	HVAC Control Module- X2

Instrument Panel Harness Routing

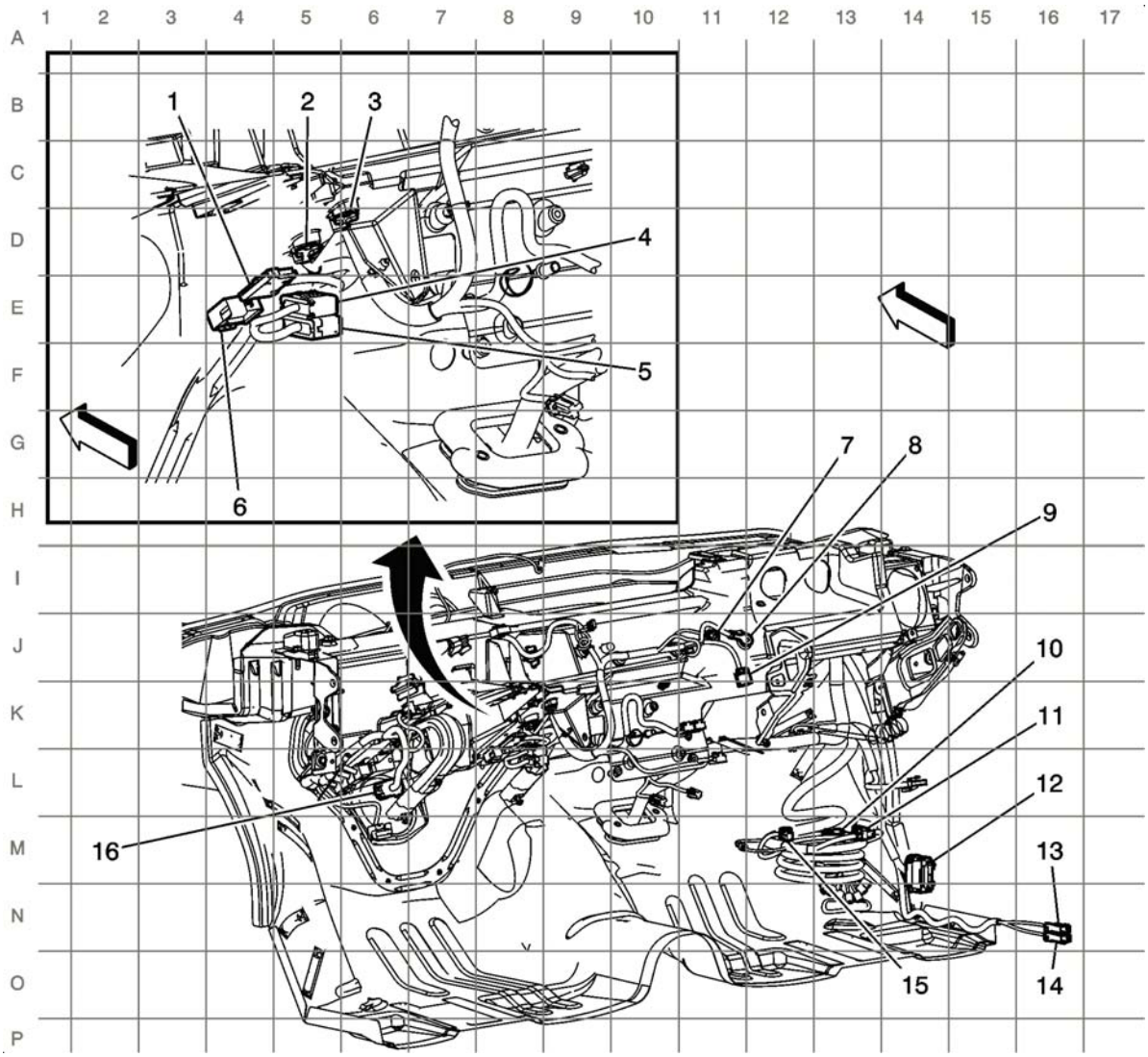


Fig. 6: Instrument Panel Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	JX205
2	G202
3	G201
4	JX206
5	JX207
6	X201
7	G200
8	G204 (9C1, 9C3)
9	X210
10	X266 (9C1, 9C3)
11	X267 (9C1, 9C3)
12	X200
13	X360 (9C1, 9C3)
14	X362 (9C1, 9C3)

Callout	Component Name
15	X297 (9C1, 9C3)
16	X203

Instrument Panel Harness Routing- Lower Left

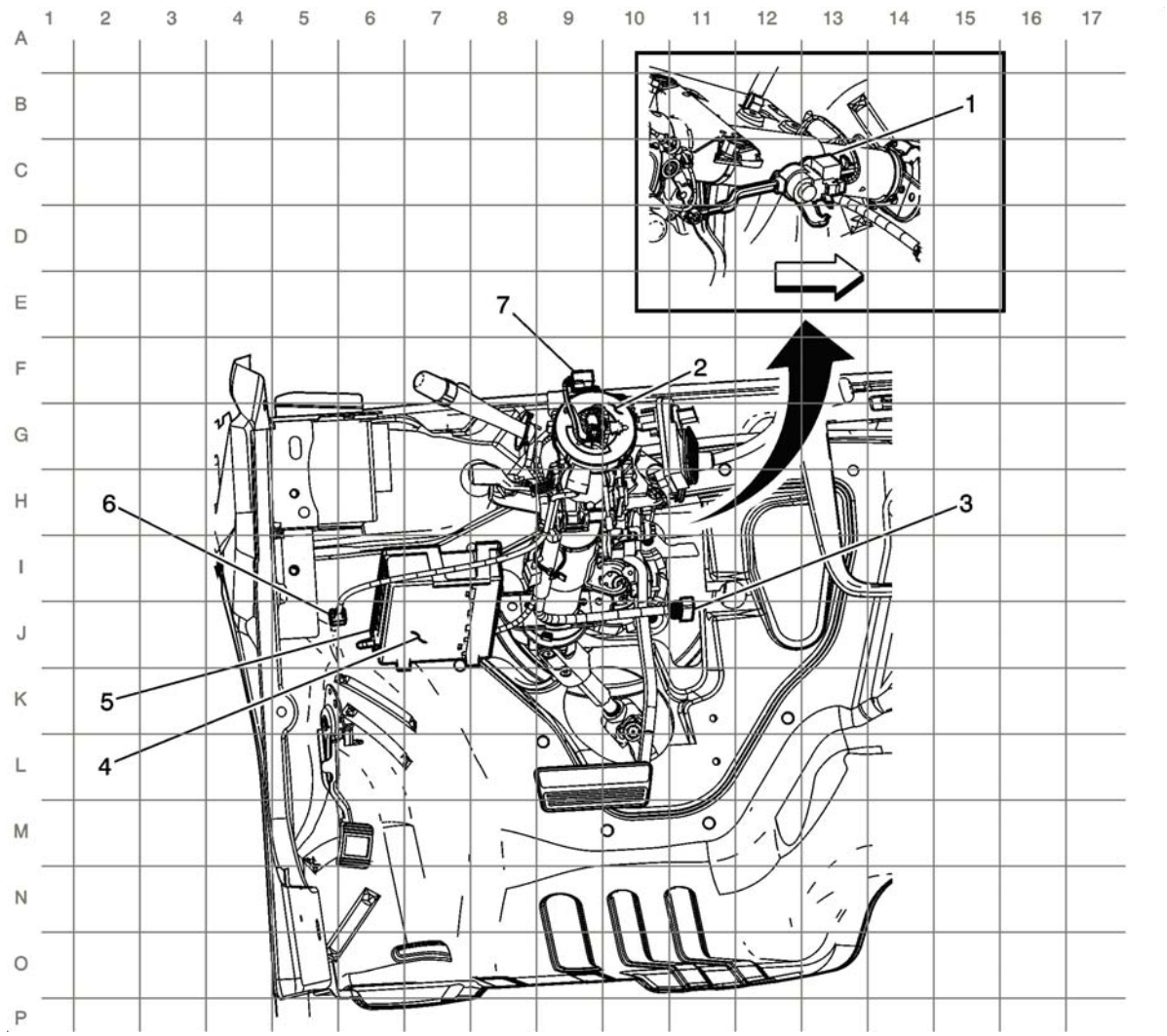


Fig. 7: Instrument Panel Harness- Lower Left
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Ignition Lock Cylinder Control Actuator
2	Inflatable Restraint Steering Wheel Module Coil
3	X201
4	Body Control Module (BCM)
5	Body Control Module (BCM) X1
6	X250
7	X277

Instrument Panel Harness Routing- Rear of the Instrument Panel Carrier

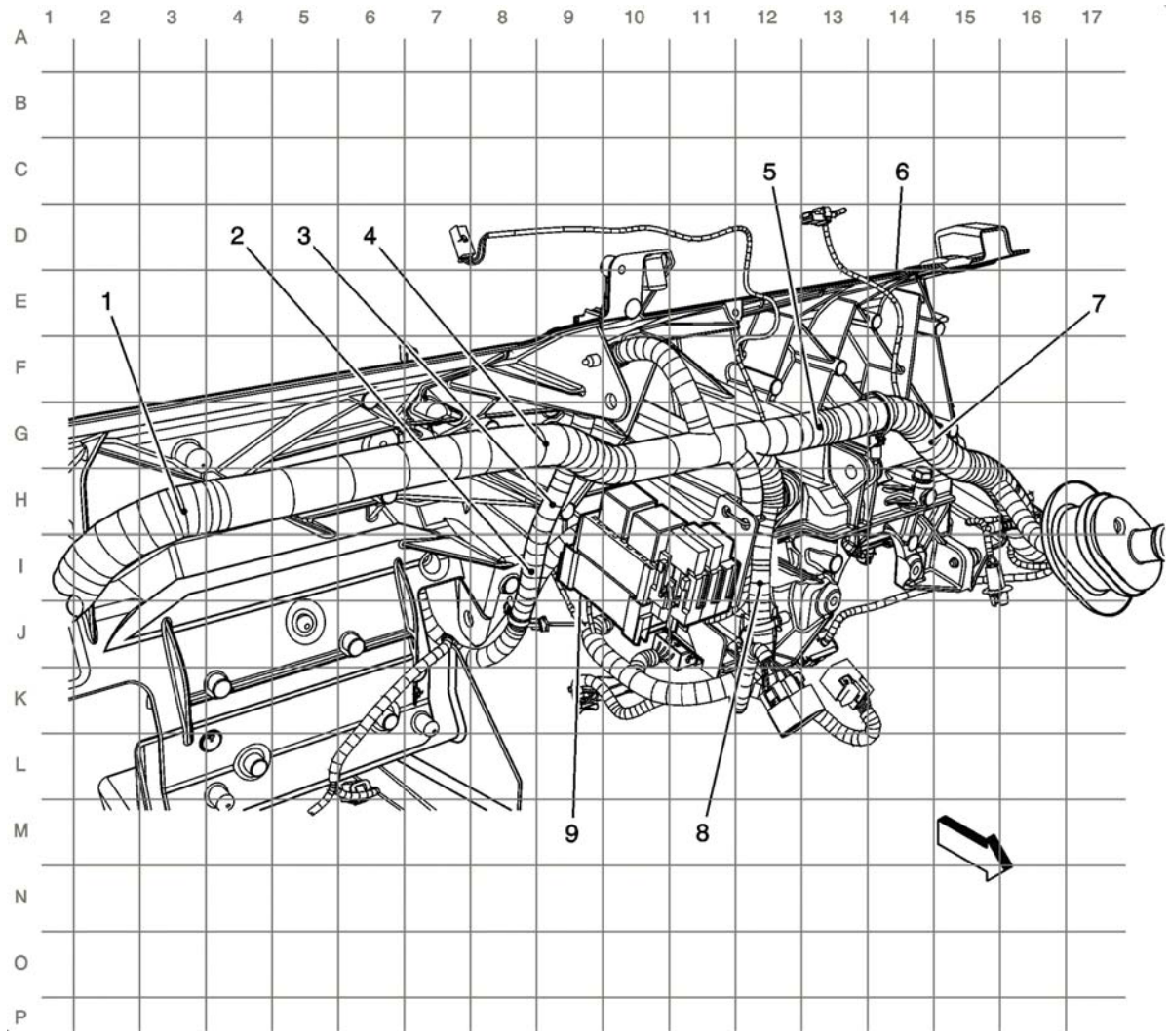


Fig. 8: I/P Harness - Rear of the I/P Carrier
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	J282
2	J203
3	J239
4	J250
5	J218
6	Instrument Panel Carrier
7	J259
8	J269
9	Fuse Block- Auxiliary (9C1/9C3)

Instrument Panel Harness Routing- Engine Compartment

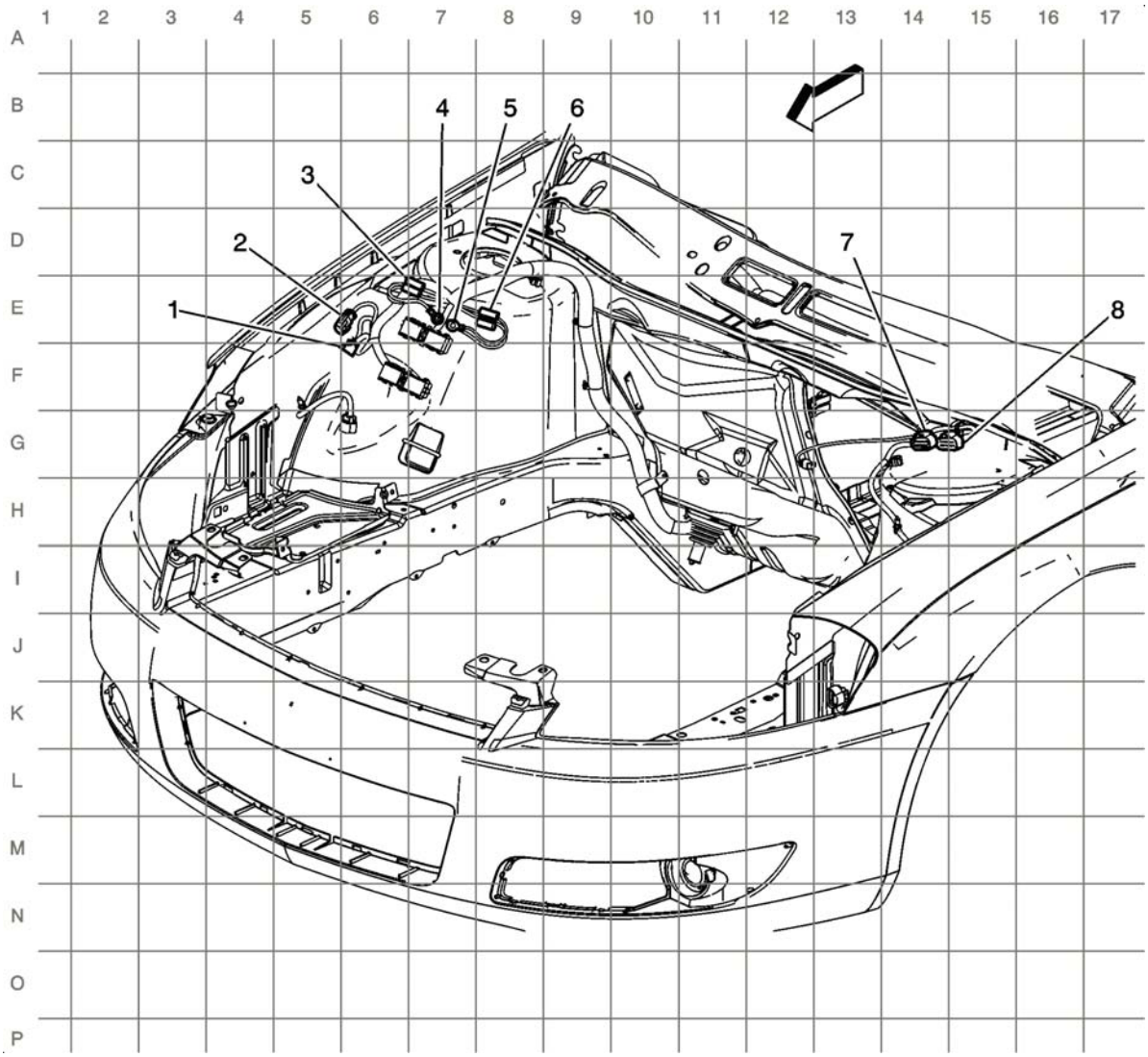


Fig. 9: Instrument Panel Harness - Engine Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X123 (9C1 or 9C3)
2	X105
3	Fusible Link (9C1 or 9C3)
4	Positive Battery Voltage Stud (Fuse Block)
5	Positive Battery Voltage Stud (Fuse Block)
6	Fusible Link (9C1 or 9C3)
7	X101
8	X111

Instrument Panel Harness Routing- Splices

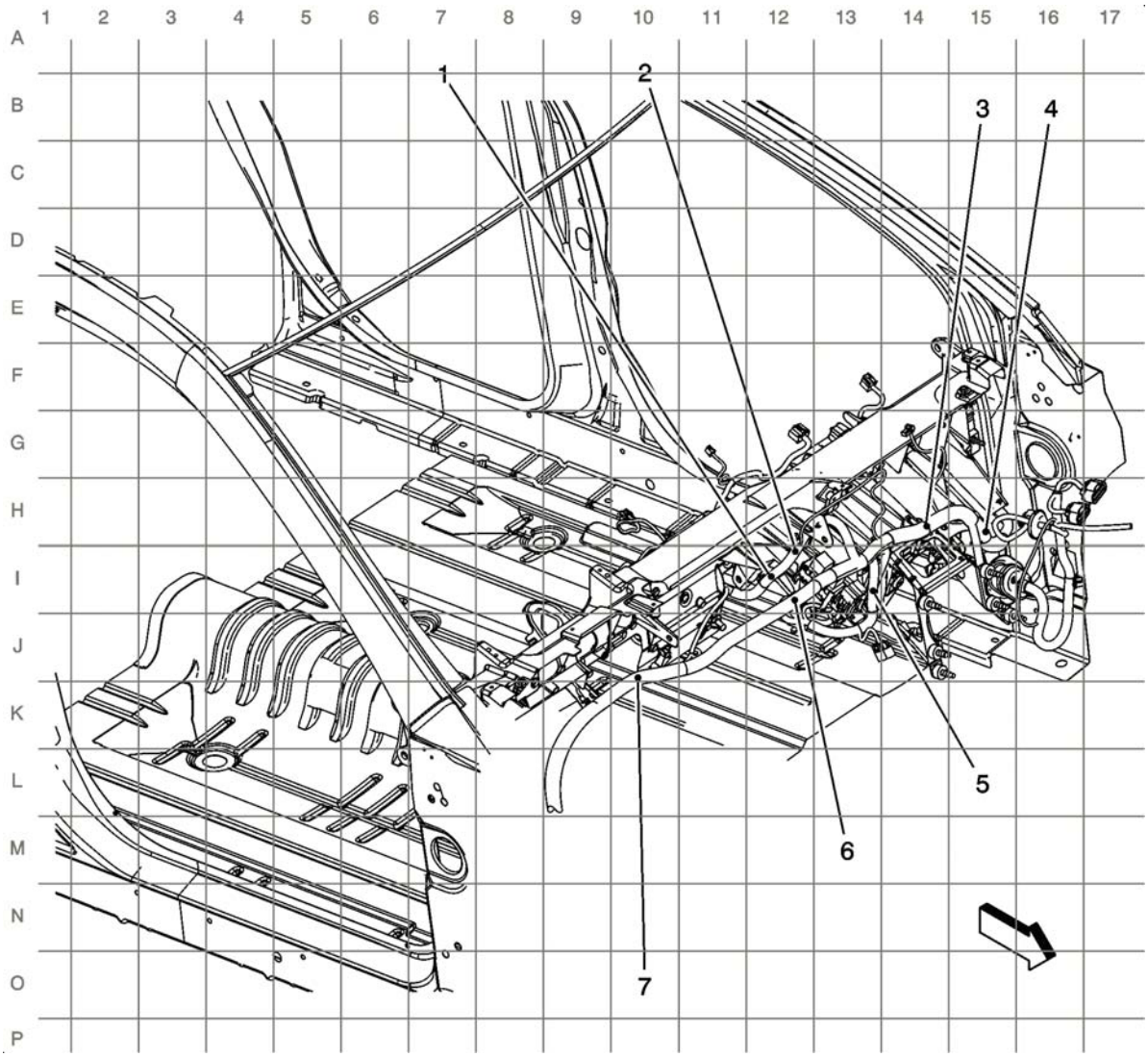


Fig. 10: Instrument Panel Harness Splices
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	J203
2	J239
3	J218
4	J259
5	J269
6	J250
7	J282

Sunroof and Headliner Harness Routing

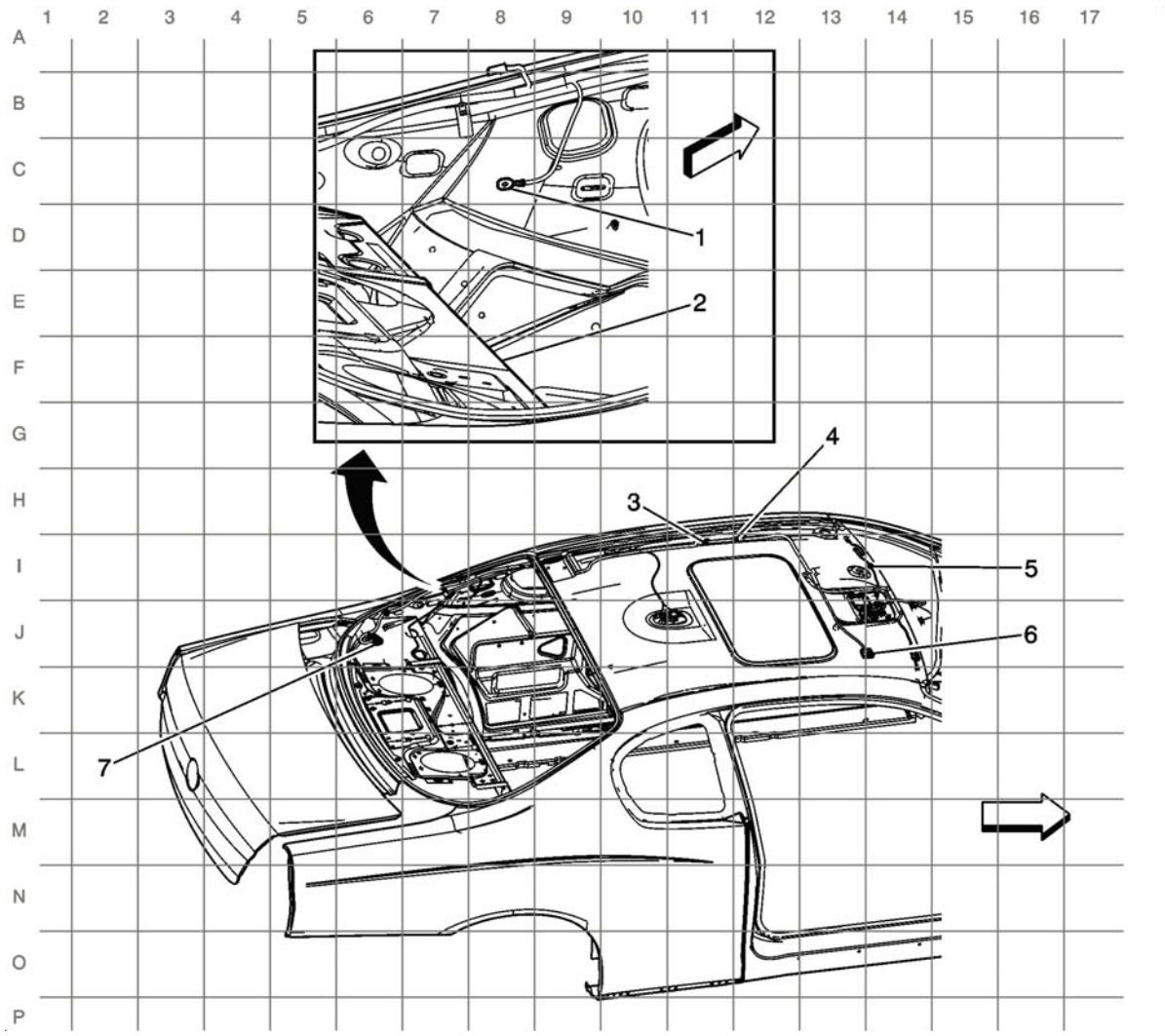


Fig. 11: Sunroof and Headliner Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	G403
2	Rear Shelf
3	J393
4	J390
5	J364
6	X398 (CF5)
7	X490

Body Harness Routing- Passenger Compartment Splices

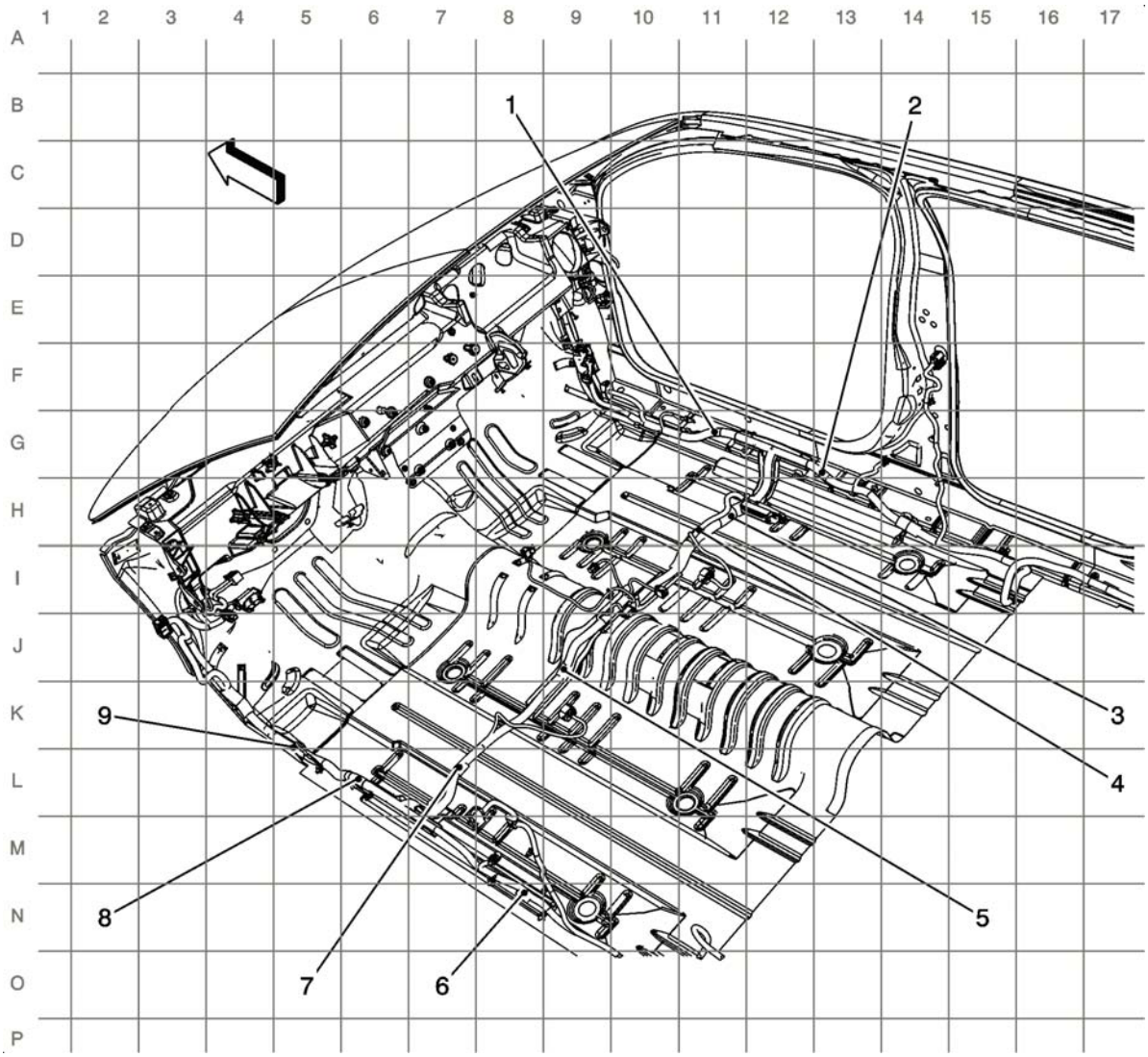


Fig. 12: Body Harness - Passenger Compartment Splices
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	J350
2	J375
3	J314
4	J315
5	J359
6	J332
7	J303
8	J308
9	J307

Body Harness Routing- Left Front Passenger Compartment

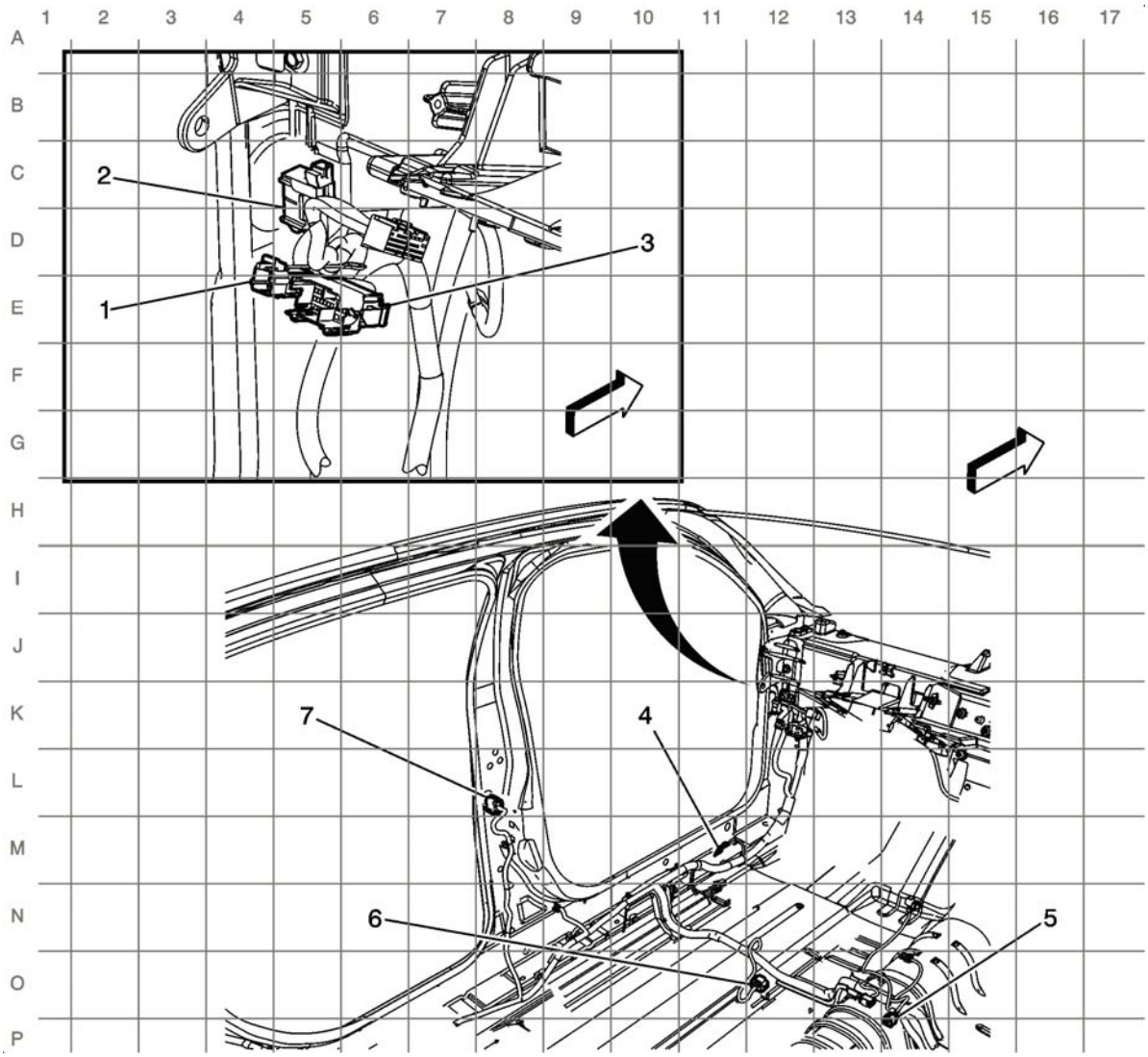


Fig. 13: Body Harness - Left Front Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X250
2	X500
3	X203
4	G301
5	X340
6	X311
7	X700

Body Harness Routing- Right Front Passenger Compartment

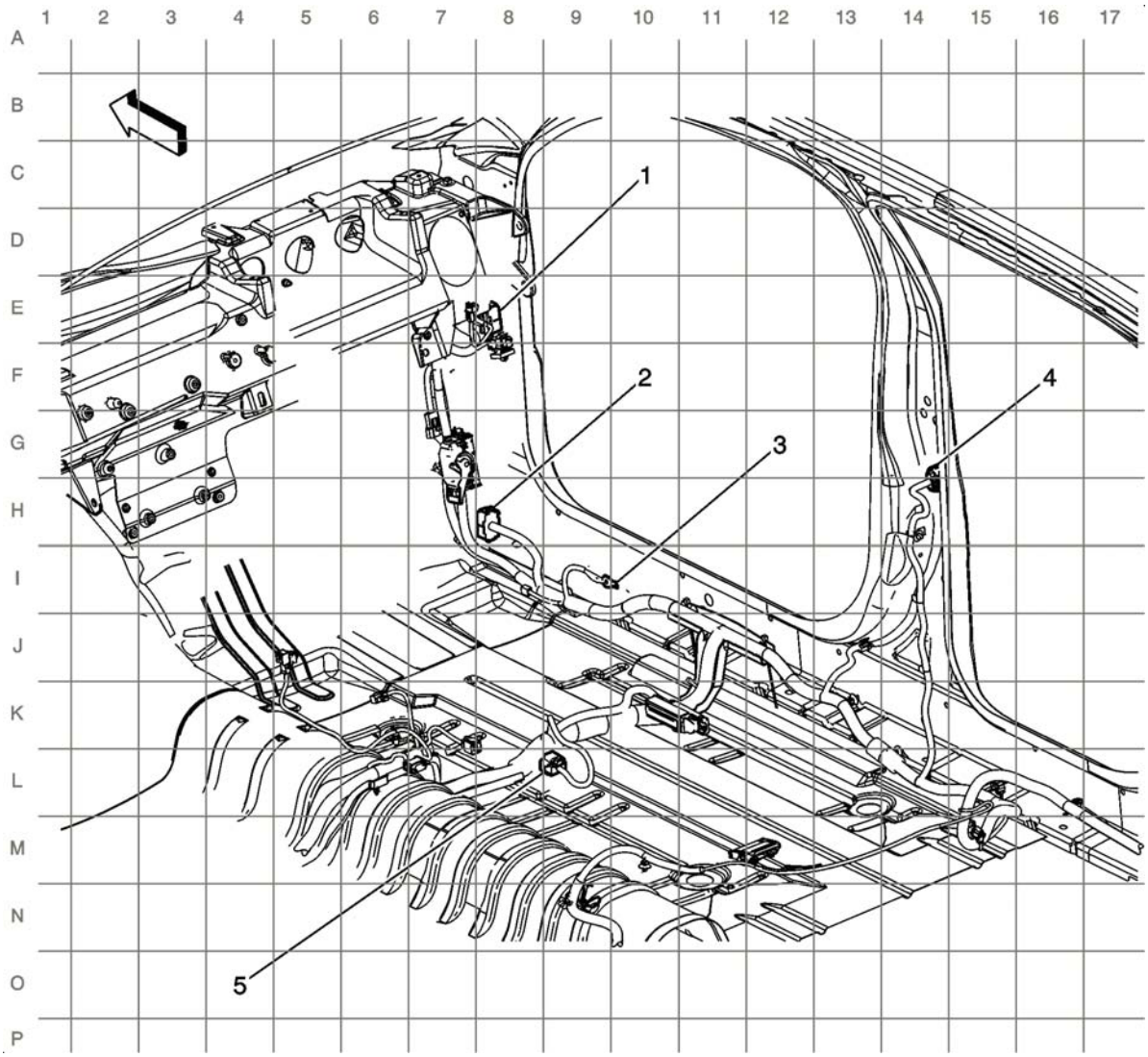


Fig. 14: Body Harness - Right Front Passenger Compartment
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X600
2	X360 (9C1 or 9C3)
3	G302
4	X800
5	X313

Body Harness Routing- Rear Passenger Compartment

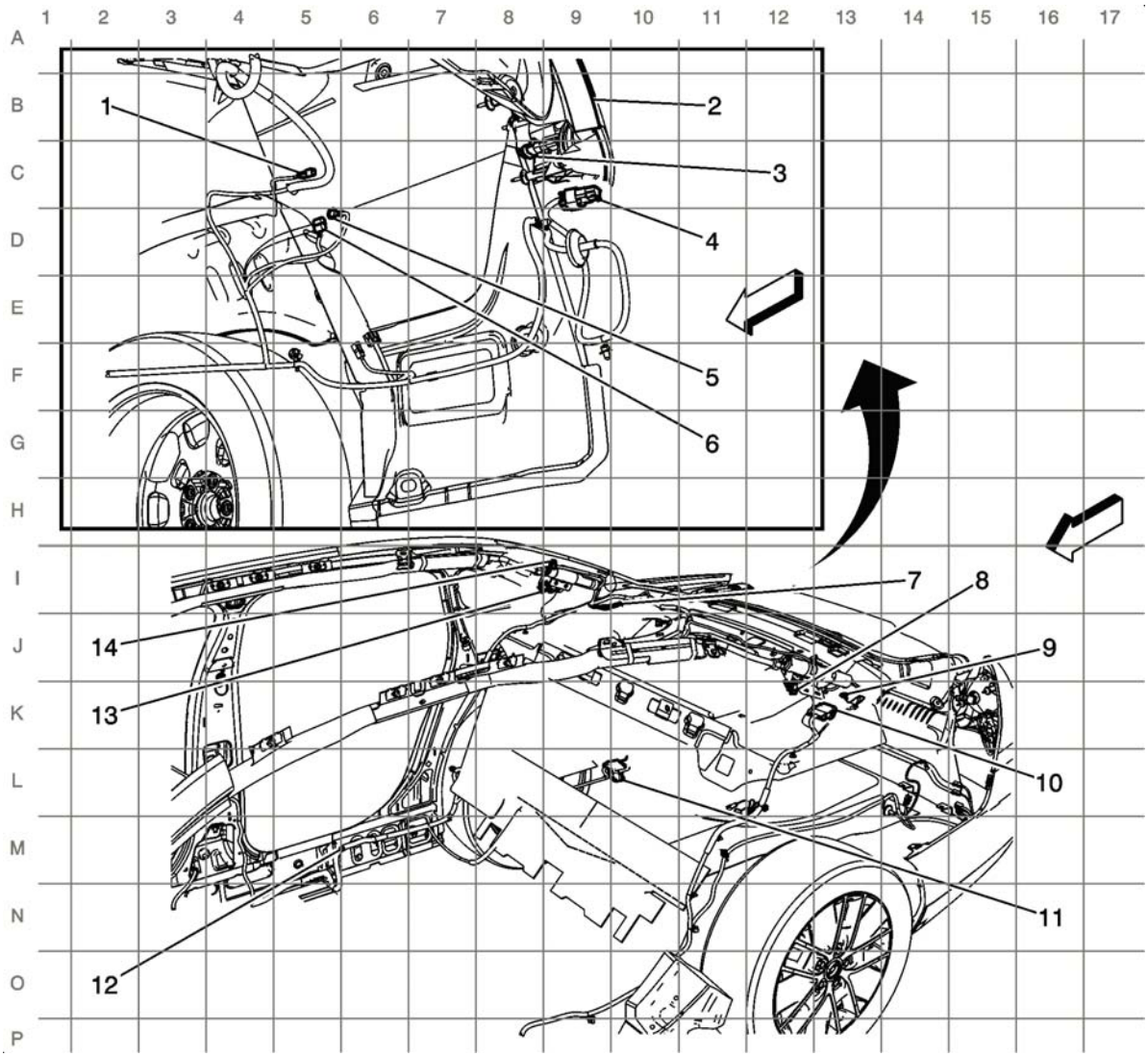


Fig. 15: Body Harness - Rear Compartment Area
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X409 (9C1 or 9C3)
2	Tail Lamp- Right
3	X402
4	X406
5	Junction Block- Rear (6J1) Positive Voltage Stud
6	Junction Block- Rear (6J1) Positive Voltage Stud
7	G404
8	X412
9	G403
10	X490
11	X405
12	J324
13	X414
14	X322- Taped to Harness (9C1 or 9C3)

Seat Harness Routing- Airbags and Inlines

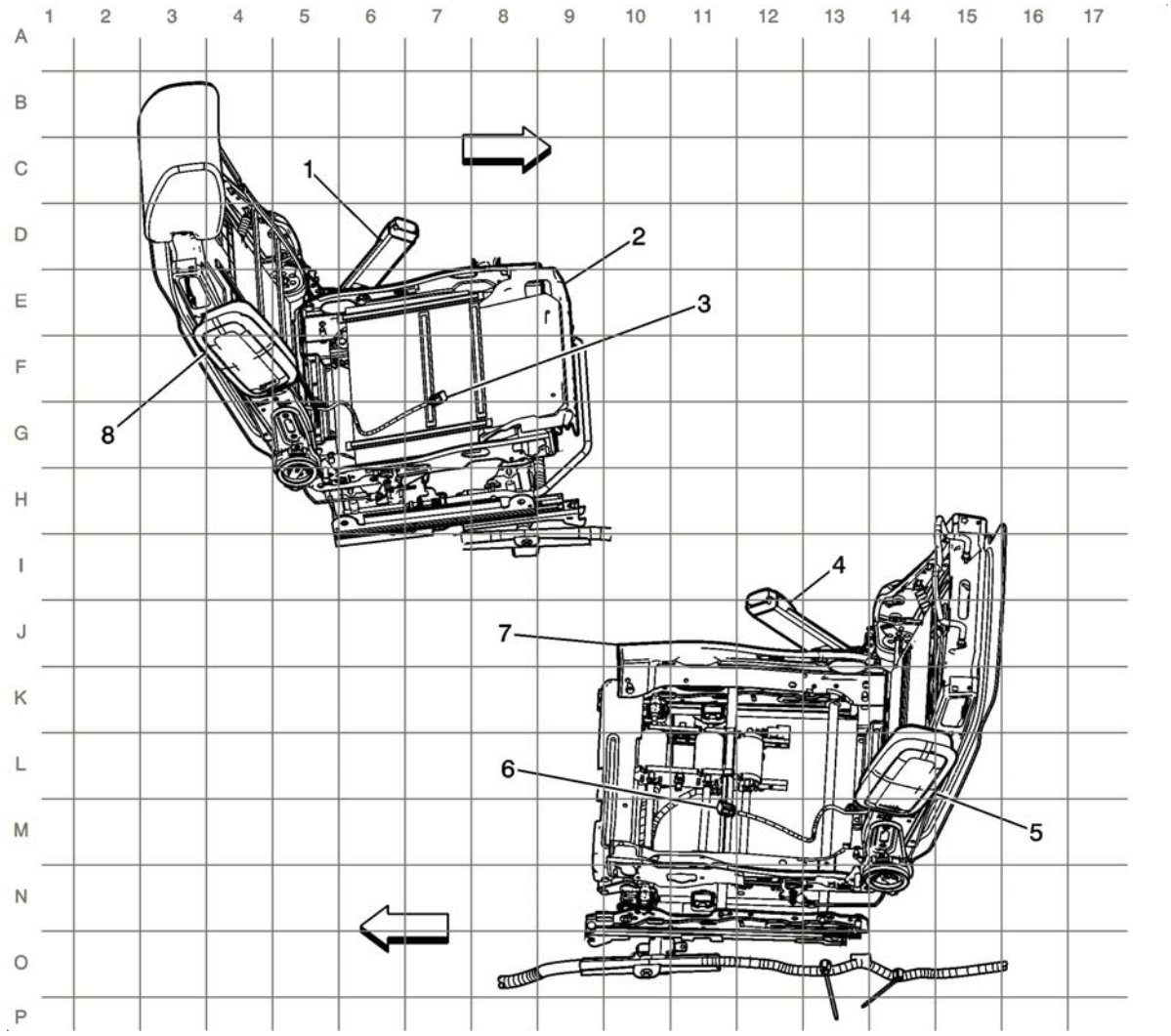


Fig. 16: Front Seat Airbag Inlines
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Seat Belt Buckle- Passenger
2	Passenger Seat
3	X316
4	Seat Belt Buckle- Driver
5	Inflatable Restraint Side Impact Module- Left
6	X315
7	Driver Seat
8	Inflatable Restraint Side Impact Module- Right

Driver Door Harness Routing

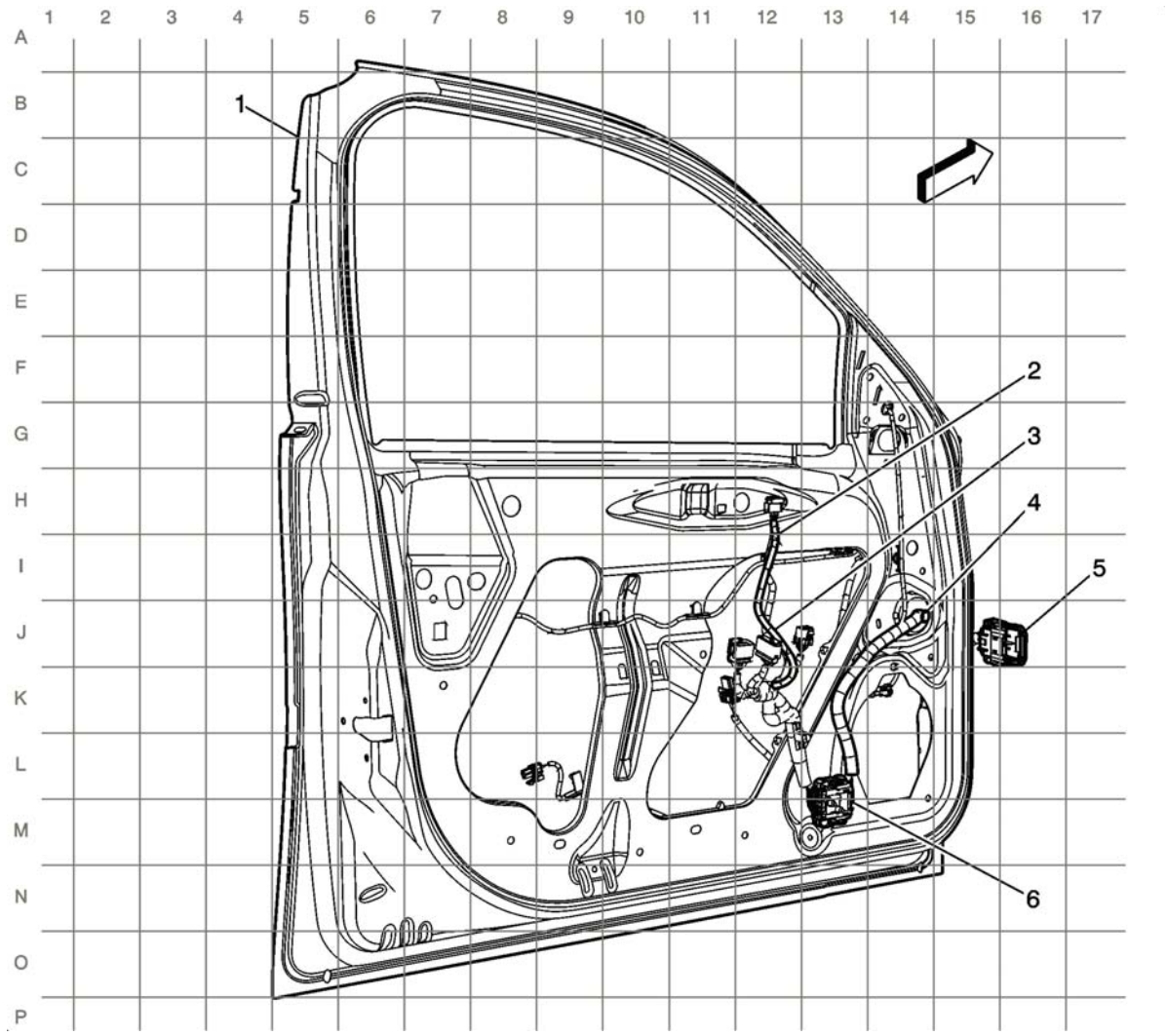


Fig. 17: Driver Door Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	J506
3	J504
4	J505
5	X500
6	X503

Passenger Door Harness Routing

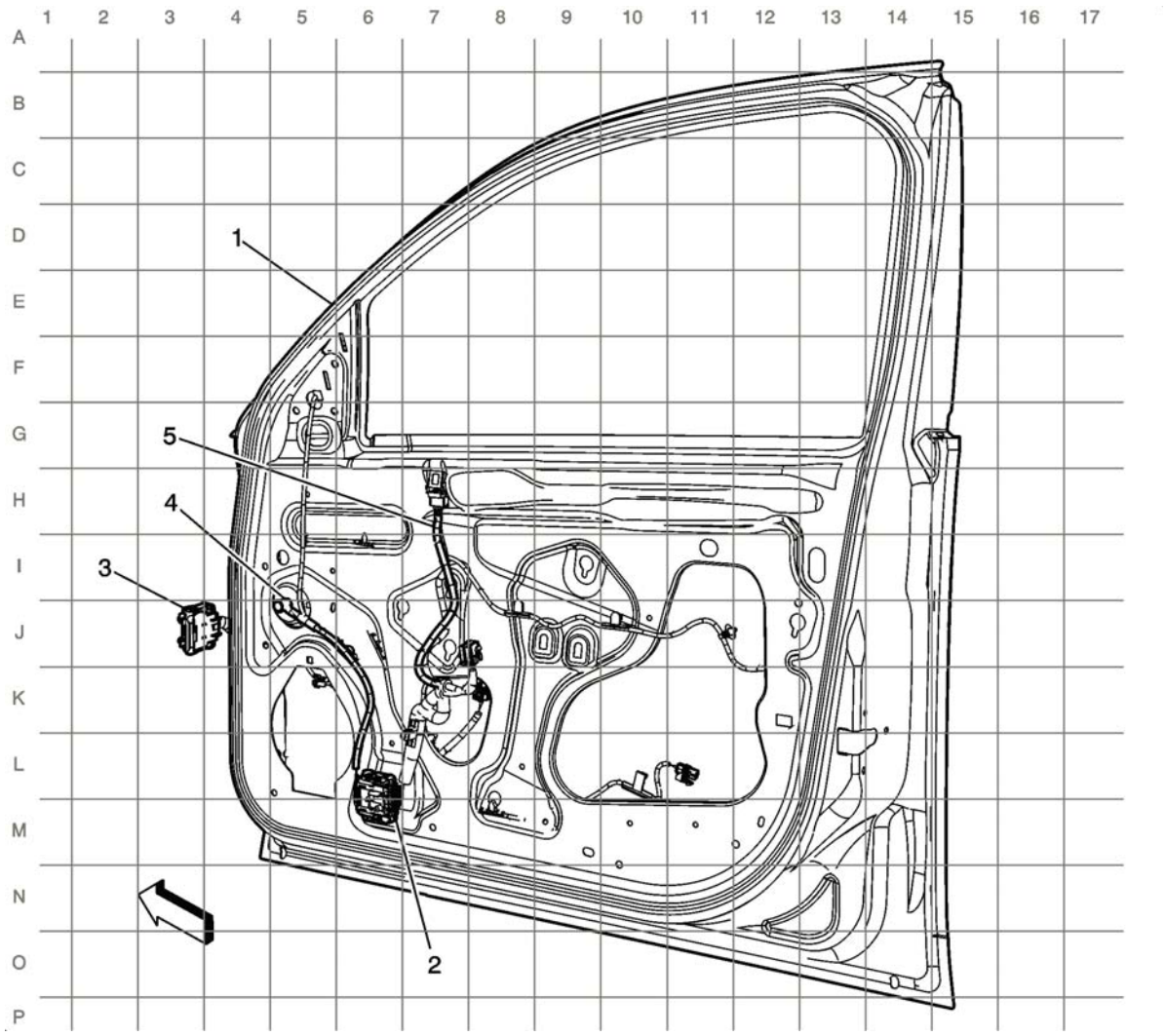


Fig. 18: Passenger Door Harnesses
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	X604
3	X600
4	J604
5	J608

Left Rear Door Harness Routing

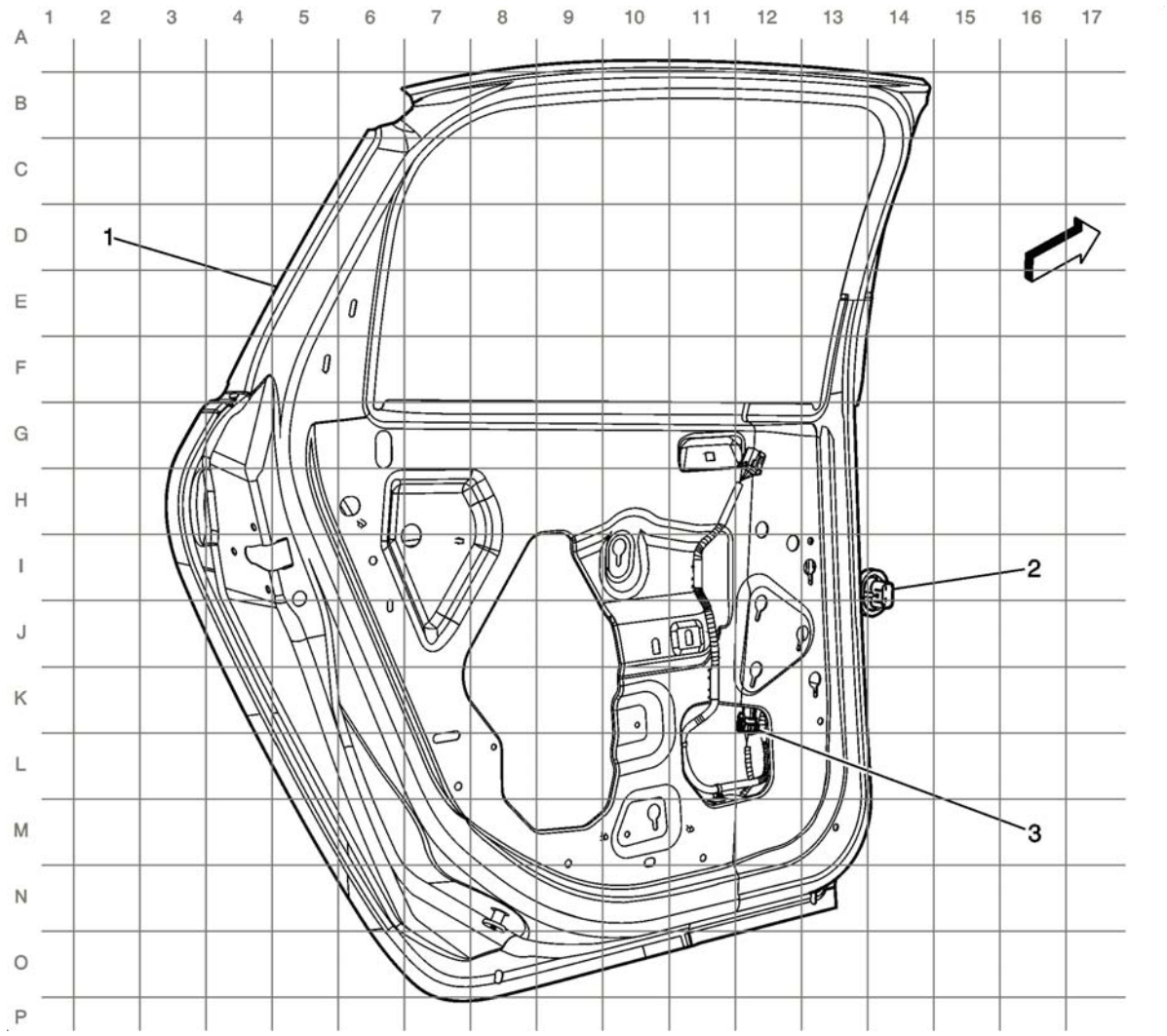


Fig. 19: Left Rear Door Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	X700
3	Window Motor- Left Rear Connector

Right Rear Door Harness Routing

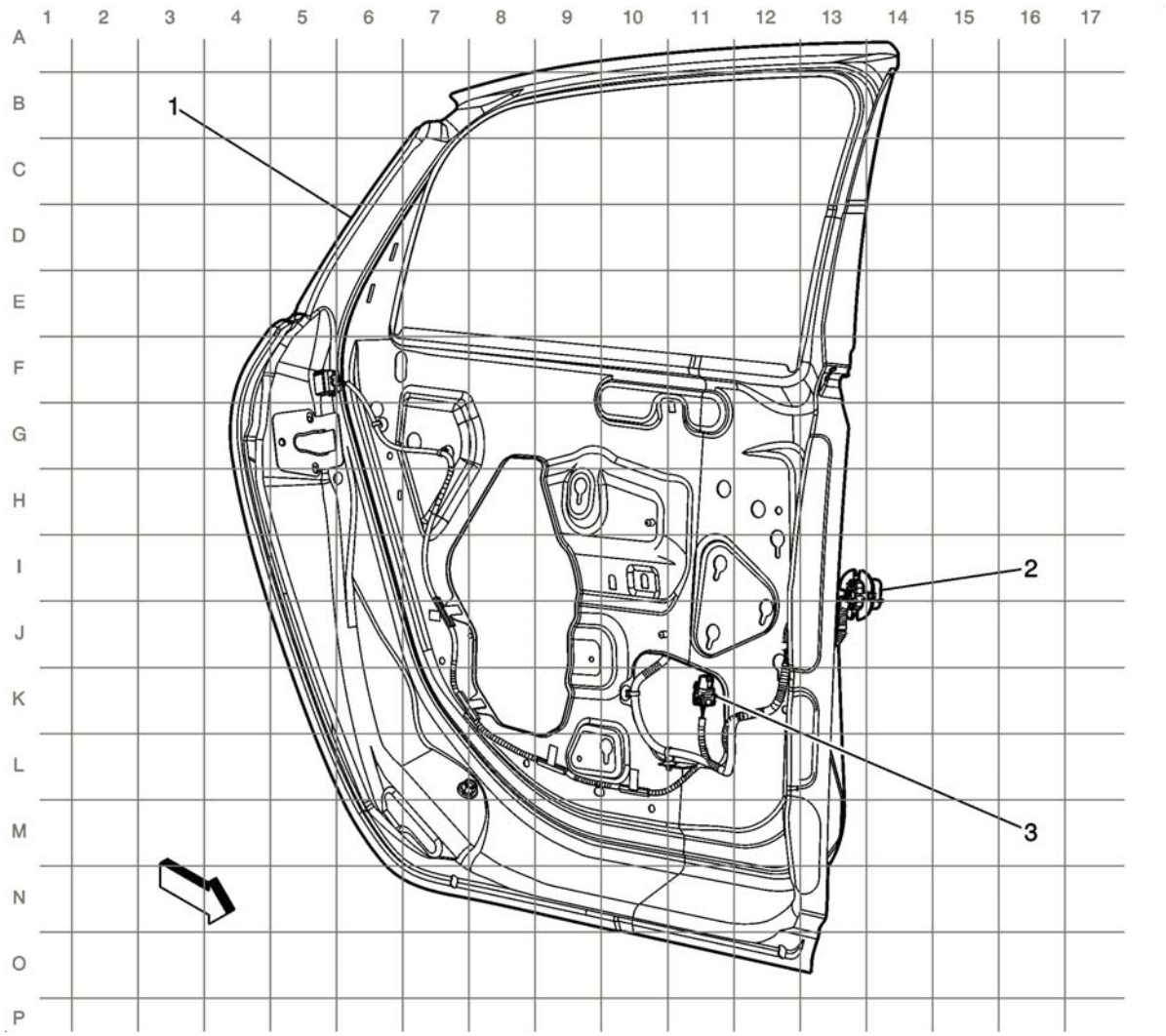


Fig. 20: Right Rear Door Harness
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Door Frame
2	X800
3	Window Motor- Right Rear Connector

Rear Compartment Lid Harness Routing

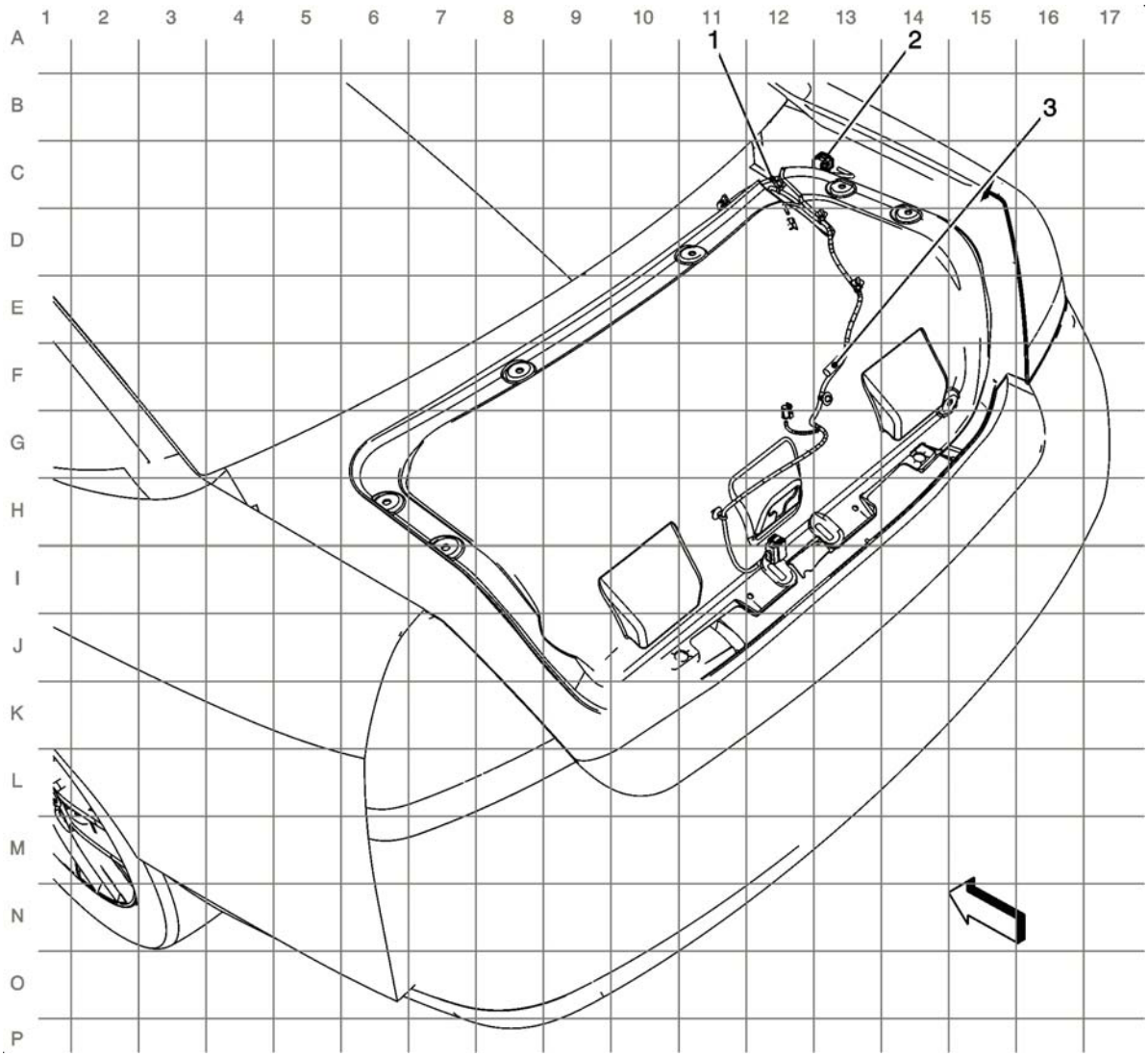


Fig. 21: Rear Compartment Lid
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	J902
2	X430
3	J901

Rear Fascia Harness Routing

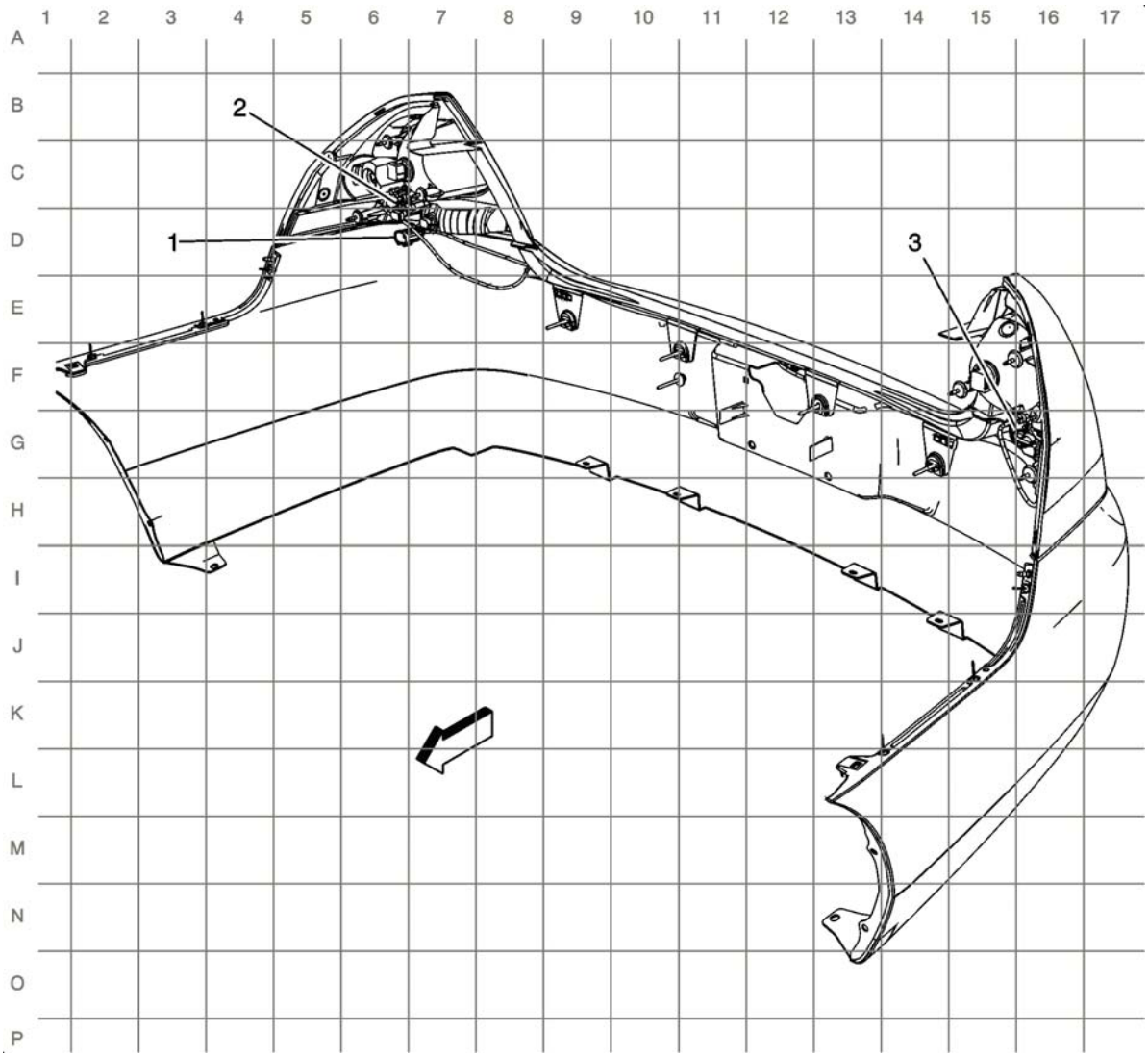


Fig. 22: Rear Fascia
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	X406
2	X402
3	X401

WIRING SCHEMATIC DIAGRAMS

Electrical Schematic Symbols

Voltage Indicators

Symbol	Description

Symbol	Description
	Battery Voltage

Symbol	Description
	Ignition Switch- Off Position

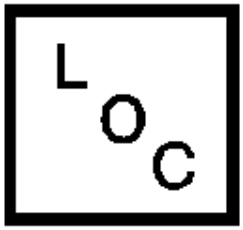
Symbol	Description
	Ignition Switch-Accessory Position

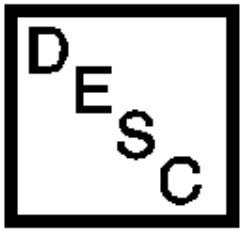
Symbol	Description
	Ignition Switch- Run Position

Symbol	Description
	Ignition Switch-Start Position

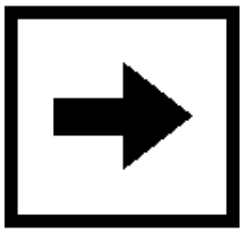
General Icons

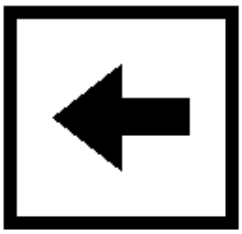
Symbol	Description

Symbol	Description
	Master Component List Icon This icon is used on the schematic to link to the Master Electrical Component List.

Symbol	Description
	Description and Operation Icon This icon is used on the schematic to link to the Description and Operation of that particular system.

Symbol	Description
	Computer Programming Icon This icon is used on the schematic to link to Control Module References, which identifies which components need programming upon replacement.

Symbol	Description
	Next Schematic Page Icon This icon is used on the schematic to navigate to the next schematic in the subsystem.

Symbol	Description
	Previous Schematic Page Icon This icon is used on the schematic to navigate to the previous schematic in the subsystem.

Symbol	Description
	Supplemental Inflatable Restraint (SIR) or Supplemental Restraint System (SRS) Icon This icon is used to alert the technician that the system contains SIR/SRS components that require certain precautions before servicing.

Symbol	Description
	Information Icon This icon is used to alert the technician that there is additional information that will aid in servicing a system.

Symbol	Description
	Danger Icon This icon is intended to alert the technician that a component within the system contains labeling with the same icon. This icon is used when a source component has potential for 60 volts DC or greater or has potential for 42 volts AC or greater.

Symbol	Description
	High Voltage Icon This icon is intended to alert the technician that a component within the system contains labeling with the same icon. This icon is used when a component/circuit has potential for 60 volts DC or greater or has potential for 42 volts AC or greater.

Symbol	Description
	Caution Icon This icon is used to advise the technician to use caution when servicing this component. This icon may be used when a component/circuit has a voltage range potential between 30-60 volts DC or 15-42 volts AC.

Symbol	Description
	Functional Serial Data Communication This icon is used to show the technician that the serial data circuit detail is shown incomplete. It also provides an active link to the Data Communication Schematics were the circuit is shown complete.

Switch Position Icons

Symbol	Description

Symbol	Description
	Generic Up Arrows

Symbol	Description
	Generic Down Arrows

Symbol	Description
	Generic Left Arrows

Symbol	Description
   	Generic Right Arrows

Symbol	Description
	Generic Express Down Arrows

Symbol	Description
	On/Off Icon

Symbol	Description
	Generic Lock Icon

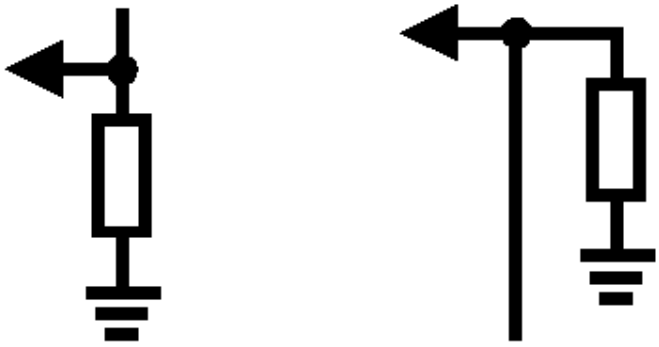
Symbol	Description
	Generic Unlock Icon

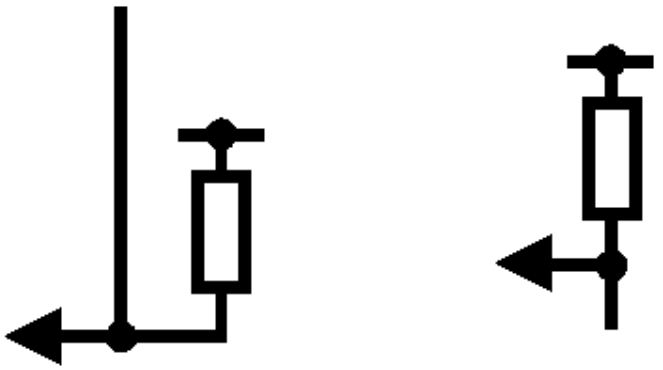
Symbol	Description
	Generic Window Switch Positions- 4 Door

Symbol	Description
	Generic Window Switch Positions- 2 Door

Module Circuit Function Icons

Symbol	Description

Symbol	Description
	I/O Pull-Down Resistors (-)

Symbol	Description
	I/O Pull-Up Resistors (+)

Symbol	Description
	I/O High-Side Drive Switch (+)

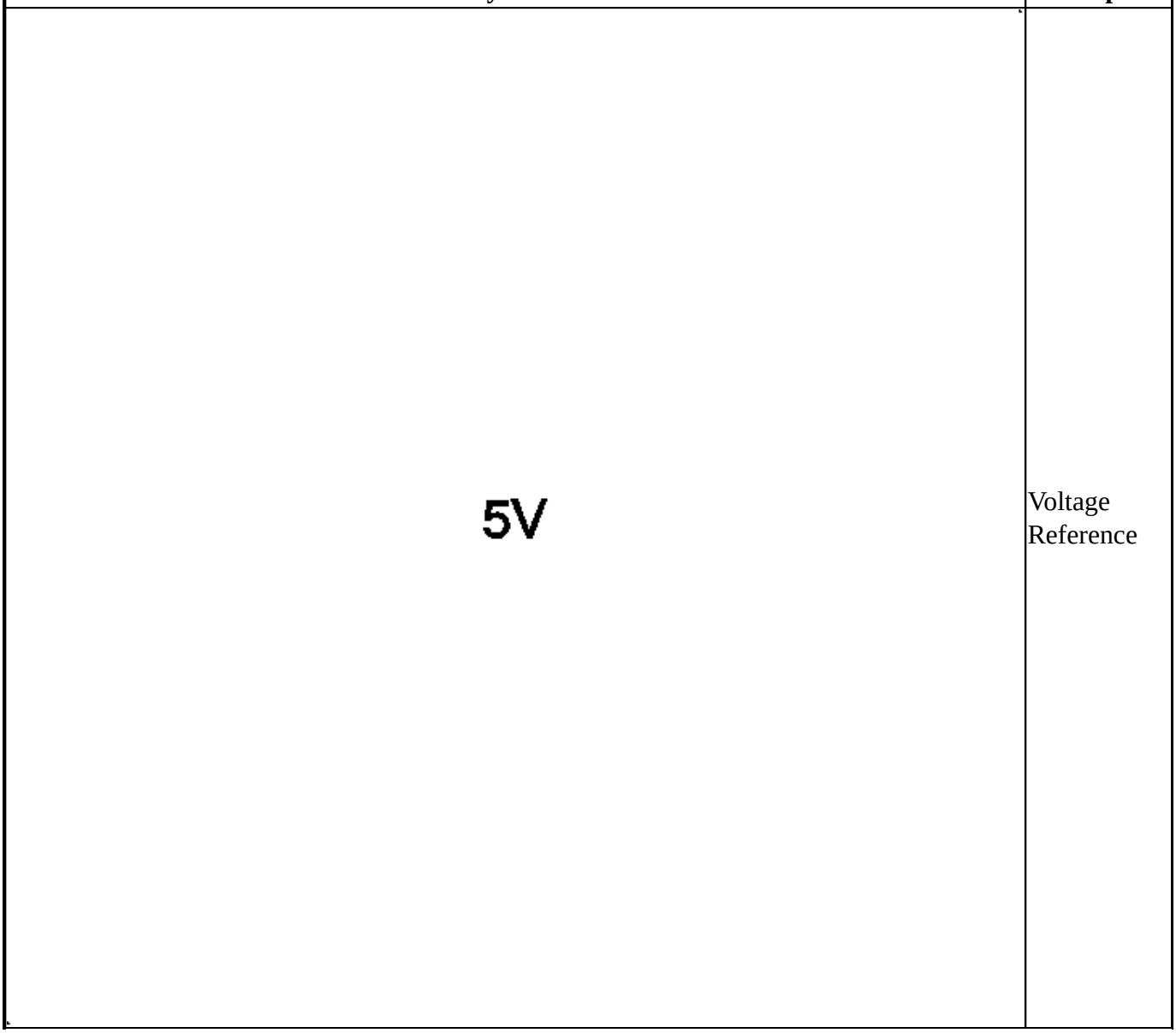
Symbol	Description
	I/O Low-Side Drive Switch (+)

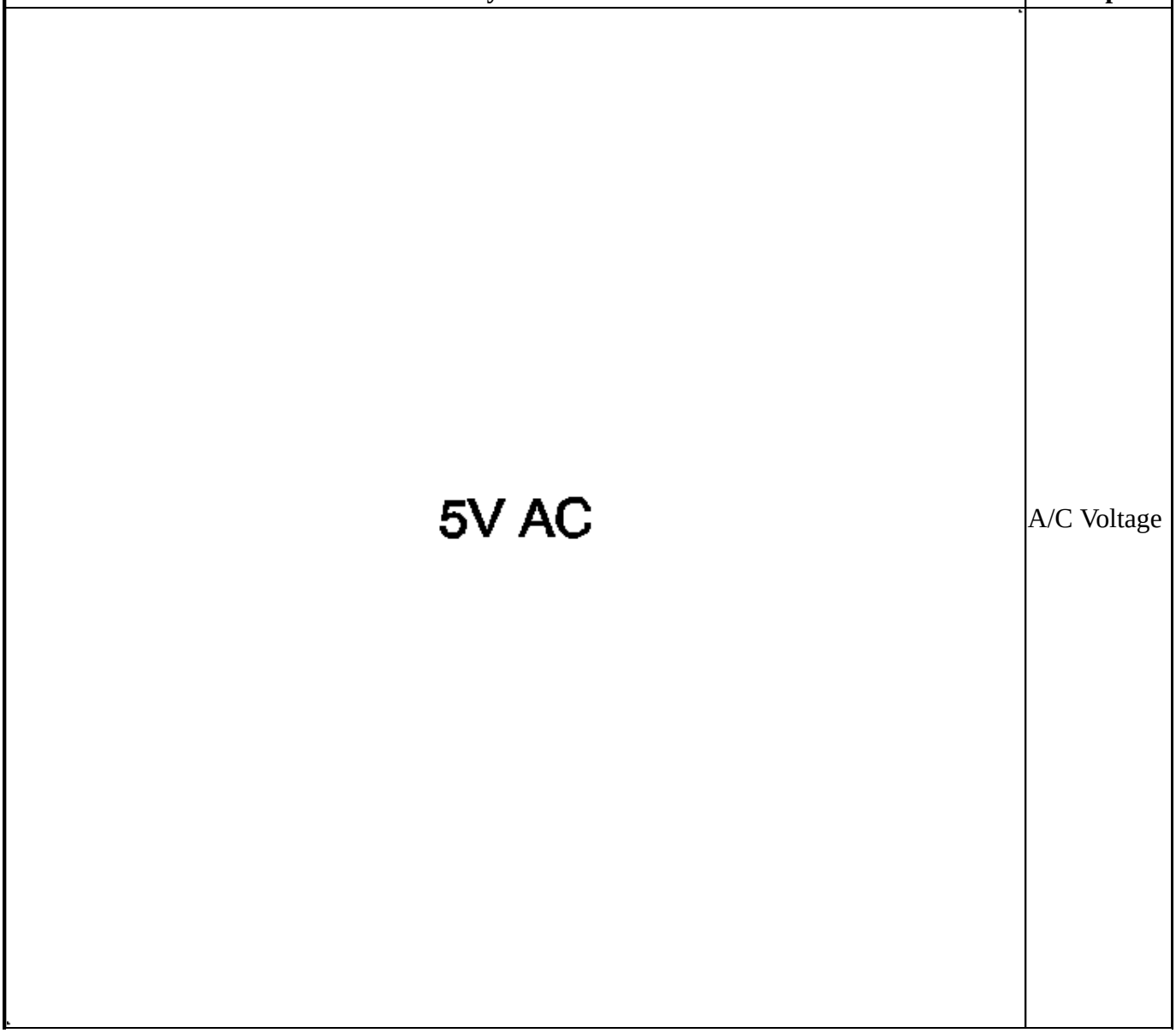
Symbol	Description
	I/O Bidirectional Switch (+/-)

Symbol	Description
	Pulse-Width Modulation Symbol

Symbol	Description
B+	Battery Voltage

Symbol	Description
IGN	Ignition Voltage

Symbol	Description
	Voltage Reference

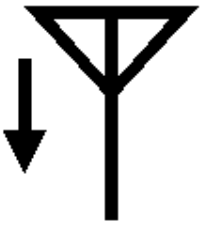
Symbol	Description
	A/C Voltage

Symbol	Description
	Low Reference

Symbol	Description
	Ground

Symbol	Description
	Serial Data

Symbol	Description
	Antenna Signal- In

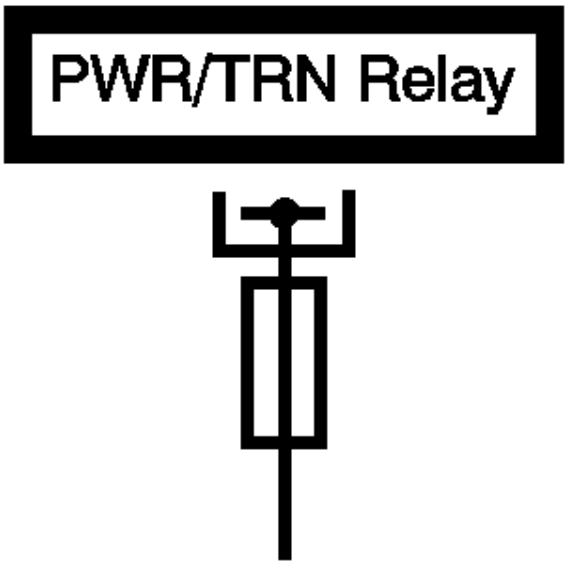
Symbol	Description
	Antenna Signal- Out

Symbol	Description
	Brake Apply

Harness Components

Symbol	Description

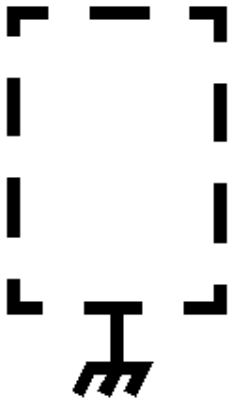
Symbol	Description
	Fuse

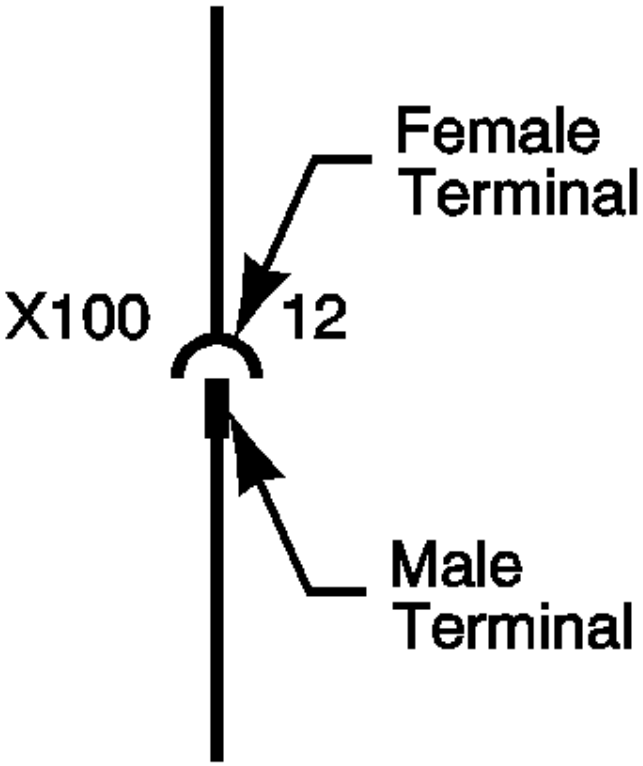
Symbol	Description
	Fuse Supplied by a Relay

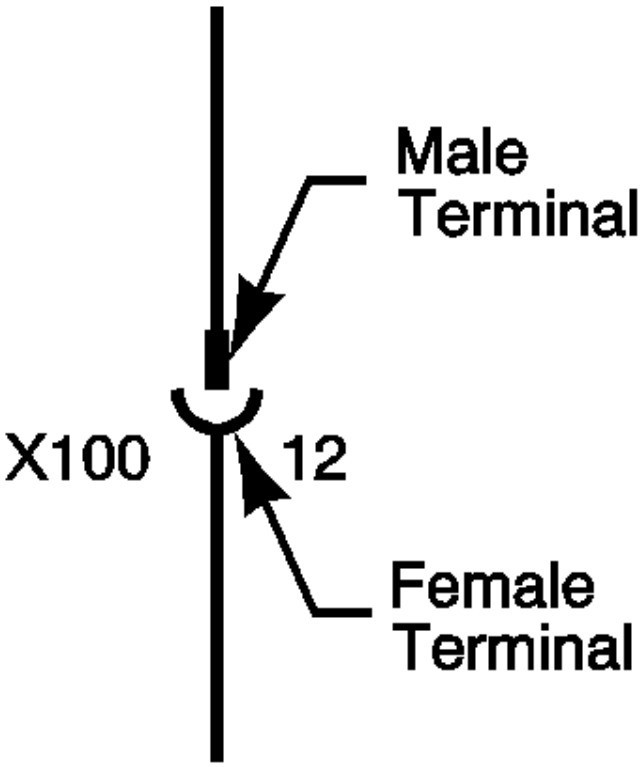
Symbol	Description
	Circuit Breaker

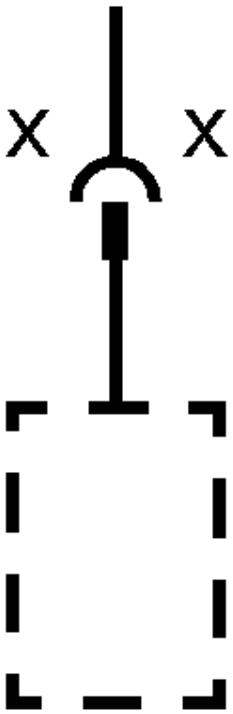
Symbol	Description
	Fusible Link

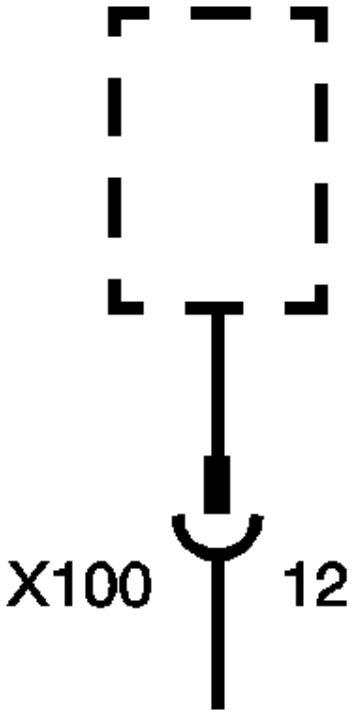
Symbol	Description
	Ground

Symbol	Description
	Case Ground

Symbol	Description
	Inline Harness Connector

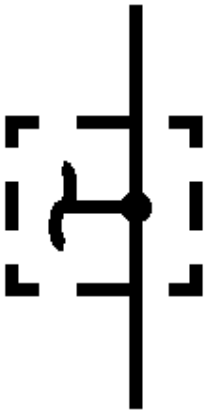
Symbol	Description
	Inline Harness Connector

Symbol	Description
	Pigtail Connection

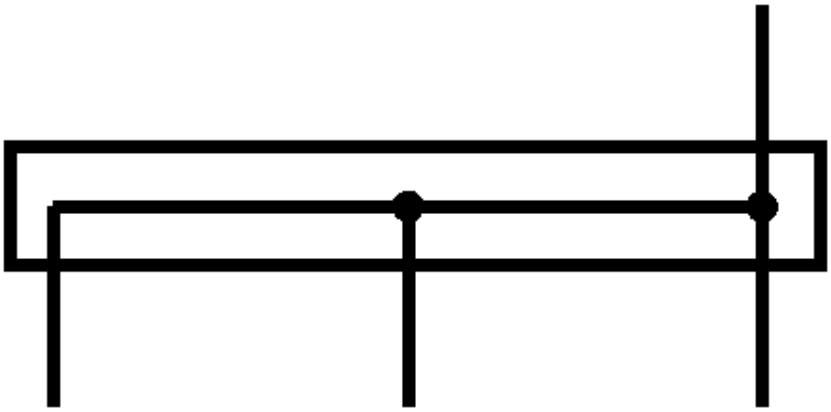
Symbol	Description
	Pigtail Connection

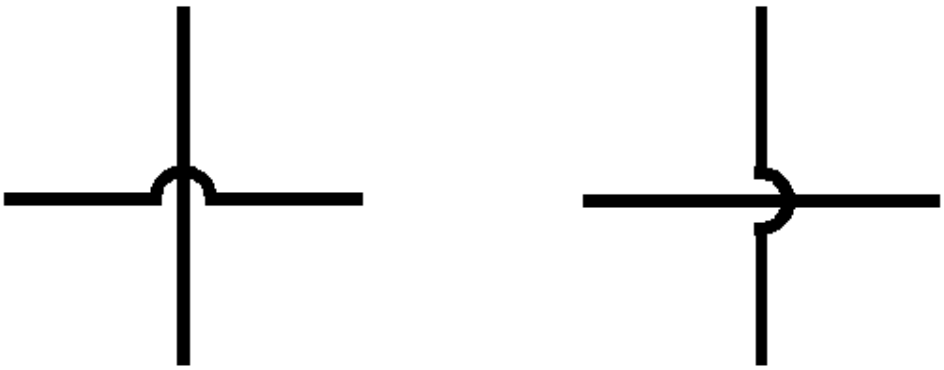
Symbol	Description
	Provisional or Diagnostic Connector

Symbol	Description
	Blunt Cut Wire

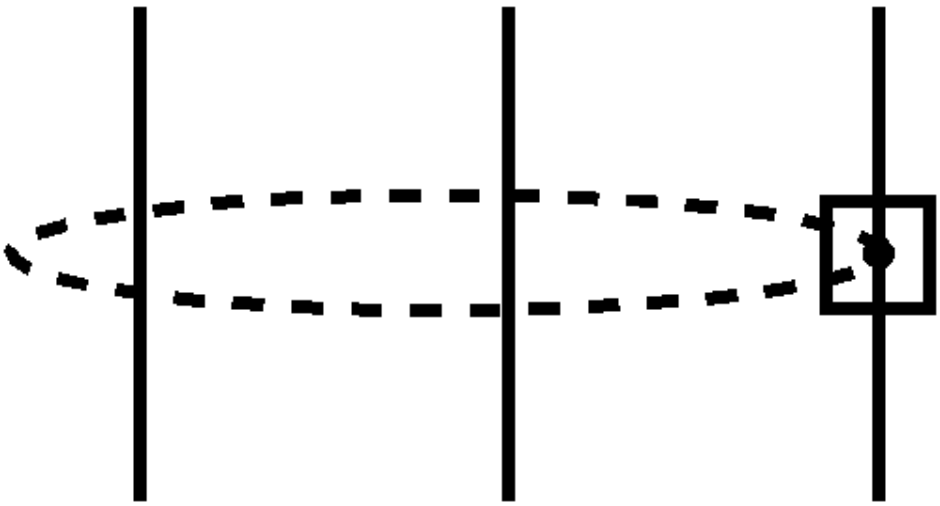
Symbol	Description
	Incomplete Physical Splice

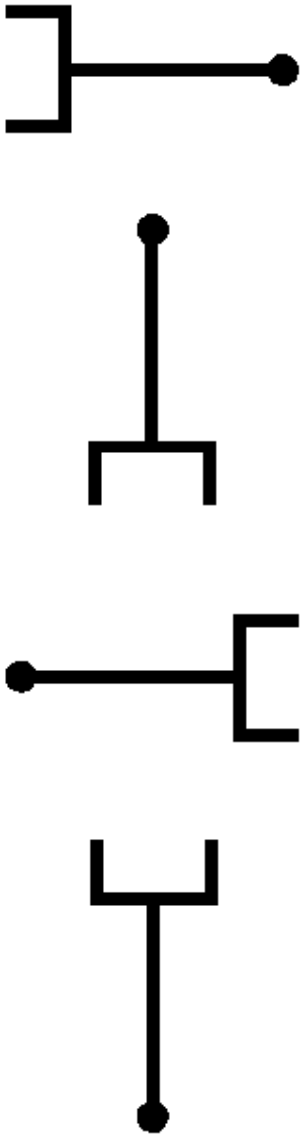
Symbol	Description
	Complete Physical Splice- 2 Wires

Symbol	Description
	Complete Physical Splice- 3 or more wires

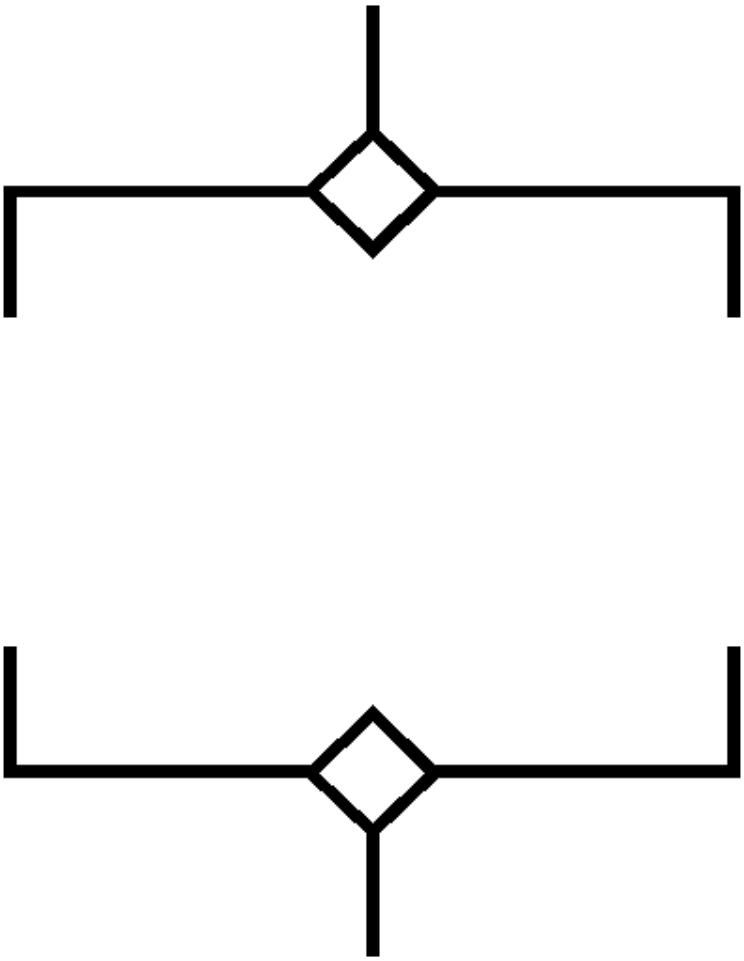
Symbol	Description
	Wire Crosses

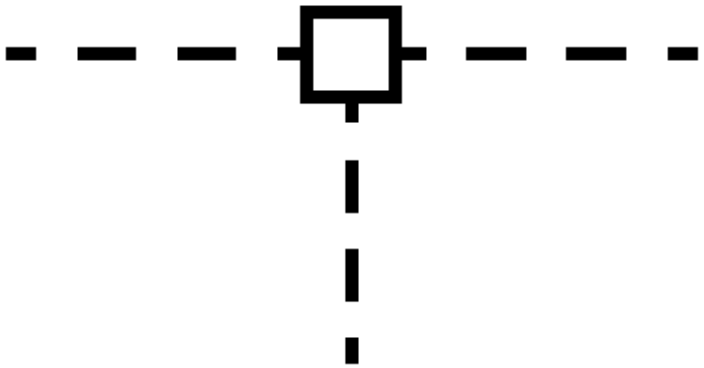
Symbol	Description
	Twisted Wires

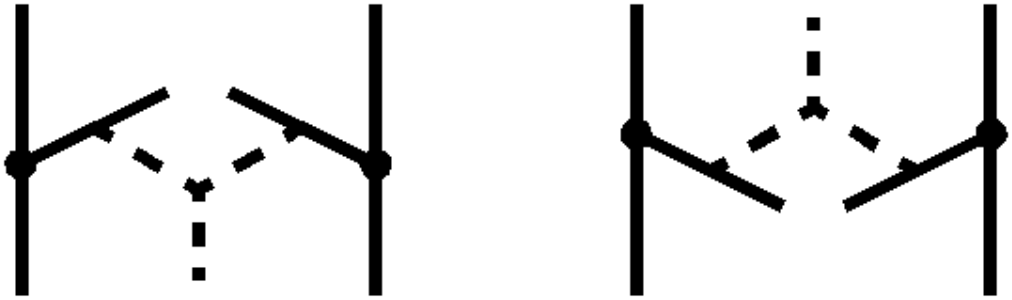
Symbol	Description
	Shield

Symbol	Description
	Circuit References

Symbol	Description
	Circuit Continuation Arrowheads

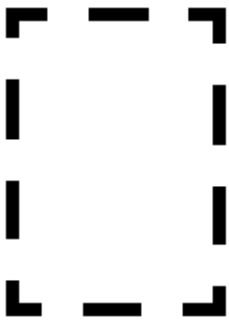
Symbol	Description
	Option Breakpoint

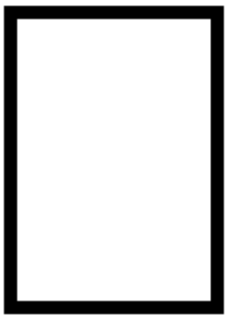
Symbol	Description
	Ground Circuit Connection

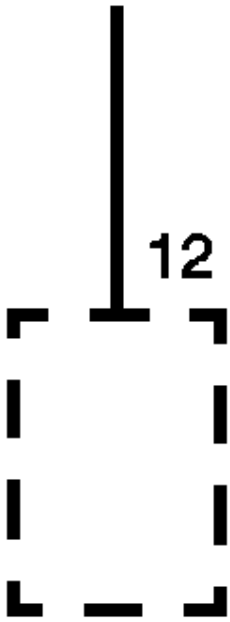
Symbol	Description
	Connector Shorting Clip

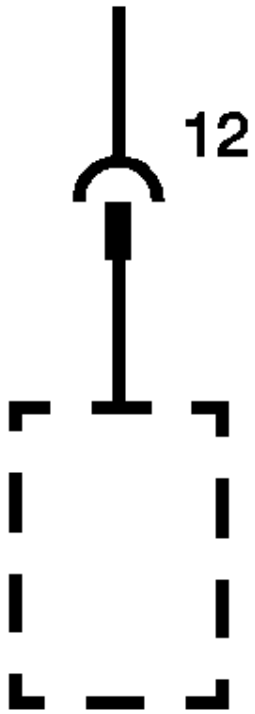
Component Parts

Symbol	Description

Symbol	Description
	Partial Component When a component is represented in a dashed box, the component or its wiring is not shown in its entirety.

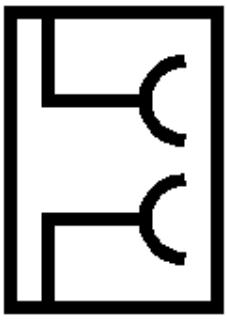
Symbol	Description
	Entire Component When a component is represented in a solid box the component or its wiring is shown in its entirety.

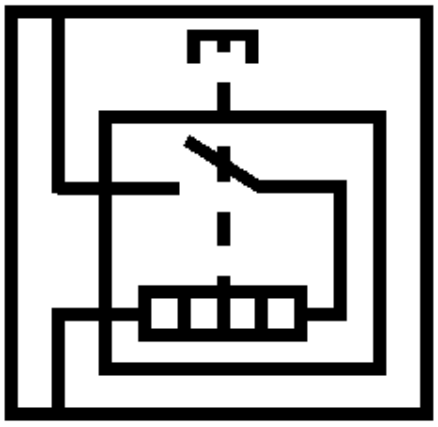
Symbol	Description
	Connector Directly Attached to Component

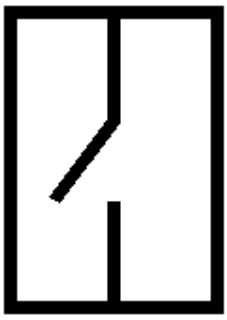
Symbol	Description
	Pigtail Connector

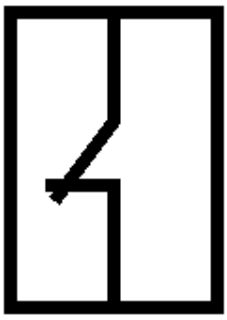
Switches and Relays

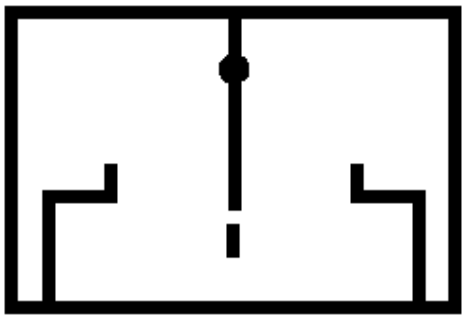
Symbol	Description

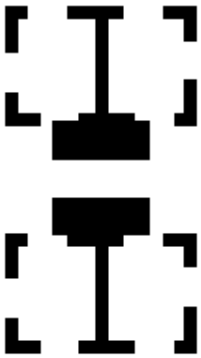
Symbol	Description
	Accessory Power Outlet

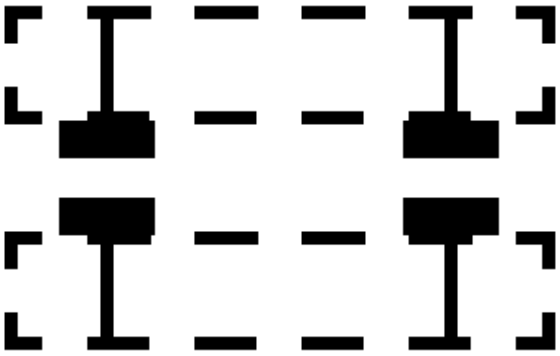
Symbol	Description
	Cigar Lighter

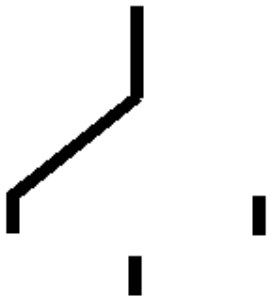
Symbol	Description
	Switch- 2 Position Normally Open

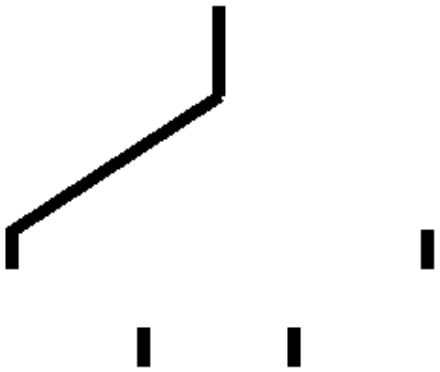
Symbol	Description
	Switch- 2 Position Normally Closed

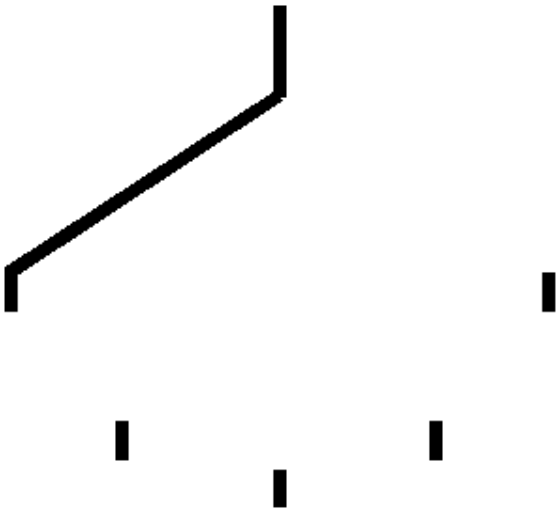
Symbol	Description
	Switch-Rocker

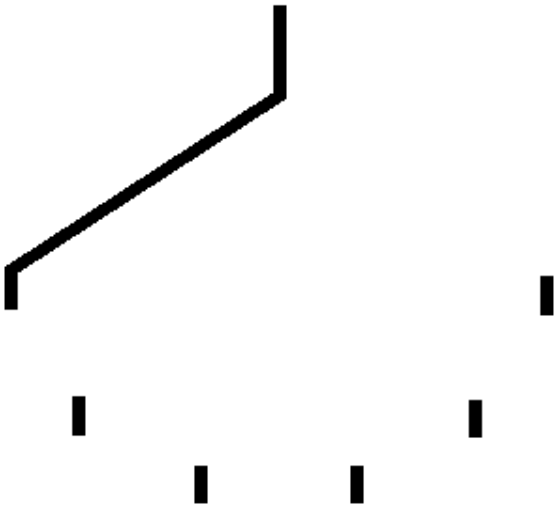
Symbol	Description
	Switch-Contact Plate (1 Wire)

Symbol	Description
	Switch-Contact Plate (2 Wire)

Symbol	Description
	Switch- 3 Position

Symbol	Description
	Switch- 4 Position

Symbol	Description
	Switch- 5 Position

Symbol	Description
	Switch- 6 Position

Symbol	Description
	Switch Actuator-Push (Momentary)

Symbol	Description
	Switch Actuator-Push (Latching)

Symbol	Description
	Switch Actuator-Pull (Momentary)

Symbol	Description
	Switch Actuator-Pull (Latching)

Symbol	Description
	Switch Actuator-Rotate (Momentary)

Symbol	Description
	Switch Actuator-Rotate (Latching)

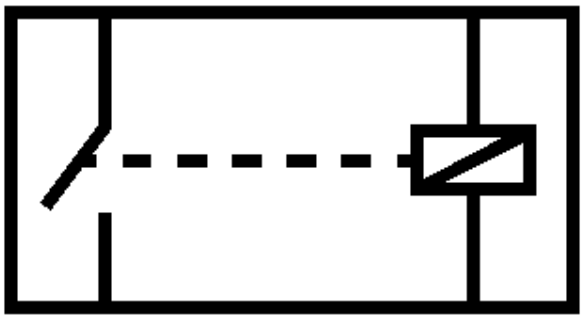
Symbol	Description
	Switch Actuator-Slide (Momentary)

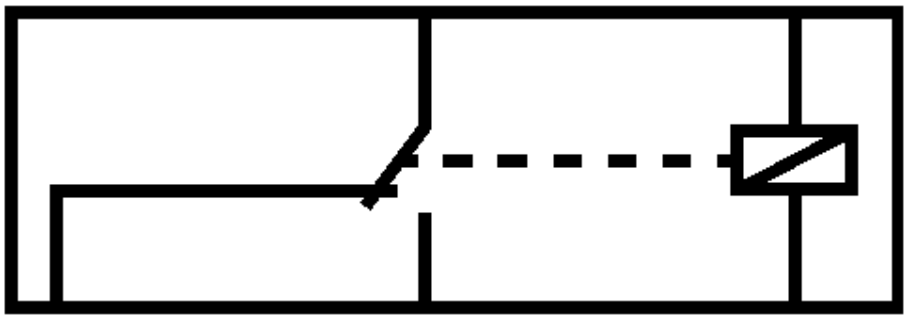
Symbol	Description
	Switch Actuator-Slide (Latching)

Symbol	Description
	Switch Actuator-Pressure (Momentary)

Symbol	Description
	Switch Actuator-Temperature (Momentary)

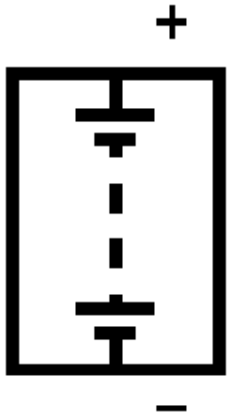
Symbol	Description
	Switch Actuator-Volume (Latching)

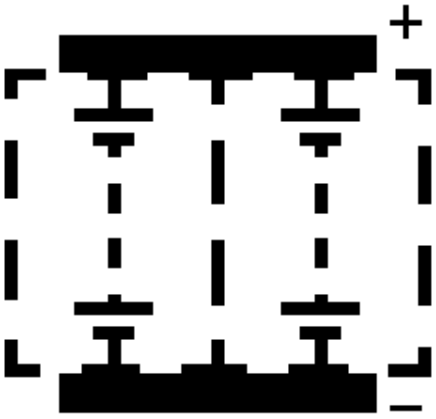
Symbol	Description
	4-Pin Single Pole/Throw Relay- Normally Open

Symbol	Description
	5-Pin Relay-Normally Closed

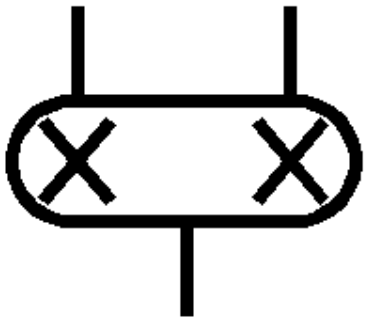
Devices and Sensors

Symbol	Description

Symbol	Description
	Battery

Symbol	Description
	Battery Assembly-Hybrid

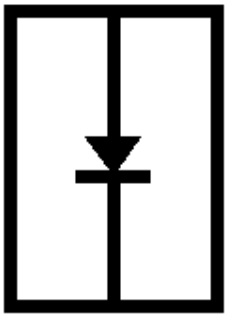
Symbol	Description
	Single Filament Light Bulb

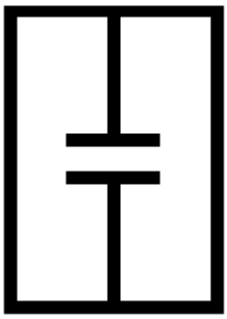
Symbol	Description
	Double Filament Light Bulb

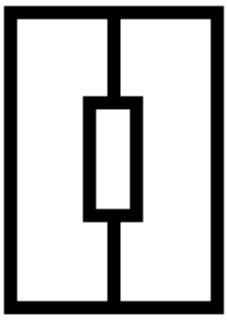
Symbol	Description
	Light Emitting Diode (LED)

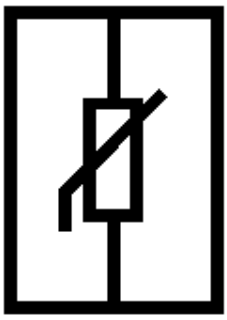
Symbol	Description
	Photo Sensor

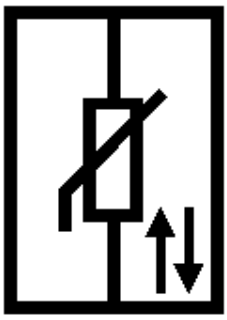
Symbol	Description
	Gauge

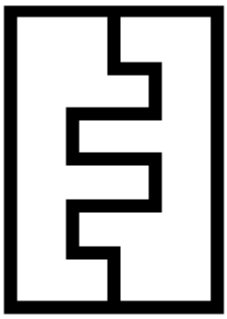
Symbol	Description
	Diode

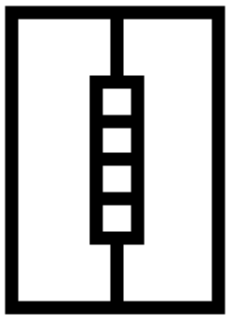
Symbol	Description
	Capacitor

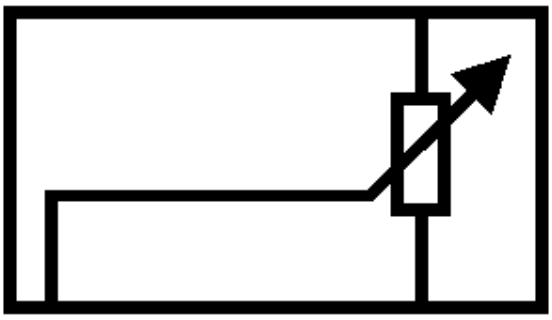
Symbol	Description
	Resistor

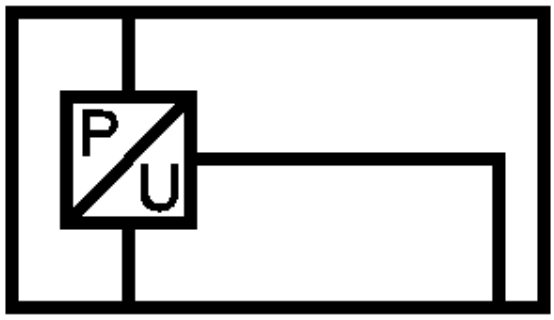
Symbol	Description
	Variable Resistor

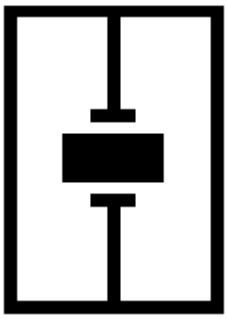
Symbol	Description
	Variable Resistor-NTC

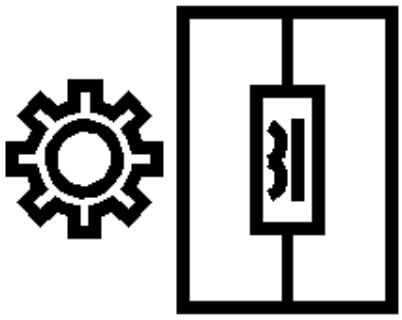
Symbol	Description
	Breakable Wire

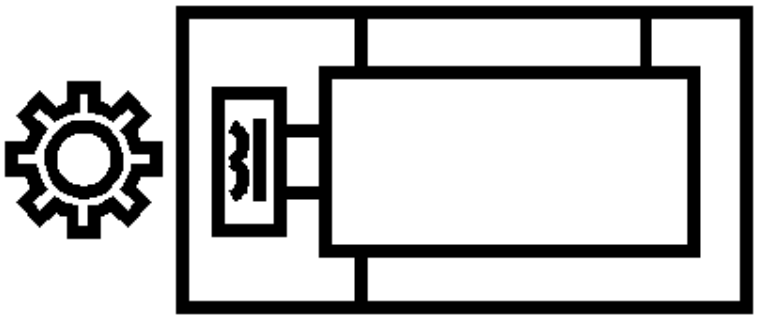
Symbol	Description
	Heating Element

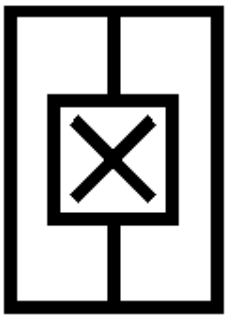
Symbol	Description
	Position Sensor

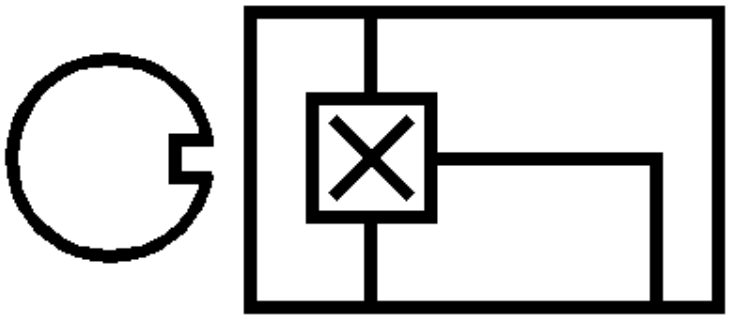
Symbol	Description
	Pressure Sensor

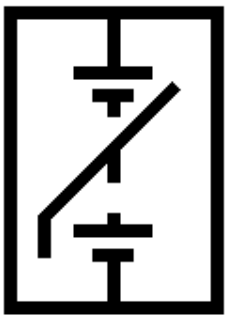
Symbol	Description
	Knock Sensor

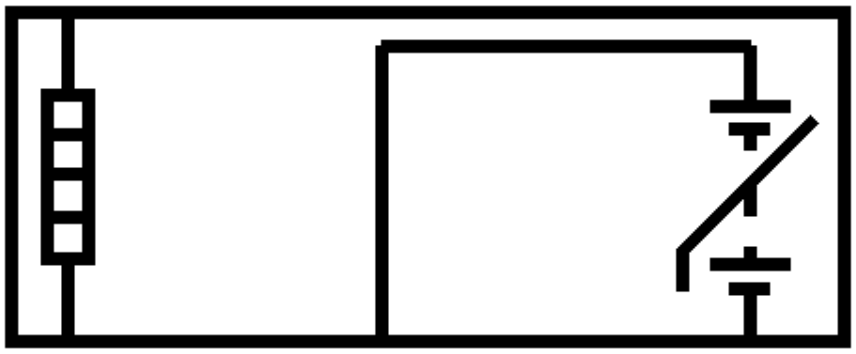
Symbol	Description
	Inductive Type Sensor-2-Wire

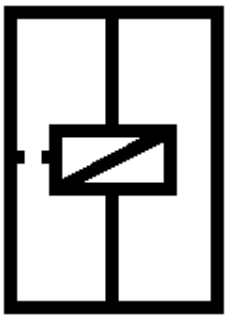
Symbol	Description
	Inductive Type Sensor- 3-Wire

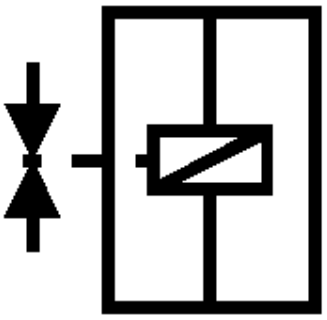
Symbol	Description
	Hall Effect Sensor- 2-Wire

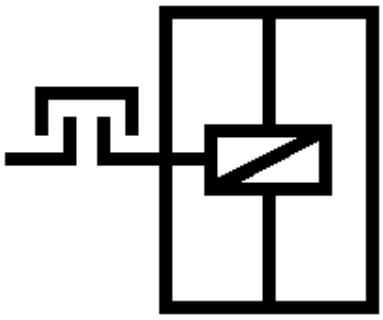
Symbol	Description
	Hall Effect Sensor- 3-Wire

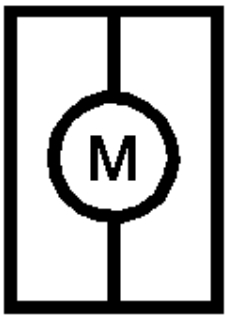
Symbol	Description
	Oxygen Sensor-2-Wire

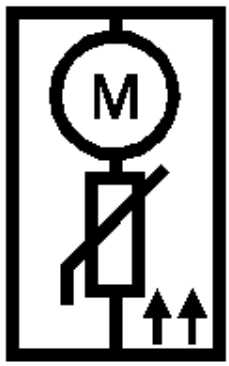
Symbol	Description
	Heated Oxygen Sensor-4-Wire

Symbol	Description
	Solenoid-Actuator

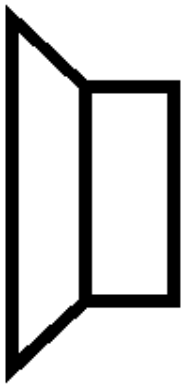
Symbol	Description
	Solenoid-Valve

Symbol	Description
	Clutch

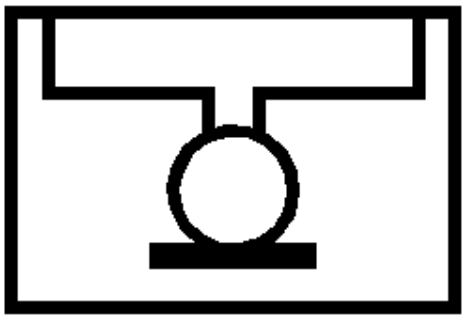
Symbol	Description
	Motor

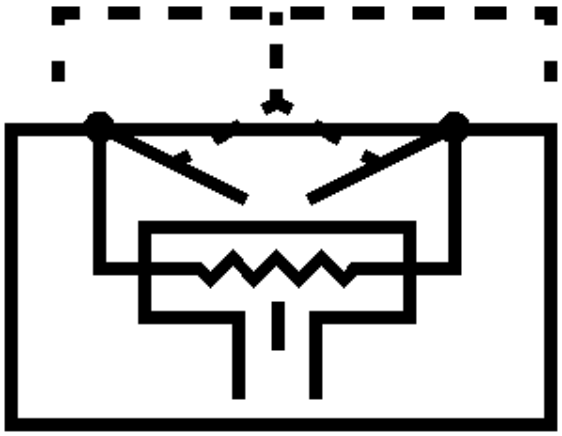
Symbol	Description
	Motor with PTC

Symbol	Description
	Antenna

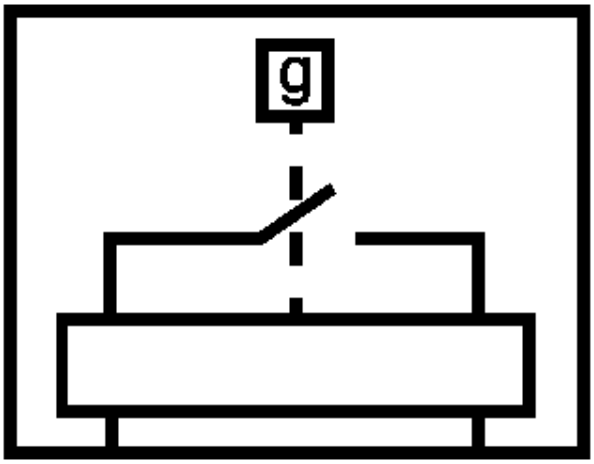
Symbol	Description
	Speaker

Symbol	Description
	Horn

Symbol	Description
	Microphone

Symbol	Description
	Airbag

Symbol	Description
	SIR Coil

Symbol	Description
	SIR Impact Sensor

Vehicle Zoning Strategy

All grounds, in-line connectors, and splices have identifying numbers that correspond to where they are located in the vehicle. The following table explains the numbering system.

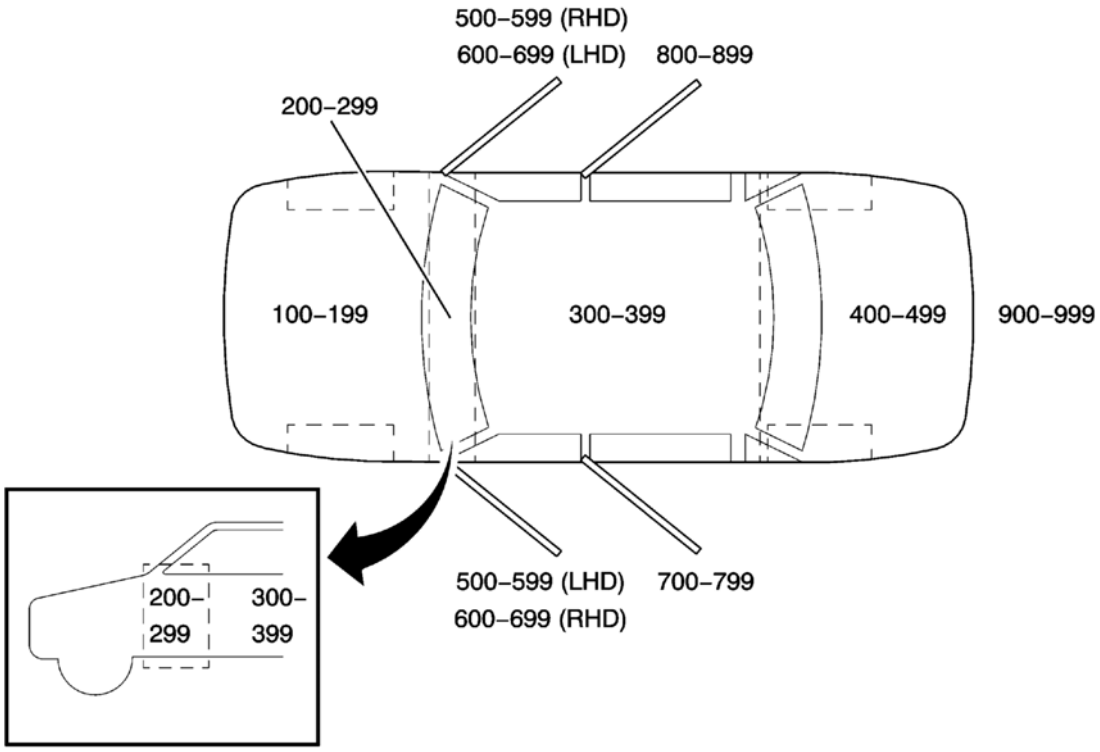


Fig. 23: Passenger Car Zoning View
Courtesy of GENERAL MOTORS COMPANY

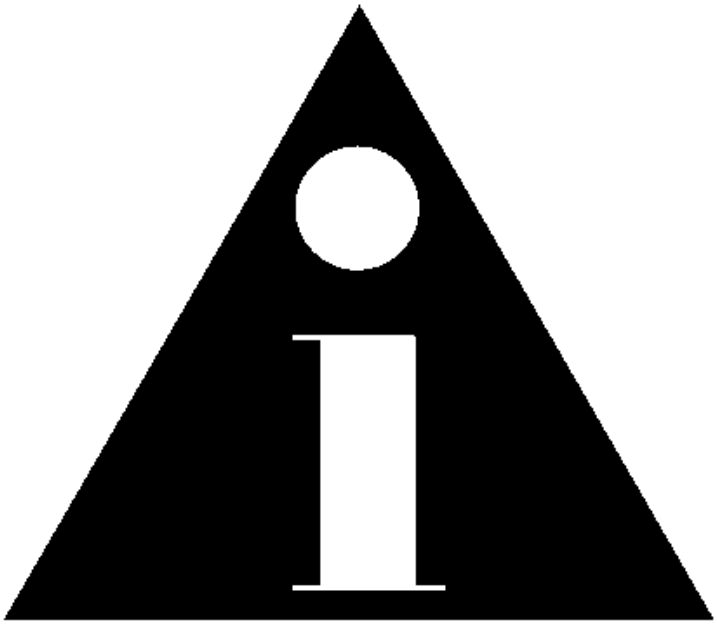
Callout Numbers	Zone Description
100-199	Engine compartment (all forward of the instrument panel)
200-299	Within the instrument panel area (between the bulkhead and the front plane of the instrument panel)
300-399	Passenger compartment (from instrument panel to the back of the rear seats)
400-499	Luggage compartment (from the back of the rear seats to the rear of the vehicle)
500-599	Inline harness connectors to or within the driver door
600-699	Inline harness connectors to or within the front passenger door
700-799	Inline harness connectors to or within the left rear door
800-899	Inline harness connectors to or within the right rear door
900-999	Inline harness connectors to or within the luggage compartment lid or hatch

Master Electrical Schematic Icons

Icon	Icon Definition

Icon	Icon Definition
	WARNING: **When performing service on or near the SIR components or the SIR wiring, the SIR system must be disabled. Refer to SIR Disabling and Enabling . Failure to observe the correct procedure could cause deployment of the SIR components, personal injury, or unnecessary SIR system repairs.**
	NOTE: **Twisted-pair wires provide an effective shield that helps protect sensitive electronic components from electrical interference.** **In order to prevent electrical interference from degrading the performance of the connected components, you must maintain the proper specification**

Icon	Icon Definition
	when making any repairs to the twisted-pair wires shown : • **The wires must be twisted a minimum of 9 turns per 31 cm (12 in) as measured anywhere along the length of the wires.** • **The outside diameter of the twisted wires must not exceed 6.0 mm (0.25 in).**

Icon	Icon Definition
	**NOTE:** **The following component has pin numbers that are known to have been changed during production by the wiring harness supplier.** • **JX206 The following lists what cavities are bussed to battery positive voltage and ignition 1 voltage: Pins A, B, C, D, E, and F are all attached to the ignition 1 voltage bus while pins G, H, J, K, and L are all attached to the battery positive**

Icon	Icon Definition

Power Distribution Schematics

Fuse Block- Underhood Bussing

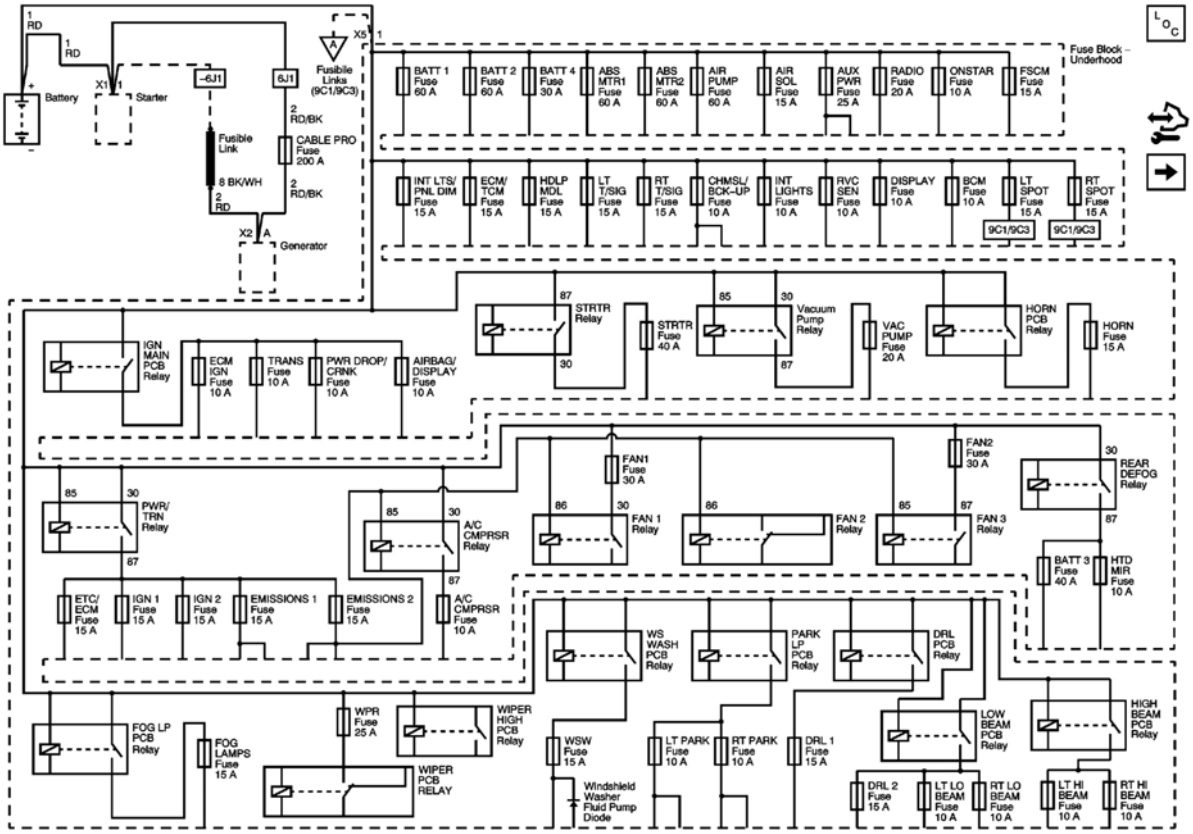


Fig. 24: Fuse Block Wiring Schematic -- Underhood Bussing
Courtesy of GENERAL MOTORS COMPANY

SEO (9C1 or 9C3)

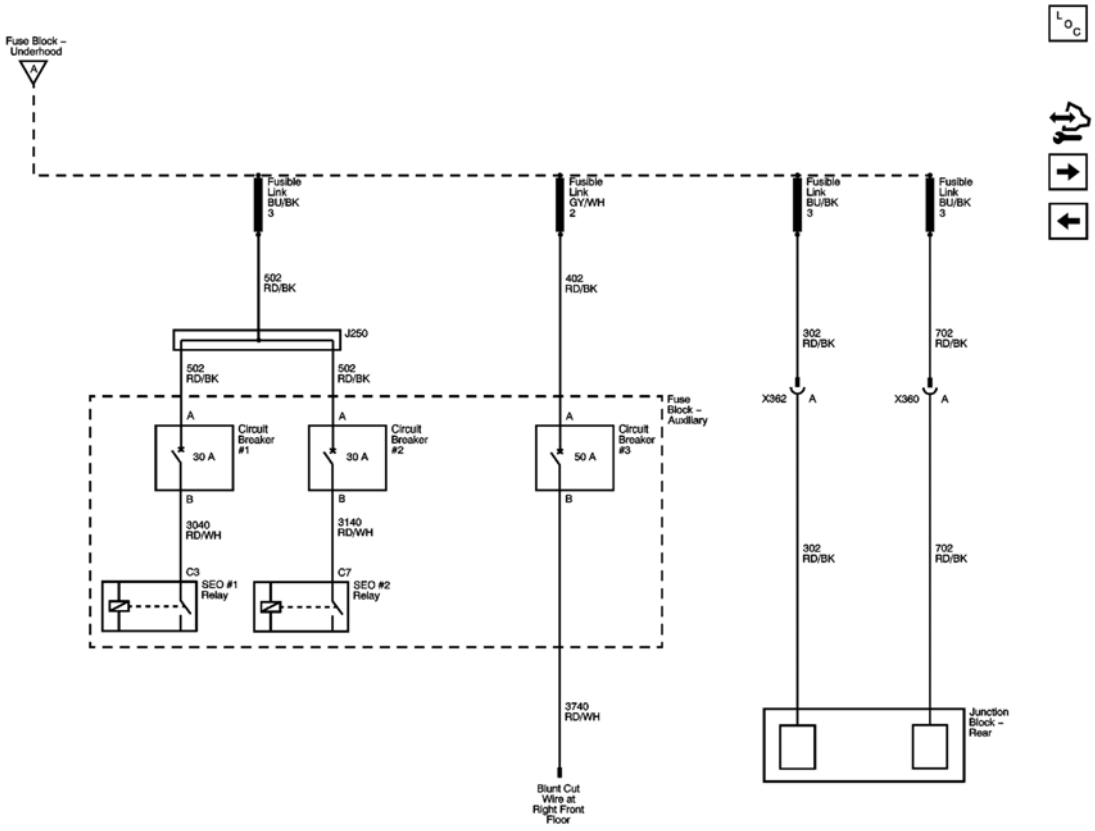


Fig. 25: SEO Wiring Schematic (9C1 or 9C3)

Courtesy of GENERAL MOTORS COMPANY

Ignition Switch

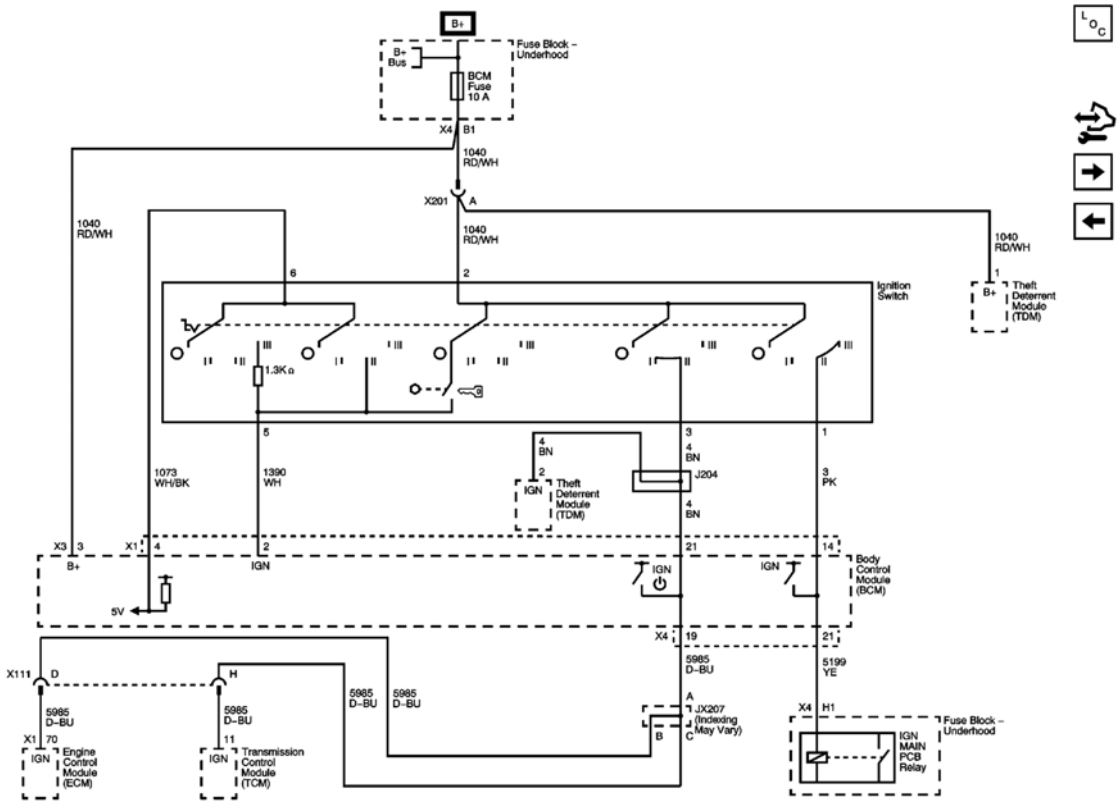


Fig. 26: Ignition Switch Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

AMP, AUX, BATT 1, CNSTR, TRUNK, XM Fuses

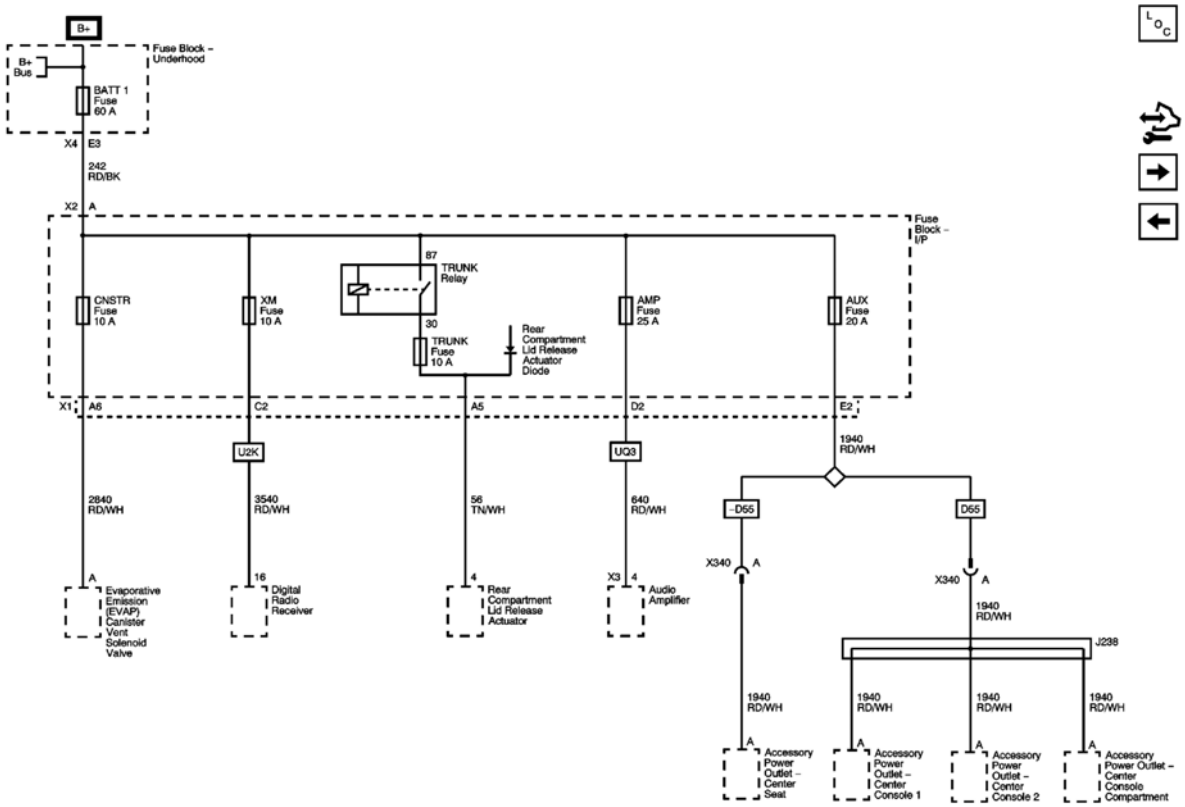


Fig. 27: AMP, AUX, BATT 1, CNSTR, TRUNK, XM Fuses Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

AIRBAG, BATT 2, HTD/SEAT, PWR/MIR Fuses, and PWR/SEAT Circuit Breaker

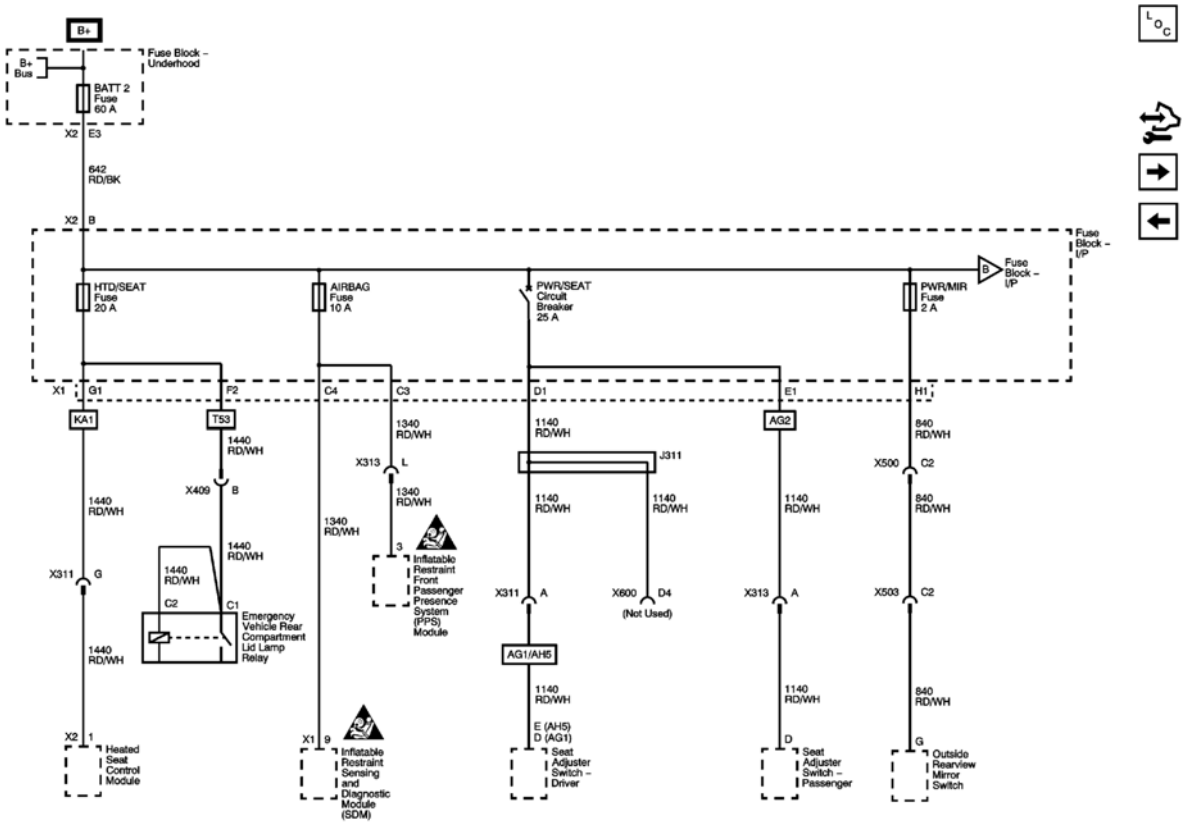


Fig. 28: AIRBAG, BATT 2, HTD/SEAT, PWR/MIR Fuses, and PWR/SEAT Circuit Breaker Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

DR/LCK, RAP, S/ROOF Fuses

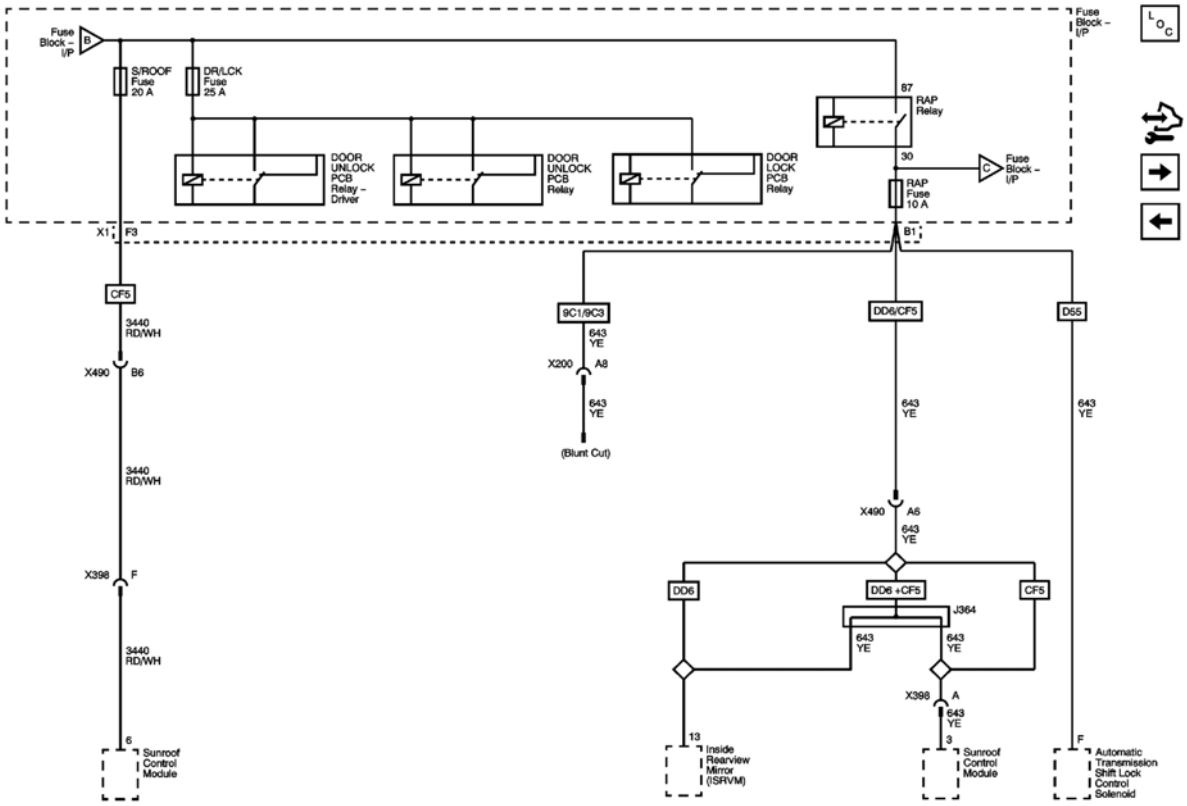


Fig. 29: DR/LCK, RAP, S/ROOF Fuses Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

ABS MTR1, ABS MTR2, AIR PUMP, AIR SOL, AUX PWR, BATT 4, Radio Fuses, and PWR/WNDW Circuit Breaker

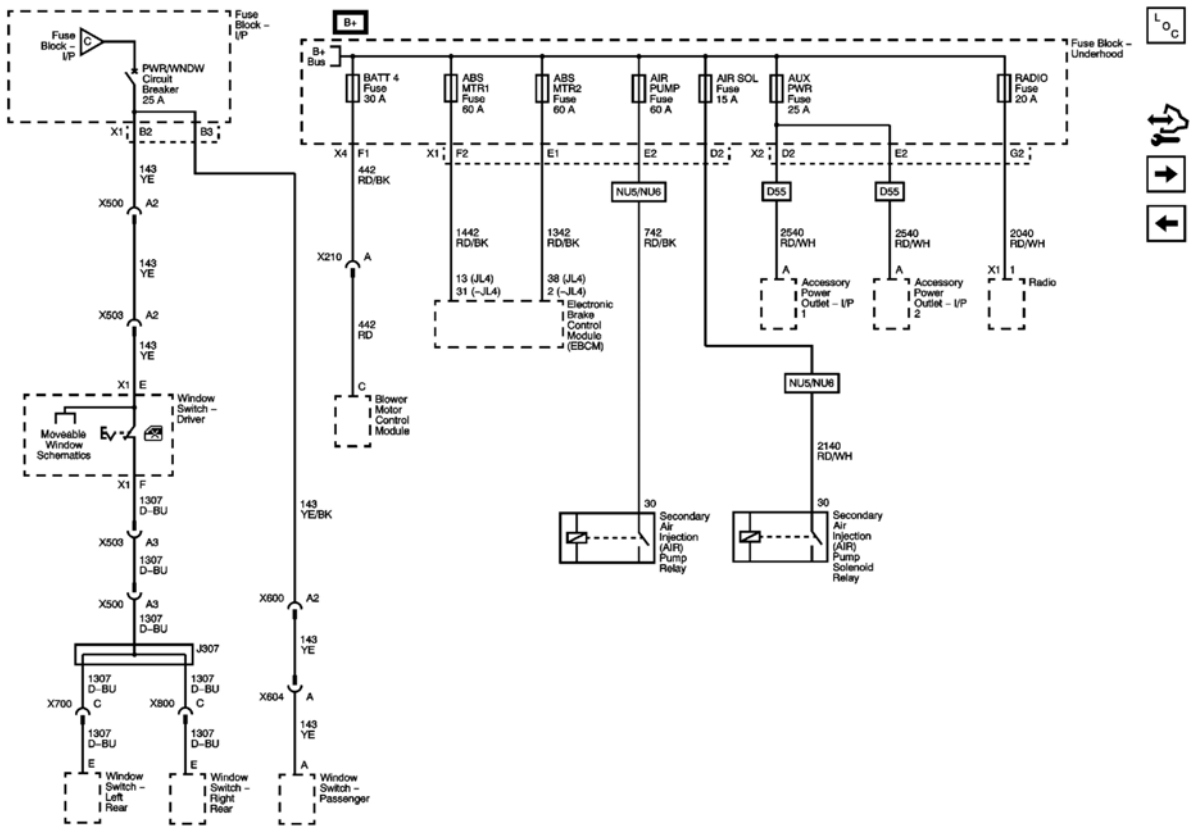


Fig. 30: ABS MTR1, ABS MTR2, AIR PUMP, AIR SOL, AUX PWR, BATT 4, Radio Fuses, and PWR/WNDW Circuit Breaker Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

CHMSL/BCK-UP, ECM/TCM, INT LIGHTS, INT LTS/PNL DIM, LT T/SIG, ONSTAR, RT T/SIG, and RVC SEN Fuses

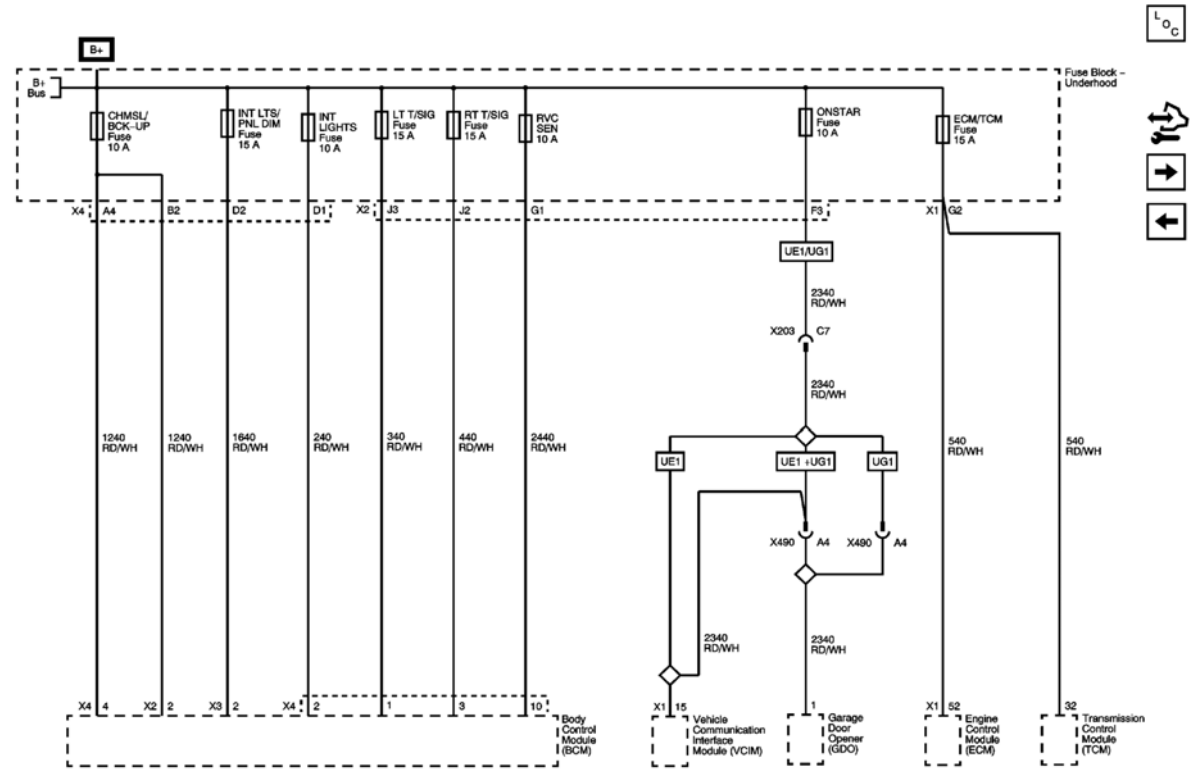


Fig. 31: CHMSL/BCK-UP, ECM/TCM, INT LIGHTS, INT LTS/PNL DIM, LT T/SIG, ONSTAR, RT T/SIG, and RVC SEN Fuses Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DISPLAY, HDLP MDL, LT SPOT, and RT SPOT Fuses

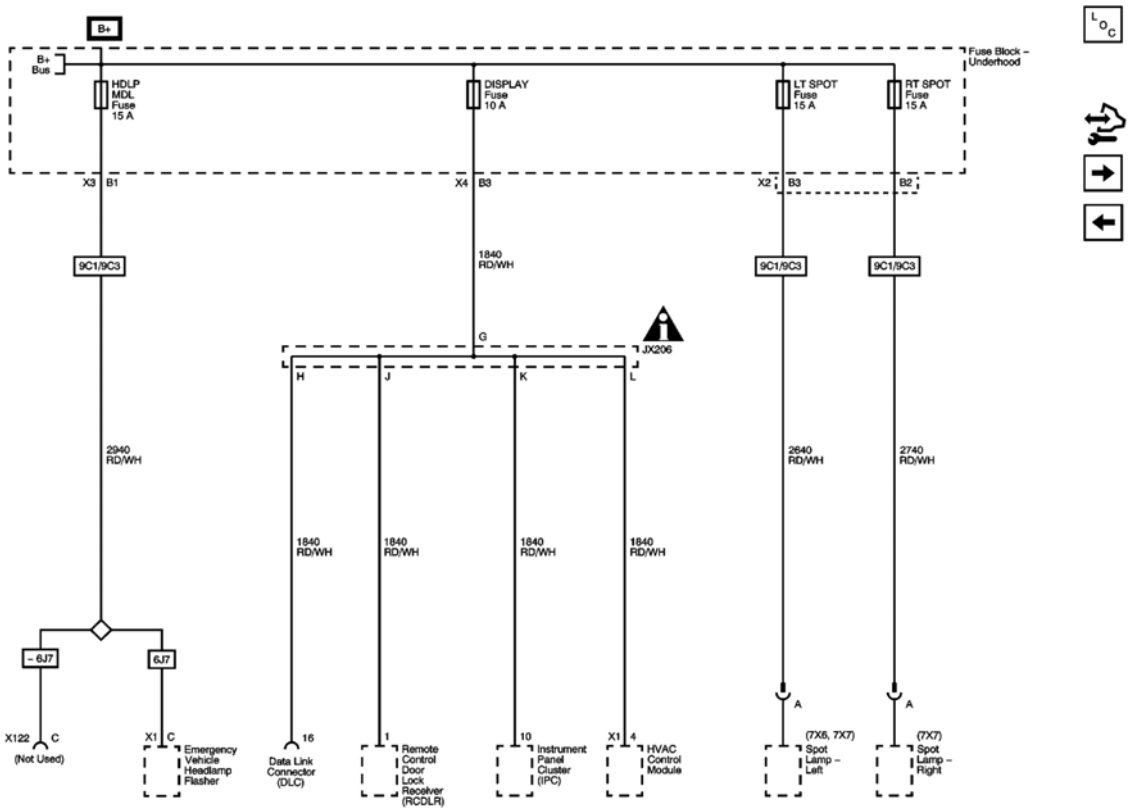


Fig. 32: DISPLAY, HDLP MDL, LT SPOT, and RT SPOT Fuses Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

AIRBAG/DISPLAY, ECM IGN, FUEL/PUMP, HORN, PWR DROP/CRNK, STRTR, and TRANS Fuses

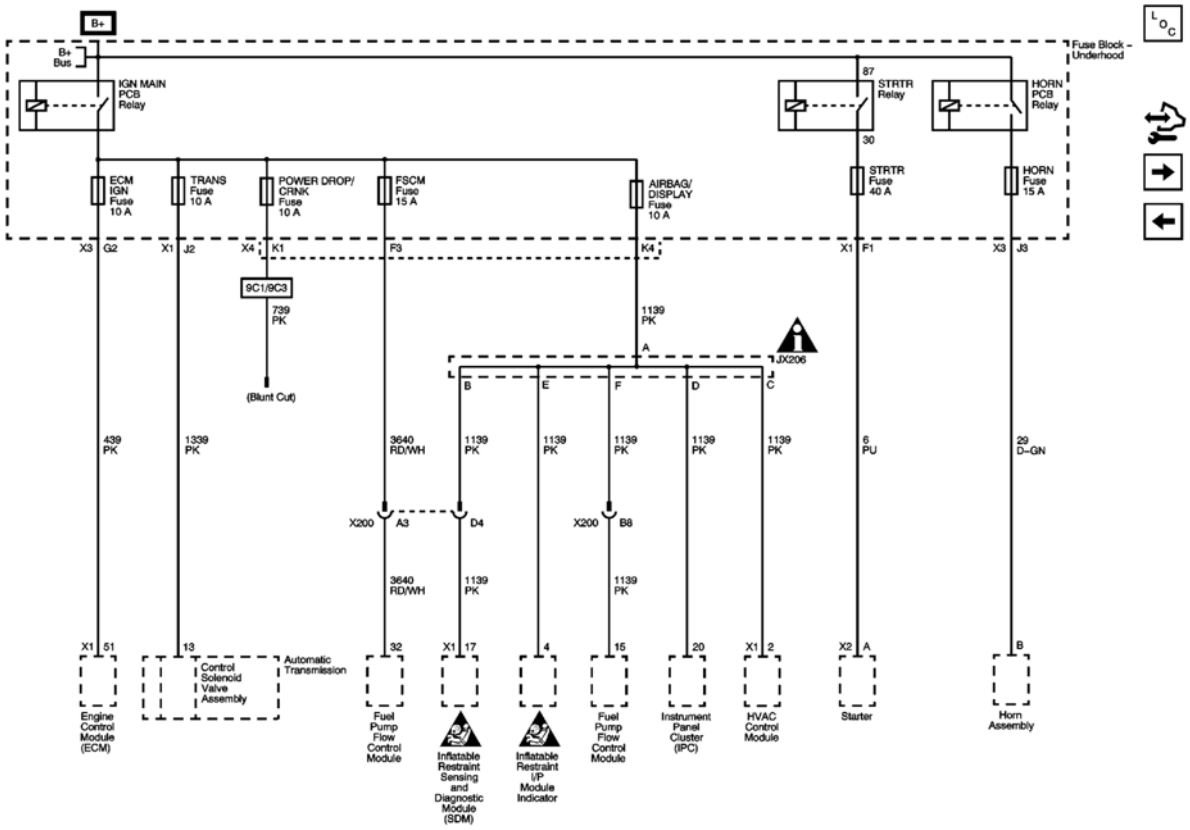


Fig. 33: AIRBAG/DISPLAY, ECM IGN, FUEL/PUMP, HORN, PWR DROP/CRNK, STRTR, and TRANS Fuses Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

ETC/ECM, IGN 1, and IGN 2 Fuses

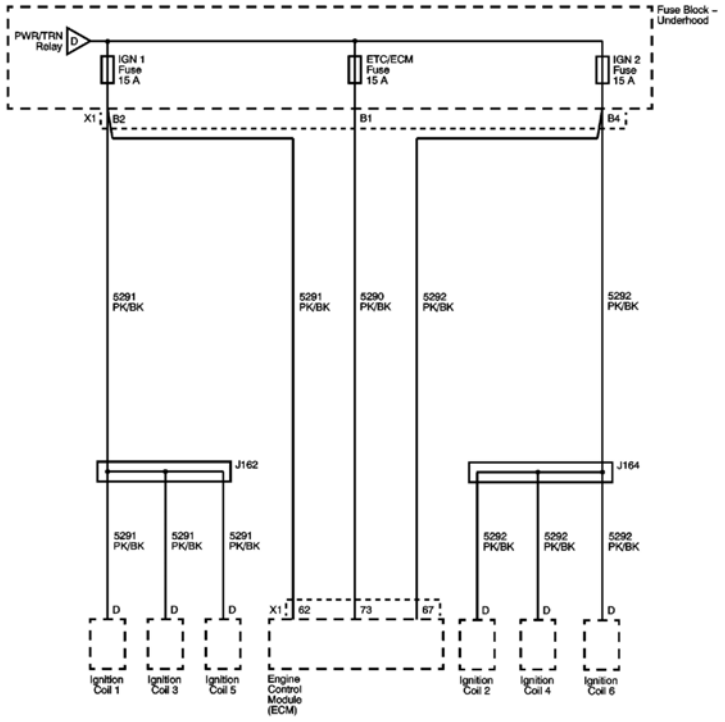


Fig. 34: ETC/ECM, IGN 1, and IGN 2 Fuses Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

A/C CMPRSR, EMISSIONS 1, and EMISSIONS 2 Fuses

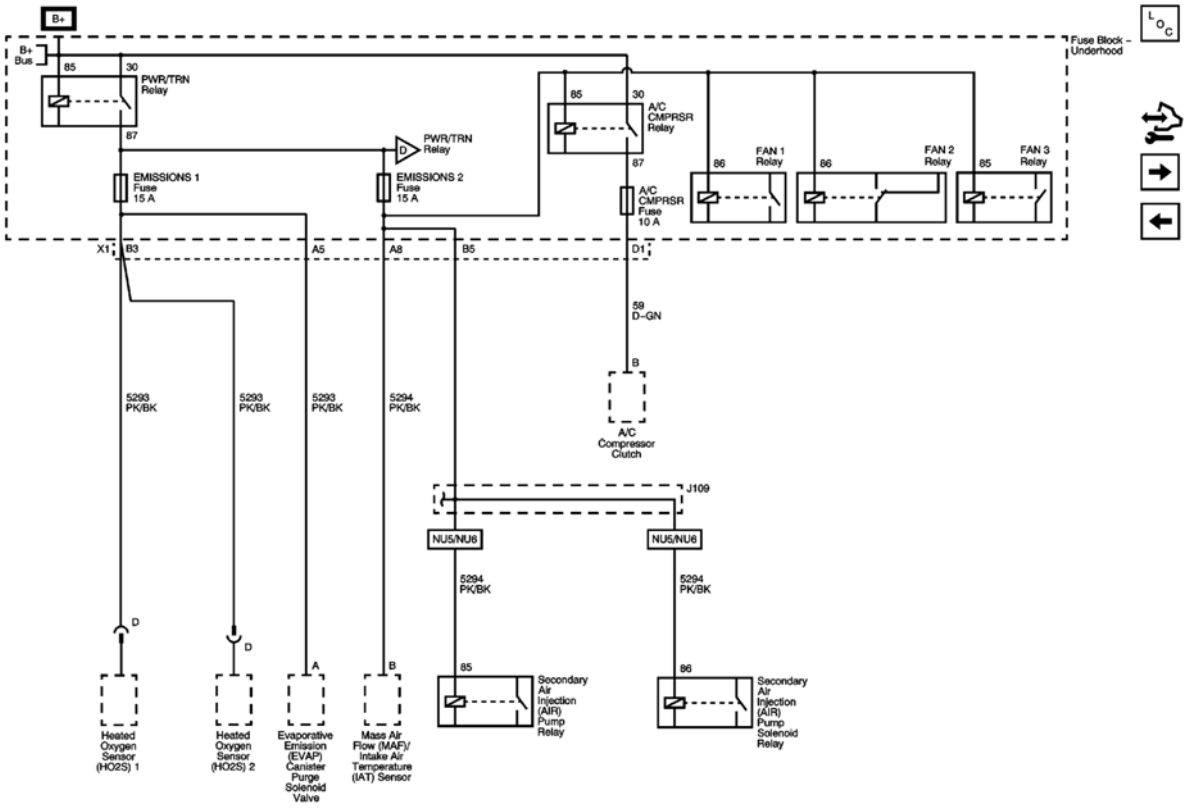


Fig. 35: A/C CMPRSR, EMISSIONS 1, and EMISSIONS 2 Fuses Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

BATT 3, FOG LAMPS, HTD MIR, LT PARK, RT PARK, and WSW Fuses

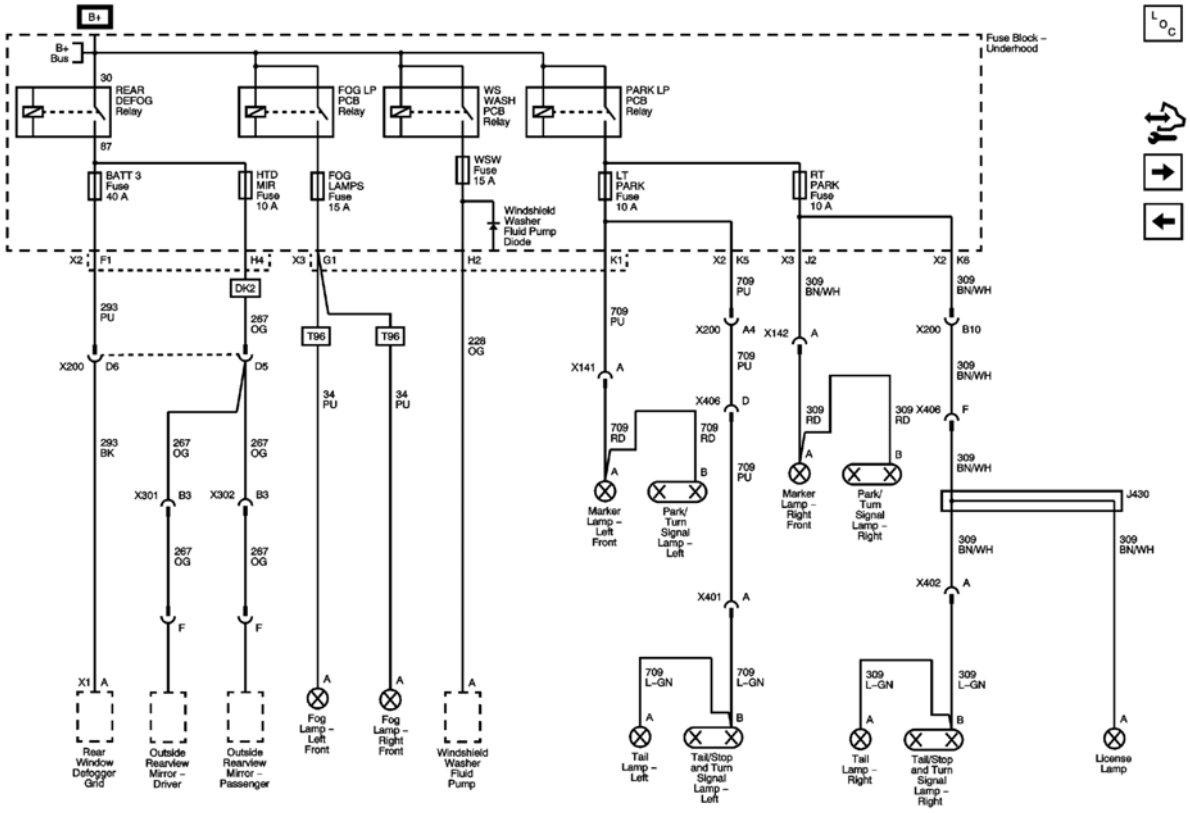


Fig. 36: BATT 3, FOG LAMPS, HTD MIR, LT PARK, RT PARK, and WSW Fuses Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

DRL 1, DRL 2, LT HI BEAM, LT LO BEAM, RT HI BEAM, RT LO BEAM, and STRG WHL Fuses

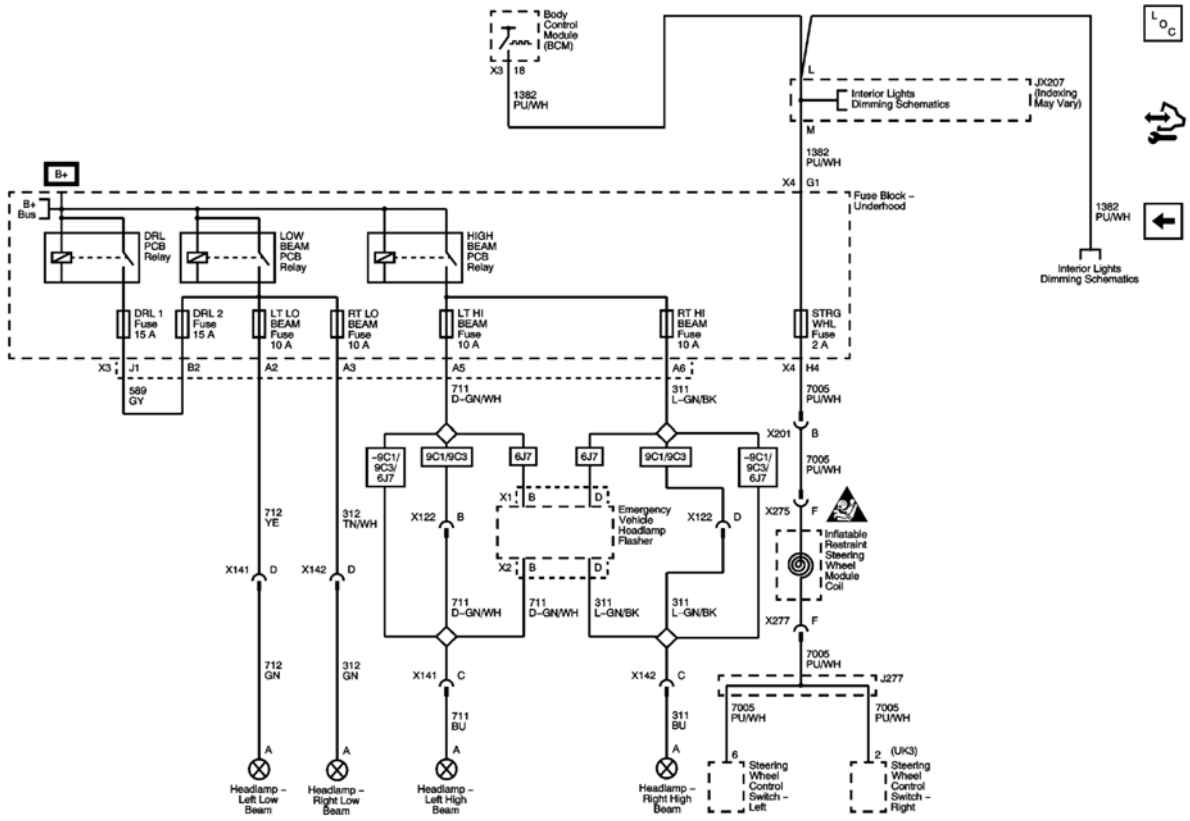


Fig. 37: DRL 1, DRL 2, LT HI BEAM, LT LO BEAM, RT HI BEAM, RT LO BEAM, and STRG WHL Fuses Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

Power Moding Schematics

RAP Fuse Circuits

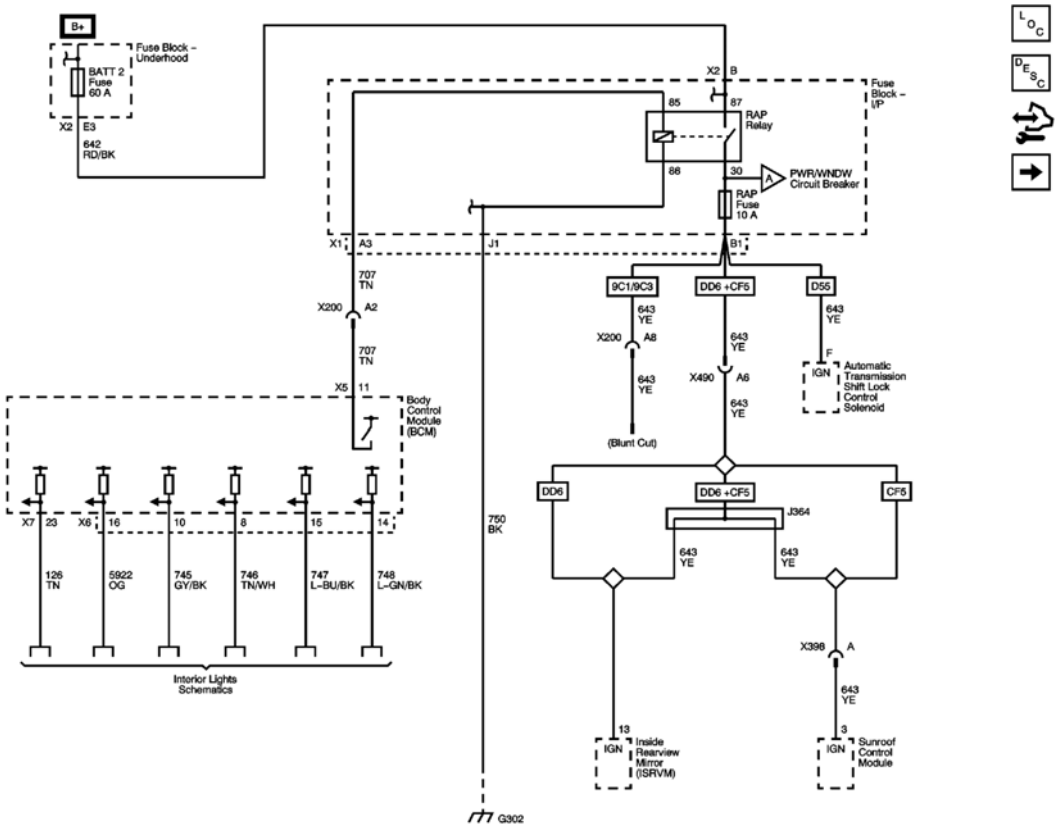


Fig. 38: RAP Fuse Circuits Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

Power Window Circuits

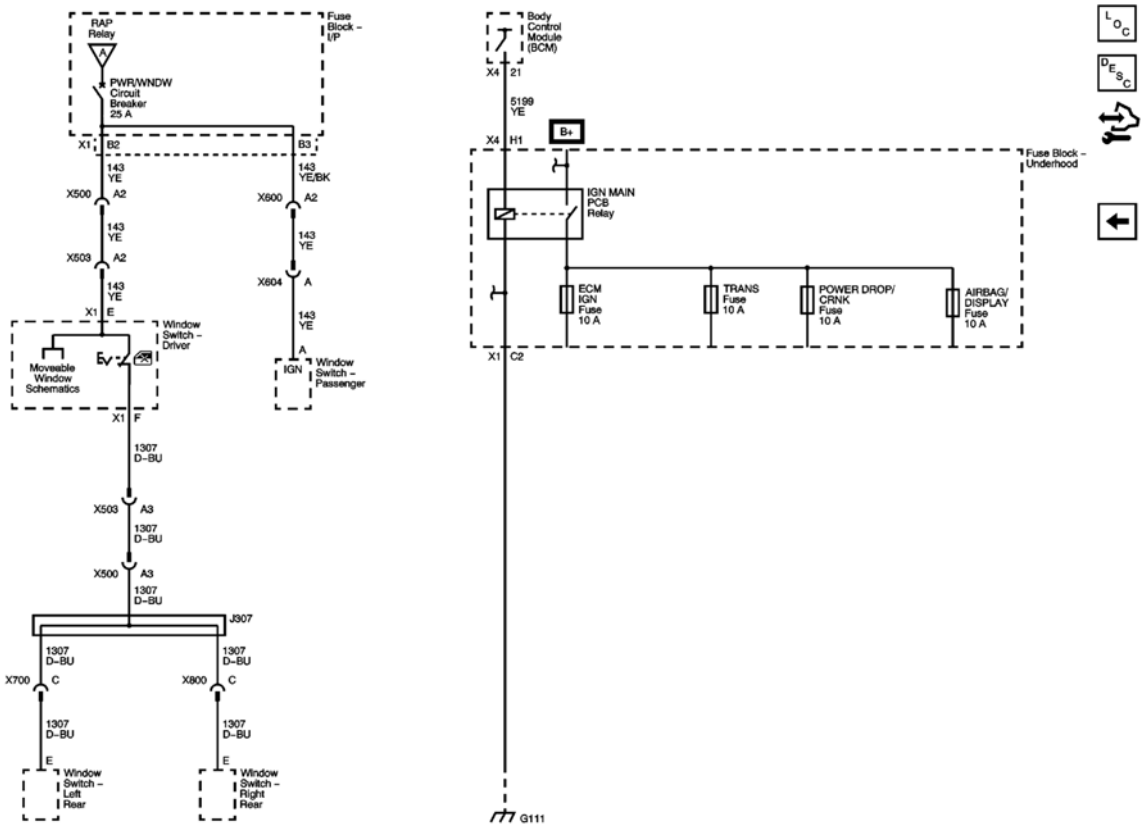


Fig. 39: Power Window Circuits Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Ignition Lock Schematics

Ignition Lock

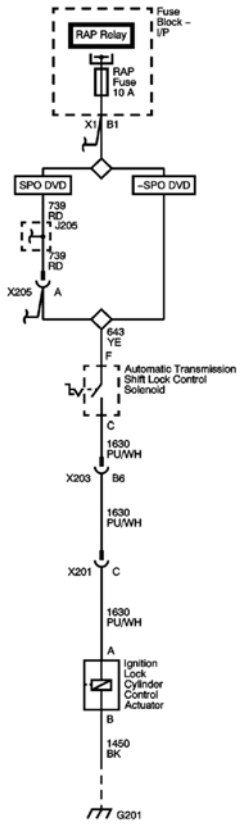


Fig. 40: Ignition Lock Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Ground Distribution Schematics

G100

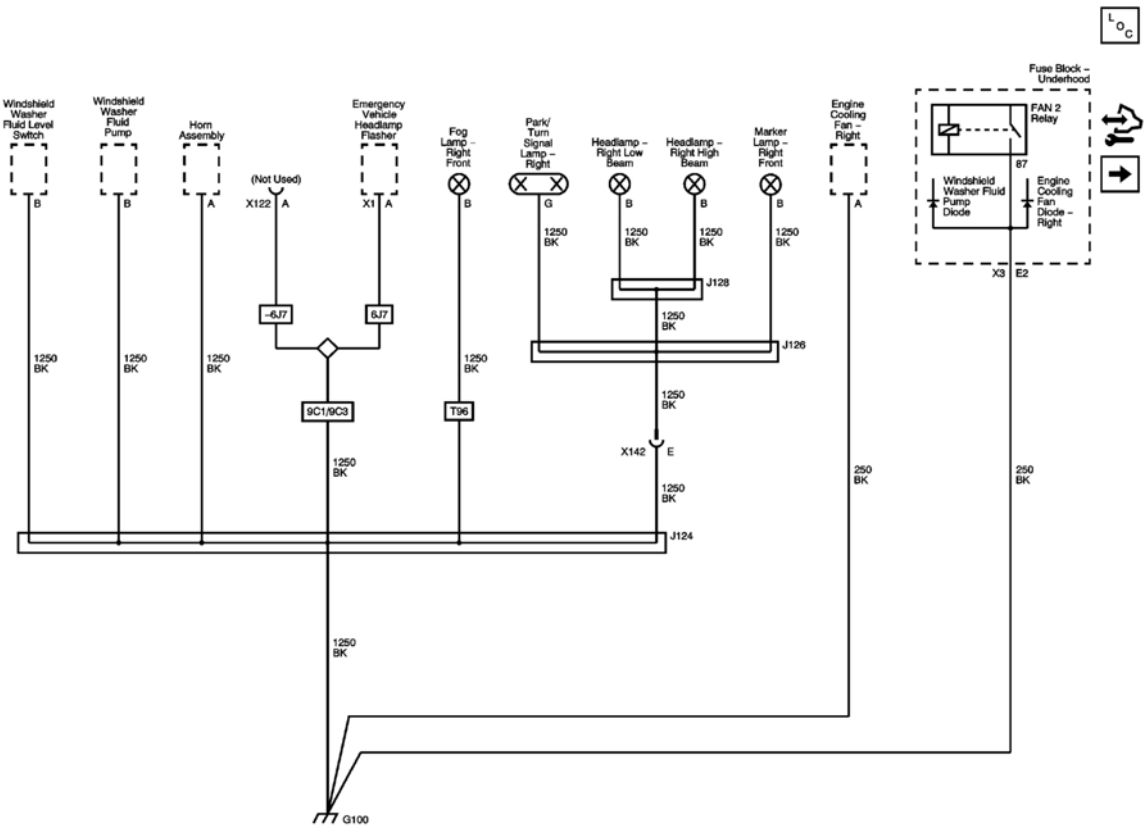


Fig. 41: G100 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

G101, G102, and G111

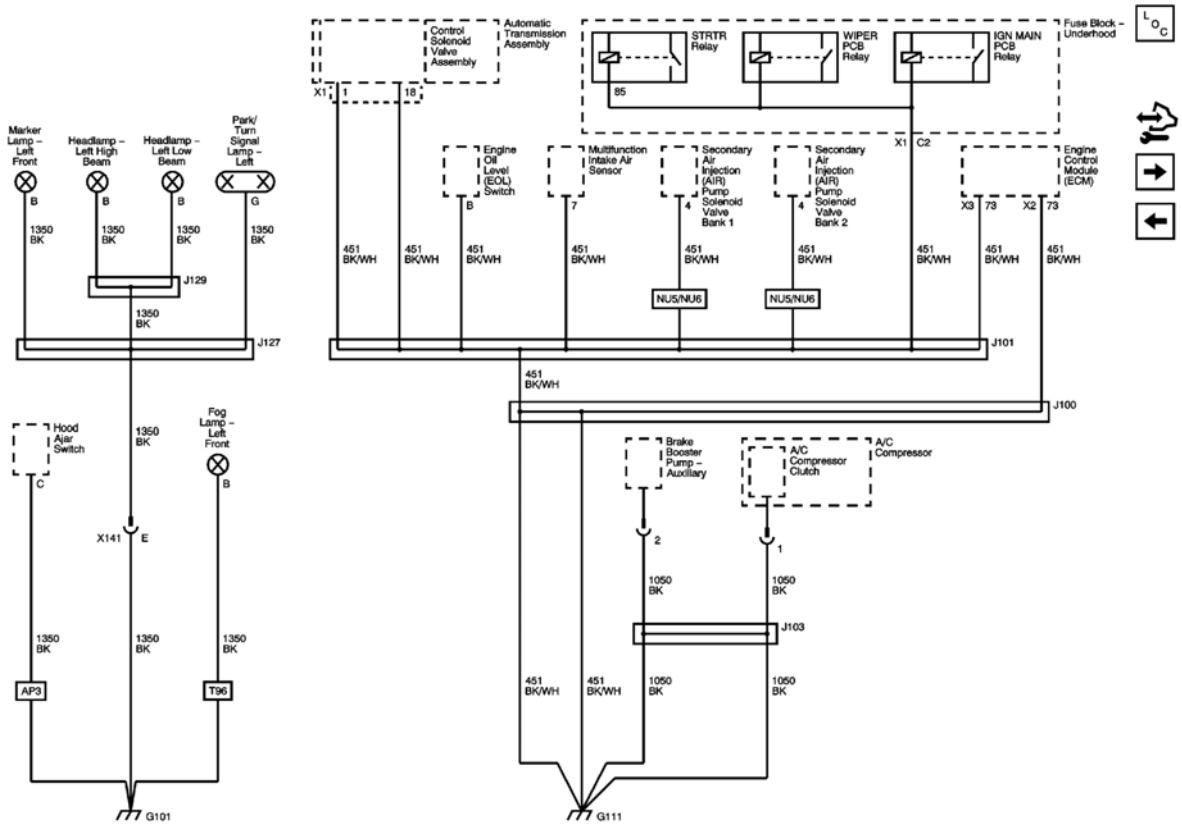


Fig. 42: G101, G102, and G111 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

G112 and G115

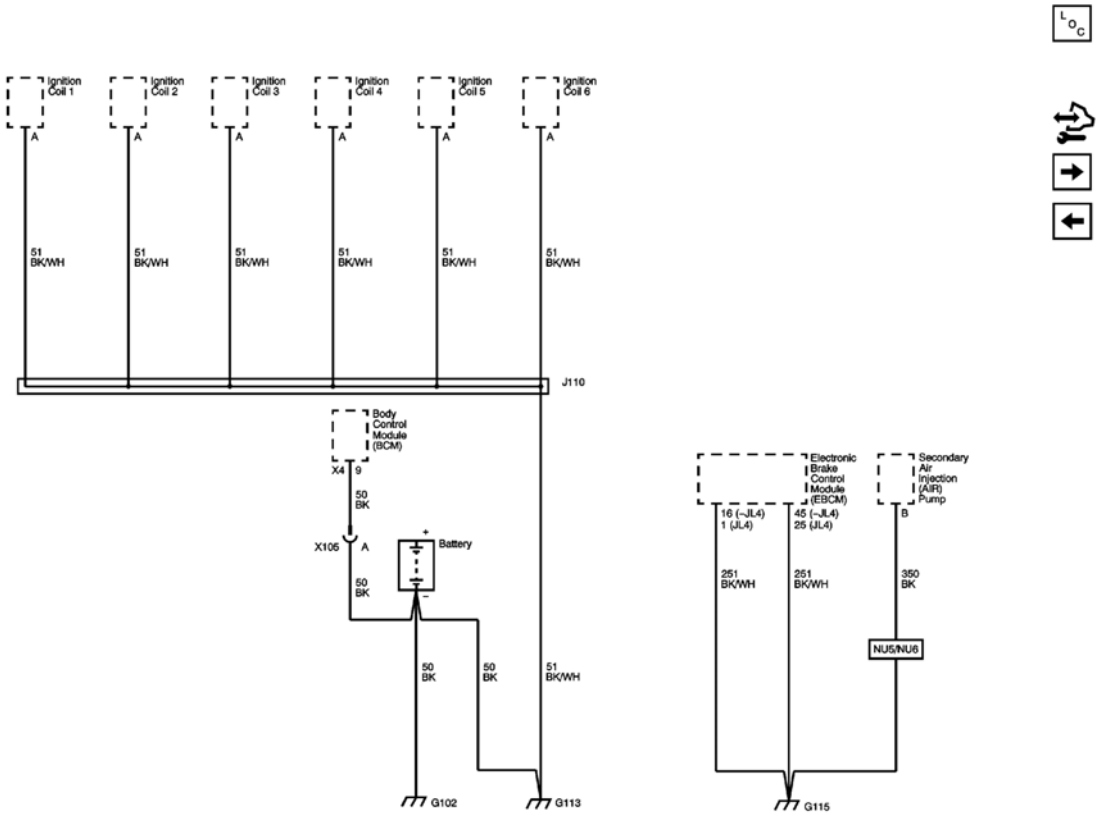


Fig. 43: G112 and G115 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

G200

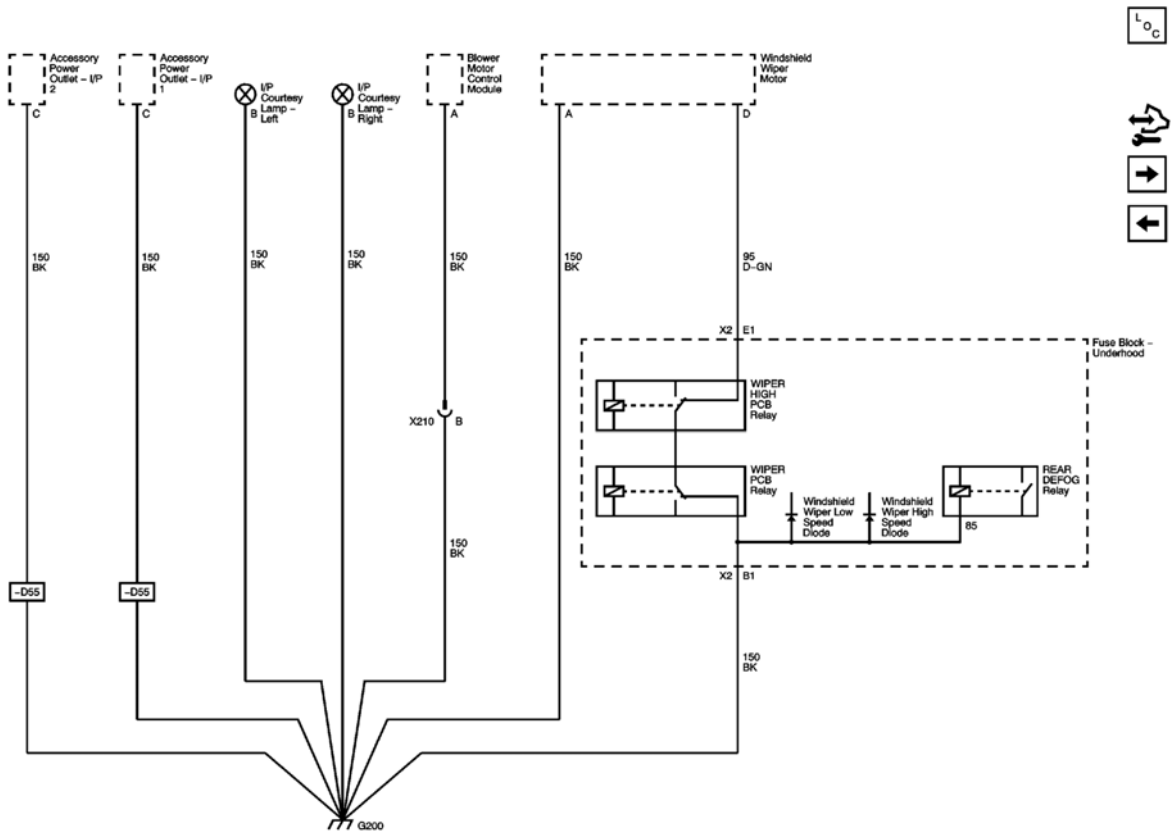


Fig. 44: G200 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

G201

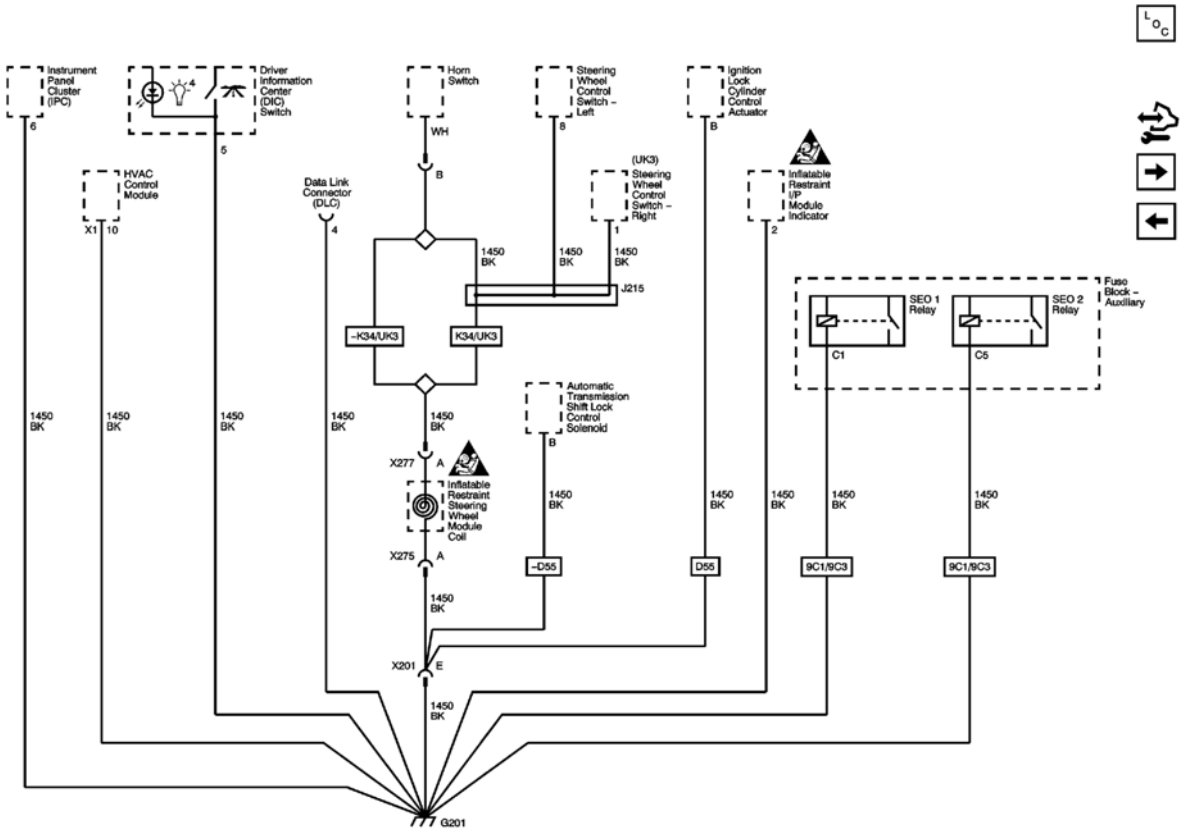


Fig. 45: G201 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

G202 and G204

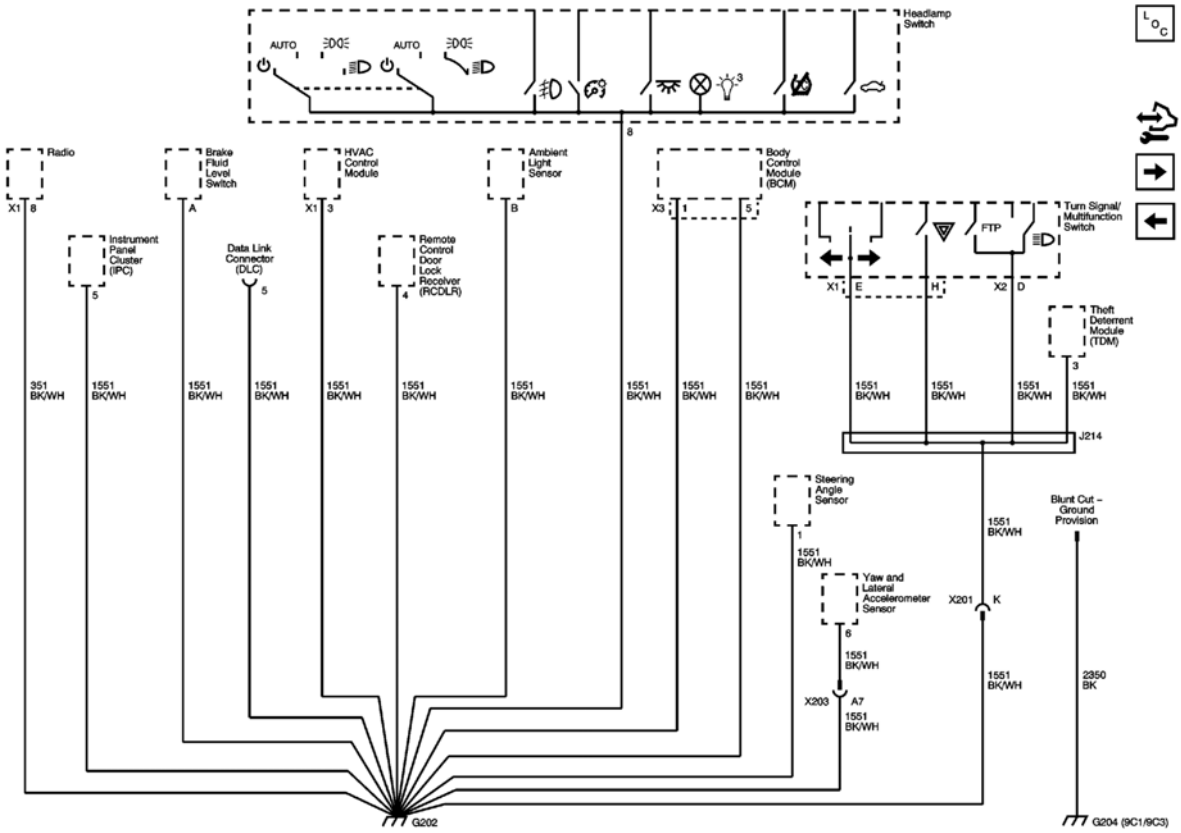


Fig. 46: G202 and G204 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

G301

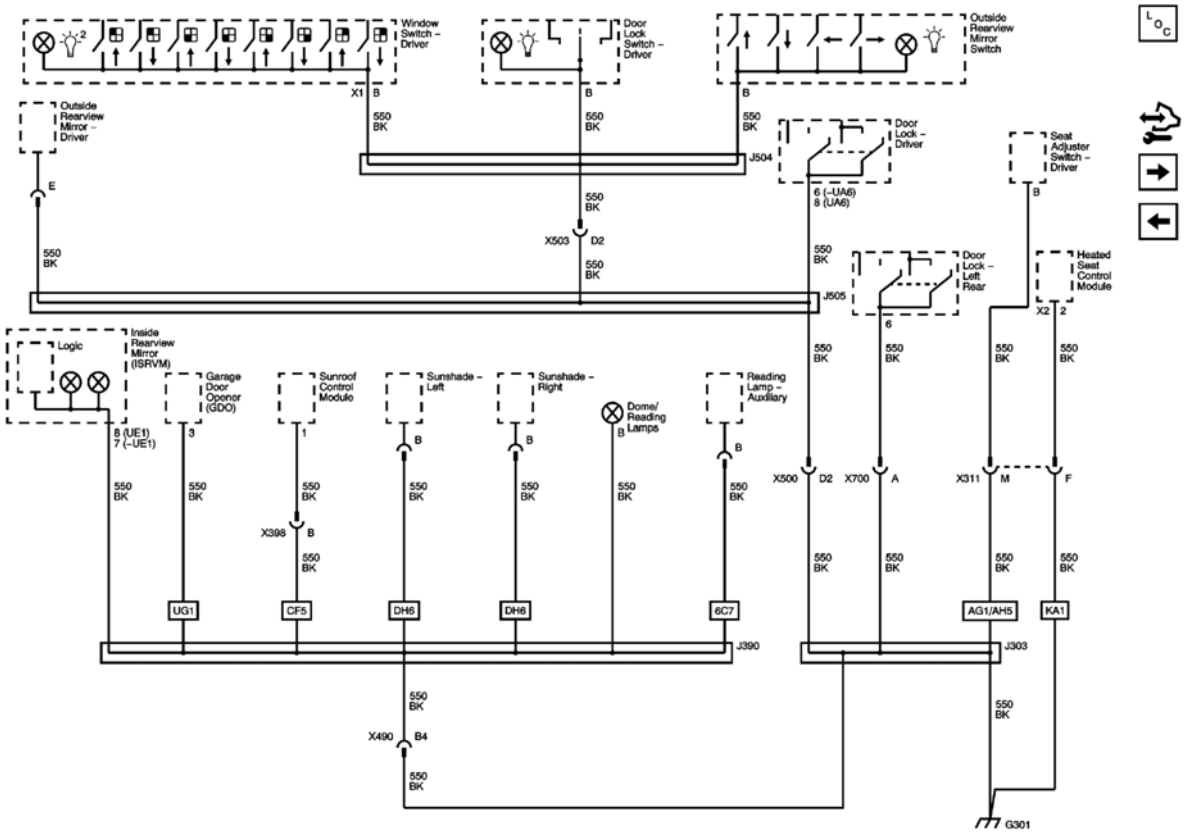


Fig. 47: G301 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

G302 (1 of 2)

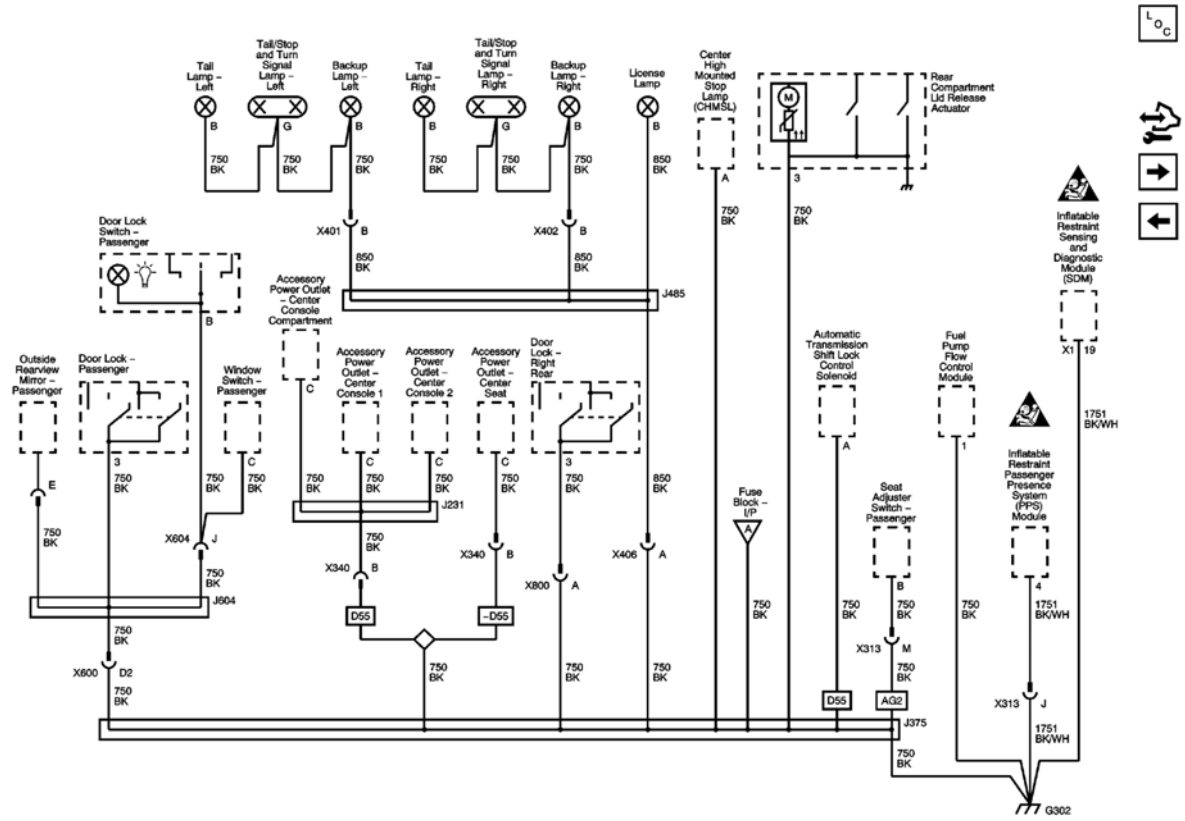


Fig. 48: G302 Wiring Schematic (1 of 2)
Courtesy of GENERAL MOTORS COMPANY

G302 (2 of 2)

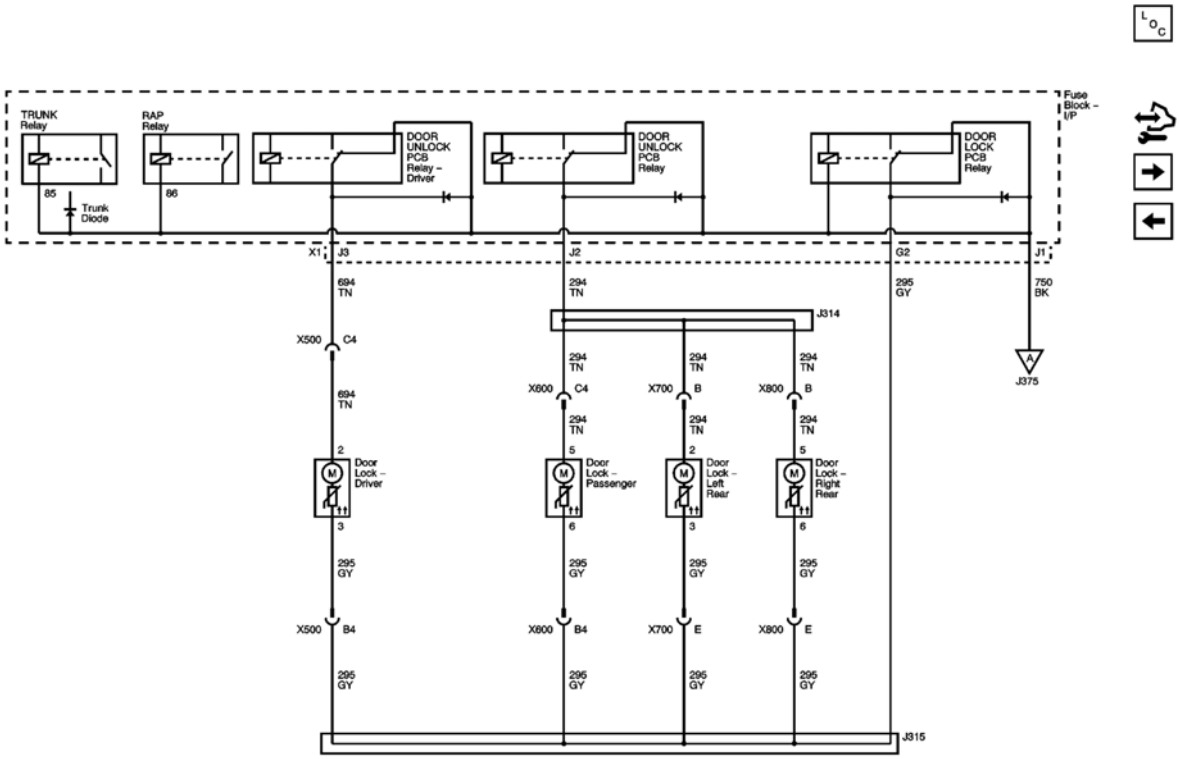


Fig. 49: G302 Wiring Schematic (2 of 2)
Courtesy of GENERAL MOTORS COMPANY

G403 and G404

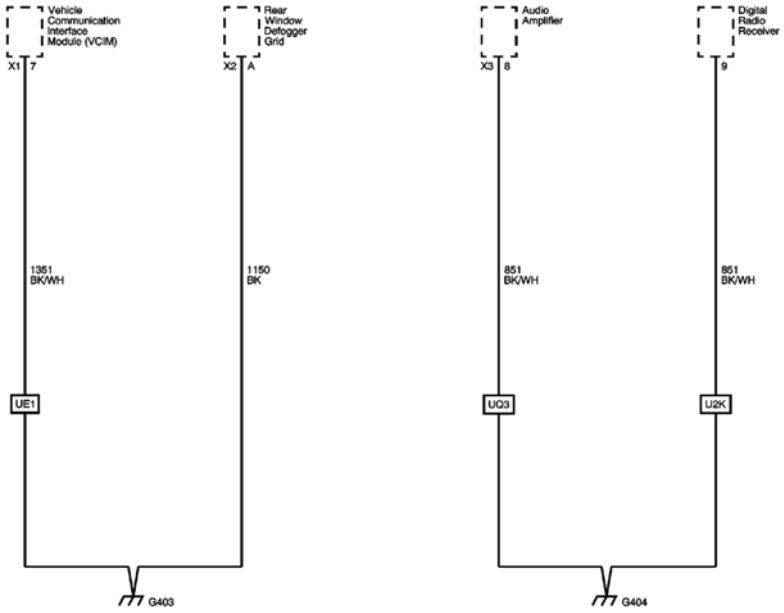


Fig. 50: G403 and G404 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

Upfitter Provision Schematics

6J1

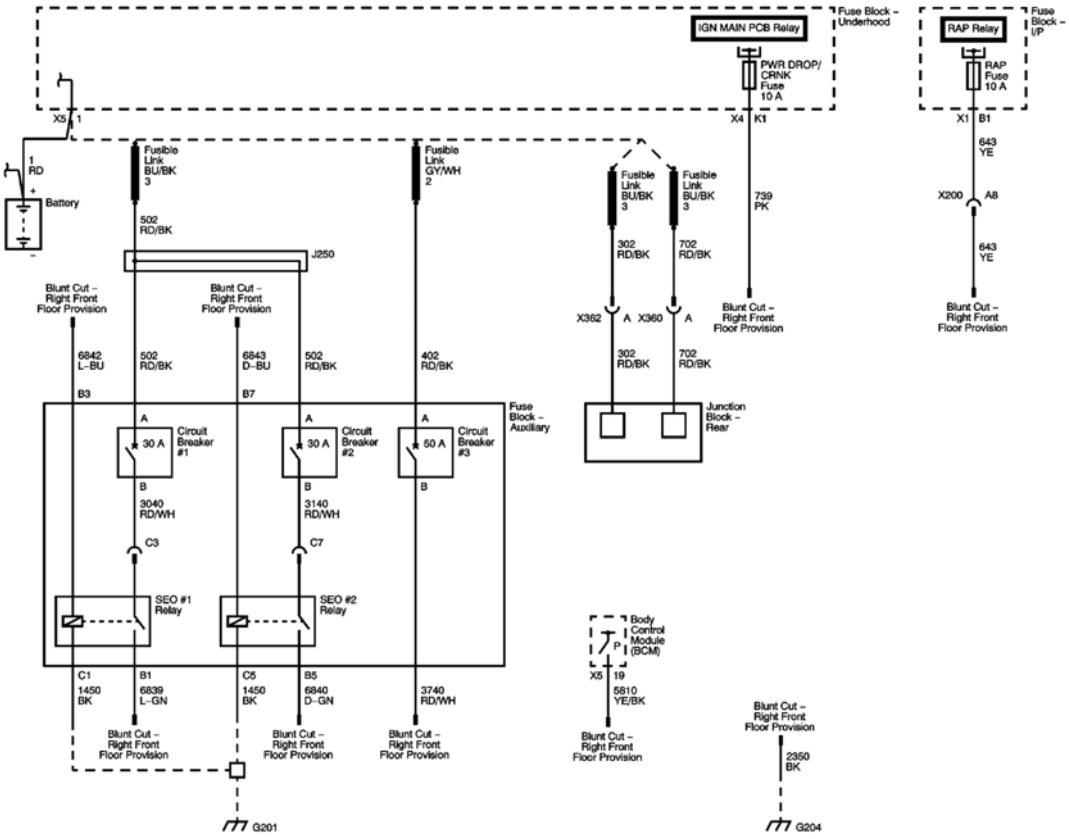


Fig. 51: 6J1 Wiring Schematic

Courtesy of GENERAL MOTORS COMPANY

6J3, 6J6, 6F5, and 6C8

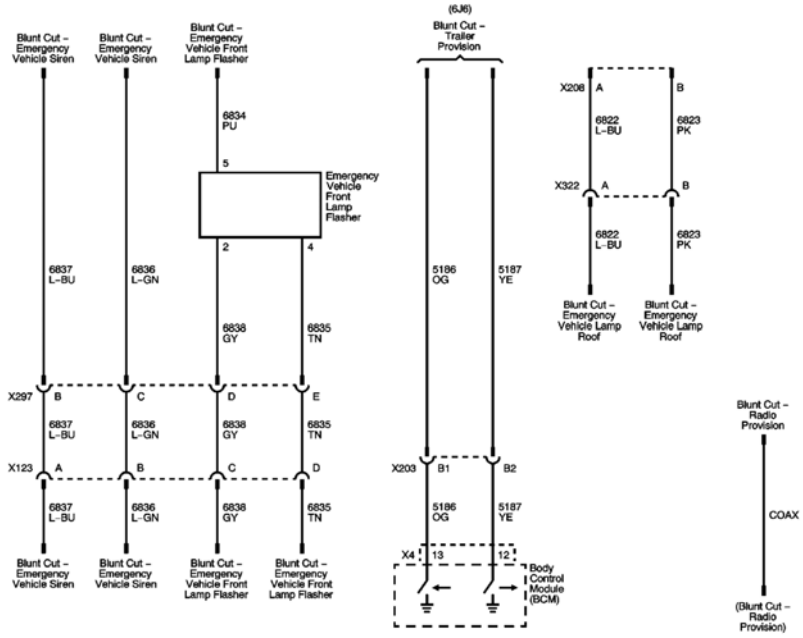


Fig. 52: 6J3, 6J6, 6F5, and 6C8 Wiring Schematic
Courtesy of GENERAL MOTORS COMPANY

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